



# Ultima<sup>®</sup> MOS-5

Intelligent Sensor for  
Hydrogen Sulfide Gas Detection



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**Instruction Manual**

**04-14**

MSA reserves the right to change published specifications and designs without prior notice.

**Part No.**  
**Revision**

MANMOS5  
**MANMOS5**  
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# Table of Contents

<b>TABLE OF FIGURES</b> .....	<b>VI</b>
<b>TABLE OF TABLES</b> .....	<b>VII</b>
<b>QUICK START GUIDE</b> .....	<b>1</b>
Mounting and Wiring .....	1
Tools Required .....	1
Terminal Connections .....	1
<b>1.0 INTRODUCTION</b> .....	<b>4</b>
1.1 Protection for Life .....	4
1.2 Special Warnings .....	4
1.3 System Integrity Verification .....	5
<b>2.0 PRODUCT DESCRIPTION</b> .....	<b>7</b>
2.1 General Description .....	7
<b>3.0 INSTALLATION</b> .....	<b>8</b>
3.1 Receipt of Equipment.....	8
3.2 Tools Required.....	8
3.3 Choosing Product Locations .....	8
3.3.1 Remote Mounting of the Sensor from the Electronics .....	9
3.4 Mounting and Wiring .....	10
3.5 Terminal Connections .....	11
3.5.1 Terminal Block TB1 – Sensor Connections .....	11
3.5.2 Terminal Block TB2 – Power and Signal Connections .....	12
3.5.3 DC Power and Ground Connections.....	13
3.5.4 Analog Signal Connections.....	13
3.5.5 Terminal Block TB3 – Relay Connections .....	14
3.5.6 European Union (EU) Approved Applications.....	15
3.5.7 Cable Termination in the Non-hazardous Area .....	15
3.6 Maintaining the X/P Integrity .....	15
<b>4.0 OPERATION</b> .....	<b>17</b>
4.1 Start-Up Checklist .....	17
4.2 Start-Up .....	17
4.3 Relay Reset.....	17
4.4 User Selectable Options .....	18
4.4.1 Ultima MOS-5 Intelligent Sensor User Menu Structure .....	19
4.4.2 Sensor Range .....	19
4.4.3 Calibration Output .....	20
4.4.4 Warning Relay Settings .....	20
4.4.5 Alarm Relay Settings.....	21
4.4.6 Modbus Channel 1 Settings.....	21
4.4.7 Modbus Channel 2 Settings.....	22

4.5	HART.....	22
4.6	Gas Check Mode .....	23
	4.6.1 Procedure for Checking the Calibration .....	23
4.7	Calibration .....	24
	4.7.1 Calibration Procedure .....	24
	4.7.2 Aborting Calibration.....	25
	4.7.3 Remaining Sensor Life.....	25
	4.7.4 Initializing the Remaining Sensor Life.....	26
4.8	Calibration Equipment.....	26
	4.8.1 Calibrating with a Breaker Bottle and Ampoules .....	26
	4.8.2 Calibrating with an H <sub>2</sub> S Portable Purge Calibrator .....	26
<b>5.0 MAINTENANCE .....</b>		<b>28</b>
5.1	General Maintenance.....	28
5.2	Storage.....	28
<b>6.0 TROUBLESHOOTING .....</b>		<b>29</b>
6.1	Fault Codes and Their Remedies .....	29
	6.1.1 F2 - Failed to Complete the Calibration .....	29
	6.1.2 F3 Flash Checksum Error .....	29
	6.1.3 F4 - Sensor Heater Open Error or Sensor Amplifier Error.....	29
	6.1.4 F5 - Sensor Heater Shorted Error.....	30
	6.1.5 F6 - Low Supply Voltage .....	30
	6.1.6 F7 - EEPROM Verification Failure .....	30
	6.1.7 F8 - Failure to Complete Setup.....	30
	6.1.8 F9 - Gas Check Period Exceeded .....	31
	6.1.9 F10 – Switch Error .....	31
	6.1.10 F11 Internal Error .....	31
<b>7.0 CUSTOMER SUPPORT .....</b>		<b>32</b>
7.1	MSA Office .....	32
<b>8.0 MODBUS INTERFACE .....</b>		<b>33</b>
8.1	Baud Rate .....	33
8.2	Data Format .....	33
8.3	Modbus Read Status Protocol (Query/Response).....	33
	8.3.1 Modbus Read Query Message .....	33
	8.3.2 Modbus Read Response Message.....	35
8.4	Modbus Write Command Protocol (Query/Response) .....	35
	8.4.1 Modbus Write Query Message .....	35
	8.4.2 Modbus Write Response Message .....	35
8.5	Function Codes Supported .....	36
8.6	Exception Responses and Exception Codes.....	36
	8.6.1 Exception Response .....	36
	8.6.2 Exception Code.....	37
8.7	Ultima MOS-5 Intelligent Sensor Command Register Locations .....	38
8.8	Ultima MOS-5 Intelligent Sensor Command Register Details .....	41
	8.8.1 Analog (00H).....	41
	8.8.2 Mode (01H) .....	41
	8.8.3 Status/Error (02H).....	41

8.8.4	Not Used (03H)	42
8.8.5	Unit Type (04H)	42
8.8.6	Software Revision (05H)	42
8.8.7	Status Block (06H)	42
8.8.8	Analog Value (06H)	42
8.8.9	Mode & Error (07H)	42
8.8.10	Error Sensor & Sensor Life (08H)	42
8.8.11	Display (0x09H & 0x0AH)	43
8.8.12	Serial Number (0BH/0CH)	43
8.8.13	Alarm Settings (0DH)	43
8.8.14	Warn Settings (0EH)	44
8.8.15	Com1 Address (0FH)	44
8.8.16	Com1 Baud Rate (10H)	44
8.8.17	Com1 Data Format (11H)	45
8.8.18	Com2 Address (12H)	45
8.8.19	Com2 Baud Rate (13H)	45
8.8.20	Com2 Data Format (14H)	45
8.8.21	Not Used (15H)	46
8.8.22	Reset Alarms (16H)	46
8.8.23	Sensor Life (17H)	46
8.8.24	Sensor Scale (18H)	46
8.8.25	MODEL 10K Controller (Co – Calibration Output) (19H)	46
8.8.26	Not Used (1A, AB, 1C H)	46
8.9	HART Enable (1D H)	46
8.9.1	HART Test (1Eh)	46
8.9.2	Abort Calibration (1Fh)	47
8.9.3	Total Receive Errors (20H)	47
8.9.4	Bus Activity Rate % (21H)	47
8.9.5	Function Code Errors (22H)	47
8.9.6	Starting Address Errors (24H)	47
8.9.7	RXD CRC Errors Hi (25H)	47
8.9.8	RXD CRC Errors Lo (Same as Hi) (26H)	47
8.9.9	Parity Errors (27H)	47
8.9.10	Overrun Errors (28H)	48
8.9.11	Framing Errors (29H)	48
8.9.12	Total Software CH1 Errors (2AH)	48
8.9.13	Not Used (2BH)	48
8.9.14	Clear Hardware Errors (2CH)	48
8.9.15	Clear Communication Errors (2DH)	48
8.9.16	User Information (60H to 6FH)	51
8.9.17	CH2 Total Receive Errors (70H)	52
8.9.18	CH2 Bus Activity Rate % (71H)	52
8.9.19	CH2 Function Code Errors (72H)	52
8.9.20	CH2 Starting Address Errors (73H)	52
8.9.21	CH2 Number of Register Errors (74H)	52
8.9.22	CH2 RXD CRC Errors Hi (75H)	52
8.9.23	CH2 RXD CRC Errors Lo (Same as Hi) (76H)	52
8.9.24	CH2 Parity Errors (77H)	52
8.9.25	CH2 Overrun Errors (78H)	52
8.9.26	CH2 Framing Errors (79H)	53
8.9.27	CH2 Total Software CH1 Errors (7AH)	53
8.9.28	Not Used (7BH)	53

8.9.29 CH2 Clear UART Errors (7CH) .....53  
8.9.30 CH2 Clear Stats (7DH) .....53

**9.0 APPENDIX..... 54**

9.1 Warranty.....54  
9.2 Principle of Operation.....54  
9.3 Specifications .....55  
9.3.1 System Specifications .....55  
9.3.2 Mechanical Specifications.....55  
9.3.3 Electrical Specifications .....55  
9.3.4 Environmental Specifications.....57  
9.4 Approvals .....57  
9.5 Spare Parts and Accessories.....57  
9.5.1 Sensors .....57  
9.5.2 Sensor Housing.....58  
9.5.3 Sensor Accessories .....58  
9.5.4 Calibration Equipment.....58  
9.5.5 Intelligent Sensor (Ultima MOS-5 Intelligent Sensor) Replacement Parts .....59  
9.5.6 Recommended Spare Parts for One Year .....59  
9.6 FM Approval.....60

## Table of Figures

Figure 1: Ultima MOS-5 Intelligent Sensor Outline and Mounting Dimensions, in inches .....	1
Figure 2: Spring Type Terminal Block Operation .....	2
Figure 3: Screw Type Terminal Block Operation.....	2
Figure 4: Ultima MOS-5 Intelligent Sensor .....	7
Figure 5: Ultima MOS-5 Intelligent Sensor Outline and Mounting Dimensions, in inches .....	10
Figure 6: Ultima MOS-5 Intelligent Sensor Terminal Block Locations .....	11
Figure 7: Spring Type Terminal Block Operation .....	12
Figure 8: Screw Type Terminal Block Operation.....	13
Figure 9: Wire Strip Length.....	13
Figure 10: Relay Protection for DC and AC Loads.....	14
Figure 11: Relay Reset.....	18
Figure 12: User Menu Structure .....	19
Figure 13: Gas Check.....	23
Figure 14: Automatic Calibration Mode .....	24
Figure 15: Calibration in Progress Mode.....	24
Figure 16: Calibration Complete Mode.....	25
Figure 17: Ampoules.....	26
Figure 18: Portable Purge Calibrator.....	27

## Table of Tables

Table 1: TB2 Power and Signal Connections.....	12
Table 2: Alarm Relay Connections.....	14
Table 3: Warn Relay Connections.....	14
Table 4: Fault Relay Connections.....	14
Table 5: MSA Contact Information.....	32
Table 6: Data Format.....	33
Table 7: Exception Codes.....	37
Table 8: Command Register Locations.....	40
Table 9: Com1 Baud Rate.....	45
Table 10: Com1 Data Format.....	45
Table 11: Com2 Baud Rate.....	45
Table 12: Com2 Data Format.....	46
Table 13: Sensor Scale.....	46
Table 14: 24 VDC Cable Lengths.....	56
Table 15: Analog Output Cable Lengths.....	56
Table 16: Sensor Cable Lengths.....	56

# Quick Start Guide

## Mounting and Wiring

### Tools Required

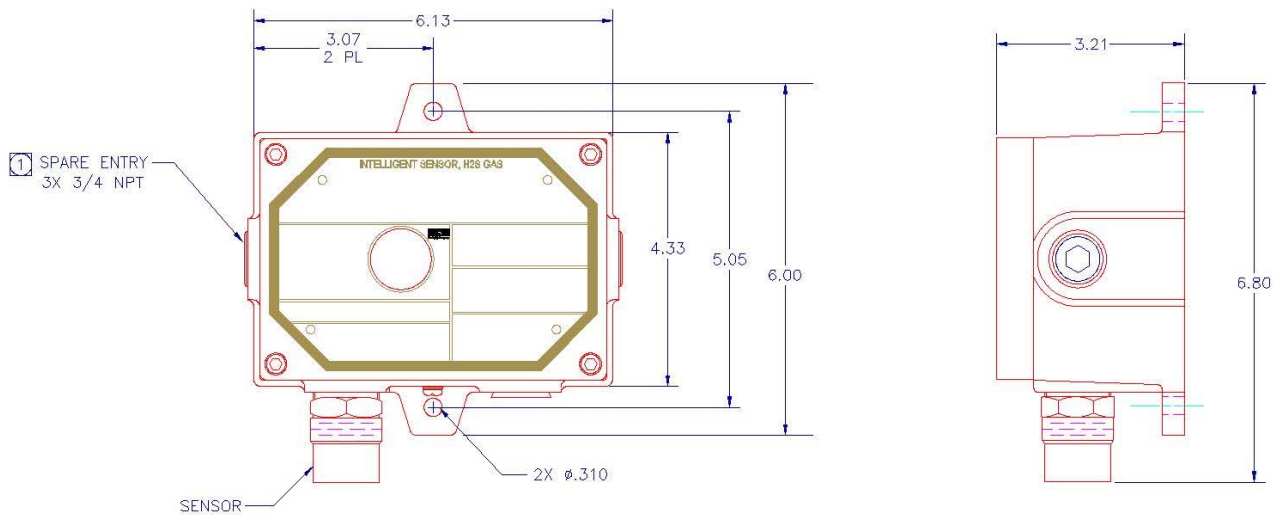
- “5mm” Allen head wrench to remove enclosure lid (included with gas detector).
- Flat-head screwdriver maximum 3/16 in (5 mm) width for terminal block (not included).
- Adjustable wrench for conduit or cable gland connections (not included).

The outline and mounting dimensions for the Ultima MOS-5 Intelligent Sensor (Figure 1) should be used when making installation determinations.

Information on Class I Division 1 and Zone 1 wiring methods can be found in the NEC and CEC.



**WARNING:** Acetic acid will cause damage to metal components, metal hardware, ceramic IC's, etc. If damage results from the use of a sealant that outgases acetic acid (RTV silicone), the warranty will be void.



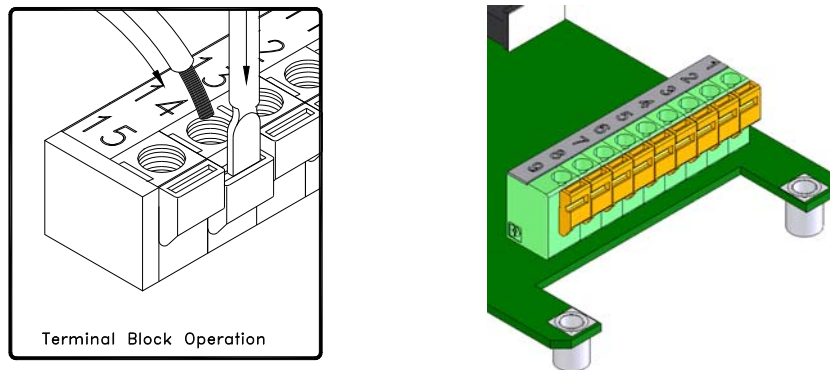
**Figure 1: Ultima MOS-5 Intelligent Sensor Outline and Mounting Dimensions, in inches**

## Terminal Connections

The terminal blocks (TB) are located inside the housing and can be accessed by removing the cover. A label inside of the housing cover provides a diagram of all the terminal connections.

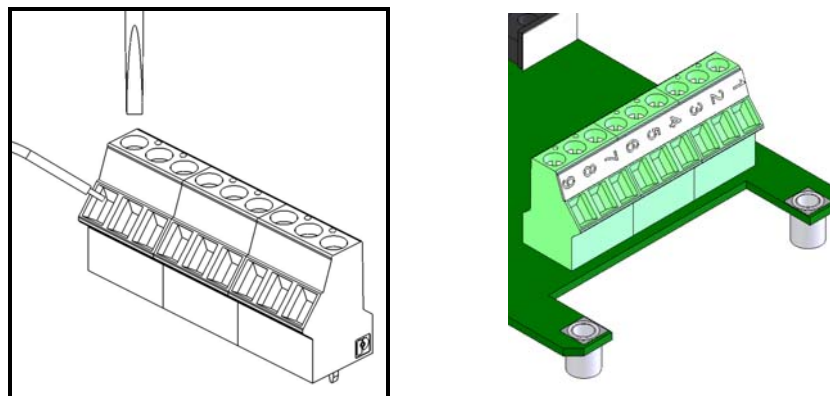
It is recommended that a minimum three-wire shielded cable be used for making the power and 0-20mA Output connection on TB2 of the Ultima MOS-5 Intelligent Sensor. It is also recommended that separate two-wire shielded twisted pair cables be used for making the Modbus connections. The spring type terminal block accepts 14 AWG to 20 AWG and the

screw type terminal block accepts 12 AWG to 18 AWG stranded or solid wire. Each wire should be stripped before wiring the Ultima MOS-5 Intelligent Sensor. To connect wiring to the spring type terminal block, insert a screwdriver into the orange tab and press down (Figure 2), opening the terminal. Insert the wire into the terminal and release the orange tab, clamping the wire in the terminal. Check the hold of the wire by gently tugging it to ensure it is locked in.



**Figure 2: Spring Type Terminal Block Operation**

To connect wiring to the screw type terminal block, loosen the top screw counter clock wise (Figure 3). Insert the wire into the terminal and tighten the top screw clockwise.



**Figure 3: Screw Type Terminal Block Operation**

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**NOTE:** Power must remain disconnected until all other wiring connections have been made.

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The maximum distance between the Ultima MOS-5 Intelligent Sensor and the power supply is 2,000 feet or 610 meters (each cable run should be as short as possible). See Section 9.3.3 for cable length specifications.

Connect +24 VDC to TB2, position 9. Connect the ground or common wire to TB2, position 8. For making power and ground connections to display devices, see Figures 2 and 3.

To connect the analog signal, please refer to Section 3.5.4.

MSA recommends that the Ultima MOS-5 Intelligent Sensor be calibrated 1 hour after start-up and that the calibration be checked at least every 90 days to ensure system integrity.

The instrument is now ready to operate. Please consult the manual for more information on the instrument's many features.

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**NOTE:** If in case of device failure during set-up or testing, please consult Troubleshooting (Sec. 6.0) or call the factory.

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# 1.0 Introduction

## 1.1 Protection for Life

MSA's mission is to benefit society by providing solutions through industry leading safety products, services, and systems that save lives and protect capital resources from the dangers of hazardous flames, gases, and vapors.

This manual provides instruction for installing and operating the Ultima MOS-5 Intelligent Sensor for hydrogen sulfide gas detection. Although the Ultima MOS-5 Intelligent Sensor is easy to install and operate, this manual should be read in full and the information contained herein understood before attempting to place the system in service.

The safety products you have purchased should be handled carefully and installed, calibrated, and maintained in accordance with the respective product instruction manual. Remember these products are for your safety.



## 1.2 Special Warnings

The Ultima MOS-5 Intelligent Sensor contains components, which can be damaged by static electricity. Special care must be taken when wiring the system to ensure that only the connection points are touched.



**WARNING:** Hydrogen sulfide (H<sub>2</sub>S) is an extremely toxic gas, and exposure may result in a loss of consciousness or death.

DO NOT OPEN WHEN AN EXPLOSIVE ATMOSPHERE IS PRESENT. READ AND UNDERSTAND INSTRUCTION MANUAL BEFORE OPERATING OR SERVICING. OPEN CIRCUIT BEFORE REMOVING COVER.

NE PAS OUVRIR UN PRÉSENCE D'ATMOSPHÈRE EXPLOSIVE. LIRE ET COMPRENDRE MANUEL D'INSTRUCTIONS AVANT D'UTILISER OU SERVICE. OUVRIR LE CIRCUIT AVANT D'ENLEVER LE COUVERCLE.

### **SPECIAL CONDITIONS OF SAFE USE PERTAINING TO ATEX/IECEX INSTALLATIONS:**

The Ultima MOS-5 shall not be used as a Safety Related Device as defined by ATEX Directive 94/9/EC,

When alternative detector elements are utilized, they shall only be mounted remotely in a suitable certified enclosure in accordance with requirements of their respective certificates and relevant local requirements. The associated cable shall be connected to the Intelligent Gas Sensors using a suitably certified cable entry device with a 3/4" thread form.

The Universal Gas Sensor (P/N 51457-XX) is suitable for use with the following enclosure types and service temperature ranges that are dependent on the type of cement used in their construction; therefore, they shall only be used with the enclosure type and where the surface temperature, at the point of mounting, is as detailed below:

Cement	Ambient Range	Enclosure Type
2850FT Cat 11 or 2762 Cat 17	-40°C to +70°C	Enclosures that are certified by a notified body and satisfy the requirements of the current edition of EN 60079-1 or EN 60079-7 and European Directive 94/9/EC.
2850FT Cat 11	-40°C to +120°C	Enclosures that are certified by a notified body and satisfy the requirements of the current edition of EN 60079-7 and European Directive 94/9/EC.
2762 Cat 17	-40°C to +180°C	Enclosures that are certified by a notified body and satisfy the requirements of the current edition of EN 60079-7 and European Directive 94/9/EC.

### 1.3 System Integrity Verification

To ensure operation at optimum performance, MSA recommends that certain maintenance items be performed.

#### **Commissioning Safety Systems**

Before power-up, verify wiring, terminal connections and stability of mounting for all integral safety equipment including the following items:

- Power supplies
- Control modules
- Field detection devices
- Signaling and output devices
- Accessories connected to field and signaling devices

After the initial application of power (and any factory specified warm-up period) to the safety system, verify that all signal outputs, to and from devices and modules, are within the manufacturers' specifications. Initial calibration, calibration checking, or testing should be performed per the manufacturer's recommendations and instructions.

Proper system operation should be verified by performing a full, functional test of all component devices of the safety system, ensuring that the proper levels of alarming occur.

Fault and malfunction circuit operation should be verified.

#### **Periodic Testing/Calibration of Field Devices**

Periodic testing/calibrating should be performed per the manufacturer's recommendations and instructions. Testing/Calibrating procedures should include, verify integrity of all optical surfaces and devices

When testing produces results outside of the manufacturer's specifications, re-calibration or repair and replacement of the suspect device(s) should be performed as necessary. Calibration intervals should be independently established through a documented procedure, including a calibration log, maintained by plant personnel or third party testing services.

### **Periodic System Verification**

The following system verifications should be performed at least annually:

Verify wiring, terminal connections and stability of mounting for all integral safety equipment including, the following items:

- Power supplies
- Control modules
- Field detection devices
- Signaling and output devices
- Accessories connected to field and signaling devices

Calibration intervals should be independently established through a documented procedure, including a calibration log maintained by plant personnel or third party testing services.

## 2.0 Product Description

### 2.1 General Description

The Ultima MOS-5 Intelligent Sensor is for the detection of hydrogen sulfide (H<sub>2</sub>S) gas. The microprocessor-based electronics process information at the sensor site within an explosion-proof housing.

A digital display provides indications and display codes that can be viewed through a window in the cover. A red LED above the digital display signifies an “alarm” condition, while a red LED below the digital display signifies a “warning” condition. Analog signal (4-20 mA) and relays provide remote and/or discrete indications of the sensor’s operation. Optional dual redundant Modbus, HART, or HART and single Modbus provide digital communication.

The Ultima MOS-5 Intelligent Sensor is rated explosion-proof for use in the following hazardous areas:

- CSA/FM: Class I, Division 1, Groups B, C, D and Class I, Zone 1, IIB+H<sub>2</sub>
- ATEX/IECEx: Zone 1, Group IIB + H<sub>2</sub>



Figure 4: Ultima MOS-5 Intelligent Sensor

## 3.0 Installation

### 3.1 Receipt of Equipment

All equipment shipped by MSA is pre-packed in shock absorbing containers, which provide protection against physical damage (original containers should be kept for future shipping or storage needs).

Shipping container contents should be carefully removed and checked against the packing list. If any damage has occurred or there is any discrepancy in the order, please notify MSA as soon as possible.

All correspondence with MSA must specify the equipment part number and serial number.

Although the factory tests each unit, a complete system checkout is suggested upon initial installation to ensure system integrity.



**WARNING:** Only suitably skilled and competent personnel should carry out installation and maintenance.



**WARNING:** The Ultima MOS-5 Intelligent Sensor contains components, which can be damaged by static electricity. Special care must be taken when wiring the system to ensure that only the connection points are touched.

### 3.2 Tools Required

- “5mm” Allen head wrench to remove enclosure lid (included with gas detector).
- Flat-head screwdriver maximum 3/16 in (5 mm) width for terminal block connections (not included).
- Adjustable wrench for conduit or cable gland connections (not included).

### 3.3 Choosing Product Locations

There are no standard rules for sensor placement, since the optimum sensor location is different for each application. The customer must evaluate conditions at the facility to make this determination. In generally, experience suggests the device is more effective at detecting gas if the following recommendations are followed:

- Mount sensor pointing down to prevent water build-up on the sensor head.
- Do not place sensor where contaminating substances may coat it.
- Although the Ultima MOS-5 Intelligent Sensor is RFI resistant, do not install sensor in close proximity to radio transmitters or similar equipment.
- Locate the Ultima MOS-5 Intelligent Sensor where prevailing air currents contain the maximum concentration of gas.
- Locate the Ultima MOS-5 Intelligent Sensor near possible sources of gas leaks.

- Observe the Ultima MOS-5 Intelligent Sensor temperature specification and locate the unit away from concentrated sources of heat.
- Install sensor in an area that is as free from wind, dust, water, shock, and vibration as possible. See Section 0 for the environmental specifications of the unit. If dust and rain cannot be avoided, we recommend the use of our splash guard (P/N 10395-1).

Sensors may be adversely affected by prolonged exposure to certain substances. Loss of sensitivity or corrosion may be gradual if such agents are present in low concentrations or it may be rapid at high concentrations. Examples of these substances are as follows:

- Silicones (often contained in greases and aerosols)
- Halides: compounds containing fluorine, chlorine, bromine and iodine
- Heavy metals, e.g. tetraethyl lead
- Caustic and Acidic liquids and vapors
- Glycol

The presence of contaminants in an area does not necessarily preclude the use of an Ultima MOS-5 Intelligent Sensor. The feasibility of using a sensor in such areas must be determined by an analysis of the specific factors in each application, and MSA should be consulted before attempting any such installation.

Sensors used in these areas usually require more frequent calibration checks than normal, and typically have a shorter life. In many such applications the standard 2-year warranty would not apply.

**IMPORTANT:** Each H<sub>2</sub>S sensor is shipped with a red plastic cap fitted over the sensor head. Inside the cap is a desiccant. Do not remove this cap until the system is ready to be powered. Save the cap and re-cap the sensor anytime the system power is off for more than 1 hour.



**WARNING:** MSA discourages the painting of sensor assemblies. If the sensor head is painted over, the gas will not be able to diffuse into the sensor. If the assembly cover is painted over, the digital display cannot be read.

### 3.3.1 Remote Mounting of the Sensor from the Electronics

If it is necessary to remotely mount the sensor from the electronics and the housing, the maximum distance can be no greater than 3,700 feet (1,125) meters, using 14 AWG wire. Sensors that are remotely mounted must be placed in an explosion-proof rated sensor housing (P/N 10252-1), and the cable run must be contained in a conduit running from the sensor housing to the electronics.

For remote mounting in Canada where the location is classified using the Zone classification system, the sensors must be mounted in sensor housing B14-020. Only sensors 51457 can be used in this configuration.

### 3.4 Mounting and Wiring



**WARNING:** Unused cable entry holes must be sealed with an approved explosion-proof plug. Red caps supplied by MSA are for dust protection only and must not be left on the unit when installed.

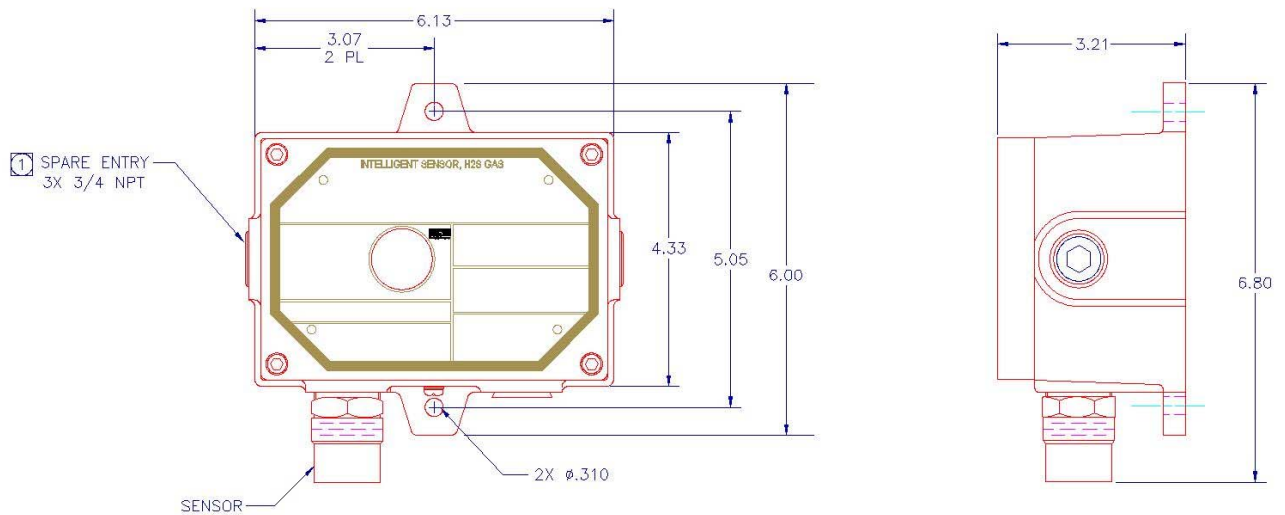
**WARNING:** Conduits must be sealed within 18 inches of the enclosure.

The outline and mounting dimensions for the Ultima MOS-5 Intelligent Sensor (Figure 5) should be used when making installation determinations. A complete list of the mechanical specifications can be found in Section 9.3.2.

To prevent possible corrosion due to moisture or condensation, the conduit connected to the Ultima MOS-5 Intelligent Sensor housing should be sealed or contain a drain loop.

**NOTE:** For ATEX and IECEx applications, conduit connections must only be made via suitably certified ATEX (or IECEx as appropriate) conduit stopping boxes.

Information on Class I Division 1 and Zone 1 wiring methods can be found in the NEC or CEC.



**Figure 5: Ultima MOS-5 Intelligent Sensor Outline and Mounting Dimensions, in inches**



**WARNING:** Acetic acid will cause damage to metal components, metal hardware, ceramic IC's and other parts. If damage results from the use of a sealant that outgases acetic acid (RTV silicone), the warranty will be void.

Once correctly installed, the Ultima MOS-5 Intelligent Sensor requires little or no maintenance, other than periodic calibration checks to ensure system integrity. MSA recommends that a schedule be established and followed.

**NOTE:** The Ultima MOS-5 Intelligent Sensor full 2-year warranty will be voided if customer personnel or third parties damage the Ultima MOS-5 Intelligent Sensor during repair attempts.

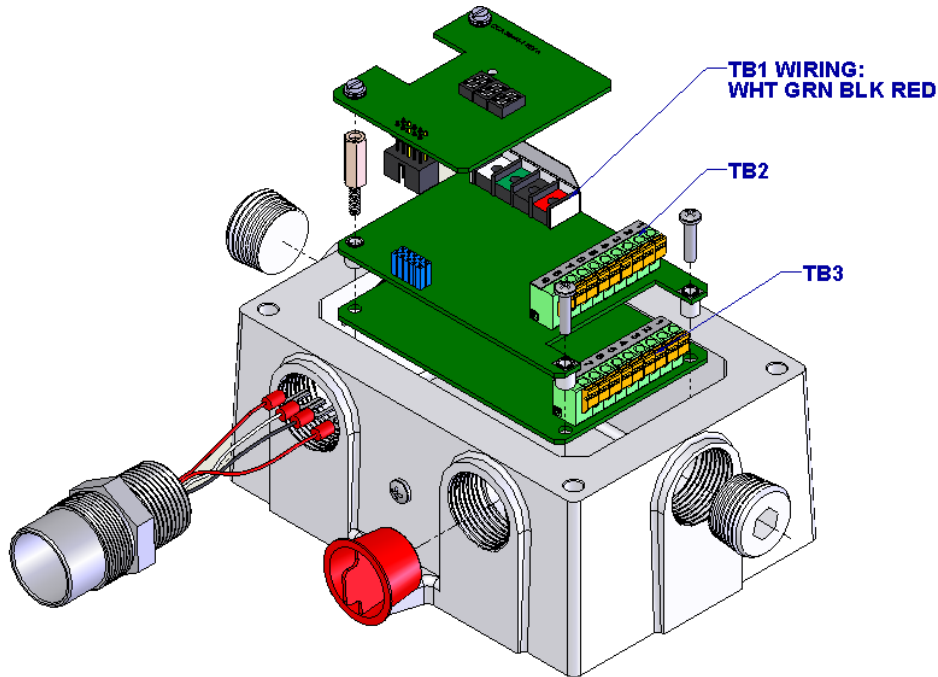
Sensor heads exposed to the elements may require the accessory mounting threads to be lubricated. Grease must not be used. As an alternate, PTFE (Teflon) tape may be used on sensor accessory threads.

**NOTE:** Do not use any material or substance on threads that contact the sensor housing.

The removal of particulate matter from sensor accessories may be done through the use of an appropriate halogen-free solvent. Water or ethanol is an example of a suitable solvent. The accessories should be thoroughly dried, with compressed air if necessary, before refitting to the sensor body.

## 3.5 Terminal Connections

The terminal blocks (TB) are located inside the housing and can be accessed by removing the cover. A label on the inside of the housing cover provides details of all the terminal connections.



**Figure 6: Ultima MOS-5 Intelligent Sensor Terminal Block Locations**

### 3.5.1 Terminal Block TB1 – Sensor Connections

TB1 contains the four sensor connections, white (W), black (B), red (R) and green (G). Remove the display board by loosening the 2 captive screws on the board and lifting it straight up. Connect the color-coded wires from the sensor to the matching colored terminals on TB1. The

label on the inside of the cover can serve as a guide. Replace the display board by pressing it into place and tightening the two captive screws.



**WARNING:** Do not connect +24 VDC to TB1. Damage to electronics or sensor may result.

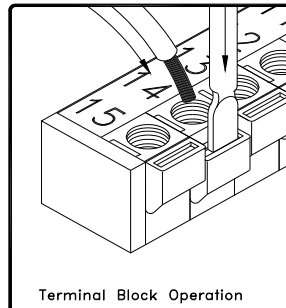
### 3.5.2 Terminal Block TB2 – Power and Signal Connections

TB2 contains the connections for Power, Relay Reset, Remote Calibration, Modbus, and 0-20 mA Output Signal. The terminal connections are as follows:

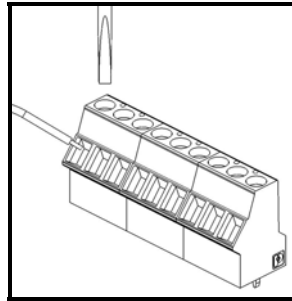
TB2 position	Function
1	0-20 mA Output
2	CH1 Modbus -
3	CH1 Modbus +
4	CH2 Modbus -
5	CH2 Modbus +
6	Remote Calibration
7	Relay Reset
8	Ground
9	+24 VDC Power

**Table 1: TB2 Power and Signal Connections**

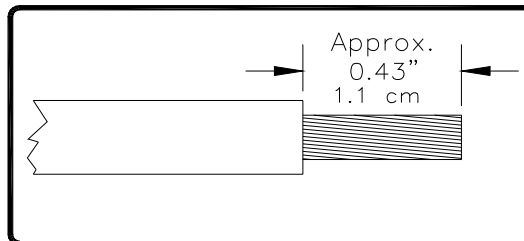
It is recommended that a minimum three-wire shielded cable be used for making the power and 0-20mA Output connection on the Ultima MOS-5 Intelligent Sensor. It is also recommended that separate two-wire shielded twisted pair cables be used for making the Modbus connections. The spring type terminal block accepts 14 AWG to 20 AWG and the screw type terminal block accepts 12 AWG to 18 AWG stranded or solid wire. Each wire should be stripped before wiring the Ultima MOS-5 Intelligent Sensor. To connect wiring to the spring type terminal block, insert a screwdriver into the orange tab and press down (Figure 7). Insert the wire into the terminal and release the orange tab, clamping the wire in the terminal. Check the hold of the wire by gently tugging it to ensure it is locked in. To connect wiring to the screw type terminal block, loosen the top screw counterclockwise (Figure 8). Insert the wire into the terminal and tighten the top screw clockwise. Check the hold of the wire by gently tugging it to ensure it is locked in.



**Figure 7: Spring Type Terminal Block Operation**



**Figure 8: Screw Type Terminal Block Operation**



**Figure 9: Wire Strip Length**

---

**NOTE:** Up to 12 AWG wire can be used if it is carefully striped. This applies only to a screw type terminal connection (Figure 8).

---

### 3.5.3 DC Power and Ground Connections

- The customer must provide primary DC power.

Since the Ultima MOS-5 Intelligent Sensor is designed to operate continuously, a power switch is not included, in order to prevent accidental system shutdown.

---

**NOTE:** Power must remain disconnected until all other wiring connections have been made.

---

See Section 9.3.3 for cable length specifications.

To connect +24 VDC to the Ultima MOS-5 Intelligent Sensor, connect the red wire (+24 VDC) to TB2, position 9. Connect the ground or common wire to TB2, position 8.

### 3.5.4 Analog Signal Connections

The Ultima MOS-5 Intelligent Sensor Intelligent Transmitter provides a 4 to 20 mA output signal. This signal can be sent to an industrial analog to digital converter, or logic solver.

The 4 to 20 mA signal provides for control room or other locations remote to the Ultima MOS-5 Intelligent Sensor to display indications of operation and alarm conditions.

To connect the 4 to 20 mA output signal with another unit, connect the wire into TB2, position 1, labeled 4-20 mA OUT.

If a readout device is being used, the DC ground, COM of both systems must be connected together. The analog output can also be configured as a HART communication link.

### 3.5.5 Terminal Block TB3 – Relay Connections

TB3 contains the connections for the relay contacts (optional). The function for the warn and alarm relay connections vary according to the normal state of the relay. Use the following as a guide for determining the Normally Open (NO) and the Normally Closed (NC) contact:

TB3 position	Relay Contact (De-Energized)	Relay Contact (Energized)
1	Normally Closed	Normally Open
2	Common	Common
3	Normally Open	Normally Closed

Table 2: Alarm Relay Connections

TB3 position	Relay Contact (De-Energized)	Relay Contact (Energized)
4	Normally Closed	Normally Open
5	Common	Common
6	Normally Open	Normally Closed

Table 3: Warn Relay Connections

TB3 position	Relay Contact (Energized)
7	Normally Open
8	Common
9	Normally Closed

Table 4: Fault Relay Connections

**NOTE:** Fault relay is normally energized. Relay will change state after power up.



**WARNING:** Contact with PCB components should be avoided to prevent damage by static electricity. All wire connections are made to the Terminal Blocks.



**WARNING:** Relay contacts must be protected against transient and over voltage conditions (Figure 10).

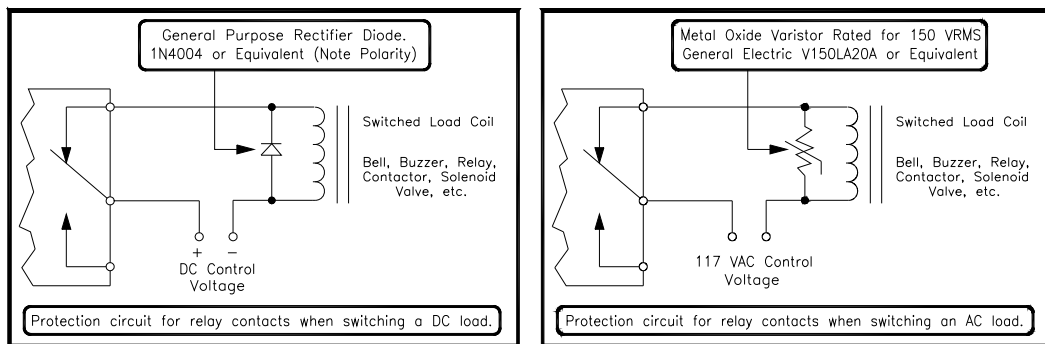


Figure 10: Relay Protection for DC and AC Loads

*North American Approved Applications* - The alarm relay contact ratings are 8 A @ 250 VAC and 8 A @ 30 VDC resistive max.

*European Union (EU) Approved Applications* - The alarm relay contact ratings are 8 A, 30 V RMS/42.4 V peak or 8 A @ 30 VDC resistive max.

### 3.5.6 European Union (EU) Approved Applications

Interconnecting cables must have an overall screen, or screen and armor. Cables BS5308 Part 2, Type 2, or equivalent, are suitable. Note that the terms 'screen' and 'shield' are equivalent for the purpose of this manual. The cable armor must be terminated in a suitable cable gland, at the detector, to ensure a positive electrical connection.

### 3.5.7 Cable Termination in the Non-hazardous Area

- The cable **armor** must be connected to **safety earth** in the safe area.
- The cable **screen** (drain wire) must be connected to an **instrument earth** in the safe area.
- The power supply **OV return** must be connected to an **instrument earth** in the safe area.
- The interconnecting cables should be segregated from power and other noisy cables. Avoid proximity to cables associated with radio transmitters, welders, switch mode power supplies, inverters, battery chargers, ignition systems, generators, switch gear, arc lights, and other high frequency or high power switching process equipment. In general, a minimum separation of at least 1 meter between instrument and other cables should be maintained. Greater separations are required where long parallel cable runs are unavoidable. Avoid running instrument cable trenches close to lightning conductor earth pits.
- Complete all cable insulation testing before connecting the cable at either end.



**WARNING:** Under **NO** circumstances should equipment be connected or disconnected when under power. This is contrary to hazardous area regulations and may lead to serious damage to the equipment. Equipment damaged in this manner is not covered under warranty.

## 3.6 Maintaining the X/P Integrity

Some of the factors that influence the explosion-proof integrity of the Ultima MOS-5 Intelligent Sensor housing are:

- Strength of the enclosure material
- Thickness of the enclosure walls
- Flame path between the housing and cover
- Flame path of threaded joints

The acceptable limits for explosion-proof housings that are used in Class I hazardous locations are defined in CSA Standard C22.2 No.30-M1986, FM 3615, and EN50014.

Anytime the cover of the Ultima MOS-5 Intelligent Sensor housing is removed or the cover bolts are loosened, the flame path between the lid and the housing is affected. If power is to be left on while removing the cover or loosening the cover bolts on the Ultima MOS-5 Intelligent Sensor, the area must be declassified.

When replacing the cover, the gap between the lid and the housing should be less than 0.0015 inch (0.038 mm). Make sure that the flame path is clear of dirt and debris before replacing the cover. This can be verified by tightening the cover bolts to a torque setting of 50 inch-pounds or by using a feeler gauge to ensure the gap between the cover and the housing is less than 0.0015 inch (0.038 mm).

There are four entry holes, one each on the left and right sides, and two on the bottom of the Ultima MOS-5 Intelligent Sensor housing. These holes are dedicated for the sensor, the reset switch, and conduit. Each hole is tapped for  $\frac{3}{4}$ " NPT threads. If a particular entry hole is not used, it must be plugged during operation in the field. The factory installs plugs in the unused entry holes, except one. A red plastic cap is placed into the remaining hole and must be removed before conduit can be attached to the housing.

The Ultima MOS-5 Intelligent Sensor will have the following items placed in the three remaining entry holes, at the factory:

- A sensor, if present (otherwise a red plastic cap)
- A reset switch, if present (otherwise an aluminum housing plug – optional)
- An aluminum housing plug

The sensor, reset switch, and aluminum - housing plug have 7 threads. Each of these components is screwed into the housing using 5 to 7 turns. If any of these parts must be replaced, apply 5 to 7 turns upon replacing the component to ensure the explosion proof integrity of the device is maintained.

## 4.0 Operation

### 4.1 Start-Up Checklist

Prior to starting the system, verify the following:

- Inhibit any external devices, such as trip amplifiers, PLC, or DCS systems.
- Verify that the optional settings are set for the desired configuration.
- Verify that the unit is properly mounted. Ensure the conduit/cable gland entries are pointed downward.
- Verify that the signal wiring is correct.
- Verify that the power supply is connected properly. The Ultima MOS-5 Intelligent Sensor is powered by +24 VDC (20 to 36 VDC voltage range). The detector will output a low voltage fault (F6) at 18.5 VDC or below.
- Make sure the lid is securely installed or the area has been declassified.
- Make sure the HART option is selected if desired.
- Make sure Modbus is properly configured if desired.

### 4.2 Start-Up

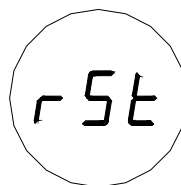
Before applying power to the system for the first time, all wiring connections should be checked for correctness and the housing cover replaced. Upon first power-up, the sensor may take up to fifteen minutes to stabilize.

At the initial application of power, the unit tests all LED segments by displaying “**88.8**”. The software revision letter is then displayed for a few seconds. When the software revision level appeared, the unit enters Operational Mode and the current gas concentration at the sensor will be displayed. For details on Calibrating and Gas Checking the unit, see Sections 4.56 and 4.7.

### 4.3 Relay Reset

If the warn and alarm relays are configured as latching, they must be manually reset after an alarm occurs. This can be accomplished by three different methods:

- The relays can be reset by using a magnet. To do this, place the magnet over the MSA logo on the cover of the unit. After 3 seconds, the display shows “rSt”. After the LED displays this code, remove the magnet. The relays are now reset (Figure 11).



**Figure 11: Relay Reset**

- The relays can be reset via the remote reset input terminals on TB2. Connect a normally open switch between terminal TB2-7 and TB2-8. Closing the switch momentarily will reset the relays. MSA explosion-proof switch, P/N 30051-1 can be used for this purpose. See Section 9.5 for ordering instructions.
- The relays can be reset via the Modbus Interface (Section 8.8.22).
- The relays can be reset via the HART communication.

---

**NOTE:** Red LEDs above and below the digital display indicate that the alarm and warn relays are active. Latching relays can only be reset if the gas concentration has fallen below the respective relay set point.

---

## 4.4 User Selectable Options

The Ultima MOS-5 Intelligent Sensor includes many selectable options to provide the user with the most flexible H<sub>2</sub>S gas detector possible. These options include selectable sensor range, warn and alarm relay set points and configuration, HART communications and Modbus communications settings. These allow the unit to operate with a wide variety of PLC and DCS systems. The following sections explain the available options and how they can be customized.

A flow diagram is included to help the user in understanding the process of reviewing and changing the available options (Figure 12).

---

**NOTE:** If the unit was ordered without relays, HART, or Modbus communications, changing the relay, HART, or Modbus settings will have no effect on the operation of the unit.

---

### Modbus

- Dual Redundant Modbus
- Single Modbus and HART

### HART

- HART is a Master to Slave -One to One communication channel.

### 4.4.1 Ultima MOS-5 Intelligent Sensor User Menu Structure

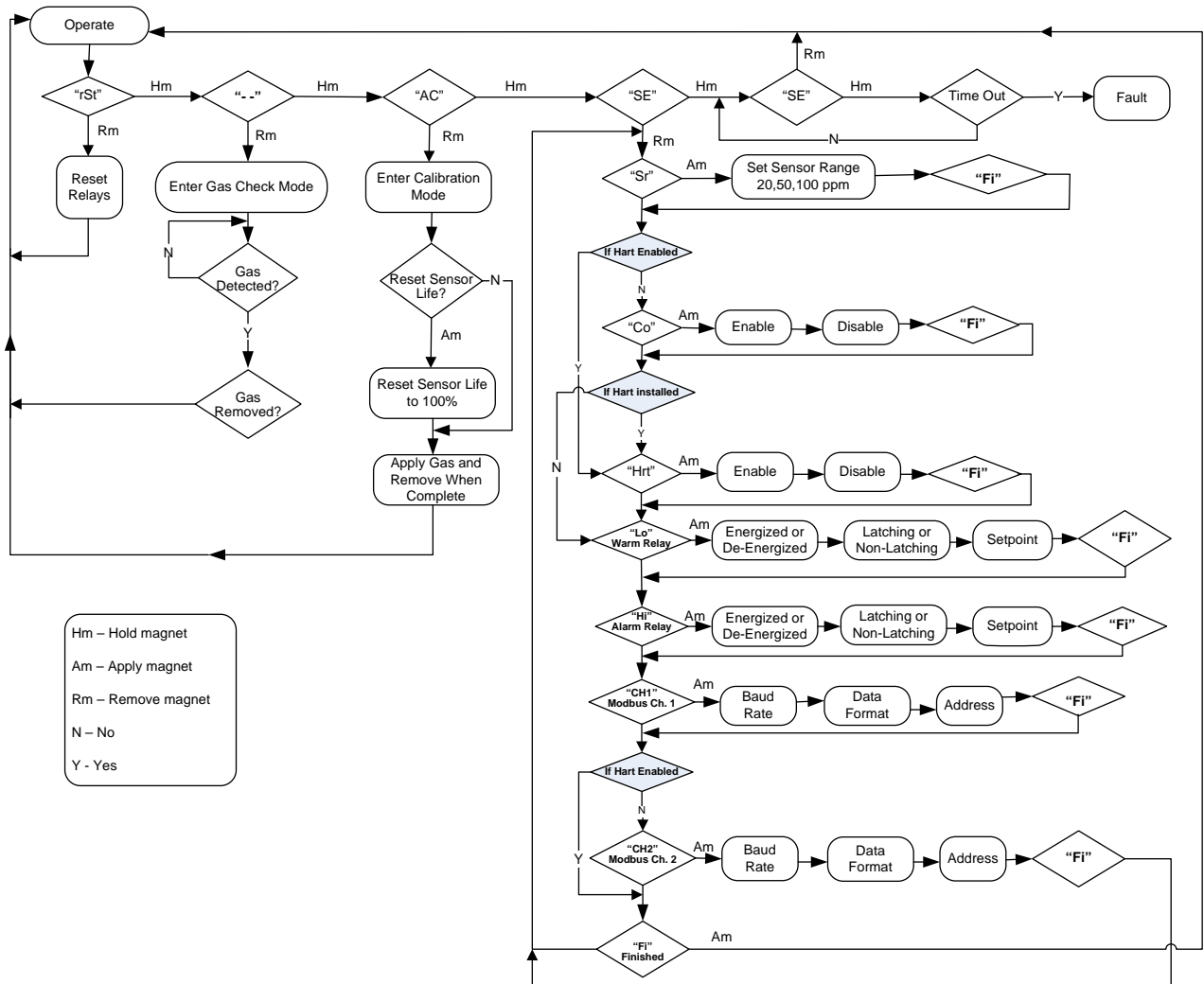


Figure 12: User Menu Structure

**NOTE:** “Co” stands for Calibration Output. When “Co” is enabled and calibration is successful, the analog output goes from 1.5 mA to 3.2 mA for five seconds, settling at the desired value of 4 mA. This option is commonly used with the MSA Model 10000 Controller system.

### 4.4.2 Sensor Range

The sensor range is selectable between 0-20 ppm, 0-50 ppm, or 0-100 ppm depending on the installed sensor. To adjust the sensor range of the Ultima MOS-5 Intelligent Sensor, apply the magnet to the MSA logo on the cover of the unit until “SE” is displayed, then remove the magnet. This puts the unit into setup mode. After a few seconds “Sr” will be displayed. Apply and remove the magnet to adjust the sensor range. The current sensor range will be displayed. To change the sensor range, apply and remove the magnet repeatedly until the desired range is displayed. Once the desired range is displayed, wait three seconds and “Fi” will be displayed.

Apply and remove the magnet, to return to the next level of the setup menu. When "Fi" is displayed again, apply and remove the magnet, the unit will go to calibration mode. The display will flash the remaining sensor life for a few seconds. Ensure that the sensor is seeing clean air during this time. Apply the calibration gas concentration to the sensor (50% FS of the desired range of H<sub>2</sub>S. \*See notes section below.). The display will change from "AC" (Automatic Calibration) to "CP" (Calibration in Progress) indicating that the sensor is responding to the calibration gas.

**After 3 to 5 minutes, the display will change from "CP" to "CC",** indicating that the calibration is complete. Remove the gas and wait for the unit to return to normal operation. The unit is now calibrated and the new span value has been stored in the non-volatile memory (EEPROM). ***If a fault occurs during this process, please refer to the notes section below.***

---

**NOTE:** When the sensor range is changed, the warning and alarm set points are automatically scaled to the new range. The unit must now be calibrated to the new range (Section 4.7.1). The Sensor Range and the Alarm/Warning set points will remain at the previous setting if the calibration is aborted, faulted, or the power is cycled before the calibration is completed.

It is recommended to go back through the SE mode to confirm range and sensor set-points have been changed correctly. Changing the sensor range will require that the operator change the H<sub>2</sub>S concentration previously used for calibrating the unit. It is necessary to use 50% of the "new" full scale reading when changing the scale, as well as after the scale is changed during normal calibration maintenance periods (i.e. 10ppm for a 0-20ppm, 25ppm for a 0-50ppm and 50ppm for a 0-100ppm). **It is important to note that changing a unit's range may require changing the sensor to match the new sensor range. (-1 sensor for 0-100 ppm, -5 sensor for 0-50 ppm, and -9 for 0-20 ppm).**

---

Once the operator reaches the calibration mode, the operator will have 12 minutes to complete a calibration. If the 12 minute timeframe elapses and the calibration is not complete (unit must return to "0" reading for calibration to be considered complete), the unit's display will show an "F2" fault. If this occurs while changing the Sensor Range, the operator must start the Sensor Range process over until the process is completed properly without any faults being shown throughout the process. If faults continue during this process, please consult the factory directly.

### 4.4.3 Calibration Output

To enable the calibration output feature of the Ultima MOS-5 Intelligent Sensor, apply the magnet to the MSA logo on the cover of the unit until "SE" is displayed, then remove the magnet. This puts the unit into setup mode. After a few seconds "Co" will be displayed. Apply and remove the magnet to enter the calibration output setting. The current setting (Enable or Disable) will then be displayed. To change this setting, apply and remove the magnet repeatedly until the desired setting is displayed. Once it is displayed, wait three seconds and "Fi" will be displayed. Apply and remove the magnet to return to the next level of the setup menu. When "Fi" is displayed again, apply and remove the magnet to return to normal operation.

### 4.4.4 Warning Relay Settings

To adjust the warning relay settings of the Ultima MOS-5 Intelligent Sensor, apply the magnet to the MSA logo on the cover of the unit until "SE" is displayed, then remove the magnet. This

puts the unit into setup mode. After a few seconds “Lo” will be displayed. Apply and remove the magnet to change the warning or “low” alarm settings.

First, the energized/de-energized state of the relay is shown by either “En” or “dE” being displayed, respectively. Apply and remove the magnet until the desired state is displayed.

After a few seconds the latching/non-latching state of the relay is shown by either “La” or “nL”. Apply and remove the magnet, until the desired state is displayed.

After a few seconds, the current warning relay set point is displayed. Apply and remove the magnet, until the desired set point is displayed. Once the desired set point value is displayed, wait 3 seconds and “Fi” will be displayed. Apply and remove the magnet to return to the next level of the Setup menu. When “Fi” is displayed again, apply and remove the magnet to return to normal operation.

**The default warning relay settings are non-latching, de-energized, 30% FS set point. The maximum allowable set point is 50 ppm.**

---

**NOTE:** The warn relay set point cannot be set higher than the alarm relay set point.

---

### 4.4.5 Alarm Relay Settings

To adjust the alarm relay settings of the Ultima MOS-5 Intelligent Sensor, apply the magnet to the MSA logo on the cover of the unit until “SE” is displayed, then remove the magnet. This puts the unit into setup mode. After a few seconds “Hi” will be displayed. Apply and remove the magnet, to change the alarm or “high” alarm settings.

First, the energized/de-energized state of the relay is displayed by either “En” or “dE” being displayed respectively. Apply and remove the magnet, until the desired state is displayed.

After a few seconds the latching/non-latching state of the relay is displayed by either “La” or “nL”. Apply and remove the magnet until the desired state is displayed.

After a few seconds the current Alarm relay set point is displayed. Apply and remove the magnet until the desired set point is displayed. Once the desired set point value is shown, wait 3 seconds and “Fi” will be displayed. Apply and remove the magnet to return to the next level of the setup menu. When “Fi” is displayed again, apply and remove the magnet, to return to normal operation.

**The default Alarm relay settings are: latching, de-energized, 60% FS set point.**

---

**NOTE:** The alarm relay set point cannot be set lower than the Warning relay set point.

---

### 4.4.6 Modbus Channel 1 Settings

To change the Modbus Channel 1 settings of the Ultima MOS-5 Intelligent Sensor, apply the magnet to the MSA logo on the cover of the unit until “SE” is displayed, then remove the magnet. This puts the unit into setup mode. After a few seconds “CH1” will be displayed. Apply and remove the magnet to change the Modbus Channel 1 settings.

First, the current Baud Rate Modbus Channel 1 is displayed. If another baud rate is to be selected, apply and remove the magnet until the desired baud rate is displayed. The choices are 19.2k baud “**19.2**”, 9600 baud “**96**”, 4800 baud “**48**”, or 2400 baud “**24**”.

After a few seconds, the current Data Format for Modbus Channel 1 is displayed. If another data format is to be selected, apply and remove the magnet until the desired data format is displayed. The choices are: 8-N-1 “**8n1**”, 8-N-2 “**8n2**”, 8-E-1 “**8E1**”, or 8-O-1 “**8O1**”.

After a few seconds, the current address for Modbus Channel 1 is displayed. Apply and remove the magnet until the desired address is displayed. Once the desired address is displayed, wait for 3 seconds and “**Fi**” will be displayed. Apply and remove the magnet to return to the next level of the Setup menu. When “**Fi**” is displayed again, apply and remove the magnet to return to normal operation.

**Default settings for Channel 1 are: address 1, 19.2k baud, 8-N-1.**

---

**NOTE:** The address can be adjusted from 1 to 247. Channel 1 and Channel 2 addresses may be the same.

---

### 4.4.7 Modbus Channel 2 Settings

---

**NOTE:** If HART is enabled the Modbus 2 settings do not appear on the display. To use Modbus 2 make sure HART is disabled.

---

To change the Modbus channel 2 settings, apply the magnet to the MSA logo and set the unit in set up mode. Once “CH2” is displayed, follow the same steps as in section 4.4.5 above.

**Default settings for Channel 2 are: address 2, 19.2k baud, 8-N-1.**

---

**NOTE:** The address can be adjusted from 1 to 247. Channel 1 and Channel 2 addresses may be the same.

---

## 4.5 HART

This option is not shown if HART was not purchased for the Ultima MOS-5 Intelligent Sensor. When HART is selected via setup, the Channel 2 setup is not displayed or available. When Channel 2 is changed from HART to Modbus, the previous settings are used.

To change the HART setting of the Ultima MOS-5 Intelligent Sensor, apply the magnet to the MSA logo on the cover of the unit until “**SE**” is displayed, then remove the magnet. This puts the unit into setup mode. After a few seconds “**Hrt**” will be displayed. Apply and remove the magnet to enter the HART setting. The current setting (Enable or Disable) will then be displayed. To change this setting, apply and remove the magnet repeatedly until the desired setting is displayed. Once it is displayed, wait three seconds and “**Fi**” will be displayed. Apply and remove the magnet to return to the next level of the setup menu. When “**Fi**” is displayed again, apply and remove the magnet to return to normal operation.

The Ultima MOS-5 Intelligent Sensor has a HART option. The HART option allows the user to get management information and to remotely calibrate the unit. Because HART preserves the 4-20 mA signal, it enables two-way digital communication to occur without disturbing the

integrity of the analog connection. The DDL is available at the HART foundation's website (<http://www.hartcomm2.org/index.html>). If the Ultima MOS-5 Intelligent Sensor is ordered with the HART option it is in the enabled state. The HART function can also be disabled and then Channel 2 can be used for Modbus.

The Ultima MOS-5 Intelligent Sensor HART configuration is compatible with the Emerson 375 Field Communicator and AMS Aware. <http://www.emersonprocess.com/>  
<http://www.emersonprocess.com/ams/>

### 4.6 Gas Check Mode

The sensor's response can be checked without activating external alarms by placing the Ultima MOS-5 Intelligent Sensor in Gas Check Mode. In this mode, the alarm relays are inhibited and the analog output is fixed at 1.5 mA. Please see section 9.3.3 for more information on the analog output values.

---

**NOTE:** If HART is enabled, the current may be different. See HART analog output selection chart.

---

#### 4.6.1 Procedure for Checking the Calibration

Place the magnet over the MSA logo on the cover of the Ultima MOS-5 Intelligent Sensor. Remove the magnet when a flashing pair of bars, “- -” appears on the display (about 10 seconds) (Figure 13). Apply the test gas to the sensor. The value of the gas concentration will be indicated by the flashing display and should stabilize in 1 to 2 minutes.



**Figure 13: Gas Check**

When the reading has stabilized and the test is complete, remove the gas and the unit will return to normal operation, when the concentration drops below 5% full-scale.

If, after the reading has stabilized, the sensor is to be calibrated, simply apply the magnet to the MSA logo on the housing cover and the unit will enter Calibration Mode.

Gas Check Mode can be aborted if gas has not been applied to the sensor. Simply reapply the magnet to the MSA logo on the cover and the unit will return to normal operation.

---

**NOTE:** The test gas concentration must be at least 10% full-scale before the unit will complete the gas check sequence. If the Ultima MOS-5 Intelligent Sensor is placed in the gas check mode and no gas is applied for twelve minutes, the unit will revert to a Fault condition. Re-applying the magnet over the MSA logo will return the unit to normal operation.

---

### 4.7 Calibration

MSA recommends that the Ultima MOS-5 Intelligent Sensor be calibrated 1 hour after start-up, and again 24 hours after initial start-up, and that the calibration be checked at least every 90 days to ensure system integrity of this life protecting equipment.

The above statement is not intended to discourage the customer from checking calibration more frequently. Frequent calibration checks are recommended for environments that have problems, such as mud collecting on the sensor head, sensors accidentally being painted over, etc.

MSA recommends that a calibration schedule be established and followed. A logbook should also be kept, showing calibration dates and dates of sensor replacement.

#### 4.7.1 Calibration Procedure

If hydrogen sulfide (H<sub>2</sub>S) gas is suspected to be present, it will be necessary to purge the sensor environment with clean air.

Entering Calibration Mode automatically disables the alarm circuits by sending a 1.5 mA output signal and disabling the warn and alarm relays, if present. This will also prevent activation of the remote relay contacts when using an MSA readout/relay display module with the Ultima MOS-5 Intelligent Sensor. Please see section 9.3.3 for more information on the analog output values.

To enter Calibration Mode, place the magnet over the MSA logo on the cover of the unit (Figure 4) and hold it there until “AC” (Figure 14) appears on the display (about 10 seconds). The display will flash the remaining sensor life (Section 4.7.3) for a few seconds. Ensure that the sensor is seeing clean air during this time.



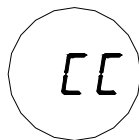
**Figure 14: Automatic Calibration Mode**

Apply the calibration gas concentration to the sensor (50% FS of the desired range of H<sub>2</sub>S). The display will change from “AC” (Automatic Calibration) to “CP” (Calibration in Progress) indicating that the sensor is responding to the calibration gas (Figure 15).



**Figure 15: Calibration in Progress Mode**

After 3 to 5 minutes, the display will change from “CP” to “CC” indicating that the calibration is complete. (Figure 16).



**Figure 16: Calibration Complete Mode**

Remove the gas and wait for the unit to return to normal operation. Once the gas concentration decreases, the display will read a few percent LEL and then will reach “0.”

The unit is now calibrated and the new span value has been stored in the non-volatile memory (EEPROM).

---

**NOTE:** The sensor life figure displayed is that calculated on completion of the last calibration. To determine the current sensor life, calibrate unit and then repeat steps 1 and 2.

---

### 4.7.2 Aborting Calibration

If calibration is to be aborted and gas has not been applied, wait ninety seconds and reapply the magnet. The unit will then return to normal operation with the previous calibration values unchanged.

---

**NOTE:** Once gas has been applied, it is not possible to abort a calibration.

---

If the Ultima MOS-5 Intelligent Sensor is placed in the Calibration Mode and no gas is applied for 12 minutes, the unit reverts to a Fault (F2) condition. Re-applying the magnet over the MSA logo returns the unit to operational mode with the previous calibration values unchanged.

### 4.7.3 Remaining Sensor Life

The Ultima MOS-5 Intelligent Sensor provides an estimate of remaining sensor life, in percent remaining, to provide the user with an early warning of the need for sensor replacement. The remaining sensor life is updated each time the unit is calibrated. The current remaining sensor life estimate is displayed during the zeroing portion of a calibration sequence. It can also be read via the Modbus or HART interface (Section 8.0).

---

**NOTE:** Remaining sensor life is an estimate of sensor degradation derived from sensor sensitivity. Because sensor sensitivity is affected by factors other than the natural sensor degradation, users must establish their own reference by resetting sensor life whenever these factors are at play. Some examples of these factors are new sensor installations, sensor replacement, change of the target gas, and changes in the access of gas to the sensor. If sensor life is not reset, the remaining sensor life indicator will no longer reflect the true state of the sensor.

---

#### 4.7.4 Initializing the Remaining Sensor Life

The remaining sensor life estimate must be initialized each time a new hydrogen sulfide sensor is installed. The initialization should be done during the first calibration of a newly installed sensor. After the sensor has been on power for a minimum of 1 hour, enter calibration mode as described in Section 4.7. While the display is flashing the remaining sensor life estimate during zeroing, apply the magnet to the MSA logo on the cover. The flashing number will change to “100”, indicating the sensor has 100% of remaining sensor life. Complete the calibration per Section 4.7.1.

### 4.8 Calibration Equipment

#### 4.8.1 Calibrating with a Breaker Bottle and Ampoules

MSA offers ampoules with breaker bottles as a method of reliably introducing calibration gas to the Ultima MOS-5 Intelligent Sensor. The ampoule is placed inside the breaker bottle into the breaker slot, and the breaker bottle is placed over the sensor. The ampoule should contain 50% FS of H<sub>2</sub>S of the sensor range. Follow the calibration procedure in Section 4.7. When the display indicates “AC”, break the ampoule by turning the thumbscrew on the side of the breaker bottle clockwise. The display will change to “CP” indicating that the sensor is seeing the gas. When the display reads “CC”, the calibration is complete. Remove the breaker bottle and allow the sensor to see clean air. It will return to normal operation once the gas at the sensor is below 5% of full-scale. See Section 9.5 for available equipment.



Figure 17: Ampoules

#### 4.8.2 Calibrating with an H<sub>2</sub>S Portable Purge Calibrator

An alternate method for introducing calibration or test gas to the Ultima MOS-5 Intelligent Sensor is available. The H<sub>2</sub>S Portable Purge Calibrator is a compact, practical, accurate and safe system for field calibration of H<sub>2</sub>S sensors. The bottle is filled with a hydrogen sulfide (H<sub>2</sub>S) in air mixture and is available in seven concentrations. The temperature limitation for operation and storage is 0°F to +130°F (-18°C to +54°C).



**Figure 18: Portable Purge Calibrator**

---

**NOTE:** Do not store the cylinder with the regulator fully engaged in the cylinder valve.

---

To calibrate, make sure the portable purge calibrator contains a gas concentration equivalent to 50% of full-scale for the unit that is going to be calibrated. Ensure that the sensor is seeing clean air. If it is suspected that hydrogen sulfide gas is present, it will be necessary to purge the sensor environment with clean air.

Place the gas cup over the sensor and initiate the calibration sequence, by placing the magnet over the MSA logo on the cover of the unit. When the letters “**AC**” appear in the display window, remove the magnet and apply the calibration gas (50% of full-scale) by opening the valve on the cylinder. When the sensor begins to see the gas, the display will change from “**AC**” to “**CP**” to indicate “Calibration in Progress”. When the calibration sequence is complete, the display will change from “**CP**” to “**CC**” to indicate “Calibration Complete”.

Remove the gas by closing the valve on the cylinder, and remove the cup allowing the sensor to see clean air. The display will change from “**CC**” to indicate a few parts per million (ppm) and then drop to “**0**”. The unit is now calibrated and the new values have been stored in the EEPROM (non-volatile memory). See Section 9.5 for available equipment.

## 5.0 Maintenance

### 5.1 General Maintenance



**WARNING:** Disconnect or inhibit external devices such as trip amplifiers, PLC's, or DCS systems before performing any maintenance.

*European Union (EU) Approved Applications:* The following grease compound is recommended for use: PBC Polybutylcuprysil, (or equivalent), which has BASEEFA Health & Safety Executive Component Approval No. 1051U for use as a jointing compound on flameproof electrical enclosures. This is available from MSA.

The neoprene rubber gasket should also be lubricated with Type P80 lubricant, available from MSA (P/N 610-010).

### 5.2 Storage

The Ultima MOS-5 Intelligent Sensor should be stored in a clean, dry area and within the temperature and humidity ranges quoted in the Appendix under Environmental Specifications. Insert red dust caps into any vacant cable entry holes. See section 9.3.4.

## 6.0 Troubleshooting



**CAUTION:** Component level repair must be undertaken by MSA personnel or by competent authorized service engineers. SMT PCB repair shall only be performed at an MSA facility. Failure to comply with this requirement will invalidate the warranty.

Be sure to inhibit or disconnect external alarm wiring before making any check, which might send the unit into alarm.

### 6.1 Fault Codes and Their Remedies

The Ultima MOS-5 Intelligent Sensor has self-diagnostics incorporated into the microprocessor's program. If a fault is detected, the output signal drops to 0 mA, the fault relay de-energizes and a fault code is displayed. The output signal informs a remote display module that the Ultima MOS-5 Intelligent Sensor is in the Fault Mode. The display indicates a fault code that can be viewed at the sensor site. Refer to section 9.3.3 for more information on analog output values.

There are nine fault conditions that are monitored by the microprocessor as follows:

#### 6.1.1 F2 - Failed to Complete the Calibration

This fault occurs if the unit is placed in the calibration mode and no gas is applied within twelve minutes, or if gas is left on for more than twelve minutes.

**ACTION** - Remove gas, if present. Apply magnet to MSA logo on the cover to clear fault. Re-calibrate, if necessary.

#### 6.1.2 F3 Flash Checksum Error

This fault indicates that the contents of the Ultima MOS-5 Intelligent Sensor's program memory have changed. This usually occurs when powering the unit up after a lightning strike or large voltage transient on the power or signal lines to the unit.

**ACTION** - The unit must be returned to the factory or authorized service center for repair.

#### 6.1.3 F4 - Sensor Heater Open Error or Sensor Amplifier Error

This fault indicates that either one of the remote sensor leads is open or shorted or that the sensor has drifted greater than -10% of the reading. The Ultima MOS-5 Intelligent Sensor has an additional protection feature. If any of the sensor wires are shorted to ground, the sensor power is turned off. After one minute the power turns back on. If the short is still present, power is quickly turned off.

**ACTION** - Check the integrity of all sensor connections, and ensure that the cable from the Ultima MOS-5 Intelligent Sensor to the remote sensor is not damaged. If all sensor leads are connected properly, attempt to re-calibrate the unit. If calibration fails, replace the sensor and re-calibrate.

---

**NOTE:** Anytime a sensor is replaced, the unit should be disconnected from all alarms as the unit may go upscale upon power-up.

---

If this does not solve the problem the internal sensor amplifier has a defective part. The unit must be returned for service.

### 6.1.4 F5 - Sensor Heater Shorted Error

This fault indicates that one of the sensor circuit leads is short-circuited to ground or +24 V.

**ACTION** - Check the integrity of all sensor connections and ensure that the cable from the Ultima MOS-5 Intelligent Sensor to the remote sensor is not damaged. If this does not correct the problem, replace the sensor and recalibrate.

---

**NOTE:** When the black lead is accidentally shorted to +24 Volts, the Ultima MOS-5 Intelligent Sensor delays coming out of fault to allow parts to cool down.

---

### 6.1.5 F6 - Low Supply Voltage

This fault occurs if the supply voltage at the Ultima MOS-5 Intelligent Sensor drops below +18.5 VDC.

**ACTION** - Ensure that the supply voltage is at least +20 VDC at the Ultima MOS-5 Intelligent Sensor.

---

**NOTE:** With long supply leads, a considerable voltage drop may occur due to the electrical resistance of the leads. The maximum cable resistance, which the Ultima MOS-5 Intelligent Sensor can tolerate, is dependent on the supply voltage.

---

### 6.1.6 F7 - EEPROM Verification Failure

In the event of an EEPROM error, the user must recycle the power to potentially clear the error. After power reset, the following may occur:

- 1) Unit returns to normal.
  - a. This indicates the EEPROM writing did not keep up with changing events or the Modbus write cycle is too fast.
- 2) Unit goes to F2. The user must recalibrate after 1-2 minute sensor warm up.
  - a. This means the non-critical part of the EEPROM was corrupted.
  - b. This is probably caused by an event-logging problem.
  - c. There is a possibility any of the following may be corrupted:
    - i. Event logging data
    - ii. Modbus settings
    - iii. HART Settings
    - iv. Calibration information
- 3) Unit returns to F7
  - a. This is a critical error. This fault occurs when an attempt to verify the setup/calibration parameters just written to the EEPROM memory fails.

**ACTION** - The unit must be returned to the factory or authorized service center for repair.

### 6.1.7 F8 - Failure to Complete Setup

This fault occurs if the unit is left in setup mode for more than six minutes.

**ACTION** - Exit setup mode. Enter setup mode again to change any user selectable options, if necessary.

### 6.1.8 F9 - Gas Check Period Exceeded

If the Ultima MOS-5 Intelligent Sensor is left in the Gas Check Mode for more than 12 minutes with test gas applied, this fault occurs.

**ACTION** - Place the magnet over the MSA logo on the cover to return the unit to normal operation.

---

**NOTE:** Anytime a sensor is replaced, the unit should be disconnected from all alarms, as the unit may go upscale upon power-up.

---

### 6.1.9 F10 – Switch Error

This fault occurs if either the “remote test,” “remote calibrate,” or magnetic switch is closed for more than two minutes.

**ACTION** – Check the wiring on the remote reset and remote calibrate switches. Once the short circuit is cleared, the unit will return to normal operation. If the magnetic switch is shorted, the unit must be returned to the factory or to an authorized service center for service.

### 6.1.10 F11 Internal Error

An internal error has occurred.

**ACTION** - The unit must be returned to the factory for service. A possible error is that internal voltages are not at their proper values. Different options will have different internal errors.

## 7.0 Customer Support

### 7.1 MSA Office

Address	Phone/Email
<b>Mine Safety Appliances Co.</b> <b>26776 Simpatica Circle</b> <b>Lake Forest, CA 92630</b>	Toll Free: 1-800-MSA-INST Email: <a href="mailto:customer.service@msanet.com">customer.service@msanet.com</a>
<b>MSA Corporate</b> <b>1000 Cranberry Woods Drive</b> <b>Cranberry Twp, PA 16066</b> <b>United States</b>	Toll Free: 1-800-MSA-7777 Email: <a href="mailto:customer.service@MSAnet.com">customer.service@MSAnet.com</a>
<b>MSA Europe</b> <b>Thiemannstrasse 1</b> <b>12059 Berlin</b> <b>Germany</b>	Phone: +49 [30] 68 86 0 Fax: +49 [30] 68 86 15 58 Email: <a href="mailto:info.de@MSAsafety.com">info.de@MSAsafety.com</a>

Additional MSA office locations can be found on our website –  
[www.MSAsafety.com](http://www.MSAsafety.com)

**Table 5: MSA Contact Information**

## 8.0 Modbus Interface

### 8.1 Baud Rate

The baud rate is selectable via the Modbus Communications Interface. The selectable baud rates are 19200, 9600, 4800, or 2400 bits per second.

### 8.2 Data Format

The Data Format is selectable via the Modbus Communications Interface. The selectable data formats are as follows:

Data Bits	Parity	Stop Bit	Format
8	None	1	8-N-1
8	Even	1	8-E-1
8	Odd	1	8-O-1
8	None	2	8-N-2

Table 6: Data Format

### 8.3 Modbus Read Status Protocol (Query/Response)

#### 8.3.1 Modbus Read Query Message

Byte	Modbus	Range	Referenced to Ultima MOS-5 Intelligent Sensor
1 <sup>st</sup>	Slave Address	1-247* (Decimal)	Ultima MOS-5 Intelligent Sensor ID (Address)
2 <sup>nd</sup>	Function Code	03	Read Holding Registers
3 <sup>rd</sup>	Starting Address Hi**	00	Not Used by Ultima MOS-5 Intelligent Sensor
4 <sup>th</sup>	Starting Address Lo**	00-FF (Hex)	Ultima MOS-5 Intelligent Sensor Commands
5 <sup>th</sup>	No. Of Registers Hi	00	Not Used by Ultima MOS-5 Intelligent Sensor
6 <sup>th</sup>	No. Of Registers Lo	01	No. Of 16 Bit Registers
7 <sup>th</sup>	CRC Lo	00-FF (Hex)	CRC Lo Byte
8 <sup>th</sup>	CRC Hi	00-FF (Hex)	CRC Hi Byte

**\*NOTE:** Address 0 is reserved for broadcast mode and will not be supported at this time.

**\*\* NOTE:** Start Address can be a maximum of 9999 Address Locations (0000-270E).

### 8.3.2 Modbus Read Response Message

Byte	Modbus	Range	Referenced to Ultima MOS-5 Intelligent Sensor
1 <sup>st</sup>	Slave Address	1-247* (Decimal)	Ultima MOS-5 Intelligent Sensor ID (Address)
2 <sup>nd</sup>	Function Code	03	Read Holding Registers
3 <sup>rd</sup>	Byte Count	02	No. Of Data Bytes
4 <sup>th</sup>	Data Hi	00-FF (Hex)	Ultima MOS-5 Intelligent Sensor Hi Byte Status Data
5 <sup>th</sup>	Data Lo	00-FF (Hex)	Ultima MOS-5 Intelligent Sensor Lo Byte Status Data
6 <sup>th</sup>	CRC Lo	00-FF (Hex)	CRC Lo Byte
7 <sup>th</sup>	CRC Hi	00-FF (Hex)	CRC Hi Byte

## 8.4 Modbus Write Command Protocol (Query/Response)

### 8.4.1 Modbus Write Query Message

Byte	Modbus	Range	Referenced to Ultima MOS-5 Intelligent Sensor
1 <sup>st</sup>	Slave Address	1-247* (Decimal)	Ultima MOS-5 Intelligent Sensor ID (Address)
2 <sup>nd</sup>	Function Code	06	Preset Single Register
3 <sup>rd</sup>	Register Address Hi	00	Not Used by Ultima MOS-5 Intelligent Sensor
4 <sup>th</sup>	Register Address Lo	00-FF (Hex)	Ultima MOS-5 Intelligent Sensor Commands
5 <sup>th</sup>	Preset Data Hi	00-FF (Hex)	Ultima MOS-5 Intelligent Sensor Hi Byte Command Data
6 <sup>th</sup>	Preset Data Lo	00-FF (Hex)	Ultima MOS-5 Intelligent Sensor Lo Byte Command Data
7 <sup>th</sup>	CRC Lo	00-FF (Hex)	CRC Lo Byte
8 <sup>th</sup>	CRC Hi	00-FF (Hex)	CRC Hi Byte

**\*NOTE:** Address 0 is reserved for broadcast mode and will not be supported at this time.

**\*\*NOTE:** Start Address can be a maximum of 9999 Address Locations (0000-270E).

### 8.4.2 Modbus Write Response Message

Byte	Modbus	Range	Referenced to Ultima MOS-5 Intelligent Sensor
1 <sup>st</sup>	Slave Address	1-247* (Decimal)	Ultima MOS-5 Intelligent Sensor ID (Address)
2 <sup>nd</sup>	Function Code	06	Preset Single Register
3 <sup>rd</sup>	Register Address Hi	00	Not Used by Ultima MOS-5 Intelligent Sensor
4 <sup>th</sup>	Register Address Lo	00-FF (Hex)	Ultima MOS-5 Intelligent Sensor Commands
5 <sup>th</sup>	Preset Data Hi	00-FF (Hex)	Ultima MOS-5 Intelligent Sensor Hi Byte Command Data
6 <sup>th</sup>	Preset Data Lo	00-FF (Hex)	Ultima MOS-5 Intelligent Sensor Lo Byte Command Data
7 <sup>th</sup>	CRC Lo	00-FF (Hex)	CRC Lo Byte
8 <sup>th</sup>	CRC Hi	00-FF (Hex)	CRC Hi Byte

## 8.5 Function Codes Supported

Function Code 03 (Read Holding Registers) is used to read status from the slave unit.

Function Code 06 (Preset Single Register) is used to write a command to the slave unit.

## 8.6 Exception Responses and Exception Codes

### 8.6.1 Exception Response

In a normal communications query and response, the master device sends a query to the Ultima MOS-5 Intelligent Sensor and the Ultima MOS-5 Intelligent Sensor receives the query without a communications error and handles the query normally within the master device's allowable timeout. The Ultima MOS-5 Intelligent Sensor then returns a normal response to the master. An abnormal communications produces one of four possible events:

- If the Ultima MOS-5 Intelligent Sensor does not receive the query due to a communications error, then no response is returned from the Ultima MOS-5 Intelligent Sensor and the master device eventually processes a timeout condition for the query.
- If the Ultima MOS-5 Intelligent Sensor receives the query, but detects a communication error (CRC, etc.), then no response is returned from the Ultima MOS-5 Intelligent Sensor and the master device eventually processes a timeout condition for the query.
- If the Ultima MOS-5 Intelligent Sensor receives the query without a communications error, but cannot process the response to the master within the master's timeout setting, then no response is returned from the Ultima MOS-5 Intelligent Sensor. The master device eventually processes a timeout condition for the query. In order to prevent this condition from occurring, the maximum response time for the Ultima MOS-5 Intelligent Sensor is 200 milliseconds. Therefore, the master's timeout setting should be set to 200 milliseconds or greater.
- If the Ultima MOS-5 Intelligent Sensor receives the query without a communications error, but cannot process it due to reading or writing to a non-existent Ultima MOS-5 Intelligent Sensor command register, then the Ultima MOS-5 Intelligent Sensor returns an exception response message informing the master of the error.

The exception response message (ref. No. 4 above) has two fields that differentiate it from a normal response:

Byte	Modbus	Range	Referenced to Ultima MOS-5 Intelligent Sensor
1 <sup>st</sup>	Slave Address	1-247* (Decimal)	Ultima MOS-5 Intelligent Sensor ID (Address)
2 <sup>nd</sup>	Function Code	83 or 86 (Hex)	MSB is set with Function Code
3 <sup>rd</sup>	Exception Code	01 - 06 (Hex)	Appropriate Exception Code (See Below)
4 <sup>th</sup>	CRC Lo	00-FF (Hex)	CRC Lo Byte
5 <sup>th</sup>	CRC Hi	00-FF (Hex)	CRC Hi Byte

### 8.6.2 Exception Code

**Exception Code Field:** In a normal response, the Ultima MOS-5 Intelligent Sensor returns data and status in the data field, which was requested in the query from the master. In an exception response, the Ultima MOS-5 Intelligent Sensor returns an exception code in the data field, which describes the Ultima MOS-5 Intelligent Sensor condition that caused the exception. Below is a list of exception codes that are supported by the Ultima MOS-5 Intelligent Sensor:

Code	Name	Description
01	Illegal Function	The function code received in the query is not an allowable action for the Ultima MOS-5 Intelligent Sensor
02	Illegal Data Address	The data address received in the query is not an allowable address for the Ultima MOS-5 Intelligent Sensor.
03	Illegal Data Value	A value contained in the query data field is not an allowable value for the Ultima MOS-5 Intelligent Sensor.
04	Slave Device Failure	An unrecoverable error occurred while the Ultima MOS-5 Intelligent Sensor was attempting to perform the requested action.
05	Acknowledge	The Ultima MOS-5 Intelligent Sensor has accepted the request and is processing it, but a long duration of time will be required to do so. This response is returned to prevent a timeout error from occurring in the master.
06	Device Busy	The Ultima MOS-5 Intelligent Sensor is engaged in processing a long-duration program command. The master should retransmit the message later when the slave is free.

**Table 7: Exception Codes**

## 8.7 Ultima MOS-5 Command Register Locations

Parameter	Function	Type	Scale	Access	Register Address	Master I/O Address
Analog	0-20 mA Current Output	Value	16-Bit	R	0000	40001
Mode	Indicates and Controls Mode	Bit		R/W	0001	40002
Status/Error	Indicates Errors		Bit	R	0002	40003
Not Used	N/A				0003	40004
Unit Type	Identifies the Ultima MOS-5 Intelligent Sensor in Decimal	Value	16-Bit	R	0004	40005
Software Rev	Indicates the Software Revision	ASCII	2-Char	R	0005	40006
Status Block	Returns Analog, Mode, Status, Error, and Sensor Life Returns Address 6,7,8	Multi	6-bytes	R	0006	40007
Analog	Analog 2	Value		R	0006	40007
Mode	Mode	Bit		R	0006	40007
Error 2	Error 2	Bit		R	0007	40008
Error 1	Error 1	Bit		R	0007	40008
Sensor Life	Sensor Life	Value		R	0008	40009
Display	Display (LED & MSD)	Bit /ASCII		R	0009	40010
Display	Display (Mid & LSD)	ASCII		R	000A	40011
Serial Number	Upper serial number	Value		R	000B	40012
Serial Number	Lower serial number	32 bit		R	000C	40013
Alarm Settings	Read or change settings for the high alarm	Bit	(0-15)	R/W	000D	40014
Warn Settings	Read or change settings for the low alarm	Bit	(0-15)	R/W	000E	40015
Com1 Addr.	Read or change settings for the Com1 Address	Value	8-Bit	R/W	000F	40016
Com1 Baud	Read or change settings for the Com1 Baud Rate	Bit	(0-7)	R/W	0010	40017
Com1 Data Format	Read or change settings for the Com1 Data Format	Bit	(0-7)	R/W	0011	40018
Com2 Addr.	Read or change settings for the Com2 Address	Value	8-Bit	R/W	0012	40019
Com2 Baud	Read or change settings for the Com2 Baud Rate	Bit	(0-7)	R/W	0013	40020
Com2 Data Format	Read or change settings for the Com2 Data Format	Bit	(0-7)	R/W	0014	40021
Not Used	N/A				0015	40022
Reset Alarms	Reset any latched alarms	Bit	(0)	W	0016	40023
Sensor Life	Read the Remaining Sensor Life	Bit	(0)	R	0017	40024
Sensor Scale	Change the Scale for the H <sub>2</sub> S sensors on the Ultima MOS-5 Intelligent Sensor	Value	8-Bit	R/W	0018	40025
MODEL 10K Controller (Co)	Indicates Calibration Success	Value	8-Bit	R/W	0019	40026
Not Used					001A	40027
Not Used					001B	40028

## Ultima MOS-5 Detector

Parameter	Function	Type	Scale	Access	Register Address	Master I/O Address
Not Used					001C	40029
HART EN/DE	Enable/Disable	Bit	1/0	R/W	001D	40030
HART Test	Transmit a constant 1 or 0 signal	Value	0,1,2	R/W	001E	40031
Cal Abort	Abort calibration			R/W	001F	40032
Total Receive Errors	Total # of Receive Errors	Value	8-Bit	R	0020	40033
Bus Activity Rate %	Bus Activity Rate in % of This Addressed Node vs. Other Addressed Nodes	Decimal		R	0021	40034
Function Code Errors	Total # of Function Code Errors	Value	8-Bit	R	0022	40035
Starting Addr. Errors	Total # of Starting Address Errors	Value	8-Bit	R	0023	40036
No. of Register Errors	Total # of Register Errors	Value	16-Bit	R	0024	40037
RXD CRC Hi Errors	Total # of RXD CRC Hi Errors	Value	16-Bit	R	0025	40038
RXD CRC Low Errors	Total # of RXD CRC Low Errors Same as 38	Value	16-Bit	R	0026	40039
Ch1 Parity Errors	Total parity errors	Value	16-Bit	R	0027	40040
Ch1 Overrun errors	Total overrun errors	Value	16-Bit	R	0028	40041
Ch1 Framing errors	Total Framing errors	Value	16-Bit	R	0029	40042
Ch1 Software Errors	Total Software request errors	Value	16-Bit	R	002A	40043
Not used					002B	40044
Clear CH1 Errors	Clear Ch1 Hardware Errors	Bit	(0)	W	002C	40045
Clear Ch1 Errors	Clear Ch 1 Software Errors	Bit	(0)	W	002D	40046
HART Ao Range	Changes the range of Ao for HART only			R/W	002E	40047
Not used	Internal use only				002F	40048
Event Timer	Event Set Time Hi				0030	40049
Event Timer	Event Set Time Lo				0031	40050
	<b>See Event CHART</b>					
	Clear Event				005F	40096
User Info	User information 1				0060	40097
User Info	User information 2				0061	40098
	“	“”				
	“					
User info	User information 16				006F	40112
Ch2 Total Receive Errors	Total # of Receive Errors	Value	16-Bit	R	0070	40113

Parameter	Function	Type	Scale	Access	Register Address	Master I/O Address
Ch2 Bus Activity Rate	Bus Activity Rate in % of This Addressed Node vs. Other Addressed Nodes	Decimal		R	0071	40114
Ch2 Function Code Errors	Total # of Function Code Errors	Value	16-Bit	R	0072	40115
Ch2 Starting Addr Errors	Total # of Starting Address Errors	Value	16-Bit	R	0073	40116
Ch2 No of Register Errors	Total # of Register Errors	Value	16-Bit	R	0074	40117
Ch2	CRC errors	Value	16-Bit	R	0075	40118
Ch2	CRC errors	Value	16-Bit	R	0076	40119
Ch2 Parity Errors	Total parity errors	Value	16-Bit	R	0077	40120
Ch2 Overrun errors	Total overrun errors	Value	16-Bit	R	0078	40121
Ch2 Framing errors	Total Framing errors	Value	16-Bit	R	0079	40122
Ch2 Software Errors	Total Ch 2 Software request errors	Value	16-Bit	R	007A	40123
Not used	Not used				007B	40124
Ch2 Clear errors	Ch2 Clear Hardware errors	Bit	0	R/W	007C	40125
Ch2 Clear errors	Ch2 Clear Software errors	Bit	0	R/W	007D	40126
Not used	Not used				007E	40127

Table 8: Command Register Locations

## 8.8 Ultima MOS-5 Command Register Details

### 8.8.1 Analog (00H)

A read returns a value, which is proportional to the 0-20 mA output current. The current is based on a 16-bit value. The scaling is 0 - 65535 decimal, which corresponds to 0 - 21.7 mA.

### 8.8.2 Mode (01H)

A read returns the present mode of the Ultima MOS-5 Intelligent Sensor.

A write command changes the mode to the requested mode. A data value of 08 starts calibration mode if the unit is in the run mode. It also goes from cal check to cal mode.

Exception: Returns an exception code 01 (illegal function) if an illegal write is requested.

A calibrate command returns an exception code 01 (Acknowledge 05). The operation will take a long time to complete.

Function	Bit Position	Access
Calibration Complete	7 MSB	Read
Spanning	6	Read
Zero Complete, Waiting for Gas	5	Read
Zeroing	4	Read
Calibration Mode	3	Read/Write
Calibration Check Mode	2	Read/Write
Run Mode	1	Read
Startup Mode	0 LSB	Read

### 8.8.3 Status/Error (02H)

A read returns the alarm state and errors that are occurring at the present time, which are indicated, by bit position.

Function	Bit Position	Access
Alarm	15 MSB	Read
Warn	14	Read
Fault	13	Read
Not Used	12	Read
Not Used	11	Read
Not Used	10	Read
Not Used	9	Read
Switch Error	8	Read
Setup Error	7	Read
Calibration Check Timeout	6	Read
EEPROM Error	5	Read
EPR0M Error	4	Read
Sensor Error	3	Read
Fail to Calibrate	2	Read
Low Supply Voltage	1	Read

**8.8.4 Not Used (03H)**

**8.8.5 Unit Type (04H)**

A read returns the decimal value 4005. This identifies the Ultima MOS-5 Intelligent Sensor.

**8.8.6 Software Revision (05H)**

A read returns the software revision of the Ultima MOS-5 Intelligent Sensor in 2 ASCII characters.

**8.8.7 Status Block (06H)**

A read returns a 6-byte message containing the analog (2 bytes), mode (1 byte), status/error (2 bytes), and sensor life (1 byte) in that order. For the format of each byte, refer to the appropriate individual commands.

---

**NOTE:** These registers can be read individually or as a group. Only when the starting address is 06 is a block return.

---

**8.8.8 Analog Value (06H)**

A value which is proportional to the 0-20 mA output current. The current is based on a 16-bit value. The scaling is 0 - 65535 decimal, which corresponds to 0 - 21.7 mA.

**8.8.9 Mode & Error (07H)**

See mode (02)

Calibration Complete	8000
Spanning	4000
Zero Complete, Waiting for Gas	2000
Zeroing	1000
Calibration Mode	0800
Calibration Check Mode	0400
Run Mode	0200
Startup Mode	0100
Alarm	0080
Warn	0040
Error ( any error)	0020
NA	0010
NA	0008
NA	0004
Internal	0002
Switch	0001

**8.8.10 Error Sensor & Sensor Life (08H)**

**8.8.10.1 Upper Bit for Sensor Errors**

Setup error	80
Cal Check error	40
EEPROM Check sum error	20
Flash Check sum	10

Sensor	08
Calibration error	04
Low supply	02
NA	01

### 8.8.10.2 Lower Bit for Sensor Life

Sensor Life	0-100%
-------------	--------

### 8.8.11 Display (0x09H & 0x0AH)

The display is also present on the Modbus. It is at address 0x09 and 0x0A. The first address (0x09) contains the LED, the decimal point location, and the most significant digit (MSD). The upper word represents the LED and Decimal point. They are defined as shown below. The lower word is the ASCII value for the MSD. The second address (0x0A) represents the middle digit (MID) and the least significant digit (LSD) in ASCII. The upper word represents the MID and the lower word represents the LSD.

DP_LSD	0x01
DP_MID	0x02
DP_MSD	0x04
WRN_LED	0x08
ALM_LED	0x10

### 8.8.12 Serial Number (0BH/0CH)

The serial number is a 32-bit word but the value is only 23 bits long. The upper bits are always zero. This is done to keep the same serial number as the HART serial number. Address 0x0C contains the lower part of the number and address 0x0B contains the upper part.

### 8.8.13 Alarm Settings (0DH)

A read returns the present alarm settings of the Ultima MOS-5 Intelligent Sensor. A write command changes the settings to the requested values. The set points are programmable in 5% FS steps (1% FS steps for 20 ppm range).

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**NOTE:** The maximum alarm setting for the Ultima MOS-5 Intelligent Sensor is 60% LEL.

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A “1” in the 9<sup>th</sup> bit position means the output is latching, a “0” means it is non-latching. A “1” in the 8<sup>th</sup> bit position means the output is normally energized a “0” means it is normally de-energized. The alarm set point cannot be set below the warn set point.

**Factory default is 60% FS, latching, de-energized.**

Exception: Returns an exception code 01 (illegal function) if an illegal write is requested.

Byte	Function	Bit Position	Access
High	Not Used	15 MSB	Read
	Not Used	14	Read
	Not Used	13	Read
	Not Used	12	Read
	Not Used	11	Read
	Not Used	10	Read
	Latching/Non-Latching	9	R/W
	Energized/De-Energized	8	R/W
Low	Set point	(7-0)	R/W

#### 8.8.14 Warn Settings (0EH)

A read returns the present warn settings of the Ultima MOS-5 Intelligent Sensor. A write command changes the settings to the requested values. The set points are programmable in 5% FS steps (1% FS steps for 20 ppm range).

**NOTE:** The maximum alarm setting for the Ultima MOS-5 Intelligent Sensor is 60% LEL.

A “1” in the 9<sup>th</sup> bit position means the output is latching, a “0” means it is non-latching. A “1” in the 8<sup>th</sup> bit position means the output is normally energized a “0” means it is normally de-energized. The warn set point cannot be set above the alarm set point.

**Factory default is 30% FS, non-latching, de-energized. The maximum allowable set point is 50 ppm.**

Exception: Returns an Exception Code 01 (illegal function) if an illegal write is requested.

Byte	Function	Bit Position	Access
High	Not Used	15 MSB	Read
	Not Used	14	Read
	Not Used	13	Read
	Not Used	12	Read
	Not Used	11	Read
	Not Used	10	Read
	Latching/Non-Latching	9	R/W
	Energized/De-Energized	8	R/W
Low	Set point	(7-0)	R/W

#### 8.8.15 Com1 Address (0FH)

A read command returns the current address for Com1. A write command changes the address to the requested value. Valid addresses are 1-247 decimal. **Factory default is 1.**

Exception: If the address is not in range an illegal data value (03) is returned.

#### 8.8.16 Com1 Baud Rate (10H)

A read command returns the current baud rate for Com1. A write command changes the baud rate to the requested values. Valid settings are shown in the table on the following page. **Factory default is 19200.**

Baud Rate	Value	Access
2400	24	Read/Write
4800	48	Read/Write
9600	96	Read/Write
19200	192	Read/Write

**Table 9: Com1 Baud Rate**

Exception: If the baud rate is not in range, an illegal data value (03) is returned.

### 8.8.17 Com1 Data Format (11H)

A read command returns the current data format for Com1. Write command changes the data format to the requested values. Valid settings are shown in the table below. **Default format is 8-N-1.**

Data	Parity	Stop	Format	Data(Bits 9-8)	Access
8	None	1	8-N-1	0	Read/Write
8	Even	1	8-E-1	1	Read/Write
8	Odd	1	8-O-1	2	Read/Write
8	None	2	8-N-2	3	Read/Write

**Table 10: Com1 Data Format**

Exception: If the data format is not in range, an illegal data value (03) is returned.

### 8.8.18 Com2 Address (12H)

A read command returns the current address for Com2. A write command changes the address to the requested values. Valid addresses are 1-247 decimal. **Factory default is 2.**

Exception: If the address is not in range an illegal data value (03) is returned.

### 8.8.19 Com2 Baud Rate (13H)

A read command returns the current baud rate for Com2. A write command changes the baud rate to the requested values. Valid settings are shown in the table below. **Factory default is 19200.**

Baud Rate	Value	Access
2400	24	Read/Write
4800	48	Read/Write
9600	96	Read/Write
19200	192	Read/Write

**Table 11: Com2 Baud Rate**

Exception: If the baud rate is not in range an illegal data value (03) is returned.

### 8.8.20 Com2 Data Format (14H)

A read command returns the current data format for Com2. Write command changes the data format to the requested values. Valid settings are shown in the table below. **Factory default is 8-N-1.**

Data	Parity	Stop	Format	Data(Bits 9-8)	Access
8	None	1	8-N-1	0	Read/Write
8	Even	1	8-E-1	1	Read/Write
8	Odd	1	8-O-1	2	Read/Write
8	None	2	8-N-2	3	Read/Write

**Table 12: Com2 Data Format**

Exception: If the data format is not in range an illegal data value (03) is returned.

### 8.8.21 Not Used (15H)

### 8.8.22 Reset Alarms (16H)

A write to this register with a data value of 1 resets any latched alarms provided the current gas level is below the alarm set point.

### 8.8.23 Sensor Life (17H)

A read returns the current estimate of remaining sensor life in percentage.

### 8.8.24 Sensor Scale (18H)

A read returns the current H<sub>2</sub>S sensor scale selected: 0-20 ppm, 0-50 ppm, 0-100 ppm. A write changes the scale to the desired scale. If the scale is changed, a calibration fault is generated, forcing the operator to calibrate the unit.

H <sub>2</sub> S Sensor Scale	Value (decimal)
0-20 ppm	20
0-50 ppm	50
0 –100 ppm	100

**Table 13: Sensor Scale**

### 8.8.25 MODEL 10K Controller (Co – Calibration Output) (19H)

This register indicates when a successful calibration takes place. In MODEL 10K Controller mode, the current goes to 3.2 mA for five seconds then to 4.0 mA. An aborted calibration would go straight to 4.0 mA. A read to this register will return the status of the MODEL 10K Controller option.

0x01 enables this option, 0x00 disables this option, similar to the write.

### 8.8.26 Not Used (1A, AB, 1C H)

## 8.9 HART Enable (1D H)

This command enables or disables the HART. A “0” is Modbus a “1” is HART.

### 8.9.1 HART Test (1Eh)

This command is used to test the HART output. It produces constant zeros or constant ones on the HART output.

Code	Results
0	Normal
1	Constant ones
2	Constant zeros

### 8.9.2 Abort Calibration (1Fh)

Sending a "1" causes a calibration or calibration abort.

### 8.9.3 Total Receive Errors (20H)

A read indicates the total number of Modbus communication receive errors that occurred in the slave device. When the counter for these errors reaches 255, it rolls over to zero and begins counting again. The total errors are an accumulation of the individual communication errors listed below.

### 8.9.4 Bus Activity Rate % (21H)

A read indicates the bus activity rate in percent of this Slave's addressed node versus other addressed nodes. Range of this value is in hex (0-64) which translates to decimal (0-100%).

### 8.9.5 Function Code Errors (22H)

A read indicates the number of function code errors that occurred in the slave device. When the counter for these errors reaches 255, it rolls over to zero and begins counting again.

### 8.9.6 Starting Address Errors (24H)

The counter is incremented for each address that does not equal the device address.

A read indicates the number of starting address errors that occurred in the slave device. When the counter for these errors reaches 255, it rolls over to zero and begins counting again.

### 8.9.7 RXD CRC Errors Hi (25H)

A read indicates the number of RXD CRC errors that occurred in the slave device. When the counter for these errors reaches 255, it rolls over to zero and begins counting again.

### 8.9.8 RXD CRC Errors Lo (Same as Hi) (26H)

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**NOTE:** Hi and Lo CRC errors are now reported in the same word. A read from either Hi or Lo returns the same count.

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### 8.9.9 Parity Errors (27H)

A read indicates the number of hardware UART parity errors that occurred in the slave device. When the counter for these errors reaches 65535, it rolls over to zero and begins counting again.

### 8.9.10 Overrun Errors (28H)

A read indicates the number of hardware UART overrun errors that occurred in the slave device. When the counter for these errors reaches 65535, it rolls over to zero and begins counting again.

### 8.9.11 Framing Errors (29H)

A read indicates the number of hardware UART framing errors that occurred in the slave device. When the counter for these errors reaches 65535, it rolls over to zero and begins counting again.

### 8.9.12 Total Software CH1 Errors (2AH)

A read indicates the number of address or data errors that occurred in the slave device. When the counter for these errors reaches 65535, it rolls over to zero and begins counting again.

### 8.9.13 Not Used (2BH)

### 8.9.14 Clear Hardware Errors (2CH)

Clear parity, framing, and overrun errors.

### 8.9.15 Clear Communication Errors (2DH)

#### 8.9.15.1 HART Low Current Select (2EH)

Normally in HART mode the low current does not decrease below 3.5 mA. If use of current levels below 3.5mA is required by an application, the Ultima MOS-5 Intelligent Sensor features and expanded scale that permits faults to be set as low as 1.25 mA. A read returns "1" or "0."

Condition	HART Current Normal	HART Expanded Scale
Run	4 to 20 mA	4 to 20 mA
Off Line	3.5 mA	1.5 mA
Fault	3.5 mA	1.25 mA

#### 8.9.15.2 Internal Use (2FH)

#### 8.9.15.3 Event Logging (30H to 5FH)

##### Faults

- Whenever the fault word changes, the time is recorded.
- Time of fault is saved.
- The quantity of faults is saved in a counter.
- When the fault is removed, it is not saved and the counter is not incremented.
- A fault event is logged for every 30 seconds recorded.
- There are a total of ten event time stamps stored.

### Warning

The time the gas level reaches the warning level is recorded. Each time this happens a counter is incremented. The end of the event is when the gas goes below 5%. The counter is also saved. There are a total of ten event time stamps stored.

### Alarm

The time where the gas level reaches the alarm level is recorded. Each time this happens a counter is incremented. The end of the event is when the gas goes below 5%. The counter is also saved. There are a total of ten event time stamps stored.

### Calibration

The time a successful zero and calibration occurs is saved in the event log. A counter is increment for each successful calibration. If the unit fails to zero or calibrate, the event is not recorded. If the calibration is aborted the event is also not recorded. Note the zero and calibration are one operation in the Ultima MOS-5 Intelligent Sensor. There are a total of ten event time stamps stored.

### Maintenance

The time a Check Calibration occurs is saved in the maintenance event log. Each successful calibration increments the maintenance counter. There are a total of 10 event time stamps stored.

### Setting structure clock

See table below.

**Event Logging Registry Table**

Address (hex)	Parameter	Function	Data Type	Data range	Access
30	Seconds Time Hi	Seconds Time Hi	Numeric value	0 – 65535	<b>Timer Sec</b>
31	Seconds Time Low	Seconds Time	Numeric value	0 – 65535	<b>Timer Sec</b>
32	Real Time Clock Year, Month	Read/Set year and month of RTC	2 Numeric Values	0-99 year, 1 – 12 month	<b>Timer Struct</b>
33	Real Time Clock Day, Hour	Read/Set day and hour of RTC	2 Numeric Values	1 – 31 day, 0 – 23 hour	
34	Real Time Clock Minute, Second	Read/Set minutes and seconds of RTC	2 Numeric Values	0 – 59 minute, 0 – 59 second	<b>Timer Struct</b>
35	Power Cycle Flag	Read Power Cycle Flag.	Numeric Value	1 – Time Not Reset; 0 – Time Was Reset	<b>Flag</b>
36	Event Index	Event index of Logged Event	Numeric value	0 - 9	<b>Index</b>
37	Warn Seconds Time Hi	Seconds Time Hi for warning event log entries	Numeric value	0 – 65535	<b>Warn</b>
38	Seconds Time Low	Seconds Time Low for warning event log entries	Numeric value	0 – 65535	<b>Warn</b>

## Ultima MOS-5 Detector

Address (hex)	Parameter	Function	Data Type	Data range	Access
39	Structure time Hi	Hi byte – year, low byte – month for warning	Numeric value	0 – 65535	<b>Warn</b>
3A	Structure time Mid	Hi byte – day, low byte – hour warning event log entries	Numeric value	0 – 65535	<b>Warn</b>
3B	Structure time Low	Hi byte – min, low byte – sec for warning event log entries	Numeric value	0 – 65535	<b>Warn</b>
3C	Reserved	Reserved	Numeric value	0	
3D	Reserved	Reserved	Numeric value	0	
3E	Warn Event Count	Warning Event Count	Numeric value	0 – 65535	<b>Warn</b>
3F	Alarm Seconds Time Hi	Seconds Time Hi for alarm event log entries	Numeric value	0 – 65535	<b>Alarm</b>
40	Seconds Time Low	Seconds Time Low for alarm event log entries	Numeric value	0 – 65535	<b>Alarm</b>
41	Structure time Hi	Hi byte – year, low byte – month for alarm event log entries	Numeric value	0 – 65535	<b>Alarm</b>
42	Structure time Mid	Hi byte – day, low byte – hour alarm event log entries	Numeric value	0 – 65535	<b>Alarm</b>
43	Structure time Low	Hi byte – min, low byte – sec for alarm event log entries	Numeric value	0 – 65535	<b>Alarm</b>
44	Reserved	Reserved	Numeric value	0	
45	Reserved	Reserved	Numeric value	0	
46	Alarm Event Count	Alarm Event Count	Numeric value	0 – 65535	<b>Alarm</b>
47	Fault Seconds Time Hi	Seconds Time Hi for fault event log entries	Numeric value	0 – 65535	<b>Fault</b>
48	Seconds Time Low	Seconds Time Low for fault event log entries	Numeric value	0 – 65535	<b>Fault</b>
49	Structure time Hi	Hi byte – year, low byte – month for fault event log entries	Numeric value	0 – 65535	<b>Fault</b>
4A	Structure time Mid	Hi byte – day, low byte – hour alarm event log entries	Numeric value	0 – 65535	<b>Fault</b>
4B	Structure time Low	Hi byte – min, low byte – sec for fault event log entries	Numeric value	0 – 65535	<b>Fault</b>
4C	Fault code	Fault code. Same code as register 2	Numeric value	0 – 65535	<b>Fault</b>
4D	Reserved	Reserved	Numeric value	0	
4E	Fault Event Count	Fault Event Count	Numeric value	0 – 65535	<b>Fault</b>

Address (hex)	Parameter	Function	Data Type	Data range	Access
4F	Maintenance Seconds Time Hi	Seconds Time Hi for lamp test event log entries	Numeric value	0 – 65535	<b>Maintenance</b>
50	Seconds Time Low	Seconds Time Low for lamp test event log entries	Numeric value	0 – 65535	<b>Maintenance</b>
51	Structure time Hi	Hi byte – year, low byte – month for lamp test event log entries	Numeric value	0 – 65535	<b>Maintenance</b>
52	Structure time Mid	Hi byte – day, low byte – hour lamp test event log entries	Numeric value	0 – 65535	<b>Maintenance</b>
53	Structure time Low	Hi byte – min, low byte – sec for lamp test event log entries	Numeric value	0 – 65535	<b>Maintenance</b>
54	Maintenance code	Cal check	Numeric value	0	<b>Maintenance</b>
55	Reserved	Reserved	Numeric value	0	
56	Maintenance Count	Maintenance Count	Numeric value	0 – 65535	<b>Maintenance</b>
57	Calibrate Seconds Time Hi	Seconds Time Hi for lamp test event log entries	Numeric value	0 – 65535	<b>Calibrate</b>
58	Seconds Time Low	Seconds Time Low for lamp test event log entries	Numeric value	0 – 65535	<b>Calibrate</b>
59	Structure time Hi	Hi byte – year, low byte – month for lamp test event log entries	Numeric value	0 – 65535	<b>Calibrate</b>
5A	Structure time Mid	Hi byte – day, low byte – hour lamp test event log entries	Numeric value	0 – 65535	<b>Calibrate</b>
5B	Structure time Low	Hi byte – min, low byte – sec for lamp test event log entries	Numeric value	0 – 65535	<b>Calibrate</b>
5C	Calibrate code	Cal	Numeric value	0	<b>Calibrate</b>
5D	Reserved	Reserved	Numeric value	0	
5E	Calibrate Count	Calibrate Count	Numeric value	0 – 65535	<b>Calibrate</b>
5F	Reset Event Counters	Reset Event Counters	Numeric value	1	<b>Reset</b>

### 8.9.16 User Information (60H to 6FH)

There is a section in memory that allows the user to store information. This is useful if the physical location or other user identification is required. The only restriction on the information is it must be Modbus compatible. Only one word can be written per command. There are a total of 16 words for the user.

### **8.9.17 CH2 Total Receive Errors (70H)**

A read indicates the total Modbus communication hardware receive errors that occurred in the slave device. The maximum count is 65535 and then the counter will rollover to zero and begin counting again. The total errors are an accumulation of the individual communication errors listed below.

### **8.9.18 CH2 Bus Activity Rate % (71H)**

A read indicates the bus activity rate in percent of this slave's addressed node versus other addressed nodes. Range of this value is in hex (0-64), which translates to decimal (0-100%).

### **8.9.19 CH2 Function Code Errors (72H)**

A read indicates the number of function code errors that occurred in the slave device. The maximum count is 65535 and then the counter will rollover to zero and begin counting again.

### **8.9.20 CH2 Starting Address Errors (73H)**

The counter is incremented for each address that does not equal the device address. A read indicates the number of starting address errors that occurred in the slave device. The maximum count is 65535 and then the counter will rollover to zero and begin counting again.

### **8.9.21 CH2 Number of Register Errors (74H)**

A read indicates the number of register errors that occurred in the slave device. The maximum count is 65535 and then the counter will rollover to zero and begin counting again.

### **8.9.22 CH2 RXD CRC Errors Hi (75H)**

A read indicates the number of RXD CRC errors that occurred in the slave device. The maximum count is 65535 and then the counter will rollover to zero and begin counting again.

### **8.9.23 CH2 RXD CRC Errors Lo (Same as Hi) (76H)**

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**NOTE:** Hi and Lo CRC errors are now reported in the same word. A read from either Hi or Lo will return the same count.

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### **8.9.24 CH2 Parity Errors (77H)**

A read indicates the number of hardware UART parity errors that occurred in the slave device. The maximum count is 65535 and then the counter will rollover to zero and begin counting again.

### **8.9.25 CH2 Overrun Errors (78H)**

A read indicates the number of hardware UART overrun errors that occurred in the slave device. The maximum count is 65535 and then the counter will rollover to zero and begin counting again.

### **8.9.26 CH2 Framing Errors (79H)**

A read indicates the number of hardware UART framing errors that occurred in the slave device. The maximum count is 65535 and then the counter will rollover to zero and begin counting again.

### **8.9.27 CH2 Total Software CH1 Errors (7AH)**

A read indicates the number of address or data errors that occurred in the slave device. The maximum count is 65535 and then the counter will rollover to zero and begin counting again.

### **8.9.28 Not Used (7BH)**

### **8.9.29 CH2 Clear UART Errors (7CH)**

### **8.9.30 CH2 Clear Stats (7DH)**

## 9.0 Appendix

### 9.1 Warranty

MSA warrants the Ultima MOS-5 Intelligent Sensor to be free from defects in workmanship or material under normal use and service within two years from the date of shipment.

MSA will repair or replace without charge any such equipment found to be defective during the warranty period. Full determination of the nature of, and responsibility for, defective or damaged equipment will be made by MSA personnel.

Defective or damaged equipment must be shipped to the MSA plant or representative from which the original shipment was made. In all cases this warranty is limited to the cost of the equipment supplied by MSA. The customer will assume all liability for the misuse of this equipment by its employees or other personnel.

All warranties are contingent upon proper use in the application for which the product was intended and does not cover products which have been modified or repaired without MSA approval, or which have been subjected to neglect, accident, improper installation or application, or on which the original identification marks have been removed or altered.

EXCEPT FOR THE EXPRESS WARRANTY STATED ABOVE, MSA DISCLAIMS ALL WARRANTIES WITH REGARD TO THE PRODUCTS SOLD, INCLUDING ALL IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS AND THE EXPRESS WARRANTIES STATED HEREIN ARE IN LIEU OF ALL OBLIGATIONS OR LIABILITIES ON THE PART OF MSA FOR DAMAGES INCLUDING, BUT NOT LIMITED TO, CONSEQUENTIAL DAMAGES ARISING OUT OF, OR IN CONNECTION WITH, THE PERFORMANCE OF THE PRODUCT.

### 9.2 Principle of Operation

MSA uses a proprietary Metal Oxide Semiconductor (MOS) film on the sensor for detecting hydrogen sulfide ( $H_2S$ ) gas. The MOS film is deposited onto a substrate between two electrodes. With no gas present, the measured resistance between these two electrodes is very high (in the mega-Ohms). As  $H_2S$  adsorbs onto the film, the resistance between the two electrodes decreases (to kilo-Ohms). This decrease in resistance is logarithmically proportional to the concentration of  $H_2S$  that is present.

The change in resistance is converted to a change in voltage, and amplified by the input circuit. This amplified signal is fed to an Analog to Digital (A/D) Converter, converted to a digital signal and sent to the microprocessor to be processed. The process of  $H_2S$  adsorbing onto the MOS film is most effective at an elevated temperature. On the outer edge of the substrate is a heater ring. The temperature of this heater ring is measured with a thermistor, and kept constant by a circuit located inside the body of the sensor.

As  $H_2S$  adsorbs onto the film, electrons move more freely from one electrode to the other. This is represented as a decrease in resistance. The process of  $H_2S$  adsorbing onto the MOS film is completely reversible. As the concentration of  $H_2S$  decreases ( $H_2S$  desorbs), the resistance between the electrodes will increase.

## 9.3 Specifications

### 9.3.1 System Specifications

<b>Sensor Type:</b>	Continuous diffusion, adsorption type metal oxide semiconductor (MOS)
<b>Sensor Life:</b>	3 to 5 years typical
<b>Repeatability:</b>	$\pm 2$ ppm or 10% of the applied gas, whichever is greater
<b>Long Term Drift:</b>	$\pm 2$ ppm or 10% of reading, whichever value provides the wider tolerance (as defined per ISA-92.0.01)
<b>Response Time</b>	$T_{50} < 14$ seconds (screen); $T_{50} < 30$ seconds (sintered)
<b>Typical:</b>	with full scale gas applied according to ISA 92.0.01
<b>Measuring Ranges:</b>	0-20 ppm, 0-50 ppm, 0-100 ppm
<b>Modes:</b>	Calibration, gas check, setup
<b>Approvals:</b>	<b>CSA/FM:</b> Class I, Division 1, Groups B, C, D T6; $T_{amb} = -40^{\circ}\text{C}$ to $+60^{\circ}\text{C}$ (FM); $-40^{\circ}\text{C}$ to $+75^{\circ}\text{C}$ (CSA) <b>CSA:</b> Ex d IIB + H <sub>2</sub> T5 Gb ( $T_{amb} = -40^{\circ}\text{C}$ to $+70^{\circ}\text{C}$ ) <b>ATEX/IECEX:</b> II 2 G Ex d IIB+H <sub>2</sub> T5 Gb ( $T_{amb} = -40^{\circ}\text{C}$ to $+70^{\circ}\text{C}$ )
<b>Warranty:</b>	Two years

### 9.3.2 Mechanical Specifications

<b>Length:</b>	6.4 inches (161 mm)
<b>Height:</b>	3.4 inches (86 mm)
<b>Width:</b>	4.1 inches (104 mm)
<b>Weight:</b>	5.5 lbs. (2.5 kg) – AL, 14.0 lbs (6.4 kg) – SS
<b>Mounting Holes:</b>	5.0 inches (127mm) (center to center)
<b>Housing:</b>	Aluminum alloy (6061-T6 cover, A356-T6 base) or 316 stainless steel

### 9.3.3 Electrical Specifications

<b>Input Power:</b>	24 VDC nominal, 20 to 36 VDC, 350 mA max.
<b>Power Consumption</b>	Start-up 270 mA, Normal Operation 120 mA

<b>Relay Ratings:</b>	8 A @ 250 VAC / 8 A @ 30 VDC resistive max. (3x) SPDT - Warning, Alarm & Fault
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#### Analog Signal:

	HART not enabled	HART	HART modified AO
Malfunction	0 mA	3.5 mA	1.25 mA
Calibration	1.5 mA	3.5 mA	1.5 mA
Gas Check	1.5 mA	3.5 mA	1.5 mA
Setup mode	1.5 mA	3.5 mA	1.5 mA
Startup	4.05 mA	4.05 mA	4.05 mA
Zero reading	4.05 mA	4.05 mA	4.05 mA
0-100% LEL	4-20 mA	4 – 20 mA	4.0 – 20 mA
Over-range	20-22 mA	20 – 21.7 mA	20 – 21.7 mA

<b>Status Indicators:</b>	Three-digit digital display with gas concentration, warn and alarm LEDs, calibration prompts, fault codes, and setup options
<b>RS-485 Output:</b>	Dual Redundant Modbus RTU, suitable for linking up to 128 units or up to 247 units with repeaters
<b>Baud Rate:</b>	2400, 4800, 9600, or 19200 BPS

**Faults Monitored:** Calibration error, sensor heater error, low DC supply, EEPROM, EPROM, setup error, gas check time exceeded, switch error, magnet error.

**EMC Protection:** Complies with EN 50270, EN 61000-6-4

**HART:** RX 100K CX 5nF

**Cable Requirements:** 3-wire shielded cable. Maximum distance between Ultima MOS-5 Intelligent Sensor and power source @ 24 VDC nominal with warn & alarm relay energized. If no relays are used the distance can be increased by 20%.

AWG	FEET	METERS
14	2240	824
16	1408	518
18	886	326
20	557	205

**Table 14: 24 VDC Cable Lengths**

Based on 20 Ohm cable resistance the recommended analog output cable length is shown in Table 16. The total resistance should not exceed 600 Ohms @ 24 Volts.

AWG	FEET	METERS
14	8000	2400
16	5000	1500
18	3100	950
20	2000	600

**Table 15: Analog Output Cable Lengths**

Maximum distance between the transmitter and sensor with one way resistance of 10 Ohms (20-Ohm loop):

AWG	FEET	METERS
14	4000	1200
16	2500	750
18	1500	460
20	1000	300

**Table 16: Sensor Cable Lengths**

*European Union (EU) Approved Applications:* PSU noise and ripple voltage 1.0 Vpp max. The customer supplied PSU must comply with IEC 1010-1, limiting current to 8 A under fault conditions in order to comply with the CE Marking requirements.

### 9.3.4 Environmental Specifications

Operating Temperature Range	CSA	FM	ATEX/IECEX
Electronics	<b>Division Classification</b> -40°F to 167°F (-40°C to 75°C) <b>Zone Classification</b> -40°F to 158°F (-40°C to 70°C)	-40°F to 140°F (-40°C to 60°C)	-40°F to 158°F (-40°C to 70°C)
<b>Storage Temperature Range</b>	-58°F to 185°F (-50°C to +85°C)		
<b>Operating Humidity Range</b>	10% to 95% RH, non-condensing		

## 9.4 Approvals

CE Marking; CSA, FM, ATEX, IECEx and GOST approved. Complies with ANSI/ISA-92.0.01:1998, performance requirements. SIL 2/3 suitable (*use in typical environments has a lower safety rating than in clean environments*). HART Registered.

HART:

- Approved by the HART Communication Foundation.
- Compatible with Emerson 375 Field Communicator.
- Listed in Emerson Process Management's Aware device list.

## 9.5 Spare Parts and Accessories

To order spare parts and/or accessories, please contact the nearest MSA Representative or, MSA directly, and give the following information:

- Part Number of Spare Part or Accessory
- Description of Spare Part or Accessory
- Quantity of Spare Part or Accessory

### 9.5.1 Sensors

50445-1	0 to 100 ppm, Aluminum Body, Wire Screen Arrestor
50445-5	0 to 50 ppm, Aluminum Body, Wire Screen Arrestor
50445-9	0 to 20 ppm, Aluminum Body, Wire Screen Arrestor
50448-1	0 to 100 ppm, Stainless Steel Body, Wire Screen Arrestor
50448-5	0 to 50 ppm, Stainless Steel Body, Wire Screen Arrestor
50448-9	0 to 20 ppm, Stainless Steel Body, Wire Screen Arrestor
51457-1L	0 to 100 ppm, Stainless Steel Body, Sintered Steel Arrestor

51457-5L 0 to 50 ppm, Stainless Steel, Sintered Steel Arrestor

51457-9L 0 to 20 ppm, Stainless Steel, Sintered Steel Arrestor

### 9.5.2 Sensor Housing

10252-1 Universal Housing

### 9.5.3 Sensor Accessories

10041-1 Duct Mounting Plate

10044-1 Dust Guard Kit - 1 Guard, 12 Replaceable Screens

10042-1 Replaceable Screens, Box of 12

10395-1 Splash Guard Assembly

10110-1 Dust Guard Assembly

1800822-1 Dust Guard, Sintered SST

10066 Sensor Flow Chamber

### 9.5.4 Calibration Equipment

50000 Breaker Bottle, Single

50004-3 Individual Ampoules, 10 ppm (12 minimum)

50004-21 Individual Ampoules, 25 ppm (12 minimum)

50004-13 Individual Ampoules, 50 ppm (12 minimum)

50008-9 12 Ampoules at 50 ppm (0-100ppm scale)

50008-16 12 Ampoules at 25 ppm (0-50ppm scale)

50008-10 12 Ampoules at 10 ppm (0-20ppm scale)

50009-9 12 Ampoules at 50 ppm, includes breaker bottle (0-100 ppm scale)

50009-16 12 Ampoules at 25 ppm, includes breaker bottle (0-50 ppm scale)

50009-10 12 Ampoules at 10 ppm, includes breaker bottle (0-20 ppm scale)

1400250-1 10 ppm H<sub>2</sub>S Portable Purge Calibration Assembly

1400250-3 25 ppm H<sub>2</sub>S Portable Purge Calibration Assembly

1400250-5 50 ppm H<sub>2</sub>S Portable Purge Calibration Assembly

1400255-1	10 ppm H <sub>2</sub> S Replacement Cylinder
1400255-3	25 ppm H <sub>2</sub> S Replacement Cylinder
1400255-5	50 ppm H <sub>2</sub> S Replacement Cylinder

### **Case for Portable Purge Assembly**

922-016	Replacement Regulator (0.2 L/min)
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### **Replacement Hose**

960-345	Hose Clamp, 5/16"
960-346	Hose Clamp, 1/4"
1400152-1	Calibration Cup

## **9.5.5 Intelligent Sensor (Ultima MOS-5 Intelligent Sensor) Replacement Parts**

32471-1,-2,-3,-4	Control Board Electronics
32451-1,-2	Output Board Electronics
32441-1	Display Board Electronics
32424-2	Enclosure Cover Assembly with Window
31195-2	Enclosure Base Assembly
30051-1	Explosion-Proof SPST Switch
30060-2	Calibration Magnet
925-5007	Cover Assembly O-Ring

## **9.5.6 Recommended Spare Parts for One Year**

30060-2	Extra Calibration Magnet (Qty. 1)
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## 9.6 FM Approval

Factory Mutual Research Corporation  
1151 Boston-Providence Turnpike  
Norwood, Massachusetts 02062

Approval of the transmitter does not include or imply approval of apparatus, to which the transmitter may be connected and which processes the electronic signal for the eventual end use. In order to maintain FMRC approved system, the control instrument, to which the subject instrument is connected, must also be FMRC approved.

The following sensors have been FMRC approved for use with the Ultima MOS-5 Intelligent Sensor:

- 50445-1 Aluminum Body H2S Gas Specific MOS Sensor, 0 to 100 ppm
- 50445-5 Aluminum Body H2S Gas Specific MOS Sensor, 0 to 50 ppm
- 50445-9 Aluminum Body H2S Gas Specific MOS Sensor, 0 to 20 ppm
- 50448-1 Stainless Steel Body H2S Gas Specific MOS Sensor, 0 to 100 ppm
- 50448-5 Stainless Steel Body H2S Gas Specific MOS Sensor, 0 to 50 ppm
- 50448-9 Stainless Steel Body H2S Gas Specific MOS Sensor, 0 to 20 ppm