



elf3

**All Models are covered in this
Manual**

A01235 – Generic Reference Number

Earth Leakage Module

Operation Manual

elf3 Manual
Part number: A01235 – (Generic Reference Number)

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1 OVERVIEW

The ELF3 is an earth leakage module that provides protection against earth leakage faults and gives clear visual indication of the fault conditions. It uses an earth leakage toroid to measure RMS current and operates tripping contacts when the measured RMS current exceeds the trip setting for the duration of the trip time setting.

1.1 FEATURES

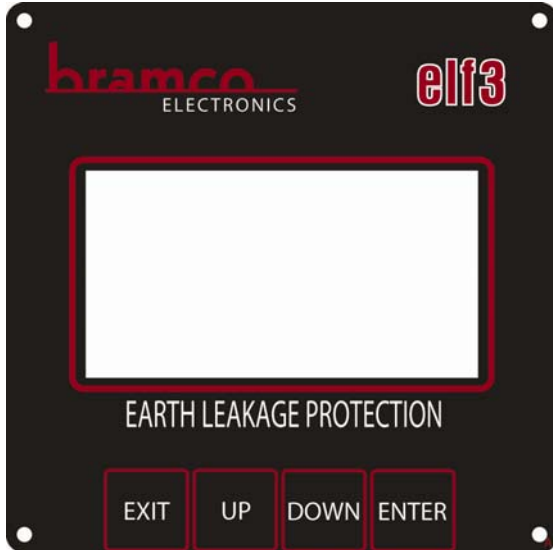
- 32-bit microprocessor core
- 30mA-20A trip current settings available (see "models" section)
- 50ms-20s trip time settings available (see "models" section)
- 50-60Hz (VSD Mode OFF), 5-100Hz (VSD Mode ON)
- Graphic LCD
- Settings adjustable through menu
- Optional password protection for settings
- Toroid open fault indication
- Failsafe / non failsafe and latch/non-latch operation, configured via the menu (for A01325 and A01326 only)
- Coloured LCD Backlight:
 - Red for trip condition
 - Yellow for warning
 - Green for healthy
- Protection settings and status clearly visible at all times
- Diagnostics screen to view all current conditions and settings
- Wide voltage supply range (24-48V AC or DC, 110-240V AC 50/60Hz)
- Local reset functionality configurable through the menu
- Provision for a remote reset button
- Clear opening door protection to IP66
- Instrumentation output: 4-20mA Current loop or 2-10V voltage output
- Use with range of Bramco Earth Leakage Toroids
- Last fault duration reading
- Logging of previous trip details
- Current settings, measurement information and status available via RS485 MODBUS

- Communications settings such as baud rate configurable via menu
- Compatible with ELF2 connections

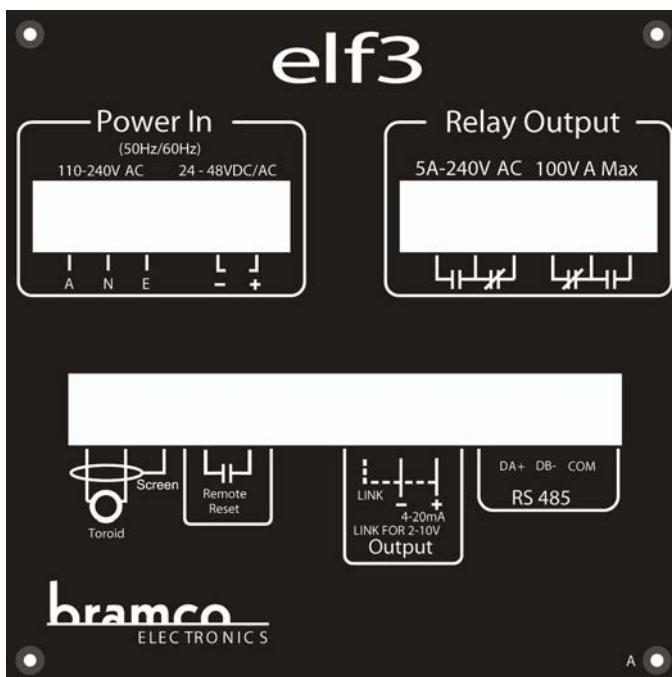
2 PHYSICAL LAYOUT

Face plate Front View

Standard Models



Rear View



2.1 Connections

Terminal Number	Terminal Function
1	AC power
2	AC power
3	EARTH
4	No Connection
5	DC NEG
6	DC POS

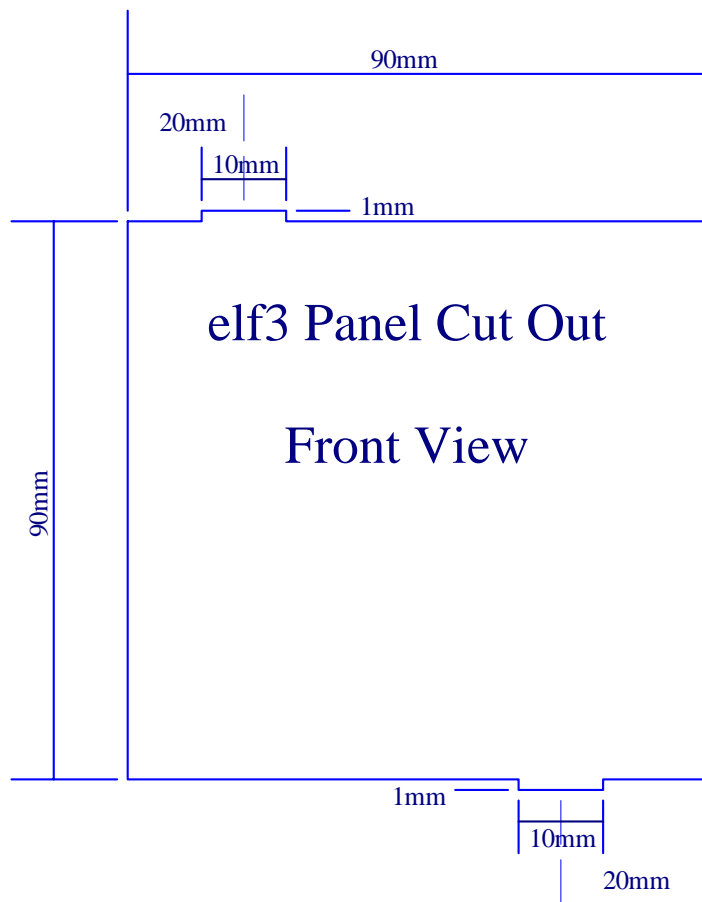
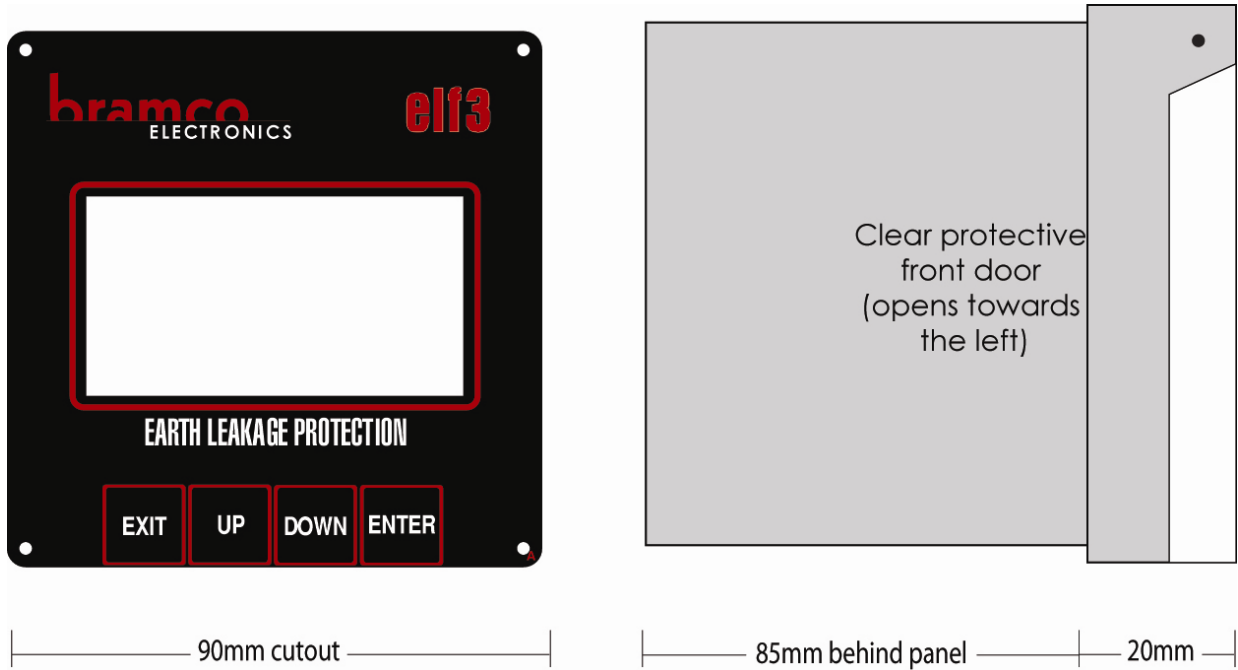
Terminal Number	Terminal Function
7	EL N/O
8	EL COM
9	EL N/C
10	EL N/C
11	EL COM
12	EL N/O

Terminal Number	Terminal Function
13	EL TOROID
14	EL TOROID
15	SCREEN EL TOROID
16	REMOTE RESET
17	REMOTE RESET
18	No Connection
19	No Connection
20	2-10V OUTPUT (Link to 22)
21	4-20mA / 2-10V Common (0V)
22	4-20mA OUTPUT (+)

Terminal Number	Terminal Function
23	RS485 DA(+)
24	RS485 DB(-)
25	RS485 0V

2.2 ELF3 Mounting Panel cut-out dimensions

NOTE: Allow 50mm minimum rear depth behind the elf3 to allow for cabling to Phoenix plugs



2.3 Models

Part Number	Description	Current Range	Time Range
A01324	Compliant	30 - 500mA	50 – 500ms
A01325	Low Range	500mA – 5A	50ms – 20s
A01326	High Range	2 – 20A	50ms – 20s

3 OPERATION

3.1 Power Supply

The elf3 has a wide voltage supply range. It can be run from 24-48V AC or DC by using terminals 5 and 6 (see overview – connections). Alternatively, it can be run from 110-240V AC by using terminals 1, 2 and 3.

Both power supplies should not be used simultaneously, as this will damage the unit. In either case, the elf3 should be earthed using terminal 3.

3.2 Interface

The following table summarises the buttons functions in the various menus:

Screen	Button			
	Exit	Up	Down	Enter
Home	Local Reset (if enabled)	No Function		Go to main Menu
Main Menu	Exit to Home Screen	Navigate through options		Go to selected menu
Settings Menu	Return to main menu When updating a setting, discards changes	Navigate through options Change value of setting		Change selected setting When updating a setting, accepts changes
Diagnostics	Exit to Main Menu	Scroll through settings		Exit to Main Menu
Last Trip Details	Exit to Main Menu	No Function		Exit to Main Menu
Test ELF3	Exit to Main Menu	Navigate through options		Go to selected menu
Test Trip Settings	Exit to Main Menu	No Function		Exit to Main Menu

The elf3 uses non-mechanical capacitive sensors for buttons. These buttons work by sensing a change in capacitance. A human finger contacting the button changes the capacitance and triggers the sensor. It is recommended that only fingers be used to contact the buttons as this will provide the most reliable operation. If metal objects are placed near the unit, a false button trigger may occur. The sensors automatically re-calibrate themselves every minute to compensate for any such changes.

3.3 Setup

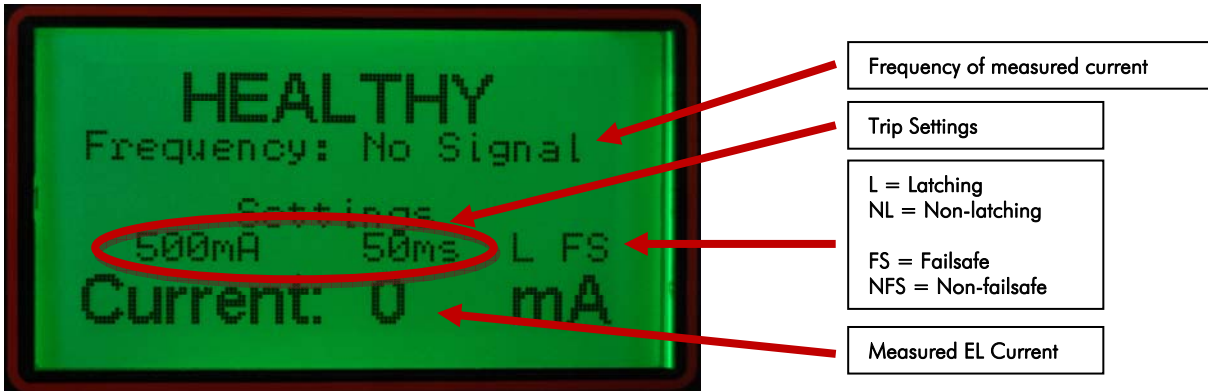
Trip current	Sets the trip point of the ELF3. Once the measured RMS current reaches this value and stays at or above it for the duration of the trip time setting, the ELF3 will trip the relay.
Trip time	This setting controls how long a fault must be present for the ELF3 to trip.
Local reset	Enables or disables the local reset functionality. See "Resetting" for more information.
Latching	Sets whether the unit will latch when tripped. See "Tripping" for more information.
Fail safe	Controls whether the relay is energised or de-energised when the unit is healthy. See "Tripping" for more information.
VSD Operation	Enables or disables the digital FIR filter. See "FIR Filter" for more information.
Communication	Allows the user to set the parameters for the MODBUS communications. See "RS485 MODBUS" for more information.
Set 4-20mA Range	Sets the full scale value of the 4-20mA/2-10V instrumentation output. See "Instrumentation Output" for more information.
Change Password	Allows the user to change the password. This feature allows the user to prevent unauthorised changes to the ELF3's configuration. This feature can be disabled by setting the password to "000000".
Clr Prev Trip Data	The ELF3 stores the details of the most recent trip. This option erases that data.
Set Defaults	Reverts all settings back to factory defaults.

All Settings are viewable in the diagnostics screen.

3.4 Main Menu Features

3.4.1 Home Screen

The home screen displays the trip state, the measured EL current, the trip current and time settings and if the unit is configured for failsafe/non-failsafe and latching/non-latching.



3.4.2 Diagnostics

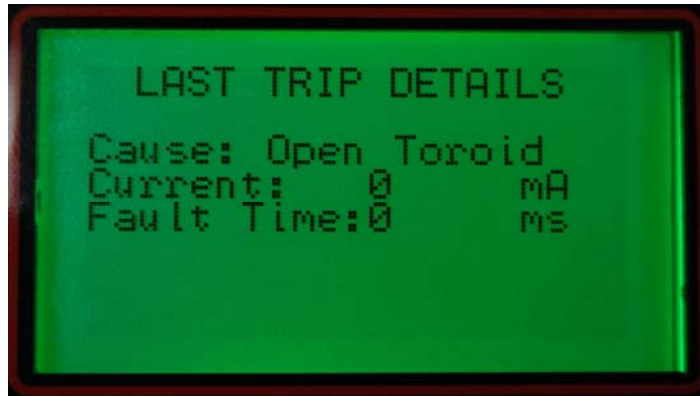
The Diagnostics screen shows all current configuration settings and also MODBUS communications activities and errors. This menu can be accessed by anyone, even if a password is set.



3.4.3 Last Trip Details

Displays the details of the last trip. The details include the trip type (EL fault, open toroid etc), and if the trip was caused by an EL fault, the fault current and trip time setting are also displayed.

If there is no previous trip data then the cause will be displayed as "No Trip"



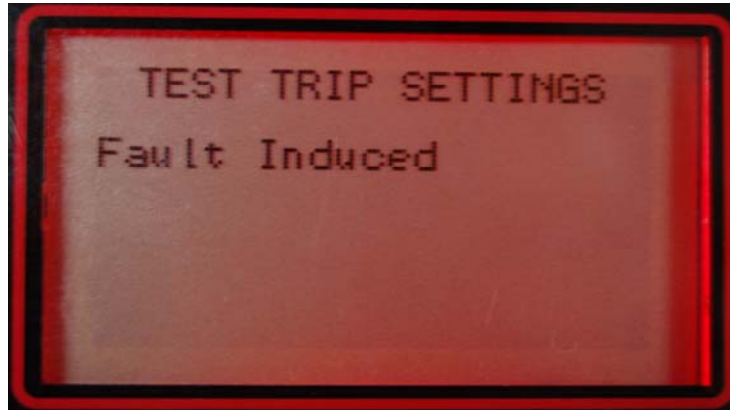
3.4.4 Test ELF3

This menu allows the user to check the display and buttons for correct operation. The 'Display Test' is used to check for dead pixels by turning all pixels on. The 'Button Test' shows when a button is active (except the exit button).



3.4.5 Test Trip Settings

This menu induces a software fault current to test that the relay operates properly. This test only verifies the internal operation of the unit, and is not a replacement for injecting a fault test current via the toroid.



3.5 Tripping

The following trip types are handled by the ELF3:

Trip Type	Cause
Earth Leakage	The measured EL RMS current has exceeded the trip current setting for the duration of the trip time setting
Open Toroid	There is no/loose connection to the EL toroid (terminals 13 and 14)
Trip Test	A 'fault' was induced via the menu option "Test Trip Settings"
Power Supply Low	The power supply dropped below the threshold of reliable operation for more than 2s
Harmonic EL Trip	When VSD Mode is OFF (50-60Hz mode) a current at a frequency outside of the 50-60Hz range has saturated the measurement hardware. This trip ensures that a 50-60Hz fault will not be ignored if the limits of the measurement hardware are reached.

An earth leakage trip will occur if the measured current from the EL toroid exceeds the trip current setting for a time equal to the trip time setting.

E.g. if the unit is set for 50mA 50ms and a current $\geq 50\text{mA}$ is measured for 50ms the ELF3 will trip. All internal latencies are compensated for (delay of relay, measurement and calculation delay, etc) so that the ELF3 will always trip before the trip time setting (with 150% of set trip level injected according to ASNZS2081.3:2002 clause 3.3.6.1)

3.6 Resetting

The ELF3 will need to be reset to go "HEALTHY" if it is in LATCHING mode. The ELF3 can be reset locally or remotely. The fault must **NOT** be present in order to perform a reset. **If a fault is present, the ELF3 will not allow any reset.**

Local Reset

A local reset is performed via the buttons on the ELF3. This setting must be enabled in the configuration. Once the fault is no longer present, the screen will read "To reset hold EXIT".

To reset the unit, press and hold the EXIT button for 2s. The screen will then change to the "LOCAL RESET" screen and read "To confirm reset push DOWN button". The DOWN button must be pressed within 5s or the reset will be aborted. Once the DOWN button is pushed, the unit will reset.

This process prevents any unintentional resets taking place.

If a fault appears during the reset process, the reset is ignored.



Remote Reset

A remote reset is enabled by wiring a normally open (NO) pushbutton to terminals 16 and 17. A remote reset is performed by pressing and holding the remote reset push button for at least 0.1s. If a fault is present whilst pushing the remote reset, the reset is ignored.

In **NON-LATCHING** mode, the ELF3 will automatically reset once the fault has dropped below 80% of the trip setting.

Note: Compliant models do not allow the latching or failsafe setting to be changed, as this would violate AS2081

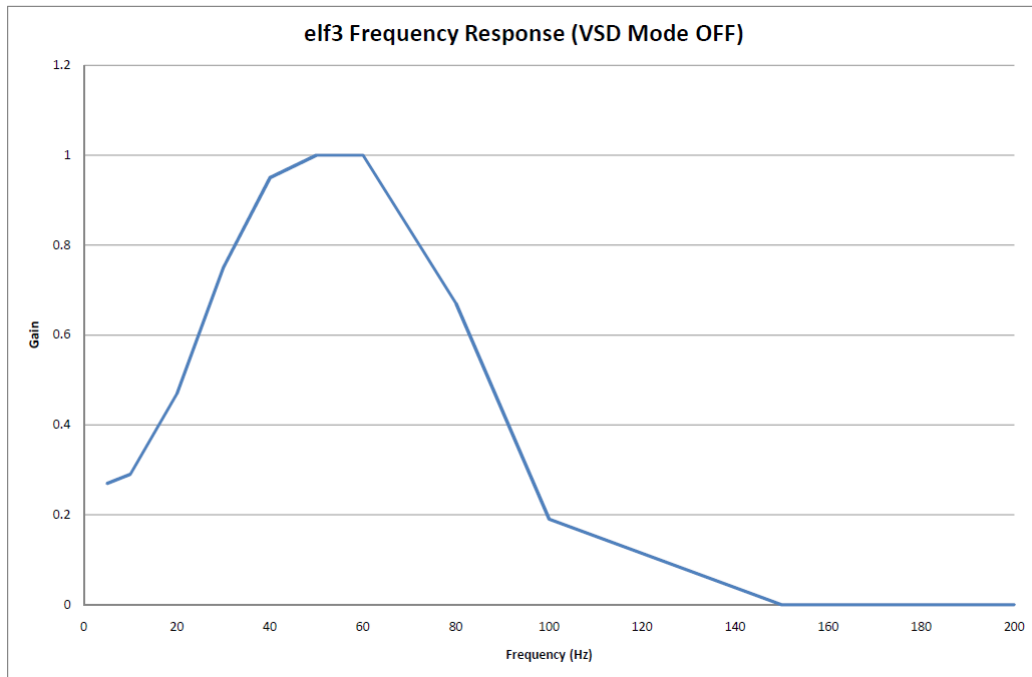
3.7 Toroids

The ELF3 uses a 1000:1 Bramco Earth Leakage Toroid (ELT). This toroid provides significant improvements in accuracy and reliability over the ELF2. This toroid is **recommended** for all ELF3 units.



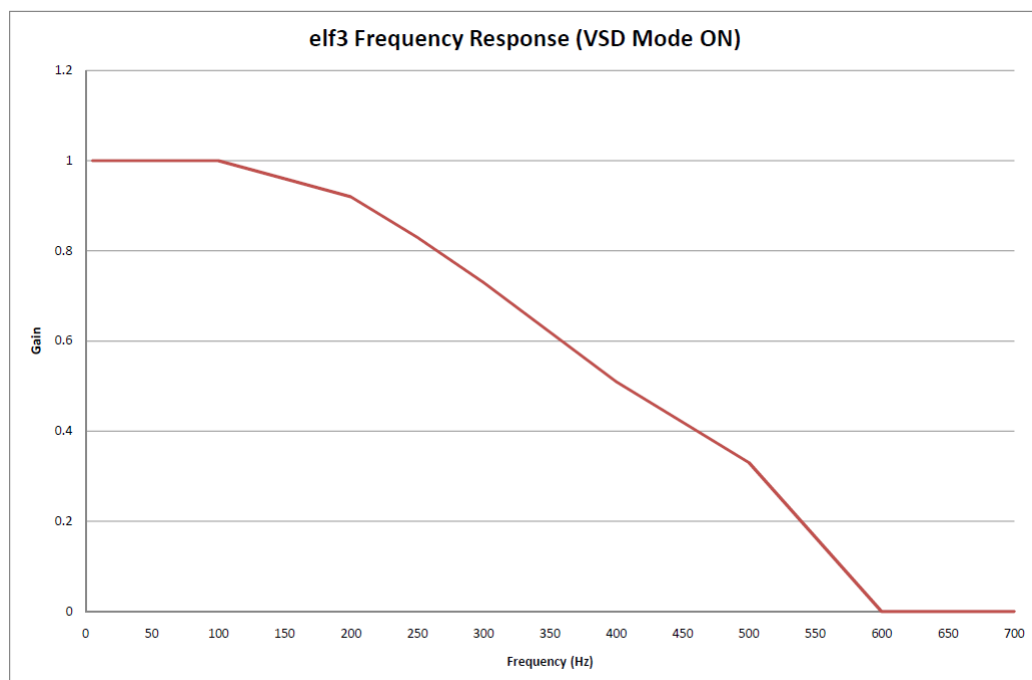
3.8 VSD Operation

When the ELF3 is set for VSD operation OFF, a 50-60Hz digital Finite Impulse Response (FIR) filter is enabled, which filters out currents outside of this frequency range.



When VSD operation is enabled (ON) the FIR filter is disabled. The elf3 will measure the frequency of the EL current and calculate an RMS value. When in this mode, frequencies from 5-100 Hz can be accurately measured.

In order to maintain AS2081 compliance over this range (for A01324), the minimum trip time is limited to 250ms. This ensures that the unit will have enough time to calculate the RMS value for a 5Hz current and still trip within +0%, -20% as defined in AS2081.



3.9 Instrumentation Output

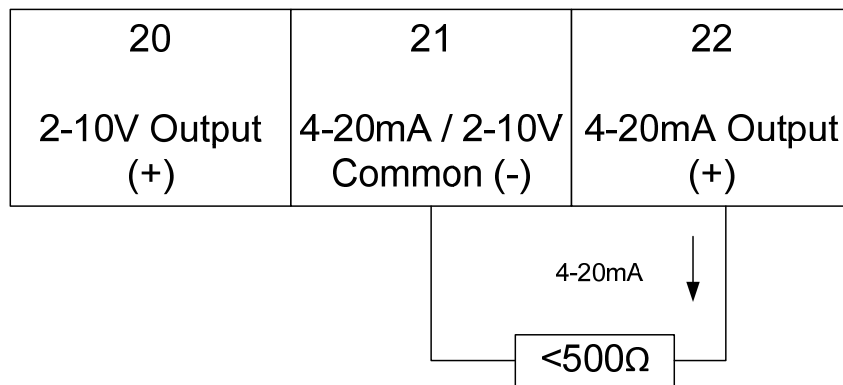
The 4-20mA/2-10V instrumentation output indicates the measured fault current as a percentage of the full-scale value, to an analog measurement device. The full scale value is settable through the settings menu. The equation for the measured current in terms of the instrumentation output current is:

$$\text{Measured Current(mA)} = (\text{Instrumentation Output(mA)} - 4) \times \frac{\text{Fullscale Value(mA)}}{16}$$

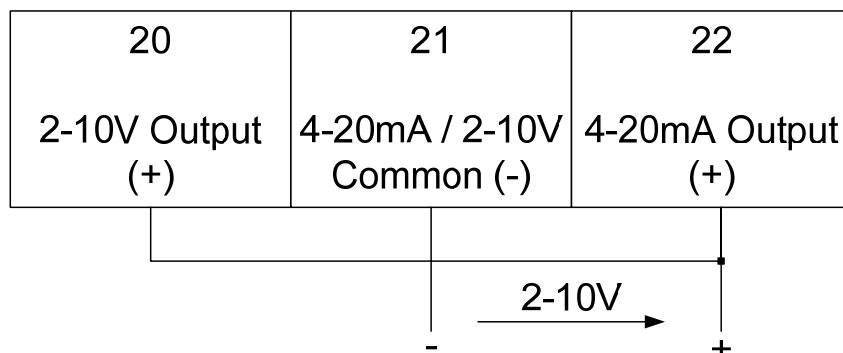
If using 2-10V output:

$$\text{Measured Current(mA)} = (\text{Instrumentation Output(V)} - 2) \times \frac{\text{Fullscale Value(mA)}}{8}$$

For 4-20mA output, terminals 21 and 22 must be used, with 21 being negative and 22 positive. A load resistor less than 500 ohm should be used for the 4-20mA output.



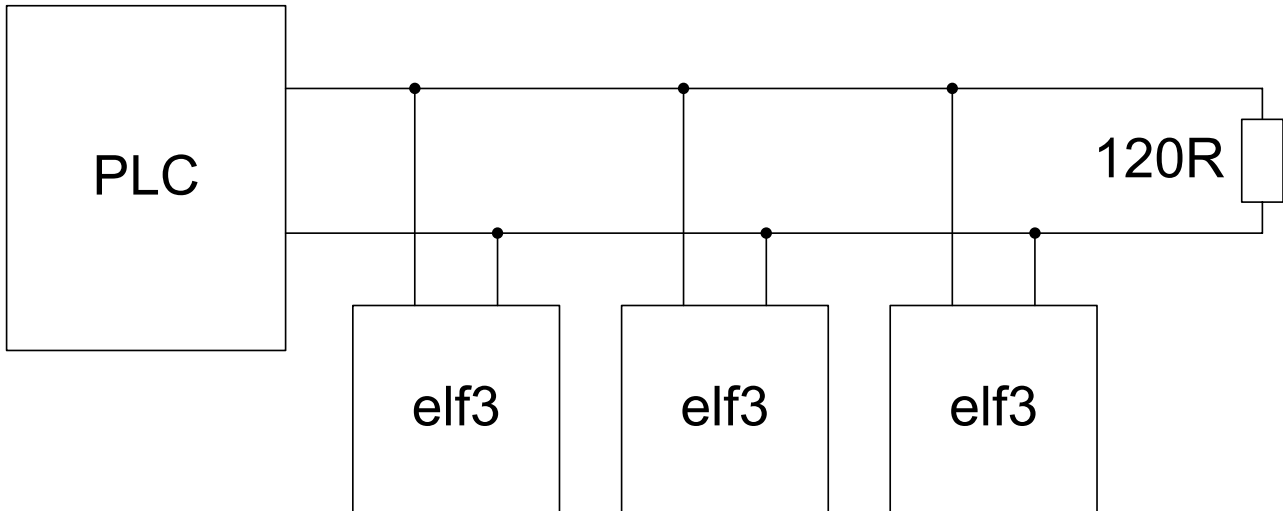
For 2-10V output, terminals 20 and 22 must be linked (with wire). Terminals 20 and 22 are then positive with terminal 21 negative. No load resistor is required (internal).



4 RS485 MODBUS

The ELF3 implements MODBUS over RS485 to communicate settings and measured values.

An external 120Ω 0.25W metal film resistor will be required on the RS485 network at the furthest point from the PLC (between terminals 23 and 24, see diagram below).



4.1 PROTOCOL

4.1.1 MODBUS ASCII

7 Data Bits

1 Stop Bit (2 if no parity used)

Maximum poll rate 10Hz

Accepted MODBUS command: 03 (Read Holding Registers)

Baud rate and parity as per unit settings

4.1.2 MODBUS RTU

8 Data Bits

1 Stop Bit (2 if no parity used)

Maximum poll rate 10Hz

Accepted MODBUS command: 03 (Read Holding Registers)

Baud rate and parity as per unit settings

4.2 SETTINGS

The following communication settings can be changed in the ELF3:

MODBUS Address Can be set between 1 and 247. This is the address that the ELF3 will respond to on the RS485 network.

Transmission Mode RTU or ASCII. RTU(Remote Terminal Unit) is typically used as it is capable of transferring data faster than ASCII (ASCII transmits two bytes per byte of data while RTU transmits one).

Baud Rate Can be set to 9600, 19200, 38400, 57600 and 115200. The lowest acceptable baud rate should be chosen for maximum reliability.

Parity ODD, EVEN or NONE. Typically set to EVEN.

Response Delay The minimum delay between the end of the request packet (from the bus master) and the start of the return packet (from the ELF3). This can be set between 50ms and 1000ms. This setting only applies when in RTU mode.

Any changes to these settings will take effect as soon as the settings are saved into memory.

4.3 MODBUS REGISTERS

Address	Register	Description
0000	Failsafe	0:Non-failsafe; 1:Failsafe
0001	Latching	0:Non-latching; 1:Latching
0002	Trip Type	0:No Trip 3:EL Fault 7:Power Supply Trip 11:Harmonic EL trip 1:Toroid Fault 6:Trip Test
0003	Trip Current Setting	30 – 20000mA
0004	Trip Time Setting	50 – 20000ms
0005	Current Measurement	0 – 65535mA
0006	Last fault duration	50 – 20000ms
0007	Local Reset	0:Disabled 1:Enabled
0008	VSD Operation	0:ON (FIR Filter off) 1:OFF(FIR Filter on)
0009	Blank	Future Use
0010	Blank	Future Use

4.4 ERRORS

4.4.1 MODBUS Errors

There are three conditions under which an error response frame may be transmitted:

1. An invalid function was requested
2. An invalid register address was requested
3. An invalid number of registers was requested

The frame structure of an error response is:

Start	Address	Function	Error Code	LRC or CRC	End
-------	---------	----------	------------	------------	-----

Error Code	Description
01	Invalid function requested
02	Invalid register address requested
03	Invalid number of registers requested

4.4.2 Communication Errors

Timeout	In ASCII mode, the gap between characters exceeded the maximum allowed.
Checksum	The checksum (LRC or CRC) was wrong for the packet received.
Packet Length	The size of the received packet was below the minimum expected.
Protocol	The hardware level protocol was incorrect eg Master set to :8 databits, no parity, 2 stop bits and slave set to: 7databits, even parity, 1 stop bit
Exception	The unit has sent a MODBUS exception response (see 4.4.1 MODBUS errors).

5 SPECIFICATIONS

Supply Voltage	110V - 240VAC \pm 20% 50/60Hz, 3VA, Terminals 1, 2 & 3. 24 – 48V AC/DC \pm 20%, 3VA, Terminals 5 & 6.
Trip Current Range	30mA – 20A (Standard models) See "Models" section for more information
Frequency Range	50/60Hz (VSD Mode OFF), 5-100Hz (VSD Mode ON) <i>NOTE: For lower frequencies(<40Hz), latching mode is recommended.</i>
Trip Delay Range	50ms – 20s See "Models" section for more information
Instrumentation Output	4 – 20mA into 500 ohms maximum. Terminals 21 & 22. 2 – 10V available by linking terminal 20 to 22.
Relay Function	Failsafe or Non-Failsafe (Menu selection) Latching or Non-Latching (Menu selection)
Latch Reset	Local Reset: Enabled via menu Remote Reset: Momentary closure (>100ms) of terminals 16 & 17 from remote N/O pushbutton for reset
ELF3 Contact ratings	2 x C/O 5A 250VAC, 100VA max 5A 30VDC Resistive 3A 30VDC Inductive load 90W L/R 7mS
Maximum Switching Voltage	380VAC/125VDC

6 INSTALLATION

6.1 MOUNTING

The ELF3 relay is fascia packaged for through-panel mounting. Panel cut out is 90 x 90 mm. See the "Physical Layout" section for cut-out detail.

Use the sealing gasket provided, positioned behind the front bezel for panel sealing and use the 2 adjustable clamps to fasten the ELF3 to the mounting panel. When mounted as above the exposed ELF3 Relay bezel has an IP66 rating.

The ELF3 relay and EL Toroid should be mounted away from stray flux sources such as power supplies, transformers, control relays, contactors and cables carrying load currents.

6.2 CABLING

Use 2 core screened cable for the following inputs:

- EL Toroid
- EL Remote RESET

Each individual cable screen should be connected to the ELF3 relay Terminal 15.

NOTE: Do not earth the non-relay end of these screened cables.

It is recommended that these 2 screened cables are run by a direct route to the ELF3 relay, BUT are not to run with, or in cable harness or ducting with control or power cabling.

Where necessary, cross other cables at 90 degrees and provide maximum clearance from high voltage/current circuits as much as practically possible.

6.3 TOROIDS

Bramco EL toroids (1000:1) have a powder coated mild steel, open faced enclosure, which acts as a shield to stray flux. For this to be effective the open side of the ELT should face away from stray flux sources such as transformers, relays and contactors, and for best effect, facing but not touching the steel enclosure body.

The three phase load power cables should be arranged to pass symmetrically through the centre of the EL toroid window. If the cables are asymmetrical through the centre of the toroid, incorrect EL detection may occur.



7 FAULT DIAGNOSIS

7.1 Function

Indication	Possible condition/suggestion
"No Toroid Detected" on screen	Check connections to EL toroid
The unit will not go healthy	If the unit is set to latching, a remote or local reset must be performed. The unit will never reset as long as a fault is present.
Remote reset doesn't work	The remote reset button contacts must be closed for >100ms before the unit will reset. The unit will look for a change in the remote reset input so holding the reset will not work.

8. TYPICAL CONNECTIONS SCHEMATIC

