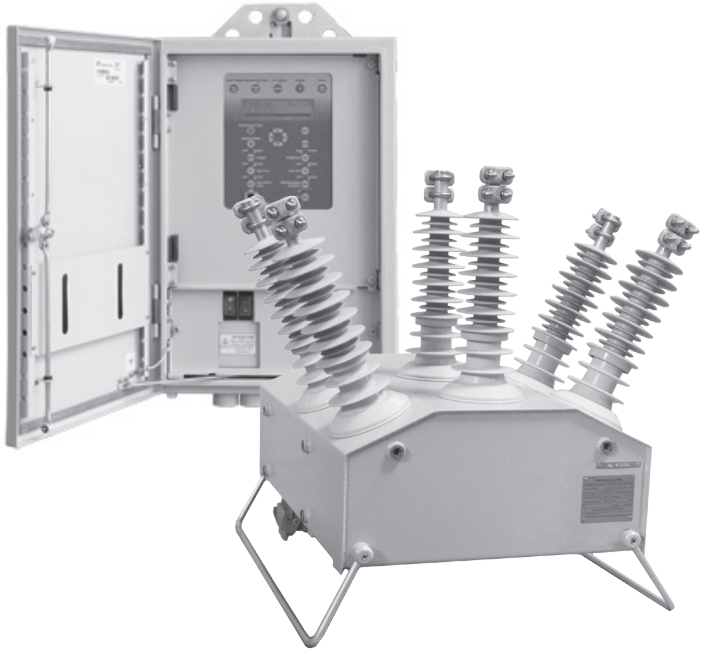
TAVRIDA ELECTRIC



OSM

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

Technical Manual

The present Technical Manual contains information necessary for the installation, commissioning and operation. It is absolutely necessary for the proper use of the OSM to read the Technical Manual carefully before starting and to adhere to the instructions and the relevant regulations.

Safety first

- Installation, operation and maintenance shall only be carried out by trained and experienced personnel who are familiar with the equipment and the electrical safety requirements.

- During installation, commissioning, operation and maintenance of the equipment the relevant legal regulations (such as DIN/VDE/IEC), accident prevention regulations and the connecting conditions of the electric utilities shall be followed.

- Take note that during operation of the autorecloser certain parts are subject to dangerous voltage. Mechanical parts, also remote-controlled, can move quickly. Failure to comply may result in death, severe personal injury or damage to equipment.

- Pay attention to the hazard statements located throughout this manual. 

- The operating conditions of the OSM shall comply with the technical data specified in this manual.

- Personnel installing, operating and maintaining the equipment shall be familiar with this manual and its contents.

For special configurations please contact Tavrida Electric AG.

CE Recloser Controls (RC) of all types meet the requirements of the EMC Directive 89/336/EEC and Low Voltage Directive 73/23/EEC.

Contents

Introduction 1

Applicability

This Technical Manual applies to a range of Outdoor Circuit Breakers (OSM) and Recloser Controls (RC) manufactured by Tavrida Electric.

The following products are covered by this manual:

- OSM/TEL-15.5-16/630-204
- OSM/TEL-27-12.5/630-205
- RC/TEL-05E
- RC/TEL-05P

The model numbers are shown on the equipment nameplates. If your equipment does not correspond to these numbers then this manual is not applicable. Please contact your nearest Tavrida Electric office or Distributor.

Every care has been taken in the preparation of this manual. However, please note that not all the details or variations in the equipment or process being described can be covered. Neither is it expected to address all contingencies associated with the installation and operation of this equipment. For any further information please contact your nearest Tavrida Electric office or Distributor.

Hazard Statements

This manual contains three types of hazard statements, as follows:

DANGER: Indicates an imminently hazardous situation that, if not avoided, will result in death or serious injury.

WARNING: Indicates a potentially hazardous situation that, if not avoided, could result in death or serious injury.

CAUTION: Indicates a potentially hazardous situation that, if not avoided, could result in personal injury or equipment damage.

Safety Instructions

General hazard statements applying to this equipment are described in this section. Statements relating to specific tasks or procedures are located throughout this manual.

DANGER: Contact with hazardous voltage will cause death or severe personal injury. Contact with Recloser or Control Cubicle terminals should only be undertaken when equipment is isolated from applicable sources of voltage.

WARNING: This equipment is not intended to protect human life. Follow all locally approved safety procedures when installing or operating this equipment. Failure to comply may result in death or severe personaly injury.

WARNING: Before working with equipment described in this manual carefully read and understand the contents thereof. Improper handling, installation, operation or maintenance can result in death, severe personal injury or damage to equipment.

WARNING: Power distribution equipment must be properly selected for the intended operation. It must be installed, used and understand all relevant safety procedures. Failure to comply can result in death, personal injury or equipment damage.

Abbreviations

ABR	Automatic Backfeed Restoration
BAT	Battery
BF	Bolted Fault
BTM	Bluetooth Module
CC	Control Cable (Umbilical)
CLP	Cold Load Pickup
CML	Change Messages Log
CPM	Control Panel Module CPM/TEL-01
D	Delayed
DPS	Door Position Switch
DRVE	Driver
DRVM	Driver Module
EF	Earth Fault
EF1	Low set Earth Fault element for Delayed trips
EF2	Low set Earth Fault element for Instantaneous trips
EF3	High set Earth Fault element for Instantaneous trips
EL	Event Log
FPL	Fault Profile Log
I	Instantaneous
IDC	Indication Data Conditioner / Logs
I/O	Input/Output
IOI	Input/Output Interface
IOM	Input/Output Module IOM/TEL-12/60-02 or IOM/TEL-100/250-02
ISM	Indoor Switching Module
LCD	Liquid Crystal Display
HL	Hot Line
LP	Load Profile
LS	Loss of Supply
ME	Measurement
ML	Malfunction Log
MMI	Man Machine Interface
MPM	Main Processor Module
OC	Overcurrent
OC1	Low set Overcurrent element for Delayed trips
OC2	Low set Overcurrent element for Instantaneous trips
OC3	High set Overcurrent element for Instantaneous trips
OCR	Overcurrent element with build in reclosing
OSM	OSM Automatic Circuit recloser / Outdoor Switching Module
PCI	Personal Computer Interface
PSE	Power Supply
PSFM	Power Supply Filter Module PSFM/TEL-01
PSM	Power Supply Module
RC	Recloser Control Cubicle
RCM	Recloser Control Module RCM/TEL-02
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 build in reclosing
SF AB	Rechargeable Battery Circuit Breaker
TEL	Tavrida Electric
TELARM	Tavrida Electric Automated Relay Manager
TCI	Telecommunications Interface
TDI	Telarm Dispatcher Interface
UF	Under Frequency
UV	Under Voltage
VRC	Voltage Reclosing Control
VT	Voltage Transformer
WA	Wiring Assembly
ZSC	Zone Sequence Coordination

OSM
Outdoor Circuit Breaker

Overview

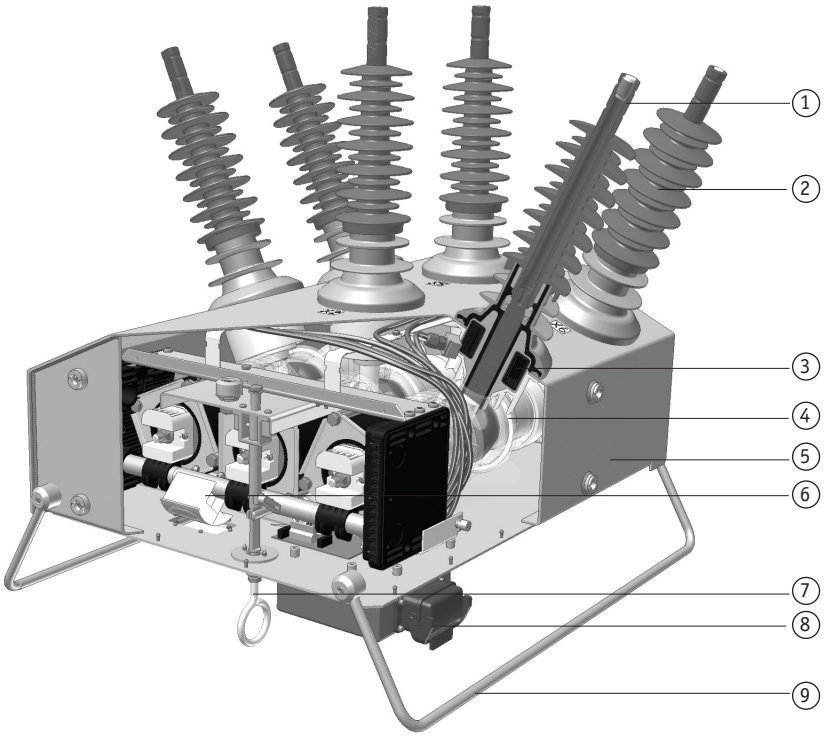
Tavrida Electric's outdoor circuit breakers provide the following advantages:

Environmental friendly
The OSM/TEL-15.5-16/630-204 and the OSM/TEL-27-12.5/630-205 are air insulated outdoor circuit breaker. The patented combined insulation makes them the environmental friendly option.
The reliability of the design is proven by the most severe climate and pollution conditions test in Koeberg Insulator Pollution Test Station (KIPTS) in South Africa.

Lowest Weight
Tavrida Electric's light weight vacuum circuit breaker and the robust aluminium tank contribute to the total weight of the OSM of not more than 72kg making these the most light weight outdoor circuit breaker in the market. Consequently shipment, handling and installation are simplified to the greatest extent.

Highest Availability
30,000 C-O operations with rated current and 200 operations with full short circuit breaking current without any maintenance makes them the most reliable product in the market.

Optimized Measurement
All OSM are equipped with voltage sensors in all six bushings to measure each 3-phase voltages on both recloser sides. Non-saturable Rogowski coils in all 6 bushings guarantee high accuracy over a wide measurement range. They measure 3-phase currents and residual current simultaneously.



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

Figure 1
General arrangement of the OSM

Protective Tank

The OSM's are constructed from an aluminium tank incorporating the vacuum circuit breaker with single coil magnetic actuator. The protective tank consists of two main parts: the housing and the bottom protective cover riveted to the housing. The OSM housing and the cover are made of a corrosion resistant aluminium alloy. Watertight aluminium rivets are used to fit the cover. The tank is powder coated in light grey (RAL 7038). The tank including the fitted intermediate module provides IP65 degree of protection.

Threaded holes (M12x30) on each side of the tank allow mounting equipment for pole or substation installation to be fitted. These threaded holes are also used to install the set of lifting lugs on the tank.
The earthing provision (M12x30 threaded hole) is labelled for identification.

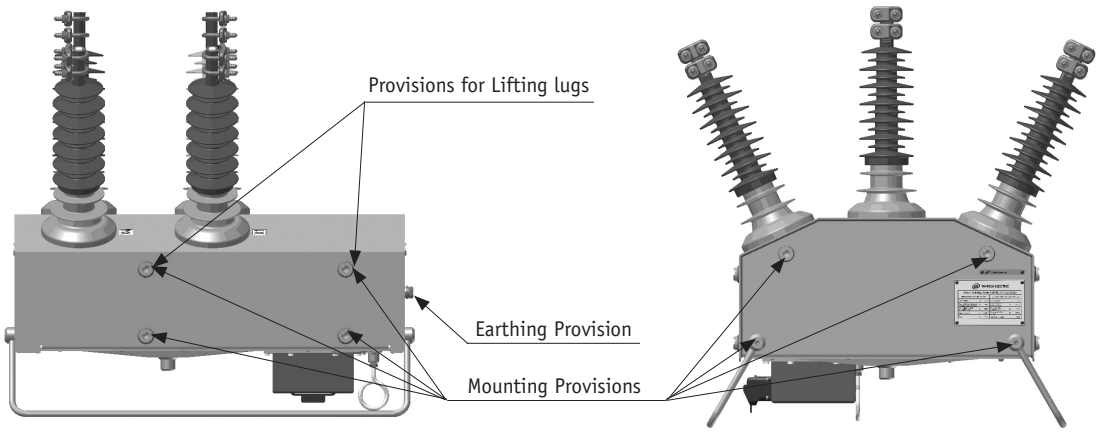


Figure 2

The tank supports provide a firm, stable support.

The protective tank is equipped with a ceramic breather.
It is placed on the bottom.
The breather ensures that no dust or pollution can ingress.

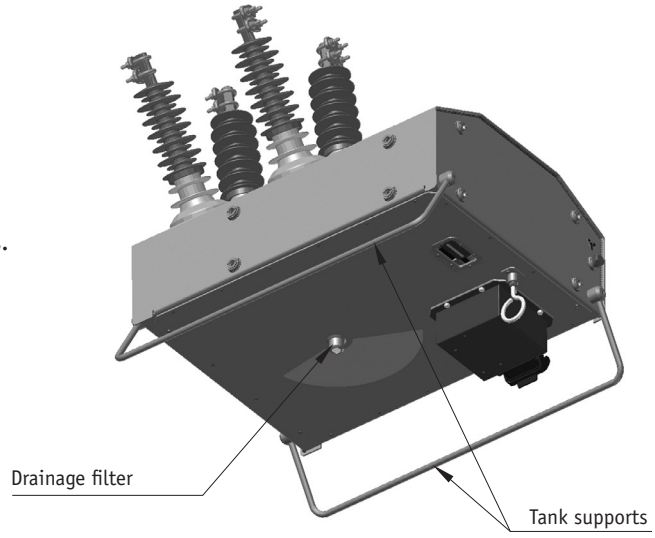


Figure 3

Each OSM has the following plates:
· Serial number plate
· Nameplate

Outdoor Switching Module
OSM/TEL-27-12,5/630-205

IEEE C37,60/IEC 62271-111			O-0,1s-CO-1s-CO-1s-CO		
Rated voltage,	Ur	**27 kV**	Rated frequency,	fr	**50/60 Hz**
Rated power frequency short-duration withstand voltage,	Ud	**60 kV**	Rated short-circuit breaking current,	Isc	**12,5 kA**
Rated lightning impulse withstand voltage,	Up	**125 kV**	Rated peak withstand current,	Ip	**31,5 kA**
Rated nominal current,	Ir	**630 A**	Rated short-time withstand current (4s),	Ik	**12,5 kA**
Mass,	M	**70 kg**	Year of manufacturing		**2012**

TAVRIDA ELECTRIC

Figure 4
Example of the nameplate

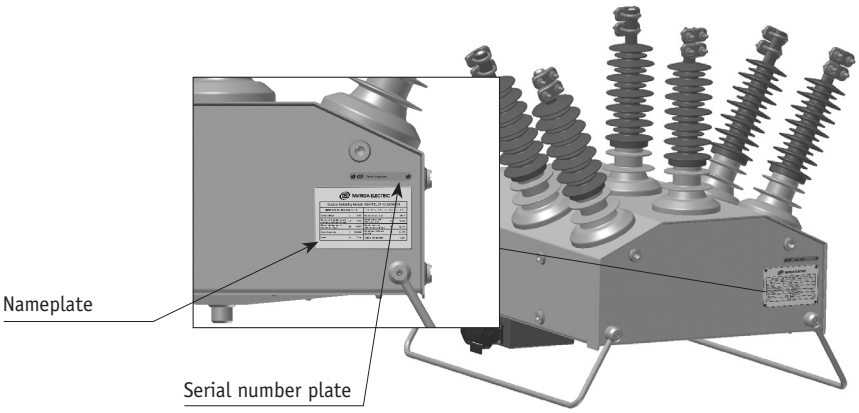


Figure 5
OSM Plates

Main Circuit Bushings

The main circuit bushings are manufactured from UV stable polymer. They are covered by light grey silicon rubber bushing boots which provide a creepage distance of 500mm for the 12 & 15.5 kV version and 860 mm for the 27 kV version.

The bushings are indelibly marked by stickers with the terminal designation X1, X2, X3 for the normal incoming side and X4, X5 and X6 for the normal outgoing side (figure 6).

Allowable wire tension at the connection point is 300 N.

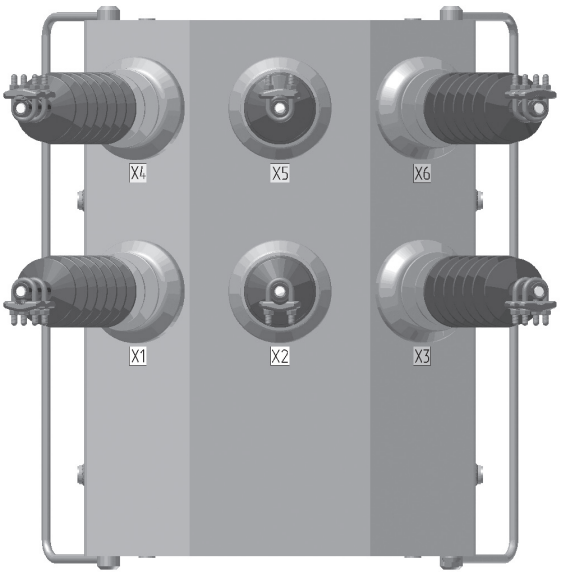


Figure 6
Bushings marking

Bushing Extensions

Bushing extensions of OSM (figure 7, 8) have cylinder endings with milled cable connection surfaces. This surface provides reliable contact area for cable or conductor connection. All parts are tin plated and allow both aluminum and copper conductor connection. Terminal connectors are used to fix the cables.

Bushing extension of 12 and 15.5 kV OSMs

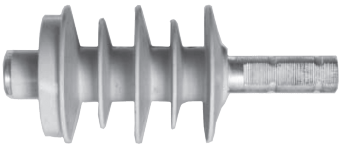


Figure 7

Bushing extension of 27 kV OSMs

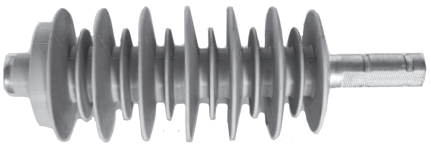


Figure 8

Bushing extensions have threaded inserts on butt-end (figure 9).
Inserts are covered by plastic plugs (figure 10) that shall be removed before connecting lugs.

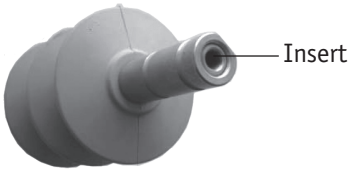


Figure 9

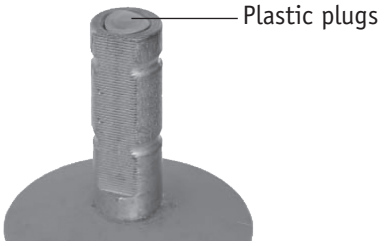


Figure 10

Terminal Connection Options

U-bolt Terminal Connectors

U-bolt connector (figure 11) provides reliable connection of cable conductors with 35 to 240 mm2 cross section. The set of this type of connectors (12 pcs) is provided by default in each OSM package.

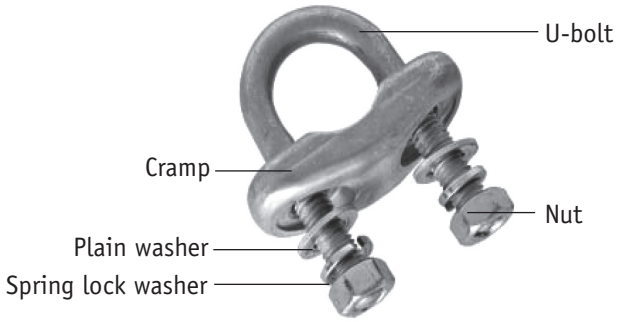


Figure 11

One connector is enough to connect conductors up to 90 mm2 (figure 12). Two clamps shall be used to connect 120 mm2 and greater cross section conductors (figure 13).

Figure 12

Tightening torque of connector nuts is 20±1 Nm.

Protective covers can be used to protect connections against environment (figure 14, 15).

Figure 13

If diameter of cable used is more than 10 mm then the cone end of each cover shall be cut to the corresponding diameter to fit the cable tightly (figure 16).

Figure 14

Figure 15

If cable lugs are used for connection they shall have 10.5 mm holes.

Figure 16

NEMA connectors

L-shaped clamp (figure 17) provides reliable connection of cable conductors with up to 240 mm^2 cross section. This type of connectors can be ordered separately, see Accessories paragraph.

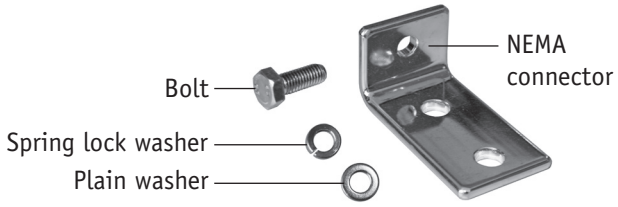


Figure 17

Connectors are fixed with bolts M10x25 to the butt-end of bushing extension. Tightening torque of 30±2 Nm shall be applied (figure 18).

Figure 18

Cable lug with two holes is fixed to the clamp with bolts M12. Tightening torque of 30±2 Nm shall be applied. Protective covers are not installed in this case (figure 19).

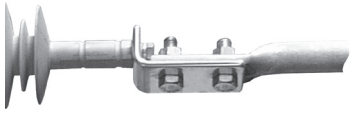


Figure 19

Lug connection

Lugs can be used to connect cables from 16 to 240 mm^2. Lugs are fixed with bolts M10x25. Tightening torque of 30±2 Nm shall be applied. Protective covers are not installed in this case (figure 20).

Figure 20

Current and Voltage Sensing

Each bushing has built in current and voltage sensors. Current sensing is carried out by six (6) Rogowski sensors. The sensors on the X1, X2, X3 terminals measure phase currents. The sensors on the X4, X5, X6 terminals have secondaries connected in series for residual current measurement. Capacitive sensors are used for voltage measurement on all six bushings.

The parameters of the sensors are specified in “Technical Data” section of this manual.

Mechanical Trip

A mechanical trip hook is located in the base of the tank. When the hook is pulled down, the OSM is mechanically locked in the OPEN position and electrically interlocked against closing. A “OSM Coil Isolated” warning event is generated by recloser control to provide indication of the locked state. Until the trip hook is pushed back up into the operating position, the OSM remains locked and cannot be electrically operated.

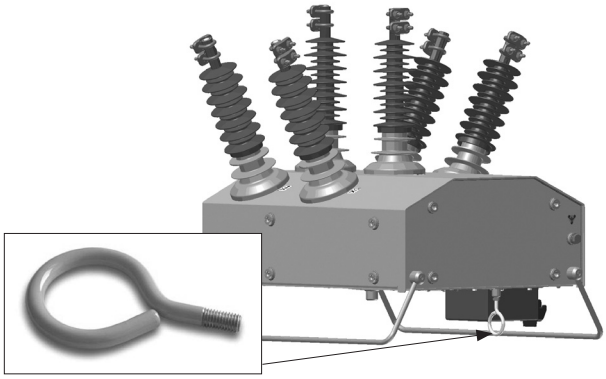


Figure 21

Mechanical trip hook

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.

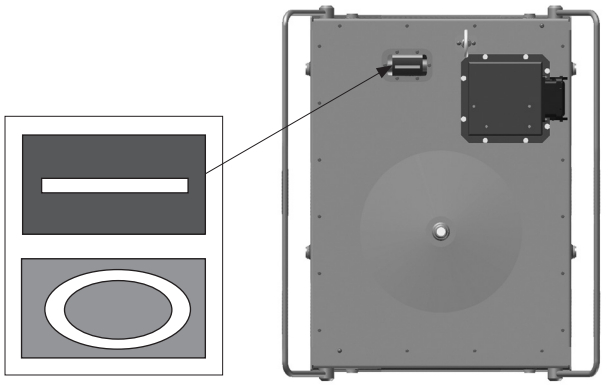


Figure 22

Position indicator

Intermediate Unit

The Intermediate unit provides the housing for the electronic components of the voltage and current sensors. It also provides termination for the voltage and current sensors, the actuator coils and the auxiliary switch to the control cable. Protective surge suppressors for measurement inputs of Recloser Control are also installed in intermediate unit.

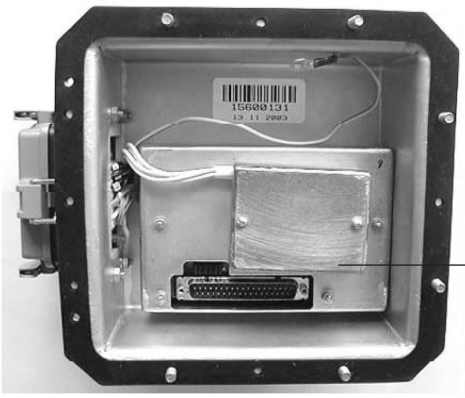


Figure 23

Intermediate unit with installed clamp cover

1. Protective cover
2. Wago cage clamps
3. Control Cable terminal

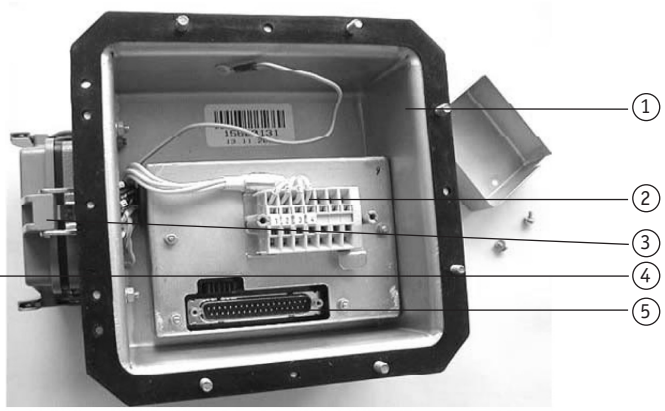


Figure 24

Intermediated unit with removed clamp cover

4. Clamp cover
5. Intermediate board

Intermediate unit is protected by a cover (IP65). The cover is made from the same material as the OSM tank and painted with the same colour. It is mounted on the tank with eight (8) captive screws (M5x20).

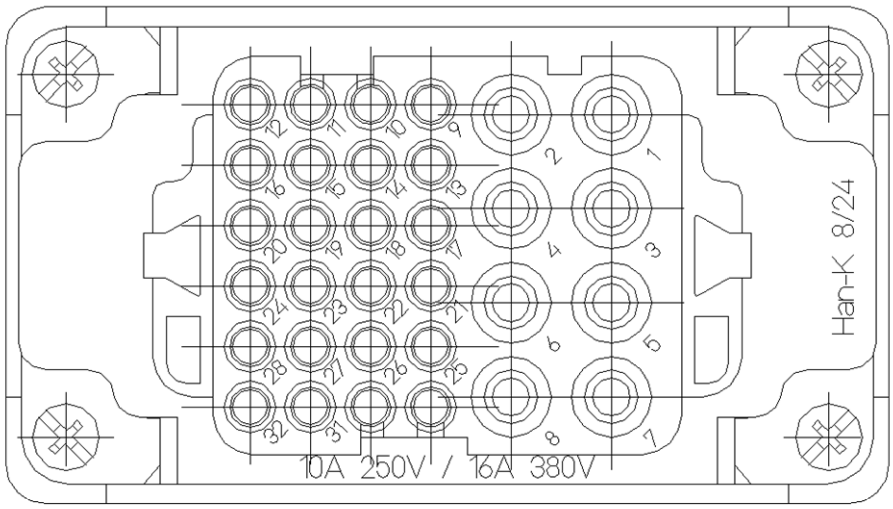


Figure 25
Control Cable terminal

Designation of the control cable terminal pins

Pin No.	Designation	Note
1	EM1	Actuator coil (1)
2	EARTH	Earth
3	EM2	Actuator coil (2)
4	EARTH	Earth
5	AUX2.1	NC auxiliary switch 1(1)
6	EARTH	Earth
7	AUX2.2	NC auxiliary switch 1(1)
8	EARTH	Earth
9		
10	+IA1	
11	+IB1	
12	+IC1	
13		
14	-IA1	
15	-IB1	
16	-IC1	

Pin No.	Designation	Note
17	+I0	
18	+UA1	
19	+UB1	
20	+UC1	
21	-I0	
22	-UA1	
23	-UB1	
24	-UC1	
25		
26	+UR1	
27	+US1	
28	+UT1	
29		
30	-UR1	
31	-US1	
32	-UT1	

Vacuum Circuit Breaker

Each OSM is equipped with Tavrida Electric's innovative vacuum circuit breaker. Tavrida Electric has simplified the mechanical structure of the vacuum circuit breaker to the greatest possible degree. 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 mounted in a steel frame and mechanically linked by a synchronizing shaft.

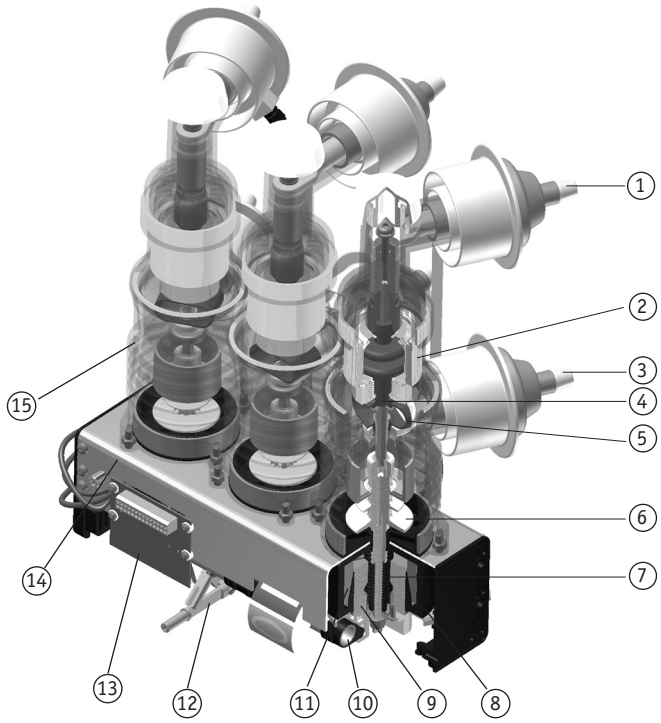
Failure of critical components, such as
· mechanical latching
· gears, chains, bearings and levers
· tripping and closing coils
· motors to charge springs
are completely avoided.

Maximizing the benefits of the drive mechanism requires vacuum interrupters that combine small dimensions with an extraordinary long mechanical and electrical lifespan. The use of a predefined axial magnetic field shape provides even distribution of current density and consequently substantial improvement of vacuum interrupting performance. Carefully selected contact material and expert contact design as well as optimized movement and switching speed result in bounce-free closing.

The result is 30,000 C-O cycles at rated current or 200 operations at full short-circuit breaking current without the need to replace or adjust any parts of the vacuum circuit breaker.

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

Vacuum Circuit Breaker



1. Upper terminal
2. VI
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 26
View into the Vacuum Circuit Breaker

Closing

Closing operation is possible only if manual trip hook is in upper position. Contacts are kept in Open position by the force of the opening springs. To close the contacts the coils of the magnetic actuators are excited by a current impulse of the close capacitors of the CM. As a result the contacts close. At the same time the opening springs are compressed. In the close position the contacts are kept closed by means of the magnetic force only. The SM maintains the closed position without mechanical latching also in case of a failure of the auxiliary power supply (Figure 27).

Opening

To open the contacts a current impulse in the reverse polarity derived from the opening capacitors of the CM is injected in the coils of the magnetic actuators releasing the magnetic holding force. The compressed opening springs and contact pressure springs open the contacts (Figure 27).

Mechanical Closing

The SM can only be closed electrically via the CM. In the case of a failure of auxiliary power supply the contacts can be closed using an alternative auxiliary power supply such as a battery. Mechanical closing is not possible.

Mechanical Trip

When the manual trip hook is pulled down the synchronizing shaft is rotated. Thus a force exceeding the magnetic attraction forces of the ring magnet is applied to the armature, which subsequently starts to move. As the air gap increases, the opening springs and the contact pressure springs overcome the magnetic holding force, and the vacuum interrupter opens.

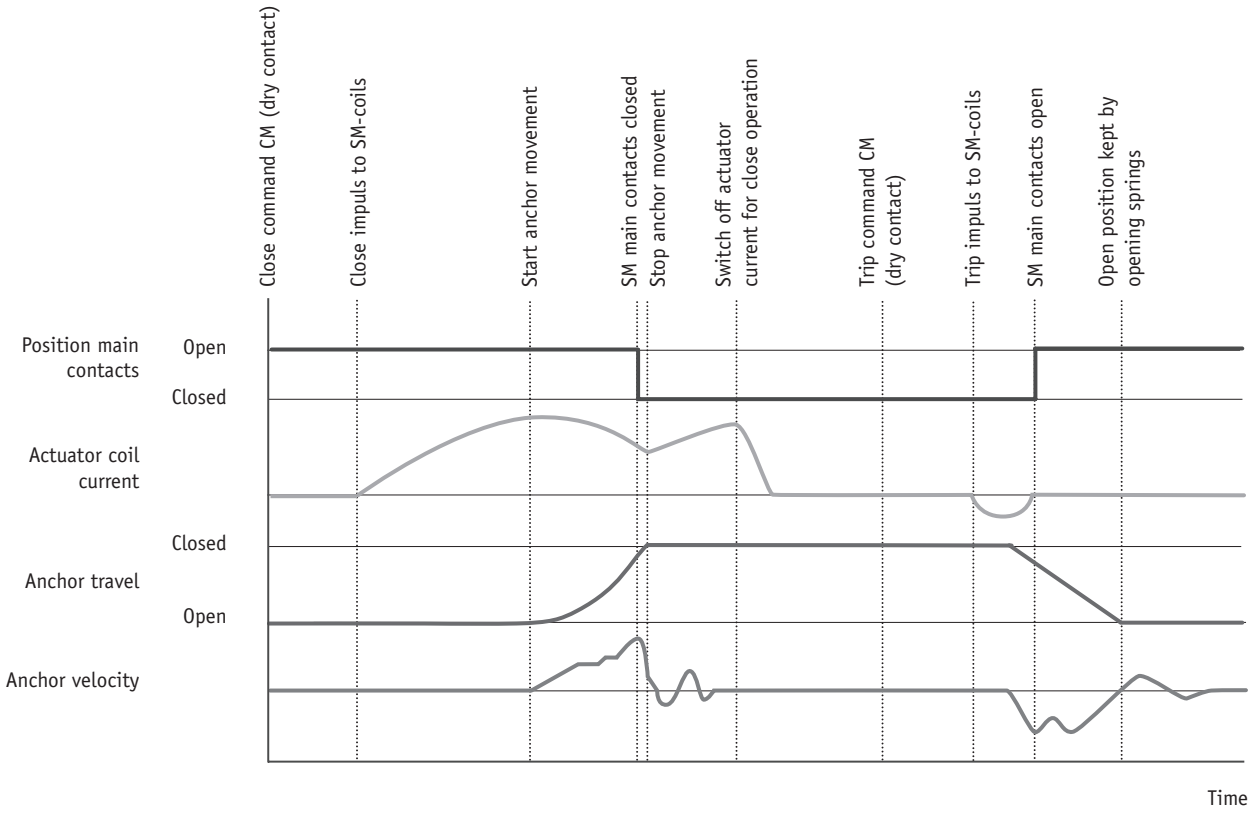


Figure 27

Typical oscillogram of OSM operation

Recloser Control

3

Overview

Tavrida Electric's Recloser Control provides the following advantages:

Recloser Control Cubicle

· MMI with 6-lines-40-characters graphical LCD for clear indication of events

Measurement

· Application of advanced transformer magnetizing inrush current filters

Protection

Well designed protection elements for identification of particular fault types:

· Short circuit fault (phase-to-phase and three-phase short circuits, single-phase and double-phase earth faults)
· Bolted Fault
· Sensitive Earth Fault
· Upstream broken wire
· Downstream broken wire
· Low System voltage
· Low System frequency
· Loss of Supply (for ring-line configuration)
· Automatic Backfeed Restoration (for ring-line configuration)

· Unique Source detector capable of source side identification under static and dynamic conditions such as motor start/stop and reverse reactive power flow
· Separate Bolted Fault detector which works independently of over-current elements and thus provides high flexibility in settings of overcurrent protection elements
· Auto-reclosing elements for under-voltage and under-frequency resilient to nuisance tripping
· Automatic Group Transfer of settings according to date/season
· Flexible Time Current Characteristics (TCC) providing user-friendly configuration of inverse curves and automatic configuration of upstream TCC for configured downstream TCC (Auto coordination, Auto correction)

Monitoring

Highly comprehensive log files with well-structured information:

· 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)

Software Package

· Unique Software package to:
  - Calculate optimum settings based on real network topology
  - Verify settings philosophy
  - Simulate complex successive faults
· The same software that is used to calculate the optimized settings is used to upload the settings to the recloser
· Quick uploading of multiple recloser settings and downloading of operating history

Recloser Control Cubicle

RC/TEL-05 recloser control cubicle is constructed from Aluminium, the same material as the OSM tank.
All RC cubicles are powder coated in fawny-light-grey RAL 7032 and provide IP54 protection degree.

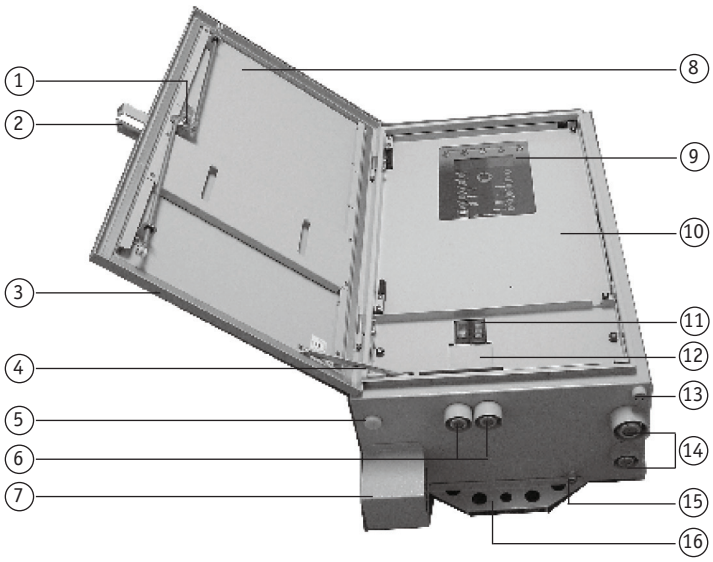
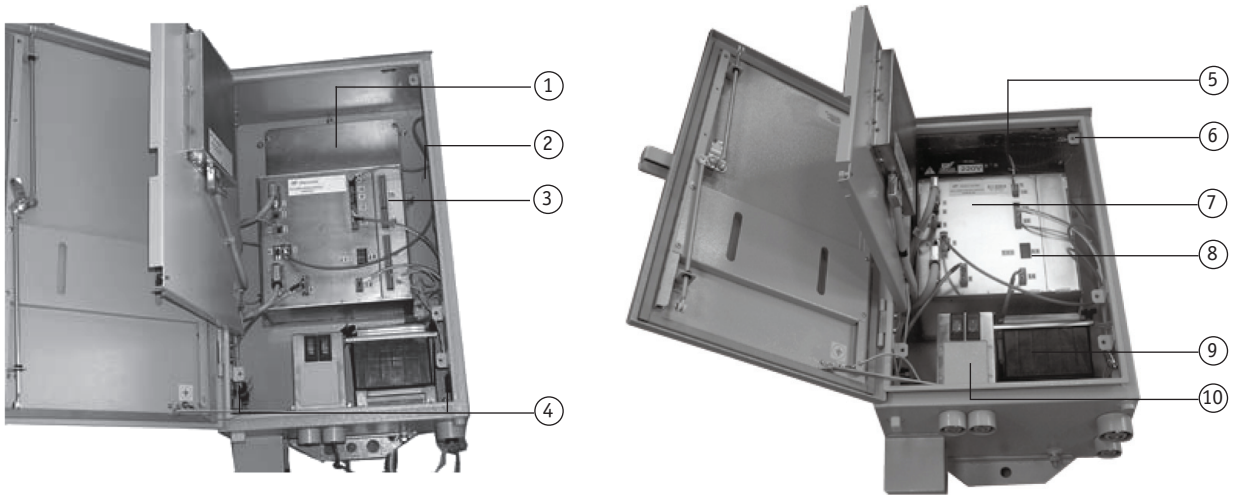


Figure 28

RC/TEL-05 with closed internal door

1. Three-point locking system
2. Padlocking provisions
3. Rubber seals
4. Fixing rod
5. Output of internal installed Bluetooth Module (with protective cap)
6. IP65 glands for Power supply cable
7. Anti-vandal shield of Control Cable
8. External door
9. CPM
10. Internal door
11. Thermal overcurrent circuit breakers
12. Place for power outlet
13. Dust proof drainage filter
14. IP65 glands for:
    - I/O control cable (ø 9...25 mm),
    - Antenna (ø 6...18 mm)
15. Earthing stud
16. Mounting brackets



1. RTU mounting plate
2. WA:RCM-RTU for connection of RTU
3. IO Module
4. EMI filter
5. RTU mounting tray
6. Door position switch
7. Recloser Control Module (RCM)
8. Battery Circuit Breaker
9. Battery
10. Power Supply Filter Module (PSFM)

Figure 29

RC/TEL-05 with open internal door and removed bottom panel

External door of Recloser Control Cubicles RC/TEL-05 is equipped with padlocking provisions. The external door can be securely fixed in the open position in three positions - 60°, 90° and 130°. Padlock provision is capable of accepting a padlock shackle up to 12 mm diameter.

RC/TEL-05 housing provides protection of the umbilical cable from unauthorized disconnection.
An anti-vandal shield is fixed from inside of the housing with four wing nuts.

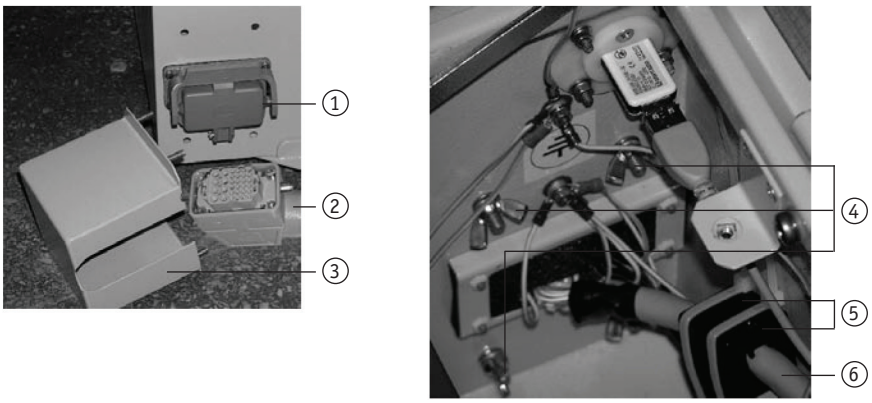


Figure 30

1. Control cable terminal
2. Control cable
3. Protective cover (anti-vandal shield)
4. Wing nuts
5. EMI clamper
6. WA:RCM-CC

RC/TEL-05 is equipped with different cable glands for:
· I/O cable or external RTU connections (ø 9...25 mm)
· antenna (ø 6...18 mm)
· power supply cable (ø 6...18 mm)

Cable glands are delivered with installed plastic caps.
The housing has provisions for the protection against the ingress of dust and water.

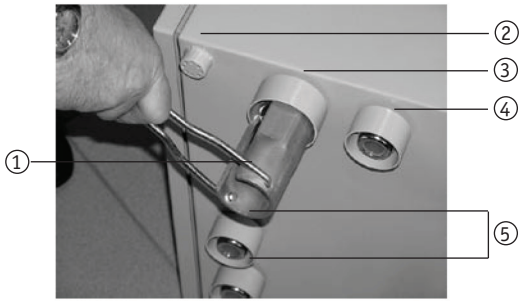


Figure 31

1. Boxspanner for installing cable glands
2. Dustproof drainage filter
3. Entry gland for I/O cable or external RTU connections
4. Entry gland for antenna
5. Entry glands for power supply cable

RC/TEL-05 is equipped with a Door Position Switch.

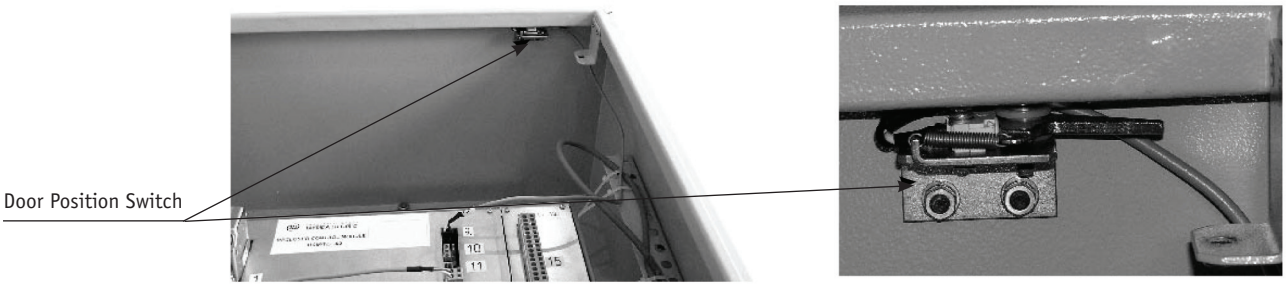


Figure 32

RC/TEL-05 control cubicle consists of the following modules:

- Control Panel Module (CPM)
- Recloser Control Module (RCM)
- Power Supply Filter Module (PSFM)
- Battery and Filter Module (BFM)
- Input/Output Module (IOM)
- Remote Telecommunication Unit (RTU)
- Bluetooth Module (BTM)

Module or Component	Standard	Optional
CPM	●	
RCM	●	
PSFM	●	
BFM		
Battery	●	
BTM		●
IOM		●
RTU		●
WA: RCM-CPM	●	
WA: RCM-BAT	●	
WA: MPM - RTU	●	
WA: RCM - DPS	●	
WA: RCM - CC	●	

WA - Wiring Assemblies

Control Panel Module (CPM)

The CPM module provides key control and indication functions to RC/TEL-05. Its 6-lines-40-symbols graphical LCD provides sufficient space for clear indication without the need to use cryptical abbreviations.
The CPM is connected to the Recloser Control Module (RCM) through 25 pins lockable plug 19. The CPM is mounted on the internal door with six M4 wing nuts and earthed through mounting spots. The CPM has an integrated USB interface for the connection of PCs.
For further information about functionality of CPM please refer to Indication and Control section of this manual.

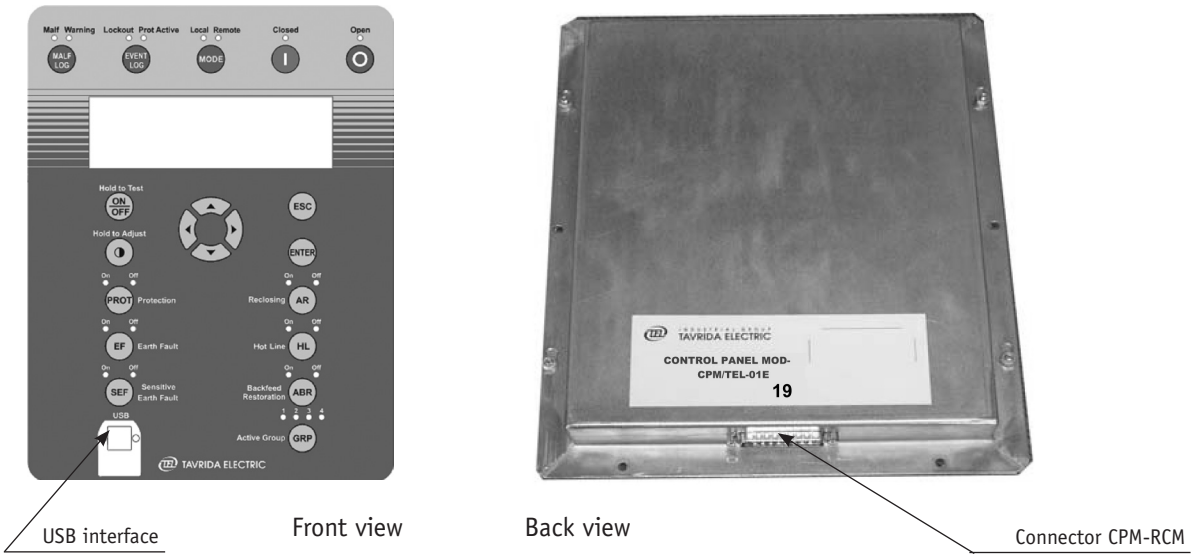


Figure 33

Recloser Control Module (RCM)

Recloser control module incorporates the following sub-modules:
· Main Processor
· Uninterruptible Power Supply (UPS)
· Switching module Driver

It is responsible for all recloser functionality. RCM is connected with other RC modules by several wiring assemblies (refer to “Wiring Assemblies”, part of this section for details).

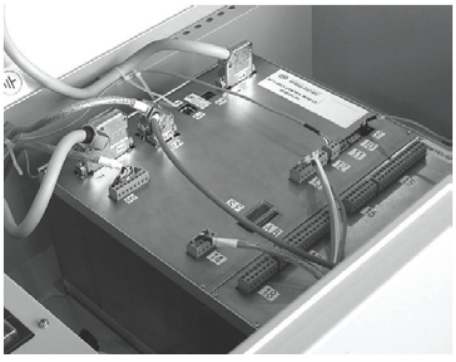


Figure 34
RCM connections with other RC modules

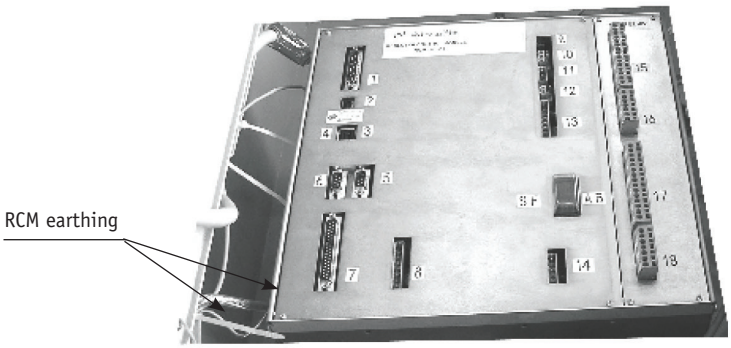


Figure 35
RCM earthing

Main Processor

The Main Processor provides the following functions:
· Measurement
· Protection
· Monitoring
· Indication and Control
· Real Time Clock
· Driving the Communication Interfaces
· Storage of Logs and Counters

Uninterruptable Power Supply (UPS)

The UPS provides power management for the Recloser Control from an AC Supply with a battery for backup. AC can be supplied from two separate sources to increase auxiliary supply reliability.

Battery temperature is monitored and charging current is adjusted to ensure optimum charging. After loss of AC Supply an external load (e.g. radio or modem) can be supplied for a time, which depends on environmental temperature, residual charge and loading before automatically shutting down to conserve batteries.

The UPS controls the operating voltage of all system modules. There are three levels of supply:
· System (RCM, CPM, BTM, IOM) power supply: It shuts down when the residual battery capacity drops below set-up shutdown level;
· RTU power supply: It shuts down when the residual battery capacity drops below set-up RTU shutdown level;
· RTC and wake-up circuit power supply: never shuts down.

Power supply has user adjustable settings. List of settings is available in a table below. Settings can be adjusted from TELARM software or MMI (Main menu -> Settings -> System). PS element settings:

Setting	Applicable range	Resolution	Factory default
Rated battery capacity	5 to 50 Ah	1 Ah	26 Ah
Shutdown level	0.1 to 0.8 p. u.	0.1 p. u.	0.2 p. u
RTU shutdown level	0.1 to 0.8 p. u.	0.1 p. u.	0.5 p. u.
RTU supply voltage	5.0 to 15.0 V	0.1 V	12 V
RTU reset cycle	0 to 168 h	1 h	0 h
RTU reset duration	1 to 30 s	1 s	1 s

Driver

The basic operation of the Driver can be described as follows.
When the Driver receives Trip or Close Request, a current pulse is injected into the OSM coils, initiating Open/Close of OSM main contacts as described in the section dedicated to the OSM operation.

The driver will then send a “Closed” signal (binary 0/1 for open/closed) back to the telecommunication or protection elements. This signal replicates the inverse position of the normally closed OSM auxiliary switch.

The Driver does not have user configurable settings.

The health of the OSM coil circuit and drivers own readiness to execute the next Trip/Close operation are continuously monitored. Depending on the problem the following events are logged:

Event	Condition
Closed	Activates 10ms after the OSM auxiliary switch stays bounce-free in open position. Deactivates 10ms after the OSM auxiliary switch stays bounce-free in closed position.
Request processing	Activates after receiving Trip/Close requests. Deactivates after receiving changed state of OSM auxiliary switch.
Excessive trip time	Activates if changed state of OSM auxiliary switch was not received within 100 ms after initiation of Trip request. Deactivates after deactivation of Closed signal (OSM opening).
Excessive close time	Activates if changed state of OSM auxiliary switch was not received within 100 ms after initiation of Close request. Deactivates after processing activation of Closed signal (OSM closing).
Driver not ready	The Driver continuously monitors if the voltage of the trip/close capacitors is sufficient to execute relevant operation. If this voltage appears to be not sufficient this signal is activated (for charging timing details refer to the technical specification of power supply module). Close instruction will not be executed while driver not ready event is present. This signal is also activated if any of Request Processing, OSM coil short circuit, OSM coil isolated and DRVE fault signals is activated.
OSM coil short circuit	OSM coil short circuit detected.
OSM coil isolated	OSM coil open circuit detected.
DRVE fault	The Driver continuously monitors its own health. This signal is activated when internal malfunction is found.

Power Supply Filter Module (PSFM)

This module provides impulse noise protection for all internal modules of RC/TEL-05.
It is enclosed in housing made from zinc galvanized mild steel.

Figure 36
Power Supply Filter Module

PSFM is connected to RCM with the aid of WAGO plug (Fig. 36). It also incorporates two thermal overcurrent circuit breakers on the front panel (Fig. 36). These breakers protect auxiliary voltage inputs from overloads and short circuits.

PSFM is mounted using two M6 wing nuts and earthed by its own earthing wires.

Rechargeable Battery (BAT)

The rechargeable battery is used for backup supply in RC/TEL-05.
The power supply system of the cubicle is designed to provide optimum charging and long life of this battery.

Bluetooth Module (BTM)

The Bluetooth Module provides point-to-point wireless connection between RC and a personal computer.
The BTM is connected to RCM by USB cable (Fig. 37).

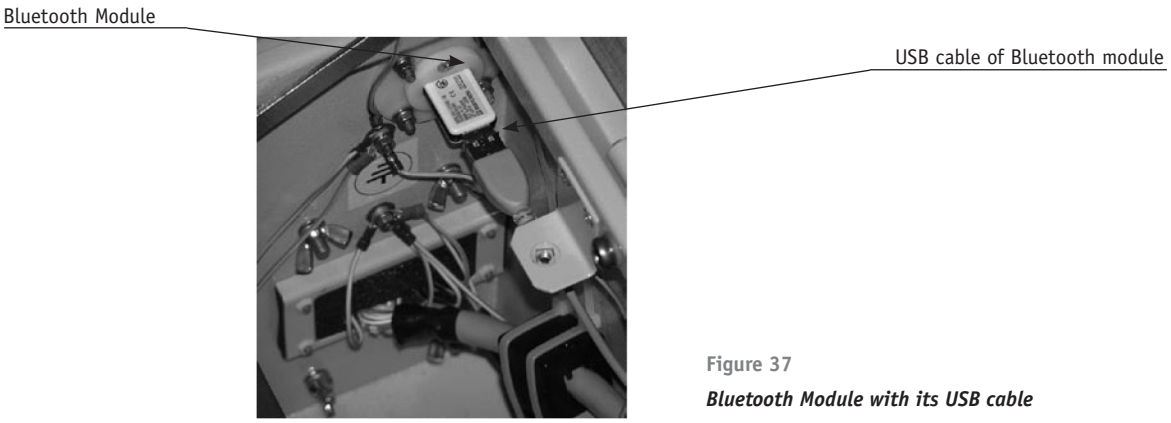


Figure 37
Bluetooth Module with its USB cable

I/O Module (IOM)

An IOM (Fig. 38) can be supplied with the RC cubicle as an option. It is used to provide control and indication functions with the aid of digital inputs/outputs (Refer to Digital Input/Output Interface (IOI) in Indication and Control section for further information on functionality). IOM contains twelve digital inputs and twelve digital outputs. Location of connectors (marked “15”...”18”) with these inputs and outputs are shown in Fig. 39.

Figure 38
Overall view of IO module

Digital inputs are represented with optocouplers (Fig. 40).

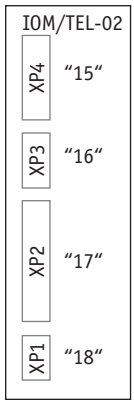


Figure 39

Location of IOM connectors

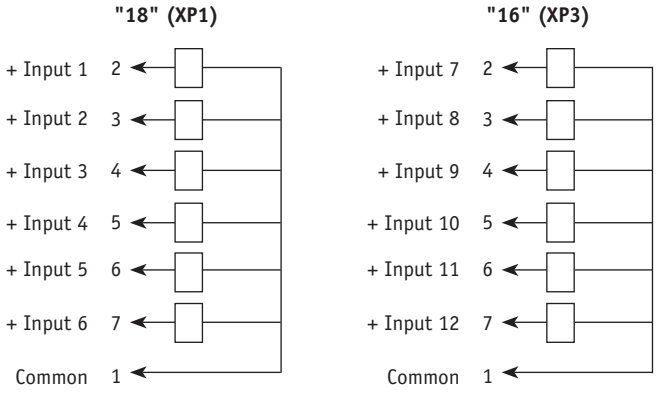


Figure 40

Digital inputs

3

Digital outputs are represented with bistable relays with changeover contacts as illustrated in Fig. 41.

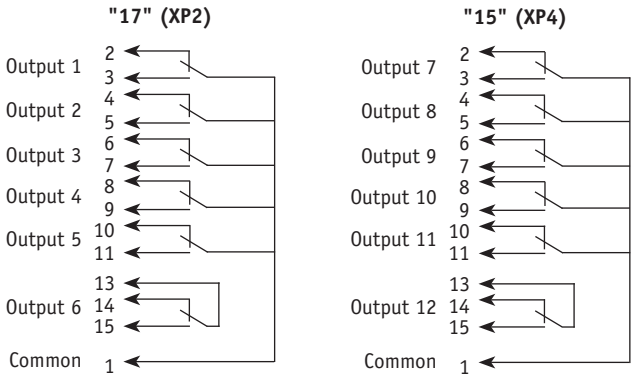


Figure 41

Digital outputs

Remote Telecommunication Unit (RTU)

The space available for RTU mounting on the mounting tray is 300w x 175d x 60h mm. The RC provides 5...15VDC auxiliary power supply voltage. Two RS232 ports are provided at the rear of 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 RTU shall be mounted the special tray through mounting holes drilled by the customer.

Wiring Assemblies (WA)

Wiring assemblies allow to link all RC/TEL modules together (refer to Fig. 42).

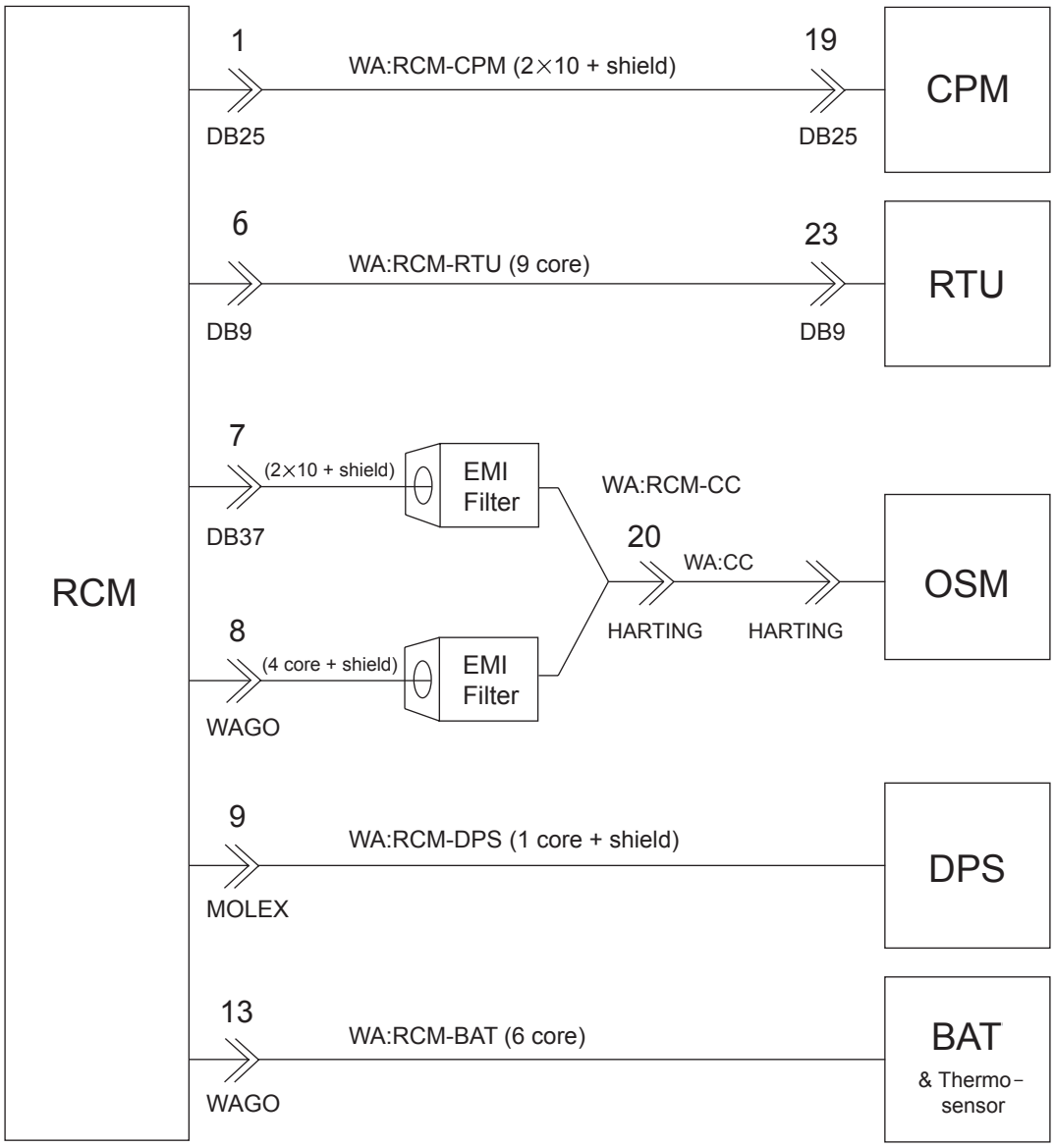


Figure 42
WAs for RC/TEL-05

Small Wiring Terminations

At the stage of delivery RC/TEL-05 are wired in accordance with the following table :

Main wirings of RC/TEL-05

RCM	Wiring assemblies	Designation
"1"	WA:RCM-CPM ("19")	Operative control and indication
"2"	–	USB2 (B) – For connection PC with TELARM if CPM is not used
"3"	–	USB1.1 (A)
"4"	–	USB1.2 (A)
"5"	COM1 (RS232)	TELARM dispatcher interface
"6"	COM2 (RS232)	Telecommunication interface
"7"	WA:RCM-CC ("20")	Connections to Control Cable (to OSM)
"8"	WA:RCM-CC ("20")	Connections to Control Cable (to OSM)
"9"	WA:RCM-DPS	Door Position Switch
"10"	XP1	RTU power supply
"11"	XS1	Heater power supply (is not used in this version)
"12"	–	
"13"	WA:RCM-BAT	Battery
"14"	RCM-PSFM	Power supply AC (85...265 V)
"15"	XS4	Remote Control (Outputs), page 29
"16"	XS3	Remote Control (Inputs), page 29
"17"	XS2	Remote Control (Outputs), page 29
"18"	XS1	Remote Control (Inputs), page 29

The only terminations to be wired by customer are terminations of I/O modules (see page 29) and RTU power supply shown in Fig. 43.

RCM connector "10" (XP1)
for RTU power supply

Contact	Signal
1	+ RTU
2	- RTU

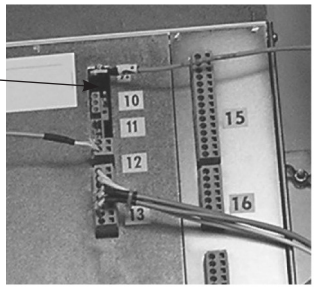


Figure 43

Power supply for RTU

Connectors XS5, XS4, XS1

Figure 44

PSFM connectors XS1, XS4, XS5 (PFSM is open)

WAGO cage clamps are used to provide customer wired terminations shown in Fig. 45. Wires are connected into the clamps using a special screwdriver, supplied with each module.
The WAGO clamps can accept either solid or stranded wire within the range 0.5–1.5 sq mm. Insulation stripping length shall be 6–10 mm.

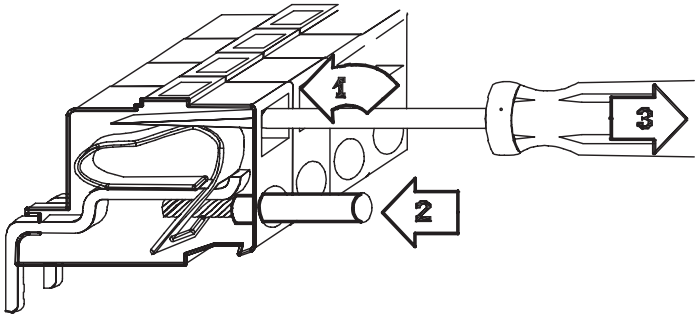


Figure 45

WAGO cage clamps for small wiring terminations

Measurement

4

Overview

The Main Processor takes the analogue signals generated by the OSM current and voltage sensors, converts it into digital format, and filters it for Harmonic content. The RMS values of the converted signals are used for protection and indication as shown in the table below.

Value	Designation	Range	Resolution	Applicability	
				Protection	Indication
Phase currents	Ia, Ib, Ic	0...7000A	1A	✓	✓
Residual current [1]	In	0...7000A	1A	✓	✓
Positive sequence current	I1	0...7000A	1A	✓	✓
Negative sequence current	I2	0...7000A	1A	✓	✓
Positive sequence voltage measured from Source + side	U1+	0...18kV	0.1kV	✓	✓
Positive sequence voltage measured from Source - side	U1-	0...18kV	0.1kV	✓	✓
Negative sequence voltage measured from Source + side	U2+	0...18kV	0.1kV	✓	✓
Negative sequence voltage measured from Source - side	U2-	0...18kV	0.1kV	✓	✓
Frequency measured from Source + side [2]	F+	40...65Hz	0.01Hz	✓	✓
Frequency measured from Source - side [2]	F-	40...65Hz	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	Ua+, Ub+, Uc+	0...18kV	0.1kV		✓
Phase-to-earth voltages measured from Source - side	Ua-, Ub-, Uc-	0...18kV	0.1kV		✓
Phase-to-phase voltages measured from Source + side	Uab+, Ubc+, Uac+	0...30kV	0.1kV		✓
Phase-to-phase voltages measured from Source - side	Uab-, Ubc-, Uac-	0...30kV	0.1kV		✓
Positive sequence active power	P1	0...65535kW	1kW		✓
Single-phase active power	Pa, Pb, Pc	0...65535kW	1kW		✓
Three-phase active power	P3ph	0...65535kW	1kW		✓
Single-phase reactive power	Qa, Qb, Qc	0...65535kVAr	1kVAr		✓
Three-phase reactive power	Q3ph	0...65535kVAr	1kVAr		✓
Single-phase active energy	Wa, Wb, Wc	0...9999999kWh	1kWh		✓
Three-phase active energy	W3ph	0...9999999kWh	1kWh		✓
Single-phase reactive energy	Ea, Eb, Ec	0...9999999kVArh	1kVArh		✓
Three-phase reactive energy	E3ph	0...9999999kVArh	1kVArh		✓

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

[2] When all three phase to earth voltages on any side drop below approximately 0.5kV, prior frequency is ´remembered´ by the measurement element.

Applied filtering allows effectively rejecting higher harmonics and avoids overshooting. For phase currents anti-inrush filtering is additionally applied. This continuously operating filter provides reliable rejection of transformer inrush current. For further information regarding filtering please refer to chapter below and „Technical Data“ section.

Inrush filter

Tavrida Electric has developed and implemented in RC/TEL-05 measurement element a special filter. It recognizes and cuts off transformer inrush current from measured current value using algorithm developed by Tavrida Electric. As a result only true RMS current value present in the line is output to protection elements of recloser control.

This prevents possible unpredictable recloser behavior caused by transformer inrush currents.
Diagrams below illustrate results of inrush filter work.

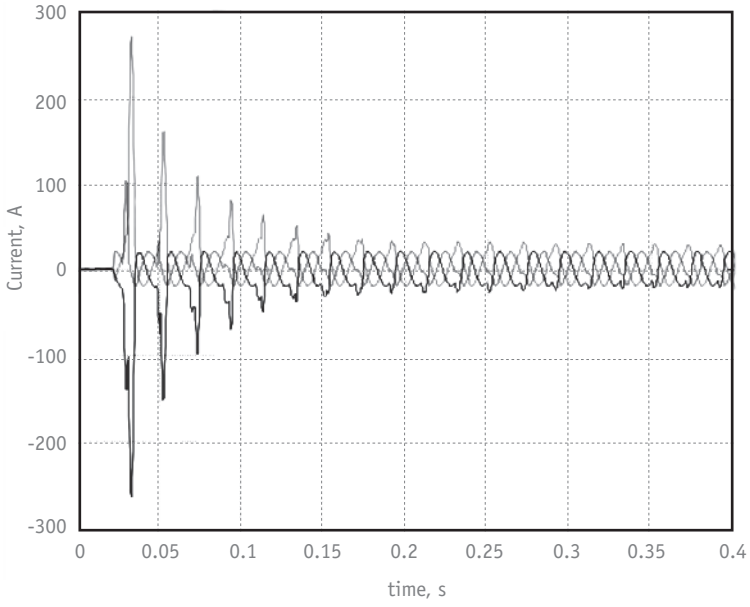


Figure 46
Typical uniform of transformer inrush current

Typical uniform of transformer magnetizing inrush current is shown in figure 46. Following diagrams illustrate output of measurement element under transformer inrush current conditions. Three diagrams show the output of measurement element with no filter applied (figure 47), filter based on second harmonic correction (figure 48) applied and Tavrida Electric inrush filter applied (figure 49), the latter is implemented in RC/TEL-05 recloser control.

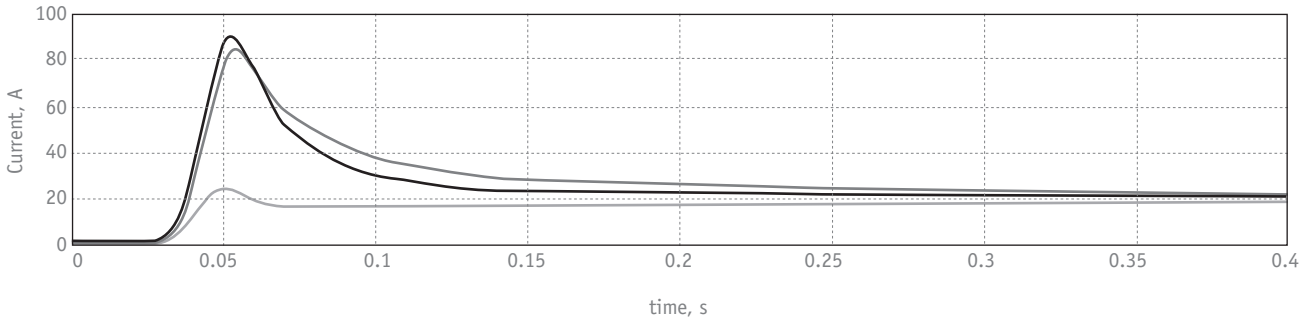


Figure 47
Basic frequency phase currents RMS.
No inrush filter applied

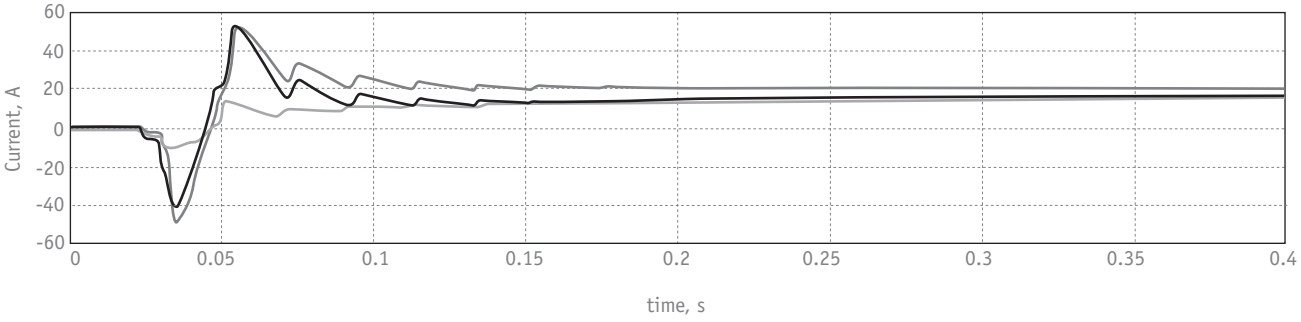


Figure 48

Basic frequency phase currents RMS. Inrush filter based on second harmonic correction applied

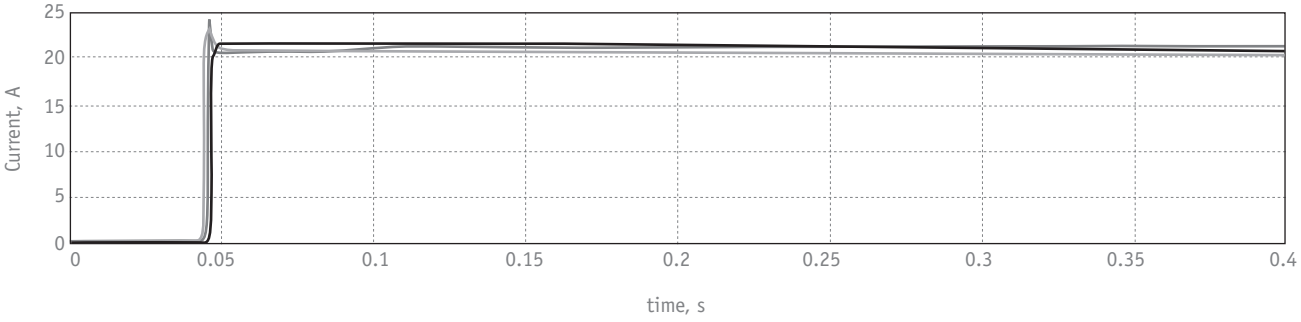


Figure 49

Basic frequency phase currents RMS. Tavrida Electric inrush filter applied

Measurement Settings

The following settings have to be made by the user for correct operation:

Value	Designation	Range	Resolution	Default
Rated voltage	Ur	6…27kV	0.1kV	
Rated frequency	fr	50/60Hz	NA	
Load profile time step	Tlp	5/10/15/30/60min	NA	
OSM serial number	OSM	0…9999999999	1	
Phase current sensor transformation coefficient	CIx1, CIx2, CIx3	1.8…2.2V/kA	0.0001V/kA	2 V/kA
Residual current sensor transformation coefficient	CIn	1.8…2.2V/kA	0.0001V/kA	2 V/kA
Phase to earth voltage sensor transformation coefficient on Source + side	CUx1, CUx2, CUx3	0.1…0.2V/kV	0.0001V/kV	0.1350V/kV
Phase to earth voltage sensor transformation coefficient on Source - side	CUx4, CUx5, CUx6	0.1…0.2V/kV	0.0001V/kV	0.1350V/kV

Protection 5

Overview

The protection functionality supports the following key applications:
· Radial line recloser
· Ring line recloser

Radial line configuration covers the following types of faults:
· short circuit (phase-to-phase and three-phase short circuits, single-phase and double-phase earth faults)
· bolted fault (caused by human error)
· sensitive earth fault
· upstream broken wire
· downstream broken wire
· low system voltage
· low system frequency

Additionaly to the above-mentioned functions Ring line configuration provides Loss of Supply and Automatic Backfeed Restoration functionality in normally open ring lines. Ring line configuration supersedes the Radial line one and has two sets of protection element settings depending on at which side of the recloser the source has been found.

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

All protection elements are controlled by a source detector element, which detects the presence of the power supply source on the designated side of each recloser. The protection elements are blocked if the power supply source can not be found.

The reclosing elements as well as the Automatic Backfeed Restoration are controlled by the Voltage Reclosing Control, which looks at the compliance of global reclosing conditions: the presence of high quality power supply.

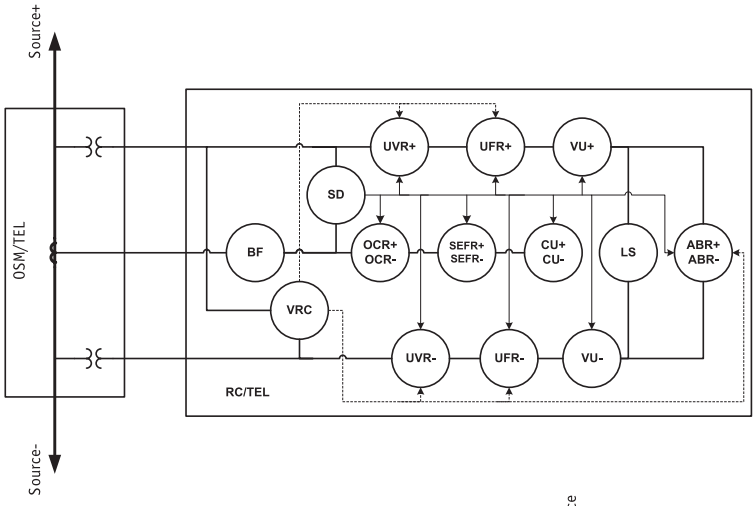


Diagram 1

Functional diagram for Ring type recloser

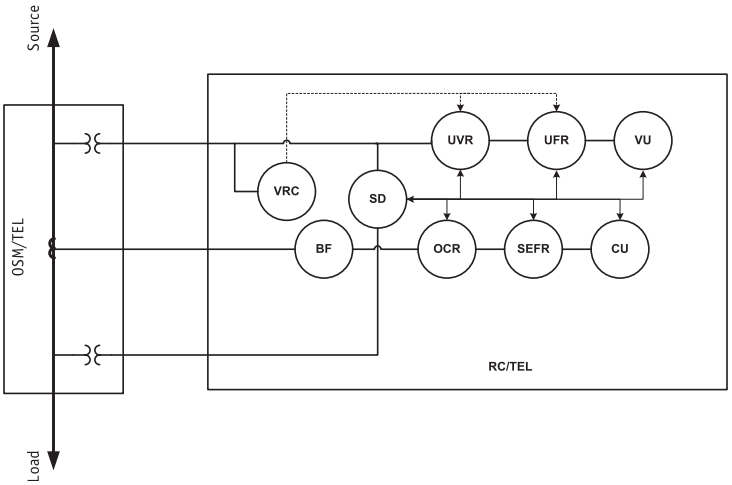


Diagram 2

Functional diagram for Radial type recloser

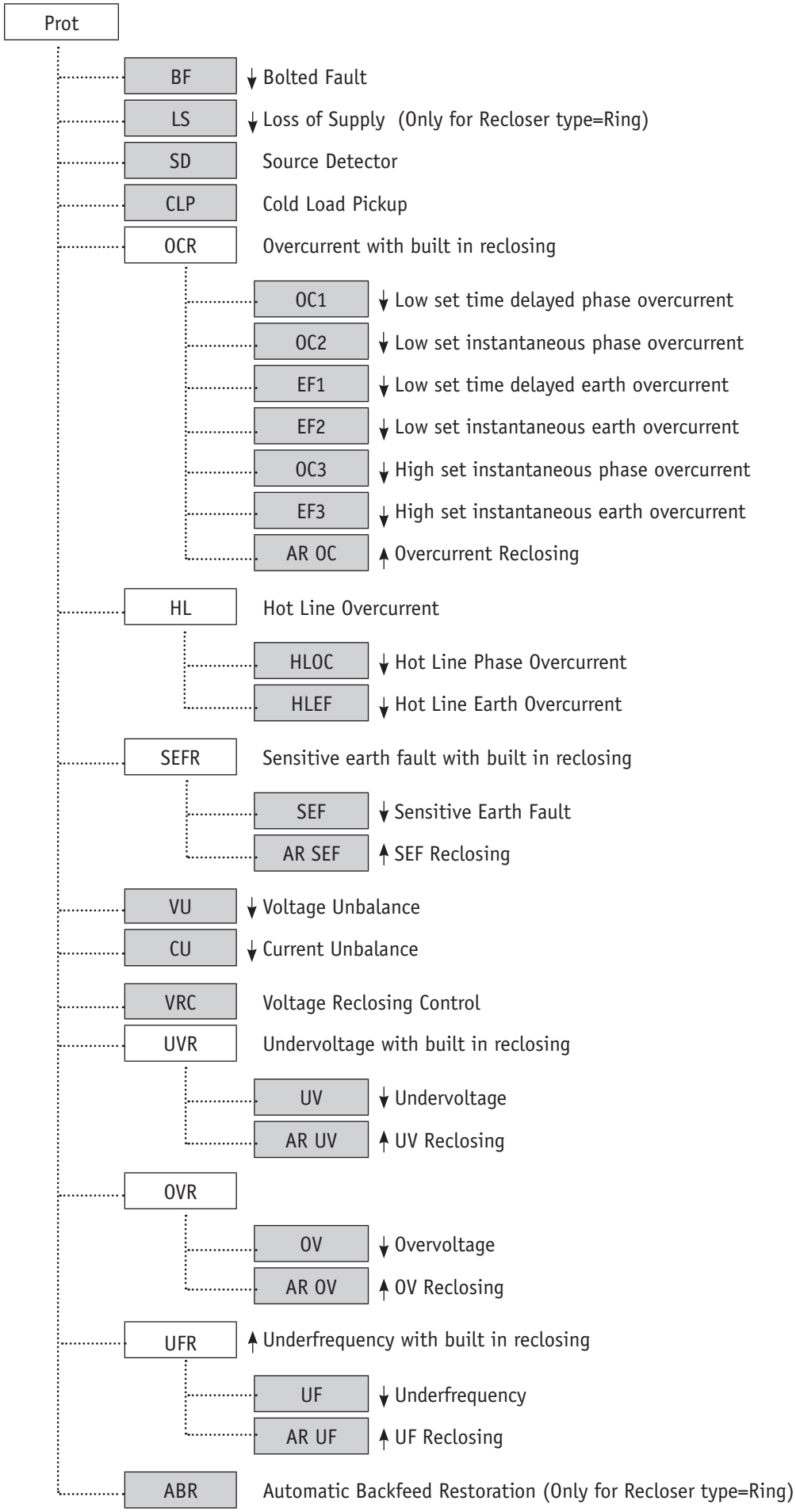


Diagram 3

Structural tree of protection elements

Individual protection elements are colored with grey. Sets of elements are not colored. Furthermore elements providing closing or tripping are marked with upward (↑) and downward (↓) arrows correspondingly. Auxiliary elements and sets of elements are not marked with arrows.
Some elements are interlocked by active timers of other elements to avoid nuisance tripping at complex faults. For example, due to a short circuit fault one could expect pickup of SEF, UV, VU, CU, UF elements (the latter due to rotor deceleration or acceleration at a motor). This would have been incorrect pickup that could lead to nuisance tripping. To avoid this the OCR element provides blocking of the mentioned elements. For the same reason when SEF element picks up it blocks operation of VU, UV, CU and UF elements. When VU picks up it blocks operation of UV, CU and UF elements.

Protection elements are blocked when the recloser trips and are unblocked when the recloser closes under normal operating conditions. See description of SEF, UV, VU, CU, UF elements for details.

For the above protection elements, four groups of protection settings are available. Group 1 is the default group setting. Preset groups of protection settings can for example be used to facilitate adaptation to different local conditions, which depend on the weekday or season. An active group may be changed automatically or by communications commands.

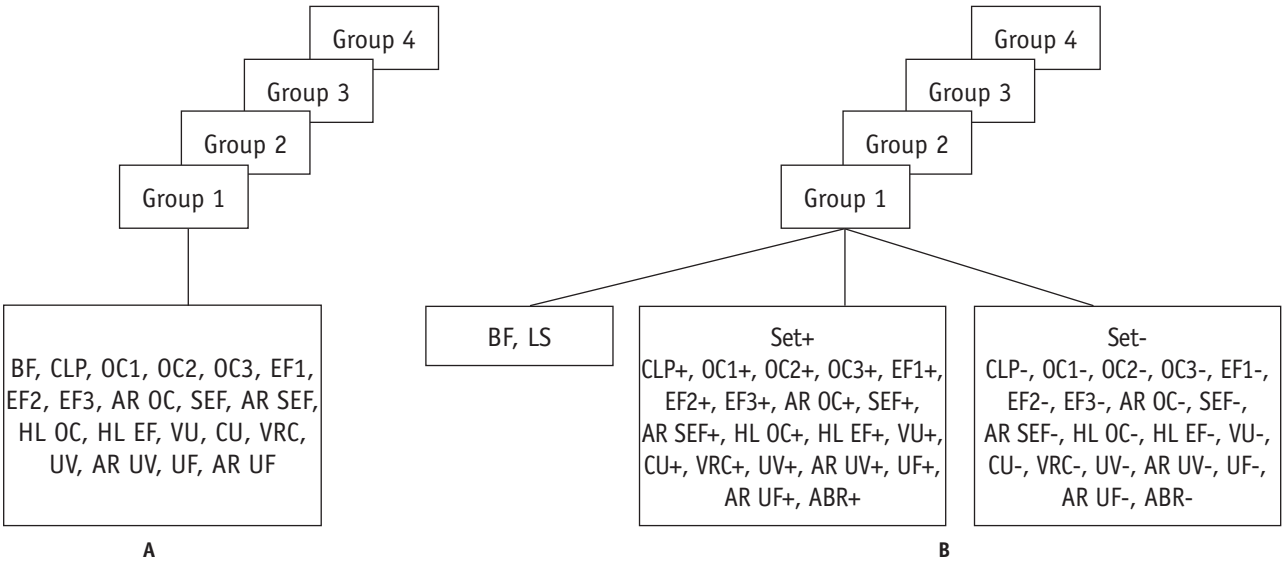


Diagram 4

Protection settings structure:

A - for Recloser type=Radial; B - for Recloser type=Ring

At it is seen from Diagram 4 B, some elements have two identical settings sets in each group if Recloser type = Ring. The active set depends on the state of SD element. Thus, for example, the “Pickup current” setting of SEF element is determined with one only setting in each group if Recloser type=Radial. For Recloser type = Ring there are two settings in each group – the first one in Set + and the second one in Set -.

See description of SD element for details.

Protection Elements

Source Detector (SD)

For radial lines this element detects the presence of a source on the designated side for both closed and open recloser states.
All protection elements except for BF will work with their particular settings as long as a source is detected on the desingated side. The SD will block these elements in case of loss of source.

For ring lines it detects the presence of a source on the positive or negative side for both closed and open recloser states. The operation of the protection elements OCR, HL, SEFR, VU, CU, UVR, UFR and ABR depend on the source side identified. If source found at the Source+ side those elements use the settings “Set +”. If source found at the Source- side those elements use settings “Set -”.

The element will not be able to identify the source only if both voltage and current drops below relevant levels of sensitivity or at open recloser state both sources are present.

The element includes an algorithm, which provides correct operation for various transient conditions including motor start/stop when connected to the line. It responds correctly even during fault conditions where the motor acts as generator feeding power into the network. The same it true for reactive power flow in reverse direction.

Setting	Designation	Range	Resolution	Default
Operating mode	Mode	Enable/Disable	N.A.	Disable

Important: SD Operating Mode = Disabled is intended for recloser testing only. This mode allows recloser testing with current source only, without voltage source.
When recloser is installed in a real line, the SD element should be always set to Enable for proper protection functioning!

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 regarding bolted faults than conventional highset overcurrent elements.

BF element settings:

Setting	Designation	Range	Resolution	Default
Pickup current	Ip	20-6000 A	1 A	6000 A

The element will respond to a fault if the positive sequence current I1 exceeds the pickup current Ip and the positive sequence voltage U1+ is below 500V.

The element is blocked when the following communication signal is activated:
· Protection Off

Loss of Supply (LS)

This element is applicable for ring lines only. The Loss of Supply element detects loss of voltage on all six bushings and loss of current in all three phases. This element provides tripping resulted from loss of supply. This functionality is applicable for sectionalizing recloser in order to support automatic backfeed restoration.

LS element settings:

Setting	Designation	Range	Resolution	Default
Operating mode	Mode	Enable/Disable	N.A.	Disable
Tripping time	Tt	0.1-100 s	0.01 s	10 s

The operation of the element can be described as follows: It is passive as long as SD reports a source present. It starts timing up the user set Tripping time Tt when the SD cannot find the source. When this time expires and the source is still not found, LS initiates a trip request to the driver to open the recloser. If the source is found whilst element is timing up its tripping time, this element becomes passive again and the timer is reset.

The element is blocked when the following communication signal is activated:
· Protection Off

Cold Load Pickup (CLP)

When supply to a feeder is restored after an extended outage the load is higher than usual because all the thermostat controlled loads, such as heater, refrigerator or air conditioner have turned on. The longer the period without supply the greater the loss of diversity and the higher the load current when supply is restored. The purpose of the CLP element is to hold the load without tripping.

CLP element is used for Recloser type = Radial only.
The operation of the element can be described as follows: The CLP element picks up when the positive sequence current I1 is less than 5 A and the positive sequence voltage U1- is less than 500 V. After the outage condition is found the element increases the Operational Cold Load Multiplier (OCLM) from 1 to a user set value (Cold Load Multiplier CLM) over a user set period of time (Cold Load recognition time Trec) (see the diagram below). Once supply is restored the OCLM returns to 1 over a second user set time (Cold load reset time Tres). Thus, Cold load multiplier superimposed on the Time Current characteristics of low set overcurrent elements shifts the latter along the current axis backward to its initial position.
Provision of variable ramp rates for increase and decrease of the Operational Cold Load Multiplier provides flexibility for different system characteristics.

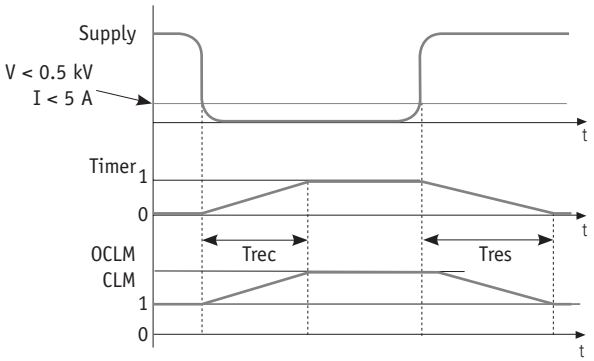
CLP element settings:

Setting	Designation	Range	Resolution	Default
Recognition time	Trec	0-60 min	1 min	30 min
Reset time	Tres	1-400 min	1 min	30 min
Cold load multiplier	CLM	1.0-2.0	0.1	1.0

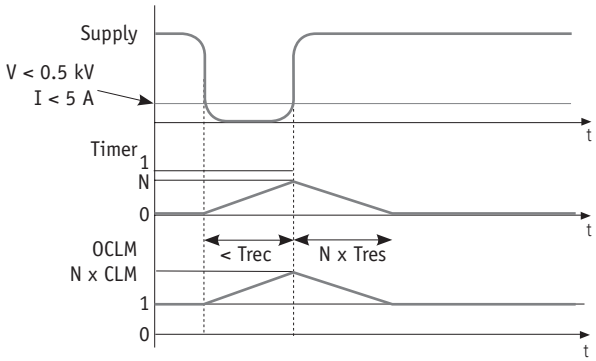
OCLM is recalculated every cycle and is applicable for OC1 and OC2 elements.

Operation of the CLP element is illustrated in the diagram 5 below.

Cold Load Pickup when Loss of Supply is longer than the cold load recognition time



Cold Load Pickup when Loss of Supply is shorter than the cold load recognition time



CLM *cold load multiplier*
OCLM *operational cold load multiplier*
Tres *cold load reset time*

Trec *cold load recognition time*
N *CLP timer reading when supply is restored*

Diagram 5 ***Operation of Cold Load Pickup Element***

Phase Overcurrent (OC)

This element provides protection against 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 Overcurrent Reclosing element (Instanteneous I; Delayed D).

OC2 Phase overcurrent low set element OC2 is designated to provide instantaneous trips. If sequence step in Overcurrent Reclosing Element is set "D" (Delayed) OC2 element is disabled. If sequence step in Overcurrent Reclosing element is set "I" (Instanteneous) OC2 element is enabled.

Low set elements can be modified with CLP element.

The operation of the low set elements OC1 and OC2 (radial feeder) can be described as follows: It starts timing up the Tripping time Tt defined by the time current characteristic TCC curves, when the phase current exceeds the Pickup Current value Ip multiplied by the Operational Cold Load Multiplier OCLM. When this time expires and the phase current still exceeds a dropout value, the low set overcurrent element initiates a trip request to the driver to open the recloser. If the phase current is lower than the dropout value[1)] whilst the timer is active, then the element starts counting down the reset time Tres after which this element becomes passive again (refer to description of TCC for details).

OC1 and OC2 are blocked when the following communication signals are activated:
· Hot Line On
· Protection Off

OC2 can also be blocked by the AR OC element if it is executing a delayed (D) trip sequence step.

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

High set element is not affected by CLP.

The operation of the high set element OC3 (radial feeder) can be described as follows: It starts timing up the user set Tripping time Tt when the phase current exceeds the Pickup current value Ip. When this time expires and the phase current still exceeds the Pickup current value Ip, OC3 initiates a trip request to the driver to open the recloser.

OC3 is blocked when the following communication signals are activated:
· Hot Line On
· Protection Off

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 Forward (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 Overcurrent Reclosing element (Instanteneous I; Delayed D).

EF2 Earth fault low set element EF2 is designated to provide instantaneous trips. If sequence step in Overcurrent Reclosing Element is set "D" (Delayed) EF2 element is disabled. If sequence step in Overcurrent Reclosing element is set "I" (Instanteneous) EF2 element is enabled.

Earth fault elements are not affected by CLP.

The operation of the low set elements EF1 and EF2 (radial feeder) can be described as follows: It starts timing up the Tripping time Tt defined by the time current characteristic TCC curves, when the residual current In exceeds the Pickup Current value Ip. When this time expires and the residual current still exceeds the dropout value [1)], low set element initiates a trip request to the driver to open the recloser. If the residual current is lower than the dropout value whilst the timer is active, then the element starts counting down the reset time Tres after which this element becomes passive again.

EF1 and EF2 are blocked when the following local and remote communication signals are activated:
· Hot Line On
· Protection Off
· Earth Fault Off

EF2 can also be blocked by the AR OC element if the latter is executing a delayed (D) trip sequence step.

EF3 Earth fault high set instantaneous element provides protection against high earth current faults with reduced number of trips to lockout. If there is no intention to reduce the number of trips to lockout at high current faults enabling of this element is not recommended. TCC applied for EF1 and EF2 allows reduction of tripping time to any desired value at high currents. Like OC3 this element is also generally not applied for downstream recloser and for systems with resistively earthed neutral.

The operation of the high set element EF3 can be described as follows: It starts timing up the user set Tripping time Tt, when the residual current In exceeds the Pickup current value Ip. When this time expires and the residual current still exceeds the Pickup current value, EF3 initiates a trip request to the driver to open the recloser.

EF3 is blocked when the following communication signals are activated:
· Hot Line On
· Protection Off
· Earth Fault Off

Settings for Low Set Elements (OC1, OC2, EF1, EF2):
The following Time Current Characteristics (TCC) can be selected independently for the low set elements.

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)** **TEL:** TEL Inverse (TEL I), TEL Auto-Coordinated (TEL A) **Custom:** on request custom curves are available. Please contact your local Tavrida Electric representative.	TD

12 selected curves can be uploaded to recloser control using TELARM configuration software.

For time current characteristic settings refer to the TCC description later in this chapter.

Settings for High Set Elements (OC3, EF3):
The following settings can be selected independently for the high set elements.

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

Note: [1)] The lower value of either 95% of Pickup Current value (Ip) multiplied by the Operational Cold Load Multiplier (OCLM) or Ip multiplied by the OCLM minus 1A.

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 differently for each trip in a sequence. If the fault still exists the recloser will trip again under protection. This will happen 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 not reclose automatically anymore. This is known as lockout and the recloser can only be closed by local or remote operator command, which clears the lockout condition.
To control the number of trips to lockout in a reclosing sequence, the number has to be set. It can be selected individually for low set (Nt) and high set (Nhs) protection elements, while Nhs cannot exceed Nt. If the high set elements (OC3, EF3) are enabled they can initiate trip during the whole reclosing sequence defined by Nt. But only for trips 1...Nhs-1 it could be the trip to reclose.

Finally the reclosing sequence (Seq) has to be selected. The Seq setting consists of i=1...Nt characters. Seq[i]="I" means that the corresponding trip in sequence is set instantaneous, Seq[i]="D" means that it is set to delayed. Each character enables or disables the operation of instantaneous (OC2, EF2) elements on the corresponding step in sequence (counting characters from the left to the right).

Reclosing will be made only if the voltage from source side of reclosers (recloser is open) meets the requirements of VRC element. Otherwise, recloser will not reclose and indicate "Reclosing suspended by VRC" in the Event log. If the voltage did not recover until Autoreclosing timeout is expired (see section Autoreclosing timeout), the recloser will go to lockout, see also Scenario 4.

AR OC element settings for Recloser type = Radial:

Setting	Designation	Range	Resolution	Default
Number of trips to lockout	Nt	1/2/3/4	n.a.	4
Number of highset trips to lockout	Nhs	1/2/3/4	n.a.	1
Reclosing sequence	Seq	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	n.a.	IIDD
First closure mode *	SST	Normal/Accelerate/Decelerate	n.a.	Normal
First reclose time	Tr1	0.10-180.00 s	0.01 s	1.00 s
Second reclose time	Tr2	1.00-1800.00 s	0.01 s	10.00 s
Third reclose time	Tr3	1.00-1800.00 s	0.01 s	30.00 s
Reset time	Tres	1-180 s	1s	1s
Zone sequence coordination mode *	ZSC mode	Enable/Disable	n.a.	Enable

AR OC element settings for Recloser type = Ring:

Setting	Designation	Range	Resolution	Default
Number of trips to lockout +	Nt +	1/2/3/4	n.a.	4
Number of highset trips to lockout +	Nhs +	1/2/3/4	n.a.	1
Reclosing sequence +	Seq +	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	n.a.	IIDD
First closure mode + *	SST +	Normal/Accelerate/Decelerate	n.a.	Normal
First reclose time +	Tr1 +	0.10-180.00 s	0.01 s	1.00 s
Second reclose time +	Tr2 +	1.00-1800.00 s	0.01 s	10.00 s
Third reclose time +	Tr3 +	1.00-1800.00 s	0.01 s	30.00 s
Reset time +	Tres +	1-180 s	1s	1s
Zone sequence coordination mode + *	ZSC mode	Enable/Disable	n.a.	Enable
Number of trips to lockout -	Nt -	1/2/3/4	n.a.	4
Number of highset trips to lockout -	Nhs -	1/2/3/4	n.a.	1

Setting	Designation	Range	Resolution	Default
Reclosing sequence -	Seq -	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	n.a.	IIDD
First closure mode - *	SST -	Normal/Accelerate/Decelerate	n.a.	Normal
First reclose time -	Tr1 -	0.10-180.00 s	0.01 s	1.00 s
Second reclose time -	Tr2 -	1.00-1800.00 s	0.01 s	10.00 s
Third reclose time -	Tr3 -	1.00-1800.00 s	0.01 s	30.00 s
Reset time -	Tres -	1-180 s	1s	1s
Zone sequence coordination mode - *	ZSC mode	Enable/Disable	n.a.	Enable

* - settings available only in firmware version 2.49 and higher.

Single shot to lockout algorithm is supported by the AR OC element.

The operation of the element for single shot can be described as follows:
After the first close, the AR OC element starts timing up the reset time. If a fault occurred before this time expires, corresponding overcurrent element starts timing up its tripping time and prevents the timer of AR OC from counting the reset time. If the fault is still present after tripping time expires, a trip request is sent to the driver to make a single shot to lockout independent of which number of trips to lockout is set (see the diagram Single shot to lockout). If no fault was sensed or the fault disappeared during the reset time, the element gets passive after this time expires and can perform set autoreclosing sequence (see diagram Successful first closing).

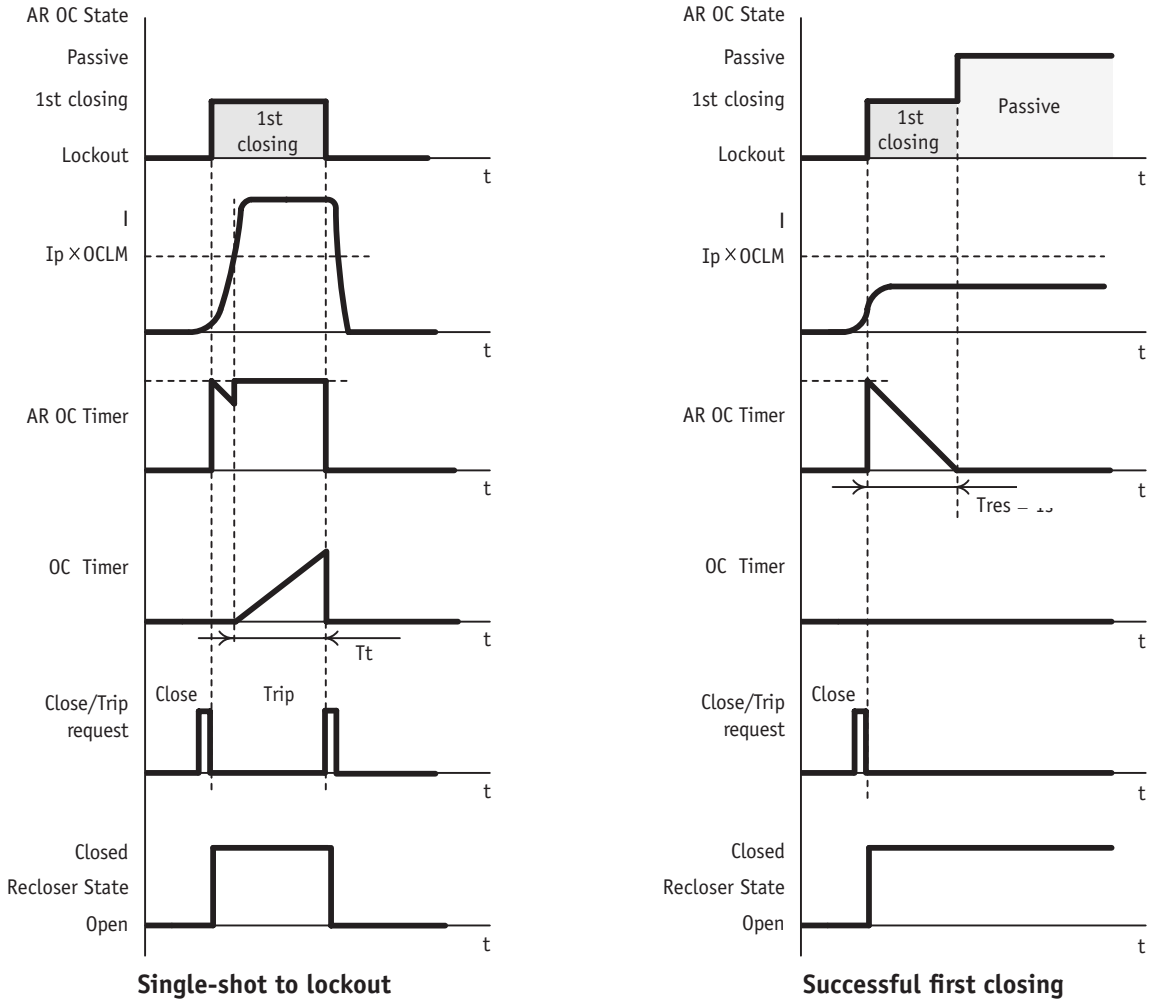


Diagram 6

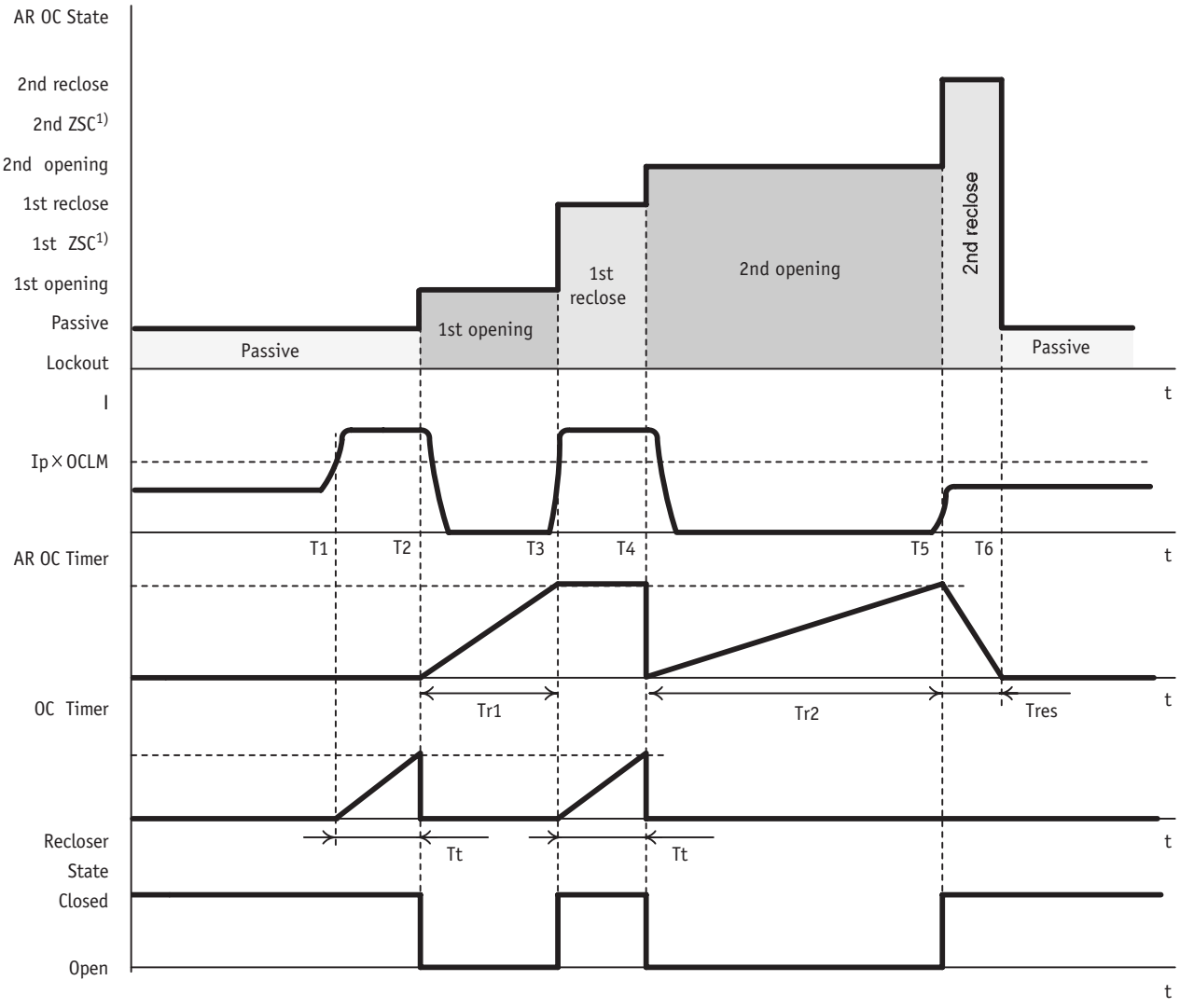
Single shot to lockout algorithm of AR OC element

The functionality of the element is described below for several particular scenarios.

Scenario 1: Appearance of a transient fault

A sequence of events could occur when a transient short circuit fault appears. Here it is assumed that the number of trips to lockout is set 4 and the second reclosing cleared the fault.

Initially the AR OC element is passive and can perform the user set reclosing sequence. The fault is sensed by overcurrent or earth fault elements (OC1, OC2, OC3, EF1, EF2, EF3) at time T1 (see the diagram below). After tripping time of corresponding protection element expires it trips the recloser (time T2). AR OC element proceeds to trip to reclose (first opening) and starts timing up first reclose time. After this time expires AR OC closes the recloser (time T3, first reclosure). As the fault is still present, the corresponding protection element starts timing up its tripping time, thus preventing AR OC from resetting. After the protection element initiated trip (time T4, third opening), the AR element starts timing up the second reclose time. After this time expires, the AR OC closes the recloser to the healthy line (time T5, second reclosure). As no fault is sensed by the protection elements, the AR OC starts timing up the reset time. After expiration of the reset time (time T6) the AR OC becomes passive and the recloser is ready to provide the user set reclosing sequence again.



Successful reclosing

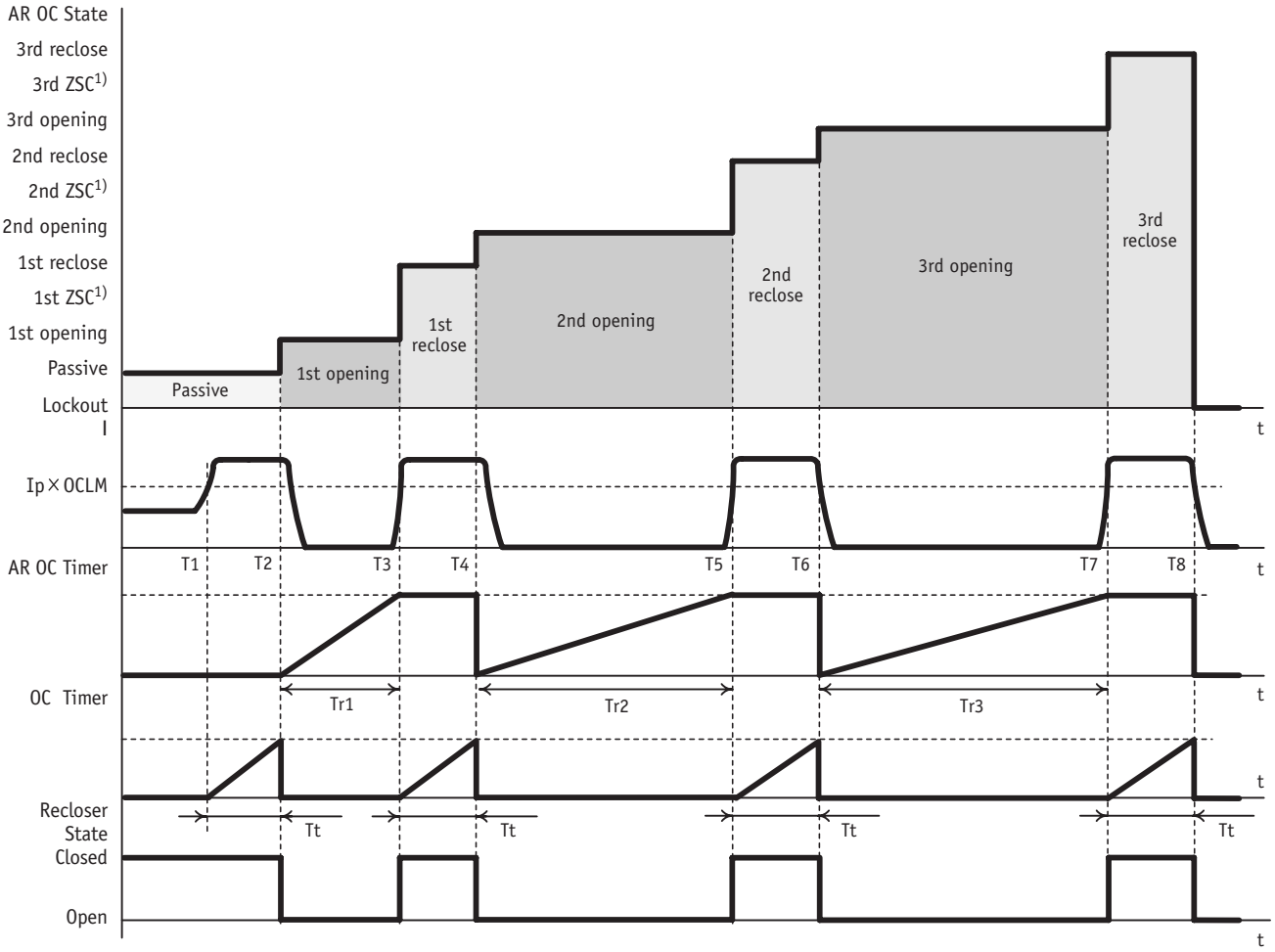
Diagram 7

1) ZSC = Zone Sequence Coordination; Refer to Scenario 3 for description of ZSC.

Scenario 2: Appearance of a permanent fault

It is assumed that the settings are the same as for Scenario 1: the number of trips to lockout is set 4. In this case the permanent fault appears in the line.

When the permanent fault appears, corresponding elements of the recloser act the same way as in Scenario 1 up to the moment T5 (see diagram Unsuccessful reclosing). Since after the second reclosing the fault is still present, the corresponding overcurrent element will trip the recloser after tripping time of this element expires (time T6, third opening). The AR OC starts timing up the third reclose time and after the timer expires it closes the recloser (time T7, forth closing). Since the fault is still present, the recloser will trip to lockout (open to lockout) after tripping time of corresponding overcurrent element expires (time T8).



Unsuccessful reclosing

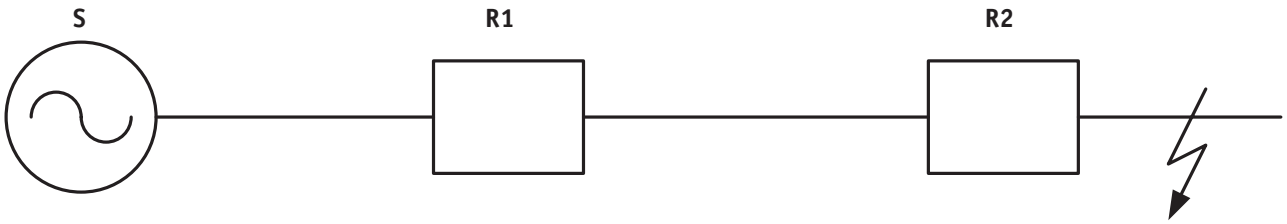
Diagram 8

Scenario 3: Zone Sequence Coordination

The AR OC also provides Zone Sequence Coordination (ZSC). ZSC causes 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.

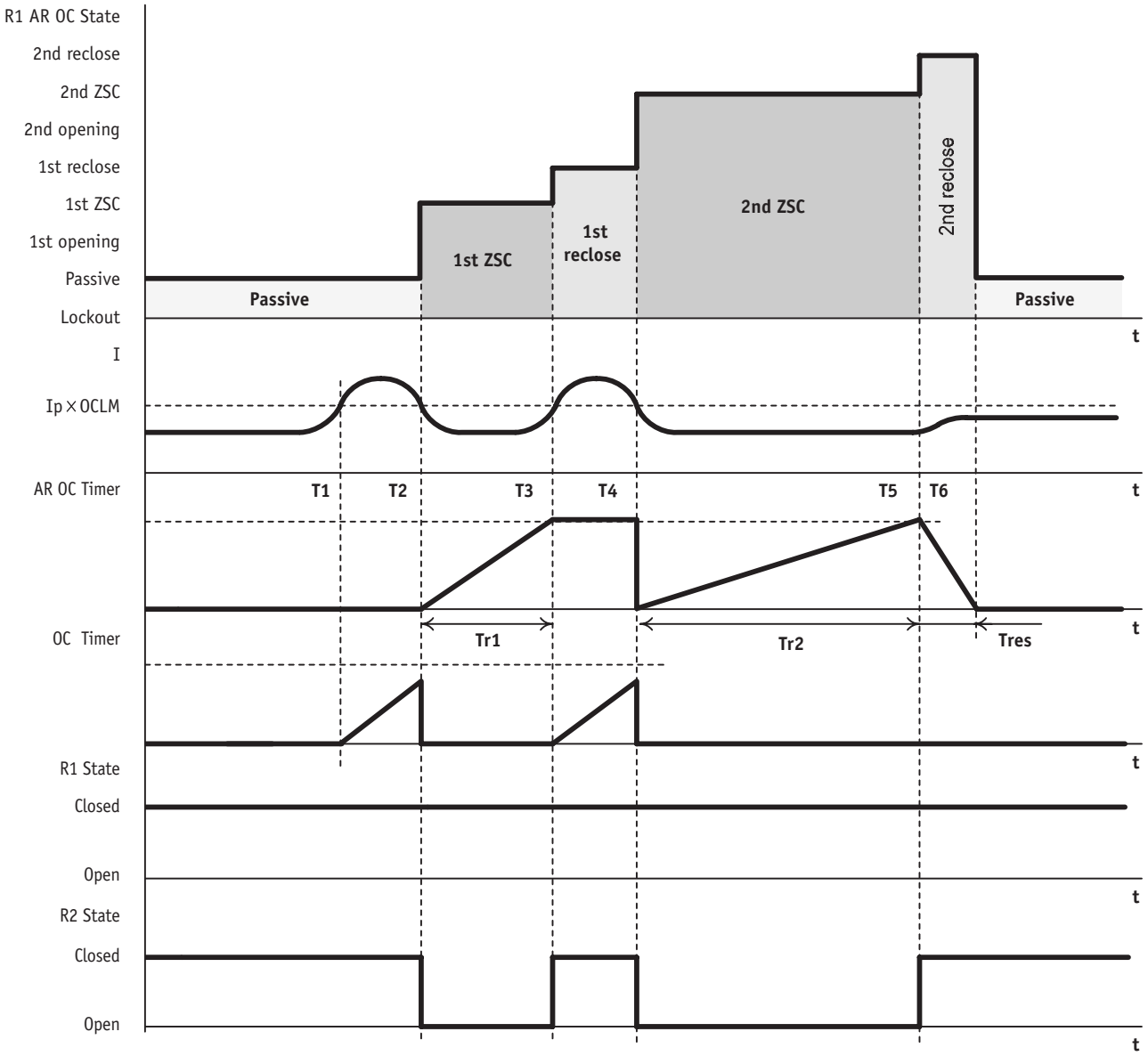
A simple radial line sectionalized with two recloser is presented in the figure below. ZSC is applied for the upstream recloser R1 and is not applicable for the downstream recloser R2.

It is assumed that: .
- a transient short circuit fault appears below the downstream recloser
- the number of trips to lockout is set to 4 for both recloser
- the second reclosure of downstream device cleared the fault
- reclosing times are set equal for both reclosers



In this case the operation of the downstream recloser R2 is similar to the one given in Scenario 1. The operation of R1 with applied ZSC algorithm can be described as follows:

Initially the AR OC elements of both reclosers are passive. The fault is sensed by both reclosers at time T1 (see the diagram below). After tripping time of the corresponding protection element of R2 expires it trips the recloser (time T2). At this moment R1 initiates the dropout event because the current and/or time grade is used to coordinate the recloser. The AR OC element of R1 initiates the first zone sequence coordination and (simultaneously with R2) starts timing up the first reclose time, as if it made trip to reclose. After this time expires, R2 closes the recloser (time T3, first reclosure). At the same time AR OC of R1 attempts to count the reset time (as its first reclose time expires), as if it made first reclosure. As the fault is still present, corresponding protection elements of R1 and R2 start timing up their tripping time, thus preventing AR OC elements (of both R1 and R2) from resetting. After this time expires the protection element of R2 initiates the trip (time T4, second opening).
At the same time AR OC element of R1 initiates a second zone sequence coordination due to the dropout event and starts timing up the second reclose time simultaneously with R2. After this time expires, R2 closes to the healthy line (time T5, second reclosure). At the same time AR OC of R1 behaves as if it made second reclosure. Because no fault is sensed by both reclosers, their AR OC elements start timing up the reset time. After expiration of the reset time (time T6) the AR OC elements of both recloser become passive.



Zone Sequence Coordination

Diagram 9

ZSC can be enabled or disabled by adjusting according setting of AROC element.

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 a trip to lockout. An independent definite time can be selected for each. Enabling the HL element automatically disables any automatic reclosing. Close command from any source is blocked when HL is On.

HLOC element settings for Recloser type = Radial:

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

HLOC element settings for Recloser type = Ring:

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

HLEF element settings for Recloser type = Radial:

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

HLEF element settings for Recloser type = Ring:

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

The operation of HLOC (radial feeder) can be described as follows: It starts timing up the user set Tripping time Tt, when the phase current exceeds the Pickup current value Ip. When this time expires and the phase current still exceeds the Pickup current value, HLOC initiates a trip request to the driver to open the recloser.

The operation of HLEF (radial feeder) can be described as follows: It starts timing up the user set Tripping time Tt, when the residual current In exceeds the Pickup current value Ip. When this time expires and the residual current still exceeds the Pickup current value, HLEF initiates a trip request to the driver to open the recloser.

The element is blocked when the following communication signals are activated:
· Hot Line Off
· Protection Off

Sensitive Earth Fault (SEF)

This element provides protection against resistive earth faults.

SEF element settings for Recloser type = Radial:

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

SEF element settings for Recloser type = Ring:

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

The operation of the element (radial feeder) can be described as follows: It starts timing up the user set Tripping time Tt, when the residual current exceeds the Pickup current value Ip. When this time expires and the residual current still exceeds the Pickup current value, SEF initiates a trip request to the driver to open the recloser.

The element is blocked when the following communication signals are activated:
· Hot Line On
· Protection Off
· Earth Fault Off

Sensitive Earth Fault Reclosing (AR SEF)

This element provides reclosing initiated by SEF element. It also supports single shot to lockout and logical reset functionality.

AR SEF element settings for Recloser type = Radial:

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

AR SEF element settings for Recloser type = Ring:

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

The operation of AR SEF is similar to that of AR OC element including Scenarios 1 and 2.
ZSC is not applicable for AR SEF.

The element also proceeds to open to lockout when the following communication signals are activated:
· Hot Line On
· Protection Off
· Auto Reclose Off

Voltage Unbalance (VU)

This element provides protection of sensitive load against upstream broken wire. It is generally applied when the upstream device cannot provide relevant protection. Otherwise it is generally disabled.

VU element settings for Recloser type = Radial:

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

VU element settings for Recloser type = Ring:

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

The operation of the element (radial feeder) can be described as follows: It starts timing up the user set Tripping time Tt when the calculated Negative Sequence Voltage (U2) exceeds the Voltage Unbalance setting Uu multiplied by measured Positive Sequence Voltage (U1). When this time expires and U2 still exceeds the dropout value, VU initiates a trip request to the driver to open the recloser.

The element is blocked when the following communication signals are activated:
· Protection Off

It is also blocked by the OCR and SEFR protection elements.

Current Unbalance (CU)

This element provides protection against downstream broken wire. It is generally applied for protection of three phase loads sensitive to current unbalance, for example, electrical motors.

CU element settings for Recloser type = Radial:

Setting	Designation	Range	Resolution	Default
Operating mode	Mode	Enable/Disable	n.a.	Disable
Current unbalance	Iu	0.60-1.00	0.01	0.80
Tripping time	Tt	0.10-300.00 s	0.01 s	10.00 s

CU element settings for Recloser type = Ring:

Setting	Designation	Range	Resolution	Default
Operating mode +	Mode +	Enable/Disable	n.a.	Disable
Current unbalance +	Iu +	0.60-1.00	0.01	0.80
Tripping time +	Tt +	0.10-300.00 s	0.01 s	10.00 s
Operating mode -	Mode -	Enable/Disable	n.a.	Disable
Current unbalance -	Iu -	0.60-1.00	0.01	0.80
Tripping time -	Tt -	0.10-300.00 s	0.01 s	10.00 s

The operation of the element (radial feeder) can be described as follows: It starts timing up the user set Tripping time Tt when the negative sequence current I2 exceeds the positive sequence current I1 multiplied by the Current Unbalance setting Iu. When this time expires and the negative sequence current still exceeds the dropout value, CU initiates a trip request to the driver to open the recloser.

The element is blocked when the following communication signals are activated:
· Protection Off

It is also blocked by the OCR, VU and SEFR protection elements.

Voltage Reclosing Control (VRC)

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

The operation of the element (radial feeder) can be described as follows: It becomes active (power fail) when any parameter of voltage on source side bushings of the OSM does not meet the requirements set in VRC element. It becomes passive (power good) when voltage parameters are within the requirements set in VRC element.

For more flexibility every high voltage power supply parameter checked by VRC element can be enabled/disabled (see the settings table below).

VRC element settings for Recloser type = Radial:

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	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

VRC element settings for Recloser type = Ring:

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

Setting	Designation	Range	Default
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+	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-	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 protection against low source voltage.

UV element settings for Recloser type = Radial:

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	Tt	0.10-100.00 s	0.01 s	10.00 s

UV element settings for Recloser type = Ring:

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

The operation of the element (radial feeder) can be described as follows: It starts timing up the user set tripping time Tt when the positive sequence voltage measured from Source + side (U1+) is less than the phase voltage multiplied by Pickup voltage multiplier (Up). When this time expires and U1+ still exceeds the dropout value, UV initiates a trip request to the driver to open the recloser.

The element is blocked when the following communication signals are activated:
· Protection Off

It is also blocked by the OCR, VU and SEFR protection elements.

Undervoltage Reclosing (AR UV)

This element provides reclosing initiated by UV element. It also provides single shot to lockout functionality to avoid multiple reclosing in case of incorrect coordination of pickup or settings of VRC and UV elements.

AR UV element settings for Recloser type = Radial:

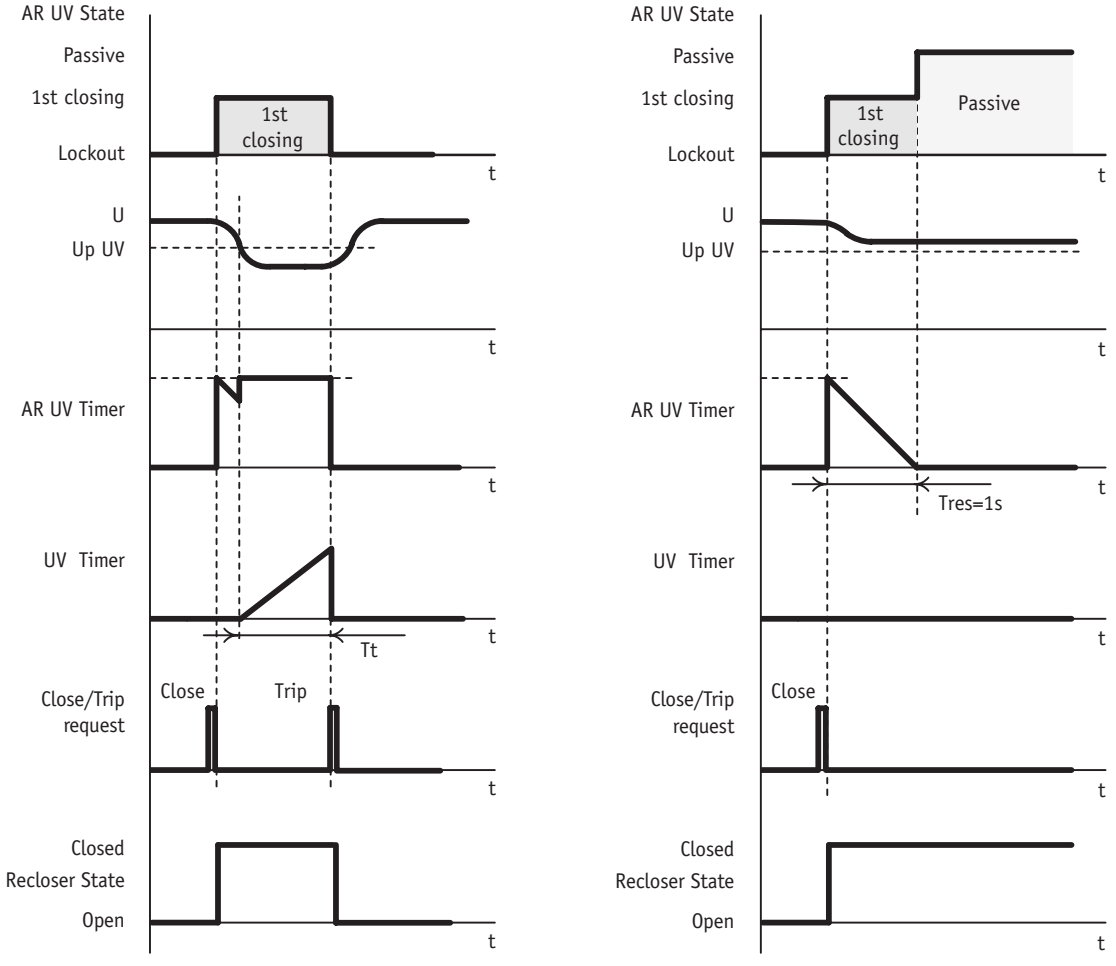
Setting	Designation	Range	Resolution	Default
Number of trips to lockout	Nt	1/2	n.a.	1
Reclose time	Tr	0.10-180.00 s	0.01 s	10.00 s

AR UV element settings for Recloser type = Ring:

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

Single shot to lockout algorithm is supported by AR UV element.

The operation of this algorithm can be described as follows:
After initial closing the AR UV element goes to state “1st closing” and starts timing up the reset time (1 second). If the system voltage dropped below the pickup level of UV element before this time expires, UV element starts timing up its tripping time and prevents the timer of AR UV from counting the reset time. If the low system voltage is still present after tripping time expires, the recloser will make a single shot to lockout even if the number of trips to lockout is set 2 (see the diagram Single shot to lockout). If low source voltage was not sensed during the reset time, the AR UV element becomes Passive after this time expires and can make reclosing (see diagram Successful first closing).



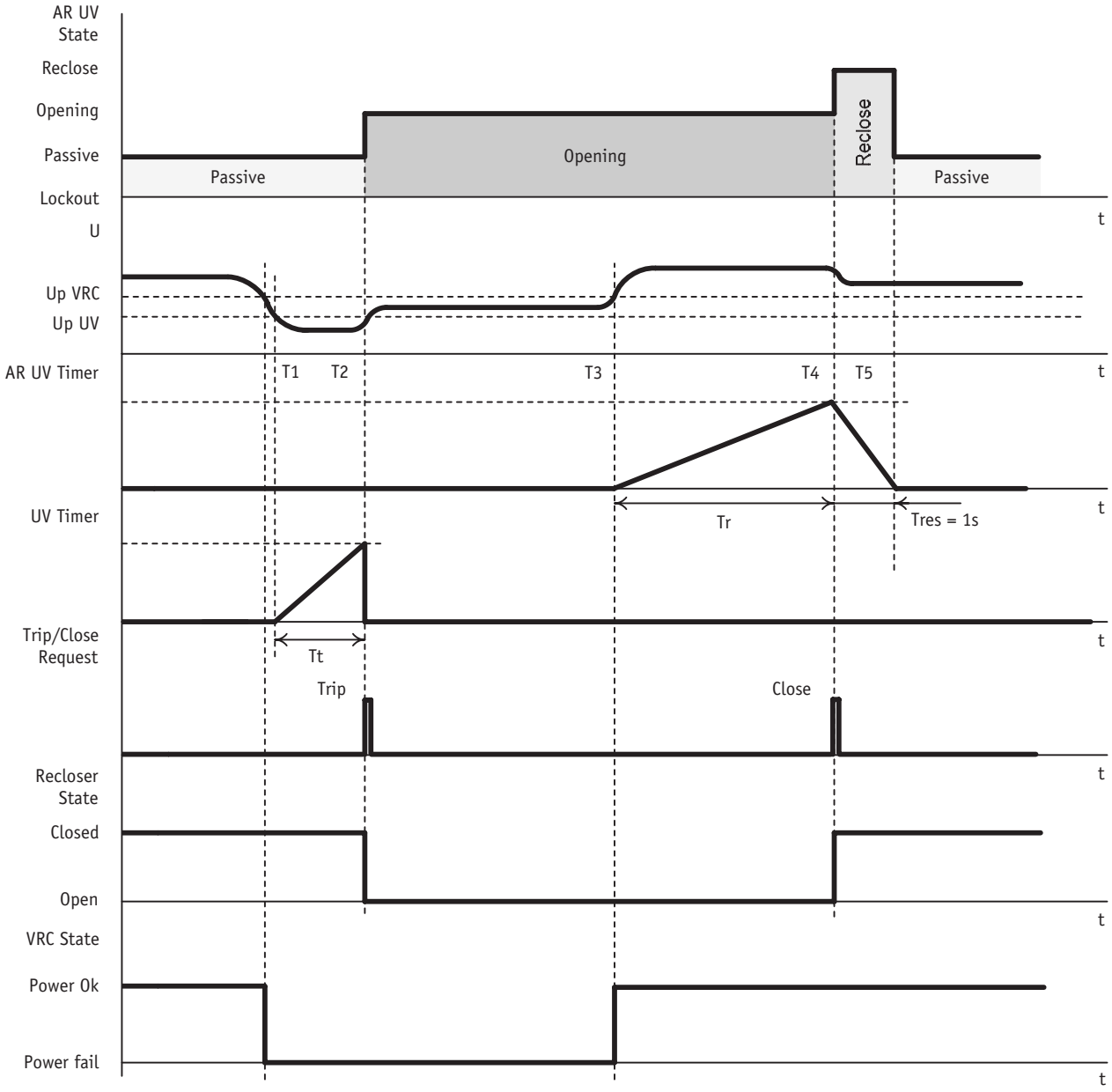
AR UV Single-shot to lockout **AR UV Successful first closing**

Diagram 10

Scenario 1. Successful AR UV reclosing.

It is assumed that the number of trips to lockout is set 2 and the reclosing does not lead to system voltage drop below the pickup level of UV element.

Originally AR OC element is passive and can provide the complete user set autoreclosing sequence. The system voltage drops below the UV pickup level (Up UV) at the time T1 (see the diagram below). After the tripping time of the UV element expires it trips the recloser. AR UV element proceeds to trip to reclose state (time T2, first opening), and waits until Voltage reclosing control element allows reclosing. As soon as VRC element detects high quality power supply (time T3), AR UV starts timing up the reclose time Tr. After this time expires AR UV closes the recloser (time T4, reclosure). As the system voltage after closing exceeds the pickup level of UV element, AR UV starts timing up the reset time (1 second). When this time expires and system voltage still exceeds Up of UV, the AR UV becomes passive (time T5) and is ready to provide the complete autoreclosing sequence again.



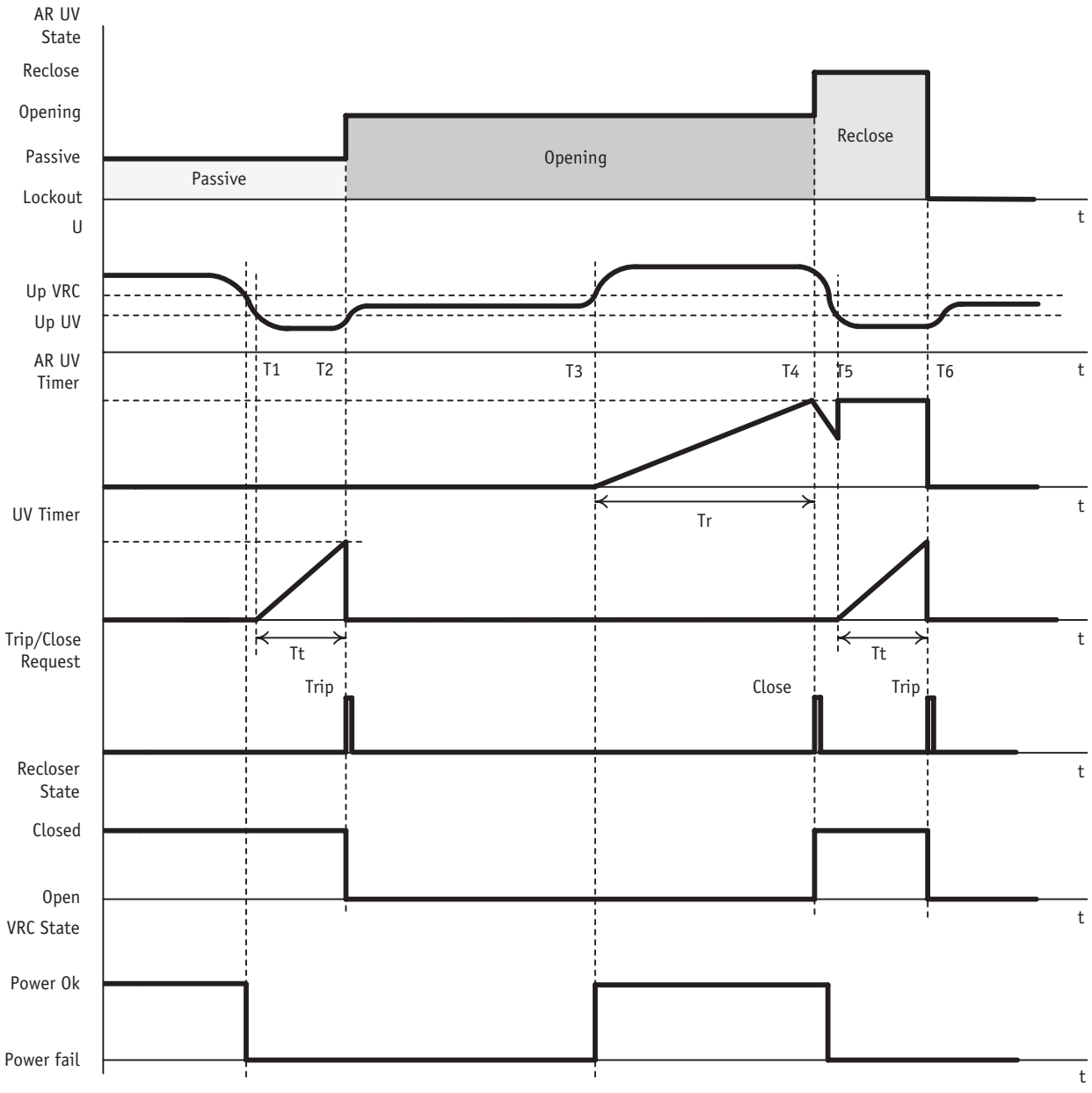
AR UV Successful reclosing

Diagram 11

Scenario 2. Unsuccessful AR UV reclosing.

It is supposed that the number of trips to lockout is set 2 and the reclosing results in system voltage drop below the pickup level of UV element.

In this case UV and UV AR elements act the same way as in Scenario 1 up to the moment T4 (see diagram AR UV unsuccessful reclosing). Because after reclosing the system voltage drops below the pickup level of UV element, this element starts timing up tripping time (time T5) and prevents AR UV from resetting. When this time expires and the system voltage is still below the pickup level of UV element, the recloser trips to lockout (time T6).



AR UV Unsuccessful reclosing

Diagram 12

The element also proceeds to open to lockout when the following communication signals are activated:

· Hot Line On
· Protection Off
· Auto Reclose Off

Overvoltage (OV)

This element provides protection against high source voltage. Overvoltage element is available in firmware versions 2.50 and higher.
OV element settings for Recloser type = Radial:

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	Tt	0.10-100.00s	0.01s	10.00

OV element settings for Recloser type = Ring:

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

The operation of the element (radial feeder) can be described as follows: It starts timing up the user set tripping time Tt when the positive sequence voltage measured from Source + side (U1+) is greater than the phase voltage multiplied by Pickup voltage multiplier (Up). When this time expires and U1+ still exceeds the dropout value, OV initiates a trip request to the driver to open the recloser.

The element is blocked when the following communication signals are activated:

· Protection Off

Overvoltage reclosing (AR OV)

This element provides reclosing initiated by UV element. It also provides single shot to lockout functionality to avoid multiple reclosing in case of incorrect coordination of pickup or settings of VRC and OV elements. Overvoltage element is available in firmware versions 2.50 and higher.
AR OV element settings for Recloser type = Radial:

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

AR OV element settings for Recloser type = Ring:

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

Single shot to lockout algorithm is supported by AR OV element.

The operation of this algorithm can be described as follows:

After initial closing the AR OV element goes to state “1st closing” and starts timing up the reset time (1 second).

If the system voltage exceeds the pickup level of OV element before this time expires, OV element starts timing up its tripping time and prevents the timer of AR OV from counting the reset time. If the high system voltage is still present after tripping time expires, the recloser will make a single shot to lockout even if the number of trips to lockout is set 2. If high system voltage was not sensed during the reset time, the AR OV element becomes Passive after this time expires and can make reclosing.

Underfrequency (UF)

This element provides protection against low system frequency. It is generally applied for under-frequency shedding.

UF element settings for Recloser type = Radial:

Setting	Designation	Range	Resolution	Default
Operating mode	Mode	Enable/Disable	n.a.	Disable
Pickup frequency	Fp	45.00-50.00 Hz for rated frequency=50 Hz 55.00-60.00 Hz for rated frequency=60 Hz	0.01 Hz	45.00 Hz 55.00 Hz
Tripping time	Tt	0.10-180.00 s	0.01 s	1.00 s

UF element settings for Recloser type = Ring:

Setting	Designation	Range	Resolution	Default
Operating mode +	Mode +	Enable/Disable	n.a.	Disable
Pickup frequency +	Fp +	45.00-50.00 Hz for rated frequency=50 Hz 55.00-60.00 Hz for rated frequency=60 Hz	0.01 Hz	45.00 Hz 55.00 Hz
Tripping time +	Tt +	0.10-180.00 s	0.01 s	1.00 s
Operating mode -	Mode -	Enable/Disable	n.a.	Disable
Pickup frequency -	Fp -	45.00-50.00 Hz for rated frequency=50 Hz 55.00-60.00 Hz for rated frequency=60 Hz	0.01 Hz	45.00 Hz 55.00 Hz
Tripping time -	Tt -	0.10-180.00 s	0.01 s	1.00 s

The operation of the element (radial feeder) can be described as follows: It starts timing up the user set Tripping time Tt when the Frequency measured from Source + side (F+) is less than the Pickup Frequency Fp. When this time expires and F+ still exceeds the dropout value, UF initiates a trip request to the driver to open the recloser.

The element is blocked when the following communication signals are activated:
· Protection Off

It is also blocked by the OCR, VU and SEFR protection elements.

Underfrequency Reclosing (AR UF)

This element provides reclosing initiated by UF element. It also provides single shot to lockout functionality to avoid multiple reclosing in case of incorrect coordination of voltage pickup, settings of VRC and UF elements.

AR UF element settings for Recloser type = Radial:

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

AR UF element settings for Recloser type = Radial:

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

The basic operation of the element can be described as follows:

A Trip Request is received from the UF element and subsequently the recloser opens and the driver signals that it has opened. If the number of trips to lockout Nt=1, then the recloser is in Open to Lockout. If Nt=2, a timer is activated for the duration of the Closing time Tr. When this time expires, the recloser will close and a timer is activated for one second. In the majority of cases, the fault will have been cleared. The AR UF element then becomes passive. If the fault is still present, then the AR UF proceeds to Open to Lockout.

First closing for recloser:
This is the initial closed position of the recloser. It remains in this condition whilst a timer is activated for one second and then proceeds to passive. If however the recloser is tripped due to a fault or due to a communication signal, the ARUF will proceed to Open to Lockout.

The element also proceeds to Open to Lockout when the following communication signals are activated:
· Hot Line On
· Protection Off
· Auto Reclose Off

Automatic Backfeed Restoration (ABR)

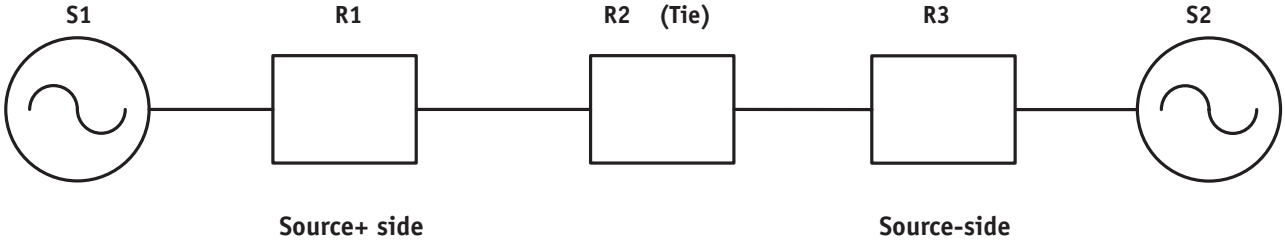
Automatic Backfeed Restauration is used to automatically close a normally open recloser if it detects a source (via SD element) on the alternative source side. This allows the recloser to be used as a tie point in an automation system.

This element is only applicable for ring line recloser type and provides automatic backfeed restoration when relevant conditions are met.

ABR element settings:

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

The operation of the element (radial feeder) can be described as follows:



It is supposed that two sources are presented in the line (see the figure above). The Operation mode of ABR element of tie recloser R2 is set “Both”.

Under normal operation where power supply is provided from designated sources, a tie recloser R2 will be in normal open position. In this case the SD element cannot detect the presence of Source because both Sources are present (see the diagram below). When for example the recloser R1 trips to lockout, the SD element senses the presence of the Source- (time T1). After the VRC element detects the presence of high quality power supply from Source- side, it goes to “Power Ok” state and allows the operation of ABR element (time T2). The ABR element starts timing up the set Restoration time Tr-. When this time expires, the Source+ has not been returned and VRC is still in Power Ok state, ABR initiates a close request to the driver to close the recloser (time T3).

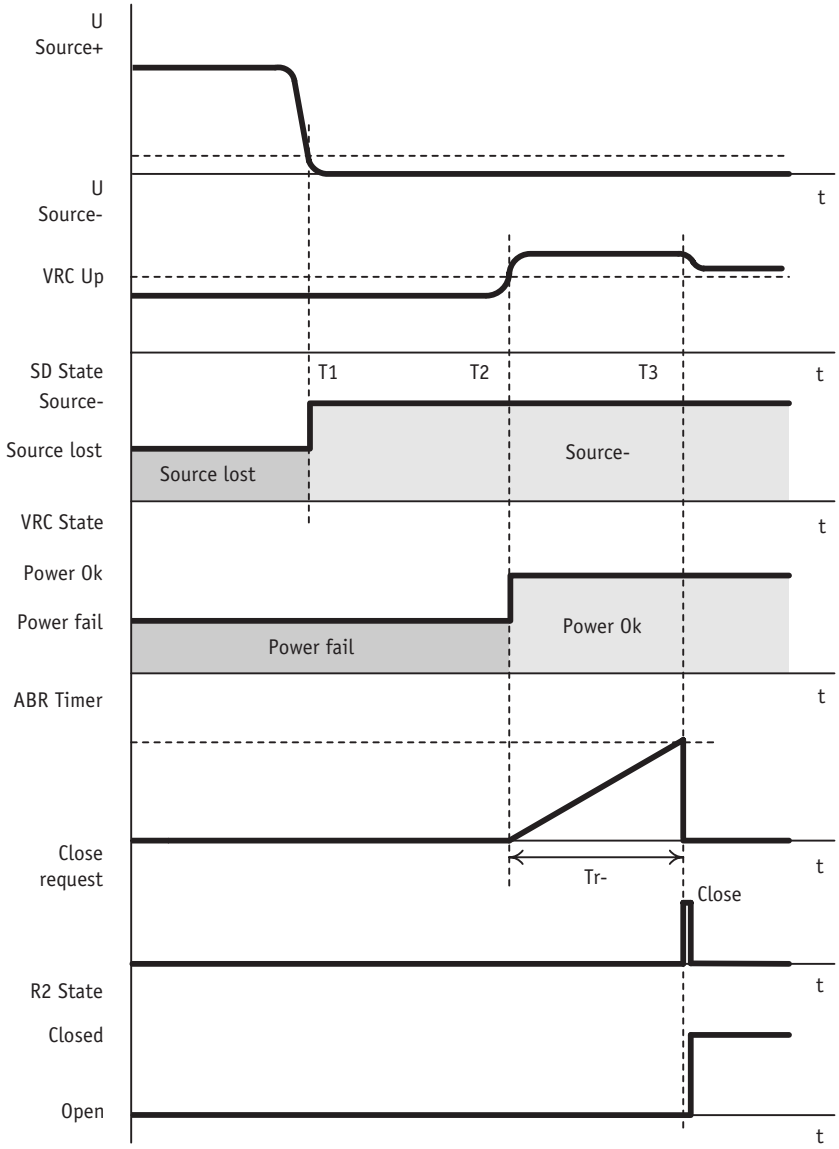


Diagram 13

Automatic Backfeed Restoration

The element is blocked when the following Communication signals are activated:

· Protection Off
· Hot Line On
· Auto Reclose Off

It is also blocked by the SD and VRC protection elements.

Time Current Characteristics

The TCC define the trip and reset times as functions of input current.
As some types of TCC are only defined on limited intervals of current values the following assumptions are made:

- if input current is lesser than minimum current for which the TCC function is defined then minimum current value is used for time calculations;
- if input current is higher than maximum current for which the TCC function is defined then maximum current value is used for time calculations.

Definite Time (TD)

This TCC consists of one section as shown in Fig. 50.

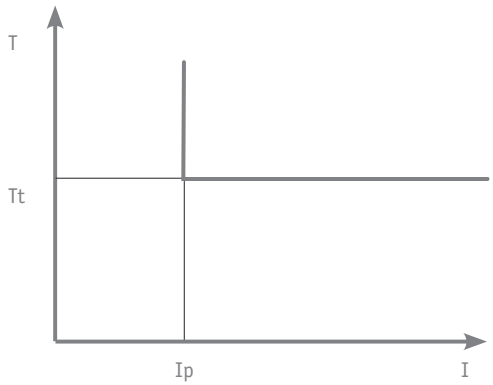


Figure 50
Appearance of TD

TD is provided with instantaneous reset timer.
The following settings are applicable for element equipped with TD.

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

These parameters can be changed either with the aid of direct dialling or with the aid of TELARM graphical interface.

TEL Inverse (TEL I)

This TCC consists in general case of three inverse sections as shown in Fig. 51.

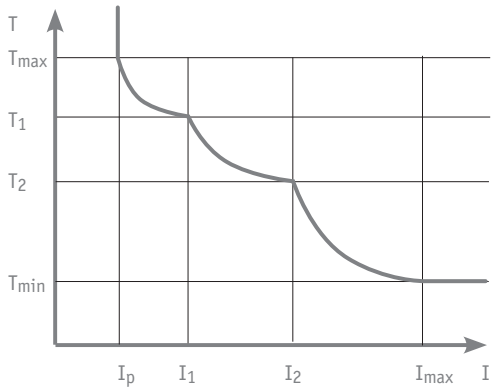


Figure 51
Appearance of TEL I with three sections

Where I_p, I_1, I_2, I_{max}, T_{min}, T_1, T_2, T_{max} - TCC settings (refer to the table below). Each section is described with the following parameters (Fig. 52):

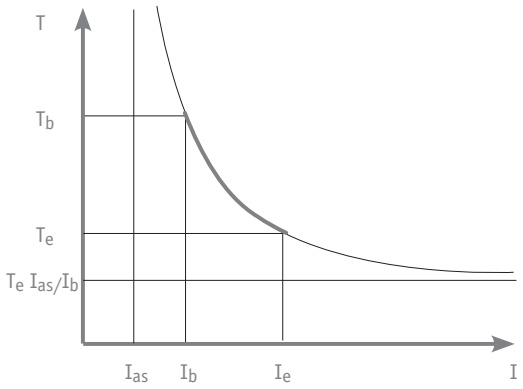


Figure 52
Appearance of each section of TEL I

Where I_{as} - asymptote current, I_b, T_b - current and time corresponding to the beginning of the particular section, I_e, T_e - current and time corresponding to the end of the particular section, T_m, n - constants (refer also to the settings description). T_m, n are determined on the basis of T_b, T_e, I_b, I_e, I_{as} .

When I_{as} is set to minimum possible value (10A) curvature of the section will be minimum. It will increase with I_{as} approaching I_b (Refer to Fig. 53).

5

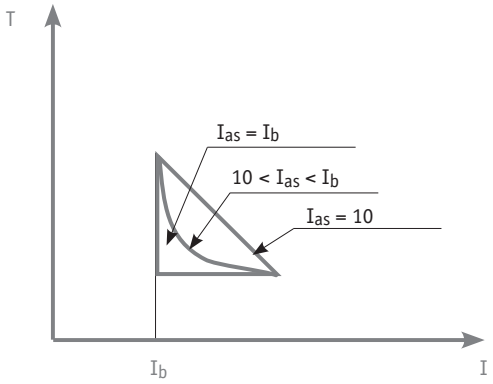


Figure 53
Effect of I_{as} on section shape

If number of sections equals 2, appearance of TEL I complies with Fig. 54.

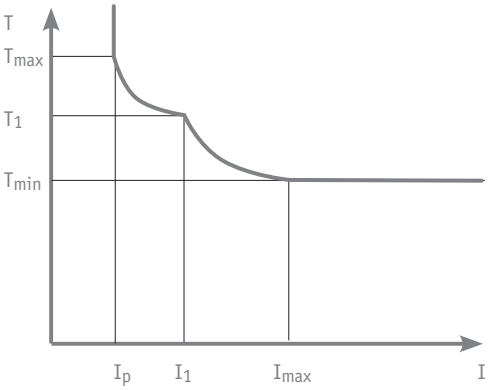


Figure 54
Appearance of TEL I with two sections

At this T_2, I_s, I_{as3} settings are not applicable for this TCC.

If number of sections equals 1 appearance of TELI complies with Fig. 55.

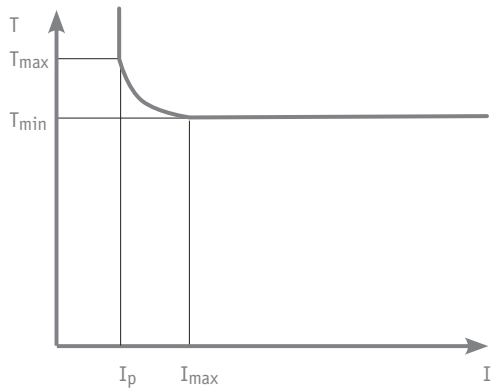


Figure 55
Appearance of TEL I with one section

At this T_1, T_2, I_1, I_2, I_{as2}, I_{as3} settings are not applicable for this TCC.
TEL I is provided with instantaneous reset timer.

The following settings are applicable for element equipped with TEL I.

Settings	Designation	Range	Step size	Factory defaults
Number of sections	NA	1/2/3	NA	3
Maximum time, sec	T_{max}	0.05-100.00	0.01	10.00
First intermediate time, sec	T_1	0.05-100.00	0.01	3.00
Second intermediate time, sec	T_2	0.05-100.00	0.01	0.25
Minimum time, sec	T_{min}	0.05-100.00	0.01	0.05
Pickup current, A	I_p	10-6000	1	100
First intermediate current, A	I_1	10-6000	1	500
Second intermediate current, A	I_2	10-6000	1	1000
Maximum current, A	I_{max}	10-6000	1	3000
First section asymptote	I_{as1}	0-10	0.01	1
Second section asymptote	I_{as2}	0-10	0.01	1
Third section asymptote	I_{as3}	0-10	0.01	1

Parameters T_{max}, T_1, T_2, T_{min}, I_{min}, I_1, I_2, I_{max} can be only set when the following inequalities are valid:
$I_{min} < I_1 < I_2 < I_{max}$, $T_{max} > T_2 > T_1 > T_{min}$.

When number of sections is reduced or increased default values for T_{max}, T_1, T_2, T_{min}, I_{min}, I_1, I_2, I_{max}, I_{as1}, I_{as2}, I_{as3} are set. These parameters can be changed either with the aid of direct dialling or with the aid of TELARM graphical interface via adjustment positions of the characteristic points (refer to TELARM user guide for details).

TEL Auto-Coordinated (TEL A)

This TCC's shape is based on the TCC's of the downstream devices. TEL A delivers the highest pickup currents and the minimum possible tripping times for the given time and current grades. An unlimited number of downstream TCC's can be selected for coordination. TEL A has in general three sections (Fig. 56).

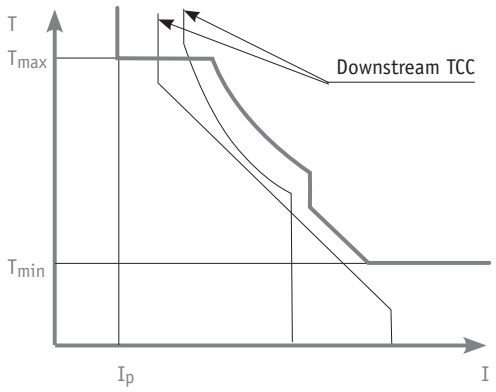


Figure 56
Appearance TEL A

Tripping time for first and third sections equals T_{max} and T_{min} respectively. For second section tripping time equals $\underset{i=1}{\overset{n}{Max}}[T_{TCCi}(\frac{I}{1+\xi})]$+time_grade, where ξ = current_grade/100, n – number of downstream TCC, T_{TCCi} (I) – operating time for the given current according to the i-th downstream TCC.

Thus, this section represents maximum of the background TCC shifted (1+ξ) times along current axis and by time_grade along time axis. Appearance of this TCC can be different if $T_{max} > \underset{i=1}{\overset{n}{Max}}[T_{TCCi}(\frac{I_p}{1+\xi})]$+time_grade. In this case first section does not exist (Fig. 57).

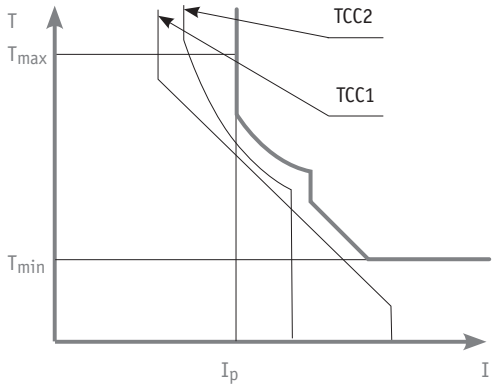


Figure 57
Appearance of TEL A with first section aborted

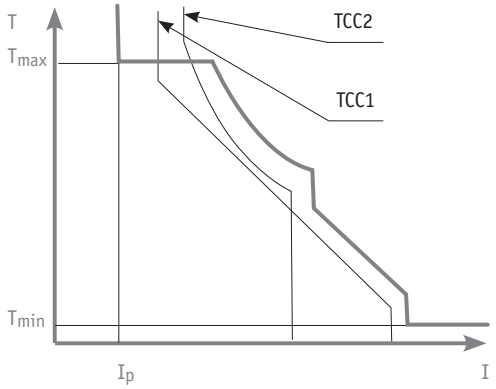


Figure 58
Appearance of TEL A with T_{min} decreased

TEL A is provided with instantaneous reset timer.
The following settings are applicable for element equipped with TEL A.

Settings	Designation	Range	Step size	Factory defaults
Maximum time, sec	T_{max}	0.05-100.00	0.01	100.00
Minimum time, sec	T_{min}	0.00-100.00	0.01	0.00
Pickup current, A	I_p	10-6000	1	100

Parameters T_{max}, T_{min} can be only set when $T_{max} > T_{min}$.

ANSI

ANSI TCC consists in general of three sections as shown in Fig. 59.

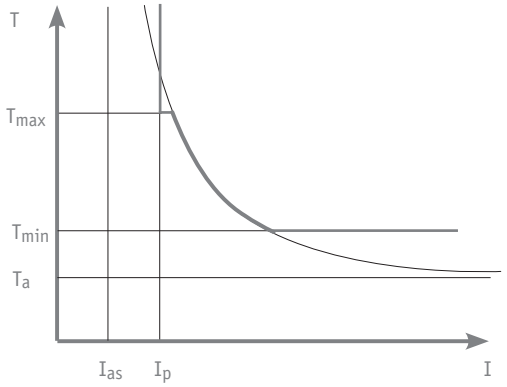


Figure 59
General appearance of ANSI TCC

Tripping times for the first and third sections equal T_{max} and T_{min} respectively. For the second section tripping time is determined with the aid of the following equation:

$$T = T_m\left(B + \frac{A}{\left(\frac{I}{I_{as}}\right)^n - 1}\right) + T_a \ ,$$

Where: A, B, n – constants presented in table, T_m – time multiplier, I_{as} - asymptote current, T_a - time adder.

If $T_{max} > T_m\left(B + \frac{A}{\left(\frac{I_{min}}{I_{as}}\right)^n - 1}\right) + T_a$ first section is aborted, and TCC appearance complies with Fig. 60.

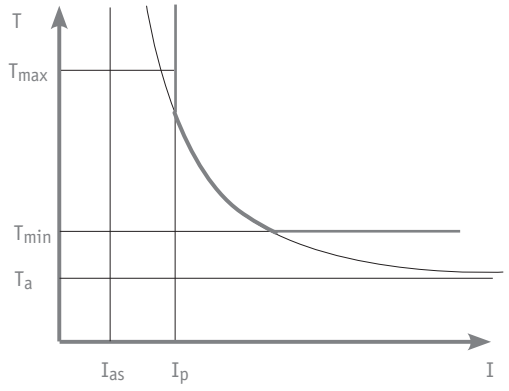


Figure 60
ANSI TCC appearance when $T_{max} > T_m\left(B + \frac{A}{\left(\frac{I_{min}}{I_{as}}\right)^n - 1}\right) + T_a$

If $T_{max} < T_a$ third section is aborted, and TCC has the following appearance.

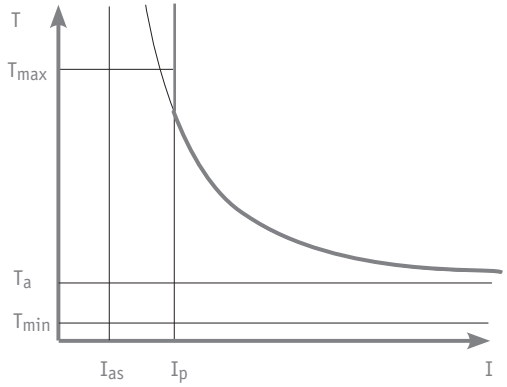


Figure 61
ANSI TCC appearance when $T_{max} < T_a$

ANSI TCC is provided with disk reset timer described with the aid of following general equation:
$T_{res} = D / (1 - 0.998 \times I / (OCLM \times I_p))$, where D – constant presented in Table.
OCLM – operational cold load multiplier (refer to the description of CLP element):

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

The following settings are applicable for element equipped with ANSI TCC.

Settings	Designation	Range	Step size	Factory defaults
Asymptote current, A	I_{as}	10-1280	1	100
Time multiplier	T_m	0.01-15.00	0.01	1.00
Minimum time, sec	T_{min}	0.00-10.00	0.01	0.00
Maximum time, sec	T_{max}	1.00-100.00	0.01	10.00
Pickup current, A	I_p	10-1280	1	200
Time adder, sec	T_a	0.00-2.00	0.01	0.00

Parameters T_{max}, T_{min} can be only set when $T_{max} > T_{min}$.

IEC

IEC TCC has the same appearance as ANSI TCC with second section described with the following general equation:

$$T = \frac{A \cdot T_m}{\left(\frac{I}{I_{as}}\right)^n - 1} + T_a$$

Where: A, n – constants presented in table below, T_m – time multiplier, I_{as} - asymptote current, T_a - time adder.

IEC TCC is provided with fixed reset timer providing reset characteristics independent of current.
The following Table presents applicable IEC TCC and their 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

The following settings are applicable for element equipped with IEC TCC.

Settings	Designation	Range	Step size	Factory defaults
Asymptote current, A	I_{as}	10-1280	1	100
Time multiplier	T_m	0.01-15.00	0.01	1.00
Minimum time, sec	T_{min}	0.00-10.00	0.01	0.00
Maximum time, sec	T_{max}	1.00-100.00	0.01	10.00
Pickup current, A	I_p	10-1280	1	200
Time adder, sec	T_a	0.00-2.00	0.01	0.00
Reset time, sec	T_{res}	0.02-2.00	0.01	0.02

Parameters T_{max}, T_{min} can be only set when $T_{max} > T_{min}$.

Monitoring 6

Overview

The RC generates and maintains the following records:
- Event log
- Malfunction log
- Load profile
- Fault profile
- Change messages log
- Comms log
- Protection counters
- Lifetime counters
- Log filling counters
- User defined data

Event Log (EL)

The EL registers up to 1000 events associated with the operation of protection and open/close events. Each event is time stamped with an accuracy of 1ms. For some events additional information is provided. The EL is arranged as a ring buffer.

Event	Additional information provided
Bolted fault	NA
Short circuit fault	Source side (+/-) for Ring recloser
Sensitive earth fault	Source side (+/-) for Ring recloser
Voltage unbalance	Source side (+/-) for Ring recloser
Current unbalance	Source side (+/-) for Ring recloser
Low system voltage	Source side (+/-) for Ring recloser
Low system frequency	Source side (+/-) for Ring recloser
Loss of supply	NA
Fault dropout	Maximum values of Ia, Ib, Ic, In, I2, U2+, minimum values of U1+, F+ since fault appearance
BF open to lockout	Maximum value of I1 since fault appearance
LS open to lockout	NA
OC1a/OC1b/OC1c/OC2a/OC2b/OC2c/OC3a/ OC3b/ OC3c open to lockout/reclose	Maximum value of Ia, Ib, Ic since fault appearance
EF1/EF2/EF3/SEF open to lockout/reclose	Maximum value of In since fault appearance
VU open to lockout	Maximum value of U2+ since fault appearance
CU open to lockout	Maximum value of I2 since fault appearance
UV open to lockout/reclose	Minimum value of U1+ since fault appearance
UF open to lockout/reclose	Minimum value of F+ since fault appearance
First/second/third AR OC/AR SEF reclosure	NA
AR UV/UF reclosure	NA
Automatic backfeed restoration	Source side (+/-)
First/second/third zone sequence coordination	NA
Trip request from MMI/PCI/TCI/TDI/IOI	NA
Open via MMI/PCI/TCI/TDI/IOI/Manually	NA
Close request from MMI/PCI/TCI/TDI/IOI	NA
Closed via MMI/PCI/TCI/TDI/IOI/Undefined	NA

Note: [1] As there are no provisions for mechanical closing, “Closed undefined” event appears e.g. when OSM is in Open position and control cable is disconnected from Recloser control.

Malfunction Log (ML)

The ML registers up to 1000 events associated with malfunction or warning signals issued by different elements. Each event is stamped with accuracy of 1ms. The ML is arranged as a ring buffer.

The list of indicated warnings/malfunctions is given below.

RCM related warnings/malfunctions:
· Watchdog restart
· RCM fault/RCM recovery
· Shutdown/Power restart
· Driver fault/Driver recovery
· OSM coil isolated/OSM coil short circuit/OSM coil recovery
· Driver not ready/Driver ready
· Excessive trip time/Excessive close time
· RTC resetted/RTC adjusted

Power supply related warnings/malfunctions:
· Low battery found/Battery restoration
· Loss of AC supply/Restoration of AC supply
· Battery fault/Battery recovery
· Battery sensor fault/Battery sensor recovery

RTU related warnings/malfunctions:
· RTU short circuit/RTU reconnection
· RTU disconnected/RTU reconnection
· RTU fault/RTU recovery
· RTU initialization error/RTU initialized

TDI related warnings/malfunctions:
· TDI modem short circuit/TDI reconnection
· TDI provider disconnected/TDI provider connected
· TDI disconnected/TDI server not responses/TDI connected
· TDI modem fault/TDI modem recovery
· TDI modem initialization error/TDI modem initialized

IOI related warnings/malfunctions:
· IOM fault/IOM recovery
· IOM disconnected/IOM reconnection

BTM related warnings/malfunctions:
· BTM disconnected/BTM reconnection
· BTM fault/BTM recovery
· BTM initialization error/BTM initialized

Load Profile (LP)

The LP registers up to 9000 readings of the continuously monitored data. Each reading is time stamped with an accuracy of 1 ms. Time interval between readings equals to user configurable “Load profile step“. Load profile is arranged as a ring buffer.

Data	Designation	Applicable range	Resolution
Currents	Ia, Ib, Ic, In	0 ... 7000 A	1 A
Phase to phase voltages	Uab, Ubc, Uca	0.0 to 30.0 kV	0.1 kV
Single-phase reactive power	Pa, Pb, Pc	0 to 65535 kW	1 kW
Three-phase active power	P3ph	0 to 65535 kW	1 kW
Single-phase reactive power	Qa, Qb, Qc	0 to 65535 kW	1 kW
Three-phase reactive power	Q3ph	0 to 65535 kW	1 kW
Three-phase power factor	PF	0.00 to 1.00	0.01
Power source side	Side	NA	NA

Time interval between readings equals to user configurable «Load profile step».

Setting	Applicable Range	Factory Default
Load profile step	5/10/15/30/60 min	30 min

All analogue data used for filling load profile represent relevant ME data averaged within the period between two sequential records (equal to load profile step). «Power source side» represents a list of the states of source detector (refer to description of protection element for details) and OSM open state existing between two sequential load profile records. In general case it has the following format: + / - / ? / 0.

Conditions of appearance of each symbol are described in the following Table:

Symbol	Condition of appearance
+	Within time interval between two sequential records source detector state «Source +» existed with OSM being closed
-	Within time interval between two sequential records source detector state «Source -» existed with OSM being closed
?	Within time interval between two sequential records source detector state «Source lost» existed with OSM being closed
0	Within time interval between two sequential records Closed signal has been equal to 0 (OSM has been open)

For example, «Power source side» record +/0 would mean that within time interval between current and previous records Source detector existed in «Source +» state with OSM being closed, and for some time OSM has been open.

Fault Profile Log (FPL)

The FPL registers up to 10,000 readings of the data related to activity of protection. Each reading is time stamped with an accuracy of 1ms. The time interval between the readings equals to one cycle of the power frequency. The fault profile is arranged as a ring buffer.

Value	Designation	Range	Resolution
Phase currents	Ia, Ib, Ic	0...7000 A	1 A
Residual current	In	0...7000 A	1 A
Positive sequence current	I1	0...7000 A	1 A
Negative sequence current	I2	0...7000 A	1A
Positive sequence voltage measured from Source + side	U1 +	0...18 kV	0.1 kV
Positive sequence voltage measured from Source - side	U1 -	0...18 kV	0.1 kV
Negative sequence voltage measured from Source + side	U2 +	0...18 kV	0.1 kV
Negative sequence voltage measured from Source - side	U2 -	0...18 kV	0.1 kV
Frequency measured from Source + side	F +	40...65 Hz	0.01 Hz
Frequency measured from Source - side	F -	40...65 Hz	0.01 Hz
State of Protection elements: BF/OC1a/OC1b/OC1c/ OC2a/OC2b/OC2c/OC3a/OC3b/OC3c/EF1/EF2/EF3/AR OC/CLP/SEF/AR SEF/VU/CU/UV/AR UV/UF/AR UF/ VRC	refer to table below	refer to table below	NA
Closed	Refer to DRV	NA	NA

Data point	Designation	Applicable range
State of BF element	St (BF)	Blocked/Passive/Trip request
State of OC1a element	St (OC1a)	Blocked/Passive/Timing up/Resetting/Trip request
State of OC1b element	St (OC1b)	Blocked/Passive/Timing up/Resetting/Trip request
State of OC1c element	St (OC1c)	Blocked/Passive/Timing up/Resetting/Trip request
State of OC2a element	St (OC2a)	Blocked/Passive/Timing up/Resetting/Trip request
State of OC2b element	St (OC2b)	Blocked/Passive/Timing up/Resetting/Trip request
State of OC2c element	St (OC2c)	Blocked/Passive/Timing up/Resetting/Trip request
State of OC3a element	St (OC3a)	Blocked/Passive/Timing up/Resetting/Trip request
State of OC3b element	St (OC3b)	Blocked/Passive/Timing up/Resetting/Trip request
State of OC3c element	St (OC3c)	Blocked/Passive/Timing up/Resetting/Trip request
State of EF1 element	St (EF1)	Blocked/Passive/Timing up/Resetting/Trip request
State of EF2 element	St (EF2)	Blocked/Passive/Timing up/Resetting/Trip request
State of EF3 element	St (EF3)	Blocked/Passive/Timing up/Resetting/Trip request
State of HLOCa element	St (OCHLa)	Blocked/Passive/Timing up/Resetting/Trip request
State of HLOCb element	St (OCHLb)	Blocked/Passive/Timing up/Resetting/Trip request
State of HLOCc element	St (OCHLc)	Blocked/Passive/Timing up/Resetting/Trip request
State of HLEF element	St (EFHL)	Blocked/Passive/Timing up/Resetting/Trip request
State of Source Detector	St (SD)	Source+/Source-/Source lost
State of AR OC element	St (AR OC)	Open/Closed_1/Passive/Open_1/CloseReq_1/ ZSC_1/ Closed_2/Open_2/CloseReq_2/ZSC_2/ Closed_3/ Open_3/CloseReq_3/ZSC_3/Closed_4
State of SEF element	St (SEF)	Blocked/Passive/Timing up/Trip request

Data point	Designation	Applicable range
State of AR SEF element	St (AR SEF)	Open/ Closed_1/ Passive/Open_1/CloseReq_1/ Closed_2/ Open_2/CloseReq_2/Closed_3/ Open_3/ CloseReq_3/Closed_4
State of VU element	St (VU)	Blocked/Passive/Timing up/Trip request
State of CU element	St (CU)	Blocked/Passive/Timing up/Trip request
State of UV element	St (UV)	Blocked/Passive/Timing up/Trip request
State of VU element	St (VU)	Blocked/Passive/Timing up/Trip request
State of UV element	St (UV)	Blocked/Passive/Timing up/Trip request
State of AR UV element	St (AR UV)	Open/Closed_1/Passive/Open_1/CloseReq/Closed_2
State of UF element	St (UF)	Blocked/Passive/Timing up/Trip request
State of AR UF element	St (AR UF)	Open/Closed_1/Passive/ Open_1/CloseReq/Closed_2
State of VRC element	St (VRC)	Power Good/Power Fail
State of CLP element	St (CLP)	Passive/Timing up/Charged/Resetting

FPL registers data when Protection is active.

Change Messages Log (CML)

The CML registers up to 100 events associated with control instructions issued via MMI, PCI, TDI or TCI. Each event is time stamped with an accuracy of 1ms. CML is arranged as a ring buffer. Each message is accompanied with the additional information that always includes source of control instruction and for some messages old and new values of the parameter being subject for change.

The following table presents list of applicable message types (XXX means the name of setting or element); several settings of one element can be changed, that will result in appearance of several Change messages, one for each changed setting.

Change message	Applicability of old/new values	Applicable source of control instruction	Reference (where to find description of relevant data point)
System settings uploaded	NA	PCI/TDI	Comms: settings uploaded via PCI/TCI/TDI
Protection settings uploaded	NA	PCI/TDI	Comms: settings uploaded via PCI/TCI/TDI
Comms settings uploaded	NA	PCI/TDI	Comms: settings uploaded via PCI/TCI/TDI
Control mode changed	Applicable	MMI/PCI	IDC: standard indication signals
MMI: setting XXX changed	Applicable	MMI	MMI
TCI: element XXX: setting XXX changed	Applicable	MMI	TCI: relevant element
RTC: setting XXX changed	Applicable	MMI	RTC
PSE: setting XXX changed	Applicable	MMI	PSE
ME: setting XXX changed	Applicable	MMI	ME
IDC: setting XXX changed	Applicable	MMI	IDC: generating load profile
Prot: element XXX: Group X: setting XXX changed	Applicable	MMI	Prot: relevant element
Protection status changed	Applicable	MMI/PCI/TCI/TDI/IOI	IDC: protection statuses
Dummy mode changed	Applicable	MMI/PCI/TCI/TDI	IDC: protection statuses
Total CO	NA	MMI/PCI/TCI/TDI	IDC: lifetime counters
Contactwear	NA	MMI/PCI/TCI/TDI	IDC: lifetime counters
Protection counters erased	NA	PCI/TCI/TDI/IOI	IDC: protection counters
TCI/TDI counters erased	NA	MMI/PCI/TCI/TDI	Comms: TCI/TDI indication data
Energy meters erased	NA	MMI/PCI/TCI/TDI	Measurement
Logs erased	NA	MMI/PCI/TCI/TDI	IDC
Password erased	NA	MMI	IDC
Prot password changed	NA	MMI/PCI/TDI	CII: Password
Comms password changed	NA	MMI/PCI/TDI	CII: Password
System password changed	NA	MMI/PCI/TDI	CII: Password
PCI password changed	NA	MMI/PCI/TDI	CII: Password
RTU supply switched on/off	Applicable	MMI/PCI/TDI	PSE: RTU supply on
Date/Time adjusted	NA	MMI/PCI/TCI/TDI	RTC: RTC indication data

The following table presents particular examples of change messages presented above:

Change message	From	To	Source of control instruction
System settings uploaded	NA	NA	PCI
Protection settings uploaded	NA	NA	PCI
Comms settings uploaded	NA	NA	PCI
Control mode changed	Local	Remote	PCI
MMI: AR pushbutton mode changed	Enable	Disable	MMI
TCI: Modbus : Slave address changed	2	23	MMI
RTC: Date and time format changed	12h	24h	MMI
PSE: RTU shutdown level changed	0.3	0.2	MMI
ME: X1 current sensor coefficient changed	2.0000 V/kA	1.9800 V/kA	MMI
IOI: Setting of an input for Trip signal changed	1	5	MMI
IDC: load profile step changed	5min	15min	MMI
Prot: OC1: Group 1: pickup current+ changed	100A	120A	MMI
Protection status changed	AR on	AR off	PCI
Total CO	0	300	PCI
Contact wear	0	2	MMI
Protection counters erased	NA	NA	MMI
TCI counters erased	NA	NA	MMI

Comms Log (CL)

The CL is a file which contains a sequence of up to 1000 events associated with data transfer via Comms element. Each event is time stamped with an accuracy of 1ms. For some events additional information is provided.
The CL is arranged as a ring buffer.

Event	Additional information provided
MMI session started	NA
MMI session completed	NA
PCI session started	Via USB/BTM/RS232
PCI session completed	Number of transferred/received bytes and frames during connection session
TCI session started	NA
TCI session completed	Number of transferred/received bytes and frames during connection session
TDI session started	NA
TDI session completed	Number of transferred/received bytes and frames during connection session
IOI session started	NA
IOI session completed	NA
MMI user authenticated	User rights (Protection, Communication, System)
MMI authentication failed	NA
PCI user authenticated	NA
PCI authentication failed	NA
TDI user authenticated	NA
TDI authentication failed	NA
TCI user authenticated	NA
TCI authentication failed	Phone number
PCI protocol restart	NA
TDI protocol restart	NA
TCI protocol restart	DNP3/Modbus
TCI UR initiated	NA
TCI UR confirmed	NA
TCI UR failed	NA
MMI refusal of command execution	Reason, Command name
IOI refusal of command execution	Reason, Command name
PCI refusal of command execution	Reason, Command name
TCI refusal of command execution	Reason, Command name
TDI refusal of command execution	Reason, Command name

Protection Counters

The Protection counters record the number of protection trips.

Counter	Incrementing Conditions	Applicable Range
BF trips	Tripping initiated by BF element	0 to 100000
OC trips	Tripping initiated by one of the following elements: OC1a, OC1b, OC1c…	0 to 100000
EF trips	Tripping initiated by one of the following elements: EF1, EF2, EF3 and EFLL	0 to 10000
SEF trips	Tripping initiated by SEF element	0 to 10000
VU trips	Tripping initiated by VU element	0 to 10000
CU trips	Tripping initiated by CU element	0 to 10000
UV trips	Tripping initiated by UV element	0 to 10000
UF trips	Tripping initiated by UF element	0 to 10000
LS trips	Tripping initiated by LS element	0 to 10000
AR OC reclosures	Reclosing initiated by AR OC element	0 to 10000
AR SEF reclosures	Reclosing initiated by AR SEF element	0 to 10000
AR UV reclosures	Reclosing initiated by AR UV element	0 to 10000
AR UF reclosures	Reclosing initiated by AR UF element	0 to 10000
ABR reclosures	Reclosing initiated by ABR element	0 to 10000

Log Filling Counters

The Log filling counters reflect the percentage of log filling (with regard to total number of recorded events).

Data Point	Incrementing Conditions
Load profile filling Event log filling Fault profile filling Malfunction log filling Change messages filling Comms log filling	Recording event results in counter increment equal to 100/total number of events in the log

Log filling counters can be erased with the aid of “Erase logs” instruction from MMI, PCI, TCI or TDI.

Lifetime Counters

The Lifetime counters calculate and record the total number of Close-Open (CO) Operations, the mechanical and the contact wear of the OSM main contacts.

· Total CO Operations – A close operation and the subsequent open operation are treated as a CO Operation
· Mechanical wear – The value is calculated as a ratio of the total number of CO operations to the rated OSM mechanical life (30,000) and expressed as a percentage
· Contact wear – The value is calculated for each phase using a recurrent formula to calculate the total contact wear consumed after each interruption. The maximum recalculated wear on any of the three phases is recorded as a percentage

Values are calculated and updated after each Close Open (CO) cycle.

Data point	Data type	Applicable range
Total CO	Counter	0 to 100000
Mechanical wear	Counter	0 to 100%
Contact wear	Counter	0 to 100%

User Defined Data

User defined data are prepared with the aid of TELARM and indicated via all interfaces (MMI, PCI, TCI, TDI, IOI).

Indication and Control

7

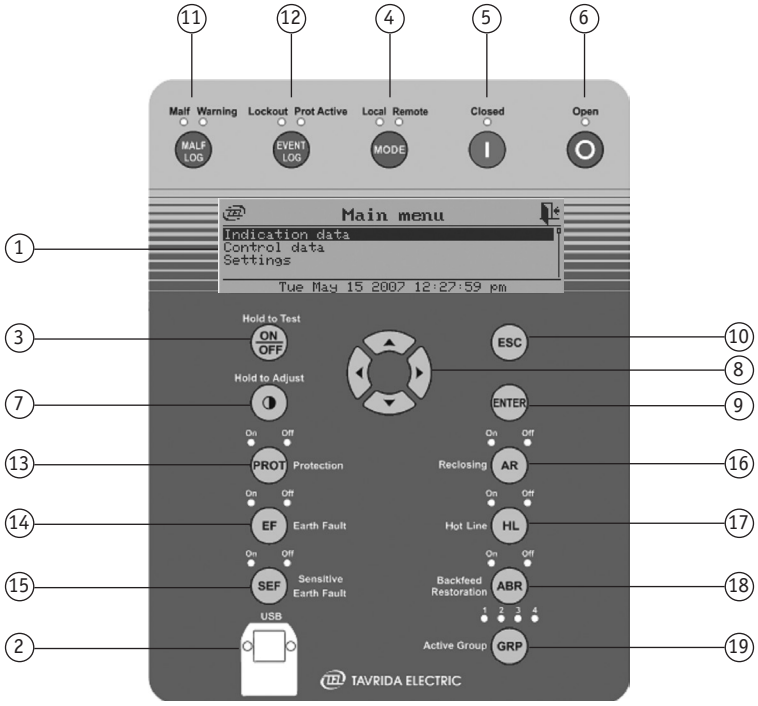
Overview

Indication and control are handled by the following interfaces:
· Man-Machine Interface (MMI)
· Personal Computer Interface (PCI)
· Telecommunication Interface (TCI)
· TELARM dispatcher Interface (TDI)
· Digital Input/Output Interface (IOI)

In the Local mode the Recloser is controlled via Man-Machine Interface (MMI) or Personal Computer Interface (PCI). In the Remote mode the Recloser is controlled via Tele-communication Interface (TCI), TELARM dispatcher Interface (TDI) or digital Input/Output Interface (IOI). Indication is provided via all interfaces in both modes. The Local/ Remote mode can be switched via MMI or PCI only.

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 Pushbottons

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 Restauration ON/OFF
19. Active (Protection) Group

Fig. 62
Control Panel Module (CPM)

The MMI becomes active automatically after opening the door of the recloser control cubicle or by pressing the ON/OFF pushbutton.
When the MMI is active, the LCD display and relevant light diodes are on. The MMI becomes passive automatically if no pushbutton was pressed for 15 minutes (and corresponding setting it set in System settings – MMI settings) or after closing the door of the recloser control cubicle or by pressing the ON/OFF pushbutton. When the MMI is passive, the LCD display and relevant light diodes do not light.
Pressing the «ON/OFF» pushbutton for more than 2 s activates the test state of the MMI. MMI will leave the test state through pressing the «ON/OFF» pushbutton again.

All types of settings (including settings for each Group of protection settings) can be edited from the control panel. For complete list of MMI Indications and Control refer to MMI Menus in Appendix 1.

LCD Display

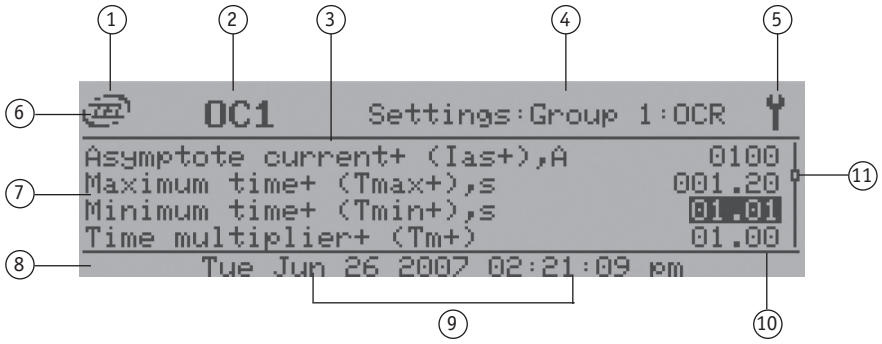


Fig. 63
Liquid Crystal Display (LCD)

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

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

Context icon may have different appearance depending on the current menu functionality as shown in the Table below.

N	Context icon appearance	Conditions of appearance
1		Transition to higher (by pressing ENTER pushbutton) and lower (by pressing ESC pushbutton) level menu is possible
2		Observed parameter being subject for editing
3		View only
4		Editing parameter
5		Last/first value is reached
6		Conflict of value

Pushbuttons

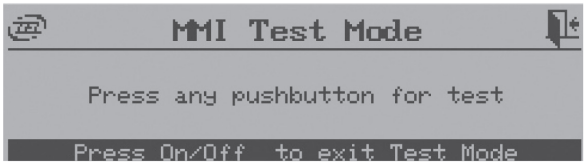
General Control Pushbuttons

ON/OFF/TEST

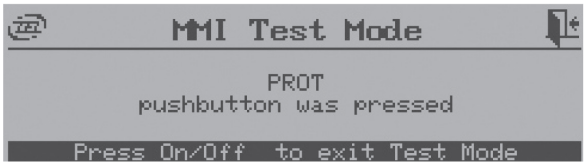
The CPM must be turned on before it can be used for control and indication. The CPM automatically turns off again if no operator activity is detected for 15 minutes and corresponding setting it set in System settings → MMI settings.

In case events have happened Event Log will show off at first after turning on the LCD Display.
To leave the Event Log to the Main Menu press Escape.

The ON/OFF pushbutton also provides a means of testing of the LCD and all indicating diodes. Pressing the button for about 2s will cause all LED´s to blink and the following message appears:



In this condition functionality test for each push button can be provided. E.g. pressing the Protection push button results in the following message:



Exceptions are the ON/OFF and the LCD contrast pushbuttons.
The test mode will be left through pressing the ON/OFF push button again.

Control Mode

The Control Mode pushbutton allows the Recloser Control to be set to either Local Control or Remote Control mode.
In Local Control mode, indication is available to both local and remote applications but controls can only be executed locally. In Remote Control mode indication is available to both local and remote applications but controls can only be executed by remote applications.
MPM data can still be viewed locally on the LCD panel.

The exception of this is the Open command, which can be executed locally or remotely, independent of the Control mode.

Closed

The Closed pushbutton is red and labelled I . It is used to close the recloser main circuit contacts. The command is only executed if the Control Mode is set to Local Control. If the Control Mode is set to Remote Control the Close command will not be accepted and the following message will be displayed in the LCD:

Pushbotton Closed is disabled in Remote mode.

Open

The Open pushbutton is green and labelled . It is used to open the recloser main circuit contacts. The Open command is executed in both Local and Remote mode.

LCD Control Pushbuttons

LCD Contrast

Adjusting LCD contrast is carried out by holding or repeatedly pressing this pushbutton to cycle through the available range of contrast settings. Once released, the LCD will remain in the last contrast setting.

Navigation

These pushbuttons allow movement through the menu structure to view or edit settings. Pressing ▲ or ▼ pushbuttons results in sequential up and down stepping along the values of the applicable parameters. Pressing ◄ or ► pushbuttons will result in jumping the first/last available parameter.
Once a field has been selected for editing pressing the ◄ or ► pushbuttons are used to select each digit, ▲ or ▼ are used to change the value of the digit.

The setting range of some parameters is restricted by the setting of another parameter. For example minimum tripping time cannot exceed preset maximum tripping time. If somebody tries to enter such a value the conflict icon appears on the menu bar and the setting change cannot proceed. A message explaining reason for conflict appears on the status bar.

Enter

The Enter pushbutton is used to access a selected field.

If a setting is changed it must be confirmed by pressing the Enter pushbutton. To leave the menu without changing the setting press the ESC pushbutton.

Escape

The Escape pushbutton is used to either move back to a previous level screen in the menu structure or to de-select a variable.

Fast Keys

Fast keys allow the status of the protection elements and the active protection group to be set using a single push button. They also provide fast access to the Malfunction and Event Logs.

Malfunction Log

The Malfunction Log pushbutton provides direct access to the Malfunction Log from any menu. Pressing ESC pushbutton provides transition from this screen back to the previous menu. The events is sorted in ascending order of their appearance time, thus, the last records are located at the end of the list. Two LEDs are provided to display either Warning or Malfunction if applicable.

Event Log

The Event Log pushbutton provides direct access to the Event Log from any menu. Pressing ESC pushbutton provides transition from this screen back to the previous menu. The events is sorted in ascending order of their appearance time, thus, the last records are located at the end of the list. Date and Time of the selected event are showed in Status bar. If the selected event has additional information, the transition to lower level context icon will be displayed in the Title bar, otherwise the view only icon wil be displayed. Two LEDs are provided to display either Recloser OPEN in Lockout state or Protection Activated (Prot. Active).

Protection

The Protection fast key is used to turn Protection ON or OFF.
When set to OFF all protection elements for all protection groups are disabled.

Earth Fault

The Earth Fault fast key is used to enable or disable all Earth Fault overcurrent elements for all protection groups. When set to OFF, all EF elements including Sensitive Earth Fault are disabled.

Sensitive Earth Fault

The Sensitive Earth Fault fast key is used to enable or disable all Sensitive Earth Fault overcurrent elements for all protection groups. Sensitive Earth Fault can only be enabled together with Earth Fault elements.

Reclosing

The Reclosing fast key is used to enable or disable all Autoreclose elements for all protection groups.

Hot Line

The Hot Line fast key is used to enable or disable all Hot Line elements for all protection

Backfeed Restoration

The Backfeed Restoration fast key is used to enable or disable all Backfeed Restoration elements for all protection groups.

Active (Protection) Group

The Active Group fast key is used to select which of the four Protection Groups is active. Once the appropriate group has been chosen (indicated by flashing LED) press ENTER to make it active. The Active Protection group cannot be changed if a protection element pickup occurs. Where this happens subsequent to pressing ENTER, the new group will become active once all protection elements have reset.

MMI Settings

Setting	Range	Resolution	Default
Security mode	Enable/Disable	NA	Disable
MMI shutdown	Enable/Disable	NA	Enable
Close delay	0 - 300 s	1 s	0 s
“PROT” pushbutton mode	Enable/Disable	NA	Disable
“GRP” pushbutton mode	Enable/Disable	NA	Enable
“EF” pushbutton mode	Enable/Disable	NA	Enable
“SEF” pushbutton mode	Enable/Disable	NA	Enable
“AR” pushbutton mode	Enable/Disable	NA	Enable
“HL” pushbutton mode	Enable/Disable	NA	Enable
“ABR” pushbutton mode	Enable/Disable	NA	Disable

Indication Data Generated by MMI

Signal	Condition of appearance
MMI active	The signal is activated when the MMI is in Active or Test state.
CPM disconnected	When the CPM mode = Enable the connection between the RCM and the CPM is continuously monitored. The signal is activated when the connection is interrupted.

Passwords

All data and settings being subject for editing via MMI are password protected. The passwords are required if the Security mode in MMI settings is set “Enable”. Three types of password are provided, intended for:

· system service engineer
· protection engineer
· communication engineer

The following table describes the applicability of these passwords for different elements.

Type of Password	Applicable for Elements	Default
System	Measurement, Power Supply Element, Real Time Clock, MMI, Indication Data Conditioner	1
Protection	Protection	2
Communication	TCI, TDI, IOI	3

Passwords can be erased by pressing the security pushbutton through the hole in the front of the RCM panel.

Control of Data and Settings via MMI

Control via MMI interface can be fulfilled only if Mode is set Local. The only exception is the Trip request signal, which will be executed independent of the selected mode.

The following signals and data can be controlled via MMI:

Control Data	Procedure	Protected by Password	Type of Password
Trip request	Press «O» pushbutton	No	NA
Close request	Press «I» pushbutton	No	NA
Set Local/Remote mode	Press «MODE» pushbutton	No	NA
Set Protection on/off	Press «PROT» pushbutton	Yes	Protection
Set Reclosing on/off	Press «AR» pushbutton	Yes	Protection
Set Earth Fault on/off	Press «EF» pushbutton	Yes	Protection
Set Earth Fault on/off	Press «EF» pushbutton	Yes	Protection
Set Sensitive Earth Fault on/off	Press «SEF» pushbutton	Yes	Protection
Set Hot Line on/off	Press «HL» pushbutton	Yes	Protection
Set Backfeed Restoration on/off	Press «ABR» pushbutton	Yes	Protection
Set Active Protection Group 1/2/3/4	Press «GRP» pushbutton until required Group LED blinks, then press <<Enter>> pushbutton	Yes	Protection
Switch RTU on/off	Main Menu>>Control Data>>Set RTU supply on/off and press <<Enter>> pushbutton	Yes	System
Erase protection counters	Main Menu>>Control Data>>Erase protection counters and press <<Enter>> pushbutton	Yes	System, Protection
Erase energy meters	Main Menu>>Control Data>>Erase energy meters and press <<Enter>> pushbutton	Yes	System
Erase logs	Main Menu>>Control Data>>Erase logs and press <<Enter>> pushbutton	Yes	System
Erase TCI counters	Main Menu>>Control Data>>Erase TCI counters and press <<Enter>> pushbutton	Yes	System, Communication
Erase UD counters	Main Menu>>Control Data>>Erase UD counters and press <<Enter>> pushbutton	Yes	System
Set Date and time	Edit parameter in MMI Main menu » Control data » Set Date and time	Yes	System
Set Total CO	Edit parameter in MMI Main menu » Control data » Lifetime counters	Yes	System
Set Contact wear	Edit parameter in MMI Main menu » Control data » Lifetime counters	Yes	System
Change System password	Edit parameter in MMI Main menu » Control data » Passwords	Yes	System
Change Protection password	Edit parameter in MMI Main menu » Control data » Passwords	Yes	System
Change Comms password	Edit parameter in MMI Main menu » Control data » Passwords	Yes	System

Notes:

· Control with fast keys is provided only if relevant pushbutton is set to Enable

· Active group can be changed by pressing «GRP» pushbutton if Protection is passive, i.e. there are no protection elements timing up and Automatic group transfer is set to Disable

· If EF is switched off, SEF will also be switched off automatically

The following setting changes can be made by MMI:

Settings	Path	Protected by Password	Type of Password
Protection	Main menu » Settings » Protection	Yes	System, Protection
IOI	Main menu » Settings » Comms » IOI Digital IO interface	Yes	System, Communication
TCI	Main menu » Settings » Comms » TCI Telecommunication interface	Yes	System, Communication
TDI	Main menu » Settings » Comms » TDI TELARM dispatcher interface	Yes	System, Communication
Measurement	Main menu » Settings » System » ME Measurement	Yes	System
Power supply	Main menu » Settings » System » PSE Power supply	Yes	System
Real time clock	Main menu » Settings » System » RTC Real time clock	Yes	System
Indication Data Conditioner	Main menu » Settings » System » IDC Indication data conditioner	Yes	System
MMI	Main menu » Settings » System » MMI Man machine interface	Yes	System

Personal Computer Interface (PCI)

The PCI provides Indication and control via a PC (with installed TELARM software). The connection is established via USB port located on the front the Control Panel Module (CPM), via RS-232 port #5 on the RCM or via Bluetooth module (BTM). If COM2 port is set to Disabled or TDI mode, no PCI connection can be established via it.
If BTM mode = Disabled no control and indication functions are supported by the PCI element via BTM.

The PCI provides the following control and indication functionality (refer to TELARM software):
· Indication signals generated by PCI
· Uploading & Downloading of data via PC
· Uploading software via PC

Indication Signals Generated by PCI

Signal	Condition of appearance
PCI active	The signal is activated at establishing of the communication link between the PC and the Recloser Control Module (RCM) via USB port , RS-232 port or BTM. The signal is deactivated after completion of the data transmission.
BTM fault	When the BTM mode=Enable the PCI continuously monitors the healthiness of the BTM and the BTM-RCM wiring. The signal is activated when an internal BTM fault is discovered.
BTM initialization error	The signal is activated when a BTM initialization error is discovered.
BTM disconnected	The signal is activated when the connection is interrupted.

Uploading/Downloading Data via PC

Data can be uploaded/downloaded via PC (refer also to description of the on-line mode of TELARM software) when the communication link is established. The communication link is password protected. The password is uploaded from the PC during 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 at the next communication session.

The following controls is possible with PC:

Control Data	Protected by Password	Type of Password
Set Dummy on	No	NA
Set Dummy off	No	NA
Trip Request	No	NA
Close request	No	NA
Set Remote mode	No	NA
Set Local mode	No	NA
Set Protection on	Yes	Protection
Set Protection off	Yes	Protection
Set Reclosing on	Yes	Protection
Set Reclosing off	Yes	Protection

Control Data	Protected by Password	Type of Password
Set Earth Fault on	Yes	Protection
Set Earth Fault off	Yes	Protection
Set Sensitive Earth Fault on	Yes	Protection
Set Sensitive Earth Fault off	Yes	Protection
Set Hot line on	Yes	Protection
Set Hot line off	Yes	Protection
Set Backfeed Restoration on	Yes	Protection
Set Backfeed Restoration off	Yes	Protection
Set Active Protection Group 1	Yes	Protection
Set Active Protection Group 2	Yes	Protection
Set Active Protection Group 3	Yes	Protection
Set Active Protection Group 4	Yes	Protection
Switch RTU on	Yes	System
Switch RTU off	Yes	System
Erase protection counters	Yes	System, Protection
Erase energy meters	Yes	System
Erase logs	Yes	System
Erase TCI counters	Yes	System, Communication
Erase UD counters	Yes	System
Set Date and time	Yes	System, Communication, Protection
Set Total CO	Yes	System
Set Contact wear	Yes	System
Change System password	Yes	System
Change Protection password	Yes	System
Change Communication password	Yes	System
Change PCI password	Yes	System

The following settings can be uploaded to RC using a PC:

Settings	Protected by Password	Type of Password
Protection	Yes	System, Protection
IOI	Yes	System, Communication
TCI	Yes	System, Communication
Measurement	Yes	System
Power supply	Yes	System
Real time clock	Yes	System
Indication Data Conditioner	Yes	System
MMI	Yes	System

All settings as above can be downloaded from RC using PC.

The following data can be downloaded to PC:

- System Status (Date & Time, Open/Closed indication, All indication data of IDC, Measurements, Power Supply data, I/O indication, Identification, TCI data - excluding change event times in case of DNP3)
- Event Log
- Fault Profile
- Load Profile
- Change Messages
- Malfunction Log
- Comms Log

Uploading Software via PC

New Firmware for RC can be uploaded with PC. (Refer to TELARM software)

Telecommunication Interface (TCI)

The TCI element provides control and indication via RTU connected to port “6” located on the Recloser Control Module. If RTU mode = Disable (System Settings) no control and indication functions are supported via RTU connected to port “6”.

TCI Settings

Setting	Range	Default
RTU	Radio modem / Phone modem / GSM modem / RS485-RS232 Converter / Direct connection	Radio modem
Protocol	DNP3 / Modbus	DNP3

The scope of the generated indication and control data depends on the configuration, i.e. only data related to the selected RTU and protocol are generated.
Telecommunications interface is fully described in RC/TEL-05 Telecommunications interface user guide.

Indication of Data via TCI

All data and signals described in the Section Indication data and signals are provided via TCI. For each protocol only indication data applicable to the protocol are indicated via TCI. Refer to Description of relevant protocol for details.

Modbus protocol indication data:

Data point	Data type	Resolution
Transmitted frames	Counter	1
Received frames	Counter	1
CRC errors	Counter	1
Timeouts	Counter	1
Exception responses	Counter	1
Last transmitted frame time	Date and time	1 ms
Last received frame time	Date and time	1 ms
Last CRC error time	Date and time	1 ms
Last timeout time	Date and time	1 ms
Last exception response time	Date and time	1 ms

DNP3 protocol indication data:

Data point	Data type	Resolution
Transmitted frames	Counter	1
Received frames	Counter	1
CRC errors	Counter	1
Timeouts	Counter	1
Unsolicited responses	Counter	1
Class 1 buffer filling	Counter	1
Class 2 buffer filling	Counter	1
Class 3 buffer filling	Counter	1
Last transmitted frame time	Date and time	1 ms
Last received frame time	Date and time	1 ms
Last CRC error time	Date and time	1 ms
Last timeout time	Date and time	1 ms
Last unsolicited response time	Date and time	1 ms

RTU indication data:

Data point	Data type	Applicable for RTU
Transmitted Bytes	Counter	All
Received Bytes	Counter	All
Call Drop Outs	Counter	Phone modem, GSM mode, converter, direct connection
Collisions	Counter	Radio modem

Port RS-232 indication data includes only “TCI active” indication signal.

Telarm Dispatcher Interface (TDI)

General

TELARM Dispatcher Interface provides control and indication via GPRS-modem, connected to serial port “5” in the rear of recloser control module or via USB-Ethernet adapter connected to one of the USB ports of the RCM.
If COM port #2 mode is set to „Disabled“ or „PCI“, data transmission via TDI is not supported.

TDI Settings

Provider settings

Setting	Applicable range	Factory default
SIM card PIN code		
	Symbol string. 4 chars max length	0000
Authentication protocol	CHAP/ PAP	CHAP
Login	Symbol string. 255 chars max length	Empty string
	Symbol string. 255 chars max length	Empty string
Password	Symbol string. 255 chars max length	Blank
	Symbol string. 255 chars max length	Empty password
Access point	Symbol string. 255 chars max length	Blank

Local interface settings

Setting	Applicable range	Factory default
IP address	0.0.0.1 – 223.255.255.255	192.168.1.100
Net mask	0.0.0.0 – 255.255.255.255	255.255.255.0
Default gateway	0.0.0.1 – 223.255.255.255	Blank

Internet server settings

Setting	Applicable range	Factory default
IP address	0.0.0.1 – 223.255.255.255	192.168.1.1
TCP port	0-65535	9000

TDI indication data

Signal	“1” signal value	“0” signal value
TDI active	The communication channel between PC and RC is open	The communication channel between PC and RC is closed or lost
TDI modem fault	“TDI mode” setting value is “Enable” and internal TDI modem fault is detected.	“TDI mode” setting value is “Disable” and internal TDI modem fault is absent
TDI modem initialization error	“TDI mode” setting value is “Enable” and TDI modem initialization error is detected	“TDI mode” setting value is “Disable” or TDI modem is initiated
TDI provider disconnected	GPRS connection with GPRS provider is not established or has been interrupted.	GPRS connection with GPRS provider is successfully established
TDI disconnected	Internet connection with RC Internet server is not established or has been interrupted	Internet connection with RC Internet server is successfully established
TDI server not responses	RC sends responses or echo-requests, but confirmation on them are not received, and RC has not defined at TCP level a socket of connection release	RC sends responses or echo-requests and receives confirmation on them

TDI unsolicited responses

Unsolicited Response	Generation conditions
Prot open to lockout	UR Prot open to lockout is generated if one of events according to Event Log occurred: BF open to lockout or LS open to lockout or OC1a/OC1b/OC1c/OC2a/OC2b/OC2c/OC3a/ OC3b/OC3c open to lockout or EF1/EF2/EF3/SEF open to lockout or VU open to lockout or CU open to lockout or UV open to lockout or UF open to lockout
Successful reclosing	UR Successful reclosing is generated if one of AR elements goes to Passive state after reclosing
Automatic backfeed restoration	UR Automatic backfeed restoration is generated when recloser is closed due to Automatic backfeed restoration
Closed externally	UR Closed externally is generated if recloser is Closed via MMI/PCI/TCI/ TDI/IOI/Undefined
Open externally	UR Open externally is generated if recloser is Open via MMI/PCI/TCI/TDI/IOI/Manually
Event log updated	UR Event log updated is generated if any new event is added into Event Log
Malfunction log updated	UR Malfunction log updated is generated if any new event is added into Malfunction Log
Load profile updated	UR Load profile updated is generated if any new record is added into Load profile
Fault profile updated	UR Fault profile updated is generated if new records associated with the fault are added into Fault profile provided that all records from the log have been downloaded before
Comms Log updated	UR Comms Log updated is generated if any new event is added into Comms Log
Change Messages updated	UR Change Messages updated is generated if any new event is added into Change Messages
Refusal of command execution	UR Refusal is generated if a command cannot be executed. Additional data include initial interrogation code and cause of exception (Local control mode/Prot active/AGT)

TDI physical layer settings

Physical layer settings include settings of RS232 port and GPRS-modem.

Port settings

Setting	Applicable range	Factory default
Baud rate	300/600/1200/2400/4800/9600/19200 /38400/57600/115200	115200
Flow control	On/Off	On
DTR mode	Ignore/Control	Ignore
DSR mode	Ignore/Monitor High/Monitor Low	Monitor High
DTR low time	50 to 5000ms, step size 10ms	500

GPRS-modem settings

Setting	Applicable range	Factory default
MTU (Maximum Transmission Unit)	128 -16384	16384
MRU (Maximum Receive Unit)	128 -16384	16384
Init string	String, starting with command prefix[1] , 255 chars max length	ATE0
Reset string	String, starting with command prefix[1] , 255 chars max length	ATZ

[1] For string format description refer to description of the modem.

Note:
RS232 standards are defined by EIA/TIA (Electronic Industries Alliance /Telecommunications Industry Association). RS232 defines both the physical and electrical characteristics of the interface. RS232 is practically identical to ITU V.24 (signal description and names) and V.28 (electrical). RS232 is an Active LOW voltage driven interface and operates at +12V to -12V where:

Signal = 0 (Low) > +3.0V
Signal = 1 (High) < -3.0V

TDI Indication Data

"TDI active" indication signal is activated when connection is established.
This signal is deactivated when connection session is completed.

TDI Indication data

Data point	Incrementing condition	Erasure condition
Transmitted Bytes	Transmission of any byte results in counter increment by unit	Activation of "Erase TDI counters" control signal
Received Bytes	Reception of any byte results in counter increment by unit	Activation of "Erase TDI counters" control signal

Digital Input / Output Interface (IOI)

The IOI provides control and indication via digital Input-Output Module (IOM) if IOM mode=Enable.
If IOM mode = Disable (System Settings) no control and indication functions are supported by IOI , i.e. all control and indication signals are passive and relays stay in normal positions.

Thus the following clauses describe the functionality of the IOI when the IOM mode=Enable.

IOI Settings

The IOI settings include general settings, digital outputs and digital inputs settings.

General settings	Applicable Range	Factory Default
Operation mode	Normal/Test	Test

Digital outputs settings (mapped indication signal)	Applicable Range	Factory Default (digital output №)
Remote on	0 to 12	1
Lockout	0 to 12	2
Reclosing initiated	0 to 12	3
Protection active	0 to 12	0
Closed	0 to 12	4
Active Protection Group 1 on	0 to 12	8
Active Protection Group 2 on	0 to 12	9
Active Protection Group 3 on	0 to 12	10
Active Protection Group 4 on	0 to 12	11
Protection on	0 to 12	0
Earth Fault on	0 to 12	0
Sensitive Earth Fault on	0 to 12	0
Hot Line on	0 to 12	0
Reclosing on	0 to 12	0
Automatic Backfeed Restoration on	0 to 12	0
RC cubicle door open	0 to 12	7
Recloser Control Module fault	0 to 12	0
Malfunction	0 to 12	5
Warning	0 to 12	6
User Defined signal 1	0 to 12	0
User Defined signal 2	0 to 12	0
User Defined signal 3	0 to 12	0
User Defined signal 4	0 to 12	0
User Defined signal 5	0 to 12	0
User Defined signal 6	0 to 12	0
User Defined signal 7	0 to 12	0
User Defined signal 8	0 to 12	0
User Defined signal 9	0 to 12	0
User Defined signal 10	0 to 12	0
User Defined signal 11	0 to 12	0
User Defined signal 12	0 to 12	0

Digital inputs settings (mapped indication signal)	Applicable Range	Factory Default (digital output №)
Trip	0 to 12	1
Close	0 to 12	2
Active Protection Group 1 on	0 to 12	3
Active Protection Group 2 on	0 to 12	4
Active Protection Group 3 on	0 to 12	5
Active Protection Group 4 on	0 to 12	6
Protection on	0 to 12	7
Earth Fault on	0 to 12	8
Sensitive Earth Fault on	0 to 12	9
Hot Line on	0 to 12	10
Reclosing on	0 to 12	11
Automatic Backfeed Restoration on	0 to 12	12

Indication Signals Generated by IOI

Signal	Condition of appearance
IOI active	The signal is activated if voltage applied to any digital input exceeds the pickup level (refer to IOM technical specification for details) and the Remote mode is set On. When IOI is active, control and indication functions are supported. The signal is deactivated if voltage applied to any digital input does not exceed the dropout level (refer to IOM technical specification for details) for 15 min or the Remote mode is set Off. When IOI is passive, control functions are not supported but indication functions are supported.
IOI fault	The IOI continuously monitors the healthiness of the IOM and the IOM-RCM connection. The signal is activated when an internal IOM fault is discovered.
IOI disconnected	The signal is activated when the connection is interrupted.
Input i-th[1)] on	The signal is activated when the voltage applied to the i-th digital input exceeds the pickup level. The signal is deactivated when the voltage drops below the dropout level.
Output i-th[1)] on	If the Operation mode = Normal, “Output i-th on” signal equals to the mapped indication signal, i.e. it activates and deactivates at the same time as the mapped indication signal. If i-th output is not mapped for any indication signal, “Output i-th on” is always deactivated. If the Operation mode = Test “Output i-th on” = “Input i-th on”, i.e. the application of voltage to the particular input results in activation of relevant output.

[1)] i-th = 1...12

Control of Signals via IOI

The list of control signals available via IOI is presented in table Digital inputs settings (see Paragraph IOI settings). If “Operation mode” = Normal, and when “Input i-th on” signal is activated the IOI generates a rising edge control signal relevant for the control function mapped for the i-th digital input. When “Input i-th on” signal is deactivated the IOI generates a falling edge control signal relevant for the control function mapped for the i-th digital input.

The following table presents description of rising/falling edge control signals relevant for all applicable control functions.

Mapped Control Function	Rising Edge Control Signal	Falling Edge Control Signal
Close	Close request from IOI	NA
Trip	Trip request from IOI	NA
Group 1 on	Set Group 1 on from IOI	NA
Group 2 on	Set Group 2 on from IOI	NA
Group 3 on	Set Group 3 on from IOI	NA
Group 4 on	Set Group 4 on from IOI	NA
Prot on	Set Prot on from IOI	Set Prot off from IOI
EF on	Set EF on from IOI	Set EF off from IOI
SEF on	Set SEF on from IOI	Set SEF off from IOI
HL on	Set HL on from IOI	Set HL off from IOI
AR on	Set AR on from IOI	Set AR off from IOI
ABR on	Set ABR on from IOI	Set ABR off from IOI

Indication of Signals via IOI

The list of signals indicated via IOI is presented in the table Digital outputs settings (see Paragraph IOI settings). The i-th output relay always reflects the activation of the relevant «Output i-th on» signal, i.e. it is switched on when the signal is activated and switched off when it is deactivated. In this way the relay indicates activation of the mapped indication signal.

IOI indication data includes statuses of all inputs and outputs of input/output module. This data is indicated via MMI, PCI, TDI and TCI.

Indication

The RC provides the following indication data and signals:

Real Time Clock (RTC) Indication Data

Value	Format	Resolution
Date and time	24 or 12 hours depending on settings	1 s

Power Supply Indication Data

Event	Data type	Applicable range	Resolution
RTU supply on	Binary signal	NA	NA
First auxiliary voltage	Binary signal	NA	NA
Second auxiliary voltage	Binary signal	NA	NA
Residual battery capacity	Numerical	1 to 100%	1%
Loss of AC supply	Binary signal	NA	NA
Battery low	Binary signal	NA	NA
Shutdown	Binary signal	NA	NA
Battery fault	Binary signal	NA	NA
Battery sensor fault	Binary signal	NA	NA
RTU short circuit	Binary signal	NA	NA

Standard Indication Signals

Signal	Condition of appearance
Dummy on	Dummy mode is set from MMI or PC or SCADA or IOM
Remote on	Remote mode is set from MMI or PC
Lockout	All AR elements are in Open state, i.e. none of the AR elements is timing up its reclose time
AR initiated	Any of the AR element is timing up its reclose time
Protection active	Any protection element is timing up-, or resetting-, or issuing trip request
RC door open	RC door position switch is closed (door open)
RCM fault	Internal fault of RCM (Recloser Control Module) was found
Malfunction	Malfunction was found (RCM fault, Driver fault, Battery fault, Battery sensor fault, IOM fault, BTM fault, DCE fault, BTM short circuit, OSM coil short circuit, RTU short circuit, DCE initialization error, BTM initialization error, Excessive trip time, Excessive close time)
Warning	Warning message (Shutdown, Battery should be exchanged, Low battery found, Loss of AC supply, RTU supply off, OSM coil isolated, Driver not ready, IOM disconnected, RTC reset, BTM not connected, DCE not connected)

Protection Statuses

Signal	Condition of appearance
Prot on/off	Protection element is enabled/disabled
Autoreclosing on/off	Autoreclosing is enabled/disabled for all protection elements with autoreclosing functionality
EF on/off	Earth fault element is enabled/disabled
SEF on/off	Sensitive earth fault element is enabled/disabled
HL on/off	Hot line element is enabled/disabled
ABR on/off	Automatic backfeed restoration element is enabled/disabled
Group i-th on	Group i-th is active

Identification Data

Data point	Data type
MPM manufacturing number	Numerical
DRVM manufacturing number	Numerical
PSM manufacturing number	Numerical
MPM software version	String
DRVM software version	String
PSM software version	String

Control of Data and Signals

Control of data and signals is provided via MMI, PCI, TCI, TDI and IOI.
General control data available via different interfaces (refer to relevant interface description for details):

Control Data	MMI	PCI,TDI	TCI	IOI
Trip Request	✓	✓	✓	✓
Close request	✓	✓	✓	✓
Set Prot on/off	✓	✓	✓	✓
Set AR on/off	✓	✓	✓	✓
Set EF on/off	✓	✓	✓	✓
Set SEF on/off	✓	✓	✓	✓
Set HL on/off	✓	✓	✓	✓
Set ABR on/off	✓	✓	✓	✓
Set Group 1 on	✓	✓	✓	✓
Set Group 2 on	✓	✓	✓	✓
Set Group 3 on	✓	✓	✓	✓
Set Group 4 on	✓	✓	✓	✓
Set Dummy on/off	✓	✓	✓	✓
Erase protection counters	✓	✓	✓	
Erase energy meters	✓	✓	✓	
Erase logs	✓	✓	✓	
Erase TCI counters	✓	✓	✓	
Set Remote/Local mode	✓	✓		
Switch RTU supply on/off	✓	✓		
Set Date and time	✓	✓	✓*	
Set Total CO	✓	✓		
Set Contact wear	✓	✓		
Change Protection password	✓	✓		
Change Comms password	✓	✓		
Change System password	✓	✓		

* - with DNP3 only

Product Line

8

Outdoor Circuit Breaker (OSM)

Type	Rated voltage	Rated short-circuit breaking current	Rated current	Type designation
	kV	kA	A	
OSM/TEL	15.5	16	630	OSM/TEL-15.5-16/630-204
	27	12.5	630	OSM/TEL-27-12.5/630-205

Accessories

Product	Description	Order Number
Set of protective covers (6 pcs)	Rubber cover (1 pcs) for protection of connection places from environmental effects. The set of these covers (6 pcs) is included in OSM package, but if it was incorrect cut during installation it can be ordered separately.	RecKit_Ins_OSM-Al
Secondary plug	Components for assembling of Plug for connecting of CM and other equipment to Harting terminal Han-K 8/24 type which is placed on the Protective lid of OSM Assembling of Plug is given on the page 40	RecKit_Plug_OSM-Al
OSM pole mounting kit with fixing hardware	Hot-dip galvanized metal bracket for OSM installation on a pole. Includes provisions for surge arrestors installation.	MountKit_OSM15_Al(Standard1)
OSM pole mounting kit without fixing hardware	Hot-dip galvanized metal bracket for OSM installation on a pole. Includes provisions for surge arrestors installation.	MountKit_OSM15_Al(Standard2)
Set of NEMA terminal connectors (6 pcs)		RecKit_Con_OSM(NEMA)
Set of U-bolt terminal connectors (12 pcs)	The set of U-bolt terminal connectors is included in OSM package, but it can be ordered separately.	RecKit_Con_OSM(U-BOLT)

8

Recloser Control (RC)

Product	Order Number
Recloser Control, series 05E (English MMI Label)	RC/TEL-05E
Recloser Control, series 05P (Portuguese MMI Label)	RC/TEL-05P

Recloser Control Modules

Product	Order Number
Recloser Control Module	RCM/TEL-02
Control Panel Module (English MMI Label)	RecComp_MMI_CPM-1(EN)
I/O Module for 12/24/30/48/60 VDC	IOM/TEL-12/60-02
Control Panel Module (Portuguese MMI Label)	RecComp_MMI_CPM-1(PT)
I/O Module for 100/110/125/250 VDC	IOM/TEL-100/250-02
Power Supply Filter Module	PSFM/TEL-01
Bluetooth Module (Includes USB Cable)	RecComp_BTM_1

Recloser Control Components

Product	Order Number
Wiring Assembly for RCM-CC connection	WA:RCM-CC
Wiring Assembly for RCM-CPM connection	WA:RCM-CPM
Wiring Assembly for RCM-BAT connection	WA:RCM-BAT
Wiring Assembly for RCM-RTU connection	WA:RCM-RTU
Door Position Switch with cable	WA:RCM-DPS
Rechargeable Battery	Genesis G26EPX EnerySys 0765-2003

Control Cables

Product	Order Number
Control Cable, 5 m	RecComp_Umbilical_1(5)
Control Cable, 7 m	RecComp_Umbilical_1(7)
Control Cable, 12 m	RecComp_Umbilical_1(12)

Dimensions 9

Dimensions of the OSM

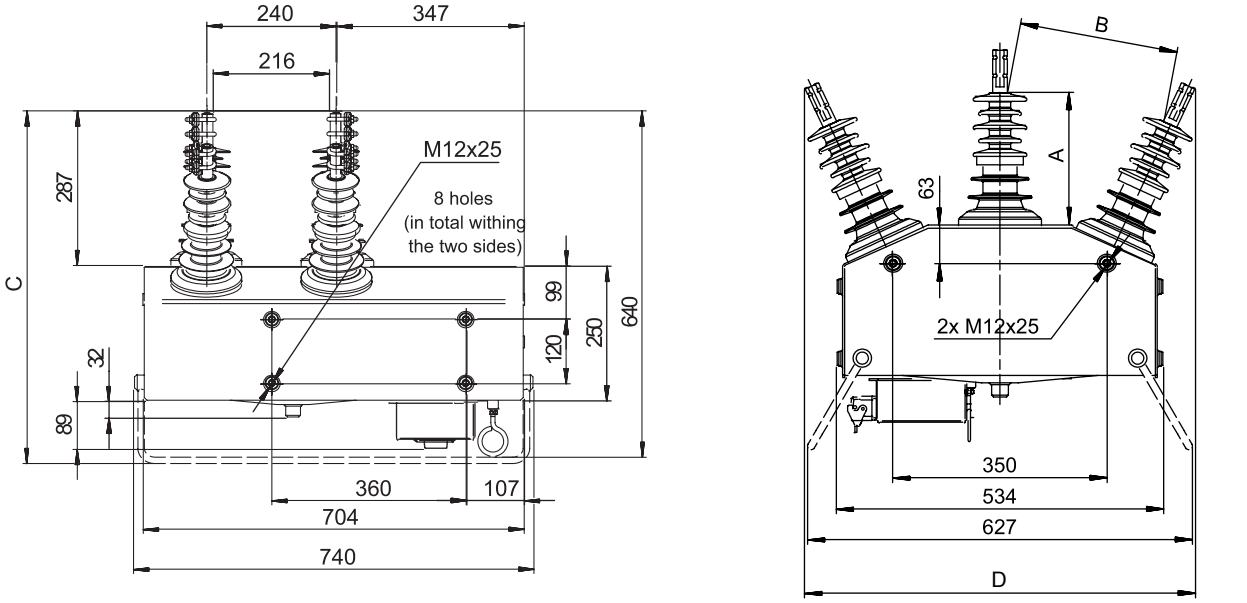


Figure 64

OSM Dimensions

Rated voltage, kV	Dimensions, mm						Weights, kg
	A	B	C	D	Creepage distance	Minimum taut string distance	
15.5	216	260	652	637	500	203	62
27	296	294	731	703	860	203	72

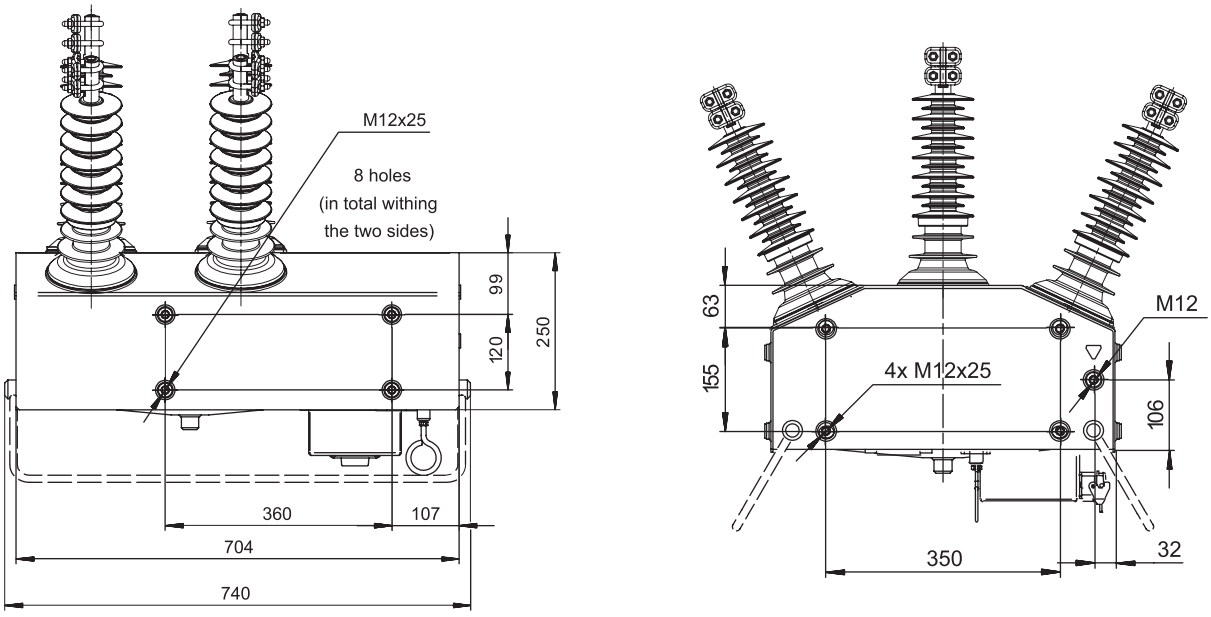


Figure 65

Dimensions of Mounting provisions

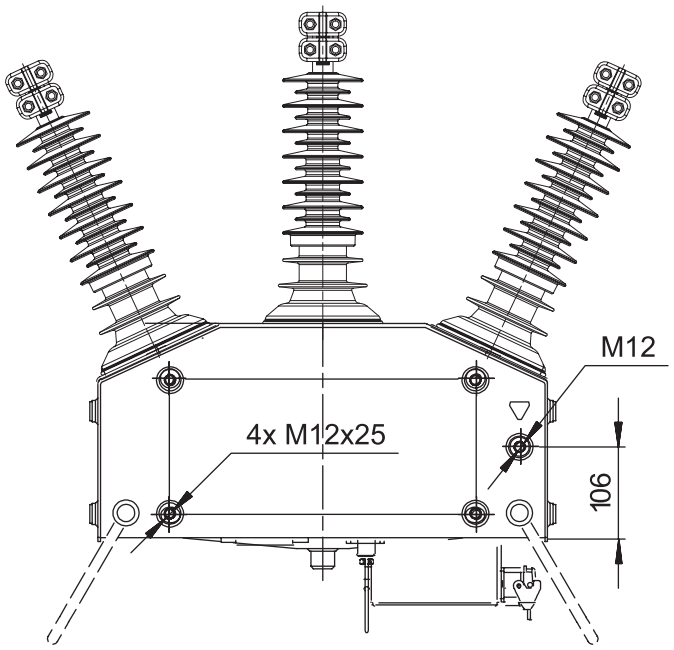


Figure 66

Dimensions of Earthing provision

Dimensions of the RC

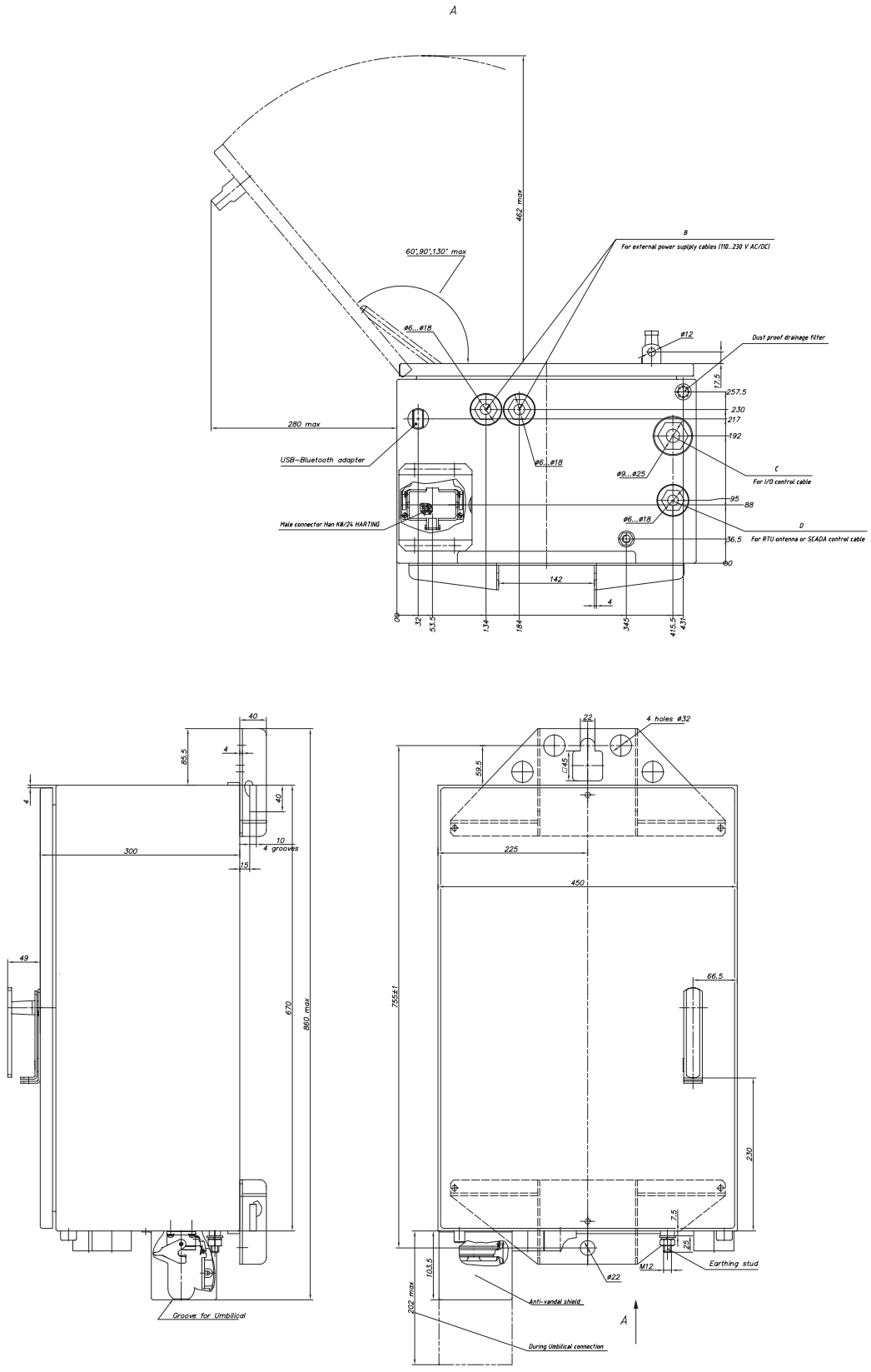


Figure 67

Dimensions of RC/TEL-05

OSM Mounting Bracket

OSM mounting bracket is universal and can be used on wooden and concrete poles. The mounting bracket is complimented with surge arrestors brackets and can be complimented with PT bracket. Please contact your nearest Tavrida Electric partner for further information:

Application sample for round wooden pole

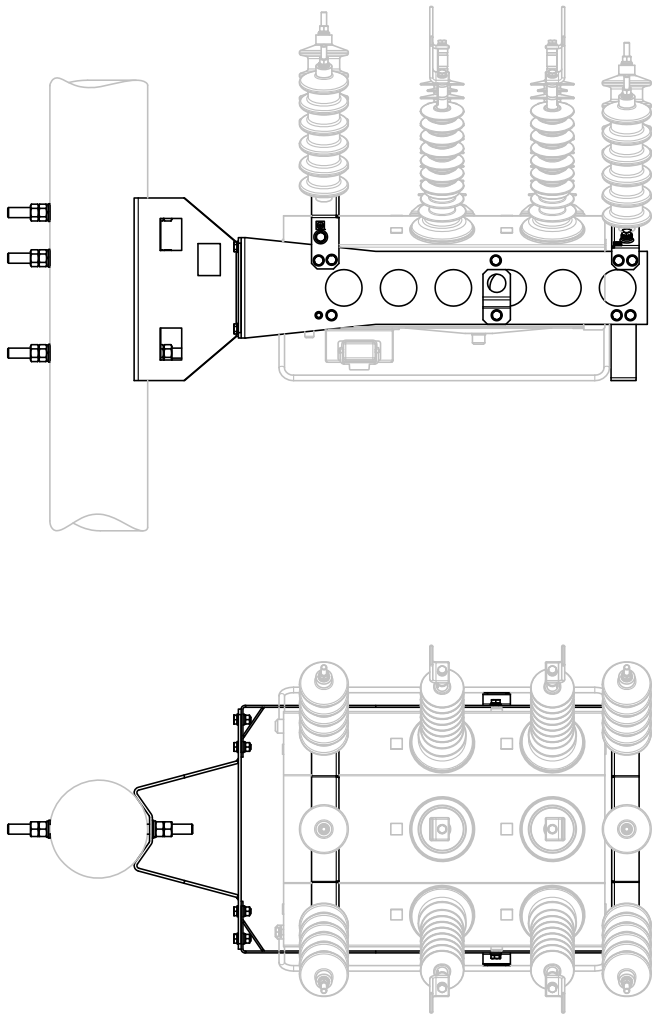


Figure 68

OSM mounting kit on wooden pole

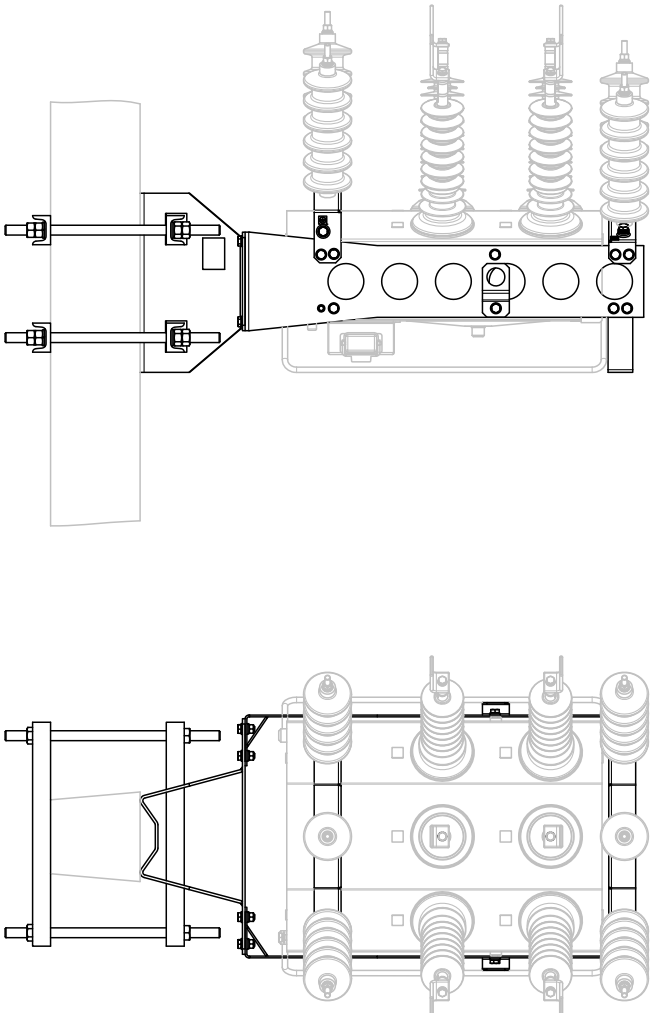
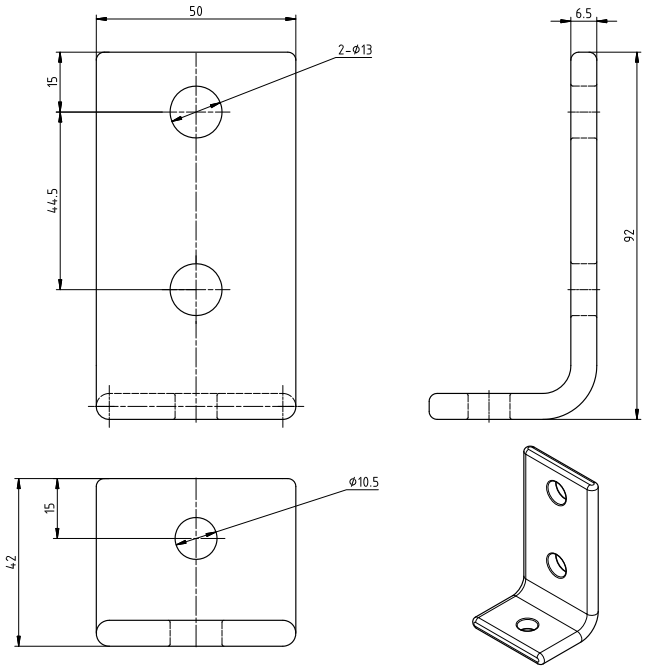


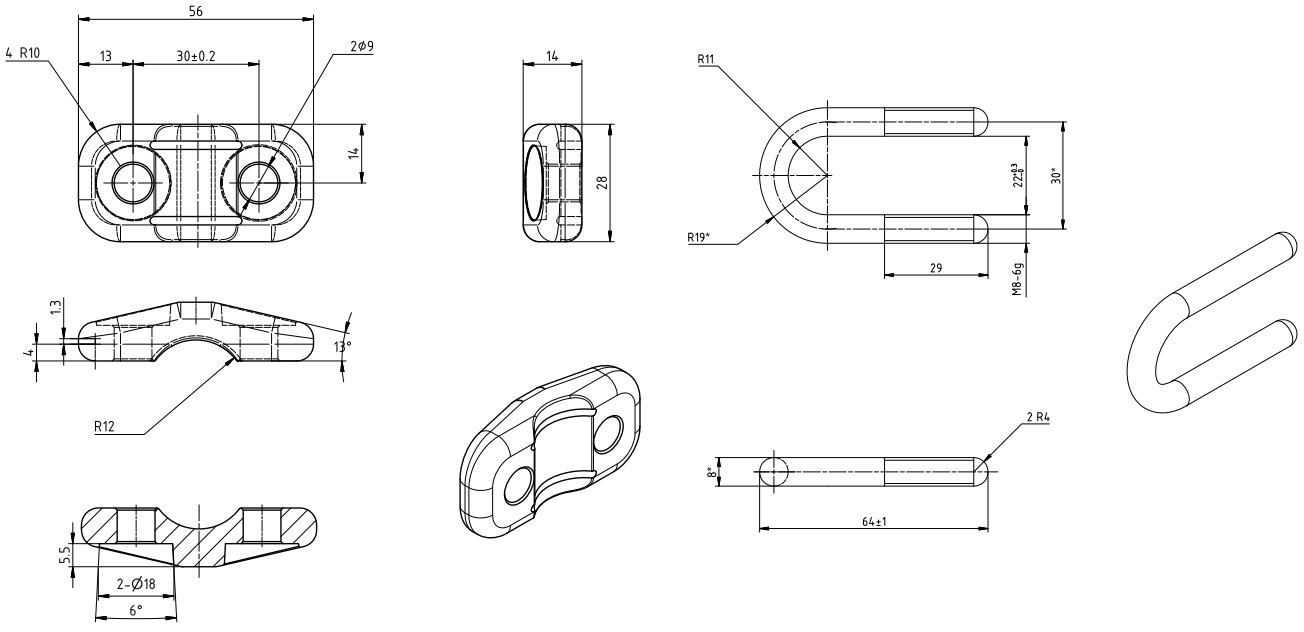
Figure 69

OSM mounting kit on concrete trapezoidal pole

Dimensions and Weights of Terminal Connectors



NEMA terminal connector
Weight: 0.3 kg RecKit_Con_OSM(NEMA)



U-bolt terminal connector
Weight: 0.3 kg RecKit_Con_OSM(U-BOLT)

Technical Data 10

Outdoor Circuit Breaker (OSM)

Basic Operating Parameters	OSM/TEL 15.5-16/630-204	OSM/TEL 27-12.5/630-205
Rated data		
Rated voltage (U_r)	15.5 kV	27 kV
Rated power frequency withstand voltage (U_d), 1 min dry	50 kV	60 kV
Rated power frequency withstand voltage, 10s wet	45 kV	50 kV
Rated lightning impulse withstand voltage (peak) (U_p)	110 kV	125 kV [1)]
Rated current (I_r)	630 A	
Cable charging current	10 A	25 A
Line charging current	2 A	5 A
Rated short-circuit breaking current (I_{sc})	16 kA	12.5 kA
Rated peak withstand current (I_p)	40 kA	31.5 kA
Rated short-time withstand current (I_k)	16 kA	12.5 kA
Rated duration of short circuit (t_k)	4 s	4 s
Rated frequency (f_r)	50/60 Hz	
Switching performance		
Mechanical life [2)] (CO-cycles)	30 000	
Operating cycles [2)], rated current (CO-cycles)	30 000	
Operating cycles [2)], rated–short circuit breaking current (CO-cycles)	200	
Closing time [3)], not more than	77 ms	
Opening time [3)], not more than	32 ms	
Break time [3)], not more than	42 ms	
Rated operating sequence	O-0.1s-CO-1s-CO-1s-CO	
Standards		
Standards	IEC 62271-100 IEC 62271-111 IEEE C37.60 - 2003	
Other data		
Resistance of main circuit	< 85 µOhm	< 95 µOhm
Weight	62 kg	72 kg
Altitude	3000 m (above 1000m derating according to ANSI C37.60)	
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 defined in IEC 60815)	

Parameters of sensors

Parameter	Phase current sensors	Earth current sensor	Voltage sensors
Rated frequency		50 Hz, 60 Hz	
Range where accuracy is guaranteed	1-8000 [4] A	4 ... 8000 [4] A	0.3 ... 16 kV
Operating temperature range [5] (T)		-40 °C ... +95 °C	
Coefficient	1.95 ... 2.04 V/kA	1.93 ... 2.02 V/kA	0.11 ... 0.13 V/kV
Accuracy at 20 °C		± 0.5 %	± 1 %
Additional temperature error limits		-0.015·(T-20) %	-0.1·(T-20) %
Additional error from direct sequence current (I_1)	-	$\pm(3.5\cdot10^{-3}+0.03\cdot10^{-3}\cdot T)\cdot I_1$	-
Phase error in the operating temperature range		-0.2 ... 0 degrees	0 ... 1.2 degrees

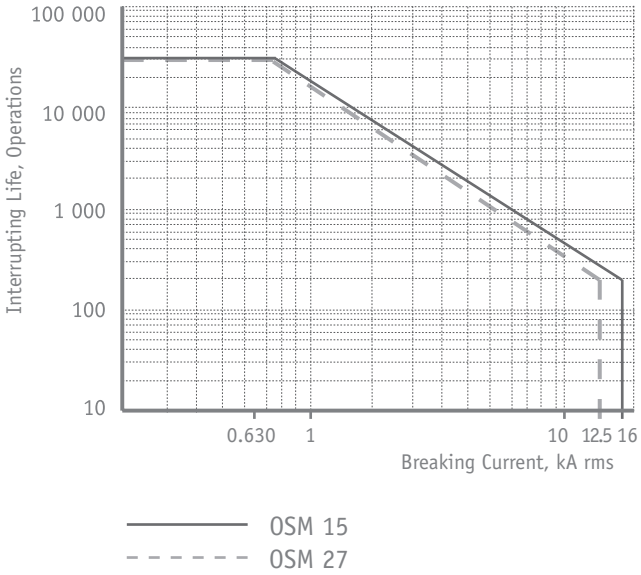


Figure 70

Service Life of OSM

Notes:

[1] 150kV BIL on request

[2] See Figure 70

[3] In combination with the associated RCM

[4] The Rogowski coil can measure current in a wide range but in order to protect a cable of the sensors and the control cable against overvoltages excess-voltage suppressors are fitted in the intermediate unit. These suppressors chop signal from the Rogowski coil if current is greater than 8 kA.

[5] The temperature of the sensors should be calculated as T=Ta+Tc+Ts.
Where: Ta - ambient temperature, Tc= 0...25 °C – additional heating from current.
Ts= 0...15 °C – additional heating from solar radiation.

Recloser Control (RC)

Basic Operating Parameters	Value
Rated frequency	50/60 Hz
Rated cubicle (auxiliary) AC supply voltage	85 ... 265 V
Operating duty cycle	O-0.1s-CO-1s-CO-1s-CO
Degree of protection	IP54
Temperature range	-40 °C ... +55 °C
Maximum humidity	100 %
Maximum attitude above sea level	2000 m
Vibration endurance (Pole mounted)	IEC 60255-21-1 Class 1
Vibration response (Pole mounted)	IEC 60255-21-1 Class 2
Shock withstand (Pole mounted)	IEC 60255-21-2 Class 1
Shock response (Pole mounted)	IEC 60255-21-2 Class 2
Bump	IEC 60255-21-2 Class 1
Seismic	IEC 60255-21-3 Class 1
Operating time after loss of auxiliary supply [1], hours, not less: - at 25°C - at -40°C - at +55°C	 48 12 48
RTU power supply: - voltage range - max output power - max output power at 0.5 duty cycle (range 12-15 V)	 5...15 V, step 0.5 V 15 W 30 W
Maximum power consumption of RC from auxiliary supply	60 W
Weight [2]	29 kg
Dimensions (w x h x d)	450x860x390 mm

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Notes:

[1] Without providing power for RTU and USB, without IOM, CPM off

[2] Battery, IOM, RTU and tare are not included

Measurement accuracy

Measured value	Basic error	Ranges where accuracy is guaranteed
Phase to earth voltages	The greater of ±1.0% or ±0.1 kV	0.3…16.0 kV
Line to line voltages	The greater of ±1.0% or ±0.1 kV	0.5…27.0 kV
Phase currents	The greater of ±1% or ±2A	0…630 A
Active, reactive and total power	±2%	40 … 630 A, 4.5 … 27 kV
Residual current at $I_1/3I_0 \leq 25$	The greater of ±5% or ±0.5A	0…400 A
Frequency - at dF/dt<0.2Hz/s - at dF/dt<0.5Hz/s	 ±0.025Hz ±0.05Hz	 45…55 Hz, 55…65 Hz
Power factor	±0.02	0 … 1
Active and reactive energy	±2%	40…630 A, 4.5…27 kV

Notes:

1) Applicable for sensor conversion coefficients:
   - current sensor - 2.0 V*kA
   - voltage sensor - 0.135V*kV

2) The additional error caused by temperature variation shall not exceed ±2BE where BE is the basic error specified above.

Filtering

Parameter	Value
Harmonics rejection rates for voltages, not less than - second - third - fifth	 40 dB [1 / 100] 40 dB [1 / 100] 40 dB [1 / 100]
Harmonics rejection rates for currents, not less than [1] - second - third - fifth	 40 dB [1 / 100] 46 dB [1 / 200] 50 dB [1 / 317]
Noise rejection rates, not less than - Low frequency noise [2]: 350 Hz < Fnoise < 10000 Hz - High frequency noise [3]: 80 kHz < Fnoise < 200 kHz	 20dB + 20log (Fnoise / 350) 40 dB [1 / 100]
Response delay to the step change of input current or voltage, ms - at output value changed by 95% of the input step	35

Notes:

[1] Because of Rowgowski sensor amplitude vs frequency dependency

[2] Immunity on sympathetic inrush, poor arcing noises, etc. See also Figure 71

[3] Distribution line resonances noise immunity

Low frequency noise rejection

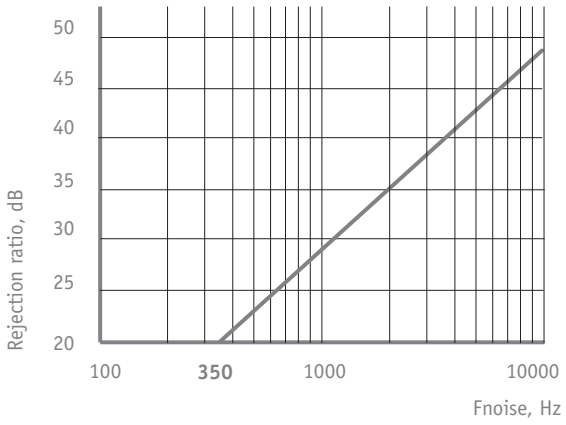


Figure 71

Protection accuracy

Parameter	Basic error	Ranges where accuracy is guaranteed
Operational pickup current [1)] - for phase overcurrent elements - for earth overcurrent elements	 the greater of ±2% or ±2A the greater of ±5% or ±1A	 10-6000A 4-1280A
Phase accuracy	±2°	at U1 ≥ 0.5 kV and I1 ≥ 40A
Operational pickup voltage [1)]	the greater of ±1% or ±0,1kV	0.5 … 30kV
Operational pickup frequency	±0.05Hz	45 … 55Hz for Frated=50Hz 55 … 65Hz for Frated=60Hz
Tripping time for time current characteristics:	the greater of:	
- definite time at 1.05xIp	+1%/-1%; +35ms/-10ms	0-120s for all time current characteristics
- definite time at 2xIp	+1%/-1%; +25ms/-10ms	
- definite time at 5xIp	+1%/-1%; +15ms/-10ms	
- definite time at 10xIp	+1%/-1%; +10ms/-10ms	
- ANSI: I/STI/LTI; IEC: I at 2xIp	+3%/-3%; +35ms/-10ms	
- ANSI: I/STI/LTI; IEC: I at 5xIp	+3%/-3%; +35ms/-10ms	
- ANSI: I/STI/LTI; IEC: I at 10xIp	+3%/-3%; +30ms/-10ms	
- ANSI: I/STI/LTI; IEC: I at 20xIp	+3%/-3%; +25ms/-10ms	
- IEC: VI/LTI at 2xIp	+3%/-3%; +40ms/-10ms	
- IEC: VI/LTI at 5xIp	+3%/-3%; +35ms/-10ms	
- IEC: VI/LTI at 10xIp	+3%/-3%; +35ms/-10ms	
- IEC: VI/LTI at 20xIp	+3%/-3%; +35ms/-10ms	
- ANSI: EI/VI/STEI/LTEI/LTVI; IEC: EI at 2xIp	+3%/-3%; +50ms/-10ms	
- ANSI: EI/VI/STEI/LTEI/LTVI; IEC: EI at 5xIp	+3%/-3%; +50ms/-10ms	
- ANSI: EI/VI/STEI/LTEI/LTVI; IEC: EI at 10xIp	+3%/-3%; +50ms/-10ms	
- ANSI: EI/VI/STEI/LTEI/LTVI; IEC: EI at 20xIp	+3%/-3%; +40ms/-10ms	

Notes:

[1)] Applicable for sensor conversion coefficients:

· current sensor - 2.0 V*kA

· voltage sensor - 0.135V*kV

10

Electromagnetic compatibility (EMC) requirements

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

I/O Module (IOM)

Digital inputs	Value
Rated voltages - for IOM/TEL-12/60-02 - for IOM/TEL-100/250-02	 12/24/30/48/60 V DC 110/125/220 V DC
Pickup voltage - for IOM/TEL-12/60-02 - for IOM/TEL-100/250-02	 Above 7 V Above 100 V
Reset voltage - for IOM/TEL-12/60-02 - for IOM/TEL-100/250-02	 Below 3 V Below 30 V
Maximum continuous voltage - for IOM/TEL-12/60-02 - for IOM/TEL-100/250-02	 75 V 275 V
Input resistance - for IOM/TEL-12/60-02 - for IOM/TEL-100/250-02	 3 kOhm 125 kOhm
Recognition time	20 ms
Reset time	20 ms

Contacts of output relays	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)

Rechargeable Battery (BAT)

BAT parameters	Value
Type	G26EPX EnerSys 0765-2003 sealed lead acid
Rated voltage	12 V
Rated capacity	26 Ah
Temperature range	-40 °C...+55 °C
Maximum amount 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 %
Float life, years - at +20°C - at + 25°C - at +30°C - at +40°C	 16 10 6.5 2.7

Installation 11

Inspection

Inspect the Recloser prior to installation. If a critical damage is found please contact your nearest Tavrida Electric office or agent.

RC Cubicle Preparation

RC/TEL-05
Open the external door of the RC and fix it in the open position with the fixing rod. Unscrew the two captive screws fixing the internal door and open the internal door. Unscrew the two captive screws fixing the bottom panel and remove the panel (Fig. 29).

Installation of Rechargeable Battery

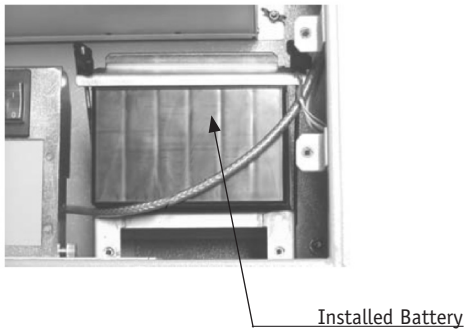


Figure 72
Installed Battery

- Switch off the Battery circuit breaker located on RCM (marked as SF1 AB).
- Install the battery as shown in Fig. 72.
- Loosen the wing nuts, move the battery-holder on its near overhead edge and tighten the wing nuts.
- Remove the temporary cable ties fixing the WA: RCM-BAT and connect to the battery terminals as shown in Fig. 73 (the plus clamp must be connected first)
- Switch on the Battery circuit breaker SF1 AB

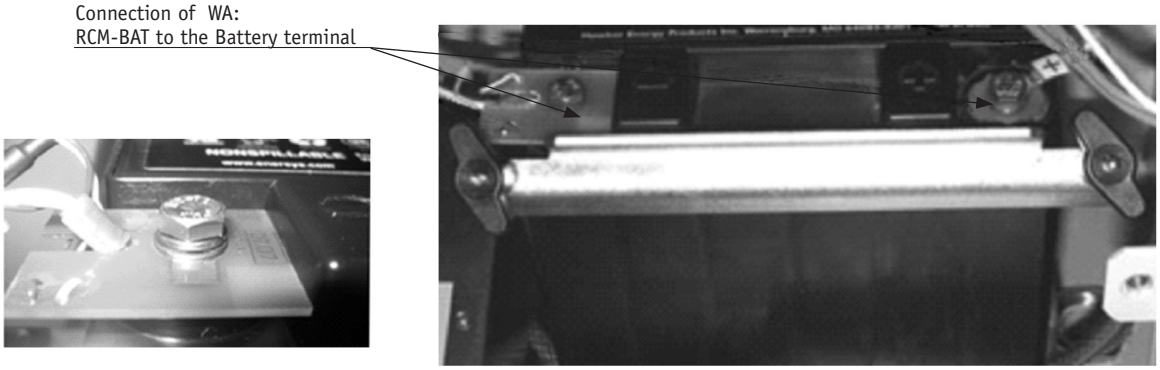


Figure 73
Connection to Battery terminals

Installation of RTU

· Unscrew the two M5 captive screws and remove the RTU mounting tray (Fig. 74).
· Unscrew the five screws and remove the insulating plastic mounting plate.
· Drill appropriate holes in the plate to fit particular RTU.
· Install the RTU on the plate.
· Install the plate with the RTU on its regular position and fix it with five M3 screws.
· Install the RTU mounting tray on its regular position on RCM.
· Remove the temporary cable tie fixing the WA:RCM-RTU and connect the plug “23” to RTU (Fig. 74)
· Connect the RTU to the connector “10” of the RCM (cable not included, to be provided by user). See Fig. 50 for recommendations for connection of wires to WAGO cage clamps.
· Remove the plastic cap from the gland for RTU antenna (Fig. 28) using the box spanner (Fig. 31).
· Lead out RTU antenna through the cable gland. Screw gland nut tightly using gland grommets to provide reliable antenna fixing.
· Install EMI cable shield on the antenna and fix shield and antenna with cable ties.

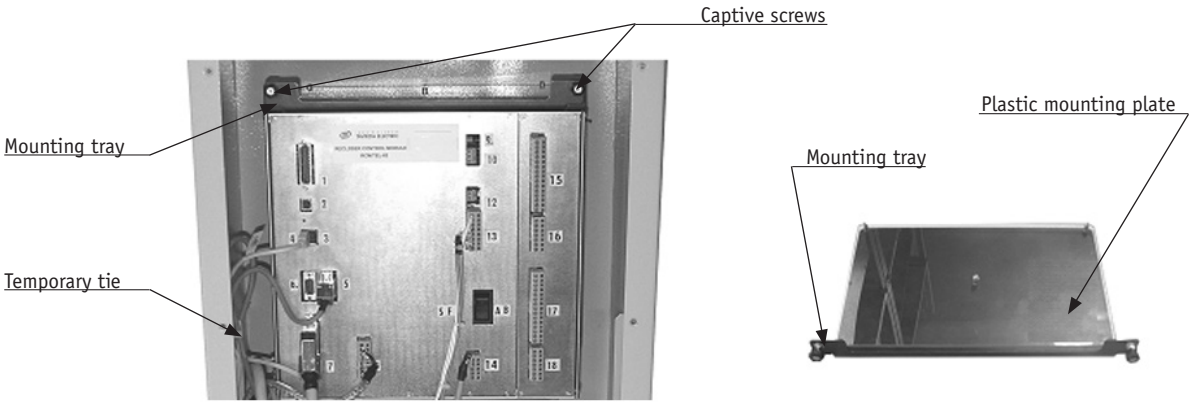


Figure 74
Installation of RTU on tray

Installation of I/O Module

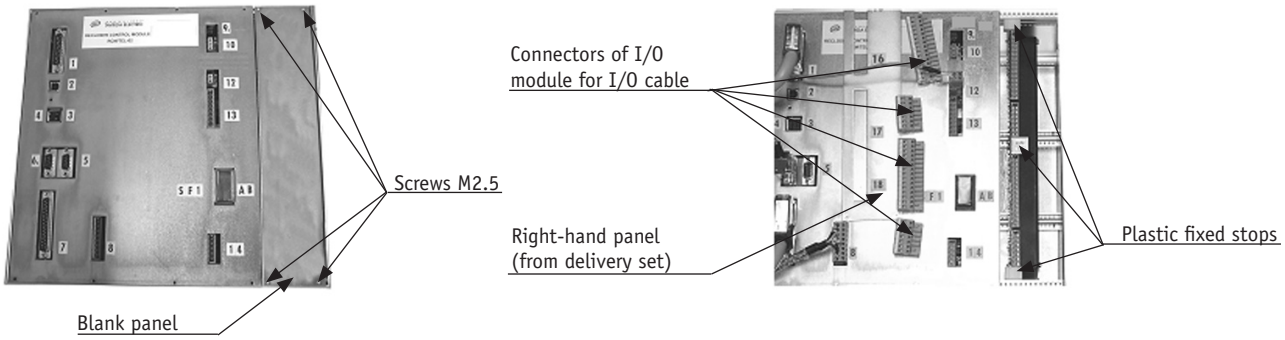


Figure 75

Installation of I/O Module

· Unscrew four screws M2.5 on the right-hand blank panel of the RCM and remove it (Fig. 2)
· Remove the plastic fixed stops (Fig. 75).
· Install the I/O module to its regular position.
· Install the plastic fixed stops.
· Install the panel taken out of the IOM delivery set and fix it with four screws M2.5 (Fig. 75).
· Remove plastic cap from the gland with the aid of box spanner (Fig. 31).
· Feed in the I/O control cable through the cable gland. Fix the gland nut tightly with the box spanner.
· Install the EMI cable shield on the cable as shown in Fig. 28. Refer to delivery set for details.
· Fix the EMI cable shield and the I/O control cable-by-cable ties.
· Connect I/O control cable to the required RCM connectors ("15"..."18"). Follow the recommendations provided for the connection of wires to WAGO cage clamps in Chapter 3 under section Small wiring Terminations.

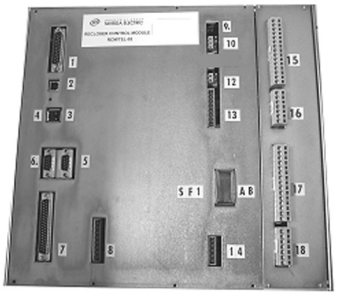


Figure 76

Installed I/O Module

11

Connection of Power Supply Cables

Before connection to auxiliary power:
1) Earth the control cubicle (conductor size min 1.5 mm^2) using its earthing stud (M12 on the bottom)
2) Disconnect existing earthing jumpers from RC AC power connectors when RC is supplied from LV phase to earth power supply. (Fig. 77)

Warning

Failure to comply can result in death, personal injury or equipment damage.

The RC cubicle can be fitted with two separate AC supplies. It allows connection of auxiliary voltage in the range 85...265 V AC.

The RC is supplied with installed earthing jumpers that connect the neutral inputs of both auxiliary supplies to the RC metal enclosure (fig. 77). This is required for the typical application when phase-to-phase auxiliary voltage from VT is used, to protect electronics against overvoltages occurring in case of BIL impulses on primary side. However for testing purposes in the workshop when LV phase to earth voltage is used, these earthing jumpers must be removed to avoid possible short-circuit through cubicle earthing if line and neutral wires were accidently swapped.

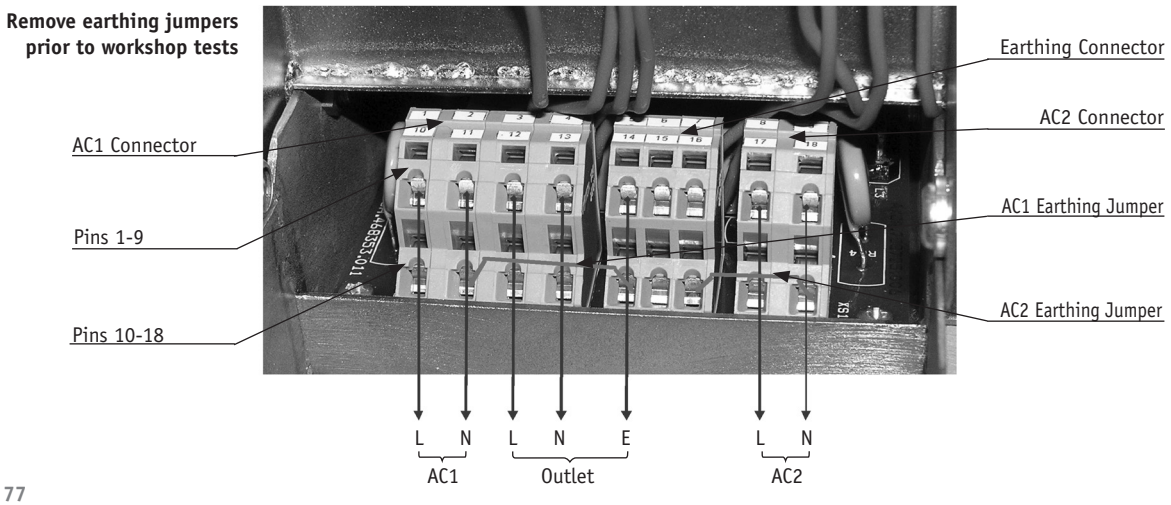


Figure 77

Auxiliary supply connections inside PSFM

- Make sure that the OSM and RC are earthed.
- Open the external and internal door, unscrew captive screws on the bottom panel and remove it.
- Unscrew two captive screws on sides of PSFM and open it.
- Unscrew power cable glands (with the aid of the box spanner from RC tool kit) and remove plastic caps from them.
- Feed in the power supply cables through the cable glands.
- Clamp cable gland nuts tightly using gland grommets.
- Connect the wires of the power supply cables to the relevant contacts of PSFM connectors as shown in Fig. 77. See Fig. 45 for recommendations for connection of wires to WAGO cage clamps.
- Close PSFM and fix it with two captive screws.
- Install the bottom panel in its regular position and fix it by two captive screws.

Programming of Calibration Coefficients

For measurement within specification, each OSM requires a set of calibration coefficients for current and voltage to be programmed into the RC Cubicle memory. These coefficients are provided in routine test certificate on each OSM switching module. For programming through Control Panel Module (CPM) go to 'Main Menu'→'Settings'→'System'→'ME Measurement'. (Refer to Fig. 90). Alternately the TELARM software can be used to set the calibration coefficients.

Caution

Incorrect measurement coefficients may result in performance outside of specified accuracy for voltage and current measurement.

OSM Preparation

Fitting of Lifting lugs

Bolt down the lifting lugs (supplied with the Mounting kit) to the provisions on the tank and tighten to 30Nm (refer to Fig. 2).

Fitting of the Mechanical Trip Hook

The Mechanical trip hook is supplied with OSM and should be installed prior to OSM testing.

1. Lift the OSM to a comfortable height.
2. Screw the M8 retaining nut to the end of the thread of the hook.
3. Screw the hook into the mechanical trip mechanism underneath the tank. Do not screw in all the way.
4. Hold the trip hook in position so it won't move and tighten to 10Nm against the trip mechanism using a 13mm spanner as shown in Fig. 78.

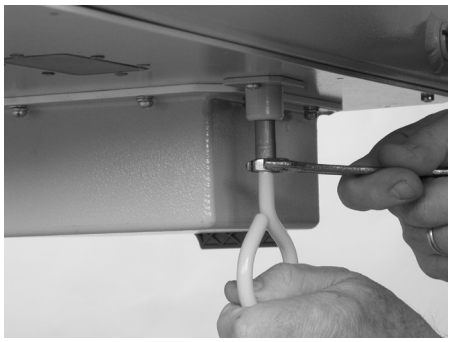


Figure 78

Fitting of the mechanical trip hook

Caution

The Mechanical trip hook is held in place by the retaining nut. Do not allow the mechanism to twist when installing the hook as it can be damaged.

Connection of Control Cable

The control cable was tested during factory testing. Inspect the connectors to ensure they have not been damaged in transit. Also inspect the length of the cable to ensure it has not been crushed or otherwise damaged.

Connect the control cable to the plug in the base of the recloser and secure it using the integral clamping arrangement.

To connect the Control cable to RC:

- Open external and internal door and remove the bottom panel.
- Unscrew four wing nuts inside the housing (Fig. 30).
- Remove the protective cover (anti-vandal shield) (Fig. 30).
- Connect Control cable.
- Install the protective cover on its regular position and fix it with four wing nuts.

Testing

The RC control is shipped with default System, Protection and Communication settings. All the tests described below can be carried out with default settings once AC supply and OSM are connected. Prior to commissioning, the correct settings for the intended application must be programmed. Refer to section Configuration of Settings in this Chapter.

Control Panel Module Testing

CPM testing includes pushbutton functionality testing in MMI Test mode and LCD pixels testing. Refer to On/Off/Test Pushbutton in Chapter Indication and Control for testing of CPM.

Power Supply Testing

1. Apply AC power to desired power supply input of RC (see section "Connection of power supply" in this chapter). Check that backlight of corresponding thermal overcurrent circuit breaker is ON. (Fig. 28)
2. Switch ON the thermal overcurrent circuit breakers.
3. Switch on the control panel by pressing ON/OFF pushbutton of CPM.
4. Go to 'Indication Data' → 'PSE Power Supply. Check presence of AC input voltage indication and the residual battery capacity indication.

OSM Operation Testing

To confirm the OSM and RC are functioning correctly:

1. Press the ON button on the RC cubicle operator panel, confirm that the position LED is lit and complies with the position indicator onboard the recloser. If necessary, press the green trip button and confirm the recloser opens, the OPEN LED is lit and the indicator shows the correct status.
2. Press the red CLOSE push button and confirm that the recloser closes and the CLOSED LED is lit.
3. Use the mechanical trip ring to affect a mechanical trip, ensure the mechanism is fully withdrawn.
4. Press MALF LOG push button and confirm that 'OSM Coil Isolated' appears to indicate that the recloser is unable to be closed. Confirm that pressing the CLOSE push button does not cause the recloser to close, press the ESC key to return to 'MAIN MENU'.
5. Push the mechanical trip ring back into the operating position and confirm that pressing the close pushbutton causes the recloser to close.
6. Go to 'Settings' → 'System' → 'ME Measurement' on MMI and confirm that the OSM Measurement coefficients match those on the testing document supplied with the OSM recloser.
7. Ensure the OSM is in the closed position.
8. From MMI MAIN MENU go to 'Indication Data' → 'ME Measurement' . Inject primary current, one phase at a time and confirm that indications of phase and earth current are correct in each case.

HV Testing

All Tavrida Electric switching devices pass ANSI C37–60 requirements for power frequency and partial discharge testing prior to dispatch from the manufacturer.

Power frequency testing prior to installation is recommended to ensure that no damage has occurred during transit. Application of the full withstand voltage is not required; testing to 80% is recommended to confirm insulation integrity without unduly stressing insulating components. The recommended test voltage for power frequency testing is:

Equipment Rating	Recommended 1minute Test Voltage
15kV	42kV
27kV	50kV

Warning

Inappropriate grounding of the recloser, cubicle or test equipment will apply hazardous voltage that may result in personal injury or death or equipment damage.

Only personnel trained in HV testing should carry out the tests described in this section.

HV should be applied to the OSM HV terminals. Follow the procedure below for OSM recloser HV testing. The OSM recloser should be tested with RC and control cable connected and earthed as described below. The recloser should be tested in the CLOSED position.

- Apply an earth (min 1.5 mm^2) from the OSM earth point to the RC earth point and then to the HV test set earth point.
- Where a single phase HV test set is being used, tie the three phases together, on one side only, using fusing wire or test each phase individually as preferred.
- Select 'Indication Data' → 'Measurement' from the RCM panel Main Menu. Energize the recloser terminals to system phase to ground voltage, confirm voltage indications for each terminal.
- Apply a slowly rising AC voltage to the OSM HV circuit. Increase the voltage to 42kV for OSM15 or 50kV for OSM27 and then keep the voltage steady for 1 min.

Test Completion

1. Turn the Operator Panel OFF using the ON/OFF pushbutton and disconnect the Auxiliary supply.
2. Turn the battery OFF.
3. If a phase-to-phase AC supply from VT (single or double side) is to be connected on site, restore the earthing jumpers into their original position, as shown on Fig. 81.
4. Disconnect the control cable from OSM and RC.

Configuration of Settings

The RC cubicle must be programmed by a competent technician with knowledge of the equipment and the intended protection application.

Settings can be manually entered using the MMI or transferred using the PC based TELARM software. This can be done either on site or in the workshop as preferred.

For description of measurements, protections and their settings see chapter 4 and 5.
For configuration of settings via operator control panel see chapter 7.
For configuration of settings via PC see TELARM Software User Guide.

Configuration of System Settings

N	System Settings	Range	Factory default	Recommendations
Configuration				
1.	Recloser type	Radial/Ring	Radial	Select type “Ring” if recloser is applied for open ring feeder, otherwise select type “Radial”
2.	Rated voltage, kV	6.00-27.00	11.00	Set average value for particular network. Note that settings of undervoltage, voltage reclosing and voltage unbalance control elements are set as multiples of this setting.
3.	Rated frequency, Hz	50/60	50	Select applicable frequency
4.	Source + title	50 characters	Source	Set the name of a line from Source + side
5.	Source + title	50 characters	Load	Set the name of a line from Source + side
6.	Source + side terminals	X1X2X3/ X4X5X6	X1X2X3	Set contacts for connection of source + side terminals
7.	Wire to terminals connection	ABC/ACB/BAC/ BAC/CAB/CBA	ABC	Set sequence of wires to terminals connection
8.	CPM mode	Enable/Disable	Enable	Set Enable when CPM is connected, otherwise set Disable
9.	IOM mode	Enable/Disable	Disable	Set Enable when IOM is connected otherwise set Disable.
10.	BTM mode	Enable/Disable	Disable	Set Enable when Bluetooth is connected otherwise set Disable.
11.	RTU mode	Enable/Disable	Enable	Set Enable when RTU is connected otherwise set Disable.
Measurement				
12.	Umbilical length	0 to 12 m	7 m	Set the length of the applied umbilical cable. Note that declared accuracy of voltage sensor is guaranteed only if cable length is properly set. Zero setting is used for testing RC rated measurement accuracy without umbilical
13.	CIX1	(1.8-2.2) V/kA, step size 0.0001V/kA	2.0 V/kA	Set value taken from production certificate of relevant OSM
14.	CIX2			
15.	CIX3			
16.	CIn			
17.	CUX1	(0.1-0.2) V/kV, step size 0.0001V/kV	0.1200V/kV	Set value taken from production certificate of relevant OSM
18.	CUX2			
19.	CUX3			
20.	CUX4			
21.	CUX5			
22.	CUX6			

N	System Settings	Range	Factory default	Recommendations
Power Supply Element				
23.	Rated battery capacitance	2.0 to 30.0 Ah, step size 0.5 Ah	26.0 Ah	Set rated battery capacitance in Ah
24.	Shutdown level	0.1 to 0.8	0.2 p.u.	Set shutdown level at reaching which RC/TEL will switch to shutdown
25.	RTU shutdown level	0.1 to 0.8 p.u.	0.5 p.u.	Set RTU shutdown level at reaching which RTU power supply will be switched off. Note that this setting must be equal or greater Shutdown level
26.	RTU supply voltage	5.0 to 15.0 V	12.0 V	Set required RTU supply voltage
27.	RTU reset cycle	0 to 168 h	0 h	If RTU reset cycle is not used, it is necessary to set "0". Set required periodicity of RTU resetting. Set "0" if resetting of RTU is not required
28.	RTU reset duration	1 to 30 s	1 s	Set requested RTU reset duration. Note that this setting does not apply if RTU reset cycle = 0
Real Time Clock				
29.	Time format	12 hours/24 hours	12 hours	Follow local practice
30.	Daylight saving	Enable/Disable	Disable	Follow local practice
31.	Daylight saving start	HH:MM MMM DD	00:00 Jan 00	Follow local practice
32.	Daylight saving end	HH:MM MMM DD	00:00 Jan 00	Follow local practice
33.	Daylight saving offset	-2/-1/+1/+2	+1	Follow local practice
Indication Data Conditioner				
34.	Load profile step	5/10/15/ 30/60min	30 min	Select load profile step. Note that only 9000 load profile readings can be recorded covering interval from 31.25 to 375 days
Automatic Group Transfer				
35.	Automatic group transfer	Enable/Disable	Disable	Set Enable if automatic seasonal and weekly group changes are preferable. Otherwise set Disable
36.	Summer working days group	1-4	1	Set Group № that will be activated at during working days at summer time. Note that this setting does not apply if Automatic Group Transfer is disabled
37.	Summer weekend group	1-4	2	Set Group № that will be activated at during weekends at summer time. Note that this setting does not apply if Automatic Group Transfer is disabled
38.	Winter working days group	1-4	3	Set Group № that will be activated at during working days at winter time. Note that this setting does not apply if Automatic Group Transfer is disabled
39.	Winter weekend group	1-4	4	Set Group № that will be activated at during weekends at winter time. Note that this setting does not apply if Automatic Group Transfer is disabled
40.	Summer start	MMM DD HH:MM	Apr 15 13:30	Follow local practice
41.	Summer end	MMM DD HH:MM	Oct 15 13:30	Follow local practice
42.	Weekend start	DoW HH:MM	Fri 18:01	Follow local practice
43.	Weekend end	DoW HH:MM	Mon 9:30	Follow local practice
MMI				
44.	"PROT" pushbutton mode	Enable/Disable	Disable	Follow local practice to make this key available or not available for linesman

N	System Settings	Range	Factory default	Recommendations
45.	“GRP” pushbutton mode	Enable/Disable	Enable	Follow local practice to make this key available or not available for linesman
46.	“EF” pushbutton mode	Enable/Disable	Enable	Follow local practice to make this key available or not available for linesman
47.	“SEF” pushbutton mode	Enable/Disable	Enable	Follow local practice to make this key available or not available for linesman
48.	“AR” pushbutton mode	Enable/Disable	Enable	Follow local practice to make this key available or not available for linesman
49.	“HL” pushbutton mode	Enable/Disable	Enable	Follow local practice to make this key available or not available for linesman
50.	“PROT” pushbutton mode	Enable/Disable	Disable	Follow local practice to make this key available or not available for linesman
51.	Close delay	0 to 300s	0	If Close delay is not used, it is necessary to set “0”. Set required delay of close command execution (generally determined by safety issues, i.e. by “walk away” time)
52.	Security mode	Enable/Disable	Disable	To switch on security select Enable Set Enable if passwords protection for settings change is preferable, otherwise set disable
53.	MMI shutdown	Enable/Disable	Enable	To enable automatic power down of MMI. Disabled automatic power down is sometimes required by safety regulations.

Configuration of Comms Settings

N	Comms Settings	Recommendations
IOI		
1.	Operation mode	Set Test operating mode when testing IOM operability only. In this case i-th digital output will replicate state of i-th digital input. Otherwise select Normal operating mode
Digital Outputs		
2.	Remote on	Map each applicable signal for particular digital output №. Otherwise map to 0
3.	Lockout	
4.	AR initiated	
5.	Protection active	
6.	Closed	
7.	Group 1 on	
8.	Group 2 on	
9.	Group 3 on	
11.	Prot on	
12.	EF on	
13.	SEF on	
14.	HL on	
15.	AR on	
16.	ABR on	
17.	RC door open	
18.	RCM fault	
19.	Malfunction	
20.	Warning	

N	Comms Settings	Recommendations
21.	UD signal 1	Map each applicable signal for particular digital output №. Otherwise map to 0
22.	UD signal 2	
23.	UD signal 3	
24.	UD signal 4	
25.	UD signal 5	
26.	UD signal 6	
27.	UD signal 7	
28.	UD signal 8	
29.	UD signal 9	
30.	UD signal 10	
31.	UD signal 11	
32.	UD signal 12	
Digital Inputs		
33.	Trip	Map each applicable control function for particular digital output №. Otherwise map to 0
34.	Close	
35.	Group 1 on	
36.	Group 2 on	
37.	Group 3 on	
38.	Group 4 on	
39.	Prot on	
40.	EF on	
41.	SEF on	
42.	HL on	
43.	AR on	
44.	ABR ON	

Refer to RC/TEL-05 Telecommunications interface user guide for description of communication settings.

Configuration of Protection Settings

Element	Protection Settings	Recommendations
BF	Pickup current, A	In auto-coordination mode this parameter is set equal to the level of three-phase short circuit current at the location of the recloser minus selected current grade. In auto-correction mode any value being less than mentioned value can be set. It is recommended to follow the same rule for independent mode.

Element	Protection Settings	Recommendations
LS	Operating mode	This element is not applicable for radial type recloser. For ring recloser in auto-coordination and auto-correction modes this parameter is configured as “Enable” for sectionalizing recloser (first downstream with regard to feeder breaker), and “Disable” for other reclosers. It is generally recommended to follow the same rules for independent mode.
	Tripping time	Setting this parameter is only relevant when operating mode of LS element is set “Enable” (i.e. for sectionalizing recloser). In auto-coordination mode this parameter is set equal to the maximum reclose time of the feeder breaker plus 1s. In auto-correction mode any value exceeding maximum reclose time of the feeder breaker for at least selected time grade can be set. It is recommended to follow the same rule in independent mode.
CLP	Trec, min	Setting this parameter is only relevant when CLM does not equal 1 This parameter is not automatically configured in auto-coordination and auto-correction modes. However, in these modes parameters of series reclosers are set equal that ensures correctness of their operation. It is recommended to follow the same rule in independent mode. Generally this parameter is selected equal to the feeder “cold load charging time”, i.e. time necessary for the load to “cool down” to the limit, so that maximum achievable cold load current will be experienced after restoration of supply. This time is generally determined on the basis of the available field experience with the particular feeder.
	Trec, min	Setting this parameter is only relevant when CLM does not equal 1 This parameter is not automatically configured in auto-coordination and auto-correction modes. However, in these modes parameters of series reclosers are set equal that ensures correctness of their operation. It is recommended to follow the same rule in independent mode. Generally this parameter is selected equal to “cold load restoration time”, i.e. time required for load current to restore to normal condition after prolonged outage (longer than “cold load charging time”). This time is generally determined on the basis of the available field experience with the particular feeder.
	CLM, CLM+, CLM-	In auto-coordination mode this parameter equals 1 (if solution of the coordination task exists). In auto-correction mode this parameter is calculated as minimum of the values fitting the following requirements: - modified pickup current exceeds maximum cold load current for at least selected current grade, - modified pickup current provides coordination with upstream and downstream devices, - modified pickup current provides protection against phase-to-phase faults via maximum selected fault resistance at the end of the next downstream section, - modified pickup current exceeds maximum wire thermal current for at least selected current grade. In independent mode it is recommended to follow the same rules.
VRC	Pickup voltage multiplier+, V Pickup voltage multiplier-, V	Setting this parameters is only relevant when operating mode of UV element is set “Enable” This parameter is not automatically configured in auto-coordination mode or auto-correction modes. It is recommended to set this parameter to the value that will not result in voltage drop below pickup level of UV element at load closing when fed from Source+ side. In any case it shall be set above pickup level of UV element related to Set+.
	Pickup frequency+, Hz Pickup frequency-, Hz	Setting this parameters is only relevant when operating mode of UF element is set “Enable” This parameter is not automatically configured in auto-coordination mode or auto-correction modes. The value of this parameter is determined by the level of hierarchy of the section protected by recloser in load shedding scheme. In any case it shall be set above pickup level of UF element related to Set+.

Element	Protection Settings	Recommendations
ABR	Operating mode	In auto-coordination and auto-correction modes this parameter is automatically configured as “Enable” for normally closed (tie) recloser. It is configured as “Disable” for other reclosers. In independent mode it is generally recommended to follow the same rules.
	Restoration time+, s Restoration time-, s	Setting this parameter is only relevant if operating mode of ABR element is set “Enable”. In auto-coordination mode this parameter is calculated equal to the tripping time of LS element of the sectionalizing recloser located at relevant source side plus 1s. In auto-correction mode any value that exceeds tripping time of the said sectionalizing recloser for at least selected time grade can be set. It is recommended to follow the same rule in independent mode.
OC1	Type of time current characteristic+ Type of time current characteristic-	In auto-coordination and auto-correction modes TEL A is automatically selected. In independent mode any type of the available TCC can be used. In independent mode selection is generally based upon better coordination with the delayed TCC of the downstream devices (including fuse in fused network). Note that in this regard TEL A presents the best possible solution (providing requested time and current grades within the entire applicable current range).
	Asymptote current+, A Asymptote current-, A	This parameter is not applicable for auto-coordination and auto-correction modes (as in these modes only TEL A is used, for which this setting does not apply). In independent mode selection is based upon better coordination with the delayed TCC of the downstream devices (including fuse for the fused network).
	Time multiplier+ Time multiplier-	This parameter is not applicable for auto-coordination and auto-correction modes (as in these modes only TEL A is used, for which this setting does not apply). Selection is generally based upon achieving requested time grade with the downstream devices (including fuse in the fused network)
	Minimum time+, s Minimum time-, s	In auto-coordination mode this parameter is set to 0 for downstream recloser. For upstream reclosers minimum possible values providing coordination with the downstream devices for a selected time grade are used. In auto-correction mode any value that does not breach coordination between series devices can be set. In independent mode it is recommended to follow the same rule.
	Maximum time+, s Maximum time-, s	In auto-coordination mode this parameter is set equal to the selected maximum arcing time for upstream (closest to the feeder breaker) recloser. For downstream reclosers it is set in order to provide coordination with upstream devices for at least selected time grade. In autocorrection mode any value that does not breach coordination rule can be set. It is also recommended to follow this rule in independent mode.
	Pickup current+, A Pickup current-, A	In auto-coordination mode this parameter is selected as a maximum of the values fitting the following requirements: -they exceed maximum load current for at least selected current grade, -they provide coordination with upstream and downstream devices, -they provide protection against phase-to-phase faults via maximum selected fault resistance at the end of the next downstream section, -they exceed maximum wire thermal current for at least selected current grade. In auto-correction mode any of value complying with the mentioned requirements can be selected. In independent mode it is recommended to follow the same rule.
	Time adder+, s Time adder-, s	This parameter is not applicable for auto-coordination and auto-correction modes (as in these modes only TEL A is used, for which this setting does not apply). In independent mode selection is based upon better coordination with the downstream devices (including fuse in the fused network).
OC2	Type of time current characteristic+ Type of time current characteristic-	In auto-coordination and auto-correction modes TEL A is automatically selected. In independent mode any type of the available TCC can be used. In independent mode selection is generally based upon better coordination with the delayed TCC of the downstream devices (excluding fuse in the fused network). Note that in this regard TEL A presents the best possible solution (providing requested time and current grades within the entire applicable current range).

Element	Protection Settings	Recommendations
OC2	Asymptote current+, A Asymptote current-, A	This parameter is not applicable for auto-coordination and auto-correction modes (as in these modes only TEL A is used, for which this setting does not apply). In independent mode selection is based upon better coordination with the delayed TCC of the downstream devices (excluding fuse for the fused network.
	Time multiplier+ Time multiplier-	This parameter is not applicable for auto-coordination and auto-correction modes (as in these modes only TEL A is used, for which this setting does not apply). Selection is generally based upon achieving requested time grade with the downstream devices (excluding fuse in the fused network).
	Minimum time+, s Minimum time-, s	In auto-coordination mode this parameter is set to 0 for downstream recloser. For upstream reclosers minimum possible values providing coordination with the downstream devices for a selected time grade are used. In auto-correction mode any value that does not breach coordination between series devices can be set. In independent mode it is recommended to follow the same rule.
	Maximum time+, s Maximum time-, s	In auto-coordination mode this parameter is set equal to the selected maximum arcing time for upstream (closest to the feeder breaker) recloser. For downstream reclosers it is set in order to provide coordination with upstream devices for at least selected time grade. In autocorrection mode any value that does not breach coordination rule can be set. It is also recommended to follow this rule in independent mode.
	Pickup current+, A Pickup current-, A	In auto-coordination and auto-correction mode this parameter is the same as for OC1 element. In independent mode it is recommended to follow the same rule.
	Time adder+, s Time adder-, s	This parameter is not applicable for auto-coordination and auto-correction modes (as in these modes only TEL A is used, for which this setting does not apply). In independent mode selection is based upon better coordination with the downstream devices (excluding fuse in the fused network).
EF1	Type of time current characteristic+ Type of time current characteristic-	In auto-coordination and auto-correction modes TEL A is automatically selected. In independent mode any type of the available TCC can be used. In independent mode selection is generally based upon better coordination with the delayed TCC of the downstream devices (including fuse in fused network). Note that in this regard TEL A presents the best possible solution (providing requested time and current grades within the entire applicable current range).
	Asymptote current+, A Asymptote current-, A	This parameter is not applicable for auto-coordination and auto-correction modes (as in these modes only TEL A is used, for which this setting does not apply). In independent mode selection is based upon better coordination with the delayed TCC of the downstream devices (including fuse for the fused network).
	Time multiplier+ Time multiplier-	This parameter is not applicable for auto-coordination and auto-correction modes (as in these modes only TEL A is used, for which this setting does not apply). Selection is generally based upon achieving requested time grade with the downstream devices (including fuse in the fused network).
	Minimum time+, s Minimum time-, s	In auto-coordination mode this parameter is set to 0 for downstream recloser. For upstream reclosers minimum possible values providing coordination with the downstream devices for a selected time grade are used. In auto-correction mode any value that does not breach coordination between series devices can be set. In independent mode it is recommended to follow the same rule.
	Maximum time+, s Maximum time-, s	In auto-coordination mode this parameter is set equal to the selected maximum arcing time for upstream (closest to the feeder breaker) recloser. For downstream reclosers it is set in order to provide coordination with upstream devices for at least selected time grade. In autocorrection mode any value that does not breach coordination rule can be set. It is also recommended to follow this rule in independent mode.
	Pickup current+, A Pickup current-, A	In auto-coordination mode this parameter is selected as a maximum of the values fitting the following requirements: -they provide coordination with upstream and downstream devices, -they provide protection against phase-to-earth faults via maximum selected fault resistance at the end of the next downstream section. In auto-correction mode any of the values complying with the mentioned requirements can be selected. In independent mode it is recommended to follow the same rule.

Element	Protection Settings	Recommendations
EF1	Time adder+, s Time adder-, s	This parameter is not applicable for auto-coordination and auto-correction modes (as in these modes only TEL A is used, for which this setting does not apply). In independent mode selection is based upon better coordination with the downstream devices (including fuse in the fused network).
EF2	Type of time current characteristic+ Type of time current characteristic-	In auto-coordination and auto-correction modes TEL A is automatically selected. In independent mode any type of the available TCC can be used. In independent mode selection is generally based upon better coordination with the delayed TCC of the downstream devices (excluding fuse in the fused network). Note that in this regard TEL A presents the best possible solution (providing requested time and current grades within the entire applicable current range).
	Asymptote current+, A Asymptote current-, A	This parameter is not applicable for auto-coordination and auto-correction modes (as in these modes only TEL A is used, for which this setting does not apply). In independent mode selection is based upon better coordination with the delayed TCC of the downstream devices (excluding fuse for the fused network).
	Time multiplier+ Time multiplier-	This parameter is not applicable for auto-coordination and auto-correction modes (as in these modes only TEL A is used, for which this setting does not apply). Selection is generally based upon achieving requested time grade with the downstream devices (excluding fuse in the fused network).
	Minimum time+, s Minimum time-, s	In auto-coordination mode this parameter is set to 0 for downstream recloser. For upstream reclosers minimum possible values providing coordination with the downstream devices for a selected time grade are used. In auto-correction mode any value that does not breach coordination between series devices can be set. In independent mode it is recommended to follow the same rule.
	Maximum time+, s Maximum time-, s	In auto-coordination mode this parameter is set equal to the selected maximum arcing time for upstream (closest to the feeder breaker) recloser. For downstream reclosers it is set in order to provide coordination with upstream devices for at least selected time grade. In autocorrection mode any value that does not breach coordination rule can be set. It is also recommended to follow this rule in independent mode.
	Pickup current+, A Pickup current-, A	In auto-coordination and auto-correction mode this parameter is the same as for EF1 element. In independent mode it is recommended to follow the same rule.
	Time adder+, s Time adder-, s	This parameter is not applicable for auto-coordination and auto-correction modes (as in these modes only TEL A is used, for which this setting does not apply). In independent mode selection is based upon better coordination with the downstream devices (excluding fuse in the fused network).
OC3	Operating mode+ Operating mode-	In auto-coordination and auto-correction modes this parameter is set “Disable”. In independent mode it is recommended to set it “Enable” only for feeder breaker and only in case when it is considered privileged to reduce number of high-set trips to lockout. Generally this consideration applies for high-current faults (few kA) if risk of setting fire, injuring personnel, damaging equipment, etc dominates over risk of supply interruption in case of transient fault.
	Pickup current+, A Pickup current-, A	Setting this parameter is only relevant if OC3 operating mode is set “Enable”. This parameter is not automatically configured in auto-coordination and auto-correction modes. It is recommended to set it equal to the level of three-phase short circuit fault above which restriction of the number of reclosures is required (i.e. safety considerations dominate over reliability ones). In any case it shall exceed pickup currents of OC1, OC2 elements.
	Tripping time+, s Tripping time-, s	Setting this parameter is only relevant if OC3 operating mode is set “Enable”. In autocoordination and auto-correction modes this parameter is not automatically configured. Generally the value of this parameter is set equal to 0 (instantaneous tripping). In any case tripping time of this element shall not exceed tripping times of OC1, OC2 elements.
EF3	Operating mode+ Operating mode-	In auto-coordination and auto-correction modes this parameter is set “Disable”. In independent mode it is recommended to set it “Enable” only for feeder breaker and only in case when it is considered privileged to reduce number of high-set trips to lockout. Generally this requirement applies if for high-current faults (few kA) risk of setting fire, injuring personnel, damaging equipment, etc dominates over risk of supply interruption in case of transient fault.

Element	Protection Settings	Recommendations
EF3	Pickup current+, A Pickup current-, A	Setting this parameter is only relevant if EF3 operating mode is set "Enable". This parameter is not automatically configured in auto-coordination and auto-correction modes. It is recommended to set it equal to the level of phase-to-earth short circuit fault above which restriction of the number of reclosures is required (i.e. safety considerations dominate over reliability ones). In any case it shall exceed pickup currents of EF1, EF2 elements.
	Tripping time+, s Tripping time-, s	Setting this parameter is only relevant if EF3 operating mode is set "Enable". In autocoordination and auto-correction modes this parameter is not automatically configured. Generally the value of this parameter is set equal to 0 (instantaneous tripping). In any case tripping time of this element shall not exceed tripping times of EF1, EF2 elements.
AR OCEF	Number of trips to lockout+ Number of trips to lockout-	This parameter is not automatically configured in auto-coordination and auto-correction modes. However, in these modes parameters of series reclosers are set equal that ensures correctness of their operation. It is recommended to follow the same rule in independent mode. Selection of this parameter depends on the accepted protection philosophy [1]. General choice is 3 or 4 trips to lockout.
	Number of highset trips to lockout+ Number of highset trips to lockout-	Setting this parameter is only relevant if operating mode of EF3 or OC3 elements is set "Enable". In auto-coordination and auto-correction modes this parameter is not automatically configured. Generally the value of this parameter is set to 1. Other choices depending on the balance of safety/ reliability risks (refer to the description of OC3/EF3 elements setting rules) are also applicable
	Reclosing sequence+ Reclosing sequence-	This parameter is not automatically configured in auto-correction and auto-coordination modes. However, in these modes parameters of series reclosers are set equal that ensures correctness of their operation. It is recommended to follow the same rule in independent mode. This setting depends on the accepted protection philosophy [1]. For fuse-saving philosophy general choices are IIDD, IIDI for four trips to lockout, and IID, IDI, IDD for three trips to lockout. For sensitive deep fusing philosophy general choices are DIII, DDII, DDDI, and DDDD for four trips to lockout, and DII, DDI, DDD for three trips to lockout. Note that RC can provide instantaneous trips after delayed trip maintaining at the same time zone sequence coordination. Using this option is advantageous compared with the sequence of delayed trips from safety and network reliability standpoint.
	First reclose time+, s First reclose time-, s	Setting this parameter is only relevant if number of trips to lockout exceeds 1. This parameter is not automatically configured in auto-correction and auto-coordination modes. However, in these modes parameters of series reclosers are set equal that ensures correctness of their operation. It is recommended to follow the same rule in independent mode. Generally the value of this parameter is selected below time interval counted by particular utility for MAIFI. At the same time it shall exceed arc dissipation time that is generally accepted to be not less than 0.3 s for 15 kV and 0.5 s for 27 kV applications.
	Second reclose time+, s Second reclose time-, s	Setting this parameter is only relevant if number of trips to lockout exceeds 2. This parameter is not automatically configured in auto-correction and auto-coordination modes. However, in these modes parameters of series reclosers are set equal that ensures correctness of their operation. It is recommended to follow the same rule in independent mode. General choice for this parameter is (5-30) s (time considered sufficient for mechanical objects (branches, animals) to fall apart from the line. In any case it shall be set below time interval counted by particular utility for SAIDI/SAIFI
	Third reclose time+, s Third reclose time-, s	Setting this parameter is only relevant if number of trips to lockout exceeds 3. This parameter is not automatically configured in auto-correction and auto-coordination modes. However, in these modes parameters of series reclosers are set equal that ensures correctness of their operation. It is recommended to follow the same rule in independent mode. Generally the value of this parameter is selected slightly below time interval counted by particular utility for SAIDI/SAIFI (to give as much time as possible for transient fault to disappear). General choice is (30-180) s.
	Reset time+, s Reset time-, s	Follow local practice

Element	Protection Settings	Recommendations
HLOC	Pickup current+, A Pickup current-, A	In auto-coordination mode the value of this parameter is set equal to the maximum load current plus selected current grade. In auto-correction mode any value equal or exceeding of this value can be selected. It is recommended to follow the same rule in independent mode.
	Tripping time+, s Tripping time-, s	In auto-coordination mode the value of this parameter is set to 0 (instantaneous tripping). In auto-correction and independent modes any value can be set.
HLEF	Pickup current+, A Pickup current-, A	In auto-coordination mode the value of this parameter is set equal to 4A (minimum available setting). In auto-correction and independent modes any value can be set.
	Tripping time+, s Tripping time-, s	In auto-coordination mode the value of this parameter is set to 0 (instantaneous tripping). In auto-correction and independent modes any value can be set.
SEF	Operating mode+ Operating mode-	In auto-coordination and auto-correction modes this parameter is set to "Enable". This is general practice that is recommended to follow in independent mode as well.
	Pickup current+, A Pickup current-, A	Setting this parameter is only relevant if operating mode of SEF element is set "Enable". In auto-coordination mode this parameter is set to the maximum of 4 A (minimum available setting value) and feeder capacitive earth current for downstream recloser. For upstream reclosers it is set in order to provide coordination with the downstream devices for selected current grade. In auto-correction mode any value that does not breach coordination rule can be set. It is recommended to follow the same rule in independent mode as well.
	Tripping time+, s Tripping time-, s	Setting this parameter is only relevant if operating mode of SEF element is set "Enable" In auto-coordination mode this parameter equals to the selected maximum arcing time for upstream recloser (closest to the feeder breaker). For downstream reclosers it has lower value and is set to provide coordination with the upstream devices for selected time grade. In auto-correction mode any value that does not breach coordination rule can be set. It is recommended to follow the same rule in independent mode as well.
AR SEF	Number of trips to lockout+ Number of trips to lockout-	This parameter is not automatically configured in auto-coordination and auto-correction modes. However, in these modes parameters of series reclosers are set equal that ensures correctness of their operation. It is recommended to follow the same rule in independent mode. Selection of this parameter is subject to tradeoff between safety (less reclosures are better) and reliability (more reclosures are better). Proper balance of this contradictive requirements is generally determined by particular utility
	First reclose time+, s First reclose time-, s	Setting this parameter is only relevant if number of trips to lockout exceeds 1. This parameter is not automatically configured in auto-correction and auto-coordination modes. However, in these modes parameters of series reclosers are set equal that ensures correctness of their operation. It is recommended to follow the same rule in independent mode. Generally selected below time interval counted by particular utility for MAIFI. At the same time it shall exceed arc dissipation time that is generally accepted to be not less than 0.3 s for 15 kV and 0.5 s for 27kV applications
	Second reclose time+, s Second reclose time-, s	Setting this parameter is only relevant if number of trips to lockout exceeds 2. This parameter is not automatically configured in auto-correction and auto-coordination modes. However, in these modes parameters of series reclosers are set equal that ensures correctness of their operation. It is recommended to follow the same rule in independent mode. General choice for this parameter is (5-30) s (time considered sufficient for mechanical objects (branches, animals) to fall apart from the line. In any case it shall be set below time interval counted by particular utility for SAIDI/SAIFI.
	Third reclose time+, s Third reclose time-, s	Setting this parameter is only relevant if number of trips to lockout exceeds 3. This parameter is not automatically configured in auto-correction and auto-coordination modes. However, in these modes parameters of series reclosers are set equal that ensures correctness of their operation. It is recommended to follow the same rule in independent mode. Generally selected slightly below time interval counted by particular utility for SAIDI/SAIFI (to give as much time as possible for transient fault to disappear). General choice is (30-180) s.
	Reset time+, s Reset time-, s	Follow local practice

Element	Protection Settings	Recommendations
VU	Operating mode+ Operating mode-	In auto-coordination and auto-correction modes this parameter is set to "Disable". In independent mode it can be set to "Enable" if load is sensitive to the upstream broken wire (generally motors are considered in this regard)
	Voltage unbalance+ Voltage unbalance-	Setting this parameter is only relevant if operating mode of VU element is set "Enable". This parameter shall exceed natural system voltage unbalance (generally 3-5%). At the same time it shall be set below level dangerous for loads sensitive to voltage unbalance (generally motors are considered)
	Tripping time+, s Tripping time-, s	Setting this parameter is only relevant if operating mode of VU element is set "Enable". This parameter shall exceed maximum tripping time of overcurrent elements in order to prevent nuisance tripping at upstream asymmetrical short circuit faults. At the same time it shall be set below level dangerous for loads sensitive to broken wire (generally motors are considered).
CU	Operating mode+ Operating mode-	In auto-coordination and auto-correction modes this parameter is set to "Disable". In independent mode it can be set to "Enable" if load is sensitive to the downstream broken wire (generally motors are considered).
	Current unbalance+ Current unbalance-	Setting this parameter is only relevant if operating mode of CU element is set "Enable". This parameter shall exceed natural current unbalance resulted from unbalance of load and natural unbalance of source voltage. At this it shall be taken into account that unbalance of source voltage for motor load results in much higher (6-10 times) current unbalance. At the same time in order to increase sensitivity to downstream broken wire condition this parameter shall be set as low as possible.
	Tripping time+, s Tripping time-, s	Setting this parameter is only relevant if operating mode of CU element is set "Enable". This parameter shall exceed maximum tripping time of overcurrent elements in order to prevent nuisance tripping at upstream asymmetrical short circuit faults. At the same time it shall be set below level dangerous for loads sensitive to broken wire (generally motors are considered).
UV	Operating mode+ Operating mode-	In auto-coordination and auto-correction modes this parameter is set to "Disable". In independent mode it may be set "Enable" when recloser is applied as feeder breaker. Two application are foreseen for this element: -protection of sensitive load (generally motors are considered) against low system voltage resulted from failure of voltage regulator, -support of sequential starting of several parallel motors (if their simultaneous starting resulted in voltage drop on the bus bars to the level insufficient for successful starting).
	Pickup voltage multiplier+ Pickup voltage multiplier-	Setting this parameter is only relevant if operating mode of UV element is set "Enable". This parameter is not automatically configured in auto-coordination and auto-correction modes. In case of protection of sensitive load (motors) this parameter shall be selected above the value dangerous for the said load. In case of supporting sequential motor starting this parameter shall be selected above the level critical for motor starting.
	Tripping time+, s Tripping time-, s	Setting this parameter is only relevant if operating mode of UV element is set "Enable". This parameter is not automatically configured in auto-coordination and auto-correction modes. This parameter shall exceed maximum tripping time of the overcurrent elements in order to prevent nuisance tripping at upstream short circuit faults. At the same time it shall be set below level dangerous for sensitive load (generally motors are considered).
AR UV	Number of trips to lockout+ Number of trips to lockout-	This parameter is not automatically configured in auto-coordination and auto-correction modes. When UV element is used for protection sensitive load against faulty regulator single trip to lockout shall be selected. When UV element is used for supporting sequential motor starting two trips to lockout shall be selected.
	Reclose time+, s Reclose time-, s	Setting this parameter is only relevant if operating mode of UV element is set "Enable" and number of trips to lockout of AR UV element is set to 2. This parameter is not automatically configured in auto-coordination and auto-correction modes. The value of this parameter shall generally exceed typical motor starting time (depends on the motor types used).

Element	Protection Settings	Recommendations
OV	Operating mode+ Operating mode-	In auto-coordination and auto-correction modes this parameter is set to “Disable”. In independent mode it may be set “Enable” when recloser is applied as feeder breaker. This element protects sensitive load against high system voltage.
	Pickup voltage multiplier+ Pickup voltage multiplier-	Setting this parameter is only relevant if operating mode of OV element is set “Enable”. This parameter is not automatically configured in auto-coordination and auto-correction modes. In case of protection of sensitive load this parameter shall be selected below the value dangerous for the said load.
	Tripping time+, s Tripping time-, s	Setting this parameter is only relevant if operating mode of OV element is set “Enable”. This parameter is not automatically configured in auto-coordination and auto-correction modes. This parameter shall be set below level dangerous for sensitive load.
AR OV	Number of trips to lockout+ Number of trips to lockout-	This parameter is not automatically configured in auto-coordination and auto-correction modes.
	Reclose time+, s Reclose time-, s	Setting this parameter is only relevant if operating mode of OV element is set “Enable” and number of trips to lockout of AR UV element is set to 2.This parameter is not automatically configured in auto-coordination and auto-correction modes.
UF	Operating mode+ Operating mode-	In auto-coordination and auto-correction modes this parameter is set to “Disable”. In independent mode it can be set to “Enable” if load is sensitive to the downstream broken wire (generally motors are considered).
	Pickup frequency+, Hz Pickup frequency-, Hz	Setting this parameter is only relevant if operating mode of CU element is set “Enable”. This parameter shall exceed natural current unbalance resulted from unbalance of load and natural unbalance of source voltage. At this it shall be taken into account that unbalance of source voltage for motor load results in much higher (6-10 times) current unbalance. At the same time in order to increase sensitivity to downstream broken wire condition this parameter shall be set as low as possible.
	Tripping time+, s Tripping time-, s	Setting this parameter is only relevant if operating mode of CU element is set “Enable”. This parameter shall exceed maximum tripping time of overcurrent elements in order to prevent nuisance tripping at upstream asymmetrical short circuit faults. At the same time it shall be set below level dangerous for loads sensitive to broken wire (generally motors are considered).
AR UF	Number of trips to lockout+ Number of trips to lockout-	Setting this parameter is only relevant when UF operating mode is set to “Enable”. The value of this parameter is determined by philosophy accepted for load shedding scheme (i.e. whether automatic reconnection is relevant or not).
	Reclose time+, s Reclose time-, s	Setting this parameter is only relevant when UF operating mode is set to “Enable” and number of trips to lockout of AR UV element is set to 2. The value of this parameter is determined by philosophy of the load shedding scheme.

Site Installation

Warning

Follow all locally approved safety procedures when installing or operating this equipment. Failure to comply may result in death or severe personal injury.

Transport to Site

Remove mechanical trip ring when transporting to site to prevent damage.

OSM Recloser Installation

For instructions on installation of mounting brackets, surge arresters and installation of OSM on the pole refer to the Mounting instructions that comes with the Mounting Kit.

RC Cubicle Installation

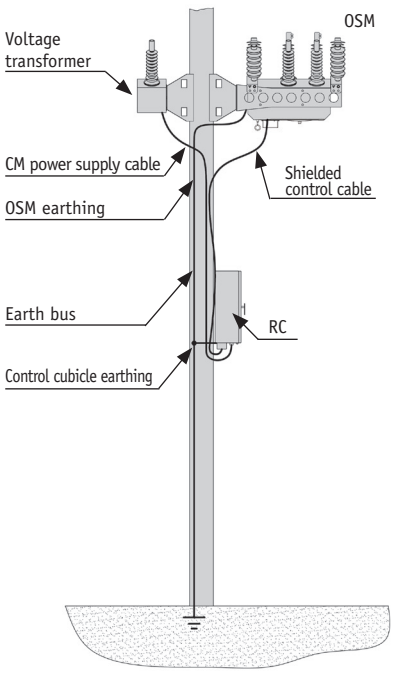
For installation on a wooden pole drill two mounting holes in the pole (diameter 22 mm, 775±1 mm apart for RC/TEL-05). Install RC cubicle on the pole as shown on Fig. 79.

Figure 79

RC Cubicle installed on the wooden pole

It is also possible to fix RC/TEL on different type of poles with the aid of metal strapping through RC bracket mounting grooves.

Earthing



OSM and RC should be earthed as shown on Fig. 80.

The OSM is earthed by means of a M12 hex head bolt (with the two washers and lock washer) into a captive thread on the back wall of the tank (see Fig. 2). Earthing copper conductor (min size 35mm^2) with a tin plated cable lug should be used. Screw the lug to the earth provision and tighten to 30 Nm.

The RC Cubicle is earthed by means of a M12 stud on the base of the cubicle. Use a short length of earth conductor with tin plated cable lug on one end and screw to earthing stud. On the other end connect to OSM earth conductor by means of parallel groove clamp or similar.

Figure 80

OSM and RC earthing

Connection of Control Cable

Refer to OSM Preparation in this chapter for Control cable connection.

Connection of Power Supply on Site

When phase-to-phase power supply (e.g. VTs) is used, reconnect earthing jumpers in their original positions as shown in Fig. 81. Refer to Connection of power supply cable under RC preparation.

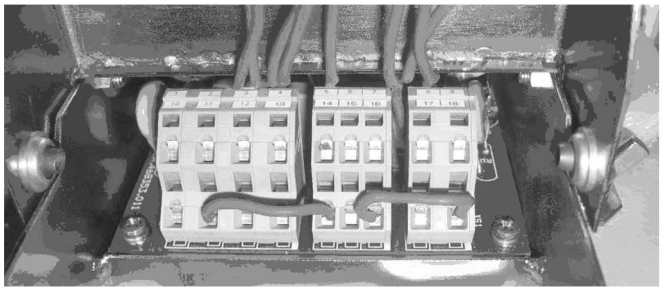


Figure 81

Connection of Earthing jumpers when phase-to-phase power supply is used (e.g. VTs)

HV Terminal Connection

If an insulated cable is used for HV connection the insulation should be stripped for at least 70 mm (Fig. 82). If existing cable is used to reconnect to the HV terminals, remove any old lubricant. Smooth out with a card file or metallic brush and remove abrasive dust with rags. Apply a thin layer of the lubricant (CG60 contact lubricant: Electrolube www.electrolube.co.uk or similar) with a thickness of not exceeding 1 mm, to connection tip with the help of a spatula. Fix the cable on the HV terminal with the clamps (see OSM section for details).

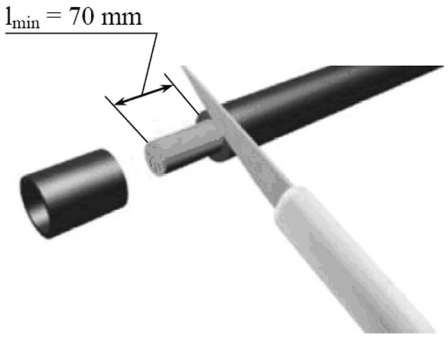


Figure 82

Stripping of Cable tail

Maintenance 12

The OSM recloser and RC Control Cubicle are inherently maintenance free. No maintenance is needed during their entire lifetime. Their expected lifetime is at least 30 years. Only the Battery requires periodic replacement.

Replacement of Battery

The Rechargeable Battery must be replaced once in 10 years if the average annual battery temperature is 25°C or below. At higher temperatures battery float life will decrease and can be calculated using table below. Battery temperature should be calculated as average annual ambient temperature on site plus 2°C overheating of battery placed inside RC.

Battery Float lifetime vs. Battery Temperature

Temperature, °C	AF	Float Time, year	Temperature, °C	AF	Float Time, year
-40	0.115	10.00	35	2.378	4.21
0	0.273	10.00	36	2.594	3.86
20	0.648	10.00	37	2.828	3.54
21	0.707	10.00	38	3.084	3.24
22	0.771	10.00	39	3.364	2.97
23	0.841	10.00	40	3.668	2.73
24	0.917	10.00	41	4	2.50
25	1	10.00	42	4.362	2.29
26	1.091	9.17	43	4.757	2.10
27	1.189	8.41	44	5.187	1.93
28	1.297	7.71	45	5.657	1.77
29	1.414	7.07	46	6.169	1.62
30	1.542	6.49	47	6.727	1.49
31	1.682	5.95	48	7.336	1.36
32	1.834	5.45	49	8	1.25
33	2	5.00	50	8.724	1.15
34	2.181	4.59			

Firmware Updates

Tavrida Electric is continuously working on improvement of recloser firmware. New firmware can be uploaded from PC using TELARM software. For more details refer to Firmware Uploading Instruction in TELARM User Guide.

Contact Wear

The Recloser's Main Contacts can be monitored for wear by accessing MMI Panel through 'Main Menu' → Indication Data → IDC → Lifetime counters, or through TELARM software (refer to TELARM User Guide). For more detail refer to Lifetime counters in Chapter 6. Once the mechanical wear or vacuum Interrupter contact wear has reached 100% contact your nearest Tavrida office for a refurbishment assessment.

Troubleshooting

RC cubicle provides self-diagnostic and generates relevant malfunction and warning signals. Active malfunction, if any, can be viewed by pressing Malf Log push button on MMI panel. Malfunction log can be accessed through 'Main Menu' → Indication Data → IDC → Malfunction log, or through TELARM software (refer to TELARM User Guide).

Signal	Possible reason	Malfunction tracing procedure	Recommended action
Malfunctions	**See list below**	**See list below**	**See list below**
RCM fault	Internal fault of recloser control module.	N/A	Replace recloser control module.
Driver fault	Internal fault of driver module.	N/A	Together with this message RCM fault message appears (see above)
IOM fault	Internal fault of input output module.	N/A	Replace input output module.
BTM fault	Internal fault of Bluetooth module.	N/A	Replace Bluetooth module.
RTU short circuit	1) Internal RTU short circuit 2) Short circuit in the wires connecting RTU and “10”plug 3) PSM malfunction	Disconnect power supply wires from RTU. Switch on external load supply with the aid of MMI. If signal disappears short circuit exists inside RTU. If signal does not disappear wires connecting RTU and “10” plug are short circuited. If RTU and “10” plug are not short circuited internal PSM malfunction is the most probable one.	1) Avoid short circuit or replaceRTU. 2) Avoid short circuit or replacewires. 3) Replace RCM.
Low battery found	AC supply voltages were absent for a long time because of: 1) Damaging in auxiliary voltages circuits 2) Distribution line is disconnected or damaged from the source side	Check the phase voltages on MMI. 1) If the phase voltages on MMI are normal, then the possible problem is in the auxiliary voltages circuits or HVT damaging. 2) If the phase voltages on MMI are not normal then distribution line is disconnected or damaged in the source side.	1) Check WA:RCM-CC, auxiliary voltages and HVT. Fix it in case of damaging. 2) Deal with the person or the unit which is responsible for the distribution line state
Loss of AC supply	1) Damage of the high voltage transformer (HVT) 2) Distribution line is disconnected or damaged from the source side	Check the phase voltages on MMI. 1) If the phase voltages on MMI are normal, then the possible problem is in the auxiliary voltages circuits or in HVT damaging or in switching off the thermal overcurrent circuit breakers of RC. 2) If the phase voltages on MMI are not normal then distribution line disconnected or damaged in the source side.	1) Switch to ON state the thermal overcurrent circuit breakers of RC. Check WA:RCM-CC, circuits of auxiliary voltages and HVT, fix it in case of damaging. 2) Deal with the person or the unit which is responsible for the distribution line state
Battery fault	Internal fault of the battery, i.e. short circuit or isolated state. The battery was disconnected manually or by the aid of the battery switcher placed on RCM	Uninstall the battery and if possible check its parameters according to manufacturer methodic and recommended equipment.	Exchange the battery.
Battery sensor fault	1) Failure of battery temperature sensor 2) Short or open circuit of WA:RCM-BAT connecting wires 3) Disconnected “13” plug	Check if “13” plug is properly connected.	1), 2) Replace wiring assembly WA:RCM-BAT 3) Connect “13” plug properly

Signal	Possible reason	Malfunction tracing procedure	Recommended action
Malfunctions	**See list below**	**See list below**	**See list below**
Excessive trip time	1) Driver is not ready 2) Open circuit in Control Cable auxiliary switch circuit 3) OSM auxiliary switch malfunction 4) Mechanical damage of OSM	Check up, that there is a message "Driver not ready ". If message "Driver not ready" is absent visually check up that OSM has perform command “Open”, and message “Excessive trip time” is remained. It testifies to malfunctions 2), 3).	1) Wait Driver readiness or remove the reason caused message “Driver not ready” 2) Sequentially replace wiring assemblies WA:RCM-CC, Control Cable 3), 4) Replace OSM
Excessive close time	1) Driver is not ready 2) Short circuit in Control Cable auxiliary switch circuit 3) OSM auxiliary switch malfunction 4) Mechanical damage of OSM	Check up, that there is a message "Driver not ready ". If message "Driver not ready" is absent visually check up that OSM has perform command “Close”, and message “Excessive close time” is remained. It testifies to malfunctions 2), 3).	1) Wait Driver readiness or remove the reason caused message “Driver not ready” 2) Sequentially replace wiring assemblies WA:RCM-CC, Control Cable 3), 4) Replace OSM
OSM coil isolated	1) Mechanical Trip hook is in down position 2) “8” plug is disconnected 3) Wiring assembly WA:RCM-CC is open circuited 4) Control Cable open circuited 5) Control Cable plug X2 is disconnected. 6) Control Cable plug X1 is disconnected 7) OSM coil open circuited	Check if mechanical trip hook is in down position. Check if “8” plug is properly connected, if it is disconnecting Control Cable. If signal does not disappear wiring assembly WA: RCM-CC is open circuited. If it does not reasons 4)-6) may be in effect. Check if X1, X2 plugs are properly connected. If signal does not disappear, possibly OSM coil or Control Cable is open circuited.	1) Push back Mechanical trip hook in normal position if lockout is no longer required. 2) Connect “8” plug properly 3) Replace WA:RCM-CC 4) Replace Control Cable 5) Connect Control Cable plug X2 properly 6) Connect Control Cable plug X1 properly 7) Replace OSM
OSM coil short circuit	1) Control Cable is short circuited 2) OSM coil is short circuited 3) Wiring assembly WA:RCM-CC is short circuited	Disconnect Control Cable. If signal does not disappear wiring assembly WA:RCMCC is short circuited. If signal disappears and the message “OSM coil isolated” will appear Control Cable or OSM coil is short circuited. Disconnect Control Cable from OSM. If signal disappears and the message “OSM coil isolated” will appear OSM coil is short circuited. Otherwise Control Cable is short circuited.	1) Replace Control Cable 2) Replace OSM 3) Replace wiring assembly WA:RCM-CC
Driver not ready	1) Charging time has not expired 2) OSM coil SC or OSM coil Isolated 3) Internal Driver malfunction 4) Internal power supply module malfunction	Wait for 60 s. If signal disappears this warning is not associated with any malfunction. If this message has not disappeared and appears messages “OSM coil SC” or “OSM coil Isolated” it is necessary to remove the reason called them. If signal still exists check output voltage of power supply module. If voltage fits the range 10.5-16V internal Driver malfunction is the most probable one. If it does not internal power supply malfunction is the most probable one.	1) Not required 2) Remove the reason called messages “OSM coil SC” or “OSM coil Isolated” 3) ,4) Replace RCM

Replacement of Modules

Attention

Replacement of all modules and wiring assemblies must be carried out with disconnected external power supply cables and control cable.

Replacement of RC Cubicle

1. Unscrew RC earthing bolt and disconnect earthing wire.
2. Convey strips of the lifting device through lifting holes.
3. Unscrew and remove lower fixing bolt.
4. Loosen upper fixing bolt.
5. Take RC off the upper fixing bolt and move it to the ground.
6. Remove strips of the lifting device.
7. For Installation of RC see Chapter Site Installation

Replacement of RCM

1. Disconnect all wiring assemblies and the earthing wire connected to RCM.
2. Unscrew four wing nuts fixing RCM and remove washers (Fig. 83).
3. Remove RCM from the fixing stud-bolts and take it out from the housing.
4. To install RCM follow instructions above in the reverse order.

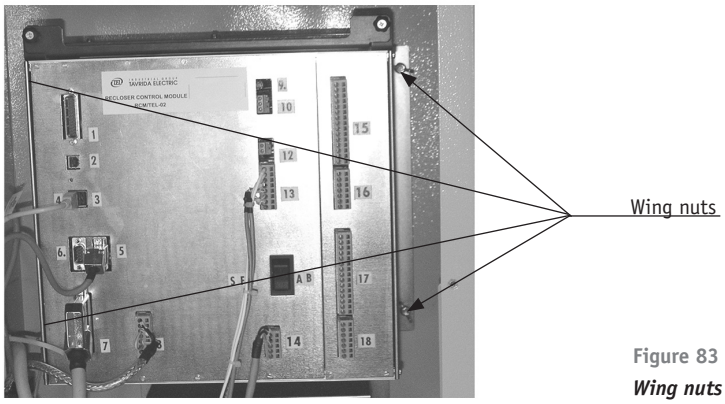


Figure 83
Wing nuts fixing RCM

Replacement of PSFM

1. Disconnect connector “14” connected to RCM.
2. Remove cable ties fixing connector “14”.
3. Unscrew two wing nuts fixing PSFM and remove washers (Fig. 84).
4. Take out PSFM from the housing.
5. To install PSFM follow instructions above in the reverse order.

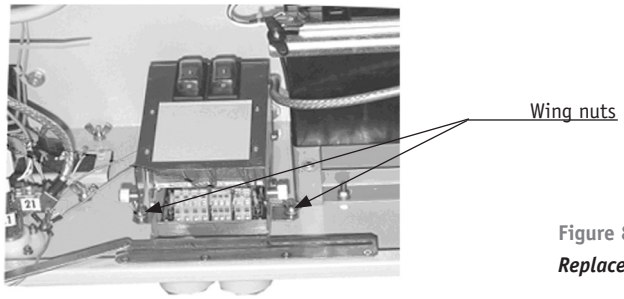


Figure 84
Replacement of PSFM

Replacement of Battery for RC/TEL-05

1. Switch off Battery circuit breaker SF1 AB (Fig. 29).
2. Disconnect WA:RCM-BAT from Battery clamps (Fig. 71) - the minus clamp must be disconnected first.
3. Loosen wing nuts, move battery-holder to extremely lower position.
4. Remove the Battery.
5. To install Battery follow instructions above in the reverse order.

Replacement of CPM

1. Disconnect connector “19” from CPM (Fig. 85).
2. Unscrew six wing nuts fixing CPM and remove washers (Fig. 85).
3. Remove CPM from the fixing stud-bolts and take it out from the housing.
4. To install CPM follow instructions above in the reverse order.

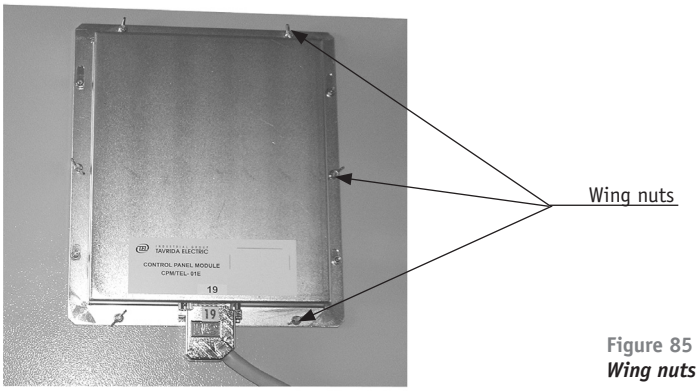


Figure 85
Wing nuts fixing CPM

Replacement of IOM

1. Disconnect connectors “15”...“18” from IOM.
2. Unscrew four screws M2.5 and remove IOM panel (Fig. 75).
3. Remove plastic fixed stops (Fig. 75).
4. Take IOM out from RCM.
5. To install IOM follow instructions above in the reverse order.

Replacement of BTM

1. Disconnect USB cable (Fig. 37).
2. Unscrew two screws and remove plastic cover (Fig. 37).
3. Remove Bluetooth module, install the plastic cover on its regular position and fix it by two screws.
4. To install BTM follow instructions above in the reverse order.

Replacement of RTU

1. Disconnect all connectors connected to RTU.
2. If RTU is installed on the tray, unscrew two captive screws and remove the tray with RTU.
3. If RTU is installed on the mounting plate, unscrew 4x M6 nuts and remove RTU mounting plate with RTU.
4. Remove RTU from the tray (mounting plate).
5. Install the tray (mounting plate) on its regular position.
6. To Install RTU see Installation of RTU in Chapter Installation.

Replacement of WA: RCM-CC

1. Disconnect connectors “7” and “8” from RCM.
2. Remove cable ties fixing connectors “7” and “8”.
3. Unscrew four wing nuts inside the housing (Fig. 32)
4. Remove the protective cover.
5. Unscrew four screws fixing connector “20” (from the outside of the housing).
6. Remove anti-spray rubber and the hold-down from the cable (Fig. 30).
7. Remove WA: RCM-CC from the housing.
8. To install WA: RCM-CC follow instructions above in the reverse order.

Replacement of WA: RCM-RTU

1. Disconnect connectors “5” and “23” connected to RCM and RTU respectively.
2. Remove cable ties fixing WA:RCM-RTU.
3. Remove WA:RCM-RTU from the housing.
4. To install WA:RCM-RTU follow instructions above in the reverse order.

Replacement of WA: RCM-BAT

1. Disconnect connector “13” from RCM.
2. Disconnect WA:RCM-BAT from the battery.
3. Remove cable ties fixing WA: RCM-BAT.
4. Remove WA: RCM-BAT from the housing.
5. To install WA: RCM-BAT follow instructions above in the reverse order.

Replacement of WA: RCM-CPM

1. Disconnect connectors “1” and “19” from RCM and CPM respectively.
2. Remove cable tie fixing WA: RCM-CPM.
3. Unscrew the nut fixing the clamp on the RC internal door. Remove washers and the clamp.
4. Remove WA: RCM-CPM from the housing.
5. To install WA: RCM-CPM follow instructions above in the reverse order.

Replacement of WA: RCM-DPS

1. Disconnect connector “9” from RCM.
2. Remove cable ties fixing WA: RCM-DPS.
3. Unscrew two nuts fixing the WA: RCM-DPS angle staff and remove washers (Fig. 86).
4. Remove the angle staff from the fixing stud-bolts and remove WA:RCM-DPS from the housing.
5. To install WA: RCM-DPS follow instructions above in the reverse order.

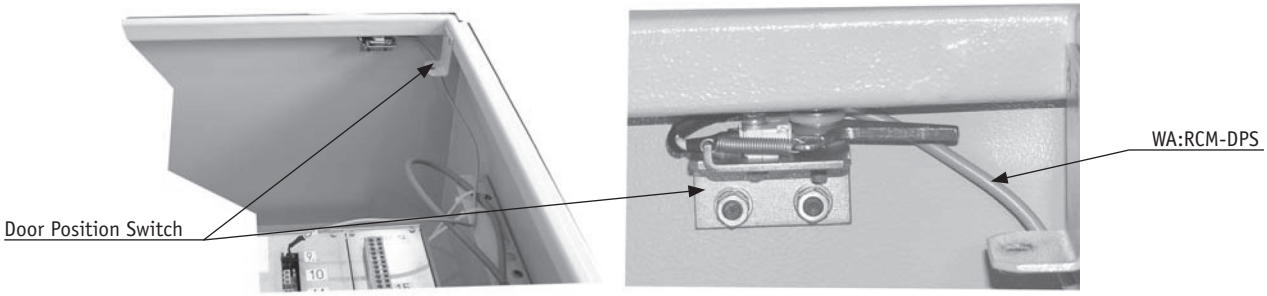


Figure 86
Door Position Switch and WA:RCM-DPS

Replacement of Intermediate Unit

1. Unscrew eight captive screws and remove the Protective lid.
2. Disconnect the earthing wire by taking out screw on tank.
3. Disconnect connector from Intermediate board, taking out two screws.(Fig. 87)
4. Remove clamp cover, taking out two screws.
5. Disconnect four wires from Wago cage clamps.
6. Take out the bundled conductors of the module supplying circuits, placed under clamp.
7. The trimming resistor jumpers of new Intermediate unit should be set the same as for the removed unit.
8. To Install Intermediate unit follow instructions above in the reverse order.

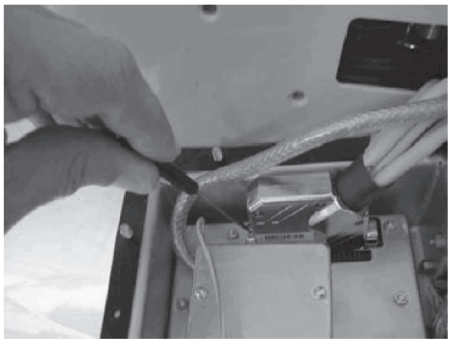


Figure 87
Replacement of Intermediate unit

Disposal

The OSM Recloser and Control Cubicle (excluding the Battery) do not contain any materials that are hazardous for the environment or personnel. No special methods of disposal are required.
The Rechargeable Battery contains toxic materials (Pb and H_2SO_4) and must be recycled. Contact the battery recycling company in your area.

Appendix 13

MMI Menu Structure

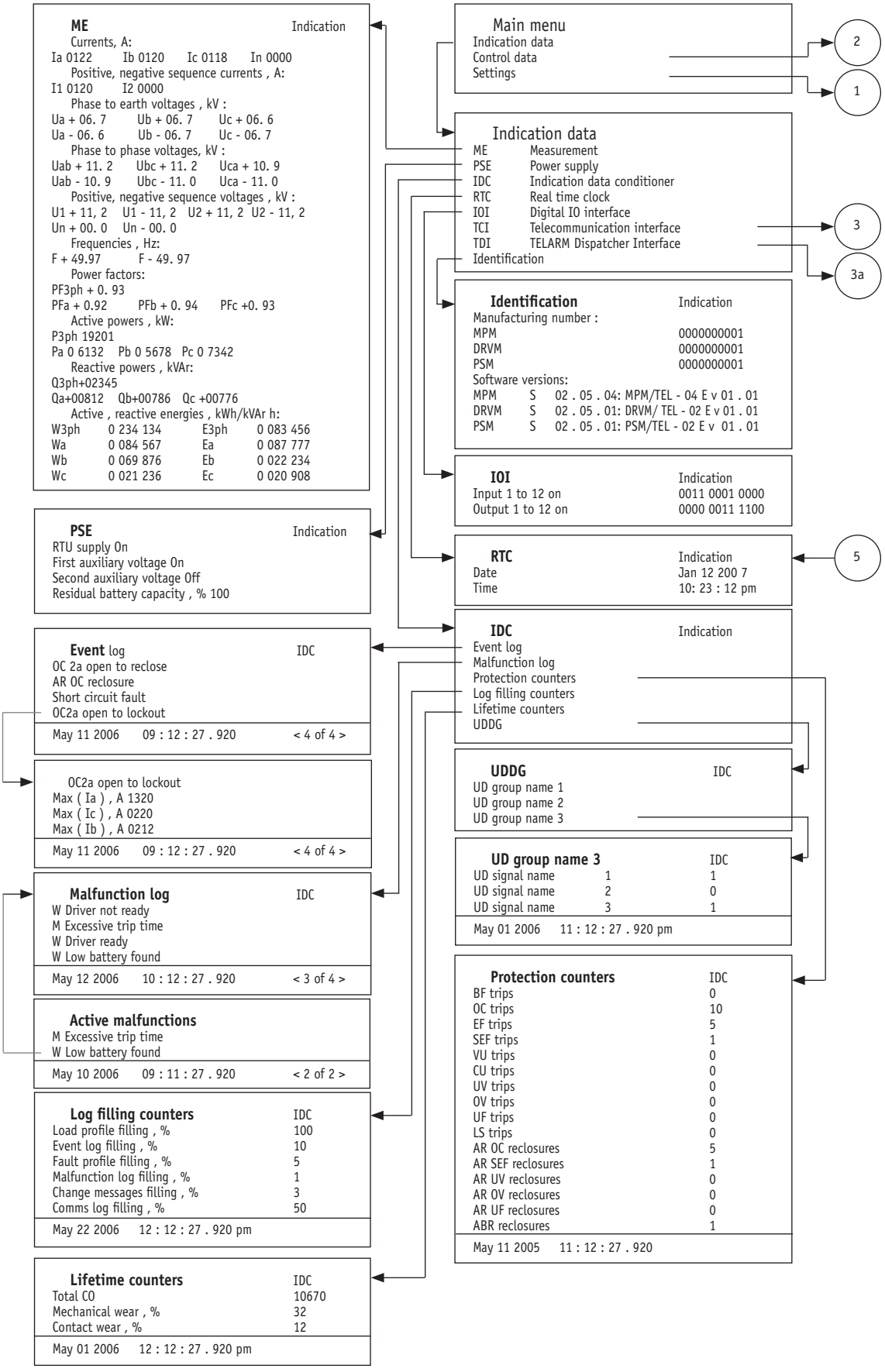


Figure 88

Main menu and Indication data

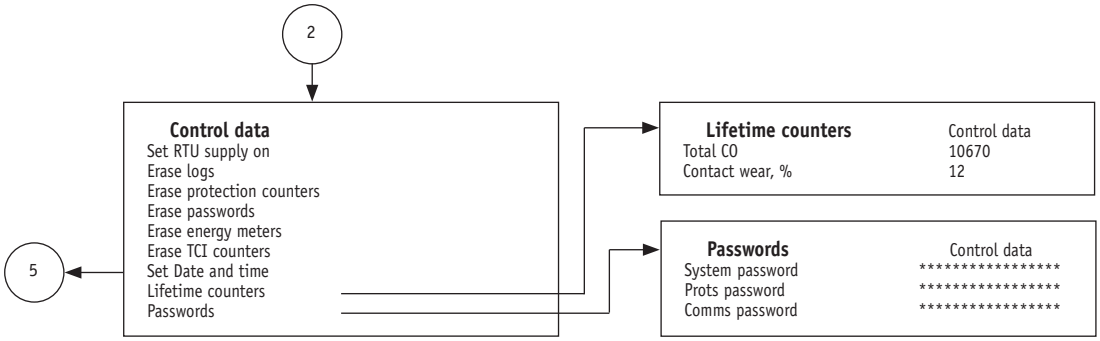


Figure 89

Control data

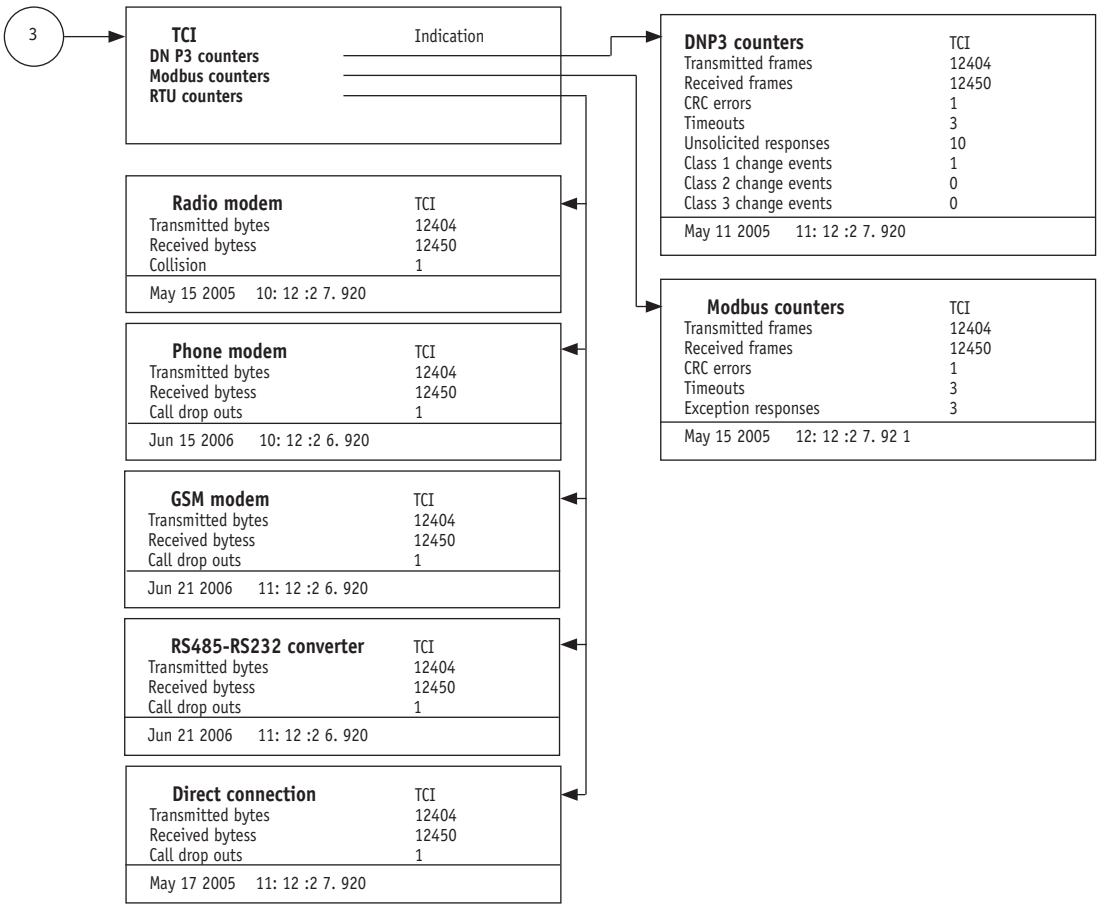


Figure 90

TCI indication data

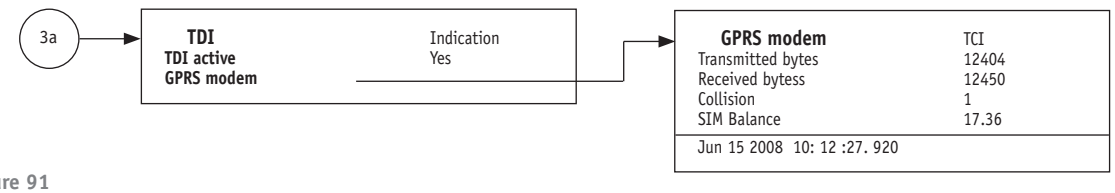


Figure 91

TDI indication data

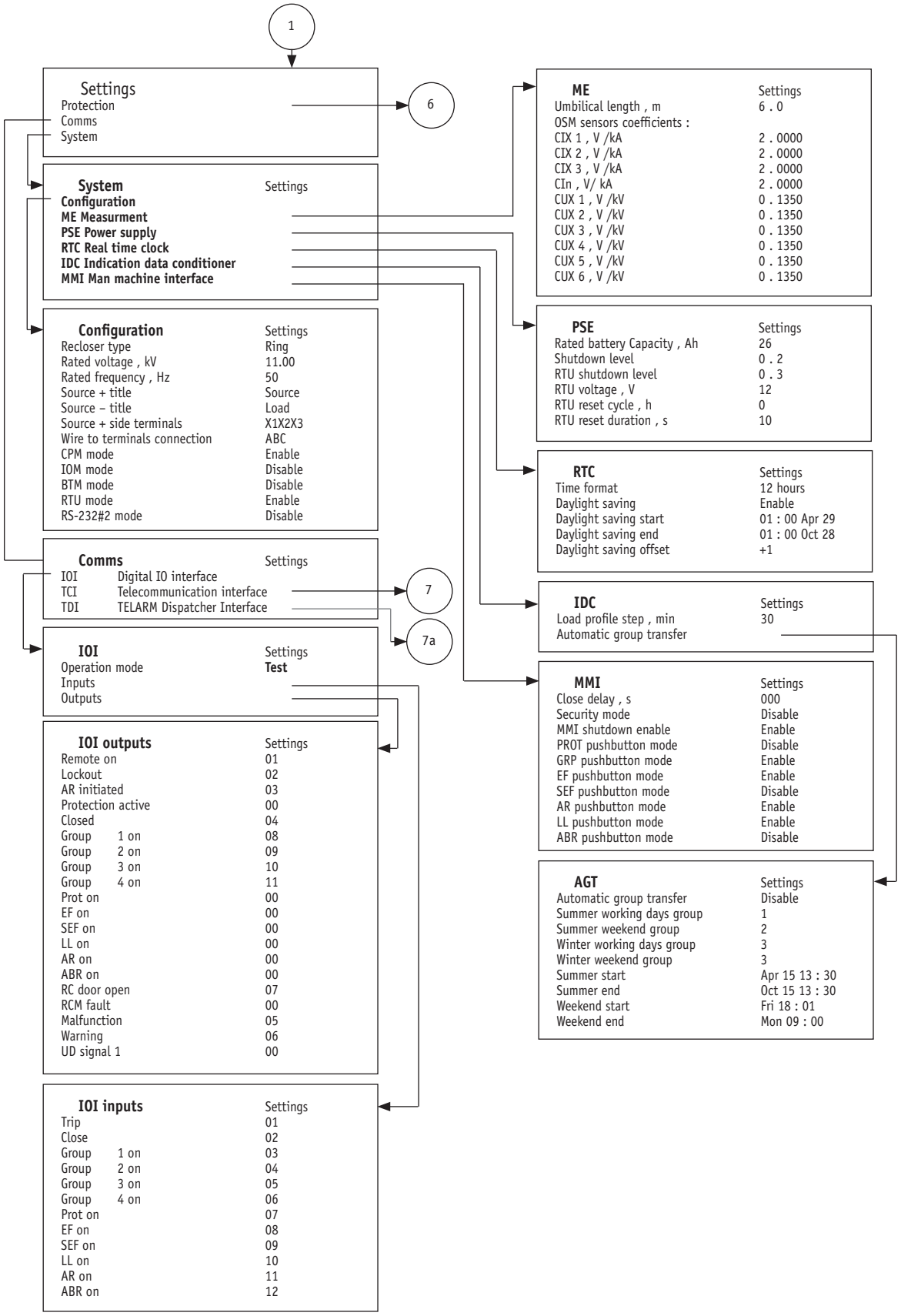


Figure 92

Comms and system settings

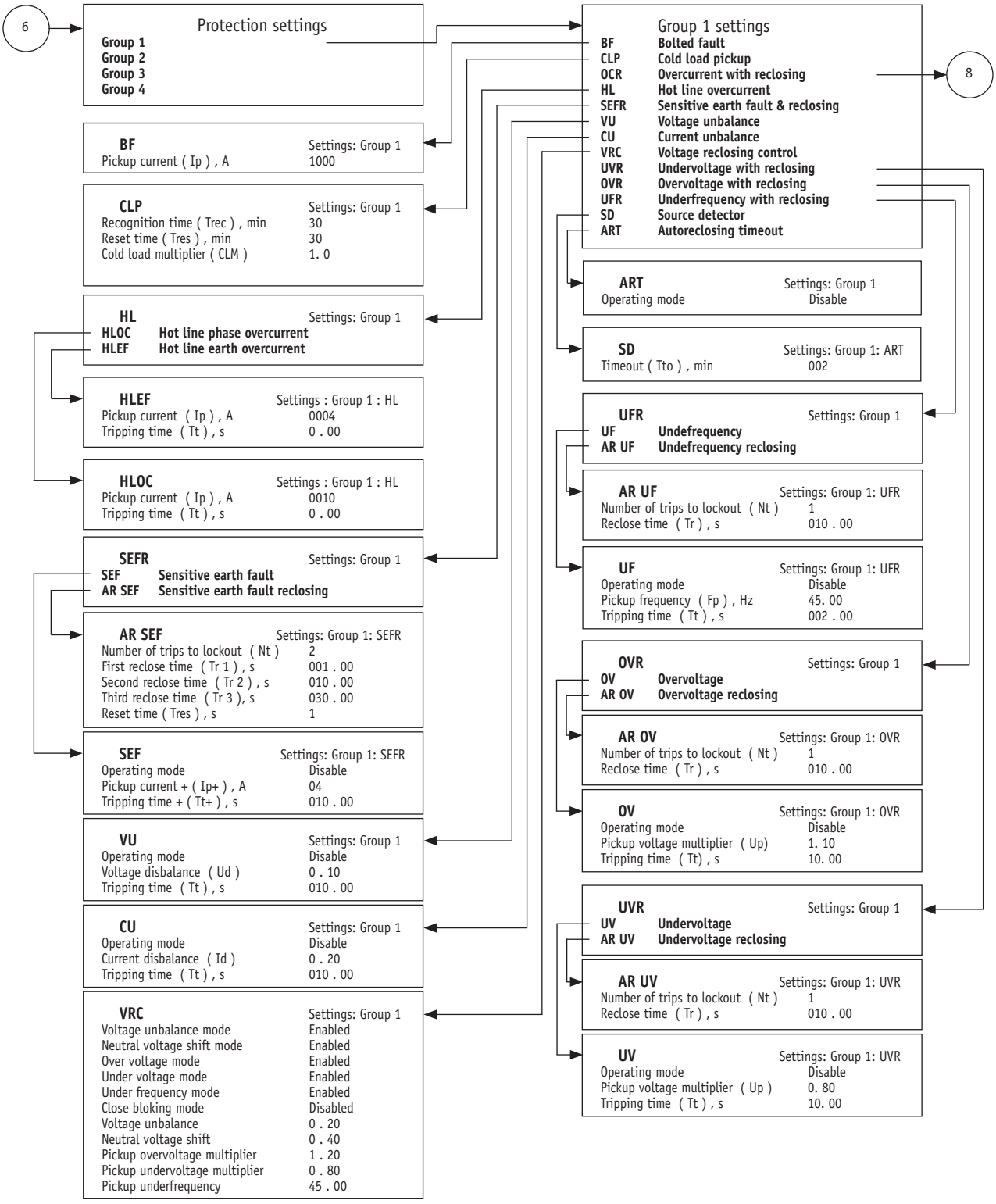


Figure 93

Protection settings

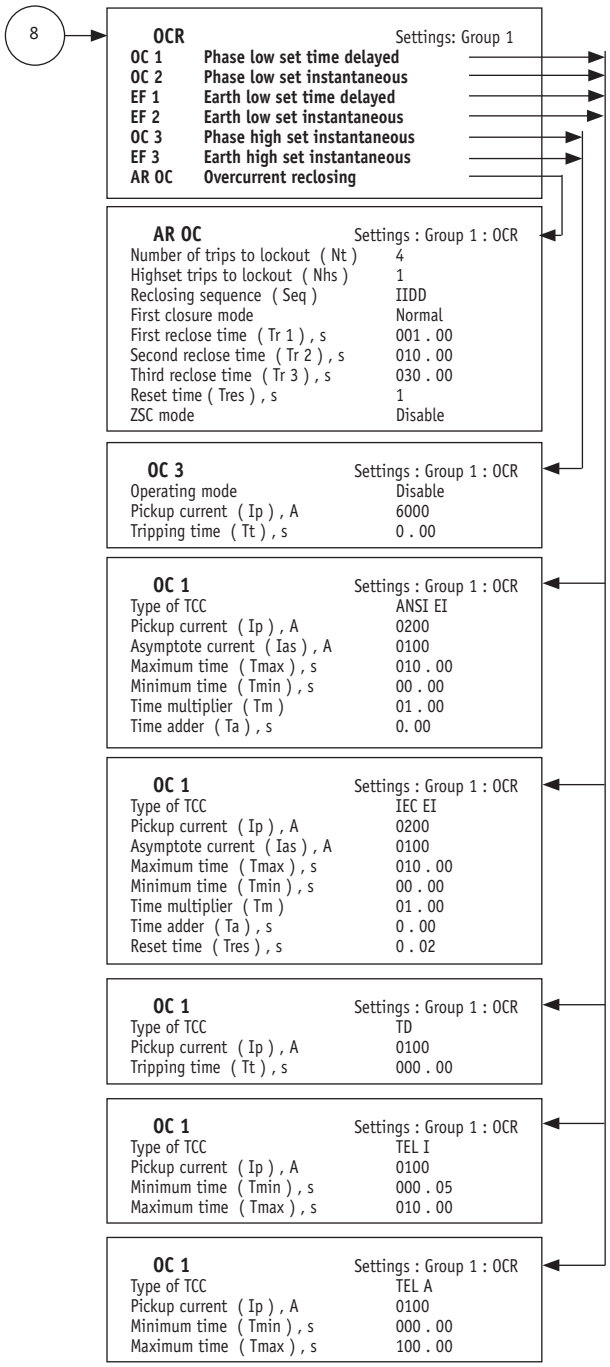


Figure 94

Protection setting for Recloser type=Radial (continuation)

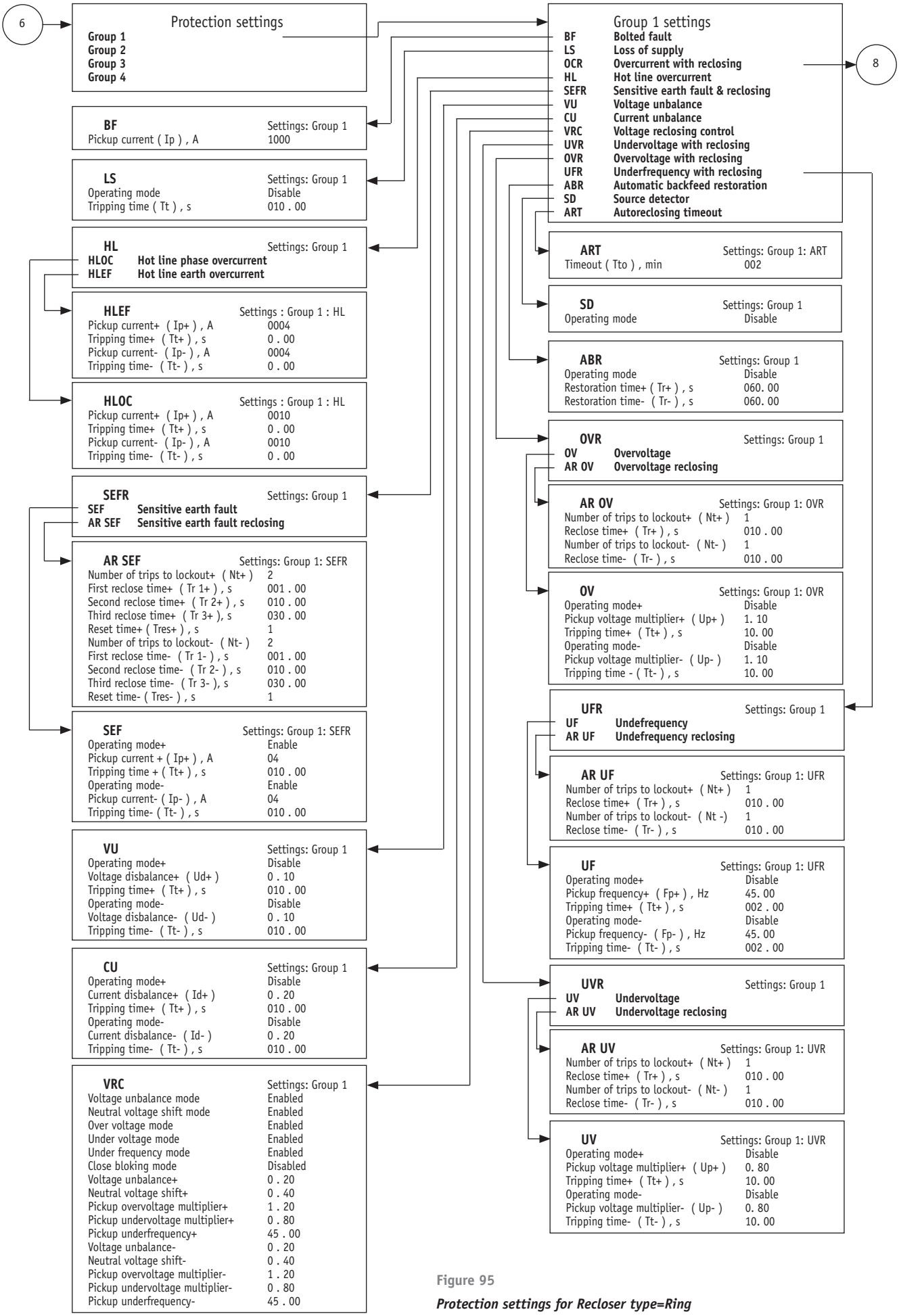


Figure 95

Protection settings for Recloser type=Ring

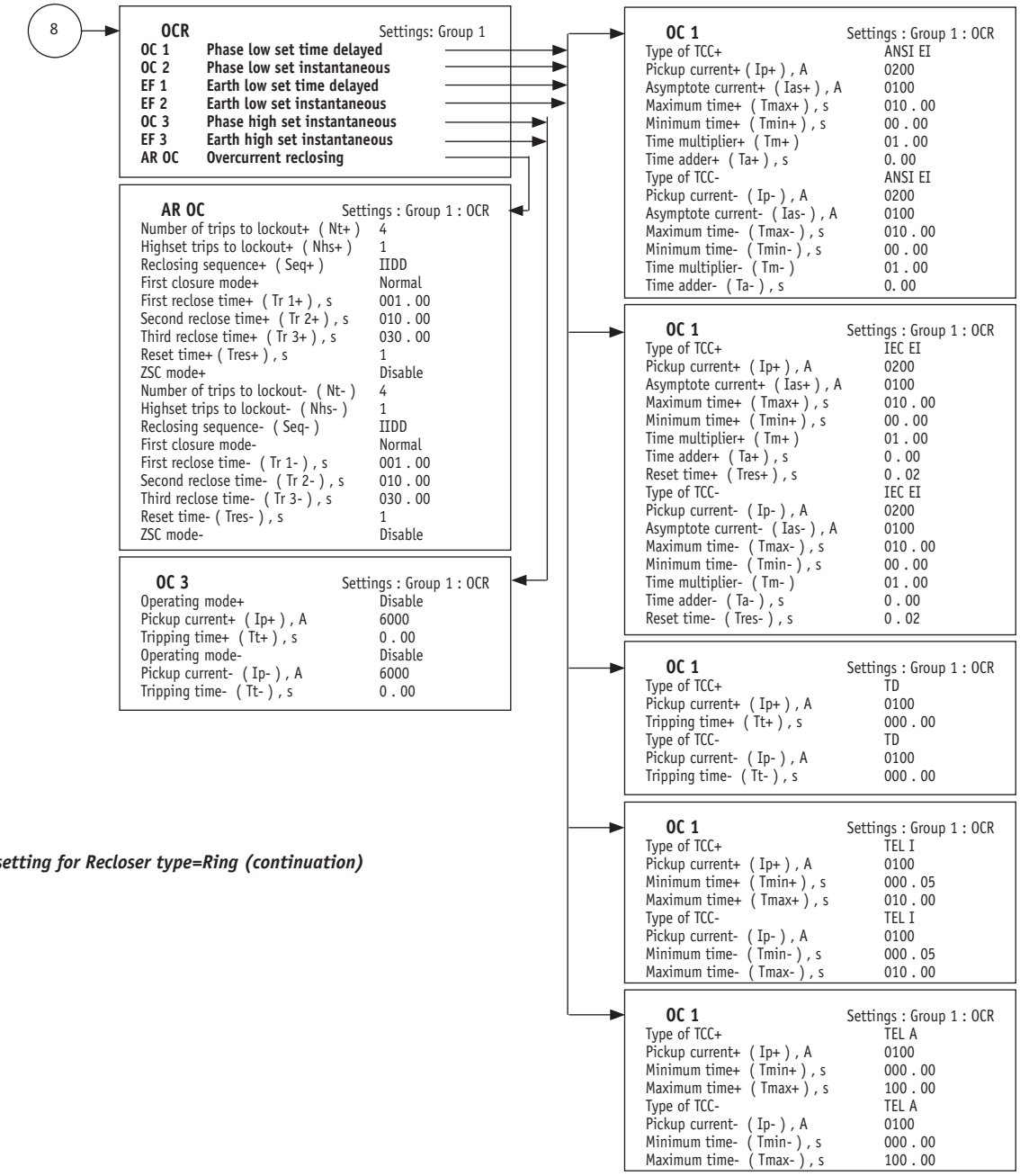


Figure 96

Protection setting for Recloser type=Ring (continuation)

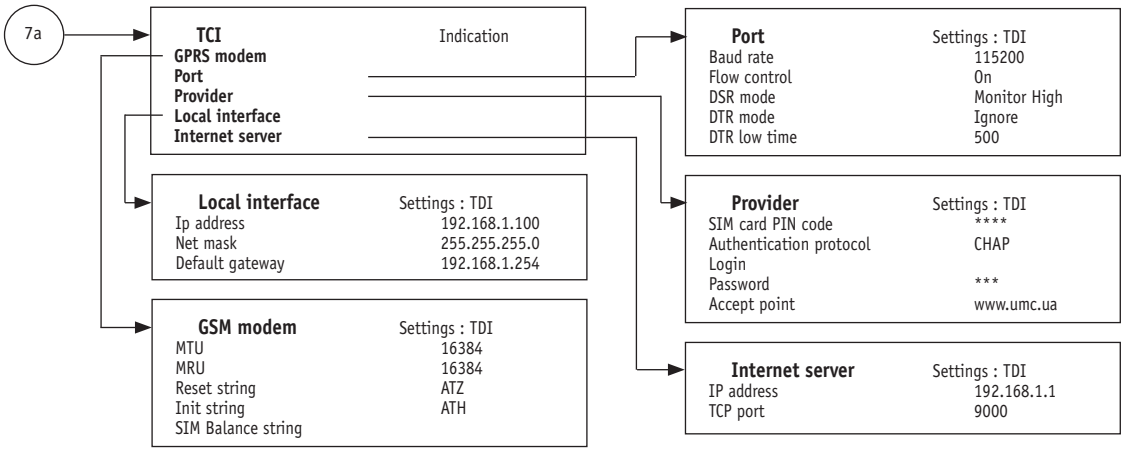


Figure 97

TDI settings

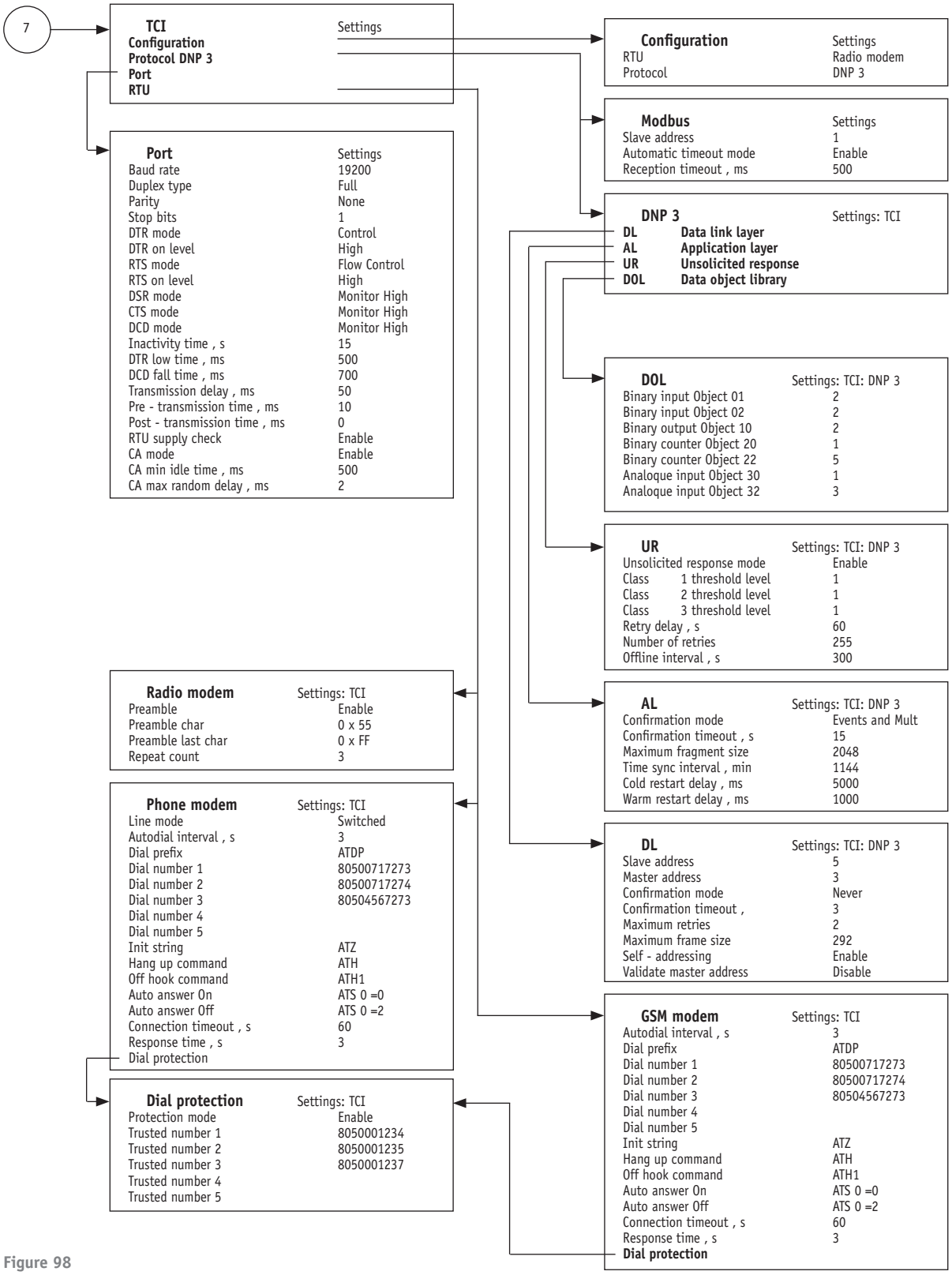
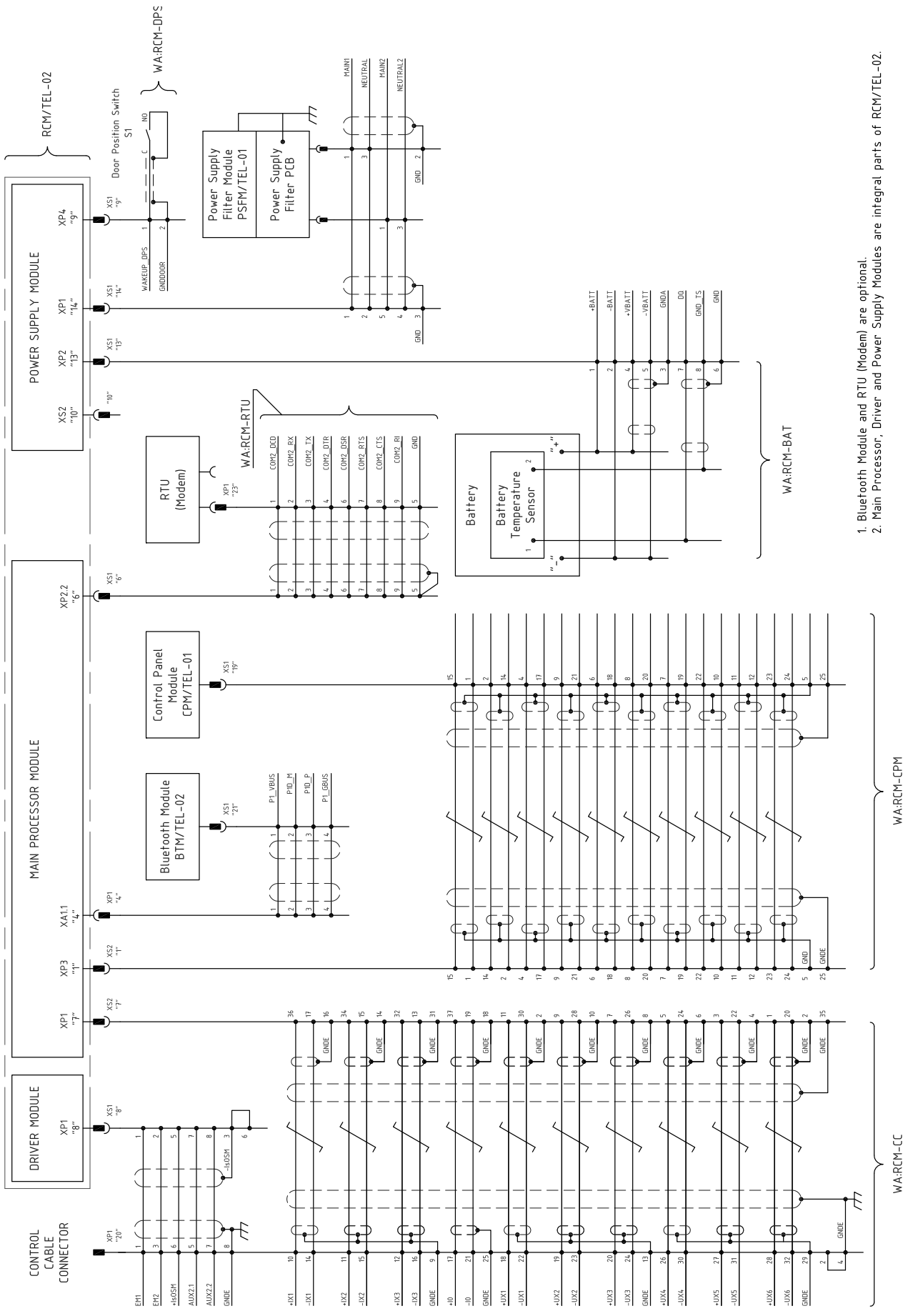


Figure 98

TCI settings

Recloser Control Cubicle Electric Diagram



Legal Information

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Warranty

Unless otherwise stated in the contract, the warranty period is 3 years from date of invoice. If agreed to otherwise, the contract conditions apply. No warranty is given in the case of …

a) … the warranty period having run out during the period of storage with the customer.
b) … the operating conditions, ambient conditions, transport and storage conditions have not been adhered to according to the application description or the Technical Manual.
c) … an unauthorized manipulation of the device has been carried out, such as opening the housing or damaging the seal.
d) … the device has not been properly installed, such as incorrect connection voltages.

Quality Regulations

All manufacturing facilities of the company have been certified by KEMA and DEKRA in the Netherlands and comply with (DIN EN) ISO 9001:2008 and ISO 14001:2004.

All technical data of the automatic circuit recloser are stored in an electronic database for each step of the manufacturing process. Testing of the automatic circuit recloser is carried out in accordance with the relevant standards and beyond that the following test are carried out:

- 1000 C-O cycles
- Insulation strength of the primary and auxiliary circuits at operating frequency
- Measurement of the resistance of the main circuit
- All test results are automatically stored

Complaints and Transport Damage

All products are shipped exclusively with original packing to ensure safe transport and avoid transport damage (see Packing, Goods Received).

Tavrida Electric will not accept any claims for damages caused by improper transport, storage as well as unpacking. Transport damage must be reported in writing to the supplier as soon as it is discovered. A period of maximum 3 weeks after receipt is allowed for this.

For legitimate claims Tavrida Electric will supply replacement equipment free of charge according to our warranty regulations. Tavrida Electric reserves the right to verify any claim.

Environmental Friendliness

The modules are manufactured from environmentally friendly material. Therefore, special disposal is not required.

Non-Conformity

Tavrida Electric has taken every care in designing, assembling and testing of this product. However, in case of any Non-conformity please contact your nearest Tavrida Electric office or Distributor.

Liability

Damages and demands for reimbursement of expenses incurred by the customer (in the following: compensation) for what-ever legal reasons, especially due to non-compliance of obligations of the contractual obligations and for unauthorized actions, are excluded. This does not apply, insofar as there is a compulsory liability such as according to the product liability law in cases of malice, gross negligence, because of damage to life, the body or health, because of damage to important contractual obligations.

Compensation for damage to important contractual obligations, however, is limited to the damage which can be predicted as typical of the contract insofar as there is no malice or gross negligence, because of damage to life, the body or health. A change of the obligation to provide proof to the disadvantage of the customer is not connected with these regulations.

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Without our written permission, this documentation may not be used, also not in extract form, for own general publications, printouts, handbooks, training, lectures, etc. nor copied and further processed. This includes also the duplicating or re-copying in any form of data carriers and microfilms. A one-time written permission is not automatically to be taken as a part or complete surrender of the copyright provisions. We reserve the right to changes. The issue of a new version of these operating instructions renders all other older versions obsolete. Tavrida Electric and its associated companies make every effort to adapt the contents of their documentation to the latest and most current state of development of the products.

The present documentation was produced with the greatest care. However, we are not liable for possible errors in this information text, user-side incorrect interpretation and/or for consequences arising therefrom.

TAVRIDA ELECTRIC AG
General Terms of Delivery

I. General

(1) Scope of Application Regarding Subject-Matter & Parties Concerned
The following terms apply to all our deliveries and services (including secondary services, such as e.g. proposals, planning aids, advice) pro-vided to businesses as defined in German Civil Code [Bürgerliches Gesetzbuch - BGB s. 14,] legal entities under public law, and special trusts under public law. They do not apply to legal relationships with consumers as defined in German Civil Code s. 13.

(2) Exclusion of Other Terms of Business
Customer's diverging terms of business are herewith refuted, nor shall we be bound by them if we fail to expressly contradict them again on receipt. Our terms shall be deemed accepted on placement of the order, or on receipt of the confirmation of order, or at the latest on acceptance of our delivery.

(3) Validity
If any provisions are or become invalid, this shall not affect the validity of the remaining terms of these Terms of Delivery. In the event of any provision being invalid, an effective provision shall be deemed agreed such as approximates as nearly as possible that which was intended in business terms.

(4) Written
FormDivergences from the following terms, and other amendments or supplements to the order, must be confirmed by us in writing in order to become effective. This also applies to any cancellation of this requirement for written form.

II. Assignments

(1) Written Confirmation
Our quotations shall be without obligation until an assignment (order) placed on the basis of a quotation is confirmed by us in writing. Each and every assignment (order) must be confirmed by us in writing in order for acceptance to have legal effect. In the case of deliveries without any written confirmation, our invoice shall count as a confirmation of order at the same time.

(2) Essence of the Assignment
We reserve the right to make due technical and design-related chang-es to the goods ordered provided this does not impair or only slightly alters the goods' technical function, normal usage, and value. If any such change means that Customer may not reasonably be expected to accept delivery, then it may cancel the order. Further rights are excluded.

(3) Technical Data
The technical data given in our quotations, drawings and illustrations are approximate values, unless they have been expressly termed binding in writing and tolerance figures are given. In all other respects, the relevant technical regulations on acceptance and safety that apply in the country of origin shall apply exclusively to our deliveries.

III. Obligation to Deliver

(1) Subject to Own Deliveries
Our own obligation to deliver shall be contingent upon our being properly supplied on time with the necessary goods and materials. In the event of a permanent obstacle for reasons for which we are not responsible, in particular force majeure, strikes, lock-outs, import and export restrictions, transport problems, intervention by government authorities and suchlike, we shall be entitled to rescind the contract on exclusion of all and any obligation to pay compensation. We shall also be entitled to rescind the contract on exclusion of all and any obligation to pay compensation if any more than insubstantial change occurs in the availability, pricing or quality of the goods delivered to us by our own suppliers or in the services provided by other third parties on which proper performance of the order placed with us largely depends.

(2) Part Deliveries, Excess & Short Deliveries
Part deliveries are permitted, and with regard to payments and complaints they shall be deemed separate independent deliveries. We are entitled to make excess or short deliveries of up to 10% of the am-ount ordered, insofar as Customer may be reasonably expected to accept this.

(3) Substantial Deterioration in Customer's Financial Circumstances
If, after the contract has been concluded, any substantial deterioration in Customer's financial circumstances and/or liquidity occurs, or if any such circumstances or events existing prior to conclusion of the contract subsequently become known, then we may rescind the contract or demand immediate payment in cash of all outstanding bills, at our option, even if extra time has already been allowed for all or any invoiced amounts or if such amounts have already been fully or partly paid by bill of exchange. In particular, the following shall be deemed such deterioration: a reduced credit rating by a credit reporting agency, protests involving bills of exchange and cheques, liens, suspension of payments, institution of insolvency proceedings, and the dismissal of such proceedings due to lack of assets. In the event that we do not rescind the contract in spite of a deterioration in financial circumstances, we shall deliver only in return for ongoing instalments, and in the case of bigger orders only in return for advance payment.

IV. Delivery Date

(1) General Provisions on Delivery Dates
Unless otherwise agreed, all delivery dates and periods quoted are to be understood to be approximate and non-binding. The delivery date shall be deemed reasonably extended if it cannot be met due to circumstances for which we are not responsible, whereby as a matter of principle a period of one month shall be regarded as reasonable, unless some shorter period is agreed in writing in individual cases, taking both parties' interests into account.

(2) Fixed-Date Transactions
Agreements on binding fixed dates or fixed delivery periods must be explicitly labelled fixed-date transactions and confirmed in writing. Delivery periods commence on the date of our written confirmation, but not before all the implementation details and other requirements having to be met by Customer for proper handling of the contract have been sorted out. The same applies to delivery dates.

(3) Obligation to Cooperate
Customer is under obligation to provide all the data, records and other instructions needed for performing the contract along with the placement of order or immediately thereafter. If such records and data are not received on time, Customer may not insist on delivery dates or periods being met. In any such case, the assertion of compensation for delay is excluded. The delivery date or period shall be deemed reasonably extended.

V. Passing of Risk

(1) Passing of Risk on Dispatch
The risk of the delivery's destruction or deterioration shall pass to Customer as soon as it has left the works from which it is being dispatched. This shall also apply if the consignment is made at our expense or with our means of transport. Dispatch shall in any event be at Customer's risk, even if freight-paid delivery has been agreed.

(2) Passing of Risk on Notification of Readiness for Dispatch
If dispatch of the consignment is delayed at Customer's request or for reasons for which we are not responsible, then the risk shall pass to Customer on notification of readiness for dispatch.

VI. Prices

(1) General Terms on Prices
Our prices are ex works plus packaging and statutory value added tax [Mehrwertsteuer]. Agreement of fixed prices must be expressly confirmed in writing. Unless otherwise agreed, our prices for all deliveries, including ones outside the European Currency Union, shall be in Euro.

(2) Packaging & Packaging Materials
We shall take back packaging and packaging materials. The cost of return transport shall be paid by Customer. In the case of deliveries outside Germany, returning any manner of packaging is excluded.

VII. Terms of Payment

(1) Payment Dates
Unless otherwise agreed, the invoiced amounts are payable without deduction within 30 days of the date of invoice, and with 2% discount within 10 days of the date of invoice.

(2) Default Interest
In the event of Customer defaulting in payment, it shall pay interest on the outstanding amount at a rate of 8% over and above the European Central Bank's base rate; the right to claim further default damages is reserved.

(3) Payment by B/E and Cheque
Bills of exchange shall only be taken if expressly agreed, and - like cheques - by way of payment only, subject to our acceptance in each individual case. Discount fees and other charges must be paid by Customer.

(4) Other Factors
Interfering with Counter-PerformanceDeliveries shall be made contingent upon Customer's credit standing and liquidity. In the event of default in payment, non-payment of cheques or bills of exchange, the suspension of payments, the institution of proceedings for settling debts, non-compliance with the terms of payment, a poorer credit rating by a credit reporting agency, and in the event of circumstances likely to impair Customer's credit standing, we shall be entitled at any time to reasonably amend the contractual terms and to rescind the contract if performance is ultimately refused.

(5) Set-Off, Right of Retention
In respect of our due claims, Customer shall only be entitled to a right of set-off or retention based its own counter-claims up to the amount of demands which have been established res judicata or acknowledged in writing.

VIII. Reservation of Title

(1) Agreement on Reservation of Title
The goods delivered (goods subject to reservation of title) shall remain our property until such time as all and any claims to which we are entitled vis-à-vis Customer on the basis of the business relationship have been satisfied. Bills of exchange and cheques shall only be deemed to effect payment once they have been honoured.

(2) Extended Reservation of Title
If the goods subject to reservation of title are processed or combined by Customer with other goods not belonging to us to make a new single object, then we shall be entitled to co-ownership of the new object up to the value of our goods in proportion to the other processed and/or added goods at the time of processing and/or combination. Our coownership thus created shall be deemed reservation of title as defined in these provisions.

(3) Sale, Advance Assignment
Customer may only sell the goods subject to our reservation of title during the course of normal business, and only as long as it does not default in settling all our claims. Customer here and now assigns to us its claims based on a resale of the goods subject to reservation of title by way of securing all our claims arising from the business relationship. We herewith accept such assignment. If Customer sells the goods subject to reservation of title along with other goods not belonging to us or in which we have no rights of co-ownership, then the claim arising from such resale shall be assigned to us only up to the value of our goods subject to reservation of title. The value of the goods subject to reservation of title shall be assessed on the basis of the invoiced amount. Customer is entitled to collect the claims based on resale that have been assigned to us, unless we revoke such entitlement at any time.

(4) Threat to Ownership Rights
As long as we have reservation of title, Customer is not allowed to pledge the goods or assign them by way of security. In the event of liens, seizures or other third-party disposition or interference, in particular by way of levying execution, Customer must notify us as once in writing.

(5) Obligation to Surrender
If Customer defaults in settling our claims in whole or in part, then we shall be entitled to demand at any time that the goods subject to reservation of title be surrendered and to otherwise dispose thereof, and to withhold outstanding deliveries, even if we do not cancel the sales contract. No further reminder or deadline shall be required. Our assertion of rights to reservation of title shall not be deemed rescission of the contract.

(6) Release of Security
If the value of the security to which we are entitled under the above provisions exceeds outstanding invoiced amounts by more than 20%, then at Customer's request we shall be obliged to release excess security at our own option, subject to the proviso however that, except for deliveries in an actual current account relationship, release of security shall only apply to deliveries or equivalents which have been paid in full.

IX. Material Defects

(1) Specification of Characteristics
The characteristics of the product to be supplied by us are conclusively specified in our written or electronic quotation records and/or in/on our catalogues, CDs or other data carriers. Unless otherwise agreed in writing, the usage given in our quotation shall be deemed the sole subject-matter of the contract.

(2) Customer's Obligation to Inspect & Lodge Complaints
Customer must inspect our products immediately on receipt and lodge written complaints about any obvious defects within a period of two weeks of delivery. Defects which are not discovered within this period despite careful inspection must be reported to us in writing without delay, at the latest within two weeks of being discovered. If Customer fails to report defects in good time, then our delivery shall be deemed made in accordance with the contract and free of defects.

(3) Minor Defects, Wear & Tear, Improper Usage, External Factors
Claims based on defects shall not be deemed to exist if there is only a minor deviation from the agreed characteristics, if usability is only slightly impaired, in cases of natural wear and tear or damage caused subsequent to passing of risk as a result of wrong or negligent handling, in cases of excess usage, unsuitable materials, defective building work, unsuitable building land, chemical, electrochemical, electronic, electric or other specific external influences which are not provided for under the contract, and in the case of non-reproducible software errors. If alterations or repairs are carried out improperly by Customer or third parties, there shall similarly be no claims for defects in respect of such alterations or repairs or for the consequences resulting therefrom.

All claims under the warranty shall lapse if the Tavrida seal affixed to the defective product has been damaged, unless such damage is not due to the deliberate acts of one or more persons.

Customer may not refuse to accept deliveries of goods due to minor defects.

(4) Liability for Material Defects
Our goods or services shall be subsequently improved or resupplied - at our option - free of charge if any material defect occurs during the prescriptive period, provided the cause for such defect already existed at the time of passing of risk, furnishing proof of which shall be incumbent upon Customer. We must initially be granted a reasonable period for such post-performance. If our attempts at post-performance fail more than three times, Customer may rescind the contract or reduce the payment. Claims to compensation shall remain unaffected.

(5) Warranty Period
Claims based on material defects shall become statute-barred after twelve months. This shall not apply if longer periods are prescribed by law (German Civil Code s. 438 (1) no. 2 Buildings & Objects for Buildings , s. 479 (1) Claims under Right of Recourse , and s. 634 a) (1) no. 2 Constructional Defects), or in cases of loss of life or limb or health hazards, or in instances of wilful or gross violation of duty on our part, or in the event of malicious non-disclosure of defects. The statutory regulations on the suspension, interruption and recommencement of periods with a fixed deadline shall remain unaffected.

(6) Reimbursement of Expenses
Customer's claims to expenses required for the purpose of postperformance, in particular costs for transport, travel, labour and materials, are excluded insofar as such costs are increased due to the delivery object subsequently being removed to a place other than Customer's establishment, unless such removal is in line with its intended usage.

(7) Exclusion of Claims to Recourse
Customer shall only be entitled to have recourse to us pursuant to German Civil Code s. 478 (Contractor's Recourse) insofar as Customer has not reached any agreements with its own customer going beyond the statutory claims for defects, and/or insofar as equivalent arrangements on compensation pursuant to German Civil Code s. 478 (4) have not otherwise been reached between Customer and ourselves.

(8) Returning Defective Products
Insofar as Customer justifiably asserts warranty claims on us, it shall be under obligation to return the defective products to us freight paid, or to keep them ready for inspection and checking at the place where its establishment is located, at our option.

(9) Other Compensation
In all other respects, Section XII of these Terms of Delivery (Other Claims to Compensation) shall apply to claims to damages. Claims based on material defects other than or going beyond those regulated in this Section IX that are imposed by Customer on ourselves and on those assisting us in performing our obligations, are excluded.

X. Additional Product Warranty

(1) General Terms of Warranty
Over and above the warranty rights pursuant to Section IX of these Terms, we shall grant a product warranty for material and/or manufacturing defects. Unless otherwise agreed in writing, we permit Customer and each of its own customers to impose claims for material and/or manufacturing defects on us:

a) if the Tavrida Electric product has been bought from us or from an authorised Tavrida Electric dealer;

b) if the product has been properly employed by the user with the care of a diligent businessman in accordance with the normal usage stipulated in the product specifications;

c) if damaging factors in the environment and/or surroundings - such as excessive heat, cold or moisture (going beyond the limits given in the manufacturer's specifications) - can be ruled out, or if the user proves that such factors have had no influence on the product's ability to function properly;

d) if no force has been exerted due to accident, lightning or excess voltage (going beyond the range tested for the respective product);

e) if the wrong functioning of our product due to installation errors, operating errors - in particular derogation from the rules laid down in the operating instructions - or other culpable third-party conduct can be ruled out;

f) if the Tavrida seal is still affixed to the product undamaged.

(2) Warranty Period
The warranty period lasts 5 (five) years and commences on the day after the purchase date given on our invoice or on the invoice issued by an authorised Tavrida Electric dealer. The warranty period for a Tavrida Electric product shall not be extended due to the rendering of postperformance or warranty services, which shall not have the effect of the warranty period being interrupted or re-commencing.

(3) Warranty Services
If during the warranty period we are given proof of a warranty claim pursuant to the General Terms of Warranty (Section X, Item (1)), then we shall provide Customer/Buyer with a replacement of equal value. All the costs for transport, disassembly and installation and all other

costs incurred in connection with the replacement of the part covered by the warranty shall be borne by Customer/Buyer. Customer's contractual or statutory warranty rights shall remain unaffected by the handling of the warranty.

(4) Obligation to Return
If Customer/Buyer justifiably imposes claims on us under a warranty, it shall be obliged to return the replaced defective product to our main branch at its own expense.

XI. Legal Defects, Industrial Property Rights, Copyright

1) Third-Party Protective Rights
Unless otherwise agreed, we are only under obligation to make deliveries free of third-party industrial property rights and copyrights (referred to hereafter as "protective rights") inside Germany. If a third party asserts on Customer legitimate claims due to a infringement of protective rights caused by deliveries made by us and used in accordance with the contract, then we shall be liable vis-à-vis Customer as follows during the period stipulated in Section IX, Item 5:

a) At our own option and at our own expense, we shall either obtain a usufructuary right for the deliveries concerned, or alter the latter in such a manner that the protective right is not infringed, or exchange it. If we are unable to do so on reasonable terms, then Customer shall be entitled to its statutory right to rescind the contract or reduce the price.

b) Any obligation on our part to pay damages shall be governed by Section XII of these Terms of Delivery.

c) We shall only have the aforementioned obligations provided Customer informs us without delay in writing about the claims being asserted by third parties, fails to acknowledge any infringement, and leaves all the defence measures and settlement negotiations up to us. If Customer ceases using the delivered object so as to minimise losses or for other important reasons, then it shall be under obligation to point out to the third party that suspension of usage does not constitute any manner of acknowledgement.

(2) Customer's Responsibility
Customer's claims are excluded if it is responsible for the infringement of protective rights.

(3) Other Grounds for Exclusion
Customer's claims shall moreover be excluded if the infringement of protective rights is due to Customer's specific instructions, or due to a form of usage not predicted by us, or due to the delivery being altered or used by Customer in conjunction with other products not supplied by us.

(4) Other Legal Defects
In the event of other legal defects, the provisions laid down in Section IX shall apply mutatis mutandis.

(5) Exclusion of Further Claims
Claims due to legal defects asserted by Customer on us and on those assisting us in performing our obligations which go beyond or differ from those regulated in this Section IX and in Section X above are excluded.

XII. Other Claims to Compensation

(1) Exclusion of Liability
Customer's claims to compensation and reimbursement of costs,for whats oever legal cause, in particular due to violation of the obligations ensuing from the contractual relationship or in tort, are excluded.

(2) Mandatory Liability
This shall not apply insofar as liability is mandatory, e.g. under the Product Liability Act, in cases of intent or gross negligence, in the event of loss of life or limb or health hazards, due to the violation of cardinal duties, or due to the assumption of warrantys. However, claims to compensation and reimbursement of costs in the event of the violation of cardinal duties are limited to predictable damage typical for the type of contract, provided intent or gross negligence do not apply, and provided no liability arises by reason of loss of life or limb or health hazards. The foregoing arrangements do not shift the onus of proof to Customer's disadvantage.

(3) Prescription
Insofar as Customer is entitled to claims to compensation pursuant to this Section XII, such claims shall become statute-barred on expiry of the prescriptive period for claims for material defects pursuant to Section IX, Item 5 above. In the case of claims to compensation under the Product Liability Act, the statutory regulations on prescription shall apply.

XIII. Information about Products

(1) Information about Products in Printed Matter & Advertising
Unless expressly termed warranted characteristics, everything contained in our quotation records and other printed matter or on data carriers shall merely constitute a description of the product, and not imply any offer to conclude a warranty agreement. The same applies to information given in our advertisements.

XIV. Miscellaneous

(1) Rescission by Customer
Customer's statutory right to rescind the contract shall not depend on fault if the delivery is defective. In all other instances, Customer may only rescind the contract in the event of a violation of duty for which we are responsible.

(2) Data Protection
We draw our customers' attention to the fact that with the help of EDP we process and disclose personal data for business purposes in line with the regulations laid down in the Data Protection Act.

XV. Place of Performance, Venue, Governing Law

(1) Place of Performance
Place of performance for the services owing under the contract by both parties shall be Erlangen.

(2) Venue
Exclusive venue for all disputes arising directly or indirectly from the contractual relationship shall be Erlangen. However, we are also entitled to bring action at the location of Customer's registered establishment.

(3) Governing Law
Legal relations between Customer and ourselves shall be exclusively governed by Federal German law on exclusion of CISG.

Date: _____

TAVRIDA ELECTRIC

Applicable for the following types:

OSM/TEL-15.5-16/630-204
OSM/TEL-27-12.5/630-205

RC/TEL-05E
RC/TEL-05P

Australia

Tavrida Electric Australia Pty Ltd.
5/490 Frankston Dandenong Road
Carrum Downs Victoria 3201
Australia
Phone: +61 3 9786 7444
Fax: +61 3 9011 9681
E-Mail: info@tavrida.com.au
Web: www.tavrida.com.au

China

Tavrida Electric Beijing Ltd.
First Floor West, Building 11, No. 28 Yuhua Road,
Area B, Beijing Airport Industrial Zone,
101300 Beijing, China
Phone: +86 (10) 80492474/-5474
Fax: +86 (10) 80497114
E-Mail: info@tavrida.cn
Web: www.tavrida.cn

Germany

Tavrida Electric GmbH
Georgstr. 7
88069 Tettnang
Germany
Phone: +49 (0) 7542 9467851
Fax: +49 (0) 7542 9467861
E-Mail: info@tavrida.de
Web: www.tavrida.de

India

Tavrida Electric India Private Limited
15 NC, Block-A, New Alipore
Kolkata - 700 053
West Bengal, India
Phone: +91 33 2488 1715/3260 8634
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E-Mail: info@tavrida.in
Web: www.tavrida.in

South Africa

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Web: www.tavrida.ch

If your country is not listed above please consult www.tavrida.com to find your nearest Tavrida Electric partner.

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