



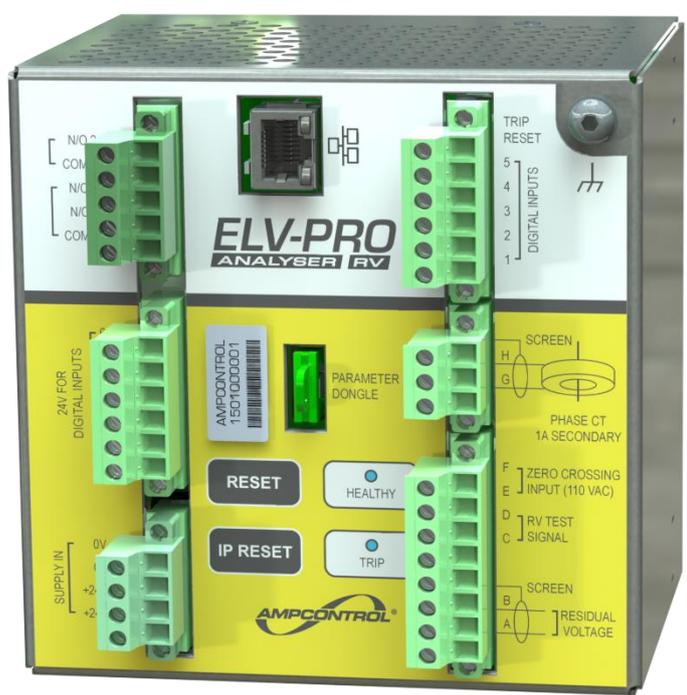
# ELV-PRO RV

## EARTH FAULT RESIDUAL VOLTAGE RELAY

### User Manual

Version: 2, July 2023

Designed and manufactured in Australia by Ampcontrol Pty Ltd



**WARNING!**



The **warning** symbol highlights a potential risk of **injury or death**.  
Please share these warnings with other operators.

**CAUTION!**



The **caution** symbol highlights a potential risk of **damage to equipment**.  
Please share these cautions with other operators.

**NOTE**



The **note** symbol highlights **key information**.  
Please share these notes with other operators.

**ENVIRO**



The **enviro** (environmental) symbol highlights areas which may have an impact on the surrounding **fauna and/or flora**.

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## Before You Begin

Thank you for purchasing the Ampcontrol ELV-PRO RV Relay.

### WARNING!



In the interests of **safety and correct equipment operation**, please take the time to read and understand the content in this manual.

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Table 1: Definitions

Term	Definition
<i>BUEL</i>	Back Up Earth Leakage
<i>CB</i>	Circuit Breaker: Main circuit breaker that controls power to all outlets
<i>CCM</i>	Cable Connection Module
<i>CIP</i>	Common Industrial Protocol
<i>CT</i>	Current Transformer
<i>EC</i>	Earth Continuity (Pilot to earth loop resistance)
<i>DHCP</i>	Dynamic Host Configuration Protocol
<i>EFLO</i>	Earth Fault Lock Out
<i>FFT</i>	Fast Fourier Transform
<i>FLC</i>	Full Load Current
<i>GUI</i>	Graphical User Interface
<i>HMI</i>	Human/Machine Interface
<i>HTTP</i>	Hypertext Transfer Protocol
<i>IP</i>	Internet Protocol
<i>MC</i>	Main Contactor; the main power circuit opening device. The main contactor is opened and closed in order to turn the outlet on and off
<i>MCR</i>	Main Contactor Relay: A relay installed within the protection module to control the supply to the main contactor coil. All trip times specified are to the opening of the MCR
<i>NER</i>	Neutral Earthing Resistor
<i>NTP</i>	Network Time Protocol
<i>RMS</i>	Root Means Square
<i>RTC</i>	Real Time Clock
<i>TCP</i>	Transmission Control Protocol
<i>UTP</i>	Unshielded Twisted Pair

Table 2: Firmware Versions

Firmware	Definition
<i>Backend = 6</i> <i>Website = 7</i>	Initial Release

# 1 SAFETY AND OTHER WARNINGS

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*For safety reasons, the ELV-PRO RV Relay must be installed, operated, and serviced only by competent personnel. Please read and understand this instruction manual completely before installing, operating, or servicing this equipment. Failure to install or operate this instrument in accordance with the instructions contained in this manual may create hazardous operating conditions.*

## 1.1 Safe Use of Equipment

The equipment supplied has been designed and manufactured to ensure safe operation. The equipment must only be used within the design parameters.

The instructions within this manual must be observed as an aid towards achieving the safest possible installation.

**Persons responsible for installation, maintenance, or operation, must observe the following instructions:**

### 1.1.1 Changes to Equipment

Changes in the design and modifications to the equipment are not permitted. Unauthorised changes made to the hardware or operating firmware will void the manufacturer's warranty and may compromise the integrity of the system into which it is installed and other connected equipment.

### 1.1.2 Equipment Knowledge

Experience with, or understanding of, this equipment is essential for the safe installation and removal of the equipment. Therefore, please read and understand this manual prior to use. Competency based training courses are recommended and are available on request.

### 1.1.3 Manual Handling

Precautions have been taken to ensure all equipment is safe to handle and free from sharp edges. However, care should always be taken when handling enclosures and gloves should be worn.

### 1.1.4 Installation

Correct operation and safety depend on the relay being installed correctly. Mechanical and or electrical installation and maintenance of plant and equipment must only be carried out by appropriately qualified personnel and must be tested thoroughly prior to operation.

### 1.1.5 Operation

As safety depends on the relay functioning correctly, it is highly recommended that all safety functions of the relay be periodically tested to ensure correct operation.

## 2 RECEIVING AND STORAGE

### 2.1 Receiving

All possible precautions are taken to protect the equipment against damage or losses during shipment; however, before accepting delivery, check all items against the packing list or bill of loading. If there is evidence of physical damage, notify Ampcontrol immediately.

Notify Ampcontrol immediately in the case of any discrepancies to the packing list. Keep a record of any claims and correspondence. Photographs are recommended.

Where practicable do not remove protective covers prior to installation unless there are indications of damage. Boxes opened for inspection and inventory should be carefully repacked to ensure protection of the contents or else the parts should be packaged and stored in a safe place. Examine all packing boxes, wrappings and covers for items attached to them, retain and store any approval documentation for your safety file as applicable prior to wrapping being discarded.

### 2.2 Inspection

Equipment that is found to be damaged or has been modified away from its published specifications must not be used. Please contact Ampcontrol if the equipment is suspected to be different than that ordered or if it does not match the published specifications.

### 2.3 Storage after Delivery

When the equipment is not to be installed immediately, proper storage is important to ensure protection of equipment and validity of warranty.

All equipment should be stored indoors between 0-40°C, preferably on shelves and protected from moisture and sunlight.

### 2.4 Unpacking of Equipment

The method of packing used will depend on the size and quantity of the equipment. The following cautions should be interpreted as appropriate.

#### CAUTION!



Take care when unpacking crates as the **contents may have shifted during transport.**

#### ENVIRO



The disposal of packaging materials, replaced parts, or components must comply with environmental restrictions without polluting the soil, air or water.

Ensure that any timber and cardboard used as **packaging is disposed of in a safe and environmentally responsible manner.**

Where possible, dispose of all waste products i.e. oils, metals, plastic and rubber products by using an approved recycling service centre.

## 3 PRODUCT OVERVIEW

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### 3.1 Description

Ampcontrol's ELV-PRO RV is a high performance, microprocessor based, wide bandwidth earth fault protection relay that is capable of measuring and analysing Residual Voltages of a high impedance IT power system. The ELV-PRO RV uses patented technology (US20130258537) to characterise residual voltage components giving superior fault discrimination.

The relay is designed to identify faults in these power systems that may exhibit complex residual voltages and hazardous touch potentials typically associated with variable speed drives in mining environments.

### 3.2 Key Features

The ELV-PRO RV has the following key features:

- Compliance to AS/NZS 4871 and designed to AS/NZS 2081
- Patented analysis method\*
- Fail safe operation
- Wide range residual voltage measurement (20Hz to 8kHz)
- Wideband, Narrowband and Weighted frequency response modes (Wideband Mode recommended for most scenarios)
- Adjustable trip level and trip times
- On board memory logs last 1000 data logs and 50 events
- CIP over Ethernet/IP for control and monitoring
- Modbus TCP
- Continuous CCM connection monitoring
- DIN rail mounted

\* International patent application number PCT/AU2011/000705

### 3.3 Application

The ELV-PRO RV is intended for use in high impedance IT power systems. The relay is intended to be used as the backup earth fault protection relay in conjunction with the OCS-RV providing primary protection on each outlet. The relay allows greater earth fault data to be captured relating to variable frequency components not identified by the OCS-RV.

The relay also provides data logging to assist in fault finding. On each event trigger, the relay stores system data for a window of two seconds before and two seconds after the triggered event, which includes system time, wideband earth fault voltages and phase current.

Ethernet connection to the relay provides the ability to monitor the device parameters and real time measured current from an internet browser. All data logs stored on the unit can also be viewed.

## 4 INSTALLATION

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### 4.1 General Warnings

These instructions have been designed to assist users of the relay with installation.

Before the relay can be installed, there are a number of things that need to be considered and understood to prevent incorrect or unsafe operation of the relay or the system into which it is installed.

Along with relevant competence, and an understanding of the target application, the following points should be considered:

#### **4.1.1 Ensure that the information provided in this user manual is fully understood.**

It is extremely important that the limitations and functionality of the relay are understood to prevent incorrect installation or use, creating a potentially dangerous risk. If in doubt as to the nature of the limitations or their implication, consult a competent authority such as a supervisor or Ampcontrol technical representative.

#### **4.1.2 Ensure that the application into which the relay is being installed has been properly defined, designed and approved.**

Any system intended to mitigate the risk of injury needs to be properly designed and implemented. Such a system must be the result of structured risk analysis with the outcomes used to define the system requirements. These requirements, in turn, will guide the choice of instrumentation, logic solvers and actuators needed to implement the system. Understanding the needs of the system will ensure proper selection of equipment.

#### **4.1.3 Ensure that the relay will properly perform the required functions within the system design.**

It is important to understand how the relay is intended to interact with other equipment within a system. For safe and reliable use, it is crucial that neither the logical operation nor its signalling be compromised by incompatibilities with connected equipment.

#### **4.1.4 Modifications of any form to the relay are prohibited.**

If modifications of any form are made to the relay, the equipment may no longer be fit for use. If any modifications or damage to the relay is evident, do not use the equipment and contact Ampcontrol for advice.

### 4.2 Mandatory Installation Practices

The following information must be adhered to when installing the relay. Failure to adhere to this information may give rise to unsafe operation.

Using the relay in a manner that exceeds its electrical or functional specifications, or in a way that is contrary to its operating restrictions, may create risks to personnel and/or equipment resulting in injury or death.

- The ELV-PRO RV system must be supplied by a regulated voltage within the specified range.
- The installation of the ELV-PRO RV system must be carried out by suitably trained and qualified personnel.
- Identification labels fixed to the ELV-PRO RV system components must not be damaged, removed or covered.
- The installation is to be in accordance with the relevant installation Standards/Codes of Practice.
- Modifications must not be made to any part of the ELV-PRO RV system. Modifications to its construction will render the unit non-compliant.
- Complete and accurate records of the installation must be retained for warranty purposes.

### 4.3 Mechanical Installation Information

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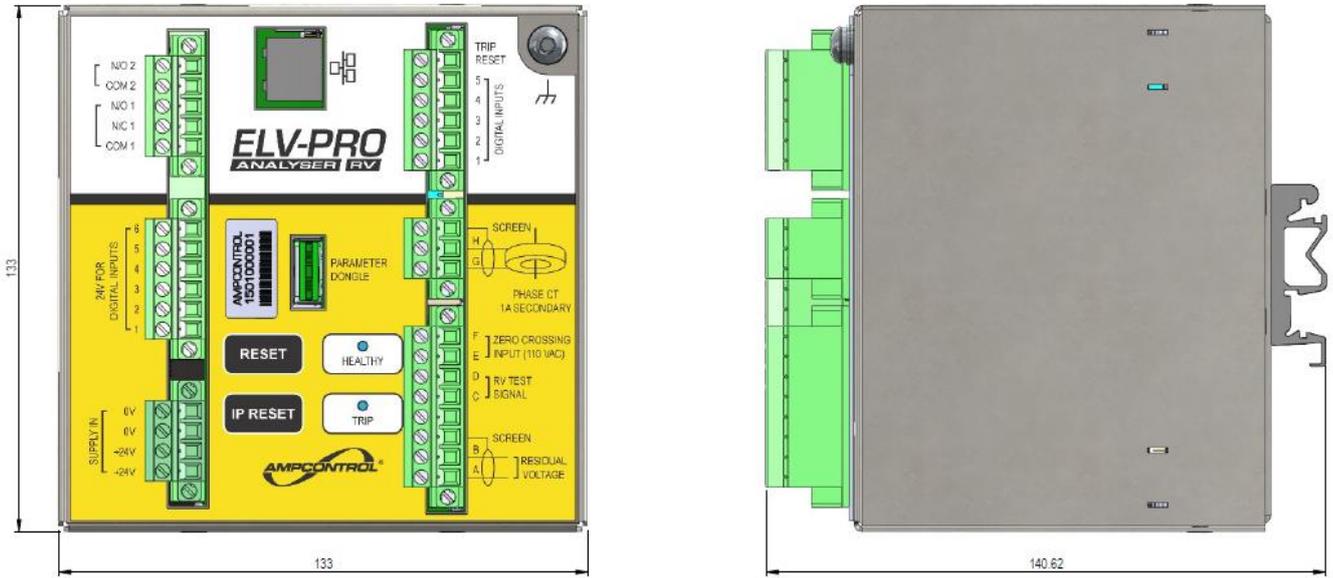


Figure 1: ELV-PRO RV Dimensions

The ELV-PRO RV stainless-steel enclosure is rated at IP20. It is DIN Rail mounted and measures 135mm x 135mm and 107mm deep as per Figure 1. The terminal layout and description are shown in Figure 2: ELV-PRO RV Terminal Layout and Table 3 respectively.

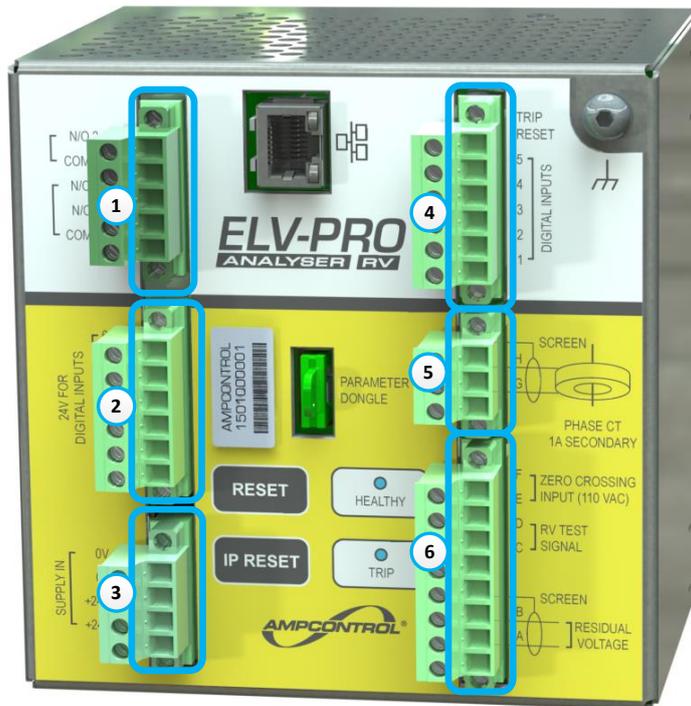


Figure 2: ELV-PRO RV Terminal Layout

Table 3: ELV-PRO RV Terminal Designators

Plug	Label	Designator	Plug	Label	Designator
1	P1_5	Contact 2: Normally Open	4	P4_6	Trip Reset Input
	P1_4	Contact 2: Common		P4_5	Digital Input 5
	P1_3	Contact 1: Normally Open		P4_4	Digital Input 4
	P1_2	Contact 1: Normally Closed		P4_3	Digital Input 3
	P1_1	Contact 1: Common		P4_2	Digital Input 2
				P4_1	Digital Input 1
2	P2_6	Digital Input 6: 24V Supply	5	P5_3	Phase CT Cable Screen
	P2_5	Digital Input 5: 24V Supply		P5_2	Phase CT Input: Signal (H)
	P2_4	Digital Input 4: 24V Supply		P5_1	Phase CT Input: Common (G)
	P2_3	Digital Input 3: 24V Supply	6	P6_8	Zero Crossing Input (110VAC) (F)
	P2_2	Digital Input 2: 24V Supply		P6_7	Zero Crossing Input (110VAC) (E)
	P2_1	Digital Input 1: 24V Supply		P6_6	CT Test Signal (D)
		P6_5		CT Test Signal (C)	
3	P3_4	Power Supply Input: 0V		P6_4	Unused
	P3_3	Power Supply Input: 0V		P6_3	RV Signal Cable Screen
	P3_2	Power Supply Input: +24V	P6_2	RV Signal Input: Signal (B)	
	P3_1	Power Supply Input: +24V	P6_1	RV Signal Input: Common (A)	
Screw					
		Chassis Earth Connection			

The ELV-PRO RV has been tested and validated for use with the ELV-PRO RV CCM Adapter. Use of any other CCM adapter will cause the system to not perform as designed. The certification will also be void.

The ELV-PRO RV CCM Adapter can be seen in Figure 3. The CCM Adapter is made up of two separate components, the CCM Adapter Module and an IPX Base.

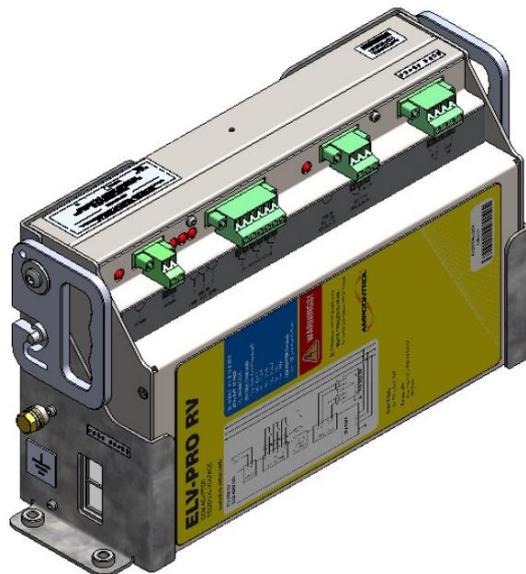


Figure 3: CCM Adapter Module Kit (CCM + Base)

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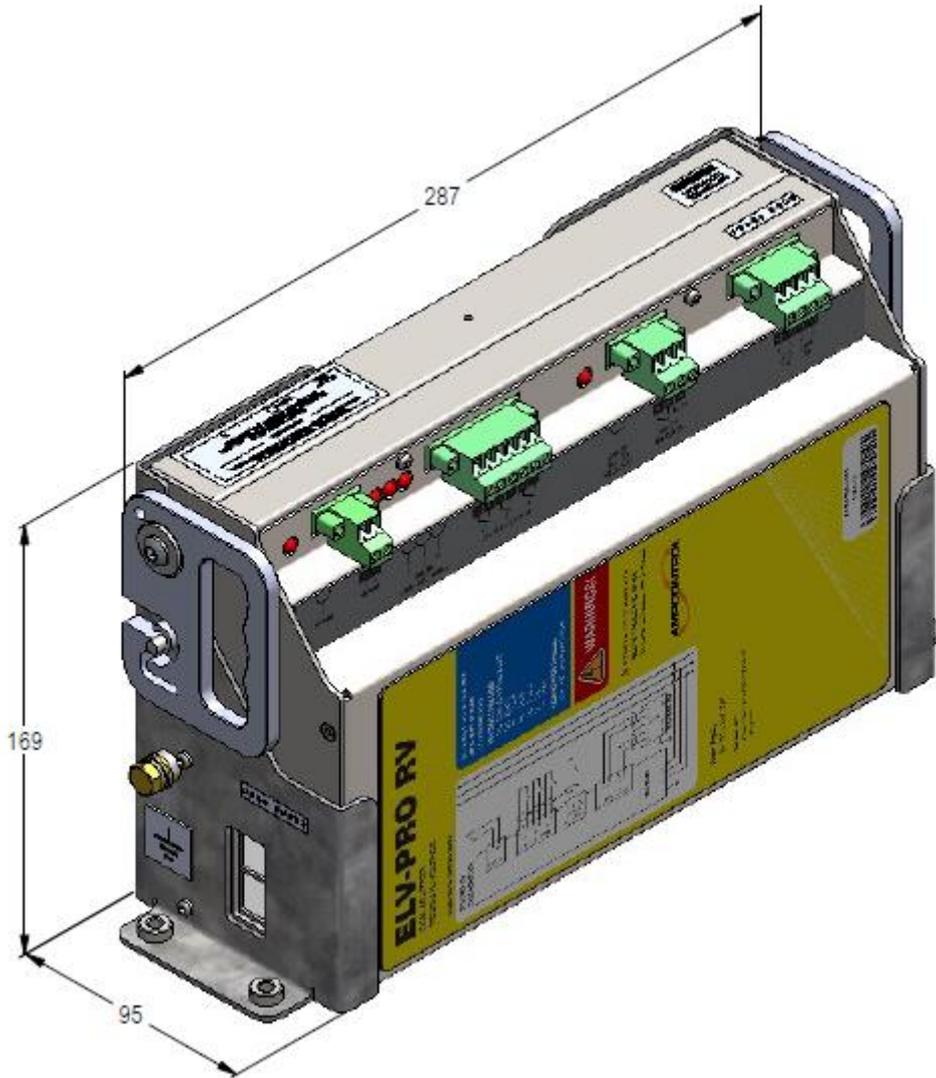


Figure 4: CCM Module In Base Dimensions

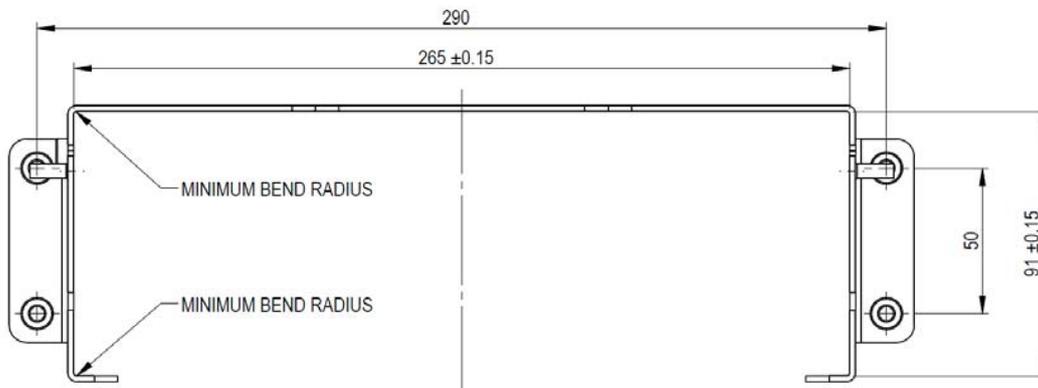


Figure 5: IPX Base Mounting Details

### 4.4 Electrical Installation Information

A typical installation diagram of the ELV-PRO RV System is shown below, Figure 6. The following sub-sections provide a more detailed description of each of the individual circuit elements.

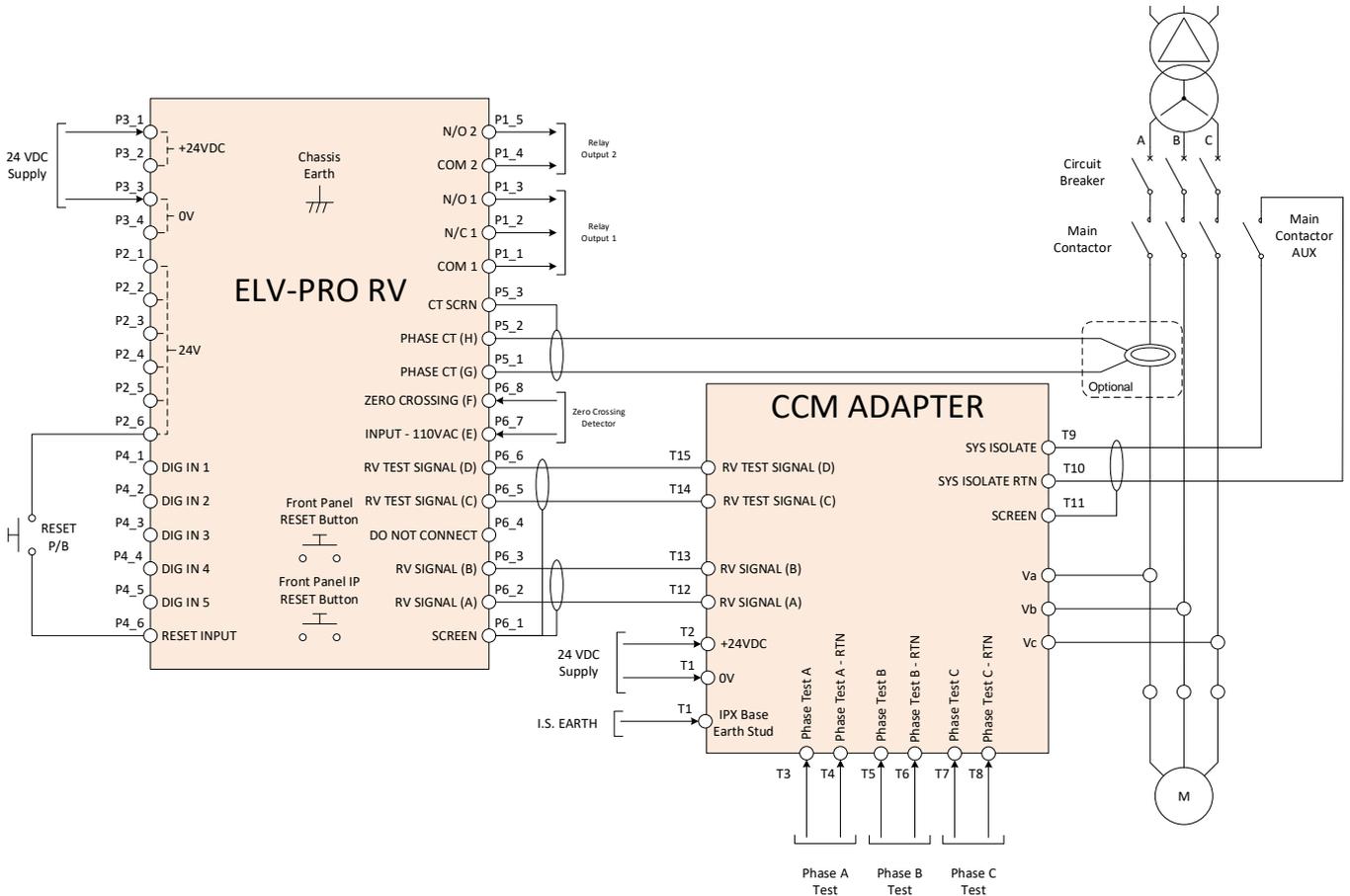


Figure 6: Electrical Connections – ELV-PRO RV Circuit Diagram

**WARNING!**



Ensure all connections are correct prior to putting into service. Incorrect wiring may cause damage to the various modules and / or the systems into which they are installed.

### 4.4.1 ELV-PRO RV: Power Supply (Plug 3)

The ELV-PRO RV requires a regulated 24VDC power supply. There are two input supply connections for both the 0V and +24VDC inputs. These connections are internally connected. Terminals P3\_1 & P3\_2 are the positive supply inputs. Terminals P3\_3 & P3\_4 are the negative supply inputs.

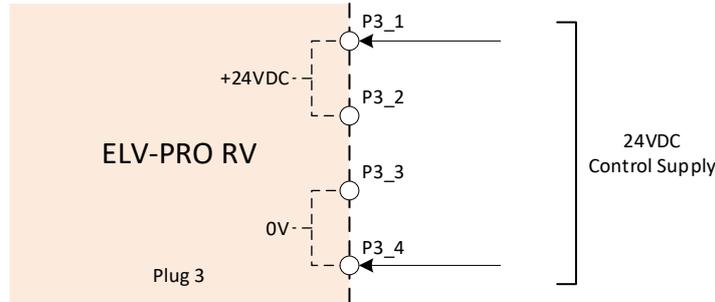


Figure 7: Electrical Connections – ELV-PRO RV Power Supply (Plug 3)

**NOTE**



There are two internally connected input supply terminations for each input. The additional connection is to allow for daisy chaining to other devices.

### 4.4.2 ELV-PRO RV: Trip Reset and Digital Inputs (Plug 2 & Plug 4)

The trip reset and digital inputs are split across two plugs; Plug 2 and Plug 4 (see Figure 8). Plug 2 (right) is a dedicated digital input and Trip Reset 24V supply. All terminals of plug 2 are internally connected. Plug 4 (left) is a dedicated input plug; terminals P4\_1 - P4\_5 are assignable digital inputs, with terminal P4\_6 the Reset input. The Trip Reset Input allows the ELV-PRO RV to be reset remotely.

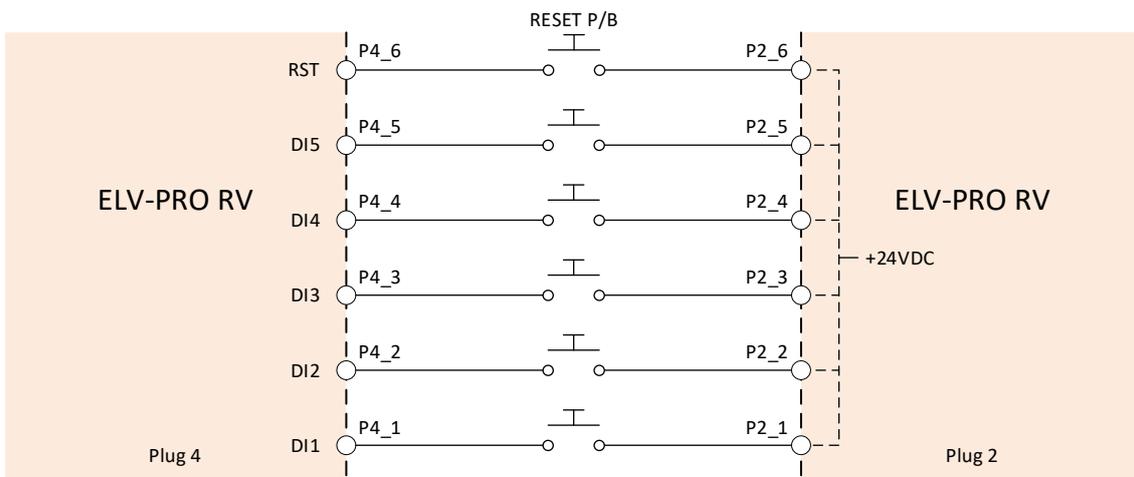


Figure 8: Electrical Connections – Trip Reset and Digital Inputs (Plugs 2 & 4)

### 4.4.3 ELV-PRO RV: CCM Adapter, Zero Crossing Input Connections (Plug 6)

The Earth Fault protection is achieved through the use of a CCM Adapter Module. The connections to this are through terminals P6\_1 & P6\_2. Terminal P6\_3 is the screen termination point for the cable connecting the CCM Adapter signal to the relay.

	<p><b>NOTE</b></p> <p><b>The loop impedance of the cables used to connect the CCM Adapter to the ELV-PRO RV Relay must be less than 1Ω.</b> It is recommended that this is wired as a twisted pair shielded cable.</p>
--	--

To ensure the CCM Adapter is connected and the signal the relay monitors is correct, a RV Test Signal is provided on terminals P6\_5 & P6\_6. A missing test signal will cause the ELV-PRO RV to trip. The test signal is applied every two seconds and may be seen on the live screens and data logs. If a residual voltage is detected the test signal will not be used.

**Terminal 4 of Plug 6 (P6\_4) on the ELV-PRO RV should not be connected.**

The Zero Crossing input, terminals P6\_7 & P6\_8, are provided for logging purposes. The ELV-PRO RV is directly wired to the CCM Adapter terminals as indicated below.

ELV-PRO RV Connection		CCM Adapter Connection	
P6_2	RV SIGNAL (A)	T12	RV SIGNAL (A)
P6_3	RV SIGNAL (B)	T13	RV SIGNAL (B)
P6_5	RV TEST SIGNAL (C)	T14	RV TEST SIGNAL (C)
P6_6	RV TEST SIGNAL (D)	T15	RV TEST SIGNAL (D)

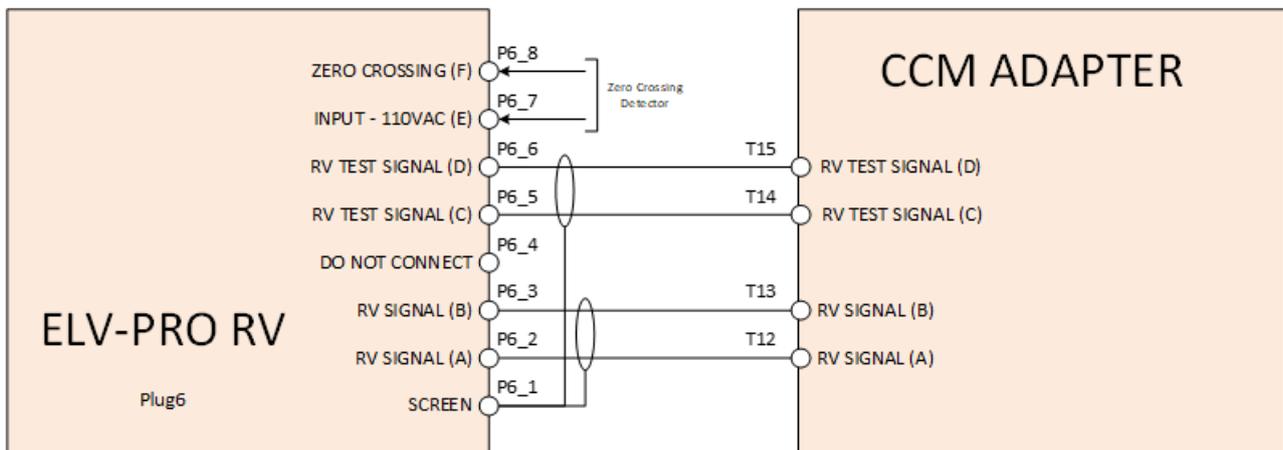


Figure 9: Electrical Connections – CCM Adapter and Zero Crossing Connections (Plug 6)

**NOTE**  The protection system constantly injects a CCM test signal every two seconds. As such, the residual voltage graph will record a small non-zero value, even when the outlet is open (Not connected to the load). This confirms that the system is operational.

Typical RV User Log with 0V RV showing two consecutive RV Test Pulses in OSC display mode.

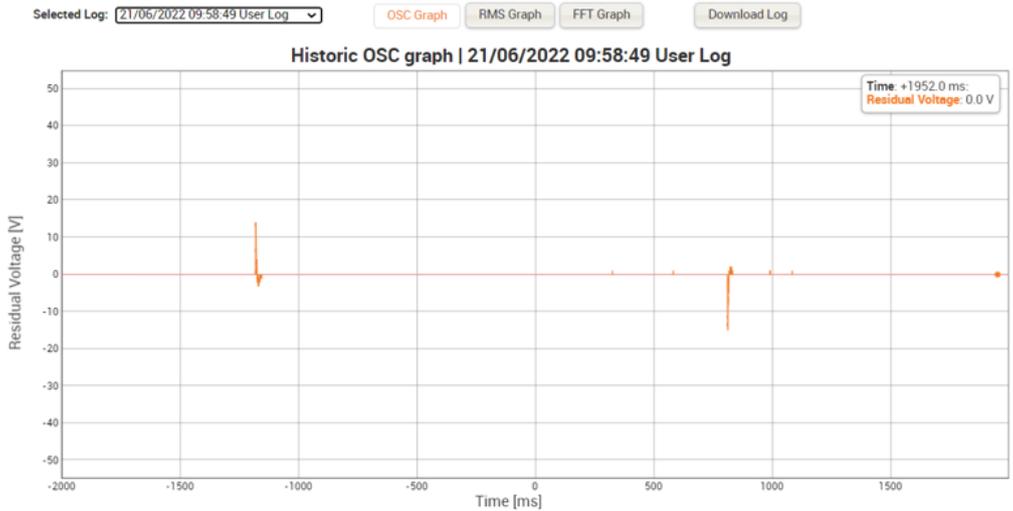


Figure 10: CCM Adapter RV Test Pulses – OSC Graph

The typical RV Test Pulses are seen as ~1V RMS. It is possible at the low resolution for RV test Pulses not to be drawn on the RV trace.

When the Trip level is much higher than 40V then it may not be possible at the autoscaling of the voltage to discern the RV test Pulse (except via a log preview or on the OSC graph)

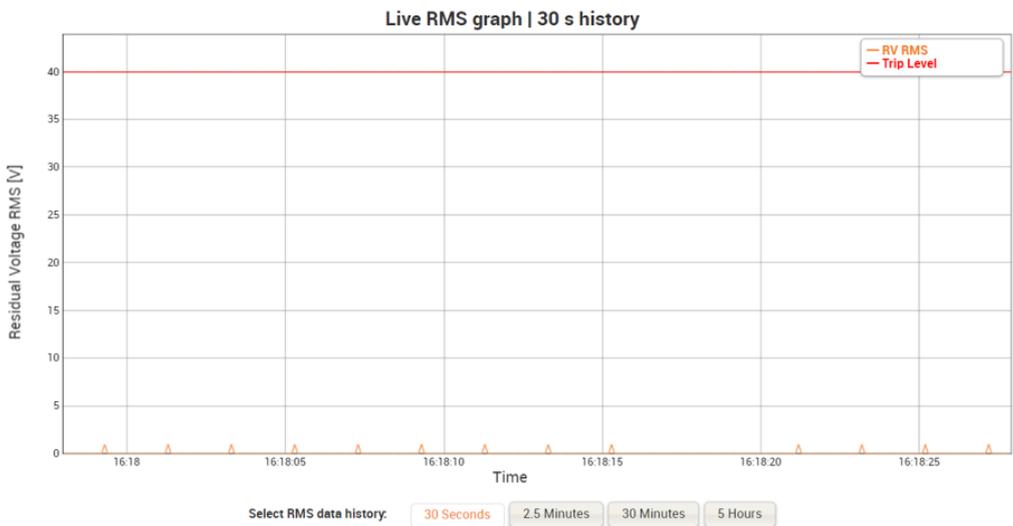


Figure 11: CCM Adapter RV Test Pulses - RMS

Calibration of the relay’s ADC channels should be undertaken through the internal website for new installations, alterations to circuits or change of relay or modules. This ensures that the relay factors in any external influences that could impact the signal analysis. This is achieved through the relays setting page, see section 6.2.6.

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When performing a calibration, the system isolate input needs to be active (calibration with phase connections earthed). It is also important that none of the phase test inputs are active during this process.

**NOTE**

When Calibrating ADC Channels, **System Isolate** needs to be active and **Test Phase** inputs are **NOT** to be active.

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#### 4.4.4 ELV-PRO RV: Phase CT Input (Plug 5)

The ELV-PRO RV has an optional phase CT input (Any suitable toroid with a secondary rating of 5A) which is captured only during a logged event if available. The CT is connected to terminals P5\_1 & P5\_2. Terminal P5\_3 is the screen termination point for the cable connecting the phase CT to the relay.

**NOTE**

No settings are required within the unit for the connection of this additional toroid, but the ratio of the toroid should be recorded so that when data is analysed, the actual phase current can be calculated.

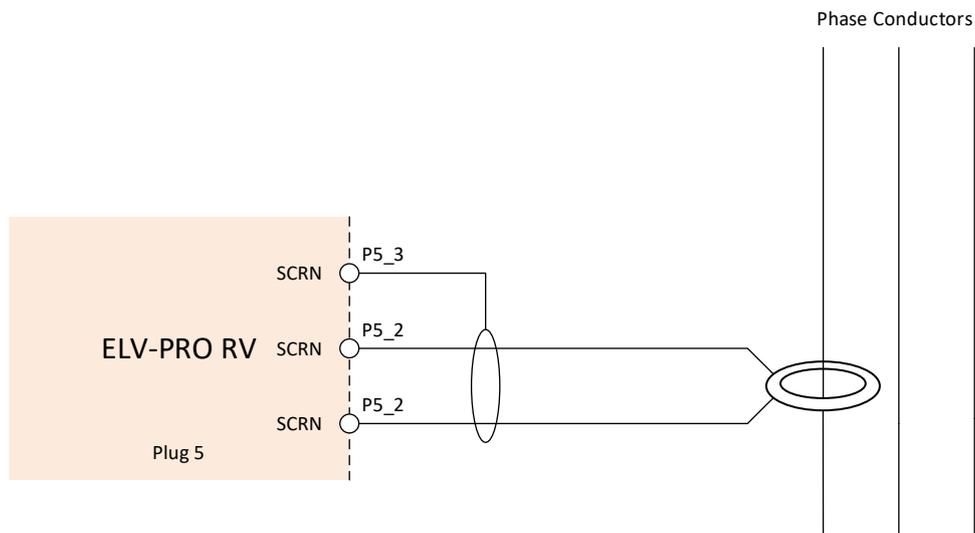


Figure 12: Electrical Connections – Phase CT Input (Plug 5)

**NOTE**

The loop impedance of the cables used to connect the phase CT to the ELV-PRO RV Relay must be less than 1Ω. It is recommended that this is wired as a twisted pair shielded cable.

**NOTE**

No settings are required to be set for connection of additional toroid, However the turns ratio of the toroid should be recorded. This will allow the actual phase current to be calculated during analysis.

### 4.4.5 ELV-PRO RV: Control Contact Output Connections (Plug 1)

The ELV-PRO RV has two control contact output Relays.

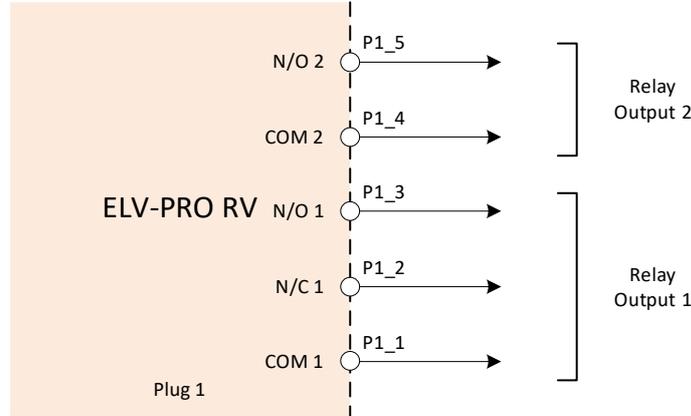


Figure 13: Electrical Connections – Control Contact Outputs Connections (Plug 1)

It should be noted that any ELV-PRO RV built before August 2023 (Serial lower than 2308000000) will have transient suppression filters (RC combination, 22Ω + 100nF) installed across the trip outputs, see Figure 14. The transient suppression filters can allow up to 4.5mA of current when utilised with 110VAC. This current is sufficient for some OEM interposing relays with low VA ratings to hold in, see Industry Notice IN00016, and as such needs to be taken into consideration during system design. If the relay has been modified to have the filters removed, a HW label will be applied next to the trip contacts to identify the modification has been implemented and hardware removed.

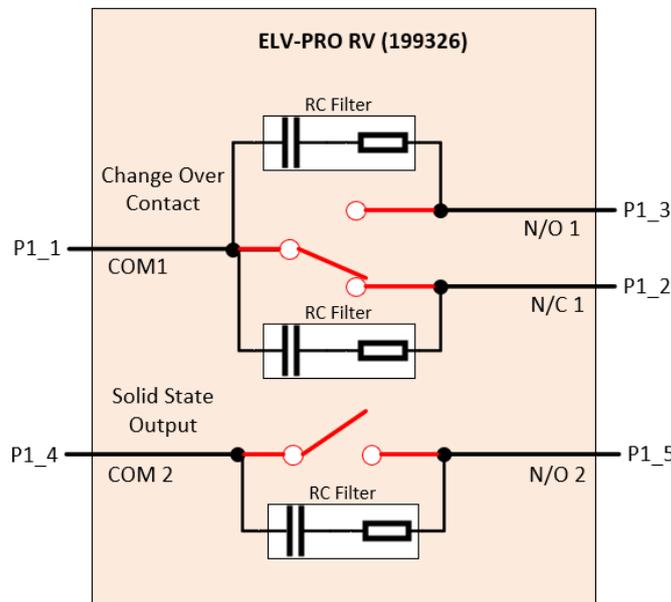


Figure 14: Trip Contact Internal Transient Suppression Filters

All relays with serial number 2308000000 or higher will not contain the internal transient suppression filters. This allows customers the freedom to select and utilise an external snubber filter network appropriate for their application.

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#### 4.4.6 ELV-PRO RV: Dongle Input Slot

The ELV-PRO RV has a dedicated dongle input slot, item 2 of Figure 16. The dongle is keyed and therefore has a specific orientation.



Figure 15: ELV-PRO RV Parameter Dongle

#### 4.4.7 ELV-PRO RV: Ethernet Input

The ELV-PRO RV has an Ethernet socket to allow the ELV-PRO RV to be connected to a network switch or directly to a PC or Ethernet device, see item 1 of Figure 16

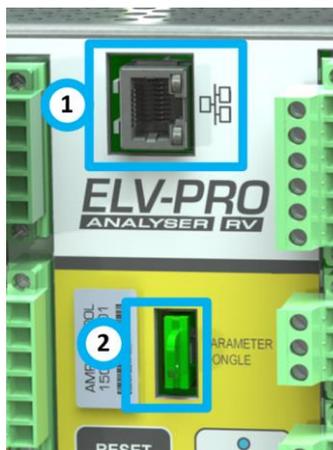


Figure 16: Ethernet and Dongle Connections

#### 4.4.8 CCM Adapter: IPX Base

The IPX Base has 3 HV phase flying leads. These leads are to connect to the system phase connections (Va, Vb, Vc) appropriately.

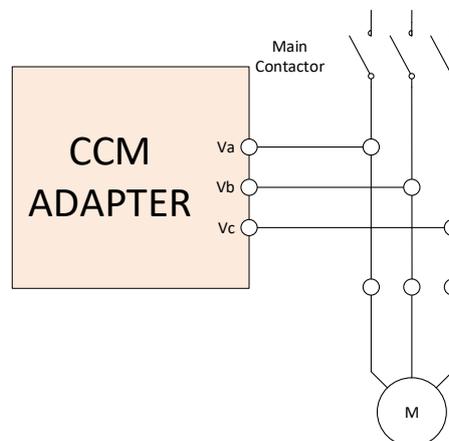


Figure 17: CCM Adapter Phase Connections

#### 4.4.1 CCM Adapter: Power Supply and I.S. Earth Stud

The IPX Base has an Earth Stud which is the dedicated I.S. Earth Connection, installation shall follow I.S. installation requirements.

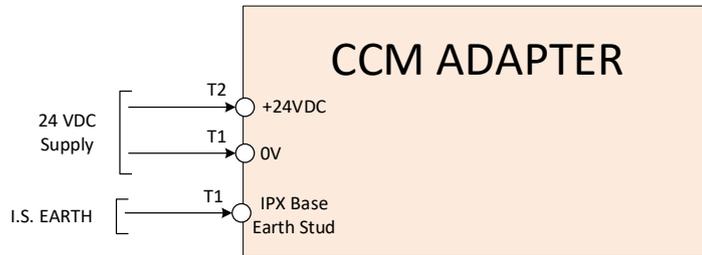


Figure 18: CCM Adapter Power Connections

#### 4.4.1 CCM Adapter: System Isolate Terminals

The system isolate input on the CCM Adapter should be wired to the upstream contactor auxiliary using screen cable.

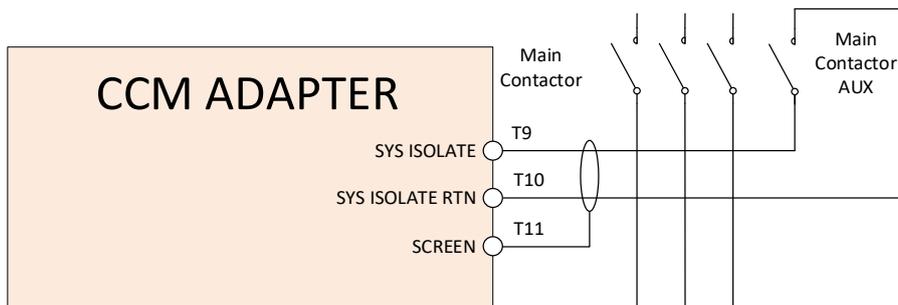


Figure 19: CCM Adapter System Isolate

#### 4.4.1 CCM Adapter: Phase Test Input Terminals

The phase test inputs are used to initiate a system test by opening a phase leg connection and in turn tripping the system. This can be wired to push buttons or controller outputs.

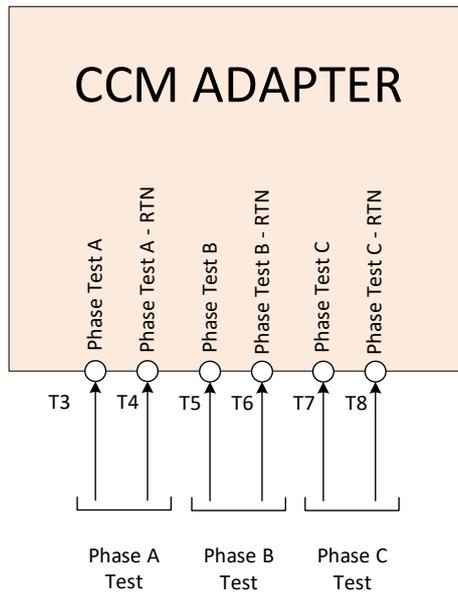


Figure 20: CCM Adapter Phase Test Inputs

#### 4.4.2 Removal of Components

The ELV-PRO RV can be removed by simply removing the plugs and dislodging the relay from the DIN rail. Each plug is secured to the relay through two screws on either end to prevent the plugs becoming loose during operation or transport.

Similarly, the CCM adapter connection can be removed using the two screws and disconnected. The securing handles on the adapter module can then be un-clipped from the base and used to remove the adapter itself.

To remove the IPX base will require the adapter module to be removed and then the phase connections before the 4 screws can be removed along with the base.

## 5 PRODUCT OPERATION

The ELV-PRO RV primary function is to provide effective residual voltage earth fault detection while in addition providing advanced analysis functionality. This section will discuss the various features of the relay.

### 5.1 Earth Fault Protection

The Earth fault protection used in the ELV-PRO RV incorporates functionality similar to the OCS-RV protection element with attributes of the ELV Wideband EL Protection Relay and the standard ELV-PRO relay. The relay is designed to AS/NZS 2081:2011 in principle. The ELV-PRO RV uses wideband technology to characterise the residual voltage measured giving superior fault discrimination, particularly in applications involving switching power electronics and variable speed drives.

The earth fault voltage is measured using a Cable Connection Module Adapter, with the trip time and trip threshold being able to be independently adjusted through the web interface. When a fault occurs above the relays trip level and time delay settings, the relay's trip function is activated. A trip will de-energise the trip contacts wired into the system control circuit. The trip condition is latched and requires a reset input to clear, either through the web interface, Ethernet IP or Modbus IP. A local reset is also provided on the fascia of the relay.

The user has the ability to switch the relay between wideband (up to 8kHz, Recommended setting), narrowband (power frequency) and weighted frequency mode (up to 8kHz, high frequency compensated).

#### NOTE



The recommended setting for Residual Voltage (RV) detection is the Wideband mode.

The ELV-PRO RV Relay has been designed and tested for use on high impedance earth referenced (IT) systems. To ensure maximum protection, the system should be used in conjunction with the other protection systems covered by AS/NZS 2081 as needed. The collective systems are designed to limit touch and step potentials.

The relay is also suitable for industry where equipment or system residual voltage protection is required, the relay is not suitable for personal protection.

The ELV-PRO RV has three operating modes:

- Wideband mode: The relay will see all voltages between 20Hz and 8kHz and trips if the true RMS level of residual voltage is above the trip level (adjustable from 40V to 500V). This mode is the recommended setting.
- Narrowband (power frequency) mode: The relay will see all voltage between 20Hz and 100Hz and trips if the true RMS level of residual voltage is above the trip level (adjustable from 50mA to 5A). This setting should only be used when assessed appropriate for application.
- Weighted frequency mode: This mode sets a modified form of wideband operation for demanding applications; these settings allow increased trip levels at higher frequencies to take into account the reduced sensitivity of the human body to touch potentials at these frequencies. This setting should only be used when assessed appropriate for application.

## 5.2 Earth Fault Analysis Tool

The ELV-PRO RV offers real time analysis of the earth fault voltages along with a logging function that allows the data to be analysed later.

The real time analysis consists of three live graphs; an Oscilloscope graph, RMS Graph and a Fast Fourier Transform Graph.

- OSC (Oscilloscope) graph: Plots the instantaneous voltages measured by the relay, it displays the last 80ms of data.
- RMS graph: Plots the Root Mean Square voltages measured. The user is able to select the time interval on the graph by selecting from the buttons below the graph.
- FFT graph: This plot shows the frequency content of the past 80ms worth of instantaneous measurements.

For further details on navigating these graphs and utilising the analysis tools refer to Section 0.

## 5.3 Data Logging

Data logs are triggered by a trip or alarm event, a trigger from a digital input, or can be set to happen periodically. On each event trigger, the relay stores system data for two seconds before and two seconds after the event. This includes:

- System time,
- Residual voltage,
- Phase current (with connection of a toroid, 5A secondary connection, within  $\pm 5\%$  of full-scale),
- Zero crossing of the phase current (with connection of a 110VAC supply), and
- Temperature

The last 1000 events are stored in the unit. The internal storage cannot be overwritten by the user. When the unit's memory reaches capacity, the oldest entries are overwritten.

Besides being triggered by a trip, logging can be initiated in three other ways:

- Digital Inputs: By a signal at digital inputs 1-5.
- Periodically: Logging initiated by the relay's software at a regular interval.
- Alarm level logging: The user selects a trip level and delay below that of the unit's main trip settings; typically, those of the downstream protection. This allows the user to see the operation of the downstream protection. A cool down time can also be selected to prevent the unit from continuously logging.

## 5.4 Real Time Clock (RTC)

Recorded data is stored on the relay with a time stamp, indicating the system time when the log was made. For the purposes of aligning recorded data with other records, it is important that the user regularly checks that the time on the RTC reflects a level of accuracy acceptable to the user.

Without regular synchronisation, the RTC may become different from actual time. The relay does not have an on-board battery to maintain the RTC settings.

### NOTE



The ELV-PRO RV does not have an on-board battery to maintain the real time clock. Without regular synchronisation, the RTC may be different from the actual time.

If the relay is not configured to use a NTP server, on power-up the relay will look at the last event stored in the memory, add 30 seconds, and use this time as the current time. When a change is made to the relay's time, an event is recorded, capturing the relative time with reference to the power-up time, and a second event is captured with a time stamp of the new configured time.

By doing this any events that occur between power-up and time synchronism can be manually timestamped to the correct time relative to the configured time change. The relay can be configured to utilise an NTP server on a connected network. Refer to Section 6.2.6 for further information. This allows the relay to automatically update the time. Similarly, to a manual time change, if the NTP server causes the relay to adjust its time configuration, the previously mentioned events will be captured.

## 5.5 IP Configuration

The Ethernet connection can be configured in two ways, Static IP or DHCP configurations.

If there is a DHCP server running on your local network, the DHCP setting should be selected in the relay's settings page, Section 6.2.6. Alternatively, if you wish to manually configure a static IP address, this can also be adjusted in the settings page.

- DHCP: Requires no further user configuration.
- Static IP: Requires the user to manually set up the required network parameters. These include IP address, subnet mask and gateway address. These are typically specified by your network administrator.

Connection to the ELV-PRO RV internal web server requires access to a web browser on a connected PC or GUI that has access to HTTP port 80. Network settings will need to be configured correctly to successfully connect to the web server. If there are multiple relays used on a single network switch, initial configuration through a dedicated connection may be required before you can access through a network switch.

### NOTE



Minimum recommended browser versions for full functionality: Microsoft Internet Explorer 9, Google Chrome 20, Apple Safari 5 (or Mobile Safari from iOS 6), Mozilla Firefox 13, Opera 12.

### NOTE



Initial Configuration of an ELV-PRO RV may require direct connection to a PC / GUI using a standard through-type Ethernet cable (CAT5 UTP).

### 5.5.1 Configuration through a Dedicated Connection

First time operation and operation after an IP Reset may require configuration through a dedicated connection. After connecting the relay directly your computer, the red cross over the wireless/hardwired icon on your task bar icon should disappear. If the wireless icon was displayed prior to connecting, the icon will change to the hardwired icon. There will be a Globe shown with a small circle, as shown in Figure 21. This symbol simply means that internet access is unavailable.



Figure 21: Taskbar Icon: Wired Connection Available

You will need to configure the network adapter settings by right-clicking on this icon and selecting “**Open Network & Internet Settings**” as shown in Figure 22: Network Settings.

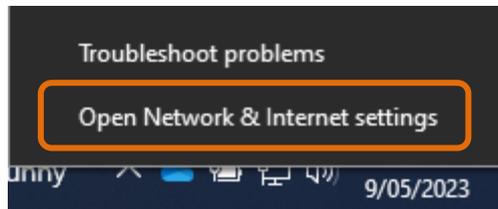


Figure 22: Network Settings

Click on “**Network and Sharing Centre**” as shown in Figure 23: Advanced Network Settings

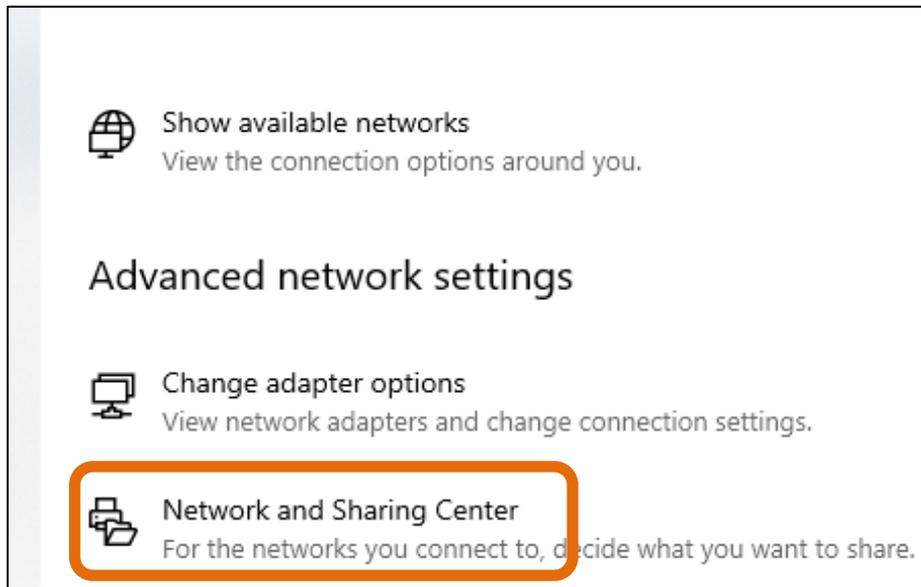


Figure 23: Advanced Network Settings

Open Network and Sharing Centre. The following will appear depending on operating system:

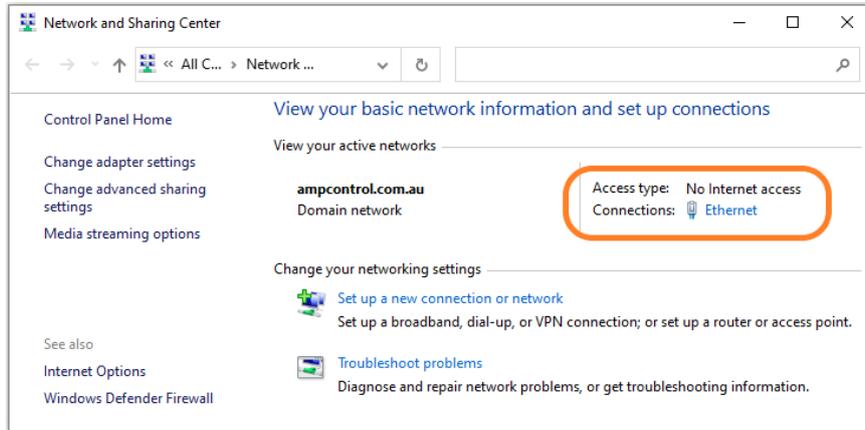


Figure 24: Network and Sharing Centre

Click on “Connections: Ethernet” for the status page to appear as in Figure 25.

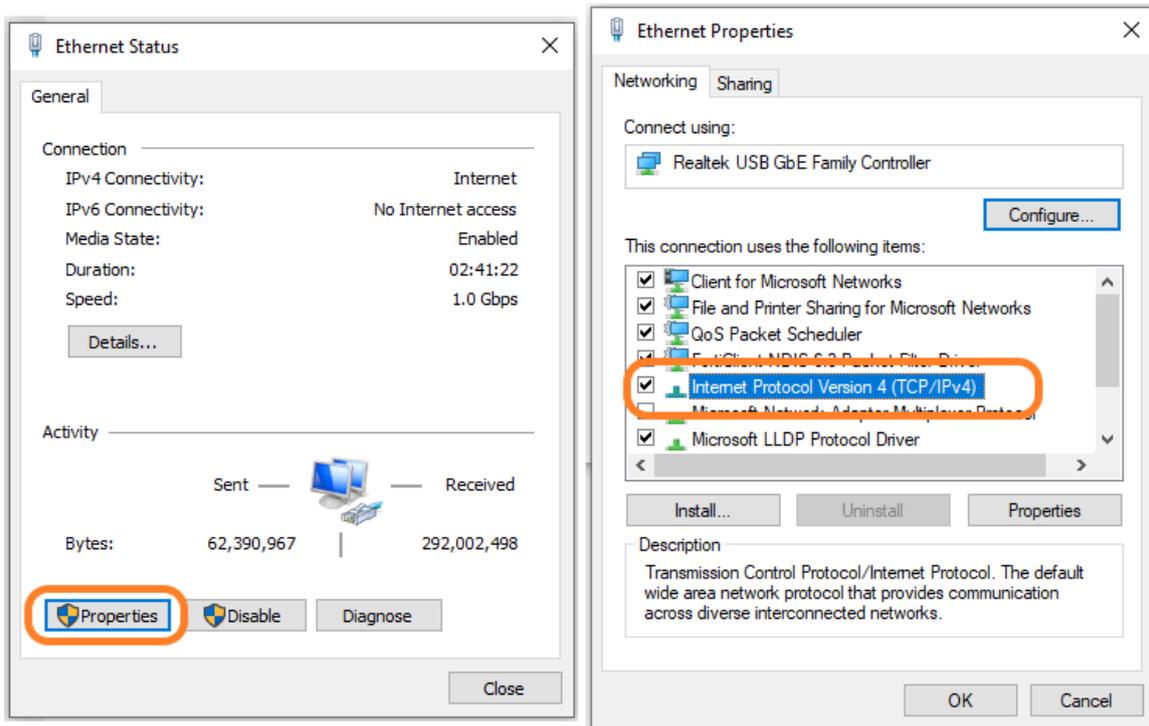


Figure 25: Ethernet Status (left) and Properties (right)

Click the “Properties” button for the “Ethernet Properties” window to appear as shown on the right image. Double click on “Internet Protocol Version 4 (TCP/IPv4)”.

The image in Figure 26: Internet Protocol Versions 4 (TCP/IPv4) Properties will display.

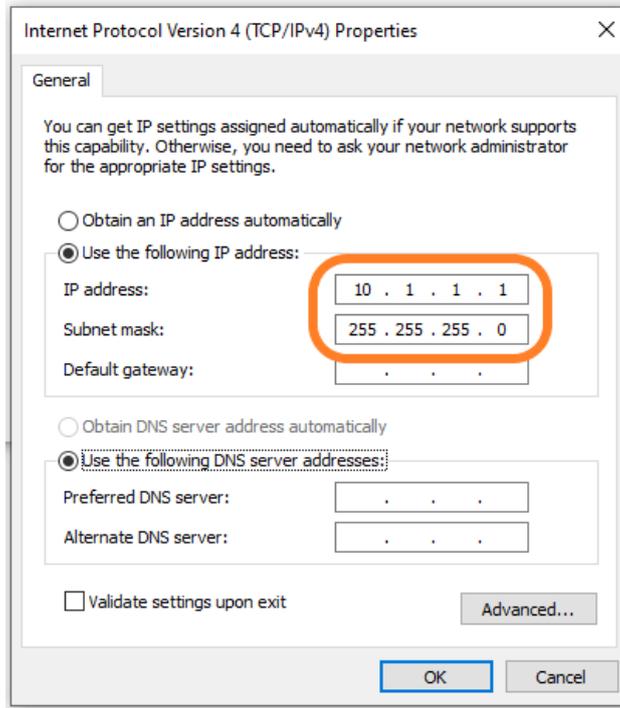


Figure 26: Internet Protocol Versions 4 (TCP/IPv4) Properties

Assign the following IP address and Subnet mask:

- IPv4 Address = **10.1.1.xxx**, where **xxx** is a value between 1 and 250 excluding address 10 (The relay's default setting is 10 so will cause a clash)
- IPv4 Subnet Mask = **255.255.255.0**.

Once you have configured the network adapter settings, open up a web browser and type the default IP address (**10.1.1.10**) into the browser's address bar. The web interface should appear as detailed in Section 0.

## 5.6 Protection Settings

The modifiable settings of the ELV-PRO RV include the following:

- Residual Voltage Trip Level
- Residual Voltage Trip Time
- Residual Voltage Alarm Trip Level
- Residual Voltage Alarm Time
- Alarm Cool Down
- Residual Voltage Mode
- Digital Input Settings

### 5.6.1 Residual Voltage Trip Level

This defines the residual voltage level which will cause a trip. The voltage is detected via the CCM adapter module and phase connections and is given in RMS. The setting can be any value between 40V and 500V inclusive. The web server however has used values in set intervals to make adjustment easier and quicker. These values can be seen below, Table 4.

*Table 4: Residual Voltage Trip level*

Value (V)	Value (V)
40	200
50	250
60	300
70	350
80	400
90	450
100	500
150	

### 5.6.2 Residual Voltage Trip Time

This defines how quickly the residual voltage trip will occur when the measured voltage is greater than the trip level. These values are the maximum trip time, not the minimum (that is a trip is guaranteed to occur in less than 100ms when set to 100ms). The setting can be any value between 50ms and 500ms inclusive. The web server however has used values in set intervals to make adjustment easier and quicker. These values can be seen below.

Table 5: Residual Voltage Trip Time

Max. Trip Time	Max. Trip Time
Instant (50ms)	300ms
100ms	350ms
150ms	400ms
200ms	450ms
250ms	500ms

### 5.6.3 Residual Voltage Alarm Trip Level

The setting can be any value between 40V and 500V inclusive. The web server however has used values in set intervals to make adjustment easier and quicker. These values are identical to the RV Trip Level, as shown in Table 4.

### 5.6.4 Residual Voltage Alarm Time

This can be set to any value between 100ms and 1500ms inclusive. The web server however has used values in 50ms intervals to make adjustment easier and quicker.

### 5.6.5 Alarm Cool Down

This is the number of seconds that needs to have elapsed before the alarm can re-trigger. The value can be set to any value between 5 seconds and 300 seconds inclusive. The web server however has used values in set intervals of 5 seconds to make adjustment easier and quicker.

### 5.6.6 Digital Input Settings

The five (5) digital inputs are individually configured to suit the user's application requirements. The following settings can be selected.

Table 6: Digital Input Settings

Digital Input Polarity	Digital Input Action
Normally Open	None
Normally Closed	Log

## 5.7 CIP over Ethernet/IP Interface

The ELV-PRO RV has included EIP protocol to allow external equipment (capable of communicating in this protocol) to monitor and reset the relay, such as a PLC. The EIP commands and configuration can be seen in APPENDIX A: ELV-PRO RV CIP OVER ETHERNET/IP.

## 5.8 Modbus TCP Interface

The ELV-PRO RV has included a Modbus IP protocol to allow external equipment (capable of communicating in this protocol) to monitor and reset the relay, such as a PLC. The Modbus IP commands, and configuration can be seen in APPENDIX B: ELV-PRO RV Modbus TCP.

## 5.9 CCM Adapter - Phase Test Inputs

Designed to create voltage imbalance within the ELV-PRO RV CCM to force a trip of the ELV-PRO RV Relay. There is one Test input for each of the 3 phases. These inputs are not to be conducted when System Isolate control input is active as this would not cause sufficient RV imbalance when not connected to the HVR.

Activating all 3 test inputs at the same time will not work as all phases will remain “in balance”.

Ideally a single test input should be activated with a relay trip being observed and then reset. Then proceed to the next test input to test and reset etc. This will verify that each phase has continuity to through the HVR + ELV-PRO RV CCM ADAPTOR.

## 5.10 System Certification Details

The ELV-PRO RV CCM Adapter is a certified piece of equipment, details are as follows

[Ex ia Ma] |  $0^{\circ}\text{C} \leq T_a \leq 60^{\circ}\text{C}$

IECEX ExTC 22.0005X

I.S. Parameters

HVR Base Flying Leads

Um: 2286Vrms Phase to Earth  
Uo: 28.0V  
Io: 114uA  
Po: 1mW  
Co: 3.76uF  
Ci: NIL  
Lo: 300H

CCM Adapter Terminals

Um: 132Vrms Phase to Earth

## 6 OPERATIONAL INTERFACE

This section provides information relating to the interfacing of the ELV-PRO RV. All interfacing elements will be defined here including the front Facia, Web server, Ethernet IP and Modbus IP.

### 6.1 Relay Front Facia Interface

The relay has a basic interface on the front of the relay. The relay has been specifically designed to operate through a PC or web server when connected to a network. The interface is shown in Section 6.2.

The front of the relay has two buttons and two indicators shown in Figure 27. The 'Reset' button (Item 3), functions as a local reset button allowing a trip to be reset, provided the fault has cleared. The 'IP Reset' button (Item 4), is used to reset the IP address to the factory default setting (10.1.1.10). An IP Reset requires a 'press and hold' operation for 8 seconds. A successful IP Reset will be confirmed through the front LED indication sequence as indicated in Table 7.

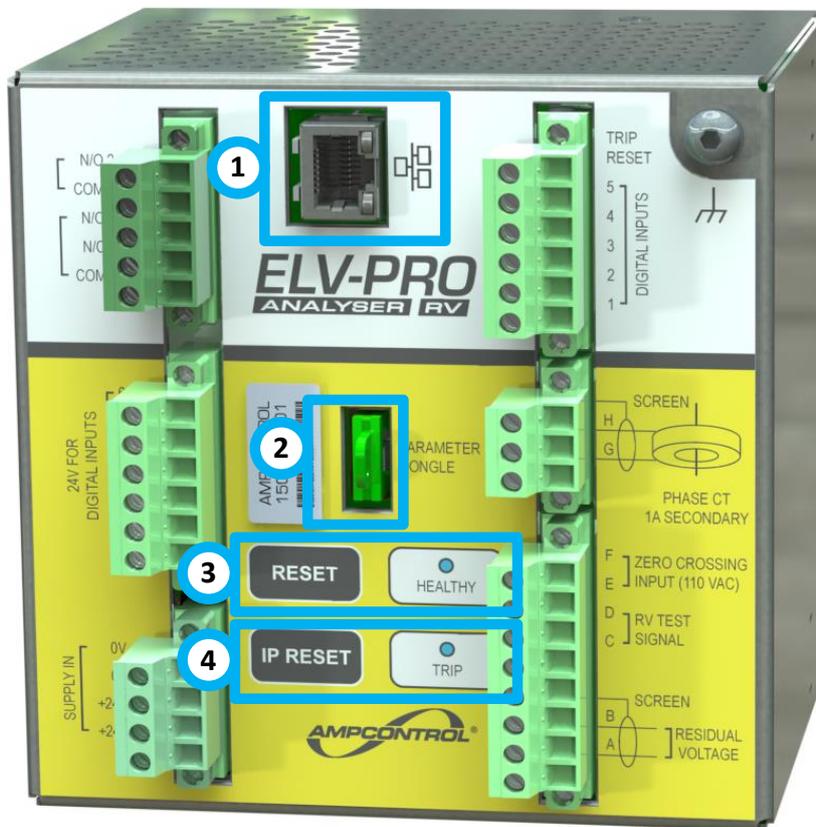


Figure 27: Relay Front Fascia Interface

Table 7: Relay Front Fascia LED Operation

LED		Description
Healthy / Green	Trip / Red	
Flash (1Hz)	Off	Healthy Relay
	Flash (5Hz)	Tripped Relay
Flash (2Hz)	OFF/ON	IP Reset. Once the reset has taken effect the red indicator will remain on for 5 seconds

## 6.2 Web Interface

The Web Interface allows the user to remotely access the information stored within the ELV-PRO RV. This includes live data, event and data logs, device information and settings. The relay has six main tabs, accessible from the left-hand side of the page. These are:

- Live Graphs
- Data Logs
- Event Logs
- Device Info
- Settings
- About

### 6.2.1 Connecting to the Web Interface

In order to connect to the Web Interface, the computer that is accessing the relay must be connected to the same network as the relay. The user must then type the IP address of the relay that they wish to connect to into their web browsers address bar. For more information on IP configuration, refer to Section 5.5.

The Live Graphs tab is the default landing page and will automatically be displayed upon accessing the Web Interface. Refer to Section 6.2.2 for more information on the Live Graphs.

The web interface has a number of features that are common to all views. These features are identified in Figure 28 by numbered circles. Items identified by these numbered circles are explained in further detail in the following sub-sections.

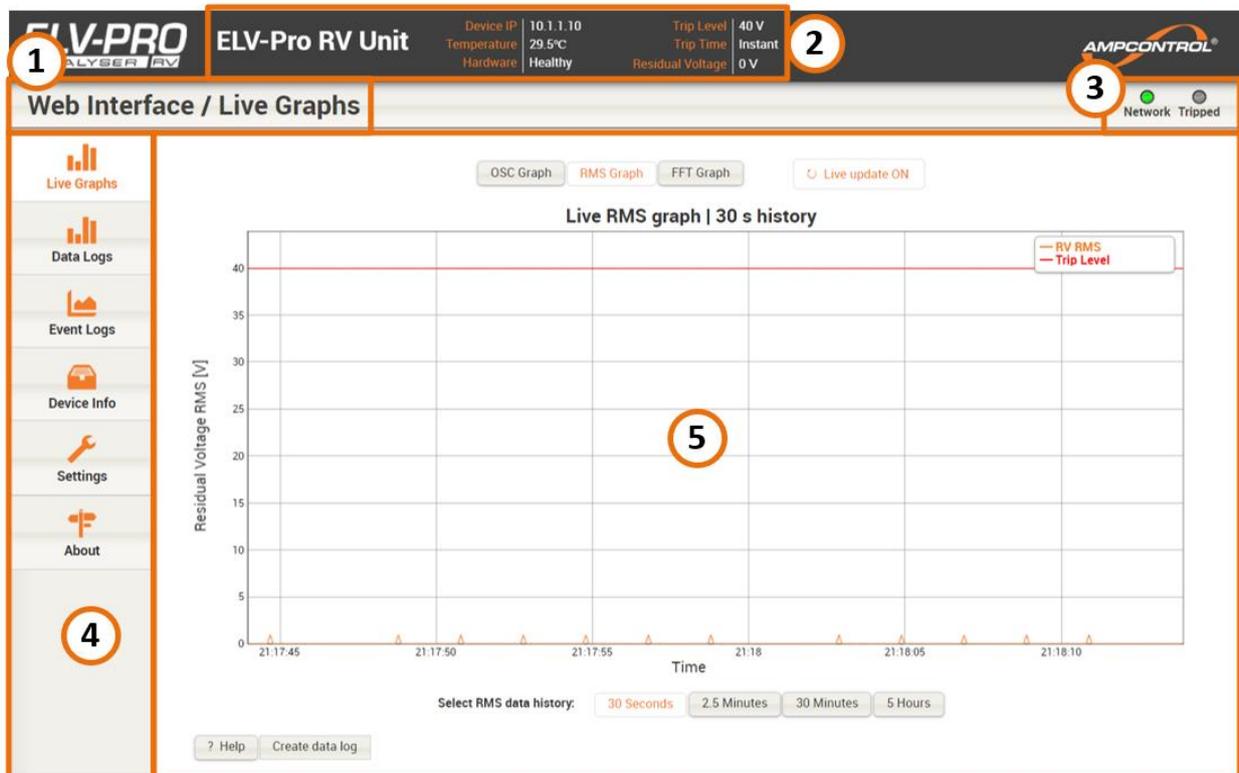


Figure 28: ELV-PRO RV Web Interface – Overview

**NOTE**



In order to view the Web Interface, the ELV-PRO RV and the computer that is accessing the Analyser must be on the same network.

**NOTE**



Minimum recommended browser versions for full functionality: Microsoft Internet Explorer 9, Google Chrome 20, Apple Safari 5 (or Mobile Safari from iOS 6), Mozilla Firefox 13, Opera 12

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**6.2.1.1 Item 1: Selected Tab**

This name of the tab that is currently visible is displayed here.

When the relay is tripped, the web server reset button is also displayed next to the tab name (see Section 0).

**6.2.1.2 Item 2: IP Address | Temperature | Unit Date and Time**

This area of the Web Interface displays:

- The relay description/name
- The IP address of the relay
- The temperature that the relay is currently operating at
- The Hardware status
- Trip Level
- Trip Time
- EL Current

The relay description in the top of the screen is defined in the dongle settings (see Section 6.2.6). This description is also used to correctly identify the connected relay.

**6.2.1.3 Item 3: Status Indicators**

The relay Status Indicators display the status of the Web Interface network connection, as well as the status of the relay. The functionality of these indicators is outlined in Table 8.

*Table 8: Web Interface Status Indicators*

Indicator	Colour	Description
Network	Green/Red	The network indicator flashes green every time a network request is made to the unit. If a network request fails, this indicator will flash red.
Tripped	Red	This indicator illuminates red when the unit trips. The header block and page background will also change to red.

**6.2.1.4 Item 4: Tab Selection Panel**

The Tab Selection Panel allows the user to switch between the different views in the ELV-PRO RV Web Interface. To move between tabs, simply mouse over the desired tab and select it with the left mouse button.

**6.2.1.5 Item 5: Tab Viewing Area**

This area of the Web Interface will display the information that is relevant to the tab that has been selected. The area outside of this zone will remain constant.

### 6.2.2 Live Graphs Tab

Figure 29 shows the ELV-PRO RV Live Graphs interface. By default, the Live Graphs tab displays the RMS graph of the past 30 seconds. The graphs in this tab are refreshed every second; provided the Live Update button (Item 2) is activated (default is ON). With the Live Update button disabled the plot is static which can allow for better inspection of the data shown using the interactive features of the plots (described in Section 0). The buttons above the graphs (item 1) allow the graph to alternate between the three possible options. These are:

- **RMS graph:** In this view, Root Mean Square (RMS) values of the measured voltage are shown. The user is able to select the time interval on the graph by selecting from the buttons below the graph, Figure 29.
- **OSC (Oscilloscope) graph:** Plots the instantaneous values of residual voltage measured by the ELV-PRO RV. At every update, it displays the last 80ms of data, Figure 30.
- **FFT graph:** This plot shows the frequency content of the past 80ms worth of instantaneous measurements, Figure 31.

For information on navigating the interactive graphs see Section 0. There is also a Help button below the plots, item 4, which allows access to online help information.

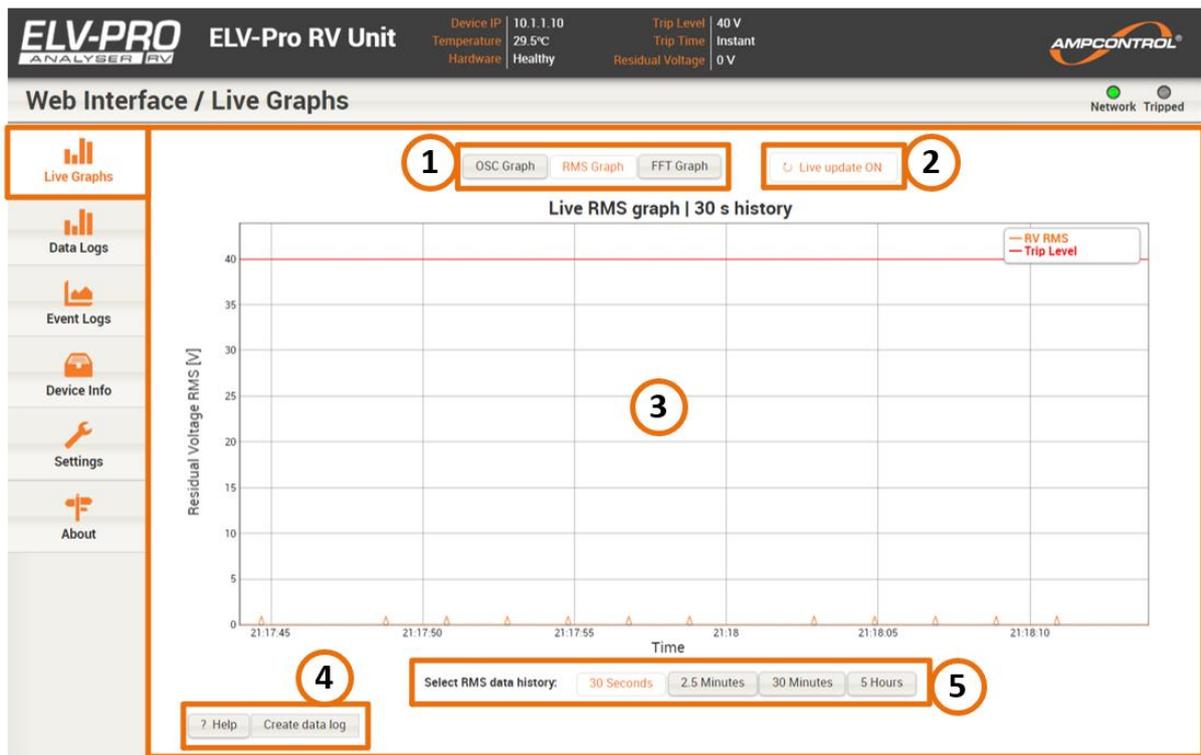


Figure 29: ELV-PRO RV Web Interface - Live Graphs (RMS)

**NOTE**

The protection system constantly injects a CCM test signal through to the CCM Adapter Module every two seconds. As such, the Residual Voltage graph will record a small non-zero value, even when the outlet is de-energised. This confirms that the residual voltage detection is operational.

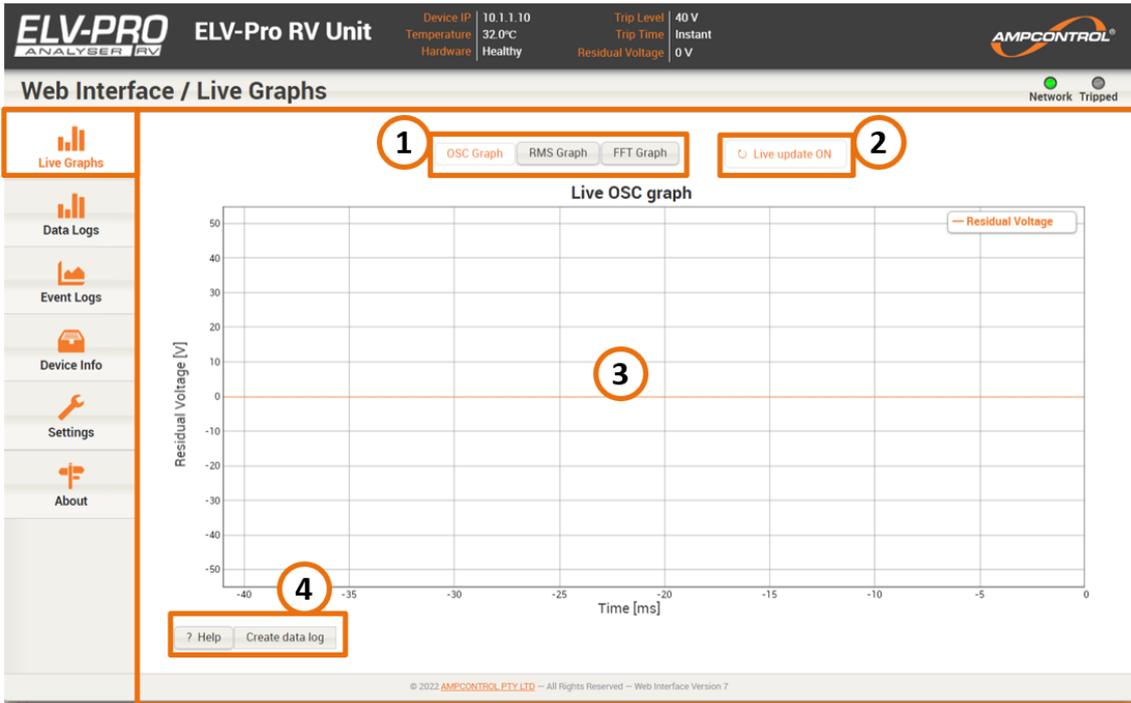


Figure 30: ELV-PRO RV Web Interface - Live Graphs (OSC)

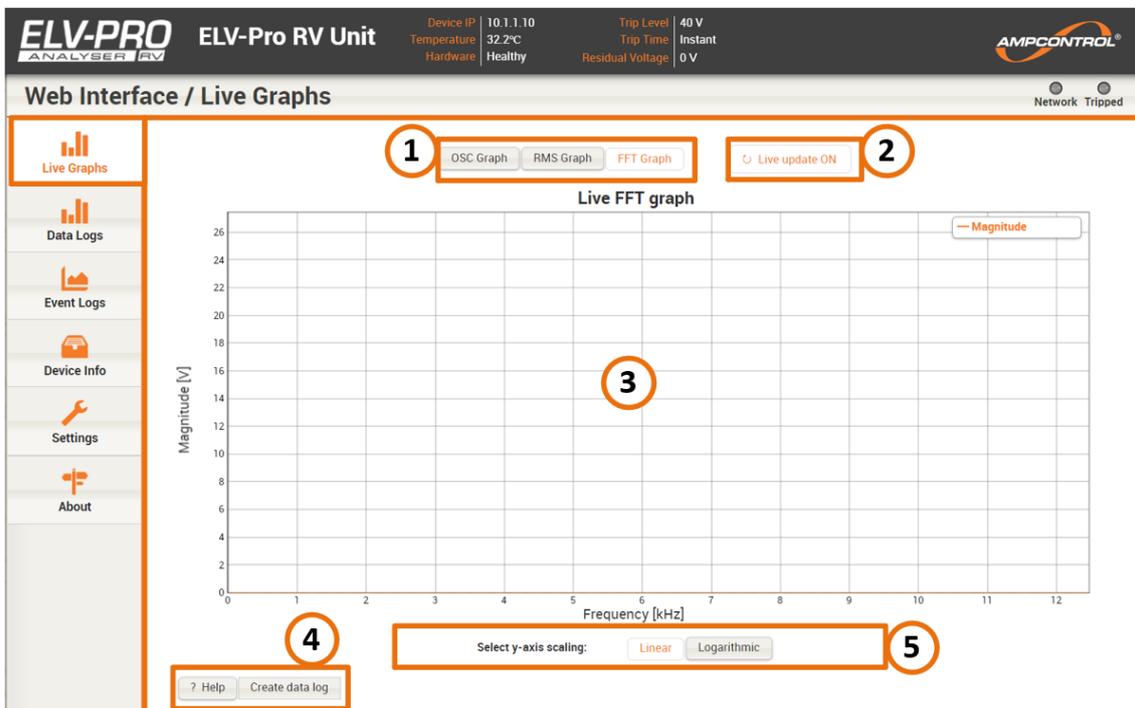


Figure 31: ELV-PRO RV Web Interface - Live Graphs (FFT)

### 6.2.3 Data Logs Tab

The Data Logs tab is similar to the Live Graphs tab, in that it allows inspection of measured residual voltages. However, in this tab, historic measurements from data logs stored on the relay are shown.

Each data log is centred on a trip or log event (i.e. the log covers the two seconds before and two seconds after the log initiation, making the command instant at the centre of the graph).

Once a particular log is selected from the list (Item 1 of Figure 32) in the drop-down menu, OSC, RMS and FFT views are available as they are in the Live Graph tab.

The RMS view (Figure 34) is calculated using a running window of 300 data points.

The FFT graph (Figure 35) corresponds to the selected 80ms of signal. A small oscilloscope plot of the signal (item 2 of Figure 35) is provided to indicate where in the recording the data is being analysed. Use the slider below the plot to select another window within the recording.

Data logs can also be downloaded by clicking on the ‘Download Log’ button. This will export the data in an Ampcontrol proprietary format.

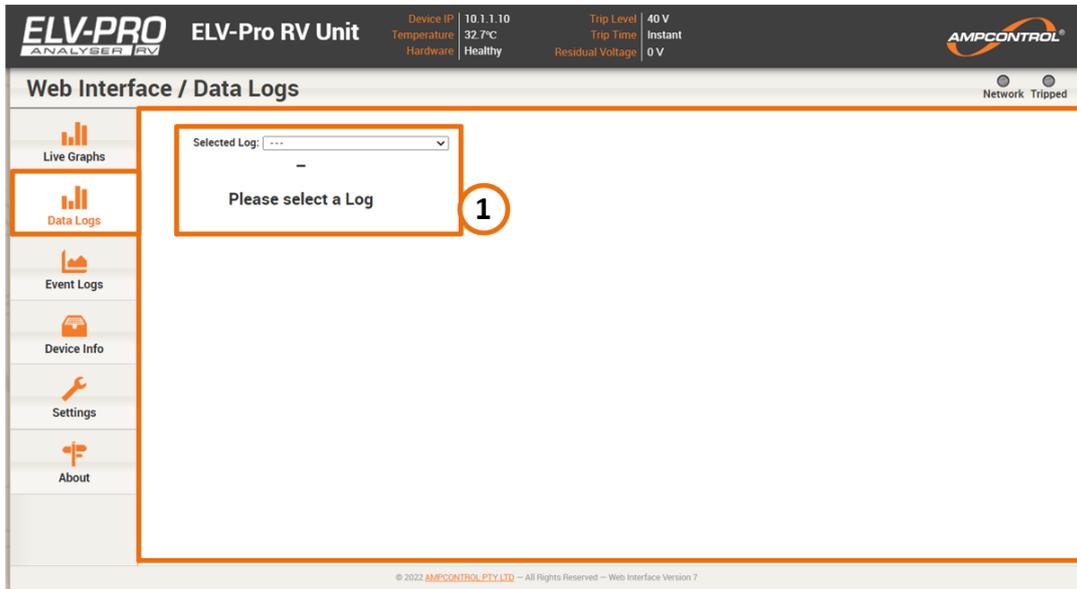


Figure 32: ELV-PRO RV Web Interface - Data Logs

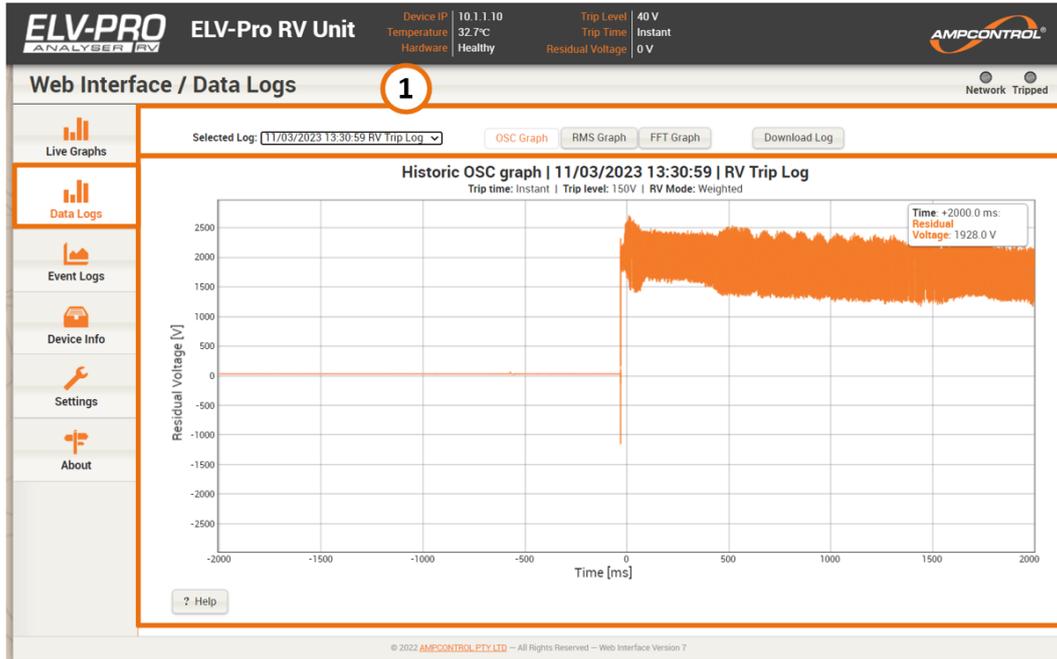


Figure 33: ELV-PRO RV Web Interface - Data Logs (OSC)

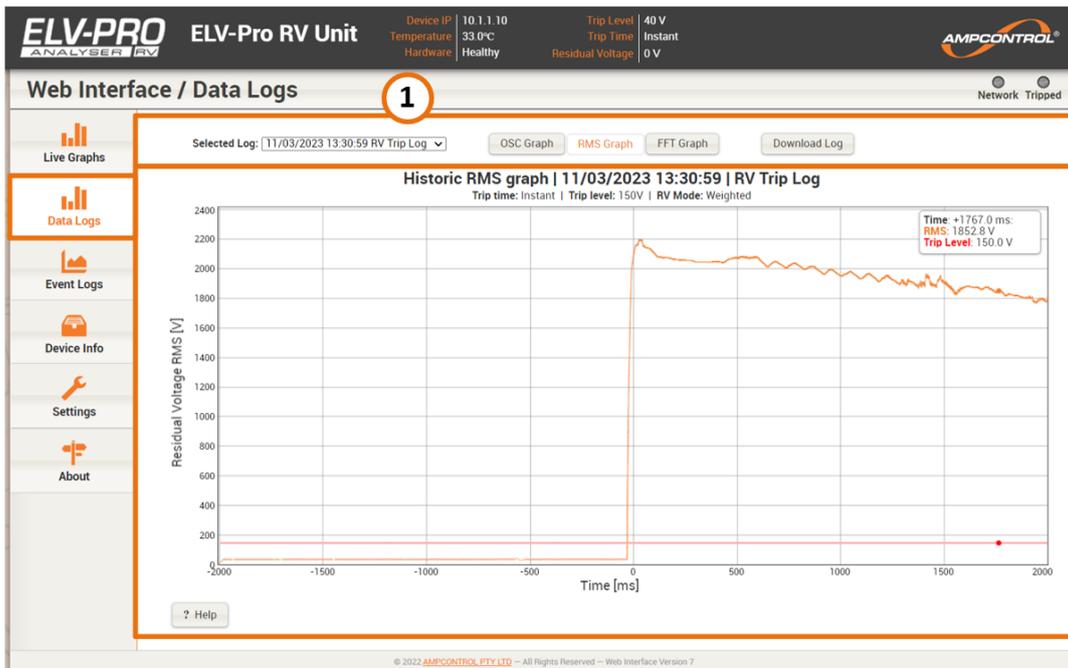


Figure 34: ELV-PRO RV Web Interface - Data Logs (RMS)



Figure 35: ELV-PRO RV Web Interface - Data Logs (FFT)

### 6.2.4 Event Logs Tab

This tab shows the 50 most recent user changes made at the unit, see Figure 36. To export this list, use the link above the log (item 1) to show the log entries in a separate popup window for printing or copy-pasting. The Event log descriptions can be found in **Table 9** below.

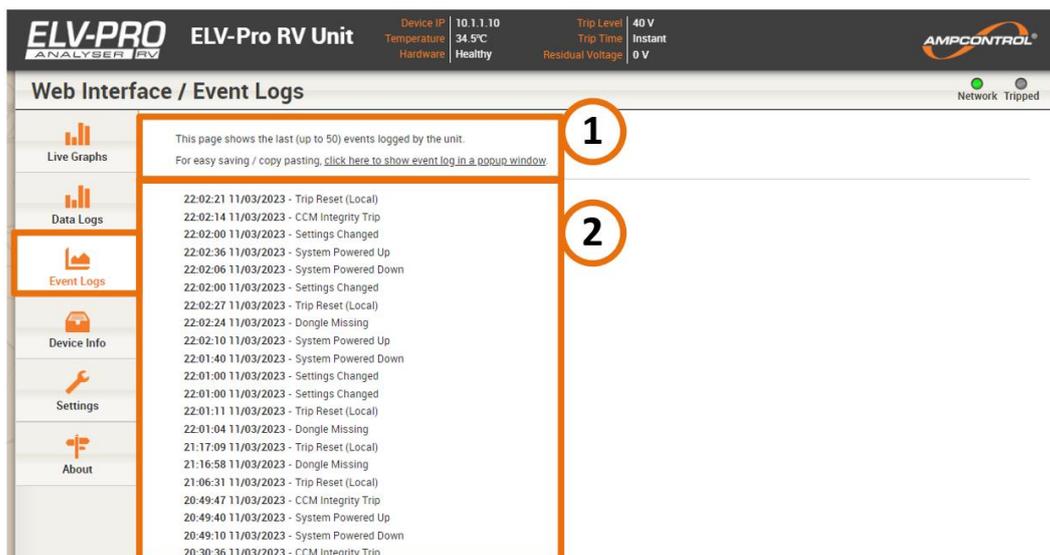


Figure 36: ELV-PRO RV Web Interface - Event Logs

**Table 9: Event ID Descriptions**

Event ID	String	Description
0	<i>Unused</i>	Not a valid message. Should not be seen
1	System Powered Up	When the unit received power following a normal shut down
2	System Powered Down	When the unit had power removed in a normal shut down
3	Loss of RTC Detected	The Real Time Clock has been lost
4	Stored Trip Corrupted	The trip value as stored in the EEPROM is corrupted. Defaulting to the unit being tripped
5	Trip Reset (Local)	When the unit has been reset after a trip using the Local Trip Reset
6	Trip Reset (Ext Input)	Unit has been reset after a trip using a pushbutton on the external input
7	Residual Voltage Trip	Unit tripped due to detection of residual voltage at or exceeding the trip settings
8	Ext Input Trip	Unit tripped due to a signal from an external input
9	Ext Input Log	A signal change is seen at any configured input
10	Periodic Log	Periodic log has been taken
11	Settings Changed	User has changed settings
12	EEPROM has failed	The internal EEPROM chip has failed
13	OS Scheduler fault	The internal Threading Scheduler has failed
14	CCM Integrity Trip	Unit tripped because it could not sense the Cable Connection Module (CCM)
15	Relay failed to close	Relay contacts failed to close when expected
16	Relay failed to open	Relay contacts failed to open when expected
17	System Restarted	The unit has restarted un-expectedly
22	Power State Corrupted	The unit's previous power state is corrupted
23	Alarm tripped Log	Unit has made a log on the alarm level setting
24	Serial Number Corrupted	Serial Number value Corrupted and is out of range (Not a valid number)
25	MAC Address Corrupted	Serial Number value Corrupted (Not a valid number)
26	EL Sample rate Error	The internal protection loop has failed to execute in the required time
27	Dongle Missing	The parameter dongle has been removed or is not operating
28	Invalid Dongle Type	The parameter dongle is not correctly setup for the ELV-PRO RV
29	IP Address Reset	The unit's IP address has been reset to its factory default
30	Trip Reset (Webpage)	When the unit has been reset after a trip using the web interface, or EIP / MODBUS TCP
31	Pre-Large NTP Time Adjustment	The system's time is about to be modified based upon the NTP server (used to determine size of system time change.)
32	Post Large NTP Time Adjustment	The system's time has been modified based upon the NTP server (used to determine size of system time change.)

### 6.2.5 Device Information Tab

The Device Information Tab (Figure 37) shows settings, states and measurements relating to the hardware and software of the Analyser. The information is updated once a second and includes:

- Trip Settings
- Network Settings
- NTP Settings
- ADC Settings
- Software Information
- General Settings
- Systems Trips
- Digital Input Settings
- Hardware Status

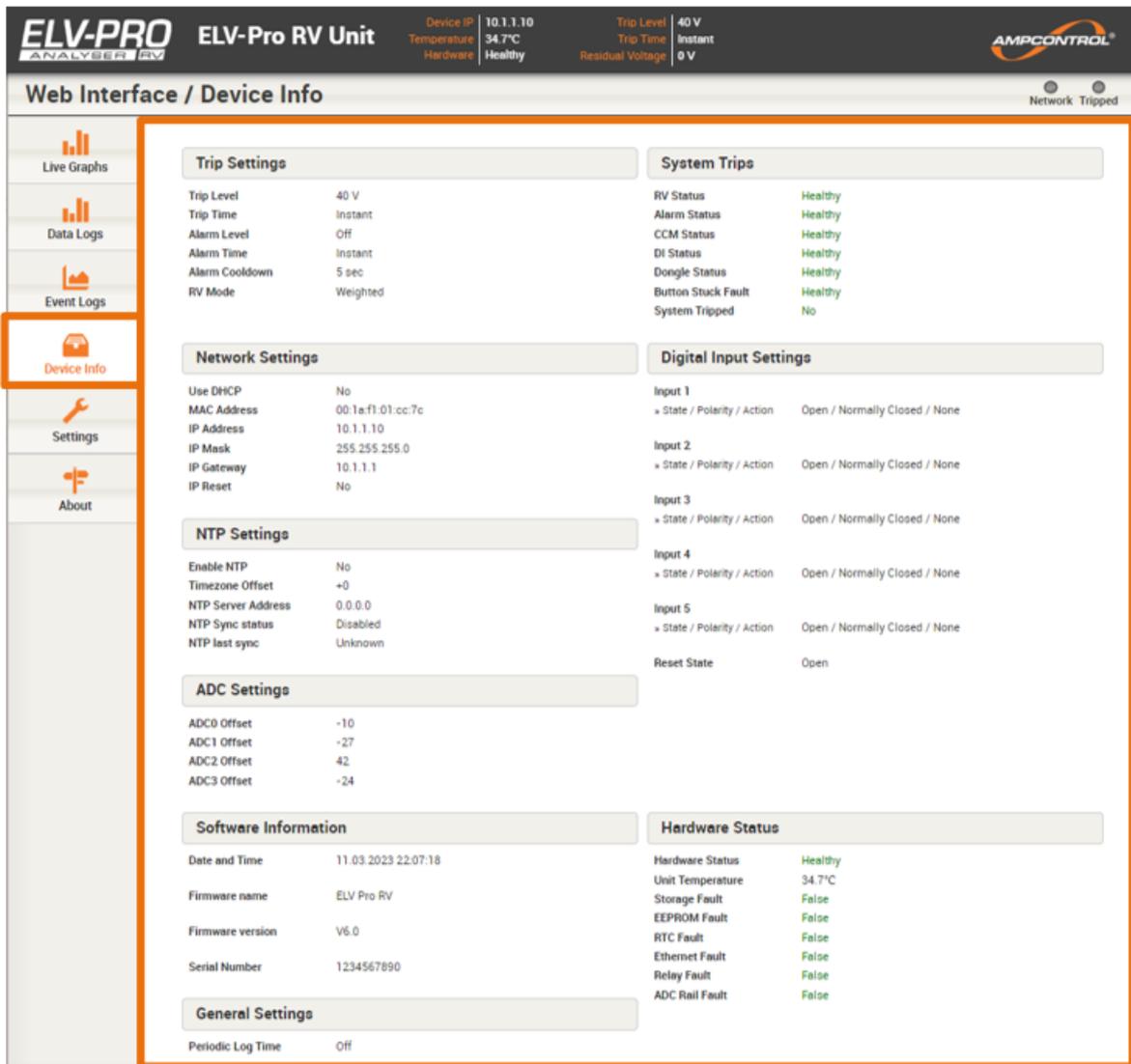


Figure 37: ELV-PRO RV Web Interface - Device Info

### 6.2.6 Settings Tab

The settings Tab (Figure 38) allows for configuration of the following:

- Trip Settings
- Network Settings
- NTP Settings
- Date and Time
- Digital Input Settings
- Unit Configuration
- ADC Settings
- Passwords

To access the Settings page, the user will be prompted to enter a Username and Password. The default login details are shown in Table 10 below. Once the desired settings have been changed, select “Save Settings” to save and return to the home page.

Table 10: Login Details

<b>Username</b>	admin
<b>Password</b>	Password

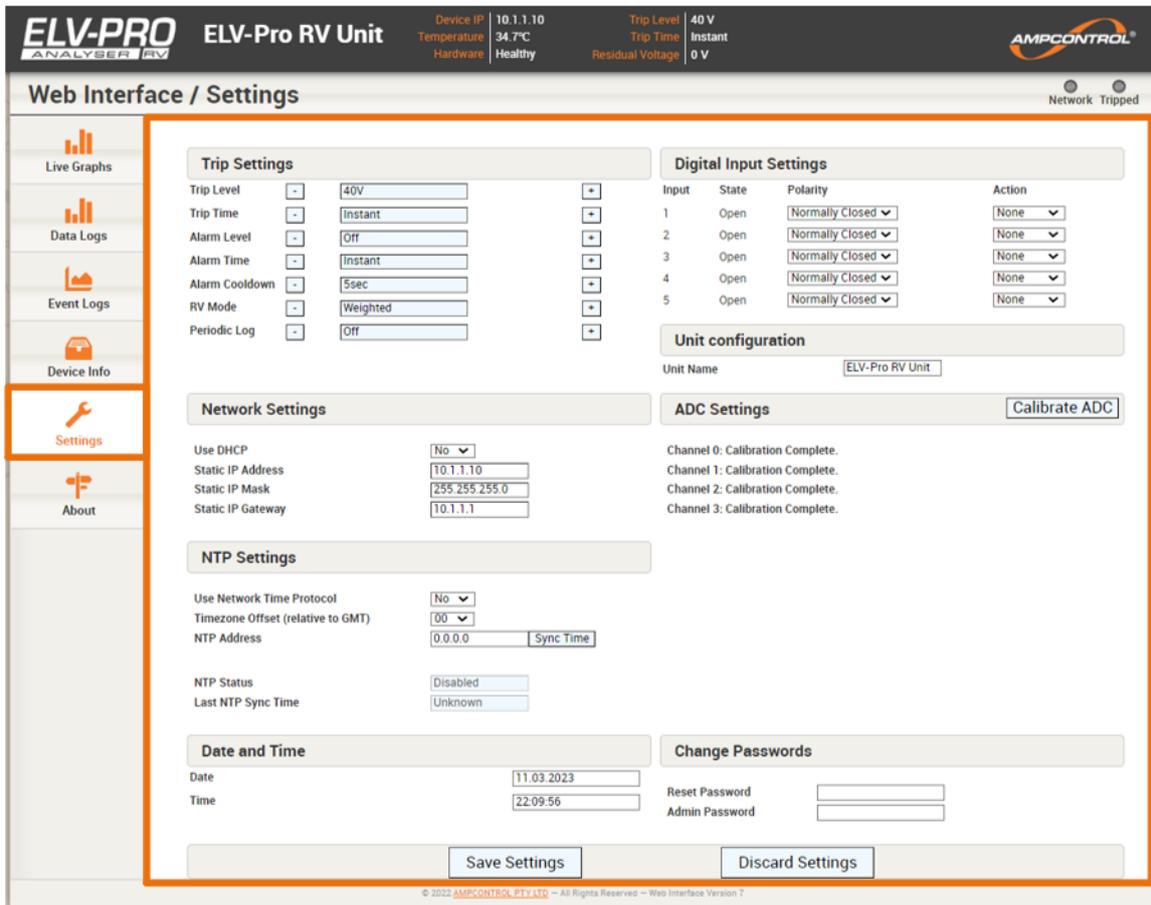


Figure 38: ELV-PRO RV Web Interface – Settings

**NOTE**



Username and Password are case sensitive. Record the Username and Password as resetting these will require the ELV-PRO RV to be reset. This will erase all user settings.

**NOTE**



Failure to calibrate ADC for new installation or after alterations can cause false CCM detection trips.

When the ELV-PRO RV has been installed and powered up for the first time in an installation, it is recommended that the user press the ‘Calibrate ADC’ button on the settings page. When doing this the outlet or outlets the relay is protecting should not be energised. This will allow the relay to factor in the cable wiring, CCM differences and any influences due to the installation and location of the equipment for the application/installation.

### 6.2.7 About Tab

The About Tab (Figure 39) provides contact details and licensing information about the device and website.

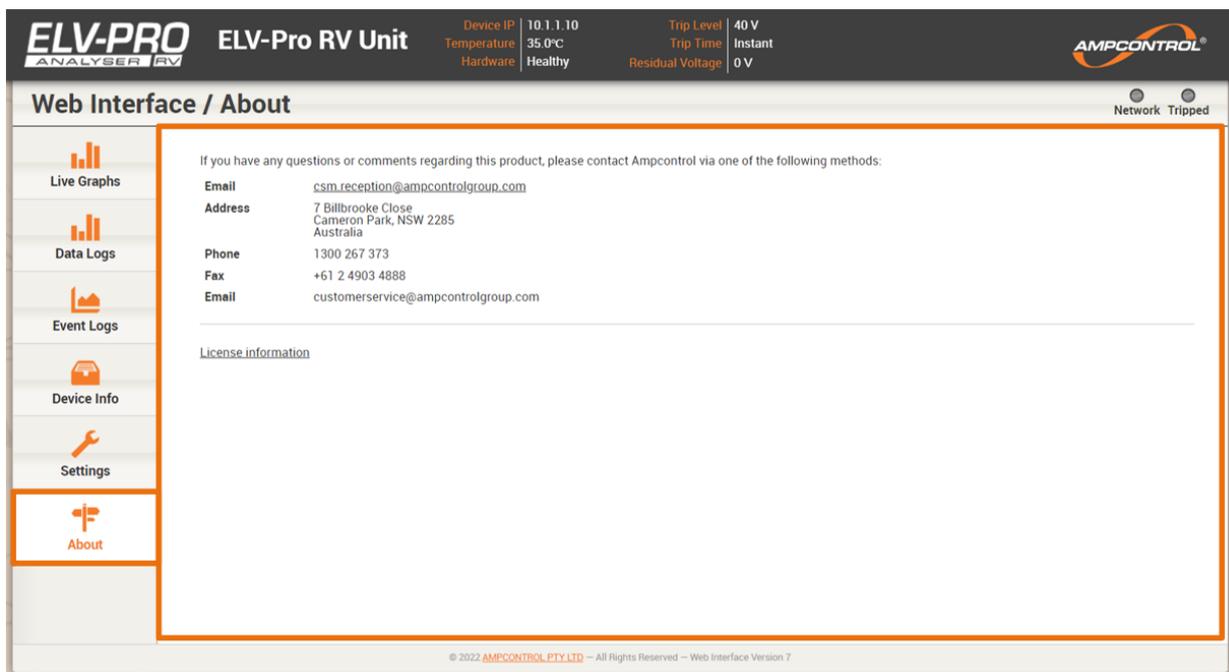


Figure 39: ELV-PRO RV Web Interface - About

## 6.2.8 Interactive graph navigation

The graphs shown on the website are interactive. The user can zoom, pan, and display values:

- To zoom in, click on the graph and drag either horizontally (as shown in Figure 40) or vertically. Alternatively, for touchscreen devices pinch out to zoom in.
- To zoom out, double click the graph area (or pinch in on touchscreen devices)
- To pan around, shift-click and drag (mouse driven devices) or swipe (touchscreen devices)
- To display signal values, simply mouse over the plot to show the extended legend in the top right of the graph area (not available on touchscreen devices).

In the Oscilloscope and RMS graphs of a historic data log, time intervals can be determined by marking the start and end time with single clicks and then reading off the selected range from the box in the top left of the plot. To remove the marked range, click the box. To refine the selection, use single clicks near either end of the marked range to move the markers.



Figure 40: ELV-PRO RV Web Interface - Interactive Graph Navigation

### 6.2.9 Protection Function Trip

Should a trip occur, the trip indicator illuminates red (Item 3 of Figure 41) and the header block (Item 1 of Figure 41) and page background changes to red. The Reset pin code entry and button will also appear, see Item 2 in Figure 41. To reset, simply enter the pin and select the reset button.

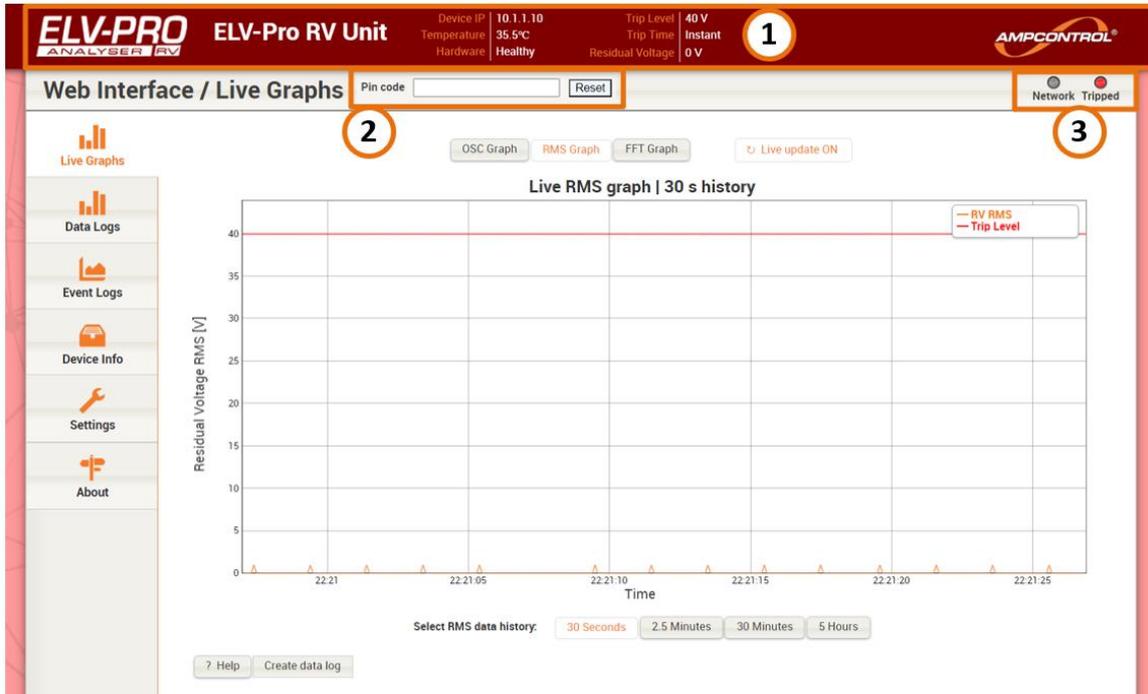


Figure 41: ELV-PRO RV Web Interface - Protection Function Trip

## 7 SERVICE, MAINTENANCE & DISPOSAL

---

### 7.1 Equipment Service

A number of external system-based checks should be completed on a regular basis. These 'routine inspections' must be carried out by suitably trained people with knowledge of the ELV-PRO RV and the systems into which it is fitted. Routine inspections may take the form of either visual-only checks, or visual and 'hands-on' checks.

#### 7.1.1 Visual Only Inspections

A basic visual inspection focuses on looking at the installation for signs of physical damage, water or dust ingress and the condition of cables and labels. This type of inspection may involve opening cabinets to gain access to the relay and other equipment. This level of inspection may also include cleaning display windows that have become obscured by dirt.

Observations would typically be:

- Check that equipment enclosures, cable trays, conduits, etc. are in good order with no physical damage.
- Check that sealed wall boxes are free from water and dust ingress internally. Door seals are in good condition.
- Check that connected cables are free from cuts, abrasions and obvious signs of damage. Cable restraints are in good order and correctly fitted.
- Check that labels on equipment, wall boxes and cables are present and in good condition (especially certification labels).
- Check that no modifications have been carried out to installed equipment.

#### 7.1.2 Hands-On (Detailed) Inspections

A more detailed inspection would include all of the elements of a visual inspection, plus some checks that cover the integrity of connections, fixtures and fittings.

In addition to basic visual observations, more detailed integrity checks would involve:

- Verify that equipment housings, wall boxes and other mechanical fixtures are secured in place. This includes terminal box lids, tightness of cable glands, integrity of wall-box mountings, security of equipment fixing to walls/DIN rails etc.
- Verify all electrical connections are secure with no loose screw terminals or DIN rail terminals not fitted to rails etc.

### 7.1.3 Electrical Testing / Commissioning

Prior to being put into service, the electrical protection system must be correctly commissioned. This manual does not cover system commissioning; the scope of commissioning tests should be determined during the risk assessment or FMEA covering the design of the electrical protection system.

The following points can provide guidance on checking the correct operation of ELV-PRO RV during commissioning. This is not intended to provide an exhaustive commissioning checklist but should be considered to be a minimum.

- Ensure that the system is connected in accordance with the manufactures' instructions and conforms to the intended design.
- In the case of monitoring the NER circuit, ensure that no alternate earth paths exist that bypass the NER.
- Perform Residual voltage tests on each phase and verify that the unit behaves as expected and that when it trips it also operates the intended circuit breaking device.

**Note:** During testing, the physical opening of the interposing circuit should be verified: PLC indication feedback alone does not provide adequate test coverage.

- The ADC settings should be calibrated through the web server interface on each installation or routine maintenance.

## 7.2 Equipment Maintenance

	<b>WARNING!</b>	The ELV-PRO RV has no user-serviceable parts. <b>All repairs must be carried out by Ampcontrol only.</b>
		If a fault develops, return the unit to Ampcontrol for repair. It is essential that <b>no attempt be made to repair the unit</b> as any attempt to dismantle or repair the unit can <b>seriously compromise the safety of the unit and voids product warranty.</b>

It is recommended that the electrical protection system incorporating the ELV-PRO RV be subject to regular functional tests at intervals determined by risk assessment of FMEA. These intervals typically coincide with periodic maintenance checks and will cover (but not limited to) tests such as earth continuity tests.

## 7.3 Disposal

	<b>ENVIRO</b>	The electronic equipment discussed in this manual <b>must not be treated as general waste.</b> By ensuring that this product is disposed of correctly you will be helping to prevent potentially negative consequences for the environment which could otherwise be caused by incorrect waste handling of this product.

## 8 EQUIPMENT LIST

Part Number	Description
199326	ELV-PRO RV Wideband Residual Voltage Relay
199313	ELV-PRO RV Settings Dongle
199350	ELV-PRO RV CCM Adapter Kit

199350 - ELV-PRO RV CCM Adapter Kit	
Part Number	Description
199351	CCM Adapter
180902	IPX Base

## 9 SPECIFICATIONS

<b>Specifications</b>	
<b>Supply</b>	
<i>Regulated Voltage</i>	24 VDC ± 25 %
<i>Power Supply Requirement</i>	12 W
<b>Dimensions</b>	
<i>ELV-PRO RV (W x H x L)</i>	135 x 135 x 107 (mm)
<b>Operating Conditions</b>	
<i>Ambient operating temperature</i>	0 °C - 60 °C
<i>IP Rating</i>	IP20
<b>Residual Voltage Protection</b>	
<i>Trip Current Level</i>	40 V – 500 V (40 V – 100 V in 10 V increments, 100 V – 500 V in 50 V increments)
<i>Trip Operation Time</i>	Instantaneous – 500 ms in 50 ms increments
<b>Output Contacts</b>	
<i>Relay 1 – Fail Safe</i>	1xCO (Mechanical) 250 VAC 1.6 A / 30 VDC 1.6 A (@50 VDC ~0.3 A)
<i>Relay 2 – Fail Safe</i>	1xNO (Solid State) 110 VAC/DC 0.2 A
<i>Internal Transient Suppression Filter Across Terminals</i>	Serial < 2308000000: Present (unless identified by label) Serial > 2308000000: Removed
<b>ELV-PRO RV Inputs</b>	
<i>Inputs 1-5</i>	Programmable Trip/Log functions
<i>Input 6 – Trip Reset</i>	Manual trip reset by external pushbutton
<i>Residual Voltage (RV)</i>	Interface to ELV-PRO RV CCM ADAPTOR RV output
<i>Residual Voltage Test (RV TEST)</i>	Interface to ELV-PRO RV CCM ADAPTOR RV TEST input
<b>Communication Interface</b>	
<i>Ethernet Socket</i>	Relay 10BASE-TX or 100BASE-TX accessible via http (using a standard web browser)
<i>Ethernet IP</i>	Standard Protocol, See below for details
<i>Modbus IP</i>	Standard Protocol, See below for details
<b>Certification Details</b>	
<i>Certification Number</i>	IECEX ExTC 22.0005X
<i>Type</i>	[Ex ia Ma]
<i>Temperature</i>	0 °C ≤ Ta ≤ 60 °C
<i>I.S. Parameters:</i>	HVR Base Flying Leads
	Um: 2286 Vrms Phase to Earth Uo: 28.0 V Io: 114 uA Po: 1 mW Co: 3.76 uF Ci: NIL Lo: 300H
	CCM Adapter Terminals
	Um: 132 Vrms Phase to Earth
<b>Find Out More</b>	
For more information on this product, contact Ampcontrol Customer Service on +61 1300 267 373 or <a href="mailto:customerservice@ampcontrolgroup.com">customerservice@ampcontrolgroup.com</a> or visit the Ampcontrol website: <a href="http://www.ampcontrolgroup.com">www.ampcontrolgroup.com</a>	

## APPENDIX A: ELV-PRO RV CIP OVER ETHERNET/IP

The ELV-PRO RV communicates with a PLC, implementing CIP (Common Industrial Protocol) over Ethernet/IP.

### A1 ELEMENTARY DATA TYPES

The elementary data types used within this document are taken from table A-2.1 from the CIP Specification and are as follows.

Keyword	Description	Range	
		Minimum	Maximum
BOOL	Boolean	0	1
SINT	Short Integer	-128	127
INT	Integer	-32768	32767
DINT	Double Integer	$-2^{31}$	$2^{31}-1$
LINT	Long Integer	$-2^{63}$	$2^{63}-1$
USINT	Unsigned Short Integer	0	255
UINT	Unsigned Integer	0	65535
UDINT	Unsigned Double Integer	0	$2^{32}-1$
ULINT	Unsigned Long Integer	0	$2^{64}-1$
STRING	Character string (1 byte per character)		

#### Character String Data Types

The declaration of a variable of type STRING is equivalent to declaring a structured data type for the variable which allocates a UDINT variable containing the current size of the string in characters and an array of declared character size elements.

## A2 LIVE DATA SEGMENT DEFINITION

	Value
Assemble Instance	100
Size	8
Data Type	UINT

Offset	Value Name	Details
0	Residual Voltage	The unbalanced 3-phase voltage between Neutral and Earth. Value returned in V.
1	RTC – Data Upper	Upper byte of the RTC number. The RTC is sent as a standard 32bit number that represents the number of seconds since 1 <sup>st</sup> January 2000.
2	RTC – Data Lower	Lower byte of the RTC number
3	Trip Mask 1	The 16-bit mask of possible trips
4	Status Mask 1	The 16-bit mask of status updates
5	Internal Temperature	Temperature measured inside the relay. Value is given to 1 decimal point by multiplying actual temp by 10. Range of values is -20°C to +100°C.
6	Digital IO	Digital Input status
7	<Reserved>	Reserved

### A2.1 Trip Mask 1

Bitmask	Trip Name	Details
0x0001	System Tripped	General Bitmask denoting the system is currently Tripped
0x0002	Residual Voltage RV Test Detect	The Residual Voltage test signal is not being detected on the RV input. <b>This trip will NOT automatically clear once the RV Test Signal is detected</b>
0x0004	Unused	Unused
0x0008	Relay Fault	The Relay didn't respond quickly enough or has failed to go to the desired state
0x0010	ADC Rail Fault	The power rails supplying the external ADC has failed
0x0020	Dongle Tripped	If the Dongle is corrupt or removed the relay will trip
0x0040	Residual Voltage Tripped	A Residual Voltage greater than the specified limit was detected
0x0080	Digital Input Tripped	The unit was tripped by a change from the Digital Inputs

### A2.2 Status Mask 1

Bitmask	Trip Name	Details
0x0001	Storage Fault	Internal Storage fault, either unable to read or write.
0x0002	EEPROM Fault	The EEPROM Isn't responding or is corrupted
0x0004	RTC Fault	An error has been detected with the Real Time Clock
0x0008	Digital Input Fault	The sampling of the digital inputs are in fault

### A2.3 Digital IO

Bitmask	Trip Name	Details
0x0001	Digital Input 1	User Defined digital Input, 1 = CLOSED INPUT
0x0002	Digital Input 2	User Defined digital Input, 1 = CLOSED INPUT
0x0004	Digital Input 3	User Defined digital Input, 1 = CLOSED INPUT
0x0008	Digital Input 4	User Defined digital Input, 1 = CLOSED INPUT
0x0010	Digital Input 5	User Defined digital Input, 1 = CLOSED INPUT
0x0020	Digital Input 6	External Reset Input, 1 = CLOSED INPUT

## A3 CONTROLS

This is a Write Only Class 1 service.

	Value
Assemble Instance	150
Size	4
Data Type	UINT

Offset	Value Name	Details
0	Reset Control	Resets various trip types (if safe to do so).
1	<i>Unused</i>	
2	<i>Unused</i>	
3	<i>Unused</i>	

### A3.1 Reset Control

This reset bit should only be set by an authorised person. A Residual Voltage Trip requires investigation by a suitably trained electrician before being reset. The reset requests occur on the zero to one bit transition. Transitions from one to zero have no effect. This mask will always read as zero.

Bitmask	Action	
0x0001	Trip Reset	Attempts to clear any active trips within the system
Others	<i>Unused</i>	

#### NOTE



Unused bits should not be written. They may be used in future software versions.

## A4 EXPLICIT MESSAGES

### A4.1 ELV-PRO RV Settings

Class Code: 70 hex

#### Class Attributes

#	Name	Access	Type	Value
1	Revision	Get	UINT	Object revision (current value = 0001h).
2	Max Instance	Get	UINT	
3	Number of Instances	Get	UINT	

Implemented Instances: 1

#### Instance Attributes

Attribute ID	Access Rule	Name	Data Type	Description of Attribute
1	Get	Unit Name	String	User settable name
2	Get	Residual Voltage Trip Level	UINT	Value returned in V
3	Get	Residual Voltage Trip Time	UINT	Value returned in ms
4	Get	RV Alarm Trip Level	UINT	Value returned in V
5	Get	RV Alarm Trip Time	UINT	Value returned in ms
6	Get	Alarm Cool Down	UINT	Values returned in seconds
7	Get	RV Mode	USINT	0 = Narrow Band 1 = Wide Band 2 = Weighted Band
8	Get	Digital Input Settings - 1	USINT	See table below
9	Get	Digital Input Settings - 2	USINT	See table below
10	Get	Digital Input Settings – 3	USINT	See table below
11	Get	Digital Input Settings – 4	USINT	See table below
12	Get	Digital Input Settings – 5	USINT	See table below

#### Digital Input Settings

Value	Digital Input State	Digital Input Action
0	Normally Open	No Action
1	Normally Closed	No Action
2	Normally Open	Generate Log
3	Normally Closed	Generate Log
4	Normally Open	Trip Unit
5	Normally Closed	Trip Unit

## Common Services

Service Code	Service Name	Description of Service
0E hex	Get_Attribute_Single	Returns the contents of the specified attribute
01 hex	Get_Attributes_All	Returns a predefined listing of this object's attributes (See the Get_Attributes_All_Response definition below)

## Get\_Attributes\_All Response Data – Instance Level

Byte	Name	Data Structure
0-19	Unit Name	Byte array String
20-21	Residual Voltage Trip Level	UINT
22-23	Residual Voltage Trip Time	UINT
24-25	RV Alarm Trip Level	UINT
26-27	RV Alarm Trip Time	UINT
28-29	Alarm Cool Down	UINT
30	RV Mode	USINT
31	Digital Input Settings - 1	USINT
32	Digital Input Settings - 2	USINT
33	Digital Input Settings – 3	USINT
34	Digital Input Settings – 4	USINT
35	Digital Input Settings – 5	USINT

## A4.2 ELV-PRO RV Firmware

**Class Code: 71 hex**

### Class Attributes

#	Name	Access	Type	Value
1	Revision	Get	UINT	Object revision (current value = 0001h).
2	Max Instance	Get	UINT	
3	Number of Instances	Get	UINT	

**Implemented Instances: 1**

### Instance Attributes

Attribute ID	Access Rule	Name	Data Type	Description of Attribute
1	Get	Firmware Name	String	
2	Get	Firmware Version	String	
3	Get	Unit Serial Number	String	

## Common Services

Service Code	Service Name	Description of Service
0E hex	Get_Attribute_Single	Returns the contents of the specified attribute

## A5 EVENT LOGS

The ELV-PRO RV stores the last 50 events. The events are stored from new to old as a new event is created an old event is deleted (provided that the 50 event spaces are full). To allow the PLC to access these events, the ELV-PRO RV presents them as 5 instances, each containing 10 encoded event structures. Instance 1 contains the most recent event logs (with the first attribute containing the most recent event log). All events stored within an instance can be read using the 'Get\_Attributes\_All' service as described below.

**Class Code: 72 hex**

### Class Attributes

#	Name	Access	Type	Value
1	Revision	Get	UINT	Object revision (current value = 0001h).
2	Max Instance	Get	UINT	
3	Number of Instances	Get	UINT	

**Implemented Instances: 5**

### Instance Attributes

Attribute ID	Access Rule	Name	Data Type	Description of Attribute
1	Get	Event Log N	EVENT STRUCT	
2	Get	Event Log N+1	EVENT STRUCT	
3	Get	Event Log N+2	EVENT STRUCT	
4	Get	Event Log N+3	EVENT STRUCT	
5	Get	Event Log N+4	EVENT STRUCT	
6	Get	Event Log N+5	EVENT STRUCT	
7	Get	Event Log N+6	EVENT STRUCT	
8	Get	Event Log N+7	EVENT STRUCT	
9	Get	Event Log N+8	EVENT STRUCT	
10	Get	Event Log N+9	EVENT STRUCT	

## EVENT STRUCT

Byte Offset	Byte Name	Description
0	Log ID	The log counter where 1 is always the latest log and 50 is the oldest log.
1-4	Ampcontrol Timestamp	The time at which the event occurred is stored as a 32 bit number. Add 946684800 to convert to a UTC Time Stamp.
5	Event ID	The Event Type number. This number is defined in Section 6.2.



**Common Services**

Service Code	Service Name	Description of Service
0E hex	Get_Attribute_Single	Returns the contents of the specified attribute
01 hex	Get_Attributes_All	Returns a predefined listing of this object's attributes (See the Get_Attributes_All_Response definition below)

**Get\_Attributes\_All Response Data – Instance Level**

Byte	Name	Data Structure
0-5	Event Log, Instance N, Attribute 0	EVENT STRUCT
6-11	Event Log, Instance N, Attribute 1	EVENT STRUCT
12-17	Event Log, Instance N, Attribute 2	EVENT STRUCT
18-23	Event Log, Instance N, Attribute 3	EVENT STRUCT
24-29	Event Log, Instance N, Attribute 4	EVENT STRUCT
30-35	Event Log, Instance N, Attribute 5	EVENT STRUCT
36-41	Event Log, Instance N, Attribute 6	EVENT STRUCT
42-47	Event Log, Instance N, Attribute 7	EVENT STRUCT
48-53	Event Log, Instance N, Attribute 8	EVENT STRUCT
54-59	Event Log, Instance N, Attribute 9	EVENT STRUCT

\*NOTE: N ranges from 1-5.

## APPENDIX B: ELV-PRO RV Modbus TCP

### B1 Modbus Commands

The following Modbus commands are supported:

Table 11: Modbus Commands

Modbus CMD	Comment
03	Read Holding Registers
06	Store Single Register

Valid read registers are in the range from 4 to 109. An attempt to read a register outside this range will result in an exception scan. Supported Modbus exception responses are:

Table 12: Modbus Exception

Modbus Exception	Comment
01	Illegal Function
02	Illegal Data Address
03	Illegal Data Value

### B2 Modbus Status

Table 13: Modbus Status

Status	Comment
Address	The Modbus slave address the relay is set to
Read	A solid block when a READ command is received
Wrt	A solid block when a WRITE command is received
Exc	A solid block when an unsupported Modbus command is received
CRC	A solid block when a checksum error is detected
Par	A solid block when a parity error is detected
NE	A solid block when noise is detected
FE	A solid block when a framing error is detected

### B3 Read Modbus Address Table

Modbus Address	Name	Bit Identification	
0-3		Reserved	
4	Residual Voltage	The unbalanced 3-phase voltage between Neutral and Earth. Voltage V returned.	
5	RTC – Data Upper	The RTC is sent as a standard 32bit number that represents the number of seconds since 1 <sup>st</sup> January 2000. RTC upper byte number.	
6	RTC – Data Lower	RTC lower byte of number.	
7	Trip Mask 1	Bit	Description
		0	System Tripped
		1	Residual Voltage RV Test Detect
		2	Unused
		3	Relay Fault
		4	ADC Rail Fault
		5	Dongle Tripped
		6	Residual Voltage Tripped
		7	Digital Input Tripped
8-15	Reserved		
8	Status Mask 1	Bit	Description
		0	Storage Fault
		1	EEPROM Fault
		2	RTC Fault
		3	Digital Input Fault
4-15	Reserved		
9	Internal Temperature	Temperature measured inside the ELV-PRO. Value is given to 1 decimal point by multiplying actual temp by 10. Range of values is -20°C to +100°C.	
10	Digital IO	Bit	Description (0 = open, 1 = closed)
		0	Digital Input 1
		1	Digital Input 2
		2	Digital Input 3
		3	Digital Input 4
		4	Digital Input 5
		5	Digital Input 6
6-15	Reserved		
11-17	Reserved		
18-25	Software Version	Uint16 encoded String	
26-33	Serial Number	Uint16 encoded String	
34-39	Reserved		
44-54	ELV-PRO RV Name	Uint16 encoded String	
55	RV Trip Level	Value returned in V	

Modbus Address	Name	Bit Identification
56	RV Trip Time	Value returned in ms. When Instant is chosen in settings it returns a 50ms value. Other values return a value the same as the setting.
57	RV Alarm Level	Value returned in V. Off returns a value of 0 (zero). Actual value returned for other settings.
58	RV Alarm Time	Value returned in ms
59	Alarm Cool Down	Value returned in Seconds
60	RV Mode	0 = Narrowband 1 = Wideband 2 = Weighted
61	Reserved	
62	Digital Input Settings – 1	0 – Normally Open, No Action 1 – Normally Closed, No Action 2 – Normally Open, Generate Log 3 – Normally Closed, Generate Log
63	Digital Input Settings – 2	
64	Digital Input Settings – 3	
65	Digital Input Settings – 4	
66	Digital Input Settings – 5	
67-79	Unused	
80-82	Most Recent Log Details	Word 0 – Ampcontrol Timestamp Upper 16 bits Word 1 – Ampcontrol Timestamp Lower 16 bits Word 2 – Event ID
83-85	Log Details	
86-88	Log Details	
89-91	Log Details	
92-94	Log Details	
95-97	Log Details	
98-100	Log Details	
101-103	Log Details	
104-106	Log Details	
107-109	Oldest Log Details	

## B4 Uint16 Encoded String

To help with efficient data transfer, all strings transmitted via Modbus have been ‘compressed’ to contain two characters per 16bit word, with the upper byte containing the first character and the lower byte containing the second character. The characters themselves are encoded using the ASCII encoding standard and are terminated with a NULL character.

**NOTE**



Data returned after the NULL character should be ignored as its value is undefined.

E.g., the string ‘Hello’ will be encoded as  
 0x4865, 0x6c6c, 0x6f00

## B5 Write Modbus Address Table

Modbus Address	Name	Bit Identification	
		Bit	Description
0	Reset Control	0	Reserved
		1	Trip Reset
		2-15	Reserved
1-3	Reserved		

## APPENDIX C: ELV-PRO RV Default Settings

The following settings are considered the factory default settings. Default settings will be utilised on an ELV-PRO RV that is booted with a new dongle installed. When a new dongle is installed into a powered and running ELV-PRO RV, the relay will load the settings on the dongle. The settings on the dongle will only be updated when modified and saved.

If a dongle has been configured or has been initialised from another ELV-PRO RV, then the settings may not match those in the table below. If a dongle is removed when in operation the settings will not be altered.

### WARNING!



Ampcontrol recommends the user review the configured settings before operating equipment.

Parameter	Setting
Trip Level	40V
Trip Time	Instant (50mS)
Alarm Level	Off
Alarm Time	Instant
Alarm Lockout	5sec
RV Mode	Weighted
Periodic Log Time	Off
Input 1 Polarity	Normally Closed
Input 1 Action	None
Input 2 Polarity	Normally Closed
Input 2 Action	None
Input 3 Polarity	Normally Closed
Input 3 Action	None
Input 4 Polarity	Normally Closed
Input 4 Action	None
Input 5 Polarity	Normally Closed
Input 5 Action	None
DHCP	No
Static IP Address	10.1.1.10
Static IP Mask	255.255.255.0
Static IP Gateway	10.1.1.1
Admin Password	"Password"
Unit Name	"ELV-PRO RV Unit"
User Password	"Reset"
NTP Server Enabled	No
NTP Server IP	0.0.0.0
UTC Offset	+0Hr