



Ultima[®] X Series Gas Monitors

instruction manual

WARNING

THIS MANUAL MUST BE CAREFULLY READ BY ALL INDIVIDUALS WHO HAVE OR WILL HAVE THE RESPONSIBILITY FOR USING OR SERVICING THE PRODUCT. Like any piece of complex equipment, the unit will perform as designed only if it is installed, used and serviced in accordance with the manufacturer's instructions. OTHERWISE IT COULD FAIL TO PERFORM AS DESIGNED AND PERSONS WHO RELY ON THIS PRODUCT FOR THEIR SAFETY COULD SUSTAIN SEVERE PERSONAL INJURY OR DEATH.

The warranties made by Mine Safety Appliances Company with respect to the product are voided if the product is not used and serviced in accordance with the instructions in this manual. Please protect yourself and others by following them. We encourage our customers to write or call regarding this equipment prior to use or for any additional information relative to use or repairs.

In the U.S., to contact your nearest stocking location, dial toll-free 1-800-MSA-INST. To contact MSA International, dial 1-412-967-3354.

This manual is available on the internet at www.msanet.com

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Manufactured by
MSA INSTRUMENT DIVISION
P.O. Box 427, Pittsburgh, Pennsylvania 15230

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MSA Instrument Warranty

- 1. Warranty-** Seller warrants that this product will be free from mechanical defect or faulty workmanship for a period of eighteen (18) months from date of shipment or one (1) year from installation, whichever occurs first, provided it is maintained and used in accordance with Seller's instructions and/or recommendations. This warranty does not apply to expendable or consumable parts whose normal life expectancy is less than one (1) year such as, but not limited to, non-rechargeable batteries, sensor elements, filter, lamps, fuses etc. The Seller shall be released from all obligations under this warranty in the event repairs or modifications are made by persons other than its own or authorized service personnel or if the warranty claim results from physical abuse or misuse of the product. No agent, employee or representative of the Seller has any authority to bind the Seller to any affirmation, representation or warranty concerning the goods sold under this contract. Seller makes no warranty concerning components or accessories not manufactured by the Seller, but will pass on to the Purchaser all warranties of manufacturers of such components. **THIS WARRANTY IS IN LIEU OF ALL OTHER WARRANTIES, EXPRESSED, IMPLIED OR STATUTORY, AND IS STRICTLY LIMITED TO THE TERMS HEREOF. SELLER SPECIFICALLY DISCLAIMS ANY WARRANTY OF MERCHANTABILITY OR OF FITNESS FOR A PARTICULAR PURPOSE.**
- 2. Exclusive Remedy-** It is expressly agreed that Purchaser's sole and exclusive remedy for breach of the above warranty, for any tortious conduct of Seller, or for any other cause of action, shall be the repair and/or replacement at Seller's option, of any equipment or parts thereof, which after examination by Seller is proven to be defective. Replacement equipment and/or parts will be provided at no cost to Purchaser, F.O.B. Seller's Plant. Failure of Seller to successfully repair any nonconforming product shall not cause the remedy established hereby to fail of its essential purpose.
- 3. Exclusion of Consequential Damage-** Purchaser specifically understands and agrees that under no circumstances will seller be liable to purchaser for economic, special, incidental or consequential damages or losses of any kind whatsoever, including but not limited to, loss of anticipated profits and any other loss caused by reason of nonoperation of the goods. This exclusion is applicable to claims for breach of warranty, tortious conduct or any other cause of action against seller.

General Warnings and Cautions

WARNING

1. The Ultima X Series Gas Monitors described in this manual must be installed, operated and maintained in strict accordance with their labels, cautions, warnings, instructions, and within the limitations stated.
2. The Ultima X Series Gas Monitor is designed to detect gases or vapors in air. It cannot measure the concentration of gases or vapors in steam or inert or oxygen-deficient atmospheres. The oxygen sensor can measure oxygen-deficient atmospheres.
3. Electrochemical sensors are sealed units which contain a corrosive electrolyte. Should a sensor develop leakage, it must be immediately removed from service; then, remove it from the sensing head and discard it properly. Caution must be exercised so that the electrolyte does not contact skin, eyes, clothing or circuitry; otherwise, serious personal injury (burns) and/or equipment damage may result.
4. Use only genuine MSA replacement parts when performing any maintenance procedures provided in this manual. Failure to do so may seriously impair instrument performance. Repair or alteration of the Ultima X Series Gas Monitor, beyond the scope of these maintenance instructions or by anyone other than an authorized MSA service personnel, could cause the product to fail to perform as designed and persons who rely on this product for their safety could sustain serious personal injury or death.
5. Do not locate the general-purpose enclosure models in an area which may contain a flammable mixture of gas and air; otherwise, an explosion may occur. The general-purpose Ultima X Series Gas Monitors can be a source of ignition and must not be mounted in an area where a flammable mixture of combustible gas and air may become present; otherwise, an explosion may occur. If such a location must be monitored, use an explosion-proof Ultima X Series Gas Monitor model.
6. The Ultima XIR Infrared combustible gas monitor detects the presence of most combustible gases by identifying the difference in the amount of infrared light energy absorbed during the presence of these gases. This monitor,

however, does NOT detect the presence of hydrogen gas and must never be used to monitor for hydrogen gas.

7. The Ultima XIR Infrared Combustible Gas Monitor does not detect the presence of acetylene gas and the presence of acetylene gas will degrade sensor performance.

Failure to follow the above can result in serious personal injury or death.

⚠ CAUTION

1. As with all gas monitors of these types, high levels of, or long exposure to, certain compounds in the tested atmosphere could contaminate the sensors. In atmospheres where an Ultima X Series Gas Monitor may be exposed to such materials, calibration must be performed frequently to ensure that operation is dependable and display indications are accurate.
2. The Ultima X Series Gas Monitor must not be painted. If painting is done in an area where a Monitor is located, care must be exercised to ensure that paint is not deposited on the sintered, metal flashback arrestor in the inlet fitting of the Ultima X Series Gas Monitor, if so equipped. Such paint deposits would interfere with the diffusion process, whereby a sample of the atmosphere being monitored diffuses into the Monitor.
3. The only absolute method to ensure proper overall operation of an Ultima X Series Monitor is to check it with a known concentration of the gas for which it has been calibrated. Consequently, calibration checks must be included as part of the routine inspection of the system.
4. Protect the Ultima X Series Gas Monitor from extreme vibration. Do not mount the sensing head in direct sunlight as this may cause overheating of the sensor.

Failure to follow the above can result in injury, product damage and/or an unsafe condition.

Table of Contents

Chapter 1

Installation 1-1

General Description 1-1

Identifying Your Unit 1-1

 Figure 1-1. General-Purpose Ultima.XA.Monitor 1-1

 Figure 1-2. Explosion-Proof Ultima.XE.Monitor 1-1

 Figure 1-3. Explosion-Proof Ultima.XIR.Monitor. 1-1

 Figure 1-4. General-Purpose XA Remote Sensor Model 1-2

 Figure 1-5. Explosion-Proof XE Remote Sensor Model 1-2

Installing Your Gas Monitor 1-3

 ▲ CAUTION 1-3

 ▲ WARNING 1-3

 Figure 1-6. Explosion-Proof XIR Remote Sensor Model 1-3

Installing the Ultima XA Gas Monitor 1-4

Installing the Ultima XE Gas Monitor 1-4

 Figure 1-7. Ultima XE and XIR Mounting Strap Mounting Method ... 1-4

Installing the Ultima XIR Gas Monitor 1-5

 ▲ WARNING 1-5

 ▲ CAUTION. 1-5

Electrical Connections for Ultima X Gas Monitors 1-5

 ▲ WARNING 1-5

 Figure 1-8. Ultima XIR 1-5

Wiring for all Models 1-6

For Milliamp Output 1-6

 ▲ WARNING 1-7

 Table 1-1. Power Signal Cable Length and Wire Size (Toxic Gas or Oxygen) Sensor, 4-20 mA Signal Output (Two Wire Sensor) 1-7

 Table 1-2. Ultima XE and XA Maximum Cable Length and 4-20 mA Signal Load 1-7

Typical Ultima X Series Gas Monitor Wiring 1-8

 Table 1-3. Cable Length and Wire Size (Power Supply 24 VDC) (Toxic Gas or Oxygen) Sensor, 4-20 mA Signal Output (Three Wire Sensor) 1-8

Table of Contents

Table 1-4. Ultima XIR Maximum Cable Length and 4-20 mA Signal Load	1-8
Figure 1-9. Circuit Board	1-9
Figure 1-10. General-Purpose Two-Wire Operation	1-10
Figure 1-11. General-Purpose Three-Wire 4 to 20 mA Operation	1-10
Figure 1-12. Explosion-Proof Two-Wire Operation	1-11
Figure 1-13. Explosion-Proof Three-Wire 4 to 20 mA Operation	1-11
Installing the Ultima X Remote Sensor Module	1-12
Electrical Connections for the Ultima X Series Remote Sensor Module	1-12
▲ WARNING	1-12
▲ CAUTION	1-12
Table 1-5. Remote Module Wiring and Placement*	1-13
Table 1-6. Remote Sensor Wiring Cable	1-13
Table 1-7. Low Temperature Wiring Cable	1-13
At the Ultima X Series Remote Sensor Location:	1-13

Chapter 2	
Start-up and Calibration	2-1
Initial Start-up	2-1
Figure 2-1. LCD Gas Concentration Display	2-1
▲ CAUTION	2-2
Table 2-1. Instrument Operation	2-3
Calibration Basics	2-4
▲ CAUTION	2-4
▲ CAUTION	2-4
Non-combustible Chemicals that Reduce Catalytic Sensor Sensitivity	2-4
Figure 2-2. Ultima Calibrator	2-4
Ultima Calibrator	2-5
Ultima Controller	2-5
Note on Resetting Latched Alarms with Controller or Calibrator	2-5
Ultima X Series Gas Monitor Calibration Output Signal	2-5
Figure 2-3. Ultima Controller	2-5
Calibration Kit	2-6
Ultima X Series Gas Monitor Calibration Procedure	2-6
INITIAL Calibration	2-6
Regular Calibration	2-7

Zeroing	2-7
Figure 2-4. Apply Zero Gas Flag	2-8
Spanning	2-9
Figure 2-5. Apply SPAN Gas Flag	2-9
Figure 2-6. Calibration End Display	2-10
XIR Calibration	2-11
▲ WARNING	2-11
Calibration Documentation	2-12

Chapter 3
Specifications **3-1**

Table 3-1. Performance Specifications	3-1
Table 3-2. Sensor Response to Interferants	3-4

Chapter 4
Maintenance **4-1**

General	4-1
Ultima XIR Cleaning Procedure	4-1
▲ CAUTION.	4-2
▲ CAUTION.	4-2
Replacing an Ultima XE or Ultima XA Sensor	4-2
Figure 4-1. "Change Sensor" Scrolls Across the Display	4-2
▲ WARNING	4-3
▲ CAUTION	4-3
▲ WARNING	4-3
Figure 4-2. Sensor Assembly and Sensor Guard for General Purpose Model	4-3
Table 4-1. Operational Display Messages	4-4
Table 4-2. Configuration Display Messages	4-5
Table 4-3. Troubleshooting Guidelines	4-5
Obtaining Replacement Parts	4-6
▲ WARNING	4-7
Table 4-4. Replacement Parts	4-7

Appendix A	
Internal Relay Option	A-1
General Information	A-1
▲ CAUTION	A-1
Unpacking, Mounting and Wiring the Ultima X Series Gas Monitor with Internal Relays	A-1
Figure A-1. Dual Module General-Purpose Ultima X Series Wiring ..	A-2
Figure A-2. Dual Module Explosion-Proof Ultima X Series Wiring . . .	A-3
Figure A-3. Single Module General-Purpose Ultima X Series Wiring	A-4
Figure A-4. Single Module Explosion-Proof Ultima X Series Wiring .	A-4
TABLE A-1. Power Cable Distances for the Ultima X Series Gas Monitor with Internal Relays (4-20 mA Model) . .	A-5
Ultima X Series Gas Monitor Internal Relays	A-5
Relay Specifications	A-5
Table A-2. Relay Specifications	A-5
Alarm Relays	A-5
Fault Relay or Trouble	A-6
Figure A-5. Relay Contacts	A-7
Optional RESET Push-button	A-8
General	A-8
RESET Button Selection	A-8
TABLE A-3. RESET Push-button Vendor	A-8
Relay Connections	A-8
▲ WARNING	A-9
Figure A-6. Relay Printed Circuit Board	A-10

Chapter 1 Installation

General Description

The Ultima X Gas Monitor is designed to sample the environment where mounted and alert you to potentially dangerous levels of your target gas, depending on your particular model. The unit is factory-calibrated and shipped ready for installation.

Identifying Your Unit

- The Ultima XA Gas Monitor is housed in a rugged, plastic general-purpose enclosure (FIGURE 1-1).
- The Ultima XE Gas Monitor is housed in a 316 stainless steel explosion-proof enclosure (FIGURE 1-2).
- The Ultima XIR Gas Monitor is housed in a 316 stainless steel explosion-proof enclosure (FIGURE 1-3).
- The Remote Sensor Models are shown in FIGURES 1-4, 1-5 and 1-6. If your unit contains internal relays, see Appendix A.

To determine your sensor type and options, check the shipping carton. Checked items are included in the carton. Also check the sensor ID label located on the sensor module. The carton label identifies:

- Type of unit supplied (Gas Monitor, Gas Monitor Less Sensor, or Sensing Module)
- Type of gas (combustible gas, toxic gas or oxygen)
- Range [% LEL, PPM (parts per million), or %]
- Output (2 or 3 wire, 4 to 20 mA)
- Any options such as internal relays and/or LEDs.



Figure 1-1.
General-Purpose Ultima
XA Monitor



Figure 1-2. Explosion-Proof
Ultima XE Monitor



Figure 1-3. Explosion-Proof
Ultima XIR Monitor

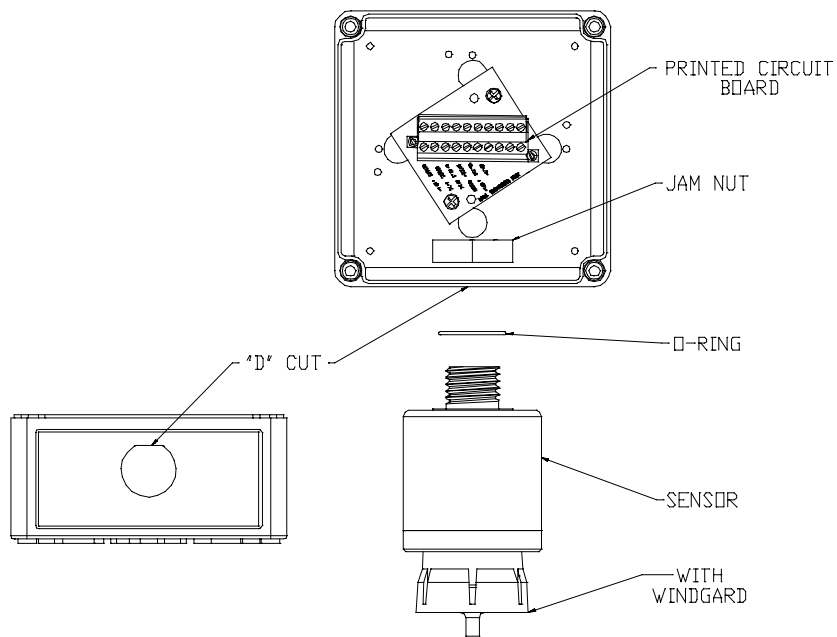


Figure 1-4.
General-Purpose XA Remote Sensor Model

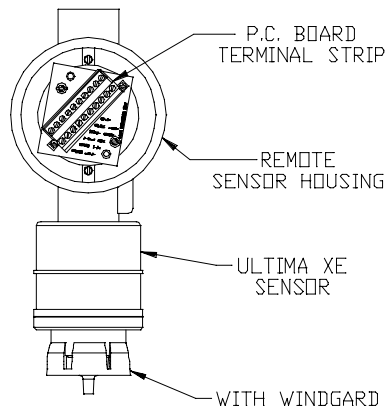


Figure 1-5.
Explosion-Proof XE Remote Sensor Model

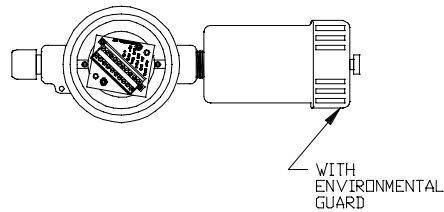


Figure 1-6.
Explosion-Proof XIR Remote Sensor Model

Installing Your Gas Monitor

NOTE: Reference installation outline drawings listed in Chapter 3, "Specifications".

Generally, the Ultima X Series Gas Monitors or remote sensing module should be mounted close to the area where a leak is likely to occur or where the gas is expected. Install the Ultima X Series Gas Monitors or the remote sensing module at a high level (ceiling) or low level (floor), depending on the density of the gas most likely to be found. Install the unit so that the front display of the unit is not blocked or hidden from view.

⚠ CAUTION

Mount the Ultima XE or XA Gas Monitor or remote sensing module with the sensor inlet fitting (FIGURE 1-1, 1-2, 1-4 or 1-5) pointed downwards; otherwise, the inlet may become clogged with particulate matter or liquids.

Mount the Ultima XIR Gas Monitor or Remote Sensing Module with the sensor inlet fitting extended horizontally from the main enclosure (FIGURE 1-3 and 1-6) to help prevent the build-up of particulate or liquid matter on the monitor's optical surfaces.

Do not paint the Ultima X Series Gas Monitors. If painting is done in an area where a sensor is located, exercise CAUTION to ensure paint is not deposited on the sensor inlet fitting. Such paint deposits would interfere with the diffusion process, whereby a sample of the monitored atmosphere diffuses into the sensor. In addition, solvents in the paint may cause an alarm condition to occur.

Protect the Ultima X Series Gas Monitors from extreme vibration. Do not mount sensing head in direct sunlight as this may cause overheating of the sensor.

⚠ WARNING

Do not locate the general-purpose enclosure models in an area which may contain a flammable mixture of gas and air; otherwise, an explosion may occur. The general-purpose Ultima X Series Gas Monitors can be a source of ignition and must not be mounted in an area where a flammable mixture of combustible gas and air may become present; otherwise, an explosion may occur. If such a location must be monitored, use an explosion-proof gas monitor.

Installing the Ultima XA Gas Monitor

Remove lid and drill enclosure for power, signal and optional relay cable entry. Use one of the following methods to mount the general-purpose Ultima XA Gas Monitor/Less Sensor or the Ultima XA Gas Monitor.

- Using customer-installed wiring holes, install the Ultima XA Gas Monitor to the end of rigid conduit.
- Use mounting holes in the corners of the Ultima XA enclosure to mount directly to a wall.

Installing the Ultima XE Gas Monitor

- Use the optional mounting strap (P/N 697281) that can be attached to the rear holes of the Ultima XE Gas Monitor (FIGURE 1-7).
- The Ultima XE Gas Monitor main enclosure can be rotated 360° and mounted to ensure easy access to any of the four entryways. The electronics assembly can be installed in any of the four self-aligning positions to ensure the display is properly oriented.
- The Ultima XE Gas Monitor sensor is not shipped attached to the main enclosure. Mount the sensor module with the applicable conduit only. Ensure the sensor wiring harness is through the entry and the sensor is pointing downward. Tighten with a strap wrench.

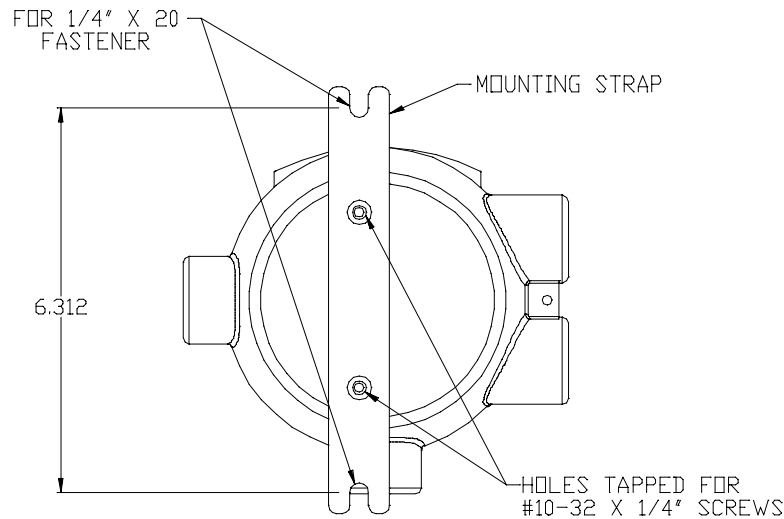


Figure 1-7.
Ultima XE and XIR Mounting Strap Mounting Method

Installing the Ultima XIR Gas Monitor

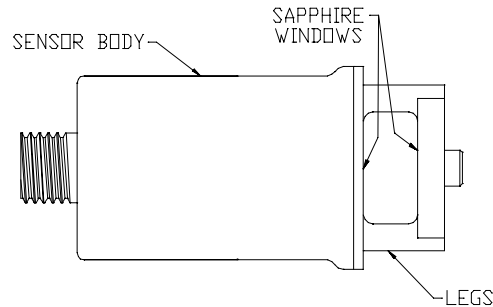


Figure 1-8.
Ultima XIR

⚠ WARNING

The Ultima XIR Combustible Gas Monitor contains no user- or field-serviceable parts and must be returned to the factory for repair. Any attempt to open the monitor will damage the unit and void the warranty.

- Use the optional mounting strap (P/N 697281) that can be attached to the rear holes of the Ultima XE Gas Monitor (FIGURE 1-7).
- The Ultima XE Gas Monitor main enclosure can be rotated 360° and mounted to ensure easy access to any of the four entryways. The electronics assembly can be installed in any of the four self-aligning positions to ensure the display is properly oriented.

⚠ CAUTION

Under no circumstances should a wrench or pry-bar be applied to the two legs that support the unit's reflectors during installation or removal of the sensor (FIGURE 1-8). Applying force to the legs can permanently damage the monitor.

The monitor's environmental guard should be installed on the unit at all times. If the monitor is to be operated without the guard, frequent checks should be made to ensure particulate or liquid matter has not collected on the windows.

Electrical Connections for Ultima X Gas Monitors

⚠ WARNING

Before wiring the Ultima X Series Gas Monitors, disconnect power source supplying the monitor; otherwise, electrical shock could occur.

For Ultima XE and XIR installations, the internal grounding terminal must be used for equipment grounding. The external grounding terminal is only to be used as a supplemental bonding connection where local authorities permit or require such a connection.

NOTE: For Ultima X Series units with internal relays, see Appendix A.

This assembly is marked to identify power, ground and signal connections.

- A *two-wire* connection is possible for certain:
 - Toxic Gas models with 4 to 20 mA output
 - Oxygen models with 4 to 20 mA output
- A *three-wire* connection is required for all:
 - Combustible Gas models
 - Toxic and Oxygen Models with 4 to 20 mA output, that are to be operated in connection with accessory functions (relays, etc.).

Wiring for all Models

In these installations, twisted-pair, instrument quality cable is recommended. Shielded cable is recommended for cable runs where interferences from radio frequency interference (RFI), electromagnetic interference (EMI) or other noise sources exist (such as motors, welding equipment, heaters, etc.).

NOTE: See Installation Outline Drawings for wiring details as specified in Chapter 3, "Specifications".

Conduit may also be needed in areas where large amounts of electrical noise is expected.

Use caution when selecting a cable size. The following tables express the maximum cable length when only using the Ultima X Series Gas Monitors. Ultima X Series options may take additional power which requires a heavier cable or a short cable run.

When selecting cable size, consider future needs (i.e., addition of sensors and/or options available with the Ultima X Series Monitors). See Chapter 3, "Specifications" for proper input voltage.

Ensure that water and dirt are not able to enter the unit via the wire or conduit. If the unit is installed in a location known to be wet or damp, it is good practice to loop or bend the entry into the unit that prevents water incursion.

For Milliamp Output

The Ultima X Series Gas Monitors may be connected to any device capable of accepting 4 to 20 mA analog signals such as:

- Model 5000 unit (with 4 to 20 mA inputs)
- Quad Gas Controller
- Programmable controllers
- DCS's, etc.

An external power supply is required. (For power requirements, see Chapter 3, "Specifications".) All connections should be made by following appropriate wire code procedures.

- See TABLES 1-1 through 1-4 for typical cable length and wire size for installation.

⚠ WARNING

When using any of the the Ultima X Series accessories (such as relays) with the 4 to 20 mA output Ultima X Series Gas Monitor, a three-wire connection must be used. Failure to use a three-wire connection could damage the electronics within the Ultima X Series Gas Monitor which can result in serious personal injury or death.

Be sure to install your Ultima X Series Gas Monitor according to National Electrical and local procedural codes. Failure to do so can result in an unsafe condition.

NOTE: TABLES 1-1 through 1-4 do not apply to Ultima X Series Gas Monitors with Internal Relays. If Internal Relays exist, see Appendix A.

Table 1-1. Power Signal Cable Length and Wire Size (Toxic Gas or Oxygen) Sensor, 4-20 mA Signal Output (Two Wire Sensor)				
WIRE SIZE	MAXIMUM CABLE LENGTH IN FEET @ 24 VDC	MAXIMUM LOAD RESISTANCE	MAXIMUM CABLE LENGTH IN FEET @ 12 VDC	MAXIMUM LOAD RESISTANCE
22 AWG	7,000	600 Ohms	4,000	100 Ohms

Table 1-2. Ultima XE and XA Maximum Cable Length and 4-20 mA Signal Load				
POWER SUPPLY	24 VOLTS		12 VOLTS	
CONFIGURATION	NO RELAYS	RELAYS INSTALLED	NO RELAYS	RELAYS INSTALLED
22 AWG CABLE	1000 FEET	800 FEET	---	---
18 AWG CABLE	2500 FEET	2100 FEET	900 FEET	640 FEET
16 AWG CABLE	4200 FEET	3000 FEET	1400 FEET	900 FEET
12 AWG CABLE	10,000 FEET	7700 FEET	3600 FEET	2200 FEET
MAXIMUM LOAD ON 4 - 20 mA SIGNAL	600 OHMS		300 OHMS	

**Table 1-3.
Cable Length and Wire Size (Power Supply 24 VDC) (Toxic Gas or Oxygen) Sensor, 4-20 mA Signal Output (Three Wire Sensor)**

WIRE SIZE	MAXIMUM CABLE LENGTH IN FEET	MAXIMUM LOAD RESISTANCE
22 AWG	12,000	600 Ohms

Table 1-4. Ultima XIR Maximum Cable Length and 4-20 mA Signal Load

POWER SUPPLY	24 VOLTS		12 VOLTS	
CONFIGURATION	NO RELAYS	RELAYS INSTALLED	NO RELAYS	RELAYS INSTALLED
18 AWG CABLE	2000 FEET	1500 FEET	300 FEET	250 FEET
16 AWG CABLE	3500 FEET	2500 FEET	500 FEET	400 FEET
12 AWG CABLE	5000 FEET	4000 FEET	900 FEET	600 FEET
MAXIMUM LOAD ON 4 - 20 mA SIGNAL	600 OHMS		300 OHMS	

Typical Ultima X Series Gas Monitor Wiring

- Two-wire 4 to 20 mA Ultima X Series Monitors operate in the current loop mode (FIGURE 1-10 for general-purpose) (FIGURE 1-12 for explosion-proof)
- Three-wire Ultima X Series Monitors operate in the current source mode (see FIGURE 1-11 for general-purpose) (FIGURE 1-13 for explosion-proof).
 1. Identify the main pc board as a two-wire or a three-wire unit:
 - **For XA Gas Monitors**
while looking at the main pc board, locate the identifying label on the underside of the lid:
 - A-ULTX-PCB-A-B is a two-wire unit
 - A-ULTX-PCB-A-E is a three-wire unit
 - **For XE and XIR Gas Monitors**
locate the identifying label on the side of the plastic shroud for the main pc board:
 - A-ULTX-PCB-E-B is a two-wire unit
 - A-ULTX-PCB-E-E is a three-wire unit

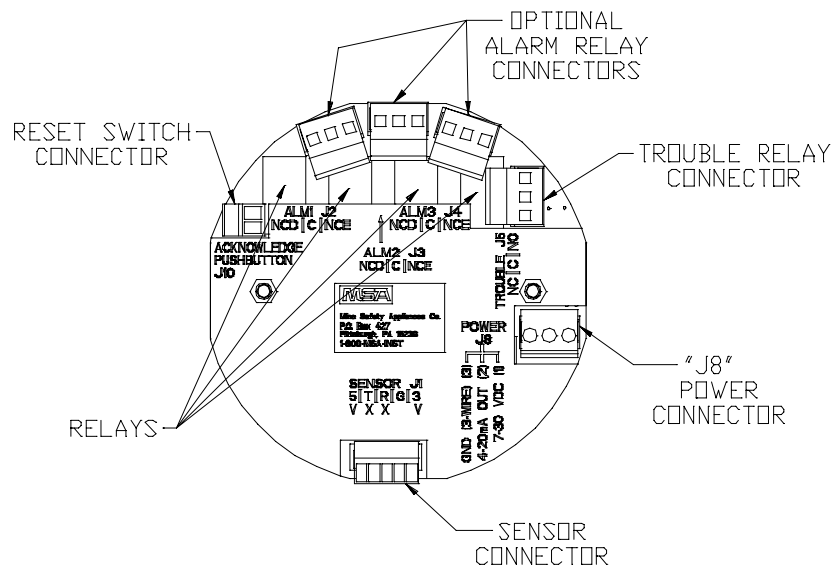


Figure 1-9.
Circuit Board

2. Connect 7 to 30 VDC power lead to J8-1 (see FIGURE 1-9).
3. Connect J8-2 to 4 to 20 mA input on remote system.
4. For three-wire operation, connect the signal ground to J8-3 (for two-wire operation, there is no connection to J8-3).
5. Connect the sensor module to labeled connector J-1 on the main pc board.
6. Wire for optional relays and/or acknowledge push-button (see Appendix A).
7. Assemble lid on enclosure.

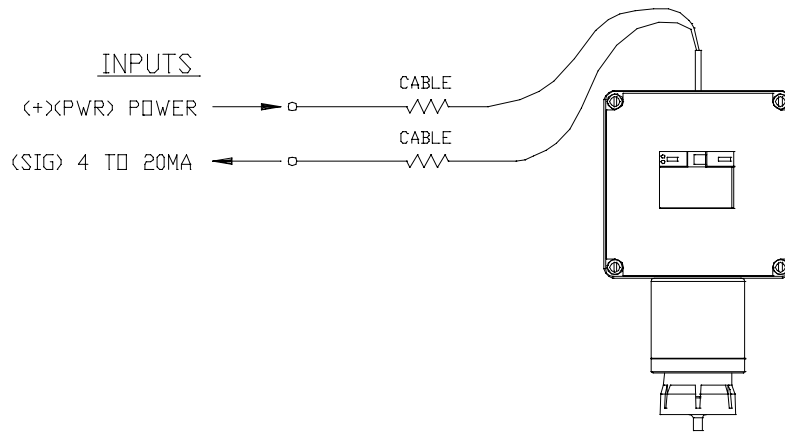


Figure 1-10.
General-Purpose Two-Wire Operation

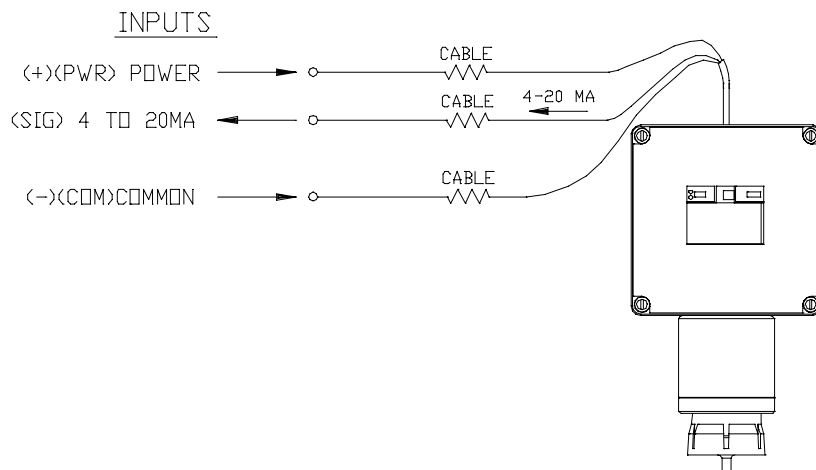


Figure 1-11.
General-Purpose Three-Wire 4 to 20 mA Operation

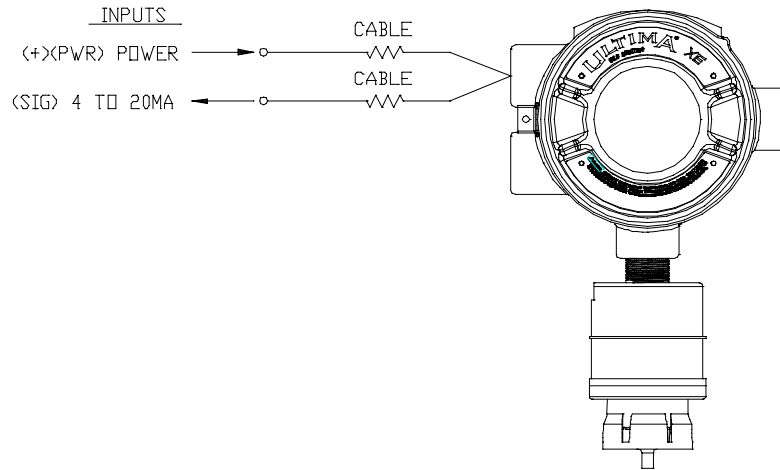


Figure 1-12.
Explosion-Proof Two-Wire Operation

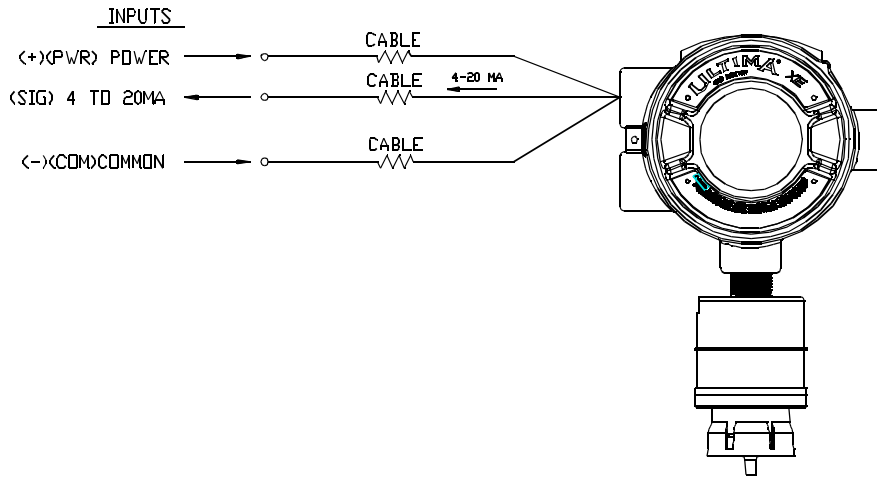


Figure 1-13.
Explosion-Proof Three-Wire 4 to 20 mA Operation

Installing the Ultima X Remote Sensor Module

The Remote Sensor Module is used with the Ultima X Gas Monitor/less sensor.

The Remote Sensor Module can be mounted in a manner similar to the gas monitor installation in the preceding procedure and at a maximum distance outlined in TABLE 1-5.

Permanently connect 1/4" ID tubing to the post on the windguard. Route this tubing to the Ultima X Gas Monitor, ensuring that there are no kinks, leaks or other obstructions. Secure this tubing near the monitor; it is used to deliver check gas to the sensor module during calibration.

Electrical Connections for the Ultima X Series Remote Sensor Module

WARNING

Before wiring the Ultima X Series Remote Sensor Module, disconnect the power source feeding the Remote Sensor Module and the Ultima X Series Gas Monitor/Less Sensor; otherwise, electrical shock could occur.

CAUTION

When installing an Ultima X Series Remote Sensor Module with its mating Ultima X Series Gas Monitor/Less Sensor, follow National Electrical and local procedural Codes; failure to do so can result in an unsafe condition.

Five conductors are required for the Ultima XE and Ultima XA Remote Sensor Modules. Four conductors are required for the Ultima XIR Remote Sensor Module. The Ultima X Series Monitor has a five-wire terminal to accommodate up to #16 AWG conductors.

Some installations require metal pipe or metallic conduit. In these cases, separate conductors or unshielded cable may be used.

For open wiring, shielded wire or cable should be used to minimize the possibility of noise interference and contact with other voltages. Selection of this shielded cable must comply with local requirements.

Table 1-5. Remote Module Wiring and Placement*		
GAS TYPE	MINIMUM WIRE SIZE	MAXIMUM DISTANCE
Toxic and Oxygen	20 AWG	100 FEET
Catalytic Combustible	18 AWG	50 FEET
	16 AWG	100 FEET
IR Combustible	16 AWG	50 FEET
	12 AWG	100 FEET
* CE-Approved instruments have a maximum 50-foot distance.		

TABLE 1-6 shows suggested cables for Ultima X Series inhalations; other cables are available which are also adequate.

Table 1-6. Remote Sensor Wiring Cable		
SUPPLIER	CATALOG NUMBER	DESCRIPTION
ALPHA WIRE CORP.	5525	5 cond., shielded, 18 AWG
	5535	5 cond., shielded, 16 AWG
	5514	4 cond., shielded, 20 AWG

Table 1-7. Low Temperature Wiring Cable		
SUPPLIER	CATALOG NUMBER	DESCRIPTION
ALPHA WIRE CORP.	45525	5 cond., shielded, 18 AWG
	45366	6 cond., shielded, 16 AWG
	45545	5 cond., shielded, 14 AWG

At the Ultima X Series Remote Sensor Location:

1. Open the Ultima X Series Remote Sensor cover by removing lid.
2. For the Ultima XA Gas Monitor, route the cable from the Gas Monitor through a customer-supplied opening in the enclosure and wire it to the terminal block (FIGURE 1-4).
For the Ultima XE or XIR Gas Monitor, route the cable from the Gas Monitor through a wire entry hole in the enclosure and wire it to the terminal block (FIGURE 1-5 or 1-6).
3. Verify the identity of each conductor of the cable and connect the wire to the terminal block.
4. Re-install the cover of the Ultima X Series Remote Sensor

NOTES:

- Incoming power and signal cable shield should be earth grounded at the power source. Connect power and remote sensor cable shields to shield terminals on main pc board. Provide shield terminations inside the sensor housing as indicated on Installation Outline Drawings for Remote Sensor; see Table 3-1 for Installation Outline Drawing document numbers.
- Cables larger than #16 AWG will require a splice of smaller cable to fit the connector.

Chapter 2 Start-up and Calibration

Initial Start-up

- The Ultima X Series Gas Monitors are factory-calibrated and ready for immediate use.
- Once power is applied to the unit, the LCD shows a test of all display words. The software version number displays; then, a 30-second (self-check) countdown for sensor stability begins.
- During the 30-second countdown, the output signal is the same as the calibration signal when enabled during a normal calibration. This is described later in this chapter under "Ultima X Series Gas Monitor Calibration Output Signal".
- For units with LEDs, the Alert red LED will be solid ON during the 30-second countdown.
- After the 30-second countdown, observe that the gas type and gas concentration (ppm, % Gas, or % LEL) alternately flash (FIGURE 2-1).
- For units with LEDs, the Normal green LED will be solid ON after the 30-second countdown.
- A complete listing of instrument operation features can be found in TABLE 2-1.

During normal operation, the Ultima X Monitor displays the gas concentration of the surrounding environment. The corresponding output signal can be transmitted to a controller.

NOTE: The catalytic combustible model of the Ultima X Series Gas Monitors is capable of detecting concentrations of certain combustible gases above 100% LEL. When exposed to these concentrations, the Ultima X Series Gas Monitors will display one of two modes:

- **+LOC % LEL** - The Ultima X Series Gas Monitor has been exposed to a high concentration of gas (above the LEL)

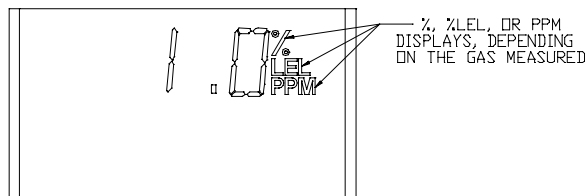


Figure 2-1.
LCD Gas Concentration Display

and there is a *possibility* that the over-range condition may still exist.

- **OVER % LEL** - The Ultima X Series Gas Monitor has been exposed to a high concentration of gas (above the LEL) and the over-range condition *definitely* still exists.

⚠ CAUTION

In either mode, correct the condition causing the excessive gas level and vent or purge the area before attempting the following.

In the +LOC % LEL mode, the output signal will also be locked at full-scale. If this condition occurs, the Ultima X Series Gas Monitor must be unlocked by performing a "Zero Function" with the Ultima X Series Gas Monitor Calibrator or Controller. The Ultima X Series Gas Monitor will not revert to a normal condition until a successful zero operation has been performed. This is an exclusive safety feature of the Ultima X Series Gas Monitor which pre-empts the possibility of ambiguous readings when the sensor is exposed to concentration of gas above 100% LEL.

In the OVER % LEL mode, the combustible gas is over the 100% LEL range. It returns to normal operation when gas concentration level falls below 100% LEL.

Table 2-1. Instrument Operation				
OPERATION	LEDs		4 to 20 mA	FAULT RELAY
	GREEN	RED		
NORMAL NO ALARMS	ON steady	OFF	Gas value	Energized
ALARMING	OFF	Flashing	Gas value	Energized
FAULT	OFF	ON steady	3.0 mA	De-energized
POWER UP/COUNTDOWN	OFF	ON steady	ALERT option ¹ disabled: 21.0 mA for O ₂ ; 3.75 mA for others	Energized if ALERT option disabled
			ALERT option ¹ enabled: 3.75 mA for all	De-energized if ALERT option enabled ¹
SENSOR MISSING/COUNTDOWN	OFF	ON steady	3.0 mA if SWAP delay timeout ² expired, SWAP Delay ³ disabled or FAULT	De-energized if SWAP delay timeout ² expired, SWAP delay ³ disabled or FAULT
			Previous gas value if SWAP delay ³ enabled and SWAP delay timeout ² not expired	Energized if swap delay ³ enabled and SWAP delay timeout ² not expired
SENSOR CAL	OFF	ON steady	3.75 mA if cal signal enabled and ALERT option ¹ enabled; gas value if cal signal disabled	Energized if ALERT option disabled
			21.0 mA for O ₂ if cal signal enabled and ALERT option ¹ disabled	De-energized if ALERT option enabled ¹
CAL 4-20	OFF	ON steady	4 mA if 4 mA calibration selected	Energized if ALERT option disabled
			20 mA if 20 mA calibration selected	De-energized if ALERT option enabled ¹
CAL FAULT	OFF	ON steady	Gas value	De-energized two seconds every minute
UNDERRANGE	OFF	ON steady	3.0 mA if gas value 0 or less; gas value otherwise	De-energized
OVERRANGE/LOC	ON steady ⁴	OFF ⁴	21.0 mA	Energized
NOTES:				
¹ See Controller/Calibrator manual for ALERT option				
² Swap Delay timeout is 60 seconds if enabled; 0 seconds otherwise				
³ See Controller/Calibrator manual for SWAP Delay option				
⁴ Alarming operation will be followed if the alarms are enabled				

Calibration Basics

While the Ultima X Series Gas Monitor is factory-calibrated, it is good practice to calibrate the unit once it is installed in its final environmental destination.

As with any type of gas monitor, the only true check of its performance is to apply gas directly to the sensor. The frequency of the calibration gas tests depends on the operating time and chemical exposures of the sensors. New sensors should be calibrated more often until the calibration records prove sensor stability. The calibration frequency can then be reduced to the schedule set by the safety officer or plant manager.

Before calibrating, the Ultima X Series Gas Monitor must be powered for a minimum of one hour to allow the sensor to settle into its new environment.

⚠ CAUTION

Before attempting a calibration, power the unit at least one full hour.

⚠ CAUTION

To ensure a fully functional sensor, perform a calibration check and adjustments at initial start-up and at regular intervals.

Non-combustible Chemicals that Reduce Catalytic Sensor Sensitivity

Catalytic Combustible sensors located in areas where non-combustible chemicals may leak, particularly ones known to reduce the sensitivity (see following list) should be calibrated after such exposures.

- Silanes, Silicates, Silicones and Halides (compounds containing Fluorine, Chlorine, Iodine or Bromine)
- TABLE 3-2 in Chapter 3 lists interferants for electrochemical sensors.

When it is determined that calibration adjustments are required, the Ultima X Series Gas Monitor provides a one-man, non-intrusive method of adjustment at the unit.

To calibrate the unit, one of the following accessories is necessary:

- Ultima Calibrator P/N 809997 (FIGURE 2-2)

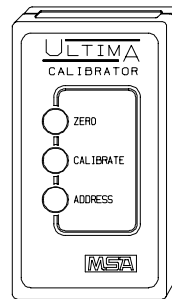


Figure 2-2.
Ultima Calibrator

- Ultima Controller P/N 809086 (FIGURE 2-3)

Ultima Calibrator

The Ultima Calibrator allows the following functions:

- Zero
- Calibration (zero and span)
- Changing address for some models.

Ultima Controller

The Ultima Controller also provides the above functions plus access to the following features:

- Three levels of alarm and relays
- Date of last successful calibration
- Maximum gas readings over selected time periods
- Average gas readings over selected time periods
- Changing span gas value from factory-set value
- Access to real-time clock for time and date
- Changing of full scale value.

NOTE: See Ultima/Ultima X Controller/Calibrator manual (P/N 813379) for full functionality.

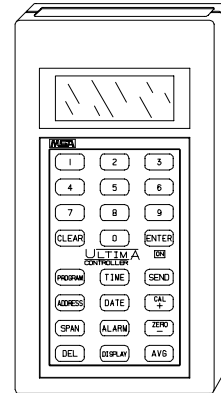


Figure 2-3.
Ultima Controller

Note on Resetting Latched Alarms with Controller or Calibrator

When an Ultima X Series Gas Monitor has an active latched alarm (indicated by a flashing alarm display):

- An infrared (IR) remote device (such as the Ultima Calibrator or Controller) may be used to reset this alarm.
- The next IR command it receives from a calibration device will reset the latched alarm (if it is not beyond the alarm threshold). The intended IR command will be ignored and interpreted as an 'alarm reset.' When the latching alarm function is inactive, other valid IR commands may be used.

Ultima X Series Gas Monitor Calibration Output Signal

The Ultima X Series Gas Monitor is shipped with the calibration output signal disabled so the output signal will track the gas concentration value during the calibration process. In some applications, it may be desirable to disable or lock the output to a pre-determined output value to prevent activation of alarm devices. The calibration signal can be enabled using the Ultima Controller. When the calibration signal is enabled, the output signal is 3.75 milliamps for the 4 to 20 milliamp output models.

NOTE: For the range of 25% oxygen, the calibration signal will be 21 mA. Oxygen can be set to a 3.75 mA calibration signal (see Ultima Controller manual).

Calibration Kit

Calibration Kits are available for the Ultima X Gas Monitors. For the recommended calibration kit, see Ultima Controller/Calibrator manual (P/N 813379).

Ultima X Series Gas Monitor Calibration Procedure

Read all calibration instructions before attempting an actual calibration. Also, identify and become familiar with all of the calibration components. During the calibration, it is necessary to quickly apply the span gas to the unit. Prior connection of the calibration components will aid in the ease of unit calibration.

The only true check of any gas monitor's performance is to apply gas directly to the sensor. The calibration procedure must be performed regularly.

INITIAL Calibration

When the unit is powered up for the first time, or when a new sensor module is placed in the unit, an *INITIAL* Calibration is recommended. This procedure enables the unit to gather data about the sensor to make accurate decisions for the CHANGE SENSOR function and the CAL FAULT function to work properly. During normal use, *INITIAL* calibration should only be used when a regular calibration will not clear a fault condition due to use of incorrect calibration gas or another similar situation.

The *INITIAL* calibration is accomplished by simultaneously pressing the ZERO and CALIBRATE buttons of the Ultima Calibrator or by pressing and holding the SPAN button on the Ultima Controller.

- The display should show "APPLY ZERO GAS"
- The word "ICAL" on the display distinguishes an *INITIAL* Calibration from a regular calibration. If "ICAL" does not appear, abort the calibration; then, retry the above procedure.

NOTE: The zero or calibration process can be aborted at any time simply by pressing any button during the 30-second countdown on the Calibrator while aiming at the unit.

- The remainder of the procedure is now the same as that for a regular calibration, as described in the following procedure.

Regular Calibration

A regular calibration includes a "zero" and "span" procedure as described in the following procedures. If the user chooses to only perform a "zero" procedure, they may do so by pressing the ZERO button on the Calibrator or Controller instead of the CALIBRATE button as described as follows.

Zeroing

1. **If Using the zero cap:**

If the ambient air is suitable, with no traces of the gas of interest, place the appropriate Calibration Kit zero cap over the SensorGard inlet and wait two minutes; otherwise, use zero gas.

2. **If Using zero gas cylinder:**

- a. Locate the zero gas cylinder and the Calibration Kit Flow Controller.
- b. Screw the Flow Controller onto the top of the zero gas cylinder.
- c. Locate the Tube Assembly from the cal kit.
- d. Push the smaller end of the Tube Assembly over the Flow Controller gas outlet and ensure tubing completely covers the gas outlet.
- e. When using Cal Kit 40, connect the other end of the tubing over the SensorGard inlet.

When using Cal Kit 41, locate the cal cap (with hole for tubing) and push the tubing through the hole in the bottom of the cap. Then, connect the end of the tubing over the sensor inlet and push the calibration cap over the entire sensor inlet.

- f. Turn on the zero gas flow by turning the knob on the flow controller.
3. Point the Calibrator or Controller at the Ultima X Series Monitor display; press the CALIBRATE button.

NOTE: The zero or calibration process can be aborted at any time during the 30-second countdown interval; simply press any button on the Calibrator or Controller while aiming it at the unit.

NOTE: The 30-second countdown interval is omitted for oxygen units; it is electronically zeroed.

The display shows:

- A countdown from 30 to 0 seconds
- APPLY ZERO GAS (FIGURE 2-4)

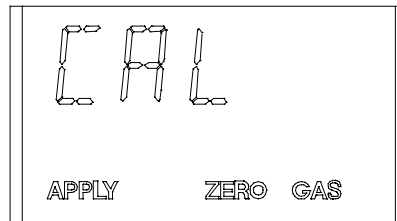


Figure 2-4.

Apply Zero Gas Flag

4. After the 30 second countdown:
 - The display alternates between "CAL" and a value. This value is the actual reading of the gas concentration the sensor is detecting.
 - Once the gas value on the display is stable, the alternating display stops. If the calibration is successful, the display will show END.
 - a. **If using the zero cap:** remove it.
 - b. **If using a zero gas cylinder:**
 - 1) Turn OFF the gas flow by turning the flow controller knob.
 - 2) Remove the tubing from the SensorGard.
 - If the calibration output signal is enabled during calibration, it will be held at the lockout value for an additional two minutes or until after the span routine if performing a full calibration.
 - c. If CAL FAULT appears on the display, this indicates:
 - An unsuccessful attempt to zero or calibrate the Ultima X Series Monitor
 - The Ultima X Series Monitor is operating with the calibration parameters defined before the calibration was attempted.
 - See Troubleshooting Guidelines found in Chapter 4.

To extinguish the CAL FAULT, a complete, successful calibration procedure must be performed.

The Ultima X Series Monitor allows automatic zero adjustment only within a pre-defined range. It cannot make corrections outside this range, such as when an empty or wrong cylinder of gas is applied or failure to begin gas flow within the allotted 30-second countdown occurs.

- If only a ZERO was performed, the procedure is complete and the user should return the calibration equipment to the cal kit. If a CAL was performed, the gas monitor will continue to the "span" sequence as described in the following section.

Spanning

5. During a regular calibration, the Ultima X Series Monitor automatically begins the span countdown after a successful zeroing of the unit. The span countdown is 30 seconds (FIGURE 2-5).

NOTE: The span process can be aborted at any time during the countdown by simply pressing any button on the Calibrator while aiming it at the unit.

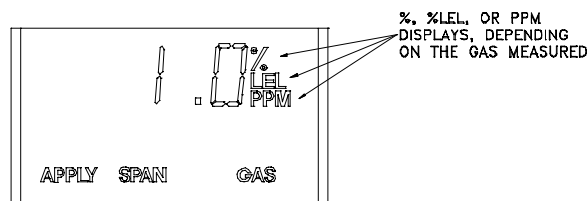


Figure 2-5.
Apply SPAN Gas Flag

6. Locate the span gas cylinder and the Calibration Kit Flow Controller.
7. Screw the Flow Controller onto the top of the span gas cylinder.
8. Locate the Tube Assembly from the cal kit.
9. Push the smaller end of the Tube Assembly over the gas outlet of the Flow Controller and ensure that the tubing completely covers the gas outlet.
10. When using Cal Kit 40, connect the other end of the tubing over the SensorGard inlet.

When using Cal Kit 41, locate the cal cap (with hole for tubing) and push the tubing through the hole in the bottom of the cap. Then, connect the end of the tubing over the sensor inlet and push the calibration cap over the entire sensor inlet.

11. Turn ON the gas flow by turning the flow controller knob.
 - It is good practice to have all calibration components previously assembled.
 - Ensure that any calibration gases are applied during the 30-second count down period.
 - If a CAL FAULT indication is on the Ultima X Series Monitor display before the user is able to apply the gas, a steady state gas condition was reached, causing the unit to use a wrong reading as a span indication.
 - It is necessary to restart the calibration process to clear this condition.
12. After the 30 second countdown:
 - The display alternates between "CAL" and a value. This value is the actual reading of the gas concentration the sensor is detecting.
 - Once the gas value on the display is stable, the alternating display stops. If the calibration is successful, the display will show END for approximately two seconds. (FIGURE 2-6).
 - No user adjustments are necessary.
 - The display will show the span gas value while the span gas is flowing to the unit.

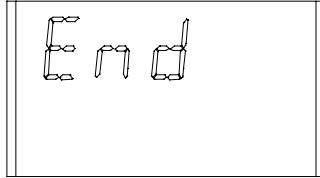


Figure 2-6.
Calibration End Display

13. Turn OFF the gas flow by turning the knob on the flow controller.
 - If the calibration output signal is enabled during calibration, it will be held at the lockout value for two additional minutes after END is displayed.
 - When the span gas is removed from the sensor, the sensor reading should change to show an ambient condition.
 - If a CAL FAULT appears on the display, this indicates:

- An unsuccessful attempt to calibrate the Ultima X Series Monitor
- The Ultima X Series Monitor is operating with the calibration parameters defined before the calibration was attempted.

To extinguish the CAL FAULT flag, a complete calibration procedure must be performed.

The Ultima X Series Monitor allows automatic zero and span adjustments within a pre-defined range. It cannot make corrections outside this range, such as when an empty or wrong cylinder of gas is applied or failure to begin gas flow within the allotted 30-second countdown occurs.

14. After a successful calibration, remove the tubing from the Flow Controller and remove the Flow Controller from the cylinder; return all items to their appropriate location in the Calibration Kit.

XIR Calibration

Although a full calibration (zero and span) can be performed on the Ultima XIR Gas Monitor, a no-gas calibration is sufficient to properly calibrate the monitor. Typically, a zero adjustment is all that is required for a full calibration. Normally, any degradation of the sensor's performance is associated with slight drifts in its zero response which, in turn, will adversely affect its span performance. Restoring the sensor's zero is typically sufficient to restore its span performance.

A zero adjustment is performed by pressing the ZERO button on the Calibrator or Controller and following the "Zeroing" instructions given earlier in this chapter. After completing the zeroing function, perform a span check to ensure proper operation. If the span check is unsuccessful, perform a full calibration.

NOTE: For calibration of an XIR sensor operating with a Flow Cap, temporarily replace the Flow Cap with the Environmental Guard (packaged with the instrument) and perform the following procedure.

WARNING

The Calibration Cap must be removed from the XIR environmental guard after completing the Zeroing and/or Spanning procedure; otherwise, the sensor cannot perform properly.

Calibration Documentation

The Ultima X Series Monitor records the date of the last successful calibration. This date can then be displayed on the front-panel LCD (with the use of the Controller).

Chapter 3

Specifications

GAS TYPES		Combustibles, Oxygen & Toxics		
TEMPER- ATURE RANGE	TOXICS & OXYGEN	OPERATING RANGE	0 to 40°C (32 to +104°F)	
		*EXTENDED RANGE	-20 to +50°C (-4 to +122°F)	
		OPERATING RANGE NH ₃	0 to +30°C (32 to +86°F)	
		*EXTENDED RANGE NH ₃ , CL ₂ , CLO ₂	-10 to +40°C (-14 to +104°F)	
		Calibrate within operating range		
	CATALYTIC COMBUSTIBLES	SINGLE MODULE	-40 to +60°C (-40 to +140°F)	
		DUAL MODULE	-40 to +60°C (-40 to +140°F)	
		IR COMBUSTIBLES	SINGLE MODULE	-40 to +60°C (-40 to +149°F)
			DUAL MODULE	-40 to +60°C (-40 to +149°F)
	DRIFT	ZERO DRIFT	Less than 5%/year, typically	
SPAN DRIFT		Less than 10%/year, typically		
NOISE		Less than 1% FS		

Table 3-1. Performance Specifications			
	GAS	LINEARITY	REPEATABILITY
ACCURACY	CARBON MONOXIDE	the greater of $\pm 2\%$ full scale (FS)	$\pm 1\%$ FS or 2 ppm
	OXYGEN	$\pm 2\%$ FS	$\pm 1\%$ FS
	HYDROGEN SULFIDE	$\pm 10\%$ FS or 2 ppm	$\pm 1\%$ FS or 2 ppm
	CHLORINE	$\pm 10\%$ FS or 2 ppm	$\pm 5\%$ FS or 1 ppm
	SULFUR DIOXIDE	$\pm 10\%$ FS or 2 ppm	$\pm 1\%$ FS or 2 ppm
	NITRIC OXIDE	$\pm 10\%$ FS or 2 ppm	$\pm 1\%$ FS or 2 ppm
	NITROGEN DIOXIDE	$\pm 10\%$ FS or 2 ppm	$\pm 4\%$ FS or 1 ppm
	HYDROGEN CYANIDE	$\pm 10\%$ FS or 2 ppm	$\pm 4\%$ FS or 2 ppm
	HYDROGEN CHLORIDE	$\pm 10\%$ FS or 2 ppm	$\pm 10\%$ FS or 2 ppm
	CATALYTIC COMBUSTIBLE GAS	<50% LEL $\pm 3\%$ FS	$\pm 1\%$ FS
		>50% LEL $\pm 5\%$ FS	
ACCURACY	IR COMBUSTIBLE GAS: METHANE, PROPANE	<50% LEL - $\pm 2\%$ >50% LEL - $\pm 5\%$	$\pm 2\%$ FS
	CHLORINE DIOXIDE	$\pm 10\%$ FS or 2 ppm	$\pm 5\%$ FS or 1 ppm
	ETHYLENE OXIDE	$\pm 10\%$ FS	$\pm 5\%$ FS
	AMMONIA	$\pm 10\%$ FS	$\pm 5\%$ FS
	HYDROGEN	$\pm 5\%$ FS	$\pm 5\%$ FS
	PHOSPHINE	$\pm 10\%$ FS	$\pm 10\%$ FS
	ARSINE	$\pm 10\%$ FS	$\pm 10\%$ FS
	GERMANE	$\pm 10\%$ FS or 0.5 ppm	$\pm 10\%$ FS
	SILANE	$\pm 10\%$ FS or 2 ppm	$\pm 1\%$ FS or 2 ppm
	DiBORANE	$\pm 10\%$ FS or 2 ppm	$\pm 1\%$ FS or 2 ppm
	FLUORINE	$\pm 10\%$ FS or 2 ppm	$\pm 5\%$ FS or 1 ppm
	BROMINE	$\pm 10\%$ FS or 2 ppm	$\pm 5\%$ FS or 1 ppm

*Extended Range = The sensor may not meet all of the accuracy parameters listed.

STEP CHANGE RESPONSE	TIME TO REACH 20% OF SCALE - OXYGEN & TOXICS	Less than 12 seconds (typically 6 seconds) Less than 20 seconds (ETO)	
	TIME TO REACH 50% OF SCALE - OXYGEN & TOXICS	Less than 30 seconds (typically 12 seconds) Less than 45 seconds (ETO)	
	TIME TO REACH 50% OF SCALE - COMBUSTIBLES	Less than 10 seconds	
	TIME TO REACH 90% OF SCALE - COMBUSTIBLES	Less than 30 seconds	
HUMIDITY		15 to 95% RH, non-condensing, 24 hours or less	
		35 to 95% RH, long term	
SENSOR LIFE	CATALYTIC COMBUSTIBLES	3 years, Typically	
	OXYGEN & TOXICS	2 years, Typically	
	FULL REPLACEMENT WARRANTY	1 year; 2 years for IR Combustibles (see "MSA Instrument Warranty" in this manual)	
WIRING REQUIREMENTS	mA OUTPUT	OXYGEN & TOXICS	2-wire or 3-wire
		COMBUSTIBLES	3-wire
POWER INPUT (for power input with internal relays, see Appendix A)	mA VERSIONS	OXYGEN & TOXICS	7-30 VDC @ 41 mA max.
		CATALYTIC COMBUSTIBLES	7-30 VDC @ 450 mA max., no relays
SIGNAL OUTPUT	4-20 mA	COMBUSTIBLES	3-wire current source
		OXYGEN & TOXICS	2-wire current sink or 3-wire current source
XA PHYSICAL	SIZE	9.423" H x 5.125" W x 3" D inches (239.34 mm x 130 mm x 76 mm)	
	WEIGHT	1.5 pounds (0.7 kilograms)	
XE PHYSICAL	SIZE	10.280" H x 6.312" W x 3.911" D inches (261.11 mm x 160.33 mm x 99.34 mm)	
	WEIGHT	10.4 pounds (4.72 kilograms)	

Table 3-1. Performance Specifications			
INSTALLATION OUTLINE DRAWINGS	MODEL	TYPE	DOCUMENT NO.
	ULTIMA XA	GAS MONITOR	10000015059
		REMOTE MONITOR	10000015111
	ULTIMA XE	GAS MONITOR	10000015095
		REMOTE MONITOR	10000015112
	ULTIMA XIR	GAS MONITOR	10000015283
		REMOTE MONITOR	10000015284

Table 3-2. Sensor Response to Interferants

If your readings are higher or lower than expected, it could be due to the presence of an interferant gas. The gas listed in column 1 is presented to the sensor. Column 2 indicates the concentration of that gas presented to the sensor. The remaining columns indicate the respective responses by the sensors to each particular gas.

For Example: Scan column 1 until you locate "hydrogen". Column 2 shows that 500 ppm of hydrogen was presented to the sensor. Column 3 shows that a CO sensor gave an equivalent response of 28 ppm. Column 4 shows that an H₂S sensor gave an equivalent response of 0.5 ppm, etc.

INTER-FERANT	CONCENTRATION (PPM)	CO	H ₂ S	SO ₂	HCN	NO ₂	CL ₂	NO	CLO ₂
Acetone	1000	0	0	0	0	0	No Data	No Data	No Data
Acetylene	12000	No Data	0	No Data	No Data	0	No Data	No Data	No Data
Ammonia	100	0	0	No Data	0	0	-1.0	No Data	0
Benzene	20	0	0	0	0	0	0	No Data	0
Carbon Dioxide	5000	0	0	0	2.5	0	1.0	No Data	0
Carbon Disulfide	15	2	0	No Data	0.1	No Data	0	No Data	0
Carbon Monoxide	100	100	7	0.2	1	0	0	-3	0
Chlorine	5	0	0	-6	-0.2	4	5	0	2.5
Dimethyl Sulfide	5	2	0.4	3	-0.2	0	0	No Data	0
Ethanol	100	115	0	0	0	0	0.0	No Data	No Data
Ethylene	50	99	0.1	0	-0.3	0	0	No Data	0
Ethyl Ether	400	3	No Data	No Data	No Data	0	No Data	No Data	No Data
Freon 12	1000	-2	0	No Data	2	0	0	No Data	0
Freon 113	1000	1	0	No Data	2.4	No Data	No Data	No Data	No Data
Freon 12BI	1000	0	0	No Data	No Data	No Data	No Data	No Data	No Data
Freon 13BI	1000	0	0	No Data	No Data	No Data	No Data	No Data	No Data
Hexane	500	0	0	0	0	0	0	No Data	0
Hydrogen	500	28	0.5	15	0	-15	0	No Data	0
Hydrogen Chloride	50	0	0	No Data	No Data	0	0.0	4	No Data
Hydrogen Cyanide	10	5	0	3	10	0	0.1	0	0
Hydrogen Sulfide	10	0	10	0	50	-8	-1.4	4	-0.25
Isopropanol	50	40	0	0	0	0	0	No Data	0
Mercaptan (Ethyl)	5	7	2.7	No Data	6.5	No Data	0	No Data	0
Mercaptan (Methyl)	5	7	4.5	No Data	6	No Data	No Data	No Data	No Data

Table 3-2. Sensor Response to Interferants (continued)

INTERFERANT	CONCENTRATION (PPM)	Br ₂	F ₂	SiH ₄	PH ₃	AsH ₄	GeH ₃	B ₂ H ₆	HCL
Methane	50000	0	0	0	1	0	0	No Data	0
Methanol	50	130	0	0	0.1	0	0	No Data	0
Methyl Amine	100	0	No Data	No Data	No Data	0	No Data	No Data	No Data
Methyl Bromide	500	0	No Data	0	No Data	0	No Data	No Data	No Data
Methyl Ethyl Ketone	200	0	No Data	0	No Data	0	No Data	No Data	No Data
Nitric Oxide	100	10	2.2	2	-3	3	0.0	100	1
Nitrogen Dioxide	10	-2	-8.4	-10	-20	10	0.1	2	6
Sulfur Dioxide	150	1	4.7	NA	400	0	0	7.5	0
Tichloroethylene	1000	0	No Data	0	No Data	No Data	No Data	No Data	No Data
Bromine	2	2	3	No Data	No Data	No Data	No Data	No Data	0
Fluorine	5	1.5	5	No Data	No Data	No Data	No Data	No Data	0
Chlorine	2	2.5	4	No Data	No Data	No Data	No Data	No Data	0
Phosgene	10	0.5	1.5	0	0	0	0	0	0
Silane	5	No Data	No Data	5	0.1	0.2	0.2	15	7
Phosphine	0.5	No Data	No Data	0.7	0.5	1	1	3	2
Arsine	1	No Data	No Data	1	0.7	1	1	5	1
Germane	1	No Data	No Data	1	0.7	1	1	5	1
Diborane	20	No Data	No Data	4	3.5	5	5	20	0
Hydrogen	400	No Data	No Data	0.2	0.1	0.2	0.2	0.1	0
Hydrogen Chloride	40	0	0	No Data	No Data	No Data	No Data	No Data	40
Hydrogen Sulfide	10	0	0	20	3	7	7	50	40
Nitrogen Dioxide	5	0	0	No Data	No Data	No Data	No Data	No Data	0

INTERFERANT	CONCENTRATION (PPM)	NH₃	ETO	H₂	CO₂
Ammonia	25	25	0	No Data	No Data
Hydrogen Cyanide	10	0	0	No Data	No Data
Nitrogen Oxide	50	0	0	No Data	No Data
Sulfur Dioxide	10	0	0	15	2.5
Methane	2.5%	0	0	0	0
Butane	100	0	0	0	0
Carbon Monoxide	100	0	0	0	0
Carbon Dioxide	2000	0	0	0	2000
R134A	10	0	0	0	0
Ammonia	25	25	0	No Data	No Data
Carbon Monoxide	100	0	No Data	2	No Data
Carbon Monoxide	300	No Data	No Data	No Data	0
Chlorine	10	0	0	0	No Data
Ethylene	50	0	No Data	No Data	No Data
Hydrogen Chloride	40	0	No Data	0	No Data
Hydrogen Cyanide	10	0	0	0	No Data
Hydrogen Sulfide	40	2	No Data	0	No Data
Methane	2.5%	No Data	No Data	No Data	0
Nitric Acid	50	0	No Data	3	No Data
Nitrogen Dioxide	10	0	0	0	No Data
Pentane	0.75%	No Data	No Data	No Data	0
Phosphine	0.5	0	0	0	No Data
Propane	0.6%	No Data	No Data	No Data	0
Sulfur Dioxide	10	0	No Data	0	No Data

Chapter 4 Maintenance

General

The Ultima X Gas Monitor is constantly performing a self-check. When a problem is found, it displays the appropriate error message. (Table 4-3, "Troubleshooting Guidelines"). When a critical error is detected within the unit, the output signal goes to a fault condition.

- For 4 to 20 milliamp output models: output is 3.0 mA
- The "Change Sensor" indication is not an error and does not affect the output.

NOTE: TABLES 4-1 and 4-2 describe the messages that users may see.

Ultima XIR Cleaning Procedure

The presence of particulate matter, oil films, liquid water, or the residue from water drops on the two monitor windows can adversely affect its performance. The environmental guard is designed to prevent foreign solids or liquids from reaching the monitor's optical system. Additionally, heating elements are incorporated into the unit to prevent water condensation. Under severe conditions, however, some material may collect on these surfaces and it may be necessary to occasionally check and clean the windows.

The windows can be readily inspected after removing the environmental guard. While both windows are made of a highly durable material that is not easily scratched, avoid excessive pressure when cleaning them. Clean, cotton-tipped applicators are the most convenient tool to remove material collected on the windows. Dust can be removed by wiping the window with a dry applicator or one moistened with distilled water. An additional clean, dry applicator should be used to remove any residual water. An applicator moistened with isopropyl alcohol can be used to remove heavy deposits of solids, liquids or oil films. Clean the window again with a second applicator moistened with distilled water; then, dry the window with a final applicator. Avoid using excessive amounts of water or alcohol in the cleaning procedure, and inspect the window to ensure that the entire surface has been cleaned. If water or isopropyl alcohol was used, allow the unit to operate for 15 minutes to completely dry before replacing the environmental guard and continuing to monitor for combustible gas. After cleaning the windows, it is

advisable to check both the monitor's response to zero and calibration gas (see Chapter 2, "Start-up and Calibration").

⚠ CAUTION

Do not place foreign objects in the sensor's analytical region; otherwise, the infrared beam can be partially blocked, causing the sensor to generate false readings. All objects must be removed from the sensor's analytical region for it to function properly. Similarly, if water or isopropyl alcohol is used to clean the sensor's windows, any residue from the cleaning procedure must be completely dissipated before returning the unit to service. Checking the sensor's response to zero gas is the best way to purge residual cleaning materials from the sensor and to make sure that sensor's reading is stable before zeroing or calibrating the sensor (see Chapter 2, "Start-up and Calibration").

⚠ CAUTION

To prevent activation of alarms while cleaning the XIR sensor's windows, use the Ultima/Ultima X Controller to disable the alarm relays.

Replacing an Ultima XE or Ultima XA Sensor

The only routine maintenance item is the sensing element itself, which has a limited lifetime. When the Ultima X Series Gas Monitor's read-out indicates that the sensor must be changed, there is very little sensor lifetime remaining. It is good practice to obtain a replacement sensing element before the sensing element within your unit becomes inoperative. Typically, the Ultima X Series Monitor LCD display shows a maintenance message when the sensor is due for replacement (FIGURE 4-1).

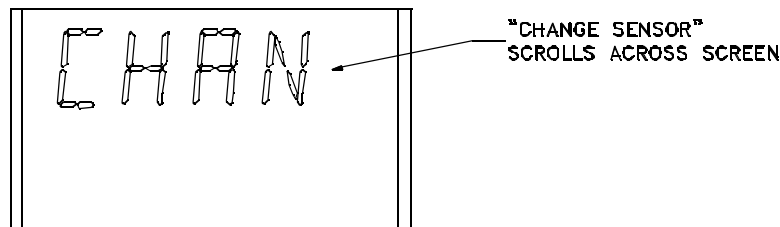


Figure 4-1.
"Change Sensor" Scrolls Across the Display

⚠ WARNING

Handle the sensor carefully; the electrochemical version is a sealed unit which contains a corrosive electrolyte. If electrolyte is leaking from the sensor, exercise CAUTION to ensure the electrolyte does not contact skin, eyes or clothing, thus avoiding burns. If contact occurs, rinse the area immediately with a large quantity of water. In case of contact with eyes, immediately flush eyes with plenty of water for at least 15 minutes. Call a physician.

⚠ CAUTION

Do not install a leaking sensor in the sensing head assembly. The leaking sensor must be disposed of in accordance with local, state and federal laws. To obtain a replacement sensor, contact MSA at the address given under "Obtaining Replacement Parts."

1. There is no need to open the main enclosure; simply unscrew the sensor assembly located on the bottom of the Ultima X Series Gas Monitor main assembly (FIGURE 4-2).

⚠ WARNING

For Ultima XE Gas Monitors, unscrew sensor cap at least three full turns (but no more than four full turns from its tightly-closed position), wait 10 seconds, and then remove cap completely. Failure to follow this warning can result in the ignition of a hazardous atmosphere.

2. Identify the sensor assembly needed and obtain the appropriate sensor assembly; replace sensor assembly.

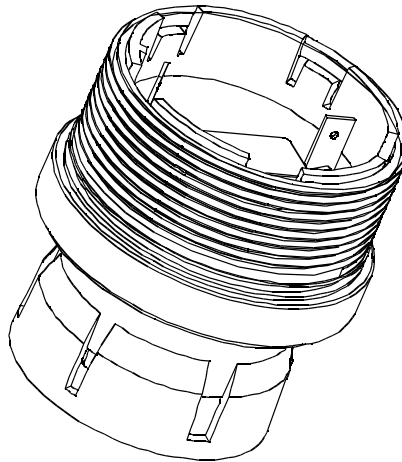


Figure 4-2.

Sensor Assembly and Sensor Guard for General Purpose Model

NOTE: Alarm setpoints and relay functions (energized/de-energized, latching/unlatching, and upscale/downscale) will not change when changing a sensor module from its current gas type to the same gas type (e.g., carbon monoxide to carbon monoxide). Alarm setpoints and the upscale/downscale relay function will change to the new sensor's default settings when changing a sensor module from its current gas type to a different gas type (e.g., carbon monoxide to oxygen).

3. The Ultima X Series Gas Monitor is shipped with the Sensor Swap Delay enabled. This means that the 4-20 mA output signal and the FAULT relay will hold off a fault indication for 60 seconds after the sensor missing indication is displayed on the instrument. This setting allows the operator to exchange sensor modules without a FAULT indication.
4. Refer to Chapter 2, "Calibration".

It is recommended that all other maintenance be performed at an MSA factory-authorized service center.

Table 4-1. Operational Display Messages	
MESSAGE	INDICATES
MM/DD/YY	Format for date scrolling
VER	Software version level will display next
TIME	Time will display next
DATE	Date will display next
MIN	MIN value for this interval will display next
MAX	MAX value for this interval will display next
AVG	AVG value for this interval will display next
Adr	Instrument's address will display next
End	End of calibration cycle
Err	An Error code will display next
HR	Special case indicates hours (two characters or less)
OVER	Gas value is greater than the set range

MESSAGE	INDICATES
CAL SIG ON	Instrument will output the calibration signal during calibration
CAL SIG OFF	Instrument will output gas value during calibration
LTCH/	Latching relay operations
UNLTCH/	Non-latching relay operations
INCR/	Increasing Alarm relay operations
DECR/	Decreasing Alarm relay operations
ENER	Energized relay operations
DENER	De-energized relay operations
CAL	Normal calibration or 4-20 calibration cycle
iCAL	Initial calibration cycle
OFF	Alarm is OFF
ON	Alarm is ON
RNGE	Instrument's operational full-scale will display next
PCAL	Instrument's previous calibration date will display next
TBLE	Instrument gas table selection (if applicable)
ALERT OP ON	Instrument output will follow ALERT mode
ALERT OP OFF	Instrument output will not follow ALERT mode
SWAP DELAY ON	60-second delay after sensor missing before fault
SWAP DELAY OFF	Fault occurs at sensor missing condition

MESSAGE	INDICATES	ACTION
CHANGE SENSOR	Sensor is at its end of life	Replace sensor
CAL FAULT	Instrument did not calibrate successfully	Repeat calibration; check for proper calibration gas; check for blockage in the flow system
SENSOR MISSING	Instrument has lost communication with the sensor module	Connect or replace sensor
CHECK CAL	Calibration should be verified	Perform bump test or calibration
SENSOR WARNING	Sensor is approaching its end of life	Prepare to replace sensor module
SNSR FLASH FAULT	Sensor module program memory is invalid	Replace sensor module
SNSR RAM FAULT	Sensor module has a defective RAM location	Replace sensor module
SNSR DATA FAULT	Sensor module datasheet is invalid	Send reset data sheet command from the controller; if error persists, replace sensor

Table 4-3. Troubleshooting Guidelines		
MESSAGE	INDICATES	ACTION
MN SUPPLY FAULT	Power supply on main PCBA is out of range	Check sensor wiring or replace main pc board
MN EEPROM FAULT	EEPROM on the main PCBA is invalid	Replace main pc board
MN FLASH FAULT	Program memory on the main PCBA is invalid	Replace main pc board
MN RAM FAULT	Defective RAM memory location was found on the main PCBA	Replace main pc board
INVALID SENSOR	Attached sensor module is not compatible with the main instrument	Replace with correct sensor type
CONFIG RESET	Main EEPROM memory was reset	Use Controller to reset all configurations (e.g., alarm levels, calibration signals ON or OFF, etc)
RELAY FAULT	Error with the internal relays has occurred	Cycle power to the unit or replace main pc board
TEMP FAULT	Temperature sensor is out of range for operation	Relocate unit to area within the specified temperature range
SNSR POWER FAULT	Power at the sensor module is out of range	Correct wiring error, replace main pc board, or replace sensor module
und	Under-range condition - quick	Recalibrate or replace sensor
Und	Under-range condition - slow	Recalibrate or replace sensor
+LOC	Instrument is locked in over-range condition	Recalibrate or reset sensor
IR SOURCE FAULT	IR source failure	Replace or consult factory
REF SIG FAULT	IR reference detector failure	
ANA SIG FAULT	IR analytical detector failure	
LOW SIGNAL	Low IR signal	Clean optics or replace sensor module
- SUPPLY FAULT	The negative supply sensor module is out of range	Check wiring or replace sensor module
PARAM FAULT	An operational parameter is out of range or sensor failed internal check	Restart; replace, if necessary

Obtaining Replacement Parts

See Table 4-4 for replacement sensor kits. To obtain a replacement sensor, address the order or inquiry to:

Mine Safety Appliances Company
Instrument Division
P.O. Box 427, Pittsburgh, PA 15230-0427

or call, toll-free, 1-800-MSA-INST.

⚠ WARNING

Use only genuine MSA replacement parts when performing any maintenance procedures provided in this manual. Failure to do so may seriously impair sensor performance. Repair or alteration of the Ultima X Series Gas Monitor, beyond the scope of these maintenance instructions or by anyone other than authorized MSA service personnel, could cause the product to fail to perform as designed and persons who rely on this product for their safety could sustain serious personal injury or death.

Table 4-4. Replacement Parts

GAS SELECTION	SENSOR KIT PART NO.	
	GENERAL-PURPOSE MODELS A AND T	EXPLOSION-PROOF MODELS E AND L
Carbon Monoxide, 100 ppm	A-ULTX-SENS-11-0	A-ULTX-SENS-11-1
Carbon Monoxide, 500 ppm	A-ULTX-SENS-12-0	A-ULTX-SENS-12-1
Oxygen, 10% - compensated	A-ULTX-SENS-13-0	A-ULTX-SENS-13-1
Oxygen, 25% - compensated	A-ULTX-SENS-14-0	A-ULTX-SENS-14-1
Hydrogen Sulfide, 10 ppm	A-ULTX-SENS-15-0	A-ULTX-SENS-15-1
Hydrogen Sulfide, 50 ppm	A-ULTX-SENS-16-0	A-ULTX-SENS-16-1
Hydrogen Sulfide, 100 ppm	A-ULTX-SENS-17-0	A-ULTX-SENS-17-1
Chlorine, 5 ppm	A-ULTX-SENS-18-0	not available
Sulfur Dioxide, 25 ppm	A-ULTX-SENS-19-0	A-ULTX-SENS-19-1
Nitric Oxide, 100 ppm	A-ULTX-SENS-20-0	A-ULTX-SENS-20-1
Nitrogen Dioxide, 10 ppm	A-ULTX-SENS-21-0	A-ULTX-SENS-21-1
Hydrogen Cyanide, 50 ppm	A-ULTX-SENS-22-0	A-ULTX-SENS-22-1
Hydrogen Chloride, 50 ppm	A-ULTX-SENS-23-0	not available
Chlorine Dioxide, 3 ppm	A-ULTX-SENS-24-0	not available
Combustible Gas, 100% LEL Natural Gas and H ₂ , 5% CH ₄	A-ULTX-SENS-31-0	A-ULTX-SENS-31-1
Combustible Gas, 100% LEL Petroleum Vapors, 2.1% Propane	A-ULTX-SENS-32-0	A-ULTX-SENS-32-1
Combustible Gas, 100% LEL Solvents, 2.1% Propane	A-ULTX-SENS-33-0	A-ULTX-SENS-33-1
Comb Gas IR - Methane, 5% CH ₄	not available	A-ULTX-SENS-38-1
Comb Gas IR - Non Methane, 2.1% Propane	not available	A-ULTX-SENS-39-1
Phosphine, 2 ppm	A-ULTX-SENS-41-0	A-ULTX-SENS-41-1
Arsine, 2 ppm	A-ULTX-SENS-42-0	A-ULTX-SENS-42-1
Silane, 25 ppm	A-ULTX-SENS-43-0	A-ULTX-SENS-43-1
Germane, 3 ppm	A-ULTX-SENS-44-0	A-ULTX-SENS-44-1
Diborane, 50 ppm	A-ULTX-SENS-45-0	not available

Table 4-4. Replacement Parts		
GAS SELECTION	SENSOR KIT PART NO.	
	GENERAL-PURPOSE MODELS A AND T	EXPLOSION-PROOF MODELS E AND L
Bromine, 5 ppm	A-ULTX-SENS-46-0	not available
Flourine, 5 ppm	A-ULTX-SENS-47-0	not available
Ammonia, 50 ppm	A-ULTX-SENS-48-0	not available
Hydrogen, 1000 ppm	A-ULTX-SENS-49-0	A-ULTX-SENS-49-1
ETO, 10 ppm	A-ULTX-SENS-50-0	not available
SENSOR GUARD REPLACEMENT PARTS		
All Sensor Types except XIR	10028904	
XIR Sensor Guard	10042600	

Appendix A

Internal Relay Option

General Information

The internal relays are designed to enable Ultima X Series Gas Monitors to control other equipment. There are four relays within the Ultima X Series Gas Monitor's module:

- three alarm relays
- one fault relay.

Once configured, the relays activate when the Ultima X Gas Monitor detects an alarm condition. Similarly, the fault relay de-energizes when a fault condition is detected.

- The internal relays will be within the read-out module.

The alarm relays are enabled in the non-latching, de-energized mode at the factory.

- To disable or configure the alarms, you need the Ultima Controller (P/N 809086).
- The fault relay is normally-energized so the relay de-activates into a fail-safe condition if a fault or power outage occurs. See "Fault Relay" later in this Appendix.

CAUTION

To prevent false alarms in the following instances, alarms/relays are temporarily disabled:

- 1) During the first minute from power-up
- 2) During calibration
- 3) For two minutes after calibration.

Unpacking, Mounting and Wiring the Ultima X Series Gas Monitor with Internal Relays

Unpack, mount and wire the Ultima X Series Gas Monitor according to Chapter 1, "Set-up." All electrical connections to the Ultima X Series Gas Monitor can be made via the clearly marked board-mounted connections.

- See FIGURES A-1 and A-2 for **Dual module** general-purpose and explosion-proof Ultima X Series Gas Monitors, respectively.
- See FIGURES A-3 and A-4 for **Single module** general-purpose and explosion-proof Ultima X Series Gas Monitors, respectively.
- See Ultima Controller and Calibrator Manual (P/N 813379) for complete configuration information.

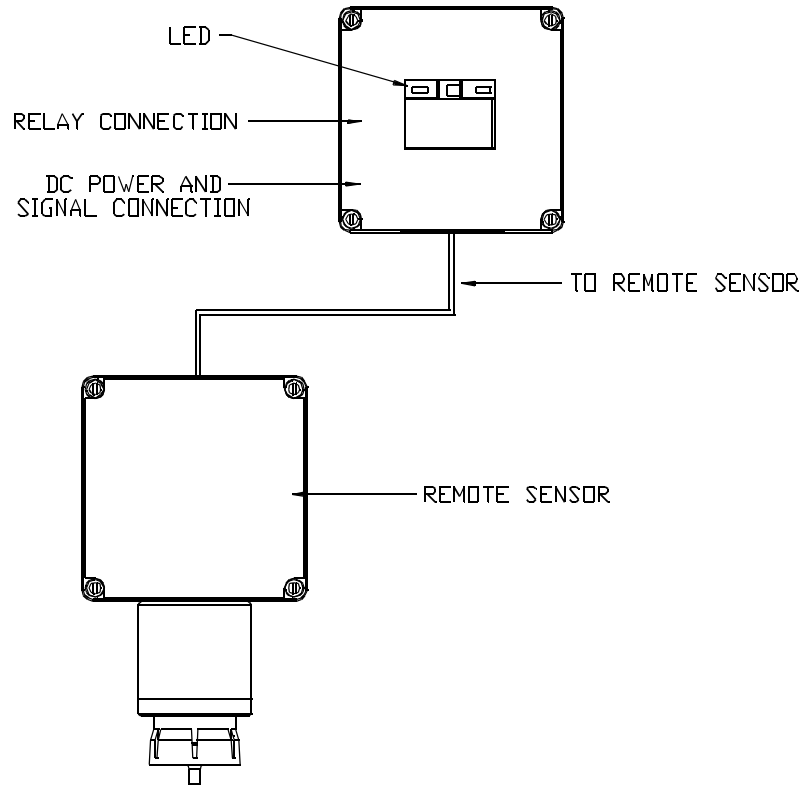


Figure A-1.
Dual Module General-Purpose Ultima X Series Wiring

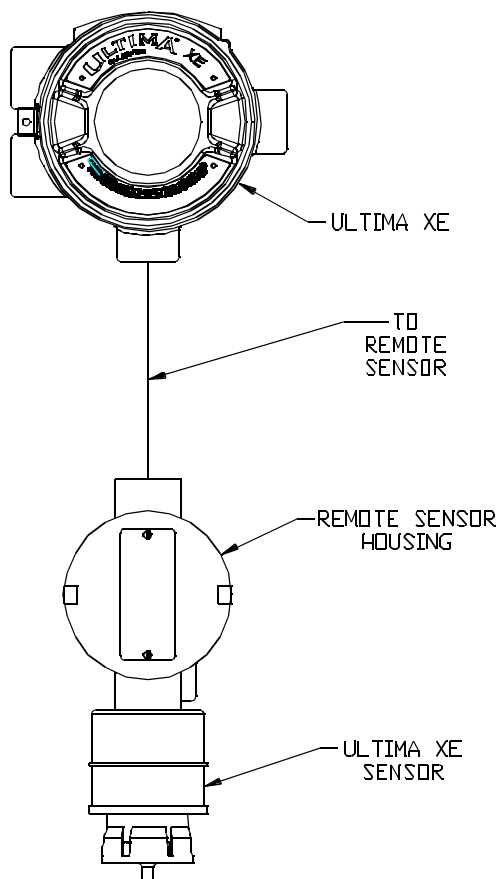


Figure A-2.
Dual Module Explosion-Proof Ultima X Series Wiring

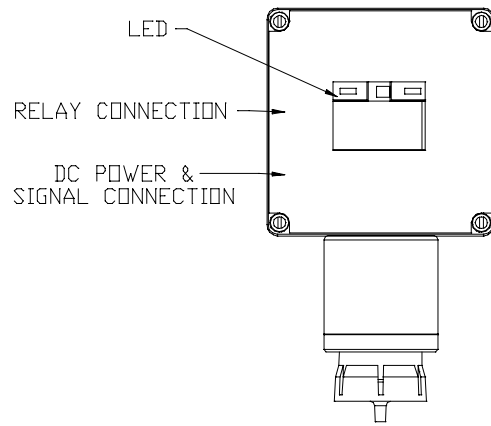


Figure A-3.
Single Module General-Purpose Ultima X Series Wiring

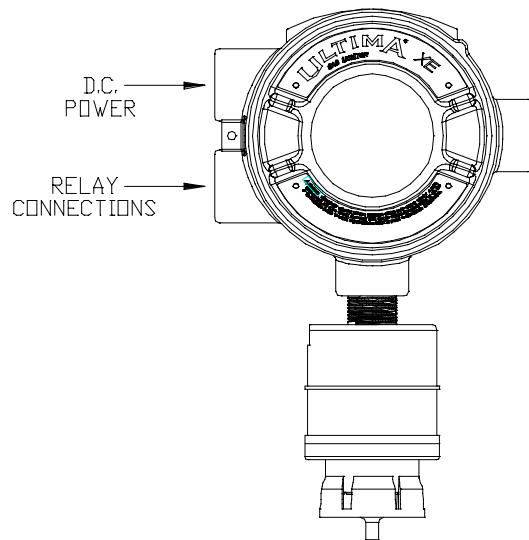


Figure A-4.
Single Module Explosion-Proof Ultima X Series Wiring

Power cable wiring lengths for the Ultima X Series Gas Monitor *with* internal relays differ from models *without* internal relays (TABLE A-1).

NOTE: To avoid electrical noise problems, do *not* run AC lines from relays in the same conduit or cable tray as the DC Signal lines.

SENSOR TYPE	POWER SUPPLY VOLTAGE	WIRE SIZE	MAXIMUM CABLE LENGTH (IN FEET)	MAXIMUM LOAD RESISTANCE (mA OUTPUT ONLY)
CATALYTIC COMBUSTIBLE	12 VDC	16 AWG	900	300 OHMS
CATALYTIC COMBUSTIBLE	24 VDC	16 AWG	3000	600 OHMS
TOXIC OR OXYGEN	12 VDC	16 AWG	2500	300 OHMS
TOXIC OR OXYGEN	24 VDC	16 AWG	8000	600 OHMS

- In all installations, twisted instrument-quality cable is recommended.
- Shielded cable is recommended in situations where radio frequency interference (RFI), electro-magnetic interference (EMI) or other electrical noise sources exist or are anticipated.

Ultima X Series Gas Monitor Internal Relays

Relay Specifications

TEMPERATURE RANGE		-40 to +60°C (-40 to +140°F)
HUMIDITY		15 to 95% RH, non-condensing
RELAYS	3 ALARMS	SPDT (Single pole, double throw)
	FAULT (NORMALLY-ENERGIZED)	SPDT (Single pole, double throw)
RELAY RATINGS	At 125 or 250 VOLTS AC, NON-INDUCTIVE	5.0 Amps or 5 Amps @ 1/10 Hp
	AT 30 VOLTS DC, NON-INDUCTIVE	5.0 Amps or 5 Amps @ 1/10 Hp
POWER CONSUMPTION (TOTAL UNIT WITH RELAYS)	OXYGEN AND TOXICS	7 to 30 VDC @ 220 mA max.
	CATALYTIC COMBUSTIBLES	7 to 30 VDC @ 610 mA max.

Alarm Relays

There are three alarm relays and one fault relay in the Ultima X Series Gas Monitors. The three alarm relays:

- Activate when the Monitor detects a gas concentration level that exceeds setpoints

- Alarms 1, 2 and 3 generally default to 10%, 20% and 30% of the full-scale reading and are set when the gas reading is above these values.
- The Oxygen Model is a special case where:
 - Alarm 1 is set to 19% oxygen and activates *below* this setpoint
 - Alarm 2 is set to 18% oxygen and activates *below* this setpoint
 - Alarm 3 is set to 22% oxygen and activates *above* this setpoint.
- These default setpoints can be changed or verified via the Ultima X Controller.
 - See Ultima/Ultima X Controller and Calibrator manual (P/N 813379).
 - The Controller can also enable the latching alarm function.
- Are factory-set to a de-energized position.
 - All relay connections have a normally-open set of contacts and a normally-closed set of contacts. These contacts are labeled as NCD (normally-closed, de-energized) or NCE (normally-closed, energized).
 - The units are shipped with alarm relays factory-set to the de-energized (non-alarm) position and the trouble relay set to the energized (non-fault) position.
 - Upon activation, the relay contacts change state and remain changed for as long as:
 - The alarm condition exists within the Ultima X Series Gas Monitor or
 - The latching mode is selected (see "Note on Resetting Latched alarms with Controller or Calibrator" in Chapter 2).
 - These defaults can be changed or verified via the Ultima Controller.

Fault Relay or Trouble

- It is a normally-energized, single-pole, double-throw (SPDT) relay.
- During normal operation, the relay contacts are normally closed (NC) and normally open (NO) as shown in FIGURE A-5.
- When a fault is detected or power is cut or turned OFF, these contacts change as follows:
 - normally closed contacts open
 - normally open contacts close.

- Provides an electrical path for fail-safe relay operation. In the event of any failure, including power loss, the relay will change to a fault condition

The Fault Relay can remain STEADY ON or PULSED. These two different modes can communicate different information to any PLC or DCS connected to the fault relay:

- **Fault Relay STEADY ON indicates:**
 - Ultima X Series sensor is not connected properly or
 - Ultima X Series Gas Monitor internal fault or
 - An inoperative relay.
- **Fault Relay PULSED (once per minute) indicates:**
 - Improper calibration of the Ultima X Series Gas Monitor or
 - Ultima X Series Gas Monitor CHECK CAL or CAL FAULT displayed.

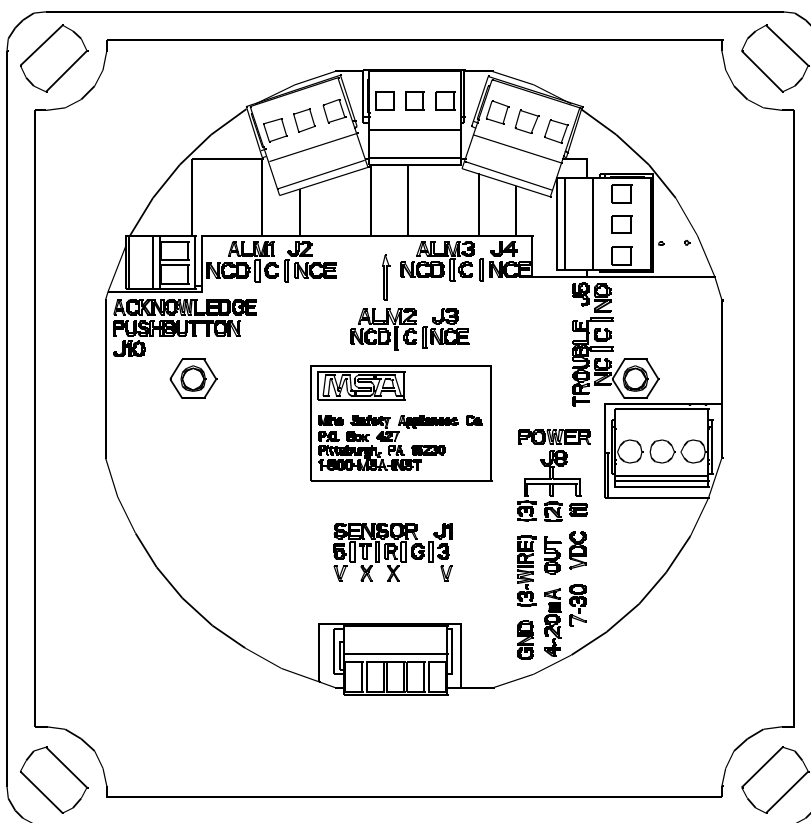


Figure A-5.
Relay Contacts

Optional RESET Push-button

General

A RESET button is an optional feature to allow latching relays to be reset at the sensor location.

- This may silence any alarm horns or turn OFF any equipment connected to the relays.
- Latching relays can be configured on the Ultima Series Monitor via the Ultima Controller.

- **In a latching configuration:**

when the RESET button is pushed and any alarm is latched and not in its active alarm state, the alarm will reset.

NOTE: An IR command can mimic the RESET button per Controller and Calibrator manual (P/N 813379).

- **In a non-latching configuration:**

the RESET button has no affect on the alarms.

RESET Button Selection

The RESET push-button can be acquired locally and wired to the Ultima X Series Gas Monitor during unit installation.

- The RESET push-button must be a normally-open type with a momentary contact when pushed.
- The electrical ratings must be at least 1 amp at 250 volts AC.

TABLE A-3 lists a source of push-buttons; you may also select to choose one from an alternative supplier.

TABLE A-3. RESET Push-button Vendor		
VENDOR NAME	CATALOG NUMBER	DESCRIPTION
Crouse Hides, Inc.	NCS2110	General-purpose push-button

Relay Connections

All electrical connections to internal relays can be made directly on the pc board (see FIGURE A-5).

If you are connecting the relays to motors, fluorescent lighting or other inductive loads, it is necessary to suppress any sparks or inductive feedback that may occur at the relay contact. These effects may render the unit inoperative. One way to reduce these effects is to install a *Quencharc[®] across the load being switched. This device is available from MSA as P/N 630413.

⚠ WARNING

Before wiring the Ultima X Series Gas Monitors, disconnect power source supplying the monitor; otherwise, electrical shock could occur.

- The Ultima X Series Gas Monitor must be disassembled for relay wiring
- The following procedure must be performed:
 1. Remove the Ultima X Series Gas Monitor cover.
 2. Pull on the wiring plugs to disconnect the connectors on the exposed board.

NOTE: Observe connector locations for later re-insertion.

3. Route customer-supplied cable into the enclosure and connect to the appropriate wiring plugs.
4. Identify each conductor of the cable to enable proper connection at the control equipment.
5. If installing a RESET push-button:
 - a. Route a two-conductor cable to terminal block J10 (FIGURE A-6).
 - Route this cable with DC power to avoid noise interference from relay wiring.
 - b. Connect the two-conductor cable to the two positions of terminal block J10.
 - c. Identify the cable to enable proper connection at the button.
 - d. Route cable to the push-button location; wire the button.
6. Re-install the wiring plugs.
 - Ensure that wiring plugs are firmly seated into their mates.
7. Pull the cable away from the unit to relieve any excess slack.
 - It is important not to have excess wire or cable within the module to avoid unwanted AC noise.
8. Re-install the cover of the Ultima X Series Gas Monitor.

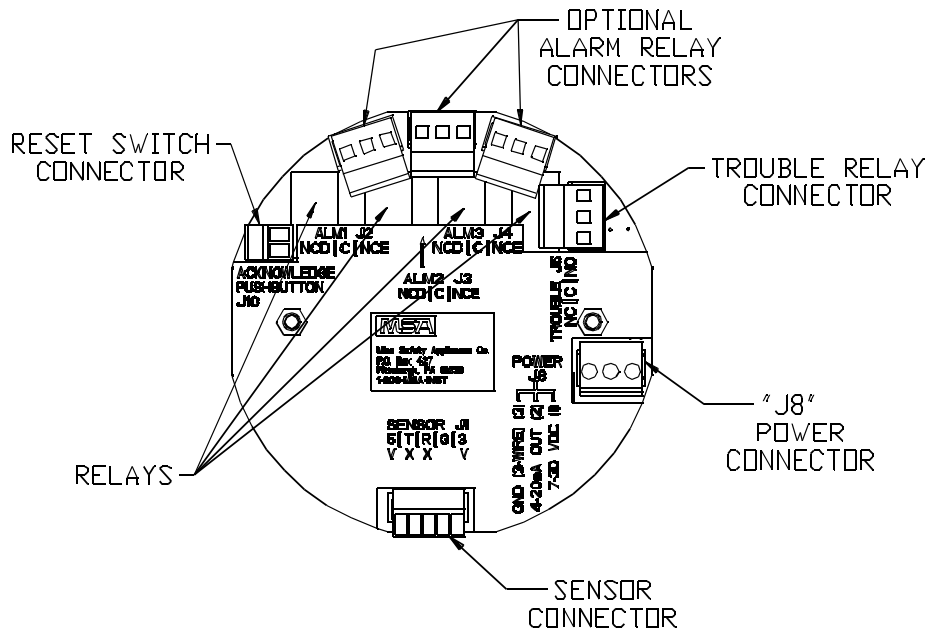


Figure A-6.
Relay Printed Circuit Board