GE
Grid Solutions

RPV311

Distributed Multifunction Fault Recorder

Technical Manual

Platform Hardware Version: C/D
Platform Software Version: 14
Publication Reference: RPV311-TM-EN-11.2A

imagination at work

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Distributed Multifunction Fault Recorder

Chapter 1: Introduction

This chapter provides some general information about the technical manual and an introduction to the device(s) described in this technical manual.

1 Foreword

This technical manual provides a functional and technical description of GE Reason RPV311, as well as a comprehensive set of instructions for using the device. The level at which this manual is written assumes that you are already familiar with protection engineering and have experience in this discipline. The description of principles and theory is limited to that which is necessary to understand the product.

We have attempted to make this manual as accurate, comprehensive and user-friendly as possible. However, we cannot guarantee that it is free from errors. Nor can we state that it cannot be improved. We would therefore be very pleased to hear from you if you discover any errors, or have any suggestions for improvement. Our policy is to provide the information necessary to help you safely specify, engineer, install, commission, maintain, and eventually dispose of this product. We consider that this manual provides the necessary information, but if you consider that more details are needed, please contact us.

All feedback should be sent to our contact center via the following URL:
http://www.gegridsolutions.com/alstomenergy/grid/grid/contactcentre

1.1 Target Audience

This manual is aimed towards all professionals charged with installing, commissioning, maintaining, troubleshooting, or operating any of the products within the specified product range. This includes installation and commissioning personnel as well as engineers who will be responsible for operating the product.

The level at which this manual is written assumes that installation and commissioning engineers have knowledge of handling electronic equipment. Also, system and protection engineers have a thorough knowledge of protection systems and associated equipment.

1.2 Nomenclature

Due to the technical nature of this manual, many special terms, abbreviations and acronyms are used throughout the manual. Some of these terms are well-known industry-specific terms while others may be special product-specific terms used by GE

Grid. The first instance of any acronym or term used in a particular chapter is explained. In addition, a separate glossary is available on the GE website, or from the GE contact center.

We would like to highlight the following changes of nomenclature however:

- British English is used throughout this manual.
- The British term 'Earth' is used in favour of the American term 'Ground'.

1.3 Acronyms and Abbreviations

AC - Alternating Current;
CF - Constituição Federal (Federal Constitution);
COMNAME - IEEE C37.232 Recommended Practice for Naming Time Sequence Data Files;
COMTRADE - IEEE C37.111 Common Format for Transient Data Exchange;
DC - Direct Current;
DFR - DataFlex file extension;
EMC - Electromagnetic Compatibility;
FRQ - Frequency;
FUT - Firmware Upgrade Tool;
GOOSE - Generic Object Oriented Substation Events;
GPS - Global Positioning System;
HDD - Hard disk drive;
HTML - HyperText Markup Language;
IMB - Imbalance;
IEEE - Institute of Electric and Electronic Engineers;
IEC - International Electrotechnical Commission;
IED - Intelligent Electronic Devices;
IP - Internet Protocol;
IRIG-B -Inter Range Instrumentation Group (Rate Designation B);
KML - Keyhole Markup Language;
MAC - Media Access Control;
MODBUS - Modicon Bus;
PC - Computer;
PMU - Phasor Measurement Unit;
PST - Product Support Tools;
Pst - Short-term flicker severity;
Plt - Long-term flicker severity;
RAM - Random-access Memory;
RFC, DEFLATE - RFC 1951, DEFLATE Compressed Data Format Specification;
RMS - Root Mean Square;
RPV - Multifunction Digital Fault Recorder;
SCADA - Supervisory Control and Data Acquisition;
SCD, CID - Input files extensions for the IED GOOSE messages;
SCL - Edit Configuration File for the GOOSE Configurator;
SNTP - Simple Network Time Protocol;

SOE - Sequency of Events;
SQL - Structured Query Language;
SSD - Solid-state Drive;
TCP - Transmission Control Protocol;
THD - Total harmonic distortion;
TTL - Transistor-Transistor Logic;
TW - Travelling Wave;
UDP - User Datagram Protocol;
UTC - Coordinated Universal Time;
VLAN - Virtual Local Area Network;
XML - Extensible Markup Language.

2 Product Scope

The processing unit RPV311 and the acquisition modules RA331, RA332, and RA333 offer a distributed solution for Multifunction Digital Recording. The solution is designed for the acquisition, monitoring and recording of electrical quantities normally associated with electrical power generation, transmission or distribution equipment. It is the solution for applications which require flexibility, allowing installation of RPV311 Processing Unit in existing panels and the Acquisition Modules RA331, RA332, and RA333 near to the plant seeing monitored the applications installation.

The RPV311Solution is a multifunction equipment with fan-less and no rotating part design. It has an acquisition system with 16-bit A/D D converters that provide an acquisition rate of 256 points-per-cycle synchronized by the IRIG-B signal.

It has a high processing capability, which allows the acquisition of up to 64 analog channels and 256 digital channels divided in up to 8 acquisition modules connected by fiber-optic links. Additionally, it is able to detect IEC 61850 GOOSE messages.

It allows communication through the electrical Ethernet ports and optionally has a double internal converter for optical Ethernet interfaces.

Monitoring and configuration are performed through a web interface; also, it has a human-machine interface on the front panel for displaying information. It has a MODBUS and DNP3 interface for SCADA integration.

The RA331 module allows data acquisition of up to 8 analogue channels (voltage, current, or DC transducers) and up to 32 digital channels. The RA332 module allows data acquisition of up to 16 analogue channels (voltage, current, or DC transducers) and up to 32 digital channels. Both modules use 16-bit A/D converters providing an acquisition rate of 256 points-per-cycle.

The RA333 module allows data acquisition of high-speed analog channels (voltage) for one transmission line. This module allows the scheme to obtain traveling wave records for fault locating. Additionally, the RA333 module allows data acquisition of up to 8 analog channels (voltage, current, or DC transducers) and up to 16 digital channels, using 16-bit A/D converters providing an acquisition rate of 256 points-per-cycle.

3 Unpacking

Unpack the equipment carefully and make sure that all accessories and cables are put away so they will not be lost.

Check the contents against the packing list. If any of the contents listed is missing, please contact GE immediately (see contact information at the beginning of this manual).
Examine the equipment for any shipping damage. If the unit is damaged or fails to operate, notify the shipping company immediately. Only the consignee (the person or company receiving the unit) can file a claim against the carrier for occasional shipping damages.
We recommend that the user retain the original packing materials for use in case of need to transport or ship the equipment at some future time.

4 External Indication

4.1 RPV311 Nameplate

Information about the company, power supply and the serial number and part number is shown on a small nameplate affixed to the rear of the equipment, as shown in Figure 1.

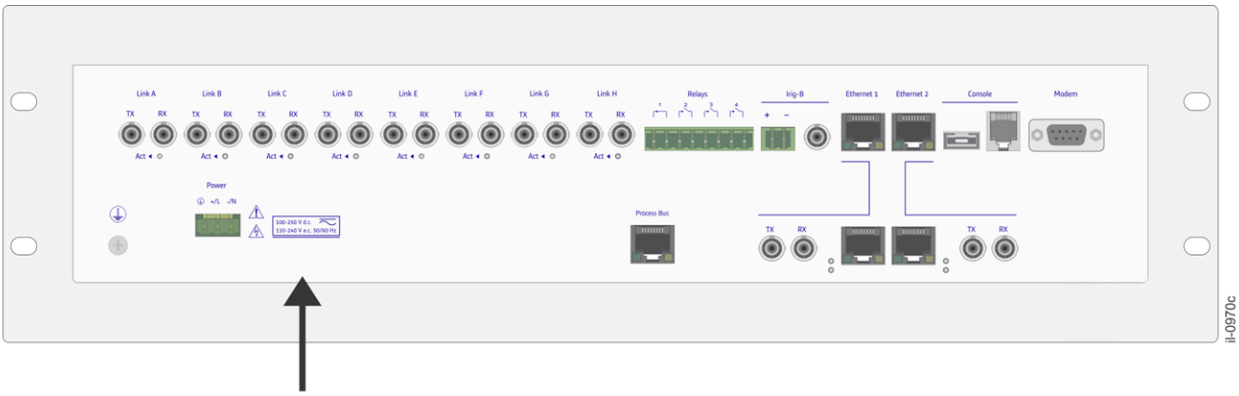

Figure 1: Location of Serial Number, Part Number and specifications

4.2 RA331, RA332, and RA333 Nameplate

Information about the company, power supply, the serial number and part number and specifications about the equipment are shown on a small nameplate affixed to the side of the equipment, as shown in Figure 2.

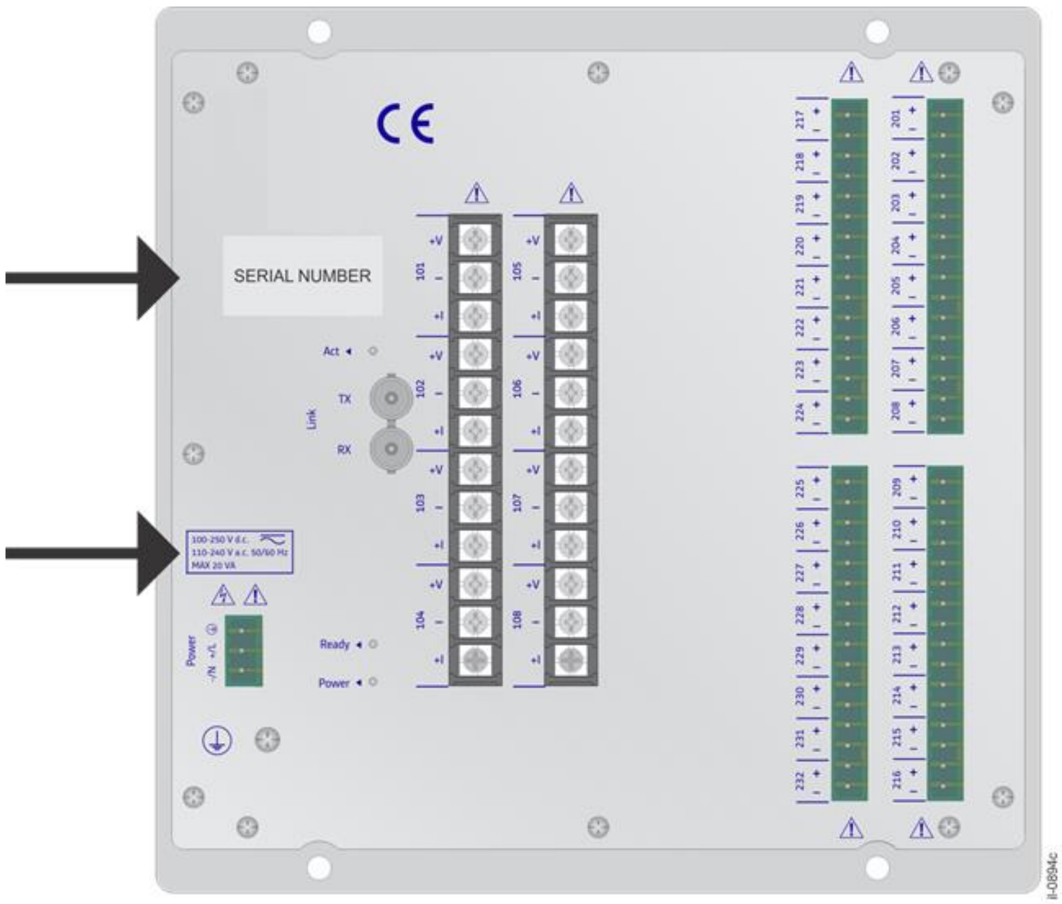

Figure 2: Location of Serial Number, Part Number and specifications

5 Key Features

The RPV311 plus RA33x acquisition modules solution presents the following key features:

- Acquisition system:
  - 16-bit opto-isolated analog-to-digital converters, independent for each channel (50/60 Hz channels);
  - 256 points-per-cycle sampling rate (50/60 Hz channels);
  - Frequency response of DC to 3.0 kHz;
  - 8-bit opto-isolated analog-to-digital converters, independent for each channel (high-speed channels);
  - MHz sampling frequency (high-speed channels);
  - Internal time skew compensation;
  - Sampling rate synchronized to external IRIG-B reference;

- Channel capacity:
  - Up to 64 analog inputs (voltage, current, DC transducers);
  - Up to 12 high-speed analog inputs for Traveling Wave Fault Location;
  - Up to 256 digital inputs;

    - Up to 8 fiber-optic links to connect to RA331, RA332 or RA333 remote acquisition modules;
- Fan-less and no rotating part design
- Trigger waveform recorder at 256, 128, or 64 points-per-cycle;
- Continuous waveform recorder at 16 points-per-cycle;
- Continuous disturbance recorder and trigger recorder (optional);
- IRIGB-004 and SNTP/NTP version 2, 3 or 4 time synchronization
- Trigger using Boolean logic equations;
- TWFL - Traveling wave recorder for fault location (optional),
    - TWFL also for consecutive faults and switch-on to fault;
- MODBUS and DNP3 interface for SCADA integration (optional);
- Synchrophasor Class M measurement according to IEEE C37.118 (optional);
- Power quality records:
- Historical average at aggregation intervals of 1 or 10 minutes (optional);
- Measurement and recording of harmonics up to the 50th order according to IEC 61000-4-7 (optional);
- Measurement and recording of flicker according to IEC 61000-4-15:1997+A1:2003 (optional);
- Cross-trigger using standard network connection;
- One-end fault location based on Takagi algorithm;
- Flexible communication:
- Two 10/100BaseT electrical Ethernet interfaces;
- Two embedded optical Ethernet converters;
- RS232 serial port for modem connection;
- Support for IEC 61850:
- Up to 320 binary inputs related to IEC 61850-8-1 GOOSE messages – KEMA Certified (optional);
- Two Ethernet ports for redundant connection (optional);
- One Ethernet port for Process Bus (IEC 61850-9-2LE Sampled Values) connection (optional).
- Local interface on the front panel;
- 4 dry-contact relays for remote signalling;
- Fax and/or e-mail message after detection of a trigger. The fax can be sent to two different destinations and the e-mail to four different destinations (optional).

6 Standards Compliance

The RPV311 product has undergone a range of extensive testing and certification processes to ensure and prove compatibility with all target markets. A detailed description of these criteria can be found in the Technical Specifications Chapter.

6.1 Standard Compliance

Compliance with the European Commission Directive, UK Conformity Assessed on EMC and LVD is demonstrated by self-certification against international standards.

6.2 EMC Compliance

Compliance with IEC 60255-26:2013 was used to establish conformity.

6.3 Product Safety: 2006/95/EC

Compliance with IEC 61010-1:2010 was used to establish conformity.

Protective Class

Protective Class 1. This equipment requires a protective conductor (earth) to ensure user safety.

Installation category

IEC61010-1:2010 Overvoltage Category II.

Environment

IEC 60068-2-1, IEC 60068-2-2, IEC 60068-2-30, IEC 60068-2-14, IEC 60255-21-1, IEC 60255-21-2. The equipment shall always be installed in a specific cabinet or housing which will enable it to meet the requirements of IEC 60529 with the classification of degree of protection IP54 or above.

6.4 R&TTE Compliance

Radio and Telecommunications Terminal Equipment (R&TTE) directive 99/5/EC. Conformity is demonstrated by compliance to both the EMC directive and the Low Voltage directive, to zero volts.

7 Cyber Security Disclaimer

The Multifunctional Digital Fault Recorder RPV311 is designed to be installed and operated in industrial and power sub-station environments and connected to private networks.

GE strongly recommend users to protect their digital devices using a defense-in-depth strategy to protect their products, their network, its systems and interfaces against cyber security threats. This includes, but is not limited to, placing digital devices inside the control system network security perimeter, deploy and maintain access controls, monitoring of Intrusion Detection, security awareness training, security policies,

network segmentation and firewalls, password management, data encryption, antivirus and other mitigating applicable technologies.
It is users' sole responsibility to make sure that the devices are installed and operated considering its cyber security capabilities and security context.
GE Grid Automation and its affiliates may not be liable for damages and/or losses related to cyber security incidents.

8 Functional Overview

The processing unit RPV311 and the acquisition modules RA331, RA332, and RA333 offer a distributed solution for Multifunction Digital Recording. The solution is designed for the acquisition, monitoring and recording of electrical quantities normally associated with electrical power generation, transmission or distribution equipment. It is the solution for applications which require flexibility, allowing installation of RPV311 Processing Unit in existing panels and the Acquisition Modules RA331, RA332, and RA333 near to the plant seeing monitored the applications installation.

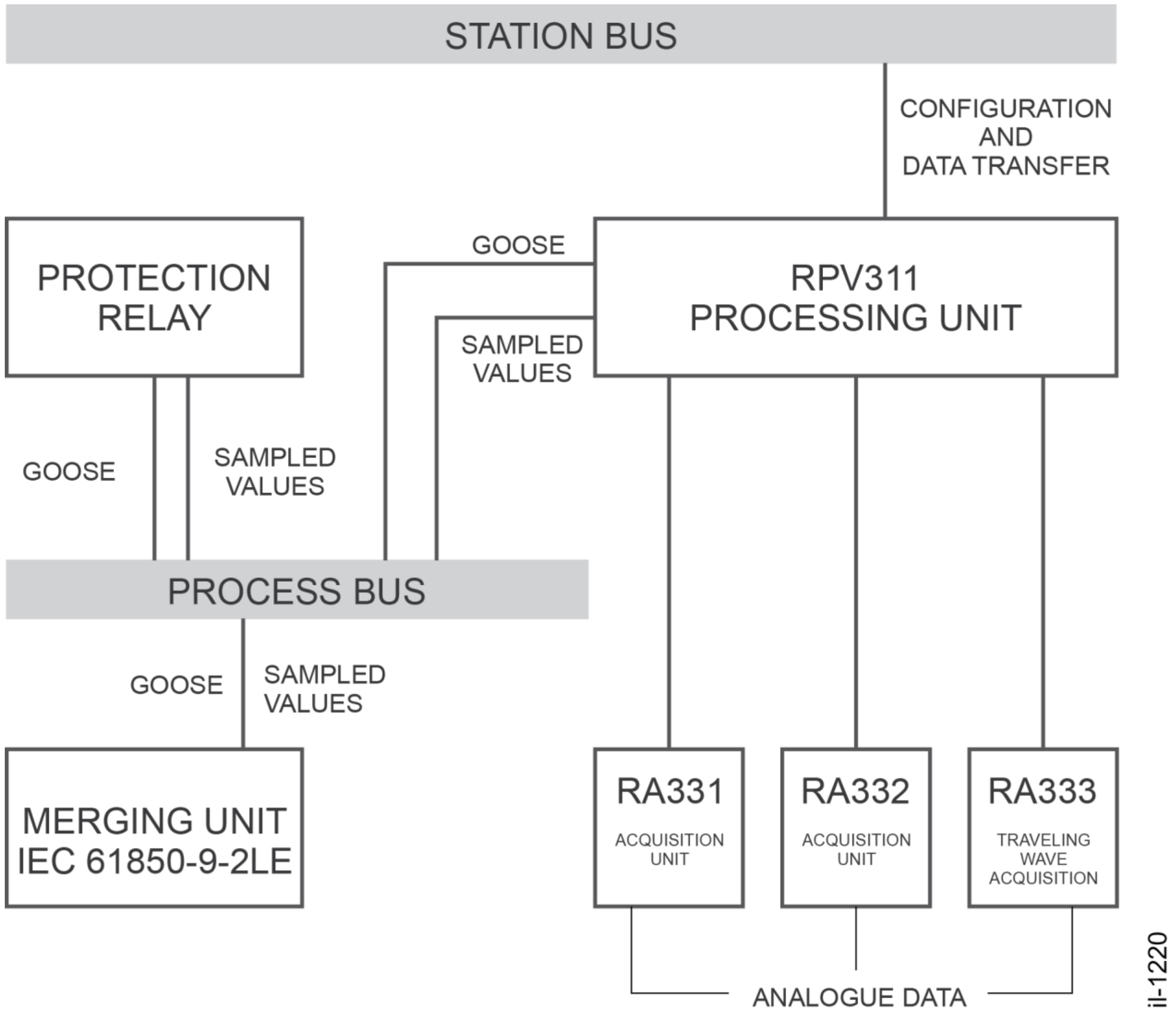

Figure 1: Functional design overview

9 Programs Under the GPL 2 License

The RPV311 uses GPL 2 licenses in its implementation.

In case the user wants get ahold of the source code, please contact out contact centre.

10 Ordering Options

10.1 RPV311

Variants	Order Number						
	1-6	7	8	9-11	12	13-14	15
Model Type							

RPV311 Multifunction Recorder	RPV311
Power Supply	
24-48 Vdc	1
100-250 Vdc / 110-240 Vac	3
Network Interface	
Two RJ45 copper 100BASE-TX Ethernet interfaces	E
Two RJ45 copper or duplex ST-type connector 100BASE-X Ethernet interfaces	O
Functions and Protocols	
Fault Recorder	***
Sequence of Events Recorder	***
Disturbance Recorder	***
Continuous Fault and Disturbance Recorder	***
Phasor Measurement Unit (PMU)	***
GOOSE Message Subscription	***
MODBUS/DNP3.0 Interface	***
Power Quality	***
IEC 61850-9-2LE Inputs	***
Travelling Wave Fault Location	***
Waveform Measurement Unit (WMU)	***
Customization / Regionalisation	
GE branding	C
Firmware Version	
Firmware 14	14
Firmware 13	13
Hardware Design Suffix	
~~Third version (withdraw)~~	~~C~~
Fourth version	D

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10.2 RA331

Variants	Order Number							
	1-5	6	7	8	9	10	11	12
Model Type								
RA331 Acquisition Module for RPV311	RA331							
Power Supply								
24-48 Vdc		1						
100-250 Vdc / 110-240 Vac		3						
Analogue Inputs 1 to 4								
~~Voltage inputs 115 V / Current inputs 1 A; full-scale 20 A (Ith = 40 A) (withdrawn)~~			~~1~~					
Voltage inputs 115 V / Current inputs 1 A; full-scale 40 A (Ith = 100 A)			2					
Voltage inputs 115 V / Current inputs 5 A; full-scale 100 A (Ith = 200 A)			5					
Voltage inputs 115 V / Current inputs 5 A; full-scale 200 A (Ith = 200 A)			6					
~~Voltage inputs 115 V / Current inputs 5 A; full-scale 14 A (Ith = 32 A) (withdrawn)~~			~~T~~					
Voltage inputs ±10 Vdc / Current inputs 0-20 mAdc			D					
Voltage inputs 115 V / Current inputs 100 mA; full-scale 100 mA (Ith = 2 A)			P					
Not installed			X					
Analogue Inputs 5 to 8								
~~Voltage inputs 115 V / Current inputs 1 A; full-scale 20 A (Ith = 40 A) (withdrawn)~~				~~1~~				
Voltage inputs 115 V / Current inputs 1 A; full-scale 40 A (Ith = 100 A)				2				
Voltage inputs 115 V / Current inputs 5 A; full-scale 100 A (Ith = 200 A)				5				
Voltage inputs 115 V / Current inputs 5 A; full-scale 200 A (Ith = 200 A)				6				
~~Voltage inputs 115 V / Current inputs 5 A; full-scale 14 A (Ith = 32 A) (withdrawn)~~				~~T~~	-	-	-	
Voltage inputs ±10 Vdc / Current inputs 0-20 mAdc				D				
Voltage inputs 115 V / Current inputs 100 mA; full-scale 100 mA (Ith = 2 A)				P				
Not installed				X				
Digital Inputs 1 to 16								
24 V / 48 V					1			
125 V					2			
250 V					3			
Not installed					X			
Digital Inputs 17 to 32								
24 V / 48 V						1		
125 V						2		
250 V						3		
Not installed						X		
Customization / Regionalisation								
GE branding							C	
Hardware Design Suffix								
Third version								C

10.3 RA332

Variants	1-5	6	7	8	9	10	11	12	13	14
Model Type										
RA332 Acquisition Module for RPV311	RA332									
Power Supply										
24-48 Vdc		1								
100-250 Vdc / 110-240 Vac		3								
Analogue Inputs 1 to 4										
~~Voltage inputs 115 V / Current inputs 1 A; full-scale 20 A (Ith = 40 A) (withdrawn)~~			~~1~~							
Voltage inputs 115 V / Current inputs 1 A; full-scale 40 A (Ith = 100 A)			2							
Voltage inputs 115 V / Current inputs 5 A; full-scale 100 A (Ith = 200 A)			5							
Voltage inputs 115 V / Current inputs 5 A; full-scale 200 A (Ith = 200 A)			6							
~~Voltage inputs 115 V / Current inputs 5 A; full-scale 14 A (Ith = 32 A) (withdrawn)~~			~~T~~							
Voltage inputs ±10 Vdc / Current inputs 0-20 mAdc			D							
Voltage inputs 115 V / Current inputs 100 mA; full-scale 100 mA (Ith = 2 A)			P							
Not installed			X							
Analogue Inputs 5 to 8										
~~Voltage inputs 115 V / Current inputs 1 A; full-scale 20 A (Ith = 40 A) (withdrawn)~~				~~1~~						
Voltage inputs 115 V / Current inputs 1 A; full-scale 40 A (Ith = 100 A)				2						
Voltage inputs 115 V / Current inputs 5 A; full-scale 100 A (Ith = 200 A)				5	-	-	-			
Voltage inputs 115 V / Current inputs 5 A; full-scale 200 A (Ith = 200 A)				6						
~~Voltage inputs 115 V / Current inputs 5 A; full-scale 14 A (Ith = 32 A) (withdrawn)~~				~~T~~						
Voltage inputs ±10 Vdc / Current inputs 0-20 mAdc				D						
Voltage inputs 115 V / Current inputs 100 mA; full-scale 100 mA (Ith = 2 A)				P						
Not installed				X						
Analogue Inputs 9 to 12										
~~Voltage inputs 115 V / Current inputs 1 A; full-scale 20 A (Ith = 40 A) (withdrawn)~~					~~1~~					
Voltage inputs 115 V / Current inputs 1 A; full-scale 40 A (Ith = 100 A)					2					
Voltage inputs 115 V / Current inputs 5 A; full-scale 100 A (Ith = 200 A)					5					
Voltage inputs 115 V / Current inputs 5 A; full-scale 200 A (Ith = 200 A)					6					
~~Voltage inputs 115 V / Current inputs 5 A; full-scale 14 A (Ith = 32 A) (withdrawn)~~					~~T~~					
Voltage inputs ±10 Vdc / Current inputs 0-20 mAdc					D					
Voltage inputs 115 V / Current inputs 100 mA; full-scale 100 mA (Ith = 2 A)					P					
Not installed					X					
Analogue Inputs 13 to 16										

~~Voltage inputs 115 V / Current inputs 1 A; full-scale 20 A (Ith = 40 A) (withdrawn)~~	~~1~~
Voltage inputs 115 V / Current inputs 1 A; full-scale 40 A (Ith = 100 A)	2
Voltage inputs 115 V / Current inputs 5 A; full-scale 100 A (Ith = 200 A)	5
Voltage inputs 115 V / Current inputs 5 A; full-scale 200 A (Ith = 200 A)	6
~~Voltage inputs 115 V / Current inputs 5 A; full-scale 14 A (Ith = 32 A) (withdrawn)~~	~~T~~
Voltage inputs ±10 Vdc / Current inputs 0-20 mAdc	D
Voltage inputs 115 V / Current inputs 100 mA; full-scale 100 mA (Ith = 2 A)	P
Not installed	X
Digital Inputs 1 to 16	
24 V / 48 V	1
125 V	2
250 V	3
Not installed	X
Digital Inputs 17 to 32	
24 V / 48 V	1
125 V	2
250 V	3
Not installed	X
Customization / Regionalisation	
GE branding	C
Hardware Design Suffix	
Third version	C

10.4 RA333

Variants	Order Number								
	1-5	6	7	8	9	10	11	12	13
Model Type									
RA333 Travelling Wave and DFR Acquisition Module for RPV311	RA333								
Power Supply									
100-250 Vdc / 110-240 Vac		3							
100-250 Vdc / 110-240 Vac		3							
Analogue Inputs 1 to 4									
~~Voltage inputs 115 V / Current inputs 1 A; full-scale 20 A (Ith = 40 A) (withdrawn)~~			~~1~~						
Voltage inputs 115 V / Current inputs 1 A; full-scale 40 A (Ith = 100 A)			2						
Voltage inputs 115 V / Current inputs 5 A; full-scale 100 A (Ith = 200 A)			5						
Voltage inputs 115 V / Current inputs 5 A; full-scale 200 A (Ith = 200 A)			6						
~~Voltage inputs 115 V / Current inputs 5 A; full-scale 14 A (Ith = 32 A) (withdrawn)~~			~~T~~						
Voltage inputs ±10 Vdc / Current inputs 0-20 mAdc			D						
Voltage inputs 115 V / Current inputs 100 mA; full-scale 100 mA (Ith = 2 A)			P						
Not installed			X						
Analogue Inputs 5 to 8									
~~Voltage inputs 115 V / Current inputs 1 A; full-scale 20 A (Ith = 40 A) (withdrawn)~~				~~1~~					
Voltage inputs 115 V / Current inputs 1 A; full-scale 40 A (Ith = 100 A)				2					
Voltage inputs 115 V / Current inputs 5 A; full-scale 100 A (Ith = 200 A)				5	-	-	-		
Voltage inputs 115 V / Current inputs 5 A; full-scale 200 A (Ith = 200 A)				6					
~~Voltage inputs 115 V / Current inputs 5 A; full-scale 14 A (Ith = 32 A) (withdrawn)~~				~~T~~					
Voltage inputs ±10 Vdc / Current inputs 0-20 mAdc				D					
Voltage inputs 115 V / Current inputs 100 mA; full-scale 100 mA (Ith = 2 A)				P					
Not installed				X					
Digital Inputs 1 to 16									
24 V / 48 V					1				
125 V					2				
250 V					3				
Not installed					X				
Digital Inputs 17 to 32									
24 V / 48 V						1			
125 V						2			
250 V						3			
Not installed						X			
Travelling Wave Input									
Three-phase bus or line voltage							V		
Customization / Regionalisation									
GE branding								C	

Hardware Design Suffix	
Fourth version	D
Third version (withdrawn)	~~C~~

RPV311

Distributed Multifunction Fault Recorder

Chapter 2: Safety Information

This chapter provides information about the safe handling of the equipment. The equipment must be properly installed and handled in order to maintain it in a safe condition and to keep personnel safe at all times. You must be familiar with information contained in this chapter before unpacking, installing, commissioning, or servicing the equipment.

1 Health and Safety

Personnel associated with the equipment must be familiar with the contents of this Safety Information.

When electrical equipment is in operation, dangerous voltages are present in certain parts of the equipment. Improper use of the equipment and failure to observe warning notices will endanger personnel.

Only qualified personnel may work on or operate the equipment. Qualified personnel are individuals who are:

- familiar with the installation, commissioning, and operation of the equipment and the system to which it is being connected.
- familiar with accepted safety engineering practises and are authorised to energise and de-energise equipment in the correct manner.
- trained in the care and use of safety apparatus in accordance with safety engineering practises
- trained in emergency procedures (first aid).

The documentation provides instructions for installing, commissioning and operating the equipment. It cannot, however cover all conceivable circumstances. In the event of questions or problems, do not take any action without proper authorisation. Please contact your local sales office and request the necessary information.

Each product is subjected to routine production testing for Dielectric Strength and Protective Bonding Continuity

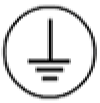
2 Symbols

Throughout this manual you will come across the following symbols. You will also see these symbols on parts of the equipment.

Caution: Refer to equipment documentation. Failure to do so could result in damage to the equipment

Risk of electric shock

Ground terminal. Note: This symbol may also be used for a protective conductor (ground) terminal if that terminal is part of a terminal block or sub-assembly.



Protective conductor (ground) terminal

Both direct and alternating current

Instructions on disposal requirements

The term 'Ground' used in this manual is the direct equivalent of the European term 'Earth'.

3 Installation, Commissioning and Servicing

3.1 Lifting Hazards

Many injuries are caused by:

- Lifting heavy objects
- Lifting things incorrectly
- Pushing or pulling heavy objects
- Using the same muscles repetitively

Plan carefully, identify any possible hazards and determine how best to move the product. Look at other ways of moving the load to avoid manual handling. Use the correct lifting techniques and Personal Protective Equipment (PPE) to reduce the risk of injury.

3.2 Electrical Hazards

All personnel involved in installing, commissioning, or servicing this equipment must be familiar with the correct working procedures.

Consult the equipment documentation before installing, commissioning, or servicing the equipment.

Always use the equipment as specified. Failure to do so will jeopardise the protection provided by the equipment.

Removal of equipment panels or covers may expose hazardous live parts. Do not touch until the electrical power is removed. Take care when there is unlocked access to the rear of the equipment.

Isolate the equipment before working on the terminal strips.

Use a suitable protective barrier for areas with restricted space, where there is a risk of electric shock due to exposed terminals.

Disconnect power before disassembling. Disassembly of the equipment may expose sensitive electronic circuitry. Take suitable precautions against electrostatic voltage discharge (ESD) to avoid damage to the equipment.

NEVER look into optical fibres or optical output connections. Always use optical power meters to determine operation or signal level.

Testing may leave capacitors charged to dangerous voltage levels. Discharge capacitors by reducing test voltages to zero before disconnecting test leads.

If the equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired.

Operate the equipment within the specified electrical and environmental limits.

Before cleaning the equipment, ensure that no connections are energised. Use a lint free cloth dampened with clean water.

Integration of the equipment into systems shall not interfere with its normal functioning.

The functioning of the device has been certified under the circumstances described by the standards mentioned in

Chapter 17: Technical Specifications (item Type Tests). Usage of the equipment in different conditions from the specified in this manual might affect negatively its normal integrity.

The equipment shall have all their rear connectors attached even if they are not being used, in order to keep their levels of ingress protection as high as possible

Never manipulate liquid containers near the equipment even when it is powered off.

Avoid modification to the wiring of panel when the system is running.

VT circuits must never be left short circuited.

3.3 Fusing and Insulation Requirements

A high rupture capacity (HRC) fuse type with a maximum current rating of 10 Amps and a minimum dc rating of 250 V dc may be used for the auxiliary supply (for example Red Spot type NIT or TIA). Alternatively a miniature circuit breaker (MCB) of type C, 10A rating, compliant with IEC 60947-1 and IEC 60947-3 may be used.

Digital input circuits should be protected by a high rupture capacity NIT or TIA fuse with maximum rating of 10 A, or equivalent MCB as above. For safety reasons, current transformer circuits must never be fused. Other circuits should be appropriately fused to protect the wire used.

Reason devices contain an internal fuse for the power supply which is only accessed by opening the product. This does not remove the requirement for external fusing or use of an MCB as previously mentioned. The ratings of the internal fuses are:

RPV unit: 5 Amp, type T, 250V rating

RA units: 2 Amp, type T, 250V rating

CTs must NOT be fused since open circuiting them may produce lethal hazardous voltages.

Models with a low DC power source must be supplied with a DC supply source to the equipment that is derived from a secondary circuit which is isolated from the AC/DC Mains by Double or Reinforced Insulation (e.g.: UL Certified ITE power supply which provides Double or Reinforced Insulation).

3.4 Equipment Connections

Terminals exposed during installation, commissioning and maintenance may present a hazardous voltage unless the equipment is electrically isolated.

Tighten M3 clamping screws of heavy duty terminal block connectors to a nominal torque of 1.0 Nm.
Tighten captive screws of header-type (Euro) terminal blocks to 0.5 Nm minimum and 0.6 Nm maximum.

Always use insulated crimp terminations for voltage and current connections.

Always use the correct crimp terminal and tool according to the wire size.

In order to maintain the equipment's requirements for protection against electric shock, other devices connected to the RPV311 and RA33x shall have protective class equal or superior to Class I.

Watchdog (self-monitoring) contacts are provided to indicate the health of the device on some products. We strongly recommend that you hard wire these contacts into the substation's automation system, for alarm purposes.

Earth the equipment with the supplied PCT (Protective Conductor Terminal).

Do not remove the PCT.

The PCT is sometimes used to terminate cable screens. Always check the PCT's integrity after adding or removing such earth connections.

The user is responsible for ensuring the integrity of any protective conductor connections before carrying out any other actions.

The PCT connection must have low-inductance and be as short as possible. For best EMC performance, ground the unit using a 10 mm (0.4 inch) wide braided grounding strap.

All connections to the equipment must have a defined potential. Connections that are pre-wired, but not used, should be earthed, or connected to a common grouped potential.

Pay extra attention to diagrams before wiring the equipment. Always be sure that the connections are correct before energizing the circuits.

The connections: Console1, Console2, MODEM and Process bus are non-isolated and for local connection only.

3.5 Pre-energisation Checklist

Check voltage rating/polarity (rating label/equipment documentation).

Check CT circuit rating (rating label) and integrity of connections.

Check protective fuse or miniature circuit breaker (MCB) rating.

Check integrity of the PCT connection.

Check voltage and current rating of external wiring, ensuring it is appropriate for the application.

3.6 Peripheral Circuitry

Do not open the secondary circuit of a live CT since the high voltage produced may be lethal to personnel and could damage insulation. Short the secondary of the line CT before opening any connections to it.

Reason devices DO NOT feature any automatic CT shorting feature. Therefore external shorting of the CTs is mandatory. Check the equipment documentation and wiring diagrams carefully.

Where external components such as resistors or voltage dependent resistors (VDRs) are used, these may present a risk of electric shock or burns if touched.

Operation of computers and equipment connected to RPV311 and RA33x under environmental conditions such as temperature and humidity that exceed the conditions specified in their respective manuals can cause malfunctioning or even irreversible damage to them or the nearby installation.

There might be situations in which the RPV311 and RA33x are operating within its environmental operational range, but the computers, equipment connected to them or nearby equipment are operating outside their operational range. That situation can cause malfunctioning and/or irreversible damage to those devices. In that occasion the communication to the Reason equipment might be compromised but its recording, operational and safety capacities will not be affected.

Take extreme care when using external test blocks and test plugs such as the MMLG, MMLB and P990, as hazardous voltages may be exposed. Ensure that CT shorting links are in place before removing test plugs, to avoid potentially lethal voltages.

3.7 Upgrading/Servicing

Do not insert or withdraw modules, PCBs or expansion boards from the equipment while energized, as this may result in damage to the equipment. Hazardous live voltages would also be exposed, endangering personnel.

Internal modules and assemblies can be heavy and may have sharp edges. Take care when inserting or removing modules into or out of the IED.

4 Decommissioning and Disposal

Before decommissioning, completely isolate the equipment power supplies (both poles of any dc supply). The auxiliary supply input may have capacitors in parallel, which may still be charged. To avoid electric shock, discharge the capacitors using the external terminals before decommissioning.

Avoid incineration or disposal to water courses. Dispose of the equipment in a safe, responsible and environmentally friendly manner, and if applicable, in accordance with country-specific regulations.

RPV311

Distributed Multifunction Fault Recorder

Chapter 3: Hardware Design

This chapter provides information about the hardware design of the products.

1 Hardware Architecture

The RPV311 is a multifunction processing unit and has an acquisition system with 16-bit A/D D converters that provide an acquisition rate of 256 points-per-cycle synchronized by the IRIG-B signal.

It has a high processing capability, which allows the acquisition of up to 64 analog channels and 256 digital channels divided in up to 8 acquisition modules connected by fiber-optic links. Additionally, it is able to detect IEC 61850 GOOSE messages.

All the registers are stored in a SSD hard disk.

It allows communication through the electrical Ethernet ports and optionally has a double internal converter for optical Ethernet interfaces.

Monitoring and configuration are performed through a web interface; also, it has a human-machine interface on the front panel for displaying information. It has a MODBUS and DNP3 interface for SCADA integration.

The RA331 module allows data acquisition of up to 8 analog channels (voltage, current, or DC transducers) and up to 32 digital channels. The RA332 module allows data acquisition of up to 16 analog channels (voltage, current, or DC transducers) and up to 32 digital channels. Both modules use 16-bit A/D converters providing an acquisition rate of 256 points-per-cycle.

The RA333 module allows data acquisition of high-speed analog channels (voltage) for one transmission line. This module allows the scheme to obtain traveling wave records for fault locating. Additionally, the RA333 module allows data acquisition of up to 8 analog channels (voltage, current, or DC transducers) and up to 32 digital channels, using 16-bit A/D converters providing an acquisition rate of 256 points-per-cycle

Figure 2: RA332, RA333 and RPV311

1.1 Processing Capability

The RPV311 has 8 link connections to communicate with RA33x acquisition units. As each acquisition unit has different number of channels and functions, they require different levels of demand from the RPV311. In order to respect the RPV311 processing capability the number of RA33x that can be connected to the RPV311 obey the following rule:
The RPV311 can process 12 logical slots and each RA demands the following number of slots.

Device	Logic Demand (slots)
RA331	1
RA332	2
RA333 DFR	1
RA333 TW	2

The user can combine the RA units as long as the logical sum of the slots value of each RA do not exceed the maximum number of 12.

> *Note:*
> *Differently from the RA331/332 the RA333 has two link: One for the DFR functionality and another for the TW functionality.*

2 Mechanical Implementation

2.1 RPV311

2.1.1 Main features

- Fan-less and no rotating part design
- Trigger waveform recorder at 256, 128, or 64 points-per-cycle;
- Continuous waveform recorder at 16 points-per-cycle;
- Continuous disturbance recorder and trigger recorder (optional);
- Trigger using Boolean logic equations;
- Traveling wave recorder for fault location (optional);
- MODBUS and DNP3 interface for SCADA integration (optional);

- Synchrophasor measurement according to IEEE C37.118 (optional);
- Power quality records:
  - Historical average at aggregation intervals of 1 or 10 minutes (optional);
  - Measurement and recording of harmonics up to the 50th order according to IEC 61000-4-7 (optional);
  - Measurement and recording of flicker according to IEC 61000-4-15:1997+A1:2003 (optional);
- Cross-trigger using standard network connection;
- One-end fault location based on Takagi algorithm;
- Flexible communication:
  - Two 10/100BaseT electrical Ethernet interfaces;
  - Two embedded optical Ethernet converters;
  - RS232 serial port for modem connection;
- Support for IEC 61850:
  - Up to 320 binary inputs related to GOOSE messages (optional);
  - Two Ethernet ports for redundant connection (optional);
  - One Ethernet port for Process Bus (Sampled Values) connection (optional).
- Local interface on the front panel;
- dry-contact relays for remote signalling;
- Fax and/or e-mail message after detection of a trigger. The fax can be sent to two different destinations and the e-mail to four different destinations (optional).

2.1.2 Components

Front view of the RPV311, showing all the main components on the front panel.

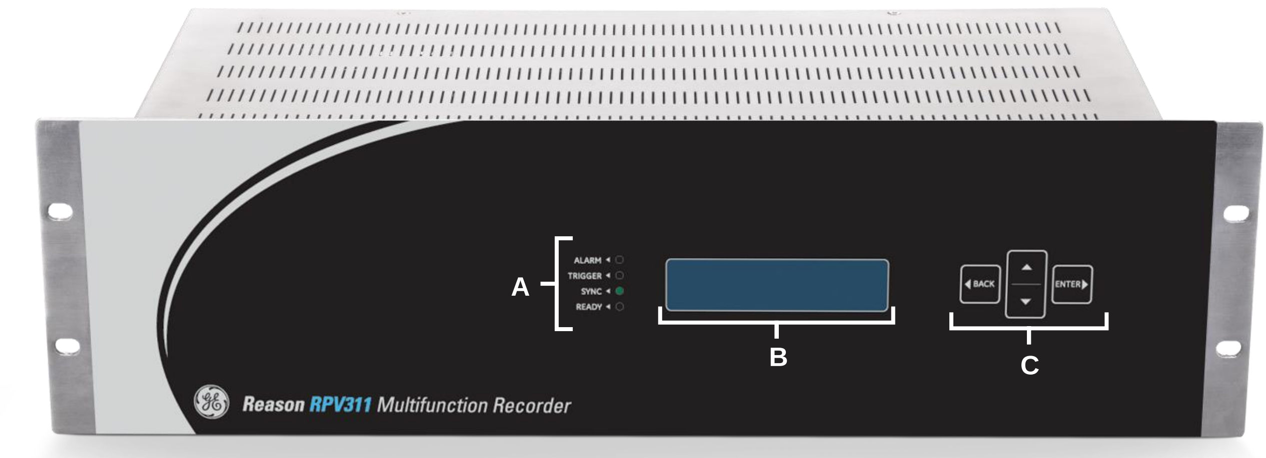


Figure 3: Front View of the RPV311

A Indicators of the state of the equipment:

Alarm: Lights up when the equipment requires attention of the operator.

Trigger: Flashes when a threshold has been triggered;

Sync: Lights up when the internal clock and the acquisition system are synchronized through the IRIG-B signal, whether the GPS Clock that provides the IRIG-B signal is locked or not;

Ready: Lights up after the equipment has passed through the self-test routines and is then in normal operation.

B Local interface for human-machine interaction.

C Buttons for navigation on the local interface.

Back view of the RPV311, showing all the main components on the back panel.

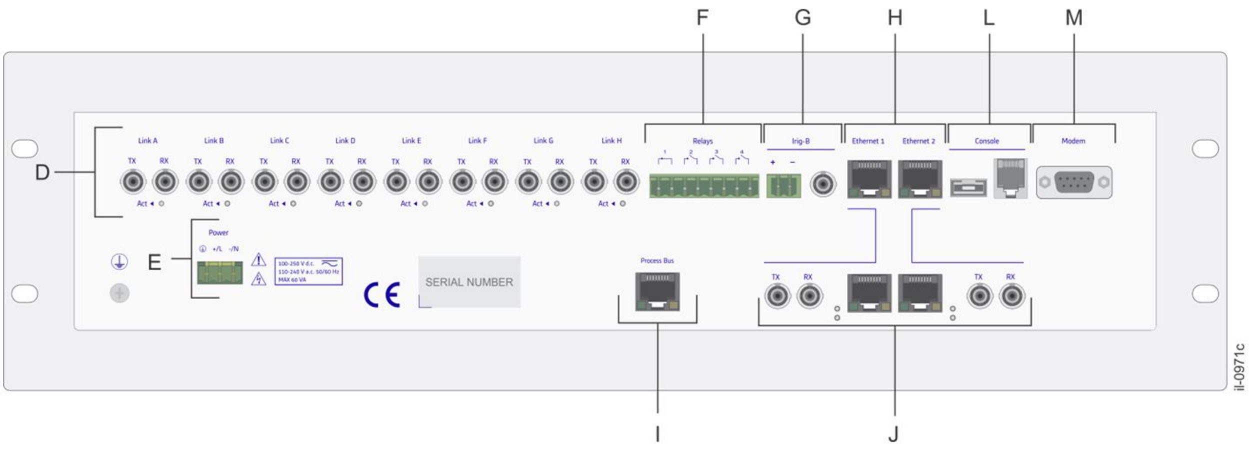


Figure 4: Back view of the RPV311

D Up to 8 pairs of connectors for fiber-optic links. For each link there is an Act indicator that lights up when the link is receiving data of the acquisition module.

E AC or DC power input.

F 4 dry contact relays.

G Electrical and Optical (optional) IRIG-B input for the external synchronization of the equipment.

H 2 electrical Ethernet interfaces for the communication between the equipment.

I 1 electrical Ethernet interface for the Process Bus communication.

J Double internal converter for optical Ethernet interface.

K Serial port RS232 for modem connection.

L Maintenance ports for exclusive use by GE's technical support personnel.

2.2 RA331

2.2.1 Main Features

- Up to 8 analog inputs (voltage, current, DC transducers, probes);
- Up to 32 digital inputs;
- 16-bit analog-to-digital converters, 256 points-per-cycle sampling rate;
- Frequency response of DC to 3.0 kHz;
- Fiber-optic interface to connect to the processing module;
- Up to 2 km fiber-optic links;
- Front panel mounting or internal panel mounting.

2.2.2 Components

Figure 5 shows all the components of the RA331 module.

Figure 5: Rear and front views of the RA331, respectively

A AC or DC power input.

B Mains and Ready back panel indicators: The Mains is lit when the module is powered. Ready indicator lights up after the module self-test is completed.

C Up to 8 analog inputs for voltage, current, or DC transducers, identified as 101 to 108.

D Up to 32 digital inputs identified as 201 to 232.

E One connector for fiber optic links. The connector has an Act indicator that lights up when its link is active (i.e., it is receiving requests of the processing module).

F Front Panel Indicators: Mains lights up when the module is powered-up. Ready indicator lights up after the module self-test is completed. The Link1 indicator lights up when active.

2.3 RA332

2.3.1 Key Features

- Up to 16 analog inputs (voltage, current, DC transducers, probes);
- Up to 32 digital inputs;
- 16-bit analog-to-digital converters, 256 points-per-cycle sampling rate;
- Frequency response of DC to 3.0 kHz;
- Fiber-optic interface to connect to the processing module;
- Up to 2 km fiber-optic links;
- Front panel mounting or internal panel mounting.

2.3.2 Components

Figure 6 shows all the components of the RA332 module.

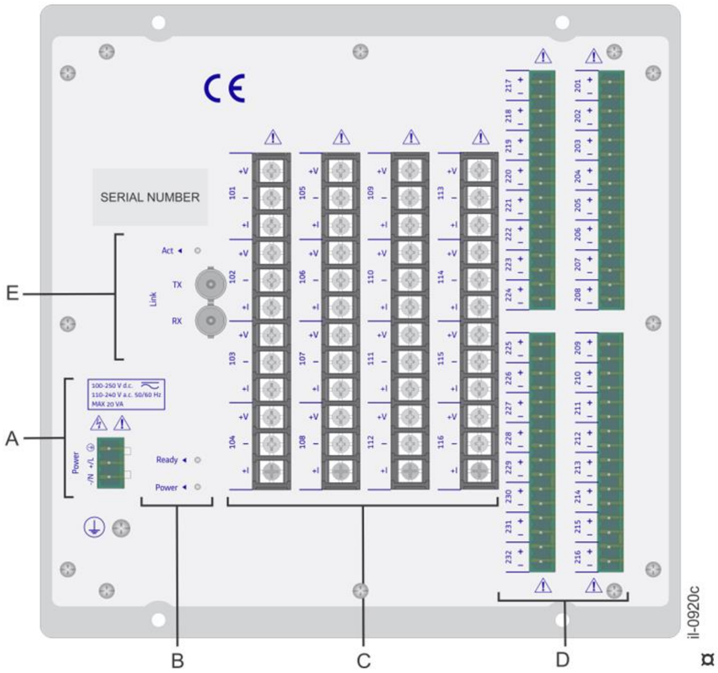


Figure 6: Rear view of the RA332

A AC or DC power input.

B Mains and Ready back panel indicators: Mains is lit when the module is powered-up. Ready indicator lights up after the module self-test is completed.

C Up to 16 analog inputs for voltage, current, or DC transducers, identified as 101 to 116.

D Up to 32 digital inputs identified as 201 to 232.

E One connector for fiber optic links. The connector has an Act indicator that lights up when its link is active (i.e., it is receiving requests of the processing module).

Front Panel Indicators: Mains lights up when the module is powered-up. Ready indicator lights up after the module self-test is completed. The Link1 indicator lights up when active. The front panels indicator of the RA332 are the same as the RA331, see Figure 5.

2.4 RA333

2.4.1 Key Features

- 3 high-speed analog inputs with 5 MHz;
- Up to 8 analog inputs with 50/60 Hz (voltage, current, DC transducers);
- Up to 32 digital inputs;
- 16-bit analog-to-digital converters, 256 points-per-cycle sampling rate for 50/60 Hz acquisition;
- 8-bit analog-to-digital converters, 5 MHz sampling frequency for high-speed acquisition;
- Frequency response of DC to 3.0 kHz;
- 2 fiber-optic interface to connect to the processing module, one for 50/60 Hz and other for high-speed acquisition;
- Up to 2 km fiber-optic links;
- Front panel mounting or internal panel mounting.

2.4.2 Components

Figure 7 shows all the components of the RA333 module.

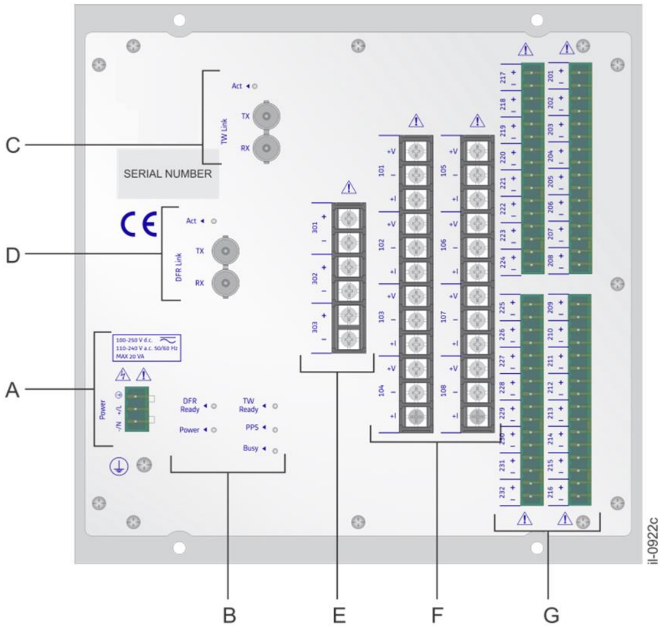


Figure 7: Front and back views of the RA333

A AC or DC power input.

B Rear TW and DFR indicators, that means:

The Ready indicator lights up after the module's self-test is completed;
The Mains indicator lights up when the module is powered;
The PPS indicator flashes signaling that the timing signal of the processing module is detected;
The Busy indicator lights up when a traveling wave signal is detected and the RA333 is transmitting the data for processing module.

C Connector for fiber optic link between RA333 and processing module of the TW acquisition. The connector has an Act indicator that lights up when its link is active (i.e., it is receiving requests of the processing module).

D Connector for fiber optic link between RA333 and processing module of the analog acquisition. The connector has an Act indicator that lights up when its link is active (i.e., it is receiving requests of the processing module).

E 3 high-speed analog inputs with 5 MHz identified as 301 to 303.

F Up to 8 analog inputs for voltage, current, or DC transducers, identified as 101 to 108.

G Up to 32 digital inputs identified as 201 to 232.

The front panel of the RA333 has the following indicative LEDs:

The DFR Link indicators are lit when their links are active.

The DFR Ready indicators light up after the module self-test is completed.

The TW Busy indicator lights up when a traveling wave signal is detected and the RA333 is transmitting the data for processing module.

The TW PPS blinks once per second indicating that the unit is synchronized.

The TW LINK indicates that the TW module in the RA333 is communicating with the RPV311 processing unit.

The TW READY indicates that the TW module in the RA333 is healthy.

MAINS lights up when the RA333 is powered on.

RPV311

Distributed Multifunction Fault Recorder

Chapter 4: Configuration

This chapter includes concise instructions of how to configure all available features in the device.

1 Accessing the Equipment Configuration

Access to the equipment's configuration is provided by the Web Interface. When the equipment is accessed, a copy of the current configuration is maintained on the equipment until a new configuration is sent.
To enter the configuration interface, click on the <CONFIGURE> button of the initial Web Interface. A new window is open. The username and password are required. The default username and password are:

Default username and password to enter the configuration interface	
Username	admin
Password	1234

The available information on the initial configuration screen is described below:

A Menu configuration items. It is recommended that the configuration of the equipment be performed item by item in top-to-bottom order. The menu items in the configuration can be configured one by one and by clicking on the <OK> button, the changes are saved in the interface but will not be sent to the equipment. By clicking on the <CANCEL> button, the changes are discarded.

B The <LOGOUT> button allows user to logout the configuration section.

C To send the changes to the equipment, click on the <UPLOAD> button. Before sending the configuration to the equipment, the user must define the changes to be included in the configuration history. By clicking the <OK> button, the configuration is send and the equipment will be temporarily unavailable.

D Arrows to pass by the menu items.

If the configuration is not transmitted to the equipment, the changes are not applied.

Opening more than one configuration section at a time is not allowed. If a second session is required, the following message will show:

The server is temporarily unable to service your request due to maintenance downtime or capacity problems. Please try again later.

By using the Configuration Tool, which is part of the DR Manager software, it is possible to receive, manage, save, edit and transmit the configuration between equipment and a computer.

For information about the Configuration Tool, see Chapter 13: Software – DR Manager.

1.1 Configuration History

The history of changes in the equipment configuration can be shown in the Web Interface. The information shown is:

Revision Indicates the number of each configuration;
Time stamp Indicates the date and time the configuration was changed;
User Indicates who changed the configuration;
Description Describes the change.

To obtain a report about the configuration, select the revision of the configuration and click on the <REPORT> button. A new window will open displaying all the information about the configuration selected.

The configuration of the RPV311 can be done in 4 languages: English, Spanish, Russian, Polish and Portuguese.

2 Equipment

2.1 Identification

On this screen, shown below, it is possible to configure the equipment identifier, location and owner.
These three fields make up the equipment file name pursuant to the COMNAME rule.
The equipment identification will appear in the name of the records; therefore, it is very important that it be properly identified. The name format of the records is:

date,hour,location,identifier,owner...

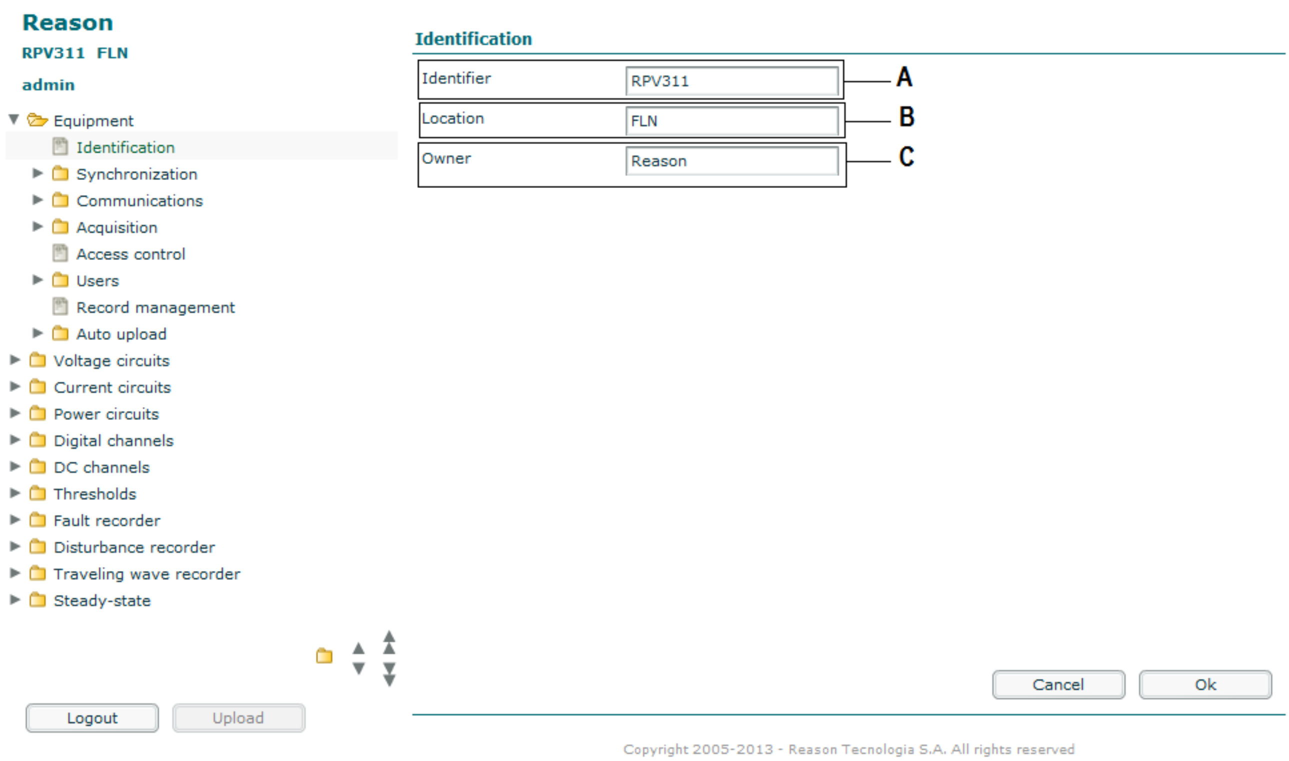


Figure 8: Equipment identification configuration section

A The IDENTIFIER text field allows user to enter an equipment code (maximum 12 characters).

B The LOCATION text field allows user to enter a substation code (maximum 12 alphanumeric characters, _ , — , 0 , 0-9 , a-z , A-Z)

C The OWNER text field allows user to enter the name of the company which purchased the equipment (maximum 12 characters).

2.2 Synchronization

If the IRIG-B signal has the CF extensions (IEEE1344), timing information as date, hour, year, time zone and daylight saving time can be provided by the signal. Time zone and daylight saving time information can also be manually set via the Web Interface, overriding the information of the IRIG-B signal.

2.2.1 Time Source

On the screen TIME SOURCE it is possible to configure how the RPV311 will interpret the time zone of the IRIGB signal and also the IP address of the NTPv2, 3 or 4 server.
The configurable settings are:

A Synch Source: Allows to user to choose between the **IRIG-B** signal or **No Source**.

B The TIMEZONE defines if time zone information is supplied by the IEEE1344 extensions of the IRIG-B signal, or if it is manually set. This option will allow the RPV311 to identify the UTC time using information from the signal or from the manual configuration of the user:

- When Auto (IRIGB with extensions) is selected the RPV311 shall use the information of time zone sent within the IRIGB signal to recover the UTC time.
- When Manual is selected the RPV will not consider eventual time zones within the IRIGB signal, and rather it will use the UTC time zone configured in the Manual parameter to retrieve the UTC time. This option is used specially when the IRIGB does not inform the time zone, so the RPV311 cannot retrieve the UTC time unless we inform the time zone manually.

The time setting that the RPV will use for time stamping is configured on the screen Internal Clock.

It is possible to configure 30 min time zones.

C The NTP FALLBACK SERVER defines the IP address of the SNTP time server to be used to provide time synchronism when the IRIG-B is not connected.

2.2.2 Internal Clock

On the screen the internal clock for time stamping the registers and logs is configured, as well as day light saving configurations.The configurable settings are:

A The TIMEZONE defines if time zone information is supplied by the IEEE1344 extensions of the IRIG-B signal, or if it is manually set.

- When Auto is selected the RPV311 will use the same local time sent within the IRIGB signal.
- When Manual is selected the RPV311 will use the UTC time (retrieved using information from the Time Source screen) and calculate the local time using the UTC time zone configured on the Internal Clock screen.

B The DAYLIGHT SAVING TIME defines if time information is supplied by IEEE1344 extensions of the IRIG-B signal, or if it is either manually set or disabled. If it is manually set, it is possible to choose the date and time of the start and the end of the DST period.

It is possible to configure 30 min time zones.

2.3 Communications

The RPV311 communication may be via Ethernet and serial ports. The equipment may also operate as a gateway over a local subnet.
Optionally the user can choose between two types of Ethernet, optical and electrical.

Gateway setup will enable the RPV311 to communicate with other equipment connected over a local subnetwork. The Gateway can be configured by accessing the equipment gateway configuration section, shown in Figure 9.

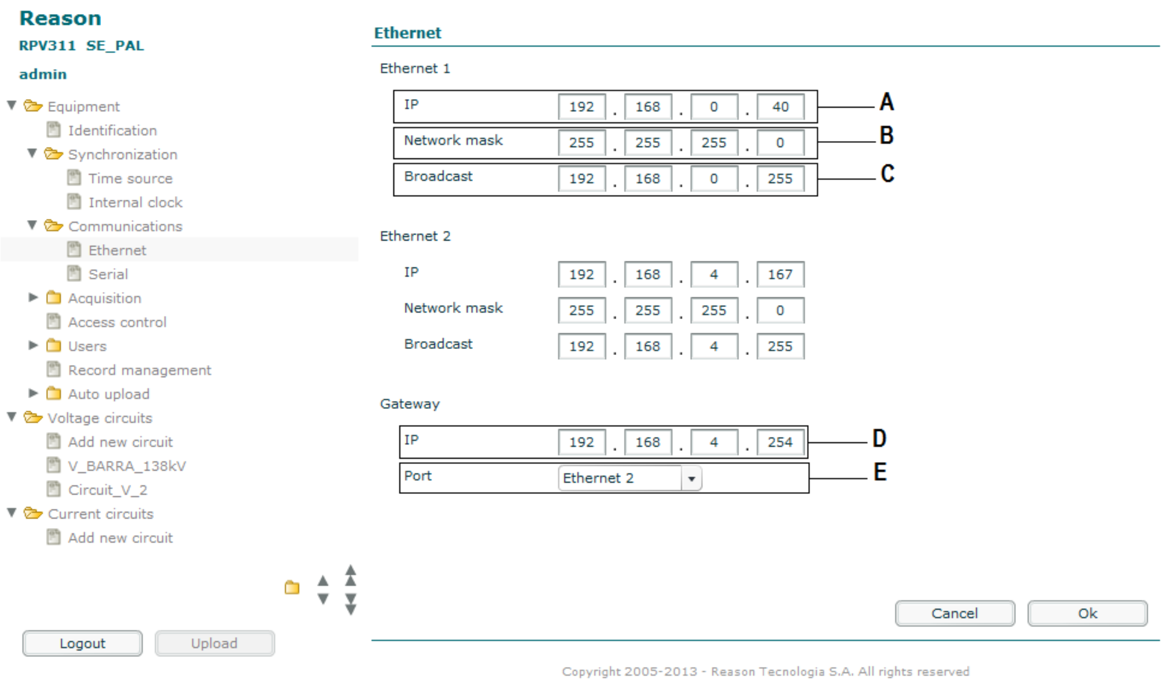


Figure 9: Equipment Ethernet configuration section

A The IP text field allows user to enter the equipment's IP address.

B The NETWORK MASK text field allows user to enter the subnetwork mask to which the equipment is connected.

C The BROADCAST text field allows user to enter the sub network broadcast address to which the equipment is connected.

D The IP text field allows user to enter the equipment's IP address.

E The PORT scroll box allows user to select the communication port of the equipment used as gateway.

Ethernet 1 and Ethernet 2 can be configured.

The Ethernet port enables the RPV to connect to the TCP / IP / UDP / IP networks.

The RPV311 allows point-to-point communication with a conventional modem, cellular phone, GPRS and radio links. The Serial Port can be configured by accessing the section shown in Figure 10.

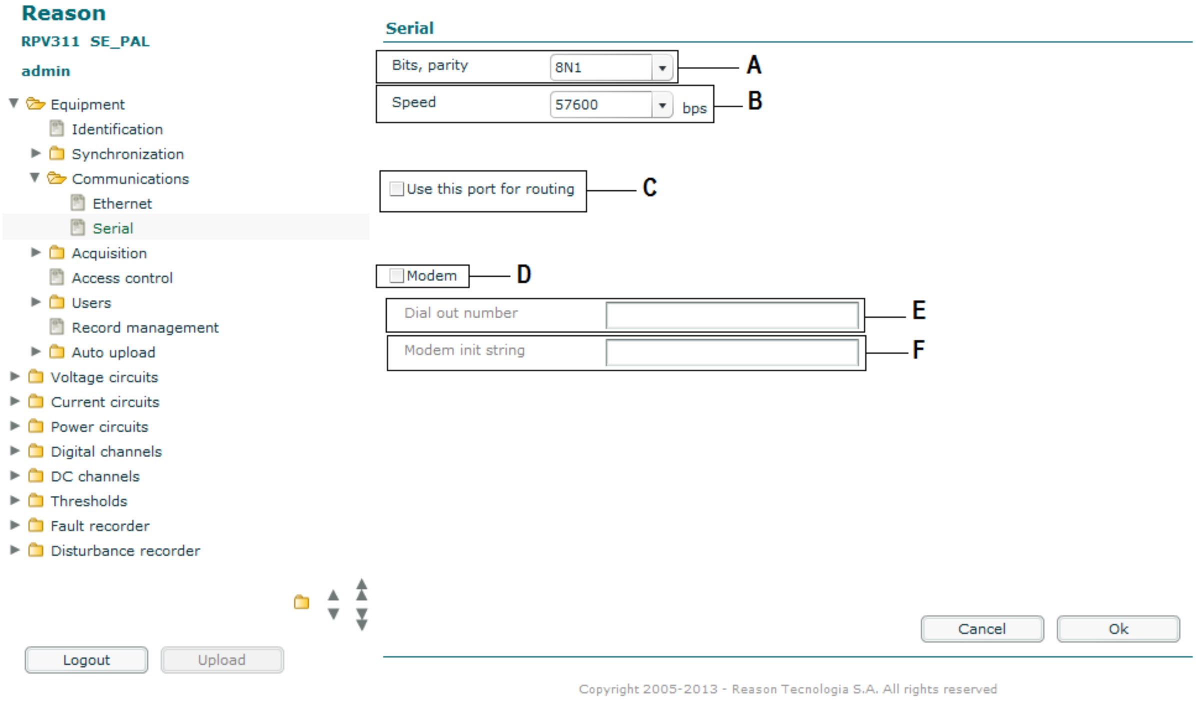


Figure 10: Equipment serial port configuration section

A The Bits, parity scroll box allows user to select the data bits (7 or 8), parity (none, even or odd) and stop bit (1 or 2).

B The Speed scroll box allows user to select the speed: 4800, 9600, 19200, 57600 or 115200 bps.

C The Use this port for routing check box enables the use of the equipment as a router for another network.

D The Modem check box allows permanent communication between an RPV311 and a server through a telephone line.

E The Dial out number text field allows user to enter a number to be dialed via modem. This can be left blank if a direct serial communication link is used.

F The Modem init string text field allows user to enter a string of characters which will be sent to the modem before any communication is attempted. This can be left blank.

2.4 Acquisition with remote acquisition modules

The RPV311 data acquisition can be performed by the RA331, RA332 and RA333 remote acquisition modules.

The RA333 module consists of two different acquisition systems. One, called DFR, is used for analog data acquisition of 50/60 Hz of voltage, current, or DC. The other, called TW, is used for high-speed acquisition of traveling waves. The RA333 (TW) and RA333 (DFR) are physically installed in the same module, but are logically independent, i.e., the RPV311 will be treated as two logical modules.

The RA331, RA332 and RA333 (DFR) modules are independent and use 16-bit opto-isolated A/D converters with simultaneous acquisition of all channels provided by the IRIG-B signal, thus ensuring that the frequency acquisition is kept constant.

The analog channels for current measurement use internal shunts to minimize the effects of phase variation caused by transformers.

There is a delay in the data transmission of the acquisition module for the processing module proportional to the length of the fiber-optic cable. This delay is compensated by the RPV311 considering the information of the fiber length specified in the configuration of the equipment.

The links should be installed of positions A to L. Intermediate empty positions are considered as "using" 8 analog channels.

Each link must be configured considering the module type and its inputs.

To configure the links, access the LINKS section, shown in Figure 11.

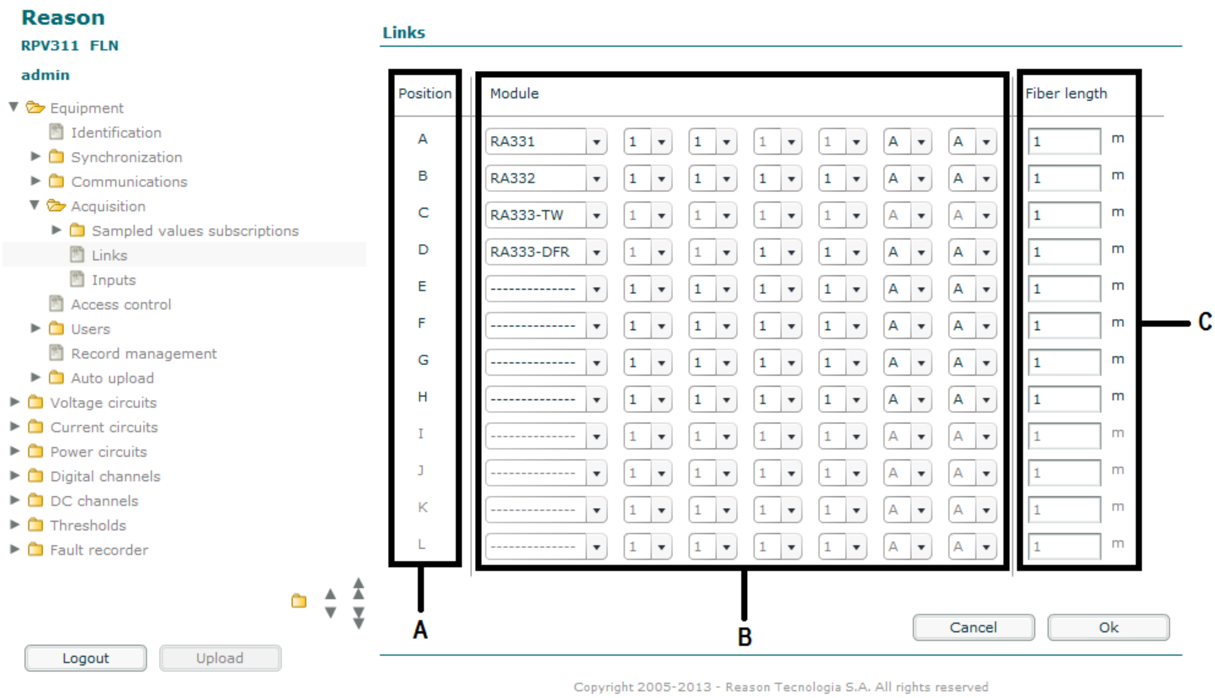


Figure 11: Links between RPV and acquisition modules configuration section

A The Position represents the position where the acquisition module is physically connected to the RPV311. Positions A to L.

B The Module scroll box allows user to select the acquisition module used in the link and its characteristics based on the Part Number of the module. The modules can be:

RA331: Acquisition module with up to 8 analog (voltage, current, or DC) and 32 digital channels;

RA332: Acquisition module with up to 16 analog (voltage, current, or DC) and 32 digital channels;

RA333 (TW): High frequency acquisition module with 3 high-speed analog channels for acquisition of the traveling waves;

RA333 (DFR): Acquisition module with up to 8 analog (voltage, current, or DC) and 16 digital channels.

Note 1:
The last two fields related to the binary inputs are configure according to the physical order of the inputs in the back of the RA33x, as in Figure 6: Rear view of the RA332. The last field corresponds to the inputs 201 to 216 and the next to the last to 217 to 232. In the Part Number the binary fields are inverted in comparison with the physical order.
Note 2:
The board options 2 and 6 are only available from RPV311 firmware version 14 onwards

C The Fiber length text field allows user to enter the fiber length, in meters, to compensate the delay in the data transmission between the acquisition and processing modules.

All analog channels have two configuration options. Circuits and channels will be configured based on the option selected.
In the Inputs section, shown in **Figure 12**, it is possible to configure the analog inputs of the acquisition module connected with the RPV311 configured in the previous section.
It is important to configure the analog inputs for voltage or current, according to the physical configuration of the module, shown in Chapter 15: Installation. The RA333's high-speed acquisition channels do not require configuration, since they are dedicated for voltage measurement.
To improve the accuracy of the measurement, a correction factor can be manually provided. Inputs without the correction factor have accuracy better than 1%.
The digital channels do not have type selection.

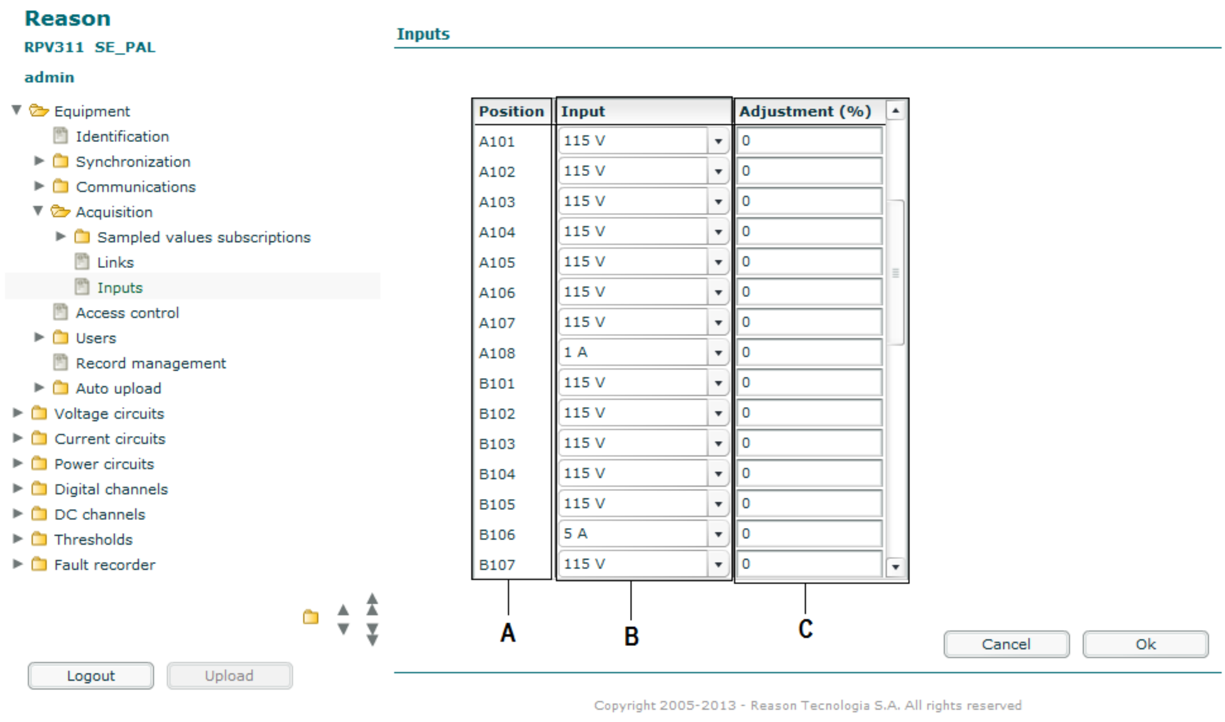


Figure 12: Analog inputs configuration section

A The POSITION indicates the position of each analog input on the back panel of the module.

B The INPUT scroll box allows user to select the type of the signal to be measured (AC voltage 115 V, AC current 1 A, AC current 5 A, DC current 0-20 mA or DC voltage ±10 V).

C The ADJUSTMENT text field allows user to enter a correction factor to adjust the accuracy of the measurement.

2.5 Acquisition with Sampled Values

The RPV311 data acquisition can be performed by Sampled Values data, incoming of Merging Units. The acquisition is done by connecting the Process Bus Ethernet port to the Sampled Values generator.

If the acquisition is done by Sampled Values, there is no physical link to configure. The configuration is performed by Subscription links. Each subscription link contains data of 4 current (Phases A, B, C and Neutral) and 4 voltage (Phases A, B, C and Neutral) circuits. Once a subscription link is created, the RPV311 automatically configures the first channels as current and the last as voltage, as shown in Figure 86. This is done because the Merging Units send the Sampled Values package according to the IEC 61850-9-2LE.

The RPV311 processing module can be configured with up to 8 Subscription links.

To configure the links, access the SAMPLED VALUES SUBSCRIPTIONS section, shown in Figure 13.

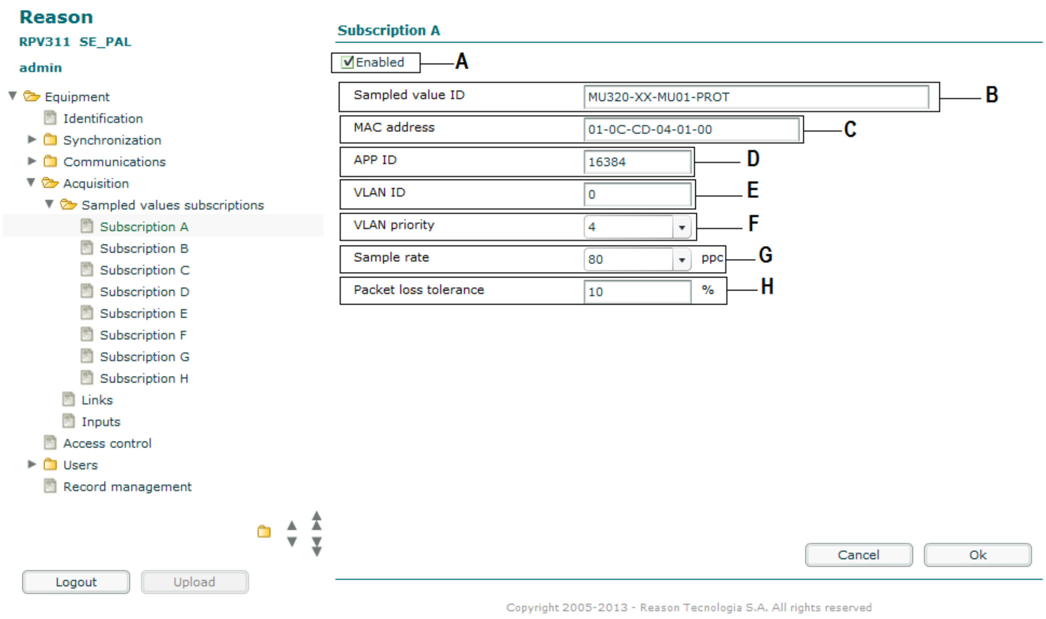


Figure 13: Sampled Values subscriptions links configuration section

A The ENABLED check box allows user to enable the Subscription link feature.

B The SAMPLED VALUE IDENTIFIER text field allow user to insert the monitored Sampled Values identification.

C The MAC ADDRESS text field allow user to insert the monitored Merging Unit MAC Address.

D The APP ID text field allow user to insert the monitored Sampled Values APP ID.

E The VLAN ID text field allow user to insert the VLAN ID of the monitored Sampled Values.

F The VLAN PRIORITY scroll box allow user to select the priority of the Sampled Values data at the configured VLAN.

G The SAMPLE RATE scroll box allow user to select the Sampled Values sample rate. 80 points-per-cycle is used for protection purposes and 256 points-per-cycles is used for measurement purposes.

H The PACKET LOSS TOLERANCE allow user to insert a package-loss rule.

In the Inputs section, shown in **Figure 14**, it is possible to configure the analog inputs of the Sampled Values configured in the previous section. It is important to configure the analog inputs for voltage or current, according to the Sampled Values messages received of the monitored Merging Unit.

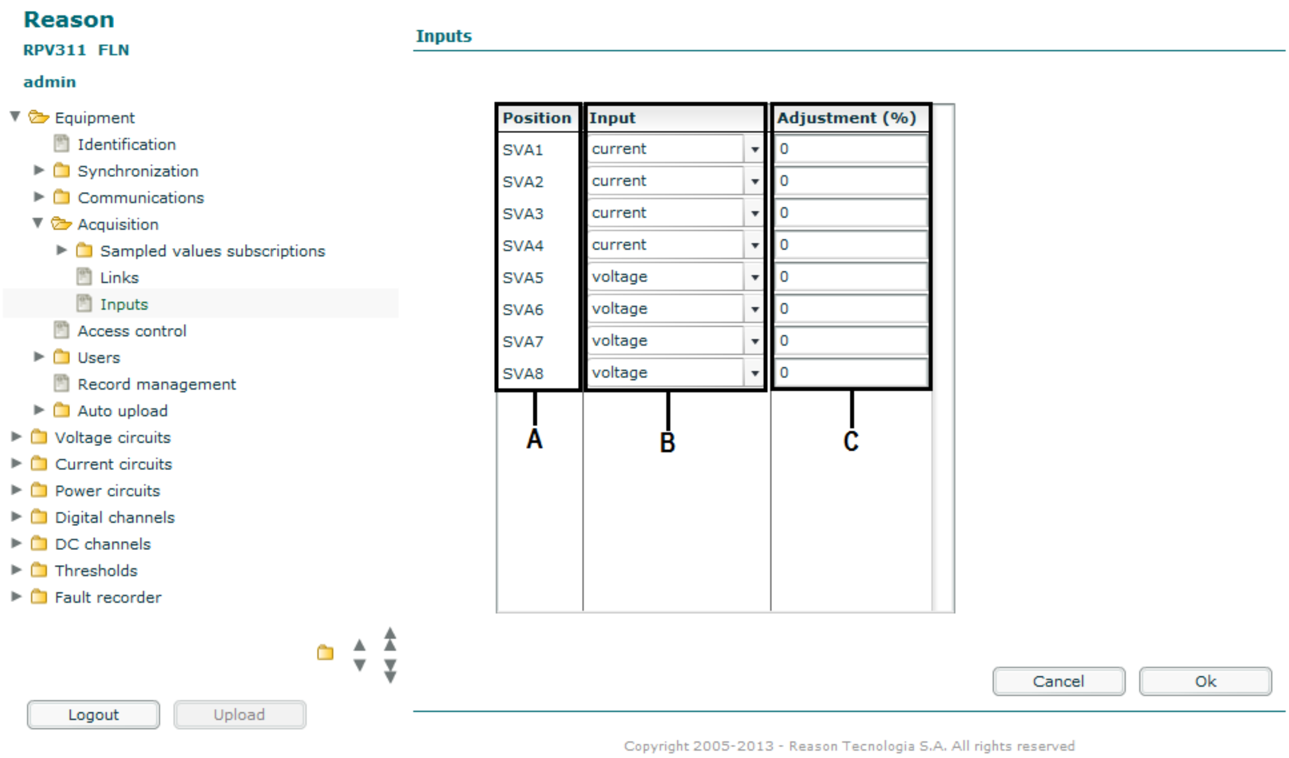


Figure 14: Analog inputs configuration section for Sampled Values channels

A The POSITION indicates the position of each analog input according to the Sampled Value message.

B The INPUT scroll box allows user to select the type of the signal to be received as Sampled Values.

C The ADJUSTMENT text field allows user to enter a correction factor to adjust the accuracy of the measurement.

2.6 Access Control

The equipment has independent access control to:

- Check the equipment status, monitor the measured values, access the records and the equipment's configuration;
- Firmware Upgrade;
- Maintenance;
- Modem connection.

In the section shown in Figure 15, it is possible to determine whether the password will be required for every access and it also allows user to exchange the update firmware password and the download password.

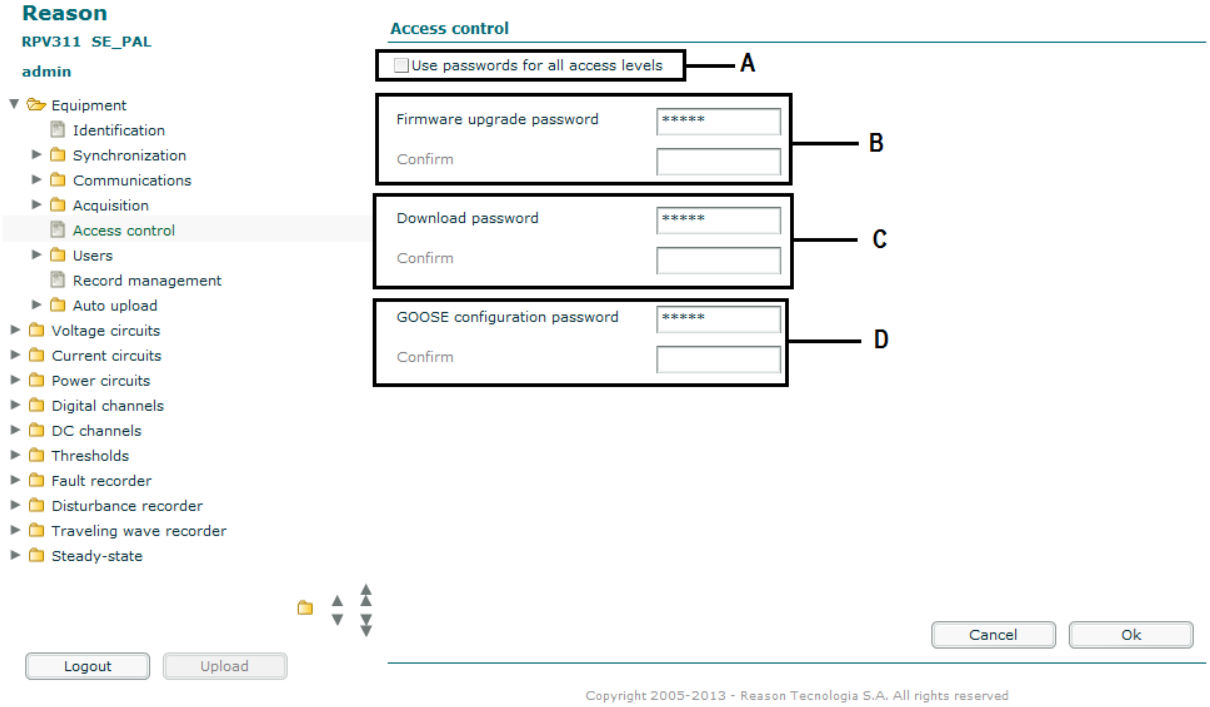


Figure 15: Equipment access control configuration section

A The USE PASSWORD FOR ALL ACCESS LEVELS check box enables use of password to access equipment operation and configuration via Web Interface.

B The FIRMWARE UPDATE PASSWORD text field allows user to enter an independent password to update the firmware for the equipment. The factory-set default password is 12345. This field cannot be disabled.

C The DOWNLOAD PASSWORD text field allows user to enter an independent password to access the automatic file records scanning. The factory-set default password is 12345. This field cannot be disabled.

D The GOOSE CONFIGURATION PASSWORD text field allows user to enter an independent password to configure the GOOSE application. The factory-set default password is 12345. This field cannot be disabled.

The password can have up to 8 characters and following ones are allowed: Alphabetic, numeric, upper and lower case, dash (-) and underscore (_).

2.7 User

It is possible to either add a new user or configure the administrator user.
In the Add a new user section, shown in Figure 16, it is possible to add users with different access levels.

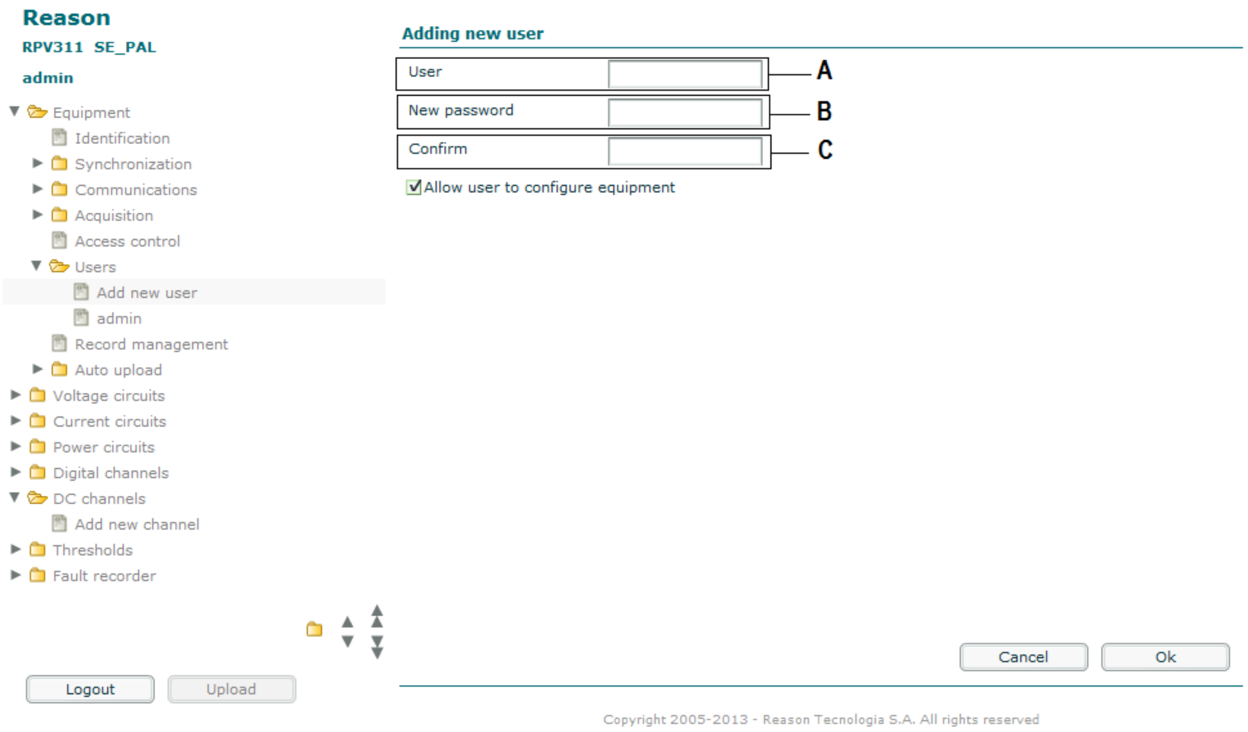


Figure 16: Adding new user section

A The USER text field allows entering a user identification (maximum 8 characters). No editing is allowed.

B The NEW PASSWORD text field allows user to enter a new password to access the Web Interface (maximum 8 characters).

C The CONFIRM text field allows user to confirm password entered in the field above.

D The ALLOW user to configure equipment check box allows user to set the equipment and also to access the Web Interface.

To delete a user, select the user in the configuration interface menu and click on the <REMOVE> button. User can be deleted only if there is more than one user entered and may be performed by any user who is authorized to access equipment setup.
In the User - admin section, shown in Figure 17, it is possible to change the administrator password.
The following characters are allowed in the passwords: Alphabetic, numeric, upper and lower case, dash (-) and underscore (_).

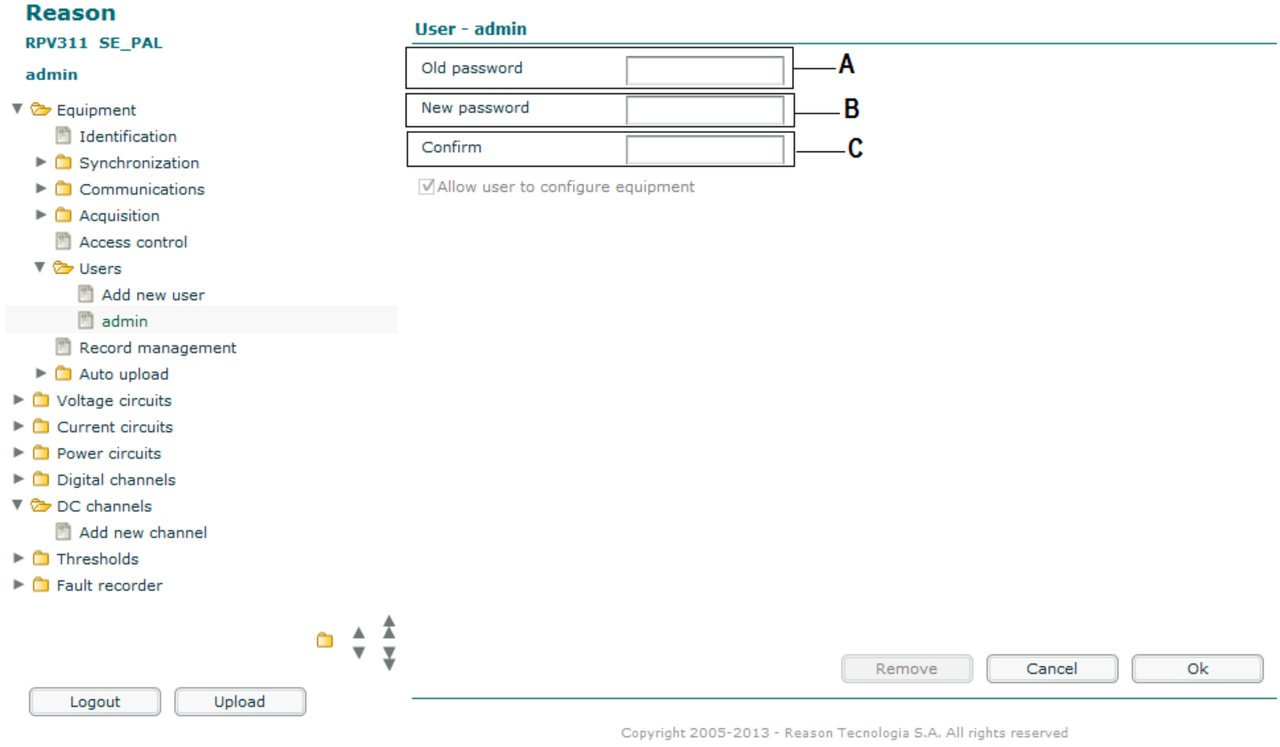


Figure 17: Changing the administrator password section: Changing the administrator password section

A The OLD PASSWORD text field allows user to enter an old password.

B The NEW PASSWORD text field allows user to enter a new password to access the Web Interface (maximum 8 characters).

C The CONFIRM text field allows user to confirm password entered in the field above.

The user administrator is always able to configure the equipment and cannot be deleted.

2.8 Record Management

In this section, shown in Figure 18, it is possible to configure the permanent deletion of equipment records, when memory capacity exceeds 90%.

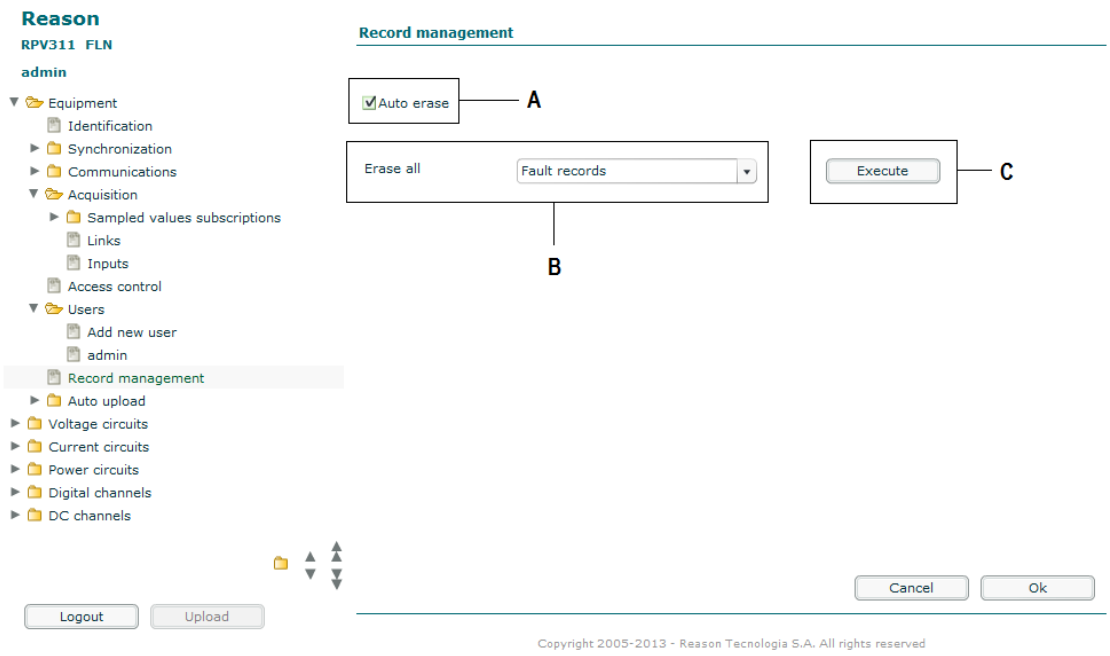


Figure 18: Record management configuration section

A Selecting the Auto erase check box, erases older record automatically if memory capacity exceeds 90%.

B The Erase all scroll box allows user to choose a type of record (fault, disturbance, steady-state and SOE) to be removed.

C The <Execute> button allows user to erase all the records on the list.

For details about the memory capacity of each record type, see Chapter 6: Records.

2.9 Auto Upload

2.9.1 Records

It is possible to send a record to two different servers. In the configuration interface it is possible to configure the IP address of each destination server and the type of record which will be sent. When a new record is generated and the record type is enabled for auto upload, it is automatically transmitted to the servers.

If at the upload time the server is not available or the network is unreadable, the record is not retransmitted. In this case, the record will be transmitted only through the automatic scanning by the server.

The automatic upload of records is a process in which the records are transferred to the server in advance. To ensure that all the records are stored in the server, it is necessary that the server perform the scanning process periodically. The records that have already been transmitted to the server are not retransmitted.

In the section shown in Figure 19, it is possible to automatically upload records to a preset destination.

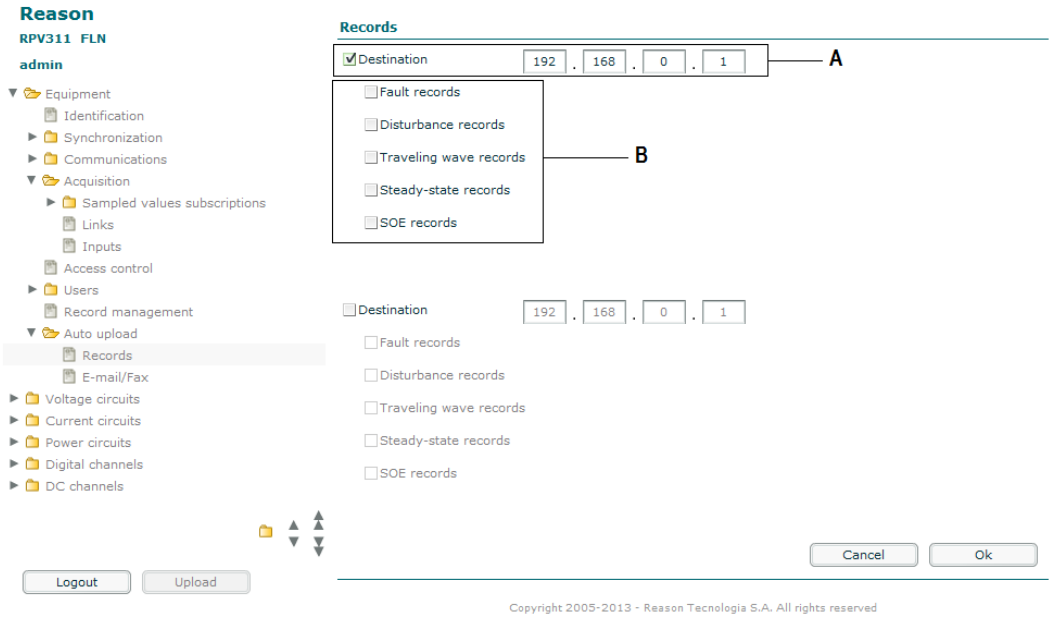


Figure 19: Auto upload configuration section

A The DESTINATION check box allows user to select a record destination IP address previously entered.

B Selecting the FAULT, DISTURBANCE, STEADY-STATE, TRAVELING WAVE OR SOE check boxes, these records will be automatically uploaded to a preset destination.

2.9.2 E-mail/Fax

The RPV311 is capable of sending email up to 4 different addresses and fax up to 2 different numbers.
Upon creating a new COMTRADE file the RPV send a warning email/fax with the name of the register that has been created. The file name contains the time stamp of the fault.

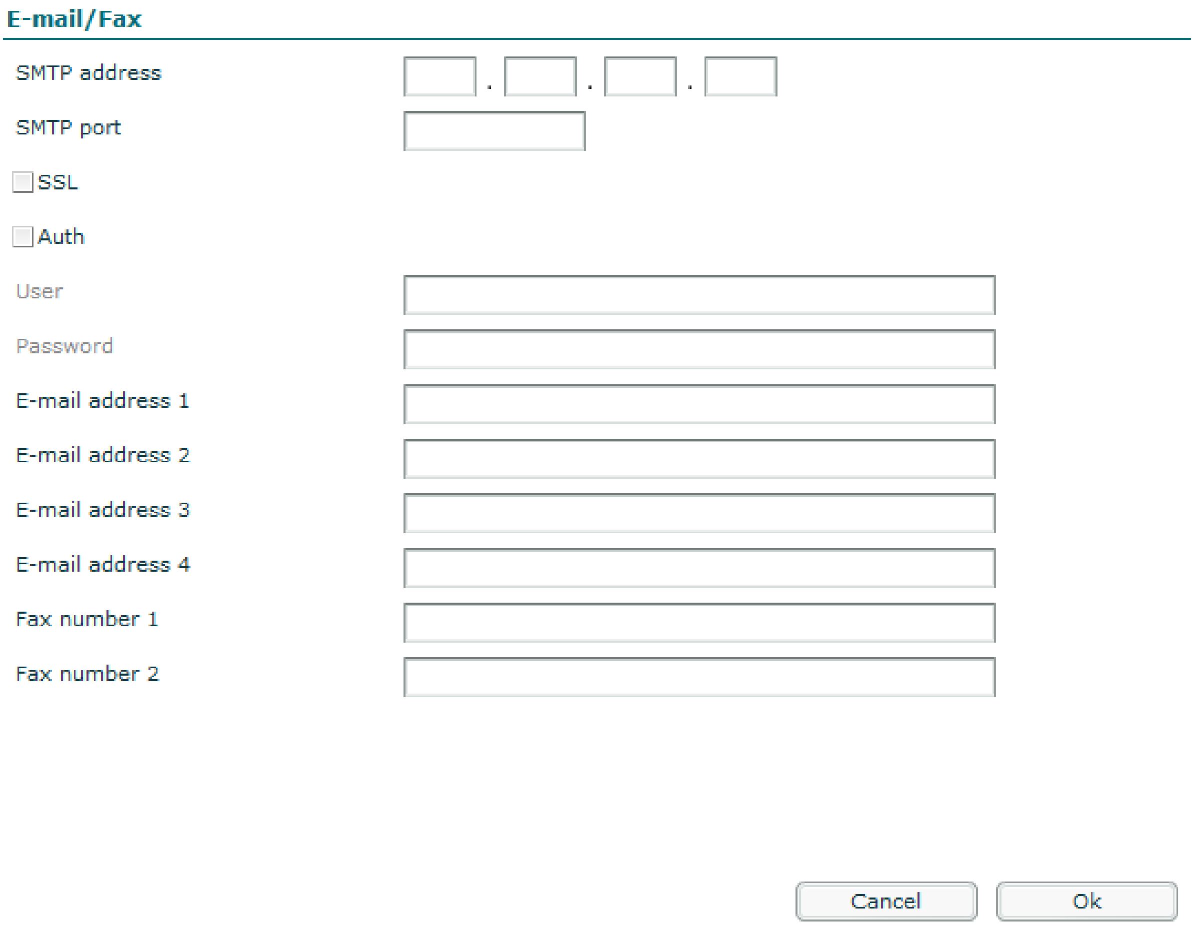


Figure 20: Email/Fax configuration

3 Voltage Circuit

Considering the input type configurations, it is possible to create voltage circuits with 1, 2, 3, or 4 elements.

The circuit sequences supported by the equipment are ABC, BCA, CAB, CBA, BAC, and CBA and may be customized by the user in the equipment setup. The default sequence is ABC.

To add a new voltage circuit select the VOLTAGE CIRCUITS section and fill in the following:

The IDENTIFIER text field allows user to enter a single code for the circuit being defined (maximum 15 characters). No editing allowed;

The WIRING scroll box allows user to select a number of elements used for measuring (1, 2, 3, or 4). No editing allowed;

Selecting the 3-PHASE CIRCUIT SYNTHESIS check box, the 3-phase circuit synthesis is enabled. It is only possible to select 3-phase circuit synthesis in a 1 element circuit (phase A, B, or C);

The INPUTS scroll box allows user to select the inputs to which each measuring element is connected. No editing allowed;

The NOMINAL VALUE text field allows user to enter a circuit rated voltage;

The Ratio text fields allows user to enter ratio of power transformers for each input.

Once the circuit is created, it appears in the configuration interface menu. When selecting the circuit, a screen shows the characteristics of the circuit selected, as shown in Figure 21. It is possible to edit some parameters, such as nominal value and transformation ratio.
The frequency is calculated individually for each circuit as long as the magnitude of the voltage is over 10% of the nominal magnitude configured in the Voltage Circuit window. The frequency track occurs within the range of Nominal Frequency ±5Hz.

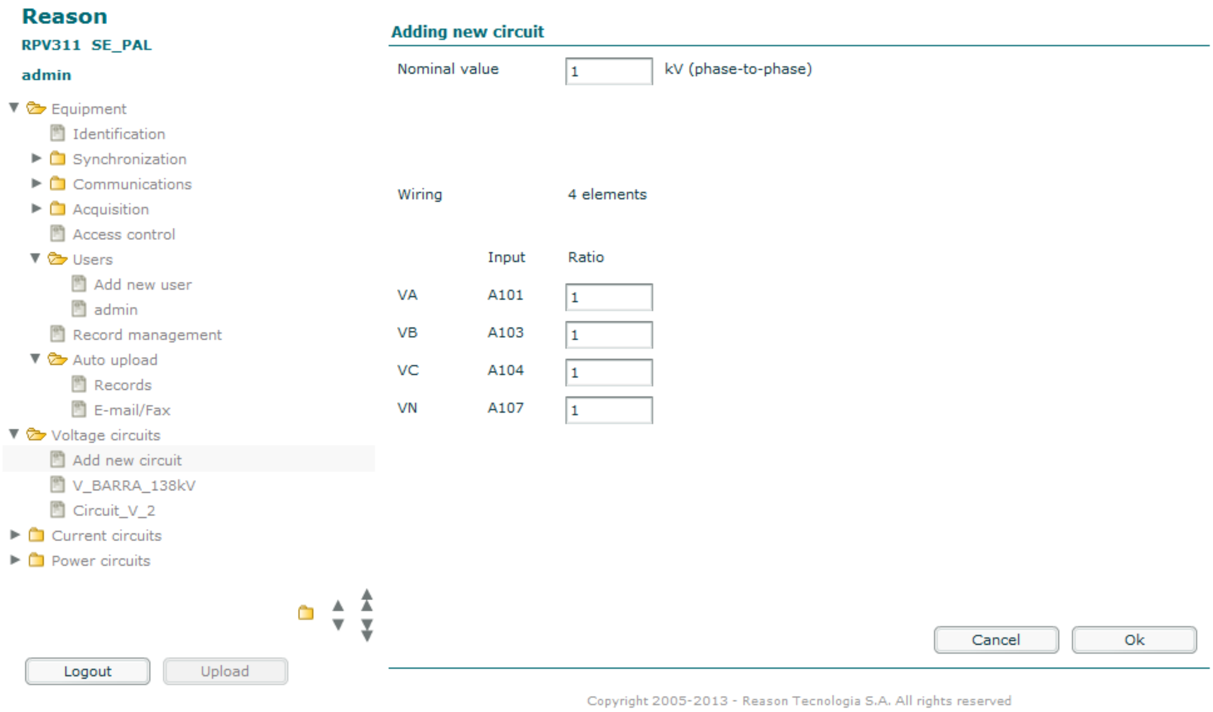


Figure 21: Adding and editing voltage circuits

4 Current Circuits

Considering the input type configurations, it is possible to create current circuits with 1, 2, 3, or 4 elements.
The phase sequences of the circuits supported by the equipment are ABC, BCA, CAB, CBA, BAC, and CBA and may be customized by the user in the Equipment Setup, shown in Section 2.9. The default sequence is ABC.
To add a new current circuit, select the Current Circuits section and fill in the following:

The Identifier text field allows user to enter a single code for the circuit being defined (maximum 15 characters). No editing allowed;

The Wiring scroll box allows selecting a number of elements used for measuring (1, 2, 3 or 4). No editing allowed;

Selecting the 3-phase circuit synthesis check box, the 3-phase circuit synthesis is enabled. It is only possible to select 3-phase circuit synthesis in a 1 element circuit (phase A, B, or C);

The Inputs scroll box allows user to select the inputs to which each measuring element is connected. No editing allowed;

The Nominal value text field allows user to enter a circuit rated current;

The Frequency reference scroll box allows user to select a reference voltage circuit;

The Ratio text fields allows user to enter ratio of power transformers for each input

.

Once the circuit is created, it appears in the configuration interface menu. When selecting the circuit, a screen shows the characteristics of the circuit selected, as shown in **Figure 22**. It is possible to edit some parameters, such as nominal value, frequency reference, and transformation ratio.

The frequency is calculated individually for each circuit as long as the magnitude of the current is over 10% of the nominal magnitude configured in the Current window of the chosen Voltage Circuit. The frequency track occurs within the range of Nominal Frequency ±5Hz.

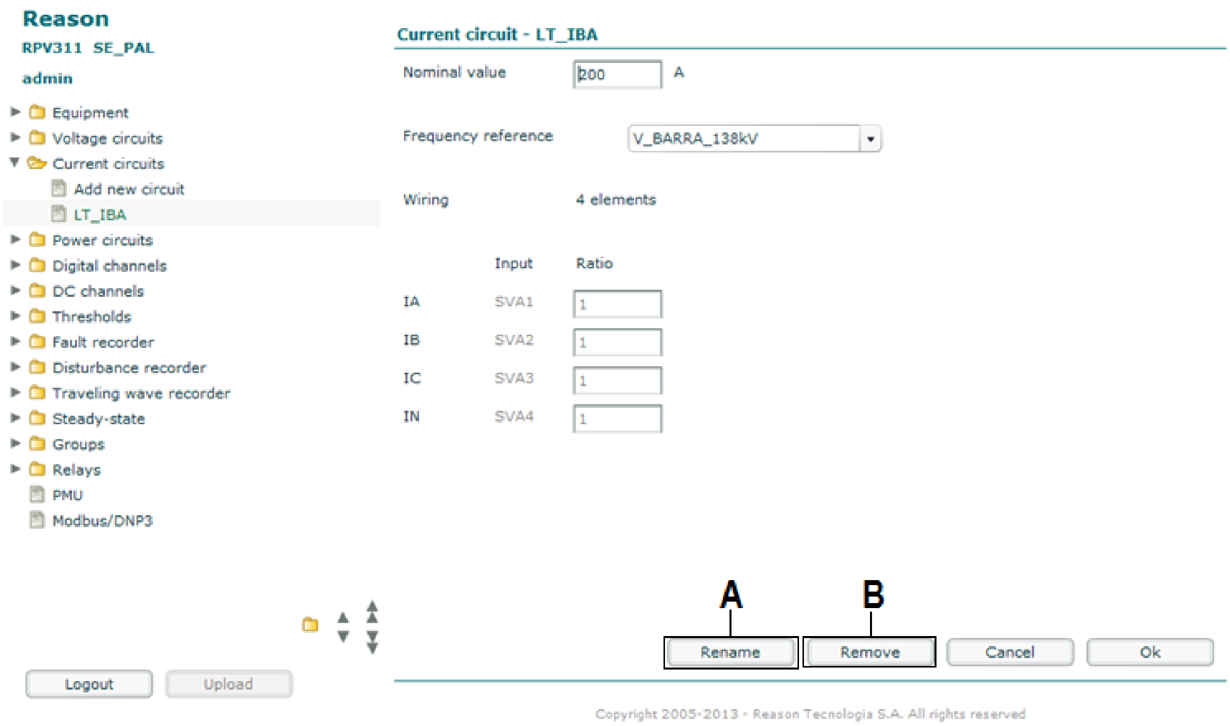


Figure 22: Adding and editing current circuits

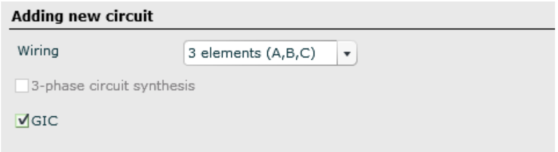
A The <Rename> button allows user to rename the circuit.

B The <Remove> button allows user to delete the circuit.

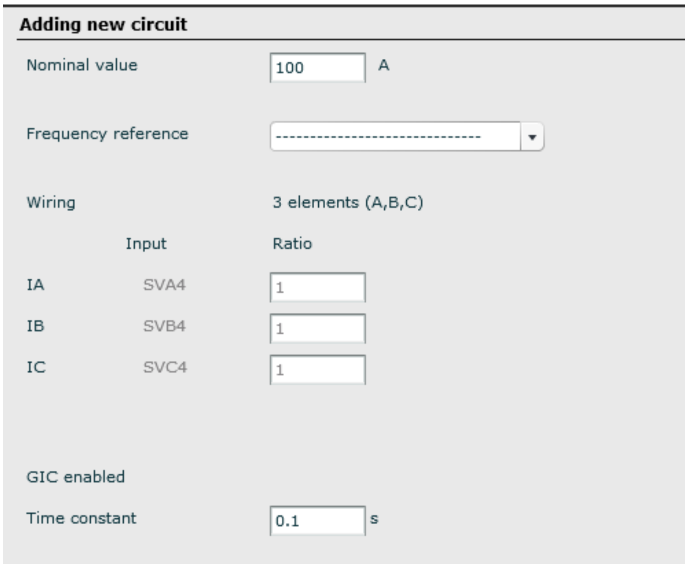
4.1 GIC Configuration (Geomagnetically Induced Current)

GICs are quasi-DC currents that cannot be measured with conventional CTs. In conjunction with optical CT and IEC 61850-9-2LE Merging Units, the RPV311 can be applied to monitored GIC currents in the power system

To create a circuit to monitor GIC, check the GIC check box in the current circuit wiring screen, as below:



This check box configuration will disable the autozero filter that all the RPV311 channels have (autozero is slow filter that removes the DC components from the measurement) and apply a low-pass first order filter to the current measurement. This channel will only monitor and show DC measurement then, instead of RMS.
The first order filter has a configurable time constant ranging from 0,1 to 1000 seconds that can be chosen in the last screen of the current circuit configuration, as below.



> *Note:*
> *In a GIC circuit, the RMS measurement is replaced by the DC measurement. When creating a threshold in a GIC circuit, the ABC threshold is related to the DC measurement.*

5 Power Circuit

Power circuits can be created of circuit voltage and current.
To add a new power circuit select the Power Circuits section and fill in the following:

The Identifier text field allows user to enter a single code for the circuit being defined (maximum 15 characters). No editing allowed;
The Voltage circuit scroll box allows user to select a code of the voltage circuit to be used;
The Current circuit scroll box allows user to select a code of the current circuit to be used.

Once the circuit is created, it shows in the configuration interface menu. When selecting the circuit, a screen shows the characteristics of the circuit selected, as shown in Figure 23. It is possible to edit the voltage or current circuit.
The frequency is calculated individually for each circuit as long as the magnitude of the voltage is over 10% of the nominal magnitude configured in the Voltage Circuit window. The frequency track occurs within the range of Nominal Frequency ±5Hz.

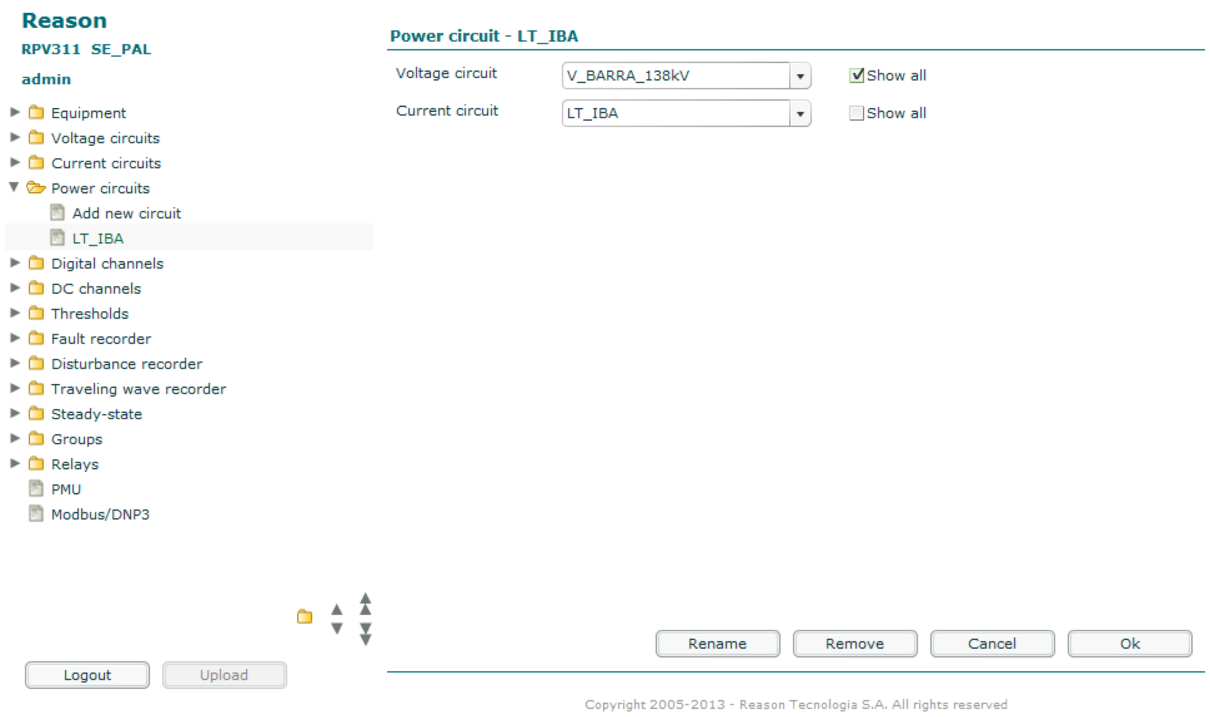


Figure 23: Adding and editing power circuits

The <Rename> button allows user to rename the circuit.
The <Remove> button allows user to delete the circuit.

6 Digital Channels

The acquisition is simultaneous and synchronized with a time resolution of 65.104 μs at 60 Hz or 78.125 μs at 50 Hz. The polarity is user-programmable (active high, active low). Digital channels can be associated with physical electrical digital inputs or associated with the detection of IEC61850 GOOSE messages. For details about the GOOSE messages, see Chapter 11: GOOSE Message Detection. The level of the state transitions for physical inputs can be seen in Chapter 17: Technical Specifications

It is possible to adjust denouncing of the digital input to eliminate the effect of switching of the relay contacts. The debounce time has a 0 to 20ms with 1ms steps.

All transitions of the digital channels are stored in the sequence of events (SOE) record.

To add a new digital channel, select the Digital Channels section and fill in the following:

The IDENTIFIER text field allows user to enter a single code for the channel being defined (maximum 15 characters). No editing allowed;

The INPUT scroll box allows user to define the input to which each digital channel is connected. No editing allowed;

The POLARITY scroll box allows user to select the input logic level (normal or inverted);

DEBOUNCING TIME: the RPV311 will only start a record once the binary activation time has exceeded the debouncing time parameter.

Once the digital channel is created, it shows in the configuration interface menu. When selecting the digital channel, a screen shows the characteristics of the digital channel selected, as shown in Figure 24. It is possible to edit the polarity and the debounce time.

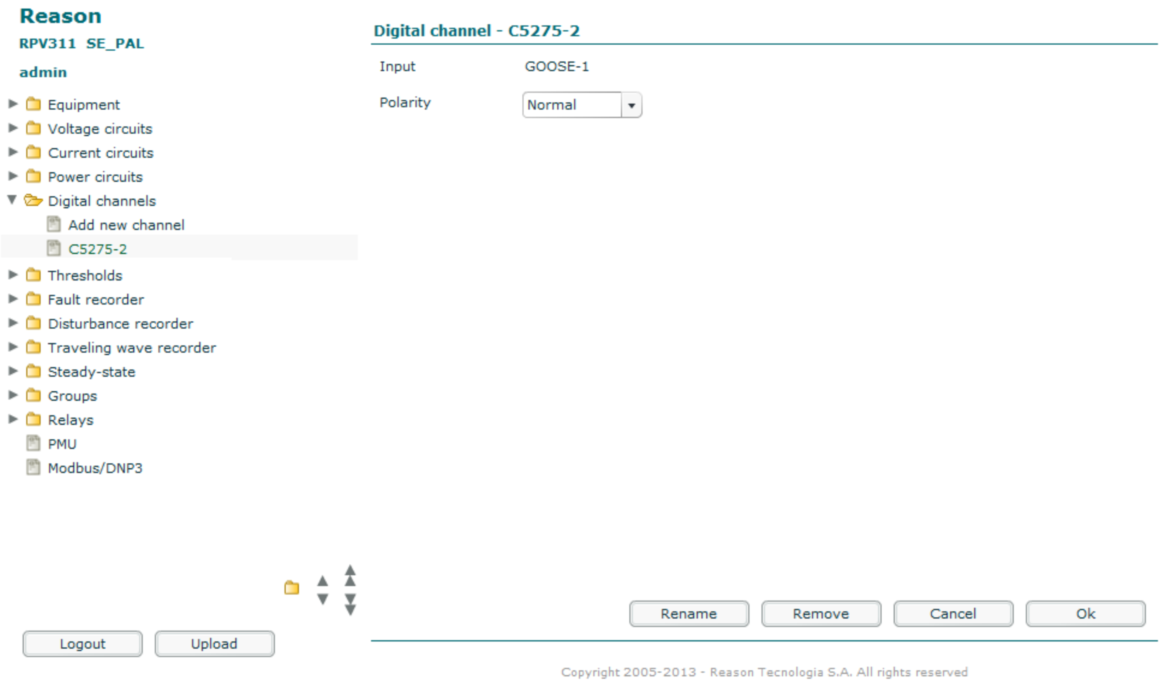


Figure 24: Adding and editing digital channels

The <RENAME> button allows user to rename the digital channel.

The <REMOVE> button allows user to delete the digital channel.

7 DC Channels

The signal of the transducer (±10 V or 0-20 mA) is converted in to the desired physical measurement using a first order transfer function with the parameters of gain (A) and offset (B) defined by the user:

$$y = A(x + B)$$

where y is the converted value and x is the value read by the DC channel in Volts or Amps.
The RMS value of the DC channels (transducers) is calculated every cycle.
To add a new DC channel, select the DC CHANNELS section and fill in the following:
The IDENTIFIER text field allows user to enter a single code for the channel being defined (maximum 15 characters). No editing allowed;
The INPUT scroll box allows user to define the input to which each DC channel is connected. No editing allowed;
The FREQUENCY REFERENCE scroll box allows user to select a reference voltage circuit;
The GAIN and the OFFSET text field allows user to define the transfer connected transducer function;
The UNIT text field allows user to define the connected transducer unit (maximum 6 characters, letters only).

Once the DC channel is created, it shows in the configuration interface menu. When selecting the DC channel, a screen shows the characteristics of the DC channel selected, as shown in Figure 25. It is possible to edit the frequency reference, gain, offset and unit.

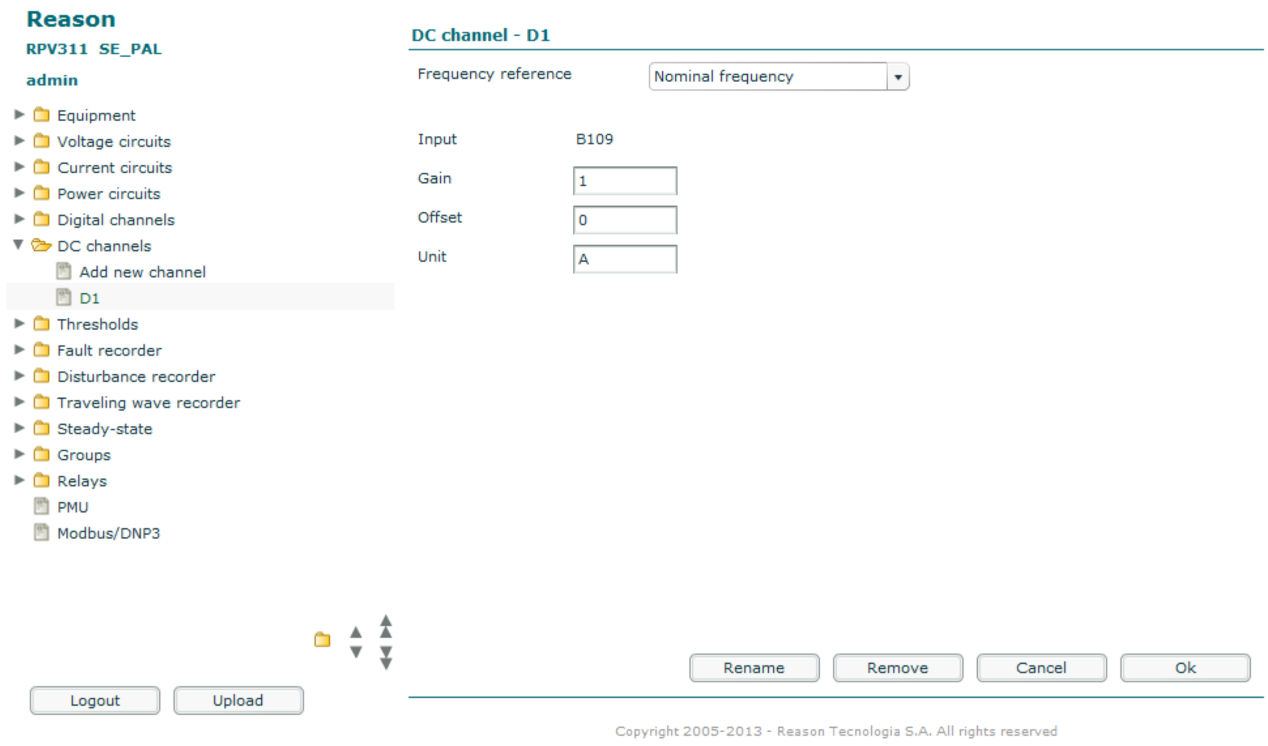


Figure 25: Adding and editing DC channels

The <RENAME> button allows user to rename the DC channel.
The <REMOVE> button allows user to delete the DC channel.

8 Thresholds

Measured values are continuously monitored and may be tested once every cycle of the nominal frequency of the system, against lower and upper thresholds and range rates involving:

- Magnitude;
- Frequency;
- Active, Reactive, and Apparent Powers;
- Positive and Negative Sequences;
- Imbalance;
- Digital Signals.
- Variation (d/dt)[1]
- GOOSE Signals

[1] The variation thresholds are calculated using a 1-cycle time window.

The results of all thresholds are processed using user-definable Boolean equations and can be used to trigger the recording of fault, traveling waves, and disturbance data. The thresholds can be associated with power, voltage and current circuits, digital channels or DC channels, as follows:

Voltage and Current: upper and lower limits, and rate of change:

- ABC - RMS value;
- N - neutral RMS value;
- $\mathrm{ABC1}$ - RMS value of fundamental component;
- $\mathrm{N1}$ - RMS value of neutral fundamental component;
- F - frequency;
- S^+ - positive sequence;
- S^- - negative sequence;
- U - imbalance;
- THD - total harmonic distortion.
- VOSC - voltage oscillation;
- FRQOSC - frequency oscillation (measured from voltage);

Power: upper and lower limits, and rate of change:

- S - combined apparent power;
- S_1 - fundamental apparent power;
- P_1 - fundamental active power;
- Q_1 - fundamental reactive power.

Power: upper limits:

- $SOSC$ - power swing.

DC Transducers: upper and lower limits;

Digital channels: "L" to "H" transition, "H" to "L" transition, "H" and "L" level.;

Following parameters can be set for every defined threshold:

Parameters set for every defined threshold		
Hysteresis	0 … 100 %	0.1 %
Hold time	0 … 0.5 s	0.01 s

To add new thresholds, select the ADD NEW THRESHOLDS section and choose the type of threshold (voltage, current, power, digital, or DC). Each threshold is related to a circuit or channel previously created.

8.1 Adding New Voltage Thresholds

To add a voltage threshold fill in the following:
The SOURCE scroll box allows user to define a code of a voltage circuit used. No editing allowed;
The QUANTITY scroll box allows user to select the associated magnitude to be monitored. For voltage circuits:

- ABC and N - magnitude or effective value;
- ABC and N1 - phasors;
- S^{+} - positive sequence;
- S^{-} - negative sequence;
- VIMB - imbalance;
- VFRQ - frequency;
- VTHD - total harmonic distortion;
- VOSC - voltage oscillation;
- FRQOSC - frequency oscillation;
- dABC and dN: - magnitude or effective value variation;
- dABC1 and dN1 - phasor variation;
- dS^{+} - positive sequence variation;
- dS^{-} - negative sequence variation;
- dVIMB - unbalance variation;
- dVFRQ - frequency variation;
- dVTHD - THD variation.

The OPERATOR scroll box allows user to select greater than or less than for analog magnitude;
The VALUE text field allows user to enter the magnitude value associated with greater than or less than operator;
The HOLD TIME text field allows user to enter the time in milliseconds, where the threshold needs to be exceeded to be considered valid. Due to internal processing time the trigger might start up to 2 cycles after the hold time;
The HYSTERESIS text field allows user to enter a percentage of the VALUE , the quantity monitored needs to exceed that percentage in order to end the event and to reset the threshold detector.

Once the threshold is created, it appears in the configuration interface menu. When selecting the threshold, a screen shows the characteristics of the threshold selected, as shown in Figure 26. It is possible to edit the value, hold time, and hysteresis.

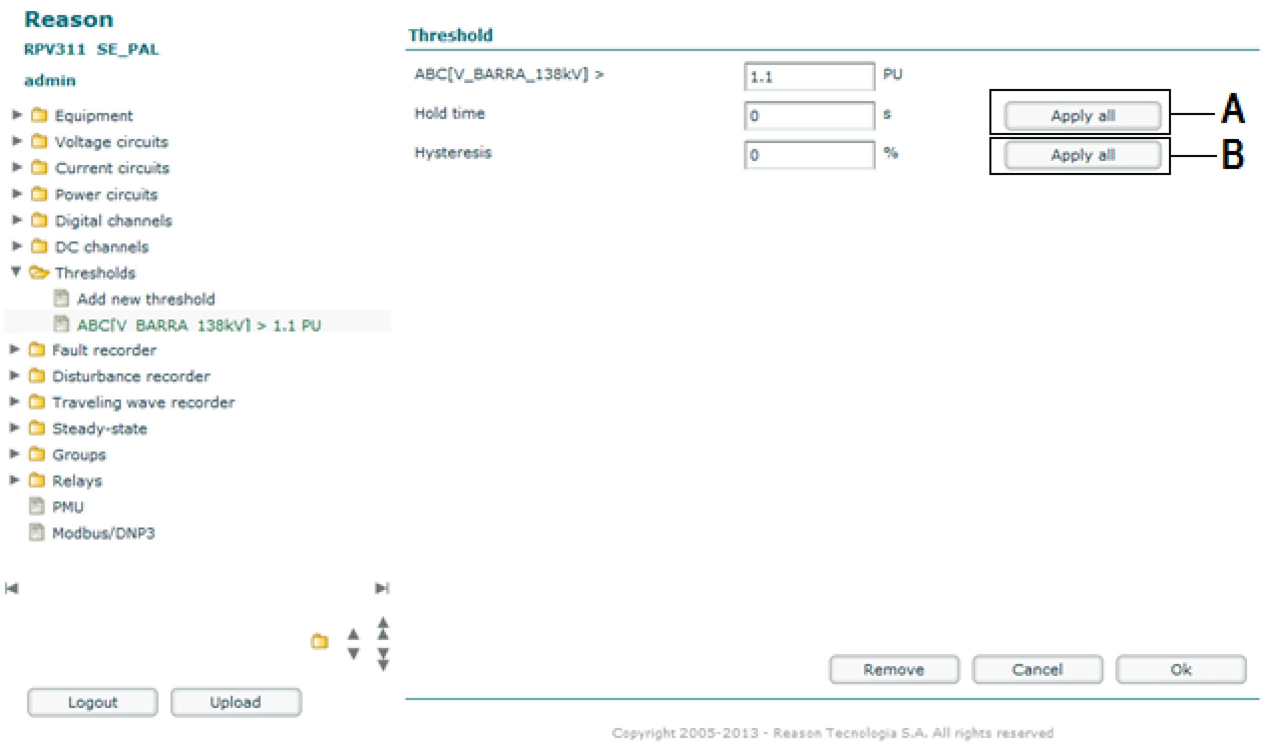


Figure 26: Adding and editing a voltage threshold

A The <APPLY ALL> button allows user to apply the hold time or the hysteresis for all thresholds.

B The <REMOVE> button allows user to delete the threshold.

8.2 Adding New Current Thresholds

To add a current threshold, fill in the following:
The SOURCE scroll box allows user to define a code of a current circuit used. No editing allowed;
The QUANTITY scroll box allows user to select the associated magnitude to be monitored.
For current circuits:

- ABC and N - magnitude or effective value (DC measurement for GIC circuits);
- ABC1 and N1 - phasors;
- S^+ - positive sequence;
- S^- - negative sequence;
- IIMB - imbalance;
- IFRQ - frequency;
- ITHD - total harmonic distortion;

- dABC and dN: - magnitude or effective value variation;
- dABC1 and dN1 - phasor variation;
- dS^{+} - positive sequence variation;
- dS^{-} - negative sequence variation;
- dIIMB - unbalance variation;
- dIFRQ - frequency variation;
- dITHD - THD variation.

The OPERATOR scroll box allows user to select greater than or less than for analog magnitude;
The VALUE text field allows user to enter the magnitude value associated with greater than or less than operator;
The HOLD TIME text field allows user to enter the time in milliseconds, where the threshold needs to be exceeded to be considered valid. Due to internal processing time the trigger might start up to 2 cycles after the hold time;
The HYSTERESIS text field allows user to enter a quantity in %, whose the value needs to be smaller in relation to the threshold to determine the end of the event and to reset the threshold detector.

Once the threshold is created, it appears in the configuration interface menu. When selecting the threshold, a screen shows the characteristics of the threshold selected, as shown in the figure below. It is possible to edit the value, hold time, and hysteresis.

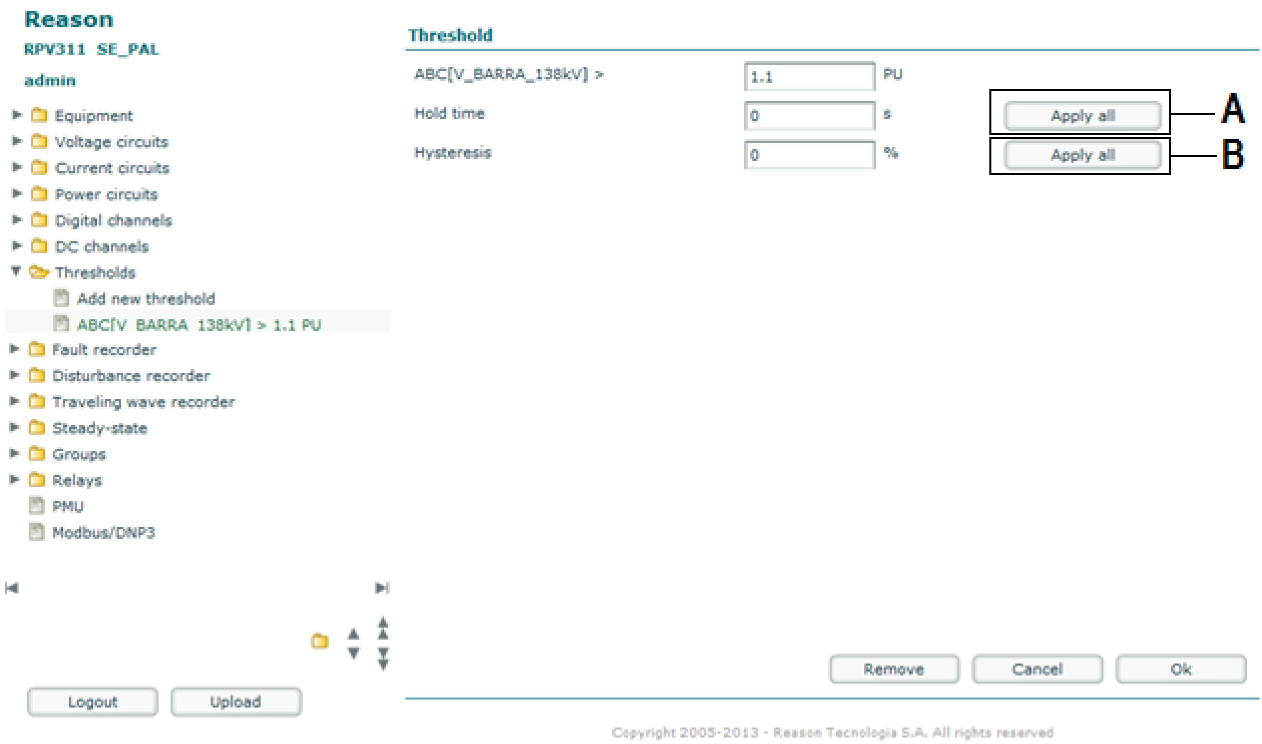


Figure 27: Adding and editing a current threshold

A The <APPLY ALL> button allows user to apply the hold time or the hysteresis for all thresholds.

B The <REMOVE> button allows user to delete the threshold.

8.3 Adding New Power Thresholds

To add a power threshold, fill in the following:

- The SOURCE scroll box allows user to define a code of a power circuit used. No editing allowed.
- The QUANTITY scroll box allows user to select the associated magnitude to be monitored. For power circuits:
  - S - total apparent power;
  - S1 - apparent power;
  - P1 - active power;
  - Q1 - reactive power;
  - dS - total apparent power variation;
  - dS1 - apparent power variation;
  - dP1 - active power variation;
  - dQ1 - reactive power variation;
  - SOSC - power swing;

- The Operator scroll box allows user to select greater than or less than for analog magnitude.
- The Value text field allows user to enter the magnitude value associated with greater than or less than operator.
- The Hold time text field allows user to enter the time in seconds, where the threshold needs to be exceeded to be considered valid. For the SOSC power threshold, this field is called Oscillation Time. Due to internal processing time the trigger might start up to 2 cycles after the configured time;
- The Hysteresis text field allows user to enter a quantity in %, whose value needs to be smaller in relation to the threshold to determine the end of the event and to reset the threshold detector.

Once the threshold is created, it shows in configuration interface menu. When selecting the threshold, a screen shows the characteristics of the threshold selected, as shown in Figure 28. It is possible to edit the value, hold time, and hysteresis.

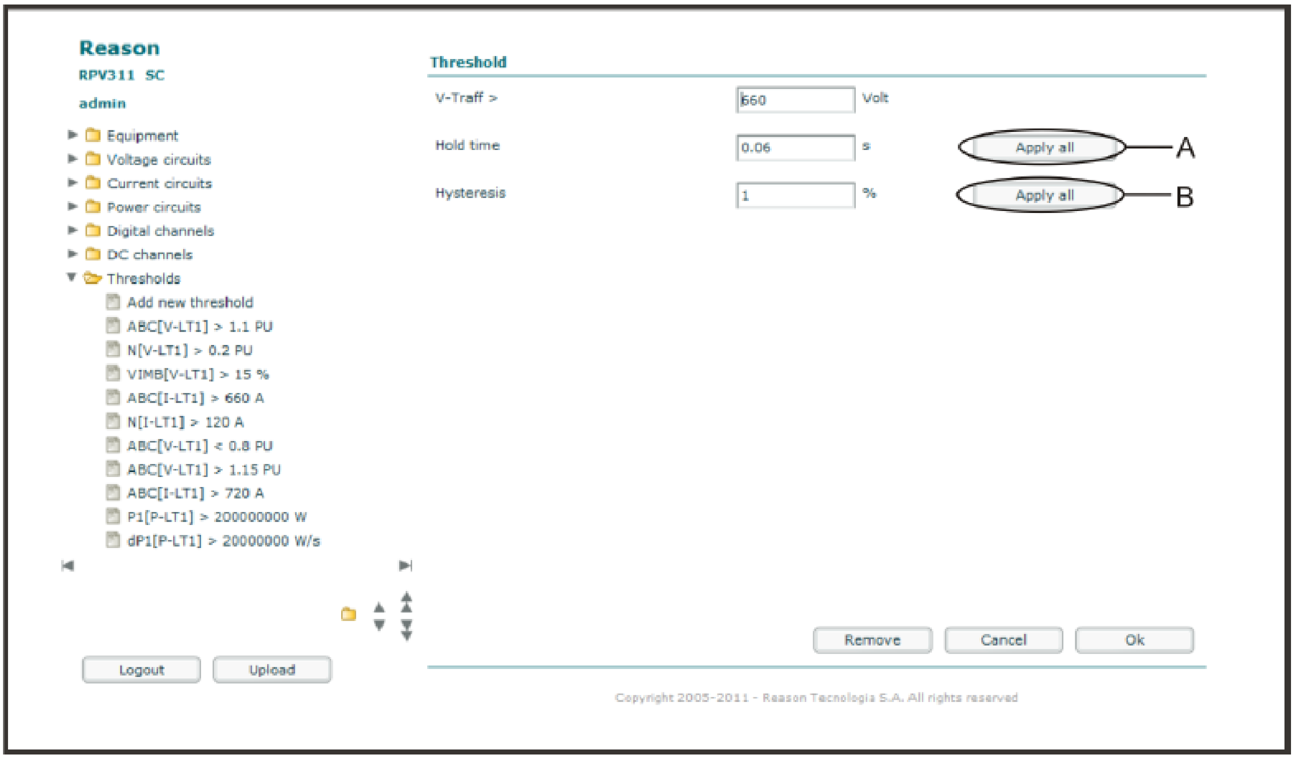


Figure 28: Adding and editing a power threshold

A The <Apply all> button allows user to apply the hold time or the hysteresis for all thresholds.

B The <Remove> button allows user to delete the threshold.

- **Power Swing, Voltage Oscillation and Frequency Oscillation:**

The parameters that are configurable in Power Swing, Voltage Oscillation and Frequency Oscillation threshold are: Oscillation magnitude (in MVA, PU and Hz), Oscillation time (in seconds) and Hysteresis (in percentage). The Operator scroll box can only be set to Greater Than. To trigger, the RPV311 uses a fixed band-pass filter adjusted at 0.1 Hz to 5 Hz.

8.4 Adding New Digital Thresholds

To add a digital threshold, fill in the following:

- The SOURCE scroll box allows user to define a code of a digital channel used. No editing allowed;
- The CONDITION scroll box allows user to select the threshold condition:
  - (blank) - High level;
  - (!) - Low level;
  - (∧) - Rising edge;
  - (∨) - Falling edge.

Once the threshold is created, it shows in the configuration interface menu. When selecting the threshold, a screen shows its operator and identifier.
The <REMOVE> button allows user to delete the threshold.

8.5 Adding New DC Thresholds

To add a DC threshold, fill in the following:

- The Source scroll box allows user to define a code of a DC channel used. No editing allowed;
- The Operator scroll box allows user to select greater than or less than for analog magnitude;
- The Value text field allows user to enter the magnitude value associated with greater than or less than operator;
- The Hold time text field allows user to enter the time in milliseconds, where the threshold needs to be exceeded to be considered valid. Due to internal processing time the trigger might start up to 2 cycles after the hold time;
- The Hysteresis text field allows user to enter a quantity in %, whose value needs to be smaller in relation to the threshold to determine the event end and reset the threshold detector.

Once the threshold is created, it appears in configuration interface menu. When selecting the threshold, a screen shows the characteristics of the threshold selected, as shown in **Figure 29**. It is possible to edit the value, hold time and hysteresis.

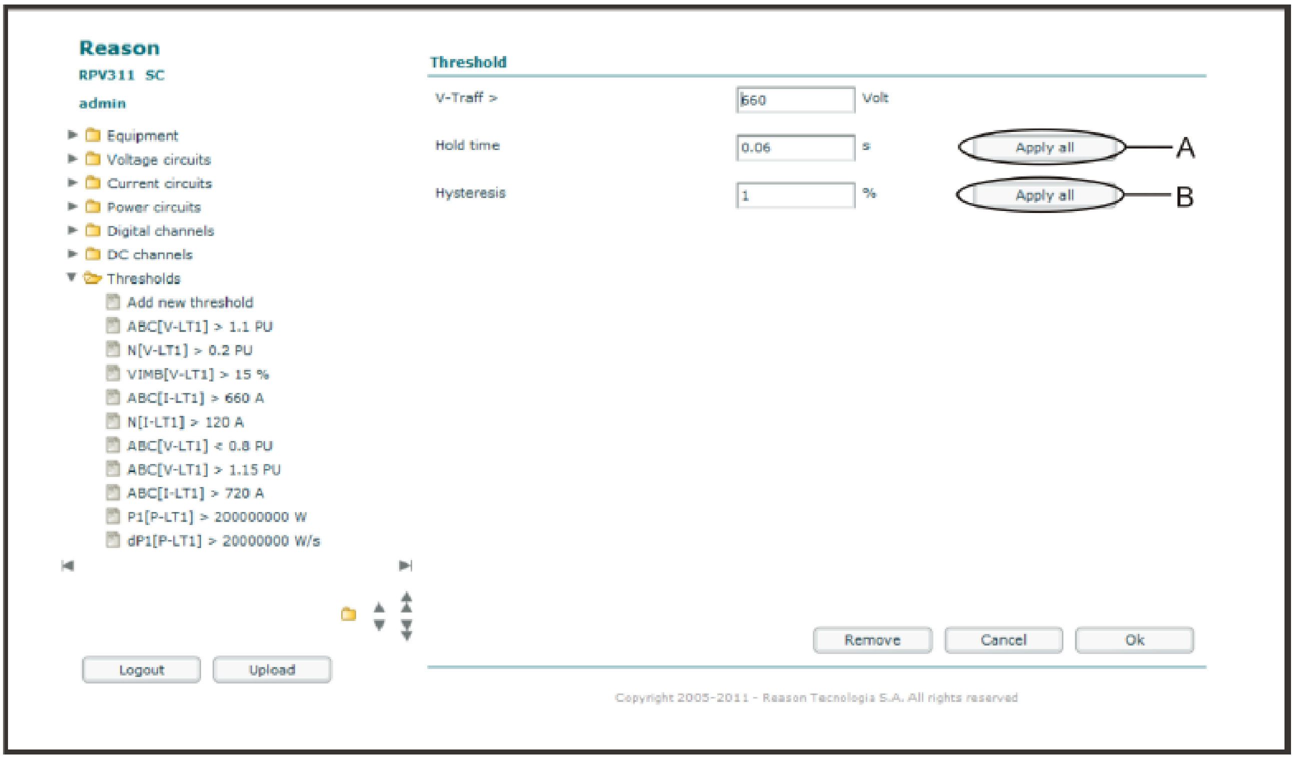


Figure 29: Adding and editing a DC threshold

A The <APPLY ALL> button allows user to apply the hold time or the hysteresis for all threshold.

B The <REMOVE> button allows user to delete the threshold.

9 Cross-Trigger

The cross-trigger is performed through an Ethernet broadcast UDP message sent whenever the device triggers, then all the RPV311 within the network with the cross-trigger enabled will receive the message and trigger as well.

10 Fault Recorder

The RPV311 allows user to register triggered and continuous fault recorder.

10.1 Trigger'd Recording

In this section, shown in Figure 30, it is possible to configure the equipment's fault triggered recorder.

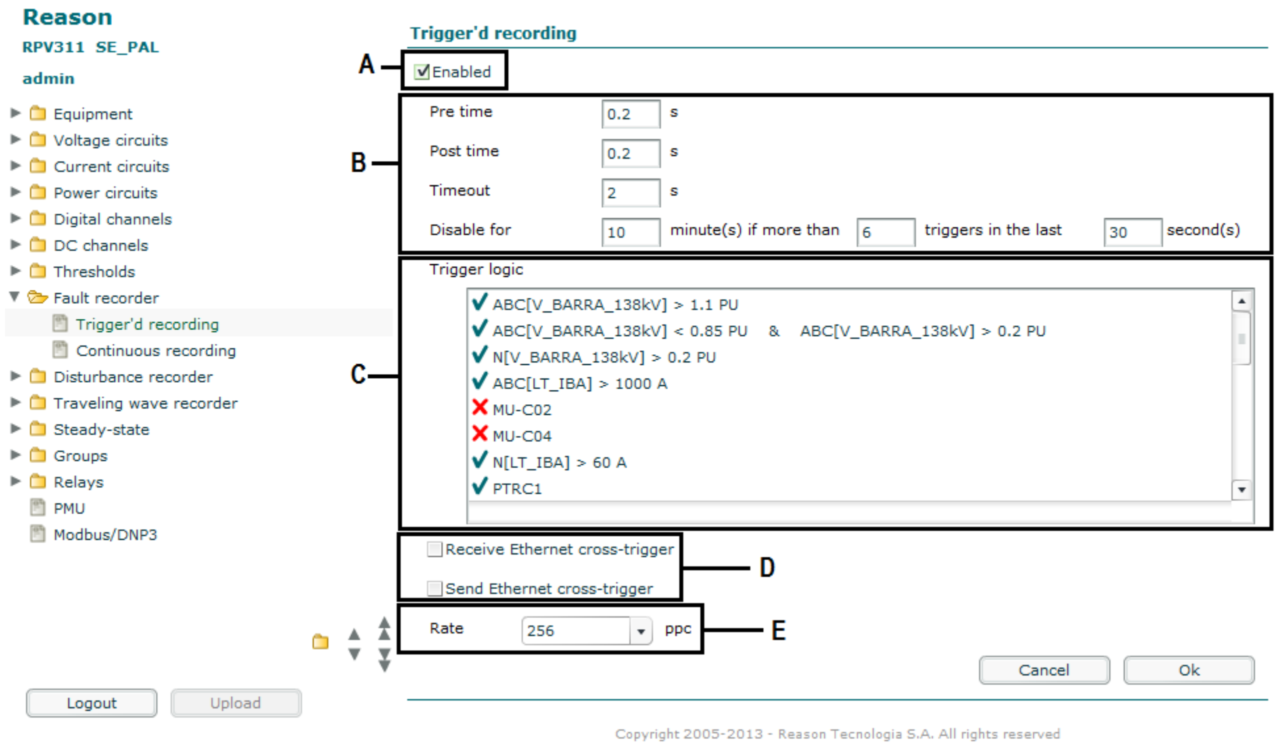


Figure 30: Fault recorder – triggered recording configuration section

A The Enabled check box allows user to enable the fault recorder feature.

B The Pre time text field allows user to enter the recording time before the event in seconds. The Post time text field allows user to enter the recording time after the event in seconds. The Time out text field allows user to enter the maximum time (in seconds) that the event will be recorded while the trigger is active. The Disabled for – minutes if more than – triggers in the last – seconds allows user to disable recorder if the event repeats within a programmed time period.

C The Trigger logic field contains all the thresholds created. The logic equation uses AND and OR logic operators over previously defined thresholds. Initially, all preset thresholds are displayed as implicit OR operators, one per line.

To enable thresholds individually, click on the threshold and select Enable;
To disable discarded thresholds individually, click on the threshold and select Disable;
To break or remove complex thresholds, click on the threshold and select Cut last;
To create equations with AND operators, follow the procedures below:

- Click on the threshold and select Cut last;
- Click on the threshold to which is desired to add the previously selected threshold and then select the threshold to be added.

D Selecting the Receive Ethernet cross-trigger or Send Ethernet cross-trigger check box enables these features. It allows the start of the recording of an exceeded threshold by Ethernet cross-trigger.

E The RATE scroll box allows user to select the rate on the fault recorder (64, 128, or 256).

10.2 Continuous Recording

In this section, shown in the figure below, is possible to configure the equipment's continuous recorder.

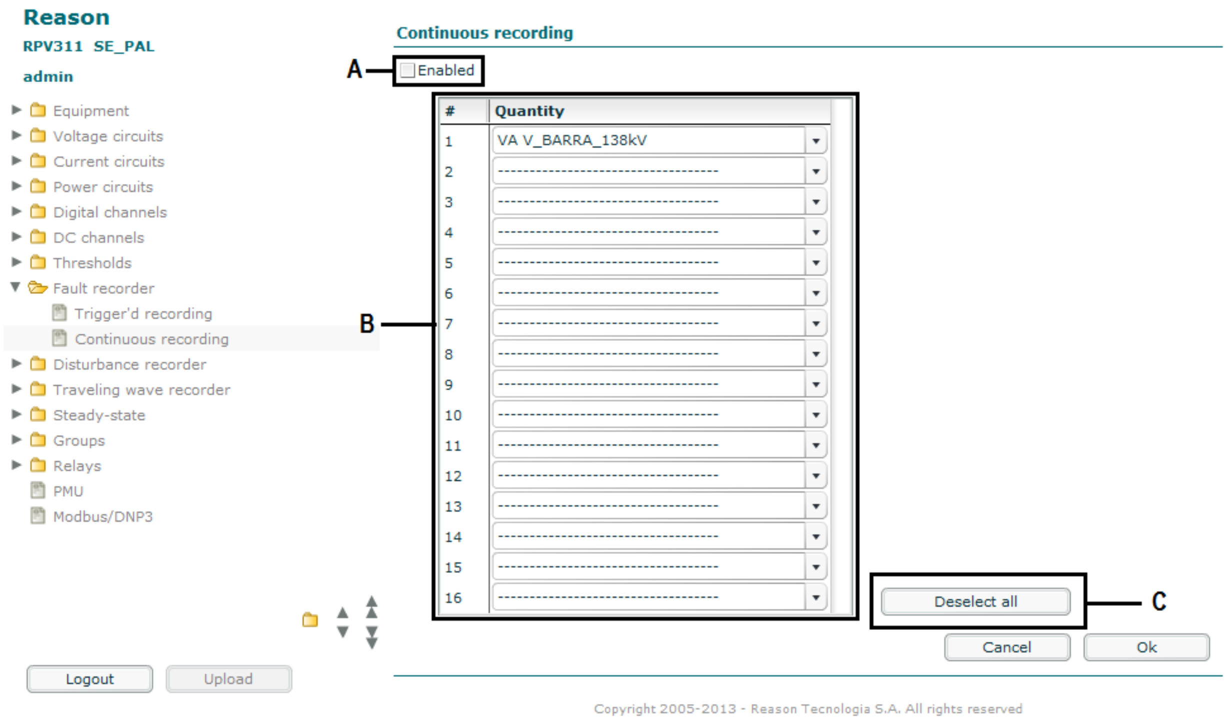


Figure 31: Fault recorder – continuous recording configuration section

A The ENABLED check box allows user to enable the continuous fault recording feature.

B The QUANTITY scroll box allows user to select the derived quantity of continuous disturbance records.

C The <DESELECT ALL> button allows user to deselect magnitudes selected.

It is possible only to enable the fault continuous recorder if the disturbance continuous recorder is disabled. It is not possible to use both recorders simultaneously.

11 Disturbance Recorder

The RPV311 allows user to configure triggered and continuous disturbance recording.

11.1 Trigger'd Recording

In this section, shown in Figure 32, it is possible to configure the equipment disturbance triggered recorder.

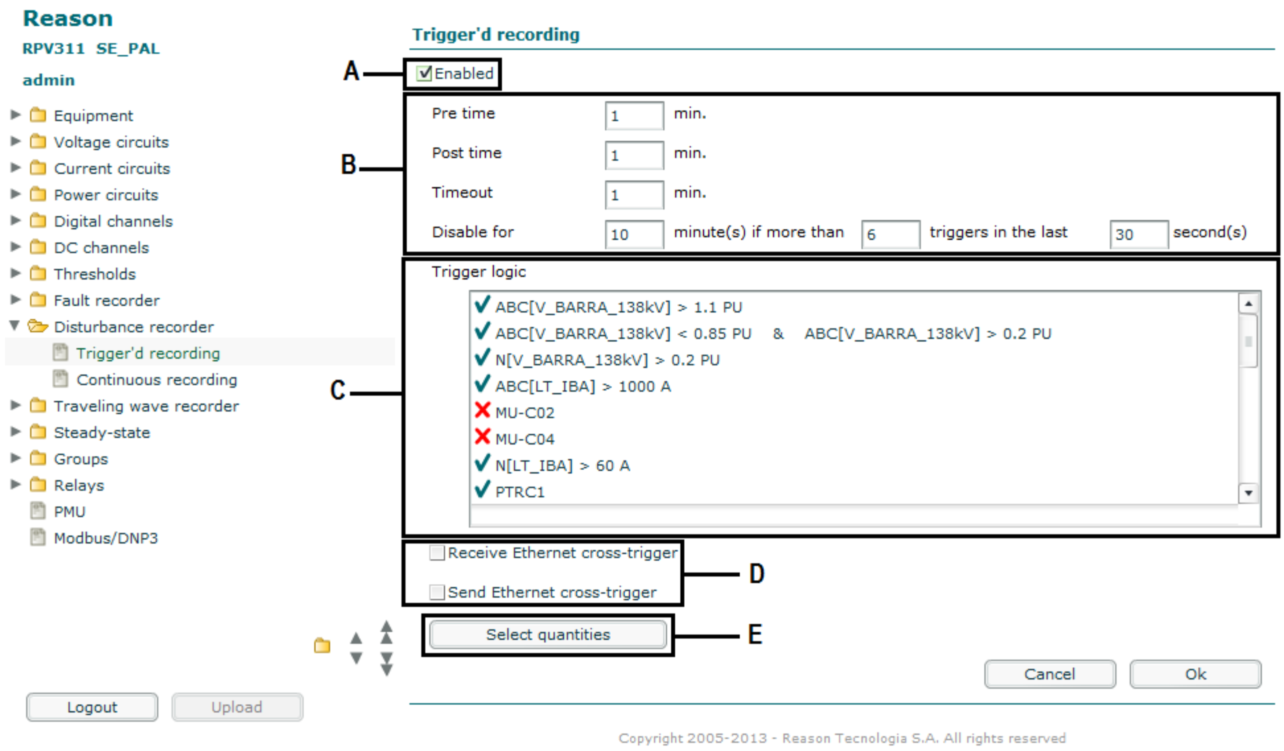


Figure 32: Disturbance recorder – trigger'd recording configuration

A The ENABLED check box allows user to enable the disturbance triggered recorder feature.

B The PRE TIME text field allows user to enter the recording time before the event in seconds. The POST TIME text field allows user to enter the recording time after the event in seconds. The TIME OUT text field allows user to enter the maximum time (in seconds) that the event will be recorded while the trigger is active. The DISABLED FOR – MINUTES IF MORE THAN – TRIGGERS IN THE LAST – SECONDS allows user to disable recorder if the event repeats within a programmed time period.

C The TRIGGER LOGIC field contains all the thresholds created. The logic equation uses AND and OR logic operators over previously defined thresholds. Initially, all preset thresholds are displayed as implicit OR operators, one per line.

To enable thresholds individually, click on the threshold and select ENABLE;
To disable discarded thresholds individually, click on the threshold and select DISABLE;
To break or remove complex thresholds, click on the threshold and select CUT LAST;
To create equations with AND operators, follow the procedures below:

- Click on the threshold and select CUT LAST;
- Click on the threshold to which is desired to add the previously selected threshold and then select the threshold to be added.

D Selecting the RECEIVE ETHERNET CROSS-TRIGGER or SEND ETHERNET CROSS-TRIGGER check box enables these features. It allows the start of the recording of an exceeded threshold by Ethernet cross-trigger.

E The <SELECT QUANTITY> button allows user to select the derived quantity of triggered disturbance records. If the quantities are not manually selected, the record will consist of all the quantities available for measurement.

11.2 Continuous Recording

In this section, shown in Figure 33, it is possible to configure the equipment's continuous recorder.

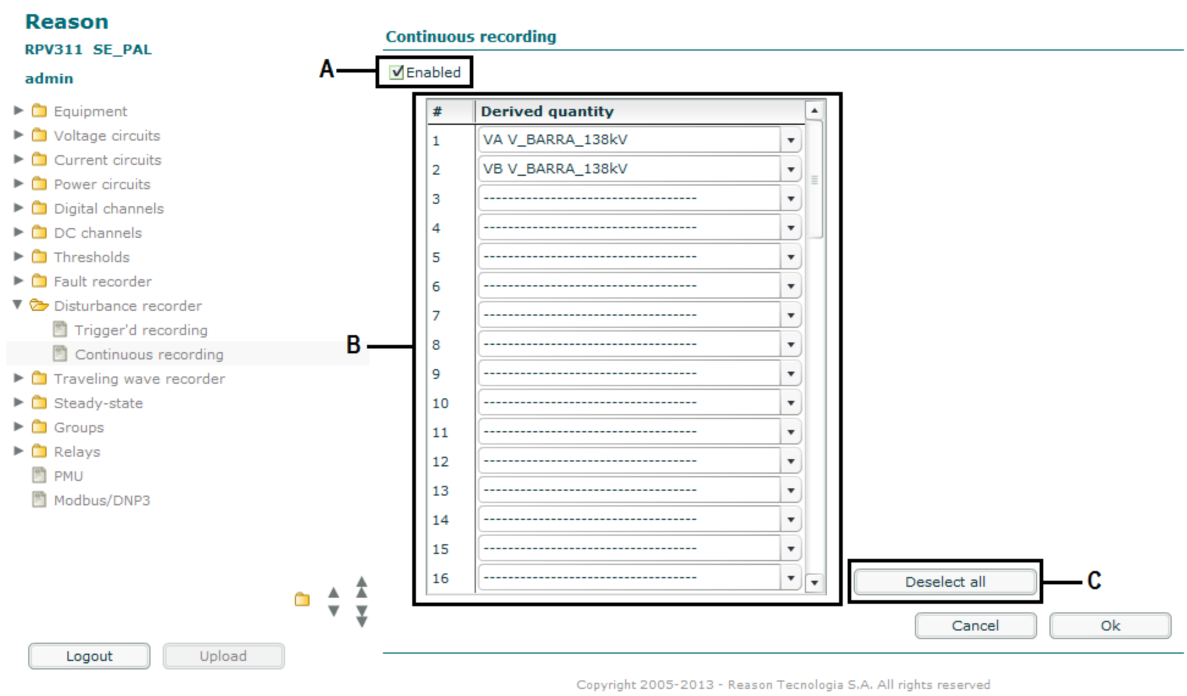


Figure 33: Disturbance recorder – continuous recording configuration section

A The Enabled check box allows user to enable the continuous disturbance reordering feature.

B The Derived quantity scroll box allows user to select the derived quantity of continuous disturbance records.

C The <Deselect all> button allows user to deselect magnitudes selected.

It is possible only to enable the disturbance continuous recorder if the fault continuous recorder is disabled. It is not possible to use both recorders simultaneously.

12 Traveling Waves Recorder

The RPV311 allows user to configure a traveling wave recorder for fault location, by trigger. To start the configuration, it is necessary add a new recorder in accordance with the position of selected links in equipment.
Once created, the traveling wave recorder can be configured as per the section shown in Figure 34.

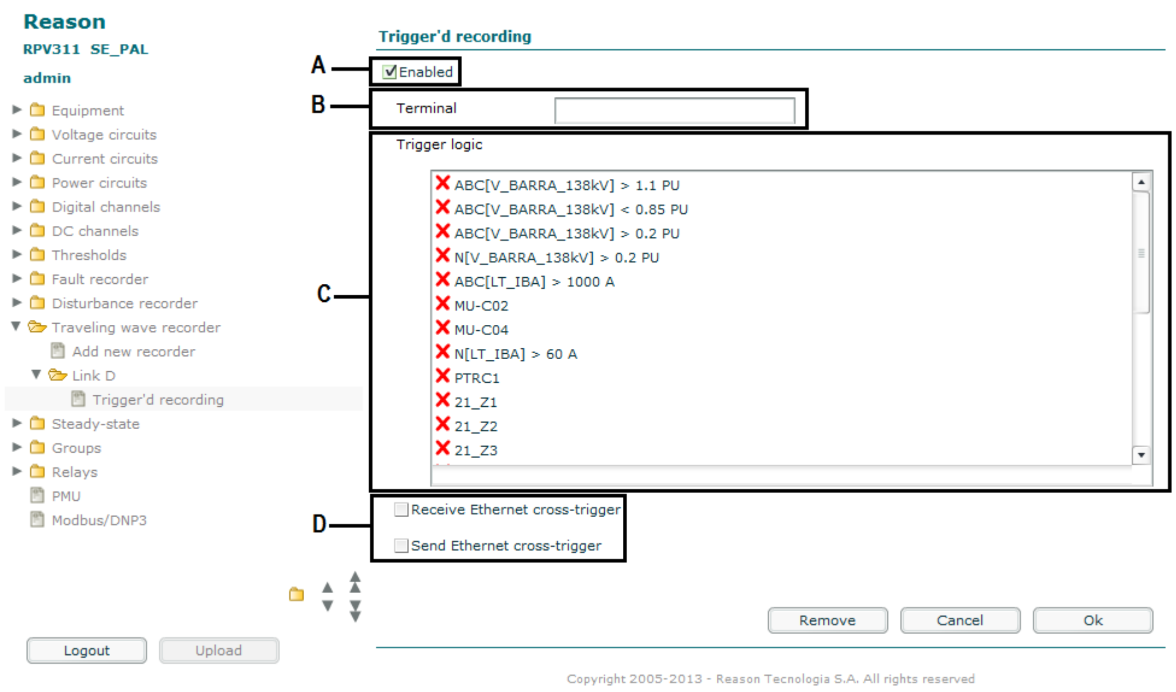


Figure 34: Traveling waves recorder – triggered recording configuration section

A The Enabled check box allows user to enable the fault recorder feature.

B The TERMINAL text field allows user to enter the terminal of this recorder.

C The TRIGGER LOGIC field contains all the thresholds created. The logic equation uses AND and OR logic operators over previously defined thresholds. Initially, all preset thresholds are displayed as implicit OR operators, one per line.

To enable thresholds individually, click on the threshold and select Enable;
To disable discarded thresholds individually, click on the threshold and select Disable;
To break or remove complex thresholds, click on the threshold and select Cut last;
To create equations with AND operators, follow the procedures below:

- Click on the threshold and select Cut last;
- Click on the threshold to which is desired to add the previously selected threshold and then select the threshold to be added.

D Selecting the RECEIVE ETHERNET CROSS-TRIGGER or SEND ETHERNET CROSS-TRIGGER check box enables these features. It allows the start of the recording of an exceeded threshold by Ethernet cross-trigger.

> *Note:*
> *The maximum number of RA333 that can be connected to the RPV311 is 4.*
>
> *The RA333 module has to be connected to the RPV311 processing module before its initialization. Otherwise a log message will tell the user to reboot the device.*

13 Recommended Sources of Trigger

In order to register the beginning of the fault's traveling wave it is important to use instantaneous protections trips (or starts) as digital input for trigger, for example: 50, 21Z1, 67I, 87 etc. In addition, we recommend the following thresholds:

Threshold	Limit
Phase Overcurrent	1,2 pu
Neutral Overcurrent	0,2 pu
Current Negative Sequence	0,15 pu
Phase Undervoltage	0,85 pu
Neutral Overvoltage	0,10 pu

The limits values can be adjusted depending on the needs of each installation using real events as basis

14 Steady-State

RPV311 allows user to register average series, harmonics, and flicker in the steady-state recorder.

14.1 Average series

In this section, shown in Figure 35, it is possible to configure the equipment's average series recorder.
The average series the following voltage and current circuits quantities: magnitude or effective value, neutral magnitude or effective value, frequency, unbalance and total harmonic distortion.

Figure 35: Steady-state recorder – average series configuration section

A The PERIOD scroll box allows user to select the recording average series every 1 or 10 minutes.

14.2 Harmonics

In this section, shown in Figure 36, it is possible to configure the equipment's harmonics recorder.

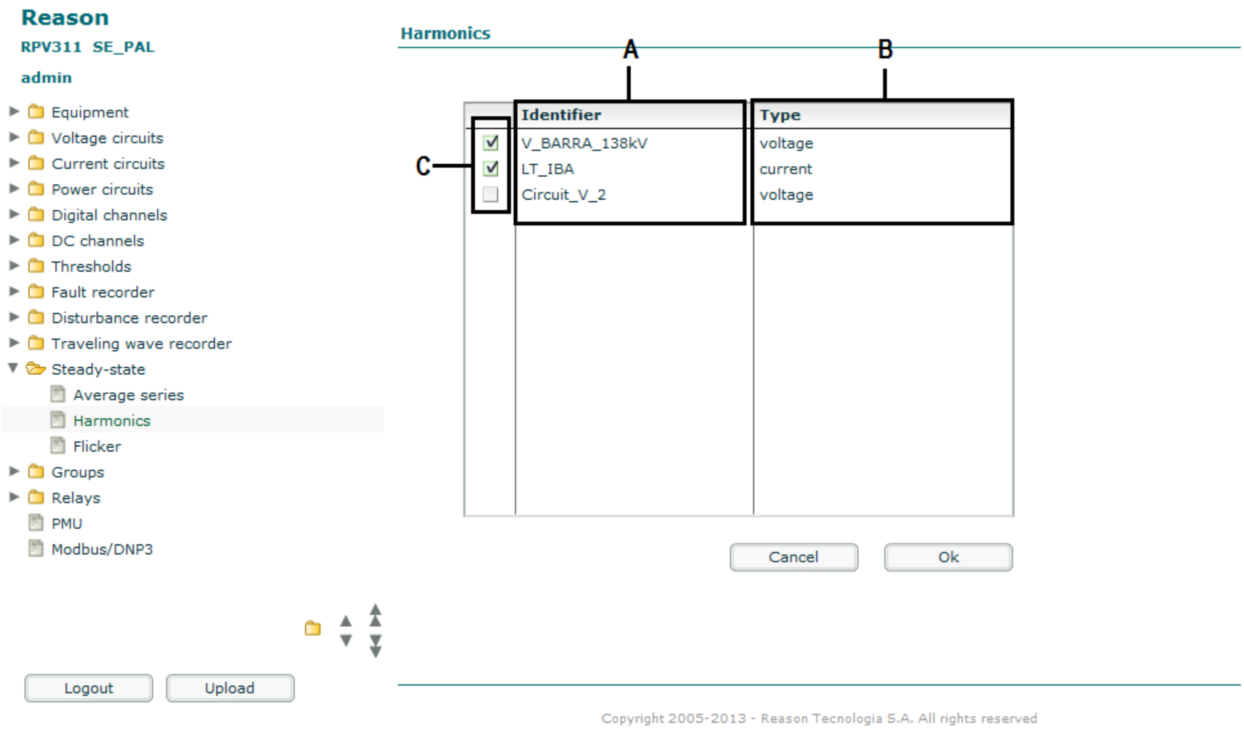


Figure 36: Steady-state recorder – harmonics configuration section

A The IDENTIFIER field shows all the circuits previously configured.

B The TYPE field shows the circuit type.

C The check box allows the selection of preset circuits for the steady-state record formation.

In the harmonics recorder, only 2 circuits can be selected at the same time.

14.3 Flicker

Figure 37 shows the configuration screen of the Flicker feature.

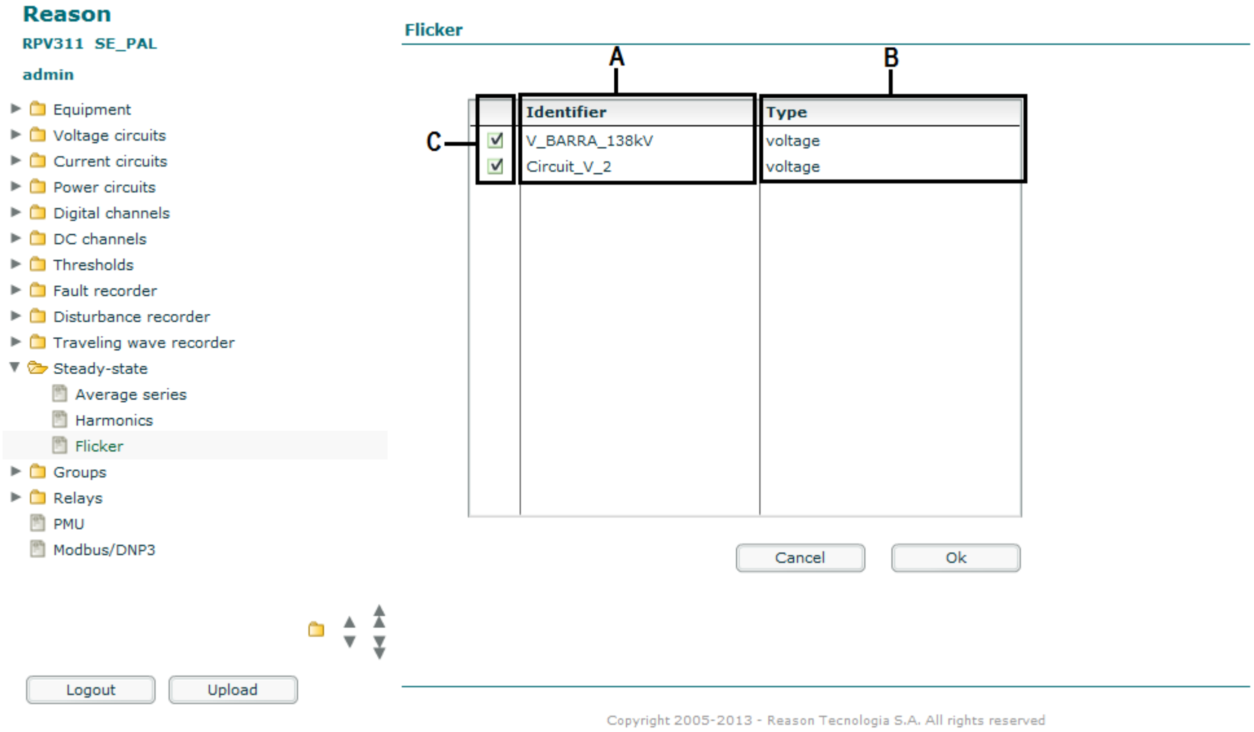


Figure 37: Steady-state recorder – flicker configuration section

A The Identifier field shows all the voltage circuits previously configured.

B The Type field shows the circuit type.

C The check box allows the selection of circuits to be included in the steady-state record.

In the flicker recorder, up to 6 circuits can be selected at the same time.

15 Groups

Group setup allows the user to monitor voltage and current circuit information via local interface or the Monitoring screen at the web interface operation.
It is not possible to monitor circuits that are not included in either group.
To add new groups fill in the following:

- The Identifier text field allows user to enter a single code for the group being defined (maximum 15 characters). No editing allowed;
- The Identifier field shows all the circuits and channels previously configured;
- The Type field shows the circuits type;
- The check box allows user to include the preset circuits for the group formation;
- The <Deselect all> button allows user to deselect all circuits marked;
- The <Select all> button allows user to select all circuits;
- The Length, R0, X0, R1 and X1 text fields allow user to enter the transmission line characteristics (length and impedance), for the fault location.

The RPV311 uses one-end impedance fault location based on the Takagi algorithm

Once the group is created, it shows in the configuration interface menu. When selecting the group, a screen shows its characteristics, as shown in the figure below. It is possible to edit all the fields.

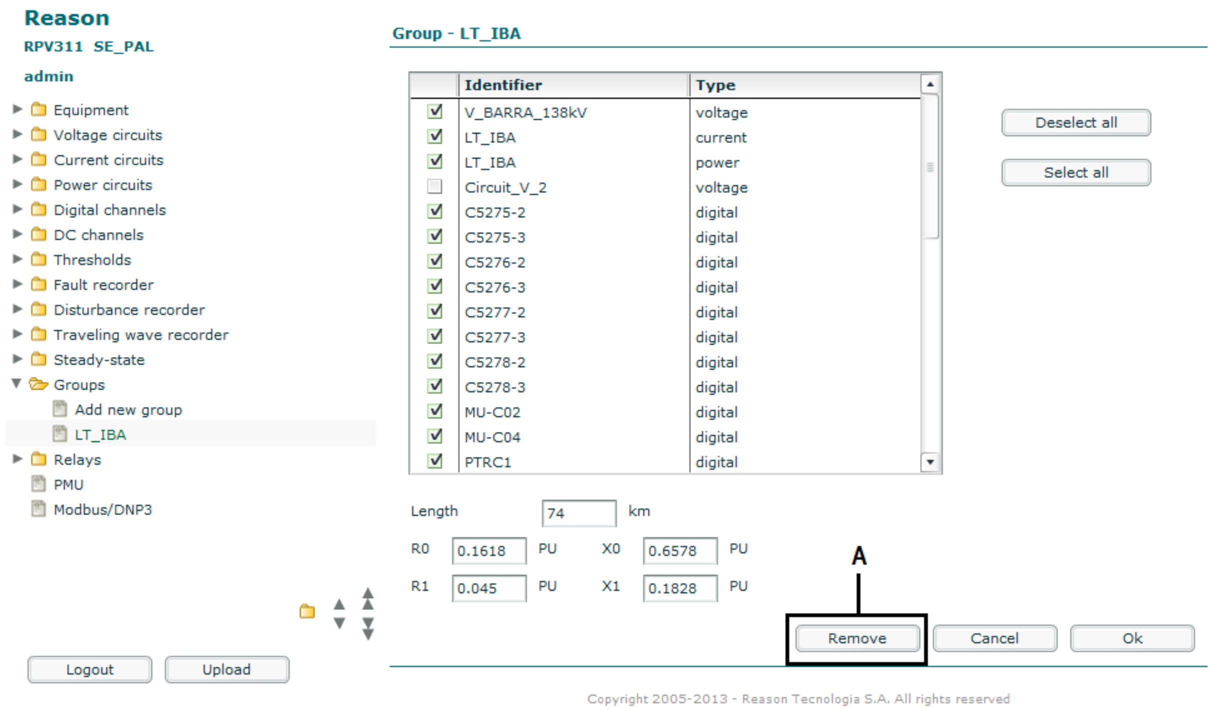


Figure 38: Adding and editing a group

A The <Remove> button allows user to delete the group.

16 Relays

Relays indicate events or state transitions and set off the alarm on the equipment. RPV311 provides four relays: three relays set by the user and one factory default relay, which signals internal equipment failure.

16.1 On time

In this section, shown in **Figure 39**, it is possible to configure the relays on time for logging signaling events.

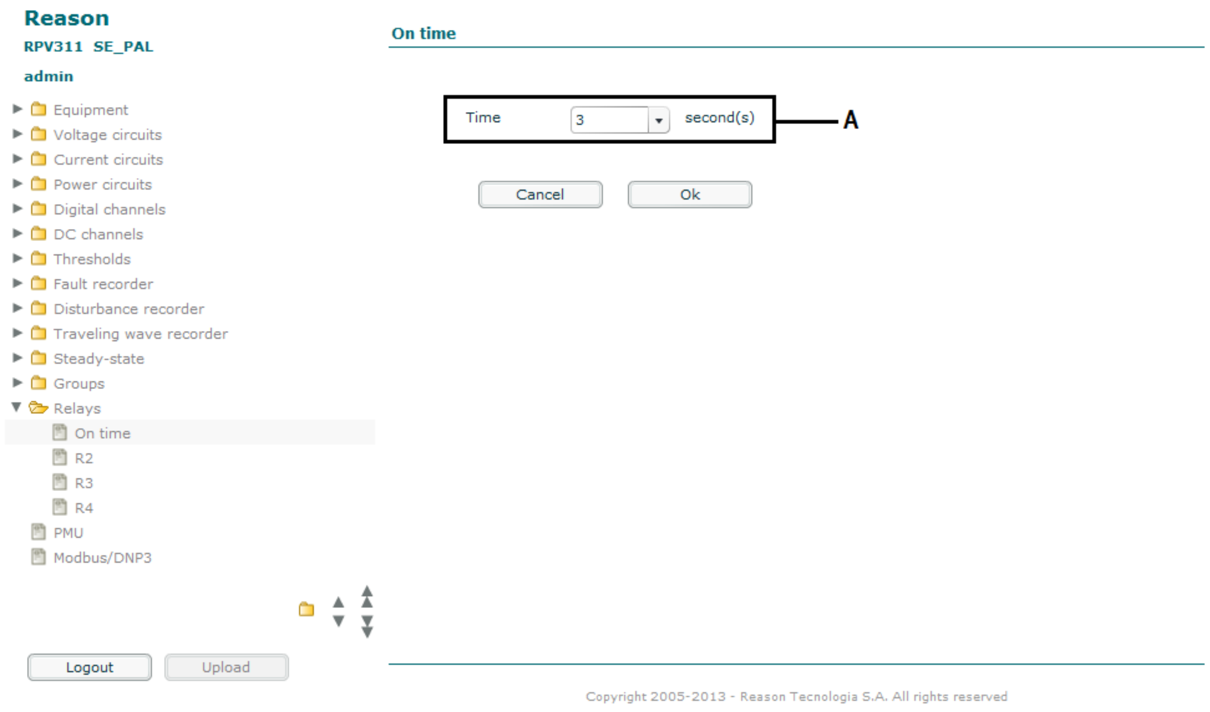


Figure 39: Relays on time configuration section

A The TIME scroll box allows user to select the relays on time for logging signaling events (1 to 10 seconds).

16.2 Relays 2, 3, and 4

Below is shown the configuration screen of the signaling relays.

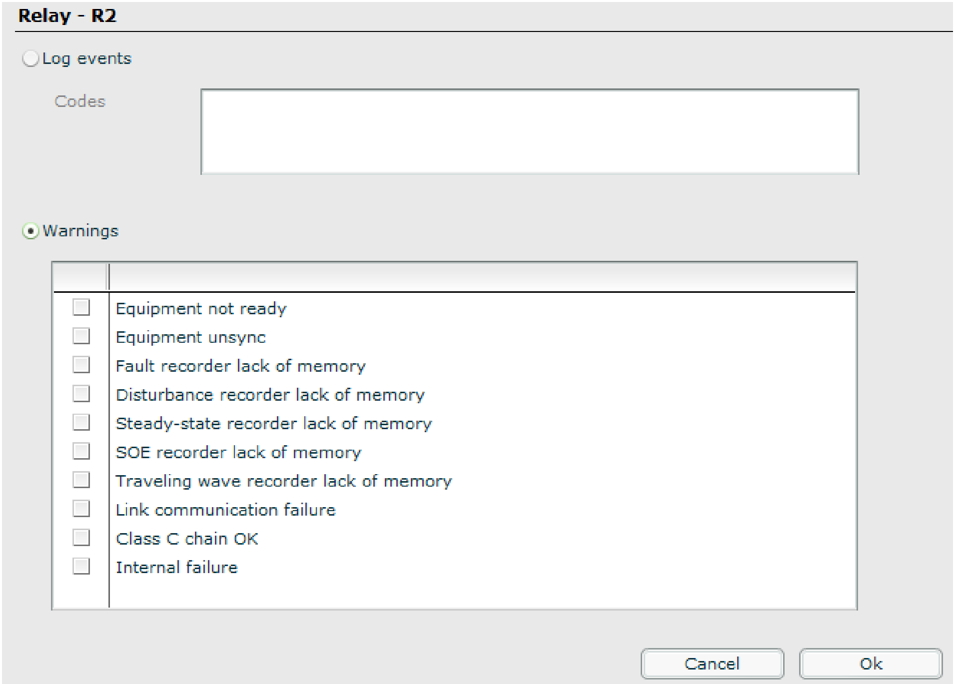


Figure 40: Relay signaling events configuration section

A The LOG events text field allows user to enter a code used for signaling events. Refer to Appendix Afor log references. The relays will stay closed during the time set in the On time configuration (previous section). In order to combine several LOG events to trigger the alarm, use “comma” to separate the LOG numbers, for instance: 709, 710.

B The WARNINGS check box allows user to select the following events for signaling:

- Equipment not ready;
- Primary power failure;
- Equipment unsync;
- Fault recorder lack of memory;
- Disturbance recorder lack of memory;
- Steady-state recorder lack of memory;
- SOE recorder lack of memory;
- Link communication failure;
- Internal failure.
- Class C chain OK[1]

[1] - Class C chain OK: output relay is closed when two conditions happen simultaneously: Equipment healthy (code 50) and Synchronization OK (code 102). When “No Source” is selected as Synch source on the synchronization page, then the “Class C chain OK” relay closes when Equipment healthy (code 50) condition is met.

In addition to closing the output relays, the warning events will cause the Alarm LED in the front panel of the RPV311 to light up. The Both the outputs and the LED will stay active as long as the warning event in active.

17 PMU

Synchrophasors are measured and broadcast according to the specifications contained in IEEE C37.118, Standard for Synchrophasors for Power Systems.

For further information about the PMU, see Chapter 8: PMU.

The RPV311 is able to send up to 4 PMU in the frame of data and the configuration is divided into three sub menus: General, Data and Communication described below.

17.1 General

This window is responsible for configuring the following settings:

<Enable> Turns the PMU streaming on and off.

The <ID> text field allows user to enter a single ID for the entire PMU streaming; the range is of 1 to 65534.

The <Rate> scroll box allows user to select a frame transmission rate; at 60Hz the parameters are10, 12, 15, 20, 30, and 60 fps; at 50Hz they are 10, 25 and 50Hz.

17.2 Data

The data selection is related to the groups configuration (refer to Chapter 4: Configuration, Section 15 - Groups). Each group can configure a PMU with its specific data and frequency.

The parameters present on the screen are:

<GROUP> this setting displays all the values related to the selected group that can be transmitted. Each group has a particular setting for the frequency and rate of change of frequency related to it.

The <ENABLE> check box allows user to enable data packet transmission.

The <ID> text field allows user to enter a single PMU transmitter ID; the range is of 1 to 65534.

<FREQUENCY> selects the reference frequency of PMU. It is possible to choose which signal is used to calculate the frequency, namely: Voltage from phases A, B or C, voltage positive sequence, current from phases A, B or C.

The <PHASORS>, Analog data and Digital data fields contain all the inputs configured on the equipment. The check box allows user to select the input to evaluate magnitudes.

The <DESELECT ALL> button allows user to deselect all the magnitudes selected.

17.3 Communication

The RPV311 has two types of operation modes: Commanded; and Spontaneous.

When using the Commanded mode the RPV only transmits data when the client requests. This mode allows up to 4 destinations of the PMU frame through the UDP ports.

The ports the RPV311 uses to send synchrophasors are:

Stream of data	Port number
1	4713
2	4714
3	4715
4	4716

In *Spontaneous* mode the RPV sends the PMU data automatically up to 4 different socket addresses (IP + port number). All 4 destination configuration can be set as unicast or multicast transmission.

The parameters of the Communication screen are listed below:

<COMMANDED> Sets the respective streams of data to Commanded mode. When set to Commanded mode. The RPV311 can send the HDR, CFG2 and CFG3 frames according to the client's IED request.

<SPONTANEOUS> Sets the respective streams of data to Spontaneous mode. When in Spontaneous mode it is also possible to select which CFG frame the PMU will use. The options are CFG2 and CFG3, at least one of them must be set. Additionally, it is possible to choose if the HDR frame will be sent.

<UNICAST> Sets the addressing of the respective streams of data to Unicast mode. This kind of transmission connects to a single IP address and the routing of the messages though the available Ethernet ports are managed by the RPV system. It is important that the destination IP and the RPV311 share the same subnetwork address.

<MULTICAST> Sets the addressing of the respective streams of data to Multicast mode. This mode required the user to choose which Ethernet interface the RPV shall use to convey the data.

Note 1:
*When the PMU is configured in **spontaneous** mode, the RPV311 will transmit the PMU data through the Ethernet port whose IP address is within the same subnet as the destination IP address of the PMU stream. In case different streams are configured, they will be transmitted simultaneously through both Ethernet ports 1 and 2, in case, the subnets of the destination IP addresses match the configured IP of the RPV311 Ethernet ports.*
*When the PMU is configured in **commanded** mode, the RPV311 will transmit the PMU data through the same Ethernet port as the PMU requisition was made.*
Note 2:
When the primary values being read are less then 1A or 1 V, the PMU TVE will not work properly, i.e. in performance test scenarios do not use transformer ratios equal to 1.

18 MODBUS

Status, analog and digital data are available in MODBUS registers.
Access to SCADA integration is provided over the Ethernet interface. Up to 8 simultaneous connections are allowed a maximum rate of 60 accesses per second.
For further information about MODBUS, see Chapter 9: MODBUS.
Each register reports 16-bit data. Registers are divided into 3 groups:

Registers groups	
0	Status
100 to 199	Analog data
200 to 223	Digital channels

In the MODBUS section shown in **Figure 41**, it is possible to configure MODBUS.

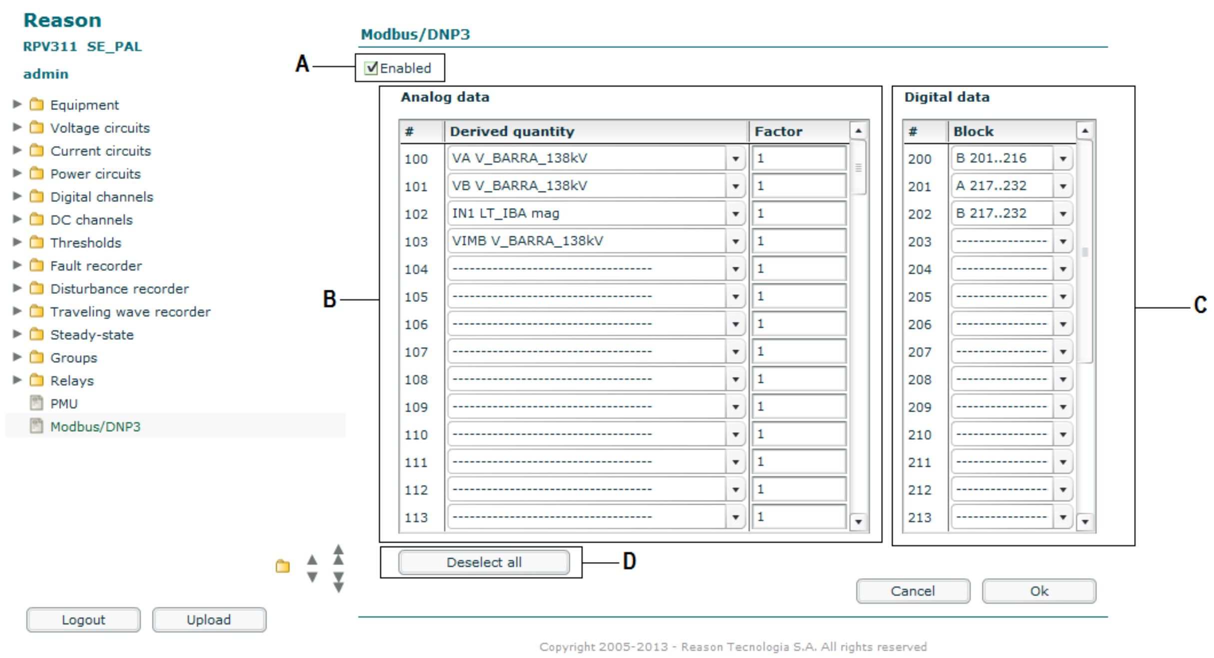


Figure 41: MODBUS configuration section

A The ENABLE check box allows user to enable recording.

B The ANALOG DATA field allows user to select a derived quantity and insert a decimal correction factor of an analog input.

C The DIGITAL DATA field allows user to select a block of a digital input.

D The <DESELECT ALL> button allows user to deselect all the magnitudes selected.

Note: Whenever MODBUS/DNP3 feature is enabled, the RPV will send both types of messages. It is not possible to enable just one protocol.

19 DNP3

The DNP3 functionality is fully associated with the MODBUS functionality in the RPV311. To use the DNP3 protocol, it is necessary to insert a configuration key at the equipment to unlock the MODBUS and DNP3 functionalities. However, it is necessary to check the HABILITATED option at the web interface and insert analog channels block or digital channel blocks at MODBUS/DNP3 menu.

19.1 Configuring the DNP3 function

To add binary data to the DNP3 slave database (RPV311), it’s just necessary to add a digital channel in the equipment’s configuration, as shown at section 6. At the RPV311 restarting proccess, the DNP3 library reads the configuration archive and adds digital channels sequentially, associating to an integer number plus an increment, starting at **zero**, for each digital channel. GOOSE digital channels are not added to the DNP3 database.

19.2 DNP3 configuration example

19.2.1 Adding digital channels

First step for digital channel DNP3 database association is to create a digital channel. **Figure 42** shows the digital channels configured and table below shows associated number at the DNP3 database for each digital channel of the example.

Figure 42: Digital Channels Configured

Channel name	RA33x input	Channel type	DNP3 Database associated number
D1	A201	Physical	00
D2	A217	Physical	01
D4	C201	Physical	02
D_Linha2	B201	Physical	03
D_Linha3	B202	Physical	04
G1		GOOSE	
G2		GOOSE	
D10	A210	Physical	05
D11	A211	Physical	06
D12	A212	Physical	07

19.2.2 Adding analog channels

The analog data possibilites for the DNP3 communication procol are the same as for MODBUS. The MODBUS analog data are shown in section 1.3.
To configure the analog data, access the MODBUS/DNP3 menu via web interface. Analog data are added in a sequential way, like the digital channels, but the starting number for the analog channels is **5**. Numbers 0, 1, 2, 3 and 4 are reserved for equipment information.

Note:

For analog channels, the first number associated at the DNP3 database is 5. Numbers 1, 2, 3 and 4 are reserved for equipment information.

Figure 43 shows the analog channels selected at the MODBUS/DNP3 menu and the table below it shows the associated number at the DNP3 database for each example analog channel.

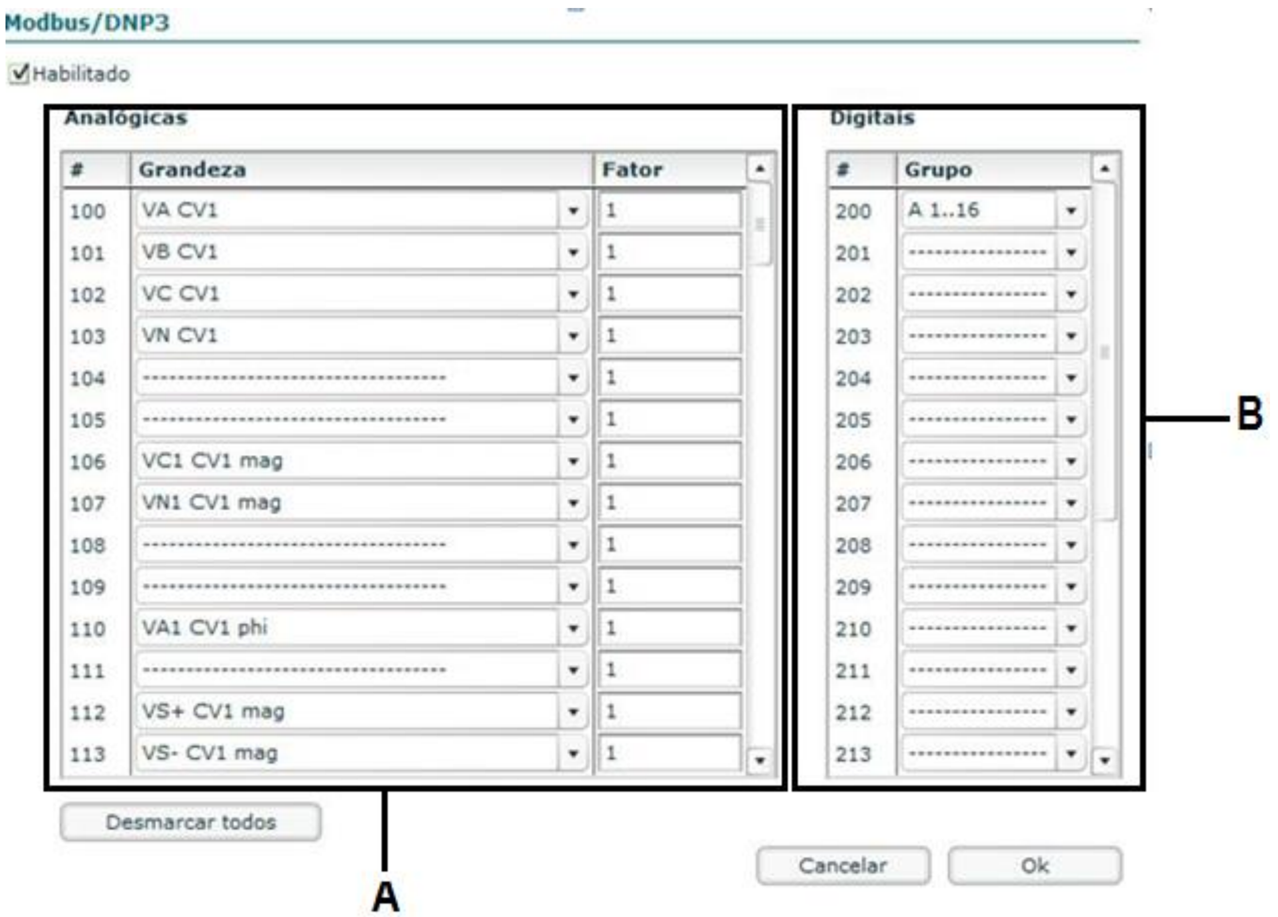


Figure 43: Analog channels selected

A The field is only used for analog quantities with DNP3***;***

B Used to configure the digital inputs that will be sent.

Data name	MODBUS register number	DNP3 Database associated number	Data type
	0	00	Alarms: bit 0: Equipment NOK bit 1: Primary power failure bit 2: Not used bit 3: Not used bit 4: Equipment not synchronized bit 5: Fault recorder low memory bit 6: Disturbance recorder low memory bit 7: Steady-state recorder low memory bit 8: SOE recorder lack of memory bit 9: Internal failure
	1	01	Not used
	2	02	Not used
	3	03	Not used
	4	04	Time quality
VA CV1	100	05	CV1 voltage circuit, phase A RMS value
VB CV1	101	06	CV1 voltage circuit, phase B RMS value
VC CV1	102	07	CV1 voltage circuit, phase C RMS value
VN CV1	103	08	CV1 voltage circuit, neutral RMS value
VC1 CV1 mag	106	09	CV1 voltage circuit, phase C phasor magnitude
VN1 CV1 mag	107	10	CV1 voltage circuit, neutral phasor magnitude
VA1 CV1 phi	110	11	CV1 voltage circuit, phase A phasor angle
VS+ CV1 mag	112	12	CV1 voltage circuit, positive sequence magnitude
VS- CV1 mag	113	13	CV1 voltage circuit, negative sequence magnitude

Note:

The 104, 105, 108, 109 and 111 registers (without configuration, as shown in figure 114) have no influence DNP3 Database analogue object number's increment

Note: Whenever MODBUS/DNP3 feature is enabled, the RPV will send both types of messages. It is not possible to enable just one protocol.

Note: The phase angles are sent in degrees for the MODBUS and radian for DNP3

RPV311

Distributed Multifunction Fault Recorder

Chapter 5: Operation

This chapter provides information on possible ways to access and operate the device. .

1 Local Interface

The RPV311 has a local interface for human-machine interaction, composed of a display, navigation buttons, and status indicators, as shown in the figure below.

Figure 44: Local interface of the RPV311

1.1 Status Indicators

The local interface has 4 status indicators:

- ALARM: Lights up when the equipment requires attention of the operator;
- TRIGGER: Flashes when a threshold has been triggered;
- SYNC: Lights up when the internal clock and the acquisition system are synchronized through the IRIG-B signal;
- READY: Lights up when the equipment has passed through the self-test routines and is in normal operation.

Note: If during the RPV311 initialization (boot) the Alarm LED is active due to an opened link of the RA333 TW link (log code 297 – Traveling wave not identified). The user must reboot the RPV311 after normalizing the link connection, otherwise the RPV311 will not create the TW COMTRADE recordings.

1.2 Menu Navigation

The navigation buttons are used as follows:

- The Back button returns to the previous menu level;
- The Enter button selects an item of the list;
- The arrows allow the user to scroll through the list of items displayed.

1.3 Local Interface Menus

1.3.1 Status

The information below is displayed in the local menu:

- Date and time;
- If the equipment is in normal operation;
- If the RPV311 is being synchronized by IRIGB or NTP;
- Date and time since last power up;
- Percentage of mass memory used;

To access the items, use the sequence shown in **Figure 45**.

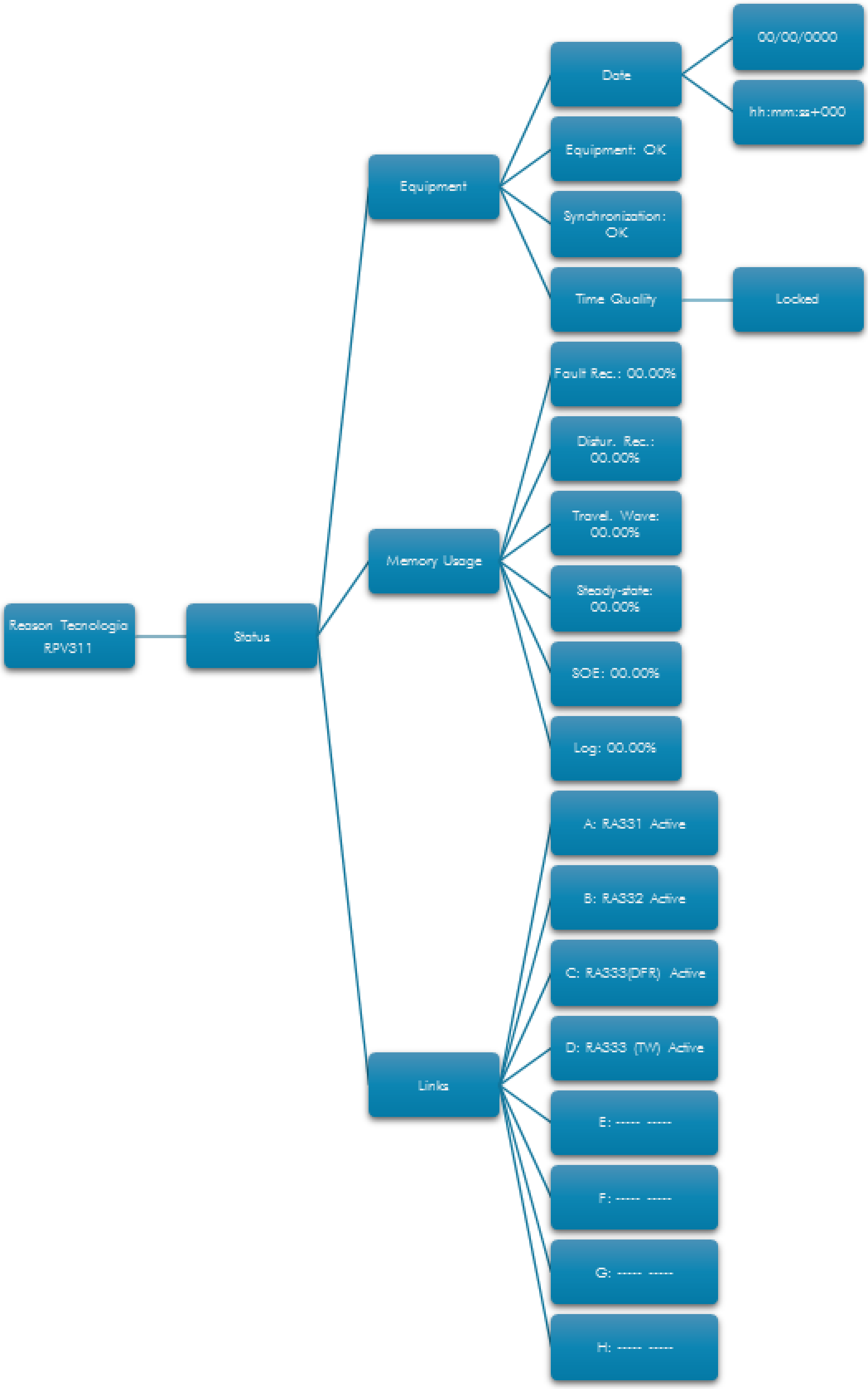


Figure 45: Status monitoring sequence

1.3.2 Monitoring

It is possible to locally monitor the analog quantities measured by the RPV311. Quantities are separated by the name of the circuit and the data is updated once per second.

To view the values related to quantities associated with a circuit, select the circuit group, choose the circuit type (voltage, current, or power) and then select the name of the circuit to be monitored.

To access the Monitoring items, use the sequence shown in **Figure 46**.

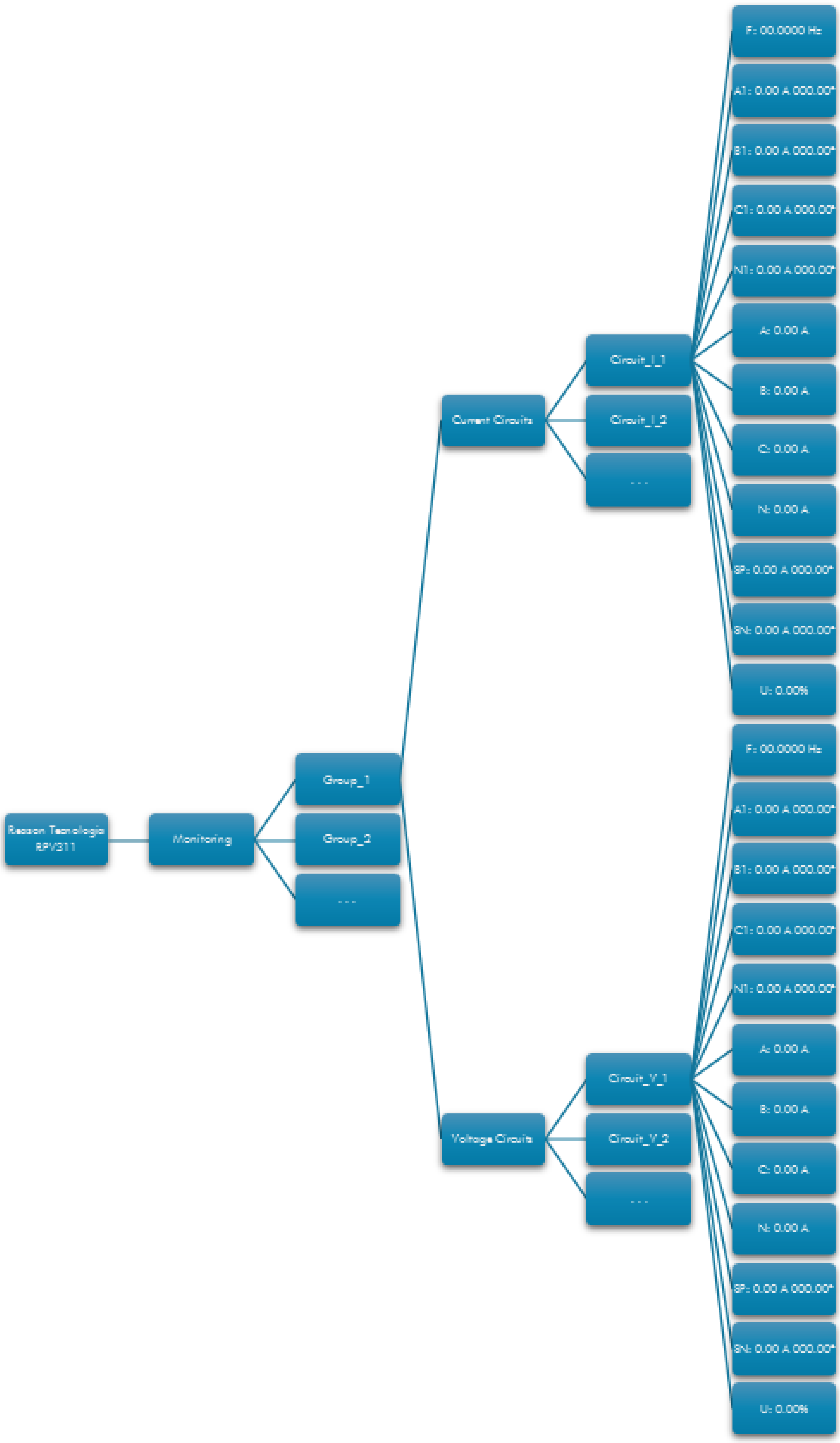


Figure 46: Monitoring sequence

1.3.3 Records

This menu shows the list of records provided by the equipment in decreasing chronological order (of the latest to the oldest).
To view a record, select the type of the record (Waveform, Synchrophasors, Steady-state, TW or SOE), and then select the date and the time of the record to be viewed. For each record the following data will be shown:

- Time stamp of the record;
- Record duration;
- Thresholds exceeded (triggered records only);
- Time quality;
- The fault location (waveform records only).

To access the Record, use the sequence shown in Figures 49 and 50.

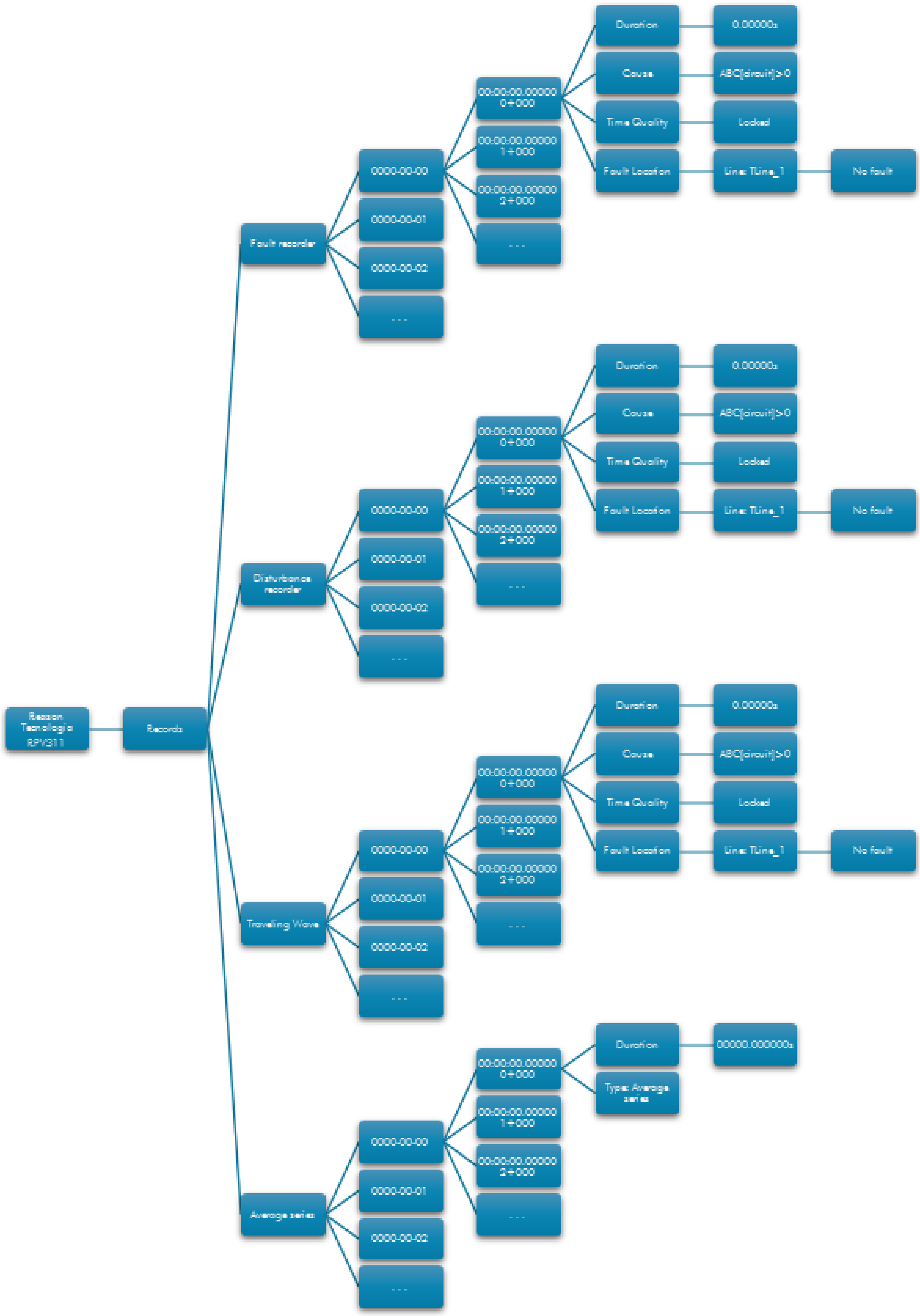


Figure 47: Records monitoring sequence: Fault disturbance, TW and average series

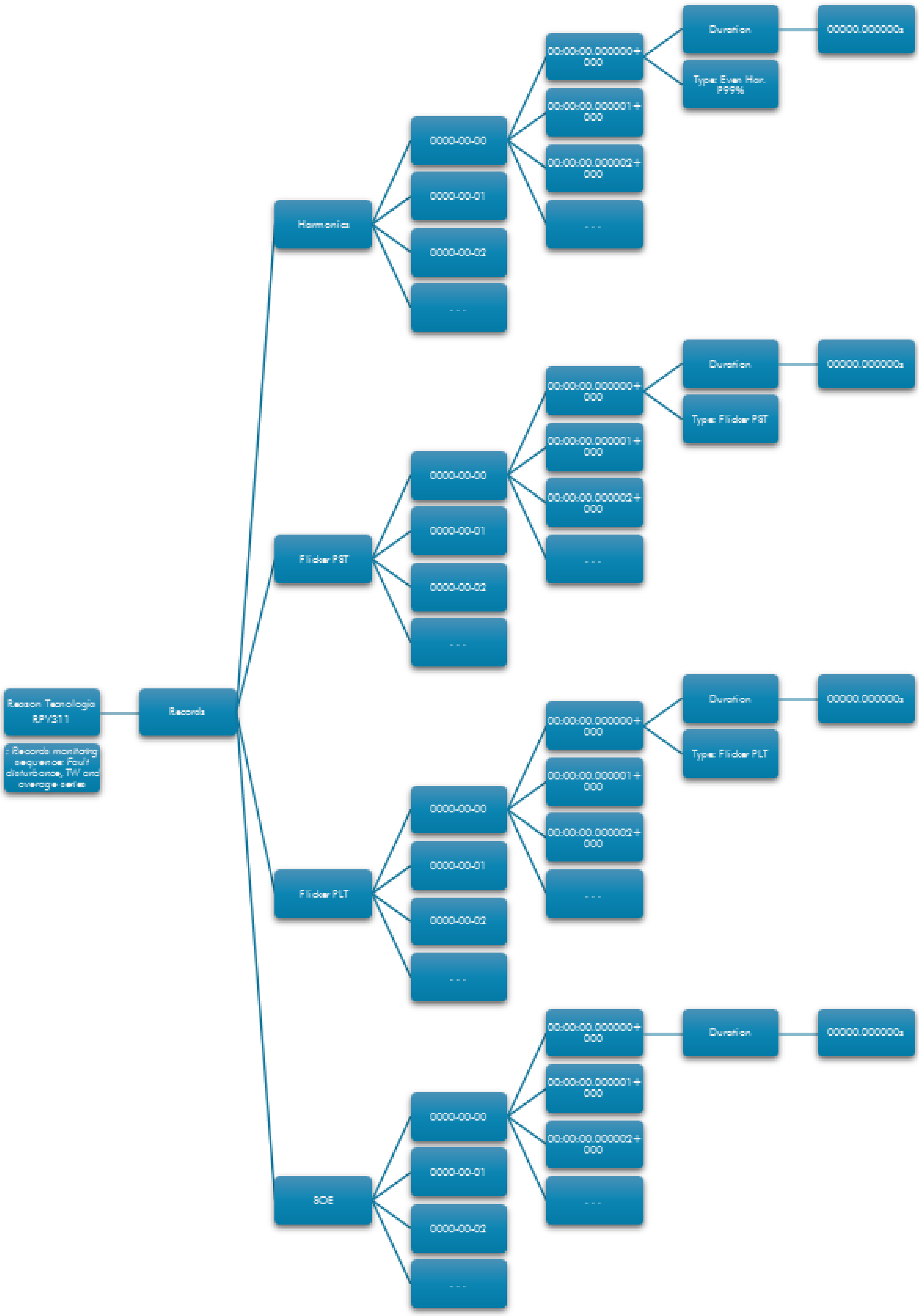


Figure 48: Records monitoring sequence: harmonics, flicker and SOE

1.3.4 Settings

Shows the RPV311 configuration, related to:

- Equipment identification;
- Synchronization information;
- Communication settings (gateway, serial port and Ethernet);
- Information about voltage, current and power circuits and digital channels;
- Relay configuration.

To access the Setting items, use the sequence shown in Figures 51 to 53.

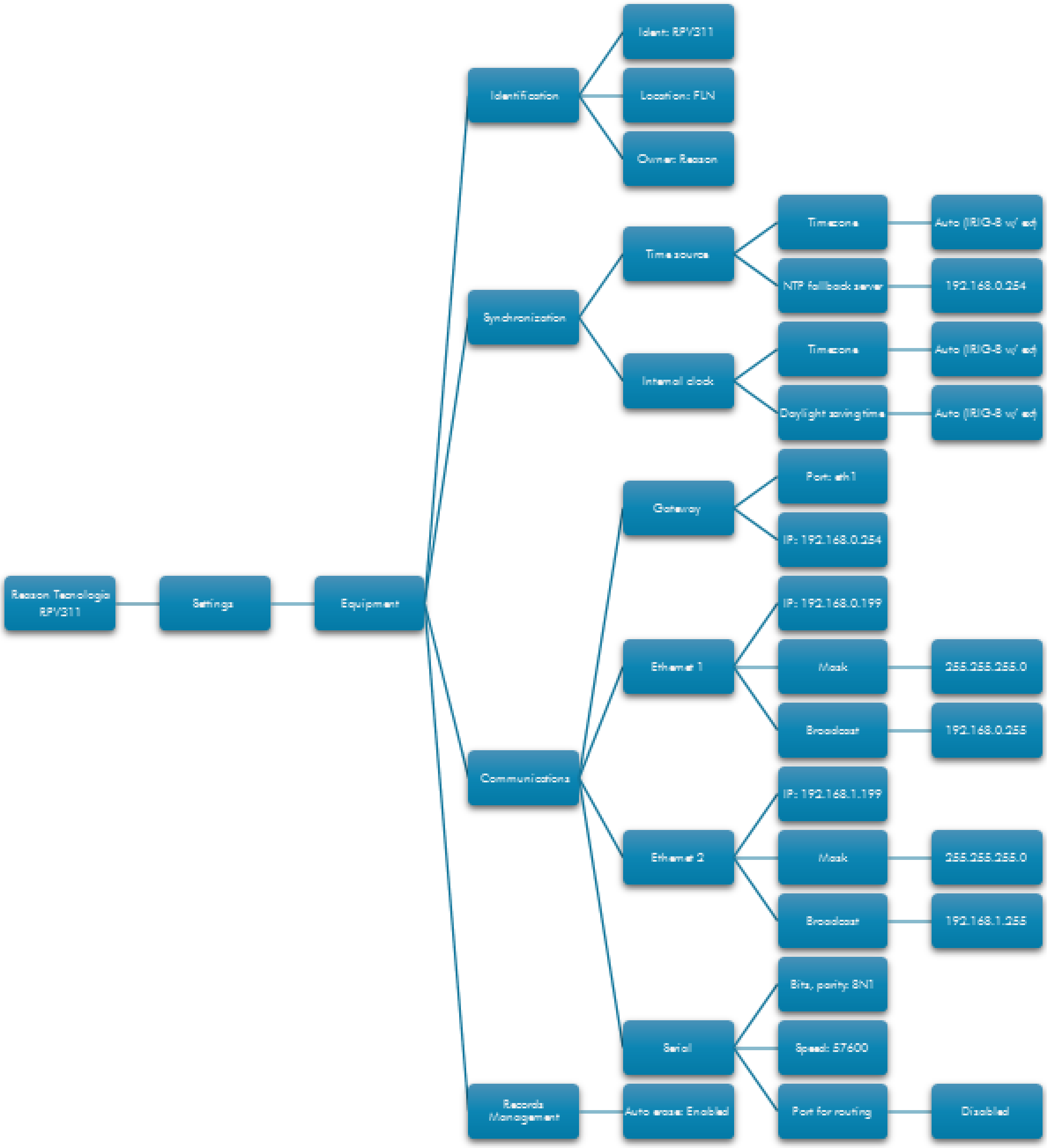


Figure 49: Equipment settings monitoring sequence

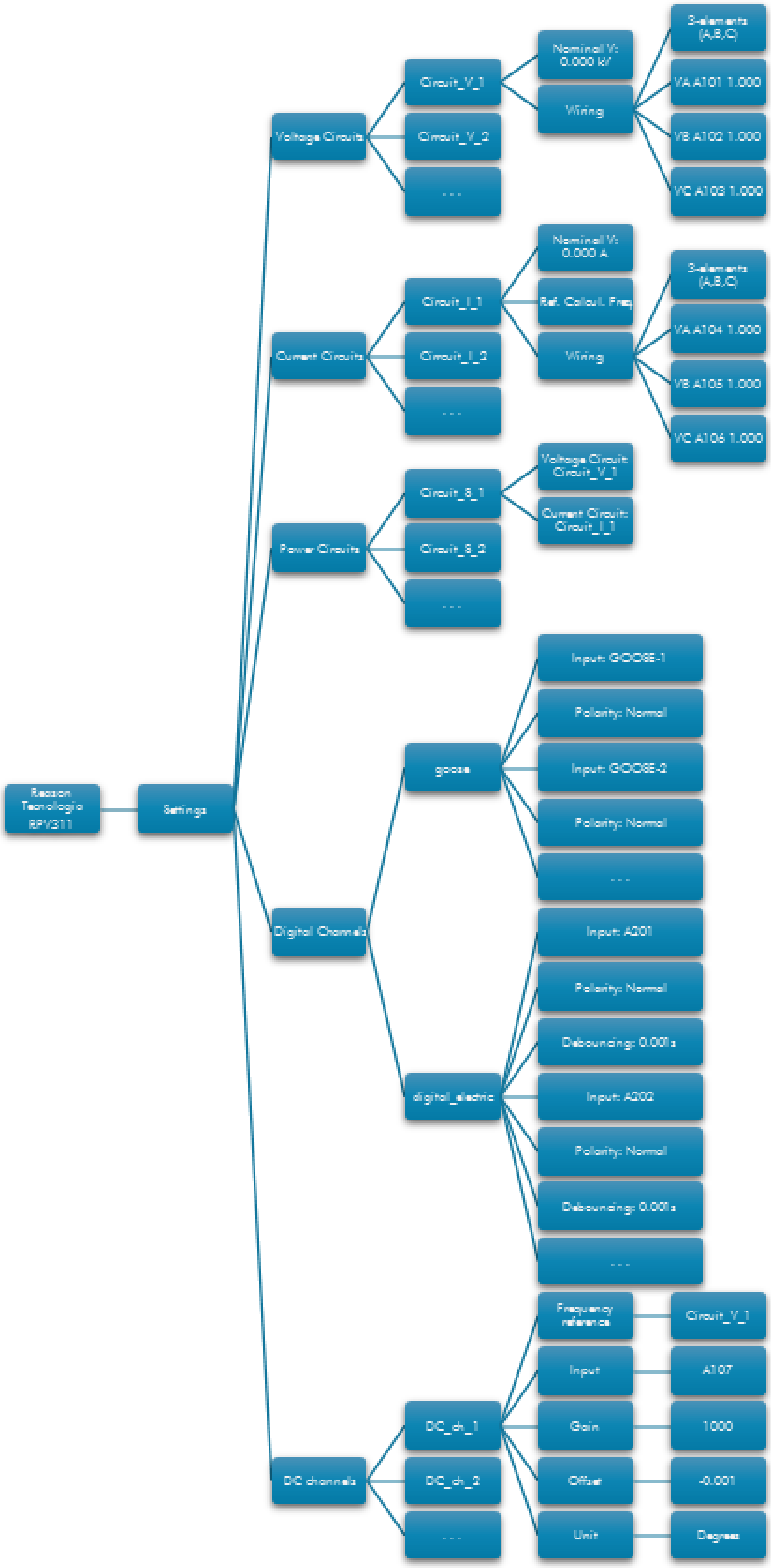


Figure 50: Circuit and channel settings monitoring sequence

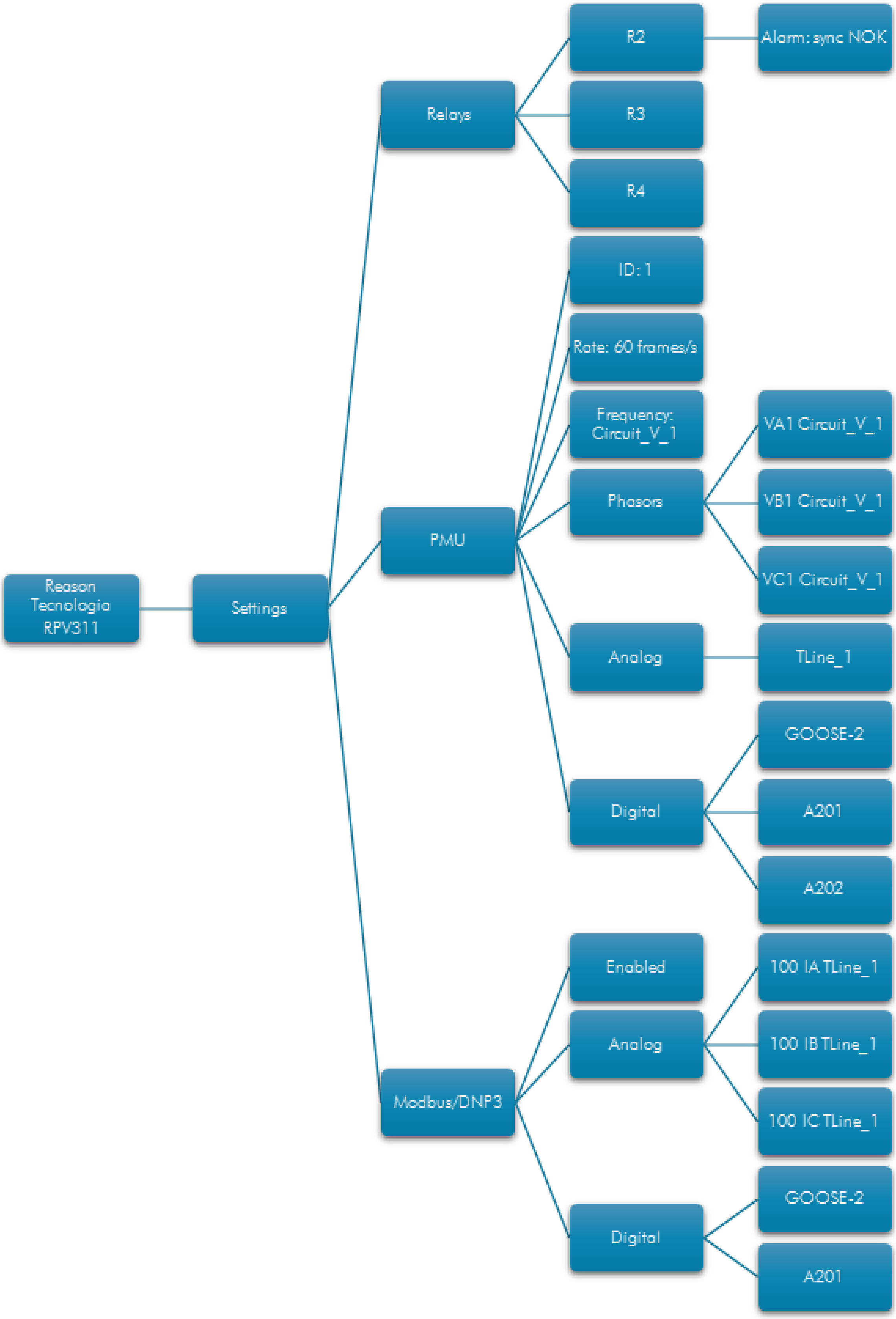


Figure 51: Relays, PMU and MODBUS settings monitoring sequence

1.3.5 General Information

Shows general information about the equipment, such as:

- Equipment model;
- Processor;
- Module identification;
- Frequency;
- Type of sequence;
- Key (to enable the equipment functions);
- Features (features enabled).

To access the items of General Information, use the sequence shown in **Figure 52**.

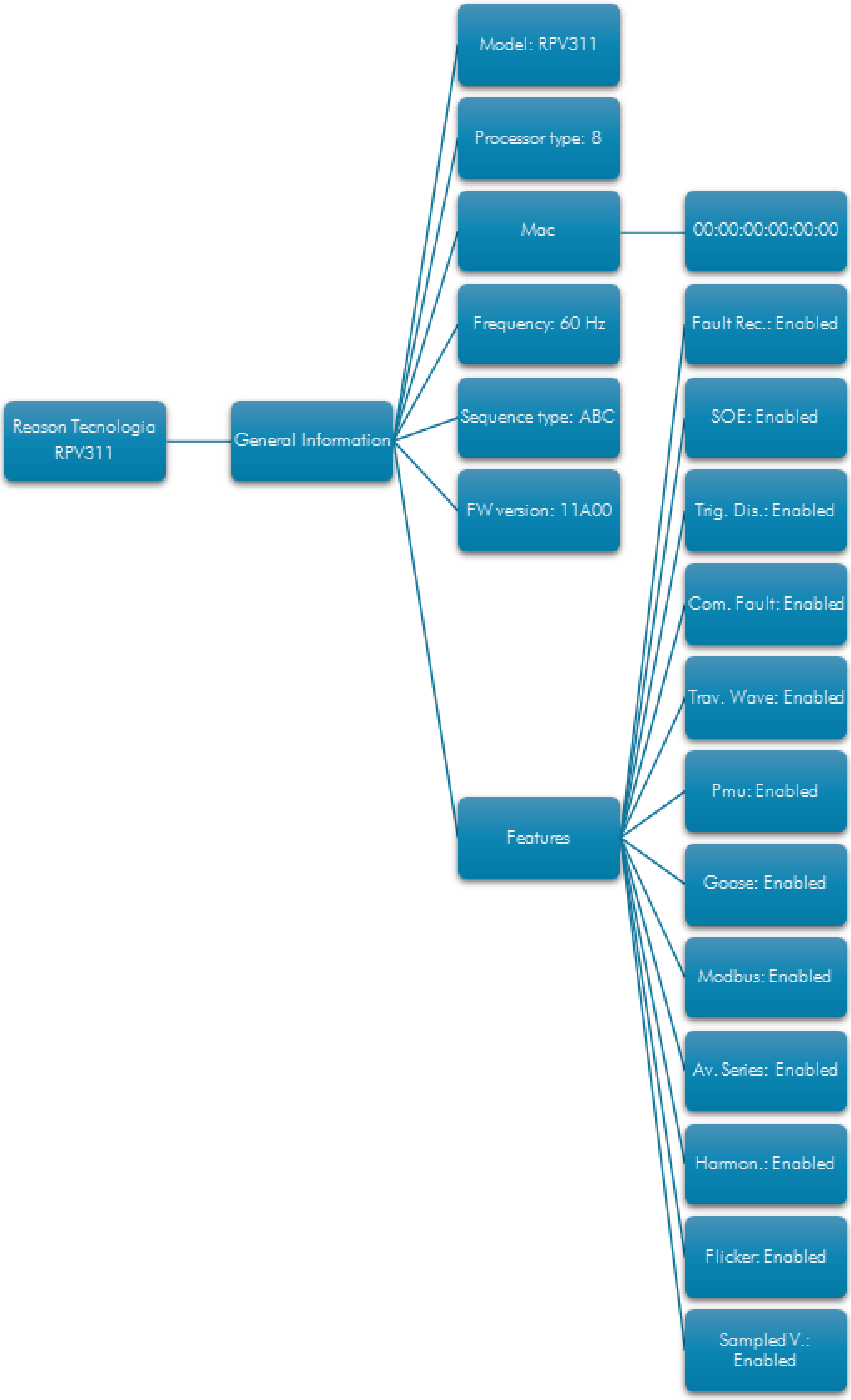


Figure 52: General information monitoring sequence

2 Monitoring Web Interface

2.1 Accessing the Monitoring Web Interface

The equipment’s monitoring interface allows access to the equipment and link status, event log, manual trigger, records, monitoring of magnitudes, configuration history, and general information about the equipment.

Refer to Chapter 14: Communications in order to verify the support applications and the minimum requirements needed to access all the RPV311 web interface features.

To access the monitoring interface, enter the equipment's Ethernet IP in a web browser. If the Flash Player 9.0 (or higher) plug-in is not already installed on the computer, it will be automatically installed by the operating system. The Ethernet interface default settings are shown in Chapter 14: Communications.

.

If the equipment is not fond with the default IP settings, refer to Chapter 5: Operation in order to be able to verify the current IP address.

2.2 Navigating

The default screen of the Web Interface is shown in Figure 53.

Figure 53: Default screen for browsing on the Web Interface

A Equipment identification.

B Menu and scroll bar.

C Buttons to close a section or start a new configuration.

D Desktop.

Web Interface navigation follows the rules below:

- The menu items near the arrows are expandable. To expand or compress a menu item, click on the arrow or click on the item.
- To expand or compress all menu items, click on the folder at the bottom of the screen beside the scroll bar.
- To select a menu sub-item, click on the item.
- To move through the menu using the scroll bar, click on the arrow related to the direction desired. Click on the single arrow to move one step or on the double arrow to move 10 steps.

To finish the session, click on the <LOGOUT> button. A confirmation box will appear. Click Yes to confirm or No to keep logged in. If the screen is closed before pressing the logout button, the user will remain connected until a time delay expires (1 minute).

2.3 Status

In the Status screen the statuses of the equipment and of the links are shown.
If any information of the Status screen indicates a parameter different of the normal operation of equipment, such indication will be shown in red.

2.3.1 Equipment Status

The Equipment screen, shown in **Figure 54**, displays a summary of the status of the equipment.

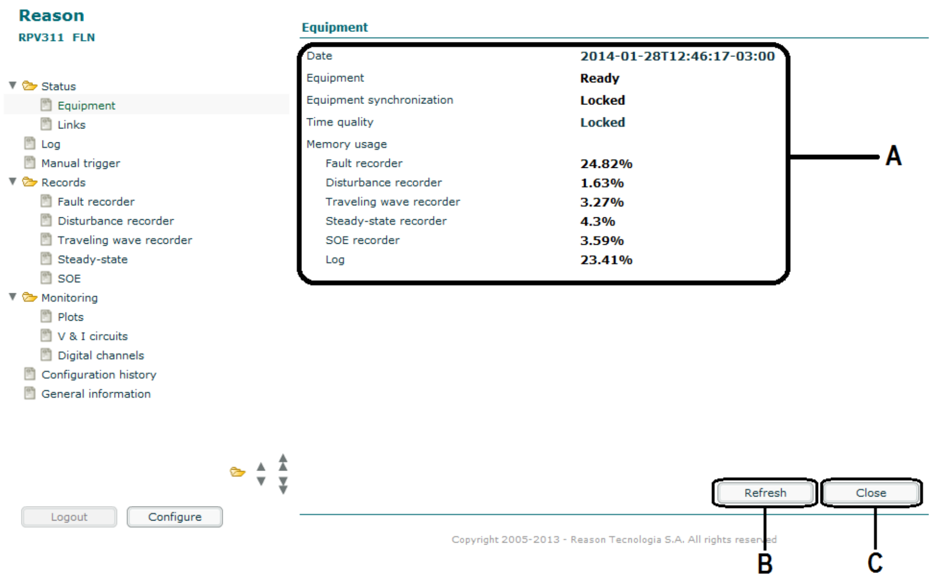


Figure 54: Equipment status screen

A Equipment status, with the following information:

- **Date:** indicates the date the equipment status was last updated in the yyyy-mm-dd hh:mm:ss + 0000 format where o is UTC time offset;
- **Equipment:** indicates whether the equipment is operational or not;
- **Synchronization:** indicates locked if receiving a valid IRIG-B signal and the acquisition system is synchronized with the IRIG-B signal, even if the time quality is different of locked;
- **Time quality:** indicates the received IRIG-B signal quality;
- **Memory usage:** indicates the memory usage related to the fault, disturbance, TW, steady-state and SOE records and log;
- **Last power-up:** indicates the date and time since the last power up.

B The <Refresh> button allows user to refresh the screen information.

C The <Close> button allows user to close the section.

2.3.2 Links Status

The Links screen, shown in **Figure 55**, displays the equipment links status.

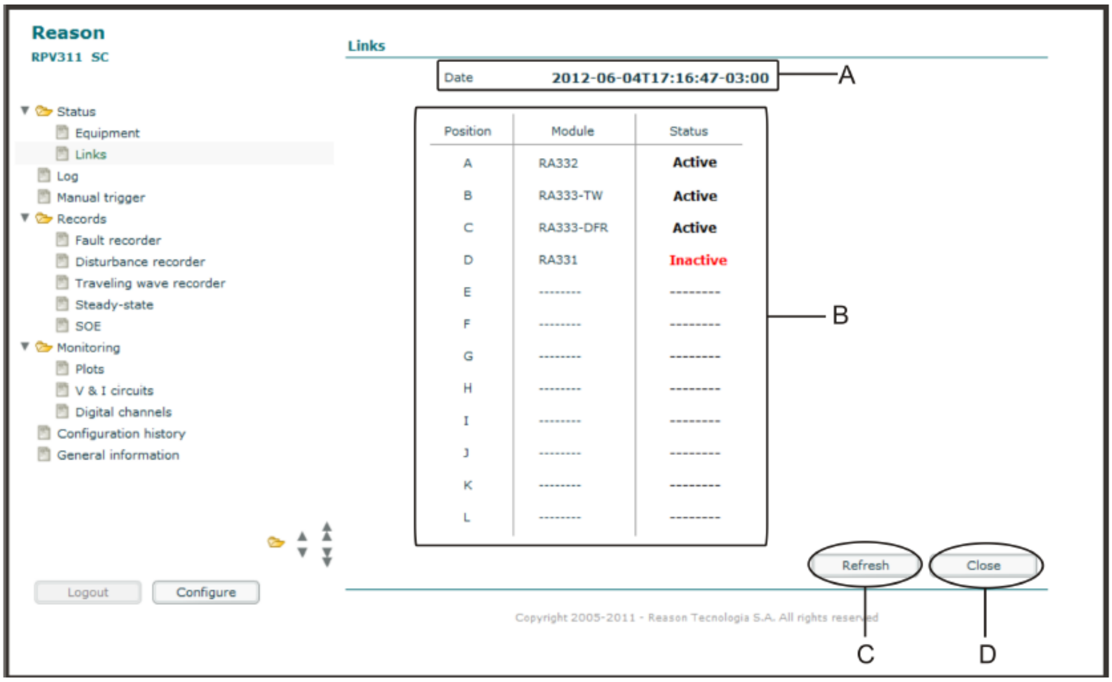


Figure 55: Link status screen

A Indicates the date the equipment status was last updated in the yyyy-mm-dd hh:mm:ss + 0000 format where o is UTC time offset.

B Link status, with the following information:

- **Position:** indicates the link position of A to L;
- **Module:** indicates the module type related to the link position;
- **Status:** indicates the status of the link. Active if it is sending and receiving data and inactive if it is not.

C The <Refresh> button allows user to refresh the screen information.

D The <Close> button allows user to close the section.

2.4 Log

The Log screen, shown in Figure 56, displays a history of equipment event logs.

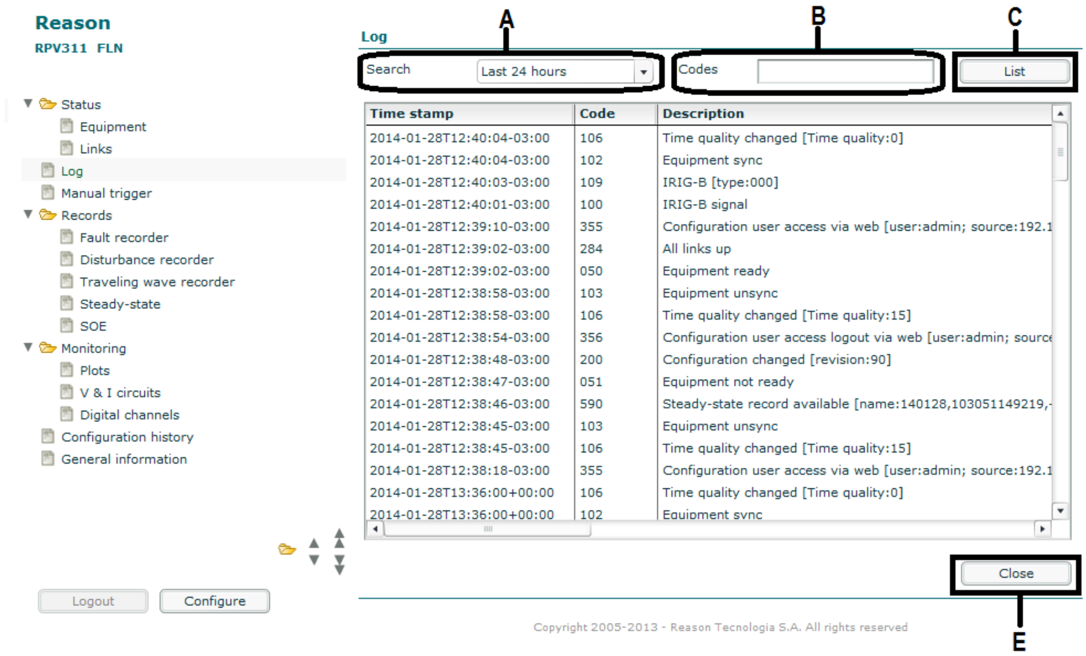


Figure 56: Log screen

A The Search box allows user to choose the period of time of the oldest to the latest to display.

B The Codes box allows user to search for specific logs or time intervals. For example, to search a log between 300 and 399, fill 3?? and to search a list, fill 2??, 507, 700. Codes shall be entered with 3 digits.

C The <LIST> button allows user to show the list of records according to the filtering parameters.

D Logs listed, with the following information:

- **Time stamp:** indicates the date and time of event log (yyyymm-dd hh:mm:ss[.uuuuuu] ± 0000 (UTC time offset);
- **Code:** indicates the log code;
- **Description:** describes the log.

E The <CLOSE> button allows user to close the section.

2.5 Manual Trigger

The Manual Trigger screen, shown in Figure 57, allows the user to trigger the equipment manually even if no threshold was exceeded.

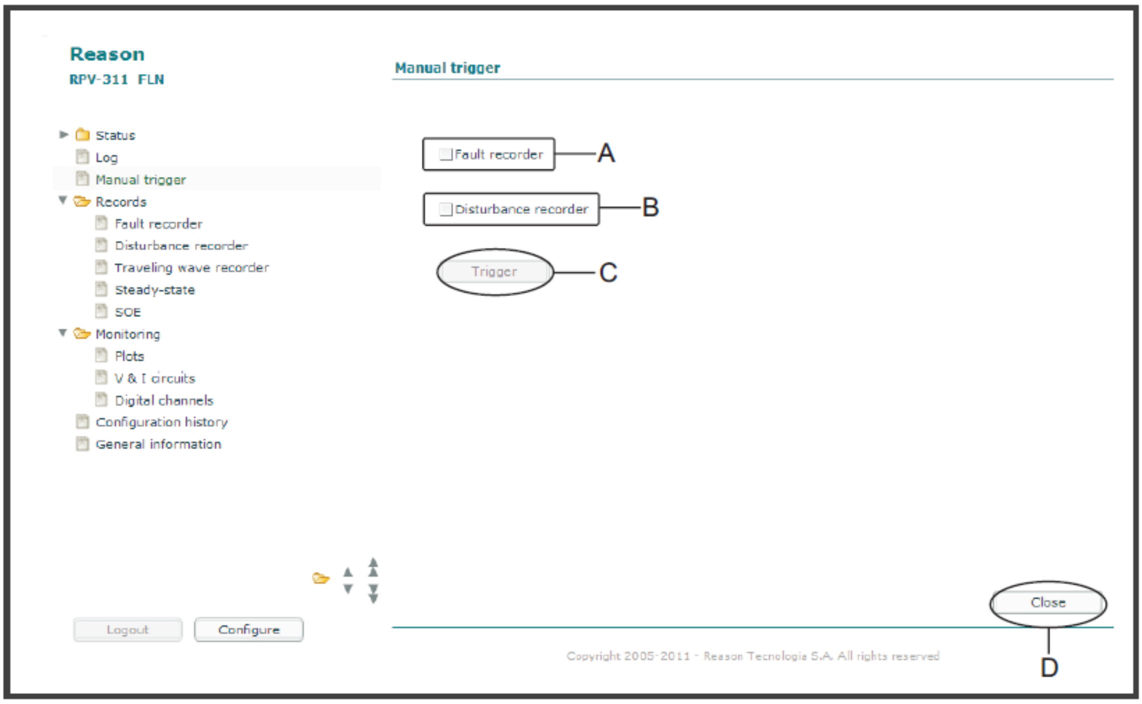


Figure 57: Manual Trigger screen

A By selecting this box, a fault recording is triggered.

B By selecting this box, a disturbance recording is triggered.

C The <TRIGGER> button allows user to trigger the selected record.

D The <CLOSE> button allows user to close the section.

2.6 Records

This section describes how to access different types of records on the RPV311. For details about the records, see Chapter 6: Records.

The Fault recorder screen, shown in **Figure 58**, displays a history of equipment fault records.

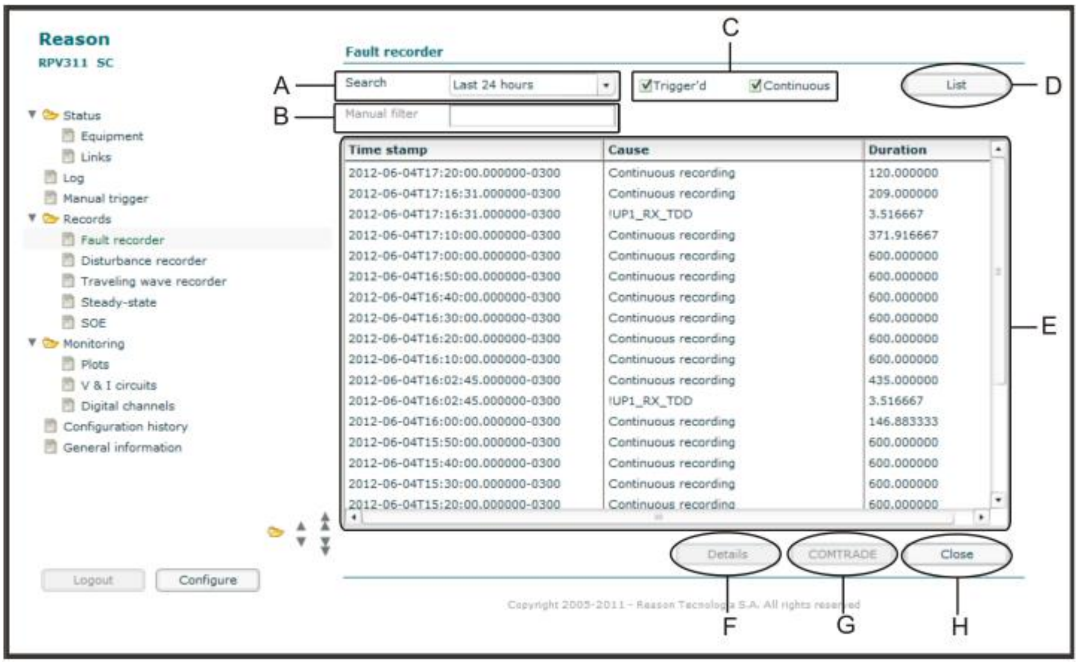


Figure 58: Fault recorder screen

A The Search box allows user to choose the period of time of the oldest to the latest to display.

B The Manual Filter box allows user to filter the records manually, according to their selection.

C The Trigger and the Continuous boxes allow user to select either or both types of record present on the list.

D The <LIST> button allows user to show the list of records according to the filtering parameters. If clicking <LIST> finds no record available, a window will be opened with a message: "No records available´´. So click <OK> and return to the previous section.

E Fault records listed, with the following information:

- **Time stamp:** indicates the date and time of event log (yyyymm-dd hh:mm:ss[.uuuuuu] ± 0000 (UTC time offset);
- **Cause:** indicates threshold exceeded;
- **Duration:** record length in seconds.

F The <DETAILS> button allows user to view information about the record. This information is also included in the .HDR file.

G The <COMTRADE> button allows download of record, line per line, and saving it in the Comtrade format, and compression as .zic file.

H The <CLOSE> button allows user to close the section.

2.6.1 Disturbance recorder

The Disturbance recorder screen, shown in Figure 59, displays a history of equipment disturbance records.

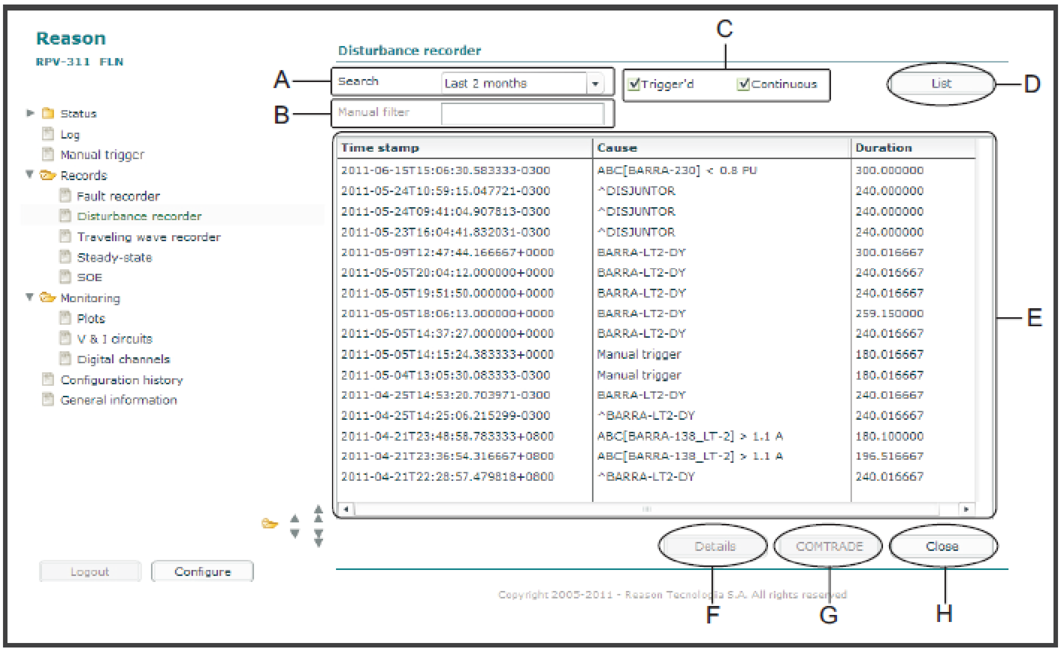


Figure 59: Fault recorder screen

A The Search box allows user to choose the period of time of the oldest to the latest, in order to display it in the interface.

B The Manual Filter box allows user to filter the records manually, according to their selection.

C The Trigger and the Continuous boxes allow user to select either or both types of record to be present on the list.

D The <LIST> button allows user to show the list of records according to the filtering parameters. If clicking <LIST> finds no record available, a window will be opened with a message: "No records available´´. So click <OK> and return to the previous section.

E Disturbance records listed, with the following information:

- **Time stamp:** indicates the date and time of event log (yyyymm-dd hh:mm:ss[.uuuuuu] ± 0000 (UTC time offset);
- **Cause:** indicates threshold exceeded;
- **Duration:** records length in seconds.

F The <DETAILS> button allows user to view information about the record. This information is also included in the .HDR file.

G The <COMTRADE> button allows download of record, line per line, and saving it in the COMTRADE format, and compression as .zic file.

H The <CLOSE> button allows user to close the section.

2.6.2 Traveling Wave Recorder

The Traveling wave recorder screen, shown in **Figure 60**, displays a history of equipment traveling wave records.

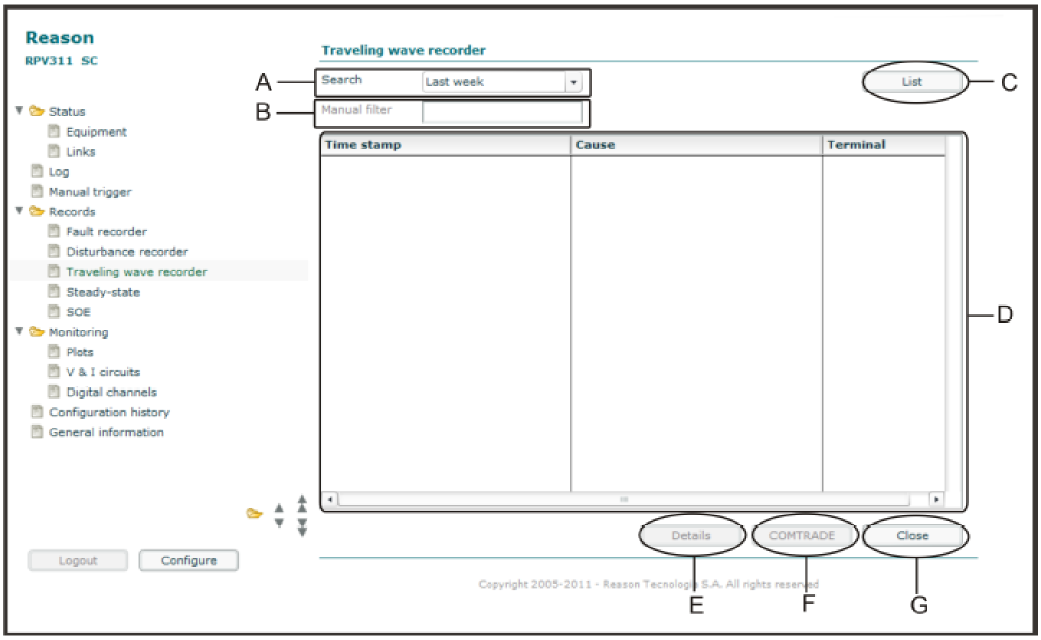


Figure 60: Traveling Wave recorder screen

A The Search box allows user to choose the period of time of the oldest to the latest to display.

B The Manual Filter box allows user to filter the records manually, according to the their selection.

C The <LIST> button allows user to show the list of records according to the filtering parameters. If clicking <LIST> finds no record available, a window will be opened with a message: "No records available´´. So click <OK> and return to the previous section.

D Fault records listed, with the following information:

- **Time stamp:** indicates the date and time of event log (yyyymm-dd hh:mm:ss[.uuuuuu] ± 0000 (UTC time offset);
- **Cause:** indicates threshold exceeded;
- **Terminal:** terminal where the traveling wave was detected.

E The <DETAILS> button allows user to view information about the record. This information is also included in the .HDR file.

F The <COMTRADE> button allows download of record, line per line, and saving it in the COMTRADE format, and compression as .zic file.

G The <CLOSE> button allows user to close the section.

2.6.3 Steady-state

The Steady-state recorder screen, shown in **Figure 61**, displays a history of equipment steady-state records.

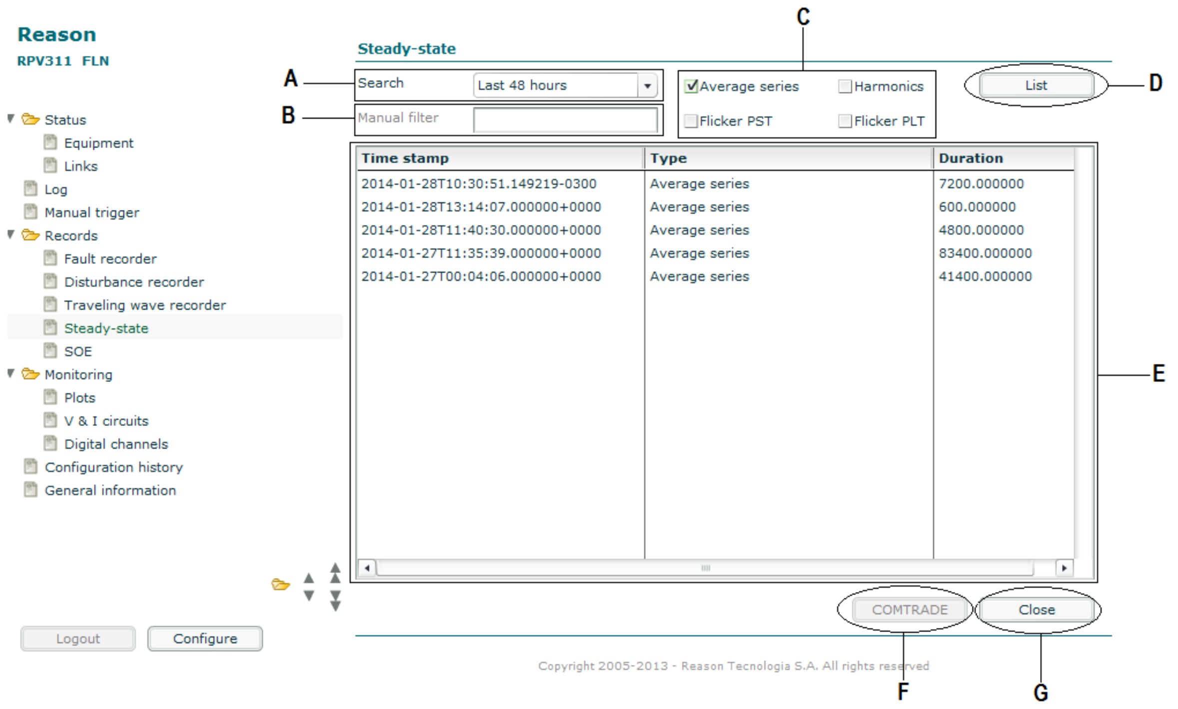


Figure 61: Steady-state recorder screen

A The Search box allows user to choose the period of time of the oldest to the latest to display.

B The Manual Filter box allows user to filter the records manually, according to their selection.

C The Average series, Harmonics, Flicker PST, and Flicker PLT boxes allow user to select only this type of record on the list.

D The <LIST> button allows user to show the list of records according to the filtering parameters. If clicking <LIST> finds no record available, a window will be opened with a message: "No records available´´. So click <OK> and return to the previous section.

E Steady-state records listed, with the following information:

- **Time stamp:** indicates the date and time of event log (yyyymm-dd hh:mm:ss[.uuuuuu] ± 0000 (UTC time offset);
- **Cause:** indicates threshold exceeded;
- **Duration:** record length in seconds.

F The <COMTRADE> button allows download of record, line per line, and saving it in the Comtrade format, and compression as .zic file.

G The <CLOSE> button allows user to close the section.

2.6.4 SOE

The SOE recorder screen, shown in **Figure 62**, displays a history of equipment SOE records.

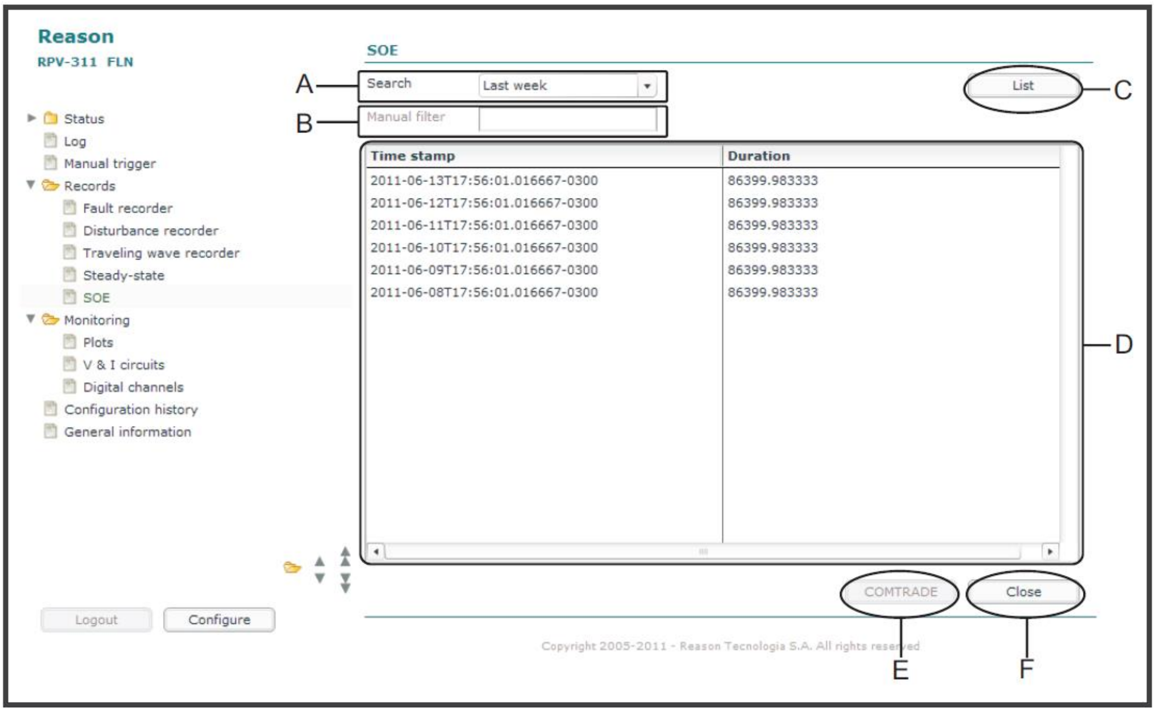


Figure 62: SOE recorder screen

A The Search box allows user to choose the period of time of the oldest to the latest to display.

B The Manual Filter box allows user to filter the records manually, according to their selection.

C The <LIST> button allows user to show the list of records according to the filtering parameters. If clicking <LIST> finds no record available, a window will be opened with a message: "No records available´´. So click <OK> and return to the previous section.

D SOE records listed, with the following information:

- **Time stamp:** indicates the date and time of event log (yyyymm-dd hh:mm:ss[.uuuuuu] ± 0000 (UTC time offset);
- **Cause:** indicates threshold exceeded;
- **Duration:** record length in seconds.

E The <COMTRADE> button allows download of record, line per line, and saving it in the Comtrade format, and compression as .zic file.

F The <CLOSE> button allows user to close the section.

2.7 Monitoring

With the Web Interface it is possible to monitor the values related to circuits and channels in three different ways: through Plots, Current and Voltage Circuits, and Digital Channels.

2.7.1 Measurements

- Voltage and Current Measurement:

The values listed below are computed at the nominal system frequency (50 or 60 Hz):

Voltage and current measurement	
ABC	RMS value [2]
N	RMS value (neutral) [2]
ABC1	Phasors [1]
N1	Phasors (neutral) [1]
S^+	Positive sequence [1 2]
S^-	Negative sequence [1 2]
U	Imbalance [1 2]
F	Fundamental frequency [2]
THD	Total harmonic distortion [2]

[1] Is not calculated for circuits of 1 element without 3-phase synthesis.
[2] Is not calculated for neutral circuits.

The fundamental frequency of the input signal must be within a range of ± 6 Hz of the nominal frequency of the electrical system.

- Power Measurement:

Power measurement is computed based on the values of a voltage circuit and a current circuit. The following values are computed once per cycle:

Voltage and current measurement

S	Combined apparent power
S_1	Fundamental apparent power
P_1	Phasors [1]
Q_1	Phasors (neutral) [1]

Reactive power has a positive sign for circuits with inductive characteristics and a negative sign for circuits with capacitive characteristics.

- DC Transducers Measurement:

The RMS value of the DC channels (transducers) is calculated once per cycle.

- High-speed Voltage Measurement:

There is an 8-bit opto-isolated analog-to-digital converter, independent for each channel. The acquisition is performed with 5 MHz sampling frequency (high-speed channels), that means one acquisition each 200 ns.

2.7.2 Plots

To graphically monitor the values related to circuits and DC channel quantities, access the Web Interface:

Monitoring > Plots

In this screen it is possible to monitor up to 6 different voltage, current, or DC channel quantities, as shown in **Figure 63**.

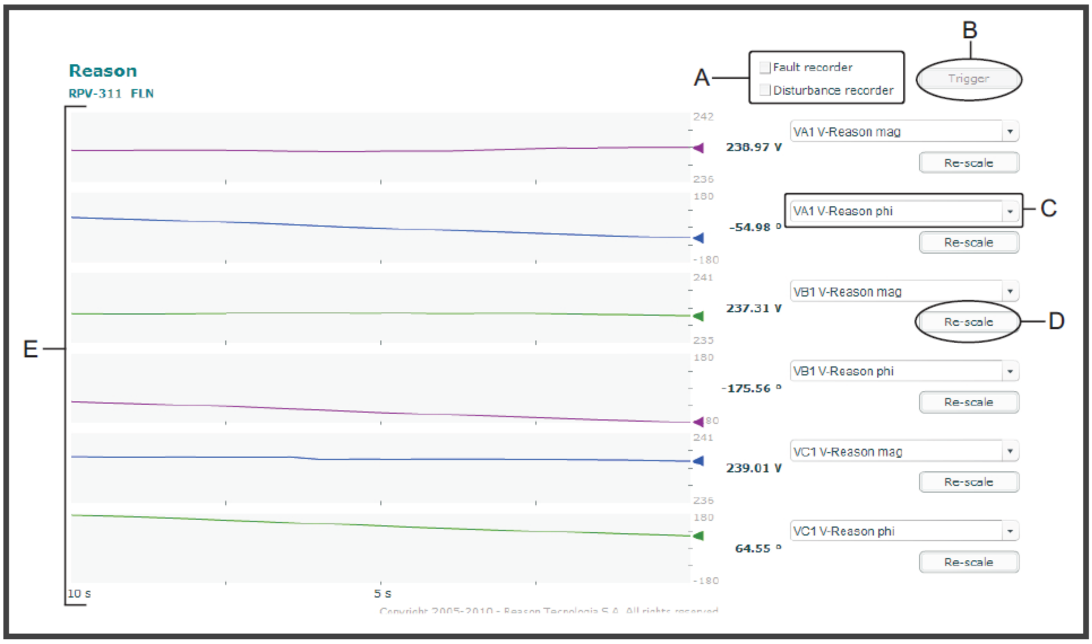


Figure 63: Monitoring with plots

A The Fault Recorder or Disturbance Recorder check boxes allows user to select which type of recording to trigger.

B The <TRIGGER> button allows user to trigger the selected record.

C Quantities selected to be monitored.

D <RE-SCALE> button.

E Plots with time evolution for the values related to the selected quantity.

The graphics show the time evolution of the selected quantity with the update frequency of 2 points per second. The time selected is related to the pre-fault time of the synchrophasor recorder.
The plotted points are automatically scaled based on the previous points displayed. The range between the minimum and maximum current values is adjusted by using the <RE-SCALE> button.
It is possible to create a waveform or synchrophasor records using the buttons at the top right corner of the screen.

2.7.3 V & I Circuits

The user will be able to monitor the values of voltage and current circuits, via Web Interface:
MONITORING > V & I CIRCUITS

In this interface, up to 4 channels of voltage or current can be simultaneously monitored, as shown in Figure 64.

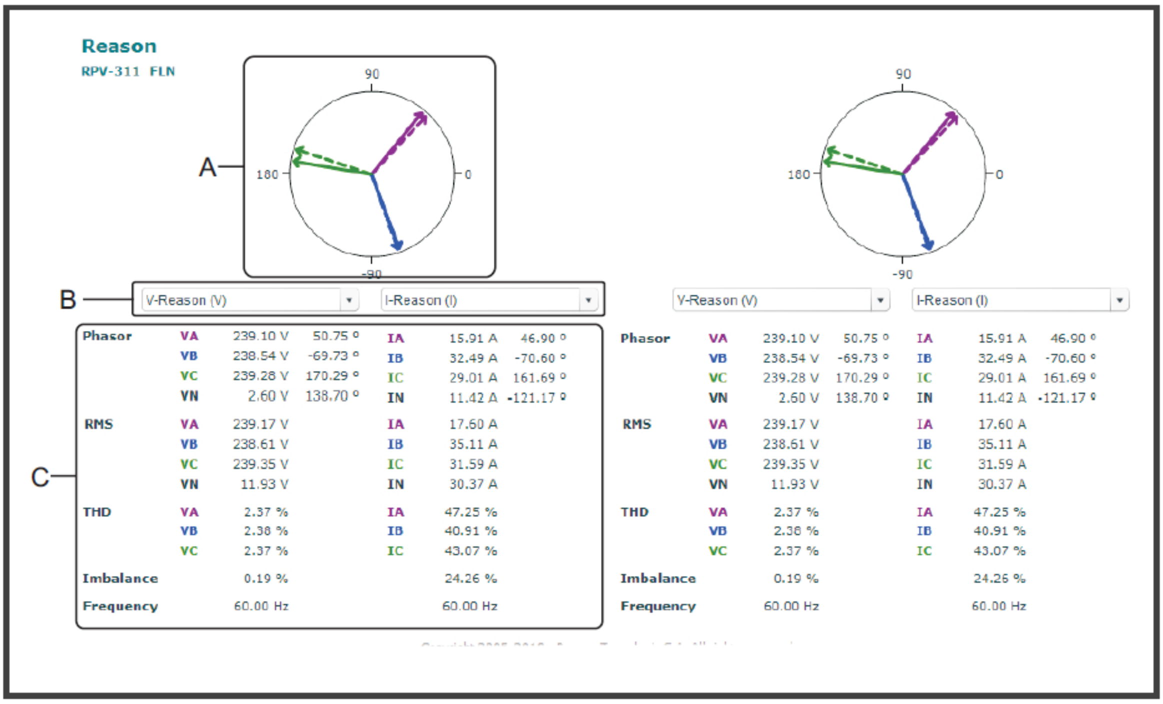


Figure 64: Monitoring circuit quantities via Web interface

A Phasor angle for each phase of the selected circuit.

B Selected circuit to be monitored.

C Quantities related to the circuits being monitored.

Phasor angles measured and displayed are absolute angles referenced to the PPS signal provided by the synchronization. When no sync signal is connected, the measured angles are referenced to Phase A of the reference circuit.
Values are updated at the rate of 2 points per second, however, when two or more circuits are simultaneously displayed, their time stamps may not be related to each other.

Note: The RPV311 has an autozero automatic feature, which is a slow filter that takes about 15 minutes to filter the DC components of the reading signal and then subtracts it from the readings in order to locate the correct position of the signal reference on the graph. The response of the filter is stored in the solid memory with the purpose of turning this process faster for subsequent reboots on the device. This filter will not interfere with the registering of the DC components generated by faults.

2.7.4 Digital Channels

The status of each digital channel can be monitored via Web Interface, as shown inFigure 65.

Access:

MONITORING > DIGITAL CHANNELS

It is possible to monitor the status of up to 64 digital channels per page and up to six pages.

The data is updated every 2 seconds.

The channels status is represented according to the following:

Voltage and current measurement	
Active channel	●
Non-active channel	○

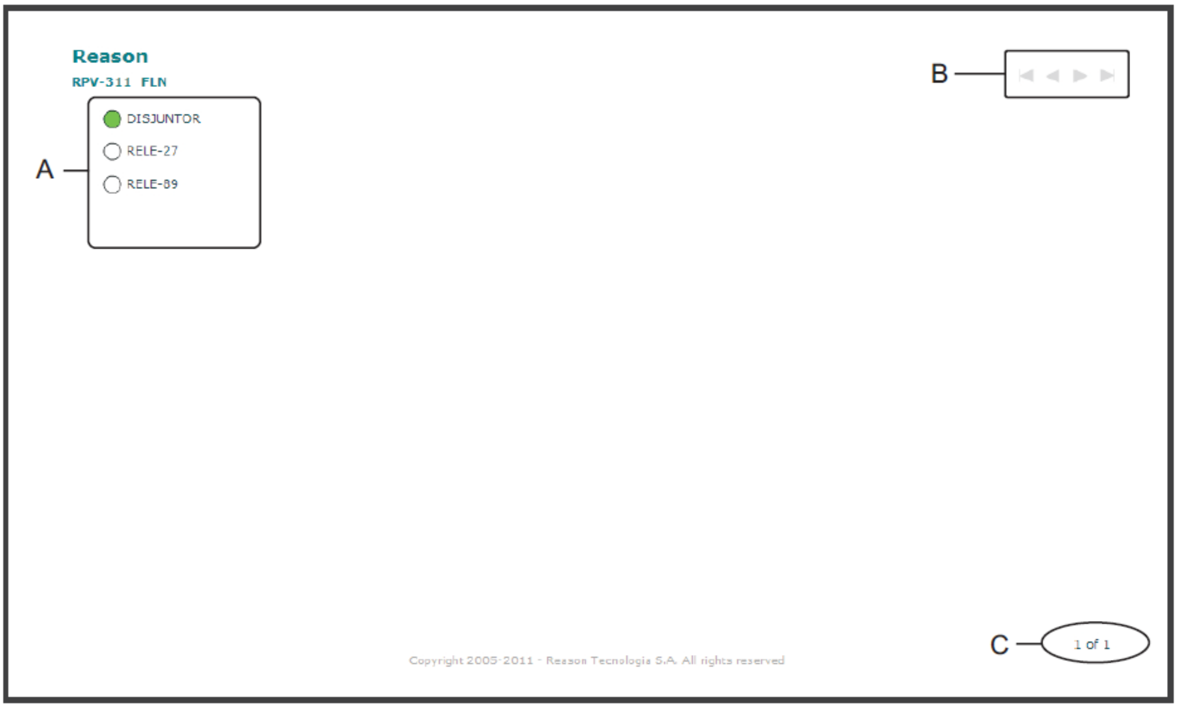


Figure 65: Monitoring the status of digital channels

A Status of the digital channel.

B Changes pages being monitored.

C Shows the number of the page being monitored.

2.8 Configuration History

The Configuration History screen, shown in **Figure 66**, displays the history of changes made in the equipment configuration and its corresponding revision number.

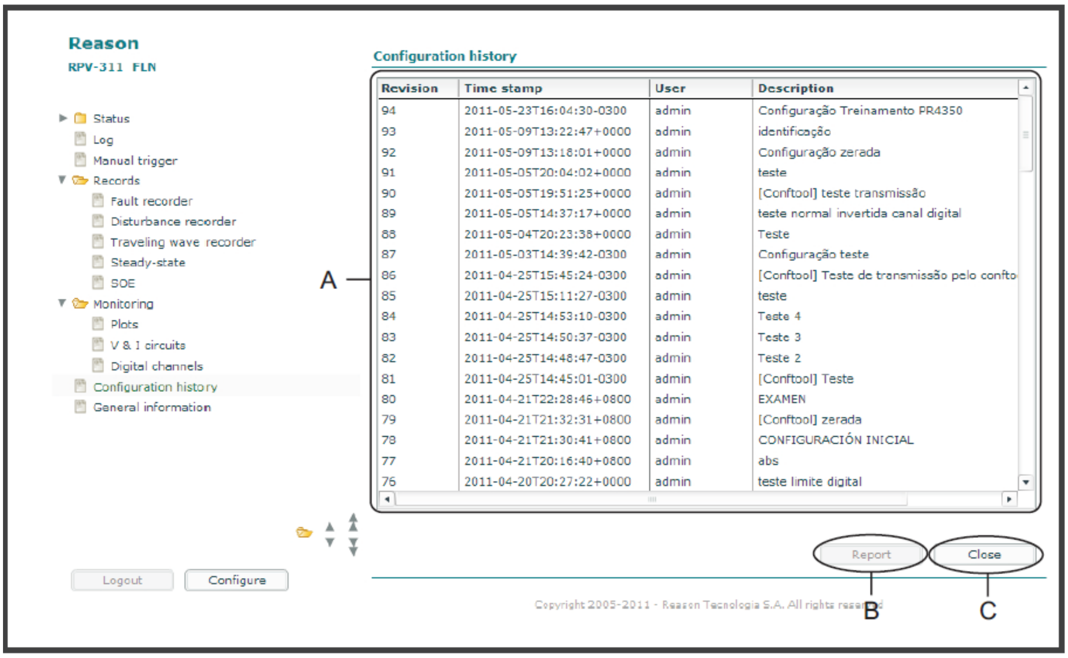


Figure 66: Configuration History screen

A Configuration history, with the following information:

- **Revision:** indicates the number of each change in configuration;
- **Time stamp:** indicates the date and time of change in configuration;
- **User:** indicates the user who changed the configuration;
- **Description:** describes the change.

B The <REPORT> button allows user to print an equipment configuration report.

C The <CLOSE> button allows user to close the section.

2.9 General Information

The General Information screen, shown in Figure 67, displays general information about the equipment, such as:

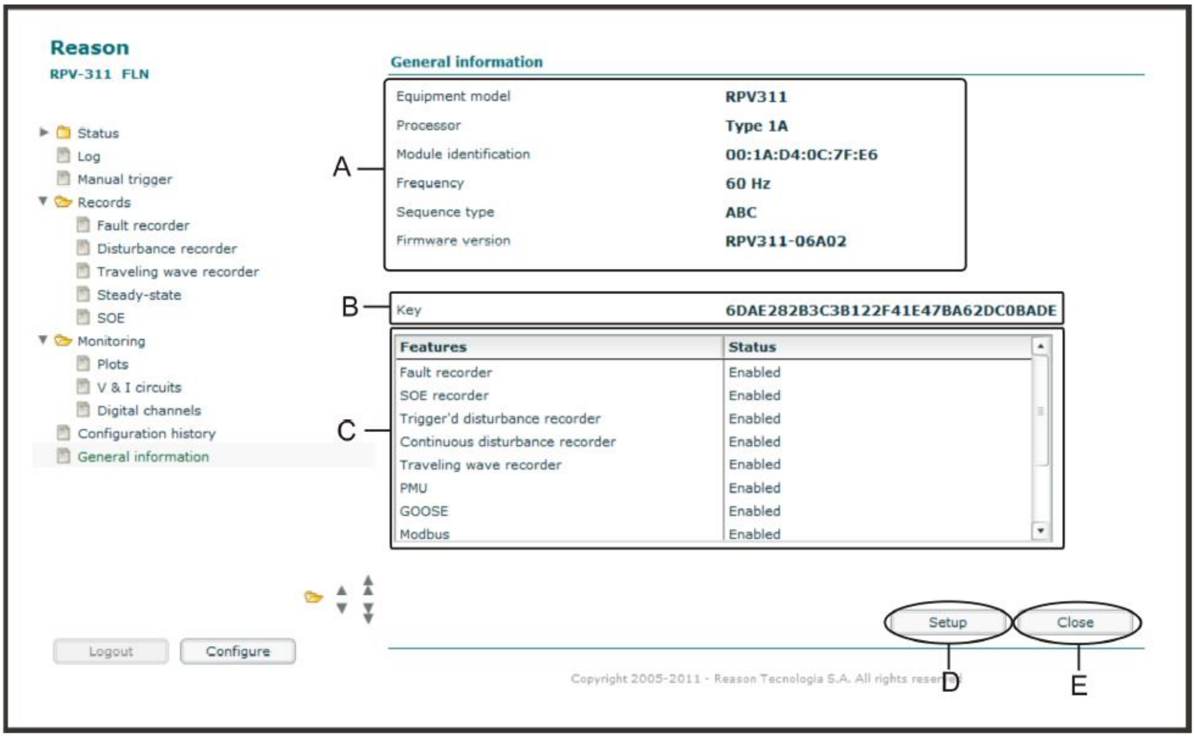


Figure 67: General Information screen

A General information about the equipment, such as:

- **Equipment model:** model of RPV;
- **Processor:** processor type;
- **Module identification:** unique identification code of the module;
- **Frequency:** nominal frequency reference;
- **Type of sequence:** phase sequence reference (ABC, ACB, BAC, BCA, CAB, CBA);
- **Firmware version:** the current firmware version for the equipment.

B The key related to the features enabled on the equipment.

C The equipment features enabled or disabled.

D The <SETUP> button allows user to set some features of the equipment.

E The <CLOSE> button allows user to close the section.

Clicking on the <Setup> button will open a screen, shown in Figure 68, which displays the equipment model, processor type used, and enables the user to change the following parameters:

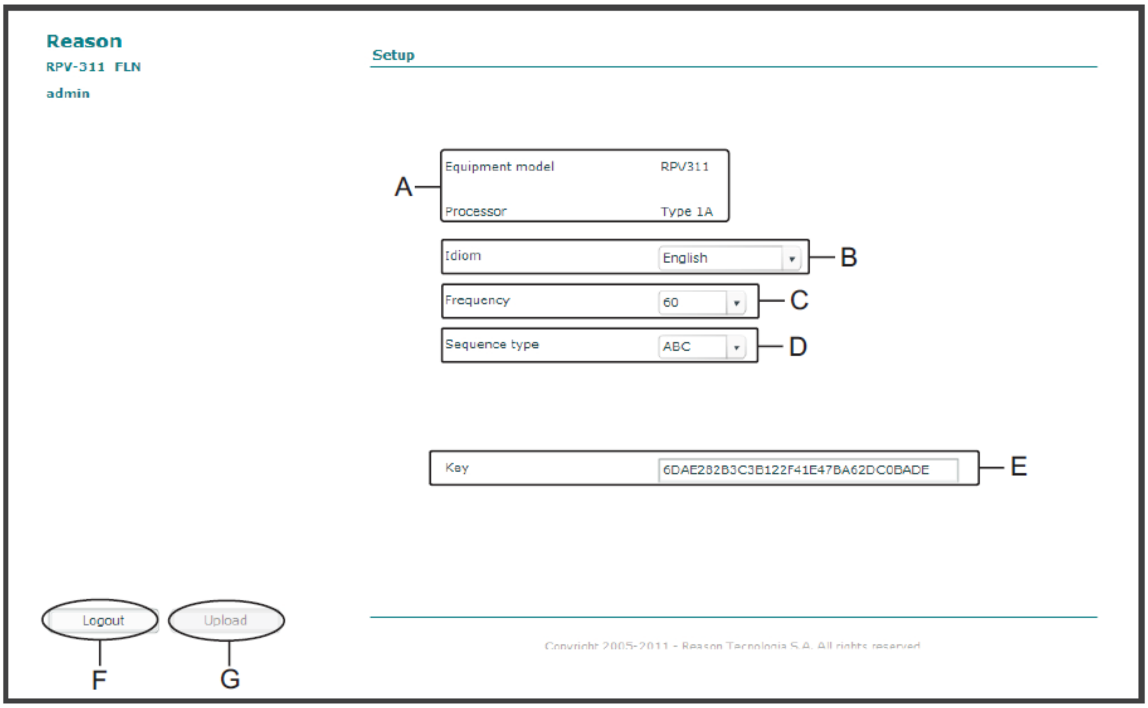


Figure 68: Setup screen

A Information about the equipment, such as:

- **Equipment model:** model of RPV;
- **Processor:** processor type.

B The Language box allows choice of the language of the Web Interface - English, Spanish, Russian, Polish and Portuguese

C The Frequency box allows choice of the nominal frequency reference - 50 Hz or 60 Hz.

D The Type of sequence box allows choice of the phase sequence reference.

E The Key box allows user to enable the equipment features.

F The <LOGOUT> button allows user to logout of the section.

G The <TRANSMIT> button allows user to send the changes to the equipment.

When contacting our support personnel, it is necessary to inform the equipment serial number and part number.
GE's support personnel will send an email with the new key.
In order to enable the new key, please follow the instructions below:

1. Click on the <SETUP> button to enter the new key. A new window will open, enter the username and password (username and password for Web Interface configuration).

2. Another window will open indicating that all open Web Interface windows should be closed (except the key window). Close the windows and click on the <OK> button.
3. Copy the code key sent by e-mail and enter it in the <KEY> box to replace the old one. Then click on the <TRANSMIT> button.

3 COMTRADE files download

There are four different ways to get the COMTRADE files from the RPV311 to a computer, one manual way and three automatic way.
The manual method uses the web interface and is described in the item Chapter 5: Operation, 1.3.3 Records
The three ways automatic ways listed below:

- Scanner software (Chapter 12: Software – RPV Tools): Simple platform that download specific types of files (fault, disturbance, SOE, TW...) from specific IP address with preset time intervals.
- DR Manager (Chapter 13: Software – DR Manager): Elaborate software that downloads the records from several separate RPVs, performs TW fault location and shows the equipment alarms.
- Auto-upload which is a feature of the RPV where the user specifies an IP address and prepare a computer to be the server. Upon creating a record the RPV will automatically send it to the destination IP. If for some reason, it is not able to send the record at that time it will not send again later.

All those means save the record to a folder named based on the DFR’s information **LOCATION,IDENTIFIER** within another folder located in C:\RPV\records\.

RPV311

Distributed Multifunction Fault Recorder

Chapter 6: Records

This chapter details all types of registers created by the RPV311.

1 Continuous and Triggered Fault Records

Fault records can be created in the following ways:

- Continuously:

Measurements are continuously recorded. A new record is available every 10 minutes. The record size depends on the number of derived measurements selected by the user. Up to 16 measurements can be selected. The continuous fault records does not contain the digital inputs status.

- By trigger:

The fault recorder can be triggered by a Boolean equation, by a cross-trigger signal of another recorder or by a manual trigger using the Web Interface.
Continuous and triggered fault records share the same mass storage area.

1.1 Recorded Values

The following values are recorded by the fault recorder:

- Voltage waveform of all voltage circuits (A, B, C, and N);
- Current waveform of all current circuits (A, B, C, and N);
- Transducer waveform of all transducer channels;
- Digital channels (state of digital inputs and binary GOOSE messages – digital inputs are recorded only in the triggered fault records).

1.2 Recording Times by Trigger

Once triggered, the following parameters are considered by the fault recorder:

Parameter	Allowed values	Increment
Pre-fault time (t_{pre})	0 … 5 s	0.1 s
Post-fault time (t_{pos})	0 … 60 s	0.1 s
Timeout	1 … 60 s	0.1 s

The Timeout configures the maximum duration that the actual fault (threshold exceeded/trigger ON) can reach within a record. The maximum timeout of the fault record is 60 seconds.

The maximum time of the recorded will be composed of the pre-fault time plus fault duration plus post-fault time.

1.3 Sampling Rate

The trigger recorder sampling rate is user-selectable from 256, 128, or 64 points-per-cycle of the nominal frequency of the input signal. The size of the records is proportionally affected.

The continuous recorder sampling rate is 16 points-per-cycle of the nominal frequency of the input signal.

Both analog and digital inputs are recorded at the same sampling rate depending on the type of recorder, i.e. Triggered fault records: 256, 128, or 64ppc and Continuous fault record: 16ppc.

1.4 Re-trigger and Record Concatenation

When two or more consecutive triggers happen, case the post-fault time of the first trigger and the pre-fault time of the second trigger cross each other, then the RPV311 concatenates both records and stores it in a single COMTRADE file.

In the figure below, if the time T≤ pre-fault time + post-fault time, then the records are concatenated:

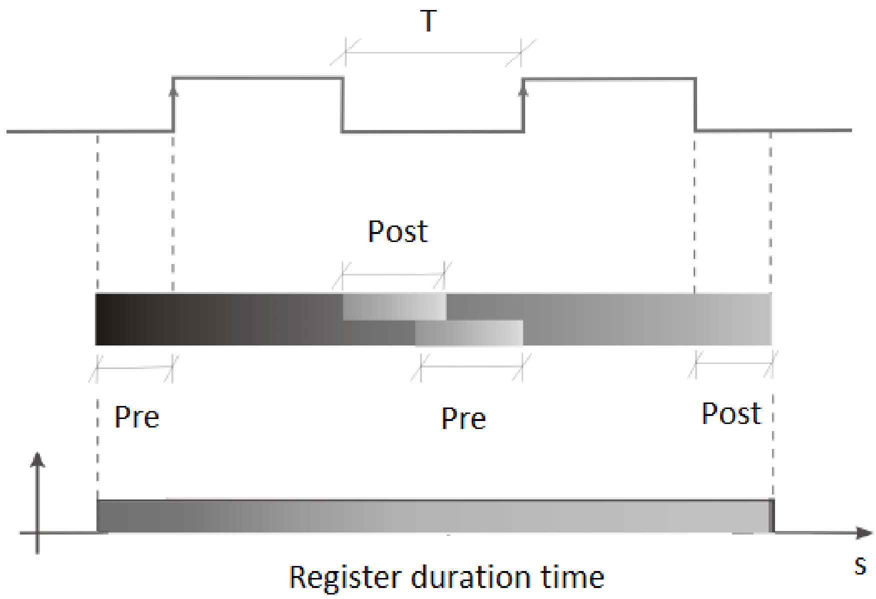


Figure 69: Concatenation event example

If the pre-fault time of the second register does not overlap the post-fault time of the first records, then the RPV311 creates two separate COMTRADE files.

In the figure below, if T ≥ pre-fault time + post-fault time, then the RPV311 creates two separate COMTRADE files.

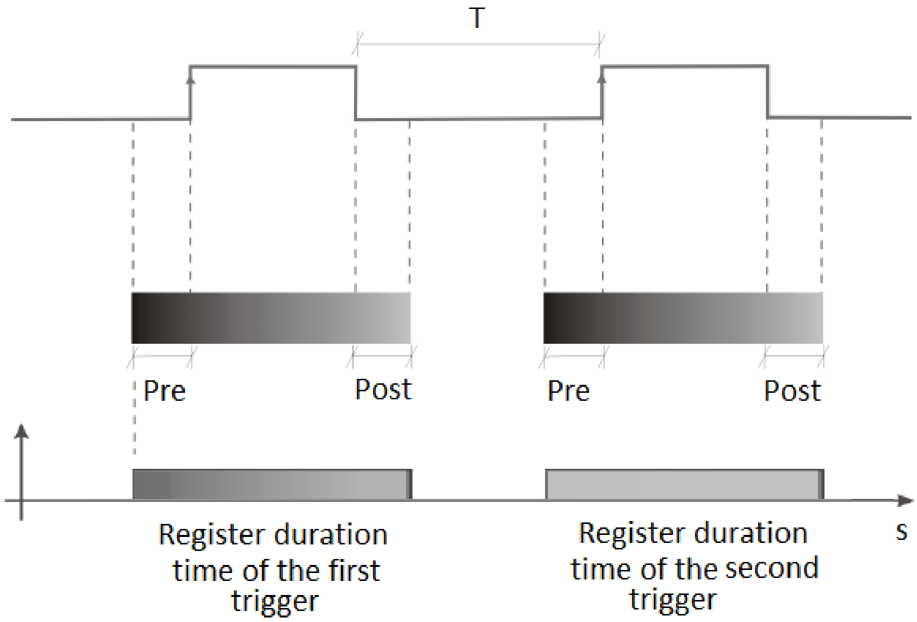


Figure 70: Example of an event without concatenation

1.5 Trigger Burst Limiter

There is an user-configurable trigger burst limiter for the fault recorder.
The burst limiter is based on the number of triggers time interval (both parameters are user-configurable). When the limit is exceeded, recording will be disabled for a period of time defined by the user.

Parameter	Allowed values	Increment
Number of triggers	0 … 12	1
Time interval	0 … 60 s	1 s
Disabling time	1 … 60 min	1 min

2 Continuous and Trigger'd Disturbance Records

Disturbance records can be created in the following ways:

- Continuously:

Derived measurements are continuously recorded. A new record is created at each hour rollover. The record size depends on the number of derived measurements selected by the user (limited to 64).

- By trigger:

The disturbance recorder can be triggered by a Boolean equation, by a cross-trigger signal of another recorder, by a manual trigger using the Web Interface, or by the triggering of the fault recorder. It is possible to select the derived quantity of triggered disturbance records. If the quantities are not manually selected, the record will consist of all the quantities available for measurement. The record size depends of the number of derived measurements selected by the user.
Continuous and triggered disturbance records share the same mass storage area.

2.1 Recorded Values

The following values are recorded by the continuous and triggered disturbance recorders:

- RMS value of voltage and current circuits;
- Voltage and current phasors;
- Frequency of voltage circuits;
- Positive sequence of voltage and current circuits;
- Negative sequence of voltage and current circuits;
- Imbalance of voltage and current circuits;
- Total harmonic distortion of voltage and current circuits;
- Apparent combined power of power circuits;
- Apparent fundamental power of power circuits;
- Active fundamental power of power circuits;
- Reactive fundamental power of power circuits;
- Digital channels (state of digital inputs and binary GOOSE messages).

2.2 Recording Times by Trigger

Once triggered, the following parameters are considered by the disturbance recorder:

Parameter	Allowed values	Increment
Pre-fault time (t_{pre})	0 … 2 min	0.1 min
Post-fault time (t_{pos})	0 … 20 min	0.1 min
Timeout	1 … 20 min	0.1 min

The Timeout configures the maximum duration that the actual fault (threshold exceeded/trigger ON) can reach within a record. The maximum timeout of the disturbance record is 20 minutes.

2.3 Sampling Rate

The trigger and continuous recorder sampling rate is one-per-cycle.
Both analog and digital inputs are recorded at the same sampling rate depending on the type of recorder.

2.4 Re-trigger and Record Concatenation

Two records will be concatenated if the disturbance recorder is re-triggered and there is an overlap between the post-fault time of the first record and the pre-fault time of the second record.

2.5 Trigger Burst Limiter

There is an user-configurable trigger burst limiter for the disturbance recorder which is identical to the fault recorder limiter.

3 Traveling Wave Fault Records

Faults in a transmission line cause transients traveling along the line as waves composed of by a frequencies ranging of a few kilohertz to several megahertz.
These traveling waves have a wave front with a very fast rise time and a down time which is relatively slow. The waves move at speeds near that of light, away of the fault point toward the end points of the line.
The waves are not limited to the transmission line where the fault occurred, spreading through the adjacent electrical system with decreasing amplitude, the result of the combined effects of the impedance of the line and successive reflections.
Fault location by traveling waves is based on accurate determination of the moment that the wave fronts pass the two terminals of the line. The traveling wave recorder can be triggered by a Boolean equation.

3.1 Pre-conditions

The traveling wave fault location requires that a second equipment with the same functionality is installed at the other end of the monitored power line.
Both units must be synchronized by an IRIG-B signal with less than 100 ns jitter.
Specific traveling wave fault location software must be installed in the user´s computer.
This software, using the traveling wave records of both terminal lines and the power line parameters, executes the fault location algorithm and shows the fault location estimation. For details about the Traveling Waves Fault Locator software, please refer to Chapter 12: Software – RPV Tools and Chapter 13: Software – DR Manager.

3.2 Sampling Rate and Acquisition

The acquisition module RA333 has 3 independent channels (one circuit A, B, C), with an 8-bit A/D converter. The sampling frequency acquisition is 5 MHz, synchronized by a PPS signal, which means one acquisition each 200 ns.
The acquisition module conditions the line voltage signal. With an efficient band-pass filter, the passing frequency is limited between 1 kHz and 1 MHz.
The module constantly acquires signals and storing the measured values locally in a 64 MB RAM (approximately 4 seconds). The data is written into a circular buffer where the oldest data will be overwritten by the latest until a threshold violation occurs.
On detecting violation of the threshold, the memory writing is interrupted. The memorized data is sent to the processing module at this moment. The complete transfer of data takes about 2 minutes, and in this time the BUSY indicators are lit.
While data is being transferred to the processing module (2 minutes), new TW records will not be registered. During this time, the other acquisition and processing modules continue functioning normally.

3.3 Recording Times

The recording parameters are fixed and the record has 3 electrical cycles (50 or 60 Hz) before the violation of the limit and one cycle after, approximately 67 ms at 60Hz and 80 ms at 50 Hz. The duration of recording may vary slightly but this does not cause in implications for fault location.

4 Steady-State Records

Steady-state records are composed of the following records and measurements:

- Average Series;
- Harmonics;
- Flicker.

One separate record for each measurement above are created once per day and recorded at 1 ppc.

4.1 Average Series

The equipment continuously records averaged values of

Values of average series recorder	
RMS (voltage)	Simple average
RMS (current)	Simple average
Voltage imbalance	Simple average
Frequency	Simple average

Voltage total harmonic distortion	Quadratic average
Current total harmonic distortion	Quadratic average
Fundamental active Power	Simple average
Fundamental reactive Power	Simple average
DC transducers	Simple average

The aggregation time interval is user-selectable between 1 minute or 10 minutes, synchronized to UTC minute rollover. The timestamp refers to the end of the averaging window.

.

4.2 Harmonics

Harmonics are computed for phases A, B and C and for the neutral of up to two voltage or current circuits. The algorithm used conforms to IEC 61000-4-7:1991.

The signal is band-limited by Hanning-windows with width T_w = 200 ms, overlapped every $\frac{T_w}{2}$ = 100 ms.

A Fourier transform is used to obtain all frequency components of the input signal up to the 50 th order.

The values obtained at every measuring window are aggregated over T_{vs} = 3 s.

Values resulting of the T_{vs} = 3 s aggregation are aggregated a second time over T_{sh} = 10 min using classifiers. The result is the cumulative probability for each harmonic component of the input signal.

For each harmonic component of the input signal, the value that does not exceed the p = 1, 10, 50, 90, 95, and 99 % percentiles in the T_{sh} time interval is recorded.

4.3 Flicker

Flicker is computed for phases A, B, and C for up to six voltage circuits. The algorithm used conforms to IEC 61000-4-15:1997+A1:2003.

The aggregation time interval is 10 minutes in the Pst Flicker or Plt Flicker 2 hours, synchronized to UTC minute rollover. The timestamp refers to the end of the averaging window.

5 SOE - Sequence of Events Records

All variations of the equipment inputs occurred are recorded on this record.
The events in the SOE are recorded with accuracy better than 100µs.
One SOE file is created per day.

6 Record Format and Naming, and Mass Storage Capacity

6.1 Record Format

Records comply with the COMTRADE standard IEEE C37.111-1999, *IEEE Standard Common Format for Transient Data Exchange for Power Systems*. The ".dat", ".hdr", ".cfg", ".inf" and ".tri" files are zipped together in a ".zic" (*zi*pped *c*omtrade) file for faster transmission.
The ".zic" files are created following the RFC 1951, DEFLATE Compressed Data Format Specification.
The ".hdr" files have the information about the Reason for the trigger and the location of the fault, the md5sum of the ".dat" and ".cfg" files, and the status of the equipment when the record was created.
The ".inf" files have the groups and the power lines parameters. The data are formatted according to the requirements of GE's *Analise* software.
The ".tri" files have the sequence of digital events. The data was formatted according to the requirements of GE's *Analise* software.
The following information about the register and the RPV311 can be found within the .zic file:

- Trigger cause
- Date
- Equipment health and sync status
- Memory usage
- Last power up
- Firmware version
- Identifier
- Location
- Owner

6.2 Record Naming

Records are named using the COMNAME methodology, according to IEEE C37.232, *Recommended Practice for Naming Time Sequence Data Files*.
Fault, Disturbance, Steady-state, and Sequence of Events records are named as follows:
STARTDATE,STARTTIME,TIMECODE,STATIONID,DEVICEID,COMPANY,DURATION,TYPE.ZIC
Traveling wave records are named as follows:
STARTDATE,STARTTIME,TIMECODE,STATIONID,DEVICEID,COMPANY,DURATION,TW,TERMINAL.ZIC

Parameter	Format	Description
STARTDATE	yymmdd	Record's start date (year, mounth, day)
STARTTIME	hhmmssuuuuuu	Record's start time (hour, minutes, seconds, microsseconds)
TIMECODE	soohmm	Indication of timezone offset (the last three characters are included only when fractional hours are in use)
STATIONID		Location of the equipment, configurable in: EQUIPMENT > IDENTIFICATION > LOCATION (up to 12 characters)
DEVICEID		Equipment identifier, configurable in: EQUIPMENT > IDENTIFICATION > IDENTIFIER (up to 12 characters)
COMPANY		Equipment owner description, configurable in: EQUIPMENT > IDENTIFICATION > OWNER (up to 12 characters)
DURATION	sssssuuuuuu	Duration of the record (seconds, microsseconds)
TYPE		Record type: *Fault* (fault record) *Disturbance* (disturbance record) *Avgs* (historical averages) *SOE* (sequence-of-events) *Oharm* (odd harmonics) *Eharm* (even harmonics)

TERMINAL		Terminal identification of the Power Line where the wave front has been recorded.

6.3 Mass Storage Capacity

Memory	Capacity	Typical use
Fault	22 GB	3300 records (triggered) or 14 days (continuous with 16 measurements selected) - 12 circuits, 2 seconds and 256 points-per-cycle
Disturbance	9 GB	1350 records (triggered) or 9 days (continuous with 64 measurements selected) - 12 circuits, 2 minutes
Steady state	1 GB	1 year - 12 circuits@ 1 minute, 2 samples of harmonics @ 10 minutes
SOE	500 MB	36 days - 256 channels @ 10 events per minute
TW	1 GB	410 records (2.4 MB each)

The equipment can be configured to automatically remove the oldest records as the soon as mass storage occupation exceeds 90%.
All RPV311 files including configuration and records are stored in the SSD non-volatile memory.

7 Record Management and Access

Records can be accessed in three ways:

- Through the Web Interface, see further information in Chapter 5: Operation;
- Through the Scanner which is part of the RPVTools package, see further information in Chapter 12: Software – RPV Tools;
- Through auto upload, see further information in Chapter 4: Configuration.

Management of records is done using the DR Manager. For details about the DR Manager, see Chapter 13: Software – DR Manager.

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Distributed Multifunction Fault Recorder

Chapter 7: TW Fault Locator

This chapter provides information regarding the architecture and the proper use of the Reason Traveling Wave Fault Location.

1 TWFL Overview

The figure below shows an overview of the Traveling Wave Fault Location architecture.

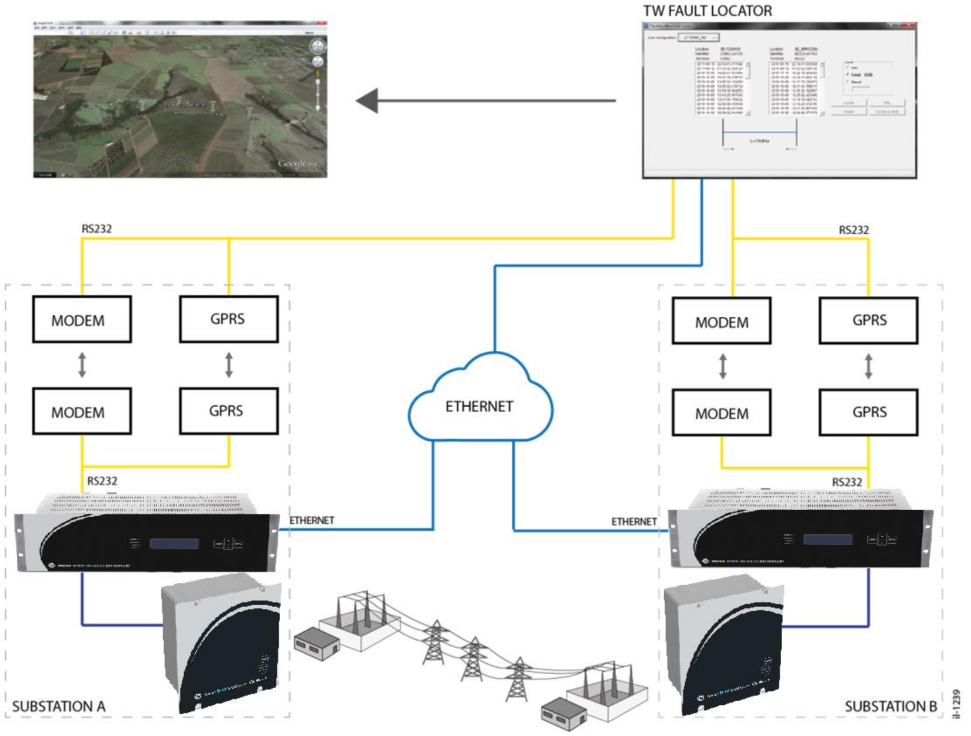

Figure 71 – TW Fault Locator architecture overview

Each terminal of the line must have a set of RPV311 processing unit+RA333 acquisition unit; and each RPV311 has to be synchronized with a GPS Clock as accurate as possible. The signal used to extract the traveling waves if the voltage signal from the secondary circuitry of the VT.

During a fault the RPV311 in each terminal will register the waveform of the traveling wave in a COMTRADE file, after being triggered by any of the thresholds described in Chapter 4 - Thresholds.

The DR Manager software will download the COMTRADE files with the TW capture automatically and periodically from all the RPV311 within the ethernet network and will calculate the distance to fault automatically. More information on the DR Manager is found in Chapter 13: Software – DR Manager or in the DR Manager user manual.

The RPV from one terminal does not need to communicate with the other terminal's RPV in order to create the TW COMTRADE file.
A communication link is only needed between the control centers and the RPVs (or local data concentrators) the user wants to implement remote access to the equipment.
The communication setup that the user would deploy to download the TW record and perform the fault location is exactly the same as the one used to download the fault records.
The fault distance is calculated based on the time that each wavefront arrived at the line terminal. According to the following equation.

$$d = \frac{l + Kc(t_a - t_b)}{2}$$

Where:
d: fault distance from terminal A;
l: length of the line;
k: constant of the line attenuation of the speed of the wave;
c: speed of light
t_a: time which the traveling wave gets to terminal A
t_b: time which the traveling wave gets to terminal B

The means to get the COMTRADE files from the RPV311 to the computer where the fault location will be performed are described in Chapter 5: Operation, COMTRADE files download.

2 TW Fault Location Information

2.1 TW Triggering System

The TW record is a COMTRADE file with 3 cycles prior to the trigger plus 1 cycle after the trigger, that means approximately 67 ms @ 60 Hz and 80 ms @ 50 Hz. The RPV311 takes about 30 seconds to create a record and it can create up to 4 records at the same time. When 4 records are being created at the same time new triggers will not create a record and the "BUSY" LED in the RA333 will turn on. After the record from the first trigger is finished, then the RA333 will be able to capture the next trigger.
Trigger events that happen within a time window of 1 electric cycle will create a single TW COMTRADE file. If another trigger happens after 1 cycle from the first trigger of the event, then another TW COMTRADE file will be created.

2.1.1 Consecutive Faults

The RPV311 can have up to 4 TW COMTRADE files being created at the same time, it means that it can record and locate faults in at least 4 consecutive events in a 2-minute time frame, such as evolving faults and switch-on to fault operations

Note:
For regular 3-phase circuits, the triggers are also 3-phase, i.e. in an event where a fault evolve to another phase, the trigger will already be sensitized by the previous fault. Since the TW recorder do not have a retrigger system it is necessary that a new trigger activates for the TW recorder to capture the consecutive event. To do so, it is necessary to have binary triggers monitoring the different protection trips that will detected the consecutive events, by doing so only the phase involved in each fault will trigger at a time, allowing the multiple recordings.

2.2 Switch-on to Fault

When a short circuit occurs right after the circuit breaker closes, the behavior of the traveling waves become different from regular faults, mainly because the circuit breaker itself can create traveling waves that can be misinterpreted as traveling wave from the fault and it may turn the fault location calculation more difficult. To avoid that, the DR Manager analyses both the waveform/fault and the TW COMTRADE records to first identify that a switch-on event occurred and then to apply a special fault location algorithm. Additionally, special conditions need to be met for the switch-on to fault (SOTF) events to be located automatically:

- The fault shall be at least 6 km away from both line terminals.
- The transmission line maximum length shall be 2000 km.
- The fault location for switch-on events will not work for mixed (hybrid) lines.
- There needs to be a corresponding waveform recording for each event (Chapter 4: Configuration. 10. Fault Recorder).

Even meeting all the conditions above, SOTF events are rare and difficult to interpret automatically, thus, the DR Manager will indicate on its interface whenever an event is characterized as a switch-on so the user can be cautious and double check the recordings.

2.3 Maximum Number of Lines Monitored by the TW Fault Locator

If the voltage is sourced from a bus VT you only need one RA333 to capture TWs from all the lines connected to that bus. Moreover, it is possible to connect up to 4 modules RA333 to one processing unit RPV311.

2.4 Underground and Overhead Cables

There are no restraints regarding the fact that the cable is underground. In the calculation of the fault location, there is a parameter **k** (as presented in the fault location formula aforementioned) that depends on the physical characteristics of the wire. When the TW fault locator method is used on combination of cable. The user can configure the TW fault location in two manners: using the mixed lines configuration, where the user will configure a different **k** parameters for each section of the line. This method does not lose accuracy; or use a single average **k** for the entire line. , note that the average **k** will not represent the actual **k** of the line at the faults location. It is an approximation, therefore it will present less accuracy.

Note:
The maximum number of RA333 that can be connected to the RPV311 is 4.

The RA333 module has to be connected to the RPV311 processing module before its initialization. Otherwise a log message will tell the user to reboot the device.

3 Automatic Fault Location

The DR Manager software is a tool design for management of COMTRADE files, configuration and fault location. One of its features is the automatic TW fault location. The DR Manager download the COMTRADE files from both terminals of the line, performs the fault location calculations, displays the fault location results in its interface and sends the location via MODBUS to the supervisory system.
Details on the configuration procedure, please refer to Chapter Software – DR Manager.

4 How to Test the TW Fault Location in Lab

The most complete test would be using two sets of RPV311+RA333:

1. Make sure that both RPV311 are properly time synced. For conditions that are more realistic, the sync sources could be independent;
2. Configure a line arbitrarily long on the DR Manager or TW Fault Locator software connecting the two sets of equipment;
3. Configure the TW register to be triggered by an undervoltage threshold in both RPV311;
4. Connect three phase voltage to the TW analogic inputs in both RPV311 though a circuit-breaker or test switch;
5. Switch off the circuit-breaker (or test switch), both RA333 should indicate the BUSY state, showing that the TW is being processed. register is being processed;
6. Download both files to a computer with the TW Fault Locator tool installed.
7. Run the TW Fault Locator tool to find the fault location (Procedure described RPV311 manual, in topic 14.5). The fault location should be 50% of the line.

Alternatively, it is possible to useone RPV311 and two RA333 connected to the same RPV311. Taking care when creating the powerline file, in which only the “line” parameter will be different, for example:

<terminal_a>LOCATION,IDENTIFIER,LINE_A</terminal_a>
<terminal_b>LOCATION,IDENTIFIER,LINE_B</terminal_b>

Another possibility that also tests the acquisition system of the RA333 module, is to use only one RPV311+RA333 and configure the powerline file with the same parameters for both terminals, for example:

<terminal_a>LOCATION,IDENTIFIER,LINE_A</terminal_a>
<terminal_b>LOCATION,IDENTIFIER,LINE_A</terminal_b>

In this case, the TW fault locator tool will use the same file for both ends locating the fault.
For all the previous mentioned tests, the algorithm shall point the fault location at 50% of the line length, as we are using with very short cable lengths or using the same TW register for both ends.

5 Three Terminal Line Application

The figure below shows a line of three-terminal. The Terminal A, B and C (sources X, Y and Z respectively).

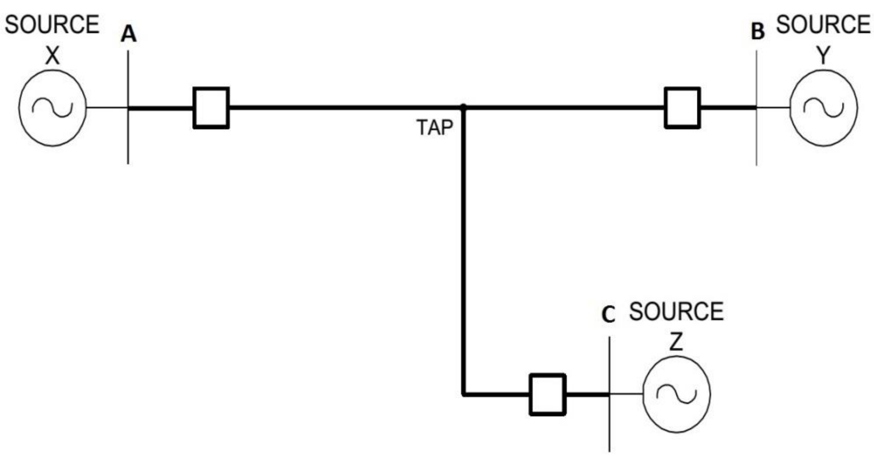

Figure 72 - Typical Circuit Three-Terminal Application

To use TWFL in the case above 3 sets of equipment are necessary: 3(RPV311 + RA333). One set for each terminal (Figure 73).
In this application, it is necessary to configure two transmission lines in the TW Fault Locator tool, which means to create two powerline configuration files. The first powerline configuration file is regarding line A -> B with length and k1 equal to L1 = L1’

+ L1'' (Figure 73), and the second powerline file configuration regarding the section C -> B with length and k1 equal L1'' + L2 (Figure 73).
In order to locate the fault is necessary to combine the fault location of both situations describe above.

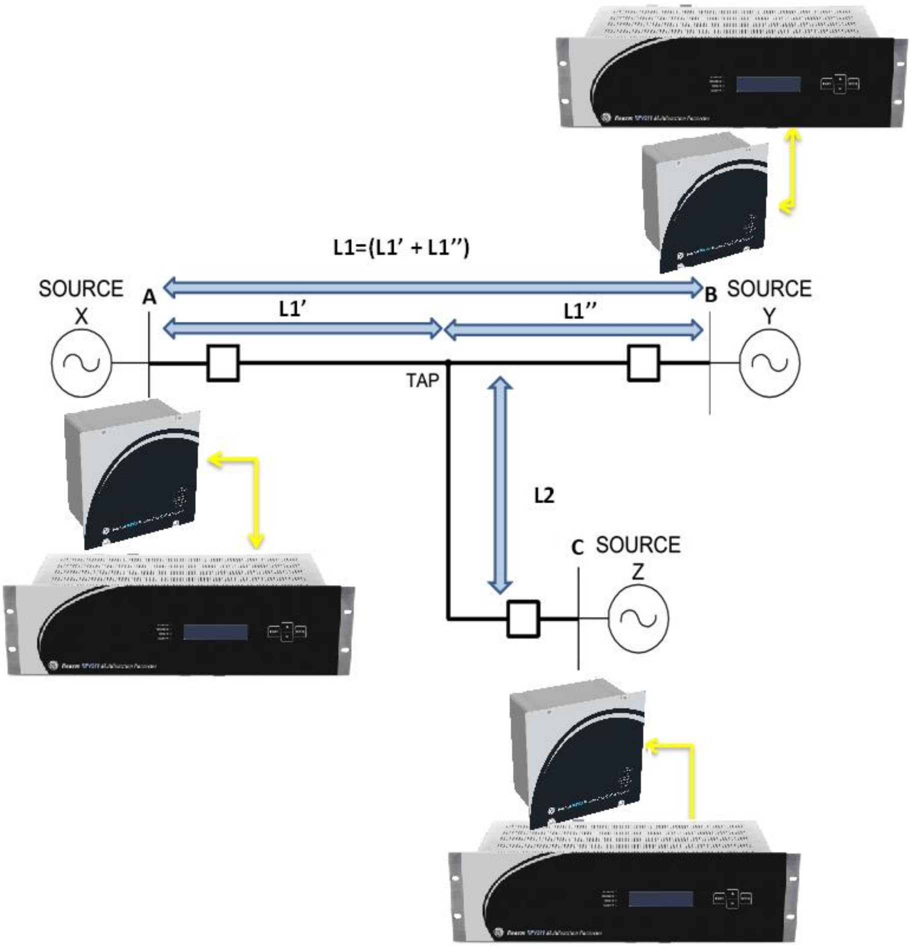

Figure 73 – Three terminal line application

5.1 Examples

Consider the TAP point located at 50% of line A-B and 50% of line C-B. Consider the names and topology of **Figure 73**.
Example 1:
If the result of the fault location of the line A-B returns more than 50% of the length of the line and the result of the fault location of line C-B also returns more the 50% of the length, then we know the fault is in the L1'' section, as in **Figure 73** Figure 74.
Example 2
Now consider the result of fault location on line A-B being at more than 50% of the length and the result of the fault location on line C-B at less than 50%, then we know

the fault is in the L2 section, as in Figure 74 and Figure 75 show the location of the faults in example 1 and 2, respectively.

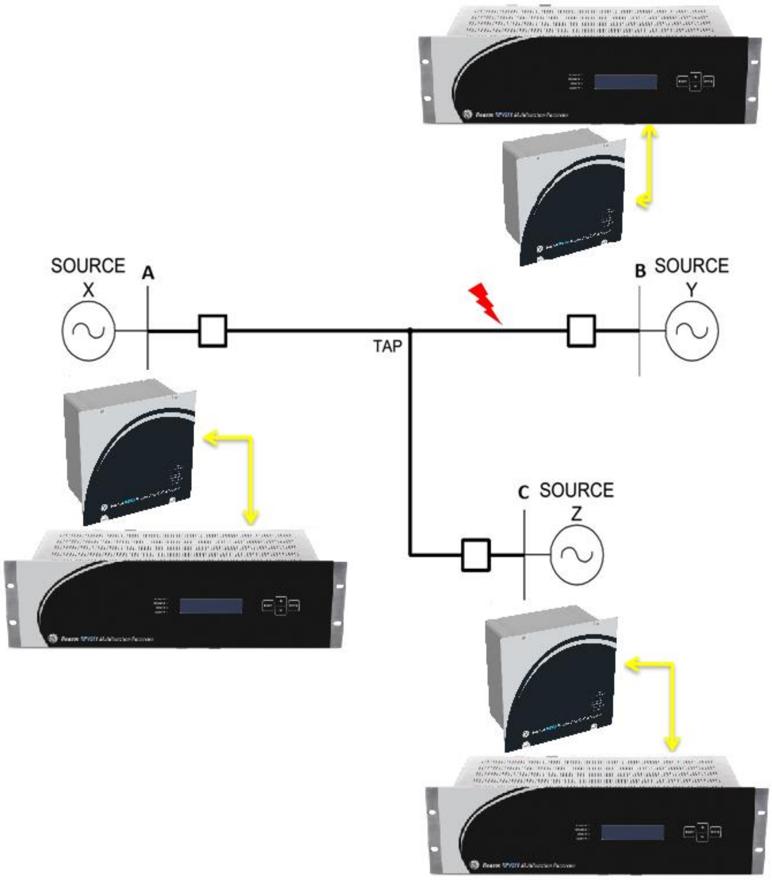

Figure 74 – TW Fault Location example 1

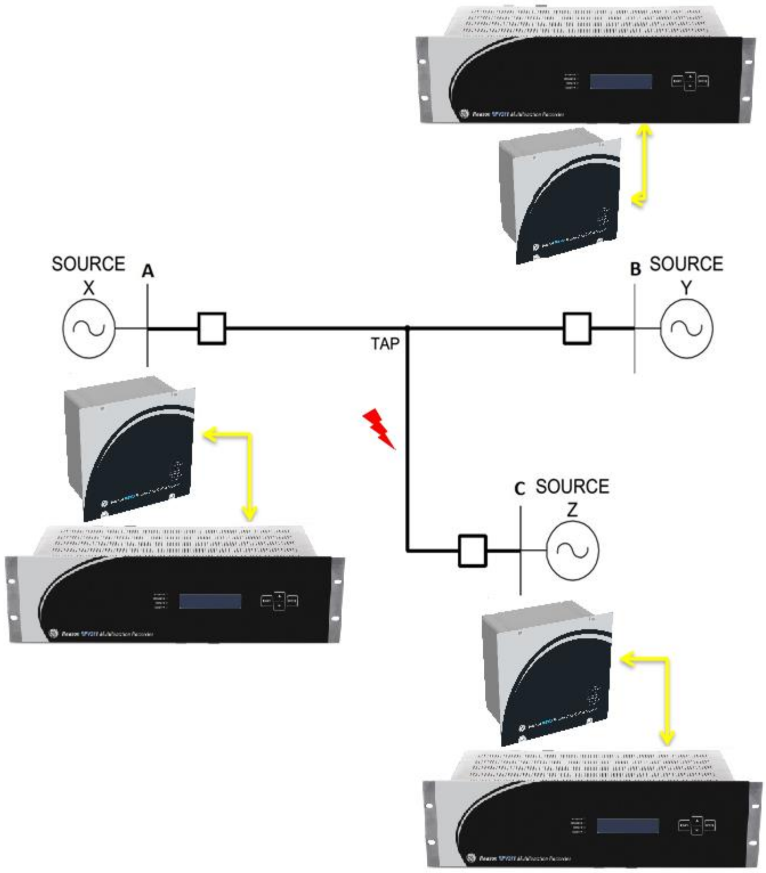

Figure 75 - TW Fault Location example 2

6 TWFL in Mixed (Hybrid) Lines

A hybrid transmission line is comprised of two or more different line types. That matters for the TWFL because the velocity of the fault wave is different in each section of the line and that shall be taken into account during the fault distance calculations.
The wave velocity is related to the relative permittivity of the main insulation and different thicknesses of the semi-conducting layers. Assuming one constant wave velocity for such a line will result in errors.

6.1 K Factor Calculation – Overhead Section

In the case of K factor relating to overhead line, without insulating material, it is considered that the dielectric material insulating the cable is only the air. In this case, the constant of permeability and permittivity is very close to 1.0.

$$\mu_{r_{air}} \cong 1 \qquad \epsilon_{r_{air}} \cong 1$$

$$V_{wave_{overhead}} = \frac{KC}{\sqrt{\mu_{r_{air}} \epsilon_{r_{air}}}} \cong 1.0C$$

In overhead lines, the velocity of the fault wave is very close the speed of light, between 98% and 99.5%, it means that the factor K ranges from 0.985 to 0.995. Calculating the K precisely is a very complex task, because it depends on unknown constants of permeability and permittivity of the overhead cable dielectric, which in this case is the air. That means that these constants may vary with humidity, atmospheric pressure and distance between the conductors of the transmission line in question.
Therefore, during commissioning, the K is usually set to 0.99 and improved later based on the data from subsequent fault location distances.

6.2 K Factor Calculation – Underground Section

In this type of table the insulation material have permeability and permittivity well defined for the entire cable, which makes it easier to calculate the k factor more accurately.
A common material used in the insulation of these cables is the XLPE. The example below shows the calculation of the K parameter using XLPE cable and its permeability and permittivity constants, where the result is K = 0.66.

$$\mu_{r_{xlpe}} \cong 1 \qquad \epsilon_{r_{xlpe}} \cong 2.3$$

$$V_{wave_{overhead}} = \frac{KC}{\sqrt{\mu_{r_{air}} \epsilon_{r_{air}}}} \cong 0.66C$$

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Chapter 8: PMU

This chapter provides detailed information about the PMU feature.

1 Synchrophasor Measurement and Broadcast

Synchrophasors UDP/IP Class M are measured and broadcast according to the specifications contained in IEEE C37.118, Standard for Synchrophasors for Power Systems.

1.1 Reported Values

The reported values are user-selectable of the list below.

Reported values user-selectable	
Phasors	Voltage synchrophasors (any phase)
	Current synchrophasors (any phase)
	Positive and Negative sequence for voltage circuits
	Positive and Negative sequence for current circuits
Frequency	Frequency and frequency variation of the respective frequency chosen frequency
Scalars	Any DC channel
	Voltage (RMS) value (any phase)
	Current (RMS) value (any phase)
	Voltage circuit imbalance
	Current circuit imbalance
	Total voltage harmonic distortion (any phase)
	Total current harmonic distortion (any phase)

	3-phase Apparent Power from phasor (S1) and from RMS (S) 3-phase Real Power from phasor (P1) 3-phase Reactive Power from phasor (Q1)
Digitals	Any digital channel

1.2 Accuracy Limits

The Total Vector Error defined through

$$\mathrm{TVE} = \sqrt{\frac{(X_r(n) - X_r)^2 + (X_i(n) - X_i)2}{X_r^2 + X_i^2}}$$

Represents the magnitude of the error vector, obtained by subtracting the measured synchrophasor of the theoretical value. It is represented as a fraction of the magnitude of the theoretical value.
In the equation above, $X_r(n)$ and $X_i(n)$ are the measured values, while X_r and X_i are the theoretical values of the input signal at the instant of measurement.
All 1A and 5A analog inputs/boards in RA33x modules have the proper accuracy necessary for the RPV311 PMU solution to be rated as level 1 compliant according to IEEE C37.118 under the condition below.

Influence quantity	Range	TVE max
Signal frequency	± 5 Hz of Fnom	1 %
Signal magnitude	10 % … 120 % rated	1 %
Phase angle	± 180°	1 %
Harmonic distortion	10 % [1]	1 %
Out-of-band interfering signal [3] $\|f_i - f_N\| > \frac{F_s}{2}$	10 % [2]	1 %

[1] Any harmonic up to 50 th order
[2] Of input signal magnitude

[3] f_i frequency of interfering signal, f_N nominal frequency and F_s synchrophasors broadcast frequency

1.3 Communication Ports, Transmission Rates

Each stream of data is transmitted through a particular UDP/IP port listed in the table below:

Stream of data	Port number
1	4713
2	4714
3	4715
4	4716

The transmission rate options at 60Hz are: 10, 12, 15, 20, 30, or 60 frames per second At 50Hz the rates are: 10, 25, or 50 frames per second.

1.4 Timestamp

The reported timestamp is synchronized to the UTC second rollover and refers to the middle of the sampling window.

1.5 Configuration

The PMU configuration is carried out through the Web Interface. For details about the PMU configuration, see Chapter 4: Configuration.

1.6 Standards Compliance

The RPV311 PMU Class M complies with the following standards:

IEEE C37.118-2005
IEEE C37.118.1-2011
IEEE C37.118.2-2011
IEEE C37.118.1a-2014

2 WMU – Waveform Measurement Unit

The WMU transmits Ethernet messages that are analogue signals calculated and sent within a PMU frame with a transmission rate equal to 4 times the system nominal frequency.

The analog signal sent is a representation of a three-phase signal that is used to evaluate wide-area subcyclic oscillations. The WMU uses the analogue field (No 10) of the frame below to send its data.

The WMU uses the commanded logic through the port number **4723.**

The table below exemplifies a frame of PMU described as per IEEE C37.118.2-2011.

No	Field	Size (bytes)	Comment
1	SYNC	2	Sync byte followed by frame type and version number
2	FRAMESIZE	2	Number of bytes in frame
3	IDCODE	2	Stream source ID number, 16-bit integer
4	SOC	4	SOC timestamp, for all measurements in frame.
5	FRACSEC	4	Fraction of Second and Time Quality, for all measurements in frame.
6	STAT	2	Bit mapped flags.
7	PHASORS	4 x PHNMR or 8 x PHNMR	Phasor estimates. May be single phase or 3-phase positive, negative, or zero sequence. 4 or 8 bytes each depending on the fixed 16-bit or floating point format used, as indicated by the FORMAT field in configuration the frame. The number of values is determined by the PHNMR field in configuration 1, 2, and 3 frames.
8	FREQ	2 / 4	Frequency (fixed or floating point).
9	DFREQ	2 / 4	Rate of change of frequency (fixed or floating point).
10	ANALOGUE	2 x ANNMR or 4 x ANNMR	Analog data, 2 or 4 bytes per value depending on fixed or floating point format used, as indicated by the FORMAT field in configuration 1,2, and 3 frames. The number of values is determined by the ANNMR field in configuration 1, 2, and 3 frames.
11	DIGITAL	2 x DGNMR	Digital data, usually representing 16 digital status points (channels). The number of values is determined by the DGNMR field in configuration 1, 2, and 3 frames
	Repeat 6 – 11	4 x ANNMR	Fields 6 - 11 are repeated for as many PMUs as in NUM_PMU field in configuration frame.
12 +	CHK	2	CRC-CCITT

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Chapter 9: MODBUS

This chapter provides detailed information about the MODBUS feature.

1 Description

Status, analog and digital data are available in MODBUS registers. Access to SCADA integration is provided over Ethernet interface. Up to 8 simultaneous connections are allowed at a maximum rate of 60 accesses per second.

1.1 Register Types

Each register reports 16-bit data. Registers are divided into 3 groups:

Register	Type
0	Status
100 to 199	Analog data
200 to 223	Digital channels

1.2 Status

The equipment status is reported by the following registers:

Register	Type
0	General State Bit 0: General failure Bit 1: Low primary power voltage Bit 2: Not used Bit 3: Not used

	Bit 4: IRIG-B synchronization failure Bit 5: Fault recording low memory Bit 6: Disturbance recording low memory Bit 7: Steady-state recording low memory Bit 8: Sequence-of-events recording low memory Bit 9: Internal failure

1.3 Analog Data

The user must manually associate analog data to a register number. The following analog data can be selected:

- RMS value of voltage and current circuits (any phase);
- Voltage and current synchrophasors (any phase, angles are sent in degrees units);
- Frequency of voltage and current circuits;
- Positive sequence of voltage and current circuits;
- Negative sequence of voltage and current circuits;
- Imbalance of voltage and current circuits;
- Total harmonic distortion of voltage and current circuits;
- Apparent combined power of power circuits;
- Apparent fundamental power of power circuits;
- Active fundamental power of power circuits;
- Reactive fundamental power of power circuits;
- RMS value of transducer channels.

1.4 Digital Channels

All digital channels are reported in groups of 8 channels. A register data is composed of 16-bit data where the least significant bit represents the state of the first digital channel of the group. The user must manually associate a digital group with a register number.

1.5 Configuration

The MODBUS configuration is carried out through the Web Interface. For details about the MODBUS configuration see Chapter 4: Configuration.

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Distributed Multifunction Fault Recorder

Chapter 10: DNP3

This chapter provides detailed information about the DNP3 feature.

1 Description

Status, analog and digital data are available in DNP3 registers. Access to SCADA integration is provided via Ethernet interface. The DNP3 functionality is fully dependent on the MODBUS functionality. To use DNP3, it is necessary for a configuration key to unlock the MODBUS functionality.

Each register reports 16-bit data. Registers are divided into 3 groups, status, analog and digital channels.

For each digital channel added to the DNP3 library database, a number is associated. These numbers are integers and start at zero. The number associated follows the order that the digital channels are created at equipment configuration.

For each analog channel added to the DNP3 library database, a number is associated. These numbers are integers and, for analog channels, start at number five. The number associated follows the order that the analog channels are configured at the MODBUS/DNP3 configuration.

Associated number at DNP3 database	
0 a 4	Status
5 a 199	Analog data
0 to 23	Digital data.

Note:
The phase angles are sent in radians units.

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Distributed Multifunction Fault Recorder

Chapter 11: GOOSE Message Detection

This chapter provides detailed information about the GOOSE message detection functionality.

1 Description

Digital channels can be associated with physical electrical digital inputs or associated to the detection of IEC61850, GOOSE messages.

GOOSE messages are captured and filtered by one of the Ethernet interfaces installed at the communications module. The state of the binary variables in the GOOSE message associated with digital channels and can be included in trigger equations, and can be stored in the fault record, disturbance record, and in the sequence of event (SOE) record.

The equipment can detect up to 320 binary inputs. The dataset types supported are:

- Boolean data type (1 bit);
- Bitstring data type (group of 64 bits);
- Enumeration data type (compare with some value to create a Boolean state).

GOOSE messages can be filtered by VLAN, MAC addresses and by the application identifier.

The association between the GOOSE messages and digital channels is made using the GOOSE Configurator, which is part of the RPVTools package. For details about the GOOSE Configurator configuration see Chapter 12: Software – RPV Tools.

The RPV311 GOOSE subscription is tested and attested for conformance according to IEC 61850 by DNV GL (KEMA).

> *Note:*
> *All the three rear Ethernet ports are capable of reading the GOOSE messages, but the same GOOSE messages shall not be sent to more than one port at the same time because they will be processed again by the device as it was the same message causing wrong readings.*

1.1 GOOSE Timestamp Behavior

Depending on the following conditions, the RPV311 will chose whether to use the timestamp within the GOOSE message or the RPV311 own internal clock to position the message in time in the records.

The RPV311 considers two different time quality bits of the GOOSE message (IEC61850-8-1) when deciding the point in time the message should be positioned. Whenever either the “ClockFailure” or the “Clock not synchronized” are asserted in the message coming in; or the difference between the GOOSE timestamp and the RPV311 internal clock is larger than 1 electric cycle, then the RPV311 will disregard the timestamp within the message and use the internal clock as time reference to record the message.

RPV311

Distributed Multifunction Fault Recorder

Chapter 12: Software – RPV Tools

This chapter provides detailed information about the features, configuration and usage of the DR Manager software.

1 RPV Tools Description

The RPV Tools are a suite of applications to be installed on the PC and allow the communication and the transfer of records between several pieces of equipment and a PC. It also allows user to receive, manage, edit, and transmit configurations of different pieces of equipment.

The suite consists of: Scanner, Configuration Tool, Fault Locator and GOOSE Configurator.

The Scanner is a tool that makes a sequential scanning of the records. It searches, transfers and saves the records on the PC according to the user configuration.

The Configuration Tool allows user to receive, manage, save, and transmit the configuration between the equipment and a PC.

The Fault Locator application allows user to define where an event has happened, based on traveling wave records (two ends of the transmission line).

The GOOSE Configurator allows the user to configure the RPV in order for it to receive and filter GOOSE messages Ethernet.

1.1 RPV Tools Installation

1.1.1 Installing

The installation of the RPV Tools applications on the PC is performed with a special tool called Installer, which is part of the software.

The minimum hardware requirements for the installation and execution of the RPV Tools are:

Supported operational systems

Windows XP operational system Service Pack 2.

Windows 7.

Applications

Mozilla Firefox version 17.0 or higher;
Adobe Flash Player version 12 or higher.

Minimum requirements

Processor 1 GHz or higher;
Minimum 512 MB RAM memory;
Minimum 500 MB free space on disk.

Only the administrator of the system can install the RPV Tools. To check if the user is the administrator click START > SETTINGS > CONTROL PANEL > USER ACCOUNTS. The computer administrator information will show below the login. If the user is not the computer administrator contact the manager of your system.

To install the software, follow the procedures below:

1. Insert the CD-ROM in the CD-ROM unit of the PC;
2. Access the CD-ROM unit, double click on the rpv-software. install-en-swvrr.msi file (for example: rpv-software.install-en- 04A00.msi);
3. The screen RPV Tools Setup will appear. Accept the terms in the License Agreement and click <INSTALL>. Wait for the complete installation of the software;
4. After installation is finished, click <FINISH> and then click <YES> to restart the system.

Four icons for quick access to the applications will be created on the Desktop and an RPV directory will be created in the root directory where Windows is installed. For example: C:\RPV\conftool\conf. The same applications also can be accessed by clicking Start > Programs > RPV.

It is necessary to restart the PC to complete the removal process.

The RPV Tools installation is in the same disk where Windows is installed.

The installation process takes up to 5 minutes.

1.1.2 Uninstalling

To uninstall the software, click START > SETTINGS > CONTROL PANEL > ADD OR REMOVE PROGRAMS. And then select RPV TOOLS on the list and click <REMOVE> then click <YES> on the ADD OR REMOVE PROGRAMS window.

The removal process takes about 4 minutes.

The directory containing the files will not be removed.

1.2 Scanner

1.2.1 Description

The Scanner is a tool that searches for the records in several pieces of equipment; it transfers and saves them in an organized manner on the user's PC. The Scanner does a recurrent scanning of the equipment's records, meaning that it scans all the pieces of equipment and, after some programmable period of time, it starts the scanning again.

1.2.2 Access

Scanner is accessed through an xml configuration file, where it is possible to configure a list of pieces of equipment to be scanned in each cycle, the configuration file can be saved either in a standard file (C:\RPV\scanner\conf\conf.xml) or in an alternative file, which in turn can be indicated by command line.
The Scanner can also be started directly of the desktop icon on the desktop created when the user install the RPV Tools.

1.2.3 Editing Configuration File

Using Notepad or any other editor, open the xml configuration file located in C:\RPV\scanner\conf\conf.xml.
The configuration file must be saved; otherwise, the configuration will be lost.
To configure each RPV311, it is necessary to fill in the file fields as shown below:

Configuration file fields	
<interval>xxx</interval>	Time interval between the beginning of a cycle and the beginning of another, expressed in seconds
<equipment enabled=”xxx”>	Indicates whether the configured RPV will be scanned or not (yes or no)
<address>xxx.xxx.xxx.xxx</address>	IP address of the RPV to be scanned
<timeout>xx</timeout>	Waiting time for communication with the RPV expressed in seconds
<record>xxxxx</record>	Indicates the type of the record that will be transferred or saved on the PC. The records can be fault, disturbance, steady-state, SOE and TW.
<bandwidth>x</bandwidth>	Limits or raises the baud rate of the records, where zero means no baud limits, expressed in KB
<delete>xxx</delete>	Determine whether automatic removal, programmed on the RPV, will be ignored or not (yes or no)

<modem enabled=”xx”>	Enter Yes if communication with the RPV is only by modem or enter No if the modem is not necessary for, communication with the RPV
<phonenumber>xxxxx</phonenumber>	Telephone number to connect the modem automatically

The configuration file can be changed during the scanning process. The update will occur in the next scanning cycle, after the waiting time.
Once the file is configured, scanning will be performed following the configuration of the file whenever the Scanner is started.
Example of a configuration file with RPV:
Below is the configuration of the xml file with an interval of 300 seconds between the cycles.
First RPV: activated scanning, RPV 192.168.0.195, waiting time for connection of 60 seconds, scanning fault, disturbance, steady state and SOE records, no baud rate limit, automatic deletion of records, activated modem, telephone number for connection to the modem 21080 300;
Second RPV: activated scanning, RPV 192.168.0.199, waiting time for connection of 60 seconds, scanning fault records, no baud rate limit, automatic deletion of records, no modem.


```
<?xml version="1.0" encoding="UTF-8"?>

<scanner>

        <interval>300</interval>

        <list>

        <equipment enabled="yes >

        <address>192.168.0.195</address>

        <timeout>60</timeout>

        <records>

        <record>fault</record>

        <record>disturbance</record>

        <record>steadystate</record>

        <record>soe</record>

        </records>

        <bandwidth>0</bandwidth>

        <delete>yes</delete>

        <modem enabled="yes">

        <phonenumber/>21080300</phonenumber>
```

```
</modem>
        </equipment>
        <equipment enabled="yes">
        <address>192.168.0.199</address>
        <timeout>60</timeout>
        <records>
        <record>fault</record>
        </records>
        <bandwidth>0</bandwidth>
        <delete>yes</delete>
        <modem enabled="no">
        </modem>
</equipment>
        </list>
</scanner>
```


1.2.4 Starting Scanner

There are 2 possible ways to start the Scanner:

1. Double click on the Scanner icon on the Desktop;
2. Click on Start > Programs > RPV > Scanner.

The Windows security alert window may appear during the first cycle of the Scanning. Click on the <UNBLOCKED> button to start the second cycle.

Example:

C:\RPV\scanner\resources>scanner Scanner 02A00 Starting cycle #1
#1: Scanning records of the RPV 192.168.0.195: "fault disturbance steadystate soe"
#1: Records transferred of 192.168.0.195. Waiting 300.0 seconds for the next cycle...

1.2.5 Terminating the Scanner

To stop using the Scanner, either press <CTLR> + <C> or close the command Prompt.

1.2.6 Records

The records received are saved in C:\RPV\records,as shown in Figure 76.
[location, RPV identifier]\[record type]\.

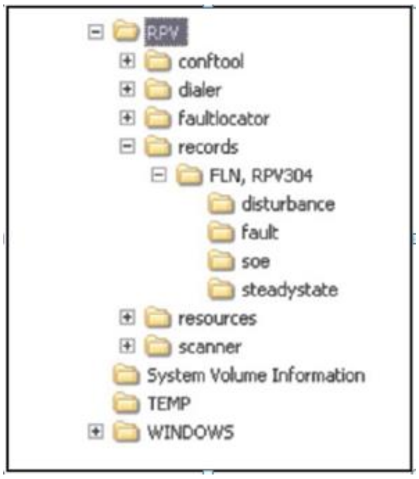


Figure 76: Directory of the records received of the equipment

1.2.7 Logging

The Scanner generates a log file with all the information about the ongoing process.
The log messages are available in the directory C:\RPV\scanner\log\scanner.log

1.2.8 Troubleshooting

Problem	Solution
The connection with the RPV311 was not possible	Check if the modem or the network is working

1.3 Configuration Tool

1.3.1 Description

The Configuration Tool allows creation of offline equipment configuration and sending of it to several RPV's. With this tool it is possible to make a safety backup of all the equipment configurations and either export them to a file server or keep them locally on the user's PC.

The user interface is based on the Web Interface used to access the equipment. A Web browser is required to run this tool.

An Ethernet or a modem interface makes access for sending or receiving configuration to from the equipment. Once it is received, the equipment configuration is stored locally and may be edited or renamed without requiring any other access to such equipment.

To send a configuration it is mandatory that the connection to equipment be available. The same configuration may be sent to different pieces of equipment.

The user must beware that all configuration parameters are immediately effective once the configuration has been transmitted. Wrong configuration parameters may set the equipment to *Not Ready* or cause loss of communication.

By clicking the Configuration Tool icon, the PC's default Web browser will open the tool. The main screen is shown in Figure 77.

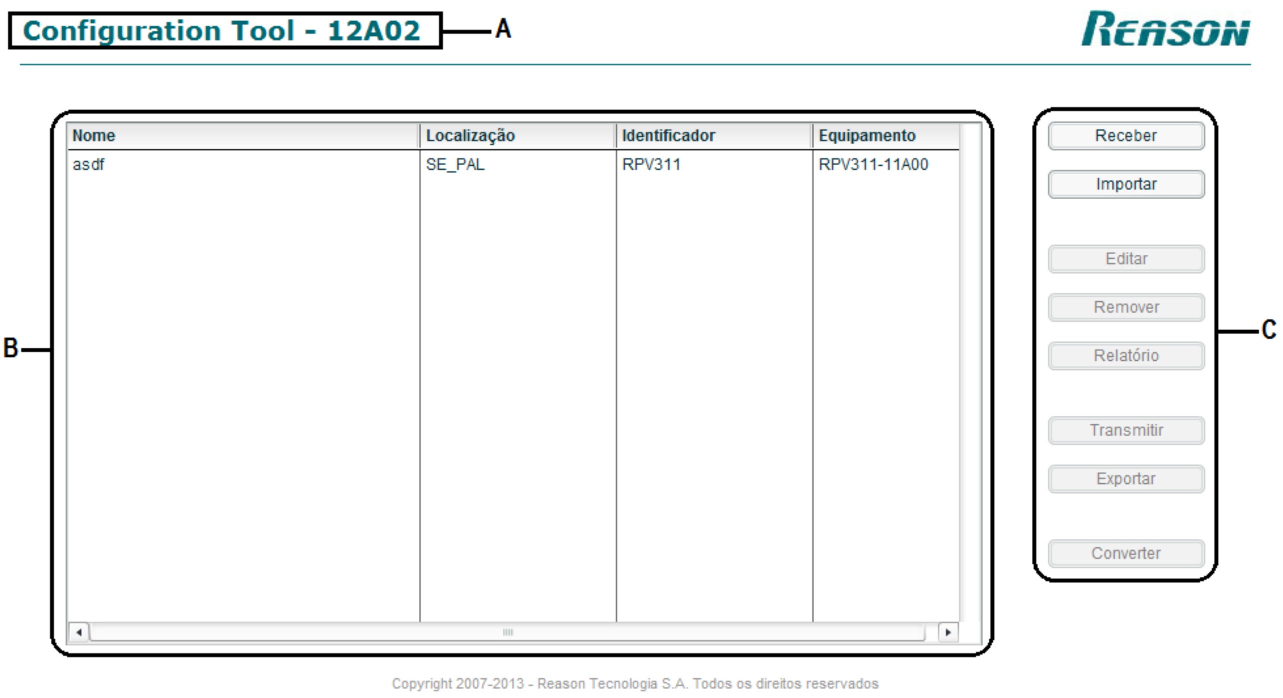


Figure 77: Configuration Tool main screen

A Shows the identification and the version of the RPV Tools.

B List of equipment configurations stored locally:

Equipment configurations	
Name	Configuration name defined by the user
Location	Shows location of the equipment. The location of the equipment is defined in the RPV configuration. This information is read of the EQUIPMENT > CONFIGURATION FILE
Identification	Shows the identification of the equipment. The identification of the equipment is defined in the RPV configuration. This information is read of the EQUIPMENT > IDENTIFICATION
Equipment	Shows the equipment model and firmware version to which the configuration refers

C Buttons to send or receive a configuration to or of a piece of equipment, to import or export a configuration to or of a file, to edit or remove an equipment configuration which is locally stored, and to convert an older version configuration for a newer version (the Convert button is applicable only for the model RPV-310).

Before using the Configuration Tool it may be necessary to install a plug-in file related to the firmware version installed on the equipment.

1.3.2 Plug-in

Every equipment model and firmware upgrade has a new plug-in file to incorporate the changes to the Configuration Tool.
The plug-in file is available with the firmware release.
Installation of the plug-in file is mandatory for any equipment model and firmware version that is to use this tool.
To install the plug-in, do the following:
1. Double click on the plug-in file (example: rpv310-software.plugin. install-en-21A00).
2. Select the checkbox with the text to *Accept the agreement license terms* and click on the <Install>button. Wait for installation to be completed and then click on the <Finish> button.

See C:\RPV\conftool\resourses\plugins to check which plug-ins are installed.

To remove a plug-in, go to Start > Control Panel > Add or remove programs. Select the plug-in file to be removed and click on the <Remove> button.
The uninstall process takes about 1 minute.

1.3.3 How to Use It

To open the Configuration Tool, double click on the *Conftool* icon and wait while default Web browser is opening.
To close the Configuration Tool, close the Web browser window.

1.3.4 Web Browser Configuration

The Configuration Tool runs on a Web browser (Internet Explorer or Mozilla Firefox). Before using it for the first time, it is necessary to configure some security parameters of the Web browser and the Flash Player. To perform the configuration, follow these steps:
In the configuration tool window, right click and select Global Settings. The Adobe Flash Player Settings will open;
Click on Trusted locations settings. The window will open;
Click on Add and then click on Browse for folder, find the RPV folder, then click it and after that click on the <OK> button.
Close the Flash Player Help window.

1.3.5 Receiving Equipment Configuration

To be able to receive an equipment configuration, the user must be connected to the equipment by Ethernet or modem interface.
Double click *Conftool* icon. The Configuration Tool interface will open in the default Web browser;
Click on the <Received> button. A new window will open;
Type IP address of the equipment and click on the <OK> button. An RPV-like configuration interface will open. It is possible to check the configuration parameters as if user were on-line with the equipment;
Change the configuration if necessary;
Click on the <Save> button. A new window will open and require a name for this configuration. Type the configuration name (maximum of 22 characters including _, -, 0-9, a-z and A-Z);
Click on the <Save> button once again to save the new configuration on the PC;
Click on the <Finish> button to go back to the main screen of the Configuration Tool. The configuration will be on the list of locally stored configurations.
The configuration window will appear in the Configuration Tool. The user can choose to edit the configuration again, store it or transmit it to the RPV.
It is possible to save the configuration with the same name as an existing one. However, the existing configuration will be overwritten.

1.3.6 Importing Equipment Configuration

It is possible to import a configuration previous saved on the computer. To import a configuration, the exported configuration XML file has to be first stored in the folder C:\RPV\conftool\conf and then proceed as follows:

Double click *Conftool* icon. The Configuration Tool interface will open in the default Web browser;

Click on the <IMPORT> button. A new window will open;

Click on the Browse button to choose the configuration file previously saved on the computer;

Enter a name for the configuration;

Click on the <OK> button. An RPV configuration interface will open. It is possible to check the configuration parameters as if user were on-line with the equipment;

Click on the <SAVE> button once again to save the new configuration on the PC;

Click on the <FINISH> button to go back to the main screen of the Configuration Tool.

The configuration will be on the list of locally stored configurations.

The configuration window will appear in the Configuration Tool. The user can choose to edit the configuration again, store it or transmit it to the RPV.

It is possible to save the configuration with the same name as an existing one. However, the existing configuration will be overwritten.

1.3.7 Editing a Stored Configuration

To edit a stored configuration follow these steps.

Select the name of the stored configuration to be edited and click on the <EDIT> button;

Change the configuration parameters and click on the <SAVE> button;

A new window will open requiring the name of the configuration (maximum of 22 characters including _, -, 0-9, a-z and A-Z);

Click on the <SAVE> button once again to save it on the PC;

Click on the <FINISH> button to go back to the main screen of the Configuration Tool.

1.3.8 Deleting a Locally Stored Configuration

To remove a configuration that is locally stored, follow these steps:

Select the name of the stored configuration to be deleted and click on the <REMOVE> button;

The message Remove this item will be shown. Click on the <YES> button to remove the configuration.

1.3.9 Creating a Configuration Report

To create the configuration report, follow these steps:

Select the name of the stored configuration to be deleted and click on the <REPORT> button;

An HTML Web page will open with a list of all configuration parameters.

The report consists of a header with the following information: owner, identifier, and location of the equipment, revision number, date and time of the last configuration change.

To print this report, click on the <PRINT> button.

1.3.10 Transmitting a Configuration

To be able to transmit an equipment configuration, the user must be connected to the equipment by an Ethernet or Modem interface.

Select the name of the stored configuration to be sent and click on the <TRANSMIT> button;

Type the IP address of the equipment that will receive the configuration;

Type the description of the configuration changes and click on the <OK> button;

Type the user name and the password to configure the equipment;

Click on the <OK> button to transmit the configuration and to go back to the main screen of the Configuration Tool.

1.3.11 Exporting a Configuration

It is possible to export a configuration to the computer. To export a configuration, do the following:

Select the name of the stored configuration to be exported and click on the <EXPORT> button;

Type the name of the configuration file (.txt extension) and choose the storage location, then click on the <SAVE> button.

The configuration file will be saved in the chosen location and can be imported into the RPV Tools.

1.4 TW Fault Locator

1.4.1 Description

The TW Fault Locator is a tool that uses the records of the traveling wave front signals at two ends of a transmission line to locate a fault in this line.

To record traveling waves in RPV it is necessary to install the appropriate acquisition module, RA333. The records of traveling waves at both ends of the line should be transferred of RPV's to the specific area of records in the user's computer that will run the Fault Locator software.

By using a graphic interface, based on the distance between terminals A and B and on the time stamp of the wave front, and by running the algorithm, the fault can be located. If unable to locate the fault automatically by the software, it is necessary to use a graphical tool to identify the times of the wave front of each terminal manually. Of the time identified it is possible run the fault locator graphically. If the locations of the towers between the ends of the line are defined, the results are georeferenced and a KML file is created for viewing through Google Earth.

1.4.2 The Power Line Configuration

Before running the fault locator algorithm, it is necessary to establish the power line configuration. The basic information related to the power line must be described in an XML file with the following fields:

Power line file configuration	
<length>nnn</length>	Nominal length of the line as the owner of the line claims (in kilometers)
<k1>nnn<k1>	Is the coefficient related to the length of the line, represents the actual length of the cable of the line. This value can be adjusted using data of faults subsequent to the commissioning
<k2>nnn<k2>	Is the coefficient related to the light speed factor
<terminal_a>Location,Identifier,Line</terminal_a>	STATIONID,DEVICEID and the terminal identifier
<terminal_b>Location,Identifier,Line</terminal_b>	STATIONID,DEVICEID and the terminal identifier
<tower id=”X” name=”NAME”>	Is the identification of the towers and their geographic coordinates. This information must be provided by the user
<latitude>nnn</latitude>	
<longitude>nnn</longitude>	
<distance>nnn</distance>	
</tower>	

The geographic coordinates are optional and must be provided by the user.
The technical note "Traveling Wave Fault Locator (NT0802)" shows how the coefficients K1 and K2 are calculated.
A model of the power line configuration file is created in the directory C:\RPV\faultlocator\conf of Windows after the RPV Tools installation. The power line configuration model is shown below.

```
<?xml version="1.0" encoding="UTF-8"?>
<line>
<length>100</length>
<k1>100</k1>
<k2>1</k2>
<terminal _ a>LOCATION,IDENTIFIER,LINE</terminal _ a>
<terminal _ b>LOCATION,IDENTIFIER,LINE</terminal _ b>
</line>
```

Make a copy of the file and edit it with the parameters related to the power line to be monitored.

Below is an example of the power line configuration:

```
<?xml version"1.0" encoding="UTF-8"?>
<line>
<length>248.5993</length>
<k1>248.28</k1>
<k2>0.98658</k2>
<terminal _ a>substation1,RPV311-TW,term _ a</terminal _ a>
<terminal _ b>substation2,RPV311-TW,term _ b</terminal _ b>
<towers>
<tower id"0" name="Pórtico substation1">
<latitude>-13.82689</latitude>
<longitude>-48.29898</longitude>
<distance>0</distance>
</tower>
<tower id"1" name="T1">
<latitude>-13.82665</latitude>
<longitude>-48.29866</longitude>
<distance>43.7</distance>
</tower>
...
<tower id="581" name="Pórtico substation2">
<latitude>-15.923331</latitude>
<longitude>-48.175103</longitude>
<distance>248593.3</distance>
</tower>
</towers>
</line>
```

1.4.3 The Traveling Wave Fault Location

The graphical interface must be open, double click the Fault Locator icon on the desktop.

The Fault Locator interface is shown in Figure 78.

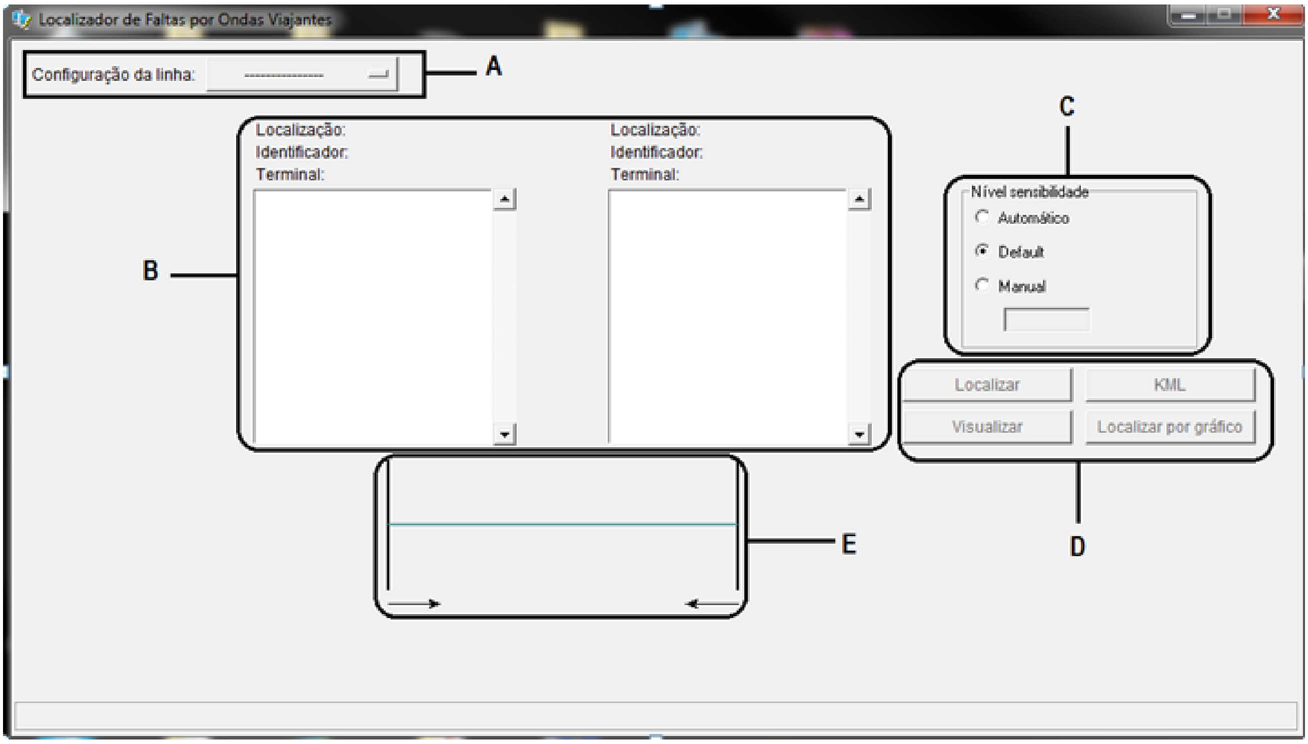


Figure 78: Fault Locator Interface

A Selection of the power line to be checked. The lines available are these with XML files already configured by the user. To appear in the list, the files must be stored the directory C:\RPV\faultlocator\conf.

B Terminal identification of each end of the line and the list of the traveling wave records of each terminal. Each record on this list is named with a time stamp. User must select one time stamp of each terminal that matches the same event. When selecting the record one terminal, it automatically selects a record with the same timestamp at the other terminal.

The TW Fault Locator Software considers the time zone information in the COMTRADE file's name, in order to set the register of both sides of the transmission line at UTC Time for calculations. Therefore, lines that go beyond two diferent time zones will not canse the algorithm to miscalculate the fault location.

C Selector of sensitivity for the fault location.

D Buttons for fault location, where:

The <LOCATE> button allows user to run the fault location algorithm;
The <VIEWER> button allows user to open the manual graphical tool to locate the time of the wave fronts in each terminal;
The <LOCATE BY CHART> button allows user to use the wave front times located in the graphical tool, to run the algorithm of fault location;
The <KML> button allows user to create a KML file, only if the tower's geographic coordinates have been provided.

E Location of the fault of terminals A and B.

In order to locate a fault, select a power line configuration and then, select one record of terminal A and the related record of terminal B is automatically selected. The user can manually exchange the terminal B record.
Click on the <LOCATE> button to run the fault location algorithm. If it is possible to locate the fault automatically, the result is the distance between both terminals A and B and the estimated fault location, and a "*Success fault location*" message is declared.
If some problem occurs in the fault location, a "*Fault not be locate*" message will appear. Possibly the selected records are not about the same event or the wavefront is less than the threshold set. In this case change the threshold levels of the location and click the <LOCATE> button again.
If the fault is still not located, use the graphical tool to identify the times of the wave fronts in the two terminals manually.
To use the graphical tool, click on the <VIEWER> button. Each terminal of the transmission line has a record of traveling waves, which are simultaneously displayed in the graphics window. In each record it is necessary to position the cursor at the exact moment of the beginning of the wave front, as shown in Figure 79.

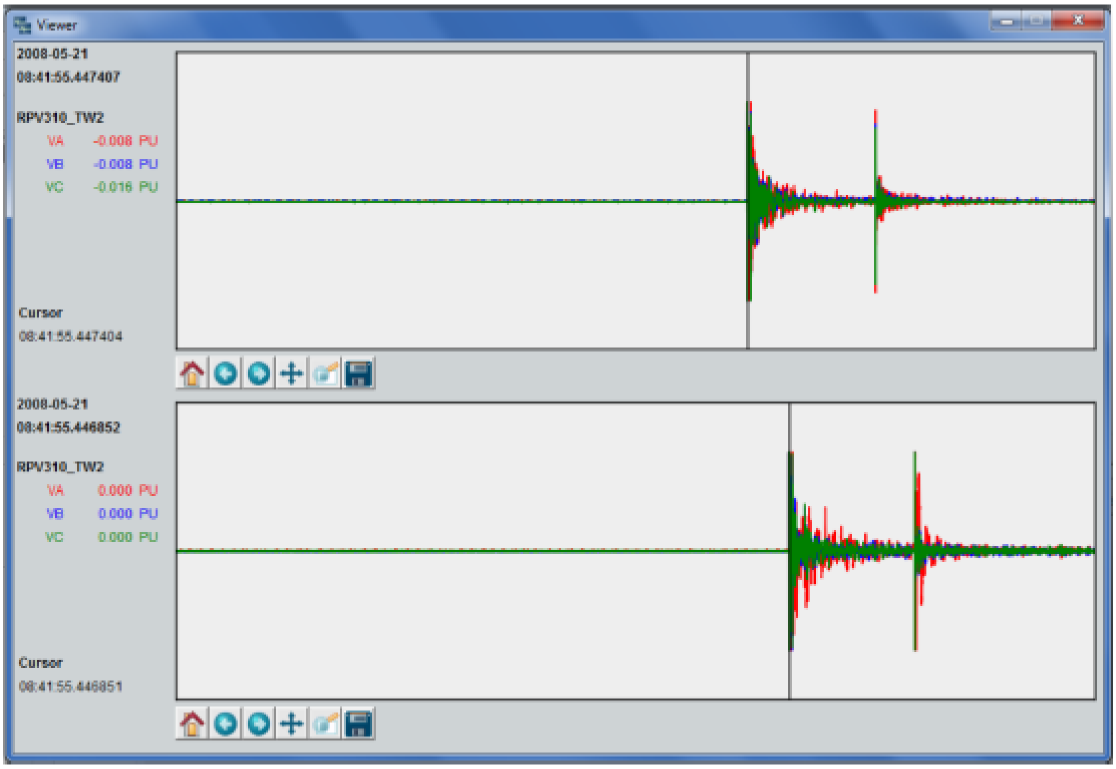


Figure 79: Graphical tool of Fault Locator interface

To move the cursor with the keyboard, first click on the corresponding graph with the left mouse button and navigate the graph, as follows:
Right mouse button position the cursor on the local clicked;
<LEFT/RIGHT ARROW> position the cursor each 1 us;

<SHIFT> + <LEFT/RIGHT ARROW> position the cursor each 50 µs;
<CRTL> + <LEFT/RIGHT ARROW> position the cursor each 100 µs;
<HOME> position the cursor at the record beginning;
<END> position the cursor at the record end;

To manipulate the graphic windows, use the following buttons of the software:

TW Fault Locator software's buttons
The <HOME> button displays the graphic in the format of the initial display
The <BACK> and <FORWARD> allow the zoom graph to navigate the front and rear positions
The <PAN> button allows manual dressing of the graphic
The <ZOOM> button allows selection of the area of the graph to enlarge
The <SAVE> button allow saving in an image file

The information presented for each of the records is:
Date and time stamp of the record beginning;
Terminal identification;
Voltage values of the phases A, B and C at the moment when the cursor is positioned;
Time stamp when the cursor is positioned.

It is possible to only one open window graphics for viewing. If the viewer is open and runs a new location for another set of records it is necessary to close the preview window and open it again.
After manually setting the times of the wave fronts, it is possible to use the <LOCATE BY CHART> button to find the fault, of the time stamps marked on the graph.
While the fault location algorithm is running, no other time stamps can be selected.
The graphical tool can also be used to confirm the results of automatic fault location.
If the user provides the tower's geographic coordinates in the .tw file, the program enables the <KML> button. Click on this button and a KML file is created to be viewed on Google Earth. In addition, the geographic coordinates of the fault are shown on the graphic interface.

1.5 GOOSE Configurator

1.5.1 Description

The GOOSE Configurator is an application that combines elements of a configuration GOOSE message file of the IED with the digital channels of the RPV.
The software allows the user to receive, edit, and transmit a configuration of the RPV.

1.5.2 Interface

When installing the RPV Tools, it creates a desktop icon for quick access. The configuration interface can be accessed directly via this icon.
To access the configuration interface, do the following:

1. Click Start > Programs > Accessories > Command Prompt;
2. At Prompt, access C:\RPV\goosemon_config\resources;
3. Run the Goosemon_Config.exe file and the application will open.

The initial screen of the GOOSE Configurator application is shown in Figure 80 and has the following characteristics:

A The GOOSE's list the configuration files loaded. These files are divided into GOOSE CONTROL BLOCK, which are composed of datasets with binary elements that can be associated with the digital channels of the RPV.

B The Digital channel of the RPV has the 320 binary magnitudes of the RPV, which can be associated to GOOSE messages. These inputs shall be identified in the RPV.

C The buttons allow association or disassociation of a GOOSE CONTROL BLOCK to a digital input of the RPV.

D The STATUS indicates the status of each operation.

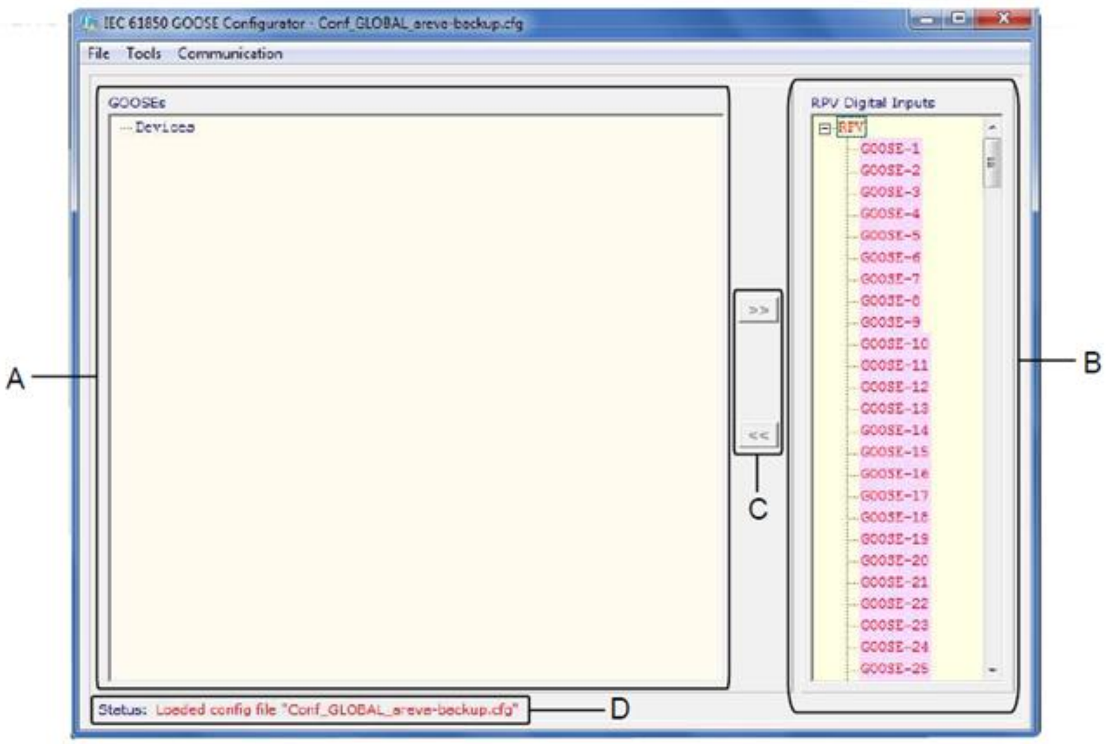


Figure 80: Initial screen of the GOOSE Configurator

1.5.3 Configuration

Starting a Configuration

To perform a configuration, it is possible to either edit a pre-existing configuration on the equipment, create a new configuration,or open a file containing a pre-existing configuration.

- Receiving an equipment configuration

To receive a configuration file of the RPV, access COMMUNICATION > RECEIVE. A window will open and then the user must enter the RPV IP address and click on the <OK> button to confirm. This prompts a login password that can be obtained of the Web Interface of the RPV in the configuration of the access control. This password can be changed through a new configuration in the Web Interface of the RPV.
When receiving the configuration of RPV, a temp.cfg temp file is saved in the directory config files. It is recommended that the user save that file with a different name because every time a new file is received, the previous file will be overwritten.

- Creating a new configuration

To create a new configuration access: FILE > NEW CONFIGURATION. This will create a template configuration file, called TEMP.CFG. This file will be saved in the directory CONFIG_FILES, and can be opened and/or modified.
When saving changes to file TEMP.CFG, it is recommended that the user save it with a different name because every time a new file is received, the previous file will be overwritten.

- Open a configuration

To open a configuration file that has been previously made, access File > Open Configuration. Select the location where the file is stored and click on the file to open it.

- Remove links of the configuration file

To remove links of the configuration file, access Tools > Remove All Configuration Files. All links will be removed.

Edit Configuration

- SCL File Input

To select the SCL input file access File > Select SCL. A screen will open to perform configuration of the SCL file, which is shown in **Figure 81**.
The input files can be SCD or CID and contain the IED GOOSE message configurations, according to IEC61850.

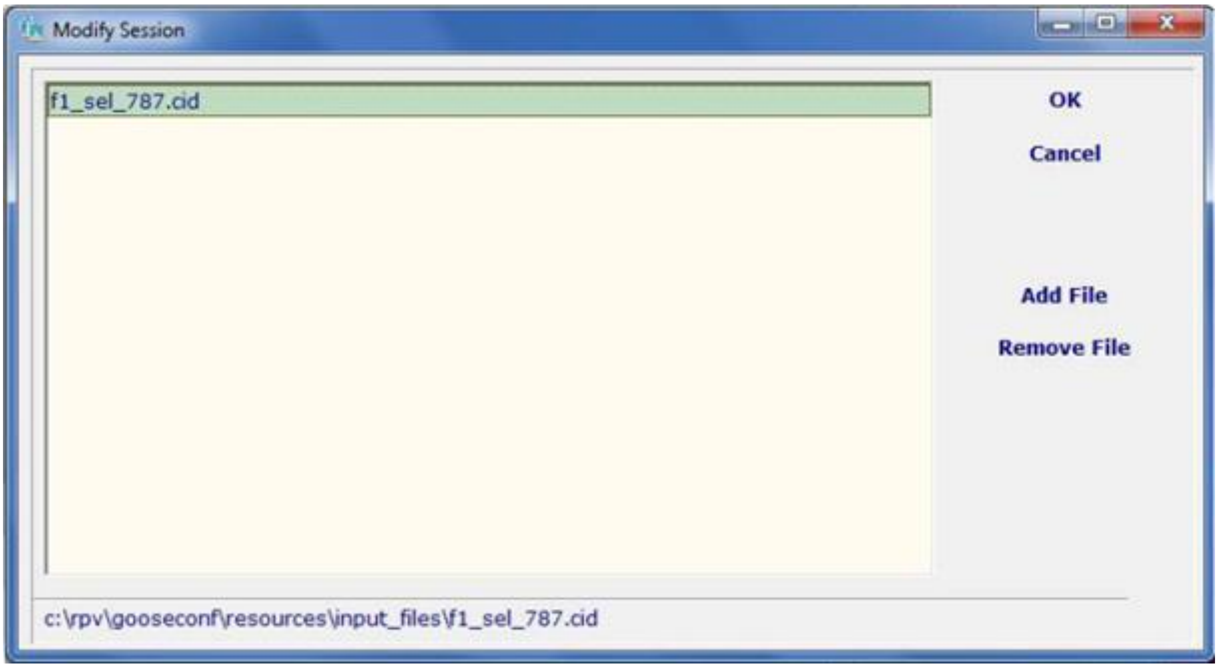


Figure 81: Screen to configuration on the SCL file

The <Ok> button is to confirm the changes in the files list. The <Cancel> button is to cancel the changes. The <Add Files> and <Remove Files> buttons are used to add or remove a file of the list of IED configurations, loaded onto the initial screen.
When a file is removed, it is necessary to know that the configuration files are not modified. It is not possible to view the GOOSE Control Block, associated with an input if the file is removed, however the configuration of the digital input of the RPV remains active.

- Association between GOOSE messages RPV digital inputs

To associate a GOOSE Control Block to a digital input, do the following:
Initially select an element GOOSE binary of the GOOSE Control Block list, obtained of the SCL files generated by IED;
Select one of the 320 RPV digital inputs according to GOOSE;
Click on the button to make association between the GOOSE message and the previously selected RPV digital input;
The message indicating the operation will show in the status area;
To remove the association click on the disassociation button.;
The user can only associate a GOOSE Control Block with a digital input if the data is compatible with the permitted limits on GOOSE. An example of a combination of GOOSE Control Block with a digital input.

It is possible to associate a GOOSE Control Block with a digital input only if the data is compatible with the permitted GOOSE message data. An example of association of a GOOSE Control Block with a digital input is shown in Figure 82.

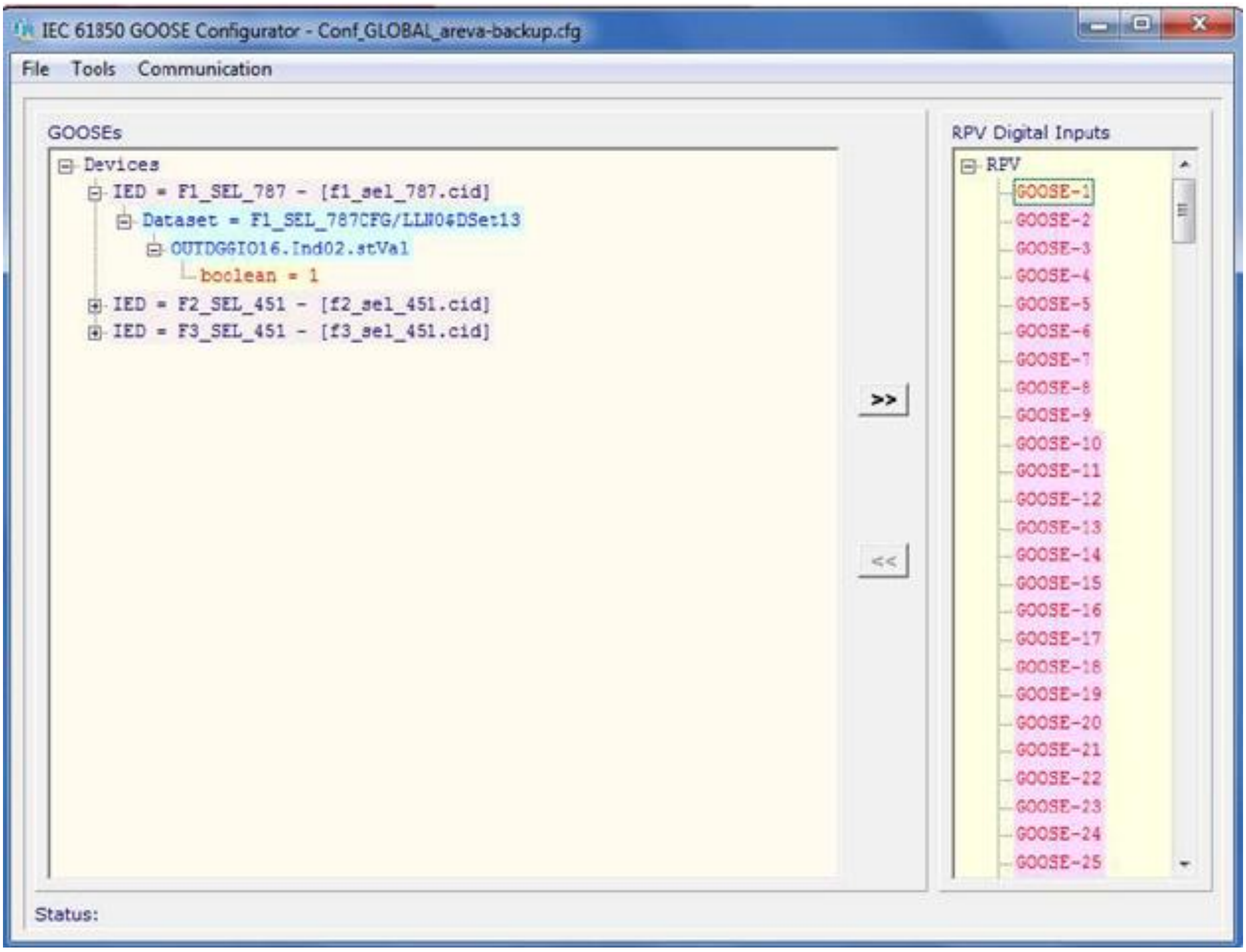


Figure 82: Association of a GOOSE Control Block with a digital input

- Filter parameters

To edit the filter parameters, access TOOLS > FILTER PARAMETERS. A screen will open and show the parameters that can be changed, shown in ***Figure 83***.

The parameters that can be changed in the configuration files are:

Ethernet: indicates the Ethernet interfaces used for capture;
VLAN: enables the VLAN filtering;
MAC Address filtering: enables MAC address filtering;
Filtering by identifying the application: enables the filtering by identifying the application.

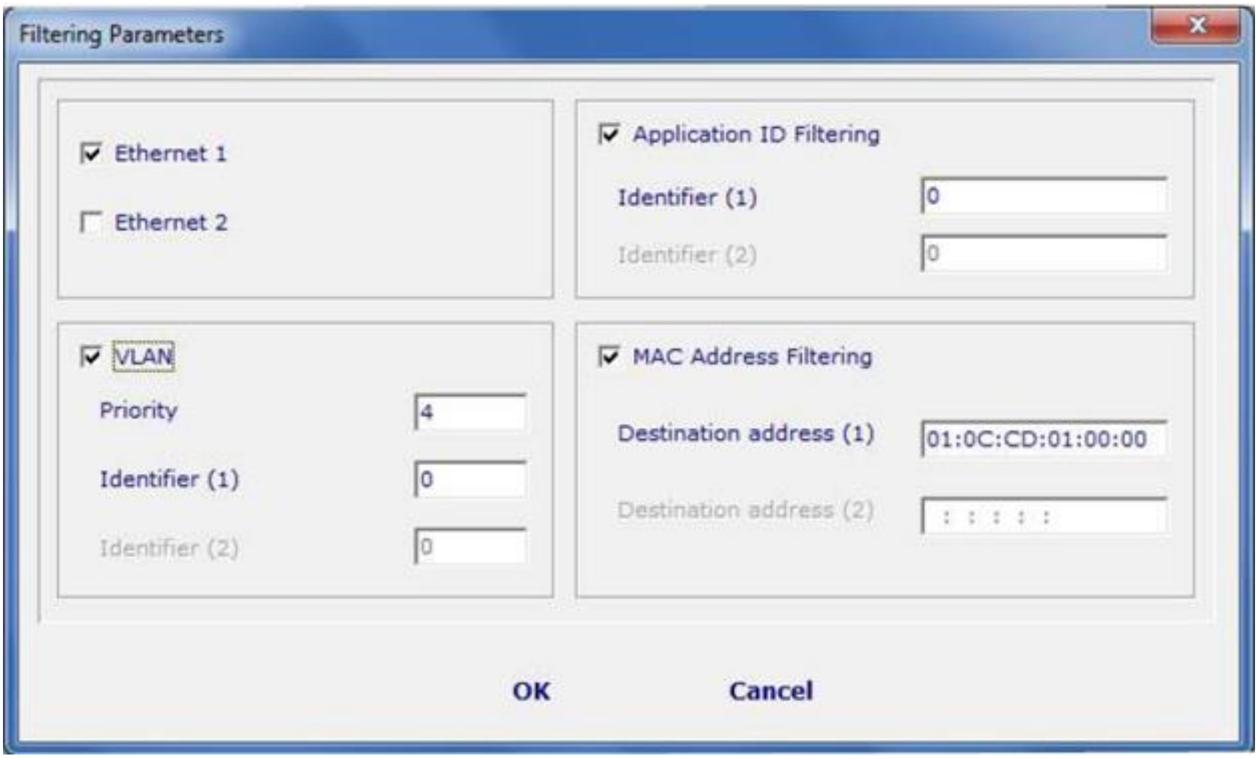


Figure 83: Filter parameters

Transmission of the Configuration

- Transmitting the configuration

To transmit the configuration to the RPV access COMMUNICATION > TRANSMIT. A window will open for user to enter the RPV IP address, and then click on the <OK> button to confirm.

- Saving changes in the configuration file

To save changes in the configuration file, access FILE > SAVE THE CONFIGURATION.
The user is recommended to save files received of the RPV with name different of that of the temp.cfg that is saved when creating a new configuration.

1.5.4 Additional Tools

Setting the Colors
To set the colors used on the GOOSE Configurator, access TOOLS > SETTING THE COLORS. The colors may indicate:

- Currently selected item;
- Existence of link between SCL and the setting;
- Bit set to an unknown SCL file;
- Item that must be selected or not;
- Line that contains the original SCL filename

View the Configuration Files

To view the contents of the configuration file to be sent to the equipment, access TOOLS > VIEW THE CONFIGURATION FILES. A new window will open only for reading of data, it cannot be modified.

RPV311

Distributed Multifunction Fault Recorder

Chapter 13: Software – DR Manager

The DR Manager is a tool that allows data management of the equipment.

1 Requirements

The DR Manager Installer works on Microsoft Windows and needs .NET 4 (client profile) to run. It also depends on a database engine, PostgreSQL 9.3. The user must have administrative rights to install the software.
The software is supported on Windows 7 and 10.
This manual refers to DR Manager version 09A00.

2 Software Description

2.1 DR Manager Main Window

2.1.1 System Monitor

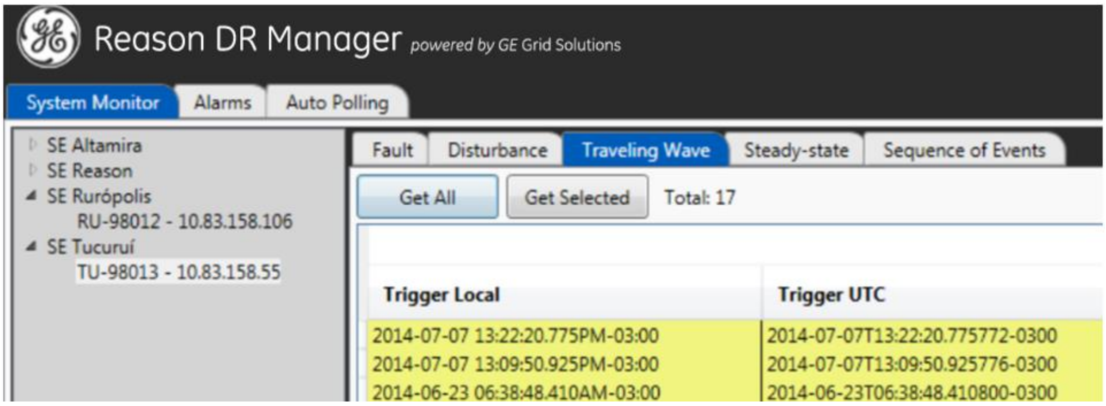


Figure 84 - DR Manager main window

The software main tab is called System Monitor. All the substation and RPV311 configured in the software are listed in a tree menu on the left corner of the window. The top level of the tree shows the user created facilities and the equipment installation on the second level.
After clicking on the device with the left mouse button, the equipment records will be loaded and displayed in tabs depending on the type of record selected (Fault, Disturbance, Traveling Wave, Steady-State or Sequence of Events). This information is updated after a Refresh.

By right-clicking on the equipment, the user can update the State of the equipment, through the option "Refresh", or access the equipment web configuration page, through the option "Access Web Configuration".
The records highlighted yellow are stored only in equipment memory which can be seen each time Refresh occurs.
Green highlight represents the records that have already been downloaded and then saved in the database in the respective directory including data of the equipment within the COMTRADE directory.
If communication is lost with the equipment, only records in green will be displayed.
Download of records can be done automatically or manually. In the manual case either a few selected records or all records can be downloaded.

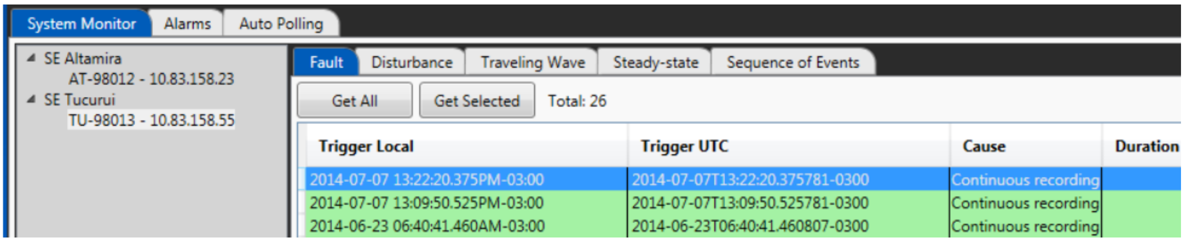


Figure 85 - Downloaded records

2.1.2 Alarms

Alarms tab shows all registered equipment alarms, including information of "Time Quality" and "firmware version".

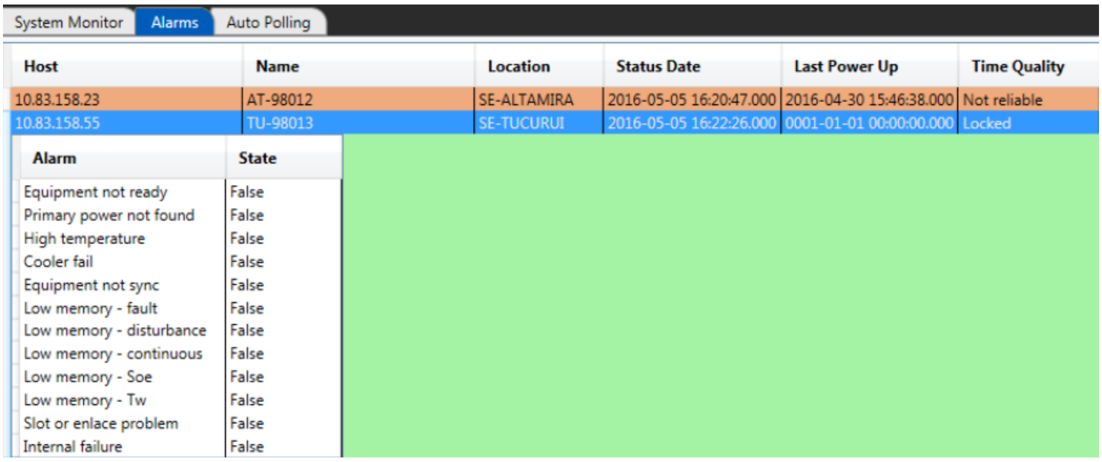


Figure 86: Alarms tab

There are four background colours:

White: Communication not yet established with the equipment.
Yellow: Alarm(s) active
Green: No alarms
Orange: Communication lost with the equipment.

The user can check details on the alarms and their states by clicking the equipment’s name.

2.1.3 Auto Polling

With the Auto Polling tab the user can check the number of files that have been downloaded and the number of files waiting to be downloaded.
When active, the software will check which records have not yet been saved and will download them. Records will only be downloaded automatically from equipment with Auto Polling enabled.
A background colour indicates that the equipment is being checked.
During the download, the data is updated on the screen as the records are transferred.

2.1.4 Download Modes

- Automatic download:

The procedure to activate the *Auto Polling* can be seen in the Settings Menu 2.2.2.

- Manual Download:

Selected records:
Select the records required, and click the button “Get Selected”;

All records:
Click "Get All".

Double click on the downloaded record to open (it is necessary to have a software to open .zic files already installed).
To close this window use the close button in the top right, or use File >Exit.
A confirmation message will be shown after closing.

2.2 DR Manager Settings

DR Manager presents some settings that user can access through the menu bar. These settings are shown below.

2.2.1 File Menu

In the File menu, the user can:

- Open COMTRADE folder;

The Open containing folder option will open the default register's downloaded folder. By default, the folder is **C:\RPV\Records.**

- , Refresh All Devices.

- Refresh the list with COMTRADE files (but does not download them);
- Refresh Alarms tab;
- Check alarms to send email/fax when new ones are exist;

- Compares the local configuration file with the respective RPV311 configuration file.

- Close the software with the "Exit" option.

2.2.2 Settings Menu

In the Settings menu, the user can:

- Create, edit and remove Installations;
- Create and remove Devices;
- Transmission line configuration for TW fault location;
- Create, edit and remove contacts for e-mail and fax sending;
- Create, edit and remove Warnings to be sent.

Signing up RPVs to the DR Manager:

The DR Manager sorts the devices in the follow manner:

First, it is necessary to create what is called Installation, that can ben, for example, the substation where de RPV is installed. Then the user has to register the RPV and assign each of them to an installation by creating what is called Device.

Below mentioned is the procedure to create **Installations** and **Devices**.

1.1.1.1 CREATING INSTALLATIONS

The process to create a new Installation is:

1. Click <SETTINGS> menu and then click <INSTALLATIONS>;
2. Click <NEW> to create. Type the Installation's name and description and then press <OK>.

The user can view the list of registered substations and add, edit, or remove a substation. Substations can only be removed without any equipment being associated.

1.1.1.2 CREATING DEVICES

The user can view the list of registered equipment, add, edit, or remove some equipment. Equipment can only be removed when there is no transmission line associated and if the Auto Polling is disabled. bellow

The process to create a new device is:

- Click <SETTINGS> menu and then click <DEVICES>;
- Click <NEW> to create.
- At <HOST>, type equipment's IP address;
- Choose device installation in the Installation list;
- Click at <Get Info> and then press <Ok>.

Generally, User name and Password are not required to download DFR registers. If required for the application, then type Users name and password for administrator user of the equipment (GE’s default, user name is **admin** and password is **1234**). The figure below shows the Device configuration window.

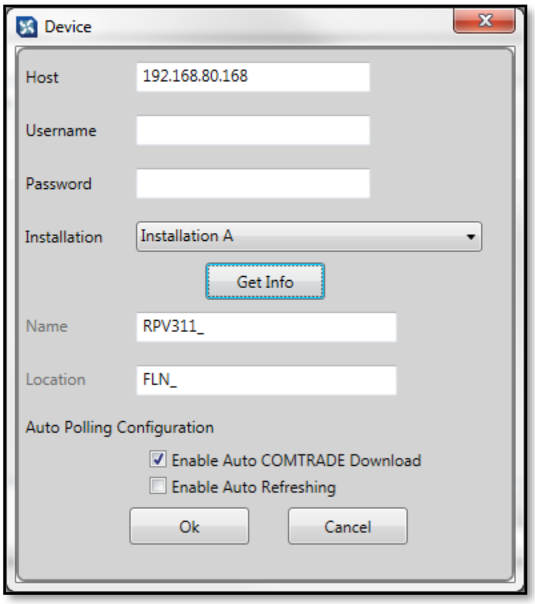


Figure 87: Device window

There are two parameters to be configured by the user:

Enable Auto COMTRADE Download: When enabled, the unit will be part of the Auto Polling process, where records not yet saved are automatically downloaded.
Enable Auto Refreshing: When enabled, the unit will be part of the process of Auto Refresh, where the equipment state will be updated automatically during the process.
The user can change the equipment host address, and enable or disable the "Enable Auto COMTRADE Download" and "Enable Auto Refreshing". At the end of the editing, the software automatically communicates with the equipment in order to upgrade the name and location information.
If the equipment is associated with any transmission, a message will be shown to the user at the beginning of the Edit.
After the closing the 'Device' window, the equipment updates are registered.

1.1.1.3 TRANSMISSION LINES (AUTOMATIC FAULT LOCATION)

The transmission line window configures the parameters necessary to execute the Traveling Wave Fault Location algorithm on the TW high acquisition frequency records.

On this menu the user can view the list of the registered lines, add, edit, or remove any transmission line.

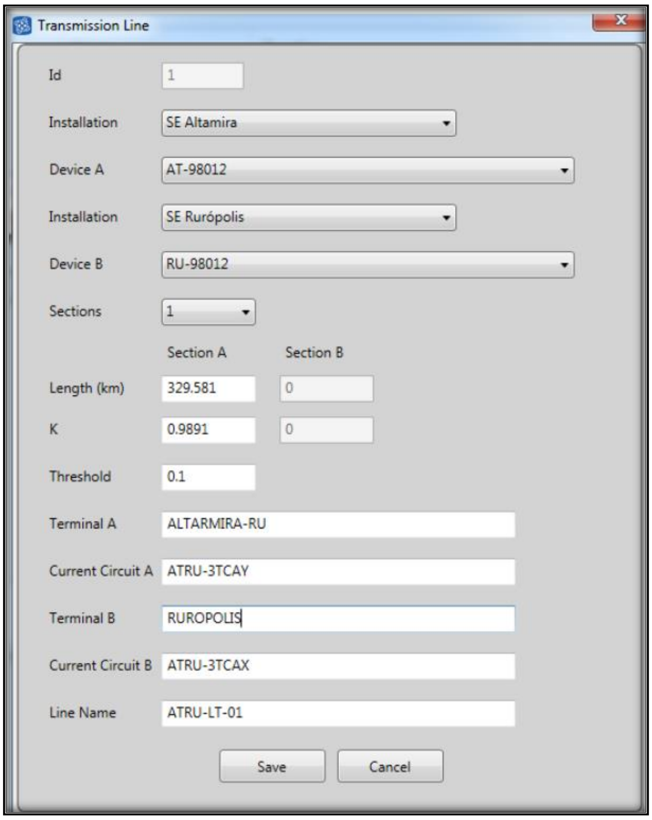


Figure 88- Transmission Line configuration

In order to add and edit a transmission line, the user must:

1. Select the installation A at one terminal of the line;
2. Select the device A that is monitoring the line in installation A;
3. Select the installation B at the other terminal of the line;
4. Select the device B that is monitoring the line in installation B;
5. The field Section is used to select how many sections the line has, i.e. how many different propagation constants K (used when the line has overhead an underground sections)
6. Enter the line lengths and K for each section of the line. Refer to Chapter 7, section 6 TWFL in Mixed (Hybrid) Lines for further information on the constant K.
7. Enter the Threshold used in the TWFL Basic method. Refer to 2.3 Automatic TW Fault Location for further information.
8. Enter the names of the Current Circuits A and B. As it is configured in the RPV311, **Figure 89** . These circuit names are used to identify the correct Fault chart used in the Advanced TWFL Method. Refer to TW Fault Location Methods 2.3.3 for more information.

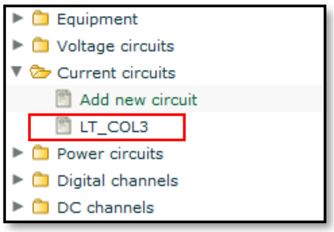


Figure 89: Current Circuit name

1. Enter the names for the terminals A and B. As configured on the TW screen in the RPV311, see below.

Figure 90: Terminal name configuration

1. Finally, enter the name of the transmission line.

The field ID shows the ID of the MODBUS transmission of the fault location. Further information in 2.3 Automatic TW Fault Location.

1.1.1.4 CONTACTS

This menu configures the contacts to which the RPV can send emails notifications.
On this window the user can view the list of registered contacts, add, edit, or remove any contact. During the removal of any contact, if any association with any warning, a confirmation message will be displayed to the user.

1.1.1.5 WARNINGS

On this screen the user can view the list of warnings, add, edit or remove any warning.
By setting the warning the user can select which contact will receive the alarms.
It is possible to configure which events will make the DR Manager send warning email, according to the following settings:

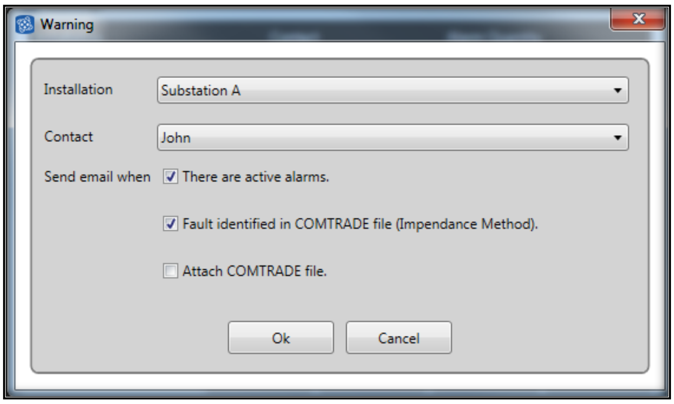


Figure 91- Warning menu

Send email when the RPV311 being monitored have active alarms, when a fault is found in the COMTRADE files. In case a fault has been identified it is possible to attach the COMTRADE file of that fault to the email.

2.2.3 Polling Menu

In the Polling menu, the user can:

- Select software polling to be manual;
- Select software polling to be automatic;

In the manual mode, both the Refresh of the COMTRADE list and the download of register has to be commanded by the user.

In the automatic mode, the software will download the registers and refresh the COMTRADE list automatically according the parameters set on the Configuration>Polling menu. Also, each device has to have those option enabled on the Settings>Device menu.

2.2.4 Tools Menu

In the Tools menu, the user can:

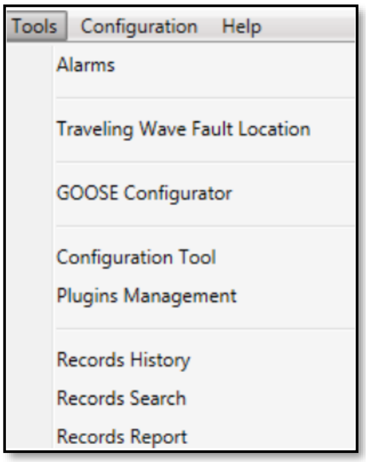


Figure 92 - Tools menu

- View software alarms and alarms history;
- Calculate Traveling Wave fault location;
- Execute the GOOSE configuration tool Chapter 12, Section 1.5 GOOSE Configurator;
- Execute the RPV311 Configuration tool and manage the software plugins
- View records history;
- Search for records (with date filter);
- View records report.

1.1.1.6 SOFTWARE ALARMS AND HISTORY

The Alarm window shows active alarms and the alarm history.

The Active Alarms tab displays the alarms still on. Examples of these alarms are: Equipment not Ready, Slot or Enlace Problem, Equipment not sync, primary power not

found and communication error. The History tab displays alarms that came back to off state.
The list is updated by the Refresh command.

1.1.1.7 TRAVELING WAVES FAULT LOCATION

To locate the fault in the transmission line using the Traveling Wave method, the user must:

1. Select the transmission line, enabling the other fields for editing;
2. Select the COMTRADE TW files of both terminals of the line. Note that when you select the Transmission Line, the directory selection window will open directly the register folder in C:\RPV\records.
3. Click Locate to run the algorithm and locate the fault.

1.1.1.8 GOOSE CONFIGURATOR

This option opens the GOOSE configuration software described in Chapter 12, Section 1.5 GOOSE Configurator. The GOOSE configuration software is responsible for the association of the SCL file of the sending IED with the RPV311 GOOSE inputs.

1.1.1.9 CONFIGURATION TOOL

This option open the Configuration Tool described in Chapter 12, section 1.3 Configuration Tool. This software is responsible for the management of the several RPV311 configurations and offline configuration.

Note: The Configuration Tool access through the DR Manager works only with firmware versions from 13A02 onwards. To deal with firmware version before that, the RPV Tools (Chapter 12 Software – RPV Tools) should be used.

1.1.1.10 PLUGINS MANAGEMENT

This menu is used to install the plugins that the Configuration Tool mentions above uses to work with offline configurations. Each firmware version requires a separate plugin to work offline.

1.1.1.11 VIEW RECORDS HISTORY

In this option the user can view the records download history, sort by download date, by registry and by duration time.

The maximum number of records displayed is configured in the option *Display Downloaded*
COMTRADES Limit on the Polling configuration window.

1.1.1.12 SEARCH FOR RECORDS

In this option user can use filters to search for specific downloaded records of a selected DFR.
The search can be made taking into account:

- Selection of one or more equipment;
- Period start and/or end of the occurrence of the registry;
- Reason of occurrence;
- Record type:
- All (This will get all types of records);
- Fault recorder: records of short duration, with two advanced search options: Triggered and Continuous.
- Disturbance recorder: records, with two advanced search options: Triggered and Continuous.
- Travelling Wave recorder: records of travelling wave
- Steady-state: measuring records continues with four advanced search options: Average series, Harmonics, Flicker PST and PLT.
- SOE: records of sequence of events.

1.1.1.13 RECORDS REPORT

This option displays, for the selected equipment, month and year, the number of downloaded registers. They are separated by register type and displayed as a Pie chart in the records report window. Number of records percentage are displayed by default, and if the user passes the mouse over the register type displayed at the bottom of the window, the number of records are displayed in the record's type region on the pie chart.

1.1.1.14 RECORDS REPORT

This menu displays a chart with the percentage number of each kind of register downloaded.
To view the chart you must select a period of time, select a device and click the button "Report". That will display the graph showing the percentages of each type of record. Hover the mouse cursor over the graph to see the number of records saved, as shown in the figure below:

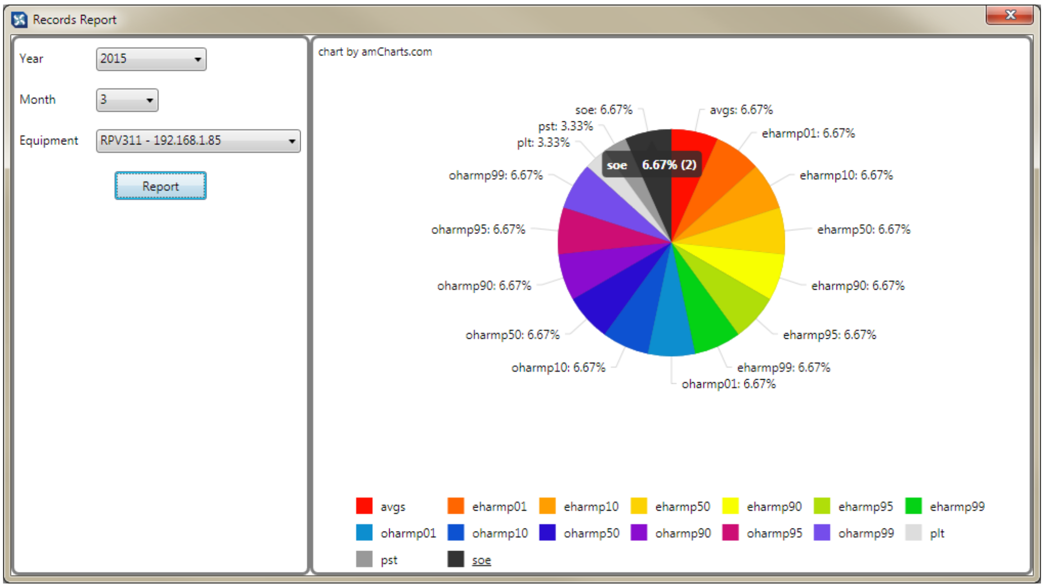


Figure 93: Percentage of records chart

It is possible for certain periods to have no downloaded files available so no graph will be loaded on the interface.

2.2.5 Configuration Menu

In the Configuration menu, the user can:

- Configure software polling;
- Configure the coefficients used in TW calculation
- Configure e-mail.
- Choose which Browser will be used to open the Configuration Tool

1.1.1.15 POLLING

On the Polling Configuration menu, the user can configure the COMTRADE polling, refresh and storage of files. The Figure below shows the Polling configuration window.

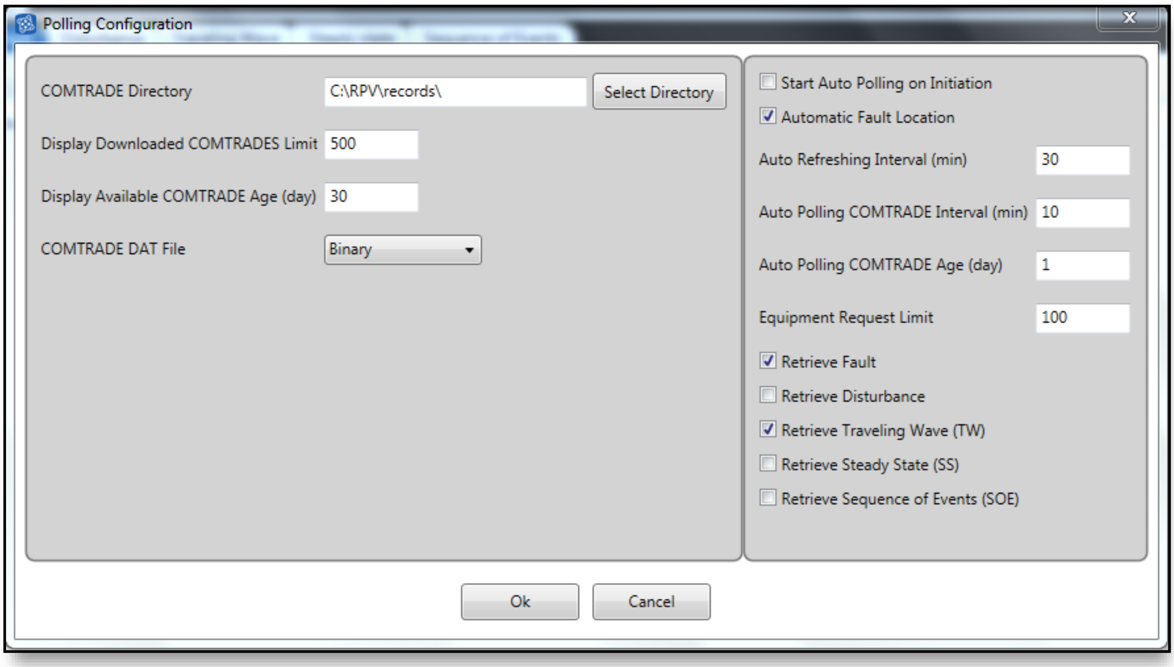


Figure 94: Polling configuration

Polling Configuration fields description:

COMTRADE Directory: directory path where the new records are downloaded and where the fault locator calculation searches.

Display Downloaded COMTRADES Limit: maximum COMTRADE records already downloaded that will be displayed on the screen

Display Available COMTRADE Age (day): limit, in days, of downloaded records that will be fetched and displayed on the screen.

COMTRADE DAT File: format in which the COMTRADE file will be saved.

Start Auto Polling on Init: starts Auto Polling automatically by the application.

Automatic Fault Location: performs the fault location calculation after the COMTRADE file refresh.

Auto Refresh Interval (min): interval, in minutes, that anautomatic update of the data of the device will run when the Auto Polling is active.

Auto COMTRADE Polling Interval (min): interval, in minutes, that will be held the automatic download of COMTRADE files.

Auto Polling COMTRADE Age (day): maximum age, in days, of records that will be downloaded automatically in Auto Polling. For example, if a register was made 5 days ago and the DR Manager is started today and the Auto Polling COMTRADE Age (day) is set to 4 (or 1, 2 or 3) the register will not be downloaded during the auto polling.

Equipment Request Limit: limit of records that will be requested from the equipment in each query.

Retrieve Fault: When selected, automatically downloads the short duration records, both triggered and continuous.

Retrieve Disturbance: When selected, performs the automatic download of the slower disturbance records, both triggered and continuous.

Retrieve Travelling Wave (TW): When selected, performs the automatic download of the travelling wave records.

Retrieve Steady State (SS): When selected, performs the automatic download of the continuous measurement records.

Retrieve Sequence of Events (SOE): When selected, performs the automatic download of
the sequence of events records.

If modification on this windows is made, a message will be displayed asking the user to restart the program.

1.1.1.16 COEFFICIENTS

The TW fault location algorithm uses a few coefficients during the fault location process. The DR Manager default coefficients shall not be altered unless advised by GE Grid Solutions.

1.1.1.17 EMAIL

Allows the configuration of the email accout that the DR Manager will use to send emails.

1.1.1.18 BROWSER

This option allows the user to choose which Browser will be used to open the Configuration Tool. The MS Internet Explorer and the Mozilla Firefox are supported.

2.2.6 Help Menu

- About

The About screen shows information on the software such as: software version, copyright ans memory usage.

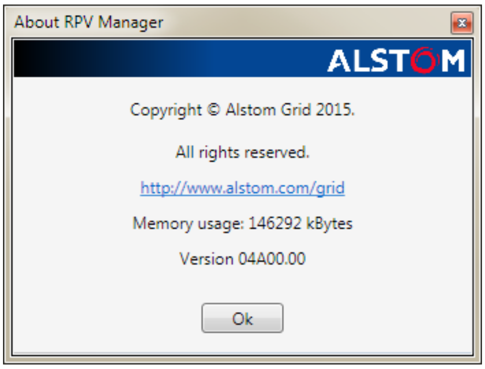


Figure 95: About window

2.3 Automatic TW Fault Location

DR Manager features an automatic TW fault location capability, where the DR Manager automatically downloads the COMTRADE registers from both line ends, calculates the fault location, displays it on the software interface and make it available via Ethernet MODBUS.

2.3.1 Description

After the fault location calculations are performed, the distance to fault is displayed on the software interface and it is made available via MODBUS communication according to the MODBUS IDs configured on the Transmission Line configuration menu and the IP address configured in the windows Ethernet properties of the DR Manager computer.

MODBUS Fault Location Transmission

Whenever a TW fault location is performed the DR Manager will provide three separate 16-bit MODBUS registers. The registers are described below:

Description	MODBUS	Observation
Register_1	30001	MODBUS identifier configured on the Transmission Line menu used to identify which transmission line the current fault location refers to.
Register_2	30002	As the fault location is split into 2x16-bit register. This register carries the LSBs (least significant bits) of the 32-bit register.
Register_3	30003	Second part of the fault location. This register carries the MSBs (most significant bits) of the 32-bit register.

In order to achieve the actual fault location, it is necessary to combine the 2 fault location registers (30002 and 30003) into a single 32-bit value. The register 30003 is a decimal representation of the 16 most significant bits of the complete 32-bit register which contains the fault location and the register 30002 is a decimal representation of the 16 least significant bits of the 32-bit register. The combination of them will result in the actual fault location in meters.
Below is the necessary operation to combine both fault location registers:

Actual fault location in meters = ((Register_2 & 0XFFFF) | (Register_3 << 16))

When consecutives fault locations are found for the same line, the DR Manager will display all the fault locations as list. And these locations are going to be sent via MODBUS with a 1-minute time interval between them.

2.3.2 Switch-on to Fault

When a short circuit occurs right after the circuit breaker closes, the behavior of the traveling waves become different from regular faults, mainly because the circuit breaker itself can create traveling waves that can be misinterpreted as traveling wave from the fault and it may turn the fault location calculation more difficult. To avoid that, the DR Manager analyses both the waveform/fault and the TW COMTRADE records to first identify that a switch-on event occurred and then to apply a special fault location algorithm. Additionally, special conditions need to be met for the switch-on to fault (SOTF) events to be located automatically:

- The fault shall be at least 6 km away from both line terminals.
- The transmission line maximum length shall be 2000 km.
- The fault location for switch-on events will not work for mixed (hybrid) lines.

- There needs to be a corresponding waveform recording for each event (Chapter 4: Configuration. 10. Fault Recorder).

Even meeting all the conditions above, SOTF events are rare and difficult to interpret automatically, thus, the DR Manager will indicate on its interface whenever an event is characterized as a switch-on so the user can be cautious and double check the recordings.

2.3.3 TW Fault Location Methods

The DR Manager uses two calculation methods for TW fault location. They are called "Basic" and "Advanced". The method used for each calculation is identified on the DR Manager interface, as shown in Figure 96. The two methods are described below:

- Basic Method

Uses a threshold configured on the Transmission Line menu, which is a percentage value of the full scale of the register, to identify the beginning of the traveling wave created by the fault and, consequently, to find its timestamp in order to use in TWFL calculations. This method uses only the high frequency COMTRADE files acquired by the RA333 units locate the fault.

- Advanced Method

This method uses both the fault register (waveform at 50/60Hz) and the TW register (high frequency register) to identify the fault location. The fault register is analyzed using a high-pass filter in order to find the time window that contains the fault begging, then that time window is used in the TW register to enhance the location of the correct time stamp for the fault. As the time window to track the fault waveform in narrow down using this method, various system noises are eliminated from the calculations increasing significantly the chances to automatically find the fault.

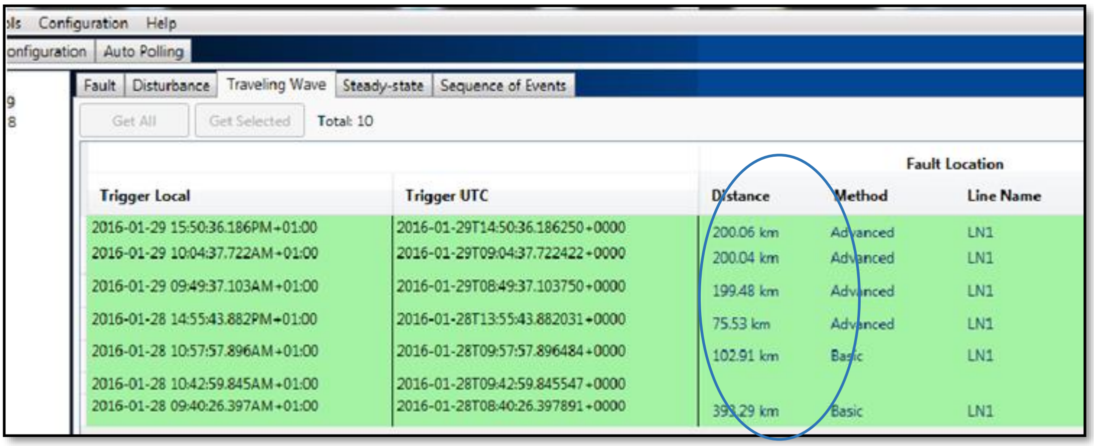


Figure 96: DR Manager TWFL methods

2.4 Polling and Refresh

2.4.1 Refresh

The equipment refresh option performs the following actions:

- Update of the list of records on the home screen;
- Updating the status of the equipment;
- Update of Alarms (Alarms tab);
- Verification of alarms for sending e-mail/fax;
- Check the settings (local and remote).

This refresh may occur in the following situations

- "Refresh" option from the equipment menu, access by right clicking on the substations equipment tree in the System Monitor. This option will update
- the data of the selected equipment;
- "Refresh All Devices", access through the File menu. This option will update all registered equipment;
- "Auto Refresh". This option will update only the information of configured equipment.

To configure the Auto Refresh:

1. For each device the the box Enable Auto Refresh on the Settings>Device menu;
2. To set the update interval change the field "Auto Refresh Interval " on the Configuration>Polling menu;
3. To activate or deactivate the Auto Refresh, access the Polling menu and choose between Manual or Auto options;
4. To ensure that the software starts with the Auto Refresh option active, check the box "Auto Polling on Init" on the Configuration>Polling menu;

The refresh action also happens during the:

- Start of application execution;
- Change in list of substations;
- Change in the equipment list.

After communication with the equipment, the software checks if any information was changed and updates the information as follows:

- Interface: System Monitor equipment tree tab and equipment lists in the other tabs;
- Database;
- Information of the Transmission Line configurations for each device;
- Name of the directory where the new records will be downloaded.

2.4.2 Polling

The polling routine is responsible for performing the automatic download of records from each equipment.

Configure the Auto Polling as follows:

1. For each equipment if you want to have Auto Polling functionality, "Enable Auto COMTRADE Download " should be enabled.
2. To set the update interval, the field "Auto Polling Interval" must be changed in the Polling configuration screen.
3. To activate or deactivate the Auto Polling, access the menu Polling Auto, to activate, and Polling > Manual, to disable.
4. To ensure that the software starts with the Auto option active Polling, select the field "Auto Polling on Init" on the Polling configuration screen
5. COMTRADES records will only be downloaded that are younger than the period entered in the field “Polling COMTRADE Acts ", in Polling configuration screen,
6. Only the types of COMTRADE records configured through the fields "Retrieve ..." in the Polling configuration screen of will be downloaded.
7. To run the fault location algorithm automatically after downloading a COMTRADE record, select the field "Automatic Fault Location", in Polling configuration screen.
8. Once everything is configured, the records will be downloaded to the directory "COMTRADE Directory "/Records.

When the Auto Polling is set to on it will run during the following occasion:

1. At system start up;
2. When closing the *Device* window.

Enable Automatic Polling by clicking the menu Polling>Auto;

If the Auto Polling is active, each time interval is set in "Auto Polling COMTRADE Interval ".

If the execution time of the Polling process exceeds the polling interval configured, the next polling procees will be ignored until the pending execution ends.

RPV311

Distributed Multifunction Fault Recorder

Chapter 14: Communications

This chapter provides detailed information about the communication options and how to configure them

1 Communication Interfaces

The RPV311 has the following communication interfaces:
Two 10/100BaseT Ethernet interfaces using RJ45 connectors (ETH 1 and ETH 2);
One 100 Mbps Ethernet interface using RJ45 connectors (Process Bus)
Two optical Ethernet interfaces (100BaseFX), using ST connectors for use with multimode fiber-optic, of an internal electric-optical Ethernet converter (optional);
A serial interface in RS232C level, using DB-9 female connector, DTE standard (Modem). This interface can be used only to communicate by Modem.

1.1 Electrical and Optical Ethernet

The RPV311 has 2 electrical 10 / 100 Mbps Ethernet interfaces for configuration, monitoring and GOOSE reading and one electrical 100 Mbps Ethernet interface for Process Bus (IEC 61850-9-2LE Sampled Values and GOOSE)
Optionally it is possible to use the double internal converter for optical Ethernet interface, making the connection between the RJ45 connector of the electrical Ethernet interface and the RJ45 connector of the internal optical Ethernet converter by using a jumper cable, and connecting the fiber-optic pair with the appropriate ST connectors.
Figure 97 shows the electrical and optical Ethernet interfaces. On the left are the interfaces for configuration, monitoring and GOOSE. On the right is the interface for Sampled Values and GOOSE reading.

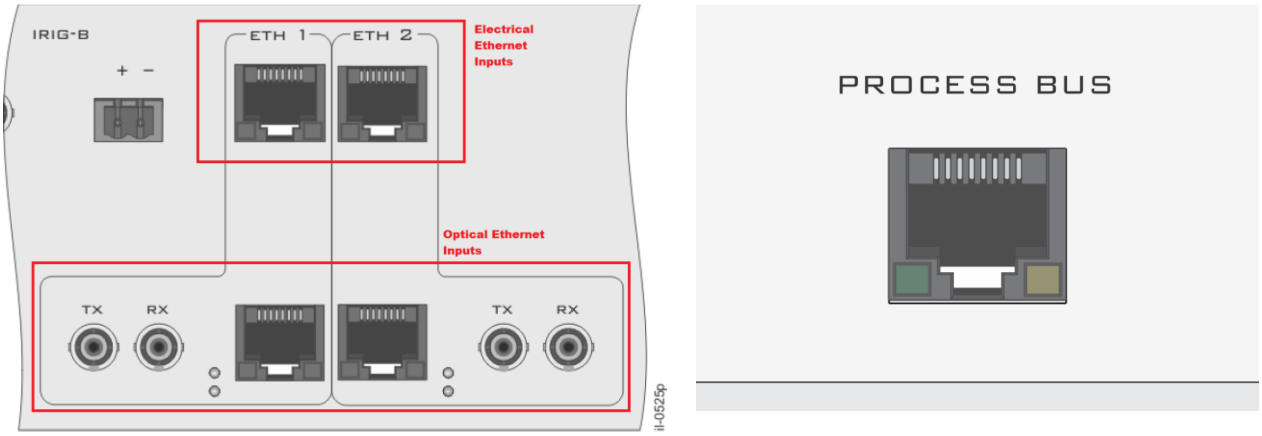


Figure 97: Electrical and optical Ethernet inputs

To minimize EMC effects, the use of fiber-optic cables is recommended for communication over distances greater than 3 m.

Ethernet Port Default Settings

The Ethernet interface default settings are:

Ethernet 1 default setting	
IP Address	192.168.0.199
Netmask	255.255.255.0
Broadcast	192.168.0.255

Ethernet 2 default setting	
IP Address	192.168.1.199
Netmask	255.255.255.0
Broadcast	192.168.1.255

Gateway default setting

Gateway	192.168.0.1

1.2 Serial Port

The RPV311 has a serial communication port, shown in Figure 98, for connection through modem, which can be used to transfer records. The port can be configured by the user through the Web Interface.

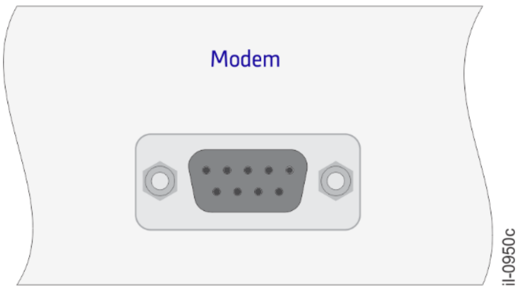


Figure 98: Serial communication port

Although the serial port is compatible with the RS232, the pinout is not according to the standard and rather it follows the specification below:

DB9-Female	Signal
5	DCD
4	RX
3	TX
2	DTR
1	GND
9	DSR
8	RTS
7	CTS
6	Not used

In order to convert the RPV311 pinout to standard RS232 pinout, the user shall use a cable or adapter with the following pinout specification:

DB9 Male	DB9 Male
1	5
2	4
3	3
4	2
5	1
6	9
7	8
8	7
9	6

2 Communication Ports and Protocols

To guarantee the full permission for communication equipment via Ethernet, it is necessary that the following ports and protocols are freed:

Port	Protocol	Use
22	TCP / IP	Remote record download, automatic record upload, firmware upgrade, remote diagnostics and maintenance.

80	TCP / IP	Interface Web remote access.
123	UDP	Time-of-day synchronism over SNTP
4041	TCP / IP	Real-time monitoring using Web interface.
	UDP	Cross-trigger
4042	TCP / IP	Manual Trigger
4713 4714 4715 4716	UDP/IP	Synchrophasors data streams
502	TCP	MODBUS interface
20000	TCP / IP	DNP3 interface
	UDP	DNP3 interface

3 Communication Using the Electrical Ethernet Port

To connect to the RPV311 locally or through Ethernet switches, it is necessary that the device and the computer be on the same network. To achieve this, configure the network connection of the computer according to the IP address, Broadcast and Netmask of the equipment, as shown below:
Given the following IP address, broadcast and netmask of the RPV311:

IP address, broadcast and netmask of the RPV311	
IP Address	192.168.0.199
Netmask	255.255.255.0
Broadcast	192.168.0.255

Set the local connection as follows:

IP address, broadcast and netmask of the local connection	
IP Address	192.168.0.190
Netmask	255.255.255.0

Broadcast	192.168.0.255

If the equipment is not with the default IP settings, see Chapter 5: Operation to see how to check the current IP address.
After connecting the equipment with the computer, see Chapter 4: Configuration for details about equipment access.

Note:

Process Bus Ethernet port is used only to receive data of merging units (Sampled Values measured on monitored Power System). It is not possible to communicate to this RPV311 using that Ethernet port for s their purposes.

3.1 Checking the Connection

In order to verify whether the equipment connection is correctly set up, connect a *crossover* network cable between the computer and the equipment and, using a command line terminal, run a *ping* command to the IP address of the equipment.

4 Communication Through Network Using the Serial Port

Communication via modem is a Dial-in access method, but in cases of automatic connection via modem, the connection is permanent and is automatically started by the equipment.
For communication through network using the serial port, it is first necessary to make a pre-configuration of the computer, as following:

1. Access the Control Panel of the computer;
2. On the Control Panel, access the Network Connection icon, and then access File > New Connection > Connect to Internet;
3. Select the Set up my connection manually check box and then, click on the <Next> button;
4. Select the Connect using a dial-up modem check box and then, click on the <Next> button;
5. Insert a connection name and click on the <Next> button;
6. Insert a phone number to dial and click on the <Next> button;
7. Enter a username and password. The default username and password to connect via modem, that cannot be changed by the user, are:
8.

Default username and password to connect via modem	
Username	PQFW

Password	PQFW

1. Then, click on the <Finish> button to end the configuration.

To access the Web Interface of the RPV-311, verify the Server IP Address of the connection properties and then, enter this IP address in the web browser.

Application to Access the Equipment

The equipment can be accessed through the Web Interface using a web browser. Please note that some applications may need to be installed and the minimum computer requirements should be met.

5 Accessing the Equipment

Enter the equipment IP via a web browser. If the Flash Player 9.0 plug in or higher is not previously installed on the computer, it will be automatically installed by the operating system.
For details about the Web Interface, refer to Chapter 5: Operation.

5.1 Computer Support Applications

Internet Explorer version 7 or higher, or Mozilla Firefox version 3.0 or higher;
Adobe Flash Player 9.0 or higher.

The support applications can be obtained on the Internet.

5.2 Minimum Computer Requirements

1GHz processor or higher;
512 MBytes RAM;
500 MBytes free disk space;
Super VGA 1024 x 768 video card.

5.3 Communication Configuration

It is possible to configure the communication ports (Ethernet, Gateway and Modem) of the RPV311 in the Web Interface. For communication configuration details, refer to Chapter 4: Configuration.

5.4 Auto Upload

When any new record is generated, it can be transmitted to up to two different servers automatically. When using the configuration interface, each destination IP address should be entered, along with the designated record type.

If at the upload time the server is not available or the network is unreadable, the record will not be transmitted. Within such case, it is always advisable to use the application Scanner or the DR Manager to

For further Scanner application information see Chapter 12: Software – RPV Tools.

For further DR Manager application information seeChapter 13: Software – DR Manager.

For auto upload configuration details, see Chapter 4: Configuration.

RPV311

Distributed Multifunction Fault Recorder

Chapter 15: Installation

This chapter provides information about the product installation.

1 Handling the Goods

Our products are of robust construction but require careful treatment before installation on site. This section discusses the requirements for receiving and unpacking the goods, as well as associated considerations regarding product care and personal safety.

Before lifting or moving the equipment you should be familiar with the Safety Information chapter of this manual.

1.1 Receipt of the Goods

On receipt, ensure the correct product has been delivered. Unpack the product immediately to ensure there has been no external damage in transit. If the product has been damaged, make a claim to the transport contractor and notify us promptly.
For products not intended for immediate installation, repack them in their original delivery packaging.

1.2 Unpacking the Goods

When unpacking and installing the product, take care not to damage any of the parts and make sure that additional components are not accidentally left in the packing or lost. Do not discard any CDROMs or technical documentation. These should accompany the unit to its destination substation and put in a dedicated place.
The site should be well lit to aid inspection, clean, dry and reasonably free from dust and excessive vibration. This particularly applies where installation is being carried out at the same time as construction work.

1.3 Storing the Goods

If the unit is not installed immediately, store it in a place free from dust and moisture in its original packaging. Keep any de-humidifier bags included in the packing. The de-humidifier crystals lose their efficiency if the bag is exposed to ambient conditions. Restore the crystals before replacing it in the carton. Ideally regeneration should be carried out in a ventilating, circulating oven at about 115°C. Bags should be placed on flat racks and spaced to allow circulation around them. The time taken for regeneration will depend on the size of the bag. If a ventilating, circulating oven is not available, when using an ordinary oven, open the door on a regular basis to let out the steam given off by the regenerating silica gel.

On subsequent unpacking, make sure that any dust on the carton does not fall inside. Avoid storing in locations of high humidity. In locations of high humidity the packaging may become impregnated with moisture and the de-humidifier crystals will lose their efficiency.

The device can be stored between –25º to +70ºC for unlimited periods or between -40°C to + 85°C for up to 96 hours (see technical specifications).

1.4 Dismantling the Goods

If you need to dismantle the device, always observe standard ESD (Electrostatic Discharge) precautions. The minimum precautions to be followed are as follows:

Use an antistatic wrist band earthed to a suitable earthing point.

Avoid touching the electronic components and PCBs.

2 Normal Use of the Equipment

In order to maintain the equipment integrity, levels of protection and assure user safety, the RPV311 and RA33x shall be installed in an enclosed panel with recommended ingress protection rating of IP42 or above. The Reason range of equipment shall be kept in an environment where their rear connection and sides are protected against impact and water. The enclosing panel shall ensure that the equipment rear connections are not exposed, meanwhile maintaining adequate temperature and humidity condition for the devices. Furthermore, the equipment shall have all their rear connectors attached, even if not being used, in order to keep their levels of ingress protection as high as possible.

The RPV311 and RA33x modules are IEC 61010-1 rated at Installation/Overvoltage Category II and Pollution Degree 3. These ratings allow mounting of the equipment indoors or in an outdoor (extended) enclosure where the equipment is protected against exposure to direct sunlight, precipitation, and full wind pressure.

During the normal use of the device only its the frontal panel shall be accessible.

3 Mounting the Device

3.1 RPV311 Mechanical Installation

The RPV311 must be installed in a 19-inch rack.

The RPV311 must be installed at least 10 cm away from any other equipment to avoid obstruction of air circulation impairing the cooling efficiency.

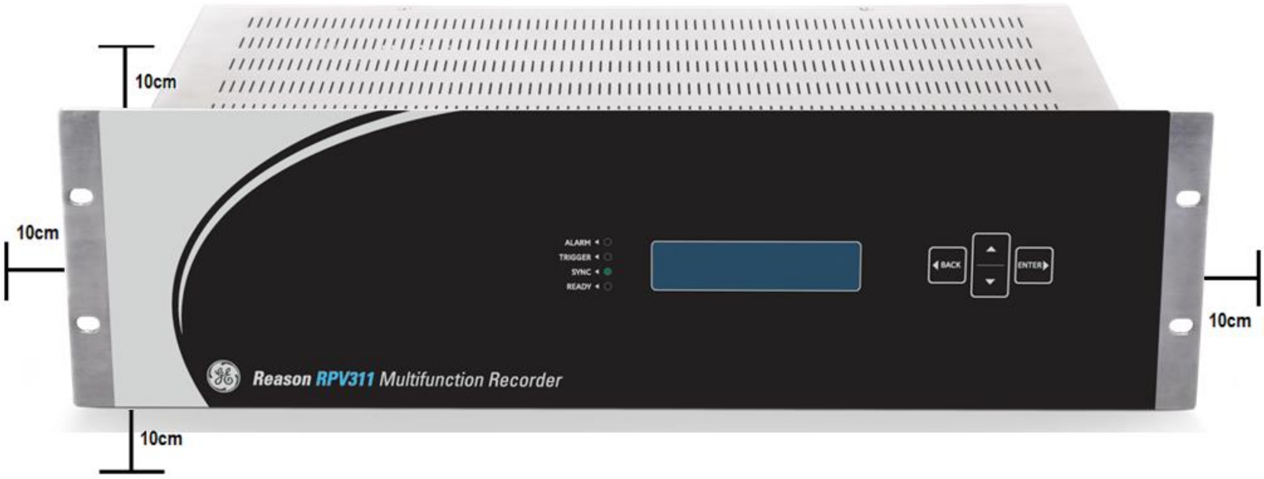


Figure 99: Minimum distances for the equipment mounting

The screws for fixing the equipment are of the M6 type.
The curvature of fiber-optic connected to the back of the equipment must have a minimum radius of 30 mm.
The fixing screws are not included in the product order.

3.2 RA331, RA332 and RA333 Mechanical Installation

To install the module in the panel, make a cut with the drilling and dimensions described in Section 22.1. The screws used for fixation are of the M6 type.
It is possible to order an optional panel for installation of one or two modules adapted to a 19-inch rack.
To install either a single or two modules of RA331, RA332 or RA333 it is available for ordering the optional panels presented below. The screws used for fixing are of the M6 type.

3.2.1 Panel for Installation of Two Remote Acquisition Modules (Q61)

The Mounting panel to install two remote acquisition modules (RA331/332) in a 19-inch rack is shown in Figure 100.

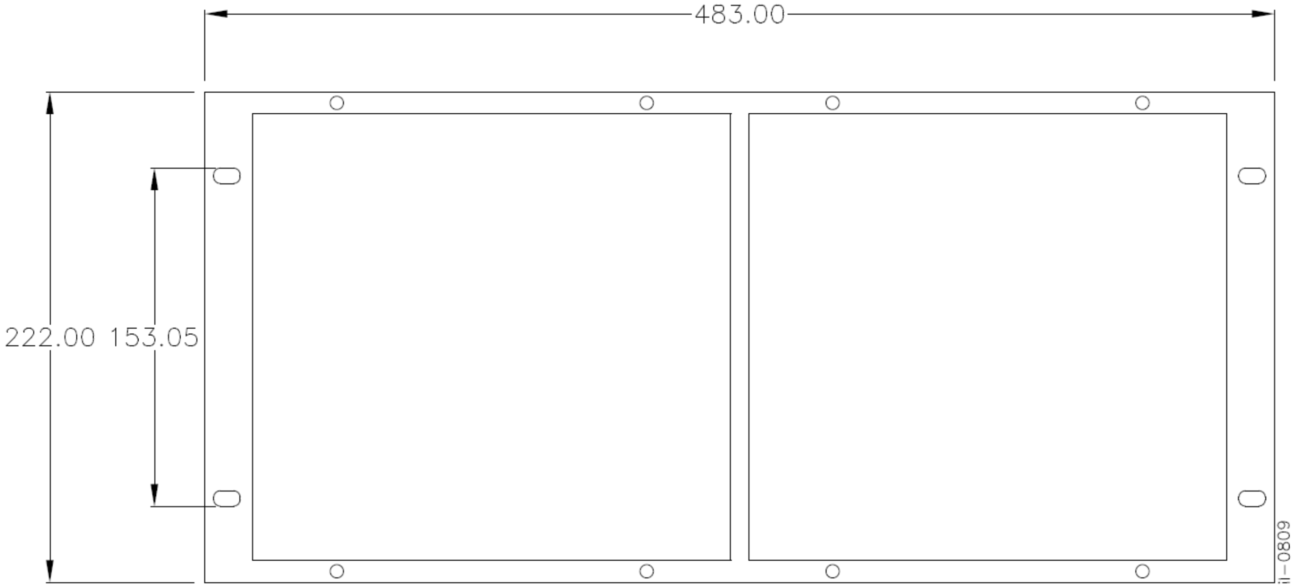


Figure 100: Mounting panel to install two remote acquisition modules (RA331/332) in a 19-inch rack

4 Cables and Connectors

This section describes the type of wiring and connections that should be used when installing the device. For pin-out details please refer to the Hardware Design chapter or the wiring diagrams.

⚠ Before carrying out any work on the equipment you should be familiar with the Safety Section and the ratings on the equipment's rating label.

⚠ The connections: Console1, Console2, MODEM and Process bus are non-isolated and for local connection only.

5 Power Supply Connections

The RPV311, RA331, RA332 and RA333 can be powered-up by DC or AC power source within the limits specified in Chapter 17: Technical Specifications.

The power connections shall use insulated flexible conductors anti-flame (BWF type) with 1.5 mm² section, thermal class 70 °C and isolation voltage of 750 V.

To reduce risk of electrical shock, pre-insulated pin terminals, as shown in Figure 101, should be used on the ends of the power connections.

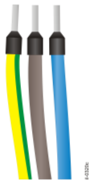


Figure 101: Pre-insulated tubular pin terminals

The pin terminals should be completely inserted into the header connector supplied with the unit so that no metallic parts are exposed, as shown in Figure 102.

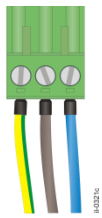


Figure 102: Header connector assembly

A safety ground lead shall be connected to the terminal marked with the functional earth symbol.
For better electromagnetic compatibility, ground the unit using a 10 mm (0.4 in) wide grounding strap to connect the back panel of the unit to a good grounding point on the mounting rack.

Models with a low DC power supply must be supplied with a DC supply source to the equipment that is derived from a secondary circuit which is isolated from the AC/DC Mains by Double or Reinforced Insulation (e.g.: UL Certified ITE power supply which provides Double or Reinforced Insulation).

6 RPV311 AC and DC Power Connection

Figure 103 show the wiring diagram for the AC and DC of the RPV311 respectively.

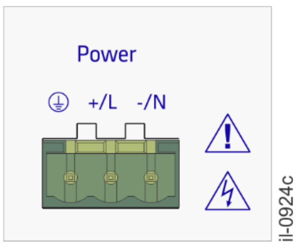


Figure 103: AC/DC power connection

For compliance with IEC 61010, install a suitable external switch or circuit breaker in each current-carrying conductor of RPV311 power supply; this device should interrupt both the hot (+/L) and neutral (-/N) power leads. An external 10 A, category C, bipolar circuit-breaker is recommended. The circuit breaker should have an interruption capacity of at least 25 kA and comply with IEC 60947-1 and IEC 60947-3. The switch or circuit-breaker must be suitably located and easily reachable, also it shall not interrupt the protective earth conductor.
Information about nominal voltage range, maximum voltage range, frequency and power consumption, refer to Specifications Chapter 17: Technical Specifications.

7 RA331, RA332 and RA333 AC and DC Power Connection

Figure 104 show the wiring diagram for the AC and DC of the RA331, RA332 and RA333 respectively.

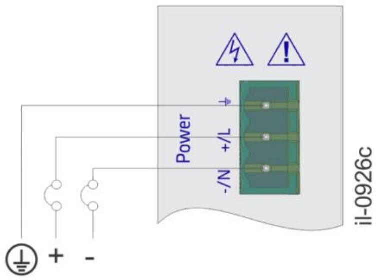


Figure 104: AC/DC power connection

For compliance with IEC 61010, install a suitable external switch or circuit breaker in each current-carrying conductor of RA33x power supply; this device should interrupt both the hot (+/L) and neutral (-/N) power leads. An external 10 A, category C, bipolar circuit-breaker is recommended. The circuit breaker should have an interruption capacity of at least 25 kA and comply with IEC 60947-1 and IEC 60947-3. The switch or circuit-breaker must be suitably located and easily reachable, also it shall not interrupt the protective earth conductor.
For information about nominal voltage range, maximum voltage range, frequency and power consumption, see Section 2.9 of the Specifications Chapter.

8 Powering Up

8.1.1 RPV311

Do not operate the unit without the safety ground connection in place;
Connect power cable (including safety grounding) to the unit;

A self-test will be executed and at the end, if no configuration has been sent, the READY indicator on the front panel will light up;

If any pair of optical fibers has already been connected to the acquisition module, the ACT indicator will light up, indicating that there is communication between the modules;

If the module does not work as described, carefully check all power and signal connections. Refer to Chapter 16: Maintenance and Troubleshooting for troubleshooting guide;

To turn off the module, switch off the external switch or circuit breaker. All indicators will be off.

8.1.2 RA331, RA332 and RA333

Do not operate the module without the safety ground connection in place;

Connect power cable (including safety grounding) to the module. The Mains indicator on the front and back panel will light immediately;

A self-test will be executed and the Ready indicators on the front and back panels will light up when the process has ended;

If a pair of fiber-optics have already been connected to the processing unit, the Link indicator will light up, indicating that there is a communication between the modules;

If the module does not work as described, carefully check all power and signal connections. Refer to Chapter 16: Maintenance and Troubleshooting for troubleshooting guide;

To turn off the module, switch off the external switch or circuit breaker. All indicators on the front and the back panels will be off.

9 Earth Connection

To ensure proper operation of the equipment under adverse conditions of electromagnetic compatibility, connect the equipment protective earth terminal to the panel using a copper strap of at least 10 mm wide with M6 ring lug. As shown in the Figure 105.

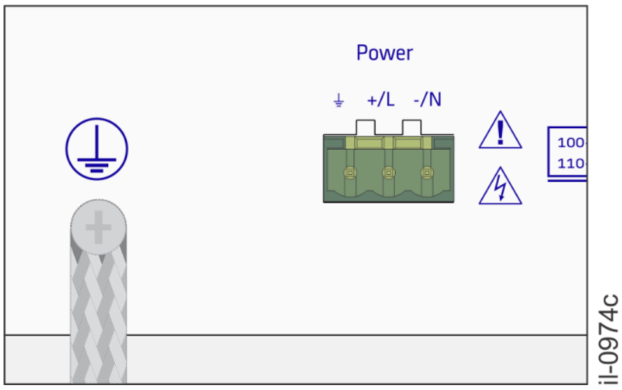


Figure 105: RPV311 Grounding

9.1.1 RA33x Earthing

To ensure proper operation of the equipment under adverse conditions of electromagnetic compatibility, connect the equipment protective earth terminal to the panel using a copper strap of at least 10 mm wide with M6 ring lug. As shown in the Figure 106.

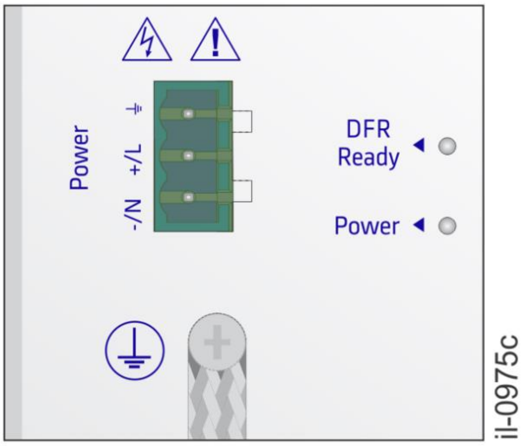


Figure 106: RA33X Grounding

10 Connection Between RPV311 and RA331, RA332 or RA333

The RPV311 can process a maximum number of 64 analogue channels that can be achieved using 8 acquisition modules.

The RPV311 processing unit allows connection with up to 8 RA331 acquisition modules, up to 4 RA332 acquisition modules or up to 4 RA333 acquisition modules respecting the maximum quantity of 64 analog channels. That is: when it is using only RA332, it is possible to install a maximum of 4 modules with 16 analog inputs each, and when it is using only RA331, it is possible to install up to 8 modules with 8 analog inputs each. When it is using only RA333, it is possible to install a maximum of 4 modules with 8 analog and 3 TW inputs each one (each TW board counts as 8 analogue channels). The RA331, RA332, and RA333 can be connected to the same RPV311 processing module.

Each link on the RPV311, composed of a pair of fiber-optic connectors, is named from A to H. For each link, an optical fibers pair is used to make transmission and reception of data between the processing module and the acquisition modules. Connections with acquisition modules must be made according to the sequence of RPV311 identification: the first connection should be made with link A, the second, with link B, and so forth.

On the RPV311, each link has an ACT indicator, as shown in Figure 107, which lights up when the link is receiving data of the acquisition module.

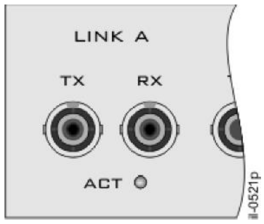


Figure 107: RPV311 Fiber Optic Connectors

The RA331 and RA332 modules each occupy one physical link of the processing module. The RA333 occupies two physical links of the processing module, one for data transmission of analog channels (DFR) and the other for data transmission of TW channels (TW).

On the RA331, RA332 and RA333 (TW and DFR) modules, each link has an indicator showing the state of the connection with the processing module, as shown in **Figure 108**. These indicators, LINK and ACT, on the front panel and back panel, respectively, light up when the link is active (i.e. it is receiving requests of the processing module).

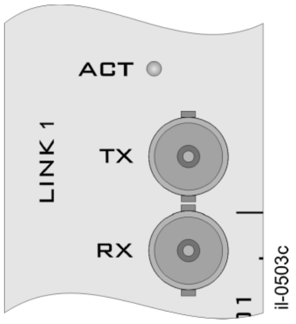


Figure 108: RA331, RA332 and RA333 fiber optic connectors

The connectors are identified as RX for receiving data and TX for transmitting data. The corresponding fibers must be linked to the acquisition module so that the TX of RPV311 is connected to the RX of the RA331, RA332, or RA333 and RX of RPV311 is connected to the TX of the RA331, RA332, or RA333, according to **Figure 109**.

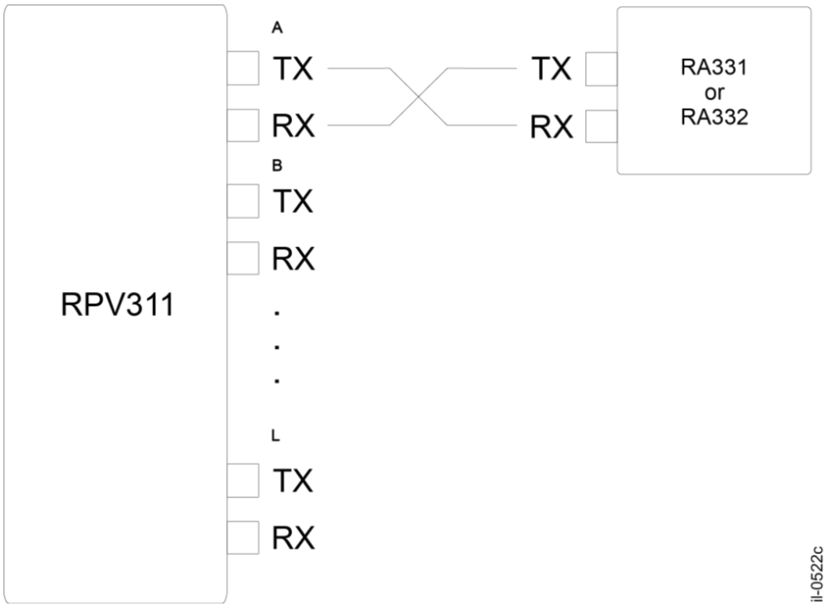


Figure 109: Connection between RPV311 and the RA331, RA332 or RA333

The length of the fiber-optic cables shall not exceed 2 km.
Make sure to use the appropriate optical fiber, considering its curvature radius.
For information about optical fiber types and link specifications, see Chapter 17: Technical Specifications.
When more than one RA333 module is required, an internal module jumper must be configured, according to the TW link position. The position of links does not have to be consecutive, but module installation related to A to H position must match the jumper identification. For example, ID 0 must be the first RA333 (TW) link, ID 1 must be the second RA333 (TW) link, and so on.
In order to configure these jumpers, remove all connectors and cables which are connected to the module and remove the back panel of the RA333 removing the 12 screws of the panel and the screw of the protective grounding, as shown in **Figure 110**.

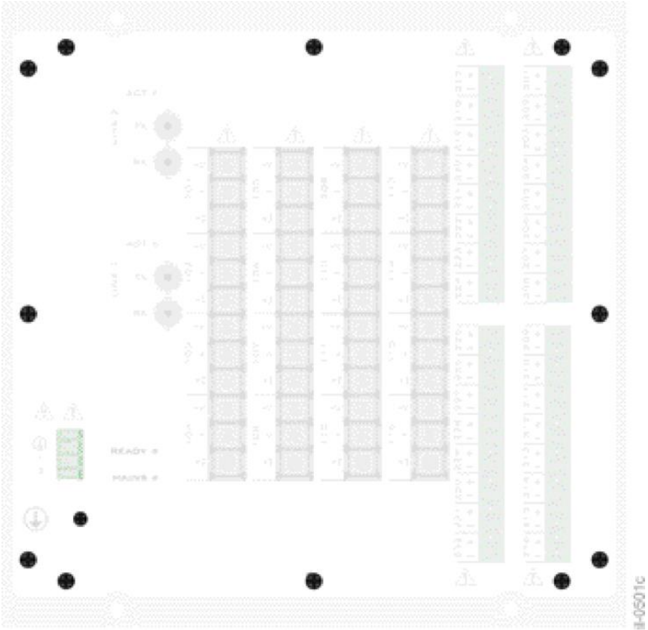


Figure 110: Screws of the Back Panel

Remove the QTW board, which corresponds to the traveling waves acquisition board. Configure jumper identification as shown at table 4.1, according to the RA333 TW link positions.

JP4	JP3	ID
Open	Open	0
Closed	Open	1
Open	Closed	2
Closed	Closed	3

Re-fit the board in the case until perfectly connected.
Secure the case by screwing the back panel and connecting the terminal cables.

11 Analog Voltage Inputs (50/60 Hz)

The RA331, RA332, and RA333 modules have up to 8, 16 or 8 analog inputs, respectively, which can be configured for measurement of voltage. All channels are identified of 101 to 108 for the RA331 and RA333, and 101 to 116 for the RA332. Each analog input has three terminals: positive voltage, positive current and negative terminal, which are used for the current and for the voltage, as shown in **Figure 111**To define if the driver will measure voltage, it is necessary to select an internal jumper in the module. The binary and analog inputs are galvanically isolated.

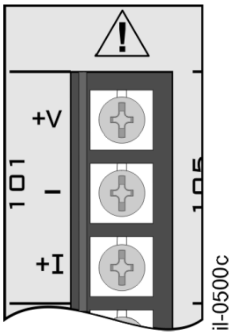


Figure 111: Analog input terminals

In order to configure the analog input to measure voltage signals, remove all connectors and cables which are connected to the module and remove the back panel of the RA331, RA332, or RA333 removing the 12 screws of the panel and the screw of the protective grounding, as shown in Figure 112.

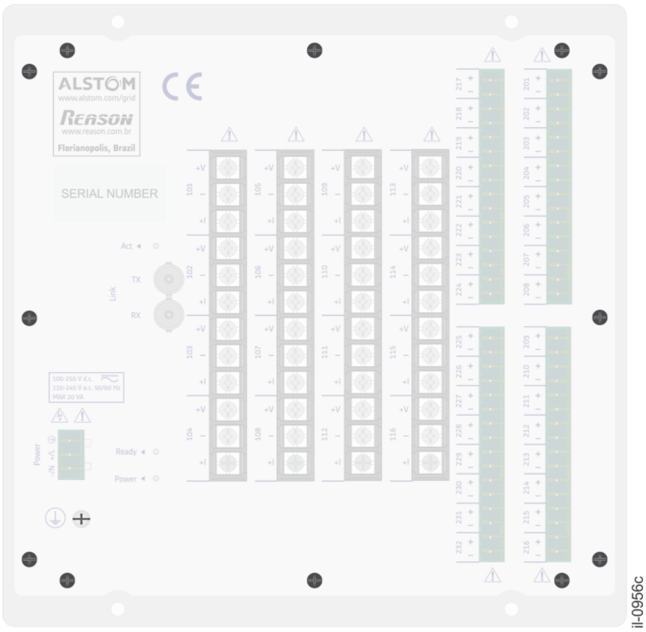


Figure 112: Screws of the Back Panel

Remove the board corresponding to the channel to be configured. In order to configure a channel for voltage, connect the jumper between positions 1 and 2 as shown in **Figure 113**.

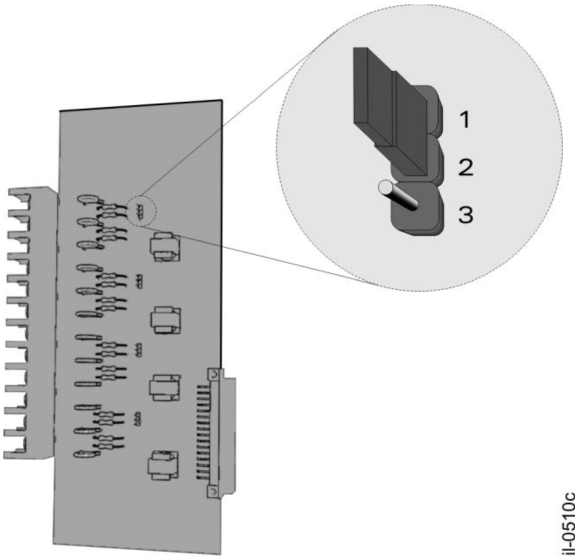
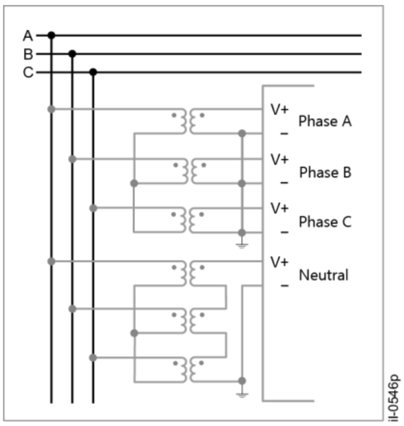


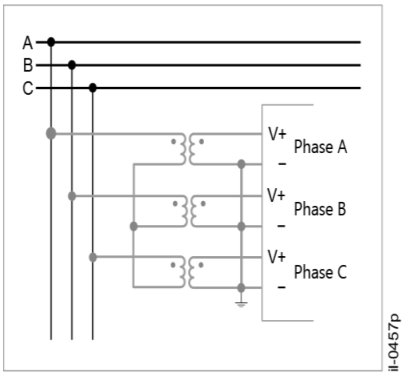
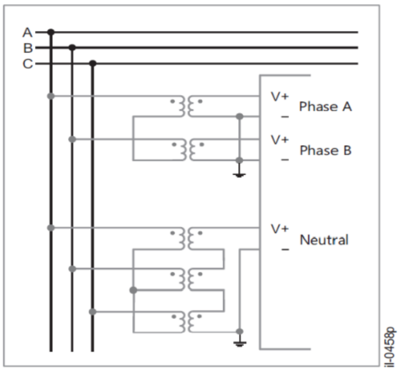
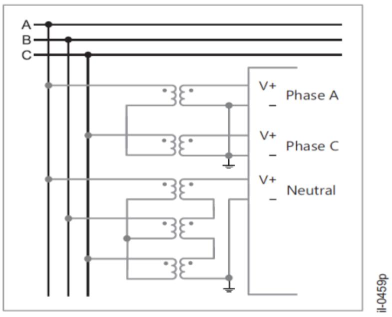
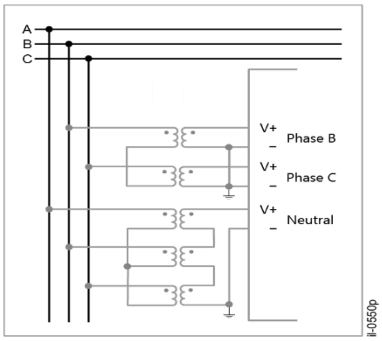
Figure 113: Internal Jumper

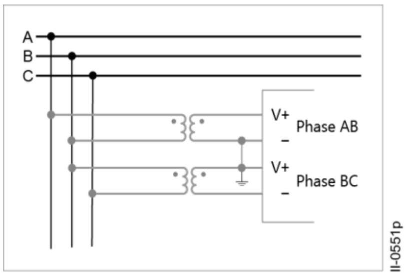
Place the board back in the case.
Secure the case by screwing the back panel and connecting the terminal cables.
Connections shall use insulated flexible wires of 1.5 mm² cross section, 8 mm ring terminals, and M3 holes.
Before making the electrical connection, make sure the signal is applied in accordance with the technical specifications of the equipment. For information about analog voltage inputs specifications, see Chapter 17: Technical Specifications.

11.1.1 Connection diagram of the voltage inputs

The RPV311 provides the capability for making some different voltage signal connections for a 3-phase circuit:

Connection diagram of the voltage inputs	
4-element connection: in this case, the values shown are equivalent to the voltages of phases A, B and C, and to the neutral voltage applied to the equipment.	

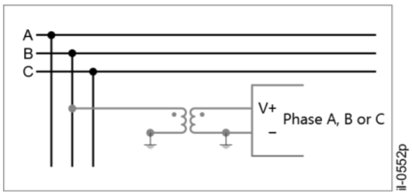
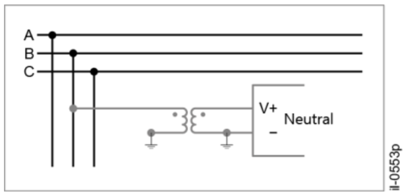
3-element (Phases A, B and C) connection: in this case, the fourth element is derived of the values measured by the other elements. The three elements are equivalent to the values applied to the equipment	
3-element (Phases A, B and neutral) connection: in this case, the fourth element is synthesized of the values measured by the other elements. The three elements are equivalent to the values applied to the equipment.	
3-element (Phases A, C and neutral) connection: in this case, the fourth element is derived of the values measured by the other elements. The three elements are equivalent to the values applied to the equipment.	
3-element (Phases B, C and neutral) connection: in this case, the fourth element is derived of the values measured by the other elements. The three elements are equivalent to the values applied to the equipment.	

2-element connection: in this case, the neutral voltage is zero, and the three phase-to-ground voltage are computed based on the two line-to-line voltages applied to the equipment.	

In circuits of one element, the measurements can be in two different ways:

An isolated phase or neutral measurement: If the element is a phase, only the voltage related to this channel is measured considering the off-set compensation. If the element is a neutral, the voltage related to this channel is measured without the off-set compensation.

A 3-Phase synthesis: The magnitude for the 3-phases is considered with the same value as that of the channel measured and balanced (i.e., angles with 120º between each other).

Connection diagram for 1 voltage element connection	
1-element connection: Connection diagram of 1 element (phase A, B or C).	
1-element connection: Connection diagram of 1 element (neutral).	

In all cases, the equipment will compute the phase-to-ground voltage and the neutral voltage.

12 High-speed Analog Voltage Inputs (TW)

The RA333 module has 3 high-speed analog inputs for measurement of TW voltage, with a sampling frequency of 5 MHz. All channels are identified from 301 to 303.

Each analog input has two terminals: positive voltage, and negative, which are used for one phase voltage, as shown in Figure 114. The binary and analog inputs are galvanically isolated.

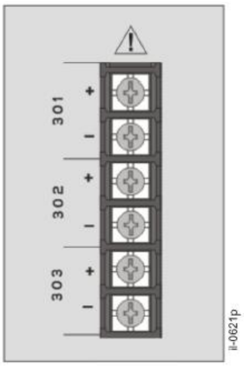


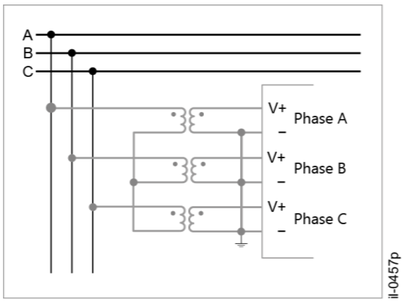
Figure 114: Analog Input Terminals to TW Measurement

Connections shall use insulated flexible wires of 1.5 mm² cross section, 8 mm ring terminals, and M3 holes.

Before making the electrical connection, make sure the signal is applied in accordance with the technical specifications of the equipment. For information about analog voltage inputs specifications, refer to Chapter 17: Technical Specifications.

12.1.1 Connection diagram of the TW inputs

The RPV311 provides the capability for connecting one 3-phase circuit (phases A, B, and C):

Connection diagram for TW inputs	
3-element (Phases A, B and C) connection: in this case, the three elements are equivalent to the values of TW voltage.	

13 Analog Current Inputs

The RA331, RA332, and RA333 modules have up to 8, 16 or 8 analog inputs, respectively, which can be configured for measurement of current. All channels are identified of 101 to 108 for the RA331 and RA333, and 101 to 116 for the RA332. Each analog input has three terminals: positive voltage, positive current and negative terminal, which are used for the current and for the voltage, as shown in Figure 115. To define if the driver will measure current, it is necessary to select an internal jumper in the module. The binary and analog inputs are galvanically isolated.

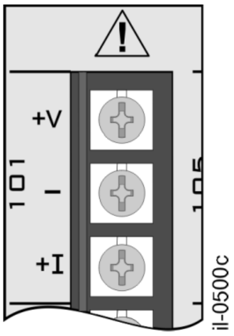


Figure 115: Analog Input Terminals

In order to configure the analog input to measure current signals, remove all connectors and cables which are connected to the module and remove the back panel of the RA331, RA332 or RA333, removing the 12 screws of the panel and the screw of the protective grounding, as shown in **Figure 116**

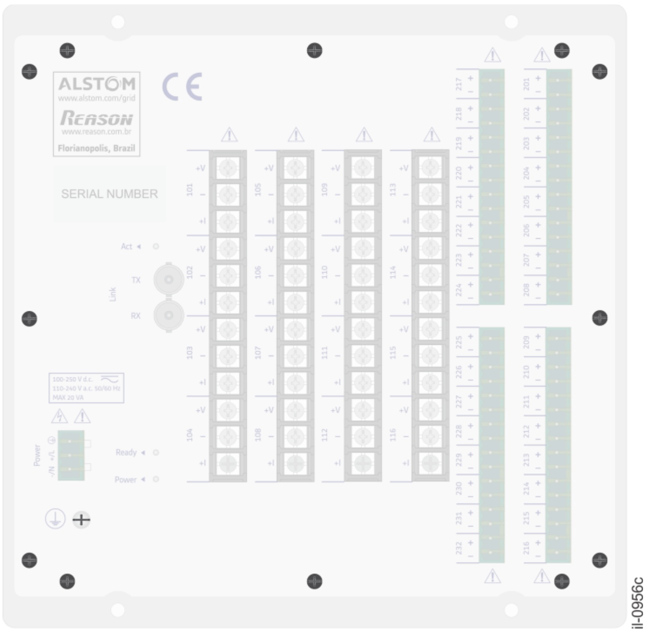


Figure 116: Screws of the Back Panel

Remove the board corresponding to the channel to be configured. For each channel to be configured for current, connect the jumper between positions 2 and 3 as shown in **Figure 117**.

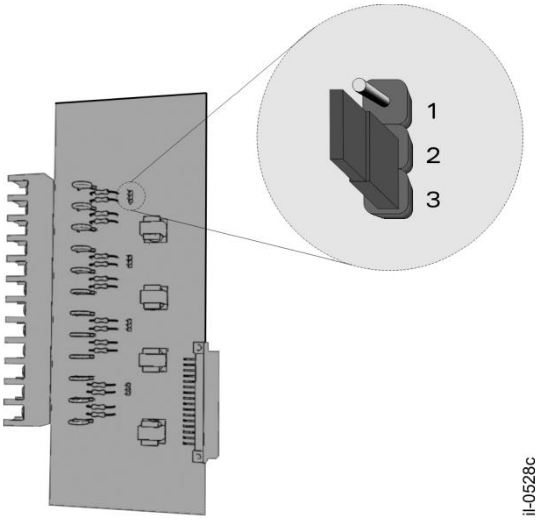
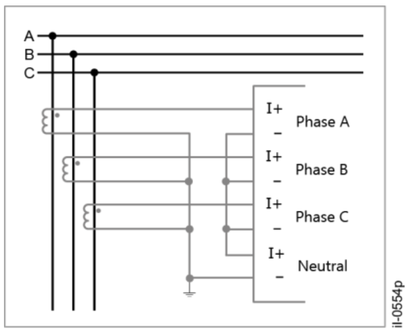


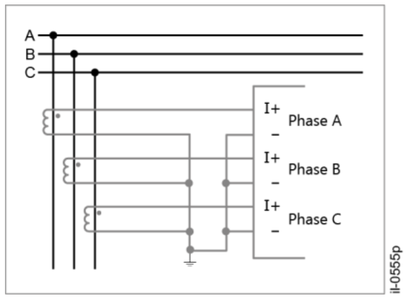
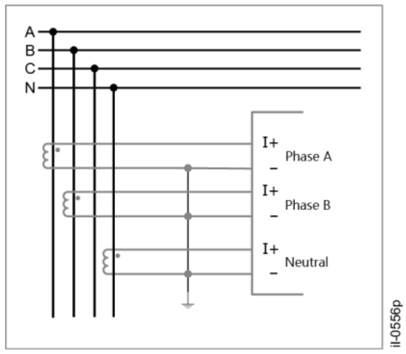
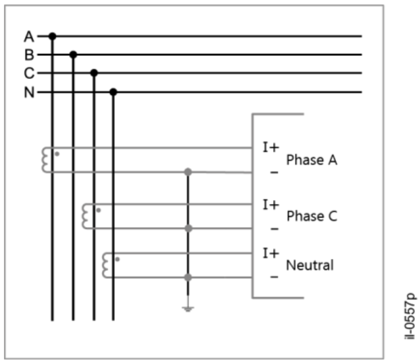
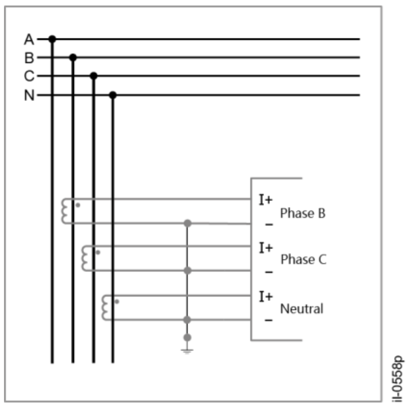
Figure 117: Internal Jumper

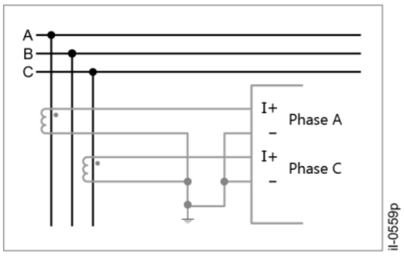
Place the board back in the case.
Secure the case by screwing the back panel and connecting the terminals cables.
Connections shall use insulated flexible wires of 1.5 mm² cross section, 8 mm ring terminal, and M3 holes.
Before making the electrical connection, make sure the signal is applied in accordance with the technical specifications of the equipment. For information about analog current inputs specifications, see Chapter 17: Technical Specifications.

13.1.1 Connection diagram of the current inputs

The RPV311 provides the capability for connecting some different current signal connections for a 3-phase circuit:

Connection diagram of the current inputs	
4-element connection: in this case, the values shown are equivalent to the voltages of phases A, B and C, and to the neutral voltage applied to the equipment.	

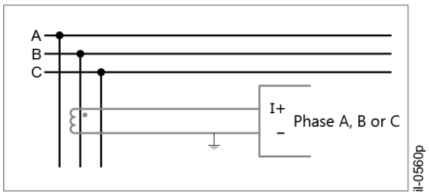
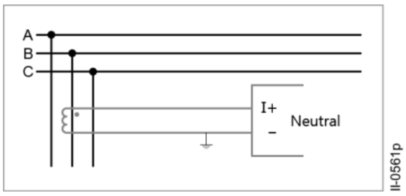
3-element (Phases A, B and C) connection: in this case, the fourth element is derived of the values measured by the other elements. The three elements are equivalent to the values applied to the equipment	
3-element (Phases A, B and neutral) connection: in this case, the fourth element is derived of the values measured by the other elements. The three elements are equivalent to the values applied to the equipment.	
3-element (Phases A, C and neutral) connection: in this case, the fourth element is derived of the values measured by the other elements. The three elements are equivalent to the values applied to the equipment.	
3-element (Phases B, C and neutral) connection: in this case, the fourth element is derived of the values measured by the other elements. The three elements are equivalent to the values applied to the equipment.	

2-element connection: in this case, the neutral voltage is zero, and the three phase-to-ground voltage are computed based on the two line-to-line voltages applied to the equipment	

In circuits of 1 element, the measurements can be in two different ways:

An isolated phase or neutral measurement: If the element is a phase, only the current related to this channel is measured considering the off-set compensation. If the element is a neutral, the current related to this channel is measured without the off-set compensation.

A 3-Phase synthesis: The magnitude for the 3-phases is considered with the same value as that of the channel measured and balanced (i.e., angles with 120º between each other).

Connection diagram for 1 current element connection	
1-element connection: Connection diagram of 1 element (phase A, B or C).	
1-element connection: Connection diagram of 1 element (neutral).	

In all cases, the equipment will compute the line current and the neutral current.

14 Analog DC Transducer Inputs ± 10 V

The RA331, RA332 and RA333 modules have up to 8, 16 or 8 analog inputs, respectively, which can be configured for measurement of voltages of DC transducers of -10 V to +10 V. All channels are identified of 101 to 108 for the RA331 and RA333, and 101 to 116 for the RA332.

Each analog input has three terminals: positive voltage, positive current and negative terminal which are used for the current and for the voltage, as shown in Figure 118. To define if the driver will measure voltage of a DC transducer it is necessary to select an internal jumper in the module. The binary and analog inputs are galvanically isolated.

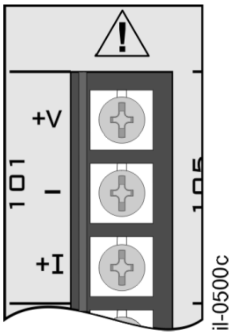


Figure 118: Analog Input Terminals

In order to configure the analog input to measure voltage signals of DC transducers, remove all connectors and cables which are connected to the module and remove the back panel of the RA331, RA332 or RA333, removing the 12 screws of the panel and the screw of the protective grounding, as shown in **Figure 119**.
The fixing screws are not included in the product order.

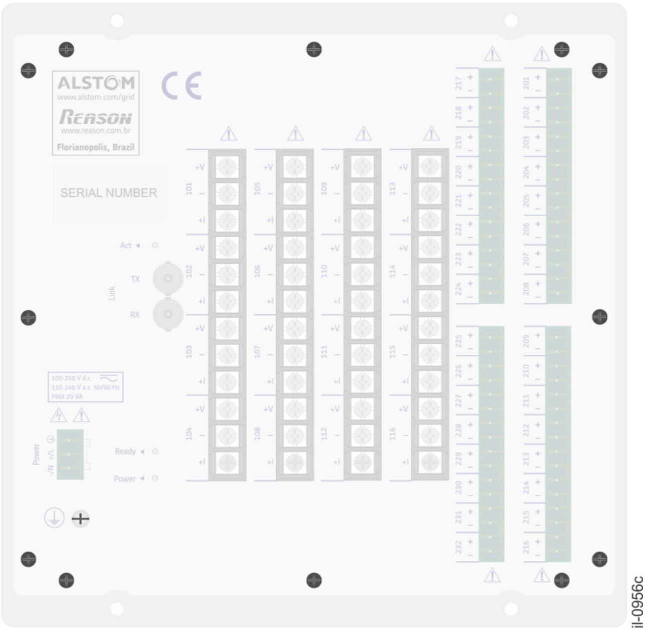


Figure 119: Screws of the Back Panel

Remove the board corresponding to the channel to be configured. For each channel to be configured to DC transducers of ± 10 V, connect the jumper between positions 1 and 2 as shown in **Figure 120**.

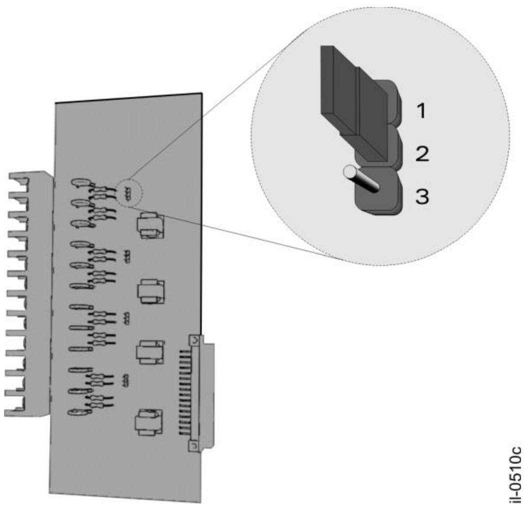


Figure 120: Internal Jumper

Place the board back in the case.
Secure the case by screwing the back panel and connecting the terminals cables.
Connections shall use insulated flexible wires of 1.5 mm² cross section, 8 mm ring terminals, and M3 holes.
Before making the electrical connection, make sure the signal is applied in accordance with the technical specifications of the equipment. For information about DC transducer inputs specifications, see Chapter 17: Technical Specifications.

14.1.1 Connection diagram of the DC transducer inputs of ± 10 V

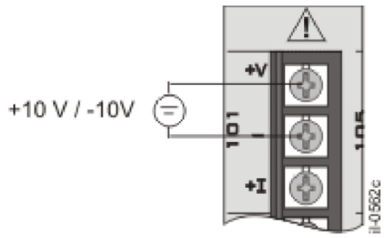


Figure 121: Connection Diagram of DC Transducer Inputs ± 10 V

15 Analog DC Transducer Inputs ± 20 mA

The RA331, RA332, and RA333 modules have up to 8, 16, or 8 analog inputs, respectively, which can be configured for measurement of currents of DC transducers of -20 mA to 20 mA. All channels are identified of 101 to 108 for the RA331 and RA333, and 101 to 116 for the RA332.
Each analog input has three terminals: positive voltage, positive current and negative terminal which are used for the current and for the voltage, as shown in **Figure 122**.
To define if the driver will measure current of a DC transducer it is necessary to select an internal jumper in the module. The binary and analog inputs are galvanically isolated.

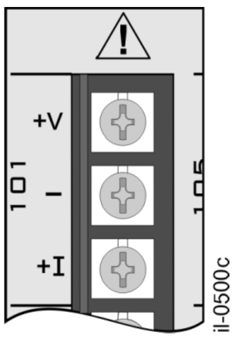


Figure 122: Analog Input Terminals

In order to configure the analog input to measure currents signals of DC transducers, remove all connectors and cables which are connected to the module and remove the back panel of the RA331, RA332 or RA333, removing the 12 screws of the panel and the screw of the protective grounding, as shown in Figure 123.
The fixing screws are not included in the product order.

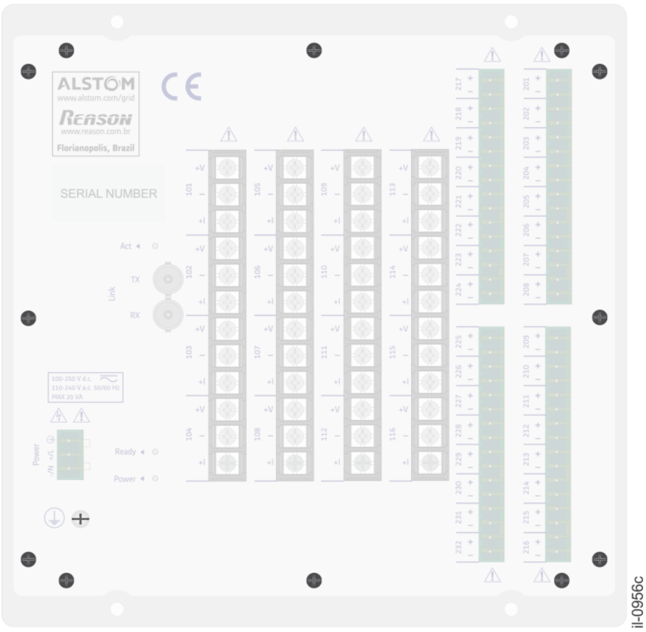


Figure 123: Screws of the back panel

Remove the board corresponding to the channel to be configured. For each channel to be configured to DC transducers of ±20 mA, connect the jumper between positions 2 and 3 as shown in Figure 124.

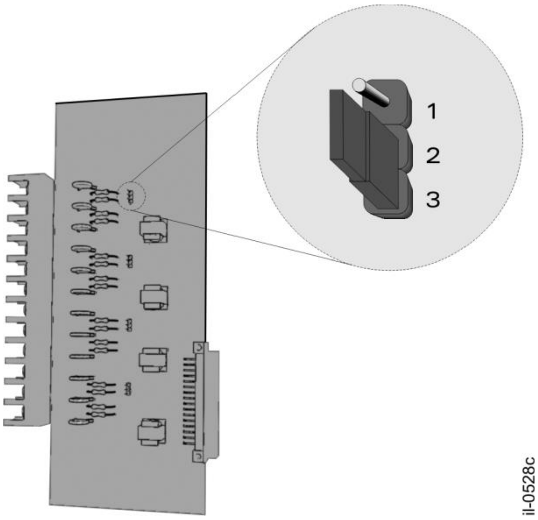


Figure 124: Internal Jumper

Place the board back in the case.
Secure the case by screwing the back panel and connecting the terminals cables.
Connections shall use insulated flexible wires of 1.5 mm² cross section, 8 mm ring terminals, and M3 holes.
Before making the electrical connection, make sure the signal is applied in accordance with the technical specifications of the equipment. For information about DC transducer input specifications, see Chapter 17: Technical Specifications.

15.1.1 Connection diagram of the DC transducer inputs ± 20 mA

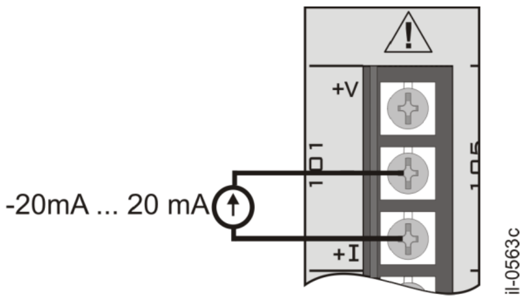


Figure 125: Connection Diagram of DC Transducer Inputs ± 20 mA

16 Current Clamps

In order to operate the equipment with the current clamps connection, it is necessary that the RA33x have the proper analog input board (CORTEC description: Analog Input 100 mA / 115 V).

As the measuring principle is based on current, the RA's internal jumper needs to be set to current mode. To do so, follow the procedure described on the topic 13 Analog Current Inputs.
After setting the internal jumper and reassembling the device, connect the outputs of the current clamp to the correct inputs terminals of the RA respecting the polarity of the outputs and the inputs, as shown in the figure below.

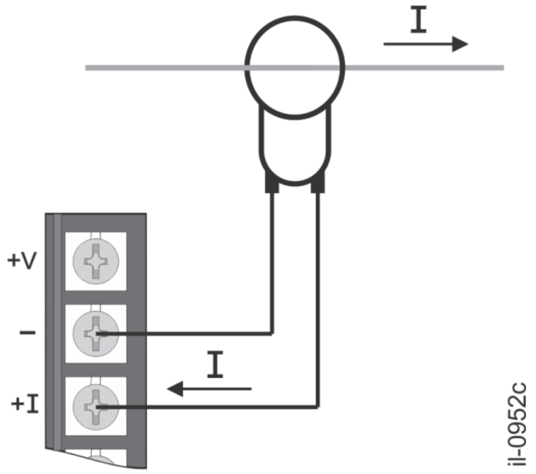


Figure 126: Polarity of the Current Clamp Connection

17 Digital Inputs

The RA331 and RA332 modules have up to 32 insulated digital inputs, and the RA333 module has up to 16, as shown in **Figure 127**. The digital inputs of RA331 and RA332 modules are identified of 201 to 232. The digital inputs of RA333 module are identified of 201 to 216. Make sure that the appropriate terminal pair are selected to the voltage applied.

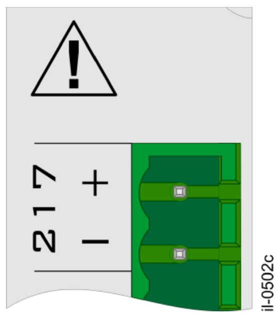


Figure 127: Digital Input Terminals

Each block of 8 inputs uses an appropriate connector which can be disconnected of the module. When plugging it, make sure that it is perfectly fitted.
Connections shall use insulated flexible wires of 1.5 mm² cross section and 5.08 mm pitch plug terminals.
For information about digital input specifications, see Chapter 17: Technical Specifications.

17.1.1 Connection diagram of the digital inputs

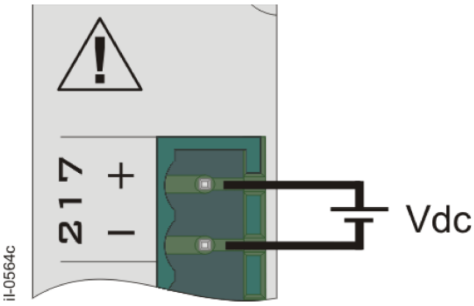


Figure 128: Connection Diagram of Digital Inputs

18 Time Synchronization Inputs

Timing synchronism is provided by the IRIG-B000/001/002/003/004/005/006/007 signal. The IRIG-B signal is used to keep the RPV311 data acquisition frequency constant and to provide the time stamp for the equipment.
The equipment indicates sync when the data acquisition frequency is according to the equipment's nominal acquisition frequency and the equipment's internal clock is updated.
The RPV311 internal clock is updated with every hour rollover or when the equipment turns to sync mode.
If the IRIG-B signal is not valid or not connected, the device indicates no sync. If the IRIG-B signal is connected and valid, the time quality of the time reference reported in the IRIG-B frame is shown by the RPV311, but the time quality is not considered by the synchronization.
In the absence of the IRIG-B signal, the equipment can be synchronized by an SNTP time server, however, the acquisition frequency does not have the same stability afforded by the IRIG-B signal (accuracy less than 12 ppm), and the equipment does not indicate sync.
The IRIG-B signal is preferred over the SNTP time server.
If no IRIG-B signal is available and the SNTP server is unreachable, the unit obtains the time of an internal CMOS clock. Drift is better than 0.1 second in 24 hours.
The RPV311 has an electrical and an optical IRIG-B input, as shown in **Figure 129**.

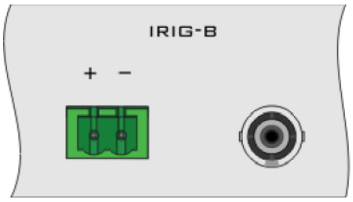


Figure 129: Electrical and optical inputs for sync using IRIG-B

To synchronize the equipment using fiber-optic input, use the appropriate fiber-optic type, considering its minimum curvature radius.
The use of a twisted pair cable is recommended for the electrical input.
For distances greater than 3 m, to minimize EMC effects, the use of fiber-optic cable is recommended.

18.1.1 Connection diagram of the synchronism inputs

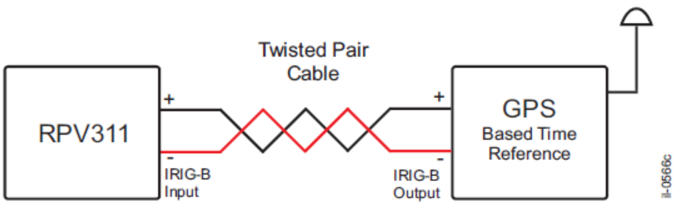


Figure 130: Connection diagram of electrical synchronism inputs

For information about electrical synchronism input specifications, Chapter 17: Technical Specifications.

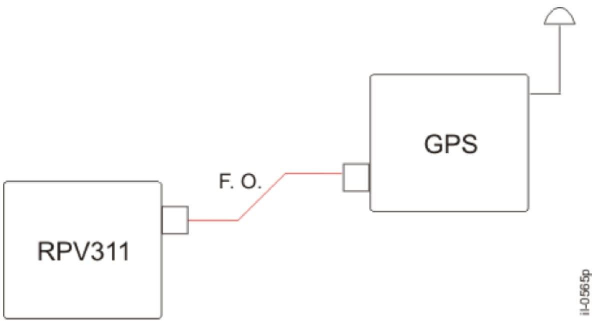


Figure 131: Connections diagram of optical synchronism inputs

Information about optical synchronism inputs specifications, see Chapter 17: Technical Specifications.

19 Dry Contact Relays

The RPV311 has 4 electromechanical signaling relays. Each relay has one dry contact, as shown in **Figure 132**.
The first relay contact is normally closed and it opens when the unit goes into operation and it is not configurable by the user.
The other three contacts are normally open and can be individually configured using the Web Interface. For information about relays output configuration, Chapter 17: Technical Specifications.

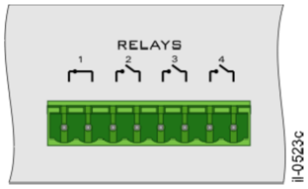


Figure 132: Dry contact relays of the RPV311

19.1.1 Dry contact relay connection diagram

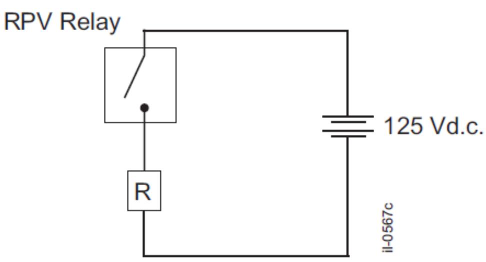


Figure 133: Dry contact relay connection diagram

For information about relay outputs specification, see Chapter 17: Technical Specifications.

20 Case Dimensions

20.1 RPV311 and RA33X

Refer to the technical specification section to check the RPV311 and RA33X dimensions and weight.

21 RPV311 Accessories

Fiber-optic pair, ST connector (Q026):	
Fiber type	Multimode 62.5 / 125 µm
Curvature ratio (min)	30 mm
Connector	ST

Figure 134: Fiber-optic pair

22 RA33x Accessories

RA33x accessories	
Q061	Mounting panel to install two remote acquisition modules (RA331 / RA332 / RA333) in a 19-inch rack + blank plate to cover one cutout in case only one RA33x is being used.

22.1 Panel Cutout

The RA331, RA332 and RA333 panel cutout is shown in **Figure 135**.

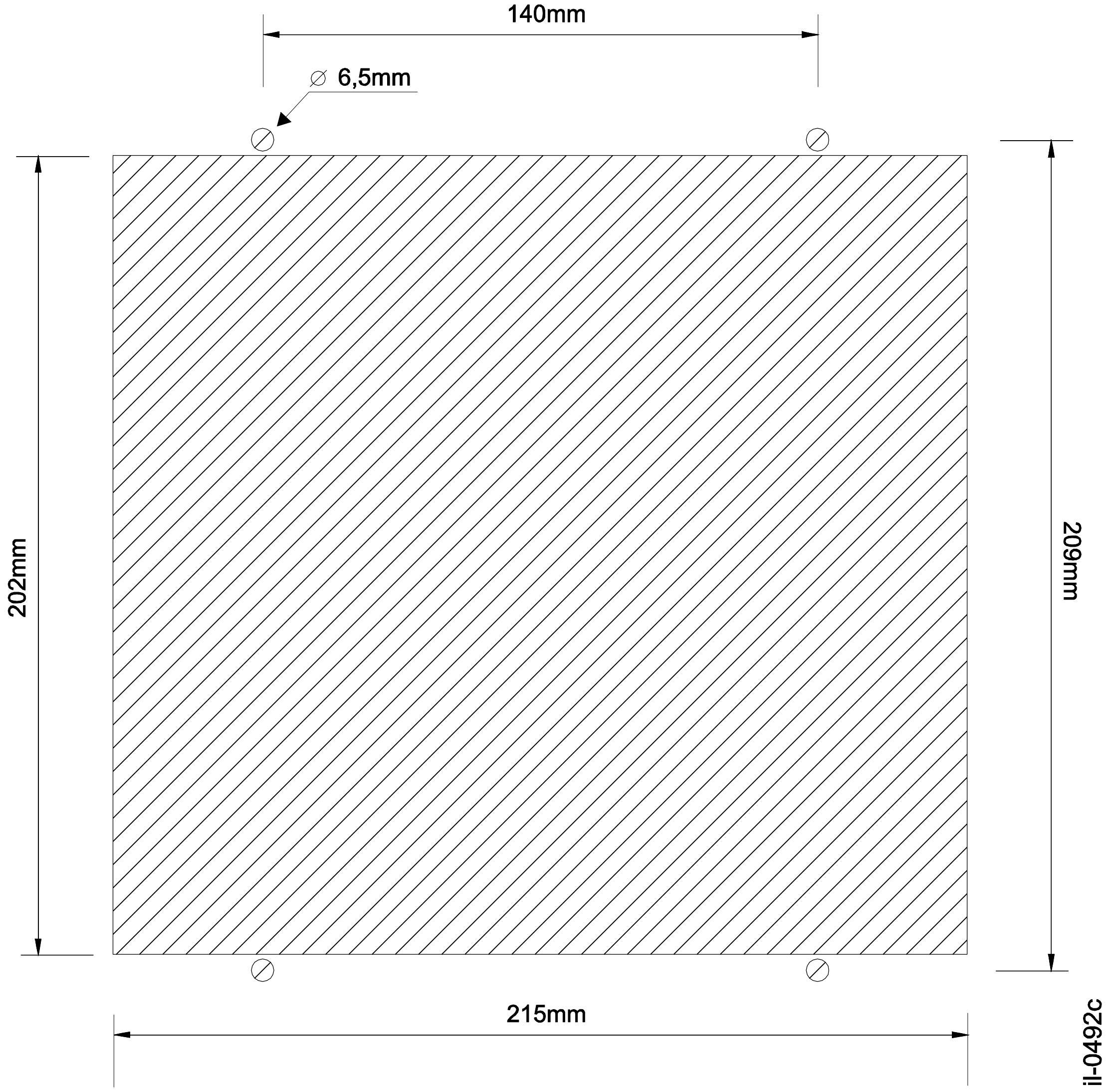


Figure 135: RA331, RA332 and RA333 panel cutout

23 Panel for Installation of Two Remote Acquisition Modules (Q61)

The Mounting panel to install two remote acquisition modules (RA331/332) in a 19-inch rack is shown in Figure 136.

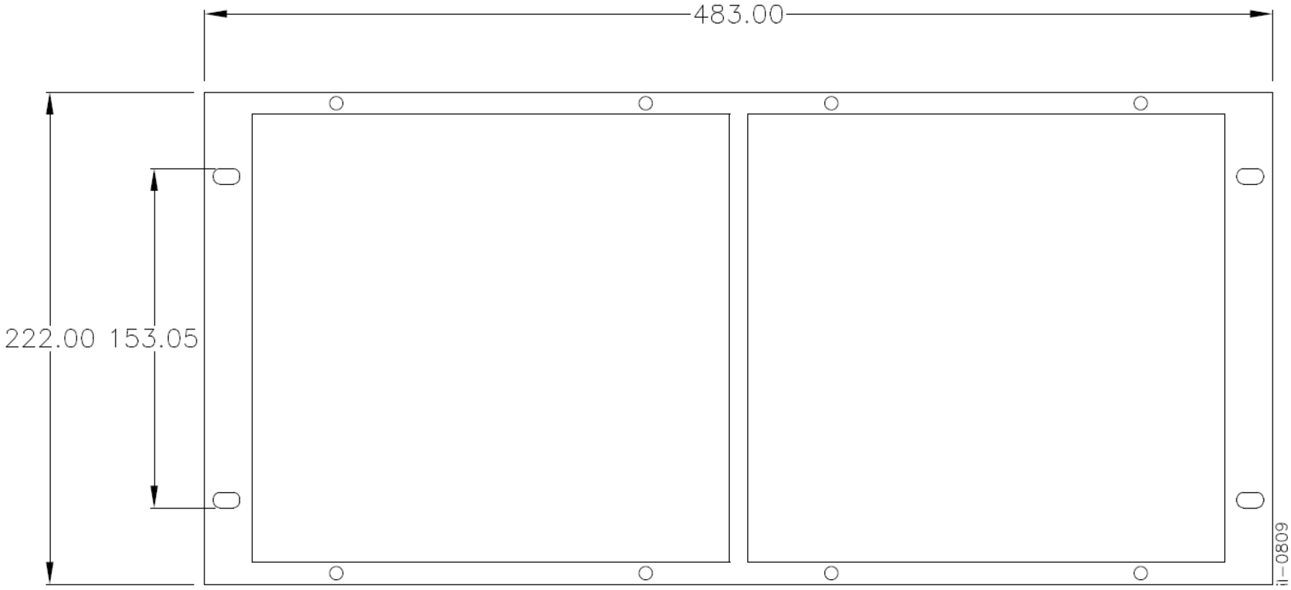


Figure 136: Mounting panel to install two remote acquisition modules (RA331/332) in a 19-inch rack

RPV311

Distributed Multifunction Fault Recorder

Chapter 16: Maintenance and Troubleshooting

This chapter provides information about proper equipment maintenance and troubleshooting.
The troubleshooting part of the chapter allows an error condition on the IED to be identified so that appropriate corrective action can be taken.

1 Maintenance

1.1 Maintenance Checks

In view of the critical nature of the application, GE Grid products should be checked at regular intervals to confirm they are operating correctly. GE Grid products are designed for a life in excess of 20 years.
The devices are self-supervising and so require less maintenance than earlier designs of protection devices. Most problems will result in an alarm, indicating that remedial action should be taken. However, some periodic tests should be carried out to ensure that they are functioning correctly and that the external wiring is intact. It is the responsibility of the customer to define the interval between maintenance periods. If your organisation has a Preventative Maintenance Policy, the recommended product checks should be included in the regular program. Maintenance periods depend on many factors, such as:

- The operating environment
- The accessibility of the site
- The amount of available manpower
- The importance of the installation in the power system
- The consequences of failure

Although some functionality checks can be performed from a remote location, these are predominantly restricted to checking that the unit is measuring the applied currents and voltages accurately and checking the circuit breaker maintenance counters. For this reason, maintenance checks should also be performed locally at the substation.

Before carrying out any work on the equipment you should be familiar with the contents of the Safety Section and the ratings on the equipment's rating label.

The RPV311 has a small coin-battery to power the internal clock. In order to replace it, please follow the battery replacement procedures presented in this chapter.

1.1.1 Alarms

First check the alarm status LED to see if any alarm conditions exist. If so, press the Read key repeatedly to step through the alarms.

After dealing with any problems, clear the alarms. This will clear the relevant LEDs.

1.1.2 Measurement Accuracy

If the power system is energised, the measured values can be compared with known system values to check that they are in the expected range. If they are within a set range, this indicates that the A/D conversion and the calculations are being performed correctly.

Alternatively, the measured values can be checked against known values injected into the device using the test block, (if fitted) or injected directly into the device's terminals..

1.2 Replacing the Unit

If your product should develop a fault while in service, depending on the nature of the fault, the watchdog contacts will change state and an alarm condition will be flagged. In the case of a fault, you should normally replace the cradle which slides easily out of the case. This can be done without disturbing the scheme wiring.

In the unlikely event that the problem lies with the wiring and/or terminals, then you must replace the complete device, rewire and re-commission the device.

If the repair is not performed by an approved service centre, the warranty will be invalidated.

Before carrying out any work on the equipment, you should be familiar with the contents of the Safety Information section of this guide or the Safety Guide SFTY/4LM, as well as the ratings on the equipment's rating label. This should ensure that no damage is caused by incorrect handling of the electronic components.

Before working at the rear of the unit, isolate all voltage and current supplying it.

1.3 Cleaning

Before cleaning the device, ensure that all AC and DC supplies and transformer connections are isolated, to prevent any chance of an electric shock while cleaning.

Only clean the equipment with a lint-free cloth dampened with clean water. Do not use detergents, solvents or abrasive cleaners as they may damage the product's surfaces and leave a conductive residue.

1.4 Watchdog

The RPV311 presents an internal watchdog algorithm. This algorithm verifies, every second, if the device's system is responding correctly. Case the system does not respond the device performs a hardware reboot while the output relay 1 signals that the RPV311 is off.

1.5 Coin-battery replacement procedure

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Before carrying out any work on the equipment, you should be familiar with the contents of the Safety Information section of this manual, as well as the ratings on the equipment's rating label. This should ensure that no damage is caused by incorrect handling of the electronic components.

Before working at the rear of the unit, isolate all voltage and current supplying it.

The RPV311 coin-battery (3V CR2032) supplies energy for the internal clock and mother-board BIOS. Its average life span is 3 years, after which it is advisable to replace the battery.
The user can either ship the device to a GE technical support center or replace it following carefully the procedure described in this section.
The battery is only accessed using specific tools to open the equipment cabinet and expose the battery.

The battery connector is design to fit only battery with right size and with correct polarity position. In case, the battery does not fit, do not force the fitting. Stop and reassess whether the right battery and right polarity is being applied.

To replace the battery, follow the procedure below:

1. Disconnect the power supply;
2. Disconnect all other connections leaving the grounding strap to be removed at the end;
3. Perform a visual inspection to make sure the equipment is isolated;

4. Position the device in place where there is free space to work and make sure to install proper working and safety warnings at the location, also keep available all tools and aids that is going to be used;
5. Wait a few minutes so the capacitors may discharge;
6. Disassemble the device by unscrewing the case screws and pulling up the top side of the case; after that. Keep in mind that disassembling the equipment may expose sensitive electronic circuitry. Take suitable precautions against electrostatic voltage discharge (ESD) to avoid damage to the equipment.
7. Locate the CR2032 battery. It has 20mm of diameter and looks like the picture below:

8. Use your fingers to grab on the edge of the battery and pull it up and out of the socket holding it in place.
9. Insert the new battery.

After the replacement, follow the procedure below in order to verify the safe state of the equipment and to put it back into operation.

1. Reconnect all internal cable that have been removed for the repair;
2. Perform a visual inspection on the device to make sure there are no remainders of the repair service inside the casing or any other noncompliance;
3. Place back the top side of the case and fasten it using the proper screws;
4. Connect the grounding strap and then the power supply to the equipment;
5. Wait for the equipment to initialize, it will run self-diagnostic routines and if everything is right the “Ready” LED on its front panel will light up indicating the equipment is safe and operational;

2 RPV311 Troubleshooting

2.1 Ready in processing module does not light up

The unit continuously executes an internal auto-diagnosis routine. The result of this diagnosis is reflected by the Ready led on the front panel of the unit, on the status page of the Web Interface and by the failure relay (normally closed contact) on the back panel of the unit.

If the local interface does not operate, the Ready indicator does not light up. In this case, the processing module must be sent for technical assistance.

2.2 Alarm LED lights up

If the indicator is lit up, the equipment may have some of the problems described below. To identify the problem that generated the alarm, access the status of equipment and links in the Web Interface, as shown in Chapter 5: Operation.

Problem	Solution
Transmission of configuration	Normal behavior, no action should be taken
Internal failure	Equipment is not operating, replace the processing module
Opened link	Check the links between RPV and acquisition modules. *If during the RPV311 initialization (boot) the Alarm LED is active due to an opened link of the RA333 TW link (log code 297 – Traveling wave not identified). The user must reboot the RPV311 after normalizing the link connection, otherwise the RPV311 will not create the TW COMTRADE recordings.

2.3 SYNC does not light up

Make sure that on IRIG-B signal is present at the optical or electrical input, and connect signal if is not;
Verify the quality of the IRIG-B signal, in Web or Local Interface. If the signal is low quality, try to use the optical input.

2.4 Date or time incorrect

Make sure that time zone and daylight-saving time have been properly configured and set correctly if is not.

2.5 Time drift throughout operation week

The equipment must be operating without an external reference.
Make sure that an IRIG-B signal is present at the optical or electrical input, and connect signal if is not;
Verify the NTP/SNTP server and guarantee this alternative source of timing.

3 RPV311 Firmware Update

When installing the application software package accompanying the equipment (refer to Software Installation), the Firmware Upgrade Tool (FUT) is installed and associated having an files with extension .fw allowing an RPV firmware update to be easily carried out by user.
The steps to be followed for updating the equipment firmware are:

1. Request GE for the firmware file.
2. Copy the file to the PC on which the RPV application software is installed (see Software Installation). The file shall have a .fw extension.
3. Double click file.
4. A screen opens and if it is the first-time connection between the local PC and the equipment is made an acknowledgement message will appear in the interface. Answer <Y> and press <ENTER>;
5. Provide the RPV IP address and press <ENTER>;
6. Enter the password for firmware updating and press <ENTER>;
   Default firmware upgrade password: **12345**
7. The entire updating process is performed automatically and can be followed on the PC screen;
8. The process requires resetting of the equipment. Therefore, answer <Y>. Equipment will take a few minutes to return to normal operation;
9. After performing the update operation, press <ENTER> to end.

The updating operation log can be checked locally in the fut.log file which is in the folder where the RPV software has been installed.

4 Product Support Tools - PST

The PST is a tool used to obtain internal information about the equipment.
Before using the PST it is necessary to install the dotNet program. To use the PST tool, install it on the computer by using the installation file.
Set IP and click on the <CONNECT> button. Once connected, use the following tabs:

Logs: Equipment information can be downloaded. The default location is on the user´s Desktop. Deselect ONLY CURRENT LOG to obtain all the log files. Click on GET LOGS to start the process. The OPEN DIR link opens the directory. The UPLOAD FILE link opens the Web browser for uploading the file to GE´s technical support personnel;

Online: Equipment information is shown. Click on the command in the tree and the result will show on the right;
Prompt: Type the command and then <ENTER> to execute (the password will be prompted in the first command). If no interaction is requested, the command will not return (use another tool in such a case);
Contact: Shows the contacts for assistance and support by GE.

5 RA331, RA332, and RA333 Troubleshooting

5.1 MAINS indicator does not light up

Make sure the terminal is connected;
Make sure there is power supply.

5.2 READY indicator does not light up

If the Ready indicator does not light up, the module has failed the self-test. In such case, contact the technical support personnel.

5.3 PPS indicator does not light up (Only RA333)

Make sure the synchronism signal is present on the processing module;
Make sure the link with the processing module is active.

5.4 Link with the processing module is not active

Make sure that Link and Act indicators are lit;
Verify that the fiber-optic cables are properly connected in the RA332 and in the processing module;
Verify that the processing module is on;
Make sure the connectors for receiving and transmitting data are not mixed;
Verify that the fiber optic cables are in good condition;
If possible, do the test using another fiber-optic cable;
Make sure that the distance between the processing module and the RA332 does not exceed 2 km;
Verify that the type of fiber is in accordance with the specifications.
If the problem persists, contact technical support.
http://www.gegridsolutions.com/alstomenergy/grid/grid/contactcentre

6 Equipment Return

All parts and components comprising Reason devices shall be repaired exclusively by GE. In case of equipment malfunction the customer shall get in contact with GE's Contact Centre and never attempt to repair the device by his own.

To request equipment repair service, call GE to check out shipment options and receive the technical assistance order code.

The equipment shall be packed in its original package or a suitable package to protect against impacts and moisture.

7 Instructions for Equipment Repair/Service for Service Personnel

The instructions presented in this topic shall only be followed by GE service Personnel.

In case any repair needs to be done, follow the procedure below to ensure the safety of the operation.

10. Disconnect power supply;
11. Disconnect all other connections leaving the grounding strap to be removed at the end;
12. Perform a visual inspection to make sure the equipment is isolated;
13. Position the device in place where there is free space to work and make sure to install proper working and safety warnings at the location, also keep available all tools and aids that is going to be used;
14. Wait a few minutes so the capacitors may discharge;
15. Disassemble the device by unscrewing the case screws and pulling up the top side of the case; after that, carry on with the proper repairs. Keep in mind that disassembling the equipment may expose sensitive electronic circuitry. Take suitable precautions against electrostatic voltage discharge (ESD) to avoid damage to the equipment.

After the repairs are done, follow the procedure below in order to verify the safe state of the equipment and to put it back into operation.

6. Reconnect all internal cable that have been removed for the repair;
7. Perform a visual inspection on the device to make sure there are no remainders of the repair service inside the casing or any other noncompliance;
8. Place back the top side of the case and fasten it using the proper screws;
9. Connect the grounding strap and then the power supply to the equipment;
10. Wait for the equipment to initialize, it will run self-diagnostic routines and if everything is right the "Ready" LED on its front panel will light up indicating the equipment is safe and operational;
11. Follow the procedures in the Chapter 2: Safety Information.

RPV311

Distributed Multifunction Fault Recorder

Chapter 17: Technical Specifications

This chapter describes the technical specifications of the product.

1 RPV311 Specifications

1.1 Electrical Ethernet Port

Electrical Ethernet - Ports 1 and 2	
Use	Configuration, monitoring and GOOSE
Interface	10BASE-T / 100BASE-TX
Bit Rate	10 / 100 Mbps
Connector	RJ 45
Isolation Level	1.44 KVdc

Electrical Ethernet - Process Bus Port (Sampled Values)	
Use	IEC 61850-9-2LE Sampled Values and GOOSE
Interface	10BASE-T / 100BASE-TX
Bit Rate	100 Mbps
Connector	RJ 45
Isolation Level	1.44 KVdc

1.2 Optical Ethernet Port (optional)

Optical Ethernet port	
Interface	10BASE-T / 100BASE-TX
Bit Rate	10 / 100 Mbps
Connector	ST
Wavelength	1300nm
Fiber Type	Multimode 62.5 / 125 µm
Emission Power	- 20 dBm
Receiver sensitivity	- 32 dBm
Maximum Applicable Power	- 14 dBm

1.3 Modem Serial Port

Modem Serial Port	
Signal level	RS232
Bitrate	1200, 2400, 4800, 9600, 19200, 38400 bps
Databits	7 or 8
Stopbits	1 or 2
Parity	None, even, odd
Connector	DB9 (female), standard DTE
Isolation Level	1.44 KVdc

1.4 TTL IRIG Input

TTL IRIG	
Signal	IRIG-B004
Minimum voltage input	4.20 V
Maximum input voltage	9.80 V
Impedance	200 Ω
Connector	PCB pluggable
Isolation Level	1.44 KVdc

1.5 Optical IRIG-Input (optional)

Optical IRIG	
Signal	IRIG-B004
Wavelength	820 nm
Fiber type	Multimode 62.5 / 125 µm
Connector	ST
Sensitivity	- 24 dBm

1.6 Dry-contact Relay Outputs

Dry-contact Relay Outputs	
Max Voltage	250 Vdc
Max Current	1A
Load	Resistive
Contact Numbers	1 normally closed
	3 normally open
Isolation Level	3.3 KVdc

1.7 Fiber-optic Links

Fiber-optic Links	
Wavelength	1300 nm
Fiber Type	Multimode 62.5 / 125 µm
Connector	ST
Emission Power	- 20 dBm
Receiver sensitivity	- 32 dBm
Maximum Applicable Power	- 14 dBm

1.8 Power Supply

Power Supply	
Nominal voltage range	125-250 V dc, 110-240 V ac
Maximum voltage range	102-300 V dc, 88-264 V ac
Frequency	50 / 60 Hz, ± 3 Hz
Power consumption	MAX 60 VA
	Typically 50W
Isolation Level	3.3 KVdc

Power supply specifications 24/48 Vdc	
Operating nominal voltage	24/48 Vdc
Operating voltage range	20 – 75 Vdc
Power Consumption	MAX 50W
Isolation Level	3.3 KVdc

1.9 Environmental Conditions

Environmental Conditions	
Operating temperature range	- 40… +50 °C (or –13°F to +122°F)
Maximum operating altitude	2000 m (6560 ft)
Relative humidity	5 … 95 %, noncondensing
As tested per 60068-2-1	-40°C
As tested per 60068-2-2	+55°C

1.10 Type Tests RPV311

EMC tests were performed according to IEC 60255-26 referring to the following standards

Type Tests RPV311		
Test	Standard	Level
Electrostatic discharge	IEC 61000-4-2:2008	8kV contact / 15KV air (level 4)
RF immunity	IEC 61000-4-3:2010	10 V/m (level 3)
Fast transient disturbance	IEC 61000-4-4:2012	2 KV @ 5KHz (level 3)
Surge immunity	IEC 61000-4-5:2005	Differential mode: 1 kV Common mode: 2 kV (level 3)
Conducted RF immunity	IEC 61000-4-6:2008	10V
Power magnetic immunity	IEC 61000-4-8:2009	30A/m continuous - 300A/m @ 1s.
Voltage dip, short interruptions and voltage variation immunity tests	IEC 61000-4-11:2004 IEC 61000-4-29:2000	AC and DC voltage dips Test level: 0% residual voltage Duration time a.c.: 1 cycle d.c.: 16.6ms Test level: 40% residual voltage Duration time a.c.: 12 cycle d.c.: 200ms Test level: 70% residual voltage Duration time a.c.: 30 cycle d.c.: 500ms AC and DC voltage interruptions Test level: 0% residual voltage Duration time a.c.: 300 cycles

		d.c.: 5s
Conducted RF immunity, 0 to 150 kHz	IEC 61000-4-16:1998+A2:2009	Test frequency: Test frequency: 16,7 Hz, 50 Hz and 60 Hz Test Voltage: 100V (differential mode) with 1 sec dwell time -Coupling resistor 100 Ω -Coupling capacitor 0,047µF 300V (common mode) with 1 sec dwell time -Coupling resistor 200 Ω -Coupling capacitor 0,47µF Number of repetition: 3 (Level 4)

Voltage ripple	IEC 61000-4-17:1999	Test level: 15 % of rated d.c. value Test frequency: 120Hz, sinusoidal waveform. (Level 4)
Damped oscillatory wave immunity test	IEC 61000-4-18:2006	Voltage oscillation frequency: 1MHz Differential mode: 1kV peak voltage; Common mode 2,5kV peak voltage (Level 3)
---	Gradual Startup	Shut-down ramp: 60s Power off: 5m Start-up ramp: 60s
Radio-frequency disturbance	CISPR11:2009	Radiated emission Limits:

		30 to 230MHz - 50dB(µV/m) quasi peak at 3m 230 to 1000MHz - 57dB(µV/m) quasi peak at 3m
Radio disturbance	CISPR22:2008	■ Radiated emission Limits: 1 to 3GHz - 56dB(µV/m) average; 76dB(µV/m) peak at 3m 3 to 6GHz - 60dB(µV/m) average; 80dB(µV/m) peak at 3m The test frequency is defined based on the maximum internal frequency of equipment. ■ Conducted emission Limits: 0.15 to 0.50MHZ - 79dB(µV) quasi peak; 66dB(µV) average 0.5 to 30MHz - 73dB(µV) quasi peak; 60dB(µV) average
Seismic	IEC 60255-21-3: 1995	Class 2 Horizontal Axes: Frequency Range: 1Hz – 35Hz Cross-over Frequency: 8.14Hz Severity: 7.5mm zero-peak displacement below 8.14Hz 2g zero-peak acceleration above 8.14Hz Sweep Rate: 1 Octave/minute Number of Sweep Cycles: 1 Configuration: Operational throughout Vertical Axis: Frequency Range: 1Hz – 35Hz Cross-over Frequency: 8.42Hz Severity: 3.5mm zero-peak displacement below 8.14Hz 1g zero-peak acceleration above 8.14Hz Sweep Rate: 1 Octave/minute Number of Sweep Cycles: 1 Configuration: Operational throughout

1.11 Safety Tests

Safety tests	
Safety	IEC 61010-1
IEC 60255-5	Inpulse - 5KV Dielectric withstand - 3,3KVDC for 60 seconds Insulation > 100M Ω

1.12 Environmental tests

Environmental tests		
Cold	IEC 60068-2-1	-40°C, 16 hours (Cold)
Dry heat	IEC 60068-2-2	+55°C, 16 hours (Dry heat)
Damp heat	IEC 60068-2-30	95% no condensation, 55°C (Damp heat)
Change of temperature	IEC 60068-2-14	-40°C to 55ºC / 9 hours / 2 cycles (Change of temperature)
Vibration	IEC 60255-21-1	Class 2 (Vibration)
Shock	IEC 60255-21-2	Class 1 (Shock)

1.13 Enclosure Protection IEC 60529

Enclosure Protection IEC 60529	
Front flush mounted with panel	IP40
Rear and sides	IP20

1.14 Dimensions

RPV311 dimensions	
Height (front panel)	133.55 mm (3 U)
Height (rear)	86 mm
Width (front panel)	482.6 mm (19’’)
Width (rear)	427 mm
Depth	260 mm
Weight	< 4.0 kg

The RPV311 dimensions are shown in **Figure 137**.
Dimension in accordance to IEC 60297-3.

Figure 137: RPV311 Dimensions

2 RA331, RA332, and RA333 Specifications

2.1 Analog Acquisition (50/60 Hz)

Analog acquisition specifications (50/60Hz)	
Resolution	16 bits
Acquisition Rate	256 ppc
Bandwidth	DC to 3.0 kHz
Attenuation @ 3000 Hz	< 0.1 dB
Attenuation @ 6400 Hz	> 30 dB
Time skew	0 µs
Frequency Tracking Range	Nominal Frequency ±5Hz

2.2 Analog Acquisition (High-speed – Only RA333 Module)

Analog acquisition RA333	
Resolution	8 bits
Sampling frequency	5 MHz
Time skew	0 µs

2.3 Voltage Inputs

Voltage inputs specifications (50/60 Hz)	
Nominal Voltage (V_n)	115 V
Voltage range	0.02-230 V
Analog Input Accuracy	± 0.1 % of FS magnitude range
Impedance	> 200 kΩ
Burden V_n	< 0.1 VA
Continuous Overload	230 V (2 x V_n)
Maximum Overload (1 s)	460 V (4 x V_n)

2.4 Current Inputs

Current inputs specifications (50/60Hz)					
CORTEC option	1	2	5	6	T
Nominal Current (I_n)	1 A		5 A		5 A (Measurement CT)
Current range	0.01… 20 A (20In)	0.01…40 A (240In)	0.05… 100 A (20In)	0.05…200 A (40In)	0.01… 14 A
Analog Input Accuracy	± 0.1 % FS				
Resistance	15 mΩ	5 mΩ	3 mΩ	1 mΩ	15 mΩ
Burden I_n	< 0.02 VA				
Continuous overload (rms)	10 A (10 x I_n)		20 A (4 x I_n)		10 A (2 x I_n)
AC current thermal withstand (I_{th} rms for 1 sec)	40 A (40 x I_n)	100 A (100 x I_n)	200 A (40 x I_n)		40 A (8 x I_n)

2.5 Current clamps inputs specification

Current clamp inputs	
Nominal Current (I_n)	100 mA (Clamps)
Current range	0.005 ... 0.1 A
Analog Input Accuracy	± 1 % FS
Impedance	1 Ω
Burden	< 0.01 VA
Continuous Overload	0.5 A
Maximum Overload (1 s)	2 A

2.6 DC Transducer Inputs

DC Transducer inputs specifications		
Full Scale	± 10 V	± 20 mA
Input range	- 13,7 to + 13,7 V	- 32 to 32 mA
Analog Input Accuracy	± 0.1 % of FS magnitude range	± 1 % of FS magnitude range
Impedance	> 5 kΩ	10 Ω

2.7 Binary Inputs

Binary Inputs specifications			
Nominal Voltage	125 Vdc	250 Vdc	24 / 48 Vdc
Level Low	40 V	110 V	08 V
Level High	85 V	170 V	17 V

Impedance	82 kΩ	180 kΩ	15 kΩ
Burden	< 0.25 W	< 0.5 W	< 0.2 W
Continuous Overload [1]	240 V	340 V	100 V

[1] The digital inputs are protected against continuous reverse polarity for the nominal voltage

2.8 Fiber-optic Links

Fiber-optic links specifications	
Wavelength	1300 nm
Fiber Type	Multimode 62.5 / 125 µm
Connector	ST
Emission Power	- 20 dBm
Receiver sensitivity	- 32 dBm
Maximum Applicable Power	- 14 dBm

2.9 RA33x Power Supply

RA33x Power supply specifications	
Nominal voltage range	100-250 V dc, 110-240 V ac
Maximum voltage range	80-300 V dc, 88-264 V ac
Frequency	50 / 60 Hz, ± 3 Hz
RA331 and RA332 Power Consumption	MAX 20 VA
RA333 Power Consumption	MAX 30 VA

Power supply specifications 24/48 Vdc	
Operating nominal voltage	24/48 Vdc
Operating voltage range	18 – 75 Vdc
Power Consumption	MAX 30W

2.10 Environmental Conditions

RA33x Environmental Conditions	
Operating temperature range	-40 … +55 °C
Maximum operating altitude	2000 m (6560 ft)
Relative humidity	5 … 95 % noncondensing
Tested as per 60068-2-1	-40°C
Tested as per 60068-2-2	+85°C

2.11 Type Tests RA33x

EMC tests were performed according to IEC 60255-26 referring to the following standards

	Type Tests RA33x	
Test	Standard	Level
Electrostatic discharge	IEC 61000-4-2:2008	8kV contact / 15KV air (level 4)
RF immunity	IEC 61000-4-3:2006	10 V/m (level 3)
Fast transient disturbance	IEC 61000-4-4:2012	2 KV @ 5KHz (level 3)

Surge immunity	IEC 61000-4-5:2005	Differential mode: 1KV Common mode: 2KV (level 3)
Conducted RF immunity	IEC 61000-4-6:2008	10V
Power magnetic immunity	IEC 61000-4-8:2009	30A/m continuos – 300A/m @ 1s.
Voltage dip, short interruptions and voltage variation immunity tests	IEC 61000-4-11:2004 IEC 61000-4-29:2000	A.C. and d.c. voltage dips Test level: 0% residual voltage Duration time a.c.: 1 cycle d.c.: 16,6ms Test level: 40% residual voltage Duration time a.c.: 12 cycles d.c.: 200ms Test level: 70% residual voltage Duration time a.c.: 30 cycles d.c.:500ms A.C. and d.c. voltage interruptions Test level: 0% residual voltage Duration time a.c.: 300 cycles d.c.: 5s

Conducted RF immunity, 0 to 150 kHz	IEC 61000-4-16:1998+A2:2009	Test frequency: 16,7 Hz, 50 Hz and 60 Hz Test Voltage: 100V (differential mode) with 1 sec dwell time -Coupling resistor 100 Ω -Coupling capacitor 0,047µF 300V (common mode) with 1 sec dwell time -Coupling resistor 200 Ω -Coupling capacitor 0,47µF Number of repetition: 3 (Level 4)
Voltage ripple	IEC 61000-4-17:1999	Test level: 15 % of rated d.c. value Test frequency: 120Hz, sinusoidal waveform. (Level 4)
Damped oscillatory wave immunity test	IEC 61000-4-18:2006	Voltage oscillation frequency: 1MHz Differential mode: 1kV peak voltage; Common mode 2,5kV peak voltage
---	Gradual Startup	Shut-down ramp: 60s Power off: 5m Start-up ramp: 60s
Radio-frequency disturbance	CISPR11:2009	Radiated emission Limits: 30 to 230MHz – 50dB(µV/m) quasi peak at 3m 230 to 1000MHz – 57dB(µV/m) quasi peak at 3m
Radio disturbance	CISPR22:2008	Radiated emission The definition of the limit frequency is based on the maximum internal

		frequency of the equipment. On RA33x, the maximum internal frequency is 100 MHz. For this case, the levels of CISPR 11 satisfy the normative IEC 60255-26. Conducted emission Limits: 0.15 to 0.50MHZ – 79dB(µV) quasi peak; 66dB(µV) average 0.5 to 30MHz – 73dB(µV) quasi peak; 60dB(µV) average
Seismic	IEC 60255-21-3: 1995	Class 2 Horizontal Axes: Frequency Range: 1Hz – 35Hz Cross-over Frequency: 8.14Hz Severity: 7.5mm zero-peak displacement below 8.14Hz 2g zero-peak acceleration above 8.14Hz Sweep Rate: 1 Octave/minute Number of Sweep Cycles: 1 Configuration:Operational throughout Vertical Axis: Frequency Range: 1Hz – 35Hz Cross-over Frequency: 8.42Hz Severity: 3.5mm zero-peak displacement below 8.14Hz 1g zero-peak acceleration above 8.14Hz Sweep Rate: 1 Octave/minute Number of Sweep Cycles: 1 Configuration: Operational throughout

2.12 Safety Tests

Safety tests	
Safety	IEC 61010-1
IEC 60255-5	Inpulse – 5KV Dielectric withstand – 3,3KVDC for 60 seconds Insulation > 100M Ω

2.13 Environmental tests

Environmental tests	
IEC 60068-2-1	-40°C, 16 hours (Cold)
IEC 60068-2-2	+85°C, 16 hours (Dry heat)
IEC 60068-2-30	95% no condensation, 55°C (Damp heat)
IEC 60068-2-14	-40°C to 85ºC / 9 hours / 2 cycles (Change of temperature)
IEC 60255-21-1	Class 2 (Vibration)
IEC 60255-21-2	Class 1 (Shock)

2.14 Enclosure Protection IEC 60529

Enclosure Protection IEC 60529	
Front flush mounted with panel	IP54
Sides	IP20
Rear	IP10

2.15 Dimensions

RA33x dimensions	
Height (front panel)	222 mm (5 U)
Height (rear)	200 mm
Width (front panel)	222 mm ($\frac{1}{2}$ 19’’)
Width (rear)	214 mm
Depth	100 mm
Weight	< 3.0 kg

The RA331, RA332, and RA333 dimensions are shown in Figure 138.

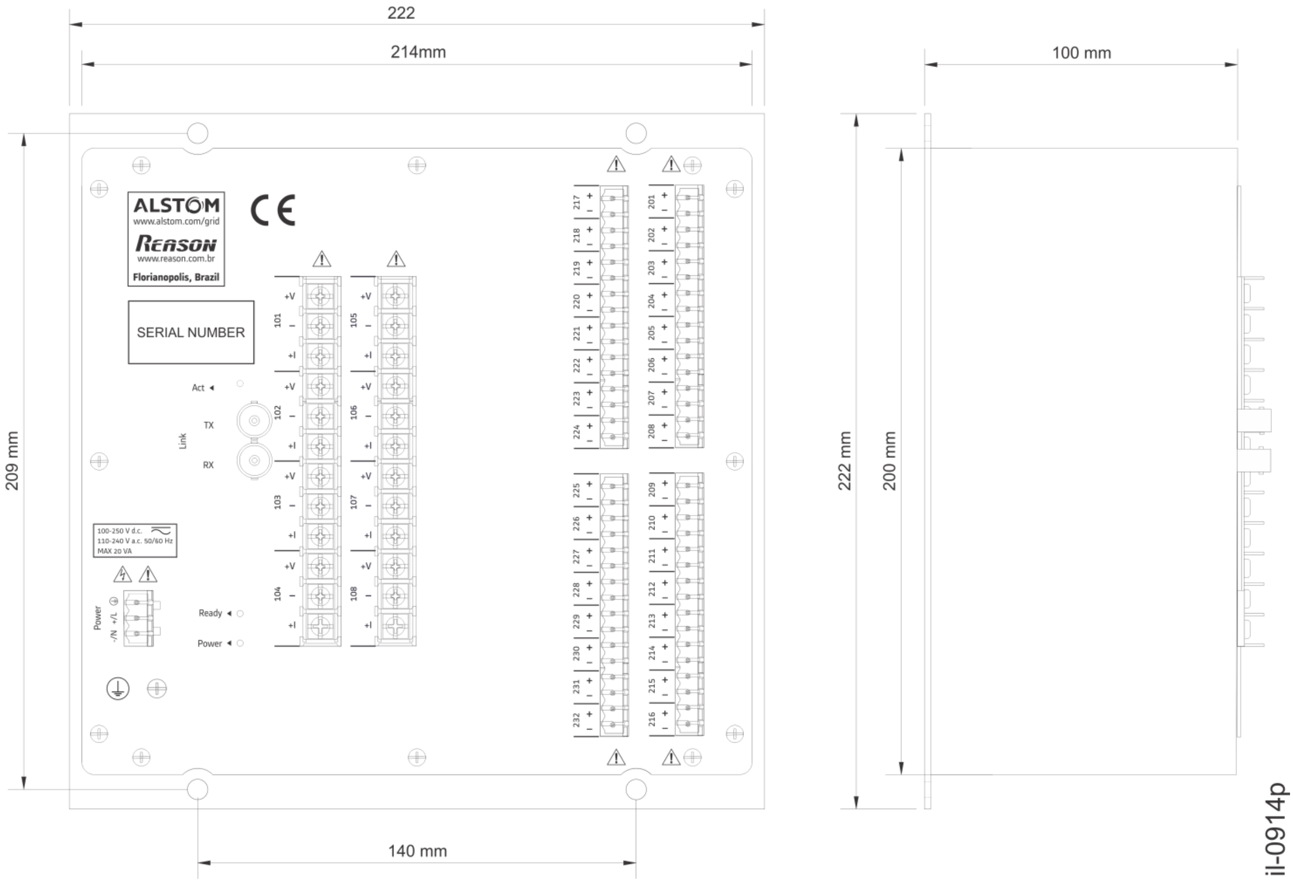


Figure 138: RA331, RA332 and RA333 dimensions

2.16 Current Clamps

Current clam specification	
Manufacturer / Model	AEMC / MN312
Dynamic range	0.1 A … 100 A
Output	1mA/A
Frequency response	40 Hz … 10 kHz
Accuracy	2 % ± 0.02 mA (0.1 to 1 A)
	1 % ± 0.02 mA (1 to 80 A)
	2 % ± 0.02 mA (80 to 100 A)
Jaw opening	21 mm
Maximum conductor size	20 mm
Weight	180 g
Operating temperature	- 10 … 55 °C

Figure 139: AEMC / MN312 (PN 2468) current clamps

RPV311

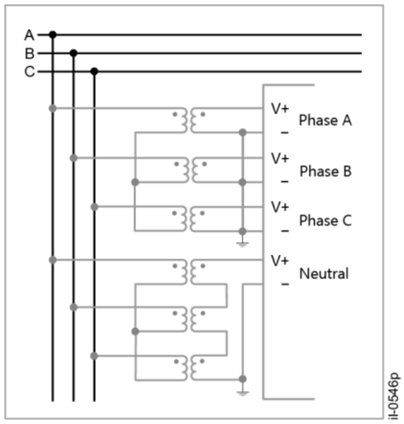
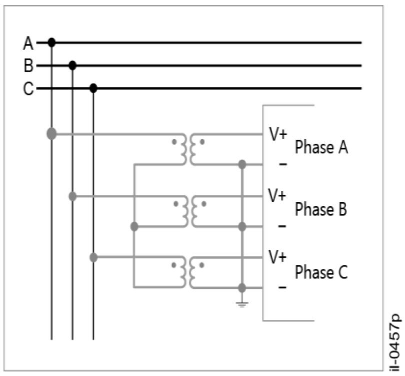
Distributed Multifunction Fault Recorder

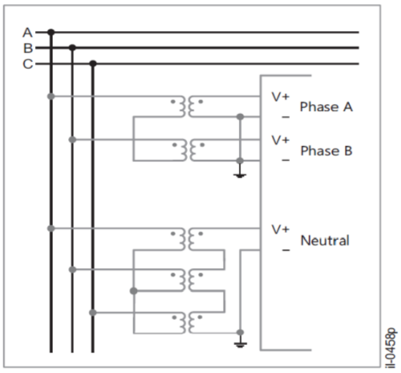
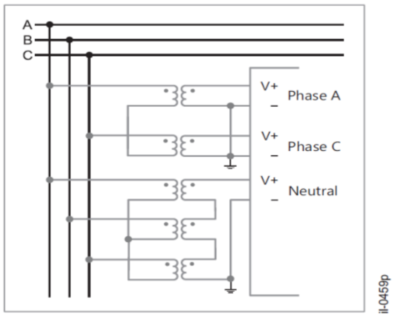
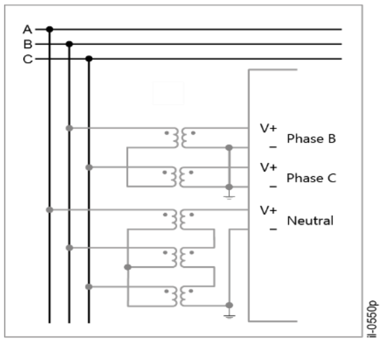
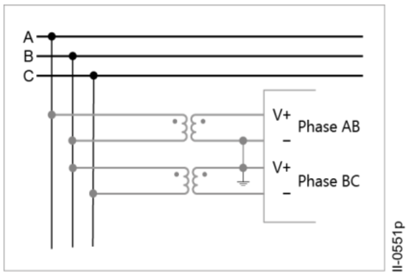
Chapter 18: Wiring Diagrams

This chapter contains the all the possible wiring diagrams for the analogue inputs. For further details on the inputs, refer to Chapter 15: Installation.

1 Connection Diagrams of the Voltage Inputs

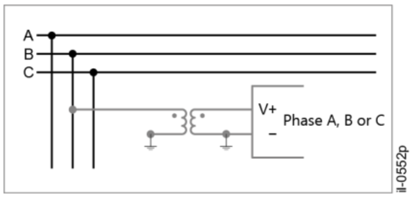
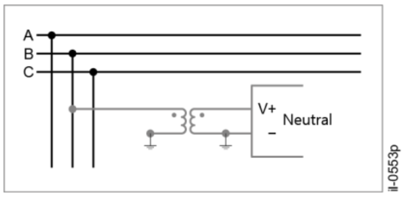
The RPV311 provides the capability for making some different voltage signal connections for a 3-phase circuit:

Connection diagram of the voltage inputs	
4-element connection: in this case, the values shown are equivalent to the voltages of phases A, B and C, and to the neutral voltage applied to the equipment.	
3-element (Phases A, B and C) connection: in this case, the fourth element is derived of the values measured by the other elements. The three elements are equivalent to the values applied to the equipment	

3-element (Phases A, B and neutral) connection: in this case, the fourth element is synthesized of the values measured by the other elements. The three elements are equivalent to the values applied to the equipment.	
3-element (Phases A, C and neutral) connection: in this case, the fourth element is derived of the values measured by the other elements. The three elements are equivalent to the values applied to the equipment.	
3-element (Phases B, C and neutral) connection: in this case, the fourth element is derived of the values measured by the other elements. The three elements are equivalent to the values applied to the equipment.	
2-element connection: in this case, the neutral voltage is zero, and the three phase-to-ground voltage are computed based on the two line-to-line voltages applied to the equipment.	

In circuits of 1 element, the measurements can be in two different ways:
An isolated phase or neutral measurement: If the element is a phase, only the voltage related to this channel is measured considering the off-set compensation. If the element is a neutral, the voltage related to this channel is measured without the off-set compensation.

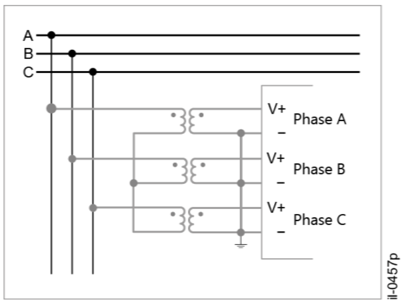
A 3-Phase synthesis: The magnitude for the 3-phases is considered with the same value as that of the channel measured and balanced (i.e., angles with 120º between each other).

Connection diagram for 1 voltage element connection	
1-element connection: Connection diagram of 1 element (phase A, B or C).	
1-element connection: Connection diagram of 1 element (neutral).	

In all cases, the equipment will compute the phase-to-ground voltage and the neutral voltage.

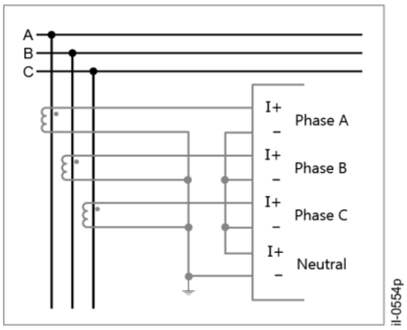
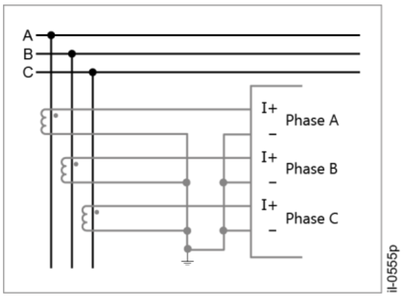
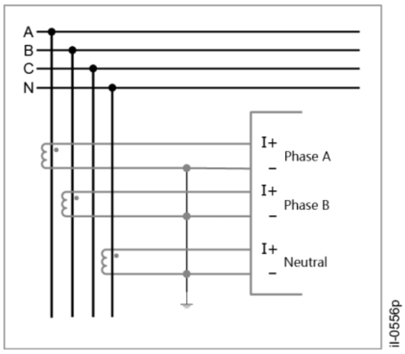
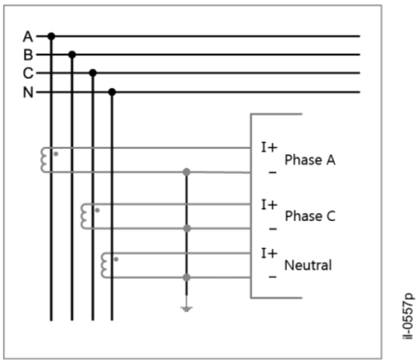
2 Connection Diagrams of the TW Inputs

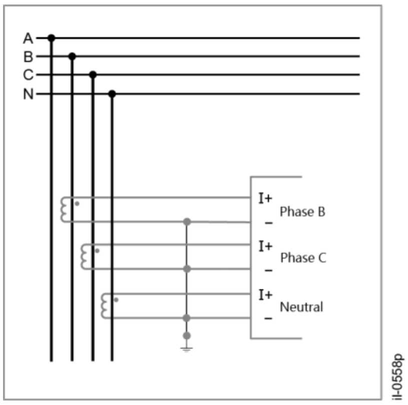
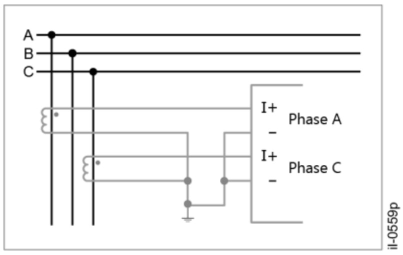
The RPV311 provides the capability for connecting one 3-phase circuit (phases A, B, and C):

Connection diagram for TW inputs	
3-element (Phases A, B and C) connection: in this case, the three elements are equivalent to the values of TW voltage.	

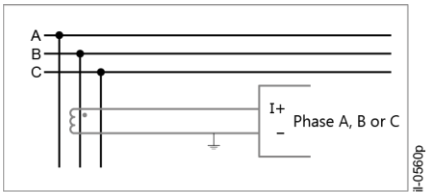
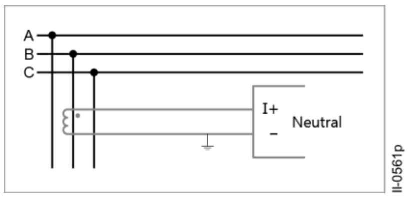
3 Connection Diagrams of the Current Inputs

The RPV311 provides the capability for connecting some different current signal connections for a 3-phase circuit:

Connection diagram of the current inputs	
4-element connection: in this case, the values shown are equivalent to the voltages of phases A, B and C, and to the neutral voltage applied to the equipment.	
3-element (Phases A, B and C) connection: in this case, the fourth element is derived of the values measured by the other elements. The three elements are equivalent to the values applied to the equipment	
3-element (Phases A, B and neutral) connection: in this case, the fourth element is derived of the values measured by the other elements. The three elements are equivalent to the values applied to the equipment.	
3-element (Phases A, C and neutral) connection: in this case, the fourth element is derived of the values measured by the other elements. The three elements are equivalent to the values applied to the equipment.	

3-element (Phases B, C and neutral) connection: in this case, the fourth element is derived of the values measured by the other elements. The three elements are equivalent to the values applied to the equipment.	
2-element connection: in this case, the neutral voltage is zero, and the three phase-to-ground voltage are computed based on the two line-to-line voltages applied to the equipment	

In circuits of 1 element, the measurements can be in two different ways:
An isolated phase or neutral measurement: If the element is a phase, only the current related to this channel is measured considering the off-set compensation. If the element is a neutral, the current related to this channel is measured without the off-set compensation.
A 3-Phase synthesis: The magnitude for the 3-phases is considered with the same value as that of the channel measured and balanced (i.e., angles with 120º between each other).

Connection diagram for 1 current element connection	
1-element connection: Connection diagram of 1 element (phase A, B or C).	
1-element connection: Connection diagram of 1 element (neutral).	

In all cases, the equipment will compute the line current and the neutral current.

RPV311

Distributed Multifunction Fault Recorder

Appendix A

1 Equipment Log

The equipment log contains information about:

- Threshold violations, fault and disturbance triggers and data recording;
- Data record transfer (including the IP address to which data has been transferred);
- Access to the unit's configuration pages (including IP address of which the access was performed);
- Alarms and the results of auto-diagnosis routines;
- Power-up and shutdown.

The equipment log cannot be erased by the user. Its capacity is enough for approximately 5 years of typical use, with past events being erased if memory space is needed.

Log	Event	Cause
000	Internal failure	Hardware or processing failure
001	Invalid key	The key applied to the equipment is not valid
003	Insufficient processing time	High volume of processing data and events in a short period of time
004	Data Acquisition Failure	Failure on data acquisition
010	Power up	Equipment power-up
011	Power off	Equipment power-off
012	Auto power-off (primary power failure)	Battery operated power time run-out

013	Emergency power-off (low battery)	Battery charge below expected, equipment shut off automatically
020	Primary power OK	Primary power supply voltage equipment
021	Primary power NOK	Battery backup equipment
029	Battery status [value:]	Battery voltage indication
030	Temperature normal [value:]	Temperature return to normal values
031	Temperature high [value:]	Internal temperature high
039	Temperature status [value:]	Equipment temperature indication
050	Equipment ready	Equipment normal operation
051	Equipment not ready	Equipment is not operational
100	IRIG-B signal	Equipment is connected to IRIG-B signal
101	No IRIG-B signal	Equipment is not connected to IRIG-B signal
102	Equipment sync	Equipment synchronization of IRIG-B external timing reference signal
103	Equipment unsync	Loss of synchronization with IRIG-B external timing reference
104	Out-of-sync IRIG-B frame received [at:]	Equipment received out of sync IRIG-B signal data
105	Missing IRIG-B frame [at:]	Equipment did not receive IRIG-B signal data
106	Time quality changed [Time quality:]	The time quality was changed
109	IRIG-B [type: 00x]	Indication of IRIG-B type connected

120	DST started [at:]	Equipment started operating at the daylight saving time
121	DST ended [at:]	Equipment stopped operating at the daylight saving time
129	Leap second added [at:]	Add 1 second to the UTC time
190	Internal clock updated by fallback SNTP server	Equipment synchronization by SNTP time server
191	Internal clock updated by IRIG-B	Equipment time reference provided by IRIG-B signal
192	Internal clock running without external reference	The internal clock is running without external reference
200	Configuration changed [revision:]	Equipment set up changed
202	Default configuration reestablished	The default configuration was reestablished

203	Default configuration reestablished by local interface	Default settings reset via the local interface
210	Default access reestablished by local interface	Factory set access password reset at local interface
211	Default access reestablished	The default parameters to access the equipment was reestablished
250	Firmware upgrade [revision:]	Firmware upgrade indication
270	Sequential sampled values loss in [sv stream]	Indicates loss of Sampled Values (SV) packets
271	Sampled values loss in [sv stream]	Indicates loss of Sampled Values (SV) connections
273	Stream [sv stream] up	Indicates that the RPV311 is reading Sampled Values (SV)
280	Link down	The link connection was down
281	Link up	The link connection was up
282	Thresholds related to inputs of link disabled	The thresholds related to inputs of the link was disabled
283	Thresholds related to inputs of link enabled	The thresholds related to inputs of the link was enabled
284	All links up	All the links was up
290	Acquisition module calibration date [slot:%p; date:%p]	Date of the acquisition module calibration
291	Unused acquisition module [slot:]	Exist an unused acquisition module
292	Unused conditioning module [slot:]	Exist an unused conditioning module
293	Missing acquisition module [slot:]	An acquisition module was missing
294	Missing conditioning module [slot:]	An conditioning module was missing

295	Invalid acquisition module [slot:]	Exist an invalid acquisition module
296	Invalid conditioning module [slot:]	Exist an invalid conditioning module
300	Invalid Ethernet cross-trigger	Ethernet cross-trigger communication was not validated by equipment
350	Operation user access via web [user: ; source:]	Start of operation user access
351	Operation user access logout via web [user: ; source:]	End of operation user access

352	Operation user access failure via web [user: ; source:]	Invalid password or user indication
355	Configuration user access via web [user: ; source:]	Start of configuration user access
356	Configuration user access logout via web [user: ; source:]	End of configuration user access
357	Configuration user access failure via web [user: ; source:]	Invalid password or user indication
405	Steady-state record download [name: ; user: ; source:]	Steady-state record downloaded by user
406	SOE record download [name: ; user: ; source:]	SOE record downloaded by user
407	Fault record download [name: ; user: ; source:]	Fault record downloaded by user
408	Disturbance record download [name: ; user: ; source:]	Disturbance record downloaded by user
409	Traveling wave record download [name: ; user: ; source:]	Traveling wave record downloaded by user
414	Traveling wave record auto upload [name:; user: ; destination:]	Traveling wave record auto uploaded
415	Steady-state record auto upload [name: ; user: ; destination:]	Steady-state record auto upload indication
416	SOE record auto upload [name: ; user: ; destination:]	SOE record auto upload indication
417	Fault record auto upload [name: ; user: ; destination:]	Fault record auto upload indication

418	Disturbance record auto upload [name: ; user: ; destination:]	Disturbance record auto upload indication
419	Auto upload failure [name: ; user: ; destination:]	Invalid password or user indication
504	Traveling wave record removed [name:]	Traveling wave record erased
505	Steady-state record removed [name:]	Steady-state record erased
506	SOE record removed [name:]	SOE record erased
507	Fault record removed [name:]	Fault record removed
508	Disturbance record removed [name:]	Disturbance record removed
510	Record memory usage limit exceeded	Recorder memory capacity exceeded 90 % capacity
514	Traveling wave recorder memory usage limit exceeded	Traveling wave recorder memory capacity exceeded 90 % capacity
515	Steady-state recorder memory usage limit exceeded	Steady-state recorder memory capacity exceeded 90 % capacity
516	SOE recorder memory usage limit exceeded	SOE recorder memory capacity exceeded 90 % capacity
517	Fault recorder memory usage limit exceeded	Fault recorder memory capacity exceeded 90 % capacity
518	Disturbance recorder memory usage limit exceeded	Disturbance recorder memory capacity exceeded 90% capacity
520	Record memory usage limit no longer exceeded	Return of memory capacity below 90 % with deletion of older records

524	Traveling wave recorder memory usage limit no longer exceeded	Return of memory capacity below 90 % with deletion of older records
525	Steady-state recorder memory usage limit no longer exceeded	Return of memory capacity below 90 % with deletion of older steadystate records
526	SOE recorder memory usage limit no longer exceeded	Return of memory capacity below 90 % with deletion of older SOE records
527	Fault recorder memory usage limit no longer exceeded	Return of memory capacity below 90 % with deletion of older fault records
540	All traveling wave records scheduled manually for removal	Request for removal of all Traveling wave records by user
541	Oldest traveling wave records scheduled automatically for removal	Request for removal of oldest traveling wave records automatically
528	Disturbance recorder memory usage limit no longer exceeded	Return of memory capacity below 90 % with deletion of older disturbance records
550	All steady-state records scheduled manually for removal	Request for removal of all steady-state records by user
551	Oldest steady-state records scheduled automatically for removal	Request for removal of oldest steady-state records automatically
560	All SOE records scheduled manually for removal	Request for removal of all SOE records by user
561	Oldest SOE records scheduled automatically for removal	Request for removal of oldest SOE records automatically
570	All fault records scheduled manually for removal	Request for removal of all fault records by user
571	Oldest fault records scheduled automatically for removal	Request for removal of oldest fault records automatically

580	All disturbance records scheduled manually for removal	Request for removal of all disturbance records by user
581	Oldest disturbance records scheduled automatically for removal	Request for removal of oldest disturbance records automatically
590	Steady-state record available [name: ; time stamp: ; duration:]	Steady-state record creation
591	SOE record available [name: ; time stamp: ; duration:]	SOE record creation
592	Continuous record available [name: ; trigger: ; cause: ; duration: s; md5sum:]	Continuous record creation
593	Continuous record updated [name: ; trigger: ; cause: ; duration: ; md5sum:]	Continuous record update
600	Traveling wave recorder threshold exceeded [at: ; threshold:]	Traveling wave recorder preset threshold exceeded
601	Traveling wave recorder threshold no longer exceeded [at: ; threshold:]	Return to normal level for the traveling wave recorder
602	Maximum traveling wave recorder threshold time exceeded [at: ; threshold:]	Indicates the maximum traveling wave recorder threshold time was exceeded
609	Traveling wave trigger detected [at:]	Indicates the detection of a traveling wave recorder trigger
610	Traveling wave recording started [at:]	Start of traveling wave recording threshold exceeded
614	Traveling wave recording finished [at:]	End of traveling wave recording threshold exceeded

619	Traveling wave recording refused (equipment unsync) [at:]	Trigger rejected due to excess consecutive triggering protection enabled
630	Traveling wave recorder Ethernet cross-trigger started [at: ; identifier: ; location: ; owner:]	Start of traveling wave recorder Ethernet cross-trigger detection
631	Traveling wave recorder Ethernet cross-trigger finished [at: ; identifier: ; location: ; owner:]	End of traveling wave recorder Ethernet cross-trigger detection
632	Traveling wave recorder Ethernet cross-trigger timed-out [at: ; identifier: ; location: ; owner:]	Traveling wave recorder Ethernet crosstrigger exceeded the maximum preset recording time
633	Start of traveling wave recorder Ethernet cross-trigger ignored [at: ; identifier: ; location: ; owner:]	Traveling wave recorder Ethernet crosstrigger ignored due to another cross-trigger being recorded by equipment
634	End of traveling wave recorder Ethernet cross-trigger ignored [at: ; identifier: ; location: ; owner:]	Ignored traveling wave recorder Ethernet cross-trigger finished
650	Traveling wave record available [name: ; trigger: ; cause ; duration:]	Indicates the traveling wave record creation
700	Fault recorder threshold exceeded [at: ; threshold:]	Fault recorder preset threshold exceeded
701	Fault recorder threshold no longer exceeded [at: ; threshold:]	Return to normal level for the fault recorder
702	Maximum fault recorder threshold time exceeded [at: ; threshold]	Indicates the maximum fault recorder threshold time was exceeded
709	Fault recorder trigger detected [at:]	Indicates the detection of a fault recorder trigger

710	Fault recording started [at:]	Start of fault recording threshold exceeded
712	Fault recording extended [at:]	Fault recording extended due to threshold exceeded
714	Fault recording finished [at:]	End of fault recording threshold exceeded
716	Fault recording timed-out [at:]	Threshold exceeded the maximum preset recording time
720	Fault recording refused [at:]	Trigger rejected due to excess consecutive triggering protection enabled
721	Fault recording disabled [at: ; timeout: s]	Recording disabled due to fault recorder repeat in preset time period
722	Fault recording enabled [at:]	Recorder enable due to threshold exceeded
730	Fault recorder Ethernet crosstrigger started [at: ; identifier: ; location: ; owner:]	Start of fault recorder Ethernet cross-trigger detection
731	Fault recorder Ethernet crosstrigger finished [at: ; identifier: ; location: ; owner:]	End of fault recorder Ethernet cross-trigger detection
732	Fault recorder Ethernet crosstrigger timed-out [at: ; identifier: ; location: ; owner:]	Fault recorder Ethernet crosstrigger exceeded the maximum preset recording time
733	Start of fault recorder Ethernet cross-trigger ignored [at: ; identifier: ; location: ; owner:]	Fault recorder Ethernet crosstrigger ignored due to another cross-trigger being recorded by equipment
734	End of fault recorder Ethernet cross-trigger ignored [at: ; identifier: ; location: ; owner:]	Ignored fault recorder Ethernet cross-trigger finished

740	Fault recorder manual trigger detected [at:]	Indicates a manual fault recorder trigger activated by user
741	Fault recorder manual trigger ignored [at:]	Manual fault recorder trigger activated by user was ignored
750	Fault record available [name: ;trigger: ;cause: ;duration:]	Indicates the fault record creation
800	Disturbance recorder threshold exceeded [at: ; threshold:]	Fault recorder preset threshold exceeded
801	Disturbance recorder threshold no longer exceeded [at: ; threshold:]	Return to normal level for the disturbance recorder
802	Maximum disturbance recorderthreshold time exceeded [at: ; threshold:]	Indicates the maximum disturbance recorder threshold time was exceeded
809	Disturbance recorder trigger detected [at:]	Indicates the detection of a disturbance recorder trigger
810	Disturbance recording started [at:]	Start of disturbance recording threshold exceeded
812	Disturbance recording extended [at:]	Disturbance recording extended due to threshold exceeded
814	Disturbance recording finished [at:]	End of disturbance recording threshold exceeded
816	Disturbance recording time-out [at:]	Threshold exceeded the maximum preset recording time
820	Disturbance recording refused [at:]	Trigger rejected due to excess consecutive triggering protection enabled

821	Disturbance recording disabled [at: ; timeout: s]	Recording disabled due to disturbance recorder repeat in preset time period
822	Disturbance recording enabled [at:]	Recorder enable due to threshold exceeded
830	Disturbance recorder Ethernet cross-trigger started [at: ; identifier: ; location: ; owner:]	Start of disturbance recorder Ethernet cross-trigger detection
831	Disturbance recorder Ethernet cross-trigger finished [at: ; identifier: ; location: ; owner:]	End of disturbance recorder Ethernet cross-trigger detection
832	Disturbance recorder Ethernet cross-trigger timed-out [at: ; identifier: ; location: ; owner:]	Disturbance recorder Ethernet cross-trigger exceeded the maximum preset recording time
833	Start of disturbance recorder Ethernet cross-trigger ignored [at: ; identifier: ; location: ; owner:]	Disturbance recorder Ethernet cross-trigger ignored due to another cross-trigger being recorded by equipment
834	End of disturbance recorder Ethernet cross-trigger ignored [at: ; identifier: ; location: ; owner:]	Ignored disturbance recorder Ethernet cross-trigger finished
840	Disturbance recorder manual trigger detected [at:]	Indicates a manual disturbance recorder trigger activated by user
841	Disturbance recorder manual trigger ignored [at:]	Manual disturbance recordertrigger activated by user was ignored
850	Disturbance record available [name: ; trigger: ; cause: ; duration:]	Indicates the disturbance record creation