# PureAire Monitoring Systems
# Explosion Proof Universal (EPU) Gas Monitors

**Instruction Manual**

For models/series
EPU-MPS (980--)
EPU-EC (981--)
EPU-PEL (982--)
EPU-NDIR (983--)
EPU-PID (984--)

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Rev 1.10 August 31, 2026

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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 (224) 443-5445. 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**
**CEO**

**Notices**

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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.

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# 1: Introduction

The PureAire Explosion Proof Universal (EPU) Gas Monitors are advanced, durable instruments engineered for the continuous monitoring of flammable gases, toxic gases, refrigerants, volatile organic compounds (VOCs), and other hazardous substances. Designed for use in areas classified as hazardous or potentially explosive, the EPU series ensures reliable performance even in challenging and harsh environmental conditions. Each monitor is enclosed in a robust, explosion-proof housing compliant with stringent safety standards, including Class I Division 1&2 Groups B, C, D, Class II Groups E, F, G, Class III, NEMA 4X, and IP66 protection levels.

All EPU models feature common state-of-the-art electronics and a user-friendly, non-intrusive magnetic wand (Hall-effect) interface, enabling safe access to menus and settings without the need to open the explosion-proof enclosure. This approach significantly enhances user safety in explosion-risk environments.

PureAire's EPU series provides flexibility through its universal design, allowing multiple sensor technologies to be incorporated into a standardized platform. Sensor selection is based on application specific needs, and each sensor offers distinct performance characteristics, lifespan, calibration requirements, and operational features.

## 1.1 Universal Features of EPU Gas Monitors

The Explosion Proof Universal (EPU) 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 Explosion-Proof Enclosure

Heavy-duty, explosion-proof construction compliant with Class I Div 1&2 Groups B, C, D, Class II Groups E, F, G, Class III, and NEMA 4X standards ensures safe operation in hazardous environments.

### 1.1.2 Smart Electronics

Advanced electronic circuitry continuously monitors the status of the sensor cell and associated electronics, promptly identifying sensor degradation or failure and communicating faults via relay outputs and signal outputs.

### 1.1.3 Flexible Integration

The common electronic architecture allows easy integration with a variety of sensor technologies, providing tailored solutions for diverse gas detection requirements.

### 1.1.4 Reliable Signal Outputs

Includes standard 4-20 mA analog output, dual-level user-configurable alarm relays, and fault relay outputs. Standard RS-485 communication ensures easy integration into existing safety management systems.

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### 1.1.5 Factory Calibration & Minimal Maintenance

All monitors ship factory calibrated, and feature streamlined maintenance routines, enhancing uptime and reducing lifecycle costs. Sensor-specific calibration and verification requirements vary and are detailed in subsequent sections.

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

## 1.2 Overview of Sensor Technologies in EPU Series

### 1.2.1 MPS (Molecular Property Spectrometry) Sensor (99214/980--)

- **Application:** Flammable gases detection with TrueLEL™ accuracy, ideal for safety-critical applications.
- **Technology:** Advanced MEMS-based molecular property spectrometry by NevadaNano.
- **Lifespan & Calibration:** 15+ years lifespan, calibration-free operation over the entire lifetime, built-in environmental compensation ensures reliability across varying temperature, humidity, and pressure ranges.

### 1.2.2 EC (Electrochemical) Sensor (981--)

- **Application:** Detection of toxic gases in the PPM/PPB ranges, suitable for process monitoring.
- **Technology:** Electrochemical cells from Alphasense.
- **Lifespan & Calibration:** 3-5 years lifespan depending on environmental conditions; annual calibration recommended. Sensors are field-replaceable.

### 1.2.3 PEL (Pellistor) Sensor (982--)

- **Application:** Traditional industry-standard for %LEL detection of combustible gases in environments where MPS may not be optimal.
- **Technology:** Catalytic bead sensor from N.E.T. Sensors, Italy.
- **Lifespan & Calibration:** 3-5 years lifespan; annual calibration recommended; accuracy depended on cross-factor calibration.

### 1.2.4 NDIR (Non-Dispersive Infrared) Sensor (983--)

- **Application:** Monitoring refrigerants (R- gases), toxic gases such as SF6, and others requiring infrared detection methods.
- **Technology:** Infrared gas sensing for stable, long-term operation.
- **Lifespan & Calibration:** 5+ years typical lifespan, recommended yearly calibration.

### 1.2.5 PID (Photoionization Detector) Sensor (984--)

- **Application:** Detection of volatile organic compounds (VOCs) and certain particulate hazards.
- **Technology:** PID sensors provide rapid response and sensitivity to VOC presence.
- **Lifespan & Calibration:** 5+ year lifespan, yearly calibration is recommended.

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## 1.3 Purpose of This Manual

This manual provides comprehensive guidance for installing, operating, and maintaining the PureAire Explosion Proof Universal Gas Monitors across various sensor technologies. It covers general guidelines, sensor-specific details, and specifications. For optimal monitor performance, ensure you carefully follow instructions regarding sensor-specific calibration, maintenance intervals, and operating procedures provided in the corresponding sections.

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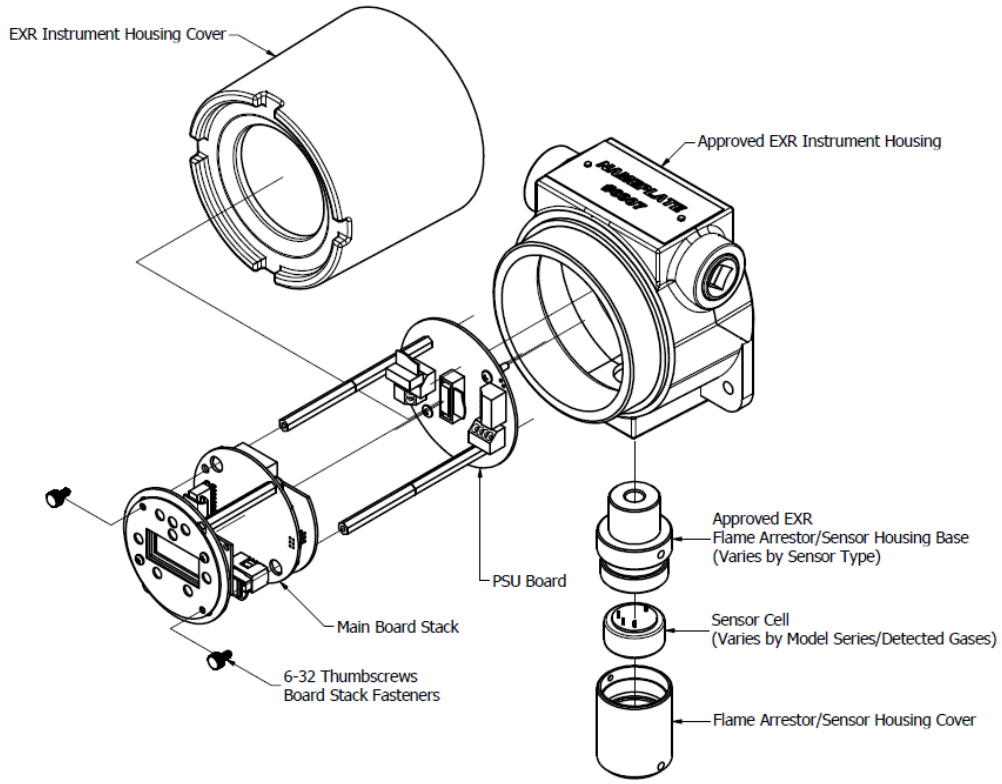
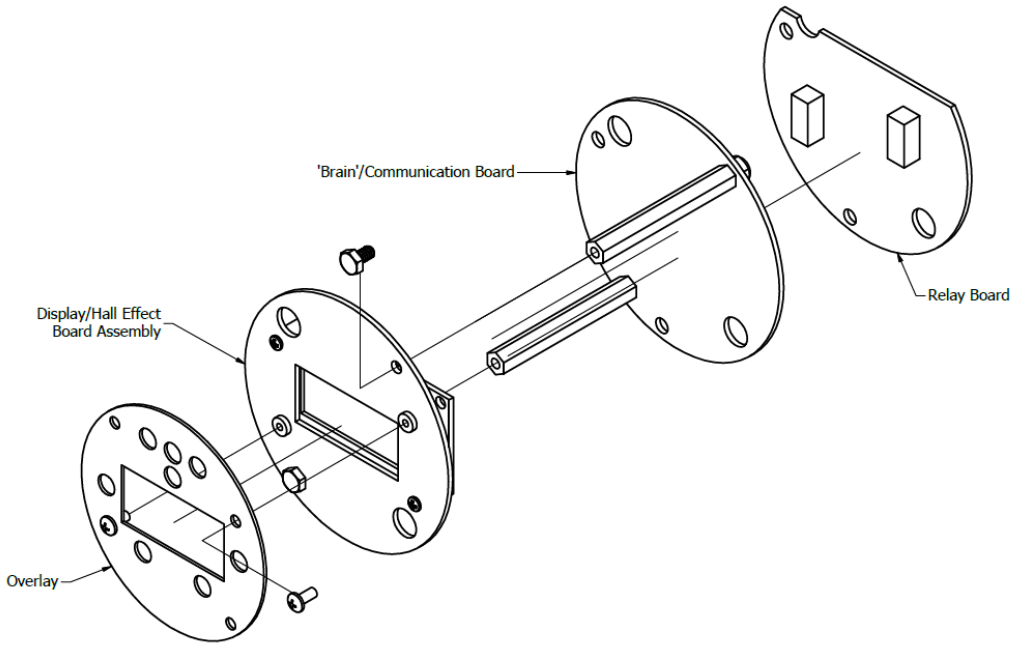
## 1.4 Component Identification

### 1.4.1 Major Component Overview




### 1.4.2 Main Board Stack Overview

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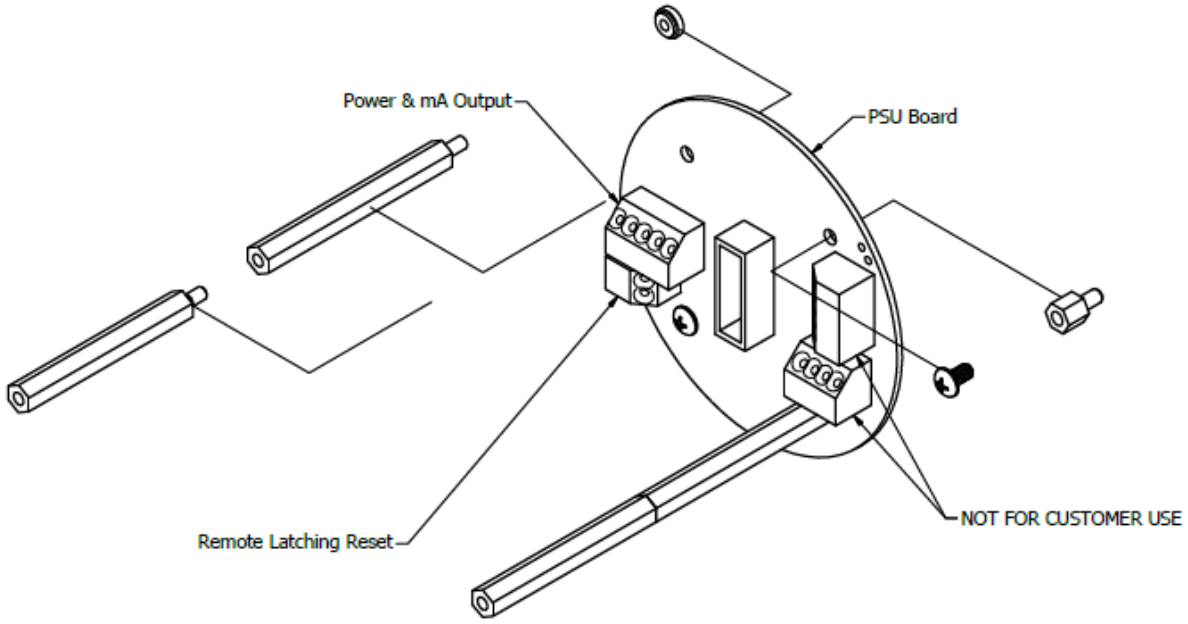
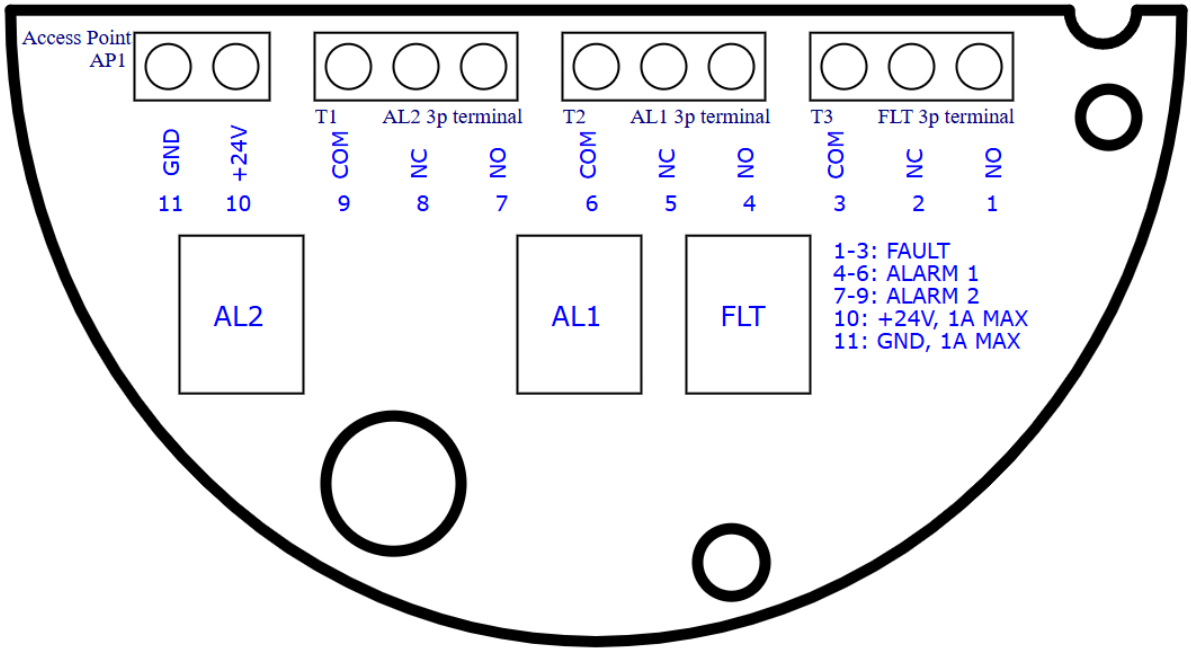
### 1.4.3 Power Supply (PSU) Board Assembly




### 1.4.4 Relay Board




COM: Common
NC: Normally Closed
NO: Normally Open

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# 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<br>Hydrogen ($H_2$): ±5% LEL<br>Other gases: Varies (see specific gas accuracy in datasheet) | |
| Fault Indicators: | Loss of VDC power (analog signal drops to 0 mA).<br>Sensor cell failure: Fault relay activated. | |
| Operating Cond.: | -40° to +167°F (-40° to +75°C)<br>0 to 100% RH | |
| Sensor Type: | Electrochemical (EC) Sensor. | PPM/PPB Ranges |
| Response Time: | < 60 seconds (T50) | |
| Accuracy: | Varies (see specific gas accuracy in datasheet) | |
| Operating Cond.: | -4°F to +122°F (-20° to +50°C)<br>80 to 120 kPa<br>15 to 90% RH | |
| Storage Period: | 6 months @ 3 to 20°C (stored in sealed pot) | |
| Sensor Type: | Pellistor (PEL) Sensor. | Linear: 0-60% LEL,<br>Nonlinear: 60-100% LEL |
| Response Time: | < 20 seconds (T90) | |
| Accuracy: | ±1% LEL (CH4); Varies by gas (see specific gas accuracy in datasheet) | |
| Operating Cond.: | +40°F to +302°F (-40°C to +150°C)<br>0 to 95% RH noncondensing | |
| Sensor Type: | Non-Dispersive Infrared (NDIR) Sensor. | Various Ranges |
| Response Time: | < 30 seconds (T50); < 60 seconds (T90) | |
| Accuracy: | Varies (see specific gas accuracy in datasheet) | |
| Operating Cond.: | +32°F to +122°F (0° to +50°C)<br>80 to 120 kPa<br>0 to 95% RH noncondensing | |
| Sensor Type: | Photoionization Detector (PID) Sensor. | Various Ranges |
| Response Time: | < 10 seconds (T50); < 30 seconds (T90) | |
| Accuracy: | Varies (see specific gas accuracy in datasheet) | |
| Operating Cond.: | -40° to +131°F (-40° to +55°C)<br>80 to 120 kPa<br>15 to 95% RH noncondensing | |

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## 2.2 Certifications and Standards

### 2.2.1 Explosion Proof Enclosure Certifications

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

#### 2.2.1.1 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 |

#### 2.2.1.2 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 |

#### 2.2.1.3 UL

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

#### 2.2.1.4 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.

### 2.2.2 Flame Arrestor Certifications

| | |
|---|---|
| Manufacturer: | Dynament LTD, Mansfield, UK |
| Model: | GSH-Series housing |
| Temperature: | -20°C to +60°C |

#### 2.2.2.1 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 |

#### 2.2.2.2 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 |

#### 2.2.2.3 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)<br>2012/19/EU: Waste Electrical and Electronic Equipment (WEEE)<br>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<br>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 |

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## 2.3 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 Standard. |
| Relay Output: | Includes dual-level user-selectable alarm relays and one fault relay, all rated at ≤ 2amps @ ≤ 24VDC. |

## 2.4 Electrical Requirements

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

## 2.5 Physical Characteristics

| | |
|---|---|
| Dimensions: | 5.125 (W) x 8.00 (H) x 6.40 (D) inches; 130 x 200 x 160 mm (Max w/ feet) |
| Weight: | 6.5 pounds (3 kg) |
| Enclosure Type: | Approved Instrument Housing; For use in Hazard locations as to **Explosion and Fire Hazard ONLY**. |

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## 2.6 Default Factory Settings

The PureAire Explosion Proof Universal (EPU) Gas 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<br>Alarm 2 = Normal<br>Fault = Normal | When alarm activates, the relays should energize (Normal), or de-energize (Inverted) |
| **Set Polarity†** | Alarm 1 = Normal<br>Alarm 2 = Normal | Alarm should activate above specified concentration (Normal), or when lower (Inverted) than the alarm thresholds |
| **Set Latching†** | Alarm 1 = Non-latching<br>Alarm 2 = 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%<br>Alarm 2 = 40% | Alarm levels |
| **Set Alarm Hysteresis†** | Alarm 1 = 0.0%<br>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.

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# 3: Installation

## 3.1 Site Requirements

The PureAire Explosion Proof Universal (EPU) Gas 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 $ft^2$. This coverage is approximately a circle with a radius of around 15 ft, assuming an ideal and uniform gas dispersion in an open space.

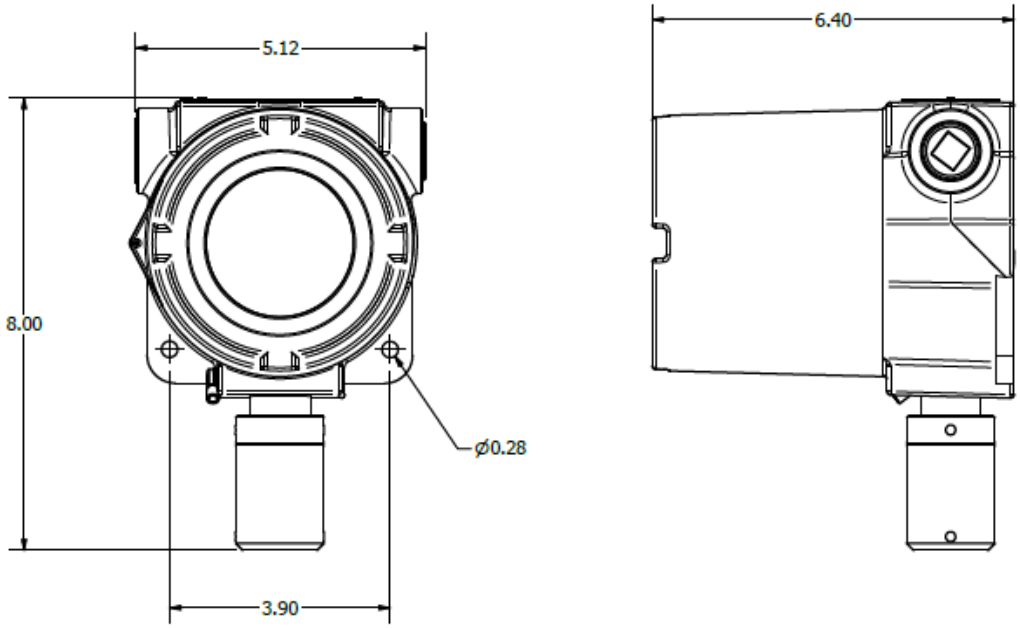
For optimal safety and effectiveness, the EPU Gas Monitor should ideally be situated as close as possible to potential leak sources, such as gas lines, gas cylinders, or other areas prone to gas leaks. While the monitor should not be placed more than 21 ft away from these potential leak points, positioning 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.

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### 3.2.2 Installation Guidance

The EPU 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.**

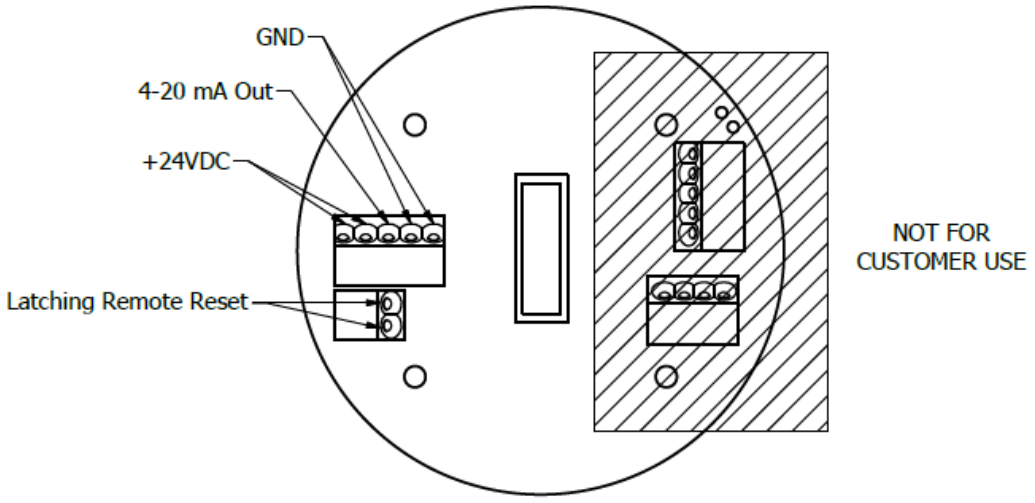
## 3.3 Wiring

The EPU 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.

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# 4: Normal Operation

The EPU monitor is a single point monitor designed for the continuous detection and measurement of flammable and toxic gas concentration levels in ambient air.

## 4.1 Signal Outputs

The EPU monitor consistently outputs an analog signal ranging from 4-20 mA, corresponding directly to the measured flammable or toxic gas concentration. A 4-mA output signifies 0% of the full range, while a 20-mA output denotes 100% of 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 EPU 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±0.5VDC. 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 the target 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.

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During normal operation, the unit should be outputting a 4-mA signal when the flammable gas level is at 0% of the full scale. The LCD digital display should also indicate ‘00’ 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 EPU 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 gas levels must return to under alarm thresholds.

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# 5: Monitor Programming

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

The PureAire EPU 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 EPU monitor will keep monitoring 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 EPU 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.

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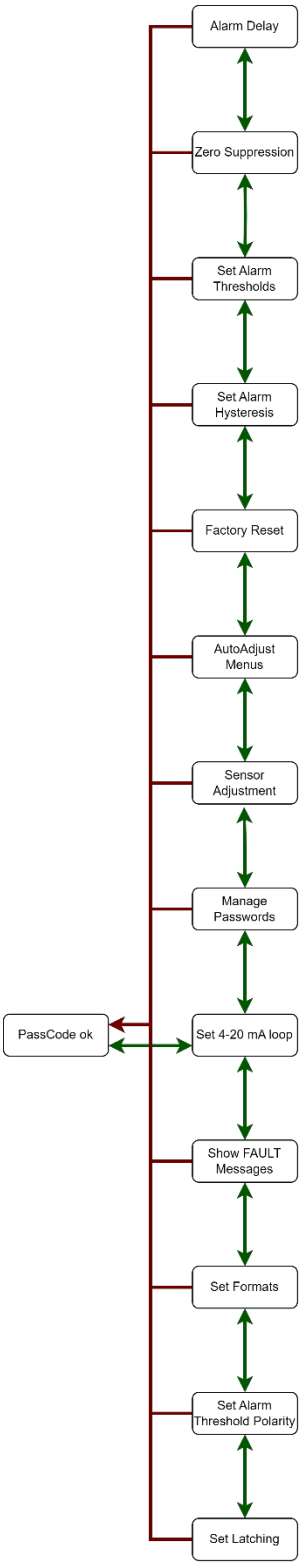
## 5.2 Overall Program Flowchart




### 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.

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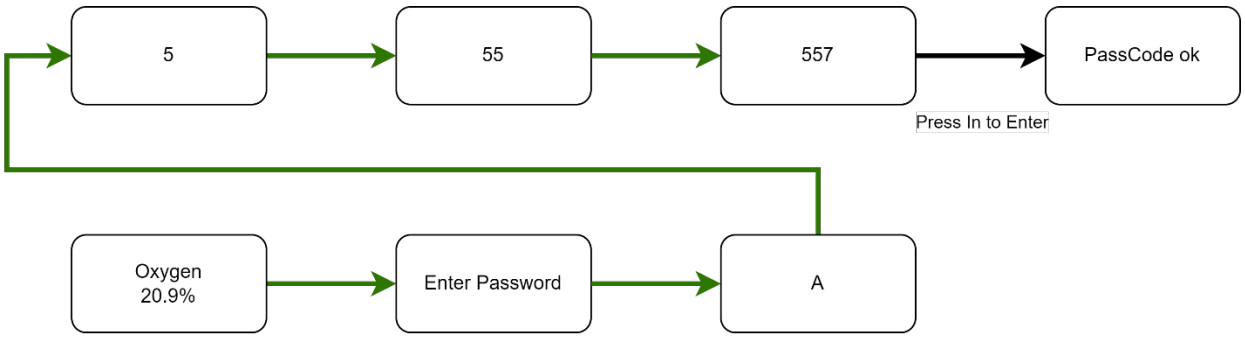
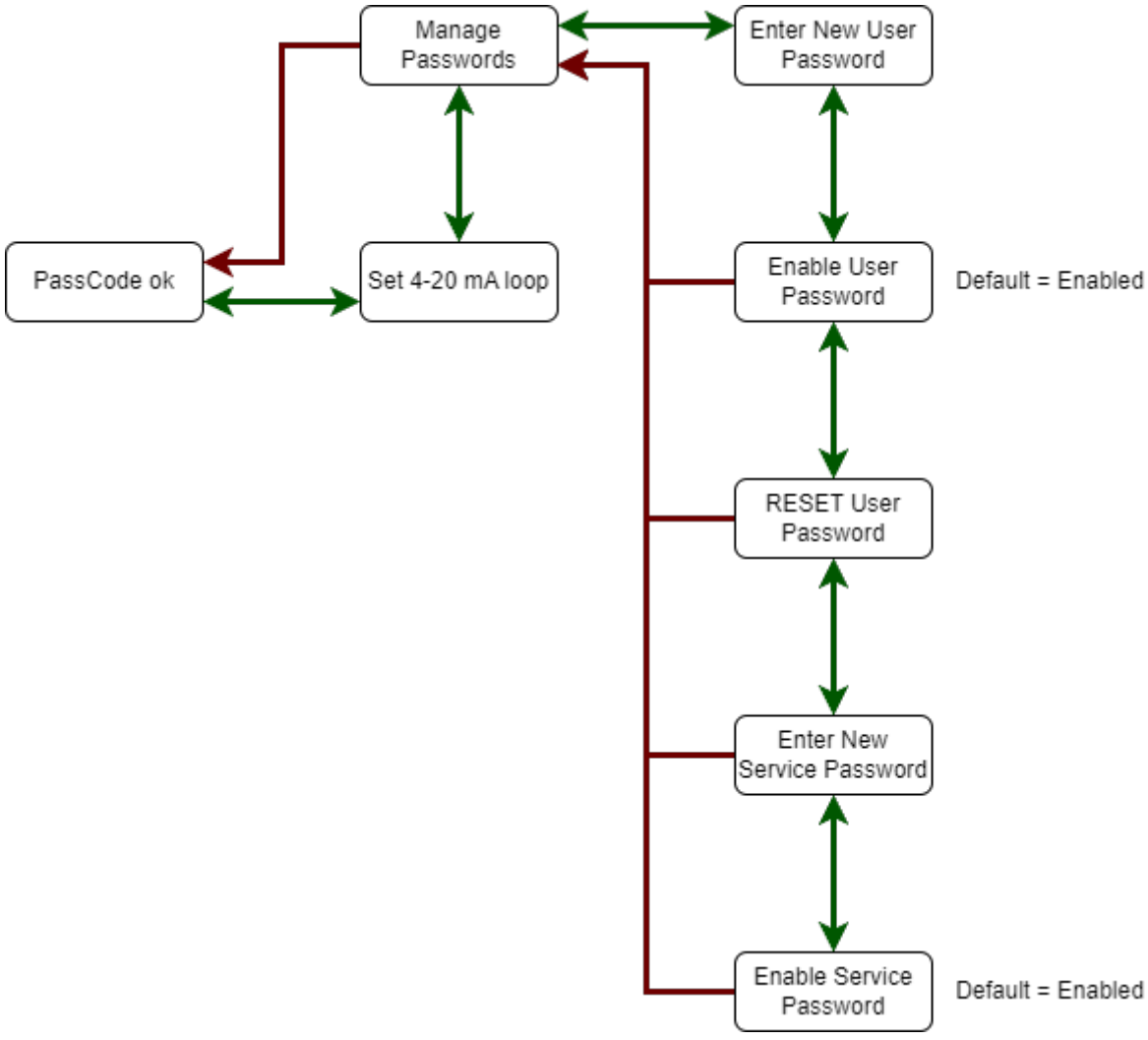
## 5.3 Entering Password




## 5.4 Changing the User Password

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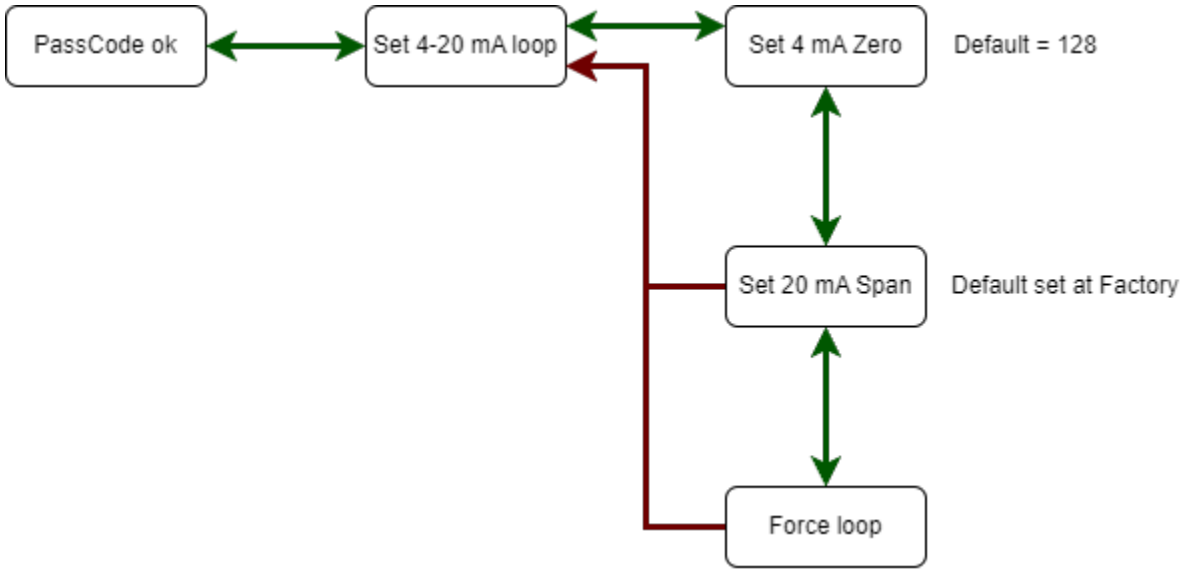
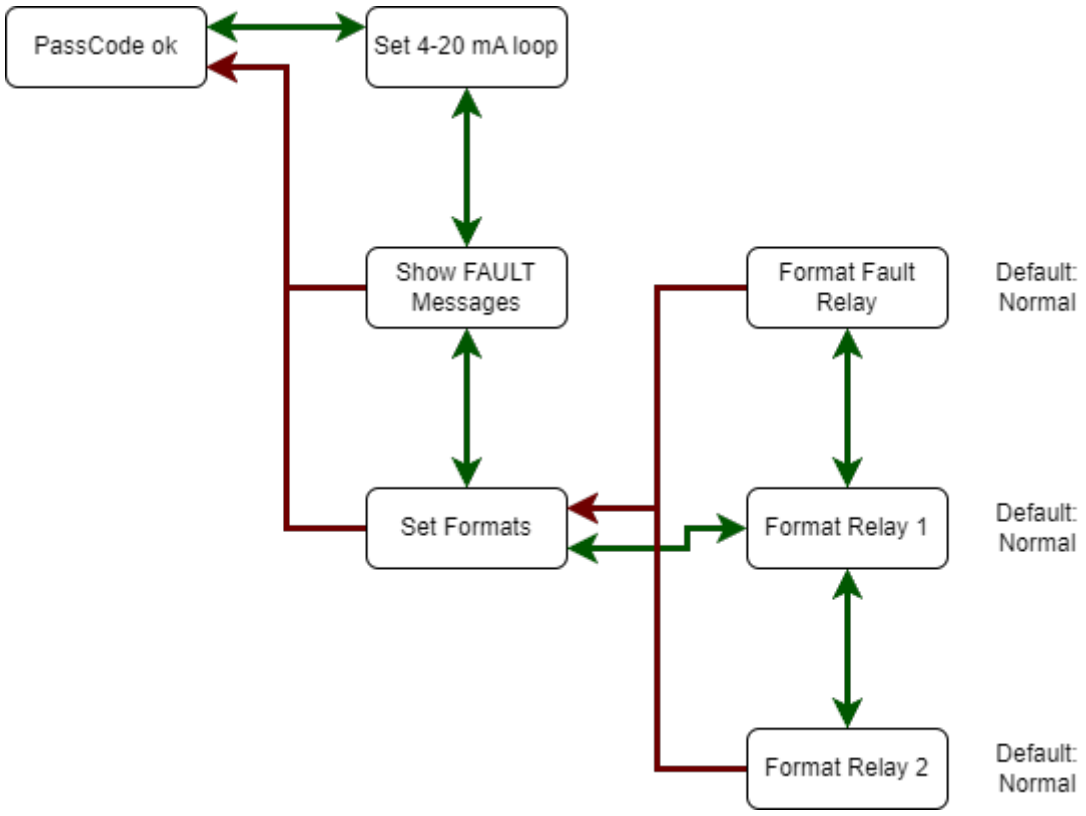
## 5.5 Setting 4-20mA Loop




## 5.6 Setting Relay Formats

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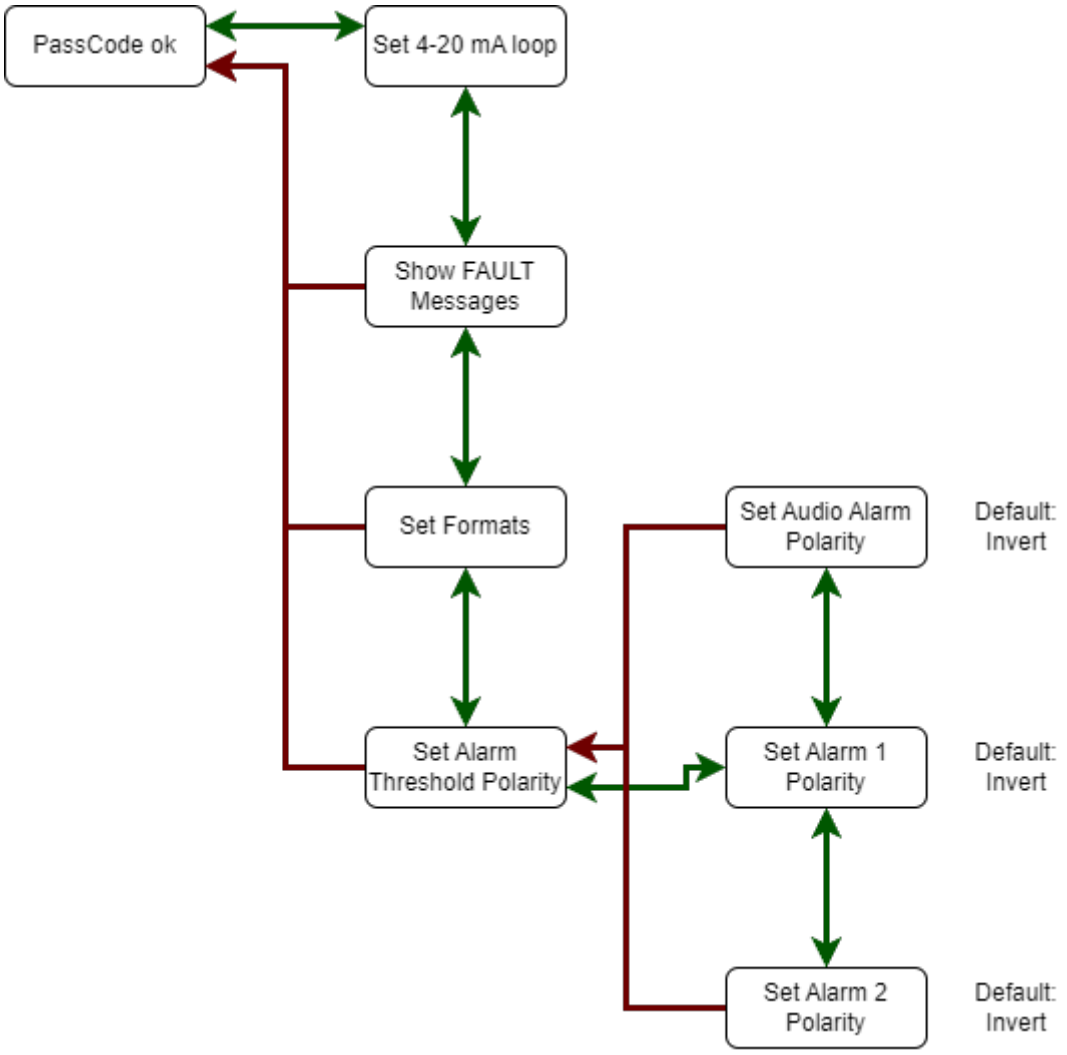
## 5.7 Setting Alarm Polarity

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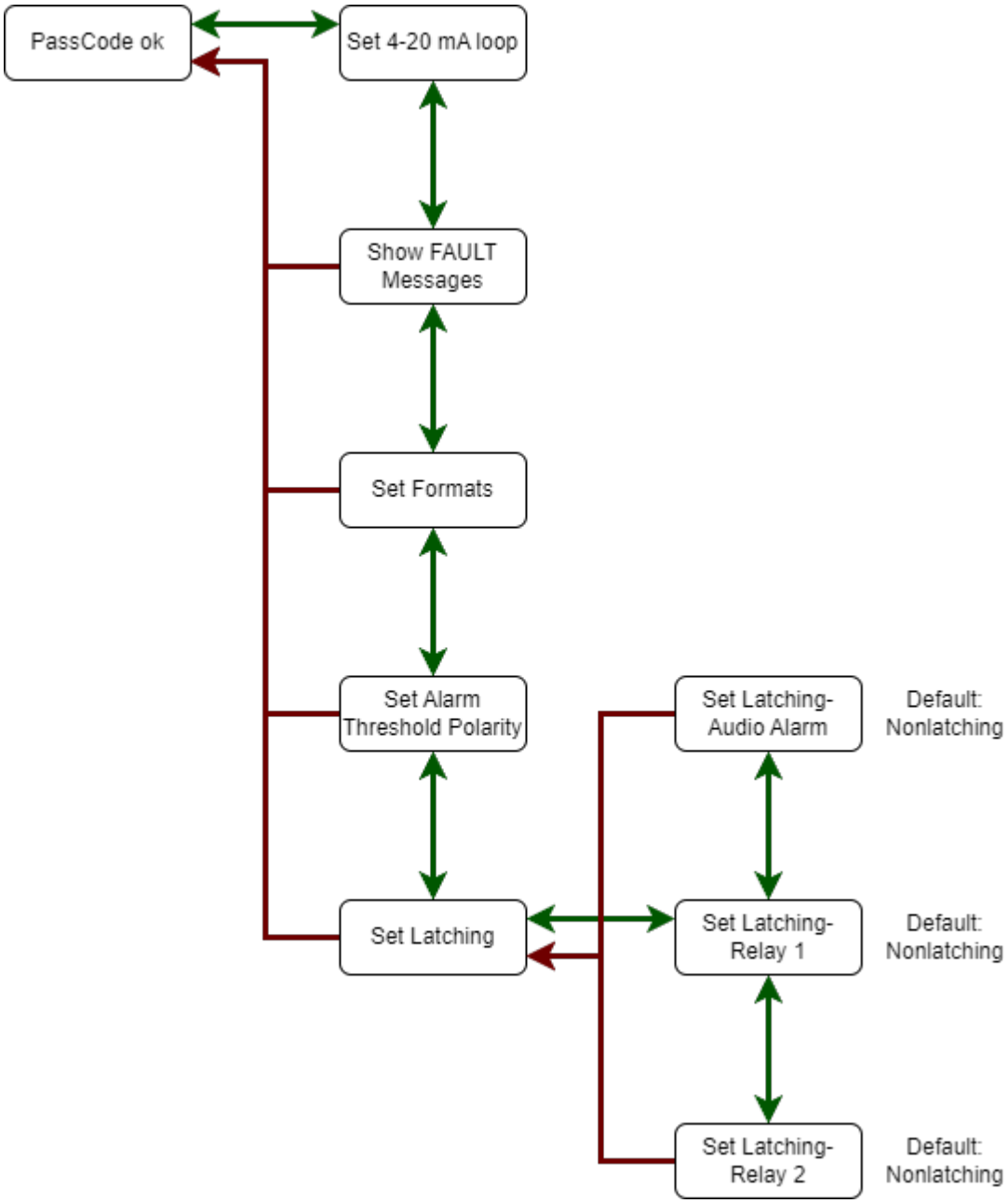
## 5.8 Setting Alarm Latching

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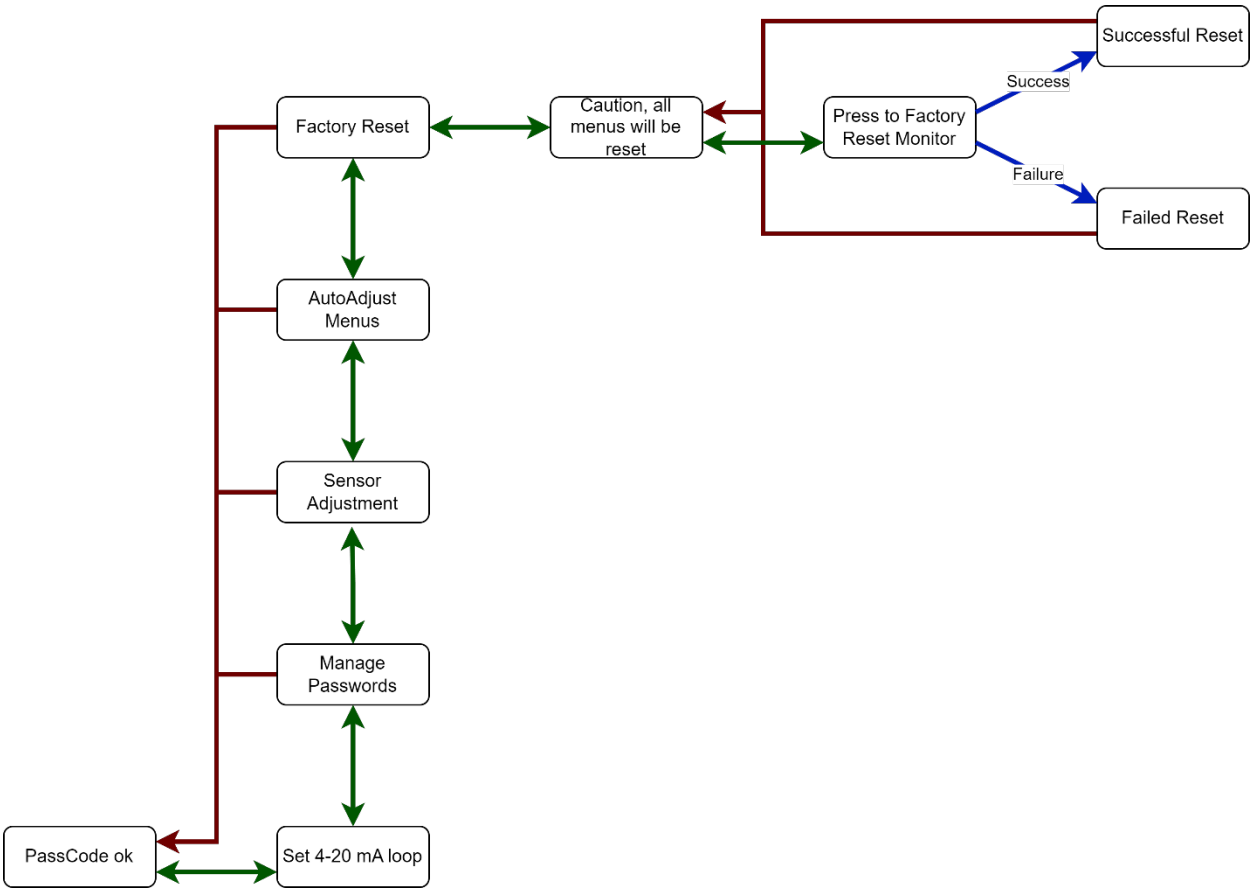
## 5.9 Factory Reset Menus




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

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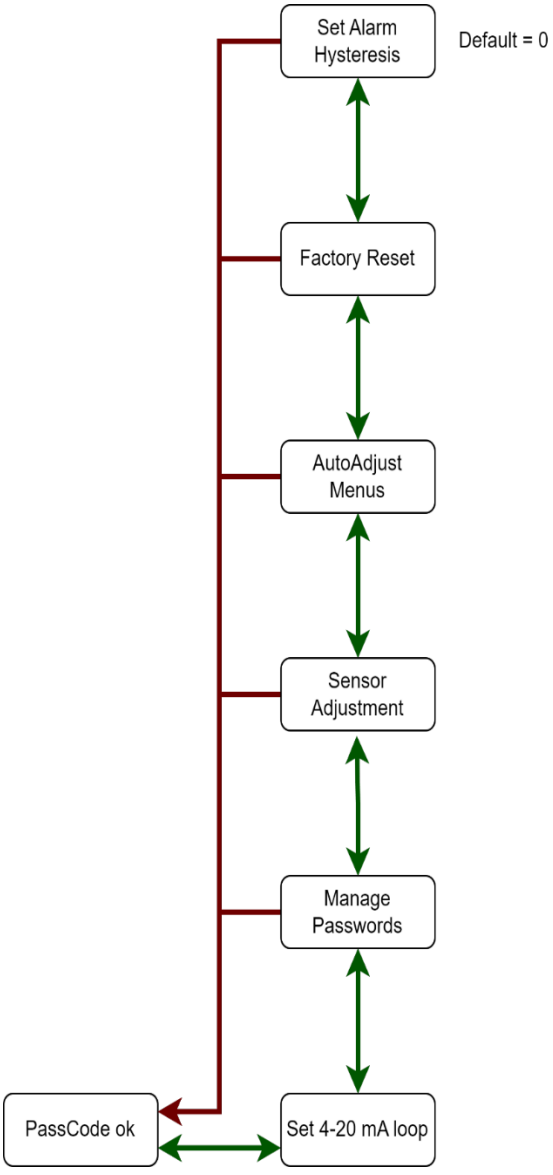
## 5.10 Setting Alarm Hysteresis




### 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

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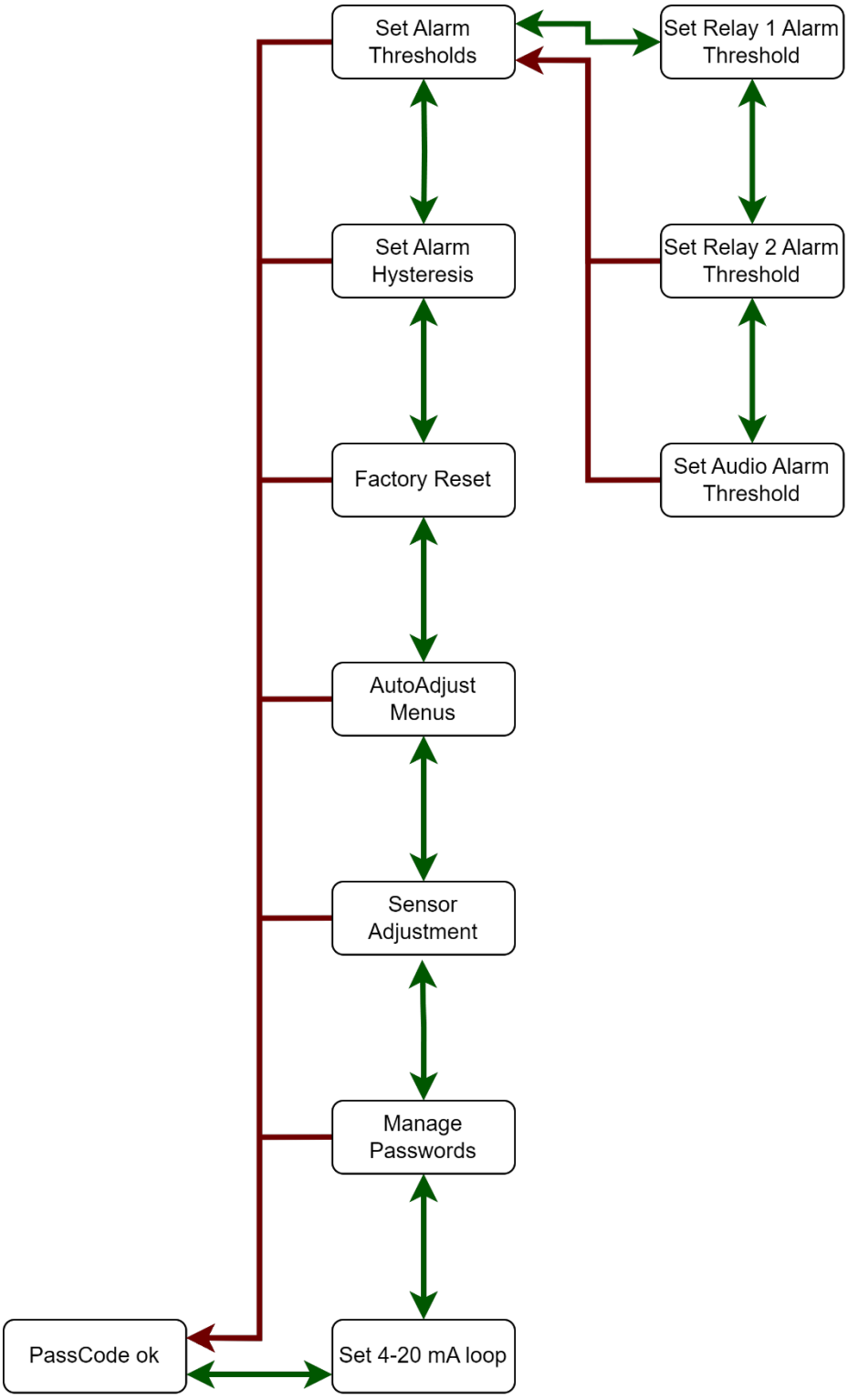
## 5.11 Setting Alarm Thresholds

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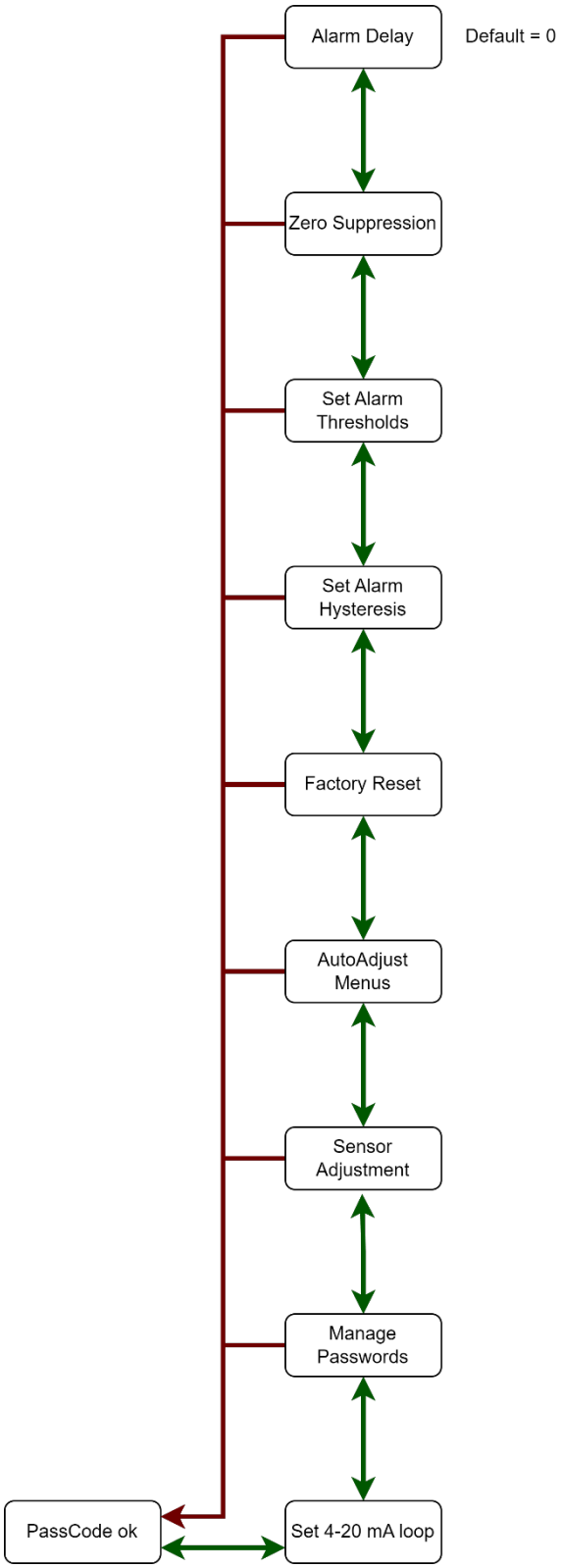
## 5.12 Setting Alarm Delay

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# 6: Maintenance & Sensor Verification

*Only qualified personnel should perform maintenance and sensor verification.*

## 6.1 General Guidelines

All Explosion Proof Universal (EPU) Gas Monitors are designed for high reliability, but periodic verification of sensor functionality is recommended to ensure continuous optimal performance and safety compliance.

While the EPU Gas Monitor's electronics require minimal maintenance, sensor cells have different lifespans, calibration intervals, and verification requirements. Please refer to your specific sensor type listed below for guidance.

### 6.1.1 EPU-MPS Sensor

The Molecular Property Spectrometry (MPS) sensor is designed for long-term operation (15+ years) without routine calibration. Periodic sensor verification every 12 months is recommended to ensure continued responsiveness.

- Verification Gas: Standard butane lighter or 50% LEL hydrogen or methane mixture.
- Equipment Required: Standard butane lighter or regulated gas supply (e.g., 50% LEL hydrogen mixture), regulator, and tubing.
- Recommended Gas Flow Rate: 500cc/min (0.5LPM).

### 6.1.2 EPU-EC Sensor

Electrochemical (EC) sensors require periodic calibration, typically annually. Verification involves applying a known concentration of the target toxic gas (ppm/ppb range).

- Required Equipment: Certified gas cylinder specific to the gas monitored, compatible regulator, and tubing.
- Recommended Gas Flow Rate: Refer to sensor datasheet (typically 250cc/min).

### 6.1.3 EPU-PEL Sensor

The Pellistor (PEL) sensor typically has a 3–5-year lifespan depending on usage conditions. Annual calibration is required using specific calibration gases with cross-factors clearly indicated in the sensor datasheet.

- Recommended Gas Flow Rate: 500cc/min (0.5LPM).

### 6.1.4 EPU-NDIR Sensor

The Non-Dispersive Infrared (NDIR) sensors have a lifespan of approximately 5+ years. Annual calibration is recommended using a known reference gas for the specific refrigerant or toxic gas being detected.

- Recommended Gas Flow Rate: Refer to sensor datasheet (typically 500cc/min).

### 6.1.5 EPU-PID Sensor

The Photoionization Detector (PID) sensor typically has a 5+ year lifespan and detects volatile organic compounds (VOCs). Calibration is recommended annually or more frequently based on environmental conditions, using certified calibration gases specific to the VOCs of concern.

- Recommended Gas Flow Rate: Refer to sensor datasheet (typically 500cc/min).

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## 6.2 General Sensor Functionality Verification Procedure

CAUTION: Always adhere strictly to all safety protocols when handling hazardous, toxic, or flammable gases.

Sensor functionality verification generally involves applying a known concentration of the target gas or using a verification gas to confirm sensor responsiveness:

1. Introduce the verification gas at the recommended flow rate.
2. Observe that the monitor reading appropriately increases in response to the introduced gas.
3. Ensure the sensor reading returns to baseline after removal of the verification gas.
4. Verify optional features such as analog outputs, alarm relays, and any attached components trigger during alarm states and reset upon returning to safe conditions.

If the sensor reading deviates beyond acceptable limits (typically ±5%), recalibration or cell replacement may be necessary. If issues persist, consult PureAire for detailed servicing instructions

CAUTION: Always adhere strictly to safety protocols when handling calibration gases or hazardous materials.

For sensor-specific details, calibration gases, and exact procedures, please refer to the appendices and related documents dedicated to each sensor technology.

**NOTE**: It is recommended to warm up the PureAire Explosion Proof Universal Gas Monitor for at least two hours before making any adjustments to the sensor.

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# Appendix A — EPU-MPS

The **Molecular Property Spectrometer (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 designed to be robust, and highly resistant to poisoning, making it extremely reliable for long-term use in various environments.

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.

## A.1 MPS — Detected Gases, Displayed Classes, & Verified Accuracy

| 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 |
| | | | | Butane | C4H10 | 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 | | | | | |

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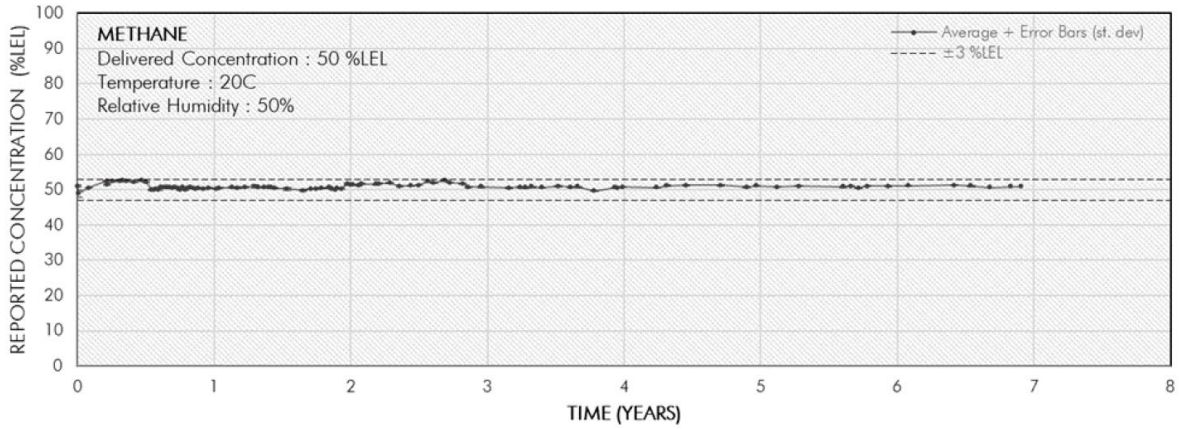
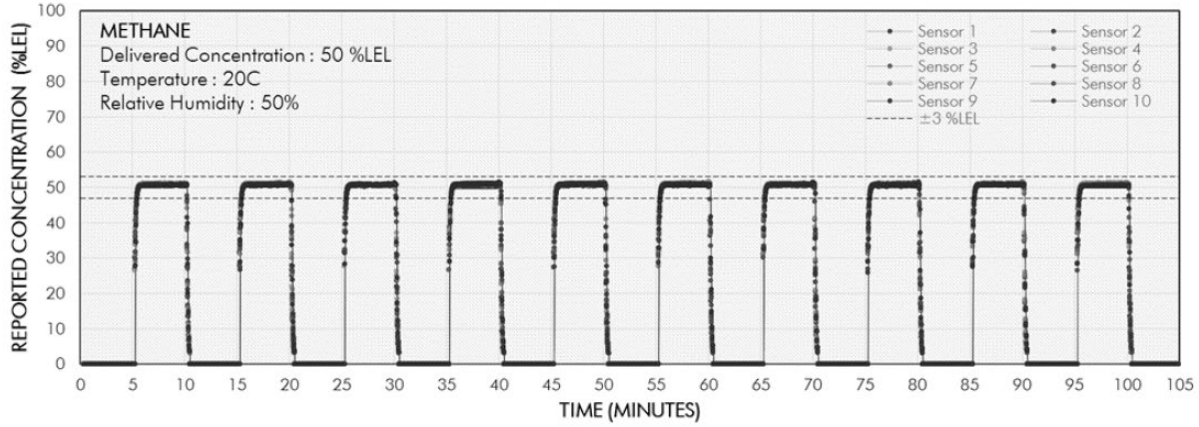
# A.2 MPS — Typical Gas Performance Characteristics

## A.2.1 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.

## A.2.2 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 |

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## A.3 MPS — All Detectable Gases

The table below outlines all gases detectable by the Molecular Property Spectrometer (MPS™). Although the MPS sensor can detect a broad range of flammable gases, not all exhibit the consistent accuracy across various environmental conditions required for inclusion in the primary verified accuracy list (Section A.1).

Gases listed under "Variable Accuracy" have varying degrees of accuracy based on environmental factors and specific gas properties. Users should note the classification symbols accompanying each gas to understand the level of testing and the expected performance:

- * = Tested with good results
- † = Tested; approximate accuracy (sniffer-level detection)
- ‡ = Tested; accuracy unknown
- ‡‡ = Tested; demonstrated poor performance

Consider these accuracy variations carefully when selecting the MPS sensor for monitoring specific gases, particularly in environments with fluctuating conditions.

| Gas Class | Verified Accuracy, Measurable Gases | | Variable Accuracy, Detectable Gases | |
|---|---|---|---|---|
| Class I | Hydrogen | | | |
| Class II | Hydrogen + Flam | | | |
| Class III | Methane | | Acetylene† | Ammonia‡‡ |
| Class IV | Ethylene | Isopropanol | 1-Butene* | Hexamethyldisilazane (HMDS)† |
| | Ethane | Isobutylene | | |
| | Propylene | Isobutane | | |
| | Propane | Butane | | |
| Class V | Acetone | Pentane | Hexane* | |
| | Methyl Ethyl Ketone (MEK) | Heptane | | |
| Class VI | Toluene | Xylene | Hexane* | Hexamethyldisiloxane (HMDSO)† |
| | Styrene | Octane | n-Nonane* | Dimethyl Carbonate (DMC)† |
| Varies by Environment | | | Cyclohexane* | Unleaded Petrol* |
| | | | Ethanol† | Fuel oil, diesel‡ |
| | | | Methanol† | n-Decane† |

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## A.4 MPS — Calibration information

The Molecular Property Spectrometer (MPS™) Flammable Gas Sensor incorporated in the PureAire EPU monitors **does not require ANY routine calibration** throughout its entire **operational lifespan of 15+ years**.

The sensor's advanced MEMS-based technology ensures continuous, built-in automatic compensation for variations in environmental factors such as:

- Temperature
- Humidity
- Pressure
- Gas Composition (real-time gas mixture analysis)

As a result, manual recalibration is unnecessary, significantly reducing maintenance efforts and lifecycle costs compared to traditional sensing technologies such as catalytic beads or standard infrared sensors (NDIR), which require frequent manual recalibration and adjustments of sensitivity factors.

### A.4.1 Recommended Periodic Verification

While calibration is not required, PureAire recommends an annual functional verification to confirm sensor responsiveness and ensure optimal safety.

Verification Procedure:

- Apply standard verification gas† (e.g., **50% LEL Methane or Hydrogen mixture**, or a **simple butane lighter gas test**).
- Confirm the monitor reading increases appropriately and returns to zero after removal of the gas.
- Recommended verification gas flow rate: 500 cc/min (0.5 LPM).

†: **Calibration kits can be purchased from PureAire** which contain carrying case, calibration gas, fixed rate regulator, tubing, and calibration cap. Also available for purchase individually.

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# Appendix B — EPU-EC

PureAire **EPU-EC** monitors use **electrochemical (EC)** cells highly specific to their target gas through **selective chemical reactions**. These EC cells are durable, offering strong resistance to variations in humidity and temperature; however, prolonged exposure and environmental conditions eventually affect their lifespan.

Typical sensor life ranges **from 3 to 5 years**, but extreme exposure can reduce it to as little as 6 months. Due to their consumable nature and limited shelf life, we recommend performing functional checks and **testing every 6 months** to ensure reliable performance.

## B.1 EC — Detectable Toxic Gases

| Detectable Toxic Gases (PPM/PPB), EPU-EC 981## | |
|---|---|
| Ethylene Oxide (EtO) | Carbon Monoxide (CO) |
| Sulfur Dioxide ($SO_2$) | Nitric Oxide (NO) |
| Hydrogen Sulfide ($H_2S$) | Ammonia ($NH_3$) |
| Hydrogen Cyanide (HCN) | Hydrogen ($H_2$) |
| Nitrogen Dioxide ($NO_2$) | Chlorine ($CL_2$) |
| Phosphine ($PH_3$) | Hydrogen Peroxide ($H_2O_2$) |
| Hydrogen Chloride (HCL) | Volatile Organic Compounds (VOCs) |

## B.2 EC — Calibration Information

PureAire Explosion-Proof Universal Electrochemical (EPU-EC) sensors rely on precise chemical reactions (redox reactions) to detect toxic gases in the PPM/PPB ranges. These sensors require **annual calibration** to ensure accuracy and optimal performance throughout their operational life **(typically 3-5 years depending on environmental conditions and exposure).**

### B.2.1 Recommended Calibration Gas

Calibration gases should be approximately **half the full-scale range** of the monitor for best accuracy.

- Example:
  - 20 PPM $Cl_2$ monitor: Use **10 PPM $Cl_2$ gas** to calibrate.
  - 100 PPM $H_2S$ monitor: Use **50 PPM $H_2S$ gas** to calibrate.

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### B.2.2 Important Considerations

**Oxygen Requirement:**
Electrochemical cells **require ambient oxygen** to perform redox reactions effectively.

- In **inert or non-oxygenated environments**, the monitor may produce inaccurate readings or may not report at all due to insufficient oxygen available for the reaction. Consider alternative monitoring solutions for monitoring in inert environments.

**Mounting Angle:**
For maximum longevity, mount the sensor at an **angle no greater than 45° from vertical**.

- Deviations from this recommendation may reduce cell lifespan.

**Shelf Life & Sensor Degradation:**
Electrochemical cells begin to degrade as soon as they're exposed to ambient air. To ensure optimal performance, PureAire produces these monitors/sensors **on-demand**.

- It is **not recommended to purchase sensor cells for shelf storage due to their limited shelf life (typically < 12 months under ideal conditions).**

### B.2.3 Recommended Calibration Procedure

1. **Prepare Calibration Setup:**
    a. Use a certified gas cylinder with gas concentration at approximately **50% of the sensor's full-scale range.**
    b. Connect calibration gas cylinder to a regulator and suitable flow tubing.
2. **Gas Flow Rate:**
    a. Set the gas regulator to a flow rate of **500 cc/min (0.5 LPM).**
3. **Apply Calibration Gas:**
    a. Introduce calibration gas at the specified flow rate and observe the monitor reading.
    b. Allow the reading to stabilize, typically **within 1-3 minutes.**
4. **Adjust & Confirm Calibration:**
    a. Use the monitor's user interface to select "Sensor Span" and adjust the span to adjust the reading to match the known calibration gas concentration.
    b. Remove the calibration gas, allow sensor reading to return to zero, confirming the sensor's responsiveness.

### B.2.4 Recommended Maintenance

1. Perform functional verification at 6-month intervals to ensure continued accuracy.
2. Plan for sensor cell replacement every **3–5 years** or as soon as sensor degradation is indicated by slower response or reduced accuracy.

### B.2.5 PureAire Support Options

- **Replacement Sensors Cells:** Available upon request.
- **Return Calibration Service:** PureAire provides a factory calibration service at an additional charge.

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# Appendix C — EPU-PEL

**Pelistor (catalytic bead)** sensors reliably detect combustible gases through catalytic oxidation and are robust against environmental factors such as humidity, providing consistent performance under vary conditions.

However, these sensors require calibration adjustments similar to selecting a "k-factor," limiting accurate detection to a single target gas, potentially causing under- or over-reporting. Additionally, pelistor sensors are **susceptible to poisoning**, notably **by hydrogen sulfide ($H_2S$).** Due to these limitations, PureAire recommends the MPS sensor technology for flammable gas monitoring unless the target gas is not listed as detectable by the MPS.

## C.1 PEL — Detectable Flammable Gases, Alphabetical

| Detectable Flammable Gases (%LEL), EPU-PEL 982## | |
|---|---|
| Acetone | Heptane |
| Acetic Acid | Iso-Butane |
| Acetonitrile | Iso-Butanol |
| Acetylene | Iso-Octane |
| Ammonia | Iso-Pentane |
| Benzene | Iso-Propanol |
| Butane | Methane |
| Butyl Acetate | Methanol |
| Cyclohexane | Methyl Ethyl Ketone |
| Cyclopentane | Octane |
| Carbon Monoxide | Pentane |
| Dichloromethane | Propane |
| Dodecane | Propanol |
| Diethyl Ether | Propylene |
| Ethane | Styrene |
| Ethanol | Tetrahydrofuran |
| Ethyl Acetate | Tert-Butanol |
| Ethylene | Toluene |
| Hydrogen | Vinyl Chloride |
| Hexane | Xylene |

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## C.2 PEL — Detectable Flammable Gases, Calibration Ratio

| Gas | Calibration Ratio | |
|---|---|---|
| Acetylene | 1:1 | 100% |
| Carbon Monoxide | | |
| Hydrogen | | |
| Methane | | |
| Methanol | ~1:1 | 96% |
| Ammonia | | 92% |
| Acetonitrile | | 90% |
| Ethylene | | 80% |
| Cyclopentane | ~2:3 | 70% |
| Ethane | | |
| Ethanol | | |
| Isobutane | | |
| Propane | | |
| Tert-Butanol | | 68% |
| Dichloromethane | | 66% |
| Iso-Pentane | | |
| Isopropanol | | |
| Pentane | | |
| Acetone | ~3:5 | 64% |
| Butane | | |
| Cyclohexane | | |
| Hexane | | |
| Benzene | | 60% |
| Propylene | | |
| Ethyl Acetate | | 56% |
| Heptane | | |
| Octane | ~1:2 | 54% |
| Toluene | | 52% |
| Diethyl Ether | | 50% |
| Tetrahydrofuran | | |
| Xylene | | |
| Iso-Butanol | | 48% |
| Iso-Octane | ~2:5 | 40% |
| Propanol | | |
| Vinyl Chloride | | |
| Styrene | | 38% |
| Butyl Acetate | ~1:3 | 32% |
| Methyl Ethyl Ketone | | 28% |
| Dodecane | 1:5 | 20% |
| Acetic Acid | 1:10 | 10% |

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## C.3 PEL — Selecting Target Gas & Number of Units

The table provided in Section C.2 categorizes gases detectable by pelistor sensors into distinct groups based on calibration ratios. Gases with calibration ratios near 1:1, such as carbon monoxide and ammonia, deliver optimal performance due to minimal cross-sensitivity with other gases. As calibration ratios diverge from 1:1 (moving downward in the table), the sensor's sensitivity must be increased, amplifying cross-sensitivity and potentially causing significant over-reporting of gases higher in the table.

Consequently, careful consideration is required when selecting target gases for monitoring. Calibrating sensors for gases with markedly different calibration ratios in the same location (e.g., acetylene and dodecane) is not advisable; one sensor will frequently trigger alarms due to over-reporting, while the other might rarely alert, depending on the actual gas present.

This challenge underscores why PureAire recommends the Molecular Property Spectrometer technology, EPU-MPS, which incorporates environmental factors and molecular weight into its calculations, providing a more accurate %LEL measurement for diverse environments. However, pelistor sensors remain suitable and effective when monitoring environments with a limited number of target gases or when the target gases are not reliably detected by the MPS.

## C.4 PEL — Calibration Information

The Pellistor (catalytic bead) sensors used in PureAire's Explosion-Proof Universal (EPU-PEL) monitors reliably detect flammable gases through catalytic oxidation. These sensors have a lifespan of approximately **3–5 years** depending on gas exposure and environmental conditions. They require regular manual calibration due to their sensitivity to gas mixtures and varying gas-specific response factors.

The Pellistor sensor's calibration is **referenced against methane**. Each detectable gas has a known calibration ratio (cross-factor) relative to methane, which is listed in the manual.

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### C.4.1 Recommended Calibration Method

There are two methods for calibrating Pellistor sensors:

**Method 1: Methane-Based Cross Factor Calibration (Recommended)**

- Calibration Gas:
  - **50% LEL methane** is used as a universal calibration gas.
- Calibration Procedure:
  - Determine the calibration cross-factor for your target gas from the provided calibration table.
    - Example (Ethanol):
      - Calibration ratio is approximately **70%** of methane (0.70).
      - When exposed to 50% LEL methane, a monitor configured for ethanol should therefore be adjusted to read:

$$\frac{50\%}{0.70} \approx 71.4\% \text{ LEL (ethanol equivalent)}$$

      - In other words, during calibration with 50% LEL methane, the monitor is tuned to it displays 71.4% LEL on the ethanol scale, not 50% LEL.
  - Adjust the monitor's calibration settings so the displayed reading matches the expected percentage based on the calibration ratio.
  - This approach allows for simple accurate field calibration using only methane, without the need for hazardous target gases.

**Method 2: Direct Calibration with Target Gas (When Possible)**

- Calibration Gas:
  - Use **50% LEL concentration of the specific target gas**.
- Calibration Procedure:
  - Apply gas at 500 cc/min (0.5 LPM) flow rate.
  - Allow the monitor to stabilize, typically within 1–3 minutes.
  - Adjust the monitor's displayed reading directly to 50% LEL.
- Practical Considerations:
  - This method provides direct calibration but is often impractical or unsafe due to hazardous nature or limited availability of many target gases.

### C.4.2 Recommended Gas Flow Rate:

500 cc/min (0.5 LPM) is recommended during calibration procedures.

### C.4.3 Maintenance Recommendations

- **Annual calibration** is required due to sensor gaining, exposure effects, and accuracy drift.
- Periodic inspection and maintenance of protective flame arrestors and filters is advised to ensure sensor performance and longevity.

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# Appendix D — EPU-NDIR

The **Non-Dispersive Infrared (NDIR)** sensors accurately detect and quantify **refrigerant gases** and **carbon dioxide ($CO_2$)** using **infrared absorption technology**. Optimized for reliable monitoring in HVAC, refrigeration, and environmental applications, these sensors offer precise measurement, minimal maintenance, and robust long-term performance. Their inherent stability and immunity to common environmental contaminants make them ideal for continuous monitoring in demanding conditions.

NDIR sensors have no defined shelf life and typically provide reliable service for over five years. However, their accuracy can be affected by high humidity, and they cannot detect hydrogen in flammable gas mixtures. Although less selective than electrochemical sensors (EC), NDIR sensors offer significantly longer lifespans. For precise monitoring of flammable gases, PureAire recommends Molecular Property Spectrometer (MPS™) or catalytic bead (pelistor) sensors over NDIR technology due to their superior selectivity and performance.

## D.1 NDIR — Detectable Refrigerant Gases

| Detectable Refrigerants, EPU-NDIR 983## | |
|---|---|
| SF6 (0-1000ppm, 0-2000ppm) | R-410 (0-2000ppm) |
| R-1233zd (0-5000ppm) | R-417a (0-2000ppm) |
| R-1234yf (0-6.2%vol, 0-2000ppm) | R-422d (0-2000ppm) |
| R-1234ze (0-6.5%vol, 0-2000ppm) | R-448a (0-2000ppm) |
| R-125 (0-2000ppm) | R-449a (0-2000ppm) |
| R-134a (0-2000ppm) | R-450a (0-2000ppm) |
| R-143a (0-2000ppm) | R-452a (0-2000ppm) |
| R-22 (0-2000ppm) | R-452b (0-11.9%, 0-2000ppm) |
| R-227ea (0-2000ppm) | R-454a (0-6.3%vol) |
| R-32 (0-14%vol, 0-2000ppm) | R-454b (0-7.7%vol, 0-2000ppm) |
| R-404a (0-2000ppm) | R-454c (0-6.2%vol) |
| R-407a (0-2000ppm) | R-455a (0-11.8%vol) |
| R-407f (0-2000ppm) | R-507 (0-2000ppm) |
| Ethylene (0-2.3%vol) | R-513a (0-2000ppm) |
| **Detectable Refrigerants through Cross Factors, EPU-NDIR 983##** | |
| R-22 | R-452a |
| R-407c | R-454b (ppm) |
| R-422a | R-454c (ppm) |
| R-424a | R-455a (ppm) |
| R-427a | R-453a |
| R-434a | R-422a |
| R-438a | R-123 |

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## D.2 NDIR — Calibration Information

The Non-Dispersive Infrared (NDIR) sensors used in the PureAire Explosion-Proof Universal (EPU-NDIR) monitors detect refrigerants, specific toxic gases, and carbon dioxide ($CO_2$) using stable infrared absorption technology. These sensors are designed with **factory-set calibration**, and their advanced self-calibration capability ensures stable operation throughout their lifespan of **5+ years**, typically without the need for manual recalibration or intervention.

### D.2.1 Recommended Periodic Verification (Bump Testing)

Although manual calibration adjustments are not required, PureAire recommends **bump testing every 6–12 months** to verify sensor functionality and ensure continuous reliable operation.

- Recommended Verification Gas Concentration:
  - Approximately **50% of the sensor's full-scale range**.
    - **2,000 PPM refrigerant monitor**: Use **1,000 PPM** calibration gas.
    - **50,000 PPM CO2 monitor**: Use **25,000 PPM** calibration gas.
- Gas Flow Rate:
  - **500 cc/min (0.5 LPM)** recommended for testing.

### D.2.2 Important Installation & Maintenance Notes

- Sensor Protection:
  - Always ensure the monitor utilizes both the supplied **PTFE particulate filter** and **flame arrestor.**
  - These protective components safeguard the sensor from:
    - Dust and particulates
    - Moisture ingress
    - Condensing humidity
  - Regularly inspect and maintain these protective measures to maximize sensor longevity and accuracy.
- Environmental Considerations:
  - Extended temperature range models are available for specific gases, enabling reliable performance in harsh environments or applications subject to wider temperature fluctuations.
  - Consult PureAire if extended temperature range capabilities are required.

### D.2.3 Recommended Verification Procedure

1. Setup:
   a. Connect a certified gas cylinder **(50% full-scale gas)** to an appropriate regulator and tubing.
2. Flow Rate Adjustment:
   a. Set the regulator to provide gas flow at **500 cc/min (0.5 LPM).**
3. Apply Verification Gas:
   a. Allow gas flow for **1–3 minutes** until the reading stabilizes.
   b. Confirm sensor response matches the expected concentration (within manufacturer tolerances).
4. Finalize Test:
   a. Remove verification gas, ensuring the monitor returns to ambient reading.

If verification indicates a deviation from expected performance, contact PureAire for servicing.

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# Appendix E — EPU-PID

PureAire **EPU-PID** monitors use **photoionization detection (PID)** to measure **volatile organic compounds (VOCs)** at **sub-TLV levels** for life-safety and occupational hygiene applications. These instruments are intended for environments where:

- The **primary concern is personnel exposure** (e.g., TLV, TWA, STEL), not %LEL, and
- **Broad VOC awareness** is more important than highly selective, single-compound identification.

Typical examples include monitoring **acetone fumes** in manufacturing or finishing areas for occupational health, indoor process rooms where multiple solvents may be present, or general VOC exposure in laboratories and maintenance bays.

EPU-PID monitors are available in PureAire's rugged EXR enclosure for indoor/outdoor service and in classified **hazardous locations**, and integrate with the same relay and 4-20 mA infrastructure as other EPU platforms. For flammability (%LEL) and combustible gas hazards, see **EPU-MPS and EPU-PEL**; for **refrigerant and $CO_2$ hazards**, see **EPU-NDIR**.

## E.1 PID — Operating Principle

A PID uses **high-energy ultraviolet (UV) light** to ionize VOC molecules:

1. Sample gas enters a small UV-illuminated chamber.
2. Compounds whose **ionization potential (IP)** is below the lamp photon energy are ionized.
3. The resulting ions and electrons are collected between electrodes, generating a small current.
4. That current is proportional to the concentration of ionizable VOCs.

The Alphasense PID cells used in EPU-PID incorporate design features that improve low-level stability, including a **fence electrode** around the collector to suppress surface-leakage currents and reduce sensitivity to condensation and contamination on insulators.

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## E.2 PID — Lamp Energy and Selectivity

The lamp energy largely determines which compounds are detected:

1. 10.6 eV krypton lamp (standard)
    a. Default lamp for EPU-PID
    b. Detects most **$C_3$ and higher hydrocarbons**, many **oxygenated VOCs** (alcohols, ketones, esters, aldehydes, glycols), and a **wide range of solvents and process vapors**.
    c. This is the lamp used for *general VOC life-safety applications*.
2. 9.6 eV xenon lamp (optional, where supported)
    a. Narrower detection window, often used where **aromatics** and **unsaturates** (e.g., BTEX) are of primary interest and some higher-IP background gases should be suppressed.
3. 11.7 eV argon lamp
    a. Extends detection to more low-molecular-weight and higher-IP VOCs (e.g., methanol, some halogenated species), but the lithium-fluoride window is mechanically and chemically fragile.
    b. **Alphasense does not recommend or supply 11.7 eV lamps** for general use; PureAire EPU-PID systems are therefore based on **10.6 eV** (and 9.6 eV where explicitly specified).

For EPU-PID, all gas applicability and correction factors in this appendix assume a 10.6 eV lamp, which is standard configuration.

## E.3 PID — Intended Use and Limitations

Intended use:

- Sub-TLV/TLV-level VOC monitoring for life-safety and occupational hygiene.
- Detection of solvents and process vapors that pose chronic or acute exposure risks.
- Situations where a “VOC present above X ppm” alarm is sufficient, rather than specific gas speciation.

Not intended for:

- Hydrogen or methane-based flammability monitoring. Many small inorganics and light hydrocarbons (methane, ethane) have ionization potentials too high for 10.6 eV lamps, and hydrogen does not ionize in PID cells.
- Primary LEL measurement. For %LEL alarms or combustible cloud detection, use **EPU-MPS** (multi-gas flammability with automatic environmental compensation) or **EPU-PEL** (target combustible gases not covered by MPS).
- Refrigerant or $CO_2$ measurement. These are better handled by **EPU-NDIR**.

In mixed environments where both exposure and flammability are concerns, a common best practice is to use **EPU-PID** for sub-TLV VOC exposure alarms and **EPU-MPS/PEL** for LEL alarms on the same process line.

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## E.4 PID — Detectable VOC Gases

With a 10.6 eV lamp and calibration to isobutylene, **EPU-PID** can measure the following gases for which published Response Factors (RFs) are available. These RFs are used to convert the isobutylene-equivalent signal to true ppm for the selected gas. Please contact PureAire for Response Factors.

- **Aldehydes, ketones & related**
  - Acetaldehyde, acetone, acetophenone, acrolein, mesityl oxide, methyl ethyl ketone (MEK), methyl isobutyl ketone, 2-pentanone, propionaldehyde (propanal), isophorone.
- **Organic acids, esters & acrylates**
  - Acetic acid, methyl acetate, ethyl acetate, n-butyl acetate, isobutyl acetate, isopropyl acetate, methyl acrylate, methyl methacrylate, vinyl acetate.
- **Alcohols & sulfur-containing organics**
  - Allyl alcohol, ethanethiol / ethyl mercaptan, methyl mercaptan (methanethiol), carbon disulfide, thiophene.
- **Aromatics & polyaromatics**
  - Benzene, toluene, ethylbenzene, styrene, cumene (isopropyl benzene), m-xylene, o-xylene, p-xylene, Naphthalene.
- **Alkanes & alkenes**
  - Heptane, isopentane, cyclohexane, ethylene, propylene, isoprene (2-methyl-1,3-butadiene).
- **Ethers, cyclic ethers & acetals**
  - Ethyl ether (diethyl ether), isopropyl ether, tetrahydrofuran (THF), dimethoxymethane (methylal).
- **Epoxides & related**
  - Ethylene oxide, propylene oxide, epichlorohydrin.
- **Halogenated organics**
  - Chlorobenzene, 1,2-dichloroethane, 1,2-dibromoethane, bromoform, vinyl bromide.
- **Nitrogen-containing organics**
  - Pyridine, 2-picoline, 3-picoline.
- **Inorganic / highly toxic gases with published RFs**
  - Ammonia, arsine, hydrazine, hydrogen sulfide, nitric oxide (NO), nitrogen dioxide ($NO_2$), phosphine.

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## E.5 PID — Calibration and Response Factors (RF)

**EPU-PID** monitors are designed to be calibrated to the true target gas whenever practical. This provides the most accurate measurement for occupational exposure and life-safety applications.

### E.5.1 Primary Method: True-Gas Calibration

For most applications, PureAire recommends calibrating the **EPU-PID** with the **actual VOC of interest** at a known concentration:

1. Enter the Sensor Adjustment menu
2. Set the ppm setpoint to the concentration of the calibration gas you will apply (for example, 100 ppm acetone).
3. Apply the calibration gas to the monitor using the appropriate flow, cap, and regulator.
4. Allow the reading to stabilize.
5. Save the adjustment in the menu.

The monitor will then be calibrated so that its reading matches the applied and entered concentration of that gas. For example, calibrating with 100 ppm acetone and saving at that point will make the EPU-PID read 100 ppm when exposed to that same acetone concentration under similar conditions.

This is the preferred method whenever a suitable calibration cylinder for the target gas is available, because it inherently accounts for that compound's true response in the sensor and electronics, rather than relying solely on a correction factor.

### E.5.2 Use of Isobutylene and Response Factors

In some cases, true-gas calibration is not practical, such as when:

- The target gas is difficult to source,
- Not stable or safe to ship as a standard cylinder,
- Only available at significant cost or lead time.

For these situations, the EPU-PID can be **calibrated with isobutylene**, and a **Response Factor (RF) is applied** for the target gas.

This approach is used only when a true-gas calibration is not feasible. It allows a single isobutylene calibration standard to support multiple VOC targets, but wherever possible PureAire recommends calibrating directly to the specific gas of concern.

### E.5.3 Recommended Service and Recalibration

For best long-term performance and to maintain confidence in sub-TLV measurements:

- Return the instrument to PureAire **yearly** for inspection, cleaning, and any necessary lamp/electrode stack maintenance or replacement.
- A full service visit also verifies sensor output, electronics, and calibration, and ensures that the unit continues to meet its specified performance for life-safety monitoring.

**Between yearly services**, users should perform routine zero checks and span checks at intervals appropriate for their environment, following the true-gas calibration method above whenever a suitable standard gas is available.

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# Appendix F — Application Guidance

This appendix provides a high-level guide to selecting the appropriate EPU platform for a given hazard. Most facilities benefit from using multiple technologies together—for example, electrochemical cells for specific toxics, PID for general VOC exposure, MPS/PEL for flammability, and NDIR for $CO_2$/refrigerants—on the same power and alarm infrastructure.

## F.1 Application Guidance — Summary of Technologies

- **EPU-EC — Electrochemical (PPM, Toxics)**
  Use EPU-EC when you need highly selective monitoring of **a specific toxic gas**, such as:
  - CO, $H_2S$, $NO_2$, $SO_2$, $Cl_2$, $NH_3$, HCl, etc.

  EC sensors are ideal where:
  - Exposure limits (TWA, STEL, ceiling) are tight and regulatory-driven.
  - **Cross-sensitivity must be minimized**.
  - You must track a defined gas with well-known exposure limits.
- **EPU-PID — Photoionization (PPM, Sub-TLV VOCs)**
  Use EPU-PID when the primary concern is VOC exposure (sub-TLV to TLV range), and a **broad response to many organics** is acceptable or preferred.
  Typical use cases:
  - Solvent usage areas (e.g., acetone, MEK, alcohols, acrylics, resins).
  - Coating, printing, cleaning, or lab environments where multiple VOCs may be present.
  - "General VOC life-safety" where you care about "**VOC above X ppm**", not speciation.

  For flammability (%LEL) of those vapors, pair EPU-PID with EPU-MPS or EPU-PEL.
- **EPU-MPS — Molecular Property Spectrometry (%LEL, Mixed Combustibles)**
  Use EPU-MPS for **flammability hazards** involving **mixtures of hydrocarbons and hydrogen** where gas composition may change over time.
  Advantages:
  - Direct **%LEL indication** across multiple gas classes.
  - Automatic environmental compensation and classification—no user-applied "k-factors".
  - Well-suited for **general combustible gas life-safety** around battery systems, gas cabinets, gas rooms, and industrial processes with varying fuels.
- **EPU-PEL — Catalytic Pellistor (%LEL, Target Combustibles)**
  Use EPU-PEL when you need %LEL monitoring for **a specific combustible gas or mixture** that:
  - Is not covered, or not ideal, for MPS classification, or
  - Must comply with an existing spec that calls out **catalytic bead / pellistor**. Typically when the process gas is tightly controlled (e.g., a defined hydrocarbon, solvent vapor, or simple mixture) and there is a desire to match legacy pellistor-based requirements.
- **EPU-NDIR — Infrared (PPM, $CO_2$ and Refrigerants)**
  Use EPU-NDIR $CO_2$ and refrigerant monitoring, including:
  - Machinery rooms and cold storage for refrigerant leak detection.

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- Environments with asphyxiation risk due to $CO_2$ or refrigerant accumulation.

EPU-NDIR uses industrial NDIR cells that are available in extended-temperature versions down to -40°C, allowing rugged indoor/outdoor installation and deployment in spaces that are not maintained at room temperature. This is distinct from PureAire's other EXR $CO_2$ sample-draw monitor, which is intended for indoor environmental monitoring and should not be used below +5°C.

These gases are not detected by PID and are not well-suited to MPS or pellistor sensing.

## F.2 Application Guidance — Typical Combinations in a Facility

A robust gas detection design often uses multiple EPU platforms together, for example:

- Battery rooms / energy storage / industrial processes
  - **EPU-MPS** for %LEL combustible gas (hydrogen + hydrocarbons).
  - **EPU-EC** for CO or specific toxic byproducts.
  - **EPU-NDIR** if $CO_2$ or refrigerants are present in cooling or fire-suppression systems.
- Solvent handling, coatings, printing, labs
  - **EPU-PID** for general VOC exposure (sub-TLV, TLV, STEL alarms).
  - **EPU-EC** for specific toxics (e.g., formaldehyde, $H_2S$, $NH_3$) or $O_2$ monitoring.
  - **EPU-MPS** or **EPU-PEL** in areas where solvent vapors or gases can reach flammable concentrations.
- Refrigeration plants, cold rooms, and machinery rooms
  - **EPU-NDIR** for refrigerant leaks and $CO_2$ systems.
  - **EPU-EC** for CO or other toxics from combustion sources

## F.3 Application Guidance — Design Approach

1. Identify the hazard type(s):
   a. Toxic exposure (ppm) → **EPU-EC** or **EPU-PID**
   b. Flammability (%LEL) → **EPU-MPS** or **EPU-PEL**
   c. Asphyxiation from $CO_2$/refrigerants → **EPU-NDIR**
2. Decide if you need selectivity or broad coverage:
   a. Need a specific gas at a regulatory limit → **EPU-EC**
   b. Need overall VOC burden for life-safety → **EPU-PID**
   c. Need multiple possible combustibles (including $H_2$) → **EPU-MPS**
3. Consider environment and maintenance:
   a. High VOC loading or contamination → more frequent PID maintenance, consider EC/NDIR where appropriate.
   b. Extreme temperatures and humidity → enclosure selection (EXR) and sensor choice matter; see each appendix for placement and maintenance details.

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## F.4 Application Guidance — Integration

All EPU platforms share a common approach to:

- Power and wiring (**24 VDC nominal**).
- **4–20 mA** and **relay outputs** for local alarms and interlocks.
- **RS-485** / Modbus interfaces (where provided) for controllers or PLC/SCADA integration.

This allows **EPU-EC, EPU-PID, EPU-MPS, EPU-PEL, and EPU-NDIR** monitors to be mixed and **matched on the same systems** so a single facility design can address:

- Toxic exposure,
- General VOC hygiene,
- Flammability and explosion risk, and
- Asphyxiant / refrigerant hazards,

Using the most appropriate technology for each gas and location.

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