FEEDERNET SYSTEM

INSTALLATION
AND
COMMISSIONING

TS00424

February 2025

LRQA CERTIFIED ISO 9001-2015 UKAS MANAGEMENT SYSTEMS 0001

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I. AMENDMENT RECORD

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N/A	February 2014	First Issue	90/0206
TS00096	September 2018	Updated with additional information	90/0206
TS00174	February 2024	Updated to reflect new Controller and Measurement Module	90/0206
TS00361	February 2025	Update for latest hardware	90/0206

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1 INTRODUCTION

The FeederNet System is used to measure the Low Voltage (LV) parameters connected to Power Network Distribution Assets. The system makes direct measurements of both Voltage and Currents and processes the information to provide the various LV parameters.

This document provides a brief description of the FeederNet System components, the safety warning that must be adhered to, the installation method, the commissioning method and finally the procedure for confirming operation.

1.1 Safety Warnings

1.1.1 Safety, Hazard Categories and Symbols

Table 1 - Safety, Hazard Categories and Symbols

Symbol	Description
	**Warning** – follow precautions to avoid injury or causing equipment malfunction.
	Do not install, maintain or remove the system in HAZARDOUS LIVE substations without applying additional protective measures. Additional protective measures can be: • De-energising the circuits • Use of personal protective equipment (PPE) suitable for high voltage work and adoption of safe operating procedures.
	**Warning** – follow precautions to avoid electric shock injury
	Approved Safety Boots are to be worn during Installation
	Approved Insulated Sole Footwear are to be worn during Installation
	Approved Safety Headgear is to be worn during Installation
	Approved High Visibility Jacket is to be worn during Installation
	Approved Safety Gloves are to be worn during Installation
	Approved Safety Overalls are to be worn during Installation

Table 1 - Safety, Hazard Categories and Symbols

Symbol	Description
	Approved Safety Eyewear are to be worn during Installation
	Do not dispose as unsorted waste
CAT IV	The FeederNet equipment is an Over-Voltage Category IV equipment as defined in EN61010-1:2010
	This equipment is for professional use and must only be installed and uninstalled by suitably trained and competent persons. Appropriate working practices must be established and personal protective equipment must be defined in accordance with Health and Safety at Work legislation for the environment in which the system is installed. Instruction and training on the HAYSYS LV Monitoring System is available.
	The Feedernet Control Unit must be fitted with a suitable external switch or circuit breaker which disconnects all current carrying conductors. The switch or circuit breaker must be in a suitable location and easily reached. It should also be marked as the disconnecting device for the FeederNet Controller An external switch or circuit breakers should meet all the relevant IEC 60947-1 and IEC 60947-3 requirements.
	Follow safe electrical work practices as specified in local and national work instructions and codes. Use appropriate personal protective equipment and gloves as required.
	Always use this product in the manner specified or the protection provided by the product may be impaired. The equipment contains no user serviceable parts.
	Always connect the neutral supply before connecting any phase. Always disconnect the neutral supply last.
	The working voltage line to neutral is 230VAC. Do not apply the Feedernet LV Monitoring System to circuits having nominal AC line to neutral voltage greater than 240V. The system may be safely used in installations where the line-to-line voltage is 415VAC.

Table 1 - Safety, Hazard Categories and Symbols

Symbol	Description
	If using a GSM / GPRS interface the Feedernet Control Unit will communicate periodically during usual system operation. Maintain a minimum distance of 20cm between the antenna and your body.
	NOTE: This product is to be used for providing information only and is not intended for use in safety-critical applications.
Electrical equipment should be installed, operated, serviced, maintained and uninstalled only by suitably qualified personnel.	
No responsibility is assumed by HAYSYS Ltd for any consequences arising out of the misuse of this equipment.	

Beneath the covers of the Control Unit exist the voltage connections made via plug/socket components. These voltages can be up to 480V RMS depending upon the particular installation. The connections made to the plug should only be undertaken with the voltage removed.

The covers of the FeederNet Units should only be removed in controlled environments.

1.2 General Safety Considerations

The FeederNet System has been designed, through the physical size and use of non-metallic external parts, to accommodate installation inside most Low Voltage (LV) Substation Pillars.

The FeederNet System has been designed specifically for installation in LV substations only and includes fuses and Metal Oxide Varistor (MOV) protection devices-built in.

It is recommended that a suitable survey of the installation site is carried out prior to deciding if the FeederNet units can be installed within the pillar, or not, along with if this installation should be completed while the Pillar remains in an energised state.

It is recommended that the survey includes a risk assessment and identifies suitable risk reduction measures.

1.2.1 Installation into an energised LV Pillar

	**Warning –** follow precautions to avoid electric shock injury
	Approved Safety Boots are to be worn during Installation
	Approved Insulated Sole Footwear are to be worn during Installation
	Approved Safety Headgear is to be worn during Installation

	Approved High Visibility Jacket is to be worn during Installation
	Approved Safety Gloves are to be worn during Installation
	Approved Safety Overalls are to be worn during Installation
	Approved Safety Eyewear are to be worn during Installation

General hazards are hazards that would be expected when undertaking any installation of this kind within ‘live’ equipment and are not specific to the FeederNet units. These hazards include:

a. Inadvertent contact with either the Low Voltage system, resulting in electric shock or burns.

b. Flashover resulting in burns or eye damage.

c. Introduction of debris, conductor strands etc. causing a risk of flashover.

It is recommended that suitable Personal Protection Equipment (PPE), be worn by all staff installing the equipment. As a minimum, this should include:

a. LV rubber gloves.

b. A full face visor.

c. Flame and Arc resistant coveralls.

The installation of the FeederNet units should only be undertaken using site approved toolkits and by authorised personnel. The installation should never be undertaken by a ‘lone-worker’.

The mounting of the FeederNet Control Unit, within the Pillar, can be achieved using several different methods. Where the installation is within a steel pillar, drilling the fabric of the Pillar is not recommended but instead should be through the use of the supplied magnetic mountings.

A suitable safe space for the control unit should be identified prior to the installation. The FeederNet units have no exposed conducting parts.

If there is any doubt regarding any risk at all, then it is recommended that the LV Pillar be de-energised for the installation activity.

2 INSTALLATION

2.1 What's in the box

The FeederNet System is supplied in two separate boxes:

a. FeederNet Control Unit Box

Control Unit – complete with wired voltage leads

Control Unit cable

GSM Antenna (if ordered)

4 off Busbar clamps (if ordered)

LV Monitoring Warning Label

b. Measurement Module Box (one per Feeder)

Measurement Module fitted with Rogowski Coils

Inter connecting cable

2.2 FeederNet System Components

The FeederNet components installed at a typical LV substation are shown in Figure 1 below.

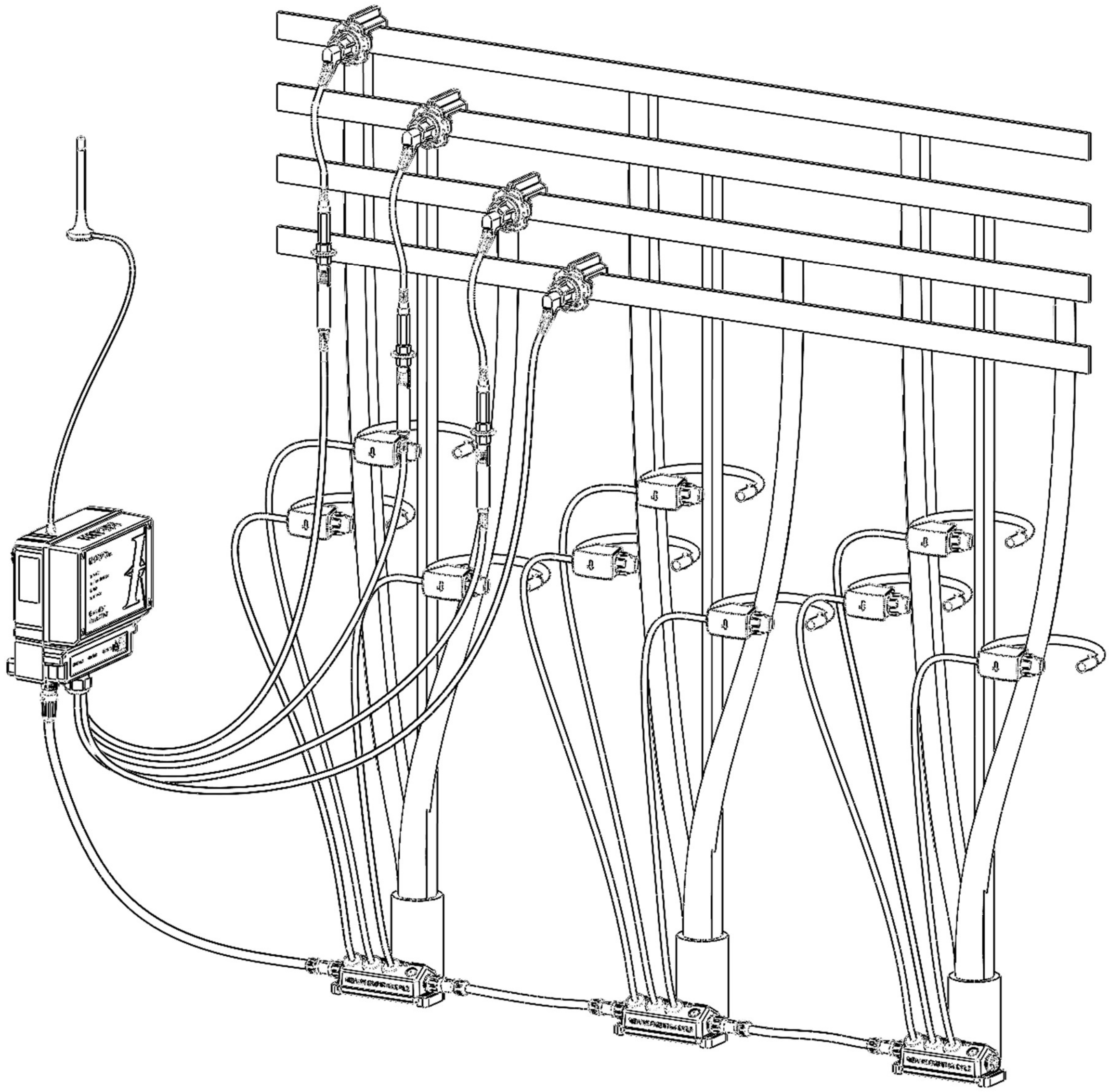


Figure 1 – FeederNet System, Typical LV Substation Installation

The installation consists of:

a. FeederNet Control Unit

b. Measurement Modules (Current)

c. Rogowski Coils

d. Voltage Leads

e. Busbar Clamps (Optional)

f. 4G GSM Antenna (Optional)

g. Interconnecting cables

A typical installation layout (for a three-feeder substation), is shown in Figure 1 above.

2.2.1 The Rogowski Coils

The Rogowski Coils, one for each phase and neutral to be monitored, are very flexible and open, to be wrapped around the conductor and then connect together again to make a complete circle around the conductor. The output of the coil is a small AC voltage that is directly proportional to the current flowing through the conductor that the coil is wrapped around.

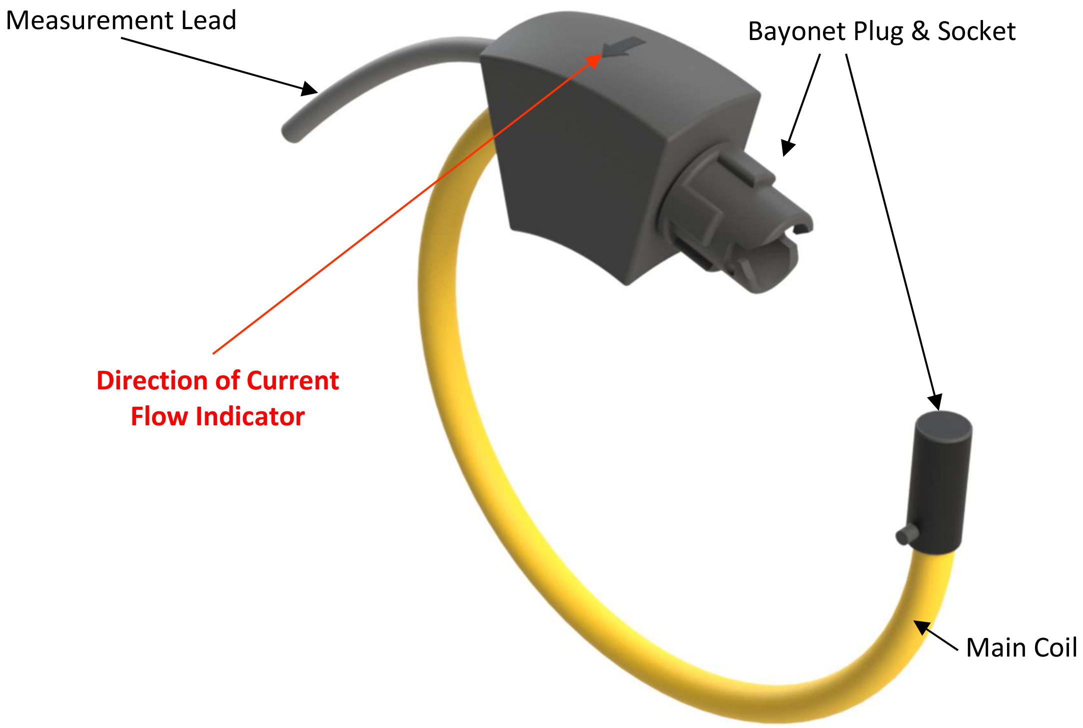


Figure 2 - The Rogowski Coil

The AC voltage corresponding to the current through the conductor being monitored, appears on two of the cores of the measurement lead, with the third being the screen for the measurement lead. The measurement lead is factory wired into the Measurement Module to ensure correct calibration of the unit.

Note: Swapping of the coil connections in the measurement module may have a detrimental effect on the calibration of the Measurement Module. However, swapping Measurement Modules with Control Units has no effect on the calibration. Each of the coils are marked with their respective Phase.

The Rogowski Coil is suitable for outside installations and is IP68 rated.

2.2.2 The Current Measurement Module

The FeederNet Current Measurement Module digitises the analogue AC voltages received from the Rogowski Coils. The Rogowski coils are connected to the Measurement Module at the factory where they are also digitally calibrated. The Rogowski coils cannot be interchanged on the Measurement Module without an impact on the system calibration.

There is one Measurement Module required per three phase Feeder to be monitored, with the ability to connect multiple Measurement Modules together, in a chain, to form a Feeder Network being monitored.

Figure 3 - The Measurement Module

The Measurement Module connectors, at either end of the housing both contain four connection pins. Two pins are the supply voltage for the modules, provided by the Control Unit, and the other two pins being digital data (one Transmit and one Receive). The plug (Male socket) is connected in the chain towards the Control Unit, whilst the socket (Female socket) is connected to the next Measurement Module in the chain (if any).

A maximum of 8 Measurement Modules can be connected to the feeder chain.

The Current Measurement Module has the capacity to measure all three phase currents and the neutral current (although the Neutral current is normally calculated by the Control Unit).

The Measurement unit also contains a small tri-colour LED, providing colour indication on the status of the Measurement Unit and the communications with the Control Unit.

- A flashing LED indicates that measurements are being taken and the unit is running and communicating with the controller.
- A flashing green LED indicates that all is ok and that current flow is being detected.
- A flashing amber LED indicates that no current flow has been detected (because there is none or it is very low (< 1A))
- A deep red LED indicates that a fault or error has been detected in the current module.

The Measurement Module is suitable for outside installations and is IP67 rated.

2.2.3 The Control Unit

The Control Unit provides the means for the Phase Voltages to be digitised, measured and receives the current measurement data along the FeederNet network from the connected Measurement Modules. The data is processed within the Control Unit to provide the various LV parameters.

The Control Unit controls the Measurement Modules and provides the communications with the with the Bluetooth configuration app and System data servers.

Figure 4 - The Control Unit

The Control Unit enclosure is manufactured from Polycarbonate material and has dimensions of 164 x 156 x 79 (not including cable gland, connectors and mounts), as shown in Figure 4 above. The weight of the Control unit is 1kg. The Control Unit has an Ingress Protection (IP) rating of IP67 and is suitable for mounting outside externally and open to the elements.

The Control Unit has three wired connections:

a. FeederNet socket connection – provides the connectivity to the FeederNet Measurement Module chain.

b. Standard Ethernet RJ45 Connection (H00217 Ethernet Version only) – Provides wired connectivity to the Data Servers.

c. Voltages – Provides wired connectivity to the three phase and neutral voltages to be measured. (These voltages and neutral also provide the power supply to the Control Unit which only requires any one phase to be powered).

d. SMA Antenna Connection (optional for H00509 Version only), this provides a means to connect the mobile 4G antenna to the unit.

2.2.4 Voltage Leads

The FeederNet Controller is self-powered from the voltage leads, that also contain an in-line fuse holder and terminated with a standard 4mm plug. The leads that meet IEC 61010 CAT IV 600V and are fitted with a quick acting 10A 600Vac 6.3 mm x 32 mm fuse.

Caution: If a fuse needs to be changed then **ALL** voltage leads must be disconnected from the mains supply to ensure isolation.

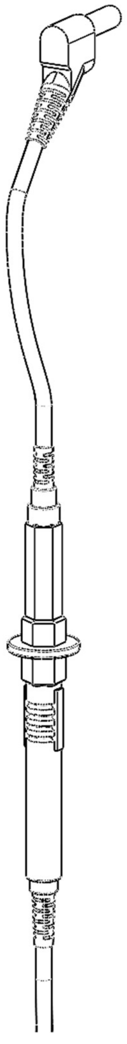


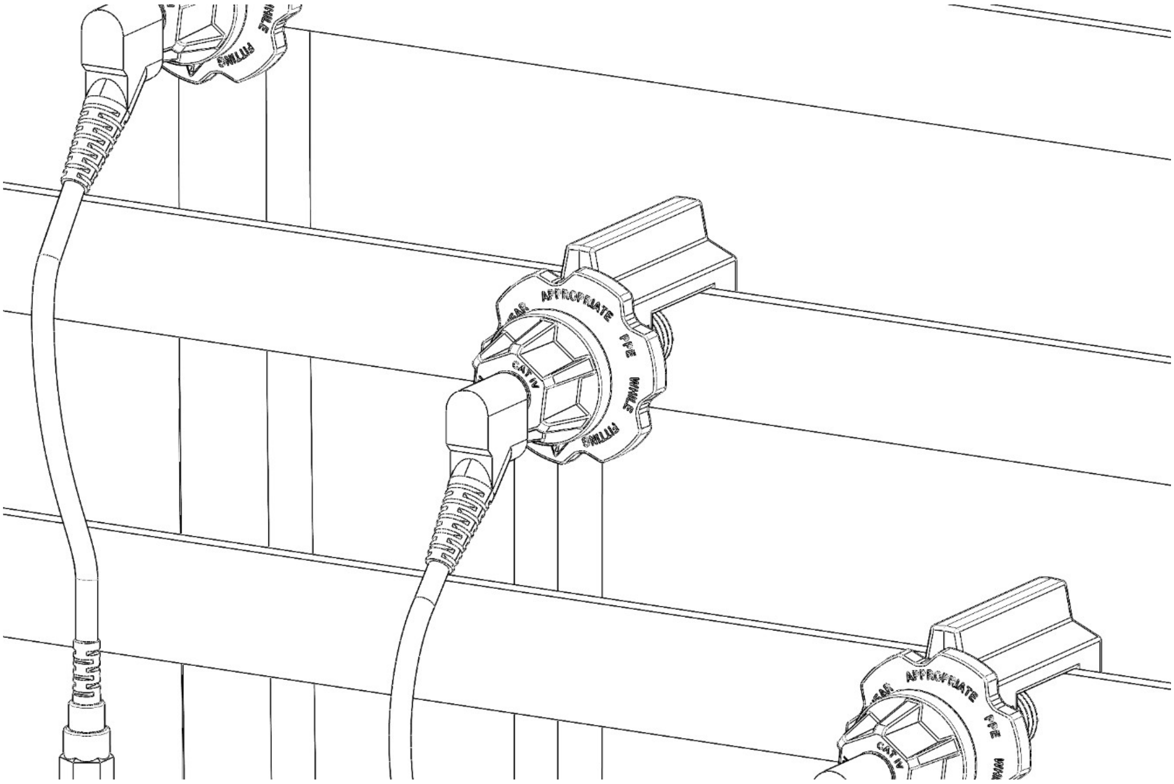
Figure 5 – Voltage Lead, fitted with in-line fuse holder and 4mm plug

NOTE: The blue coloured neutral lead is not fitted with a fuse holder. The three-phase voltage leads and neutral lead are supplied, wired into the Control Unit.

2.2.5 Busbar Clamps (Optional)

For the connection of the Controller Unit Voltage signal cables to a standard Busbar System, Busbar clamps are available, as shown in Figure 6 below.

The HAYSYS Bus Bar G Clamps are for use ONLY by TRAINED PERSONNEL conducting work on behalf of RESPONSIBLE BODIES who have inducted them on relevant HEALTH AND SAFETY protocols.



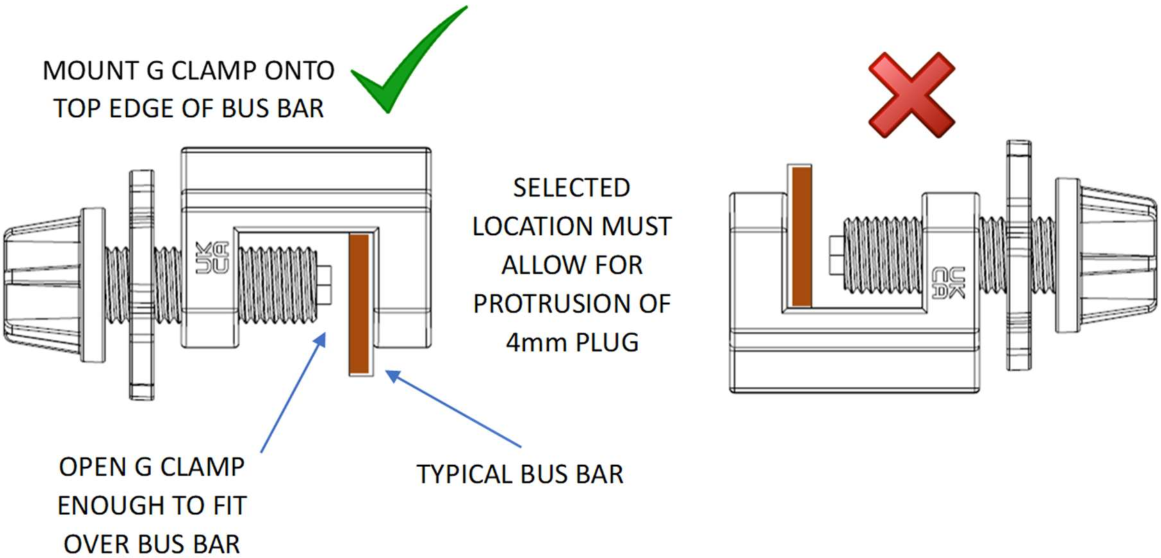


Figure 6 – Installation of Busbar Clamps

Standard Personal Protection Equipment (PPE), is to be worn when fitting the clamps to energised busbars.

2.2.6 GSM Antenna (Optional)

The FeederNet Controller includes an integral 4G GSM Antenna, for mobile communications to the data servers. If preferred, the Controller can be fitted with an external Antenna, as shown in Figure 7 below.

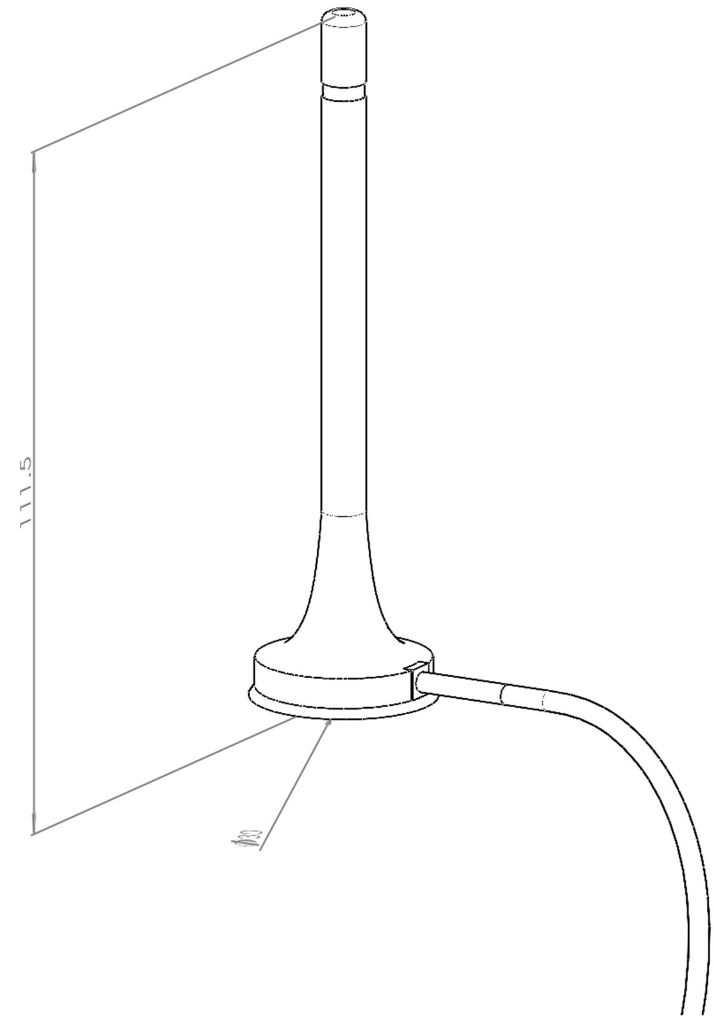


Figure 7 – 4G GSM Antenna

The external GSM Antenna, is magnetically mounted on a steel surface and comes with a 5m lead, fitted with a standard SMA connector.

2.3 Installing the Rogowski Coils and Measurement Modules

As shown in Figure 2 above, the Rogowski Coils can be opened to enable them to be wrapped around the phase or neutral conductor. Once wrapped around the conductor, the ends of the Rogowski Coil are then connected together using the Bayonet connector.

As shown in Figure 8 below, the Rogowski Coils show the direction of current flow through the conductor/Rogowski Coil. It is important that all Rogowski coils are fitted such that the direction of the arrows on the Rogowski coils correspond to the direction of the current through the conductor being monitored.

Greater accuracy can be achieved if the coils are positioned so that the conductor is in the centre of the Rogowski Coil and as far as possible away from any other adjacent conductor.

The Rogowski coils are connected directly to the Measurement Modules at the factory and cannot be interchanged without a detrimental impact on the System Calibration Accuracy. Each of the coils are labelled with either L1, L2, L3 or N.

The Measurement Modules can be installed 'floating' as it is not necessary to physically mount them.

2.3.1 Connecting the Measurement Modules

Connection between the Measurement Modules and also between Measurement Module and the Control Unit, is via a single four-pin plug and socket circular connector. The connector is twisted clockwise to lock and anti-clockwise to un-lock. Only a single cable is required between each Measurement Module and only one cable is required between Measurement Module and the Control Unit, as shown in Figure 1 above.

2.3.2 Installing the Rogowski Coils around Feeder Cables

Figure 8 below, details the installation of three Rogowski Coils around a typical three phase Feeder cables. The figure also shows the recommended position for the FeederNet Measurement unit at the base of the cable where the cable enters the LV Pillar.

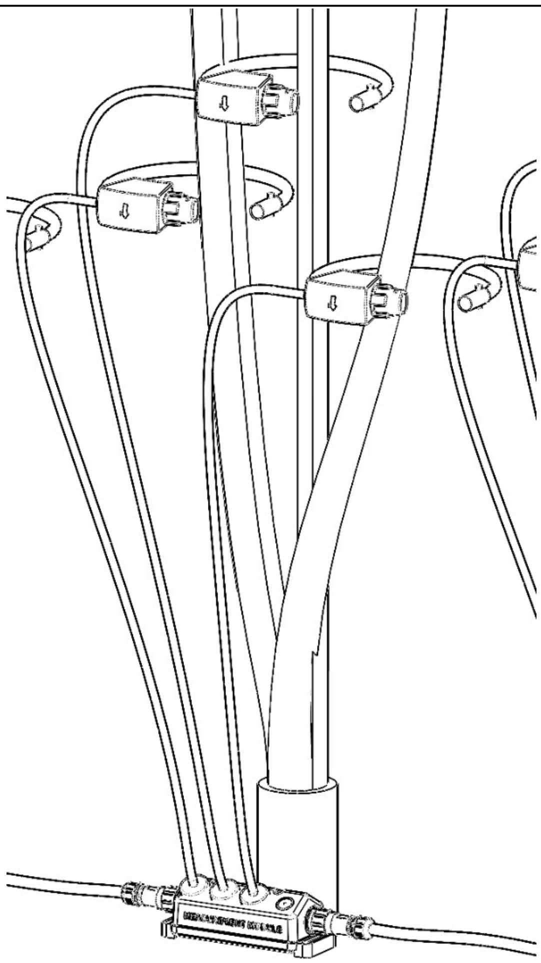


Figure 8 - Fitting the Coils to the Feeder

This installation is repeated for each of the Feeders to be monitored. Each of the measurement leads from each of the Rogowski Coils are routed to the Measurement Module, in a neat and safe manner.

Each of the Measurement Modules are then connected together, in a daisy chain, to form the Feeder Network. The final Measurement Module at either end of the daisy chain, is then connected to the FeederNet port of the Control Unit (see section 2.2.3 for further details).

2.4 Installing the Control Unit

The Control Unit can be mounted using either magnetic mountings or surface mounted. The mounting holes to be used are shown in Figure 9 below.

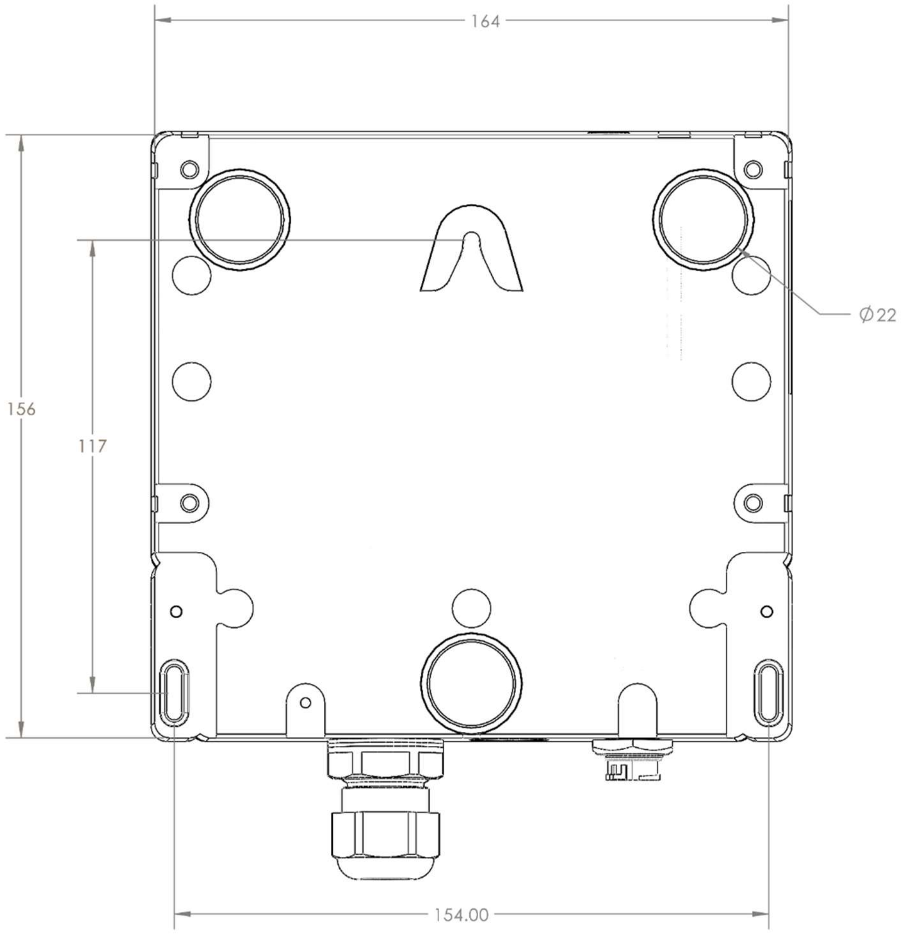


Figure 9 – Control Unit (rear view) Mounting Positions

With the Control Unit surface mounted, the design of the enclosure is such that that rear face will not be flush against the surface. This provides additional protection from damp walls etc.

2.4.1 Mag-Mounting the Control Unit

The FeederNet Control Unit is also be supplied with Magnetic Mountings, as shown in Figure 10 below.

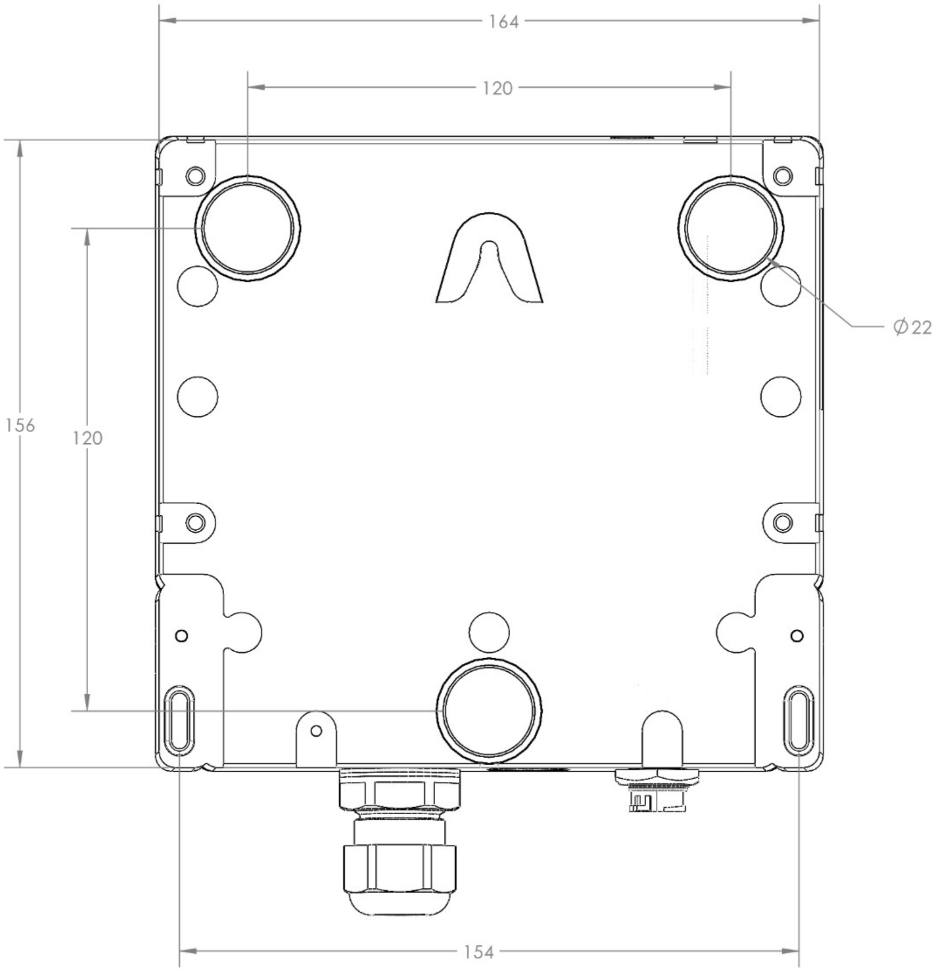


Figure 10 - Mag-Mounted Control Unit

There is a total of three rubber coated permanent magnets that provide a pull-strength of 3.8 Kgs each. This then attaches the Control Unit to a steel surface with a total pull-strength of 11.4 Kgs.

2.5 Interconnecting Cables

2.5.1 Control Unit Cable

The control unit cable is 1m long and fitted with 4-pin circular connectors. The connecters are aligned by lining up the white dots on the plug and socket and screwing the connectors together.

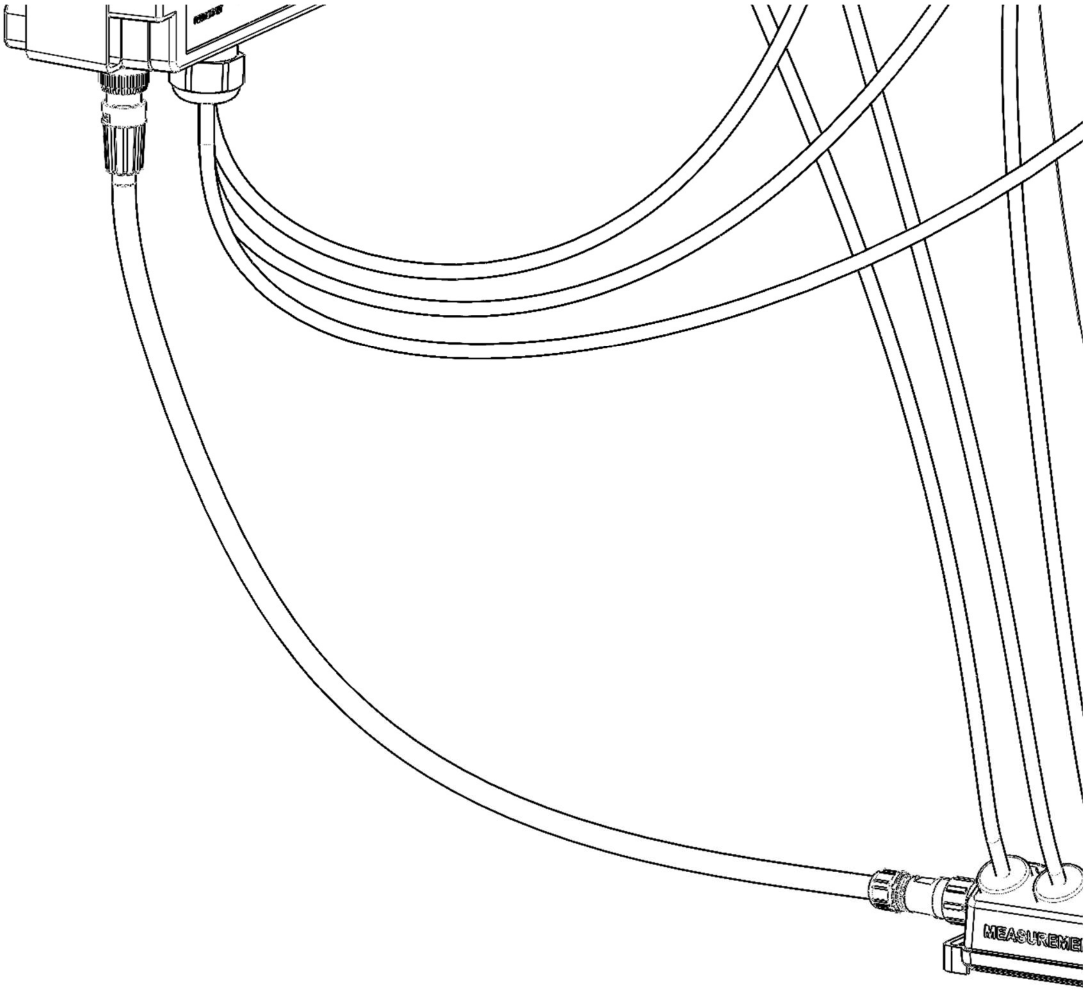


Figure 11 – Control Unit cable

The control unit cable, shown in Figure 11 above, connects between the Control Unit and the first Measurement Module. The cable can only be fitted one way.

2.6 Interconnecting cables

Between each module is a 250mm long interconnecting cable, as shown in Figure 12 below

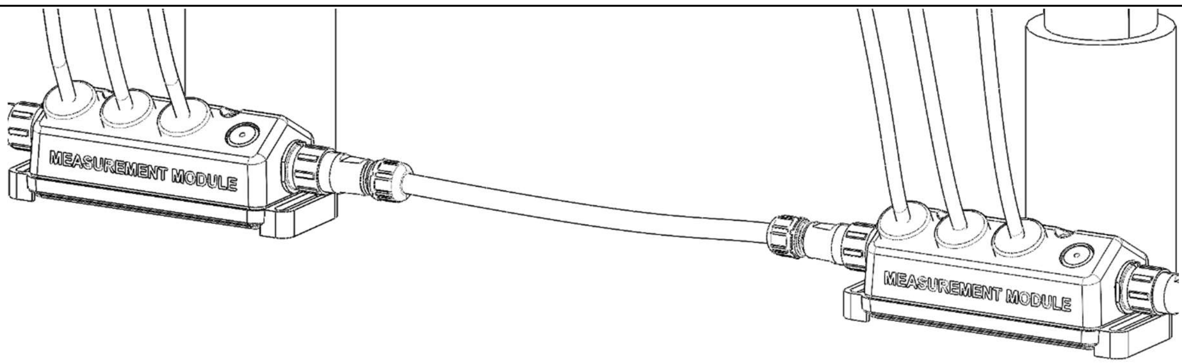


Figure 12 – Module interconnecting cable

The cables can only be fitted one way (Male – female) and are aligned by the white dots.

2.7 LV Monitoring Warning Label (Optional)

The LV Monitoring Warning Label is shown in Figure 13 below

Figure 13 – LV Monitoring Warning Label

Where required, the LV Warning label is to be attached in a clearly visible position within the LV Pillar.

3 COMMISSIONING

3.1 Power Up

Once the Measurement Units and Control Unit have been installed and with the Control Unit covers all in place (do not need to be removed for installation), the Control Unit can be powered.

The Control unit will go through its power-up sequencing and when completed (about 4 minutes), display the LED states as detailed in section 3.2 below.

3.2 Confirming Operation

Confirmation of both the Measurement Modules and the Control Unit on-site, is achieved by examining the status of the following LED indications:

a. Measurement Module LED – flashing green (assuming more that 1A flowing).

b. Control Unit Power LED – flashing blue.

c. Control Unit Communications LED – on (assuming not in commissioning mode)

d. Active LED – off

e. Link LED - off

The correct status of the LEDs detailed above demonstrate to the local user/installer, that the units are powered, alarm free and sampling both Voltages and Currents.

Further confirmation and control of the FeederNet installation is achieved using the FeederNet Android App, available for download from the Google Play Store – see below.

4 FEEDERNET MOBILE DEVICE APPLICATION

The FeederNet Mobile application connects to the FeederNet Control Unit via Bluetooth to allow confirmation of correct installation. The app also allows information about the substation and its feeders to be entered.

Figure 14 below details the connection and logging on process for which the customer unique password is required for security reasons. As seen in the figure below it is a requirement of the app that the device’s flight mode be enabled when connected to a control unit to ensure maximum security.

Once setup and commissioned the Bluetooth interface to the controller can be turned off from the data server if required.

Figure 15 shows checking the voltage, current and power measurements are correct and then taking the control unit out of commissioning mode (if in that mode) to connect live to the data server.

If no voltage, current or power is being measured then the round circle indication will be grey. The power indication circles will turn orange if power is flowing in the wrong direction indicating that a Rogoski coil may be upside down. If the power being taken is below 1kW then the circle will turn red.

The “CONFIGURATION” tab allows the substation and transformer details to be entered into the FeederNet system for upload to the data server. This tab also allows the mobile connection, error states to monitored and the GPS location of the substation to be set (may not be done automatically) as well as telling the system how many modules should be expected.

When making a change the “SEND PARAMETERS” button should be pressed to send the data to the control unit. Use the “GET PARAMETERS” button to get the parameters from the control unit. Data fields turn green when they are confirmed to match the data in the controller else, they are white.

Th “ENGINEERING MODE” button at the bottom of the tab allows the reactivation of commissioning mode, rebooting the controller and restarting the application running on the controller.

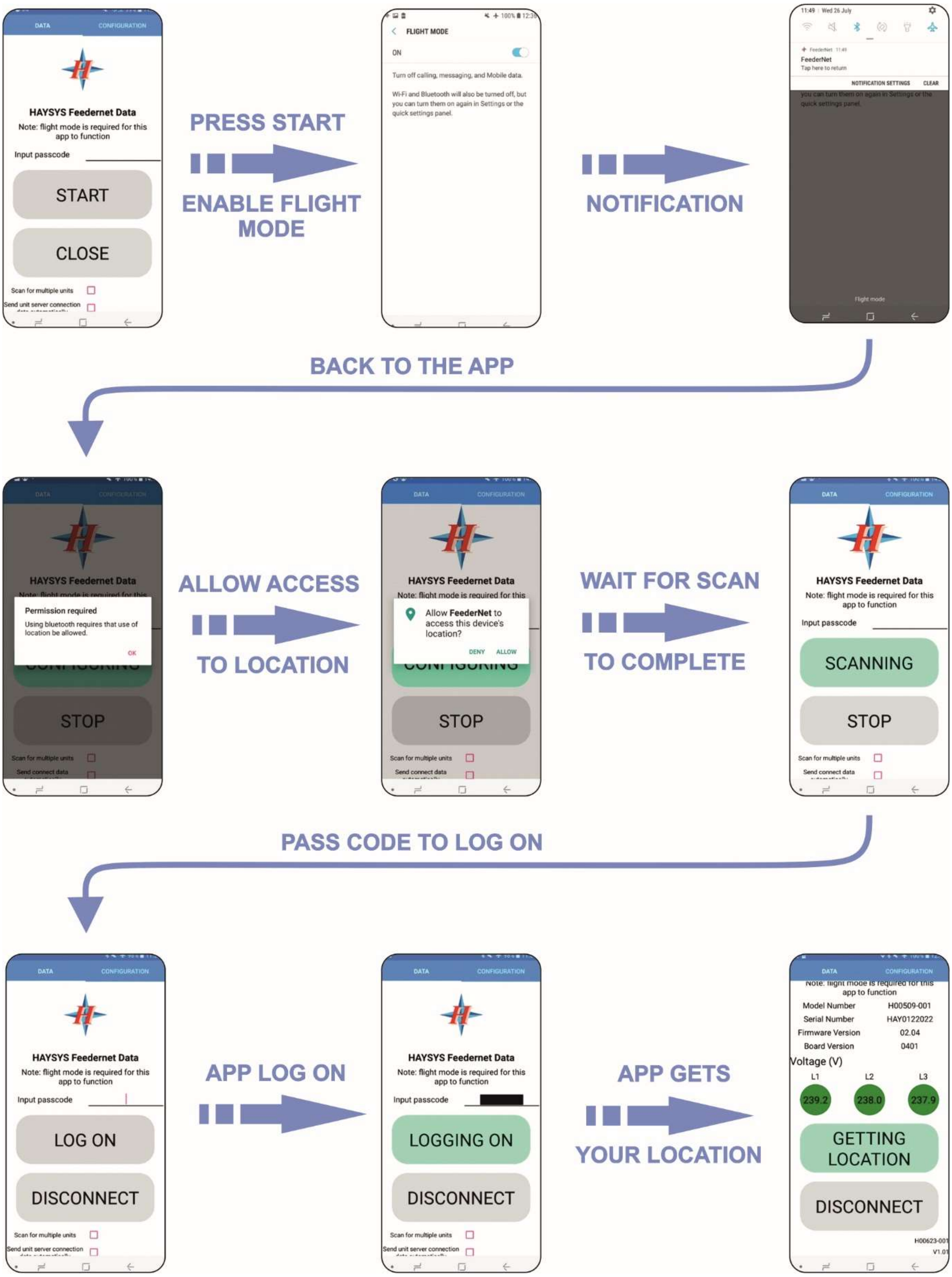


Figure 14 - Bluetooth App Logging on Flow

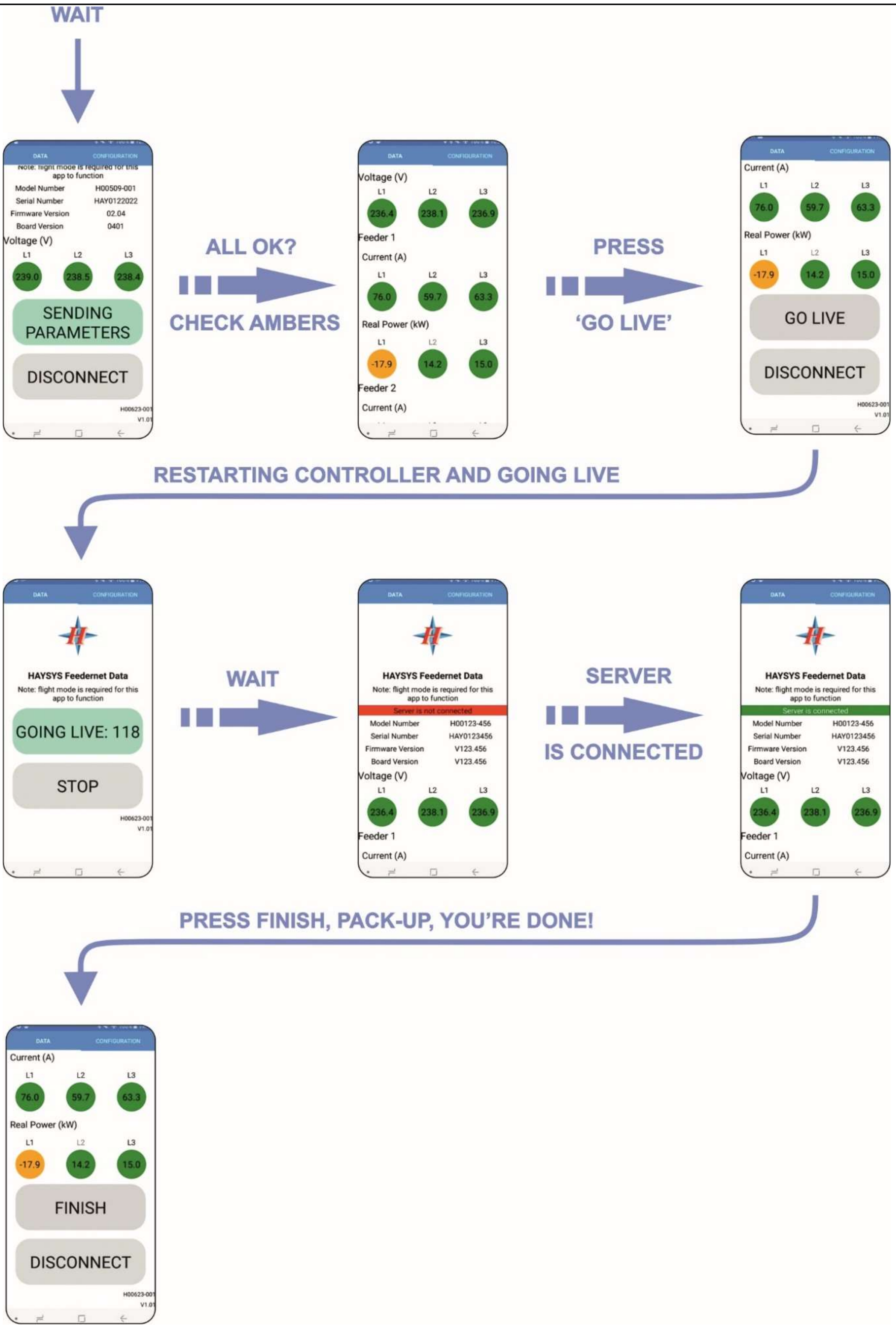


Figure 15 - Checking Installation and Commissioning via the Mobile App

5 INSTALLATION SUPPORT

Should assistance during commissioning be required, contact details are:

HAYSYS Limited – Tel: +44 (0)29 20 020871 (24/7, 365 days a year).

Support email – help@haysys.co.uk

Web: www.haysys.co.uk

6 FEEDERNET SPECIFICATIONS

This section contains the specifications for the FeederNet system. Where a specification applies to a part of the system only it will have its own section else the specification applies to the system as a whole.

6.1.1 FeederNet Physical Specifications

<u>Control Unit</u>

Dimensions:	Without connectors: W: 164mm x H: 156mm x D: 79mm With connectors: W: 164mm x H: 200mm (approx.) x D: 90mm
Weight:	1Kg
Mounting:	3 x Built-in Magnetic pads or 3 x screw fixings
First module Cable Length:	1000mm or 5000mm (other lengths available on request)

<u>Current Module</u>

Dimensions:	W: 120mm x H: 47mm x D: 45mm
Weight:	0.35Kg approx.
Inter-Module Cable Length:	250mm (other lengths available on request)

<u>Rogoski Coils</u>

Coil Diameters:	60mm 150mm 300mm (Others available on request)
Lead Lengths:	250mm, 1000mm and 2000mm (or as required)

6.1.2 FeederNet Electrical Specifications

<u>Control Unit</u>

Voltage range:	Supply rating: 100 to 240Vac ±10% per phase of 3 Phase + Netrual supply Measurement: 100 to 260Vac	
Frequency:	Supply rating: ~50Hz	Measurement: 47 to 63 Hz
Current:	Supply rating: 0.15A	
OVC Rating:	CAT IV 300V	
Mobile Connection:	4G LTE Cat 1 (Fall-back to 3G or 2.5G)	

Current Module

Current Measurement: 1 to 4000A (Depending on settings)

Rogoski Coil Accuracy: 1%

Rogoski Coil OVC Rating: CAT III 1000V / CAT IV 600V

6.1.3 FeederNet Environmental Specifications

Operating Temperature: -25°C to +40°C

Working Humidity: 20 ~ 90% non-condensing

IP Rating: IP67

Enclosure Flame Rating: UL-94 V-0

Pollution Degree: 2 (micro-environment) 4 (macro-environment)

The FeederNet System is intended for indoor and outdoor use.

The FeederNet System is NOT for use above 2000m.

6.1.4 FeederNet Reported Parameters

Frequency of Reporting: Configurable from 30s to 86400s (24 Hours)

Supported Data Protocols: HTTP, HTTPS, TLS1.2, MQTT (e.g. Azure), DNP3 (e.g. iHost), ModBus, Bluetooth, TCP/IP, Ethernet

Parameters: (global configurable options for Min, Mean and Max values)

Phase Voltages (rms), Phase Fundamental Voltages, Frequency, Voltage Total Harmonic Distortion (VTHD)* and Voltage Harmonics (1^{st} to 15^{th})*^

Feeder Phase & Neutral Currents, Feeder Phase & Neutral Fundamental Currents, Current Total Harmonic Distortion (ITHD) and Current Harmonics (1^{st} to 15^{th})*^

Power Factor Angle*, True Power Factor*, Real Power*, Reactive power*, Apparent power*, Real Energy*, Reactive Energy*, Apparent Energy*.

Busbar Values: all the above parameters are also reported as combined busbar values.

* These parameters can be enabled or disabled

^ Harmonics up to the 50^{th} can be provided on request.