

PureAire Monitoring Systems MPS™ Flammable Gas Monitors

Instruction Manual

For models
EXR MPS (99214)



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Welcome to PureAire Monitoring Systems

I would like to thank you for investing in our continuous life safety and process control toxic gas monitoring systems.

PureAire offers an unbeatable combination of experience and innovation in solving the safety and environmental needs of our customers. We can provide small systems of a few points, to a total multi-point turnkey computerized package.

PureAire's proprietary sensor cell technology and state-of-the-art electronics are designed to interface with the latest distributive or PLC based control systems. We believe that our experience, innovative products, and commitment to service will satisfy your specific monitoring needs now, and in the future.

Our growth is a result of our total commitment to supporting our customers. We are available 24 hours a day, 7 days a week to help you when you need us. Our 24-hour Emergency phone number is +1 (847) 541-1968. We can provide field service recommendations, preventative maintenance programs and training to your technicians in the operation of our equipment. Our goal is to provide the best after-sales service and support in the industry. That is just one way PureAire takes that extra step to ensure your complete satisfaction.

Thank you again for investing in PureAire Monitoring Systems for your monitoring needs and I am proud to welcome you to our family of valued and satisfied customers.

Sincerely,

Albert A. Carrino

President



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PLEASE READ BEFORE INSTALLATION

The following environmental conditions **WILL DAMAGE** the Monitor

1. The PureAire Monitor requires **24 VDC regulated power ONLY**. **DO NOT** connect the monitor to >24 VDC, or **ANY AC Voltage**.
2. **DO NOT power** the monitor **without the sensor attached** to the main assembly. **DO NOT disconnect/reconnect sensor** while monitor is powered.
3. Protect the monitor from physical impact and vibrations that exceed the specified limits.
4. Ensure installation complies with local safety regulations and standards. **INSTALLATION SHOULD ONLY BE PERFORMED BY QUALIFIED PERSONNEL**.
5. To prevent ignition of hazardous atmospheres, **DO NOT REMOVE COVER WHILE CIRCUITS ARE ALIVE**. Keep assembly **TIGHTLY CLOSED** when in operation. **Conduit seals** are required within **18"**.

The Password for entering the menus is 557.

1: Introduction

The PureAire MPS Flammable Gas Monitor is a compact and efficient system for continuous monitoring of flammable gas levels in various environments, including confined spaces and areas with potential gas leaks. Unaffected by fluctuating temperature or humidity levels, the device's robust Molecular Property Spectrometry (MPS) sensor provides accurate and stable gas readings. Suitable for both indoor and outdoor use, the monitor is factory calibrated for its entire 15+ year lifespan and carries multiple certifications, including UL, CUL, IECEx, and ATEX.

The system's centerpiece is a durable MPS sensor that quickly detects, quantifies, and classifies a wide range of flammable gases with TrueLEL™ accuracy, offering precise measurements across broad temperature and humidity spectrums. Designed for minimal maintenance, this sensor is built to work seamlessly for over a decade, eliminating the need for frequent calibration. Its built-in environmental compensation and automatic self-testing ensure fail-safe operation and significant maintenance time and cost savings.

Each system consists of a state-of-the-art MPS sensor and robust transmitter. Whether used as a stand-alone gas detector or integrated into a comprehensive safety system, the MPS Flammable Gas Monitor maintains its sensitivity and accuracy regardless of environmental conditions. The electronics are housed in a rugged, explosion-proof enclosure that is compliant with stringent safety standards. This manual will guide you through the installation, operation, and upkeep of the MPS Flammable Gas Monitor.

1.1 Key Features

The MPS Flammable Gas Monitor is designed with an array of innovative features that facilitate ease of use and efficient operation. These unique characteristics have been thoughtfully incorporated to streamline the installation process, optimize daily functionality, and minimize maintenance needs. By fusing cutting-edge technology with user-centric design, the monitor delivers reliable performance while ensuring a simplified user experience.

1.1.1 Long Life Molecular Property Spectrometry (MPS) Sensor

The MPS Flammable Gas Monitor features a durable MPS sensor with over 15 years of continuous operation. Uniquely designed by NevadaNano, this sensor can accurately detect, quantify, and classify flammable gas levels in various environments, setting it apart from conventional gas sensors.

1.1.2 Smart Electronics

The monitor integrates a specialized electronic circuit to continuously oversee the sensor's operation. This advanced circuitry can promptly identify any sensor degradation or failure, alerting the user to any sensor faults or electrical issues that might disrupt surveillance via the standard mA signal output.

1.1.3 Factory Calibration

The MPS Flammable Gas Monitor is factory calibrated for its entire lifespan, eliminating the need for any field calibration. This feature enhances usability and convenience, as the sensor maintains its accuracy and reliability without requiring periodic recalibration.

1.1.4 Environmental Compensation

The device uses a state-of-the-art MPS sensor that compensates for environmental factors like changes in temperature, humidity, and pressure. This ensures that the sensor's performance remains consistent and accurate under varying environmental conditions.

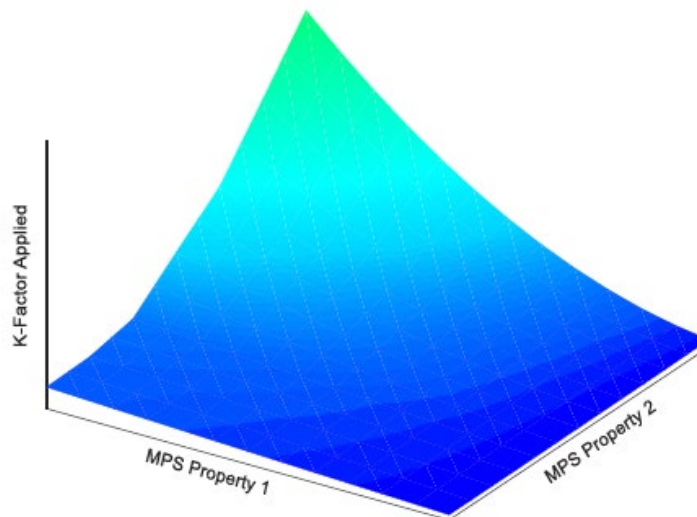
Further details about the factory reset and all specifications will be provided later in the manual.

1.2 How the MPS™ Flammable Gas Sensor Works

The MPS Flammable Gas Sensor is an advanced sensor designed with built-in environmental compensation to accurately detect and quantify over a dozen different flammable gases, as well as gas mixtures. It is engineered to be intrinsically safe, robust, and highly resistant to poisoning, making it extremely reliable for long-term use in various environments. The sensor requires zero customer-side calibration, and the monitor provides an industry-standard mA analog output.

At the core of the MPS sensor is a micro-machined membrane, which includes an embedded Joule heater and a resistance thermometer. This MEMS transducer is mounted on a PCB and enclosed in a filtered package that is permeable to ambient air. When flammable gases are present, they alter the thermodynamic properties of the air/gas mixture, which are then measured by the transducer. These measurements are processed by patented algorithms to provide an accurate concentration reading and to classify the type of flammable gas detected.

Unlike traditional sensing technologies, such as catalytic beads or NDIR sensors, which require manual selection of a “k-factor” to adjust sensitivity to specific gases, the MPS sensor applies a real-time conversion factor automatically. This conversion factor is determined using the most recent thermal properties of the ambient air/gas mixture, as well as environmental conditions. This ensures that the %LEL (Lower Explosive Limit) values reported are accurate even in complex gas mixtures, maintaining a high level of accuracy across all detected gases. Additionally, smart algorithms within the sensor allow it to classify the detected gas into specific categories, enhancing its versatility and precision in varied environments.



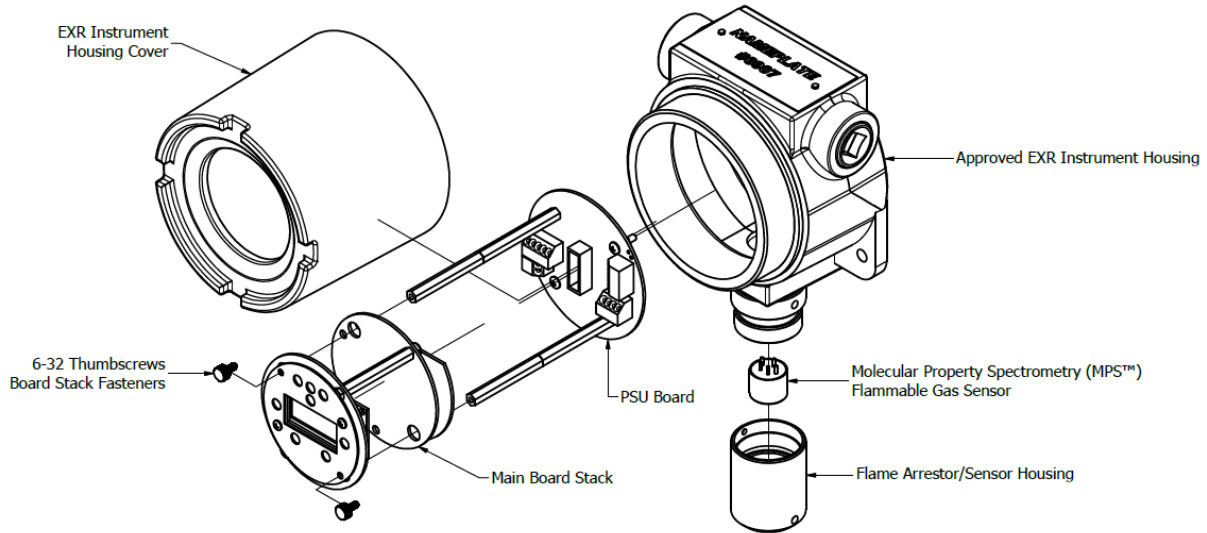
1.3 Detected Gases & Displayed Classes

Class	PureAire Displayed Text	Class Description	No. of Carbons	Gas	Formula	% Volume of gas at 100%LEL (ISO 10156)	Accuracy (0-50%LEL)
0	SENSING.	No Gas					
1	H2	Hydrogen	0	Hydrogen	H2	4.0 %Vol	±5 %LEL
2	H2 MIX	Hydrogen Mixture	Varies	Hydrogen + Flam	H2 + CxHxOx	—	—
3	CH4	Methane/Natural Gas	0-2	Methane	CH4	5.0 %Vol	±3 %LEL
4	LITE GAS	Light Gas	1-4	Ethylene	C2H4	2.7 %Vol	-12 %LEL
				Ethane	C2H6	3.0 %Vol	±5 %LEL
				Propylene	C3H6	2.4 %Vol	±5 %LEL
				Propane	C3H8	2.1 %Vol	±7 %LEL
				Isopropanol	C3H8O	2.0 %Vol	±10 %LEL
				Isobutylene	C4H8	1.8 %Vol	±5 %LEL
				Isobutane	HC(CH3)3	1.8 %Vol	±5 %LEL
5	MED. GAS	Medium Gas	2-8	Acetone	C3H6O	2.5 %Vol	±20 %LEL
				Methyl Ethyl Ketone (MEK)	C4H8O	1.4 %Vol	±5 %LEL
				Pentane	C5H12	1.5 %Vol	±7 %LEL
				Heptane	C7H16	1.1 %Vol	±12 %LEL
6	HVY. GAS	Heavy Gas	6+	Toluene	C7H8	1.2 %Vol	±12 %LEL
				Styrene	C8H8	1.1 %Vol	-20 %LEL
				Xylene	C8H10	1.1 %Vol	±12 %LEL
				Octane	C8H18	1.0 %Vol	±12 %LEL
-	OVR. RNG	>100% LEL					

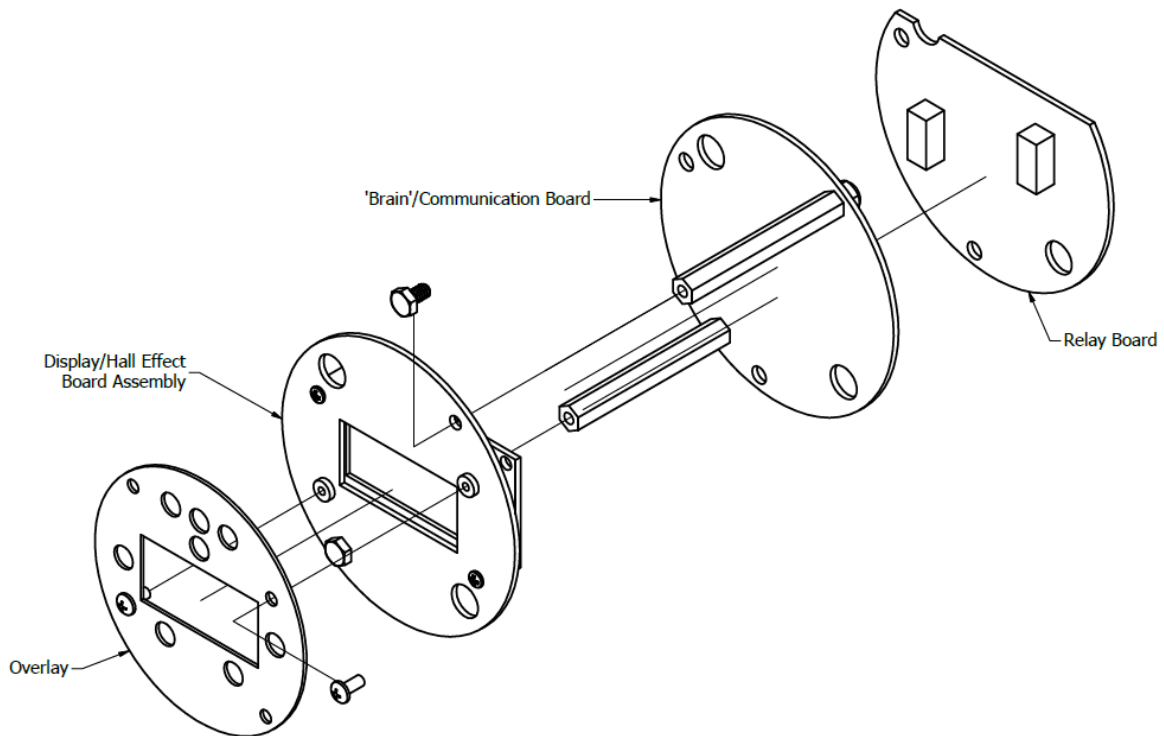
See Appendix A for linearity information and further gas information.

1.4 Component Identification

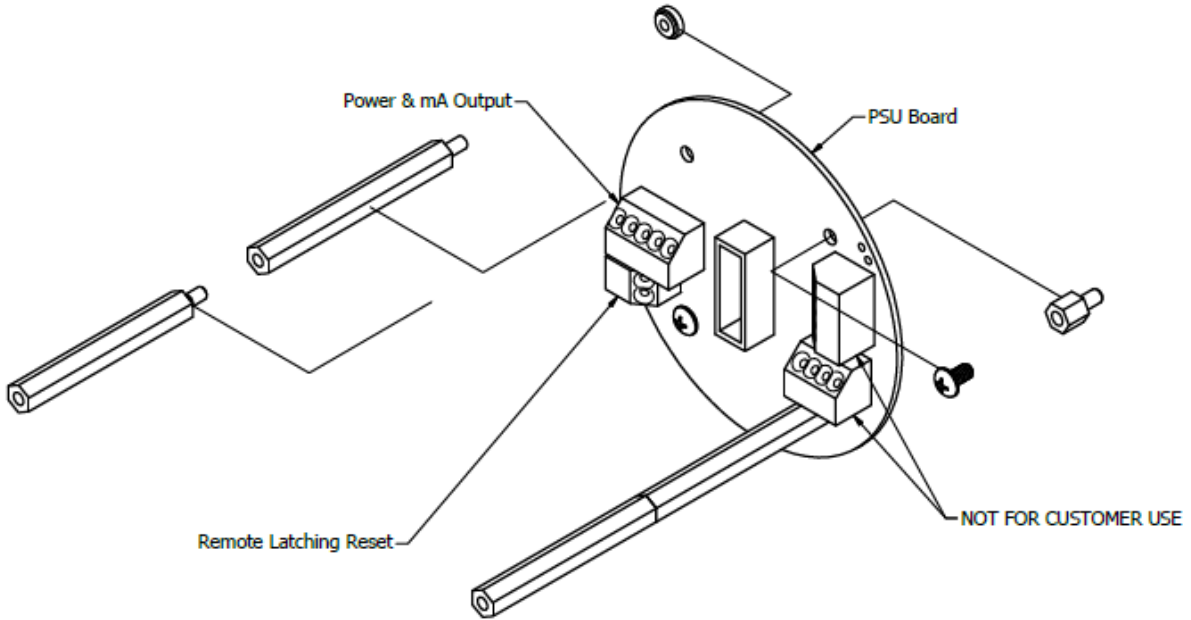
1.4.1 Major Component Overview



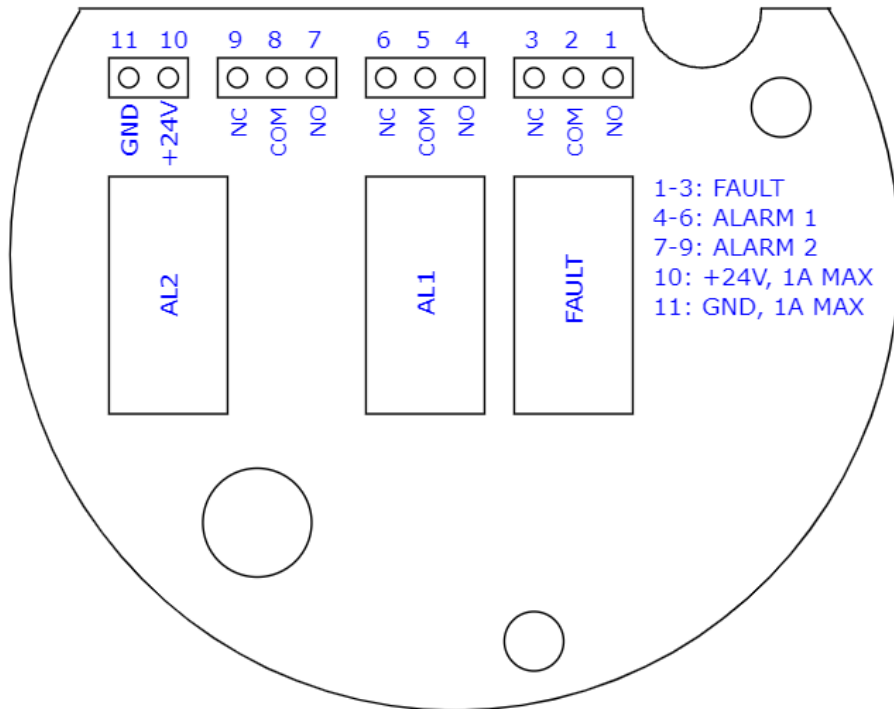
1.4.2 Main Board Stack Overview



1.4.3 Power Supply (PSU) Board Assembly



1.4.4 Relay Board



NC: Normally Closed
C: Common
NO: Normally Open

2: Specifications

NOTE: For our continual product improvement, all specifications are subject to change without notice

2.1 Performance Specifications

Sensor Type:	Molecular Property Spectrometry (MPS) Sensor.	0-100% TrueLEL™
Response Time:	< 20 seconds (T90)	
Accuracy:	Methane (CH ₄): ±3% LEL Hydrogen (H ₂): ±5% LEL Other gases: Varies (see specific gas accuracy in datasheet)	
Fault Indicators:	Loss of VDC power (analog signal drops to 0 mA). Sensor cell failure: Fault relay activated.	
Operating Cond.:	-40° to 167°F (-40° to 75°C) 0 to 100% RH	

2.2 Certifications and Standards

2.2.1 MPS Sensor Certifications

Type and Life:	MPS sensor with a lifespan of 15+ years under normal conditions.
Temperature Range:	-40°C to 75°C
Mean Time to Failure:	62 years at 60% confidence or 19 years at 99% confidence.
ISO 9001:2015:	National Standards Authority of Ireland (NSAI), Certificate Number: 19.8213
IECEX QA Report:	IEC 80079-34:2018, FM Approvals LLC, Certificate Number: GB/FME/QAR19.0020/00
ATEX QA Notif.:	2014/34/EU, FM Approvals LLC, Certificate Number: FM19ATEXQ0200
UK QA Notif.:	UKSI 2016:1107 (as amended), FM Approvals LLC

2.2.1.1 IECEX

Test Standard:	IEC 60079-0:2017, IEC 60079-11:2011
Protection Categories:	Ex ia IIC Ga, Ex ia IIIC Da
Certificate:	IECEX FMG 19.0028U

2.2.1.2 ATEX

Test Standard:	EN 60079-0:2018, EN 60079-11:2012
Protection Categories:	II 1 G Ex ia IIC Ga, II 1 D Ex ia IIIC Da
Certificate:	FM19ATEX0184U, FM21UKEX0159U

2.2.1.3 FM

Test Standard:	FM 3600:2018, FM 3610:2018, ANSI/UL 913:2019
Protection Categories:	Class I, Division 1, Group A,B,C,D; Class II and III, Division 1, Group E,F,G; Class I, Zone 0 AEx ia IIC Ga, Zone 20 AEx ia IIIC Da
Certificate:	FM19US0145U

2.2.1.4 CSA

Test Standard:	CSA 22.2 60079-0:2019, CSA 22.2 60079-11:2014
Protection Categories:	Class I, Division 1, Group A,B,C,D; Class II and III, Division 1, Group E,F,G; Class I, Zone 0 Ex ia IIC Ga, Zone 20 Ex ia IIIC Da
Certificate:	FM19CA0077U

2.2.2 Adalet Enclosure Certifications

Manufacturer:	Adalet/Scott Fetzer Co.
Catalog Number:	XIHMX Series
Temperature Range:	-34°C to +100°C
IP Rating:	IP66

2.2.2.1 IECEX

Test Standard: IEC 60079-0:2017, IEC 60079-11:2011
Protection Categories: Ex db IIC Gb, Ex tb IIIC Db IP66
Certificate: UL 08.0005U

2.2.2.2 ATEX

Test Standard: EN 60079-0:2018, EN 60079-11:2012, EN 60079-31:2014
Protection Categories: II 2 G Ex db IIC Gb, II 2 D Ex tb IIIC Db IP66
Certification: DEMKO 07 ATEX 0622294U Rev. 4

2.2.2.3 UL

Test Standard: FM 3600:2018, FM 3610:2018, ANSI/UL 913:2019
Protection Categories: Class I, Division 1, Group A,B,C,D; Class II, Division 1, Group E,F,G; Class III;
Class I, Zone 1 AEx d IIC, Ex d IIC
Certificate: Classified UL C US 34H4

2.2.2.4 Routine Tests

Routine tests according to EN 60079-1 clause 16 are not required, as the enclosures have been successfully tested at four times the reference pressure, 62.6 bar.

2.2.3 Flame Arrestor Certifications

Manufacturer: Dynamant LTD, Mansfield, UK
Model: GSH4 housing
Temperature: -20°C to +60°C

2.2.3.1 IECEX

Test Standard: IEC 60079-0:2011 Edition 6.0, IEC 60079-1:2014-06 Edition 7
Protection Categories: Ex db IIC T4 Gb
Certificate: IECEX SIR 10.0184X

2.2.3.2 ATEX

Test Standard: EN 60079-0:2012+A11:2013, EN 60079-1:2014
Protection Categories: II 2 G Ex db IIC T4 Gb
Certificate: SIRA 10ATEX1358X

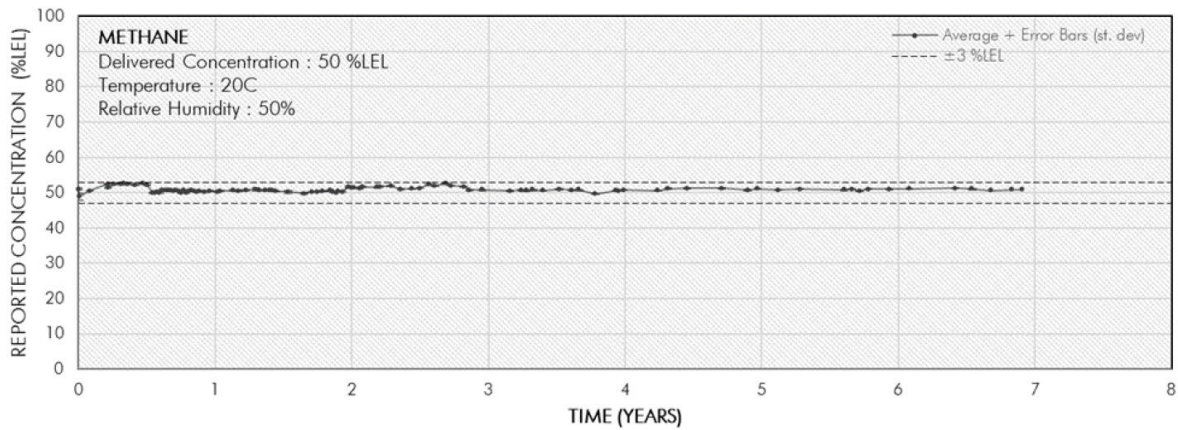
2.2.3.3 EU Declaration of Conformity

Directives: 2014/34/EU: Harmonisation of the laws of Member States relating to equipment and protective systems intended for use in potentially explosive atmospheres (ATEX)
2012/19/EU: Waste Electrical and Electronic Equipment (WEEE)
2011/65/EU: Restriction of the use of certain hazardous substances in electrical and electronic equipment (RoHS)
Harmonised Standards: EN 60079-0:2012+A11:2013: General requirements for electrical apparatus for potentially explosive atmospheres
EN 60079-1:2014: Flameproof enclosure 'd'

Notified Body for Hazardous Area Certification: CSA Group Netherlands B.V., Notified Body Number 2813
Notified Body for ATEX QA Notif.: SGS Fimko Oy, Notified Body Number: 0598

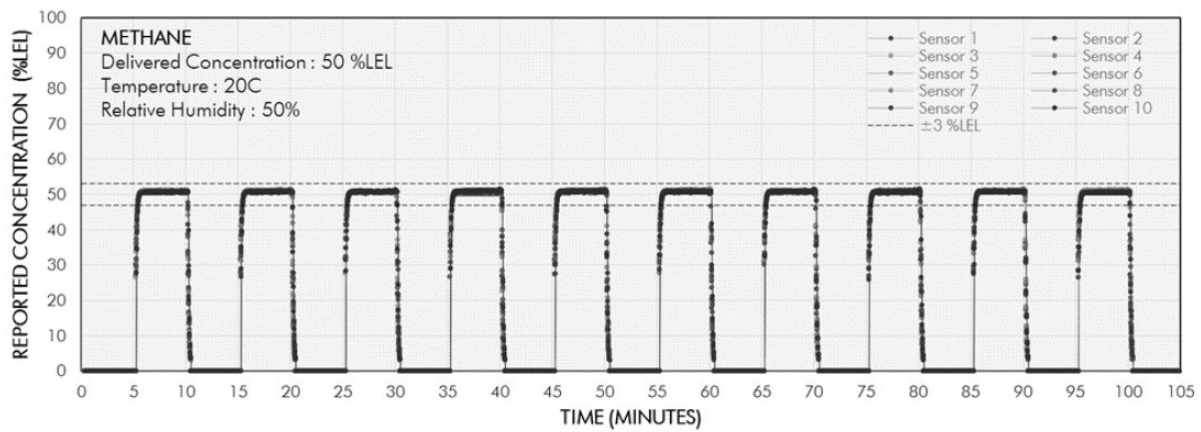
2.3 Typical Gas Performance Characteristics

2.3.1 Long-Term Accuracy/Stability



Average concentration reported to repeated exposures of 50 %LEL methane vs. time. Between exposures, all sensors operated continuously in clean air. During exposures, all sensors were placed in an environmental chamber set at standard conditions (20 °C, 50 %RH) where gas was delivered from a cylinder. Accuracy has remained within ± 3 %LEL to date. The test is ongoing.

2.3.2 Repeatability



Sensor #	Average [%LEL]	Standard Deviation [%LEL]
Sensor 1	50.8	0.15
Sensor 2	50.5	0.18
Sensor 3	50.9	0.13
Sensor 4	50.7	0.22
Sensor 5	50.7	0.14
Sensor 6	50.7	0.13
Sensor 7	50.7	0.14
Sensor 8	50.6	0.18
Sensor 9	50.7	0.10
Sensor 10	50.6	0.17

2.4 Signal Outputs

Local Display:	Offers a digital display, which can be accessed and managed via the included magnet wand. In measurement mode, selecting 'down' will toggle between scrolling the description and just the gas.
Standard Analog:	Provides DC 4-20 mA output. (RS-485 Pending)
Relay Output:	Includes dual-level user-selectable alarm relays and one fault relay, all rated at $\leq 2\text{amps @ } \leq 24\text{VDC}$.

2.5 Electrical Requirements

Power:	24VDC external power. A regulated 24VDC power supply is required.
Consumptions:	Approx. 250mA

2.6 Physical Characteristics

Dimensions:	5.125 (W) x 8.00 (H) x 6.40 (D) inches; 130 x 200 x 16 mm (Max w/ feet)
Weight:	6.5 pounds (3 kg)
Enclosure Type:	Approved Instrument Housing; For use in Hazard locations as to <u>Explosion and Fire Hazard ONLY</u> .

2.7 Default Factory Settings

The PureAire MPS Flammable Monitor is shipped with factory defaults that are saved to the memory of the unit. Factory resettable functions are denoted by †.

Menu	Factory Default	Definition
Set 4-20mA Loop†	mA output is individually set at the factory using a calibrated Fluke meter.	Use this function to adjust the PureAire monitor's 4 mA (Zero), and 20 mA (Span) analog output
Set Formats†	Alarm 1 = Normal Alarm 2 = Normal Fault = Normal	When alarm activates, the relays should energize (Normal), or de-energize (Inverted)
Set Polarity†	Alarm 1 = Normal Alarm 2 = Normal	Alarm should activate above specified concentration (Normal), or when lower (Inverted) than the alarm thresholds
Set Latching†	Alarm 1 = Non-latching Alarm 2 = Non-latching Fault = Non-latching	Automatic alarm reset (non-latching), or manual alarm reset (latching)
Alarm Delay†	Alarm = 5 Seconds	Delay until alarm is activated
Set Alarm Thresholds†	Alarm 1 = 20% Alarm 2 = 40%	Alarm levels
Set Alarm Hysteresis†	Alarm 1 = 0.0% Alarm 2 = 0.0%	Deadzone setting, more information in Section 5
Manage Passwords	Factory Default is 557	For changing the password from factory default to a new password

The LED indicators on the front panel are connected directly to the alarm relays.

3: Installation

3.1 Site Requirements

The PureAire MPS Flammable monitor should ideally be placed in an area free from excessive vibration and electrical noise or interference. Areas with high temperatures or high humidity should be avoided. When installed on a wall, the monitor effectively covers an area of about 692 ft². This coverage is approximately a circle with a radius of around 15 ft, assuming an ideal and uniform gas dispersion in an open space.

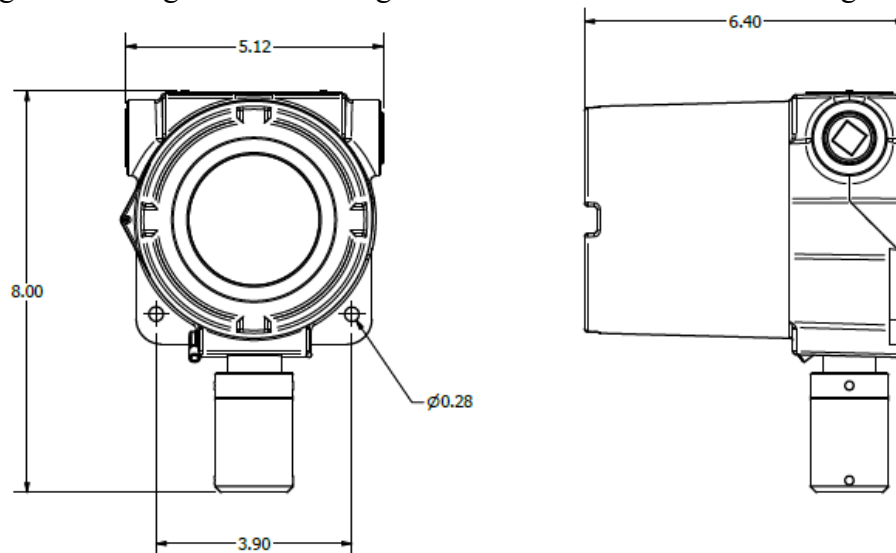
For optimal safety and effectiveness, the MPS Flammable Gas Monitor should ideally be situated as close as possible to potential leak sources, such as gas lines, gas cylinders, or other areas prone to gas leaks. While the monitor should not be placed more than 21 ft away from these potential leak points, positioning it closer enhances its ability to promptly detect changes in gas levels. When considering placement, various factors may have to be examined such as expected gas dispersion patterns, the monitor's sensitivity, and required safety margins. Therefore, the closer the monitor is to the potential source of a leak, the more effective it will be in providing timely alerts.

Furthermore, if multiple monitors are installed on the same wall, the maximum distance between two units should not exceed 30 ft for optimal safety and monitoring efficiency. However, actual coverage could be influenced by many environmental factors.

3.2 Mounting

3.2.1 EXR Enclosure Dimensions

The following is a drawing of the mounting dimensions for the monitor housing.



3.2.2 Installation Guidance

The MPS Flammable Gas Monitor is designed primarily for wall mounting and should be installed at a height convenient for operation, maintenance, and viewing of the instrument's digital display.

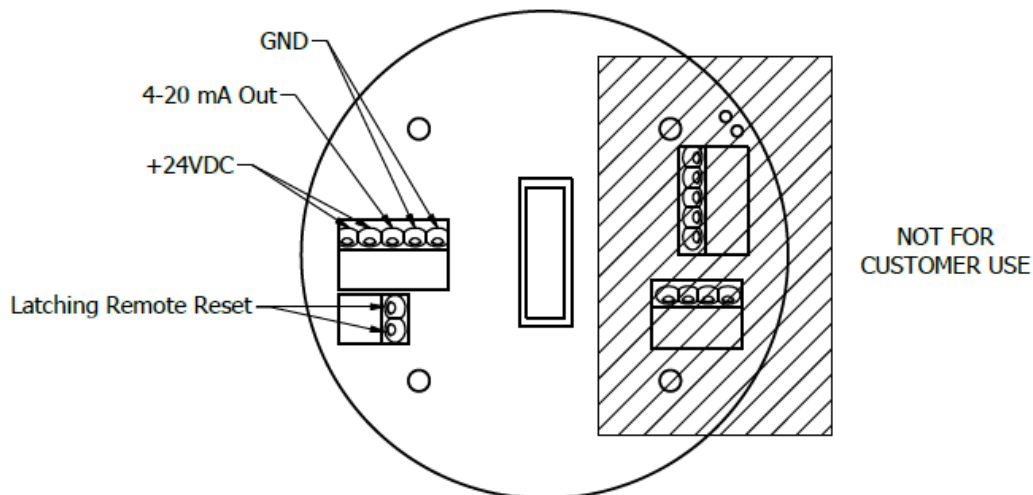
Choose a location for the transmitter and sensor where potential gas leaks could occur or where any released gases might tend to gather. The installation should not be less than 12 inches above the floor level. **Consider factors such as air circulation patterns within the area to be monitored, the properties of the gas (whether it's lighter or heavier than air), and the placement of workstations and staff when deciding on the optimal installation site.**

3.3 Wiring

The MPS Flammable Gas Monitor necessitates a singular, triple-conductor shielded cable for the purpose of analog output and 24 VDC power input. It's recommended to employ a three-wire shielded cable, ideally of 18 AWG stranded, such as the General Cable E2203S.30.860 or an equivalent. The connections for analog output and VDC power input are to be made on the internal terminal block located within the transmitter housing.

Note that all PureAire monitors, except for explosion proof monitors, come with a pre-installed plug-in power supply. THIS MONITOR REQUIRES CUSTOMER SUPPLIED POWER.

3.3.1 Power to Monitor



Caution: DO NOT connect to a powered current loop receiver. The PureAire monitor supplies the current loop power.

DO NOT disconnect or reconnect the sensor when the monitor is powered on.

4: Normal Operation

The MPS Flammable Gas Monitor is a single point monitor designed for the continuous detection and measurement of flammable gas concentration levels in ambient air.

4.1 Signal Outputs

The MPS Flammable Gas Monitor consistently outputs an analog signal ranging from 4-20 mA, corresponding directly to the measured flammable gas concentration. A 4-mA output signifies 0%LEL, while a 20-mA output denotes 100%LEL the maximum value, representing the full operational range of the monitor. If a system fault occurs, a specific factory-designated code will appear on the local digital display, which will help identify the exact issue with the system, while the analog signal will be locked to 2mA.

CAUTION: DO NOT connect to a powered current loop receiver. The PureAire monitor supplies the current loop power.

4.2 Instrument Faults

The MPS Flammable Gas Monitor incorporates several self-checking features to ensure reliable operation. If a fault condition is detected, the analog signal output is altered. Common error codes are displayed in the following table.

Condition	Error Code
Sensor Communication Error	1
EEPROM Fault	8
Supply Voltage Out of Range†	16

When the monitor is in a Fault state, the analog output will be locked to 2 mA.

† When using a non-PureAire power supply, please ensure that the voltage is regulated to $24\pm 0.5\text{VDC}$. If the voltage is outside the acceptable range, the “Supply Voltage Out of Range” fault will be activated and will disable the monitor.

*If a Fault condition clears itself, (Yellow LED is no longer illuminated) the Fault message will continue to scroll until manually cleared. To clear the fault message, select/toggle **down** ↓.*

4.3 Routine Maintenance Schedule

Continuous gas detection systems, crucial for identifying hazardous gas leaks in various environments, require routine maintenance to ensure proper functioning. The frequency of this maintenance largely hinges on the specific environmental conditions. However, as a general guideline, it is recommended to conduct visual inspections **every 1 year** to verify the physical integrity of the system. Similarly, testing the system with a flammable gas every 12 months is advisable to confirm the sensor's responsiveness. Please remember that your organization's maintenance policies, along with the unique conditions of your application, may necessitate adjustments to this recommended maintenance schedule.

During normal operation, the unit should be outputting a 4-mA signal when the flammable gas level is at 0%LEL. The LCD digital display should also indicate 00%LEL when there is no flammable gas detected.

4.4 Loss of Power Indication

In the event the PureAire monitor loses 24VDC power, the analog output signal will drop to 0mA, and the LCD display will be blank.

4.5 Alarm Reset

The PureAire MPS Flammable Gas Monitor comes equipped with alarm relays. When the monitor's alarms are triggered, the built-in alarm relays, and panel-mounted LEDs will activate simultaneously. Depending on the relay settings, the alarm systems will either automatically reset (non-latching settings) or require manual reset (latching settings) upon coming out of alarm state.

To manually reset the alarms, you can use the user-interface or the remote reset function:

1. **User-Interface:** To use the user-interface for reset, you first need to enter the designated password to access the reset function. Once the password is accepted, you can toggle enter using the provided magnetic wand to reset the alarms.
2. **Remote Reset:** The alarm relay board includes a two-pin connector for wiring to a remote switch. When a switch is connected, this remote reset function allows you to reset the alarms without using the user-interface or needing to enter a password.

Please note: Before you can reset the alarms using either the remote reset switch or the user-interface, the measured flammable gas levels must return to under alarm thresholds.

5: Monitor Programming

Only qualified personnel should perform programming, maintenance, and sensor verification.

The PureAire MPS Flammable Gas Monitor comes with customizable settings, allowing users to modify alarm settings, 4 and 20mA output, and minor sensor adjustments. These settings are organized within menus that can be navigated using the user-interface and the provided magnetic wand. Access to these menus is secured with a factory-set password.

Please note: Even while adjusting settings within these menus, the PureAire MPS Flammable Gas Monitor will keep monitoring flammable gas levels. **The alarm, fault relays, and mA output remain active and online during any changes made within the menus.**

5.1 User-Interface Operation

The PureAire MPS Flammable Gas Monitor uses a magnetic user-interface for selecting menus and changing values. The user-interface is programmed to standard protocol as follows:



Up – Increases the value

Down – Decreases the value

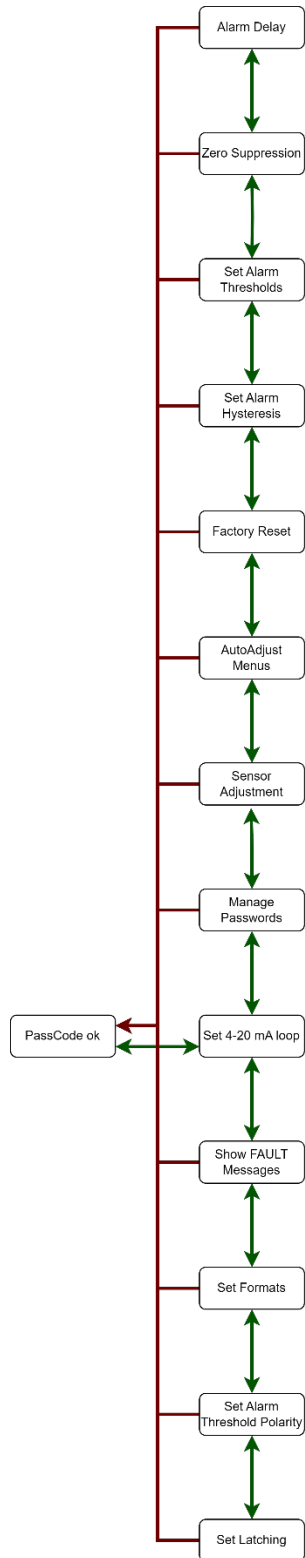
Right – Next level of menu hierarchy

Previous – Returns to previous level of menu hierarchy

Enter – Enters information into the microprocessor

NOTE: The interface has a built-in delay to prevent accidental tampering of the menus.

5.2 Overall Program Flowchart



5.2.1 Top Level Menu Navigation

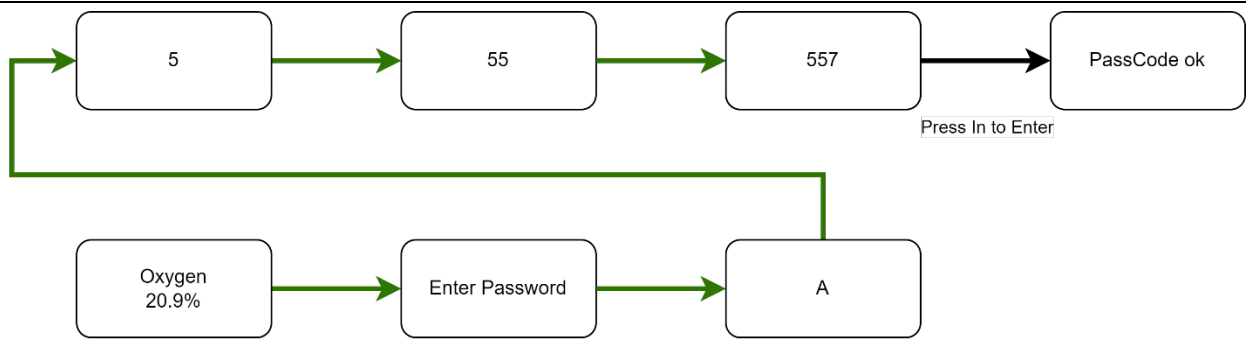
After entering the correct password, the monitor will display “PassCode ok”. To exit the password menu and return to the default screen, input ‘left’ on the user interface.

To access the internal settings, input ‘right’ to enter the ‘Set 4-20 mA loop’ top-level menu state.

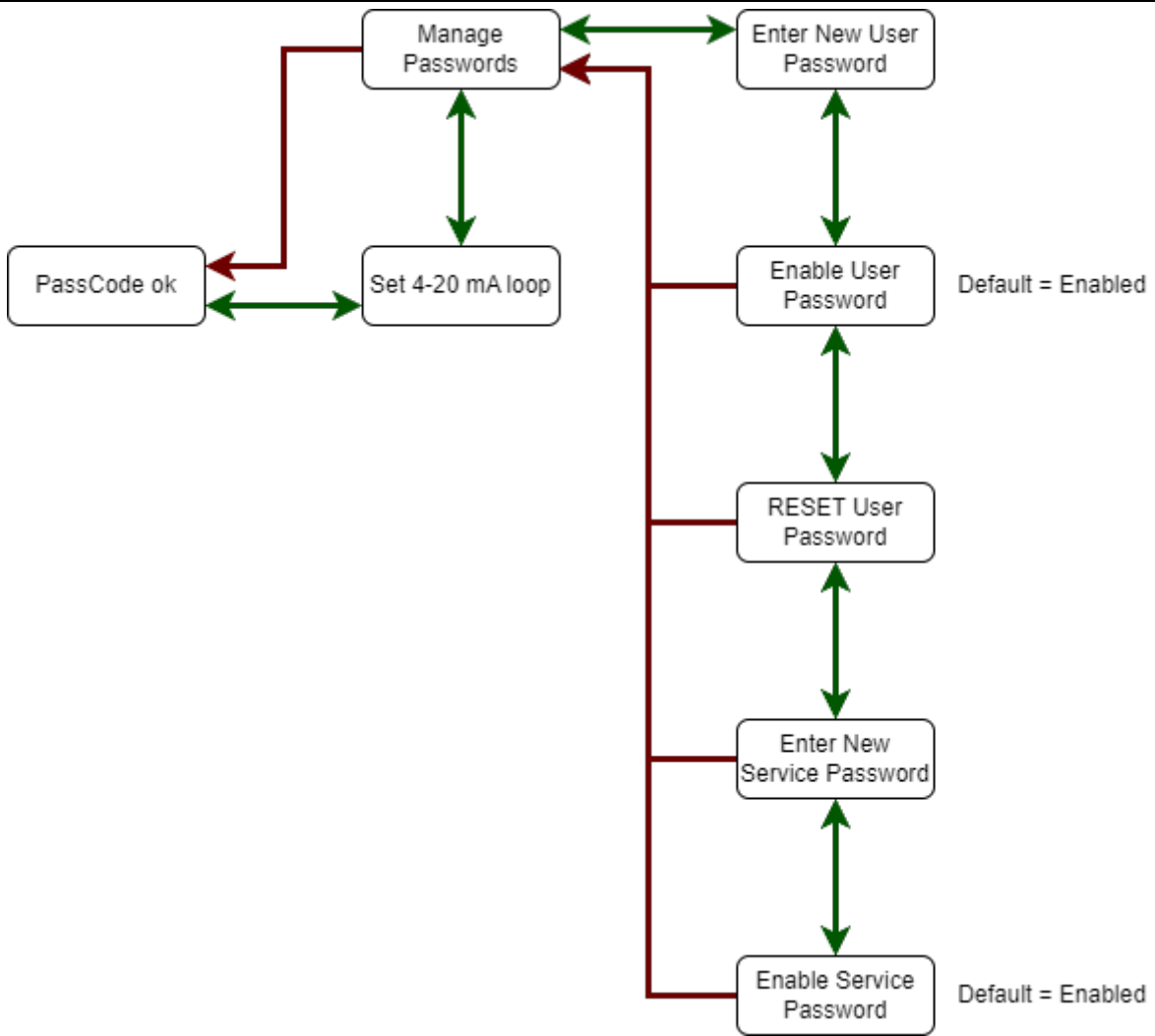
Once in this menu state, you can navigate through other top-level internal menus by inputting ‘up’ or ‘down’.

To return to the “PassCode ok” screen from any top-level internal menu, input ‘left’ on the user-interface. From sub-menus, toggle left until the “PassCode ok” menu state is reached.

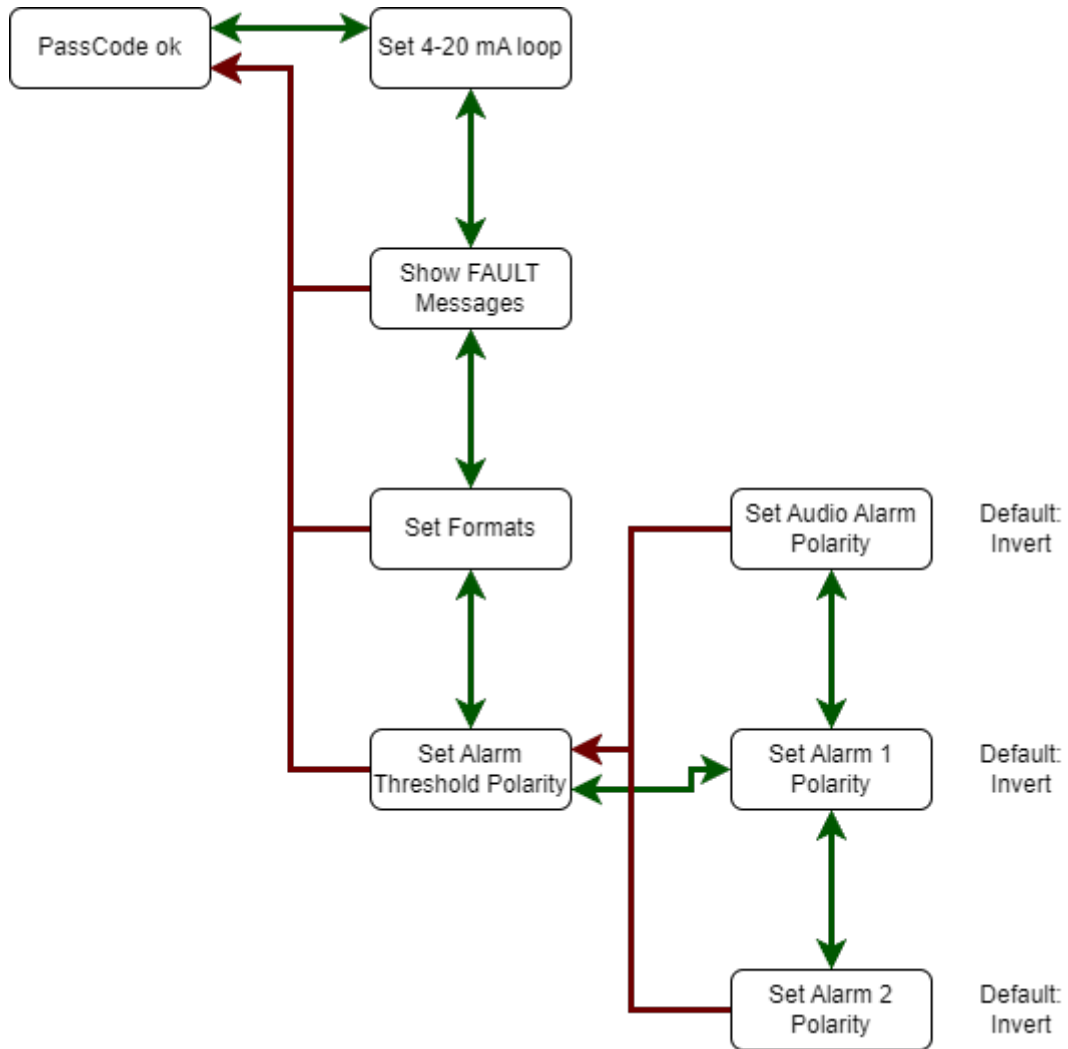
5.3 Entering Password



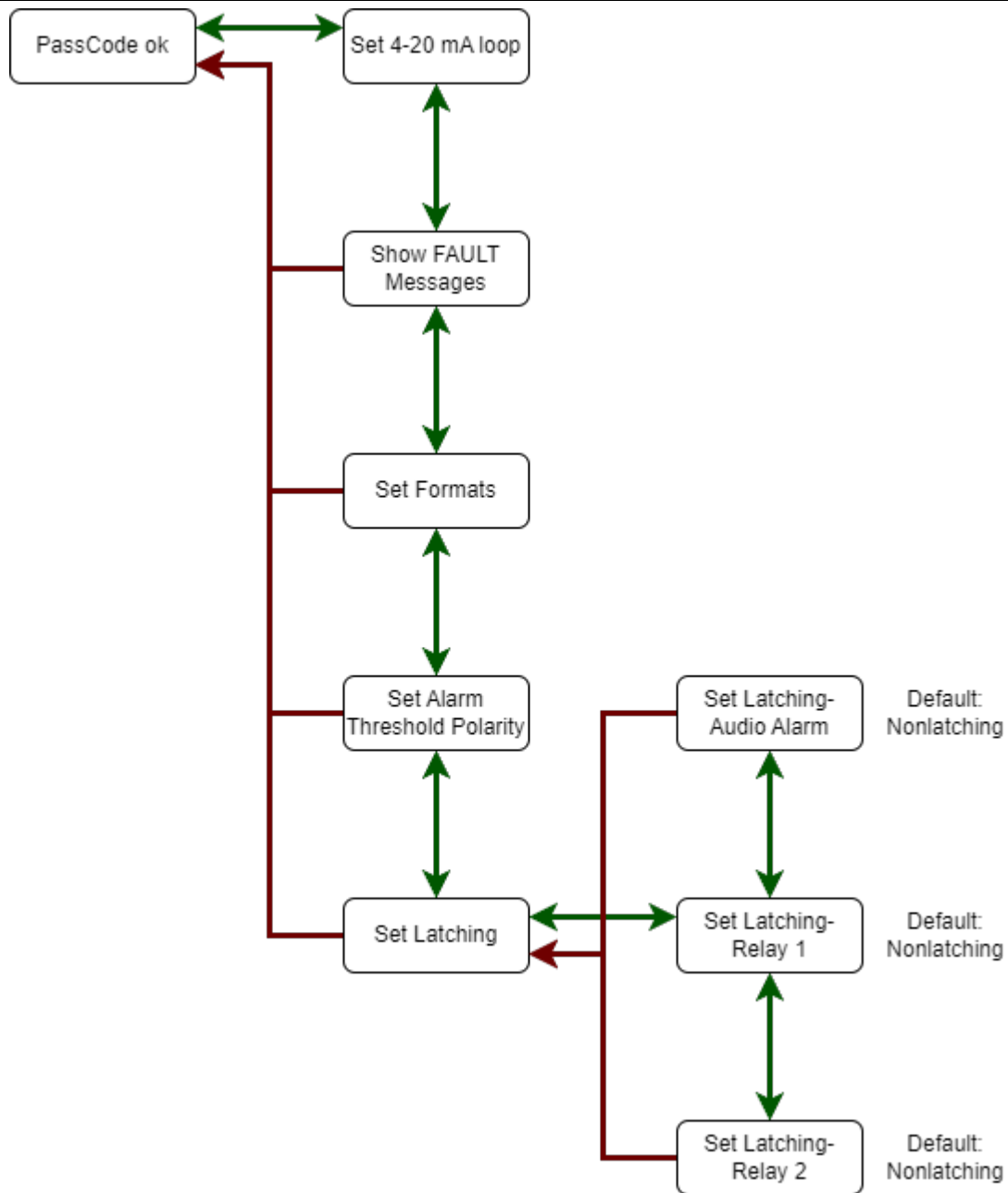
5.4 Changing the User Password



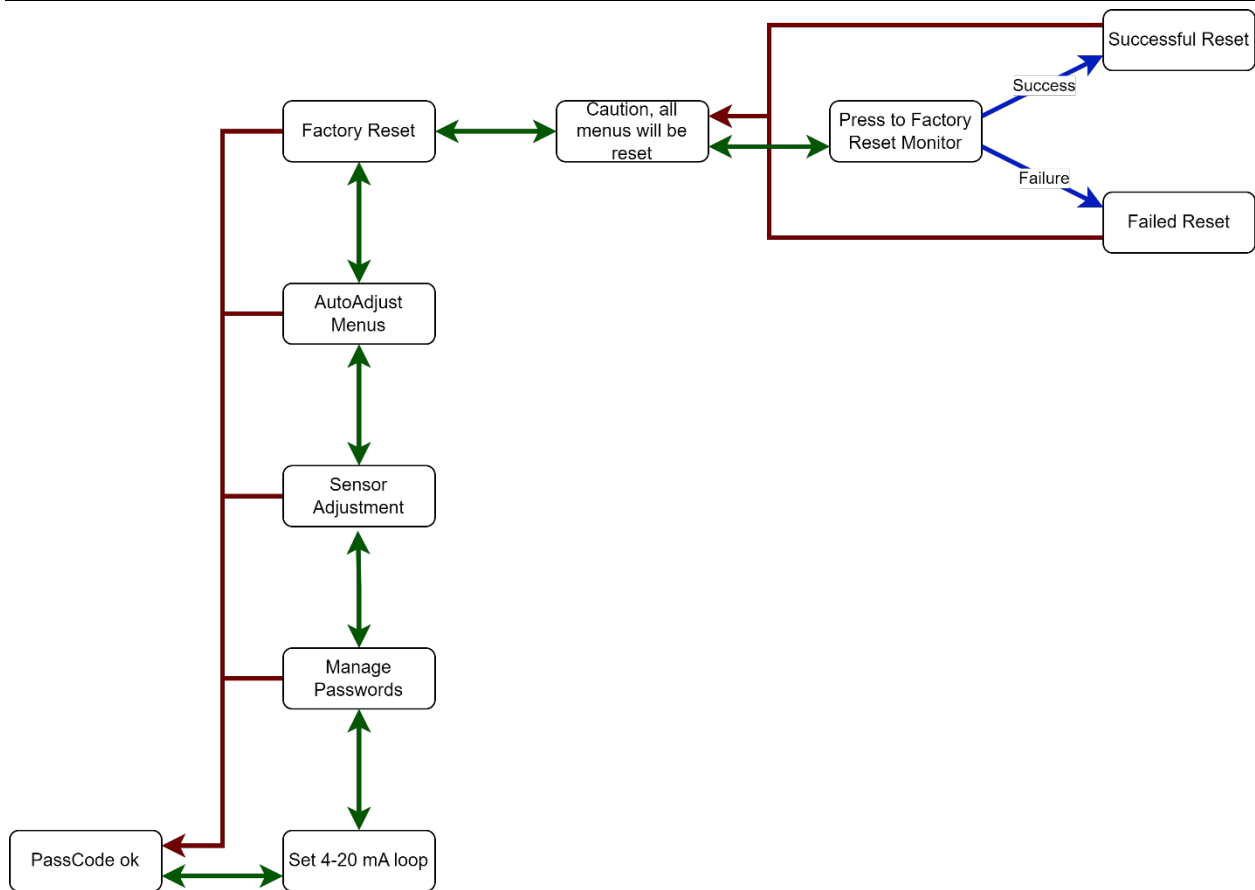
5.7 Setting Alarm Polarity



5.8 Setting Alarm Latching

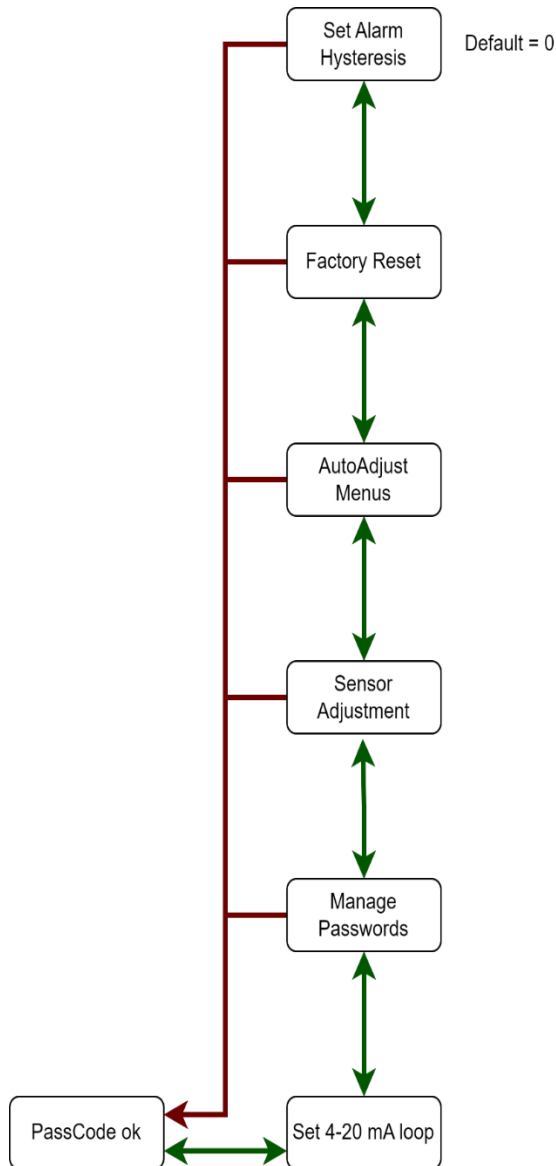


5.9 Factory Reset Menus



Please refer to Section 2.7 for Default Factory Settings and resettable settings.

5.10 Setting Alarm Hysteresis



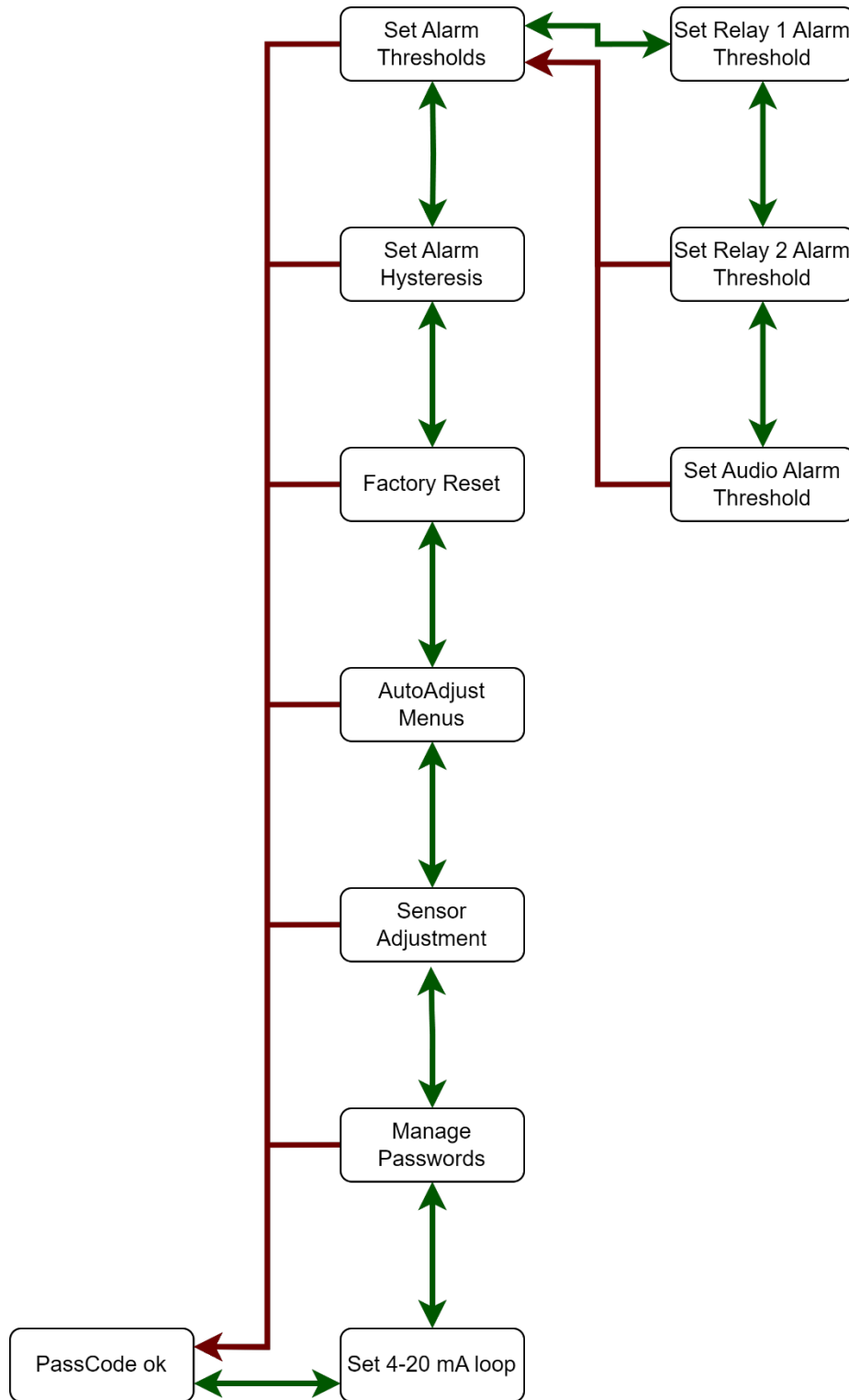
5.10.1 Hysteresis

Hysteresis refers to a system's dependency not just on its current input, but also on its past history of inputs. It's a fundamental concept employed in various scientific and engineering fields, often used to stabilize systems and prevent them from rapid fluctuations in response to minor changes in input, a phenomenon commonly referred to as "chatter". The application of hysteresis, thus, can provide more consistent and reliable system operation.

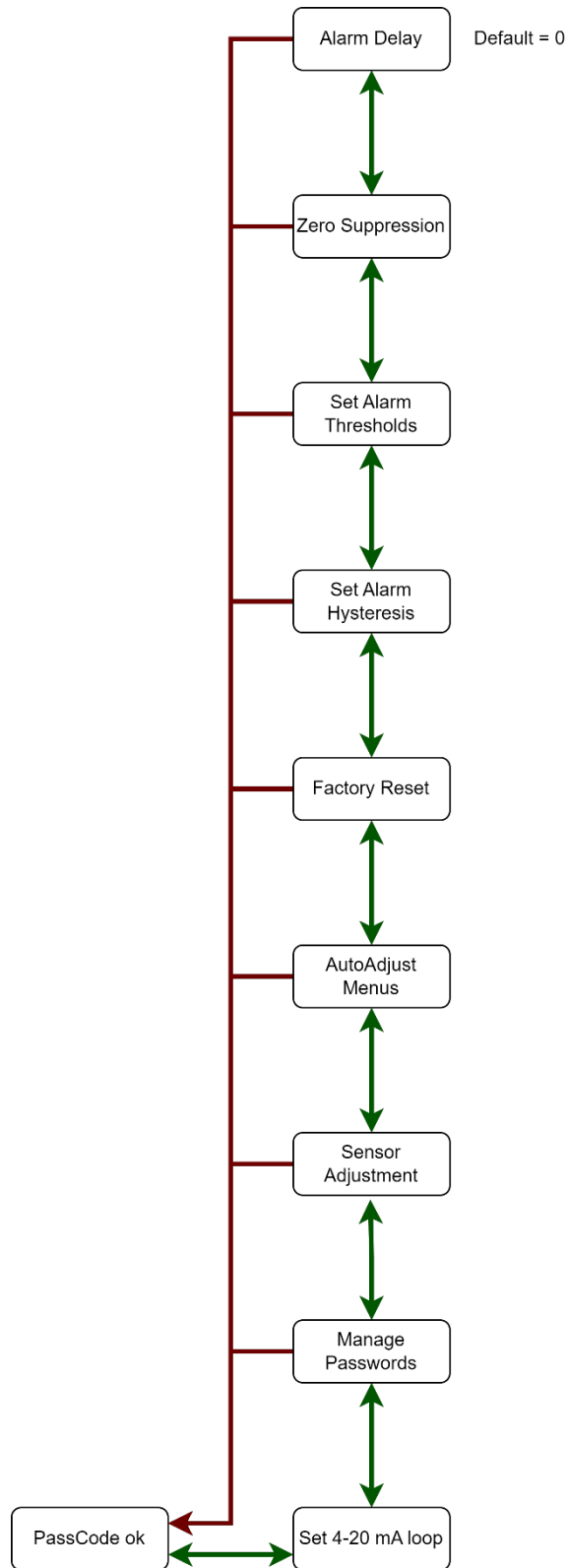
In control systems or sensors, hysteresis introduces a buffer zone of sorts, within which the system maintains its current state even as the input varies. This has the practical effect of preventing a system from overreacting to small or brief changes in the inputs.

Consider an example in an oxygen monitoring and control system where we want a valve to close when the flammable gas level drops to 14.9% and reopen when it reaches 15.5%. The implementation of hysteresis allows us to set the alarm threshold at 15.2%, with a hysteresis value of 0.3%. This means that when the oxygen level falls to 15.2%, the system will trigger the alarm, and the valve will close. However, the valve will not reopen immediately when the oxygen level rises back to 15.2%. Instead, it will wait until the oxygen level reaches the upper hysteresis limit of 15.5% (15.2% + 0.3%). This strategy prevents the valve from frequently opening and closing due to small fluctuations around the 15.2% level, ensuring more stable operation

5.11 Setting Alarm Thresholds



5.12 Setting Alarm Delay



6: Maintenance & Sensor Verification

Only qualified personnel should perform maintenance and sensor verification.

6.1 Sensor Verification

The MPS Flammable Gas Sensor is designed to operate without the need for calibration throughout its entire 15+ year lifespan, and it is highly resistant to sensor poisoning. Routine calibration is not required; however, periodic verification is recommended to ensure the system is functioning properly.

6.1.1 Sensor Verification Gas

For verifying the MPS Flammable Gas Sensor, PureAire recommends using either a standard butane source (such as a lighter) or a 50% LEL hydrogen mixture in nitrogen or air. These verification gases allow for quick and effective confirmation of the sensor's responsiveness.

6.1.2 Sensor Verification Equipment

For the verification process of the sensor, you'll require a few specific pieces of equipment:

1. Butane Source or Gas Mixture: A standard butane lighter can be used for quick checks, or for more precise verification, a 50% LEL hydrogen in nitrogen or air mixture can be applied.
2. Regulator: A regulator compatible with your chosen gas tank is necessary. In the case of a 103L lab bottle, we recommend a C10 regulator.
3. Tubing: Appropriate tubing to connect the regulator to the sensor is also required.

Remember to set your regulator to ensure a gas flow rate of 500ccs/min or 0.5LPM. This guarantees a consistent and controlled supply of gas during the verification process.

NOTE: If the instrument is connected to a controller, set the controller to standby mode to avoid accidental alarms.

6.2 Sensor Functionality Verification Procedure

CAUTION: Always adhere to all safety protocols while producing and handling flammable gases or any other oxygen-depleting or hazardous gases.

Testing the sensor and monitor's response to a flammable environment provides a quick check on their functionality. One efficient method is to apply Butane (from a lighter). The monitor reading should increase until reaching "OVR. RNG". Upon removal of the gas, the unit should recover to "SENSING." and 0%LEL.

Alternatively, you can test with a known flammable gas concentration and verify that the monitor reaches a reading within $\pm 0.2\%$ of this value. For example, using a bottle of 50% hydrogen in nitrogen balance, certified by the National Institute of Standards and Technology (NIST), should result in a monitor reading of 50% H₂.



During this verification process, check that optional features like the alarm relays and audio alarms are triggered during the alarm state and deactivate appropriately after the test.

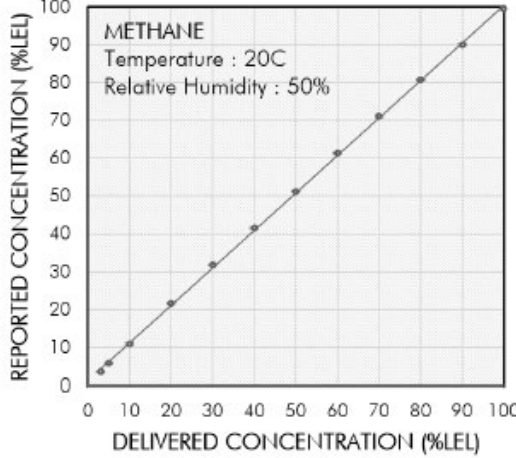
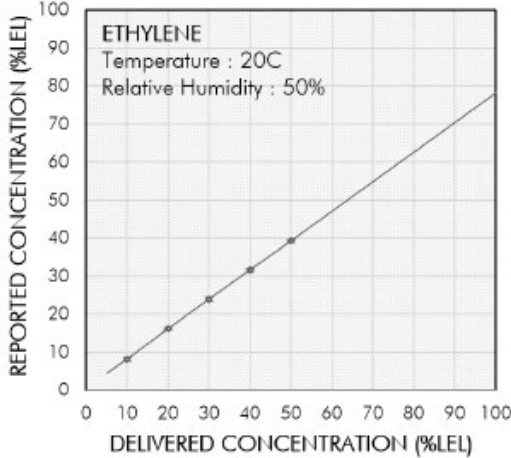
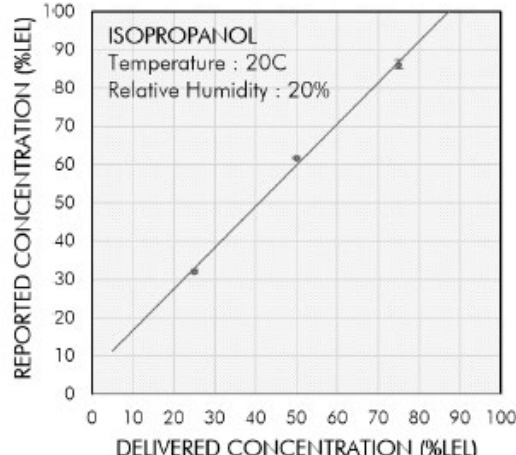
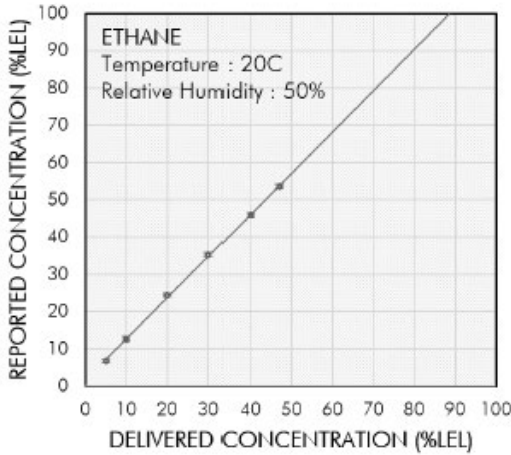
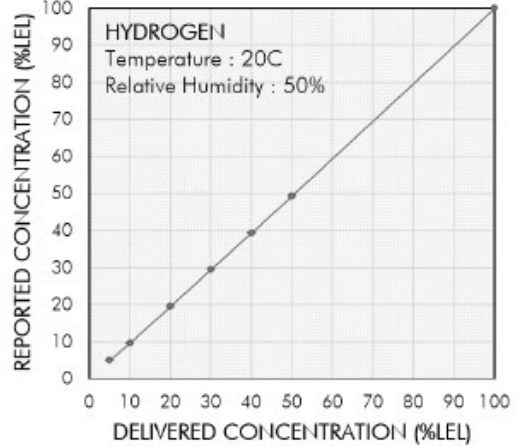
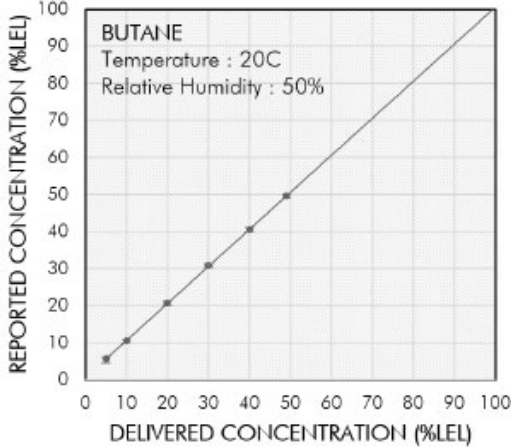
If the sensor reading deviates more than 5% from the expected value, you may need to recalibrate the monitor. If the sensor doesn't recover, or has difficulty reaching low or high percentage readings, please reach out to PureAire for more comprehensive servicing.

NOTE: It is recommended to warm up the PureAire MPS Flammable Gas Monitor for at least two hours before making any adjustments to the sensor.

Appendix A: Gas Linearity Data

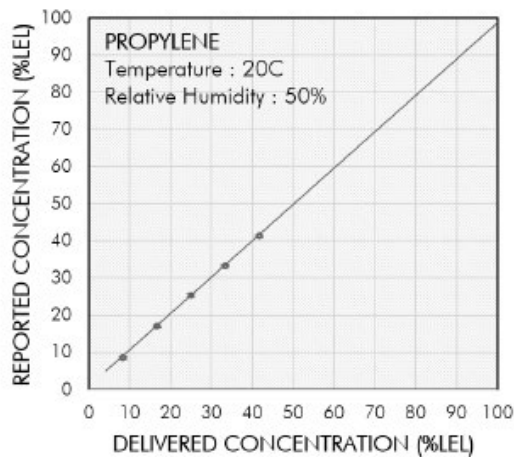
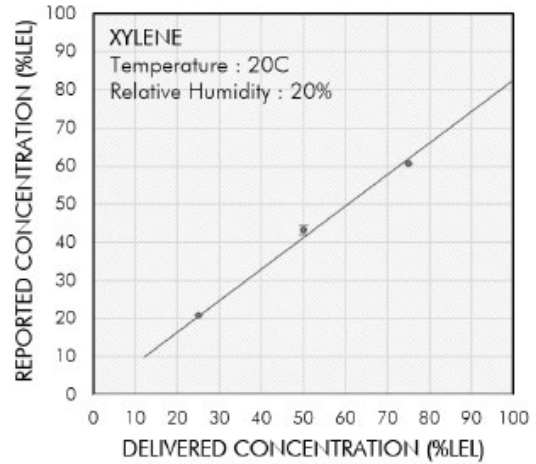
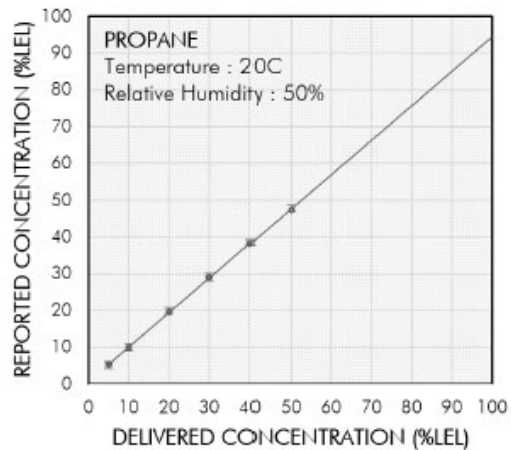
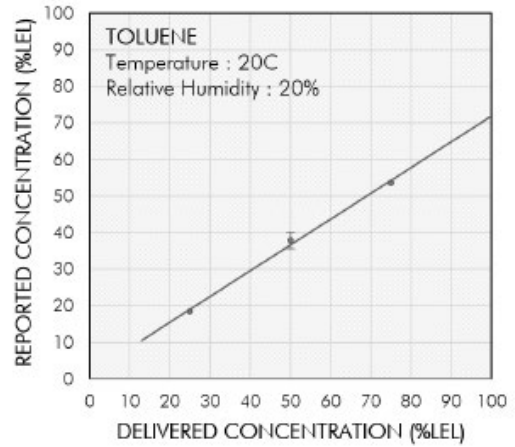
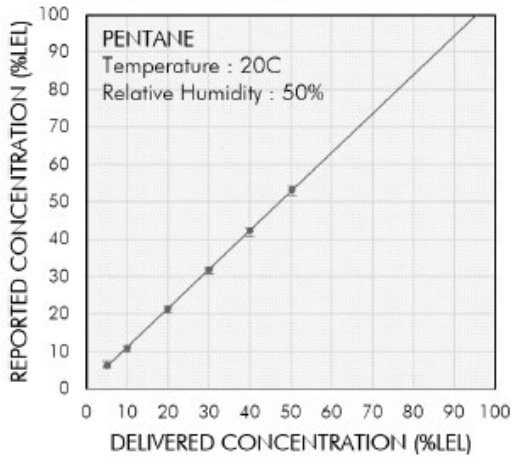
Accuracy to Representative Gases

Data points are averages of 10 sensors. Error bars indicate minimum and maximum readings. Note: all performance data provided was collected using standard, factory-calibrated MPS sensors. No recalibration for specific gases is necessary to achieve these results.



Accuracy to Representative Gases - Continued

Data points are averages of 10 sensors. Error bars indicate minimum and maximum readings. Note: all performance data provided was collected using standard, factory-calibrated MPS sensors. No recalibration for specific gases is necessary to achieve these results.



Appendix B: RS-485 Serial Data Protocol

Overview

The RS-485 communication interface for the MPS EXR Flammable Gas Monitor is a half-duplex, bidirectional system designed to provide robust data transmission. This section details the communication parameters, message structures, and command protocols for data exchange between the monitor and external control systems.

Communication Specifications

- **Interface Type:** RS-485, half-duplex
- **Connections:** +D, -D, and GND
- **Termination:** A 100-ohm termination resistor may be used for long cable lengths
- **Baud Rate:** 9600
- **Data Bits:** 8
- **Parity:** None
- **Stop Bits:** 1
- **Connection Type:** Point-to-point (no multi-drop connections)

Message Structure

The MPS EXR Monitor will transmit status information and gas readings as a 20-byte message. It can also receive commands to adjust alarm setpoints. The monitor sends data once per second and can accept commands following a strict protocol.

This message will contain 16-bit floating-point (binary16) values, following the IEEE754 standard, for the gas level, temperature, pressure, relative humidity, and absolute humidity.

Outgoing (from Monitor) Message Structure (20 bytes)

- **Start of Message:** 1 byte (01H)
- **DTM (Digital Transmitter Number):** 5 bytes
- **Gas Level (%LEL):** 2 bytes (binary16 IEEE754 format)
- **Gas Classification (0-6):** 1 byte
- **Temperature (°C):** 2 bytes (binary16 IEEE754 format)
- **Pressure (kPa):** 2 bytes (binary16 IEEE754 format)
- **Relative Humidity (%RH):** 2 bytes (binary16 IEEE754 format)
- **Absolute Humidity (g/m³):** 2 bytes (binary16 IEEE754 format)
- **Status:** 1 byte (Relay and Fault status bits)
- **Fault Mask:** 1 byte (Indicates fault conditions)
- **Checksum:** 1 byte (Two's complement of sum of previous bytes)

Details:

- **Start of Message:** 01H (fixed start byte)
- **DTM:** Unique identifier for the monitor allowing specific monitor selection
- **Gas Level, Temperature, Pressure, Relative Humidity, Absolute Humidity:** Each represented as a binary16 IEEE754 floating point-value
- **Gas Classification:** Used to indicate the detected classification of gas
 - o **00H:** No Gas Detected/Sensing
 - o **01H:** Hydrogen
 - o **02H:** Hydrogen Mix
 - o **03H:** Methane/Natural Gas
 - o **04H:** Light/Lite Gas (C1-4 gases, e.g., Propane, Butane)
 - o **05H:** Medium/Med Gas (C2-8 gases, e.g., Acetone, MEK, Pentane)
 - o **06H:** Heavy/Hvy Gas (C6+ gases, e.g., Toluene, Styrene, Octane)
 - o **Other:** Overrange/Error
- **Status:** Bits used to indicate the activation of relays and alarm states
 - o **Bit 0:** Relay 2
 - o **Bit 1:** Relay 1
 - o **Bit 3:** Fault Relay
 - o **Bits 3, 4, 5, 6, 7:** Not Used
- **Fault:** Provides information on any existing faults
 - o **Bits 0 and 1:** Not Used
 - o **Bit 2:** Monitor in warmup mode
 - o **Bit 3:** EEPROM checksum fault
 - o **Bit 4:** Power supply voltage out of range
 - o **Bit 5:** Not Used
 - o **Bit 6:** Sensor supply voltage out of range
 - o **Bit 7:** Sensor supply current out of range
- **Checksum:** Two's complement of the sum of previous bytes

Incoming (to Monitor) Command Structure

Hex Code	ASCII	Command ID	Request Packet				Payload Type
			Start Message	Cmd ID	Payload*	Calculated Checksum‡	
0x31	1	AL1 Setpoint	0x01	0x31	0x14	0xBA	Integer 0-100
0x32	2	AL2 Setpoint	0x01	0x32	0x28	0xA5	
0x33	3	AL1 Polarity	0x01	0x33	0x49	0x83	ASCII 'I' or 'N'
0x34	4	AL2 Polarity	0x01	0x34	0x4E	0x7D	
0x35	5	AL1 Format	0x01	0x35	0x49	0x81	
0x36	6	AL2 Format	0x01	0x36	0x49	0x80	
0x37	7	FLT Format	0x01	0x37	0x4E	0x7A	Integer 0-50
0x38	8	AL1 Hysteresis	0x01	0x38	0x00	0xC7	
0x39	9	AL2 Hysteresis	0x01	0x39	0x00	0xC6	ASCII 'L' or 'N'
0x41	A	AL1 Latching	0x01	0x41	0x4C	0xBE	
0x42	B	AL2 Latching	0x01	0x42	0x4E	0x6F	Integer 0-255
0x44	D	Alarm Delay	0x01	0x44	0x05	0xB6	

*Example payloads only

‡Checksums calculated using examples shown in this table. Refer to checksum calculation for other payload values.

Note: If Command ID is not recognized, the Payload is incorrectly formatted, or if the Checksum is not correctly verified, a negative acknowledgment (NAK) will be sent, and no changes will be made to the monitor.

ASCII	Hex
I	0x49
L	0x4C
N	0x4E

Checksum Calculation

```

1. # Calculating the checksum for the new array <01, 44, 05>.
2.
3. # Provided array <01, wx, yz> in hexadecimal format
4. data = [0x01, 0x44, 0x05]
5.
6. # Step 1: Sum the first three elements
7. sum_of_elements = sum(data)
8.
9. # Step 2: Take the one's complement (invert bits)
10. ones_complement = ~sum_of_elements
11.
12. # Step 3: Add 1 to complete the two's complement
13. checksum = (ones_complement + 1) & 0xFF # Ensure it stays within 0-255 range
14.
15. print (sum_of_elements, ones_complement, checksum)

```

Error Handling and Acknowledgements

- **Acknowledgement (ACK):** 06H — Sent by the monitor when a command is successfully completed.
- **Negative Acknowledgement (NAK):** 15H — Sent if the command fails or is not received correctly.
- **Response Time:** Commands should be sent within 500ms of receiving an outgoing message to prevent collisions.