OCR3 – FAT + SAT TEST PROTOCOL

Órgão de Corte de Rede (OCR 3)

Protocolo Ensaios

Elaboração: DIT, DGOS, DSAT

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1. FAT

1.1 Introduction

The purpose of this specification is to establish the tests and general characteristics that OCR3 equipment must comply with during the FAT (Factory Acceptance Test), applied to equipment to be qualified. The requirements for OCR3 equipment are described in the DMA-C64-157 – Ed2 – MAI 2023.

It is intended to standardize procedures previously adopted by E-REDES.

The FAT tests will be carried out in the factory and must comply with all the points described in this document. In addition:

- A schedule accepted by E-REDES.
- The provision of equipment to be tested in the factory.
- The supplier provides all the necessary equipment to carry out all the tests described.

1.2 Equipment Identification

Manufacturer	
Recloser Model	
Control Cabinet Model	
Firmware version	
Software version	
Serial Number	
Date of Manufacture	

1.3 Participants

Participant Name	Signature	Company

1.4 Initial Configuration

Configuration Measure	Value
Un (Phase-Phase)	
Un (Phase-Ground)	
In	

Additional Note: This FAT protocol consists on several tests in order to verify some specific requirements from the E-REDES DMA regarding the document “Órgão de Corte de Rede Tipo 3”. However, in this FAT protocol there are some tests that cannot be found in the DMA but which are considered best practice for grid equipment’s. These last mention tests will not affect the ratification of the equipment itself but provide E-REDES consistent information on the expected behavior of the OCR3 in test.

1.5 General Requirements

CHARACTERISTICS		Section	Comments	Status
R1	Standards	as 2.1		
R2	Modularity	as 2.2		
R3	Quality	as 2.3		

1.5.1 Environmental Performance

Type tests related to environmental performance carried out on the complete OCR3:

Reference	Edition	Title	Comments	Status
IEC 60068-2-1	2007	Environmental testing - Part 2-1: Tests - Test A: Cold		
IEC 60068-2-2	2007	Environmental testing - Part 2: Tests. Tests B: Dry heat		
IEC 60068-2-30	2005	Environmental testing - Part 2-30: Tests - Test Db: Damp heat, cyclic (12h + 12h cycle)"		

R4	**Recloser** Shall be maintenance free	as 3.1.1		
R5	**Recloser** Number of phases	as 3.1.3		
R6	**Recloser** Rated frequency (Hz)	as 3.1.3		
R7	**Recloser** Maximum design voltage (kV)	as 3.1.3		

R8	**Recloser** Nominal operating voltage (kV)	as 3.1.3		
R9	**Recloser** Basic insulation level (BIL) (kV)	as 3.1.3		
R10	**Recloser** Dry, One Minute	as 3.1.3		
R11	**Recloser** Wet, Ten Seconds	as 3.1.3		
R12	**Recloser** Continuous Current Rating (A) RMS	as 3.1.3		
R13	**Recloser** Interrupting Rating, Symmetric (A)	as 3.1.3		
R14	**Recloser** Maximum Short Circuit duration (s)	as 3.1.3		
R15	**Recloser** Current Sensing - Calibration	as 3.1.4		
R16	**Recloser** Voltage Sensing - Calibration	as 3.1.5		
R17	**Recloser** Operation 10000 open/close Operations	as 3.1.6		
R18	**Recloser** Poles	as 3.1.6		
R19	**Recloser** Polymer Insulation	as 3.1.6		
R20	**Recloser** Current Interruption	as 3.1.6		
R21	**Recloser** Break	as 3.1.6		
R22	**Recloser** Interruption Mechanism	as 3.1.6		
R23	**Recloser** Mounting Support	as 3.1.6		

R24	**Recloser** Power Line	as 3.1.6		
R25	**Recloser** The recloser mechanically and electrically trip free;	as 3.1.7		
R26	**Recloser** Tripping signal (mechanically or electrically) must be priority and with time-current curve;	as 3.1.7		
R27	**Recloser** Opening and closing operation times consistent for 20 m control cables; Declare the maximum possible length of the cable, further to the specified 20 m;	as 3.1.7		
R28	**Recloser** Manual opening and closing by means of hot stick; Lockout is ensured either mechanically or electrically;	as 3.1.7		
R29	**Recloser** Lockout – Locally or Remotely	as 3.1.7		
R30	**Recloser** Contact position indicator for access viewing from the ground	as 3.1.7		
R31	**Recloser** Ground connector on recloser housing;	as 3.1.7		
R32	**Recloser** Clearing Time	as 3.1.7		
R33	**Recloser** Magnetic actuator powered by batteries or capacitors;	as 3.1.7		
R34	**Recloser** Nameplate Metal-type and visible position, with IEC 62271-111 recloser information	as 3.1.8		
R35	**Recloser** Temperature Conditions	as 3.1.9		
R36	**Recloser** Altitude – 1000m above sea level	as 3.1.9		

R37	**Recloser** Pollution	as 3.1.9		
R38	**Recloser** Weather Conditions	as 3.1.9		
R39	**Recloser** Tests General	as 3.1.10.1		
R40	**Recloser** Each recloser must be type tested at least as per IEC 62271-111 chapter 6. The radiation performance of the recloser module shall be verified according to IEC 60068-2-5.	as 3.1.10.2		
R41	**Recloser – Routine Tests** Each recloser must be factory tested at least as per IEC 62271-111 chapter 7. The controls in the recloser must be factory tested (if is the case).	as 3.1.10.3		
R42	**Recloser** Separable waterproof connectors between recloser and control cabinet;	as 3.2.1		
R43	**Recloser** RIM length	as 3.2.1		
R44	**Recloser** Wires from current and voltage sensors must be protected against external electric and magnetic fields;	as 3.2.1		
R45	**Recloser** Disconnecting the RIM shall not lead to the trip of the recloser;	as 3.2.1		
R46	**Recloser** RIM shall have adequate mechanical and UV protection;	as 3.2.2		
R47	**Recloser** Voltage 0.6/1 kV;	as 3.2.3		
R48	**Recloser** The conductors shall be circular, shaped or compacted;	as 3.2.3		
R49	**Recloser** The maximum continuous conductor temperature shall be 90ºC	as 3.2.3		

1.6 Recloser Primary injection

In the following table register the current transformer/sensor characteristics:

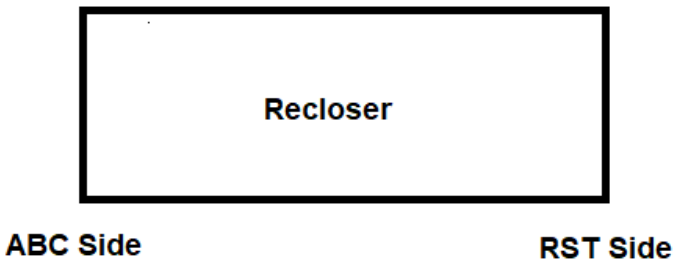
Equipment	Transformation Ratio	Accuracy Class	Accuracy limit factor (A.L.F)	CT Load
CT1				
CT2				
CT3				

In the following table register the voltage transformer/sensor characteristics:

Equipment	Transformation Ratio	Accuracy Class
VTA		
VTB		
VTC		
VTR		
VTS		
VTT		

1.6.1 CT Directionally

This test must be done with the CC connected to the recloser via the supply control cable.



In the following table and according to the recloser manufacturers recloser assembly instructions identify which side will be facing the source and which will be facing the load.

	Recloser side (ABC or RST)
Load	
Source	

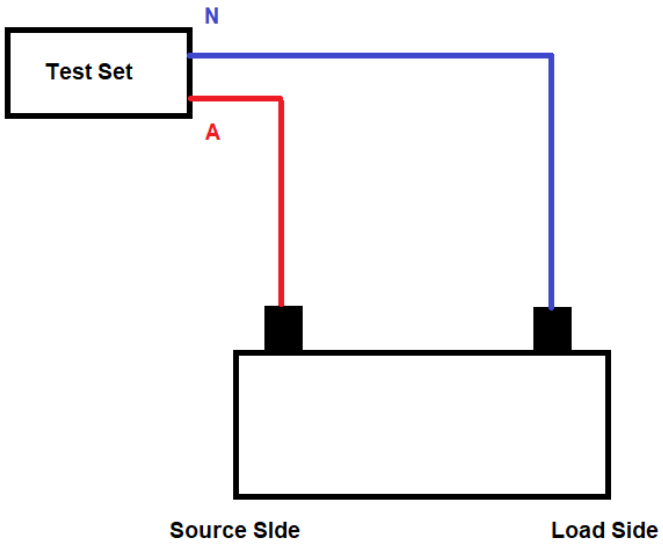


Figure 1 - Primary set test connection - A-Active; N- Return or neutral

With the primary test equipment connected in a way as to simulate injection from source to load (Figure 1) register:

- Electrical PM input where secondary current has a phase displacement of 0°;
- Electrical PM input where secondary current has a phase displacement of 180°;
- Phase displacement registered on the PM.

CT (Phase)	Injection	PM Analog input @0°	PM Analog input @180°	Phase displacement on PM		
				Expected Value	Registered Value	OK/NOK
CT1 (L1)	10%In@0°			0°		
CT2 (L2)	10%In@0°			0°		
CT3 (L3)	10%In@0°			0°		

Important Note: It is important to make sure (either electrically or via software configuration) that when a phase displacement of 0° is injected on the Test Set a 0° displacement is registered on the PM.

General comments	Global Result OK/NOK

1.6.2 Measurement error

This test must be done with the CC connected to the recloser via the supply control cable.

For the CT measurement error test check that the measurement error is according to the reported accuracy class:

Equipment	Injected Amplitude	Registered value on PM	Calculated Error	OK/NOK (accordingly to the accuracy class)
CT1	10%In			
CT2	10%In			
CT3	10%In			

For the VT measurement error test check that the measurement error is according to the reported accuracy class:

Equipment	Injected Amplitude	Registered value on PM	Calculated Error	OK/NOK (accordingly to the accuracy class)
VTA	10%Un(PG)			
VTB	10%Un(PG)			
VTC	10%Un(PG)			
VTR	10%Un(PG)			
VTS	10%Un(PG)			
VTT	10%Un(PG)			

Important Note: The registered values must be the ones registered by the PM and should be those considered to the error calculation.

General comments	Global Result OK/NOK

1.6.3 Current secondary circuit load

This test must be done with the CC connected to the recloser via the supply control cable.

Measure the load of the current secondary circuit and compare it with the specified CT load. Check that the first is always lower than the second one.

Equipment	Measured circuit load	OK/NOK
CT1		
CT2		
CT3		

General comments	Global Result OK/NOK

1.6.4 CT saturation curve (knee point)

Determine the CT saturation curve. Check that the knee point is accordingly to the CT specified ALF (accuracy limit factor).

Equipment	Knee point	OK/NOK
CT1		
CT2		
CT3		

Important Note: If it is not possible to perform this test on FAT, please refer to the factory test of the provided with the CT to evaluate the curve and refer it on the general comments.

General comments	Global Result OK/NOK

1.7 Control Cabinet

1.7.1 General Control Cabinet Requirements

CHARACTERISTICS		Section	Comments	Status
R50	**Control Cabinet** The CC shall be suitable for outdoor installation at 1,5m from ground);	as 3.3.2		
R51	**Control Cabinet** The CC shall house the PSM, RTU, FOM, CIM and the PM modules;	as 3.3.2		
R52	**Control Cabinet** Designed to protect unqualified person from opening the CC or operating the recloser.	as 3.3.2		
R53	**Control Cabinet** All control cables shall be connected with weatherproof fitting and protected against vandalism	as 3.3.2		
R54	**Control Cabinet** The CC shall be made of stainless steel or aluminum;	as 3.3.2		
R55	**Control Cabinet** The CC shall have a lock for the cabinet door;	as 3.3.2		
R56	**Control Cabinet** 4 digit operating counter in CC	as 3.3.2		
R57	**Control Cabinet** AC socket with suitable voltage and power to feed a standard Laptop PC and a testing device (at least 200W)	as 3.3.2		
R58	**Control Cabinet** Internal light	as 3.3.2		
R59	**Control Cabinet** Circuit diagram must be attached inside the CC	as 3.3.2		
R60	**Control Cabinet** Shall provide lifting facilities	as 3.3.2		

CHARACTERISTICS		Section	Comments	Status
R61	**Control Cabinet** All control, VT and antenna cables shall be connected with weatherproof fittings	as 3.3.2		
R62	**Control Cabinet** The CC shall contain all Input/Output terminal blocks for interfacing the various modules inside the CC.	as 3.3.2		
R63	**Control Cabinet** The CC shall have means to prevent condensation	as 3.3.2		
R64	**Control Cabinet** No moving parts inside CC	as 3.3.2		
R65	**Control Cabinet** Vandalism Protection	as 3.3.2		
R66	**Control Cabinet** Design security	as 3.3.2		
R67	**Control Cabinet** The CC shall have a protection level at least equivalent IP54.	as 3.3.3		
R68	**Control Cabinet** Temperature Conditions	as 3.3.3		
R69	**Control Cabinet** Instruction for transport, storage, installation, operation and maintenance	as 3.3.4.1		
R70	**Control Cabinet** Nameplate	as 3.3.4.2		
R71	**Control Cabinet** Type Tests	as 3.3.5		
R72	**Control Cabinet** Routine Test	as 3.3.6		

1.7.2 General Power Supply Module (PSM) Requirements

CHARACTERISTICS		Section	Comments	Status
R73	**Power Supply Module** Nominal input range 100 VAC to 240 VAC at 50 Hz and a tolerance of +/- 10%	as 3.4.2		
R74	**Power Supply Module** Incoming power protected and isolated by circuit breaker	as 3.4.2		
R75	**Power Supply Module** Supply from the battery protected and isolated by circuit breaker	as 3.4.2		
R76	**Power Supply Module** Signalization of all individual circuit breakers to the RTU and to be transmitted to control center	as 3.4.2		
R77	**Power Supply Module** Single phase voltage transformer for power supply from the overhead line.	as 3.4.2		
R78	**Power Supply Module** Backup control operation in the event of loss of primary supply	as 3.4.2		
R79	**Power Supply Module** Backup battery specification, catalogues and tests	as 3.4.2		
R80	**Power Supply Module** Automatic and periodic test of battery and signalization	as 3.4.2		
R81	**Power Supply Module** Detect a deteriorating state of a battery close to the end of its lifespan and shall signal it to the RTU	as 3.4.2		
R82	**Power Supply Module** Battery capacity designed for operating the recloser for a minimum of 24 hours	as 3.4.2		

CHARACTERISTICS		Section	Comments	Status
R83	**Power Supply Module** Automatically shut down	as 3.4.2		
R84	**Power Supply Module** Auxiliary power supply	as 3.4.2		
R85	**Power Supply Module** Nameplate	as 3.4.2.1		
R86	**Power Supply Module** Environmental Requirements	as 3.4.3		
R87	**Power Supply Module** Type Tests	3.4.4		

1.7.3 Specific Power Supply Module (PSM)

1.7.3.1 *Battery Test functionality*

The objective for this test is to verify:

- The functionality of executing battery periodically.
- The capacity to signal locally and remotely the state (OK/NOK) of the battery.

Answer the following:

Question	YES/NO	Comments
The period for testing is configurable? • *If the answer to the question is affirmative - indicate on the comments section the time interval that is possible to set on the PSM.* • *If the answer is negative indicate the period for the test execution.*		

1.7.3.1.1 Battery Test Execution with battery OK

Test Procedure	Expected Behaviour
1 - Ensure the battery is in good condition and with enough charge 2 - Begin a battery test (either by forcing it to start or waiting for the automatic test scheduled)	1 - Battery test shall begin when the command is given 2 - At the end of the test the “ESTADO BATERIAS” “NORMAL” signal is transmitted to the RTU and E-REDES control center (SCADA)

General comments	Global Result OK/NOK

1.7.3.1.2 Battery Test Execution with battery NOK

Test Procedure	Expected Behaviour
1 – Simulate the battery is in bad condition. 2 - Begin a battery test (either by forcing it to start or waiting for the automatic test scheduled).	1 - Battery test shall begin when the command is given. 2 - At the end of the test the “ESTADO BATERIAS” “DEFEITO” signal is transmitted to the RTU and E-REDES control center.

General comments	Global Result OK/NOK

1.7.3.2 *Battery Specification Tests*

The Objective for these tests is to verify:

- The ability to execute 6 opening and closing operation on the recloser after 24h without main power supply. (System working on battery backup)
- That the PSM can charge the battery from a low charge value.
- The automatic control shutdown when the battery charge reaches critical condition.

1.7.3.2.1 Endurance Test

Pre-Requisites:

- This test must be done with the recloser connected to the control cabinet.
- Ensure the battery is at full charge on the beginning of the test.

Test Procedure	Expected Behaviour
1 - Switch off the 230AC supply to the PSM. 2 - Wait for 24 Hours. 3 - Execute 6 opening and closing operations on the recloser from the control cabinet.	1 – At stage 3 of the test the system must have enough charge on the battery to execute the 6 opening and closing operations on the recloser.

General comments	Global Result OK/NOK

1.7.3.2.2 Battery charge test

Pre-Requisites:

- The battery charge value must be above 10%.

Test Procedure	Expected Behaviour
1 - Switch off the 230VAC supply to the PSM. 2 - Drain the battery until it reaches 10% charge. 3 - Switch on the 230VAC supply to the PSM.	1 - Battery is drained until it reaches 10% Charge. 2 – When the PSM 230VAC is turned on the battery begins increasing the charge value.

General comments	Global Result OK/NOK

1.7.3.2.3 Automatic Control Shutdown

Pre-Requisites:

- The battery charge value must be above critical charge value.

Test Procedure	Expected Behaviour
1 - Switch off the 230AC supply to the PSM. 2 – Drain the battery until it reaches critical charge level. (State what is the critical charge level on the comment section).	1 – Control is shutdown when critical charge level is reached on the battery.

General comments	Global Result OK/NOK

1.7.4 General Remote Terminal Unit (RTU) Requirements

CHARACTERISTICS		Section	Comments	Status
R88	**Remote Terminal Unit** The RTU shall be provided with: • Remote communication • Self-test and diagnosis function • Watchdog function • Failure signalization to control center	as 3.5.2		
R89	**Remote Terminal Unit** Inputs/Outputs complete measurement chain shall have an accuracy of at least 5 %	as 3.5.3		
R90	**Remote Terminal Unit** Be able to measure RMS, Phase Angle, PF, kW, kvar, kWh and kvarh	as 3.5.3		

R91	**Remote Terminal Unit** It shall support a communication protocol according to IEC 60870-5-104 (PID) and DEF-C98-422	as 3.5.4		
R92	**Remote Terminal Unit** Communication interface for engineering PC	as 3.5.4		
R93	**Remote Terminal Unit** RTU/CIM with watchdog function	as 3.5.4		
R94	**Remote Terminal Unit** Have an event detection with a time resolution of 10 ms	as 3.5.5		
R95	**Remote Terminal Unit** Have an internal clock for time stamping with maximum deviation 200 ms/h when not synchronized with NCC	as 3.5.5		
R96	**Remote Terminal Unit** Have an event buffer to store events (at least 100 events)	as 3.5.5		
R97	**Remote Terminal Unit** The configuration and the upload of files of the RTU shall be carried out from a remote PC via internet, intranet or IEC 60870-5-104	as 3.5.6		
R98	**Remote Terminal Unit** The RTU shall be fed by the battery backed PSM in the CC	as 3.5.7		
R99	**Remote Terminal Unit** RTU shall be equipped with a FOM to allow operators to locally control the switch	as 3.5.8		
R100	**Remote Terminal Unit** Environmental Requirements	as 3.5.9		
R101	**Remote Terminal Unit** Type Tests	as 3.5.10		

1.7.5 Specific Remote Terminal Unit (RTU)

The objective for these tests is to evaluet all inputs outputs for the RTU and their correct signalling to the RTU and E-REDES control center (SCADA).

1.7.5.1 *Analogue inputs*

Pre-Requisites:

- The RTU must be configured with the signal addresses from the E-REDES normalized SCADA database.

Test:

- With an external test set inject secondary values on the analogue inputs of the RTU corresponding to the following primary values:

	Va	**Vb**	**Vc**	**Vr**	**Vs**	**Vt**	**Ia**	**Ib**	**Ic**
Magnitude	25%Un (PG)	50%Un (PG)	75%Un (PG)	100%Un (PG)	75%Un (PG)	50%Un (PG)	10%In	100%In	200%In
Phase	0	-120	120	0	120	-120	180	60	300

- Register the Values Measured/Displayed on the RTU:

	Expected Value		Registered Value		OK/NOK	Comments
	Mag.	Phase	Mag	Phase		
Va	25%Un(PG)	0				
Vb	50%Un(PG)	-120				
Vc	75%Un(PG)	120				
Vr	100%Un(PG)	0				
Vs	75%Un(PG)	120				
Vt	50%Un(PG)	-120				
Ia	10%In	180				
Ib	100%In	60				
Ic	200%In	300				
P	202,5%InUn(PG)					
Q	0					
PF	-1					

- Register the Values measured/displayed in E-REDES Control Center:

Signal Description (SCADA)	Expected Value	Registered Value	OK/NOK	Comments
TENSAO LINHA ABC	66%Un(PG)			
TENSAO LINHA RST	152%Un(PG)			
CORRENTE	100%In			

- Register the Battery Charge Value measured/displayed in the following locations (the value must be the same in all locations):

Signal Description (SCADA)	PSM	RTU	E-REDES Control Center (SCADA)	OK/NOK	Comments
CAPACIDADE BAT					

General comments	Global Result OK/NOK

1.7.5.2 *Metering*

Test (First Quadrant):

- Register the metered Values Measured/Displayed on the RTU before the test:

	Registered Value
P+_beg[kW]	
Q+_beg[kVar]	
P-_beg[kW]	
Q-_beg[kVar]	

- With an external test set inject secondary values on the analogue inputs of the RTU corresponding to the following primary values during the specified time:

	Va	Vb	Vc	Vr	Vs	Vt	Ia	Ib	Ic	t
Magnitude	Un(PG)	Un(PG)	Un(PG)	Un(PG)	Un(PG)	Un(PG)	0,1In	0,1In	0,1In	15min
Phase	0	-120	120	0	-120	120	-45	-165	75	

During the injection, please register the following values and make sure they are according to expected:

	Expected Value	Registered Value	OK/NOK	Comments
P [kW]	$0,15\sqrt{2}$Un(PG)In			
Q [kVar]	$0,15\sqrt{2}$Un(PG)In			
S [kVA]	0,3Un(PG)In			

- Register the metered Values Measured/Displayed on the RTU after the test:

	Registered Value
P+_end[kW]	
Q+_end[kVar]	
P-_end[kW]	
Q-_end[kVar]	

- Subtract the values obtained at the end with the values in the beginning to observe if values are in range of the expected values:

	Expected Value	Registered Value	OK/NOK	Comments
P+_end-P+_beg	$0,0375\sqrt{2}$Un(PG)In			
Q+_end-Q+_beg	$0,0375\sqrt{2}$Un(PG)In			
P-_end-P-_beg	0			
Q-_end-Q-_beg	0			

Test (Third Quadrant):

- Register the metered Values Measured/Displayed on the RTU before the test:

	Registered Value
P+_beg[kW]	
Q+_beg[kVar]	
P-_beg[kW]	
Q-_beg[kVar]	

- With an external test set inject secondary values on the analogue inputs of the RTU corresponding to the following primary values during the specified time:

	Va	Vb	Vc	Vr	Vs	Vt	Ia	Ib	Ic	t
Magnitude	Un(PG)	Un(PG)	Un(PG)	Un(PG)	Un(PG)	Un(PG)	0,1In	0,1In	0,1In	15min
Phase	0	-120	120	0	-120	120	-225	-345	-105	

During the injection, please register the following values and make sure they are according to expected:

	Expected Value	Registered Value	OK/NOK	Comments
P [kW]	-0,15$\sqrt{2}$Un(PG)In			
Q [kVar]	-0,15$\sqrt{2}$Un(PG)In			
S [kVA]	-0,3Un(PG)In			

- Register the metered Values Measured/Displayed on the RTU after the test:

	Registered Value
P+_end[kW]	
Q+_end[kVar]	
P-_end[kW]	
Q-_end[kVar]	

- Subtract the values obtained at the end with the values in the beginning to observe if values are in range of the expected values:

	Expected Value	Registered Value	OK/NOK	Comments
P+_end-P+_beg	0			
Q+_end-Q+_beg	0			
P-_end-P-_beg	0,0375$\sqrt{2}$Un(PG)In			
Q-_end-Q-_beg	0,0375$\sqrt{2}$Un(PG)In			

General comments	Global Result OK/NOK

1.7.5.3 *Digital Inputs*

Pre-requisites:

- All the actions described in the table below must be done locally i.e from the control cabinet.
- The RTU must be configured with the signal addresses from the E-REDES normalized SCADA database.

Test:

- Execute the action specified in the table Below and check if:
  - It is signalled on the RTU front operating module (FOM).
  - An event is registered on the RTU (EVT).
  - The specified signal is registered in E-REDES Control Center (SCADA).

Action	Signal Description (SCADA)	Signal State (SCADA)	RTU FOM? (OK/NOK)	RTU EVT? (OK/NOK)	Control Center? (OK / NOK)
Using the front operating module issue a CLOSE command to the Recloser.	OCR3	FECHADO			
Using the front operating module issue OPEN command to the Recloser.	OCR3	ABERTO			
Disconnect the control cable between the recloser and the control cabinet.	OCR3	ANOMALIA 00			
Turn protection functions OFF.	PROTECOES	FORA SERVIÇO			
Turn protection functions ON.	PROTECOES	EM SERVIÇO			
Change the selector switch to the LOCAL position.	MODO FUNCION	LOCAL			
Change the selector switch to the REMOTE position.	MODO FUNCION	DISTANCIA			
Open the control cabinet door.	PORTA	ABERTA			
Close the control cabinet door.	PORTA	FECHADA			

Action	Signal Description (SCADA)	Signal State (SCADA)	RTU FOM? (OK/NOK)	RTU EVT? (OK/NOK)	Control Center? (OK / NOK)
Turn automatic back feed restoration ON.	RECONFIGURACAO AUTOMATICA	EM SERVIÇO			
Turn automatic back feed restoration OFF.	RECONFIGURAÇÃO AUTOMATICA	FORA DE SERVIÇO			
Turn auto reclosing OFF.	FUNCAO RELIGACAO	FORA DE SERVIÇO			
Turn auto reclosing ON.	FUNCAO RELIGACAO	EM SERVIÇO			
Pull the “manual open” operating handle on the recloser.	ENCRAVAMENTO OCR	ENCRAVADO			
Reset the “manual open” operating handle on the recloser	ENCRAVAMENTO OCR	NORMAL			
Disconnect the breaker protecting the PSM AC input	TENSAO AC	FALHA			
Reconnect the Breaker protecting the PSM AC input	TENSAO AC	NORMAL			
Change the OCR3 operating mode to Sectionalizer	MODO FUNCIONAMENTO	VT			
Change the OCR3 operating mode to Recloser	MODO FUNCIONAMENTO	DISJUNTOR			
Simulate a fault on the PSM	ALIMENTADOR	DEFEITO			
Normalize the PSM	ALIMENTADOR	NORMAL			
Simulate a fault in the PM (Protection Module)	WATCHDOG	FALHA			
Normalize the PM	WATCHDOG	NORMAL			
Simulate a fault on the RTU	GERAL	ALARME			
Normalize the fault on the RTU	GERAL	NORMAL			

Action	Signal Description (SCADA)	Signal State (SCADA)	RTU FOM? (OK/NOK)	RTU EVT? (OK/NOK)	Control Center? (OK / NOK)
Execute the test described in 0	ESTADO BATERIAS	NORMAL			
Execute the test described in 1.7.3.1.2	ESTADO BATERIAS	DEFEITO			
Execute the test described in 1.8.3	FECHO AUTOMATICO	EM CURSO			
Execute the test described in 1.8.3	FECHO AUTOMATICO	FIM			
Execute the test described in 1.8.1	RELIGACAO CICLO	EM CURSO			
Execute the test described in 1.8.1	RELIGACAO CICLO	FIM			
Execute the test described in 1.8.1	FUNCAO RELIGACAO	NORMAL			
Execute the test described in 1.8.1	FUNCAO RELIGACAO	BLOQUEADO			
Execute test described in 1.7.8.6.3	MAX I> INST +	ARRANQUE			
Execute test described in 1.7.8.6.3	MAX I> INST +	NORMAL			
Execute test described in 1.7.8.6.3	MAX I> TEMP +	DISPARO			
Execute test described in 1.7.8.6.3	MAX I> TEMP +	NORMAL			
Execute test described in 1.7.8.6.3	MAX I> INST -	ARRANQUE			
Execute test described in 1.7.8.6.3	MAX I> INST -	NORMAL			
Execute test described in 1.7.8.6.3	MAX I> TEMP -	DISPARO			
Execute test described in 1.7.8.6.3	MAX I> TEMP -	NORMAL			
Execute test described in 1.7.8.6.3	MAX I0> INST +	ARRANQUE			

Action	Signal Description (SCADA)	Signal State (SCADA)	RTU FOM? (OK/NOK)	RTU EVT? (OK/NOK)	Control Center? (OK / NOK)
Execute test described in 1.7.8.6.3	MAX I0> INST +	NORMAL			
Execute test described in 1.7.8.6.3	MAX I0> TEMP +	DISPARO			
Execute test described in 1.7.8.6.3	MAX I0> TEMP +	NORMAL			
Execute test described in 1.7.8.6.3	MAX I0> INST -	ARRANQUE			
Execute test described in 1.7.8.6.3	MAX I0> INST -	NORMAL			
Execute test described in 1.7.8.6.3	MAX I0> TEMP -	DISPARO			
Execute test described in 1.7.8.6.3	MAX I0> TEMP -	NORMAL			

General comments	Global Result OK/NOK

1.7.5.4 *Digital Outputs*

Pre-Requisites:

- The RTU must have the LOCAL/REMOTE selector switch in REMOTE position
- The RTU must be configured with the signal addresses from the E-REDES normalized SCADA database.

Test:

- Execute on the control center (SCADA) the commands specified in the table below and verify if:
    - The RTU event log registers the command.
    - The corresponding action is executed by the RTU.

Command Description (SCADA)	**Expected Action**	**RTU EVT? (OK/NOK)**	**Action Executed? (OK/NOK)**
ABRIR OCR3	Recloser Opens		
FECHAR OCR3	Recloser Closes		
RECONFIGURACAO AUT E/S	ABR is activated		
RECONFIGURACAO AUT F/S	ABR is deactivated		
PROTECOES E/S	Protection is activated		
PROTECOES F/S	Protection is deactivated		
FUNCAO RELIGACAO E/S	Reclosing is activated		
FUNCAO RELIGACAO F/S	Reclosing is deactivated		
MODO FUNC DISJUNTOR	Recloser mode is activated		
MODO FUNC VT	Sectionalizer mode is activated		

General comments	**Global Result OK/NOK**

1.7.6 Specific Communication interface Module (CIM) - (When applicable)

1.7.6.1 *Modem IP acquisition*

The objective for this test is to make sure the modem correctly registers on the network using a SIM card provided by E-REDES.

Test Procedure	Expected Behaviour
1 – Insert the SIM card provided by E-REDES in the modem. 2 – Please write in the comments box what was the IP acquired by the modem.	1 – The modem must be able to obtain an IP within the expected range of IP. 2 – Take annotation of the IP in comment box below.

General comments	Global Result OK/NOK

1.7.6.2 *Network Loss*

The objective for this test is to make sure the modem automatically reacquires network connection after connection loss.

Pre-Requisites:

- The modem must be registered on the network.

Test Procedure	Expected Behaviour
1 – Simulate network connection loss (i.e. remove the antenna) 2 – Confirm network connection is lost. 3 – Reconnect the antenna.	1 – The modem loses connection after the antenna is removed. 2 – The modem reacquires connection when the antenna is reconnected.

General comments	Global Result OK/NOK

1.7.7 General Protection Module Requirements

CHARACTERISTICS		Section	Comments	Status
R102	**Protection Module** Shall be mounted in the CC for continuously supervising voltages and currents of the line.	as 3.6.2		
R103	**Protection Module** Self-test and diagnosis function	as 3.6.2		
R104	**Protection Module** The PM shall provide a watchdog function	as 3.6.2		
R105	**Protection Module** In case of failure the PM shall signalled to the control center	as 3.6.2		
R106	**Protection Module** It shall be possible to set, change and update the protection parameters (time and current thresholds and curves) locally via a laptop or remotely from the control center.	as 3.6.2		
R107	**Protection Module** Four protection profiles	as 3.6.3		
R108	**Protection Module** The profiles shall be selectable both locally and remotely.	as 3.6.3		
R109	**Protection Module** It shall be possible to shift between profiles automatically if pre-determined conditions are sensed (e.g. inversion in power flow)	as 3.6.3		
R110	**Protection Module** Each profile shall allow 8 independent Time-Current Curve specifications: • Four Phase Overcurrents • Four Ground Overcurrents	as 3.6.3		

CHARACTERISTICS		Section	Comments	Status
R111	Protection Module The Time-Current shall be selected from a library from database curves to permit implementation of any standard or modified curve	as 3.6.3		
R112	**Protection Module** At least the following Time-Current curves (conform IEC 60255) can be selected: • Definite time • Standard time (SI) • Very inverse (VI) • Extremely inverse (EI)	as 3.6.3		
R113	**Protection Module** Time-Curve Editor shall be available	as 3.6.3		
R114	**Protection Module** It shall be possible to have directionality added to the overcurrent protection functions both for phase-phase and phase-ground faults	as 3.6.3		
R115	**Protection Module** Inrush Restraint features	as 3.6.3		
R116	**Protection Module** Fault Location	as 3.6.3		
R117	**Protection Module** Reclose Retry	as 3.6.3		
R118	**Protection Module** Harmonic	as 3.6.3		
R119	**Protection Module** Histogram	as 3.6.3		
R120	**Protection Module** Alarm	as 3.6.3		

CHARACTERISTICS		Section	Comments	Status
R121	**Protection Module** Event Recorder	as 3.6.3		
R122	**Protection Module** Channels	as 3.6.4		
R123	**Protection Module** Scope of Oscillography	as 3.6.4		
R124	**Protection Module** Number of digital inputs – minimum number of 40 digital inputs	as 3.6.4		
R125	**Protection Module** Number of analog inputs – minimum number of 10 analog inputs	as 3.6.4		
R126	**Protection Module** Data Availability – The stored data must be available for local or remote	as 3.6.4		
R127	**Protection Module** Minimum Frequencies – 1kHz for analog inputs – 1kHz for digital inputs	as 3.6.4		
R128	**Protection Module** Recording Time	as 3.6.4		
R129	**Protection Module** Changing recording times	as 3.6.4		
R130	**Protection Module** Recording Capacity – The IED must have sufficient storage capacity to hold a minimum of 25 oscillograph records	as 3.6.4		
R131	**Protection Module** The oscillograph record must follow the FIFO (Fisrt In, First Out) data structure	as 3.6.4		
R132	**Protection Module** Environmental Requirements	as 3.6.5		

CHARACTERISTICS		Section	Comments	Status
R133	**Protection Module** Shall be fed by the battery backed PSM in the CC	as 3.6.6		
R134	**Protection Module** Type tests	as 3.6.7		

1.7.8 Specific Protection Module Requirements

1.7.8.1 *Analogue Inputs*

The following test is only applicable if different analogue inputs are used for the PM and the RTU, otherwise the test in 1.7.5.1 will suffice.

Test:

- With an external test set inject secondary values on the analogue inputs of the RTU corresponding to the following primary values:

	Va	Vb	Vc	Vr	Vs	Vt	Ia	Ib	Ic
Magnitude	25%Un (PG)	50%Un (PG)	75%Un (PG)	100%Un (PG)	75%Un (PG)	50%Un (PG)	10%In	100%In	200%In
Phase	0	-120	120	0	120	-120	180	60	300

- Register the Values Measured/Displayed on the RTU:

	Expected Value		Registered Value		OK/NOK	Comments
	Mag.	Phase	Mag	Phase		
Va	25%Un(PG)	0				
Vb	50%Un(PG)	-120				
Vc	75%Un(PG)	120				
Vr	100%Un(PG)	0				
Vs	75%Un(PG)	120				
Vt	50%Un(PG)	-120				
Ia	10%In	180				
Ib	100%In	60				
Ic	200%In	300				

General comments	Global Result OK/NOK

1.7.8.2 *Protection functions and Protection profiles*

The objective for this test is to validate the following:

- The PM has 4 protection profiles.
- Each protection profile has 8 independent time-current curve specification:
  - Four Phase Overcurrents.
  - Four Ground Overcurrents.
- The time curves can be set as:
  - Definite time.
  - Standard Inverse (SI).
  - Very Inverse (VI).
  - Extremely Inverse (EI).

1.7.8.3 *Protection profile 1*

Pre-Requisites:

- Define the settings for this protection profile as specified in the table below (OFF means the particular stage is switched off)

Stage	Characteristic	Directionality	Iop	t	TM
OC1	Def. Time	Non-Directional	100A	0,4s	
OC2	Def. Time	Non-Directional	200A	0,3s	
OC3	Def. Time	Non-Directional	300A	0,2	
OC4	Def. Time	Non-Directional	400A	0,1	
EF1	Def. Time	Non-Directional	40A	0,8s	
EF2	Def. Time	Non-Directional	60A	0,6s	
EF3	Def. Time	Non-Directional	80A	0,4s	
EF4	Def. Time	Non- Directional	100A	0,2s	

- Select Protection profile 1 on the FOM.

Test:

- With an external test set inject secondary fault currents on the PM in order to validate the primary settings. Register the results obtained in the table below:

Stage	Expected Iop [A]	Actual Iop [A]	Expected t [s]	Actual t [s]	OK/NOK
OC1	100A		0,4s		
OC2	200A		0,3s		
OC3	300A		0,2s		
OC4	400A		0,1s		
EF1	40A		0,8s		
EF2	60A		0,6s		
EF3	80A		0,4s		
EF4	100A		0,2s		

1.7.8.4 *Protection Profile 2*

Pre-Requisites:

- Define the settings for this protection profile as specified in the table below (OFF means the stage is switched off)

Stage	Characteristic	Directionality	Iop [A]	t [s]	TM
OC1	OFF				
OC2	Standard Inverse	Non-Directional	200A		0,4
OC3	OFF				
OC4	OFF				
EF1	OFF				
EF2	Standard Inverse	Non-Directional	200A		0,3
EF3	OFF				
EF4	OFF				

- Select Protection profile 2 on the FOM.

Test:

- With an external test set inject secondary currents on the PM to simulate the primary fault currents referenced in the table below. Register the trip times and check they comply with the expected values:

I fault	OC2		EF2		OK/NOK
	Expected t [s]	Actual t [s]	Expected t [s]	Actual t [s]	
250A	12,520s		9,390s		
300A	6,878s		5,158s		
400A	4,012s		3,090s		
500A	3,028s		2,271s		

1.7.8.5 *Protection Profile 3*

Pre-Requisites:

- Define the settings for this protection profile as specified in the table below (OFF means the stage is switched off).

Stage	Characteristic	Directionality	Iop [A]	t [s]	TM
OC1	OFF				
OC2	OFF				
OC3	Very Inverse	Non-Directional	200A		0,4
OC4	OFF				
EF1	OFF				
EF2	OFF				
EF3	Very Inverse	Non-Directional	200A		0,3
EF4	OFF				

- Select Protection profile 3 on the FOM.

Test:

- With an external test set inject secondary currents on the PM to simulate the primary fault currents referenced in the table below. Register the trip times and check they comply with the expected values:

I fault	OC3		EF3		OK/NOK
	Expected t [s]	Actual t [s]	Expected t [s]	Actual t [s]	
250A	21,6s		16,2s		
300A	10,8s		8,1s		
400A	5,4s		4,050s		
500A	3,6s		2,7s		

1.7.8.5.1 Protection Profile 4

Pre-Requisites:

- Define the settings for this protection profile as specified in the table below (OFF means the particular stage is switched off)

Stage	Characteristic	Directionality	Iop [A]	t [s]	TM
OC1	OFF				
OC2	OFF				
OC3	OFF				
OC4	Extremely Inverse	Non-Directional	200A		0,4
EF1	OFF				
EF2	OFF				
EF3	OFF				
EF4	Extremely Inverse	Non-Directional	200A		0,3

- Select Protection profile 4 on the FOM.

Test:

- With an external test set inject secondary currents on the PM to simulate the primary fault currents registered in the table below. Register the trip times and check they comply with the expected values:

I fault	OC4		EF4		OK/NOK
	Expected t [s]	Actual t [s]	Expected t [s]	Actual t [s]	
250A	56,889s		42,667s		
300A	25,6s		19,2s		
400A	10,667s		8s		
500A	6,095s		4,571s		

General comments	Global Result OK/NOK

1.7.8.6 *Directional Overcurrent*

The Objective for this test is to evaluate:

- Phase overcurrent Directional operating characteristic (I1 vs U1).
- Earth Fault overcurrent Directional operating characteristic (I0 vs U0).
- The correct signalling to the RTU and E-REDES control Center (SCADA) of the pickup(s) and trips(s) coming from the directional functions.

Pre-Requirements:

- Define the settings for protection profile 1 as specified in the table below (OFF means the stage is switched off).
- All other protection profiles must have all protection functions turned OFF.

Stage	Characteristic	Directionality	Iop [A]	t [s]	TM
OC1	Def. Time	Forward	100A	0,3s	
OC2	Def. Time	Reverse	200A	0,4s	
OC3					
OC4					
EF1	Def. Time	Forward	40A	0,6s	
EF2	Def. Time	Reverse	60A	0,8s	
EF3					
EF4					

1.7.8.6.1 Phase Overcurrent (OC) operating characteristic

Considering as reference that the normal (forward) power flow is $\cos(\varphi) \sim 1$. The forward and reverse directions for phase overcurrent are defined by the angle between I1 and U1 as depicted in Figure 2.

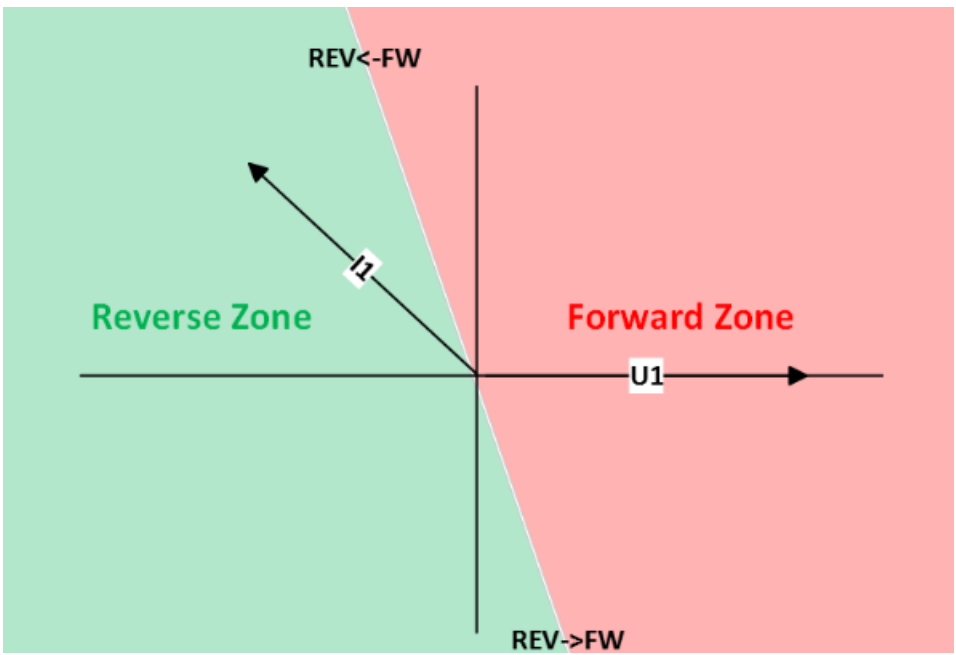


Figure 2 – Operating characteristic phase overcurrent REV<-FW and REV->FW mark the transition angles between forward and reverse.

Test:

- Using an external test set inject secondary current and voltages on the PM to determine what are the transition angles REV<-FW and REV->FW between the forward trip zone and reverse trip zone. Register the results below:

Zone Transition	Expected Angle	Actual Angle	OK/NOK
REV<-FW	90º		
REV->FW	270º		

1.7.8.6.2 Ground Overcurrent (EF) operating characteristic

Considering as reference that the normal (forward) power flow is $\cos(\varphi) \sim 1$. The forward and reverse directions for ground overcurrent are defined by the angle between I0 and U0 as depicted in Figure 3.

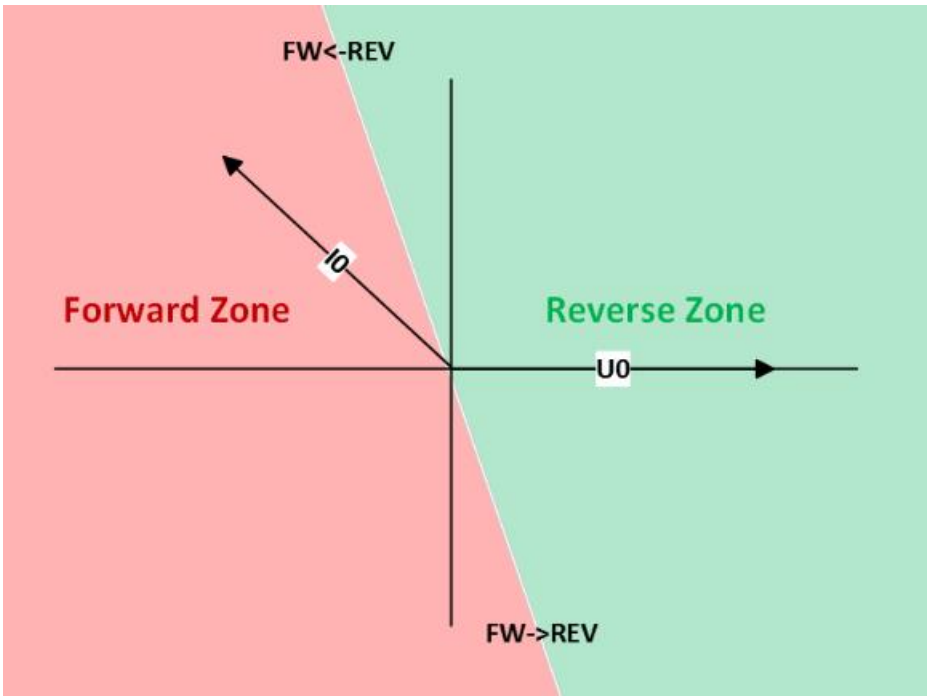


Figure 3 – Operating characteristic ground overcurrent FW<-REV and FW->REV mark the transition angles between forward and reverse.

Test:

- Using an external test set inject secondary current and voltages on the PM to determine what are the transition angles FW<-REV and FW->REV between the forward trip zone and reverse trip zone. Register the results below:

Zone Transition	Expected Angle	Actual Angle	OK/NOK
FW<-REV	100º		
FW->REV	280º		

1.7.8.6.3 Directional Pickup, Trip - SCADA Tests

Pre-Requisites:

- The RTU must be configured with the signal addresses from the E-REDES normalized SCADA database.

Test:

- Using an external test set inject the secondary values corresponding to primary values in the table below. Register the trip time and if the pickup ("ARRANQUE") and trip ("DISPARO") are signalled to the RTU, FOM, and E-REDES control center (SCADA).

	Va=Vr	Vb=Vs	Vc=Vt	Ia	Ib	Ic	Trip Time (expected)	Trip Time(actual)	Signals (SCADA)
OC FW Trip (phA-B)	50%Un 0º	50%Un -120º	100%Un 120º	150A 0º	150A -120º	50A 120º	0,3s		"MAX I> INST +" "ARRANQUE" "MAX I> TEMP+" "DISPARO"
OC FW Trip (phB-C)	100%Un 0º	50%Un -120º	50%Un 120º	50A 0º	150A -120º	150A 120º	0,3s		"MAX I> INST +" "ARRANQUE" "MAX I> TEMP+" "DISPARO"
OC FW Trip (3ph)	50%	50%	50%	150A	150A	150A	0,3s		"MAX I> INST +" "ARRANQUE" "MAX I> TEMP+" "DISPARO"
OC REV Trip (phA-B)	50%Un 0º	50%Un -120º	100%Un 120º	300A 180º	300A 60	50A 300º	0,4s		"MAX I> INST -" "ARRANQUE" "MAX I> TEMP-" "DISPARO"
OC REV Trip (phB-C)	100%Un 0º	50%Un -120º	50%Un 120º	50A 180º	300A 60º	300A 300º	0,4s		"MAX I> INST -" "ARRANQUE" "MAX I> TEMP-" "DISPARO"
OC REV Trip (3ph)	50%Un 0º	50%Un -120º	50%Un 120º	300A 180º	300A 60º	300A 300º	0,4s		"MAX I> INST -" "ARRANQUE" "MAX I> TEMP-" "DISPARO"
EF FW Trip (phA-N)	50%Un 0º	100%Un -120º	100%Un 120º	50A 0º	0A -120º	0A 120º	0,6s		"MAX I0> INST +" "ARRANQUE" "MAX I0> TEMP +" "DISPARO"

	Va=Vr	Vb=Vs	Vc=Vt	Ia	Ib	Ic	Trip Time (expected)	Trip Time(actual)	Signals (SCADA)
OC FW Trip (phB-N)	100%Un 0º	50%Un -120º	100%Un 120º	0A 0º	50A -120º	0A 120º	0,6s		"MAX I0> INST +" "ARRANQUE" "MAX I0> TEMP +" "DISPARO"
OC FW Trip (phC-N)	100%Un 0º	100%Un -120º	50%Un 120º	0A 0º	0A -120º	50A 120º	0,6s		"MAX I0> INST +" "ARRANQUE" "MAX I0> TEMP +" "DISPARO"
OC REV Trip (phA-N)	50%Un 0º	100%Un -120º	100%Un 120º	70A 180º	0A 60	0A 300º	0,8s		"MAX I0> INST -" "ARRANQUE" "MAX I0> TEMP -" "DISPARO"
OC REV Trip (phB-N)	100%Un 0º	50%Un -120º	100%Un 120º	0A 180º	70A 60º	0A 300º	0,8s		"MAX I0> INST -" "ARRANQUE" "MAX I0> TEMP -" "DISPARO"
OC REV Trip (phC-N)	100%Un 0º	100%Un -120º	50%Un 120º	0A 180º	0A 60º	70A 300º	0,8s		"MAX I0> INST -" "ARRANQUE" "MAX I0> TEMP -" "DISPARO"

General comments	Global Result OK/NOK

Final PowerFlow Validation:

CHARACTERISTICS		Section	Comments	Status
R98	Software Functional Requirements Power flow direction feature	as 4.2.4		

1.7.8.7 *Fault Locator*

The objective for this test is to evaluate if:

- For any given type of fault an R and X impedance values for the fault are calculated
- The R and X values are sent from the PM to the RTU and E-REDES Control Center (SCADA)

Pre-Requisites:

- Define the settings for protection profile 1 as specified in the table below (OFF means the stage is switched off).

Stage	Characteristic	Directionality	Iop [A]	t [s]	TM
OC1	Def. Time	Forward	100A	0,3s	
OC2	Def. Time	Reverse	200A	0,4s	
OC3					
OC4					
EF1	Def. Time	Forward	40A	0,6s	
EF2	Def. Time	Reverse	60A	0,8s	
EF3					
EF4					

- All other protection profiles must have all protection functions turned OFF.
- The RTU must be configured with the signal addresses from the E-REDES normalized SCADA database.
- For impedance calculation the protection must be configured with the following line parameters:

Line Parameter	Setting
Length	100km
Xd	28,9778 ohm
Rd	7,7646 ohm
Xh	115,9111 ohm
Rh	31,0583 ohm
Zd	30 ohm

Line Parameter	Setting
Zd angle	75º
Zh	120 ohm
Zh angle	75º
RE/RL	1
XE/XL	1
K0	1
arg(k0)	0,000

- The test is specified for a protection system that uses the following formulas to calculate the impedance:

Fault Type	Impedance Equation
A-Ground	$Va/(Ia + k_0 3I_0)$
B-Ground	$Vb/(Ib + k_0 3I_0)$
C-Ground	$Vc/(Ic + k_0 3I_0)$
A-B or A-B-Ground	V_{ab}/I_{ab}
B-C or B-C-Ground	V_{bc}/I_{bc}
C-A or C-A-Ground	V_{ca}/I_{ca}
A-B-C	$V_{ab}/I_{ab} \Leftrightarrow V_{bc}/I_{bc} \Leftrightarrow V_{ca}/I_{ca}$

Test

- Using an external test set inject the secondary values corresponding to primary values in the table below
- Confirm if the impedance value (R and X) obtained is in accordance to the expected value.

	Va=Vr	Vb=Vs	Vc=Vt	Ia	Ib	Ic	Expected Impedance		Obtained Impedance	
							R	X	R	X
OC FW Trip (A-B)	70%Un(PG) -15º	70%Un(PG) -105º	100%Un(PG) 120º	150A 0º	150A -180º	0A 0º	0.286% Un(PG)	0.165% Un(PG)		
OC FW Trip (B-C)	100%Un(PG) 105º	70%Un(PG) -30º	70%Un(PG) -120º	0A 0º	150A 0º	150A 180º	0.319% Un(PG)	0.085% Un(PG)		
OC FW Trip (C-A)	70%Un(PG) -90º	100%Un(PG) 135º	70%Un(PG) 0º	150A -180º	0A 0º	150A 0º	0.233% Un(PG)	0.233% Un(PG)		
OC FW Trip (3ph)	70%Un(PG) 10º	70%Un(PG) -110º	70%Un(PG) 130º	150A 0º	150A -120º	150A 120º	0.460% Un(PG)	0.081% Un(PG)		
OC REV Trip (A-B)	70%Un(PG) 165º	70%Un(PG) 75º	100%Un(PG) -60º	300A 0º	300A -180º	0A 0º	-0.143% Un(PG)	-0.082% Un(PG)		
OC REV Trip (B-C)	100%Un(PG) -75º	70%Un(PG) 150º	70%Un(PG) 60º	0A 0º	300A 0º	300A 180º	-0.159% Un(PG)	-0.043% Un(PG)		
OC FW Trip (C-A)	70%Un(PG) -90º	100%Un(PG) -45º	70%Un(PG) 180º	300A 180º	0A 0º	300A 0º	-0.117% Un(PG)	-0.117% Un(PG)		
OC REV Trip (3ph)	70%Un(PG) -170º	70%Un(PG) -70º	70%Un(PG) -50º	300A 0º	300A -120º	300A 120º	-0.230% Un(PG)	-0.041% Un(PG)		
EF FW Trip (A-N)	70%Un(PG) 10º	100%Un -110º	100%Un 130º	50A 0º	0A 0º	0A 0º	0.345% Un(PG)	0.061% Un(PG)		
OC FW Trip (B-N)	100%Un 150º	70%Un 30º	100%Un -90º	0A 0º	50A 0º	0A 0º	0.303% Un(PG)	0.175% Un(PG)		
OC FW Trip (C-N)	100%Un -75º	100%Un 165º	70%Un 45º	0A 0º	0A 0º	50A 0º	0.247% Un(PG)	0.247% Un(PG)		

	Va=Vr	Vb=Vs	Vc=Vt	Ia	Ib	Ic	Expected Impedance		Obtained Impedance	
							R	X	R	X
OC REV Trip (A-N)	70%Un(PG) -135º	100%Un 105º	100%Un -15º	70A 0º	0A 0º	0A 0º	-0.177% Un(PG)	-0.177% Un(PG)		
OC REV Trip (B-N)	100%Un -30º	70%Un -150º	100%Un 90º	0A 0º	70A 0º	0A 0º	-0.217% Un(PG)	-0.125% Un(PG)		
OC REV Trip (C-N)	100%Un 70º	100%Un -50º	70%Un -\70º	0A 0º	0A 0º	70A 0º	-0.246% Un(PG)	-0.043% Un(PG)		

General comments	Global Result OK/NOK

1.7.9 Interlocks

1.7.9.1 *LOCAL/REMOTE Selector*

The objective for this test is to evaluate that when the LOCAL/REMOTE selector is in the “LOCAL” position all remote commands sent from the E-REDES control center are blocked.

Pre-Requisites:

- The RTU must be configured with the signal addresses from the E-REDES normalized SCADA database.
- The LOCAL/REMOTE selector must be in “LOCAL” position

Test:

- Comply with the pre-conditions in the first column of the table below and execute the SCADA command indicated in the second column, check for each situation that the command is not executed.

Pre-Conditions	Control Center Command (SCADA)	Command Executed? (YES/NO)
OCR3 IS CLOSED	ABRIR OCR3	
OCR3 IS OPEN	FECHAR OCR3	
OCR3 IS OPEN ABR IS OFF	RECONFIGURACAO AUT E/S	
OCR3 IS OPEN ABR IS ON	RECONFIGURACAO AUT F/S	
PROTECTION IS OFF	PROTECOES E/S	
PROTECTION IS ON	PROTECOES F/S	
RECLOSING IS OFF	FUNCAO RELIGACAO E/S	
RECLOSING IS ON	FUNCAO RELIGACAO F/S	
OCR3 IN RECLOSER MODE	MODO FUNC DISJUNTOR	
OCR3 IN SECTIONALIZER MODE	MODO FUNC VT	

General comments	Global Result OK/NOK

1.7.9.2 *Manual Open Recloser Handle*

The objective for this test is to evaluate that when the Recloser Handle is pulled on the recloser it won't close when commands are issued in FOM or in E-REDES control center (SCADA).

Pre-Requisites:

- The RTU must be configured with the signal addresses from the E-REDES normalized SCADA database.
- The recloser must be connected to the control cabinet.
- The LOCAL/REMOTE selector switch must be in REMOTE.

Test Procedure	Expected Behaviour
1 – Pull the handle on the recloser. 2 – Issue a close command from the FOM. 3- Issue a close command from E-REDES control-center (SCADA).	1 – When the handle is pulled the OCR3 opens. 2 – When a command is issued from the FOM OCR3 does not close. 3 – When a command is issued from SCADA OCR3 does not close.

General comments	Global Result OK/NOK

1.7.9.3 *ABR with open position*

The objective for this test is to evaluate that the ABR can only be turned on with the OCR3 open

Pre-Requisites:

- The RTU must be configured with the signal addresses from the E-REDES normalized SCADA database.
- The LOCAL/REMOTE selector switch must be in REMOTE.
- The OCR3 must be in OPEN position at the start of the test.

Test Procedure	Expected Behaviour
1 – Issue a command to activate ABR from SCADA "RECONFIGURACAO AUT E/S". 2 – Issue a close command to the OCR from SCADA or locally. 3- Issue a command to activate ABR from SCADA "RECONFIGURACAO AUT E/S".	1 – When the command is given the ABR turns on "RECONFIGURACAO AUTOMATICA" "EM SERVIÇO" 2 – When the OCR3 is closed ABR turns OFF "RECONFIGURACAO AUTOMATICA" "FORA SERVIÇO". 3 – When the second ABR ON command is given ABR stays OFF.

General comments	Global Result OK/NOK

1.8 Automatic Functions

Pre-Requisites:

- The RTU must be configured with the signal addresses from the E-REDES normalized SCADA database.
- Define the settings for protection as specified in the table below.

Stage	Characteristic	Directionality	Iop [A]	t [s]	TM
OC1	Def. Time	Forward	100A	0,3s	
OC2	Def. Time	Reverse	200A	0,4s	
OC3					
OC4					
EF1	Def. Time	Forward	40A	0,6s	
EF2	Def. Time	Reverse	60A	0,8s	
EF3					
EF4					

Note: In these tests it is assumed that the circuit breakers that exist on both sides of the OCR3 (upstream and downstream) have the same reclosing time cycles configuration as the OCR3.

1.8.1 Recloser

In this section there are a set of tests to check the behaviour of the equipment when in Recloser mode on certain conditions as described. These tests must be executed for the 4 fault types EF+, EF-, OC+, OC-.

Pre-Requisites:

- Define the settings for the recloser as specified in the table below.

Setting	Value [Unit]
Reclosing time (1st cycle)	300ms
Reclosing time (2nd cycle)	15s
Reclosing time (3nd cycle)	30s
Lock out timer	60s

1.8.1.1 *Single Trip to lock out*

Test description	Expected behaviour
1.Both Circuit Breaker and OCR3-1 are closed. 2.OCR3-1 has the autorecloser set to off. 3.Current and voltage are set to normal. 4.Downstream of the OCR3-1 a fault appears. 5.OCR3-1 opens to lock out. 6.Voltage-1 remains present for 1 minute and OCR3-1 does not close.	• When the fault appears the OCR3-1 picks up the fault and opens. • It stays open since the automatic reclosing is off.

Illustration (OCR3 in red is the test element).

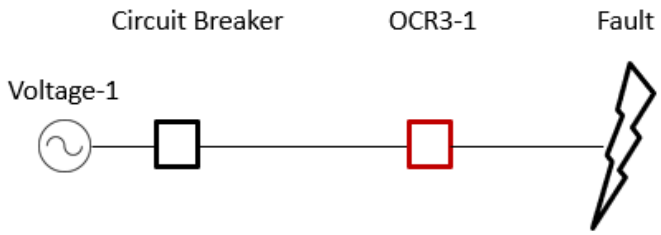


Figure 4

	OK/NOK			
Notes	**EF+**	**OC+**	**EF-**	**OC-**

1.8.1.2 *Autorecloser sequence*

Test description	Expected behaviour
1.Both Circuit Breaker and OCR3-1 are closed. 2.OCR-1 has the autorecloser set to on. 3.Current and voltage are set to normal. 4.Downstream of the OCR3-1 a fault is set. 5.OCR3-1 opens. On 300ms closes. Fault is still present. 6.OCR3-1 opens on 15s closes. Fault is still present. 7.OCR3-1 opens on 30s closes. Fault is still present. 8.OCR3-1 opens. Voltage-1 remains present for 1 minute more and OCR3-1 does not close.	• When the fault appears the OCR3-1 picks up the fault and opens. • It is signaled “RELIGACAO CICLO” “EM CURSO” to the RTU and control center. • After 300ms the OCR3-1 closes (1st cycle). • It is signaled “RELIGACAO CICLO” “FIM” to the RTU and control center. • Since fault is still present it opens again. • It is signaled “RELIGACAO CICLO” “EM CURSO” to the RTU and control center. • After 15s the OCR3-1 closes (2nd cycle). • It is signaled “RELIGACAO CICLO” “FIM” to the RTU and control center. • Since fault is still present it opens again. • It is signaled “RELIGACAO CICLO” “EM CURSO” to the RTU and control center. • After 30s the OCR3-1 closes (3rd cycle). • It is signaled “RELIGACAO CICLO” “FIM” to the RTU and control center. • Since fault is still present it opens to lockout. • It is signalled “FUNCAO RELIGACAO” “BLOQUEADO”.

Illustration (OCR3 in red is the test element)

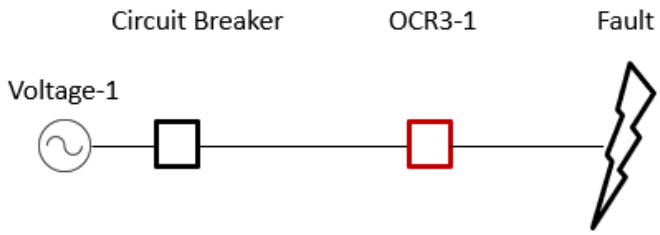


Figure 5

	OK/NOK			
Notes	**EF+**	**OC+**	**EF-**	**OC-**

1.8.1.3 *Incomplete autorecloser sequence*

Test description	Expected behaviour
1.Both Circuit Breaker and OCR3-1 are closed. 2.OCR3-1 has the autorecloser set to on. 3.Current and voltage are set to normal. 4.Downstream of the OCR3-1 a fault is set. 5.OCR3-1 opens. On 300ms closes. Fault is cleared. 6.After 30s the same fault appears. 7.OCR3-1 opens. Fault is cleared. 8.On 15s OCR3-1 closes and no fault is detected. 9.After 65s, fault is again set downstream of the OCR3-1. 10.OCR3-1 opens. On 300ms closes. Fault is cleared.	• When the fault appears the OCR3-1 picks up the fault (overcurrent or earth fault) and opens. • It is signaled “RELIGACAO CICLO” “EM CURSO” to the RTU and control center. • After 300ms the OCR3-1 closes (1st cycle). • It is signaled “RELIGACAO CICLO” “FIM” to the RTU and control center. • After 30s which is during OCR3-1 lock out timer, the fault reappears. • It is signaled “RELIGACAO CICLO” “EM CURSO” to the RTU and control center. • After 15s the OCR3-1 closes (2nd cycle). • It is signaled “RELIGACAO CICLO” “FIM” to the RTU and control center. • After 65s in which OCR3-1 lock out timer has expired, the fault reappears. • It is signaled “RELIGACAO CICLO” “EM CURSO” to the RTU and control center. • After 300ms the OCR3-1 closes (1st cycle). OCR3-1 performs its 1st reclosing cycle since the autorecloser sequence was reseted. • It is signaled “RELIGACAO CICLO” “FIM” to the RTU and control center.

Illustration (OCR3 in red is the test element)

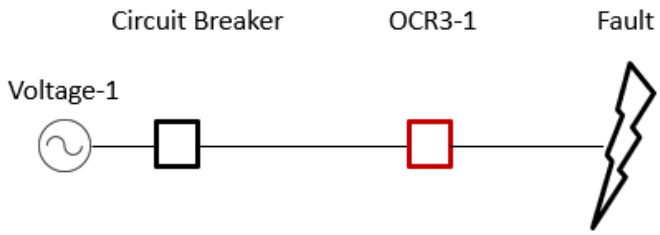


Figure 6

	OK/NOK			
Notes	**EF+**	**OC+**	**EF-**	**OC-**

1.8.1.4 *Autorecloser sequence interrupted by lack of voltage nº1*

Test description	Expected behaviour
1.Both Circuit Breaker and OCR3-1 are closed. 2.OCR-1 has the autorecloser set to on. 3.Current and voltage are set to normal. 4.Downstream of the OCR3-1 a fault is set. 5.OCR3-1 opens. 6.Voltage-1 is removed from the source. (Circuit breaker opens) 7.On 300ms OCR3-1 does not close.	• When the fault appears the OCR3-1 picks up the fault and opens. • It is signaled “RELIGACAO CICLO” “EM CURSO” to the RTU and control center. • Despite the automatic reclosing is set on the OCR3-1, it does not close during its 1st reclosing cycle since it there is no voltage on both sides. • There is no further signal change.

Illustration (OCR3 in red is the test element)

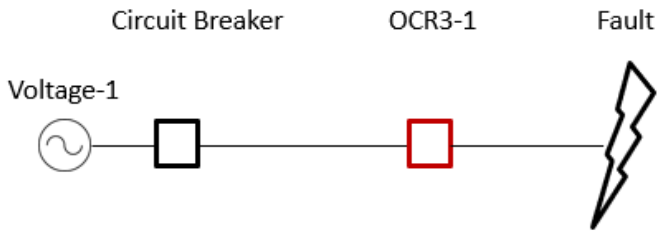


Figure 7

	OK/NOK			
Notes	**EF+**	**OC+**	**EF-**	**OC-**

1.8.1.5 *Autorecloser sequence interrupted by lack of voltage nº2*

Test description	Expected behaviour
1.Both Circuit Breaker and OCR3-1 are closed. 2.OCR3-1 has the autorecloser set to on. 3.Current and voltage are set to normal. 4.Downstream of the OCR3-1 a fault is set. 5.OCR3-1 opens. On 300ms closes. Fault is still present and it opens again. 6.Voltage-1 is removed from the source. (Circuit Breaker-1 opens)	• When the fault appears the OCR3-1 picks up the fault and opens. • It is signaled “RELIGACAO CICLO” “EM CURSO” to the RTU and control center. • After 300ms the OCR3-1 closes (1st cycle). • It is signaled “RELIGACAO CICLO” “FIM” to the RTU and control center. • Since fault is still present it opens again. • It is signaled “RELIGACAO CICLO” “EM CURSO” to the RTU and control center • Despite the automatic reclosing is set to on, OCR3-1 does not close during its 2nd reclosing cycle since it there is no voltage on both sides after 15s.

Illustration (OCR3 in red is the test element)

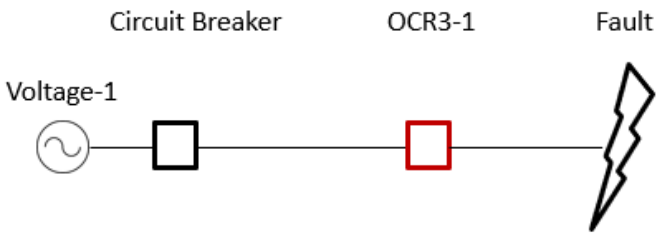


Figure 9

	OK/NOK			
Notes	**EF+**	**OC+**	**EF-**	**OC-**

1.8.1.6 *Autorecloser sequence interrupted by lack of voltage nº3*

Test description	Expected behaviour
1.Both Circuit Breaker and OCR3-1 are closed. 2.OCR3-1 has the autorecloser set to on. 3.Current and voltage are set to normal. 4.Downstream of the OCR3-1 a fault is set. 5.OCR3-1 opens. On 300ms closes. Fault is still present and it opens again. 6.On 15s OCR3-1 closes. Fault is still present and it opens again. 7.Voltage-1 is removed from the source. (Circuit breaker opens) 8.On 30s OCR3-1 does not close.	• When the fault appears the OCR3-1 picks up the fault and opens. • It is signaled “RELIGACAO CICLO” “EM CURSO” to the RTU and control center. • After 300ms the OCR3-1 closes (1st cycle). • It is signaled “RELIGACAO CICLO” “FIM” to the RTU and control center. • Since fault is still present it opens again. • It is signaled “RELIGACAO CICLO” “EM CURSO” to the RTU and control center. • After 15s the OCR3-1 closes (2nd cycle). • It is signaled “RELIGACAO CICLO” “FIM” to the RTU and control center. • Since fault is still present it opens again. • It is signaled “RELIGACAO CICLO” “EM CURSO” to the RTU and control center, • Despite the automatic reclosing is set to on the OCR3-1 does not close during its 3rd reclosing cycle since it there is no voltage on both sides.

Illustration (OCR3 in red is the test element)

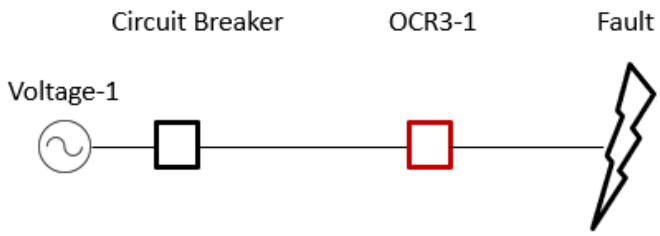


Figure 10

	OK/NOK			
Notes	**EF+**	**OC+**	**EF-**	**OC-**

1.8.1.7 *Autorecloser sequence interrupted by voltage in both ends nº1*

Test description	Expected behaviour
1.Both Circuit Breaker-1 and OCR3-1 are closed. 2.OCR3-1 has the autorecloser set to on. 3.Current and voltage-1 are set to normal. 4.Downstream of the OCR3-1 a fault is set. 5.OCR3-1 opens. Fault is cleared. 6.An additional source is set on the other end of the circuit as Circuit Breaker-2 closes. (Voltage-2) OCR3-1 detect voltage on both ends. 7.On 300ms OCR3-1 does not close.	• When the fault appears the OCR3-1 picks up the fault and opens and the fault disappears. • It is signaled “RELIGACAO CICLO” “EM CURSO” to the RTU and control center. • When OCR3-1 is performing its 1st automatic reclosing cycle it does not close since it detects voltage in both its ends.

Illustration (OCR3 in red is the test element)

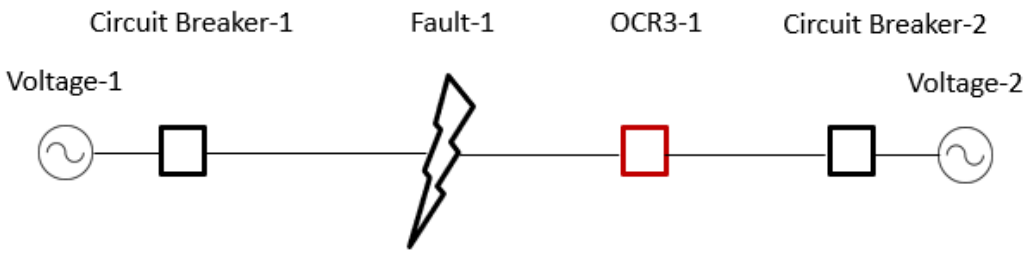


Figure 11

	OK/NOK			
Notes	**EF+**	**OC+**	**EF-**	**OC-**

1.8.1.8 *Autorecloser sequence interrupted by voltage in both ends nº2*

Test description	Expected behaviour
1.Both Circuit Breaker-1 and OCR3-1 are closed. 2.OCR3-1 has the autorecloser set to on. 3.Current and voltage-1 are set to normal. 4.Downstream of the OCR3-1 a fault is set. 5.OCR3-1 opens. On 300ms closes. Fault is still present, and it opens again. 6.Fault is cleared. 7.An additional source (voltage-2) is set on the other end of the circuit as Circuit Breaker-2 closes. OCR3-1 detect voltage on both ends. 8.On 15s OCR3-1 does not close.	• When the fault appears the OCR3-1 picks up the fault and opens. • It is signaled “RELIGACAO CICLO” “EM CURSO” to the RTU and control center. • After 300ms the OCR3-1 closes (1st cycle). • It is signaled “RELIGACAO CICLO” “FIM” to the RTU and control center. • Since fault is still present it opens again. • It is signaled “RELIGACAO CICLO” “EM CURSO” to the RTU and control center. • When OCR3-1 is performing its 2nd automatic reclosing cycle it does not close since it detects voltage in both its ends.

Illustration (OCR3 in red is the test element)

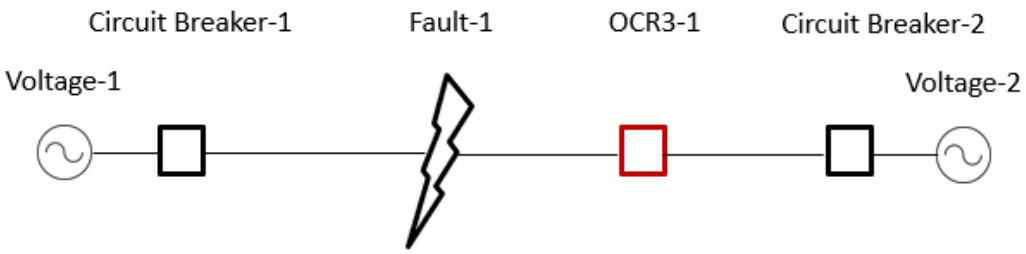


Figure 12

	OK/NOK			
Notes	**EF+**	**OC+**	**EF-**	**OC-**

1.8.1.9 *Autorecloser sequence interrupted by voltage in both ends nº3*

Test description	Expected behaviour
1.Both Circuit Breaker and OCR3-1 are closed. 2.OCR3-1 has the autorecloser set to on. 3.Current and voltage-1 are set to normal. 4.Downstream of the OCR3-1 a fault is set. 5.OCR3-1 opens. On 300ms closes. Fault is still present and it opens again. 6.On 15s OCR3-1 closes. Fault is still present and it opens again. 7.Fault is cleared. 8.An additional source (voltage-2) is set on the other end of the circuit as Circuit Breaker-2 closes and OCR3-1 detect voltage on both ends. 9.On 30s OCR3-1 does not close.	• When the fault appears the OCR3-1 picks up the fault and opens. • It is signaled “RELIGACAO CICLO” “EM CURSO” to the RTU and control center. • After 300ms the OCR3-1 closes (1st cycle). • It is signaled “RELIGACAO CICLO” “FIM” to the RTU and control center. • Since fault is still present it opens again. • It is signaled “RELIGACAO CICLO” “EM CURSO” to the RTU and control center. • After 15s the OCR3-1 closes (2nd cycle). • It is signaled “RELIGACAO CICLO” “FIM” to the RTU and control center. • Since fault is still present it opens again. • It is signaled “RELIGACAO CICLO” “EM CURSO” to the RTU and control center. • When OCR3-1 is performing its 3rd automatic reclosing cycle it does not close since it detects voltage in both its ends.

Illustration (OCR3 in red is the test element)

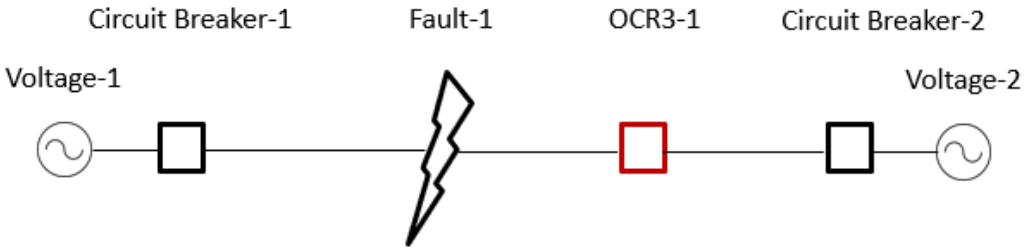


Figure 13

	OK/NOK			
Notes	**EF+**	**OC+**	**EF-**	**OC-**

1.8.1.10 *Autorecloser set to off during an autorecloser sequence nº1*

Test description	Expected behaviour
1.Both Circuit Breaker and OCR3-1 are closed. 2.OCR3-1 has the autorecloser set to on. 3.Current and voltage are set to normal. 4.Downstream of the OCR3-1 a fault is set. 5.OCR3-1 opens. On 300ms closes. Fault is still present, and it opens again. 6.In less than 15s the OCR3-1 autorecloser is set to off by an operator locally or remotely. OCR3-1 interrupts its reclosing cycle. 7.Voltage-1 remains present for 1 minute more and OCR3-1 does not close.	• When the fault appears the OCR3-1 picks up the fault and opens. • It is signaled “RELIGACAO CICLO” “EM CURSO” to the RTU and control center. • After 300ms the OCR3-1 closes (1st cycle). • It is signaled “RELIGACAO CICLO” “FIM” to the RTU and control center. • Since fault is still present it opens again. • It is signaled “RELIGACAO CICLO” “EM CURSO” to the RTU and control center. • As an operator locally or remotely sets autorecloser to off (command “FUNCAO RELIGACAO F/S”). OCR3-1 interrupts its reclosing cycle and does not attempt to close. • It is signalled “FUNCAO RELIGACAO” “FORA DE SERVIÇO” to the RTU and control cabinet.

Illustration (OCR3 in red is the test element)

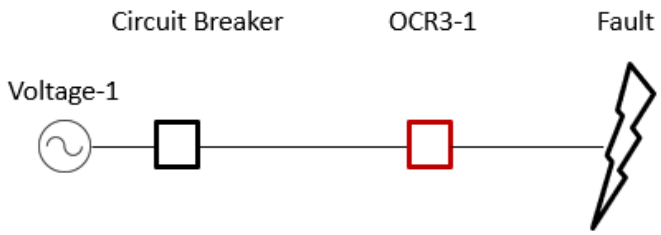


Figure 14

	OK/NOK			
Notes	**EF+**	**OC+**	**EF-**	**OC-**

1.8.1.11 *Autorecloser set to off during an autorecloser sequence nº2*

Test description	Expected behaviour
1.Both Circuit Breaker and OCR3-1 are closed. 2.OCR3-1 has the autorecloser set to on. 3.Current and voltage are set to normal. 4.Downstream of the OCR3-1 a fault is set. 5.OCR3-1 opens. On 300ms closes. Fault is still present, and it opens again. 6.On 15s OCR3-1 closes. Fault is still present, and it opens again. 7.In less than 30s the OCR1-3 autorecloser is set to off by an operator locally or remotely. OCR3-1 interrupts its reclosing cycle. 8.Voltage-1 remains present for 1 minute more and OCR3-1 does not close.	• When the fault appears the OCR3-1 picks up the fault and opens. • It is signaled “RELIGACAO CICLO” “EM CURSO” to the RTU and control center. • After 300ms the OCR3-1 closes (1st cycle). • It is signaled “RELIGACAO CICLO” “FIM” to the RTU and control center. • Since fault is still present it opens again. • It is signaled “RELIGACAO CICLO” “EM CURSO” to the RTU and control center. • After 15s the OCR3-1 closes (2nd cycle). • It is signaled “RELIGACAO CICLO” “FIM” to the RTU and control center. • Since fault is still present it opens again. • It is signaled “RELIGACAO CICLO” “EM CURSO” to the RTU and control center. • As an operator locally or remotely sets to off its autorecloser sequence (command “FUNCAO RELIGACAO F/S”). OCR3-1 interrupts its reclosing cycle and does not attempt to close. • It is signalled “FUNCAO RELIGACAO” “FORA DE SERVIÇO” to the RTU and control cabinet.

Illustration (OCR3 in red is the test element)

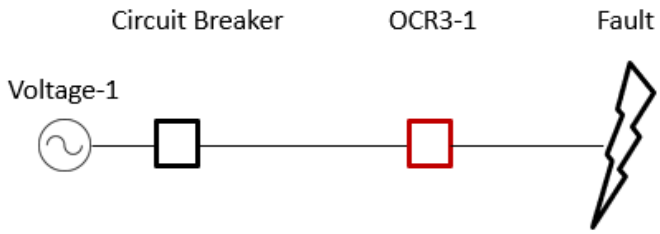


Figure 15

	OK/NOK			
Notes	**EF+**	**OC+**	**EF-**	**OC-**

1.8.1.12 *Autorecloser sequence reset by manual order*

Test description	Expected behaviour
1.Both Circuit Breaker and OCR3-1 are closed. 2.OCR3-1 has the autorecloser set to on. 3.Current and voltage are set to normal. 4.Downstream of the OCR3-1 a fault is set. 5.OCR3-1 opens. On 300ms closes. Fault is still present, and it opens again. Fault is cleared. 6.In less than 15s an operator from the dispatch center or an operator locally gives a closing order to the OCR3-1. OCR3-1 closes. 7.After 30s fault reapers. OCR3-1 opens. On 300ms closes.	• When the fault appears the OCR3-1 picks up the fault and opens. • It is signaled “RELIGACAO CICLO” “EM CURSO” to the RTU and control center. • After 300ms the OCR3-1 closes (1st cycle). • It is signaled “RELIGACAO CICLO” “FIM” to the RTU and control center. • Since fault is still present it opens again. • It is signaled “RELIGACAO CICLO” “EM CURSO” to the RTU and control center. • When OCR3-1 is performing its 2nd automatic reclosing cycles an operator locally or remotely issues an order to close the OCR3-1 (command “FECHAR OCR3”). OCR3-1 closes. • Since the closing order was set by an operator, the OCR3-1 autorecloser sequence was reset. • When 30s later the fault reapers, OCR3-1 performs its 1st reclosing cycle.

Illustration (OCR3 in red is the test element)

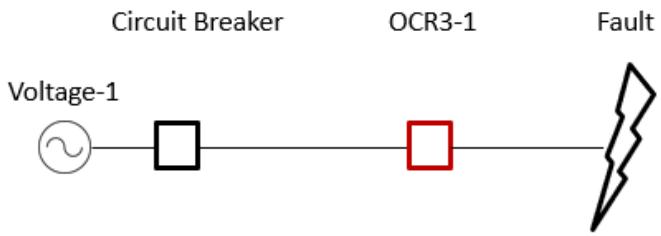


Figure 16

	OK/NOK			
Notes	**EF+**	**OC+**	**EF-**	**OC-**

1.8.1.13 *Autorecloser sequence interrupted by manual order*

Test description	Expected behaviour
1.Both Circuit Breaker and OCR3-1 are closed. 2.OCR3-1 has the autorecloser set to on. 3.Current and voltage are set to normal. 4.Downstream of the OCR3-1 a fault is set. 5.OCR3-1 opens. On 300ms closes. Fault is still present, and it opens again. 6.Fault is cleared. 7.On 15s OCR3 closes and no fault is detected. 8.In less than 60s an operator from the dispatch center or an operator locally gives an opening order. OCR3 opens. 9.After 35s, despite OCR3 detects tension from voltage-1, it stays open.	• When the fault appears the OCR3-1 picks up the fault and opens. • It is signaled “RELIGACAO CICLO” “EM CURSO” to the RTU and control center. • After 300ms the OCR3-1 closes (1st cycle). • It is signaled “RELIGACAO CICLO” “FIM” to the RTU and control center. • Since fault is still present it opens again. • It is signaled “RELIGACAO CICLO” “EM CURSO” to the RTU and control center. • After 15s the OCR3-1 closes (2nd cycle). • It is signaled “RELIGACAO CICLO” “FIM” to the RTU and control center. • Within 60s and during OCR3-1 lock out timer, an operator locally or remotely issues an order (command “ABRIR OCR3”) to open the OCR3-1. OCR3-1 opens. • It is signaled “FUNCAO RELIGACAO CICLO” “BLOQUEADO” to the RTU and control center. • Since the opening order was set by an operator the OCR3-1 autorecloser sequence was interrupted and 35s after, it did not try to close again despite detecting voltage from voltage-1.

Illustration (OCR3 in red is the test element)

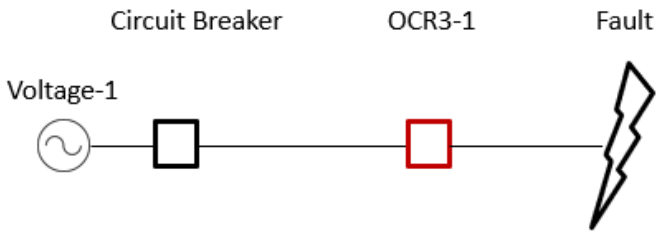


Figure 17

	OK/NOK			
Notes	**EF+**	**OC+**	**EF-**	**OC-**

1.8.1.14 *Autorecloser sequence interrupted by manual order SOTF*

Test description	Expected behaviour
1.Both Circuit Breaker and OCR3-1 are closed. 2.OCR3-1 has the autorecloser set to on. 3.Current and voltage are set to normal. 4.Downstream of the OCR3-1 a fault is set. 5.OCR3-1 opens. On 300ms closes. Fault is still present, and it opens again. 6.In less than 15s an operator from the dispatch center or an operator locally gives a closing order to the OCR3-1. OCR3-1 closes. 7.As fault is still present OCR3-1 opens to lock out. 8.After 35s, despite OCR3 detects tension from voltage-1, it stays open.	• When the fault appears the OCR3-1 picks up the fault and opens. • It is signaled “RELIGACAO CICLO” “EM CURSO” to the RTU and control center. • After 300ms the OCR3-1 closes (1st cycle). • It is signaled “RELIGACAO CICLO” “FIM” to the RTU and control center. • Since fault is still present it opens again. • It is signaled “RELIGACAO CICLO” “EM CURSO” to the RTU and control center. • When OCR3-1 is performing its 2nd automatic reclosing cycles an operator locally or remotely issues an order to close OCR3-1 (command “FECHAR OCR3”). OCR3-1 closes. • Since fault is still present it opens again (SOTF). • It is signaled “FUNCAO RELIGACAO CICLO” “BLOQUEADO” to the RTU and control center. • Since the closing order was set by an operator and on to a fault, OCR3-1 autorecloser sequence was interrupted and 35s after the closing attempt it did not try to close again despite detecting voltage from voltage-1.

Illustration (OCR3 in red is the test element)

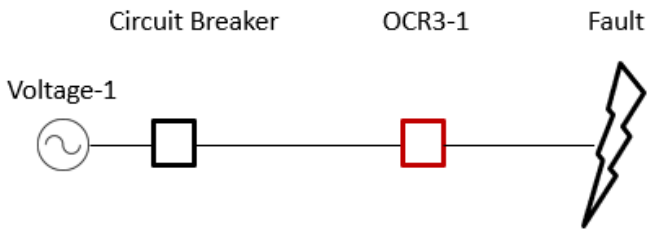


Figure 18

	OK/NOK			
Notes	**EF+**	**OC+**	**EF-**	**OC-**

Final Recloser Validation:

CHARACTERISTICS		Section	Comments	Status
R135	**Software Functional Requirements** Recloser mode	as 4.2.1		

1.8.2 Sectionalizer

In this section there are a set of tests to check the behaviour of the equipment when in sectionalizer mode on certain conditions as described. These tests must be executed for the 4 fault types EF+, EF-, OC+, OC-.

Pre-Requisites:

- Define the settings for the sectionalize as specified in the table below.

Setting	Value [Unit]
Opening timer	1.5s
Closing timer	5s
Lock out timer	4s
Blocking timer	60s

1.8.2.1 *Fast fault dropout*

Test description	Expected behaviour
1.Both Circuit Breaker and OCR3-1 are closed. 2.Current and voltage are set to normal. 3.Downstream of the OCR3-1 a fault is set. 4.Circuit breaker opens. On 300ms closes. No fault is present.	• When the fault appears the OCR3-1 picks up the fault but stays closed. • When the fault is cleared after opening and closing the circuit breaker, OCR3-1 stays closed.

Illustration (OCR3 in red is the test element)

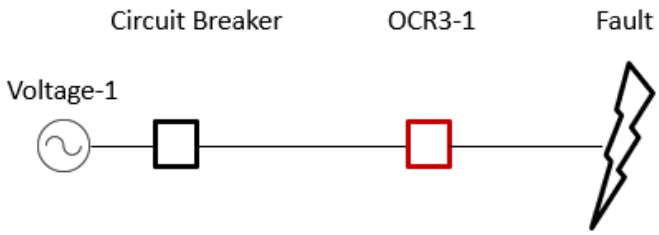


Figure 19

	OK/NOK			
Notes	**EF+**	**OC+**	**EF-**	**OC-**

1.8.2.2 *Transient fault*

Test description	Expected behaviour
1.Both Circuit Breaker and OCR3-1 are closed. 2.Current and voltage are set to normal. 3.Downstream of the OCR3-1 a fault is set. 4.Circuit breaker opens. On 300ms closes. Fault is still present, and it opens again. 5.Voltage drops for a period time longer than opening timer set on the OCR3-1, it opens. 6.Circuit breaker closes after 15s. No fault is present in the network. 7.After voltage-1 has return for a period longer than the closing timer the equipment closes.	• As the circuit breaker enters its 2nd reclosing cycle (the fault persisted), OCR3-1 opens after its opening timer. • After the circuit breaker performs its 2nd reclosing cycle the OCR3-1 must detect presence of voltage and after its closing timer must close. • As no fault is present the OCR3-1 should remain closed.

Illustration (OCR3 in red is the test element)

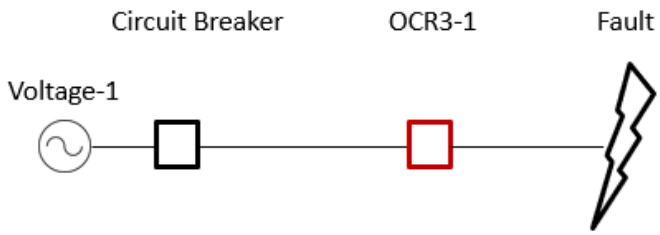


Figure 20

	OK/NOK			
Notes	**EF+**	**OC+**	**EF-**	**OC-**

1.8.2.3 *Permanent fault*

Test description	Expected behaviour
1.Circuit Breaker, OCR3-1 and OCR3-2 are closed. 2.Current and voltage are set to normal. 3.Downstream of the OCR3-2 a fault is set. 4.Circuit breaker opens. On 300ms closes. Fault is still present and it opens again. 5.Voltage drops for a period time longer than opening timer set on OCR3, both OCR3-1 and OCR3-2 open. 6.Circuit breaker closes after 15s. 7.OCR3-1 detects voltage. After closing timer, closes. Lock out timer starts. 8.OCR3-2 detects voltage. After closing timer, closes onto a fault. 9.Circuit Breaker, OCR3-1 and OCR3-2 see the fault current. Circuit Breaker open. 10.OCR3-1 remains closed. 11. OCR3-2 opens and locks out. 12.Circuit breaker closes after 30s and OCR3-1 and OCR3-2 detect voltage. OCR3-2 stays open since it is locked out.	• When the fault appears both OCR3 pick up the fault. As the fault persists after the 1st reclosing cycle of the circuit breaker both OCR3-1 and OCR3-2 must open after their opening timer. • After the circuit breaker performs its 2nd reclosing cycle, OCR3-1 must detect presence of voltage and after its closing timer it must close. Its lock out timer starts. • After OCR3-1 closes, OCR3-2 also detects voltage. After its closing timer it must close. • By this time the OCR3-1 lock out timer is already finished, and its blocking time is active. • As the OCR3-2 closes, it closes onto a fault. Circuit breaker opens as it detects the fault. • OCR3-1 stays closed because it is blocked by the blocking timer. OCR3-2 opens and locks out. • When the circuit breaker closes OCR3-1 is closed and OCR3-2 stays open.

Illustration (OCR3 in red is the one being tested):

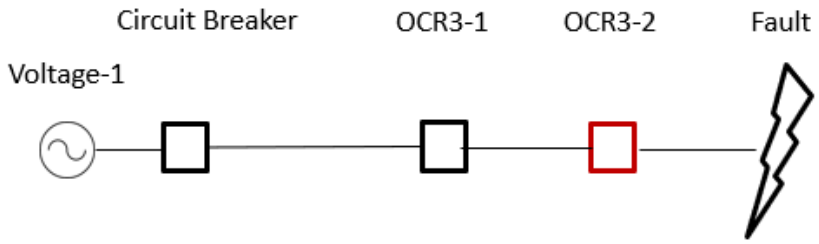


Figure 21

	OK/NOK			
Notes	**EF+**	**OC+**	**EF-**	**OC-**

1.8.2.4 *Permanent fault and "blocking timer"*

Test description	Expected behaviour
1.Circuit Breaker, OCR3-1 and OCR3-2 are closed. 2.Current and voltage are set to normal. 3.Downstream of the OCR3-2 a fault is set. 4.Circuit breaker opens. On 300ms closes. Fault is still present and it opens again. 5.As the voltage drops, after the opening timer set on the OCR3, both OCR3-1 and OCR3-2 open. 6.Circuit breaker closes after 15s. 7.OCR3-1 detects voltage. After closing timer, closes. Lock out timer starts. 8.OCR3-2 detects voltage. After closing timer, closes. Lock out timer of OCR3-1 is already completed so OCR3-1 blocking timer is active. 9.Circuit Breaker, OCR3-1 and OCR3-2 see the fault current. Circuit Breaker open. 10.OCR3-1 remains closed.	• When the fault appears both OCR pick up the fault. As the fault persist after the 1st reclosing cycle of the circuit breaker both OCR3-1 and OCR3-2 must open after their opening timer. • After the circuit breaker performs its 2nd reclosing cycle the OCR3-1 must detect presence of voltage and after its closing timer it must close and its lock out timer starts. • After OCR3-1 closes, OCR3-2 detects voltage and after its closing timer must close. • By this time the OCR3-1 lock out timer is already finished and its blocking time is active. • Since there is a fault on the network after the closing of OCR3-2, circuit breaker opens. OCR3-1 must stay closed because it is blocked by the blocking timer.

Illustration (OCR3 in red is the one being tested):

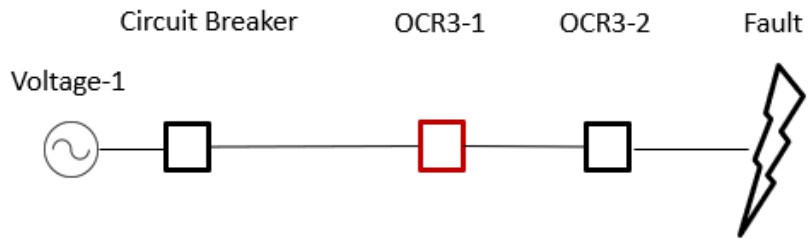


Figure 22

	OK/NOK			
Notes	**EF+**	**OC+**	**EF-**	**OC-**

1.8.2.5 *Permanent fault after blocking*

Test description	Expected behaviour
1.Circuit Breaker, OCR3-1 and OCR3-2 are closed. 2.Current and voltage are set to normal. 3.Downstream of the OCR3-2 Fault-1 is set. 4.Circuit breaker opens. On 300ms closes. Fault-1 is still present and it opens again. 5.After the opening timer set on the OCR3, both OCR3-1 and OCR3-2 open. 6.Circuit breaker closes after 15s. 7.OCR3-1 detects voltage. After closing timer, closes. Lock out timer starts. 8.OCR3-2 detects voltage. After closing timer, closes. Lock out timer of OCR3-1 is already completed so OCR3-1 blocking timer is active. 9.Circuit Breaker, OCR3-1 and OCR3-2 see the fault current. Circuit Breaker open. 10.OCR3-1 remains closed. 11.OCR3-2 opens to lock out. 12.Circuit breaker closes after 30s. 13.OCR3-1 still has its blocking timer active and there is no fault in the network. 14.Fault-2 is set when the blocking timer of OCR3-1 is finished and circuit breaker lock out timer is finished. 15.Circuit breaker opens. On 300ms closes. Fault-2 is still present and it opens again. Circuit breaker open. 16.OCR3-1 opens after its opening timer. 17.Circuit breaker closes after 15s. 18.OCR3-1 detects voltage. After closing timer, closes. 19.Both circuit breaker and OCR3-1 detect fault-2. Circuit breaker opens. 20.OCR3-1 opens and lock outs. 21.Circuit breaker closes after 30s. OCR3-1 detects voltage but stays open since it is locked out.	• When the fault appears both OCR pick up the fault. As the fault persists after the 1st reclosing cycle of the circuit breaker both OCR3-1 and OCR3-2 must open after their opening timer. • After the circuit breaker end its 2nd reclosing cycle the OCR3-1 must detect presence of voltage and after its closing timer it must close. Its lock out timer starts. • After OCR3-1 closes, OCR3-2 also detects voltage and after its closing timer it must close. • By this time the OCR3-1 lock out timer is already finished, and its blocking time is active. • Since there is a fault on the network after the closing of OCR3-2, circuit breaker opens. OCR3-1 must stay closed because it is blocked by the blocking timer. • When the circuit breaker performs its 3rd reclosing cycle, OCR3-1 blocking timer is still active and no fault in present in the network. • When OCR3-1 blocking timer and circuit breaker lock out timer has finished, fault-2 is set between OCR3-2 and OCR3-1. Circuit breaker opens and does its 1st reclosing cycle and since the fault its permanent it enters its 2nd reclosing cycle. • After its opening timer OCR3-1 opens. • The circuit breaker ends the 2nd reclosing cycle and as OCR3-1 detects voltage it closes after its closing timer. • Since fault-2 is still present circuit breaker opens. OCR3-1 opens to lock out. In its 3rd reclosing cycle the circuit breaker closes and OCR3-1 detects voltage it must stay open since it is locked out.

Illustration (OCR3 in red is the one being tested):

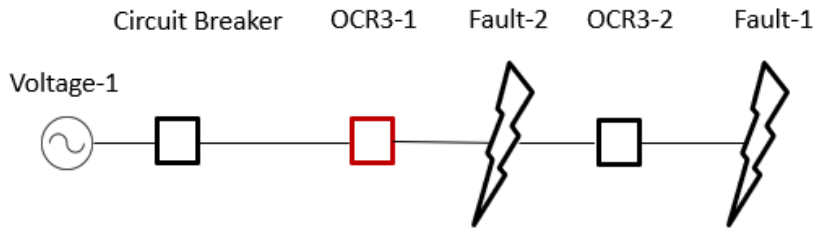


Figure 23

	OK/NOK			
Notes	**EF+**	**OC+**	**EF-**	**OC-**

1.8.2.6 *Secctionalizer mode switched off*

Test description	Expected behaviour
1.Both Circuit Breaker and OCR3-1 are closed. 2.OCR3-1 is with selector switch on remote position. 3.Current and voltage are set to normal. 4.Downstream of the OCR3-1 a fault is set. 5.Circuit breaker opens. On 300ms closes. Fault is still present, and it opens again. 6.Voltage drops for a period time longer than opening timer set on OCR3. OCR3-1 opens. 7.After 5s, a manual order is issued to turn off secctionalizer mode. 8.Circuit breaker closes after 15s. Fault is removed. 9.Despite OCR3-1 detect voltage, after its closing timer, OCR3-1 does not close.	• When Fault-1 appears circuit braker-1 opens and closes after 300ms. As fault is still present it opens again. • Since there is a voltage drop longer than the opening timer set on OCR3-1, OCR3-1 opens. After 5s an order is issued to turn off secctionalizer mode. • As so, when circuit breaker performs its 2nd reclosing cycle and OCR3-1 detects voltage, it will not close after its closing timer since its secctionalizer sequence was interrupted.

Illustration (OCR3 in red is the one being tested):

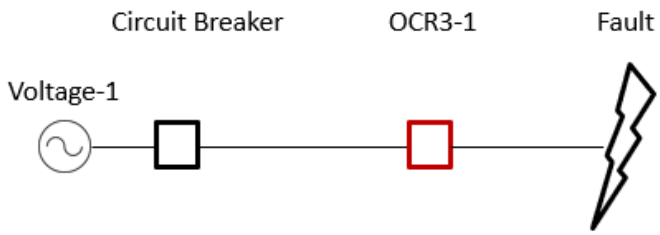


Figure 24

	OK/NOK			
Notes	**EF+**	**OC+**	**EF-**	**OC-**

Final Sectionalizer Validation:

CHARACTERISTICS		Section	Comments	Status
R136	**Software Functional Requirements** Sectionalizer mode	as 4.2.2		

1.8.3 Automatic Backfeed Restoration (ABR)

In this section there are a set of tests to check the behaviour of the equipment automatic backfeed restoration on certain conditions as described. These tests must be executed for the 4 fault types EF+, EF-, OC+, OC-.

Pre-Requisites:

- Define the settings for the recloser as specified in the table below.

Setting	Value [Unit]
Closing timer	35s

1.8.3.1 *Automatic restoration (manual) on N.O. point*

Test description	Expected behaviour
1.Circuit Breaker-1 and Circuit Breaker-2 are closed. 2.OCR3-1 is open. 3.OCR3-1 has the automatic backfeed restoration in manual restoration mode. OCR3-1 is in reclosing mode. 4.Current and voltage are set to normal. 5.Fault-1 appears. 6.Circuit Breaker-1 opens. 7.OCR3-1 remains open after 40s. 8.An operator issue a closing order to the ORC3-1. OCR3-closes. 9.OCR3-1 detects fault-1 and opens to lock out. 10.After opening, voltage-2 remains present ensure that after 1min the OCR3-1 remains open.	• When the circuit breaker-1 opens, OCR3-1 must wait for an order to close since it has the automatic backfeed restoration set to manual mode. • Operator issues a close order (command “FECHAR OCR3”). OCR3-1 closes to a fault. OCR3-1 opens to lock out. • It is signaled “FUNCAO RELIGACAO CICLO” “BLOQUEADO” to the RTU and control center.

Illustration (OCR3 in red is the one being tested):

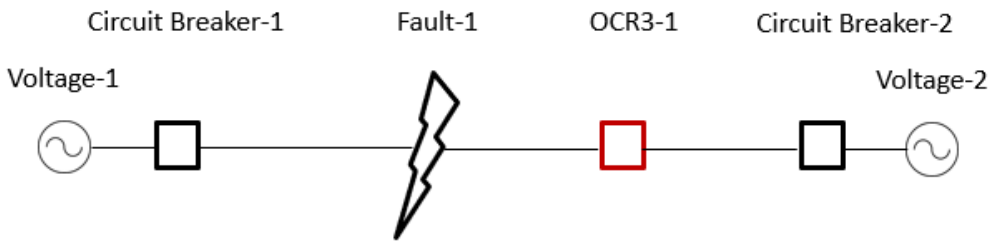


Figure 25

	OK/NOK			
Notes	**EF+**	**OC+**	**EF-**	**OC-**

1.8.3.2 *Automatic restoration (automatic) on N.O. point*

Test description	Expected behaviour
1.Circuit Breaker-1 and Circuit Breaker-2 are closed. 2.OCR3-1 is open. 3.OCR3-1 has the automatic backfeed restoration in automatic. OCR3-1 is in reclosing mode. 4.Current and voltage are set to normal. 5.Fault-1 appears. 6.Circuit Breaker-1 opens. 7.OCR3-1 closes after 35s.(Voltage-2 is still present). 8.OCR3-1 detects fault-1 and opens to lock out. 9.After opening, voltage-2 remains present ensure that after 1min the OCR3-1 remains open.	• Circuit breaker-1 opens. • It is signaled “FECHO AUTOMATICO” “EM CURSO” to the RTU and control center. • OCR3-1 must close after 35s since it has the automatic backfeed restoration set to automatic mode. • On closing it is signaled “FECHO AUTOMATICO” “FIM” to the RTU and control center. • OCR3-1 closes on to a fault. OCR3-1 opens to lock out. • It is signaled “FUNCAO RELIGACAO CICLO” “BLOQUEADO” to the RTU and control center.

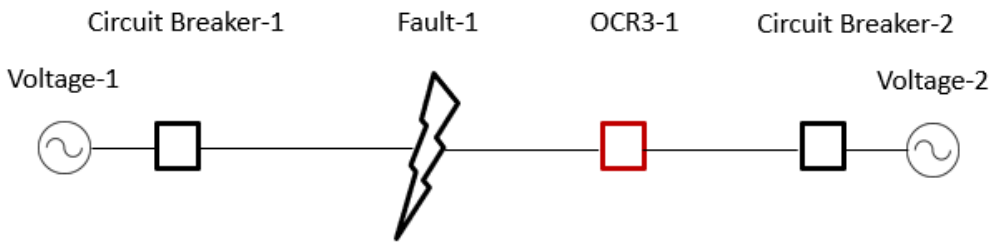


Figure 26

Illustration (OCR3 in red is the one being tested):

Notes	OK/NOK			
	EF+	OC+	EF-	OC-

1.8.3.3 *Automatic restoration (automatic) on N.O. Point with fault on both sides*

Test description	Expected behaviour
1.Circuit Breaker-1 and Circuit Breaker-2 are closed. 2.OCR3-1 is open. 3.OCR3-1 has the automatic backfeed restoration in automatic restoration mode. OCR3-1 is in reclosing mode. 4.Current and voltage are set to normal. 5.Fault-1 appears. 6.Circuit Breaker-1 opens. 7.After 5s Fault-2 appears. 8.Circuit breaker-2 opens. 9.OCR3-1 does not close. After 1min OCR3-1 remains open.	• Circuit breaker-1 opens. • It is signaled “FECHO AUTOMATICO” “EM CURSO” to the RTU and control center. • A second fault appears which opens circuit breaker-2. The OCR3-1 must not close since there is no voltage on both sides. • OCR3-1 resets ABR sequence. It is signaled “FECHO AUTOMATICO” “FIM” to the RTU and control center.

Illustration (OCR3 in red is the one being tested):

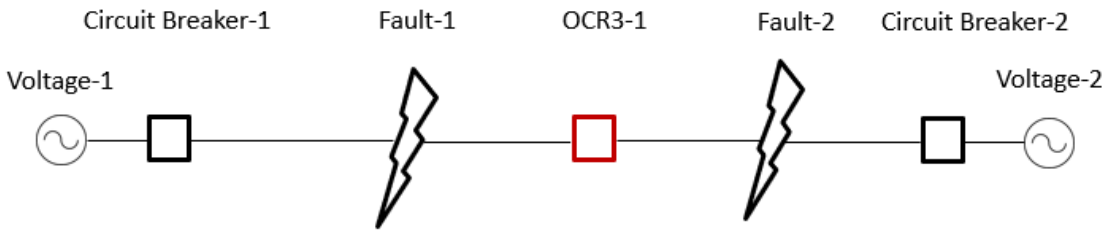


Figure 27

	OK/NOK			
Notes	**EF+**	**OC+**	**EF-**	**OC-**

1.8.3.4 *Automatic restoration manual mid cycle*

Test description	Expected behaviour
1.Circuit Breaker-1 and Circuit Breaker-2 are closed. 2.OCR3-1 is open. 3.OCR3-1 has the automatic backfeed restoration in automatic restoration mode. OCR3-1 is in reclosing mode. 4.Current and voltage are set to normal. 5.Fault-1 appears. 6.Circuit Breaker-1 opens. 7.After 10s, OCR3-1 automatic backfeed restoration is set to manual. 8.OCR3-1 does not close.	• Circuit breaker-1 opens. • It is signaled “FECHO AUTOMATICO” “EM CURSO” to the RTU and control center. • An operator switches to off the automatic backfeed restoration (command “RECONFIGURACAO AUT F/S”). • OCR3-1 resets ABR sequence. It is signaled “FECHO AUTOMATICO” “FIM” to the RTU and control center. • OCR3-1 must not close.

Illustration (OCR3 in red is the one being tested):

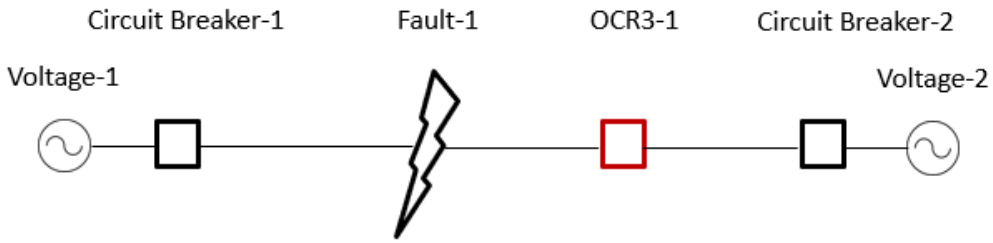


Figure 28

	OK/NOK			
Notes	**EF+**	**OC+**	**EF-**	**OC-**

Final ABR Validation:

CHARACTERISTICS		Section	Comments	Status
R137	**Software Functional Requirements** ABR - Automatic Backfeed Restoration	as 4.2.3		

Power Flow direction feature

CHARACTERISTICS		Section	Comments	Status
R138	**Software Functional Requirements** Power flow direction feature	as 4.2.4		

Synchrocheck

CHARACTERISTICS		Section	Comments	Status
R139	**Synchrocheck** Modes	as 4.2.5		
R140	**Synchrocheck** Use cases	as 4.2.5		
R141	**Synchrocheck** Voltage Thresholds	as 4.2.5		
R142	**Synchrocheck** Range Settings	as 4.2.5		
R143	**Synchrocheck** Time Settings	as 4.2.5		

1.9 Safety and Environment Legislation

CHARACTERISTICS		Section	Comments	Status
R144	**Composition and end-of-life treatment**	as 5		
R145	**Circularity and Carbon Footprint**	as 5		
R146	**Safety and environmental legislation**	as 5		
R147	**Safety and Environmental Legislation - Ecodesign**	as 5		
R148	**Safety and environmental legislation - Batteries and accumulators**	as 5		
R149	**Safety and Environment Legislation - Noise**	as 5		
R150	**Safety and Environment Legislation - REACH**	as 5		
R151	**Safety and environmental regulations - Electrical and electronic equipment**	as 5		
R152	**CE Marking**	as 5		

1.10 Markings

CHARACTERISTICS		Section	Comments	Status
R153	**Jump Program**	as 6		
R154	**CE Marking**	as 6		

1.11 Conclusions

Resume of the test results and notes:

2. SAT

2.1 Introduction

The purpose of this specification is to establish the tests and general characteristics that OCR3 equipment must comply with during SATs (Site Acceptance Tests).

It was drawn up to compile what were previously adopted procedures and are now standardized in E-REDES.

The SAT tests must be carried out after the equipment assembly work has been completed, at a location to be designated by E-REDES and all the points described must be tested.

In addition, the following conditions must be guaranteed:

- The supplier must carry out all the tests described using its own resources.
- The supplier must provide all the equipment necessary to carry them out.
- The supplier must guarantee transportation of the equipment to the E-REDES warehouse.

2.2 Equipment Identification

Manufacturer	
Recloser Model	
Control Cabinet Model	
Firmware version	
Software version	
Serial Number	
Date of Manufacture	

2.3 Participants

Participant Name	Signature	Company

2.4 Equipment conditions

The equipment to be installed in the field must be visually inspected. In addition, the entire electrical circuit must be checked to ensure that the connections are in accordance with the electrical diagram supplied.

Description	OK/NOK	Comments
Visual appearance		
Electrical Conformance (check polarity, check neutral ground connection…)		
Earth Connection		

2.5 Control Cabinet

2.5.1 Specific Power Supply Module (PSM)

2.5.1.1 *Battery Test Execution with battery OK*

Test Procedure	Expected Behaviour
1 - Ensure the battery is in good condition and with enough charge 2 - Begin a battery test (either by forcing it to start or waiting for the automatic test scheduled)	1 - Battery test shall begin when the command is given 2 - At the end of the test the “ESTADO BATERIAS” “NORMAL” signal is transmitted to the RTU and E-REDES control center (SCADA)

General comments	Global Result OK/NOK

2.5.2 **Specific Remote Terminal Unit (RTU)**

The objective for these tests is to evaluet all inputs outputs for the RTU and their correct signalling to the RTU and E-REDES control center (SCADA).

2.5.2.1 *Analogue inputs*

Pre-Requisites:

- The RTU must be configured with the signal addresses from the E-REDES normalized SCADA database.

Test:

- With an external test set inject secondary values on the analogue inputs of the RTU corresponding to the following primary values:

	Va	**Vb**	**Vc**	**Vr**	**Vs**	**Vt**	**Ia**	**Ib**	**Ic**
Magnitude	25%Un (PG)	50%Un (PG)	75%Un (PG)	100%Un (PG)	75%Un (PG)	50%Un (PG)	10%In	100%In	200%In
Phase	0	-120	120	0	120	-120	180	60	300

Register the Values Measured/Displayed on the RTU:

	Expected Value		Registered Value		OK/NOK	Comments
	Mag.	Phase	Mag	Phase		
Va	25%Un(PG)	0				
Vb	50%Un(PG)	-120				
Vc	75%Un(PG)	120				
Vr	100%Un(PG)	0				
Vs	75%Un(PG)	120				
Vt	50%Un(PG)	-120				
Ia	10%In	180				
Ib	100%In	60				
Ic	200%In	300				
P	202,5%InUn(PG)					
Q	0					
PF	-1					

- Register the Values measured/displayed in E-REDES Control Center:

Signal Description (SCADA)	Expected Value	Registered Value	OK/NOK	Comments
TENSAO LINHA ABC	66%Un(PG)			
TENSAO LINHA RST	152%Un(PG)			
CORRENTE	100%In			

- Register the Battery Charge Value measured/displayed in the following locations (the value must be the same in all locations):

Signal Description (SCADA)	PSM	RTU	E-REDES Control Center (SCADA)	OK/NOK	Comments
CAPACIDADE BAT					

General comments	Global Result OK/NOK

2.5.2.2 *Digital Inputs*

Pre-requisites:

- All the actions described in the table below must be done locally i.e from the control cabinet.
- The RTU must be configured with the signal addresses from the E-REDES normalized SCADA database.

Test:

- Execute the action specified in the table Below and check if:
  - It is signalled on the RTU front operating module (FOM).
  - An event is registered on the RTU (EVT).
  - The specified signal is registered in E-REDES Control Center (SCADA).

Action	Signal Description (SCADA)	Signal State (SCADA)	RTU FOM? (OK/NOK)	RTU EVT? (OK/NOK)	Control Center? (OK / NOK)
Using the front operating module issue a CLOSE command to the Recloser.	OCR3	FECHADO			

Action	Signal Description (SCADA)	Signal State (SCADA)	RTU FOM? (OK/NOK)	RTU EVT? (OK/NOK)	Control Center? (OK / NOK)
Using the front operating module issue OPEN command to the Recloser.	OCR3	ABERTO			
Disconnect the control cable between the recloser and the control cabinet.	OCR3	ANOMALIA 00			
Turn protection functions OFF.	PROTECOES	FORA SERVIÇO			
Turn protection functions ON.	PROTECOES	EM SERVIÇO			
Change the selector switch to the LOCAL position.	MODO FUNCION	LOCAL			
Change the selector switch to the REMOTE position.	MODO FUNCION	DISTANCIA			
Open the control cabinet door.	PORTA	ABERTA			
Close the control cabinet door.	PORTA	FECHADA			
Turn automatic back feed restoration ON.	RECONFIGURACAO AUTOMATICA	EM SERVIÇO			
Turn automatic back feed restoration OFF.	RECONFIGURAÇÃO AUTOMATICA	FORA DE SERVIÇO			
Turn auto reclosing OFF.	FUNCAO RELIGACAO	FORA DE SERVIÇO			
Turn auto reclosing ON.	FUNCAO RELIGACAO	EM SERVIÇO			
Pull the “manual open” operating handle on the recloser.	ENCRAVAMENTO OCR	ENCRAVADO			
Reset the “manual open” operating handle on the recloser	ENCRAVAMENTO OCR	NORMAL			

Action	Signal Description (SCADA)	Signal State (SCADA)	RTU FOM? (OK/NOK)	RTU EVT? (OK/NOK)	Control Center? (OK / NOK)
Disconnect the breaker protecting the PSM AC input	TENSAO AC	FALHA			
Reconnect the Breaker protecting the PSM AC input	TENSAO AC	NORMAL			
Change the OCR3 operating mode to Sectionalizer	MODO FUNCIONAMENTO	VT			
Change the OCR3 operating mode to Recloser	MODO FUNCIONAMENTO	DISJUNTOR			
Simulate a fault on the PSM	ALIMENTADOR	DEFEITO			
Normalize the PSM	ALIMENTADOR	NORMAL			
Simulate a fault in the PM (Protection Module)	WATCHDOG	FALHA			
Normalize the PM	WATCHDOG	NORMAL			
Simulate a fault on the RTU	GERAL	ALARME			
Normalize the fault on the RTU	GERAL	NORMAL			
Execute the test described in 0	ESTADO BATERIAS	NORMAL			
Execute the test described in 1.7.3.1.2	ESTADO BATERIAS	DEFEITO			
Execute the test described in 1.8.3	FECHO AUTOMATICO	EM CURSO			
Execute the test described in 1.8.3	FECHO AUTOMATICO	FIM			
Execute the test described in 1.8.1	RELIGACAO CICLO	EM CURSO			
Execute the test described in 1.8.1	RELIGACAO CICLO	FIM			

Action	Signal Description (SCADA)	Signal State (SCADA)	RTU FOM? (OK/NOK)	RTU EVT? (OK/NOK)	Control Center? (OK / NOK)
Execute the test described in 1.8.1	FUNCAO RELIGACAO	NORMAL			
Execute the test described in 1.8.1	FUNCAO RELIGACAO	BLOQUEADO			
Execute test described in 1.7.8.6.3	MAX I> INST +	ARRANQUE			
Execute test described in 1.7.8.6.3	MAX I> INST +	NORMAL			
Execute test described in 1.7.8.6.3	MAX I> TEMP +	DISPARO			
Execute test described in 1.7.8.6.3	MAX I> TEMP +	NORMAL			
Execute test described in 1.7.8.6.3	MAX I> INST -	ARRANQUE			
Execute test described in 1.7.8.6.3	MAX I> INST -	NORMAL			
Execute test described in 1.7.8.6.3	MAX I> TEMP -	DISPARO			
Execute test described in 1.7.8.6.3	MAX I> TEMP -	NORMAL			
Execute test described in 1.7.8.6.3	MAX I0> INST +	ARRANQUE			
Execute test described in 1.7.8.6.3	MAX I0> INST +	NORMAL			
Execute test described in 1.7.8.6.3	MAX I0> TEMP +	DISPARO			
Execute test described in 1.7.8.6.3	MAX I0> TEMP +	NORMAL			
Execute test described in 1.7.8.6.3	MAX I0> INST -	ARRANQUE			
Execute test described in 1.7.8.6.3	MAX I0> INST -	NORMAL			
Execute test described in 1.7.8.6.3	MAX I0> TEMP -	DISPARO			

Action	Signal Description (SCADA)	Signal State (SCADA)	RTU FOM? (OK/NOK)	RTU EVT? (OK/NOK)	Control Center? (OK / NOK)
Execute test described in 1.7.8.6.3	MAX I0> TEMP -	NORMAL			

General comments	Global Result OK/NOK

2.5.2.3 *Digital Outputs*

Pre-Requisites:

- The RTU must have the LOCAL/REMOTE selector switch in REMOTE position
- The RTU must be configured with the signal addresses from the E-REDES normalized SCADA database.

Test:

- Execute on the control center (SCADA) the commands specified in the table below and verify if:
    - The RTU event log registers the command.
    - The corresponding action is executed by the RTU.

Command Description (SCADA)	Expected Action	RTU EVT? (OK/NOK)	Action Executed? (OK/NOK)
ABRIR OCR3	Recloser Opens		
FECHAR OCR3	Recloser Closes		
RECONFIGURACAO AUT E/S	ABR is activated		
RECONFIGURACAO AUT F/S	ABR is deactivated		
PROTECOES E/S	Protection is activated		
PROTECOES F/S	Protection is deactivated		

FUNCAO RELIGACAO E/S	Reclosing is activated		
FUNCAO RELIGACAO F/S	Reclosing is deactivated		
MODO FUNC DISJUNTOR	Recloser mode is activated		
MODO FUNC VT	Sectionalizer mode is activated		

General comments	Global Result OK/NOK

2.6 Automatic Functions

Pre-Requisites:

- The RTU must be configured with the signal addresses from the E-REDES normalized SCADA database.
- Define the settings for protection as specified in the table below.

Stage	Characteristic	Directionality	Iop [A]	t [s]	TM
OC1	Tbd	Tbd	Tbd	Tbd	
OC2	Tbd	Tbd	Tbd	Tbd	
OC3					
OC4					
EF1	Tbd	Tbd	Tbd	Tbd	
EF2	Tbd	Tbd	Tbd	Tbd	
EF3					
EF4					

Note: In these tests it is assumed that the circuit breakers that exist on both sides of the OCR3 (upstream and downstream) have the same reclosing time cycles configuration as the OCR3.

Note: Tbd – To be designed

2.6.1 Recloser

In this section there are a set of tests to check the behaviour of the equipment when in Recloser mode on certain conditions as described. These tests must be executed for the 4 fault types EF+, EF-, OC+, OC-.

Pre-Requisites:

- Define the settings for the recloser as specified in the table below.

Setting	Value [Unit]
Reclosing time (1st cycle)	300ms
Reclosing time (2nd cycle)	15s
Reclosing time (3nd cycle)	30s
Lock out timer	60s

2.6.1.1 *Single Trip to lock out*

Test description	Expected behaviour
1.Both Circuit Breaker and OCR3-1 are closed. 2.OCR3-1 has the autorecloser set to off. 3.Current and voltage are set to normal. 4.Downstream of the OCR3-1 a fault appears. 5.OCR3-1 opens to lock out. 6.Voltage-1 remains present for 1 minute and OCR3-1 does not close.	• When the fault appears the OCR3-1 picks up the fault and opens. • It stays open since the automatic reclosing is off.

Illustration (OCR3 in red is the test element).

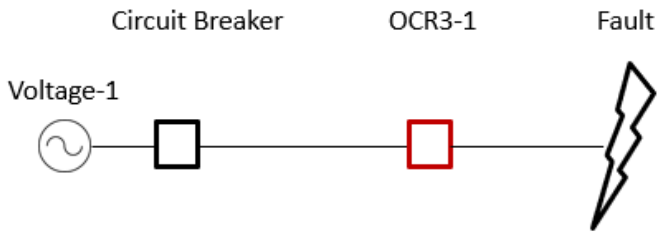


Figure 29

	OK/NOK			
Notes	**EF+**	**OC+**	**EF-**	**OC-**

2.6.1.2 *Autorecloser sequence*

Test description	Expected behaviour
1.Both Circuit Breaker and OCR3-1 are closed. 2.OCR-1 has the autorecloser set to on. 3.Current and voltage are set to normal. 4.Downstream of the OCR3-1 a fault is set. 5.OCR3-1 opens. On 300ms closes. Fault is still present. 6.OCR3-1 opens on 15s closes. Fault is still present. 7.OCR3-1 opens on 30s closes. Fault is still present. 8.OCR3-1 opens. Voltage-1 remains present for 1 minute more and OCR3-1 does not close.	• When the fault appears the OCR3-1 picks up the fault and opens. • It is signaled “RELIGACAO CICLO” “EM CURSO” to the RTU and control center. • After 300ms the OCR3-1 closes (1st cycle). • It is signaled “RELIGACAO CICLO” “FIM” to the RTU and control center. • Since fault is still present it opens again. • It is signaled “RELIGACAO CICLO” “EM CURSO” to the RTU and control center. • After 15s the OCR3-1 closes (2nd cycle). • It is signaled “RELIGACAO CICLO” “FIM” to the RTU and control center. • Since fault is still present it opens again. • It is signaled “RELIGACAO CICLO” “EM CURSO” to the RTU and control center. • After 30s the OCR3-1 closes (3rd cycle). • It is signaled “RELIGACAO CICLO” “FIM” to the RTU and control center. • Since fault is still present it opens to lockout. • It is signalled “FUNCAO RELIGACAO” “BLOQUEADO”.

Illustration (OCR3 in red is the test element)

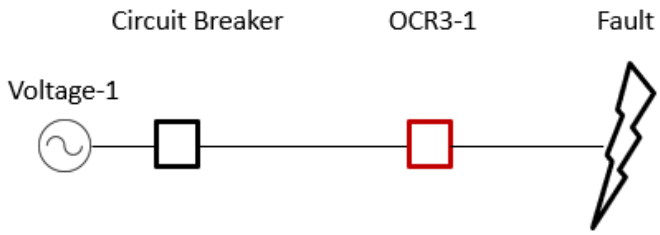


Figure 30

	OK/NOK			
Notes	**EF+**	**OC+**	**EF-**	**OC-**

2.6.1.3 *Incomplete autorecloser sequence*

Test description	Expected behaviour
1.Both Circuit Breaker and OCR3-1 are closed. 2.OCR3-1 has the autorecloser set to on. 3.Current and voltage are set to normal. 4.Downstream of the OCR3-1 a fault is set. 5.OCR3-1 opens. On 300ms closes. Fault is cleared. 6.After 30s the same fault appears. 7.OCR3-1 opens. Fault is cleared. 8.On 15s OCR3-1 closes and no fault is detected. 9.After 65s, fault is again set downstream of the OCR3-1. 10.OCR3-1 opens. On 300ms closes. Fault is cleared.	• When the fault appears the OCR3-1 picks up the fault (overcurrent or earth fault) and opens. • It is signaled “RELIGACAO CICLO” “EM CURSO” to the RTU and control center. • After 300ms the OCR3-1 closes (1st cycle). • It is signaled “RELIGACAO CICLO” “FIM” to the RTU and control center. • After 30s which is during OCR3-1 lock out timer, the fault reappears. • It is signaled “RELIGACAO CICLO” “EM CURSO” to the RTU and control center. • After 15s the OCR3-1 closes (2nd cycle). • It is signaled “RELIGACAO CICLO” “FIM” to the RTU and control center. • After 65s in which OCR3-1 lock out timer has expired, the fault reappears. • It is signaled “RELIGACAO CICLO” “EM CURSO” to the RTU and control center. • After 300ms the OCR3-1 closes (1st cycle). OCR3-1 performs its 1st reclosing cycle since the autorecloser sequence was reseted. • It is signaled “RELIGACAO CICLO” “FIM” to the RTU and control center.

Illustration (OCR3 in red is the test element)

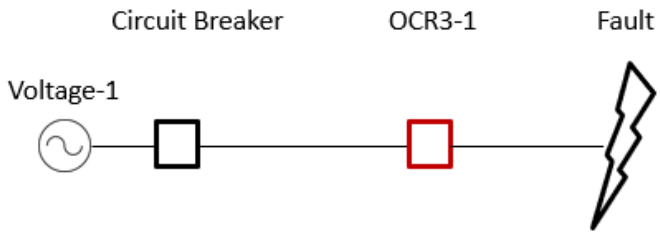


Figure 31

	OK/NOK			
Notes	**EF+**	**OC+**	**EF-**	**OC-**

2.6.1.4 *Autorecloser sequence interrupted by manual order SOTF*

Test description	Expected behaviour
1.Both Circuit Breaker and OCR3-1 are closed. 2.OCR3-1 has the autorecloser set to on. 3.Current and voltage are set to normal. 4.Downstream of the OCR3-1 a fault is set. 5.OCR3-1 opens. On 300ms closes. Fault is still present, and it opens again. 6.In less than 15s an operator from the dispatch center or an operator locally gives a closing order to the OCR3-1. OCR3-1 closes. 7.As fault is still present OCR3-1 opens to lock out. 8.After 35s, despite OCR3 detects tension from voltage-1, it stays open.	• When the fault appears the OCR3-1 picks up the fault and opens. • It is signaled “RELIGACAO CICLO” “EM CURSO” to the RTU and control center. • After 300ms the OCR3-1 closes (1st cycle). • It is signaled “RELIGACAO CICLO” “FIM” to the RTU and control center. • Since fault is still present it opens again. • It is signaled “RELIGACAO CICLO” “EM CURSO” to the RTU and control center. • When OCR3-1 is performing its 2nd automatic reclosing cycles an operator locally or remotely issues an order to close OCR3-1 (command “FECHAR OCR3”). OCR3-1 closes. • Since fault is still present it opens again (SOTF). • It is signaled “FUNCAO RELIGACAO CICLO” “BLOQUEADO” to the RTU and control center. • Since the closing order was set by an operator and on to a fault, OCR3-1 autorecloser sequence was interrupted and 35s after the closing attempt it did not try to close again despite detecting voltage from voltage-1.

Illustration (OCR3 in red is the test element)

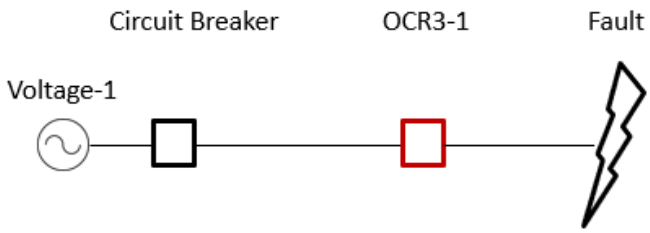


Figure 32

	OK/NOK			
Notes	**EF+**	**OC+**	**EF-**	**OC-**

2.6.2 Sectionalizer

In this section there are a set of tests to check the behaviour of the equipment when in sectionalizer mode on certain conditions as described. These tests must be executed for the 4 fault types EF+, EF-, OC+, OC-.

Pre-Requisites:

- Define the settings for the sectionalize as specified in the table below.

Setting	Value [Unit]
Opening timer	1.5s
Closing timer	5s
Lock out timer	4s
Blocking timer	60s

2.6.2.1 *Fast fault dropout*

Test description	Expected behaviour
1.Both Circuit Breaker and OCR3-1 are closed. 2.Current and voltage are set to normal. 3.Downstream of the OCR3-1 a fault is set. 4.Circuit breaker opens. On 300ms closes. No fault is present.	• When the fault appears the OCR3-1 picks up the fault but stays closed. • When the fault is cleared after opening and closing the circuit breaker, OCR3-1 stays closed.

Illustration (OCR3 in red is the test element)

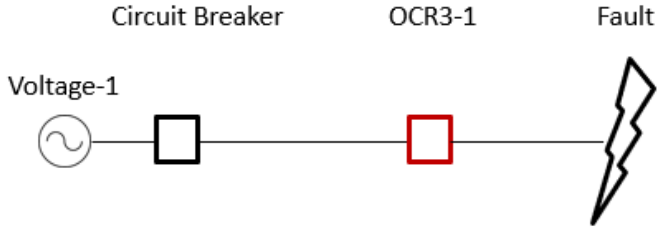


Figure 33

	OK/NOK			
Notes	**EF+**	**OC+**	**EF-**	**OC-**

2.6.2.2 *Permanent fault*

Test description	Expected behaviour
1.Circuit Breaker, OCR3-1 and OCR3-2 are closed. 2.Current and voltage are set to normal. 3.Downstream of the OCR3-2 a fault is set. 4.Circuit breaker opens. On 300ms closes. Fault is still present and it opens again. 5.Voltage drops for a period time longer than opening timer set on OCR3, both OCR3-1 and OCR3-2 open. 6.Circuit breaker closes after 15s. 7.OCR3-1 detects voltage. After closing timer, closes. Lock out timer starts. 8.OCR3-2 detects voltage. After closing timer, closes onto a fault. 9.Circuit Breaker, OCR3-1 and OCR3-2 see the fault current. Circuit Breaker open. 10.OCR3-1 remains closed. 11. OCR3-2 opens and locks out. 12.Circuit breaker closes after 30s and OCR3-1 and OCR3-2 detect voltage. OCR3-2 stays open since it is locked out.	• When the fault appears both OCR3 pick up the fault. As the fault persists after the 1st reclosing cycle of the circuit breaker both OCR3-1 and OCR3-2 must open after their opening timer. • After the circuit breaker performs its 2nd reclosing cycle, OCR3-1 must detect presence of voltage and after its closing timer it must close. Its lock out timer starts. • After OCR3-1 closes, OCR3-2 also detects voltage. After its closing timer it must close. • By this time the OCR3-1 lock out timer is already finished, and its blocking time is active. • As the OCR3-2 closes, it closes onto a fault. Circuit breaker opens as it detects the fault. • OCR3-1 stays closed because it is blocked by the blocking timer. OCR3-2 opens and locks out. • When the circuit breaker closes OCR3-1 is closed and OCR3-2 stays open.

Illustration (OCR3 in red is the one being tested):

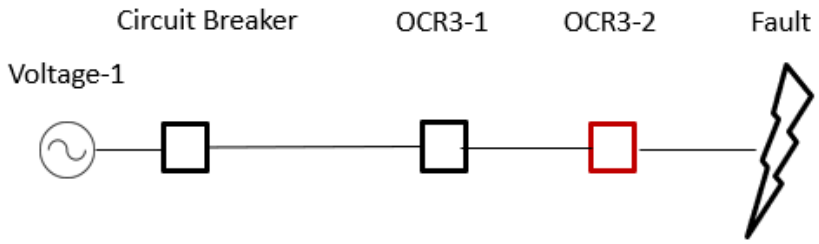


Figure 34

	OK/NOK			
Notes	**EF+**	**OC+**	**EF-**	**OC-**

2.6.2.3 *Autorecloser sequence interrupted by manual order SOTF*

Test description	Expected behaviour
1.Both Circuit Breaker and OCR3-1 are closed. 2.OCR3-1 has the autorecloser set to on. 3.Current and voltage are set to normal. 4.Downstream of the OCR3-1 a fault is set. 5.OCR3-1 opens. On 300ms closes. Fault is still present, and it opens again. 6.In less than 15s an operator from the dispatch center or an operator locally gives a closing order to the OCR3-1. OCR3-1 closes. 7.As fault is still present OCR3-1 opens to lock out. 8.After 35s, despite OCR3 detects tension from voltage-1, it stays open.	• When the fault appears the OCR3-1 picks up the fault and opens. • It is signaled “RELIGACAO CICLO” “EM CURSO” to the RTU and control center. • After 300ms the OCR3-1 closes (1st cycle). • It is signaled “RELIGACAO CICLO” “FIM” to the RTU and control center. • Since fault is still present it opens again. • It is signaled “RELIGACAO CICLO” “EM CURSO” to the RTU and control center. • When OCR3-1 is performing its 2nd automatic reclosing cycles an operator locally or remotely issues an order to close OCR3-1 (command “FECHAR OCR3”). OCR3-1 closes. • Since fault is still present it opens again (SOTF). • It is signaled “FUNCAO RELIGACAO CICLO” “BLOQUEADO” to the RTU and control center. • Since the closing order was set by an operator and on to a fault, OCR3-1 autorecloser sequence was interrupted and 35s after the closing attempt it did not try to close again despite detecting voltage from voltage-1.

Illustration (OCR3 in red is the test element)

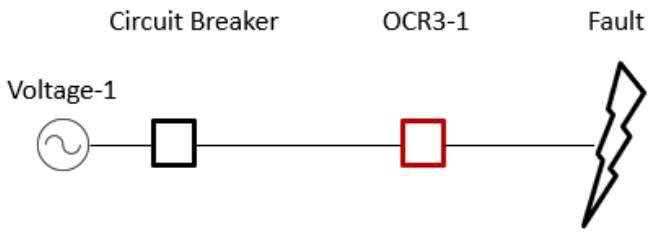


Figure 35

	OK/NOK			
Notes	**EF+**	**OC+**	**EF-**	**OC-**

2.6.3 Automatic Backfeed Restoration (ABR)

In this section there are a set of tests to check the behaviour of the equipment automatic backfeed restoration on certain conditions as described. These tests must be executed for the 4 fault types EF+, EF-, OC+, OC-.

Pre-Requisites:

- Define the settings for the recloser as specified in the table below.

Setting	Value [Unit]
Closing timer	35s

2.6.3.1 *Automatic restoration (manual) on N.O. point*

Test description	Expected behaviour
1.Circuit Breaker-1 and Circuit Breaker-2 are closed. 2.OCR3-1 is open. 3.OCR3-1 has the automatic backfeed restoration in manual restoration mode. OCR3-1 is in reclosing mode. 4.Current and voltage are set to normal. 5.Fault-1 appears. 6.Circuit Breaker-1 opens. 7.OCR3-1 remains open after 40s. 8.An operator issue a closing order to the ORC3-1. OCR3-closes. 9.OCR3-1 detects fault-1 and opens to lock out. 10.After opening, voltage-2 remains present ensure that after 1min the OCR3-1 remains open.	• When the circuit breaker-1 opens, OCR3-1 must wait for an order to close since it has the automatic backfeed restoration set to manual mode. • Operator issues a close order (command “FECHAR OCR3”). OCR3-1 closes to a fault. OCR3-1 opens to lock out. • It is signaled “FUNCAO RELIGACAO CICLO” “BLOQUEADO” to the RTU and control center.

Illustration (OCR3 in red is the one being tested):

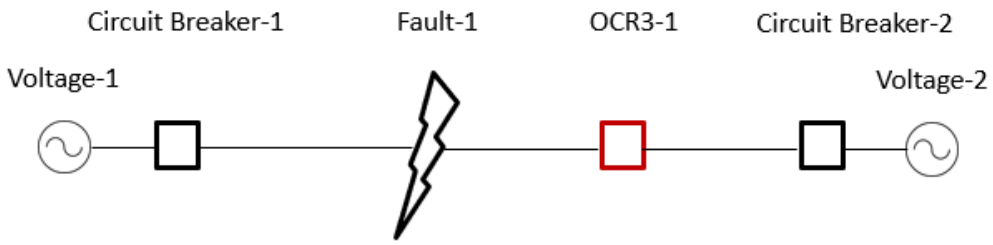


Figure 36

	OK/NOK			
Notes	**EF+**	**OC+**	**EF-**	**OC-**

2.6.3.2 *Automatic restoration (automatic) on N.O. point*

Test description	Expected behaviour
1.Circuit Breaker-1 and Circuit Breaker-2 are closed. 2.OCR3-1 is open. 3.OCR3-1 has the automatic backfeed restoration in automatic. OCR3-1 is in reclosing mode. 4.Current and voltage are set to normal. 5.Fault-1 appears. 6.Circuit Breaker-1 opens. 7.OCR3-1 closes after 35s.(Voltage-2 is still present). 8.OCR3-1 detects fault-1 and opens to lock out. 9.After opening, voltage-2 remains present ensure that after 1min the OCR3-1 remains open.	• Circuit breaker-1 opens. • It is signaled “FECHO AUTOMATICO” “EM CURSO” to the RTU and control center. • OCR3-1 must close after 35s since it has the automatic backfeed restoration set to automatic mode. • On closing it is signaled “FECHO AUTOMATICO” “FIM” to the RTU and control center. • OCR3-1 closes on to a fault. OCR3-1 opens to lock out. • It is signaled “FUNCAO RELIGACAO CICLO” “BLOQUEADO” to the RTU and control center.

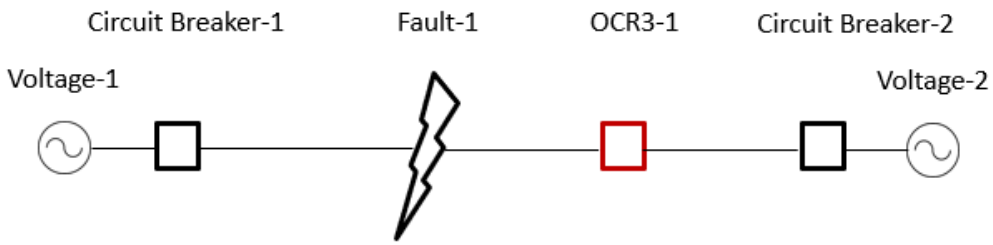


Figure 37

Illustration (OCR3 in red is the one being tested):

Notes	OK/NOK			
	EF+	OC+	EF-	OC-

2.6.3.3 *Automatic restoration (automatic) on N.O. Point with fault on both sides*

Test description	Expected behaviour
1.Circuit Breaker-1 and Circuit Breaker-2 are closed. 2.OCR3-1 is open. 3.OCR3-1 has the automatic backfeed restoration in automatic restoration mode. OCR3-1 is in reclosing mode. 4.Current and voltage are set to normal. 5.Fault-1 appears. 6.Circuit Breaker-1 opens. 7.After 5s Fault-2 appears. 8.Circuit breaker-2 opens. 9.OCR3-1 does not close. After 1min OCR3-1 remains open.	• Circuit breaker-1 opens. • It is signaled “FECHO AUTOMATICO” “EM CURSO” to the RTU and control center. • A second fault appears which opens circuit breaker-2. The OCR3-1 must not close since there is no voltage on both sides. • OCR3-1 resets ABR sequence. It is signaled “FECHO AUTOMATICO” “FIM” to the RTU and control center.

Illustration (OCR3 in red is the one being tested):

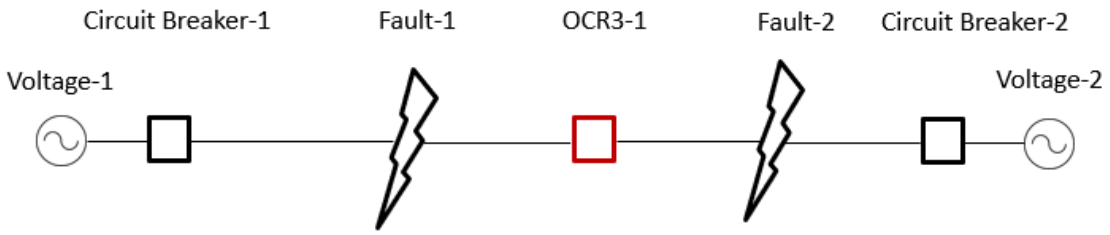


Figure 38

	OK/NOK			
Notes	**EF+**	**OC+**	**EF-**	**OC-**

2.7 Conclusions

Resume of the test results and notes: