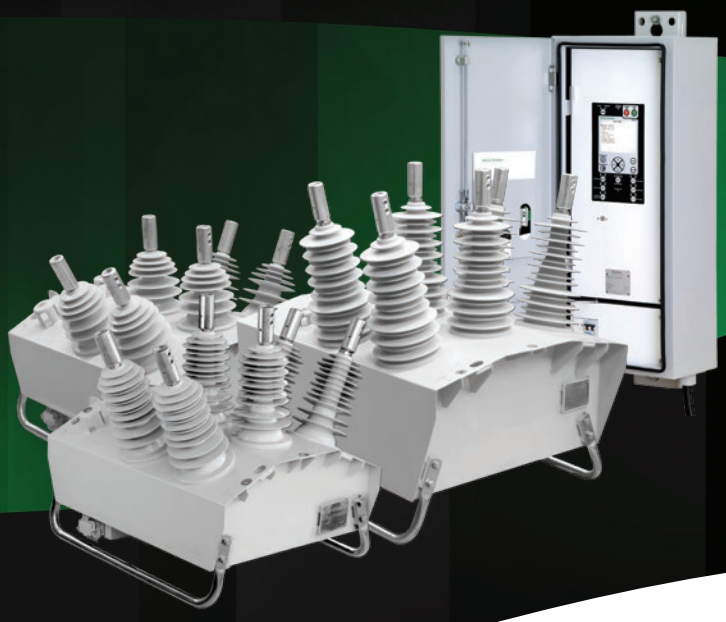
NOJA POWER®

OSM

USER MANUAL

OSM AUTOMATIC
CIRCUIT RECLOSER
15KV, 27KV & 38KV MODELS



USER MANUAL

NOJA Power®

OSM 300/310
with RC-10

Revision History

Rev	Author	Date	Comment
0	AZ	07-05-2013	First issue document of 300 and 310 Series Recloser combined. This new document replaces the 200 Series Recloser (see NOJA-548 User Manual) with new product 310 Series Recloser.
1	OA	11-11-2013	New features Power Quality, Maximum Demand Indication (MDI), Last Good Value Trapped (LGVT), new Fast Key configurations (1-4), LAN Ethernet port added, USBC2 configuration removed, new I/O Specification added, External Load (Firmware 1.8).
2	OA	06-01-2014	Negative Phase Sequencing and changes to Live Line (Firmware 1.9).
3	OA	20-02-2014	Advanced Automation, Voltage Sag Protection, OSM 312 (Firmware 1.10).
4	OA	01-11-2014	Sectionaliser functionality, Live Load Blocking, Alarm Mode, Battery Test, User Configurable Analogue Values, 2179 Protocol, Logic Channel extension from 8 to 32, Write protection of logic channels 17-32, Change in Directional Element Protection (Firmware 1.12).
5	OA	30-03-2015	Negative Sequence Overvoltage (47N), Neutral Displacement Overvoltage (59N), Battery Type, DNP3 Security Authentication, Changes to VRC and LLB. Inclusion of 2 phase 38kV recloser (Firmware 1.13).
6	OA	19-10-2015	Modifications to System Status Menu, Sequence Advance, Modifications to Alarms and Smart Grid Automation. Updates to Local and Remote Mode (Firmware 1.14).
7	OA	19-02-2016	Synchronism Check (25), Auto-Synchroniser (25A), Relay 15 Module (Mobile Network, Wi-Fi Access Point, Global Positioning System), Power Flow Direction Selection, Modifications to Overcurrent High Set and Low Set Elements, Moving Average Mode and Inhibit trip functionality for OV3 Neutral Displacement Protection (59N), Variable Fast Key Configuration (VAR1 and VAR2), IEC 61850, Communication Log Settings. Included drawing for pole installation using C-clamps (Firmware 1.15).
8	OA	13-09-2016	Relay 15 Communication Features, Broken Conductor (46BC) Protection, Admittance Protection (21Yn), Switchgear model (3 Phase SEF) with 0.2A SEF, LL Allow Close, Block functionality for EF, SEF and OV3, Changes to Fault Flags, Displaying Alerts (Firmware 1.16).
9	OA	24-02-2017	SST (Single Shot Trip) Control, SIM-03 for OSM 200 tanks (Firmware 1.17).
10	OA	27-03-2017	Fault Locator (21FL), AR Reset, Logic/SGA Throttling, Recommended actions for Warning and Malfunction signals (Firmware 1.18).
11	OA	18-08-2017	Changes to enabling/disabling SCADA protocols, Update to Reset Methods, Firmware/Hardware Mismatch Malfunction event, Sequence Active database point (Firmware 1.19).
12	OA	10-01-2018	Simple Network Time Protocol (SNTP), Advanced Polarised Detection for EF and SEF, Handling of overcurrent condition on USB ports, Addition of “Trip monitoring” measured values to list of User Analogues, Provision of User Analogues and Logic Variables to MMS and GOOSE publications for the IEC 61850 interface (Firmware 1.20).
13	AM	31-08-2018	File Transfer Protocol (FTP) for read only access Oscillography files, Renamed “Reset Trip and Max Measured values” to “Reset Fault Meas values”, Renamed “Open(UV Sag Midpoint)” to “Open(UV4 Sag Mid)”, Renamed “Rate of Change of F ABC” to “ROCOF ABC”, Changed “m” to “FltDiskm” in Fault Locator (Firmware 1.21).
14	AM	10-12-2018	Changes to Neutral voltage displacement range, Replaced Vn by Un, Added “SEF Prot” under Status Expression Form for Logic and IO, Added “Panel ON” control signal under Control and Indication, Renamed “SIM Temperature” to “Cubicle Temperature”, Renamed “SIM Power” to “Average Power”, Renamed “SIM circuit faulty” to “Battery Charger Fault”, Added Internet Protocol Version 6 (IPv6) (Firmware 1.22).
15	AM	02-07-2019	Renamed “SIM circuit faulty” to “Battery Test Circuit Fault”, Added ACO OpMode Equal On, ACO OpMode Main On, ACO OpMode Alt On and ACO: Make before break On, WLAN Enable, Mobile Network Enable and GPS Enable (Firmware 1.23).
16	EB	20/04/2020	Added ROCOF, VVS, CBF, Updated Appendices, Updated Section 9.4.1, Abbreviations.

17	EB/ON	03/06/2020	Added Directional Power protection (PDOP/PDUP), IEC60870 Redundancy Groups, PIN/PUK (Firmware 1.25)
18	ON	04/11/2020	Added Variable fast keys, IEEE & U curves, DNP3 Multiple Master, LiFePO4 batteries, Modbus. (Firmware 1.26)
19	ON	31/03/2021	Voltage-dependent OC, Multi-stage freq & voltage protection, Appendix K added. (Firmware 1.27)
20	ON/AM	18/02/2022	Harmonic Inrush Blocking, VE & FE settings ranges increased, Added OSM15-12-630 model, Updated Pickup and Reset Voltages for I/O Module (Firmware 1.28)

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CONTENTS

ABBREVIATIONS/ACRONYMS

ABR	Auto Backfeed Restoration
ACO	Auto Change Over
ACR	Automatic Circuit Recloser
AR	Auto Reclose
AP	Access Point
BC	Block Close
BT	Bluetooth
CBF	Circuit Breaker Failure
CD	Carrier Detect
CLP	Cold Load Pickup
CMS	Control and Management Software
CO	Close/Open
CRC	Cyclic Redundancy Check
CVT	Capacitive Voltage Transformer
CT	Current Transformer
CTS	Clear to Send
DCD	Data Carrier Detect
DCE	Data Communication Equipment
DE	Directional Element
DFT	Disable Fast Trips
DGPS	Differential Global Positioning System
DLLB	Dead Line/Live Bus
DNP3	Distributed Network Protocol 3
DSA	Distribution System Automation
DSP	Digital Signal Processing
DSR	Data Set Ready
DTR	Data Terminal Ready
EMC	Electromagnetic Compatibility Performance
EF	Earth Fault Element
EFLL	Earth Fault Live Line Element
FE	Frequency Protection Element
FPGA	Field Programmable Gate Array
FTP	File Transfer Protocol
GOOSE	Generic Object Oriented Substation Events
GPS	Global Positioning System
HIB	Harmonic Inrush Blocking
HLT	Hot Line Tag
HMI	Human Machine Interface
HRM	Harmonic
HV	High Voltage
IDMT	Inverse Definite Minimum Time
IEC	International Electrotechnical Commission
IEEE	Institute of Electrical and Electronics Engineers
I/O	Input/Output
IP	Internet Protocol
IR	Inrush Restraint
ITS	Interface Test Set
LCD	Liquid Crystal Display
LED	Light Emitting Diode
LGVT	Last Good Value Trapped
LL	Live Line Overcurrent
LLB	Live Load Blocking
LLDB	Live Line/Dead Bus
LLLB	Live Line/Live Bus
LSD	Loss of Supply Detection
LSRM	Loss of Supply Reclosing Mode
LV	Low Voltage
MAIFI	Momentary Average Interruption Frequency Index
MCB	Miniature Circuit Breaker
MDI	Maximum Demand Indication
MMS	Manufacturing Message Specification
MNT	Maximum Number of Trips
NPS	Negative Phase Sequence
NPSLL	Negative Phase Sequence Live Line
NVD	Neutral Voltage Detection
OC	Overcurrent
OCLL	Overcurrent Live Line

ABBREVIATIONS/ACRONYMS

OF	Over Frequency
OSM	Outdoor Switch Module
OV	Over Voltage
PB	Push-Button
PCB	Printed Circuit Board
PDOP	Power Directional Overpower
PDPR	Directional Power Protection
PDUP	Power Directional Underpower
PIN	Personal Identification Number
PPS	Pulse per Second
PROT	Protection
PSC	Protection Status Control
PSM	Power Supply Module
PUK	Personal Unlock Key
RAM	Random Access Memory
RC	Recloser Control
REL	Relay Module
RG	Redundancy Group
RI	Ring Indicator
RMS	Root Mean Squared
ROCOF	Rate Of Change Of Frequency
RTC	Real Time Clock
RTS	Request to Send
RTU	Remote Terminal Unit
SAIDI	System Average Interruption Duration Index
SAIFI	System Average Interruption Frequency Index
SCADA	Supervisory Control and Data Acquisition
SEF	Sensitive Earth Fault
SEFLL	Sensitive Earth Fault Live Line
SGA	Smart Grid Automation
SIM (Module)	Switchgear Interface Module
SIM (Card)	Subscriber Identity Module
SNTP	Simple Network Time Protocol
SSID	Service Set Identifier
SSM	Short Sequence Mode
SST	Single Shot Trip
ST	Single Triple
SW	Switch
TCC	Time Current Characteristics
TCP/IP	Transmission Control Protocol/Internet Protocol
TD	Definite Time
THD	Total Harmonic Distortion
TDD	Total Demand Distortion
TTA	Temporary Time Addition
UDC	User Defined Curve
USB	Universal Serial Bus
UV	Under Voltage
UF	Under Frequency
UPS	Uninterruptable Power Supply
UTC	Coordinated Universal Time
VC	Voltage-controlled
VE	Voltage Protection Element
VOC	Voltage-dependent Overcurrent
VR	Voltage-restrained
VRC	Voltage Reclosing Control
VT	Voltage Transformer
VVS	Voltage Vector Shift
WiFi	Wireless Fidelity (wireless networking)
ZSC	Zone Sequence Co-ordination

DEFINITION OF TERMS

AR (Auto Reclose) Reset Time	AR Reset Time refers to the period of time subsequent to a close after which the Auto Reclosing (AR) element is ready to perform its full sequence. Please refer to section 6.2 Auto Reclosing (AR OC/NPS/EF/SEF/Yn).
Fault Reset Time	Defines the time after which a pickup is no longer active before the protection timer resets.
Lockout	Lockout is when the device opens and cannot perform any auto reclosing operation.
Pickup	Pickup is an event which is initiated when the measured value exceeds the pickup value configured by the user.
Protection Operation/ Trip Request	When a protection element detects a fault, a pickup occurs. When the protection time elapses, if the fault is still present a protection operation is requested such as a trip or alarm.
Protection Trip	A Protection Trip is when the device goes into the open position when a protection operation is requested.
Sectionaliser Count	The device waits for detection of Loss of Supply (LSD) before increasing the sequence counter. In this instance the fault is detected and “counted” but the device does not open. Please refer to section 6.2.5 Sectionalising.
Sectionaliser Trip	A Sectionaliser trip is when the device waits for detection of Loss of Supply (LSD) before opening. Please refer to section 6.2.5 Sectionalising.
Sequence Counter/Trip Counter	The sequence counter is used to keep a record of the number of protection operations within the sequence that have occurred.
Single Shot Mode	When in Single Shot mode, if a protection operation occurs, the device will do one trip to lockout using the Single Shot Trip (SST) selected configuration. For SST conditions please refer to section 6.2.6 Single Shot Trip (SST).

1 Introduction

This manual applies to the 300, 310 and 312 series range of OSM Automatic Circuit Recloser (ACR) and the Recloser Control (RC) cubicle manufactured by NOJA Power.

1.1 Applicability

The following products are covered by this manual:

- OSM15-12-630-310 (Automatic Circuit 3-phase Recloser rated at 15.5 kV)
- OSM15-16-800-310 (Automatic Circuit 3-phase Recloser rated at 15.5 kV)
- OSM15-16-800-310-SEF (Automatic Circuit 3-phase Recloser rated at 15.5 kV)(1)
- OSM15-16-800-312 (Automatic Circuit 2-phase Recloser rated at 15.5 kV)
- OSM15-16-800-312-SEF (Automatic Circuit 2-phase Recloser rated at 15.5 kV)(1)
- OSM27-12-800-310 (Automatic Circuit 3-phase Recloser rated at 27 kV)
- OSM27-12-800-310-SEF (Automatic Circuit 3-phase Recloser rated at 27 kV)(1)
- OSM27-12-800-312 (Automatic Circuit 2-phase Recloser rated at 27 kV)
- OSM27-12-800-312-SEF (Automatic Circuit 2-phase Recloser rated at 27 kV)(1)
- OSM38-12-800-300 (Automatic Circuit 3-phase Recloser rated at 38 kV)
- OSM38-12-800-300-SEF (Automatic Circuit 3-phase Recloser rated at 38 kV)(1)
- OSM38-12-800-302 (Automatic Circuit 2-phase Recloser rated at 38 kV)
- OSM38-12-800-302-SEF (Automatic Circuit 2-phase Recloser rated at 38 kV)(1)
- OSM38-16-800-300 (Automatic Circuit 3-phase Recloser rated at 38 kV)
- OSM38-16-800-300-SEF (Automatic Circuit 3-phase Recloser rated at 38 kV)(1)
- OSM38-16-800-302 (Automatic Circuit 2-phase Recloser rated at 38 kV)
- OSM38-16-800-302-SEF (Automatic Circuit 2-phase Recloser rated at 38 kV)(1)
- RC-10ES (Recloser Control Cubicle)
- RC-15 (Recloser Control Cubicle)

The OSM 300 and 310 series reclosers have three poles and are used in three phase applications. The OSM 302 and 312 series reclosers only have two poles, usually configured with one phase through the recloser and one phase return for single phase applications.

Before installing and / or operating the Recloser or control, read and understand the contents of this manual.

Note that this manual cannot cover all the details or variations in the equipment or process being described. Neither is it expected to address all contingencies associated with installation and operation of this equipment. In addition, not all features described in this manual will apply to the OSM 312 series reclosers.

For any further information or if you need assistance in configuring an OSM 312 recloser please contact your nearest NOJA Power Office or Distributor.

Notes:

1. *Switchgear model with matched Current Transformers (CTs) to provide 0.2 A Sensitive Earth Fault (SEF) sensitivity.*

1.1.1 Recloser Control Firmware

This manual applies to Relay Firmware Versions 1.28.y.0, SIM version 1.14 and Relay Database Number 32.0.1.0.

Any newer versions of firmware may have additional features to those described in this manual. These features will be described in the firmware release notes.

1.1.2 Control and Management Software (CMS)

A compatible version of CMS must be used with the firmware loaded into the device. The current release of firmware requires CMS Version 3.15.0 or later.

1.2 Safety Information

Installation, use and servicing should only be carried out by trained and experienced personnel who are familiar with the equipment and electrical safety requirements.

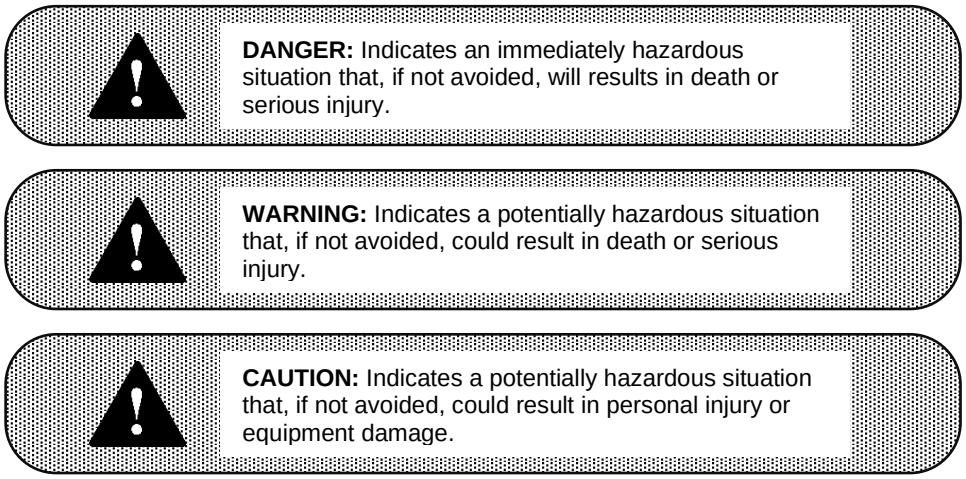
1.2.1 Personnel Competence

It is the responsibility of the purchaser to ensure the personnel installing, using and maintaining the equipment described in this manual are competent. Minimum personnel competency requirements include:

- Familiarity with this manual and its contents.
- Training in industry accepted safe operating procedures associated with both low and medium voltage equipment.
- Training and appropriate authorisation to energise, de-energise and earth power distribution equipment.
- Training in the care and use of protective equipment associated with low and medium voltage applications.

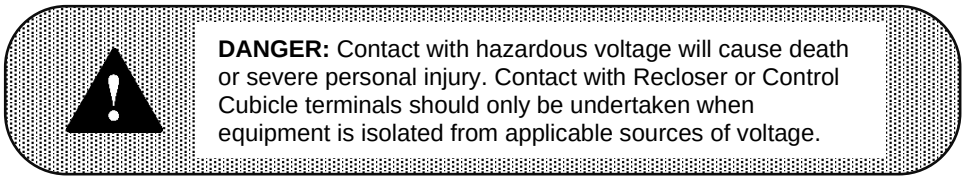
1.2.2 Hazard Statements

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

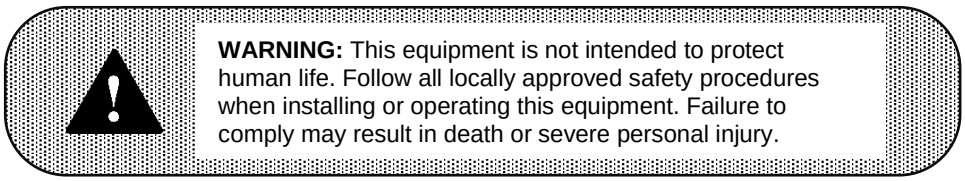


1.2.3 Safety Instructions

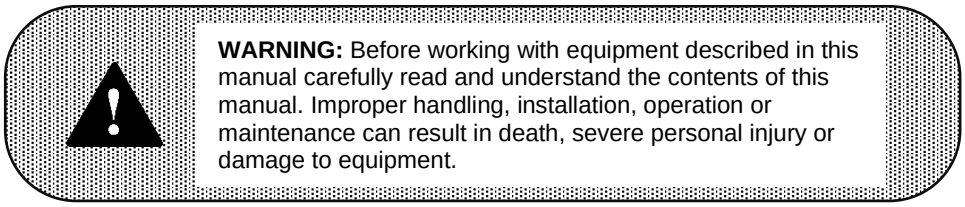
Before working with equipment ensure you read, understand and follow all safety instruction contained in this manual.



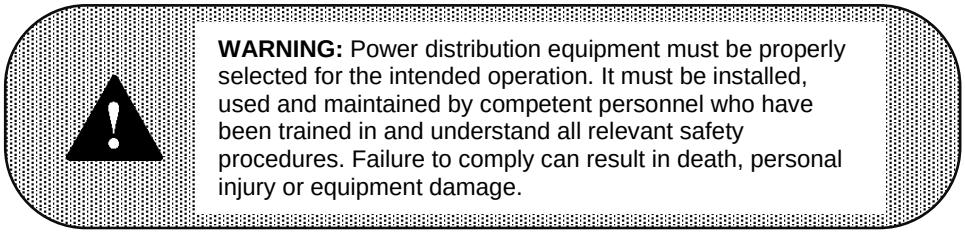
DANGER: Contact with hazardous voltage will cause death or severe personal injury. Contact with Recloser or Control Cubicle terminals should only be undertaken when equipment is isolated from applicable sources of voltage.



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 personal injury.



WARNING: Before working with equipment described in this manual carefully read and understand the contents of this manual. 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 maintained by competent personnel who have been trained in and understand all relevant safety procedures. Failure to comply can result in death, personal injury or equipment damage.

1.3 Customer Acceptance and Initial Inspection

NOJA Power products are assembled, tested, inspected, packaged and dispatched from the factory meeting all the required quality criteria.

Inspect the shipping packaging for any external signs of damage. Unpack the product and inspect it thoroughly for any signs of transit damage. File a claim with the carrier if transit damage is found.

Product damaged by incorrect handling, installation or other misuse by the customer or carrier will not be covered by a supplier warranty.

2 Specifications

2.1 OSM Automatic Circuit Recloser

All OSM Automatic Circuit Reclosers comply with ANSI/IEEE C37.60, IEC 62271-111 and IEC 62271-200 standards.

2.1.1 Basic Operating Parameters

	OSM15-310/312	OSM27-310/312	OSM38-300/302
Current Sensing	3 x Current Transformers(310)	3 x Current Transformers (310)	3 x Current Transformers (300)
	2 x Current Transformers (312)	2 x Current Transformers (312)	2 x Current Transformers (302)
Voltage sensing	6 x Voltage Sensors (310)	6 x Voltage Sensors (310)	6 x Voltage Sensors (300)
	4 x Voltage Sensors (312)	4 x Voltage Sensors (312)	4 x Voltage Sensors (302)
Ambient temperature[1]	-40°C to +55°C	-40°C to +55°C	-40°C to +55°C
Humidity	0 – 100%	0 – 100%	0 – 100%
Altitude[2]	3000 m	3000 m	3000 m
Overall dimensions (length x width x height)	800 x 668 x 653 mm (310) 800 x 668 x 594 mm (312)	800 x 746 x 744 mm (310) 800 x 749 x 677 mm (312)	932 x 751 x 913 mm (300) 932 x 751 x 884 mm (302)
Weight	100 kg (310)	109 kg (310)	150 kg (300)
	77 kg (312)	83 kg (312)	120 kg (302)

Notes:

1. *A Switchgear manufacture type capable of withstanding conditions down to -60°C is available.*
2. *For altitudes above 1000 m ratings should be corrected in accordance with ANSI C37.60.*

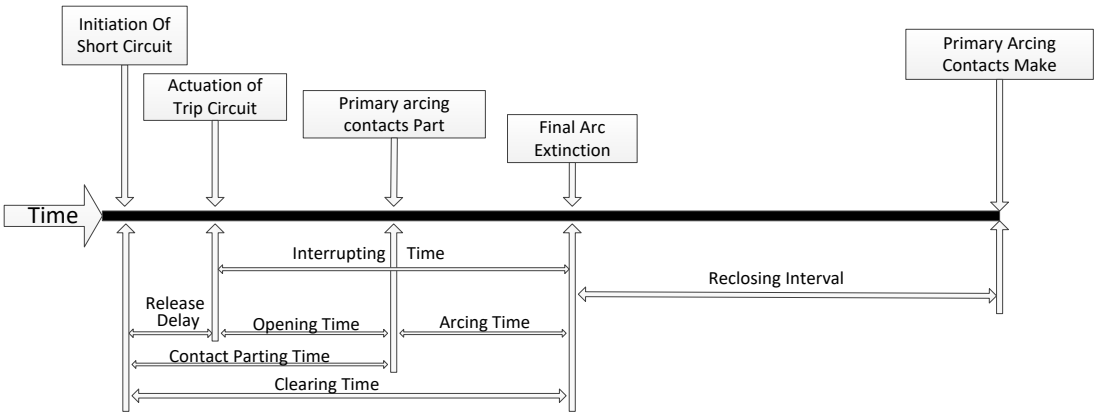
2.1.2 Ratings

OSM Type[1]	**OSM15-12-630**	**OSM15-16-800**	**OSM27-12-800**	**OSM38-12-800**	**OSM38-16-800**
Manufacturing Model	**310**	**310/312**	**310/312**	**300/302**	**300/302**
Rated maximum voltage	15.5 kV	15.5 kV	27 kV	38 kV	38 kV
Rated continuous current	630 A	800 A	800 A	800 A	800 A
Fault make capacity RMS	12.5 kA	16 kA	12.5 kA	12.5 kA	16 kA
Fault make capacity Peak (50Hz)	31.5 kA	40 kA	31.5 kA	31.5 kA	40 kA
Fault make capacity Peak (60Hz)	32.5 kA	42 kA	32.5 kA	32.5 kA	42 kA
Fault break capacity	12.5 kA	16 kA	12.5 kA	12.5 kA	16 kA
Asymmetrical Breaking Current	13 kA	17 kA	13 kA	13 kA	17 kA
DC component Interruption capacity	20%	20%	20%	20%	20%
Mechanical operations	10000	30000	30000	30000	30000
Full Load Operations	10000	30000	30000	30000	30000
Fault break capacity operations	70	70	140	100	140
Short time current withstand 3 seconds	12.5 kA	16 kA	16 kA	12.5 kA	16 kA
Mainly active breaking capacity	630 A	800 A	800 A	800 A	800 A
Cable charging current	10 A	25 A	25 A	40 A	40 A
Line charging current	2 A	5 A	5 A	5 A	5 A
Impulse withstand across the interrupter	110 kV	110 kV	150 kV	170 kV	170 kV

OSM Type[1]	OSM15-12-630	OSM15-16-800	OSM27-12-800	OSM38-12-800	OSM38-16-800
Manufacturing Model	**310**	**310/312**	**310/312**	**300/302**	**300/302**
Impulse withstand phase to earth and phase to phase	110 kV	110 kV	150 kV	195 kV	200 kV
Power frequency withstand phase to earth (dry) and across the interrupter	50 kV	50 kV	60 kV	70 kV	70 kV
Arc Fault Current Duration	16 kA/0.2 s[2]	16 kA/0.2 s[2]	16 kA/0.2 s[2]	12.5 kA/1 s	12.5 kA/1 s
Closing Time	<60 ms	<60 ms	<60 ms	<70 ms	<70 ms
Opening Time	<30 ms	<30 ms	<30 ms	<30 ms	<30 ms
Interrupting Time	<50 ms	<50 ms	<50 ms	<50 ms	<50 ms
Arcing Time	<20 ms	<20 ms	<20 ms	<20 ms	<20 ms

Notes:
1. *A Switchgear model with matched CTs to provide 0.2 A SEF sensitivity is available for all 3 phase and 2 phase tanks.*
2. *A special manufacture type with 12.5 kA/1 s Arc Fault duration capability is available.*

Interruption and Closing Operation Timing Diagram



Note: *Release Delay is the protection operating time and it is defined as the time from when the fault occurs to when the protection operation is triggered. This time will vary depending on what protection settings have been configured.*

2.1.3 Sensor Accuracy

Sensor Type	Accuracy	Ranges where accuracy guaranteed
Current Transformer	±0.2%	0 – 800 A
Current Transformer (0.2 A SEF model)[1]	±0.03%	0 – 800 A
Voltage Sensors	±5%	

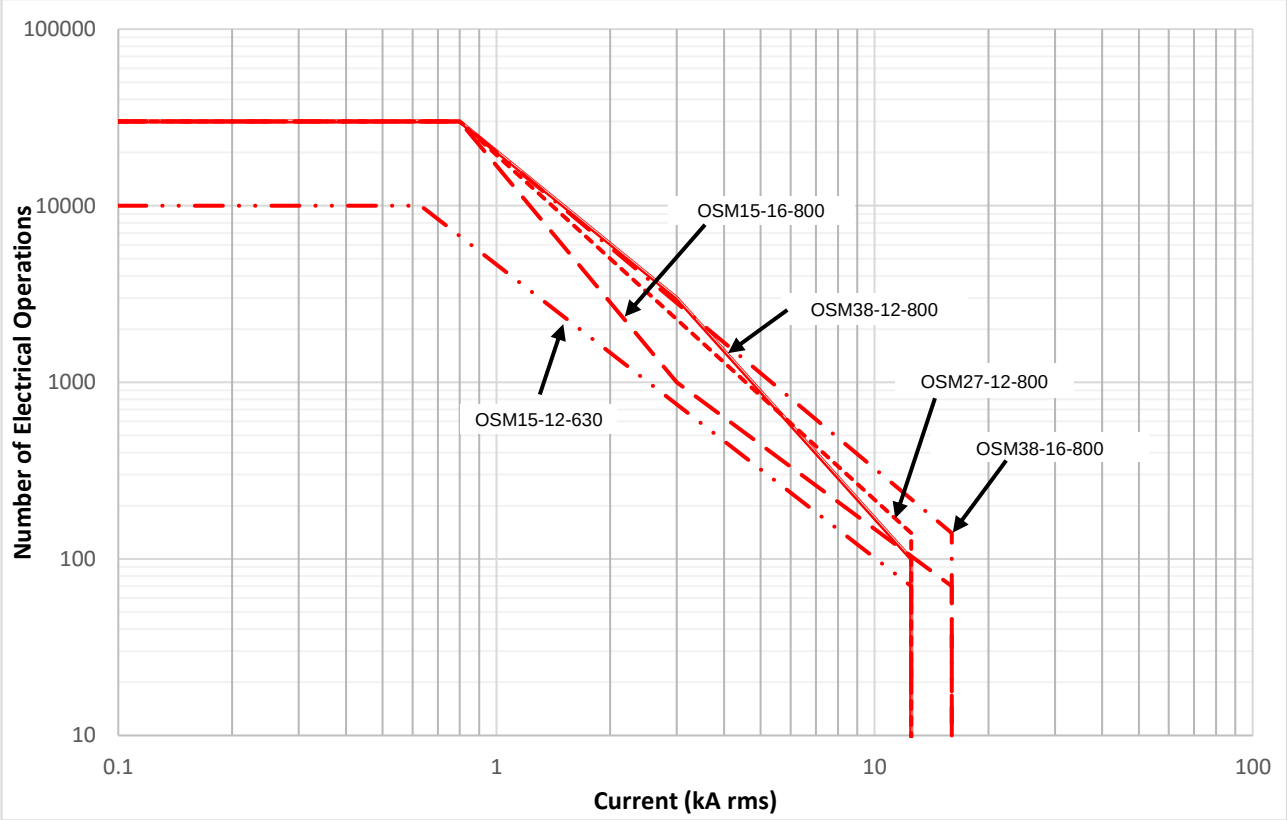
Notes:
1. *A Switchgear model with matched CTs to provide 0.2 A SEF sensitivity is available for all 3 phase and 2 phase tanks.*

2.1.3.1 Current Transformer Specification and Operating Parameters

Winding Ratio	2500:1
Percent Ratio Error	5-800 A < 0.1
Crad Phase Error >100 A	< 0.05
Crad Phase Error at 10 A	< 0.033
Cross talk up to 800 A	< 1.0 A
Ambient temperature	-40°C to +55°C
Protection Class Accuracy	5P10

2.1.4 Breaking Duty

Vacuum interrupter contact life is a function of interrupting current as illustrated in the graph below.



The high and low current number of operations for each OSM type is summarised in the table below.

	Rated Number of Operations				
	OSM15-12-630 (310)	**OSM15-16-800 (310/312)**	**OSM27-12-800 (310/312)**	**OSM38-12-800 (300/302)**	**OSM38-16-800 (300/302)**
Continuous current	10000 at 630 A	30000 at 800 A	30000 at 800 A	30000 at 800 A	30000 at 800 A
Interrupting current	70 at 12.5 kA	70 at 16 kA	140 at 12.5 kA	100 at 12.5 kA	140 at 16 kA

Rated Operating Sequence is defined as O – 0.1s – CO – 1s – CO – 1s – CO followed by 60 seconds recovery time.

2.2 Recloser Control (RC) Cubicle

The Recloser Control cubicle complies with the following standards:

- ANSI / IEEE C37.60
- IEC 62271 (Part 111 and Part 200)
- Other as noted in section 2.2.5.

2.2.1 Basic Operating Parameters

Rated frequency, Hz	50 / 60
Rated cubicle (auxiliary) AC supply voltage, V	110/220
AC (auxiliary) supply circuit breaker	4 A
Standard operating duty	O – 0.1 s – CO – 1 s – CO – 1 s – CO – 60 s

Degree of protection	IP66/NEMA4
Minimum operating temperature, °C	-40
Maximum operating temperature, °C	+55
Maximum humidity, %	100
Maximum altitude above sea level, m	3000
Operating time after loss of AC supply[1], hours	
• at -40°C	48
• at 20°C	120
• at +55°C	120
Weight[2], kg	42
Overall Dimensions, (width x height x depth) mm	400 x 1080 x 309

Notes:

1. Without I/O module or other communications device.
2. Battery included.

2.2.2 Measurement Accuracy

Measured value	Accuracy	Ranges where accuracy guaranteed
Phase to earth voltages	The greater of ±1.0% or ± 0.1 kV	0.3 – 22.0 kV
Line to line voltages	The greater of ±2.0% or ± 0.1 kV	0.5 – 38.0 kV
Phase Current	The greater of ± 1% or ± 4 A	0 – 800 A
Residual Current	The greater of ±5% or ±0.5 A	1 – 80 A
Residual Current[1] (0.2 A SEF model)	the greater of ±0.02% or ±0.1 A	0.2 – 80 A
Negative Sequence Current	The greater of ±2% or ±4 A	0 – 800 A
Active, reactive and total power	±2%	40 – 800 A, 4.5 – 38 kV
Power factor	±0.02	0 – 1
Active and reactive energy	±2%	40 – 800 A, 4.5 – 38 kV
Frequency		46 – 55 Hz, 55 – 65 Hz
– at dF/dt<0.2 Hz/s	±0.025 Hz	
– at dF/dt<0.5 Hz/s	±0.05 Hz	
Phase Angle	±2°	0-360°
Rate of Change of Frequency[2]	±0.2 Hz/s	dF/dt≤ 1 Hz/s
	±0.15 Hz/s	dF/dt > 1 Hz/s
Voltage Vector Shift	1°	2° - 40°

Notes:

1. *Switchgear model with matched CTs to provide 0.2 A SEF sensitivity.*
2. *Averaging window: 8 cycles.*

Oscillography

Phase current	The greater of ±1% or ±1 A	0 – 800 A rms
	±5%	800 – 16 000 A rms
Phase Voltage	The greater of ±1% or ±0.1 kV	0 – 22 kV rms

Measured value	Accuracy	Ranges where accuracy guaranteed
Harmonics		
Phase current (Harmonic 2 -15)	The greater of ±1% or ±4 A	H_1, 0 – 16 000 A rms
Phase voltage (Harmonic 2 -15)	The greater of ±1% or ±0.1kV	$H_{2\text{-}15}$
THD	±2%	
TDD	±2%	H_1, 0 – 16 000 A rms

Note: *Sampling rate is 1600 samples/sec.*

Fault Locator		
Distance	The greater of ±800 m or ±10%	Iph ≥ 3 A, Uph ≥ 0.5 kV

Note: *The stated accuracy is only guaranteed for fault resistance, Rf = 0 at 50% of the line and ambient temperature of 20°C when the correct values of resistance and reactance are provided.*

2.2.3 Filtering

Harmonics rejection rates, not less than

– second	1:100
– third	1:316
– fifth	1:1000

Response delay to a step change in input current or voltage

– at output value changed by 10% of the input step	5 ms
– at output value changed by 20% of the input step	10 ms
– at output value changed by 50% of the input step	18 ms
– at output value changed by 80% of the input step	25 ms
– at output value changed by 90% of the input step	30 ms
– at output value changed by 95% of the input step	35 ms

Note: *All protection and measurements are carried out on the basis of fundamental frequency values with the exception of harmonic protection. Refer to Section 6.15 Harmonic Protection.*

2.2.4 Protection Accuracy

Parameter	Accuracy	Accuracy Range
Operational pickup current[1,2]		
– for phase overcurrent elements	the greater of ±1% or ±1 A ±5%	0 – 800 A 800 – 16000 A
– for earth overcurrent elements	the greater of ±2% or ±1 A the greater of ±1% or ±4 A	1 – 80 A 80 – 800 A
– for earth overcurrent elements[3] (0.2A SEF model)	the greater of ±0.5% or ±0.1 A	0.2 – 80 A
– for negative phase sequence elements	the greater of ±3% or ±3 A ±10%	0 – 800 A rms 800 – 16000 A rms
– for admittance protection		
- Gn accuracy	the greater of ±5% or ±0.05 mSi	0.05 ≤ |Gn| ≤ 327.00 mSi
- Bn accuracy	the greater of ±5% or ±0.05 mSi	0.05 ≤ |Bn |≤ 327.00 mSi
Operational pickup voltage	the greater of ±1% or ±0.1 kV	0.5 – 38 kV
Operational pickup frequency	±0.05 Hz	46 – 55 Hz for 50 Hz system 55 – 65 Hz for 60 Hz system
ROCOF	±0.2 Hz/s ±0.15 Hz/s	≤1 Hz/s >1 Hz/s

Parameter	Accuracy	Accuracy Range
VVS	The greater of ±25% or ±1°	2° – 40°
PDOP/PDUP	the greater of ±6% or ±3 kVA ±1°	2 – 52653 kVA -179.9° to 180°
Tripping time for time current characteristics: Definite time ANSI(2) / IEC(2) / IEEE(2) / U(2) / UDC(2) / Additional IDMT curve(2)	the greater of: ±1% or +35 ms / -10 ms ±3% or +50 ms / -10 ms	0 – 120 s for all time current characteristics
Reclose time	the greater of ±1% or ±10 ms	0.1 – 180 s
Reset time(4) ANSI / IEEE / U IEC / UDC / Additional IDMT Reclosing	the greater of: ±3% or +50 ms / -10 ms ±1% or ±10 ms ±1% or ±10 ms	 0 – 120 s 0 – 10 s 5 – 180 s
Restoration time for automatic backfeed restoration element	the greater of ±1% or ±10 ms	0 – 180 s
Harmonic Inrush Blocking (H_1 > 10 A)	The greater of ±1% or ±2 A ±1%	0 – 800 A 800 – 16 000 A
Angle between voltage and current for phase overcurrent (OC), earth fault (EF), sensitive earth fault (SEF) and negative phase sequence (NPS) directional elements (DE):		
• DE OC	±2°	At $U_1 \geq 0.5$ kV and $I_1 \geq 3$ A
• DE EF, DE SEF	±2°	At $U_0 \geq 0.5$ kV and $I_n \geq 9$ A
• DE SEF	±4°	At $U_0 \geq 0.5$ kV and $1 A \leq I_n < 9$ A
• DE SEF (0.2A SEF model)(3)	±10° ±4° ±2°	At $U_0 \geq 0.5$ kV and $0.2 A \leq I_n < 0.6$ A At $U_0 \geq 0.5$ kV and $0.6 A \leq I_n < 1.2$ A At $U_0 \geq 0.5$ kV and $I_n \geq 1.2$ A
• DE NPS	±2°	At $U_2 \geq 0.5$ kV and $I_2 \geq 3$ A

Notes:

1. *Pickup is initiated at 100% of pickup current value and drops off at 97.5% (2.5% difference). When a current multiplier is applied to the pickup value the same percentage (2.5%) applies to the new calculated current.*
2. *Applies to all curves, accuracy in the range (I / Ip <1600).*
3. *Switchgear model with matched CTs to provide 0.2 A SEF sensitivity.*
4. *Trip time is not accumulated while the element is below the pickup current value. If the element is between the pickup current value and the dropout current value then the reset timer will also not accumulate. When the element is below the dropout current value then the reset timer will accumulate.*

2.2.5 Electromagnetic Compatibility (EMC) Performance

	Rated value	Applicable standard
Dielectric Withstand Voltage	2 kV	IEC 60255 – 5
Rated Impulse Voltage, at 0.5 J	6 kV	IEC 60255 – 5
Electrostatic Discharge – contact – air	 8 kV 15 kV	IEC 61000 – 4- 2
Immunity to Radiated Electromagnetic Fields	1 kHz 80% AM 10 V/m	IEC 61000 – 4- 3
Electrical Fast Transient/Burst Immunity	4.4 kV AC Supply 2 kV Signal	IEC 61000 – 4 – 4
Surge Immunity (external AC voltage terminals) – common – transverse	 4 kV 2 kV	IEC 61000 – 4 – 5

	Rated value	Applicable standard
Immunity to Conducted Disturbances	1kHz 80% AM 10 Vrms	IEC 61000 – 4 – 6
Power Frequency Magnetic Field Immunity – 1 s – 1 min	 1000 A/m 100 A/m	IEC 61000 – 4 – 8
Pulse Magnetic Field Immunity (6.4/16 µs)	1000 A/m	IEC 61000 – 4 – 9
Damped Oscillatory Magnetic Field Immunity	1000 A/m	IEC 61000 – 4 – 10
Immunity to Voltage Dips and Interruptions	0, 40, 70, 80 %	IEC 61000 – 4 – 11
High Frequency Disturbance	Class 3 100 kHz 1 kV AC Supply – diff 2.5kV AC Supply - common 2.5 kV Signal	IEC 61000 – 4 – 12
Immunity to Common mode disturbance (16.7, 50, 60 Hz)	300 Vrms	IEC 61000 – 4 – 16
Burst Disturbance	1 MHz	IEC 61000 – 4 – 18
Conducted and Radiated RFI Emissions	Class B	IEC 60255 – 26

2.2.6 Power Supply Module (PSM)

	Rated Value
Input AC voltage to PSM	99 – 146 Vac (110 Vac Setting) 198 – 264 Vac (220 Vac Setting)
Frequency of input voltage	46 – 65 Hz
PSM Output voltage to SIM	24 – 62 Vdc (typical 45 Vdc)
Output DC voltage provided for 12Vdc External Load	10.2 – 16 V
Ripple content of output DC voltage	100 mV
Maximum external Load consumption	
- continuous	20 W
- at 50% duty cycle over 1 minute	40 W
- AC only	15 W
Maximum Power Consumption(1)	65 W
External load short circuit protection level	4.0 A
Battery Hold Up Time after loss of AC Supply	Refer to Section 2.2.1

Notes:

1. *With no communication equipment connected to external load. Refer to Section 4.7.11 External Load Power Supply for Communications Equipment.*

2.2.7 Local Inputs

Input Type	Dry connection
Time from valid input to activation of the control	20 ms

Note: *Local digital inputs on the relay are for use inside cubicle only, unless additional surge protection is used.*

2.2.8 Input Output Modules

Basic parameters:	
Module DC voltage range	10.5 – 17.6 Vdc
Typical power consumption	0.1 W
Digital inputs:	
Rated voltage	0-150 Vdc
Pickup voltage	7 ± 1 Vdc
Reset voltage	4 ± 1 Vdc
Maximum continuous voltage	150 Vdc
Input current (per Input)	< 3 mA
Edge/Level Triggering	Yes
Recognition/Reset time	User Configurable [20 ms – 2 s]
Recognition time resolution	10 ms
Maximum time from valid input to activation of the control	30 ms
Output relay contacts:	
Rated voltage	
– AC	9 – 230 Vac
– DC	10 – 125 Vdc
Rated current total of all relays	12 A
Maximum breaking power	
– DC at L/R=1 ms	30 W
– DC at 125 V	62 W
– DC at 60 V	90 W
– DC at 12 V	192 W
– AC at power factor 0.3	50 VA
Minimum switching power	
– DC	1 W (min 10 V, min 100 mA)
– AC	1 VA
Minimum output pulse resolution	20 ms
Pulse time accuracy	< +25 ms
Maximum time from actuation of control to I/O	85 ms
Un Regulated DC Source for Inputs:	
Voltage Output range	10 – 16.6 V
Maximum Current Output continuous	40 mA

2.2.9 Logic

Input:	**Rated Value**
Recognition Time	User Configurable [0 – 180 s]
Reset Time	User Configurable [0 – 180 s]
Recognition Time resolution	0.01 s
Reset Time resolution	0.01 s

Output:

Maximum time from expression becoming True or False to expression output[1] for variables, I/O and blocking signals.	50 ms
Maximum time from expression becoming True or False to expression output[1], for protection configuration and control signals.	120 ms
Minimum "settling" time after an expression output which has caused a change to protection configuration or control of the switch before another configuration change or control of the switch can be initiated by logic.	1 s

Notes:

1. *More than 8 channels may result in overall slower operating times. The relay will apply logic throttling when 200 or more logic evaluations have occurred within any 3 second interval. Refer to section 8.5.2 Logic Throttling.*

2.2.10 Smart Grid Automation

	Rated Value
Average time from valid input to output[1]	500 ms
Maximum Fboot File size	1 MB

Notes:

1. *Response time is dependent on the number and types of function blocks used. In addition, a time delay is applied when the throttle threshold (150 events) is reached. Refer to section 8.5.3 SGA Throttle Threshold.*

2.2.11 Rechargeable battery

	Rated Value
Type	Sealed Lead Acid
Rated Voltage	12 Vdc
Rated capacity	24 – 26 Ah

2.2.12 Mobile Network Modem

	Rated Value
SIM Card Size	2FF (2nd Form Factor) or Mini Sim
SIM Card Recommended Ratings	-40°C to +85°C

2.2.13 WiFi Access Point

	Rated Value
Protocol Supported	802.11 b/g/n of the Wi-Fi protocol
Band	2.4 GHz
Range	50 m (Internal Antenna)

2.2.14 GPS

	Rated Value
Receiver Type	L1 Band GPS Receiver
Systems Supported	DGPS, QZSS, SBAS(WAAS/EGNOS/MSAS/GAGAN)
Accuracy for Position Dilution of Precision < 2 for 95% of time[1]:	
Timing[2]	±250 µs
Longitude	±15 m
Latitude	±15 m
Altitude	±45 m

Notes:

1. *Factors such as reflections from buildings, trees and cloud cover can degrade the location accuracy.*
2. *The stated time accuracy is in reference to the status of "Locked by GPS". Time stamps and any other displays of time are accurate to* ±5ms.

3 OSM Automatic Circuit Recloser

3.1 Overview

The OSM tank is manufactured from powder coated stainless steel and is arc-fault vented. It has a 30 year operating design life.

The OSM 300 and 310 Reclosers have three poles and the OSM 302 and 312 reclosers have two poles, each with its own vacuum interrupter and insulated drive rod contained within a solid dielectric housing. Each pole has its own magnetic actuator. The OSM tank provides an IP65 rating.

Energy for operation is provided by capacitors located in the Recloser Control (RC) Cubicle. The magnetic actuators are mechanically interlocked, guaranteeing three phase simultaneous operation for 300 and 310 reclosers and two phase simultaneous operation for 302 and 312 reclosers. Magnetic latching holds the mechanism in the closed position. Spring assisted trip operation is achieved by reversing actuator current direction to release the latch.

The Recloser can be mechanically tripped by using a hook stick to pull the Mechanical Trip Ring downwards. Position indication is located in the base of the tank and can be viewed by an operator on the ground. Recloser open / close status is detected by the RC through monitoring the status of Auxiliary Switches that reflect the position of the mechanism. An optional mechanical trip counter is available.

Voltage is measured at all six terminals for the 300 and 310 reclosers and all four terminals for the 302 and 312 reclosers, using sensors that are capacitively coupled to the High Voltage (HV) terminals.

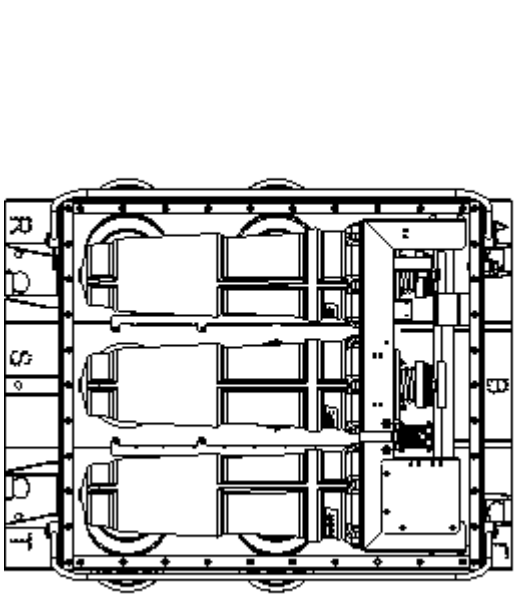
Current is measured on all three phases for the 300 and 310 recloser and two phases for the 302 and 312 recloser, using Current Transformers (CTs). These provide phase current measurement for indication, phase overcurrent protection and residual current measurement for indication and earth overcurrent protection. The Current Transformer secondaries are automatically shorted when the tank is disconnected from the control cubicle.

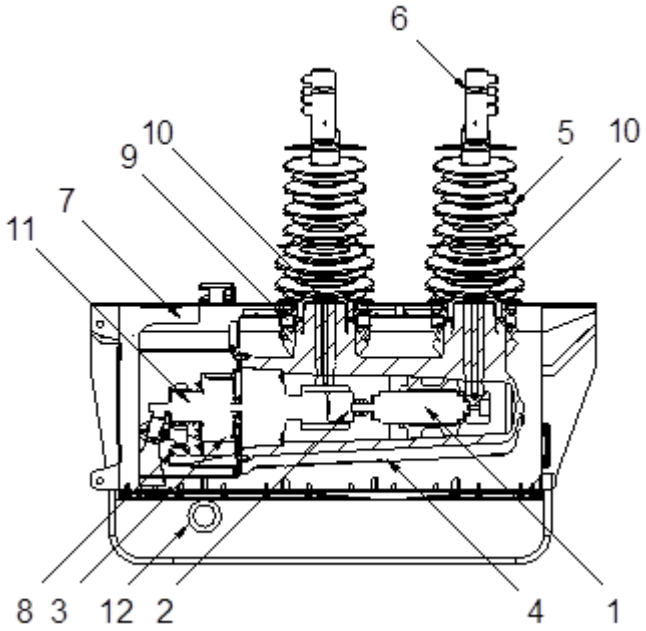
The main circuit Bushings are manufactured from aromatic epoxy resin. A silicone rubber Bushing Boot provides the required creepage distance. The Bushings have tin plated, brass connectors for termination of overhead cables. The Cable Connectors can be supplied in the form of Tunnel Terminals to suit cables up to 260 mm^2, two hole NEMA Palms and other types of terminations are available.

The same OSM Control Cable is common to all three models. Earthing point is an M12 bolt into the tank.

3.2 Cross Section Diagram - OSM

1. Vacuum Interrupter
2. Insulated Drive Rod
3. Magnetic Actuator
4. Aromatic Epoxy Resin Housing
5. Silicone Rubber Bushing Boot
6. Cable Connector
7. Stainless Steel Tank
8. Auxiliary Switches
9. Current Transformer (position varies with model)
10. Capacitively Coupled Voltage Sensor
11. Opening spring
12. Mechanical Trip Ring

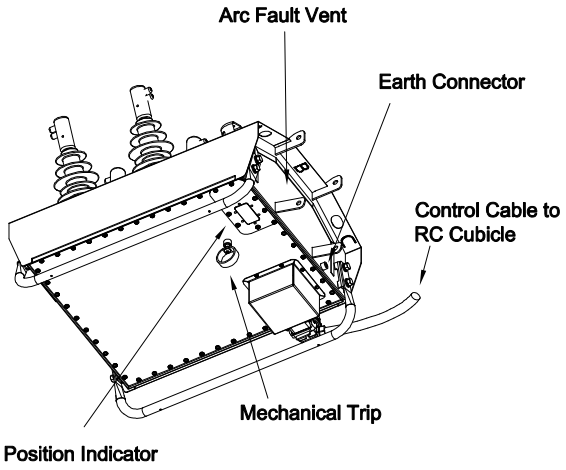


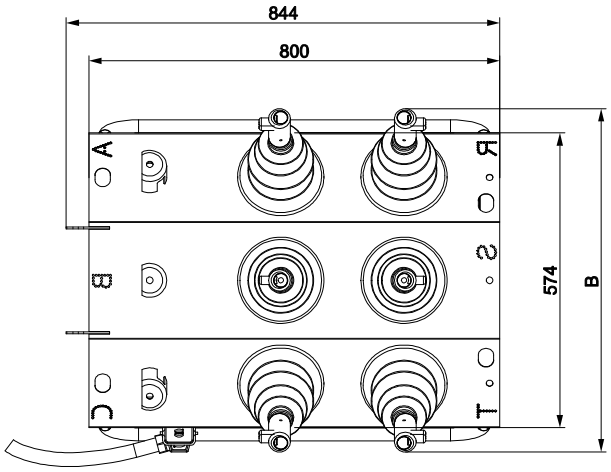


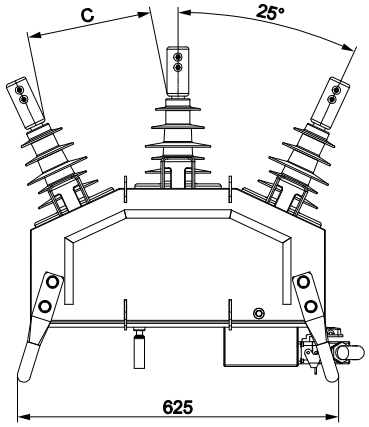
Note: *Current Transformer position varies in OSM 30x and OSM 31x series reclosers. OSM 300 model shown.*

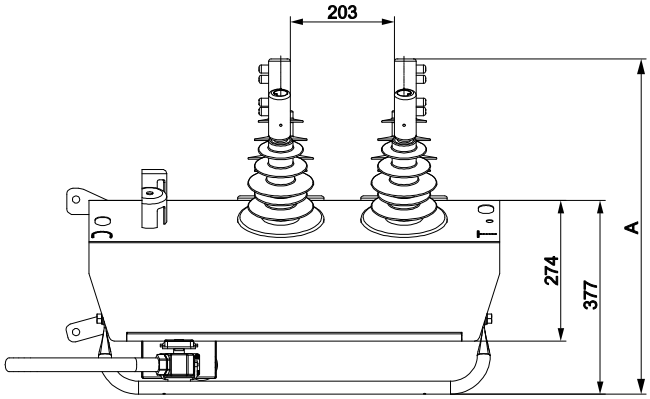
3.3 Dimensions – OSM15-310 and OSM27-310

The **OSM15-310 and OSM27-310 Auto Circuit Recloser** is illustrated in the diagrams below.





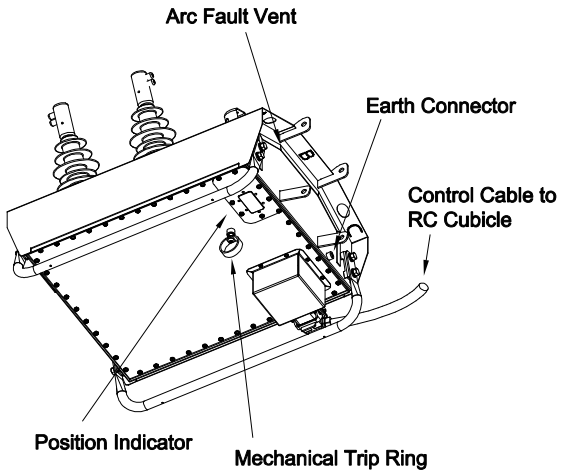


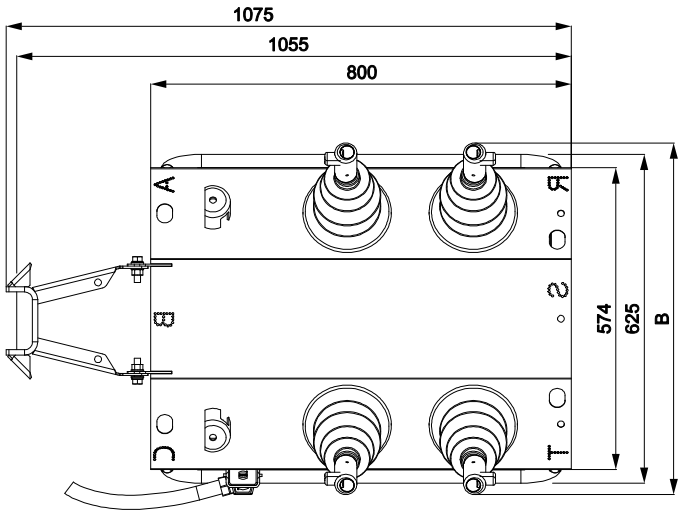


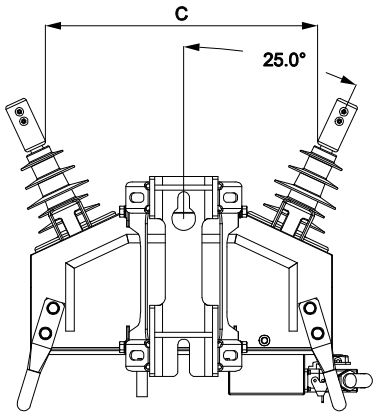
	OSM15-310	OSM27-310
Dimension A	653 mm	744 mm
Dimension B	668 mm	746 mm
Dimension C	243 mm	283 mm

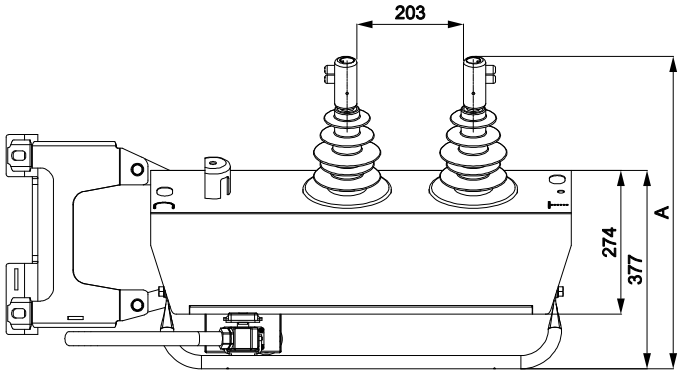
3.4 Dimensions – OSM15-312 and OSM27-312

The **OSM15-312 and OSM27-312 Auto Circuit Recloser** is illustrated in the diagram below.





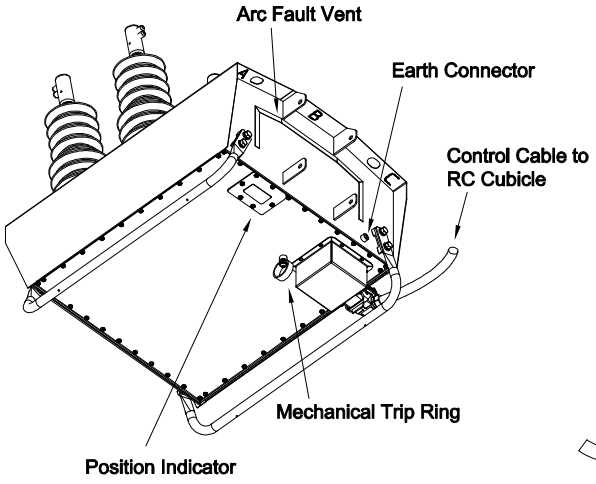


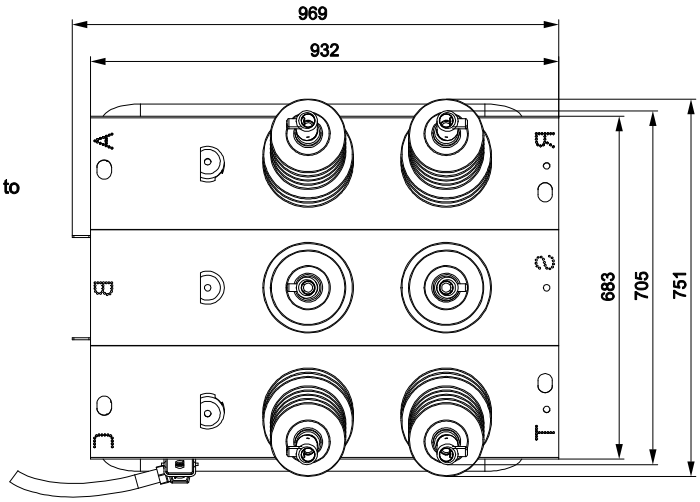


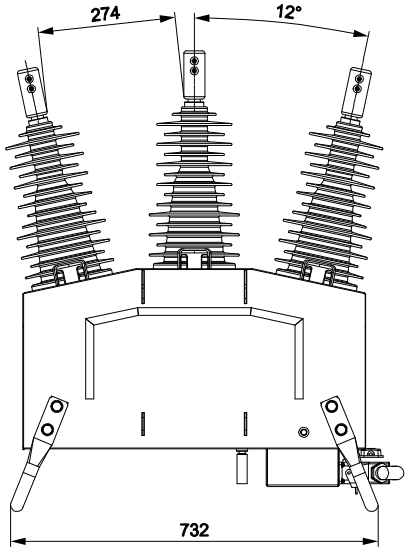
	OSM15-312	OSM27-312
Dimension A	594 mm	677 mm
Dimension B	668 mm	746 mm
Dimension C	514 mm	592 mm

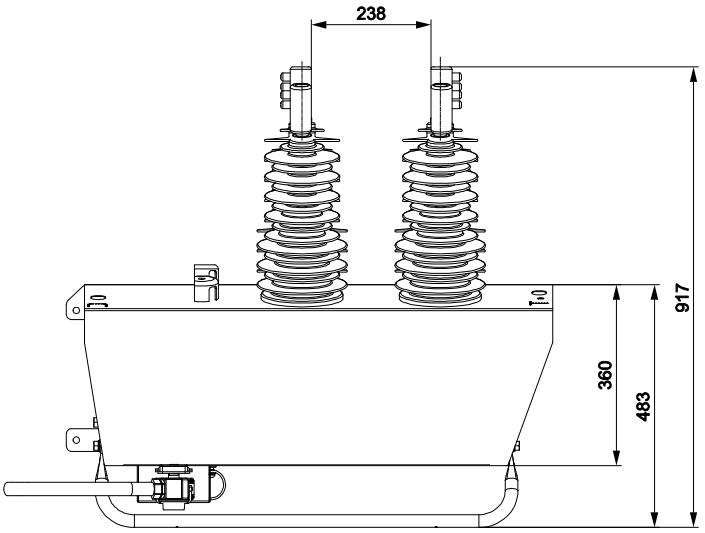
3.5 Dimensions – OSM38-300

The **OSM38-300 Auto Circuit Recloser** is illustrated in the diagram below.



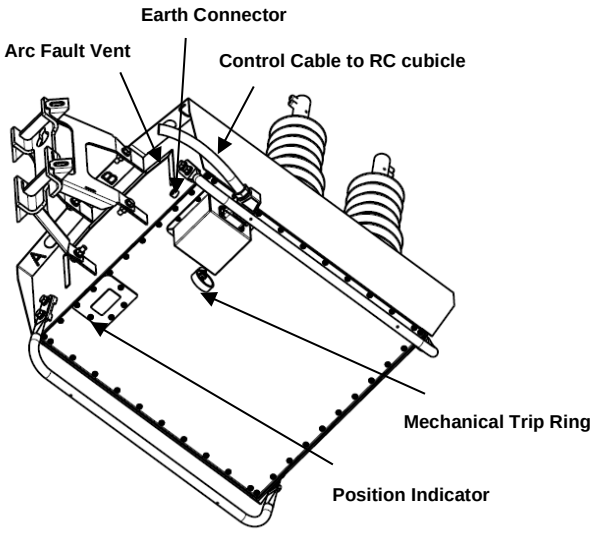


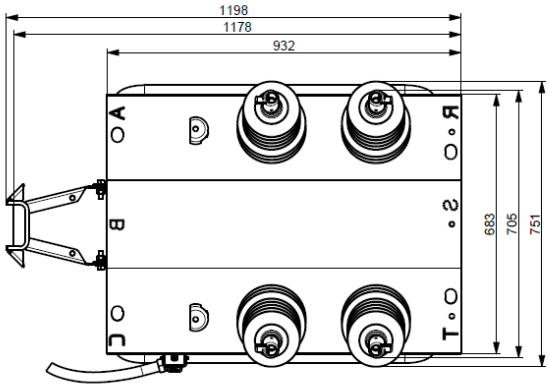


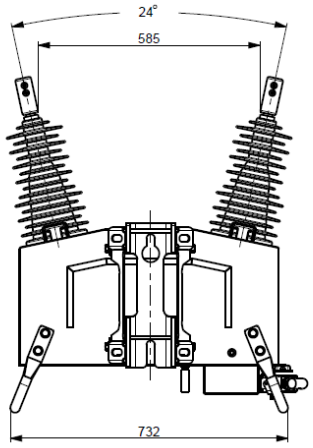


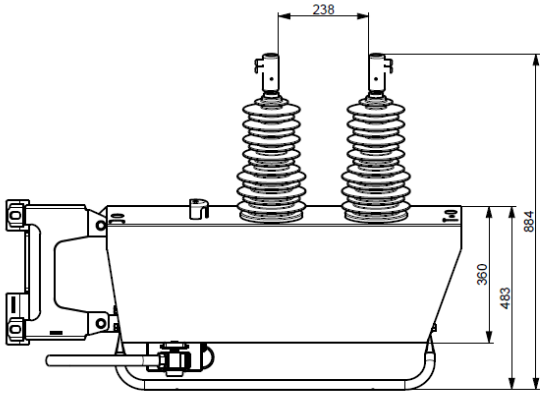
3.6 Dimensions – OSM38-302

The **OSM38-302 Auto Circuit Recloser** is illustrated in the diagram below.

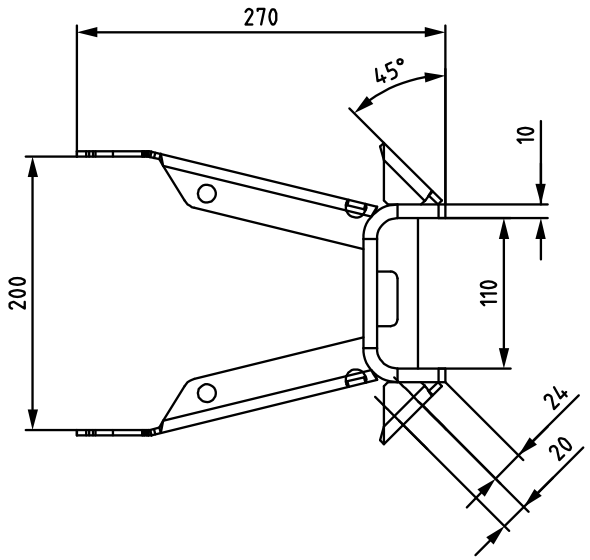


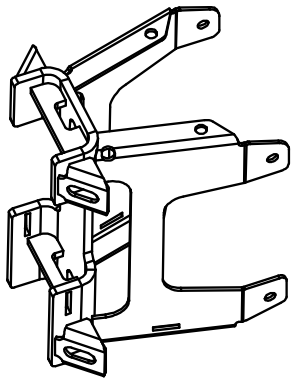


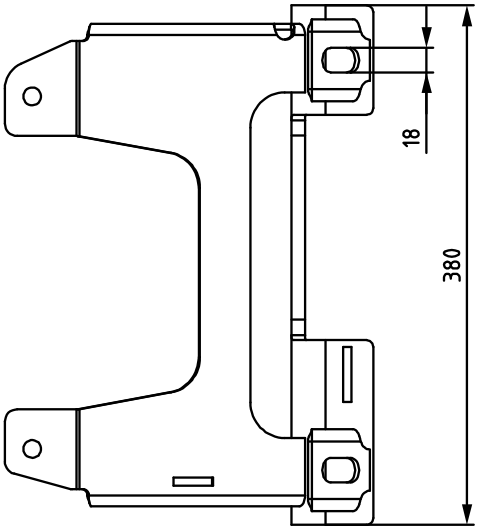


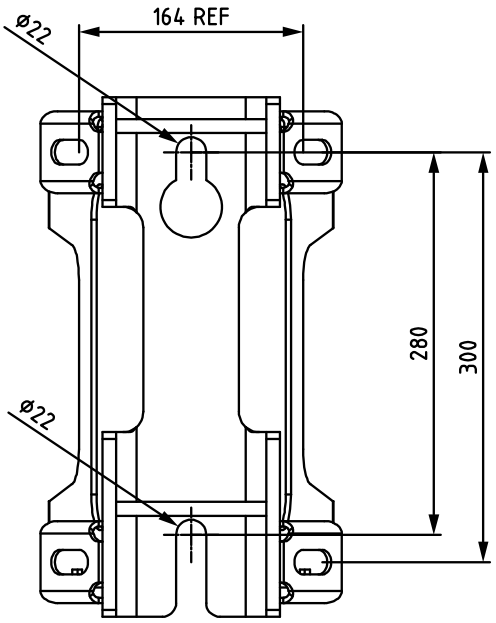


3.7 OSM Pole Mounting Bracket





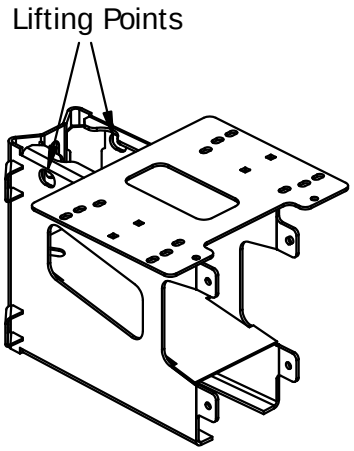


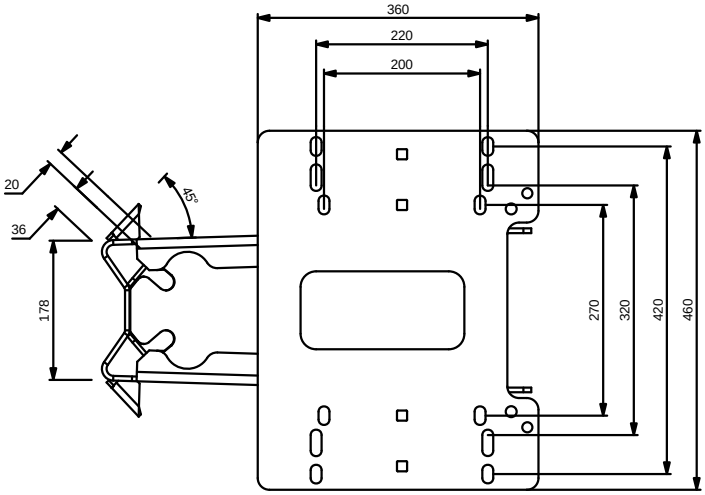


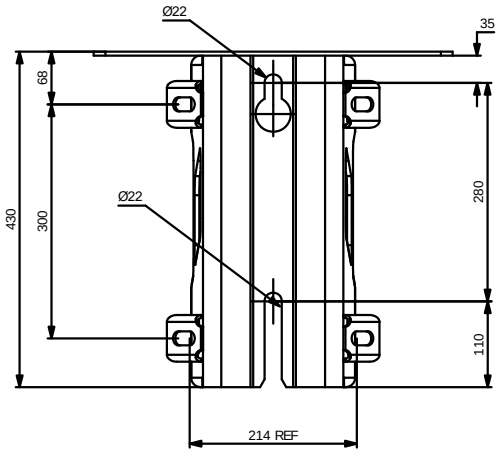
Note: The standard bracket shipped, unless specified otherwise, allows for the use of C-clamp mounting as an alternative to through bolt mounting.

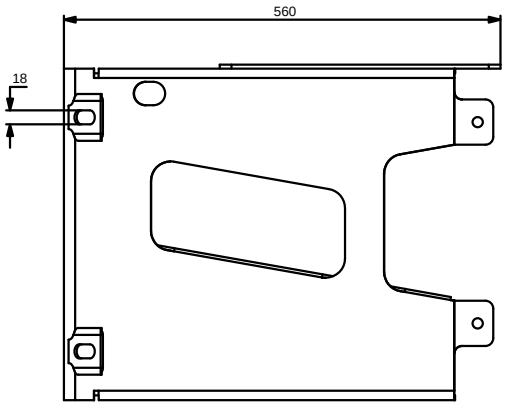
3.8 Combined OSM/VT Pole Mounting Bracket

The combined OSM/VT pole mounting bracket allows for the OSM recloser and Voltage Transformer (VT) to be mounted on the same bracket.







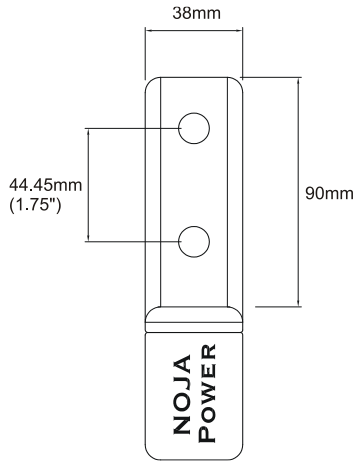


3.9 Main Circuit Bushings

The OSM Auto Circuit Recloser main circuit Bushings are fitted with Silicone Rubber Bushing Boots to provide the following creepage and taut string distances.

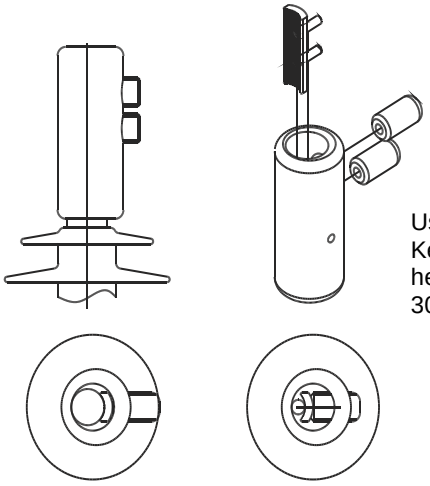
Model	Creepage Distance	Taut String Clearance
OSM15-310/312	483 mm	192 mm
OSM27-310/312	1072 mm	288 mm
OSM38-300/302	1284 mm	357 mm

The HV terminal Cable Connectors are a tin-plated, brass Tunnel Connector. This connector is suitable for cable sizes from 40 mm^2 to 260 mm^2. Cables are secured in the connector with two hexagonal socket screws. A tin-plated brass Palm Connector can be fitted to the bushing instead if required. This has two holes 44.45 mm (1.75") apart so a lug can be bolted onto the bushings.



Use an M12 socket to tighten the bolts to 50 Nm.

Note:
Tighten against the flats of the terminal base with a spanner to avoid damage to the bushing.



Use an 8mm Allen Key to tighten the hex screws to 30 Nm.

Palm Connector **Tunnel Connector**

The HV terminals on the (nominal) source side are marked A, B and C. The corresponding HV terminals are marked R, S and T.

3.10 Dead-Break Elbow Connectors

For the 310 series reclosers, dead-break elbow connectors can be used instead of the bushing boots. An alternate version of the 300 series recloser is also available for use with dead-break elbow connectors. The connector must be Interface Type C to DIN EN 50181. The model of the connector will vary depending on many factors including cable voltage, current ratings, conductor size and the diameter over the core insulation. Customers should take these factors into consideration when selecting a connector. Please contact NOJA Power for further details.

3.11 Current and Voltage Sensing

Current Sensing is carried out by three (3) Current Transformers, one on each phase.

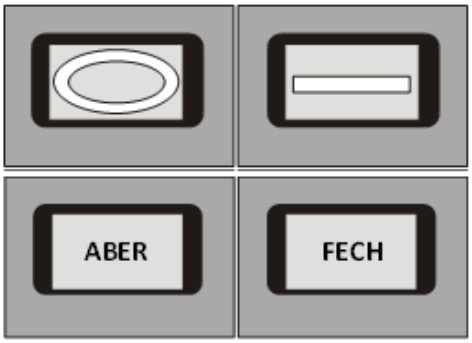
Voltage sensing is carried out by sensors that are capacitively coupled to the voltage applied to each High Voltage (HV) terminal.

3.12 Mechanical Trip

The Mechanical Trip Ring is made of stainless steel and is powder coated yellow. Less than 30 kg of downwards force is required to operate the mechanism.

When pulled down, a mechanical trip occurs and the OSM Auto Circuit Recloser is prevented from operating. A 'Mechanical Lockout' is displayed on the panel to provide indication of the locked state. Pushing the Ring back into the operating position returns the Recloser to normal mode.

3.13 Position Indicator



The OSM position indicator is located under a protective cover underneath the tank and is clearly visible from the ground.

Indicator colour is RED when closed and GREEN when open.

A choice of language indicator is available at the time of order.

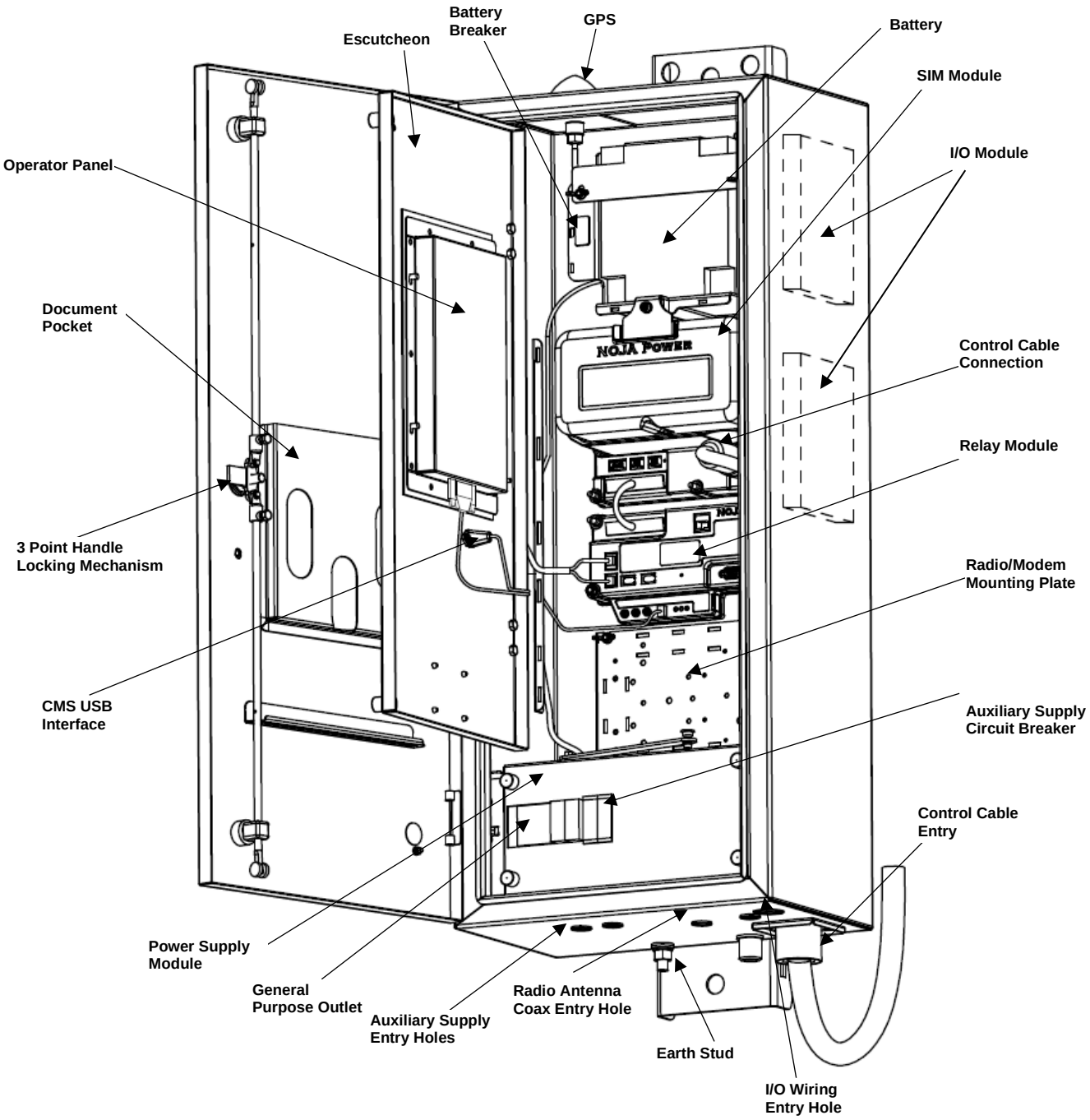
Shown are some available indicators; IEC standard I and O or Portuguese ABER (ABERTO - Opened) and FECH (FECHADO – Closed).

4 Recloser Control (RC) Cubicle

4.1 Overview

The Recloser Control (RC) Cubicles are manufactured from powder coated stainless steel and provides IP66 rated protection standard for the equipment it houses.

The RC cubicles have a secure locking system outer door with a door stay and padlock hasp.



Note: *Wi-Fi, GPS and Mobile Network connectivity only available in RC-15 cubicle.*

The door has a document pocket inside for the User Manual and other customer documentation.

The operator has a clear view of all Operator Controls, Display Panel and CMS Port.

The Auxiliary Supply **Miniature Circuit Breaker (MCB)** and Socket Outlet are easily accessible.

The RC cubicle internal modules, connecting cables and their connection points, user communication ports and relay inputs are easily visible and accessible.

The **Radio/Modem Mounting** Plate has space for extra Customer devices such as Radio, Modem and other communication equipment.

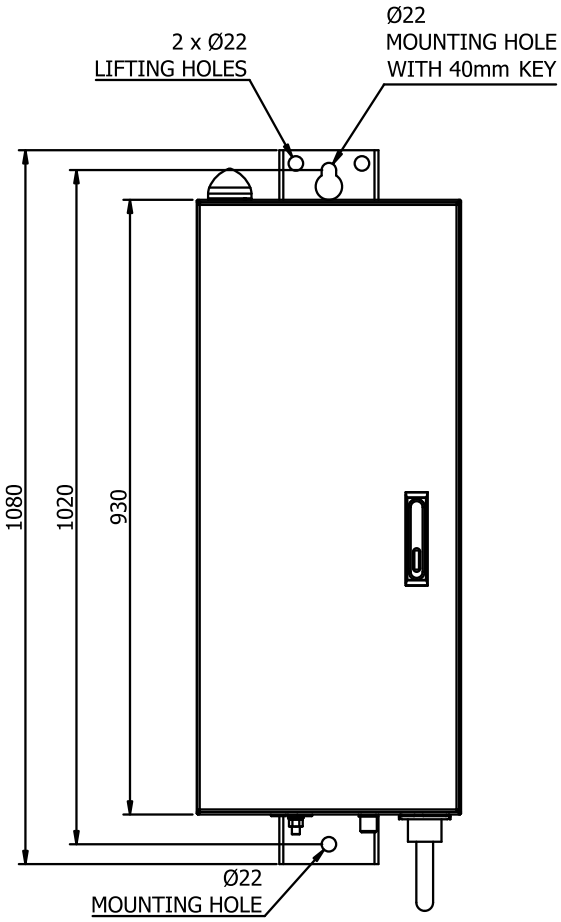
The **Power Supply Module (PSM)** compartment has room for extra circuit breakers and surge protectors.

The Control Cubicle floor has multiple cable entry holes for additional user devices.

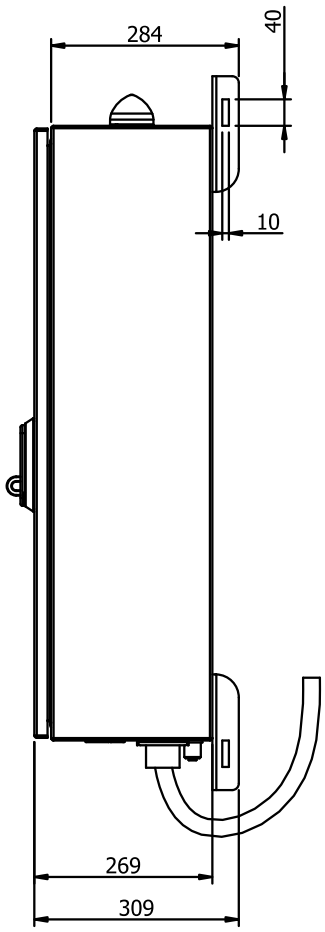
RC cubicle features include:

- Operator Pane
- Provision for a padlock with 12 mm hasp
- Space for radio, modem or other communications equipment (300 wide x 165 high x 180 deep)
- Miniature Circuit Breaker for auxiliary supply
- Socket Outlet
- Door stay to hold the door open at an angle of 110°
- Document pocket
- Vandal proof entry for control cable
- Dust proof drainage filter
- M12 Earthing stud
- Multiple Cable Entry Holes
- Battery Breaker.

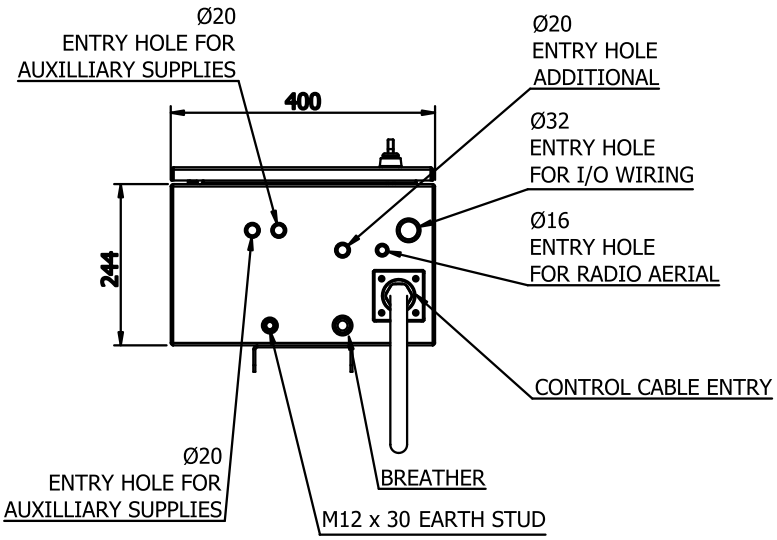
4.1.1 Dimensions – Recloser Control Cubicle



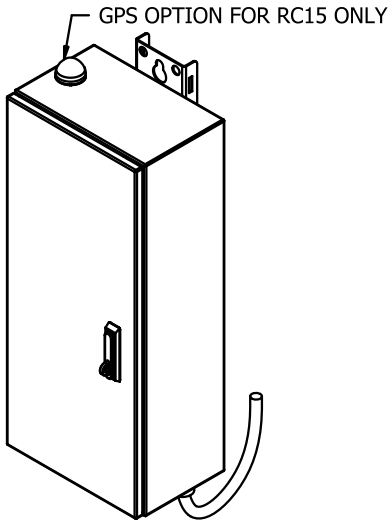
FRONT VIEW



SIDE VIEW



BOTTOM VIEW



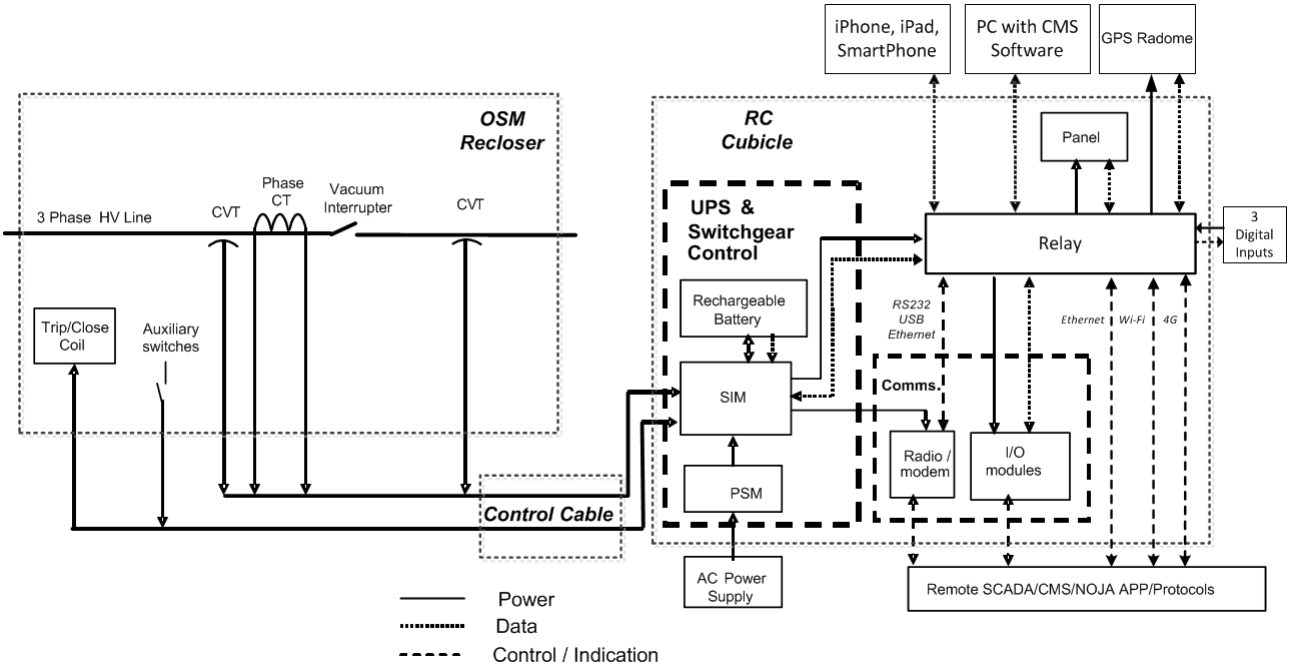
ISOMETRIC VIEW

Notes:

- *RC-15 cubicle has two additional entry holes for Radio Aerial.*

4.1.2 Functional Diagram

The functional structure of the OSM Recloser with RC cubicle is illustrated in the block diagram below.



***Note**: For the OSM 312 the HV Line is 2 Phase.*

RC Cubicle Internal Module and Component Function

The **Operator Panel Module** contains the User Interface for operator control.

The **Power Supply Module (PSM)** takes the auxiliary AC input and provides DC power supply to the SIM module.

The **Switchgear Interface Module (SIM)** module provides the power management, battery charger and incorporates the capacitors that provide the tripping and closing energy to the OSM tank.

The **Relay Module (REL)** contains the main microprocessor controller, Digital Signal Processing (DSP) functionality, Remote Terminal Unit (RTU), communications ports and standard digital inputs.

The **Communications Ports** and **I/O Modules** provide external control and indication functions for Supervisory Control and Data Acquisition (SCADA) or other remote control applications (Radio/Modem).

The RC Cubicle has been tested to stringent EMC standards. Refer to section 2.2.5 for details.

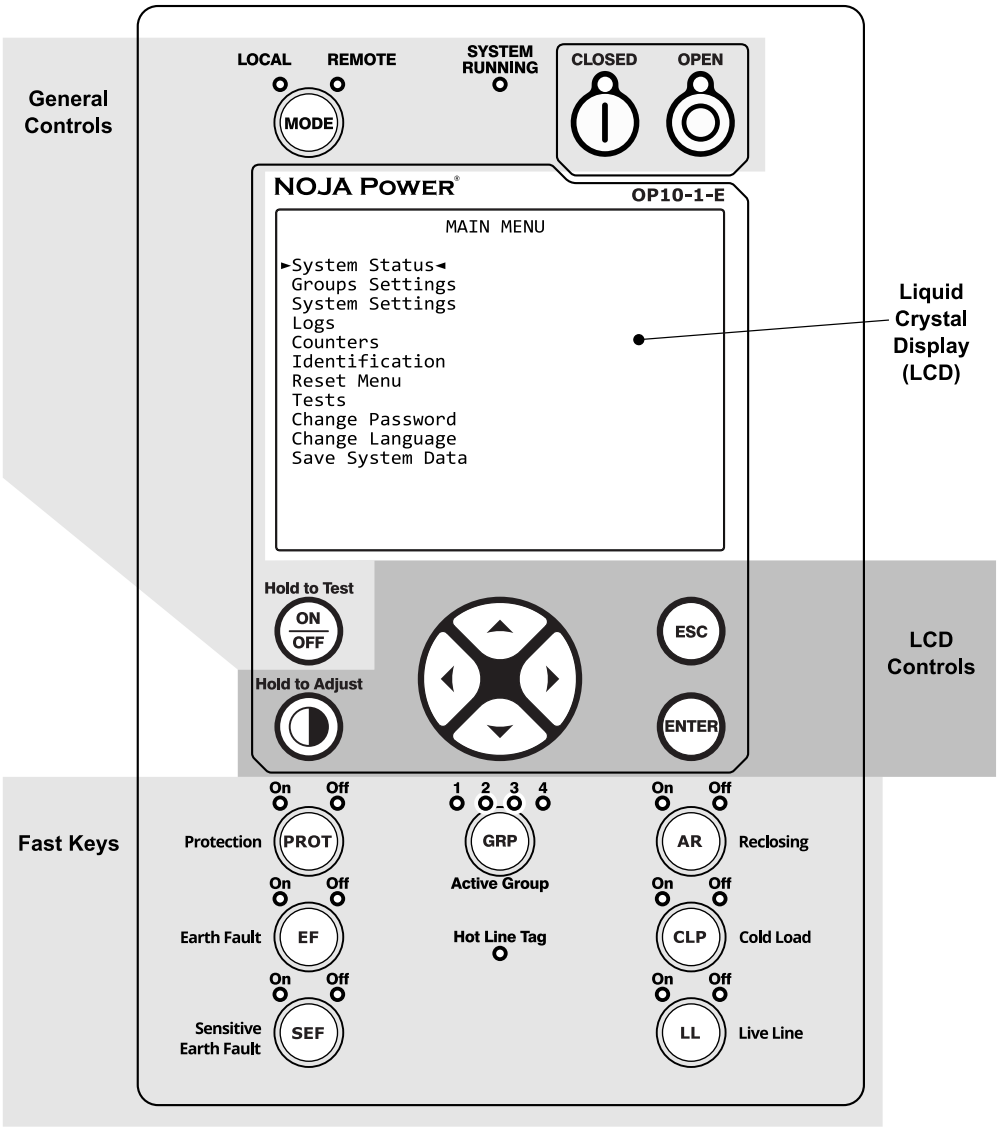
***Note:** Different SIM modules are used depending on the switchgear type connected to it. Please refer to section 10.5 Spare Parts List.*

4.2 Operator Panel

The Operator Panel Module consists of a sealed membrane keypad featuring push button controls with Light Emitting Diode (LED) indication together with a 320 x 240 Liquid Crystal Display (LCD) backlit for night operation.

The Panel is used to access the following information:

- Recloser control and indication
- Close/open (CO) operation details (log)
- View and change system and protection settings
- View and change communication settings and ports status
- View all counters (Lifetime Fault and SCADA counters)
- View the event log.



The layout of the Panel is illustrated above, each of the pushbutton groups are explained in the following sections.

LEDs embedded within the panel indicate status.

The system running LED flashes once per second in normal operation.

The Hot Line Tag LED is lit when the Hot Line feature is active. HLT is activated from the Protection Status screen or remotely and can only be removed from the source from which it was applied.

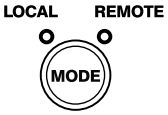
4.2.1 General Control Pushbuttons

ON / OFF

The Panel must be turned on before a user can use it for control and indication. Pushing any button on the panel will turn it on. The Panel will automatically turn itself off again if no operator activity is detected for 5 minutes.

The ON / OFF pushbutton also provides a means of testing the LCD and all indicating diodes. Pressing and holding will cause all the LEDs to blink and a test pattern to display on the LCD.

Note: *There is a Logic Expression "PANEL ON" to turn the Panel On/Off when the door of the RC Cubicle is opened/closed. When "PANEL ON" is enabled, the "Hold to Test" button on the Panel will be disabled.*



Control Mode

The Control mode pushbutton allows the Recloser Control to be set to either Local Control or Remote Control mode.

When in Local control mode, indication is available to both local and remote applications but controls can only be executed locally. When in Remote control mode, indication is available to both local and remote applications but controls can only be executed by Remote applications. Data can still be viewed locally on the LCD panel.

The exception to this is an Open control, which can be executed locally or remotely, independent of Control mode unless "Restrict Trip Mode" is enabled.

When "Restrict Trip Mode" is enabled, if the device is in Remote Control mode, local Trip commands are blocked and if the device is in Local Control mode, remote Trip commands are blocked. "Restrict Trip Mode" can be set via Logic and SGA.

Note: *All communications interfaces including I/O and communications ports can be configured as either a Local or Remote user.*

'I' (Close)

The red pushbutton labelled 'I' is used to close the recloser contacts. The control is only executed if the Panel is set to Local control mode. If the Panel is set to Remote control mode the control will not be accepted.

A delayed close can be programmed into the Panel to allow an operator time to move away from the recloser if required. A message is displayed on the LCD Panel when the Close button is pushed and the Closed LED starts blinking. Pressing the ESC or OPEN key will cancel the close operation, otherwise the device will close after the time delay has expired. Refer to section 8.1.

'O' (Open)

The green pushbutton labelled 'O' is used to open the recloser contacts. An Open control can be executed in either Local or Remote mode.

Note: *When the OSM tank is disconnected from the cubicle, both Open and Close LEDs are turned off.*

4.2.2 LCD Control Pushbuttons

LCD Contrast pushbutton

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 retain the last contrast setting unless the RC is powered down.

Navigation pushbuttons

These pushbuttons allow movement through the Panel menu structure and changes to setting values.

Once a field has been selected for editing, the up and down pushbuttons are used to change the value. Where the value being changed is a number, right and left arrow are used to select each digit, up and down arrows are used to change the value of that digit only.

ENTER pushbutton

The ENTER pushbutton is used to access a field within the data menu once it has been selected.

On pressing ENTER, the LCD will either display the next level screen or select the bracketed setting.

All settings are password protected except for those accessible using the Fast Keys, refer section 4.2.3.

A request to enter the password is automatically generated when the user tries to edit protected parameters for the first time after switching the Panel ON. The only exception is the ACO setting which does not require a password. The factory set default password is “NOJA”.

For an example of how to enter the password, refer to section 11.10.6

ESC pushbutton

The ESC pushbutton is used to either move the user back one screen or deselect a variable.

The LCD control pushbuttons provide access to the following functions within the Panel menu structure:

- View system status Date & Time, Recloser state (Open/Closed/Lockout), Malfunction and Warnings, Protection status, I/O status, Power Supply status, Indication signals, Communications Port status and Protection initiated
- View Event Log, Close/Open (CO) operations record, Lifetime counters, Fault counters, SCADA counters, System settings, Protection Group settings, Communication settings, Protocol settings
- View RC cubicle component identification and software versions
- View OSM Recloser serial numbers, measurements and calibration coefficients
- Change Protection status of all settings, except for Protection group names
- Test operability of digital input / output (I/O) relays
- Switch Panel power OFF and external load voltage ON/OFF
- Force save system data.

Refer to section 11.10 for detailed menu navigation and location of settings.

4.2.3 Fast Keys

Fast keys allow the status of protection elements and the active protection group to be set by an operator using a single push button.

The Operator Panel is supplied with one of seven available configurations of fast keys. In addition, in order for an operator to use the fast keys, they need to be enabled in Systems Settings (refer to section 8.1).

Pressing the Fast Key will cycle through ON and OFF with the exception of the Active Group key (see below).

Note: *Fast Keys cannot be changed when the Hot Line Tag (HLT) is active.*

The Protection Fast Key is used to turn Protection ON or OFF. When set to OFF, all protection elements for all groups are disabled.

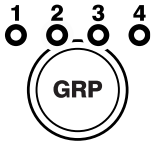
The Earth Fault Fast Key is used to turn ON or OFF all Earth Fault overcurrent elements for all groups. When set to OFF, all EF elements (including SEF) are disabled.

The Sensitive Earth Fault Fast Key is used to turn ON or OFF all Sensitive Earth Fault overcurrent elements for all groups.

The Auto-Reclosing Fast Key is used to turn ON or OFF all Auto Reclose elements for all groups.

The Cold Load Fast Key is used to turn ON or OFF Cold Load Pickup for all groups.

The Live Line Fast Key is used to turn ON or OFF all Live Line elements for all groups. It can also be linked to HLT function. Refer to Section 6.7.



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. Changing the Active Protection group will reset all protection elements.

The Automatic Backfeed Restoration Fast Key is used to turn ON or OFF the Automatic Backfeed Restoration function. Refer to Section 6.11.

The Auto Change Over Fast Key is used to turn ON or OFF the Auto Change Over function. Refer to Section 6.12.

The Under Voltage Fast Key is used to turn ON or OFF Under Voltage elements (UV1, UV2 and UV3) for all groups. Refer to Section 6.4.

4.3 Control and Management Software (CMS)

The CMS software package provides configuration and control of all features and functionality. It is a comprehensive device configuration tool and allows the user to:

- Configure all Relay settings
- Download all settings from PC to the Relay
- Upload all settings, logs, fault profile, load profile, fault counters, lifetime counters from Relay to PC
- Go On-Line and view all measurements, operate the OSM, configure Protection Status Control elements, synchronise time/date to PC clock and erase Load Profile data.
- Filter logs and profile information to assist in analysis of data
- Print settings and all Relay historical data
- Generate graphical representations of fault and load profile data
- Import and export configuration files for use by other personnel
- Configure User Defined curves and standard Time Current Characteristics using a graphical interface
- Ensure relay co-ordination by importing co-ordinating device characteristics from a library of protection curves
- Configure protocol settings for SCADA control.

A PC running CMS can connect to the RC directly via the local Escutcheon USB port (located below the Operator Panel). The connection type in CMS should be configured as “USB Direct”. The USB cable must be Type A to B and the maximum length is 3m. If a USB extension cable is used it must have a power supply.

CMS can also be connected remotely through a Serial, Ethernet or Fibre Optic connection to provide engineering access to the recloser control cubicle.

Refer to Sections 8.2 and 8.3 and NOJA-559 CMS Help File for more details on CMS and SCADA Control and Indication.

Notes:

- *In CMS, the switchgear serial number defines the recloser type. Please note that OSM 312 reclosers are created as 3 Phase devices.*
- *0.2 A SEF reclosers are created as “3 Phase SEF” devices.*

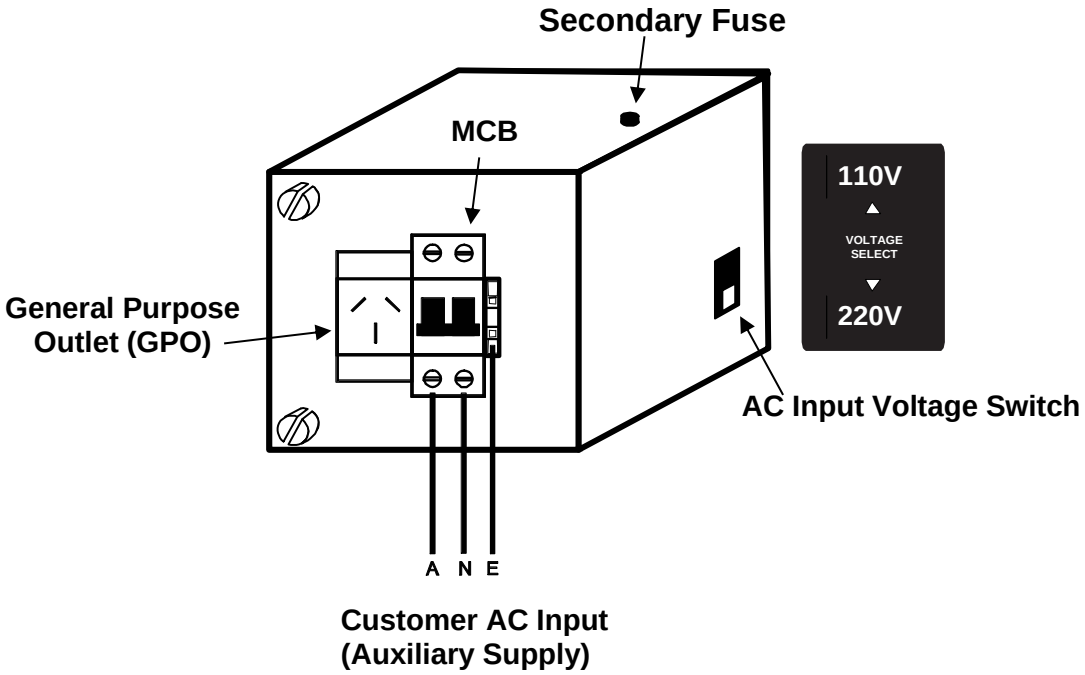
4.4 Power Supply Module (PSM)

The **Power Supply Module (PSM)** supplies DC power (rectified AC) filtered and surge protected, to the SIM.

The standard PSM allows for one AC input. Typically, the Customer AC Input to the PSM is from a step down Voltage Transformer (VT) or utility Low Voltage (LV) mains. If a second AC input is used, then a **Dual Input PSM** is available as an option.

Incoming power cables from the auxiliary supply are connected to the Active (A), Neutral (N) and Earth (E) connections as shown below. The double-pole Miniature Circuit Breaker (MCB) inputs and earth terminals are accessed by removing a safety cover. The MCB must be set to OFF before the Voltage Selector Switch is moved to either 110 Vac or 220 Vac. The secondary side of the power supply has a 6.3 A M205 fast blow fuse located on the top. Please refer to Section 10.4.3 for wiring diagram.

The PSM provides additional space for fitting customer devices such as surge protection besides the MCB.



WARNING: The earth wire MUST be connected, even if in a workshop/testing environment. Failure to comply may result in damage to equipment or personal injury.

WARNING: Only change the AC Input Voltage Switch when the MCB is set to OFF. Failure to comply may result in damage to equipment or personal injury.

Note: *The Dual Input PSM module includes two Customer AC Input connections, two AC Input Voltage Switches and two Secondary Fuses. Please refer to Section 10.5 Spare Parts List .*

4.5 Switchgear Interface Module (SIM)

The SIM module provides the power management, battery charging, and incorporates the capacitors that provide the tripping and closing energy to the OSM tank.

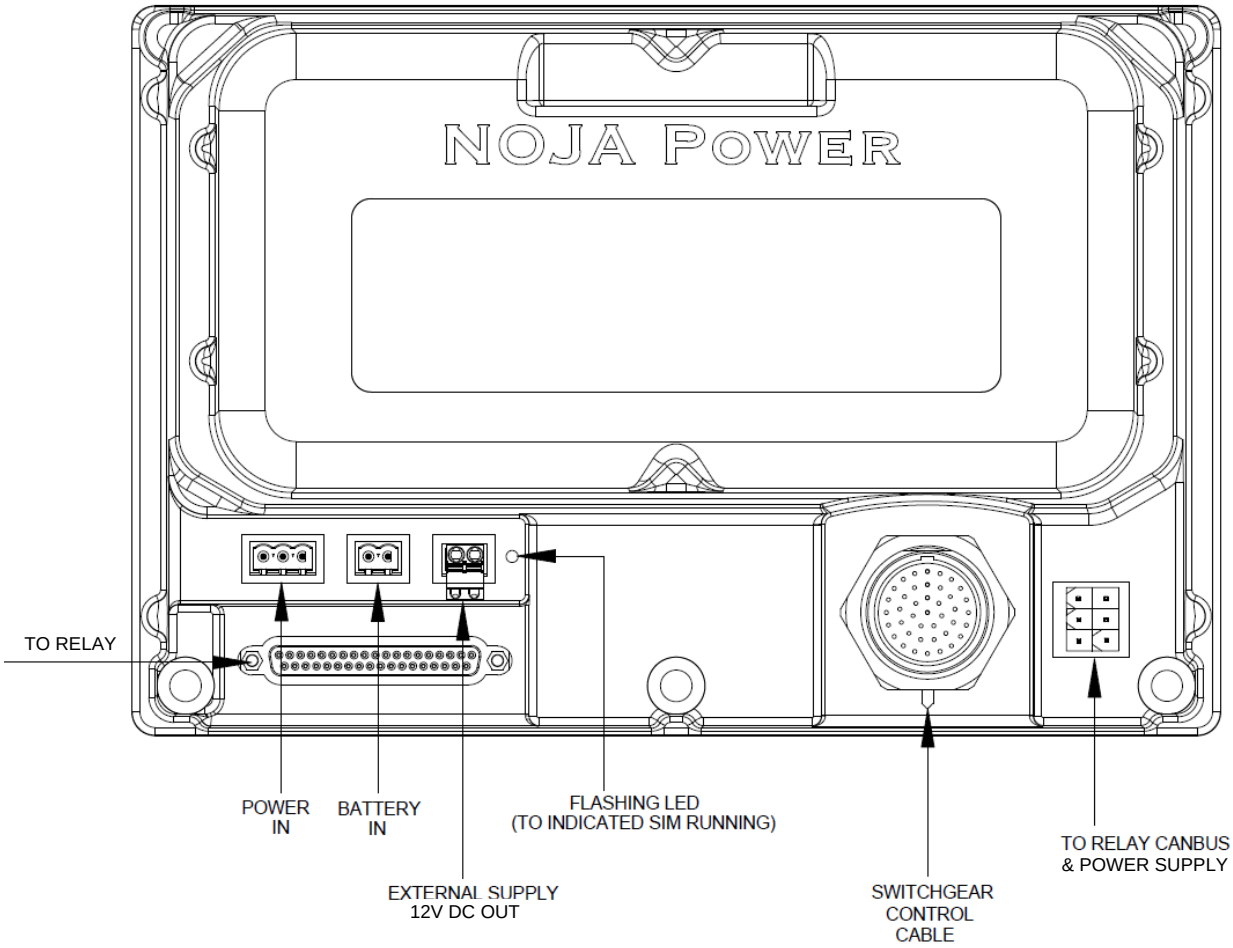
It accepts the signals from the Capacitive Voltage Transformers (CVTs) and Current Transformer (CT) outputs in the OSM tank and transfers them through to the Relay Module after filtering and scaling the signals.

The SIM module converts Trip/Close control signals from the Relay Module into current pulses applied to the magnetic actuator coil to drive the contacts into the open or closed position. It also converts the OSM auxiliary switch status into a logical position signal for use by protection and indication elements of the Relay and filters the analogue signals from the OSM Tank.

The health of the OSM coil circuit is monitored by the SIM module. Depending on the problem, an 'OSM OC' (Open Circuit), 'OSM SC' (Short Circuit) or 'Coil Isolated' (Mechanical Trip operated) malfunction event will be logged by the RC.

The actuator driver Trip and Close capacitors have the capacity to provide a complete rated duty cycle equal to O – 0.1 s – CO – 1 s – CO – 1 s – CO. The capacitors are re-charged within 60 s after execution of the above duty cycle.

The capacitors are charged within 60s (auxiliary power applied) of the Control Cable being connected to the Recloser.



Notes:

- *Connect communication equipment to the "External Supply" on the SIM module. DO NOT connect communication equipment directly to battery terminals. This can drain the battery, cause system shutdown or damage to the equipment.*
- *Different SIM modules are used depending on the switchgear type connected to it. Please refer to Section 10.5 Spare Parts List.*

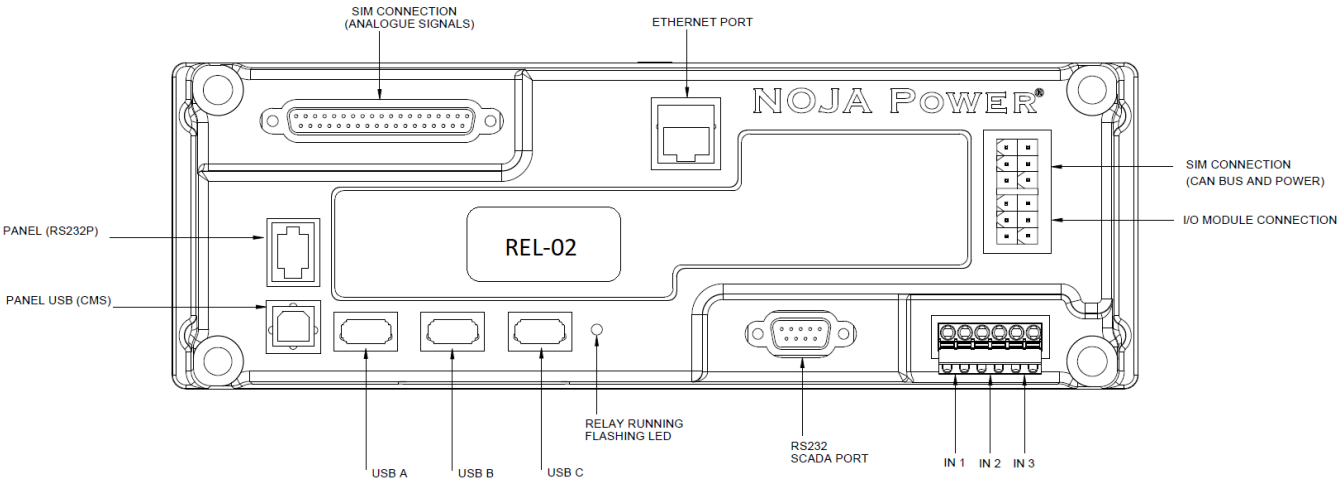
4.6 Relay Module (REL)

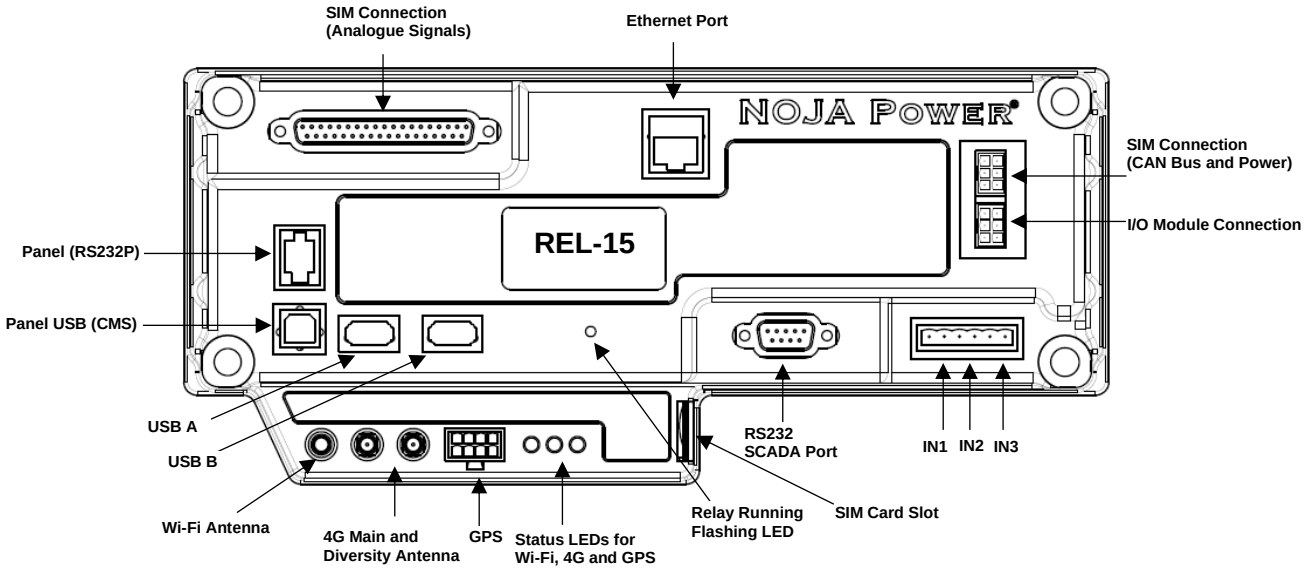
The Relay Module (REL) is responsible for all the functionality available in the Recloser Control (RC) cubicle through interaction with the OSM Recloser, Switchgear Interface Module and Operator Panel.

It contains the main microprocessor controller, Digital Signal Processing (DSP) functionality, Remote Terminal Unit (RTU), communications ports and standard digital inputs. The Relay Module converts the analogue signals received from the SIM Module into measured data (refer to section 5 Measurement).

The Relay Module provides the following functions:

- Measurement
- Protection
- Monitoring
- Control and Indication.





Communication Ports								
Relay Module	**RS232**	**USBA**	**USBB**	**USBC**	**LAN**	**Wi-Fi**	**4G**	**GPS**
REL-01	✓	✓	✓	✓				
REL-02	✓	✓	✓	✓	✓			
REL-15	✓	✓	✓		✓	✓		✓
REL-15-4GA (Europe/APAC)	✓	✓	✓		✓	✓	✓	✓
REL-15-4GB (Americas)	✓	✓	✓		✓	✓	✓	✓

Notes:

- *Various REL-15 modules are available for the RC-15 cubicle depending on cellular band support required. Please refer to section 10.5 Spare Parts List .*
- *There are three additional Status LEDs on the REL-15 module to indicate status of Wi-Fi, 4G and GPS. Please refer to section 10.3.1 Relay Module.*
- *The connectors for REL-15 4G main and diversity antennas are female SMA. The connector for the REL-15 Wi-Fi antenna is female RP-SMA.*

4.7 Communications Interface

Remote communications with the RC Cubicle can be achieved by connecting to the communications interface or by using the optional I/O Modules.

All communications interfaces including I/O and communications ports can be configured as either a Local or a Remote user.

All communications port wirings must be by means of screened cable with the screens earthed to the RC cubicle earth at one end only. Where communications cabling exits the RC cubicle, it must be isolated to at least 3kV with surge protection of 1kW or higher to prevent external surges from entering the cubicle. An appropriate RFI ferrite filter, should be fitted as well, located as close as possible to the (inside) floor of the cubicle.

Where an antenna is required, a bulk head mounting surge arrestor must be fitted to the floor of the cubicle.

The RC cubicle is supplied with a Radio/Modem mounting plate for installation of equipment with dimensions not greater than 300w x 165h x 180d mm. The Radio/Modem Mounting Plate is fitted with wing nuts and the user can drill mounting holes to accommodate a suitable Radio/Modem.

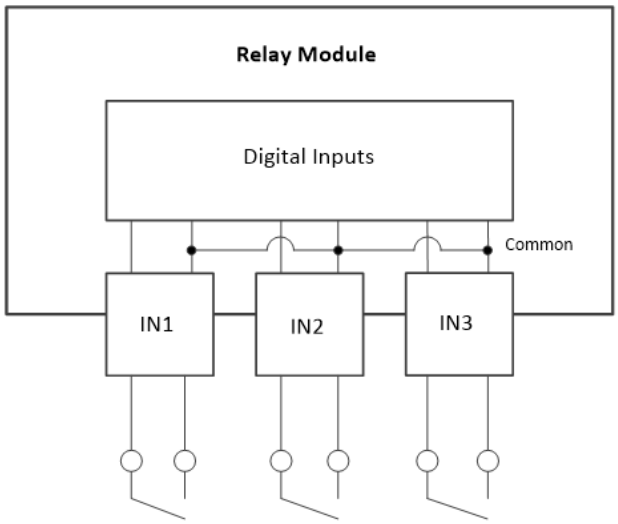
4.7.1 Local Digital Inputs

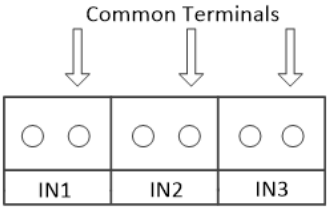
The Relay has three standard local digital inputs. These can be assigned to any standard control point, refer to Section 8 Control and Indication for a complete list of controls available.

The digital inputs are dry connections. No voltage is required to assert the input.

The inputs are not isolated and must not be connected directly to cables that exit the cubicle. An interposing relay must be used to isolate the inputs if connecting to external equipment.

Typical applications for these inputs include providing a close button on the base of the cubicle or a warning switch to monitor if the cubicle door has been opened.



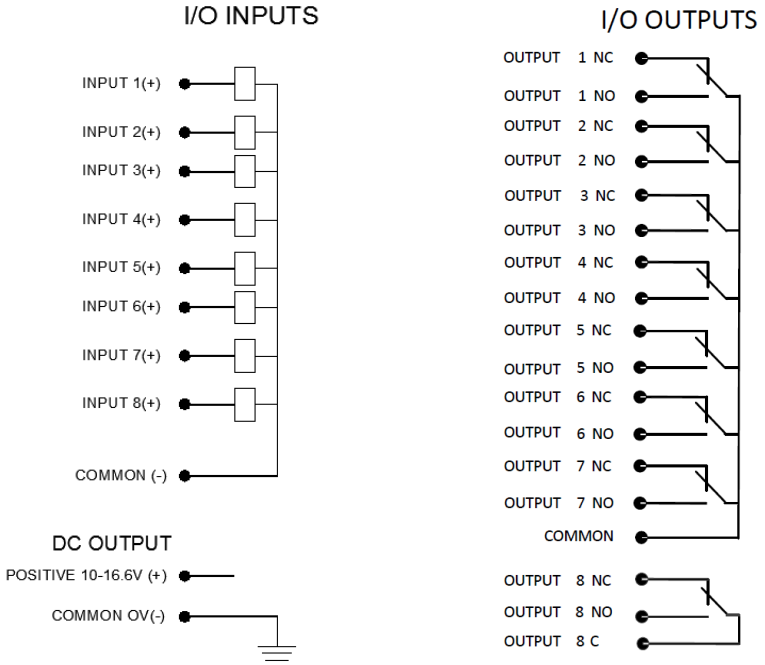


Relay Module Terminals

4.7.2 Optional I/O Modules

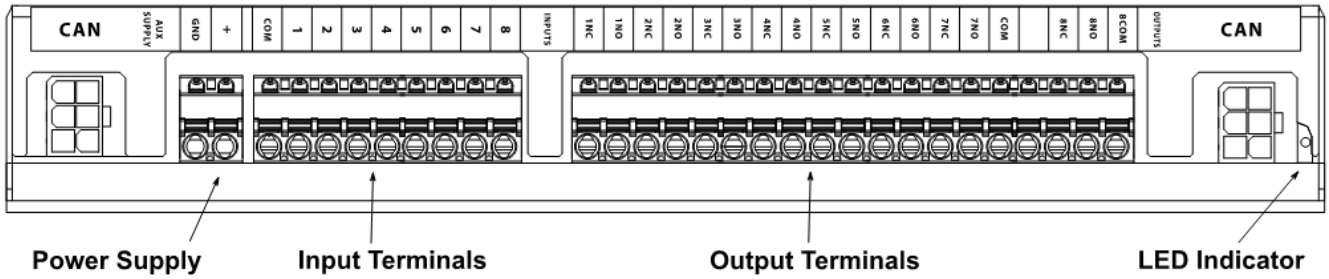
Up to two Input/Output Modules can be supplied with the RC cubicle as an option. Each I/O module has eight opto–coupled inputs and eight voltage free contact outputs with normally open and normally closed contacts.

Using the CMS software, any available control can be programmed for each input. Refer to Section 8 for a complete list of controls available for the I/O Modules. Any combination of available indications can be programmed for each output, refer Section 11.6 for a complete list of available indications. Default control and indication settings for the two modules are listed in Section 8.4 Inputs and Outputs (I/O).



A flashing LED (near the CAN connection) will flash once each second to indicate it has been allocated as I/O Module number 1. The second I/O Module LED will flash twice each second.

Power supply for the inputs may be sourced from the 12V dc terminals on the I/O Module itself.

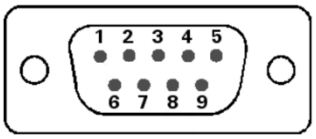


4.7.3 RS-232

An RS232 port is available on the Relay Module for connection to an RTU.

The RS232 port should not be connected directly to cables that exit the cubicle. At least 3kV of isolation and 1kW of surge protection must be used if connecting to external equipment.

DCD	1
Rx	2
Tx	3
DTR	4
GND	5
DSR	6
RTS	7
CTS	8
RI	9



RS-232 DB9
(numbering as per port on the relay)

Basic port settings can be set from the Panel as shown below. Advanced port configuration is only available via a PC running the CMS software.

Panel Navigation

[Turn Panel ON] ⇒ *[SYSTEM STATUS]* ⇒ *[Press ESC]* ⇒
⇩
[MAIN MENU]
↳ *[Systems Settings]*
↳ *[Port Settings]*
↳ *[RS232]* ⇒

```
RS232 SETTINGS

Connection Type          ▶Serial Direct◀
Device Mode                       Remote
Baud Rate                           9600
Duplex Type                         Full
Parity                              None
```

Port Settings

Title	Designation	Range	Resolution	Factory Default
Connection Type	Connection Type	Disabled/Serial Direct/ Modem/ Radio/GPRS	NA	Serial Direct
Device Mode	Device Mode	Local/Remote	NA	Remote
Baud Rate	Baud Rate	300/600/1200/2400/4800/ 9600/19200/38400/57600/115200	NA	9600
Duplex Type	Duplex Type	Half/Full	NA	Full
Parity	Parity	None/Even/Odd	NA	None

Note: *The RS232P port is the Operator Panel interface.*

Panel Navigation

[Turn Panel ON] ⇒ *[SYSTEM STATUS]*
↳ *[Communication Ports]*
↳ *[RS232 STATUS]* ⇒

```
RS232 STATUS

Detected Type                     Serial
Configured Type            Serial Direct
Device Mode                       Remote

Serial Pins:
 DTR: High    DSR: Low     CD: Low
 RTS: High    CTs: Low     RI: Low

Connection State           Disconnected
Bytes Received                       ▶1◀
Bytes Transmitted                     28
Test                                 Off
                                  Hangup
```

4.7.4 USB Communications Ports

Three USB ports are located on the Relay – USBA, USBB and USBC. Equipment with USB serial ports can be directly connected. These can be used to connect many types of communications equipment.

Other interfaces such as Serial, Wi-Fi, Bluetooth(1) and TCP/IP can be supported using approved(2) USB adaptors.

The USB ports should not be connected to cables that exit the cubicle.

The USB ports have power overload protection. Refer to Section 4.8.3. Advanced port configuration is only available via a PC running the CMS software.

Notes:

1. *If you are connected via Bluetooth to the Remote HMI App, modifying USBA settings may cause a disconnect.*
2. *Only NOJA Power approved USB devices should be connected to these ports.*

Panel Navigation

[Turn Panel ON] ⇒ *[SYSTEM STATUS]* ⇒ *[Press ESC]* ⇒
⇩
[MAIN MENU]
↳ *[System Settings]*
↳ *[Port Settings]*
↳ *[USBA]* ⇒

```
USBA SETTINGS

Connection Type          Disabled
Device Mode                Remote
```

Port Settings

Title	Designation	Range	Resolution	Factory Default
Connection Type	Connection Type	Disabled/Serial Direct/Modem/ Radio/LAN/WLAN/Bluetooth	NA	Disabled
Device Mode	Device Mode	Local/Remote	NA	Remote

Panel Navigation

[Turn Panel ON] ⇒ *[SYSTEM STATUS]*
↳ *[Communication Ports]*
↳ *[USBA STATUS]* ⇒

```
USBA STATUS

Detected Type              Unknown
Configured Type           Disabled
Device Mode                Remote
```

4.7.4.1 Bluetooth

A NOJA Power approved Bluetooth dongle can be connected to the USBA port only. When connected, Bluetooth can be enabled on the device for connection via the NOJA Power Mobile Panel App.

Note: *The Bluetooth PIN must be set via CMS before the connection will be available.*

When Bluetooth is enabled, the status screen will display the following:

Panel Navigation

[Turn Panel ON] ⇒ *[SYSTEM STATUS]*
↳ *[Communication Ports]*
↳ *[USBA STATUS]* ⇒

```
USBA STATUS

Detected Type            Bluetooth
Configured Type          Bluetooth
Device Mode                Remote

Device Name      NOJA-001A7DDA7113
Status                Disconnected


              ▸Clear Paired Devices◂
                     Allow Pairing
```

Selecting “Allow Pairing” will make the device’s Bluetooth connection discoverable for five minutes. “Clear Paired Devices” will remove all paired Bluetooth connections from the device’s memory.

4.7.5 Ethernet (LAN) Communications Port

The Relay, REL-02, has an RJ45 Ethernet port. This is used to connect directly to Ethernet enabled communications equipment.

Any Ethernet cabling entering the cubicle must be isolated. Fibre optic cable is recommended. Where cabling exits the RC cubicle, it must be isolated with surge protection. It should also be fitted with an appropriate RFI ferrite filter, located as close as possible to the (inside) floor of the cubicle. The cable shield must be earthed at the customer end (not cubicle).

Note: *Older REL-01 relay modules do not have an RJ45 Ethernet port available. In this case a NOJA approved USB to Ethernet converter can be used instead.*

Specifications

Ethernet Type:	10/100 Base-T Compatible
LED Meanings:	Left (Orange) = Link, Right (Green) = Activity
Ethernet Cable not exiting the cubicle:	Cat5, Unshielded Twisted Pair (UTP). Maximum Length=1m
Ethernet Cable exiting the cubicle:	Cat6, Screened Foiled Twisted Pair (S/FTP). Maximum Length=90m after Surge Arrestor.

Note: *Ethernet surge protection (NOJA P/N: EthernetSurge-01) must be supplied for all connections outside the cubicle.*

Panel Navigation

[Turn Panel ON] ⇒ *[SYSTEM STATUS]* ⇒ *[Press ESC]* ⇒
⇩
[MAIN MENU]
↳ *[Systems Settings]*
↳ *[Port Settings]*
↳ *[LAN]* ⇒

```
LAN SETTINGS

Connection Type                  LAN
Device Mode                   Remote
Obtain IPv4 Automatically         No
Obtain IPv6 Automatically         No
IPv4 Address                 0.0.0.0
IPv4 Subnet Mask             0.0.0.0
IPv4 Default Gateway         0.0.0.0
IPv6 Subnet Prefix Length         64
IPv6 Address:
  0000:0000:0000:0000:0000:0000:0000:0000
IPv6 Default Gateway:
  0000:0000:0000:0000:0000:0000:0000:0000
```

Port Settings

Title	Designation	Range	Resolution	Factory Default
Connection Type(1,2)	Connection Type	Disabled/LAN	NA	Disabled
Device Mode	Device Mode	Local/Remote	NA	Remote
Obtain IPv4 Automatically(3)	Obtain IPv4 Automatically	Yes/No	NA	No
Obtain IPv6 Automatically(3)	Obtain IPv6 Automatically	Yes/No	NA	No
IPv4 Address(4)	IPv4 Address	Enter an IPv4 address for the RC cubicle.	NA	0.0.0.0
IPv4 Subnet Mask	IPv4 Subnet Mask	Enter an IPv4 subnet mask.	NA	0.0.0.0
IPv4 Default Gateway(5)	IPv4 Default Gateway	Enter an IPv4 default gateway.	NA	0.0.0.0
IPv6 Subnet Prefix Length	IPv6 Subnet Prefix Length	1-128	NA	64
IPv6 Address(6)	IPv6 Address	Enter an IPv6 address	NA	::
IPv6 Default Gateway(5)	IPv6 Default Gateway	Enter an IPv6 default gateway	NA	::

Notes:

1. *REL-01 models will not show the LAN port configuration or status option.*
2. *To drop a DHCP lease and establish a new DHCP configuration, the LAN port must be disabled and then enabled.*
3. *The settings that will be displayed and configurable is dependent on whether IPv4 and IPv6 is set to "Yes/No".*
4. *Default IPv4 notation make use of the four fields and "." Separators. E.g. "192.168.1.108" where the values between each point is a numerical value. These values are limited to a range of 0 to 255.*
5. *To enable a default gateway, LAN must be assigned to a priority in the System Default Gateway settings*
6. *Default IPv6 notation make use of the ":" Separators. E.g. "2001:0db8:0000:0000:020f:24ff:febf:dbcb" where the values between each point is a hexadecimal in value. These values are limited to a range of "0" to "f". The IPv6 address must be in lower case.*

Panel Navigation

[Turn Panel ON] ⇒ *[SYSTEM STATUS]*
↳ *[Communication Ports]*
↳ *[LAN]*
↳ *[Status]* ⇒

```
              LAN STATUS

▶Status◀ Address

Detected Type                    LAN
Configured Type                  LAN
Device Mode                   Remote

                   TX             RX
Packets           791         123456
Errors              0            163
```

↳ *[LAN]*
↳ *[Address]* ⇒

```
              LAN STATUS

Status ▶Address◀

Obtain IPv4 Automatically          No
Obtain IPv6 Automatically          No
IPv4 Address                  0.0.0.0
IPv4 Subnet Mask              0.0.0.0
IPv4 Default Gateway          0.0.0.0
IPv6 Subnet Prefix Length          64
IPv6 Address:
  0000:0000:0000:0000:0000:0000:0000:0000
IPv6 Default Gateway:
  0000:0000:0000:0000:0000:0000:0000:0000
MAC                   E0:A1:98:01:01:15
```

4.7.6 Wi-Fi

The REL-15 module incorporates Wi-Fi wireless connectivity. The cubicle supports the 802.11 b/g/n version of the Wi-Fi protocol which operates in the 2.4 GHz band and has a range of up to 130 metres with an antenna outside the cubicle (50m with an internal antenna).

Where an external antenna is used, a bulk head mounting surge arrestor must be fitted to the floor of the cubicle. Any cabling entering the cubicle must be isolated with surge protection.

The device can be configured as a “Client” or “Access Point”. When it is configured as “Access Point”, a maximum of 4 clients are able to connect concurrently but only one session per protocol is permitted.

The REL-15 module does not check the WLAN settings for invalid addresses. It is up to the user to configure a valid address.

When the connection mode is configured as “Access Point” the following settings will be displayed.

Panel Navigation

[Turn Panel ON] ⇒ *[SYSTEM STATUS]* ⇒ *[Press ESC]* ⇒
⇩
[MAIN MENU]
↳ *[Systems Settings]*
↳ *[Port Settings*
↳ *[WLAN]* ⇒

```
            WLAN SETTINGS

Connection Type                  WLAN
Device Mode                   Remote

Connection Mode          Access Point
Wi-Fi Tx Power                    Low
SSID                NOJA-1513021330055
Provide IPv4 Automatically        Yes
IPv4 Address              192.168.0.1
IPv4 Subnet Mask        255.255.255.0
IPv6 Subnet Prefix Length          64
IPv6 Address:
  fe80:0000:0000:0000:0000:0000:0000:0002
```

Port Settings

Title	Designation	Range	Resolution	Factory Default
Connection Type	Connection Type	Disabled/WLAN	NA	Disabled
Device Mode	Device Mode	Local/Remote	NA	Remote
Connection Mode	Connection Mode	Access Point/Client	NA	Access Point
Wi-Fi Tx Power(1)	Wi-Fi Tx Power	High/Medium/Low	NA	Low
SSID(2)	SSID	NA	NA	NOJA-Relay Serial Number
Provide IPv4 Automatically(3,4)	Provide IPv4 Automatically	Yes/No	NA	Yes
IPv4 Address(5)	IPv4 Address	Enter an IPv4 address	NA	192.168.0.1
IPv4 Subnet Mask	IPv4 Subnet Mask	Enter an IPv4 subnet mask	NA	255.255.255.0
IPv6 Subnet Prefix Length	IPv6 Subnet Prefix Length	1-128	NA	64
IPv6 Address(6)	IPv6 Address	Enter an IPv6 address	NA	Fe80::2

Notes:

1. *This setting is used to limit the Effective Isotropic Radiated Power (EIRP) of the Wi-Fi. High Power (18 ±2) dBm)), Medium Power (10 ±1) dBm) and Low Power (7 ±1) dBm)).*
2. *"SSID" which is the name of the access point is configurable in CMS only. By default it is equal to "NOJA-Relay Serial Number". In access point mode, the default value for the Network Key (or password) is "12345678".*
3. *If "Yes" is selected, the access point provides IPv4 address automatically. If "No" is selected, the client will need to have a valid IP address. A maximum of 4 clients are allowed to connect. Two clients with the same IP Address shall not be able to connect to the Access point.*
4. *The relay does not support DHCPv6 server in access point mode. The client will need to have a valid IPv6 address. "Provide IPv6 Automatically" will not be displayed in the HMI when the Connection Mode is "Access Point".*
5. *Default IPv4 notation make use of the four fields and "." Separators. E.g. "192.168.1.108" where the values between each point is a numerical value. These values are limited to a range of 0 to 255.*
6. *Default IPv6 notation make use of the ":" Separators. E.g. "2001:0db8:0000:0000:020f:24ff:febf:dbcb" where the values between each point is a hexadecimal in value. These values are limited to a range of 0 to f and must be in lower case.*

Panel Navigation

[Turn Panel ON] ⇒ [SYSTEM STATUS]

↳ *[Communication Port Status]*

↳ *[WLAN]*

↳ *[Status] ⇒*

```
                WLAN STATUS

▶Status◀ Address  Clients


Detected Type                      WLAN
Configured Type                    WLAN
Status            Access Point Running
Device Mode                      Remote
Connection Mode             Access Point
SSID                 NOJA-1513021330055

                        TX             RX
Packets                791         123456
Errors                   0            163
```

↳ *[WLAN]*

↳ *[Address] ⇒*

```
                WLAN STATUS

Status ▶Address◀ Clients

Provide IPv4 Automatically          Yes
AP IPv4 Address              192.168.0.1
AP IPv6 Address:
   fe80:0000:0000:0000:0000:0000:0000:0002
```

Panel Navigation

[Turn Panel ON] ⇒ [SYSTEM STATUS]
↳ [Communication Port Status]
↳[WLAN]
↳[Clients] ⇒

```
WLAN STATUS

Status  Address ►Clients◄

Connected Clients IP:
192.168.32.34
192.168.32.35


Connected Clients MAC:
E1:A1:BD:17:12:C1
A0:A1:CA:C7:11:EE
```

Notes:

- *The Client IP and MAC address shall have the corresponding locations in the list. For example, a device with MAC address "E0:A1:98:18:04:E7" and IP address "10.10.150.149". If this is the first device, it shall display the MAC address in the first location under the "Connected Clients MAC:" and correspondingly the IP address shall be in the first entry under "Connected Clients IP:"*
- *If both IPv4 and IPv6 have connected clients, the "Connected Clients IP" shall be shared with the two protocols. The IP and MAC addresses shall display in a first come first server basis.*
- *If a device has an IPv4 Address and an IPv6 address, a preference is given to the IPv4 address. This address shall be displayed on the HMI.*
- *If there are clients connected to the Access Point with a static address (both IPv4 and IPv6), the Clients page will not display the IPv6 address of any client, though the MAC addresses of all clients are displayed as expected. This happens as there is no "RADVD" service running on RC-10/15.*

When the connection mode is configured as "Client" the following settings will be displayed.

Panel Navigation

[Turn Panel ON] ⇒ [SYSTEM STATUS] ⇒ [Press ESC] ⇒
⇩
[MAIN MENU]
↳ [Systems Settings]
↳ [Port Settings]
↳[WLAN] ⇒

```
WLAN SETTINGS

Connection Type                  WLAN
Device Mode                      Remote

Connection Mode                  Client
Wi-Fi Tx Power                   Low
Obtain IPv4 Automatically        No
Obtain IPv6 Automatically        No
IPv4 Address                     0.0.0.0
IPv4 Subnet Mask                 0.0.0.0
IPv4 Default Gateway             0.0.0.0
IPv6 Subnet Prefix Length        64
IPv6 Address:
  0000:0000:0000:0000:0000:0000:0000:0000
IPv6 Default Gateway:
  0000:0000:0000:0000:0000:0000:0000:0000
```

Port Settings

Title	Designation	Range	Resolution	Factory Default
Connection Type	Connection Type	Disabled/WLAN	NA	Disabled
Device Mode	Device Mode	Local/Remote	NA	Remote
Connection Mode	Connection Mode	Access Point/Client	NA	Access Point
Wi-Fi Tx Power	Wi-Fi Tx Power	High/Medium/Low	NA	Low
Obtain IPv4 Automatically(1)	Obtain IPv4 Automatically	Yes/No	NA	Yes
Obtain IPv6 Automatically(1)	Obtain IPv6 Automatically	Yes/No	NA	Yes
IPv4 Address(2)	IPv4 Address	Enter an IPv4 address.	NA	0.0.0.0
IPv4 Subnet Mask	IPv4 Subnet Mask	Enter an IPv4 subnet mask.	NA	0.0.0.0

Title	Designation	Range	Resolution	Factory Default
IPv4 Default Gateway(2,3)	IPv4 Default Gateway	Enter an IPv4 default gateway.	NA	0.0.0.0
IPv6 Subnet Prefix Length	IPv6 Subnet Prefix Length	1 – 128	NA	64
IPv6 Address(4)	IPv6 Address	Enter an IPv6 address	NA	::
IPv6 Default Gateway(3,4)	IPv6 Default Gateway	Enter an IPv6 default gateway.	NA	::

Notes:

1. *The settings that will be displayed and configurable is dependent on whether IPv4 and IPv6 is set to "Yes/No".*
2. *Default IPv4 notation make use of the four fields and "." Separators. E.g. "192.168.1.108" where the values between each point is a numerical value. These values are limited to a range of 0 to 255.*
3. *To enable a default gateway, WLAN must be assigned to a priority in the System Default Gateway settings*
4. *Default IPv6 notation make use of the ":" Separators. E.g. "2001:0db8:0000:0000:020f:24ff:febf:dbcb" where the values between each point is a hexadecimal in value. These values are limited to a range of 0 to f and must be in lower case.*

Panel Navigation

[Turn Panel ON] ⇒ [SYSTEM STATUS]

↳ *[Communication Port Status]*

↳ *[WLAN]*

↳ *[Status] ⇒*

```
                WLAN STATUS

▶Status◀ Address

 Detected Type                      WLAN
 Configured Type                    WLAN
 Status                  Connected to AP
 Device Mode                      Remote
 Connection Mode                  Client
 Signal Quality                Excellent
 SSID                 NOJA-1513021330055

                       TX              RX
 Packets              791          123456
 Errors                 0             163
```

↳ *[WLAN]*

↳ *[Address] ⇒*

```
                WLAN STATUS

 Status ▶Address◀

 Obtain IPv4 Automatically            No
 Obtain IPv6 Automatically            No
 IPv4 Address                    0.0.0.0
 IPv4 Subnet Mask                0.0.0.0
 IPv4 Default Gateway            0.0.0.0
 IPv6 Subnet Prefix Length            64
 IPv6 Address:
   0000:0000:0000:0000:0000:0000:0000:0000
 IPv6 Default Gateway:
   0000:0000:0000:0000:0000:0000:0000:0000
 MAC                   E1:A1:BD:17:12:C1
```

4.7.7 Mobile Network Modem

The REL-15 module can include a mobile network modem that supports 2G, 3G and 4G mobile network technologies. Different cellular bands are supported depending on the relay module chosen (please refer to section 10.5 Spare Parts List).

The size of the SIM card required is 2FF (2nd Form Factor) or "Mini Sim" and it should be an industrial SIM rated from -40°C to +85°C.

A bulk head mounting surge arrestor must be used for any external antennas and must be fitted to the floor of the cubicle. Any cabling entering the cubicle must be isolated with surge protection.

Panel Navigation

[Turn Panel ON] ⇒ [SYSTEM STATUS] ⇒ [Press ESC] ⇒

⇩

[MAIN MENU]

↳ *[Systems Settings]*

↳ *[Port Settings]*

↳ *[Mobile Network Settings] ⇒*

```
        MOBILE NETWORK SETTINGS

Connection Type    Mobile Network Modem

Preferred Network              Automatic
Device Mode                     Remote
IP version                        IPv6
Obtain IPv6 Automatically           No
IPv6 Subnet Prefix Length           64
IPv6 Address:
   0000:0000:0000:0000:0000:0000:0000:0000
IPv6 Default Gateway:
   0000:0000:0000:0000:0000:0000:0000:0000
```

Port Settings[1]

Title	Designation	Range	Resolution	Factory Default
Connection Type	Connection Type	Disabled/Mobile Network Modem	NA	Disabled
Preferred Network	Preferred Network	Automatic	NA	Automatic
Device Mode	Device Mode	Local/Remote	NA	Remote
IP Version[2]	IP Protocol Version	IPv4/IPv6	NA	IPv4
Obtain IPv4 Automatically[3]	Obtain IPv4 Automatically	Yes/No	NA	Yes
Obtain IPv6 Automatically[3]	Obtain IPv6 Automatically	Yes/No	NA	Yes
IPv4 Address[4]	IPv4 Address	Enter an IPv4 address	NA	0.0.0.0
IPv4 Subnet Mask	IPv4 Subnet Mask	Enter an IPv4 subnet mask.	NA	0.0.0.0
IPv4 Default Gateway[4]	IPv4 Default Gateway	Enter an IPv4 default gateway.	NA	0.0.0.0
IPv6 Subnet Prefix Length	IPv6 Subnet Prefix Length	1 – 128	NA	64
IPv6 Address[5]	IPv6 Address	Enter an IPv6 address	NA	::
IPv6 Default Gateway[5]	IPv6 Default Gateway	Enter an IPv6 default gateway.	NA	::

Notes:

1. *Additional advanced settings such as SIM card settings are available from CMS only.*
2. *Only one IP version at a time can be used and is dependent on what the Internet Service Provider supplies.*
3. *The settings that will be displayed and configurable is dependent on whether IPv4 and IPv6 is set to "Yes/No".*
4. *Default IPv4 notation make use of the four fields and "." Separators. E.g. "192.168.1.108" where the values between each point is a numerical value. These values are limited to a range of 0 to 255.*
5. *Default IPv6 notation make use of the ":" Separators. E.g. "2001:0db8:0000:0000:020f:24ff:febf:dbcb" where the values between each point is a hexadecimal in value. These values are limited to a range of 0 to f and must be in lower case.*

Panel Navigation

[Turn Panel ON] ⇒ [SYSTEM STATUS]

↳ *[Communication Port Status]*

↳ *[Mobile Network]*

↳ *[Status] ⇒*

```
        Mobile Network Status

▶Status◀ Address

Detected Type      Mobile Network Modem
Configured Type    Mobile Network Modem
Connection Status               Connected
Network Mode                    LTE(4G)
Signal Quality                  Very Good
Device Mode                      Remote
IP version                         IPv6

                        Tx             RX
Packets                  0              0
Errors                   0              0
```

Panel Navigation

[Turn Panel ON] ⇒ *[SYSTEM STATUS]*

↳ *[Communication Port Status]*

↳*[Mobile Network]*

↳*[Address]* ⇒

```
        Mobile Network Status

Status ►Address◄

Obtain IPv6 Automatically          Yes
IPv6 Subnet Prefix length           64
IPv6 Address:
  0000:0000:0000:0000:0000:0000:0000:0000
IPv6 Default Gateway:
  0000:0000:0000:0000:0000:0000:0000:0000
```

Provision has been included for users to enter SIM card PIN and PUK numbers if required. These can be accessed from the PIN/PUK screen of the Mobile Network Status.

Note: The PIN/PUK screen will only be displayed when connection status is “SIM PIN Required”, “SIM PIN Error”, “SIM Blocked”, “SIM PUK Required” or “SIM Card PUK Error”

Panel Navigation

[Turn Panel ON] ⇒ *[SYSTEM STATUS]*

↳ *[Communication Port Status]*

↳*[Mobile Network]*

↳*[PIN/PUK]* ⇒

```
        Mobile Network Status

Status  Address ►PIN/PUK◄

Connect Status        SIM PIN Required

PIN Entry                         ----
PIN Confirm                       ----

PIN Result

PUK Entry                         --------
PUK Confirm                       --------

PUK Result
```

4.7.8 System Default Gateway

The relay can have multiple ethernet ports connected to different subnets. The system default gateway is used to enable the default gateways and defines the priority of the communications ports. If the highest priority port is inactive, the system will use the next available gateway. A lower number represents a higher priority.

Panel Navigation

[Turn Panel ON] ⇒ *[SYSTEM STATUS]* ⇒ *[Press ESC]* ⇒

⇩

[MAIN MENU]

↳ *[Systems Settings]*

↳ *[Port Settings]*

↳*[System Default Gateway]* ⇒

```
        SYSTEM DEFAULT GATEWAY

Port                          Priority

Mobile Network                       0

►LAN          ◄                      1

None                                 2

None                                 3
```

System Default Gateway Settings

Title	Designation	Range	Resolution	Factory Default
Priority 0 Port(1,2)	Default Gateway Priority 0	Mobile Network	NA	Mobile Network
Priority 1 Port	Default Gateway Priority 1	None/LAN/WLAN/USB A/USB B/USB C	NA	LAN
Priority 2 Port	Default Gateway Priority 2	None/LAN/WLAN/USB A/USB B/USB C	NA	None
Priority 3 Port	Default Gateway Priority 3	None/LAN/WLAN/USB A/USB B/USB C	NA	None

Notes:

1. If the relay model is REL-15-4G, Mobile Network port will automatically be set to priority 0 and cannot be changed.
2. If the relay model is REL-01, REL-02 or REL-15 then Priority 0 will not be displayed.

Panel Navigation

[Turn Panel ON] ⇒ *[SYSTEM STATUS]*
↳ *[Communication Port Status]*
↳*[System Default Gateway]* ⇒

```
        SYSTEM DEFAULT GATEWAY

Port              Priority      Status
Mobile Network           0    Inactive
LAN                      1    Inactive
None                     2    Inactive
None                     3    Inactive
```

Note: The "Status" column indicates whether that port is Active (up) or Inactive (down). For a port to be "Active", all of the following conditions must be satisfied:
a) Port must be Enabled.
b) Priority must be assigned under System Default Gateway settings.
c) Gateway must be assigned under the communications port settings. If any port has an empty or invalid default gateway address (IPv4: "0.0.0.0" and IPv6: "::"), then that address will not be used. There is an exception for the Mobile Network port, as there is no real peer at the other end, so its default gateway address can be kept empty.

4.7.9 Global Positioning System (GPS)

The RC-15 module has Global Positioning System (GPS) capability which provides synchronisation for accurate time-stamping and location.

When GPS is enabled, the signal quality, time sync status and position (latitude, longitude and altitude) are displayed.

The signal quality is determined by the Position Dilution of Precision which relates to satellite geometry at a given time and location:

- Position Dilution of Precision less than 2: Excellent
- Position Dilution of Precision between 2-5: Very Good
- Position Dilution of Precision between 5-10: Low signal
- Position Dilution of Precision more than 10: No signal.

The time sync status will be displayed as "Locked by GPS" if the time accuracy is within 10 µs.

Panel Navigation

[Turn Panel ON] ⇒ *[SYSTEM STATUS]* ⇒ *[Press ESC]* ⇒
⇩
[MAIN MENU]
↳ *[GPS]* ⇒

```
                GPS

GPS                ►Enabled      ◄
Status              Normal
Signal Quality      Excellent
Time Sync Status    Locked by GPS

Latitude (degree)   -27.451227
Longitude (degree)  153.102239
Altitude (m)        2
```

Port Settings

Title	Designation	Range	Resolution	Factory Default
GPS	GPS	Enabled/Disabled	NA	Disabled

Note: *When GPS is enabled, it has priority over SCADA time synchronisation and set time commands from the HMI panel and CMS unless the GPS signal is not available.*

4.7.10 USB Overcurrent

When an overcurrent draw is detected on a USB port, the relay will stop power to that port. The device causing the overcurrent will be displayed as a critical parameter in the event log. Any faulty USB devices should be removed.

Power can be restored to the port using "Reset USB Overcurrent" from the Reset Menu (see panel navigation below).

Notes:

- *USB devices include on-board USB Ports A/B/C, Wi-Fi hardware, Mobile Network Modem, GPS hardware and any external devices on a USB port.*
- *If the fault is still present when resetting the USB port, it may halt the USB subsystem. If this occurs, you will need to power cycle the relay. Ensure that any faulty USB devices are removed first.*

Panel Navigation

[Turn Panel ON] ⇒ *[SYSTEM STATUS]* ⇒ *[Press ESC]*
⇩
[MAIN MENU]
↳ *[Reset Menu]*
↳ *[Reset]*
↳ *[Reset USB Overcurrent]* ⇒

```
RESET MENU

Erase ►Reset◄

Reset Hot Line Tag
Reset Logical Block Close
Reset Fault Targets
Restart GPS Hardware
Restart Wi-Fi Hardware
Restart Mobile Network Modem
Reset USB Overcurrent
```

4.7.11 External Load Power Supply for Communications Equipment

A 12V DC power supply for communications equipment is located on the SIM module. DO NOT connect the communication equipment directly to battery terminals. This can drain the battery, cause system shutdown or damage the equipment. Refer to section 4.5 Switchgear Interface Module (SIM) and section 10.4.1 RC General Layout.

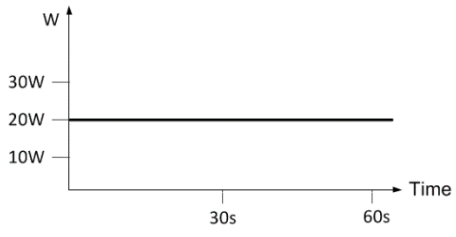
The External Supply Output can be turned ON or OFF from the Panel or CMS software. The power supply is rated at 12 V, 20 W on average over a rolling 60 seconds window. The external load supply switches off immediately if the current exceeds 5.8 A.

The external power supply output is software managed to minimize the risk of overloading the power supply system. Refer to Section 4.8.5, External Load Supply Timer and Controlled Output.

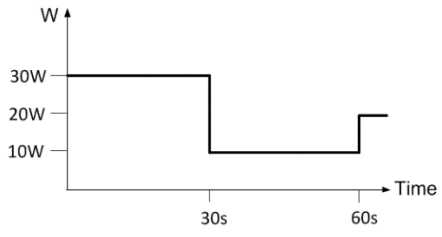
The output/overload protection mechanism is detailed below.

Battery Supply above 11.0 V:

- If the current is above 5.8 A for 25 ms then the external supply will turn off immediately and stay off until the customer turns the external supply on again. Please note that there is a 1 minute period in which the supply will stay off and cannot be turned back on until the 1 minute period has elapsed.
- The external supply will supply 20 W on average over a rolling 60 seconds window. So, for example, if the external load supplies 30 W in the first 30 seconds then only 10 W can be supplied over the next 30 seconds to ensure an overload does not occur as shown in Example 2 below.



Example 1



Example 2

- When the supply is turned off because of the power being exceeded, it will be reported in the event log as an external supply **overload**.

AC ON, Battery Supply below 11.0 V or disconnected:

- The external supply cannot draw more than 15W on average over a rolling 60 seconds window. If it does it will shut off within 10 ms. The state will be reported in the event log as **shutdown**. When the supply shuts down under this condition it automatically turns back on when a battery supply of more than 11.6 volts is connected.

  Drawing more than 15 W in this instance may cause the RC to shutdown and restart in some cases.

AC OFF, Battery Supply below 11.0 V:

- The external supply is off.

Panel Navigation

[Turn Panel ON] ⇒ *[SYSTEM STATUS]*

↳ *[Power Supply]* ⇒

```
          POWER SUPPLY STATUS

Last Power Restart:
14:00:57   14/10/21

AC Input                          OFF
Battery Voltage (Ubt)           13.8V
Battery Current (Ibt)           0.50A
Battery Capacity (%)              100
External Load Output              off
Battery Test                 Initiate

Battery Test Result:
23:52:00  22/01/2014
Battery Test Passed
```

***Warning**: Do not connect communications equipment directly to the battery terminals. This can drain the battery, cause a system shutdown or damage the equipment.*

Notes:

- *The external load output will indicate OFF when the external supply is shut-down due to External Load Time-out when there is loss of AC Supply or when the battery is low. Please refer to 4.8.5 External Load Supply Timer and Controlled Output.*
- *If a device connected to the external supply becomes faulty and the RC cubicle is operating only from the AC supply, then the controller may be forced into continuous resets. Under this circumstance the device connected to the external supply should be disconnected.*

4.8 Power Supply

The Power Supply Module (PSM) provides filtering, surge protection, and DC voltage to the SIM module. Typically the AC input (auxiliary supply) to the PSM is from a step down Voltage Transformer (VT) or utility Low Voltage (LV) mains. Refer to Section 4.4 Power Supply Module (PSM).

The SIM module provides power management for the RC cubicle with a 12 V DC battery for backup. Refer to Section 4.5 Switchgear Interface Module (SIM).

To manually shutdown the RC cubicle, turn off the auxiliary supply and the battery circuit breakers.

4.8.1 Battery Circuit Breaker

A Circuit Breaker is provided next to the battery to protect the battery from short circuit currents. Refer to Section 10.4.3 Power Supply.

It can also be used to disconnect the battery from the cubicle. If the battery is turned OFF for more than 60 seconds, or the battery voltage drops below 5 volts, then the system clock time will be reset. An inline 6.3 A M205 fast blow fuse is provided on the positive terminal of the battery for extra protection.

4.8.2 Battery Test

A battery test can be initiated manually to check the state of the battery. Alternatively the test can be configured to run automatically at a regular time interval (Refer to Section 4.8.3 UPS Settings).

The battery test will apply a load across the battery for 30 seconds. The result of the test will be displayed on the panel.

Panel Navigation

[Turn Panel ON] ⇒ [SYSTEM STATUS]

↳ [Power Supply] ⇒

```
          POWER SUPPLY STATUS

Last Power Restart:
14:00:57   14/10/21

AC Input                          OFF
Battery Voltage (Ubt)           13.8V
Battery Current (Ibt)           0.50A
Battery Capacity (%)              100
External Load Output              Off
Battery Test                 Initiate

Battery Test Result:
11:42:00  22/01/2015
Battery Test Passed
```

Notes:

- *If the battery is not connected, AC not applied, battery is discharging at > 100 mA or battery voltage < 12.5 V then a "Battery Test Not Performed" will be indicated.*
- *If a battery test is performed the next test will be blocked for 5 minutes. If an attempt is made to initiate a battery test during this period then a "Battery Test Not Performed" will also be indicated. The reason being that the Battery Test Circuit is resting.*
- *If the battery test circuit is faulty, "Battery Test Circuit Fault" will be indicated.*
- *SIM software supported is 1.8.x and above.*

4.8.3 UPS Settings

Panel Navigation

[Turn Panel ON] ⇒ [SYSTEM STATUS] ⇒ [Press ESC] ⇒

⇩

[MAIN MENU]

↳ [System Settings]

↳ [UPS SETTINGS] ⇒

```
            UPS SETTINGS

Battery Shutdown Level (%):       20
Rated Capacity (Ah)               26
Battery Type                     AGM
External Load Time (min)         120
External Load Reset Time (hr)      0
USB Host Ports Shutdown Enable    NO
Mobile Network Time (min)        120
Mobile Network Reset Time (hr)     0
WLAN Time (min)                  120
WLAN Reset Time (hr)               0

Battery Test
Auto Test                        Off
Time Interval (days)              30
```

UPS Settings

Title	Designation	Range	Resolution	Factory Default
Battery Shutdown Level (%)	Battery Shutdown Level	10% – 50%	10%	20
Rated battery capacity (Ah)	Rated Capacity	10 – 50 Ah	1 Ah	26
Battery Type(1)	Battery Type	AGM/GEL/LFP	-	AGM
External Load Time(2) (min)	External Load Time	0 – 1440 min	1 min	120
External Load Reset Time(3) (hr)	External Load Reset Time	0 – 720 h	1 h	0
USB Host Ports Shutdown Enable(4)	USB Host Ports Shutdown Enable	No/Yes	NA	No
Mobile Network Time(5) (min)	Mobile Network Time (min)	0 – 1440 min	1 min	120

Title	Designation	Range	Resolution	Factory Default
Mobile Network Reset Time (hr)	Mobile Network Reset Time (hr)	0 – 720 h	1 h	0
WLAN Time(6) (min)	WLAN Time (min)	0 – 1440 min	1 min	120
WLAN Reset Time (hr)	WLAN Reset Time (hr)	0 – 720 h	1 h	0
Auto Test(7)	Auto Battery Test	On/Off	NA	Off
Time Interval (days)	Interval (days)	1-365	NA	30

Note:

1. *Battery Type selection is applicable from SIM version 1.9.0 and above and it is password protected.* ***Warning:*** *If the wrong battery type is selected battery can be overcharged or damaged.*
2. *The time to turn off the External Load in case of loss of AC supply. The External Load will not turn off if External Load Time is set to 0.*
3. *The External Load Reset Time will not cycle the load supply if set to 0.*
4. *If USB Host Ports Shutdown is enabled and the External Load Time expires, all USB ports as well as the Relay 15 communication ports (WLAN, Mobile Network and GPS) will shutdown. If the External Load Time is set to 0, the ports will not shutdown unless they are shutdown by the Mobile Network or WLAN Time settings.*
5. *The time to turn off the Mobile Network Modem in case of loss of AC supply. The Mobile Network Modem will not turn off if Mobile Network Time is set to 0 unless it is shutdown by the USB Host Ports Shutdown Enable setting.*
6. *The time to turn off WLAN in case of loss of AC supply. The WLAN will not turn off if WLAN Time is set to 0 unless it is shutdown by the USB Host Ports Shutdown Enable setting.*
7. *Auto Test will start a battery test after the first time interval from being enabled and then the test will be conducted on a regular basis at that time interval set by the user. If the system is restarted the counter for the time interval will be reset. Refer to Section 4.8.2 for initiating the battery test manually.*

4.8.4 Power Management

Battery temperature is monitored by the SIM module and charging current is adjusted to ensure optimum charging.

An external load (e.g. radio or modem) can have power supplied to it for a user configurable time (External Load Time) of up to 1440 minutes after loss of AC supply before automatically shutting down to conserve batteries.

In the case of a prolonged loss of AC supply, the Relay Module, SIM module and External Load will be shut down in an orderly fashion. On restoration of auxiliary supply, they will be automatically restored to their normal operating condition. See also Section 4.8.5, External Load.

4.8.4.1 Operating States

The Power Supply has five operating states as described in the table below.

Controller State	Description
Running	The Power Supply is in this state when either the auxiliary supply or battery is connected with the battery voltage above the Shutdown(1) level. Protection is operational.
Powering Down	The Power Supply has received a message that the system is powering down. Data is saved to non-volatile memory by the controller during this period. After the controller has powered down it enters the Powered Down state.
Standby	The Power Supply enters this mode when the Auxiliary supply is off and the battery is below the user set capacity level or the Power Down(2) Threshold. This state will change to Controller Running if the auxiliary supply is restored, or the battery voltage rises above the Power Down(2) Threshold. This state will change to Controller Powered Down (Battery supply below the Power Down(2) Threshold and auxiliary supply is off) after 5 minutes or if the battery is disconnected.

Controller State	Description
Powered Down	The Power Supply enters this mode if the auxiliary supply is off and the battery switch is off (or the battery voltage is below the Shutdown(1) Threshold). Protection is not operational in this state. This state will change to Controller Running if either the auxiliary supply or battery is restored. The battery voltage must be above the Power Down(2) Threshold. This state will change to Controller Standby if the battery has been restored with a voltage below the Power Down(2) Threshold but above the Shutdown(1) Threshold and there is no auxiliary supply.
Five minutes Grace	If the controller is in the Powered Down state, it can be restored temporarily to the Standby state by turning the battery off, then ON again. To maintain the Real Time Clock settings this should be done within 60 seconds. The controller will be allowed to run for 5 minutes if the battery is below the Power Down(2) Threshold level (or until the battery fails(1)). This allows the system to be operated for a few minutes with a flat battery.

Notes:

1. *The Battery fail or Shutdown Threshold is 9.6 V.*
2. *The Power Down Threshold is 10.5 V for AGM and GEL types and 11.5 V for LFP types.*

4.8.5 External Load Supply Timer and Controlled Output

The external load timer starts to time down when there is a loss of auxiliary AC supply. It shuts down the external load when the timer expires. When the auxiliary AC supply is restored, supply to the external load is automatically restored and the timer is reset.

The external load supply can be cycled off, then on again, at regular intervals to reset connected communications equipment. This feature can be disabled by setting the External Load Reset Time to zero.

If battery supply is lost or is disconnected, the external load supply will continue to operate using AC supply but with reduced capacity. Drawing more than 15W on average over a rolling 60 seconds window will cause the external load supply to shut down and it will turn back on when battery supply is restored. Drawing more than 15W in this instance may cause the RC to shutdown and restart in some cases.

4.9 Saving of Settings

All settings are saved to non-volatile memory.

Setting changes from any source (Panel, CMS, SCADA, I/O, Relay Inputs or Logic) are saved as follows:

- A single setting change is saved after 15 seconds.
- Consequent setting changes are saved in 15 second intervals.
- All settings are saved when the panel is turned off manually or after five minutes of panel inactivity.
- “Save System Data” from the Main Menu is selected.
- At 6 hourly intervals.

Some recent entries may be lost if there is a sudden unexpected shutdown of the controller.

5 Measurement

The SIM Module accepts the signals from the Capacitive Voltage Transformers (CVTs) and Current Transformer (CT) outputs in the OSM tank and transfers them through to the Relay Module after filtering and scaling the signals.

The Relay Module converts the analogue signals received from the SIM Module into data as indicated in the table below.

The measurement data is filtered for harmonic content and the RMS value of the fundamental signal is used by Protection and Indication applications as shown in the table.

For User Configurable Analogue Values please refer to Section 5.6.

Measured value	Designation	Measured range	Resolution	Applicability	
				Protection	Indication
Phase currents	Ia, Ib, Ic	0 – 16000 A	1 A	✓	✓
Residual current(1)	In	0 – 16000 A	1 A	✓	✓
Residual Current (0.2A SEF model)(2)	In	0 – 16000 A	0.1 A	✓	✓
Phase to earth voltages	Ua, Ub, Uc, Ur, Us, Ut	0.5 – 22 kV	0.1 kV	✓	✓
Line to line voltages	Uab, Ubc, Uca, Urs, Ust, Utr	0.5 – 38 kV	0.1 kV	✓	✓
Positive sequence current	I1	0 – 16000 A	1 A	✓	–
Negative sequence current	I2	0 – 16000 A	1 A	✓	✓
Positive sequence voltage	U1	0.5 – 38 kV	0.1 kV	✓	–
Negative sequence voltage	U2	0.5 – 38 kV	0.1 kV	✓	–
Residual voltage(3)	Un	0.5 – 22 kV	0.1 kV	✓	–
Phase shift between positive sequence voltage and current	A1	0 – 359°	1°	✓	–
Phase shift between negative sequence voltage and current	A2	0 – 359°	1°	✓	–
Phase shift between residual voltage and current	A0	0 – 359°	1°	✓	–
Single and three phase total, active and reactive power	A, B & C kVA / kW / kVAr 3 phase kVA / kVAr / kW	0 – 65535	1	–	✓
Single and three phase total, active and reactive energy related to forward and reverse power flow directions	A, B & C +/– kVAh A, B & C +/- kWh A, B & C +/– kVArh 3 phase +/– kVAh 3 phase +/– kWh 3 phase +/– kVArh	0 – 999999999	1	–	✓
Frequency from ABC and RST recloser sides	Fabc, Frst	46 – 65 Hz	0.01 Hz	✓	✓
Phase sequence from ABC and RST sides	Phase seq.	ABC / ACB / ?(4) RST / RTS / ?(4)	NA	–	✓
Single phase and three phase power factor(5)	Power factor: 3phase, A phase, B phase, C phase	0 – 1	0.01	–	✓

Note:

1. *Residual current, I_n is equal to three times the zero sequence current, I_0.*
2. *Switchgear model with matched CTs to provide 0.2 A SEF sensitivity.*
3. *Residual voltage, U_n is equal to three times the zero sequence voltage, U_o.*
4. *"?" is displayed when any phase voltage drops below 0.5 kV.*
5. *Signed Power Factor is determined by the quadrant the angle between voltage and current is in and is dependent on the power flow direction. It is not dependent on the torque angle.*

Real time instantaneous measurements can be viewed on the Panel as shown below:

Panel Navigation

[Turn Panel ON] ⇒ *[SYSTEM STATUS]*

↳ *[Measurements]* ⇒

```
                MEASUREMENTS
►Power◄                 1 Phase Energy
 Other                  3 Phase Energy

 Voltages (kV):
 A  6.2       B  6.2       C  6.2
 R  6.2       S  6.2       T  6.2

 AB 10.7      BC 10.7      CA 10.7
 RS 10.7      ST 10.7      TR 10.7

 Currents (A):
 A  200       B  200       C  200
 N  0         I2 0
```

Note: *For 3 Phase SEF models, the measured neutral current is reported with a resolution of 0.1 A.*

5.1 Sampling and Filtering

A sigma-delta analogue to digital converter operating at a sample rate of 409 kHz eliminates the need to have a high order low pass filter at the front end, this reduces phase shift and distortion over the full temperature range.

Current and voltage channels are sampled 32 times during each power frequency cycle. Each current measurement has a low and high coefficient applied and the measurement algorithm selects the appropriate value to provide best resolution for each sample.

First harmonic RMS values for phase and residual currents together with zero, negative and positive sequence voltages are calculated 16 times per cycle by application of digital filtering algorithms using the last 32 samples. The resultant fundamental RMS values are utilised by protection and indication elements.

RMS values for active and reactive power / energy values, power frequency, power direction and phase sequence are calculated once per cycle.

Metering and display values are updated every 16 cycles.

5.2 Measurement Settings

Current sensing is carried out by Current Transformers (CTs). Voltage sensing is by means of Capacitive Voltage Transformers (CVTs). An individual calibration coefficient is determined for each of the six voltage channels received from the OSM. These six measurement coefficients and the OSM serial number are also entered by the user.

The system frequency is detected automatically by the RC when it is first installed and powered up. The system frequency is then saved into its permanent memory.

Phase Configuration allows a customer the capability to re-configure default phase designations, according to their own line connections to the Recloser. All measurements, indicators, records, protection settings and counters operate according to the new phase designations.

All user settings can be changed from the Panel. Alternatively they can be transferred using the CMS software package.

Panel Navigation

[Turn Panel ON] ⇒ *[SYSTEM STATUS]* ⇒ *[Press ESC]* ⇒

⇩

[MAIN MENU]

↳ *[System Settings]*

↳ *[Measurement Settings]* ⇒

```
          MEASUREMENT SETTINGS

System Voltage (kV)                38.0
LSD Level (kV)                      2.0
```

Title	Designation	Range	Resolution	Factory Default
System Voltage (kV)	U_rated	3.0 – 38.0 kV	0.1 kV	38
LSD Level (kV)	LSD Level	0.5 – 6.0 kV	0.1 kV	2

Note: *The system voltage is defined as the phase to phase voltage of the system the recloser is connected to – not the phase to ground voltage.*

5.3 Switchgear Configuration

In the switchgear configuration menu, you can configure the phase configuration and power flow direction.

The “LL Allow Close” option is only visible if “Factory Settings” is enabled (refer to Section 8.1.3). By default, “LL Allow Close” is Off, which means when “Live Line” is On, a close will be blocked (refer to Section 6.1.10).

Panel Navigation

[Turn Panel ON] ⇒ [SYSTEM STATUS] ⇒ [Press ESC] ⇒
⇩
[MAIN MENU]
↳ *[System Settings]*
↳ *[Switchgear Configuration] ⇒*

```
SWITCHGEAR CONFIGURATION

Phase Configuration                ABC
Power Flow Direction       RST to ABC
LL Allow Close                     Off

CBF:
Backup Trip Mode                   Off
Phase Current (A)                    1
Residual Current (A)                 1
Current Check Mode               Phase
CBF Backup Trip   Excessive To/Current
Backup Trip Time (s)              0.25
```

Switchgear Configuration Settings

Title	Designation	Range	Resolution	Factory Default
Phase Configuration	Phase Configuration	ABC/ACB/BCA/CAB/BAC/CBA	NA	ABC
Power Flow Direction(1)	Power Flow Direction	“RST to ABC”/”ABC to RST”	NA	RST to ABC
LL Allow Close	LL Allow Close	On/Off		Off

Notes:

1. *When Power Flow Direction is configured as “RST to ABC”, forward positive sequence powerflow direction in the OSM tank is from the RST side to the ABC side and reverse positive sequence powerflow direction is from the ABC side to RST side.*

5.4 Switchgear Calibration

The Switchgear Calibration settings include the measurement coefficients for the voltage and current sensors inside the OSM tank. The OSM tank and RC cubicle are calibrated at the factory prior to shipment. These settings must not be changed unless replacing the OSM Tank or RC cubicle after shipment.

Panel Navigation

[Turn Panel ON] ⇒ [SYSTEM STATUS] ⇒ [Press ESC] ⇒
⇩
↳ *[MAIN MENU]*
↳ *[Systems Settings]*
↳ *[Switchgear Calibration] ⇒*

```
SWITCHGEAR CALIBRATION

OSM Model              OSM 38-16-800-300
Switchgear Type                3 Phase
Serial Number          0200111020003

Switchgear Coefficients:

CIa 0.4000    CUa 0.0157    CUr 0.0157
CIb 0.4000    CUb 0.0157    CUs 0.0157
CIc 0.4000    CUc 0.0157    CUt 0.0157
CIn 0.4000
```

Switchgear Calibration

Title	Designation	Range	Resolution
Switchgear Type(1)	Switchgear Type	3 Phase, 3 Phase SEF(2), 1 Phase, Single Triple	NA
Serial number(3)	OSM	13 character serial number	
Ia calibration coefficient(4)	CIa	0.0 – 1.5999 A/kA	0.0001 A/kA
Ib calibration coefficient	CIb	0.0 – 1.5999 A/kA	0.0001 A/kA
Ic calibration coefficient	CIc	0.0 – 1.5999 A/kA	0.0001 A/kA
In calibration coefficient	CIn	0.0 – 1.5999 A/kA	0.0001 A/kA
Ua calibration coefficient	CUa	0.0 – 0.0627 A/MV	0.0001 A/MV
Ub calibration coefficient	CUb	0.0 – 0.0627 A/MV	0.0001 A/MV
Uc calibration coefficient	CUc	0.0 – 0.0627 A/MV	0.0001 A/MV
Ur calibration coefficient	CUr	0.0 – 0.0627 A/MV	0.0001 A/MV
Us calibration coefficient	CUs	0.0 – 0.0627 A/MV	0.0001 A/MV
Ut calibration coefficient	CUt	0.0 – 0.0627 A/MV	0.0001 A/MV

Notes:

1. *Different SIM modules are used depending on the switchgear type connected to it. Please refer to Section 10.5 Spare Parts List .*
2. *Switchgear model with matched CTs to provide 0.2 A SEF sensitivity. Refer to Section 2.2.4, Protection Accuracy.*
3. *The Serial number defines the OSM Model and Switchgear Type. It is important that the correct serial number is entered.*
4. *OSM sensor settings programmed into the RC when sent from the factory will be correct for the OSM whose serial number is also programmed.*

5.5 Real Time Clock (RTC) settings

The Real Time Clock provides measurement of real date/time for all elements with 1ms resolution. The clock is powered directly from the battery and, once set, date and time only requires adjustment if the battery has been disconnected or turned off with no auxiliary supply connected to the RC cubicle.

The Simple Network Time Protocol (SNTP) can be used to allow the relay to synchronise date and time with one of the configured servers. Once SNTP is enabled, the relay sends a synchronisation request to IP 1st and 2nd servers. The relay sends synchronisation request to both set of servers when “SNTP IP Version” is selected as “IPv4/IPv6”. The 1st server will have priority over the 2nd server in processing the synchronisation signal. If both set of servers (IPv4 and IPv6) do not respond within the retry interval period, a set number of retry attempts will be made until successful or the limit is reached.

SNTP synchronisation will only occur while GPS is disabled or GPS is enabled but not receiving a PPS signal. If GPS regains a PPS signal, SNTP synchronisation will cease until PPS signal is lost again or the GPS is disabled.

SNTP has priority over SCADA, CMS and panel set commands. If attempts to synchronise the RTC via SNTP for both servers is unsuccessful, the user can manually change the time through the RTC settings page on the panel, or initiate a time-sync via SCADA or CMS until the next SNTP update interval is reached.

Panel Navigation

[Turn Panel ON] ⇒ [SYSTEM STATUS] ⇒ [Press ESC] ⇒
⇩
[MAIN MENU]
[Systems Settings]
[RTC Settings]
[RTC] ⇒

```
        REAL TIME CLOCK SETTINGS

▶RTC◀ SNTP

 Date:                      11/12/2020
 Time:                    10:34:55 PM
 Time Sync Status            Internal

 Date Format               dd/mm/yyyy
 Time Format                  24 Hour
 Time Zone (hr)               +00:00
```

Panel Navigation

[Turn Panel ON] ⇒ *[SYSTEM STATUS]* ⇒ *[Press ESC]* ⇒
⇩
↳ *[MAIN MENU]*
↳ *[Systems Settings]*
↳ *[RTC Settings]*
↳ *[SNTP]* ⇒

```
        REAL TIME CLOCK SETTINGS

RTC ►SNTP◄

SNTP                              Disabled
SNTP IP Version                   IPv4/IPv6
Update Interval (s)                     600
Retry Interval (s)                       10
No. of Retry Attempts                     3
1st Server IPv4 Address:
0.0.0.0
2nd Server IPv4 Address:
0.0.0.0
1st Server IPv6 Address:
   0000:0000:0000:0000:0000:0000:0000:0000
2nd Server IPv6 Address:
   0000:0000:0000:0000:0000:0000:0000:0000
```

Settings

Title	Designation	Range	Resolution	Factory Default
Date	Date	In accordance with selected format		NA
Time	Time	In accordance with selected format		NA
Time Sync Status(1)	Time Sync Status	Internal/Locked by GPS/ Syncing with GPS/CMS/SCADA/Synced by IPv4 Serv1/Synced by IPv4 Serv2/ Synced by IPv6 Serv1/Synced by IPv6 Serv2		Internal
Date format	Date fmt	DD/MM/YY or MM/DD/YY		DD/MM/YY
Time format(2)	Time fmt	12 hours/24 hours		12 hours
Time Zone	Time Zone (GMT)	-12:00 to +12:00 hours		0:00
SNTP	SNTP	Enabled/Disabled	-	Disabled
SNTP IP Version	IP Version	Ipv4,IPv6, Ipv4/IPv6	-	IPv4
Update Interval (s)	Update Interval (s)	15 – 3600	1	600
Retry Interval (s)	Retry Interval (s)	1 – 10	1	10
No. of Retry Attempts	No. of Retry Attempts	1 – 5	1	3
1st Server IPv4 Address	1st Server IPv4 Address	0.0.0.0 to 255.255.255.255	1.1.1.1	0.0.0.0
2nd Server IPv4 Address	2nd Server IPv4 Address	0.0.0.0 to 255.255.255.255	1.1.1.1	0.0.0.0
1st Server IPv6 Address	1st Server IPv6 Address	Any valid address	Any valid hex value	::
2nd Server IPv6 Address	2nd Server IPv6 Address	Any valid address	Any valid hex value	::

Notes:

1. *When GPS is enabled, "Locked by GPS/ Syncing with GPS" will be displayed. "Internal" will be displayed when the time never synced by any source.*
2. *12 hour format displays (eg) 09:12:14pm; 24 hour format displays (eg) 21:12:14.*

5.6 User Configurable Analogue Values

User configurable analogues enable the addition of a new scale and offset to existing measured values such as current, voltage and power. The configurable analogue values are calculated as follows:

*Configurable Analogue Value = (Analogue Value Measured * Scale Factor) + Offset*[1]

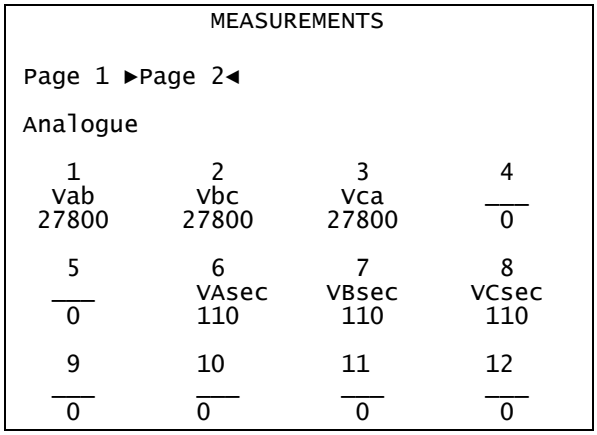
The analogue values can be configured through CMS and are displayed on the operator panel. The user can add a name of up to 8 characters to define the analogue both through the panel and CMS. The analogue will use the full resolution available but the displayed value will be signed whole values up to 7 digits. If the values are out of range or invalid '???' will be displayed[2]. The analogues can be used with any of the protocols.

Notes:

1. *The Configurable Analogue Value is converted to an integer. The result is rounded up for any fractional values >= 0.5 and round down for any fractional values < 0.4. When a large scaling factor is used and there is no signal, user analogue values may still be reported due to noise.*
2. *The scaling range is -2E32 to +2E32 and the offset range is -2E32 to +2E32.*

Panel Navigation

[Turn Panel ON] ⇒ [SYSTEM STATUS] ⇒
↳ [Measurements]
↳ [Other]
↳ [Page 2] ⇒



Measured value	Designation	Units	Scaling Multiplier[1]
Currents	Ia, Ib, Ic, In	A	0.0625
	In SEF	A	0.001
	Ia max, Ib max, Ic max, In max	A	0.25
	In max SEF	A	0.001
	Ia Trip, Ib Trip, Ic Trip, In Trip	A	0.25
	In Trip SEF	A	0.001
	I1, I2	A	0.0625
	I2 max, I2 Trip	A	0.25
	I2/I1, Max I2/I1	%	0.001
	In_WT1_average, In_WT2_average[2]	A	0.0156
Phase to earth voltages	Ua, Ub, Uc, Ur, Us, Ut	V	0.125
	UV4 Sag Min	kV	0.001
	UVA min, UVB min, UVC min	kV	1
	OVA max, OVB max, OVC max	kV	1
	OV3 max, OV4 max	kV	0.001
Line to line voltages	Uab, Ubc, Uca, Urs, Ust, Utr	kV	0.125
	UV min, OV max	kV	0.001
Positive Sequence, Negative Sequence and Residual Voltage	U1, U2, Un	kV	0.000125
Phase shift between voltage and current	A1, A2, A0	Degrees (°)	0.00069
Total, active and reactive power	A, B & C kVA / kW / kVAr 3 phase kVA / kW / kVAr Signed A, B & C kW / kVAr	VA, W, VAr VA, W, Var W, Var	1
Single and three phase total, active and reactive energy related to forward and reverse power flow directions	A, B & C +/– kVAh, kWh, kVArh	kVAh, kWh, kVArh	1
	3 phase +/– kVAh, kWh, kVArh	kVAh, kWh, kVArh	1

Measured value	Designation	Units	Scaling Multiplier(1)
Power Factor	A PF, B PF, C PF, PF	1	0.0000019
	Signed PF	1	0.0000019
Frequency	Fabc, Frst	Hz	0.01
	ROCOF ABC	Hz/sec	0.01
	Max ROCOF	Hz/sec	0.01
	Max VVS	Degrees (°)	0.1
	UF min, OF max	Hz	0.01
Harmonic	Ua Ub Uc Harmonic (n=2…15)	%	0.00001
	Ua Ub Uc THD	%	0.00001
	Ia Ib Ic In Harmonic (n=2….15)	%	0.00001
	Ia Ib Ic In TDD	%	0.00001
	HRM Max Trip	%	0.00256
UPS Status	Ubt	V	0.01
	Ibt	A	0.01
	Cbt	%	1
Switchgear Interface Module (SIM)	Cubicle Temperature	Degrees Celsius	0.01
	Average Power	W	0.01
Distance to Fault	Zf, Zloop, XLoop	Ω	0.01
	θf, θLoop	Degrees (°)	0.01
	FltDiskm	km	0.01
Admittance	Bn (Susceptance), Gn (Conductance)	mSi	0.01
	Max Gn, Max Bn, Min Gn, Min Bn	mSi	0.01
Synchronisation	∆f	Hz	0.01
	Max ∆V	V	0.001
	Max ∆φ	Degrees (°)	1
	Advance Angle	Degrees (°)	1
Directional Power	Max PDOP, Min PDUP	kVA	1
	θPDOP, θPDUP	Degrees (°)	1

Notes:

1. *Subject to measurement accuracy in 2.2.2.*
2. *Windowing algorithm which is used to obtain moving average values of In where WT1's averaging window is configurable from 1 to 50 cycles (default is 15 cycles) and WT2's averaging window is configurable from 1 to 10 times WT1's window (default is 10). WT1 and WT2's averaging windows are configurable via SGA. In_WT1_average, In_WT2_average are the resultants of In calculated over the defined averaging window and are provided as analogue values in logic and SGA. As an example they are used in an SGA application for monitoring change in residual current for increased reliability and precision.*

5.7 Last Good Value Trapped (LGVT)

LGVT records the last known good value of load current through each phase (Ia, Ib, Ic) and makes it available as a SCADA point.

LGVT is calculated as 1 minute average value of measured current in each phase. It is frozen at its previous 1-minute average value whenever the current is at 0 A or when Loss of Supply (LSD) is detected.

LGVT is implemented as DNP3 Analogue Input Points and as IEC 60870-5-101/104 Measured Values. Refer to the relevant protocol implementation user manual for further details.

6 Protection

Four individual groups of Protection Settings are available. Each group has the following protection functions:

- Overcurrent (OC)
- Negative Phase Sequence (NPS)
- Earth Fault (EF)
- Sensitive Earth Fault (SEF)
- Live Line Overcurrent (LL)
- Under/Over Voltage (UV/OV)
- Under/Over Frequency (UF/OF)
- Loss of Supply Detection (LSD)
- Voltage Reclosing Control (VRC)
- Automatic Backfeed Restoration (ABR)
- Harmonic Protection (HRM)
- Directional Power (PDPR)

Descriptions with up to 40 characters or numbers can be assigned for each of the protection groups using the CMS software package.

Group 1 – 4 settings

Title	Designation	Range
Group name	Group name	Up to 40 English alphabet letters or digits from 0 to 9

6.1 Overcurrent Protection

Individual phase currents measured by the current transformers on the OSM are monitored for Overcurrent (OC) and Negative Phase Sequence (NPS) protection. Residual current measured at the star point of the Current transformers on the OSM is monitored for Earth Fault (EF) protection.

OC, NPS and EF have three overcurrent protection elements for each of the forward and reverse powerflow directions. These allow time current characteristics to be matched across three zones of protection to meet co-ordination requirements.

A Directional Element provides effective protection in ring feed or back feed situations while maintaining co-ordination.

The Auto Reclosing element is responsible for the reclosing sequence associated with OC, NPS, EF and SEF. Global settings can be applied to the reclosing element including Zone Sequence Co-ordination (ZSC), Reclose times, Reset Time and Loss of Supply Reclosing Mode (LSRM).

The Auto Reclosing Map is used to set independent OC, NPS and EF parameters to define the operations in a reclose sequence.

Cold Load Pickup (CLP) and Inrush Restraint (IR) elements allow effective customising of protection to match system characteristics. IR does not apply to NPS elements.

The Temporary Time Adder provides a way to achieve fault clearing where a series of Reclosers on a feeder have the same Time Current Characteristic by automatically applying a grading margin time on auto reclose.

6.1.1 Protection Elements for OC, NPS and EF (ANSI 46, 50, 50N, 51, 51N)

OC, NPS and EF have three overcurrent protection elements for each of the forward and reverse powerflow directions and a directional element:

- OC1, NPS1, EF1

  Sequence Master time delayed elements, for forward powerflow direction (OC1+, NPS1+, EF1+) and for reverse powerflow direction (OC1-, NPS1-, EF1-). Used to set the maximum number of operations to lockout and provide time delayed protection operations in a reclose sequence.

- OC2, NPS2, EF2

  Low set elements, for forward powerflow direction (OC2+, NPS2+, EF2+) and for reverse powerflow direction (OC2-, NPS2-, EF2-) can be used to provide a fast fuse clearing, first operation or a first stage Time Current Characteristic (TCC) element. Low set elements are equipped with Maximum current modification mode to allow a fuse burning strategy to be implemented.

- OC3, NPS3, EF3

  High set elements, for forward powerflow direction (OC3+, NPS3+, EF3+) and for reverse powerflow direction (OC3-, NPS3-, EF3-). High set elements are used to minimise exposure of downstream equipment to high fault currents.

- DE OC, DE NPS, DE EF

  Directional elements provide a means of enabling or disabling directional protection for each of the six OC, NPS and EF elements respectively.

Note: *If DE is not enabled for a particular element then the element will respond to both forward and reverse overcurrent and operate on the magnitude of the fault only.*

6.1.2 Protection Settings for OC, NPS and EF

The forward and reverse master and low set elements (OC1+, OC1-, NPS1+, NPS1-, EF1+, EF1-, OC2+, OC2-, NPS2+, NPS2- and EF2+, EF2-) can be set with a Time Current Characteristic (TCC) type. TCC curves are selected and can be modified for each of the OC, NPS and EF elements independently. Some configurations must be done through the CMS software.

The Panel Setting layout for forward and reverse direction OC, NPS and EF elements is identical and is illustrated below for the OC1+ element using the IEC I curve as an example.

Panel Navigation

[*Turn Panel ON****]*** ⇒ ***[****SYSTEM STATUS****]*** ⇒ ***[****Press ESC****]***
⇩
[*MAIN MENU****]***
↳ ***[****Groups Settings****]***
↳ ***[****Group* ***1****…4****]***
↳ *Protection Settings:* ***[****OC****]***

```
          GROUP 1 OVERCURRENT

▶OC1+◀  OC2+  OC3+  OC1-  OC2-  OC3-

TCC Type                          IEC I
Pickup Current (A)                  300
Time Multiplier                    0.50
Minimum Current Multiplier         1.00
Definite Minimum Time (s)         00.00
Maximum Tripping Time (s)        120.00
Additional Time (s)                0.00
Fault Reset Time (s)               0.05
```

Note: *The High set elements can only be set to definite time characteristics*.

6.1.3 Time Current Characteristic (TCC) Settings

Twelve standard ANSI and IEC Inverse Definite Minimum Time (IDMT) curves are always available in the RC as well as Definite Time (TD).

Up to ten additional curves can be made available through CMS which can include any of the IEEE, U, 43 Non-Standard Curves and User Defined Curve (UDC). Non-Standard Curves are designed to emulate curves available in older protection equipment and UDC curves allow customisation of standard IDMT curves.

Configuration of IEEE, U, Non-Standard and UDC curves can only be done using CMS software.

For more information refer to Section 11.4.

6.1.3.1 Time current characteristic (TCC) types

Title	Designation	Range	Factory Default
Standard Time current characteristic	TCC Type	ANSI: EI / VI / I / STI / STEI / LTEI / LTVI / LTI IEC: EI / VI / I / LTI TD	IEC I
Downloadable Time current characteristic		IEEE: EI / VI / MI U: EI / VI / MI / I / STI TCC: 101 102 103 104 105 106 107 111 112 113 114 115 116 117 119 120 121 122 131 132 133 134 135 136 137 138 139 140 141 142 151 152 161 162 163 164 165 200 201 202 400 401 402 UDC	NA

6.1.3.2 Definite time (TD) TCC settings for Master and Low Set Elements

The following settings are the TD settings which can be applied to the master and low set elements.

Title	Designation	Range	Resolution	Factory Default
Pickup current (A) – master elements	Ip	3 – 1280 A	1 A	300
Pickup Current (A) – low set elements	Ip	3 – 16000 A	1 A	300
Tripping time (s)	Tdt min, s	0 – 120 s	0.01 s	1.00
Fault reset time (s)	FLTRes, s	0 – 10 s	0.01 s	0.05

6.1.3.3 ANSI and IEC TCC settings for Master and Low Set Elements

The following settings are the ANSI and IEC settings which can be applied to the master and low set elements. These settings also apply to the IEEE, U, 43 Non Standard and UDC curves.

Title	Designation	Range	Resolution	Factory Default
Pickup current (A) – master elements	Ip	3 – 1280 A	1 A	300
Pickup Current (A) – low set elements	Ip	3 – 16000 A	1 A	300
Time multiplier	TM	0.01 – 15	0.01	0.50
Minimum current multiplier(1)	MIN	1 – 20	0.01	1.00
Definite minimum time (s)	Tmin, s	0 – 10	0.01	0.00
Maximum tripping time (s)	Tmax, s	1 – 120	0.01	120.00
Additional time (s)	Ta, s	0 – 2	0.01	0.00
Fault reset time(2) (s)	FLTRes, s	0 – 10	0.01	0.05

Notes:

1. Set as a multiple of the pickup current (Ip) setting.

2. Not applicable for ANSI, IEEE and U TCC whose reset timer simulates a rotating disk reset characteristic.

6.1.3.4 Maximum Current Mode Settings for Low Set Elements

Maximum current mode is designed to allow a fuse burning strategy to be implemented. When current exceeds a user set maximum the trip operation timer freezes until current drops back below that level. This extends the tripping time to avoid nuisance tripping during operation of downstream fuses.

Each element can be independently set for maximum current modifying mode.

For ANSI, IEC, IEEE, U and UDC TCCs the maximum current is calculated using a multiplier applied to the pickup current.

Maximum Current modification mode is only available for the low set elements (OC2+, NPS2+, EF2+, OC2-, NPS2-, EF2-).

Title	Designation	Range	Resolution	Factory Default
Maximum Current Mode	MAX mode	Enable / Disable	NA	D
Maximum Current Multiplier(1)	ImaxM	1.1 – 10	0.01	5.00

Notes:

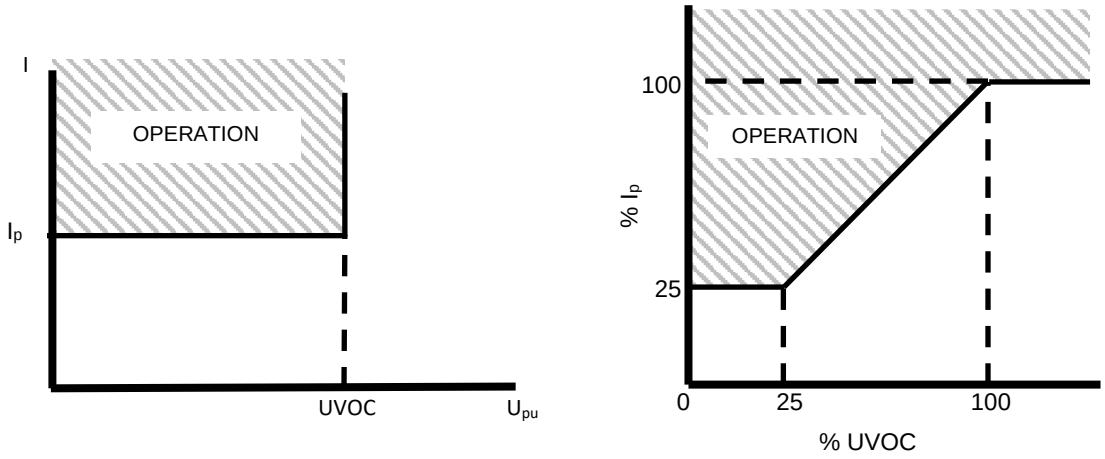
1. *This setting is displayed on the RC panel when Maximum Current Mode is enabled.*

6.1.3.5 Voltage-dependent Overcurrent (VOC) for Low Set Elements (ANSI 51V)

Voltage-dependent Overcurrent (VOC) protection provides additional protection functionality for generators. There are two functions described within the device, Voltage-Controlled (VC) and Voltage-Restrained (VR) overcurrent. Both provide more sensitive pickup to detect lower fault currents as the output voltage of a generator drops.

Voltage-dependent overcurrent is only available for low set elements OC2+ and OC2-.

Voltage-controlled (VC) overcurrent disables the element until the voltage drops below a set point. Voltage-restrained (VR) overcurrent reduces the pickup of the overcurrent element proportionally with a drop in terminal voltage. The graphs below illustrate these operating characteristics.



The settings for VOC are shown below:

Title	Designation	Range	Resolution	Factory Default
Voltage-dependent OC Mode	VOC Mode	Disabled/VC/VR	NA	Disabled
Voltage Multiplier(1)	UVOC	0.4 – 0.8	0.01	0.75

Notes:

- *For VOC, pickup voltage equals UVOC x U_rated, where U_rated is the rated system phase to phase voltage entered in the measurement settings.*

6.1.3.6 Definite Time Settings for High Set Elements

The high set elements can only be set to a definite time characteristic using the settings below:

Title	Designation	Range	Resolution	Factory Default
Pickup current (A)	Ip	3 – 16000 A	1 A	1000
Tripping time (s)	Tdt Min, s	0 – 2	0.01	0.10
Fault reset time (s)	FLTRes, s	0 – 10	0.01	0.05

6.1.4 TCC modifiers

Each ANSI, IEC, IEEE and U Time Current Characteristic can be modified with the aid of the following operators:

Definite minimum time (Tmin)

Defines the minimum time that the device can operate. By default this is set to 0 s. This may be used to define desired behaviour when an IDMT curve intersects a high set curve.

Maximum tripping time (Tmax)

Defines the maximum time that the device can operate. By default this is set to 120 s.

Minimum current multiplier (MIN)

Maximum current multiplier (ImaxM)

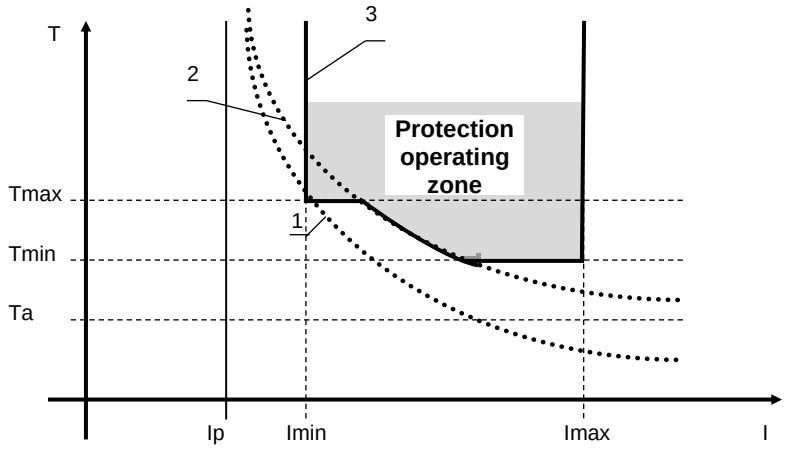
Additional time (Ta)

Adds a constant time to the selected TCC curve. By default this is set to 0 s.

Fault reset time (FLTRes)

Defines the time after which a pickup is no longer active before the protection timer resets. **Note**: The ANSI, IEEE and U curves use a disk emulation for fault reset instead of a definite time, see Section 11.4 for details.

The figure below illustrates the effect of the modifying operators on a TCC curve.

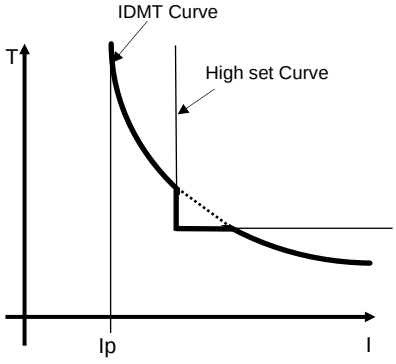


where:

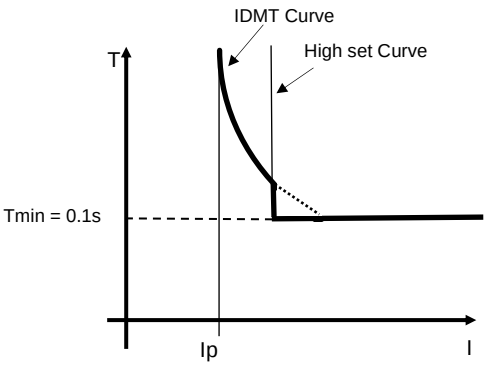
Ip *Pickup current*
Imax *ImaxM*Ip*
Imin *MIN*Ip*
1 *Original TCC (without modifications)*
2 *TCC with additional time (Ta) only*
3 *TCC with all modifications applied.*

***Note**: Maximum current modification is only applicable for the low set overcurrent elements (OC2+, OC2-, NPS2+, NPS2-, EF2+, EF2-).*

The figures below illustrate the effect of using definite minimum time (Tmin) for an IDMT curve when it intersects a high set element curve.



Tmin = 0s



Tmin = 0.1s

6.1.5 Sensitive Earth Fault (SEF) (ANSI 50N, 51N)

Sensitive Earth Fault protection monitors the residual current, In measured at the star point of the Current Transformers in the OSM. SEF protection comprises two Overcurrent elements and a Directional element.

One overcurrent element is for forward power flow direction (SEF+) and the other for reverse power flow direction (SEF–). Each element can be programmed with an independent Definite time TCC and the Directional Element allows enabling or disabling of SEF+ and SEF– as required.

Panel Navigation

[Turn Panel ON] ⇒ *[SYSTEM STATUS]* ⇒ *[Press ESC]*
⇩ *[MAIN MENU]*
↳ *[Groups Settings]*
↳ *[Group 1…4]*
↳ *Protection Settings:* *[SEF]* ⇒

```
   GROUP 1 SENSITIVE EARTH FAULT

▶SEF+◀ SEF-

Pickup Current (A)              15
Tripping Time (s)            10.00
Fault Reset Time (s)          0.05
```

SEF+, SEF– settings[1]

Title	Designation	Range	Resolution	Factory Default
Pickup Current[1] (A)	Ip	1 – 80 A	0.5 A	15
		0.2 – 80.0[2] A	0.1[2] A	15
Tripping Time (s)	Tdt Min, s	0 – 120	0.01	10.00
Fault Reset Time (s)	FLTRes, s	0 – 10	0.01	0.05

Notes:
1. *Sensitive Earth Fault uses the Definite Time TCC curve.*
2. *Switchgear model with matched CTs to provide 0.2 A SEF sensitivity.*

6.1.6 Broken Conductor (ANSI 46BC)

Detection of open circuit faults in overhead lines and underground cables can be facilitated using Broken Conductor protection (46BC) which uses the ratio of negative sequence current over positive sequence current (I2/I1 ratio). The I2/I1 ratio is relatively constant with variations of load current but as soon as an open circuit is present the ratio rapidly increases as shown in the example below.

Example	Load Variation		Broken Conductor	
	Low Load	High Load	Low Load	High Load
Positive Sequence, I1	10 A	500 A	10 A	500 A
Negative Sequence Current , I2	1 A	10 A	5 A	250 A
Ratio I2/I1	10%	2%	50%	50%

Broken Conductor protection thus provides more sensitive protection than purely using negative phase sequence current. The table below shows typical values of the I2/I1 ratio for various open fault scenarios.

Fault Condition	Ratio I2/I1
Three phase balanced	~0
One phase interrupted and floating (not on the ground)	50%
Two phases interrupted and floating	100%
Broken conductor, fallen on load side	Typically 25%-50%
Discontinuity in underground cable system	Typically 25%-50%

Panel Navigation

[Turn Panel ON] ⇒ *[SYSTEM STATUS]* ⇒ *[Press ESC]*
⇩
[MAIN MENU]
↳ *[Groups Settings]*
↳ *[Group **1**…4]*
↳ *Protection Settings: [NPS]*
↳ *[I2/I1]* ⇒

```
    GROUP 1 NEGATIVE PHASE SEQUENCE

NPS ►I2/I1◄

I2/I1  (Broken Conductor):

I2/I1 Mode                      D
Pickup Value (%)               20
Minimum I2 (A)                 15
Tripping Time (s)           10.00
```

I2/I1 settings

Title	Designation	Range	Resolution	Factory Default
I2/I1 Mode	I2/I1 ratio operation	D/L/A	-	D
Pickup Value (%)	Pickup value for I2/I1, %	10 – 100	1	20
Minimum I2 (A)	Minimum negative phase sequence current level, A	3 – 1280	1	15
Tripping Time (s)	Tdt min, s	0 – 120.00	0.01	10.00

Notes:

- *For I2/I1 to operate:*
  - *Both Protection and NPS global settings must be ON.*
  - *At least one phase current must be above 3 A.*
- *Fault reset time fixed at 50 ms.*

6.1.7 Directional Overcurrent Elements (ANSI 67, 67N)

Directional elements provide a means of enabling or disabling directional protection for each of the OC, NPS EF and SEF elements.

When the Directional Element (DE) is enabled for any protection element, the protection element will only respond to faults in the element's designated direction. For example, OC1+ would only respond to forward faults, and OC1- would only respond to reverse faults, provided DE is enabled for both of them.

If DE is not enabled for a particular element then the element will respond to both forward and reverse overcurrent and operate on the magnitude of the fault only.

The Directional function for Phase Overcurrent, Earth Fault, Sensitive Earth Fault and Negative Phase Sequence protection is provided by the directional elements, DE OC, DE EF, DE SEF and DE NPS.

The torque angle set by the user is used to determine forward and reverse zones for the fault. If the phase angle (angle between the polarising voltage, U_{pol} and operating current I_{op}) is in the forward zone then the fault is in the forward direction else the fault is in the reverse direction. The torque angle can be set separately for each set of protection elements.

The phase angle is defined as follows for the different elements:

OC	angle between positive sequence polarising voltage and positive sequence operating current
EF, SEF	angle between zero sequence polarising voltage and zero sequence operating current
NPS	angle between negative phase sequence polarising voltage and negative sequence operating current.

For a detailed description of Directional Protection refer to Appendix B – Directional Protection.

The directional elements can be set independently through the Panel menu as illustrated below for DE OC.

Panel Navigation

[Turn Panel ON] ⇒ *[SYSTEM STATUS]* ⇒ *[Press ESC]*
⇩
[MAIN MENU]
↳ *[Groups Settings]*
↳ *[Group **1**…4]*
↳ *Directional Elements: [OC]* ⇒

```
    GROUP 1 OC DIRECTIONAL ELEMENT

Torque Angle (º)                  0
Direction Not Detected        Block
Dir Change Response            Lock

DE Control Map:
OC1+                       Disabled
OC2+                       Disabled
OC3+                       Disabled
OC1-                       Disabled
OC2-                       Disabled
OC3-                       Disabled
```

Torque angle setting

Title	Designation	Range	Resolution	Factory Default
Torque angle[1] (°)	At	0 – 359°	1°	0
Direction Not Detected[2]	DND	Trip/Block	NA	Block
Dir Change Response	Dir Change response	Lock/Dynamic	NA	Lock

Notes:

1. *By default forward positive sequence powerflow direction in the OSM tank is from the RST side to the ABC side. Powerflow direction can be configured in the Switchgear Configuration menu. Refer to Section 5.3 Switchgear Configuration.*
2. *When "Direction Not Detected" is set to Trip the fastest curve of the directional elements enabled will trip once the fault reaches the pickup value.*

Direction Not Detected

The "Direction Not Detected" setting determines whether the protection element enabled for directional control will operate if the direction is not detected:

1. Block (Default)
   Protection elements enabled for directional control will not respond to a fault if the direction is not detected.

2. Trip
   Protection elements enabled for directional control will respond to a fault when the direction is not detected.

Direction Change Response

The "Dir Change Response" setting determines how the elements, enabled for directional control, behave when the power flow direction changes while the protection timer is accumulating:

- Lock
  When the direction (e.g. positive direction) is detected and a protection element e.g. OC1+ detects the fault, the protection timer for OC1+ starts to accumulate. During this time, if the direction of current changes and exceeds the pickup current of the opposite element e.g.OC1-, then OC1- will not detect the fault and the protection timer continues to accumulate for OC1+.

  Exception: *If prior to the direction changing, the direction is not detected, the protection timer for OC1+ resets immediately when a change in direction is detected and the protection timer for OC1- starts to accumulate.*

- Dynamic
  When the direction (e.g. positive direction) is detected and a protection element e.g. OC1+ detects the fault, the protection timer starts to accumulate for OC1+. During this time, if the direction of current changes and exceeds the pickup current of the opposite element e.g.OC1-, then the protection timer resets and starts to accumulate for OC1-. The OC1+ pickup resets after the fault reset time if the direction does not return back to the positive direction during the reset time.

Control Map Settings

Control Map	Element	Directional control	Factory Default
DE OC			
	OC1+	Enabled/Disabled	Disabled
	OC2+	Enabled/Disabled	Disabled
	OC3+	Enabled/Disabled	Disabled
	OC1-	Enabled/Disabled	Disabled
	OC2-	Enabled/Disabled	Disabled
	OC3-	Enabled/Disabled	Disabled
DE EF			
	EF1+	Enabled/Disabled	Disabled
	EF2+	Enabled/Disabled	Disabled
	EF3+	Enabled/Disabled	Disabled
	EF1-	Enabled/Disabled	Disabled
	EF2-	Enabled/Disabled	Disabled
	EF3-	Enabled/Disabled	Disabled
DE NPS			
	NPS1+	Enabled/Disabled	Disabled
	NPS2+	Enabled/Disabled	Disabled
	NPS3+	Enabled/Disabled	Disabled
	NPS1-	Enabled/Disabled	Disabled
	NPS2-	Enabled/Disabled	Disabled
	NPS3-	Enabled/Disabled	Disabled
DE SEF			
	SEF+	Enabled/Disabled	Disabled
	SEF –	Enabled/Disabled	Disabled

6.1.8 Advanced Polarised Detection for EF and SEF

Advanced Polarised Detection can be utilised to determine directionality of high impedance earth faults detected through EF and SEF elements in isolated and compensated neutral networks.

When “Advanced Polar Detection” is enabled the user can configure additional settings to define the boundaries of the operating zone associated with directional protection.

Note: *The fault current in isolated and compensated neutral networks is low compared to the solidly earthed systems and requires higher sensitivity to detect it. NOJA Power’s 0.2A SEF Switchgear model can provide the sensitivity required (refer to Section 2.2.4 Protection Accuracy).*

Panel Navigation

[Turn Panel ON] ⇒ *[SYSTEM STATUS]* ⇒ *[Press ESC]*
⇩
[MAIN MENU]
↳ *[Groups Settings]*
↳ *[Group **1**…4]*
↳ *Directional Elements: [SEF]* ⇒

```
    GROUP 1 SEF DIRECTIONAL ELEMENT

▶DE SEF◀ DE Control Map

 Torque Angle (º)                 0
 Direction Not Detected       Block
 Dir Change Response           Lock

 Advance Polar Det         Disabled
 Min Polar NVD Thres           0.10
 Max Forward Angle               90
 Min Forward Angle               90
 Max Reverse Angle               90
 Min Reverse Angle               90
 Polarisation                    In
```

Advance Polarized Detection Settings for DE EF/DE SEF

Title	Designation	Range	Resolution	Factory Default
Advance Polar Det	Advance Polar Det	Enabled/Disabled	N/A	Disabled
Min Polar NVD Thres(1)	Min Polar NVD Thres	0.04 – 1.00 * Un	0.01	0.10
Max Forward Angle(2)	Max Forward Angle	0 – 180 Degrees	1 Degree	90
Min Forward Angle(2)	Min Forward Angle	0 – 180 Degrees	1 Degree	90
Max Reverse Angle(2)	Max Reverse Angle	0 – 180 Degrees	1 Degree	90
Min Reverse Angle(2)	Min Reverse Angle	0 – 180 Degrees	1 Degree	90
Polarisation(3,4)	Polarisation	In, In cos θ, In sin θ	N/A	In

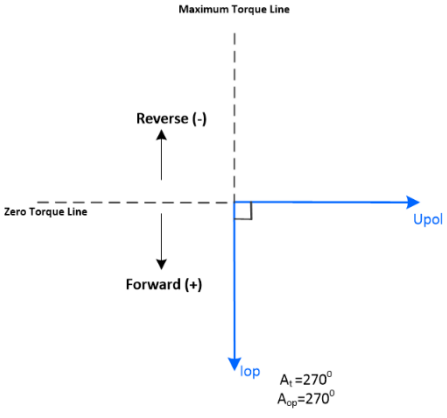
Notes:

1. *Replaces the standard Un minimum voltage for Directional Polarisation of EF/SEF where Un = U_rated / √3 and U_rated is the rated system voltage entered in the measurement settings (refer Section 5).*
2. *Additional settings to define the boundaries of the operating zone. Maximum Forward and Reverse angles are in the **counter clockwise** direction from the Maximum Torque Line and Minimum Forward and Reverse angles are in the **clockwise** direction from the Maximum Torque Line.*
3. *Applies to DE SEF only. When configured as "I_n Cos θ" or "I_n Sin θ", Min/Max Forward Angles and Min/Max Reverse Angles do not apply.*
4. *SEF elements operate on the calculated magnitude (I_n Cos θ or I_n Sin θ) rather than I_n.*

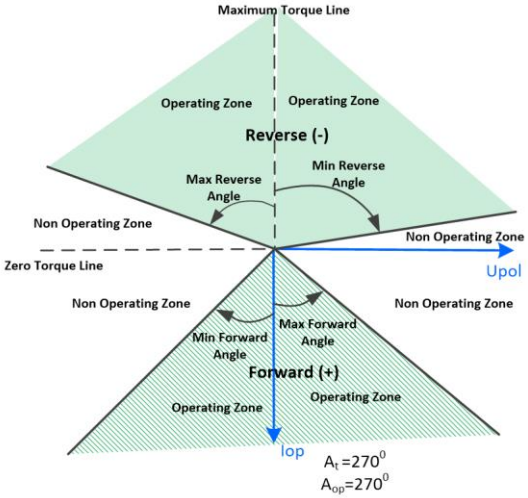
Polarisation Methods for DE SEF

Polarisation Method	Operating Current	Direction
In	Residual Current	A_{op} = is within A_t ±90° FWD A_{op} = is outside A_t ±90° REV *(Min/Max Forward Angles and Min/Max Reverse Angles apply).*
I_n Cos θ	Resistive component of the Residual Current	A_t = *0 to 90° or 270° to 360°* A_{op} = 0 to 90° or 270° to 360° FWD A_{op} = >90° to < 270° REV A_t => *90° to < 270°* A_{op} = > *90° to < 270°* FWD A_{op} = 0 to 90° or 270° to 360° REV
I_n Sin θ	Reactive component of the Residual Current	A_t = *0 to 180°* A_{op} = *0 to 180°* FWD A_{op} = > *180° to < 360°* REV A_t = > *180° to < 360°* A_{op} = 0 to 180° REV A_{op} = *180° to < 360°* FWD

The diagram below is an example showing the operating zone when the residual current, In lags the voltage by 90 degrees, with and without advanced polar detection boundaries.



Advance Polar Detection Disabled

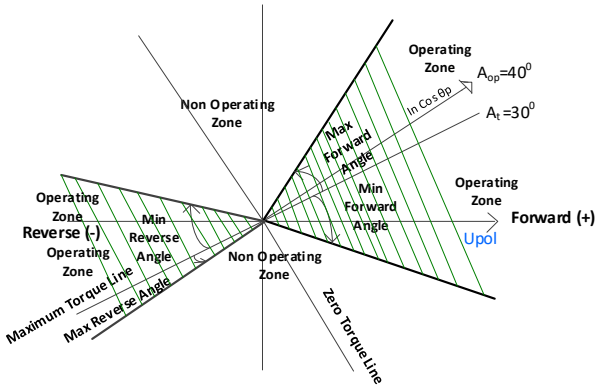


Advanced Polar Detection Boundaries

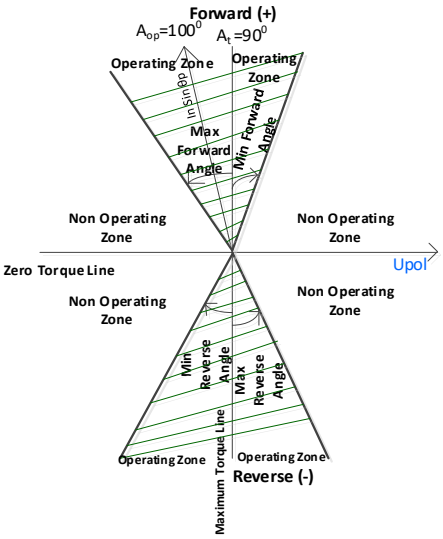
The diagrams below show the polarisation methods for DE SEF using In Cos θ with torque angle, $A_t=30^0$ and In Sin θ with torque angle, $A_t=90°$.

In Cos θ
$A_t=30°$
$A_{op}=40°$
Maximum Forward angle=30°
Minimum Forward angle=50°
Maximum Reverse angle=10°
Minimum Reverse angle=40°

In Sin θ
$A_t=90°$
$A_{op}=100°$
Maximum Forward angle=40°
Minimum Forward angle=20°
Maximum Reverse angle=30°
Minimum Reverse angle=30°



Polarisation using In Cos θ,$A_t=30°$



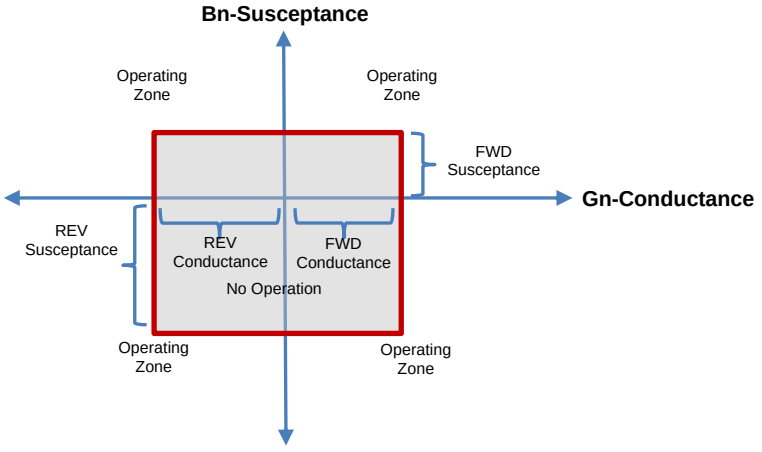
Polarisation using In Sin θ, $A_t=90°$

6.1.9 Admittance (ANSI 21Yn)

Neutral Admittance protection (21Yn) can be utilised to detect earth faults in high resistance earthed, unearthed and compensated networks.

Neutral Admittance is based on the value of conductance, Gn (real part of admittance) and susceptance, Bn (imaginary part of admittance) where *Yn=Gn + jBn*. Yn can be configured to operate based on settings for Gn, Bn or both. The Directional Mode for conductance and susceptance can be configured as forward, reverse or both.

The diagram below shows the operating zone for Yn when Operational Mode is set to “Gn & Bn” and Directional Mode is set to “Bidirectional”.



Panel Navigation

[Turn Panel ON] ⇒ [SYSTEM STATUS] ⇒ [Press ESC]
⇩[MAIN MENU]
↳ [Groups Settings]
↳ [Group 1…4]
↳ Protection Settings: [Yn] ⇒

```
GROUP 1 Yn ADMITTANCE

Operational Mode                Gn & Bn
Directional Mode             Bidirectional
Minimum Un Multiplier             0.10
Minimum In (A)                      10
Tripping Time (s)                 1.00
Fault Reset Time (s)              0.05
Forward Conductance (mSi)        +1.00
Reverse Conductance (mSi)        -1.00
Forward Susceptance (mSi)        +1.00
Reverse Susceptance (mSi)        -1.00
```

Admittance Settings

Title	Designation	Range	Resolution	Factory Default
Yn Mode(1)	Yn Mode	D/L/A/R/S/C	-	D
Operational mode(2)	Operational mode	"Gn" / "Bn" / "Gn & Bn"	-	"Gn & Bn"
Directional Mode(3)	Directional Mode	"Forward" / "Reverse" / "Bidirectional"	-	"Bidirectional"
Tripping Time (s)	Tdt Min, s	0 – 120.00	0.01	1.00
Min Un Multiplier(4)	Min Un UM	0.01 – 1	0.01	0.10
Minimum In(5) (A)	Min In, A	0.5 – 1280	0.5	10.0
Fault Reset Time (s)	FLTRes, s	0.00-10	0.01	0.05
Forward Susceptance (mSi)	Forward Susceptance (mSi)	-327.00 to 327.00	0.01	1.00
Reverse Susceptance (mSi)	Reverse Susceptance (mSi)	-327.00 to 327.00	0.01	-1.00
Forward Conductance (mSi)	Forward Conductance (mSi)	-327.00 to 327.00	0.01	1.00
Reverse Conductance (mSi)	Reverse Conductance (mSi)	-327.00 to 327.00	0.01	-1.00

Notes:

1. *Yn Mode setting can be configured via AR Reclosing Map. Refer to Section 6.2.4.*
2. *Yn can be configured to operate based on settings for Gn, Bn or both. In order for Y_n to operate, $U_0 \geq 0.5$ kV and $I_n \geq 0.5$ A where U_0 is the minimum voltage threshold.*
3. *The directional mode is based on the power flow direction selected. See Section 5.2 Measurement Settings*
4. *Pickup voltage equals Min Un Multiplier x U_rated / √3; where U_rated is the rated system voltage entered in the measurement settings (refer to Section 5.2).*
5. *Minimum residual current threshold for Yn to be operational.*

6.1.10 Live Line (LL) (ANSI 46, 50, 50N, 51, 51N)

Live Line (LL) is commonly used when work is carried out on an energised feeder. When enabled the device operates as a single protection trip i.e. no auto reclose operation is available.

Separate settings are available for Live Line protection. It consists of ten non-directional Overcurrent elements: three for OCLL, NPSLL and EFLL and one for SEFLL. All curves can be applied to OCLL1-2, NPSLL1-2 and EFLL1-2 but only definite time curves can be applied to OCLL3, NPSLL3, EFLL3 and SEFLL.

LL can be turned On from the Live Line Fast Key on the panel or from the Protection Global Settings menu (refer to Section 6.16). When LL is turned On:

- When a protection operation is initiated, the device will trip to Lockout based on the Live Line protection settings (not SST setting) and the Live Line Element map.
- A close will be blocked if "LL Allow Close" is configured as Off (which is the default setting). Refer to Section 5.3 Switchgear Configuration.

Live Line Fast Key can also be linked to Hot Line Tag (See Section 6.7). When LL and HLT are linked:

- The LL On/Off fast key on the panel will also control HLT.
- When a protection operation is initiated, the device will trip to Lockout based on the Live Line protection settings (not SST setting) and the Live Line Element map.
- Any close operations are blocked regardless of the "LL Allow Close" setting.

Panel Navigation

[Turn Panel ON] ⇒ [SYSTEM STATUS] ⇒ [Press ESC]
[MAIN MENU]
↳ *[Groups Settings]*
↳ *[Group 1…4]*
↳ *Protection Settings: [LL] ⇒*

```
       GROUP 1 LIVE LINE SETTINGS

►Element Map◄

 OCLL   NPSLL   EFLL   SEFLL
```

↳ *Protection Settings: [LL]*
↳ *NPSLL: [NPSLL1] ⇒*

```
  GROUP 1 NEGATIVE SEQUENCE LIVE LINE

►NPSLL1◄  NPSLL2   NPSLL3

TCC Type                          IEC I
Pickup Current (A)                  300
Time Multiplier                    0.50
Minimum Current Multiplier         1.00
Definite Minimum Time (s)          0.00
Maximum Tripping Time (s)        120.00
Additional Time (s)                0.00
Fault Reset Time (s)               0.05
```

↳ *Protection Settings: [LL]*
↳ *Element Map ⇒*

```
    GROUP 1 LIVE LINE ELEMENT MAP

OCLL1  ►Disabled◄     EFLL1   Disabled
OCLL2   Disabled      EFLL2   Disabled
OCLL3    Enabled      EFLL3    Enabled

NPSLL1  Disabled      SEFLL   Disabled
NPSLL2  Disabled
NPSLL3  Disabled
```

Live Line Element Map

Element	Setting	Factory Default
OCLL1	Enable/Disable	Disable
OCLL2	Enable/Disable	Disable
OCLL3	Enable/Disable	Enable
EFLL1	Enable/Disable	Disable
EFLL2	Enable/Disable	Disable
EFLL3	Enable/Disable	Enable
NPSLL1	Enable/Disable	Disable
NPSLL2	Enable/Disable	Disable
NPSLL3	Enable/Disable	Disable
SEFLL	Enable/Disable	Disable

Live Line Protection Settings

OCLL1, NPSLL1, EFLL1 Settings[1]

Title	Designation	Range	Resolution	Factory Default
TCC Type[2]	TCC Type	UDC, TD ANSI: EI / VI / I / STI / STEI / LTEI / LTVI / LTI IEC: EI / VI / I / LTI TCC: 101 102 103 104 105 106 107 111 112 113 114 115 116 117 119 120 121 122 131 132 133 134 135 136 137 138 139 140 141 142 151 152 161 162 163 164 165 200 201 202 400 401 402	NA	IEC I
Pickup current (A)[3]	Ip	3 – 1280 A	1 A	300 A
Time Multiplier	TM	0.01 – 15	0.01	0.50
Minimum Current Multiplier	MIN	1 – 20	0.01	1.00
Definite Minimum Time (s)	Tmin ,s	0 – 10 s	0.01 s	0.00
Maximum Tripping Time (s)	Tmax,s	1 – 120 s	0.01 s	120.00
Additional Time (s)	Ta, s	0 – 2 s	0.01 s	0.00
Fault Reset Time (s)	FLTRes, s	0 – 10 s	0.01 s	0.05 s

OCLL2, NPSLL2, EFLL2 Settings[1]

Title	Designation	Range	Resolution	Factory Default
TCC Type[2]	TCC Type	UDC, TD ANSI: EI / VI / I / STI / STEI / LTEI / LTVI / LTI IEC: EI / VI / I / LTI TCC: 101 102 103 104 105 106 107 111 112 113 114 115 116 117 119 120 121 122 131 132 133 134 135 136 137 138 139 140 141 142 151 152 161 162 163 164 165 200 201 202 400 401 402	NA	TD
Pickup current[3] (A)	Ip	3 – 1280 A	1 A	300 A
Tripping time (s)	Tdt Min, s	0 – 2 s	0.01 s	1.00
Maximum Current Mode	Enable Max Current multiplier	Enabled/Disabled		Disabled
Fault Reset Time (s)	FLTRes, s	0 – 10 s	0.01 s	0.05 s

OCLL3, NPSLL3 Settings[1,4]

Title	Designation	Range	Resolution	Factory Default
TCC Type[2]	TCC Type	TD	NA	TD
Pickup current[3] (A)	Ip	3 – 1280 A	1 A	1000 A
Tripping time (s)	Tdt Min, s	0 – 2 s	0.01 s	0.20 s
Fault Reset Time (s)	FLTRes, s	0 – 10 s	0.01 s	0.05 s

EFLL3 Settings[1,4]

Title	Designation	Range	Resolution	Factory Default
TCC Type[2]	TCC Type	TD	NA	TD
Pickup current (A)	Ip	1 – 1280 A	1 A	1000 A
Tripping time (s)	Tdt Min, s	0 – 2 s	0.01 s	0.20 s
Fault Reset Time (s)	FLTRes, s	0 – 10 s	0.01 s	0.05 s

SEFLL Settings[1]

Title	Designation	Range	Resolution	Factory Default
TCC Type[2]	TCC Type	TD	NA	TD
Pickup current (A)	Ip	1 – 80 A	1 A	15 A
		0.2 – 80.0 A[5]	0.1 A	15.0 A
Tripping time (s)	Tdt Min, s	0 – 2 s	0.01 s	0.20 s
Fault Reset Time (s)	FLTRes, s	0 – 10 s	0.01 s	0.05 s

Notes:

1. *OCLL, EFLL, SEFLL and NPSLL elements are equipped with a 50ms reset timer.*
2. *For TCC type, please refer to Section 11.4. All curves can be applied to OCLL1-2, NPSLL1-2 and EFLL 1-2. Only the DT curve can be applied to OCLL3, NPSLL3, EFLL3 and SEFLL. A maximum of 10 non-standard curves can be loaded into the RC.*
3. *The timing accuracy is only guaranteed for I/Ip values < 1600.*
4. *When upgrading the firmware, prior settings of OCLL and EFLL from an earlier version will be copied to the OCLL3 and EFLL3 element respectively.*
5. *A Switchgear model with matched CTs to provide 0.2 A SEF sensitivity is available for all 3 phase and 2 phase tanks.*

6.1.11 Cold Load Pickup Element (CLP)

Restoring supply to a feeder after an extended outage will often result in a higher than normal load as thermostat controlled loads (heaters, air-conditioners, refrigerators, etc) will all come on at the same time. The extent and duration of the increased demand will depend on the characteristics of the feeder load.

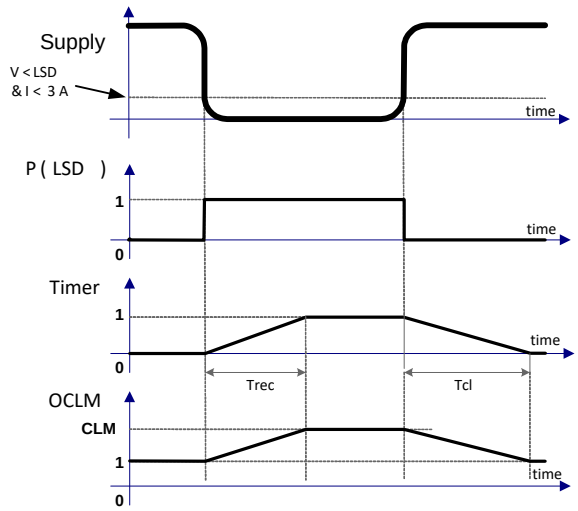
Cold Load Pickup caters for loss of load diversity due to an extended outage by increasing the Operational Cold Load Multiplier (OCLM) from 1 to a user set value (cold load multiplier) over a user set period of time (Cold Load recognition time). Once supply is restored the OCLM returns to one over a second user set time (Cold Load Time). OCLM is recalculated every cycle and is not applicable for OC3 (high set), EF (Earth Fault), SEF (Sensitive Earth Fault) and NPS (Negative Phase Sequence) elements.

Provision of variable ramp rates for increase and decrease of the Operational Cold Load Multiplier provides flexibility for differing system characteristics.

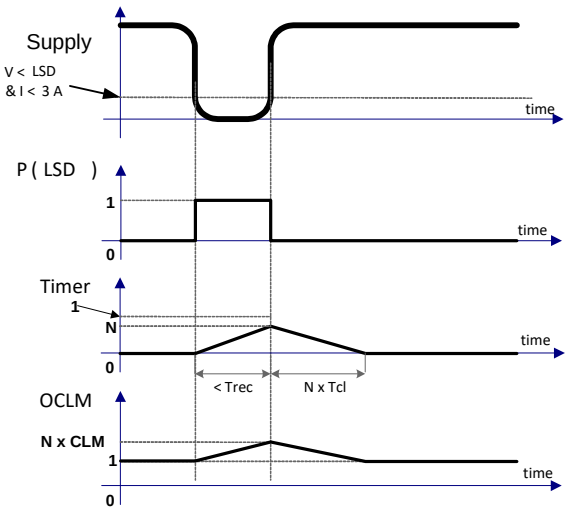
The CLP element is initiated by Loss of Supply Detection (LSD) a condition defined by volts less than the LSD level on all three phases and current less than 3A on all three phases. The LSD level is configurable between 0.5kV and 6.0kV (refer to Section 6.9, Loss of Supply Detector (LSD)).

Operation of the Cold Load Pickup element is illustrated in the following diagrams.

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



where: *CLM* *cold load multiplier*
OCLM *operational cold load multiplier*
Tcl *cold load time (setting)*
P(LSD) *Loss of Supply Detector (LSD) element pickup*
Trec *cold load recognition time*
N *CLP timer reading when supply is restored*

Panel menu layout for Cold Load Protection settings is as follows.

Panel Navigation

[*Turn Panel ON****]*** ⇒ ***[****SYSTEM STATUS****]*** ⇒ ***[****Press ESC****]***
⇩
[*MAIN MENU****]***
↳ ***[****Groups Settings****]***
↳ ***[****Group 1…4****]***
↳ *Other:* ***[****CLP****]*** ⇒

```
    GROUP 1 COLD LOAD PROTECTION

Cold Load Multiplier                1.0
Cold Load Time (min)                 15
Cold Load Recognition Time (min)     15
```

Cold Load Pickup Settings

Title	Designation	Range	Resolution	Factory Default
Cold Load Multiplier	CLM	1 – 5	0.1	1.0
Cold Load Time (min)	Tcl, min	1 – 400 min	1 min	15
Cold Load Recognition Time (min)	Trec, min	0 – 60 min	1 min	15

6.1.12 Inrush Restraint (IR)

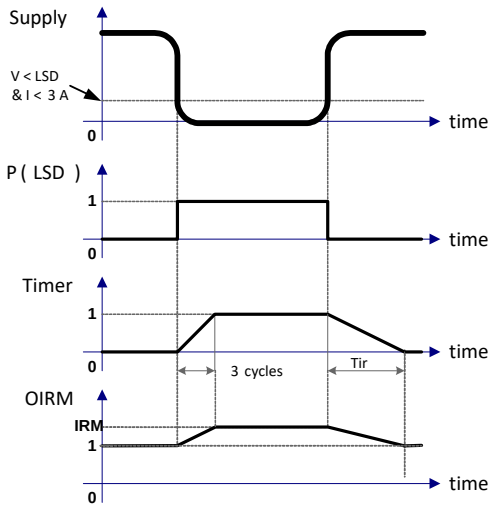
Whenever a feeder is energised, even after short outages caused by an auto reclose, there are inrush currents associated with certain types of load causing higher than normal loading. Examples are transformer excitation current and motor start current.

The inrush element applies a temporary multiplier to the level of pickup current on detection of loss of supply (refer to Section 6.9) which is ramped back down to one when the supply is restored. “Inrush Restraint Time” determines how long it takes for the multiplier to be ramped down.

Inrush restraint is not applicable for OC3 (high set phase overcurrent), Negative Phase Sequence (NPS), EF (Earth Fault), SEF (Sensitive Earth Fault) or LL (Live Line) protection elements.

Appropriate application of Inrush Restraint allows protection co-ordination the flexibility to cope with transient increases in load current caused by inrush without compromising protection sensitivity.

Operation of the Inrush element is illustrated in the diagram below.



Where, *IRM* – *Inrush Restraint Multiplier*
OIRM – *Operational Inrush Restraint Multiplier*
P(LSD) – *Pickup signal derived from LSD element*
Tir – *Inrush Restraint Time*

Panel Navigation

[*Turn Panel ON****]*** ⇒ ***[****SYSTEM STATUS****]*** ⇒ ***[****Press ESC****]***
⇩
[*MAIN MENU****]***
↳ ***[****Group Settings****]***
↳ ***[****Group 1…4****]***
↳ *Other:* ***[****IR****]*** ⇒

```
        GROUP 1 INRUSH RESTRAINT

Inrush Restraint Multiplier       ▸5.0◂
Inrush Restraint Time (s)          0.10
2nd Harmonic Blocking          Disabled
2nd Harmonic Blocking (%)            20
2nd Harmonic Block Time (s)        1.00
5th Harmonic Blocking          Disabled
5th Harmonic Blocking (%)            20
5th Harmonic Block Time (s)        1.00
```

Inrush Restraint settings

Title	Designation	Range	Resolution	Factory Default
Inrush Restraint Multiplier	IRM	1 – 20	0.1	05.0
Inrush Restraint Time (s)	Tir,s	0.01 – 10 s	0.01 s	0.10

6.1.13 Harmonic Inrush Blocking (HIB)

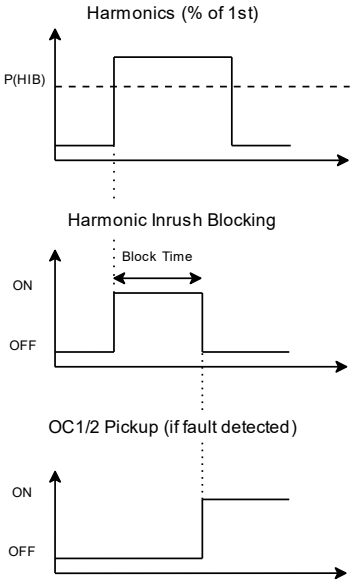
The controller provides Harmonic Inrush Blocking on the 2nd and 5th harmonics. This can be used to block tripping caused by an inrush of magnetising currents within a transformer. The element must be enabled in the Protection Status Control, refer to section 6.16.

Harmonic Inrush Blocking is applicable to the OC1 and OC2 protection elements. The 2nd and 5th harmonic blocking can be individually enabled.

The diagram to the right displays the operational characteristics of the Harmonic Inrush Blocking elements.

When the detected harmonic is above the set pickup level, the pickup of OC1 and OC2 are disabled.

The blocking ends when either the harmonics fall below the pickup level or the block time is exceeded. When the blocking ends, if the current levels are still above the OC1/OC2 pickup, then the element will pickup and the trip time will begin.



Panel Navigation

[Turn Panel ON] ⇒ [SYSTEM STATUS] ⇒ [Press ESC]
⇩
[MAIN MENU]
↳ *[Group Settings]*
↳ *[Group 1…4]*
↳ *Other: [IR] ⇒*

```
GROUP 1 INRUSH RESTRAINT

Inrush Restraint Multiplier        5.0
Inrush Restraint Time (s)         0.10
2nd Harmonic Blocking          Disabled
2nd Harmonic Blocking (%)            20
2nd Harmonic Block Time (s)        1.00
5th Harmonic Blocking          Disabled
5th Harmonic Blocking (%)            20
5th Harmonic Block Time (s)        1.00
```

Title	Designation	Range	Resolution	Factory Default
2nd Harmonic Blocking	HIB2 Mode	Enabled/Disabled	NA	Disabled
2nd Harmonic Blocking, %	HIB2,%	5 – 100	1	20
2nd Harmonic Block Time (s)	HIB2,t	0.04 – 120	0.01	1
5th Harmonic Blocking	HIB5 Mode	Enabled/Disabled	NA	Disabled
5th Harmonic Blocking, %	HIB5,%	5 – 100	1	20
5th Harmonic Block Time (s)	HIB5,t	0.04 – 120	0.01	1

6.1.14 Temporary Time Addition (TTA)

The Temporary Time Addition (TTA) element can be used to achieve fault isolation with series reclosers programmed with the same Time Current Characteristic (TCC).

The principle of operation is that each recloser opens in response to a fault. Voltage Reclosing Control (refer to Section 6.10) inhibits reclose operations of downstream devices unless the upstream device closes. TTA is used to extend the tripping time when the device closes and no fault is detected.

TTA can operate in two modes, continuous or transient. In both modes, when the device closes onto a healthy Section of the feeder and no fault is detected within 3 cycles, TTA is added. If the device closes on a fault then TTA is not added.

In continuous mode, TTA remains on until the device opens. In transient mode, TTA is removed when the Auto Reclose reset time has expired.

TTA is added to the TCC low set instantaneous elements (OC2, NPS2 and EF2) only and is not applicable if those elements are mapped to disable (D) in the reclose sequence.

Panel menu layout for TTA settings is illustrated below.

Panel Navigation

[Turn Panel ON] ⇒ [SYSTEM STATUS] ⇒ [Press ESC]
⇩
[MAIN MENU]
↳ *[Groups Settings]*
↳ *[Group 1…4]*
↳ *Other: [TTA] ⇒*

```
GROUP 1 TEMPORARY TIME ADDITION

Time Addition Mode             Transient
Transient Additional Time (s)       0.00
```

TTA settings

Title	Designation	Range	Resolution	Factory Default
Time Addition Mode	TTA mode	Transient/Continuous	NA	Transient
Transient Additional Time (s)	Tat,s	0 – 1 s	0.01 s	0.00

Note: *Voltage Reclosing Control (VRC) must be enabled for the TTA feature to work. Refer to Section 6.10.*

6.2 Auto Reclosing (AR OC/NPS/EF/SEF/Yn) (ANSI 79, 86)

The Reclosing element is responsible for reclosing sequences associated with the Phase Overcurrent, Negative Phase Sequence, Earth Fault, Sensitive Earth Fault and Admittance protection elements.

When Auto Reclosing is active and a protection trip occurs, the device closes after the Reclose Time has passed. The sequence counter is then incremented and the Reset Timer is started. If a fault occurs within the Reset Time, the device will operate in accordance with the next trip in the AR reclose sequence. When the Reset Time expires the sequence counter is reset to 1 and AR is ready to perform its full sequence. A user can configure separate reclose times for each trip in a reclose sequence and the number of trips before the device goes to lockout.

When AR is enabled, if at any time the device is closed by a manual source (i.e. HMI, SCADA or Logic) or by a protection scheme such as Automatic Backfeed restoration the device will be in Single Shot Mode until the AR Reset time expires. When in Single Shot mode, if a fault occurs, the device will do one trip to lockout using the Single Shot Trip (SST) selected configuration. Please refer to Section 6.2.6 Single Shot Trip (SST).

Notes:

- *Auto Reclosing is active when Protection and Auto Reclosing are ON, Live Line and Hot Line Tag are OFF and one of the protection elements has "R" in the reclose map.*
- *Each of the OC, NPS, EF, SEF and Yn protection element groups have their own sequence counter which is only incremented when an element in that group generates a protection trip.*
- *A global trip counter only allows a maximum of four protection trips regardless of the source of the trip (includes any protection element trip e.g. Under Voltage trip).*

Panel Navigation

[Turn Panel ON] ⇒ ***[****SYSTEM STATUS****]***

↳ ***[****Protection****]***

↳ ***[****Page 1****]***

```
        PROTECTION GLOBAL SETTINGS

▶Page 1◀ Page 2  Page 3

  Active Group                    1
  Protection                    Off
  AR Auto Reclose               Off
  LL Live Line                  Off
  EF Earth Fault                Off
  SEF Sensitive Earth Fault     Off
  CLP Cold Load Pickup          Off
  ABR Autobackfeed Restore      Off
  UV Undervoltage               Off
  UV4 Sag                       Off
  LLB Live Load Blocking        Off
  HLT Hot Line Tag              Off
```

Panel Navigation

[*Turn Panel ON****]*** ⇒ ***[****SYSTEM STATUS****]*** ⇒ ***[****Press ESC****]***

⇩

[*MAIN MENU****]***

↳ ***[****Groups Settings****]***

↳ ***[****Group* ***1****…4****]***

↳ *Auto Reclosing:* ***[****AR****]*** ⇒

```
         GROUP 1 AUTO RECLOSING

▶Auto Reclosing Map◀

 Voltage Reclosing Control     Disabled
 1st Reclose Time (s)             10.00
 2nd Reclose Time (s)             20.00
 3rd Reclose Time (s)             20.00
 Reset Time                       30.00
 ZSC Mode                      Disabled
 LSRM Mode                     Disabled
 LSRM Time (s)                      15
 Sequence Advance                    0

 OC Trips: 3, NPS Trips: 3
 EF Trips: 3, SEF Trips: 0
 Yn Trips: 0
```

Reclose Sequence Settings

Title	Designation	Range	Resolution	Factory Default
Voltage reclosing control element	VRC Enable	Enabled/Disabled	–	Disabled
1st Reclose Time (s)	Tr1,s	0.1 – 180 s	0.01 s	10.00
2nd Reclose Time (s)	Tr2,s	1.0 – 180 s	0.01 s	20.00
3rd Reclose Time (s)	Tr3,s	1.0 – 180 s	0.01 s	20.00
Reset time(1)	Tres	5.0 – 180 s	0.01 s	30.00
LSRM Mode	LSRM Mode	Enabled/Disabled	-	Disabled
LSRM Time (s)	Timer, sec	1 – 300 s	1 s	15
Zone sequence co-ordination mode	ZSC Mode	Enabled / Disabled	–	Disabled
Sequence Advance	Sequence Advance	0-3	NA	0

Notes:

1. *Also referred to as AR Reset Time.*

6.2.1 Loss of Supply Reclosing Mode (LSRM)

Loss of Supply Reclosing Mode (LSRM) is used in automation schemes to restrict a recloser going through the full AR sequence when a fault occurs after a loss of supply.

If LSRM is enabled, when a Loss of Supply (LSD) is registered, the recloser waits for the “tie-in recloser” to close and restore supply (LSD flag cleared) before starting the LSRM timer.

Single shot characteristic (refer to 6.2.6) will be activated for the duration of the LSRM timer.

If no fault pickup is registered while the LSRM timer is active then when the LSRM time expires, normal configured auto reclose sequence will be enabled.

Note: *LSRM is applicable to OC, NPS, EF and SEF protection elements.*

6.2.2 Zone Sequence Co-ordination (ZSC)

Enabling Zone Sequence Co-ordination makes the device move its trip counter forward by one if it detects a downstream protection device has operated (loss of fault current is detected). The counter increments only after all protection elements have reset. This allows co-ordination with downstream devices with fast times for initial operations and slow times for subsequent operations.

Notes:

- *ZSC is applicable to OC, NPS, EF, SEF and Yn protection elements.*
- *If ZSC and Sectionaliser mode are enabled, if there is a protection operation, ZSC will be blocked.*
- *ZSC will not update the trip and maximum current recorded.*

6.2.3 Sequence Advance

This feature advances the sequence counter, forward by one if it detects that an upstream device has operated (a loss of supply is detected). When the number of LSDs reaches the predefined Sequence Advance value (1-3), no other sequence advances can occur. Sequence Advance applies to all overcurrent elements. It operates on a “C” or an “R” in the AR map and is not allowed to exceed the furthest “S” or “L” on the right hand side of the AR map for all of the master elements that are enabled (regardless of whether the sequence advance value has been reached). The sequence advance feature will never cause a trip to occur. Refer to Section 6.9 for description of LSD.

Note: *Sequence Advance will not update the trip and maximum current recorded and does not operate when in alarm mode.*

6.2.4 Auto Reclosing Map

Panel Navigation

[Turn Panel ON] ⇒ *[SYSTEM STATUS]* ⇒ *[Press ESC]*
⇩
[MAIN MENU]
↳ *[Groups Settings]*
↳ *[Group **1**…4]*
↳ *Auto Reclosing: [AR]*
↳ *[Auto Reclosing Map]*
↳ *[OC/NPS]* ⇒

```
       GROUP 1 AUTO RECLOSING MAP

►OC/NPS◄ EF/SEF  Yn

      1  2  3  4          1  2  3  4
SST   E  -  -  -    SST   E  -  -  -
OC1+  R  R  L  L    OC1-  D  D  D  D
OC2+  D  D  D  D    OC2-  D  D  D  D
OC3+  L  L  L  L    OC3-  D  D  D  D

SST   E  -  -  -    SST   E  -  -  -
NPS1+ R  R  L  L    NPS1- D  D  D  D
NPS2+ D  D  D  D    NPS2- D  D  D  D
NPS3+ L  L  L  L    NPS3- D  D  D  D
```

↳ *[Auto Reclosing Map]*
↳ *[EF/SEF]* ⇒

```
       GROUP 1 AUTO RECLOSING MAP

 OC/NPS ►EF/SEF◄ Yn

      1  2  3  4          1  2  3  4
SST   E  -  -  -    SST   E  -  -  -
EF1+  R  R  L  L    EF1-  D  D  D  D
EF2+  D  D  D  D    EF2-  D  D  D  D
EF3+  L  L  L  L    EF3-  D  D  D  D

SEF+  D  D  D  D    SEF-  D  D  D  D
```

↳ *[Auto Reclosing Map]*
↳ *[Yn]* ⇒

```
       GROUP 1 AUTO RECLOSING MAP

 OC/NPS  EF/SEF ►Yn◄

      1  2  3  4
Yn    D  D  D  D
```

Available operating modes for each of the elements (OC1+, OC1-, OC2+, OC2-, OC3+, OC3-, EF1+, EF1-, EF2-, EF2+, EF3-, EF3+, NPS1+, NPS1-, NPS2+, NPS2-, NPS3+, NPS3-, SEF+, SEF- and Yn) are;

trip and **R**eclose	trip and **L**ockout
Alarm only	**D**isable.

The maximum number of operations to lockout is defined by applying master element settings e.g. if 3 operations are required, the appropriate OC1, EF1, NPS1, SEF, Yn elements have an L for the 3rd trip.

For OC, EF and NPS, fuse saving or burning regimes can be implemented through application of an appropriate operating mode to the stage 2 and 3 protection elements

6.2.5 Sectionalising

A Sectionaliser “Counts” the number of upstream operations under fault conditions and opens to isolate the downstream fault when a pre-configured number of “C”s (counts) is reached in the AR map and the upstream device is open.

When Sectionalise Mode is enabled, the “C” (Count) and “S” (Sectionalise) in the recloser map will become available:

- “C” (Count) - Sectionaliser Count: When the fault current exceeds the pickup settings and the protection timer expires, the device will wait for detection of Loss of Supply (LSD) before increasing the sequence counter in the AR map.

- "S" (Sectionalise) – Sectionaliser Trip: When the fault current exceeds the pickup settings and the protection timer expires, the device will wait for detection of Loss of Supply (LSD) before opening the device.

Note: *If the last entry in the Auto Reclose Sequence is "L" (Lockout) then the recloser will not wait for LSD and will open as soon as the protection timer expires causing a Protection Trip.*

The sectionalising capability can be enabled for each of the Protection Group Settings.

Autoreclose Map

- When Sectionalise Mode is enabled, the "C" (Count) and "S" (Sectionaliser) in the recloser map will become available. All other auto reclose options will still be available. Standard AR mapping logic applies but in addition, note the following:
  - "R" can only precede "L" whereas "C" can precede "S" or "L".
  - "S" and "L" can be used in the same AR mapping group for each of the forward and reverse elements. For example if the sequence C-S-S-S is used for OC1+ then we can use C-L-L-L for OC2+.
  - "R" and "C" cannot be used in the same AR mapping group for each of the forward and reverse elements. For example if the sequence R-R-L-L is used for OC1+ then we cannot use C-S-D-D for OC2+.
  - If "R" is used in the forward element group then it is possible to use "C" in the reverse element group and vice versa. For example if R-R-L-L is used for OC1+ then we can use C-S-D-D for OC2- (if OC1- has a "C" or "S" in the configuration).
- When Sectionalise Mode is disabled, "C" in the recloser map will change to "R" and the "S" in the recloser map will change to "L". This change applies to all overcurrent based protection elements (OC/NPS/EF/SEF/Yn).

Live Line (LL)

When LL is enabled the device will trip to lockout immediately on a fault based on the LL protection settings.

Single Shot Mode (SST)

- Please refer to Section 6.2.6 for behaviour when device is in SST mode.

Panel Navigation

[*Turn Panel ON****]*** ⇒ ***[****SYSTEM STATUS****]*** ⇒ ***[****Press ESC****]***

⇩

[*MAIN MENU****]***

↳ ***[****Group Settings****]***

↳ ***[****Group 1…4****]***

```
            GROUP 1 SETTINGS

Sectionaliser Mode          ►Disabled◄

Protection Settings
OC      NPS     EF      SEF     Yn      LL
MNT     FE      VE      ABR     VRC     HRM

Auto Reclosing:
AR      ARVE    SST Control

Directional Elements:
OC      NPS     EF      SEF

Other:
CLP     IT      TTA
```

Warnings:

- *When Sectionaliser Mode is enabled, a warning message is displayed asking the user to review the AR mapping for correct configuration and the user has the option to confirm or cancel the request.*
- *When Sectionaliser is disabled a warning message is displayed informing the user that the "C"s and "S"s in the AR map will change to "R" s and "L"s, respectively. The user has the option to confirm or cancel the request.*

When Sectionaliser mode is enabled, its status will be displayed in the System Status screen.

6.2.6 Single Shot Trip (SST)

Any trip in a sequence (trip 1, 2, 3 or 4) can be selected for a Single Shot Trip (SST) and this determines the time current characteristics used when Single Shot is initiated.

The Single Shot Trip can be set independently for OC+, OC-, EF+ EF-, NPS+ and NPS- elements in the Auto Reclosing map.

When the device is in SST mode, if a protection operation occurs, the device will do one shot to lockout based on the SST settings in the AR map.

The device is expected to be in SST mode in the following situations[1,2,5]:

- When AR is disabled, any time the device is closed from any source.
- When AR is enabled, any time the device is closed from a LOCKOUT state and the AR reset timer is not expired (or the SST Timer has not expired if SST control is enabled).
- When AR is enabled, any time the device is closed from an OPEN state by a manual source or automation scheme such as Automatic Backfeed Restoration (ABR) and the AR reset timer has not expired (SST Timer does not apply).
- From a closed position when Auto Reclosing is turned ON and the AR reset timer has not expired.
- If LSRM mode is enabled and the LSRM timer has not expired.
- When HLT is turned ON[4,5].

Notes:

1. *Protection must be enabled for Single Shot trip to be initiated. SST does not apply to SEF and Yn elements.*
2. *Device may behave differently when Sectionalise is enabled. Refer to the Section below.*
3. *Automation schemes include ABR, Auto Change Over (ACO) and UV3 AutoClose.*
4. *When HLT is ON, the SST protection settings apply with the exception of when HLT is linked to LL. In that instance the LL protections settings apply.*
5. *When Live Line is turned ON and a protection operation is initiated the device will trip to lockout based on the Live Line protection settings (not SST settings). Refer to Section 6.1.10.*

6.2.6.1 SST and Sectionaliser mode

If Sectionalising is enabled and the device is in Single Shot mode it will do one shot to lockout immediately on a fault for safety reasons (i.e. it will not wait for LSD) when certain conditions apply. See the tables below for more details.

Auto Reclosing - SST Conditions

Settings	Condition	AR Reset Timer	SST Timer	SST Mode	AR Map	Device waits for LSD
AR Enabled	Device is open but NOT in a lockout state and is closed from a manual source	Not Expired	NA	Yes	“L”, “R”, “S” or “C”	No
	Device is closed from a lockout state and SST Control is Disabled	Not Expired	NA	Yes	“L”, “R”, “S” or “C”	No
	Device is closed from a lockout state and SST Control Enabled	NA	Not Expired	Yes	“L”, “R”, “S” or “C”	No
	Device is closed from a protection/automation scheme such as ABR.	Not Expired	NA	Yes	“L” or “R”	No
	Device is closed from a protection/automation scheme such as ABR.	Not Expired	NA	Yes	“S” or “C”	Yes
AR Disabled	Device is closed from any source	Not Expired	NA	Yes	“L”, “R”, “S” or “C”	No
	Device is closed from any source	Expired	NA	Yes	“L” or “R”	No
	Device is closed from any source	Expired	NA	Yes	“S” or “C”	Yes

HLT and LSRM - SST conditions

Settings	Condition	AR Reset Timer	SST Timer	SST Mode	AR Map	Device waits for LSD
HLT Enabled	Device is closed from any source	NA	NA	Yes	“L”, “R”, “S” or “C”	No
LSRM Enabled	Device is closed and LSRM time has not expired	NA	NA	Yes	“L” or “R”	No
	Device is closed and LSRM time has not expired	NA	NA	Yes	“S” or “C”	Yes

6.2.7 AR OC/NPS/EF/SEF/Yn Settings

The Auto Reclose map for OC, NPS, EF, SEF and Yn determines how each element operates. Any of the trips can be selected as a single shot trip. By default the first trip is selected for SST.

The operating modes are defined as follows:

R = trip and Reclose A = Alarm only L = trip and Lockout C = Count S = Sectionalise

D = Disable + = SST Set to this Trip

AR OC/NPS/EF/SEF/Yn Element Operating Mode Settings

Factory defaults are in the column on the right hand side of each field.

Element	1st trip		2nd trip		3rd trip		4th trip	
SST OC+		+						
OC1+	R/L/A/D/C/S	R	R/L/A/D/C/S	R	R/L/A/D/C/S	L	L/A/D/S	L
OC2+	R/L/A/D/C/S	D	R/L/A/D/C/S	D	R/L/A/D/C/S	D	L/A/D/S	D
OC3+	R/L/A/D/C/S	L	R/L/A/D/C/S	L	R/L/A/D/C/S	L	L/D/S	L
SST NPS+		+						
NPS1+	R/L/A/D/C/S	R	R/L/A/D/C/S	R	R/L/A/D/C/S	L	L/A/D/S	L
NPS2+	R/L/A/D/C/S	D	R/L/A/D/C/S	D	R/L/A/D/C/S	D	L/A/D/S	D
NPS3+	R/L/A/D/C/S	L	R/L/A/D/C/S	L	R/L/A/D/C/S	L	L/D/S	L
SST EF +								
EF1+	R/L/A/D/C/S	R	R/L/A/D/C/S	R	R/L/A/D/C/S	L	L/A/D/S	L
EF2+	R/L/A/D/C/S	D	R/L/A/D/C/S	D	R/L/A/D/C/S	D	L/D/S	D
EF3+	R/L/A/D/C/S	L	R/L/A/D/C/S	L	R/L/A/D/C/S	L	L/A/D/S	L
SEF+	R/L/A/D/C/S	D	R/L/A/D/C/S	D	R/L/A/D/C/S	D	L/A/D/S	D
SST OC-		+						
OC1-	R/L/A/D/C/S	D	R/L/A/D/C/S	D	R/L/A/D/C/S	D	L/A/D/S	D
OC2-	R/L/A/D/C/S	D	R/L/A/D/C/S	D	R/L/A/D/C/S	D	L/A/D/S	D
OC3-	R/L/A/D/C/S	D	R/L/A/D/C/S	D	R/L/A/D/C/S	D	L/D/S	D
SST NPS-		+						
NPS1-	R/L/A/D/C/S	D	R/L/A/D/C/S	D	R/L/A/D/C/S	D	L/A/D/S	D
NPS2-	R/L/A/D/C/S	D	R/L/A/D/C/S	D	R/L/A/D/C/S	D	L/A/D/S	D
NPS3-	R/L/A/D/C/S	D	R/L/A/D/C/S	D	R/L/A/D/C/S	D	L/D/S	D
SST EF-		+						
EF1-	R/L/A/D/C/S	D	R/L/A/D/C/S	D	R/L/A/D/C/S	D	L/A/D/S	D
EF2-	R/L/A/D/C/S	D	R/L/A/D/C/S	D	R/L/A/D/C/S	D	L/A/D/S	D
EF3-	R/L/A/D/C/S	D	R/L/A/D/C/S	D	R/L/A/D/C/S	D	L/D/S	D
SEF-	R/L/A/D/C/S	D	R/L/A/D/C/S	D	R/L/A/D/C/S	D	L/A/D/S	D
Yn	R/L/A/D/C/S	D	R/L/A/D/C/S	D	R/L/A/D/C/S	D	L/A/D/S	D

Notes:

- *All elements can be configured to "C" and "S" when Sectionalising is enabled. AR map logic applies. Please refer to Section 6.2.5.*
- *Alarms (A) are activated when a protection element detects that a protection operation is required and will reset when the protection element resets. This is independent of what is in the AR map unless the element is Disabled ("D"). Refer to Section 6.2.15 Alarm Latching for more details.*
- *SST does not apply to SEF and Yn elements.*

6.2.8 SST Control

When AR is enabled, any time the device is closed from a lockout state it will be in single shot mode until the AR Reset time expires. Refer to Section 6.2.6 Single Shot Trip (SST).

SST Control is used to override AR Reset Time in specific applications where it is required to have a Single Shot reset time that is different to the Reclose sequence reset time.

When SST Control is enabled, the SST Time applies after closing the device from a lockout state. While the SST Time has not expired the device will be in Single Shot Mode. In this instance the AR Reset time does not apply. If SST Time is set to "0" then the device will not go to single shot mode after being in a lockout state and AR will perform its configured reclosing sequence.

Auto reclosing (AR) must be enabled for SST control to operate.

Panel Navigation

[Turn Panel ON] ⇒ *[SYSTEM STATUS]* ⇒ *[Press ESC]*

⇩

[MAIN MENU]

↳ *[Group Settings]*

↳ *[Group 1…4]*

↳ *[SST Control]*

```
GROUP 1 SST Control

SST Control                    Disabled
SST Time (sec)                       30
```

SST Control settings

Title	Designation	Range	Resolution	Factory Default
SST Control	SST Control	Disabled/Enabled	-	Disabled
SST Time (sec)	Tst, s	0.0 – 180.0	0.1	30

6.2.9 Disable Fast Trips (DFT)

This setting disables the low set elements (OC2+/OC2-, NPS2+/NPS2- and EF2+/EF2-). It will disable the elements but will not change the AR Map.

Panel Navigation

[Turn Panel ON] ⇒ *[SYSTEM STATUS]*

↳ *[Protection]*

↳ *[Page 2]*

```
PROTECTION GLOBAL SETTINGS

Page 1 ►Page 2◄ Page 3

 NPS Negative Sequence             Off
 OV  Over Voltage                  Off
 UF  Under Frequency               Off
 OF  Over Frequency                Off
 HRM Harmonics                     Off
 HLT Link HLT to LL                Off
 MNT Maximum Number of Trips       Off
 SSM Short Sequence Mode           Off
 DFT Disable Fast Trips            Off
 Max No. of Trips to Lockout    Normal
 Alarm mode                        Off
```

DFT settings

Title	Designation	Range	Resolution	Factory Default
Disable Fast Trips	DFT	On/Off	NA	Off

6.2.10 Maximum Number of Trips (MNT)

Maximum Number of Trips (MNT) limits the number of protection trips allowed for low set elements (OC2+/OC2-, NPS2+/NPS2- and EF2+/EF2-) in a sliding window of time. The user sets the maximum number of trips to occur over a set amount of time. If the number of trips is exceeded during this period, the disable fast trips (DFT) setting is activated. Refer to Section 6.2.9 .

The counter is reset by:

- turning off the MNT control
- a manual trip or close (including a I/O, SCADA or PC source)
- changing the group settings.

The Sectionaliser trip is counted in the MNT functionality only when “C” and/or “S” are in the AR Map in one direction (e.g. forward elements) and “R” and/or “L” are in the AR map in the opposite direction (e.g. reverse elements).

Panel Navigation

[Turn Panel ON] ⇒ *[SYSTEM STATUS]* ⇒ *[Press ESC]* ⇒ *[MAIN MENU]*

↳ *[Groups Settings]*

↳ *[Group 1…4]*

↳ *Protection Settings:* *[MNT]* ⇒

```
GROUP 1 MAXIMUM NUMBER OF TRIPS

Maximum Number of Trips        Disabled
Number of Protection Trips            6
Prot Trip Window (Hrs)                3
```

Max No of Trips settings

Title	Designation	Range	Resolution	Factory Default
Maximum Number of Trips	Excess Fast Trip Mode	Enabled/ Disabled	NA	Disabled
Number of Protection Trips	Trip Count	1 - 50	1	6
Protection Trip Window	Trip Window	1 – 24 h	1	3

6.2.11 Max No of Trips to Lockout (79 Lockout)

Max No of Trips to Lockout limits OC, NPS, EF, SEF, Yn and VE protection to a user specified number of trips.

There are three options:

- Normal: 4 shot to lockout protection sequences
- 79-3: overrides 4 shot to lockout protection sequences. Lockout occurs at the 3rd trip
- 79-2: overrides 4 shot to lockout protection sequences. Lockout occurs at the 2nd trip.

If there is an “S” in the AR map the device will do a Sectionaliser trip to lockout.

Panel Navigation

[Turn Panel ON] ⇒ *[SYSTEM STATUS]*

↳ *[Protection]*

↳ *[Page 2]*

```
      PROTECTION GLOBAL SETTINGS

Page 1 ►Page 2◄ Page 3

 NPS Negative Sequence              Off
 OV  Over Voltage                   Off
 UF  Under Frequency                Off
 OF  Over Frequency                 Off
 HRM Harmonics                      Off
 HLT Link HLT to LL                 Off
 MNT Maximum Number of Trips        Off
 SSM Short Sequence Mode            Off
 DFT Disable Fast Trips             Off
 Max No. of Trips to Lockout     Normal
 Alarm mode                         Off
```

Max No of Trips to Lockout settings

Title	Designation	Range	Resolution	Factory Default
MNT Maximum Number of Trips	MNT Maximum Number of Trips	Off/On	NA	Off
Max No of Trips to Lockout	Max No of Trips to Lockout	Normal/3/2	NA	Normal

6.2.12 Short Sequence Mode (SSM)

Short Sequence Mode limits OC, NPS, EF, SEF and VE protection to the first and last trips of an Auto Reclose trip sequence. The last reclose time in the sequence is used as the reclose time for the short sequence setting. For example, a 4 trip to lockout sequence such as O-5s-CO-5s-CO-10s-CO-lockout would become O-10s-CO-lockout.

Panel Navigation

[Turn Panel ON] ⇒ *[SYSTEM STATUS]*

↳ *[Protection]*

↳ *[Page 2]* ⇒

```
        PROTECTION GLOBAL SETTINGS

Page 1 ►Page 2◄ Page 3

 NPS Negative Sequence              Off
 OV  Over Voltage                   Off
 UF  Under Frequency                Off
 OF  Over Frequency                 Off
 HRM Harmonics                      Off
 HLT Link HLT to LL                 Off
 MNT Maximum Number of Trips        Off
 SSM Short Sequence Mode            Off
 DFT Disable Fast Trips             Off
 Max No. of Trips to Lockout     Normal
 Alarm mode                         Off
```

SSM settings

Title	Designation	Range	Resolution	Factory Default
Short Sequence Mode	SSM	On/Off	NA	Off

6.2.13 Alarm Mode

When Alarm mode is ON and Protection is OFF all protection elements remain enabled, however the trip map behaves such that all “L, S, R and C” settings in the reclose map operate as “A”. Alarm operations will be logged and reported via protocols.

Alarm Mode Summary

Protection	Alarm Mode	Behaviour
ON	ON or OFF	Protection acts as normal regardless of Alarm mode settings
OFF	ON	All protection elements remain enabled, however the trip map changed such that all “L, S, R, C and A” settings in the reclose map operate as “A”.
OFF	OFF	There will be no pickups or alarms.

Panel Navigation

[Turn Panel ON] ⇒ *[SYSTEM STATUS]*

↳ *[Protection]*

↳ *[Page 2]* ⇒

```
        PROTECTION GLOBAL SETTINGS

Page 1 ►Page 2◄ Page 3

 NPS Negative Sequence              Off
 OV  Over Voltage                   Off
 UF  Under Frequency                Off
 OF  Over Frequency                 Off
 HRM Harmonics                      Off
 HLT Link HLT to LL                 Off
 MNT Maximum Number of Trips        Off
 SSM Short Sequence Mode            Off
 DFT Disable Fast Trips             Off
 Max No. of Trips to Lockout     Normal
 Alarm mode                         Off
```

Alarm Mode settings

Title	Designation	Range	Resolution	Factory Default
Alarm Mode	Alarm	On/Off	NA	Off

6.2.14 Operating Mode

The Operating mode of the switchgear is defined as follows:

Protection	Alarm Mode(1)	Sectionaliser	Operating Mode
ON	ON or OFF	OFF	Recloser
OFF	OFF	NA	Switch
OFF	ON	NA	Alarm Switch
ON	ON or OFF	ON	Sectionaliser

Notes:

1. *Please refer to Section 6.2.13 Alarm Mode.*

The System Status menu displays the configuration (Config) of the switchgear which includes the switchgear type and operating mode as shown below.

Panel Navigation

[*Turn Panel ON****]*** ⇒ ***[****SYSTEM STATUS****]*** ⇒

```
              SYSTEM STATUS

▶GENERAL◀ WARNING  MALFUNCTION

 Date/Time : 21/01/2020, 10:00:18 AM
 Config    : 3 Phase
             Recloser
 Status    : Lockout

 Measurements        Power Quality
 Input/Output        Power Supply
 Protection          Communication Ports
 Automation          Protocols
                     Logic
```

6.2.15 Alarm Latching

Alarms are activated when a protection element detects that a protection operation is required. If alarms are configured as "Not Latched", they will reset when the protection element resets, otherwise if they are configured as "Latched", they will remain active.

Alarms will reset automatically on a close operation if "Reset Flags on Close" is enabled and can be manually reset from the Reset Menu and the Alerts page on the panel or through SCADA or Logic (refer to Sections 7.8 and 7.9.1).

Note: *While a protection element is active the alarm for that element cannot be reset.*

Panel Navigation

[*Turn Panel ON****]*** ⇒ ***[****SYSTEM STATUS****]*** ⇒ ***[****Press ESC****]*** ⇒

⇩

[*MAIN MENU****]***

↳ ***[****System Settings****]***

↳ *[Fault Flags]* ⇒

```
              Fault Flags

 Reset Fault Flags on close     Enabled
 Display Alerts                Disabled
 Alarm                     Not Latched
```

Alarm Latching Settings

Title	Designation	Range	Resolution	Factory Default
Alarm Latching	Alarm Latching	Latched/Not Latched	N/A	Not Latched

6.3 Logical Block Close

Logical Block Close is a command that can be issued from an I/O module, a logic expression or through a SCADA point to block close operations from any source.

"Reset Logical Block Close" is used to reset the Logical Block Close and can be issued from the HMI panel as shown below.

Panel Navigation

[Turn Panel ON] ⇒ [SYSTEM STATUS] ⇒ [Press ESC]
⇩
[MAIN MENU]
↳ *[Reset Menu]*
↳ *[Reset]*
↳ *[Reset Logical Block Close] ⇒*

```
RESET MENU

Erase ►Reset◄

Reset Hot Line Tag
Reset Logical Block Close
Reset Fault Targets
Restart GPS Hardware
Restart Wi-Fi Hardware
Restart Mobile Network Modem
Reset USB Overcurrent
```

6.4 Voltage Protection (VE)

Voltage protection allows protection to operate in response to dips or rises in three phase voltage, phase imbalance, loss of phase or loss of three phase supply. There are four Under Voltage elements (UV1, UV2, UV3 and UV4 Sag), four Over Voltage elements (OV1, OV2, OV3 and OV4) and an Auto Reclosing element (AR VE). Additionally, the phase to phase and phase to ground elements (UV1, UV2, OV1 and OV2) each have three stages.

The Auto Reclosing element allows up to three reclose operations if the device has operated in response to any voltage element. Each element can be enabled or disabled but the reclose time is the same for all voltage elements. Additional auto reclose settings can be configured for the Loss of Supply Under Voltage element (UV3). Refer to Section 6.6.

Note: *An element must be in either "Reclose" or "Lockout" in the AR VE Map for it to operate.*

For the UV4 Sag element additional settings apply. Please see below and refer to Section 6.4.4 Voltage Sag Protection (UV4 Sag) (ANSI 27).

Note: *The fault reset time for the VE protection elements is 50 ms and is not configurable.*

6.4.1 Phase Under Voltage (UV1, UV12, UV13) (ANSI 27)

Phase Under Voltage is mainly used for load shedding. It responds to three phase positive sequence voltage falling below a user set level. There are three stage elements available.

Panel Navigation

[Turn Panel ON] ⇒ [SYSTEM STATUS] ⇒ [Press ESC]
⇩
[MAIN MENU]
↳ *[Groups Settings]*
↳ *[Group 1…4]*
↳ *Protection Settings [VE]*
↳ *Under Voltage*
↳ *[Page 1] ⇒*

```
GROUP 1 VOLTAGE ELEMENT

<Under Voltage> Over Voltage  Sag

►Page 1◄ Page 2  Page 3

 UV1 (Phase):
 Voltage Multiplier                0.85
 Tripping Time (s)                10.00

 UV12 (Phase Stage 2):
 Voltage Multiplier                0.85
 Tripping Time (s)                10.00

 UV13 (Phase Stage 3):
 Voltage Multiplier                0.85
 Tripping Time (s)                10.00
```

UV1 settings

Title	Designation	Range	Resolution	Factory Default
Voltage Multiplier	UV1 UM	0.6 – 1	0.01	0.85
Tripping Time (s)	UV1 Tdt Min, s	0 – 180	0.01	10.00

UV12 settings

Title	Designation	Range	Resolution	Factory Default
Voltage Multiplier	UV12 UM	0.6 – 1	0.01	0.85
Tripping Time (s)	UV12 Tdt Min, s	0 – 180	0.01	10.00

UV13 settings

Title	Designation	Range	Resolution	Factory Default
Voltage Multiplier	UV13 UM	0.6 – 1	0.01	0.85
Tripping Time (s)	UV13 Tdt Min, s	0 – 180	0.01	10.00

Notes:

- *For UV1, UV12 and UV13, pickup voltage equals UM x U_rated / √3; where U_rated is the rated system voltage entered in the measurement settings (refer to Section 5.2).*
- *UV1, UV12 and UV13 will not operate under LSD condition – use UV3 for this situation.*

6.4.2 Line to Line Under Voltage (UV2, UV22, UV23) (ANSI 27)

Line to Line Under Voltage is used to protect downstream loads sensitive to voltage imbalance or dips in voltage. It responds to a voltage drop across any two phases. There are three stage elements available.

Panel Navigation

[*Turn Panel ON****]*** ⇒ ***[****SYSTEM STATUS****]*** ⇒ ***[****Press ESC****]***

⇩

[*MAIN MENU****]***

↳ ***[****Groups Settings****]***

↳ ***[****Group 1…4****]***

↳ *Protection Settings [VE]*

↳ *Under Voltage*

↳ ***[****Page 2****]*** ⇒

```
        GROUP 1 VOLTAGE ELEMENT

<Under Voltage> Over Voltage  Sag

 Page 1 ►Page 2◄ Page 3

 UV2 (Line to Line):
 Voltage Multiplier                0.80
 Tripping Time (s)                10.00

 UV22 (Line to Line Stage 2):
 Voltage Multiplier                0.80
 Tripping Time (s)                10.00

 UV23 (Line to Line Stage 3):
 Voltage Multiplier                0.80
 Tripping Time (s)                10.00
```

UV2 Settings

Title	Designation	Range	Resolution	Factory Default
Voltage multiplier	UV2 UM	0.6 – 1	0.01	0.80
Tripping time (s)	UV2 Tdt Min, s	0 – 180	0.01	10.00

UV22 Settings

Title	Designation	Range	Resolution	Factory Default
Voltage multiplier	UV22 UM	0.6 – 1	0.01	0.80
Tripping time (s)	UV22 Tdt Min, s	0 – 180	0.01	10.00

UV23 Settings

Title	Designation	Range	Resolution	Factory Default
Voltage multiplier	UV23 UM	0.6 – 1	0.01	0.80
Tripping time (s)	UV23 Tdt Min, s	0 – 180	0.01	10.00

Notes:

- *For UV2, UV22 and UV23, pickup voltage equals UM x U_rated; where U_rated is the rated system voltage entered in the measurement settings (refer to Section 5.2).*
- *UV2, UV22 and UV23 will not operate under LSD condition – use UV3 for this situation.*

6.4.3 Loss of Supply Under Voltage (UV3) (ANSI 27)

Loss of Supply Under Voltage allows the recloser to open in response to a loss of three phase supply. This element monitors the output of the Loss of Supply Detector (LSD) and responds to a loss of current on all three phases plus a loss of voltage on either the ABC or RST side terminals (or all six HV terminals). Refer to Section 6.9 for a description of LSD.

Panel Navigation

[Turn Panel ON] ⇒ [SYSTEM STATUS] ⇒ [Press ESC]
⇩
[MAIN MENU]
↳ *[Groups Settings]*
↳ *[Group 1…4]*
↳ *Protection Settings [VE]*
↳ *Under Voltage*
↳ *[Page 3] ⇒*

```
        GROUP 1 VOLTAGE ELEMENT

<Under Voltage> Over Voltage  Sag

 Page 1  Page 2 ►Page 3◄

UV3 (Loss of Supply):
Tripping Time (s)                60.00
```

UV3 settings

Title	Designation	Range	Resolution	Factory Default
Tripping time (s)	UV3 Tdt Min, s	0 – 180 s	0.01 s	60.00

Note: *For UV3 AutoClose functionality please refer to Section 6.6 Auto Reclosing Voltage Element (AR VE).*

6.4.4 Voltage Sag Protection (UV4 Sag) (ANSI 27)

The Voltage Sag Protection element (UV4 Sag) protects against a voltage sag condition when the voltage drops within a user defined window for greater than a pre-configured time (operation time) as shown below:

UV4 Sag min < Voltage < UV 4 Sag max for ≥ Operation Time (seconds)

When the UV4 Sag condition occurs and the device is closed a protection operation is initiated e.g. a trip or alarm.

UV4 Sag Blocking
When the UV4 Sag condition occurs and the device is open, a close operation from any source (e.g. AR VE, HMI panel, SCADA, I/O or logic) is blocked and the device goes to lockout.

If AR is turned ON or OFF, UV4 Sag Blocking is reset. If the UV4 Sag fault is present the operation timer restarts. If the UV4 Sag fault is still present when the operation time expires then UV4 Sag blocking will prevent a close operation from any source and if a close command is issued the device goes to lockout.

UV4 Sag Lockout Time
The device will automatically go to lockout when the UV4 Sag condition is true for longer than the Lockout Time (see table below).

Panel Navigation

[Turn Panel ON] ⇒ [SYSTEM STATUS] ⇒ [Press ESC]
⇩
[MAIN MENU]
↳ *[Groups Settings]*
↳ *[Group 1…4]*
↳ *Protection Settings [VE]*
↳ *SAG ⇒*

```
        GROUP 1 VOLTAGE ELEMENT

Under Voltage  Over Voltage ►Sag◄

UV4 Sag:
Min Multiplier                   0.10
Max Multiplier                   0.90
Mid Multiplier                    0.5
Operation Time (s)                 10
Lockout time (Min)                 10
Voltage Type                   Ph/Gnd
Voltages                      ABC_RST
```

UV4 Settings

Title	Designation	Range	Resolution	Factory Default
Min Multiplier(1)	UM (Min)	0.01 – 0.8	0.01	0.10
Max Multiplier	UM (Max)	0.5 – 1.0	0.01	0.90
Mid Multiplier(2)	UM (Mid)	0.5 – 1.0	0.01	0.5

Title	Designation	Range	Resolution	Factory Default
Operation Time (s)	Tdt Min, s	1 – 180	0.01	10
Lockout Time[3] (min)	Lockout time, min	0 – 1440	1	10
Voltage Type[4]	Voltage Type	Ph/Gnd, Ph/Ph	N/A	Ph/Gnd
Voltages[5]	Voltages	ABC_RST, ABC, RST	N/A	ABC_RST

Notes:

1. *UV4 Sag Min equals Min Multiplier x U_rated, UV4 Sag Max equals Max Multiplier x U_rated, UV4 Sag Mid threshold equals Mid Multiplier x U_rated, where U_rated is the system voltage (**Note:** When Phase to Ground voltage is monitored then the multipliers refer to U_rated / √3).*
2. *The UV4 Sag Mid threshold is used to generate a mid-point alarm (SCADA only) and does not prevent a close.*
3. *If Lockout Time is set to 0, UV4 Sag will prevent a close indefinitely and not go to lockout (a UV4 Sag blocking event generated).*
4. *The user can select to monitor phase to ground voltages Ua, Ub, Uc, Ur, Us, Ut (generally for single phase) or phase to phase voltages Uab, Ubc, Uca, Urs, Ust, Utr*
5. *When the ACR is open: ABC_RST monitors all 6 bushings, ABC or RST monitors one set of bushings.*
   When the ACR is closed: only ABC bushings are monitored.

UV4 Sag protection is deactivated when:

- UV4 Sag pickup has reset and the 50 ms reset timer has expired
- UV4 Sag global control is turned OFF
- UV4 Sag element is disabled
- UV global control is turned OFF
- Global protection is turned OFF.

6.4.5 Phase Over Voltage (OV1, OV12, OV13) (ANSI 59)

Phase Over Voltage responds to three phase positive sequence voltage rising above a user set level. There are three stage elements available.

Panel Navigation

[Turn Panel ON] ⇒ *[SYSTEM STATUS]* ⇒ *[Press ESC]*
⇩
[MAIN MENU]
↳ *[Groups Settings]*
↳ *[Group 1…4]*
↳ *Protection Settings [VE]*
↳ *Over Voltage*
↳ *[Page 1]* ⇒

```
        GROUP 1 VOLTAGE ELEMENT

 Under Voltage <Over Voltage> Sag

▶Page 1◀ Page 2  Page 3

 OV1 (Phase):
 Voltage Multiplier              1.15
 Tripping Time (s)              10.00

 OV12 (Phase Stage 2):
 Voltage Multiplier              1.15
 Tripping Time (s)              10.00

 OV13 (Phase Stage 3):
 Voltage Multiplier              1.15
 Tripping Time (s)              10.00
```

OV1 settings

Title	Designation	Range	Resolution	Factory Default
Voltage multiplier	OV1 UM	1.0 – 1.5	0.01	1.15
Tripping time (s)	OV1 Tdt Min, s	0 – 180	0.01	10.00

OV12 settings

Title	Designation	Range	Resolution	Factory Default
Voltage multiplier	OV12 UM	1.0 – 1.5	0.01	1.15
Tripping time (s)	OV12 Tdt Min, s	0 – 180	0.01	10.00

OV13 settings

Title	Designation	Range	Resolution	Factory Default
Voltage multiplier	OV13 UM	1.0 – 1.5	0.01	1.15
Tripping time (s)	OV13 Tdt Min, s	0 – 180	0.01	10.00

Note: *For OV1, OV12 and OV13, pickup voltage equals UM x U_rated / √3; where U_rated is the rated system voltage entered in the measurement settings (refer to Section 5.2).*

6.4.6 Line to Line Over Voltage (OV2, OV22, OV23) (ANSI 59)

Line to Line Over Voltage responds to a voltage rise across any two phases. There are three stage elements available.

Panel Navigation

[Turn Panel ON] ⇒ *[SYSTEM STATUS]* ⇒ *[Press ESC]*
⇩
[MAIN MENU]
↳ *[Groups Settings]*
↳ *[Group 1…4]*
↳ *Protection Settings [VE]*
↳ *Over Voltage*
↳ *[Page 2]* ⇒

```
        GROUP 1 VOLTAGE ELEMENT

Under Voltage <Over Voltage> Sag

Page 1 ►Page 2◄ Page 3

OV2 (Line to Line):
Voltage Multiplier                1.15
Tripping Time (s)                10.00

OV22 (Line to Line Stage 2):
Voltage Multiplier                1.15
Tripping Time (s)                10.00

OV23 (Line to Line Stage 3):
Voltage Multiplier                1.15
Tripping Time (s)                10.00
```

OV2 Settings

Title	Designation	Range	Resolution	Factory Default
OV2 Voltage multiplier	OV2 UM	1.0 – 1.5	0.01	1.15
OV2 Tripping time (s)	OV2 Tdt Min, s	0 – 180	0.01	10.00

OV22 Settings

Title	Designation	Range	Resolution	Factory Default
OV2 Voltage multiplier	OV22 UM	1.0 – 1.5	0.01	1.15
OV2 Tripping time (s)	OV22 Tdt Min, s	0 – 180	0.01	10.00

OV23 Settings

Title	Designation	Range	Resolution	Factory Default
OV2 Voltage multiplier	OV23 UM	1.0 – 1.5	0.01	1.15
OV2 Tripping time (s)	OV23 Tdt Min, s	0 – 180	0.01	10.00

Note: *For OV2, OV22 and OV23, pickup voltage equals UM x U_rated; where U_rated is the rated system voltage entered in the measurement settings (refer to Section 5.2).*

6.4.7 Neutral Displacement Overvoltage (OV3) (ANSI 59N)

Neutral Displacement Overvoltage protection (59N) is used in distribution networks with high grounding impedance. 59N is designed to be used for earth-fault protection in isolated neutral, resistance grounded or reactance grounded systems.

Pickups due to OV3 can be blocked when Moving Average Mode is enabled (see below).

Moving Average Mode

When “Moving Average Mode” is enabled, OV3 values accumulate at each quarter cycle and are averaged every 100ms. The calculated values of OV3 during the “Moving Average Window” are used instead of the instantaneous values of OV3.

When Moving Average Mode is enabled, if on a close, OV3 pickup is present on any side of the recloser (i.e. ABC and/or RST side), the protection operation due to OV3 is inhibited and Block P(OV3) is set, until the measured OV3 values become less than the threshold.

Panel Navigation

[Turn Panel ON] ⇒ [SYSTEM STATUS] ⇒ [Press ESC]
⇩
[MAIN MENU]
↳ *[Groups Settings]*
↳ *[Group 1…4]*
↳ *Protection Settings [VE]*
↳ *Over Voltage*
↳ *[Page 3] ⇒*

```
        GROUP 1 VOLTAGE ELEMENT

Under Voltage <Over Voltage> Sag

Page 1  Page 2 ▶Page 3◀

OV3 (Neutral Displacement):
Voltage Multiplier                0.05
Tripping Time (s)                10.00
Moving Average Mode           Disabled
Moving Average Window (s)          5.0

OV4 (Negative Sequence):
Voltage Multiplier                0.05
Tripping Time (s)                10.00
```

OV3 Settings

Title	Designation	Range	Resolution	Factory Default
OV3 Voltage multiplier	OV3 UM	0.01-1	0.01	0.05
OV3 Tripping time (s)	OV3 Tdt Min, s	0 – 180 s	0.01 s	10.00
Moving Average Mode	Moving Average Mode	Disabled/Enabled	NA	Disabled
Moving Average Window (s)	Moving Average Window, s	0.1 to 10 s	0.1 s	5.0

Notes:

- *The neutral (or residual) voltage is equal to three times the zero sequence voltage.*
- *For OV3 element pickup voltage equals UM x U_rated / √3; where U_rated is the rated system voltage entered in the measurement settings (refer to Section 5.2).*
- *OV3 does not operate if all of the 3 phase to ground voltages fall below 0.5 kV.*
- *If the pickup voltages are below 0.1 kV they are reported as 0.1 kV.*
- *Update rate for moving average window is 100 ms.*
- *The global control status for OV and OV3 must both be ON for the OV3 element to operate. Refer to Section 6.16 Protection Status Control (PSC).*

6.4.8 Negative Sequence Overvoltage (OV4) (ANSI 47N)

Negative Sequence Overvoltage (47N) protects the system against voltage imbalance and operates when the negative sequence voltage exceeds the threshold set by the user.

Panel Navigation

[Turn Panel ON] ⇒ [SYSTEM STATUS] ⇒ [Press ESC]
⇩
[MAIN MENU]
↳ *[Groups Settings]*
↳ *[Group 1…4]*
↳ *Protection Settings [VE]*
↳ *Over Voltage*
↳ *[Page 3] ⇒*

```
        GROUP 1 VOLTAGE ELEMENT

Under Voltage <Over Voltage> Sag

Page 1  Page 2 ▶Page 3◀

OV3 (Neutral Displacement):
Voltage Multiplier                0.05
Tripping Time (s)                10.00
Moving Average Mode           Disabled
Moving Average Window (s)          5.0

OV4 (Negative Sequence):
Voltage Multiplier                0.05
Tripping Time (s)                10.00
```

OV4 Settings

Title	Designation	Range	Resolution	Factory Default
OV4 Voltage multiplier	OV4 UM	0.01-1	0.01	0.05
OV4 Tripping time (s)	OV4 Tdt Min, s	0 – 180 s	0.01 s	10.00

Notes:

- *For OV4 element pickup voltage equals UM x U_rated / √3; where U_rated is the rated system voltage entered in the measurement settings (refer to Section 5.2).*
- *OV4 does not operate if all of the 3 phase to ground voltages fall below 0.5 kV.*
- *A pickup will not be activated when the switch is open unless the reclose map is set to alarm.*
- *When in the open state OV4 is only applicable to the ABC bushings.*
- *OV4 does not operate if the pickup voltage < 0.5 kV.*
- *If the pickup voltages are below 0.1 kV they are reported as 0.1 kV.*

6.5 Directional Power (PDPR)

Directional power protection is used where a generator runs in parallel to another generator or a utility. Directional power protection schemes inhibits the generators from running as a motor due to power flow in the reverse direction. PDOP/PDUP are triggered when the apparent power generation from the generator exceeds/falls below a certain threshold.

Panel Navigation

[Turn Panel ON] ⇒ *[SYSTEM STATUS]* ⇒ *[Press ESC]*
⇩
[MAIN MENU]
↳ *[Groups Settings]*
↳ *[Group 1…4]*
↳ *Protection Settings*: **[***PDPR]* ⇒

```
 GROUP 1 DIRECTIONAL POWER ELEMENT

Overpower:
Mode                          ▶Disable◀
Apparent Power (KVA)               150
Power Angle (°)                    0.0
Tripping Time (s)                10.00

Underpower:
Mode                             Disable
Apparent Power (KVA)                 2
Power Angle (°)                    0.0
Tripping Time (s)                10.00
Disable Time (s)                  0.00
```

6.5.1 Overpower protection (PDOP) (ANSI 32R/32O)

Direction Overpower (32O/32R) inhibits generators from running as a motor due to reverse power flow.

PDOP Settings

Title	Designation	Range	Resolution	Factory Default
Apparent Power	PDOP, kVA	2 – 52653 kVA	1 kVA	150 kVA
Power angle	θPDOP, °	-179.9° to 180°	0.1°	0.0°
Tripping Time	Tdt Min, s	0.00 – 180.00 s	0.01 s	10.00 s

6.5.2 Underpower protection (PDUP) (ANSI 37U)

Directional Underpower (37U) operates when the measured apparent power from the generator falls below the threshold.

PDUP Settings

Title	Designation	Range	Resolution	Factory Default
Apparent Power	PDUP, kVA	2 – 52653 kVA	1 kVA	2 kVA
Power angle	θPDUP, °	-179.9° to 180°	0.1°	0.0°
Tripping Time	Tdt Min, s	0.00 – 180.00 s	0.01 s	10.00 s
Disable Time(1)	Dis Tdt, s	0.00 – 60.00 s	0.01 s	0.00 s

***Notes**:*

1. *Disable Time for Underpower is an additional wait time after the recloser closes, PDUP is enabled or Protection is enabled. This is used during generator startup wherein an additional time is applied before operating due to Underpower.*

6.6 Auto Reclosing Voltage Element (AR VE) (ANSI 79, 86)

Voltage Element Reclosing is activated by a protection operation initiated by any of the voltage elements. The number of trips to lockout and a single reclose time for all voltage elements can be user set. The reclose sequence reset time is set by AR OC/NPS/EF/SEF.

If none of the voltage elements are mapped for Trip to Reclose then AR VE is disabled.

UV4 Sag can block a close operation. Please refer to Section 6.4.4.

Panel Navigation

[Turn Panel ON] ⇒ *[SYSTEM STATUS]* ⇒ *[Press ESC]*
⇩
[MAIN MENU]
↳ *[Groups Settings]*
↳ *[Group 1…4]*
↳ *Auto Reclosing*: **[***ARVE]*
↳ *[Page 1]* ⇒

```
              GROUP 1 AR VE

<Page 1> Page 2

 VE Reclose Time (s)              ►10.00◄
 No of Trips to lockout                4

 Auto Reclose Time Map:
 OV1 (Phase)                     Disabled
 OV12 (Phase Stage 2)            Disabled
 OV13 (Phase Stage 3)            Disabled
 OV2 (Line to Line)              Disabled
 OV22 (Line to Line Stage 2)     Disabled
 OV23 (Line to Line Stage 3)     Disabled
 Ov3 (Neutral Displacement)      Disabled
 OV4 (Negative Sequence)         Disabled
```

↳ *Auto Reclosing*: **[***ARVE]*
↳ *[Page 2]* ⇒

```
              GROUP 1 AR VE

 Page 1 <Page 2>

 UV1 (Phase)                     ►Disabled◄
 UV12 (Phase)                     Disabled
 UV13 (Phase)                     Disabled
 UV2 (Line to Line)               Disabled
 UV22 (Line to Line)              Disabled
 UV23 (Line to Line)              Disabled
 UV3 (Loss of Supply)             Disabled
 Operation in SST only            Disabled
 AutoClose Mode                   Disabled
 AutoClose Time (s)                    120
 UV4 Sag                          Disabled
```

Reclose sequence settings

Title	Designation	Range	Resolution	Factory Default
Reclose time	Tr	1 – 180s	0.01s	10
No of Trips to Lockout	No of Trips to Lockout	1 - 4	1	4
Operation in SST only[1]	Operation in SST only	Enabled/Disabled	NA	Disabled
AutoClose Mode[2]	AutoClose Mode	Enabled/Disabled		Disabled
AutoClose Time[2]	AutoClose Time, sec	1-180 s	1 s	120

Notes:

1. *Applies to UV3 element only. When "Operation in SST only" is enabled, UV3 will ONLY operate when a UV3 protection operation is requested AND the device is in single shot mode. In this instance it will do one shot to lockout.*
2. *Applies to UV3 element only.*

When UV3 AutoClose Mode is enabled and the device is opened by the UV3 element, the recloser will stay open until voltage is detected above the LSD threshold on both sides of the recloser for the duration of the configured AutoClose time.

“Open UV3 AutoClose” will be displayed on the panel and in CMS to indicate that AutoClose can take place.

If AutoClose is pending the following actions will cancel AutoClose:

- Protection, AR or UV turned OFF
- UV3 set to Disabled
- Protection settings changed
- Protection Group changed
- Hot Line Tag is turned ON
- UV4 Sag Blocking
- Recloser closed from any source
- “Operation in SST only” is enabled

Note: *When the recloser closes due to UV3 Autoclose the sequence counter is reset.*

Reclosing map

Element	Settings	Factory Default
UV1	Reclose/Disabled/Alarm/Lockout	Disabled
UV12	Reclose/Disabled/Alarm/Lockout	Disabled
UV13	Reclose/Disabled/Alarm/Lockout	Disabled
UV2	Reclose/Disabled/Alarm/Lockout	Disabled
UV22	Reclose/Disabled/Alarm/Lockout	Disabled
UV23	Reclose/Disabled/Alarm/Lockout	Disabled
UV3	Reclose/Disabled/Alarm/Lockout	Disabled
UV4 Sag	Reclose/Disabled/Alarm/Lockout	Disabled
OV1	Reclose/Disabled/Alarm/Lockout	Disabled
OV12	Reclose/Disabled/Alarm/Lockout	Disabled
OV13	Reclose/Disabled/Alarm/Lockout	Disabled
OV2	Reclose/Disabled/Alarm/Lockout	Disabled
OV22	Reclose/Disabled/Alarm/Lockout	Disabled
OV23	Reclose/Disabled/Alarm/Lockout	Disabled
OV3	Reclose/Disabled/Alarm/Lockout	Disabled
OV4	Reclose/Disabled/Alarm/Lockout	Disabled

Notes:

- *When an element is set to alarm, the alarm will be activated only when the recloser is closed. It applies to all voltage elements with the exception of OV4 where the alarm is activated whether the recloser is open or closed.*
- *When an element is set to reclose, the pickup will be activated only when the recloser is closed. It applies to all voltage elements.*
- *Please refer to Section 6.2.11 for Max No of Trips to Lockout (79 Lockout) and Section 6.2.12 for Short Sequence Mode.*
- *If OV3 is set to Reclose, Alarm or Lockout prior to upgrading to firmware 1.15 and above please note that it will not operate after the upgrade until the OV3 global control is enabled. Please refer to Section 6.16 Protection Status Control (PSC).*

6.7 Hot Line Tag

Hot Line Tag (HLT) blocks a close operation from any source. If the recloser is closed and a protection operation is initiated, the device will trip to lockout based on SST settings.

The panel Hot Line Tag LED is lit when HLT is active.

HLT can only be disabled from the source it was enabled from. Protection settings cannot be changed while Hot Line Tag is active.

HLT is activated on the Protection Status screen in the same way as other protection elements.

The Live Line Fast Key can be linked to enable Hot Line Tag. When LL is linked to HLT, if a protection operation is initiated, the device will trip to Lockout based on the Live Line protection settings (not SST). Refer to Section 6.1.10 for more details. See panel HLT Settings below.

Panel Navigation

[Turn Panel ON] ⇒ *[SYSTEM STATUS]*

↳ *[Protection]*

↳ *[Page 1]* ⇒

```
      PROTECTION GLOBAL SETTINGS

▶Page 1◀ Page 2  Page 3

 Active Group                        1
 Protection                        Off
 AR Auto Reclose                   Off
 LL Live Line                      Off
 EF Earth Fault                    Off
 SEF Sensitive Earth Fault         Off
 CLP Cold Load Pickup              Off
 ABR Autobackfeed Restore          Off
 UV Undervoltage                   Off
 UV4 Sag                           Off
 LLB Live Load Blocking            Off
 HLT Hot Line Tag                  Off
```

↳ *[Protection]*

↳ *[Page 2]* ⇒

```
      PROTECTION GLOBAL SETTINGS

Page 1 ▶Page 2◀ Page 3

 NPS Negative Phase Sequence       Off
 OV  Over Voltage                  Off
 UF  Under Frequency               Off
 OF  Over Frequency                Off
 HRM Harmonics                     Off
 HLT Link HLT to LL                Off
 MNT Maximum Number of Trips       Off
 SSM Short Sequence Mode           Off
 DFT Disable Fast Trips            Off
 Max No. of Trips to Lockout    Normal
 Alarm mode                        Off
```

HLT settings

Title	Designation	Range	Resolution	Factory Default
Hot Line Tag	HLT	On/Off	NA	Off
Link HLT to LL(1)	Link HLT to LL	On/Off	NA	Off

Notes:

1. *The link (Link HLT to LL) when enabled turns on HLT when the Panel LL Fast Key is pushed. HLT and LL must be OFF before the link can be made.*

HLT can be reset from the Panel by a local user. This may be necessary if Hot Line Tag is applied by SCADA and then communication is lost. A password is required by the local user to reset HLT.

Panel Navigation

[Turn Panel ON] ⇒ *[SYSTEM STATUS]* ⇒ *[Press ESC]*

⇩

[MAIN MENU]

↳ *[Reset Menu]*

↳ *[Reset]*

↳ *[Reset Hot Line Tag]* ⇒

```
            RESET MENU

Erase ▶Reset◀

Reset Hot Line Tag
Reset Logical Block Close
Reset Fault Targets
Restart GPS Hardware
Restart Wi-Fi Hardware
Restart Mobile Network Modem
Reset USB Overcurrent
```

6.8 Frequency Protection (FE)

Frequency Protection monitors measurement of HV supply frequency and responds to changes in system frequency. The Frequency elements can be set to Alarm, Disable or trip to Lockout.

Auto Reclose is not available for Frequency protection.

6.8.1 Under Frequency (UF, UF2, UF3) (ANSI 81)

Under Frequency responds to dips in system frequency. There are three stage elements available.

Panel Navigation

[Turn Panel ON] ⇒ *[SYSTEM STATUS]* ⇒ *[Press ESC]*
⇩
[MAIN MENU]
↳ *[Groups Settings]*
↳ *[Group 1…4]*
↳ *Protection Settings:*: **[***FE]* ⇒
↳ *[UF]*

```
      GROUP 1 FREQUENCY ELEMENT

▶UF◀ OF  ROCOF  VVS

 UF Mode                      Disabled
 Pickup Frequency (Hz)           49.50
 Tripping Time (s)               10.00

 UF2 Mode (Stage 2)           Disabled
 Pickup Frequency (Hz)           49.50
 Tripping Time (s)               10.00

 UF3 Mode (Stage 3)           Disabled
 Pickup Frequency (Hz)           49.50
 Tripping Time (s)               10.00
```

UF settings

Title	Designation	Range	Resolution	Factory Default
UF Mode	UF Mode	Lockout / Alarm / Disabled	–	Disabled
Pickup Frequency (Hz)	Fp	46 – 50 (for rated freq. 50 Hz), 55 – 60 (for rated freq. 60 Hz)	0.01	49.50
Tripping Time (s)	Tt	0.05 – 180	0.01	10.00

UF2 settings

Title	Designation	Range	Resolution	Factory Default
UF2 Mode	UF2 Mode	Lockout / Alarm / Disabled	–	Disabled
Pickup Frequency (Hz)	Fp	46 – 50 (for rated freq. 50 Hz), 55 – 60 (for rated freq. 60 Hz)	0.01	49.50
Tripping Time (s)	Tt	0.05 – 180	0.01	10.00

UF3 settings

Title	Designation	Range	Resolution	Factory Default
UF3 Mode	UF3 Mode	Lockout / Alarm / Disabled	–	Disabled
Pickup Frequency (Hz)	Fp	46 – 50 (for rated freq. 50 Hz), 55 – 60 (for rated freq. 60 Hz)	0.01	49.50
Tripping Time (s)	Tt	0.05 – 180	0.01	10.00

6.8.2 Over Frequency (OF, OF2, OF3) (ANSI 81)

Over Frequency responds to a rise in system frequency.

Panel Navigation

[Turn Panel ON] ⇒ *[SYSTEM STATUS]* ⇒ *[Press ESC]*
[MAIN MENU]
↳ *[Groups Settings]*
↳ *[Group 1…4]*
↳ *Protection Settings:*: **[***FE]* ⇒
↳*[OF]*

```
      GROUP 1 FREQUENCY ELEMENT

UF ►OF◄ ROCOF  VVS

OF Mode                      Disabled
Pickup Frequency (Hz)           50.50
Tripping Time (s)               10.00

OF2 Mode (Stage 2)           Disabled
Pickup Frequency (Hz)           50.50
Tripping Time (s)               10.00

OF3 Mode (Stage 3)           Disabled
Pickup Frequency (Hz)           50.50
Tripping Time (s)               10.00
```

OF settings

Title	Designation	Range	Resolution	Factory Default
OF Mode	OF Mode	Lockout / Alarm / Disabled	–	Disabled
Pickup frequency (Hz)	Fp	50 – 55 (for rated freq. 50 Hz), 60 – 65 (for rated freq. 60 Hz)	0.01	50.50
Tripping time (s)	Tt	0.05 – 180	0.01	10.00

OF2 settings

Title	Designation	Range	Resolution	Factory Default
OF2 Mode	OF Mode	Lockout / Alarm / Disabled	–	Disabled
Pickup frequency (Hz)	Fp	50 – 55 (for rated freq. 50 Hz), 60 – 65 (for rated freq. 60 Hz)	0.01	50.50
Tripping time (s)	Tt	0.05 – 180	0.01	10.00

OF3 settings

Title	Designation	Range	Resolution	Factory Default
OF3 Mode	OF Mode	Lockout / Alarm / Disabled	–	Disabled
Pickup frequency (Hz)	Fp	50 – 55 (for rated freq. 50 Hz), 60 – 65 (for rated freq. 60 Hz)	0.01	50.50
Tripping time (s)	Tt	0.05 – 180	0.0	10.00

6.8.3 Rate Of Change Of Frequency (ROCOF) (ANSI 81R)

Rate Of Change Of Frequency (ROCOF) protection is used to detect situations of loss of grid such as islanding or loss of mains and trips the circuit to isolate the distributed generation plant from the main grid.

Generator-Load imbalances occur when a distributed generation plant is connected to a network that loses its main generation and this results in changes to the system frequency. ROCOF monitors the frequency continuously and detects when the rate of frequency shifts past a set threshold. Once ROCOF exceeds the set limit, the circuit breaker is tripped after a set time delay.

Note: *In situations where the protected generation and the network demand matches that a change of frequency may not occur. There may need to be additional measures taken to detect this situation and trigger a trip, such as through a SCADA control system.*

Panel Navigation

[Turn Panel ON] ⇒ *[SYSTEM STATUS]* ⇒ *[Press ESC]*
⇩
[MAIN MENU]
↳ *[Groups Settings]*
↳ *[Group 1…4]*
↳ *Protection Settings:*: **[***FE]* ⇒

```
      GROUP 1 FREQUENCY ELEMENT

UF  OF ►ROCOF◄ VVS

Mode                         Disabled
Pickup ROCOF (Hz/s)              1.0
Tripping Time (s)               0.50
```

The settings are as follows:

Title	Designation	Range	Resolution	Factory Default
Rate Of Change Of Frequency (Hz/s)	ROCOF, Hz/s	0.4 – 5	0.1	1
Tripping time (s)	Tdt Min, s	0.15 – 180	0.01	0.5

6.8.4 Voltage Vector Shift (VVS) (ANSI 78)

Voltage Vector Shift (VVS) protection is used to detect sudden changes in the main voltage angle caused by a change in the output from the generating plant or changes to the demand connected to the network. It is primarily used to detect when islanding has occurred on an embedded generation plant and initiates a trip to isolate the circuit from the main grid.

VVS protection monitors the phase angle of the terminal load voltage (V_T) and the generator internal voltage (E_I) for all the energised phases and calculates their difference $(\Delta\theta)$ continually over time. Once the VVS threshold has been exceeded, a Pickup is initiated.

A VVS protection pickup cannot be reset once initiated. This provides VVS with a "Permanent Pickup" feature. The tripping time setting sets how long a delay before opening the OSM. The VVS pickup can only be reset by an open event, or a trip request from another protection element within the tripping time delay period.

Note: *When configured as an alarm or in alarm mode, an angle value less than the pickup angle will result the VVS element resetting after 50ms*

Panel Navigation

[*Turn Panel ON****]*** ⇒ ***[****SYSTEM STATUS****]*** ⇒ ***[****Press ESC****]***

[*MAIN MENU****]***

↳ ***[****Groups Settings****]***

↳ ***[****Group 1…4****]***

↳ *Protection Settings:*: **[***FE***]** ⇒

```
      GROUP 1 FREQUENCY ELEMENT

UF  OF  ROCOF ►VVS◄

Mode                          Disabled
VVS Angle (°)                       10
Tripping Time (s)                  0.0
```

The settings are as follows:

Title	Designation	Range	Resolution	Factory Default
Voltage Vector Shift Angle	VVS, °	2° - 40°	1°	10°
Tripping time (s)	Tdt Min, s	0 – 180	0.1	0.0

6.9 Loss of Supply Detector (LSD)

The Loss of Supply Detector detects loss of voltage (measured phase to ground) and current on all three phases.

Uabc< activates when voltage < LSD_level on each of the A,B and C terminals

Urst< activates when voltage < LSD_level on each of the R,S and T terminals

Iabc< activates when current < 3A on all three phases

The first two elements (Uabc< and Urst<) are used by Voltage Reclosing Control (VRC) and Automatic Backfeed Restoration (ABR) elements as inputs.

The LSD element indicates to other protection elements that supply has been lost. To provide validation of loss of supply both voltage and current are monitored, activation of the Loss of Supply Detector output requires ((Uabc< OR Urst< OR (Uabc< AND Urst<)) AND Iabc<).

The LSD_level is configurable between 0.5kV and 6.0kV. Refer to Section 5.2 for details on how to change the LSD_level setting.

6.10 Voltage Reclosing Control (VRC)

Voltage Reclosing Control (VRC) inhibits an auto reclose operation by any of AR OC/NPS/EF/SEF, AR VE and ABR elements when voltage on the source side falls below a user set threshold. Correct application of VRC prevents potentially hazardous backfeed situations from arising by isolating the source on perceived loss of upstream supply during an operation to clear a downstream fault.

The recloser will attempt an auto reclose when VRC is no longer active. If VRC is active for longer than 200s then the recloser will go to lockout and will not continue the auto reclose sequence.

Note: *The VRC Blocking event will not start or record lockout as the relevant state when VRC blocking ends (after 200s) under the following conditions:*

- *Switch has transitioned to lockout by any other source.*
- *AutoClose Mode is enabled and the switch is open due to UV3.*
- *Switch is closed.*

VRC has three operating modes. Two related to designation of source in radial protection applications and a third for use in ring feed situations.

ABC The recloser A, B and C terminals are connected to the source side in a radial feed situation. In ABC mode an auto reclose is blocked if any of the A, B, and C terminals see voltage below the VRC threshold.

RST The recloser R, S and T terminals are connected to the source side in a radial feed situation. In RST mode an auto reclose is blocked if any of the R, S, and T terminals see voltage below the VRC threshold.

Ring In Ring Operating Mode, source and load cannot be determined. An auto reclose is allowed if only one side of the open recloser sees voltage above the VRC threshold.

Panel Navigation

[*Turn Panel ON****]*** ⇒ ***[****SYSTEM STATUS****]*** ⇒ ***[****Press ESC****]***

⇩

[*MAIN MENU****]***

↳ ***[****Groups Settings****]***

↳ ***[****Group 1…4****]***

↳ *Protection Settings:* ***[****VRC****]*** ⇒

```
GROUP 1 VOLTAGE RECLOSING CONTROL

VRC Mode                      ►ABC◄
Voltage Multiplier            0.80

LLB                           Disabled
Voltage Multiplier            0.80
```

Note: *When ABR is enabled it will automatically use the VRC mode settings. VRC does not need to be enabled.*

VRC settings

Title	Designation	Range	Resolution	Factory Default
VRC Mode	VRC Mode	ABC/RST/Ring	NA	ABC
Voltage Multiplier(1)	UM	0.6 – 0.95	0.01	0.80

Notes:

1. *VRC threshold equals UM x U_rated / √3; where U_rated is the rated system voltage entered in the measurement settings (refer Section 5.2 Measurement Settings).*

Summary VRC Operation

Mode	A, B or C Terminal Voltage	R, S or T Terminal Voltage	Result
ABC	Below VRC Level	Above or Below LSD Level	Reclose Blocked
	Above VRC Level	Below LSD Level	Reclose Not Blocked
	Above VRC Level	Above LSD Level	Reclose Blocked
RST	Above or Below LSD Level	Below VRC Level	Reclose Blocked
	Below LSD Level	Above VRC Level	Reclose Not Blocked
	Above LSD Level	Above VRC Level	Reclose Blocked
Ring	Below VRC Level	Above VRC Level	Reclose Not Blocked
	Above VRC Level	Below VRC Level	Reclose Not Blocked
	Below VRC Level	Below VRC Level	Reclose Blocked
	Above VRC Level	Above VRC Level	Reclose Blocked

6.10.1 Live Load Blocking (LLB)

Live Load Blocking (LLB) prevents a close operation from any source (e.g. Protection (AR), HMI, CMS, SCADA, IO or Logic) when the voltage on the nominated load side is above the threshold set by the user.

The load side is defined by the VRC mode. If VRC is setup tor Ring then the LLB will block if both sides are live and will not block if only one side is live.

If LLB is active and a close operation is issued from any source, the close command will be blocked and the recloser will go to lockout. If ABR is ON, turning LLB ON will force ABR Off.

Panel Navigation

[Turn Panel ON] ⇒ *[SYSTEM STATUS]* ⇒ *[Press ESC]*
⇩
[MAIN MENU]
↳ *[Groups Settings]*
↳ *[Group 1…4]*
↳ *Protection Settings: [VRC]* ⇒

```
GROUP 1 VOLTAGE RECLOSING CONTROL

VRC Mode                          ABC
Voltage Multiplier               0.80

LLB                          ▶Disabled◀
Voltage Multiplier               0.80
```

LLB settings

Title	Designation	Range	Resolution	Factory Default
LLB	LLB	Enabled/Disabled	NA	Disabled
Voltage Multiplier	UM	0.6 – 0.95	0.01	0.80

Notes:

- *LLB threshold equals UM x U_rated / √3; where U_rated is the rated system voltage entered in the measurement settings (refer Section 5).*
- *Live Load Blocking is a configurable setting within each protection group. A global Live Load Blocking setting is available on the Protection Status Settings Page to enable/disable all of the Live Load Blocking group settings.*

Warning:

- *LLB will not operate if Protection is turned OFF.*

6.11 Automatic Backfeed Restoration (ABR)

Automatic backfeed restoration is the process whereby two feeders are tied by a “normally open” recloser. This recloser monitors voltage using voltage sensors on both Source and Load side. If supply is lost from the Load side and power is present on the Source side, then the “tie-in” recloser will close (after the configured restoration time has elapsed), restoring power by backfeeding from the non-faulted feeder. ABR has instantaneous reset time and thus the timer is reset to zero when power is restored.

ABR operation is dependent on the settings for Voltage Reclosing Control (VRC) including “VRC mode” and “Min Voltage Multiplier” and Loss of Supply Detection (LSD) settings.

The source side is determined by the VRC mode i.e. ABC or RST. The Load side will be the other side of the recloser. If VRC mode is set to Ring, ABR will operate on restoration of voltage to either (but not both) sides of an open switch. The recloser can be set to automatically open again depending on the mode selected for AutoOpen.

Note that enabling Live Line or disabling Protection or Auto Reclose automatically disables ABR. Closing the Recloser by any means also disables ABR. ABR will also be disabled if Protection settings or some System settings are downloaded to the relay via CMS.

ABR can only be turned ON if the OSM is in the open position, Protection is ON, Auto Reclose is ON, Live Line is OFF, LLB is OFF and ABR Mode is Enabled.

AutoOpen mode can be set to Timer Mode or Power Flow Mode. These modes cannot be enabled at the same time.

Timer Mode

The recloser can be set to automatically open after a set period of time and re-enable ABR. If the Load side still has no supply, ABR will then cause another close operation to occur (after 60ms). This cycle can be limited to a set amount of operations. If AutoOpen Operations is set to 0 then there will be no limit to the amount of AutoOpen/ABR operations.

Power Flow Mode

In this mode the recloser will be able to detect reduction and/or change in power flow direction and open automatically without operator intervention.

If AutoOpen is pending the following actions will cancel AutoOpen operation:

- ABR turned OFF
- Protection turned OFF
- AR turned OFF
- Protection settings changed
- Protection Group changed
- Live Line or Hot Line Tag is turned ON
- Recloser Opens from any source.

Note:

- *ABR is not supported for Single Double devices.*

Panel Navigation

[Turn Panel ON] ⇒ *[SYSTEM STATUS]* ⇒ *[Press ESC]*
⇩
[MAIN MENU]
↳ *[Groups Settings]*
↳ *[Group 1…4]*
↳ *Protection Settings: [ABR]* ⇒

```
   GROUP 1 BACKFEED RESTORATION

ABR Mode                      Enabled
Restoration Time (s)          100.00
AutoOpen                      Timer
AutoOpen Time (m)             120
AutoOpen Operations           1
```

ABR settings

Title	Designation	Range	Resolution	Factory Default
Operating Mode(1)	ABR Mode	Enabled/Disabled	NA	Disabled
Restoration Time	Tr	0 – 180 s	0.01 s	100.00
AutoOpen	Mode	Disabled/Timer/PowerFlow	NA	Disabled
Timer Mode(2)				
AutoOpen Time (m)	Tr, min	1 – 360 min	1 min	120
AutoOpen Operations	OPS	0 – 10	1	1
Power Flow Mode(2)				
Power Flow Dir Changed	Power Flow Dir Changed	Enabled/Disabled	NA	Disabled
Power Flow Reduced	Power Flow Reduced	Enabled/Disabled	NA	Disabled
% Power Flow Reduced	% Power Flow Reduced	50-90%	1%	50
AutoOpen Time (s)	Tr, sec	1 – 300 s	1 s	180

Notes:

1. *ABR global protection is automatically set to OFF on startup of the controller.*
2. *When the AutoOpen Operating Mode is set to Timer, the Timer fields will be displayed on the panel. When the AutoOpen Operating mode it set to **Powerflow** then the PowerFlow mode fields will be displayed on the panel.*

6.12 Auto Change Over (ACO)

The Auto Change over (ACO) system provides automatic switch over from one supply to another supply source when the first supply becomes unavailable. This system requires two OSM Reclosers and two recloser controllers mounted back to back with a common load. A communication link is required between the two controllers.

The two modes of operation are “Make Before Break” which allow restoration of supply without interruption or “Break Before Make” which allows restoration of supply with momentary interruption of supply. Both methods use a user set “ACO Time” between the opening and closing of the Reclosers.

The system also allows the two sources to be designated as “Equal” or alternatively one being “Main” and the other “Alternative”. This allows continuous supply from either source (whilst available) or switching back to the preferred main source when available.

The changeover mechanism runs additional checks between the Reclosers using “Peer to Peer Protocol” for communication.

ACO uses the protection element UV3 to determine if there has been a loss of supply and any of the voltage and frequency protection elements that are enabled (set to reclose or lockout) to determine if a source is not healthy.

The ACO scheme can only be enabled when the following conditions are met:

- One ACR must be open and one ACR must be closed.
- Protection must be On.
- LL, HLT, ABR, LLB, Synchronisation and Sectionaliser must be Off.
- At least the UV3 element must be set to lockout or reclose through the reclose map.
- The VRC source must be set to ABC or RST but not Ring.
- Both reclosers must be in a healthy state (no malfunctions or operational warnings).
- The communications link between the two reclosers must be healthy.
- "AR Timer Active" message must not displayed.

Refer to document NOJA-594 ACO User Manual for more detail.

Panel Navigation

[Turn Panel ON] ⇒ *[SYSTEM STATUS]*

↳ *[Automation]*

↳ *[ACO]* ⇒

```
                Automation

▶ACO◀ Auto-Synchroniser

ACO                              Off
Mode                 Break Before Make
ACO Time (s)                      0.1
Peer Comms                         OK
ACR            This ACR    Remote ACR
                   Main           Alt
                 Closed         Open
ACO Health           OK            OK
Source Health        OK            OK

   Information and other dynamic messaging
```

ACO settings

Title	Designation	Range	Resolution	Factory Default
ACO[1]	ACO	On/Off	NA	Off
Mode	Mode	Break Before Make/Make Before/Break	NA	Break Before Make
ACO Time	ACO Time (s)	0 – 180 s	0.1 s	0.1
ACR	ACR	This ACR Main/Equal/Alt	N/A	Main

Notes:

1. *ACO is automatically set to Off at startup of the controller.*

6.13 Synchronisation

The synchronisation functionality can be used to connect incoming generators to the grid and to re-establish a connection between two parts of the network or two islanded systems.

Synchronisation is a global control which must be enabled to be able to use the Sync-Check and Auto-Synchroniser functionality which operate in "Live Line" / "Live Bus" (LLLB) conditions:

- Sync-Check "supervises" the closing of a device and only allows a close when synchronising conditions are met (refer to Section 6.13.1 Synchronism-Check).
- Auto-Synchronisation can be initiated via the panel or CMS and it will wait for the auto-synchroniser conditions to be met prior to requesting a close of the device (refer to 6.13.2 Auto-Synchroniser).

When synchronisation is enabled if the bus voltage or line voltage is less than the live voltage limit and above the dead voltage limit i.e.

Dead Voltage Limit < V_{bus} < *Live Voltage Limit or Dead Voltage Limit* < V_{line} < *Live voltage limit*

any manual or automatic close will always be prevented.

A user can configure whether to allow or prevent a manual or automatic close under the following conditions:

- "Live Line" "Dead Bus" (LLDB)
- "Dead Line" "Live Bus" (DLLB)
- "Dead Line" "Live Bus" OR "Live Line" "Dead Bus" (DLLB or LLDB).

Notes:

- *When synchronisation is enabled, VRC and LLB will not operate and ABR and ACO are disabled.*
- *Synchronisation takes priority over Auto-Synchroniser even though they can work in parallel.*
- *"Dead Voltage Limit" is the predefined "LSD" limit. Refer to Section 6.9 Loss of Supply Detector (LSD).*

Please refer to Appendix C - Synchronisation for more details.

Panel Navigation

[**Turn Panel ON**] ⇒ ***[**SYSTEM STATUS**]*** ⇒ ***[**Press ESC**]***
⇩
[**MAIN MENU**]
↳ ***[**System Settings**]***
↳ ***[**Synchronism Settings**]***
[**General**] ⇒

```
        Synchronism Settings

►General◄ Sync-Check  Auto-Synchroniser

 Synchronisation                Disabled
 Phase Selection         Phase to Ground
 Bus and Line:      Bus: ABC & Line: RST
 Live/Dead Autoreclose          Disabled
 DLDB Autoreclose               Disabled
 Live/Dead Manual Close         Disabled
 DLDB Manual Close              Disabled
 Live Bus Voltage Multiplier        0.80
 Live Line Voltage Multiplier       0.80
 Bus Max Voltage Multiplier         1.20
 Line Max Voltage Multiplier        1.20
 Voltage Difference Multiplier      0.05
```

Synchronism General Settings

Title	Designation	Range	Resolution	Factory Default
Synchronisation	Synchronisation	Enable/Disable	N/A	Disable
Phase Selection	Phase Selection	Phase to Ground/Phase to Phase	N/A	Phase to Ground
Bus and Line Selection	Bus and Line	"Bus: ABC & Line: RST"/ "Bus: RST & Line: ABC"	N/A	Bus: ABC & Line: RST
Live/Dead Auto-Reclose(1)	Live/Dead Autoreclose	"Disabled"/ "LLDB" / "DLLB" / "LLDB or DLLB"	N/A	Disabled
DLDB Autoreclose(2)	DLDB Autoreclose	Enable/Disable	N/A	Disabled
Live/Dead Manual Close(3)	Live/Dead Manual Close	"Disabled"/"LLDB"/"DLLB" / "LLDB or DLLB"	N/A	Disabled
DLDB Manual Close(4)	DLDB Manual Close	Enable/Disable	N/A	Disabled
Live Bus Voltage Multiplier(5,10)	Live Bus Voltage Multiplier	0.3-1.2	0.01	0.8
Live Line Voltage Multiplier(6,10)	Live Line Voltage Multiplier	0.3-1.2	0.01	0.8
Bus Max Voltage Multiplier(7,10)	Bus Maximum allowed Voltage	0.8-1.4	0.01	1.2
Line Max Voltage Multiplier(8,10)	Line Maximum allowed Voltage	0.8-1.4	0.01	1.2
Voltage Difference Multiplier(9,10)	Voltage Diff Multiplier	0.03-0.50	0.01	0.05

Note:

1. *Auto-reclose mode when energising a dead section of the network during synchronisation.*
2. *Auto-reclose mode in case of reconnection of two dead sections during synchronisation.*
3. *Manual close mode when energising a dead section of the network during synchronisation.*
4. *Manual close mode in case of reconnection of two dead sections during synchronisation.*
5. *Live bus minimum voltage limit for synchronisation.*

6. *Live line minimum voltage limit for synchronisation.*
7. *Bus maximum allowed voltage during synchronisation.*
8. *Line maximum allowed voltage during synchronisation.*
9. *Maximum allowable voltage difference for synchronisation*
10. *Minimum and maximum voltage limits equal Multiplier x U_rated where U_rated is the rated system voltage entered in measurement settings (refer to Section 5.2). (**Note:** When Phase to Ground is selected then the multipliers refer to U_rated / √3).*

6.13.1 Synchronism-Check (ANSI 25)

Synchronism-check (25) "supervises" the closing of a device and only allows a close when both sides of the recloser are within the desired limits of frequency, phase angle and voltage to permit the paralleling of two circuits.

Synchronism Check will only operate for "Live Bus" / "Live Line" conditions. The "Bus" and "Line" of the recloser and the "Live" conditions can be configured under the General tab (refer to Section 6.13). When Synchronisation-Check is enabled, synchronising conditions must be met for the duration of a pre-configured time (pre-sync time) before allowing a close of the device.

If the request to close occurs due to an auto reclose sequence, the pre-sync time delay is fixed at 80ms whereas for a manual close it can be set by the user (manual pre-sync time).

Synchronisation must be enabled for Synchronism-Check to be operational (refer to Section 6.13).

Panel Navigation

[Turn Panel ON] ⇒ *[SYSTEM STATUS]* ⇒ *[Press ESC]*
⇩
[MAIN MENU]
↳ *[System Settings]*
↳ *[Synchronism Settings]*
[Sync-Check] ⇒

```
        Synchronism Settings

General ►Sync-Check◄ Auto-Synchroniser

Sync-Check                      Disabled
Max Sync Slip Frequency (Hz)        0.03
Phase Angle Difference (º)            20
Manual Pre-Sync Time (s)               5
```

Sync-Check Settings

Title	Designation	Range	Resolution	Factory Default
Sync-Check	Sync-Check	Enable/Disable	N/A	Disable
Max Sync Slip Frequency(1)	Max Sync Slip Frequency, Hz	0.03 – 0.1 Hz	0.01 Hz	0.03 Hz
Phase Angle Difference(2)	Phase Angle Difference, deg	0 – 90°	1°	20°
Manual Pre-Sync Time	Manual Pre-Sync Time, s	0 – 60 s	1	5 s

Notes:

1. *Maximum slip frequency to detect synchronous conditions. A moving average of 32 samples at quarter cycle rate on the 2 frequencies (ABC and RST) is provided to compare f_{bus} and f_{line}. The frequency difference should be minimised to practical response limitations.*
2. *Maximum allowable phase angle difference for synchronisation. A close should ideally take place when the ABC and RST sides of the recloser are at zero degrees phase angle difference. To accomplish this, the recloser will initiate a close in advance of phase angle coincidence to accommodate for the recloser closing time.*

6.13.2 Auto-Synchroniser (ANSI 25A)

The Auto-Synchroniser functionality (25A) is used for the connection of incoming generators to the grid or the re-establishment of the connection between two islanded systems. When Auto-Synchroniser is initiated, it will wait for the auto-synchroniser conditions to be met prior to requesting a close of the device. If the conditions are not met within the Auto-sync waiting time then a close will not be requested.

Auto-Synchroniser is only operational in Live Line/Live Bus conditions, when the device is open and when Synchronisation has been enabled (refer to Section 6.13). It can be initiated via the HMI panel, I/O, SCADA, CMS, Logic and SGA. The Auto-Synchroniser tab will only appear when Synchronisation is enabled.

"Anti-Motoring" can be used to prevent motoring condition and prime mover damage. When "Anti-Motoring" is enabled the following conditions must be met for auto-synchroniser to be operational:

$$V_{bus\_rms} \geq 1.025 \times V_{line\_rms}$$

$$f_{bus} - f_{line} \geq 0.01 \text{ Hz}.$$

Panel Navigation

[Turn Panel ON] ⇒ [SYSTEM STATUS] ⇒ [Press ESC]
⇩
[MAIN MENU]
↳ *[System Settings]*
↳ *[Synchronism Settings]*
[Auto-Synchroniser] ⇒

```
        Synchronism Settings

General  Sync-Check ►Auto-Synchroniser◄

Fundamental Frequency (Hz)          50
Max Frequency Deviation (Hz)      0.50
Max Slip Frequency (Hz)           0.10
Max ROC Slip Freq (Hz/Sec)         0.2
Auto-sync Waiting Time (s)         200
Anti-Motoring                  Enabled
```

Auto-Synchroniser Settings

Title	Designation	Range	Resolution	Factory Default
Fundamental Frequency(1) (Hz)	Fundamental Frequency, Hz	47-64 Hz	1 Hz	50 Hz
Max Frequency Deviation (Hz)	Max Frequency Deviation, Hz	0 to 1 Hz	0.01 Hz	0.5 Hz
Max Slip Frequency(2) (Hz)	Max Slip Frequency, Hz	0.03 to 0.5 Hz	0.01 Hz	0.1 Hz
Max Rate of Change of (ROC) Slip Frequency(2)	Max ROC Slip Frequency, Hz/s	0.01-1 Hz/s	0.01 Hz/s	0.25 Hz/s
Auto-sync Waiting Time	Auto-sync Waiting Time, s	100-3600 s	1 s	200 s
Anti-Motoring	Anti-Motoring	Enable/Disable	N/A	Enabled

Notes:

1. *Fundamental frequency for Synchronism to determine the deviation from "normal".*
2. *A moving average of 32 samples at quarter cycle rate on the 2 frequencies (ABC and RST) is provided to compare f_{bus} and f_{line}.*

Panel Navigation

[Turn Panel ON] ⇒ [SYSTEM STATUS]
↳ *[Automation]*
↳ *[Auto-Synchroniser] ⇒*

```
          Automation

ACO ►Auto-Synchroniser◄

Auto-Synchroniser          Initiate

Synchronising status             OK
Voltage status                   OK
Slip Frequency Status            OK
Advance Angle Status             OK
Phase Angle Difference (°)      -10
```

6.14 Fault Locator

The Fault Locator (21FL) functionality provides one-end impedance based fault location estimation in a radial distributed system. The 21FL function operates based on the measurements of current and voltage phasors on one side of the line.

The fault location algorithm utilises zero and negative phase sequence current as the polarising values which eliminates dependency on load, source and load impedances and improves accuracy.

Distance to fault is calculated in two steps(1). First the fault type is determined, then the distance to fault is calculated based on the detected fault type.

The fault location algorithm is applicable to OC, EF(2), SEF(2), OCLL(2), EFLL(2) and SEFLL(2) elements.

When the calculation is completed, following values are reported:

- FltDiskm Distance to Fault (km)
- Zf Magnitude of Fault Impedance
- θf Angle of Fault Impedance (degree)
- ZLoop Magnitude of Fault Loop Impedance
- XLoop Measured Positive Sequence Reactance from the Relay to Fault Location
- θLoop Angle of Fault Loop Impedance (degree).

Notes:

1. *The algorithm for single phase earth faults is not suitable for ungrounded and Petersons' coil grounded systems. As the fault type detection depends on the operation of overcurrent elements, high impedance faults will not be detected if overcurrent elements do not operate.*
2. *An OC pickup must occur to trigger the Fault Locator.*

Panel Navigation

[**Turn Panel ON**] ⇒ ***[**SYSTEM STATUS**]*** ⇒ ***[**Press ESC**]***

⇩

[**MAIN MENU**]

↳ ***[**System Settings**]***

↳ ***[**Fault Locator Settings**]***

FAULT LOCATOR SETTINGS	
Fault Locator	**Disabled**
R0 (Ω/km)	**0.010**
X0 (Ω/km)	**0.100**
R1 (Ω/km)	**0.010**
X1 (Ω/km)	**0.100**
Length of Line (km)	**1.00**

Fault Locator Settings

Title	Designation	Range	Resolution	Factory Default
Fault Locator	Fault Locator	Enabled/Disabled	N/A	Disabled
R0 (Ω/km)	Zero Sequence Resistance	0.001-50	0.001	0.010
X0 (Ω/km)	Zero Sequence Reactance	0.001-50	0.001	0.100
R1 (Ω/km)	Positive Sequence Resistance	0.001-50	0.001	0.010
X1 (Ω/km)	Positive Sequence Reactance	0.001-50	0.001	0.100
Length of Line (km)	Length of line in forward direction from the relay	0.01-300	0.01	1.00

Notes:

- *It is assumed all zero and positive impedances as well as lengths are the same for all phases.*
- *It is assumed that impedance settings are valid in both forward and reverse direction.*
- *If the absolute value of the fault distance is more that the configured line with tolerance of 2.5%, "Out of Range" will be reported.*
- *Fault locator status and measured values can be reset through "Reset Fault Targets" from the Reset Menu on the panel or CMS. Refer to Section 7.8 Fault Targets.*
- *Fault locator status and measured values will also be reset if fault locator is disabled or a new fault occurs.*
- *Fault locator measured values will be calculated for enabled Sequence advance functionality only if the sequence advance is set to "0".*

6.15 Harmonic Protection

The RC Power Quality System provides monitoring and protection features for power quality issues such as Harmonics Distortion, Interruptions, and Sags and Swells (Refer to Section 7.11 Power Quality).

Harmonics are waves which have frequency multiples of the fundamental frequency. Distortions due to harmonics are measured in two separate methods, known as Total Harmonic Distortion (THD) and Total Demand Distortion (TDD). THD is a ratio between the fundamental voltage wave and all the voltage harmonics. TDD is used to calculate the current distortion relative to the peak current demand.

The system provides harmonic protection by allowing the user to configure responses such as triggering an alarm or a trip.

The controller measures THD, TDD, Individual Harmonics for Current and Voltage (HRMI and HRMV) up to the 15th harmonic. The signals are the 3 bushing voltages (Ua, Ub, Uc), 3 phase currents and the neutral current.

Protection

- The user can configure a set point for each harmonic and for the total harmonic distortion. If a value exceeds any of the set points then an alarm or lockout is triggered.
- Up to five individual harmonics can be user selected and monitored.
- Protection and measurements are based on the bushing phase configuration.
- The TDD and current harmonic protection will not pick up when the current of any phase exceeds 800A rms.

Groups Settings - THD/TDD Settings

Panel Navigation

[Turn Panel ON] ⇒ *[SYSTEM STATUS]* ⇒ *[Press ESC]*
⇩
[MAIN MENU]
↳ *[Groups Settings]*
↳ *[Group 1 Feeder]*
↳ *Protection Settings: [HRM]*
↳ *[THD/TDD]* ⇒

```
          GROUP x Harmonics

►THD/TDD◄ INDIVIDUAL HRM

Voltage THD                    Disabled
Voltage THD Level (%)               5.0
Voltage THD Tripping Time (s)       1.0

Current TDD Mode               Disabled
Current TDD Level (%)               5.0
Current TDD Tripping Time (s)       1.0
```

THD/TDD Settings

Title	Designation	Range	Resolution	Factory Default
Voltage THD	THD Mode	Disable/Alarm/Lockout	N/A	Disable
Voltage THD Level(1)	THD %	1.0 to 100.0	0.1	5.0
Voltage THD Tripping Time (s)	THD Time	1.0 to 120.0	0.1	1.0
Current TDD Mode(2)	TDD Mode	Disable/Alarm/Lockout	N/A	Disable
Current TDD Level	TDD Level	1.0 to 100.0	0.1	5.0
Current TDD Tripping Time (s)	TDD Time	1.0 to 120.0	0.1	1.0

Notes:

1. *The tripping condition is met if any one of Ua, Ub, or Uc voltages exceeds the threshold.*
2. *The tripping condition is met if any one of Ia, Ib, Ic, or In currents exceeds the threshold*.

Individual HRM Settings

Panel Navigation

[Turn Panel ON] ⇒ *[SYSTEM STATUS]* ⇒ *[Press ESC]*
⇩
[MAIN MENU]
↳ *[Groups Settings]*
↳ *[Group 1 Feeder]*
↳ *Protection Settings: [HRM]*
[Individual HRM] ⇒

```
          GROUP x Harmonics

THD/TDD ►INDIVIDUAL HRM◄

Individual Harmonics Mode      Disabled
Individual Tripping Time (s)        1.0
Harmonic A                     Disabled
Level A (%)                         5.0
Harmonic B                     Disabled
Level B (%)                         5.0
Harmonic C                     Disabled
Level C (%)                         5.0
Harmonic D                     Disabled
Level D (%)                         5.0
Harmonic E                     Disabled
Level E (%)                         5.0
```

Individual HRM Settings

Title	Designation	Range	Resolution	Factory Default
Individual Harmonics Mode	IND Mode	Disable/Alarm/Lockout	N/A	Disable
Individual Tripping Time (s)	IND Time	1 to 120.0	0.1	1.0
Harmonic A	IND A Name	Disable/I2/I3/I4/....In15/....V15	N/A	Disable
Level A (%)	IND A Level	1 to 100	0.1	5.0
Harmonic B	IND_B Name	Disable/I2/I3/I4/....In15/....V15	N/A	Disable
Level B (%)	IND_B Level	1 to 100	0.1	5.0
Harmonic C	IND_C Name	Disable/I2/I3/I4/....In15/....V15	N/A	Disable

Title	Designation	Range	Resolution	Factory Default
Level C (%)	IND_C Level	1 to 100	0.1	5.0
Harmonic D	IND_D Name	Disable/I2/I3/I4/....In15/....V15	N/A	Disable
Level D (%)	IND_D Level	1 to 100	0.1	5.0
Harmonic E	IND_E Name	Disable/I2/I3/I4/....In15/....V15	N/A	Disable
Level E (%)	IND_E Level	1 to 100	0.1	5.0

The following individual harmonics can be selected (ITDD and UTHD values apply across all three phases):

- Disable
- I2, I3, I4, I5, I6, I7, I8, I9, I10, I11, I12, I13, I14, I15
- In2, In3, In4, In5, In6, In7, In8, In9, In10, In11, In12, In13, In14, In15
- V2, V3, V4, V5, V6, V7, V8, V9, V10, V11, V12, V13, V14, V15

6.16 Protection Status Control (PSC)

Protection Status Control allows global changes to protection status from a variety of sources. Changes to PSC status can be done from the Panel, Supervisory Control and Data Acquisition (SCADA) systems, digital input and output (I/O) interface or Personal Computer running the CMS software program.

The table below lists the available PSC elements. Setting an element to the indicated state causes the PSC to change all associated protection elements as shown.

Note that Live Line is unique in that it causes elements to be disabled when turned ON or OFF. Setting any other element to ON simply enables all affected elements.

PSC Element	Effect on associated protection elements	Factory Default
S(Active Group)=1-4[1]	All protection elements for the identified group are enabled[3]. All protection elements for all other groups are disabled.	1
S(Protection)= Off[2]	All protection elements for all groups are disabled.	Off
S(AR)=Off[2]	AR OC/NPS/EF/SEF, AR VE, ABR for all groups are disabled	Off
S(LL)=On[2]	OC1+, OC2+, OC3+, OC1- ,OC2- , OC3- , NPS1+, NPS2+, NPS3+, NPS1-, NPS2-, NPS3-, EF1+, EF2+, EF3+, EF1-, EF2- , EF3- , SEF+, SEF–, AR OC/EF/NPS/SEF, AR VE, ABR, CLP, IR for all groups are disabled	Off
S(LL)=Off[2]	OCLL1-3, NPSLL1-3, EFLL1-3, SEFLL for all groups are disabled	Off
S(EF)=Off[2]	EF1+, EF2+ , EF3+ , EF1-, EF2-, EF3- for all groups are disabled	Off
S(SEF)=Off[2]	SEF+, SEF– for all groups are disabled	Off
S(CLP)=Off[2]	CLP for all groups is disabled	Off
S(ABR)=Off[2]	ABR for all groups is disabled	Off
S(UV)=Off[2]	UV1, UV2 and UV3 for all groups are disabled	Off
S(UV4 Sag)=Off	UV4 Sag for all groups are disabled	Off
S(HLT - Hot Line Tag)=Off[2]	Hot Line Tag is disabled	Off
S(NPS)=Off	NPS1+, NPS2+, NPS3+, NPS1-, NPS2-, NPS3- for all groups are disabled	Off
S(OV)=Off[2]	OV1, OV2, OV3 and OV4 for all groups are disabled	Off
S(OV3)	OV3 for all groups is disabled	Off
S(Yn)	Yn for all groups is disabled	Off
S(UF)=Off	UF for all groups is disabled	Off
S(OF)=Off	OF for all groups is disabled	Off
S(ROCOF)=Off	ROCOF for all groups is disabled	Off
S(VVS)=Off	VVS for all groups is disabled	Off
S(PDOP)=Off	PDOP for all groups is disabled	Off
S(PDUP)=Off	PDUP for all groups is disabled	Off
S(HRM)=Off	HRM elements for all groups are disabled	Off
S(HIB)=Off	Harmonic Inrush Blocking for all groups is disabled	Off
S(HLT - Link HLT to LL)=Off	Link HLT to LL	Off
S(MNT)=Off	Maximum Number of Trips for all groups is disabled	Off
S(SSM)=Off	Short Sequence Mode for all groups is disabled	Off
S(DFT)=Off	Disable Fast Trips for all groups is disabled	Off

PSC Element	Effect on associated protection elements	Factory Default
S(Alarm Mode)=Off	Alarm Mode for all groups is disabled	Off
S (LLB)=Off	Live Load Blocking for all groups is disabled	Off
S(79-2 Lockout)=Off	79-2 Lockout for all groups is disabled	Off
S(79-3 Lockout)=Off	79-3 Lockout for all groups is disabled	Off
S(ACO)=Off[2]	Auto Change Over for all groups is disabled	Off
S(Logical Block Close)=Off	Logical Block Close for all groups is disabled	Off

***Notes**:*

1. *When Group 1 is switched ON, other Groups are automatically switched OFF.*
2. *On / Off control available from the Panel fast keys (depending on fast key configuration option).*
3. *Conditional on the individual element being enabled.*

Panel Navigation

[Turn Panel ON] ⇒ *[SYSTEM STATUS]*

↳ *[Protection]*

↳ *[Page 1]*

```
      PROTECTION GLOBAL SETTINGS

▶Page 1◀ Page 2  Page 3

 Active Group                    1
 Protection                    Off
 AR Auto Reclose               Off
 LL Live Line                  Off
 EF Earth Fault                Off
 SEF Sensitive Earth Fault     Off
 CLP Cold Load Pickup          Off
 ABR Autobackfeed Restore      Off
 UV Undervoltage               Off
 UV4 Sag                       Off
 LLB Live Load Blocking        Off
 HLT Hot Line Tag              Off
```

↳ *[Protection]*

↳ *[Page 2]*

```
      PROTECTION GLOBAL SETTINGS

Page 1 ▶Page 2◀ Page 3

 NPS Negative Sequence         Off
 OV  Over Voltage              Off
 UF  Under Frequency           Off
 OF  Over Frequency            Off
 HRM Harmonics                 Off
 HLT Link HLT to LL            Off
 MNT Maximum Number of Trips   Off
 SSM Short Sequence Mode       Off
 DFT Disable Fast Trips        Off
 Max No. of Trips to Lockout   Normal
 Alarm mode                    Off
```

↳ *[Protection]*

↳ *[Page 3]*

```
      PROTECTION GLOBAL SETTINGS

Page 1  Page 2 ▶Page 3◀

 OV3 Neutral Displacement      Off
 Yn  Admittance Protection     Off
 RCF ROCOF Protection          Off
 VVS VVS Protection            Off
 HIB Harmonic Inrush Blocking  Off
 PDOP Dir Overpower Protection Off
 PDUP Dir Underpower Protection Off
```

6.17 Circuit Breaker Failure (CBF) (ANSI 50BF)

Circuit Breaker Failure (CBF) ensures that the OSM recloser has correctly opened when a trip operation occurs.

The CBF has two modes of operation,

1. CBF Default Mode and
2. User Configurable Backup Trip Mode

CBF Default Mode:

In the CBF default mode, the recloser is monitored locally and user is notified/warned if there is any malfunction detected. The malfunctions include:

Title	Description
Excessive To	Occurs when the RC controller retries 3 times and the recloser does not indicate open. “Excessive To” is the default setting and cannot be disabled.
CBF Malfunction	Occurs when “Excessive To” Malfunction occurs or the recloser indicates “Open” but at least one phase still indicates phase current is flowing which exceeds the set threshold.

The fault reset time is 50 ms. Hysteresis is applicable where Pickup will occur at 100% and Drop Off will occur at 97.5% of the set current value.

***Note**: CBF Malfunction is reported after a fixed time of 150 ms.*

User Configurable CBF Backup Trip Mode:

Backup Trip Mode is to facilitate operation of an upstream Circuit Breaker by sending a “CBF Backup Trip” signal in case the local recloser has not operated. This helps to isolate the fault.

The modes available for the CBF Backup trip are:

- Excessive To
- Current
- Excessive To/Current.

These modes check whether the recloser has failed to open or the enabled currents have exceeded the threshold’s critical parameters

The global malfunction signal will be triggered by “CBF Malfunction” or “CBF Backup Trip”.

The CBF settings are:

Title	Range	Resolution	Factory Default
Backup Trip Mode	On/Off	NA	Off
Phase Current (A)	1-800	1	1
Residual Current (A)	1-800	1	1
Current Check Mode	Phase, Residual Phase/Residual	NA	Phase
CBF Backup Trip	Excessive To Current Excessive To/Current	NA	Excessive To/Current
Backup Trip Time (s)	0.15 – 60 s	0.01 s	0.25 s

***Note**: The fault reset time is 50ms.*

Blocking Functionality

It is possible to block the Backup trip output by applying a “Block Backup Trip” signal through Logic, I/O module or SGA logic.

CBF Reset

Backup Trip Pickup and CBF Backup Trip is reset after disabling Backup Trip Mode. When Backup Trip Mode is enabled after being disabled, a reassessment of the conditions occurs.

The malfunctions are reset when the next successful operation of the OSM recloser occurs.

Panel Navigation

[Turn Panel ON] ⇒ *[SYSTEM STATUS]* ⇒ *[Press ESC]*
⇩
[MAIN MENU]
↳ *[System Settings]*
↳ *[Switchgear Configuration]* ⇒

```
        SWITCHGEAR CONFIGURATION

Phase Configuration                ABC
Power Flow Direction         ABC to RST

CBF:
Backup Trip Mode                   Off
Phase Current (A)                    1
Residual Current (A)                 1
Current Check Mode               Phase
CBF Backup Trip    Excessive To/Current
Backup Trip Time (s)              0.25
```

The Malfunction will be displayed in the panel as:

```
              System Status

GENERAL WARNING ►MALFUNCTION◄

<29/11/2018, 10:19:35 AM              >
CBF Malfunction
<29/11/2018, 10:21:35 AM              >
CBF Backup Trip
```

7 Monitoring

The RC Cubicle generates and maintains the following records:

- Close / Open (CO) operations — OSM operation data
- Fault Profile — Fault episode data
- Event log — Event data
- Change Log — Setting and status change data
- Load Profile — Energy, Frequency, Real, Reactive and Active Power profile data
  See full listing in Section 7.6
- Lifetime Counters — Number of Close Open operations and associated Contact Wear
- Fault Counters — Number of Protection Trips
- SCADA Counters — Communication Protocol Data
- Power Quality — Oscillography, Harmonics, Interruption, Sags/Swells
- Maximum Demand Indication

Records and counters are accessible via the panel or can be captured via the CMS software. To analyse power quality data the Power Quality Software (PQS) is used.

Note: *Fault and SCADA counters can be reset but not logs.*

7.1 Communication Log Settings

A trace logging of protocol information can be enabled for each of the protocols. A USB flash drive must be plugged into one of the USB relay ports and left plugged in for the logging to be saved to (communication logs are not stored on the relay). Please refer to NOJA-565 SCADA Interface Description for more details.

Panel Navigation

[Turn Panel ON] ⇒ *[SYSTEM STATUS]* ⇒ *[Press ESC]*
⇩
[MAIN MENU]
↳ *[System Settings]* ⇒
↳ *[Comms Log Settings]* ⇒
↳ *[SCADA]* ⇒

```
          COMMs LOG SETTINGS

▶SCADA◀ Other

DNP3 Data Logging              Disabled
DNP3 Max Log size (MB)                2
IEC 60870 Data Logging         Disabled
IEC 60870 Max Log size (MB)           2
Modbus Data Logging            Disabled
Modbus Max Log size (MB)              2
```

↳ *[Comms Log Settings]* ⇒
↳ *[Other]* ⇒

```
          COMMs LOG SETTINGS

SCADA ▶Other◀

CMS Data Logging               Disabled
CMS Max Log size (MB)                 2
P2PComms Data Logging          Disabled
P2PComms Max Log size (MB)            2
Panel Data Logging             Disabled
Panel Max Log size (MB)               2
GPS Data Logging               Disabled
GPS Max Log size (MB)                 2
```

Notes:

- *Logging for only one protocol can be enabled at any one time. Enabling data logging for one protocol will disable data logging for an already enabled protocol.*
- *Must eject USB flash drive through USB operations before unplugging otherwise data may be lost.*

7.2 Close Open (CO) Operations

This record registers the last 1,000 Closed/Open events associated with changes in OSM position.

The CO Operations log is accessible via the Panel or can be captured using CMS software.

Panel Navigation

[Turn Panel ON] ⇒ *[SYSTEM STATUS]* ⇒ *[Press ESC]*
⇩
[MAIN MENU]
↳ *[Logs]* ⇒
↳ *[CLOSE/OPEN]* ⇒

```
                    LOGS

<Close/Open> Event

▶18/02/2013 04:42:16 PM Open    UV3     ◀
 18/02/2013 04:42:06 PM Close   HMI
 18/02/2013 04:42:03 PM Open    HMI

 Source:   UV3
 State:    Lockout
                     Trip (Ia), A=0
 Trip (Ib), A=0      Trip (Ic), A=0
 Trip (In), A=0
```

↳ *[Select any Close/Open entry for detail]* ⇒

```
       CLOSE/OPEN OPERATION DETAIL

 Date/time:  18/02/2020 04:42:16.702 PM
 Type:       Open
 Source:     UV3
 State:      Lockout

 Critical Parameters:
 Trip (Ia), A=0
 Trip (Ib), A=0
 Trip (Ic), A=0
 Trip (In), A=0
```

Each event is described by the following characteristics.

- Date and time event registered
- Event title (Open/Closed)
- Source of event
- Relevant state
- Critical parameter
- Currents at time of initiation of trip command.

The table below provides further information on CO Operation events.

Event	Applicable sources of event	Relevant state	Critical parameter
Open	Any protection element Operated by means of HMI, CMS, I/O, SCADA or mechanical trip ring	Open 1 (Lockout) or Open 2/Open 3/Open 4 (waiting to reclose) ***Note**: For any protection element that does not have an auto reclose map the relevant state is blank unless it is in Lockout State*	Values registered between pickup start and open events Maximum phase current (Max(Ia) / Max(Ib) / Max(Ic)) for OC elements VR Active, VC Active for OC2+, OC2- Maximum residual current (Max(In)) for EF and SEF elements Maximum negative sequence current Max(I2) for NPS elements Max (I2/I1) registered in pickup duration and protection operation currents, {Trip(Ia), Trip(Ib), Trip(Ic), and Trip(In)}. Max(Gn FWD) = Maximum Recorded Conductance during fault when “forward conductance” exceeded for Yn Max(Bn FWD) = Maximum Recorded Susceptance during fault when “forward Susceptance” exceeded for Yn Min(Gn REV) = Minimum Recorded Conductance during fault when “reverse conductance” exceeded for Yn Min(Bn REV) = Minimum Recorded Susceptance during fault when “reverse Susceptance” exceeded for Yn Minimum positive sequence voltage (Min(U1)) for UV1, UV12, UV22 Minimum line to line voltage (Min(Uab) / Min(Ubc) / Min(Uca)) for UV2, UV22, UV23 Maximum positive sequence voltage (Max(U1)) for OV1, OV12, OV13 Maximum line to line voltage (Max(Uab) / Max(Ubc) / Max(Uca)) for OV2, OV22, OV23 Max (Un*)* registered in pickup duration and protection operation currents, {Trip(Ia), Trip(Ib), Trip(Ic) and Trip(In)} for OV3. Max (U2*)* registered in pickup duration and protection operation currents, {Trip(Ia), Trip(Ib), Trip(Ic) and Trip(In)} for OV4. Minimum frequency (Min(F)) for UF, UF2, UF3 Maximum frequency (Max(F)) for OF, OF2, OF3 Maximum of any of the following: THD, TDD, A,B,C,D,E (where A,B,C,D,E are individual harmonics selected by the user) Min UV4Sag for UV4 Sag Max ROCOF Max(PDOP) (kVA) for PDOP Min(PDUP) (kVA) for PDUP
	Sectionaliser	Lockout	Maximum current during fault in Sectionaliser mode (recorded from pickup through to LSD)
	UV3	Open UV3 AutoClose	
		Open UV3	Trip(Ia), A=0; Trip(Ib), A=0; Trip(Ic), A=0; Trip(In), A=0
	AutoOpen Power Flow Dir Changed	Open ABR	

Event	Applicable sources of event	Relevant state	Critical parameter
	AutoOpen Power Flow Reduced	Open ABR	
Closed	Any Auto Reclose element, ABR, HMI, SCADA, PC, I/O, ACO	Close 2/Close 3/Close 4 for AR OC/NPS/EF/SEF/Yn ARVE OV/UV Close 0 or Close 1 for others ***Note**: For any protection element that does not have an auto reclose map the relevant state is blank.*	
	UV3 AutoClose		

7.3 Fault Profile

The Fault Profile is made up of records related to each of the last 8 protection trip operations caused by any protection element. The fault profile is not visible on the Panel and can be viewed using CMS software.

Each record includes Ia, Ib, Ic, In, Ua, Ub, Uc, Uab, Ubc, Uca, U1, F, A0 and A1 values logged for each cycle of power frequency for up to 1 second prior to trip operation. The values for each cycle are identified by a sequential number from 1 to 50. The record with the highest sequential number is the time at which the OSM tripped.

7.4 Event log

The Event Log registers up to 10,000 events associated with changes of particular signals or parameters. The Event Log is visible on the Panel and can also be viewed using CMS software. Each event is described by the following characteristics:

- Date and time registered
- Event title
- Source of event
- Relevant phase
- Critical parameter

For the full list of Events, refer to Appendix G – Events.

7.5 Change Log

The Change Log record contains up to 1,000 events associated with changes of settings, protection status, external load status, control mode or erasing energy meter readings and fault counters. The Change Messages log is not visible on the Panel but can be captured using CMS software. Each event is described by the following:

- Date and Time of change
- Changed parameter
- Old value
- New value
- Source of change (HMI, CMS, SCADA, I/O)

For a full list of Change Log Messages, refer to Appendix H – Change Log Messages.

7.6 Load Profile

This log registers up to 10,000 readings of Load Profile data. Up to 30 items can be selected for each interval record. These are configured by a PC using the CMS software package. Data that can be selected for recording includes:

- Currents on all three phases and neutral
- Phase to ground voltage on each bushing
- Phase to phase voltages
- Three phase and single phase Active, Apparent and Reactive Power
- Three phase and single phase Power Factor
- Frequency on ABC and RST
- Lifetime Energy in forward and reverse power flow direction. Three phase and single phase Active, Apparent and Reactive.
- Energy used per Load Profile Interval in forward and reverse power flow direction. Three phase and single phase Active, Apparent and Reactive.
- Positive and Negative Sequence Current
- Positive, Negative and Zero Sequence Voltage
- Battery Voltage, Current and Capacity
- Cubicle Temperature and Average Power

The readings are averaged over a pre-set time interval 1/2/5/10/15/30/60/120 min. If a 1 minute interval was selected, 10,000 records would give 6.9 days of data. If a 120 minute interval was selected there would be 832 days of data. When the RC reaches 10,000 readings it will start discarding the oldest records.

Each load profile reading is provided with a date and time stamp. The Load profile is not visible on the Panel but can be captured using CMS software.

7.7 Counters

The RC monitors the number of operations and energy throughput during a fault and calculates the percentage of contact wear remaining after each Close – Open operation.

Two lifetime counters are maintained, one for mechanism wear and the other for contact wear.

Fault counters provide indication of the number and type of each fault the OSM has operated for.

Counters can be reset via the operator panel from Main Menu - > Reset Menu or via CMS.

7.7.1 Lifetime counters

Lifetime counters calculate and record the total number of Close Open (CO) Operations and the mechanical contact wear. They are accessible via the Panel or can be captured using CMS software.

- 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 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) Operation.

Panel Navigation

[Turn Panel ON] ⇒ *[SYSTEM STATUS]* ⇒ *[Press ESC]*
⇩
[MAIN MENU]
↳ *[Counters]*
↳ *[Lifetime Counters]* ⇒

```
          LIFETIME COUNTERS

Close/Open Total                  100
Mechanical Wear (%)              1.00
Contact Wear (%)                 2.00
```

7.7.2 Fault counters

Fault counters record the number of protection operations (faults) provided by each of the following

- Phase Overcurrent (OC) (per phase)
- Earth Fault (EF)
- Frequency Protection (FE)
- Negative Phase Sequence (NPS)
- Sensitive Earth Fault (SEF)
- Voltage Protection (VE)

Records are calculated and updated after each protection operation (fault). They are accessible via the Panel or can be captured using CMS software.

Panel Navigation

[Turn Panel ON] ⇒ *[SYSTEM STATUS]* ⇒ *[Press ESC]*
⇩
[MAIN MENU]
↳ *[Counters]*
↳ *[Fault Counters]* ⇒
↳ *[Page 1]* ⇒

```
FAULT COUNTERS

▶Page 1◀ Page 2

OC A                    12
OC B                    10
OC C                    15
EF                      22
SEF                      3
NPS                      0
I2/I1                    0
Yn                       0
UF                       0
OF                       0
```

↳ *[Fault Counters]* ⇒
↳ *[Page 2]* ⇒

```
FAULT COUNTERS

Page 1 ▶Page 2◀

ROCOF                    0
VVS                      0
PDOP                     0
PDUP                     0
UV                       0
OV                       0
HRM                      0
```

7.7.3 SCADA Counters

The SCADA counters record data which can assist with commissioning and testing communications links.

Panel Navigation

[Turn Panel ON] ⇒ *[SYSTEM STATUS]* ⇒ *[Press ESC]*
⇩
[MAIN MENU]
↳ *[Counters]*
↳ *[SCADA Counters]* ⇒

```
SCADA COUNTERS

Call Drop outs           0
Calls Failed             0
Tx Frames               32
Rx Frames               56
Length Errors            0
CRC Errors               0
C1 Buffer               12
C2 Buffer                0
C3 Buffer                0
```

7.7.4 DNP3-SA Counters

The DNP3-SA counters record data which can assist with monitoring DNP3 security such as monitoring session key changes, error messages and authentication failures.

Panel Navigation

[Turn Panel ON] ⇒ [SYSTEM STATUS] ⇒ [Press ESC]
⇩
[MAIN MENU]
↳ *[Counters]*
↳ *[DNP3-SA Counters] ⇒*

DNP3-SA COUNTERS	
Unexpected Messages	0
Authorization Failures	0
Authentication Failures	0
Reply Timeouts	0
Rekeys Due to Auth. Failure	0
Total Messages Sent	0
Total Messages Received	0
Critical Messages Sent	0
Critical Messages Received	0
Discarded Messages	0
Error Messages Sent	0
Error Messages Rxed	0
Successful Authentications	0
Session Key Changes	0
Failed Session Key Changes	0

7.7.5 GOOSE Counters

The GOOSE counters record subscription and publishing of GOOSE messages for the IEC 61850 protocol.

Panel Navigation

[Turn Panel ON] ⇒ [SYSTEM STATUS] ⇒ [Press ESC]
⇩
[MAIN MENU]
↳ *[Counters]*
↳ *[GOOSE Counters] ⇒*

GOOSE COUNTERS	
Subscribed GOOSE Messages	0
Published GOOSE Messages	0

7.8 Fault Targets

Fault Targets include the following:

- Fault Flags (Binary Fault Targets) — Set when a protection operation has been initiated e.g. Open(OC) is set when the recloser has opened due to overcurrent protection.
- Fault Measured Values (Trip, Min, Max) — The “trip” fault measured values are updated when a trip occurs and the “max” and “min” measured values are recorded from pickup to operation of the device. In Sectionaliser mode, the Ia max, Ib max, Ic max and In max values are recorded from pickup to LSD.
- Fault Locator Status — Please refer to Section 6.14 Fault Locator.
- Fault Locator Measured Values. — Please refer to Section 6.14 Fault Locator.

If “Reset Fault Flags on Close” is enabled:

- Fault flags and fault measured values are automatically reset to zero when the switch transitions from open to close.

If “Reset Fault Flags on Close” is disabled:

- Fault flags will remain set unless the relay restarts or they are reset manually.
- Fault measured values will retain their value until the next protection operation or they are reset manually.

Fault Flags and Measured values can be reset manually from the panel, SCADA, Logic, CMS or SGA.

Panel Navigation

[Turn Panel ON] ⇒ [SYSTEM STATUS] ⇒ [Press ESC]
⇩
[MAIN MENU]
↳ *[System Settings]*
↳ *[Fault Flags] ⇒*

```
FAULT FLAGS

Reset Fault Flags on close     Enabled
Display Alerts                 Disabled
Alarm                      Not Latched
```

Fault Flags Settings

Title	Designation	Range	Resolution	Factory Default
Reset Fault Flags on Close	Reset Fault Flags on Close	Enabled/Disabled	N/A	Enabled
Display Alerts	Display Alerts	Enabled/Disabled	N/A	Disabled
Alarm Latching	Alarm Latching	Latched/Not Latched	N/A	No Latched

Panel Navigation

[Turn Panel ON] ⇒ [SYSTEM STATUS] ⇒ [Press ESC]
⇩
[MAIN MENU]
↳ *[Reset Menu]*
↳ *[Reset]*
↳ *[Reset Fault Targets]⇒*

```
RESET MENU

Erase ►Reset◄

Reset Hot Line Tag
Reset Logical Block Close
Reset Fault Targets
Restart GPS Hardware
Restart Wi-Fi Hardware
Restart Mobile Network Modem
Reset USB Overcurrent
```

Reset Methods

Reset Method	What is reset?	Where from?
Reset Fault Targets	• Open and alarm fault flags • Fault measured values (Trip, Min, Max) • Fault locator status and fault locator measured values	Panel
Reset Fault Location	• Fault locator status and fault locator measured values	CMS
Reset Fault Flags on Close	• Open and alarm fault flags • Fault measured values (Trip, Min, Max)	Panel, CMS
Reset Binary Fault Targets	• Open and alarm fault flags	SCADA, IO, Logic, SGA, CMS
Reset Fault Meas Values	• Fault measured values (Trip, Min, Max)	SCADA, IO, Logic, SGA, CMS

Fault Targets

Fault Flags	
Open	Open(Prot), Open(OC), Open(EF), Open(SEF), Open(NPS), Open(Yn), Open(UV), Open(OV), Open(OF), Open(OF2), Open(OF3), Open(UF), Open(UF2), Open(UF3), Open(ROCOF), Open(VVS), Open(PDOP), Open(PDUP), Open(ACO), Open(OC1+), Open(OC2+), Open(OC3+), Open(OC1-), Open(OC2-), Open(OC3-), Open(EF1+), Open(EF2+), Open(EF3+), Open(EF1-), Open(EF2-), Open(EF3-), Open(SEF+), Open(SEF-), Open(NPS1+), Open(NPS2+), Open(NPS3+), Open(NPS1-), Open(NPS2-), Open(NPS3-), Open(I2/I1), Open(PhA), Open(PhB), Open(PhC), Open(PhN), Open(Any HRM), Open(OCLL1), Open(OCLL2), Open(OCLL3), Open(NPSLL1), Open(NPSLL2), Open(NPSLL3), Open(EFLL1), Open(EFLL2), Open(EFLL3), Open(SEFLL), Open(UV1), Open(UV12), Open(UV13), Open(UV2), Open(UV22), Open(UV23), Open(UV3), Open(UV4 Sag), Open(UV4 Sag Mid), Open(OV1), Open(OV12), Open(OV13), Open(OV2), Open(OV22), Open(OV23), Open(OV3), Open(OV4), Open(LSRM), Open(ABR AutoOpen), Open(Sectionaliser).
Alarm	Alarm(Any), A(OC1+), A(OC2+), A(OC3+), A(OC1-), A(OC2-), A(OC3-), A(EF1+), A(EF2+), A(EF3+), A(EF1-), A(EF2-), A(EF3-), A(SEF+), A(SEF-), A(UV1), A(UV12), A(UV12), A(UV2), A(UV22), A(UV23), A(UV3), A(OV1), A(OV12), A(OV13), A(OV2), A(OV22), A(OV22), A(OV3), A(OV4), A(I2/I1), A(OF), A(OF2), A(OF3), A(UF), A(UF2), A(UF3), A(ROCOF), A(VVS), A(PDOP), A(PDUP), A(PhA), A(PhB), A(PhC), A(PhN), A(Any HRM), A(NPS1+), A(NPS2+), A(NPS3+), A(NPS1-), A(NPS2-) A(NPS3-), A(OC), A(EF), A(SEF), A(UV), A(OV), A(UV4 Sag), A(Uabc UV4 Sag), A(Urst UV4 Sag), A(UV4 Sag Midpoint), A(Uabc UV4 Sag Midpoint), A(Urst UV4 Sag Midpoint), A(SW Phase A), A(SW Phase B), A(SW Phase C), A(NPS), A(OCLL), A(EFLL), A(NPSLL), A(OCLL1), A(OCLL2), A(OCLL3), A(NPSLL1), A(NPSLL2), A(NPSLL3), A(EFLL1), A(EFLL2), A(EFLL3), A(SEFLL), A(LSRM), A(Yn), A(I2/I1).
Fault Measured Values	
	Ia Trip, Ib Trip, Ic Trip, In Trip, In Trip SEF, I2 Trip, Ia Max, Ib Max, Ic Max, In Max, In Max SEF, I2 Max, Max I2/I1, UV min, OV Max, HRM Max Trip, UVA Min, UVB Min, UVC Min, UV4 Sag Min, OVA Max, OVB Max, OVC Max, OV3 Max Voltage Trip, OV4 Max voltage trip, Max Gn, Max Bn, Min Gn, Min Bn, ROCOF, VVS, Max PDOP, θPDOP, Min PDUP, θPDUP.
Fault Location	
	Fault Locator Status, FltDiskm, Zf, θf, ZLoop, θLoop, XLoop, Fault Type.

7.9 User Notifications

Notifications are displayed on the panel to inform the operator when particular events are generated. These include Alerts, Warnings and Malfunctions and will be displayed in the corresponding tabs in the System Status Menu. If an alert is active, the Alert tab will be displayed when the panel is turned on.

Warnings and Malfunctions are automatically generated by the relay. For a list of indication signals, please refer to Section 11.6. Alerts on the other hand, are configured and enabled in CMS.

7.9.1 Configuring Alerts

Alerts include “Open” Fault Flags, Measured Values and any logic signal (using variables VAR1 to VAR32).

To configure alerts:

1. Open CMS, go to **Offline Settings - > Logic - > Alerts**.
2. Select “Enable” for the Alerts mode.
3. Select “Enable” for the mode of an individual alert.
4. Save settings.
5. Go Online with the device and download Logic settings to the device.

In CMS, you will notice that a number of “Open” alerts are already listed and can be enabled. Additional alerts can be selected which include “Open” fault flags, variables and analogue values. Refer to CMS Help File for more details.

Notes:

- *You can enable/disable the display of alerts from the Fault Flags menu on the panel.*
- *“Reset Fault Targets” on the Alerts page, can be used to reset “Open” Fault Flags, Fault Measured Values (Trip, Min, Max), Fault Locator Status and Fault Locator Measured values.*
- *The reset of a variable is dependent on the logic and its associated expression.*
- *Measured values that are not fault targets will always be displayed. Values which are not updated will be displayed by “???”.*
- *Any non-zero value will result in the Alerts page remaining active.*

Panel Navigation

[Turn Panel ON] ⇒ [SYSTEM STATUS] ⇒ [Press ESC]
⇩
[MAIN MENU]
↳ *[System Settings]*
↳ *[Fault Flags] ⇒*

```
FAULT FLAGS

Reset Fault Flags on close     Enabled
Display Alerts                 Enabled
Alarm                      Not Latched
```

The Alerts tab will only be visible if any of the configured Alerts are enabled and active. The Alerts tab includes "Reset Fault Targets" which allows the user to manually reset any of the fault flags or fault measured values. Refer to Section 7.8 Fault Targets and the CMS Help File for more details.

Panel Navigation

[Turn Panel ON] ⇒ [SYSTEM STATUS]
↳ *[Alerts]*

```
SYSTEM STATUS

►ALERTS◄ GENERAL  WARNING  MALFUNCTION

<Reset Fault Targets>

Open(Prot)      Open(OV)
Open(PhA)       Open(UF)
Open(PhB)       Open(OF)
Open(PhC)       Open(Yn)
Open(PhN)       VAR1
Open(OC)        VAR12
Open(EF)        VAR32
Open(SEF)
Open(NPS)
Open(UV)
```

7.10 Maximum Demand Indication (MDI)

MDI is implemented as Protocol Points only and only report values of currents (Ia, Ib, Ic and In). The RMS value of current in phases A, B, C and In are averaged in accordance with Load Profile configuration. See Binary Counters, Document NOJA-522 DNP3 Device Profile, and Integrated Totals, Document NOJA-5604 IEC60870-5-101 and 104 Protocol Implementation.

Load Profile is user configurable for the intervals of 1/2/5/10/15/30/60/120 minutes. For customer, to have average MDI time of 15 minutes, the Load Profile time must be set to 15 minutes. All of the MDI values are volatile and will be reset back to zero when the controller is reset.

The MDI records are reported as for TODAY, YESTERDAY and LAST WEEK.

Definitions of these are:

- The TODAY Load Profile is monitored for the highest value in the records from last midnight till now.
- The YESTERDAY Load Profile is monitored for the highest value in the records for the 24 hours till last midnight.
- The LAST WEEK Load Profile is monitored for the highest record during the last 7 days till last midnight.

The values for record types (YESTERDAY and LAST WEEK) are updated only on expiration of the relevant period. The value for record type TODAY is updated when a new maximum for TODAY is detected.

7.11 Power Quality

The RC Power Quality System provides monitoring and protection features for power quality issues such as Harmonics Distortion, Interruptions, and Sags and Swells. The system:

- Uses the "Fast Fourier Transform" or FFT algorithm to provide exact values for the harmonic frequency and its magnitude
- Captures an oscillogram of the waveform (IEEE COMTRADE format)
- Captures information for short and long interruptions (IEEE P1159.3 PQDIF format)
- Records the number of sags and swells (IEEE P1159.3 PQDIF format).

Data is logged and can be analysed to determine the power quality flowing through the device using the Power Quality Software (PQS) installed on a PC.

The system provides protection by allowing the user to configure responses such as triggering an alarm or a trip. For harmonic protection refer to Section 6.15.

7.11.1 Oscillography

The RC can capture an oscillogram of the waveform when a user specified event occurs such as a Pickup, Trip or Alarm. The amount of waveform captured prior to the trigger can be configured. This ranges from 0 to 80% of the capture prior to the trigger point.

Data can be saved in the internal file system or on an external USB flash drive and can be used for analysis of power quality fluctuations.

The number of files which can be stored in the internal file system is dependent on the file size and thus the capture time. It is based according to: 1 file at 3 s, 3 files at 1 s and 6 files at 0.5 s. An option is available to overwrite the files or write once.

If a USB flash drive is used, it must be formatted with FAT32. The relay supports both USB 2.0 and 3.0 devices. There is a limit of 500 files per day which can be stored on the USB flash drive. A 0.5 s capture is approximately 25 kB.

Power Quality Data can be uploaded to PQS by connecting to the device or from a USB flash drive. Alternatively, the File Transfer Protocol (FTP) can be used to access the files. Oscillography files can be found in either of the following locations:

- /var/nand/osc (internal file system)
- /var/usb/rc10/osc/*relay serial number* (USB flash drive).

To access the files, the FTP protocol must be enabled and a user name and password is required. The username is "nojaftp" and the password is the HMI password for the device (default "NOJA"). Please refer to Section 11.10.6 Entering Passwords.

The signals recorded are the 6 bushing voltages, 3 phase currents and the neutral current. The data is recorded at a sample rate of 1600 samples per second.

***Note**: Oscillography captures raw sensor data from the OSM.The forward positive sequence power flow direction is always RST→ABC, regardless of direction setting in Section 5.3.*

Oscillography Logs

- The RC file system uses IEEE Std C37.111-1999 Comtrade binary format for Oscillography capture.
- The log files will contain the following:
  - Relay serial number providing a unique identifier
  - Station text "NOJA-RC serial-number"
  - Date and time the data is captured.

Panel Navigation

[Turn Panel ON] ⇒ *[SYSTEM STATUS]* ⇒ *[Press ESC]*
⇩
[MAIN MENU]
↳ *[System Settings]*
↳ *[Power Quality Settings]*
[Osc] ⇒

```
          Power Quality Settings

▶OSC◀ HRM  Interruptions  Sags/Swells

 Oscillography                  Enable
 Event                            Trip
 Capture Time (s)                  0.5
 Capture prior to event (%)         50
 Overwrite Capture             Disable
 Save to USB                   Disable
```

Oscillography Configuration Settings

Title	Designation	Range	Resolution	Factory Default
Oscillography	Mon	Enable/Disable	N/A	Enable
Event	Event	Pickup/Trip/Close/ Alarm/Logic/IO Inputs/ Prot Operation	N/A	Trip
Capture Size (s)(1)	Capture T,s	0.5/1/3	N/A	0.5
Capture Prior to Event (%)	Capture %	0/5/10/20/40/50/60/80	N/A	50
Overwrite Capture(2)	Overwrite	Enable/Disable	N/A	Disable
Save to USB(3)	USB Save	Enable/Disable	N/A	Disable

Notes:

1. *Time required to save the collected data to an external USB can be up to 75% of the capture size e.g. for a 3 s capture it may take 2.25 s to save to USB. If a triggering event occurs during this time it may not be captured.*
2. *If enabled overwrites the existing files, otherwise writes once only.*
3. *If "Save to USB" is enabled and a USB flash drive is not available, data will be saved to internal memory.*

7.11.2 Harmonics

The controller measures THD, TDD, Harmonic Current (HRM_I) and Harmonic Voltage (HRM_V) up to the 15th harmonic. The signals are the 3 bushing voltages (Ua, Ub, Uc), 3 currents and the neutral current.
The measured values are:

- Fundamental frequency in rms (Ia, Ib, Ic, In, Ua, Ub, Uc)
- Frequency harmonics 2 to 15 (Ia, Ib, Ic, In, Ua, Ub, Uc)
- Total Harmonic Distortion (THD) (Ua, Ub, Uc)
- Total Demand Distortion (TDD) (Ia, Ib, Ic, In)

The harmonic data collected is averaged over 64 cycles and made available every 32 cycles.

Harmonic Logs

- The RC file system uses IEEE P1159.3 PQDIF format for harmonic data.
- An independent deadband value and time can be configured for each of THD, TDD, HRM_I and HRM_V which allows the capture of harmonic data.
- A single timer setting for all deadbands is available such that when the harmonic exceeds the user set deadband for the user set time period, the value at the end of that time period will be logged.
- The log will capture all of the set values associated with a deadband value and the time it occurred. For example if the HRM_I deadband value is exceeded on the 3rd harmonic of Ib then the values for Ib 1 to 15 will be saved into the log with an indication that it was the 3rd harmonic that exceeded the HRM_I deadband value.
- Limited to a maximum of 1000 records.

Panel Navigation

[Turn Panel ON] ⇒ *[SYSTEM STATUS]* ⇒ *[Press ESC]*
⇩
[MAIN MENU]
↳ *[System Settings]*
↳ *[Power Quality Settings]*
[Hrm] ⇒

```
        Power Quality Settings

OSC ▶HRM◀ Interruptions  Sags/Swells

Log Harmonics                 Enabled
THD                           Enabled
THD Deadband (%)                  5.0
TDD                           Enabled
TDD Deadband (%)                  5.0
HRM_I                         Enabled
HRM_I Deadband (%)                5.0
HRM_V                         Enabled
HRM_V Deadband (%)                5.0
Time (s)                           10
```

Harmonics Settings

Title	Designation	Range	Resolution	Factory Default
Log Harmonics	HRM Log	Enable/Disable	N/A	Enable
THD	THD Enable	Enable/Disable	N/A	Enable
THD Deadband	THD %	0.1 to 50.0	0.1	5.0
TDD	TDD Enable	Enable/Disable	N/A	Enable
TDD Deadband	TDD %	0.1 to 50.0	0.1	5.0
HRM_I	HRM_I	Enable/Disable	N/A	Enable
HRM_I Deadband	HRM_I %	0.1 to 50.0	0.1	5.0
HRM_V	HRM_V	Enable/Disable	N/A	Enable
HRM_V Deadband	HRM_V %	0.1 to 50.0	0.1	5.0
Time (s)	T, s	1.0 to 120.0	0.1	10

Notes:

- *THD is the Total Harmonic Distortion defined as*

$$THD = \frac{\sqrt{{V_2}^2 + \cdots + {V_{15}}^2}}{\mathrm{V1}}$$

- *TDD is the Total Demand Distortion defined as*

$$TDD = \frac{\sqrt{I_2^2 + \cdots + I_{15}^2}}{I_L\,(\mathrm{Weekly})}$$

where I_L (Weekly) is the maximum rms demand current over the week.

7.11.3 Long and Short Duration Interruptions

The long and short duration interruption information collected can be used to calculate System Average Interruption Duration Index (SAIDI), System Average Interruption Frequency Index (SAIFI) and Momentary Average Interruption Frequency Index (MAIFI).

An interruption starts when all 3 phase voltages fall below the Loss of Supply Detection (LSD) voltage. The interruption ends when one phase voltage is equal to or greater than the LSD voltage.

The RC allows the user to set a duration to determine the difference between a short and long interruption and can log all the information relevant to each of these interruptions separately. If the duration time is set to zero it will capture all interruptions as Long Duration Interruptions.

The duration time is the minimum time for LSD to be true (no voltage on terminals) in order to be counted as a long interruption. It is also used as the minimum reset time for restored voltage before an interruption is considered finished.

If, after voltage has been restored, LSD transitions to true, before the minimum reset time has expired, the interruption time will continue to accumulate and the reset timer will reset.

Interruption Logs

- The RC file system uses IEEE P1159.3 PQDIF format for long and short duration interruptions.
- The log contains:
  - the U(a,b,c) or U(r,s,t)
  - the duration (LSD true to LSD false)
  - the start and finish times
  - each interruption on either side of the Recloser
  - a maximum of 2,000 records.

To configure the Interruption duration and turn on the logging of the fields, see below.

Panel Navigation

[Turn Panel ON] ⇒ *[SYSTEM STATUS]* ⇒ *[Press ESC]*
⇩
[MAIN MENU]
↳ *[System Settings]*
↳ *[Power Quality Settings]*
[Interruptions] ⇒

```
          Power Quality Settings

OSC  HRM ►Interruptions◄ Sags/Swells

Monitor Interruptions          Disabled
Log Short Interruptions        Disabled
Duration (s)                         60
```

Interruptions Configuration Settings

Title	Designation	Range	Resolution	Factory Default
Monitor Interruptions	Mon	Enable/Disable	N/A	Disable
Log Short Duration Interruptions	Log Short Duration	Enable/Disable	N/A	Disable
Duration (s)	Duration T, s	0 to 300	1	60

Note: *If the Duration is set to zero then all interruptions will be captured as long interruptions.*

7.11.4 Sags and Swells

The RC records voltage variations that last for a user-set period of time. Sag and Swell voltages are based on the phase to ground voltages.

Sags

A voltage Sag occurs when one or more of the 3 phase voltages fall below the Sag Normal Threshold voltage. The Sag ends when all of the 3 phase voltages are equal to or greater than the Sag Normal Threshold voltage plus a 2% hysteresis voltage. A new Sag occurrence can only be generated when a previous Sag has ended.

If all 3 phase voltages fall below the Sag Min Threshold voltage then the Sag with the duration and minimum voltage will be generated immediately.

The lowest Sag value is recorded after the Reset Time providing the sag duration is equal to or greater than the user set Sag Time period.

The lowest Sag voltage, the other 2 phase voltages and the time duration is recorded with the time stamp at the end of the Sag Event.

Swells

A voltage Swell begins when one of more of the 3 phase voltages is above the Swell Normal Threshold voltage and ends when all of the 3 phase voltages are equal to or less than the Swell Normal Threshold voltage minus a 2% hysteresis voltage.

The highest swell value and the other 2 phase voltages at that time is recorded with the duration after the Reset Time providing the duration is equal to or greater than the user set Swell Time period.

The swell ends when the voltage returns to Normal minus 2% hysteresis, for the Reset Time. If the voltage is picked up again before the Reset Time expires the reset timer is reset. The Reset Time is user configurable.

Sag/Swell Logs

- The RC file system uses IEEE P1159.3 PQDIF format for Sag/Swells data.
- The Sags/Swells log contains the following:
  - lowest/highest voltage along with the other two phases
  - duration of each Sag/Swell
  - the start and finish times of a Sag/Swell on either side of the Recloser
  - a maximum of 2,000 records.

Panel Navigation

[Turn Panel ON] ⇒ *[SYSTEM STATUS]* ⇒ *[Press ESC]*
⇩
MAIN MENU]
↳ *[System Settings]*
↳ *[Power Quality Settings]*
[Sags/Swells] ⇒

```
        Power Quality Settings

OSC  HRM  Interruptions ►Sags/Swells◄

Sag Monitoring                Disabled
Sag Normal Threshold            0.90
Sag Min Threshold               0.10
Sag Time (ms)                     20
Swell Monitoring              Disabled
Swell Normal Threshold          1.10
Swell Time (ms)                   20
Reset Time (ms)                   50
```

Sags/Swells Configuration Settings

Title	Designation	Range	Resolution	Factory Default
Sag Monitoring	Mon	Enable/Disable	N/A	Disable
Sag Normal Threshold	Normal pu	0.50 to 0.90	0.01	0.90
Sag Min Threshold	Min pu	0.10 to 0.50	0.01	0.10
Sag Time (ms)	T, ms	10 to 1000	1	20
Swell Monitoring	Mon	Enable/Disable	N/A	Disable
Swell Normal Threshold	Normal pu	1.01 to 1.80	0.01	1.10
Swell Time (ms)	T, ms	10 to 1000	1	20
Reset Time (ms)	Sag/Swell Reset Time, ms	0 to 1000	1	50

Note: *The threshold value is specified as a per unit value of the system phase to ground voltage (U_rated/√3).*

7.11.5 Erasing Power Quality Data Records and Counters

Power quality records and counters can be **erased** from Main Menu - > Reset Menu - > Erase on the panel or from "Online Operations" in CMS.

Panel Navigation

[Turn Panel ON] ⇒ [SYSTEM STATUS] ⇒ [Press ESC]
⇩
[MAIN MENU]
[Reset Menu]
[Erase]

```
                RESET MENU

 ▶Erase◀ Reset

 Energy Meters
 Fault Counters
 SCADA Counters
 DNP3-SA Counters
 GOOSE Counters
 Oscillography Records
 Interruption Counters and Duration
 Sag/Swell Counter and Duration
```

7.11.6 Saving Power Quality Data to USB

Power Quality data captured by the RC can be saved manually to a USB flash drive.

Go to the Power Quality Status screen and insert a USB flash drive into a port on the relay. The option "Transfer Internal Captures to USB" will be displayed. Select this option and press enter to save the power quality data to USB.

Please note that for all logs except for oscillography files the RC retains a copy of the logs in the internal flash memory. For oscillography files though, the RC deletes them from the internal flash memory, after confirming a successful transfer.

Note: *Power quality data is saved automatically to internal flash memory although limited oscillography captures (up to 6) can be stored to internal memory. If more oscillography captures are required it is recommended to automatically save the oscillography files to USB by enabling the "Save to USB" option in the Power Quality System Settings menu (refer to Section 7.11.1 Oscillography).*

Panel Navigation

[Turn Panel ON] ⇒ [SYSTEM STATUS] ⇒ *[Press ESC]*
⇩
[MAIN MENU]
[System Status]
[Power Quality]
[Osc] ⇒ Insert a USB drive ⇒

```
          Power Quality

<OSC> HRM  Interruptions Sags/Swells

 Save To USB                    Disabled
 Number of Internal Captures           4

▶Transfer Internal Captures to USB◀
```

```
              Power Quality

<OSC>  HRM  Interruptions  Sags/Swells

 Save To USB                     Enabled
 Number of Internal Captures           0

   ------------------------------------
   >Transfer  Internal  Captures  to
   USB< (In Progress)
   ------------------------------------
```

8 Control and Indication

Recloser Control and Indication capabilities are handled by four independent Control and Indication Elements:

- Operator Panel
- Personal Computer with CMS software installed
- Supervisory Control and Data Acquisition (SCADA)
- Digital Input and Output (I/O).

Control Capabilities

Control Data			Panel	CMS	SCADA	I/O	Logic
Date			✓	✓	✓	-	-
Time			✓	✓	✓	-	-
Settings	System Settings	Switchgear Calibration	✓	✓	-	-	-
		Switchgear Configuration	✓	✓	-	-	-
		Measurement Settings	✓	✓	-	-	-
		Synchronism Settings	✓	✓	-	-	-
		Fault Locator Settings	✓	✓	-	-	-
		I/O Settings	✓	✓	-	-	-
		UPS Settings	✓	✓	-	-	-
		Protocol Settings	✓	✓	-	-	-
		Port Settings	✓	✓	-	-	-
		RTC Settings	✓	✓	-	-	-
		HMI Settings	✓	✓	-	-	-
		Comms Log Settings	✓	✓	-	-	-
		Power Quality Settings	✓	✓	-	-	-
		Fault Flags	✓	✓	-	-	-
	Group 1-4 Settings		✓	✓	-	-	-
Control Signals		Remote On/Off	✓	✓	-	-	✓
		Trip/Close	✓	✓	✓	✓	✓
		On(Prot)/Off(Prot)	✓	✓	✓	✓	✓
		1 Group On (of 4)	✓	✓	✓	✓	✓
		On(DFT)/Off(DFT)	✓	✓	✓	✓	✓
		On(SSM)/Off(SSM)	✓	✓	✓	✓	✓
		On(MNT)/Off(MNT)	✓	✓	✓	✓	✓
		On(HLT)/Off(HLT)	✓	✓	✓	✓	✓
		On(Link HLT to LL)/Off(Link HLT to LL)	✓	✓	-	-	-
		On(EXT)/Off(EXT)	✓	✓	✓	✓	✓
		On(AR)/Off(AR)	✓	✓	✓	✓	✓
		On(NPS)/Off(NPS)	✓	✓	✓	✓	✓
		On(EF)/Off(EF)	✓	✓	✓	✓	✓
		On(SEF)/Off(SEF)	✓	✓	✓	✓	✓
		On(LL)/Off(LL)	✓	✓	✓	✓	✓
		On(CLP)/Off(CLP)	✓	✓	✓	✓	✓
		On(UV)/Off(UV)	✓	✓	✓	✓	✓
		On(UV4 SAG)/Off(UV4 SAG)	✓	✓	✓	✓	✓
		On(OV)/Off(OV)	✓	✓	✓	✓	✓
		On(OV3)/Off(OV3)	✓	✓	✓	✓	✓
		On(Yn)/Off(Yn)	✓	✓	✓	✓	✓
		On(UF)/Off(UF)	✓	✓	✓	✓	✓
		On(OF)/Off(OF)	✓	✓	✓	✓	✓
		On(ABR)/Off(ABR)	✓	✓	✓	✓	✓

Control Data		Panel	CMS	SCADA	I/O	Logic
Control Signals	Reset Fault Counters	✓	✓	✓	-	-
	Reset SCADA Counters	✓	✓	✓	✓	✓
	Reset HLT	✓	-	-	-	✓
	Reset DNP3-SA Counters	✓	✓	✓	✓	✓
	79-2 Trips to Lockout	✓	✓	✓	✓	✓
	79-3 Trips to Lockout	✓	✓	✓	✓	✓
	Test Mode Start	✓	✓	✓	✓	✓
	Reset Fault Targets	✓	-	-	-	-
	Reset Binary Fault Targets	-	✓	✓	✓	✓
	Reset Fault Meas Values	-	✓	✓	✓	✓
	Reset Fault Location	-	✓	-	-	-
	Reset Mobile Network Modem	✓	✓	-	✓	✓
	Reset Wi-Fi	✓	✓	-	✓	✓
	Reset GPS	✓	✓	-	✓	✓
	VAR 1 On (of 32)	-	-	✓	✓	✓
	IO1 Output 1 On (of 8)	✓	-	✓	✓	✓
	IO2 Output 1 On (of 8)	✓	-	✓	✓	✓
	On(Logical Block Close)/Off(Logical Block Close)	✓	✓	✓	✓	✓
	On(ACO)/Off(ACO)	✓	✓	✓	✓	✓
	On(HRM)/Off(HRM)	✓	✓	✓	✓	✓
	On(Alarm Mode)/Off(Alarm Mode)	✓	✓	✓	✓	✓
	On(LLB)/Off(LLB)	✓	✓	✓	✓	✓
	Backup trip(CBF) / Block Backup Trip(CBF)				✓	✓
	On(VVS)/ Off(VVS)	✓	✓	✓	✓	✓
	On(ROCOF) / Off(ROCOF)	✓	✓	✓	✓	✓
	On(PDOP)/Off(PDOP)	✓	✓	✓	✓	✓
	On(PDUP)/Off(PDUP)	✓	✓	✓	✓	✓
	On(Block P(EF-))/Off(Block P(EF-))	-	-	-	✓	✓
	On(Block P(EF+))/Off(Block P(EF+))	-	-	-	✓	✓
	On(Block P(SEF-))/Off(Block P(SEF-))	-	-	-	✓	✓
	On(Block P(SEF+))/Off(Block P(SEF+))	-	-	-	✓	✓
	On(Block P(OV3))/Off(Block P(OV3))	-	-	-	✓	✓
	Initiate Battery Test	✓	✓	✓	✓	✓
	Initiate Auto-Sync	✓	✓	✓	✓	✓
	Cancel Auto-Sync	✓	✓	✓	✓	✓
	Panel ON	-	-	-	-	✓

Indication Capabilities

Indication Data			Panel	CMS	SCADA	I/O	Logic
System Status	Date, Time		✓	✓	✓	-	-
	Measured Data		✓	✓	✓	-	-
	UPS Status		✓	✓	✓	-	-
	Indication Signals	Local Mode	✓	✓	✓	✓	✓
		Lockout	✓	✓	✓	✓	✓
		AR Initiated	-	-	✓	✓	✓
		Prot Initiated	✓	✓	✓	✓	✓
		Pickup Signals	-	-	✓	✓	✓
		Alarm Signals	-	-	✓	✓	✓
		Open/Closed Signals	-	-	✓	✓	✓
		ACO Messages	-	-	✓	-	-
		Prot Status Signals	✓	✓	✓	✓	✓
		Malfunctions	✓	✓	✓	✓	✓

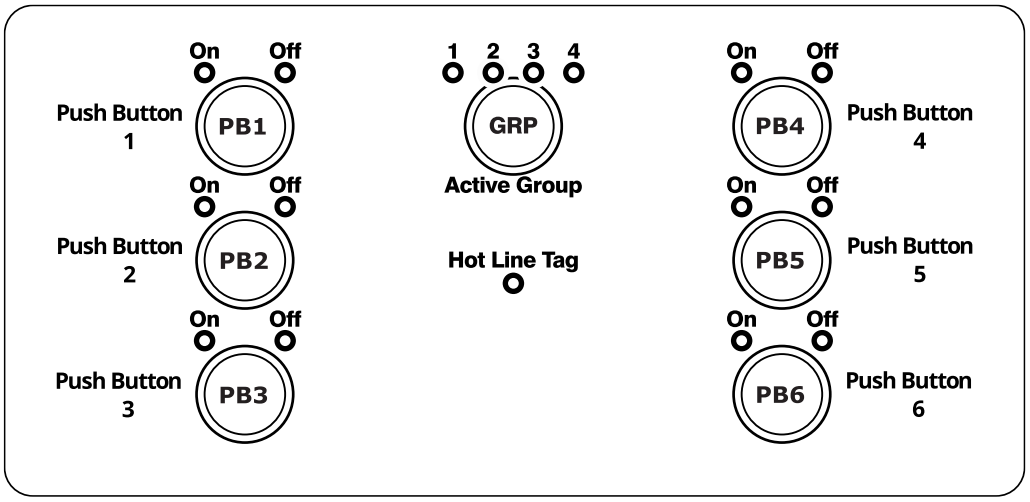
Indication Data		Panel	CMS	SCADA	I/O	Logic
	Warnings	✓	✓	✓	✓	✓
Counter Readings	Lifetime Counters	✓	✓	✓	-	-
	Fault Counters	✓	✓	✓	-	-
	SCADA Counters	✓	✓	✓	-	-
	DNP3-SA Counters	✓	✓	✓	-	-
	GOOSE Counters	✓	✓	✓	-	-
Records	Close/Open Operations	-	✓	-	-	-
	Fault Profile	✓	✓	-	-	-
	Event Log	-	✓	-	-	-
	Change Log	-	✓	-	-	-
	Load Profile	✓	✓	-	-	-

Refer to:

- *Section 5 for details on Measured Data*
- *Section 11.6 for details of Indication Signals*
- *Section 6.16 for details on Protection Status Control*
- *Appendix I – Control and Indication of Settings.*

8.1 Operator Panel Settings

The Operator Panel has a number of push buttons (PB) which are configured as fast keys. The panel can be supplied with one of seven different fast key configurations (option 1-7).



Key Configuration Options

Option	PB 1	PB 2	PB 3	PB 4	PB 5	PB 6
1	PROT	EF	SEF	AR	CLP	LL
2	PROT	EF	ABR	AR	UV	LL
3	PROT	EF	SEF	AR	ACO	LL
4	PROT	EF	SEF	AR	UV	LL
5(1)	PROT	GF	HLT	A	B	C
6(2)	PROT	EF	SEF	AR	VAR1	VAR2
7(2)	VAR1	VAR2	VAR3	VAR4	VAR5	VAR6

Notes:

1. *For Single Triple switchgear only.*
2. *VAR1–6 are variable fast keys which can be configured by the user via logic and SGA.*

The user can modify the fast key configuration option but it can only be done through CMS. Please note that the fast key configuration should match the HMI labels. If a different option is selected, the labels on the panel need to be changed accordingly. Please contact NOJA if you require a new HMI label.

The operator can enable/disable the fast keys within the configuration, through system settings on the operator panel or CMS. In the panel navigation example below, the operator can make changes to each of the fast keys in "Key Configuration Option 1".

Panel Navigation

[Turn Panel ON] ⇒ *[SYSTEM STATUS]* ⇒ *[Press ESC]*
⇩
[MAIN MENU]
⇩ *[System Settings]*
⇩ *[HMI Settings]* ⇒

```
              HMI SETTINGS

Fast Keys Control:

Key Configuration Option              1

Protection                      Enabled
EF Earth Fault                  Enabled
SEF Sensitive Earth Fault       Enabled

AR Auto Reclose                 Enabled
CL Cold Load                    Enabled
LL Live Line                    Enabled

Active Group Selection          Enabled
Delayed Close                  Disabled
Close Delay (s)                      30
```

HMI settings

Title	Designation	Settings	Factory Default
Protection Fast Key Mode	Protection On/Off	Enabled/Disabled	Enabled
EF Fast Key mode	Earth Fault On/Off	Enabled/Disabled	Enabled
SEF Fast Key mode	Sensitive Earth Fault On/Off	Enabled/Disabled	Enabled
AR Fast Key mode	Auto-Reclose On/Off	Enabled/Disabled	Enabled
CLP Fast Key mode	Cold Load On/Off mode	Enabled/Disabled	Enabled
LL Fast Key mode	Live Line On/Off	Enabled/Disabled	Enabled
GRP Fast Key mode	Active Group Selection	Enabled/Disabled	Enabled
VAR1 Fast Key mode	VAR1 On/Off	Enabled/Disabled	Enabled
VAR2 Fast Key mode	VAR2 On/Off	Enabled/Disabled	Enabled
VAR3 Fast Key mode	VAR3 On/Off	Enabled/Disabled	Enabled
VAR4 Fast Key mode	VAR4 On/Off	Enabled/Disabled	Enabled
VAR5 Fast Key mode	VAR5 On/Off	Enabled/Disabled	Enabled
VAR6 Fast Key mode	VAR6 On/Off	Enabled/Disabled	Enabled
Delayed Close	Delayed Close	Enabled/Disabled	Disabled
Delayed Close Delay Time	Close Delay (s)	0-300 seconds	30
ABR Fast Key mode	Automatic Backfeed Restoration On/Off mode	Enabled/Disabled	Enabled
ACO Fast Key mode	Auto Change Over On/Off mode	Enabled/Disabled	Enabled
Under Voltage Fast Key mode	Under Voltage On/Off mode	Enabled/Disabled	Enabled

Notes:

- *Only those keys which are in the fast key configuration chosen will be available.*
- *VAR1–6 are variable fast keys which can be configured by the user via logic.*

8.1.1 Enabling and Disabling Fast Keys

The panel Fast Keys can be programmed to be enabled or disabled by the operator, through systems settings, in accordance with local operating practice. If a fast key is disabled, pushing it will have no effect.

8.1.2 Delayed Close

This feature inserts a delay before closing the Recloser when the “Close” button is pressed on the Operator Panel. The delay can be set from 0 – 300 seconds. This allows an operator time to move away from the Recloser before the close operation occurs.

A message is displayed on the LCD Panel when the Close button is pushed and the Closed LED starts blinking.

Pressing the ESC or OPEN key will cancel the close operation, otherwise the device will close after the time delay has expired.

8.1.3 Factory Settings

The Factory Settings menu can be accessed under USB operations on the panel. Insert a USB flash drive into one of the three Relay USB ports. After a few seconds “USB Operations” will appear as a last entry on the Main Menu. USB Operations and Factory Settings are password protected. Please contact NOJA if you don’t have the password(s).

Panel Navigation

[Turn Panel ON] ⇒ *[SYSTEM STATUS]* ⇒ *[Press ESC]* ⇒
⇩
[MAIN MENU]
↳ *[USB Operations]*
↳ *[Factory Settings]*

```
            FACTORY SETTINGS

Factory Settings              ►Disabled◄

Lifetime Counters
Recovery Options
Identification
Switchgear Settings
HMI Settings
Install from USB
Logic CH 17-32 Write Protect  Disabled
```

8.2 CMS Control and Indication

The CMS Software can be used to provide control and indication functions via an external PC. Settings configured from CMS can be downloaded to the device.

For indication data, control signals and applicable settings refer to the description of each control and indication element in this manual. Activation of control signals and settings via CMS is possible only when the control mode on the RC is set to local. Indication via CMS is possible in both Local and Remote control modes.

8.3 SCADA Control and Indication

The RC supports a number of SCADA protocols which can be used to provide control and indication functions. Only one SCADA protocol can be enabled at any one time.

Indication via SCADA is possible in both Local and Remote control modes. Devices connected to a SCADA port can be set to run as a Local or Remote user.

SCADA functionality is determined by the applicable communications protocol. Please refer to NOJA-565 SCADA Interface Description and the relevant protocol document such as NOJA-522 DNP3 Device Profile, and NOJA-5604 IEC60870-5-101 and 104 Protocol Implementation.

If a protocol is enabled when the system is already running, the controller will need to be restarted for the protocol to be operational.

8.3.1 DNP3 Settings

The settings listed below are available from the Panel menu system. Additional advanced settings are available from CMS only. Please refer to the CMS Help File and DNP3 Device Profile for full point list and more details.

Panel Navigation

[Turn Panel ON] ⇒ *[SYSTEM STATUS]* ⇒ *[Press ESC]*
⇩
[MAIN MENU]
⇩ *[System Settings]*
⇩ *[Protocol Settings]*
⇩ *[DNP3]*
⇩ *[RC]*⇒

```
                DNP3 SETTINGS

<RC> Master  C1  C2

 DNP3                                ►Enabled◄
 Status                                Ready
 SCADA Time                           GMT/UTC
 Slave Address                               5
 Unsolicited                         Enabled
 Port                                    LAN
 Connection Type                         LAN
 IP version                             IPv4
 Check Master IP Address                 Yes
 Poll Watchdog Time(min)                   0
 Binary Control Watchdog Time(min)         0
```

Protocol Settings

Title	Designation	Range	Resolution	Factory Default
DNP3	DNP3	Disabled / Enabled	NA	Disabled
Status(1)	Status	Ready/Controller Restart Req	NA	Controller Restart Req
SCADA Time	SCADA Time	Local/ [GMT/UTC]	NA	GMT/UTC
Slave Address	Slave addr	0 – 65519	1	5
Unsolicited	Unsolicited	Disabled / Enabled	NA	Disabled
Port(2)	Port type	RS232/RS232P/USBA/USBB/ USBC/LAN/WLAN/ MOBILENETWORK	NA	RS232
Connection Type(3)	Connection Type	Serial Direct/Disabled/ Serial Modem/Serial Radio/LAN/WLAN/ GPRS/Mobile Network Modem	NA	Serial Direct
IP Version(4)	IP Version	IPv4/IPv6	NA	IPv4
Check Master IP Address	Check Master IP Address	Yes/No	NA	No
Poll Watchdog Time	Poll Watchdog Time(min)	0 – 1440 min	1 min	0
Binary Control Watchdog Time	Binary Control Watchdog Time(min)	0 – 1440 min	1 min	0
Master IPv4 Address(5)	Master IPv4 Address	NA	NA	0.0.0.0
Master IPv6 Address(5)	Master IPv6 Address	NA	NA	::

Notes:

1. *If a protocol is enabled when the system is already running, the controller will need to be restarted for the protocol to be operational.*
2. *RS232P cannot be used as it is used by the operator panel.*
3. *The Connection Type is dependent on the Port setting*.
4. *If the Connection type is an Ethernet connection and the Port is either USB or Mobile network, the IP version will match with the port's IP version and the user will not be able to edit the "IP version" field.*
5. *Settings found in "Master" Page, refer to Multiple Master settings below.*

Poll Watchdog Time is a user set period of time before the external supply will be reset, if the protocol is not polled. Whenever protocol is polled this timer is reset. This timer overrides the External Load Reset Time. Set to zero this timer is de-activated.

Binary Control Watchdog Time is a user set period of time before the external supply will be reset, if the binary control is not activated. Whenever an allocated binary control point is modified this timer is reset. This timer overrides the External Load Reset Time. Set to zero this timer is de-activated.

DNP Multiple Master

DNP3 Multiple Master allows for two master stations to simultaneously access the same outstation. Two methods for connection are provided. In Method 1, when a connection request is accepted, the Connection Management layer assigns the socket to the logical connection with the matching source IP address/port and proceeds to route all DNP3 messages from that master to that address. In Method 2, the Connection Management layer listens on different TCP Ports. Each logical connection is assessed in the collection based on the DNP3 destination address.

Panel Navigation

[Turn Panel ON] ⇒ *[SYSTEM STATUS]* ⇒ *[Press ESC]*
⇩
[MAIN MENU]
↳ *[System Settings]*
↳ *[Protocol Settings]*
↳ *[DNP3]*
↳ *[Master]*⇒

```
DNP3 SETTINGS

RC <Master> C1  C2

DNP Multiple Master:
Multiple Master:            ►Disabled◄
Connection Method            Method 1

Master:
Master Address                      3
Master TCP Port                 20000
Master IPv4 Address           0.0.0.0
```

DNP3 Multiple Master Settings

Title	Designation	Range	Resolution	Factory Default
Multiple Master	Multiple Master Enable	Disabled / Enabled	NA	Disabled
Connection Method	Connection Method	Method 1/Method 2	NA	Method 1
Master Address(1)	Master Address	0 – 65534	1	3
Master TCP Port(1)	Master TCP Port	1 – 65534	1	20000
Master IPv4 Address(1,2)	Master IPv4 Address	NA	NA	0.0.0.0
Master IPv6 Address(1,2)	Master IPv6 Address	NA	NA	::

Notes:
1. Master address details applicable to normal DNP3 operation only. C1 & C2 settings will apply when Multiple Master enabled.
2. Relevant address will display depending on IP version setting in DNP3 RC menu.

Connection 1 and Connection 2 have the same settings. Connection 1 is shown below:

Panel Navigation

[Turn Panel ON] ⇒ *[SYSTEM STATUS]* ⇒ *[Press ESC]*
⇩
[MAIN MENU]
↳ *[System Settings]*
↳ *[Protocol Settings]*
↳ *[DNP3]*
↳ *[RC]*⇒

```
DNP3 SETTINGS

RC  Master <C1> C2

Master:
Master Address                  ►3◄
Master TCP Port                20001
Master IPv4 Address          0.0.0.0

RC:
Port                           USBA
Connection Type             Disabled
IP version                      IPv4
Slave TCP Port                 20001
```

DNP3 Multiple Master Settings

Title	Designation	Range	Resolution	Factory Default
Master Address	Master Address	0 – 65534	1	3
Master TCP Port	Master TCP Port	1 – 65534	1	20001(1)
Master IPv4 Address	Master IPv4 Address	NA	NA	0.0.0.0
Master IPv6 Address	Master IPv6 Address	NA	NA	::
Port(2)	Port	USBA/USBB/USBC/LAN/ WLAN/MOBILENETWORK	NA	USBA
IP Version	IP Version	IPv4/IPv6	NA	IPv4
Slave TCP Port	Slave TCP Port	1024 – 65535	1	20001(1)

Notes:
1. Factory default for C1 = 20001, C2 = 20002.
2. Only LAN an WLAN connections are valid when using USB port.

DNP3 Secure Authentication

The RC supports DNP3 Secure Authentication (DNP3-SA) version 2 (SAv2) and version 5 (SAv5).

CMS can be used to generate the DNP3-SA Update Key file. The file can be uploaded to the RC by placing it in the "\rc10\Updates" folder on a USB flash drive, plugging it into a USB port on the relay module then installing it from the factory settings screen as shown below.

Please refer to NOJA- 559 CMS Help File and NOJA-522 DNP3 Device Profile for more details.

Panel Navigation

[Turn Panel ON] ⇒ [SYSTEM STATUS] ⇒ [Press ESC]

⇩

Insert USB Flash Drive

(Wait a few seconds)

[MAIN MENU]

[USB Operations]

<Enter Password 1>

[Factory Settings]

<Enter Password 2>

[Install DNP3-SA Update Key] ⇒

```
          FACTORY SETTINGS

Factory Settings              Disabled
Lifetime Counters
Recovery Options
Identification
Switchgear Calibration
HMI Settings
Install Firmware from USB
►Install DNP3-SA Update Key◄
Logic CH 17-32 Write Protect  Disabled

DNP3-SAUpdateKeyFile_1.1.0
```

Notes:
- *The update folder on the USB Flash drive must only contain the DNP3-SA Update Key file*
- *Please contact NOJA Support if you require passwords*
- *Can only install the DNP3-SA Update key if the system is in local mode.*

To view the status of DNP3-SA via the panel go to System Status -> Protocols - > DNP3.

Panel Navigation

[Turn Panel ON] ⇒ [SYSTEM STATUS]

[Protocols]

[DNP3] ⇒

```
          DNP3 STATUS


Invalid IP                    0.0.0.0
DNP3-SA Update Key        Not Installed
```

Notes:
- *If the "IP version" for DNP3 has been set to "IPv4", the Address shall be displayed on the same line in IPv4 format.*
- *If the "IP version" for DNP3 has been set to "IPv6", the Address shall be displayed on the next line in IPv6 format.*

8.3.2 IEC 60870-5-101/104 Settings

The settings listed below are available from the Panel menu system. Additional advanced settings are available from CMS only. Please refer to the CMS Help File and IEC 60870-5-101 and 104 Protocol Implementation document for full point list and more details.

Panel Navigation

[Turn Panel ON] ⇒ *[SYSTEM STATUS]* ⇒ *[Press ESC]*
⇩
[MAIN MENU]
⇩ *[System Settings]*
⇩ *[Protocol Settings]*
⇩ *[IEC 60870]* ⇒

```
          IEC 60870 SETTINGS

▶RC◀ Master  RG1C1  RG1C2  RG2C1  RG2C2

 IEC 60870-5-101/-104          ▶Enabled◀
 Status                          Ready
 SCADA Time                     GMT/UTC
 Data Link Address                    5
 Common Address of ASDU               5
 Poll Watchdog Time(min)              0
 Binary Control Watchdog Time(min)    0
 Port                             RS232
 Connection Type           Serial Direct
```

60870 Protocol Settings

Title	Designation	Range	Resolution	Factory Default
IEC 60870-5-101/104	Protocol Enable	Disabled / Enabled	NA	Disabled
Status(1)	Status	Ready/Controller Restart Req	NA	Controller Restart Req
SCADA Time	Time	GMT/UTC/Local	NA	GMT/UTC
Data Link Address	Data Link Address	1 – 254 or 1-65534(2)	1	5
Common Address of ASDU	Common Address of ASDU	1 – 254 or 1-65534(3)	1	5
Poll Watchdog Time (min)	Poll Watchdog Time, min	0-1440	1 min	0
Binary Control Watchdog Time (min)	Binary Control Watchdog Time, min	0-1440	1 min	0
Port	Port	RS232/RS232P/USBA/USBB/USBC/LAN/WLAN/MOBILENETWORK(3)	NA	RS232
Connection Type(4)	Connection Type	Serial Direct/Disabled/ Serial Modem/Serial Radio/LAN/WLAN/GPRS/Mobile Network Modem	NA	Serial Direct
IP Version(5)	IP Version	IPv4/IPv6	NA	IPv4
Slave TCP Port	Slave TCP Port	1024 – 65535	1	2404
Check Master IP Address	Check Master IP Address	Yes/No	NA	No

Notes:

1. *If a protocol is enabled when the system is already running, the controller will need to be restarted for the protocol to be operational.*
2. *Dependent on Link Address Size (set via CMS). 0: Link Address is ignored; 1: range is 1–254; and 2: range is 1–65534.*
3. *For IEC 60870-101 range is 1-254. For IEC 60870-104 range is 1-65534.*
4. *The Connection Type is dependent on the Port setting. RS232P is used for communication by the operator panel.*
5. *If the Connection type is an Ethernet connection and the Port is either USB or Mobile network, the IP version will match with the port's IP version and the user will not be able to edit the "IP version" field.*
6. *Settings found in "Master" Page, refer to Redundancy Groups settings below.*

IEC60870-5-104 Redundancy Groups

Redundancy group capability allows multiple master operation of the IEC 60870-5-104 protocol using TCPIP over Ethernet interfaces. When enabled, the IEC 60870-5-104 protocol supports more than one master connection.

The Redundancy Groups (RG) can operate alone, or with other RGs to support multiple communications paths or Master Stations. Through multiple RGs, it is possible for the operator to enable Multi Master capabilities, where one of the active connections is considered to be in “Master” configuration.

There are two connection methods within the redundancy group operation – Method 1 and Method 2. In Method 1, when a connection request is accepted, the Connection Management layer assigns the socket to the logical connection with the matching source IP address/port and proceeds to route all IEC 60870-5-104 messages from that master to that address. In Method 2, the Connection Management layer listens on different TCP Ports. Each logical connection is assessed in the collection based on the IEC 60870-5-104 destination address.

Panel Navigation

[Turn Panel ON] ⇒ [SYSTEM STATUS] ⇒ [Press ESC]
⇩
[MAIN MENU]
↳ *[System Settings]*
↳ *[Protocol Settings]*
↳ *[IEC 60870]*
↳ *[Master] ⇒*

```
          IEC 60870 SETTINGS

RC <Master> RG1C1  RG1C2  RG2C1  RG2C2

Redundancy Group 1:
Group Enabled                ▶Disabled◀
Connection Method             Method 1

Redundancy Group 2:
Group Enabled                   Enabled
Connection Method             Method 2

Master:
Master IPv4 Address    172.016.056.023
```

Redundancy Group Settings

Title	Designation	Range	Resolution	Factory Default
Group enabled	RGX enabled	Disabled / Enabled	NA	Disabled
Connection Method	RGX Connection Method	Method 1/Method 2	NA	Method 1
Master IPv4 Address(1)	Master IPv4 Address	NA	NA	0.0.0.0
Master IPv6 Address(1)	Master IPv6 Address	NA	NA	::

Notes:

1. *Master IPv4/IPv6 address applies to normal operation of IEC60870. When a redundancy group is enabled, its individual master IP address will be used.*

The screens for the connections are all the same. RG1C1 is shown here:

Panel Navigation

[Turn Panel ON] ⇒ [SYSTEM STATUS] ⇒ [Press ESC]
⇩
[MAIN MENU]
↳ *[System Settings]*
↳ *[Protocol Settings]*
↳ *[IEC 60870]*
↳ *[RG1C1] ⇒*

```
          IEC 60870 SETTINGS

RC  Master <RG1C1> RG1C2  RG2C1  RG2C2

Connection Enabled           ▶Disabled◀
Allow Controls                 Enabled
Connection Name                  RG1 C1
Port                              USBA
Connection Type                Disabled
IP version                         IPv4
Slave TCP Port                     2405
Constraints                M Port+M IP
Originator Address                    1
Master TCP Port                    2405
Master IPv4 Address             0.0.0.0
```

Redundancy Group Connection Settings

Title	Designation	Range	Resolution	Factory Default
Connection Enabled	RGXCY Enable	Disabled / Enabled	NA	Disabled
Allow Controls	RGXCY Allow Controls	Disabled / Enabled	NA	Disabled
Port	RGxCY Port	USBA/USBB/USBC/ LAN/WLAN/ MOBILENETWORK	NA	USBA
IP Version	RGXCY IP Version	IPv4/IPv6	NA	IPv4
Slave TCP Port	RGXCY Slave TCP Port	1024 – 65535	1	2405(1)
Constraints(2)	RGXCY Constraints	OA/M Port/M IP/OA + M Port/OA + M IP/OA + M Port + M IP/M Port + M IP	NA	M Port + M IP
Originator Address	RGXCY Originator Address	1 – 255	1	1
Master TCP Port	RGXCY Master TCP Port	1024 – 65535	1	2405(1)
Master IPv4 Address	RGXCY Master IPv4 Address	NA	NA	0.0.0.0
Master IPv6 Address	RGXCY Master IPv6 Address	NA	NA	::

Notes:
1. Factory default for RG1C1 = 2405, RG1C2 = 2406, RG2C1 = 2407, RG2C2 = 2408.
2. OA = Originator Address, M Port = Master's Port, M IP = Master's IP Address.

8.3.3 IEC 61850 Settings

NOJA's implementation of the IEC 61850 protocol provides the following:

- Manufacturing Message Specification (MMS)
- Generic Object Oriented Substation Events (GOOSE) Publisher and GOOSE Subscriber.

MMS functionality can be used for monitoring and control (SCADA functions) and GOOSE functionality can be used for peer-to peer co-ordination. For more details refer to NOJA-5005 IEC 61850 IED Definition and Conformance Statement, NOJA-5017 IEC 61850 Logical Nodes Definition and NOJA-5036 IEC 61850 User Guide.

Panel Navigation

[Turn Panel ON] ⇒ *[SYSTEM STATUS]* ⇒ *[Press ESC]*
⇩
[MAIN MENU]
↳ *[System Settings]*
↳ *[Protocol Settings]*
↳ *[IEC 61850]*

↳ *[IEC 61850]*
↳ *[MMS]* ⇒

```
          IEC 61850 SETTINGS

▶General◀ MMS  GOOSE

IED name                              RC
Monitor GOOSE Sim Flag           Enabled
Process Simulated GOOSE         Disabled
Quality Test Bit Handling        Enabled
```

```
          IEC 61850 SETTINGS

General ▶MMS◀ GOOSE

MMS Server                       Enabled
Status           Controller Restart Req
Port                        MOBILENETWORK
Connection Type           Mobile Network
IP Version                          IPv4
```

Panel Navigation

[Turn Panel ON] ⇒ *[SYSTEM STATUS]* ⇒ *[Press ESC]*
⇩
[MAIN MENU]
↳ *[System Settings]*
↳ *[Protocol Settings]*
↳ *[IEC 61850]*
↳ *[GOOSE]* ⇒

```
          IEC 61850 SETTINGS

General  MMS ►GOOSE◄

GOOSE Publisher              Disabled
Status          Controller Restart Req

GOOSE Subscriber             Disabled
Status          Controller Restart Req

Port                       MOBILENETWORK
Connection Type          Mobile Network
```

61850 Protocol Settings

Title	Designation	Range	Resolution	Factory Default
General				
IED Name	IED Name	Up to 20 characters	NA	
Monitor GOOSE Sim Flag	Mon GOOSE SimFlag	Enabled/Disabled	NA	Enabled
Process Simulated GOOSE	ProcSimGOOSE	Enabled/Disabled	NA	Disabled
Quality Test Bit Handling	QualTestHandling	Enabled/Disabled	NA	Enabled
MMS				
MMS Server	MMS Server	Enabled/Disabled	NA	Disabled
Status(1)	Status	Ready/Controller Restart Req	NA	Controller Restart Req
Port	MMS Port	USBA/USBB/USBC/ LAN/WLAN/MOBILE NETWORK(2)	NA	USB A
Connection Type(2)	Connection Type	Serial Direct/Disabled/ Serial Modem/Serial Radio/LAN/WLAN/Mobile Network Modem	NA	Disabled
IP Version(3)	IP Version	IPv4/IPv6	NA	IPv4
GOOSE				
GOOSE Publisher	GOOSE Publisher	Enabled/Disabled	NA	Disabled
Status(1)	Status	Ready/Controller Restart Req	NA	Controller Restart Req
GOOSE Subscriber	GOOSE Subscriber	Enabled/Disabled	NA	Disabled
Status(1)	Status	Ready/Controller Restart Req	NA	Controller Restart Req
Port	GOOSE Port	USBA/USBB/USBC/ LAN/WLAN/MOBILE NETWORK	NA	USB A
Connection Type(2)	Connection Type	Serial Direct/Disabled/ Serial Modem/Serial Radio/LAN/WLAN/Mobile Network Modem	NA	Disabled

Notes:

1. *If MMS, GOOSE Publisher or Subscriber are enabled when the system is already running, the controller will need to be restarted for the protocol to be operational.*
2. *The Connection Type is dependent on the port setting and the relay module version.*
3. *If the Connection type is an Ethernet connection and the Port is either USB or Mobile network, the IP version will match with the port's IP version and the user will not be able to edit the "IP version" field.*

Panel Navigation

[Turn Panel ON] ⇒ [SYSTEM STATUS]

↳ [Protocols]

↳[IEC 61850] ⇒

```
          IEC 61850 STATUS

MMS Server                    Enabled
Client IP Addresses:
0.0.0.0
0.0.0.0
0.0.0.0
0.0.0.0

GOOSE Publisher               Enabled
GOOSE Subscriber              Enabled

Monitor GOOSE Sim. Flag       Enabled
Process Simulated GOOSE       Disabled
Quality Test Bit Handling     Enabled
```

Notes:

- *If the "IP version" for IEC 61850 MMS has been set to "IPv4", the Address shall be displayed on the same line in IPv4 format.*
- *If the "IP version" for IEC 61850 MMS has been set to "IPv6", the Address shall be displayed on the next line in IPv6 format.*

8.3.4 2179 Settings

Panel Navigation

[Turn Panel ON] ⇒ [SYSTEM STATUS] ⇒ [Press ESC]

⇩

[MAIN MENU]

↳ [System Settings]

↳ [Protocol Settings]

↳ [2179] ⇒

```
          2179 SETTINGS

2179                          Disabled
Status          Controller Restart Req
Slave Address                      1
Master Address                     0
Port                           RS232
SBO Timeout                        5
```

2179 Protocol Settings

Title	Designation	Range	Resolution	Factory Default
2179	2179	Disabled / Enabled	NA	Disabled
Status(1)	Status	Ready/Controller Restart Req	NA	Controller Restart Req
Slave Address	Slave address	1 – 2046(2)	1	1
Master Address	Master address	0 - 31	1	0
Port	Port	RS232/USBA/USBB/USBC/RS232P/None(3)	NA	RS232
SBO Timeout (s)(4)	SBO Timeout	1-3600	1	5

Notes:

1. *If a protocol is enabled when the system is already running, the controller will need to be restarted for the protocol to be operational.*
2. *Address 2047 is reserved for broadcasting.*
3. *LAN is not available as a configurable port as the 2179 protocol is for serial communication networks. RS232P is used for communication by the operator panel.*
4. *Select Before Operate (SBO) is the amount of time after a select command is received before which an operate command must be received.*

8.3.5 Communication Port Status

The settings and status of a communication port can be viewed through the Panel under System Status. The example below is for an RS232 port. Refer to Sections 4.7.3, 4.7.4 and 4.7.5 for communication port configuration details.

Panel Navigation

[Turn Panel ON] ⇒ *[SYSTEM STATUS]*
↳ *[Communications Ports]*
↳ *[RS232]*⇒

```
            RS232 STATUS

Detected Type                    Serial
Configured Type          Serial Direct
Device Mode                      Remote

Serial Pins:
DTR: High     DSR: Low     CD: Ignore
RTS: High     CTS: Ignore  RI: Low

Connection State:          Disconnected
Bytes Received:                  123456
Bytes Transmitted:                 3456
Test                                Off
                                 Hangup
```

Serial Port Status

Item	Description	Range
Configured Type	Configured Type	Disabled/Serial Direct/Modem/Radio/GPRS
Device Mode	Local or Remote Device	Local/Remote
Serial Pins[1] DTR, RTS, CD, DSR, CTS, RI	RS232 Port Serial Pins	High/Low/Ignore
Connection State	Displays port connection status	Disconnected/Connected/Dialing Redialing/Autodialing
Bytes Received	Displays amount of bytes received. Count can be reset to zero by pressing enter.	0 - 999999999
Bytes Transmitted	Displays amount of bytes transmitted. Count can be reset to zero by pressing enter.	0 - 999999999
Test[2]	Sends ASCII string “NOJA” out through the RS232 port (radio and serial direct). Message continues for 30s or until turned off.	Off/On
NA	Hangup (modem only) due to inactive timeout or received “NO CARRIER” string from DCE or the DCD signal has changed from high to low.	Hangup

Notes:

1. *DTR=Data Terminal Ready, RTS=Request to Send, DSR=Data Set Ready, CTS=Clear to Send, CD=Carrier Detect, RI=Ring Indicator*
2. *The Test string can also be seen through a USB port if using a USB to RS232 adaptor.*

For modems, there is an additional setting in CMS, “Modem is powered from external load”. This is used when the communications protocol is running. When this setting is On and the External Load is Off, the RC will not try and use the communication device. Please refer to the SCADA Interface Description document for a detailed description of this feature.

8.3.6 FTP Settings

In the Protocol Settings, FTP runs only if it is Enabled, and when a FTP request is made from a FTP Client. The FTP application in the Relay Controller is not interlocked with any SCADA protocols in the Relay Controller.
The user is permitted to read files, obtain directory listings, print working directory and change directory. The user is not permitted to write, delete, rename and make directory.

Panel Navigation

[Turn Panel ON] ⇒ [SYSTEM STATUS] ⇒ [Press ESC]
⇩
[MAIN MENU]
↳ *[System Settings]*
↳ *[Protocol Settings]*
↳ *[FTP] ⇒*

```
FTP SETTINGS

FTP                          ►Disabled◄
```

Notes:

- *By default, FTP is disabled though there are options to Enable or Disable.*
- *The FTP service is limited to one connection from the Client to reduce resource usage in the Relay.*
- *Additional timeouts will be required in the Client as listing of large directory takes several minutes. The CPU load increases for listing large directories. Therefore, the transfer rate is limited to 40% max to reduce the CPU load.*
- *No additional FTP specific log files are produced.*

8.3.7 CMS Settings

Panel Navigation

[Turn Panel ON] ⇒ [SYSTEM STATUS] ⇒ [Press ESC]
⇩
[MAIN MENU]
↳ *[System Settings]*
↳ *[Protocol Settings]*
↳ *[CMS] ⇒*

```
CMS SETTINGS

Port 1                              USB-L
P1 Connection Type                    CMS
P1 Maximum Frame Size (Bytes)        4096
Enable Port 2                     Enabled
Port 2                              RS232
P2 Connection Type          Serial direct
P2 Maximum Frame Size (Bytes)        4096
IP Version                           IPv4
```

CMS Protocol Settings

Title	Designation	Range	Resolution	Factory Default
Port 1	Port 1	USB-L	NA	USB-L
P1 Connection Type	P1 Connection Type	CMS	NA	CMS
P1 Maximum Frame Size (Bytes)	P1 Maximum Frame Size	512 – 4096	1	4096
Enable Port 2	Enable Port 2	Disabled / Enabled	NA	Disabled
Port 2	Port 2	RS232/LAN/USBA/USBB /RS232P/WLAN/MOBILE NETWORK	NA	RS232
P2 Connection Type	P2 Connection Type	Serial Direct/ LAN/ Mobile Network/WLAN/ Serial Modem/Serial Radio	NA	Serial Direct
P2 Maximum Frame Size (Bytes)	P2 Maximum Frame Size	512 – 4096	1	4096
IP Version[(1)]	IP Version	IPv4/IPv6	NA	IPv4

Notes:

1. *If the Connection type is an Ethernet connection and the Port is either USB or Mobile network, the IP version will match with the port's IP version and the user will not be able to edit the "IP version" field.*

8.3.8 P2PComms Settings

Panel Navigation

[Turn Panel ON] ⇒ *[SYSTEM STATUS]* ⇒ *[Press ESC]*
⇩
[MAIN MENU]
↳ *[System Settings]*
↳ *[Protocol Settings]*
↳ *[P2PComms]* ⇒

```
P2PCOMMS SETTINGS

Peer to Peer                Enabled
Comms Port                    WLAN
Function                       ACO
Update Rate(s)                0.10
IP Version                    IPv4
Remote ACR LAN Addr          0.0.0.0
```

P2PComms Protocol Settings

Title	Designation	Range	Resolution	Factory Default
Peer to Peer	Peer to Peer	Enabled/Disabled	NA	USB-L
Comms Port	Comms Port	RS232/LAN/USBA/USBB/RS232P/ WLAN/MOBILENETWORK	NA	RS232
Function	Function	ACO	NA	ACO
Update Rate (s)	Update Rate (s)	0.04-300.00	NA	0.10
IP Version(1)	IP Version	IPv4/IPv6	NA	IPv4
Remote ACR LAN Addr	Remote ACR LAN Addr	Enter an IPv4 address/ Enter an IPv6 address	NA	0.0.0.0

Notes:

1. *If the Connection type is an Ethernet connection and the Port is either USB or Mobile network, the IP version will match with the port's IP version and the user will not be able to edit the "IP version" field.*

8.4 Inputs and Outputs (I/O)

The controller functionality can be extended by using the three local digital inputs on the relay module and two optional Input/Output (I/O) Modules.

For more details, please refer to NOJA 5591 RC Relay IO and Logic User Guide.

8.4.1 I/O Control

The Relay Module local inputs (IN1, IN2 and IN3) are dry connections. No voltage is required to assert the input. Each I/O module has eight voltage activated inputs and eight relay outputs.

Inputs

The Input Status will follow the input voltage signal i.e. it will change to On when the input voltage signal changes from low to high and it will change to Off when the input voltage signal changes from high to low. A Recognition Time delay can be applied to eliminate spurious controls.

Please note that the control point is set when the Input Status changes from Off to On.

If an I/O module is set to Disable mode, its input control voltages are ignored.

The Inputs operate as latched commands. Therefore there is usually an On/Off pair of commands. For example, if you want to turn on Sensitive Earth Fault, use "SEF On". If you want to turn Sensitive Earth Fault protection Off you need to use a separate input and assign it to "SEF Off".

Note: *In order for the Input to operate with Recognition Time delay, the setting "Edge Triggered" must be set to "No".*

Outputs

The outputs can be activated by assigning actuating signal, SCADA protocol or Logic.

A Recognition Time can be set for each output. This applies a delay before activating the output relay contacts.

Reset Time delays the de-activation of the relay output after the actuating signal is deactivated.

The Outputs can be configured to operate as pulsed contacts when they are programmed to stay open (or closed) for the specific time. In this mode of operation, the "Pulse Enable" needs to be set to ON and the Pulse Time must be set.

8.4.2 Enabling I/O Modules

I/O Modules can be fitted at the time of manufacture or installed in the controller at a later stage.

When the I/O Module(s) are first connected they are recognised by the relay software and the Serial Number and I/O Number are displayed on the Input/Output settings screen (it may take about 60 seconds for the modules to be recognised). If the two Modules are available then the I/O1 or I/O2 designation can be re-assigned as required.

Panel Navigation

[Turn Panel ON] ⇒ [SYSTEM STATUS] ⇒ [Press ESC]

⇩

[MAIN MENU]

↳ *[System Settings]*

↳ *[I/O Settings] ⇒*

```
        INPUT/OUTPUT SETTINGS


            Device Mode
Local Inputs:                  ▶Local◀
I/O 1:                          Local
I/O 2:                          Local

        I/O Configuration
Serial Number           I/O Number
0151200090407                   1
0151200090408                   2
```

General settings

Title	Designation	Range	Resolution	Factory Default
Local Inputs operation mode	Local Inputs	Local/Remote	–	Local
I/O1 operation mode(1)	I/O 1	Local/Remote	–	Local
I/O2 operation mode(1)	I/O 2	Local/Remote	–	Local
I/O Number(2)	I/O Number	1/2	–	N/A

Notes:

1. *The Operational Mode for an I/O module can be set to Local or Remote mode and applies to inputs only. This allows the commands to be executed in the same mode as the RC-10. Selection of operation mode is only relevant when an I/O Module is connected.*
2. *To confirm that the correct number is assigned to the I/O module, check the displayed serial number of the I/O module on the panel and confirm with the label on the I/O module. The flash rate will indicate if this is I/O module 1 or 2. Module 1 LED will flash once each second, I/O Module 2 will flash twice each second.*

For wiring details, refer to Sections 4.7.1 and 4.7.2.

The I/O modules can be enabled or disabled from CMS or the Operator Panel (in CMS go to Online Operations - > I/O Configuration).

Individual inputs and outputs on the I/O Modules can be enabled or disabled using CMS **only** whereas local Inputs can be enabled or disabled through the operator panel as well as CMS. To Enable or Disable individual inputs or outputs in CMS go to Offline Settings - > I/O.

Individual inputs and outputs can only be configured through CMS.

Panel Navigation

[Turn Panel ON] ⇒ [SYSTEM STATUS]

↳ *[Input/Output] ⇒*

```
        INPUT/OUTPUT STATUS

Local Inputs:  ▶Disable◀
               1   2   3
               Na  Na  Na

I/O 1 Module:   Disable
       1   2   3   4   5   6   7   8
In:    Na  Na  Na  Na  Na  Na  Na  Na
Out:   Na  Na  Na  Na  Na  Na  Na  Na

I/O 2 Module:   Disable
       1   2   3   4   5   6   7   8
In:    Na  Na  Na  Na  Na  Na  Na  Na
Out:   Na  Na  Na  Na  Na  Na  Na  Na
```

General settings

Title	Designation	Range	Resolution	Factory Default
Local Inputs	Local Inputs	Disable/Enable	–	Disable
I/O1 Module	I/O 1 Module	Disable/Enable/Test1/Test2/Test3(1)	–	Disable
I/O2 Module	I/O 2 Module	Disable/Enable/Test1/Test2/Test3(1)	–	Disable

Notes:

1. *Three Test Modes are available through the operator panel to check the correct I/O Module operation:*
   - *Test1 - Activation of any input activates all eight outputs.*
   - *Test2 - Activation of any input activates its corresponding output.*
   - *Test3 - Activation of any input activates its corresponding output with any assigned parameters (such as pulse time or recognition time) for the input or output.*

8.4.3 Local Digital Inputs Signal Map

Input Signal Map

Input	Range	Factory Default
1	Any control signal	Generic Input
2	Any control signal	Generic Input
3	Any control signal	Generic Input

Configurable Settings *(*applicable for each local input – configured through CMS)

Title	Designation	Range	Resolution	Factory Default
Mode	Mode	Enable/Disable	N/A	Enable
Recognition Time	Recognition Time, s	0.01 – 1.00 s	0.01 s	0.01

8.4.4 I/O Modules Signal Map

If the I/O Modules are replaced, the Digital Mapping is retained in the Relay Module.

Input signal map

Input	Range	Factory Default
1	Any control signal	Generic Input
2	Any control signal	Generic Input
3	Any control signal	Generic Input
4	Any control signal	Generic Input
5	Any control signal	Generic Input
6	Any control signal	Generic Input
7	Any control signal	Generic Input
8	Any control signal	Generic Input

Configurable Settings (applicable for each I/O module digital input – configured through CMS))

Title	Designation	Range	Resolution	Factory Default
Mode	Mode	Enable/Disable	N/A	Enable
Edge Triggered(1)	Edge Triggered	Yes/No	N/A	No
Recognition Time(1)	Recognition Time, s	0.01 – 2.00 s	0.01 s	0.01

Notes:

1. *The input status follows the input signal i.e. it will change to On when the input voltage signal changes from low to high and it will change to Off when the input voltage signal changes from high to low. The control signal is activated when the input status changes from Off to On. In order for an Input to operate with a time delay (apply Recognition Time), the Edge Trigger must be set to "No".*

Output signal map

Output	Range	Factory Default
1	Any indication signal	Generic output
2	Any indication signal	Generic output
3	Any indication signal	Generic output
4	Any indication signal	Generic output
5	Any indication signal	Generic output
6	Any indication signal	Generic output
7	Any indication signal	Generic output
8	Any indication signal	Generic output

Configurable settings (applicable for each I/O module digital output - configured through CMS)

Title	Designation	Range	Resolution	Factory Default
Mode	Mode	Enable/Disable	N/A	Enable
Recognition Time	Recognition Time, s	0.00 – 180.00 s	0.01 s	0.00
Reset Time	Reset Time, s	0.00 – 180.00 s	0.01 s	0.00
Pulse Enable(1)	Pulse Enable	On/Off	N/A	Off
Pulse Time(1)	Pulse Time, s	0.02 – 180.00 s	0.01 s	0.02

Notes:

1. *The outputs can be configured to operate as pulsed contacts when they are programmed to stay open (or closed) for the specific time. In this mode of operation, the "Pulse Enable" needs to be set to "On" and the Pulse Time must be set.*

8.5 Logic

Logic expressions can be built using CMS software. The expressions employ logic operators such as "or, nor, xor, and, nand, not and ( )" with other variables such as pickup, open, alarm, closed, status, malfunction or any general control or indication point.

The Logic Expression is evaluated on change of state of any of it s input signals, upon download of logic settings from CMS and upon startup of the controller.

Recognition and Reset Times are applied to the Expression Output. The "Set When" mode will be applied to the Logic Expression to determine the Expression Output. The output can then be assigned to SCADA points or the I/O to initiate other actions. For more details, please refer to NOJA 5591 RC Relay IO and Logic User Guide.

Note: *The operation of Logic is independent of the device being in local or remote mode.*

The "Set when" mode is set by the user in CMS. Definition of Operation for the "Set When" mode is described below:

EITHER	The Expression Output will be activated when the Logic Expression is TRUE and it will be deactivated when the Logic Expression is FALSE.
TRUE	The Expression Output will be activated when the Logic Expression is TRUE and it will stay in this state. (Equivalent to turning the Output ON and leaving it in the ON state).
FALSE	The Expression Output will be deactivated when the Logic Expression is FALSE and it will stay in this state. (Equivalent to turning the Output OFF and leaving it in the OFF state).

CMS Logic Device Settings

Recognition Time	User set time before a change in the Logic Expression causes the Expression Output to change. Recognition time initiation is dependent on the "Set When" mode selected.
Reset Time	User set time before a change in the Logic Expression causes the Expression Output to change. Reset time initiation is dependent on the "Set When" mode selected.
Pulse time	Time the Expression Output remains ON or OFF depending on "set when" condition.
Log Enable	Enables a log entry (expression name) to occur for this expression output.

Recognition and Reset Time Initiation

"Set when" Mode	Expression Output Change	Recognition Time Initiated	Reset Time Initiated
Either	False to True	Yes	No
	True to False	No	Yes
True	False to True	Yes	No
	True to False	No	Yes
False	False to True	No	Yes
	True to False	Yes	No

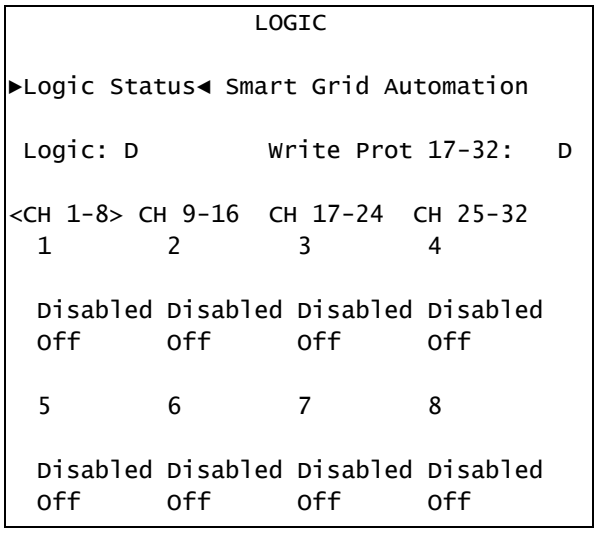
CMS Configurable Settings (applicable for each logic output)

Title	Designation	Range	Resolution	Factory Default
Mode	Mode	Enable/Disable	N/A	Enable
Recognition Time	Recognition Time, s	0.00 – 180.00 s	0.01 s	0.00
Reset Time	Reset Time, s	0.00 – 180.00 s	0.01 s	0.00
Pulse Enable	Pulse Enable	On/Off	N/A	Off
Pulse Time	Pulse Time, s	0.02 – 180.00 s	0.01 s	0.02
Log Enable	Log Enable	On/Off	N/A	Off

Panel Navigation

[Turn Panel ON] ⇒ *[SYSTEM STATUS]*

↳ *[Logic]* ⇒



General Settings

Title	Designation	Range	Resolution	Factory Default
Logic	Logic	Disable/Enable/Test	N/A	Disable
Write Prot 17-32(1,2)	Write Prot CH 17-32	Disable/Enable	N/A	Disable

Notes:

1. *The field Write Prot 17-32 indicates whether the logic channels 17-32 are write protected. By default write protection of channels 17-32 is disabled.*
2. *The field Write Prot 17-32 can be changed through the factory settings menu or in CMS.*

8.5.1 Smart Grid Automation

NOJA Power's Smart Grid Automation (SGA) enables customers to implement and deploy distributed control and automation applications on the RC recloser in accordance with the IEC 61499 standard. The functionality includes PC software tools and embedded software for the RC recloser.

Panel Navigation

[Turn Panel ON] ⇒ *[SYSTEM STATUS]* ⇒ *[Press ESC]*
⇩
[MAIN MENU]
↳ *[System Status]*
↳ *[Logic]*
↳ *[Smart Grid Automation]* ⇒

```
                LOGIC

 Logic Status ►Smart Grid Automation◄

 Smart Grid Automation          Enabled
 TCP Port Number                61499
 Command
  Send SGA WARM Event           Initiate
  Send SGA STOP Event           Initiate
  Delete FBOOT                  Initiate
  Install FBOOT from USB        Initiate
Status
  Available resources                  1
  Failed resources                     0
  FBOOT Status                 Installed
```

Smart Grid Automation

Title	Designation	Range	Resolution	Factory Default
Smart Grid Automation	SGA	Disabled / Enabled	NA	Disabled
TCP Port Number(1)	TCP Port Number	1025-65535	1	61499
Send SGA WARM Event(2)	Send SGA WARM Event(1)	Initiate	NA	Initiate
Send SGA STOP Event(3)	Send SGA STOP Event(2)	Initiate	NA	Initiate
Delete FBOOT	Delete FBOOT	Initiate	NA	Initiate
Install FBOOT from USB(4)	Install FBOOT from USB	Initiate	NA	Initiate

Notes:

1. *Changing the TCP port number on the relay will cause the SGA runtime to re-start and any resources in volatile memory will be erased.*
2. *A WARM Event will be sent to the Smart Grid Application.*
3. *A STOP event will be sent to the Smart Grid Application.*
4. *When a file is installed from USB, the file is copied to non-volatile memory on the relay.*

SGA Status

Status	Description	Comment
Available resources	Displays the number of available resources on the RC.	Resources are loaded into the runtime from the sga.fboot file or downloaded to the relay via the SGA application.
Failed resources	Displays number of resources that have failed to load into the runtime.	
FBOOT Status	Displays whether the FBOOT file is installed.	When FBOOT is installed, the resources included in the sga.fboot file are loaded into the non-volatile memory of the device. Deleting FBOOT does not remove the resources from memory.

Notes:

- *From firmware 1.16 onwards, the relay allows a maximum of three SGA embedded resources to run simultaneously.*
- *If you have any failed resources, please go back to the SGA application to check the function blocks and links.*
- *The operation of SGA is independent of the device being in Local or Remote mode.*

For more details please refer to NOJA 5019 Smart Grid Automation (SGA) User Guide.

8.5.2 Logic Throttling

If the number of logic operations impacts on the performance of the device, the relay limits the responsiveness of the logic process. This 'logic throttling' will occur for 30 minutes or until a new logic configuration is downloaded or the system restarts. While logic throttling is applied, the relay will enforce a minimum interval of 200ms between the handling of logic triggering events. It is possible for triggering events to be missed while this occurs.

Notes:

- *The relay will apply logic throttling when 200 or more logic evaluations have occurred within any 3 second interval. A "Logic/SGA Throttling" warning and event will be reported. Refer to Appendix F – Indication Signals and Appendix G – Events. A "Logic Configuration Issue" warning will also be reported via logic.*
- *The "Logic/SGA throttling" warning will be visible until 2 hours after the last throttling event, even if there is no throttling active. The Logic Configuration issue 'End' Log indicates when the logic throttling has ended.*

8.5.3 SGA Throttle Threshold

If the number of executed SGA events in a one second window exceeds the throttle threshold (150 events), a time delay is applied before the application can move to the next event. The throttle threshold and the time delay are dependent on the number of embedded resources running on the device i.e. if there is one SGA embedded resource running on the device, after 150 events have been executed there will be a 1ms time delay, if there are two SGA embedded resources running on the device each embedded resource will have a throttle threshold of 75 and the time delay will be 2 ms, if there are three SGA embedded resources running on the device each embedded resource will have a throttle threshold of 50 and the time delay will be 3 ms.

Notes:

- *The time delay will only be applied to the embedded resource that has reached the throttle threshold.*
- *From firmware 1.16 onwards, the relay only allows a maximum of three SGA embedded resources to run simultaneously (if an SGA application was developed for earlier versions of firmware please make any necessary changes to ensure that only three resources are used).*
- *You could have one or more embedded resources associated with one SGA application. Please refer to NOJA 5019 Smart Grid Automation (SGA) User Guide for more details.*
- *A "Logic/SGA Throttling" warning and event will be reported. Refer to Appendix F – Indication Signals and Appendix G – Events.*
- *The Logic/SGA throttling warning will be visible until 2 hours after the last throttling event, even if there is no throttling active. The Logic Configuration issue 'End' Log indicates when the logic throttling has ended.*

9 Installation

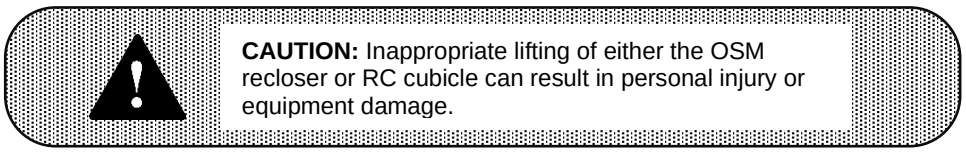
Installation of both the OSM Auto Circuit Recloser and RC Cubicle is straightforward. It is recommended the preparation for installation be done in a clean workshop environment and the prepared equipment is transported to site.

9.1 De–crating

The OSM Auto Circuit Recloser and RC Cubicle are packed in a single crate containing:

- Routine Test Summary and User Manual in the document pocket Inside the RC Cubicle
- OSM Auto Circuit Recloser Tank
- Pole Mounting Bracket and fasteners
- Recloser Control Cubicle
- Control Cable
- VT (if required) and its mounting bracket

Access into the crate is by panels fastened with tabs. The top and sides of the crate can be removed by bending up the metal tabs with a screwdriver and hammer allowing product removal.



CAUTION: Inappropriate lifting of either the OSM recloser or RC cubicle can result in personal injury or equipment damage.

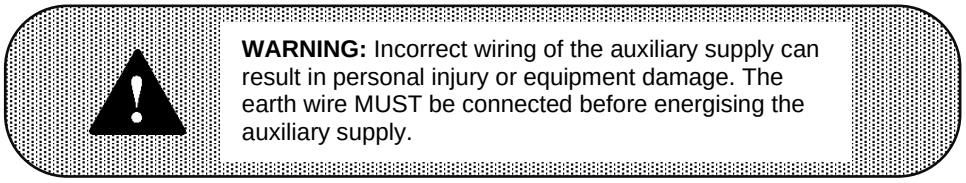
9.2 RC Cubicle Preparation

The battery of the Control Cubicle may have discharged during transit or storage. The Control Cubicle should have an auxiliary AC supply fitted prior to carrying out preparatory testing.

9.2.1 Auxiliary Supply Connections

The RC Cubicle requires an AC supply to be connected into the circuit breaker. The cubicle is configured for the correct auxiliary supply voltage (110Vac or 220Vac) at the factory as requested by the customer prior to delivery.

Refer to Section 4.4 for configuration and connection details.



WARNING: Incorrect wiring of the auxiliary supply can result in personal injury or equipment damage. The earth wire MUST be connected before energising the auxiliary supply.

9.2.2 RC and OSM Compatibility

The OSM Recloser and RC Cubicle are matched and tested together in the factory. Recloser type is defined by the OSM Serial Number. It is important that the OSM Serial Number matches the OSM Serial Number programmed into the controller. Refer to Section 9.2.5.

Measurement within specification requires a set of sensor calibration coefficients to be programmed into the Relay memory. During factory Routine Test, the calibration coefficients relating to the OSM have been pre-programmed into the memory of the controller accompanying it. Where this is not done, the correct set of sensor calibration coefficients and OSM Recloser serial number must be programmed into the Relay. OSM measurement coefficients are recorded on the Routine Test Summary document provided.

Retaining pairing is not critical, but advisable, otherwise accurate line measurements cannot be expected. If programming for another OSM is required, Section 5.4 shows where the calibration coefficients are located. Alternately, CMS software can be used to download a configuration file that has been prepared in advance.

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

If the correct calibration coefficients have been misplaced, they can be supplied by your nearest NOJA Power office or distributor. For provision of the correct settings the OSM Recloser serial number, as recorded on the rating plate, is required.

9.2.3 Initial Checks

The RC cubicle is shipped with default Protection settings. Prior to commissioning, the correct settings for the intended application must be programmed.

Before commencing tests make sure the AC supply is connected. Next open the escutcheon panel and turn on the battery circuit breaker. Observe the start-up message on the LCD Panel, the flashing System running LEDs on the front panel and others on the SIM, Relay and I/O Module(s).

1. Press the Panel ON button to see the SYSTEM STATUS display.

Panel Navigation

[Turn Panel ON] ⇒ [SYSTEM STATUS] ⇒

```
            SYSTEM STATUS

▶GENERAL◀ WARNING  MALFUNCTION

 Date/Time : 21/01/2020, 10:00:18
 Config    : 3 phase
             Recloser
 Status    : Closed

 Measurements       Power Quality
 Input/Output       Power Supply
 Protection         Communication Ports
 Automation         Protocols
                    Logic
```

Check the date and time are displayed correctly. If incorrect, adjust as illustrated in the diagram below.

Panel Navigation

[Turn Panel ON] ⇒ [SYST. STAT.] ⇒ [Press ESC]
⇩
[MAIN MENU]
↳ *[System Settings]*
↳ *[RTC Settings] ⇒*

```
        REAL TIME CLOCK SETTINGS

▶RTC◀ SNTP

 Date:                        11/12/2020
 Time:                      10:34:55 PM
 Time Sync Status              Internal

 Date Format                  dd/mm/yyyy
 Time Format                    24 Hour
 Time Zone (hr)                 +00:00
```

Select a parameter, enter the password (default is “NOJA”), then change the setting.

Use the arrow keys to change the settings.

Press the Enter key when finished, or ESC to cancel the change.

2. Select any Malfunction or Warning messages and press Enter for extra details.

Panel Navigation

[Turn Panel ON] ⇒ [SYSTEM STATUS]
↳ *[WARNING] ⇒*

```
            SYSTEM STATUS

GENERAL ▶WARNING◀ MALFUNCTION

21/01/2011, 14:12:18 OSM Disconnected
```

Press the ESC key to return to SYSTEM STATUS.

3. Select 'Power Supply', select the External Load Output and change it from OFF to ON.

Panel Navigation

[Turn Panel ON] ⇒ *[SYSTEM STATUS]*

↳ *[Power Supply]*

↳ *[External Load Output]* ⇒

```
          POWER SUPPLY STATUS

Last Power Restart:
12:01:14 16/11/2010

AC Input                              OFF
Battery Voltage (Ubt)               13.8V
Battery Current (Ibt)               0.50A
Battery Capacity (%)                  100
External Load Output                  OFF
Battery Test                     Initiate

Battery Test Result:
04:44:03 AM 02/10/2015
Battery Test Passed
```

Confirm that 12Vdc appears across the External Load terminals on the SIM module. Set the External Load Output voltage back to OFF, press the ESC key to return to SYSTEM STATUS.

4. If any optional I/O Modules are fitted, note the Serial Number on the module case. Observe that the I/O Modules running LEDs are flashing. I/O Module 1, one flash each second. The second I/O Module, twice each second.

Panel Navigation

[Turn Panel ON] ⇒ *[SYST. STAT.]* ⇒ *[Press ESC]*

⇩

[MAIN MENU]

↳ *[Systems Settings]*

↳ *[I/O Settings]* ⇒

```
          INPUT/OUTPUT SETTINGS

              Device Mode
Local Inputs:                         Local
I/O 1:                                Local
I/O 2:                                Local

          I/O Configuration
Serial Number                  I/O Number
0151200090407                           1
```

Confirm that the I/O Module(s) Serial Number is displayed on the panel.

5. From the SYSTEM STATUS screen, select and view 'Input/Output' to confirm the I/O Modules are indicating correctly. Note that if an I/O module is not fitted, or is disabled, NA appears next to the input / output status.

Panel Navigation

[Turn Panel ON] ⇒ *[SYSTEM STATUS]*

↳ *[Input/Output]* ⇒

```
          INPUT/OUTPUT STATUS

Local Inputs:  ▶Disabled◀
               1   2   3
               Na  Na  Na

I/O 1 Module:   Disable
       1   2   3   4   5   6   7   8
In:    Off Off Off Off Off Off Off Off
Out:   Off Off Off Off Off Off Off Off

I/O 2 Module:   Disable
       1   2   3   4   5   6   7   8
In:    Na  Na  Na  Na  Na  Na  Na  Na
Out:   Na  Na  Na  Na  Na  Na  Na  Na
```

General settings

Title	Designation	Range	Resolution	Factory Default
I/O1 Module	I/O 1	Disable/Enable/Test1/Test2/Test3	–	Disable

Note: *Selection of modes (Enable/Disable/Test1/Test2/Test3/) is only applicable if the relevant module is connected and communication is established between the module and Panel.*

6. Select a 'Test1' mode for an I/O Module. In this mode, application of the correct operating voltage to any input will cause ALL outputs to change state. Applying voltage to each input and confirming that all outputs change state each time tests operation of the I/O module. Refer to Section 8.4.2.

7. On completion set the module under test back to 'Disable' mode. Press the ESC key to return to SYSTEM STATUS.

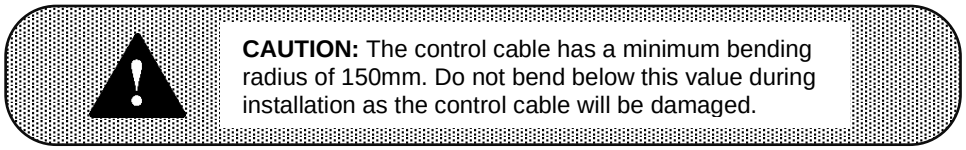
The above checks confirm the recloser control system is functioning correctly and can be connected to an OSM Recloser for further testing.

9.2.4 Control Cable

Remove the protective plastic covering the ends of the cable and 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 socket inside the cubicle on the SIM module – make sure the plug is aligned correctly before inserting. Secure the plug by pushing the clamping ring in and turning it until it clicks (locks) into place (about 1/3 of a turn).

Care must be taken to not apply undue strain on the Control Cable plug and socket before the Control Cable is secured with wing nuts at the Cubicle Control Cable Entry Hole.



CAUTION: The control cable has a minimum bending radius of 150mm. Do not bend below this value during installation as the control cable will be damaged.

9.2.5 OSM Recloser Operation

Once the OSM Recloser has been removed from the crate it should be placed on a worktable or level surface.

1. Connect the Control Cable to the plug in the base of the Recloser and ensure the plug is firmly locked into place using the integral clamping arrangement.
2. Press the ON button on the RC Cubicle operator panel. Allow 60 seconds before operating the Recloser. Confirm the OSM Recloser Model and Serial Number matches the panel displayed Recloser Model and Serial Number. Confirm the position LED is lit and agrees with the indicator at the base of the Recloser. If the OSM is closed, press the green OPEN Button and confirm the Recloser opens, that the OPEN LED is lit and that the indicator shows the correct status.
3. Press the red CLOSED button and confirm that the Recloser closes and the CLOSED LED is lit.
4. Trip the OSM using the mechanical trip ring ensuring the mechanism is fully withdrawn.
5. View 'System Status' on the panel. Select 'Warning' and confirm that a 'Mechanical Lockout' message is displayed. This indicates that the Recloser is unable to be closed. Press the CLOSE push button to confirm it does not cause the Recloser to close.
6. Push the mechanical trip ring back into the operating position and confirm that pressing the close pushbutton causes the Recloser to close.
7. Navigate to 'System Settings' as illustrated in the diagram below and confirm the 'OSM Serial Number' field matches the number engraved on the rating plate of the Recloser. Also confirm the OSM Voltage Sensor Coefficients match those on the testing document supplied with the OSM Recloser.

Panel Navigation

[Turn Panel ON] ⇒ *[SYSTEM STAT.]* ⇒ *[Press ESC]*

⇩

[MAIN MENU]

↳ *[Systems Settings]*

↳ *[Switchgear Calibration]* ⇒

```
          SWITCHGEAR CALIBRATION

OSM Model           OSM 38-12-800-300
Switchgear Type               3 phase
OSM Serial Number     ▶0200112080770◀

Switchgear Coefficients:

 CIa 0.4000   CUa 0.0157   CUr 0.0157
 CIb 0.4000   CUb 0.0157   CUs 0.0157
 CIc 0.4000   CUc 0.0157   CUt 0.0157
 CIn 0.4000
```

8. Press the 'ESC' button twice to return to the MAIN MENU.
9. Ensure the recloser is in the closed position.
10. Go to the SYSTEM STATUS page and select 'Measurements'. Inject 20A primary current, one phase at a time and confirm that indications of phase and earth current are correct in each case.

Panel Navigation

[Turn Panel ON] ⇒ *[SYSTEM STATUS]*

↳ *[Measurements]* ⇒

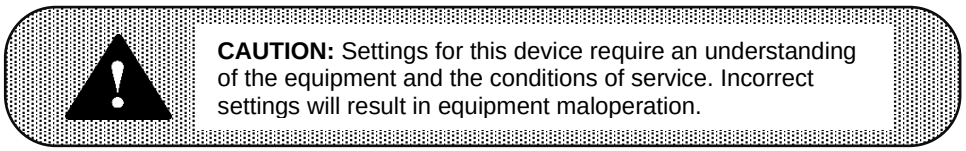
```
            MEASUREMENTS
▶Power◀              1 Phase Energy
 Other               3 Phase Energy

 Voltages (kV):
 A  0.0       B  0.0       C  0.0
 R  0.0       S  0.0       T  0.0

 AB 0.0       BC 0.0       CA 0.0
 RS 0.0       ST 0.0       TR 0.0

 Currents (A):
 A  20        B  0         C  0
 N  20        I2 0
```

11. If HV testing is required, refer to Section 9.3.2
12. Turn the Operator Panel OFF using the ON/OFF pushbutton and disconnect the Auxiliary supply.
13. Disconnect the control cable and replace the plastic covering over each connector end for protection from dust, grit and moisture entering during transportation to site.

The above confirms the OSM and RC are functioning correctly.

9.2.6 Programming Settings

Settings for the RC cubicle must be programmed by a competent technician with knowledge of the equipment, CMS (SCADA communication) as described in this manual and the intended protection application.



CAUTION: Settings for this device require an understanding of the equipment and the conditions of service. Incorrect settings will result in equipment maloperation.

Settings can be manually entered using the Panel or transferred using the PC based CMS software. Refer to Section 4.3 CMS Software. This can be done on site or in the workshop as preferred. To prevent unauthorized changes it is recommended the factory set default password "NOJA" is changed. Refer to Section 11.10.5.

9.3 OSM Recloser Preparation

9.3.1 OSM HV Terminal Connections

No preparation is required for the OSM HV terminals other than to ensure they are clean prior to installation.

9.3.2 HV Testing

All NOJA Power outdoor switching devices pass ANSI C37.60 requirements for power frequency and partial discharge testing prior to dispatch from the manufacturer. Where power frequency testing is required prior to installation, testing to 80% ANSI C37.60 Power Frequency withstand voltage is recommended to confirm insulation integrity without unduly stressing insulating components.

Equipment Rating	Recommended 1minute Test Voltage	
15 kV	40 kV AC	50 kV DC
27 kV	48 kV AC	60 kV DC
38 kV	56 kV AC	80 kV DC

Energise the OSM HV circuit to the correct voltage as indicated in the table above for 1 minute.

HV should only be applied to the OSM HV terminals.

The OSM Recloser should be connected to the RC Cubicle by the Control Cable. The Recloser should be tested in the closed position.

1. Connect (using min 1.5 mm^2 wire) the OSM Recloser, RC and HV Test Set earth points to ground.
2. Where a single phase HV test set is being used, test across each phase individually or if preferred, all three phases at once. Use fuse wire or similar to tie the phases together.
3. Energise the OSM HV terminals to system phase to ground voltage.
4. Select 'Measurement' from the SYSTEM STATUS page. Confirm the six voltage indications for each terminal.

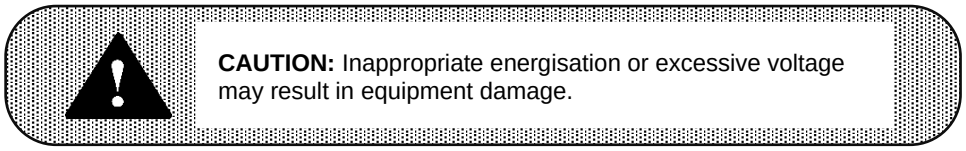
Panel Navigation

[Turn Panel ON] ⇒ *[SYSTEM STATUS]*

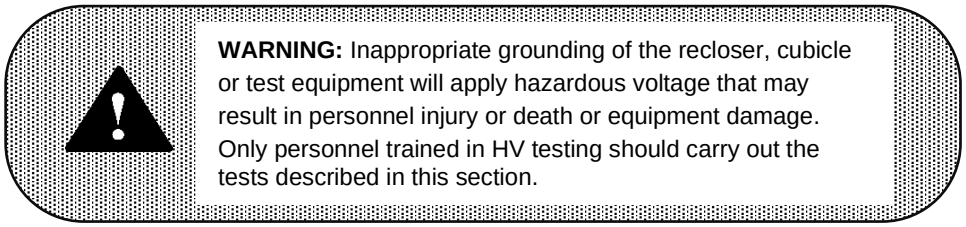
↳ *[Measurements]* ⇒

```
                MEASUREMENTS
▶Power◀                1 Phase Energy
 Other                 3 Phase Energy

 Voltages (kV):
 A  6.3       B  6.3       C  6.3
 R  6.3       S  6.3       T  6.3

 AB 10.2      BC 10.2      CA 10.2
 RS 10.2      ST 10.2      TR 10.2

 Currents (A):
 A  0         B  0         C  0
 N  0         I2 0
```

5. Turn off the HV and remove the connections from the OSM HV terminals.
6. Disconnect the Control Cable from the OSM Recloser.



CAUTION: Inappropriate energisation or excessive voltage may result in equipment damage.



WARNING: Inappropriate grounding of the recloser, cubicle or test equipment will apply hazardous voltage that may result in personnel injury or death or equipment damage. Only personnel trained in HV testing should carry out the tests described in this section.

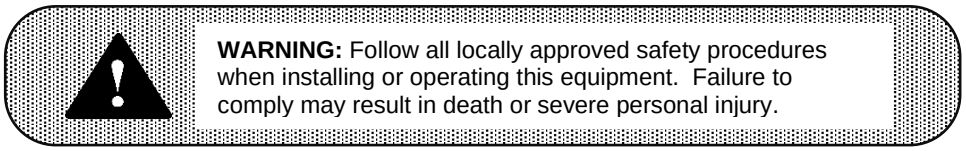
9.3.3 Mounting Bracket

The OSM15-310 and OSM27-310 Pole Mounting Brackets are normally supplied attached to the Recloser tank. The OSM38-300 requires fitting of the mounting bracket by the customer. If the OSM15-310, OSM27-310 or OSM38-300 requires bracket fitting use the four supplied M12 bolts with split ring and flat washers.

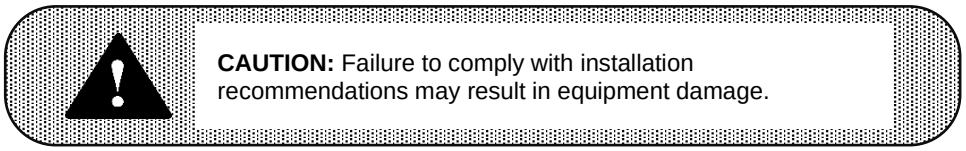
The two M20 bolts for attaching the mounting bracket to the pole are not supplied.

9.4 Site Installation

The recommendations that follow are designed to minimise installation effort and product damage.



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



CAUTION: Failure to comply with installation recommendations may result in equipment damage.

9.4.1 Transport to Site

For transport to site the OSM tank, RC cubicle and Control Cable should be fixed back onto the crate base as factory supplied.

Any items which can be affected by dust, dirt, water or moisture before they are installed must be kept clean and dry. The control cable is supplied with plastic caps to prevent water and dirt entering the connectors during transport and storage. It is recommended that these are stored inside the cubicle after installation so they can be put back on if the control cable has to be removed or disconnected for any length of time.

9.4.2 HV Surge Arrestors

It is recommended that HV surge arrestors are fitted to the OSM prior to installation on a pole.

All six surge arrestors can be mounted on the tank using the mounting points supplied. The surge arrestor mounts have a 13mm diameter hole for fitting of a surge arrestor or stand-off.

The recommended connection to the HV conductor is by means of a Parallel Groove Clamp with cable length as short as possible.

9.4.3 OSM Installation

The OSM has four lifting points. Ensure the Pole Mounting Bracket is fitted to the OSM before lifting it onto the pole.

The Pole Mounting Bracket is secured to the pole by two M20 bolts at 280mm centres. The bracket has the top hole keyed to facilitate fitting over a bolt head or nut. Once the top bolt is secured, the bottom bolt can be fitted and tightened to fix the Recloser in place.

The Pole Mounting Bracket can also be used to mount the Recloser on concrete poles using a bolt through the top hole and a banded strap through bottom slots to go around the pole.

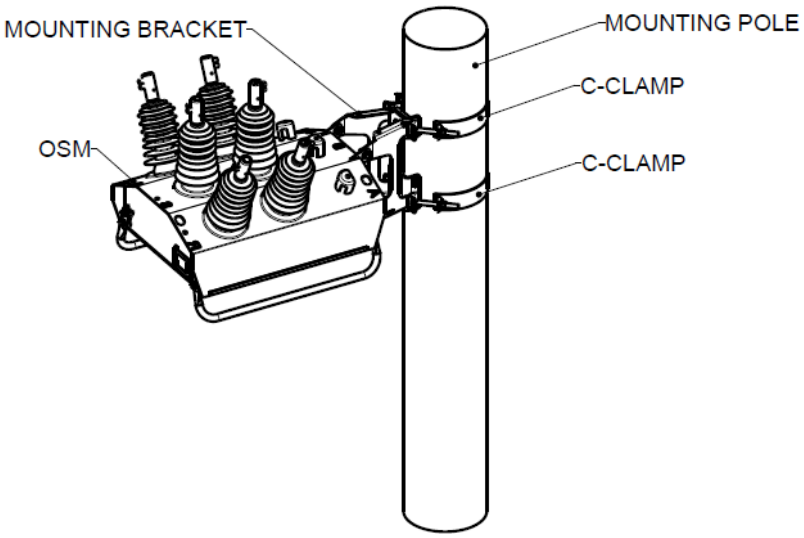
Note: *The pole mounting bracket allows for the use of C-clamp mounting as an alternative to through bolt mounting.*

Connect the HV cables to the HV Tunnel Connectors on each bushing. Tighten the hexagonal socket screws with an 8mm Allen Key to 30 Nm.

If a tin-plated brass Palm Connector is fitted to the bushing use two M12 bolts to attach a matching cable lug and tails. Tighten bolts to 50 Nm. When other connectors are used, phase clearances must be validated and additional insulation (bird guards) to be used to maintain rating.

Lock the Control Cable into the OSM when the OSM is positioned on the pole.

Warning: *The OSM tank is normally mounted in a horizontal position. If it is not possible, it may be mounted in a vertical position with no considerable impact on the operational speed of the recloser. If the arc vent is pointing down the arc fault feature may be compromised and safety needs to be reviewed.*



Standard pole mounting with C-clamps

9.4.4 RC Installation

The RC cubicle has two lifting holes in the top section of its pole mounting bracket. The RC cubicle is secured to the pole by bolts or coach screws with diameter up to 22 mm. The top hole is keyed to allow fitting over a bolt or nut. Once the top is secured the bottom bolt can be fitted and tightened. Refer to Section 4.1.1 for RC cubicle dimensions.

9.4.5 Earthing

The OSM Recloser is earthed by means of a M12 hex head bolt (earth point) positioned on the back wall of the tank.

The RC is earthed by means of an M12 stud (earth point) on the base of the cubicle.

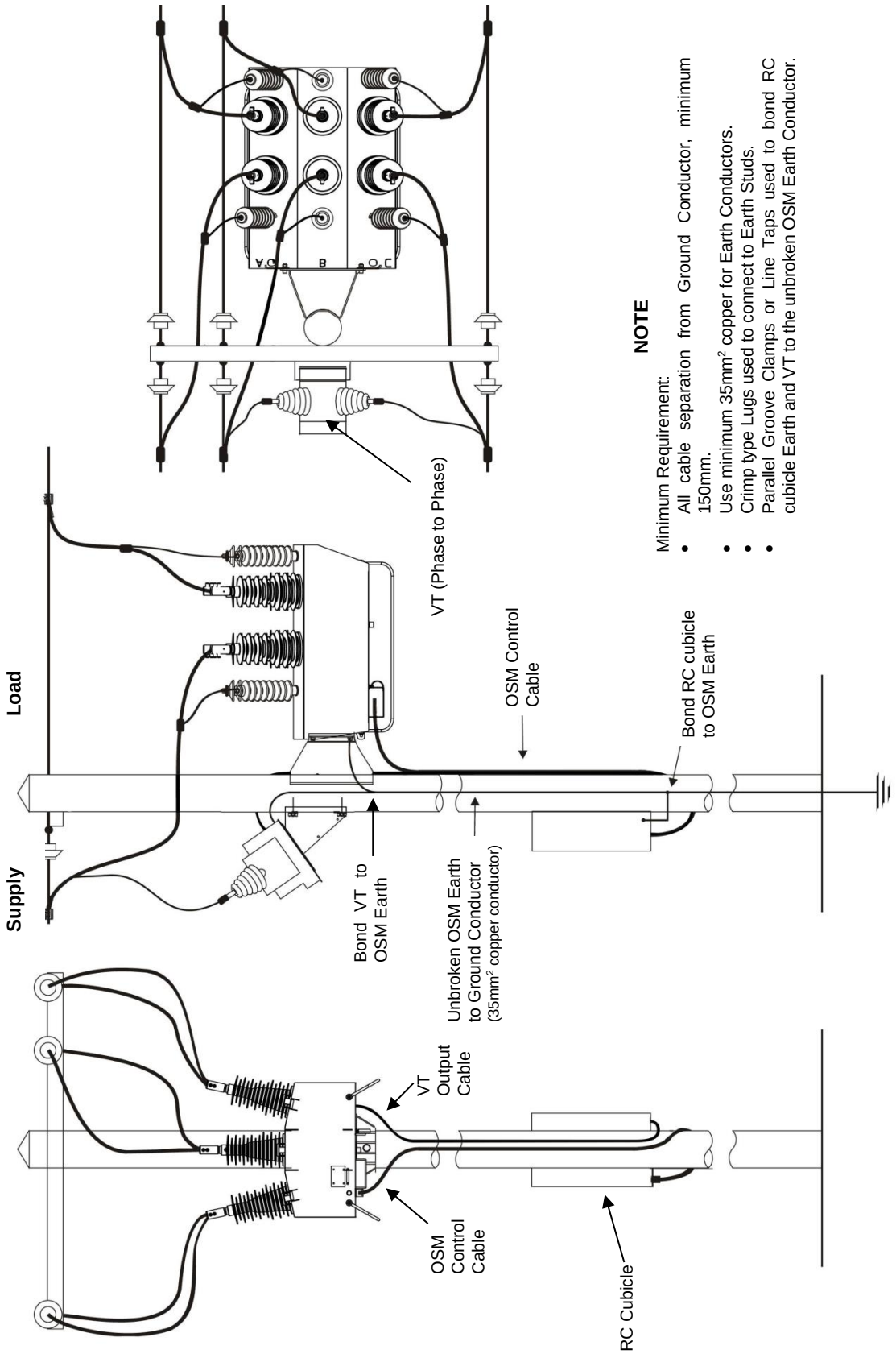
Recommended torque for connecting the Earth Lugs is 40 Nm.

There should be no earthing metal or cables between the bushing and the surge arrestor or stand-off.

Minimum recommended Earth Conductor requirement for OSM Recloser and RC cubicle:

- 35 mm^2 copper conductor
- Crimp type Connection Lugs
- Parallel Groove Clamp be used for bonding the RC short length conductor to OSM unbroken Earth Conductor. See the following diagrams.

WARNING: The main earth bond from the OSM tank to the main earth connection at the base of the pole must be a single, unbroken run. The cubicle earth is clamped to the main earth conductor as it runs past the cubicle without breaking the main earth conductor.



Typical Pole Mounting Arrangement for OSM300 and OSM310 with VT

9.4.6 Bird Guards and HV Cables

It is recommended that Bird Guards and Insulated Cables are used for the HV connections.

Bird Guards must be fitted under the top shed on the bushing so the bushing creepage distance is not compromised.

***Notes**:*

- *OSM38-300 Installations requiring 170 kV BIL must have bird guards installed as a minimum.*
- *OSM38-300 Installations requiring 195 kV BIL levels must use bird guards and insulated cable tails.*

9.4.7 Auxiliary Supply

The Recloser Control allows connection to either 110 Vac or 220 Vac configured supply.

Check the power supply input setting before connecting to ensure the correct voltage has been configured.

Refer to Section 4.4 for connection details.

9.4.7.1 LV Surge Arrestor

It is recommended the user install an LV surge protector at the point of supply of the auxiliary voltage, either at the VT terminals or tee off from utility mains.

9.4.8 Communications Interface

Remote communications with the Recloser Control can be achieved by using the I/O Modules or by connecting to the SCADA interfaces. In either case, all communications wiring must be by means of screened cable with the screens earthed to the RC cubicle earth at one end only. Where cabling exits the RC cubicle, it should be fitted with an appropriate RFI ferrite filter, located as close as possible to the (inside) floor of the cubicle.

Opto or galvanic isolation and surge protection must be used on the SCADA ports if conductive twisted pair cables are to be used as the communications medium.

Do not connect customer equipment directly to the RC battery under any circumstances. The External Load Power Supply is provided for this purpose.

Refer to Section 4.7 for details.

9.4.9 Interface Test Set

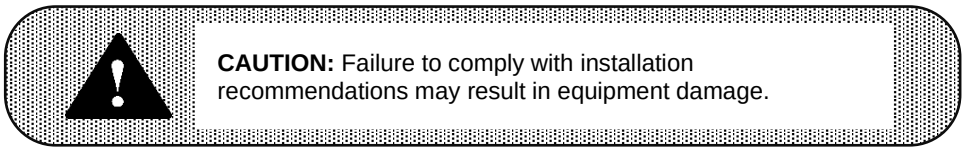
The Interface Test Set (ITS-04) can be connected to the OSM Control Cubicle and OSM Tank for testing purposes. It is used to simulate the current and voltage signals generated by sensors inside the OSM 300 and 310 series reclosers.

Note: *The current transformers in the ITS-04 are connected in the same direction as the OSM 300 and 310 series reclosers i.e. forward positive sequence powerflow direction is from the RST side to the ABC side.*

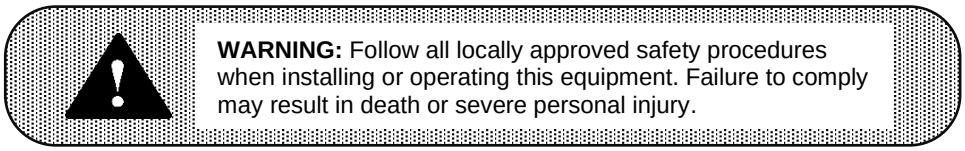
10 Maintenance

The OSM Auto Circuit Recloser and RC cubicle are designed for a maintenance free pole life.

This section provides recommendations for monitoring equipment condition.



CAUTION: Failure to comply with installation recommendations may result in equipment damage.



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

10.1 OSM Recloser

Contact Wear (both mechanical and fault) is calculated for every Open / Close operation. Mechanical Wear due to a single Open / Close operation (without fault interruption) is negligible since the mechanism is rated for 30,000 operations. Fault Wear is calculated during fault interruption considering the breaking current. Refer Section 2.1.2 for the rated number of operations under fault conditions.

The maximum contact wear on any one phase is indicated by the RC as percentage consumed. On reaching 100% the Vacuum Interrupter contacts should be considered to be at the end of their service life. The values for number of operations and contact wear should be monitored by the user through periodic captures of the RC memory to a computer using CMS software or a SCADA master application. Refer Section 7.7.1 Lifetime Counters for monitoring wear.

Where an RC cubicle is connected to a new OSM Recloser, the lifetime and contact wear counter values for that OSM must be reset. This can be done with a PC using CMS.

Once the Mechanism or Contact (Vacuum Interrupter) Wear on any pole has reached 100% contact your nearest NOJA Power office or distributor for a refurbishment assessment.

10.2 RC Cubicle

The RC cubicle is maintenance free with the exception of the sealed lead acid battery which requires periodic replacement. Refer to Section 10.5 Spare Parts List.

10.2.1 Battery Replacement

Approved batteries:

Part Number	Recommended service interval	Temp rating
BAT-14	2 years	-20°C to +50°C
BAT-11	4 years	-40°C to +60°C

Temperatures outside of ambient 25°C may negatively affect battery longevity. For further information contact the battery manufacturer. NOJA Power does not warrant battery life.

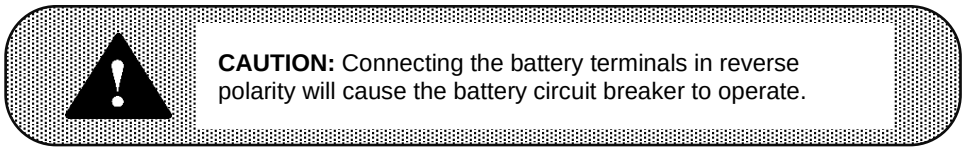
To ensure information is not accidentally lost during battery replacement, all historical data stored within the Relay should be captured using CMS software prior to proceeding.

10.2.1.1 Replacement Procedure

Refer to Section 10.4.1 RC General Layout.

Battery replacement is carried out as follows:

1. Open the escutcheon and turn off the battery Circuit Breaker.
2. Disconnect the battery supply connection to the SIM module.
3. Disconnect the negative terminal of the battery and secure the wiring harness to avoid accidental shorting.
4. Disconnect the positive terminal of the battery.
5. Remove the wingnuts securing the battery.
6. Remove the battery, install a replacement and tighten the wingnuts.



CAUTION: Connecting the battery terminals in reverse polarity will cause the battery circuit breaker to operate.

7. Connect the positive terminal followed by the negative terminal.
8. Reconnect the battery supply to the SIM module and turn on the battery Circuit Breaker.
9. Close the escutcheon, turn the Panel ON, select 'SYSTEM STATUS' and then 'Power Supply' to confirm battery voltage and charging current are correctly indicated.

Notes:

- *Damage due to accidental reverse polarity connection is prevented by a circuit breaker switch.*
- *Make sure the AC Supply is left on during this process so the system time clock does not reset after 60 seconds.*

10.2.2 Door Seal

The integrity of the cubicle door seal should be monitored. It is recommended to be included as a periodic check with the same cycle as battery replacement.

Ingress of dust at any time indicates the cubicle IP rating has been compromised and that the cubicle door seal or cable entry glands require attention.

10.2.3 Upgrading Firmware

The Relay and SIM modules can be upgraded to provide improvements or new features. These are released as firmware updates which can be downloaded from the NOJA Power secure website and loaded into the RC.

The firmware upgrade can be performed from CMS using the Update Tool. Alternatively files can be updated manually using a USB Flash drive. Ensure that the USB flash drive is formatted with FAT32 and files are stored in the "//rc10/updates" directory. Plug the USB Flash drive into one of the three USB ports located on the Relay module and follow the panel navigation as shown below.

Refer to NOJA-793 RC Relay Firmware Upgrade for a step by step instruction on the upgrade process.

Note: *When upgrading from versions earlier than firmware 1.14, please ensure there are no more than 7 files in the "//rc10/updates" folder.*

Upgrading Firmware

Panel Navigation

[Turn Panel ON] ⇒ [SYSTEM STATUS] ⇒ [Press ESC]

⇩

Insert USB Flash Drive

(Wait a few seconds)

[MAIN MENU]

[USB Operations]

<Enter Password>

[Install Updates]

```
            USB OPERATIONS

 Install Updates
►Copy Logs to USB◄
 Eject USB
 Factory Settings (Disabled)
 Status   : Ready
 Files    : 5
 Update Files:
 RLM-01_HW2_DB31_S2_1.27.0.0
```

Downgrading Firmware

Warning: *Downgrading to an earlier version is not recommended as this will reset all settings to default and erase all logs.*

Panel Navigation

[Turn Panel ON] ⇒ [SYSTEM STATUS] ⇒ [Press ESC]

⇩

Insert USB Flash Drive

(Wait a few seconds)

[MAIN MENU]

[USB Operations]

<Enter Password 1>

[Factory Settings]

<Enter Password 2>

[Install Firmware from USB]

```
            FACTORY SETTINGS

Factory Settings              Disabled

Lifetime Counters
Recovery Options
Identification
Switchgear Calibration
HMI Settings
►Install Firmware from USB◄
Install DNP3-SA Update Key
Logic CH 17-32 Write Protect  Disabled
```

Notes:

- *The update folder on the USB Flash drive must only contain the firmware files required.*
- *Please contact NOJA Support if you require password(s).*

10.3 Fault Finding

10.3.1 RC Cubicle

10.3.1.1 Operator Panel

When the cubicle is powered up from a shutdown state, the panel will display the “System Powering Up” message. This message can stay on the screen for up to 90 seconds. In normal operation the message will be replaced by the System Status page, and the System Running LED will start flashing every second.

A “Communications Error” message will be displayed if the Panel does not establish a connection to the Relay after 90 seconds. This indicates that the Relay is not communicating with the Panel at all. Check that the Relay is running by checking the Relay Running LED is flashing once a second. If the relay is running, reset the Operator Panel by re-starting the cubicle to re-establish communications.

If the panel detects some communications, but there is a problem with the data received, then the Panel will display “Cable Fault”. Check the cable between the Relay and Panel. Replace the cable if necessary.

10.3.1.2 Relay Module

In normal operation, the Relay module will flash the “Relay Running” LED every second.

The Relay module is powered from the SIM module. If the Relay Running LED is not lit, then check that the SIM module is running, and that the battery and AC power is connected.

If the power is connected and the “SIM Running LED” is flashing normal once every two seconds, then replace the Relay module.

10.3.1.3 Status of Wi-Fi, 4G and GPS

There are three additional LEDs on the Relay 15 module indicating the status of Wi-Fi, 4G and GPS.

LED	Off	Solid On	Flickering Fast	Fast Flashing	Slow Flashing
Wi-Fi	Disabled/Restarting	Initialising	Wi-Fi Active	-	
4G	Disabled/Restarting	Initialising/No Sim Card	-	Connection Active	Connection Inactive
GPS	Disabled/Insufficient Signal Strength/Restarting	-	-		Receiving GPS Signal

10.3.1.4 SIM Module

In normal operation, the SIM module LED will flash once every two seconds.

If the LED is not lit at all, check that there is DC power being supplied from the battery and the Power Supply module. Check the fuses in the battery wiring loom and the Power Supply module.

The battery voltage should measure above 10.5 VDC. If AC supply is off and the battery is below this voltage, then the SIM will not be able to power up the cubicle. Refer to Section 4.8.4.

The DC output to the SIM from the Power Supply module should be in the range of 22 – 60 VDC. Normal voltage is usually around 45 VDC.

If power to the SIM module looks correct and the LED is not lit at all, replace the SIM module.

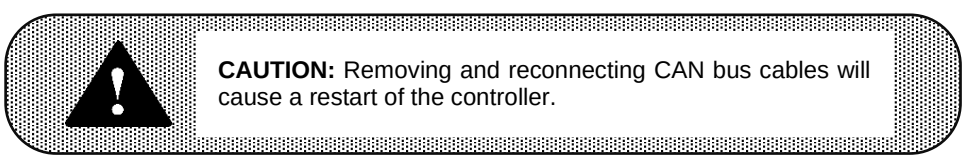
10.3.2 Recovery Mode

The controller will move into Recovery mode if it restarts three times in quick succession.

It is important to identify the cause of these restarts. Any cables between the SIM and Relay modules should be checked carefully and then try selecting “Restart”.

It the problem persists, it is recommended that “Format File System” is selected to reset the relay back to factory settings. Please note that all settings will need to be reloaded after a file system format has been done.

For more information or assistance please contact NOJA Power.



CAUTION: Removing and reconnecting CAN bus cables will cause a restart of the controller.

10.3.3 Copy Logs to USB

The RC generates and maintains a number of logs which can be imported into CMS for analysis.

Plug a USB Flash drive into one of the USB ports on the Relay module, enter the HMI password and click on “Copy Logs to USB” as shown below.

Eject the USB and plug it into a laptop or PC running CMS.

In CMS, from the Device menu, click “Import Device” then click “Import RC10 Logs”. Refer to CMS Help file for more details.

Panel Navigation

[Turn Panel ON] ⇒ *[SYSTEM STATUS]* ⇒ *[Press ESC]*

⇩

Insert USB Flash Drive

(Wait a few seconds)

[MAIN MENU]

↳ *[USB Operations]*

<Enter Password>

↳ *[Copy Logs to USB]*

```
            USB OPERATIONS

 Install Updates
►Copy Logs to USB◄
 Eject USB
 Factory Settings (Disabled)
 Status   : Ready
 Files    : 5
 Update Files:
 RLM-01_HW2_DB16_S2_1.13.0.31748
```

10.3.4 Upload Settings to CMS

RC settings can be uploaded to CMS for analysis:

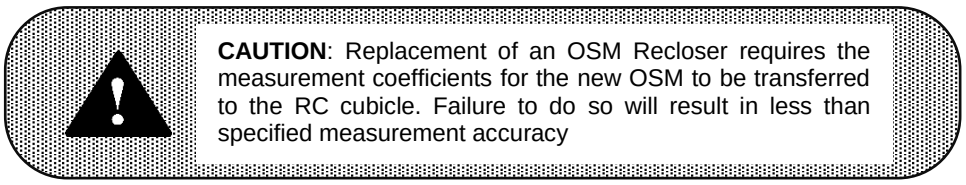
1. In CMS, ensure you are Online with the device.
2. From the Connection menu, click “Upload Settings” then click “Start Transfer”.
3. From the Device menu, click “Copy” to copy uploaded settings to a device.

If you need assistance, export the device, attach to an email and send to support staff at NOJA Power.

Refer to CMS Help file for more details.

10.3.5 OSM Recloser

Where an OSM fault is suspected it should be confirmed by substituting a second RC cubicle and control cable. If the fault reoccurs the OSM should be taken to a workshop for further diagnostic testing.



CAUTION: Replacement of an OSM Recloser requires the measurement coefficients for the new OSM to be transferred to the RC cubicle. Failure to do so will result in less than specified measurement accuracy

10.3.5.1 OSM Actuator Coil Resistance Testing

The actuator coil resistance can be measured from the control cable connector located on the tank if a malfunction is suspected. The resistance measured should be:

- OSM15-12/16-800-310 pins 15 and 16 9 ohms ±2 ohms
- OSM15-12/16-800-312 pins 15 and 16 14 ohms ±2 ohms
- OSM27-12-800-310 pins 15 and 16 9 ohms ±2 ohms
- OSM27-12-800-312 pins 15 and 16 14 ohms ±2 ohms
- OSM38-12-800-300 pins 15 and 16 9 ohms ±2 ohms
- OSM38-12-800-302 pins 15 and 16 14 ohms ±2 ohms

See Section 10.4.2 Control Cable connectors to help identify pin positions.

10.3.5.2 OSM Current Sensor Resistance Testing

The CT resistance can only be measured when the Recloser is de-energized, otherwise it shorts automatically.

CT resistance is 13.2 ±0.3 Ohm measured on Harting connector pins on the OSM.

- CT Phase A - pins 1 and 2
- CT Phase B - pins 3 and 4
- CT Phase C - pins 5 and 6

See Section 10.4.2 Control Cable connectors to help identify pin positions.

10.3.5.3 OSM Position Microswitch Status Testing

The OSM Recloser reports its position status to the RC Cubicle using micro switches. They can be measured from the control cable connector located on the tank as follows:

- When OSM is Open pins 21 and 18 is closed
  pins 21 and 19 is open
- When OSM is closed pins 21 and 19 is closed
  pins 21 and 18 is open

See Section 10.4.2 Control Cable connectors to help identify pin positions.

10.3.5.4 OSM Manual Trip Microswitch Testing

The status of the OSM manual trip micro switches can be checked. They can be measured from the control cable connector located on the tank as follows:

- When Manual Trip is engaged (Down) pins 20 and 21 is open
  pins 15 and 16 is open
- When Manual Trip is Off (Up) pins 20 and 21 is closed
  pins 15 and 16 is closed

See Section 10.4.2 Control Cable connectors to help identify pin positions.

10.3.5.5 OSM HV Contact Resistance Testing

Contact resistance between HV Connector to HV Connector across a closed vacuum interrupter, should be:

- OSM15-12/16-800-310/312 – 130 micro ohms or less
- OSM27-12-800-310/312 – 130 micro ohms or less
- OSM38-12-800-300/302 – 130 micro ohms or less

10.3.6 Warning Signals

The following table describes a number of warning events and signals available from the controller and what they indicate. It also suggests steps to assist in determining why the event/signal was generated and recommended actions. For a full list of signals and events please refer to Section 11.6 and 11.7.

Signal	Description	Possible Cause	Recommended actions
AC Supply High	Power supply voltage into SIM module is too high.	Wrong selection of AC input voltage	Check that the AC input voltage selection on the PSM is in the correct position for the nominal voltage.
		Incoming voltage is high	
AC Off (On Battery Supply)	No AC Supply available	Loss of AC Supply	Check AC Supply on the input of the Miniature Circuit Breaker in the cubicle.
		Failed PSM fuse	Check the PSM fuse. Replace if required.
		Wrong selection of AC input voltage	Check that the AC input voltage selection on the PSM is in the correct position for the nominal voltage.
		Miniature Circuit Breaker (MCB) is OFF or Faulty	Ensure MCB is ON.
			Check the voltage on the output of the MCB. If there is no voltage replace MCB.
		PSM does not supply voltage to the SIM	Ensure the cable from the PSM is plugged into the SIM and that all wires are connected properly.
			Check that all connectors on the printed circuit board (PCB) in the PSM are fully plugged in. Replace PCB if faulty.
		SIM does not detect the incoming voltage	Confirm that the supply is coming to the SIM from the PSM. If it is normal, replace the SIM.
AC Status (Surge)	SIM will report a voltage surge when the input voltage to the SIM is high. When in this state, the SIM operates on battery only until the AC input drops back to normal levels.	Incoming voltage is high	Check that the AC input voltage selection on the PSM is in the correct position for the nominal voltage.
			Fit Low Voltage surge arrestor protection to Auxiliary AC input.
ACO Unhealthy	Conditions detected not to allow an ACO operation	ACO unhealthy condition is present.	Refer to Section 6.12 to check ACO unhealthy conditions.
Battery Off (On AC Supply)	No battery supply is available	Battery circuit breaker is Off	Turn On the battery circuit breaker.
		Failed battery fuse	Check battery fuse. Replace if required.
		Disconnected battery or battery not connected to “battery” input on SIM	Check battery connections. Ensure the battery is plugged into the connector marked “battery” on the SIM module.
		Positive and negative terminal are in reverse polarity.	Check that the battery terminals are in the right position.
		Flat or damaged battery	Run battery test to determine state of the battery. Replace battery if faulty.
			Unplug battery cable from SIM. Check battery voltage. If it is less than 2 Vdc, replace the battery.
Battery Status Abnormal	Battery is either high, low or disconnected	Disconnected battery	Check battery connections.
		Failed battery fuse	Check battery fuse. Replace if required.
		Flat or damaged battery	Unplug battery cable from SIM. Check battery voltage. If it is less than 2 Vdc, replace the battery.

Signal	Description	Possible Cause	Recommended actions
Check Battery	Battery needs to be checked. Battery Test performed and battery suspect.	Disconnected battery	Check battery connections.
		AC not supplied or low	Check AC supply
		Failed battery fuse	Check battery fuse. Replace if required.
		Flat or damaged battery	Unplug battery cable from SIM. Check battery voltage. If it is less than 2Vdc, replace the battery.
Close Req. Blocked	The switch is in a mode that will block a close operation from ANY source	Live line or Hot Line Tag functions are ON	Check if this setting is required. Turn OFF if not required.
		Live Load Blocking	Check event log for details. Refer to Section 6.10.1 Live Load Blocking (LLB).
		IO or Logic close block interlock condition may be active.	Check event log for details.
		Close blocked by a protection element.	Check event log for details.
		UV4 Sag Blocking	Check event log for details. Refer to Section 6.4.4 Voltage Sag Protection (UV4 Sag).
		Close blocked if synchronising conditions are not met.	Check event log for details. Refer to Section 6.13 Synchronisation.
		LL Allow Close is Off	Check LL Allow Close settings and LL settings.
Close Request Fail	A request to close the OSM has failed	Too many operations in a row and the electronic circuit exceeded the duty cycle and did not have enough time to recharge the capacitors.	Wait 2 minutes while the capacitors charge and electronics reset.
		Mechanical trip ring was operated.	Push mechanical trip ring back to return the recloser to normal mode.
		OSM not connected properly or faulty control cable	Ensure both ends of control cable are securely connected and latched. Refer to Section 10.4.2 to carry out a control cable continuity test. Replace control cable if required.
		CAN Bus Cable not connected properly or faulty.	Check CAN Bus cable fully plugged in. Test cable by substitution.
		Relay Module is not sending signals	Replace relay module.
		Close or Trip Capacitors Faulty	Replace SIM module
		Faulty Actuator or Mechanism Failure	Refer to Section 10.3.5 to check actuator coil resistance. If faulty replace OSM.
Critical Battery Level	System shutdown in less than 5 minutes due to low battery level.	AC supply is OFF	Turn AC Supply ON and allow battery to recharge
		Disconnected battery or battery not connected to “battery” input on SIM	Check battery connections. Ensure the battery plug is plugged into the connector marked “battery” on the SIM module.
		Failed battery fuse	Check battery fuse. Replace if required.
		Flat or damaged battery	Unplug battery cable from SIM. Check battery voltage. If it is less than 2 Vdc, replace the battery.
Dial Up failed	The Dial Up Failed	Wrong configuration from SCADA Settings	Check SCADA settings and re-configure it if required.
		Modem does not connect	Check modem connection.
			Check modem settings and re-configure if required.
			Check for modem's coverture signal
		The device has sent a response to the master station without receiving a request (unsolicited)	May need to re-configure settings on the master for unsolicited responses.
Incorrect Phase Sequence	Incorrect phase sequence has been detected.	Actual connected phase sequence and configured phase sequence do not match.	Amend Phase Configuration setting to match measured sequence

Signal	Description	Possible Cause	Recommended actions
Mechanically Locked	OSM Mechanically Locked.	Mechanical trip ring pulled down.	Push mechanical trip ring back to return the recloser to normal mode.
		Control Cable Faulty	Refer to Section 10.4.2 to carry out a control cable continuity test. Replace control cable if required.
		OSM Manual Trip Microswitch faulty	Refer to 10.3.5 to confirm micro switch fault. Replace OSM if fault confirmed.
OSM Disconnected	OSM Disconnected	The OSM Tank is disconnected	Check the connection to the OSM Tank.
		Faulty SIM	Replace SIM.
		Control Cable Faulty	Refer to Section 10.4.2 to carry out a control cable continuity test. Replace control cable if required.
		OSM auxiliary switch faulty	Refer to 10.3.5 to confirm auxiliary switch fault. Replace OSM if fault confirmed.
		Control cable not correctly seated in SIM.	Check the connection to the SIM module.
OSM Position Status Unavailable	OSM Position Status is Unavailable due to being disconnected or a malfunction.	The OSM Tank is disconnected	Check the connection to the OSM Tank.
		Control cable not correctly seated in SIM.	Check the connection to the SIM module.
		Faulty SIM	Replace SIM.
		OSM auxiliary switch faulty	Refer to Section 10.3.5 to confirm auxiliary switch fault. Replace OSM if fault confirmed.
		Control Cable Faulty	Refer to Section 10.4.2 to carry out a control cable continuity test. Replace control cable if required.
Power Restart	Power Restart	Flat or damaged battery	Unplug battery cable from SIM. Check battery voltage. If it is less than 2 Vdc, replace the battery.
		No communication between SIM and Relay	Check CAN Bus cable fully plugged in. Test cable by substitution.
		SIM Faulty	Replace SIM module.
		Relay Module Faulty	Replace relay module.
Shutdown	Set into Shutdown state	User Shutdown	N/A
		After a prolonged loss of AC supply the system will shutdown.	Restore AC. Replace battery if required.
		If the battery supply is lost, or the battery is disconnected, the external load supply will continue to operate with reduced capacity. Drawing more than 15 W may cause the controller to shutdown. Refer to Section 4.8.5.	Check the external load if supply is lost
		Internal Error	If it continues to re-occur, format the file system, upgrade the relay software and reload settings.
		Communication equipment connected directly to battery terminals.	DO NOT connect communication equipment directly to battery terminals. This can drain the battery, cause system shutdown or damage the equipment. Connect communication equipment to external supply on SIM module.
SIM and OSM Model Mismatch	SIM does not match OSM model number	SIM connected to the relay does not match OSM model number. SIM-01 is designed for single phase, 2 phase and 3-phase, SIM-02 is for single triple and SIM-03 is for OSM 200 tanks.	Ensure you have correct SIM for the OSM tank used.
		Incorrect OSM Model Number	Enter correct OSM Model Number.

Signal	Description	Possible Cause	Recommended actions
SIM Caps Not Charged	SIM Module capacitors are not fully charged.	Less than 60 seconds after the OSM tank was connected.	Wait 60 seconds.
		OSM not connected	Connect OSM
		No AC Supply or battery power provision	Check and connect the AC Supply and/or battery power
		Too many operations in a row and the electronic circuit exceeds the duty cycle and does not have enough time to recharge the capacitors.	Wait 2 minutes while the capacitors charge.
		Faulty SIM	Replace SIM
SIM Driver Q503 Failed	SIM actuator driver has failed	Faulty SIM	Replace SIM
SIM Not Calibrated	SIM module voltage and current coefficients required	SIM faulty or requires calibration	Contact NOJA Power
Source Not Healthy	The ACO algorithm uses protection elements to determine if a source is healthy or not, to change over from one source to another.	A protection element is outside user configurable parameters.	Check event log and ACO messages to determine cause and whether any action is required. Refer to NOJA-594 Auto Change Over with Recloser Control User Manual.
Trip Request Fail	The request of trip operation fails	OSM not connected	Check the connection to the OSM Tank.
		Control Cable Faulty	Refer to Section 10.4.2 to carry out a control cable continuity test. Replace control cable if required.
		OSM Mechanically Locked Out	Push mechanical trip ring back to return the recloser to normal mode.
		Operation Active	Check if a previous protection operation has interrupted the trip sequence.
		Faulty Actuator or Mechanism Failure	Replace OSM
USB Host Power Off	USB Host power supply turned off on expiry of External Load Time	After loss of AC supply and the External Load Timer expires, the USB ports shutdown.	Restore AC supply
			Disable “USB Host Ports Shutdown”. Refer to Section 4.8.3
USB Unsupported	USB device inserted into Relay USB Port is not a NOJA Supported device	Non-NOJA Power USB devices do not have a driver stored in the relay.	Use a NOJA Power approved USB Accessory.

10.3.7 Malfunction Signals

The following table describes a number of malfunction events and signals available from the controller and what they indicate. It also suggests steps to assist in determining why the event/signal was generated and recommended actions. For a full list of signals and events please refer to Section 11.6 and 11.7.

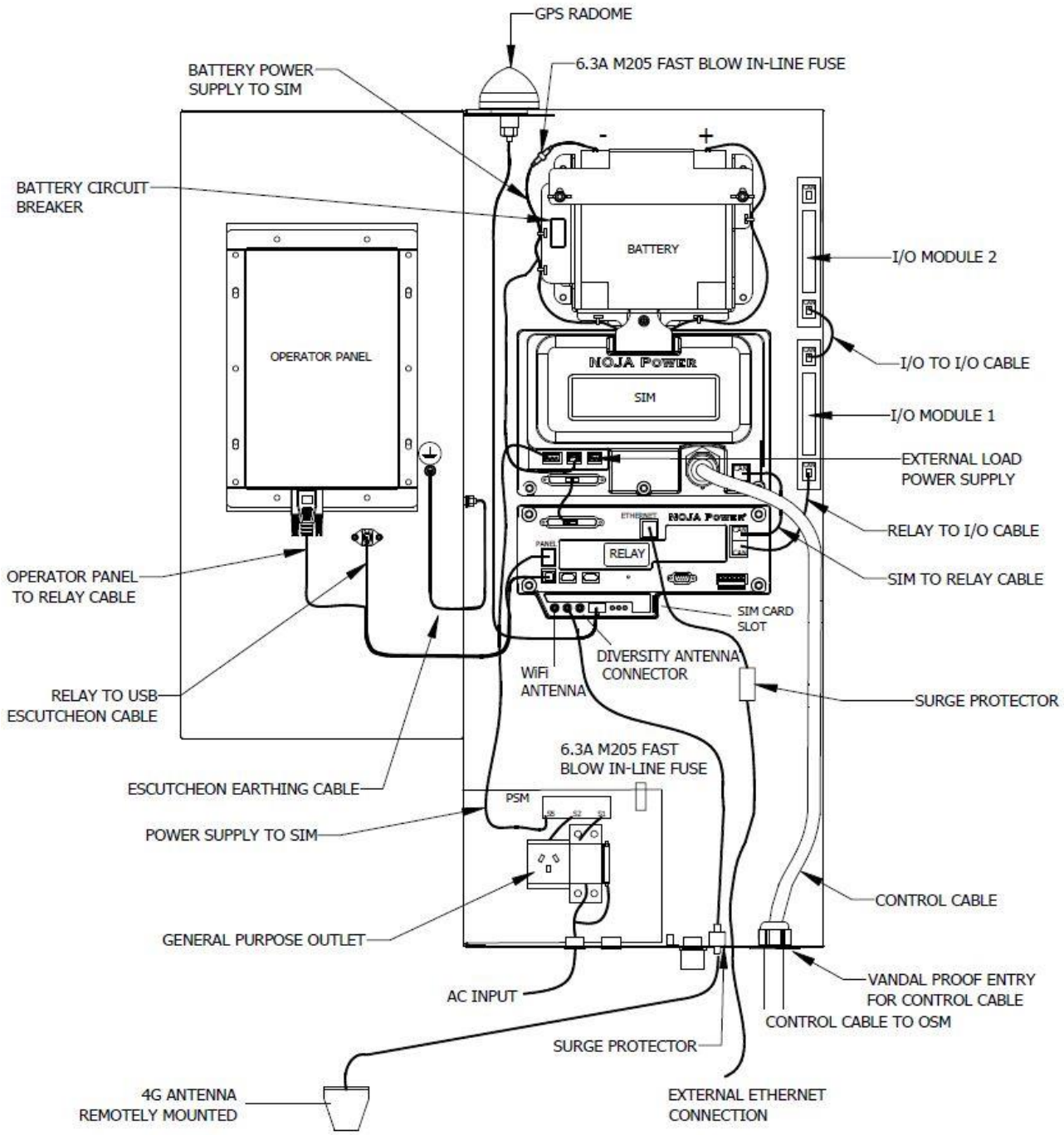
Signal	Description	Possible Cause	Recommended actions
Battery Charger Fault	Battery is not charging	Disconnected battery or faulty wiring	Check battery connections and wiring.
		AC not supplied or low	Check the presence of AC supply on the input to Miniature Circuit Breaker in the cubicle.
		Failed battery fuse	Check battery fuse. Replace if required.
		Damaged battery	Replace battery.
		SIM Fault	Replace SIM
CAN Bus Malfunction	Communication problem between SIM and Relay or between relay and I/O modules.	Modules out of sync	Restart relay.
		CAN Bus cable fault from SIM to relay	Check CAN Bus cable from SIM to relay fully plugged in. Test cable by substitution.
		CAN Bus cable fault from I/O to relay	Check CAN Bus cable from I/O to relay fully plugged in. Test cable by substitution.
		CAN Bus cable fault between I/O modules	Check CAN Bus cable between I/O modules fully plugged in. Test cable by substitution.
		Relay Fault	Replace relay.
		SIM Module fault	Replace SIM.
		I/O module fault	Replace I/O Module
Capacitor Voltage Abnormal	The SIM capacitor voltage below required value	Too many operations in a row and the electronic circuit exceeds the duty cycle and does not have time enough to recharge the capacitors. Close capacitor voltage drop too high or Trip capacitor voltage drop too high or Trip capacitor voltage drop on close.	Wait 2 minutes while the capacitors charge. Replace SIM if condition persists.
CBF Malfunction	CBF Protection registers a malfunction after the CBF Fixed Time of 150ms	A Current (>1 A) flows through any of the Phases despite the recloser indicates “Open”.	Malfunctions are automatically reset after the next successful operation of switchgear
CBF Backup Trip	Back trip upstream CBs	The local recloser has not operated to isolate the fault	
Controller Fault	Active due to CAN Bus malfunction, module fault, communications error or external load overload	CAN Bus Malfunction	Check CAN Bus cable fully plugged in. Test cable by substitution.
		Communication wiring fault	Check communication wiring by substitution.
		Communications device fault	Replace communication equipment.
		Exceeded the external load capacity	Do not exceed the external load capacity
		SIM module fault	Replace SIM
		Relay module fault	Replace relay.
Excessive Tc	Closing time exceeds 100ms or no confirmation received that close command was executed successfully.	Actuator Driver not ready because the capacitors need time to charge	Wait 2 minutes while the capacitors charge.
		Short Circuit or Open Circuit in Control Cable	Refer to Section 10.4.2 to carry out a control cable continuity test. Replace cable if fault confirmed.
		OSM Auxiliary Switch Fault	Refer to 10.3.5 to confirm auxiliary switch fault. Replace OSM if fault confirmed.
		SIM module fault	Replace SIM
		OSM Mechanism Fault	Replace OSM.

Signal	Description	Possible Cause	Recommended actions
Excessive To	Opening time exceeds 60ms or no confirmation received that open command was executed successfully.	Capacitors not charged	Wait 2 minutes while the capacitors charge
		Short Circuit or Open Circuit in Control Cable	Refer to Section 10.4.2 to carry out a control cable continuity test. Replace control cable if required.
		OSM Auxiliary Switch Fault	Refer to 10.3.5 to confirm auxiliary switch fault. Replace OSM if fault confirmed.
		SIM module fault	Replace SIM
		OSM Mechanism Fault	Replace OSM.
External Load Overload	Overload detected in the external load (Radio Supply)	Exceeded the external load capacity	Do not exceed the external load capacity
		Communication wiring fault	Check communication wiring by substitution.
		Communications device fault	Replace communication equipment.
		SIM module fault	Disconnect communication equipment from SIM. If the external load output is unable to be turned ON then replace SIM.
GPS Malfunction	Invalid NEMA strings received.	Cable is faulty or not connected properly.	Check connection to GPS. Test cable by substitution.
		GPS radome faulty	Replace GPS.
		Relay module faulty	Replace relay module.
I/O1 or I/O2 Comms Error	No communication with I/O1 or I/O2	I/O1 or I/O2 module not installed	Install I/O1 or I/O2 module
		Cable is faulty or not connected properly.	Check connection to I/O module. Test cable by substitution.
		I/O1 or I/O 2 module faulty	Replace I/O1 or I/O2 module
I/O1 Fault or I/O2 Fault	Internal fault detected in module I/O1 or I/O2	I/O1 or I/O2 module faulty	Replace I/O1 or I/O2 module
Incorrect DB Values Loaded	One or more database values are out of range and have been set to default.	Logic expression/ SGA application or other source has made an update to a database value outside permitted range.	Upload and Compare Settings in CMS. Review and download updated settings If required.
			Review any logic expressions or SGA applications that may update database values incorrectly. Make any required changes and download IO & Logic settings to the device.
			Restart Controller.
Module Comms Error	SIM or I/O module communication error detected	Cable is faulty or not connected properly.	Check connection to SIM and I/O modules. Test cable by substitution.
		I/O module fault	Replace I/O module.
		SIM module fault	Replace SIM.
OSM Coil OC	OSM Coil open circuit detected	Mechanical trip ring extended	Ensure mechanical trip ring is pushed back into normal mode.
		Control Cable disconnected	Ensure both ends of control cable are securely connected and latched.
		Control Cable open circuit	Refer to Section 10.4.2 to carry out a control cable continuity test. Replace control cable if required.
		SIM Faulty	Disconnect control cable from SIM. If the event is not cleared then replace SIM.
		OSM operating coil open circuit	Refer to 10.3.5 to confirm actuator coil fault. Replace OSM if faulty.
OSM Coil SC	OSM coil short circuit detected	Control cable short circuit	Refer to Section 10.4.2 to carry out a control cable continuity test. Replace control cable if required.
		SIM Faulty	Disconnect control cable from SIM. If the event is not cleared then replace SIM.
		OSM operating coil short circuit	Refer to 10.3.5 to confirm actuator coil fault. Replace OSM if faulty.

Signal	Description	Possible Cause	Recommended actions
OSM Fault	OSM Fault	OSM Coil OC	Refer to “OSM Coil OC” signal.
		OSM Coil SC	Refer to “OSM Coil SC” signal.
		Excessive To	Refer to “Excessive To” signal.
		Excessive Tc	Refer to “Excessive Tc” signal.
		Limit Switch fault	Refer to “OSM Limit Switch Fault” signal.
OSM Limit Switch Fault	OSM Limit Switch Fault	Open switch failed closed or open or Close switch failed open or close. Close and mechanical interlock switch closed	Refer to 10.3.5 to confirm auxiliary switch fault. Contact NOJA Power to replace auxiliary switches if fault confirmed.
		OSM Mechanism Fault	Test Trip/Close using ITS-04 or ITS-10. Replace OSM if required.
Panel Comms Error	Panel communication error	Cable from panel to relay is faulty or not connected properly.	Check connection from panel to relay module. Test cable by substitution.
Panel Module Fault	Internal fault of HMI (panel) module detected.	RS-232P disabled	Confirm RS-232**P** has not been disabled.
		Cable from panel to relay is faulty or not connected properly.	Check connection from panel to relay module. Test cable by substitution.
		Internal fault detected in panel module	Replace panel module.
Relay Module Fault	Internal fault of Relay Module detected	CAN data cable is faulty	Check connection from SIM to relay. Test CAN data cable by substitution.
		Connection from operator panel module is faulty	Check connection from panel to relay module. Test cable by substitution.
		No Power to Relay Module	The Relay module is powered from the SIM module. If the Relay LED is not lit, then check that the SIM module is running and that the battery and AC power is connected. If the SIM running LED is flashing normal once every two seconds then check all cable connections. Replace relay module if problem is not resolved.
		Internal Fault Detected in Relay Module	Replace relay module
RTC Hardware Fault	Real Time Clock hardware failure	RTC circuit component failure	Replace SIM
Battery Test Circuit Fault	Test circuit is faulty and the battery test could not be performed.	Hardware fault in battery test circuit.	Check battery wiring loom. Replace SIM.
SIM Comms Error	Communication error with SIM	CAN Bus between SIM and relay not connected properly or cable is faulty.	Check cable connections from SIM to relay. Test cable by substitution.
		Wrong settings configuration	Check communication settings.
		Modem not connected properly or cable is faulty.	Check cable connections to modem. Test cable by substitution.
		SIM Module Fault	Replace SIM module
		Relay Module Fault	Replace relay module
SIM minibootloader mode	SIM module software issue	SIM module software corruption	Upgrade SIM software
SIM Module Fault	SIM Module Fault detected	Firmware CRC (Cyclic redundancy Check), Bootloader CRC, RAM Memory, Flash Memory	Reinstall firmware or upgrade if required.
		No power supply	Check power to the SIM Module.
		CAN data cable is faulty	Test CAN data cable by substitution.
		Control cable short circuit	Disconnect control cable from SIM. If the event is cleared then the control cable is faulty and should be replaced.
		Internal short circuit in SIM Module	Replace SIM module.
		PSM Fault	Replace PSM.

10.4 Schematics

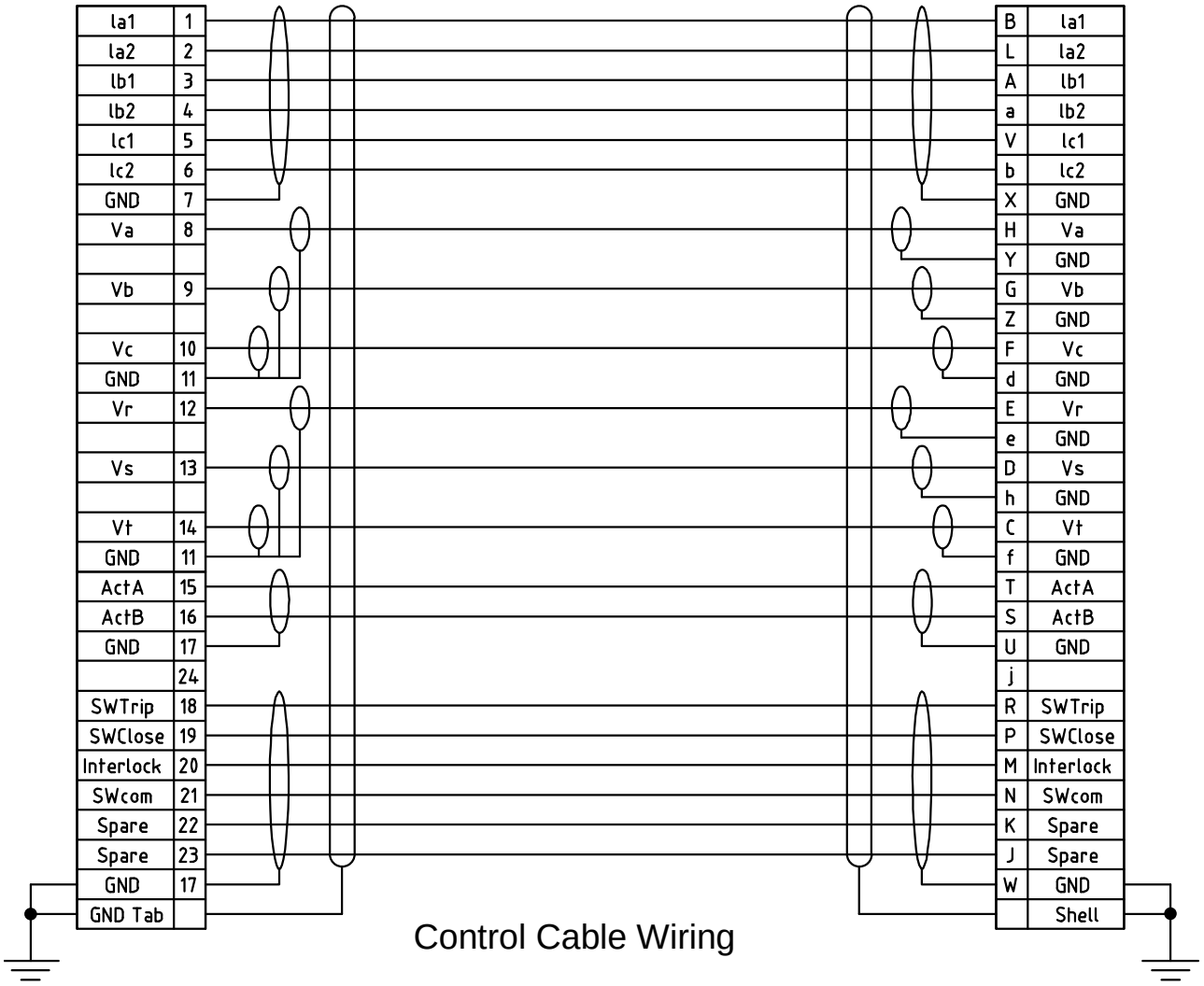
10.4.1 RC General Layout



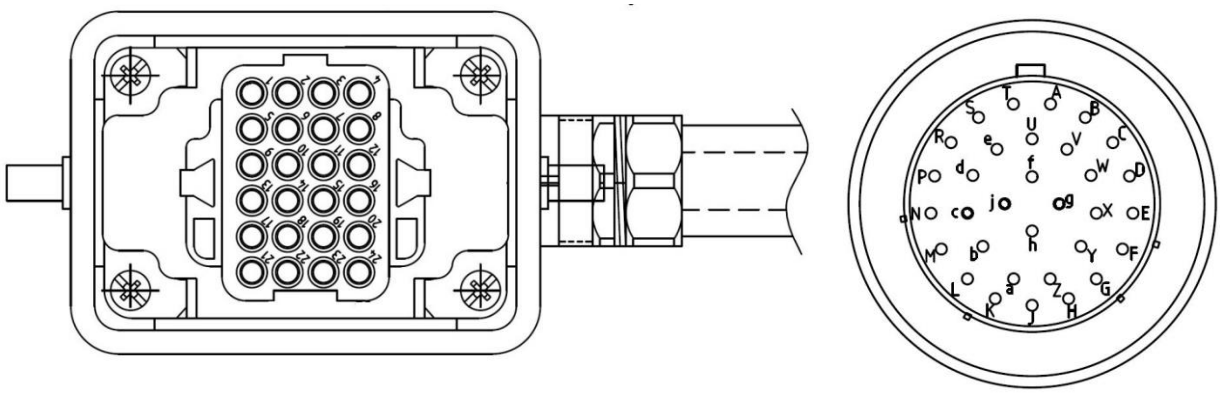
Notes:

- *Wi-Fi, GPS and Mobile Network connectivity only available in RC-15 cubicle.*
- *The Dual Input PSM module consists of 2 x AC Input connections.*

10.4.2 Control Cable



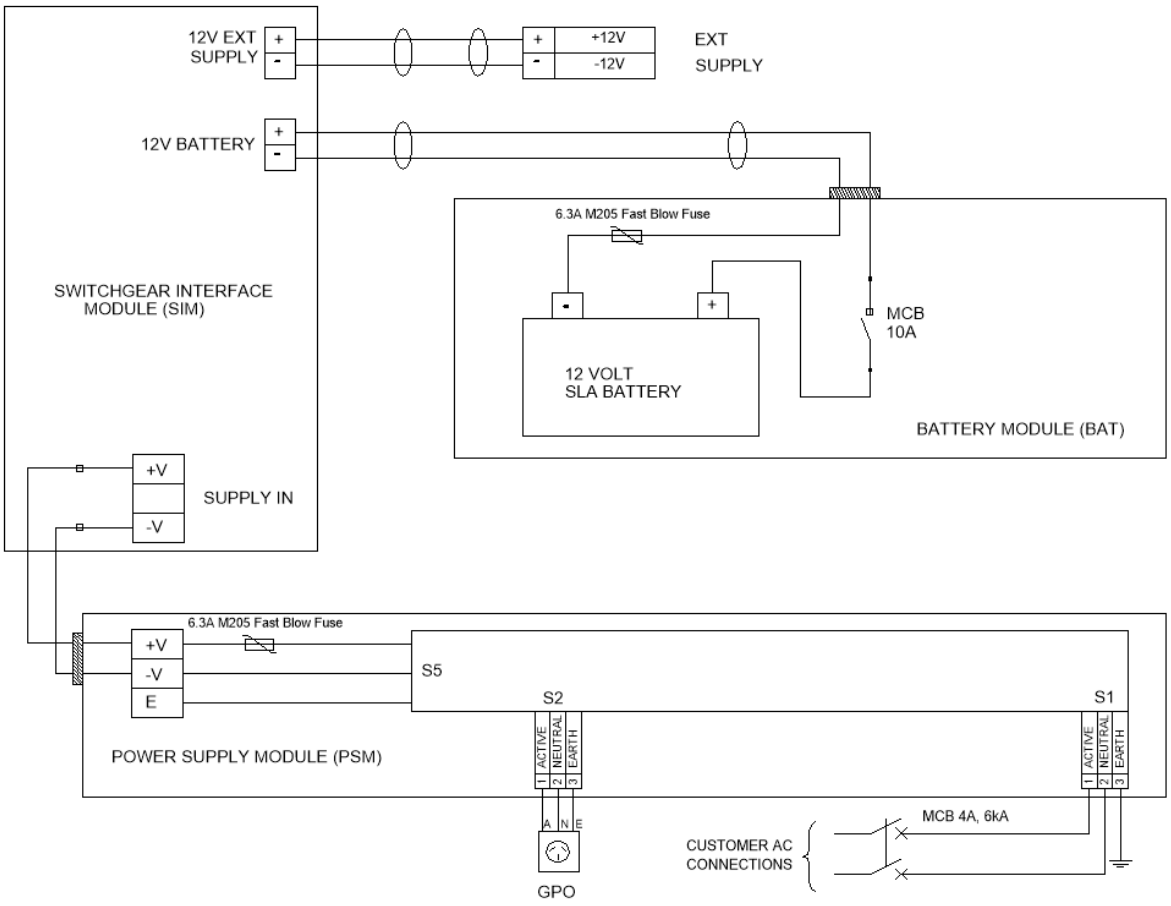
Control Cable Wiring



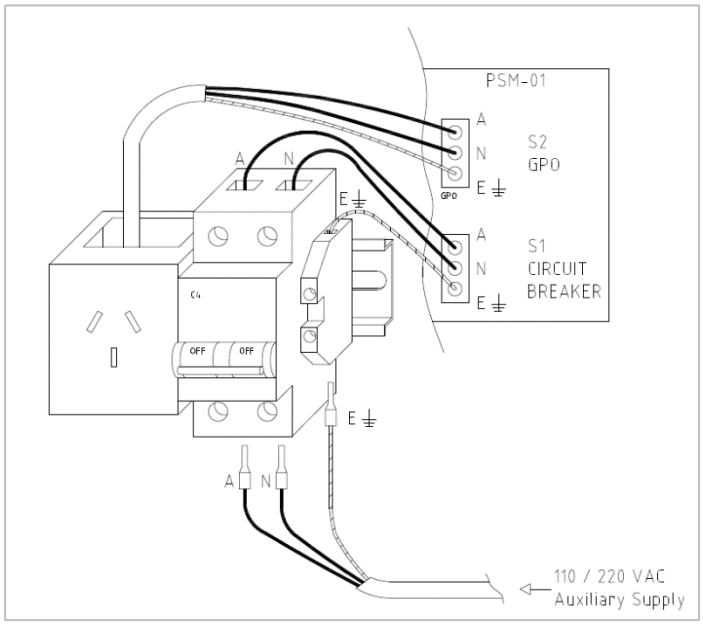
Control Cable Connectors

10.4.3 Power Supply

Below is the power supply wiring diagram. Please refer to Section 4.4 for AC voltage selections.



Power Supply Wiring Diagram



Miniature Circuit Breaker and General Purpose Outlet

10.5 Spare Parts List

Description	Part Number
Battery, Sealed Lead Acid	
Genesis 12V26AhEP Side Mount RC-10ES (Higher operational parameter battery, different mounting bracket used)	BAT-11 (Battery only BAT-0001)
NOJA Power Vertical Mount RC-10ES (Standard Generic)	BAT-14 (Battery only BAT-0004)
Control Cable, 7 metres long[(1)]	CC07-11
OSM Pole Mounting Bracket	OMB-18
Combined OSM/VT Pole Mounting Bracket	OMB-17
VT Mounting Bracket	
11 kV, 22 kV or 33 kV	VTMB-10
I/O Module	IOM-11
Operator Control Panel (including panel labels for fast keys)	
English	PAN-01-1-E
Spanish	PAN-01-1-S
Portuguese	PAN-01-1-P
US	PAN-01-1-U
US (Single Triple)	PAN-01-5-U
English (with variable fast keys, VAR 1 and VAR 2)	PAN-01-6-E
Power Supply Module (does not include general purpose outlet)	PSM-02
Power Supply Module (Dual AC Input) (does not include general purpose outlet)	PSM-04
Power Supply Module (Dual AC/DC Input) (does not include general purpose outlet)	PSM-06
Printed Circuit Board Assembly for Power Supply Module	PSMS-PCB
Relay Module (Ethernet Port)	REL-02
Relay Module (Wi-Fi, GPS, Ethernet Port)	REL-15
Relay Module (Wi-Fi, GPS, 4G, Ethernet)	REL-15-4GA (Europe/APAC)
Relay Module (Wi-Fi, GPS, 4G, Ethernet)	REL-15-4GB (Americas)
Switchgear Interface Module (Single Phase, 2-Phase, 3-Phase)	SIM-01
Switchgear Interface Module (Single Triple)	SIM-02
Cables	
SIM to Relay Analogue	WA30-10
Panel to Relay Cable Assembly	RC10-3050
IOM-11 v2.9 and below to IOM-11 v2.9 and below	CAB-0047
IOM-11 v2.9 and below to IOM-11 v3.0 and above	CAB-0064
IOM-11 v3.0 and above to IOM-11 v3.0 and above	RC10-1161
IOM-11 v2.9 and below to REL-01/REL-02 v1.0 and below	CAB-0047
IOM-11 v3.0 and above to REL-01/REL-02 v1.0 and below	CAB-0064
IOM-11 v2.9 and below to REL-02 v1.1 and above, REL-15, REL-15-4GA, REL-15-4GB	CAB-0064
IOM-11 v3.0 and above to REL-02 v1.1 and above, REL-15, REL-15-4GA, REL-15-4GB	RC10-1161
SIM-01 v4.2 and below (with RJ45) to REL-01/ REL-02 v1.0 and below	CAB-0047
SIM-02 and SIM-01 v4.3 and above (with mini-fit connector) to REL-01/ REL-02 v1.0 and below	CAB-0064
SIM-02 and SIM-01 v4.3 and above (with mini-fit connector) to REL-02 v1.1 and above, REL-15, REL-15-4GA, REL-15-4GB	RC10-1161
Voltage Transformer, Phase to Phase Type (Auxiliary Supply)	
11 kV primary, 110 V secondary	VT11/110
11 kV primary, 220 V secondary	VT11/220
22 kV primary, 110 V secondary	VT22/110
22 kV primary, 220 V secondary	VT22/220
33 kV primary, 110 V secondary	VT33/110
33 kV primary, 220 V secondary	VT33/220
33 kV primary, 110 V or 220 V secondary	VT33/110-220

Description	Part Number
HV Surge Arrestor	For Part Numbers, contact NOJA Power for each installation specific requirements.
Bird Guards	
for Tunnel Type HV Connectors	BGD-02
Palm Type HV Connectors	BGD-06
Voltage Transformer	BGD-03

Notes:

1. *Standard length supplied. Other lengths supplied upon Customer request.*

11 Appendices

11.1 Appendix A – Group Settings Elements Structure

Protection Settings		
OC - Overcurrent Elements		
	OC1+	Low set time delayed OC element attributed with forward power flow.
	OC2+	Low set OC element attributed with forward power flow
	OC3+	High set instantaneous OC element attributed with forward power flow
	OC1-	Low set time delayed OC element attributed with reverse power flow.
	OC2-	Low set OC element attributed with reverse flow
	OC3-	High set instantaneous OC element attributed with reverse power flow
NPS - Negative Phase Sequence Elements		
	NPS1+	Low set time delayed NPS element attributed with forward power flow.
	NPS2+	Low set NPS element attributed with forward power flow
	NPS3+	High set instantaneous NPS element attributed with forward power flow
	NPS1-	Low set time delayed NPS element attributed with reverse power flow.
	NPS2-	Low set NPS element attributed with reverse flow
	NPS3-	High set instantaneous NPS element attributed with reverse power flow
I2/I1 Broken Conductor Protection		
	I2/I1	Protection against broken conductor using ratio of negative sequence current over positive sequence current.
EF - Earth Fault Elements		
	EF1+	Low set time delayed EF element attributed with forward power flow.
	EF2+	Low set EF element attributed with forward power flow
	EF3+	High set instantaneous EF element attributed with forward power flow
	EF1-	Low set time delayed EF element attributed with reverse power flow.
	EF2-	Low set EF element attributed with reverse flow
	EF3-	High set instantaneous EF element attributed with reverse power flow
SEF - Sensitive Earth Fault Elements		
	SEF+	SEF element attributed with forward power flow.
	SEF-	SEF element attributed with reverse power flow.
Yn - Admittance Protection Element		
	Yn	Yn - Protection element using neutral admittance characteristics of the network
PDPR – Directional Power Elements		
	PDOP	Directional Overpower
	PDUP	Directional Underpower
LL - Live Line Overcurrent Elements		
	OCLL 1-3	OC Live Line Overcurrent elements
	NPSLL 1-3	NPS Live Line Overcurrent elements
	EFLL 1-3	EF Live Line Overcurrent elements
	SEFLL	SEFLL Overcurrent elements
MNT - Maximum Number of Trips		
FE - Frequency Element		
	UF	Under Frequency Element (Stage 1)
	UF2	Under Frequency Element (Stage 2)
	UF3	Under Frequency Element (Stage 3)
	OF	Over frequency Element (Stage 1)
	OF2	Over frequency Element (Stage 2)
	OF3	Over frequency Element (Stage 3)
	ROCOF	Rate Of Change Of Frequency

Protection Settings		
VE - Voltage Elements		
	UV1	Phase Undervoltage balanced element (Stage 1)
	UV12	Phase Undervoltage balanced element (Stage 2)
	UV13	Phase Undervoltage balanced element (Stage 3)
	UV2	Line to Line Undervoltage element (Stage 1)
	UV22	Line to Line Undervoltage element (Stage 2)
	UV23	Line to Line Undervoltage element (Stage 3)
	UV3	Loss of Supply element
	UV4 Sag	Voltage Sag Protection
	OV1	Phase Overvoltage balanced element (Stage 1)
	OV12	Phase Overvoltage balanced element (Stage 2)
	OV13	Phase Overvoltage balanced element (Stage 3)
	OV2	Line to Line Overvoltage element (Stage 1)
	OV22	Line to Line Overvoltage element (Stage 2)
	OV23	Line to Line Overvoltage element (Stage 3)
	OV3	Neutral Displacement Overvoltage
	OV4	Negative Sequence Overvoltage protection
	VVS	Voltage Vector Shift
ABR - Automatic Backfeed Restoration		
LSD - Loss of Supply Detector		
	Uabc <	Loss of Voltage detector related to abc
	Urst <	Loss of Voltage detector related to rst
	Iabc <	Loss of current detector
VRC - Voltage Reclose Control		
	VRC	Voltage Restoration Control
	LLB	Live Load Blocking
HRM - Harmonics		
	THD/TDD	Total Harmonic Distortion/Total Demand Distortion
	A,B,C,D,E	Individual Harmonics
Auto Reclosing		
	AR	Auto Reclosing Element for OC, NPS, EF and SEF
	AR VE	Voltage Reclosing Element
Directional Elements		
	DE OC	OC Directional element
	DE NPS	NPS Directional element
	DE EF	EF Directional element
	DE SEF	SEF Directional Element
Other		
	CLP	Cold Load Pickup element
	IR	Inrush Restraint element
	TTA	Temporary Time Addition adder
	CBF	Circuit Breaker Fault

Notes:

- *Each individual protection group has the same functional structure.*
- *Protection Status Control (PSC) allows global changes to protection groups from a variety of sources.*

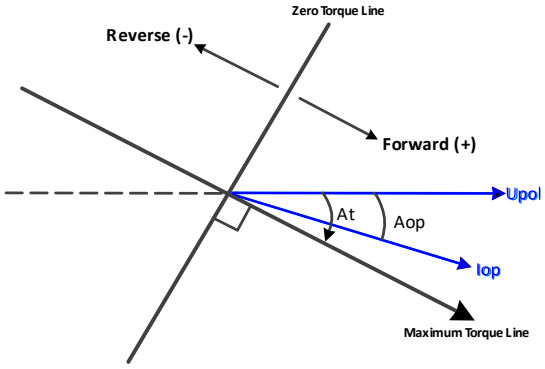
11.2 Appendix B – Directional Protection

11.2.1 Overcurrent directional elements (DE OC, DE NPS, DE EF and DE SEF)

Overcurrent directional elements use symmetrical components to provide polarising voltage and operating current for calculation of the operating angle associated with directional protection. Which symmetrical components are used depends on the element in question, DE OC, DE NPS, DE EF or DE SEF.

The phase overcurrent directional element (DE OC) uses positive sequence voltage as the polarising voltage and positive sequence current as the operating current. The Negative Phase Sequence (DE NPS) directional element uses negative sequence voltage as the polarising voltage and negative sequence current as the operating current. The Earth Fault (DE EF) and Sensitive Earth Fault (DE SEF) elements use zero sequence voltage as the polarising voltage and zero sequence current as the operating current.

In general, a directional element operates as illustrated in the diagram.



where: U_{pol} polarising voltage

I_{op} operating current

A_{op} phase angle between U_{pol} and current I_{op}

A_t preset torque angle

Depending upon the derived operating angle, the relevant directional element selects states as follows:

\+ A_{op} is within $A_t \pm 90^o$

– A_{op} is outside $At \pm 90^o$

? U_{pol} or I_{op} is too low to provide polarisation
(for OC: $U_{pol} \leq 0.5$ kV, $I_1 < 3$ A)
(for NPS: $U_{pol} \leq 0.5$ kV, $I_2 < 3$ A)
(for EF: $U_{pol} \leq 0.5$ kV, $I_n < 3$ A)
(for SEF: $U_{pol} \leq 0.5$ kV, $I_n < 1$ A)
(for 0.2 A SEF model: Upol ≤ 0.5 kV, In < 0.2 A)

Note: I_1 is the current level for DE OC
I_n is for DE EF and DE SEF
I_2 is for DE NPS.

States are defined as follows:

\+ forward fault direction; reverse protection elements enabled for directional control will not respond to the fault.

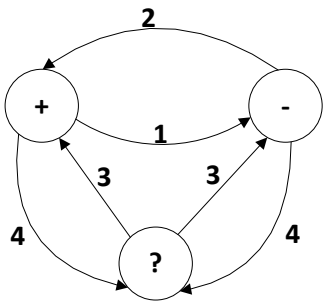
– reverse fault direction; forward protection elements enabled for directional control will not respond to the fault.

? undetermined fault direction; if a protection element is enabled for directional control, if "Direction not Detected" is set to "Block" the element will not respond to the fault, if "Direction not Detected" is set to "Trip" the element will respond to the fault. Please refer to Section 6.1.7 Directional Overcurrent Elements.

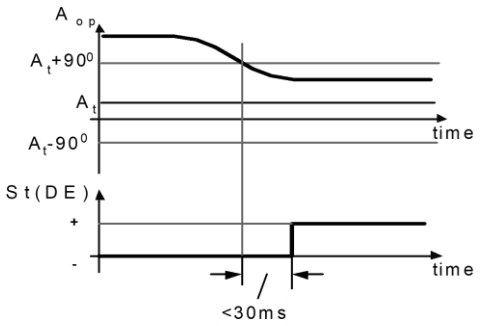
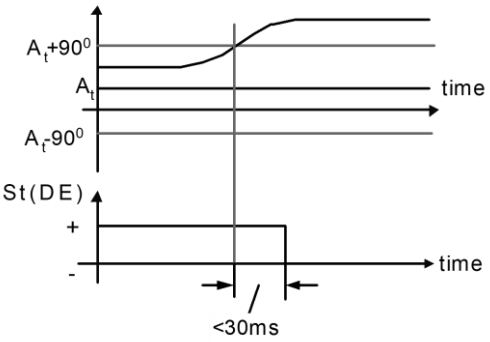
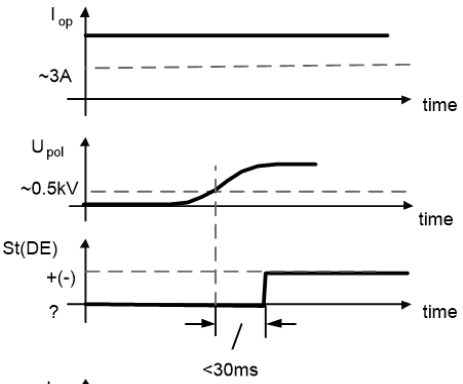
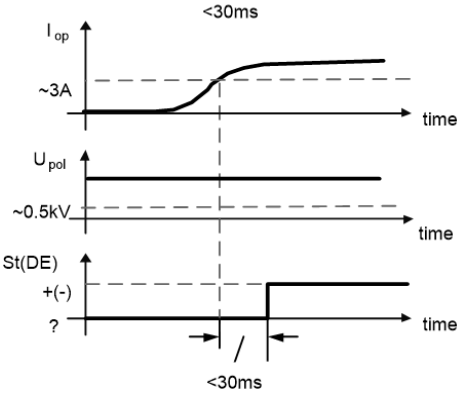
Notes:

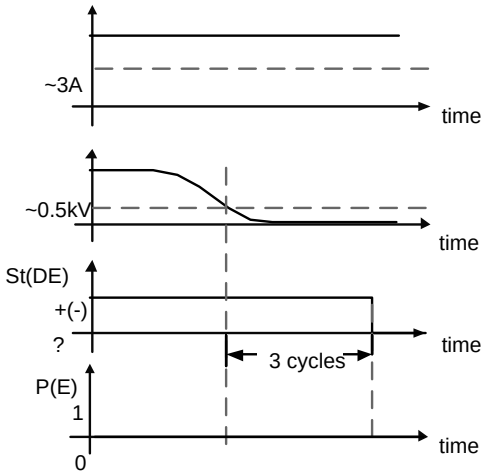
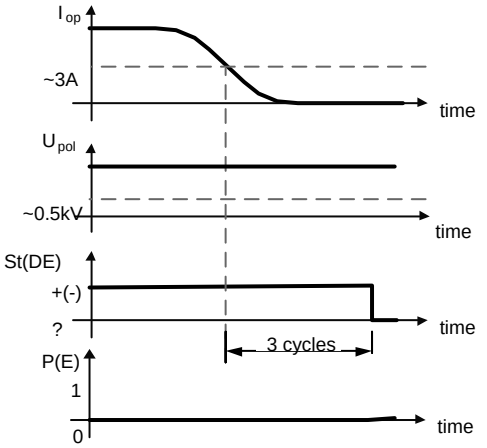
- *In the Close/Open log in CMS the phase angles A0 and A1 are displayed as "0.0" for undetermined fault directions where U_{pol} or I_{op} is too low to provide polarisation.*
- *When the torque angle is 0° and the power flow direction is configured as "RST to ABC", forward positive sequence powerflow direction in the OSM tank is from the RST side to the ABC side and reverse positive sequence powerflow direction is from the ABC side to RST side.*

Operation of the Directional Element is as illustrated in the state diagram. Transitions 1 - 4 are illustrated on the following pages.



The following operation diagrams describe transition conditions 1 – 4.

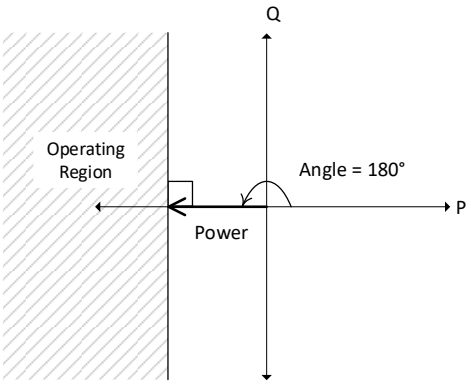
Transition	Operation diagram	Description
1		Power flow direction changes from reverse to forward
2		Power flow direction changes from forward to reverse
3	 **or**  ***Note:*** • *I_{op} level shown above is 1 A for SEF and 0.2 A for 0.2 A SEF model.*	Polarization

4	 **or**  ***Notes:*** • *During the 3 cycles DE uses remembered voltage or current for polarization* • *If a pickup related to any element enabled for directional control is detected within 3 cycles of voltage dropping below 0.5kV, depolarization cannot proceed until the pickup is reset.* *This avoids depolarization of DE during close short circuit faults.*	Depolarization

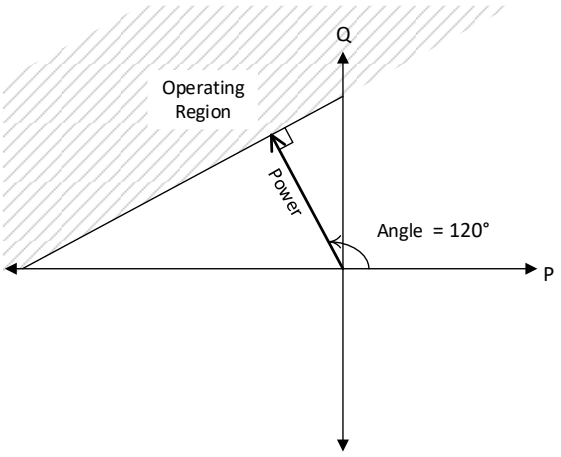
11.2.2 Directional power protection

Directional Overpower/Underpower protection inhibits power flow in the reverse direction. It is used where a generator runs in parallel to another generator or utility. Directional Overpower and Underpower protection calculate the apparent power across 3 phases based on the voltages and currents. Directional Overpower protection operates when the measured apparent power at the generator exceeds a threshold limit. Directional Underpower protection operates when the measured apparent power from the generator falls below the threshold limit. In both the cases, the generator is disconnected as the relay activates a trip.

PDOP Operating Characteristics

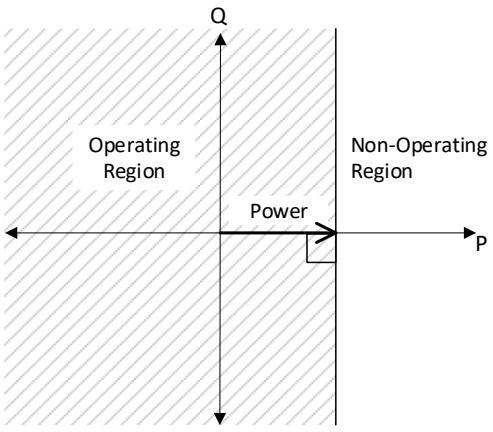


Reverse active power protection

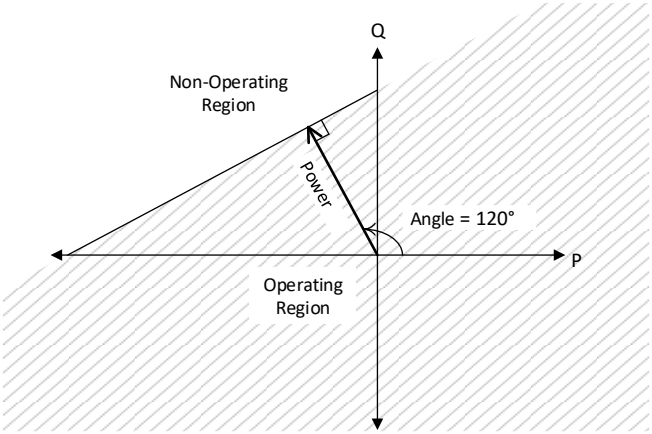


Power angle at +120°

PDUP Operating Characteristics



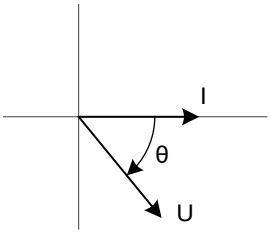
Power angle at 0°



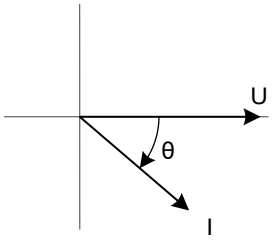
Power angle at +120°

11.2.3 Differences Between Directional Overcurrent and Directional Power Direction Detection

NOJA Power's set of directional protections provide both conventional overcurrent directional elements as well as directional power protection. The overcurrent directional elements and power flow elements are calculated separately and, under certain conditions, can show reversed signs on the phase angle for directional events. This is because the overcurrent elements calculate the phase angle from the current to the voltage, while the power flow elements use the method defined by the IEEE standards, which states the phase angle as being from the voltage to current.



Phase angle calculation for directional overcurrent elements



Phase angle calculation for directional power

11.3 Appendix C - Synchronisation

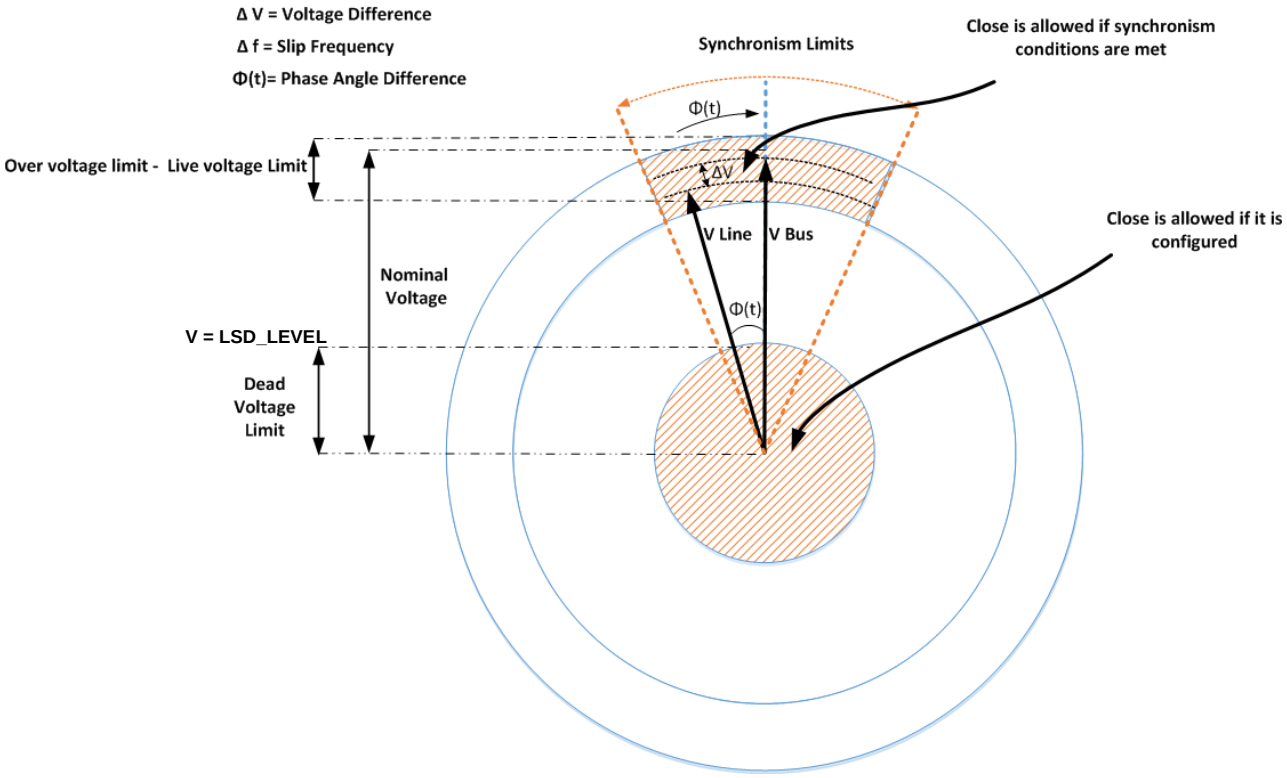
The synchronisation functionality can be used for the following applications:

- connection of incoming generators to the grid
- re-establishment of a connection between two interconnected parts of the network
- re-establishment of a connection between islanded systems.

Synchronism limits must be configured to avoid faulty synchronisation.

11.3.1 Synchronism Limits

The following figure displays the operational regions of the synchronism function.



Synchronism working limits

As shown in the figure above:

- The closing of a device is allowed when synchronism conditions are satisfied i.e. when both sides of the recloser are within the desired limits of frequency, phase angle and voltage to permit the paralleling of two circuits.
- A manual close or an auto-reclose is allowed for reconnection of two dead sections of a network or energizing a dead section of the network if the associated settings are configured.

Please refer to Section 6.13 Synchronisation for more details.

11.4 Appendix D – Time Current Characteristic (TCC) Curves

11.4.1 ANSI TCC

ANSI TCCs are described by the following general equation:

$$Tt = \left(\frac{A}{(I/Ip)^{p} - 1} + B \right) * TM$$

where:

A, B, p	*constants*
TM	*time multiplier*
Ip	*pickup current*
Tt	*tripping time*
I	*fault current*

The ANSI TCCs programmable within the RC Cubicle are defined by the parameters in the following Table, as applied to the above equation.

For currents below 16 kA the ANSI TCCs programmable within the RC cubicle are defined by the parameters in the following Table, as applied to the above equation.

For currents above 16 kA, the time to trip is a constant time defined by the above equation with I=16 kA and the appropriate parameters from the table below.

TCC type	Designation	A	B	D	p
Extremely Inverse	EI	6.407	0.025	3	2.0
Very Inverse	VI	2.855	0.0712	1.346	2.0
Inverse	I	0.0086	0.0185	0.46	0.02
Short Time Inverse	STI	0.00172	0.0037	0.092	0.02
Short Time Extremely Inverse	STEI	1.281	0.005	0.6	2.0
Long Time Extremely Inverse	LTEI	64.07	0.250	30	2.0
Long Time Very Inverse	LTVI	28.55	0.712	13.46	2.0
Long Time Inverse	LTI	0.086	0.185	4.6	0.02

ANSI TCCs are provided with a disk emulating reset timer described by the following general equation:

$$Tres(I) = \frac{D}{1 - 0.998 * \left(I/I_{min}\right)}$$

where:

Tres(I)	*reset time at given current I.*
D	*constant*
I_{min}	*minimum operating current;*

$$I_{min} = MIN \times I_p \times max(OCLM, OIRM)$$

where:

MIN	*minimum current multiplier*
Ip	*pickup current*
OCLM	*operational cold load multiplier*
OIRM	*operational inrush restraint multiplier*

Note: *OCLM and OIRM are not applicable for OC3, NPS, EF and SEF.*

11.4.2 IEC TCC

IEC TCCs are described by the following general equation:

$$Tt = \frac{A * TM}{\left(I/Ip\right)^{p} - 1}$$

where:

TM	*time multiplier*
A, p	*constants*
Ip	*pickup current*
Tt	*tripping time*
I	*fault current*

The IEC TCCs programmable within the RC Cubicle are defined by the parameters in the following Table, as applied to the above equation.

For currents below 16kA the IEC TCCs programmable within the RC cubicle are defined by the parameters in the following Table, as applied to the above equation.

For currents above 16kA, the time to trip is a constant time defined by the above equation with I=16kA and the appropriate parameters from the table below.

TCC type	Designation	A	p
Extremely Inverse	EI	80	2.0
Very Inverse	VI	13.5	1.0
Inverse	I	0.14	0.02
Long Time Inverse	LTI	120	1.0

IEC TCCs have a user configured, definite time reset timer. Consequently the IEC TCC reset characteristic is independent of current.

11.4.3 IEEE and U TCC

IEEE and U time current curves are defined by the following equations:

Tripping time; (I/Ip) > 1

$$T_t = \left(\frac{A}{\left(\frac{I}{I_p}\right)^p - 1} + B \right) * TM$$

Where:

A,B,D,p	constants
TM	Time multiplier
I	Input current
I_p	Pickup current
T_t	Tripping time
$T_{res}(I)$	Reset time at given current I

Reset Time; (I/Ip) < 1

$$T_{res}(I) = \left(\frac{D}{1 - \left(\frac{I}{I_p}\right)^2} \right) * TM$$

For trip operations with current below 16 kA, the curves are defined by the parameters in the table below as applied to the above equations. For currents above 16 kA, the time to trip is a constant time defined by the appropriate equations with I = 16 kA and their corresponding parameters from the table below.

TCC type	Designation	A	B	D	p
IEEE Curves					
IEEE Moderately Inverse	MI	0.0515	0.1140	4.85	0.02
IEEE Very Inverse	VI	19.61	0.491	21.6	2
IEEE Extremely Inverse	EI	28.2	0.1217	29.1	2
U Curves					
U1- Moderately Inverse	MI	0.0104	0.0226	1.08	0.02
U2 – Inverse	I	5.95	0.180	5.95	2
U3 – Very Inverse	VI	3.88	0.0963	3.88	2
U4 – Extremely Inverse	EI	5.64	0.02434	5.64	2
U5 – Short-Time Inverse	STI	0.00342	0.00262	0.323	0.02

11.4.4 User Defined Universal Inverse TCC (UDC)

This TCC can be applied to the master and low set OCEF elements (OC1+, OC1-, OC2+, OC2-, EF1+, EF1-, EF2+, EF2-) and consists of up to three sections.

The UDC curve is described by entering from 5 to a maximum of 32 pairs of time-current coordinates. The current coordinate of the first characteristic point (I1) determines the minimum operating current (Imin) and time coordinate of the last characteristic point determines the minimum operating time.

The UDC TCC points can only be edited in CMS.

UDC TCC Curves have a user configured, definite time reset timer.

11.4.5 Additional TCC Curves

43 additional TCC curves are available. These are designed to emulate curves available in older protection equipment.

These curves cannot be selected from the Panel. They are only available in CMS.

The available curves are:

101, 102, 103, 104, 105, 106, 107, 111, 112, 113, 114, 115, 116, 117, 119, 120, 121, 122, 131, 132, 133, 134, 135, 136, 137, 138, 139, 140, 141, 142, 151, 152, 161, 162, 163, 164, 165, 200, 201, 202, 400, 401, 402.

Additional TCC Curves have a user configured, definite time reset timer.

Note: *Definite Time, ANSI and IEC curves are always available in the RC. Up to 10 Additional TCC or User Defined curves can be loaded into the RC at one time.*

11.4.6 TCC Library

In CMS the user has access to a TCC library where standard curves, with their applicable settings, for particular zones/areas can be created and maintained (refer to CMS Help File).

11.5 Appendix E – ANSI Support

ANSI / IEEE standard C37.2, 1996 provides definition and application of function numbers for devices used in electrical substations, generating plants and in installations of power utilisation and conversion apparatus.

The table below links RC protection functions to the relevant ANSI device number.

ANSI Device Function Number	Definition	Comment
21FL	**Fault Locator** Impedance based fault locator function for single terminal systems (radial lines).	
21Yn	**Admittance Protection** A device that functions when the circuit admittance increases or decreases beyond a predetermined value.	Yn element - Protection using neutral admittance characteristics of the network based on the value of conductance, Gn (real part of admittance) and susceptance, Bn (imaginary part of admittance).
25	**Synchronism-Check Device** A device that operates when two a-c circuits are within the desired limits of frequency, phase angle, or voltage, to permit or to cause the paralleling of these two circuits.	
25A	**Auto-Synchroniser** The automatic synchronising functionality allows the switch to close automatically under synchronising satisfying conditions	
27	**Undervoltage Relay** A device that operates when its input voltage is less than a predetermined value.	RC can be set to operate on three variants of under voltage: UV1 - Phase under voltage operates in response to positive sequence voltage UV2 - Line to Line under voltage operates in response to a voltage drop across any two phases. UV3 – Loss of Supply under voltage operates in response to a loss of voltage on all six terminals and loss of current on all three phases.
32O/32R	**Overpower Protection** Inhibits generator from running as a motor due to reverse power flow.	
37U	**Underpower Protection** Operates when the measured apparent power from the generator falls below the threshold limit	.
46	**Negative Phase Sequence Relay** Protection against phase unbalance, detected by the measurement of negative sequence current.	

ANSI Device Function Number	Definition	Comment
46BC	**Broken Conductor Detection** Protection against broken conductor using ratio of negative sequence current over positive sequence current.	I2/I1 – Ratio of negative sequence current over positive sequence current.
47N	**Negative Sequence Overvoltage** If the degree of negative sequence voltage in the network exceeds the acceptable levels, the Negative Sequence Overvoltage protection shall protect the system against voltage imbalance.	OV4 element
50	**Instantaneous Overcurrent Relay** A device that operates with no intentional time delay when the current exceeds a preset value.	
50BF	**Circuit Breaker Fault (CBF)**	CBF ensures that the OSM recloser has correctly opened when a trip operation occurs.
50N	**Instantaneous Overcurrent Relay** (Neutral current)	Instantaneous Overcurrent applied to the neutral or residual current in a three phase system is differentiated as 50N. Residual current is sensed using the sum of 3 current transformers, one on each phase.
51	**AC Time Overcurrent Relay** A device that functions when the ac input current exceeds a predetermined value, and in which the input current and operating time are inversely related through a substantial portion of the performance range.	
51N	**AC Time Overcurrent Relay** (Neutral Current)	AC time overcurrent applied to the neutral or residual current in a three phase system is differentiated as 51N. Residual current is sensed using the sum of 3 current transformers, one on each phase. EF and SEF protection are provided, each with independent trip characteristics and reclose sequence settings.
51V	**Voltage Restrained Time Overcurrent** A device that modifies the operating characteristics of an AC Time Overcurrent Relay based on the measured voltage.	
59	**Overvoltage Relay** A device that operates when its input voltage is greater than a predetermined value.	RC can be set to operate on four variants of over voltage: OV1 - Phase over voltage operates in response to positive sequence voltage OV2 - Line to Line over voltage operates in response to a voltage rise across any two phases. OV3 - Neutral Displacement Overvoltage (see 59N) OV4 - Negative Sequence Overvoltage (see 47N)

ANSI Device Function Number	Definition	Comment
59N	**Neutral Displacement Overvoltage** The "Neutral Displacement Overvoltage" protection is used in distribution networks with high grounding impedance in which the neutral displacement overvoltage can reach non-acceptable levels.	OV3 element
67	**AC Directional Overcurrent Relay** A device that functions at a desired value of ac overcurrent flowing in a predetermined direction.	Positive sequence voltage is used as the reference (polarising voltage) for determining direction.
67N	**AC Directional Overcurrent Relay** (Neutral Current)	AC directional overcurrent applied to the neutral or residual current in a three phase system is sometimes differentiated as 67N. Residual current is sensed using the sum of 3 current transformers, one on each phase. Zero sequence voltage is used as the reference (polarising voltage) for determining direction. EF and SEF directional protection is provided.
78	**Voltage Vector Shift (VVS)**	VVS protection is used to detect sudden changes in the main voltage angle caused by a change in the output from the generating plant or changes to the demand connected to the network.
79	**Reclosing Relay** A device that controls the automatic reclosing and locking out of an ac circuit interrupter.	
81	**Frequency Relay** A device that responds to the frequency of an electrical quantity, operating when the frequency or rate of change of frequency exceeds or is less than a predetermined value.	
86	**Lockout Relay** A device that trips and maintains the associated equipment or devices inoperative until it is reset by an operator, either locally or remotely.	

11.6 Appendix F – Indication Signals

Indication Signals are generated by the Indication Signals Conditioner Element (ISC). The Indication Signals Conditioner derives signals applicable for indication from data generated by other elements.

It also provides diagnostic functions by monitoring operation of the RC, internal communications and opening/closing times of the OSM. If any discrepancy in operation is detected, an indication signal is generated.

A complete list of indication signals available for use by SCADA is presented in the table below. Please refer to IO and Logic Guide for a list of indication signals used for IO and Logic.

Recommended actions for warning and malfunctions are outlined in Section 10.3.6 and 10.3.7.

Signal	Description
TYPE: GENERAL	
AR initiated	Autoreclose initiated
AR Sequence Active(1)	Set to TRUE when Auto reclosing sequence is > 1 while AR is ON and Protection is ON.
DNP3-SA Enabled	DNP3-Secure Authentication is enabled
Dummy Control	Dummy control signal for testing purposes
GPS Enable	GPS is On.
Group 1 Trip	Trip request by Group 1 protection settings
Group 2 Trip	Trip request by Group 2 protection settings
Group 3 Trip	Trip request by Group 3 protection settings
Group 4 Trip	Trip request by Group 4 protection settings
Local Control	Device is in Local mode
Lockout (Any)	Device is in Lockout state for any reason
MNT Exceeded	Maximum Number of Trips exceeded.
Mobile Network Enable	Mobile Network (4G) is On.
Prot initiated	Protection initiated
Remote Control	Device is in Remote mode
Reset Fault Meas Values	Manually resets the Trip and Max Current as well as the minimum and maximum Voltage values to zero.
SGA Enable	Smart Grid Automation is enabled
Test Mode(2)	Test Mode is ON
Update Key Installed	DNP3-SA Update Key is installed
79_Lockout (Any)	Lockout due to any Protection Operation and with any number of trips
WLAN Enable	Wi-Fi is On.
TYPE: PICKUP	
CBF Pickup	Pickup output for CBF Default Mode is activated
Backup Trip Pickup	Pickup output for CBF Backup Trip Mode is activated
Pickup	Pickup output of any protection elements activated.
P(Any HRM)	Pickup output of harmonics (THD, TDD or any individual harmonic) activated
P(EF)	Pickup output of any EF element activated
P(EF1+)	Pickup output of EF1+ activated
P(EF2+)	Pickup output of EF2+ activated
P(EF3+)	Pickup output of EF3+ activated
P(EF1-)	Pickup output of EF1- activated
P(EF2-)	Pickup output of EF2- activated
P(EF3-)	Pickup output of EF3- activated
P(EFLL1-3)	Pickup output of EFLL1-3 activated
P(HRM)	Pickup output of individual harmonics activated
P(I2/I1)	Pickup output for Broken Conductor, I2/I1 is activated
P(LSD)	Pickup of Loss of Supply Detector
P(NPS)	Pickup output of any NPS element activated
P(NPS1+)	Pickup output of NPS1+ activated
P(NPS2+)	Pickup output of NPS2+ activated

Signal	Description
P(NPS3+)	Pickup output of NPS3+ activated
P(NPS1-)	Pickup output of NPS1- activated
P(NPS2-)	Pickup output of NPS2- activated
P(NPS3-)	Pickup output of NPS3- activated
P(NPSLL1-3)	Pickup output of NPSLL1-3 activated
P(OC)	Pickup output of any OC element activated
P(OC1+)	Pickup output of OC1+ activated
P(OC2+)	Pickup output of OC2+ activated
P(OC3+)	Pickup output of OC3+ activated
P(OC1-)	Pickup output of OC1- activated
P(OC2-)	Pickup output of OC2- activated
P(OC3-)	Pickup output of OC3- activated
P(OCLL1-3)	Pickup output of OCLL1-3 activated
P(OF)	Pickup output of OF activated
P(OF2)	Pickup output of OF2 activated
P(OF3)	Pickup output of OF3 activated
P(OV)	Pickup output of any OV element activated
P(OV1)	Pickup output of OV1 activated
P(OV12)	Pickup output of OV12 activated
P(OV13)	Pickup output of OV13 activated
P(OV2)	Pickup output of OV2 activated
P(OV22)	Pickup output of OV22 activated
P(OV23)	Pickup output of OV23 activated
P(OV3)	Pickup output of OV3 activated
P(OV4)	Pickup output of OV4 activated
P(PDOP)	Pickup output of PDOP is activated
P(PDUP)	Pickup output of PDUP is activated
P(PhA)	Pickup output of any OC element on Phase A – activated
P(PhB)	Pickup output of any OC element on Phase B – activated
P(PhC)	Pickup output of any OC element on Phase C – activated
P(PhN)	Pickup output of any EF or SEF element on Phase N – activated
P(ROCOF)	Pickup output for ROCOF is activated
P(SEF)	Pickup output of any SEF element activated
P(SEF+)	Pickup output of SEF+ activated
P(SEF-)	Pickup output of SEF- activated
P(SEFLL)	Pickup output of SEFLL activated
P(Ua)	Voltage on A bushing is above LSD level
P(Ub)	Voltage on B bushing is above LSD level
P(Uc)	Voltage on C bushing is above LSD level
P(Uabc>)	Pickup output of Uabc> activated
P(Uabc<)	Pickup output of Uabc< activated
P(UF)	Pickup output of UF activated
P(UF2)	Pickup output of UF2 activated
P(UF3)	Pickup output of UF3 activated
P(Ur)	Voltage on R bushing is above LSD level
P(Us)	Voltage on S bushing is above LSD level
P(Ut)	Voltage on T bushing is above LSD level
P(Urst>)	Pickup output of Urst> activated
P(Urst<)	Pickup output of Urst< activated
P(UV)	Pickup output of any UV element activated
P(UV1)	Pickup output of UV1 activated
P(UV12)	Pickup output of UV12 activated

Signal	Description
P(UV13)	Pickup output of UV13 activated
P(UV2)	Pickup output of UV2 activated
P(UV22)	Pickup output of UV22 activated
P(UV23)	Pickup output of UV23 activated
P(UV3)	Pickup output of UV3 activated
P(UV4 Sag)	Pickup output of UV4 Sag activated
P(Uabc UV4 Sag)	Pickup output of any of Ua/Ub/Uc in Single Phase mode or Uab/Ubc/Uca in Phase to Phase mode for UV4 Sag activated
P(Urst UV4 Sag)	Pickup output of any of Ur/Us/Ut in Single Phase mode or Urs/Ust/Utr in Phase to Phase mode for UV4 Sag activated
P(VVS)	Pickup output for VVS is activated
P(Yn)	Pickup output of Yn is activated
TYPE: OPEN	
Open(Any)	Open due to any source
Open(Any HRM)	Open output of harmonics (THD, TDD or any individual harmonic) activated
Open(ABR AutoOpen)	Open due to ABR AutoOpen operation
Open(ACO)	Open due to ACO being initiated
Open(EF)	Open due to any EF element tripping
Open(EF1+)	Open due to EF1+ tripping
Open(EF2+)	Open due to EF2+ tripping
Open(EF3+)	Open due to EF3+ tripping
Open(EF1-)	Open due to EF1- tripping
Open(EF2-)	Open due to EF2- tripping
Open(EF3-)	Open due to EF3- tripping
Open(EFLL1-3)	Open due to EFLL1-3 tripping
Open(HMI)	Open due to HMI control signal
Open(HRM)	Open output of individual harmonics activated
Open(I2/I1)	Open due to Broken Conductor protection, I2/I1
Open(IO)	Open due to I/O control signal
Open(Local)	Open due to Panel, CMS control signal or manual tripping
Open(Logic)	Open due to Logic
Open(LSRM)	Open due to Loss of Supply Reclosing Mode
Open(Manual)	Open due to a manual trip
Open(NPS)	Open due to any NPS element tripping
Open(NPS1+)	Open due to NPS1+ tripping
Open(NPS2+)	Open due to NPS2+ tripping
Open(NPS3+)	Open due to NPS3+ tripping
Open(NPS1+)	Open due to NPS1- tripping
Open(NPS2-)	Open due to NPS2- tripping
Open(NPS3-)	Open due to NPS3- tripping
Open(NPSLL1-3)	Open due to NPSLL1-3 tripping
Open(OC)	Open due to any OC element tripping
Open(OC1+)	Open due to OC1+ tripping
Open(OC2+)	Open due to OC2+ tripping
Open(OC3+)	Open due to OC3+ tripping
Open(OC1-)	Open due to OC1- tripping
Open(OC2-)	Open due to OC2- tripping
Open(OC3-)	Open due to OC3- tripping
Open(OCLL1-3)	Open due to OCLL1-3 tripping
Open(OF)	Open due to OF tripping
Open(OF2)	Open due to OF2 tripping
Open(OF3)	Open due to OF3 tripping

Signal	Description
Open(OV)	Open due to any OV element tripping
Open(OV1)	Open due to OV1 tripping
Open(OV12)	Open due to OV12 tripping
Open(OV13)	Open due to OV13 tripping
Open(OV2)	Open due to OV2 tripping
Open(OV22)	Open due to OV22 tripping
Open(OV23)	Open due to OV23 tripping
Open(OV3)	Open due to OV3 tripping
Open(OV4)	Open due to OV4 tripping
Open(PC)	Open due to Personal Computer control signal (CMS)
Open(PDOP)	Open due to PDOP protection tripping
Open(PDUP)	Open due to PDUP protection tripping
Open(PhA)	Open due to Phase A tripping
Open(PhB)	Open due to Phase B tripping
Open(PhC)	Open due to Phase C tripping
Open(PhN)	Open due to Phase N tripping
Open(Prot)	Open due to any of the protection elements activated.
Open(Remote)	Open due to SCADA or I/O control signal
Open(ROCOF)	Open due to ROCOF protection tripping
Open(SCADA)	Open due to SCADA control signal
Open(Sectionaliser)	Open due to Sectionaliser
Open(SEF)	Open due to any SEF element tripping
Open(SEF+)	Open due to SEF+ tripping
Open(SEF-)	Open due to SEF- tripping
Open(SEFLL)	Open due to SEFLL tripping
Open(UF)	Open due to UF tripping
Open(UF2)	Open due to UF2 tripping
Open(UF3)	Open due to UF3 tripping
Open(Undefined)	Open state recognized after On (Power) or switch reconnection
Open(UV)	Open due to any UV element tripping
Open(UV1)	Open due to UV1 tripping
Open(UV12)	Open due to UV12 tripping
Open(UV13)	Open due to UV13 tripping
Open(UV2)	Open due to UV2 tripping
Open(UV22)	Open due to UV22 tripping
Open(UV23)	Open due to UV23 tripping
Open(UV3)	Open due to UV3 tripping
Open(UV3 AutoClose)	Open due to UV3 Protection and UV3 AutoClose is enabled.
Open(UV4 Sag)	Open due to UV4 Sag
Open(UV4 Sag Mid)	Open due to UV4 Sag and midpoint alarm generated
Open(VVS)	Open due to VVS protection tripping
Open(Yn)	Open due to Admittance Protection, Yn
TYPE: ALARM[3]	
Alarm(Any)	Alarm output of any of the protection elements activated
Alarm(Any HRM)	Alarm output of harmonics (THD, TDD or any individual harmonic) activated
A(EF)	Alarm due to any EF element activated
A(EF1+)	Alarm output of EF1+ activated
A(EF2+)	Alarm output of EF2+ activated
A(EF3+)	Alarm output of EF3+ activated
A(EF1-)	Alarm output of EF1- activated
A(EF2-)	Alarm output of EF2- activated
A(EF3-)	Alarm output of EF3- activated

Signal	Description
A(EFLL1-3)	Alarm output of EFLL1-3 activated
A(I2/I1)	Alarm output for Broken Conductor, I2/I1 is activated
A(NPS)	Alarm due to any NPS element activated
A(NPS1+)	Alarm output of NPS1+ activated
A(NPS2+)	Alarm output of NPS2+ activated
A(NPS3+)	Alarm output of NPS3+ activated
A(NPS1-)	Alarm output of NPS1- activated
A(NPS2-)	Alarm output of NPS2- activated
A(NPS3-)	Alarm output of NPS3+ activated
A(NPSLL1-3)	Alarm output of NPSLL1-3 activated
A(OC)	Alarm due to any OC element activated
A(OC1+)	Alarm output of OC1+ activated
A(OC2+)	Alarm output of OC2+ activated
A(OC3+)	Alarm output of OC3+ activated
A(OC1-)	Alarm output of OC1- activated
A(OC2-)	Alarm output of OC2- activated
A(OC3-)	Alarm output of OC3- activated
A(OCLL1-3)	Alarm output of OCLL1-3 activated
A(OF)	Alarm output of OF activated
A(OF2)	Alarm output of OF2 activated
A(OF3)	Alarm output of OF3 activated
A(OV)	Alarm due to any OV element activated
A(OV1)	Alarm output of OV1 activated
A(OV12)	Alarm output of OV12 activated
A(OV13)	Alarm output of OV13 activated
A(OV2)	Alarm output of OV2 activated
A(OV22)	Alarm output of OV22 activated
A(OV23)	Alarm output of OV23 activated
A(OV3)	Alarm output of OV3 activated
A(OV4)	Alarm output of OV4 activated
A(PDOP)	Alarm output of PDOP activated
A(PDUP)	Alarm output of PDUP activated
A(PhA)	Alarm of OC Elements on Phase A Activated (OC1+, OC2+, OC1-, OC2-)
A(PhB)	Alarm of OC Elements on Phase B activated (OC1+, OC2+, OC1- , OC2)-
A(PhC)	Alarm of OC Elements on Phase C activated (OC1+, OC2+, OC1- , OC2)-
A(PhN)	Alarm of EF elements Phase N activated: (EF1+, EF2+, EF1-, EF2- , SEF+, SEF-).
A(ROCOF)	Alarm output of ROCOF protection activated
A(SEF)	Alarm due to any SEF element activated
A(SEF+)	Alarm output of SEF+ activated
A(SEF-)	Alarm output of SEF- activated
A(SEFLL)	Alarm output of SEFLL activated
A(UF)	Alarm output of UF activated
A(UF2)	Alarm output of UF3 activated
A(UF3)	Alarm output of UF3 activated
A(UV)	Alarm due to any UV element activated
A(UV1)	Alarm output of UV1 activated
A(UV12)	Alarm output of UV12 activated
A(UV13)	Alarm output of UV13 activated
A(UV2)	Alarm output of UV2 activated
A(UV22)	Alarm output of UV22 activated
A(UV23)	Alarm output of UV23 activated
A(UV3)	Alarm output of UV3 activated

Signal	Description
A(UV4 Sag)	Alarm output of UV4 Sag activated
A(UV4 Sag Midpoint)	Alarm output of UV4 Sag Midpoint activated when UV4 Sag element activated and voltages between UV4 Sag mid and UV4 Sag max
A(Uabc UV4 Sag)	Alarm output of UV4 Sag for Uabc activated
A(Uabc UV4 Sag Midpoint)	Alarm output of UV4 Sag Midpoint for Uabc activated when UV4 Sag element activated and voltages between UV4 Sag mid and UV4 Sag max
A(Urst UV4 Sag)	Alarm output of UV4 Sag for Urst activated
A(Urst UV4 Sag Midpoint)	Alarm output of UV4 Sag Midpoint for Urst activated when UV4 Sag element activated and voltages between UV4 Sag mid and UV4 Sag max
A(VVS)	Alarm output of VVS protection activated
A(Yn)	Alarm output of Yn is activated
TYPE: ALARM/OPEN	
UV4 Sag(Ua)	Open or Alarm output of Ua for UV4 Sag activated
UV4 Sag(Ub)	Open or Alarm output of Ub for UV4 Sag activated
UV4 Sag(Uc)	Open or Alarm output of Uc for UV4 Sag activated
UV4 Sag(Ur)	Open or Alarm output of Ur for UV4 Sag activated
UV4 Sag(Us)	Open or Alarm output of Us for UV4 Sag activated
UV4 Sag(Ut)	Open or Alarm output of Ut for UV4 Sag activated
UV4 Sag(Uab)	Open or Alarm output of Uab for UV4 Sag activated
UV4 Sag(Ubc)	Open or Alarm output of Ubc for UV4 Sag activated
UV4 Sag(Uca)	Open or Alarm output of Uca for UV4 Sag activated
UV4 Sag(Urs)	Open or Alarm output of Urs for UV4 Sag activated
UV4 Sag(Ust)	Open or Alarm output of Ust for UV4 Sag activated
UV4 Sag(Utr)	Open or Alarm output of Utr for UV4 Sag activated
TYPE: CLOSED	
Closed(Any)	Position Status of OSM is Closed irrespective to origin
Closed(ABR)	Closed due to ABR closing
Closed(ABR AutoOpen)	Closed due to a ABR operation while an ABR AutoOpen operation count is active
Closed(ACO)	Closed due to ACO being initiated
Closed(AR)	Closed due to AR OC/NPS/EF/SEF, AR VE, ABR control signal
Closed(AR OC/NPS/EF/SEF)	Closed due to AR OC/NPS/EF/SEF reclosing
Closed(AR VE)	Closed due to AR VE reclosing
Closed(Auto-Sync)	Closed due to Auto-Sync release command.
Closed(HMI)	Closed due to HMI control signal
Closed(I/O)	Closed due to I/O control signal
Closed(Local)	Closed due to Panel, CMS control signal or undefined closed
Closed(Logic)	Closed due to Logic
Closed(PC)	Closed due to Personal Computer control signal (CMS)
Closed(Remote)	Closed due to SCADA or I/O control signal
Closed(SCADA)	Closed due to SCADA control signal
Closed(Undefined)	Source of close undefined, recognized after On (Power) or servicing
Closed(UV3 AutoClose)	Closed due to a UV3 AutoClose
TYPE: STATUS	
ABR On	Automatic Backfeed Restoration is switched on
ACO On	Auto Change Over is ON
ACO OpMode Equal On	Auto Change Over is in Equal mode.
ACO OpMode Main On	Auto Change Over is in Main mode.
ACO OpMode Alt On	Auto Change Over is in Alt mode.
ACO: Make before break On	Auto Change Over is in Make before break mode.
Alarm Mode ON	Alarm Mode ON
AR On	Auto Reclosing for OC/EF, UV/OV, NPS, SEF and ABR are switched on
Auto Battery Test	Auto Battery Test ON

Signal	Description
Auto-Sync Initiated	Auto-Synchroniser has been initiated.
Auto-Sync Release	Auto-Synchroniser has released to close the switch.
Battery Test Not Performed	Battery Test Not Performed (Battery is not connected, AC Off, Battery discharging at > 100mA, Battery voltage < 12.5V or Battery Test Resting)
Battery Test Running	Battery Test Running
Battery Test Passed	Battery Test Passed
Block P(EF+) On(4)	Pickups and protection operations due to EF1+, EF2+ and EF3+ will be blocked.
Block P(EF-) On(4)	Pickups and protection operations due to EF1-, EF2- and EF3- will be blocked.
Block P(SEF+) On(4)	Pickups and protection operations due to SEF+ will be blocked.
Block P(SEF-) On(4)	Pickups and protection operations due to SEF- will be blocked.
Block P(OV3) On(4)	Pickups and protection operations due to OV3 will be blocked.
CBF: Backup On	CBF Backup Trip On
CLP On	Cold load pickup element is switched on
DFT On	Disable Fast Trips is On
EF On	Earth overcurrent element is switched on
Fault Locator Status	Fault Locator calculations are available
GPS Locked	The real time clock is synchronised with GPS time.
Group1 On	Active Group 1
Group2 On	Active Group 2
Group3 On	Active Group 3
Group4 On	Active Group 4
Hot line Tag On	Hot Line Tag is On
HRM On	Harmonic Protection is switched on
LL On	Live line element is switched on
LLB ON	Live Load Blocking is ON
LLB Blocking	LLB blocking is activated and has prevented a close from any source
Logical Block Close	Control to block close from all sources has been enabled.
MNT On	Maximum Number of Trips On
NPS On	Negative Phase Sequence element is switched on
OC+(1)	Set when the positive sequence operating angle is in the forward zone (+)
OC-(1)	Set when the positive sequence operating angle is in the reverse zone (-)
OF On	Over Frequency element is switched on
OV On	Over Voltage element is switched on
OV3 On	OV3 protection element is switched on
PDOP On	PDOP protection ON
PDUP On	PDUP protection ON
Phase Sequence Match Status	The phase sequence between Line and Bus matches (e.g. ABC and RST)
Power Flow Direction (ABC to RST)	ABC to RST is selected for the power flow direction
Prot On	Protection is switched on
ROCOF On	ROCOF protection ON
Sectionaliser Mode ON	Sectionaliser Capability ON
SEF On	Sensitive Earth fault element is switched on
SEF Prot	Set when Active group Trip Map Output, SEF+/SEF- = R, L, S or C. Reset when Active group Trip Map Output, SEF+/SEF- ≠ R, L, S or C.
SNTP Sync Status(1)	Set as TRUE when SNTP is running and the last synchronisation attempt was successful. It will be set to FALSE when a synchronisation attempt fails or SNTP is disabled.
SNTP IPv4 Server 1 Error(1)	Set as TRUE after a failed attempt to synchronise the time with IPv4 Server 1. This signal will be set to FALSE when a synchronisation attempt with IPv4 Server 1 is successful or SNTP is disabled.

Signal	Description
SNTP IPv4 Server 2 Error(1)	Set as TRUE after a failed attempt to synchronise the time with IPv4 Server 2. This signal will be set to FALSE when a synchronisation attempt with IPv4 Server 2 is successful or SNTP is disabled.
SNTP IPv6 Server 1 Error(1)	Set as TRUE after a failed attempt to synchronise the time with IPv6 Server 1. This signal will be set to FALSE when a synchronisation attempt with IPv6 Server 1 is successful or SNTP is disabled.
SNTP IPv6 Server 2 Error(1)	Set as TRUE after a failed attempt to synchronise the time with IPv6 Server 2. This signal will be set to FALSE when a synchronisation attempt with IPv6 Server 2 is successful or SNTP is disabled.
SSM On	Short Sequence Mode is On
Sync-Check Health	All ∆V, Δφ and ∆f are within the configured ranges.
Timed Sync-Check Health	All ∆V, Δφ and ∆f are within the configured ranges for the duration of pre-sync time.
UF On	Under Frequency element is switched on
UV On	Under Voltage element is switched on
UV4 Sag On	UV4 Sag protection ON
UV4 Sag Blocking	UV4 Sag blocking activated and has prevented a close from any source
VVS On	VVS protection ON
Yn On	Admittance Protection, Yn is ON
79-2 Trips to Lockout On	Maximum Number of Trips to Lockout is set to 2
79-3 Trips to Lockout On	Maximum Number of Trips to Lockout is set to 3
∆V Status(1)	Voltage Difference Status for Sync-Check. If the voltage difference between Line and Bus is within the specified range for synchronisation, then ∆V Status will remain true.
∆f Status(1)	Slip Frequency Status for Sync-Check. If the slip frequency is within the specified range for synchronisation, then the “sync check” health status for ∆f will remain true.
Δφ Status(1)	Phase Angle Difference Status for Sync-Check. If the phase angle difference is within the specified range for synchronisation then the “sync check” health status for ∆φ will remain true.
TYPE: IO Modules	
IO1 Input Channel1	Input Channel 1 on I/O module 1 has been activated
IO1 Input Channel2	Input Channel 2 on I/O module 1 has been activated
IO1 Input Channel3	Input Channel 3 on I/O module 1 has been activated
IO1 Input Channel4	Input Channel 4 on I/O module 1 has been activated
IO1 Input Channel5	Input Channel 5 on I/O module 1 has been activated
IO1 Input Channel6	Input Channel 6 on I/O module 1 has been activated
IO1 Input Channel7	Input Channel 7 on I/O module 1 has been activated
IO1 Input Channel8	Input Channel 8 on I/O module 1 has been activated
IO2 Input Channel1	Input Channel 1 on I/O module 2 has been activated
IO2 Input Channel2	Input Channel 2 on I/O module 2 has been activated
IO2 Input Channel3	Input Channel 3 on I/O module 2 has been activated
IO2 Input Channel4	Input Channel 4 on I/O module 2 has been activated
IO2 Input Channel5	Input Channel 5 on I/O module 2 has been activated
IO2 Input Channel6	Input Channel 6 on I/O module 2 has been activated
IO2 Input Channel7	Input Channel 7 on I/O module 2 has been activated
IO2 Input Channel8	Input Channel 8 on I/O module 2 has been activated
IO1 Output Channel1	Output Channel 1 on I/O module 1 has been activated
IO1 Output Channel2	Output Channel 2 on I/O module 1 has been activated
IO1 Output Channel3	Output Channel 3 on I/O module 1 has been activated
IO1 Output Channel4	Output Channel 4 on I/O module 1 has been activated
IO1 Output Channel5	Output Channel 5 on I/O module 1 has been activated
IO1 Output Channel6	Output Channel 6 on I/O module 1 has been activated
IO1 Output Channel7	Output Channel 7 on I/O module 1 has been activated
IO1 Output Channel8	Output Channel 8 on I/O module 1 has been activated
IO2 Output Channel1	Output Channel 1 on I/O module 2 has been activated

Signal	Description
IO2 Output Channel2	Output Channel 2 on I/O module 2 has been activated
IO2 Output Channel3	Output Channel 3 on I/O module 2 has been activated
IO2 Output Channel4	Output Channel 4 on I/O module 2 has been activated
IO2 Output Channel5	Output Channel 5 on I/O module 2 has been activated
IO2 Output Channel6	Output Channel 6 on I/O module 2 has been activated
IO2 Output Channel7	Output Channel 7 on I/O module 2 has been activated
IO2 Output Channel8	Output Channel 8 on I/O module 2 has been activated
Local Input 1	Input asserted
Local Input 2	Input asserted
Local Input 3	Input asserted
TYPE: MALFUNCTION	
Battery Charger Fault	Battery is not charging
CAN Bus Malfunction	Communication problem between SIM and Relay
Capacitor Voltage Abnormal	Close capacitor voltage drop too high or Trip capacitor voltage drop too high or Trip capacitor voltage drop on close.
CBF Malfunction	CBF Malfunction has occurred due to OSM not opening successfully
CBF Backup Trip	CBF Backup Trip signal is active due to OSM not opening successfully
Controller Fault	Active due to Relay Module Fault and Communication Error
Controller Module Fault	Active due to Panel module, SIM disconnected, SIM fault, IO1 fault, IO2 fault, Relay fault.
Excessive Tc	Closing time exceeds 100ms or no confirmation received that close command was executed successfully.
Excessive To	Opening time exceeds 60ms or no confirmation received that open command was executed successfully.
External Load Overload	Overload detected in the external load (12VDC power supply for communications equipment).
GPS Malfunction	Invalid NEMA strings received.
I/O1 Comms Error	No communication with I/O module I/O1
I/O2 Comms Error	No communication with I/O module I/O2
I/O1 Fault	Internal fault detected in module I/O1
I/O2 Fault	Internal fault detected in module I/O2
Malfunction	Any malfunction signal activated
Module Comms Error	SIM or I/O module communication error detected
OSM Coil OC	OSM Coil open circuit detected
OSM Coil SC	OSM coil short circuit detected
OSM Fault	Active due to OSM Coil OC, Limit Switch fault, Coil SC, excessive To, excessive Tc
OSM Limit Switch Fault	OSM Limit Switch Fault
Panel Comms Error	Panel communication error
Panel Module Fault	Internal fault of HMI (panel) module detected.
Relay Module Fault	Internal fault of Relay Module detected
RTC Hardware Fault	Real Time Clock hardware failure
Battery Test Circuit Fault	Test circuit is faulty and the battery test could not be performed.
SIM Comms Error	Communication error with SIM
SIM Module Fault	SIM Module Fault detected
USB Overcurrent	Overcurrent draw is detected on a USB port.
TYPE: WARNING	
AC Supply High	Power supply voltage into SIM module is too high.
AC Off (On Battery Supply)	UPS is in "AC Off" state – running on Battery supply only
ACO Unhealthy	Conditions detected not to allow an ACO operation
Battery Off (On AC Supply)	UPS is in "Battery Off" state – running on AC supply only
Battery Status Abnormal	Battery is either high, low or disconnected

Signal	Description
Check Battery	Battery needs to be checked. Battery Test performed and battery suspect.
Close Req. Blocked	A close command has been blocked.
Critical Battery Level	System shutdown in less than 5 min due to low battery level.
GPS is enabled and unplugged	GPS is enabled and unplugged
Logic/SGA Throttling	Logic or SGA throttling
Logic/SGA Stopped	Logic or SGA stopped due to an error
Mechanically Locked	OSM Mechanically Locked, Trip Ring pulled down.
OSM Disconnected	OSM Disconnected
OSM Position Status Unavailable	OSM Position Status is Unavailable due to being disconnected or a malfunction.
SIM Card Blocked Permanently.	Incorrect PUK has been entered 10 times in a row. SIM card is permanently blocked and unrecoverable, requiring a new SIM card.
SIM Card Blocked, SIM PUK required	SIM card is blocked due to multiple invalid PIN attempts until PUK is provided.
SIM Card Error	SIM Card is not installed or faulty.
SIM Card PIN Error	Invalid PIN entered for SIM card.
SIM Card PIN Required	SIM card requires a PIN to allow operation but PIN is not configured (blank).
SIM Card PUK Error	Invalid PUK entered for SIM card.
SIM and OSM Model Mismatch	SIM does not match OSM model number
Source Not Healthy	Source detected as outside specified supply parameters
SIM Caps Not Charged	SIM Module capacitors are not fully charged.
SIM Not Calibrated	SIM not calibrated
Warning	Any warning signal activated
TYPE: VARIABLES[5]	
VAR1	Logic output Variable 1
VAR2	Logic output Variable 2
VAR3	Logic output Variable 3
VAR4	Logic output Variable 4
VAR5	Logic output Variable 5
VAR6	Logic output Variable 6
VAR7	Logic output Variable 7
VAR8	Logic output Variable 8
VAR9	Logic output Variable 9
VAR10	Logic output Variable 10
VAR11	Logic output Variable 11
VAR12	Logic output Variable 12
VAR13	Logic output Variable 13
VAR14	Logic output Variable 14
VAR15	Logic output Variable 15
VAR16	Logic output Variable 16
VAR17	Logic output Variable 17
VAR18	Logic output Variable 18
VAR19	Logic output Variable 19
VAR20	Logic output Variable 20
VAR21	Logic output Variable 21
VAR22	Logic output Variable 22
VAR23	Logic output Variable 23

Signal	Description
VAR24	Logic output Variable 24
VAR25	Logic output Variable 25
VAR26	Logic output Variable 26
VAR27	Logic output Variable 27
VAR28	Logic output Variable 28
VAR29	Logic output Variable 29
VAR30	Logic output Variable 30
VAR31	Logic output Variable 31
VAR32	Logic output Variable 32

Notes:

1. *Available through IO and Logic.*
2. *"Test Mode" can be used to put a message in the event log when the Test Mode starts and when the Test Mode ends. Its purpose is to allow filtering the events to determine which sections of events were generated while the test mode was active.*
3. *An alarm is activated when a protection element detects that a protection operation is required.*
4. *Block status is available through Logic, I/O and SGA.*
5. *All 32 variables (VAR1 – VAR32) are available for Logic configuration. Only 16 Variables (VAR1-VAR16) are available as IO and SCADA signals.*

11.7 Appendix G – Events

11.7.1 Protection Events

Event title		Relevant signal/parameter		Source of event	Critical parameter
		Title	Old value → New value		
ACO	End	ACO	On→Off	ACO	OSM Status Incorrect, UV3 AR Map Incorrect, VRC Mode Incorrect, ABR On, This Recloser not Healthy, Protection is Off, LL or HLT is On, Peer Comms Failed, Prot Settings Changed, ACO Settings Changed, Main/ALT/Equal Mode Incorrect, Make before break mode Incorrect, Remote Recloser not Healthy, Operator Trip, Prot Lockout, Close/Trip Failed, AR Timer Active, Operator, Critical Error – Close Both, Remote Recloser, Load Live, ACO Enable Timeout, UV is Off, Close Blocking, Protection Open Blocking, Single Triple Mode, Sectionaliser is Enabled, Synchronisation is Enabled.
Alarm	N/A	A(E)	0→1	Any Protection Element	Relevant Phase
AR initiation	N/A	St(E)	Any closed→ Open2/Open3/ Open4	AR OC/NPS/EF/SEF/Yn AR OV/UV ABR UV3 AutoClose	Tr, s
SST Control	Start	SST Control	0→1	Protection	Tst, s= [SST Time]
	End		1→0		
Block Pickup	Start	Block Pickup	0→1	Protection	OV3, EF+, EF-, SEF+, SEF-
	End		1→0		OV3, EF+, EF-, SEF+, SEF-
Capture	N/A	N/A	N/A	OSC	Trigger Event: Pickup, Trip, Close, Alarm, IO Input Logic, SCADA. Optional: Disc full, cannot overwrite, failed to write.
Close	N/A	C(E)	0→1	AR OC/NPS/EF/SEF/Yn, ARVE OV/UV, ABR, ABR AutoOpen, HMI, PC, I/O, SCADA, ACO, UV3 AutoClose	N/A
Count	N/A	Count	C1 → C2 C2 → C3 C3 → C4	Sectionaliser	N/A
Dir. control change	N/A	St(E)	Old→New	DE OC, DE EF, DE NPS DE SEF	N/A
Hot Line Tag On	Start	Hot Line Tag On	0→1	HMI, PC	Relevant State: Lockout
	End	Hot Line Tag On	1→0	HMI, PC	
Freeze	Start	Input current	below Imax → above Imax	OC2+, OC2-, EF2+, EF2- NPS2+, NPS2-	Imax Amps
	End	Input current	above Imax → below Imax	OC2+, OC2-, EF2+, EF2-, NPS2+, NPS2-	Imax Amps
HIB2,t	start	2nd Harmonic Blocking	0 → 1	HIB2 (2nd Harmonic)	HIB2,% and A, B or C phase
	end	2nd Harmonic Blocking	1 → 0	HIB2 (2nd Harmonic)	N/A
HIB5,t	start	5th Harmonic Blocking	0 → 1	HIB5 (5th Harmonic)	HIB5,% and A, B or C phase
	end	5th Harmonic Blocking	1 → 0	HIB5 (5th Harmonic)	N/A
Inhibit OV3	Start	Inhibit OV3	0→1	Protection	“RST”,“ABC”,“RST, ABC”
	End	Inhibit OV3	1→0	Protection	

Event title		Relevant signal/parameter		Source of event	Critical parameter
		Title	Old value → New value		
LLB Blocking	Start	Live Load Blocking	0→1	LLB	
	End	Live Load Blocking	1→0	LLB	
Logic Close Blocking	Start	Logic Close Blocking	0→1	I/O, Logic or SCADA	
	End	Logic Close Blocking	1→0	I/O, Logic, SCADA, HMI, CMS	
Pickup	Start	P(E)	0→1	OC1+, OC2+, OC3+, OC1-, OC2-, OC3-, OCLL1-3	I_{op} and A,B or C phase VC Active, VR Active for OC2+, OC2-
				NPS1+, NPS2+, NPS3+ NPS1-, NPS2-, NPS3-, EF1+, EF2+, EF3+, EF1-, EF2-, EF3-, SEF+, SEF-, NPSLL1-3, EFLL1-3, SEFLL	I_{op}
				Yn	Gn REV, mSi=REV Gn; Gn FWD, mSi=FWD Gn; Bn REV, mSi=REV Bn; Bn FWD, mSi=FWD Bn for Yn
				I2/I1	I_{op}, I2/I1 = configured pickup value %
				UV1, UV12, UV13, UV2, UV22, UV23, UV3, OV1, OV12, OV13, OV2, OV22, OV23, OV3, OV4, Uabc<, Urst<, Uabc>, Urst>	Up AB, BC or CA phase for UV2X, OV2X Up for UV1X, OV1X, OV3, OV4, Uabc, Urst
				UF, UF2, UF3, OF, OF2, OF3	F_{op} Hz
				ROCOF	ROCOF Hz/s
				VVS	VVS Degrees (°)
				LSD, ABR	
				AutoOpen	T(open), secs
				HRM	THD, TDD, A, B, C, D or E > operating threshold (where A,B,C,D,E are individual harmonics selected by the user).
				UV4 Sag	Up for UV4 Sag min and UV4 Sag max (Only the first element triggering the pickup will be recorded)
				PDOP	PDOP kVA, θ_{PDOP} Degrees (°)
				PDUP	PDUP kVA, θ_{PDUP} Degrees (°)
	End	P(E)	1→0	OC1+, OC2+, OC3+, OC1-, OC2-, OC3-, OCLL1-3	Maximum current registered during pickup duration and A, B or C phase
				NPS1+, NPS2+, NPS3+ NPS1-, NPS2-, NPS3-, EF1+, EF2+, EF3+, EF1-, EF2-, EF3-, SEF+, SEF-, NPSLL1-3, EFLL1-3, SEFLL	Maximum current registered during pickup duration
				Yn	Max(Gn FWD) mSi= Maximum Recorded Conductance during pickup when “forward conductance” exceeded; Max(Bn FWD) mSi= Maximum Recorded Susceptance during pickup when “forward Susceptance” exceeded; Min(Gn REV) mSi= Minimum Recorded Conductance during pickup when “reverse conductance” exceeded; Min(Bn REV) mSi= Minimum Recorded Susceptance during pickup when “reverse Susceptance” exceeded
				I2/I1	Max (I2/I1) measured pickup value %

Event title		Relevant signal/parameter		Source of event	Critical parameter
		Title	Old value → New value		
				Uabc<, Urst<, Uabc>, Urst>	Maximum voltage registered during pickup duration for Uabc>, Urst>
				UV1, UV12, UV13	Minimum voltage registered during pickup duration
				UV2, UV22, UV23	Minimum voltage registered during pickup duration and AB, BC or CA phase
				UV3	
				OV1, OV12, OV22	Maximum voltage registered during pickup duration
				OV2, OV22, OV23	Maximum voltage registered during pickup duration and AB, BC or CA phase
				OV3	Max U_n voltage registered during pickup duration
				OV4	Max U_2 voltage registered during pickup duration
				UF, UF2, UF3	Minimum frequency registered during pickup duration
				OF, UF2, OF3	Maximum frequency registered during pickup duration
				ROCOF	Maximum ROCOF registered during pickup duration
				VVS	Maximum VVS registered during pickup duration
				LSD, ABR	
				AutoOpen	
				HRM	Max of any of the following: THD, TDD, A, B, C, D, E (where A,B,C,D,E are individual harmonics selected by the user).
				UV4 Sag	Minimum voltage registered during pickup duration
				PDOP	Maximum apparent power and its power angle registered during pickup.
				PDUP	Minimum apparent power and its power angle registered during pickup.
Protection(1) Operation	N/A	Protection Operation	0→1	Any Protection Element	Relevant Phase
CBF Pickup		CBF Pickup Backup Trip Pickup	0→1		Ia, Ib, Ic, In Ia, Ib, Ic, In
Reset	N/A	N(E)	above 0→0	OC1+, OC2+, OC3+, OC1-, OC2-, OC3- , NPS1+, NPS2+, NPS3+ NPS1-, NPS2-, NPS3-, EF1+, EF2+, EF3+, EF1-, EF2-, EF3-, SEF+, SEF-, OCLL1-3, NPSLL1-3, EFLL1-3, SEFLL Yn, I2/I1 UF, OF, UV1, UV2, UV3, UV4 Sag, OV1, OV2, OV3, OV4 AR OC/NPS/EF/SEF/Yn AR OV/UV	Relevant Phase
Sequence Advance	N/A	Sequence Advance		AR OC/NPS/EF/SEF/Yn	N/A
Time addition	N/A	Toat	0→Tat	TTA	Tat
T_rec	start	N(CLP)	0→above 0	CLP (Cold Load Protection)	OCLM (Operational Cold Load Multiplier)
	end	N(CLP)	below 1→1	CLP (Cold Load Protection)	N/A

Event title		Relevant signal/parameter		Source of event	Critical parameter
		Title	Old value → New value		
Trip Request[2]	N/A	Trip Request	0→1	Any Protection Element AutoOpen	N/A
Trip	N/A	T(E)	0→1	Sectionaliser/Protection HMI, PC, I/O, SCADA, Manual AutoOpen	N/A
$T_{,LSRM}$	start			AR (OC/NPS/EF/SEF/Yn)	
$T_{,LSRM}$	end			AR (OC/NPS/EF/SEF/Yn)	
T_ocl	start	N(CLP)	Incrementing or stable → decrementing	CLP (Cold Load Protection)	OCLM (Operational Cold Load Multiplier)
	end	N(CLP)	above 0→0	CLP (Cold Load Protection)	N/A
T_oir	start	N(IR)	1→below 1	IR (Inrush)	OIRM (Operational Inrush Multiplier)
	end	N(IR)	above 0→0	IR (Inrush)	N/A
UV4 Sag Blocking	start	UV4 Sag Blocking	0→1	UV4 Sag	N/A
	end	UV4 Sag Blocking	1→0	UV4 Sag	N/A
VRC Blocking[3]	Start	VRC Blocking	0→1	VRC	Relevant State: Lockout
	End	VRC Blocking	1→0	VRC	N/A
ZSC	N/A	AR(OC/NPS/ EF/ SEF)	C1→C2, C2→C3, C3→C4	AR (OC/NPS/EF/SEF/Yn)	N/A

Notes:

1. *The Protection Operation event is for relay firmware version 1.11.0 and above.*
2. *The Trip Request event is for relay firmware version prior to 1.11.0.*
3. *VRC blocking does not start or record an end under the following conditions:*
   - *Switch has transitioned to Lockout by any source*
   - *AutoClose Mode is enabled and the switch is open due to UV3*
   - *Switch is Closed.*

11.7.2 Status Events

Event title		Relevant signal/parameter		Source of event	Critical parameter
		Title	Old value → New value		
Auto-Sync	Start	Auto-Synchronisation	On→Off	HMI,Logic, Relay Input, SCADA	
	End	Auto-Synchronisation	Off→On	HMI,Logic, Relay Input, SCADA	Failed/Released/Cancelled
Battery Status	N/A	Battery Status	Change of status	SIM	Normal, Disconnected, Low, High
Battery Test	Start	Battery Test	On→Off	HMI, SCADA, IO, Logic, Auto	
	End	Battery Test	Off→On	HMI, SCADA, IO, Logic, Auto	Battery Test Passed, Check Battery, Battery Test Circuit Fault, Not Performed, AC Off, Resting, Battery Off, Battery being discharged, Voltage too low, Not Supported, Timeout.
Close Req. Blocked	N/A	Close Req. Blocked	Off→On	LL,HLT, LLB, UV4 Sag, I/O, SCADA, Logic, Synchronisation	LLDB Blocking / DLLB Blocking / DLDB Blocking, Sync-check Fail, ΔV Fail / Δf Fail / Δφ Fail/ LLLB Fail

Event title		Relevant signal/parameter		Source of event	Critical parameter
		Title	Old value → New value		
Connection completed	N/A	Connection completed	DCD = 1 → DCD = 0 or receive "NO CARRIER" string or hang up modem	Comms	N/A
Connection established	N/A	Connection established	DCD = 0 → DCD = 1 or receive "CONNECT" string or receive valid frame	Comms	Unsolicited Dial Out, Remote Dial In
Control Mode is Set to Remote	Start	Control mode	Local → Remote	HMI	N/A
	End	Control mode	Remote → Local	HMI	N/A
Core Dump Generated	N/A	N/A	N/A	Relay	N/A
Data Save	N/A	Data Save	N/A	HMI, Protection	N/A
Database Retored	N/A	N/A	N/A	SMP	
Dial-up initiated	N/A	Dial-up initiated	Unsol= 0 → Unsol = 1	Comms	N/A
Dir. Control Changed	N/A	N/A	N/A	DE OC/NPS/EF/SEF	N/A
Distance	N/A	Distance	N/A	Fault Locator	FltDiskm, km= [distance to fault] / Out of Range
Distance To Fault[1]	N/A	Distance to Fault	N/A	Fault Locator	
Entered Recovery Mode	N/A	N/A	N/A	SMP, Relay	System Error, System Check or User Request
External Supply Reset	N/A	External Supply Reset	N/A	Relay	N/A
External Load Off	Start	External Supply Reset	Off→On	SIM	N/A
	End	Ext. Load Off	On→Off	SIM	N/A
External Load Shutdown	Start	External Load Shutdown	Off→On	SIM	N/A
	End	External Load Shutdown	On→Off	SIM	N/A
Fault Impedance	N/A	Fault Impedance	N/A	Fault Locator	$Zf\angle\theta_f$, Ω= measured fault impedance ()
Faulted Loop Impedance	N/A	Fault Loop Impedance	N/A	Fault Locator	$Z_{Loop}\angle\theta_{Loop}$, Ω= measured faulted loop impedance (Ω)
GPS Restart[2]	NA	GPS Restart	NA	HMI/PC/Logic/Relay Input	
GPS Locked[2]	Start	GPS Locked	Off→On	GPS	
	End	GPS Locked	On→Off	GPS	
Hot Line Tag On	Start	Hot Line Tag On	Off→On	HMI, PC, SCADA, I/O	N/A
	End	Hot Line Tag On	On→Off	HMI, PC, SCADA, I/O	N/A
ICD/CID File Deleted	N/A	IEC 61850		IEC 61850	
ICD/CID File Loading	N/A	IEC 61850			Failed
ICD/CID File Loading	Start	IEC 61850			CID Name
	End	IEC 61850		IEC 61850	-
IO1 Connected	N/A	IO1 Connected	Off→On	Relay	N/A
IO2 Connected	N/A	IO2 Connected	Off→On	Relay	N/A

Event title		Relevant signal/parameter		Source of event	Critical parameter
		Title	Old value → New value		
Load profile configuration changed	N/A	Load profile configuration changed	N/A	PC	N/A
Log Id Rollover	N/A	N/A	N/A	Relay	Event Log, Close/Open Log, Fault Log, Load Pofile Log, Settings Log, Interruptions Log, Sags/Swells Log, Harmonics Log
Manual Trip	N/A	Manual Trip		SIM	N/A
Mobile Network Modem Restart[2]	N/A	Mobile Network Modem Restart	N/A	HMI/PC/UPS/Logic/ Relay Input	N/A
Mobile Network Shutdown[(2)]		Mobile Network Shutdown		UPS	
OSM Calibration Changed	N/A	Calibration data updated	N/A	HMI, PC	Switchgear Ia/Ib/Ic/In/Ua/Ub/Uc/Ur/Us/Ut is Calibrated
OSM Closed	N/A	OSM Closed		SIM	N/A
OSM Open	N/A	OSM Open		SIM	N/A
Prot status change	N/A	Protection status	Old→New	HMI, PC, SCADA, Relay Input, Logic	List of Protection Elements being switched On, AR, HLT
SCADA Config requires RC restart	Start	SCADA Config requires RC Restart	0 -> 1	System	DNP3/IEC 61850 MMS/IEC 61850 GOOSE Publisher/ IEC 61850 GOOSE Subscriber/ IEC 60870-5 101/104/2179
	End		1 -> 0		
Relay Firmware Update	N/A		N/A	PC, USB	Relay firmware version number
Restart	N/A	Restart	N/A	PC, SCADA, HMI	Protocol, System Process
Restored Logs	N/A	N/A	N/A	SMP	
RTC Reset	N/A		N/A	Relay	N/A
SGA Fboot Failed	N/A	SGA Fboot Failed	N/A	Relay, SGA	
SGA Res[(3,4,5)]	Start	SGA Res	N/A	SGA	[Resource Name].IDE
	End	SGA Res	N/A	SGA	[Resource Name].IDE, Floating point exception[3], SGA Resource Limit, SGA External Events Limit[4], SGA Internal Events Limit[5,] IEC 61499
SGA	N/A	SGA	N/A	SGA	Warm
	N/A	SGA	N/A	SGA	Stop
SIM Calibration Changed	N/A	Calibration data updated	N/A	PC	All SIM coefficients are calibrated
SIM Calibration Status	N/A		N/A	SIM	Calibrated, Not Calibrated, Cal Values corrupted
SIM Card Error[(6)]		SIM Card Error	N/A	Comms	
SIM Card Status[(6)]		SIM Card Status	N/A	Comms	SIM Card Fault / SIM PIN Error/ SIM Card Blocked, SIM PUK required[(7)]/ SIM Card PUK Error/ SIM Card Blocked permanently
Simulator Step	Start	Simulator Step	Change	PC	Simulation Step number
Simulator Run	Start	Simulator Run	Off - > On	PC	N/A
	End	Simulator Run	On - > Off	PC	N/A
System Message Logged	N/A	N/A	N/A	Relay	ID Value 1, Code Value 2

Event title		Relevant signal/parameter		Source of event	Critical parameter
		Title	Old value → New value		
Time Addition	N/A	N/A	N/A	TTA	Tat,s=time
Update Initiated	N/A	Update Initiated	N/A	USB	
Update Successful	N/A	Update Successful	N/A	Relay	Relay Firmware, SIM Firmware, Language, DB Schema
USB GPRS Connected	Start	USB GPRS Device Detected	Inserted	Relay	USB A/B/C
	End	USB GPRS Device Detached	Removed	Relay	USB A/B/C
USB LAN Connected	Start	USB LAN Device Detected	Inserted	Relay	USB A/B/C
	End	USB LAN Device Detached	Removed	Relay	USB A/B/C
USB Serial Connect	Start	USB Serial Device Detected	Inserted	Relay	USB A/B/C
	End	USB Serial Device Detached	Removed	Relay	USB A/B/C
USB WLAN Connected	Start	USB WLAN Device Detected	Inserted	Relay	USB A/B/C
	End	USB WLAN Device Detached	Removed	Relay	USB A/B/C
WLAN Error(2)	N/A	WLAN Error	N/A	Comms	AP Not Found / Wrong AP Password Length / Wrong Client Password / Wrong Client Password Length / Wrong Password Length
WLAN Fail(2)	N/A	WLAN Fail	N/A	Comms	Failed Booting / Failed Loading Firmware / Failed Initialisation / AP Config Failure / Invalid Channel / Query MAC Failed / AP Failure / AP Scan Failure / Channel Region Failed /Invalid RF band / Joining AP Failure / Password Missing / Query FW Ver Failed / Set RF Frequency Failed / Setting Password Failed / Setting RF Failed / Setting TX Power Failed / SSID Mismatch / Unsupported RF / Wrong Join Command / Wrong Join Parameter / Wrong Operation Mode / Wrong Parameter
Wi-Fi Restart(2)	N/A	Wi-Fi Restart	N/A	HMI/PC/UPS/Logic/ Relay Input	N/A
Wi-Fi Shutdown	N/A	Wi-Fi Shutdown		UPS	

Notes:

1. *Indicates that the fault locator calculation has commenced. Refer to Section 6.14 Fault Locator.*
2. *Applies only to REL-15 module.*
3. *Occurs when an application attempts to divide by zero. SGA will shutdown when this event occurs.*
4. *Occurs if the delay, cycle or self-eventing function blocks are triggered too regularly and cannot be transferred to a resource before the buffer is filled (buffer limit is 9). SGA will shutdown when this event occurs.*
5. *Occurs if there are a very high number of waiting events within a resource at any one time (buffer limit is 255). SGA will shutdown when this event occurs.*
6. *Applies only to REL-15-4G module.*
7. *This warning appears in CMS System Status as only "SIM Card Blocked".*

11.7.3 Warning Events

Event title		Relevant signal/parameter		Source of event	Critical parameter
		Title	Old value → New value		
AC Off (On Battery Supply)	Start	AC Off	Off→On	SIM	N/A
	End	AC Off	On→Off	SIM	N/A
AC Status	Start	AC Status	Off→On	SIM	Off, High, Low, Normal

Event title		Relevant signal/parameter		Source of event	Critical parameter
		Title	Old value → New value		
	End	AC Status	On→Off	SIM	Off, High, Low, Normal
Battery Charger State: Low Power	Start	Battery Charger State: Low Power	Off→On	SIM	N/A
	End	Battery Charger State: Low Power	On→Off	SIM	N/A
Battery Off (On AC Supply)	Start	Battery Off	Off→On	SIM	N/A
	End	Battery Off	On→Off	SIM	N/A
Close Request Fail	N/A	Close Request Fail	Off→On	SIM	OSM Not Connected, OSM Mechanically Locked, Command Pending, Faulty Actuator, Mechanism Failure, Duty Cycle Exceeded, Close Cap Not OK, Trip Cap Not OK, Already Closed, Excess Actuator Current Draw
Critical Battery Level	Start	Critical Battery Level	Off→On	SIM	N/A
	End	Critical Battery Level	On→Off	SIM	N/A
Dial-up Failed	N/A	Dial-up failed	Dialled all 5 phone numbers without connecting to a master	Comms	N/A
GPS Unplugged(1)	Start	GPS Unplugged	Off→On	GPS	
	End	GPS Unplugged	On→Off	GPS	
Hot Line Tag On	Start	Hot Line Tag On	Off→On	Panel,I/O, Logic,PC	N/A
	End	Hot Line Tag On	On→Off	Panel,I/O, Logic,PC	N/A
HLT Forced Reset	N/A	Hot Line Tag forced reset	On→Off	HMI	N/A
Operation Blocked by HLT	N/A	Operation Blocked by HLT		I/O1 or I/O2	I/O1 Input1-8, I/O2 Input 1-8.
Incorrect Phase Sequence	Start	Incorrect Phase Sequence	Off→On	Protection	N/A
	End	Incorrect Phase Sequence	On→Off	Protection	N/A
I/O Module Changed	N/A	N/A	N/A	HMI, OC	IO ID, serial number
Logic Channel Output	N/A	N/A	N/A	Logic	Logic Channel Name
Logic Configuration Issue	Start	Logic Configuration Issue	0→1	Logic	N/A
	End	Logic Configuration Issue	1→0	Logic	N/A
Logic Exp error	N/A	N/A	N/A	Logic	Logic Channel Name Disabled
Logic/SGA Stopped	N/A	Logic/SGA Stopped		“SGA/Logic”	
Logic/SGA Throttling	Start	Logic/SGA Throttling		“SGA/Logic”	
	End	Logic/SGA Throttling		“SGA/Logic”	
Mechanically Locked	Start	Mechanically Locked	Off→On	SIM	N/A
	End	Mechanically Locked	On→Off	SIM	N/A
Module No. Invalid	N/A	N/A	N/A	HMI, PC	Serial Number
OSM Disconnected	Start	OSM Disconnected	Off→On	SIM	N/A
	End	OSM Disconnected	On→Off	SIM	N/A
OSM Position Status Unavailable	Start	OSM Position Status Unavailable	Off→On	SIM	N/A
	End	OSM Position Status Unavailable	On→Off	SIM	N/A
Panel Disconnected	Start	Panel Disconnected	Off→On	HMI	N/A
	End	Panel Disconnected	On→Off	HMI	N/A
Panel Comms Error	Start	Panel Comms Error	0→1	HMI	N/A

Event title		Relevant signal/parameter		Source of event	Critical parameter
		Title	Old value → New value		
	End	Panel Comms Error	1→0	HMI	N/A
Power Restart	N/A	Power Restart	Off→On	SIM	N/A
Restore Failed	N/A	N/A	N/A	SMP	Relay Settings or Relay Log
Shutdown	N/A	Shutdown		SIM, Relay, PC	User Shutdown, Power Supply, Internal Error, Unknown Error, OSM Model Change
SIM Caps Not Charged	Start	SIM Caps Not Charged	Off→On	SIM	N/A
	End	SIM Caps Not Charged	On→Off	SIM	N/A
SIM Comms Fail	Start	SIM Comms OK	OK→Not OK	SIM	N/A
SIM and OSM Model Mismatch		SIM and OSM Model Mismatch		SIM	SIM01, SIM02, SIM03
SNTP Unable to Sync	Start	SNTP Unable to Sync		SNTP	
	End	SNTP Unable to Sync		SNTP	
Trip Request Fail	N/A	Trip Request Fail	Off→On	SIM	OSM Not Connected, OSM Mechanically Locked Out, Operation Active, Faulty Actuator, Mechanism Failure
Update Failed	N/A	Update Failed		Relay/IO/USB/PC	Unknown Error /Invalid Database Version/ Unsupported Hardware/Unsupported Part Number/Incompatible File System/ Invalid Microkernel/ Invalid Relay Serial Number/ Invalid Update File/GPIO Firmware Comms Error/IO1 Comms Error/ IO2 Comms Error/Incompatible Files/Internal File System Error/USB Access Error/No Files
Update Reverted	N/A	Update Reverted	Off→On	Relay	N/A
Update Settings or Logs Failed	N/A	Update Settings or Logs Failed	Off→On	Relay	N/A
USB Host Power Off	Start	USB Host Power Off	Off→On	Relay	N/A
	End	USB Host Power Off	On→Off	Relay	N/A
USB Mismatched	Start	USB Mismatched	Off→On	Relay	USBA,B,C
	End	USB Mismatched	On→Off	Relay	USBA,B,C
USB Unsupported	Start	USB Unsupported	Off→On	Relay	USBA,B,C
	End	USB Unsupported	On→Off	Relay	USBA,B,C
USB Ports Overcurrent Reset		USB Ports Reset		HMI/PC	
Wrong Control Mode	N/A	Wrong Control Mode		I/O1, I/O2 or Relay Input	I/O1 Input1-8, I/O2 Input 1-8, Local Input 1-3

Notes:

1. *Applies only to REL-15 module*

11.7.4 Malfunction Events

Event title		Relevant signal/parameter		Source of event	Critical parameter
		Title	Old value → New value		
Battery Charger Fault	Start	Battery Charger Fault	0→1	SIM	N/A
	End	Battery Charger Fault	1→0	SIM	N/A
Battery Test Circuit Fault[1]	Start	Battery Test Circuit Fault	0→1	SIM	N/A
	End	Battery Test Circuit Fault	1→0	SIM	N/A
CAN Bus Malfunction	Start	CAN Bus Fault	0→1	Relay	N/A
	End	CAN Bus Fault	1→0	Relay	N/A
CAN Buffer Overflow	N/A	CAN Buffer Overflow	0→1	SIM	N/A
CAN Bus Error	N/A	CAN Controller Error	0→1	SIM	N/A
CAN Bus Overrun	N/A	CAN Controller Overrun	0→1	SIM	N/A
Capacitor Voltage Abnormal	N/A	Capacitor Voltage	0→1	SIM	Close capacitor voltage drop too high or Trip capacitor voltage drop too high or Trip capacitor voltage drop on close.
CBF Malfunction	N/A	Excessive To	0→1	CBF	N/A
Configuration error	Start	Configuration error	0→1	System	DNP3
	End	Configuration error	1→0	System	DNP3
Excessive Tc	N/A	Excessive Tc	0→1	SIM	N/A
Excessive To	N/A	Excessive To	0→1	SIM	N/A
External Load Overload	Start	External Load Overload	0→1	SIM	N/A
	End	External Load Overload	1→0	SIM	N/A
Firmware/Hardware Mismatch	N/A	Firmware/Hardware Mismatch	N/A	Relay	N/A
GPS Malfunction[2]	Start	GPS Malfunction	0→1	GPS	N/A
	End	GPS Malfunction	1→0	GPS	N/A
I/O1 Comms Error	Start	I/O1 Comms Error	0→1	I/O	N/A
	End	I/O1 Comms Error	1→0	I/O	N/A
I/O2 Comms Error	Start	I/O2 Comms Error	0→1	I/O	N/A
	End	I/O2 Comms Error	1→0	I/O	N/A
I/O1 Fault	Start	I/O1 Fault	0→1	I/O	N/A
	End	I/O1 Fault	1→0	I/O	N/A
I/O2 Fault	Start	I/O2 Fault	0→1	I/O	N/A
	End	I/O2 Fault	1→0	I/O	N/A
Incorrect DB Values Loaded[3]	N/A	Incorrect DB Values Loaded	0→1	SIM	N/A
Log process fault	Start	Log process fault	0→1	Relay	N/A
	End	Log process fault	1→0	Relay	N/A
Module Comms Error	Start	Module Comms Error	0→1	Relay	N/A
	End	Module Comms Error	1→0	Relay	N/A
OSM Coil SC	Start	OSM Coil SC	0→1	SIM	N/A
	End	OSM Coil SC	1→0	SIM	N/A
OSM Coil OC	Start	OSM Coil OC	Normal → Open, Short, Sw Fault	SIM	N/A
	End	OSM Coil OC	Open, Short, Sw Fault → Normal	SIM	N/A
OSM Limit Switch Fault	Start	OSM Limit Switch Fault	0→1	SIM	Open Limit Switch Failed Close, Open Limit Switch Failed Open, Closed Limit Switch Failed Closed, Closed Limit Switch Failed Open, Close and Open switches both failed closed, Close and Mechanical Interlock Switch Closed

Event title		Relevant signal/parameter		Source of event	Critical parameter
		Title	Old value → New value		
	End	OSM Limit Switch Fault	1→0	SIM	N/A
Panel Module Fault	Start	Panel Module Fault	0→1	HMI	N/A
	End	Panel Module Fault	1→0	HMI	N/A
Relay Module Fault	Start	Relay Module Fault	0→1	Relay	REL-15 Module Fault, REL-15-4G Module Fault
	End	Relay module fault	1→0	Relay	N/A
RTC Hardware Fault	Start	RTC Hardware Fault	0→1	SIM	N/A
	End	RTC Hardware Fault	1→0	SIM	N/A
SIM Comms Error	Start	SIM Comms Error	0→1	SIM	N/A
	End	SIM Comms Error	1→0	SIM	N/A
SIM Disconnected	Start	SIM Disconnected	0→1	SIM	N/A
	End	SIM Disconnected	1→0	SIM	N/A
SIM Driver Q503 Failed	Start	N/A	N/A	SIM	N/A
	End	N/A	N/A	SIM	N/A
SIM Minibootloader mode	Start	SIM Minibootloader mode	0→1	SIM	Bootloader CRC
	End	SIM Minibootloader mode	1→0	SIM	N/A
SIM Module Fault	Start	SIM Module Fault	0→1	SIM	Flash, Ram, Temp Sensor, Power Supply, Firmware CRC, Bootloader CRC, Manufacturing Details, Incorrect Software.
	End	SIM Module Fault	1→0	SIM	N/A
USB Overcurrent Malfunction[4]		USB Overcurrent Malfunction		Relay	Onboard/Wifi/GPS/USB/Mobile Network Modem/External

Notes:

1. *Indicates that the battery test circuit which is used to test the battery is faulty.*
2. *Applies only to REL-15 module.*
3. *One or more saved configuration values are not within the permitted limits. The out of range values have been set to default. It is recommended to review and update the settings. The malfunction warning will be reset once the configuration settings have been updated.*
4. *When an overcurrent draw is detected on a USB port, the relay will stop power to that port. The device causing the overcurrent will be displayed as a critical parameter in the event log. Any faulty USB devices should be removed. Power can be restored to the port by using "Reset USB Overcurrent" from the Reset Menu (refer to Section 4.7.10 USB Overcurrent).*

11.8 Appendix H – Change Log Messages

Parameter	Old value	New value
ACO	Old status	New status
Auto Battery Test	Old mode	New mode
Battery Test : Interval, days	Old value	New value
Logical Block Close	Old value	New value
CBF : Backup On	Old value	New value
COMMS General: Group Settings	N/A	Changed
COMMs RS232 (USB A; USBB; LAN; WLAN; Mobile Network; RS232P): **Config Type** (Device Mode; Baud Rate; Duplex Type; Parity; IP version; Obtain IPv4 Automatically; Obtain IPv6 Automatically; Provide IPv4 Automatically; AP IP Address; IPv4 Address; IPv4 Subnet Mask;IPv4 Default Gateway; IPv6 Address; IPv6 Subnet Prefix Length ; IPv6 Default Gateway; Specify IPv4, Specify IPv6, Connection Mode; Wi-Fi Tx Power; AP Network Key; Preferred Network)	Old value	New value
COMMs RS232 (USBA; USBB; LAN; WLAN; Mobile Network; RS232P): **Group Settings**	N/A	Changed
RS-232 (USB A**,** USBB, USBC, LAN**): Port Local Remote Mode**	Old mode	New mode
RS232 (USB A; USBB; LAN; WLAN; Mobile Network; RS232P): (Device Mode; Baud Rate; Duplex Type; Parity; Obtain IP Automatically; Provide IP Automatically; AP IP Address; IP Address; Subnet Mask; Default Gateway; Connection Mode; Wi-Fi Tx Power, AP Network Key)	Old value	New value
COMMs RS232DTE: Group Settings	N/A	Changed
COMMs Status Test RS232DTE (USBA ; USBB ; USBC)	Old value	New value
COMMs: (DNP3, IEC 60870; CMS; IEC 61850; P2PComms, Panel, FTP): **Logging** (Max Log Size, MB)	Old value	New value
Control Mode	Old mode	New mode
Date/Time	N/A	Changed
Demonstration Unit	Old Value	New Value
External Load Status	Old status	New status
Energy Meters (Fault Counters; SCADA Counters)	N/A	Erased
Erase Interruption Counters	N/A	Changed
Erase Oscillography Records	N/A	Changed
Erase Sag/Swell Counters	N/A	Changed
Fault Flags: Reset Fault Flags on Close (Alarm, Display Alerts)	Old mode	New mode
Fault Locator: **Enabled**	Old mode	New mode
Fault Locator: **R0, Ω/km** (X0, Ω/km; R1, Ω/km; X1, Ω/km; Length of Line, km)	Old Value	New Value
GPS: Enable	Old value	New value
GRP 1 (2; 3; 4) **OC1+** (OC1- , NPS1+, NPS1-, EF1+, EF1-, OC2+, OC2-, NPS2+, NPS2-, EF2+, EF2-)**: TCC type**	Old TCC	New TCC
GRP 1 (2; 3; 4) **OC1+** (OC1-, NPS1+, NPS1-, EF1+, EF1-, OC2+, OC2-, NPS2+, NPS2-,EF2+, EF2-, OC3+, OC3-, NPS3+, NPS3-, EF3+, EF3-, SEF+, SEF-, OCLL1-3, NPSLL1-3, EFLL1-3, SEFLL)**: Ip, A** (Tdt Min, s, TM, MIN, Tmin, s, Tmax, s, Ta, s, FLTRes, s, ImaxM)	Old value	New value
GRP 1 (2; 3; 4) **OC2+** (OC2-): **VOC Mode** (UVOC)	Old Value	New Value
GRP 1 (2; 3; 4) **OC2+** (OC2- ; NPS2+, NPS2-, EF2+; EF2-): **MAX Mode**	Old mode	New mode
GRP 1 (2; 3; 4) **OC1+** (OC1-, NPS1+, NPS1-, EF1+, EF1-, OC2+, OC2-, NPS2+, NPS2-, EF2+, EF2-, OC3+, OC3-, NPS3+, NPS3-, EF3+, EF3-, SEF+, SEF-): **Dir En**	Old mode	New mode
GRP 1 (2; 3; 4) **DE OC** (DE EF; DE SEF, DE NPS)**: At**	Old value	New value
GRP 1 (2 ;3 ;4) **DE OC** (DE NPS, DE EF, DE SEF): **DND** (Dir Change response)	Old mode	New mode
GRP 1 (2 ;3 ;4) **DE EF** (DE SEF): Advance Polar Det	Old mode	New mode
GRP 1 (2 ;3 ;4) **DE EF** (DE SEF): **Min Polar NVD Thres** (Max Forward Angle, Min Forward Angle, Max Reverse Angle, Min Reverse Angle)	Old value	New value
GRP 1 (2 ;3 ;4) **DE SEF**: Polarisation	Old value	New value
GRP 1 (2; 3; 4): **I2/I1**: **Mode**	Old mode	New mode
GRP 1 (2; 3; 4): **I2/I1**: **Tdt Min, s** (Pickup Value, %; Min I2, A)	Old value	New value
GRP 1 (2; 3; 4): **Yn: Operational Mode** (Directional Mode)	Old mode	New mode
GRP 1 (2; 3; 4): **Yn: Tdt Min, s** (Min In, A; Min Un UM, FLTRes, s; Forward Susceptance, mSi; Reverse Susceptance, mSi; Forward Conductance, mSi; Reverse Conductance, mSi)	Old value	New value
GRP 1 (2; 3; 4) **AR OC/NPS/EF/SEF/Yn MAP**	N/A	Changed
GRP 1 (2, 3, 4) **AR OC/NPS/EF/SEF/Yn: Tr1,s** (Tr2,s, Tr3,s, Tres,s)	Old value	New value

Parameter	Old value	New value
GRP 1 (2; 3; 4): **SST Control**	Old mode	New mode
GRP 1 (2; 3; 4): **SST Time: Tst,s**	Old value	New value
GRP 1 (2; 3; 4) **SST OC+** (OC-, NPS+, NPS-, EF+; EF-) **1** (2, 3,4)	Old value	New value
GRP 1 (2; 3; 4) **AR OC/NPS/EF/SEF/Yn: ZSC mode**	Old mode	New mode
GRP 1 (2; 3; 4) **AR OC/NPS/EF/SEF/Yn: LSRM mode**	Old mode	New mode
GRP 1 (2; 3; 4) **AR OC/NPS/EF/SEF/Yn: LSRM time**	Old value	New value
GRP 1 (2; 3; 4**) Sequence Advance**	Old value	New value
GRP 1 (2; 3; 4) **CLP: CLM** (Tcl,min; Trec,min)	Old value	New value
GRP 1 (2; 3; 4) **IR: IRM** (Tir,s)	Old value	New value
GRP 1 (2; 3; 4) **TTA: TTA mode**	Old mode	New mode
GRP 1 (2; 3; 4) **TTA: Tat,s**	Old value	New value
GRP 1 (2; 3; 4) **VRC: VRC Enable**	Old mode	New mode
GRP 1 (2; 3; 4) **VRC: VRC mode**	Old mode	New mode
GRP 1 (2; 3; 4) **VRC: UM**	Old value	New value
GRP 1 (2; 3; 4) **LLB: UM**	Old value	New value
GRP 1 (2; 3; 4) **ABR: ABR mode**	Old mode	New mode
GRP 1 (2; 3; 4) **ABR: Tr, s**	Old value	New value
GRP 1 (2; 3; 4) **AutoOpen: Mode**	Old mode	New mode
GRP 1(2; 3; 4) **AutoOpen: Tr, min** (OPS), **Power Flow Dir Changed** (Power Flow Reduced; % Power Flow Reduced; Tr, sec)	Old value	New value
GRP 1 (2; 3; 4) **LSRM mode**	Old mode	New mode
GRP 1 (2; 3; 4) **LSRM: Time, s**	Old value	New value
GRP 1 (2; 3; 4) **UV: UV1 UM** (UV12 UM, UV13 UM; UV2 UM; UV22 UM; UV23 UM; UV1 Tdt Min,s; UV12 Tdt Min,s; UV13 Tdt Min,s; UV2 Tdt Min,s; UV22 Tdt Min,s; UV23 Tdt Min,s UV3 Tdt Min, s)	Old value	New value
GRP 1 (2; 3; 4) **UV3: AutoClose Mode (Operation in SST only)**	Old mode	New mode
GRP 1 (2; 3; 4) UV3: **AutoClose: Tr, sec**	Old value	New value
GRP 1 (2; 3; 4) **UV4 : UM (Min)** (UM(Max);UM(Mid); Tdt Min, s; Lockout Time , min)	Old value	New value
GRP 1 (2; 3; 4) **UV4 : (**Voltage Type, Voltages)	Old mode	New mode
GRP 1 (2; 3; 4) **OV: OV1 UM** (OV12 UM; UV13 UM; OV2 UM; OV22 UM; OV23 UM; OV3 UM; OV4 UM; OV1 Tdt Min,s; OV12 Tdt Min,s; OV13 Tdt Min,s; OV2 Tdt Min,s; OV22 Tdt Min,s; OV23 Tdt Min,s; OV3 Tdt Min,s; OV3 Moving Average Mode; OV3 Moving Average Window, s; OV4 Tdt Min,s;)	Old value	New value
GRP 1 (2; 3; 4) **AR VE: UV1 mode** (UV12 mode; UV13 mode; UV2 mode; UV22 mode; UV23 mode; UV3 mode; UV4 Sag mode; OV1 mode; OV12 mode; OV13 mode; OV2 mode; OV22 mode; OV23 mode; OV3 mode; OV4 mode)	Old mode	New mode
GRP 1 (2; 3; 4) **AR VE: Tr,s** (No. Of Trips to Lockout)	Old value	New value
GRP 1 (2; 3; 4) **PDPR: PDOP Mode** (PDUP Mode)	Old mode	New mode
GRP 1 (2; 3; 4) **PDPR: PDOP Pickup Value, kVA** (PDOP Pickup Value, °; PDOP Tdt Min, s; PDUP Pickup Value, kVA; PDUP Pickup Value, °; PDUP Tdt Min, s; PDUP Dis Tdt, s)	Old value	New value
GRP 1 (2; 3; 4) **UF: UF mode** (UF2 Mode, UF3 Mode)	Old mode	New mode
GRP 1 (2; 3; 4) **UF: UF Fp,Hz** (UF2 FP,Hz; UF3 FP,Hz; UF Tt,s; UF2 Tt,s; UF3 Tt,s)	Old value	New value
GRP 1 (2; 3; 4) **OF: OF mode** (OF2 Mode; OF3 Mode)	Old mode	New mode
GRP 1 (2; 3; 4) **OF: OF Fp,Hz** (OF2 Fp,Hz; OF3 Fp,Hz; OF Tt,s; OF2 Tt,s; OF3 Tt,s)	Old value	New value
GRP 1 (2; 3; 4) **ROCOF: Mode**	Old mode	New mode
GRP 1 (2; 3; 4) **ROCOF: Pickup Value Hz/s** (Tdt Min, s)	Old value	New value
GRP 1 (2; 3; 4) **VVS: Mode**	Old mode	New mode
GRP 1 (2; 3; 4) **VVS: Pickup Value, °** (Tdt Min, s)	Old value	New value
GRP 1 (2; 3; 4) **Group Name**	Old value	New value
GRP 1 (2; 3; 4) **Group Description**	Old value	New value
GRP 1 (2; 3; 4) **Group Settings**	Old mode	New mode
Group 1 (2; 3; 4)	N/A	Changed
GRP 1 (2; 3; 4)**: HIB2 Mode,** HIB5 Mode	Old Mode	New Mode
GRP 1 (2; 3; 4)**: HIB2, % (**HIB2, t; HIB5, %; HIB5, t**)**	Old Value	New Value
GRP 1 (2; 3; 4)**: HRM: THD Mode**	Old mode	New mode
GRP 1 (2; 3; 4)**: HRM: THD%** (THD Time)	Old value	New value
GRP 1 (2; 3; 4)**: HRM: TDD Mode**	Old mode	New mode
GRP 1 (2; 3; 4)**: HRM: TDD Level (**TDD Time**)**	Old value	New value
GRP 1 (2; 3; 4)**: HRM:**	Old value	New value
GRP 1 (2; 3; 4)**: HRM: IND Mode**	Old mode	New mode
GRP 1 (2; 3; 4)**: HRM: IND Time**	Old value	New value

Parameter	Old value	New value
GRP 1 (2; 3; 4)**: HRM: IND A (**B;C;D;E**) Name** (Level)	Old value	New value
GRP 1 (2; 3; 4):**Sectionaliser mode**	Old mode	New mode
HMI SETTINGS: Prot On/Off (EF On/Off; SEF On/Off; AR On/Off; CLP On/Off; LL On/Off; Grp 1 – 4 On/Off; ABR On/Off; ACO On/Off; UV4 Sag On/Off); Delayed Close	Old mode	New mode
HMI SETTINGS: Close Delay(s)	Old value	New value
HMI SETTINGS: Key Configuration Option	Old value	New value
HRM Log: Enable	Old mode	New mode
HRM Log: THD Enable	Old mode	New mode
HRM Log: THD%	Old value	New value
HRM Log: TDD Enable	Old mode	New mode
HRM Log: TDD %	Old value	New value
HRM Log: HRM_I Enable	Old mode	New mode
HRM Log: HRM_I%	Old value	New value
HRM Log: HRM_V Enable	Old mode	New mode
HRM Log: HRM_V%	Old value	New value
HRM Log: T,s	Old value	New value
IN1 (IN2, IN3) **SETTINGS: Control signal**	Old signal	New signal
Interruption: Mon	Old mode	New mode
Interruption: Log Short Duration	Old mode	New mode
Interruption: Duration T,s	Old mode	New mode
I/O SETTINGS: I/O1 mode (I/O2 mode)	Old mode	New mode
I/O1 (I/O2) **I1** (I2; I3; I4; I5; I6) **SETTINGS: Control signal**	Old signal	New signal
I/O1 (I/O2) **O1** (O2; O3; O4; O5; O6) **SETTINGS: Indication signal**	Old signal	New signal
I/O1 (I/O2) **O1** (O2; O3; O4; O5; O6) **SETTINGS: Trec, s** (Tres, s)	Old value	New value
Lifetime Counters	N/A	Changed
Link HLT to LLL	Old value	New value
LL Allow Close	Old value	New value
Load Profile Configuration Changed	N/A	Changed
Logic: Write Prot CH 17-32	Old mode	New mode
ME SETTINGS: U Rated, kV (LSD Level, kV)	Old value	New value
Osc: Mon	Old mode	New mode
Osc: Event (Capture T, s; Capture %; Overwrite; USB Save)	Old value	New value
Password	N/A	Changed
PORT SETTINGS: Port type (Baud rate, Duplex type, Parity)	Old value	New value
Power Flow Direction	Old value	New value
Prot On(ABR On; Alarm Mode On; AR On; CLP On; DFT On; EF On; SEF On; Yn On, HLT On; HRM On; LL On; LLB On; Link HLT to LL; MNT On; NPS On; OF On; OV On; OV3 On, SSM On; UF On; UV On; UV4 Sag On; 79-2 Trips to Lockout; 79-3 Trips to Lockout, ROCOF On, VVS On, HIB On, PDOP On, PDUP On)	Old status	New status
PROTECTION STATUS: Active Group	Old status	New status
Protocol: (DNP3; IEC60870; IEC 61850; 2179; CMS; P2PComms; FTP): **Protocol Enable** (Time; Port; Slave address; Master address; Unsolicited; Check Master IP Address; Master IPv4 Address; Master IPv6 Address; IP version; Poll Watchdog Time, min; Binary Control Watchdog Time, min; Update Key; Update Key Version; DNP3-SA; Scaling; Data Link address; Common Address of ASDU; Poll Watchdog Time, min; Binary Control Watchdog Time, min; Send Day of Week; COI Qualifier; Block Until Disconnected; SBO Timeout, s; Enable Port 2; Channel Port 2; Remote ACR LAN Address; Update Rate, s; Mon GOOSE SimFlag; ProcSimGOOSE; QualTestHandling; MMS Server; GOOSE Publisher; GOOSE Subscriber; MMS Port; GOOSE Port; SCADA IEC61850 MMS, P1 Maximum Frame Size, Bytes; P2 Maximum Frame Size, Bytes, Multiple Master Enable, Connection Method, Master Address, Master IP Address)	Old value	New value
Protocol DNP3: C1 (C2): **Master Address (**Master TCP Port, Master IPv4 Address, Master IPv6 Address, Port, IP Version, Slave TCP Port)	Old value	New value
Protocol IEC60870: RG1 (RG2): **Enable** (Connection Method)	Old value	New value
Protocol IEC60870: RG1C1 (RG1C2, RG2C1, RG2C2): **Enable** (Allow Controls, Port, IP Version, Slave TCP Port, Constraints, Originator Address, Master TCP Port, Master IPv4 Address, Master IPv6 Address)	Old value	New value
Remote Control	Old value	New value
Reset Fault Location	Old value	New value
Reset Fault Targets	Old value	New value
Reset Binary Fault Targets	Old value	New value
Reset Fault Meas Values	Old value	New value

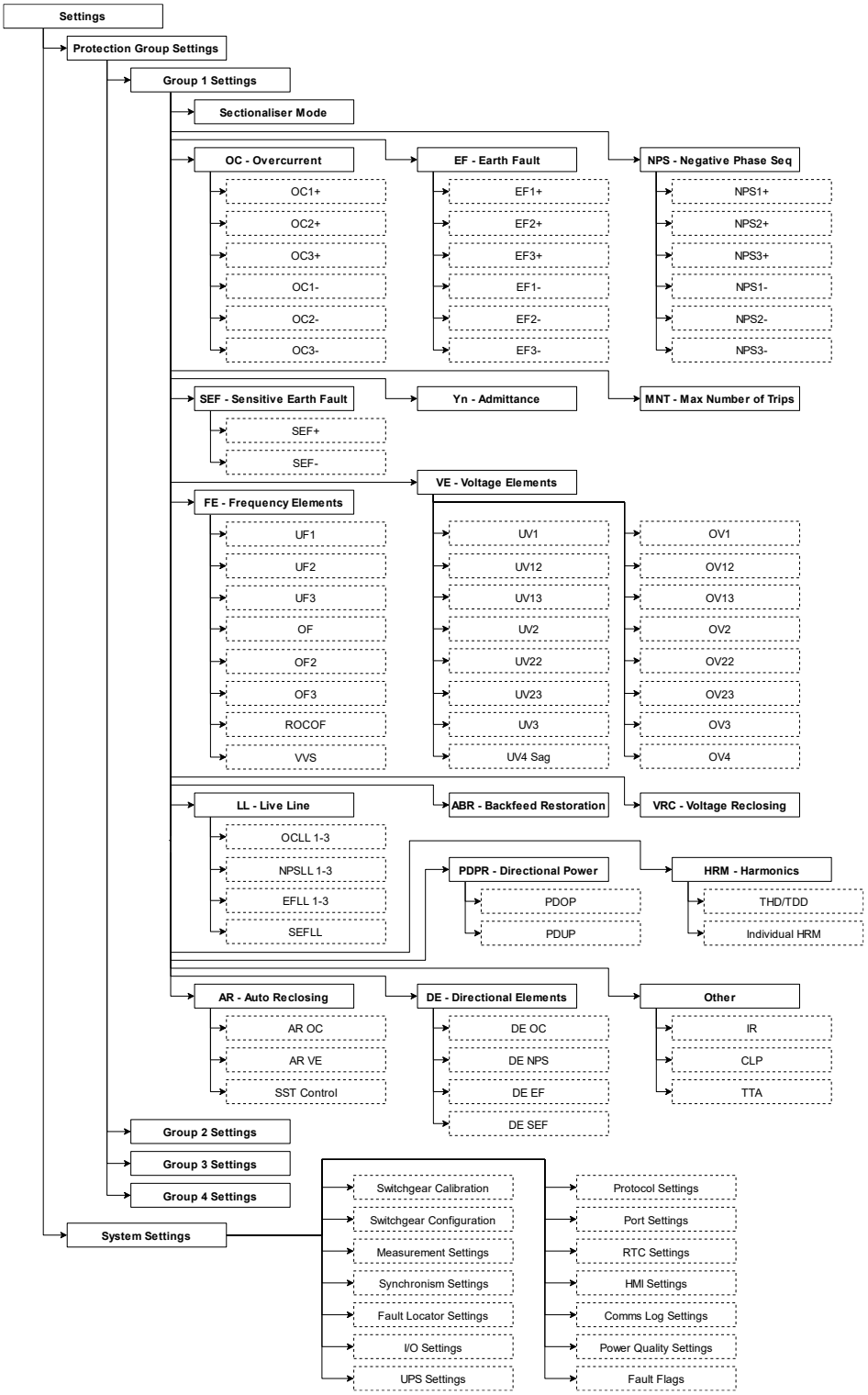
Parameter	Old value	New value
Restrict Trip Mode	Old value	New value
RTC SETTINGS: Date FMT (Time FMT)	Old format	New format
Sag: Mon	Old mode	New mode
Sag: Normal pu (Min pu; T, ms**)**	Old value	New value
Sag/Swell Reset Time, ms	Old value	New value
SET Time	Old Value	New Value
SGA: Enable (TCP Port Number, fboot)	Old value	New value
SNTP: Enable (Disable)	Old mode	New mode
SNTP: (1st Server IPv4 Address; 2nd Server IPv4 Address; 1st Server IPv6 Address; 2nd Server IPv6 Address; SNTP IP version; Update Interval, s; Retry Interval, s; No. of Retry Attempts)	Old Value	New Value
Sync: Synchronisation (Phase Selection; Bus and Line; Live/Dead Autoreclose; DLDB Autoreclose; Live/Dead Manual Close; DLDB Manual Close; Live Bus Voltage Mult; Live Line Voltage Mult; Bus Max Voltage Mult; Line Max Voltage Mult; Synch-Check; Voltage Diff Mult; Max Sync Slip Frequency, Hz; Phase Angle Difference, deg; Manual Pre-Sync Time, s; Fundamental Frequency, Hz; Max Frequency Deviation, Hz; Max Slip Frequency, Hz; Max ROC Slip Freq, Hz/s; Auto-sync Waiting Time, s; Anti-Motoring)	Old Value	New value
Swell: Mon	Old mode	New mode
Swell: Normal pu (T, ms)	Old value	New value
Switchgear Calibration: OSM Type (OSM Serial Number; Cla, AkA; CIb, AkA; CIc, AkA; CIn, AkA; CUa, AMV; CUb, AMV; CUc, AMV; CUr, AMV; CUs, AMV; CUt, AMV))	Old value	New value
System Settings (IO Settings; Logic Settings, Comms Settings; SCADA Settings)	N/A	Changed
System Status: Analogue On/Off	Old mode	New mode
UPS: Battery Shutdown Level, % (Rated Capacity, Ah; Battery Type; External Load Time, min; External Load Reset Time, hr; Enable USB Host Ports Shutdown; Battery Test, Mobile Network Time, min; Mobile Network Reset Time, hr; WLAN Time, min; WLAN Reset Time, hr)	Old value	New value
Protocol FTP: Protocol Enable	Old value	New value

Notes:

- *For groups of parameters (AR maps, Group settings, System settings (including Protocol and Power Quality), IO, Logic, Lifetime counters readings, Date/Time)) old and new values are not shown in the record when changes are made via a CMS download. Old value is left as NA or blank and "Changed" is used for New Value. Similarly, for erased data (Energy meter readings, Fault counters readings, CO Operations, Event log, Load profile and Change messages) Old and New values are not shown in the record. Statement "NA" is used in place of Old value and statement "Erased" instead of New one.*
- *Refer to the description of control and indication element for applicability of Panel, PC, SCADA and I/O for different control functions.*
- *Capital letters represent a parameter example. Applicable alternative parameters are in parentheses.*
- *Change log messages for GPS, Wi-Fi and Mobile Network apply only to REL-15, from firmware 1.16 onwards.*

11.9 Appendix I – Control and Indication of Settings

Control and Indication of Element settings are provided by the Panel and PC Control and Indication elements only. The structure of Control and Indication settings is illustrated below.



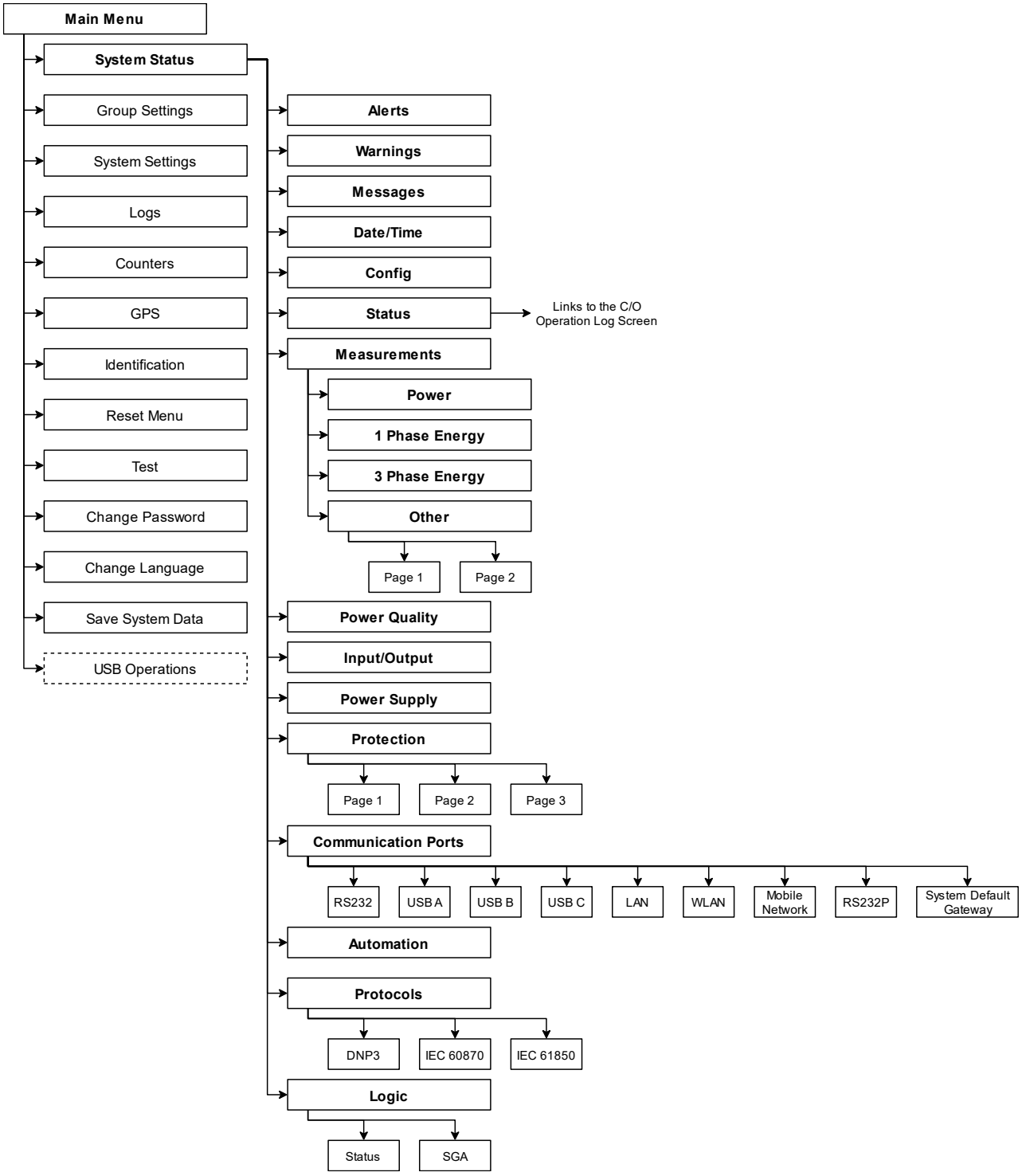
Notes:

- *Groups 1 to 4 have the same settings as shown for group 1.*
- *Within the Group 1 – 4 settings, the Group Names can only be assigned or edited using CMS software.*
- *Within the OC and EF settings, User Defined 1(UD1) characteristic points can only be assigned or edited using CMS software.*
- *On the panel, The NPS element is sometimes referred to as the "NS" element due to space restriction.*

11.10 Appendix J – Operator Panel Menu

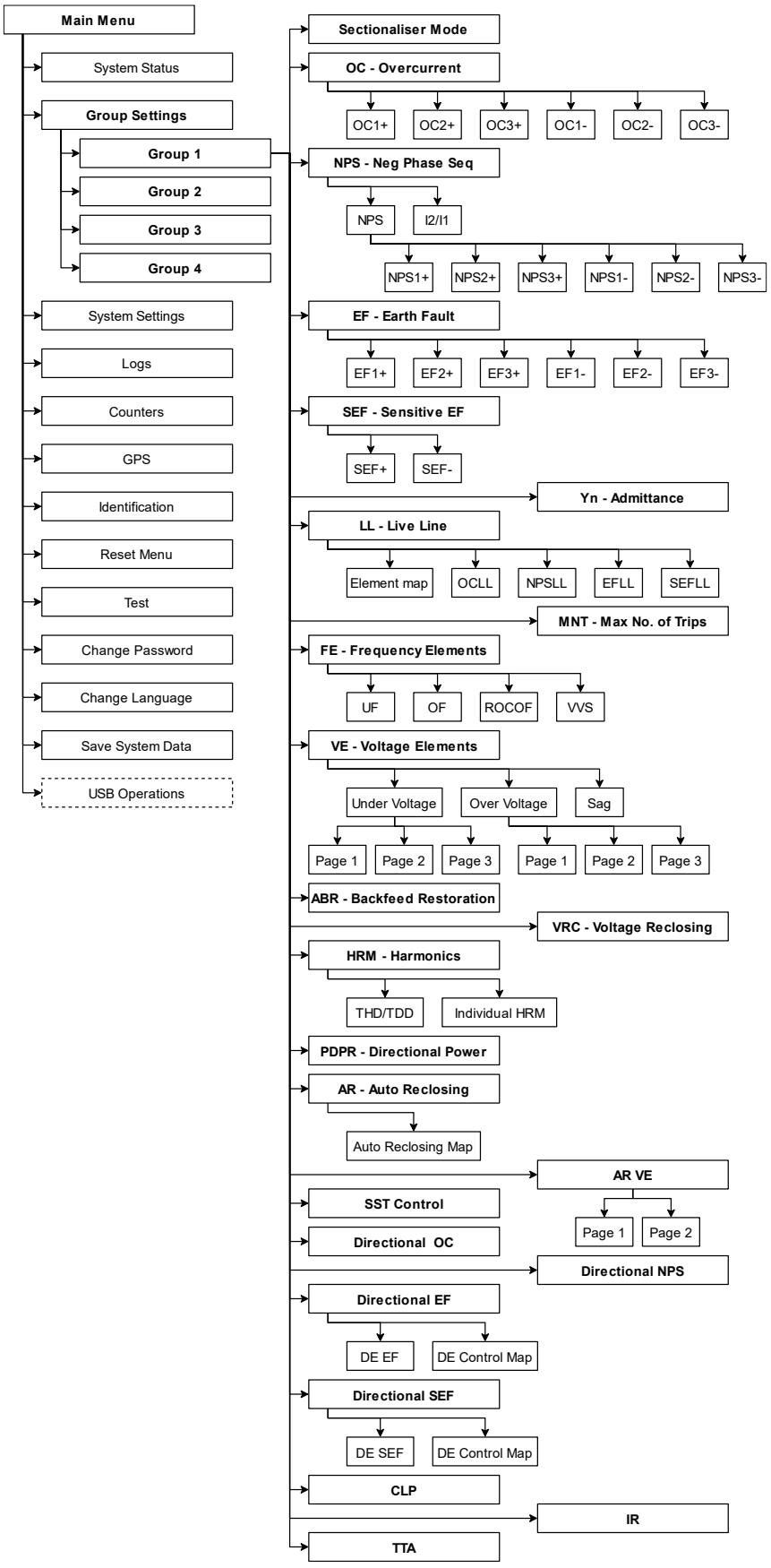
This appendix illustrates how to navigate within the menus to access information.

11.10.1 System Status Menu

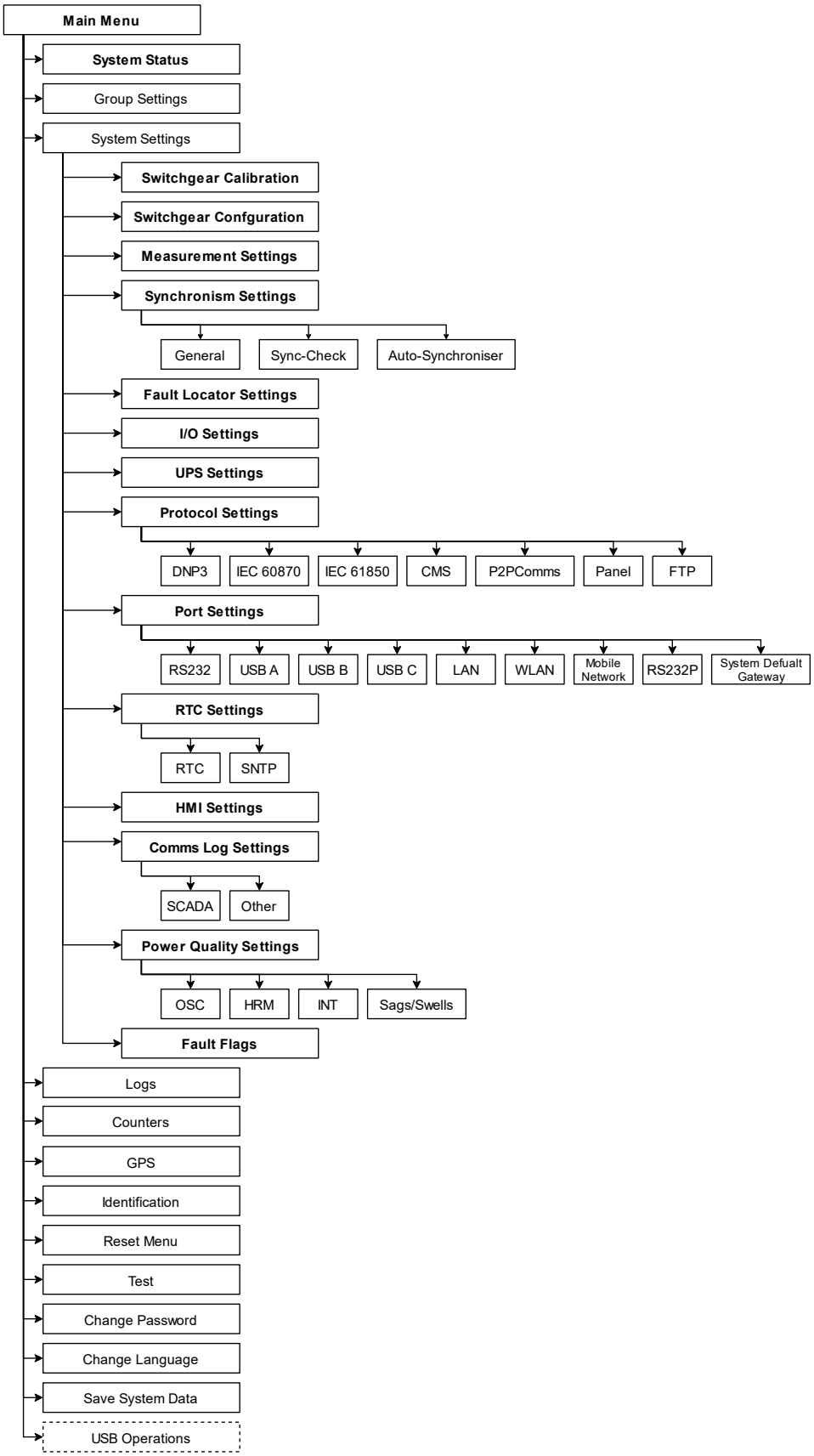


Note: *USB Operations item only appears when a USB flash drive is inserted into one of the Relay USB ports.*

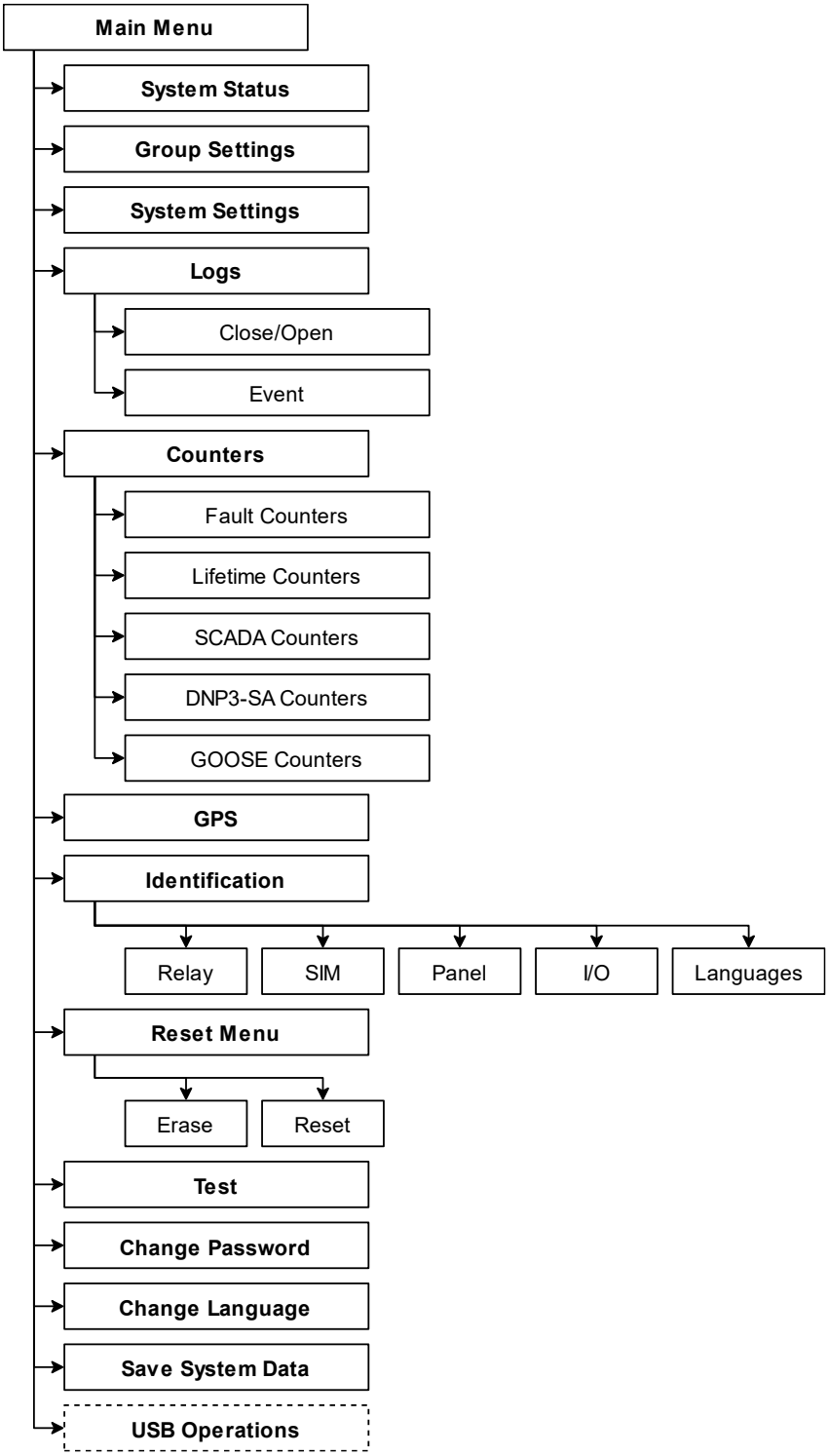
11.10.2 Group Settings Menu



11.10.3 System Settings Menu

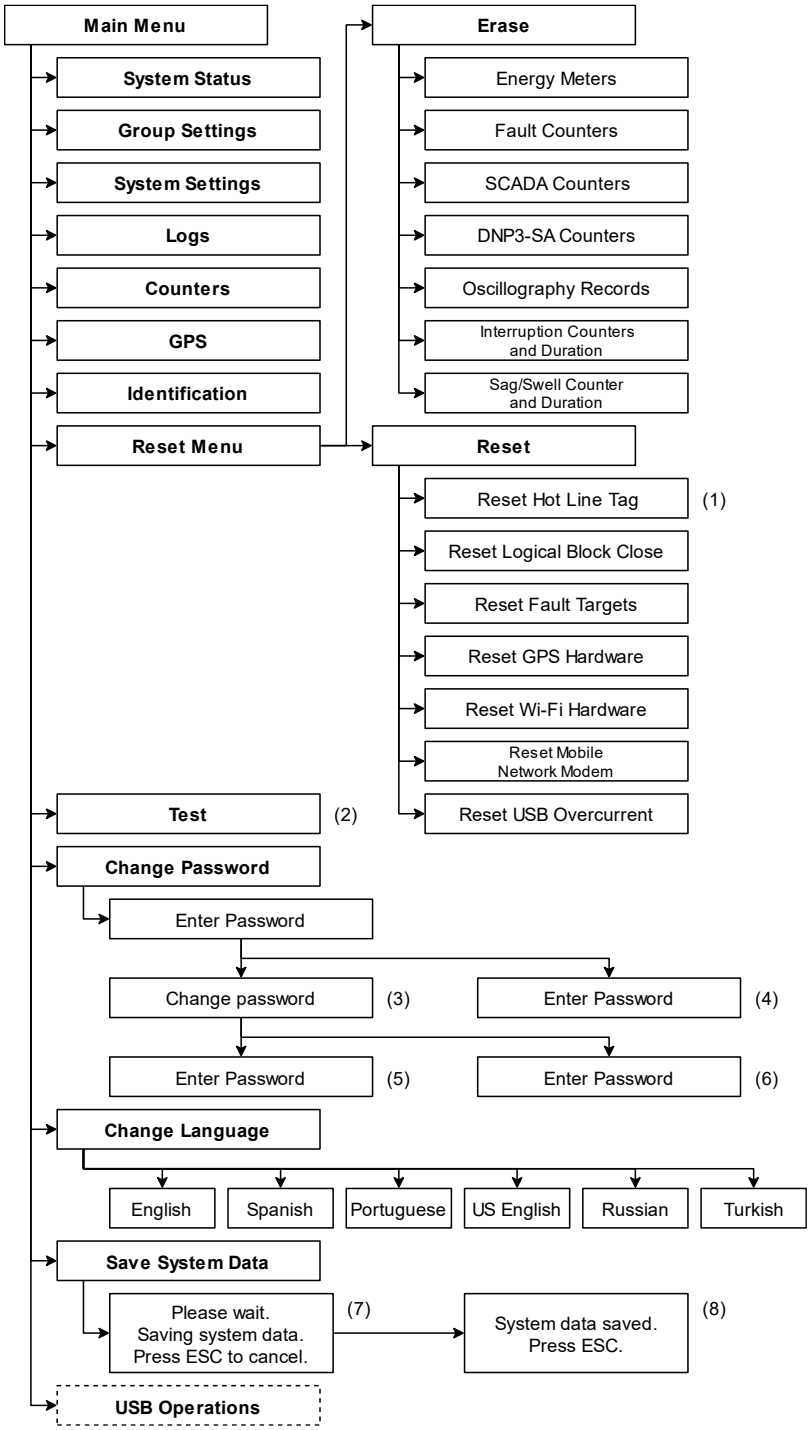


11.10.4 Event Log, Counters and Identification Menus



Note: *The Fault profile, Load profile and Change log are not visible on the Panel but can be captured using CMS software.*

11.10.5 Reset Data, Tests, Change Password and Save System Data



Notes:

(1) Password activated

(2) From the "Tests" menu the user can turn Test Mode On or Off which puts a message in the event log when Test mode starts and when Test Mode ends. Its purpose is to allow filtering the events to determine which sections of events were generated while the test mode was active.

(3) This appears when a correct password has been entered.

(4) This appears when an incorrect password has been entered.

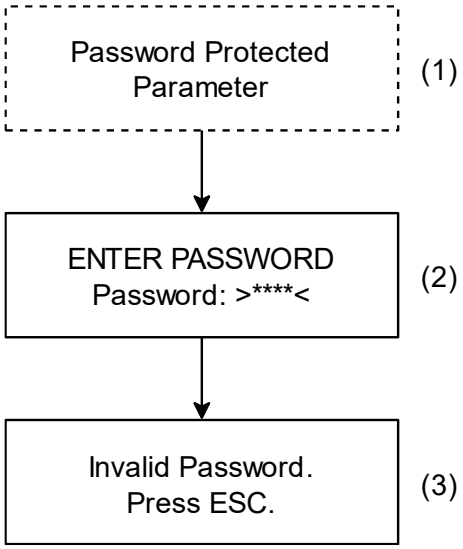
(5) This appears when the password entered at NEW and CONFIRM are the same.

(6) This appears when the password entered at NEW and CONFIRM are different.

(7) This appears during the data saving process.

(8) This appears when the system data has been saved.

11.10.6 Entering Passwords



Notes:

(1) This menu appears when user tries to edit password protected parameter

(2) This menu appears when incorrect password has been entered

(3) The default password "NOJA" is used until changed by user to prevent unauthorised setting changes. See Section 11.10.5.

Panel passwords have the format AAAA, where A can be a digit (from 1 to 9) or a letter (from A to Z).

All parameters are password protected except:

- SCADA -> CMS Settings
- Save System Data
- Power Supply Status -> External Load On/Off
- All parameters in the Protection Status menu
- ACO setting

11.11 Appendix K – Custom Fast Key Configurations

The following table outlines specific button configurations used on NOJA Power RC devices.

11.11.1 OP10-6-E3 Fast Key Option 6 Variant 3

Fast key	Label	Function
1	PROT	Protection On/Off
2	EF	Earth Fault On/Off
3	SEF	Sensitive Earth Fault On/Off
4	AR	Reclosing On/Off
5	PE	Process Enable On/Off
6	LL	Live Line On/Off

Process Enable (PE)

The PE button included in Fast Key Option 6, Variant 3, enables/disables a specific external automated process. It requires the use of an IO module as well as logic and SGA which is loaded into the device at the factory. If the IO module, logic or SGA file is modified from the factory, correct operation is not guaranteed. For further details on the required relay settings, please contact NOJA Power.

12 Index

Referenced Standards and Documents

- NOJA-793 Firmware Upgrade Procedure
- NOJA-559 CMS Help File
- NOJA-594 ACO User Manual
- NOJA-565 SCADA Interface Description
- NOJA-522 DNP3 Protocol Implementation
- NOJA-5604 IEC 60870-5-101 and 104 Protocol Implementation
- NOJA-5017 IEC 61850 RC Logical Nodes Definition
- NOJA-5005 IEC 61850 IED Definition and Conformance Statement
- NOJA-5036 IEC 61850 User Guide.
- NOJA 5591 IO and Logic User Guide
- NOJA-5019 Smart Grid Automation (SGA) User Guide
- ANSI / IEEE C37.2 – 2008 IEEE Standard Electrical Power System Device Function Numbers and Contact Designations
- ANSI / IEEE C37.60 – 2012 Standards Requirements for Overhead, Pad-Mounted, Dry Vault, and Submersible Automatic Circuit Reclosers and Fault Interrupters for Alternating Current Systems Up to 38kV
- CISPR 11:2009 Amendment 1:2010 Industrial, scientific and medical equipment – Radio-frequency disturbance characteristics – Limits and methods of measurement
- CISPR 22:2008 Information technology equipment – Radio disturbance characteristics – Limits and methods of measurement
- EN 55022 – European Standard: Information technology equipment – Radio disturbance characteristics disturbance Limits and methods of measurement
- FCC Part15 - Federal Communications Commissions (North America): Title 47 – Telecommunication Part15 Radio Frequency Devices (Subpart b Unintentional Radiators) IEC 60694 Common specification for high-voltage switchgear and control gear standards.
- IEC 60255 – 1:2009 Measuring relays and protection equipment – Part 1: Common requirements
- IEC 60255 – 5:2000 Measuring relays and protection equipment - Part 5: Insulation coordination for measuring relays and protection equipment – Requirements and tests
- IEC 60255-21-1-1988 - 1st Ed, Electrical Relays – Part 21: Vibration, shock, bump and seismic tests, Section 1 – Vibration tests (sinusoidal)
- IEC 60255-21-2-1988 - 1st Ed, Electrical Relays – Part 21: Vibration, shock, bump and seismic tests, Section Two + Shock and bump tests
- IEC 60255-21-3-1993 – 1st Ed, Electrical Relays – Part 21: Vibration, shock, bump and seismic tests, Section 3: Seismic tests
- IEC 60255 – 22 – 1 (Class III) Measuring relays and protection equipment – Part 22-1: Electrical disturbance tests – 1MHz burst immunity
- IEC 60255 – 22 – 3 Measuring relays and protection equipment – Part 22-3: Electrical disturbance tests – Radiated electromagnetic field immunity
- IEC 60255 – 25 Electrical relays – Part 25: Electromagnetic emission test for measuring relays and protection equipment
- IEC 60255 – 26: 2013 Edition 3.0 Measuring relays and protection equipment – Part 26: Electromagnetic compatibility requirements.
- IEC 61000-4-2-2008 Electromagnetic compatibility (EMC) – Part 4-2: Testing and measurement techniques – Electrostatic discharge immunity test.

- IEC 61000-4-3:2006 Amendment 1:2007 and Amendment 2:2010 Electromagnetic compatibility (EMC) – Part 4-3: Testing and measurement techniques – Radiated, radio-frequency, electromagnetic field immunity test
- IEC 61000-4-4:2012 Electromagnetic compatibility (EMC) – Part 4-4: Testing and measurement techniques – Electrical fast transient/burst immunity test
- IEC 61000-4-5:2005 Electromagnetic compatibility (EMC) – Part 4-5: Testing and measurement techniques – Surge immunity test
- IEC 61000-4-6:2008 Electromagnetic compatibility (EMC) – Part 4-6: Testing and measurement techniques – Immunity to conducted disturbances, induced by radio-frequency fields
- IEC 61000-4-8:2009 Electromagnetic compatibility (EMC) – Part 4-8: Testing and measurement techniques – Power frequency magnetic field immunity test
- IEC 61000–4-9:2001 Electromagnetic compatibility (EMC) – Part 4-9: Testing and measurement techniques – Pulse magnetic field immunity test
- IEC 61000-4-10:2001 Electromagnetic compatibility (EMC) – Part 4-10: Testing and measurement techniques – Damped oscillatory magnetic field immunity test
- IEC 61000-4-11:2004 Electromagnetic compatibility (EMC) – Part 4-11: Testing and measurement techniques – Voltage dips, short interruptions and voltage variations immunity tests
- IEC 61000-4-12:2006 Electromagnetic compatibility (EMC) – Part 4-12: Testing and measurement techniques – Ring wave immunity test
- IEC 61000-4-16:2011 Electromagnetic compatibility (EMC) – Part 4-16: Testing and measurement techniques – Test for immunity to conducted, common mode disturbances in the frequency range 0 Hz to 150 kHz
- IEC 61000-4-18:2006 Amendment 1:2010 Electromagnetic compatibility (EMC) – Part 4-18: Testing and measurement techniques – Damped oscillatory wave immunity test
- IEC 62271 – 111 High-voltage switchgear and control gear – Part 111: Overhead, pad-mounted, dry vault and submersible automatic circuit reclosers and fault interrupters for alternating current systems up to 38kV
- IEC 62271 – 200 High-voltage switchgear and control gear – Part 200: AC Metal-enclosed switchgear and control gear for rated voltages above 1kV and up to and including 52kV

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