Grid Solutions
Monitoring & Diagnostics

Kelman™ BMT 430 Installation Manual

Bushing & Partial Discharge Monitoring

GE VERNOVA

Contents

List of Tables & Figures

Related Documents

Ref#	Title
MA-044	BMT 430 - Operator Guide

Abbreviations & Definitions

Abbreviation	Meaning
BMT	Bushing Monitor for Transformers
HFCT	High Frequency Current Transformer (or Neutral CT)
HMI	Human Machine Interface
HV	High Voltage
LOTO	Lock Out, Tag Out (procedure)
LV	Low Voltage
PD	Partial Discharge
RTD	Resistive Temperature Detectors
BA	Bushing Adaptor

1 INTRODUCTION

1.1 Overview

The Kelman™ BMT 430 (the product) is an online bushings and Partial Discharge (PD) monitor for implementing Asset Performance Management (APM) across electrical generation, transmission, distribution and industrial applications.

The product as shown in Figure 1-1 is designed to continuously monitor:

- Up to three *sets* of bushings – 3, 6 or 9 individual bushings (in a single three-phase transformer, or three single-phase transformers). The condition of transformer bushings is measured through changes in Capacitance and Power Factor.
- Partial Discharges (PD) activity – measured as high frequency pulses at the bushing test tap.

Once installed, operation is intuitive and programmable. The product can be managed remotely over a network via a web-based interface or locally via a touchscreen interface. All results are stored within the product, but *online management is recommended*. Results and the full product database can also be downloaded to a PC for analysis, aggregation and trending with the Perception software suite.

Figure 1-1: Inside the BMT 430

The product is built around the common Kelman platform for expansion and future feature enhancements. This modular and retrofittable architecture combines the latest technology, firmware and support for the following:

- Set 1 of three Bushing Adaptors (Primary input) connected to the tapping point of the bushings being monitored.
- (Optional) Set 2 of three Bushing Adaptors (Secondary input) connected to the tapping point of a second set of bushings being monitored.
- (Optional) Set 3 of three Bushing Adaptors (Tertiary input) connected to the tapping point of a third set of bushings being monitored.
- (Optional) Up to three High Frequency Current Transformer (HFCT) sensors at the transformer(s) high voltage neutral (if applicable) – to improve the monitoring of PD.
- Up to four magnetically-mounted temperature sensors (MMTS) mounted on the transformer tank(s) to measure the transformer top oil temperature (if applicable).
- A combined ambient temperature and humidity sensor externally mounted on the bottom plate of the cabinet.

The product also features:

- An IP56-rated aluminium enclosure (compliant in the installed upright position) and powder coated to the RAL 9002 colour standard.
- Transformer load tracking (CT analogue input).
- Watchdog relay as standard to monitor power usage.
- Six configurable relay contacts.
- Compatible with AC or DC power.
- Four sunlight-visible LED arrays on the exterior — red for alarm, yellow for caution (both user-configurable) — and green for power, blue for service.
- A fully embedded microprocessor with 4 GB non-volatile internal memory storage, highly scalable analogue and digital I/Os, an embedded webserver, 32GB SD card to hold measurement data and an integrated 7 in. colour LCD screen with resistive touch for simplified local user interaction and visualization of data.
- Extensive range of secure communications options – Ethernet, RS-485, cellular modem (SMS Text Alerts /GPRS), and fibre optic options (E.g. IEC61850 or DNP3). Internal USB connection is provided for commissioning and service, or local data download. Other options may be available on request.
- Compatibility with GE Vernova's Perception transformer fleet management software for data download, trending and analysis as well as other SCADA systems. The product is an APM ready device with support for industry standard protocols.

All commissioning details are found in Section 13. Refer to the 'MA-044 – BMT 430 – Operator Guide' for all other operational details relating to the software interface for configuration, bushing settings, data readings and alarms.

Note: A complete list of parts and tools required for the installation is given in Appendix A.

1.2 Scope

This manual details the installation & commissioning requirements and procedure, including safety statements and pre-installation tasks to be considered when planning and preparing for the installation & commissioning. It examines mounting the product, power requirements, internal electronics, connections, wiring and communications options, and all tasks related to setting up the bushing and partial discharge monitoring, such as bushing adaptor connections, temperature sensors, CTs, and preparatory tasks — including tools, supplies and additional items to purchase. This manual also describes essential configuration operations and first start-up procedures that must be done in the HMI as part of the commissioning phase. Other operational details can be found in the product operator guide 'MA-044 - BMT 430 - Operator Guide'.

This manual must be read in its entirety prior to installation to prepare the site and obtain the necessary equipment. Refer to the appendices for details and record site details in the Installation Record (see Appendix C).

1.3 External LEDs

Table 1-1 lists the front panel LEDs that denote the operational status of the product.

Table 1-1: External LEDs

LED Colour	Symbol	Meaning
Alarm		A measured parameter has exceeded a user-programmed “alarm” threshold.
Caution		A measured parameter has exceeded a user-programmed “warning” threshold.
Power		AC power applied
Service		Service required. Triggered by a warning service event if the product detects internal issues or if equipment settings are exceeded, such as ▪ low bushing current warning ▪ power system frequency warning ▪ no signal warning ▪ bushing adaptor resistance failure warning. The product continues to take readings and will clear any service condition if the issue is no longer present.

2 SAFETY

2.1 Symbols

The meaning of symbols used on the Kelman™ BMT 430:

Caution: Refer to the Installation Manual / Operator Guide to prevent death, injury, equipment damage or loss of data.

Electrical Hazard: Risk of electric shock.

Primary Protective Earth connection.

The meaning of symbols used in this manual:

WARNING A procedure, practice, or condition could cause death, serious injury and/or significant equipment damage.

Caution: A procedure, practice, or condition could cause injury, equipment damage or loss of data.

Electrical Hazard: Risk of electric shock.

Laser radiation: LED transmitters for fibre optics are classified as IEC 60825-1 Accessible Emission Limit (AEL) Class 1. Class 1 devices are eye-safe to the unaided eye. Do not view directly with optical instruments.

2.2 Statements

The following safety statements must be observed:

WARNING: All coaxial cables from the Bushing Adaptors to the product *must* be run inside a protective electrically grounded metal conduit.

WARNING: The customer and installer are responsible for ensuring that all local regulations and site policies are complied with concerning safe working practices.

WARNING: If working at height, third parties must have received appropriate training for working at height prior to work commencing. This includes, but is not limited to, 'Working at height' and 'Using Mobile Elevated Working Platforms' training.

WARNING: If working at a height greater than 4 feet (1.2 metres) or at a height greater than that stipulated by national or site regulatory requirements, it is the responsibility of the installer to ensure that planned work complies with those requirements.

WARNING: The installer shall ensure that any third-party equipment, such as an approved platform, scaffold or lift is suitable and safe before commencing work. *Ladders or improvised platforms do not meet GE Vernova service engineer requirements.*

The minimum ambient temperature for installation and service activities is −10 °C.

Do not open the cabinet during inclement weather or when the temperature is below −40 °C.

WARNING: Before commencing any installation or maintenance work, ensure that the product is disconnected from the mains supply via the external switch or circuit breaker.

WARNING: Ensure all power sources, including relays, are de-energised as stipulated by lockout-tagout (LOTO) requirements before performing any maintenance work inside the product.

WARNING: Hazardous voltages are accessible when the door is open. Under normal use, the door can be opened to access the HMI or for service access by suitably qualified and authorised service personnel. The door shall be kept shut and locked at all other times.

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

Only GE Vernova-trained and certified personnel may commission GE Vernova products. Commissioning tasks include making any connections and/or performing any work within the product, and/or all first start-up procedures relating to equipment or firmware/software.

WARNING: All procedures in this manual must be followed. Any deviation could cause irreversible damage to the transformer being monitored and/or the product, and could lead to property damage, personal injury and/or death.

Bushing monitoring falls outside the scope of UL61010-1 and CSA C22.2 No. 61010-1 and has not been evaluated. When these products are installed in the United States and Canada, use of bushing monitoring voids the UL listing / certification of the product.

3 TECHNICAL SPECIFICATIONS

The product meets the following technical specification as outlined in Table 3-1.

Table 3-1: Measurements & Operating Specifications

BUSHING & PD MEASUREMENTS	
Input current measuring range	2 mA – 200 mA rms, 1% of reading
Relative phase angle accuracy	0.01 deg of angle
Maximum number of PD measured	200 pulses per cycle (50 to 60 Hz)
Measurement category for signal inputs	CAT III. 5 V AC rms, 200 mA; on each phase
Maximum bushing temperature at bushing adaptor	90 °C (194 °F)
ENVIRONMENTAL	
Unit operating temperature	–40 °C to 55 °C (–40 °F to 131 °F)
Bushing adaptor operating temperature	–40 °C to 90 °C (–40 °F to 194 °F) at bushing tapping point
Storage temperature	0 °C to 45 °C (32 °F to 113 °F)
Altitude	Up to 2000 m (6500 ft) above sea level
Atmospheric pressure	Up to 1050 mbar
Operating humidity	10 – 95% RH non-condensing
Enclosure	IP56, NEMA 3RX
Bushing adaptors	IP66
Weight *1	Product weight: 22.2 kg (48.9 lb) Bushing adaptor (each): 0.350 g (0.8 lb)
Pollution degree	2
POWER	
Requirements	Nominal input voltage range: 100-240 V AC, 50/60 Hz, 4 A 100-250 V DC, 4 A Input voltage range: 90-264 V AC 90-275 V DC AC frequency range: 45-65 Hz
Single phase Alarm Relays: NO and NC provided*2	10 A 250 V AC, 10 A 30 V DC, 0.3 A 110 V DC, 0.12 A 220 V DC
Over Voltage Category	II
Fuses *3	10 A 600 V AC/DC EATON KLM-10 DC distribution fuses: ▪ F1 & F2 – Schurter Series SPT 250 V DC 8 A ▪ F3-F8 – Schurter Series SPT 250 V DC 6.3 A
Coin cells	Panasonic CR2450 3 V 620 mAh
TOP OIL TEMPERATURE SENSOR	
Operating Voltage	4-20 mA
Communication	4-20 mA

*1 Note: The weight depends on the order specification. The stated weight is for a base product without packaging and excludes options such as a

mounting stand. Check the shipping document for the exact packaged weight.

[*2] Note: Maximum DC breaking capacity for a resistive load.

[*3] Note: Use only the approved and recommended fuse to ensure continued fire protection and compliance.

4 COMPLIANCE

The product is designed to meet the following type tests as listed in Table 4-1.

Table 4-1: Type Tests

CATEGORY	STANDARD	TEST
EMC Emissions EN 61326-1:2006	CISPR 11	Radiated & Conducted Emissions
	FCC Part 15	Radiated & Conducted Emissions
	IEC/EN 61000-3-2	Harmonic Current Emissions Limits
EMC Immunity EN 61326-1:2006 IEC 61000-6-5: 2015	IEC/EN 61000-4-2	Electrostatic Discharge
	IEC/EN 61000-4-3	Electromagnetic Field Immunity
	IEC/EN 61000-4-4	Electrical Fast Transients
	IEC/EN 61000-4-5	Surge Immunity
	IEC/EN 61000-4-6	Conducted RF Immunity
	IEC/EN 61000-4-8	Magnetic Field Immunity
	IECE/N 61000-4-11	Voltage Dips & Interruptions
	IEC/EN 61000-4-16	Mains Frequency Voltage
	IEC/EN 61000-4-18	Damped Oscillatory Wave
Environmental	IEC/EN 60068-2-1	Cold
	IEC/EN 60068-2-2	Dry Heat
	IEC/EN 60068-2-6	Vibration
	IEC/EN 60068-2-6	Vibration (sinusoidal)
	IEC/EN 60068-2-27	Vibration (bump, shock)
	IEC/EN 60068-2-30	Damp Heat
	IEC/EN 60529	Degree of Protection (IP56)
	UL50/NEMA	Degree of Protection (NEMA 3RX)
Safety	IEC/EN 61010-1	2010
	UL61010-1*5	
	CSA C22.2 No. 61010-1*5	

*5 Note: Bushing monitoring falls outside the scope of UL61010-1 and CSA C22.2 No. 61010-1 and cannot be included in any third-party certification for North America.

5 REQUIREMENTS

5.1 Pre-installation

To ensure success, careful planning and proper execution of the tasks outlined in this manual are essential. The regional GE Vernova Service Manager will need specific information to provide recommendations for a trouble-free installation. If GE Vernova is to perform the installation, the installation will not be scheduled until all pre-installation tasks outlined in this manual are complete (as performed by the customer and GE Vernova).

The appendices to this manual contain additional information, such as drawings, forms and checklists that need to be reviewed and completed prior to the installation. This relates to materials and facilities that need to be ordered, acquired and available well in advance of the scheduled installation date. Confirmation of this needs to reach GE Vernova as soon as possible, typically four weeks prior to the installation date unless prior arrangements have been made with the installation group. This aids in planning and supporting the installation thereby ensuring a trouble-free commissioning process. Ensure that:

- the transformer outage procedure is reviewed, practiced and facilitated by customer / host (as documented and agreed).
- safe egress, ascent and descent equipment for access to/from the transformer is available.
- all parts, tools and supplies (see Appendix A) are available and ready on the site.
- the site SCADA is tested and verified at the installation location.

5.2 Handling & Storage

The product is placed in a cardboard carton with foam pieces, sealed and wrapped in a plastic liner and shipped in a wooden crate that is bolted to a pallet. The pallets can be stacked to a maximum of three high.

It is important to take precautions prior to lifting (see Section 3 Technical Specifications for product weight details). The product shall be lifted into position using sufficient personnel or mechanical means in accordance with local regulations and company policies. The product must be lifted by the main enclosure casing — not by the door or fan as that could damage the product. Any weight more than 25 kg requires a multi-person lift.

For short-term storage (defined as less than one week), it is acceptable to store the product in the open air, provided it is protected from wet weather and direct sunlight by a suitable customer-supplied waterproof covering and

that the outside temperature does not exceed 45 °C or fall below 0 °C. For storage periods exceeding one week, customers are requested to store the product in a fully enclosed building that is free from damp and extremes in ambient temperature. The storage facility temperature should be between 2 °C and 30 °C.

Note: Customers are fully responsible for ensuring that stacked pallets are stable and, if necessary, providing additional external support. Damage incurred by improper customer handling or storage is not covered under warranty.

5.3 Location, Foundation & Clearance

The product should be located on a:

- mounting stand. If the GE Vernova manufactured mounting stand has not been purchased, a suitable stand should be constructed. See Appendix F for stand dimensions.

It is not recommended to mount the product directly on the transformer. If this method of installation is being considered, contact GE Vernova Technical Support.

- concrete foundation that can accommodate the product dimensions and take the combined distributed load of the product and its stand (see Appendix E for product dimensions). The foundation should be level and sufficiently firm to allow the stand to be bolted down.

Note: If a new concrete foundation is required, the dimensions should be at least 61 cm (24 in.) long × 122 cm (48 in.) wide × 9 cm (3 ½ in.) deep with a #3 1 cm (0.4 in.) steel reinforcing bar around the perimeter. This should be grounded and bonded in accordance with local practice and code. Consideration should also be given to increasing the size of the concrete foundation to accommodate the footprint of an additional module of the same dimensions should further functionality be required.

In addition, the chosen location must:

- allow suitable site access to transport the product to its destination.

Note: The dry weight of the product is approximately 20 kg.

- allow at least 2 m (6.5 ft.) of headroom and 75 cm (30 in.) of front clearance to allow access to the product.

not interfere with the transformer cooling system, regular maintenance activities or operation of the electrical supply disconnection device.

See Section 6 for guidance on mounting location.

5.4 Power & Cable Runs

The product requires an installation location with:

- an electrical supply of 115 V (10 A) or 230 V (10 A) nominal AC or DC
- a switch or circuit breaker so that the product can be independently de-energised

Note: The location of the switch or circuit breaker should be near the intended location of the product, within easy reach of the operator and be clearly identified with a label.

In addition, the product should be:

- sufficiently close to the transformer(s) such that cable runs from the product to the bushings are likely to be less than 25 m in length.
- within the maximum line length of the chosen communications method.

If possible, all cable runs from the intended product location to their sources should be pre-installed. All excess cabling should be removed from the area.

Coaxial cables must not be coiled (particularly inside the product enclosure) to avoid signal attenuation or interference.

See Section 7 for site layout details.

5.5 Bushing Adaptors

All coaxial cables from the Bushing Adaptors to the product cabinet *must* be run inside a protective electrically grounded metal conduit.

When installing conduit to Bushing Adaptors, ensure that the conduit drops away from the Bushing Adaptor body.

Details of recommended conduit and fittings are listed in Appendix A.

All Bushing Adaptors and HFCT cables are run into the product cabinet. Each of these coaxial cables must be properly identified using cable markers provided with the installation kit (see Appendix A) as follows:

- Cable for Set 1 (Primary) input from phase A / U / 1 / Red Bushing Adaptor: P1
- Cable for Set1 (Primary) input from phase B / V / 2 / Yellow Bushing Adaptor: P2
- Cable for Set 1 (Primary) input from phase C / W / 3 / Blue Bushing Adaptor: P3

- Cable for Set 1 (Primary) input from spare single phase Bushing Adaptor (if available): P4
- Cable for Set 2 (Secondary) input (if available) from phase A Bushing Adaptor: S1
- Cable for Set 2 (Secondary) input (if available) from phase B Bushing Adaptor: S2
- Cable for Set 2 (Secondary) input (if available) from phase C Bushing Adaptor: S3
- Cable for Set 2 (Secondary) input (if available) from spare single phase Bushing Adaptor (if available): S4
- Cable for Set 3 (Tertiary) input (if available) from phase A Bushing Adaptor: T1
- Cable for Set 3 (Tertiary) input (if available) from phase B Bushing Adaptor: T2
- Cable for Set 3 (Tertiary) input (if available) from phase C Bushing Adaptor: T3
- Cable for Set 3 (Tertiary) input (if available) from spare single phase Bushing Adaptor (if available): T4
- Cable from HFCT (single tank or single phase A, if available): N1
- Cable from single phase B (if available): N2
- Cable from single phase C (if available): N3
- Cable from spare single phase (if available): N4

The above coaxial cables are connected to the corresponding terminals inside the product cabinet, such that the central wire is routed to the core side and the braid shield wire is routed to the shield side. See Section 11.4.2.1 Connecting Coaxial Cables.

6 MOUNTING

Depending on requirements and the installation environment, the product is mounted on a separate standalone mounting stand (recommended) or direct mounted to the body of a transformer.

WARNING: Do not attempt to install the product unless the transformer is de-energised and switched off.

WARNING: Ensure that the HV and LV bushings are grounded before installation of the product.

Contact GE Vernova Technical Support before mounting the product directly on the transformer.

When considering where and how to mount the product, observe the following points to ensure an appropriate mounting arrangement:

- The product shall be lifted into position using sufficient personnel or mechanical means in accordance with local regulations and company policies. See Section 3 Technical Specifications for product weight details.
- The product must be lifted by the main enclosure casing — not by the door or fan, as this could damage the product.
- If the recommended GE Vernova mounting stand is not purchased, structurally sound weather-resistant mountings that support the weight of the product must be available (see Appendix F for dimensions). It must also be designed to be securely fastened to a flat mounting surface. Additional reinforcement and/or dampening may be necessary if local conditions (environmental or otherwise) could expose the product to potential external forces or vibration.
- The product must be mounted on a flat surface within 5 degrees of plumb and level on both axes, and the surface must support the combined weight of the product and its mounting stand (see Section 5.3 and Appendix F).
- Use adequate concrete anchors (not supplied) to anchor the mounting stand to the mounting surface e.g. three M8 threaded fasteners per leg of a recommended minimum length of 80 mm.
- The product is suitable for use outdoors but must not be mounted where it could interfere with the regular maintenance of the transformer.
- The product must not be mounted where it could interfere with the airflow of the transformer's cooling system.
- The airflow to the vent areas on the door and bottom of the product must not be blocked or restricted in any way. See Appendix E.
- At least 75 cm (2.5 ft) clearance required in front of the product to swing the front door open and gain access to the product during installation, maintenance or operation.

- It is acceptable to mount the product to the body of a transformer that is exhibiting normal operational levels of vibration, if
  - care is taken to ensure a level and secure mounting arrangement;
  - the product is mounted within 5 degrees of plumb and level on both axes;
  - the product is mounted in such a way as to support the total weight of the product;
  - the product is mounted at a height that is accessible from ground level without ladders or platforms for operation and service purposes;
  - the product is mounted to an area of the tank body with minimum vibration, such as close to a corner or the stiffeners.
- If there is concern about vibration on a transformer, GE Vernova strongly advises against mounting the product to the body of a transformer. Furthermore, should damage occur to the product that is attributable to the mounting arrangement and/or excessive transformer vibration, such damage will not be covered under warranty. Care should always be taken to ensure that damage does not occur to the transformer or the product during installation or operation.
- The chosen location should take account of the potential requirement for testing an onsite water deluge system (if applicable), such that the product is not located in the direct line of water jets. While the product provides IP56 / NEMA 3RX-rated water spray protection, a water deluge system could exceed these thresholds depending on the location, pressure and direction of the water jets. See the BMT 430 Operator Guide for further recommendations around testing a water deluge system.
- An optional sun canopy provides effective solar shade for the product in environments with intense sun exposure. See Appendix G for drawings and dimensions.

7 SITE LAYOUT

Figure 7-1 illustrates the general site layout for the product with the required connections for a single transformer. See Section 6 for guidance on mounting location.

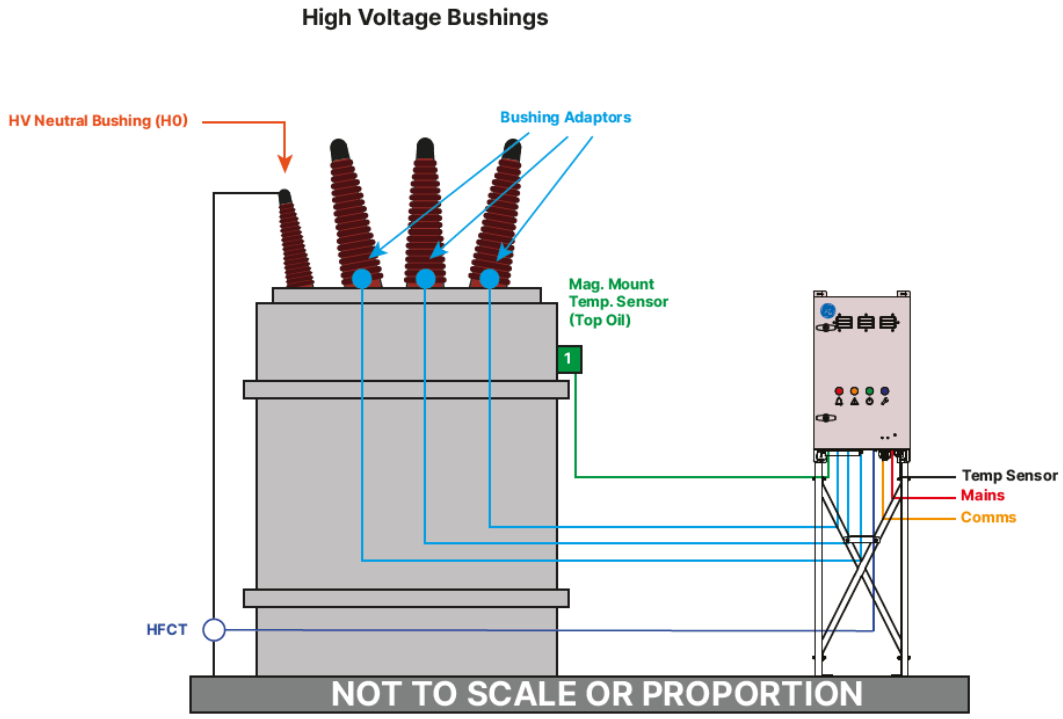


Figure 7-1: General site layout - single transformer

Figure 7-2 illustrates the general site layout for the product with the required connections for a bank of three single phase transformers.

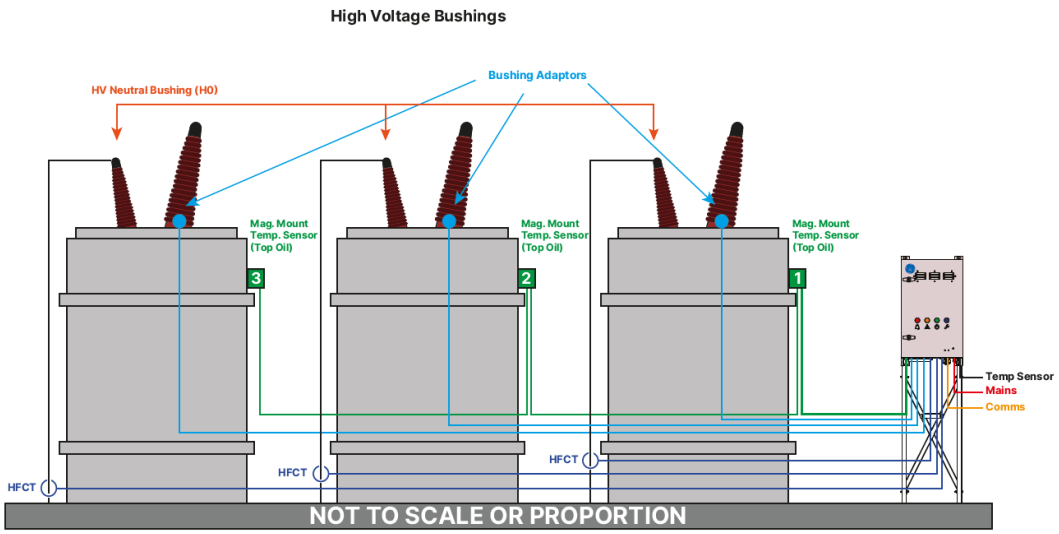


Figure 7-2: General installation layout - Bank of three single phase transformers

The product is supplied with factory default settings for all parameters, e.g. alarm thresholds. For optimal performance, specific settings are required for each installation. See Section 13.2 for Commissioning & Configuration details.

8 POWER

This section outlines the power requirements, electrical installation connections and related aspects that must be observed.

A suitable circuit meeting the technical specification requirements must be available for the product at the time of installation. Installation must be done in accordance with local wiring regulations.

Ensure that the mains power of the product is connected to a circuit that is continually on to ensure its continuous operation.

Disconnection is through an external switch or circuit breaker that must be installed on the mains supply line where it is visible from the product, easily accessible and clearly identified as the disconnect device for the product. It shall be rated at 10 A minimum 250 V AC minimum and be approved to IEC60947-1, IEC60947-3 or other standard required by local regulations.

Before commencing any installation or maintenance work, ensure that the product is disconnected from the mains supply via the external switch or circuit breaker.

All wires and cables leading to or from the product are made through four conduit connectors on the base of the product as shown in Figure 8-1. Typically, the mains wiring routes through the 20-mm conduit connector, while wiring for communications and sensors route through the other conduit connectors.

Unused conduit connectors shall be sealed. Conduit connectors may be replaced, if necessary.

Note: Depending on product options or enhancements, the installer may choose alternative routing arrangements.

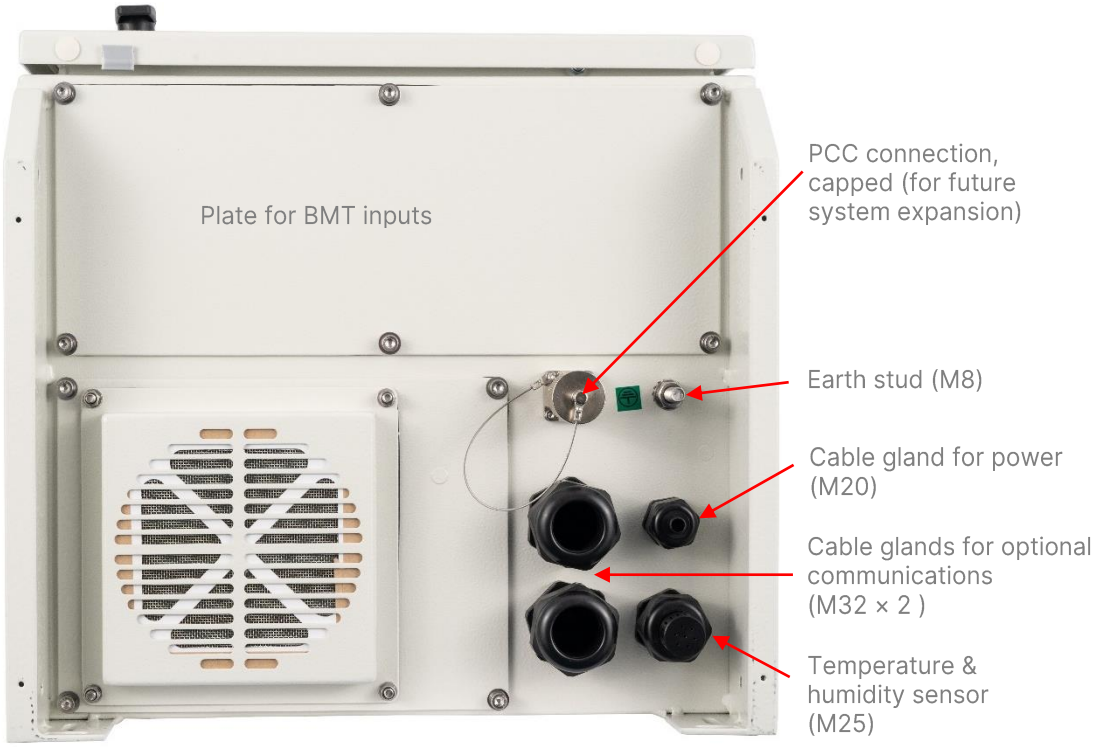


Figure 8-1: Base plate connections

8.1 Earth

The product has an M8 safety earth stud located on the bottom of the enclosure as shown in Figure 8-2. To ensure continued safety and EMC compliance, this must be connected to earth ground in accordance with local wiring regulations using at least 6 mm^2 (10 AWG) wiring.

Figure 8-2: Position of primary protective earth bonding lug

First connect the protective earth conductor to the earth protective conductor terminal, which is adjacent to the fuse holder on the DIN rail as shown in Figure 8-3.

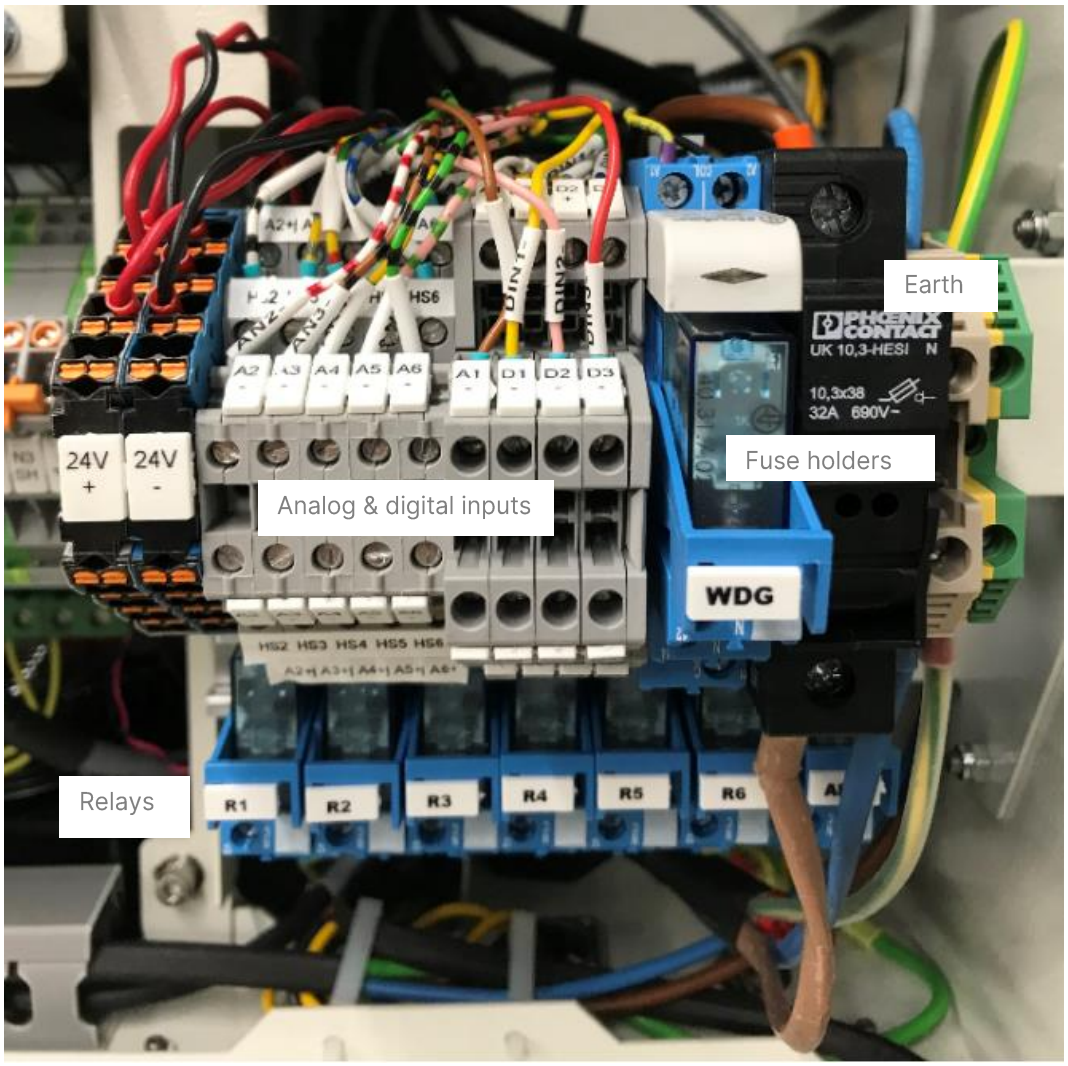


Figure 8-3: Earth adjacent to the fuse holders

8.2 Input Power

The power supply terminals for the mains supply and the modular fuse holder are shown in Figure 8-4.

Note: Depending on requirements, 24 V +/- wetting terminals can also be added leftmost (not shown).

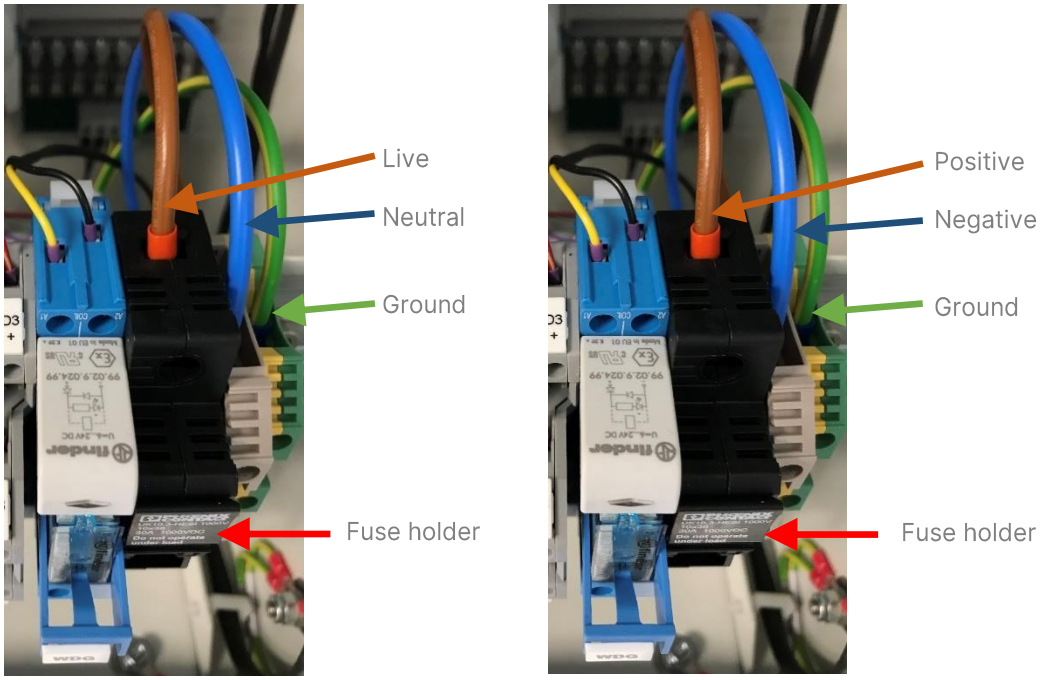


Figure 8-4: AC power (left) & DC power (right)

To ensure a safe connection to the power supply, follow these steps:

- An external switch or circuit breaker must be installed on the source near to the product and within easy reach of the operator. It should be clearly labelled as the disconnecting device for the product.
- Fuses and circuit breakers must be installed in accordance with the local and/or national wiring regulations.
- Ensure that the external switch or circuit breaker has been turned off before accessing internal components.
- Only use cables rated at 75 °C minimum for the installation.
- Ensure that the mains supply is de-energised. Route the mains supply cable through the 20-mm cable gland on the bottom of the product to the product fuse holder (see Figure 8-4).
- The outer sheath of the mains supply cable shall continue into the equipment as far as possible, so that reinforced insulation is maintained between the operator and the mains supply.
- *All* cables entering the cabinet should have at least 150 mm (6 in.) of excess length to allow for cable strain relief.
- The mains supply shall be connected so that the protective earth wire is the last wire to take the strain and break free in the event of the cord being pulled.
- Tighten the cable gland to secure the cable.

Note: Refer to the local/national wiring requirements to determine the gauge and length for the power supply wiring.

8.3 DC Distribution

The internal DC distribution block is as shown in Figure 8-5 and is fitted to the DIN rail on the back wall of the product as shown in Figure 8-6.

Figure 8-5: DC block

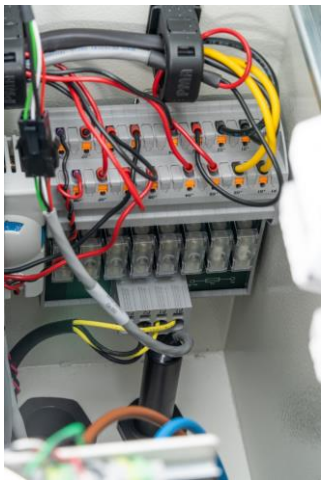


Figure 8-6: DC block fitted

The DC distribution block terminals are:

- F1 - F2: 5 x 20 mm T8 250 V: For future expansion only
- F3: 5 x 20 mm 6.3 AL 250 V fuse: Spare for customer use.
- F4-F8: 5 x 20 mm 6.3 AL 250 V fuse: For internal electronics.

9 CONTROL & COMMUNICATIONS

Prior to product use, ensure that the battery insulator tab for the coin cell battery is removed to ensure the availability of backup power for the host RAM. The tab is located on the controller card.

The product as shown in Figure 9-1 contains all the connectivity required for monitoring bushings and PD.

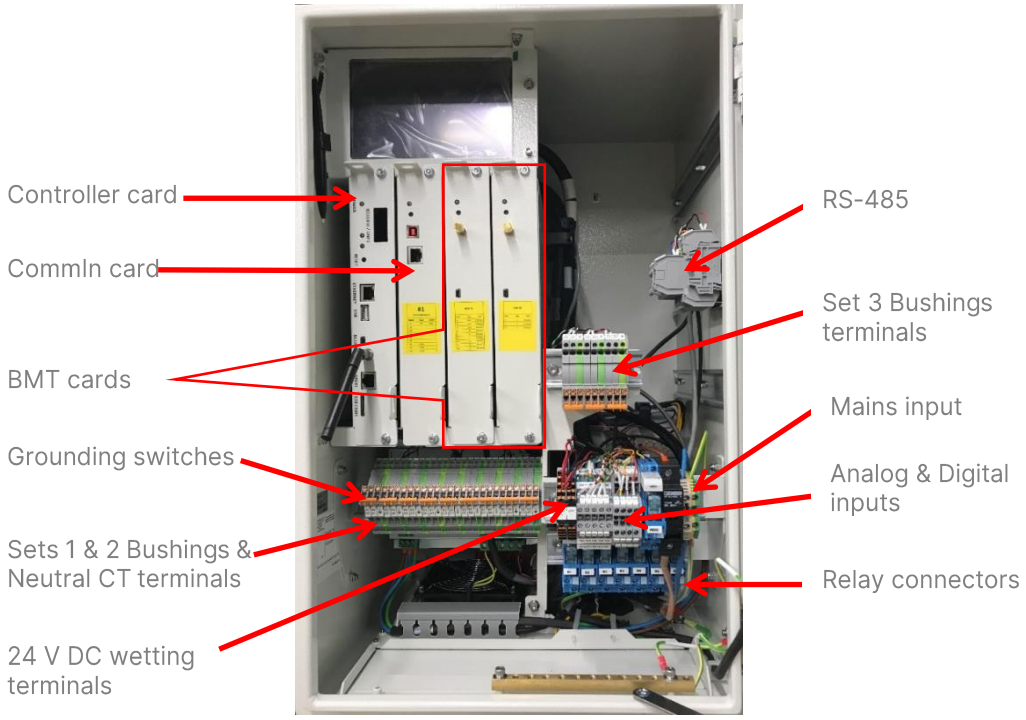


Figure 9-1: Product configuration for nine bushings

The product has four bays for PCB cards as shown in Figure 9-2. From left to right, the first bay houses the Controller card as described in Section 9.1. The second bay houses the Communications In (CommIn) card as described in Section 9.2. The remaining two bays can each house a BMT card as described in Section 9.3 depending on the number of bushings to monitor. The product can monitor up to nine bushings with two BMT cards. A blank faceplate denotes an unused bay (depending on the configuration).

Figure 9-2: Card faceplates

The product is supplied with factory default settings for all parameters, e.g. alarm thresholds, but precise commissioning steps must be followed as defined in Section 13. For all other operational details relating to the software interface for configuration, bushing settings, data readings and alarms, refer to the 'MA-044 - BMT 430 Operator Guide'.

Note: All cabling, communications and sensor wiring that lead into or out of the product are made through the cable glands at the base.

9.1 Controller Card

The Controller card is mounted vertically in the first bay and communicates data using a variety of communication protocols. All external (customer) connections are located on the faceplate as shown in Figure 9-3 with internal (system) connections at the rear. Depending on the customer configuration, typical connections include Ethernet, USB type A, USB OTG (Mini-B) and optional IEC 61850 / DNP3.0.

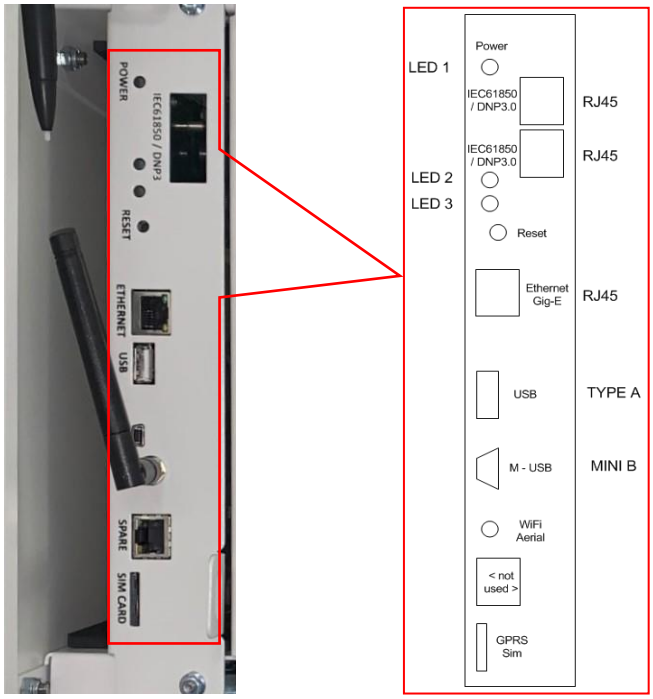


Figure 9-3: Controller card faceplate

Other Controller card features are listed in Table 9-1.

Table 9-1: Other Controller card features

LED	Label	Description
LED 1	Power (green)	+24 V Power
LED 2	On (blue)	Host heartbeat – flashing blue denotes a correct boot sequence and normal operation
LED 3	Boot (red)	Host fault – solid red denotes a fault or boot loader issue
-	Reset	Recessed soft reset button
-	Battery	3.3 V Coin cell for backup power for the host RAM

9.2 Communications In (CommIn) Card

The CommIn card is mounted vertically in the second bay (from the left) as shown in Figure 9-4 and provides a communications interface between the customer equipment and the Controller card. The respective cards are supplied with the relevant sensors (unless otherwise stated/requested) and these cards receive the sensor data and process it according to advanced algorithms.

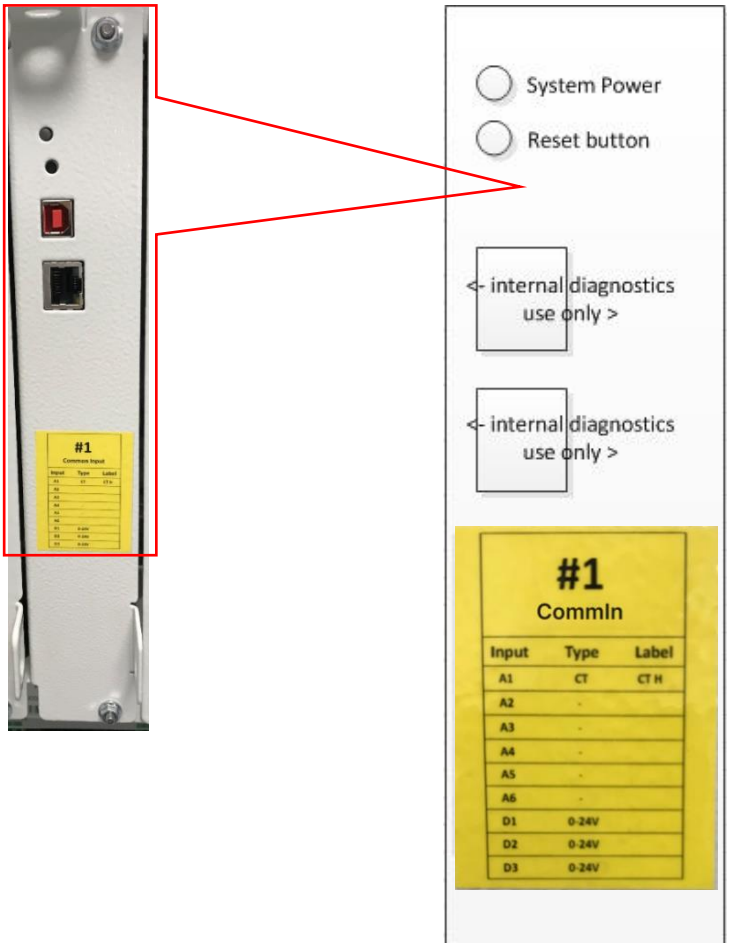


Figure 9-4: CommIn card faceplate

The CommIn card takes analogue and digital feeds from the various optional analogue and digital sensors (4-20 mA, RTD and/or CT). It supports up to six analogue inputs (five of which can be customer configurable) and up to three digital inputs. A label on the card faceplate indicates the installed options. In this example, a CT has been fitted to Analogue Input 1. The board also features a power status LED and recessed reset button.

9.3 BMT card(s)

BMT card(s) are mounted vertically in the remaining bay(s) depending on the desired configuration as shown in Figure 9-5. BMT cards monitor 3, 6 or 9 bushings and partial discharge activity.

BMT #1

Input	Type	Label
P1	LF/HF	P1 Bushing
P2	LF/HF	P2 Bushing
P3	LF/HF	P3 Bushing
S1	LF	S1 Bushing
S2	LF	S2 Bushing
S3	LF	S3 Bushing
N1	HF	Neutral CT1
N2	HF	Neutral CT2
N3	HF	Neutral CT3

Figure 9-5: BMT cards (BMT#1 & BMT#2)

The card features a power status LED and recessed reset button. To determine which configurable BMT inputs have been installed, see the label on the card faceplate.

10 ANALOGUE & DIGITAL CONNECTIONS

10.1 Overview

The product offers a series of field connection terminals for analogue and digital feeds as summarised in Figure 10-1.

Note: These passive interfaces don't supply a voltage to the connected device, so all connected devices must be powered independently.

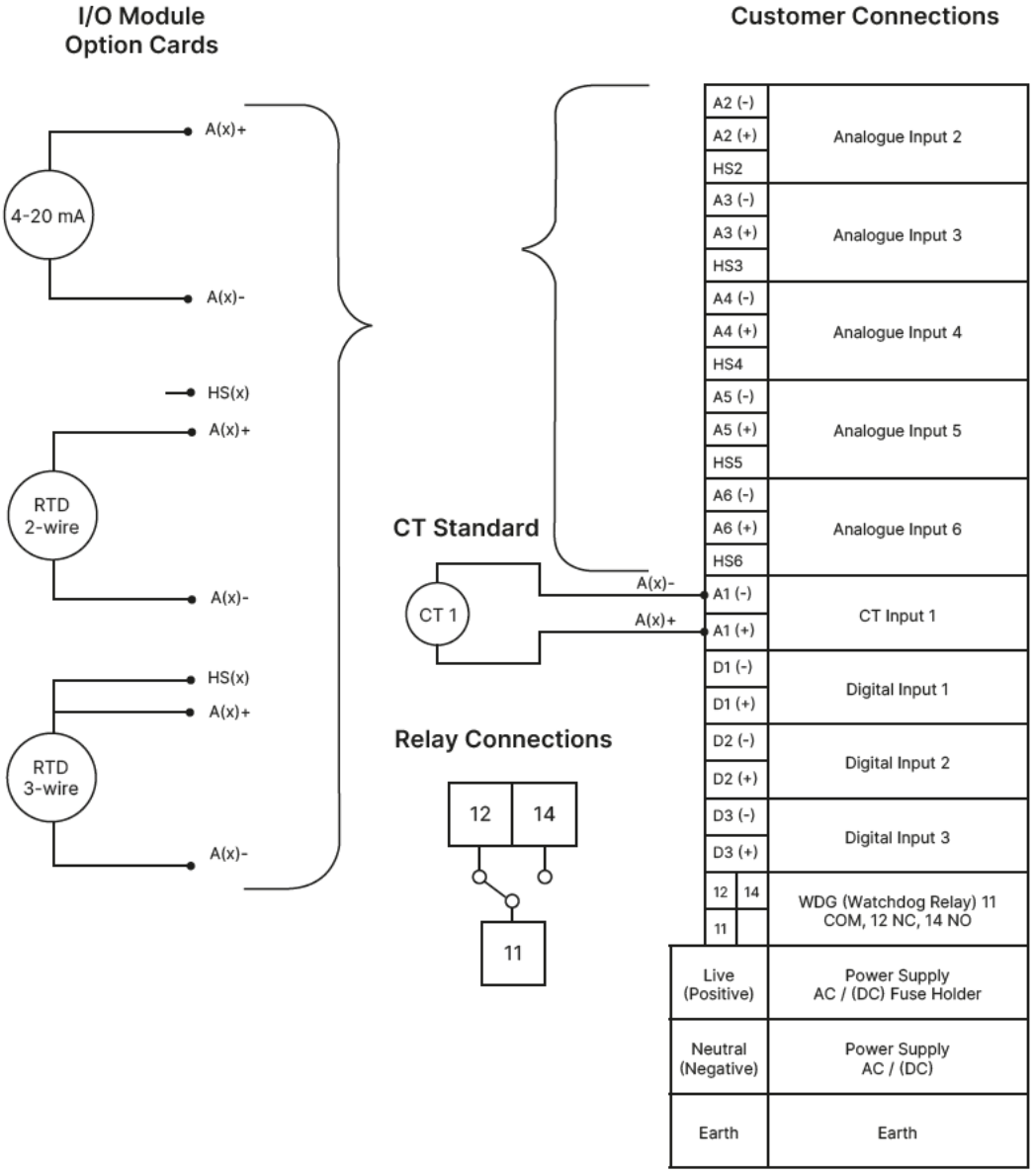


Figure 10-1: Customer Connections Overview

Note: Depending on requirements, 24 V +/- wetting terminals can also be added. Wetting terminals accept up to 24 V DC connections with a cable cross section of 0.14 mm² to 2.5 mm², AWG: 14 – 26.

To determine which configurable analogue inputs have been installed, see the label on the card faceplate, for example, as shown in Figure 10-2. In this example, a CT has been fitted to A1, but A2 to 6 are empty.

Figure 10-2: CommIn card faceplate label - example

Current Transformers (CTs), resistance temperature detectors (RTDs), 4-20 mA analogue signals and relays are wired as shown in Figure 10-3 to Figure 10-5.

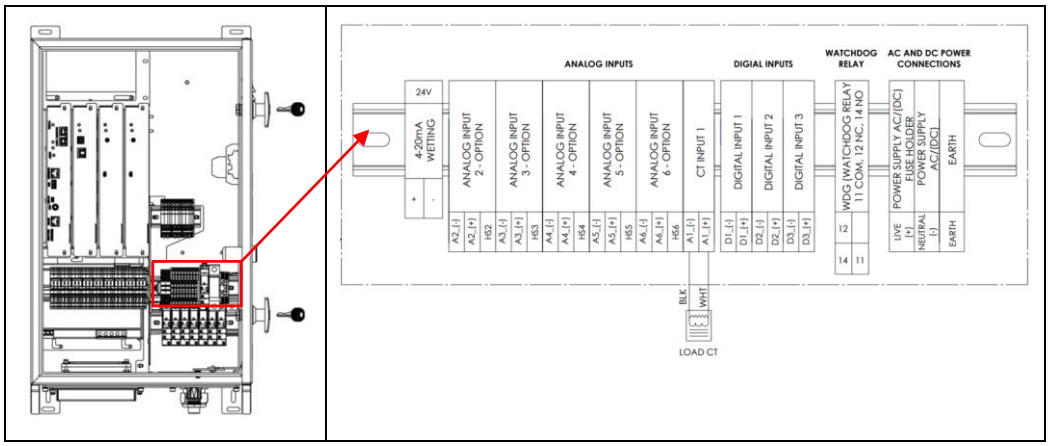


Figure 10-3: Connections – analog & digital inputs, watchdog & power

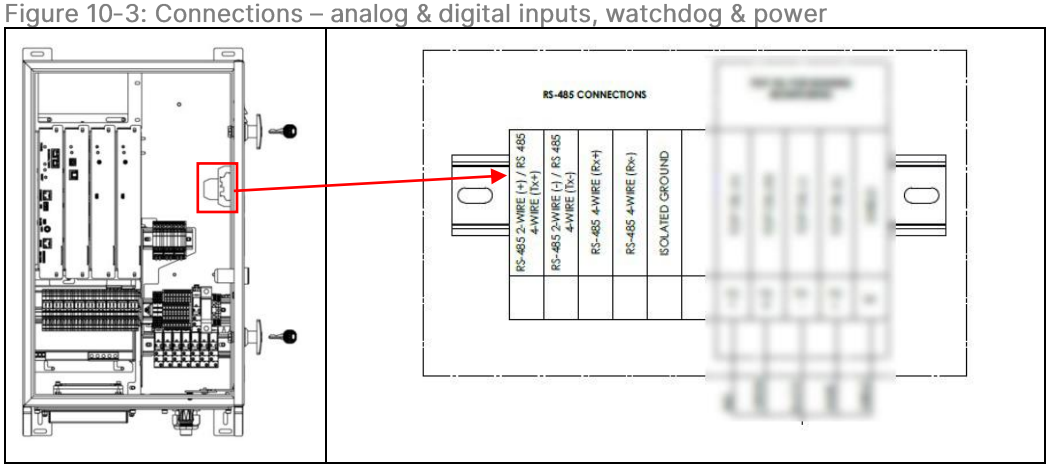


Figure 10-4: Connections – comms

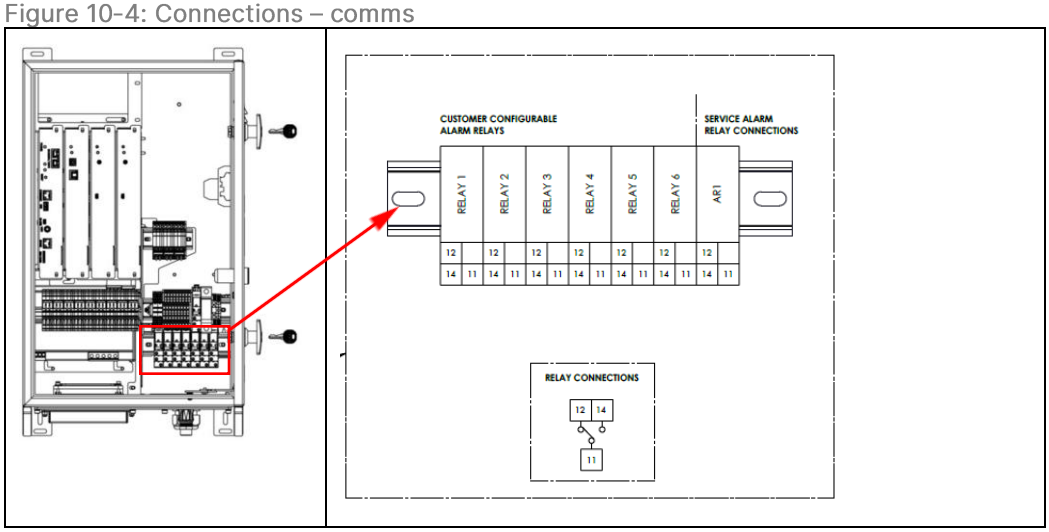


Figure 10-5: Connections – relays

10.2 Terminations

Analogue termination is as shown in Figure 10-6. Six analogue inputs are supplied at A1 to A6.

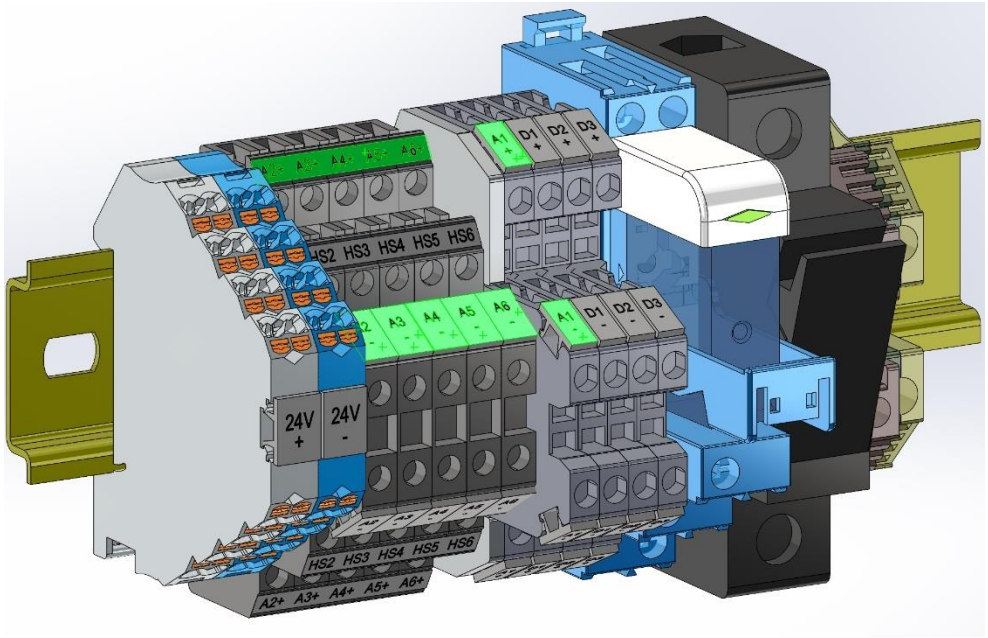


Figure 10-6: Analogue customer terminals 1-6 highlighted (also showing optional 24 V +/-)

Digital termination is as shown in Figure 10-7. Three digital inputs are supplied at D1 to D3. Digital inputs are polarised and the positive supply must be connected to the D+. Max Current: 25 mA, Max Voltage: 24 V.

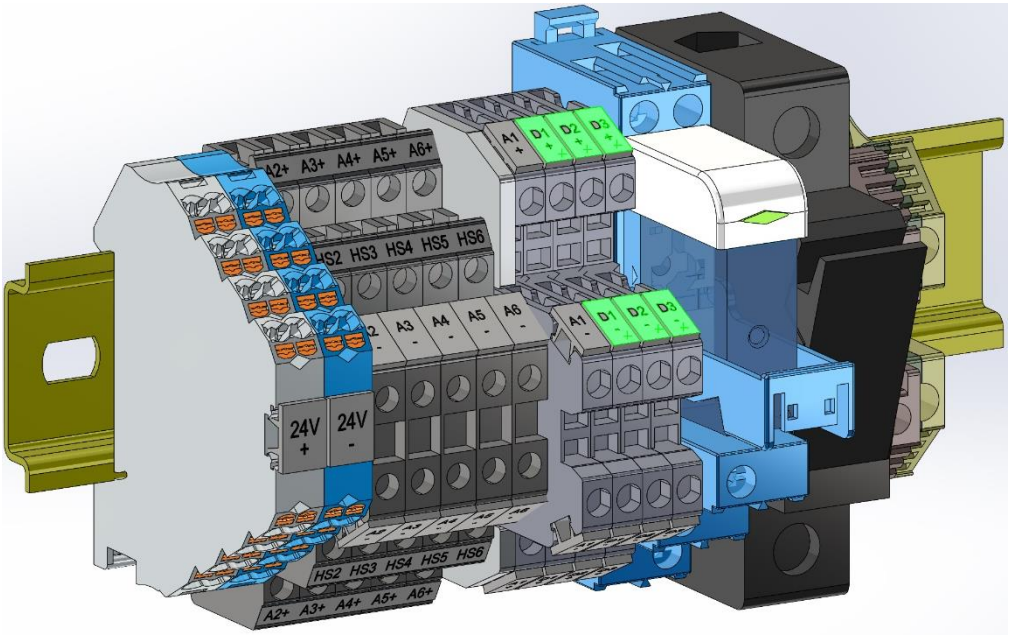


Figure 10-7: Digital customer terminals 1-3 highlighted (also showing optional 24 V +/-)

The minimum and maximum sizes for analogue and digital inputs wiring are listed in Table 10-1.

Table 10-1: Inputs wiring sizes

Type	Min (mm^2)	Max (mm^2)	Min (AWG)	Max (AWG)	Length (mm)
Solid	0.14	4	26	10	8
Flexible	0.14	4	26	12	8

Note: If used, crimp terminals shall be installed in accordance with the crimp manufacturer's instructions.

10.3 Analogue Input 4-20 mA

There are two types of 4-20 mA sensor. A passive sensor uses a two-wire configuration with the voltage in the loop powering the sensor. For example, the magnetic mount temperature sensor is configured in this manner.

An active sensor requires a separate power supply, so uses a four-wire configuration. This wiring option is used where the sensor already exists with two outputs or if the 4-20 mA is being generated by another instrument or controller.

The 4-20 mA analogue input can be wired directly to the relevant terminals as A2+ to A6+ (positive) and A2- to A6- (negative) as illustrated in Figure 10-8. See Figure 10-6 for the terminal locations and the card faceplate label for the supplied input configuration. Current: 4-20 mA, Max Voltage: 24 V

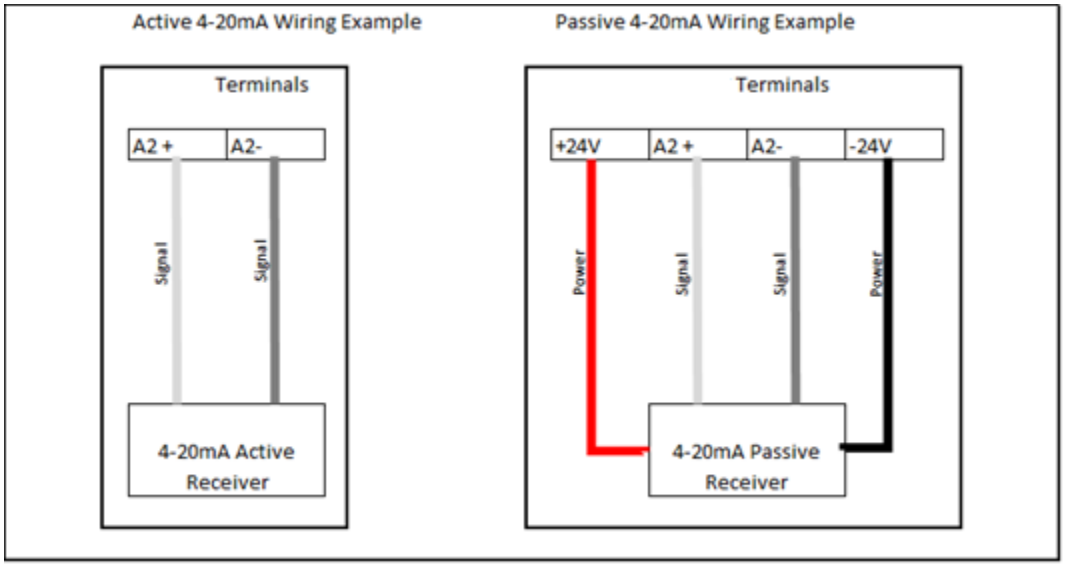


Figure 10-8: Analogue Input 4-20 mA examples - Active wiring (left) & Passive wiring (right)

Note: If a screen is present on the cable transmitting the current signal from the sensor to the BMT 430, it should be connected to the grounding bar within the product.

10.4 Resistance Temperature Detector (RTD) Input

The RTD is an optional card that is wired with a PT100 temperature sensor and is shown schematically in Figure 10-11.

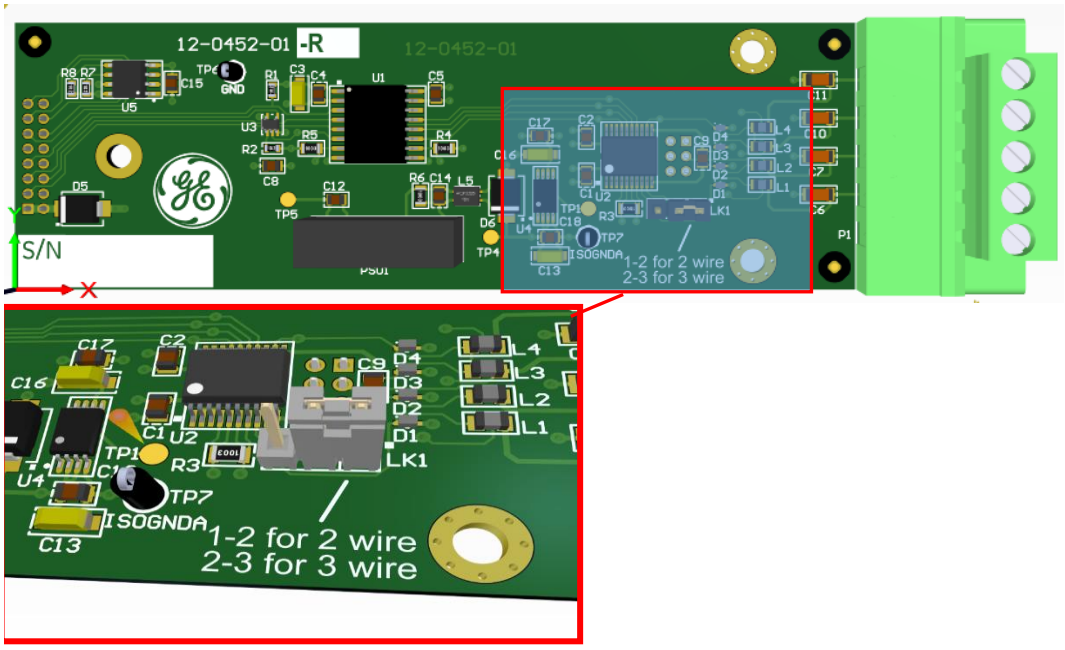


Figure 10-9: RTD PCB schematic

Figure 10-12 shows an example of an RTD module mounted on a CommIn card with a wire link in place.

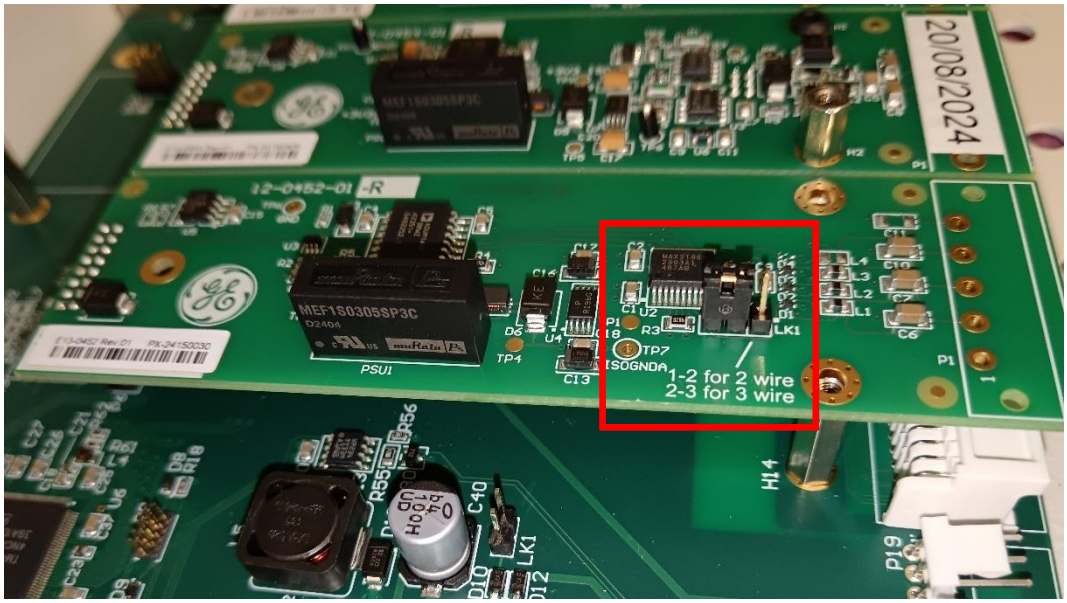


Figure 10-10: RTD PCB with wire link mounted on a CommIn card

Note: 4-wire is not supported.

A 2-wire or 3-wire RTD can be wired to the analogue terminals as outlined below.

10.4.1 RTD 2-Wire

The 2-wire requires either a wire link to be fitted between positions 1 and 2 at LK1 on the RTD PCB (E13-0452-*xxx*) as shown in Figure 10-11. The default position is 1-2 (for 2-wire as shown in Figure 10-11 rightmost).

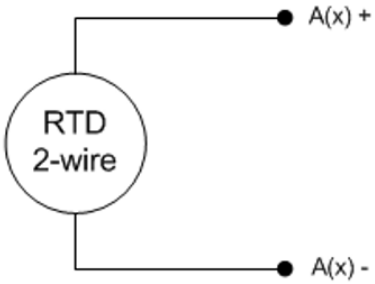


Figure 10-11: RTD 2-wire (link on rightmost pins 1-2)

Note: 'x' denotes the relevant input terminal.

10.4.2 RTD 3-Wire

For 3-wire operation, either the link (LK1) needs to be moved from position 1-2 (default on 2 wire above) to position 2-3 (for 3 wire) on the RTD PCB (E13-0452-*xxx*), or as shown in Figure 10-12 (leftmost) where the current connects to the DIN rail terminals A+ (positive) of the relevant input and the Common connects to the A- (negative) of the relevant input. A compensation Lead connects to HS(x).

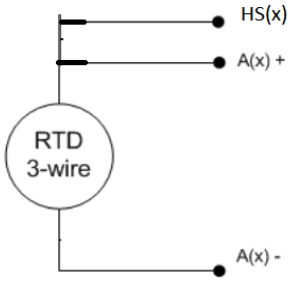


Figure 10-12: RTD 3-wire (link on leftmost pins 2-3)

Note: 'x' denotes the relevant input terminal.

10.5 Current Transformer (CT) Load Sensor

The transformer load sensor is used to measure and record the transformer load. A split core CT with an inbuilt burden as shown in Figure 10-13 is provided in the product installation kit. The CT clamps over a cable, snapping around the centre conductor to measure the current passing through. A CT with a burden provides a voltage that is proportional to the measured current.

Figure 10-13: Split core CT

The transformer load sensor can be installed unobtrusively around a CT line receiving a feed from the main bushing secondary wiring (usually located within the marshalling / control cabinet of the transformer).

It should be possible to locate a suitable current transformer with a 0 – 5 A secondary circuit on which to mount the sensor. The sensor is supplied with 2.5 m (100 in.) of cable and may be spliced to the required length to connect to the product with up to a total of 10 m (33 ft) of 20 AWG twisted pair cable. Longer cable lengths are possible depending upon the quality of the cable.

The load sensor always connects directly to the terminal A1+ and A1-, as highlighted previously in Figure 10-6 above.

10.6 Relays

The product offers a series of relays as shown in Figure 10-14 to service various alarm conditions. All relays supplied provide field termination for NO, NC and Common connections. See Section 3 for Technical Specifications and Figure 10-1 for an overview to the customer connections. Relay identification is shown in Figure 10-14 and relay terminal connections are shown in Figure 10-16.

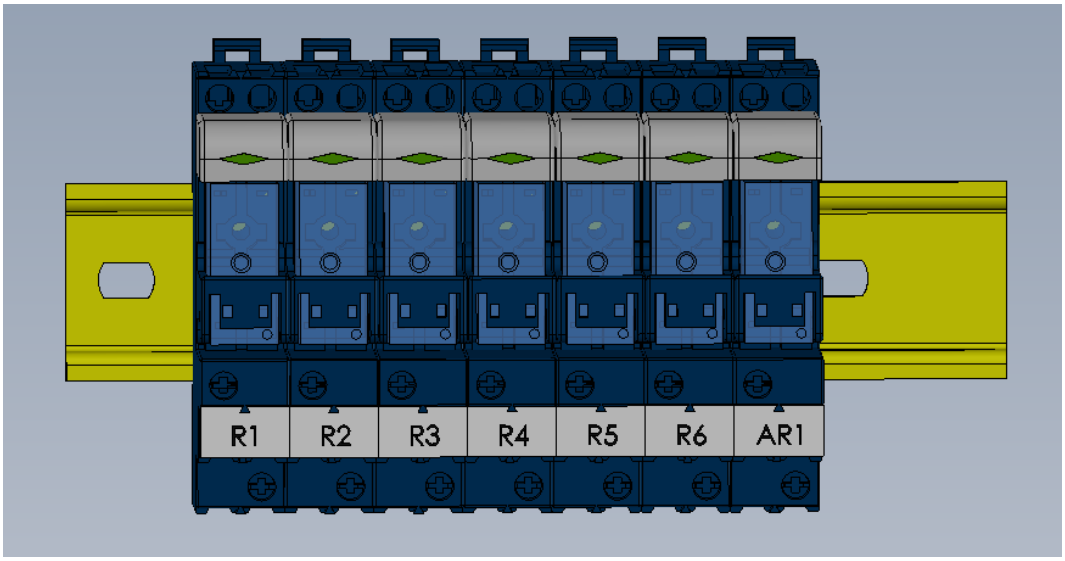


Figure 10-14: Relay identification

The minimum and maximum sizes for relay wiring are listed in Table 10-2.

Table 10-2: Relay wiring sizes

Type	Min (mm^2)	Max (mm^2)	Min (AWG)	Max (AWG)	Length (mm)
Solid	0.14	6	26	10	8
Flexible	0.14	4	26	12	8

10.6.1 Watchdog

The Watchdog relay as shown in Figure 10-15 is designed to monitor the voltage output from the PSU. If there is a 10% drop in voltage output, the watchdog relay is de-energised alerting the customer of a power supply issue. Watchdog relay wiring termination is shown in Figure 10-1.

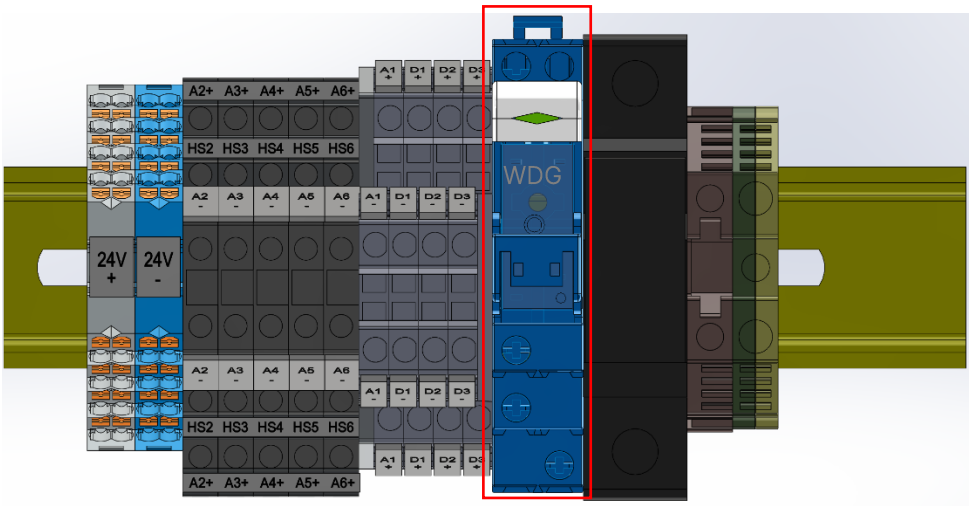


Figure 10-15: Watchdog (WDG) termination highlighted (also showing optional 24 V +/-)

Note: The PSU has its own relay contact that the watchdog relay monitors.

10.6.2 Alarms

Alarm relays are wired as shown in Figure 10-16.

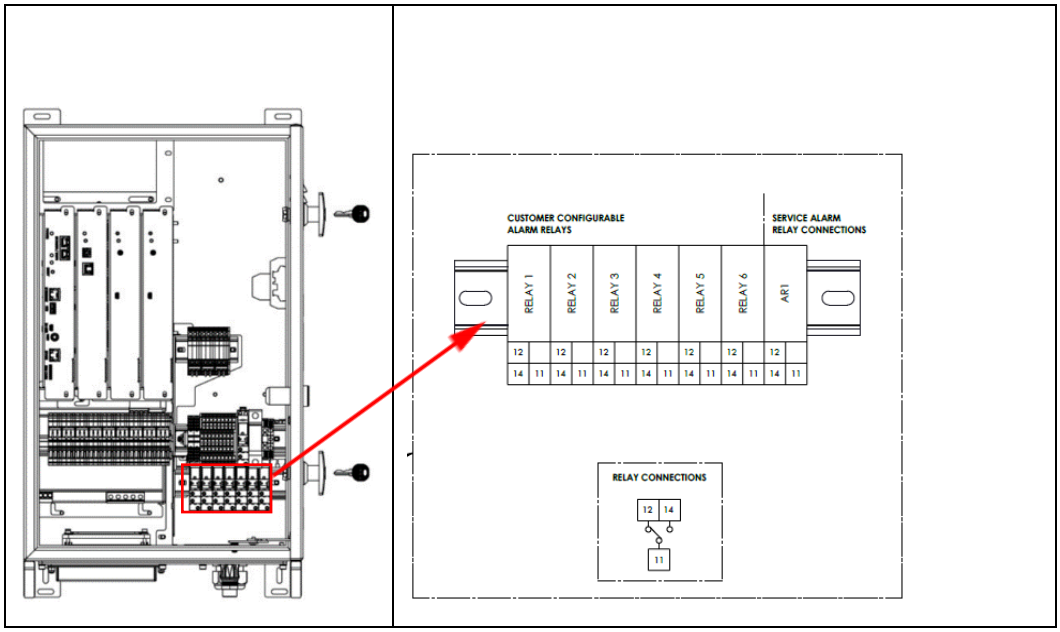


Figure 10-16: Relay terminal connections

These relays can be used to drive a hardware alarm e.g. control room light, klaxon etc. The precise alarm conditions to activate each of the relays are configured during commissioning. See the MA-044 - BMT 430 Operator Guide for more details on software configuration.

The rating of each relay is 10 A 250 V AC, 10 A 30 V DC, 0.3 A 110 V DC, 0.12 A 220 V DC.

If connecting external alarms to these relays, route the cables though one of the available cable glands.

Note: Only use cables rated at 75 °C minimum for the installation.

10.7 Ambient Sensor

The ambient temperature and relative humidity sensor is fitted in the factory to the M25 gland as shown in Figure 10-17 and Figure 10-18.


Figure 10-17: Base plate with sensor location


Figure 10-18: Sensor - closeup

11 EQUIPMENT INSTALLATION

A list of parts, tools and supplies required for the product installation is given in Appendix A. Appendix B lists a customer checklist. Appendix C requests customer and site contact details. Specific preparation of the coaxial cables is described in Section 11.4.2.1.3.

11.1 Magnetically-Mounted Temperature Sensor(s) (MMTS)

The MMTS magnetically mounts to the side wall of the transformer to measure the top oil temperature of the main tank. The default offering is a 4-20 mA MMTS, but the product also supports a CANbus MMTS (see Appendix D).

The top oil MMTS should be installed in a vertical position on one of the long sides of the transformer, typically between 20-30 cm from the top, and horizontally in the middle.

If working at heights is required during the product installation, it is the responsibility of the installer to ensure that:

- planned work complies with national and site regulatory requirements.
- third-party equipment is suitable and safe before commencing work.
- third parties have received appropriate training for working at height. This includes, but is not limited to, 'Working at height' and 'Using Mobile Elevated Working Platforms'.

The Thermal Compound and Silicone Safety Data Sheet guidelines must be followed.

At installation, the MMTS should be oriented with the cable gland pointing down. This will minimise the risk of water ingress to the sensors.

To install the MMTS on a transformer:

- Apply a liberal amount of thermal compound (Wakefield Engineering Thermal Joint Compound 120 series, GE Vernova P/N: CONS01026) on the metal probe located in the centre as shown in Figure 11-1. Note: A lack of thermal compound degrades sensor performance.
- Apply RTV silicon sealant around the edge of the MMTS. This helps keep out moisture and aids in the adhesion. Note: RTV silicon is not supplied with the product.

Route the cable from the MMTS(s) to the product, cutting as required. See Section 5.5 for wiring details.

Due to the inability to reach the MMTS(s) once the transformer is energised, communication with the sensor must be tested before the transformer is switched on (if power to the product is available). Refer to the Measurement section of the 'MA-044 - BMT 430 - Operator Guide' and check that the Field Sensors Error for Top Oil is not increasing by 1 every second and that the respective temperatures in the Field Sensors are within the expected range.

Ensure that the label number of the MMTS matches the phase / transformer to which it is mounted. For top oil mappings, refer to Section 6.6.1 General Settings in 'MA-044 - BMT 430 - Operator Guide'.

11.1.1 4-20 mA MMTS

Up to three 4-20 mA MMTS as shown in Figure 11-1 are supported and are useful where the distance exceeds 230 m. Note: A 4-20 mA MMTS is powered separately and cannot be daisy chained.

Figure 11-1: 4-20 mA MMTS (rear & front)

Table 11-1 lists the specification details for a 4-20 mA MMTS.

Table 11-1: 4-20 mA MMTS specification

Item	Value
Enclosure	Plastic cylindrical housing
Output	4-20 mA
Wiring	12 m (40 ft) twisted, shielded pair 22 AWG & thermal compound
Operating temperature	−40 °C to 150 °C (−40 °F to 302 °F)
Size	5.7 × 4.7 cm (2.25 × 1.87 in.)
Weight	230g (8 oz) excluding wire 300 g (11 oz) including wire
Power Requirements	24 V DC

See Section 10.3 for Analogue Input 4-20 mA wiring details.

Figure 11-2 provides an illustration of the 4-20 mA MMTS mounting arrangement with dimensions.

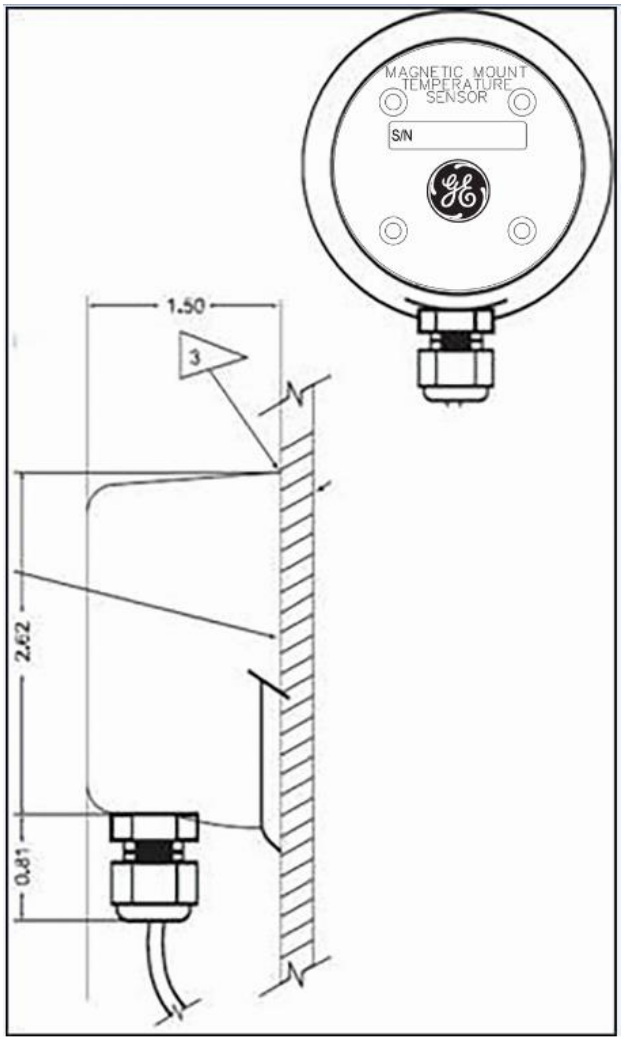


Figure 11-2: 4-20 mA illustration

An overview to the fitting of a 4-20 mA MMTS to the tank wall is shown in Figure 11-3.

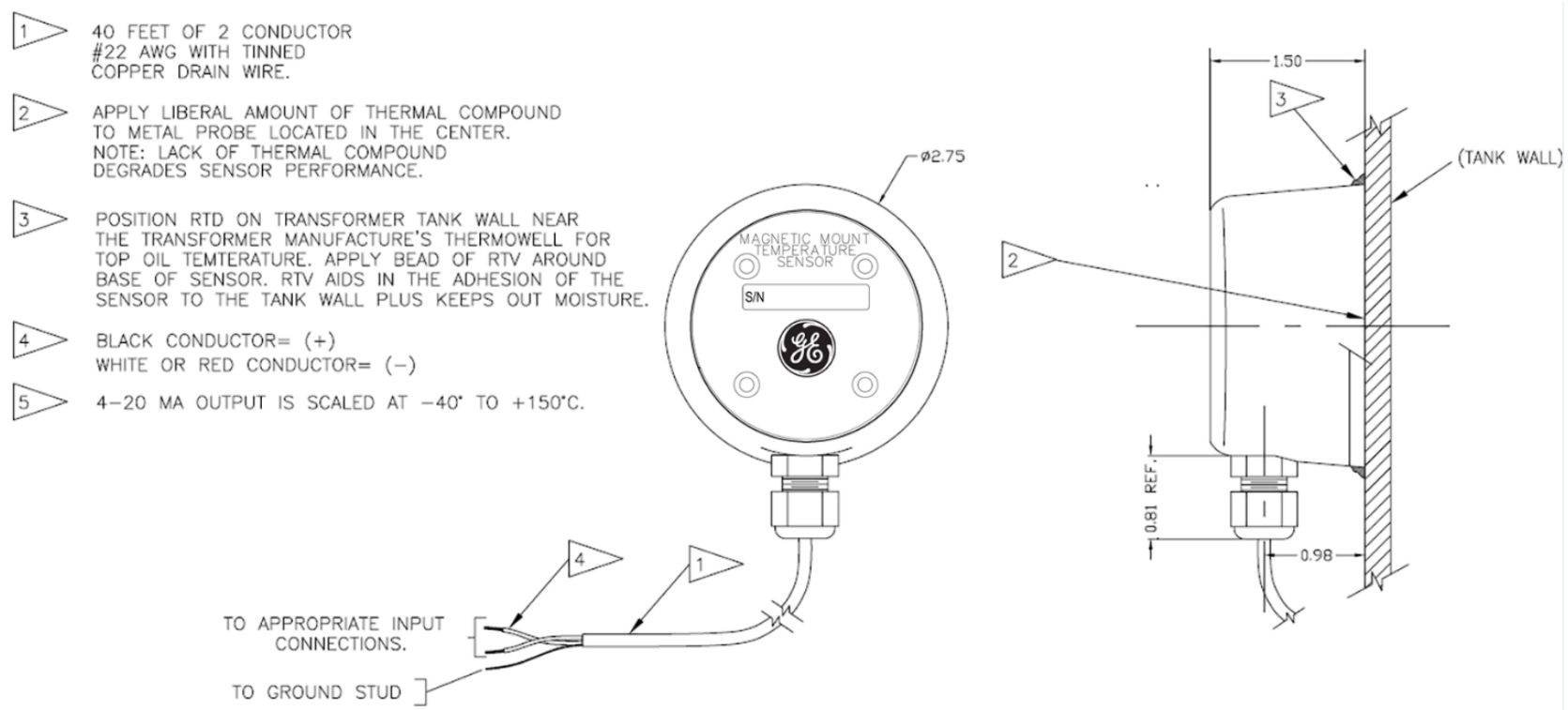


Figure 11-3: 4-20 mA MMTS installation overview

11.2 Neutral HFCT

An HFCT as shown in Figure 11-4 (if to be fitted) is specific to the transformer connection point (as provided in the pre-installation information). Note: The arrow on the HFCT must point towards earth.

Figure 11-4: HFCT

Fit the HFCT clamp to the neutral ground connection as shown in Figure 11-5. To minimise noise, the HFCT should be installed as close to the High Voltage Neutral bushing as possible, provided there is no switch on the path to ground.

Preparation of the coaxial cables is outlined in Section 11.4.2.1.3 and 11.4.2.1.6.

WARNING: The HFCT must be installed on a ground cable or bar going from the high voltage neutral bushing (typically identified as H0) directly to ground. There must not be any open switches between the path to ground from the neutral bushing while the transformer is energized.

WARNING: Prior to any test that requires the removal of the transformer neutral ground, any installed HFCT must first be removed. Replace the HFCT after the transformer ground has been reconnected.

Figure 11-5 and Figure 11-6 show the correct installation of the HFCT.

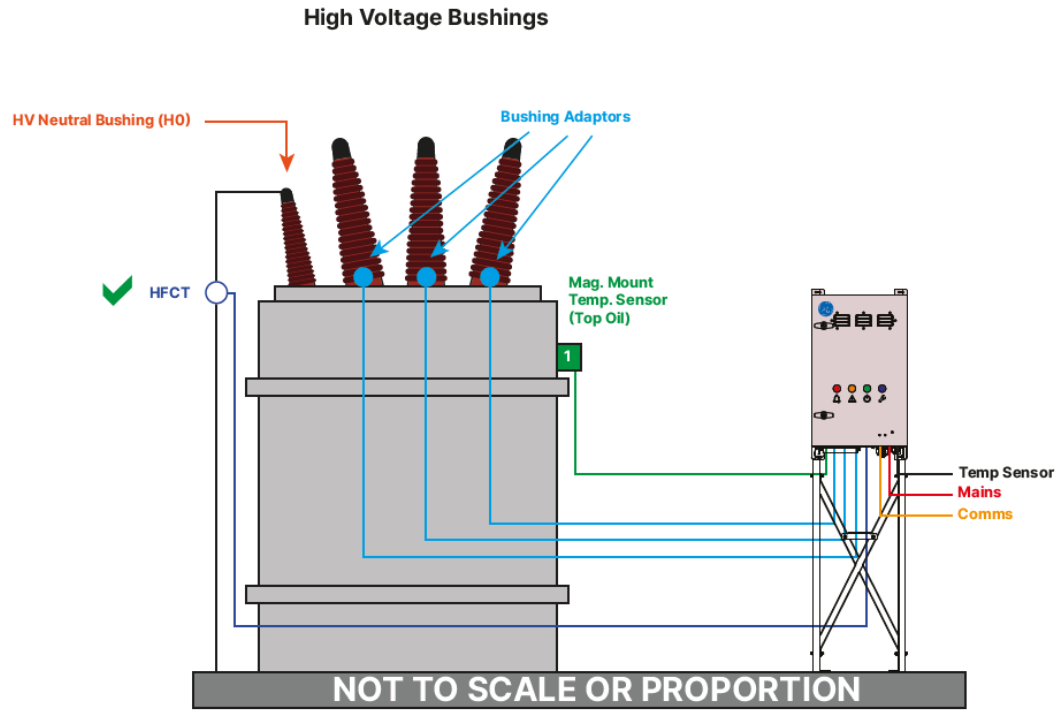


Figure 11-5: HFCT installed on cable from Neutral Bushing (H0) directly to ground

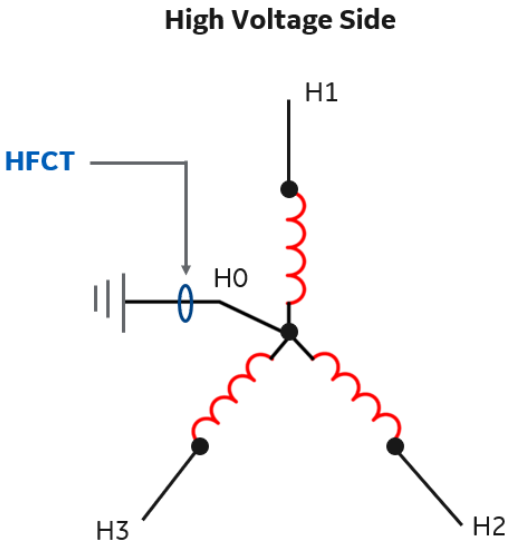


Figure 11-6: Star configuration (Y- Connection)

Similarly, in Figure 11-7, the HFCT can be installed after the switch. However, if the switch is opened, the path to ground will be interrupted and the HFCT will have no effect, meaning PD polarity discrimination would be nonexistent.

Note: PD monitoring would still be available.

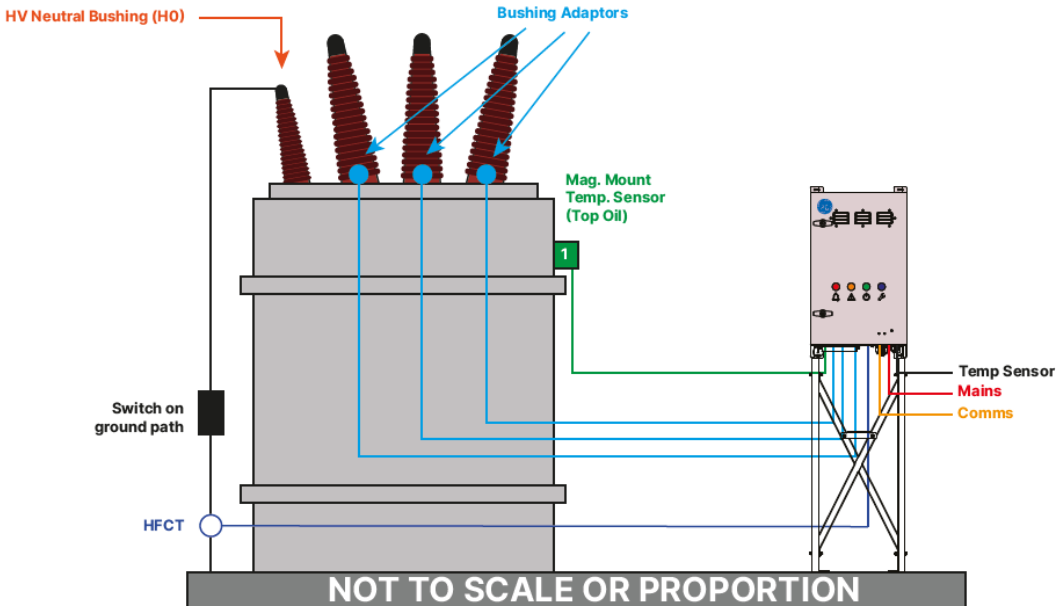


Figure 11-7: HFCT installed after the switch on cable from the Neutral Bushing to ground

WARNING: If there is a switch on the path to ground from the high voltage neutral bushing as shown in Figure 11-8, the HFCT must NOT be installed between the switch and the neutral bushing, because should the switch be opened, there will no longer be a direct path to ground, potentially causing a hazardous condition.

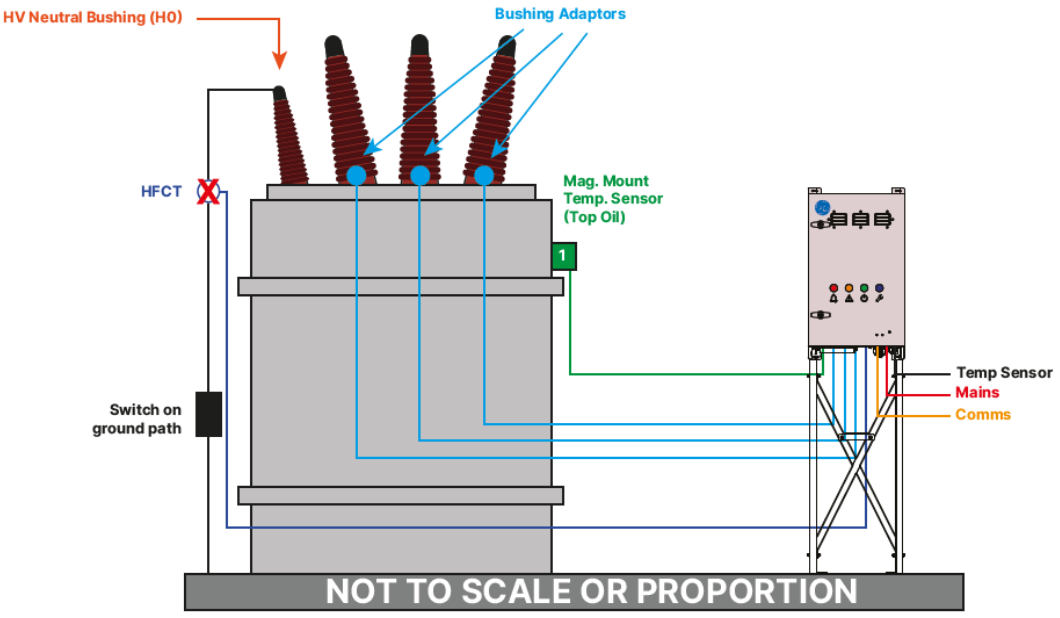


Figure 11-8: HFCT *must not be installed* if a switch is on cable from Neutral Bushing to ground

As with the Bushing Adaptor cables, the HFCT cable should be routed through the conduit to the product cabinet. If the cable routing is carried out as part of a pre-installation activity, mark the cable end to identify it as the appropriate Neutral connection.

Connect the HFCT to the appropriate connectors (N1-N3) on the main DIN rail (see Figure 11-18).

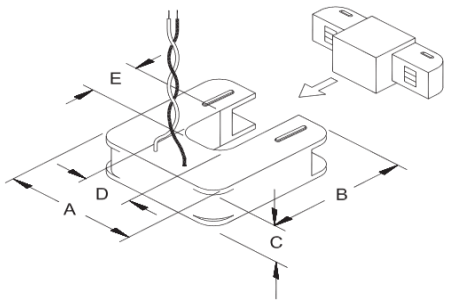
11.3 Load CT

It should be possible to locate a suitable current transformer with a 0 – 5 A secondary circuit on which to mount the sensor. The sensor is supplied with 2.5 m (100 in.) of cable and may be spliced to the required length to connect to the product with up to a total of 10 m (33 ft) of 20 AWG twisted pair cable. Longer cable lengths are possible depending upon the quality of the cable.

CT dimensions are listed in Table 11-2.

Table 11-2: CT dimensions

Dim.	in	mm
A	2.000	50.80
B	2.100	53.34
C	0.610	15.49
D	0.750	19.05
E	0.750	19.05



CT specifications are listed inTable 11-3.

Table 11-3: CT specifications

Item	Value
Opening	0.75 in / 1.905 cm ID
Connections	8 ft / 2.4 Meter Twisted Cable 20 AWG*
Input	200 Amp
Output	0.333 Volt at rated current Linearity accuracy ± 1%
Accuracy	10% to 130% of rated current
Phase angle	< 2 degrees (valid for 70 A or higher)
Operates	30 Hz to 1,000 Hz
Maximum Voltage	600 V (on bare conductor)
Compliance	UL recognized, CE, and RoHS compliant
Operating temperature	−20 °C to 110 °C

*Note: The supplied 8 ft (2.4 metres) cable can be extended to 33 feet (10 metres).

The load CT that is shipped with the BMT 430 is rated up to 5 Amps.

Connect the Load CT to the appropriate Analogue input (AIN1-AIN6), see Figure 10-6.

11.4 Bushing Adaptors

The product supports the original one-piece Bushing Adaptor as shown in Figure 11-9 and the newer two-piece Bushing Adaptor as shown in Figure 11-31. These instructions illustrate the process using the one-piece Bushing Adaptor with implementation differences for the two-piece bushing adaptor discussed in Section 11.4.3. All bushing adaptors are supplied pre-assembled, but with both O-rings separately packed. The bushing adaptors are shipped with a plastic-threaded cap as shown in Figure 11-9 and Figure 11-31.

Figure 11-9: Bushing Adaptor – plastic-threaded cap (left) & thread for protective conduit fitting (right)

When removing the original test tap cover from the bushings as shown in Figure 11-10, first check that they fit the plastic-threaded caps on the new bushing adapters as shown in Figure 11-11.

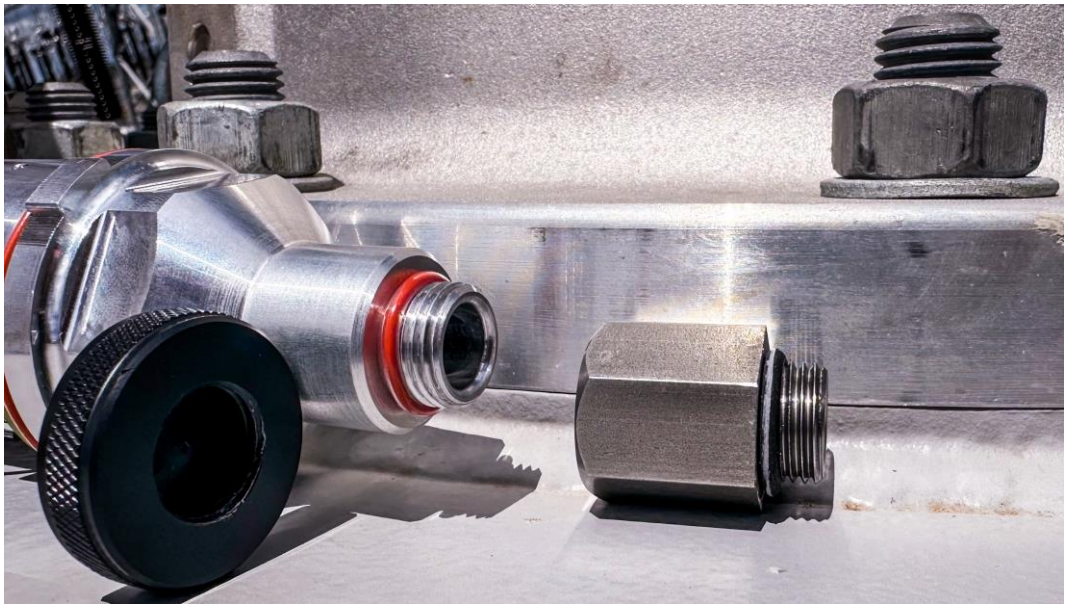


Figure 11-10: Bushing Adaptor with original test tap cover

If it is a good fit, continue with the Bushing Adaptor installation.

Figure 11-11: Bushing Adaptor with original test tap cover – thread check

WARNING: If the original test tap cover does not fit the plastic-threaded cap, halt the installation and contact GE Vernova Technical Support.

WARNING: If the bushing tapping point threads show any sign of damage, halt the installation and contact GE Vernova Technical Support.

Some examples of good, bad or aborted installations are shown in Figure 11-12 to Figure 11-14.

Figure 11-12: Bushing adaptor installation – good example

Figure 11-13: Bushing adaptor installation – bad / aborted example #1

Figure 11-14: Bushing adaptor installation – bad / aborted example #2

In overview, the installation process is summarised as follows:

- A pre-installation check is performed.
- Conductive grease is applied to thread (threaded Bushing Adaptor only).
- The whole Bushing Adaptor is screwed into the bushing tapping point.
- The top cover of the Bushing Adaptor is removed leaving the body in place as illustrated in Figure 11-15.
- A Bushing Adaptor circuit integrity test is performed. See Section 11.4.3
- The cabling is attached through the top cover and O-ring.
- The top cover of the Busing Adaptor is re-attached as illustrated in Figure 11-16.

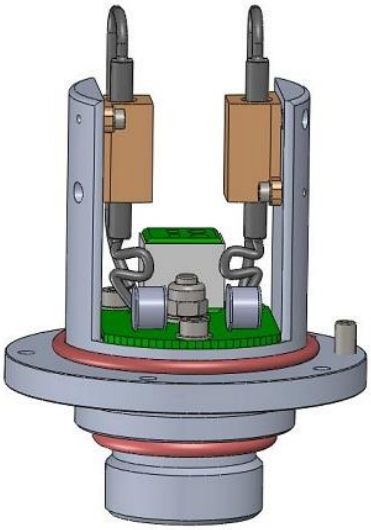


Figure 11-15: BA without top cover

Figure 11-16: BA with top cover

The rubber O-rings must not be contaminated with grease during the assembly process.

Both ends of the coaxial cables for the Bushing Adaptor and Neutral CT must be prepared and fitted with pin terminals as described in Section 11.4.2.1.

All coaxial cables from the Bushing Adaptors to the product cabinet *must* be run inside a protective electrically grounded metal conduit. See Appendix A for recommended conduit and fittings.

If working at heights is required during the product installation, it is the responsibility of the installer to ensure that:

- planned work complies with national and site regulatory requirements.
- third-party equipment is suitable and safe before commencing work.

- third parties have received appropriate training for working at height. This includes, but is not limited to, ‘Working at height’ and ‘Using Mobile Elevated Working Platforms’.

An overview of Set 1, Set 2 & Set 3 Bushing Adaptor & Neutral CT connections are shown in Figure 11-17 to Figure 11-22.

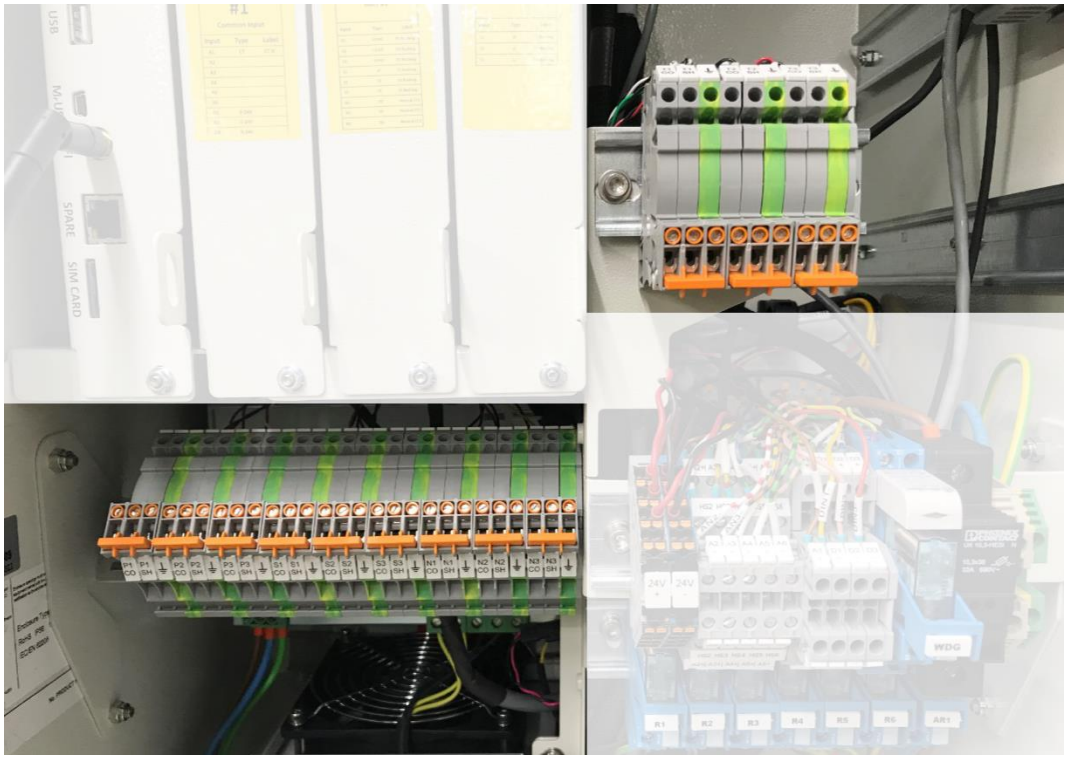


Figure 11-17: Bushing adaptor & Neutral CT connections (Set 1 & 2 - bottom left, Set 3 top right)

The input terminals for the coaxial cable connections (Core and Shield) are identified as follows:

- Set 1 (Primary) P1, P2, P3
- Set 2 (Secondary) S1, S2, S3
- Neutral HFCT N1, N2, N3.
- Set 3 (Tertiary) T1, T2, T3

See Section 5.5 for bushing adaptor cable runs.

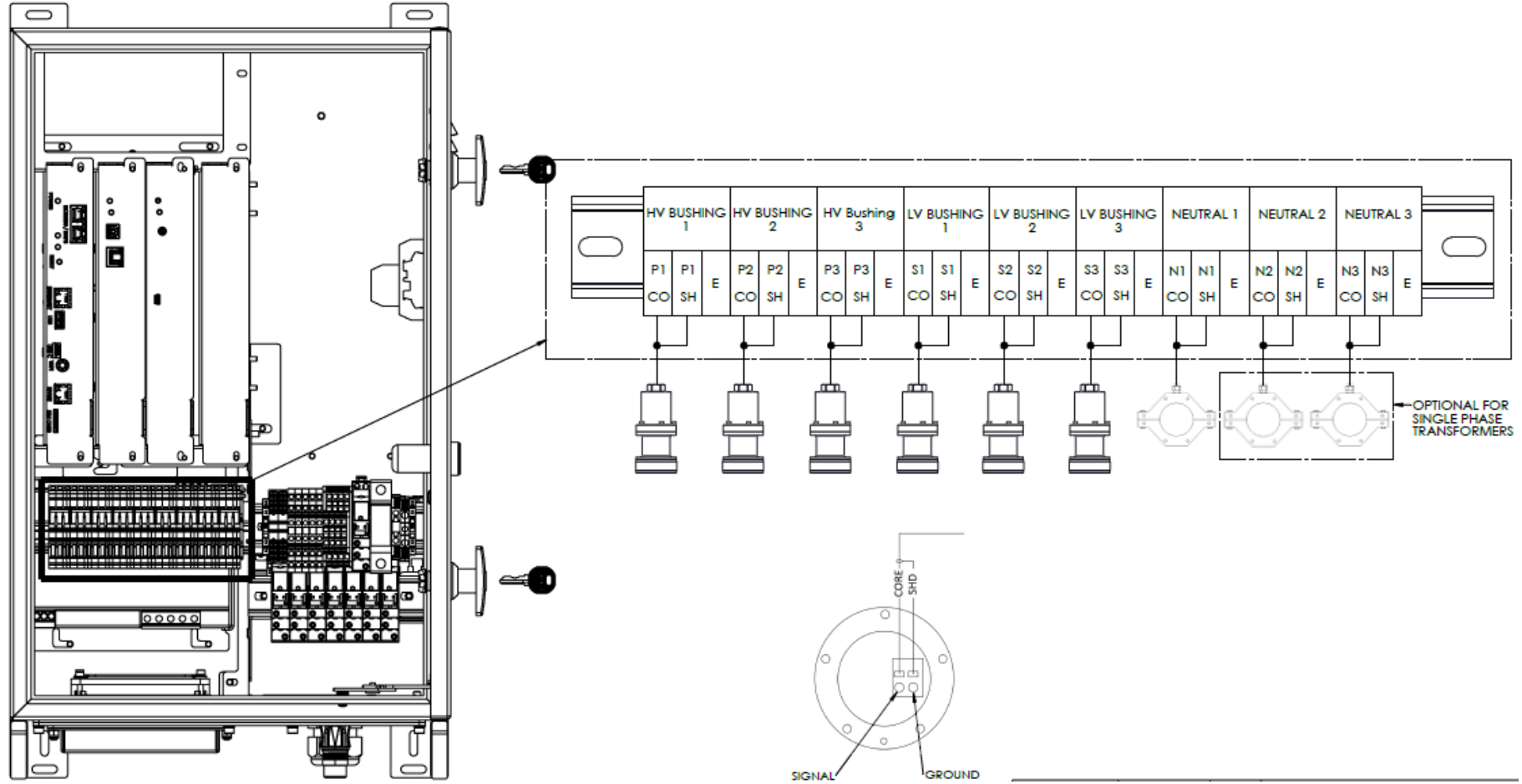


Figure 11-18: Sets 1 & 2 (6 bushings) & Neutral CT (3)

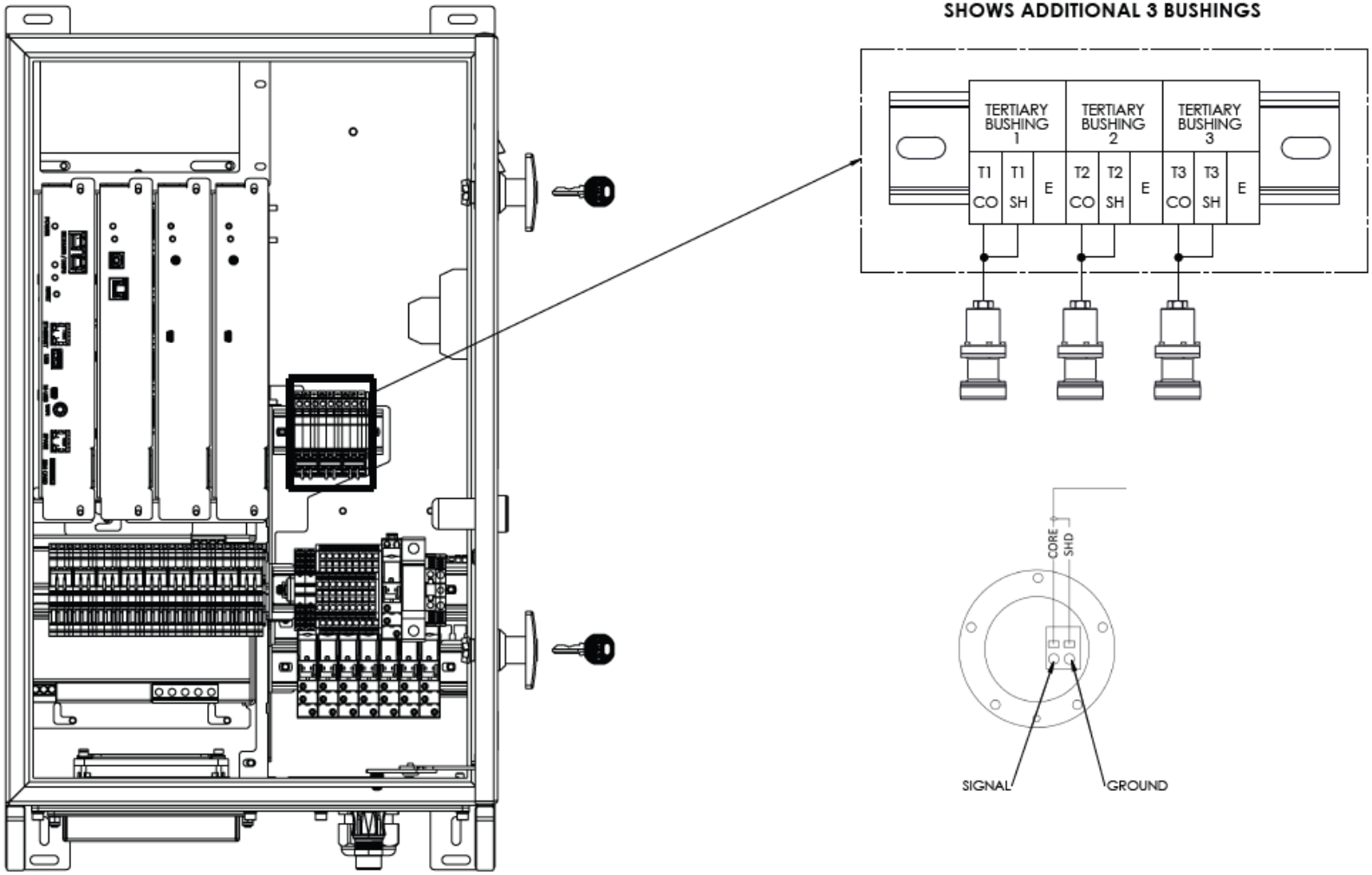


Figure 11-19: Set 3 (3 bushings)

The order of the BMT inputs is from left to right as follows as shown in Figure 11-20:

- Set 1 of Primary Bushing Adaptor inputs: phases P1, P2 and P3
- Set 2 of Secondary Bushing Adaptor inputs: phases S1, S2 and S3
- Neutral HFCTs N1, N2 and N3
- Set 3 of Tertiary Bushing Adaptor inputs: phases T1, T2 and T3

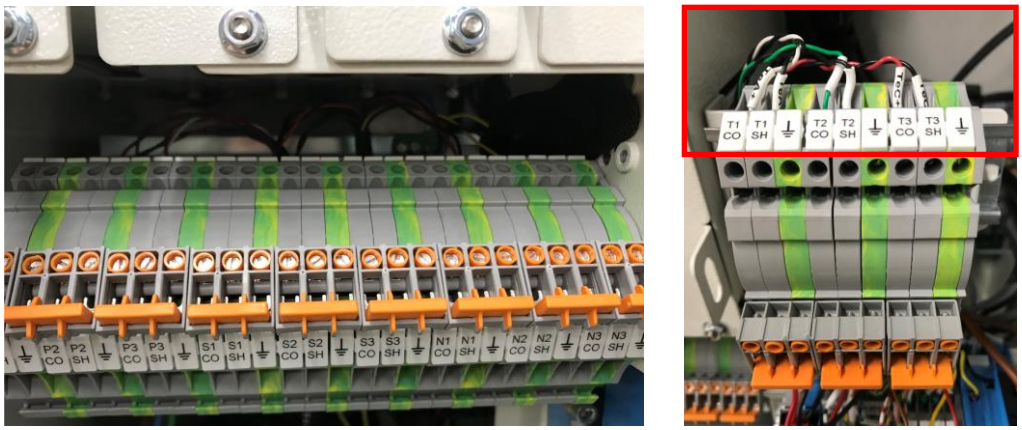


Figure 11-20: Bushing Adaptor inputs

Figure 11-21 and Figure 11-22 show the bushing adaptor cable runs at the connection points in the product cabinet. For each input, the coaxial central wire is connected to the core (CO) on the left and the shield (SH) on the right, as shown in Figure 11-21.

Figure 11-21: Phase Inputs – Set 1 (left), Set 2 (middle) & Neutral CT (right)

If the product is configured to support nine bushings in total, the Set 3 (tertiary) cables are routed through the cable clip (shown rightmost in Figure 11-21) and terminated as shown in Figure 11-22.

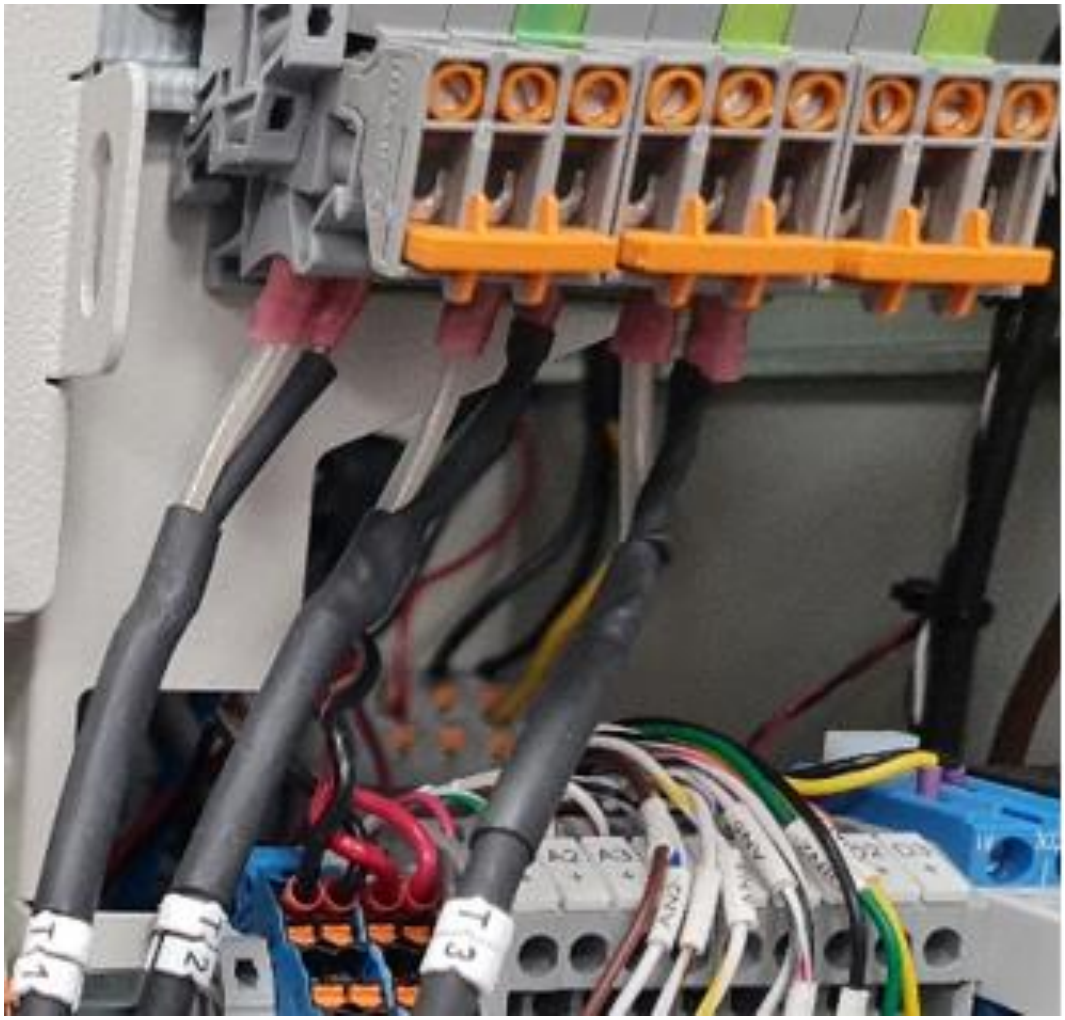


Figure 11-22: Phase Inputs - Set 3 (above)

For connection of the Bushing Adaptors and HFCT(s) to the terminals, see Sections 11.4.2.1.5 and 11.4.2.1.6.

WARNING: The *rated* maximum *working* voltage that may be present on each phase is 5 V AC rms and the *rated* maximum current that may be present is 200 mA. The measurement category is CAT III for circuits that can be connected to any coaxial cable connection.

Before connecting the Bushing Adaptor coaxial cables to the product cabinet, test that the ground connections have been made correctly. Verify that there is continuity from the shield of each of the Bushing Adaptor cables to the product cabinet ground terminal.

An external circuit breaker must be installed on the AC source near the product and within easy reach of the operator. It should be clearly labelled as the disconnecting device for the product.

11.4.1 Installation Steps

To install a Bushing Adaptor:

11.4.1.1 Ensure that the serial number of the bushing adaptor matches the phase of the bushing to which it is connected. For the bushing mappings, refer to Section 10.3 Configuration in 'MA-044 - BMT 430 - Operator Guide'.

Each bushing adaptor has been designed as per each individual bushing specification.

11.4.1.2 Ensure that the coaxial cable that will connect the BA to the cabinet has already been routed.

11.4.1.3 Ensure that the phase is properly identified on each coaxial cable in the cabinet.

11.4.1.4 Set up and calibrate the Antenna Analyser AA-230 (see Sections 11.5.2.1 and 11.5.2.2).

11.4.1.5 Measure the BA Only antenna analyser profile (see Section 11.5.2.3.1 for details).

11.4.1.6 Remove the bushing test tap cover. Retain all covers in a safe place as they are required when decommissioning the product. Note: It is the customer's responsibility to retain them.

11.4.1.7 Remove the plastic-threaded bushing adaptor cover and check that it fits the test tap cover removed previously. If the plastic-threaded bushing adaptor cover does not fit the original test tap cover, halt the installation and contact GE Vernova Technical Support.

11.4.1.8 Inspect the bushing adaptor threads for any signs of damage to the threads. If damaged, halt the installation and contact GE Vernova Technical Support.

11.4.1.9 With clean hands, put the smaller O-ring in its seat as shown in Figure 11-23 to form a seal between the bushing adaptor and the tapping point surface.

Note: There are two spare O-rings supplied in the shipping package of each Bushing Adaptor. The customer should store these safely for future use should the Bushing Adaptor need to be re-installed after offline measurements.

11.4.1.10 Apply the conductive grease to the bushing adaptor threads. The *high temperature* anti-seize *carbon conductive* grease (supplied with the installation kit) must reach all threads. To start, apply an even amount of grease to the first few threads as shown in Figure 11-23.

Figure 11-23: Bushing Adaptor with initial threads covered in grease

Note: As the bushing adaptor is installed into the tapping point of the bushing, the grease will work its way down, ensuring an even coating across all threads as shown in Figure 11-24.

Figure 11-24: Bushing Adaptor with all threads covered in grease

11.4.1.11 Screw the complete Bushing Adaptor into the tapping point of the bushing. First just hand-tighten to prevent thread damage, then tighten the Bushing Adaptor to the required torque defined in the installation drawing provided with each Bushing Adaptor. It is important to tighten the Bushing Adaptor in steps of 20 N m (15 lb ft) until you reach the final torque requirement to minimise mechanical stress.

Note: A suitable torque wrench is specified in Appendix A.2 GE Vernova Field Service Engineer (FSE)-Supplied Items.

11.4.1.12 Check that the resistance between the Bushing Adaptor body and the bushing tapping point remains less than 5 Ω.

Note: If required, scrape a little paint off the bushing surface to get a good conductive path, or alternatively, find another suitable grounded point so that ground continuity can be tested between the ground and the Bushing Adaptor body.

11.4.1.13 Remove the Allen key screws and remove the Bushing Adaptor top cover.

11.4.1.14 Verify circuit integrity. See Section 11.5.2.3.2 for the test procedure on how to verify the circuit integrity of the Bushing Adaptor.

It is crucial that the Bushing Adaptor circuit integrity tests in Section 11.4.3 are performed for each bushing.

11.4.1.15 Install a liquid-tight fitting (as listed in Appendix A.3 Customer-Supplied Items) into the Bushing Adaptor top cover. Use a sealing gasket to ensure a liquid tight seal.

Note: The Bushing Adaptor thread for the liquid-tight fitting is ½ inch NPSM thread as illustrated in Figure 11-25.

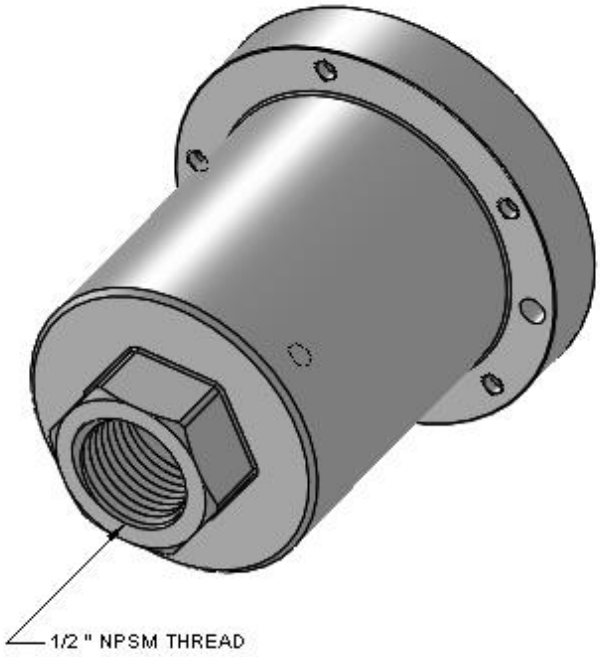


Figure 11-25: Liquid-tight fitting thread

11.4.1.16 Thread the end of the metal liquid-tight conduit as well as the coaxial cable into the fitting. Terminate the conduit into the fitting carefully to form a liquid-tight assembly.

11.4.1.17 Ensure that the O-ring is in its seat between the BA body and its cover (see Figure 11-15).

11.4.1.18 Connect the coaxial cable as outlined in Section 11.4.2.1.4.

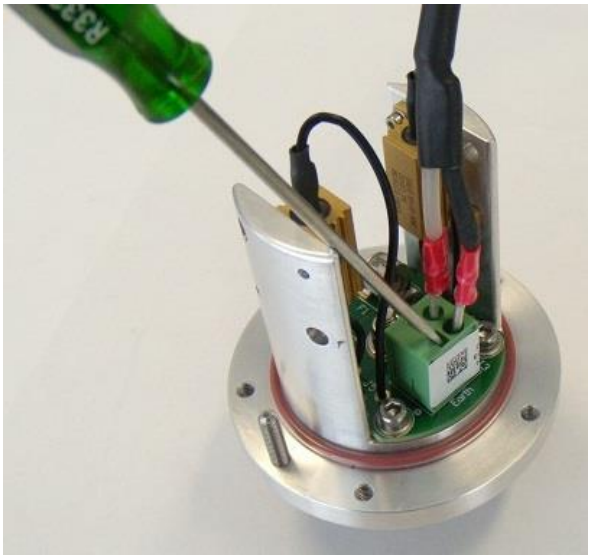


Figure 11-26: Bushing adaptor terminal block

Ensure that there is no tension or stress on the coaxial cable and that there is a loop of cable inside the Bushing Adaptor to allow for strain relief of the coaxial cable.

11.4.1.19 Replace the Bushing Adaptor cover on its seat using the keyway pin and reassemble using the Allen key screws:

To compress the sealing O-ring evenly, tighten the five screws progressively working across the circle rather than around the circle of screws as illustrated in Figure 11-27. Tighten the screws to the torque specified in the installation drawing provided with each Bushing Adaptor.

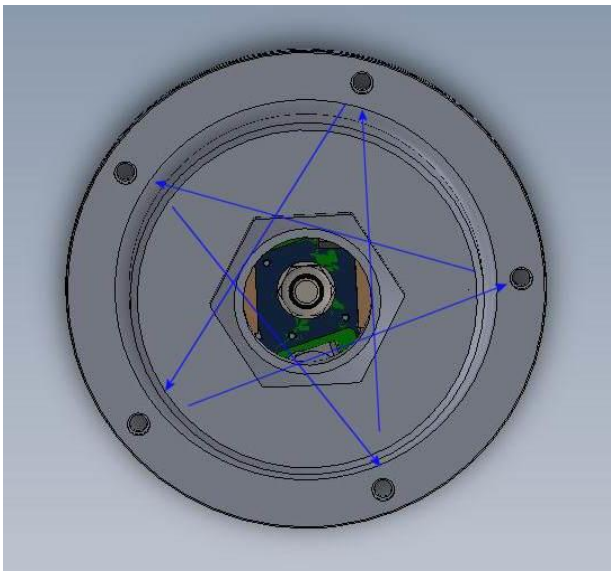


Figure 11-27: Tightening order

Ensure that the Bushing Adaptor has been assembled carefully with the liquid tight fitting and conduit to form a liquid tight connection. Water ingress inside the bushing may result in product damage.

11.4.2 Bushing Adaptor Cables

Do not open the cabinet during inclement weather.

All installation activity should take place in ambient temperatures greater than −10 °C (14 °F) to prevent damage to connectors and cabling (extreme low temperatures may make them brittle).

All coaxial cables from the Bushing Adaptors to the product cabinet must be run inside a protective electrically grounded metal conduit.

All cables entering the cabinet should have at least 150 mm (6 in.) of excess length to allow for cable strain relief.

Before connecting the Bushing Adaptor coaxial cables to the product cabinet, test that the ground connections have been made correctly. Verify that there is continuity from the shield of each of the Bushing Adaptor cables to the product cabinet ground terminal.

When installing conduit to Bushing Adaptors, ensure that the conduit drops away from the Bushing Adaptor body.

Details of recommended conduit and fittings are listed in Appendix A.

All Bushing Adaptors and Neutral HFCT cables are routed into the product. Each of these coaxial cables must be properly identified using cable markers provided with the installation kit (see 14) as follows:

- Cable for Set 1 (Primary) input from phase A Bushing Adaptor: P1
- Cable for Set 1 (Primary) input from phase B Bushing Adaptor: P2
- Cable for Set 1 (Primary) input from phase C Bushing Adaptor: P3
- Cable for Set 2 (Secondary) input (if available) from phase A Bushing Adaptor: S1
- Cable for Set 2 (Secondary) input (if available) from phase B Bushing Adaptor: S2
- Cable for Set 2 (Secondary) input (if available) from phase C Bushing Adaptor: S3
- Cable for Set 3 (Tertiary) input (if available) from phase A Bushing Adaptor: T1
- Cable for Set 3 (Tertiary) input (if available) from phase B Bushing Adaptor: T2
- Cable for Set 3 (Tertiary) input (if available) from phase C Bushing Adaptor: T3
- Cable from Neutral CT (three phase or single-phase A, if available): N1
- Cable from Neutral CT single phase B (if available): N2
- Cable from Neutral CT single phase C (if available): N3

11.4.2.1 Connecting Coaxial Cables

The marked Bushing Adaptor coaxial cables are connected to the corresponding terminals of the grounding switch inside the product, such that the central wire is routed to the core side and the braid shield wire is routed to the shield side.

Follow these steps to connect the coaxial cables:

11.4.2.1.1 Routing the Coaxial Cables

1. Route the coaxial cables through the metal conduits from each Bushing Adaptor to the product cabinet as required.
2. On the cabinet side, the coaxial cables must be routed though the connector fittings at the bottom of the cabinet. Each cable can be up to 100 m and must be identified with cable markers.
3. All the coaxial cables must be connected to the Bushing Adaptor on one end and to the grounding switch inside the cabinet on the other end.

Cables for Set 3 bushing inputs must be routed through the cable clip attached to the analogue input DIN rail as shown in Figure 11-28.

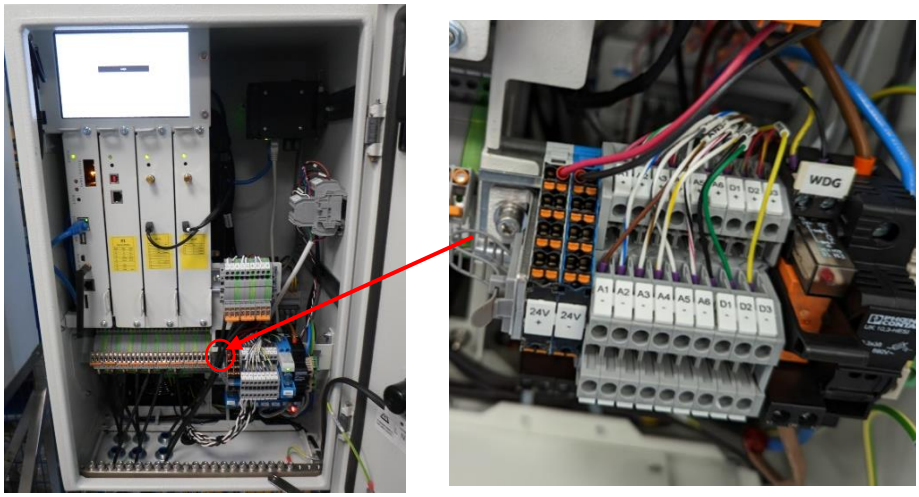


Figure 11-28: Routing of cable for Set 3 bushing

Note: Use the left-hand side of the customer gland plate (the right-hand side is used for all other cabling, such as relays, analogue and digital inputs).

11.4.2.1.2 Required Materials & Tools

The materials listed in Table 11-4 are shipped with the product and are required for connecting the coaxial cables to the Bushing Adaptors and to the shorting switch.

Table 11-4: GE Vernova-supplied materials

Coaxial cable RG-58C/U 150m (500ft)	
Red pin terminals	
Qty	15
Heat shrink $^{3}/_{16}$ in. tubing 60 mm (2.4 in.)	

Heat shrink ¼ in. tubing 60 mm (2.4 in.)								
Cable markers								
Qty	6	6	6	8	6	6	6	6

The tool as shown in Table 11-5 is supplied by the customer and is recommended for preparing the coaxial cables.

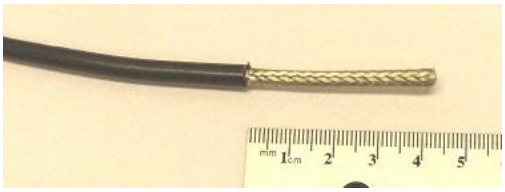
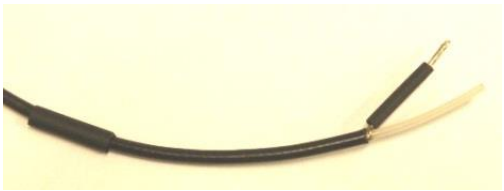
Table 11-5: Customer-supplied tools

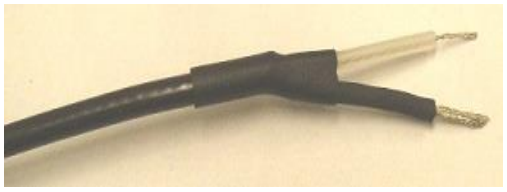
Heat gun	

11.4.2.1.3 Coaxial Cables Preparation

Each coaxial cable must be prepared on both ends (Bushing Adaptor and cabinet) as outlined in Table 11-6.

Table 11-6: Coaxial cable preparation

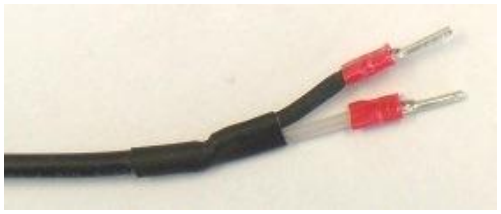
Steps	Visual
1. Cut the 3/16 in. heat shrink tubing. into pieces approximately 30 mm (1 ¼ in.) long. 2. Cut the ¼ in. heat shrink tubing into pieces approximately 30 mm (1 ¼ in.) long.	
3. Remove approximately 40 mm (1 ½ in.) of the outer jacket from the coaxial cable taking care not to cut the metallic braid.	
4. Un-strand the metallic braid shield and twist it together.	
5. First insert the ¼ in. tubing through the central conductor and shield. 6. Then insert the 3/16 in. tubing through the metallic braid.	

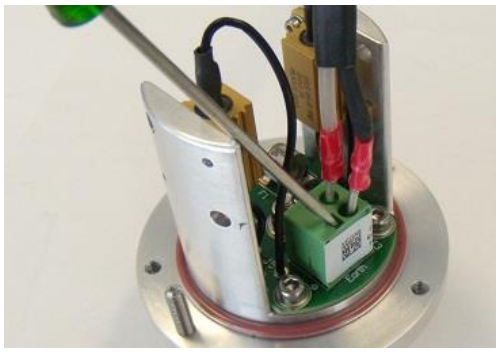
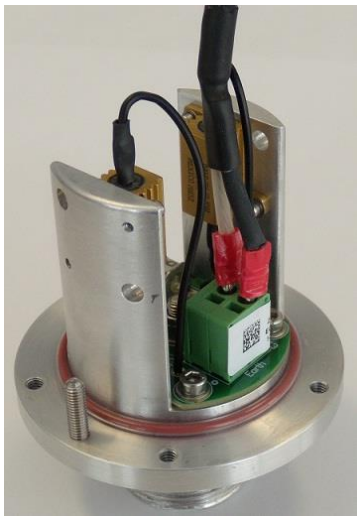
7. Use a heat gun to shrink the 3/16 in. tubing.	 
8. Then, insert the ¼ in. tubing to overlap about 15 mm (0.6 in.) over the metallic braid. 9. Use a heat gun to shrink the ¼ in. tubing. 10. Strip away about 7 mm (¼ in.) of insulation from the central conductor. Twist the strands together.	

11.4.2.1.4 Connecting to the Bushing Adaptor

At the Bushing Adaptor end, the coaxial cables must be terminated with two pin terminals as outlined in Table 11-7.

Table 11-7: Connecting to the Bushing Adaptor

Steps	Visual
1. Select two red pin terminals and the corresponding hand crimp tool.	
2. Insert the central conductor of the coaxial cable into one pin terminal and crimp that terminal. 3. Insert the braid shield into the second pin terminal and crimp that terminal. 4. The terminals must be double crimped (once on the bare wire and once on the insulation). Verify visually and by a pull test on the terminals.	

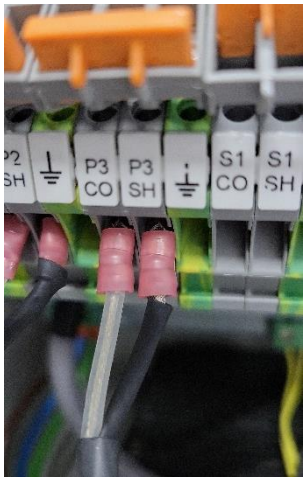
5. Insert the coaxial cable through the connector fitting of the Bushing Adaptor cover. 6. Connect the wires to connector J3 of the Bushing Adaptor board. 7. J3 is a spring-cage type connector. Open the terminal point with a small flat insulated screwdriver. 8. The central white wire must be inserted into the *inner* terminal. 9. The braid shield must be inserted into the *outer* terminal.	
10. A fully connected Bushing Adaptor is shown.	

At the cabinet end, repeat the steps 1-4 above and use the same pins to terminate the cable.

11.4.2.1.5 Connecting to the Grounding Switch

To connect to the grounding switch, follow the steps as outlined in Table 11-8.

Table 11-8: Connecting to the grounding switch

Steps	Visual
1. The central white wire must be connected to the core (CO) connector. 2. The braid shield must be connected to the shield (SH) connector.	
3. Repeat these steps for all input phases for the Bushing Adaptors and the Neutral CT(s).	

11.4.2.1.6 Connecting to the HFCT (optional)

If the optional HFCT is required for PD discrimination, ensure that the PD Settings are correct. In the HMI, select **Bushing Monitoring** > **Configuration** and in the 'PD Settings' section, ensure that the slider for 'Polarity discrimination without Neutral HFCT' is **Off** as shown in Figure 11-29.

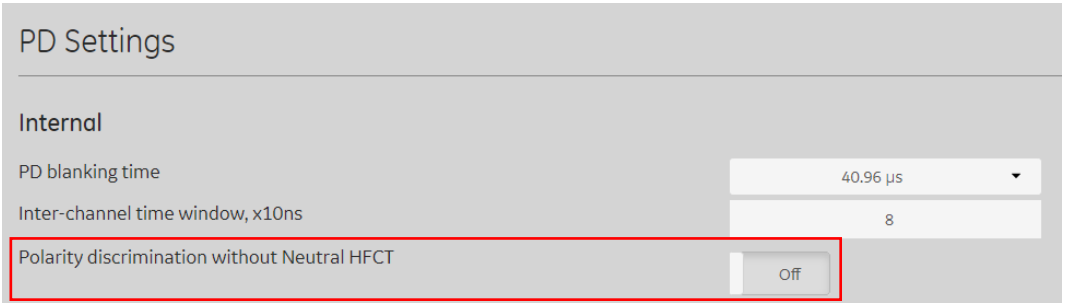
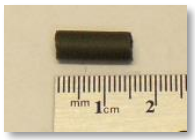
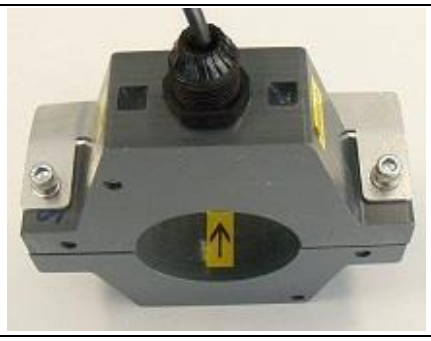


Figure 11-29: Bushing Monitoring > Configuration – PD Settings

To connect to the HFCT, follow the steps as outlined in Table 11-9.

Note: At the HFCT end, the coaxial cable does not require terminals.

Table 11-9: Connecting to the Neutral CT

Steps	Visual
1. Remove approximately 25 mm (1 in.) of the outer jacket from the coaxial cable (taking care not to cut the metallic braid).	
2. Un-strand the metallic braid shield and twist it together.	
3. Select one piece of heat shrink tubing $^{3}/_{16}$ in., about 15 mm (5/8 in.) long.	
4. Insert the tubing through the metallic braid and heat shrink the tubing. 5. Strip away about 7 mm (¼ in.) of insulation from the central conductor. Twist the strands together.	
6. Remove the connector fitting from the CT. 7. Insert the dome nut, fitting body and seal ring through the coaxial cable as shown.	
8. Connect the cable to the terminals of the HFCT. 9. The central white wire must be connected to the *core* side. 10. The braid shield must be connected to the *shield* side. 11. Tighten the set screws using a hex key wrench (1.5 mm).	
12. Screw the fitting body into the HFCT with the seal ring. Hold the wire to prevent it from twisting. Recommended torque is 3.75 N m (33 lb in). 13. Screw the dome nut tightly into place. Recommended torque is 2.50 N m (22 lb in).	

14. The fitting and the nut must be sufficiently tight to prevent water ingress.	

11.4.3 Two-Piece Bushing Adaptor

The new Bushing Adaptor is composed of two pieces – the 'test tap adaptor' and the 'sensor electronics' – as shown in Figure 11-30.

Figure 11-30: Two-piece Bushing Adaptor (vertical orientation) with plastic-threaded cap

Figure 11-31 shows the bushing adaptor inverted with the plastic threaded cap removed and the adaptor threads exposed.

Figure 11-31: Two-piece Bushing Adaptor inverted vertically showing threads (cap removed)

This two-piece design separates sensor electronics from the bushing tapping point for ease of offline testing, such that the test tap adaptor can remain in place on the bushing tapping point.

Figure 11-32: Separated two piece Bushing Adaptor– test tap adaptor (bottom) & sensor electronics (top)

11.4.3.1 Required Material

- Multimeter (capable of measuring capacitance in nanofarad (nF) – range 1 nF Resolution 0.001 nF)
- Torque Driver with 3mm bit
- Torque Wrench
- Two Pin connector Release key / Terminal screwdriver

11.4.3.2 Installation & Test Procedure

Follow this procedure to install and test the two-piece bushing adaptor.

11.4.3.2.1 Ground Level Tests

1. Use a 3 mm bit to unfasten the two top M4 × 90 mm captive screws of the sensor electronics piece as shown in Figure 11-33 and remove the cover.

Note: Do not remove the screws. These screws are double-threaded. Retain the screws and sealing washers in the cover.

Figure 11-33: Loosen M4 screws holding sensor electronics body cover

2. Inside the sensor electronics piece, measure the resistance from the earth and signal terminals as shown in Figure 11-34 (expected value is within 1% of its nominal value).

Figure 11-34: Resistance across earth and signal terminals

3. Measure the continuity between the test tap adaptor's contact pin and the sensor electronics' signal terminal as shown in Figure 11-35 (expected value is <0.5 Ω).

Figure 11-35: Continuity of test tap adaptor contact pin to sensor electronics signal terminal

4. Measure the continuity between the sensor electronics' earth terminal and the test tap adaptor's outer body as shown in Figure 11-36 (expected value is <0.5 Ω).

Figure 11-36: Continuity of the sensor electronics' earth terminal to the test tap adaptor's outer body

5. Holding the test tap adaptor, rotate the sensor electronics anticlockwise to separate the bushing adapter into its two constitute pieces.
6. Measure the capacitance between the test tap adaptor's contact pin and it's outer body (expected value ~130 nF ±20%) as shown in Figure 11-37. This measured capacitance is used in Step 7 of Section 11.4.3.2.2 and referred to as the **test capacitance** (C_T).

Figure 11-37: Capacitance of test tap adaptor's contact pin to its outer body

7. Reassemble the sensor electronics piece by refitting the top cover. Stage tighten the first-threaded section of both screws (until the screws spin freely) as shown in Figure 11-38.

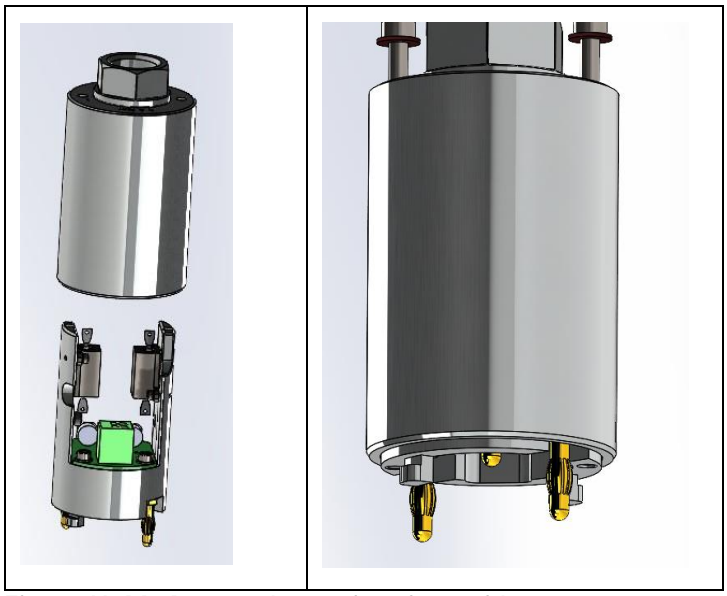
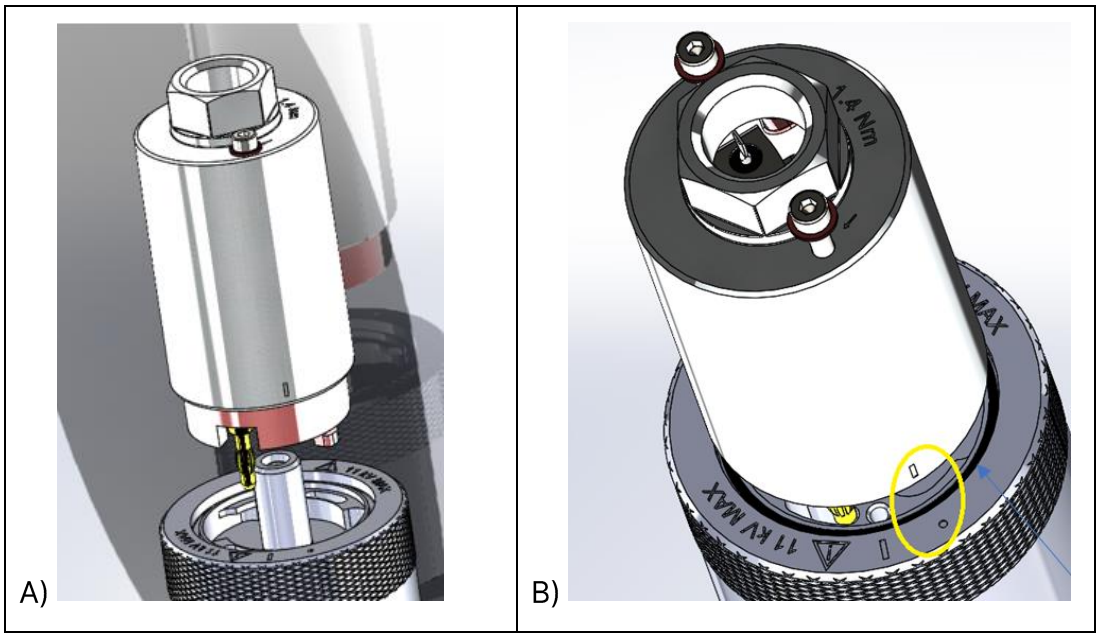


Figure 11-38: Sensor electronics piece with top cover

8. A) Position the sensor electronics piece over the test tap adaptor piece. B) Ensure that the sensor electronics' spring pins align with the grooves in the test tap adaptor. C.) Push down and rotate clockwise… D.) …until the alignment marks are aligned to secure both pieces of the bushing adaptor in place as shown in Figure 11-39.



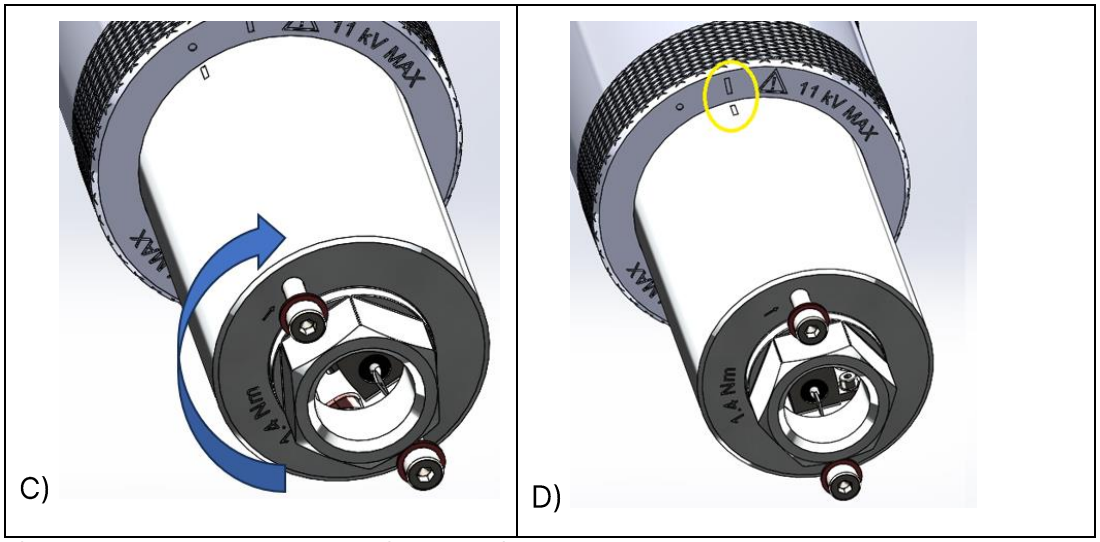


Figure 11-39: Reassemble two-piece bushing adapter

9. Stage tighten the second-threaded section of both screws until they are evenly seated with the sealing washers in place as shown in Figure 11-40 and then torque to 1.4 N m.

Figure 11-40: Reassembled two-piece bushing adaptor

11.4.3.2.2 Bushing Tapping Point Tests

1. Measure the capacitance from the bushing tapping point contact pin to bushing flange as shown in Figure 11-41 (expected value is bushing (C1 + C2) ±20%).

Figure 11-41: Bushing capacitance from contact pin to flange

2. Evenly apply conductive grease to the first few threads of the test tap adapter as shown in Figure 11-42.

Figure 11-42: Conductive grease applied to test tap adaptor initial threads

3. Hand-tighten the bushing adaptor to the bushing tapping point as shown in Figure 11-43.

Figure 11-43: Bushing adaptor hand tight to bushing tapping point

4. With a 27 mm hex socket and calibrated torque wrench, apply interval amounts of torque (as specified in the GE-supplied drawing) to the bushing adaptor as shown in Figure 11-44. For example, a 2.25 in. bushing adaptor requires 30 Nm applied incrementally in steps of 10 Nm.

Figure 11-44: Bushing adaptor torqued to bushing tapping point

5. Use a 3 mm bit to unfasten the first-threaded section of the M4 screws of the sensor electronics piece (until the screws spin freely) as shown in Figure 11-45 to allow separation.Note:These screws are double-threaded.

Undo first stage thread only. Retain the screws and sealing washers in the sensor electronics piece.

Figure 11-45: Unfasten first-threaded section of the M4 screws holding sensor electronics piece

6. Lift and rotate the sensor electronics piece anticlockwise to detach it from the test tap adapter as shown in Figure 11-46.

Figure 11-46: Lift & rotate the sensor electronics piece anticlockwise

7. Measure the capacitance between the test tap adaptor pin and the bushing flange (expected value is (C1+C2+C_T) ±20%, where C_T is the **test capacitance** measured previously in Step 6 of Section 11.4.3.2.1).

Figure 11-47: Capacitance between the test tap adaptor pin and the bushing flange

8. Unfasten the second-threaded section of the loose M4 screws of the sensor electronics piece (until the screws spin freely) to detach its cover.

Note: These screws are double-threaded. Retain the screws and sealing washers in the cover.

9. Align the uncovered sensor electronics piece with the test tap adaptor piece. Ensure that the sensor electronics' spring pins align with the grooves in the test tap adaptor. Push down and rotate clockwise until the alignment marks are aligned as shown in Figure 11-48.

Figure 11-48: Sensor electronics piece secured in test tap adaptor piece (left) & alignment marks (right)

10. Measure continuity between the sensor electronics' earth terminal and the bushing flange (expected value is <0.5 Ω) as shown in Figure 11-49.

Figure 11-49: Continuity between sensor electronics' earth terminal and the bushing flange

11. Measure resistance on the test tap adaptor's signal and its earth terminals as shown in Figure 11-50 (expected value is within 1% of its nominal value).

Figure 11-50: Resistance on test tap adaptor terminals

12. Fit the conduit-protected coaxial cable in through the sensor electronics top cover cable gland to the relevant terminals as shown in Figure 11-51.

Figure 11-51: Coax cable connected through the sensor electronics top cover

13. Reattach the sensor electronics' cover and tighten both screws fully ensuring that the sealing washers are in place. Torque the M4 screws to 1.4 Nm as shown in Figure 11-52.

Note: These screws are double-threaded. Tighten both screws fully.

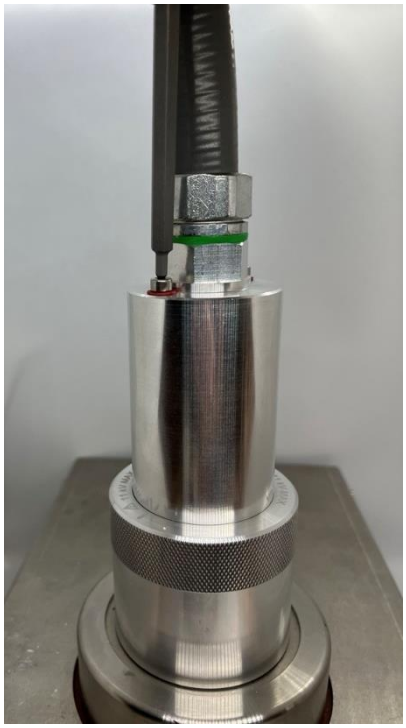


Figure 11-52: Reattached sensor electronics cover with coax conduit fitted

14. Perform the continuity tests in Section 11.5.2.5.
15. Repeat all the above steps for each bushing.

11.5 Circuit Integrity Test Record

The Circuit Integrity Test is to be performed upon installation and after bushing replacement.

11.5.1 Required Material

- Antenna Analyser, RigExpert AA-230 model (>170 MHz)
- UHF to BNC adaptor
- Coax cable with BNC connector at one end and clips at the other end as shown in Figure 11-53.

Figure 11-53: Coax BNC to clips cable

- Two small flat screwdrivers or a 2-pin connector and a release key as shown in Figure 11-54.

Figure 11-54: Two-pin connector and release key

- USB cable with type B connector
- PC with AntScope software installed
- 50 Ω wire-through resistor
- Ohmmeter

11.5.2 Test Procedure

The RigExpert handheld antenna analyser is used to verify the electrical connection of the internal Bushing Adaptor. Before commencing the test:

Ensure that the transformer is switched off and properly grounded. The product must not be energised.

Note: The calibration considers the waveguide between the measuring circuit and the load i.e. adaptor + cable + cable position.

Note: It is important to keep the cable straight between the RigExpert and the Bushing Adaptor during all the measurements.

11.5.2.1 RigExpert Setup

Follow these steps to calibrate the RigExpert:

1. Create a new folder on the computer. Create a subfolder within for each Bushing Adaptor using its corresponding serial number as the name.

Note: These folders are used to save the data measured by the RigExpert.

2. Connect the RigExpert to the PC via the USB cable.
3. Power on the RigExpert.
4. Open the AntScope software (use Version 1.2.5). If the Antenna Analyser is connected, the AntScope software should recognise and select the device (AA-230) as shown in Figure 11-55.

Note: If the Antenna Analyser is not recognised, manually assign the Antenna Analyser to the appropriate COM port.

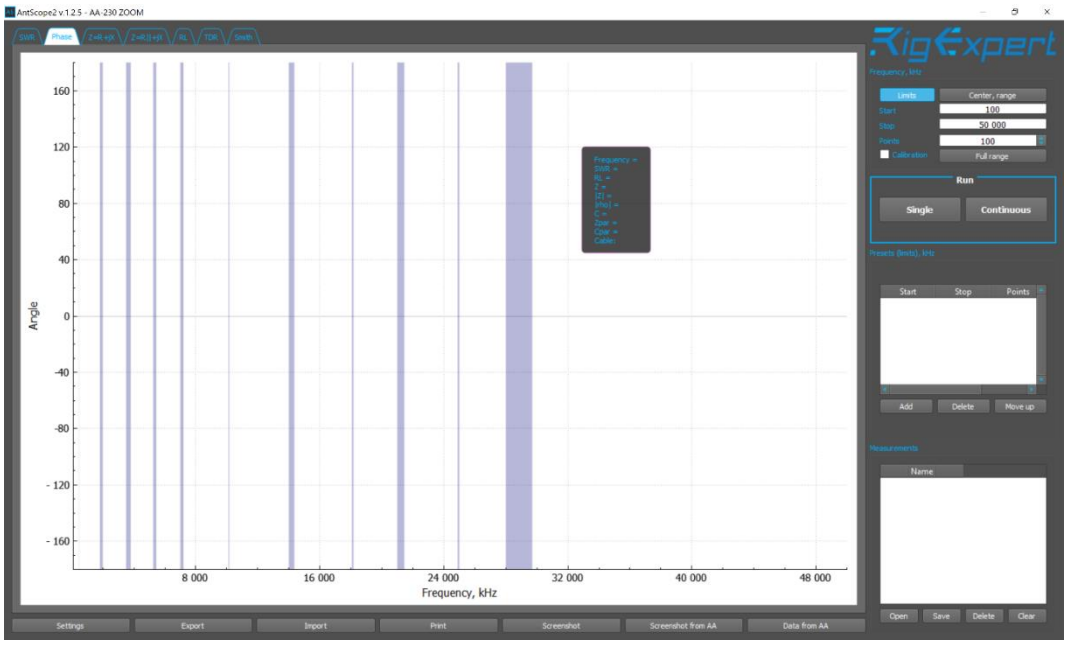


Figure 11-55: AntScope main screen with AA-230 Analyzer

11.5.2.2 RigExpert Calibration

5. In the top right corner of the main screen, set the frequency range – **Start** `100`, **Stop** `50000` kHz and **Points** `100` as shown in Figure 11-56.

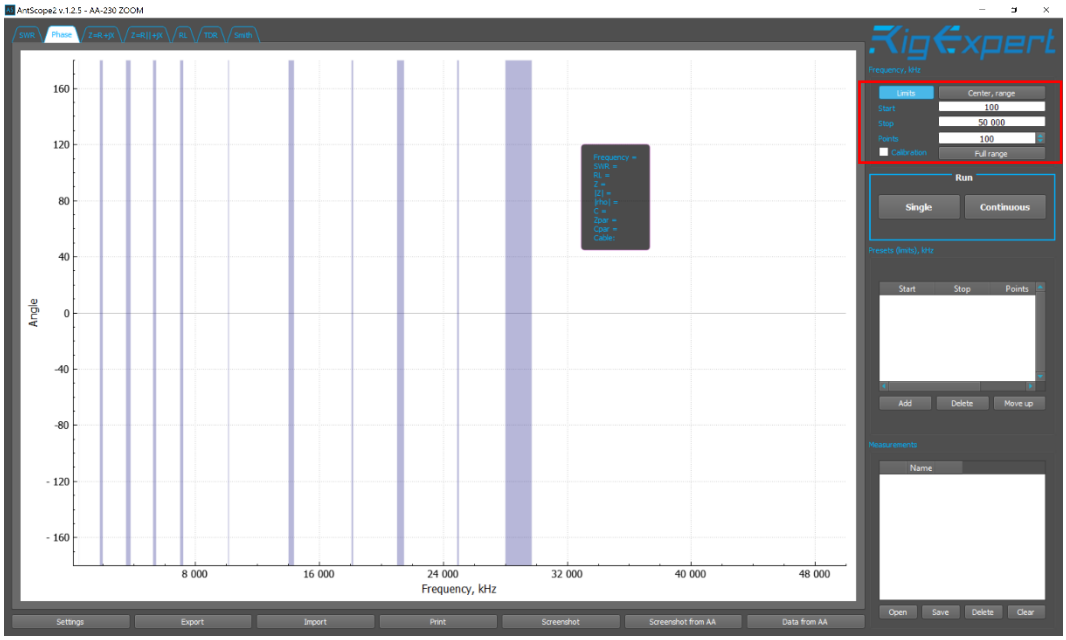


Figure 11-56: AntScope main screen

6. On the bottom navigation bar of the AntScope main screen, click **Settings** as shown in Figure 11-57.

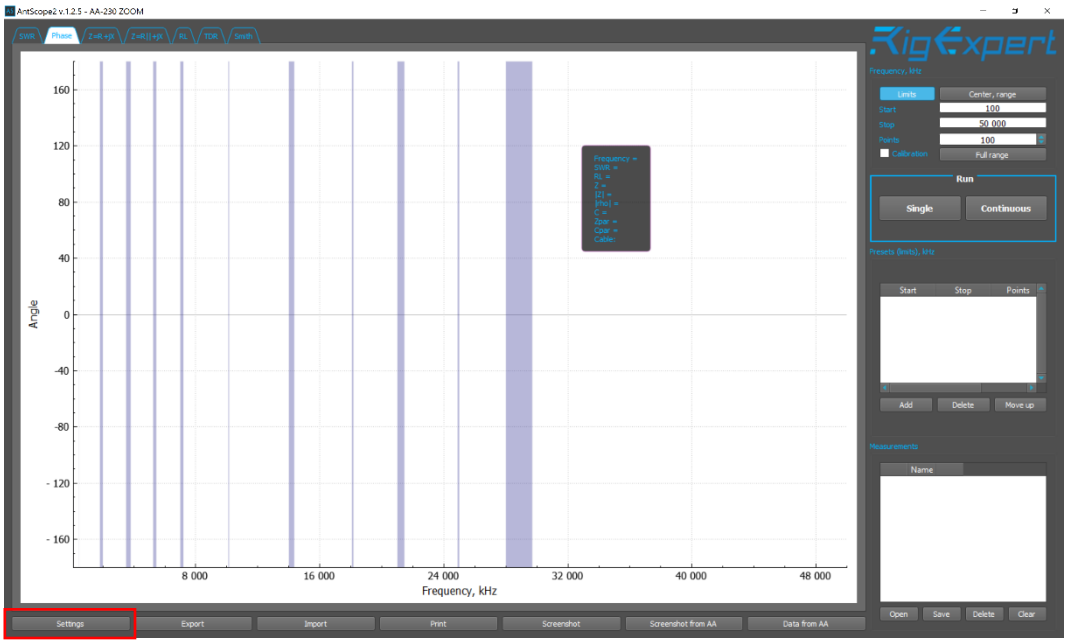


Figure 11-57: AntScope main screen > Settings

7. In the Settings dialog, select **OSL Calibration** as shown in Figure 11-58.

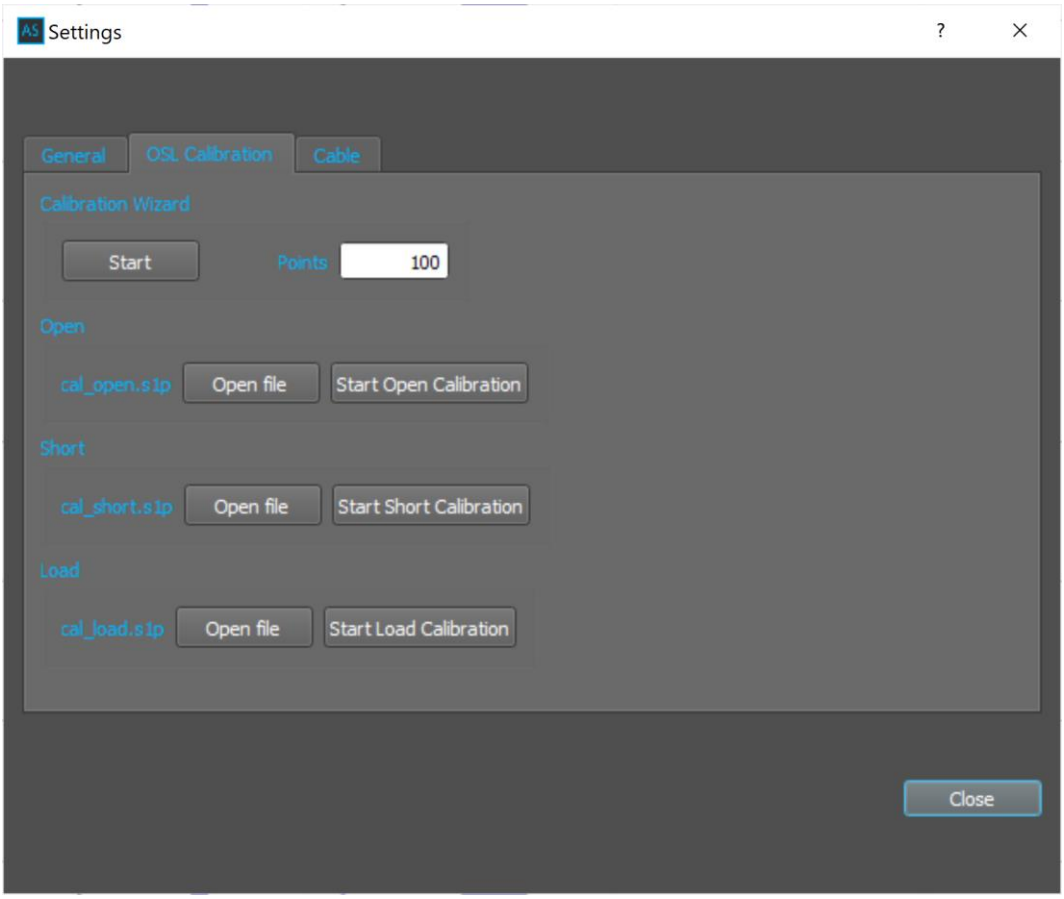


Figure 11-58: Settings > OSL Calibration > Start Open Calibration

8. Ensure that the clips are open as shown in Figure 11-59.

Figure 11-59: Clips unconnected i.e. open circuit

Note: Position the coaxial cable such that there is minimal movement of the cable during the calibration and tests.

9. In the OSL Calibration tabbed page, click **Start Open Calibration.** In the Open calibration dialog, click **OK** as shown in Figure 11-60.

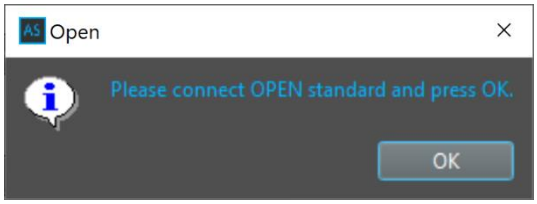


Figure 11-60: Open calibration - OK

10. The calibration begins as shown in Figure 11-61. Wait for the calibration to finish.

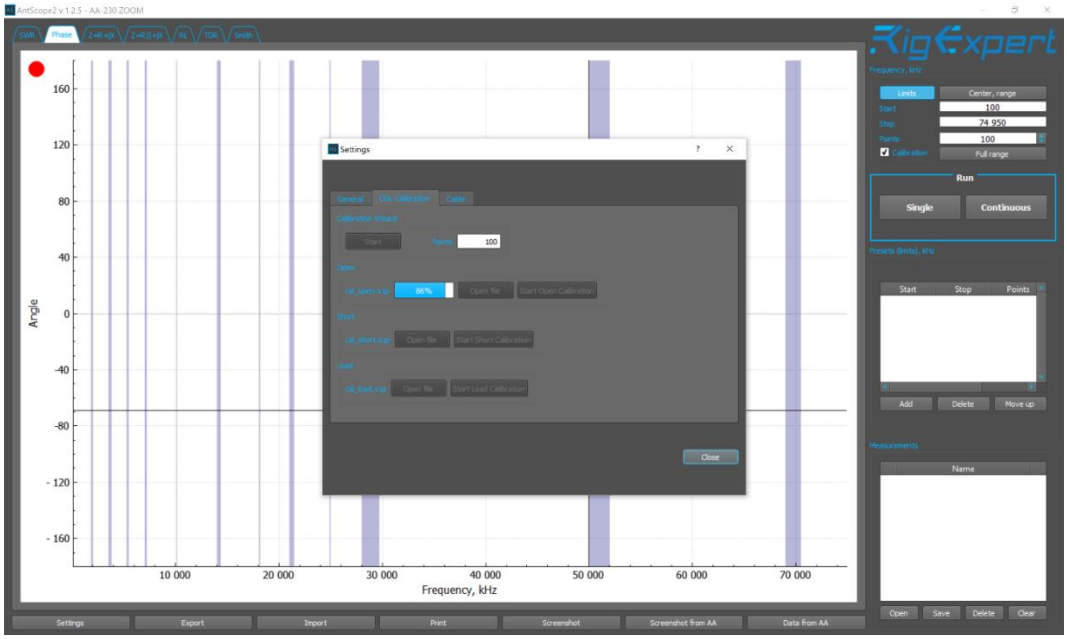


Figure 11-61: OSL Calibration – In progress

11. Connect the clips to each other as shown in Figure 11-62.

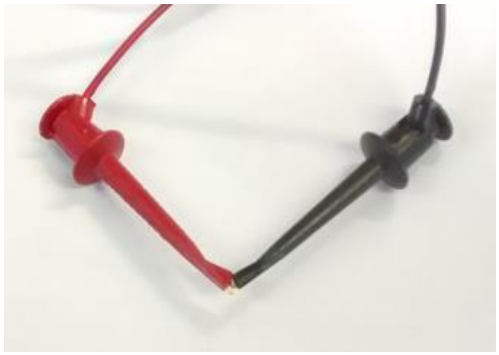


Figure 11-62: Short calibration

12. In the OSL Calibration tabbed page, click **Start Short Calibration**. In the Short calibration dialog, click **OK** as shown in Figure 11-63. Wait for the calibration to finish.

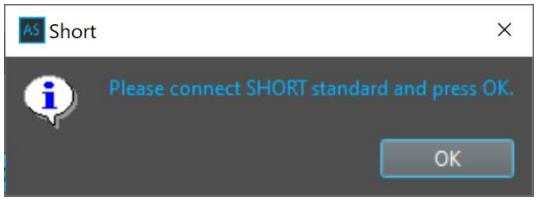


Figure 11-63: Short calibration - OK

13. Connect the 50 Ω resistor across the clips as shown in Figure 11-64.

Figure 11-64: Load calibration

14. In the OSL Calibration tabbed page, click **Start Load Calibration**. In the Load calibration dialog, click **OK** as shown in Figure 11-65. Wait for the calibration to finish.

Figure 11-65: Load calibration - OK

15. Click **Close** to close the Settings window.Bushing Adaptor Test

11.5.2.3.1 Adaptor-only

1. Connect the clips to the Bushing Adaptor using the short cables in the adaptor's connector as shown in Figure 11-66.

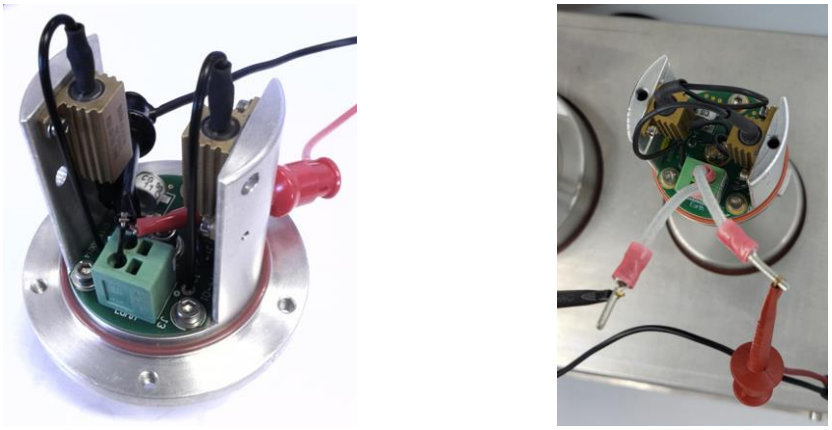


Figure 11-66: Bushing adaptor measurement – BA Only

2. In the AntScope main screen Run section, click **Single** as shown in Figure 11-67. Wait for the data to be collected.

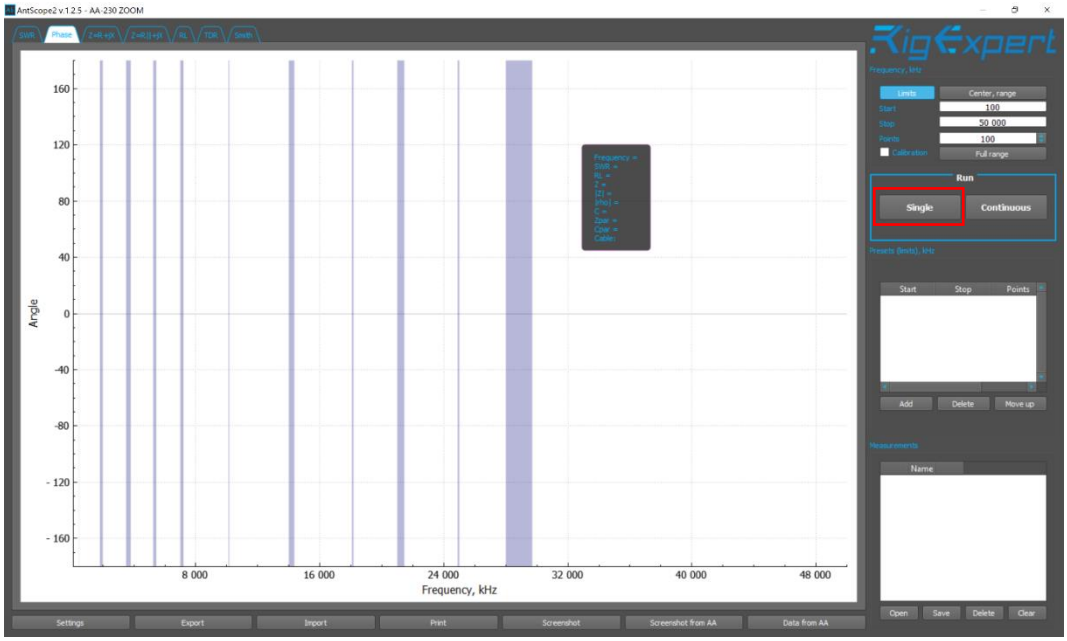


Figure 11-67: AntScope Run > Single

3. For installation records, save the data using the following naming convention <BMT `serial#`> - <`phase`> -`BA Only` and click **Save** in the Save File dialog as shown in Figure 11-68. For example, *50006163 - P1 - BA Only*.

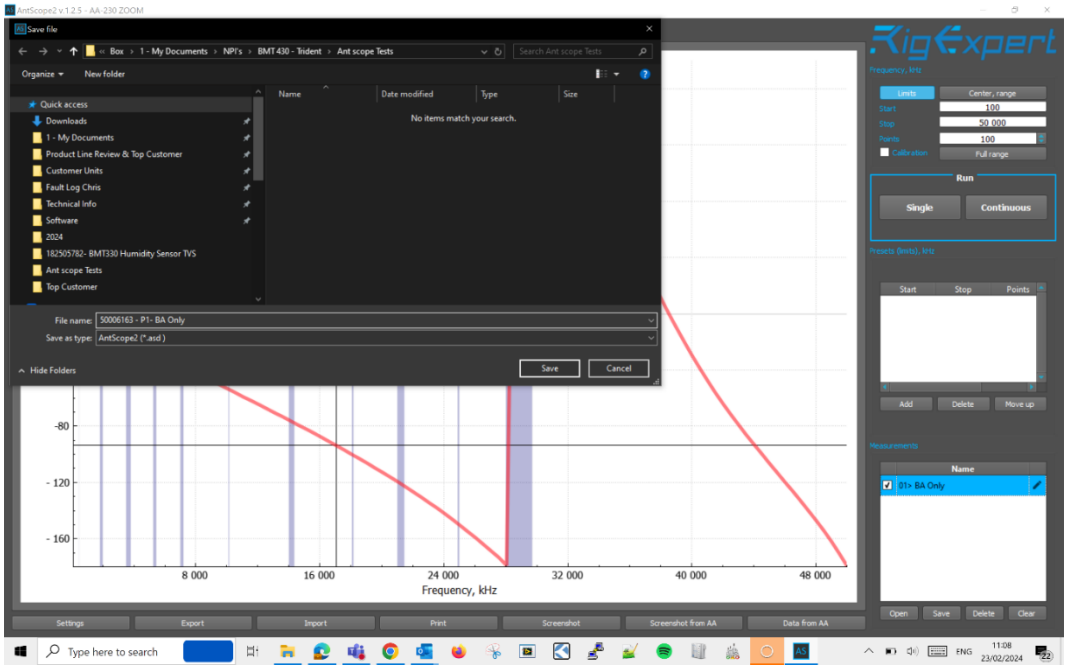


Figure 11-68: Save File "**<serial#> - <phase> -BA Only**"

11.5.2.3.2 Adaptor Installed

1. Install the Bushing Adaptor to the bushing tapping point as outlined in Section 11.4.
2. Connect the Antenna Analyser to the Busing Adaptor using the test lead as shown in Figure 11-69.

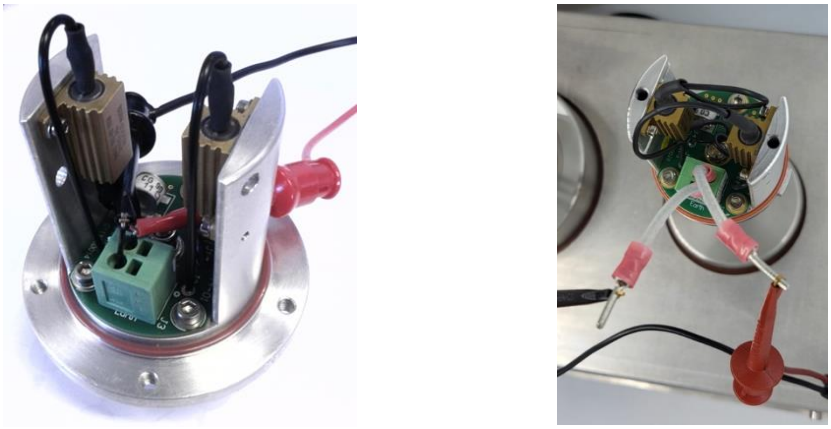


Figure 11-69: Bushing adaptor measurement - BA Installed

3. In the AntScope main screen Run section, click **Single** and wait for the data to be collected.
4. For installation records, save the data using the following naming convention <BMT `serial#`> - <`phase`> -`BA Installed` and click **Save** In the Save File dialog. For example, *50006163 - P1 - BA Installed*.

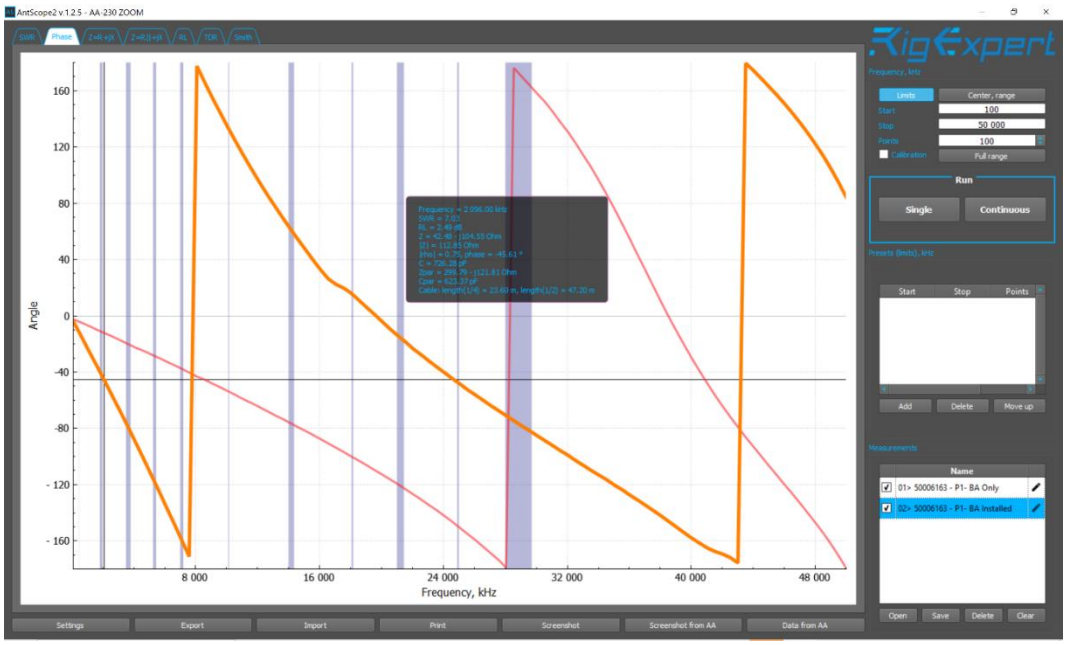


Figure 11-70: Results - typical

5. Verify that the results achieved are similar to that shown in Figure 11-70.

The internal pin of the Bushing Adaptor must make electrical contact with the bushing tapping point for a phase change to occur as demonstrated in the example shown in Figure 11-70.

Without electrical contact, the installation must be aborted, and the original test tap covers refitted.

6. Move the cursor over −45° or as close as possible and record the frequencies of both traces at which they initially intersect the −45° line, for example as shown in Figure 11-71. In this example, 'BA Only' initially intersects the −45° line at 8500 kHz, while the 'BA Installed' intersects at 2100 kHz. This result indicates that the BA is successfully connected to the bushing tapping point, which means that the installation can proceed.

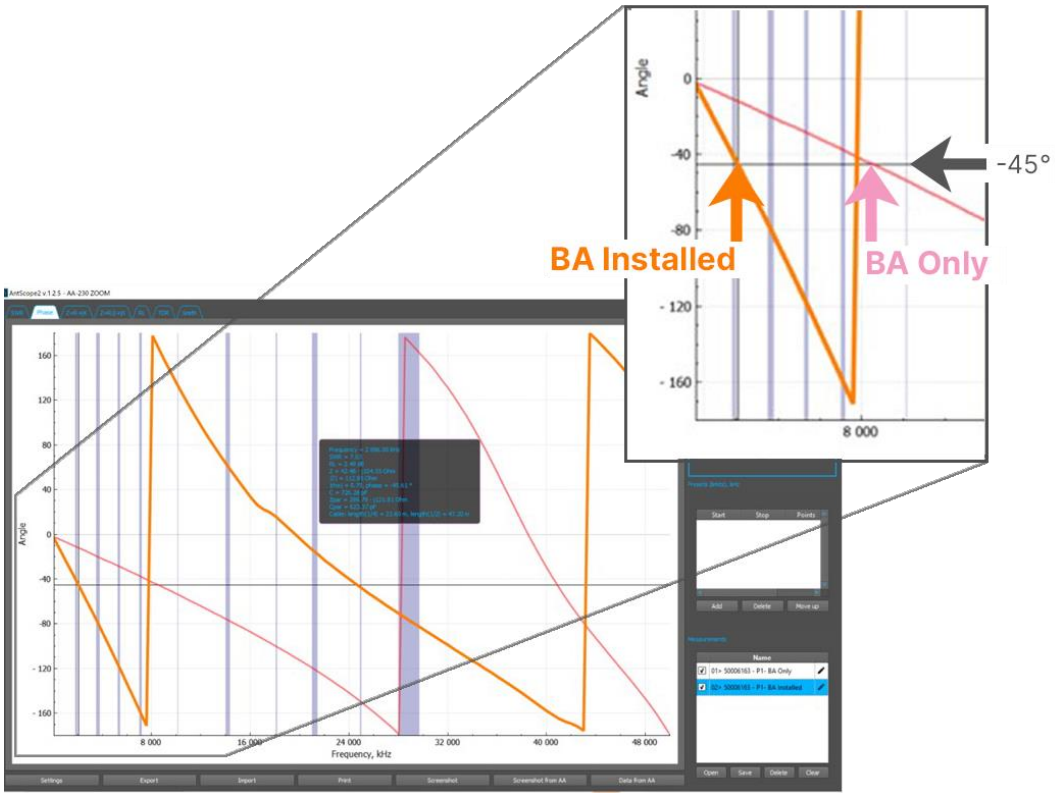


Figure 11-71: Results - typical - frequencies at −45° intersection points

A bushing adaptor is deemed connected when the 'BA Installed' frequency is 50% or less of the 'BA Only' frequency. If the test does not meet this criterion, halt the installation and contact a GE Vernova representative.

7. Repeat all the RigExpert test steps in Section 11.5.2.2 for each Bushing Adaptor installation on the transformer.

11.5.2.4 Bushing Nameplate Information

Record the bushing manufacturer nameplate information in Table 11-10. For each bushing record the:

- Serial Number
- PF%
- C1
- C2
- Temperature

If possible, photograph the bushing nameplates. The bushing nameplate images must be stored with the field service installation report and the antenna analyser data.

Also record the following items in Table 11-10:

- Bushing Adaptor ID.
- Phase that each MMTS has been fitted to during a three single phase installation.

11.5.2.5 Continuity Tests

Complete the following tests for each bushing installed and record the measurements in Table 11-10.

Before commencing the tests, ensure that the enclosure is earthed.

11.5.2.5.1 Shield to Ground Resistance Test

For each Bushing Adaptor input, test the continuity (resistance) between the coaxial cable shield and the ground terminal inside the cabinet as shown in Figure 11-72. It should be less than 5 Ω.

Record this measurement in Table 11-10.

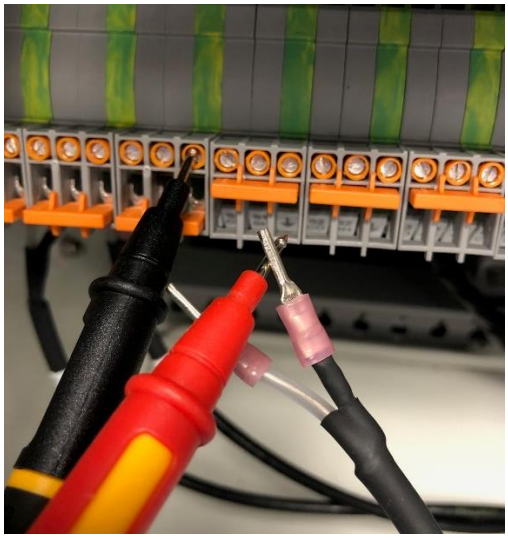


Figure 11-72: Resistance between cable shield and ground

11.5.2.5.2 Coaxial Cable Core and Shield Resistance Test

For each Bushing Adaptor, measure the resistance between the coaxial cable core and the shield as shown in Figure 11-73.

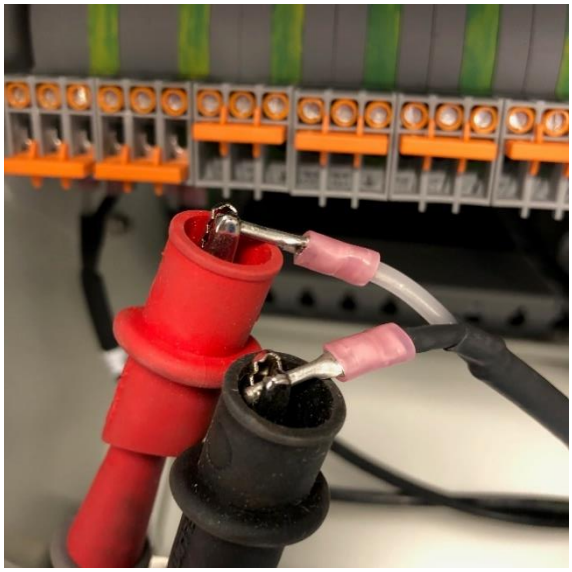


Figure 11-73: Resistance measurement

Record the measurement as [*R1*] in Table 11-10. It should be less than 3000 Ω and within 5% of the Bushing Adaptor resistance.

11.5.2.5.3 Input Resistance Test

For each input, measure the resistance at the core and shield terminals as show in Figure 11-74.

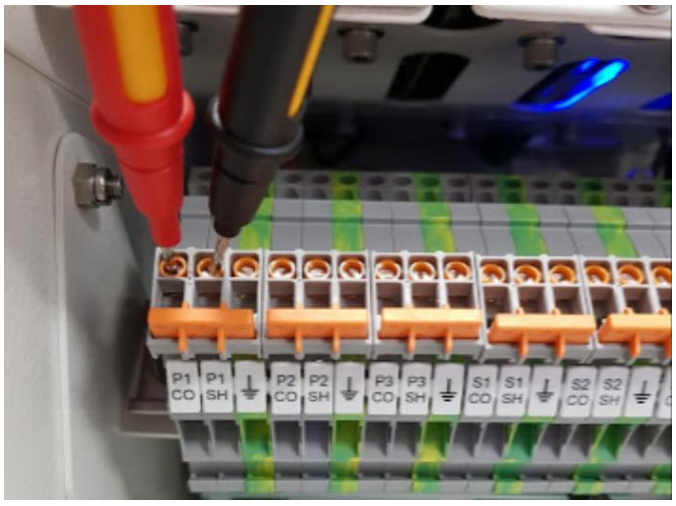


Figure 11-74: R2 resistance measurement

Record the measurement as [*R2*] in Table 11-10. It should be less than 2000 Ω and within 5 % of the input channel impedance.

11.5.2.5.4 Total Resistance Test

Reconnect all the coaxial cables.

Retest the resistance across the two screws of the connector for each available input as shown in Figure 11-75.

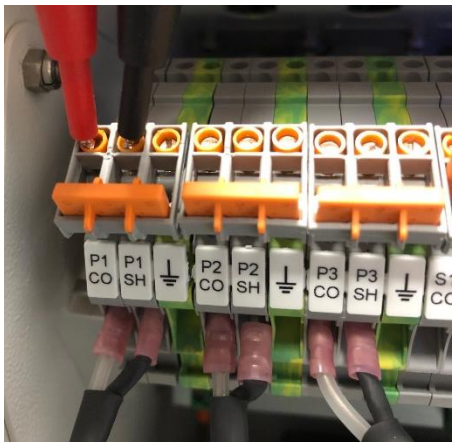


Figure 11-75: R3 total resistance measurement

Ensure that the measurement of [*R3*] is within 5% of the total input resistance [R_{input}] calculated from [*R1*] and [*R2*] for each input.

Note: The total input resistance [R_{input}] is calculated as [R_{input}]=1/(1/[R1] + 1/[R2])

11.5.2.5.5 Input voltage Test

When the transformer is energised and the grounding switches are in the operational position (i.e. not grounded), measure the voltage drop across the core and the shield at the block terminals of the coaxial cables connected to the Bushing Adaptors as shown in Figure 11-76 and record these voltages in Table 11-10. These voltages must be within 0.9 to 1.4 Vrms.

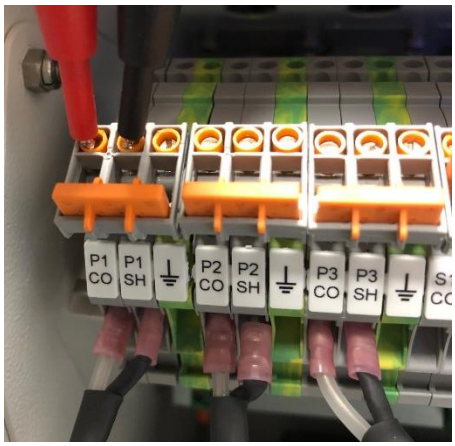


Figure 11-76: Input voltage measurement

Table 11-10: Results

Date: _____		Set 1 A (A1) Ser No:	Set 1 B (B1) Ser No:	Set 1 C (C1) Ser No:	Set 1 D (D1) Ser No:	Set 2 A (A2) Ser No:	Set 2 B (B2) Ser No:	Set 2 C (C2) Ser No:	Set 2 D (D2) Ser No:	Set 3 A (A3) Ser No:	Set 3 B (B3) Ser No:	Set 3 C (C3) Ser No:	Set 3 D (D3) Ser No:
Section	Description												
11.5.2.4	Bushing Adaptor ID												
11.5.2.4	Mag Mount Temperature Sensor (MMTS) # (3 single phase install)												
11.5.2.5 .5	Bushing Adaptor Internal Pin Correctly Installed (Yes / No)												
11.5.2.4	Manufacturer Nameplate Power Factor % [PF%]												
11.5.2.4	Manufacturer Nameplate Capacitance [C1]												
11.5.2.4	Manufacturer Nameplate Capacitance [C2]												
11.5.2.4	Manufacturer Nameplate [T]												
11.5.2.5 .1	Shield to ground resistance Test (<5 Ohm)												

11.5.2.5 .2	Coaxial cable core and shield resistance Test [R1] (<3000 Ω)												
11.5.2.5 .3	Input resistance Test [R2] (<2000 Ω)												
11.5.2.5 .4	Total resistance Test [R3]												
11.5.2.5 .4	[R3] within 5% of the [R_{input}] (Yes or No)												
11.5.2.5 .5	(when the transformer is energised) Input voltage Test Expected 0.9 – 1.4 v RMS												

12 COMMUNICATIONS OPTIONS

Various communication options are available for the product as shown in Figure 12-1.

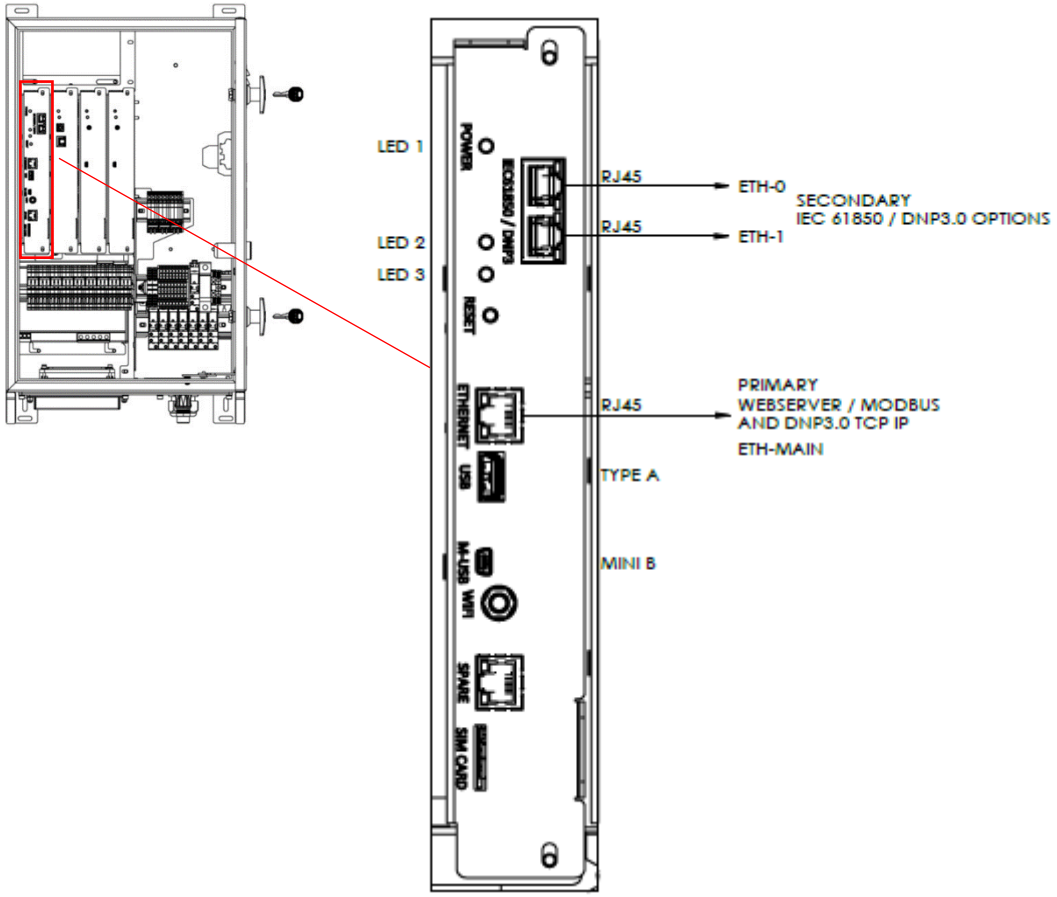


Figure 12-1: Controller card – communication options

The product supports simultaneous communication on several channels – up to three masters over Ethernet, and one master on each of the serial connections (including the USB connection) as listed in Table 12-1.

Auxiliary customer equipment can be connected via an RS-485 connection located on the DIN rail. See Section 8.3 for +24 V customer power connection.

Table 12-1: Product communications channels

Physical Layer	MODBUS/ RTU	MODBUS/ TCP	DNP3.0	IEC61850-2
USB (OTG)	-	✓	-	-
RS-485 2-wire	✓	-	✓	-
RS-485 4-wire	✓	-	✓	-
GPRS / 3G	-	✓	-	-
Ethernet	-	✓	✓	✓

The above options are correct at the time of publication, but additional options may become available. Please contact the GE Vernova Service Centre for further information.

12.1 Configuration

Use the HMI to configure the communications options. Refer to Chapter 6 of the BMT 430 Operator Guide for more details on using the HMI. Press **Communication Settings** from the local HMI or select **Settings** > **Communications** from the remote HMI as shown in Figure 12-2.

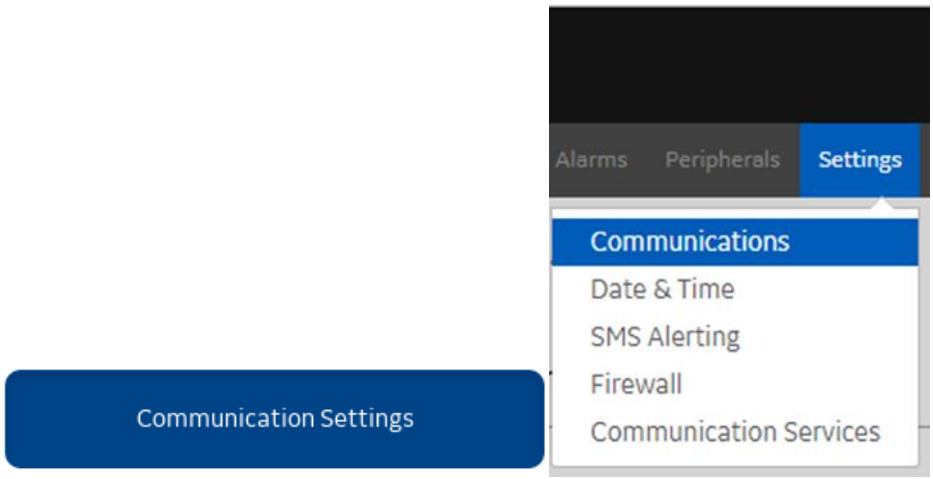


Figure 12-2: Local HMI and Remote HMI: Communication Settings

The Communication Settings page opens on the parameters for configuring **Serial** communications as shown in Figure 12-3.

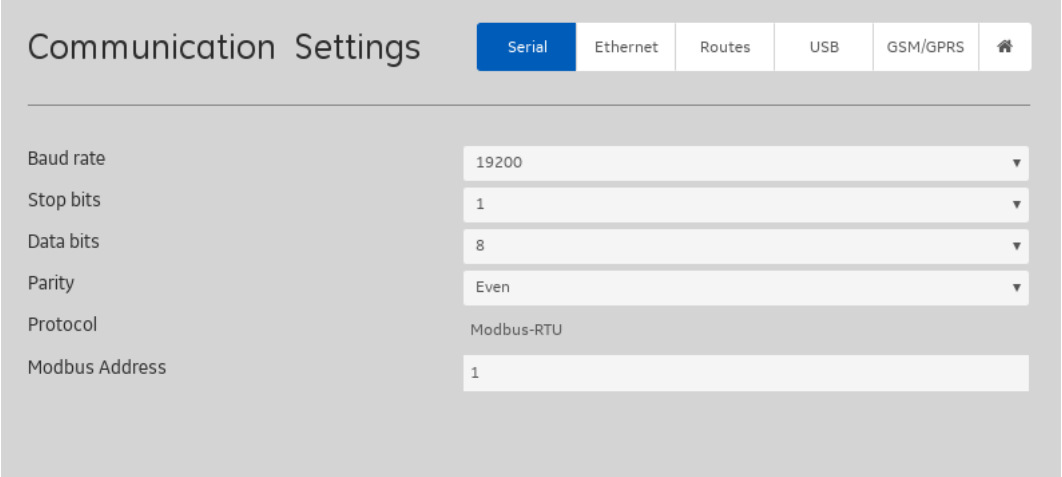


Figure 12-3: Serial settings

Select **Ethernet** on the local HMI. The default settings for Ethernet configuration are shown in Figure 12-4.

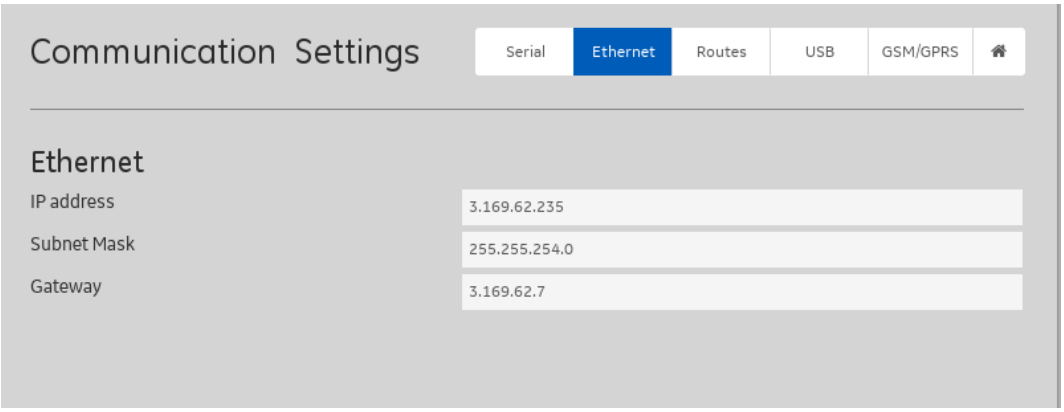


Figure 12-4: Ethernet settings

Select **Routes** on the local HMI. The default settings for routing are shown in Figure 12-5.

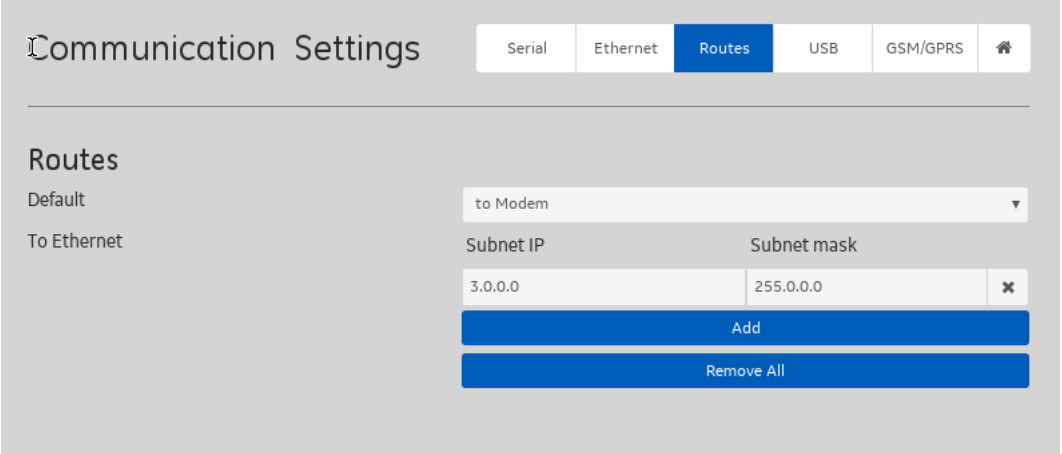


Figure 12-5: Routing settings

Select **USB** on the local HMI. The default settings for the Mini USB are shown in Figure 12-6.

Figure 12-6: USB settings

Select **GSM/GPRS** on the local HMI. The default settings for GSM/GPRS configuration are shown in Figure 12-7.

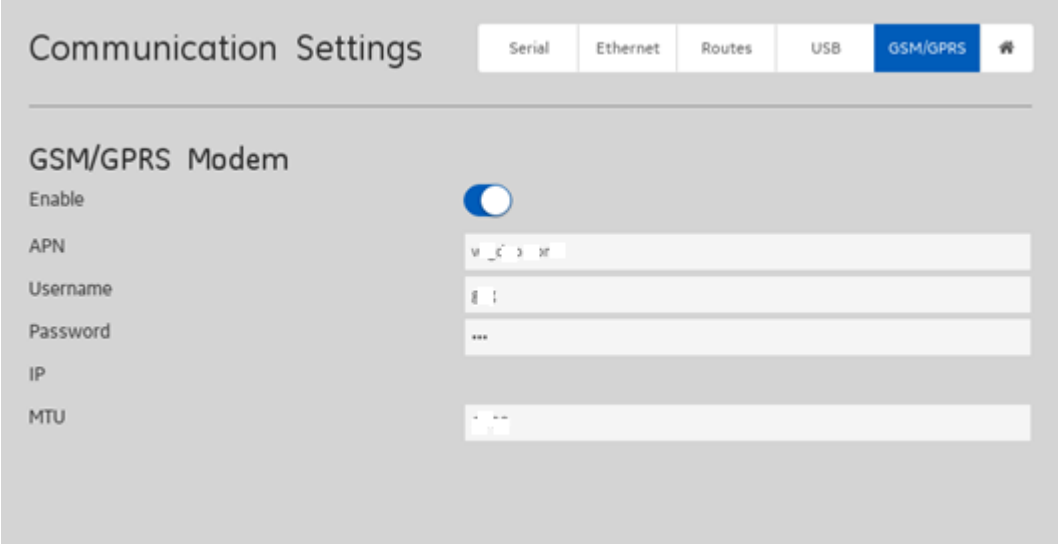


Figure 12-7: GSM/GPRS settings

12.2 RS-485 Modbus (standard)

The standard RS-485 connection is routed to the DIN rail from the main PCB as shown in Figure 12-10.

12.2.1 Configuration

The default software settings on the local HMI for an RS-485 configuration is shown in Figure 12-8.

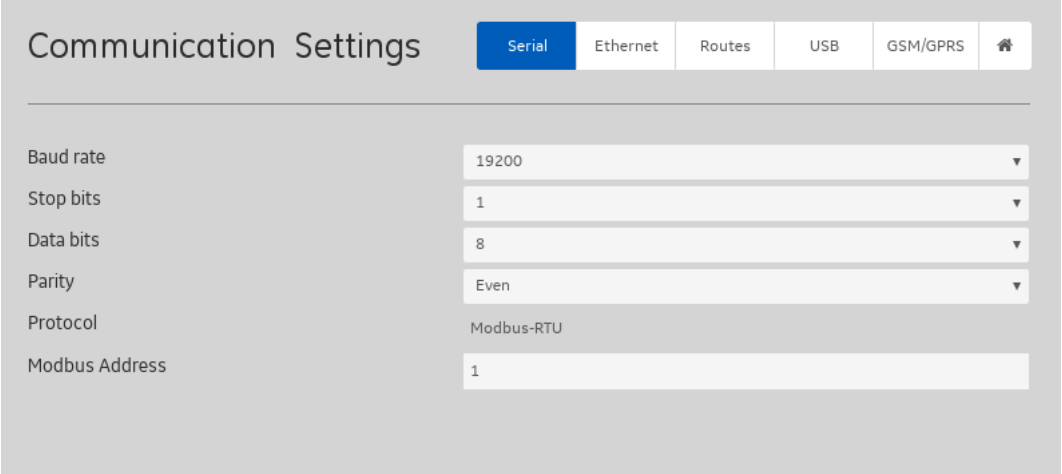


Figure 12-8: RS-485 configuration

Note: Ensure that the required RS-485 settings are entered on the Serial Communications page of the HMI.

12.2.1.1 Two Wire

RS-485 2-wire communications is configured by setting the jumper at P24 to 'Half Duplex' as shown in Figure 12-9.

Figure 12-9: Controller board P24 jumper set to 'Half Duplex'

The position of terminals A, B, Y, Z and the isolated ground (ISO) for Modbus RS-485 communications as used in the product is shown in Figure 12-10.

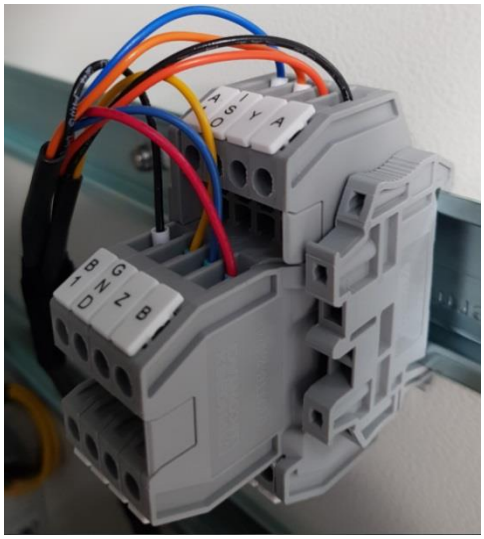


Figure 12-10: RS-485 connection block – top

To configure the unit for 2-wire communications, connect to A & B and connect link wires between A & Y and B & Z as shown in Figure 12-11. Note: The isolated ground (ISO) connection is optional but improves immunity to noise.

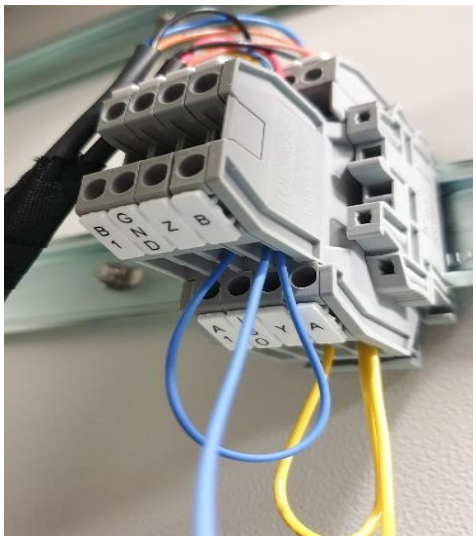


Figure 12-11: RS-485 connection block – bottom (showing link wires)

An example configuration for RS-485 2-wire is shown in Figure 12-12.

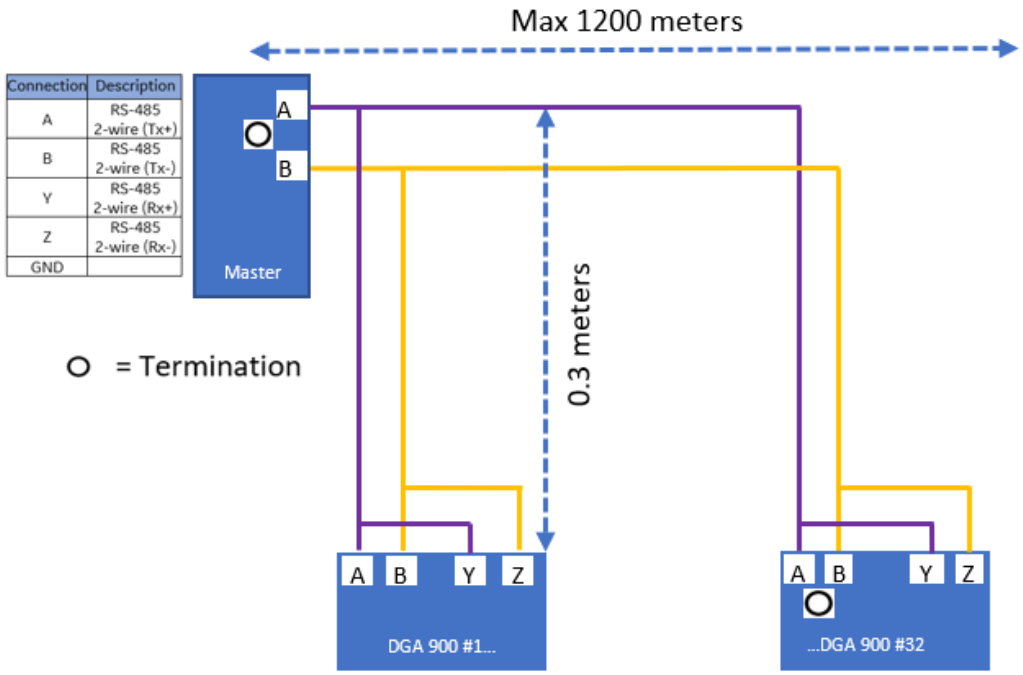


Figure 12-12: RS-485 2-wire configuration

The RS-485 terminal connections are listed in Table 12-2. For 2-wire communication, link wires are required between A&Y and B&Z on the connector block.

Table 12-2: RS-485 2-wire terminal connections

Connection	Description
A	RS-485 2-wire (+)
B	RS-485 2-wire (-)
Y	RS-485 2-wire Jumper A and Y
Z	RS-485 2-wire Jumper B and Z
ISO	Isolated Ground
A1	Transopto 2-wire (+)
B1	Transopto 2-wire (-)
GND	Ground

Note: Ensure that the required RS-485 settings are entered on the Serial Communications page of the HMI.

If the RS-485 bus exceeds 237 meters, it is necessary to use termination resistors. The BMT 430 has 120 Ω termination resistors provided as standard. Termination resistors are fitted to the master unit and the final bus slave unit only. Termination resistors are enabled/disabled by adding/removing the jumper on P22 *or* P23 as outlined in Table 12-3.

Table 12-3: BMT 430 termination requirements for 2-wire RS-485 network

Termination...	Jumper Status
required	Only *one* jumper fitted either on P22 *or* P23
not required	All jumpers removed from P22 and P23

If the BMT 430 is the last device in the chain, termination should be enabled. If the BMT 430 is in the middle of an RS-485 bus, termination should *not* be enabled. Where the BMT 430 is the last device in the chain, RS-485 two wire requires only one jumper as outlined above and as shown , for example as fitted on P22, in Figure 12-13.

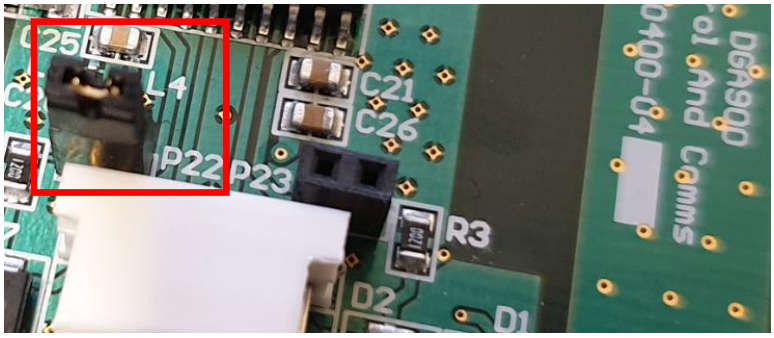


Figure 12-13: Controller board with termination jumper fitted on P22

12.2.1.2 Four Wire

RS-485 4-wire communications is configured by setting the jumper at P24 to 'RX-Enabled' as shown in Figure 12-14.

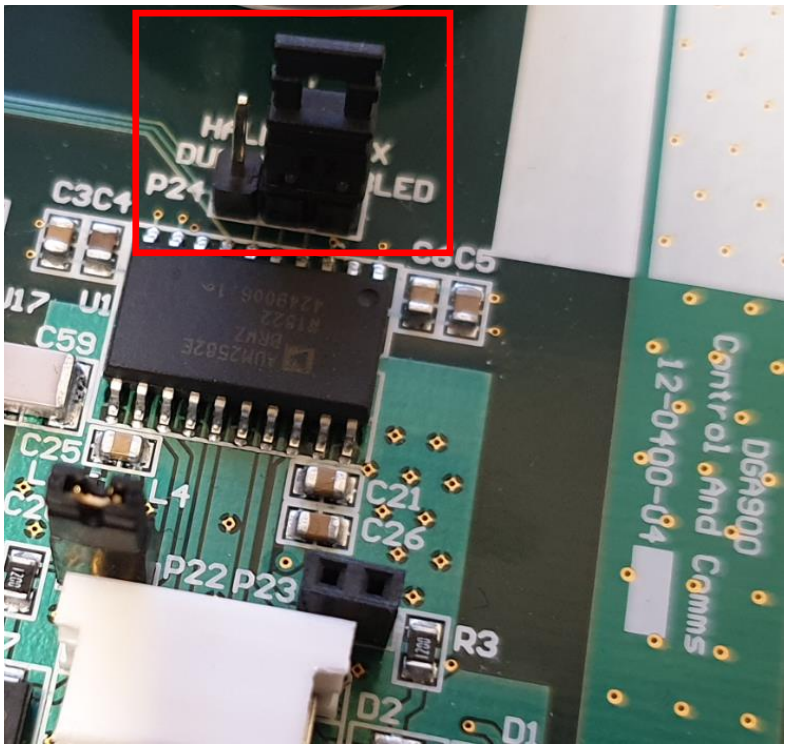


Figure 12-14: Controller board P24 jumper set to 'RX Enabled'

The position of terminals A, B, Y, Z and the ISO for Modbus RS-485 communications as used in the product is shown in Figure 12-15.

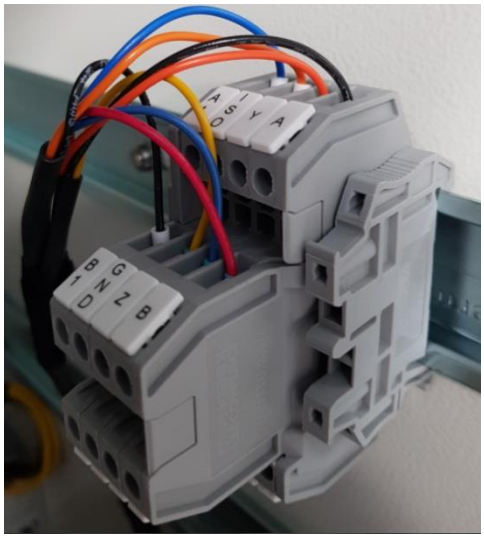


Figure 12-15: RS-485 connection block – top

An example configuration for RS-485 4-wire is shown in Figure 12-16.

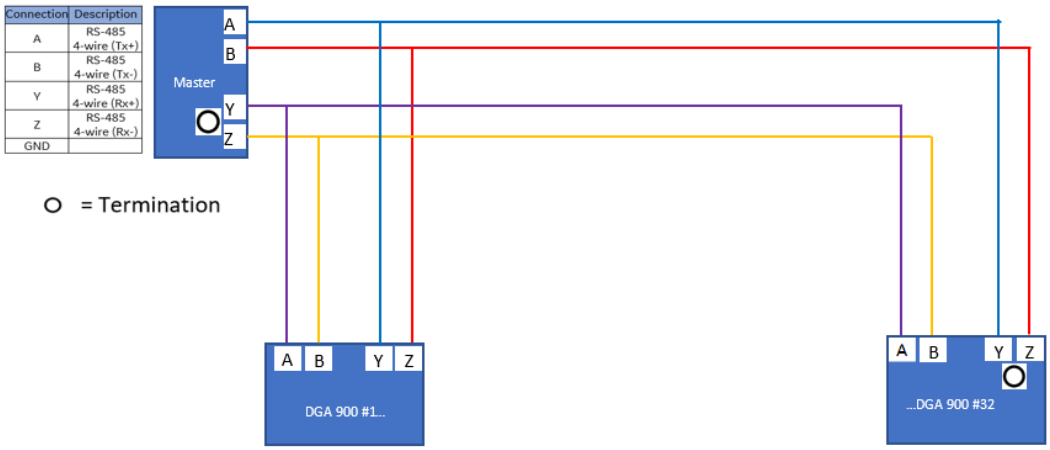


Figure 12-16: RS-485 4-wire configuration

The RS-485 terminal connections are listed in Table 12-4. Note: The isolated ground (ISO) connection is optional but improves immunity to noise.

Table 12-4: RS-485 4-wire terminal connections

Connection	Description
A	RS-485 4-wire (Tx+)
B	RS-485 4-wire (Tx-)
Y	RS-485 4-wire (Rx+)
Z	RS-485 4-wire (Rx-)
ISO	Isolated Ground
A1	Transopto 2-wire (+)
B1	Transopto 2-wire (-)
GND	Ground

Note: Ensure that the required RS-485 settings are entered on the Serial Communications page of the HMI.

If the RS-485 bus exceeds a couple of hundred meters, it is necessary to use termination resistors. The BMT 430 has 120 Ω termination resistors provided

as standard. Termination resistors are fitted to the master unit and the final bus slave unit only. Termination resistors are enabled/disabled by adding/removing the respective jumper from P22 *or* P23. If the BMT 430 is the last device in the chain, the opposite pair should have termination enabled. Where termination is required, ensure that a jumper is fitted to P22 *or* P23 (i.e. remove only one jumper as outlined in Table 12-5).

Table 12-5: BMT 430 termination requirements for 4-wire RS485 network

Termination…	Jumper Status		
required	Connection A B	Or	Connection Y Z
	P23 fitted		P22 fitted
not required	All jumpers removed from P22 and P23		

Termination is only required if the BMT 430 is the last slave. If the BMT 430 is in the middle of an RS-485 bus, termination should *not* be enabled. If termination is not required, remove the jumpers from P22 *and* P23. Where the BMT 430 is the last device in the chain, RS-485 4-wire requires only one jumper for termination as outlined above and as shown, for example as fitted on P22, in Figure 12-17.

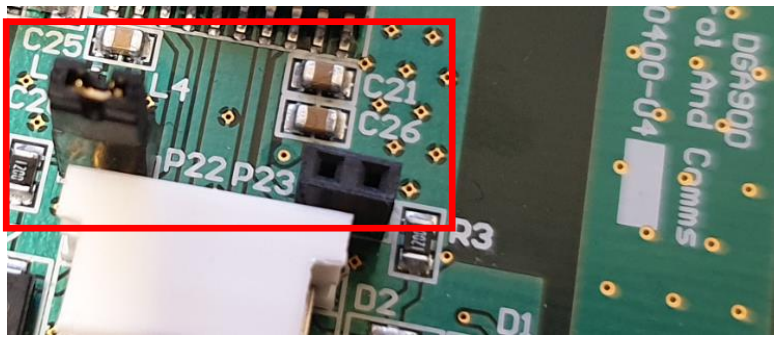


Figure 12-17: Controller board with termination jumper fitted on P22

12.3 DNP3

Refer to documents:

CG-063 - DGA 900 family & BMT 430 - DNP3 over TCP RS-485

CG-111 - DGA 900 - Points map for communications protocols

12.4 IEC 61850

Refer to documents:

CG-111 - DGA 900 - Points map for communications protocols

CG-070 / WI-053– DGA 900 – IEC 61850 Edition 2

12.5 Modbus

CG-111 - DGA 900 - Points map for communications protocols

13 COMMISSIONING

This section details essential operational tasks and all first start-up procedures that need only be performed once as part of the commissioning phase to prepare the product for deployment in the field. Refer to the relevant sections below depending on the installed options.

Note: A familiarity with the interface is assumed. If not, refer to the 'MA-044 - BMT 430 - Operator Guide' for login details and general HMI functionality.

Installation and commissioning must be performed by trained field service engineers only. Resetting certain attributes may lead to data loss if the product is already operational.

The product must undergo BMT commissioning. This section outlines parameters to be verified while the transformer is energised and running at operational conditions regarding the grid voltage (phase and amplitude).

Note: Transformer load is irrelevant for commissioning.

Note: Administrator level access is required to view settings, but to make changes a factory POTM is required to enable Service mode.

Note: While the transformer is offline, enable Service mode to switch Alarms off to prevent nuisance alarms occurring until the transformer is re-energised.

WARNING: The transformer is live during this process. Ensure that the Bushing Adaptor cables are undamaged as far as can be observed before approaching the product and always maintain a safe working area.

All settings should be checked against the customer specific workflow created for each individual bushing system and recorded in the Commissioning Report (and to be stored with the Installation Report).

Bushing options are listed in the HMI as follows:

- Set 1 – refers to three primary bushings supported by the BMT card #1
- Set 2 – refers to three secondary bushings supported by BMT card #1
- Set 3 – refers to three tertiary bushings supported by BMT card #2

This provides capacity to monitor up to nine bushings across two BMT cards.

Note: Bushing sets 1, 2 and 3 are sometimes referred to as Primary, Secondary & Tertiary bushings respectively.

13.1 Factory Settings

Select **Service** > **Factory** to view the Factory Settings page as shown in Figure 13-1.

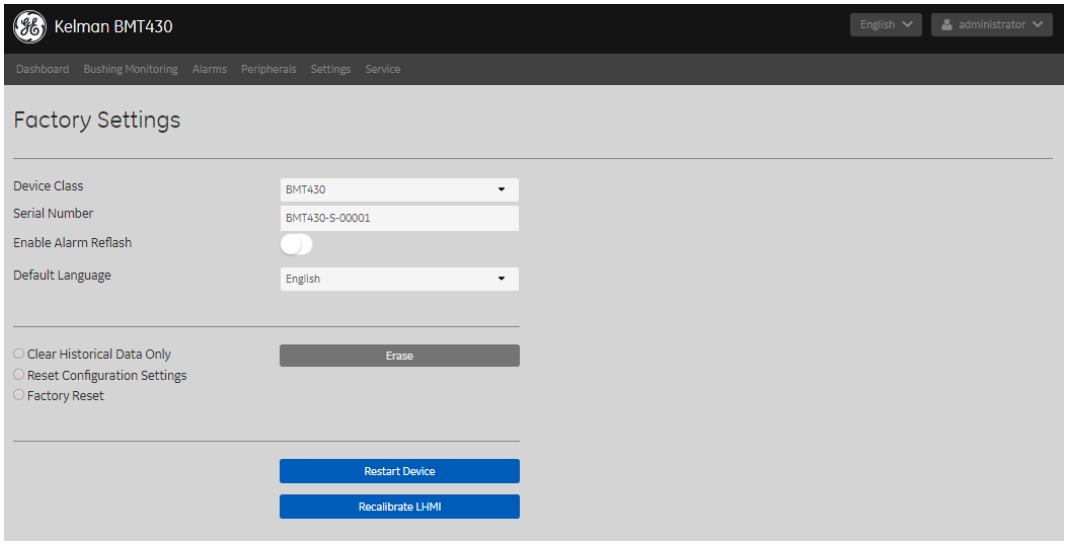


Figure 13-1: Service > Factory Settings

Select **Clear Historical Data Only** to erase all historical data.

13.1.1 Verification of BA settings

To verify the measurement, use the Administrator login and factory password of the month (POTM) to gain access to service mode. In the HMI, select **Bushing Monitoring > Configuration – Bushing Adaptor Profiles.**

An example of a load impedance is shown in Figure 13-2.

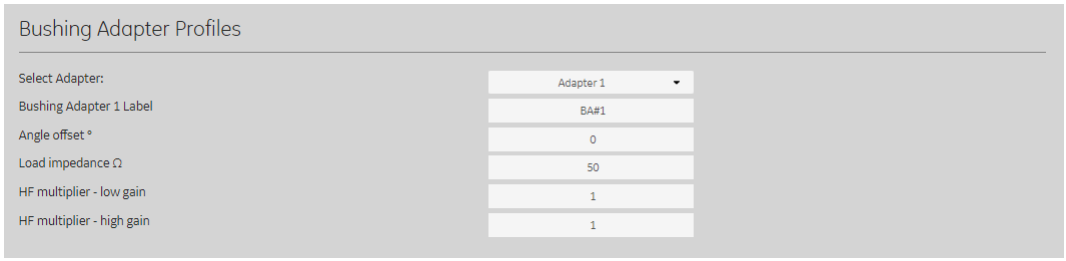
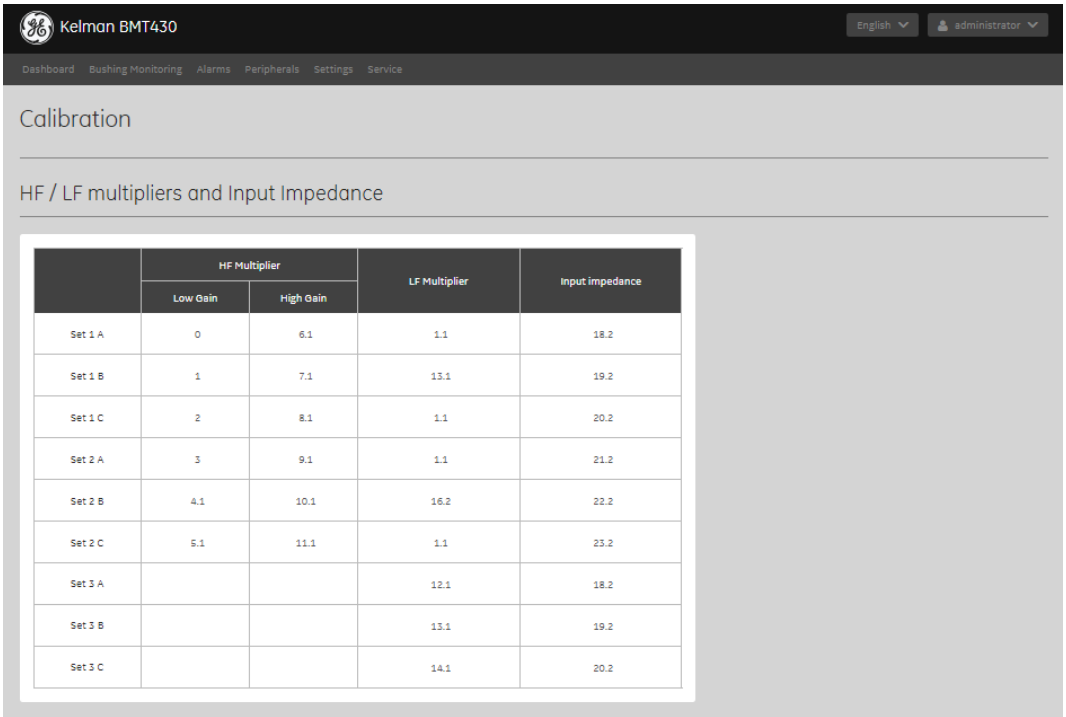


Figure 13-2: Bushing Adaptor Calibration Data

13.1.2 Verification of BMT input impedance

To verify the measurement, use the Factory Login, press **Bushing Monitoring > Calibration – 'HF / LF multipliers and Input Impedance'**. An example of input impedance is shown in Figure 13-3.



	HF Multiplier		LF Multiplier	Input impedance
	Low Gain	High Gain		
Set 1 A	0	6.1	1.1	18.2
Set 1 B	1	7.1	13.1	19.2
Set 1 C	2	8.1	1.1	20.2
Set 2 A	3	9.1	1.1	21.2
Set 2 B	4.1	10.1	16.2	22.2
Set 2 C	5.1	11.1	1.1	23.2
Set 3 A			12.1	18.2
Set 3 B			13.1	19.2
Set 3 C			14.1	20.2

Figure 13-3: Bushing Monitoring > Calibration – HF / LF multipliers and Input Impedance

13.2 Configuration

Select **Bushing Monitoring > Configuration** as shown in Figure 13-4 and ensure that the following parameters are correct:

- Operational Frequency
- Monitoring mode – **Three phase transformer** or **Bank of single-phase transformers**
- Temperature sensor source – **4-20 mA Top oil Sensor** or **CAN bus Top oil sensor**
- Operational Voltage Format – **Peak to Ground** or **RMS**
- Set 1, Set 2 & Set 3 Operational Voltage kV (where applicable)

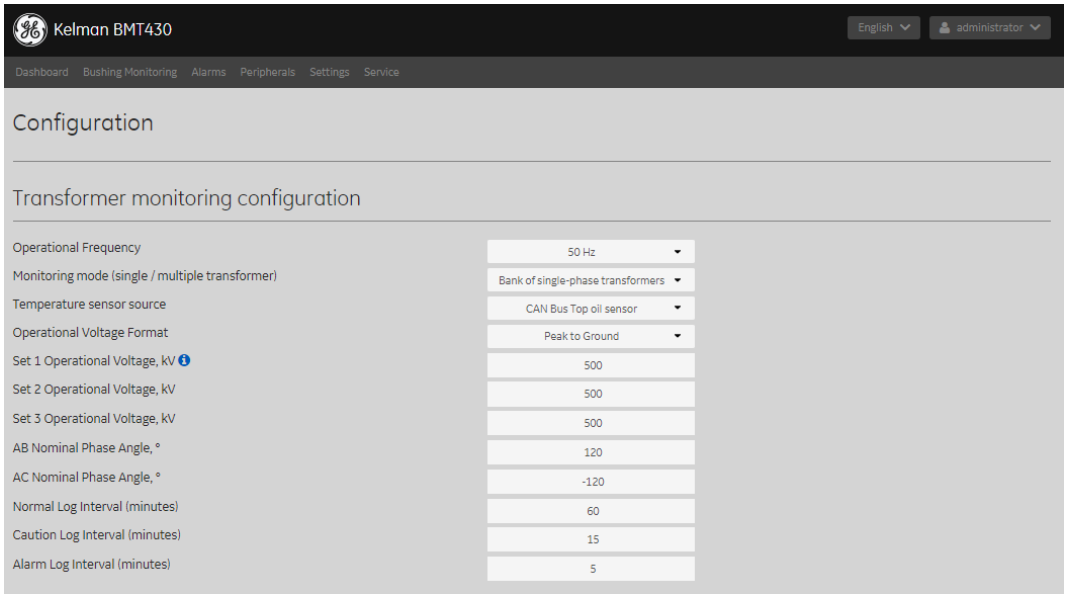


Figure 13-4: Bushing Monitoring > Configuration

13.2.1 Voltage Measurement

Measure the voltage across each bushing adaptor input on the terminal rail as shown in Figure 13-5. Each input should measure between 0.9 V rms to 1.4 V rms.

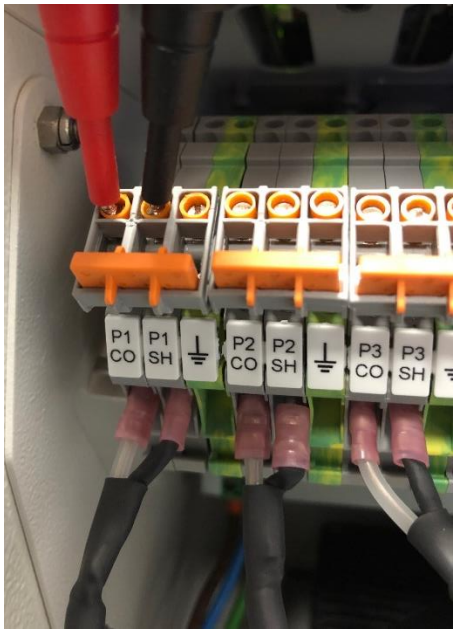


Figure 13-5: Voltage Measurement

13.2.2 Capacitance Change C1%

To ensure that the configuration is correct for this system:

- Select **Bushing Monitoring > Live Measurement** as shown in Figure 13-6 and ensure that the 'Expected Current mA' for each phase is within 10% of the measured current mA reading.

Note: Repeat for all three sources – Set1, Set2 and Set3 leakage currents.

Troubleshooting Tip: If there is a ±40% difference between the expected and measured C1 values, the likely reason for this is an incorrect 'Operational Voltage Format' (see Section 13.2 and check with the customer to confirm Peak to ground or RMS).

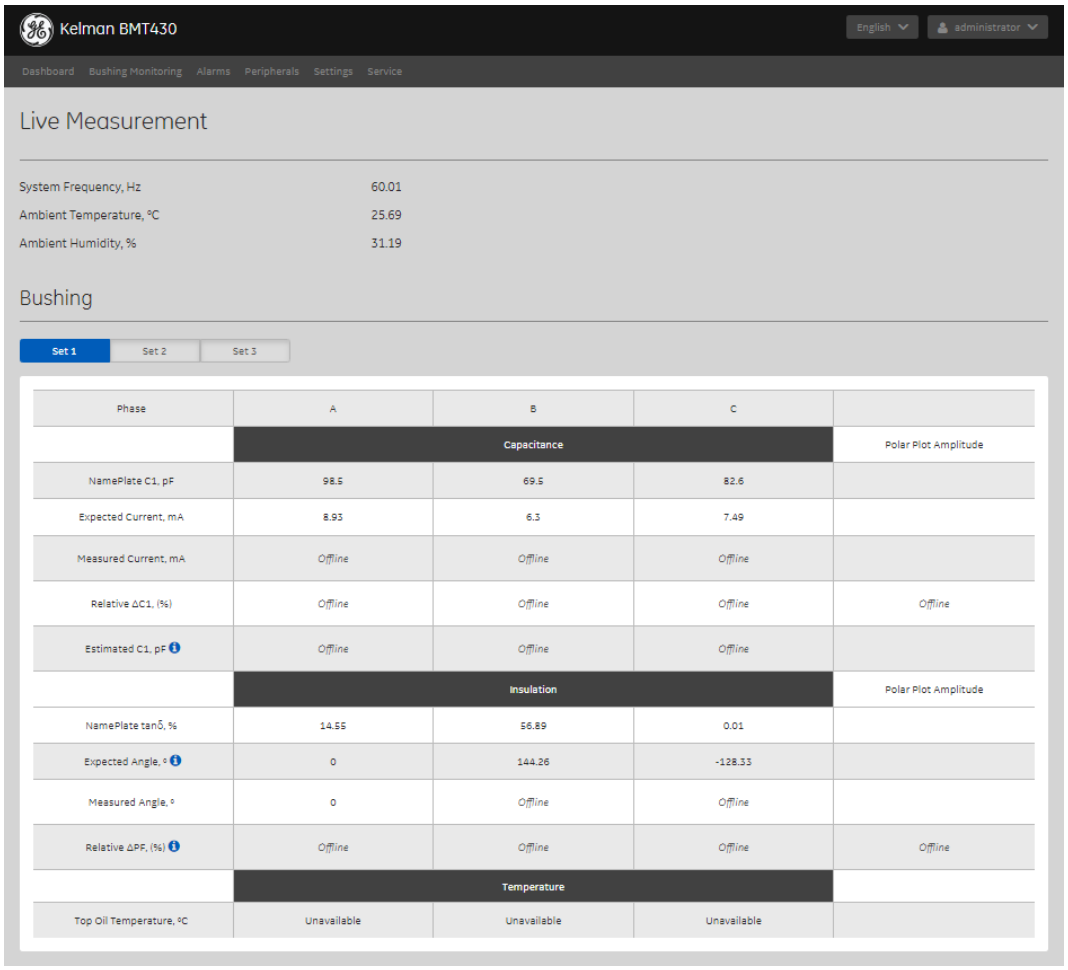


Figure 13-6: Bushing Monitoring > Live Measurement – Bushing: Set 1, Set 2 & Set 3

Note: Refer to 'Section 6.6: Bushing Monitoring' in the 'MA-044 - BMT 430 - Operator Guide' for operational guidance on the settings below.

- Select **Bushing Monitoring > Configuration** and ensure that bushing Set 1, Set 2 & Set 3 Operational voltage is correct.
- Select **Bushing Monitoring > Configuration** and ensure that the Bushing Profiles Nameplate nominal values are correct and assigned to the correct bushing.
- Select **Bushing Monitoring > Configuration** and ensure that the Bushing Adaptor Calibration Data load impedance is set correctly for each bushing profile.

If the C1% measurement is above 5% after these checks, please contact the GE Vernova customer support team.

13.2.3 Tan δ (Power Factor change)

To verify that the wiring is correct and that initial alarms levels are appropriate for the system with instantaneous Tan δ measurements:

- Select **Bushing Monitoring > Configuration** as shown in Figure 13-7 to verify the 'Exponential Moving Average Configuration'. Ensure that:
  - 'Daily Moving Average for Phase Angles Enable' is **Off**
  - 'Phase Angle' is **100** (factory default is 10000)

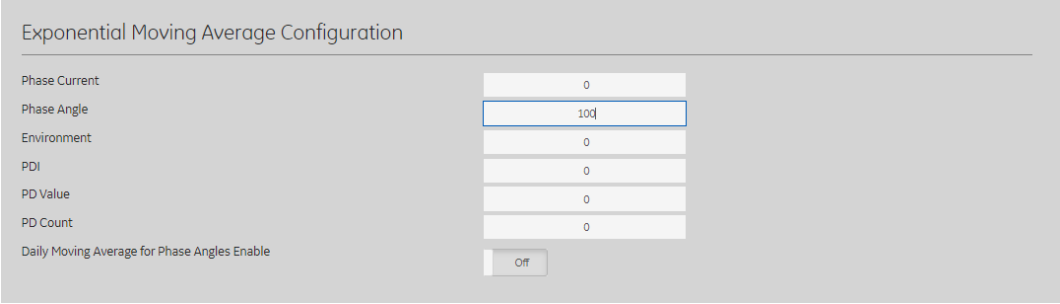


Figure 13-7: Exponential Moving Average Configuration

- Select **Bushing Monitoring > Live Measurement** as shown in Figure 13-8 to verify the 'Measured Phase Angle'. Ensure that:
  - the measured angles are within 2 degrees of the expected angles. If the phase angles are measuring more than 2 degrees, contact GE Vernova Technical Support for further guidance. If applicable, check the same on Set 2 and Set 3 bushings.
  - the imbalance (polar plot amplitude) for tan δ is less than 120%. If the tan δ is more than 120%, the alarm limit should be adjusted. The alarm is recommended to be set at 50% above the highest measurement. If applicable, check the same on Set 2 and Set 3 bushings.

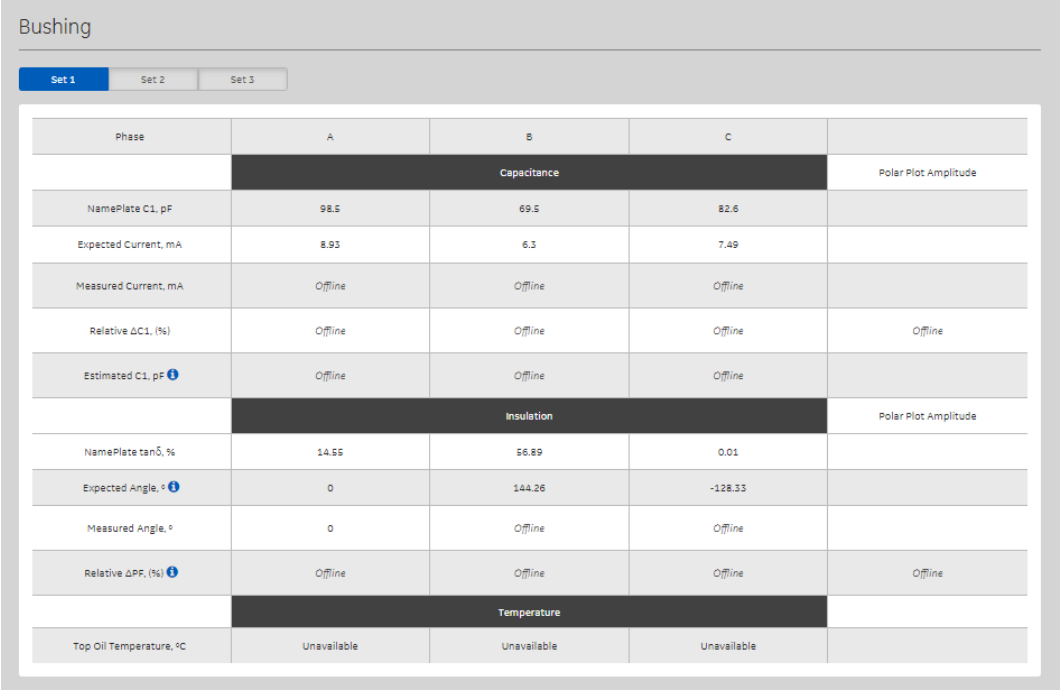


Figure 13-8: Measured Phase Angle

To change the **Polar Plot PF%** alarms:

- Select **Alarms > Bushing Alarm Configuration > Set 1 Polar Plot PF%** as shown in Figure 13-9 to adjust the alarm as required for Set 1, High-High and High limits.

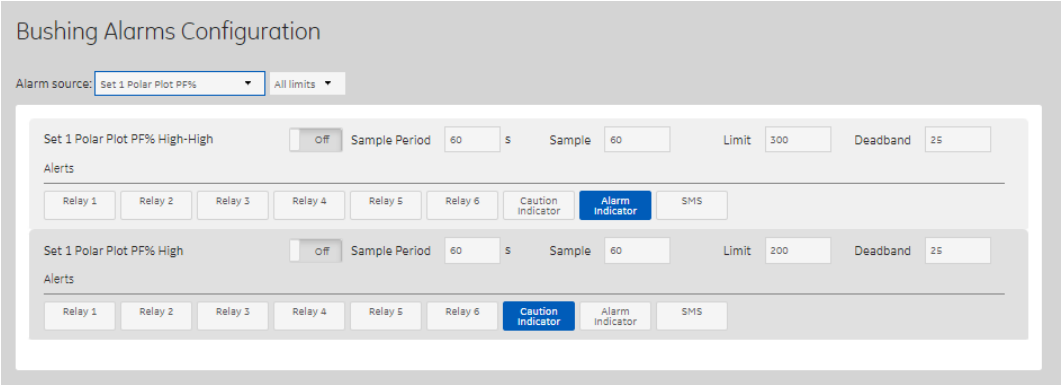


Figure 13-9: Bushing Alarms Configuration

Repeat adjustments as appropriate for Set 2 High-High and High limits.

To disable instantaneous Tan δ measurements:

- Select **Bushing Monitoring > Configuration** as shown in Figure 13-10 to verify the 'Exponential Moving Average Configuration'. Ensure that:
  - 'Daily Moving Average for Phase Angles Enable' is **On**
  - 'Phase Angle' is **10000**

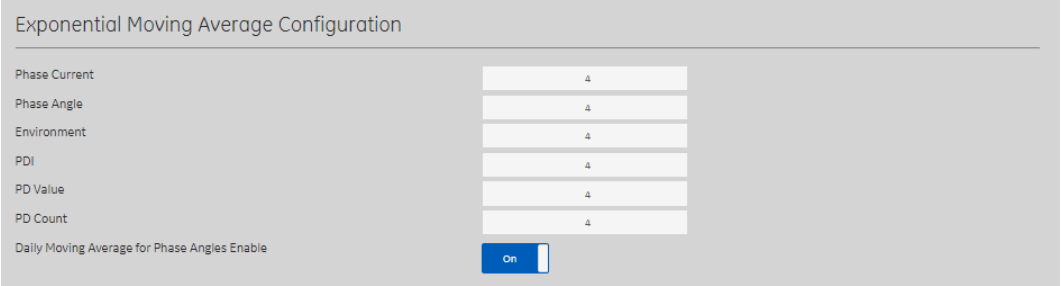


Figure 13-10: Exponential Moving Average Configuration

13.2.4 PD Live HF Noise Threshold Measurement

The HF input noise can range over many orders of magnitude depending on the transformer, so the 'Live HF Noise' is used to estimate the input noise levels and consequently adjust the input gains.

Note: PD is applicable only to Set 1 (Primary) bushings (high voltage).

- Select **Bushing Monitoring > Configuration** and scroll down to the 'HF Setup' section as shown in Figure 13-11.

Figure 13-11: HF Setup

If the 'Live Noise' value exceeds 180, select **High gain** for each affected channel as shown in Figure 13-11.

13.2.5 PDI Associated Power Measurement

- Select **Bushing Monitoring > Live Measurement** and scroll down to the 'PD' section with the Set 1 tab active as shown in Figure 13-12. Ensure that:
  - Associated Power (PDI) measurement is less than 800 mW for each phase. If above 800 mW, the PDI Polar Plot alarm levels must be adjusted.

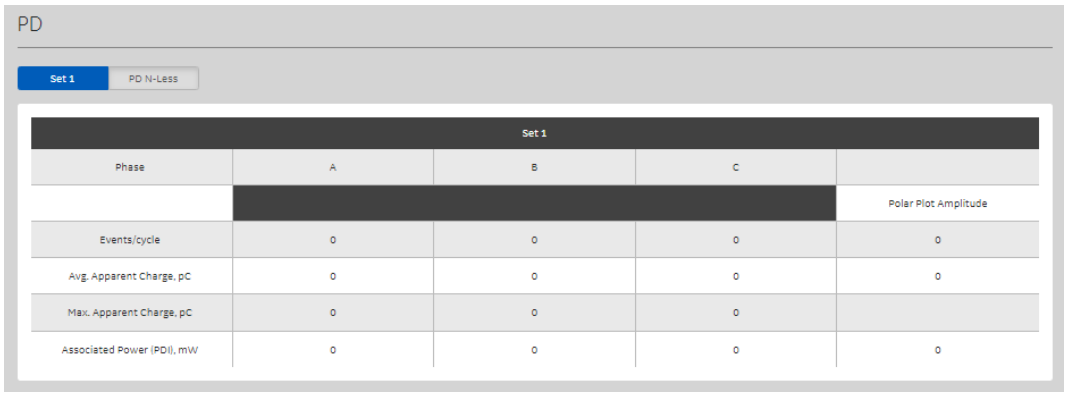


Figure 13-12: PD > Set 1 > Associated

To adjust the Associated Power Measurement alarm:

- Select **Alarms > PD Alarms Configuration** and expand the **Set 1 PDI** alarms as shown in Figure 13-13.
  - Adjust the **High** & **High-High** limits as required.

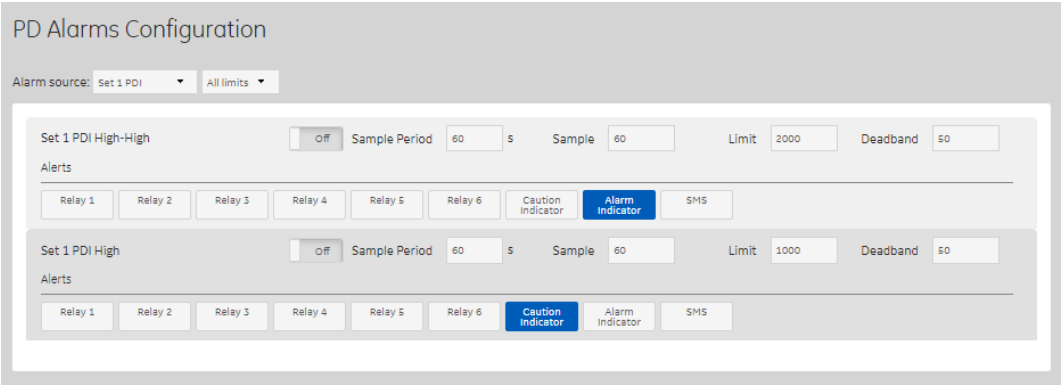


Figure 13-13: PD Alarms Configuration > Set 1 PDI

13.2.6 PD Average Apparent Charge Measurement

- Select **Bushing Monitoring > Live Measurement** and scroll down to the 'PD' section with the **Set 1** tab active as shown in Figure 13-14. Ensure that:
  - Avg Apparent Charge measurement is below 800 pC for each phase. If above 800 pC, the PD Polar Plot Level Alarm must be adjusted.

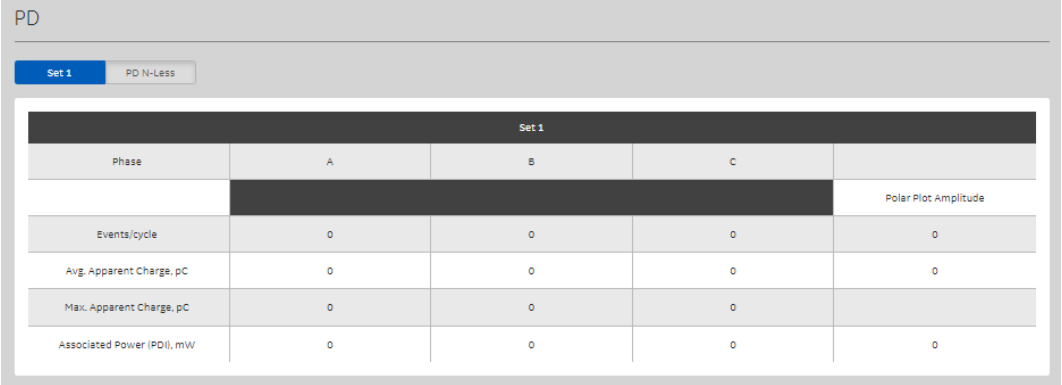


Figure 13-14: PD > Set 1 > Avg Apparent Charge

To adjust the Associated Power Measurement alarm:

- Select **Alarms > PD Alarms Configuration** and expand the **Set 1 PD value** alarms as shown in Figure 13-15.
  - Adjust the **High & High-High** limits as required.

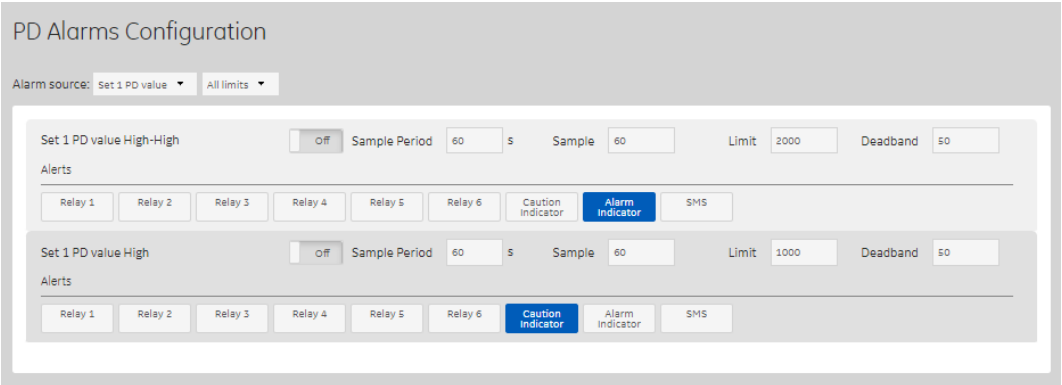


Figure 13-15: PD Alarms Configuration > Set 1 PD value

13.2.7 PD Max Apparent Charge Measurement

- Select **Bushing Monitoring > Live Measurement** and scroll down to the 'PD' section with the **Set 1** tab active as shown in Figure 13-16. Ensure that:
  - PD Max Apparent Charge measurement is below 600 pC for each phase. If above 600 pC, the PD Max Level Alarm must be adjusted.

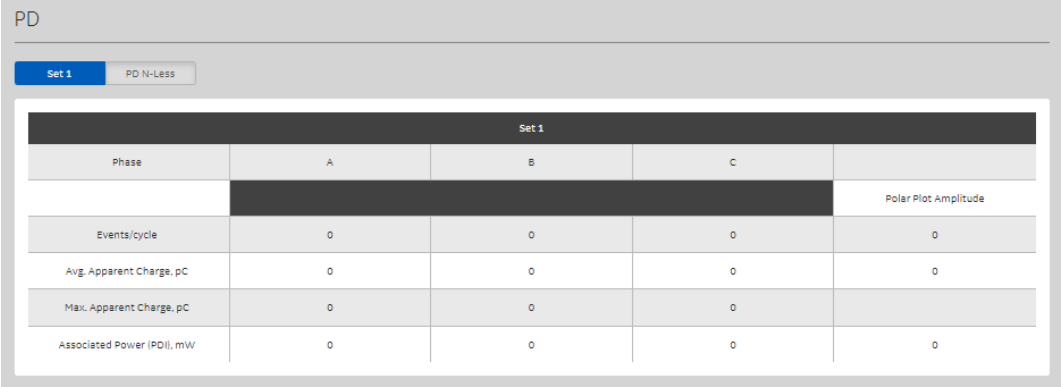


Figure 13-16: PD > Set 1 > Max Apparent Charge

To adjust the PD Max Apparent Power Measurement alarms:

- Select **Alarms > PD Alarms Configuration** and expand the **Set 1 PD value**, **Set 1 B PD Max** and **Set 1 C PD Max** alarms as shown in Figure 13-17 to Figure 13-19.
  - Adjust the **High & High-High** limits as required for each phase.

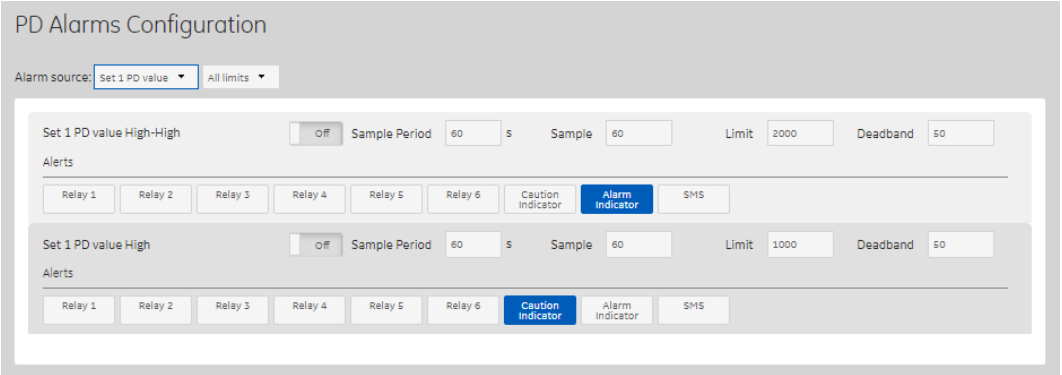


Figure 13-17: PD Alarms Configuration > Set 1 PD value

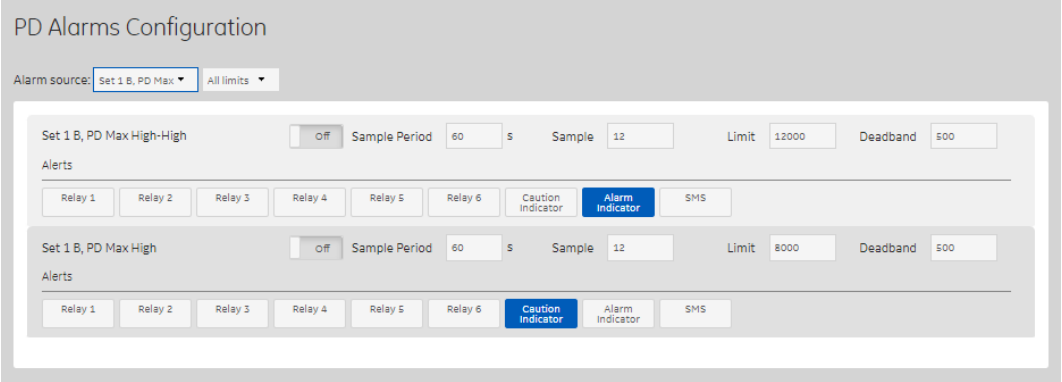


Figure 13-18: PD Alarms Configuration > Set 1 B, PD Max

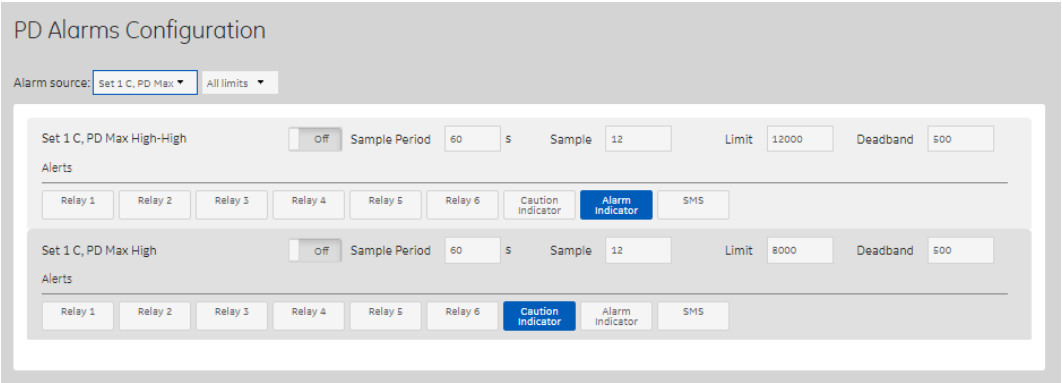


Figure 13-19: PD Alarms Configuration > Set 1 C, PD Max

13.2.8 Export Setting

After the alarms are configured on the energised transformer, select **Bushing Monitoring > General Settings** and click **Export to PC** to retain a record of the configuration as shown in Figure 13-20.

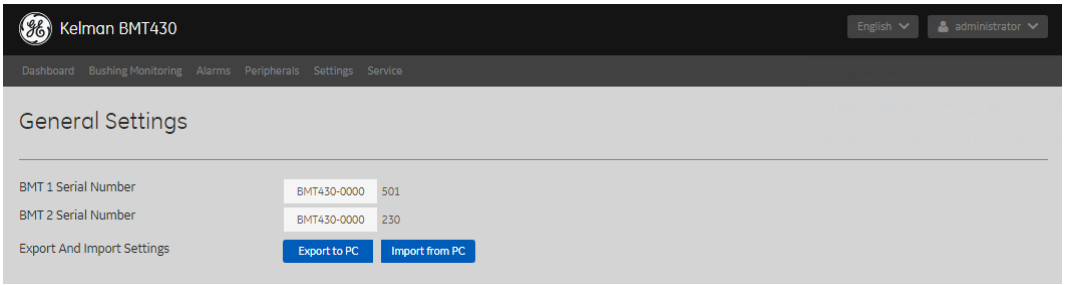


Figure 13-20: Bushing Monitoring > General Settings

Product configuration details (including alarm settings) can also be saved to a PC file and then uploaded to a new product. From the Dashboard page, click **Save Configuration** and choose **Export to PC**. See MA-044 – BMT 430 - Operator Guide for more information on exporting and importing configuration settings.

13.2.9 Finalisation

After installation, ensure that the Bushing Adaptor failure alarms are all cleared as shown in Figure 13-21.

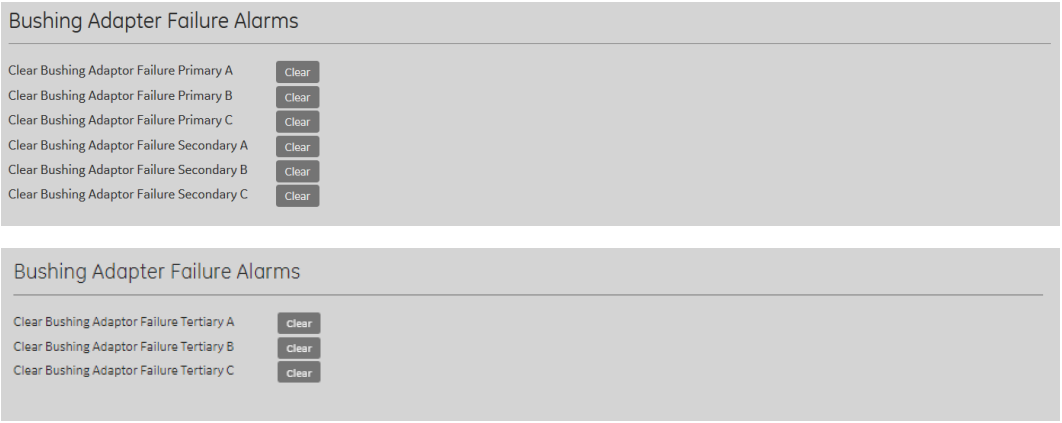


Figure 13-21: Bushing Adaptor Failure Alarms

14 DECOMMISSIONING

Before decommissioning the product, ensure that the original bushing test tap caps are available and in good condition.

WARNING: Follow the steps in the order listed below ensuring that the transformer and all AC supplies (including any relay connection) to the product cabinet are de-energised before commencing the decommissioning. Follow LOTO procedures.

Before decommissioning, use the Perception software to backup any data or use the HMI to download the system log file (if required).

Perform the following steps to decommission the product:

1. De-energise and switch off the transformer; ground the transformer main leads and apply LOTO.
2. Remove power from the AC supply to the product and apply LOTO procedures.
3. Remove power from the relay supplies that are controlled by the product and apply LOTO procedures.
4. Open the product cabinet.
5. Remove the AC supply cable from the fuse holders (see Figure 8-3).
6. Remove the relay control cables from the relay board.
7. Replace the product Bushing Adaptors with the original tap covers.

WARNING Failure to replace the original test tap caps may cause catastrophic failure of the bushing.

8. Remove cabling and external sensors (MMTS and HFCT).
9. Remove the cabinet and stand.
10. Re-energise the transformer.

Appendix A Installation Parts, Tools & Supplies

The parts, tools and supplies for a product installation are listed below in Table A-1 to Table A-3.

A.1 GE Vernova-supplied Items (shipped with the product)

Table A-1 lists the items supplied with the product:

Table A-1: Supplied items

Qty	Description
Standard Items	
1	BMT 430 with Bushing and PD monitoring card
3	Set 1 Bushing Adaptors (primary installation) Note: Each Bushing Adaptor is supplied with a full set of O-rings (and one spare set)
3	Set 2 Bushing Adaptors (secondary installation, if applicable) Note: Each Bushing Adaptor is supplied with a full set of O-rings (and one spare set)
3	Set 3 Bushing Adaptors (tertiary installation, if applicable) Note: Each Bushing Adaptor is supplied with a full set of O-rings (and one spare set)
Up to 3	High Frequency CT (1 if a primary installation only)
Up to 3	Magnetically-Mounted Temperature Sensors (1 if a primary installation only)
1	Base stand (optional – if ordered)
Installation Kit	
1	Standard: RG58C/U 50 Ω coaxial cable (Belden P/N: 8262) to connect the Bushing Adaptor and Neutral CT to the product. Length to be determined from the pre-installation information (GE Vernova P/N = CABL02048). 500 ft reel. 
	Hardware for coaxial cables connection:
15	Red pin terminals 18-22 AWG (Molex 19213-0009) 
1	Heat shrink 3/16 in. tubing 60 mm (2.4 in) 
1	Heat shrink ¼ in. tubing 60 mm (2.4 in) 

Qty	Description
6 of each (N x8)	Cable markers P, S, T, N, 1, 2, 3 and 4 
1	NYOGEL 753G (electrically conductive grease)
1	Thermal jointing compound (Wakefield Engineering, 120 series) (GE Vernova P/N: CONS01026)
1	Ethernet cable Ferrite (Würth 7427 154) when optional copper Ethernet module is ordered (GE Vernova P/N: ELEC04004)

A.2 GE Vernova Field Service Engineer (FSE)-Supplied Items

Table A-2 lists the items that the GE Vernova FSE brings to the installation:

Table A-2: FSE-supplied items

Qty	Description
1	Handheld multimeter 4½ digit with: ▪ Testing continuity capability ▪ AC voltage measurement (0.5%) ▪ Resistance measurement (0.5%) (Suggested model: Fluke 87 or 287 or equivalent).
>	Required material as described in 'Section 11.4.3 - Circuit Integrity Test Record'.
1	27 mm socket to fit ½ in. square drive torque wrench
1	½ in. square drive torque wrench with a range of 10 - 100 Nm (7 – 73 lb ft)
1	1.25 N m torque screwdriver
1	3 mm ball hex blade for torque screwdriver
1	Ratchet crimp tool.
2	$^{9}/_{16}$ in. Combination wrench (must be imperial $^{9}/_{16}$ in.)
1	½ in. Wrench
1	¾ in. Wrench
1	10 mm Socket and socket wrench
1	$^{1}/_{8}$ flat blade screwdriver
1	¼ in. flat blade screwdriver
1	#2 Phillips screwdriver
1	8 m tape measure
1	Level capable of indicating plumb and level within 5 degrees
1	Permanent marker (fine tip)
1	22 – 14 Gauge wire cutter/stripper
25	30 cm (12 in.) Nylon UV-resistant cable ties
1	Mini USB cable
1	Ethernet cable
1	Laptop computer for commissioning the product and running the software for downloading and interpreting the results.

A.3 Customer-Supplied Items

Table A-3 lists the items not supplied by GE Vernova due to site-specific specifications or size and weight restrictions, but must be available on site to complete the installation:

Table A-3: Customer-supplied items

Qty	Description
1	Armoured mains cable to power the product.
1	Grounding cable to connect primary protective earth terminal lug of the product cabinet to the ground.
>	Liquid-tight flexible metal conduit (½ in. and/or ¾ in.) to provide protection for the Bushing Adaptors' cables and Neutral CT cable (working temperature range: –55 °C to 105 °C recommended). Recommended models from Thomas & Betts: ▪ Metal conduit ½ in. liquid-tight, Model ATLA050 (length as required) ▪ Metal conduit ¾ in. liquid-tight, Model ATLA075 (length as required)
>	Liquid-tight metal fittings and gaskets for the Bushing Adaptor. Recommended model from Thomas & Betts: ▪ Liquid-tight fittings, ½ in. NPT, Model 5332-HT. ¾ in. NPT, Model 5333-HT ▪ Sealing gasket ½ in., Model 5262. ¾ in., Model 5263
>	Plastic conduit with enough length to provide protection for the temperature sensor cables (optional).
>	Cable trays and cable ties to run the cables.
1	RTV (Room Temperature Vulcanization: silicon-based mastic), 3M Super Silicone Sealant No. 8663 or equivalent for the MMTS.
1	Heat gun (for heat shrink)
>	General tools (drill, drill bits, screwdrivers, cutter and spanners)
1	12 mm (½ in.) capacity hammer drill with 9.5 mm (3/8 in.) masonry bit
1	Scaffolding, lift or approved platform to obtain access to bushings (if needed)
24	M8 threaded fasteners with a recommended minimum length of 80 mm for the concrete foundation.

Appendix B Customer Checklist

The following checklist details items that the customer must acquire prior to the installation:

- ❒ Prepared, flat mounting surface.
- ❒ Parts to fabricate a mounting stand (if the product mounting stand has not been purchased)—see Appendix F.
- ❒ Communications option tested and located at the installation site (see Section 12).
- ❒ Circuit capable of 100 – 250 V DC or 100 – 240 V AC, 50/60 Hz with suitable overcurrent protection as per local regulations (see Section 8). If heat trace cable is used, it must be on a separate circuit.
- ❒ Wiring and/or conduit for connection between the terminals within the product and to the external switch or circuit breaker. This must be performed by a suitably qualified electrician in accordance with local wiring regulations (see Section 8).
- ❒ Tools and supplies needed to complete the installation (see Appendix A).

Appendix C Customer Contact & Site Details

Project Reference: _____

Company: _____

Address: _____

City, State and Postcode (Zip): _____

Country: _____

Phone: _____

Installation Site Name: _____

Site Address: _____

City, State: _____

Postcode (Zip): _____

Country: _____

Primary Corporate Contact:

Name: _____ Title: _____

Address: _____

City, State and Postcode (Zip): _____

Country: _____

Phone: _____ Mobile: _____

Email address: _____

Primary Site Contact:

Name: _____ Title: _____

Address: _____

City, State and Postcode (Zip): _____

Country: _____

Phone: _____ Mobile: _____

Email address: _____

Secondary Contact Name: _____ Mobile: _____

Site Map

Please attach a detailed map or GPS coordinates on how to locate the site.

Appendix D CANbus MMTS

The CANbus MMTS is powered from the product. Figure D-1 to Figure D-3 show the rear, front and side views of a CANbus MMTS. Note: Multiple CANbus MMTSs must be daisy chained.

Figure D-1: MMTS Rear

Figure D-2: MMTS Front

Figure D-3: Side

Figure D-4 provides an illustration of the MMTS with dimensions.

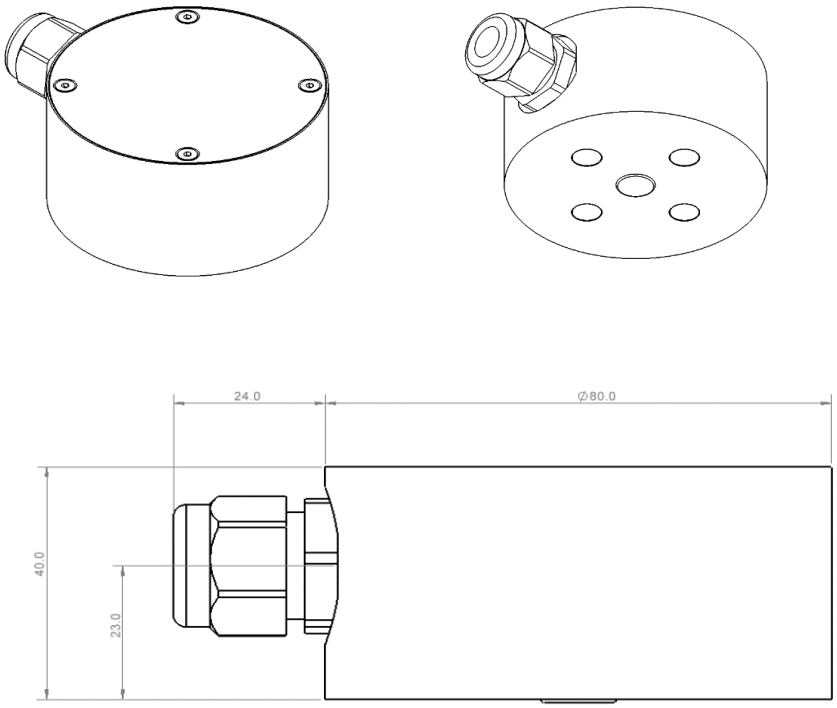


Figure D-4: MMTS dimensions

Table D-1 lists the specification details for a CANbus MMTS.

Table D-1: MMTS CANbus specification

Item	Value
Enclosure	Plastic cylindrical housing – black Delrin 127UV stabilized acetal type 1 natural. Stainless steel lid. Cable aperture fitted with gland (cable diameter range 5 – 9.5 mm)
Output	CANbus
Wiring	CAN 2 × 2 × 0.34 mm² (22 AWG). Two cores twisted into pairs, two pairs arranged to the cable core plastic foil with braid of tinned copper wires. Max OD 9 mm.
Operating temperature	−40 °C to 150 °C (−40 °F to 302 °F)
Size	Ø 79 mm × 40 mm
Weight	300 g (11 oz)
Power Requirements	12 V DC

If installing more than one CANbus MMTS, they must be wired in series ensuring that the *last* MMTS on the CANbus line is *MMTS #1*. Keep a record of which MMTS is installed to which single phase transformer so that the product can be commissioned accordingly. See Table 11-10: Results at the end of Section 11.4.3. MMTS #1 has a cable gland, a blanking plug and an internally fitted termination resistance on the PCB between H and L.

Note: Additional cabling may have to be purchased.

Note: The total CANbus length across *all* the MMTS(s) should not exceed 754 feet (230 metres).

D.1 Internal Wiring

Figure D-5 to Figure D-7 illustrate the terminal connections inside a CANbus MMTS. The shield is connected to the ground of the CANbus terminal block. It is advisable that the cables are run inside a plastic conduit to provide protection against mechanical damage. The cable must be properly inserted into the cable gland. The dome nut of the cable gland is torqued to a recommended 1.62 N m (14.4 lb in) using a torque wrench.

Figure D-5: MMTS #1 with jumper

Figure D-6: MMTS #2/3 without jumper

A wired MMTS with heat shrink sleeve fitted is shown in Figure D-7.

Figure D-7: MMTS wired

The terminal key for a CANbus MMTS is shown in Table D-2.

Table D-2: Terminal key

#		MMTS Terminal	Cable Colour	BMT 430 Terminal	Descriptor
1		SHD	Black	SH	Shield
2		+	Yellow	TO+	12 V DC
3		H	White	H	CANbus High
4		L	Green	L	CANbus Low
5		-	Brown	TO-	Ground

D.2 Product Connection Points

The CANbus MMTS is connected to the CANbus connections on the DIN rail as shown in Figure D-8. See Table D-2 for the terminal key.

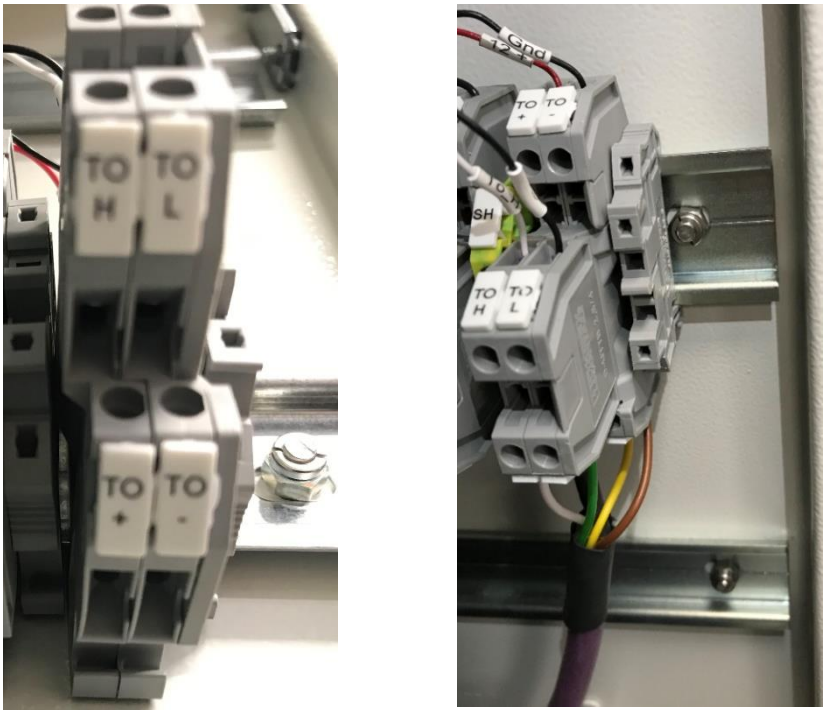


Figure D-8: CANbus – bottom connection points (left), wired (right)

Figure D-9 provides an illustration of the CANbus top oil connections.

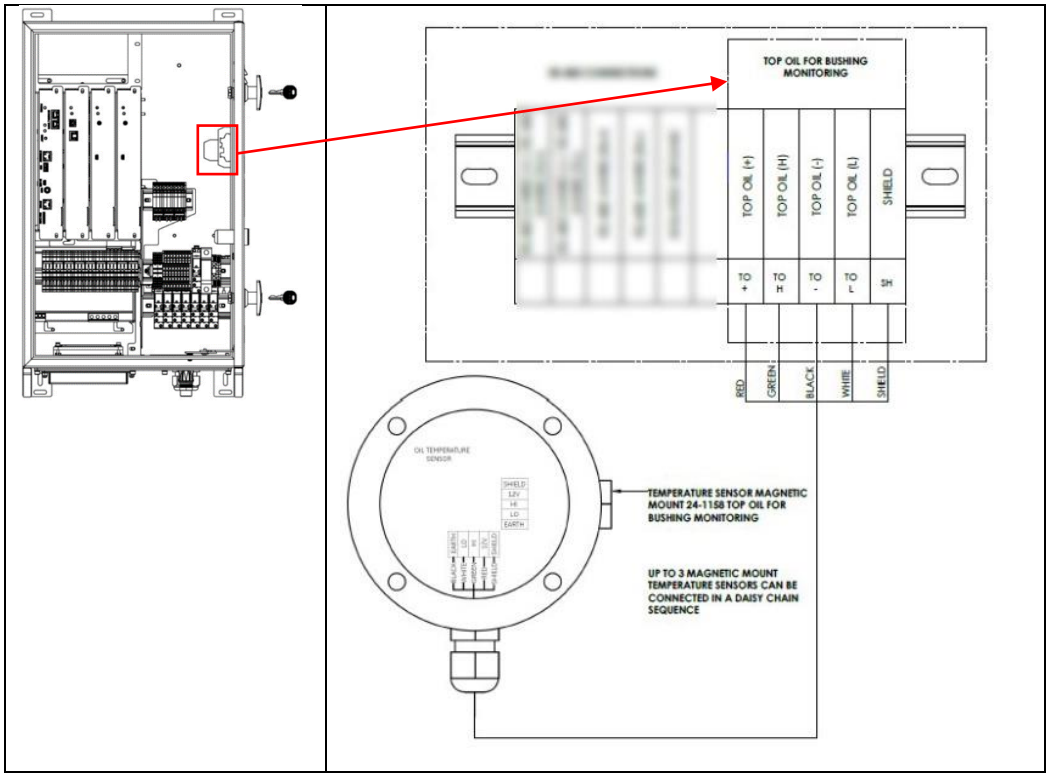


Figure D-9: CANbus MMTS – illustration of top oil connections

This appendix details dimensions and weight for a base product with a standard configuration as shown in Figure E-1 to Figure E-2. The total weight of the product is 22.2 kg (48.9 lb). All dimensions are in millimetres (mm). Tolerance is ±5 mm.

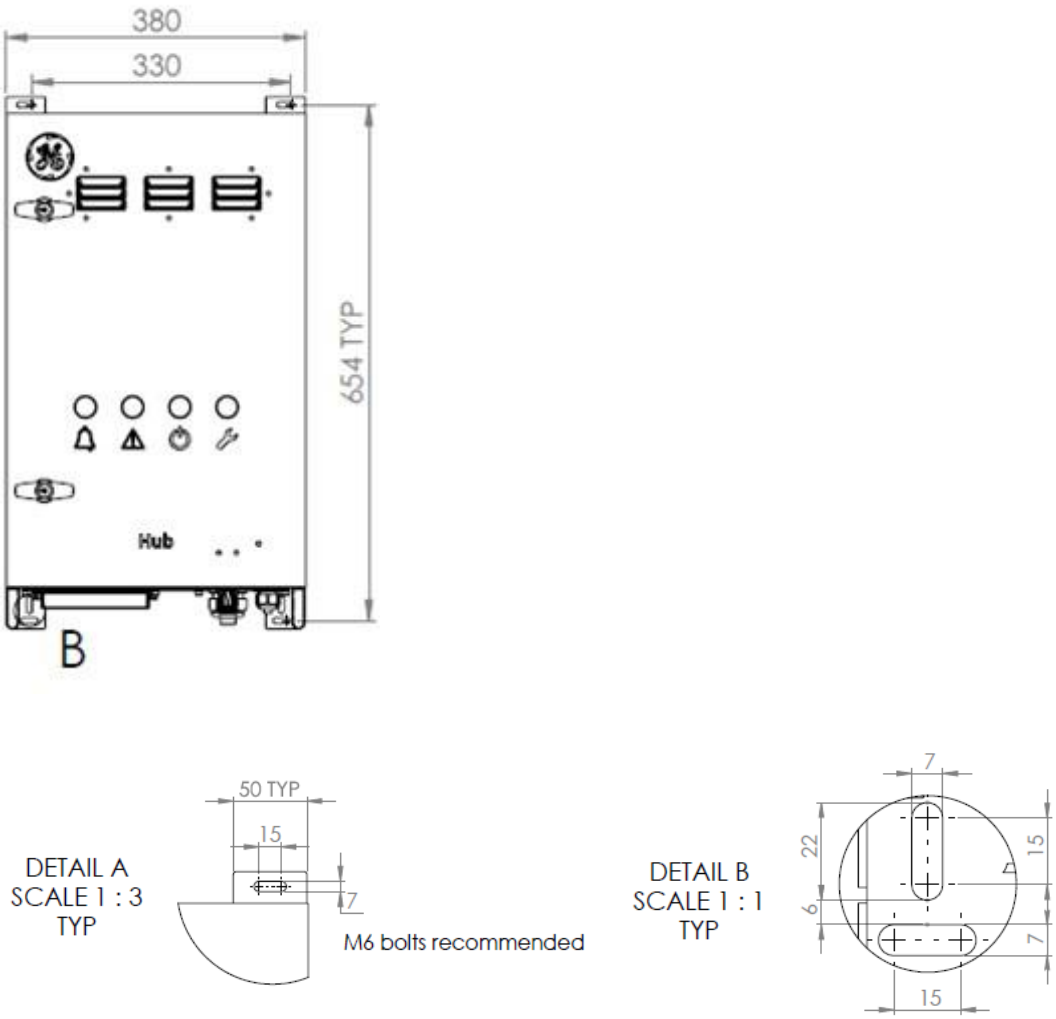


Figure E-1: Enclosure - front view

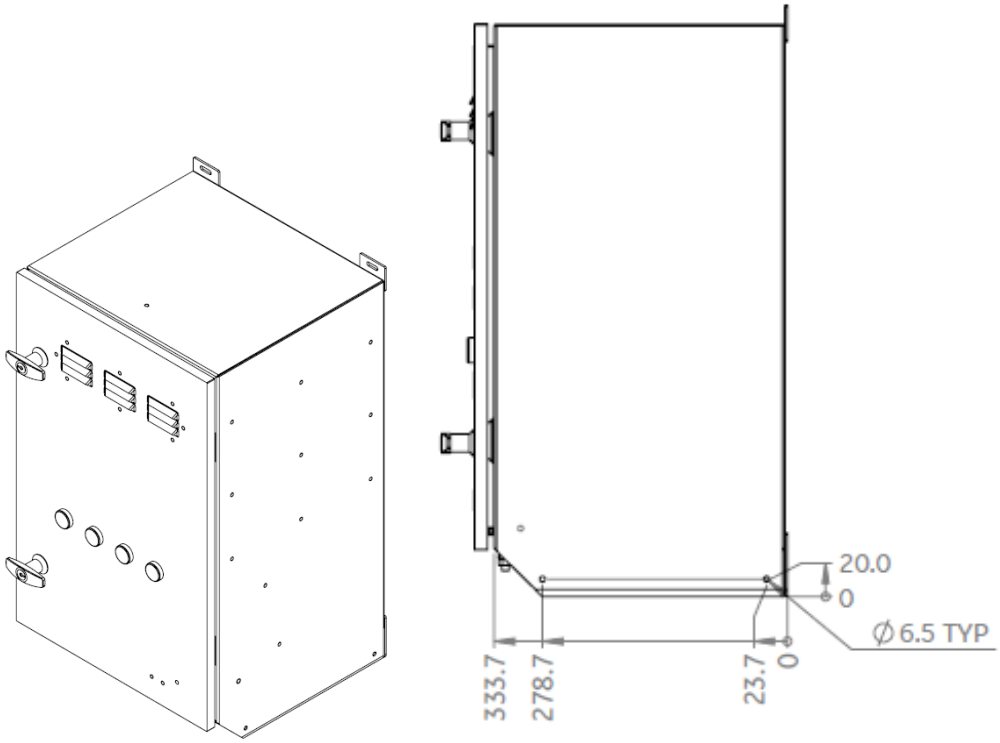


Figure E-2: Enclosure - side view

Figure E-3 to Figure E-5 shows the dimensions of the enclosure. The product weighs 18.5 kg (40.8 lb).

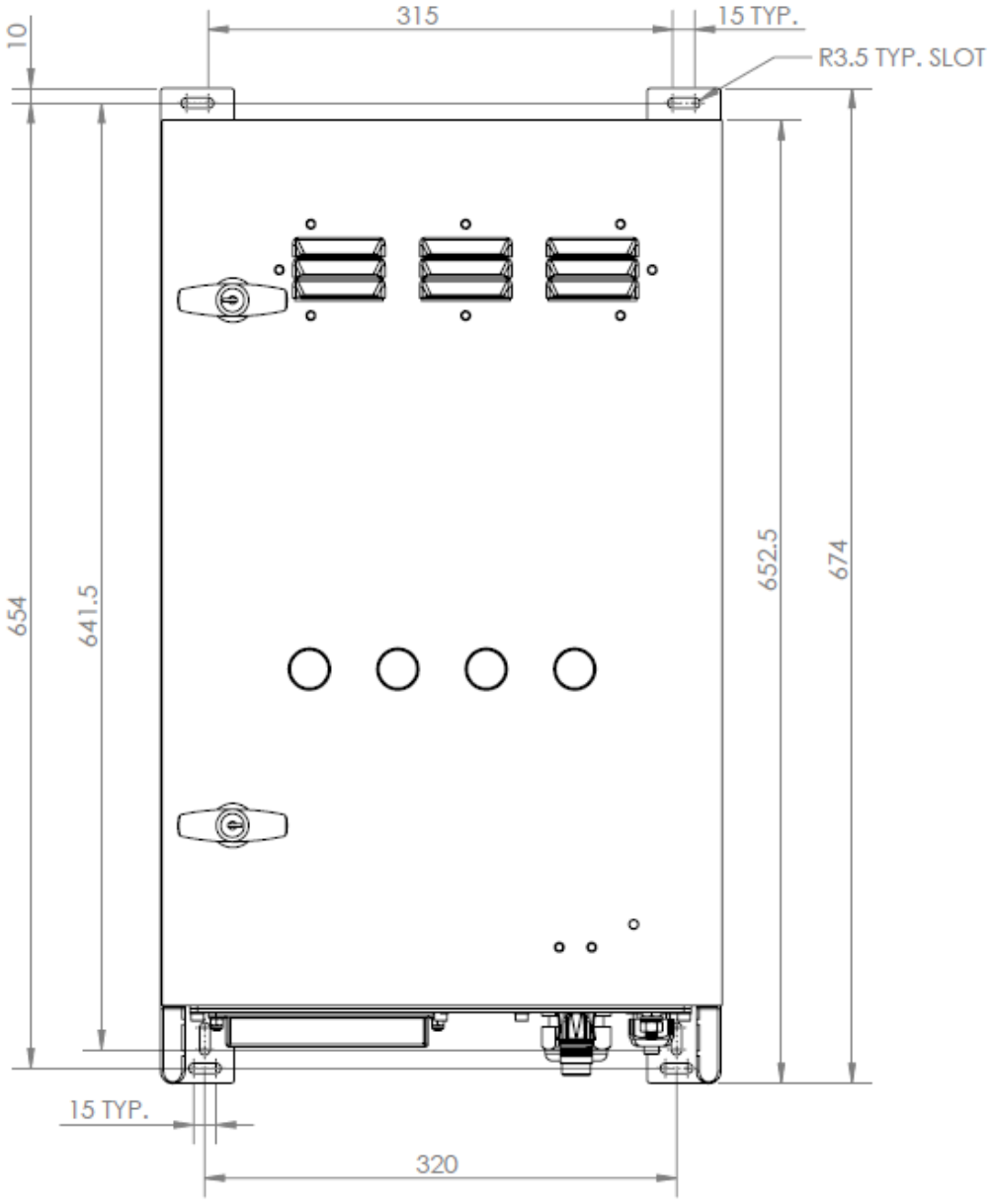


Figure E-3: Product enclosure - front dimensions

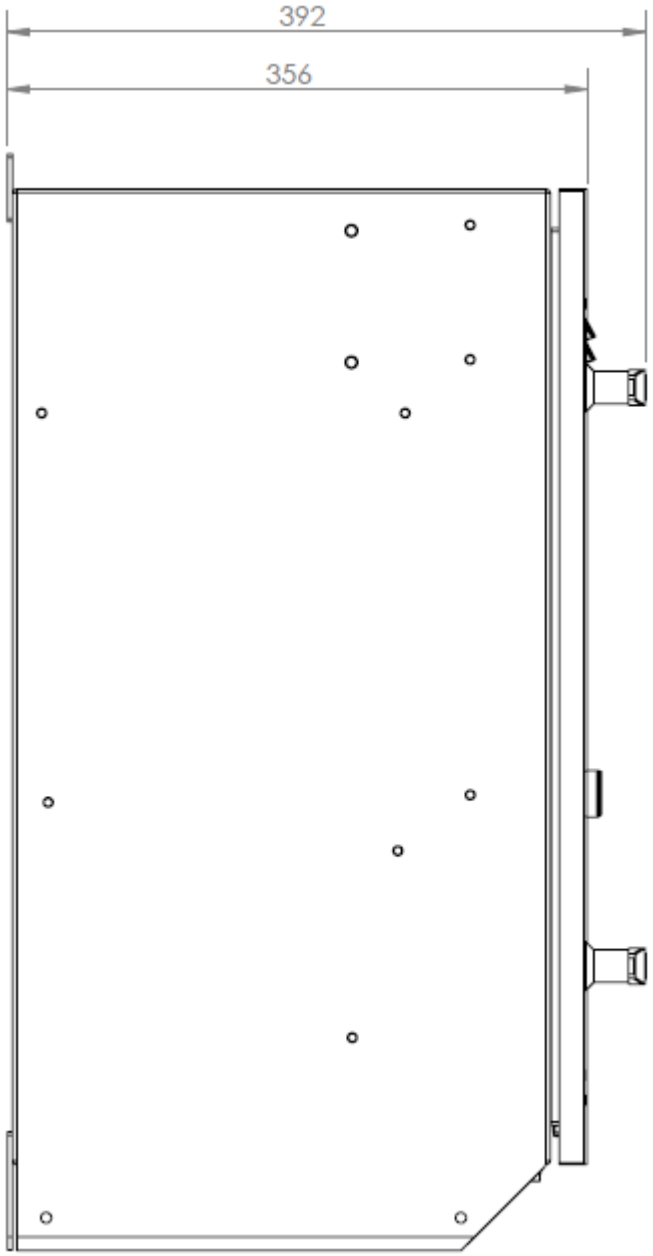


Figure E-4: Enclosure - side dimensions

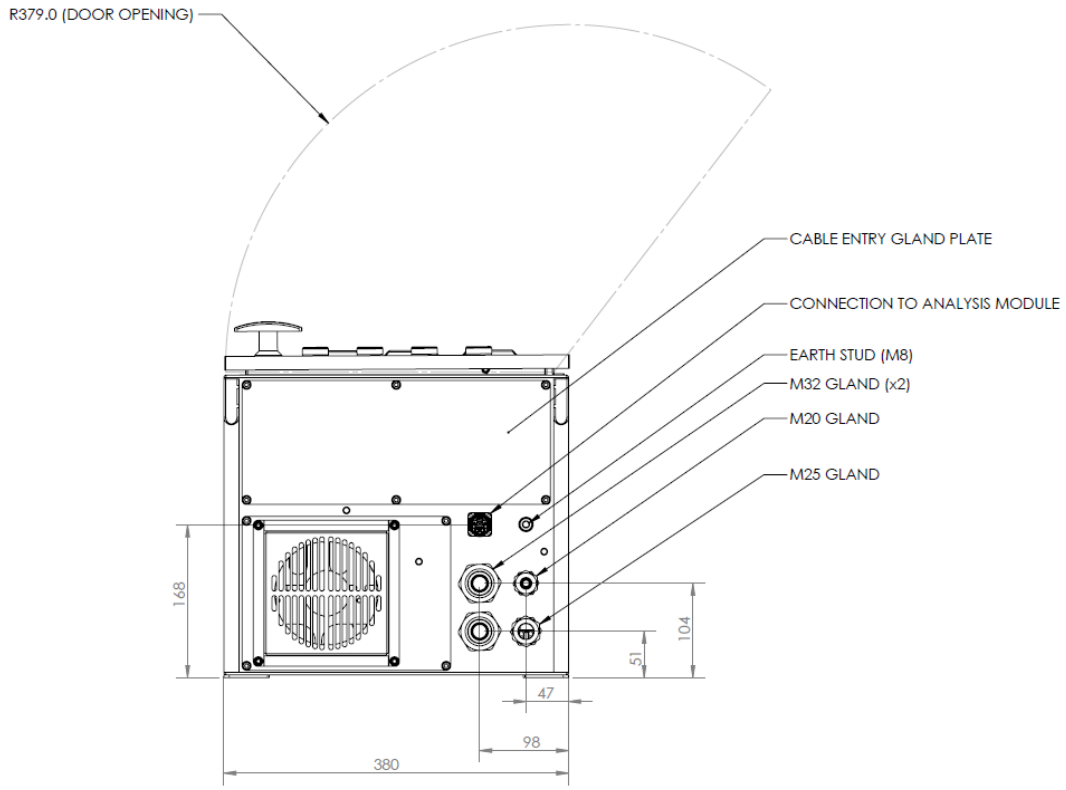


Figure E-5: Enclosure - bottom dimensions

Appendix F Mounting Stand Dimensions & Assembly

Figure F-1 shows the product mounting stand. The mounting stand weighs 20 kg (45 lb). All dimensions are in millimetres (mm). Tolerance is ±5 mm (unless otherwise stated).

The stand is shipped with the top portion inverted. Remove the hardware holding the stand together, then remove the top section that is inverted within the larger bottom section and assemble in an upright position reusing the original hardware.

Figure F-1: Mounting stand

Figure F-2 shows a front dimensioned view of the mounting stand. Use the diagram of the mounting stand footprint as shown in Figure F-3 or the physical mounting stand if available (recommended) to mark at least one hole for each mounting tab. The product shall be bolted to the mounting surface using three M8 threaded fasteners of a recommended minimum length of 80 mm (not supplied).

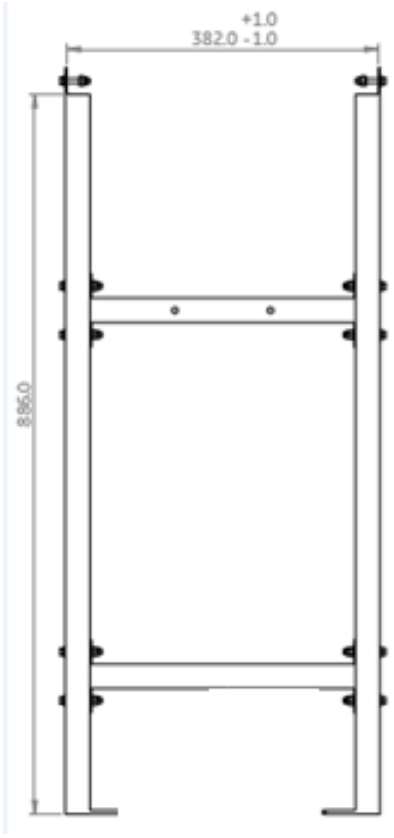


Figure F-2: Mounting stand dimensions - front view

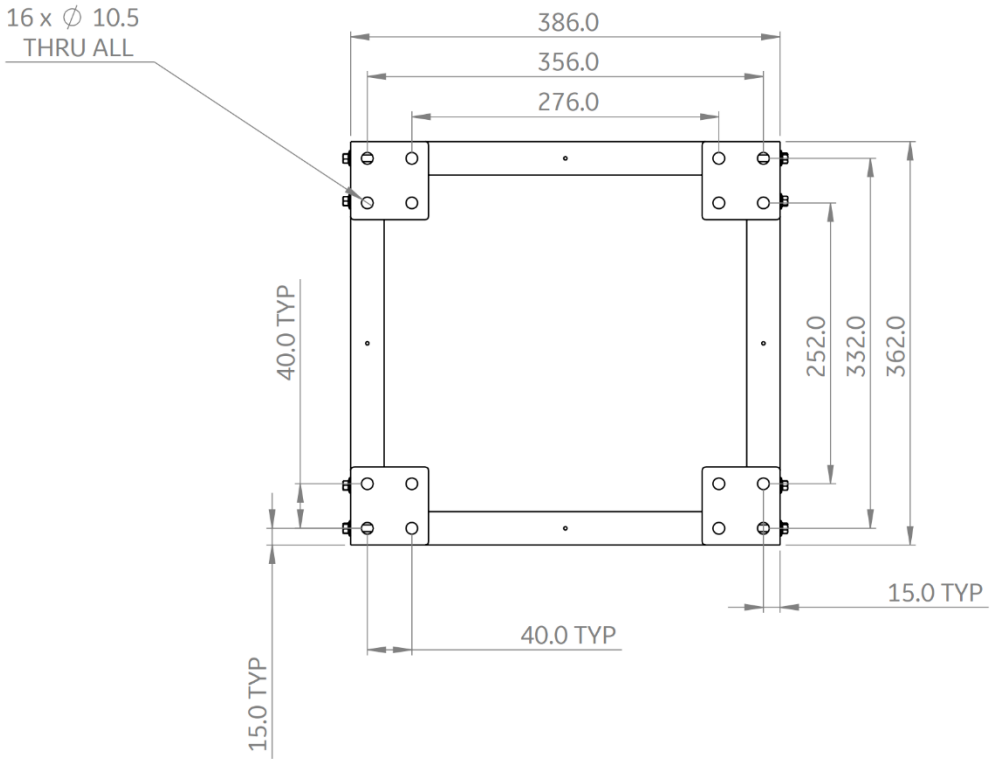


Figure F-3: Mounting stand dimensions - footprint

Note: Three holes are available on each mounting tab of the stand legs, but only one hole per tab is required for installation.

Figure F-4 shows the product mounted on the stand.

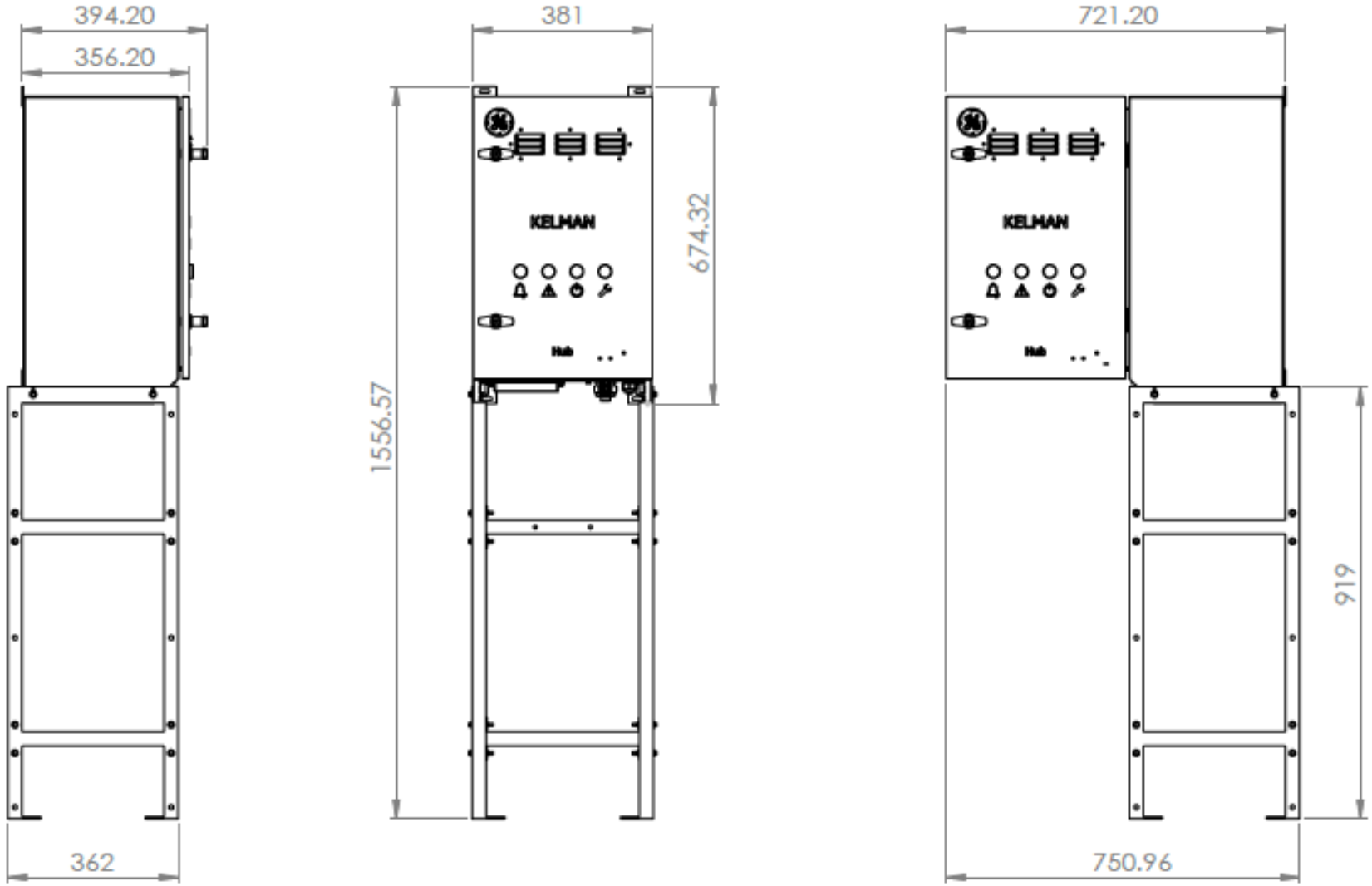


Figure F-4: Product on stand - left & front with door closed, right with door open at right angles.

Figure F-5 shows a labelled mounting stand with each part identified in Table F-1.

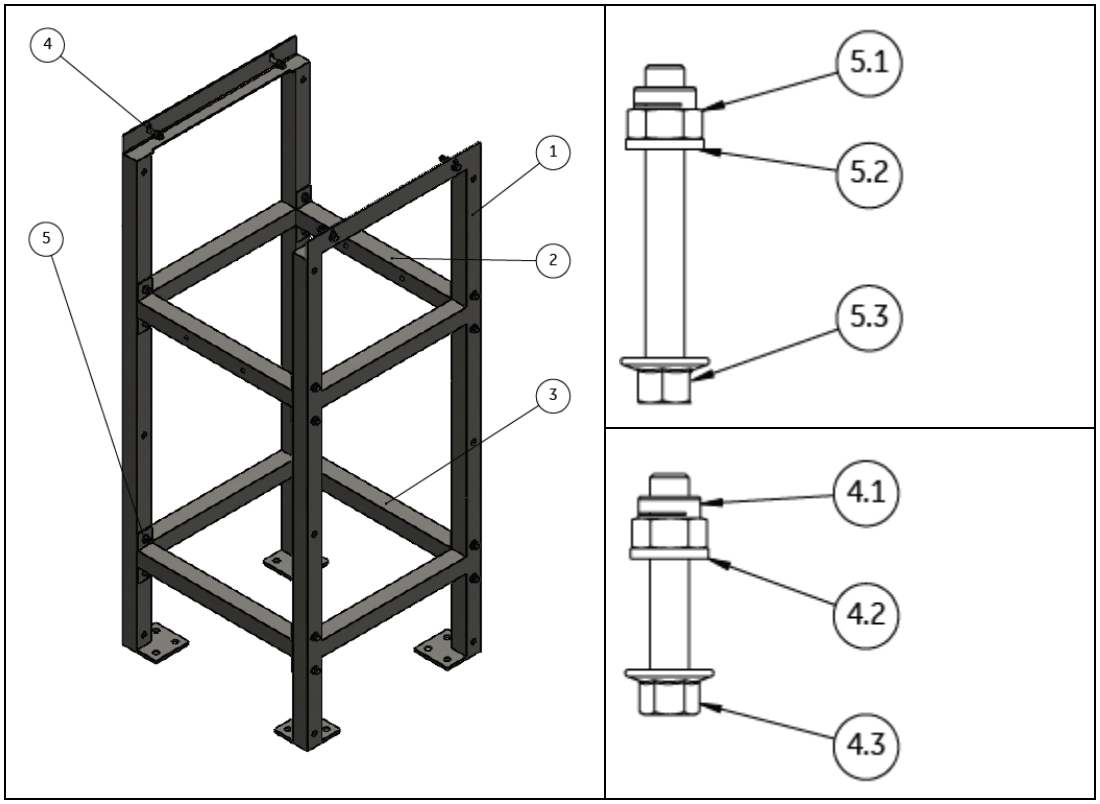


Figure F-5: Mounting stand parts

Ensure that the drain holes on the horizontal crossmembers are on the underside. Ensure that the stand is on a horizontal level surface and that the feet are level before torquing the bolts.

Table F-1: Mounting stand parts list

Item #	Description	Quantity
1	Stand side simplified	2
2	Stand-top crossmember	2
3	Stand-bottom crossmember	2
4	Stand M6 bolt assembly	4
4.1	M6 A2 SS aerotight nut	1
4.2	M6 plain washer	1
4.3	Hex flange screw M6 × 30 mm – 18N – A2 Stainless	1
5	Stand M6 × 1.0 × 45 bolt assembly	16
5.1	M6 A2 SS aerotight nut	1
5.2	M6 plain washer	1
5.3	Hex flange screw M6 × 45 mm – 18N – A2 Stainless	1

An optional sun canopy is available as shown in Figure G-1. This provides effective solar shade for the product in environments with intense sun exposure. The canopy is made from grade 304 stainless steel (24-1022) or grade 316 stainless steel (24-1025) Each canopy comprises of a hood, a pair of supporting top bars, and legs with brackets that can be positioned to suit the mounting arrangement. The canopy is fitted to the mounting arrangement onsite using the supplied screws as one of the final installation steps. All dimensions below are in millimetres (mm). Tolerance is ±1 mm.

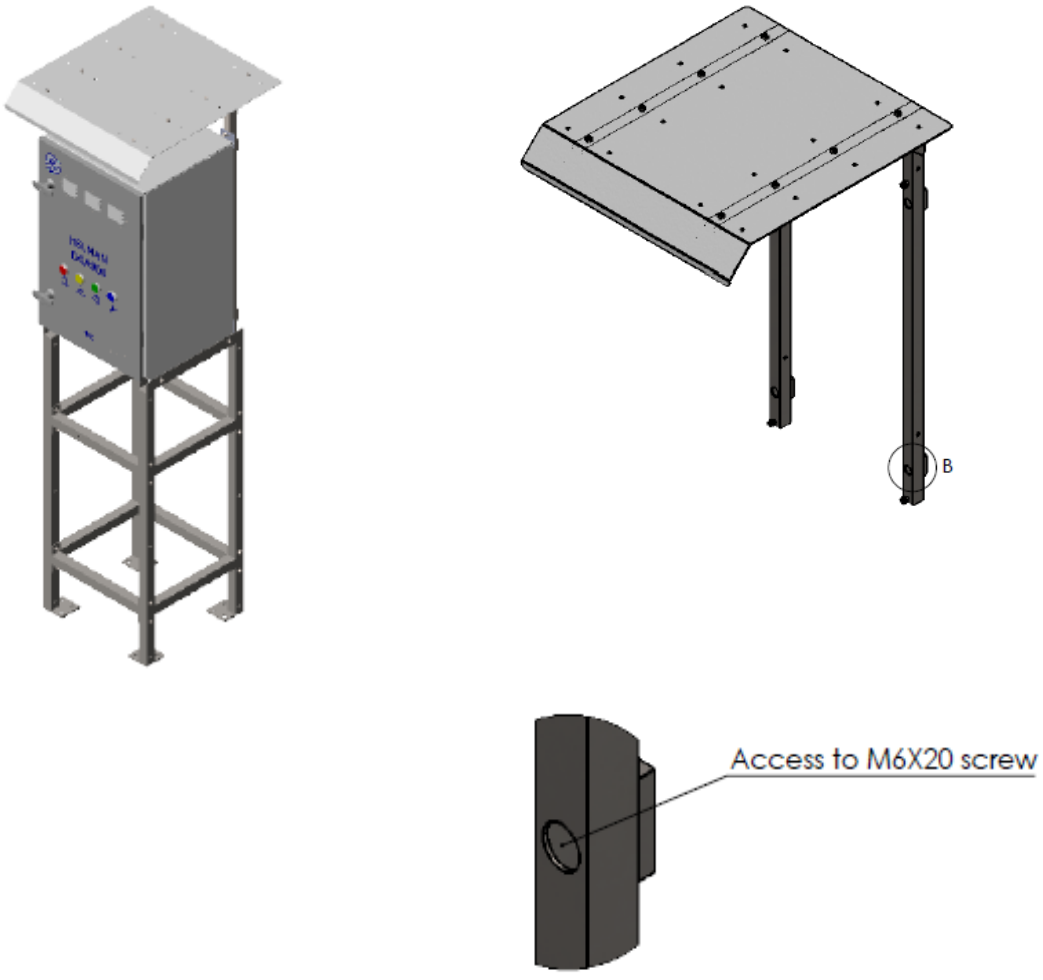


Figure G-1: Sun canopy - illustrated

G.1 Mounting-Stand Configuration

The mounting-stand configuration is shown in Figure G-2 and is used for products that are mounted on stands.

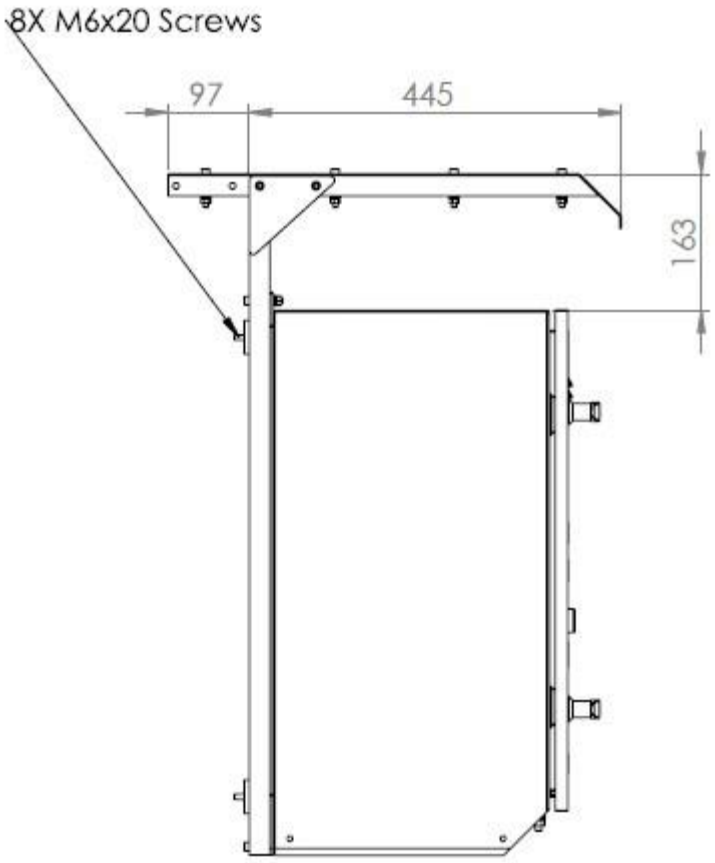


Figure G-2: Mounting-stand configuration

Screw the leg to the top bar using the second pair of hole positions on the top bar as shown in Figure G-3.

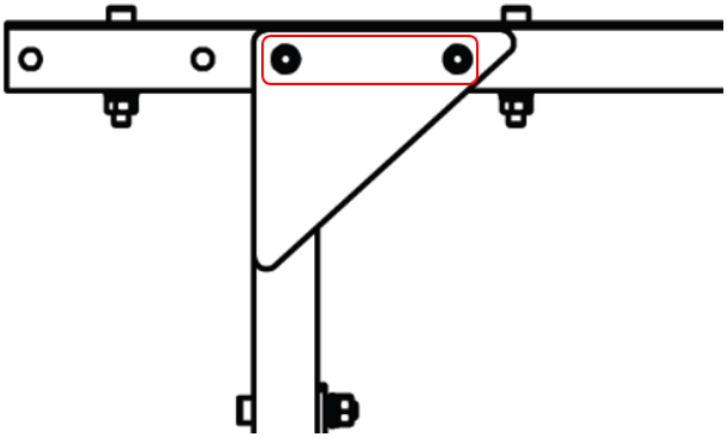


Figure G-3: Mounting stand - top bar screw positions

G.2 Direct-Mount Configuration

The direct-mount configuration is shown in Figure G-4 and is used for products that are directly mounted to the body of a transformer.

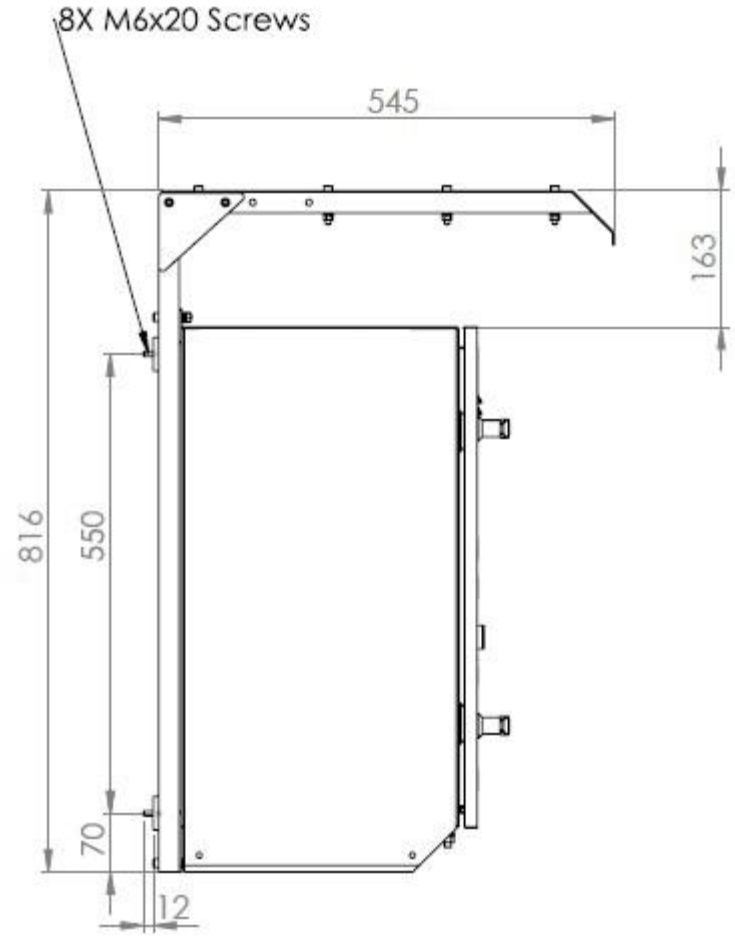


Figure G-4: Direct-mount canopy

Screw the leg to the top bar using the first pair of hole positions on the top bar as shown in Figure G-5.

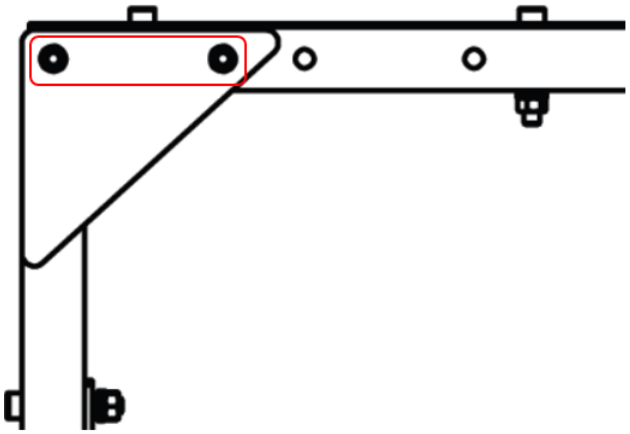


Figure G-5: Direct mount - top bar screw positions

G.3 Canopy Hood Position

The canopy hood can be positioned to suit the mounting arrangement. It is mounted to the product enclosure using the two screw positions on each leg as shown in Figure G-6 or Figure G-7.

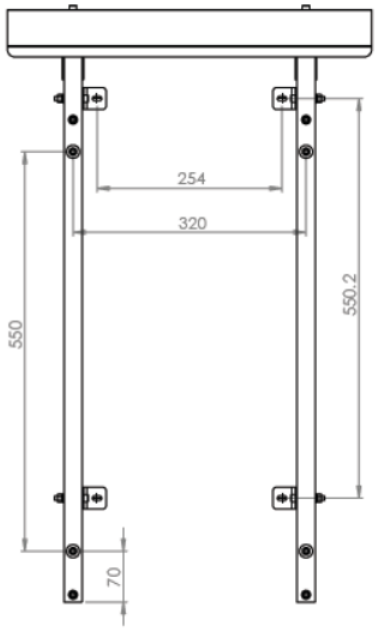


Figure G-6: Brackets positioned inner

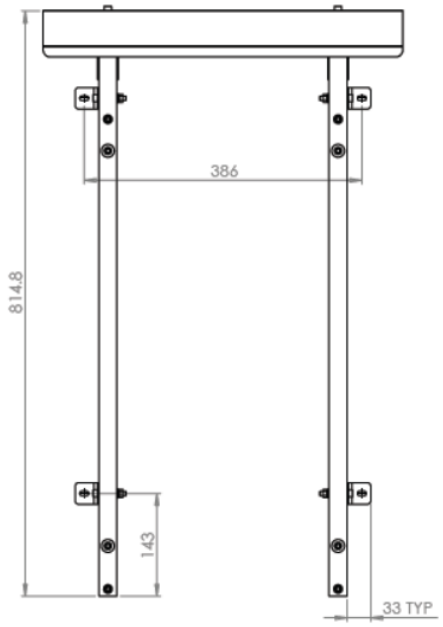


Figure G-7: Brackets positioned outer

Where the product is direct mounted to the body of a transformer, mounting brackets provide flexibility to adjust the position of the screws. The brackets can be positioned on the inside or outside of the legs and have horizontal and vertical slots for the screws.

The sun canopy can be direct mounted to the body of a transformer using a bracket fitted to the inside of the canopy legs as shown in Figure G-8.

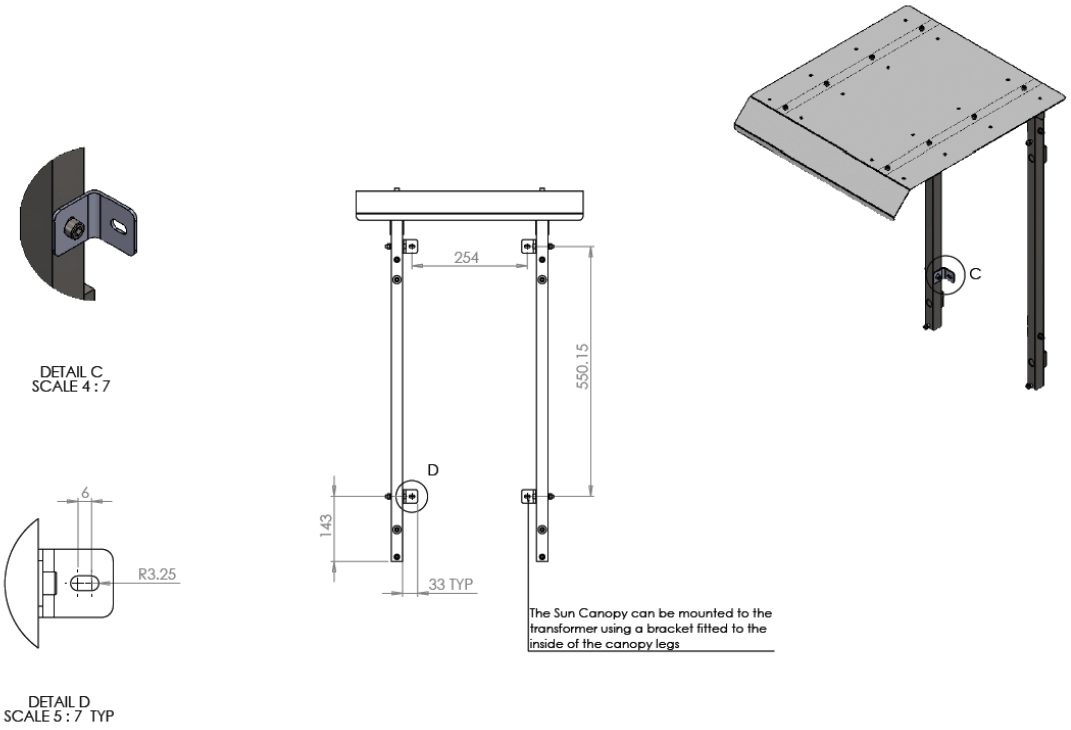


Figure G-8: Sun canopy bracket fitted inside

The sun canopy can be direct mounted to the body of a transformer using a bracket fitted to the outside of the canopy legs as shown in Figure G-9.

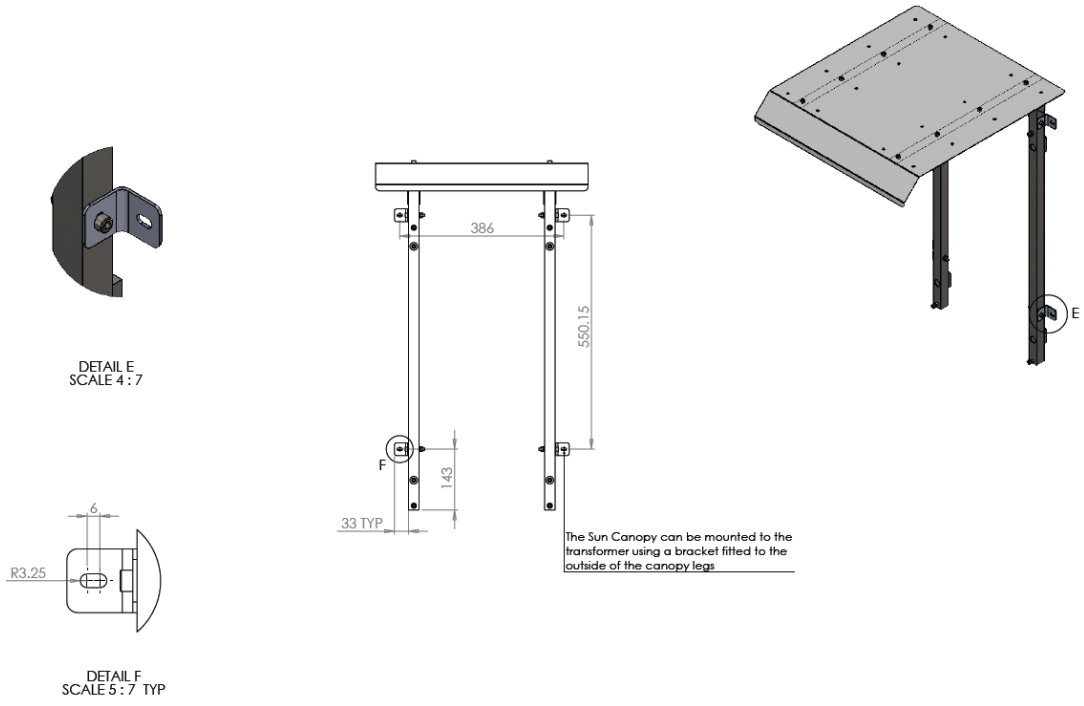


Figure G-9: Sun canopy bracket fitted outside

The hood is centred over the enclosure as shown in Figure G-10.

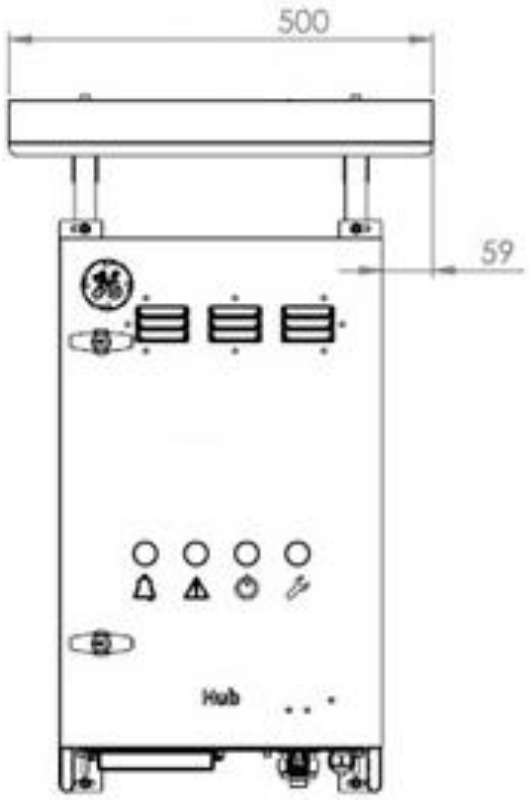


Figure G-10: Hood centred over enclosure

The hood is aligned using one of three positions. The centre position is highlighted as shown in Figure G-11.

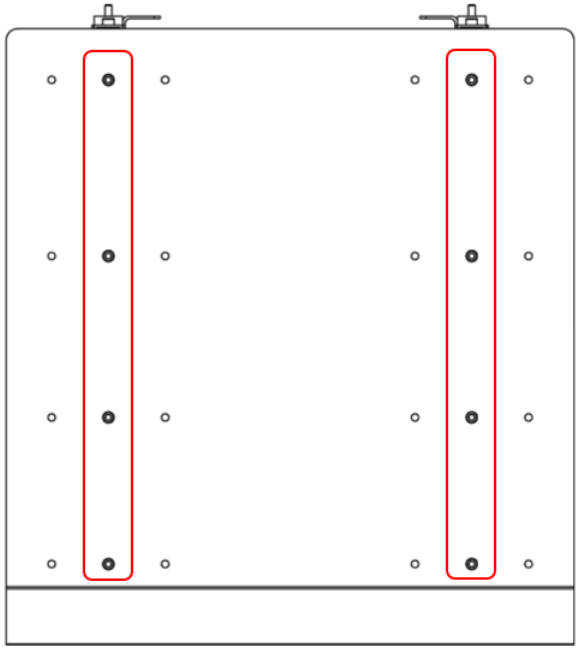


Figure G-11: Hood screw positions - centre

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Northern Ireland, United Kingdom BT28 2LU
www.gegridsolutions.com/MD.htm

For further assistance or queries please contact:

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T +44 1785-250-070 (Rest of the World)
ga.support@ge.com

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GE VERNOVA