Product Identification and Overview

BAPI's Nitrogen Dioxide Sensor offers enhanced electrochemical sensing with outstanding accuracy at low concentrations. The Duct unit samples duct air using an aspiration tube. The Rough Service unit features a ventilated BAPI-Box and is ideal for parking ramps, equipment rooms and warehouses.

The sensor has field selectable NO_2 ranges and outputs, plus two independent SPDT alarm contacts which switch at field selectable NO_2 concentrations. An alarm timer holds the output relays on for a fixed time after the NO_2 level has fallen below 80% of setpoint. This allows additional fan run time to be sure that the NO_2 has been purged.

The LCD is backlight for 10 seconds after a button push. A status LED is green when the NO_2 is below the lowest relay setpoint. The LED turns red when an alarm relay is on.
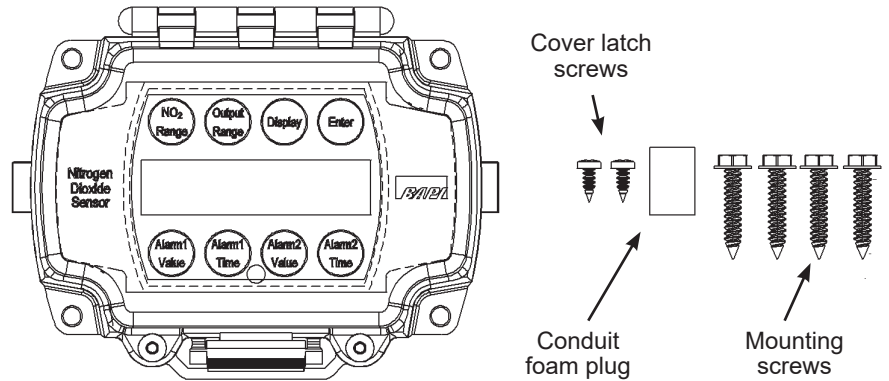

Fig. 1: NO_2 Sensor and Parts (Rough Service Unit shown)

Mounting (see full size mounting hole template on next page)

Rough Service Ventilated Unit

1. Mount the unit on a solid, non-vibrating surface 3 to 5 feet above floor level. Mount in a horizontal orientation with the enclosure hinge at the top as shown in Fig 2. Failure to do so may degrade the life of the sensor element. Do not mount near supply or return diffusers.

2. Use BAPI recommended #10 (M5) screws on the four mounting feet of the enclosure. A pilot-hole makes mounting easier. Use the enclosure mounting feet to mark the pilot-hole locations.

3. Snug up the screws so that the foam backing is partially depressed but do not over-tighten or strip the screw threads. The foam is for insulation and vibration dampening.

4. Place the provided #6 screws into the holes on each site of the lid latch to make the cover tamper resistant.
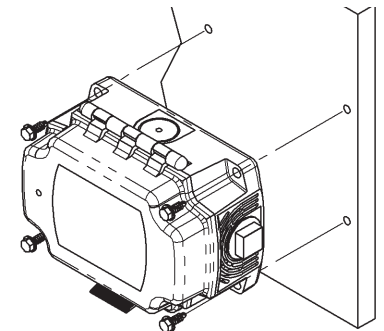

Fig. 2: Rough Service Unit mounting

Duct Aspiration Tube Unit

1. BAPI recommends placing the sensor in the middle of the duct wall, away from stratified air, to achieve the best reading. The unit should also be a minimum of 3 duct diameters from an elbow, damper or other duct restriction.

2. Drill a 1" hole for the aspiration tube. Position the box so that airflow is directly into the holes on one side of the aspiration tube. The air direction is not important.

4. Mount the enclosure to the duct using BAPI recommended #10 screws in the four mounting feet of the enclosure. A 1/8" pilot hole makes mounting easier. Use the mounting feet to mark the pilot-hole locations.

5. Snug the screws until the foam backing is compressed about 50% to prevent air leakage but do not over-tighten.

6. Use the provided #6 screws to secure the cover for IP66 rating and tamper resistance.

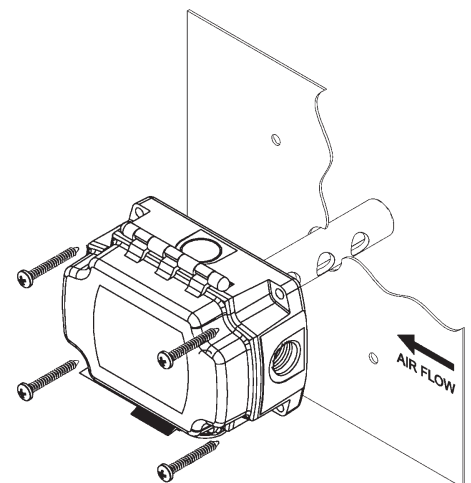7. Use the provided conduit foam plug to seal the conduit opening.

Fig. 3: Duct Unit mounting

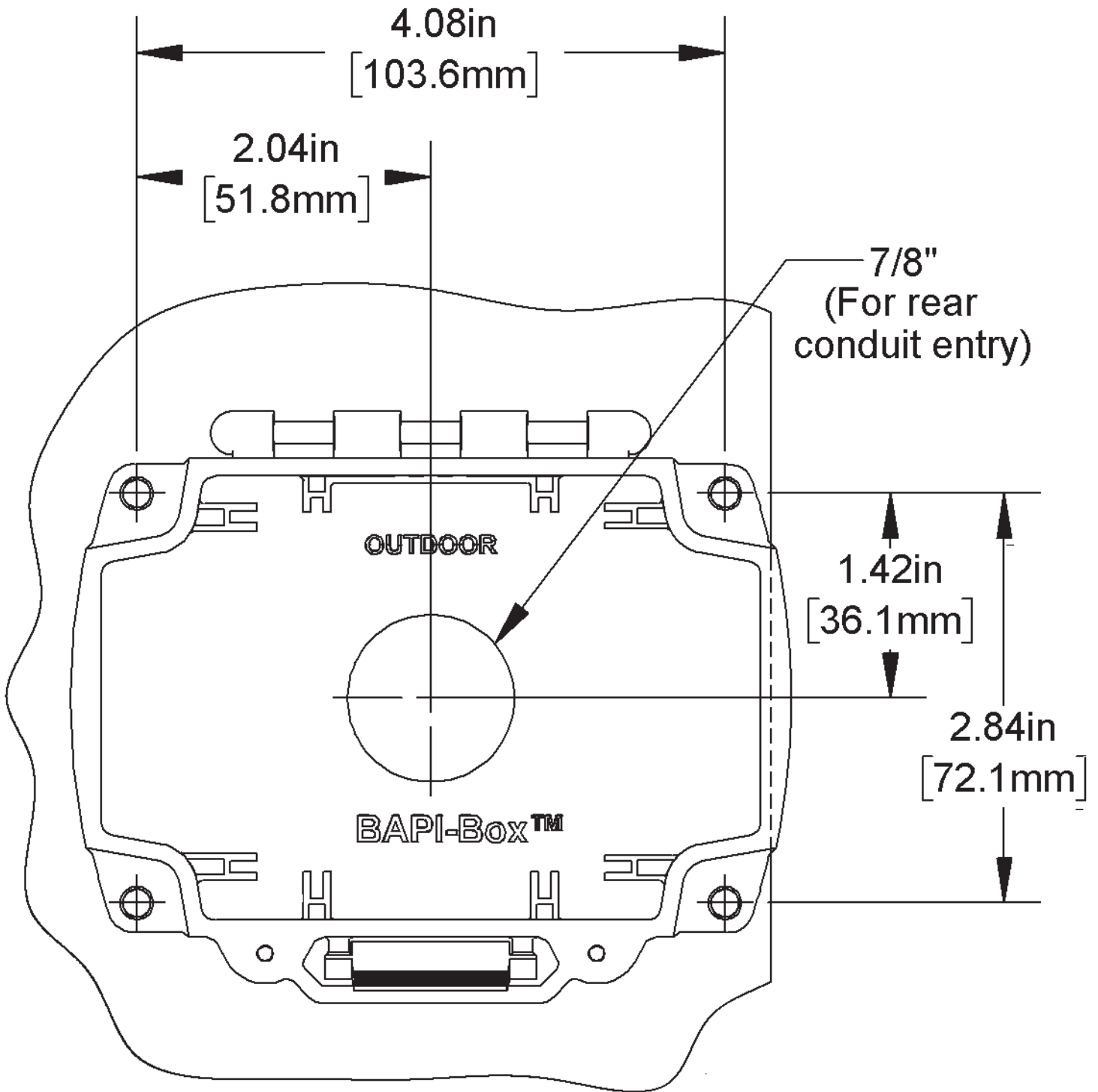Specifications subject to change without notice.

Mounting Holes Template

Fig. 3: Screw Hole Template. Shown actual size.

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Termination

BAPI recommends using twisted pair of at least 22AWG and sealant filled connectors for all wire connections. Larger gauge wire may be required for long runs. All wiring must comply with the National Electric Code (NEC) and local codes. Remove the plug from the conduit opening you wish to use. The field wiring terminals are on a board in the base of the unit. A legend, describing the function of each terminal, is printed on the circuit card in the lid. (See Fig. 4)

> **STOP** BAPI recommends wiring the product with power disconnected. Proper supply voltage, polarity and wiring connections are important to a successful installation. Not observing these recommendations may damage the product and void the warranty.
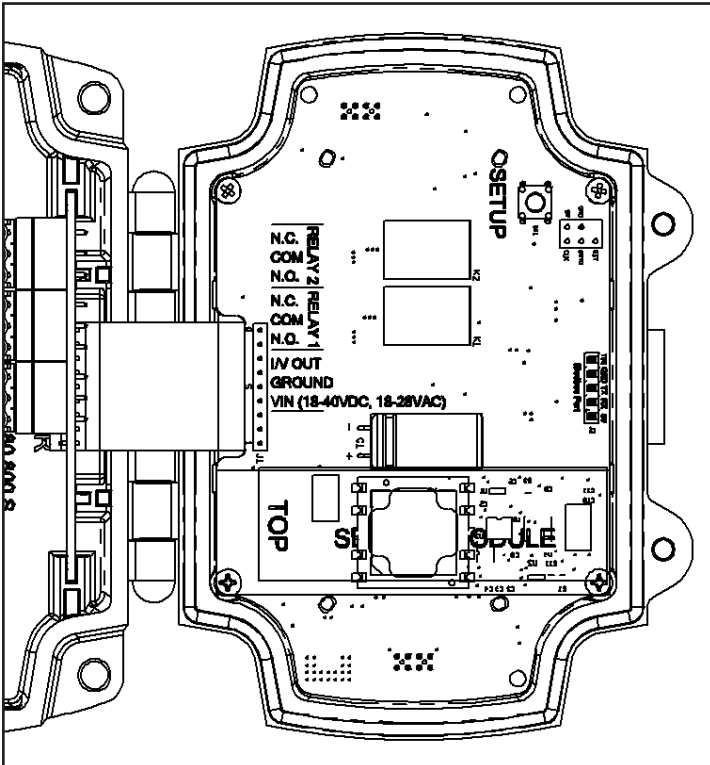
WIRING TERMINALS

VIN – Input Power
18 to 28 VAC, 7.2 VA Max
18 to 40 VDC, 180 mA Max.

GROUND:
Power and Analog Output Ground

I/V OUT
Three wire voltage or current signal

RELAYS
Relay contacts are galvanically isolated. They are not connected to each other, or to circuit power or ground in the NO_2 sensor.

N.O. – Normally Open Contact

COM – Common Contact

N.C. – Normally Closed Contact

NOTE: The connectors that plug into the jacks on the board use a rising block screw terminal to hold the wires. If the block is in a partially up position, the wire may be inserted under the block and the wire will not be held when the screw is tightened. To avoid improper wiring, turn the male connector screws counterclockwise until the block is below the wire opening before inserting the wire. Lightly tug on each wire after tightening to verify proper termination.

Keeping the Enclosure Air Tight After Termination

For the sensor to work correctly, the wiring entrance must remain air tight. If the NO_2 sensor is mounted to a hollow wall and wired through its back, or wired with conduit, it is possible that a draft of clean air may fill the enclosure through the wiring opening. This draft may prevent the unit from measuring ambient Nitrogen Dioxide.

BAPI recommends plugging the conduit at the enclosure. Included with the Nitrogen Dioxide sensor is a foam plug to seal the ½ inch EMT. Place the wires into the plug as shown in Fig. 5 and then insert the plug into the conduit sealing the conduit.
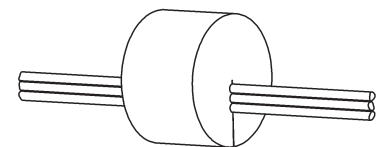

Fig. 5:
Wires Through Foam Plug

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Relay Load Termination

The Alarm Relays may be used to switch a load on or off. Fig. 6 shows a circuit that may be used to switch on a load under alarm conditions. Fig. 7 shows a circuit that may be used to switch off a load under alarm conditions. For clarity only Alarm Relay 1 is shown, Alarm Relay 2 may be used in the same way.
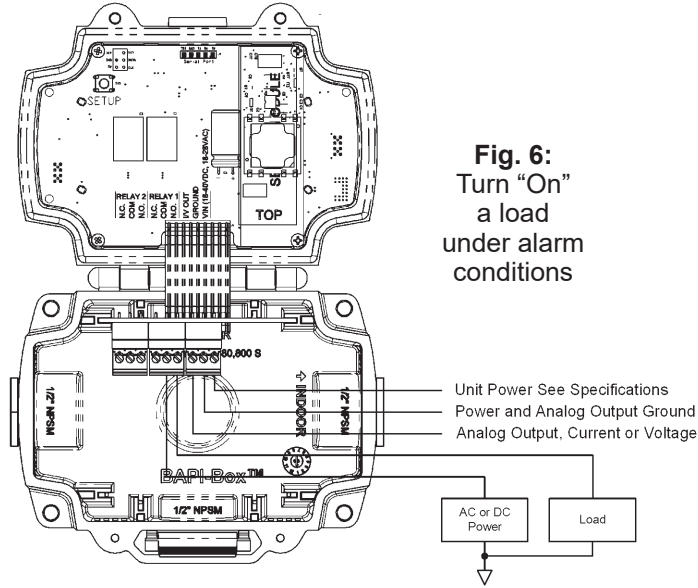
Fig. 6:
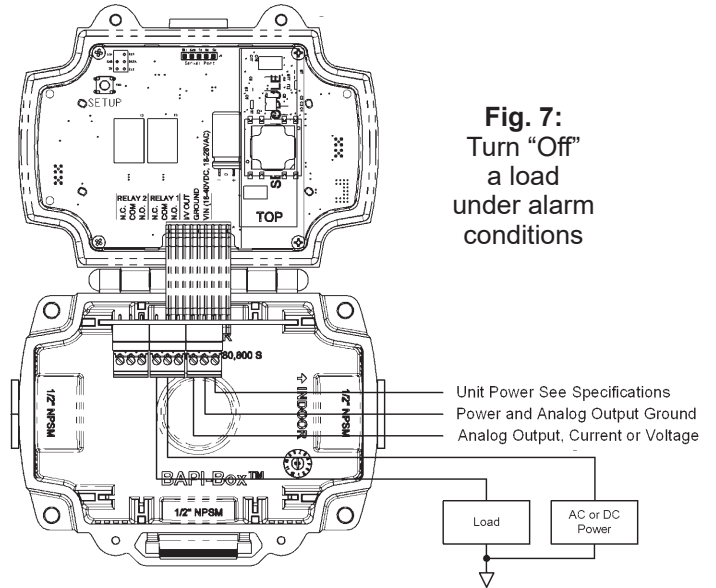Turn "On"
a load
under alarm
conditions

Unit Power See Specifications
Power and Analog Output Ground
Analog Output, Current or Voltage

AC or DC Power

Load

Fig. 7:
Turn "Off"
a load
under alarm
conditions

Unit Power See Specifications
Power and Analog Output Ground
Analog Output, Current or Voltage

Load

AC or DC Power

Fig. 8 shows how two or more Nitrogen Dioxide or Carbon Monoxide Sensors may be interconnected to switch a load. This example shows how to turn on a load under alarm conditions. Similar circuitry may be used to turn off a load under alarm conditions. Fig. 8 connects together the Normally Open terminals of Alarm Relay #1 in both units and connects them to the load. Fig. 8 also connects together the Common terminals of Alarm Relay #1 in both units and then connects them to the load's power. This wiring circuit will drive the load whenever any one of the Nitrogen Dioxide Sensors is in an alarm condition. *Note: Be sure to only connect similar terminals from each unit (Normally Open terminal to Normally Open terminal, etc.). Cross connecting any of the terminals (Normally Closed to Common, etc.) may damage the units and may void the warranty.*

For clarity only Alarm Relay 1 is shown in the example below. Alarm Relay 2 may be used in the same way.
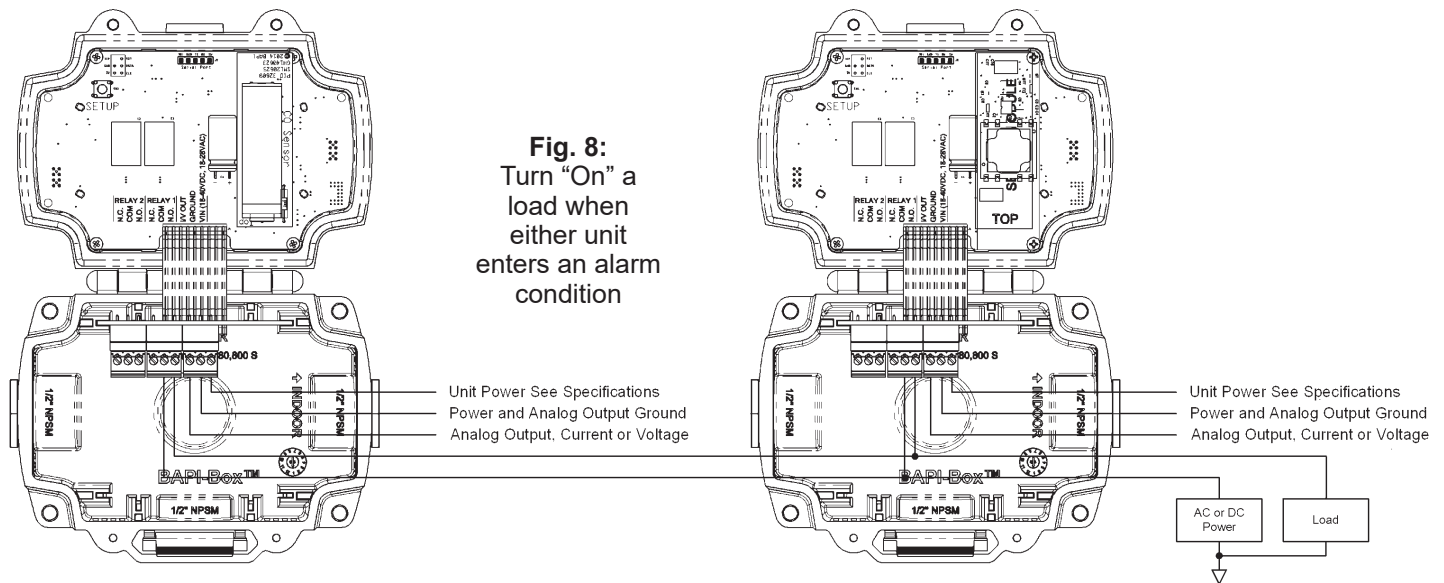
Fig. 8:
Turn "On" a
load when
either unit
enters an alarm
condition

Unit Power See Specifications
Power and Analog Output Ground
Analog Output, Current or Voltage

Unit Power See Specifications
Power and Analog Output Ground
Analog Output, Current or Voltage

AC or DC Power

Load

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Relay Load Termination continued...

Some circuits require a switched ground to operate, such as audible alarms, visual alarms, or large AC motor controllers. Fig. 9 shows how to apply ground under an alarm condition. Fig. 10 shows how to remove ground under an alarm condition. For clarity only Alarm Relay 1 is shown. Alarm Relay 2 may be used in the same way.
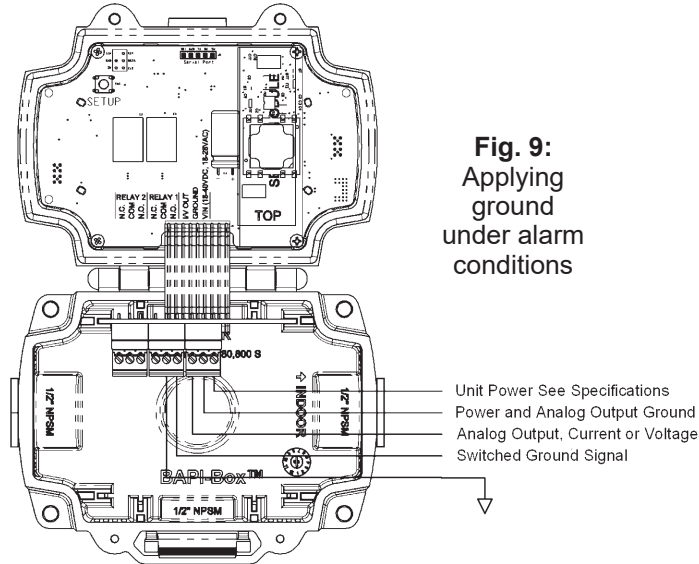

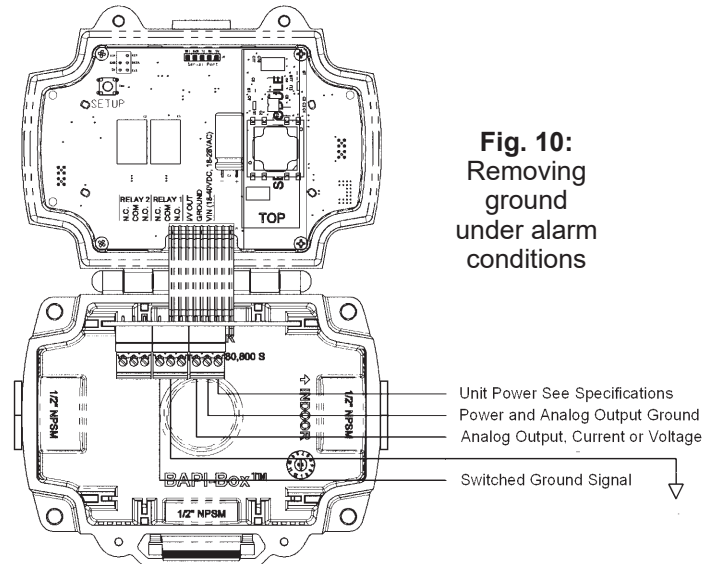**Fig. 9:** Applying ground under alarm conditions

Unit Power See Specifications
Power and Analog Output Ground
Analog Output, Current or Voltage
Switched Ground Signal

Fig. 10: Removing ground under alarm conditions

Unit Power See Specifications
Power and Analog Output Ground
Analog Output, Current or Voltage
Switched Ground Signal

Power Up

After applying power, the Nitrogen Dioxide sensor performs the following functions:

- Front panel capacitive button test;
- Displays the sensor's hardware and firmware version number;
- Displays the NO_2 Module's serial number;
- Displays the NO_2 Module's run time;

The unit also performs a NO_2 Module self-test. The self-test may last for a couple of seconds or up to 10 minutes depending on how long the NO_2 Module has been unpowered. The test runs in two parts. During the 1st part, the LCD may flash and have a solid red LED as the unit counts down the ppm reading from 20 to 0. This test may be instantaneous or take most of the 10 minutes. The 2nd part will show "Testing" in the LCD and have a solid yellow LED. When the NO_2 Module self-test is complete, the LED will turn solid green and the sensor is operational.
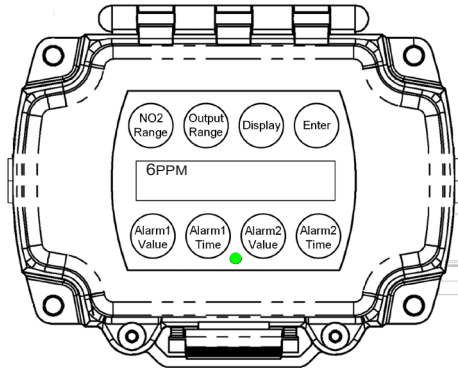
Operation

The eight buttons on the face of the unit sense the user's fingertip when pressed against the plastic cover. The buttons allow the user to review or select unit configuration parameters. The top line of the display continues to show the NO_2 measurement when reviewing or selecting parameters.

Parameter Button	Function
NO2 Range	Review or select Nitrogen Dioxide measurement range used for analog output
Output Range	Review or select analog output range
Display	Review or select PPM display on or off
Enter	View hidden values, verify edit mode, save edited configuration parameters, or end configuration parameter edit
Alarm1 Value	Review or select NO2 concentration to enable Alarm 1 relay
Alarm1 Time	Review or select number of minutes that Alarm 1 relay stays on after NO2 dissipates
Alarm2 Value	Review or select NO2 concentration to enable Alarm 2 relay
Alarm2 Time	Review or select number of minutes that Alarm 2 relay stays on after NO2 dissipates

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Operation continued...

Display On and Display Off Modes

The top line of the display shows the NO_2 measurement when the Display Mode is set to "On" . If the Display Mode is set to "Off," the top line of the display shows the word "On" rather than the NO_2 measurement. If the NO_2 measurement is below Alarm 1 or Alarm 2 levels, the LED will be green.

Fig. 11:
Display During
Normal Operation

(Reading is below
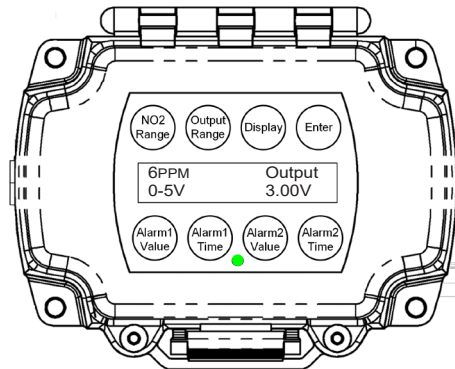NO_2 alarm value)
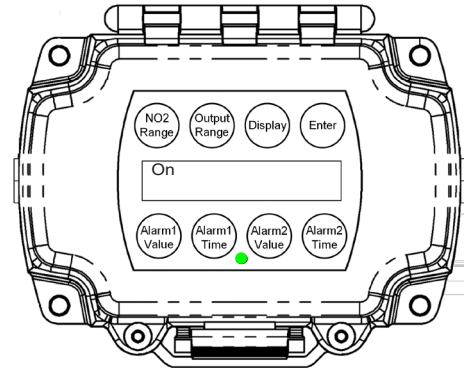
PPM Display "On" Mode   PPM Display "Off" Mode

Displaying the NO_2 Measurement, Analog Output Range and Analog Output Value
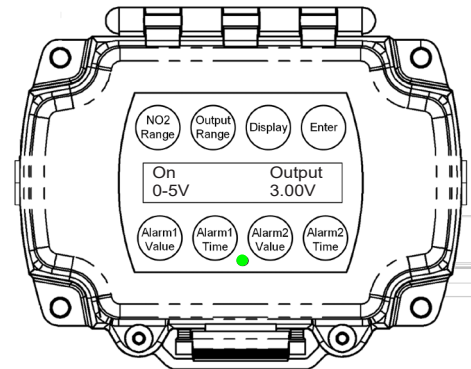
Touching the Enter button displays the Current Reading, the Analog Output Range and Analog Output Value for 10 seconds. The current reading is replaced by the word "On" if the display is set to "Off".
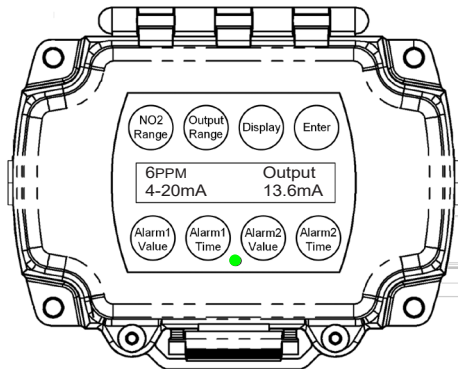
4 to 20 mA Output Mode
(PPM Display set to "On")   0 to 5 Volt Output Mode
(PPM Display set to "On")   0 to 5 Volt Output Mode
(PPM Display set to "Off")

Fig. 12: Display showing the Current Reading, the Analog Output Range and Analog Output Value

NO_2 Sensor Failure Display

The NO_2 sensor element is tested for proper operation daily. If the sensor fails:

- The top line of the display displays "Replace Sensor,"
- The analog output is set to 100% of range
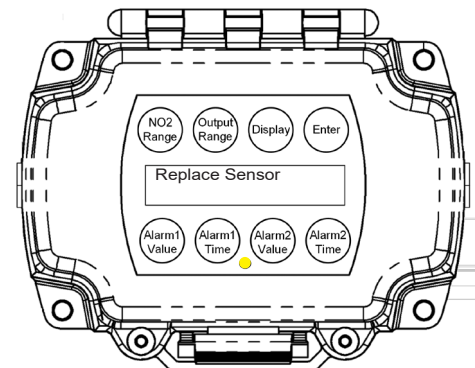- Both relays turn on,
- The LED flashes yellow.
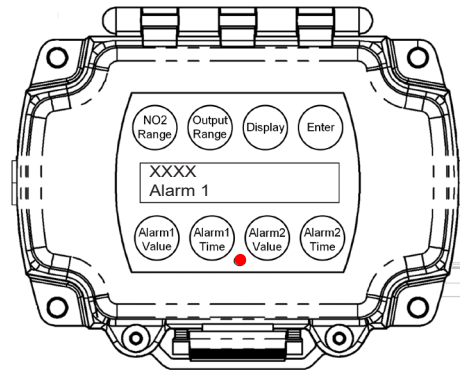
Fig. 13: NO_2 Sensor Failure

Specifications subject to change without notice.

Operation continued...

Alarm Condition 1 Display

If the NO_2 measurement exceeds the Alarm 1 setpoint:

• The NO_2 measurement or the word "On" is displayed on the first line

• The alarm condition is display on the second line

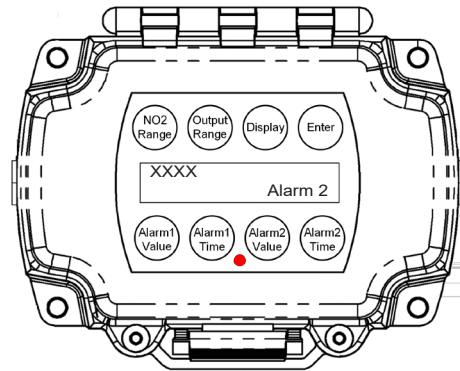• The LED will be red

• The backlight flashes

Alarm Condition 1

Fig. 14: Display when the measurement exceeds Alarm Condition 1 Setpoint

Alarm Condition 2 Display

If the NO_2 measurement exceeds the Alarm 2 setpoint;

• The NO_2 measurement or the word "On" is displayed on the first line

• The alarm condition is displayed on the second line

• The LED will be red

• The back light flashes

Note: The Alarm 2 Setpoint may be equal to, greater than or less than the Alarm 1 Setpoint.

Alarm Condition 2

Fig. 15: Display when the measurement exceeds Alarm Condition 2 Setpoint

Alarm Condition 1 & 2 Display

If the NO_2 measurement exceeds the Alarm 1 & 2 setpoint;

• The NO_2 measurement or the word "On" is displayed on the first line

• The alarm condition 1 and 2 is displayed on the second line

• The LED will be red

• The back light flashes

Note: The Alarm 2 Setpoint may be equal to, greater than or less than the Alarm 1 Setpoint.
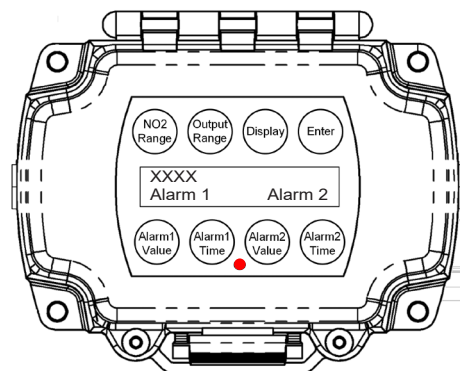

Alarm Condition 1 & 2

Fig. 16: Display when the measurement exceeds Alarm Condition 1 & 2 Setpoint

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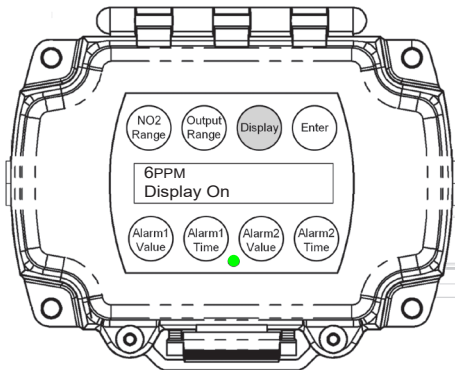7 of 11

Reviewing Parameter Settings

You can review the parameter settings at any time during normal operation by touching any of the eight buttons on the face of the unit. The following figures show a typical display when a button is touched. The values will display for 10 seconds and then the display will revert to normal.
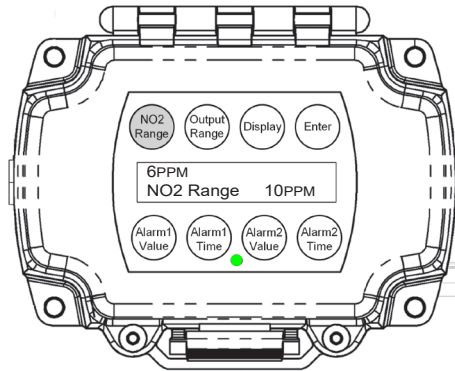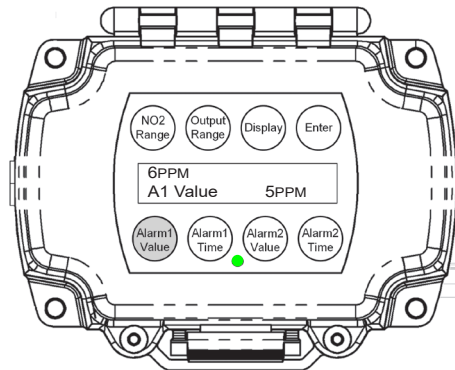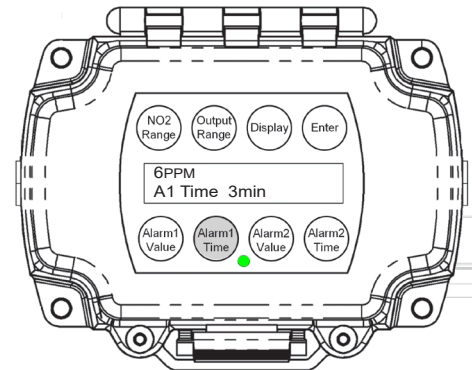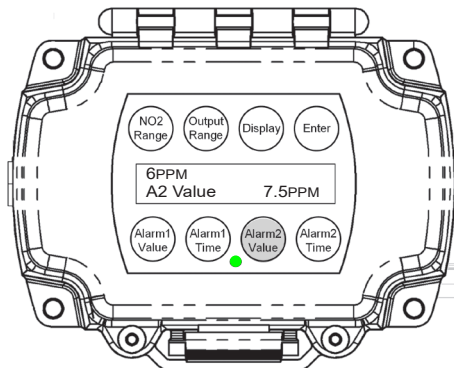

NO$_2$ Range
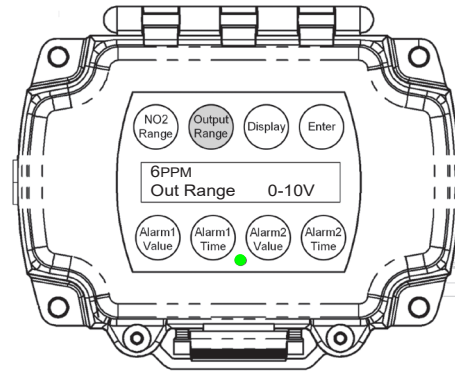
Output Range (0 to 10 Volts)

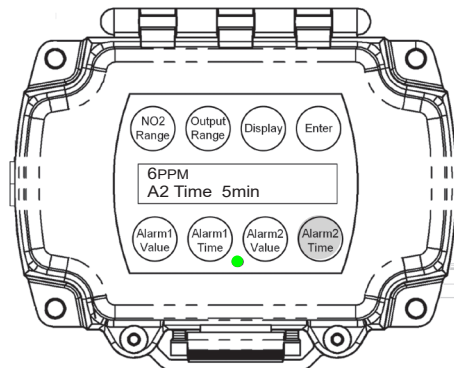
Display Mode

Alarm 1 Value

Alarm 1 Time

Alarm 2 Value

Alarm 2 Time

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Parameter Setup and Default Settings

If field personnel wish to change any parameter settings, they must remove the tamper resistant screws, open the cover, and press the switch on the board labeled "Setup." Follow Fig. 17 below to change parameters.
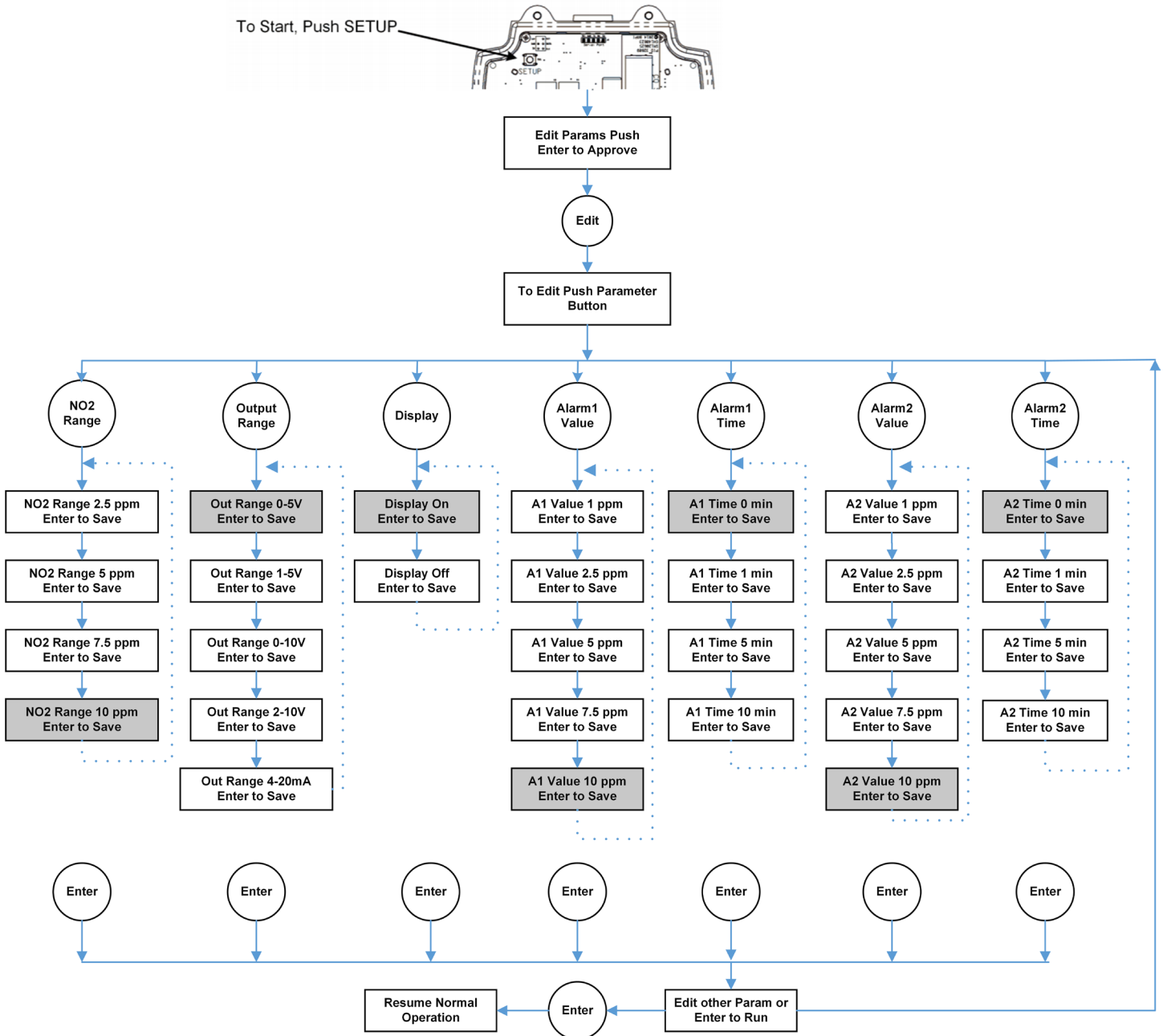

Fig. 17:
Parameter Setup Flow Chart
(Default settings are shown with gray shading)

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NO2 Sensor Module Replacement

Every BAPI NO$_2$ Sensor is factory calibrated and ready for operation after installation. The unit is not capable of field calibration. BAPI recommends replacing the sensor after 7 years of use, or at the recalibration intervals required by the local jurisdiction. Each NO$_2$ Sensor Module comes with a calibration certificate.

To replace the NO$_2$ Sensor Module (Fig. 18), follow these steps:

Warning: Observe precautions for handling electrostatic discharge sensitive devices.

- Remove the tamper resistant screws and open the lid;
- Unplug the power connector;
- Remove the two retention screws from the sensor circuit board and remove the circuit board by lifting it straight out of its sockets;
- While holding the edges of the new sensor circuit board, plug it straight into the two sockets on the main circuit board being careful not to bend any of the pins;
- Replace the two retention screws with the two spacers;
- Plug in the power connector;
- Close the lid until it clicks, and replace the tamper resistant screws.

Fig. 18: Inserting or Removing the Sensor Module
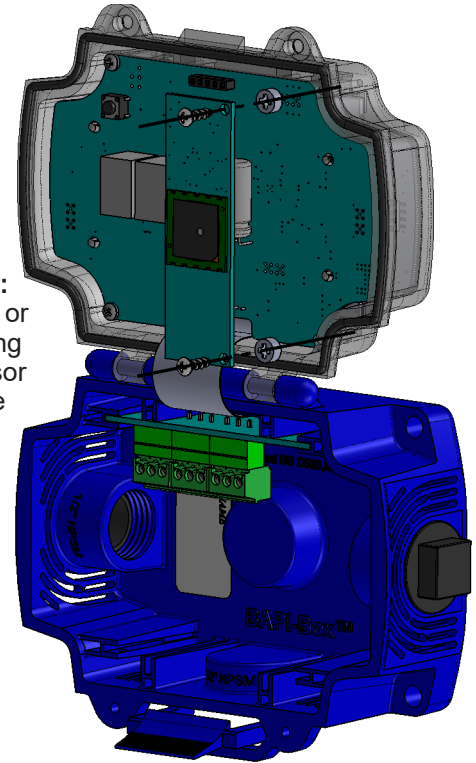
Maintenance

The unit should be vacuumed clean once a year or more, depending on the rate of accumulation of any dust or dirt. To avoid sensor damage, the unit MUST NOT be submerged in any liquids. Hosing or splashing of the unit with any liquids must also be avoided and may void the warranty.

The NO$_2$ sensor module in the unit typically has a life of over 7 years. When the module reaches the end of its life, the unit will give an alarm to indication that the NO$_2$ module needs to be replaced. The replacement NO$_2$ modules are available from BAPI.

Specifications

Power:
18 to 28 VAC, 7.2 VA Max
18 to 40 VDC, 180 mA Max

Field Selectable Ranges:
0 to 2.5 ppm • 0 to 5.0 ppm
0 to 7.5 ppm • 0 to 10.0 ppm

Accuracy: ±5.0% FS

Alarm Relays:
2 Independent, Dry SPDT (Form C)
2 Amps at 24 VAC/DC, Resistive
140 VA Inrush, 48 VA Holding at 24 VAC

Field Wiring Terminals:
Pluggable Screw Terminals, 14 to 22 AWG

Response Time:
<80 seconds from 10% to 90% of range

Alarm Relay Setpoints:
1.0, 2.5, 5.0, 7.5 or 10 ppm

Alarm Timer: 0, 1, 5 & 10 minutes

Field Selectable Analog Outputs:
3-wire 4 to 20 mA
0 to 5 VDC, 1 to 5 VDC
0 to 10 VDC, 2 to 10 VDC

Sensor Element Life: 7 Years Typical

Environmental Operation Range:
Continuous:
-4 to 104°F (-20 to 40°C), 15 to 95%RH Non-condensing
Intermittent:
-22 to 122°F (-30 to 50°C), 0 to 95%RH Non-condensing

Agency: RoHS • CE: EN 61326-1:2013 EMC

See BAPI's Application Notes on our website for further information about coverage area and mounting. Go to www.bapihvac.com and select "Resource Library". Click on "Application Notes", then "Air Quality Related", and choose the link titled "Coverage Area and Mounting Recommendations for BAPI Indoor Air Quality Sensors".

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Diagnostics

POSSIBLE PROBLEMS:	POSSIBLE SOLUTIONS:
General troubleshooting	- Make sure the input is set up correctly in the controller and BAS.
	- Check wiring for proper termination
	- Check for corrosion at either the controller or the sensor. Clean off the corrosion, re-strip the interconnecting wire and reapply the connection. In extreme cases, replace the controller, interconnecting wire and/or sensor.
	- Check the wiring between the unit and the controller. Label wires and terminals at the sensor end and the controller end. Disconnect the interconnecting wires from the controller and the sensor. With the interconnecting wires separated at both ends, measure the resistance from wire-to-wire with a multimeter. The meter should read greater than 10 Meg-ohms, open or OL depending on the meter you have. Short the interconnecting wires together at one end. Go to the other end and measure the resistance from wire-to-wire with a multimeter. The meter should read less than 10 ohms (22 gauge or larger, 250 feet or less). If either test fails, replace the wire.
Unit does not operate	- Cycle power.
	- Check power for proper polarity.
	- Disconnect the power wires at the controller and measure the voltage coming from the power source. If the voltage is outside the limits specified on page 10, troubleshoot the power source. Reconnect power wires to controller when finished
	- Disconnect the power wires at the sensor and measure the wires for the same voltage as at the controller. If the voltage is different from that measured at the source, troubleshoot the wire. Reconnect power wires to sensor when finished.
	- Measure the power at the sensor with the power wires connected to the sensor and the power source. If the voltage is outside the limits specified on page 10, call your BAPI representative.
Environmental operating range exceeded	- Temperatures above 158°F (70°C) for more than 1 month will damage the sensor.
	- Humidity below 15% for more than 3 months will damage the sensor.
	- High temperatures for short periods of time will cause the sensor to report higher than actual readings, but will recover when returned to the operating range.
	- Low temperatures and low humidity for short periods of time will cause the sensor to report lower than actual readings, but will recover when returned to the operating range

ADDITIONAL DISPLAY MESSAGES AND INDICATION

Display Message	LED	Indication
Please install module	Flashing Yellow	Sensor Module is loose or missing. Securely plug in a sensor module
mA Output Fault	Flashing Red	Unit is configured for mA output, but the loop resistance is incorrect. Troubleshoot connection.
V Output Fault	Flashing Red	Unit is configured for voltage output, but the output voltage is incorrect. Troubleshoot connection
Replace Sensor	Flashing Yellow	Sensor Module failed self-test, replace the sensor module
Self-Test	Solid Yellow	Sensor Module is performing a self-test

Note: If you are experiencing any other problems besides those described above, contact your BAPI representative.

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