

**MSA** *The Safety Company* **Ultima<sup>®</sup> XL/XT  
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 (724) 776-8626

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Manufactured by

**MSA NORTH AMERICA**

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(L)-Y Rev 4

10077029

**⚠ 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 repairs.

**NOTE: This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference, in which case the user will be required to correct the interference at his own expense.**

**⚠ WARNING**

**This is a class A product in accordance with CISPR 22. In a domestic environment, this product may cause radio interference, in which case the user may be required to take adequate measures.**

## MSA Permanent Instrument Warranty

1. **Warranty-** Seller warrants that this product is 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 comes 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 it is maintained and used in accordance with Seller's instructions and/ or recommendations. This warranty does not apply to expendable or consumable parts whose normal life expectancy is less than one (1) year. 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 onto 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 is 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 non-operation 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

### 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. General-purpose (GP) Ultima X Series Gas Monitors can be a source of ignition. Install, locate, and operate GP models in a non-hazardous area and in accordance with all applicable codes. If a hazardous area must be monitored, use only an explosion-proof/flame-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.

**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 personal injury and/or equipment damage.**

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# Chapter 1, Introduction

## General Description

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

## Identifying Your Unit

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



**Figure 1-1. General-Purpose Ultima XT Monitor**

- The Ultima XL Gas Monitor is housed in a 316 stainless steel explosion-proof/flame-proof enclosure (FIGURE 1-2).



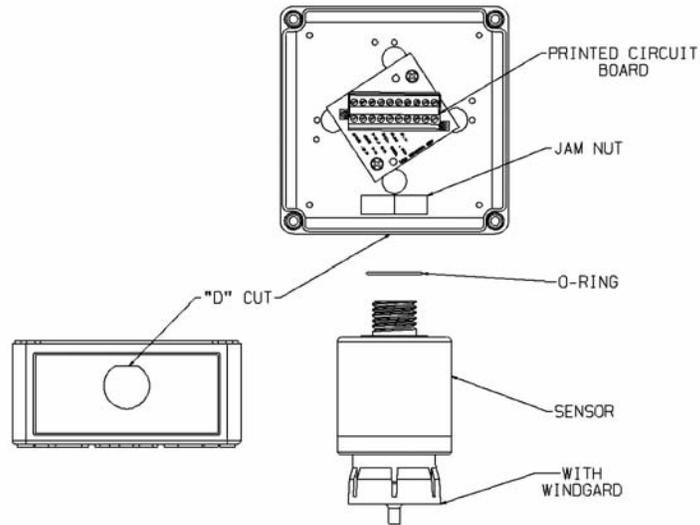
**Figure 1-2. Explosion-proof/flame-proof Ultima XL Monitor**

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

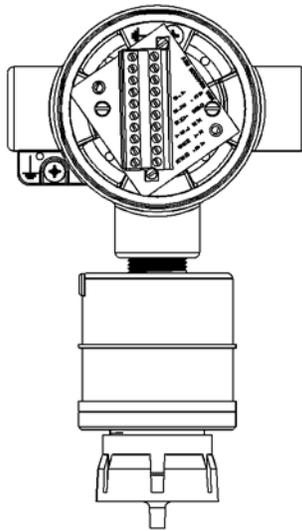


**Figure 1-3. Explosion-proof/flame-proof Ultima XL with IR Monitor**

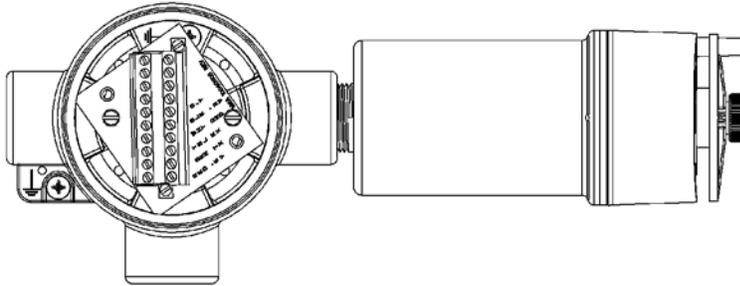
- Remote Sensor Models are shown in FIGURES 1-4, 1-5 and 1-6.



**Figure 1-4. General-Purpose XT Remote Sensor Model**



**Figure 1-5. Explosion-proof/flame-proof XL Remote Sensor Model**



**Figure 1-6. Explosion-proof/flammable-proof  
XIR Remote Sensor Model**

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

- Type of unit supplied (Gas Monitor, Gas Monitor Less Sensor, or Sensing Module)
- Type of gas (combustible gas, toxic gas or oxygen)
- Range [% LEL, PPM (parts per million), or %]
- Output (3 wire, 4 to 20 mA)

## **Installing Your Gas Monitor**

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

Generally, the Ultima X Series Gas Monitors or remote sensing module should be mounted close to the area where a leak is likely to occur or where the gas is expected. Install the Ultima X Series Gas Monitors or the remote sensing module at a high level (ceiling) or low level (floor), depending on the density of the gas most likely to be found.

### **⚠ CAUTION**

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

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

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

### **⚠ WARNING**

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

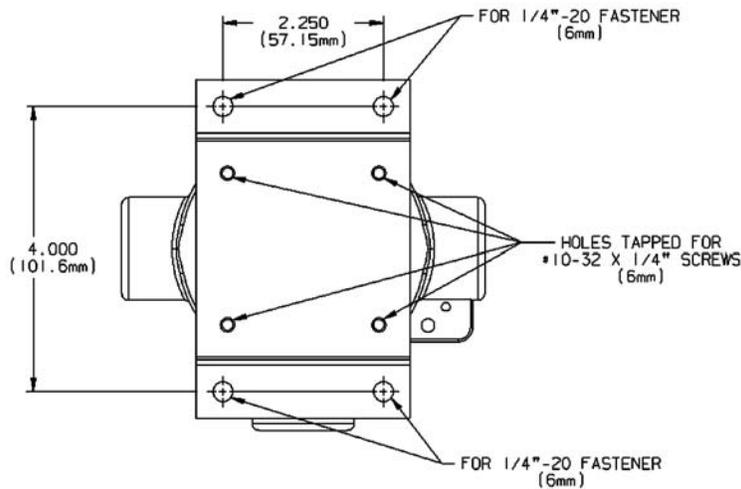
## **Installing the Ultima XT Gas Monitor**

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

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

## Installing the Ultima XL Gas Monitor

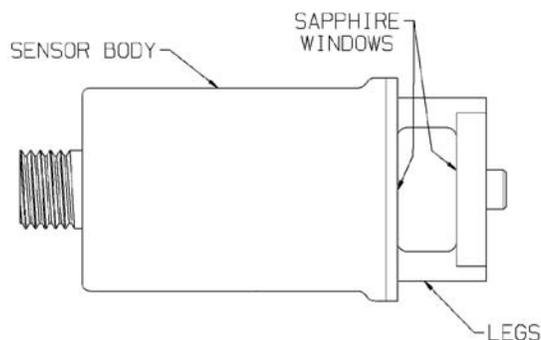
- Use the optional mounting kit (P/N 10047562) that can be attached to the rear holes of the Ultima XL Gas Monitor (FIGURE 1-7).



**Figure 1-7. Ultima XL and XIR Mounting Strap Mounting Method**

- The Ultima XL Gas Monitor main enclosure can be rotated 360° and mounted to ensure easy access to any of the three entryways. The electronics assembly can be installed in any of the four self-aligning positions to allow proper sensor orientation.
- The Ultima XL Gas Monitor sensor is not shipped attached to the main enclosure. Mount the sensor module with the applicable conduit only. Ensure the sensor wiring harness is through the entry and the sensor is pointing downward (except IR, which mounts to the side). Tighten with a strap wrench.

## Installing the Ultima XIR Gas Monitor



**Figure 1-8. Ultima XLIR**

### **⚠ WARNING**

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

- Use the optional mounting strap (P/N 10047562) that can be attached to the rear holes of the Ultima XL Gas Monitor (FIGURE 1-7).
- The Ultima XL Gas Monitor main enclosure can be rotated 360° and mounted to ensure easy access to any of the three entryways. The electronics assembly can be installed in any of the four self-aligning positions to ensure the sensor is properly oriented.

### **⚠ CAUTION**

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

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.

With its environmental guard installed, the XIR Gas Monitor's response time to a step change in gas concentration exceeds the limits specified by the Canadian Standards Association (CSA). The XIR monitor must be operated with the environmental guard removed to maintain CSA performance certification. Note that the environmental guard is required to check or adjust the XIR monitor's zero and span.

## Electrical Connections for Ultima X Gas Monitors

### **⚠ WARNING**

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

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

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

- A three-wire connection is required for all:
  - Combustible Gas models
  - Toxic and Oxygen Models with 4 to 20 mA output.

### **Wiring for all Models**

Install wiring in accordance with the electrical code of the country in use. In these installations, twisted-pair, instrument quality cable is recommended. Shielded cable is recommended for cable runs where interferences from radio frequency interference (RFI), electromagnetic interference (EMI) or other noise sources exist (such as motors, welding equipment, heaters, etc.).

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

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

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

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

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

### **Use of External Controllers**

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

- Model 5000 unit (with 4 to 20 mA inputs)
- Model 9010/9020 Controller unit
- Quad Gas Controller
- Suprema Controller
- Programmable controllers
- DCS's, etc.

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

### **Typical Ultima X Series Gas Monitor Wiring**

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

#### **⚠ WARNING**

**When using any of the the Ultima X Series accessories 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 and local procedural codes. Failure to do so can result in an unsafe condition.

**Table 1-1. Ultima XL and XT  
Maximum Cable Length and 4-20 mA Signal Load**

POWER SUPPLY	24 VOLTS	12 VOLTS
<b>CABLE SIZE</b>		
18 AWG CABLE (1.00 mm <sup>2</sup> )	2500 FEET (762 m)	900 FEET (274 m)
16 AWG CABLE (1.50 mm <sup>2</sup> )	4200 FEET (1280 m)	1400 FEET (427 m)
12 AWG CABLE (2.50 mm <sup>2</sup> )	10,000 FEET (3048 m)	3600 FEET (1097 m)
<b>MAX. LOAD ON 4-20 mA SIGNAL</b>	500 OHMS	300 OHMS

**Table 1-2. Cable Length and Wire Size  
(Power Supply 24 VDC) (Toxic Gas or Oxygen) Sensor,  
4-20 mA Signal Output (Three Wire Sensor)**

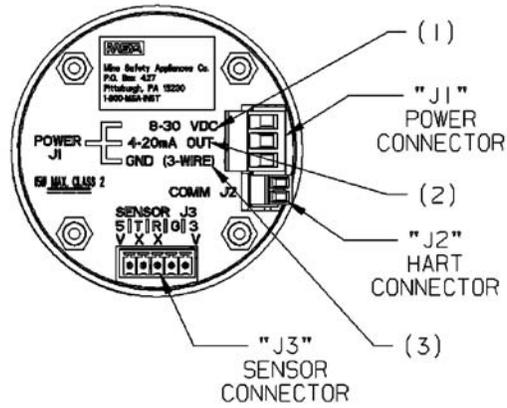
WIRE SIZE	MAX. CABLE LENGTH	MAX. LOAD RESISTANCE
22 AWG (0.25 mm <sup>2</sup> )	10000ft (3048 m)	500 ohms

**Table 1-3. Ultima XIR Maximum Cable Length  
and 4-20 mA Signal Load**

POWER SUPPLY	24 VOLTS	12 VOLTS
<b>CONFIGURATION</b>		
18 AWG CABLE (1.00 mm <sup>2</sup> )	2000 FEET (610 m)	300 FEET (91 m)
16 AWG CABLE (1.50 mm <sup>2</sup> )	3500 FEET (1067 m)	500 FEET (152 m)
12 AWG CABLE (2.50 mm <sup>2</sup> )	5000 FEET (1524 m)	900 FEET (274 m)
<b>MAX. LOAD ON 4-20 mA SIGNAL</b>	500 OHMS	300 OHMS

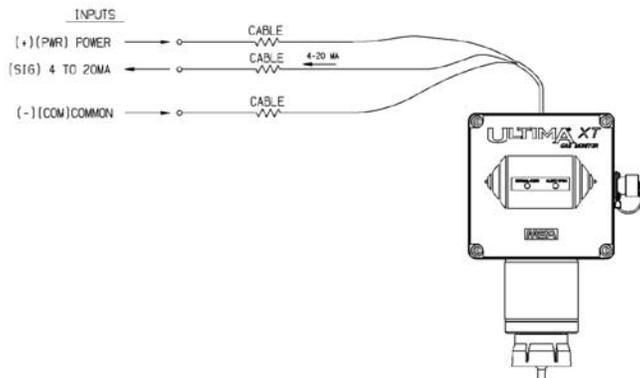
- The Ultima XL/XT Gas Monitors operate in the current source mode (see FIGURE 1-10 for general-purpose) (FIGURE 1-11 for explosion-proof/flame-proof).

NOTE: The HART communications require the load on the 4-20 mA to be between 230 to 500 ohms.

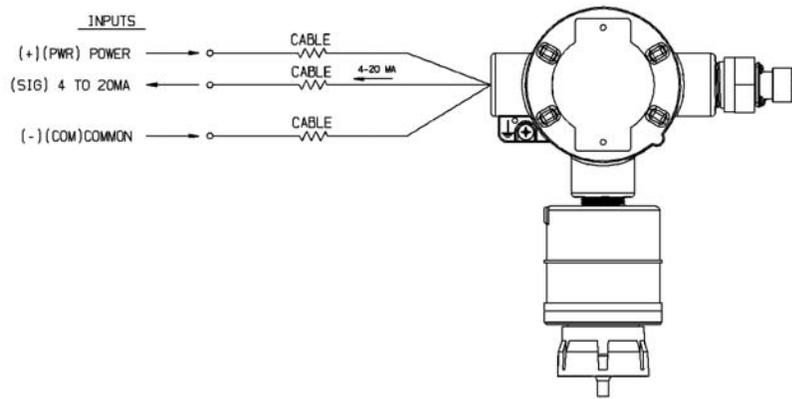


**Figure 1-9. Circuit Board**

1. Connect 12 or 24 VDC power lead to J1-1 (see FIGURE 1-9).
2. Connect J1-2 to 4 to 20 mA input on remote system.
3. Connect the signal ground to J1-3.
4. Connect the sensor module to labeled connector J-3 on the main pc board.
5. Assemble lid on enclosure.



**Figure 1-10. General-Purpose Three-Wire 4-20 mA Operation**



**Figure 1-11. Explosion-proof/flare-proof  
Three-Wire 4-20 mA Operation**

## Installing the Ultima X Remote Sensor Module

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

The Remote Sensor Module can be mounted in a manner similar to the gas monitor installation in the preceding procedure and at a maximum distance outlined in TABLE 1-4.

Permanently connect 1/4" (6 mm) ID tubing to the post on the environmental guard. 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 could occur.**

**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 for US, or relevant codes for country of installation; failure to do so can result in an unsafe condition.**

Five conductors are required for the Ultima XL and Ultima XT Remote Sensor Modules if it is desired to be able to switch between 5-volt and 3-volt sensor modules; otherwise, a four-conductor cable that connects either 5 volts or 3 volts to the sensor module is sufficient. 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 (1.32 mm<sup>2</sup>) conductors.

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

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

**Table 1-4. Remote Module Wiring and Placement**

<b>GAS TYPE</b>	<b>MINIMUM WIRE SIZE</b>	<b>MAXIMUM DISTANCE</b>
Toxic and Oxygen	20 AWG (0.562 mm <sup>2</sup> )	100 FEET (30.5 m)
Catalytic Combustible	18 AWG (1.00 C)	50 FEET (15.2 m)
	16 AWG (1.50 mm <sup>2</sup> )	100 FEET (30.5 m)
*IR Combustible	16 AWG (1.50 mm <sup>2</sup> )	50 FEET (15.2 m)
	12 AWG (2.50 mm <sup>2</sup> )	100 FEET (30.5 m)

\* CE-Approved instruments have a maximum 50 (15.2 m)-foot distance.

TABLE 1-5 shows suggested cables for Ultima X Series installations; other cables are available which are also adequate.

**Table 1-5. Remote Sensor Wiring Cable**

<b>SUPPLIER</b>	<b>CATALOG NO.</b>	<b>DESCRIPTION</b>
ALPHA WIRE CORP.	5525	5 cond., shielded, 18 AWG (0.897 mm <sup>2</sup> )
	5535	5 cond., shielded, 16 AWG (1.32 mm <sup>2</sup> )
	5514	4 cond., shielded, 20 AWG (3.08 mm <sup>2</sup> )

**Table 1-6. Low Temperature Wiring Cable**

<b>SUPPLIER</b>	<b>CATALOG NO.</b>	<b>DESCRIPTION</b>
ALPHA WIRE CORP.	45525	5 cond., shielded, 18 AWG (0.897 mm <sup>2</sup> )
	45366	6 cond., shielded, 16 AWG (1.32 mm <sup>2</sup> )
	45545	5 cond., shielded, 14 AWG (3.08 mm <sup>2</sup> )

**At the Ultima X Series Remote Sensor Location:**

1. Open the Ultima X Series Remote Sensor cover by removing lid.
2. For the Ultima XT Gas Monitor, route the cable from the Gas Monitor through a customer-supplied opening in the enclosure and wire it to the terminal block (FIGURE 1-4).

For the Ultima XL or XLIR Gas Monitor, route the cable from the Gas Monitor through a wire entry hole in the enclosure and wire it to the terminal block (FIGURE 1-5 or 1-6).

3. Verify the identity of each conductor of the cable and connect the wire to the terminal block.
4. Re-install the cover of the Ultima X Series Remote Sensor.

**NOTES:**

- Incoming power and signal cable shield should be earth grounded at the power source. Connect power and remote sensor cable shields together in the main housing. Provide shield terminations inside the sensor housing as indicated on Installation Outline Drawings for Remote Sensor; see Table 3-1 for Installation Outline Drawing document numbers.
- Cables larger than #16 AWG (1.32 mm<sup>2</sup>) 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.
- During the 30-second warmup, 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 is solid ON during the 30-second warmup.
- The Normal green LED is solid ON after the 30-second warmup.
- A complete listing of instrument operation features can be found in TABLE 2-1.

During normal operation, the Ultima X Monitor outputs the gas concentration of the surrounding environment through a digital HART connection on the 4-20 mA line or local HART controller. The corresponding 4-20 mA output signal can be transmitted to a controller or DCS (distributed control system). Setup and calibration can be performed through this connection. HART communication requires the 4-20 mA line be terminated with 230 - 500 ohms of resistance.

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 there is a possibility that the over-range condition may still exist.
- OVER % LEL - The Ultima X Series Gas Monitor has been exposed to a high concentration of gas (above the LEL) and the over-range condition definitely still exists. The 4-20 mA output will be set to the LOC/overrange value (21 mA) and the LOC and overrange flags will be set on the HART monitor.

**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 HART Calibrator or Controller, or by using the pushbutton interface. The Ultima X Series Gas Monitor will not revert to a normal condition until a successful zero operation has been performed. This is an exclusive safety feature of the Ultima X Series Gas Monitor which pre-empts the possibility of ambiguous readings when the sensor is exposed to concentration of gas above 100% LEL

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

**Table 2-1. Instrument Operation**

<b>OPERATION</b>	<b>GREEN LED</b>	<b>RED LED</b>	<b>4-20 mA OUTPUT</b>
<b>NORMAL NO ALARMS</b>	ON steady	OFF	Gas value
<b>ALARMING</b>	OFF	Flashing	Gas value
<b>FAULT</b>	OFF	ON steady	3.0 mA
<b>POWER UP/ COUNTDOWN</b>	OFF	ON steady	ALERT option <sup>1</sup> disabled: 21.0 mA for O <sub>2</sub> ; 3.75 mA for others  ALERT option <sup>1</sup> enabled: 3.75 mA for all
<b>SENSOR MISSING/ COUNTDOWN</b>	OFF	ON steady	3.0 mA if SWAP delay timeout <sup>2</sup> expired, SWAP Delay <sup>3</sup> disabled or FAULT  Previous gas value if SWAP delay <sup>3</sup> enabled and SWAP delay timeout <sup>2</sup> not expired
<b>SENSOR CAL APPLY ZERO GAS</b>	Flashing	OFF	3.75 mA if cal signal enabled and ALERT option <sup>1</sup> enabled; gas value if cal signal disabled  21.0 mA for O <sub>2</sub> if cal signal enabled and ALERT option <sup>1</sup> disabled
<b>SENSOR CAL APPLY SPAN GAS</b>	Flashing	ON	3.75 mA if cal signal enabled and ALERT option <sup>1</sup> enabled; gas value if cal signal disabled  21.0 mA for O <sub>2</sub> if cal signal enabled and ALERT option <sup>1</sup> disabled
<b>CAL 4-20</b>	OFF	ON steady	4 mA if 4 mA calibration selected  20 mA if 20 mA calibration selected
<b>CAL FAULT</b>	OFF	ON steady	Gas value
<b>UNDERRANGE</b>	OFF	ON steady	3.0 mA if gas value 0 or less; gas value otherwise
<b>OVERRANGE/ LOC</b>	ON steady	OFF <sup>4</sup>	21.0 mA

NOTES:

<sup>1</sup>See Chapter 3 for Alert option.

<sup>2</sup>Swap Delay timeout is 60 seconds if enabled; 0 seconds otherwise.

<sup>3</sup>See Chapter 3, "Command #180: Write Sensor Swap Delay Enable" for SWAP Delay option.

<sup>4</sup>Alarming operation is followed if the alarms are enabled.

## Calibration Basics

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

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

Before calibrating, the Ultima X Series Gas Monitor should be powered for a minimum of one hour to allow the sensor to settle into its new environment. ETO sensor requires 24-hour warm-up time.

### **⚠ CAUTION**

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

### **⚠ CAUTION**

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

## Reduced Catalytic Sensor Sensitivity

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

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

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

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

- HART®-compatible communications interface with Device Description Language capability (DDL) or generic HART interface with Manufacturer Specific Command capability. See Chapter 3 for command definitions.
- Optional Push-button Calibration (Chapter 2).

## **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 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 during the calibration cycle and for one minute after calibration is complete.

NOTE: For the range of 25% oxygen, the calibration signal will be 21 mA. Oxygen can be set to a 3.75 mA calibration signal by turning ON the ALERT option.

## **Ultima X Series Gas Monitor Calibration Procedure**

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

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

### **INITIAL Calibration**

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

## Overview

The following report outlines the calibration procedure for the Ultima XL/XT Gas Monitoring instrument using a Device Description language capable HART communicator. The procedure is a menu-driven process using a series of user prompts to indicate when to apply gas.

There are four HART calibration procedures available using the manufacturer specific commands and one sensor zero command available using a common practice command. These are device automated procedures with screen prompts to indicate when user interaction is needed to proceed. The steps and prompt screens are provided for each of the calibration procedures.

Each display screen gives the user the option of aborting the current calibration procedure at any time during the procedure. If aborted, the sensor retains the last calibration data recorded prior to the current procedure attempt.

The screen shots show selection from a windows directory tree menu structure. Other window style menu presentations may be available on certain host machines but the calibration information screens should remain the same.

Additionally, some screens may not appear for all sensor types. The Oxygen sensor, for instance, does not show the 30-second zero countdown screen because that sensor uses an electronic zero.

NOTE: The terms “trim” and “calibration” are used interchangeably within the HART protocol. To promote interoperability for users accustomed to either term, both are used in the menu structure.

## Equipment Required

Three calibration kits (numbered 40, 41, and 54; see FIGURES 2-1 and 2-2) are available from MSA for diffusion Ultima/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 Sampling Modules or an Ultima/Ultima X Series unit equipped with a flow cap. For flow or sample module systems, refer to the Ultima Aspirated Sampling Module Manual (P/N 710200) or to the Ultima DC Pump Sampling Module Manual (P/N 710201).

NOTE: The calibration procedure for the sample draw Ultima XL/XT 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/Ultima X Series Gas Monitor.

TABLE 2-2 shows the recommended calibration kit for Ultima and 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, when 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 (P/N 10041533) 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/Ultima X Monitor is factory-shipped with a preset span gas value (TABLE 2-2). This span gas value can be changed via the HART Controller; otherwise, the span gas must correspond to preset concentrations. See Section 3 to change the span gas value.

The span gas value of Ultima/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**

<b>GAS TYPE</b>	<b>RANGE</b>	<b>SPAN GAS PRESET VALUES</b>	<b>RP CYLINDER P/N</b>	<b>CAL KIT</b>	<b>WARM-UP TIME</b>
CARBON MONOXIDE	0-100 PPM	60 PPM	710882	40	15 minutes
	0-500 PPM	300 PPM	10027938		
	0-1000 PPM	400 PPM	10028048		
SULFUR DIOXIDE	0-25 PPM	10 PPM	10028070	40	15 minutes
	0-100 PPM	10 PPM	808978		
HYDROGEN SULFIDE	0-10 PPM	5 PPM	710414	40	15 minutes
	0-50 PPM	40 PPM	10028062		
	0-100 PPM	40 PPM	10028062		
	0-500 PPM	250 PPM	10089547		
NITRIC OXIDE	0-100 PPM	50 PPM	10028074	40	15 minutes
NITROGEN DIOXIDE	0-10 PPM	5 PPM	710332	41	30 minutes
CHLORINE	0-5 PPM	2 PPM	710331	41	30 minutes
	0-10 PPM	2 PPM	10028066		30 minutes
	0-20 PPM	10 PPM			30 minutes
HYDROGEN CYANIDE	0-50 PPM	10 PPM	10028072	41	30 minutes
HYDROGEN FLUORIDE <sup>(7)</sup>	0-10 PPM	8 PPM	10028070	41	30 minutes
CHLORINE DIOXIDE <sup>(4)</sup>	0-3 PPM	1 PPM	710331	41	30 minutes
OXYGEN	0-10%	5%	493580	40	15 minutes
	0-25%	20.8%	10028028 <sup>(2)</sup>		15 minutes
NATURAL GAS <sup>(3)</sup>	0-100% LEL	25% LEL <sup>(1)</sup>	10028034	40	15 minutes
PETROLEUM VAPORS <sup>(3)</sup> (GASOLINE)	0-100% LEL	40% LEL <sup>(1)</sup>	10028034	40	15 minutes
GENERAL SOLVENTS <sup>(3)</sup>	0-100% LEL	55% LEL <sup>(1)</sup>	10028034	40	15 minutes
NON- METHANE IR	0-100% LEL	29% LEL <sup>(1)</sup>	10028034	40	- - -
METHANE IR	0-100% LEL	50% LEL <sup>(5)</sup>	10028032	40	- - -
PHOSPHINE	2.0 PPM	0.5 PPM	710533	41	24 hours

GAS TYPE	RANGE	SPAN GAS PRESET VALUES	RP CYLINDER P/N	CAL KIT	WARM-UP TIME
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	0-100 PPM	25 PPM	10028076	40	30 minutes
	0-1000 PPM	300 PPM	10044014	40	30 minutes
HYDROGEN	0-1000 PPM	500 PPM	10022386	40	30 minutes
ETHYLENE OXIDE <sup>6</sup> (ETO)	0-10 PPM	4.0 PPM	10028070	40	24 hours
CARBON DIOXIDE IR	0-5000 PPM	2000 PPM	479266	40	- - -
	0-2%	1.5%	807386		
	0-5%	2.5%	479265		
HYDROGEN CHLORIDE	0-50 PPM	40 PPM	10028078	54	30 minutes

NOTES:

<sup>1</sup> Calibrated with Propane (.6% gas by volume)

<sup>2</sup> Not required for standard calibration procedure

<sup>3</sup> For combustible gas, it is good practice to calibrate unit with gas to be detected

<sup>4</sup> ClO<sub>2</sub> is calibrated with Cl<sub>2</sub> or use ClO<sub>2</sub> Calibrator Kit (P/N 710420)

<sup>5</sup> Methane IR is calibrated with 50% LEL Methane

<sup>6</sup> ETO is calibrated with SO<sub>2</sub>.

<sup>7</sup> Hydrogen Fluoride (HF) is calibrated with Sulfur Dioxide (SO<sub>2</sub>)

<sup>8</sup> These LEL values are based on US standards, not European EN standards

<sup>9</sup> Sensor conversion formula:

Measurement (see TABLE 2-3 for units) =  $[I_m - 4] + 16$  x full-scale.

( $I_m$  = the measured 4-20 mA loop current in mA; full-scale = instrument's maximum range).

<sup>10</sup> This is the calibration setpoint and should not be confused with the algebraic difference between the upper and lower values of a range.

Example: If measuring gases or vapors that appear in TABLE 2-3, Category 32 and Category 33, you should calibrate to the Category 33 span value (55% LEL) with .6% propane by volume applied.

If the gas or vapor you are measuring does not appear in the TABLE 2-3 categories, consult MSA 1-800-MSA-INST for the proper setting. If you wish to calibrate to the specific LEL of the gas or vapor being measured, the expected span gas value of the Ultima/Ultima X Series Gas Monitor can be changed by the HART Controller.

**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 and set the 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 and set the 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 and set the 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 and set the span gas value accordingly:

Methane	50		
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**CATEGORY 39: ULTIMA XIR NON-METHANE**

To detect non-methane gases, recalibrate with the stated % propane and set the span gas value as given in Appendix A.

For additional gases for the Ultima XIR, see Appendix A.

## Ultima X Series Gas Monitor Calibration

### WARNING

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

In some cases, it may be necessary to perform only a zero function of the Gas Monitor in lieu of a full zero and span procedure. Check with your safety officer or safety engineer to determine if only a zero function is necessary.

#### NOTES:

- If this is the first calibration or, if the sensor element has been changed or replaced, see previous section, "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. ETO sensor requires 24-hour warm-up time.
- Due to the unstable nature of Chlorine Dioxide ( $\text{ClO}_2$ ), 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.  
For example, the 2 ppm sample of Chlorine should be set to read 1 ppm of  $\text{ClO}_2$ . The default value for the calibration gas on the  $\text{ClO}_2$  Ultima/Ultima X Series Gas Monitor is 1 ppm.
- For  $\text{Cl}_2$  and  $\text{ClO}_2$  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.

Calibration of Hydrogen Chloride Gas Monitors must be performed as follows:

1. Use MSA Hydrogen Chloride (HCl) cylinder (P/N 10028078), 40 PPM Hydrogen Chloride.
2. Start with a NEW 1.5 LPM flow control regulator (P/N 478358) and tubing (P/N 711112) dedicated only for use with Hydrogen Chloride gas and included in Cal Kit #54.
3. Before starting a calibration, run HCl gas through the flow control regulator and tubing for a minimum of five minutes.

4. Perform calibration per the Instructions that follow.
5. After a successful calibration, flush the flow control regulator and tubing with 100% Nitrogen for five minutes.
6. Store the flow control regulator in a desiccated, sealed bag or container to maintain regulator performance.

NOTE: If regulator is properly flushed and stored in a sealed bag with desiccant provided in Cal Kit #54 or equivalent dry container, start with step 3 for future calibrations.

- Calibration Kit #54 contains the parts listed above for a Hydrogen Chloride diffusion calibration.

## 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 selecting the ZERO function on the HART communicator instead of the CALIBRATE selection as described as follows, or by using the optional push-button calibration as outlined in Chapter 2, "Optional Push-button Calibration".

### 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 Environmental guard 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 Environmental guard inlet.

When using Cal Kit 41, locate the cal cap (with hole for tubing)

and push the tubing through the hole in the bottom of the cap. Then, connect the end of the tubing over the sensor inlet and push the calibration cap over the entire sensor inlet.

- f. Turn ON the zero gas flow by turning the knob on the flow controller.
3. Connect the HART communicator to the Ultima XL/XT instrument or across the 4-20 mA line and select ZERO function from the menu or select the zero or calibration function as described in the following procedures.
    - The green LED should be flashing.
    - The red LED should be OFF.

NOTE: The zero or calibration process can be aborted at anytime during the 30-second countdown interval; simply select ABORT with the HART communicator 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 LEDs show:

- green LED flashing
  - red LED OFF
  - both LEDs flash once to indicate the 30-second countdown has expired.
4. After the 30 second countdown:
    - During Zero Cal:
      - green LED is flashing
      - red LED is OFF.
    - Once the gas value is stable, the LED sequence will change.
- 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 Environmental guard.
      - 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 HART communicator (or solid red LED if using the pushbutton cal), this indicates:
- An unsuccessful attempt to zero or calibrate the Ultima X Series Monitor
  - The Ultima X Series Monitor is operating with the calibration parameters defined before the calibration was attempted.
  - See Troubleshooting Guidelines found in Chapter 4.

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

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

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

### **Spanning**

5. During a standard calibration, the Ultima X Series Monitor automatically begins the span countdown after a successful zeroing of the unit. The span countdown is 30 seconds.
  - green LED is flashing
  - red LED is ON.

NOTE: The span process can be aborted at any time during the countdown by simply selecting ABORT with the HART communicator or, by pressing and releasing the push-button if push-button calibration is used.

6. Locate the span gas cylinder and the Calibration Kit Flow Controller. For a 0-25% Oxygen sensor, the sensor may be spanned using room air (20.8%).
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 Environmental guard 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 occurs on the Ultima X Series Monitor 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:
  - Once the gas value on the display is stable, the green LED stops flashing on the unit. If the calibration is successful, the green LED will be ON solid and the HART communicator will show a "Calibration complete" screen.
  - No user adjustments are necessary.
  - The HART communicator screen 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.
  - 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 HART communicator status display, or the red LED is on solid (not blinking), this indicates:
    - An unsuccessful attempt to calibrate the Ultima X Series Monitor
    - The Ultima X Series Monitor is operating with the calibration parameters defined before the calibration was attempted.

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

The Ultima X Series Monitor allows automatic zero and span

adjustments within a pre-defined range. It cannot make corrections outside this range, such as when an empty or wrong cylinder of gas is applied or failure to begin gas flow within the allotted 30-second countdown occurs.

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

## 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 extended 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 selecting Zero Calibration on the HART communicator (or by using the "Optional Push-button Calibration") and following the "Zeroing" instructions given earlier in this chapter. After completing the zeroing function, perform a span check to ensure proper operation. If the span check is unsuccessful, perform a full calibration.

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

### WARNING

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

## Calibration Recording

The Ultima X Series Monitor records the date of the last successful calibration. This date can then be displayed on the HART communicator.

## 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 for at least one second.
2. Release the push-button.
  - At this time, any recoverable alarms will be acknowledged (reset).
3. Press and hold the push-button within three seconds of the first push-button release.

4. Release the push-button when the desired calibration is displayed. See TABLE 2-4.

**Table 2-4. Push-button Calibration**

<b>CALIBRATION TYPE</b>	<b>GREEN LED</b>	<b>RED LED</b>	<b>PUSH-BUTTON HOLD TIME</b>
Zero Cal	OFF	OFF	5 seconds
Span Calibration	ON	Flashing	10 seconds
ICAL	ON	ON	20 seconds
User Cal	Flashing	Flashing out of sync	40 seconds

NOTE: The LED states are defined on the inside of the XT and XL lid for easy reference.

- Refer to Chapter 2, "Startup and Calibration" for more information on calibration.

## 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 2-8 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 2-9 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 2-10 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 2-11 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 2-12 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 2-13 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 2-14 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 2-15 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 2-18 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 2-19 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 2-20 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 2-8 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 section FIGURE 2-9 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 indicating that sensor calibration is changed. The user can abort the procedure at this time or acknowledge the screen to proceed. See FIGURE 2-10 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 2-11 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 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 2-12 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 2-13 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 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 2-14 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 2-15 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 2-16 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 2-17 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 2-18 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 2-19 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 2-20 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 2-6 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**

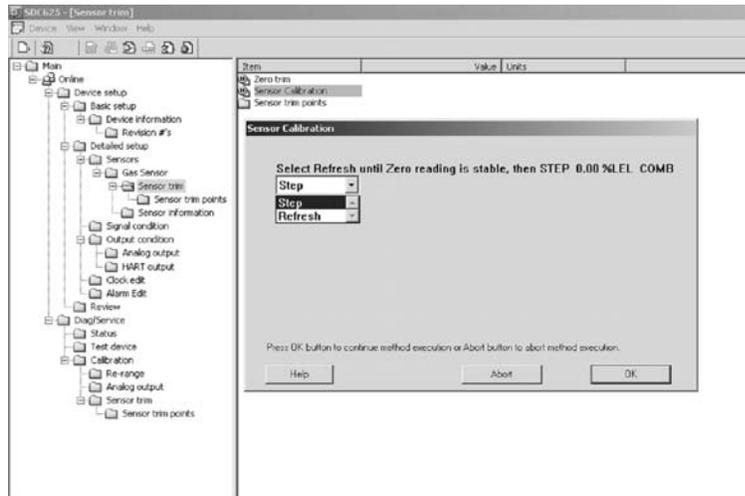
User calibration is selected in a manner similar to the standard Zero/Span calibration procedure; the steps are similar, except the function selection should be "User Cal". Normal calibrations are performed and stepped automatically by the device while prompting the user to apply the required calibration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

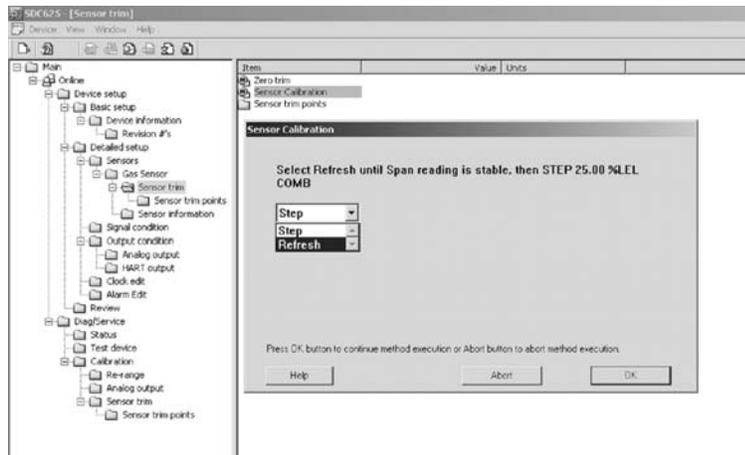
User calibration is similar to the standard procedures provided earlier under "Standard Calibration Procedures", except that the automatic adjustment screens described in "Zero Adjustment screen" and "Adjusting Span screen" sections are replaced with a Step/Refresh screen allowing the user to review the readings and decide when to advance the procedure (see FIGURES 2-3 and 2-4).

### Zero cal step screen



**Figure 2-1. Zero cal step screen**

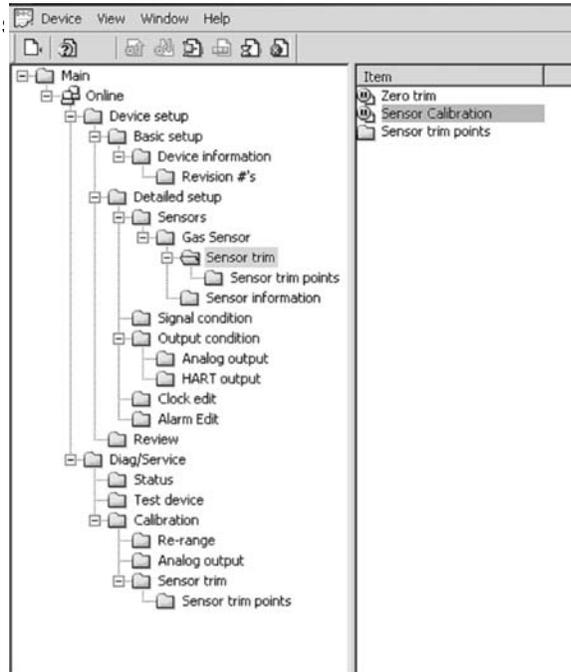
### Span cal step screen



**Figure 2-2. Span cal step screen**

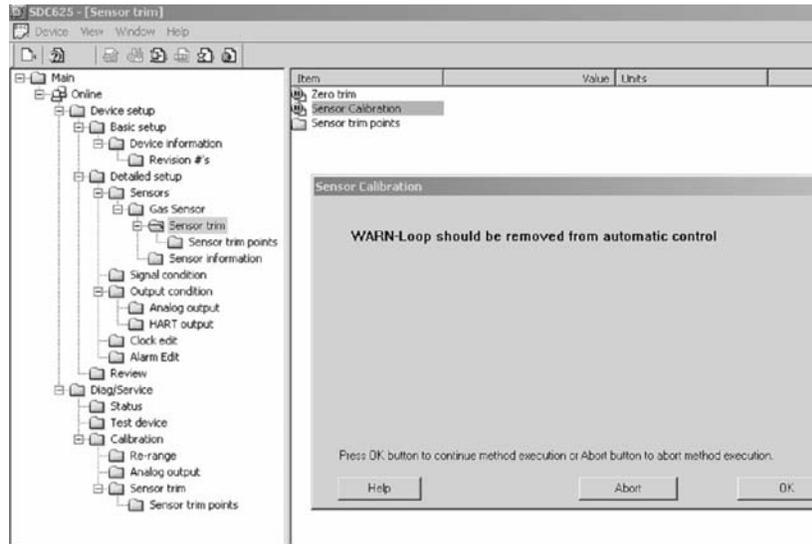
## Sample Calibration Display Screens

### HART DDL-based calibration display screens



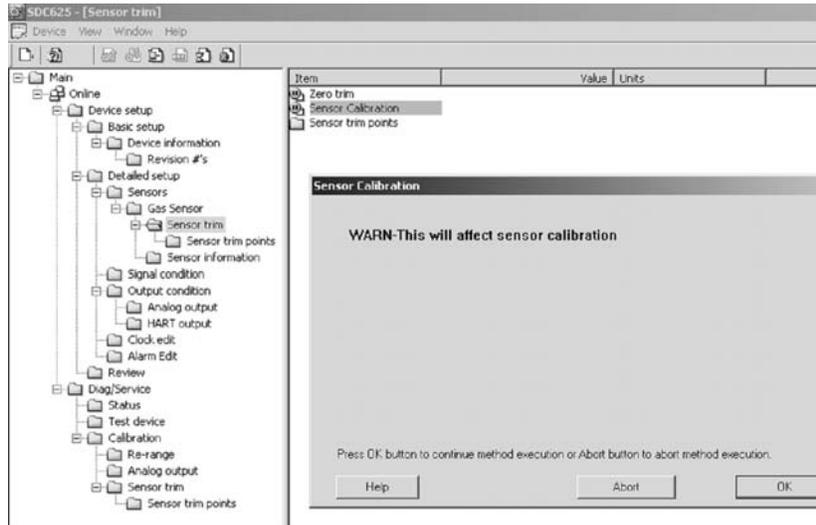
**Figure 2-3. Select Sensor Calibration from the Sensor Trim Menu**

### First warning screen



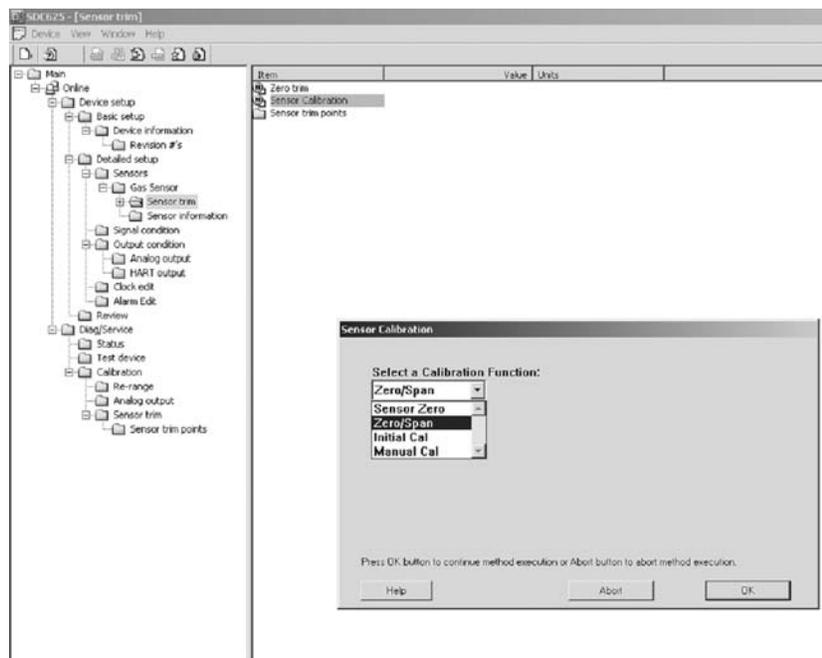
**Figure 2-4. First Warning screen**

## Second warning screen



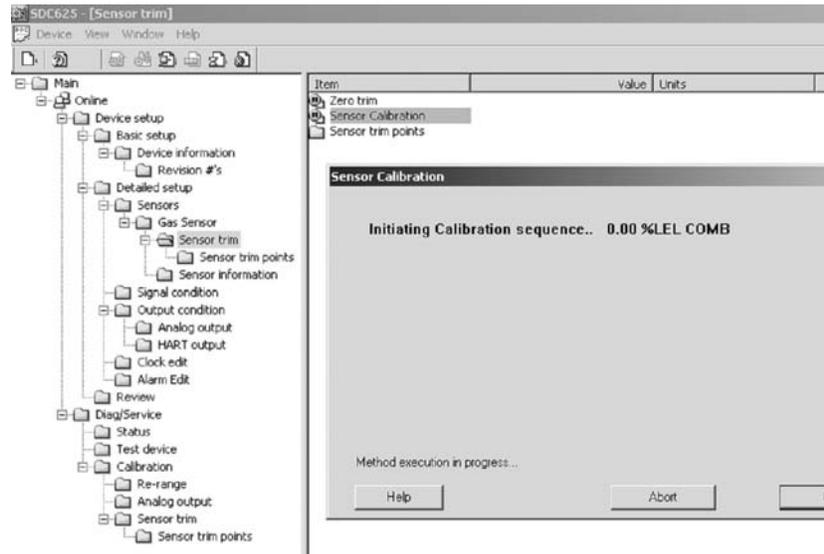
**Figure 2-5. Second Warning screen**

### Standard Calibration function select screen



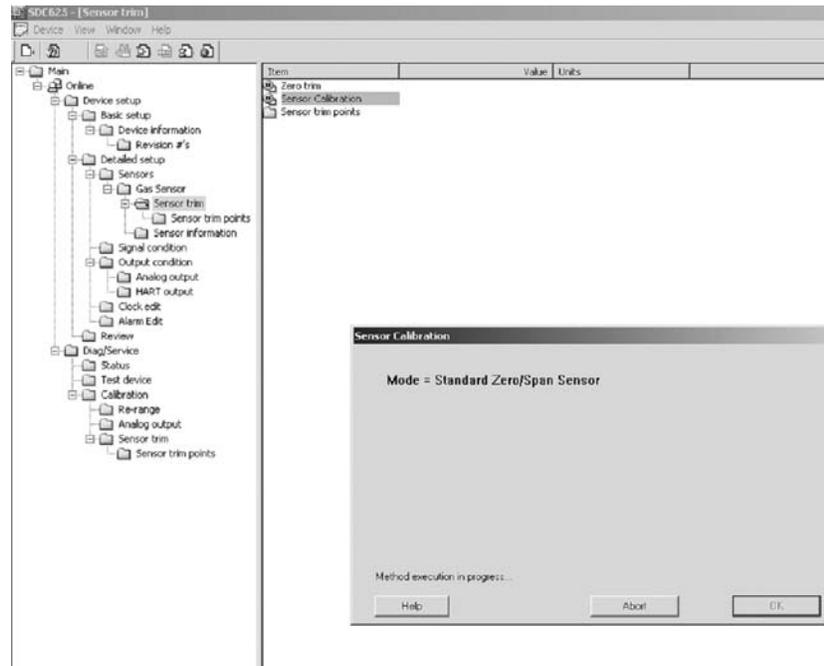
**Figure 2-6. Standard Calibration function select screen**

### Calibration initiated screen



**Figure 2-7. Calibration initiated screen**

## Selection Confirmation Screen



**Figure 2-8. Selection Confirmation screen**



## Zero Adjustment screen

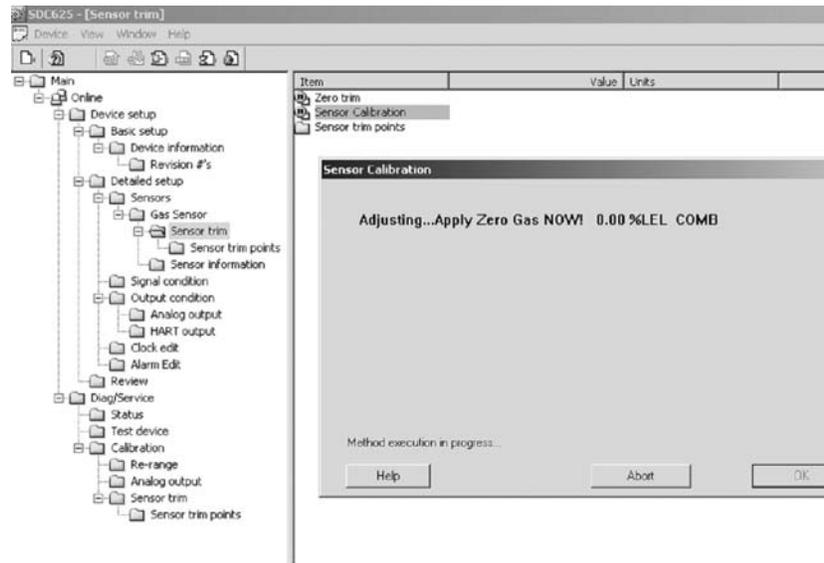
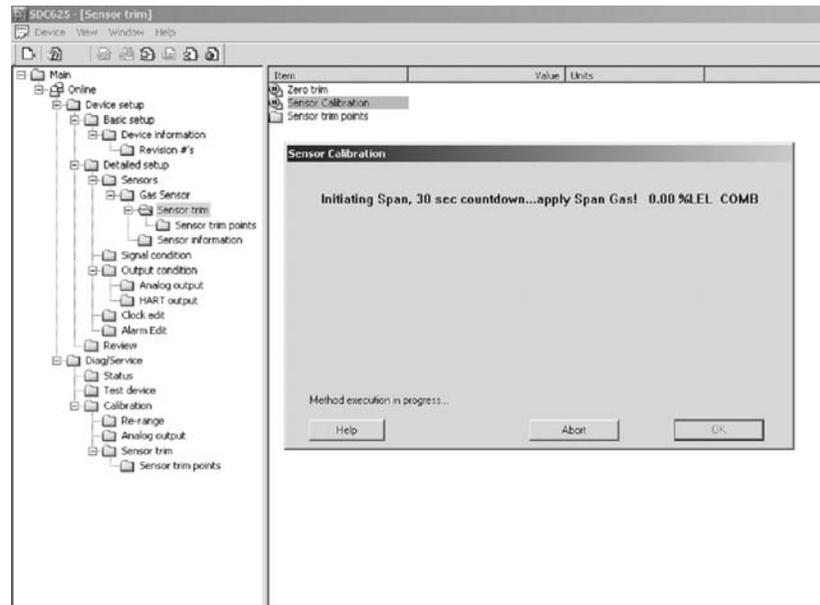


Figure 2-10. Zero Adjustment screen

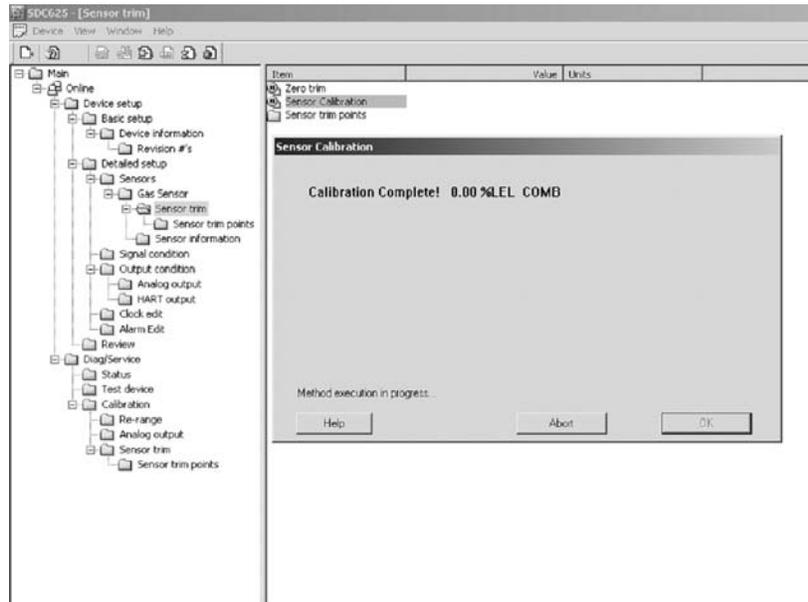
## Span countdown screen



**Figure 2-11. Span Countdown screen**

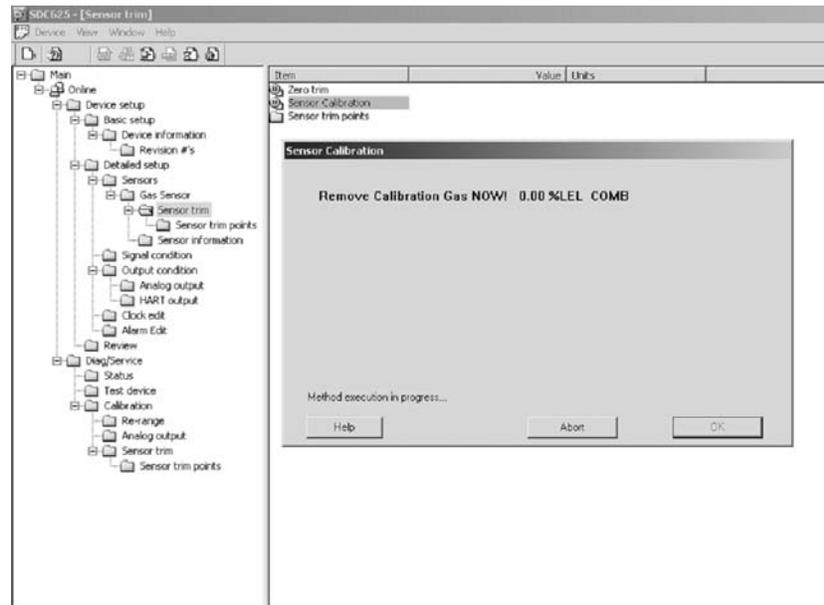


## Calibration completion message



**Figure 2-13. Calibration Completion message**

### Calibration gas reminder screen



**Figure 2-14. Calibration Gas Reminder screen**

## Loop control reminder message

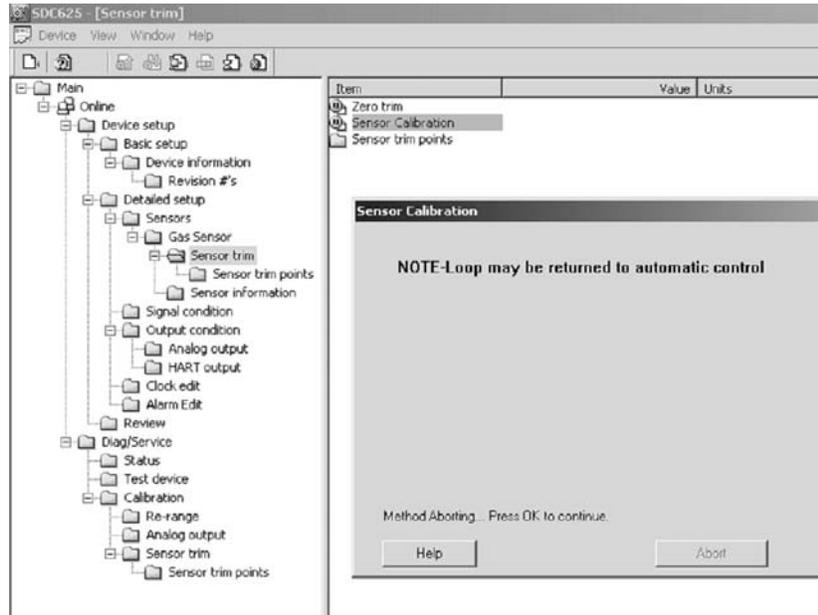


Figure 2-15. Loop Control Reminder message

## Troubleshooting

### Fault indications

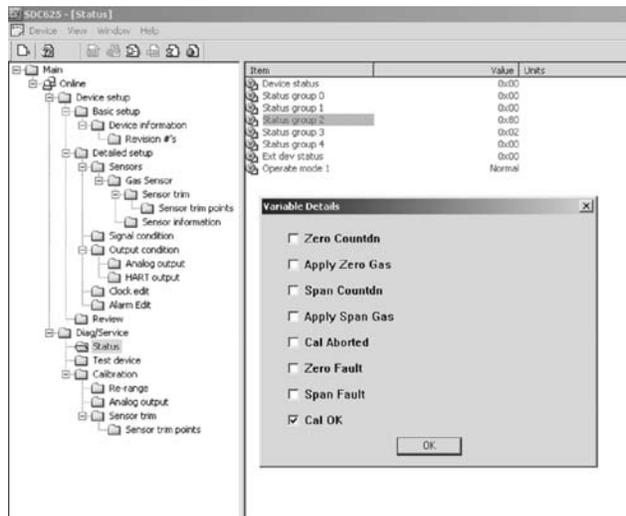
#### Span Fault

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. This fault causes the 4-20 mA output to be set to the fault level (21 mA for Oxygen, 3 mA for all other sensors). 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 2-18.

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 2-19.

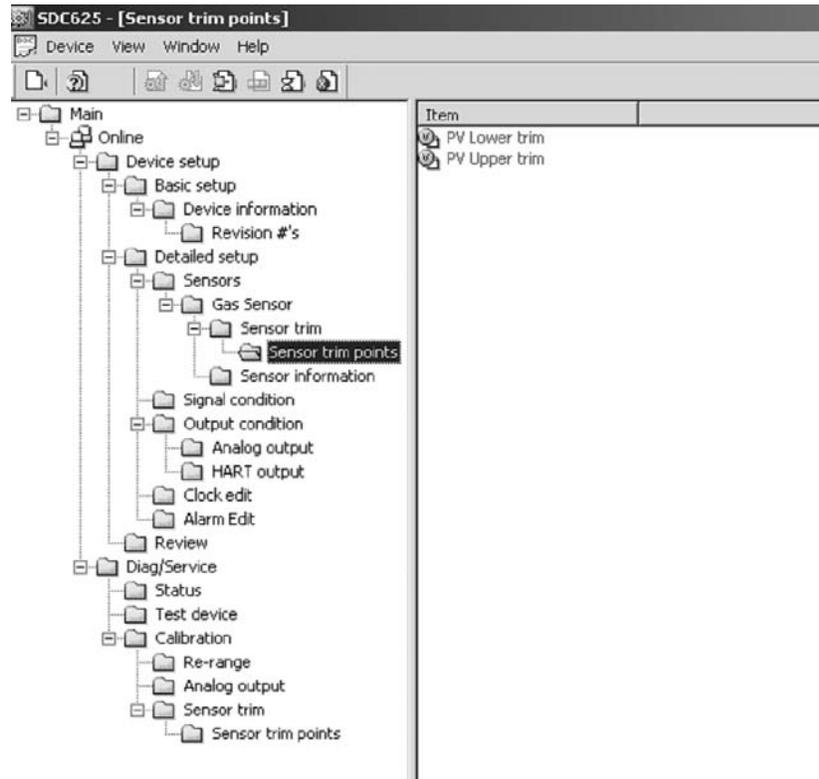
Span faults can also be caused by a bad sensor, sensor at end-of-life, or a sensor that is too far out of calibration for the Standard Zero/ Span procedure to make the adjustment. An attempt to Initial Cal the sensor may be able to correct the calibration; otherwise, the sensor must be replaced. Additional sensor status can be obtained by right-clicking on status group 3 to expand it as shown in FIGURE 2-20.

**Calibration status screen**



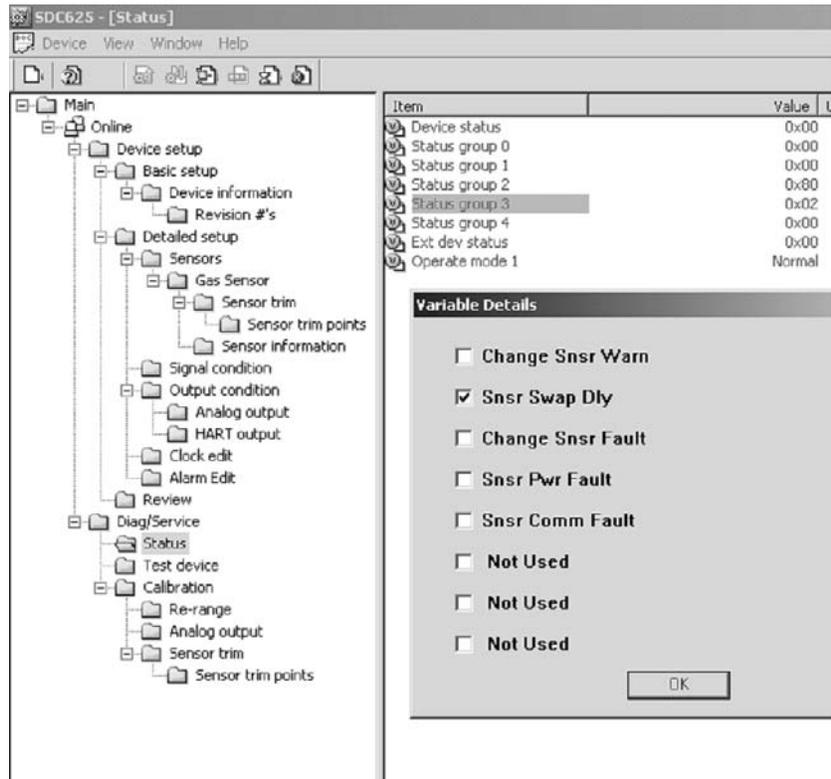
**Figure 2-16. Calibration Status screen**

**Sensor trim point screen**



**Figure 2-17. Sensor Trim Point screen**

### Additional Sensor status screen



**Figure 2-18. 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 2-16 and 2-18) 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 2-16 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 2-19 to provide additional information (also see FIGURE 2-16).

### Device status screen

The screenshot shows the SDC625 Status screen. On the left is a tree view with the following structure:

- Main
  - Online
    - Device setup
      - Basic setup
        - Device information
          - Revision #'s

On the right is a table with the following data:

Item	Value	Units
Device status	0x00	
Status group 0	0x00	
Status group 1	0x00	
Status group 2	0x80	
Status group 3	0x02	
Status group 4	0x00	
Ext dev status	0x00	
Operate mode 1	Normal	

A 'Variable Details' dialog box is open, listing the following options:

- Configuration Rreset
- Main ram fault
- Main flash fault
- EEprom write error
- Incompatible sensor
- Sensor quick underrange
- Sensor underrange
- Calibration fault

An 'OK' button is located at the bottom of the dialog box.

Figure 2-19. Device Status screen

# Chapter 3, Specifications

**Table 3-1. Performance Specifications**

<b>GAS TYPES</b>		Combustibles, Oxygen & Toxics
<b>TEMPERATURE RANGE</b>	<b>TOXICS &amp; OXYGEN</b>	<b>OPERATING RANGE</b> 0 to +40°C (32 to +104°F)
		<b>*EXTENDED RANGE</b> -20 to +50°C (-4 to +122°F)
		<b>OPERATING RANGE NH<sub>3</sub></b> 0 to +30°C (32 to +86°F)
		<b>*EXTENDED RANGE NH<sub>3</sub></b> -10 to +40°C (14 to +104°F)
		<b>STORAGE TEMPERATURE RANGE</b> -40 to +70°C (-40 to +158°F) or limits of the sensor
		Calibrate within operating range
	<b>CATALYTIC COMBUSTIBLES</b>	<b>SINGLE MODULE</b> -40 to +60°C (-40 to +140°F)
		<b>DUAL MODULE</b> -40 to +60°C (-40 to +140°F)
	<b>IR COMBUSTIBLES</b>	<b>SINGLE MODULE</b> -40 to +60°C (-40 to +140°F)
		<b>DUAL MODULE</b> -40 to +60°C (-40 to +140°F)
<b>DRIFT</b>	<b>ZERO DRIFT</b>	Less than 5%/year, typically
	<b>SPAN DRIFT</b>	Less than 10%/year, typically
<b>NOISE</b>		Less than 1% FS

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

## ACCURACY

GAS	LINEARITY	REPEATABILITY
CARBON MONOXIDE	the greater of +2% full scale (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
BROMINE	±10% FS or 2 ppm	±5% FS or 1 ppm
HYDROGEN FLUORIDE	±10% FS	±10% FS

## STEP CHANGE RESPONSE

**TIME TO REACH 20% OF SCALE- OXYGEN & TOXICS** Less than 12 seconds (typically 6 seconds)  
Less than 20 seconds (ETO)

**TIME TO REACH 50% OF SCALE- OXYGEN & TOXICS** Less than 30 seconds (typically 12 seconds)  
Less than 45 seconds (ETO)

**TIME TO REACH 50% OF SCALE- COMBUSTIBLES** Less than 10 seconds

**TIME TO REACH 90% OF SCALE- COMBUSTIBLES** Less than 30 seconds

**HUMIDITY** 15 to 95% RH, non-condensing, 24 hours or less  
 35 to 95% RH, long term  
 15 to 60% RH (SO<sub>2</sub>\*\*)

**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)

<b>WIRING REQUIREMENTS</b>	<b>mA OUTPUT</b>	<b>OXYGEN, TOXICS &amp; COMBUSTIBLES</b>	3-wire
<b>POWER INPUT</b>	<b>mA VERSIONS</b>	<b>OXYGEN &amp; TOXICS</b>	8 VDC 55 mA 12 VDC 45 mA max 24 VDC 40 mA max
		<b>CATALYTIC COMBUSTIBLES</b>	8 VDC 350 mA max 12 VDC 250 mA max 24 VDC 150 mA max
		<b>IR COMBUSTIBLES</b>	8 VDC 530 mA max 12 VDC 360 mA max 24 VDC 200 mA max

**SIGNAL OUTPUT** 4-20 mA **OXYGEN, TOXICS & COMBUSTIBLES** 3-wire current source

**XT PHYSICAL SIZE** 9.393" x 6.191" x 2.974  
(238.582 mm x 157.251 mm x 75.540 mm)

**WEIGHT** 1.75 lbs. (0.79 kg)

**XL PHYSICAL SIZE** 8.812" H x 7.079" W x 4.07" D  
(223.825 mm x 179.807 mm x 103.378 mm)

**WEIGHT** 7.7 lbs. (3.49 kg)

**XL WITH IR PHYSICAL SIZE** 6.266 H x 11.356" W x 4.077" D  
(159.156 mm x 288.442 mm x 103.556 mm)

**WEIGHT** 8.02 lbs. (3.64 kg)

<b>INSTALLATION OUTLINE DRAWINGS</b>	<b>MODEL</b>	<b>TYPE</b>	<b>DOCUMENT NO.</b>
	<b>ULTIMA XT</b>	<b>GAS MONITOR</b>	
		<b>REMOTE MONITOR</b>	<b>SK3015-1016</b>
	<b>ULTIMA XL</b>	<b>GAS MONITOR</b>	
		<b>REMOTE MONITOR</b>	<b>SK3015-1017</b>
	<b>ULTIMA XL IR</b>	<b>GAS MONITOR</b>	
		<b>REMOTE MONITOR</b>	<b>SK3015-1018</b>

\*\*SO<sub>2</sub> sensor should not be used in dirty or humid environments.

\*\*\*0-100 ppm NH<sub>3</sub> sensor is consumable at a rate of 10% for every 200 ppm-hours of exposure.  
 0-1000 ppm NH<sub>3</sub> sensor is consumable at a rate of 10% for every 1500 ppm-hours of exposure.

**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<sub>2</sub>S sensor gave an equivalent response of 0.5 ppm, etc.

ND = No Data

INTER-FERANT	CONCENTRATION (PPM)	CO filtered	H <sub>2</sub> S	Cl <sub>2</sub>	SO <sub>2</sub> filtered	NO	NO <sub>2</sub>	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

INTER-FERANT	CONCENTRATION (PPM)	CO filtered	H <sub>2</sub> S	Cl <sub>2</sub>	SO <sub>2</sub> filtered	NO	NO <sub>2</sub>	HCN	HCL
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	CONCENTRATION (PPM)	CLO <sub>2</sub>	HF	PH <sub>3</sub>	ASH <sub>4</sub>	SiH <sub>4</sub>	GeH <sub>3</sub>	B <sub>2</sub> H <sub>6</sub>	Br <sub>2</sub>
Acetone	1000	0	0	ND	ND	ND	ND	ND	0
Acetylene	12000	0	0	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	0	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

INTER-FERANT	CONCENTRATION (PPM)	CLO <sub>2</sub>	HF	PH <sub>3</sub>	ASH <sub>4</sub>	SiH <sub>4</sub>	GeH <sub>3</sub>	B <sub>2</sub> H <sub>6</sub>	Br <sub>2</sub>
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
Tichloroethylene	1000	0	0	ND	ND	ND	ND	ND	0

ND = No Data

INTER-FERANT	CONCENTRATION (PPM)	F <sub>2</sub>	NH <sub>3</sub>	H <sub>2</sub>	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

INTER-FERANT	CONCENTRATION (PPM)	F <sub>2</sub>	NH <sub>3</sub>	H <sub>2</sub>	EtO
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

## HART Field Device Specification

The MSA Ultima XL/XT Gas Detection Instrument 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).

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 and testing. These specifications assume the reader is somewhat familiar with HART Protocol requirements and terminology.

### Abbreviations and Definitions

HART	Highway Addressable Remote Transducer
CPU	Central Processing Unit
Echem	Electrochemical
Pellestor	pellement style combustible sensor
IR	Infrared

**Table 3-3. Device Identification**

<b>MANUFACTURER NAME</b>	<b>MSA</b>	<b>MODEL NAME(S)</b>	<b>ULTIMA XL/XT</b>
Manufacture ID Code	0x6008	Device Type Code	0xe08c
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		



**Figure 3-1. Ultima XL Gas Monitor**

## **Product Overview**

The Ultima XL/XT Gas Monitor is an instrument used to detect and measure gas concentrations. Detectable gases include Combustible and Toxic gas or Oxygen. The HART-based Ultima XL/XT device uses various detection methods, depending on the gas of interest. Detection methods can be electrochemical, infrared, solid state, pellistor or other technologies. The HART-based Ultima XL Gas Monitor is an explosion-proof and flame-proof device suitable for Class 1, Division 1, Groups A,B,C or D sensing applications. The HART-based Ultima XT Gas Monitor is a general-purpose version in a plastic enclosure for use in nonexplosive atmospheres only.

## **Product Interfaces**

### **Process Interface**

#### **Sensor Input channel**

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.).

## 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). Refer to the following installation outline drawings for details:

- Ultima XL Monitor - SK3015-1017
- Ultima XT Monitor - SK3015-1016.

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 CN number 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 3-4.

**Table 3-4. Current Values**

	DIRECTION	VALUES (% OF RANGE)	VALUES (MA OR V)
Linear over- range	Down	0%	4.00 mA
	Up	+105.0% $\pm$ 1.0%	20.64 to 20.96 mA
Device malfunction indication	Down: less than		3.5 mA
	Up: greater than		20.96 mA
Maximum current			22.0 mA
Multi-drop Current draw			3.5 mA
Lift-off voltage			8 VDC

## Local Interfaces, Jumpers and Switches

### Local Controls and Displays

The Ultima XL/XT device has two dual-use LED indicators:

- one green "Normal" LED and
- one red "Alert" LED.

The Ultima XL/XT device has one multi-use pushbutton used for the following purposes:

- **Acknowledge**- single push acknowledgement to release latched alarms if alarm level is no longer exceeded.
- **Initiate Sensor Calibration**- momentary push and release of the ACK/CAL button, followed by an immediate push and hold places the device into calibration mode. See Chapter 2 for further details.

### Internal Jumpers

This device has no internal jumpers.

### Intrinsically Safe Communications Port

The Ultima XL explosion-proof/flame-proof version of this device can be equipped with an intrinsically safe communications port that can be used with a HART communications device that matches the parameters (i.e. Emerson 375 or equivalent).

**Table 3-5. Device Variables Exposed by the Ultima XL/XT Monitor**

<b>VARIABLE</b>	<b>DESCRIPTION</b>	<b>VARIABLE</b>	<b>DESCRIPTION</b>
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	GT60 Ver	Main Code Ver
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		
RTC Date	Device real time clock date		
RTC Min	Device real time clock minutes		
RTC Hrs	Device real time clock hours		

**Table 3-6. Dynamic Variable implemented by Ultima XL/XT Monitor**

	<b>MEANING</b>	<b>UNITS</b>
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 XL/XT 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 3-7. 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	
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	Not Used		

BYTE	BIT	MEANING	CLASS	DEVICE STATUS BITS SET
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 XL/XT Gas Monitor. The Ultima XL/XT 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 XL /XT device:

**Table 3-8. Supported Commands**

COMMAND #	DESCRIPTION
35	Write Range Values
38	Reset "Configuration Changed" flag
40	Enter/Exit Fixed Current Mode
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

**Burst Mode**

This device supports burst mode.

**Catch Device Variable**

This Field Device does not support Catch Device Variable.

**Table 3-9. Device-Specific Commands**

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

<b>COMMAND #</b>	<b>DESCRIPTION</b>
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
138	Read Read GT60 Version
139	Read Sensor Status
140	Read Swap Delay Status
141	Read Cal Signal Status
142	Read Alert Option Status
143	Read Sensor Temperature
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

### Command #129: Read Sensor Gas Type

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

#### Request Data Bytes

None.

#### Response Data Bytes

BYTE	FORMAT	DESCRIPTION
0-3	ASCII	Sensor gas type description (see TABLE 3-10)

### Command #130: Read Device Real Time Clock

Reads the Real Time clock hours and minutes from the Ultima XL /XT 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 XL /XT 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 XL /XT Alarm Control Actions.

#### Request Data Bytes

None.

#### Response Data Bytes

BYTE	FORMAT	DESCRIPTION
0	Bit Enum	Alarm 1 Control Actions (see TABLE 3-11)
1	Bit Enum	Alarm 2 Control Actions (see TABLE 3-11)
2	Bit Enum	Alarm 3 Control Actions (see TABLE 3-11)

### Command #133: Read Min, Max, Avg Values

Returns the Ultima XL/XT 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 XL/XT 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 XL/XT 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 3-12)

### Command #136: Read Input Voltage Value

Returns the Ultima XL/XT 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 XL/XT 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 #138: Read GT60 Version

Returns the Ultima XL/XT main processor code version number as a two byte unsigned integer.

#### Request Data Bytes

BYTE	FORMAT	DESCRIPTION
None		

#### Response Data Bytes

BYTE	FORMAT	DESCRIPTION
0-1	Unsigned	GT60 version number

#### Command-Specific Response Codes

CODE	CLASS	DESCRIPTION
0	Success	No Command-Specific Errors
1-15		Undefined
16	Error	Access Restricted
17-31		Undefined
32	Error	Busy
33-127		Undefined

### Command #139: Read Sensor Status message

Returns the Ultima XL /XT 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 3-14)

### Command #140: Read Swap Delay Status

This command returns the Ultima XL /XT 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 XL /XT 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 XL /XT 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 XL /XT 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 #173: Write RTC

Writes the Ultima XL/XT 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 XL/XT Alarm Setpoint values. The Ultima XL/XT 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").

#### 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
1-4	Float	Alarm 2 Setpoint Value
8-11	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		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 3-11)

#### Response Data Bytes

BYTE	FORMAT	DESCRIPTION
0	Unsigned	Alarm Number (1, 2, or 3)
1	Bit Enum	Alarm Control Action Value (see TABLE 3-11)

#### 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		Invalid device variable index
20-31		Undefined
32	Error	Busy
33-127		Undefined

### Command #176: Write Average Interval

Writes the Ultima XL/XT 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		
2		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 XL/XT 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.

#### 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 XL /XT Gas Table selection. The Ultima XL/XT 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 3-12)

#### 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 XL /XT Gas Monitor. This command causes the Ultima XL/XT 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 XL /XT 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 XL/XT 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 3-13)

#### Response Data Bytes

BYTE	FORMAT	DESCRIPTION
0	Enum	Calibration Mode Number (see TABLE 3-13)

#### 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 XL/XT 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 XL/XT 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		Undefined
7	Error	In write protect mode
8-15		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	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 #187: Write Alert Option

This command disables or enables the Alert Option on the Ultima XL /XT 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.

#### 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	Error	Invalid selection
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

**Table 3-10. Gas Type Descriptions**

<b>GAS TYPE</b>	<b>DESCRIPTION</b>	<b>GAS TYPE</b>	<b>DESCRIPTION</b>
CO	Carbon Monoxide		Performance verified to ANSI/ISA-92.00.01 by FM Approvals
O <sub>2</sub>	Oxygen		
COMB	Combustible-pellistor		
XiIR	Infrared Combustible		
H <sub>2</sub> S	Hydrogen Sulfide		Performance verified to ANSI/ISA-92.00.01 by FM Approvals
Cl	Chlorine		
Cl <sub>2</sub>	Chlorine Dioxide		
NH <sub>3</sub>	Ammonia		

**Table 3-11. 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 3-12. Gas Table Values**

<b>TABLE</b>	<b>DESCRIPTION</b>
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 <sub>2</sub>
48	5% CO <sub>2</sub>
49	2% CO <sub>2</sub>
50	Custom
250	Unused

**Table 3-13. Calibration Modes**

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

**Table 3-14. Sensor Status Codes**

<b>CODE</b>	<b>DESCRIPTION</b>
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 3-15. 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 3, "Self-Test"), 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 4.0 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 3, "Power-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 4.0 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 3-16. 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 3-17. Capability Checklist**

Manufacturer, model and revision	MSA , Ultima XL/XT, rev. 2
Device type	Transmitter
HART revision	7.0
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	30
Bits of additional device status	32
Alternative operating modes?	No
Burst mode?	Yes
Write-protection?	Yes

## Default Configuration

Table 3-18. 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

## Chapter 4, Maintenance

### General

The Ultima XL/XT Series Gas Monitor is constantly performing a self-check. When a problem is found, it displays the appropriate error message. (TABLE 4-1, "Troubleshooting Guidelines"). When a critical error is detected within the unit, the output signal goes to a fault condition.

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

### 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" in this chapter); 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 XL or Ultima XT Sensor

The only routine maintenance item is the sensing element itself, which has a limited lifetime. When the Ultima X Series Gas Monitor 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 shows a maintenance message when the sensor is due for replacement

### **⚠ WARNING**

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

### **⚠ CAUTION**

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

1. There is no need to open the main enclosure; simply unscrew the sensor assembly located on the bottom of the Ultima X Series Gas Monitor main assembly (FIGURE4-1).

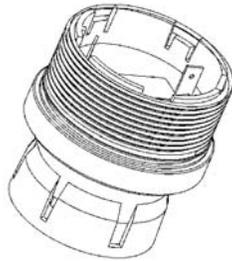
### **⚠ WARNING**

Do not open, connect, disconnect, or change any sensor when an explosive gas atmosphere may be present or any circuits are energized.

**Exception:**

**An Ultima XE sensor cap may be changed provided that a minimum of 10 seconds has expired with the sensor cap unscrewed at least three full turns, but no more than four full turns before removal of the sensor cap.**

**Failure to follow this warning can result in the ignition of a hazardous atmosphere.**



***Figure 4-1. Sensor Assembly and Environmental Guard for General-Purpose Model***

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

NOTE: Alarm setpoints and Alarm 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 Alarm 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 will hold off a fault indication for 60 seconds after the sensor missing indication is displayed on the instrument. This setting allows the operator to exchange sensor modules without a FAULT indication.
4. Refer to Chapter 2, "Calibration".

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

**Table 4-1. Troubleshooting Guidelines**

<b>MESSAGE</b>	<b>INDICATES</b>	<b>ACTION</b>
CHANGE SENSOR	Sensor is at its end of life	Replace sensor
CAL FAULT	Instrument did not calibrate successfully	Repeat calibration; check for proper calibration gas; check for blockage in the flow system
SENSOR MISSING	Instrument has lost communication with the sensor module	Connect or replace sensor
CHECK CAL	Calibration should be verified	Perform bump test or calibration
SENSOR WARNING	Sensor is approaching its end of life	Prepare to replace sensor module
SNSR FLASH FAULT	Sensor module program memory is invalid	Replace sensor module
SNSR RAM FAULT	Sensor module has a defective RAM location	Replace sensor module
SNSR DATA FAULT	Sensor module datasheet is invalid	Send reset data sheet command from the controller; if error persists, replace sensor
MN SUPPLY FAULT	Power supply on main PCBA is out of range	Check sensor wiring or replace main pc board
MN EEPROM FAULT	EEPROM on the main PCBA is invalid	Replace main pc board
MN FLASH FAULT	Program memory on the main PCBA is invalid	Replace main pc board
MN RAM FAULT	Defective RAM memory location found on main PCBA	Replace main pc board
INVALID SENSOR	Attached sensor module is not compatible with the main instrument	Replace with correct sensor type
CONFIG RESET	Main EEPROM memory was reset	Use Controller to reset all configurations (e.g., alarm levels, calibration signals ON or OFF, etc)
SNSR POWER FAULT	Power at the sensor module is out of range	Correct wiring error, replace main pc board, or replace sensor module
und	Under-range condition - quick	Recalibrate or replace sensor
Und	Under-range condition - slow	Recalibrate or replace sensor
+LOC	Instrument is locked in over-range condition	Recalibrate or reset sensor
IR SOURCE FAULT	IR source failure	Replace or consult factory

<b>MESSAGE</b>	<b>INDICATES</b>	<b>ACTION</b>
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
- SUPPLY FAULT	The negative supply sensor module is out of range	Check wiring or replace sensor module
PARAM FAULT	An operational parameter is out of range or sensor failed internal check	Restart; replace, if necessary

### Obtaining Replacement Parts

See TABLE 4-2 for replacement sensor kits. To obtain a replacement sensor, address the order or inquiry to:

- Mine Safety Appliances Company  
P.O. Box 427,  
Pittsburgh, PA 15230-0427
- or call, toll-free, 1-800-MSA-INST.

### **⚠ WARNING**

**Use only genuine MSA replacement parts when performing any maintenance procedures provided in this manual. Failure to do so may seriously impair sensor 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 4-2. Replacement Parts**

GAS SELECTION	SENSOR KIT PART NO.		
	GENERAL-PURPOSE PLASTIC MODEL T	EXPLOSION-PROOF MODEL L L	GENERAL-PURPOSE STAINLESS MODEL W
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...
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...
Hydrogen Fluoride, 10 ppm	A-ULTX-SENS-26-0...	not available	A-ULTX-SENS-26-6...
Combustible Gas, 100% LEL Natural Gas and H <sub>2</sub> , 5% CH <sub>4</sub>	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 <sub>4</sub>	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...
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...

GAS SELECTION	SENSOR KIT PART NO.		
	GENERAL-PURPOSE PLASTIC MODEL T	EXPLOSION-PROOF MODEL L	GENERAL-PURPOSE STAINLESS MODEL W
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	not available	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 <sub>2</sub> Tolerant, 0-25%	not available	not available	not available
Oxygen-Low, 0-25%	not available	not available	not available
Oxygen-Low, Solv Tolerant, 0-25%	not available	A-ULTX-SENS-64-1...*	not available

#### SENSOR GUARD REPLACEMENT PARTS

All Sensor Types except XIR	10028904
XIR Sensor Guard	10042600

## Appendix A, Calibration Guide for Additional XIR/XI Gases

Compound	LEL*	Curve	Cal Gas	Span Setting
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%
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%
MEK	1.4	1	2.5% Methane	72%
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 Chloride	8.1	6	0.6% Propane	48%
Methyl Methacrylate	1.7	6	0.6% Propane	57%
Methylene Chloride	13.0	1	2.5% Methane	68%
MIBK	2.1	6	0.6% Propane	54%
MTBE	1.6	2	0.6% Propane	29%
Morpholine	1.4	6	0.6% Propane	59%
n-Propanol	2.2	2	0.6% Propane	36%
Pentane	1.5	5	0.6% Propane	33%
Propane	2.1	2	0.6% Propane	29%
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%
Propylene Oxide	2.3	2	0.6% Propane	38%
Styrene	0.9	8	0.1% Propane	45%
Tetrahydrofuran	2.0	2	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%
* LEL based upon NFPA 1997				

## Appendix B, Approvals

*Marking, Certificates & Approvals according to Directive 94/9/EC (ATEX)*

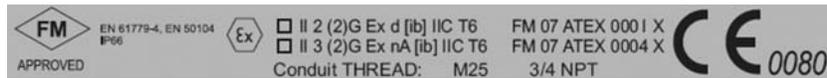
<b>Manufacturer:</b>	Mine Safety Appliances Company 1000 Cranberry Woods Drive Cranberry Township, PA 16066 USA
<b>Product:</b>	Ultima XL Control Unit A-UltimaX-XP – L – b – c – d – e – 1 – 0 – h – i – j – k – l – m  b = Gas Type: Any two digit number c = Configuration: any alpha numeric code that represents the 3/4 inch NPT threads or M25 threads d = Sensor Output: 2 or 4 e = Sensor Mounting Style: S or D h = Optional Power Supply: 0, 3, or 4 i = Gas Sample Selection: 0 or 1 j = Integrated Accessories: 0 or 1 k = Installation Hardware: Any number indicating how the product is mounted l = Manuals: Any number indicating how the manual is supplied m = Custom: 0, CB, CC, CF, or T
<b>Environmental Conditions:</b>	Temperature: -40°C to +60°C Pressure: 80 kPa (0.8 bar) to 110 kPa (1.1 bar)  Air with Normal Oxygen Content: Typically 21 % v/v
<b>Enclosure Material:</b>	316 or CF8M Stainless Steel
<b>Type of Protection:</b>	EN 60079-0, EN 60079-1, EN 60079-11
<b>Performance:</b>	EN 60079-29-1:2007, EN 50104, EN 50271
<b>Gas:</b>	Oxygen measuring range: 0-10% v/v Oxygen measuring range: 0-21% v/v

**Gas:** Methane & Propane  
measuring range: 0-100% LEL

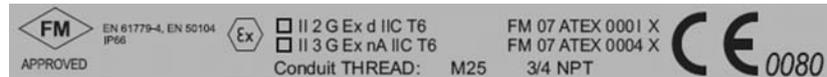
**Marking:** ULTIMA XL

**ALL Options:**  $-40^{\circ} \leq T_a \leq +60^{\circ}$

**With HART Barrier:**



**Without HART Barrier:**



NOTE: arrangement may be different or include additional information not related to this approval.

#### EC-Type Examination

**Certificates:** FM 07 ATEX 0001 X and FM 07 ATEX 0004 X

#### Quality Assurance

**Notification:** 0080

#### Year of Manufacture

**& Serial No.:** see Label

*EMC Conformance according to the Directive 2004/108/EC*

EN 50270:2006 Type 2

EN 61000-6-4:2007

#### *Special Conditions for Safe Use*

- 1) Upon installation of the Ultima XL Control Unit, the label shall be permanently marked to show the type of explosion protection used for the installation.
- 2) In order to maintain system performance for Gas Types 31, 32, 33, 38, 39, 51, 52, 53, 58 or 59, the sensor to which this instrument is connected shall also comply with the requirements of EN 60079-29-1:2007 and EN 50271, as appropriate.
- 3) In order to maintain system performance for Gas Types 13 or 14, the sensor to which this instrument is connected shall also comply with the requirements of EN50104 and EN 50271.

4) In order to maintain an ATEX compliant system, the sensor to which this instrument is connected shall also be ATEX certified.

**Product:** Ultima XE Sensor  
A-ULTX - SENS - a - b - c  
a = Gas Type: 13, 14, 31, 32, 33, 51, 52 or 53  
b = Enclosure Type: 1 or 8  
c = Custom: 0, CB, CC, CF, or T

**Environmental Conditions:** Temperature: -40°C to +60°C;  
Pressure: 80 kPa (0.8 bar) to 110 kPa (1.1 bar);  
Air with Normal Oxygen Content: Typically 21 % v/v

**Enclosure Material:** 316 or CF8M Stainless Steel

**Type of Protection:** EN 60079-0, EN 60079-1

**Performance:** EN 60079-29-1:2007, EN 50104, EN 50271

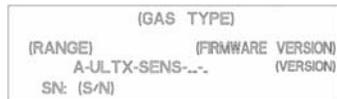
**Gas:** Oxygen  
a = Gas Type = 13, 0-10% v/v  
a = Gas Type = 14, 0-21% v/v

**Gases:** Methane and Propane  
a = Gas Type = 31, 32, 33, 51, 52 or 53  
Measure Range: 0-100% LEL

**Marking:** ULTIMA XE SENSOR  
II 2 G Ex d IIC T4  
FM07ATEX0031X  
EN 60079-29-1:2007, EN 50104  
-40°C ≤ Ta ≤ +60°C



NOTE: Arrangement may be different or include additional information not related to this approval.



Date: Included in Serial Number (SN), First Letter = A to L (January to December), next two digits indicate year of manufacture.

EC-Type  
Examination Certificate: FM 07 ATEX 0031 X

Quality Assurance Notification: 0080

*EMC Conformance according to the Directive 2004/108/EC*

EN 50270:2006 Type 2, EN 61000-6-4:2007

*Special Conditions for Safe Use*

- 1) In order to maintain system performance for Gas Types 31, 32, 33, 51, 52 or 53, the control unit to which this instrument is connected shall also comply with the requirements of EN 60079-29-1:2007 and EN 50271, as appropriate.
- 2) In order to maintain system performance for Gas Types 13 or 14, the sensor to which this instrument is connected shall also comply with the requirements of EN 50104 and EN 50271.
- 3) In order to maintain an ATEX compliant system, the control unit to which this instrument is connected shall also be ATEX certified.
- 4) The flying leads of the Ultima XE sensor shall be suitably protected against mechanical damage and terminated within a terminal or junction facility suitable for the conditions of use.

**Product:** Ultima XIR Sensor,  
A-ULTX - SENS - a - b - c  
a = Gas Type: 38, 39, 58 or 59  
b = Enclosure Type: 9 or 10  
c = Custom: 0, CB, CC, CF, or T

**Environmental**

**Conditions:** Temperature: -40°C to +60°C;  
Pressure: 80 kPa (0.8 bar)  
to 110 kPa (1.1 bar);  
Air with Normal  
Oxygen Content: typically 21 % v/v.

**Enclosure Material:** 316 or CF8M Stainless Steel

**Type of Protection:** EN 60079-0, EN 60079-1

**Performance:** EN 60079-29-1:2007, EN 50271

**Gases:** Methane and Propane  
a = Gas Type = 31, 32, 33, 51, 52 or 53

Measure Range: 0-100% LEL

**Marking:**



ULTIMA XIR SENSOR  
II 2 G Ex d IIC T5  
FM07ATEX0032X  
EN 60079-29-1:2007  
-40°C ≤ Ta ≤ +60°C



NOTE: Arrangement may be different or include additional information not related to this approval.

(GAS TYPE)	
(RANGE)	(FIRMWARE VERSION)
A-ULTX-SENS-_-_-	(VERSION)
SN: (S/N)	

Date: Included in Serial Number (SN), First Letter = A to L (January to December), next two digits indicate year of manufacture.

EC-Type

Examination Certificate: FM 07 ATEX 0032 X

Quality Assurance Notification: 0080

*EMC Conformance according to the Directive 2004/108/EC*

EN 50270:2006 Type 2, EN 61000-6-4: 2007

*Special Conditions for Safe Use*

- 1.) In order to maintain the system performance for Gas Types 38, 39, 58 or 59, the control unit to which this sensor is connected shall also comply with the requirements of EN 60079-29-1:2007 and EN 50271, as appropriate.
- 2.) In order to maintain an ATEX compliant system, the control unit to which this sensor is connected shall also be ATEX certified.



## EC Declaration of Conformity

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MANUFACTURED BY: Mine Safety Appliances Company  
1000 Cranberry Woods Drive  
Cranberry Township, PA 16066 USA

The manufacturer or the European Authorized Representative  
MSA AUER GmbH, Thiemannstraße 1, D-12059 Berlin

declares that the product: **ULTIMA XL Control Unit**

based on the EC-Type Examination Certificate :

**FM 07 ATEX 0001X and FM 07 ATEX 0004X**

complies with the ATEX directive 94/9/EC, Annex III. Quality Assurance Notification  
complying with Annex IV of the ATEX Directive 94/9/EC has been issued by Ineris, Notified  
Body number: 0080.

The product is in conformance with the directive 2004 / 108/ EC ,(EMC) :  
EN 50270 :2006 Type 2, EN 61000 - 6 - 4:2007

The product is in conformance with the directive 2006 / 95/ EC,(LVD) :  
EN 61010-1 :2002

A handwritten signature in black ink, appearing to read 'Dr. A. Schubert'.

MSA AUER GmbH  
Dr. Axel Schubert  
R & D Instruments

Berlin , June 2009



## EC Declaration of Conformity

---

MANUFACTURED BY: Mine Safety Appliances Company  
1000 Cranberry Woods Drive  
Cranberry Township, PA 16066 USA

The manufacturer or the European Authorized Representative  
MSA AUER GmbH, Thiemannstraße 1, D-12059 Berlin

declares that the product: **ULTIMA XE Sensor**

*A-UltX - Sens - a - b - c*  
a = Gas Type: 13, 14, 31, 32, 33, 51, 52 or 53  
b = Enclosure Type: 1 or 8  
c = Custom: 0, CB, CC, CF, or T

based on the EC-Type Examination Certificate : FM07 ATEX 0031 X

complies with the ATEX directive 94/9/EC, Annex III. Quality Assurance  
Notification complying with Annex IV of the ATEX Directive 94/9/EC has been  
issued by Ineris of France, Notified Body number: 0080.

The product is in conformance with the EMC directive 2004 / 108/ EC.  
EN 50270 :2006 Type 2, EN 61000 - 6 - 4:2007

MSA AUER GmbH  
Dr. Axel Schubert  
R & D Instruments

Berlin, February 2010



## EC Declaration of Conformity

---

MANUFACTURED BY: Mine Safety Appliances Company  
1000 Cranberry Woods Drive  
Cranberry Township, PA 16066 USA

The manufacturer or the European Authorized Representative  
MSA AUER GmbH, Thiemannstraße 1, D-12059 Berlin

declares that the product: **ULTIMA XIR Sensor**

*A-UltX - Sens - a - b - c*  
a = Gas Type: 38, 39, 58 or 59  
b = Enclosure Type: 9 or 10  
c = Custom: 0, CB, CC, CF, or T

based on the EC-Type Examination Certificate: FM07 ATEX 0032 X

complies with the ATEX directive 94/9/EC, Annex III. Quality Assurance  
Notification complying with Annex IV of the ATEX Directive 94/9/EC has been  
issued by Ineris of France, Notified Body number: 0080.

The product is in conformance with the EMC directive 2004 / 108/ EC .  
EN 50270 :2006 Type 2, EN 61000 - 6 - 4:2007

MSA Auer GmbH  
Dr. Axel Schubert  
R & D Instruments

Berlin, February 2010

**Marking , Certificates and Approvals according to the Directive 94/9/EC ( ATEX ) .**

Manufacturer: Mine Safety Appliances Company  
1000 Cranberry Woods Drive  
Cranberry Township, PA 16066 USA

Product: MSA ULTIMA XE

Type of protection: EN 60079-0 :2006, EN 60079-1 :2004

Performance: EN 60079-29-1:2007,  
EN 50104:2002, EN 50271:2001

Gas: Oxygen

Gas: measure range : 0-100% LEL

ULTIMA XE: Methane, Propane,2-Butanone, Acetone, Acetylene, 1,3-  
Butadiene, Diethyl ether, Ethane, Ethanol, Ethylene,  
Ethyl acetat, Ethylene oxide, (FAM-) Standard mineral  
spirit 65/95, n-Butane, n-Hexane, n-Pentane, 2-Propanol,  
Propene, Propylene oxide, Hydrogen, Cyclo pentane,  
Allyl alcohol, i-Butene, i-Butane, Methanol, Cyclohexane.

Marking: **ULTIMA XE**

 II 2G EEx d IIC T4  
-40°C < Ta < +60°C

EC-Type Examination Certificate:

DMT 02 ATEX E 202 X

Quality Assurance Notification: 0080

Year of Manufacture: see Label

Serial Nr.: see Label

**EMC Conformance according to the Directive 2004/108/EC**  
EN 50 270:2006 Type 2 EN 61000 - 6 - 4:2007



## EC Declaration of Conformity

---

MANUFACTURED BY: Mine Safety Appliances Company  
1000 Cranberry Woods Drive  
Cranberry Township, PA 16066 USA

The manufacturer or the European Authorized Representative  
MSA AUER GmbH, Thiemannstraße 1, D-12059 Berlin

declares that the product: **ULTIMA XE**

based on the EC-Type Examination Certificate : **DMT 02 ATEX E 202 X**

complies with the ATEX directive 94/9/EC, Annex III. Quality Assurance  
Notification complying with Annex IV of the ATEX Directive 94/9/EC has been  
issued by Ineris of France, Notified Body number: 0080.

The product is in conformance with the EMC directive 2004 / 108/ EC .  
EN 50270 :2006 Type 2, EN 61000 - 6 - 4 :2007

We further declare that the product complies with the provisions of LVD  
Directive 2006 / 95/ EC, with the following harmonised standard:

EN 61010-1 :2002

  
Axel Schubert  
R & D Instruments

Berlin, June 2009