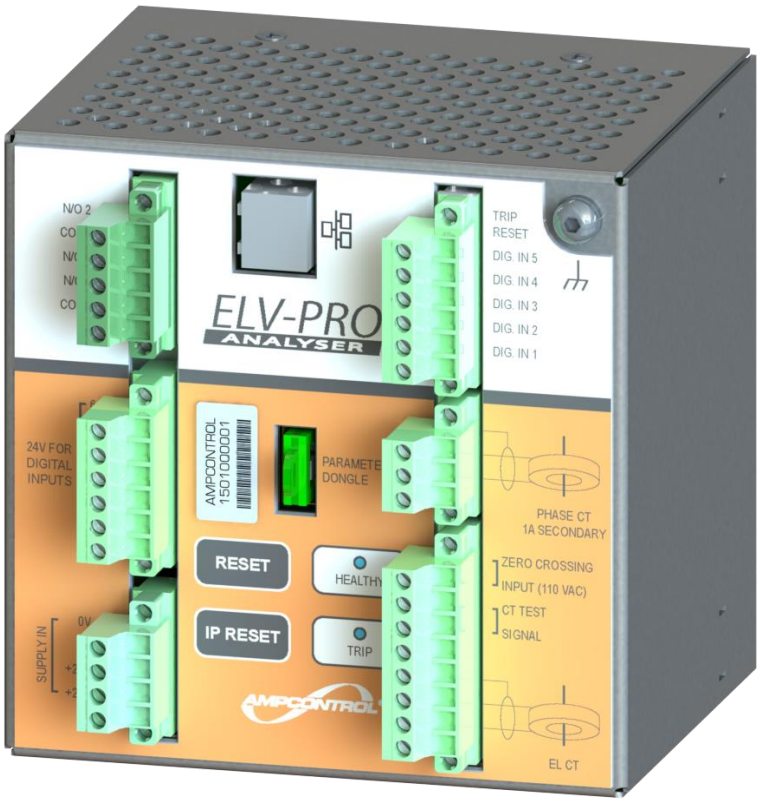
# ELV-PRO

## EARTH LEAKAGE RELAY

## User Manual

Version: 7, July 2023

Designed and manufactured in Australia by Ampcontrol Pty Ltd




AMPCONTROL®

**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 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 OF CONTENTS

# TABLE OF FIGURES

# TABLE OF TABLES

Table 1: Definitions

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

# 1 SAFETY AND OTHER WARNINGS

For safety reasons, the ELV-PRO 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

## 3.1 Description

Ampcontrol's ELV-PRO is a high performance, microprocessor based, wide bandwidth earth leakage protection relay that is capable of measuring and analysing power and switching frequency currents flowing in IT power systems. The ELV-PRO uses patented technology (US20130258537) to characterise earth leakage currents giving superior fault discrimination.

The ELV-PRO is designed for use in systems that may exhibit circulating earth currents and complex earth leakage currents typically associated with variable speed drives in mining environments.

## 3.2 Key Features

The ELV-PRO has the following key features:

- Compliance to AS/NZS 4871 and AS/NZS 2081
- Patented earth leakage analysis method*
- Fail safe operation
- Wide range Earth Leakage Current Measurement (20Hz to 8kHz)
- Wideband, Narrowband and Weighted Frequency Response Modes
- 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 Toroid Connection Monitoring
- DIN rail mounted

* International patent application number PCT/AU2011/000705

## 3.3 Application

The ELV-PRO is intended for use at transformer NER connection points as a BUEL Protection relay. The relay is not limited to be used in this configuration only and can be utilised on any individual outlet if desired. This would allow greater earth leakage current data to be captured relating to a specific outlet, rather than the entire system connected to the transformers secondary that the NER is protecting.

The ELV-PRO provides data logging to assist in fault finding. On each event trigger, the relay stores system data two seconds before and two seconds after the event including system time, earth leakage current, phase current and zero crossing of the phase current.

Ethernet connection to the ELV-PRO 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

## 4.1 General Warnings

These instructions have been designed to assist users of the ELV-PRO with installation.

Before the ELV-PRO 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 ELV-PRO. 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 must be supplied by a regulated voltage within the specified range.
- The installation of the ELV-PRO must be carried out by suitably trained and qualified personnel.
- Identification labels fixed to the ELV-PRO 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. 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

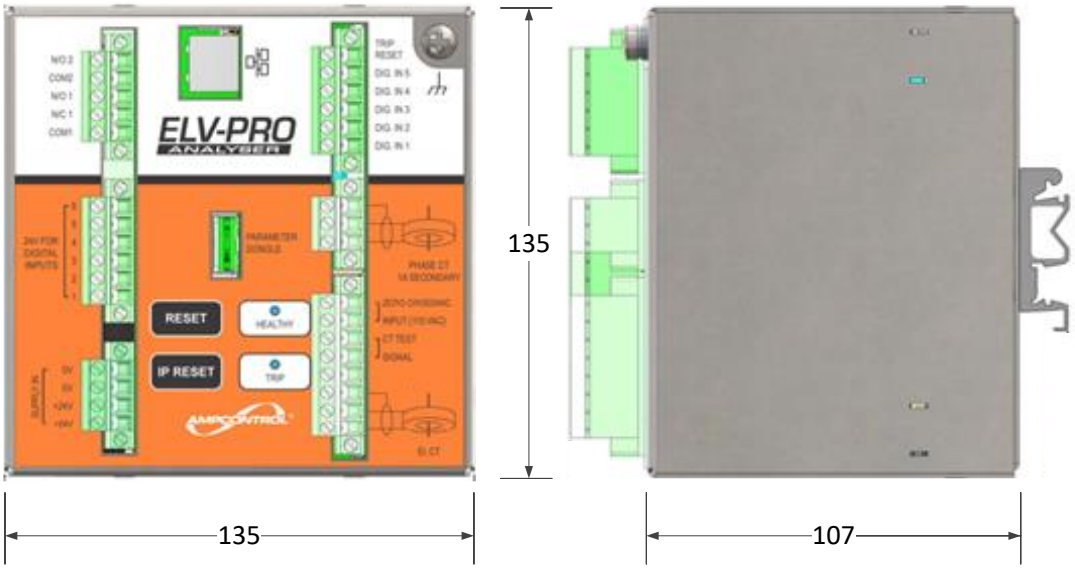



Figure 4.1: ELV-PRO Dimensions

The ELV-PRO stainless-steel enclosure is rated at IP20. It is DIN Rail mounted and measures 135mm x 135mm and 107mm deep as per Figure 4.1. The terminal layout and description are shown in Figure 4.2 and Table 2 respectively.


Figure 4.2: ELV-PRO Terminal Layout

Table 2: ELV-PRO Terminal Designators

| Plug | Label | Designator |
|---|---|---|
| 1 | P1_5 | Contact 2: Normally Open |
| | P1_4 | Contact 2: Common |
| | P1_3 | Contact 1: Normally Open |
| | P1_2 | Contact 1: Normally Closed |
| | P1_1 | Contact 1: Common |
| | | |
| 2 | P2_6 | Digital Input 6: 24V Supply |
| | P2_5 | Digital Input 5: 24V Supply |
| | P2_4 | Digital Input 4: 24V Supply |
| | P2_3 | Digital Input 3: 24V Supply |
| | P2_2 | Digital Input 2: 24V Supply |
| | P2_1 | Digital Input 1: 24V Supply |
| | | |
| 3 | P3_4 | Power Supply Input: 0V |
| | P3_3 | Power Supply Input: 0V |
| | P3_2 | Power Supply Input: +24V |
| | P3_1 | Power Supply Input: +24V |
| | | |
| Screw | | Chassis Earth Connection |

| Plug | Label | Designator |
|---|---|---|
| 4 | P4_6 | Trip Reset Input |
| | P4_5 | Digital Input 5 |
| | P4_4 | Digital Input 4 |
| | P4_3 | Digital Input 3 |
| | P4_2 | Digital Input 2 |
| | P4_1 | Digital Input 1 |
| | | |
| 5 | P5_3 | Phase CT Cable Shield |
| | P5_2 | Phase CT Input: Signal |
| | P5_1 | Phase CT Input: Common |
| | | |
| 6 | P6_8 | Zero Crossing Input (110VAC) |
| | P6_7 | Zero Crossing Input (110VAC) |
| | P6_6 | CT Test Signal |
| | P6_5 | CT Test Signal |
| | P6_4 | Unused |
| | P6_3 | EL CT Cable Shield |
| | P6_2 | EL CT Input: Signal |
| | P6_1 | EL CT Input: Common |

The ELV-PRO has been tested and validated for use with the Ampcontrol specific toroids only. Use of unspecified toroids may cause the relay to not perform as designed and not comply with the requirements of AS/NZS 2081. The approved EL500 and EL500S toroids are found below or in the part number section of this manual.

The EL500/25 toroid has a 25mm window and is DIN rail mounted.

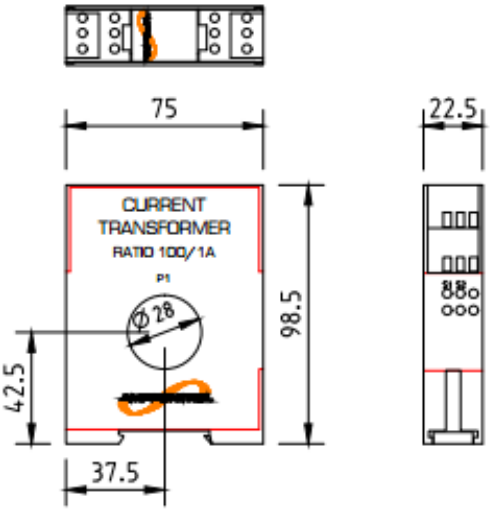



Figure 4.3: EL500S/25 Toroid (115437) Dimensions

The EL500/60 toroid has a 60mm window and is panel mounted.

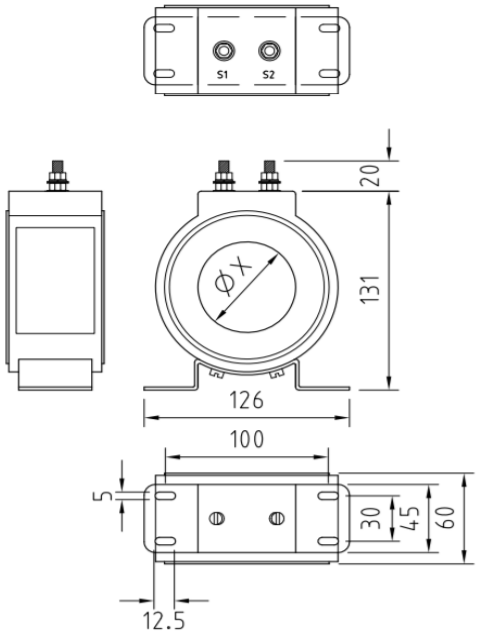



Figure 4.4: EL500/60 Toroid (101649) Dimensions

**NOTE**

Only the **later EL500 toroid is suitable**. This is denoted by the "**N**" designator at the end of the core type. For this toroid is it W-20**N**.

The EL500/60 toroid has a 60mm window and is panel mounted.

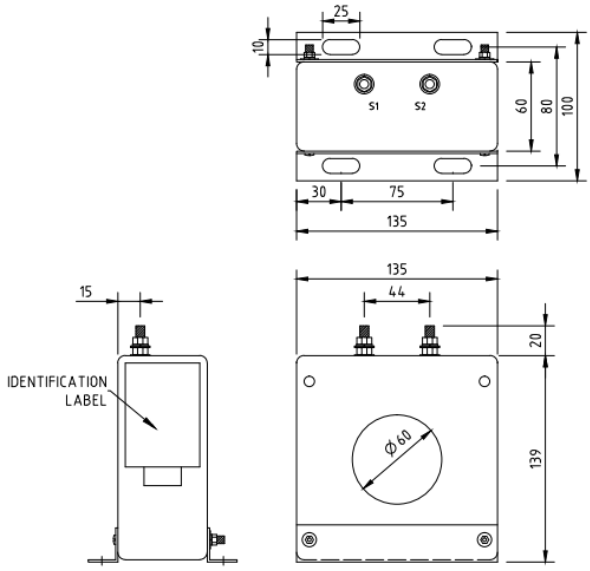



Figure 4.5: EL500S/60 Toroid (101658) Dimensions

The EL500/112 toroid has a 112mm window and is panel mounted.

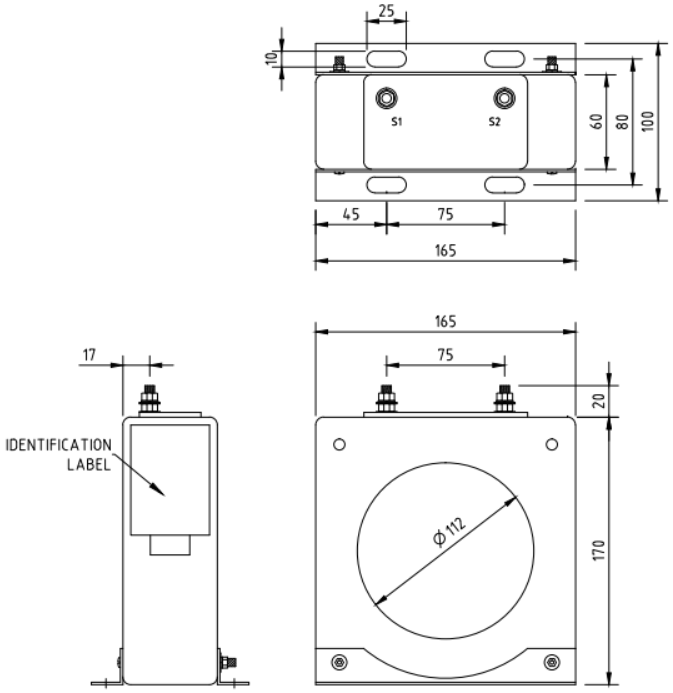



Figure 4.6: EL500S/112 Toroid (101656) Dimensions

## 4.4 Electrical Installation Information

A typical installation diagram of the ELV-PRO is shown below, Figure 4.7. The following sub-sections provide a more detailed description of each of the individual circuit elements.

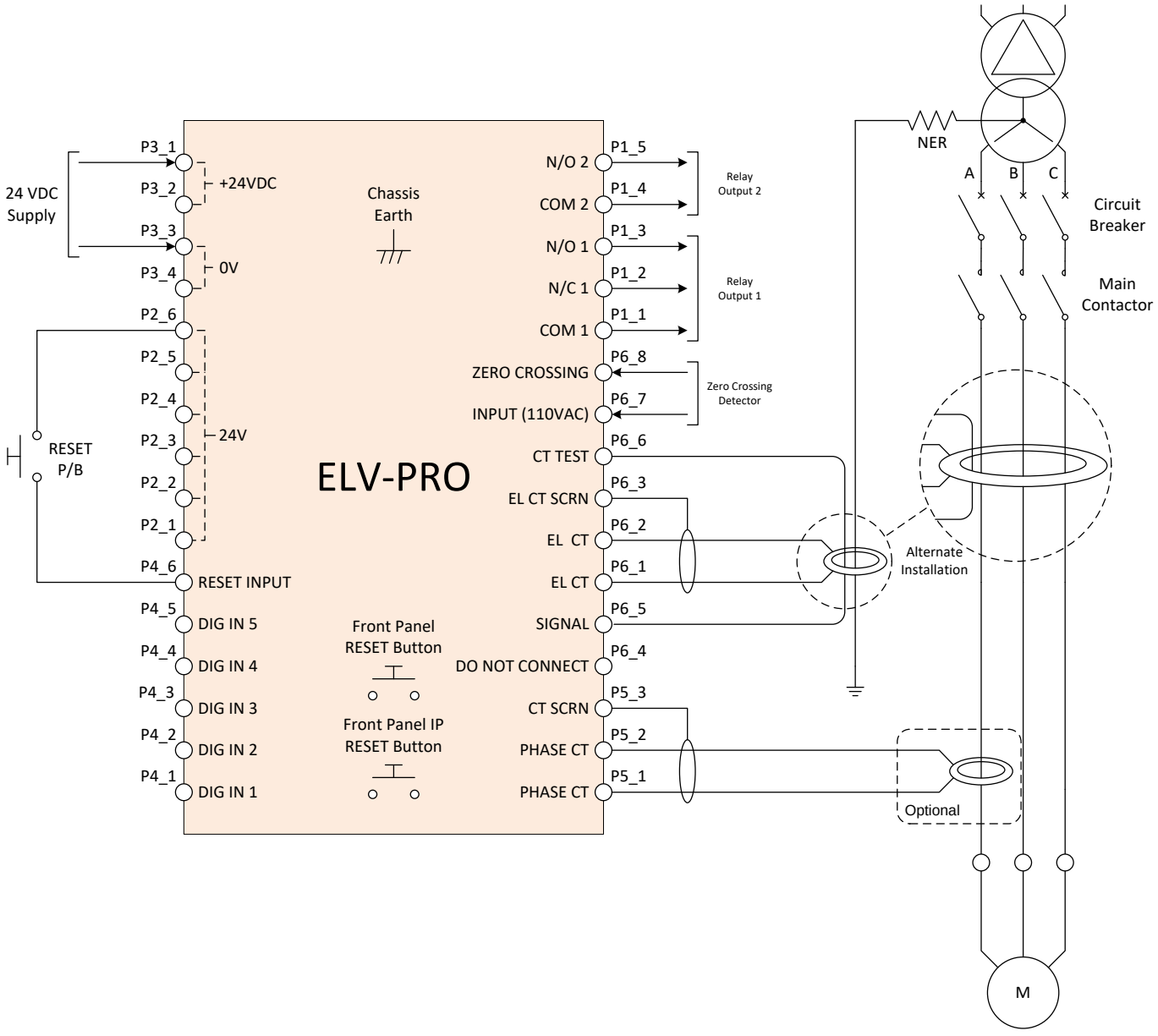



Figure 4.7: Electrical Connections – ELV-PRO Circuit Diagram

**WARNING!**


Ensure all connections to the relay are correct prior to putting into service. Incorrect wiring may cause damage to the relay and the systems into which it is installed.

### 4.4.1 Power Supply (Plug 3)

The ELV-PRO 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.

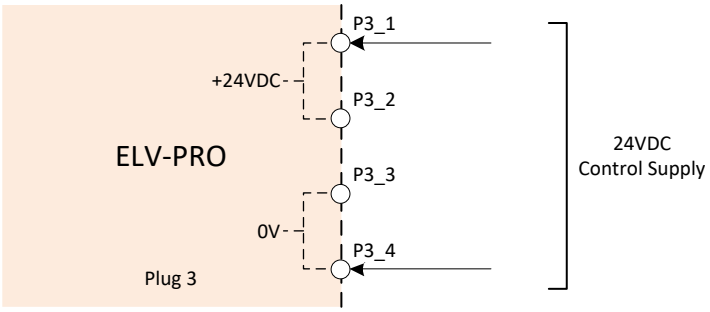



Figure 4.8: Electrical Connections – ELV-PRO Power Supply (Plug 3)

**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 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 4.9). 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 to be reset remotely.

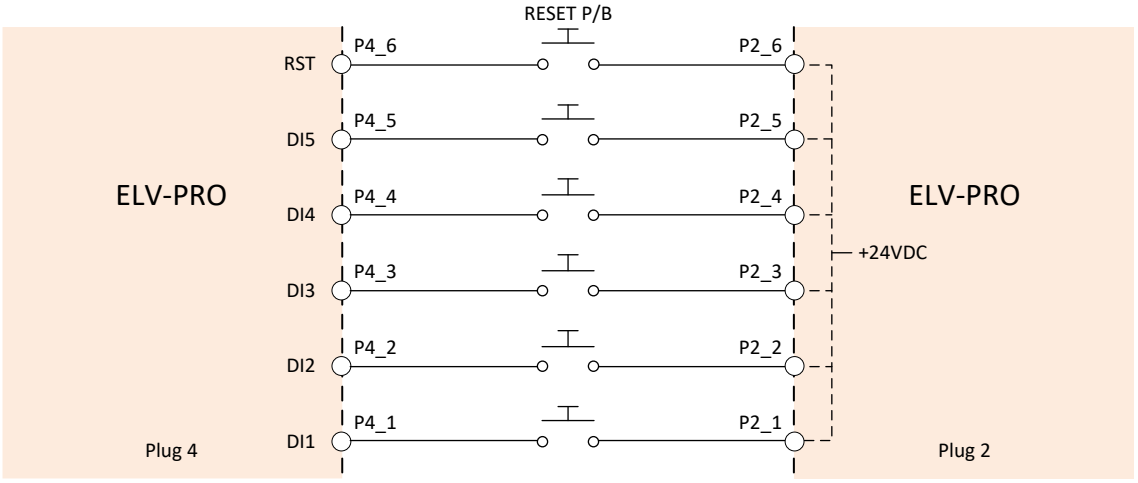



Figure 4.9: Electrical Connections – Trip Resent and Digital Inputs (Plugs 2 & 4)

### 4.4.3 Earth Leakage CT, CT Test, Zero Crossing Input Connections (Plug 6)

The Earth Leakage protection is achieved through the use of a core balance CT. The connections to the CT are terminals P6_1 & P6_2. Terminal P6_3 is the screen termination point for the cable connecting the EL CT to the relay. For further details see Section 4.4.9.

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

To ensure the CT is connected and the signal the relay monitors is correct, a CT test output is provided on terminals P6_5 & P6_6. A missing CT Test signal through the CT will cause the ELV-PRO to trip. The test signal is applied every two seconds and may be seen on the live screens and data logs.

Terminal P6_4 of Plug 6 should not be connected.

The Zero Crossing input, terminals P6_7 & P6_8, is provided for logging purposes.

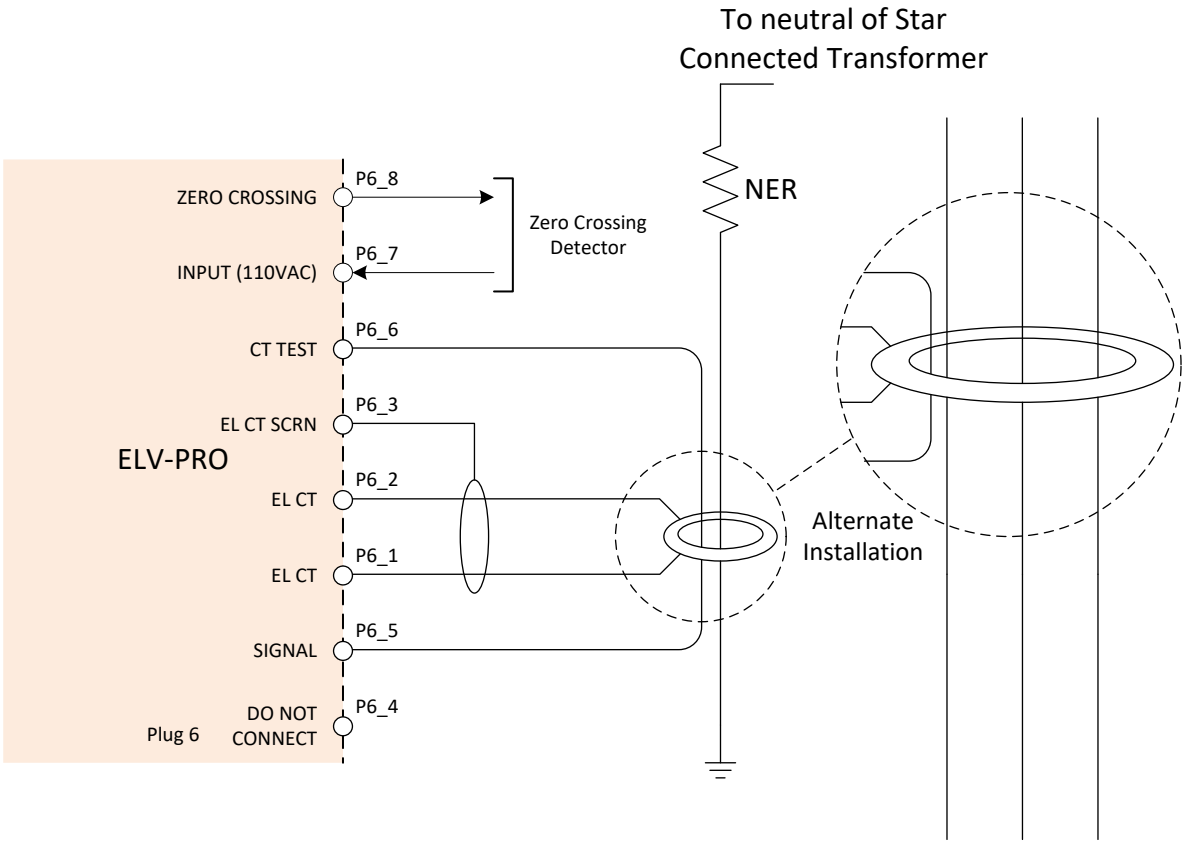



Figure 4.10: Electrical Connections – EL CT, CT Test and Zero Crossing Connections (Plug 6)

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

### 4.4.4 Phase CT Input (Plug 5)

The ELV-PRO 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. Typical connection is shown in Figure 4.11.

**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.

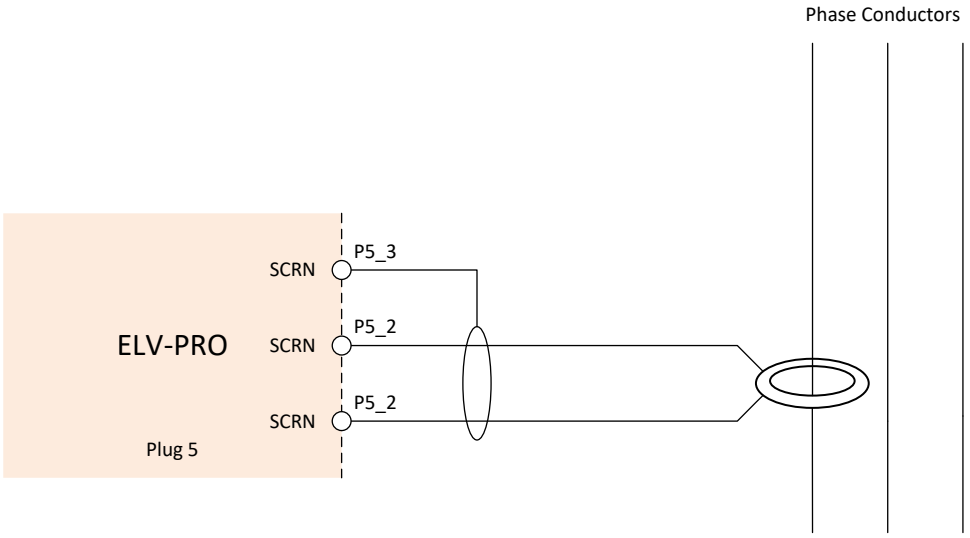



Figure 4.11: Electrical Connections – Phase CT Input (Plug 5)

**NOTE**

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

### 4.4.5 Control Contact Output Connections (Plug 1 Terminals 1,2,3,4 & 5)

The ELV-PRO has two control contact output Relays.

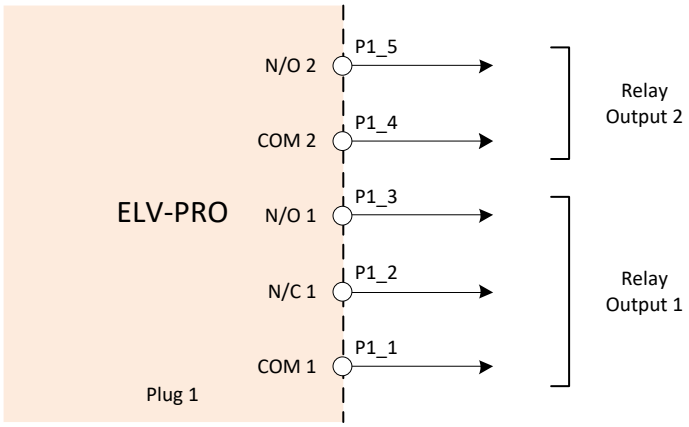



Figure 4.12: Electrical Connections – Control Contact Outputs Connections (Plug 1)

It should be noted that any ELV-PRO built before August 2023 (Serial lower than 2308000000) will have transient suppression filters (RC combination, 22Ω + 100nF) installed across the trip outputs, see Figure 4.13. 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.

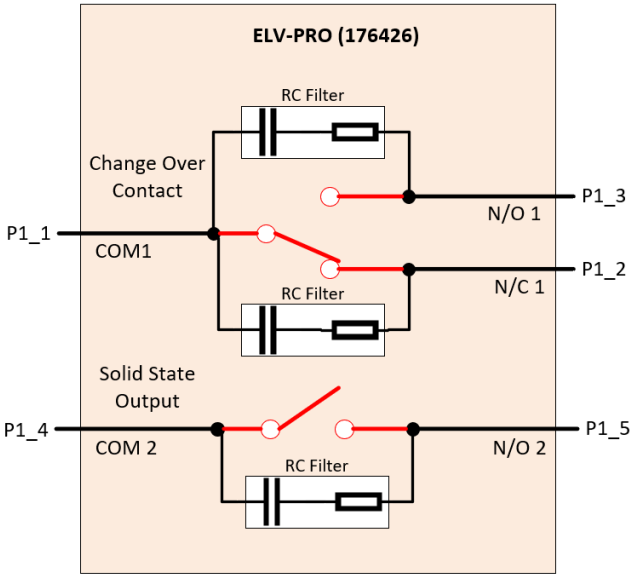



Figure 4.13: Trip Contact Internal Transient Suppression Filters

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.

### 4.4.6 ELV-PRO Dongle Input (Dedicated Dongle Slot)

The ELV-PRO has a dedicated dongle input, item 2 of Figure 4.15. The dongle is keyed and therefore has a specific orientation. Refer to Figure 4.14.


Figure 4.14: ELF-PRO Parameter Dongle

### 4.4.7 Ethernet Input (Dedicated Ethernet Socket)

The ELV-PRO has an Ethernet socket to allow the ELV-PRO to be connected to a network switch or directly to a PC or Ethernet device, see item 1 of Figure 4.15.

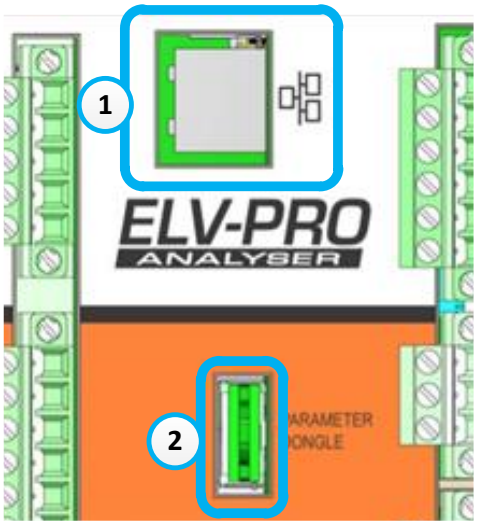



Figure 4.15: Ethernet and Dongle Connections

### 4.4.8 Removal of ELV-PRO Relay

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

### 4.4.9 ELV-PRO Current Transformer Location and Selection

The ELV-PRO has been designed for compliance to AS/NZS 2081:2011 for use on earth fault limited systems. There are generally two locations where the ELV-PRO may be installed:

1- Core balance protection performs the primary protection in an installation by protecting the outlet supplying power to a machine. In this application the relay's operation time is typically set at instantaneous. The three power phases are passed symmetrically through the centre of the toroid. If there is no earth fault present, the vector sum of the currents in a three-phase supply is zero. If current from any phase flows to earth, the toroid flux becomes unbalanced, allowing the toroid to produce an output, which in turn trips the relay.

   A test current is injected through the window of the toroid to test the operation of the relay.

2- Series neutral protection is the backup protection method and may have an operation time up to a maximum of 500ms. In this method the neutral to earth connection is passed through the toroid. An earth fault on any of the phase conductors causes an earth current which returns, through the neutral, to the star point of the transformer and is detected by the toroid.

A test circuit can connect a test resistor between a phase and earth or inject a current through the toroid as previously described.

**NOTE**

The test resistor to earth method is recommended with this type of protection as this test also proves the neutral to earth connection.

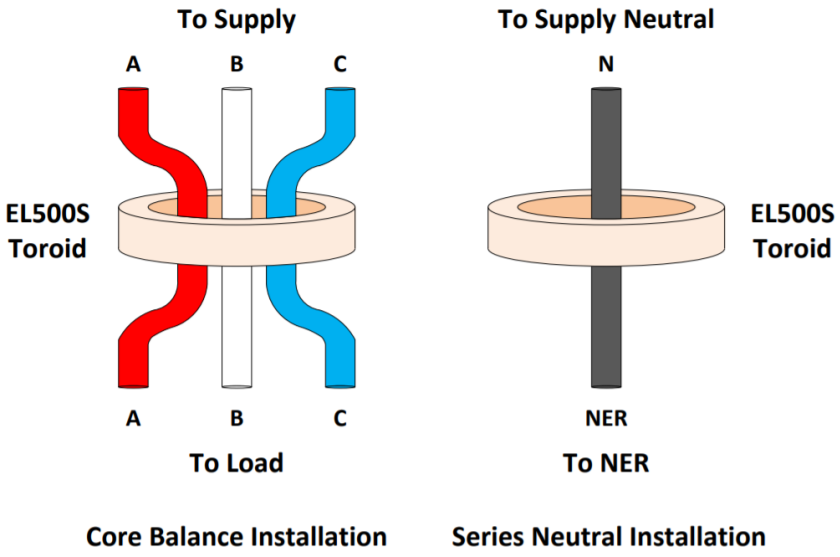



Figure 4.16: ELV-PRO Toroid Installation Examples

The ELV-PRO is designed for use with Ampcontrol 100/1A EL500S series Toroids. They are available with window sizes 25, 60, & 112mm.

**NOTE**

When installing the wideband EL relays on an outlet with VSD or VVVF drive, it is recommended that the relays toroid be installed on the cables before the drive. This will allow the relay to provide EL protection that includes the drive itself.

### 4.4.10 ELV-PRO Phase Monitoring Toroid

The ELV-PRO has provision for the connection of a suitable toroid, with a secondary rating of 5A, to monitor a phase current in the system.

**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.

# 5 PRODUCT OPERATION

The ELV-PRO's advance analysis ability does not prevent the relay operating as an effective Earth Leakage Protection Relay. This section will discuss the various features of the relay.

## 5.1 Earth Leakage Protection

The Earth Leakage (EL) protection used in the ELV-PRO is based upon the ELV Wideband EL Protection Relay. The relay is designed to AS/NZS 2081:2011 Section 6. The ELV-PRO, like the ELV, uses patented technology (AU2011264414) to characterise earth leakage currents giving superior fault discrimination, particularly in applications involving switching power electronics and variable speed drives.

The earth fault current is measured using a toroid, 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 connected in 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), narrowband (power frequency) and weighted frequency mode (up to 8kHz, high frequency compensated).

The ELV Relay has been designed and tested for use on fault-limited systems. To ensure maximum protection, the earth leakage system should be used in conjunction with the other protection systems covered by AS/NZS 2081. The collective systems are designed to limit touch and step potentials.

The relay is also suitable for industry where equipment or system earth leakage protection is required. The relay is not suitable for personal protection, which requires trip levels of 20-30mA, with instantaneous operation (refer to AS/NZS 3190).

The ELV-PRO has three operating modes:

- Wideband mode: The relay will see all currents between 20Hz and 8kHz and trips if the true RMS level of leakage current is above the trip level (adjustable from 50mA to 5A). This mode is compliant with AS/NZS 2081:2011 and would be used in most cases.
- Narrowband (power frequency) mode: The relay will see all currents between 20Hz and 100Hz and trips if the true RMS level of leakage current is above the trip level (adjustable from 50mA to 5A). This mode operates as a traditional earth leakage relay.
- 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.

## 5.2 Earth Leakage Analysis Tool

The ELV-PRO offers real time analysis of the earth leakage current and also provides 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 values of earth leakage current measured by the ELV-PRO. At every update, it displays the last 80ms of data.
- RMS graph: In this view, Root Mean Square values of the measured current are shown. 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 6.

## 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 ELV-PRO stores system data for two seconds before and two seconds after the event. This includes:

- System time,
- Earth leakage current,
- Phase current (with connection of a toroid, 5A secondary connection, within ±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 ELV-PRO 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 ELV-PRO 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 ELV-PRO does not have an on-board battery to maintain the RTC settings.

**NOTE**

The ELV-PRO 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 ELV-PRO 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 ELV-PRO 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's 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 ELV-PRO web server. If there are multiple ELV-PRO 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 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 ELV-PRO 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 likely be a yellow triangle with an exclamation mark over the hardwired icon, as shown in Figure 5.1. The triangle symbol simply means that internet access is unavailable.


Figure 5.1: Taskbar Icon: Wired Connection Available

You will need to configure the network adapter settings by right-clicking on this icon and selecting "**Open Network and Sharing Center**". The following should appear:

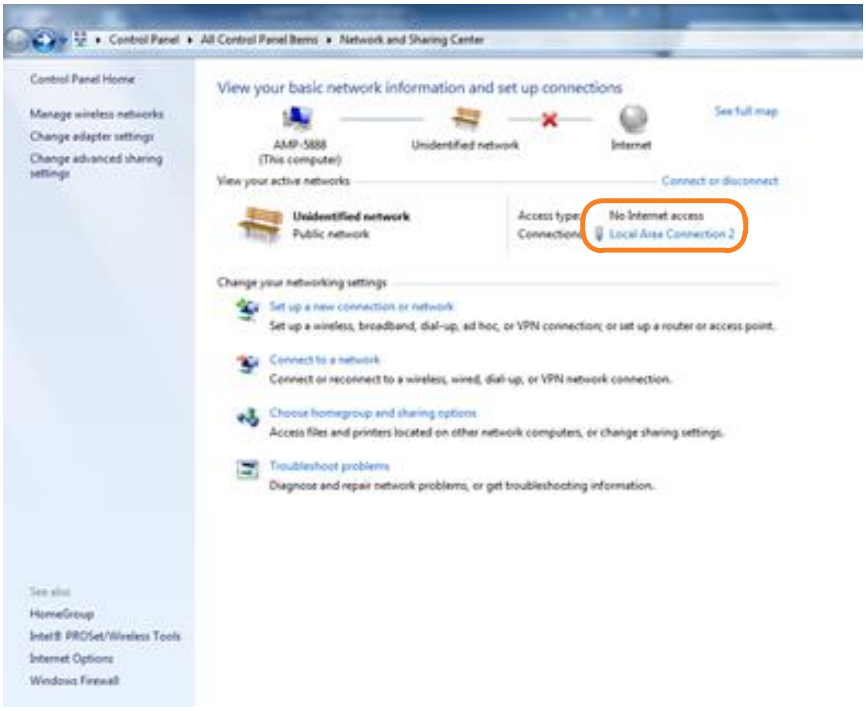



Figure 5.2: Network and Sharing Center

Click on "**Local Area Connection**" for the status page to appear as in Figure 5.3.

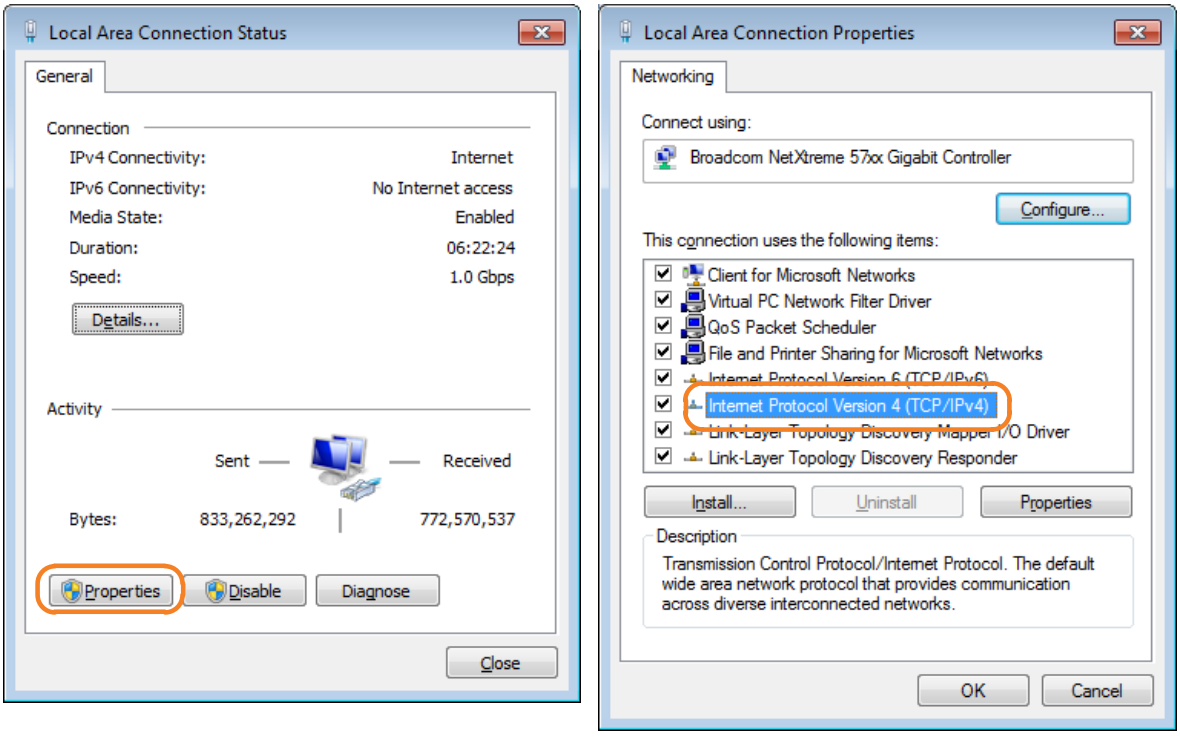



Figure 5.3: Local Area Connection Status (left) and Properties (right)

Click the "**Properties**" button for the "Local Area Connection Properties" window to appear as in Figure 5.3.

Double click on "**Internet Protocol Version 4 (TCP/IPv4)**". The following should appear:

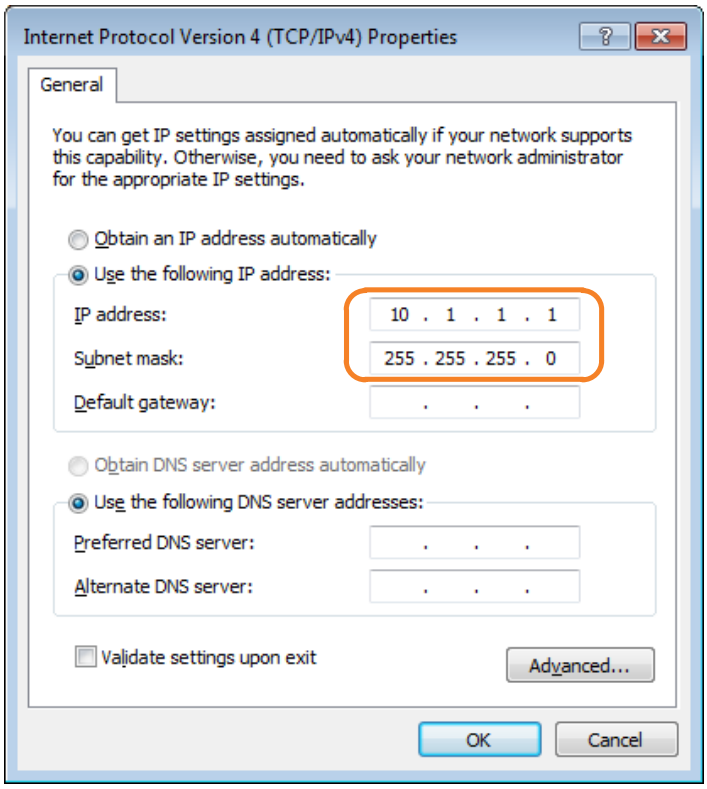



Figure 5.4: Internet Protocol Versions 4 (TCP/IPv4) Properties

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 ELV-PRO 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 following IP address into the browsers address bar:

**10.1.1.10**

The ELV-PRO Web Interface should appear as detailed in Section 6.

## 5.6 Protection Settings

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

- Earth Leakage Trip Level
- Earth Leakage Trip Time
- Earth Leakage Alarm Trip Level
- Earth Leakage Alarm Time
- Alarm Cool Down
- Earth Leakage Mode
- Digital Input Settings

### 5.6.1 Earth Leakage Trip Level

This defines the leakage current which will cause an Earth Leakage trip. The current is detected via the Earth Leakage CT and is given in RMS. The setting can be any value between 50mA and 5000mA inclusive. The web server however has used values in set intervals to make adjustment easier and quicker. These values can be seen below, Table 3.

Table 3: Earth Leakage Trip level

| Value | Value | Value |
|---|---|---|
| 50mA | 1100mA | 3100mA |
| 100mA | 1200mA | 3200mA |
| 150mA | 1300mA | 3300mA |
| 200mA | 1400mA | 3400mA |
| 250mA | 1500mA | 3500mA |
| 300mA | 1600mA | 3600mA |
| 350mA | 1700mA | 3700mA |
| 400mA | 1800mA | 3800mA |
| 450mA | 1900mA | 3900mA |
| 500mA | 2000mA | 4000mA |
| 550mA | 2100mA | 4100mA |
| 600mA | 2200mA | 4200mA |
| 650mA | 2300mA | 4300mA |
| 700mA | 2400mA | 4400mA |
| 750mA | 2500mA | 4500mA |
| 800mA | 2600mA | 4600mA |
| 850mA | 2700mA | 4700mA |
| 900mA | 2800mA | 4800mA |
| 950mA | 2900mA | 4900mA |
| 1000mA | 3000mA | 5000mA |

### 5.6.2 Earth Leakage Trip Time

This defines how quickly the Earth Leakage trip will occur when the current through the CT is greater than the Earth Leakage 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 4: Earth Leakage Trip Time

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

### 5.6.3 Earth Leakage Alarm Trip Level

The setting can be any value between 50mA and 5000mA inclusive. The web server however has used values in set intervals to make adjustment easier and quicker. These values are identical to the EL Trip Level, as shown in Table 3.

### 5.6.4 Earth Leakage Alarm Time

This can be set to any value between 1ms 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 5: Digital Input Settings

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

## 5.7 ELV-PRO CIP over Ethernet/IP Interface

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

## 5.8 ELV-PRO Modbus TCP Interface

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

# 6 OPERATIONAL INTERFACE

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

## 6.1 ELV-PRO Facia Interface

The ELV-PRO 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 ELV-PRO interface is shown in Figure 6.1.

The front of the relay has two buttons and two indicators. The 'Reset' button, Item 3 in Figure 6.1, functions as a local reset button allowing a trip to be reset, provided the fault has cleared. The 'IP Reset' button, Item 4 in Figure 6.1, 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 6.

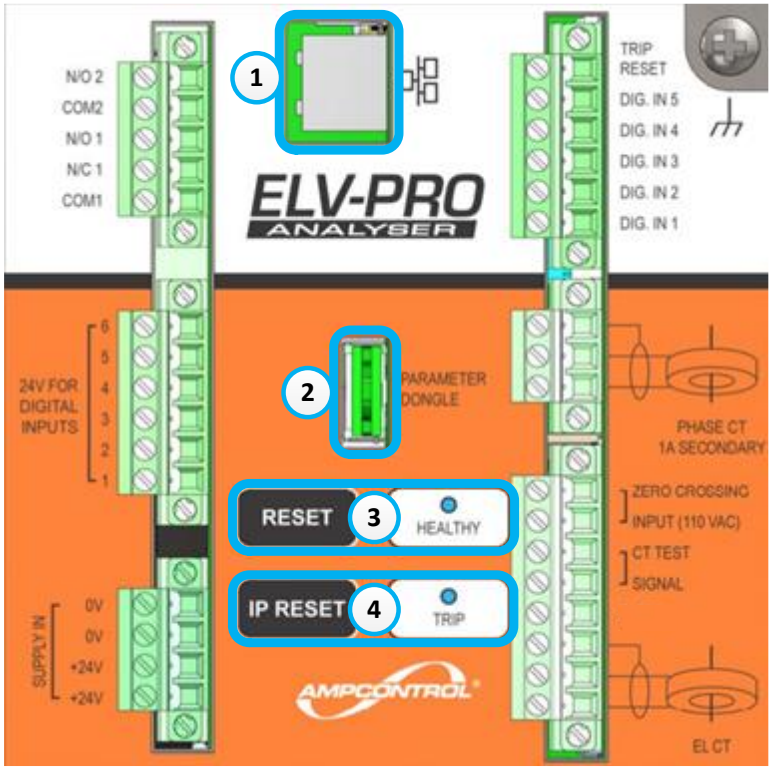



Figure 6.1: ELV-PRO Fascia Interface

Table 6: ELV-PRO 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 ELV-PRO Web Interface

The ELV-PRO Web Interface allows the user to remotely access the information stored within the ELV-PRO. This includes live data, event and data logs, device information and settings. The ELV-PRO 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 ELV-PRO Web Interface

In order to connect to the ELV-PRO Web Interface, the user must type the IP address of the Analyser that they wish to connect to into their web browsers address bar. To view the Web Interface, the computer that is accessing the Analyser must be connected to the same network as the Analyser. 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 6.2 by numbered circles. Items identified by these numbered circles are explained in further detail in the following sub-sections.

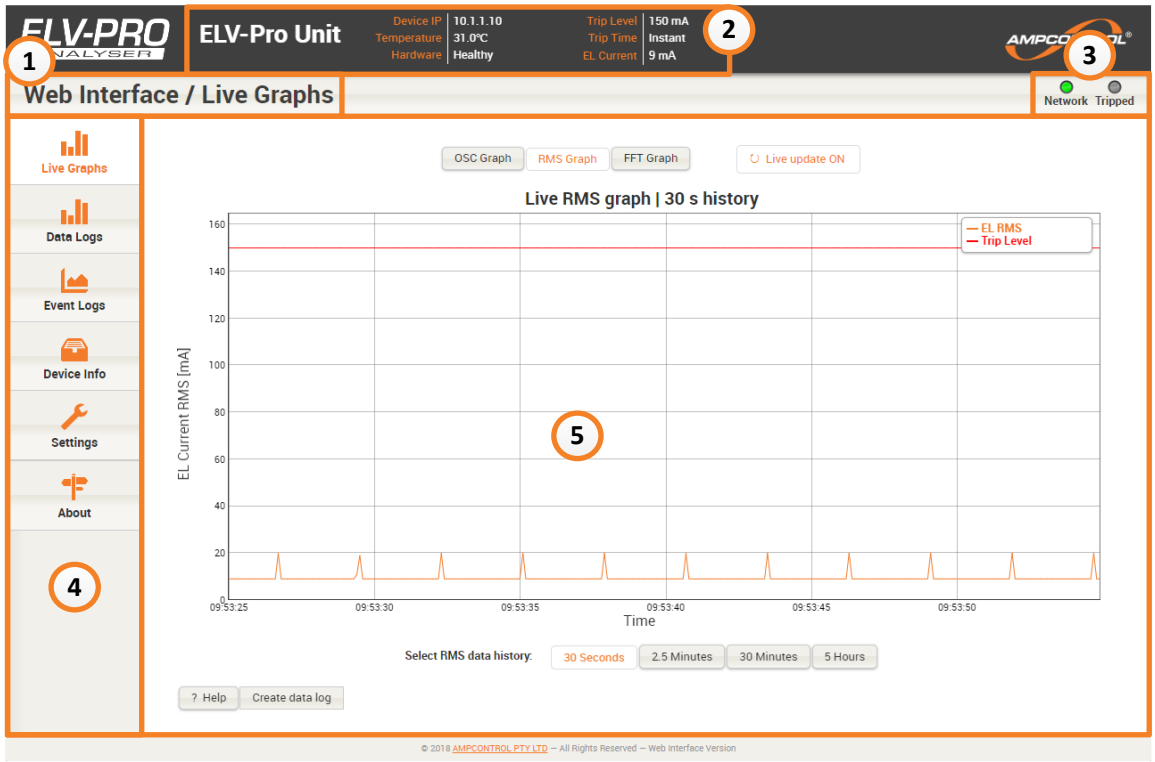



Figure 6.2: ELV-PRO Web Interface – Overview

**NOTE**

In order to view the Web Interface, the ELV-PRO 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

#### 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 6.2.9).

#### 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 ELV-PRO
- The temperature that the ELV-PRO 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 ELV-PRO dongle settings (see Section 6.2.6). This description is also used to correctly identify the connected ELV-PRO Relay.

#### 6.2.1.3 Item 3: ELV-PRO Analyser Status Indicators

The ELV-PRO Status Indicators display the status of the Web Interface network connection to the Analyser and the status of the relay. The functionality of these indicators is outlined in Table 7.

Table 7: 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 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 6.3 shows the ELV-PRO 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 of Figure 6.3) 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 6.2.8). The buttons above the graphs (item 1 of Figure 6.3) allow the graph to alternate between the three possible options. These are:

- OSC (Oscilloscope) graph: Plots the instantaneous values of earth leakage current measured by the ELV-PRO. At every update, it displays the last 80ms of data. Figure 6.4.
- RMS graph: In this view, Root Mean Square (RMS) values of the measured current are shown. The user is able to select the time interval on the graph by selecting from the buttons below the graph. Figure 6.3.
- FFT graph: This plot shows the frequency content of the past 80ms worth of instantaneous measurements. Figure 6.5.

For information on navigating the interactive graphs see Section 6.2.8. There is also a Help button below the plots, item 4 of Figure 6.4, which allows access to online help information.

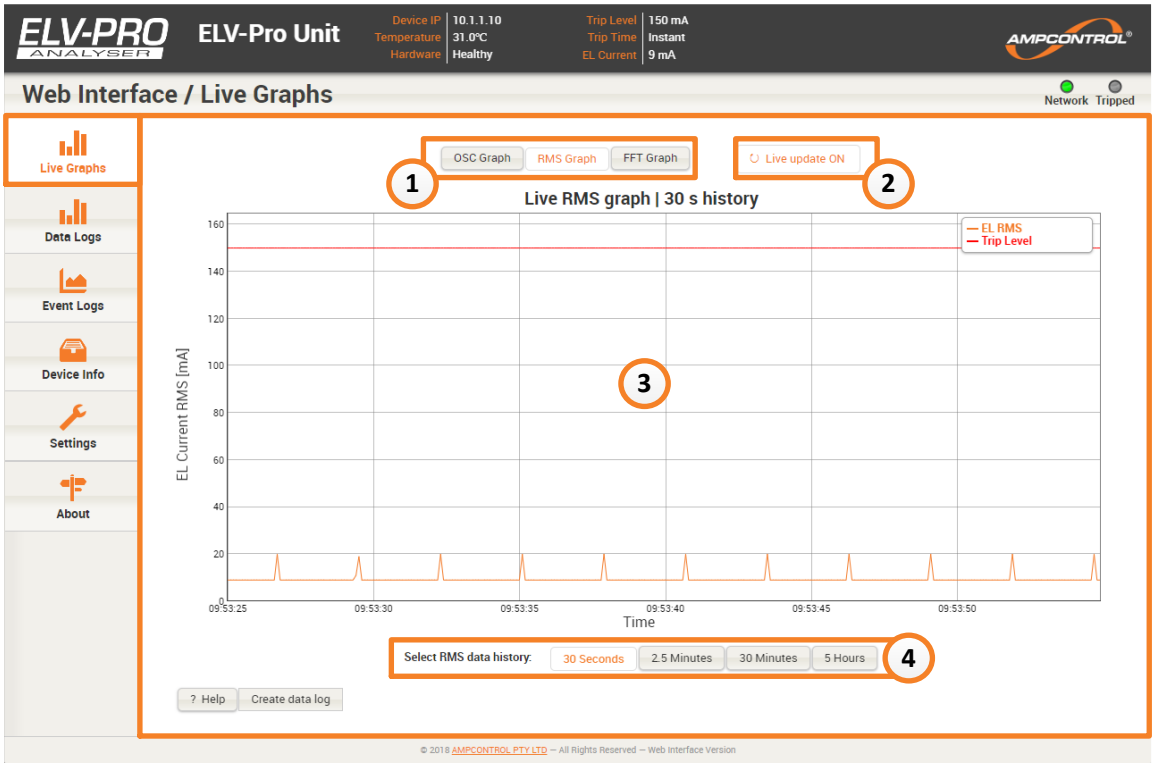



Figure 6.3: ELV-PRO Web Interface - Live Graphs (RMS)

**NOTE**

The protection system constantly injects a CT test signal into the CT every two seconds. As such, the earth leakage graph will record a small non-zero value, even when the outlet is de-energised. This confirms that the Earth Leakage detection is operational.

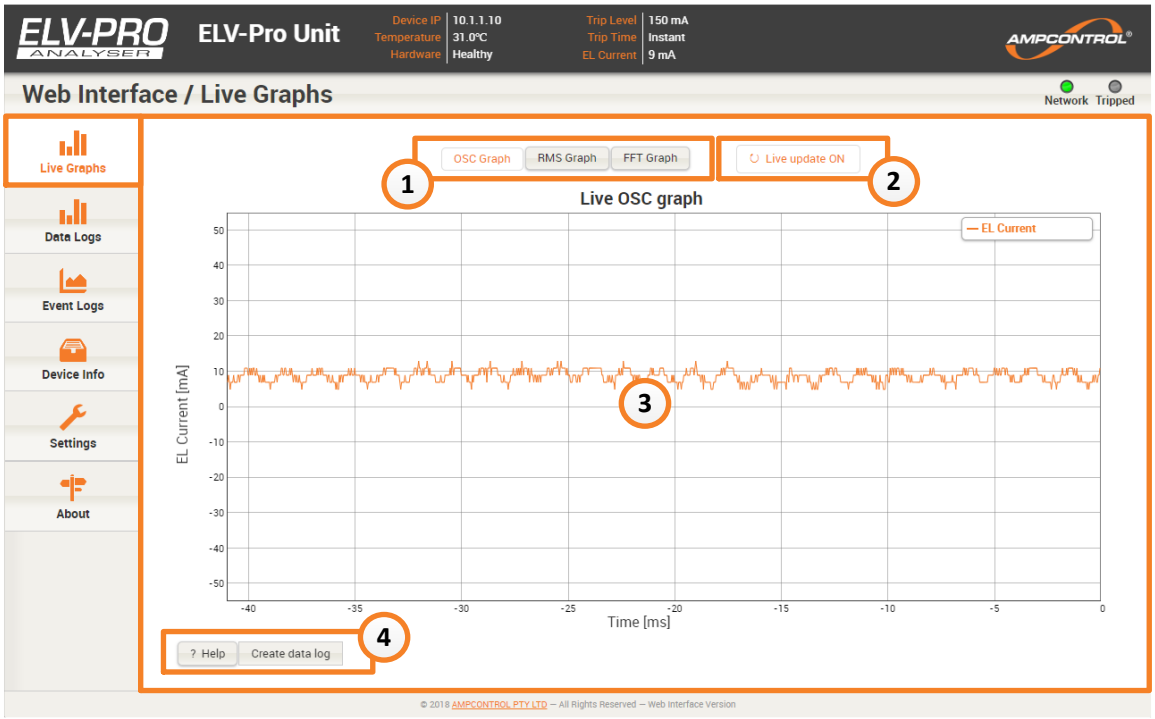



Figure 6.4: ELV-PRO Web Interface - Live Graphs (OSC)

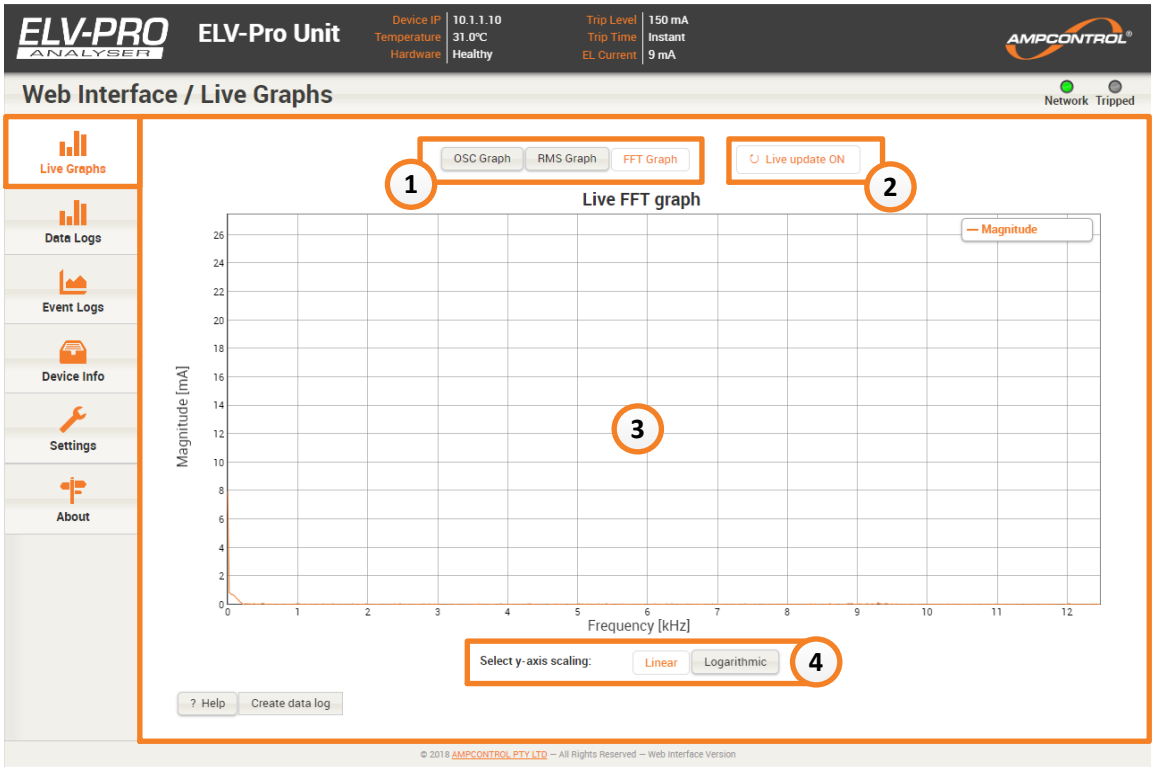



Figure 6.5: ELV-PRO Web Interface - Live Graphs (FFT)

### 6.2.3 Data Logs Tab

The Data Logs tab is similar to the Live Graphs tab, in that it allows inspection of measured earth leakage currents. However, in this tab, historic measurements from data logs stored on the ELV-PRO 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 6.6) in the drop-down menu, OSC, RMS and FFT views are available as they are in the Live Graph tab.

The RMS view (Figure 6.8) is calculated using a running window of 300 data points.

The FFT graph (Figure 6.9) corresponds to the selected 80ms of signal. A small oscilloscope plot of the signal (item 2 of Figure 6.9) 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.

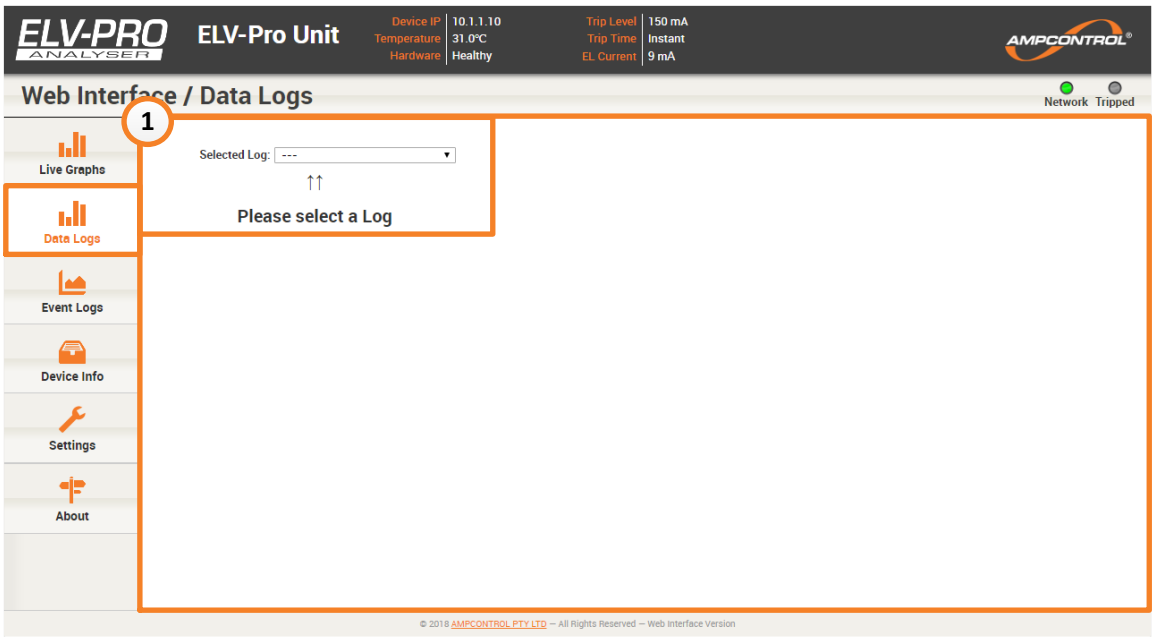



Figure 6.6: ELV-PRO Web Interface - Data Logs

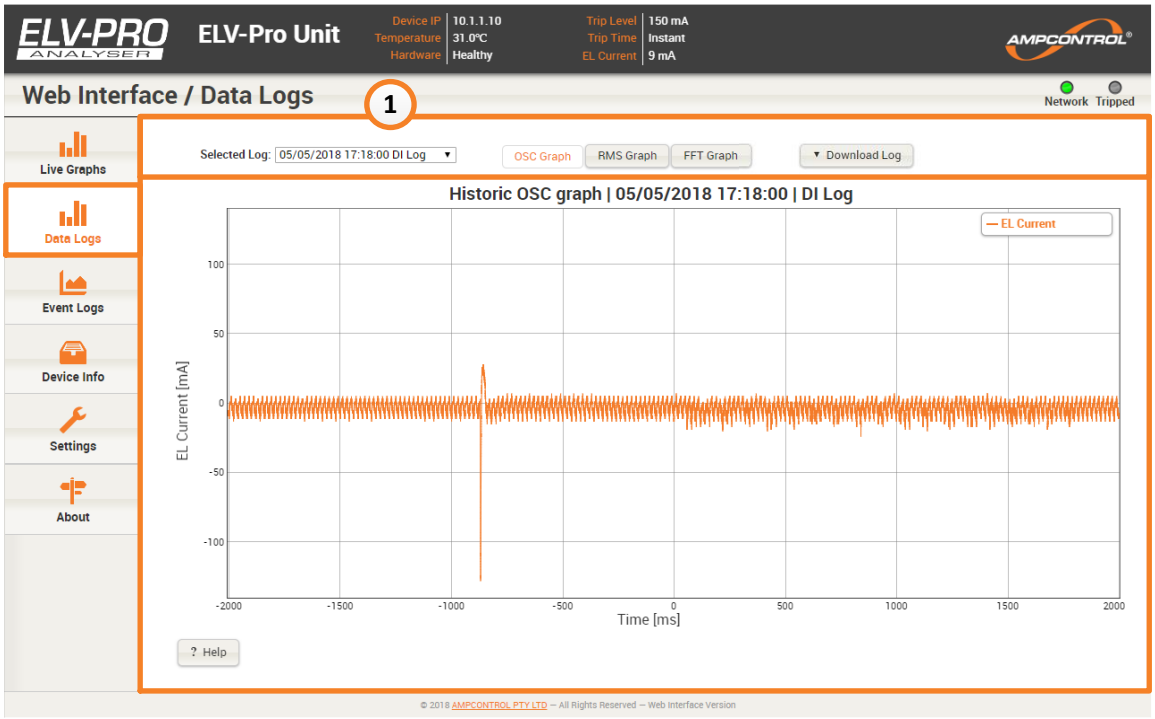



Figure 6.7: ELV-PRO Web Interface - Data Logs (OSC)

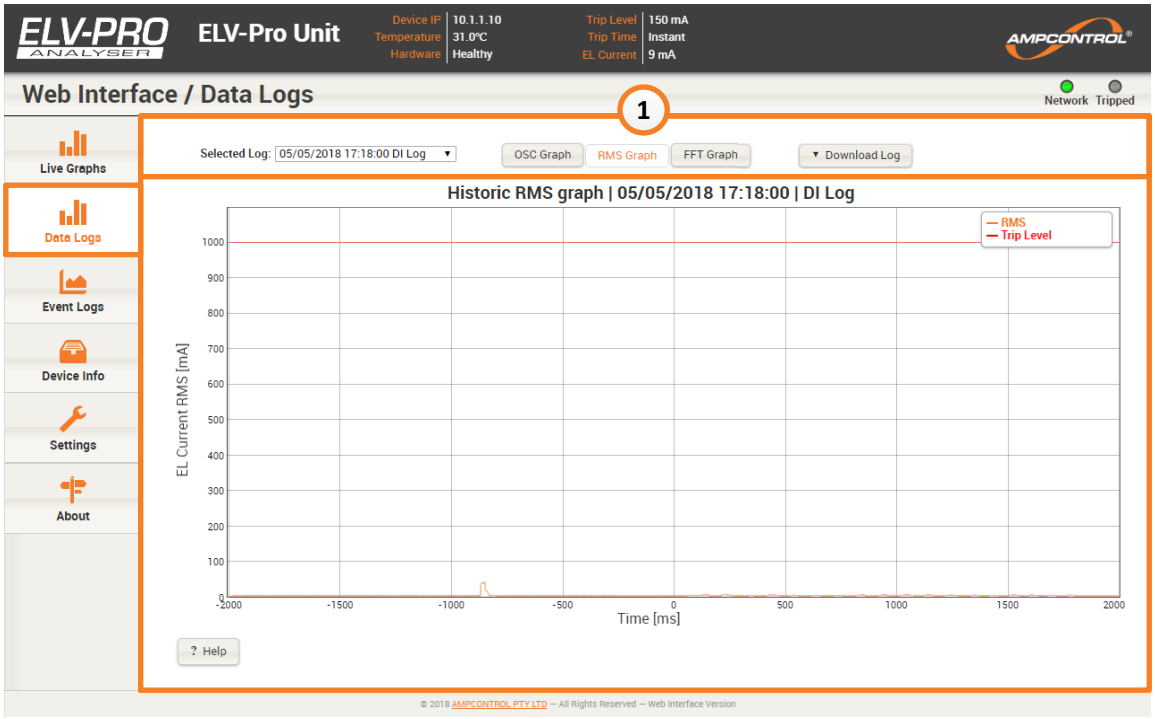



Figure 6.8: ELV-PRO Web Interface - Data Logs (RMS)

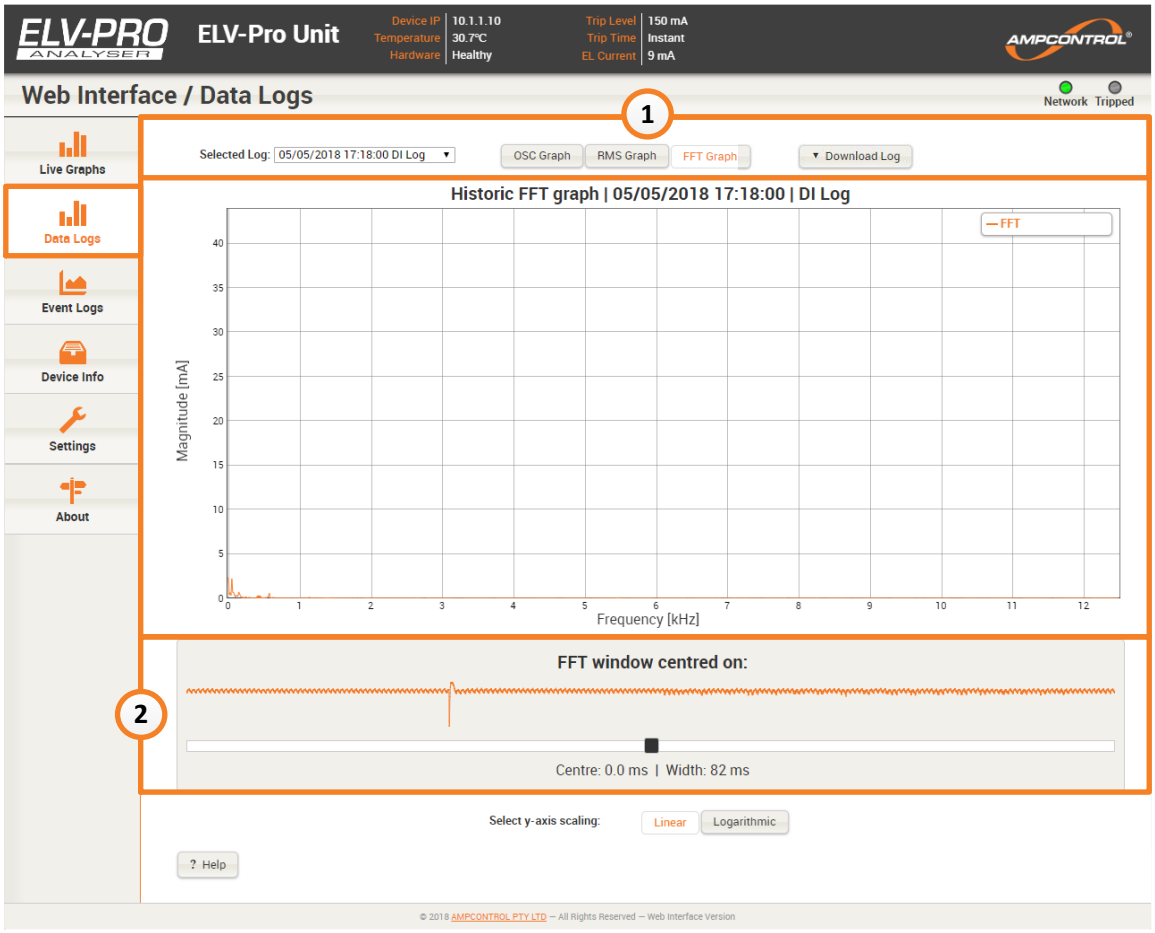



Figure 6.9: ELV-PRO Web Interface - Data Logs (FFT)

### 6.2.4 Event Logs Tab

This tab shows the 50 most recent user changes made at the unit, see Figure 6.10. 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 8 below.

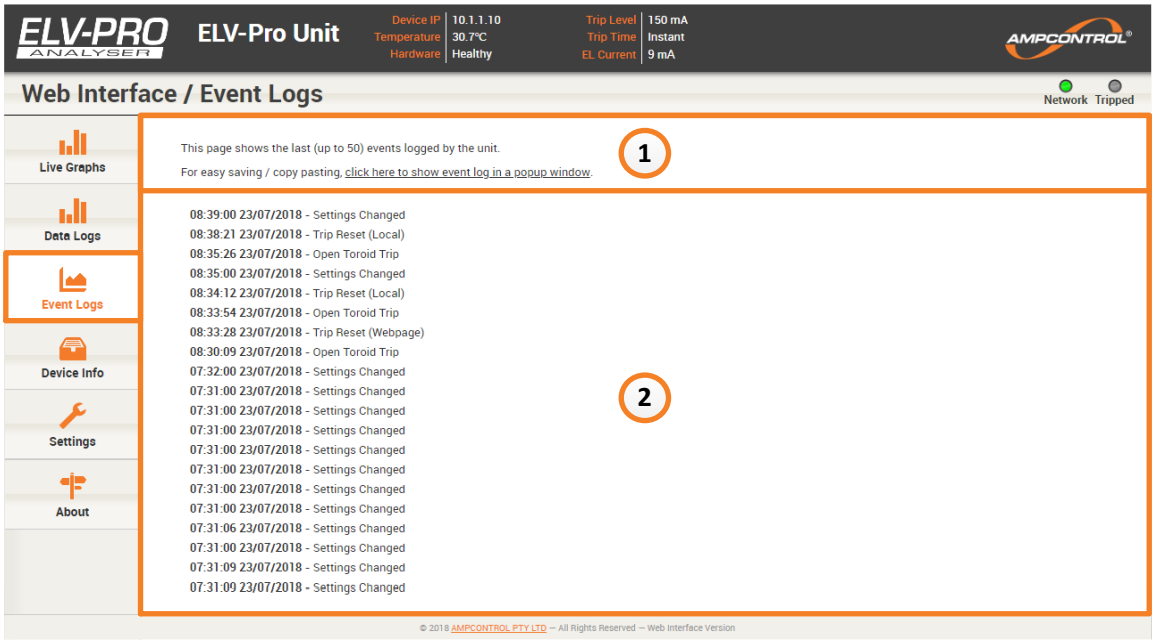



Figure 6.10: ELV-PRO Web Interface - Event Logs

Table 8: Event ID Descriptions

| Event ID | String | Description |
|---|---|---|
| 0 | Unused | 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 | Earth Leakage Trip | Unit tripped due to detection of an earth leakage current 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 | Open Toroid Trip | Unit tripped because it could not sense the earth leakage current detection toroid |
| 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 |
| 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.) |
| 33 | Button Stuck Fault | The reset button on facia of relay has been held on for 2 or more seconds.<br>Relay will not be resettable while button is stuck.<br>The external reset input will not cause a button stuck, however will be required to cycle state before a reset command will be acknowledged.<br>The IP reset button will not cause a button stuck trip |

### 6.2.5 Device Information Tab

The Device Information Tab (Figure 6.11) 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

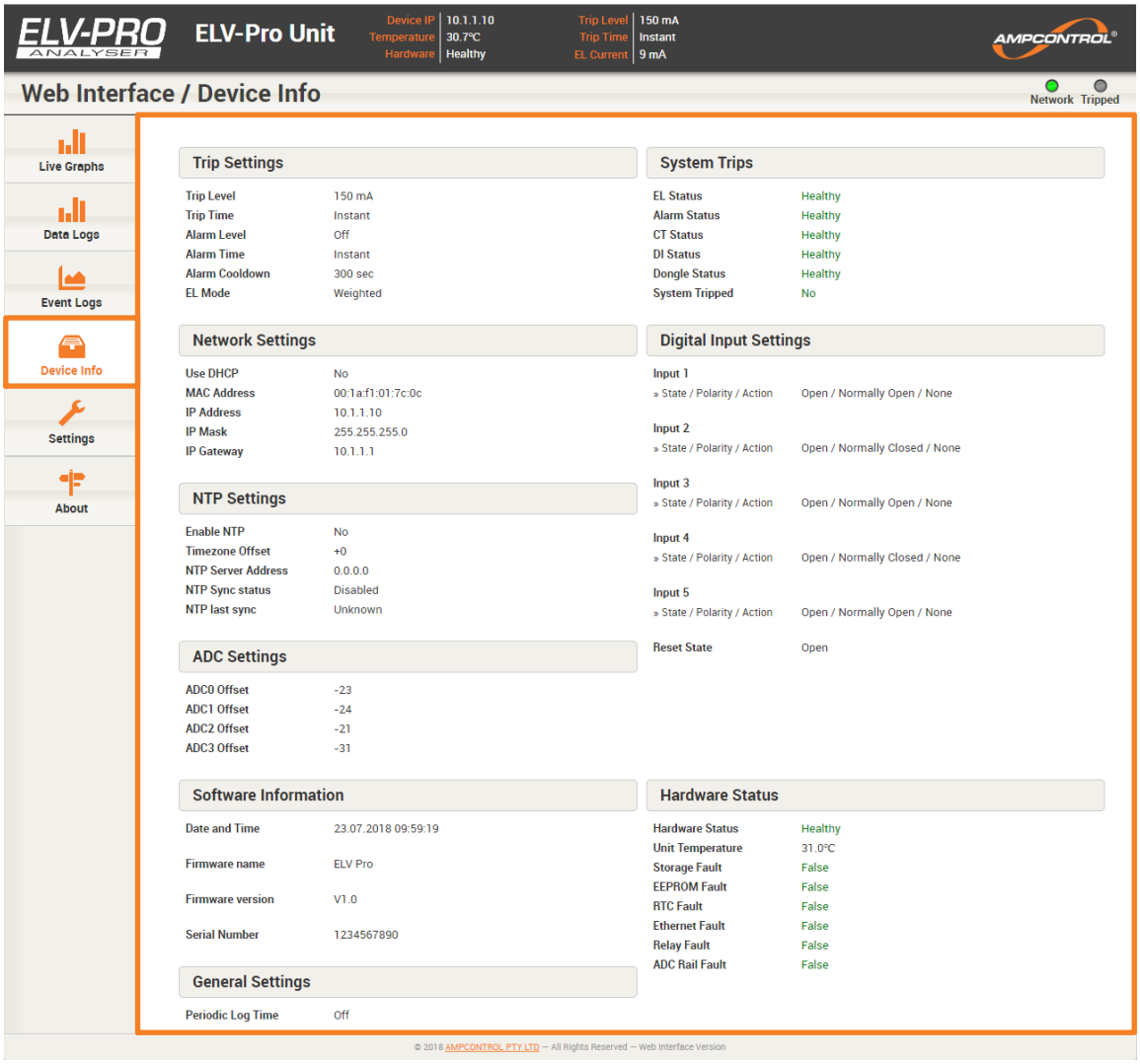



Figure 6.11: ELV-PRO Web Interface - Device Info

### 6.2.6 Settings Tab

The settings Tab (Figure 6.12) 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 9 below. Once the desired settings have been changed, select “Save Settings” to save and return to the home page.

Table 9: Login Details

| | |
|---|---|
| **Username** | admin |
| **Password** | Password |

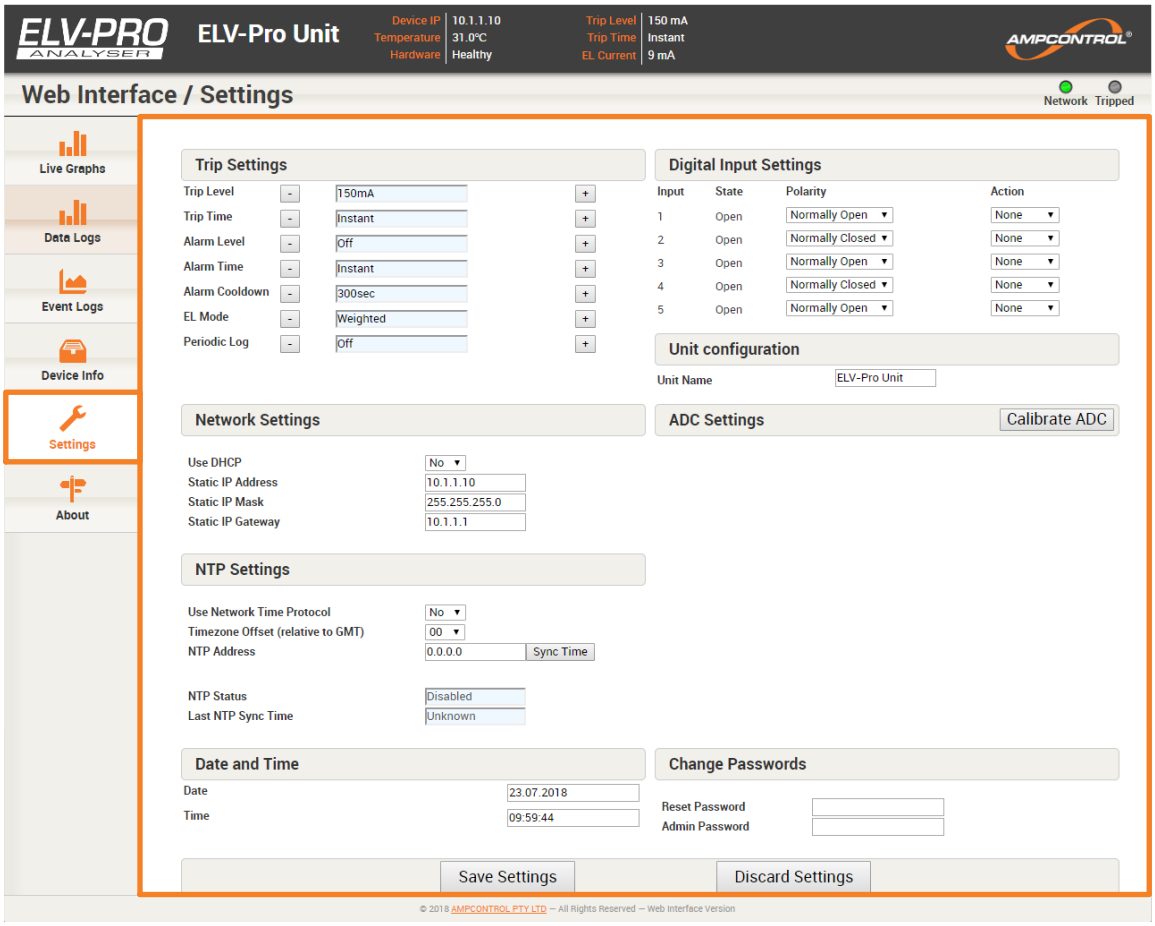



Figure 6.12: ELV-PRO Web Interface – Settings

**NOTE**

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

**NOTE**

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

When the ELV-PRO 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, toroid 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 6.13) provides contact details and licensing information about the device and website.

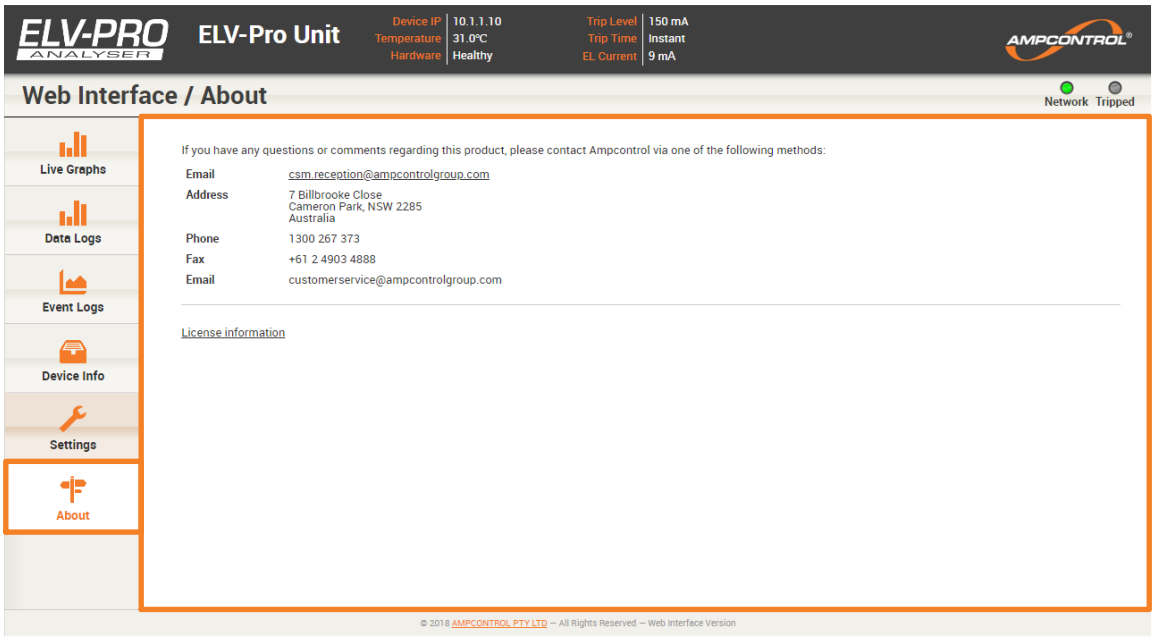



Figure 6.13: ELV-PRO Web Interface - About

### 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 6.14) 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.

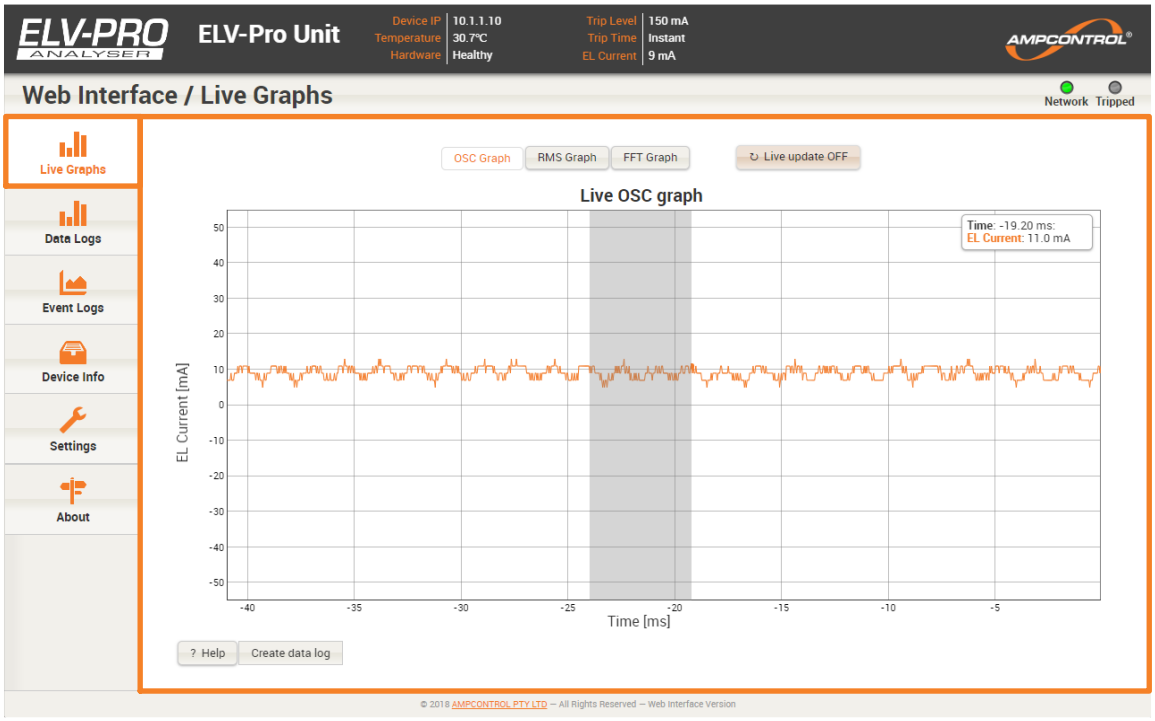



Figure 6.14: ELV-PRO Web Interface - Interactive Graph Navigation

### 6.2.9 Protection Function Trip

Should a trip occur, the trip indicator illuminates red (Item 3 of Figure 6.15) and the header block (Item 1 of Figure 6.15) and page background changes to red. The Reset pin code entry and button will also appear, see Item 2 in Figure 6.15. To reset, simply enter the pin and select the reset button.


Figure 6.15: ELV-PRO - 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 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 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 an earth leakage test by injecting a current through the primary (window) of the EL toroid 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

**WARNING!**


The ELV-PRO has no user-serviceable parts.

**All repairs must be carried out by Ampcontrol only**.

If a fault develops, return the unit to Ampcontrol for repair. It is essential that **no attempt be made to repair the unit** as any attempt to dismantle or repair the unit can **seriously compromise the safety of the unit and voids product warranty**.

It is recommended that the electrical protection system incorporating the ELV-PRO 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

**ENVIRO**

The electronic equipment discussed in this manual **must not be treated as general waste**. 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 SPECIFICATIONS

| Specifications | |
|---|---|
| **Supply** | |
| Regulated Voltage | 24 VDC ± 25 % |
| Power Supply Requirement | 12 W |
| **Dimensions** | |
| ELV-PRO (W x H x L) | 135 x 135 x 107 (mm) |
| **Operating Conditions** | |
| Ambient operating temperature | 0 °C – 60 °C |
| IP Rating | IP20 |
| **Earth Leakage Protection** | |
| Trip Current Level | 50 mA – 5 A (50 mA – 1 A in 50 mA increments, 1 A – 5 A in 100 mA increments) |
| Trip Operation Time | Instantaneous – 500 ms in 50 ms increments |
| **Compliance** | |
| AS/NZS 2081 | Section 6 – Earth Fault Protection Devices |
| **Output Contacts** | |
| Relay 1 – Fail Safe | 1xCO (Mechanical) 250 VAC 1.6 A / 30 VDC 1.6 A (@50 VDC ~0.3 A) |
| Relay 2 – Fail Safe | 1xNO (Solid State) 110 VAC/DC 0.2 A |
| Internal Transient Suppression Filter Across Terminals | Serial < 2308000000: Present (unless identified by label)<br>Serial > 2308000000: Removed |
| **ELV-PRO Inputs** | |
| Inputs 1-5 | Programmable Trip/Log functions |
| Input 6 – Trip Reset | Manual trip reset by external pushbutton |
| Earth Leakage Toroid (CT) | Toroid 100/1A (Ampcontrol EL500S series recommended) |
| Phase Monitoring Toroid (CT) | Optional; 5A secondary toroid, for monitoring a selected phase current |
| Zero Crossing (110VAC) | Optional; Phase current zero crossing detection |
| **Communication Interface** | |
| Ethernet Socket | Relay 10BASE-TX or 100BASE-TXaccessible via http (using a standard web browser) |
| Ethernet IP | Standard Protocol, See below for details |
| Modbus IP | Standard Protocol, See below for details |
| **Find Out More** | |
| For more information on this product, contact Ampcontrol Customer Service on +61 1300 267 373 or customerservice@ampcontrolgroup.com or visit the Ampcontrol website: www.ampcontrolgroup.com | |

# 9 EQUIPMENT LIST

| Part Number | Description |
|---|---|
| 176426 | ELV-PRO Wideband Earth Leakage Relay |
| 179971 | ELV-PRO Settings Dongle |
| 115437 | Toroid EL500S - 25mm ID |
| 101649 | Toroid EL500S - 60mm ID (Alternative Item 101658) |
| 101656 | Toroid EL500S - 112mm ID |

# APPENDIX A: MINING EARTH LEAKAGE PROTECTION WITH VARIABLE SPEED DRIVES

The mining working environment presents a range of unique challenges for electrical distribution systems due to the equipment used and associated hazards. As such, various protection schemes have evolved to prevent damage to equipment and injury to personnel. In particular, these include:

a) Earth fault current limitation, usually consisting of a resistor connected between the supply transformer star point and earth, commonly referred to as a Neutral Earthing Resistor (NER).
b) Earth continuity monitoring devices.
c) Earth leakage protection devices.
d) Earth fault lockout protection.

As described in Appendix C of AS/NZS 4871.1:2012, the protection scheme is

> Intended to ensure that when persons are exposed to touch potentials, the level of voltage and time exposed before protection systems trip is limited to an acceptable level

The acceptable levels are given in Figure C1 of the standard for 50Hz touch voltages.

**CAUTION!**

Relays designed to operate on earth fault limited systems are not suitable for direct personal protection.

These protection systems were originally devised to protect against touch potential hazards cause by earth fault currents driven by the power supply (50Hz). Consider, for example, that an earth fault occurs in a mobile machine powered by a trailing cable. The earth fault current will flow through the fault to the machine frame and return to the supply transformer star point via the trailing cable earth conductors. The voltage drop caused will result in a potential rise above earth on the frame, presenting a touch potential hazard. As described in AS/NZS 4871.1:2012 the system assessment must determine the earth fault limitation current that will protect people based on the achievable earth leakage clearance times and knowledge of the system in which it is installed.

## A1 Variable Speed Drives

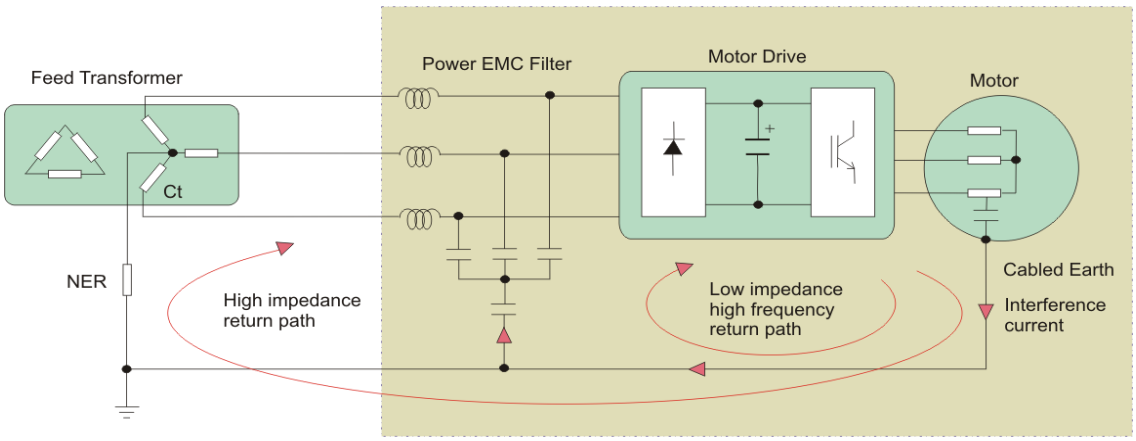
Variable speed drives (VSDs) are now finding wide use in mining applications. Most of these drives use variable frequency outputs that are produced by rectifying the supply to DC and then inverting this voltage back into AC using a high frequency carrier and pulse width modulation (PWM) to produce variable frequency currents in the motor. They complicate the situation in several ways:

1) VSDs introduce a new and complex voltage source into the power system. This may mean that earth faults can now be direct current (DC) in nature or may be driven by the inverter of the drive and so have a frequency that is primarily that of the drive PWM carrier frequency (1000Hz for example).

2) To minimise interference with protection and control systems, many drives employ electromagnetic compatibility (EMC or EMI) filters that consist primarily of a capacitive circuit between the input of the drive and earth. This provides a path for the earth currents that represents an alternative path to the NER, as shown in the figure below. In fact, it is the intention of the filter to provide this alternative path for the high frequency currents that flow (through the motor and cable stray capacitances) to earth under normal conditions. They will also provide an alternative path under fault conditions, particularly if the fault is driven by the high switching frequency drive output.
   It has also been shown that when one or more drives and filters are in use, and an earth fault occurs, there can be circulating currents between the drives and filters and/or the fault location. The fault current magnitudes may then greatly exceed the nominal current limitation value (typically 5A) determined by the NER. These large currents may cause touch potentials that greatly exceed the expected values.

3) Most earth leakage protection relays approved for use in mining applications are designed to detect 50Hz currents, not DC or high frequency currents so the relays may not trip, or if they do trip, they may take longer than expected.

The overall result is that with standard earth leakage protection relays and electrical system assessments based only on consideration of faults driven by the supply system (50Hz), protection performance is unlikely to be adequate when variable speed drives are used in mining applications.



## A2 Improving Protection

The design of earth leakage relays used in mining applications in Australia and New Zealand must comply with AS/NZS 2081. The latest version of this standard (AS/NZS 2081:2011) better recognises that system protection needs to be assessed in accordance with AS/NZS 4871.1:2010 and with the changes in the mining electrical environment.
The following extracts from AS/NZS 2081:2011 provide some key statements of interest:

> **1.1 Scope**
> Whereas this standard is based upon 50Hz supply systems, it is envisaged that the equipment described may also be installed in systems with higher, lower or variable frequencies, or in DC supplied systems.
> AS/NZS 60479, Part 1 and 2 should be referenced for consideration of the effects at other supply frequencies upon the human body.
>
> **Appendix B:**
> The diversity of operating conditions and equipment addressed by this Standard precludes reliance solely on explicitly prescribed trip levels or fault current levels, and their duration, in order to ensure a safe working environment. Rather, the onus is placed on the system designer to ensure appropriate touch voltage/operating times when integrating the protection devices addressed by this Standard.
>
> **B2 Voltage/Duration Thresholds**
> Design criteria for the protection devices have been chosen to enable compliance to the touch voltage/operating times for systems operating at 50Hz as described by Figure B1.
>
> **B3 Systems at other than 50Hz Cyclic Frequency**
> Where equipment is installed and operated within systems at other than a constant 50Hz cyclic frequency, the characteristics in paragraph B2 are not immediately applicable. In such instances, individual calculation to determine requirements at the frequency or frequencies in question will be required.
> Standards AS/NZS 60479.1 and AS/NZS 60479.2 should be referenced in relation to the effects upon the human body of other supply frequencies.

What this means is that when VSDs (or other non 50Hz sources) are used in a mining electrical system then the standard approach needs to be interpreted to ensure that protection is adequate. The key factors to consider are as follows:

1) The sensitivity of the human body to electric shock varies with frequency. In general, for a given exposure time, the allowable touch voltage magnitude increases with frequency. For example, at 10kHz, the “let go” voltage is about 5 times that level at 50Hz.
2) When EMC filters are used, this forms a path for earth currents alternative to the NER. When considering touch potentials at a mobile machine for example, strictly speaking the impedance of the filter at the frequency of interest should be examined in order to determine the earth fault current that will flow when a fault occurs in the machine. The earth leakage trip time must then be used to ensure that the touch voltage and exposure time guarantee a safe system. Care must be taken when multiple filters are connected to a single supply, as this presents many modes of possible earth fault that need to be considered and actual earth fault currents may exceed the current seen by any single filter.
3) An earth leakage relay must be able to accurately sense earth fault currents of any frequency from DC to the maximum frequency of interest.

It can be seen that this is not a trivial matter, and it is likely that the industry will need to adapt to this new and complex environment.

# APPENDIX B: ELV-PRO CURRENT TRANSFORMERS

## B1 Earth Leakage Toroids

Toroids (current transformers) are not ideal devices and if correct procedures are not followed during installation nuisance tripping can result. Consider, for example, a single-phase earth leakage system where active and neutral pass through a toroid then at all times currents in the two wires are equal and opposite so that the net current through the toroid is zero. An ideal toroid would have all of the flux from each wire contained in the core and so would accurately add the opposing fluxes to get a net result of zero. A real toroid has “leakage fluxes”. That is, a very small proportion of the total flux from each cable is not contained in the core but in the space outside it and as a result it may link some turns but not others, depending on the positioning of the cables. The effect of this is that a small output may be obtained from the toroid where none would arise if the device were ideal.

The size of the error may vary from toroids of the same type because of slight differences in the core and the symmetry of the winding. Problems caused in this way increase as the toroid size increases, as currents increase and symmetry decreases. Nuisance tripping tends to occur when the total current rises, such as when a large motor is started. The following guidelines would help to avoid such problems.

### B2 Toroid selection

1. Select the smallest internal diameter toroid, which will allow the cables to fit through. Avoid very large toroids (>200mm aperture) or toroids with square apertures.
2. Only use approved toroids specified by Ampcontrol as these have been designed to minimise problems.

### B3 Toroid installation guidelines

1. Keep cables as close to the center of the toroid as possible. Do not tie them to one side of the toroid. Remember to aim for symmetry.
2. Do not bring the cables back past the toroid within one diameter of the toroid. Trying to cram cables into a small space reduces symmetry and may lead to problems.
3. Avoid placing the toroid near any device that produces magnetic fields. This includes bus bars, transformers or other cables. Try to maintain several toroid diameters clearance.
4. Many small cables tend to be worse than say, three large ones. Try to position the toroid in the circuit with this in mind.
5. Toroids used for core balance earth leakage protection cannot have bus bars passed through them.
6. To prevent possible nuisance tripping it is suggested that the conductor screen of the earth leakage toroid should be earthed at one end only, the relay end. If both ends are earthed the possibility exists for the shield to become an earth loop, having finite resistance and injecting noise into the toroid leads

# APPENDIX C: ELV-PRO CIP OVER ETHERNET/IP

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

## C1 ELEMENTARY DATA TYPES

The elementary data types used within this document are taken from table C-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.

# C2 LIVE DATA SEGMENT DEFINITION

| | Value |
|---|---|
| Assemble Instance | 100 |
| Size | 8 |
| Data Type | UINT |

| Offset | Value Name | Details |
|---|---|---|
| 0 | Earth Leakage Current | The unbalanced 3-phase current. Value returned in mA. |
| 1 | RTC – Data Upper | Upper byte of the RTC number.<br>The RTC is sent as a standard 32bit number that represents the number of seconds since 1st 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 IPX. 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 |

## C2.1 Trip Mask 1

| Bitmask | Trip Name | Details |
|---|---|---|
| 0x0001 | System Tripped | General Bitmask denoting the system is currently Tripped |
| 0x0002 | Earth Leakage CT Detect | The Earth Leakage CT is not being detected. This trip will automatically clear once the CT is detected |
| 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 | Earth Leakage Tripped | An earth leakage current of greater than the specified limit was detected |
| 0x0080 | Digital Input Tripped | The unit was tripped by a change from the Digital Inputs |

## C2.2 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 |

### C2.3 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 |

## C3 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 | Unused | |
| 2 | Unused | |
| 3 | Unused | |

### C3.1 Reset Control

This reset bit should only be set by an authorised person. An EL 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 | Unused | |

**NOTE**

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

# C4 EXPLICIT MESSAGES

## C4.1 ELV-PRO 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 | Earth Leakage Trip Level | UINT | Value returned in mA |
| 3 | Get | Earth Leakage Trip Time | UINT | Value returned in ms |
| 4 | Get | EL Alarm Trip Level | UINT | Value returned in mA |
| 5 | Get | EL Alarm Trip Time | UINT | Value returned in ms |
| 6 | Get | Alarm Cool Down | UINT | Values returned in seconds |
| 7 | Get | EL Mode | USINT | 0 = Narrow Band<br>1 = Wide Band<br>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 | Earth Leakage Trip Level | UINT |
| 22-23 | Earth Leakage Trip Time | UINT |
| 24-25 | EL Alarm Trip Level | UINT |
| 26-27 | EL Alarm Trip Time | UINT |
| 28-29 | Alarm Cool Down | UINT |
| 30 | EL 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 |

## C4.2 ELV-PRO 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 |

## C5 EVENT LOGS

The ELV-PRO 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 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 D: ELV-PRO Modbus TCP

## D1 Modbus Commands

The following Modbus commands are supported:

Table 10: 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 11: Modbus Exception

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

## D2 Modbus Status

Table 12: Modbus Status

| Status | Comment |
|---|---|
| Address | The Modbus slave address the ELV-PRO 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 |

## D3 Read Modbus Address Table

| Modbus Address | Name | Bit Identification | |
|---|---|---|---|
| 0-3 | | Reserved | |
| 4 | Earth Leakage Current | The unbalanced 3-phase current. mA returned. | |
| 5 | RTC – Data Upper | The RTC is sent as a standard 32bit number that represents the number of seconds since 1st 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 | Earth Leakage CT Detect |
| | | 2 | Unused |
| | | 3 | Relay Fault |
| | | 4 | ADC Rail Fault |
| | | 5 | Dongle Tripped |
| | | 6 | Earth Leakage 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 Name | Uint16 encoded String | |
| 55 | EL Trip Level | Value returned in mA | |

| Modbus Address | Name | Bit Identification |
|---|---|---|
| 56 | EL 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 | EL Alarm Level | Value returned in mA. Off returns a value of 0 (zero). Actual value returned for other settings. |
| 58 | EL Alarm Time | Value returned in ms |
| 59 | Alarm Cool Down | Value returned in Seconds |
| 60 | EL Mode | 0 = Narrowband<br>1 = Wideband<br>2 = Weighted |
| 61 | Reserved | |
| 62 | Digital Input Settings – 1 | 0 – Normally Open, No Action<br>1 – Normally Closed, No Action<br>2 – Normally Open, Generate Log<br>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<br>Word 1 – Ampcontrol Timestamp Lower 16 bits<br>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 | |

## D4 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

## D5 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 E: ELV-PRO Default Settings

The following settings are considered the factory default settings. Default settings will be utilised on an ELV-PRO that is booted with no dongle installed or when booted with a brand new dongle installed. If the ELV-PRO is booted with a brand new dongle installed, settings will not be saved to the dongle until a setting is modified. When a brand new dongle is installed into a powered and running ELV-PRO, the dongle will only be updated once a setting is modified.
If a dongle has been configured or has been initialised from another ELV-PRO, 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 | 150mA |
| Trip Time | 50mS |
| Alarm Level | 0mA |
| Alarm Time | 0mS |
| Alarm Lockout | 5mS |
| EL Mode | 2 |
| Input 1 Polarity | Normally Open |
| Input 1 Action | None |
| Input 2 Polarity | Normally Open |
| Input 2 Action | None |
| Input 3 Polarity | Normally Open |
| Input 3 Action | None |
| Input 4 Polarity | Normally Open |
| Input 4 Action | None |
| Input 5 Polarity | Normally Open |
| Input 5 Action | None |
| Periodic Log Time | 0 |
| DHCP | NO |
| Static IP Address | 10.1.1.10 |
| Static IP Mask | 0.0.0.0 |
| Static IP Gateway | 0.0.0.0 |
| Admin Password | "Password" |
| Unit Name | "ELV-PRO Unit" |
| User Password | "Reset" |
| NTP Server Enabled | No |
| NTP Server IP | 0.0.0.0 |
| UTC Offset | +0Hr |