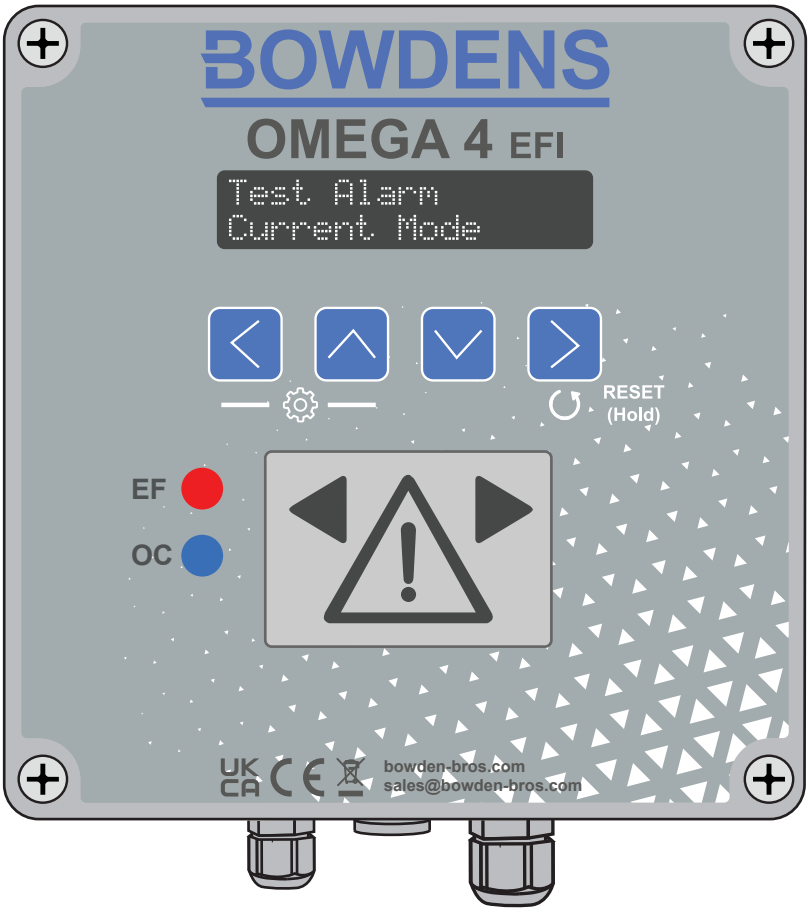
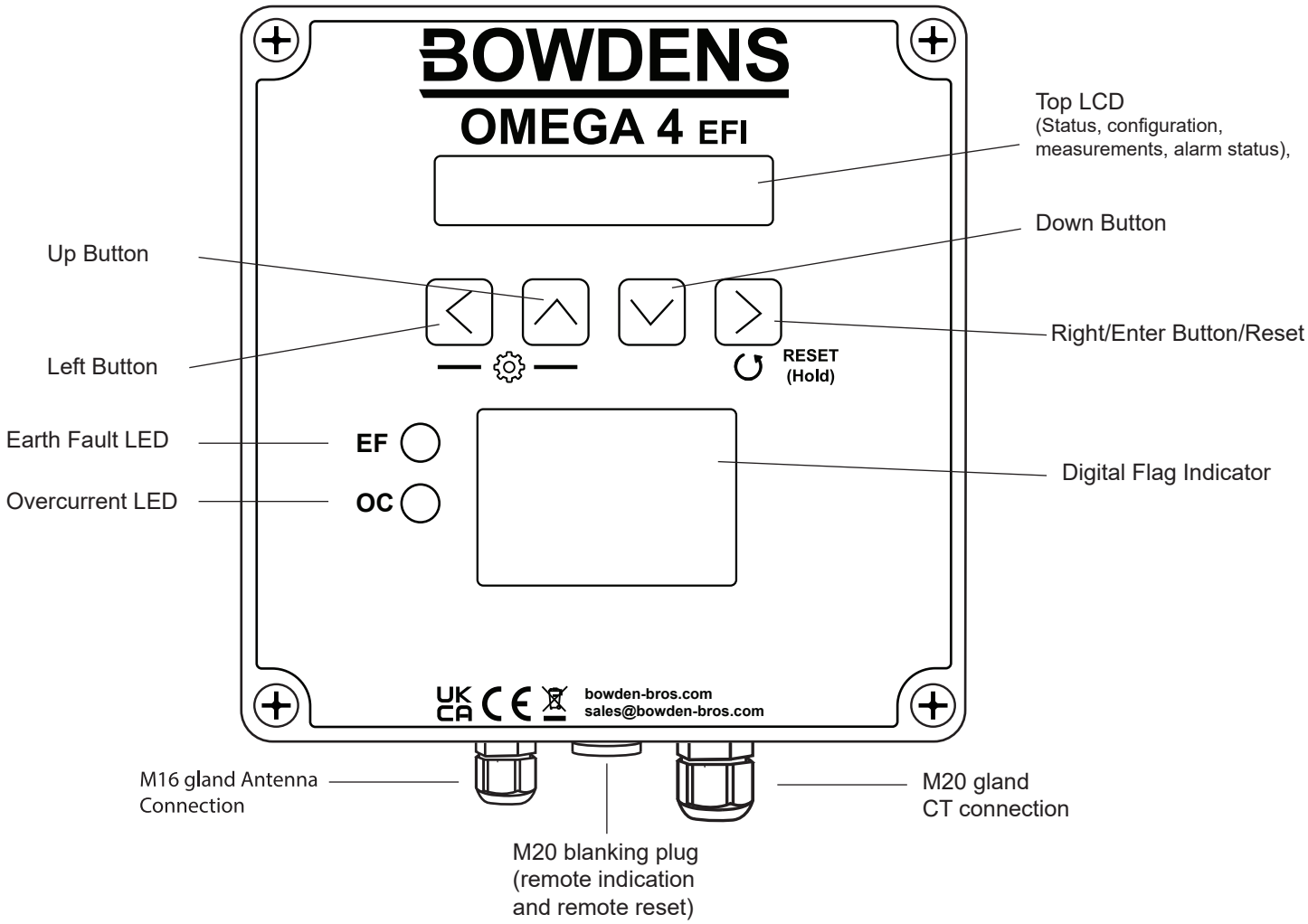
BOWDENS

OMEGA 4



ADVANCED DIRECTIONAL FAULT PASSAGE INDICATOR (FPI) FOR UNDERGROUND CABLE NETWORKS - Earth Fault and Overcurrent FPI with 4G Communications Option.

enquiries@springltd.co



1.0 Overview

Bowdens have been influential in the design of the Electronic Earth Fault Indicator (EEFI) since the company first introduced this type of indicator in 1991. It now has a wide and proven range of earth fault indicators for fault indication on 11kV cable networks. The Omega 4 fault indicator is an exciting development from this highly successful range of instruments to meet the demand of low cost instrumentation with minimal ‘life time’ costs.

The Omega 4 Fault Path Indicator (FPI) is a modular designed instrument that provides many options to the user depending on the required features. From one basic earth fault FPI, options can be added to make a full overcurrent and earth fault indicator and/or a directional FPI with integral GSM/GPRS or 4G communication and/or Modbus over RS485 with individual phase load monitoring and historic log. The Omega 4 is simply an earth fault indicator that will provide a clear visual indication of the passage of fault current and assist engineers to locate a faulted section of network on an Open Ring circuit. The faulted section of cable lies between the last fault indicator to Alarm and the first not to Alarm.

Omega 4 is designed to complement network automation and management giving greater visibility of network faults, enabling the fault engineer to isolate a fault intelligently, without the need for fault switching to locate a fault, with the inherent customer interruptions and excessive stress on plant and equipment.

The Omega 4 module consists of a polycarbonate enclosure, which has a seal rating of IP65 giving a high level of environmental protection. The front of the enclosure displays two high intensity alarm LEDs for earth fault (EF) and overcurrent (OC) indication. There are also four menu control buttons that enable the end user access to all FPI settings, including test and reset functions. An LCD display gives a visual display of all functions and data.

The Omega 4 can be configured either as a single channel Earth Fault indicator (EFI), requiring one core balanced Current Transformer (C/T) to drive the input, or as a 3 channel overcurrent and earth fault indicator (OC/EFI), requiring three single phase C/Ts.

The Omega 4 Earth Fault Indicator with a Core Balance C/T can be fitted around the MV power cable externally to the MV switch cable box or internally within the cable box, so long as appropriate station earthing arrangements apply (See Drawing 1).

The Omega 4 has the option of providing Modbus communication over RS485 to integrate with local RTU systems if required.

Two sets of isolated volt free relay contacts are provided for alarm indication. The relays can provide latched or pulsed indication. The unit also provides remote indication and remote reset functions as standard.

The Omega 4 is tested beyond normal IEC levels to ensure reliable operation in the hostile electromagnetic and electrostatic environment in which it operates. This includes testing of the communications functions, which must also perform within the same environment.

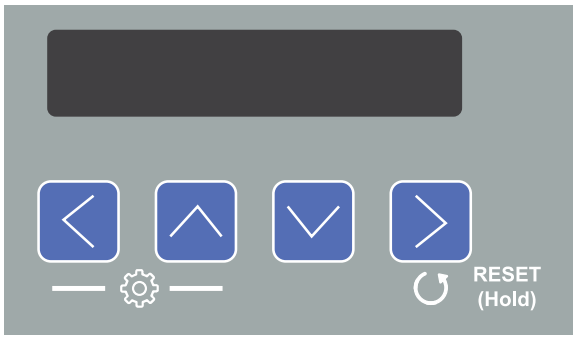
2.0 Operation

The Omega 4 can be programmed for many functions, via an LCD display and standard four button pad. Access to the programming feature is by PIN Code security, which will allow the unit to be programmed by an engineer in the office. However, the operating parameters can be pre-set at manufacture through an agreed profile which will contain all the settings required.

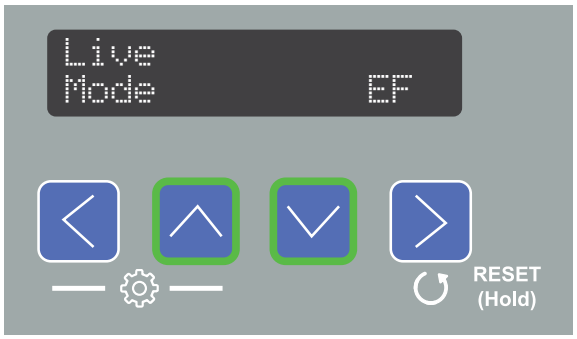
2.1 Omega 4 Interface

There are two types of data presented by the unit. Live read only data and settings. The live data is displayed after power on. The settings can be programmed by pressing and holding left and up, as indicated on the label. The right button can be used to reset an alarm, either manual test or real fault. Press and hold the right button for 5 seconds to perform the reset.

2.1.0 Startup and Live Data



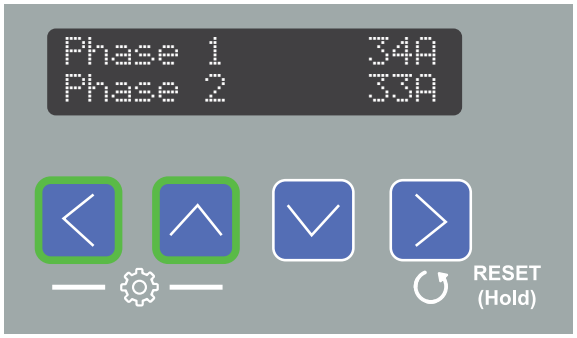
The Omega 4 has an auto sleep feature to preserve power and prevent burn in on the interface LCD, to wake up the device press any of the 4 buttons.



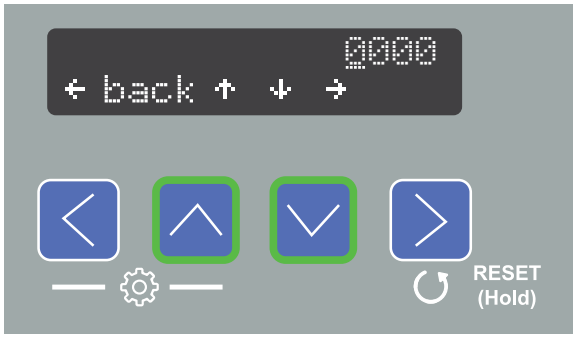
On initial start up the display will show the live data, use the up and down buttons to scroll through the rest of the items.

For a full list please see section 2.1.2.

2.1.1 Settings



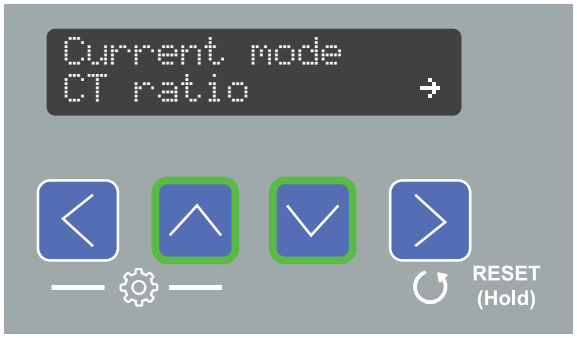
To access the settings press and hold left and up for 5 seconds.



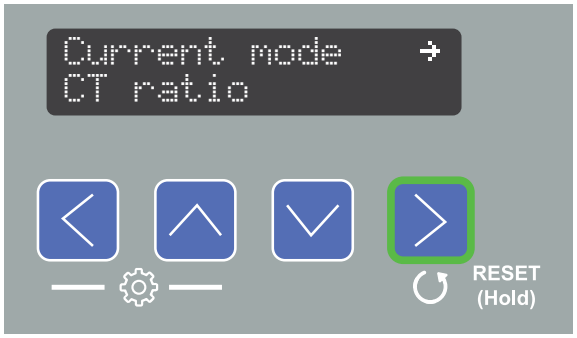
The settings are protected with a PIN code, use up and down to increment / decrement each digit and right to change digit to the correct PIN. The default PIN code is 0014. When the correct PIN is entered, press back to access the settings.

The settings are organised in a menu tree, to navigate the menu, use the up and down buttons to select a menu item, then press right to go in to that menu item. This will either follow the tree down into a child menu, or allow editing the setting.

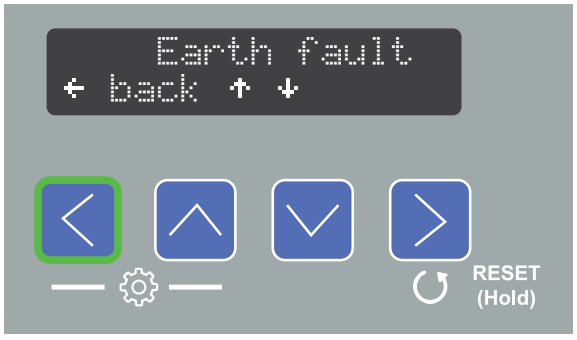
The left button will return back up the tree, either from a child menu, to parent menu or from editing a setting back to the menu. For a full list of settings see section 2.1.3.



Up / down selects the menu item, the arrow on the right hand side indicates which menu item is currently selected.



Press right to enter menu item. If this enters a child menu, this will follow the same navigation patterns as above.



To change the value of a setting use up / down. Left will return to the parent menu.

2.1.2 Live Data

Menu	Minimum	Maximum	Description
Live			Header
Mode			Mode of device, either EF, OC, EF OC, LV EF, LV OC, LV EF OC
Battery	bad	good	Indication of state of charge of battery (not shown if supercap powered)
Power	on	off	Indication of RTU Power (Only on RTU units)
Temp	-25°C	70°C	Temperature of unit
Time	00:00	23:59	System time
Date	01/01/1970	01/01/2106	System date
Phase 1	0A	1000A	Phase 1 current (not shown if mode is not OC)
Phase 2	0A	1000A	Phase 2 current (not shown if mode is not OC)
Phase 3	0A	1000A	Phase 3 current (not shown if mode is not OC)
Earth	0A	250A	Earth current (not shown if mode is not EF)
LV freq	0Hz	65Hz	Frequency of LV (not shown when mode is not LV)
Last Fault			Header
Type			Type of fault, either EF, OC, EF OC, LV EF, LV OC, LV EF OC. NOTE: if type is preceded by "T" character, then this data is generated from the internal test routines.
Time	00:00	23:59	Time of fault
Date	01/01/1970	01/01/2016	Date of fault
Phase 1	0A	1000A	Phase fault current (not shown if fault type is not OC)[1]
Phase 2	0A	1000A	Phase fault current (not shown if fault type is not OC)[1]
Phase 3	0A	1000A	Phase fault current (not shown if fault type is not OC)[1]
Earth	0A	250A	Earth fault current (not shown if fault type is not EF)[1]
P1 angle	0	359	Phase 1 fault angle, NA if not available (not shown if mode is not LV)[2]
P2 angle	0	359	Phase 2 fault angle, NA if not available (not shown if mode is not LV)[2]
P3 angle	0	359	Phase 2 fault angle, NA if not available (not shown if mode is not LV)[2]

Last fault data will be updated on each detected fault and remain in memory even after power cycling, until the next fault. Because the visible items are dynamic, the menu will be reset to the top when a new fault is detected.

[1] A '*' at the end of the line indicates the current went over threshold.

[2] A '*' at the end of the line indicates the angle was on a phase that was over threshold.

2.1.3 Settings

Menu	Default	Min	Max	Options	Description
Test alarm	Idle			idle / in alarm	Set to “in alarm” to trigger a manual test. This tests the FPI alarm functions including the alarm LEDs, fault LCD indication, alarm relay activation and test alarm communication (if modem is fitted). To RESET press and hold the right button.
Mode	EF			EF, OC, EF OC, LV EF, LV OC, LV EF OC	NOTE: test alarm data is written to history, make sure important historical data is recorded before running test Select mode of FPI EF – Earth Fault only OC – Over Current only EF OC – Earth Fault and Over Current LV EF – Earth Fault with angle to Low Voltage LV OC – Over Current with angle to Low
CT ratio	500:1			40:1, 50:1, 60:1, 500:1, 1000:1	Voltage LV EF OC – Earth Fault and Over
Link fitted	fitted			fitted, not fitted	Current with angle to Low Voltage Set to fitted CT ratio.
EF trip	50A 100A 200A	20A 40A 50A	120A 200A 500A	20-120A (10A steps) 40-200A (20A steps) 50-500A (10A steps)	Some CT ratios require the bias link to be fitted, the display will flash a warning. Fit the link and set this menu accordingly. Fault current on the cable network generates a proportional voltage at the CT secondary output, which if above a pre-set threshold will trigger the FPI. Once the trip
EF delay	50ms	20ms	200ms	20ms, 30ms, 40ms, 50ms, 60ms, 70ms, 80ms, 90ms, 100ms, 120ms, 140ms, 160ms, 180ms, 200ms	delay (EF delay) is over, the FPI will respond to any current above the pre-set Earth fault trip threshold as an alarm. Once a fault is detected it starts a trip delay during which any alarms are suppressed. This is to allow magnetising inrush or capacitive currents on the HV network to dissipate. Once this trip delay

Menu	Default	Min	Max	Options	Description
OC trip	625A	125A	750A	125A, 250A, 375A, 500A, 625A, 750A	Fault current on the cable network generates a proportional voltage at the CT secondary output, which if above a pre-set threshold will trigger the FPI. Once the trip delay (OC delay) is over, the FPI will respond to any current above the pre-set phase trip threshold as an alarm.
OC delay				20ms, 30ms, 40ms, 50ms, 60ms, 70ms, 80ms, 90ms, 100ms, 120ms, 140ms, 160ms, 180ms, 200ms	Once a fault is detected it starts a trip delay during which any alarms are suppressed. This is to allow magnetising inrush or capacitive currents on the HV network to dissipate. Once this trip delay has elapsed the FPI will alarm if the fault is over the OC trip threshold current.
Relay mode	latch			latch, pulse, multi	Sets the relay mode. In latch mode the relay will remain on after the fault is detected until a reset condition is met. In pulse mode, the relay will close for 10 seconds once when a fault is detected. In multi mode the relay will close for 10 seconds for every fault detected, including during an existing fault.
Reset time				1hr, 2hrs, 3hrs, 4hrs, 5hrs, 6hrs, 7hrs, 8hrs, 9hrs, 10hrs, 11hrs, 12hrs	The FPI will remain in the alarm state for the number of hours to which the reset time is set, unless it receives a reset from other means such as from the front panel reset button, a remote reset or an LV reset.
Reset LV	on			on, off	If LV reset is set to on, it will reset when the local LV source is re-energised.
Reset LV time	15	15	120		Number of seconds LV signal must be present to perform a reset. Only valid if Reset LV = on.
Modbus Address		1	247		Modbus base address.
Fault 1					Stores last recorded fault (see 2.1.2 live data table under Last Fault header for fault data description).

Menu	Default	Min	Max	Options	Description
Fault 2					Stores 2nd to last recorded fault (see 2.1.2 live data table under Last Fault header for fault data description).
Fault 3					Stores 3rd to last recorded fault (see 2.1.2 live data table under Last Fault header for fault data description).
Fault 4					Stores 4th to last recorded fault (see 2.1.2 live data table under Last Fault header for fault data description).
Fault 5					Stores 5th to last recorded fault (see 2.1.2 live data table under Last Fault header for fault data description).
Fault 6					Stores 6th to last recorded fault (see 2.1.2 live data table under Last Fault header for fault data description).

2.1.4 System Messages

The system has reset after a fault because the timeout has been reached.

The system has reset after a fault because the user has held the reset button.

The system has reset after a fault because the LV power has been restored.

The system has reset after a fault because the remote reset was triggered.

The CT ratio selected requires the bias resistor link to be fitted. Fit the link and change the “Bias fitted” setting to “fitted”.

The CT ratio selected requires the bias resistor link to NOT be fitted. Remove the link and change the “Bias fitted” setting to “not fitted”.

If CT ratio is equal to 60:1 the earth fault threshold MUST be below 100.

If CT ratio is equal to 50:1 the earth fault threshold MUST be below 90.

If CT ratio is equal to 40:1 the earth fault threshold MUST be below 70.

Over current detection can only be performed with a CT ratio of 500:1 or more, make sure the correct CT is used.

2.2 Software Operation

2.2.1 Alert State

In the ‘Alert’ state the unit is ready and waiting to capture the next earth fault. There is no visual indication. The ‘FAULT’ LEDs are de-energised. The Alarm Relay contacts are in the ‘no fault’ position. The digital flag indicator will be off.

2.2.2 Alarm State

In the ‘Alarm’ state the unit has captured an earth or over current fault. There are two high intensity FAULT LEDs, marked EF for Earth Fault and OC for Over Current fault, that will give short flashes alternately every 4 - 5 seconds. The digital flag indicator will flash the fault warning triangle. The Alarm Relay contacts will change to the fault / alarm position and if the modem is fitted an update will be sent over the mobile network. The unit is now in power-save mode with the LED’s and warning triangle flashing on until it receives one of the reset conditions. This could be either the built in reset timer (with selectable time), a remote reset input 6-35Vac/dc, an LV reset or manual operation of the RESET button. Any one of these resets will return the unit to the ‘Alert’ state.

2.2.3 Alarm Manual Test

Select the “Test alarm” function using the menu buttons on the front face of Omega 4, the FPI will enter alarm state as outlined in 2.2.2. The menu item will show “in alarm”. Press and hold the Enter Button to RESET or wait for timed reset to return to idle state. NOTE: test alarm data is written to history, make sure important historical data is recorded before running test.

2.2.4 Earth Fault Detection

The Earth Fault threshold is set using the menu system.

Once the unit has powered up and has entered the ‘Alert’ state it is ready to capture out of balance faults. EARTH FAULTS: When an earth fault occurs the out of balance fault current will be detected by the Current Transformer, so long as the circuit breaker or RTU earth has been brought back through the C/T to allow a positive flow of fault current through the C/T (Drawing 1). Omega 4 uses a current/time graph to detect faults, which have to be above the threshold for a set number of cycles (EF Trip delay) to identify the disturbance as fault current, rather than a spike or surge that could be caused by magnetizing or capacitive currents. The EF trip delay and Earth Fault trip threshold are set using the Omega 4 menu system.

2.2.5 Earth Fault C/T Connection

Omega 4 will operate from either the Bowdens Band Sensor C/T (120mm id.) (see Drawing 3) or a Resin Cast Core Balance C/T (90mm id or similar). It can be configured at build time to operate from most common ratios of Core Balance C/T types. The C/T must detect the out of balance when installed around a three phase cable, either externally on the incoming cable to the RTU or circuit breaker, or internally in the cable termination box. In all cases it is important to observe the correct configuration of the station earth to ensure an out of balance can be seen during fault (see Drawing 1, Fig 6.1). Omega 4 may also be connected to the three bushing C/Ts in an RTU or Circuit breaker. In this configuration the C/T outputs can be commoned to give a single input to the Omega 4 FPI.

2.2.6 Overcurrent & Earth Fault C/T detection

The Overcurrent threshold is set using the menu system. Overcurrent requires a C/T to be fitted to each phase of the supply. Normally for UK 11kV connections this means three C/Ts one each for Red, Yellow and Blue phases. A C/T monitors each individual phase to identify a current in any phase that is above the pre-set threshold for a given number of cycles, as well as the three phase currents being summated to give Earth fault current out of balance.

Omega 4 uses a current/time graph to detect faults, which have to be above the threshold for a set number of cycles (Phase Trip delay) to identify the disturbance as fault current, rather than a spike or surge that could be caused by magnetizing or capacitive currents. The Phase Trip delay and Phase Fault trip threshold are set using the Omega 4 menu. In this way the Omega 4 can detect and provide indications for both Earth Fault and Overcurrent fault conditions.

2.2.7 Overcurrent C/T Connection

OVERCURRENT FAULTS: When an overcurrent fault occurs the overcurrent will be detected by one of three Current Transformers connected (Drawing 1, Fig 6.4 and 6.5).

2.2.8 Directional Indication

The Omega 4 incorporates a Digital Flag Indicator. This has two functions:

1. It provides high visibility, high contrast visual indication that a fault has been detected with a warning triangle.
2. It provides a visual indication of the fault direction, LEFT or RIGHT (see figure below).

The Omega 4 calculates the fault direction by taking either VPIS or LV supply voltage as a reference. It is important that this voltage is connected to the LV connector.

On either side of the fault the fault current will be in opposite directions. Hence all of the FPIs downstream of the fault will indicate in one direction, whilst all FPIs upstream of the fault will indicate in the opposite direction. These directions are shown on the front of the Omega 4 but also transmitted as a remote indication and over the GSM modem.

When no fault current is detected then the warning triangle will not be shown.

When no fault direction is detectable, the direction arrows will not display and (if a fault is detected) only the warning triangle will display.

NOTE:
1. All Omega 4 units must be connected to the SAME VPIS or LV reference.
2. All C/Ts must be mounted with the same orientation to ensure correct directional indication along the network (See Drawing 2).
3. All C/T terminations to the C/T screw terminals in the Omega 4 must be connected with the same polarity. See Drawing 3.

2.2.9 Reset Conditions

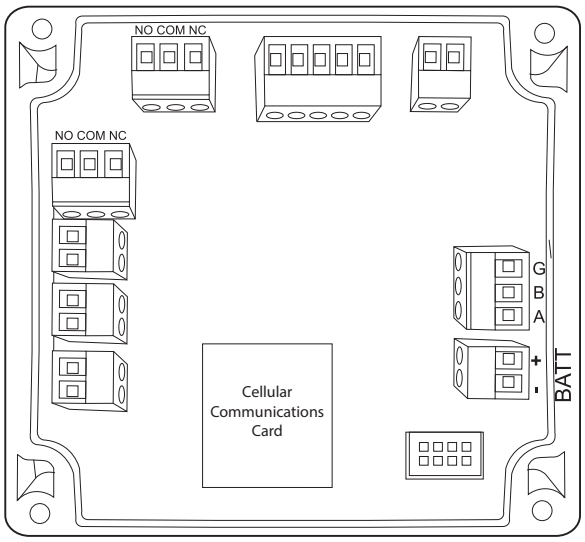
There are four ways to reset the Omega 4:
1. LV reset: the Omega 4 will reset when the local LV source is re-energised. The LEDs will flash three times and then cancel, the digital flag indicator will turn off, and the output relay will return to the normal state.
2. Manual reset: press and hold the right/enter button on the front of the Omega 4 to reset the unit manually.
3. Remote reset: an external signal between 6 – 30V ac or dc can be applied to the reset terminals for a minimum of 10 secs.
4. Timed reset: in case the local LV supply is off for a sustained period, the EFI will reset in the time set for the Reset time in the menu system.

2.2.10 Cellular Communication

Omega 4 uses an embedded System-on-Module (SoM) designed for IoT, featuring cellular connectivity via LTE-M, NB-IoT, and Cat-1, with fallback to GSM/GPRS/EDGE.

Omega 4 works by not trusting any step in the communication and using end to end encryption with strong authentication, removing the worry about how the data is sent, as any interception would not give access to the data. Each packet of data is signed with an authentication tag to prove who the packet came from and allows either end to reject a packet that has been tampered with.

Using encryption and authentication gives us these security and privacy guarantees with or without Private APNs.



Omega 4 can use the AES-256 symmetric algorithm, with a key controlled by Spring or our customers to encrypt the data on device and decrypt as close to the point of use as possible. Meaning there is no exposure of plain text data to the public internet.

For further details on how to integrate Omega 4 with iHost, PowerOn, AWS IoT or your specific control centre (Advanced Distribution Management System - ADMS) please contact Spring.

2.2.11 Installation

IMPORTANT - WARNING

1. The front section of the Omega 4 module should never be drilled as this contains the module electronics.
2. All Current Transformers should be connected to the Omega 4 module before being fitted in position round the cable.

Where practical Omega 4 box drilling's for fixing should be through corner fillets, which are outside the sealed enclosure area. If this cannot be achieved holes can be drilled through the main enclosure walls providing the weatherproof IP65 box seal can be maintained.

Alternatively, the Omega 4 module can be mounted on a zinc coated steel backplate. Please see 9.0 Mounting Data.

2.3 MODBUS Over RS485

The Omega 4 is fitted with an RS485 serial port. This is configured as standard as the following:

Baud rate: 9600
Bits per frame: 8
Parity: None
Stop bits: 1

Other configurations can be accommodated on request. The modbus address defaults to 1, but can be changed in the Modbus > Address menu. The Omega 4 uses the Modbus RTU protocol.

Address <8 bits>
function code <8 bits>
data <function dependent>
CRC <16 bits>

To simplify the protocol, only two function codes of Modbus will be implemented: read multiple holding registers and write holding register.

Code	Description	Data	Response
3	Read multiple holding registers	Address of first register <16 bits> Number of registers <16 bits>	Number of register bytes <8 bit> Register values <16 bits per register>
6	Write	Address of register <16 bits> Value to write <16 bits>	Number of register bytes <8 bit> Register values <16 bits per register>

It is convention to use register address ranges for different types of data. One convention is to use a digit at the beginning to signify the type of register. All data is considered Modbus type 4, so the addresses used in this specification have an implied 4 at the beginning of the address.

2.4 LoRa (Long Range) Radio Communication

The Omega 4 is fitted with LoRa radio hardware, operating at 860.70MHz for UK and European operation and 915MHz for USA operation. This can be used for peer to peer communication, or peer to relay communication. Data can be sent over long distances without using the mobile network.

A relay can forward data to other peers or to the cloud to centralise an internet connection and reduce cost by removing the costs of a modem in each Omega 4.

3.0 Power Supply

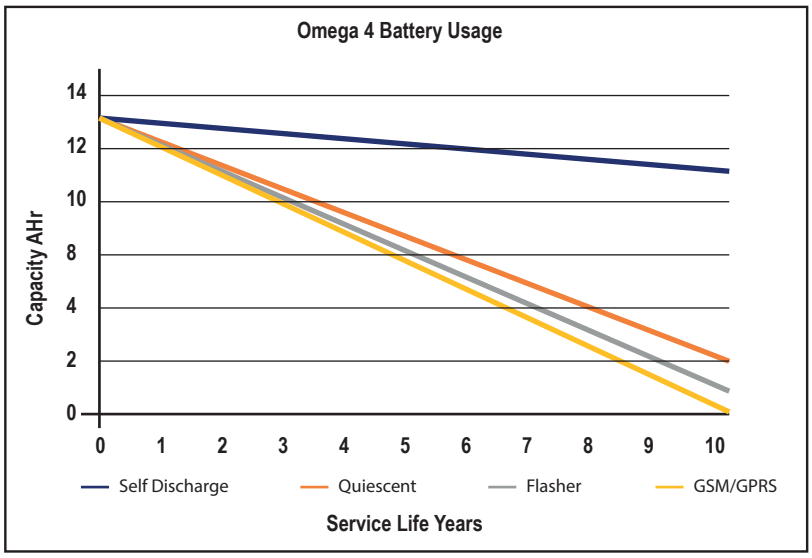
Option 1. Omega 4 LV BB - an LV powered unit with battery backup.
Option 2. Omega 4 LV SC - an LV powered unit with a Super Capacitor Backup (no battery fitted).
Option 3. Omega 4 RTU BB - an RTU (Remote Terminal Unit) with a battery backup.
Option 4. Omega 4 RTU SC - an RTU with a Super Capacitor Backup (no battery fitted).
Option 5. Omega 4 BAT - a battery powered unit (Note: Cannot have LV reset or directional fault indication).

All batteries are a Lithium Thionyl Chloride 3.6V 13Ah integral Battery with up to 10 years life depending on operational usage and environmental temperatures.

LV units (Options 1 and 2) include a power supply board in the backbox. This allows the Omega 4 to be powered from LV mains at 90-265Vac.

RTU powered units (Options 3 and 4) can be powered by 6-15VDC (special variant) or 15-115VDC (standard version).

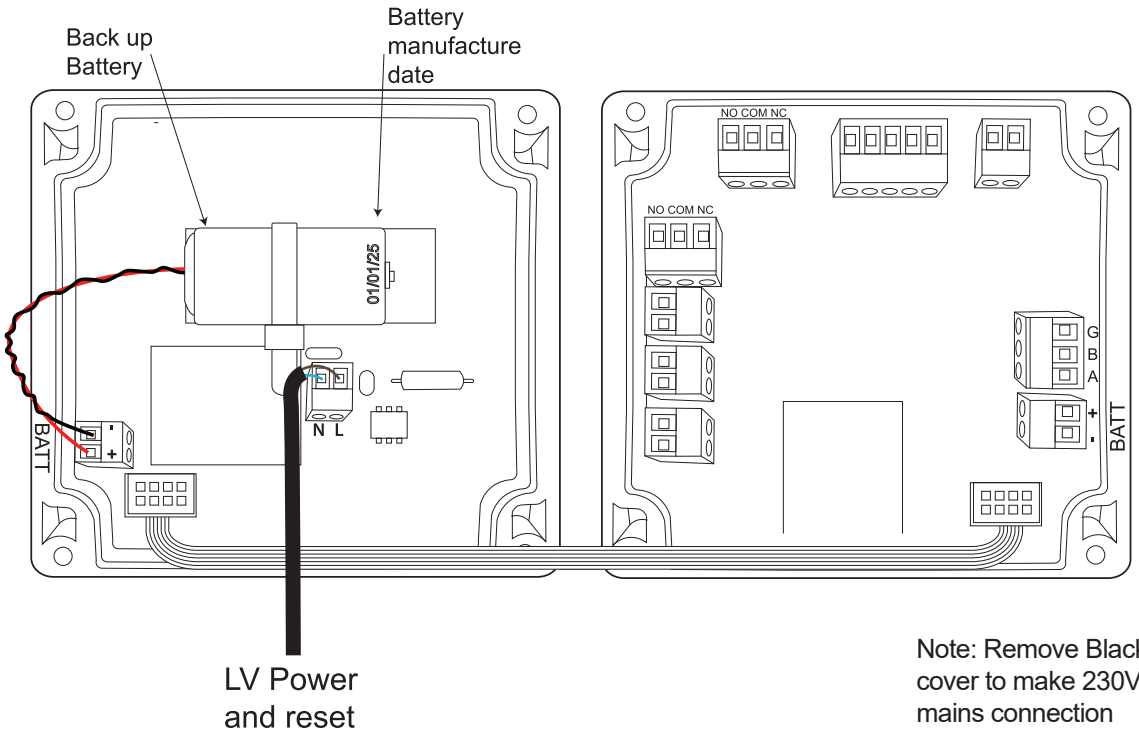
Battery Calculations based on:
150 Flashing hours per year
100 GSM/GPRS calls per year



4.0 Connections

Bowdens Omega 4 LV BB - LV powered unit with battery backup.

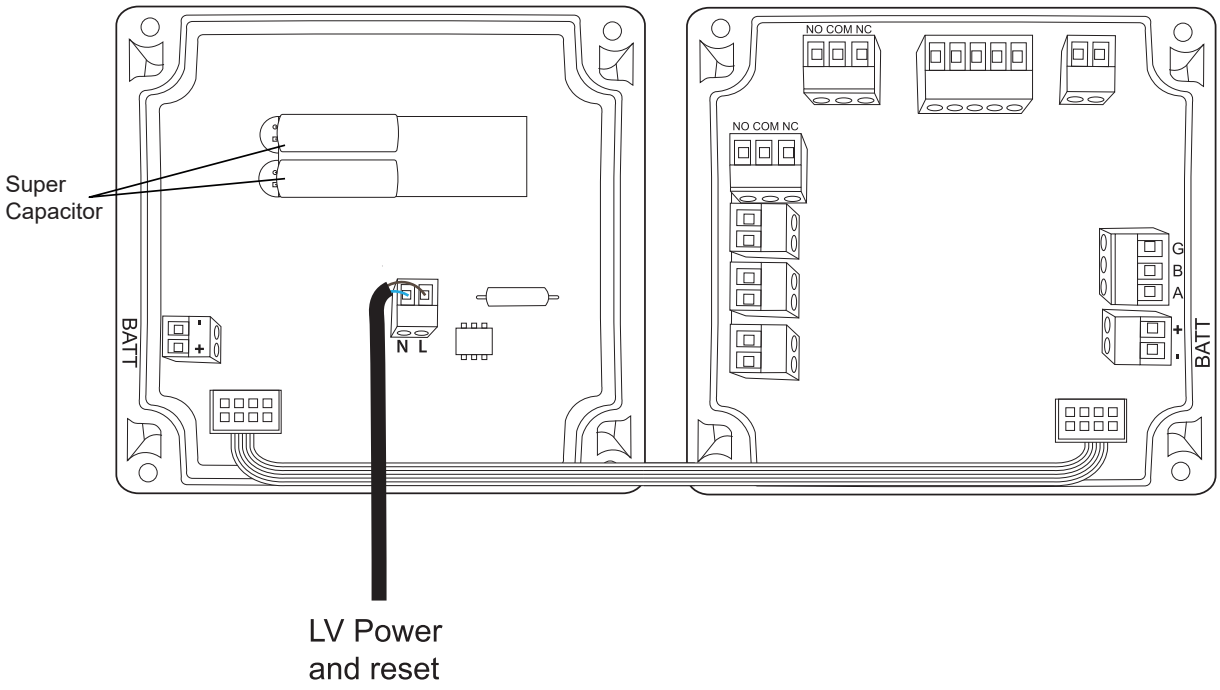
Fig 4.1



Note: Remove Black Plastic cover to make 230Vac LV mains connection

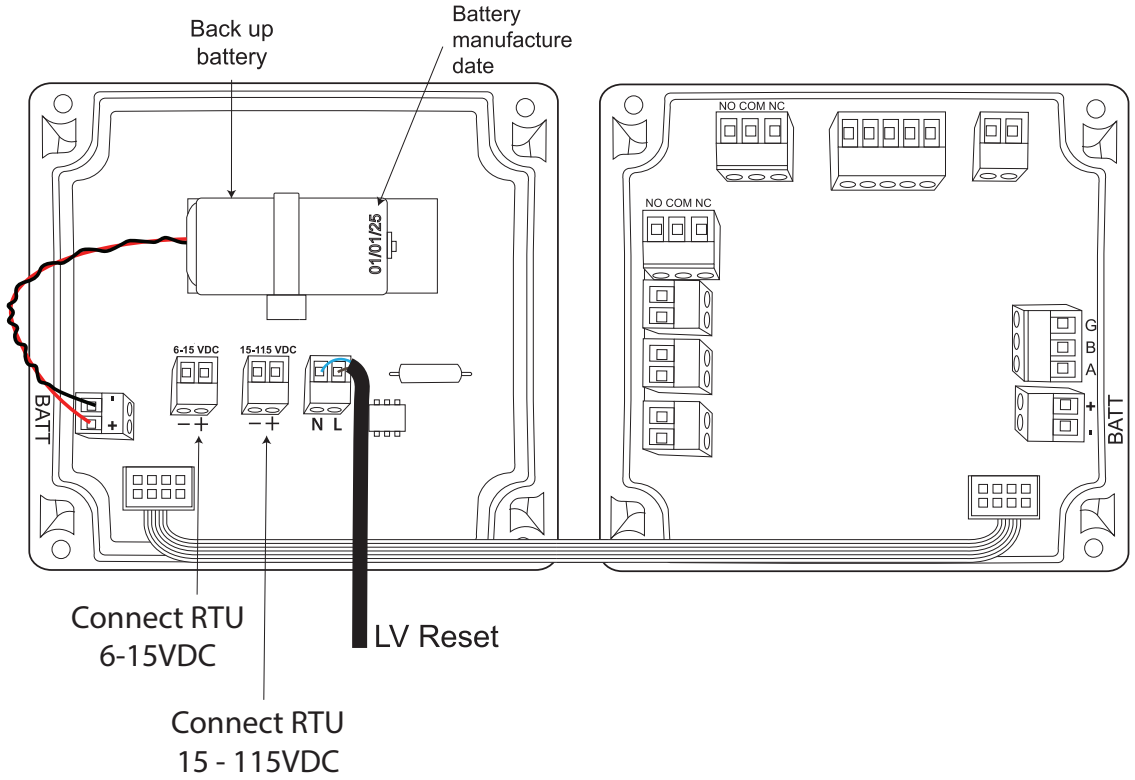
Bowdens Omega 4 LV SC - LV powered unit with a Super Capacitor Backup (no battery fitted).

Fig 4.2



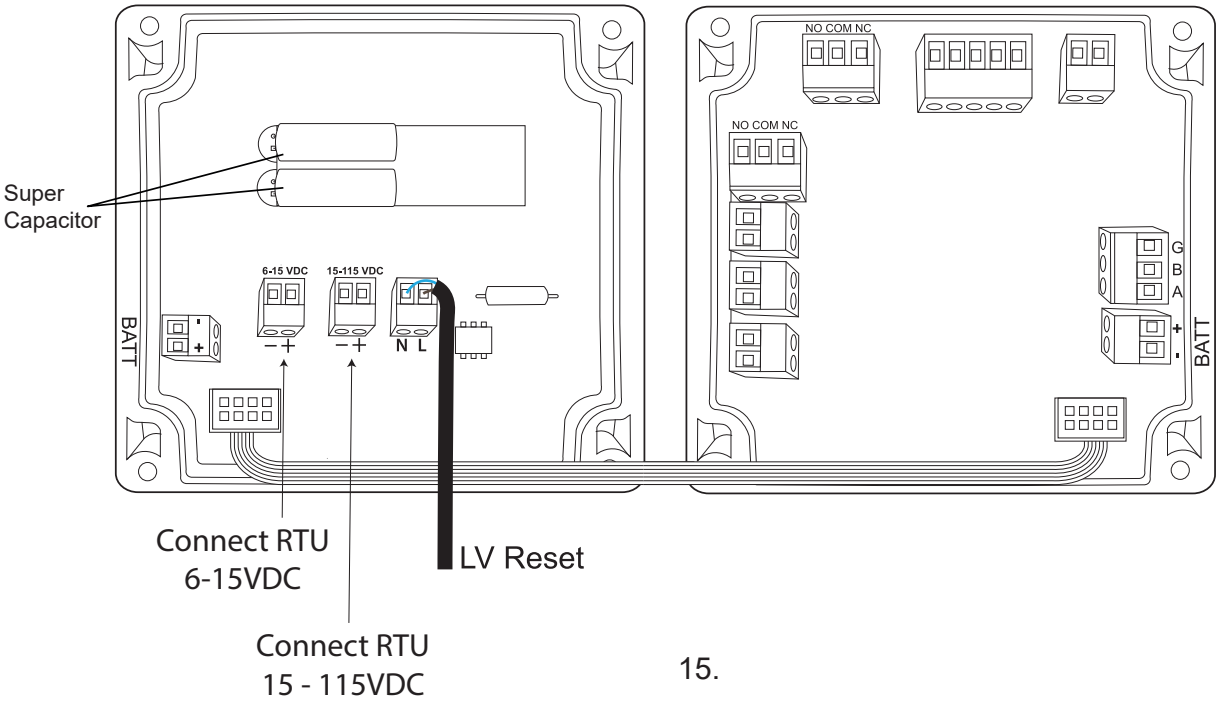
Bowdens Omega 4 RTU BB - RTU (Remote Terminal Unit) with a battery backup.

Fig 4.3



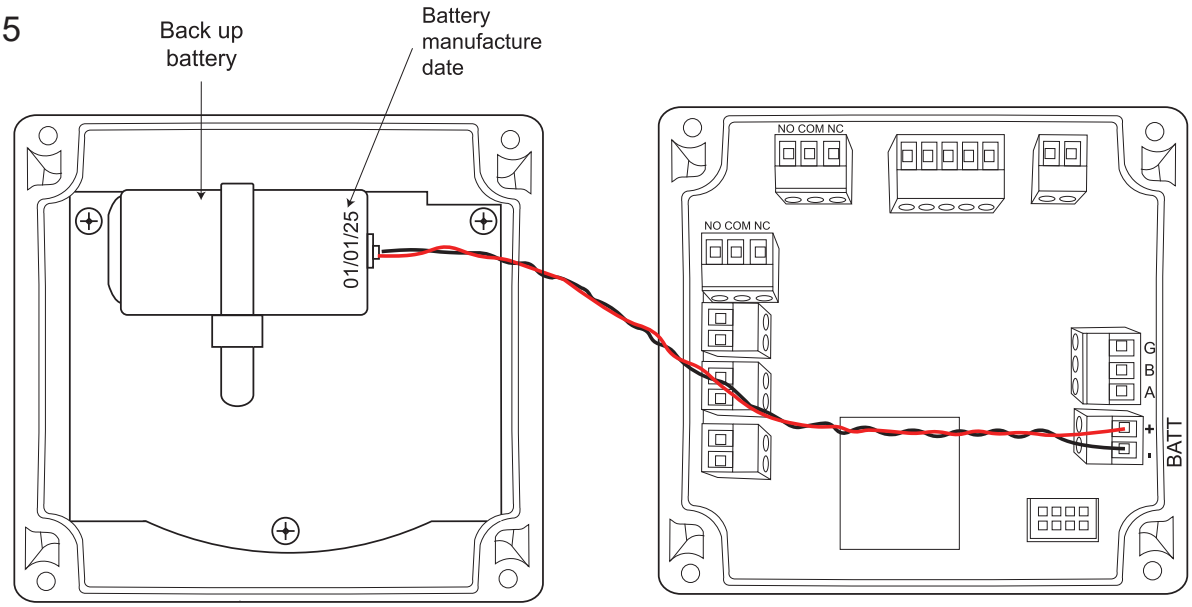
Bowdens Omega 4 RTU SC - RTU (Remote Terminal Unit) with a Super Capacitor Backup (no battery fitted).

Fig 4.4



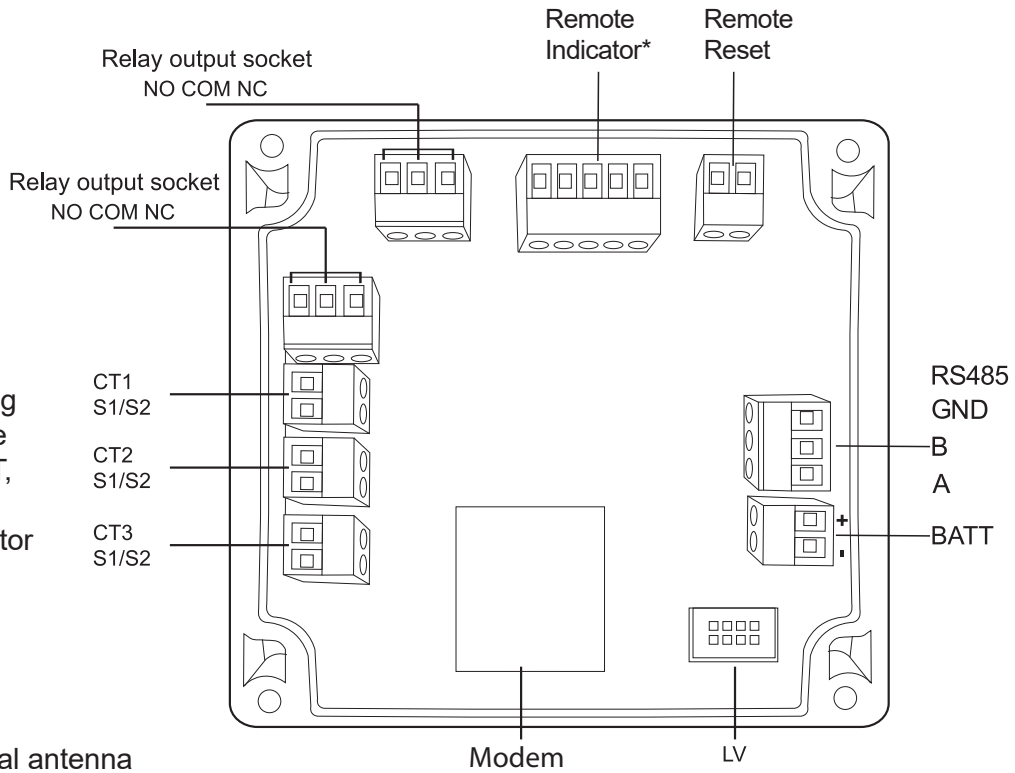
Bowdens Omega 4 BAT - Battery powered unit (Note: No LV reset or directional fault indication).

Fig 4.5



The example below shows the Omega 4 screw terminal connections.

Fig 4.6



*From left to right
Earth fault,
Overcurrent,
Direction left,
Direction right,
Common (GND)

Note: if using a single core balanced CT, connect to CT1 connector

Note: internal antenna as standard, external antennae optional

5.0 Testing of Installation and Primary Injection Testing

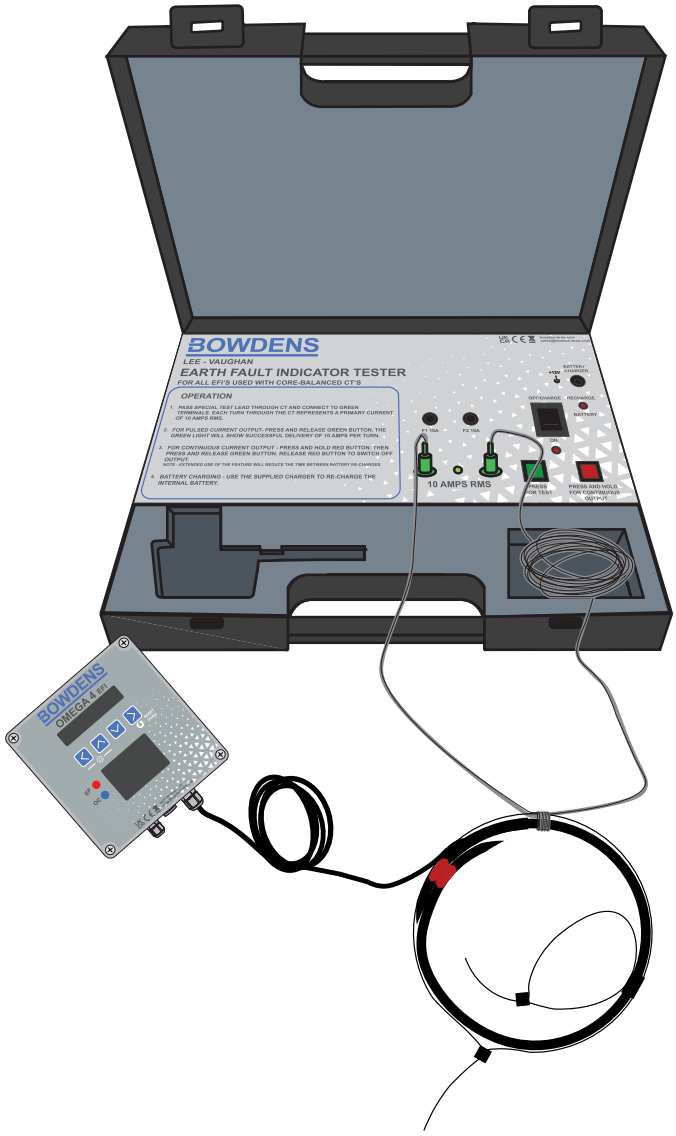
The following primary current tests prove the alarm functions and the Current Transformer input circuits.

Manual Testing

Available on all models with the Push Button Control. The twin LEDs will flash and a status 4G message will be initiated.

Primary Injection Testing

This test is applicable to all Omega 4 models and can only be carried out if the Omega 4 modules are connected to a Core Balance Current Transformer for earth fault testing or 3 x Phase C/Ts for overcurrent testing. The test will confirm the correct operation of all modules and Band Current Transformer functions.



Sufficient primary current must be passed through the Current Transformer to cause the module to alarm. The Omega 4 is set to operate at a fault current (e.g. 60A) above the user set current (e.g. 50A) threshold. Once triggered the module can either be left to reset automatically after its selected reset time, reset manually or using the LV reset option. The primary current can be generated with a suitable a.c. current injection test set or with the Bowdens Portable EFI Tester.

LV Reset

Connect the 230/240V 50 Hz (LV) supply to the 'N L' terminals in the base of the Omega 4 unit. Once the Omega 4 has detected a fault and is in the tripped condition it can be reset by the return of the LV supply. LV Reset can be turned on or off from the menu. If LV Reset is enabled, the time LV must be present before reset is achieved can be adjusted in the menu. Please see 'Reset LV' and 'Reset LV time' in section 2.1.3.

6.0 Current transformer installation

Omega 4 can operate with a Core Balance C/T for Earth Fault only indication or from 3 x Phase C/Ts for Overcurrent and Earth Fault Indication. Most C/T ratios can be accommodated via the C/T matching function in the program settings. The Omega 4 is also designed to operate from the 1000:1 Bowdens Band C/T. Install the C/T according to Drawing 1 taking note of how the earthing should be applied to the C/T. Test the installation using Bowdens Portable EFI Tester - (see 5.0 Testing of installation).

Drawing 1

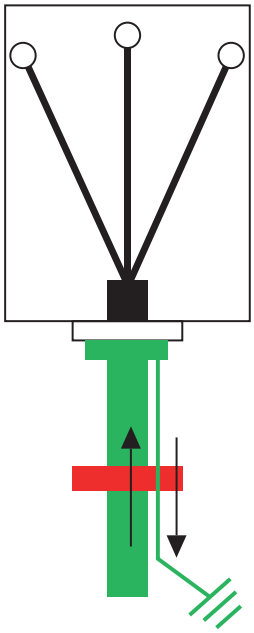


FIG 6.1
Traditional external cast resin C/T installation. Insulated gland at entry to cable box. An earth braid needs to be soldered to the earth termination and brought back through the C/T to cancel the earth fault flowing in the cable sheath.

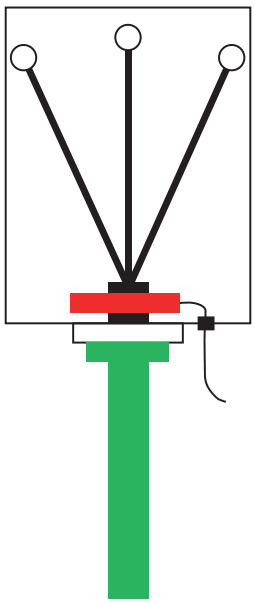


FIG 6.2
Sheath earth terminates at insulated gland and so the C/T can be installed in the base of the cable box where it will detect only out of balance caused by earth fault flowing in one phase.

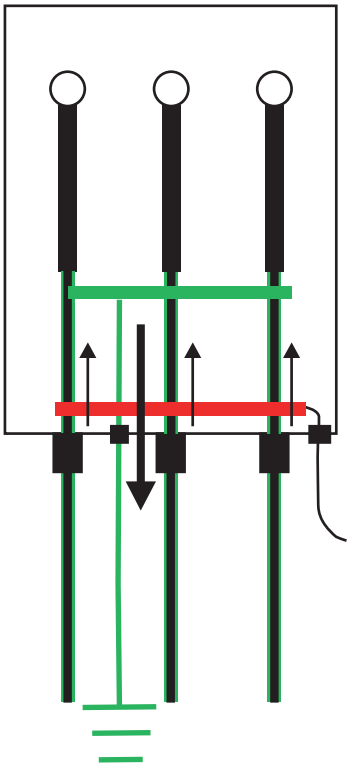


FIG 6.3
Individual phases enter cable termination box separately. A large diameter band type C/T can be placed in the base of the cable box to encompass all three phases. If the earth terminates above the C/T position then it must be collectively brought back through the C/T as shown.

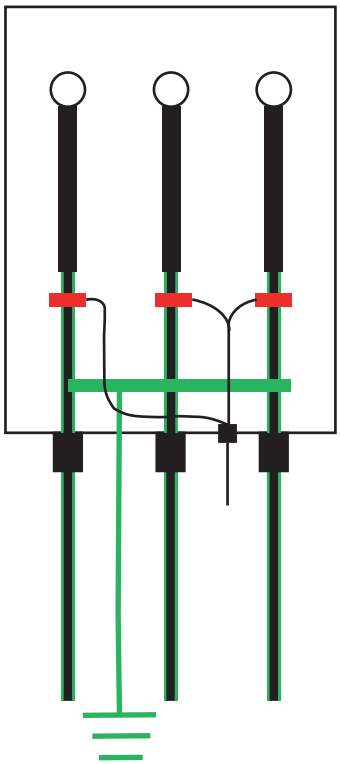


FIG 6.4
Alternatively individual phase C/Ts may be installed, and summated in parallel for earth fault output, or as phase C/Ts for Overcurrent and Earth Fault EFI. If the Earth terminates above the C/T position then it must be collectively brought back through the C/T as shown.

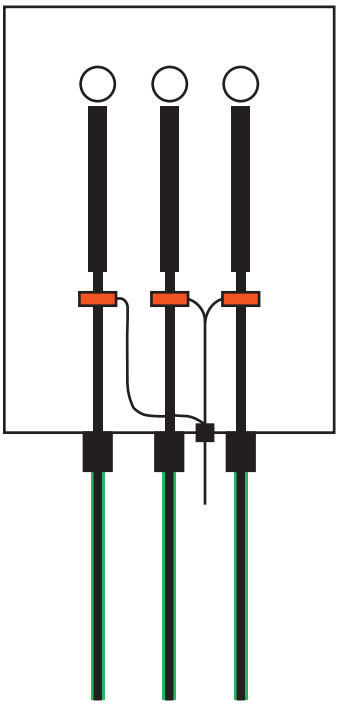
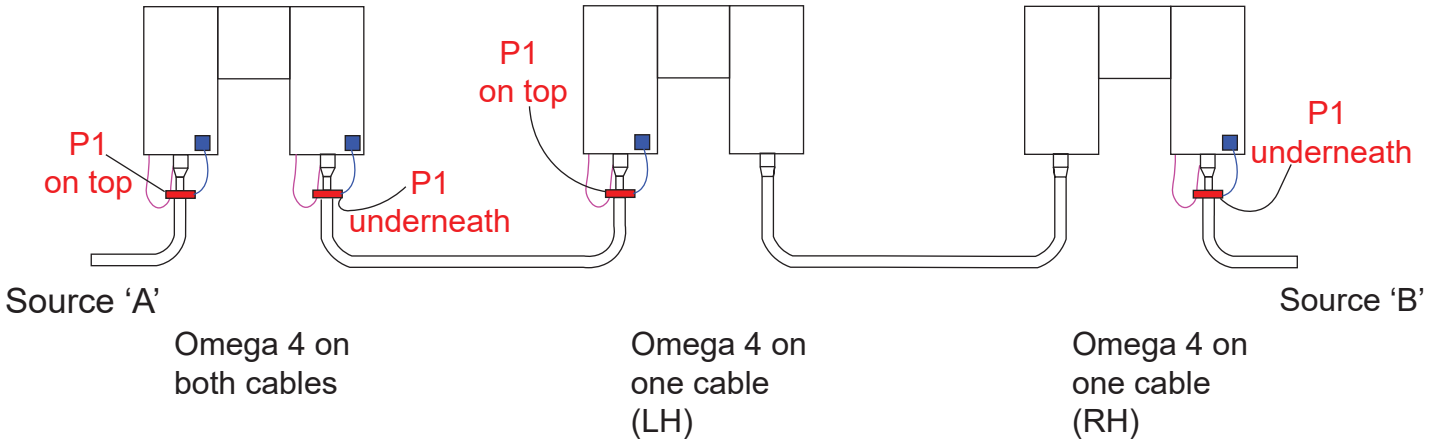


Fig 6.5
Individual phase C/T's may be installed and summated in parallel for earth fault output, or as a phase C/T's for overcurrent and Earth Fault EFI. If the earth terminates below the C/T position then it will read pure fault current.

Correct Core Balance CT Orientation

External CT and RTU with insulated cable gland

Drawing 2a

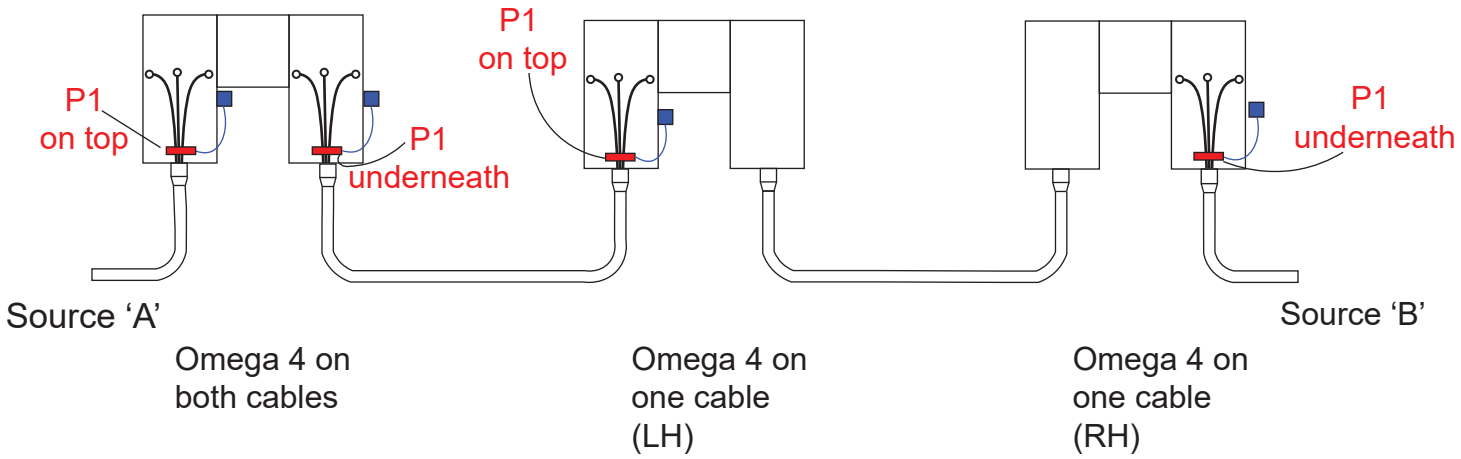


Key:
- Omega 4 module and cable to CT
- Core balance current transformer

Correct Core Balance CT Orientation

Internal CT’s inside RTU dry cable box

Drawing 2b



Key:
- Omega 4 module and cable to CT
- Core balance current transformer
- Earth wire through CT

This type of installation requires an insulated cable gland (or alternative) at each cable location where the Omega 4 core balance CT is fitted. In addition the earth wire between cable gland and switchgear must be directed through the CT.

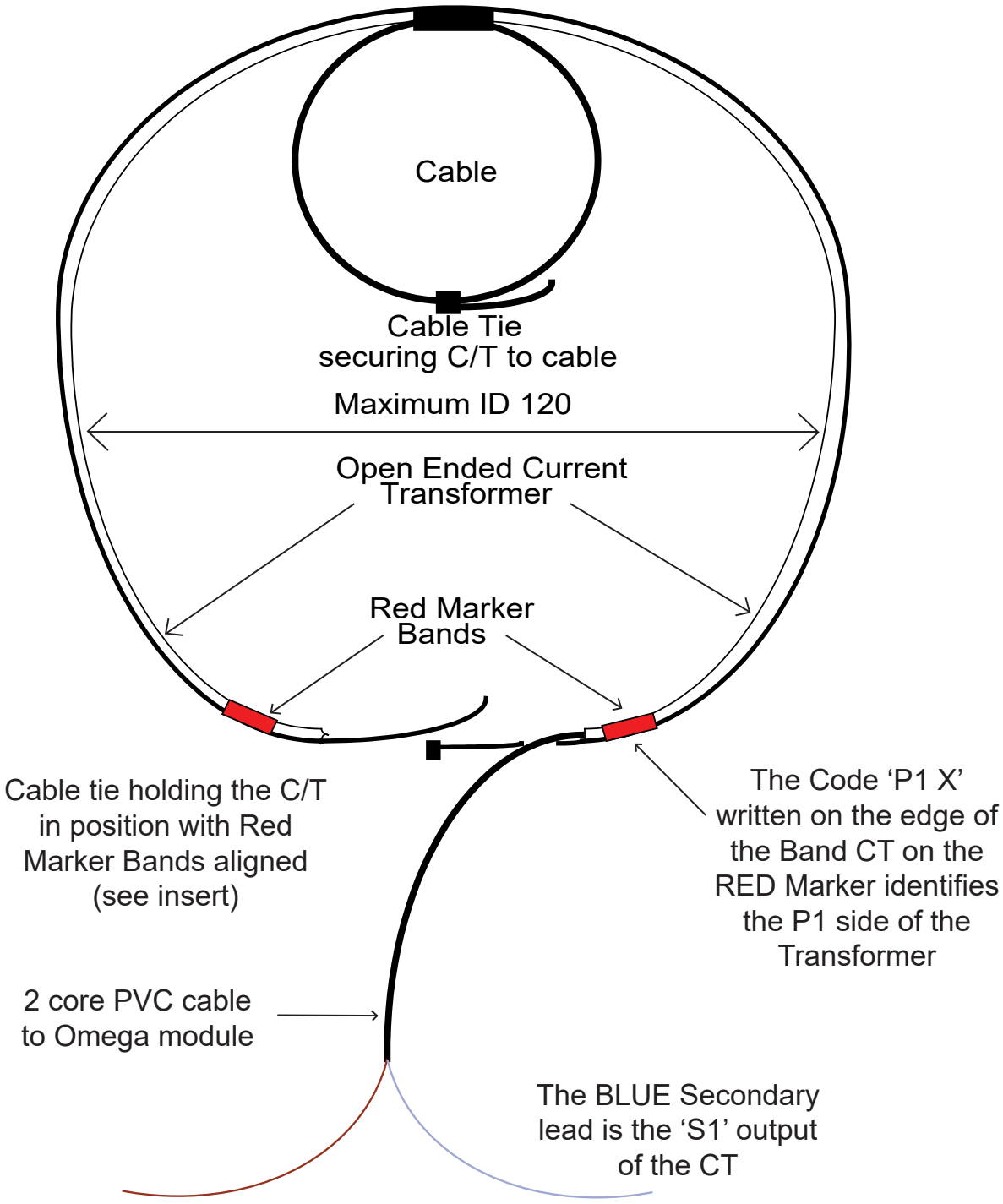
Where there are Omega 4 installations along a common HV cable circuit it is essential that the CT's are correctly orientated relative to each other.

Each CT has a P1 and P2 primary side, and S1 and S2 secondary terminals. Incorrect orientation of these features will cause incorrect Directional Indication of the Omega 4. The Overcurrent and Earth Fault indications will not be affected.

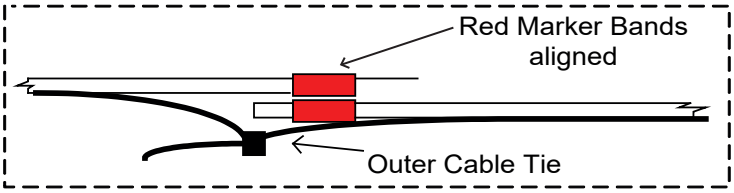
Each CT will require identification on its P1 side. The CT's secondary terminal S1 will also need to be identified. For a Bowdens Band CT S1 is the Blue lead. The other terminal will logically be S2.

In order to give correct current direction to the Omega 4 all the CT's on cables electrically connected nearest to source 'A' must have the same orientation ie. P1 on top. The S1 and S2 connections must be the same at each corresponding Omega 4 location.

Band Current Transformer Outline
Phase C/Ts 50mm ID & Core Balance 120mm ID
Drawing 3a

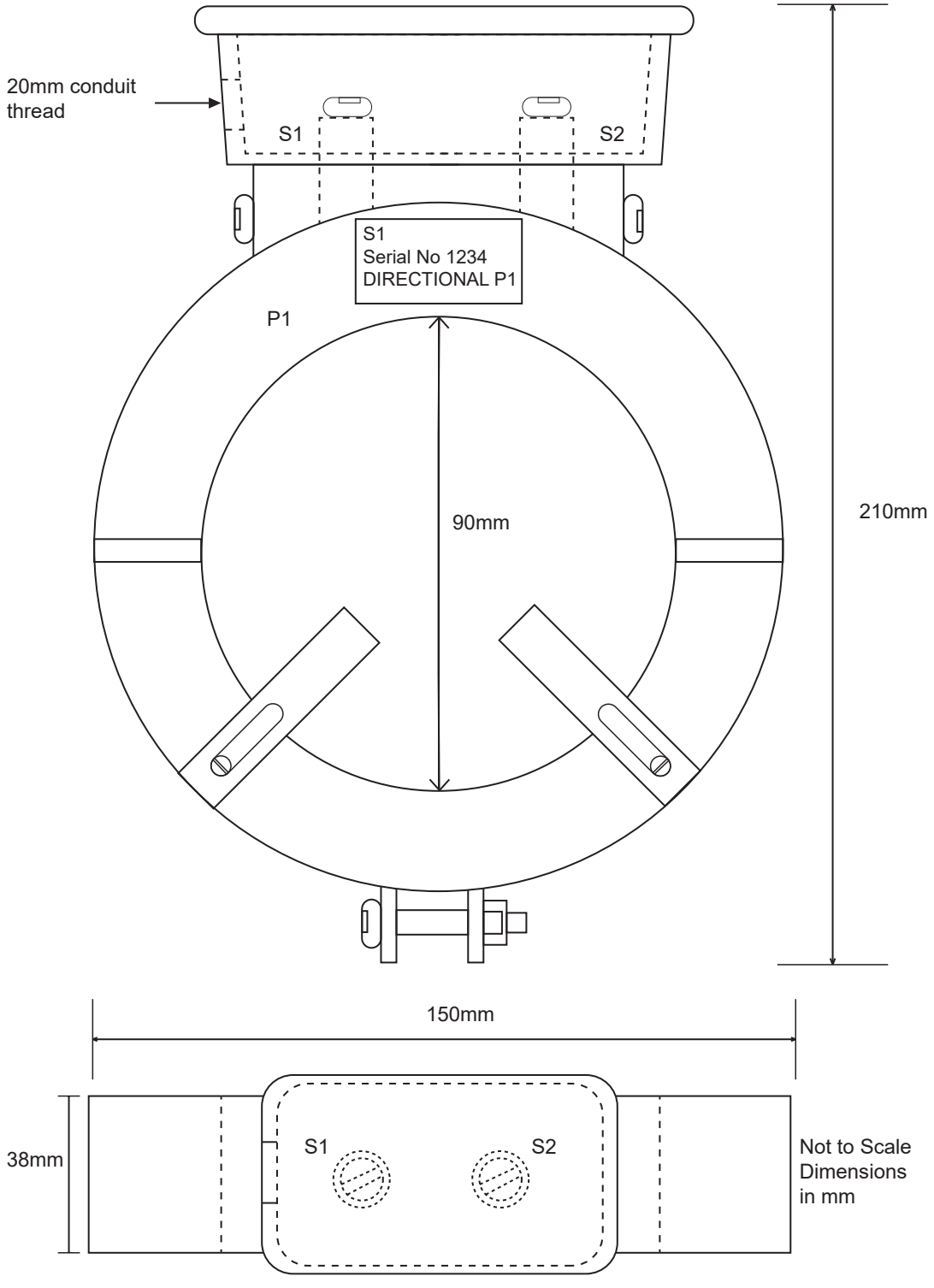


IMPORTANT
Method of determining P1 side of CT.
Hold CT in Left Hand and secondary cable in Right Hand.
The 'P1' Side of the CT is the side facing you.
The 'S1' Secondary Output is BLUE.



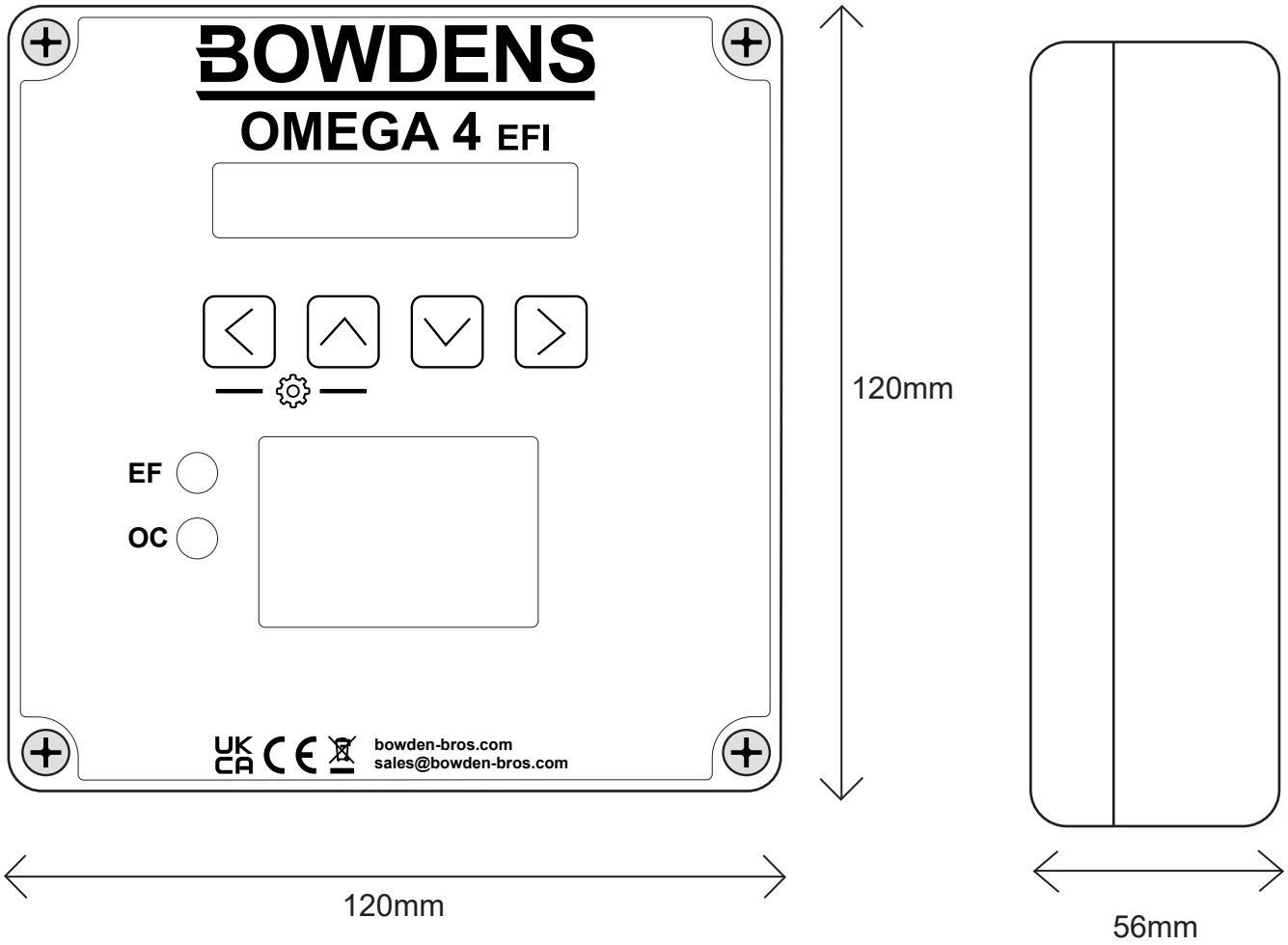
Not to Scale
Dimension in mm

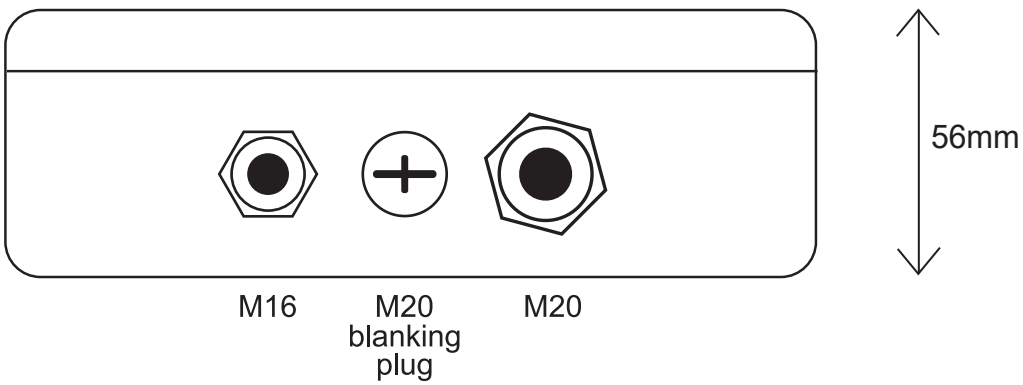
Split Core Cast Resin Current Transformer Outline
(available in ratios 500:1, 60:1, 40:1)
Drawing 3b



SPLIT EFI Cast Resin Current Transformer with Terminal Box
OUTLINE DRAWING DKM 1246/B

OMEGA 4 Programmable Fault Passage Indicator Outline
(Dimensions in mm & not to scale)
Drawing 4





7.0 Type Testing

Temperature Tests

IEC 60068 - Equipment fitted outdoors shall operate over the temperature range -20º C to + 80º C. The components and assemblies used in OMEGA 4 modules meet this temperature requirement.

Shock Withstand Tests

IEC 60255-21-2 Shock Withstand:
A random selection of modules were tested. Slight abrasions were observed, however the polycarbonate did not chip or crack. A primary current test was carried out on each module after each test. The module was found to be unaffected by the mechanical vibration. After five tests each module was fitted to a Band Current Transformer and the complete assembly tested with a primary current. All tests were successful.

Environmental & Climatic Tests

IEC60068 - Modules have been left submerged continuously under a 300mm head of water. Modules are continually left in an outdoor exposed situation where the effects of weather and natural temperature cycling can be observed.

Electro-magnetic Compatibility Tests

Generic EMC Standards

BS EN 61000-6-4: 2001	-Generic emissions standard (Heavy industrial)
BS EN55011:1998 + A1:1999	-Radiated Emissions.
BS EN55011:1998 + A1:1999	-Conducted Emissions.
BS EN 61000-6-2: 2001	-Generic immunity standard (Heavy industrial)
BS EN 61000-4-2:1995 + A1 1998 + A2:2001	-Electrostatic discharge Immunity Test
BS EN 61000-4-3:2002 + A1:2002	-Radiated Immunity.
BS EN 61000-4-4:1995 + A1:2001+A2:2001	-Fast Transient/Bursts Immunity.
BS EN 61000-4-5:1995 +A2:2001	-Surge Immunity.
BS EN 61000-4-6: 1996 + A2:2001	-Conducted RF Immunity
BS EN 61000-4-8: 1996 + A2:2001	-Magnetic Immunity

Additional EMC Testing to meet power system environmental requirements

TEST 1	-BS EN 61000-4-8: 1994 50Hz Magnetic Field up to 6mT (5000A/m) continued stable for 3 seconds.
TEST 2	-BS EN 61000-4-11:1994 + A1:2001 - Voltage Dips and Interruptions
TEST 3	-BS EN 60255-5: 2001

8.0 Specification OMEGA 4

General Data

Module case	:	Polycarbonate material. Case to IP66 (dust and water jet proof)
Temperature range	:	-25°C to + 70° C

Threshold Levels – User Settable

EF Trip Current	:	20-120A or 40-200A or 50-500A
Phase Trip Current	:	125 – 750A
EF Trip delay	:	20-200ms (Pre-set at 50ms nominal)
Phase Trip Delay	:	20-200ms (Pre-set at 100ms)
Reset time	:	Pre-set at 6 hours +/- 10 mins
EFI Accuracy	:	+/- 5% Over all readings (sinusoidal input)
60/120/240mm Band CT Accuracy	:	+/-10% Over all readings (sinusoidal input)
Line Voltage	:	6KV to 36KV
Max Current	:	>25kA

Reset Options

Manual	:	Push Button
LV Reset Signal	:	Only available with power supply board
Timed Reset	:	1 to 12 hours
Remote Reset	:	6 to 30Vac or Vdc applied for 10 secs

Alarm Mode

Permanent Faults	:	LEDs flash alternatively every 1.5 seconds
Digital Flag Indicator	:	Shows warning triangle and fault direction
Transient Faults	:	LED gives two short flashes every three seconds for 24 hrs. Occurs 15 secs after LV Reset.

Enable/Disable Transient switch

After Ready Mode/Reset	:	Three flashes
Second Fault Alarm	:	Alert to second faults during Alarmed Mode
Power Source	:	Lithium battery 3.6V 13Ah. Battery Life 10 years.
Alarm Output Relay	:	Two sets of Volt free contacts (NO, COM, NC) 30VDC, 1 A (resistive) 110VDC, 0.3 A (resistive)

Maximum earth fault reading

The maximum earth fault reading is dependant on the CT ratio. The Omega 4 uses variable gain to amplify the earth fault signal to provide the best resolution possible.

This limits the maximum earth that can be read.

CT Ratio		Max Earth Fault Current (A rms)
40	:	64
50	:	80
60	:	97
500	:	209
1000	:	209

Maximum phase current reading

The max phase current reading is only dependant on CT ratio.

CT Ratio		Max Phase Current (A rms)
40	:	65
50	:	81
60	:	98
500	:	823
1000	:	823

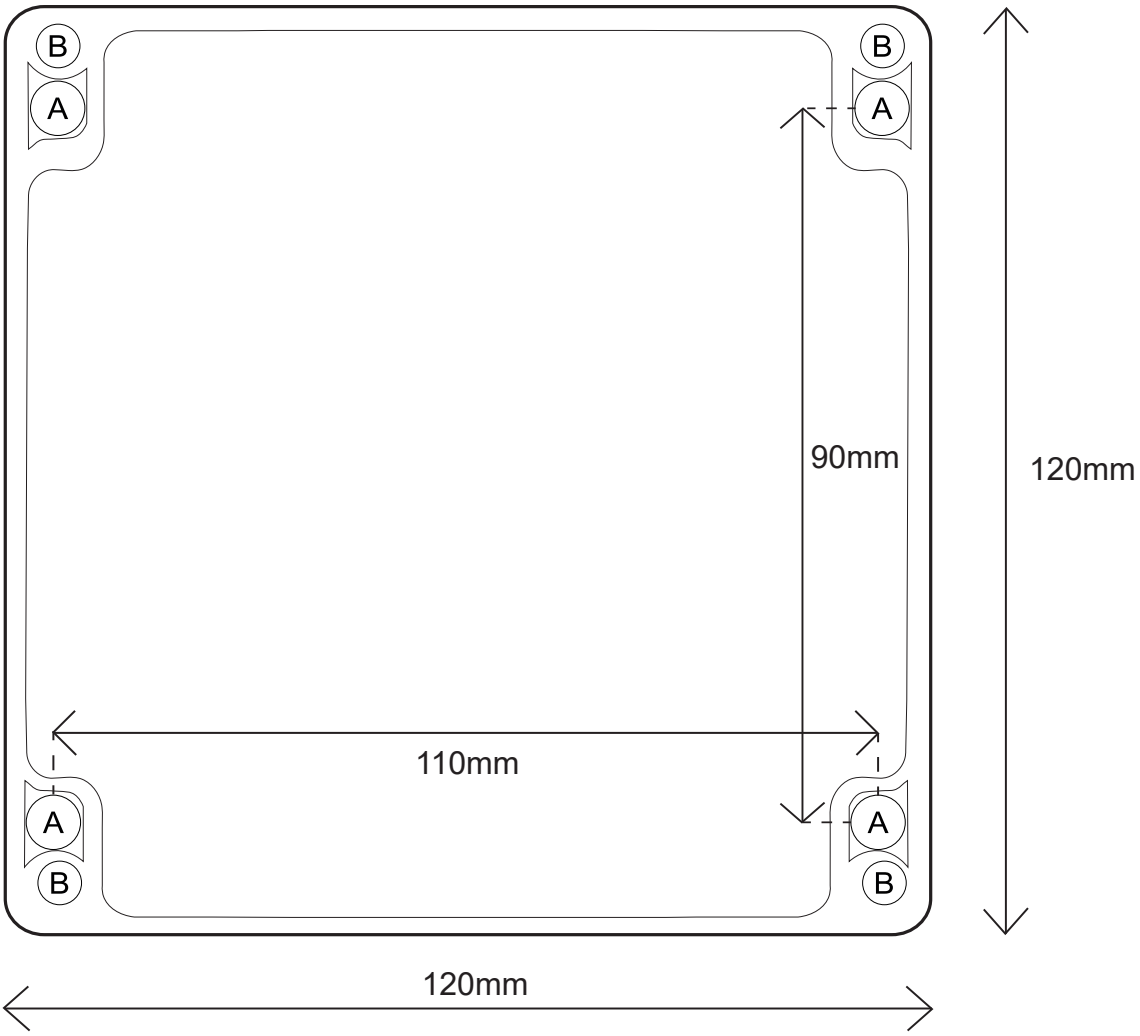
LCD display off times

External power	:	5 minutes
Battery	:	1 minute
Supercaps	:	10 seconds

9.0 Mechanical Data

9.1 Back Box Mounting Data

OMEGA Fixing Holes in Base

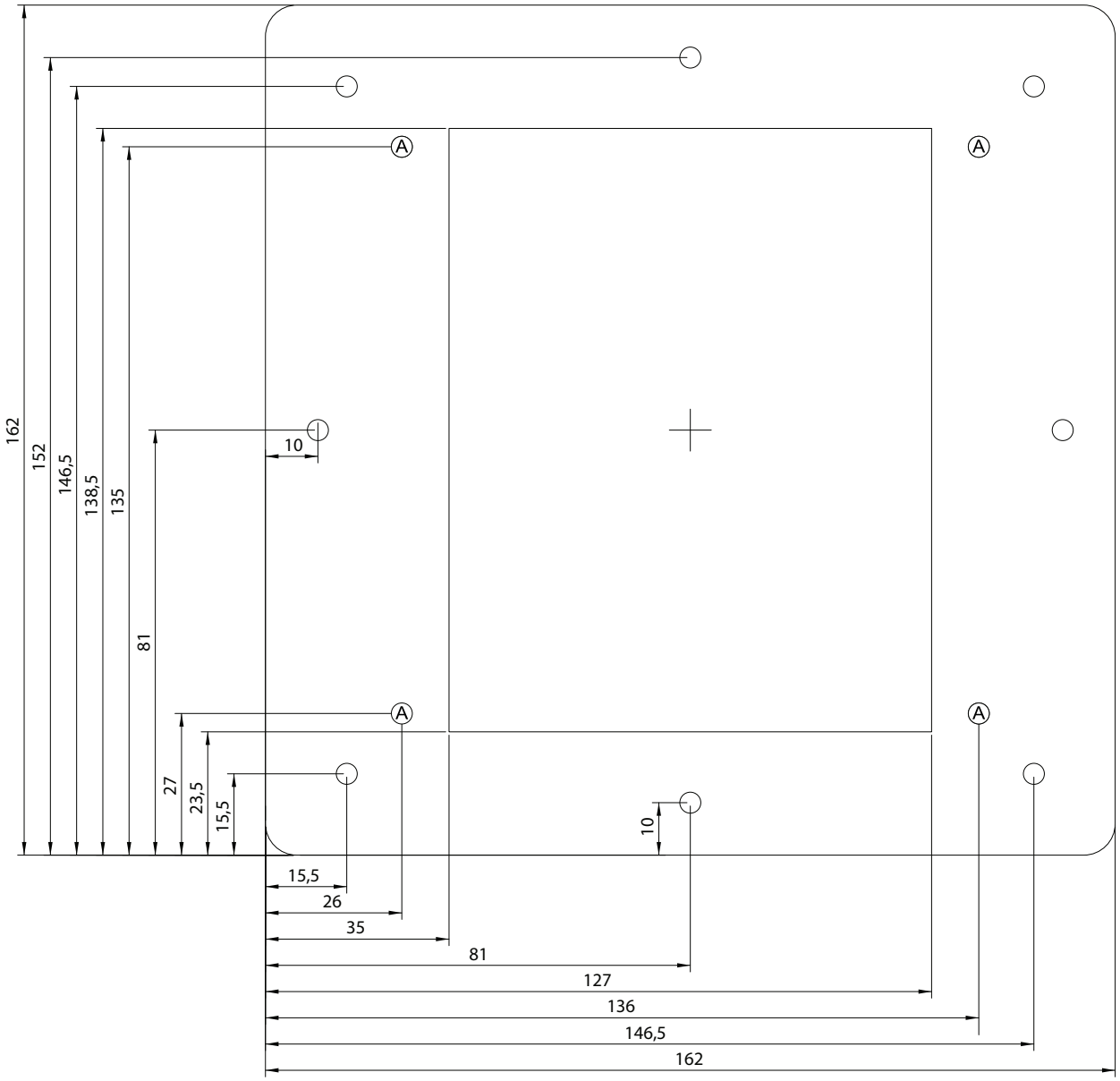


HOLES ‘A’ Corner fillet holes for fixing OMEGA 4 base
Holes 4mm diameter
Distances between centres
Dimensions in mm
Not to scale

HOLES ‘B’ Recessed screw holes for securing OMEGA 4 front panel

9.2 Panel Mount Bracket

The drawing below shows the optional panel mount bracket which allows the Omega 4 to be panel mounted.



Note 1 : All dimensions in mm.

Note 2 : All holes 4.0mm diameter, countersunk.

Note 3 : Holes marked as ‘A’ are to secure the Omega 4 behind the panel mount bracket. All other holes are to secure the bracket to the panel.

10. Modbus Registers

For all items see 2.1.2 and 2.1.3 for further explanation

Live	Register Number	Type
TempLW	3	float32 (low 16 bits)
TempHW	4	float32 (high 16 bits)
Phase 1	5	int16 read only
Phase 2	6	int16 read only
Phase 3	7	int16 read only
Earth	8	int16 read only
LV freq	9	int16 read only
Battery good	10	int16 read only
Power good	11	int16 read only
Faults 1	20	int16 read only
Fault 1 Type	21	int16 read only
Fault 1 Earth	22	int16 read only
Fault 1 Phase 1	23	int16 read only
Fault 1 Phase 2	24	int16 read only
Fault 1 Phase 3	25	int16 read only
Fault 1 DateTime LW	26	uint32 (unix time) read only
Fault 1 DateTime HW	27	uint32 (unix time) read / write
Fault 1 Angle Earth	28	int16 read only
Fault 1 Angle Phase 1	29	int16 read only
Fault 1 Angle Phase 2	30	int16 read only
Fault 1 Angle Phase 3	31	int16 read only
Faults 2	33	int16 read only
Fault 2 Type	34	int16 read only
Fault 2 Earth	35	int16 read only
Fault 2 Phase 1	36	int16 read only
Fault 2 Phase 2	37	int16 read only
Fault 2 Phase 3	38	int16 read only
Fault 2 DateTime LW	39	uint32 (unix time) read only
Fault 2 DateTime HW	40	uint32 (unix time) read / write
Fault 2 Angle Earth	41	int16 read only
Fault 2 Angle Phase 1	42	int16 read only
Fault 2 Angle Phase 2	43	int16 read only
Fault 2 Angle Phase 3	44	int16 read only

10. Modbus Registers

For all items see 2.1.2 and 2.1.3 for further explanation

Live	Register Number	Type
Faults 3	46	int16 read only
Fault 3 Type	47	int16 read only
Fault 3 Earth	48	int16 read only
Fault 3 Phase 1	49	int16 read only
Fault 3 Phase 2	50	int16 read only
Fault 3 Phase 3	51	int16 read only
Fault 3 DateTime LW	52	uint32 (unix time) read only
Fault 3 DateTime HW	53	uint32 (unix time) read / write
Fault 3 Angle Earth	54	int16 read only
Fault 3 Angle Phase 1	55	int16 read only
Fault 3 Angle Phase 2	56	int16 read only
Fault 3 Angle Phase 3	57	int16 read only
Faults 4	59	int16 read only
Fault 4 Type	60	int16 read only
Fault 4 Earth	61	int16 read only
Fault 4 Phase 1	62	int16 read only
Fault 4 Phase 2	63	int16 read only
Fault 4 Phase 3	64	int16 read only
Fault 4 DateTime LW	65	uint32 (unix time) read only
Fault 4 DateTime HW	66	uint32 (unix time) read / write
Fault 4 Angle Earth	67	int16 read only
Fault 4 Angle Phase 1	68	int16 read only
Fault 4 Angle Phase 2	69	int16 read only
Fault 4 Angle Phase 3	70	int16 read only

10. Modbus Registers

For all items see 2.1.2 and 2.1.3 for further explanation

Live	Register Number	Type
Faults 5	72	int16 read only
Fault 5 Type	73	int16 read only
Fault 5 Earth	74	int16 read only
Fault 5 Phase 1	75	int16 read only
Fault 5 Phase 2	76	int16 read only
Fault 5 Phase 3	77	int16 read only
Fault 5 DateTime LW	78	uint32 (unix time) read only
Fault 5 DateTime HW	79	uint32 (unix time) read / write
Fault 5 Angle Earth	80	int16 read only
Fault 5 Angle Phase 1	81	int16 read only
Fault 5 Angle Phase 2	82	int16 read only
Fault 5 Angle Phase 3	83	int16 read only
Faults 6	85	int16 read only
Fault 6 Type	86	int16 read only
Fault 6 Earth	87	int16 read only
Fault 6 Phase 1	88	int16 read only
Fault 6 Phase 2	89	int16 read only
Fault 6 Phase 3	90	int16 read only
Fault 6 DateTime LW	91	uint32 (unix time) read only
Fault 6 DateTime HW	92	uint32 (unix time) read / write
Fault 6 Angle Earth	93	int16 read only
Fault 6 Angle Phase 1	94	int16 read only
Fault 6 Angle Phase 2	95	int16 read only
Fault 6 Angle Phase 3	96	int16 read only

10. Modbus Registers

For all items see 2.1.2 and 2.1.3 for further explanation

Live	Register Number	Type
CT Ratio	102	int16 read / write
EF Trip	103	int16 read / write
EF Delay	104	int16 read / write
OC Trip	105	int16 read / write
OC Delay	106	int16 read / write
Reset Time	107	int16 read / write
Reset LV	109	int16 read / write
Reset LV Time	110	int16 read / write
Mode	111	int16 read / write
Relay Mode	112	int16 read / write
Bias Fitted	113	int16 read / write
Date Time LW	115	uint32 (unix time) read / write
Date Time HW	116	int16 read / write
Test Alarm	117	int16 write only
Reset Alarm	118	int16 write only

Please consider the environment at the end of this product's life.

At end of life please take this unit to your closest electrical recycling point.
or
Return this unit to Spring (Europe) Limited for recycling.

Recycle Responsibly
ISO14001

VERSION 2.4
RELEASE 23.04.26

ECO Reference	Date
ECO0290	11.06.25
ECO0371	01.09.25
ECO0417	25.02.26
ECO0420	03.03.26
ECO0431	23.04.26