Grid Solutions
Monitoring & Diagnostics

Kelman™ BMT 430 Operator Guide

Bushing & Partial Discharge Monitoring

GE VERNOVA

Contents

List of Tables and Figures

Related Documents

Ref#	Title
MA-043	BMT 430 - Installation & Commissioning Manual

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
PD	Partial Discharge
PDI	Partial Discharge Index

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) neutral (if applicable) – for monitoring a bank of single phase transformers.
- Three 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.

1.2 Scope

This guide outlines comprehensive use of the HMI for configuration, communications, alarm settings, calculations and error notifications as well as general maintenance activities.

For essential configuration operations and first start-up procedures, refer to the Commissioning section of 'MA-043 - BMT 430 - Installation & Commissioning Manual'.

Note: This guide displays screens from the web HMI using an Administrator login. All user logins have a similar look and feel, but some features are dependent on the type of user.

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 adapter 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, bodily injury, equipment damage or loss of data.

Electrical Hazard. Risk of electric shock.

Primary Protective Earth connection.

The meaning of symbols used in this guide:

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 Safety Statements

The following safety statements must be observed:

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

The product provides IP56 / NEMA 3RX water spray protection. It is possible for a water deluge system to exceed these thresholds depending on the location, pressure and direction of the water jets. Should customers require testing a water deluge system in the area in which the product is installed, GE Vernova recommends powering down the product and draping it with a suitable waterproof covering.

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 – Schurter Series SPT 250V DC 8 or 6.3 A
Coin cells	Panasonic CR2450 3 V 620 mAh
TOP OIL TEMPERATURE SENSOR	
Operating Voltage	12 V DC
Communication	CANbus

*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 POWER

The product is wired directly to the mains so is continually powered on. The mains fuse holder for the product is shown in Figure 5-1 and is located towards the bottom right-hand side of the enclosure. Note: This is not a point of electrical isolation.

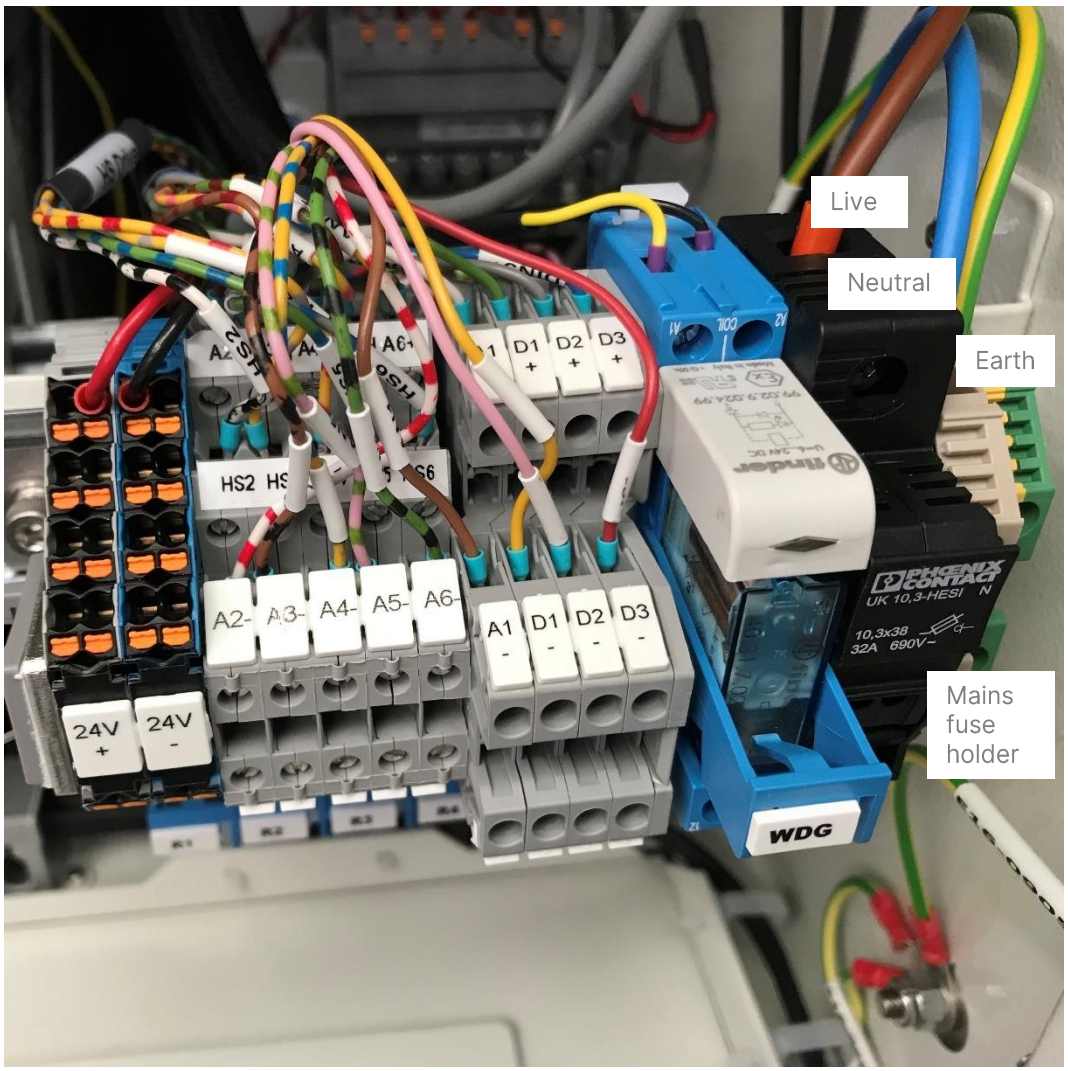


Figure 5-1: Fuse holder

The product uses four external sunlight-visible LEDs on the front door. Each LED has two states – 'Off' (-) or 'On' as outlined in Table 5-1.

Table 5-1: External LED status indicators

Mode	Alarm red LED	Caution amber LED	Power green LED	Service blue LED
Power Off	-	-	-	-
Normal	-	-	On	-
Alarm	On	-	On	-
Caution	-	On	On	-
Service	-	-	On	On

6 HMI

6.1 Introduction

The local HMI features an integrated 7 in. colour LCD panel with resistive touch screen and embedded webserver. The remote HMI is via a wireless comms option (or direct USB connection) to a web browser. The latter being the preferred means of interaction with the product since it offers the convenience of accessing the product from anywhere using a full screen web browser. The remote HMI is optimised for Chrome, but has also been tested in Firefox and Edge. The local HMI allows operators to interact directly with the product onsite without additional equipment. However, the local HMI facility is intended as an alternative or secondary access method in situations where network connectivity is unavailable.

To prevent exposure of the internal equipment to extreme weather or other adverse environmental conditions, ensure additional cover is in place prior to opening the door.

The LCD panel is inside the enclosure and is visible when the door is open as shown in Figure 6-1.

Figure 6-1: Inside the product – LCD top left

The LCD and web server are powered on by default as soon as power is supplied to the product. Access to the HMI can be gained locally via the resistive touch screen (using a finger or stylus) or remotely through the Web from any computer. Both HMI experiences are comparable with a similar look and feel.

Note: This guide uses screenshots from the remote Web access HMI. The images rendered on the local HMI are similar, but some have a different layout due to the smaller screen.

Note: This guide displays screens from an Administrator login. All user logins have a similar look and feel, but some features are dependent on the type of user.

Note: If there are any rendering issues on the remote HMI, press `Ctrl` + `F5` to refresh.

Note: If using Internet Explorer 11, ensure that the option for 'Compatibility View' is disabled.

Note: Serial connections are not used to operate the product.

6.2 Connections

The remote HMI can also be accessed from a laptop via a direct physical connection to the product. The product ships with the default IP address as shown in Figure 6-2. Use either an Ethernet or USB cable to make the connection as shown in Figure 6-2.

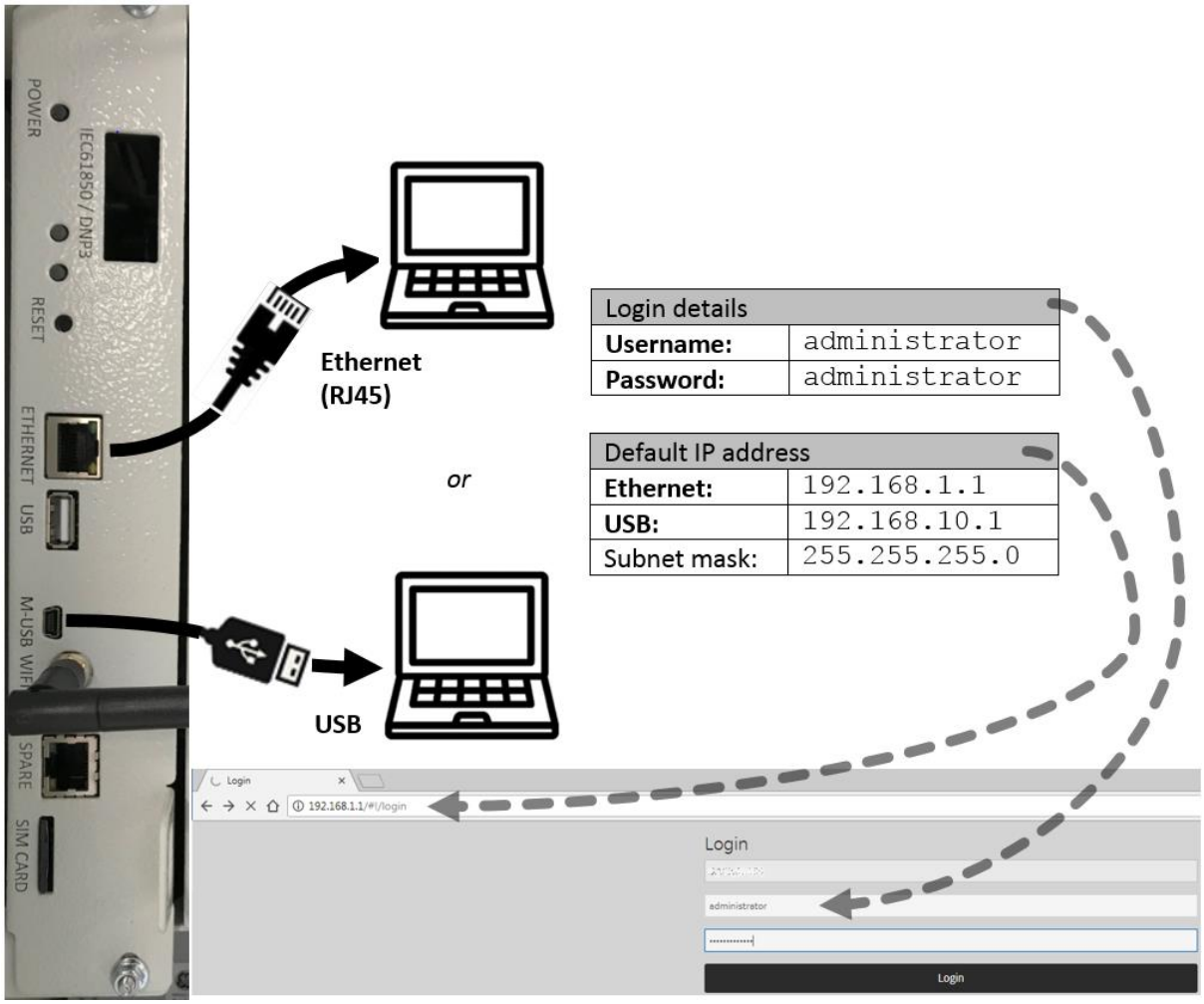


Figure 6-2: Ethernet / USB HMI connection

6.3 Start-Up Procedure

6.4 Login

The log-in page prompts for a username and password as shown in Figure 6-3. The product ships with a default username and password that can be changed after initial login.

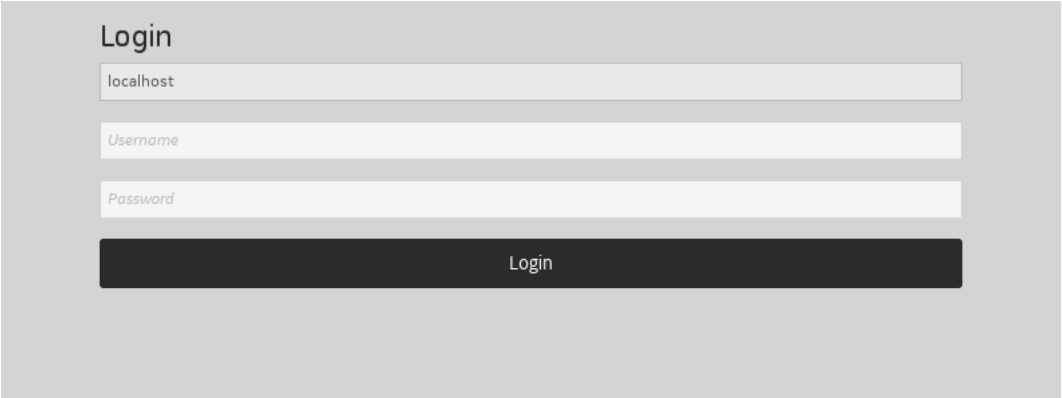


Figure 6-3: Log-in page

The system supports three roles with different levels of access as outlined in Table 6-1.

Table 6-1: User access rights

Role	Access
Observer	View information only (includes downloading if using the remote HMI)
Operator	View information and make configuration changes.
Administrator	View information, make configuration changes and perform user administration e.g. change passwords.

Note: The session inactivity timeout is 10 minutes.

The Administrator can omit to set a password for the 'Observer' role. This means anyone with physical access to the product or a connected computer can observe the measurements and data without the need to supply a password. See Section 7 for user administration details.

The opening page of the local HMI presents a Quick Access page as shown in Figure 6-4, whereas the remote access HMI presents a detailed dashboard as shown in Figure 6-5. The header on each page lists the language, user details and a menu bar.

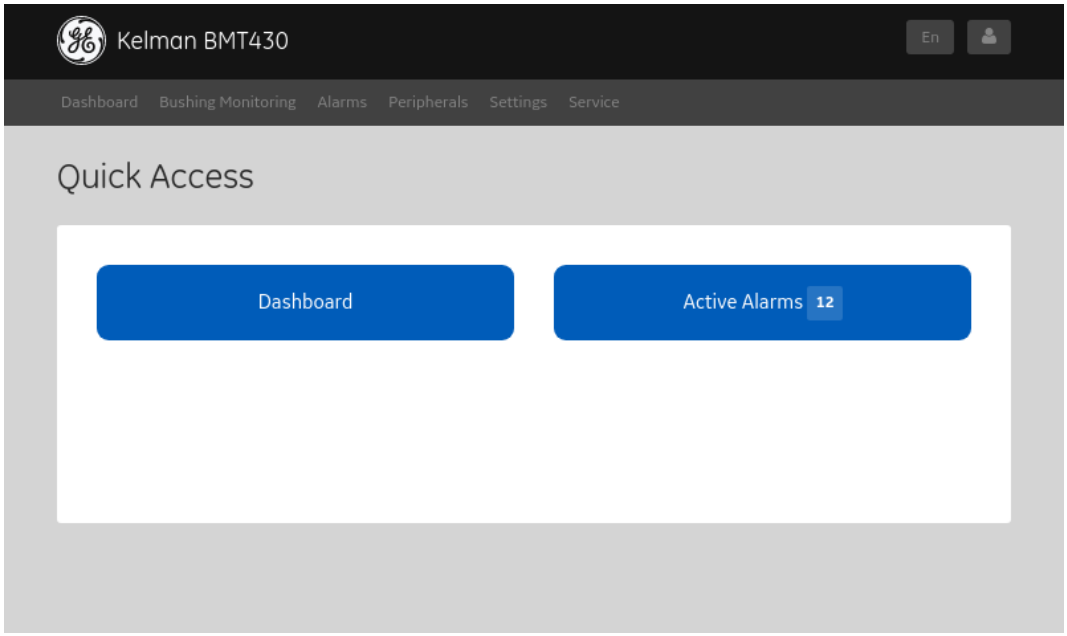


Figure 6-4: Local HMI - Quick Access page

6.5 Dashboard

After a successful login, the remote HMI displays the Dashboard page with the latest Bushing & PD measurements, System Information and three quick access buttons (for live measurements, configuration import/export and downloading a log) as shown in Figure 6-5.

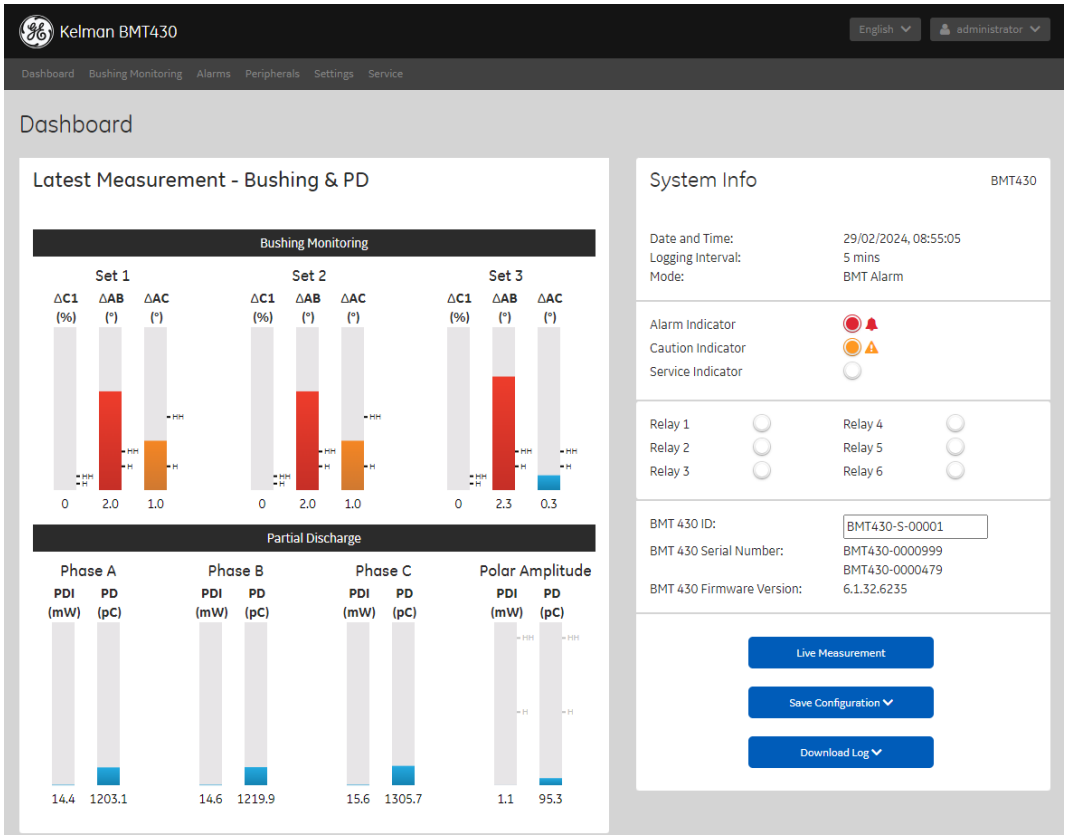


Figure 6-5: Dashboard

The Dashboard page shows Set 1, Set 2 and Set 3 bushing readings (C1, AB, AC) displayed numerically and represented graphically on a bar chart marked with the configured Caution (H for High) and Alarm (HH for High High) levels. Blue signifies a reading within the normal limits, yellow a caution — the reading has exceeded the High (H) level, and red an alarm – the reading has exceeded the High-High level. After the next measurement completes, the details automatically update.

The Partial Discharge readings are listed in picocoulombs (pC) for each phase. A quantitative index called the Partial Discharge Index (PDI) is also calculated.

The System Info gives the current date, time, logging interval and Mode (Normal, Alarm, Caution). Indicators show the status of the alarm, caution and service LEDs as well as the six relays. There is also a free text ID field to assign a meaningful name to the product. The default is the product's serial number. Note: Only Operator or Administrator changes will be saved. The product's serial and firmware version numbers are also listed.

The system also offers the following quick access buttons:

6.5.1 Live Measurement

Click **Live Measurement** to display the Live Measurement page. This button provides quick access to the latest measurement data. See Section 6.6.4 for more details on Live Measurements.

6.5.2 Save Configuration

Click **Save Configuration** to export settings to a PC or import settings from a PC. Product configuration details (including alarm settings) can be saved to a PC file and then uploaded to a replacement product eliminating the need to re-input the original settings. See 7.1.2 for details on the Configuration Import.

6.5.3 Download Log

Click **Download Log** to access the System log. This contains product performance data that is used to check product functionality. If requested, download and send the relevant log file to the GE Vernova M&D Service Support team for analysis.

Note: The System log is saved in the PC Downloads folder.

6.6 Bushing Monitoring

The bushing monitor employs several non-intrusive methods to gain insight on the condition of the bushings. Power factor and capacitance are crucial parameters to measure. Changes in dielectric strength can be caused by moisture or oil leaks, or short circuits in the capacitor or condenser layers. A

rising power factor value (Tan δ) can signify a deterioration in the bushing insulation.

Partial Discharges (PD) typically arise because of physical defects in the electrical insulation that transpire over time, such as a crack. This leads to a degradation in the overall electrical insulation material. Using the same tapping point and sensor, the PD capability records the number of discharges, measures the amplitude of the PD waves and the repeat rate. Using the Perception software, these inputs can be processed to allow characterisation of the partial discharge activity and trended over time using Phase Resolved PD analysis.

6.6.1 General Settings

Select **Bushing Monitoring** > **General Settings** to specify general setting as shown in Figure 6-6.

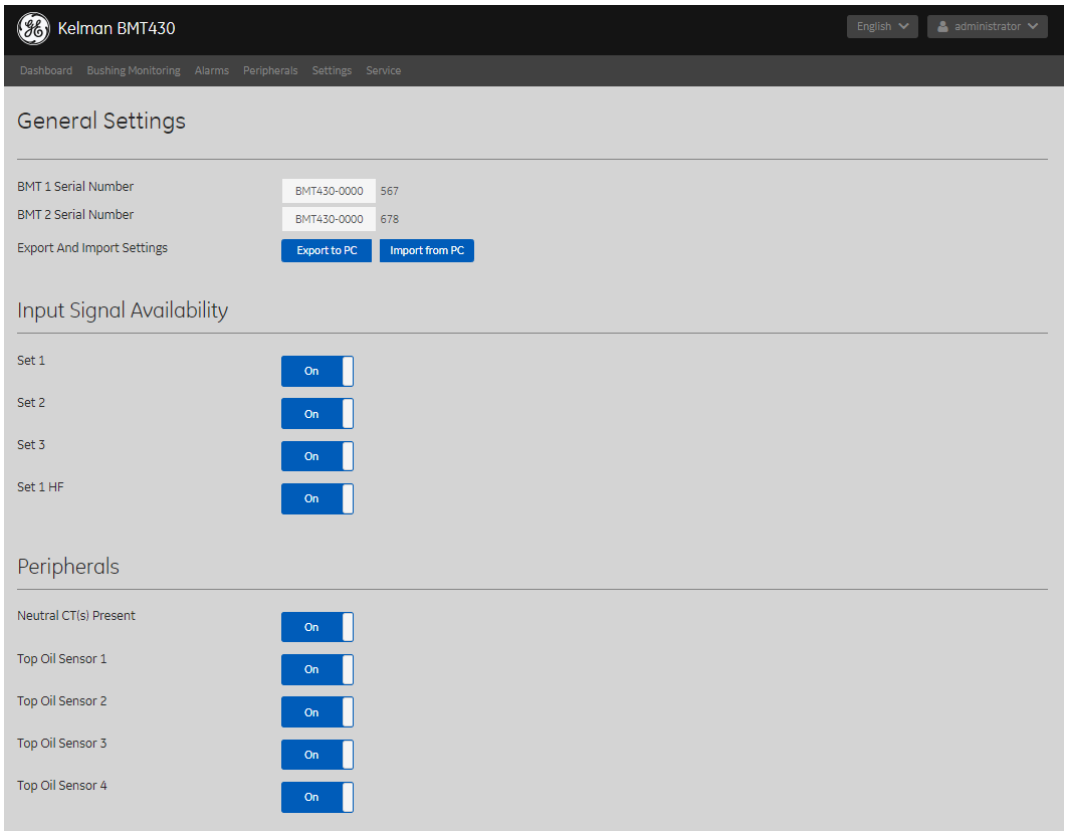


Figure 6-6: General Settings

The General Settings section lists each BMT card and provides access to the Export/Import settings. The **Export to PC** button exports the entire BMT measurement log to a text file for offline reference or forwarding.

Each BMT card is attributed with a customer configurable free text label that defaults to the product name and is hardcoded with a serial number as shown in Figure 6-6. It is recommended to change the default labels to match the naming convention in use on the site, particularly if the site has multiple transformers or monitoring devices. For example, HV1 for Set 1 and LV1 for

Set 2. Otherwise, it is fine to retain the default names. Phase names may also be changed, for example A, B, C might be R, Y, B or U, V, W.

Bushing options are listed in the HMI as follows:

- 'Set 1' of three bushings (Primary), supported by the BMT 1 card)
- 'Set 2' of three bushings (Secondary), supported by the BMT 1 card) and
- 'Set 3' of three bushings (Tertiary), supported by the BMT 2 card)

This provides capacity to monitor up to nine bushings across the bushing cards BMT 1 (Set 1 & Set 2) and BMT 2 (Set 3).

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

The Input Signal Availability section lists the availability of configured inputs. Signals from each bushing set and the high frequency signal for PD measurement can be individually toggled On or Off using the corresponding slider control as shown in Figure 6-6.

The Peripherals section lists the availability of configured peripherals namely Neutral CTs and up to four Top Oil sensors. Peripherals can be toggled On or Off using the adjacent slider control as shown in Figure 6-6.

6.6.2 Configuration

Select **Bushing Monitoring** > **Configuration** to view or modify configuration settings as shown in Figure 6-7.

Many settings are recommended factory defaults or preconfigured in the factory as per the customer-specific workflow and should not be changed unless advised by GE Vernova. Some settings are only visible to 'Administrator' users or those with Service mode enabled (see Section 6.6.1).

Scroll down the page to see all configuration sections. Let's examine each section in turn.

The Transformer monitoring configuration section is shown in Figure 6-7.

The operational frequency is typically 50 or 60 Hz. The monitoring mode is either a 'Bank of single-phase transformers' or a 'Three phase transformer'.

During installation and commissioning, all these settings must be checked against the customer-specific workflow.

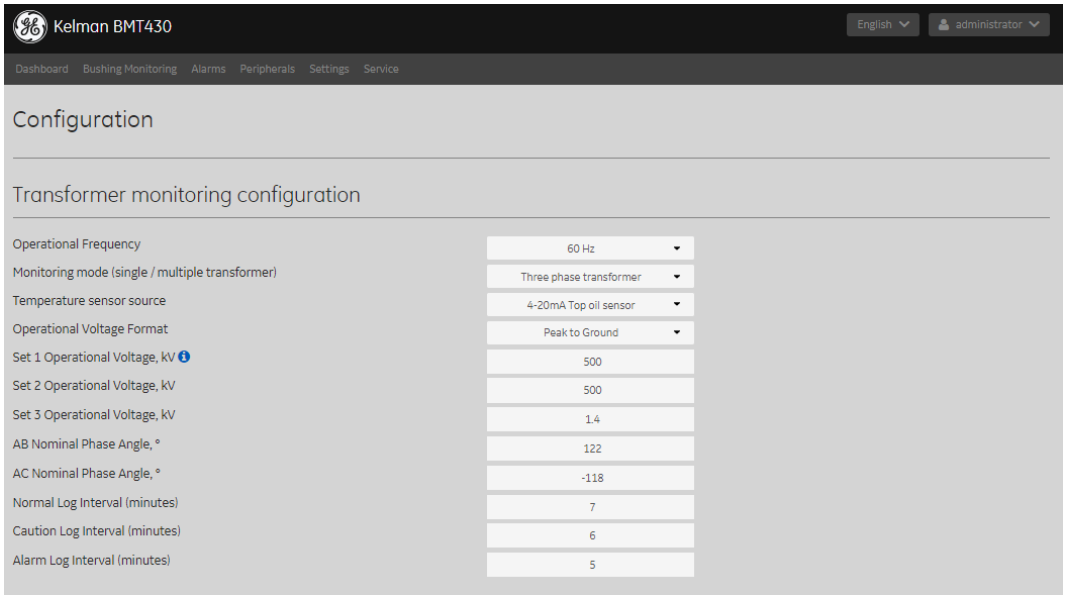


Figure 6-7:Bushing Monitoring > Configuration > Transformer monitoring

The Input Signal Mapping section is shown in Figure 6-8. The product supports one, two or three sets of three bushings in a single three-phase transformer, or three single-phase transformers.

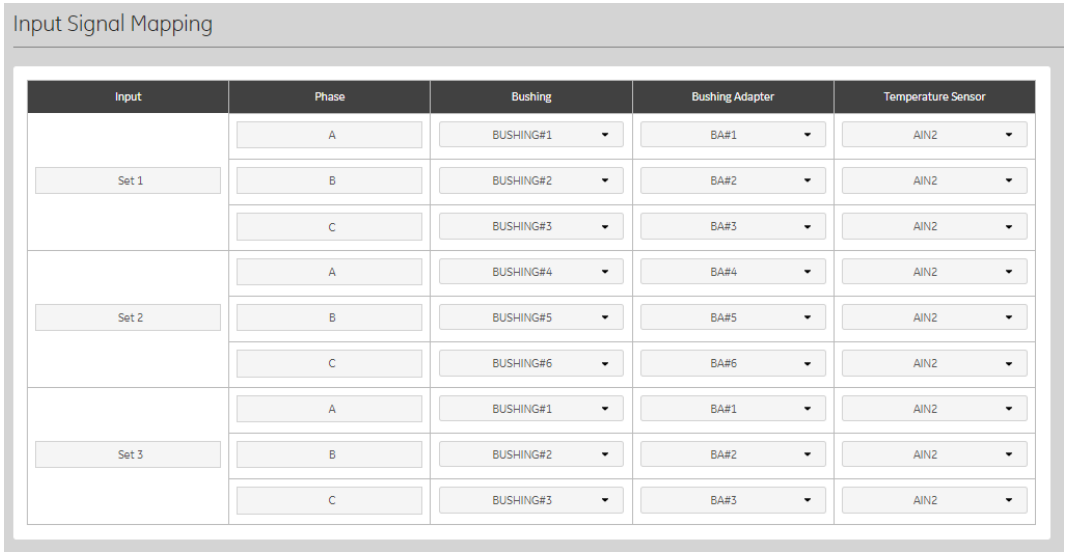


Figure 6-8: Bushing Monitoring > Configuration > Input Signal Mapping

The Bushing and Adapter Profiles section is shown in Figure 6-9. Each bushing must be mapped to a profile. Typically, it is recommended to use the bushing adapter serial number as an identifying label for the bushing. The naming will be configured during installation and commissioning.

The nominal C1 and PF values can be obtained from the bushing nameplate or customer-specific workflow. During installation and commissioning, these values must be checked to verify that each bushing has been fitted with the correct bushing adapter. If the nominal values for C1 and PF are not correct, the Service Engineer should update the bushing profiles.

Note: The bushing and adapter labels shown in this guide are generic. Every installation has its own predefined naming convention.

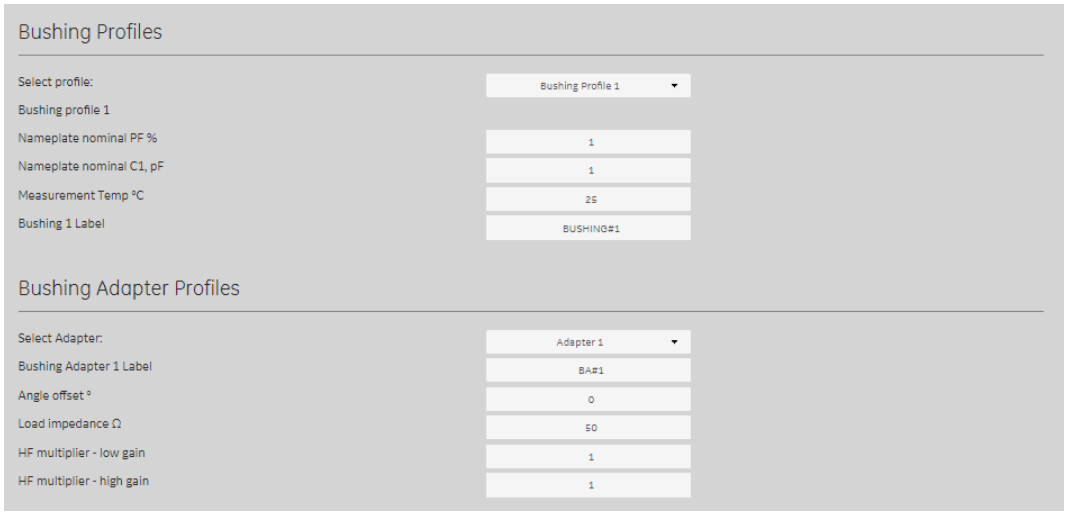


Figure 6-9: Bushing & Adapter profiles

The Exponential Moving Average Configuration section is shown in Figure 6-10.

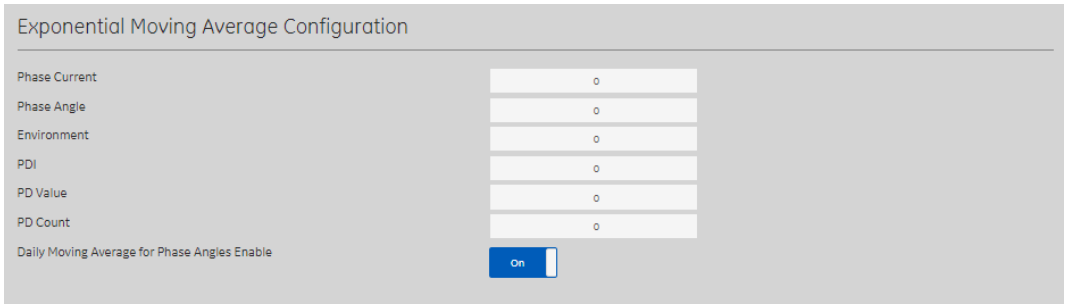


Figure 6-10: Exponential Moving Average Configuration

The HF Setup section is shown in Figure 6-11. This lists Live Noise levels, High Noise Threshold, VGA Gain and Input Relay.

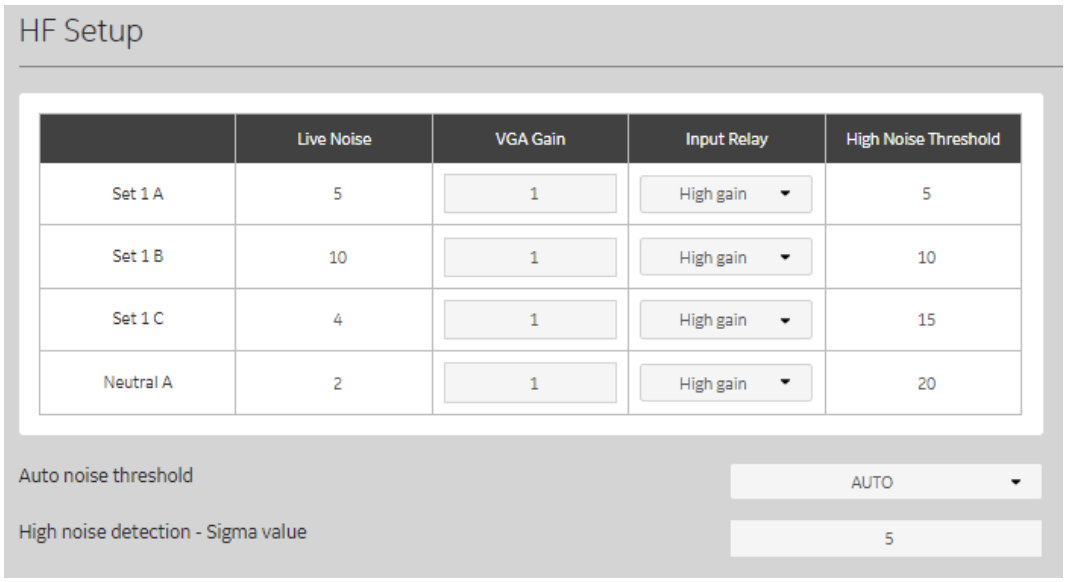


Figure 6-11: HF Gain and Control

The PD Settings are listed as shown in Figure 6-12. By default, the setting ‘Polarity discrimination without Neutral HFCT’ is ‘Off’.

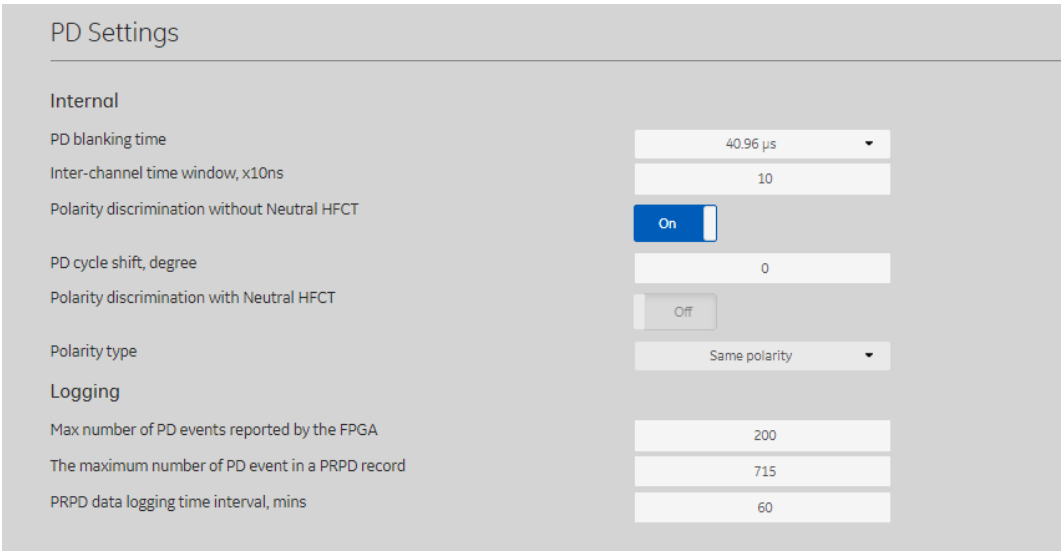


Figure 6-12: PD Settings

A unique algorithm discriminates between PD measurements internal and external to the bushing. Without a Neutral HFCT installed, the setting '**Polarity discrimination without Neutral HFCT**' must be '**On**'. This ensures that external PD measurements and alarms are active.

Note: PD is only available on Set 1 bushings.

Note: It is recommended to retain the default values unless otherwise advised by GE Vernova.

The Correlation PDi-RH value as shown in Figure 6-13 specifies in hours the time window for the effect of Relative Humidity on the PDi measurement.

Figure 6-13: Correlation PDi-RH

6.6.3 Calibration

Select **Bushing Monitoring** > **Calibration** to specify calibration settings as shown in Figure 6-14. Note: This feature is only available to users with 'Service Mode' enabled. These settings are preconfigured in the factory as per the customer order workflow and should not be modified.

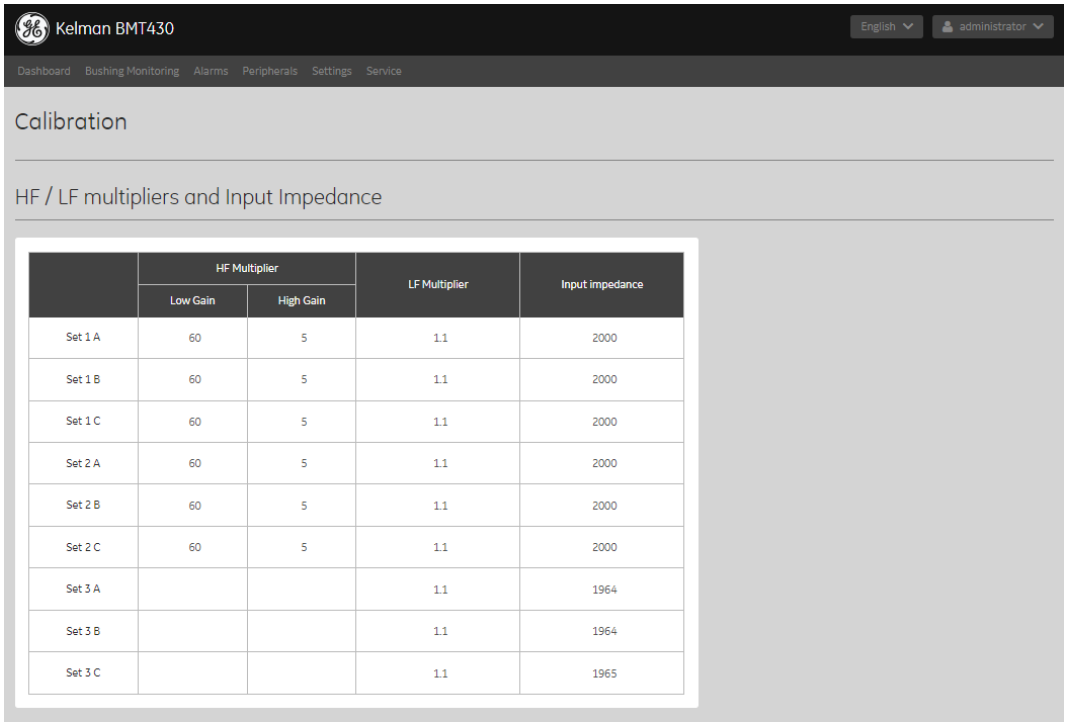


Figure 6-14: HF / LF multipliers and Input Impedance

The Phase angle calibration settings are shown in Figure 6-15.

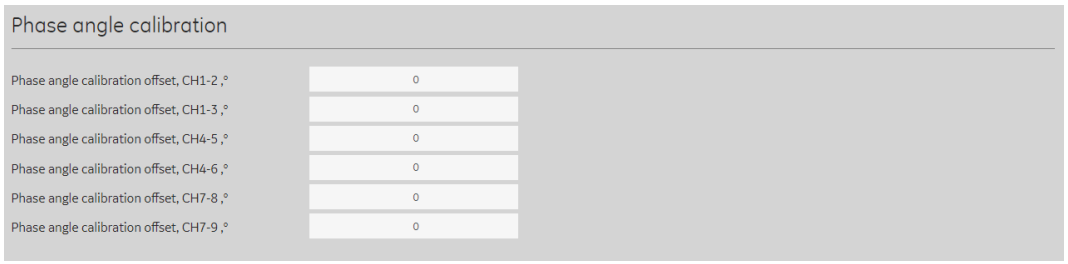


Figure 6-15: Phase angle calibration

The Channel Sync references are shown in Figure 6-16.

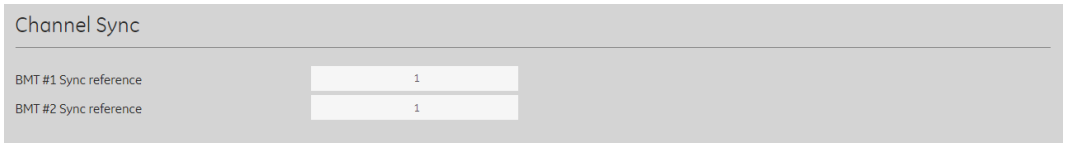


Figure 6-16: Channel Sync

6.6.4 Live Measurement

Select **Bushing Monitoring** > **Live Measurement** to view the live measurements as shown in Figure 6-17 to Figure 6-20.

The System Frequency measurement should show as either 50 or 60 Hz, along with the ambient temperature (C) and humidity (%).

Note: Realtime values for system frequency and environmental parameters update every five seconds.

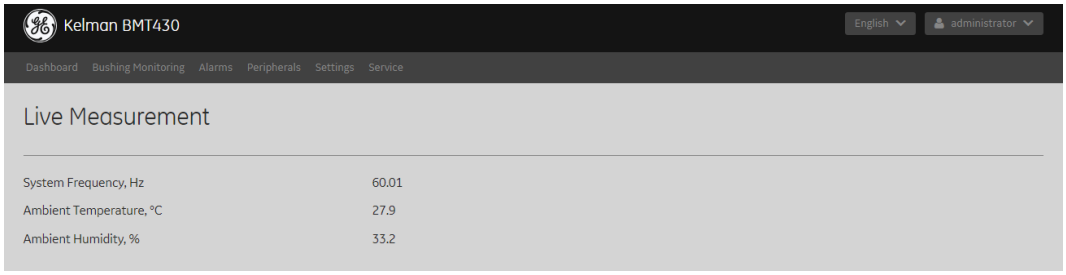
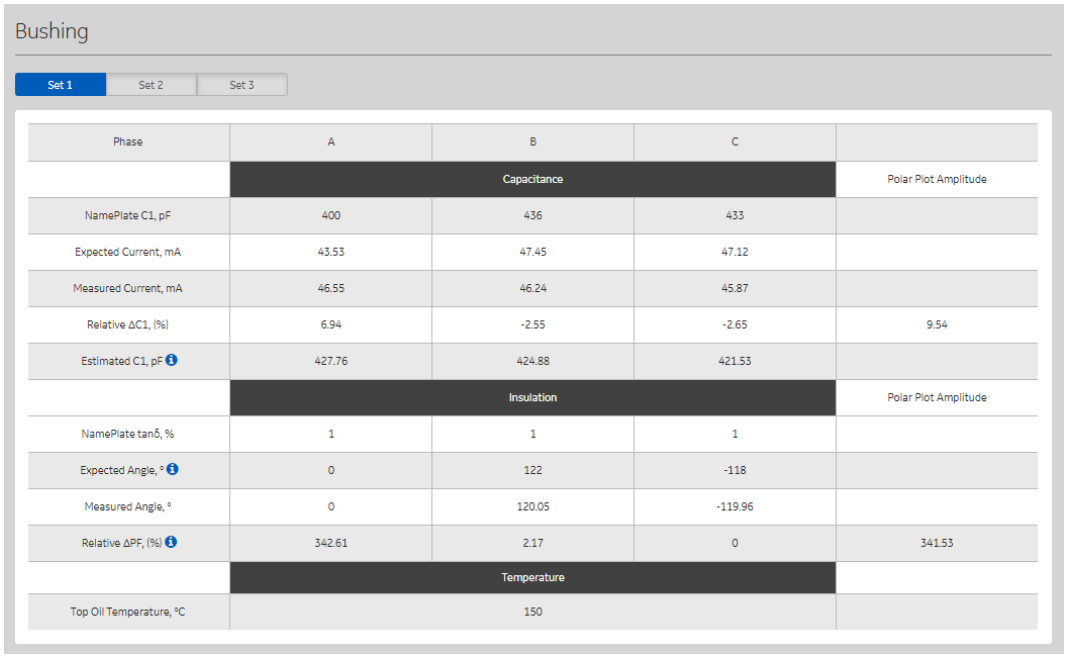


Figure 6-17: Live Measurement

Scroll down the page to see specific bushing and PD readings. Let's examine each section in turn. The Bushing readings are shown in Figure 6-18 starting with Capacitance. In this example, the naming convention of 'Set 1', 'Set 2' and 'Set 3' is used. Select **Set 1**, **Set 2**, or **Set 3** (or whatever name is assigned) to see the respective readings.

Note: The actual names depend on the prescribed naming convention followed at the site.



Phase	A	B	C	
	Capacitance			Polar Plot Amplitude
NamePlate C1, pF	400	436	433	
Expected Current, mA	43.53	47.45	47.12	
Measured Current, mA	46.55	46.24	45.87	
Relative ΔC1, (%)	6.94	-2.55	-2.65	9.54
Estimated C1, pF	427.76	424.88	421.53	
	Insulation			Polar Plot Amplitude
NamePlate tanδ, %	1	1	1	
Expected Angle, °	0	122	-118	
Measured Angle, °	0	120.05	-119.96	
Relative ΔPF, (%)	342.61	2.17	0	341.53
	Temperature			
Top Oil Temperature, °C	150			

Figure 6-18: Bushing readings

The top rows list the C1 capacitance (pF) nameplate value for the bushings with the Expected and Measured bushing leakage Current values (mA) listed below. A change in the leakage current is proportional to a change in capacitance of C1. The system calculates the total percent change in capacitance of C1 for each of the bushings compared to its nominal value when installed to determine its dielectric capability and layer integrity. The relative Change of Capacitance C1 (%) is shown below the measured current (mA).

Additionally, the system estimates the C1 Capacitance value (pF) based on the nominal C1 value (pF) and the change of C1 (%).

The Nameplate Tan δ row provides the nominal Power Factor values (%) with the Expected and Measured angle (°) between the phases. Since phase A is

taken as a reference, the expected and measured angle will be zero. The angle shown for phase B represents the angle between phase A and B and it is expected to be 120°. In an analogue manner, the angle shown for phase C represents the angle between phase A and C and is expected to be –120°.

To obtain the Measured angle (°), the system measures the timing differences between the three bushing current phases, which translate to phase angle differences relative to each other.

Since a change of phase delay equates to a change in Power Factor, we can determine the relative Change of Power Factor (%) for each bushing (compared to the others) as a percentage of the nameplate value. This is used to detect minor changes due to the deterioration of the bushing insulation.

The three phase values of A, B and C are used to calculate the amplitude of the polar plot for the relative Change of Capacitance C1 (%) and the relative Change of Power Factor (%) and are shown in the last column.

The PD readings and PDi-RH correlations are shown in Figure 6-19. Select **Set 1** or **PD N-Less** to see the respective readings.

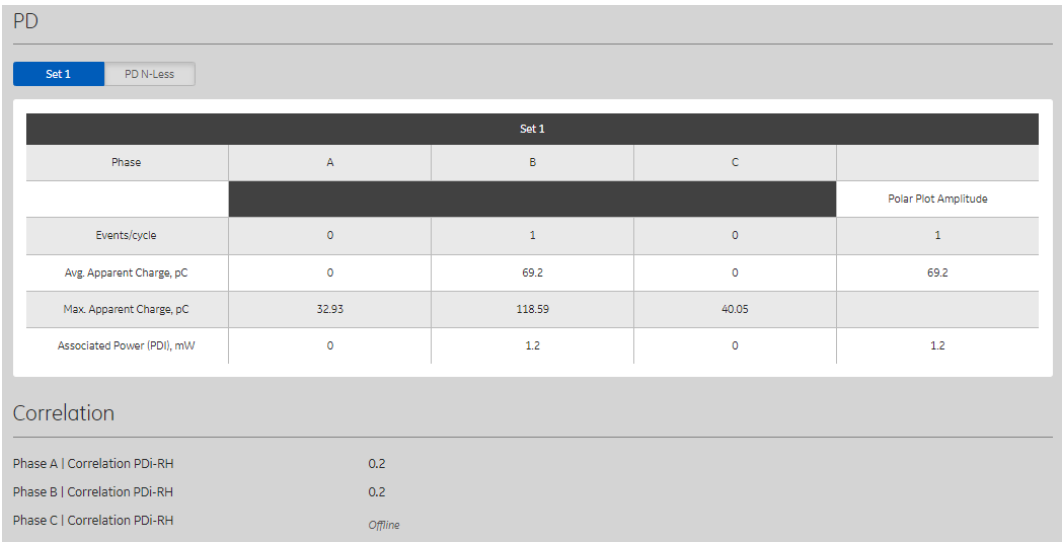


Figure 6-19: PD & PDi-RH correlations

Several plots are available for Set 1, Set 2 and Set 3 Capacitance, phase angles and temperature. The chart in Figure 6-20 shows percentage change over time for the specified date range. Use the dropdown control to change the type of plot and the date selectors to change the date range.

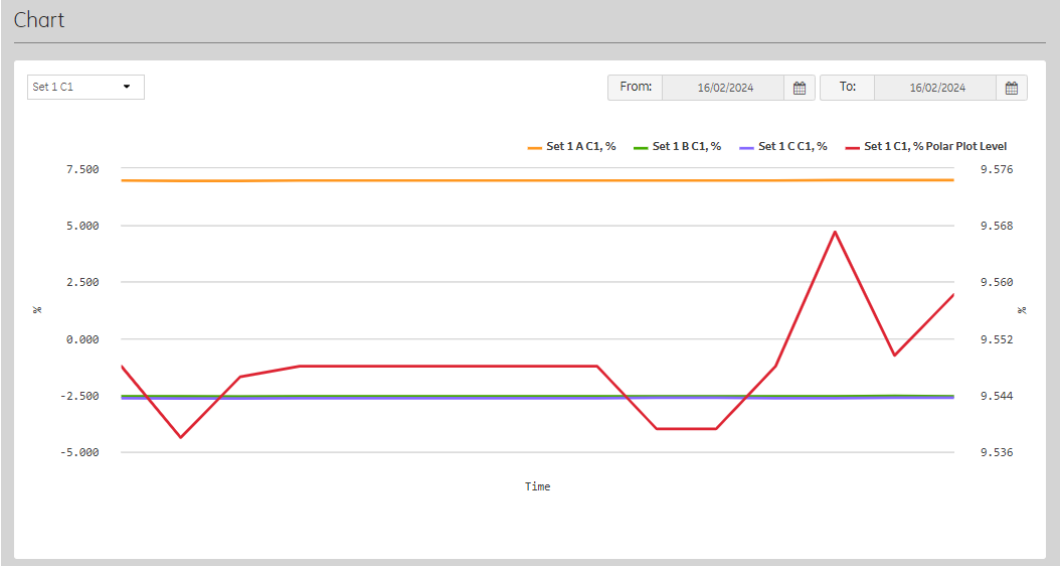


Figure 6-20: Chart

6.7 Alarms

Perception allows deadbands to be defined for each alarm. A deadband establishes another limit for clearing the alarm and prevents an alarm returning to normal until the alarm condition is cleared by the deadband. This reduces the number of false alarms and the amount of chattering. For example, an alarm triggered at 200 ppm with a deadband of 3 will remain in the alarm state until the value falls below 197 ppm.

Note: Deadbands are specified in the units being measured. E.g. temperature in degrees Celsius.

The host network must have the capability to transmit alarms and critical messages during times of heavy use, including but not limited to network storm conditions. If this requirement is not met or has not been tested, the notification of a developing hazardous situation could be delayed by a network slowdown.

6.7.1 Active Alarms

Select **Alarms** > **Active Alarms** to open the Active Alarms page as shown in Figure 6-21.

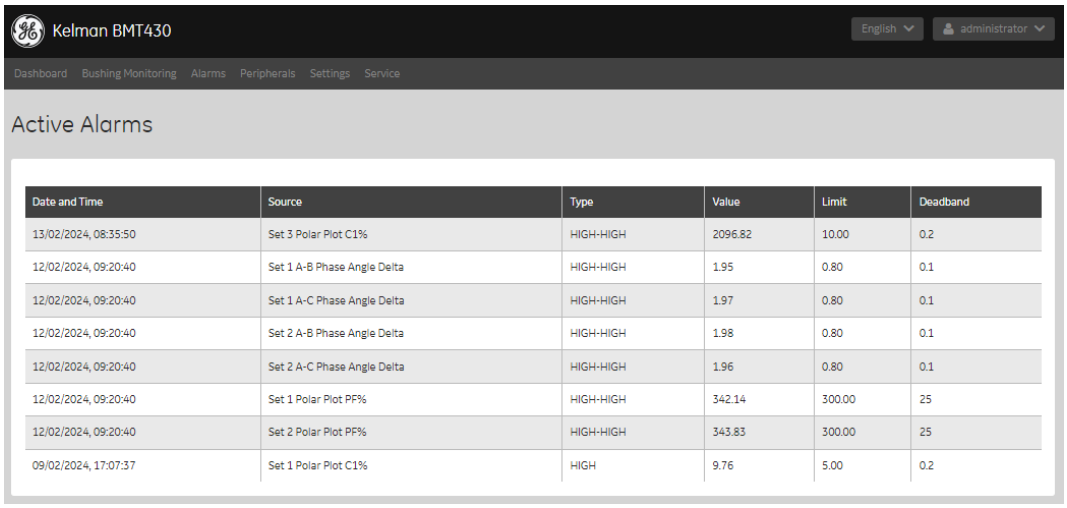
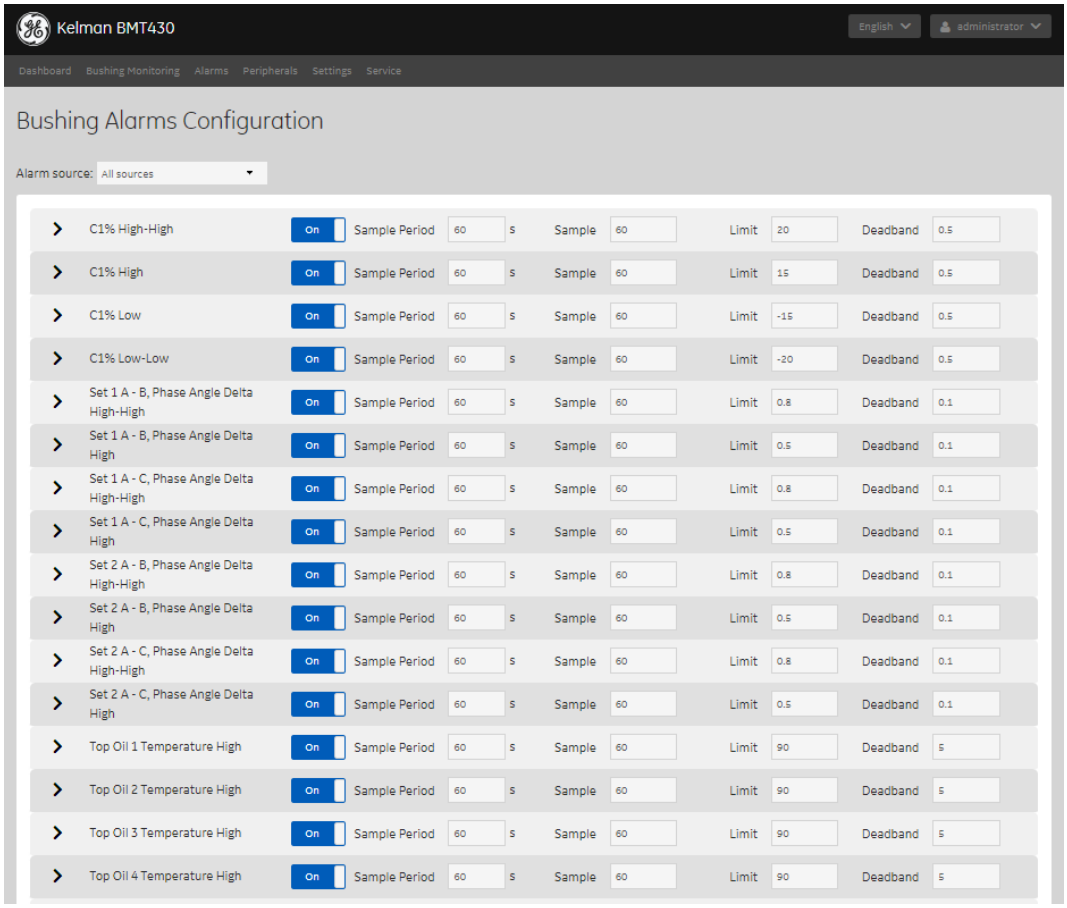


Figure 6-21: Gas Alarms Configuration

6.7.2 Bushing Alarms Configuration

Select **Alarms** > **Bushing Alarms Configuration** to open the Bushing Alarms Configuration page. A list of alarms displays as shown in Figure 6-22. Alarms can be filtered using the Alarm source dropdown and toggled On or Off using the adjacent slider control. Scroll down the list to see all available alarms.


Kelman BMT430
English
administrator
Dashboard
Bushing Monitoring
Alarms
Peripherals
Settings
Service
Bushing Alarms Configuration
Alarm source: All sources
C1% High-High
C1% High
C1% Low
C1% Low-Low
Set 1 A - B, Phase Angle Delta High-High
Set 1 A - B, Phase Angle Delta High
Set 1 A - C, Phase Angle Delta High-High
Set 1 A - C, Phase Angle Delta High
Set 2 A - B, Phase Angle Delta High-High
Set 2 A - B, Phase Angle Delta High
Set 2 A - C, Phase Angle Delta High-High
Set 2 A - C, Phase Angle Delta High
Top Oil 1 Temperature High
Top Oil 2 Temperature High
Top Oil 3 Temperature High
Top Oil 4 Temperature High
On
Sample Period
Sample
Limit
Deadband

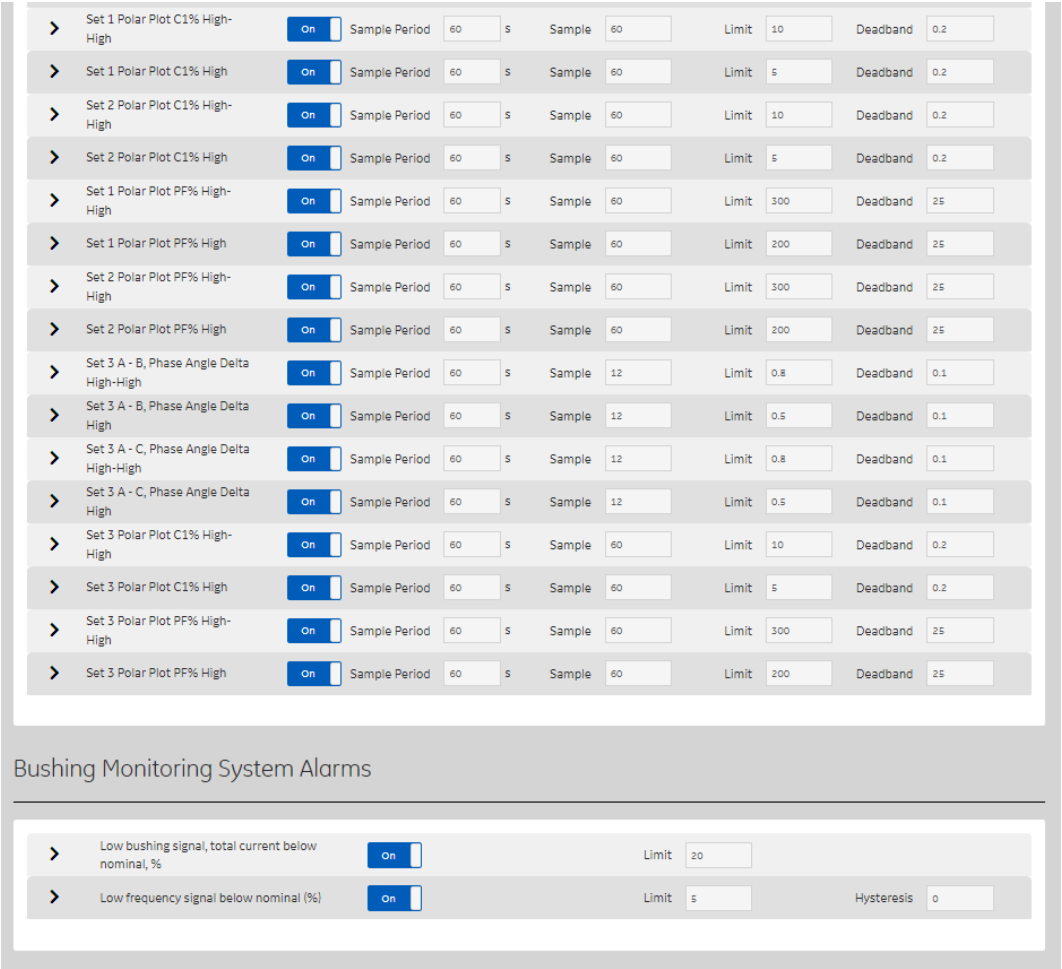


Figure 6-22: Bushing Alarms Configuration

To configure an alarm, click the > arrowhead to expand the details as shown in Figure 6-23. Every alarm can be enabled/disabled, and the triggered behaviour defined in terms of the relay and indicator (Caution, Alarm or SMS). Default values for all alarms are listed below and can be modified as appropriate or refined over time to suit the installation environment.

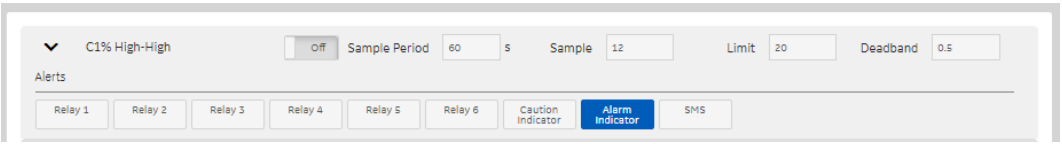


Figure 6-23: Alarm configuration – C1% High-High

Note: If alarms need to be adjusted, allow a period of approximately one month to fine tune the alarm values using the most recent accumulated data to ensure that operational thresholds are appropriate for the installation.

Table 6-2 lists the customer-configurable bushing monitor alarms, parameters, ranges and default threshold values. Other alarms are pre-set in the factory during system calibration and should not be changed unless a GE Vernova field service engineer deems it necessary.

Table 6-2: Bushing monitor – alarms configuration

	Alarm	Description	Threshold	Range	Default
Bushing Capacitance & Power Factor	Primary A C1%	Each measured relative percentual change of C1 has High-High, High, Low and Low-Low alarm thresholds.	High-High	0-50 %	20 %
	Primary B C1%		High	0-50 %	15 %
	Primary C C1%		Low	0-50 %	15%
	Secondary A C1%		Low - Low	0-50 %	20%
	Secondary B C1%		Deadband for each of the 24 alarm thresholds	0.1-5 %	0.5 %
	Secondary C C1%				
	Tertiary A C1%				
	Tertiary B C1%				
	Tertiary C C1%				
	Primary C1% Polar Plot	Every monitored set of bushings' C1% Polar Plot has High-High and High alarm thresholds.	High-High	1-25 %	10 %
			High	1-25 %	5 %
	Secondary C1% Polar Plot		Deadband for each of the 4 alarm thresholds	0.1-1 %	0.2 %
	Tertiary C1% Polar Plot				
	Primary A-B angle	Each inter-phase measured angle has High-High, High, Low and Low-Low alarm thresholds.	High – High	0.2-3°	0.8°
	Primary A-C angle		High	0.2-3°	0.5°
	Secondary A-B angle		Low	0.2-3°	0.5°
	Secondary A-C angle		Low - Low	0.2-3°	0.8°
	Tertiary A-B angle		Deadband for each of the 16 alarm thresholds	0.05-0.5°	0.1°
	Tertiary A-C angle				
	Primary PF% Polar Plot	Every monitored set of bushings' PF% Polar Plot has High-High and High alarm thresholds.	High-High	100-1500 %	300 %
	Secondary PF% Polar Plot		High	100-1500 %	200 %
			Deadband for each of the 4 alarm thresholds	10-100 %	25 %
	Tertiary PF% Polar Plot				
General Bushing Monitoring	Alarm	Description	Threshold	Range	Default
	Phase A, Top Oil Temperature	The measured top oil temperature associated to each phase has a High alarm threshold.	High	60-150 °C	90 °C
	Phase B, Top Oil Temperature		Deadband for each of the 3 alarm thresholds	1-15 °C	5 °C
	Phase C, Top Oil Temperature				
	Alarm		Description		

	Primary A Low Bushing Current	Each individual bushing test tap input has an individual digital alarm.
	Primary B Low Bushing Current	
	Primary C Low Bushing Current	
	Secondary A Low Bushing Current	
	Secondary B Low Bushing Current	
	Secondary C Low Bushing Current	
	Tertiary A Low Bushing Current	
	Tertiary B Low Bushing Current	
	Tertiary C Low Bushing Current	
	System Frequency	The bushing test tap reference input is monitored for its frequency to be around the 50/60Hz. A digital alarm is associated to the expected System Frequency.

6.7.3 PD Alarms Configuration

Select **Alarms > PD Alarms Configuration** to open the PD Alarms Configuration page. A list of alarms display as shown as shown in Figure 6-24.

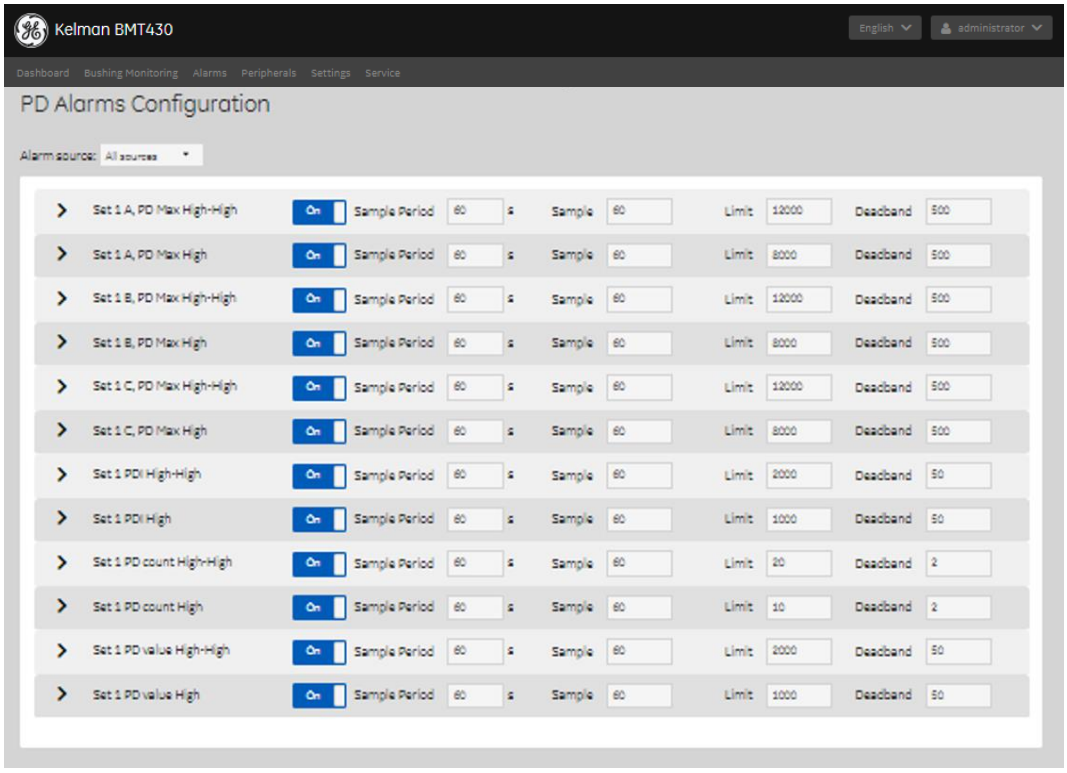


Figure 6-24: Internal PD Alarms Configuration

Alarms can be filtered using the Alarm source dropdown and toggled On or Off using the adjacent slider control.

To configure an alarm, click the > arrowhead to expand the details as shown in Figure 6-25. Every alarm can be enabled/disabled, and the triggered behaviour defined in terms of the relay and indicator (Caution, Alarm or SMS). Default values for all alarms are listed below and can be modified as appropriate or refined over time to suit the installation environment.

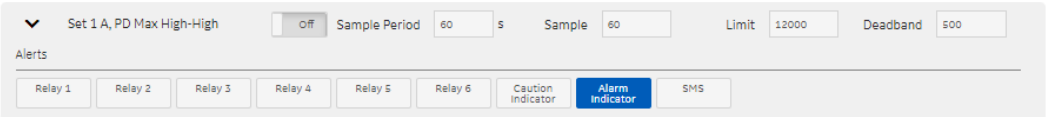


Figure 6-25: Primary A, PD Max High-High

Table 6-3 lists the customer-configurable internal PD monitor alarms, parameters, ranges and default threshold values. Other alarms are pre-set in the factory during system calibration and should not be changed unless a GE Vernova field service engineer deems it necessary.

Table 6-3: Internal PD – alarms configuration

	Alarm	Description	Threshold	Range	Default
Internal Partial Discharge	Primary A PD Max	The max. measured PD apparent charge measured from each HF input has High-High and High alarm thresholds.	High-High	1000-65535 pC	8000 pC
	Primary B PD Max		High	1000-65535 pC	12000 pC
	Primary C PD Max		Deadband for each of the 12 alarm thresholds	100-20000 pC	500 pC
	Neutral 1 PD Max				
	Neutral 2 PD Max				
	Neutral 3 PD Max				
	PD Count Polar Plot	The PD event count Polar Plot has High-High and High alarm thresholds.	High-High	1-200	20
			High	1-200	10
			Deadband for each of the 2 alarm thresholds	1-10	2
	PD Value Polar Plot	The PD Apparent Charge Polar Plot has High-High and High alarm threshold alarms.	High-High	100-65535 pC	2000 pC
			High	100-65535 pC	1000 pC
			Deadband for each of the 2 alarm thresholds	10-500 pC	50 pC
	PDI Polar Plot	The PD associated power Polar Plot has High-High and High alarm thresholds.	High-High	100-65535 mW	2000 mW
			High	100-65535 mW	1000 mW
			Deadband for each of the 2 alarm thresholds	10-500 mW	50 mW

Scroll down to see the external PD alarms as shown in Figure 6-26.

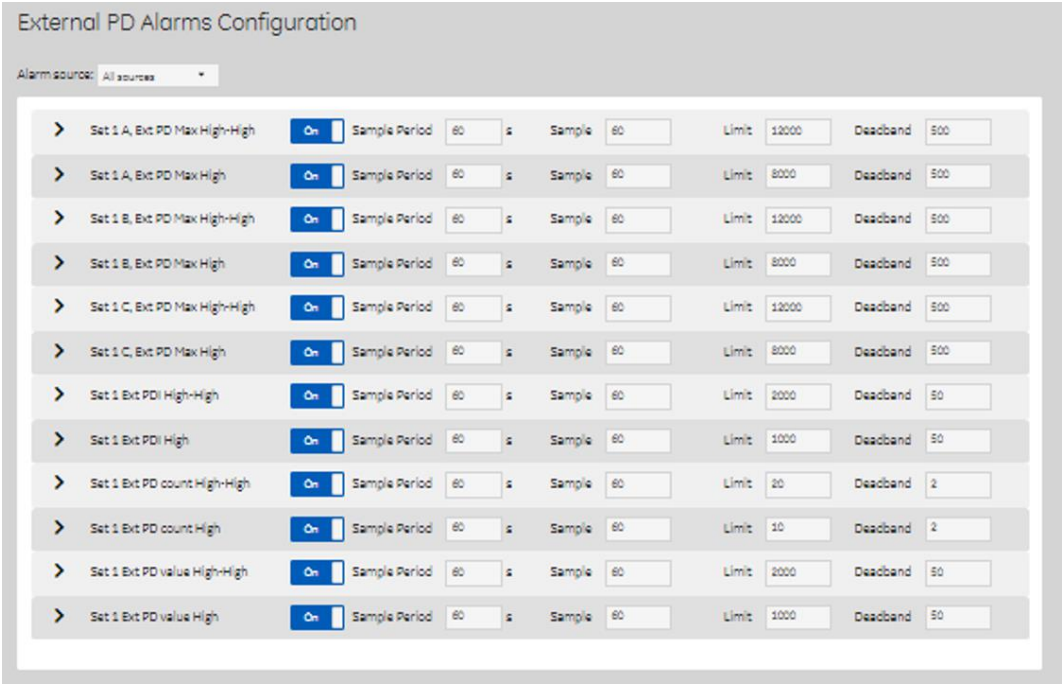


Figure 6-26: External PD Alarms Configuration

Table 6-4 lists the customer-configurable external PD monitor alarms, parameters, ranges and default threshold values. Other alarms are pre-set in the factory during system calibration and should not be changed unless a GE Vernova field service engineer deems it necessary.

Table 6-4: External PD – alarms configuration

	Alarm	Description	Threshold	Range	Default
External Partial Discharge	Primary A External PD Max	The max. measured PD apparent charge measured from each HF input has High-High and High alarm thresholds.	High-High	1000-65535 pC	8000 pC
	Primary B External PD Max		High	1000-65535 pC	12000 pC
	Primary C External PD Max		Deadband for each of the 12 alarm thresholds	100-20000 pC	500 pC
	Primary External PD Count Polar Plot	The PD event count Polar Plot has High-High and High alarm thresholds.	High-High	1-200	20
			High	1-200	10
			Deadband for each of the 2 alarm thresholds	1-10	2
	Primary External PD Value Polar Plot	The PD Apparent Charge Polar Plot has High-High and High alarm threshold alarms.	High-High	100-65535 pC	2000 pC
			High	100-65535 pC	1000 pC
			Deadband for each of the 2 alarm thresholds	10-500 pC	50 pC
	Primary External PDI Polar Plot	The PD associated power Polar Plot has High-High and High alarm thresholds.	High-High	100-65535 mW	2000 mW
			High	100-65535 mW	1000 mW
			Deadband for each of the 2 alarm thresholds	10-500 mW	50 mW

6.7.4 Analog Inputs

Select **Alarms** > **Analog Inputs** to open the Analog Inputs Alarms Configuration page as shown in Figure 6-27.

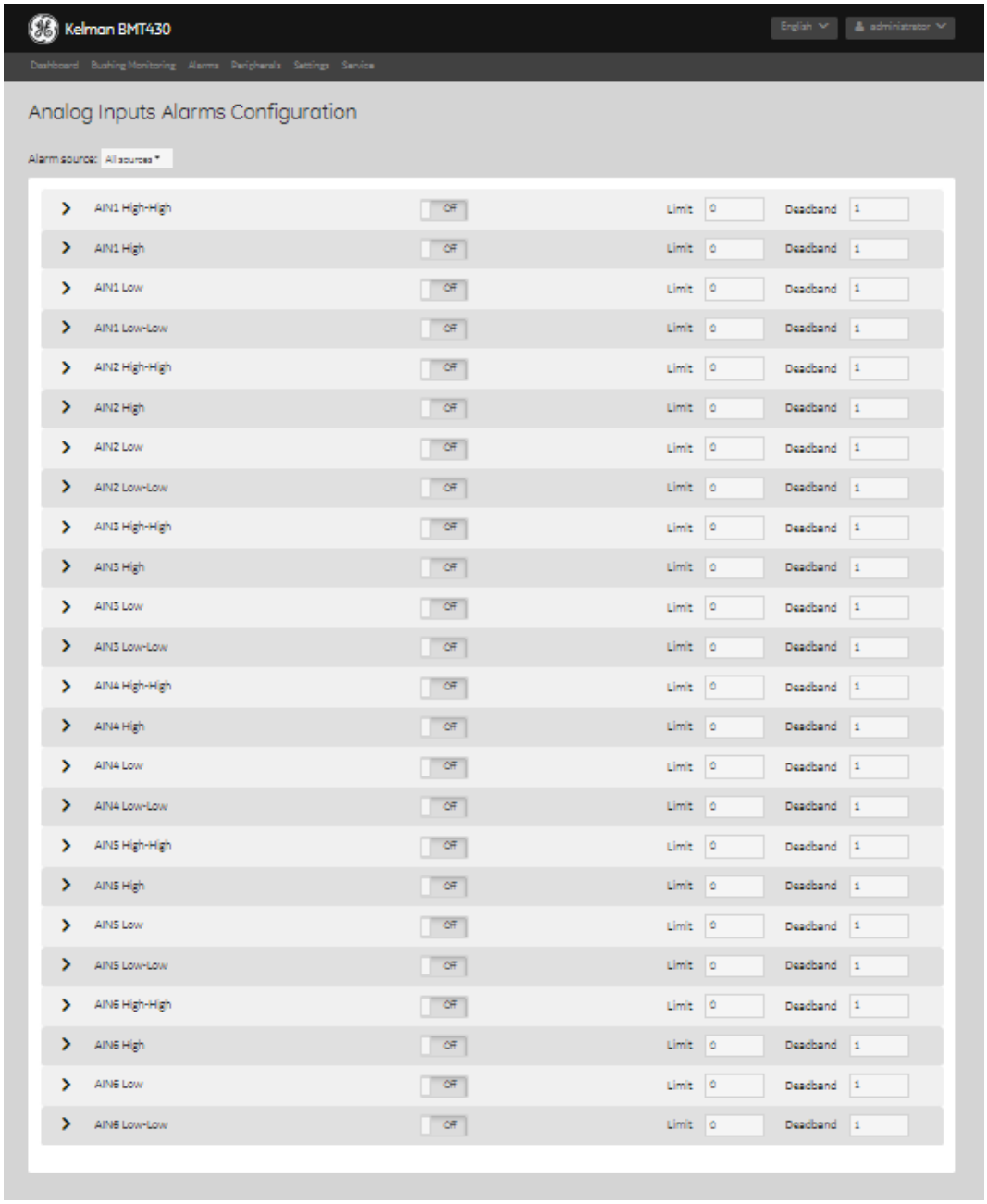


Figure 6-27: Analog Inputs Alarms Configuration

6.7.5 Analog Inputs Rate of Change

Select **Alarms** > **Analog Inputs Rate of Change** to open the Analog Inputs RoC Alarms Configuration page as shown in Figure 6-28.

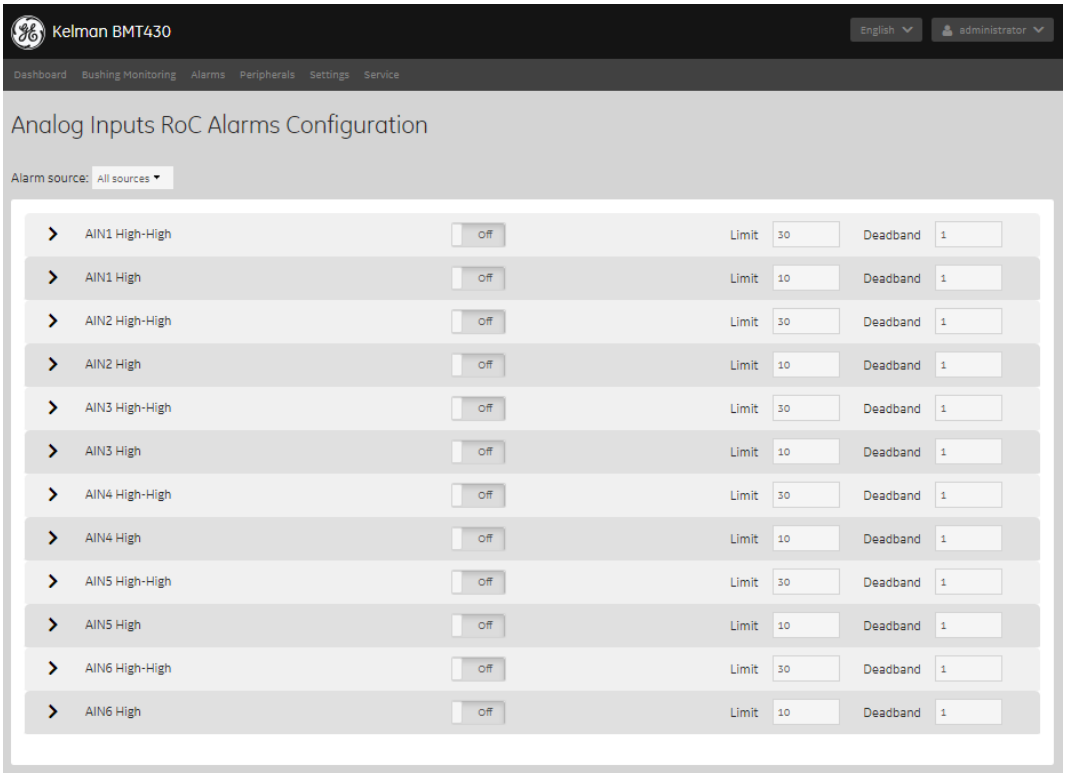


Figure 6-28: Analog Inputs RoC Alarms Configuration

6.7.6 Digital Inputs

Select **Alarms** > **Digital Inputs** to open the Digital Inputs Alarms Configuration page as shown in Figure 6-29.

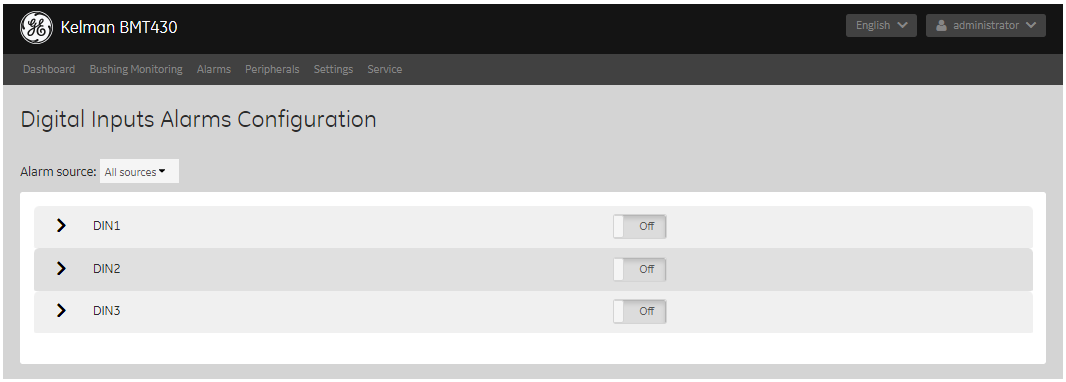


Figure 6-29: Digital Inputs Alarms Configuration

6.7.7 Digital Inputs Transition Total

Select **Alarms** > **Digital Inputs Transition Total** to open the Digital Inputs Transition Total Alarms Configuration page as shown in Figure 6-30.

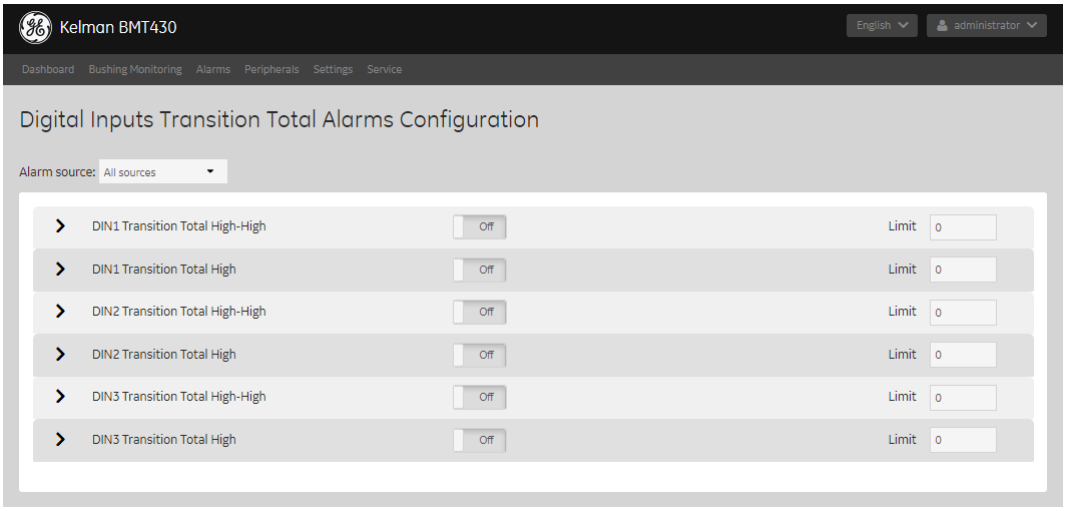


Figure 6-30: Digital Inputs Transition Total Alarms Configuration

6.8 Peripherals

6.8.1 Peripheral Scheduler

Select **Peripherals** > **Peripheral Scheduler** to open the Peripheral Scheduler page as shown in Figure 6-31.

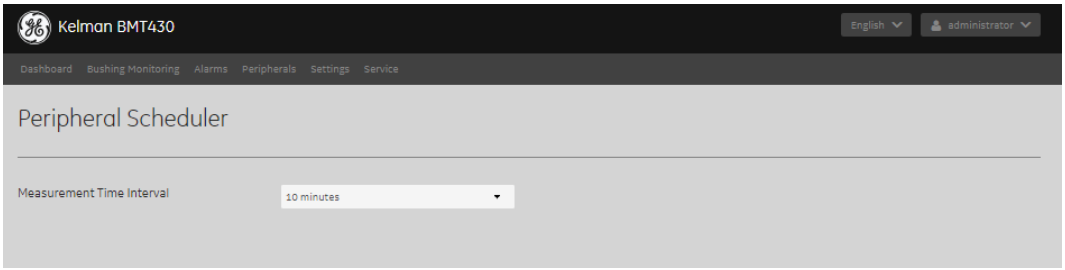


Figure 6-31: Peripheral Scheduler

The Peripheral Scheduler allows the Measurement Time Interval to be set to 5, 10, 15 or 20 minutes.

6.8.2 Analog Inputs

Select **Peripherals** > **Analog Inputs** to open the Analog Inputs Configuration page as shown in Figure 6-32.

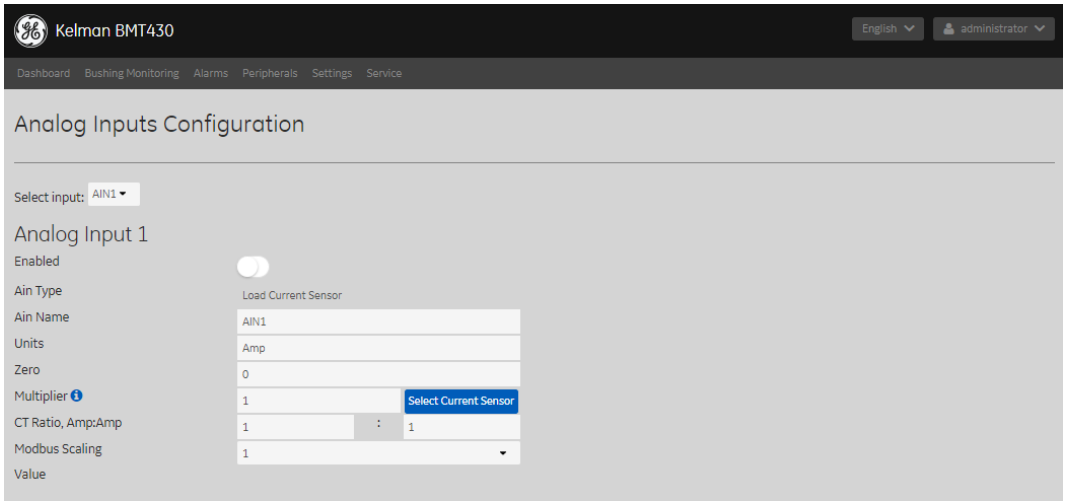


Figure 6-32: Analog Inputs Configuration

Note: If measuring from a transformer CT, the CT ratio should be used when entering a new multiplier. For example, if the transformer CT ratio is 2000:5, the new multiplier calculation would be 15.02 × (2000/5) or 15.02 × 400 = 6008.

If there are analogue cards fitted to the I/O PCB, these will auto populate with default values as shown in Figure 6-33. The next step is to configure each card to the required sensor.

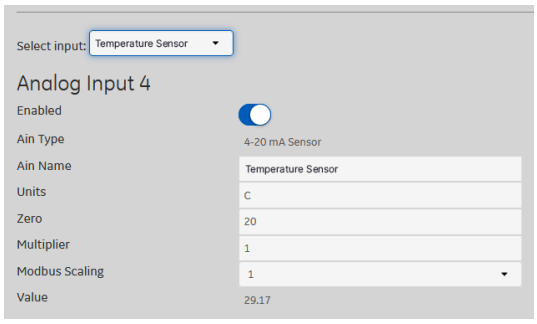


Figure 6-33: Analog Input 4 (4-20 mA Temperature Sensor)

6.8.3 Digital Inputs

Select **Peripherals** > **Digital Inputs** to open the Digital Input Configuration page as shown in Figure 6-34. Note: Name field is editable to allow custom name fields.

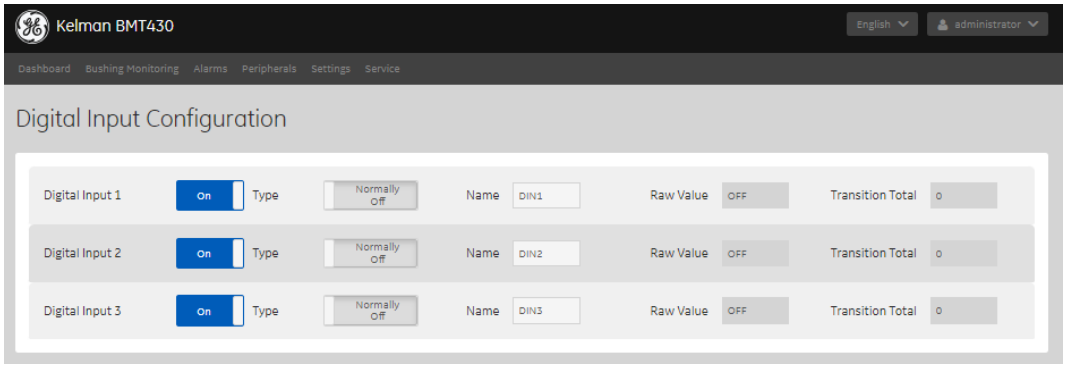
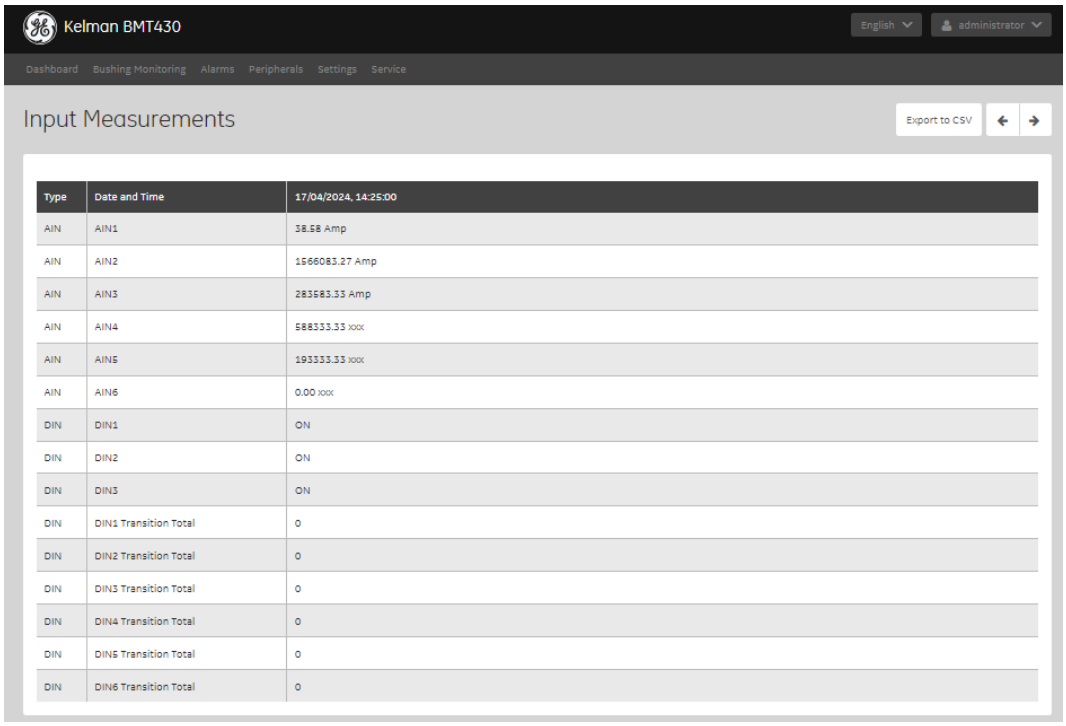


Figure 6-34: Digital Input Configuration

6.8.4 Input Measurements

Select **Peripherals** > **Input Measurements** to open the Input Measurements page as shown in Figure 6-35.



Type	Date and Time	17/04/2024, 14:25:00
AIN	AIN1	38.58 Amp
AIN	AIN2	1566083.27 Amp
AIN	AIN3	283583.33 Amp
AIN	AIN4	588333.33 xxx
AIN	AIN5	193333.33 xxx
AIN	AIN6	0.00 xxx
DIN	DIN1	ON
DIN	DIN2	ON
DIN	DIN3	ON
DIN	DIN1 Transition Total	0
DIN	DIN2 Transition Total	0
DIN	DIN3 Transition Total	0
DIN	DIN4 Transition Total	0
DIN	DIN5 Transition Total	0
DIN	DIN6 Transition Total	0

Figure 6-35: Input Measurements

Use the controls (top right) to move back and forward through the Input Measurement data and Export to CSV (if required).

6.8.5 Analog Inputs Rate of Change

Select **Peripherals** > **Analog Inputs Rate of Change** to open the Analog Inputs RoC Configuration page as shown in Figure 6-36. The default is for a CT to be installed on Analogue Input 1. The product supports up to five additional analogue inputs.

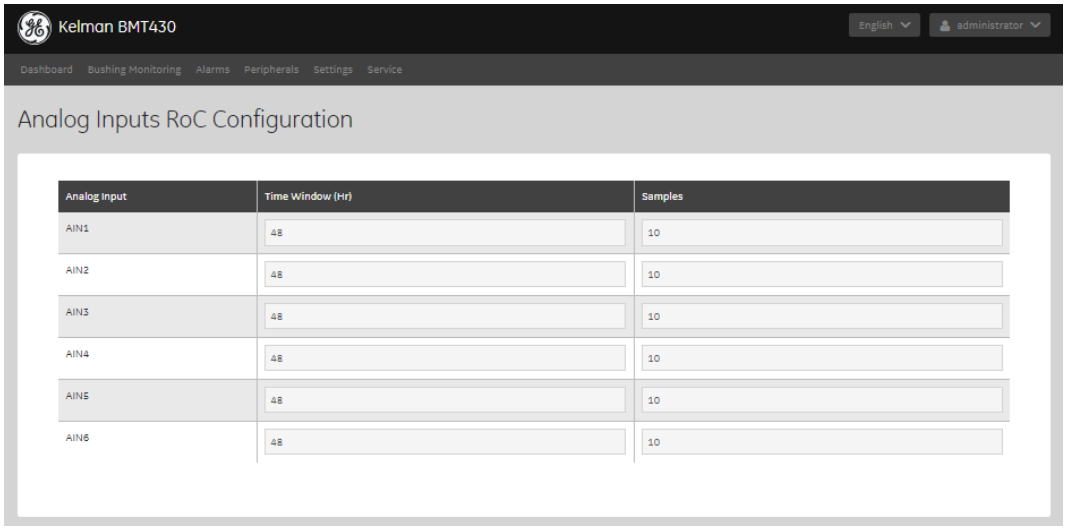


Figure 6-36: Analog Inputs Rate of Change Configuration

6.9 Settings

6.9.1 Communications

Select **Settings** > **Communications** to open the Communications Settings page as shown in Figure 6-37.

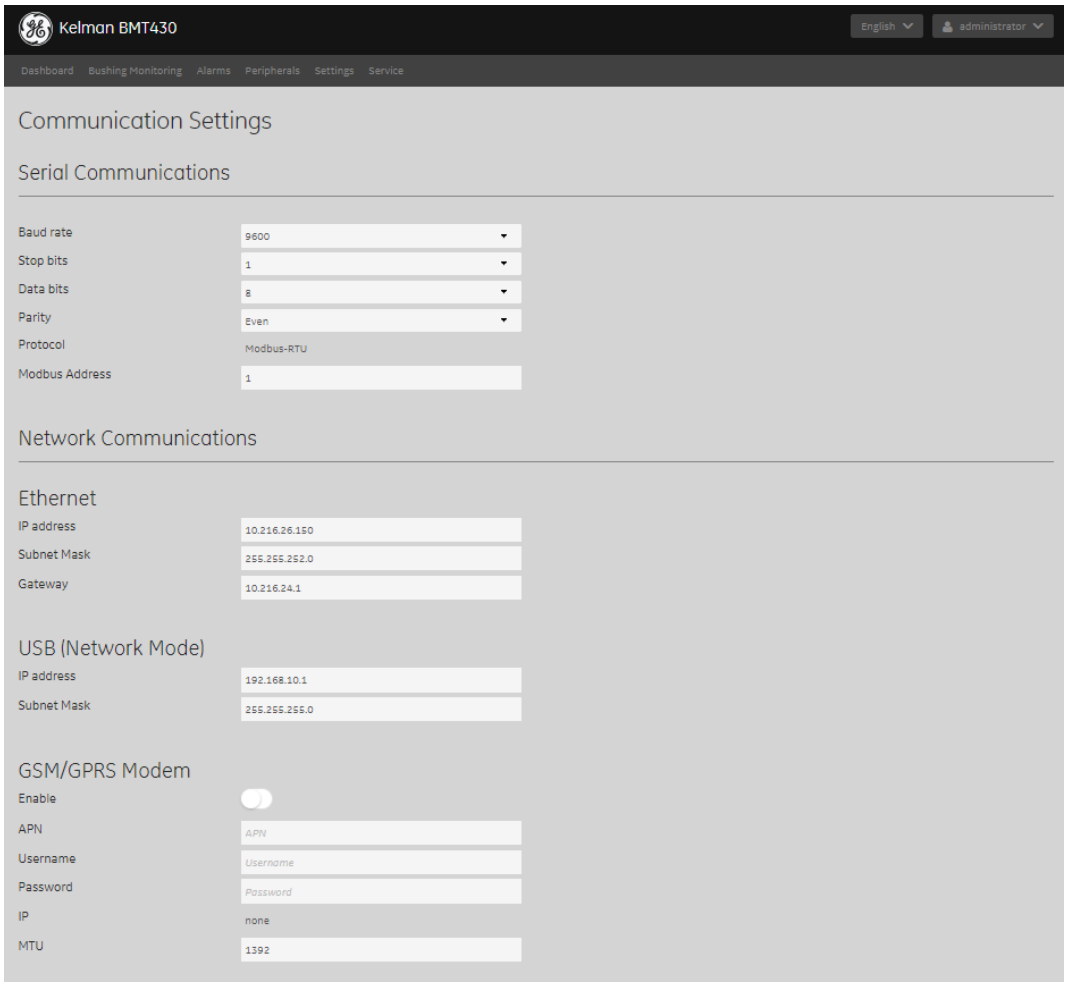


Figure 6-37: Communications Settings

If a GPRS modem is fitted and the appropriate carrier sim is installed, the IP address also displays.

See Appendix A.2 for more details on the external interfaces and supported protocols.

6.9.2 Date & Time

Select **Settings** > **Date & Time** to open the Date & Time page as shown in Figure 6-38.

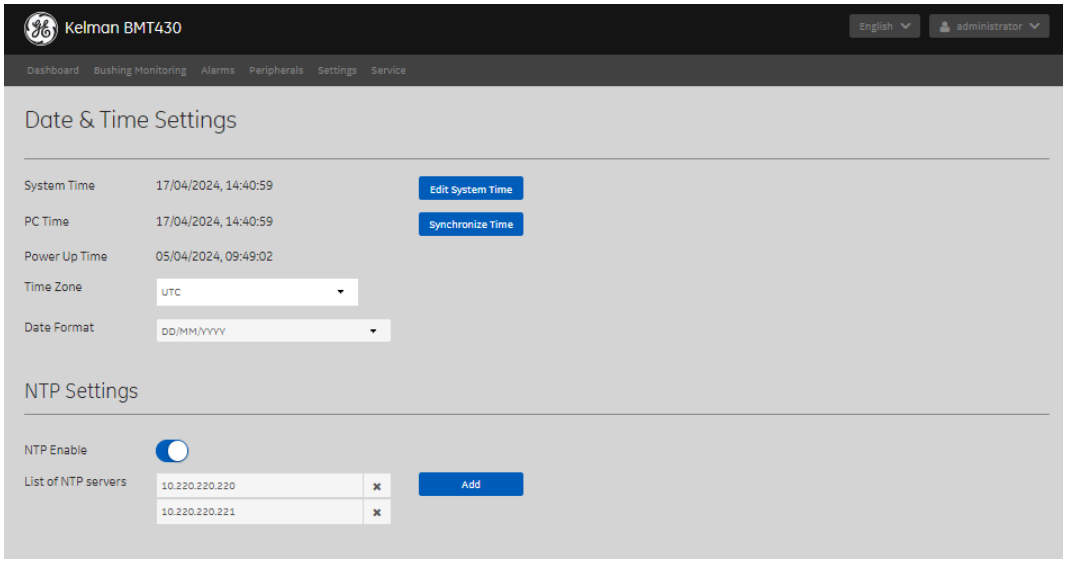


Figure 6-38: Date & Time

Click **Edit System Time**. The Date & Time Settings section becomes editable as shown in Figure 6-39. Use the controls to update the date and time.

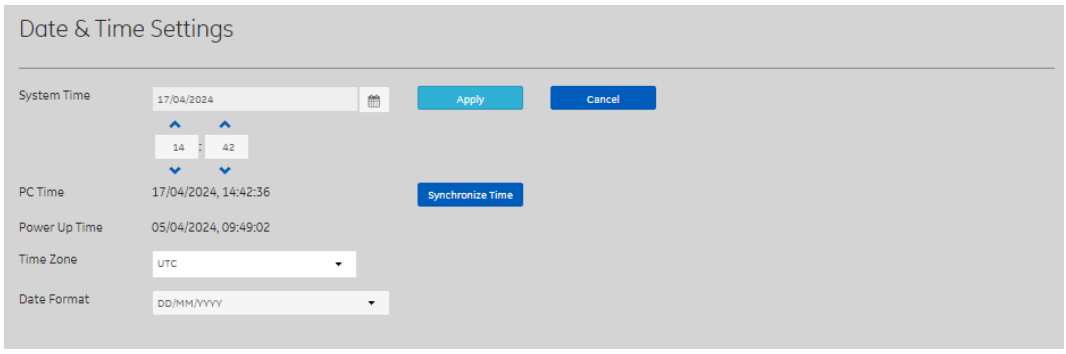


Figure 6-39: Date & Time Settings

PC time lists the current time on the PC hosting the connection. To synchronise the product's system time with that of the PC, click **Synchronize Time.**

Note: Power up Time records when the product was last powered on or rebooted.

Support for the Network Time Protocol (NTP) allows for accurate clock synchronisation. The NTP Settings section lists the IP address of all NTP

servers as shown in Figure 6-40. Use this section to enable the NTP protocol and add or remove NTP servers as required.

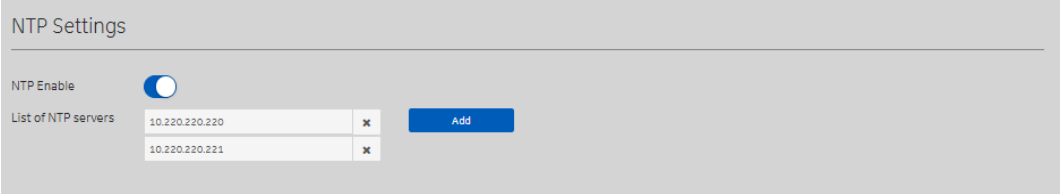


Figure 6-40: NTP Settings

Note: NTP support can be disabled for security reasons.

6.9.3 SMS Alerting

Select **Settings** > **SMS Alerting** to open the SMS Alerting page as shown in Figure 6-41. The system can be configured to send SMS messages to designated person(s) on restart, system error or heartbeat.

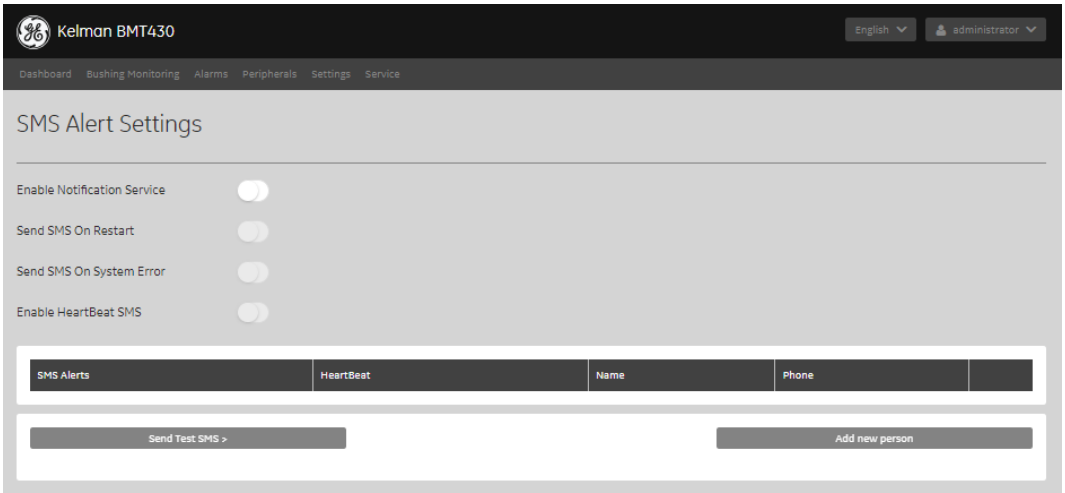


Figure 6-41: SMS Alerting

6.9.4 Firewall

To create a custom security policy, select **Settings** > **Firewall** to open the Firewall Settings page as shown in Figure 6-42. Rules can be added, edited or deleted to create a suitable access policy for each type of interface. These rules are used to block unused ports and specify distinct firewall actions (accept, reject or drop) based on the IP or port.

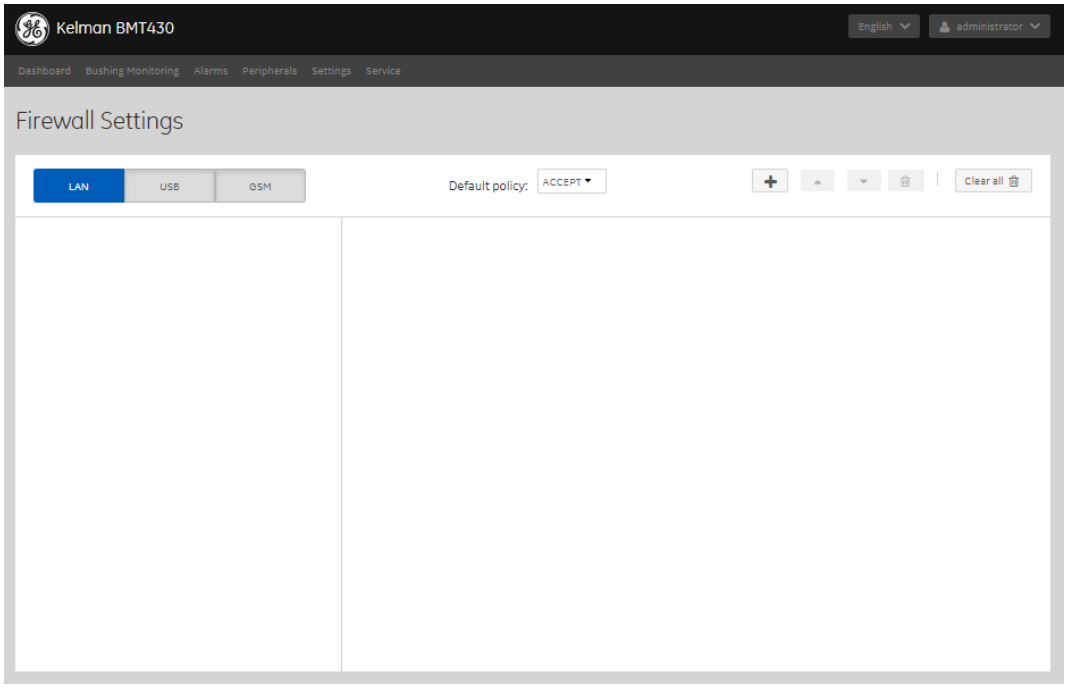


Figure 6-42: Firewall configuration

See Appendix A.4 for more details on firewall configuration.

6.9.5 Communication Services

Select **Settings** > **Communication Services** to open the Communication Services page as shown in Figure 6-43.

Note: This functionality is available only to 'Operator' and 'Administrator' users.

All configuration settings specified on this page apply to *all* interfaces (Ethernet, USB and GSM-GPRS modem).

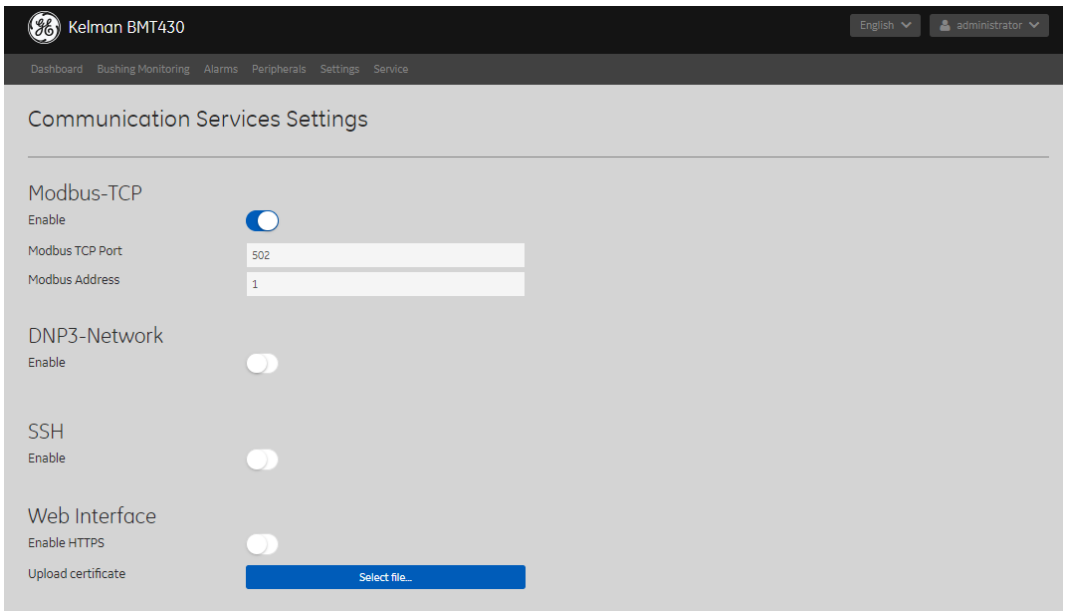


Figure 6-43: Communication Services

Select the relevant slider control to enable/disable the relevant communication service. E.g. primary Modbus-TCP, primary DNP3-TCP, SSH (Secure Shell) and HTTPS — but do not rely on the firewall settings.

Note: The primary DNP3 Configuration and object map can also be imported / exported.

To implement a custom security policy, upload a new certificate and enable HTTPS requests.

Note: If HTTPS is enabled, all requests via HTTP are blocked.

In the Upload certificate field, click the **Select file** button, select the new certificate (PEM file), and click **Open**. Click the 'Save' button  in the application header to apply the changes and then restart the product.

Note: SSL certificates are small data files that digitally bind a cryptographic key to an organization's details. When installed on a web server, it activates the padlock and the HTTPS protocol and allows secure connections from a web server to a browser.

Note: If HTTPS is disabled, the certificate will be applied when HTTPS is enabled.

Note: The HMI has no automatic redirection between HTTP and HTTPS (or vice versa). This results in the following browser message "Site cannot be reached over HTTP".

6.10 Service

6.10.1 Controller Reprogramming

Consult with Technical Support to confirm the availability of new firmware for the Controller PCB. Upgrade to the latest version of the firmware via an Ethernet connection to avail of new features.

Note: A firmware upgrade resets passwords back to their default values.

To upgrade the Controller PCB firmware, select **Service** > **Controller Reprogramming** to open the Controller Reprogramming page as shown in Figure 6-44.

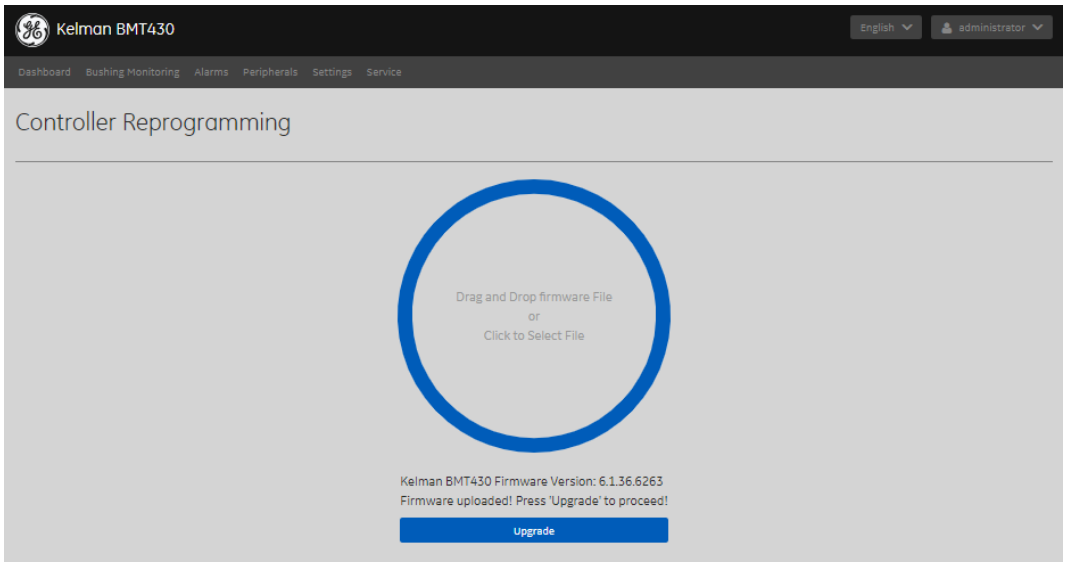


Figure 6-44: Controller Reprogramming

Drag and drop the firmware file into the circle or click in the circle to select the file. Click **Upgrade** and the status information and a progress bar display as shown in Figure 6-49.

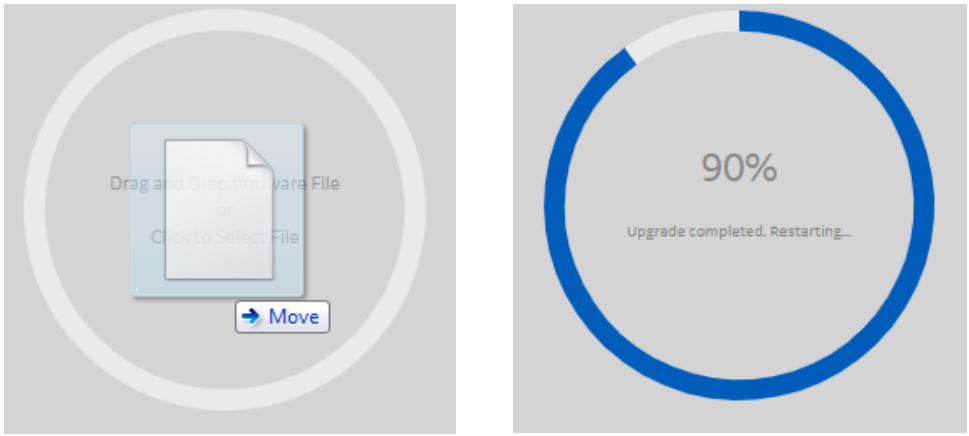


Figure 6-45: Upgrade in progress

Once complete, the firmware image is applied and the system restarts. On initial power up, the product's LCD screen remains blank, but the 'On' heartbeat LED and 'Boot' LED illuminate (solid blue and red respectively). After a moment, the Boot LED switches off and the 'On' heartbeat LED flashes blue to indicate normal operation. The restart sequence takes approximately 3 minutes after which the onboard HMI loads up.

6.10.2 I/O PCB Reprogramming

Consult with Technical Support to confirm the availability of new firmware for the I/O PCB. Upgrade to the latest version of the firmware via an Ethernet connection to avail of new features.

Note: A firmware upgrade resets passwords back to their default values.

To upgrade the I/O PCB firmware using an Ethernet connection, select **Service > I/O Board Reprogramming** to open the I/O Board Reprogramming page as shown in Figure 6-46.

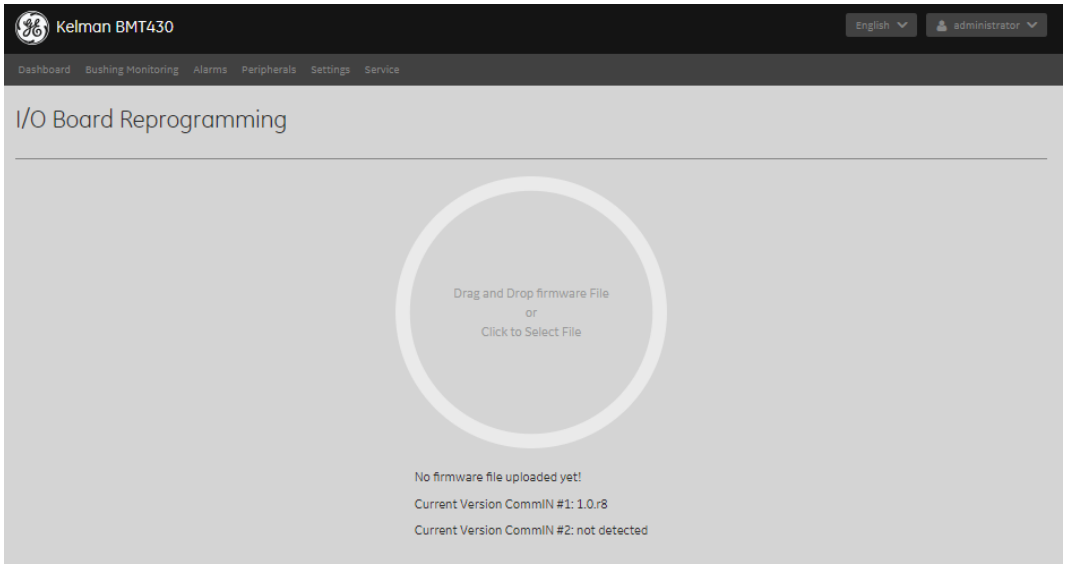
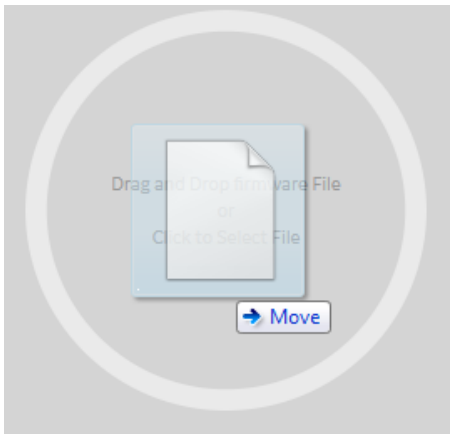


Figure 6-46: I/O Board Reprogramming

Drag and drop the firmware file into the circle or click in the circle to select the file. Click **Upgrade** and the status information and a progress bar displays as shown in Figure 6-47.



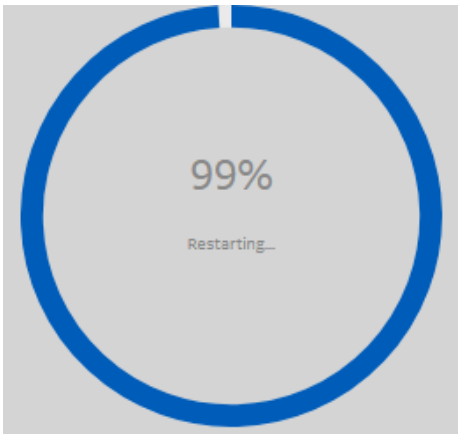


Figure 6-47: Upgrade in progress

Once complete, the firmware image is applied and the system restarts. On initial power up, the product's LCD screen remains blank, but the 'On' heartbeat LED and 'Boot' LED illuminate (solid blue and red respectively). After a moment, the Boot LED switches off and the 'On' heartbeat LED flashes blue to indicate normal operation. The restart sequence takes approximately 3 minutes after which the onboard HMI loads up.

6.10.3 BMT Reprogramming

Consult with Technical Support to confirm the availability of new firmware for the Bushings and PD card. Upgrade to the latest version of the firmware via an Ethernet connection to avail of new features.

Note: A firmware upgrade resets passwords back to their default values.

To upgrade the BMT card firmware, select **Service** > **BMT Reprogramming** to open the BMT Reprogramming page as shown in Figure 6-48.

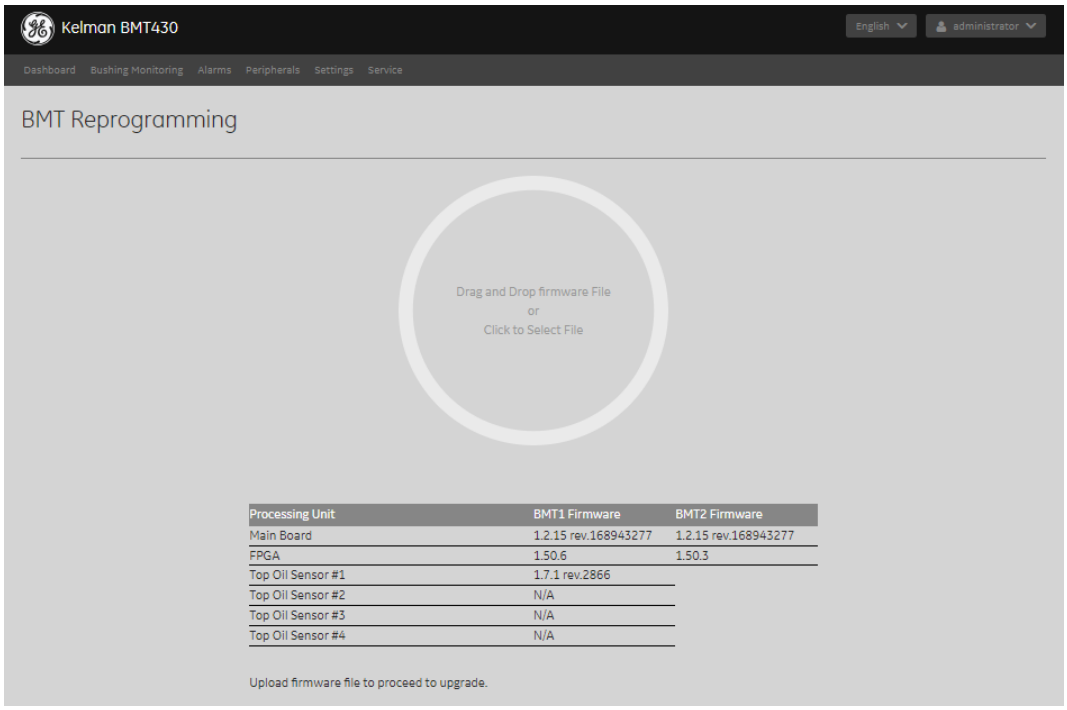


Figure 6-48: BMT Reprogramming

Drag and drop the firmware file into the circle or click in the circle to select the file. Click **Upgrade** and the status information and a progress bar display as shown in Figure 6-49.

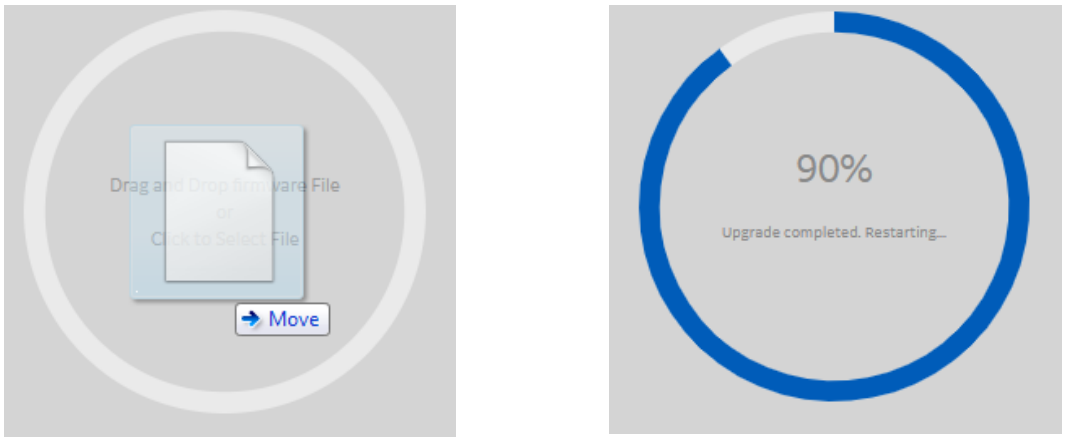


Figure 6-49: Upgrade in progress

Once complete, the firmware image is applied and the system restarts. On initial power up, the product's LCD screen remains blank, but the 'On' heartbeat LED and 'Boot' LED illuminate (solid blue and red respectively). After

a moment, the Boot LED switches off and the 'On' heartbeat LED flashes blue to indicate normal operation. The restart sequence takes approximately 3 minutes after which the onboard HMI loads up.

6.10.4 Factory

Select **Service** > **Factory** to open the Factory Settings page as shown in Figure 6-50.

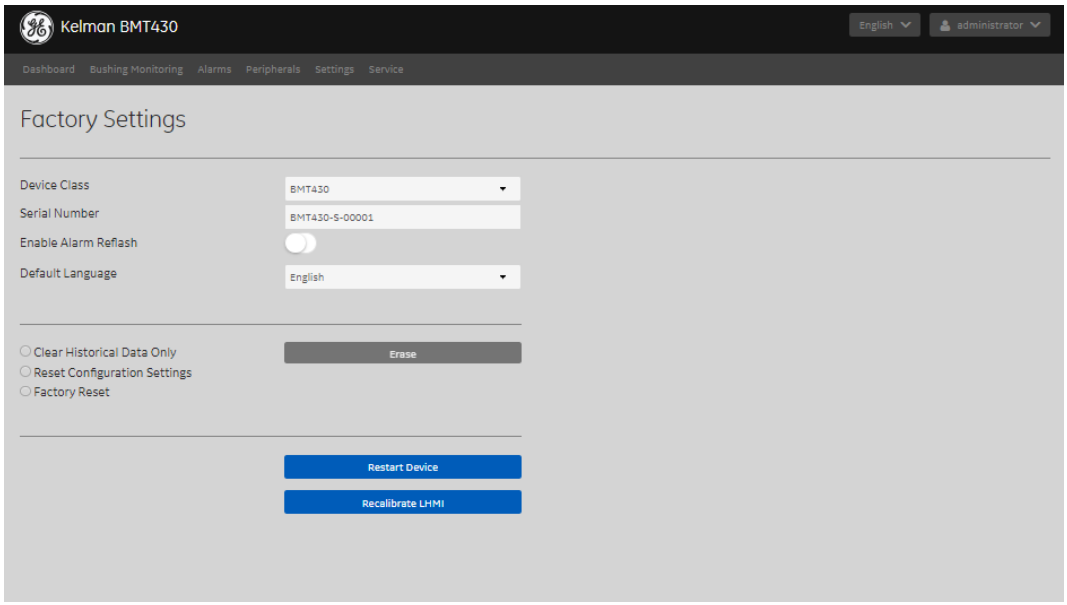


Figure 6-50: Factory Settings

6.10.4.1 Alarm Reflash

The Alarm Reflash option ensures that a relay's digital output reflashes (if already activated) when another source triggers the same relay. An alarm reflash applies only to relays 1-6 and is achieved by deactivating the relevant digital output for a duration of 1 second before reactivating it to achieve a flashing effect. This signifies to an operator or control room in real time that multiple sources have triggered the same relay.

Note: This ensures that further alarms raised by the same source have no further effect.

6.10.4.2 Clear Historical Data Only

Clears all historical data — bushing & PD measurements and alarm data. Table 6-5 outlines the type of data items that get erased.

6.10.4.3 Reset Configuration Settings

Clears all historical data described previously *and* resets configuration settings (*except* Communications) to the default state. Table 6-5 outlines the type of data items that get erased.

6.10.4.4 Factory Reset

Clears everything — historical measurement data, configuration settings *and* communication settings, so that the product returns to the initial factory state. Table 6-5 outlines the type of data items that get erased.

Table 6-5: Factory Settings: Data and configuration cleardown

		Clear Historical Data Only	Reset Configuration Settings	Factory Reset
Measurements	Bushing & PD	✓		✓
Alarms	Alarms	✓	✓	✓
Peripherals	Analog Inputs		✓	✓
	Digital Inputs		✓	✓
Settings	Communications			✓
Service	Factory		✓	✓

6.10.4.5 Restart Device

Some configuration changes require a device restart. Click **Restart Device** to restart the device and then click **Restart** to confirm as shown in Figure 6-51.

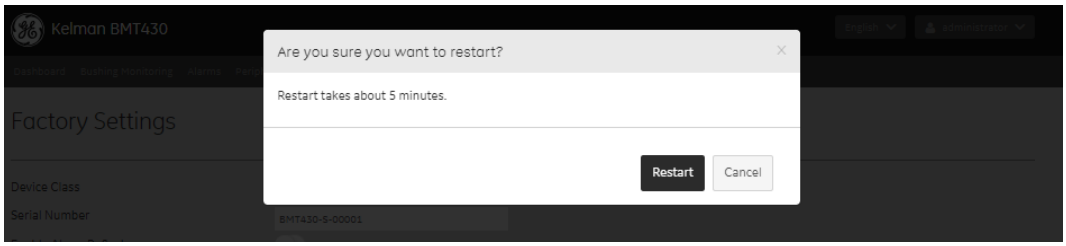


Figure 6-51: Restart the device

6.10.4.6 Recalibrate LHMI

The local HMI (LHMI) can be recalibrated to adjust the sensitivity of the touchscreen.

Note: It is not recommended to change the default settings for the touchscreen unless there is an issue.

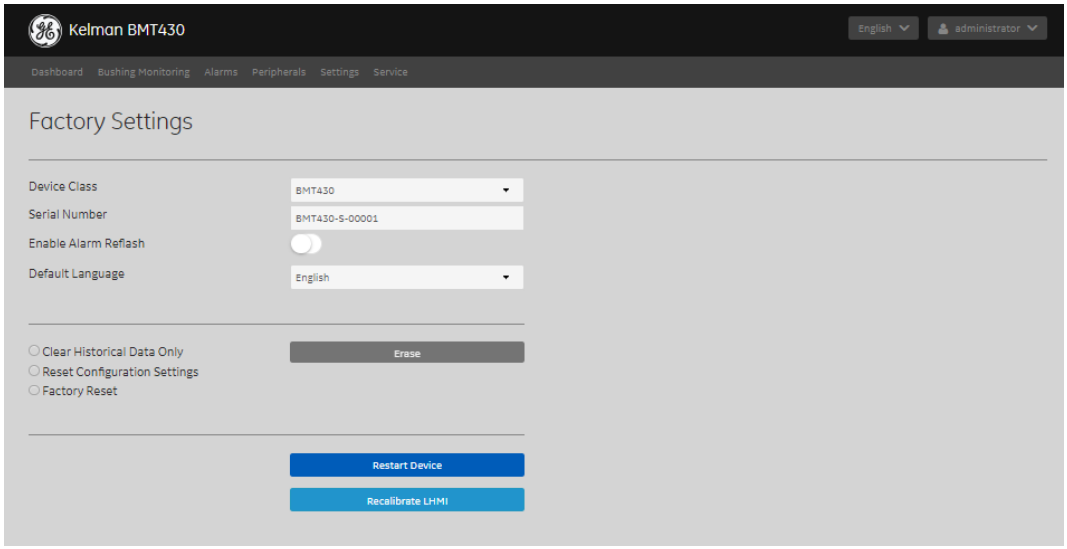


Figure 6-52: Service > Factory

To initiate calibration mode, click **Recalibrate LHMI** or press and hold the touchscreen for 20 seconds.

Follow the onscreen instructions until the new calibration settings have been measured. Once measured, ensure to tap the screen to store the new calibration data to the product.

Note: Tap the screen within the time limit otherwise the settings are not stored, and a reminder prompts for screen calibration.

7 USER ADMINISTRATION

Select **Service** > **User Administration** to open the User Administration page as shown in Figure 7-1.

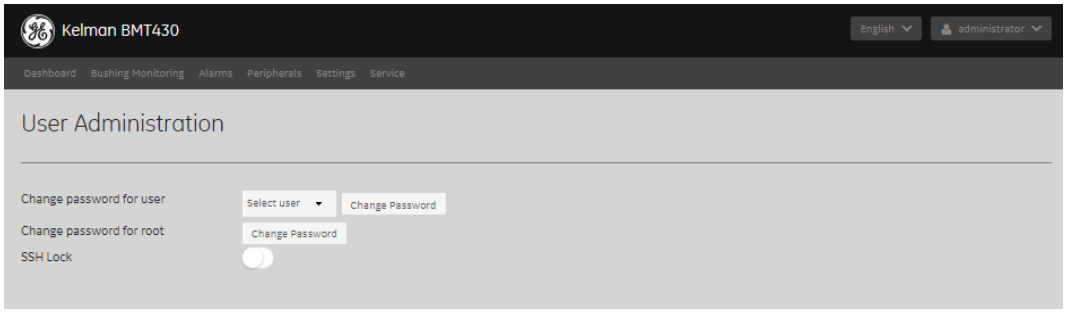


Figure 7-1: User Administration

Choose between the user or root password. Click **Change Password** to enter a new password. On typing, the strength of the password is assessed as shown in Figure 7-2.

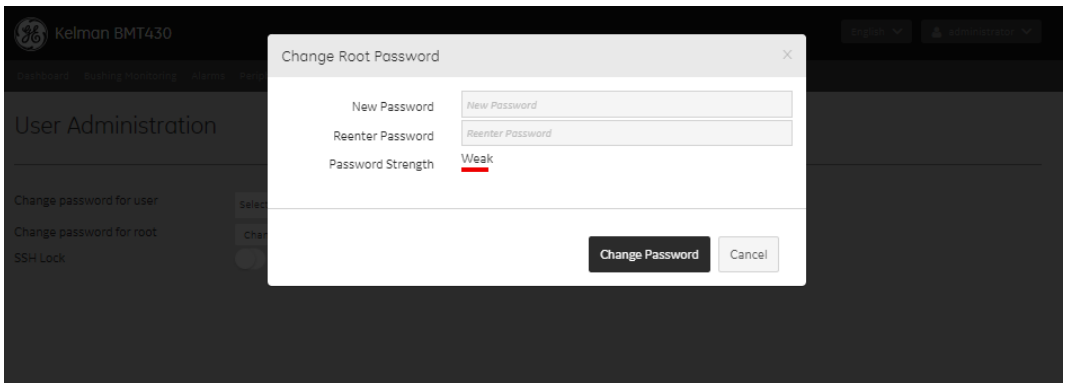


Figure 7-2: Change Password

A password strength is categorised as listed in Table 7-1.

Table 7-1: Password Strength

Password Strength Rating	Description
Strong	8 characters or more. The password string must contain at least one each of the following characters – lowercase, uppercase, numeric, and special. Certain special characters are *not* accepted i.e. # ` $ ^ & * ( ) | ' % " \ including the space character and no more than two consecutive characters of a user's role.
Weak	Anything less than the above description is not permitted.

Other security options relating to all accounts include implementing the *Hypertext Transfer Protocol Secure (HTTPS)* to increase login security over the Internet and a means to enable the password for Observer accounts.

Note: The default factory password for 'Observer' is blank.

Note: A changed password cannot be reset to use the default factory password.

Users are advised to implement a password management policy to ensure that passwords are maintained and secure. To regain access to a product with a lost password requires a GE Vernova service engineer visit to replace the system board.

7.1.1 BMT Service

Select **Service** > **BMT Service** to open the BMT Service page as shown in Figure 7-3.

Figure 7-3: Service > BMT Service

7.1.2 Configuration Import

To upgrade the product configuration, select **Service** > **Configuration Import** to open the Configuration Import page as shown in Figure 7-4. Product configuration details (including alarm settings) can be uploaded to a replacement product eliminating the need to re-input the original settings.

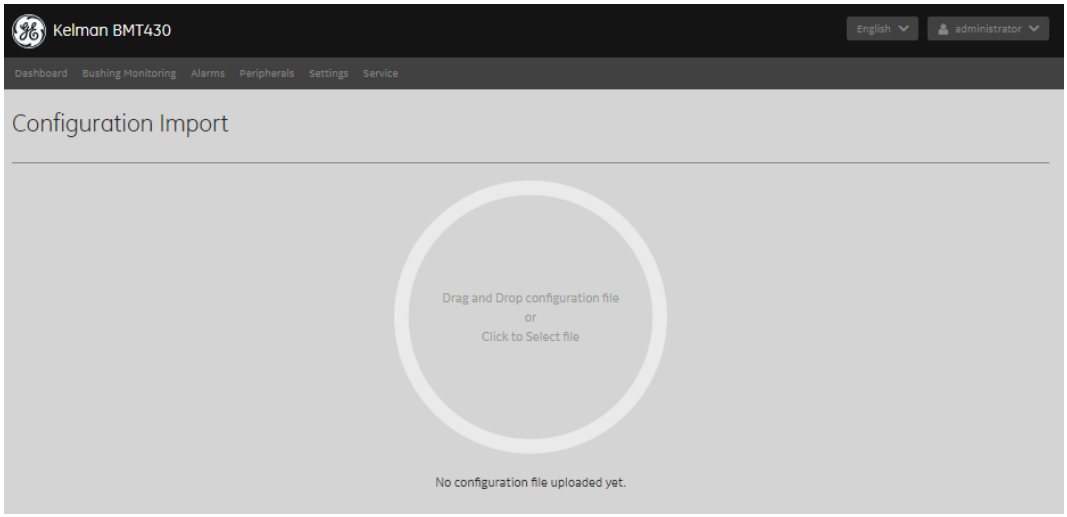


Figure 7-4: Configuration Import

Drag and drop the configuration file into the circle or click in the circle to select the file. The status information and a progress bar display as shown Figure 7-5. Click **Apply** to proceed.

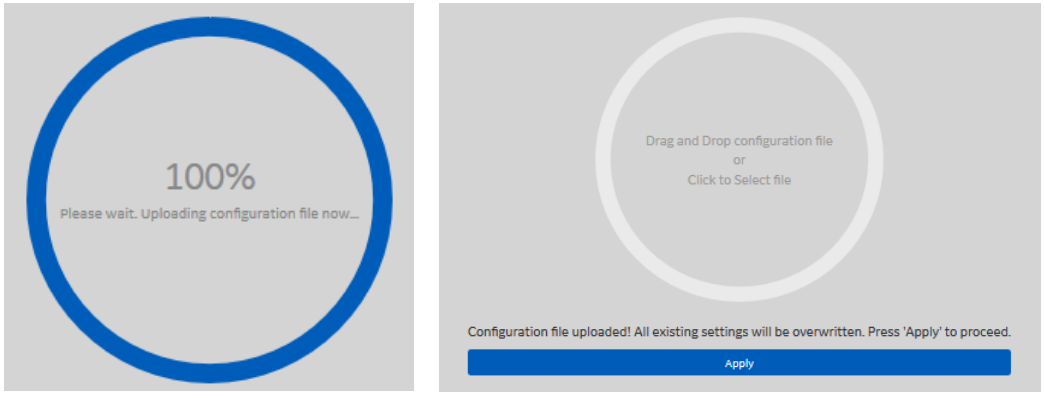


Figure 7-5: Configuration Import in progress

Once complete, the system restarts. On initial power up, the product's LCD screen remains blank, but the 'On' heartbeat LED and 'Boot' LED illuminate (solid blue and red respectively). After a moment, the Boot LED switches off and the 'On' heartbeat LED flashes blue to indicate normal operation. The restart sequence takes approximately 3 minutes after which the onboard HMI loads up.

7.2 Logout

Select the **Logout** option below the username as shown in Figure 7-6.

Figure 7-6: Logout

The Log-in page displays as shown in Figure 7-7.

Figure 7-7: Log-in page

8 COMMUNICATIONS

See the Communications section of 'MA-043 - BMT 430 - Installation & Commissioning Manual' for available communication options.

8.1 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

8.2 IEC 61850

Refer to documents:

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

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

8.3 Modbus Protocol

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

8.4 HTTP / HTTPS Protocol

The HTTP and HTTPS protocols are used for communication with the Perception software suite. The login credentials for such communication are independent of the local and remote HMI. The login credentials to communicate with Perception from the product are as follows:

Username: `perception`

Password: `perception`

Refer to the Perception software documentation for further details.

9 TECHNICAL SUPPORT

For technical support, please contact the GE Vernova Customer Service Centre (24 hours a day, 365 days a year):

Customer Service Centre (24 hours a day, 365 days a year)

T 1-877-605-5777, option 4 (United States and Canada)

T +44 1785-250-070 (Rest of the World)

GA.support@ge.com

Appendix A Security Configuration

A.1 Introduction

This appendix addresses security configuration for remote operations and the software firewall.

A.1.1 General Recommendations

GE Vernova recommends the 'Defence in depth' approach. The Defence in depth approach advocates multiple layers of independent security controls to make it as difficult as possible for an attack to succeed. When using GE Vernova products and solutions, consider adopting the following security best practices:

- Care must be taken when connecting hardware to a wide area network including but not limited to a corporate network or the Internet at large. The network segmentation and firewall rules at each network interface must be carefully considered to reduce the allowed traffic to the bare minimum needed for operation. Access rules customised to the site's specific needs must be used to access devices from outside the local control networks. Care must be taken to control, limit, and monitor all access, using, for example, virtual private networks (VPN) or Demilitarised Zone (DMZ) architectures. If a device is being used in a manner that does not require wide area network access, it is strongly recommended that the device not be connected to any wide area network to reduce the attack surface.
- It is recommended that the hardware is not connected to the same network as transformer protection equipment.
- Harden system configurations by enabling/using the available security features, and by disabling unnecessary ports, services, functionality, and network file shares.
- Apply all the latest GE Vernova product security updates, SIMs, and other recommendations.
- Apply all the latest operating system security patches to control systems PCs.
- Use antivirus software on control systems PCs and keep the associated antivirus signatures up to date.
- Use whitelisting software on control systems PCs and keep the whitelist up to date.

A.1.2 Sample Checklist

This section provides a sample checklist to help guide the process of securely deploying GE Vernova products.

- Create or locate a network diagram.

- Identify and record the required communication paths between nodes.
- Identify and record the protocols required along each path, including the role of each node.
- Revise the network as needed to ensure appropriate partitioning, adding firewalls or other network security devices as appropriate. Update the network diagram.
- Configure firewalls and other network security devices.
- Enable and/or configure the appropriate security features on each GE Vernova product.
- On each GE Vernova product, change every supported password to something other than its default value.
- Harden the configuration of each GE Vernova product, disabling unneeded features, protocols and ports.
- Test / qualify the system.
- Create an update/maintenance plan.

A.2 Communication Requirements

Communication between different parts of a control system is, and must be, supported. However, the security of a control system can be enhanced by limiting the protocols allowed, and the paths across which they are allowed, to only what is needed. This can be accomplished by disabling every communication protocol that isn't needed on a particular device, and by using appropriately configured and deployed network security devices (e.g. firewalls, routers) to block every protocol (whether disabled or not) that doesn't need to pass from one network/segment to another.

GE Vernova recommends limiting the protocols allowed by the network infrastructure to the minimum set required for the intended application. Successfully doing this requires knowing which protocol is needed for each system-level interaction.

A.2.1 External Interfaces

The product features the following external interfaces as shown in Table A-1.

Table A-1: External Interfaces

External interface	Comment
RS-485	
Ethernet	HMI/SSH access
Ethernet	Multi-protocol module DNP3/IEC 61850
GSM-GPRS modem	
microSD	
USB host	
USB device	USB-Ethernet

A.2.2 Supported Protocols

The product supports the following protocols as shown in Table A-2.

Table A-2: Protocols

Network Layer	Protocol
Link	ARP
Internet	ICMP
	IPv4
Transport	TCP
Application	DHCP Server
	SSH
	HTTP Server
	HTTPS Server
	Modbus RTU Slave
	Modbus TCP Slave

A.3 Secure Remote Operations

Select **Settings** > **Communication services** as shown in Figure A-1.

Note: This functionality is available only to 'Operator' and 'Administrator' users.

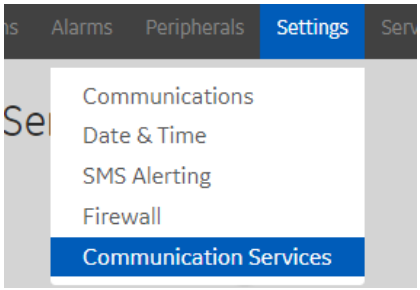


Figure A-1: Settings > Communication Services

The Communication Services page displays as shown in Figure A-2. All configuration settings specified on this page apply to *all* interfaces (Ethernet, USB and GSM-GPRS modem).

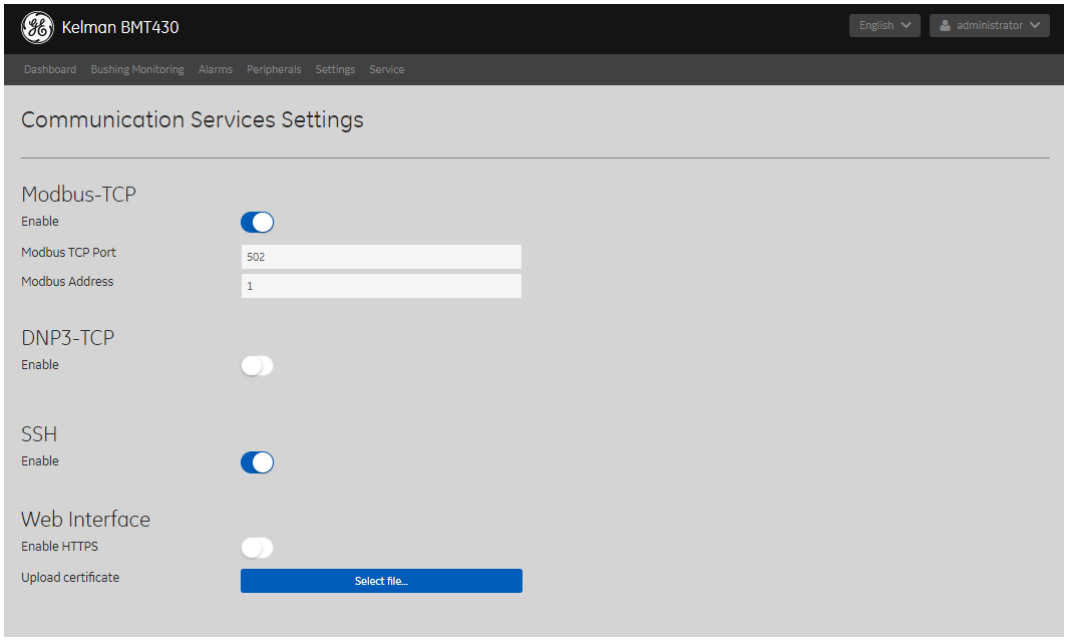


Figure A-2: Communication Services

Select the relevant slider control to enable/disable the relevant communication service. E.g. primary Modbus-TCP, primary DNP3-TCP, SSH (Secure Shell) and HTTPS — do not rely on the firewall settings.

To implement a custom security policy, upload a new certificate to replace the GE Vernova self-signed certificate and enable HTTPS requests only.

In the Upload certificate field, click the **Select file** button, select the new certificate (PEM file) and click **Open**.

Click the 'Save' button  in the application header to apply the changes and then restart the product.

Note: SSL certificates are small data files that digitally bind a cryptographic key to an organization's details. When installed on a web server, it activates the padlock and the HTTPS protocol and allows secure connections from a web server to a browser.

Note: If HTTPS is disabled, the certificate will be applied when HTTPS is enabled.

Note: The HMI has no automatic redirection between HTTP and HTTPS (or vice versa). This results in the following browser message "Site cannot be reached over HTTP".

Note: Key encryption is not supported when generating the private key.

A.3.1 Enable/disable Modbus-TCP protocol

- Use the HMI to login as either 'Administrator' or 'Operator'.
- Select **Settings** > **Communication Services**.
- Select the Modbus-TCP **Enable** slider control to enable/disable the Modbus-TCP protocol.

- Click the ‘Save’ button  in the application header to apply the changes.
- Restart the product.

A.3.2 Enable/disable SSH service (root access over SSH)

- Use the HMI to login as either ‘Administrator’ or ‘Operator’.
- Select **Settings** > **Communication Services**.
- Select the SSH **Enable** slider control to enable/disable the Secure Socket Shell service.
- Click the ‘Save’ button  in the application header to apply the changes.
- Restart the product.

A.3.3 Enable/disable HTTPS protocol

- Use the HMI to login as either ‘Administrator’ or ‘Operator’.
- Select **Settings** > **Communication Services**.
- Select the **Enable HTTPS** slider control to enable/disable the HTTPS protocol.
- Click the ‘Save’ button  in the application header to apply the changes.
- Restart the product.

Note: The HMI has no automatic redirection between HTTP and HTTPS (or vice versa). This results in the following browser message “Site cannot be reached over HTTP”.

A.3.4 Apply customer certificates for HTTPS

- Use the HMI to login as either ‘Administrator’ or ‘Operator’.
- Select **Settings** > **Communication Services**.
- To implement a custom security policy, upload a new certificate to replace the GE Vernova self-signed certificate and enable HTTPS requests only.
- In the Upload certificate field, click the **Select file** button, select the new certificate (PEM file) and click **Open**.
- Click the ‘Save’ button  in the application header to apply the changes.
- Restart the product.

Note: If HTTPS is disabled, the certificate will be applied when HTTPS is enabled.

A.4 Software Firewall

The product has a built-in firewall that defines the security settings for the various interfaces. Firewall policies are configured separately for each interface (Ethernet, USB, GSM-GPRS modem). The product ships with a

standard GE Vernova self-signed certificate with the firewall enabled by default to accept all HTTP requests. You should customise the firewall.

To create a custom security policy, select **Settings** > **Firewall** to open the Firewall Settings page as shown in Figure A-3.

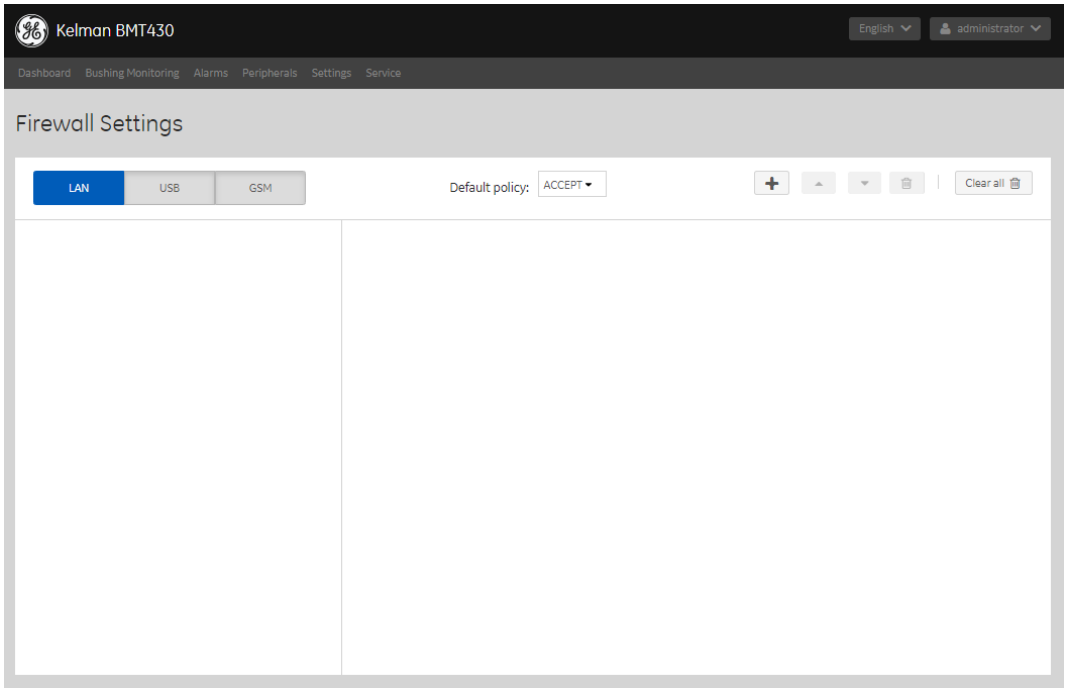


Figure A-3: Firewall Settings

Rules can be added, edited or deleted to create a suitable access policy for each type of interface. These rules are used to block unused ports and specify distinct firewall actions (accept, reject or drop) based on the IP address or port.

A.4.1 Default Policy

The default policy is to accept all incoming requests and applies for all cases not covered by specific policies. The default policy provides a dropdown list of three options as shown in Figure A-4.

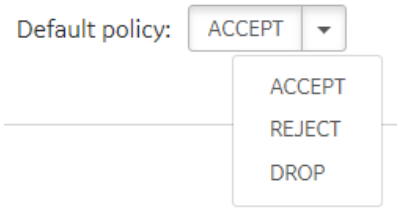


Figure A-4: Default policy options

A.4.2 Specific Policies

The specific policy adds exceptions to the default policy.

Click the 'Create new rule' button  to create a new policy. The rule options are as shown in Figure A-5.

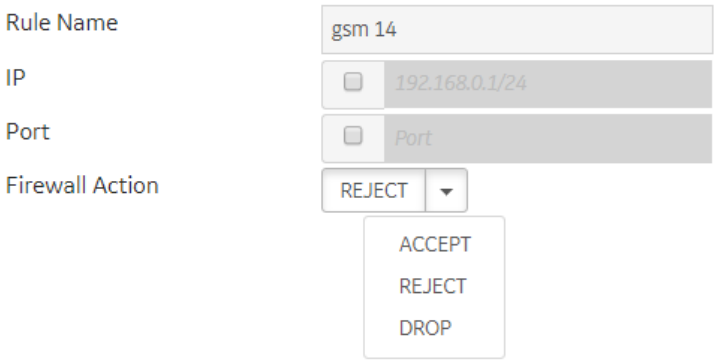


Figure A-5: Specific policy options

A.4.3 Disable all Connections on a dedicated interface

In the Firewall Settings page, select the interface type e.g. **LAN** and in the Default policy dropdown, select **REJECT** as shown in Figure A-6.

Figure A-6: LAN interface

A.4.4 Disable all Connections except HTTPS

Click the 'Create new rule' button  to create a new policy. The policy requires completing several fields as shown in Figure A-7.

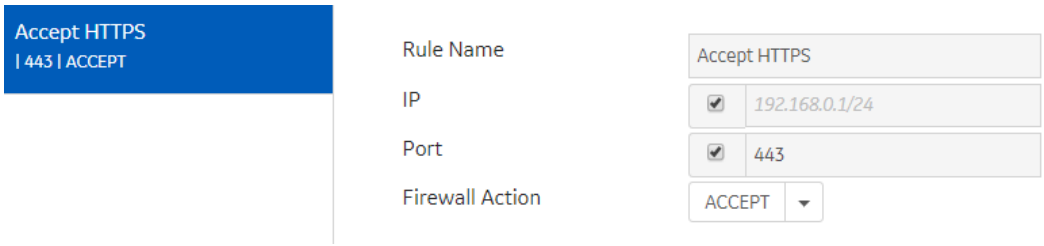


Figure A-7: Accept HTTPS

1. In the 'Rule Name' field, type a descriptive name e.g. **Accept HTTPS**.
2. In the 'IP' field, select the IP checkbox and specify/edit the IP address e.g. 192.168.0.124.
3. In the 'Port' field, select the Port checkbox and type **443**.
4. In the 'Firewall Action' dropdown list, select **ACCEPT**.

Repeat the above steps for each interface type to ensure that only HTTPS requests are permitted on those interfaces e.g. 'USB' and 'GSM'.

After all interfaces have been configured, click the 'Save' button  in the application header to save the security settings and then restart the product.

Use the following QR code to view demonstrations of general maintenance activities.

Figure B-1: QR code for maintenance activities

B.1 Battery Replacement

The product uses a non-rechargeable lithium coin cell battery (Panasonic CR2450 3 V 620 mAh) on the Controller PCB as shown in Figure B-2. If the battery needs to be replaced, data from the product should be backed up. Failure to do so may result in historical data loss.

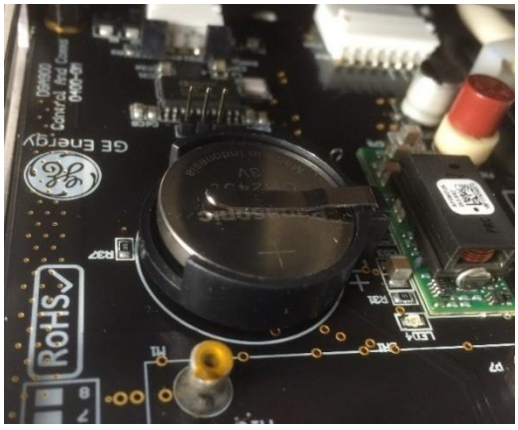


Figure B-2: Controller PCB coin cell battery

The following steps describe how to change the battery:

1. Open the door and locate the battery on the relevant board.
2. Carefully slide the battery out of its housing.
3. Replace with a new Panasonic CR2450 3 V 620 mAh coin cell.
4. Close the door.

There is a danger of a new battery exploding if installed incorrectly.

Dispose of the used battery in accordance with local regulations — not in a fire or with household waste. Contact your local waste

disposal agency for the address of the nearest battery deposit site. Perchlorate material — special handling may apply.

See: www.dtsc.ca.gov/hazardouswaste/perchlorate/

B.2 Air Filter Replacement

The product draws air from the base and expels it via the air outlet on the front door. The intake air is filtered to remove the largest particles, so depending on environmental conditions, the air filter cartridge may need periodic replacement.

To replace the air intake filter:

1. ⚠ First isolate the product through the external circuit breaker or external switch and apply LOTO.
2. Remove the four M8 hex nuts from the four M2.5 hex bolts securing the filter holder assembly as shown in Figure B-3 and then prise the holder off the base plate as shown in Figure B-4.
3. Remove the used filter mesh cartridge from the holder and dispose of it as shown in Figure B-5. Replace with a new filter mesh cartridge as shown in Figure B-6 in the orientation shown in Figure B-4. Note: the metallic mesh cover must face downwards and outwards in the holder.
4. Place the filter holder assembly back onto the product's base plate and secure in place using the four nuts and bolts previously removed as shown in Figure B-3.

Figure B-3: Fan air inlet

Figure B-4: Detached inlet cover with filter – facedown

Figure B-5: Detached inlet cover with filter removed

Figure B-6: Filter mesh cartridge – face up

The air outlet filter on the rear of the front door should also be periodically checked and replaced if required.

To replace the air outlet filter:

1. ⚠ First isolate the product through the external circuit breaker or external switch and apply LOTO before opening the door.
2. Remove the eight M5 aerotight nuts that secure the Louvre catchment tray to the top rear of the front door as shown in Figure B-7, and then lift the tray away from the neoprene 3 mm gasket as shown in Figure B-8.
3. Remove the used white filter from the tray (it's disposable and can be pulled out) as shown in Figure B-9. Insert a new Louvre air filter as shown in Figure B-10 into the tray ensuring that the filter evenly fills the entire space.
4. Refit the tray to the gasket on the front door and secure in place using the eight nuts previously removed as shown in Figure B-7.

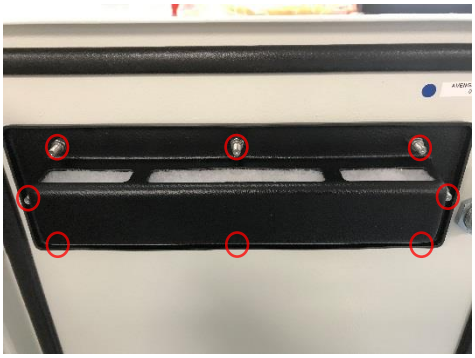


Figure B-7: Louvre catchment tray – attached

Figure B-8: Louvre gasket – tray removed

Figure B-9: Louvre catchment tray – detached & filter removed

Figure B-10: Louvre air filter

Appendix C Time Sync Implementation

The product has a time-sync feature that allows users to synchronize the clock. This Appendix explains the data format options for the “time sync” and its implementation.

C.1 Time Format

Under the standard Modbus® register list, the timing is defined in Table C-1.

Table C-1: Timing

Register	Permissions	Group Size	Description	Data Format
1200	R/W	4*	UTC Clock: Years	YYYY (BCD)
1201			UTC Clock: Months, days	MMDD (BCD)
1202			UTC Clock: Hours, minutes	HHMM (BCD)
1203			UTC Clock: Seconds, Day of week (0-6, 0 Sunday)	SSWW (BCD)

This R/W (read/write) register is in BCD format (Binary Coded Decimal). Some systems are not compatible with this data format. *The time registers can be written separately in 5 second intervals in any order.

C.2 UNIX® Epoch register

A UNIX Epoch register was added to the host board firmware (v1.12.2) to make systems integration easier in cases of system incompatibility. Both register formats (BCD & UNIX) will be maintained in future firmware versions and both affect the same single clock. The details of the UNIX time registers are listed in Table C-2.

Table C-2: UNIX time registers

Register	Access Flags	Version	Storage Class	Effect After	Name	Description	Data Format
1197	rg2,wg2	1.12.2	RAM	immediately	RTC_UNIX_TIME	Current Time UTC in UNIX format	32-bit integer
1198							

These registers are readable and writable, but should be written together as a single 32-bit value.

C.2.1 UNIX Time Format

The number of seconds from the UNIX epoch time of Jan 1st 1970 00:00:00.

C.2.2 UNIX Time Example

For reference, the time on a device is reported in the UTC format on the HMI as 11/29/2017 00:00:00 BST and the corresponding value in the registers mentioned above is 1511913600.

When testing, please check that you are reading registers 1197-1198 (assuming addresses start at 999 +1) and decoding an unsigned 32-bit big endian number. The epoch time is in UTC. This matches the device time. An online converter e.g. http://www.epochconverter.com/ can be used to verify.

C.2.3 Register Access Control

The product registers are protected with access flags. The register map details the relevant access flags for each register. Each register may have one or more access flags, separated by commas. Table C-3 lists the supported access flags:

Table C-3: Access flags

Flag	Access	Description
R	Read	Read access to a single register
rgN	Read group	Read access to a group of length N (Nmax = 120)
W	Write	Write access to a single register
wgN	Write group	Write access to a group of length N (Nmax = 120)

Access flags may be modified with the addition of the modifier flags listed in Table C-4.

Table C-4: Modifier flags

Flag	Access	Description
u	User	Only accessible if the master is authorised with user access
c	Config	Only accessible if master is authorised as config (commissioning) user
f	Factory	Only accessible if master is authorised as factory (service) user

GE Grid Solutions (UK) Ltd
Lissue Industrial Estate East
Unit 1, 7 Lissue Walk, Lisburn, Co. Antrim
Northern Ireland, United Kingdom BT28 2LU
www.gegridsolutions.com/MD.htm

For further assistance or queries please contact:

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T 1-877-605-5777, option 4 (United States and Canada)
T +44 1785-250-070 (Rest of the World)
ga.support@ge.com

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