Ultima® X Series Gas Monitors

Instruction Manual

In North America, to contact your nearest stocking location, dial toll-free 1-800-MSA-INST.
To contact MSA International, dial 1-412-967-3354.
Inquiries can also be e-mailed to customer.service@msanet.com.

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

Manufactured by

MSA NORTH AMERICA

P.O. Box 427, Pittsburgh, Pennsylvania 15230

(L) -Y Rev 6 **10036101**

⚠ 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, this instrument will perform as designed only if it is 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 LOSS OF LIFE.

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 service.

MSA Instrument Warranty

1. **Warranty-** Seller warrants that this product will be free from mechanical defect or faulty workmanship for the following periods:
   - Gas Monitor: eighteen (18) months from date of shipment or one (1) year from installation, whichever occurs first
   - Oxygen, Toxic or Catalytic Combustible Sensor: eighteen (18) months from date of shipment or one (1) year from installation, whichever occurs first
   - IR Sensor source: ten (10) years from date of shipment.
     All other IR components: two (2) years from date of shipment.

   This warranty is applicable provided the product 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. 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. Verify that the class, group, and temperature ratings of the equipment agree with the actual classification of the location.
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 loss of life.

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 standard Ultima XIR Infrared Combustible Gas Monitor does not detect the presence of acetylene gas and the presence of acetylene gas will degrade sensor performance. Custom-built acetylene sensors are available through your MSA representative.
8. Gas detectors depend on an unimpeded gas flow for proper operation. In environments where contamination is possible, ensure that the flow remains unobstructed at the sensor. Failure to follow this may prevent gas detection and generate inaccurate readings.
9. CSA performance Certification to standard C22.2 No. 152 is valid only when the instrument is calibrated on methane per the instruction manual.
10. Install Product in accordance with all markings and the regulations of the country in use.
11. Product components may have different hazardous location ratings. Ensure all components are suitable for the area of installation and protection technique.

Failure to follow the above can result in serious personal injury or loss of life.

⚠ 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.

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Chapter 1, Installation

General Description

The Ultima X Series 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 Ultima X Series device uses various detection methods, depending on the gas of interest. Detection methods can be electrochemical, infrared, pellement or other technologies. The Ultima XE Gas Monitor is an explosion-proof device suitable for installation in hazardous locations. The Ultima XA Gas Monitor is a general-purpose version in a plastic enclosure for use in nonexplosive atmospheres only. The Ultima X Gas Monitor can be ordered with the standard 4 to 20 mA analog output or with an optional HART (Highway Addressable Remote Transducer) protocol, which is superimposed on the 4 to 20 mA signal. The unit is factory-calibrated and shipped ready for installation.

The main sensor input is provided via a five-terminal interface that provides a digital interface for 3 VDC or 5 VDC sensor modules. Many different sensor modules are available, providing sensing capability for a large variety of gases. The operating range varies with the type of cell (e.g., electrochemical, pellistor or infrared combustible, etc.).

Identifying Your Unit

The Ultima XA Gas Monitor is housed in a rugged, plastic general-purpose enclosure (FIGURE 1-1).

Figure 1-1. General-Purpose Ultima XA Monitor

The Ultima XE Gas Monitor is housed in a 316 stainless steel explosion-proof enclosure (FIGURE 1-2 shows the Ultima XE with the optional explosion-proof HART port).

Figure 1-2. Explosion-Proof Ultima XE Monitor

The Ultima XIR Gas Monitor is housed in a 316 stainless steel explosion-proof enclosure (FIGURE 1-3).

Figure 1-3. Explosion-Proof Ultima XIR Monitor

If your application requires the sensor head to be located separately from the control unit, all models are available with Remote Sensor Modules (shown in FIGURES 1-4, 1-5 and 1-6).

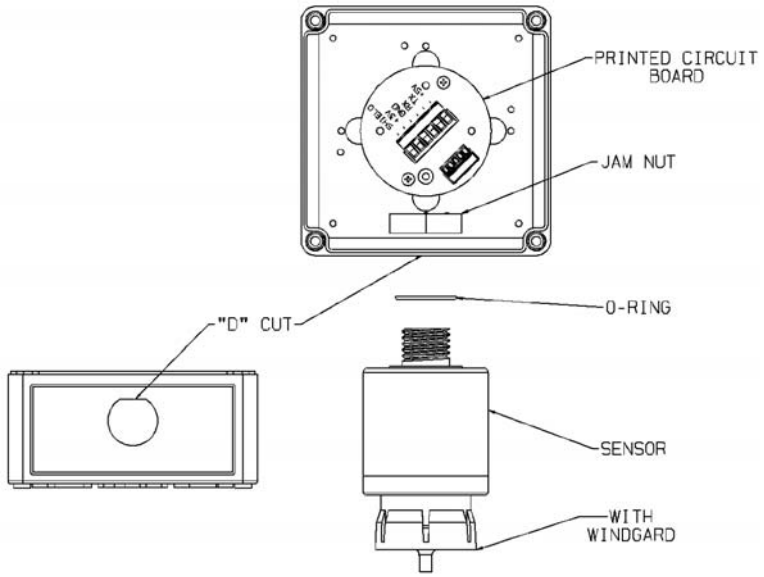

Figure 1-4. General-Purpose XA Remote Sensor Module

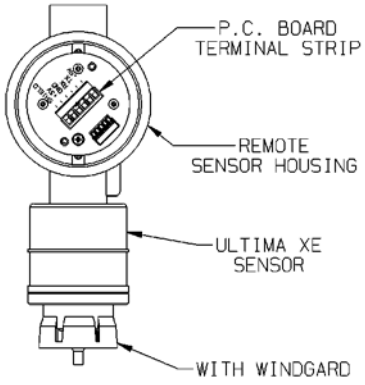

Figure 1-5. Explosion-Proof XE Remote Sensor Module

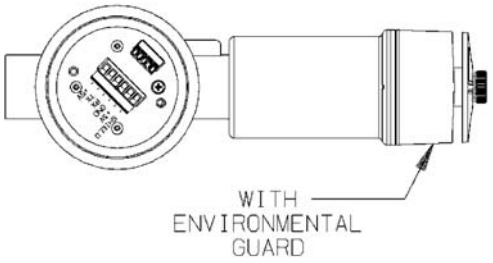

Figure 1-6. Explosion-Proof XIR Remote Sensor Module

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

- Type of unit supplied (Gas Monitor, Gas Monitor Less Sensor, or Remote Sensor 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, or 4 to 20 mA with HART)
- Any options such as internal relays and/or LEDs.
    - If your unit contains internal relays, see Appendix A.

Also check the sensor ID label located on the inside of the sensor. This can be viewed by unscrewing the lower portion of the sensor. If performing this while the unit is powered, see the following Warning. The sensor ID label identifies the detectable gas and the gas range.

⚠ WARNING

For Ultima XE sensors marked Class I, Groups A, B, C and D and not used in Class II areas, 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.

For the Ultima XE Sensor marked Class II Groups F and G, atmosphere must be free of dust and the power removed from the unit before the sensor cap can be removed from the housing. Failure to follow this warning can result in the ignition of a hazardous atmosphere.

Your Ultima XE Series Gas Monitor may also include a separate HART Module if you ordered the following optional accessories:

1). Internal Power Supply and explosion-proof HART Port

2). External RESET Push-button and explosion-proof HART Port.

Installing Your Gas Monitor

NOTE: Reference installation outline drawings listed in TABLE 1-1.

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 downward; otherwise, the inlet may become clogged with particulate matter or liquids.

Mount the Ultima XIR Gas Monitor or XIR Remote Sensing Module with the sensor inlet fitting extended horizontally from the main enclosure (FIGURE 1-3 and 1-6) to 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.
- Use mounting holes in the corners of the Ultima XA enclosure to mount to the optional Mounting Kit (P/N 10047561); see FIGURE 1-7.
- The Ultima XA gas sensor is not shipped attached to the main enclosure. Ensure the sensor wiring harness is through the entry and the sensor is pointed downward.

Installing the Ultima XE Gas Monitor

- The optional Mounting Bracket Kit (P/N 10047561) 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 inside the metal enclosure can be repositioned in any of the four self-aligning interior holes to ensure the display is properly oriented.
- The Ultima XE Gas Monitor sensor is not shipped attached to the main enclosure. Ensure the sensor wiring harness is through the entry and the sensor is pointing downward. Tighten with a strap wrench.

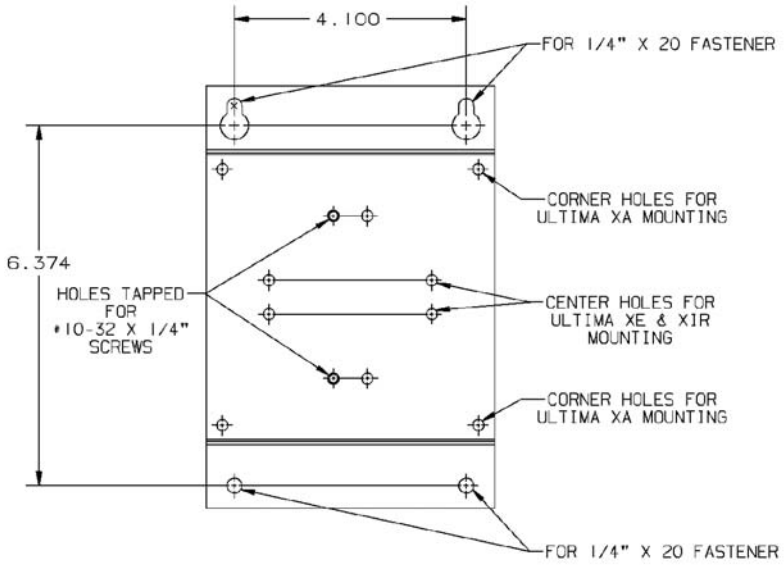

Figure 1-7. Ultima XE and XIR Mounting Bracket

Installing the Ultima XIR Gas Monitor

⚠ WARNING

The Ultima XIR 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.

⚠ 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.

It is recommended that the monitor's environmental guard 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.

- The optional Mounting Bracket (P/N 10047561) can be attached to the rear holes of the Ultima XE Gas Monitor (FIGURE 1-7).
- The Ultima XIR Gas Sensor is factory-installed on the stainless steel gas monitor. The Ultima XIR Monitor must be installed with the XIR sensor in a horizontal position (see FIGURE 1-3) to prevent the build-up of particulate or liquid matter on the monitor optical surface.
- The Ultima XIR Gas Sensor is intended for use only on metal enclosures.

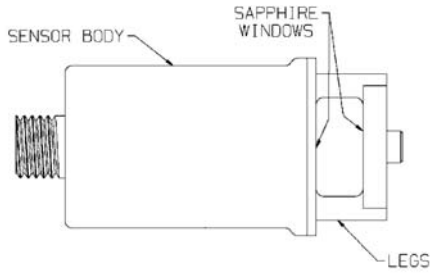

Figure 1-8. Ultima XIR

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 or ignition of hazardous atmospheres could occur.

For Ultima XE and XIR installations, the internal grounding terminal (located on the interior bottom of the Ultima XE main enclosure) 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. See FIGURE 1-9 for location of grounding terminals.

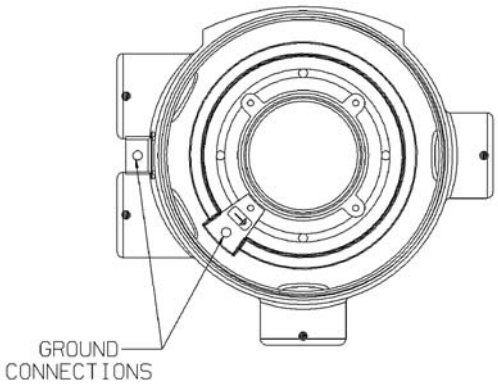

Figure 1-9. Ultima XE Grounding Terminals

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
  - Oxygen models
- A three-wire connection is required for all:
  - Combustible Gas models
  - Toxic and Oxygen models with internal relays.

Wiring for all Models

Install wiring in accordance with the electrical code of the country in use and UL 61010-A1 or CSA C22.2 No. 1010.1, as applicable. 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 TABLE 1-1.

Table 1-1. Installation Outline Drawing List

MODEL	TYPE	DOCUMENT NO.
Ultima XA	Gas Monitor	SK3015-1027
Ultima XE	Gas Monitor	SK3015-1025
Ultima XIR	Gas Monitor	SK3015-1026

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

Use caution when selecting a cable size. TABLE 1-2 expresses 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. Cable distances for units with internal relays are specified in Appendix A, TABLE A-1.

When selecting cable size, consider future needs (i.e., addition of sensors and/or options available with the Ultima X Series Gas Monitors). See Chapter 3, TABLE 3-1, "Performance 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.

All cable shields should be terminated to earth ground at one end only.

Table 1-2. Cable Length and Wire Size for Units Without Internal Relays

GAS TYPE	SENSOR OUTPUT	DC VOLTAGE SUPPLY	WIRE SIZE (AWG)	MAXIMUM CABLE LENGTH WITHOUT HART (FEET)	(METERS)	MAXIMUM LOAD RESISTANCE (OHMS)
Oxygen or Toxic	2 Wire	12 VDC	22	4000 900(w/HART)	1219 274 (w/HART)	100 50 (w/HART)
		24 VDC	22	7,000	2134	500
Oxygen or Toxic	3 Wire	24 VDC	22	10,000	3048	500
Combustible	3 Wire	12 VDC	18	900	274	250
			16	1,400	427	250
			12	3,600	1097	250
Combustible	3 Wire	24 VDC	18	2,500	762	500
			16	4,200	1280	500
			12	10,000	3048	500
XIR	3 wire	12 VDC	18	300	91	250
			16	500	152	250
			12	900	274	250
XIR	3 wire	24 VDC	18	2,000	610	500
			16	3,500	1067	500
			12	5,000	1524	500

An external power supply is required to supply 8-30 VDC to the Ultima X Series Gas Monitor (For power requirements, see Chapter 3, "Specifications"). All connections should be made by following appropriate wire code procedures.

For proper installation of an AC power supply used with an Ultima X Series transmitter, refer to the following drawings for detailed information. Optional 12 VDC or 24 VDC internal and external power supplies can be ordered with the Ultima X Series Gas Monitors.

Table 1-3. Installation Outline Drawings for Ultima X Power Supplies

MODEL	POWER SUPPLY	POWER SUPPLY OUTPUT VOLTAGE	POWER SPECIFICATION	INSTALLATION OUTLINE DRAWING NUMBER
XA	External	12 VDC	1.25 Amps, 15 W	10000020129
	External	24 VDC	0.46 Amps, 11 W	10000020127
	Internal	12 or 24 VDC	see above	SK3015-1027
XE	External	12 VDC	1.25 Amps, 15 W	10000020130
	External	24 VDC	0.46 Amps, 11 W	10000020128
	Internal	12 or 24 VDC	see above	SK3015-1025 (XE) or SK3015-1026 (XIR)

Use of External Controllers

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

- Suprema Controller
- Model 9010/9020 Controller
- GasGard family controllers
- Quad Gas Controller
- Programmable Controllers
- DCS's, etc.

⚠ 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 loss of life.

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.

Identify PCB Configuration

- 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-1 is a two-wire unit, 4-20 mA output
    - A-ULTX-PCB-A-2 is a two-wire unit with HART protocol on the 4-20 mA output
    - A-ULTX-PCB-A-3 is a three-wire unit, 4-20 mA output
    - A-ULTX-PCB-A-4 is a three-wire unit with HART protocol on the 4-20 mA output
  - **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-1 is a two-wire unit, 4-20 mA output
    - A-ULTX-PCB-E-2 is a two-wire unit with HART protocol on the 4-20 mA output
    - A-ULTX-PCB-E-3 is a three-wire unit, 4-20 mA output
    - A-ULTX-PCB-E-4 is a three-wire unit with HART protocol on the 4-20 mA output.

- Two-wire 4 to 20 mA Ultima X Series Monitors operate in the current loop mode (FIGURE 1-10 for general-purpose) (FIGURE1-11 for explosion-proof).

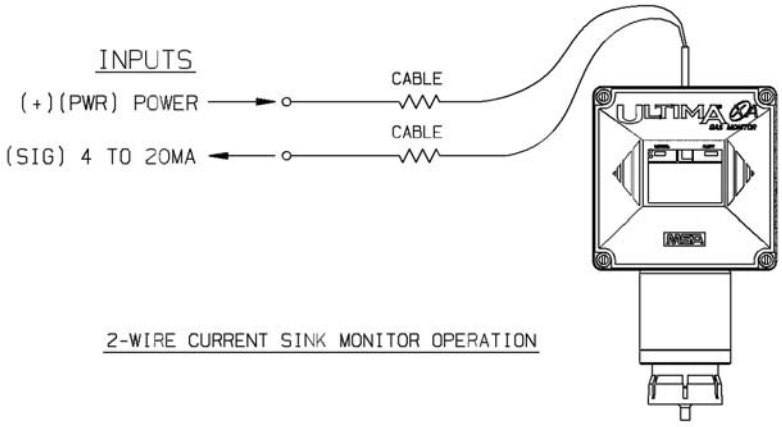

Figure 1-10. General-Purpose Two-Wire Operation

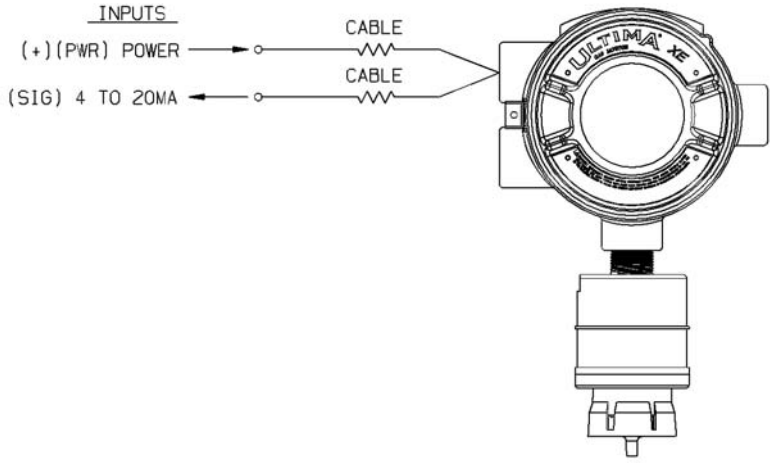

Figure 1-11. Explosion-Proof Two-Wire Operation

- Three-wire Ultima X Series Monitors operate in the current source mode (see FIGURE 1-12 for general-purpose) (FIGURE 1-13 for explosion-proof).

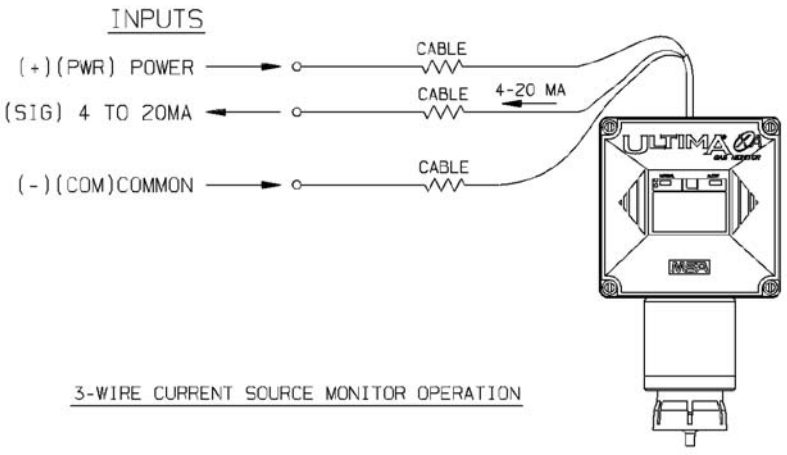

Figure 1-12. General-Purpose Three-Wire Operation

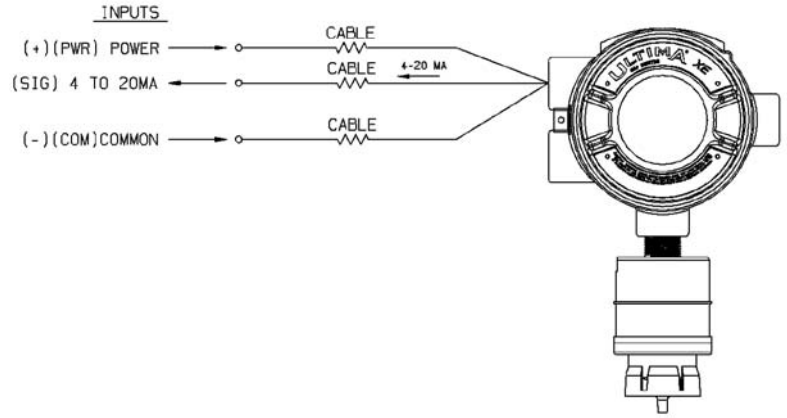

Figure 1-13. Explosion-Proof Three-Wire Operation

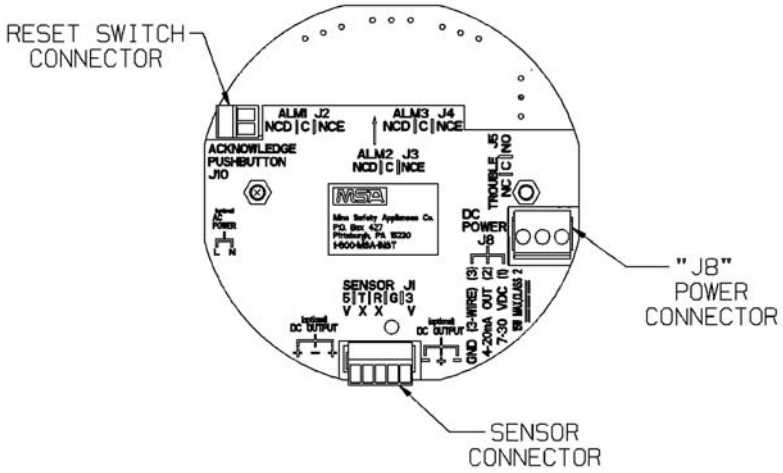

Figure 1-14. Two-Wire Printed Circuit Board (no HART Protocol)

Installation of Two-Wire, 4-20 mA Output (no HART Protocol)

1. Connect 8-30 VDC power lead to J8-1 (see FIGURE 1-14)
2. Connect J8-2 to the 4-20 mA output on the remote system.
3. Connect the sensor module to main pc board connector J-1.
4. Assemble lid on the enclosure.

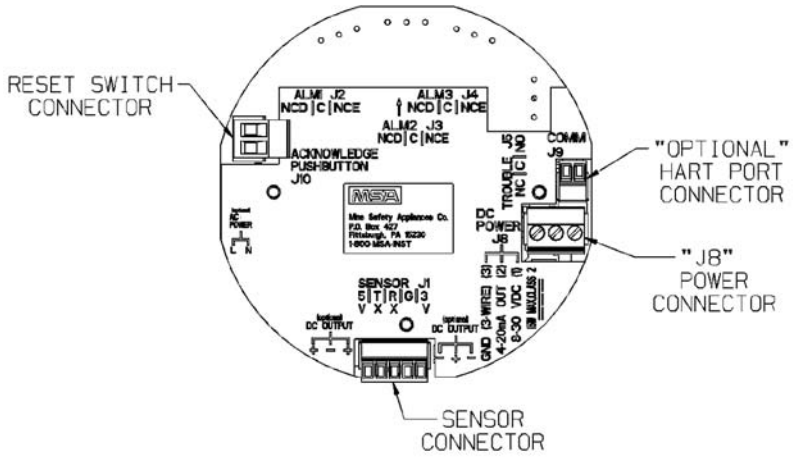

Figure 1-15. Two-Wire Printed Circuit Board (with HART Protocol)

Installation of Two-Wire, 4-20 mA Output with HART Protocol

1. Connect 12-30 VDC power lead to J8-1 (see FIGURE 1-15).

   NOTE: The HART signal is not available below 12 VDC on the two-wire pc board.

2. Connect J8-2 to the 4-20 mA input on the remote system.
3. Terminate the 4-20 mA line with 230-500 Ohms of resistance.
4. Connect sensor module to main pc board connector J-1.
5. Assemble lid on the enclosure.

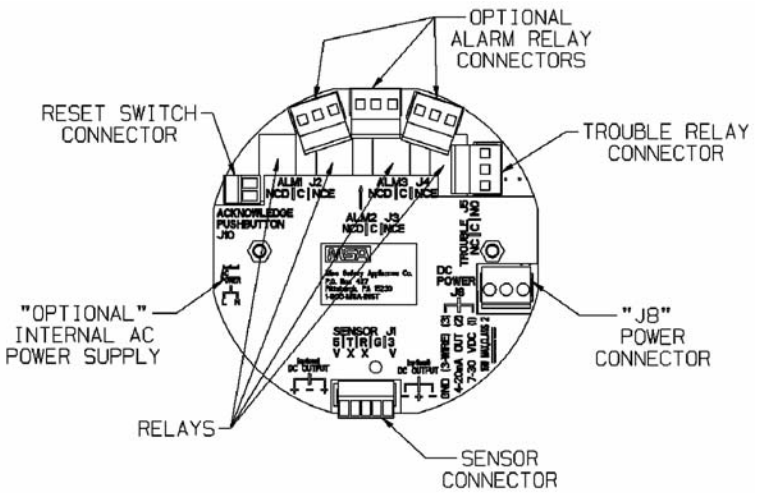

Figure 1-16. Three-Wire Printed Circuit Board (no HART Protocol)

Installation of Three-Wire, 4-20 mA Output (no HART Protocol)

1. Connect 8-30 VDC power lead to J8-1 (see FIGURE 1-16)
2. Connect J8-2 to the 4-20 mA output on the remote system.
3. For three-wire operation, connect the signal ground to J8-3.
4. Connect the sensor module to main pc board connector J-1.
5. Wire for optional relays, if applicable (see Appendix A).
6. Assemble lid on the enclosure.

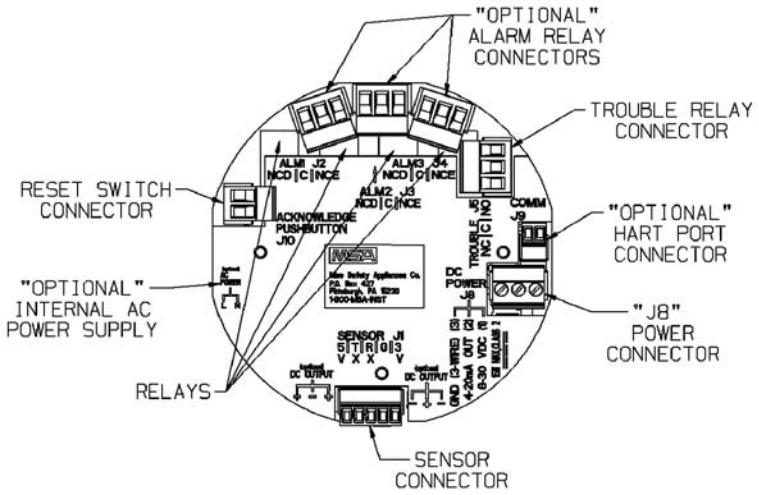

Figure 1-17. Three-Wire Printed Circuit Board (with HART Protocol)

Installation of Three-Wire, 4-20 mA Output with HART Protocol

1. Connect 8-30 VDC power lead to J8-1 (see FIGURE 1-17)
2. Connect J8-2 to the 4-20 mA input on the remote system.
3. Terminate the 4-20 mA line with 230-500 Ohms of resistance.
4. For three-wire operation, connect the signal ground to J8-3.
5. Connect the sensor module to main pc board connector J-1.
6. Wire for optional relays, if applicable (see Appendix A).
7. Assemble lid on the enclosure.

Installing the Ultima X Remote Sensor Module

The Remote Sensor Module is used with the Ultima X Gas Monitor for installations requiring remote placement of the gas sensor.

FIGURES 1-18 and 1-19 show the general-purpose and explosion-proof configurations.

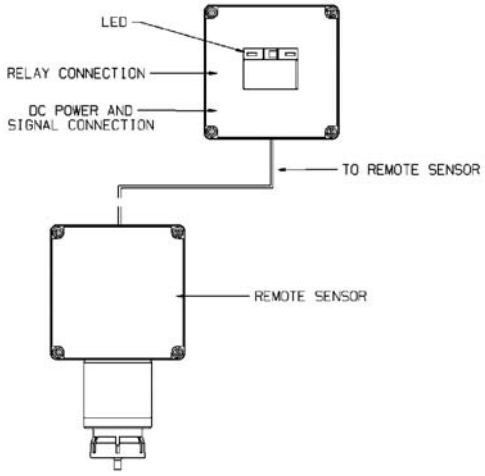

Figure 1-18. Remote Module General-Purpose Ultima X Series Wiring

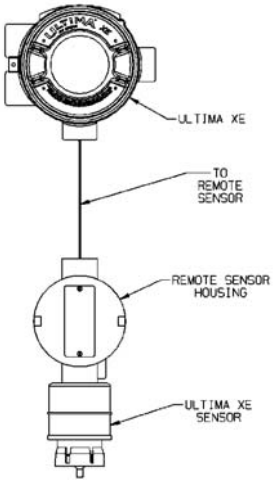

Figure 1-19. Remote Module Explosion-Proof Ultima X Series Wiring

The Remote Sensor Module should be mounted in a manner similar to the Ultima X (see Chapter 1, "Installing Your Gas Monitor") and at a maximum distance outlined in TABLE 1-6.

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 Remote Sensors

⚠ 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 or ignition of hazardous atmospheres could occur.

⚠ WARNING

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. For wiring details, see the applicable Installation Outline Drawing listed in TABLE 1-1.

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 1-4. Remote Module Wiring and Placement

GAS TYPE	MINIMUM WIRE SIZE	MAXIMUM DISTANCE
Toxic and Oxygen	20 AWG	100 feet (30m)
Catalytic Combustible	18 AWG 16 AWG	50 feet (15 m) 100 feet (30 m)
*IR Combustible	16 AWG 12 AWG	50 feet (15 m) 100 fee (30 m)

TABLES 1-7 and 1-8 show suggested cables for Ultima X Series installations; other cables are available which are also adequate.

Table 1-5. 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 1-6. 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 power and signal cable from the Gas Monitor through a customer-created opening in the enclosure and wire it to the appropriately labeled connection on 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 appropriately labeled connection on the terminal block (FIGURE 1-5).
3. Verify the sensor connector is firmly seated on the terminal board.
4. Re-install the cover of the Ultima X Series Remote Sensor.

NOTES:

Grounding

- 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 1-1 for Installation Outline Drawing document numbers.

Cable Size

- 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 or read directly from the optional HART port with an HCF-approved communicator (such as the Emerson 375 HART Communicator, or equivalent).

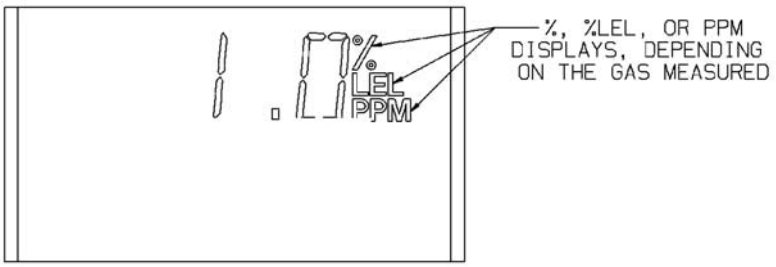

Figure 2-1. LCD Gas Concentration Display

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) and it is possible 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 the100%LEL range. It returns to normal operation when gas concentration level falls below 100%LEL.

Table 2-1. Instrument Operation

NOTES:
[1] ALERT option causes the 4-20 mA output to be set to 3.75 mA during O_2 sensor calibration (if the Cal Signal Option is also enabled). If the ALERT option is disabled and the Cal Signal enabled, the output is set to 21 mA during the O_2 sensor calibration.
[2] Swap Delay timeout is 60 seconds if enabled; 0 seconds otherwise.
[3] The Swap Delay feature enables a one-minute hold-off of the Sensor Missing Fault, allowing the user to "Swap" or change sensors without having the 4-20 mA set to a fault condition.
[4] Alarming operation are followed if the alarms are enabled.

OPERATION	LEDs GREEN	RED	4 to 20 mA	FAULT RELAY
NORMAL	ON steady	OFF	Gas value	Energized
ALARMING	OFF	Flashing	Gas value	Energized
FAULT	OFF	ON steady	3.0 mA	De-energized
POWER UP (HART Version)	OFF	ON steady	<3.75 mA	De-energized
POWER UP (Non-HART Version)	OFF	ON steady	<3.1 mA	De-energized
COUNT DOWN (All Versions)	OFF	ON steady	ALERT option[1] disabled; 21.0 mA for O_2; 3.75 mA for others ALERT option[1] enabled: 3.75 mA for all	Energized if ALERT option disabled De-energized if ALERT option enabled[3]
SENSOR MISSING/ COUNT-DOWN	OFF	ON steady	3.0 mA 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	De-energized if Swap Delay timeout[2] expired, Swap Delay[3] disabled or FAULT 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 21.0 mA for O_2 if cal signal enabled and ALERT option[1] disabled	Energized if ALERT option disabled De-energized if ALERT option enabled[1]
CAL 4-20	OFF	ON steady	4 mA if 4 mA calibration selected 20 mA if 20 mA calibration selected	Energized if ALERT option disabled De-energized if ALERT option enabled[1]
CAL FAULT	OFF	ON steady	Gas value	De-energized two seconds every minute
UNDER-RANGE	OFF	ON steady	3.0 mA if gas value 0 or less; gas value otherwise	De-energized
OVER-RANGE/ LOC	ON steady[4]	OFF[4]	21.0 mA	Energized

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.

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.

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.

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

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)
- Ultima Controller P/N 809086(FIGURE 2-3)
- Optional Push-button Calibration (FIGURE 2-4). Instructions for use of the optional push-button are given in Appendix A.

- HART®-compatible communications interface with Device Description Language capability (DDL) or generic HART interface with Manufacturer Specific Command capability. This hand-held HART Communicator must be HART revision 7 compliant and can be obtained from a HART-authorized supplier. See Appendix D for command definitions.

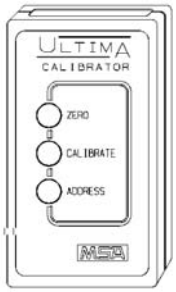

Figure 2-2. Ultima Calibrator

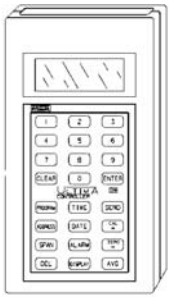

Figure 2-3. Ultima Controller

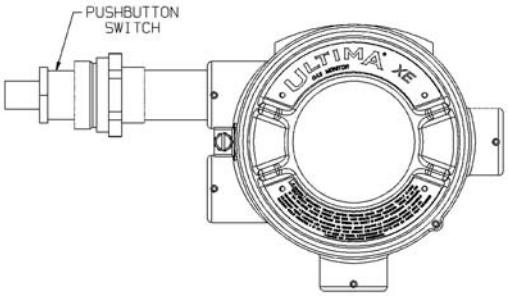

Figure 2-4. Ultima X Optional Push-button Calibrator

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 Controller/Calibrator manual (P/N 813379) for full functionality.

NOTE: 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.

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 or a HART controller with DDL- or manufacturer-specific command capability. When the calibration

signal is enabled, the output signal is 3.75 milliamps for the 4 to 20 milliamp output models.

NOTE: For oxygen sensors, the calibration signal will be 21 mA. Oxygen can be set to a 3.75 mA calibration signal by turning ON the ALERT option as described in the 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.

NOTES:

- If this is the first calibration or, if the sensor element has been changed or replaced, see Chapter 2, "Initial Calibration."
- If this is an **oxygen sensor**, see subsequent section, "Oxygen Calibration."
- If this is an **XIR sensor**, see subsequent section, "XIR Calibration."
- Apply power to the unit at least 1 hour before calibrating.
- Due to the unstable nature of Chlorine Dioxide (ClO_2), Chlorine gas is used as a calibration simulant. If using the MSA calibration system and gas cylinder (P/N 710331), the response ratio is 2:1. In other words, the 2 ppm sample of Chlorine should be set to read 1 ppm of ClO_2. The default value for the calibration gas on the ClO_2 Ultima X Series Gas Monitor is 1 ppm.
- For **Cl_2** and **ClO_2** calibration, do not mix regulators. Use only one regulator for each of these gases. They will not work properly if one regulator is used for multiple gases.

- Due to the reactivity of HCL with flow system components, the flow control regulator must only be used for HCL gas. HCL gas must be run through the flow control regulator and tubing for five minutes before attempting a calibration. After a successful calibration, flush the flow control regulator and tubing with 100% Nitrogen for five minutes. Store the flow control regulator in the desiccated bag included in Calibration Kit 54 or equivalent dry container.

Equipment Required

Three calibration kits (numbered 40, 41, and 54) are available from MSA for diffusion Ultima X Series Gas Monitors. Kit 40, 41, and 54 are housed in a convenient carrying case and contain all items necessary (less gas) for a complete and accurate calibration.

These Kits do not calibrate Ultima X Series units equipped with a flow cap.

NOTE: The calibration procedure for the sample draw Ultima XE/XA Monitor is the same as the procedure for the diffusion version, except calibration gas is applied to the calibration entry port of the inlet flow block and the cal kit for pumped units provides a flow matching regulator.

The check or calibration gases can also be carried in the case. See TABLE 2-2 for the appropriate zero and span gas cylinders for your Ultima X Series Gas Monitor.

TABLE 2-2 shows the recommended calibration kit for Ultima X Series Gas Monitors. Typically, Cal Kit 41 uses 0.25 LPM regulator and a calibration cap to contain the calibration gas. Cal Kits 40 and 54 use a 1.5 LPM regulator and no calibration cap. If Cal Kit 41 is recommended and the application is such that the calibration cap cannot be used (such as for a remote sensor application), Cal Kit 40 may be used. However, any time Cal Kit 40 is used, ambient wind conditions must be minimized to avoid a calibration with increased sensitivity.

NOTE: The Ultima XIR uses Cal Kit 40 and does require a calibration cap. This calibration cap (P/N 10041533) is shipped with the product.

⚠ WARNING

These calibration kits contain zero caps to use in place of zero calibration gas. These caps can only be used when the ambient air does not contain the gas the monitor is detecting. If there is any doubt, use zero gas when zeroing the Ultima X Monitor; otherwise, improper calibration could occur.

Span Gas Values

The Ultima X Series Gas Monitor is factory-shipped with a preset span gas value (TABLE 2-2). This span gas value can be changed via the Ultima Controller or a HART controller; otherwise, the span gas must correspond to preset concentrations. See Section 3 of the Controller/Calibrator Manual (P/N 813379) to change the span gas value. See Appendix D for the equivalent HART command

The span gas value of Ultima X Gas Monitor catalytic combustible models are pre-set to one of the broad categories shown in TABLE 2-2. Specific span gas values for all combustible models are listed under each category given in TABLE 2-3.

⚠ WARNING

Always calibrate for the least sensitive gas or vapor (higher number category) expected to be measured (TABLE 2-3); otherwise, instrument readings may be incorrect.

Table 2-2. Factory-set Span Values

GAS TYPE	RANGE	SPAN GAS PRESET VALUES	RP CYLINDER P/N	CAL KIT	WARM-UP TIME
CARBON MONOXIDE	0-100 PPM 0-500 PPM 0-1000 PPM	60 PPM 300 PPM 400 PPM	710882 10027938 10028048	40	15 minutes
SULFUR DIOXIDE	0-25 PPM 0-100 PPM	10 PPM 10 PPM	10028070 808978	40	15 minutes
HYDROGEN SULFIDE	0-10 PPM 0-50 PPM 0-100 PPM 0-500 PPM	5 PPM 40 PPM 40 PPM 250 PPM	710414 10028062 10028062 10089547	40	15 minutes
NITRIC OXIDE	0-100 PPM	50 PPM	10028074	40	15 minutes
NITROGEN DIOXIDE	0-10 PPM	5 PPM	710332 41	41	30 minutes

GAS TYPE	RANGE	SPAN GAS PRESET VALUES	RP CYLINDER P/N	CAL KIT	WARM-UP TIME
CHLORINE	0-5 PPM 0-10 PPM 0-20 PPM	2 PPM 2 PPM 10 PPM	710331 10028066	41	30 minutes 30 minutes 30 minutes
HYDROGEN CYANIDE	0-50 PPM	10 PPM	10028072	41	30 minutes
HYDROGEN FLUORIDE[7]	0-10 PPM	8 PPM	10028070	41	30 minutes
CHLORINE DIOXIDE[4]	0-3 PPM	1 PPM	710331	41	30 minutes
OXYGEN	0-10% 0-25%	5% 20.8%	493580 10028028[2]	40	15 minutes 15 minutes
NATURAL GAS[3]	0-100% LEL	25% LEL[1]	10028034	40	15 minutes
PETROLEUM VAPORS[3] (GASOLINE)	0-100% LEL	40% LEL[1]	10028034	40	15 minutes
GENERAL SOLVENTS[3]	0-100% LEL	55% LEL[1]	10028034	40	15 minutes
NON-METHANE IR	0-100% LEL	29% LEL[1]	10028034	40	- - -
METHANE IR	0-100% LEL	50% LEL[5]	10028032	40	- - -
PHOSPHINE	2.0 PPM	0.5 PPM	710533	41	24 hours
ARSINE	2.0 PPM	1.0 PPM	710533	41	24 hours
SILANE	25 PPM	5 PPM	10014897	41	4 hours
DIBORANE	50 PPM	15 PPM	10014897	41	30 minutes
FLUORINE	5.0 PPM	4.0 PPM	710331	41	30 minutes
BROMINE	5.0 PPM	2.5 PPM	710331	41	30 minutes
AMMONIA	100 PPM 0-1000 PPM	25 PPM 300 PPM	10028076 10044014	40 40	30 minutes 30 minutes
HYDROGEN	0-1000 PPM	500 PPM	10022386	40	30 minutes
ETHYLENE[6] OXIDE	0-10 PPM	4.0 PPM	10028070	40	24 hours
CARBON DIOXIDE IR	0-5000 PPM 0-2% 0-5%	2000 PPM 1.5% 2.5%	479266 807386 479265	40	- - -
HYDROGEN CHLORIDE	0-50 PPM	40 PPM	10028078	41	30 minutes

NOTES:

[1] Calibrated with Propane (.6% gas by volume)

[2] Not required for standard calibration procedure

[3] For combustible gas, it is good practice to calibrate unit with gas to be detected

[4] ClO_2 is calibrated with Cl_2 or use ClO_2 Calibrator Kit (P/N 710420)

[5] Methane IR is calibrated with 50% LEL Methane

[6] ETO is calibrated with SO_2.

[7] Hydrogen Fluoride (HF) is calibrated with Sulfur Dioxide (SO_2).
10 ppm SO_2 equals 8 ppm HF.

Table 2-3. Calibration Guide for Combustible Gas Sensor

CATEGORY 31: FOR CATALYTIC TYPE 1S NATURAL GAS

To detect the following gases, recalibrate with 0.6% propane & set span gas value accordingly			
Acetaldehyde	23	Hydrogen	16
Acetylene	24	MAPP Gas	20
Butadiene, 1, 3	25	Methane	20
Carbon Monoxide	20	Methanol	20
Ethane	24	Methylene Chloride	24
Ethylene	25	Monomethyl Amine	22
Ethylene Dichloride	22	Trigonox B	22

CATEGORY 32: FOR CATALYTIC TYPE 1S PETROLEUM VAPORS

To detect the following gases, recalibrate with 0.6% propane & set span gas value accordingly			
1, 1, 1-Trichloroethane	32	Ethylene Oxide	36
Acetic Acid	28	Freon 152A	28
Acetone	37	Gasoline	35
Acrolein	28	Hexane	40
Acrylonitrile	26	Isoprene	33
Allyl chloride	30	Methyl Acetate	34
Benzene	37	Methyl Chloride	32
Butane (n)	36	Methyl Propene (2)	29
Butane (iso)	32	Methyl t-Butyl Ether	35
Butanol (iso)	38	Pentane (n)	36
Butene-1	34	Pentane (iso)	36
Butene-2	37	Pentene	35
Butyl Acetate (n)	28	Propane	29
Butylene	33	Propanol (n)	36
Butyraldehyde	30	Propanol (iso)	37
Chlorobenzene	38	Propylene	33
Cyclohexane	37	Propylene Oxide	33
Dimethoxyethane	26	Tetrahydrofuran	30
Dioxane, 1, 4	39	Toluene	39
Epichlorhydrin	33	Trichloroethylene	35
Ethanol	30	Triethylamine	38
Ether, Diethyl	37	Vinyl Acetate	34
Ether, Dimethyl	30	Vinyl Chloride	32

CATEGORY 33: FOR CATALYTIC TYPE 1S GENERAL SOLVENTS

To detect the following gases, recalibrate with 0.6% propane & set span gas value accordingly			
Amyl alcohol	43	JP-4	41
Butanol (n)	48	Methyl Cellosolve	49
Butyl Acrylate	46	Methyl Ethyl Ketone	52
Cellosolve	42	Methyl Isobutyl Ketone	53
Di isopropylamine	42	Methyl Methacrylate	40
Diethylamine	41	Naphtha, VM&P	53
Ethyl Acetate	43	Octane (iso)	52
Ethyl Acrylate	52	Propyl Acetate	45
Ethyl Benzene	41	Styrene	42
Heptane	42	Xylene	50
Hexene	42		

CATEGORY 38: ULTIMA XIR METHANE	
To detect the following gases, recalibrate with 2.5% methane & set span gas value accordingly	
Methane	50

CATEGORY 39: ULTIMA XIR NON-METHANE
To detect non-methane gases, recalibrate with stated % propane & set span gas value as given in Appendix B
For additional gases for the Ultima XIR, see Appendix B.

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 standard 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
- pressing and holding SPAN button on the Ultima Controller or
- using the optional push-button calibration as outlined in Appendix A, "Optional Push-button Calibration"
- using the HART Communicator as described in Appendix D.

After starting the INITIAL calibration:

- 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 or by pressing and releasing the push-button if push-button calibration is available.

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

Standard Calibration

A standard 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, or by using the optional push-button calibration as outlined in Appendix A, "Optional Push-button Calibration". Both the "zero" and the "span" functions are available on the HART Controller and are described in Appendix D.

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 zero gas flow by turning 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 anytime during the 30-second countdown interval; simply press any button on the Calibrator or Controller while aiming it at the unit or by pressing and releasing the push-button if push-button calibration is available.

   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 2-5).

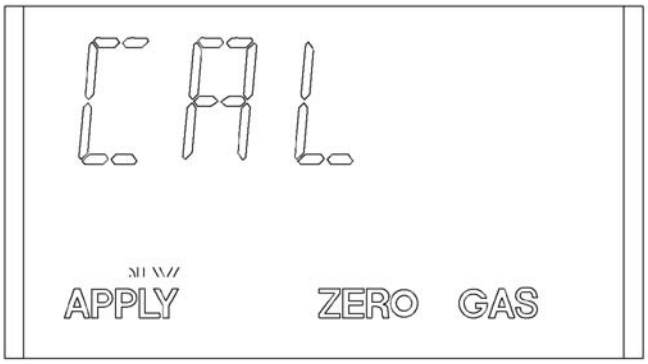

Figure 2-5. Apply ZERO Gas Flag

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 Gas 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 Gas Monitor automatically begins the span countdown after a successful zeroing of the unit. The span countdown is 30 seconds (FIGURE 2-6).

   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 or by pressing and releasing the push-button if push-button calibration is available.

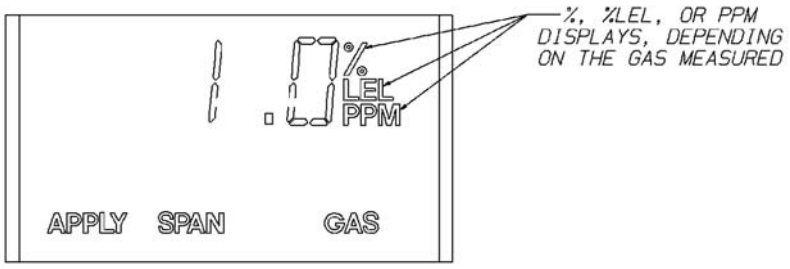

Figure 2-6. Apply SPAN Gas Flag

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 Gas 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 2-7).
    - No user adjustments are necessary.
    - The display will show the span gas value while the span gas is flowing to the unit.
13. Turn OFF the gas flow by turning the knob on the flow controller.

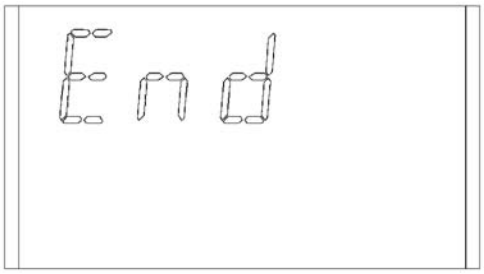

Figure 2-7. Calibration End Display

- 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 Gas Monitor
  - The Ultima X Series Gas 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 Gas 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.

OXYGEN Calibration

NOTE: If this is the first calibration after the sensor element is replaced, perform an "Initial Calibration."

Oxygen calibration is slightly different from other gases. When the **ZERO** function is performed, the 30-second countdown is omitted because the Ultima/Ultima X Series unit performs the zero electronically. No calibration cap or zero gas is necessary.

To meet the specification stated, it is necessary to span the oxygen Ultima/Ultima X Series Gas Monitor with the Calibration Kit and an oxygen cylinder. The concentration of oxygen in air varies slightly due to changing relative humidity and pressure levels. These variations in oxygen levels are detected by the oxygen Ultima/Ultima X Series Gas Monitor. To meet the reproducibility specification, it is necessary to use a calibration gas cylinder. This ensures the same concentration of oxygen for every calibration.

25% Oxygen Ultima/Ultima X Series Gas Monitor

For the **SPAN** function, ambient air is generally adequate for the 25% oxygen Ultima/Ultima X Series Gas Monitor as the expected default span value is 20.8%. Therefore, when the display prompts "APPLY SPAN GAS" it would be adequate to simply allow the countdown to occur without applying gas.

NOTE: If the sensor is located in an area of normally low or enriched oxygen, then a 20.8% oxygen sample must be applied when the display prompts: "**APPLY SPAN GAS**".

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 one of the following methods:

- pressing the ZERO button on the Calibrator or Controller
- using the optional push-button calibration as outlined in Appendix A, "Optional Push-button Calibration"
- using the HART Controller or DCS, as described in Appendix D.

Follow 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 calibration 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 or via the HART Controller).

Chapter 3, Specifications

Table 3-1. Performance Specifications

GAS TYPES	Combustibles, Oxygen & Toxics		
TEMPERATURE 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 & DUAL MODULES**	-40 to +60°C (-40 to +140°F)
	IR COMBUSTIBLES	**SINGLE & DUAL MODULES**	-40 to +60°C (-40 to +140°F)
STORAGE TEMPERATURE RANGE			-40 to +70°C (-40 to +158°F) or limits of the sensor
DRIFT	**ZERO DRIFT**	Less than 5%/year, typically	
	SPAN DRIFT	Less than 10%/year, typically	
NOISE		Less than 1% FS	

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

ACCURACY GAS	LINEARITY	REPEATABILITY
CARBON MONOXIDE	±2% FS	±1% FS or 2 ppm
OXYGEN	±2% FS	±1% FS
HYDROGEN SULFIDE	±10% FS or 2 ppm	±1% FS or 2 ppm
CHLORINE	±10% FS or 2 ppm	±5% FS or 1 ppm
SULFUR DIOXIDE	±10% FS or 2 ppm	±1% FS or 2 ppm
NITRIC OXIDE	±10% FS or 2 ppm	±1% FS or 2 ppm
NITROGEN DIOXIDE	±10% FS or 2 ppm	±4% FS or 1 ppm
HYDROGEN CYANIDE	±10% FS or 2 ppm	±4% FS or 2 ppm
HYDROGEN CHLORIDE	±10% FS or 2 ppm	±10% FS or 2 ppm
CATALYTIC COMBUSTIBLE GAS	<50% LEL ±3% FS >50% LEL ±5% FS	±1% FS ±1% FS
IR COMBUSTIBLE GAS: METHANE, PROPANE	<50% LEL - ±2% >50% LEL - ±5%	±2% FS ±2% FS
CHLORINE DIOXIDE	±10% FS or 2 ppm	±5% FS or 1 ppm
ETHYLENE OXIDE	±10% FS	±5% FS
AMMONIA	±10% FS	±5% FS
HYDROGEN	±5% FS	±5% FS
PHOSPHINE	±10% FS	±10% FS
ARSINE	±10% FS	±10% FS
SILANE	±10% FS or 2 ppm	±1% FS or 2 ppm
DIBORANE	±10% FS or 2 ppm	±1% FS or 2 ppm
FLUORINE	±10% FS or 2 ppm	±5% FS or 1 ppm
HYDROGEN FLUORIDE	±10% FS	±10% FS
BROMINE	±10% FS or 2 ppm	±5% FS or 1 ppm

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 15 to 60% RH (SO_2**) 35 to 95% RH, long term
SENSOR LIFE	**CATALYTIC COMBUSTIBLES**	3 years, typically
	OXYGEN & TOXICS	2 years, typically
	AMMONIA	***
	FULL REPLACEMENT WARRANTY	1 year from installation; 10 years for IR Sensor source (see "MSA Instrument Warranty" in this manual for complete details)
WIRING REQUIRE- MENTS	**OXYGEN & TOXICS**	2-wire or 3-wire
	COMBUSTIBLES	3-wire
	RELAYS	3-wire

**SO_2 sensor should not be used in dirty or humid environments.

***0-100 ppm NH_3 sensor is consumable at a rate of 10% for every 200 ppm/hours of exposure.
0-1000 ppm NH_3 sensor is consumable at a rate of 10% for every 1500 ppm/hours of exposure.

POWER CONSUMPTION * (TOTAL UNIT WITH RELAYS)	**OXYGEN & TOXICS**	8 VDC 12 VDC 24 VDC	250 mA max 175 mA max 100 mA max
	CATALYTIC COMBUSTIBLES	8 VDC 12 VDC 24 VDC	600 mA max 400 mA max 210 mA max
	IR COMBUSTIBLES	8 VDC 12 VDC 24 VDC	870 mA max 550 mA max 290 mA max
SIGNAL OUTPUT	**COMBUSTIBLES**	3-wire current source	
	OXYGEN & TOXICS	2-wire current sink 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)	

* The HART output signal is not available below 12 VDC on the two-wire pc board.

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 (filtered) sensor gave an equivalent response of 200 ppm. Column 4 shows that an H_2S sensor gave an equivalent response of 0.5 ppm, etc.

ND = No Data

INTER-FERANT	CONCEN-TRATION (PPM)	CO filtered	H_2S	Cl_2	SO_2 filtered	NO	NO_2	HCN	HCL
Acetone	1000	0	0	0	0	ND	0	ND	ND
Acetylene	12000	0	0	0	0	ND	ND	ND	ND
Ammonia	25	0	0	0	0	ND	0	0	0
Arsine	1	0	0	0	0	0	ND	ND	1
Benzene	20	0	0	0	0	ND	ND	0	ND
Bromine	2	0	0	2.5	ND	0	0	0	ND
Carbon Dioxide	5000	0	0	0	0	0	0	0	0
Carbon Disulfide	15	0	0	0	0	0	ND	0.1	0
Carbon Monoxide	100	100	0.3	0	0.2	ND	0	0	0
Chlorine	5	0	-3	5	0	0	0	-0.2	0
Diborane	20	0	0	0	0	ND	ND	ND	0
Ethylene	50	100	0.1	0	0	ND	0	-0.3	ND
Ethyl Alcohol	100	115	0	0	0	ND	ND	0	ND
Ethylene Oxide	10	ND	ND	ND	0	ND	ND	ND	ND
Ether	400	3	0	0	0	ND	0	ND	ND
Fluorine	5	0	0	2.5	0	0	ND	0	0
Freon 12	1000	0	0	0	0	0	0	0	0
Germane	1	0	0	0	0	0	ND	ND	1
Hexane	500	0	0	0	0	ND	0	0	ND
Hydrogen	500	200	0.5	0	15	ND	-10	0	0
Hydrogen Chloride	50	0	0	0	0	4	0	ND	50
Hydrogen Cyanide	10	0	0	0	0	0	0	10	0
Hydrogen Fluoride	10	0	0	0	0	ND	ND	ND	6.5
Hydrogen Sulfide	10	1	10	-0.1	0	1	-8	50	40
MEK	200	0	0	0	0	0	0	ND	ND
Mercaptan (Methyl)	5	0	4.5	-0.1	0	1	ND	6	ND
Methane	5000	0	0	0	0	0	0	0	0
Nitric Oxide	100	0	2	0	2	100	ND	-3	40
Nitrogen Dioxide	5	-1	-4	0.5	-5	1.5	5	ND	0
Phosphine	0.5	ND	0	0	ND	0	ND	ND	2
Silane	5	0	0	0	0	0	ND	ND	7
Sulfur Dioxide	10	0	0.3	0	10	0.5	ND	-0.3	0
Tichloro-ethylene	1000	0	0	0	0	0	ND	ND	ND

ND = No Data

INTER-FERANT	CONCEN-TRATION (PPM)	ClO_2	HF	PH_3	ASH_4	SiH_4	GeH_3	B_2H_6	Br_2
Acetone	1000	0	0	ND	ND	ND	ND	ND	0
Acetylene	12000	0	0.1	ND	ND	ND	ND	ND	0
Ammonia	25	0	0	ND	ND	ND	ND	ND	0
Arsine	1	0	ND	0.7	1	1	1	5	0
Benzene	20	0	ND	ND	ND	ND	ND	ND	0
Bromine	2	1	ND	ND	ND	ND	ND	ND	2
Carbon Dioxide	5000	0	0	ND	ND	ND	ND	ND	0
Carbon Disulfide	15	0	ND	0	0	0	0	0	0
Carbon Monoxide	100	0	0	0	1	0	0	0	0
Chlorine	5	2.5	5	ND	ND	ND	ND	ND	4
Diborane	20	0	ND	3.5	5	4	5	20	0
Ethylene	50	0	0	0.5	1	1	1	2	0
Ethyl Alcohol	100	0	0	ND	ND	ND	ND	ND	0
Ethylene Oxide	10	0	ND	ND	ND	ND	ND	ND	ND
Ether	400	0	0	ND	ND	ND	ND	ND	0
Fluorine	5	1	ND	ND	ND	ND	ND	ND	2
Freon 12	1000	0	0	0	0	0	0	0	0
Germane	1	0	ND	0.7	1	1	1	5	0
Hexane	500	0	0	ND	ND	ND	ND	ND	0
Hydrogen	500	0	0	0	0	0	0	0	0
Hydrogen Chloride	50	0	30	ND	ND	ND	ND	ND	0
Hydrogen Cyanide	10	0	0	ND	ND	ND	ND	ND	0
Hydrogen Fluoride	10	0	10	ND	ND	ND	ND	ND	0
Hydrogen Sulfide	10	0	3	ND	ND	ND	ND	ND	0
MEK	200	0	ND	ND	ND	ND	ND	ND	0
Mercaptan (Methyl)	5	0	ND	ND	ND	ND	ND	ND	0
Methane	5000	0	0	ND	ND	ND	ND	ND	0
Nitric Oxide	100	0	2	ND	ND	ND	ND	ND	0
Nitrogen Dioxide	5	0.2	2.5	ND	ND	ND	0.5	ND	0.4
Phosphine	0.5	0	0	0.5	1	0.7	1	3	0
Silane	5	0	ND	0.1	0.2	5	0.2	15	0
Sulfur Dioxide	10	0	8	ND	1	2	3	6	0
Tichloro-ethylene	1000	0	0	ND	ND	ND	ND	ND	0

ND = No Data

INTER-FERANT	CONCEN-TRATION (PPM)	F_2	NH_3	H_2	EtO
Acetone	1000	0	ND	ND	ND
Acetylene	12000	0	ND	ND	ND
Ammonia	25	0	25	ND	0
Arsine	1	0	ND	ND	ND
Benzene	20	0	ND	ND	ND
Bromine	2	12	ND	ND	ND
Carbon Dioxide	5000	0	0	0	ND
Carbon Disulfide	15	0	ND	ND	ND
Carbon Monoxide	100	0	0	2	ND
Chlorine	5	10	0	0	0
Diborane	20	0	ND	ND	ND
Ethylene	50	0	0	40	ND
Ethyl Alcohol	100	0	ND	ND	10
Ethylene Oxide	10	ND	ND	ND	10
Ether	400	0	ND	ND	ND
Fluorine	5	5	ND	ND	ND
Freon 12	1000	0	0	0	0
Germane	1	0	ND	ND	ND
Hexane	500	0	ND	ND	ND
Hydrogen	500	0	ND	500	ND
Hydrogen Chloride	50	0	0	0	ND
Hydrogen Cyanide	10	0	0	3	0
Hydrogen Fluoride	10	0	ND	ND	ND
Hydrogen Sulfide	10	-0.2	0.5	1	ND
MEK	200	0	0	ND	3
Mercaptan (Methyl)	5	-0.2	ND	ND	ND
Methane	5000	0	ND	ND	ND
Nitric Oxide	100	0	0	3	ND
Nitrogen Dioxide	5	1	ND	ND	0
Phosphine	0.5	0	0	0	0
Silane	5	0	ND	ND	ND
Sulfur Dioxide	10	0	0	0	ND
Tichloro-ethylene	1000	0	ND	ND	ND

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 4-20 mA output signal goes to a fault condition of 3.0 mA

The "Sensor Warning" indication is not an error and does not affect the output. TABLES 4-1 and 4-2 describe the messages that users may see.

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

Table 4-2. Configuration Display Messages

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

Table 4-3. Troubleshooting Guidelines (In priority order)

MESSAGE	INDICATES	ACTION
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
MN EEPROM FAULT	EEPROM on the main PCBA is invalid	Replace main pc board
SENSOR MISSING	Instrument has lost communication with the sensor module	Connect or replace sensor
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
INVALID SENSOR	Attached sensor module is not compatible with main instrument	Replace with correct sensor type

MN SUPPLY FAULT	Power supply on main PCBA is out of range	Check sensor wiring or replace main pc board
RELAY FAULT	Error with the internal relays has occurred	Cycle power to the unit or replace main pc board
SNSR POWER FAULT	Power at the sensor module is out of range	Correct wiring error, replace main pc board, or replace sensor module
IR SOURCE FAULT	IR source failure	Replace or consult factory
FIXED CURRENT MODE	4-20 mA is at a set level and will not change when Controller gas is applied or under fault conditions	Exit Fixed Current Mode using the HART
- SUPPLY FAULT	The negative supply sensor module is out of range	Check wiring or replace sensor module
REF SIG FAULT	IR reference detector failure	Replace or consult factory
ANA SIG FAULT	IR analytical detector failure	Replace or consult factory
LOW SIGNAL	Low IR signal	Clean optics or replace sensor module. If in cleaning mode, no action required
PARAM FAULT	An operational parameter is out of range or sensor failed internal check	Restart; replace, if necessary
CONFIG RESET	Main EEPROM memory was reset	Use Controller to reset all configurations (e.g., alarm levels, calibration signals ON or OFF, etc)
CHANGE SENSOR	Sensor is at its end of life	Replace sensor
ZERO CAL FAULT OR SPAN CAL FAULT	Instrument did not calibrate successfully	Repeat calibration; check for proper calibration gas; check for blockage in the flow system
SENSOR WARNING	Sensor approaching end of life	Prepare to replace sensor module
CHECK CAL	Calibration should be verified	Perform bump test or calibration
+LOC	Instrument is locked in over-range condition	Recalibrate or reset sensor
OVER % LEL	Sensor is exposed to a gas concentration above the LEL	The instrument will return to normal operation when the gas concentration drops below 100% LEL
und	Under-range condition - quick	Recalibrate or replace sensor
Und	Under-range condition - slow	Recalibrate or replace sensor

The highest priority message is displayed first. Lower priority messages are output only after the highest priority message is cleared. A manual selected scanning of low-priority messages is not possible.

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.

1. Remove the environmental or flow cap.
2. Place an opaque object (piece of paper, end of wrench handle, etc.) between the light source window and the mirror to completely obscure the light path for two to three seconds.
   - The Ultima XIR/Ultima XI Monitor enters the Cleaning Mode for two minutes.

   NOTE: While in the Cleaning Mode, the sensor will not respond to the presence of gas.

   - The analog current output is 3.0 mA during this time.
   - The display indicates 'low signal''.
3. 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.
   - Use a dry applicator or one moistened with distilled water to wipe the window and remove dust.
   - Use an additional clean, dry applicator to remove any residual water.
   - Use an applicator moistened with isopropyl alcohol 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 is clean.
     - The unit remains in the Cleaning Mode for a minimum of two minutes. If active cleaning is still in progress at the end of this period, the sensor detects the motion of this object in its light path and automatically extends the Cleaning

Mode for 15 seconds. Further 15-second Cleaning Mode extensions continue until no motion is detected.

NOTE: When the cleaning process is complete, be sure to remove all objects from the light path.

4. When exiting the Cleaning Mode, the unit returns to normal operation. 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.
5. Replace the environmental or flow cap.
6. After cleaning the windows, it is advisable to check the sensor's response to both zero and calibration gas.

⚠ CAUTION

Do not place foreign objects in the sensor's analytical region (except per the "Ultima XIR Cleaning Procedure" as described above); 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").

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).

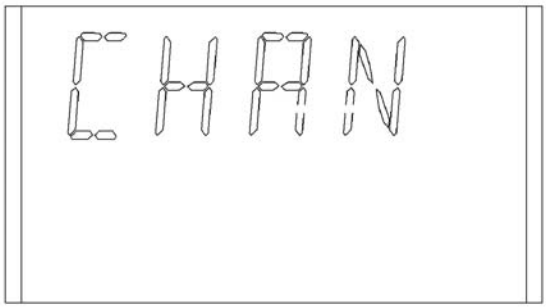

Figure 4-1. "Change Sensor" Scrolls Across the Display

⚠ WARNING

Electrochemical sensors are sealed units which contain 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 sensors marked Class I, Groups A, B, C and D and not used in Class II areas, 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.

For the Ultima XE Sensor marked Class II Groups F and G, atmosphere must be free of dust and the power removed from the unit before the sensor cap can be removed from the housing. Failure to follow this warning can result in the ignition of a hazardous atmosphere.

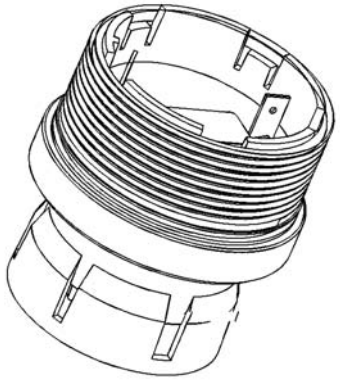

Figure 4-2. Sensor Assembly and Sensor Guard for General-Purpose Model

2. Identify the sensor assembly needed via the A-ULTX-SENS code on the interior sensor label and obtain the appropriate sensor assembly; replace sensor assembly.

   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" to calibrate with the new sensor.

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

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
MSA North America
P.O. Box 427, Pittsburgh, PA 15230-0427

or call, toll-free, **1-800-MSA-INST**. Inquiries can also be e-mailed to ***customer.service@msanet.com***.

⚠ WARNING

Use only genuine MSA replacement parts when performing any maintenance procedures provided in this manual. Failure to do so may seriously impair sensor and gas monitoring 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 loss of life.

Table 4-4. Replacement Parts

GAS SELECTION	SENSOR KIT PART NO.		
	GENERAL-PURPOSE PLASTIC MODEL A	EXPLOSION-PROOF MODEL E E	GENERAL-PURPOSE STAINLESS MODEL G
Carbon Monoxide, 100 ppm	A-ULTX-SENS-11-0...	A-ULTX-SENS-11-1...	A-ULTX-SENS-11-6...
Carbon Monoxide, 500 ppm	A-ULTX-SENS-12-0...	A-ULTX-SENS-12-1...	A-ULTX-SENS-12-6...
Oxygen, 10% - compensated	A-ULTX-SENS-13-0...	A-ULTX-SENS-13-1...	A-ULTX-SENS-13-6...
Oxygen, 25% - compensated	A-ULTX-SENS-14-0...	A-ULTX-SENS-14-1...	A-ULTX-SENS-14-6...
Hydrogen Sulfide, 10 ppm	A-ULTX-SENS-15-0...	A-ULTX-SENS-15-1...	A-ULTX-SENS-15-6...
Hydrogen Sulfide, 50 ppm	A-ULTX-SENS-16-0...	A-ULTX-SENS-16-1...	A-ULTX-SENS-16-6...
Hydrogen Sulfide, 100 ppm	A-ULTX-SENS-17-0...	A-ULTX-SENS-17-1...	A-ULTX-SENS-17-6...
Chlorine, 5 ppm	A-ULTX-SENS-18-0	not available	A-ULTX-SENS-18-6...
Sulfur Dioxide, 25 ppm	A-ULTX-SENS-19-0...	A-ULTX-SENS-19-1...	A-ULTX-SENS-19-6...
Nitric Oxide, 100 ppm	A-ULTX-SENS-20-0...	A-ULTX-SENS-20-1...	A-ULTX-SENS-20-6...
Nitrogen Dioxide, 10 ppm	A-ULTX-SENS-21-0...	A-ULTX-SENS-21-1...	A-ULTX-SENS-21-6...
Hydrogen Cyanide, 50 ppm	A-ULTX-SENS-22-0...	A-ULTX-SENS-22-1...	A-ULTX-SENS-22-6...

GAS SELECTION	SENSOR KIT PART NO.		
	GENERAL-PURPOSE PLASTIC MODEL A	EXPLOSION-PROOF MODEL E	GENERAL-PURPOSE STAINLESS MODEL G
Hydrogen Chloride, 50 ppm	A-ULTX-SENS-23-0...	not available	A-ULTX-SENS-23-6...
Chlorine Dioxide, 3 ppm	A-ULTX-SENS-24-0...	not available	A-ULTX-SENS-24-6...
Combustible Gas, 100% LEL Natural Gas and H_2, 5% CH_4	A-ULTX-SENS-31-0...	A-ULTX-SENS-31-1...	A-ULTX-SENS-31-6...
Combustible Gas, 100% LEL Petroleum Vapors, 2.1% Propane	A-ULTX-SENS-32-0...	A-ULTX-SENS-32-1...	A-ULTX-SENS-32-6...
Combustible Gas, 100% LEL Solvents, 2.1% Propane	A-ULTX-SENS-33-0...	A-ULTX-SENS-33-1...	A-ULTX-SENS-33-6...
Comb Gas IR - Methane, 5% CH_4	not available	A-ULTX-SENS-38-1...	not available
Comb Gas IR - Non Methane, 2.1% Propane	not available	A-ULTX-SENS-39-1...	not available
Phosphine, 2 ppm	A-ULTX-SENS-41-0...	A-ULTX-SENS-41-1...	A-ULTX-SENS-41-6...
Arsine, 2 ppm	A-ULTX-SENS-42-0...	A-ULTX-SENS-42-1...	A-ULTX-SENS-42-6...
Silane, 25 ppm	A-ULTX-SENS-43-0...	A-ULTX-SENS-43-1...	A-ULTX-SENS-43-6...
Germane, 3 ppm	A-ULTX-SENS-44-0...	A-ULTX-SENS-44-1...	A-ULTX-SENS-44-6...
Diborane, 50 ppm	A-ULTX-SENS-45-0...	not available	A-ULTX-SENS-45-6...
Bromine, 5 ppm	A-ULTX-SENS-46-0...	not available	A-ULTX-SENS-46-6...
Fluorine, 5 ppm	A-ULTX-SENS-47-0...	not available	A-ULTX-SENS-47-6...
Ammonia, 100 ppm	A-ULTX-SENS-48-0...	not available	A-ULTX-SENS-48-6...
Hydrogen, 1000 ppm	A-ULTX-SENS-49-0...	A-ULTX-SENS-49-1...	A-ULTX-SENS-49-6...
ETO, 10 ppm	A-ULTX-SENS-50-0...	not available	A-ULTX-SENS-50-6...
Ammonia, 0-1000 PPM	A-ULTX-SENS-54-0...	not available	A-ULTX-SENS-54-6...
Oxygen-Solvent Tolerant, 0-25%	not available	A-ULTX-SENS-55-1...	not available
Carbon Monoxide, 0-1000 PPM	A-ULTX-SENS-57-0...	A-ULTX-SENS-57-1...	A-ULTX-SENS-57-6...
Chlorine, 0-20 PPM	A-ULTX-SENS-61-0...	not available	A-ULTX-SENS-61-6...
Oxygen-Solv & CO_2 Tolerant, 0-25%	not available	A-ULTX-SENS-62-1...	not available
Oxygen-Low, 0-25%	not available	A-ULTX-SENS-63-1...	not available
Oxygen-Low, Solv Tolerant, 0-25%	not available	A-ULTX-SENS-64-1...	not available

SENSOR REPLACEMENT PARTS

PART	PART NO.
XE Sensor Guard	10028904
XIR Sensor Guard	10041265
XIR Flow Cap	10042600

Appendix A, Optional Features

1) Internal Relays

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 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) or a HART Communicator.
- 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.

4) For one minute after the sensor missing indication displays (if the Delay feature is enabled).

Unpacking, Mounting and Wiring

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

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.

See Ultima Controller and Calibrator Manual (P/N 813379) for complete relay configuration information.

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

Table A-1. Cable Length and Wire Size for Units With Internal Relays

GAS TYPE	SENSOR OUTPUT	DC VOLTAGE SUPPLY	WIRE SIZE (AWG)	MAXIMUM CABLE LENGTH WITHOUT HART (FEET)	(METERS)	MAXIMUM LOAD RESISTANCE (OHMS)
Oxygen or Toxic	3 Wire	12 VDC	16	2,500	762	250
		24 VDC	16	8,000	2,438	500
Combustible	3 Wire	12 VDC	16	900	274	250
		24 VDC	16	3,000	914	500
XIR	3 wire	12 VDC	16	400	152	250
		24 VDC	16	2,500	762	500

- 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

Table A-2. Relay Specifications

TEMPERATURE RANGE		-40 to +60°C (-40 to +140°F)
HUMIDITY		15 to 95% RH, non-condensing
RELAYS	**3 ALARMS SPDT FAULT (NORMALLY-ENERGIZED)**	(Single pole, double throw) 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

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/N813379).
    - 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 X 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-1.

NOTE: FIGURE A-1 depicts the version of the printed circuit board assembly without HART components. FIGURE 1-17 is the equivalent HART version.

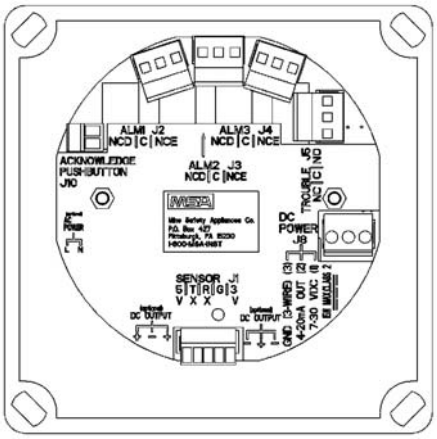

Figure A-1. Relay Contacts

- 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.

Relay Connections

All electrical connections to internal relays can be made directly on the pc board (see FIGURE A-1).

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 or ignition of hazardous gases 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-2).

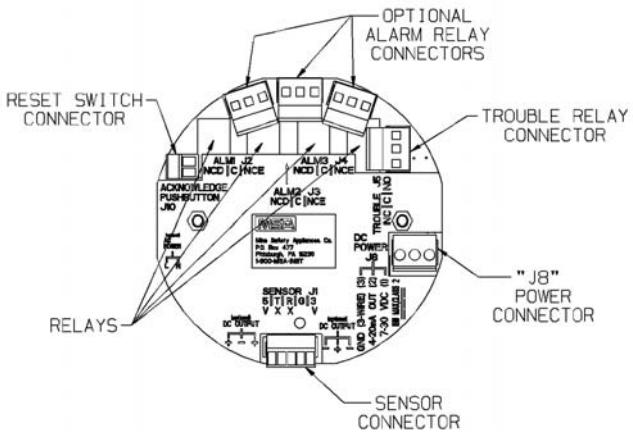

Figure A-2. Relay Printed Circuit Board

- 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.

2) Optional RESET Push-button

- If you are going to specify a switch to use with the Ultima X series, it should have, as a minimum, an equivalent (or better) approvals classification. The MSA provided pushbutton (P/N 10046923) is explosion-proof for Class I, Groups B, C, and D only. When relied upon for an explosion-proof capacity, do not install on equipment mounted or intended to be mounted in any other hazardous location.

  This pushbutton has been approved for use in Group A with the Ultima X Series when the protection technique is Nonincendive and the hazardous location is Division 2. Check product labels for protection technique.

⚠ WARNING

When the pushbutton is used in conjunction with the Ultima XE Gas Monitor, the highest classification rating for the system is reduced to Class I, Div. 1, Groups B, C, & D. See MSA P/N 10048833 for installation instructions. Misuse can result in ignition of hazardous gases.

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 X Series Gas 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.
- Specific push-buttons may be sourced by manufacturers such as Appleton Electric and Crouse Hindes, Inc.

Optional Push-button Calibration

The following procedure is used to enter the calibration by using the push-button.

1. Press and hold the push-button until the ♥ heart is displayed.
2. Release the push-button.
   - At this time, any recoverable alarms will be acknowledged.
3. Press and hold the push-button within three seconds of the push-button release.
4. Release the push-button when the desired calibration is displayed. See TABLE A-3.

Table A-3. Push-button Calibration

CALIBRATION TYPE	DISPLAYED DATA	PUSH-BUTTON HOLD TIME
Zero Calibration	CAL ZERO	5 seconds
Span Calibration	CAL SPAN	10 seconds
ICAL	iCAL	20 seconds

   - Refer to Chapter 2, "Startup and Calibration" for more information on calibration.
5. The calibration can be aborted during the 30-second countdown by pressing the push-button until the ♥ is displayed.
   - When the push-button is released, the calibration will be aborted.

3) Optional Horn Relay Software

The Ultima X Series Gas Monitor is available with optional Horn Relay Software to allow an audible horn to be used with Relay 1. The following describes the use and functionality of this optional feature.

Relay 1 is considered the Horn Relay. It does not function directly with Alarm 1 as in the standard software. To configure, note that:

- Alarm 1 function is still active on the display
- Alarm 1 display has its own latching/non-latching configuration setting
- Horn Relay is configured as normally energized/de-energized via the Alarm 1 configuration setting; this is the only Alarm 1 configuration setting that uniquely controls the Horn Relay.
- Alarm/Relay 2 and Alarm/Relay 3 action remains unchanged.

NOTE: All relays, including Horn Relay hardware, have NO (normally open) and NC (normally closed) terminals.

To Activate the Horn Relay

The Horn Relay is initially active when any alarm (1, 2, or 3) condition is active. Once Horn Relay is reset, it is set again if the gas level:

- clears below or above the active setpoint and then moves back through the setpoint or
- continues to move through the next alarm set point.

To Reset the Horn Relay

The Horn Relay is reset by momentary contact closure using the pushbutton or by IR communications, regardless of whether or not the alarm has cleared.

- The Horn Relay automatically resets if all alarms are clear (such as when all alarms are unlatched and fall below or rise above their setpoints for negative acting alarms).
- If any alarm remains latched after the gas value moves out of the alarm range, the Horn Relay remains active until reset by the user.

Clearing latched alarms is done by using the optional pushbutton or the IR Controller.

Appendix B,
Calibration Guide
for Additional XIR/XI Gases

Compound	LEL	Curve	Cal Gas	Span Setting
Acetaldehyde	4.0	8	0.1% Propane	29%
Acetic Acid	4.0	3	0.6% Propane	12%
Acetone	2.5	8	0.1% Propane	20%
Acrolein	2.8	8	0.1% Propane	59%
Acrylic Acid	2.4	2	0.6% Propane	10%
Allyl Alcohol	2.5	1	2.5% Methane	85%
Allylamine	2.2	8	0.1% Propane	18%
Benzene	1.2	8	0.1% Propane	42%
1,3 - Butadiene	2.0	8	0.1% Propane	23%
Butane	1.9	4	0.6% Propane	29%
Butanol	1.4	6	0.6% Propane	42%
Butene	1.6	6	0.6% Propane	57%
Butyl Acetate	1.7	6	0.6% Propane	40%
Butyl Acrylate	1.5***	6	0.6% Propane	45%
Cyclohexane	1.3	1	2.5% Methane	50%
Cyclohexanone	1.1	6	0.6% Propane	74%
Cyclopentane	1.5	7	0.6% Propane	31%
1,2 - Dichloroethane	6.2	8	0.1% Propane	14%
Diethylamine	1.8	2	0.6% Propane	32%
Diethyl Ether	1.9	2	0.6% Propane	38%
Difluoro -1- Chloroethane (142-b)	6.2	8	0.1% Propane	20%
1,1 - Difluoroethane (152a)	3.7	2	0.6% Propane	52%
Diisopropyl Ether	1.4	6	0.6% Propane	34%
Dimethylamine	2.8	2	0.6% Propane	37%
Dimethyl Ether	3.4	2	0.6% Propane	32%
Dimethylethylamine (DMEA)	2.3	2	0.6% Propane	22%
Dimethylisopropylamine (DMIPA)	1.0***	6	0.6% Propane	47%
Epichlorohydrin	3.8	6	0.6% Propane	46%
Ethane	3.0	3	0.6% Propane	25%
Ethanol	3.3	6	0.6% Propane	31%
Ethyl Acetate	2.0	6	0.6% Propane	60%
Ethyl Acrylate	1.4	8	0.1% Propane	15%
Ethyl Benzene	0.8	8	0.1% Propane	15%
Ethylene	2.7	8	0.1% Propane	28%
Ethylene Oxide	3.0	6	0.6% Propane	52%
Heptane	1.1	2	0.6% Propane	35%
Hexamethyldisiloxane (HMDS)	0.5***	8	0.1% Propane	22%
Hexane	1.1	6	0.6% Propane	41%
Iso-Butane	1.8	2	0.6% Propane	60%
Iso-Butyl Alcohol	1.7	6	0.6% Propane	41%
Iso-Butylene	1.8	6	0.6% Propane	62%
Iso-Propanol	2.0	6	0.6% Propane	47%
Iso-Propyl Acetate	1.8	6	0.6% Propane	57%
Methane	5.0	1	2.5% Methane	50%

Methanol	6.0	3	0.6% Propane	23%
Methyl Acetate	3.1	5	0.6% Propane	46%
Methyl Amyl Ketone (MAK)	1.1	6	0.6% Propane	51%
Methyl Chloride	8.1	6	0.6% Propane	48%
Methylene Chloride	13.0	1	2.5% Methane	68%
Methyl Ethyl Ketone (MEK)	1.4	1	2.5% Methane	72%
Methyl Isobutyl Ketone (MIBK)	2.1	6	0.6% Propane	54%
Methyl Methacrylate	1.7	6	0.6% Propane	57%
Methyl Propyl Ketone (MPK)	1.5	6	0.6% Propane	54%
Methyl tert-butyl Ether (MTBE)	1.6	2	0.6% Propane	29%
Morpholine	1.4	6	0.6% Propane	59%
Nitro Methane	7.3	8	0.1% Propane	45%
Pentane	1.5	5	0.6% Propane	33%
Propane	2.1	2	0.6% Propane	29%
n-Propanol	2.2	2	0.6% Propane	36%
Propionaldehyde (Propanal)	2.6	6	0.6% Propane	69%
Propyl Acetate	1.7	6	0.6% Propane	41%
Propylene	2.0	6	0.6% Propane	77%
Propyleneimine	1.32**	6	0.6% Propane	72%
Propylene Oxide	2.3	2	0.6% Propane	38%
Pyridine	1.8	8	0.1% Propane	20%
Styrene	0.9	8	0.1% Propane	45%
Tetrahydrofuran (THF)	2.0	2	0.6% Propane	40%
Tetrahydropyran (THP)	1.6**	6	0.6% Propane	40%
tert - Butanol	2.4	2	0.6% Propane	27%
Toluene	1.1	8	0.1% Propane	18%
1,1,1 - Trichloroethane	7.5	8	0.1% Propane	20%
Triethylamine	1.2	6	0.6% Propane	36%
Trimethylamine	2.0	2	0.6% Propane	38%
Vinyl Acetate	2.6	8	0.1% Propane	63%
Xylenes (O-Xylene)	0.9	1	2.5% Methane	59%

All LEL values taken from NFPA (Dated 1997) except where noted.

Appendix C,
General Certification Information

Product	Agency	Country	Approval
Ultima XE Main	CSA	Canada	Explosionproof for CL. I, Div. 1, Gps A-D
	FM	USA and Canada	Explosionproof for CL. I, Div. 1, Gps A-D, T4; Nonincendive for CL. I, Div. 2, Gps A-D, T4; TYPE 4X, IP66
		IECEx scheme	Ex d IIC T4, IP66
	MET	USA and Canada	Unclassified locations
	UL	USA and Canada	Enclosure: CL. I, Div. 1, Gps A-D; CL. II, Gps F & G; CL. III
		USA and Canada	This equipment is suitable for use in CL. I, Div. 2, Gps A-D; CL. II, Div. 2, Gps F, G; CL. III Hazardous Locations or Non-Hazardous Locations Only; Type 4X
Ultima XE Main with XP Port (i.e. HART Barrier)	FM	USA and Canada	Explosionproof with Intrinsically safe Connection for CL. I, Div. 1, Gps A-D, T4; Nonincendive with Nonincendive field wiring connections for CL. I, Div. 2, Gps A-D, T4; TYPE 4X, IP66
		IECEx scheme	Ex d [ib] IIC T4, IP66
	UL	USA and Canada	This equipment is suitable for use in CL. I, Div. 2, Gps A-D; CL. II, Div. 2, Gps F, G; CL. III Hazardous Locations or Non-Hazardous Locations Only; Type 4X
Ultima XE Sensor	CSA	Canada	Explosionproof for CL. I, Div. 1, Gps A-D
	FM	USA and Canada	Explosionproof for CL. I, Div. 1, Gps A-D, T4; Nonincendive for CL. I, Div. 2, Gps A-D, T4; TYPE 4X, IP66
		IECEx scheme	Ex d IIC T4, IP66
	MET	USA and Canada	Unclassified locations
	UL	USA and Canada	Enclosure: CL. I, Div. 1, Gps A-D; CL. II, Gps F & G; CL. III
		USA and Canada	This equipment is suitable for use in CL. I, Div. 2, Gps A, B, C, D; CL. II, Div. 2, Gps F, G; CL. III Hazardous Locations or Non-Hazardous Locations Only; Type 4X
Ultima XIR Sensor	CSA	Canada	CL. I, Div. 1, Gps B-D
	FM	USA	Explosionproof for CL. I, Div. 1, Gps A-D, T5; Nonincendive for CL. I, Div. 2, Gps A-D, T5
		Canada	Explosionproof for CL. I, Div. 1, Gps B-D, T5; Nonincendive for CL. I, Div. 2, Gps A-D, T5
		IECEx scheme	Ex d IIC T5, IP66
	MET	USA and Canada	Unclassified locations
	UL	USA and Canada	Enclosure: CL. I, Div. 1, Gps B-D; CL. II, Gps E-G; CL. III
		USA and Canada	This equipment is suitable for use in CL. I, Div. 2, Gps A-D; CL. II, Div. 2, Gps F, G; CL. III Hazardous Locations or Non-Hazardous Locations Only; Type 4X

Product	Agency	Country	Approval
Hart Module	FM	USA and Canada	Explosionproof with Intrinsically Safe Connections for CL. I, Div. 1, Gps A-D. Nonincendive with Nonincendive field wiring connections for CL. I, Div. 2, Gps A-D.
		IECEx scheme	Ex d IIC T5, IP66
	UL	USA and Canada	This equipment is suitable for use in CL. I, Div. 2, Gps A-D; CL. II, Div. 2, Gps F, G; CL. III Hazardous Locations or Non-Hazardous Locations Only; Type 4X
Ultima X Power Supply	FM	USA and Canada	Explosionproof for CL. I, Div. 1, Gps A-D, T4; Nonincendive for CL. I, Div. 2, Gps A-D, T4;
		IECEx scheme	Ex d IIC T4, IP66
	UL	USA and Canada	This equipment is suitable for use in CL. I, Div. 2, Gps A-D; CL. II, Div. 2, Gps F, G; CL. III Hazardous Locations or Non-Hazardous Locations Only; Type 4X
Ultima Calibrator	CSA	Canada	Intrinsically Safe for CL. I, Div. 1, Gps A-D, T3C
	FM	USA and Canada	Intrinsically Safe for CL. I, Div. 1, Gps A-D, T3C
		IECEx scheme	Ex ia IIC T3
Ultima Controller	CSA	Canada	Intrinsically Safe for CL. I, Div. 1, Gps A-D, T3C
	FM	USA and Canada	Intrinsically Safe for CL. I, Div. 1, Gps A-D, T3C
		IECEx scheme	Ex ia IIC T3

NOTES:

1. Approvals subject to change without notice. Refer to label for current approval information.
2. FM – See Control Drawing SK3098-1057 for intrinsically safe connections.
3. FM – See Control Drawing SK3098-1108 for Nonincendive field wiring connections.
4. FM – Performance approval for Combustibles and Oxygen only.
5. FM – The Ultima X Control Unit complies with IEC 61779-1 and IEC 61779-4 when connected to a Detector Head that also has been evaluated to IEC 61779-1 and IEC 61779-4.
6. FM – The Ultima XE Sensor, Ultima XI Sensor, and Ultima XIR Sensor complies with IEC 61779-1 and IEC 61779-4 when connected to a Control Unit that also has been evaluated to IEC 61779-1 and IEC 61779-4.
7. FM - The Ultima XE Sensor and the Ultima XIR Sensor shall be connected directly to an Ultima X Series Control Unit or remote junction box.
8. Use of Teflon tape or Non-hardening thread sealant for environmental reasons is acceptable.
9. This Class A digital apparatus complies with Canadian ICES-003. Cet appareil numérique de la classe A est conforme à la norme NMB-003 du Canada
10. Check product label for specific approval information.

INSTALLATION AND OPERATING INSTRUCTIONS FOR DIVISION 2:

11. **WARNING – Explosion Hazard – Substitution of Components May Impair Suitability For CL. I, Div. 2.**
12. **WARNING – Explosion Hazard – Do Not Disconnect Equipment Unless Power Has Been Switched Off Or The Area Is Known To Be Non-Hazardous.**
13. Relay Output – 240Vac, 5 A or 30 Vdc, 5 A for Unclassified Locations.
14. Input and output wiring must be in accordance with CL. I, Div. 2 wiring methods and in accordance with the authority having jurisdiction.
15. UL – See Control Drawing SK3098-1072 for Nonincendive field wiring connections.

Appendix D,
HART Specific Information

HART Field Device Specification

The Ultima X Series Gas Monitor is available with an optional HART (Highway Addressable Remote Transducer) output communications protocol. With this option, the Ultima X Series Gas Monitor complies with HART Protocol Revision 7 and uses the 16-bit manufacturer and device codes. This document specifies all the device specific features and documents HART Protocol implementation details (e.g., the Engineering Unit Codes supported). These specifications assume the reader is somewhat familiar with HART Protocol requirements and terminology.

This specification is a technical reference for HART-capable HOST Application Developers, System Integrators and knowledgeable End Users. It also provides functional specifications (e.g., commands, enumerations and performance requirements) used during Field Device deployment, maintenance, testing, and operations. It is recommended that the 4-20 mA output be the primary gas monitoring signal. The HART signal can be the secondary method.

NOTE: The two-wire units' HART protocol does not comply fully with Immunity Standards EN61000-4-3 (2006) and EN61000-4-6 (2007).

Table D-1. Device Identification

MANUFACTURER NAME	MSA	MODEL NAME(S)	ULTIMA
Manufacture ID Code	0x6008	Device Type Code	0xE09F
HART Protocol Revision	7.0	Device Revision	1
Number of Device Variables	1	Notes:	
Physical Layers Supported	FSK, 4-20 mA		
Physical Device Category	Current Output		

Host Interface

Analog Output

The three-wire 4-20 mA current loop is connected on terminals marked 8-30 VDC(1), 4-20 mA OUT(2), and GND (3-wire)(3). The two-wire 4-20 mA current loop is connected on the 8-30 VDC(1) and 4-20 mA OUT(2) terminals. Refer to the installation outline drawings shown in Chapter 1, TABLE 1-1 for details.

This is the main output from this transmitter, representing the process gas measurement, linearized and scaled according to the configured instrument range. This output corresponds to the Primary Variable (PV). HART communications are supported on this loop. This device has a Capacitance Number (CN) of 1.

An inoperative device can be indicated by down-scale or up-scale current, depending on the sensor type. Current values are shown in TABLE D-2.

Table D-2. Current Values

	DIRECTION	VALUES (% OF RANGE)	VALUES (MA OR V)
Linear over- range	Down Up	0% +105.0% ±1.0%	4.00 mA 20.64 to 20.96 mA
Device malfunction indication	Down: less than Up: greater than		3.5 mA 20.96 mA
Maximum current			22.0 mA
Multi-drop Current draw			3.5 mA
Lift-off voltage, 3-wire PCBA			8 VDC
Lift-off voltage, 2-wire PCBA			13 VDC @ 250 Ohms

Table D-3. Device Variables Exposed by the Ultima Monitor

VARIABLE	DESCRIPTION	VARIABLE	DESCRIPTION
Gas Type	Sensor gas type description	Last Cal Date	Date sensor was last calibrated
Alarm Setpoints	Gas value at which an alarm status bit is set	Auto Zero comp	Amount of compensated below zero drift
Alarm Action	increasing or decreasing alarm type, latching or non latching	Alert option status	See next section
Alarm Status	Indication of alarm setpoint exceeded	Swap Delay status	See next section
Input Voltage	Device input voltage level		
Min/Max/Avg	Minimum, maximum and avg. value of PV over time	Sensor Temp	
Avg Interval	Time interval for min, max, avg (1,8 or 24 hr)	Sensor Status	Status returned by sensor
Gas Table	Linerization table selection	Relay EN/De-eng	Relay EN/De-eng
RTC Date	Device real time clock date	Cal Sig	Cal Signal Status
RTC Min	Device real time clock minutes		
RTC Hrs	Device real time clock hours		

Table D-4. Dynamic Variable implemented by Ultima Monitor

	MEANING	UNITS
PV	Gas Value	%, %LEL, PPM

Status Information

Device Status

Bit 4 ("More Status Available") is set when any failure is detected. Command #48 gives further details.

Extended Device Status

The Ultima Monitor can predict when certain maintenance will be required. This bit is set if a sensor fault or maintenance warning is detected. "Device Variable Alert" is set if the PV is out of limit.

Table D-5. Additional Device Status (Command #48)

Command #48 returns 5 bytes of data, with the following status information:

BYTE	BIT	MEANING	CLASS	DEVICE STATUS BITS SET
0	0	Configuration Reset	Error	4,7
	1	Main ram fault	Error	4,7
	2	Main flash fault	Error	4,7
	3	EEprom write error	Error	4,7
	4	Incompatible sensor	Error	4,7
	5	Sensor quick under range	Error	4,7
	6	Sensor UNDer range	Error	4,7
	7	Calibration fault	Error	4,7
1	0	Sensor Missing	Error	4,7
	1	Sensor Overrange	Warning	
	2	Overrange Lock	Warning	
	3	Parameter Fault	Error	4,7
	4	Sensor Warm up	Warning	
	5	Sensor Config Reset	Warning	
	6	Sensor Power Fault	Error	
	7	5V Power Fault	Error	
2	0	Zero Countdown	Info	
	1	Apply Zero Gas	Info	
	2	Span Countdown	Info	
	3	Apply Span Gas	Info	
	4	Cal Aborted	Info	
	5	Zero Fault	Info	
	6	Span Fault	Info	
	7	Cal OK	Info	

BYTE	BIT	MEANING	CLASS	DEVICE STATUS BITS SET
3	0	End of Life Warning	Warning	4,7
	1	Sensor Swap Delay	Info	
	2	Change Sensor Fault	Error	
	3	Sensor Power Fault	Error	4,7
	4	Internal Comm Fault	Error	
	5	Cal Sig Enable	Info	
	6	Alert Option Enable	Info	
	7	Relay Fault	Error	
4	0	Alarm 1 Set	Warning	
	1	Alarm 2 Set	Warning	
	2	Alarm 3 Set	Warning	
	3			
	4			
	5			
	6			
	7			

"Not used" bits are always set to 0.

Some bits used in this transmitter indicate device or sensor failure and, therefore, also set bit 7 and bit 4 of the Device Status byte.

These bits are set or cleared by the self-test executed at power up, or following a reset. They are also set (but not cleared) by any failure detected during continuous background self-testing.

Universal Commands

All Universal commands have been implemented in the Ultima Gas Monitor. The Ultima Gas Monitor returns a 7 in the Universal rev to indicate the device is using the expanded 16-bit manufacturer and device codes.

Common-Practice Commands

The following Common Practice commands have been implemented in the Ultima X device:

Table D-6. Supported Commands

COMMAND #	DESCRIPTION
35	Write Range Values
38	Reset “Configuration Changed” flag
40	Enter/Exit Fixed Current Mode (See the following **Warning**)
42	Perform Master Reset
45	Trim DAC Zero
46	Trim DAC Gain
48	Read Additional Device Status
59	Write Number of Response Preambles
71	Lock Device
72	Squawk
80	Read Device Variable Trim Point

⚠ WARNING

The gas monitor will NOT register gas concentration changes on the 4-20 mA signal line if the operator places the unit in Fixed Current Mode. Implement alternate protection measures when the unit is placed in this mode. Make sure the unit is returned to Standard Operational Mode prior to use for gas detection. Failure to follow this warning can result in serious personal injury or loss of life.

Burst Mode

This device supports burst mode.

Catch Device Variable

This Field Device does not support Catch Device Variable.

Table D-7. Device-Specific Commands

The following device-specific commands are implemented in the Ultima Monitor:

COMMAND #	DESCRIPTION
129	Read Sensor Gas Type
130	Read Device RTC
131	Read Alarm Setpoints
132	Read Alarm Control Actions
133	Read Min/Max/Average Values
134	Read Last Cal Date
135	Read Gas Table
136	Read Input Voltage
137	Read Auto Zero Comp
139	Read Sensor Status
140	Read Swap Delay Status
141	Read Cal Signal Status
142	Read Alert Option Status
143	Read Sensor Temperature
144	Read Relay Normal State
173	Write Device RTC
174	Write Alarm Setpoints
175	Write Alarm Control Actions
176	Write Average Interval
177	Write Upper Trim Point
178	Write Gas Table
179	Write Sensor Data sheet Reset
180	Write Sensor Swap Delay Enable
181	Write Cal Signal Enable
182	Write Calibration Mode
183	Write Calibration Abort
184	Write Calibration Step
185	Write Alarm Acknowledge
186	Write Protect Mode
187	Write Alert Option
188	Write Relay Normal State

Command #129: Read Sensor Gas Type

Reads the Gas Type of the sensor currently connected to the Ultima Gas Monitor.

Request Data Bytes

None.

Response Data Bytes

BYTE	FORMAT	DESCRIPTION
0-3	ASCII	Sensor gas type description (see TABLE D-8)

Command #130: Read Device Real Time Clock

Reads the Real Time clock hours and minutes from the Ultima X Gas Monitor.

Request Data Bytes

None.

Response Data Bytes

BYTE	FORMAT	DESCRIPTION
0	Unsigned	RTC Hours
1	Unsigned	RTC Minutes

Command #131: Read Alarm Setpoints

Reads the Ultima X Alarm Setpoint values.

Request Data Bytes

None.

Response Data Bytes

BYTE	FORMAT	DESCRIPTION
0-3	Float	Alarm 1 Setpoint Value
4-7	Float	Alarm 2 Setpoint Value
8-11	Float	Alarm 3 Setpoint Value

Command #132: Read Alarm Control Actions

Reads the Ultima X Alarm Control Actions.

Request Data Bytes

None.

Response Data Bytes

BYTE	FORMAT	DESCRIPTION
0	Bit Enum	Alarm 1 Control Actions (see TABLE D-9)
1	Bit Enum	Alarm 2 Control Actions (see TABLE D-9)
2	Bit Enum	Alarm 3 Control Actions (see TABLE D-9)

Command #133: Read Min, Max, Avg Values

Returns the Ultima minimum, maximum and average values recorded over an average interval. The average interval can be a value of 1 , 8, or 24 hours. For a one-hour interval, the value is updated at the top of each hour. For an eight-hour interval, the values are updated at 800, 1600 and 2400 hours.

Request Data Bytes

None.

Response Data Bytes

BYTE	FORMAT	DESCRIPTION
0-3	Float	Minimum Value
4-7	Float	Maximum Value
8-11	Float	Average Value
12	Unsigned	Average interval (1, 8, or 24)

Command #134: Read Last Cal Date

Returns the Ultima last calibration date of the currently connected sensor.

Request Data Bytes

None.

Response Data Bytes

BYTE	FORMAT	DESCRIPTION
0-2	Unsigned	Last sensor calibration date

Command #135: Read Gas Table

This command returns the Ultima sensor Gas Table currently in use. The Gas Tables are linearization reference tables used with certain sensors to provide accurate response for different gases from the same sensor.

Request Data Bytes

None.

Response Data Bytes

BYTE	FORMAT	DESCRIPTION
0	Unsigned	Gas Table Number (see TABLE D-10)

Command #136: Read Input Voltage Value

Returns the Ultima input supply voltage value. This number should be in the range of 8-30 volts DC.

Request Data Bytes

None.

Response Data Bytes

BYTE	FORMAT	DESCRIPTION
0-3	Float	Input Voltage Value

Command #137: Read Auto Zero Comp Value

Returns the Ultima Automatic Zero Compensation value. This value is accumulated by the device when the sensor reading attempts to drift below zero. This value is used to compensate the actual Zero calibration. The device will attempt to compensate up to 10 counts (display units) before setting the under-range bit.

Command #139: Read Sensor Status message

Returns the Ultima X sensor status message. This is a single byte containing hex codes. This byte is sent from the sensor module to the main processor and passed to the HART communications processor.

Request Data Bytes

BYTE	FORMAT	DESCRIPTION
None		

Response Data Bytes

BYTE	FORMAT	DESCRIPTION
0	Enum	Sensor Status message (See TABLE D-12)

Command #140: Read Swap Delay Status

This command returns the Ultima X sensor swap delay status. This is a single byte containing a 0 if disabled or 1 if enabled. If enabled, the swap delay will hold off a sensor missing error for 1 minute. This hold-off allows a sensor module to be swapped out with a calibrated sensor module without triggering a "sensor missing" alarm and dropping the 4-20 mA to the trouble level.

Request Data Bytes

BYTE	FORMAT	DESCRIPTION
None		

Response Data Bytes

BYTE	FORMAT	DESCRIPTION
0	Enum	Sensor Swap Delay Status (0 –disabled, 1 - enabled)

Command #141: Read Cal Signal Status

This command returns the Ultima X Cal Signal status. This is a single byte containing a 0 if disabled or 1 if enabled. If enabled, the output will be set to 3.75 mA during calibration (21 mA for oxygen). If disabled, the output will track the gas concentration.

Request Data Bytes

BYTE	FORMAT	DESCRIPTION
None		

Response Data Bytes

BYTE	FORMAT	DESCRIPTION
0	Enum	Sensor Cal Signal Status (0 –disabled, 1 - enabled)

Command #142: Read Alert Option Status

This command returns the Ultima X Alert Option Status status. This is a single byte containing a 0 if disabled or 1 if enabled. If enabled, the Alert Option will cause the 4-20 mA to be set to 3.75 mA during calibration of an Oxygen sensor (if the Cal Signal Option is also enabled). If the Alert Option is disabled and the Cal Signal enabled, the output will be set to 21 mA during Oxygen sensor calibration.

Request Data Bytes

BYTE	FORMAT	DESCRIPTION
None		

Response Data Bytes

BYTE	FORMAT	DESCRIPTION
0	Enum	Alert Option Status (0 - disabled, 1 - enabled)

Command #143: Read Sensor Temperature

This command returns the Ultima X Sensor Temperature. This is a single byte containing an integer value representing the temperature returned by the gas sensor. Not all gas sensors have an on-board temperature.

Request Data Bytes

BYTE	FORMAT	DESCRIPTION
None		

Response Data Bytes

BYTE	FORMAT	DESCRIPTION
0	Unsigned	Sensor temperature (°C)

Command #144: Read Relay Normal State

This command returns the Ultima X to the Normal relay state. This is a single byte containing a bit map of the three alarm relays' non alarm states. Not all gas sensors have on-board relays.

Request Data Bytes

BYTE	FORMAT	DESCRIPTION
None		

Response Data Bytes

BYTE	FORMAT	DESCRIPTION
0	Bit 0	Alarm #1 0 = normally de-energized, 1 = normally energized
0	Bit 1	Alarm #2 0 = normally de-energized, 1 = normally energized
0	Bit 2	Alarm #3 0 = normally de-energized, 1 = normally energized

Command #173: Write RTC

Writes the Ultima Real Time Clock hours and minutes values.The real time clock is used to compute the minimum, maximum and average values and to date stamp the last sensor calibration date.

Request Data Bytes

BYTE	FORMAT	DESCRIPTION
0	Unsigned	RTC hours (0-23)
1	Unsigned	RTC minutes (0-59)

Response Data Bytes

BYTE	FORMAT	DESCRIPTION
0	Unsigned	RTC hours (0-23)
1	Unsigned	RTC minutes (0-59)

Command-Specific Response Codes

CODE	CLASS	DESCRIPTION
0	Success	No Command-Specific Errors
1-2		Undefined
3	Error	Parameter too large
4		Undefined
5	Error	Too few data bytes
6		Undefined
7	Error	In write protect mode
8-15		Undefined
16	Error	Access Restricted
17-31		Undefined
32	Error	Busy
33-127		Undefined

Command #174: Write Alarm Setpoints

Writes the Ultima Alarm Setpoint values. The Ultima Gas Monitor uses alarm setpoint values to set alarm status bits in the device. The alarms can be enabled or disabled, set to increasing or decreasing and can be set to latching (see "Command 175: Write Alarm Setpoint Control Actions"). The adjustment range is greater than zero and less than full - scale.

Request Data Bytes

BYTE	FORMAT	DESCRIPTION
0	Unsigned	Alarm Number (1, 2, or 3)
1-4	Float	Alarm Setpoint Value

Response Data Bytes

BYTE	FORMAT	DESCRIPTION
0	Unsigned	Alarm Number (1, 2 or 3)
1-4	Float	Alarm Setpoint Value

Command-Specific Response Codes

CODE	CLASS	DESCRIPTION
0	Success	No Command-Specific Errors
1-2		Undefined
3	Error	Parameter too large
4	Error	Parameter too small
5	Error	Too few data bytes
6		Undefined
7	Error	In write protect mode
8-15		Undefined
16	Error	Access Restricted
17-18		Undefined
19	Error	Invalid device variable index
20-31		Undefined
32	Error	Busy
33-127		Undefined

Command #175: Write Alarm Setpoint Control Actions

Writes the Ultima X Alarm Setpoint Control Actions. The Ultima X Gas Monitor uses alarm setpoint Control Actions to enabled or disabled, set to increasing or decreasing and to set the alarm to latching or non latching.

Request Data Bytes

BYTE	FORMAT	DESCRIPTION
0	Unsigned	Alarm Number (1, 2, or 3)
1	Bit Enum	Alarm Control Action Value (see TABLE D-9)

Response Data Bytes

BYTE	FORMAT	DESCRIPTION
0	Unsigned	Alarm Number (1, 2, or 3)
1	Bit Enum	Alarm Control Action Value (see TABLE D-9)

Command-Specific Response Codes

CODE	CLASS	DESCRIPTION
0	Success	No Command-Specific Errors
1-4		Undefined
5	Error	Too few data bytes
6		Undefined
7	Error	In write protect mode
8-15		Undefined
16	Error	Access Restricted
17-18		Undefined
19	Error	Invalid device variable index
20-31		Undefined
32	Error	Busy
33-127		Undefined

Command #176: Write Average Interval

Writes the Ultima Average Interval. This interval is in hours and is used by the device to determine the collection interval for Minimum, Maximum and Average values. The Average collection interval can be for 1, 8 or 24 hours.

Request Data Bytes

BYTE	FORMAT	DESCRIPTION
0	Unsigned	Average Interval

Response Data Bytes

BYTE	FORMAT	DESCRIPTION
0	Unsigned	Average Interval

Command-Specific Response Codes

CODE	CLASS	DESCRIPTION
0	Success	No Command-Specific Errors
1		Undefined
2	Error	Invalid Selection
3-4		Undefined
5	Error	Too few data bytes
6		Undefined
7	Error	In write protect mode
8-15		Undefined
16	Error	Access Restricted
17-31		Undefined
32	Error	Busy
33-127		Undefined

Command #177: Write Upper Trim Point

Writes the Ultima X Upper Trim or Span point value. The Ultima Gas Monitor uses the Upper trim point value to perform Span calibration. When a Span calibration is performed, the device automatically sets the highest reading obtained to this Span value. The adjustment range on the Upper Trim Point is one display unit to the full-scale limit.

Request Data Bytes

BYTE	FORMAT	DESCRIPTION
0-3	Float	Upper Trim Point (Span) Value

Response Data Bytes

BYTE	FORMAT	DESCRIPTION
0-3	Float	Upper Trim Point (Span) Value

Command-Specific Response Codes

CODE	CLASS	DESCRIPTION
0	Success	No Command-Specific Errors
1-2		Undefined
3	Error	Parameter too large
4	Error	Parameter too small
5	Error	Too few data bytes
6		Undefined
7	Error	In write protect mode
8-15		Undefined
16	Error	Access Restricted
17-31		Undefined
32	Error	Busy
33-127		Undefined

Command #178: Write Gas Table

Writes the Ultima X Gas Table selection. The Ultima Gas Monitor uses the Gas Table value to select a reference table of linearization values for certain sensors.

Request Data Bytes

BYTE	FORMAT	DESCRIPTION
0	Unsigned	Gas Table selection number (see TABLE D-10)

Response Data Bytes

BYTE	FORMAT	DESCRIPTION
0	Unsigned	Gas Table selection number

Command-Specific Response Codes

CODE	CLASS	DESCRIPTION
0	Success	No Command-Specific Errors
1-2		Undefined
3	Error	Parameter too large
4	Error	Parameter too small
5	Error	Too few data bytes
6		Undefined
7	Error	In write protect mode
8-15		Undefined
16	Error	Access Restricted
17-31		Undefined
32	Error	Busy
33-127		Undefined

Command #179: Write Sensor Data Sheet Reset Control

Writes a data sheet reset command to Ultima X Gas Monitor. This command causes the Ultima Monitor to reset the current sensor data sheet to factory default settings. This command will set certain device warning status bits and require the user to re-calibrate the sensor. At current, the only valid number for this command is 1.

Request Data Bytes

BYTE	FORMAT	DESCRIPTION
0	Unsigned	Sensor reset control

Response Data Bytes

BYTE	FORMAT	DESCRIPTION
0	Unsigned	Sensor reset control

Command-Specific Response Codes

CODE	CLASS	DESCRIPTION
0	Success	No Command-Specific Errors
1-2		Undefined
3	Error	Parameter too large
4	Error	Parameter too small
5	Error	Too few data bytes
6		Undefined
7	Error	In write protect mode
8-15		Undefined
16	Error	Access Restricted
17-31		Undefined
32	Error	Busy
33-127		Undefined

Command #180: Write Sensor Swap Delay Enable

This command writes command number to the Ultima X Gas Monitor to enable or disable the two-minute swap delay feature. This device feature enables a two-minute hold-off of the sensor missing fault, allowing the user to “Swap” or change sensor modules without having the 4-20 mA set to the fault condition. The configuration change bit will be set, and the configuration change counter will be incremented.

Request Data Bytes

BYTE	FORMAT	DESCRIPTION
0	Enum	Swap Delay 1 = Enable 0 = Disable

Response Data Bytes

BYTE	FORMAT	DESCRIPTION
0	Enum	Swap Delay 1 = Enable 0 = Disable

Command-Specific Response Codes

CODE	CLASS	DESCRIPTION
0	Success	No Command-Specific Errors
1-2		Undefined
3	Error	Parameter too large
4		Undefined
5	Error	Too few data bytes
6		Undefined
7	Error	In write protect mode
8-15		Undefined
16	Error	Access Restricted
17-31		Undefined
32	Error	Busy
33-127		Undefined

Command #181: Write Cal Signal Enable

This command writes command number to the Ultima X Gas Monitor to enable or disable the Cal signal output. Without the Cal Signal enabled, the 4-20 mA output will follow the gas reading during calibration. With the Cal Signal enabled, the 4-20 mA output will be set to 3.75 ma during calibration and be held there for one minute after calibration has ended to allow the sensor to re-stabilize. Status group 3 indicates the current setting of this mode.

Request Data Bytes

BYTE	FORMAT	DESCRIPTION
0	Enum	Cal Signal 1 = Enable 0 = Disable

Response Data Bytes

BYTE	FORMAT	DESCRIPTION
0	Enum	Cal Signal 1 = Enable 0 = Disable

Command-Specific Response Codes

CODE	CLASS	DESCRIPTION
0	Success	No Command-Specific Errors
1-2		Undefined
3	Error	Parameter too large
4		Undefined
5	Error	Too few data bytes
6		Undefined
7	Error	In write protect mode
8-15		Undefined
16	Error	Access Restricted
17-31		Undefined
32	Error	Busy
33-127		Undefined

Command #182: Write Calibration Mode

This command writes a calibration mode number to the Ultima Gas Monitor. The mode commands initiate a calibration sequence in the device. Device status byte 2 can be monitored to determine the progress of the calibration.

Request Data Bytes

BYTE	FORMAT	DESCRIPTION
0	Enum	Calibration Mode Number (see TABLE D-11)

Response Data Bytes

BYTE	FORMAT	DESCRIPTION
0	Enum	Calibration Mode Number (see TABLE D-11)

Command-Specific Response Codes

CODE	CLASS	DESCRIPTION
0	Success	No Command-Specific Errors
1-2		Undefined
3	Error	Parameter too large
4		Undefined
5	Error	Too few data bytes
6		Undefined
7	Error	In write protect mode
8-15		Undefined
16	Error	Access Restricted
17-31		Undefined
32	Error	Busy
33-127		Undefined

Command #183: Write Calibration Abort

This command writes a calibration Abort command to the Ultima Gas Monitor. The calibration abort command instructs the device to suspend the calibration sequence initiated by the calibration mode command. Valid number for this command is 1.

Request Data Bytes

BYTE	FORMAT	DESCRIPTION
0	Unsigned	Calibration Abort Command number

Response Data Bytes

BYTE	FORMAT	DESCRIPTION
0	Float	Calibration Abort Command number

Command-Specific Response Codes

CODE	CLASS	DESCRIPTION
0	Success	No Command-Specific Errors
1-2		Undefined
3	Error	Parameter too large
4	Error	Parameter too small
5	Error	Too few data bytes
6		Undefined
7	Error	In write protect mode
8-15		Undefined
16	Error	Access Restricted
17-31		Undefined
32	Error	Busy
33-127		Undefined

Command #184: Write Calibration Step

This command writes a calibration Step Command to the Ultima Gas Monitor. The Step command instructs the device to advance to the next step during a manual calibration sequence. Device status byte 2 can be monitored to determine the progress of the calibration. Valid number for this command is 1.

Request Data Bytes

BYTE	FORMAT	DESCRIPTION
0	Unsigned	Calibration Step Number

Response Data Bytes

BYTE	FORMAT	DESCRIPTION
0	Float	Calibration Step Number

Command-Specific Response Codes

CODE	CLASS	DESCRIPTION
0	Success	No Command-Specific Errors
1-2		Undefined
3	Error	Parameter too large
4	Error	Parameter too small
5	Error	Too few data bytes
6		Undefined
7	Error	In write protect mode
8-15		Undefined
16	Error	Access Restricted
17-31		Undefined
32	Error	Busy
33-127		Undefined

Command #185: Write Alarm Acknowledge

This command writes an Alarm Acknowledge command to the Ultima X Gas Monitor. The alarm acknowledge command instructs the device to clear any latched alarms in the device, provided the setpoint level for the alarm has receded. Valid command number is on 1.

Request Data Bytes

BYTE	FORMAT	DESCRIPTION
0	Unsigned	Alarm Acknowledge command number

Response Data Bytes

BYTE	FORMAT	DESCRIPTION
0	Float	Alarm Acknowledge command number

Command-Specific Response Codes

CODE	CLASS	DESCRIPTION
0	Success	No Command-Specific Errors
1-2		Undefined
3	Error	Parameter too large
4	Error	Parameter too small
5	Error	Too few data bytes
6-15		Undefined
16	Error	Access Restricted
17-31		Undefined
32	Error	Busy
33-127		Undefined

Command #186: Write Protect Mode

This command sends a single, unsigned byte to the device. Sending a one puts the device in write protect mode. In write protect mode, all writes and commands are ignored except a command to disable the write protect. Only reads to the device can be made. Sending a disable, releases the device from write protect mode. During write protect mode, all local (Pushbutton) controls are locked out as well.

Request Data Bytes

BYTE	FORMAT	DESCRIPTION
0	Enum	Write protect Mode (0 = disable, 1 = Enable)

Response Data Bytes

BYTE	FORMAT	DESCRIPTION
0	Enum	Write protect Mode (0 = disable, 1 = Enable)

Command-Specific Response Codes

CODE	CLASS	DESCRIPTION
0	Success	No Command-Specific Errors
2	Error	Invalid selection
3-4		Undefined
5	Error	Too few data bytes
6		Undefined
7	Error	In write protect mode
8-15		Undefined
16	Error	Access Restricted
17-31		Undefined
32	Error	Busy
33-127		Undefined

Command #187: Write Alert Option

This command disables or enables the Alert Option on the Ultima X unit. This is a single byte containing a 0 if disabled or 1 if enabled. If enabled, the Alert Option will cause the 4-20 mA to be set to 3.75 mA during calibration of an Oxygen sensor (if the Cal Signal Option is also enabled). If the Alert Option is disabled and the Cal Signal enabled, the output will be set to 21 mA during Oxygen sensor calibration.

Alert Options

	ON	OFF
Calibration	Alert relay de-energized	Alert relay energized
Power on RESET (Countdown)	Alert relay de-energized	Alert relay energized
4 - 20 CAL mA (Oxygen)	3.75 mA	21 mA
4 -20 POR mA (Oxygen)	3.75 mA	21 mA

Request Data Bytes

BYTE	FORMAT	DESCRIPTION
0	Enum	Alert Option Mode (0 - disabled, 1 - enabled)

Response Data Bytes

BYTE	FORMAT	DESCRIPTION
0	Enum	Alert Option Mode (0 - disabled, 1 - enabled)

Command-Specific Response Codes

CODE	CLASS	DESCRIPTION
0	Success	No Command-Specific Errors
2		Undefined
3	Error	Parameter too large
4		Undefined
5	Error	Too few data bytes
6		Undefined
7	Error	In write protect mode
8-15		Undefined
16	Error	Access Restricted
17-31		Undefined
32	Error	Busy
33-127		Undefined

Command #188: Write Relay Normal State

This command sets the Ultima X Normal relay state. This is a single byte containing a bit map of the three alarm relays' non alarm states. Not all gas sensors have on-board relays.

Request Data Bytes

BYTE	FORMAT	DESCRIPTION
0	Bit 0	Alarm #1 0 = normally de-energized, 1 = normally energized
0	Bit 1	Alarm #2 0 = normally de-energized, 1 = normally energized
0	Bit 2	Alarm #3 0 = normally de-energized, 1 = normally energized

Response Data Bytes

BYTE	FORMAT	DESCRIPTION
0	Bit 0	Alarm #1 0 = normally de-energized, 1 = normally energized
0	Bit 1	Alarm #2 0 = normally de-energized, 1 = normally energized
0	Bit 2	Alarm #3 0 = normally de-energized, 1 = normally energized

Command-Specific Response Codes

CODE	CLASS	DESCRIPTION
0	Success	No Command-Specific Errors
1-4		Undefined
5	Error	Too few data bytes
6		Undefined
7	Error	In write protect mode
8-15		Undefined
16	Error	Access Restricted
17-31		Undefined
32	Error	Busy
33-127		Undefined

Table D-8. Gas Type Descriptions

GAS TYPE	DESCRIPTION	GAS TYPE	DESCRIPTION
CO	Carbon Monoxide		
O_2	Oxygen		
COMB	Combustible-pellistor		
XIIR	Infrared Combustible		
H_2S	Hydrogen Sulfide		
Cl	Chlorine		
Cl_2	Chlorine Dioxide		
NH_3	Ammonia		

Table D-9. Alarm Control Actions

Bit0	Alarm Enable	1 = enabled, 0 = disabled
Bit1	Alarm Direction	1 = increasing, 0 = decreasing
Bit2	Alarm Latch Status	1 = latching , 0 = non-latching
Bit3-7	Unused	

Table D-10. Gas Table Values

TABLE	DESCRIPTION
1	Methane
2	Propane
3	Ethane
4	n-Butane
5	n-Pentane
6	n-Hexane
7	Cyclopentane
8	Ethylene
21	Acetylene
47	5000 PPM CO_2
48	5% CO_2
49	2% CO_2
50	Custom
250	Unused

Table D-11. Calibration Modes

MODE #	DESCRIPTION
0	Initiate Zero Sensor sequence
1	Initiate Standard calibration sequence
2	Initiate Initial calibration sequence
3	Initiate Manual (stepped) calibration sequence

Table D-12. Sensor Status Codes

CODE	DESCRIPTION
0x01	Flash Fault
0x05	Ram Fault
0x07	Pellement Fault
0x0A	Data Sheet Fault
0x1E	Power Fault
0x1F	IR Factory Mode
0x20	IR Lamp Fault
0x28	EEPROM R/W Fault
0x2D	EEPROM Checksum Fault
0x2F	Sensor Missing Fault
0x3A	Negative Power Supply Fault
0x3B	IR Reference Fault
0x3C	Temperature Fault
0x3D	IR Analyte Fault
0x3E	IR Low Signal Fault
0x3F	IR Parameter Fault
0X40	Calibration Fault
0x41	Zero Mode
0x42	Span Mode
0x7C	Sleep Mode
0x7D	Warm Up Mode
0x7E	Power On Reset Mode
0x7F	Sensor OK

Performance

Typical sampling rates are shown in the following table.

Table D-13. Sampling Rates

Gas Samples	4 per second
PV digital value calculation	5 per second
Analog output update	5 per second

Power-Up

On power-up, the transmitter goes through a self-test procedure (see Chapter 2, "Initial Start-up"), and a sensor warm up and initialization period which takes approximately 30 seconds. During this period, the device will not respond to HART commands, and the analog output is set at 3.75 mA.

When the self-test is satisfactorily completed, and the sensor initialized, the PV value is set, and the analog output moves to a value representing the measurement. The rate of this calculation is limited by an internal filter damping time. Only after the PV and SV are correctly set, will the device respond to HART commands.

If the self-test fails, all live measurement data (PV, current and percent of range) are set to "Not A Number", and the analog output is set to the configured malfunction-indicating current. The device will attempt to respond to HART commands.

Fixed-current mode is cancelled by power loss.

Reset

Command 42 ("Device Reset") causes the device to reset its microprocessor. The resulting restart is identical to the normal power-up sequence. (See Chapter 2, "Initial Start-up".)

Self-Test

The self-test procedure is executed at power-up or following Command 42 ("Device Reset"). Some self-test procedures are continuously run in a background mode. The self-test includes:

- Microprocessor
- RAM

- Program ROM
- Configuration storage EEPROM
- Sensor communications
- Data sheet integrity
- Internal communications.

This self-test takes about 10 seconds. During self-test, following power-up or reset, the analog output is set to 3.75 mA and the device does not respond to HART commands.

During self-test run in background mode, the analog output updates continuously and the device responds normally to HART commands.

Continuous self-testing is part of the normal device operation. The same checks are made, but over a longer period between measurement function cycles.

Table D-14. Command Response Times

Minimum	20 ms
Typical	50 ms
Maximum	100 ms *

* During self-test following a power up reset or reset command, the device may take up to 10 sec to respond.

Busy and Delayed-Response

The transmitter may respond with "busy" status if a further command is received while self-test or certain command functions are underway.

Delayed-response is not used.

Long Messages

The largest data field used is in the response to Command 21: 34 bytes including the two status bytes.

Non-Volatile Memory

EEPROM is used to hold the device’s configuration parameters. Both the main board and sensor module contain EEPROM devices. New data is written to this memory on execution of certain write commands, during calibration operations and during normal operation.

Modes

Fixed current mode is implemented, using Command 40. This mode is cleared by power loss or reset.

Write Protection

Write-protection is provided by command 186. When in the Write Protect mode, all read commands are available, no "write" or "command" commands are accepted.

Damping

Damping is internally-fixed, affecting only the PV and the loop current signal. There is no user-settable damping control.

Capability Checklist

Table D-15. Capability Checklist

Manufacturer, model and revision	MSA , Ultima, rev. 2
Device type	Transmitter
HART revision	7
Device Description available	Yes
Number and type of sensors	1
Number and type of actuators	0
Number and type of host side signals	1: 4 - 20mA analog
Number of Device Variables	13
Number of Dynamic Variables	1
Mappable Dynamic Variables?	No
Number of common-practice commands	11
Number of device-specific commands	31
Bits of additional device status	32
Alternative operating modes?	No
Burst mode?	Yes
Write-protection?	Yes

Default Configuration

Table D-16. Default Configuration

PARAMETER	DEFAULT VALUE
Lower Range Value	0
Upper Range Value	Sensor dependent
PV Units	Sensor dependent
Sensor type	various
Number of wires	3
Damping time constant	N/A
Fault-indication jumper	Sensor dependent
Write-protect mode	write enabled
Number of response preambles	5
Alarms	Enabled

Calibration Using a HART® Communicator

Sensor Zero Selection Menu

Select Sensor Calibration from the "Sensor Trim" Menu

Sensor calibration or “trim” functions are available from several locations in the menu structure. See FIGURE D-8 for a view of this selection menu.

First warning screen

Once the sensor calibration feature is selected, a warning message displays to indicate that the 4-20 mA output should be disabled from any automatic control loop to prevent false action during calibration. The user must acknowledge this screen to continue. See FIGURE D-9 for a view of this warning screen. Optionally, the user may abort the process at this screen.

Second warning screen

After acknowledgement of the control loop message, a second warning message displays, informing the user that sensor calibration will be changed. The user can abort the procedure at this time or acknowledge the screen to proceed. See FIGURE D-10 for a view of this screen.

Zero Sensor function select screen

Upon acknowledgement of the calibration change warning screen, a calibration function selection screen appears. To zero the sensor, select

the “Sensor Zero” function and acknowledge the screen. See FIGURE D-11 for a view of this screen.

Calibration initiated screen

Once a calibration selection function is selected, the command is sent to the device. A status messages is then returned to indicate the progress. The first status message should indicate that the calibration sequence has started. This screen also shows the sensor value, units and type information. No action is required as it is only a five-second information screen and advances automatically. The user may abort the process at this time. See FIGURE D-12 for a view of this screen.

Selection confirmation screen

After the initiating screen displays for five seconds, a second information screen displays. This screen displays for five seconds and provides the user confirmation of the current calibration selection. No action is required at this screen, but the user may press the ABORT button to stop the process. See FIGURE D-13 for a view of this screen.

Sensor Zero countdown screen

Once the information screens are displayed, the device should start sending back a status byte to indicate calibration progress. The first status message should be the 30-second device countdown message. This message prompts user to start applying Zero gas if necessary. This screen also displays the current gas reading from the sensor.(This screen is skipped for the Oxygen sensor as it uses an electronic Zero). This message displays during the 30-second countdown and the user can abort the process at any time. See FIGURE D-14 for a view of this screen message.

Zero Adjustment screen

After the 30-second countdown screen (or the selection confirmation screen for an Oxygen sensor), the device should send back a status message indicating that the device is attempting to adjust the internal calibration. The user is instructed to apply Zero gas (or room air) at this time. The device waits for a stable reading to occur and then saves the zero calibration data automatically. The user can abort the process at any time by selecting the ABORT button. See FIGURE D-15 for a view of this screen.

Calibration completion message

Following a successful zero calibration, an information screen displays, indicating the calibration process has completed. This is a five-second, timed message and requires no user input. See FIGURE D-18 for a sample view of this information screen.

Calibration gas reminder screen

Once the device has performed a successful Zero function and stored the calibration information, it returns a calibration OK message. This causes a series of calibration closure messages to appear. The first closure message is a reminder to disconnect any calibration gases from the device. See FIGURE D-19 for a sample view of this message screen. The user can abort this screen, but the only affect at this time would be that the last information screen will not display.

Loop control reminder message

The final information screen following a calibration procedure is a reminder to return the loop to automatic control. See FIGURE D-20 for a sample of this screen.

Standard Calibration Procedures
Standard Zero/Span Calibration Selection Menu

Select Sensor Calibration from the Sensor Trim Menu

Sensor calibration or “trim” functions are available from several locations in the menu structure. See FIGURE D-6 for a view of this selection menu.

First warning screen

Once the sensor calibration feature is selected, a warning message displays to indicate that the 4-20 mA output should be disabled from any automatic control loop to prevent false action during calibration. The user must acknowledge this screen to continue. See section FIGURE D-7 for a view of this warning screen. Optionally, the user may abort the process at this screen.

Second warning screen

After acknowledgement of the control loop message, a second warning message displays indicating that sensor calibration is changed. The user can abort the procedure at this time or acknowledge the screen to proceed. See FIGURE D-8 for a view of this screen.

Standard Calibration function select screen

Upon acknowledgement of the calibration change warning screen, the user is presented with a calibration function selection screen. To perform a standard Zero/Span of the sensor, select the “Zero/Span” function and acknowledge the screen. See FIGURE D-9 for a view of this screen.

Calibration initiated screen

Once a calibration selection function is selected, the command is sent to the device. A status message is then returned to indicate the progress. The first status message should indicate that the calibration sequence has started. This screen also shows the sensor value, units and type information. No action is required for this screen as it is only a five-second information screen and will advance automatically. The user may abort the process at this time. See FIGURE D-10 for a view of this screen. The red and green LEDs on the main board blink momentarily to indicate the device has begun the procedure.

Selection Confirmation Screen

After the initiating screen displays for five seconds, a second information screen displays. This screen also displays for five seconds and provides confirmation of the current calibration selection. No action is required at this screen, but the user may press the ABORT button to stop the process. See FIGURE D-11 for a view of this screen.

Sensor Zero Countdown screen

Once the information screens are displayed, the device should start sending back a status byte to indicate the progress of the calibration. The first status message should be the 30-second device countdown message prompting the user to start applying Zero gas if necessary. This screen also displays the current gas reading from the sensor. (This screen is skipped for the Oxygen sensor, as it uses an electronic Zero). This message displays during the 30-second countdown; the user can abort the process at any time. See FIGURE D-12 for a view of this screen message. The red LED is OFF and the green LED is blinking on the main circuit board to indicate the start of the Zero procedure.

Zero Adjustment screen

After the 30-second countdown screen (or the selection confirmation screen for an Oxygen sensor), the device should send back a status message indicating that the device is attempting to adjust the internal calibration. The user is prompted to apply Zero gas (or room air) at this time. The device waits for a stable reading to occur and then saves the zero calibration data automatically. The user can abort the process at any time by selecting the ABORT button. See FIGURE D-13 for a view of this screen.

Sensor Span countdown screen

After successful completion of the sensor Zero procedure, the device automatically steps to the Span routine and displays an information screen indicating the Span procedure has started. This is a 30-second

countdown wait for gas connection and transport. The user is prompted to start applying the Span calibration gas at this time. (For a 0-25% Oxygen sensor, the sensor can be spanned using room air.) See FIGURE D-14 for a sample view of this screen. The red LED is ON solid and the green LED is blinking on the main board to indicate the start of the Span procedure.

Adjusting Span screen

After the 30-second Span initialization, a Span adjustment screen displays and continually updates with the gas (PV) reading, units and type information. Once the device detects a stable reading, the data is stored automatically and the user is notified of the completion status. See FIGURE D-15 for a sample view of the Span adjustment screen. The user can abort the procedure at any time and the prior calibration data is restored.

Calibration completion message

Upon successful completion of the SPAN procedure, an information screen displays. See FIGURE D-16 for a sample completion screen. This is a five-second information screen; no user action is required.

Calibration gas reminder screen

Following the Calibration completion screen, another information screen is presented to inform the user to disconnect any calibration gas from the device. This is a five-second timed message; no user acknowledgement is required. See FIGURE D-17 for a view of this information screen.

Loop control reminder message

The final calibration screen is an information screen prompting the user to reconnect the sensor output to any automatic control process that was disconnected at the start of the procedure. The user is required to acknowledge this screen. See FIGURE D-18 for a sample view of this screen.

Initial Calibration Procedures

Initial Calibration Selection Menu

Initial calibration is selected in a manner similar to the standard Zero/Span calibration procedure and the steps are similar (except the function selection should be “Initial Cal”). Initial calibration should be run when a new sensor is connected to the unit or when a standard Zero/Span procedure will not clear a fault condition (such as when the wrong Span gas is used). The Initial Calibration function allows the device to make accurate decisions for the CHANGE SENSOR and CAL FAULT functions.

Initial Calibration function select screen

Upon acknowledgement of the calibration change warning screen (see "Second warning screen" earlier in this chapter), a calibration function selection screen appears. To perform an Initial Calibration of the sensor, select the “Initial Cal” function and acknowledge the screen. See FIGURE D-4 for a view of this screen. Refer back to "Standard Calibration Procedures" for the complete calibration procedure.

User (Stepped) Calibration Procedures

User Calibration Selection Menu

User calibration is selected in a manner similar to the standard Zero/Span calibration procedure; the steps are similar, except the function selection should be “User Cal”. Normal calibrations are performed and stepped automatically by the device while prompting the user to apply the required calibration gas.

This is a timed function and, if the calibration gas is not applied in time or the reading does not stabilize within the given timeout period (windy conditions, duct mount, high sensitivity sensor modules, extended gas sample lines, etc.), it will timeout and send a “Cal Fault” status. User calibration allows the user to manually step through the Zero and Span calibrations and decide when the reading has reached optimum stability.

User Calibration step screens

User calibration is similar to the standard procedures provided earlier under "Standard Calibration Procedures", except that the automatic adjustment screens described in "Zero Adjustment screen" and "Adjusting Span screen" sections are replaced with a Step/Refresh screen allowing the user to review the readings and decide when to advance the procedure (see FIGURES D-1 and D-2).

Zero cal step screen

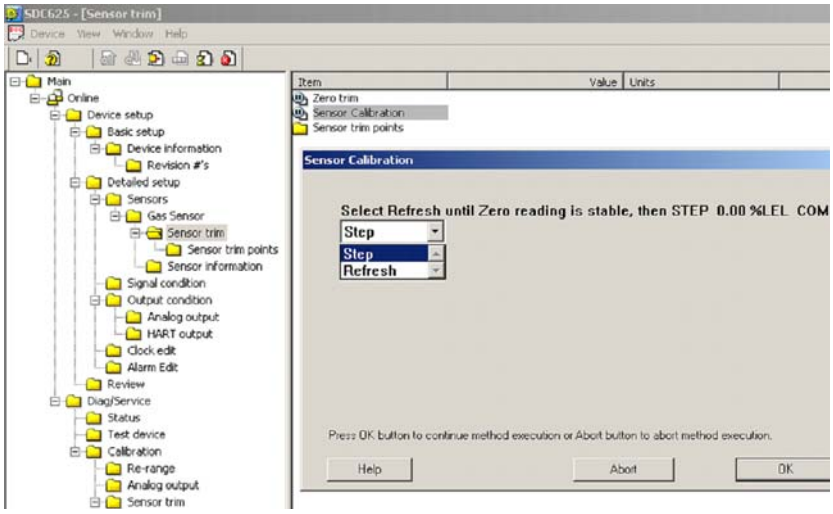

Figure D-1. Zero cal step screen

Span cal step screen

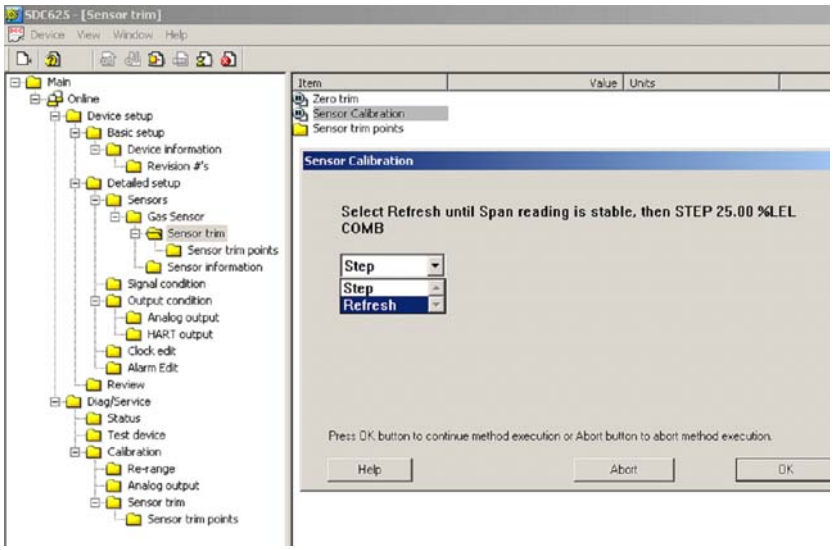

Figure D-2. Span cal step screen

Sample Calibration Display Screens

HART DDL-based calibration display screens

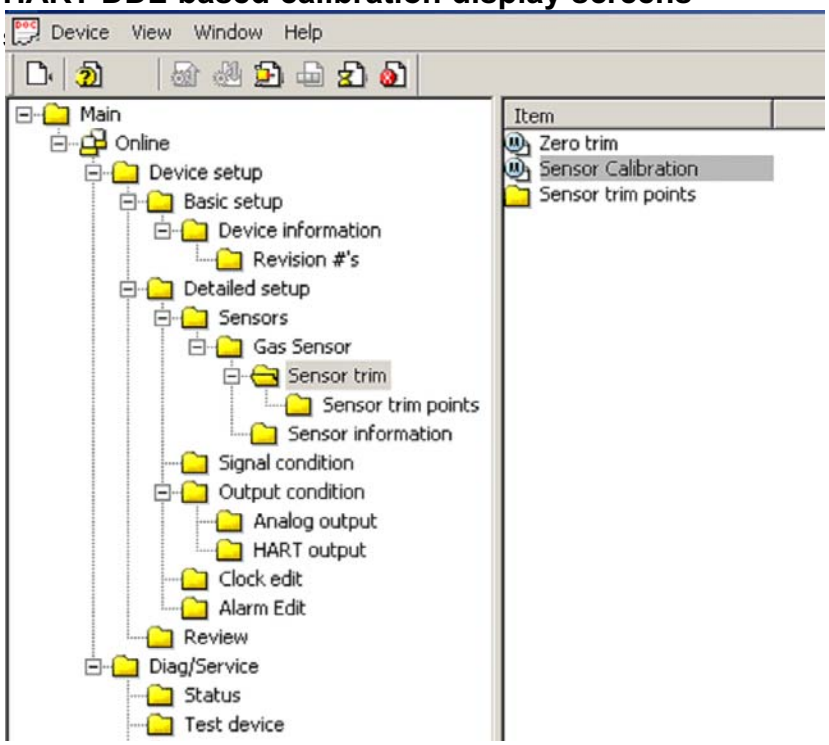

Figure D-3. Select Sensor Calibration from the Sensor Trim Menu

First warning screen

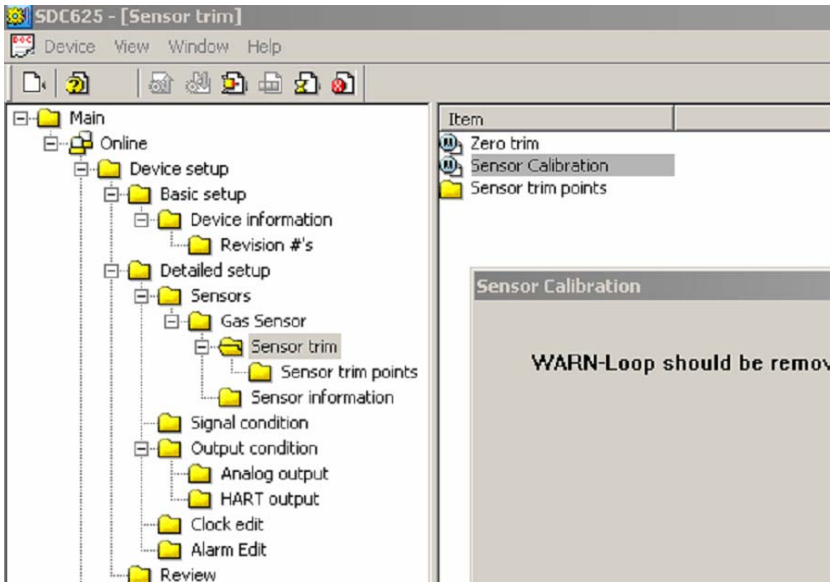

Figure D-4. First Warning screen

Second warning screen

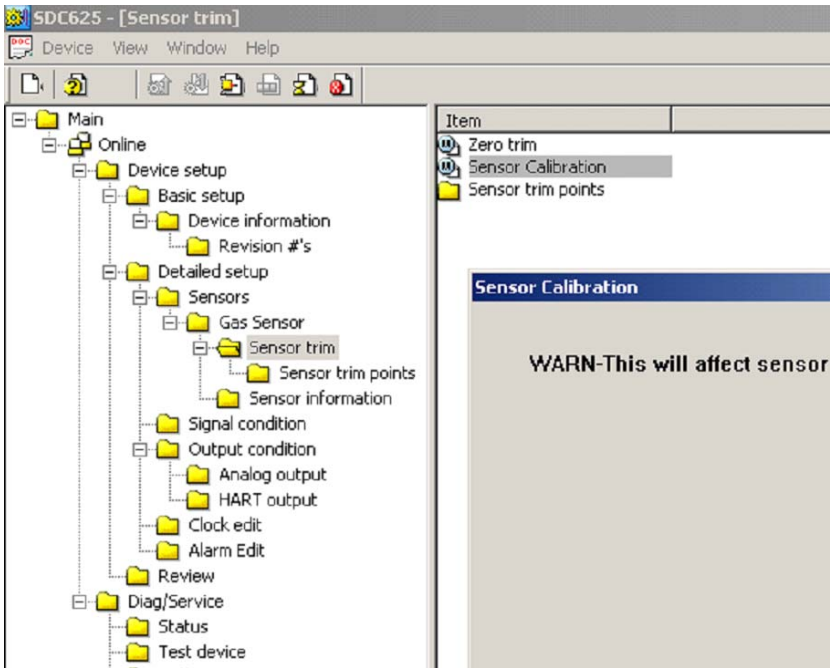

Figure D-5. Second Warning screen

Standard Calibration function select screen

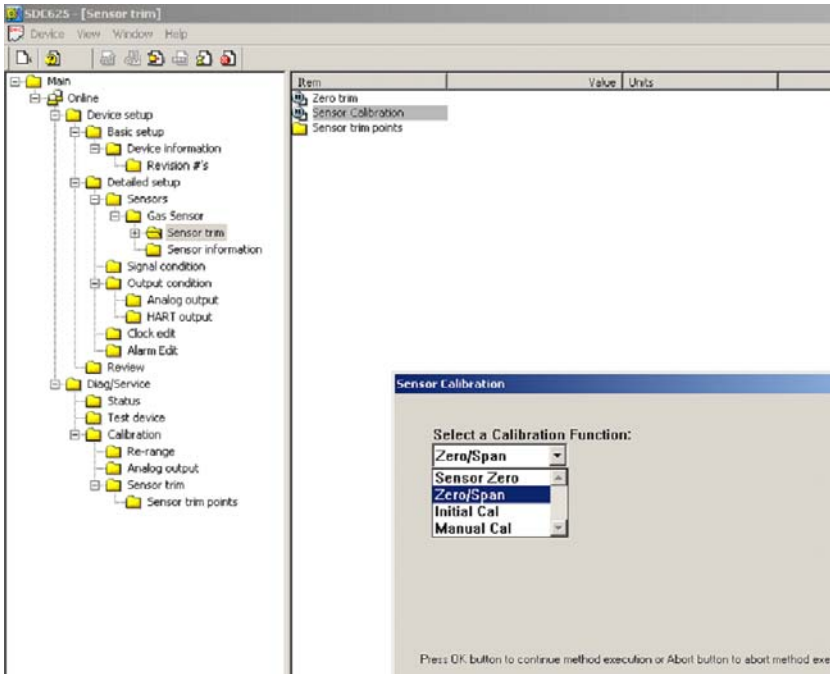

Figure D-6. Standard Calibration function select screen

Calibration initiated screen

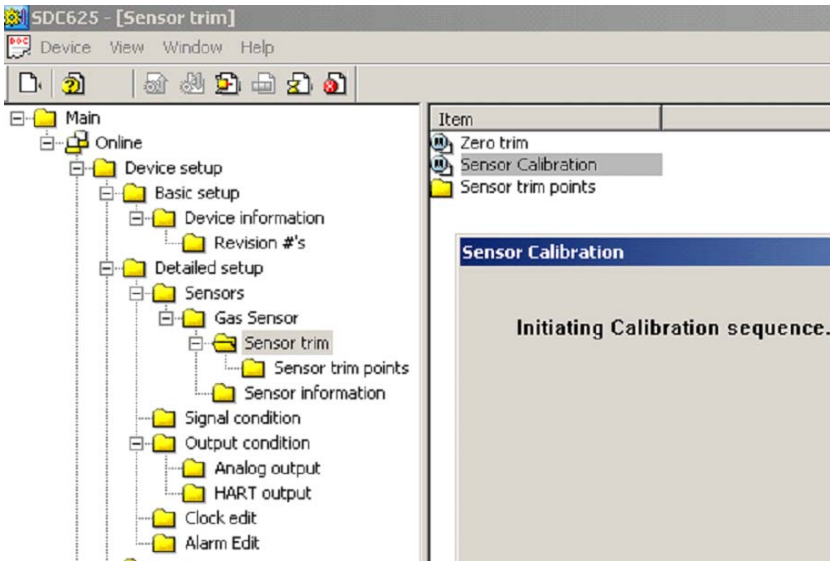

Figure D-7. Calibration initiated screen

Selection Confirmation Screen

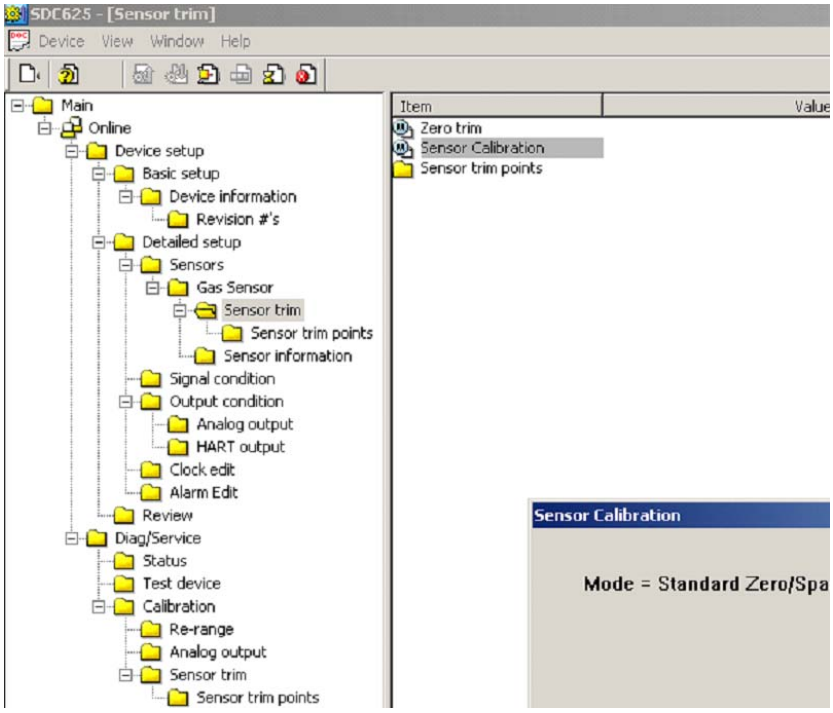

Figure D-8. Selection Confirmation screen

Sensor Zero Countdown screen

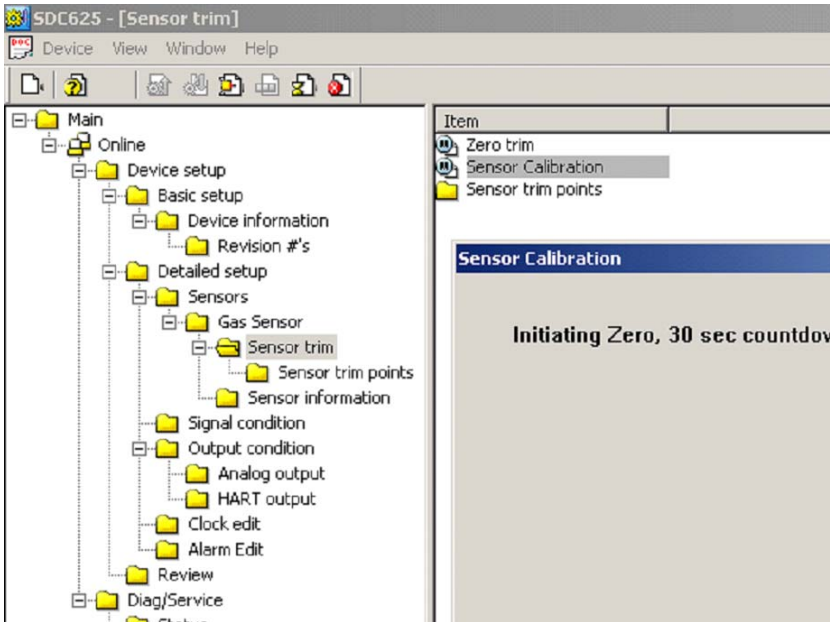

Figure D-9. Sensor Zero Countdown screen

Zero Adjustment screen

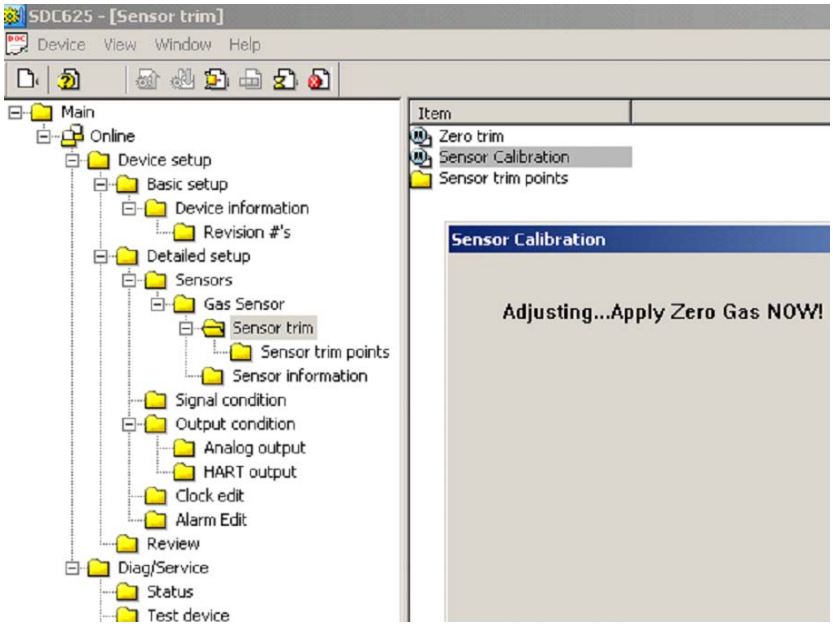

Figure D-10. Zero Adjustment screen

Span countdown screen

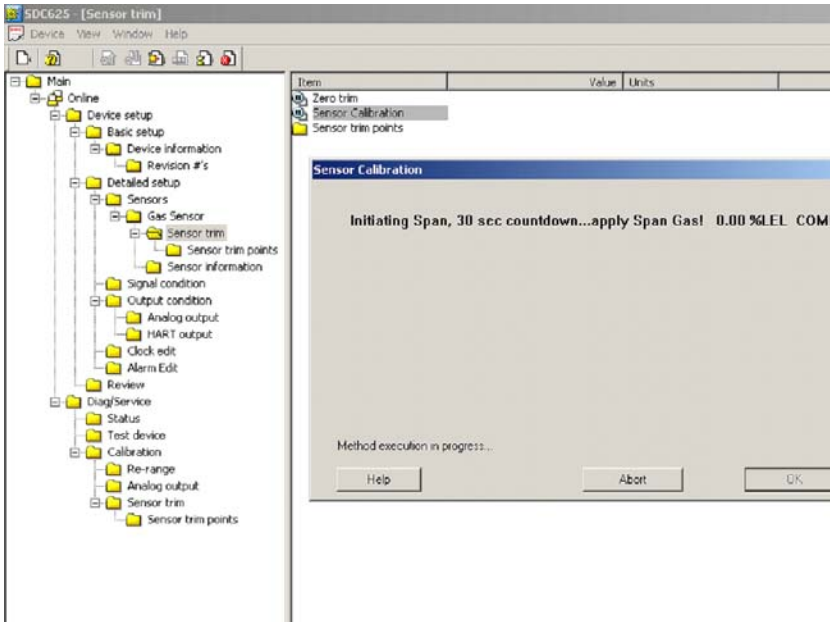

Figure D-11. Span Countdown screen

Adjusting Span screen

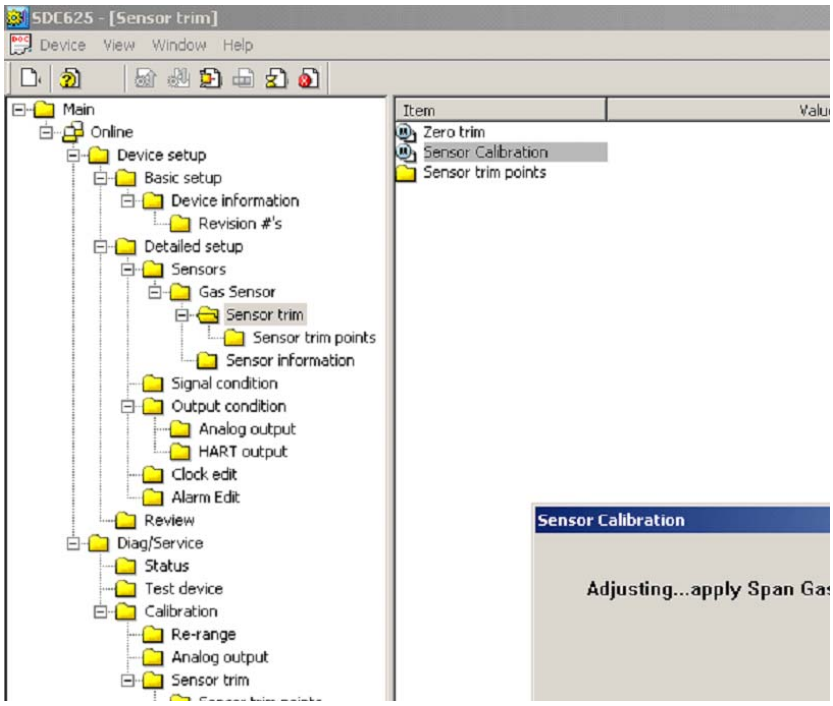

Figure D-12. Adjusting Span screen

Calibration completion message

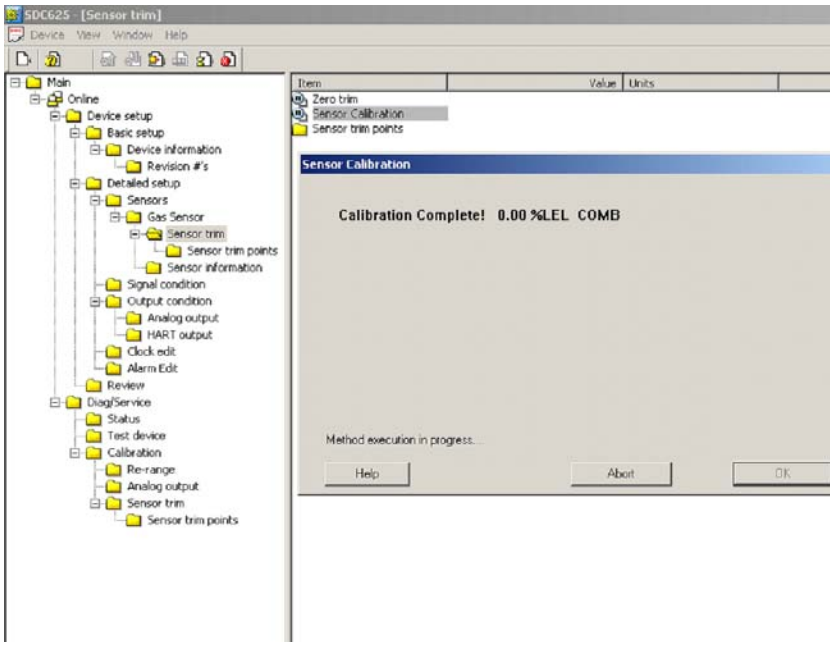

Figure D-13. Calibration Completion message

Calibration gas reminder screen

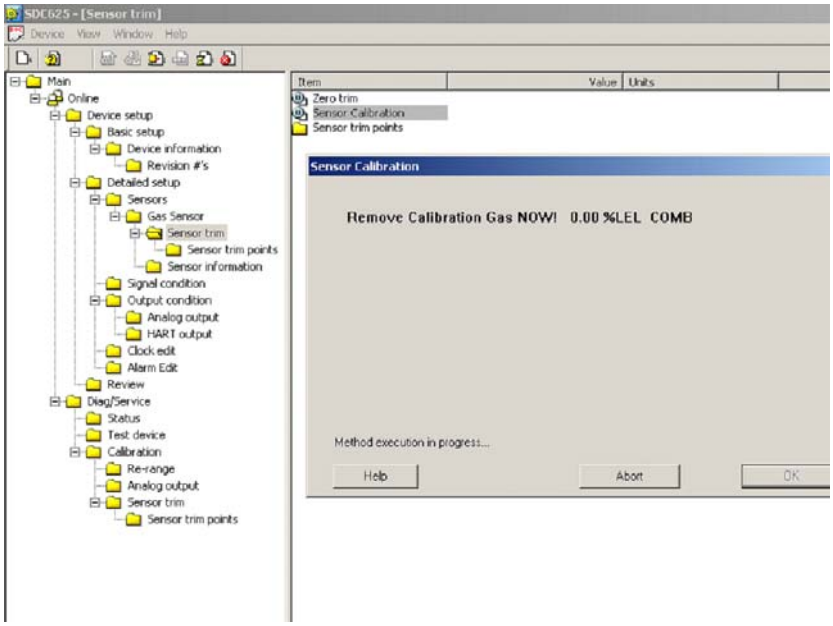

Figure D-14. Calibration Gas Reminder screen

Loop control reminder message

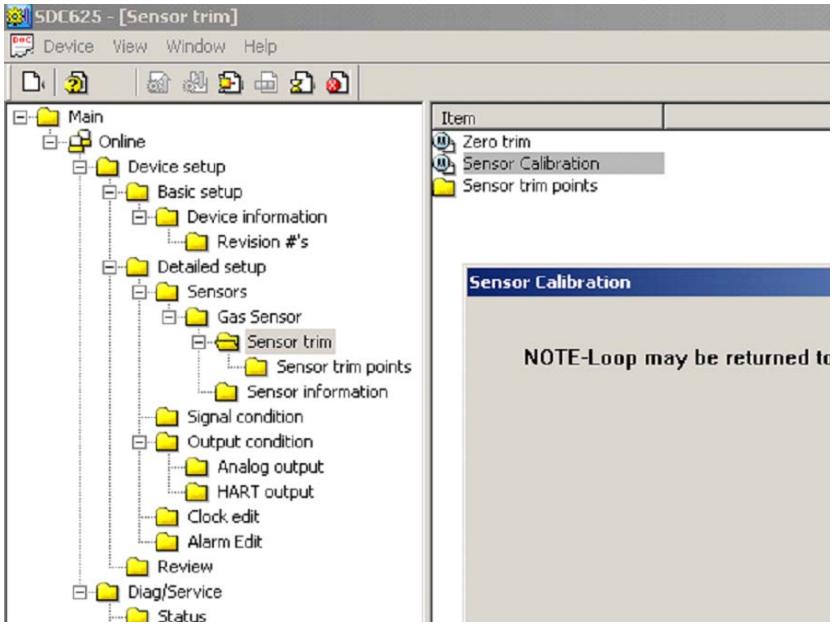

Figure D-15. Loop Control Reminder message

Troubleshooting

Fault indications

Span Fault

This fault can occur if the sensor is in cal mode and the required SPAN gas is not applied to the sensor at the indicated time or within the timeout period. The 4-20 mA returns the measured gas value based upon the last successful calibration parameters. This fault sets several status flags in the digital output to indicate that an error has occurred. The current calibration status can be observed by right-clicking on status group 2 to expand it as shown in FIGURE D-16.

Other possible cause for a Span Fault could be the use of an incorrect Span gas or improperly set PV Upper Trim point (Span) setting. The Trim (calibration) point information can be viewed from the sensor trim points menu as shown in FIGURE D-17.

Span faults can also be caused by a bad sensor, sensor at end-of-life, or a sensor that is too far out of calibration for the Standard Zero/ Span procedure to make the adjustment. An attempt to Initial Cal the sensor may be able to correct the calibration; otherwise, the sensor must be replaced. Additional sensor status can be obtained by right-clicking on status group 3 to expand it as shown in FIGURE D-18.

Calibration status screen

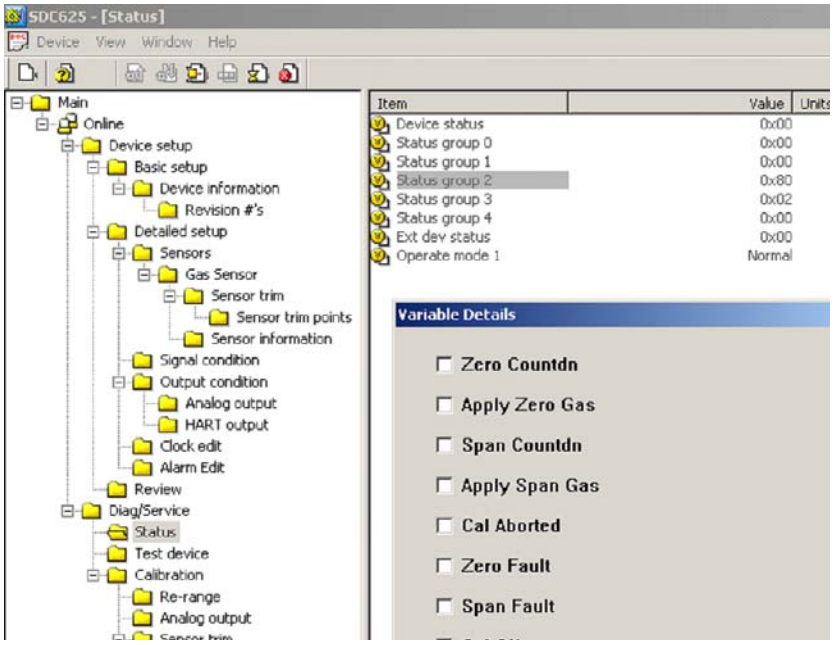

Figure D-16. Calibration Status screen

Sensor trim point screen

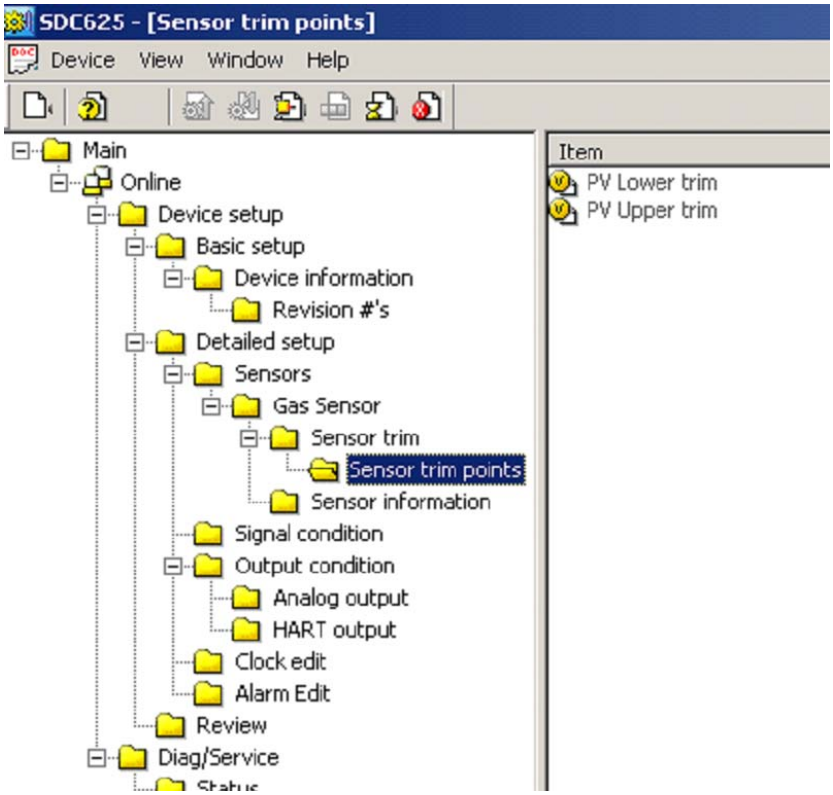

Figure D-17. Sensor Trim Point screen

Additional Sensor status screen

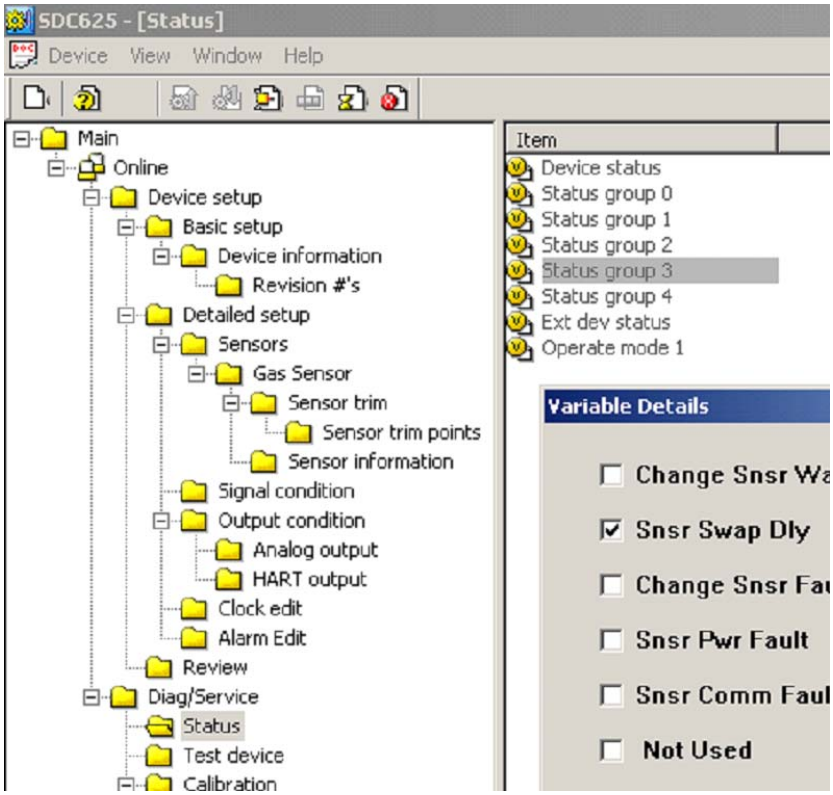

Figure D-18. Additional Sensor Status screen

Zero Fault

The Zero Fault can be caused by a faulty sensor, calibration out of the Standard Zero/Span calibration range, sensor in change, sensor fault or attempting to zero the sensor with Span gas applied. The application of Zero gas should be checked and the sensor status (as defined in FIGURES D-16 and D-18) verified if this fault occurs.

Calibration Aborted

User calibration abort or sensor calibration faults can cause a calibration process to abort. Status group 2 as shown in FIGURE D-16 can be viewed to determine if the abort was caused by a cal fault. Status group 2 can be expanded by right-clicking the selection as shown in FIGURE D-19 to provide additional information (also see FIGURE D-16).

Device status screen

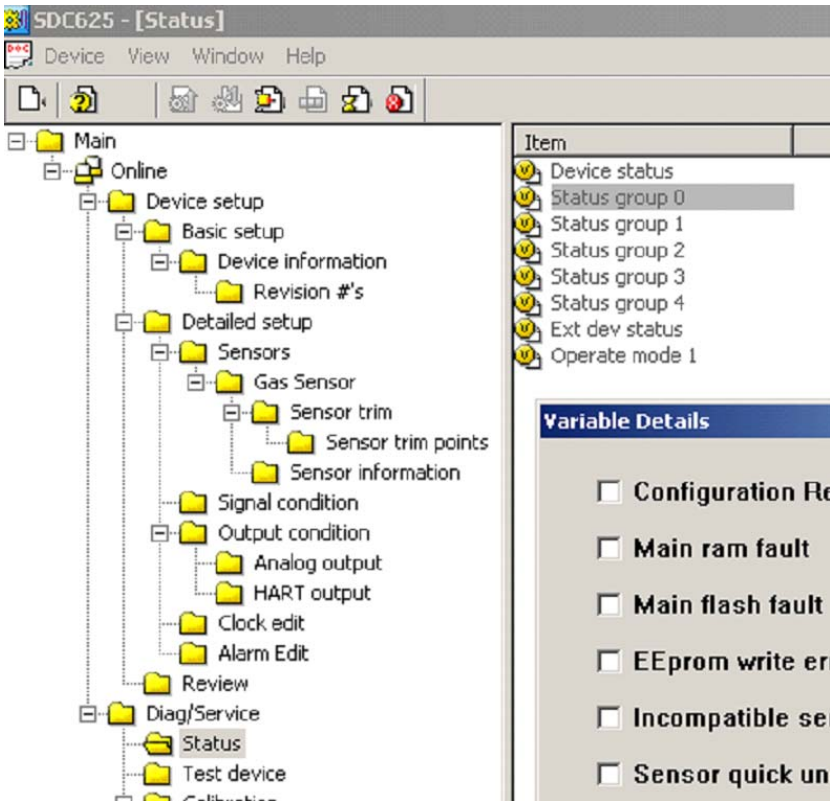

Figure D-19. Device Status screen