ULTIMA MOS-5E

Hydrogen Sulphide
Smart Transmitter

The information and technical data disclosed in this document may be used and disseminated only for the purposes and to the extent specifically authorized in writing by General Monitors.

Instruction Manual

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

Part No. ULTIMAMOS5E-EU
Revision 01

Warranty Statement

MSA warrants the Model ULTIMA MOS-5E to be free from defects in workmanship or material under normal use and service within two (2) years from the date of shipment. MSA will repair or replace without charge any 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 prepaid to MSA plant or the representative from which 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 do 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 use or performance of the product.

Warnings

The instrument should be calibrated at least every 90 days. See sub-section 4.1.

Take note of sub-section 3.4 Sensor Poisons.

Install and maintain all hazardous area equipment in accordance with the relevant regulations and practices of the country concerned. See Section 3 Installation.

The ULTIMA MOS-5E must be protected by in-line 500mA PC≥ 1500A Char "T" fuse is required if voltage at unit is between 18VDC and 35VDC in the 24 VDC supply line. This is necessary to fully comply with approval requirements and good installation practices.

Note: MSA series of Trip Amplifiers have the 500mA fuse as standard.

The ULTIMA MOS-5E must be protected by an in-line 63mA; PC≥ 1500A Char "F" fuse in the analogue output line. This is necessary to fully comply with approval requirements and good installation practices.

WARNING - Installation and Maintenance must be carried out by suitably skilled and competent personnel only.

EC Declaration of Conformity

The manufacturer or his in the community established authorized representative

MSA AUER GmbH , Thiemannstraße 1 , D-12059 Berlin

declares that the product : **ULTIMA MOS-5E**

based on the EC-Type Examination Certificate : SIRA 11ATEX3129

complies with the ATEX directive 94/9/EC, Annex II. Quality Assurance Notification complying with Annex IV of the ATEX Directive 94/9/EC has been issued by SIRA Certification Service , Notified Body number: 0518.

Relevant Standards:
EN 50014:1997 + A1 / A2 EN 50019:1994
EN 50028: 1987

This product has been further evaluated against the requirements of EN 60079-0:2006 and EN 60079-1:2007 which include no changes that materially affects the state of technological progress with respect to this product.

The product is in conformance with the directive 89/336/EEC, (EMC) :

EN 50081-2: 1993 EN 61000 - 6 – 4

Dr. A. Schubert

MSA AUER GmbH
Dr. Axel Schubert
R & D Instruments

Berlin , April 2011

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1.0 Introduction

1.1 General Description

The MSA Model ULTIMA MOS-5E Smart Transmitter is a highly reliable, self contained, microprocessor controlled, single point calibration Hydrogen Sulphide monitor with integral 3-digit readout. The Transmitter is connected to the user's indicating and shut-down equipment by means of a screened and armoured cable.

The ULTIMA MOS-5E is designed to measure and display concentrations of Hydrogen Sulphide in one of three ranges: 0 to 20ppm, 0 to 50ppm and 0 to 100ppm, but will continue to display concentrations up to 120% of FSD.

No user adjustments are required. The instrument will record the number of successful calibrations, compute the sensor resistance in kohm during calibration and store in non-volatile memory, along with calibration and setup parameters.

The entire electronics modules is fully encapsulated in compliance with the relevant standards.

The Smart Transmitter's user interface is menu driven. In addition the instrument may be addressed via the dual Modbus RTU serial interface.

The accuracy of the Smart Transmitter depends upon routine re-calibration which should be carried out at least every 90 days. This procedure is extremely simple and may be carried out by one person aided by prompts from the digital display. Calibration may be completed in less than 5 minutes. All calibration parameters are tested by advance software routines before being accepted. Any errors detected will be shown on the digital display by means of an appropriate fault code.

Hydrogen Sulphide is an extremely dangerous gas. To ensure optimum performance the sensors should be tested at frequent intervals, especially in areas where risk of release or leakage is considered to be significant, or in conditions where the sensor may become blocked or damaged by adverse environmental conditions.

MSA is recognised as a leader in the field of gas detection and a team of experts is always available to provide advice or service as required.

2.0 Specifications

2.1 Approvals

Hazardous Area Standards	EN50014, EN50019, EN50028
Code of Protection	EExem II T5 (-50°C + 55°C) EExem II T4 (-50°C + 70°C) Cable insulation rated to at least 110°C
IP Rating:	IP66/67
Application:	Hydrogen Sulphide Gas Monitor

2.2 Functional

Measuring Range:	0-20 ppm, 0-50 ppm and 0-100 ppm, user selectable option setup
Measuring Resolution	1 ppm
Over-range Indication:	Display flashes for readings greater than 99% FSD, but continues to display gas concentration up to 120%
Calibration Level:	50% of selected measuring range
A1 Trip Level:	User selectable in 1 ppm increments 1 – 19 ppm for 0-20 ppm Measuring Range, default 5 ppm 5 – 45 ppm for 0-50 ppm Measuring Range, default 10 ppm 10 – 60 ppm for 0-100 ppm Measuring Range, default 25 ppm
A1 Open Collector Output	User selectable Energised/De-energised and Latching/Non-latching
A2 Trip Level:	User selectable in 1 ppm increments 1 – 19 ppm for 0-20 ppm Measuring Range, default 10 ppm 5 – 45 ppm for 0-50 ppm Measuring Range, default 25 ppm 10 – 95 ppm for 0-100 ppm Measuring Range, default 50 ppm
A2 Open Collector Output	User selectable Energised/De-energised and Latching/Non-latching
Fault Open Collector Output	Normally Energised
Analogue Output during Calibration	User selectable 0.0 mA, 1.5 mA and 2.0 mA
Modbus Baud Rate	User selectable 2400, 4800, 9600 and 19200 Baud
Modbus Format	User selectable 1/2 stopbits, odd/even/no parity, 8 databits
Modbus Node Address	User selectable 1 – 255; Address 0 is recognised as broadcast mode
Stability, Long Term:	± 4 ppm or 10% of applied gas whichever is greater (over 21 days)
Accuracy (Linearity)	± 4 ppm or 10% of applied gas whichever is greater (10°C to 50°C)
Temperature Variation	± 4 ppm or 10% of applied gas whichever is greater (-50°C to +70°C)
Humidity Variation:	± 4 ppm or 10% of applied gas whichever is greater (5%RH – 90% RH)
Response Time	T50<2 minutes

2.3 Mechanical

Height	150mm (6”)
Height incl. Sensor:	200mm (8”)
Width:	150mm (6”)
Depth:	95mm (3.75”)
Weight including Sensor:	2.5kg (5.5lbs)
Mounting Holes:	4 x 7 mm (0.28”) dia holes
Termination:	EExe II Terminal Block

2.4 Environmental

Operating temperature range (continuous) min/max	- 50°C to + 70°C
Storage temperature range min/max	- 50°C to + 70°C
Relative humidity min/max:	5% to 100%
Operating Altitude max:	8000 ft
Non-operating Altitude max:	16000 ft
EMI/RFI Emission:	Meets EN50081-2

2.5 Electrical

Supply voltage min/max:	18.5 VDC / 35 VDC
Supply voltage abs min/max:	18.5 VDC / 40 VDC
Supply voltage ripple & noise max.	1Vpp
Supply current consumption, including sensor typ/max:	140mA/200mA @ 24VDC 240mA/360mA @ 12VDC
Supply fuse rating: 18VDC – 35VDC operation	500mA Chart “T” PC ≥ 1500A
Supply voltage low detection threshold min/max:	9.20VDC / 10.32 VDC
Sensor Bias Current (Rsensor + Rcable = zero ohms) max:	420uA
Sensor Resistance range @ 50% FSD	3-80 kohms
Analogue Output Current Range:	0 – 22.0mA
Analogue Output Current abs max:	22.1mA
Analogue Output Current Ripple and Noise max.	20uApp
Analogue Output Current Tolerance max:	±50uA
Analogue output termination resistance min/max: (including total cable resistance)	0 – 750 ohms
Analogue output open-circuit detection current range min/max:	1.0mA – 22.0mA
Analogue output fuse rating:	63mA Char “F” PC ≥ 1500A
Remote calibration input Isink max	2.7mA
Remote calibration input Vin max:	24VDC
Open collector output Isink max Note: Inductive loads require an external clamp diode	100mA
Open collector output Vin max:	35VDC
Open collector output Vdrop-out @ 100mA max:	1VDC

2.6 Factory default settings

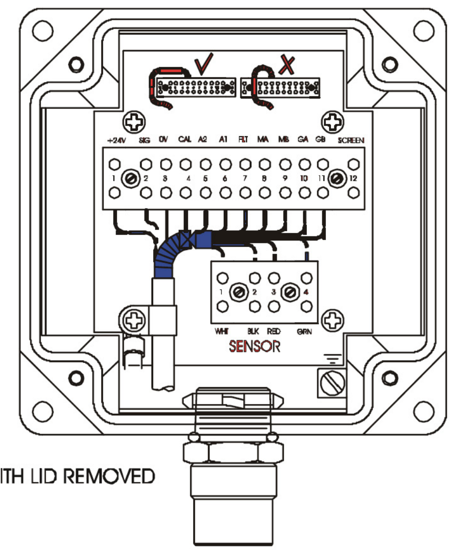
Option	-5 (0-50 ppm)
A1 Trip Level	10 ppm
A1 Open Collector Output:	De-energised and non-latching
A2 Trip Level:	25 ppm
A2 Open Collector Output	De-energised and non-latching
Analogue output during calibration	1.5mA
Modbus Baud rate:	19200 Baud
Modbus Format:	1 stopbit, no parity, 8 databits
Modbus Node address;	1

2.7 Sensor Material and Specifications when connected to ULTIMA MOS-5E

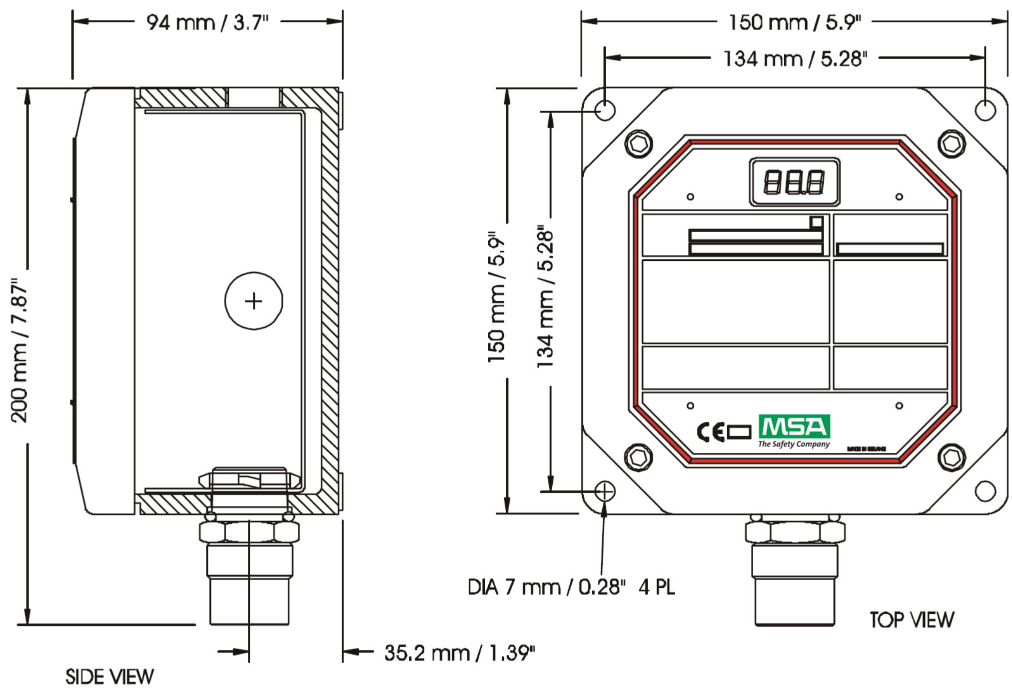
MSA Sensors (51457-X) are constructed from 316 Stainless Steel. The temperature and classification becomes

EEx emd IIC T5 (Tamb -40ºC to +55ºC)
EEx emd IIC T4 (Tamb -40ºC to +70ºC) when the sensors are fitted to the ULTIMA MOS-5E units only.

2.8 Outline Drawing



VIEW WITH LID REMOVED



3.0 Installation

WARNING - Installation and Maintenance must be carried out by suitably skilled and competent personnel only.

3.1 On Receipt of your Equipment

All instruments shipped by MSA are pre-packed in stout containers and enclosed in a shock absorbing filling which affords a considerable degree of protection against physical damage. The contents should be carefully removed and checked against the enclosed packing slip.

All discrepancies between the contents and the packing slip must be reported to MSA within 10 days of receipt of equipment. MSA cannot be held responsible for shortages not reported within this period.

Damage to the contents of a shipment should be brought to the attention of the carrier immediately and a claim filed.

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

3.2 Smart Transmitter location Guidelines

The following guidelines should be observed with regard to the location in which to install a Smart Transmitter.

- Consider how the leaking gas will disperse. Locate the Smart Transmitter where prevailing air currents are likely to contain the maximum amount of leaking gas, but sufficiently distant from minor leak sources so as to avoid spurious alarms.
- Hydrogen Sulphide gas is heavier than air and therefore tends to accumulate in low-lying areas, but do not rely on this property when selecting sensor locations. The lower concentrations of gas which result from natural dilution in the atmosphere will be carried along with the prevailing air currents. In general, the Smart Transmitter should be located close to ground level (but out of the splash zone) and close enough to the likely leak sources to avoid excessive dilution.
- Site the Smart Transmitter so as to facilitate routine re-calibration; refer to the Ancillary Equipment Section for details. In particular, ensure that the mounting allows sufficient clearance for the Field Calibrator (P/N 50000). Ensure that the mounting allows for the replacement of a faulty sensor and that access to any accessories is not restricted. Check that the calibration instructions and display will be visible under all normal weather conditions whenever required. A combination of rain and sun guard is recommended for outdoor locations because it protects the Smart Transmitter against the heat of direct sunlight and the adverse effects of rain-borne grime whilst simultaneously improving display visibility under sunny conditions.

- Observe the ambient temperature limitations quoted in the specification. If a sampling preconditioning system is employed, take steps to ensure that vapours will not condense in the associated pipework.

- The mounting should be as free from shock and vibration as possible. Avoid mounting Smart Transmitters directly on structures or process equipment prone to high levels of vibration or shock.

- Select sensor accessories (see Section 7 – Ancillary Equipment) so as to protect the sensor against high wind velocities, rain, dust, hosing down and any other anticipated environmental hazards.

- Avoid locations where the Smart Transmitter will be subjected to strong electromagnetic interference (greater than 10V/m field strength) such as found in proximity to radio transmitters, welders, switched mode power supplies, inverters, battery chargers, ignition systems, generators, switch-gear, arc lights and other high frequency or high power switching process equipment. Walkie-talkie radios should not be operated at a distance less than 0.75m from the Smart Transmitter.

3.3 Sensor Poisons

H_2S Sensors may be adversely affected by prolonged exposure to certain atmospheres.

Silicones contained in grease or aerosols are the most common coating agents which are not true sensor poisons, but reduce sensor response.

Other materials that have a deleterious effect on H_2S Sensors include mineral acid vapours and caustic vapours that attack the sensor physically.

The presence of such damaging vapours does not imply that the MSA sensor may not be used in these locations. A careful analysis of ambient air conditions should be undertaken and the customer should be aware that sensor calibration might need to be repeated at shorter intervals.

3.4 Interconnecting cable Guidelines

- The Smart Transmitter requires an interconnecting cable with an overall screen (shield) and armour. Cables to BS5308 Part 2, Type 2 or equivalent are suitable.

- Interconnecting cables should be segregated from power and other “noisy” cables. Avoid proximity to cables associated with radio transmitters, welders, switched 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, maintain a separation of at least 1m between instrument and other cables. Greater separation is required where long parallel cable runs are unavoidable. Avoid running instrument cable trenches close to lightning conductors earthing pits.

- Complete all cable insulation tests **<u>before</u>** connecting the cable at either end.

- MSA do not recommend the use of cable shoes or crimps on any junction box or housing wiring terminals. Poor crimping can cause bad connection when unit experiences temperature variations. We therefore recommend good practice is to just terminate cable or sensor wires as is, especially in remote sensor applications.

3.5 Installation of Sensor

MSA sensors are machined to a ¾ NPT thread for fixing into the junction box, through a suitably machined entry. Each sensor requires a suitable O'Ring and Lock Nut to ensure correct assembly. To assemble the sensor into the junction box the wires should be placed through the O'Ring, over the ¾ NPT thread until it rests at the end of the machined thread. The sensor is then placed through the entry of the junction box and held in place by fitting the ¾ NPT Lock Nut. The sensor should be tightened sufficiently to ensure a good seal, but not over tightened to damage the O'Ring. The colour coded wires should then be connected into the corresponding locations of the connector which is installed and labelled in the junction box. Care should be taken not to tighten the connection on the insulation of the wires.

3.6 Installation Instructions

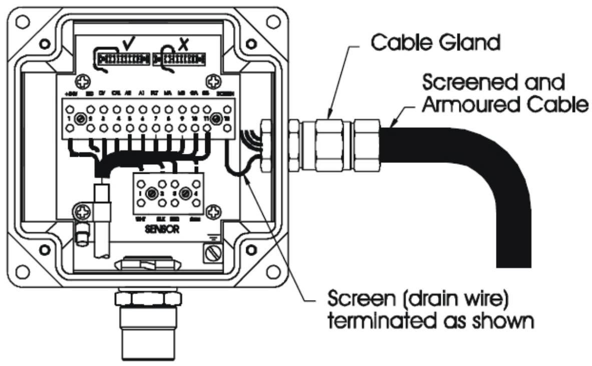
3.6.1 Smart Transmitter Cable Termination

- The Smart Transmitter should be installed in accordance with the certification documents and the relevant regulations of the country concerned.
- Ensure that the gas sensor, if used, points downwards so as to protect it from rain and the accumulation of deposits.
- Ensure that approved Exe cable glands are used and installed according to the manufacturer's instructions.
- The cable glands must be electrically connected to the continuity plate by means of a suitable nut. The cable armour must be terminated in the gland to ensure a positive electrical connection.
- The cable screens (drain wires) must all be terminated on the isolated terminal in the transmitter housing (and sensor junction box if the sensor is mounted remotely). The cable screens must not be connected electrically to the electronic circuitry of the Smart Transmitter or the sensor.
- Connect an external earth stud in accordance with local practice if required.
- Ensure no wires cross over the top of the connector blocks as they may become trapped between the blocks and the electronics module when the lid is fitted.
- When fitting the lid, ensure the fly-lead and earth-strap from the electronics module fit freely into the box. Press the lid home and verify it fits snugly against the box, before tightening the screws.

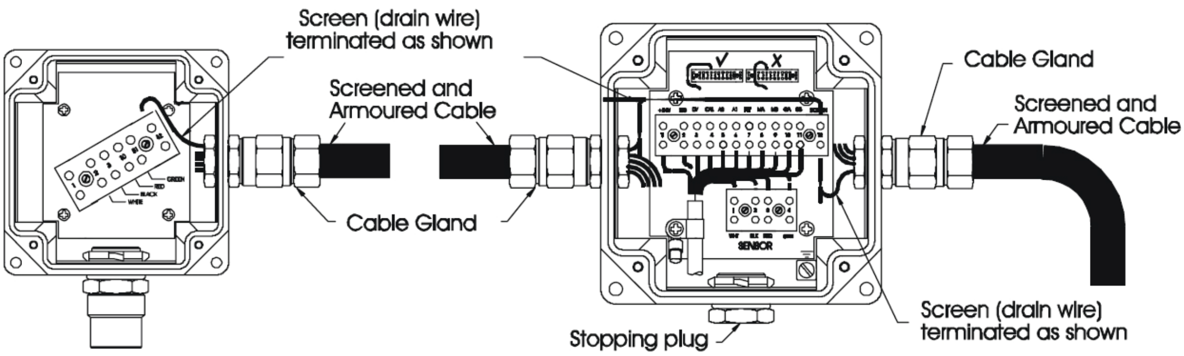
3.6.2 Cable Termination in Safe Area

- The cable armour must be connected to Safety Earth.
- The cable screens (drain wire) and power supply return (OV) must be connected to Instrument Earth.
- The power supply or power distribution system employed should meet the requirements of IEC 1010-1: 1990 + Amd 1:1992 + Amd 2: 1995.
- **Power supply or MSA Trip Amplifier Power and analogue output must be fused in accordance with the Smart Transmitter specification.**

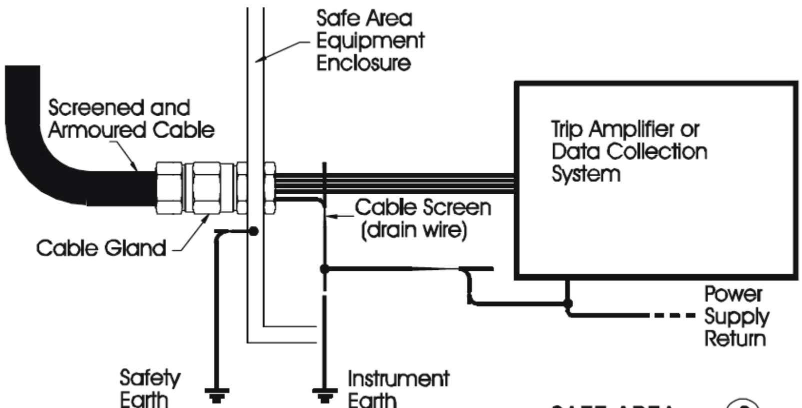
3.6.3 Cable Termination Drawing



INTEGRAL SENSOR ①



REMOTE SENSOR ②

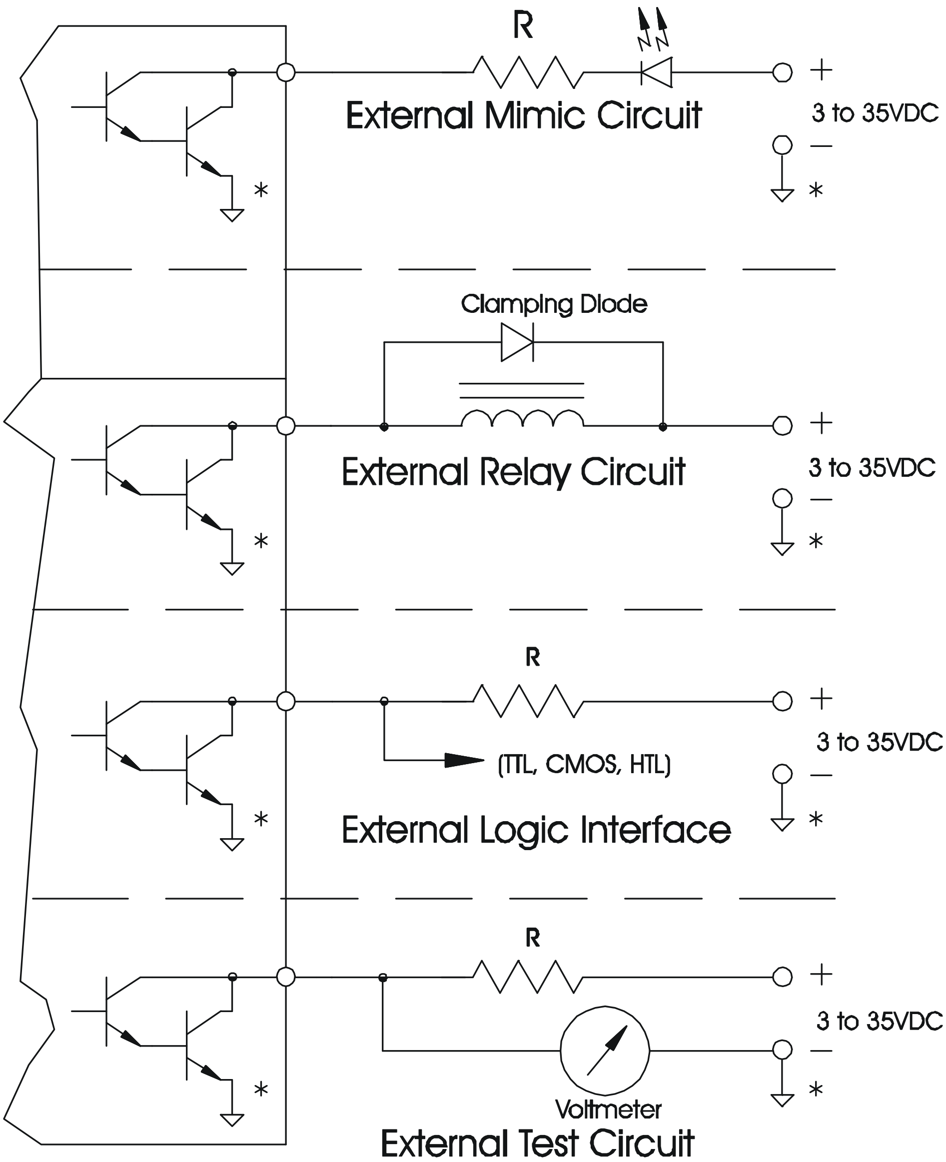


SAFE AREA ③

NOTE:
Cable Armour connected to
Safety Earth via Gland or otherwise

The electrical rating for all open collector outputs is 100mA @ 35VDC.

The diagram below illustrates some typical open collector external circuits.



* Note: All system commons ( ) must be tied together.

3.7 Interconnection Details

Signal Name	12-Way Terminal	Function	If not used	Module Fly lead colour
+ 24VDC	1	Power Supply		brown
SIG	2	Analogue output	connect to OV	yellow
OV	3	Power Supply Return		blue
CAL	4	Remote calibration input (Note)	leave unconnected*	grey
A2	5	Alarm 2 open collector output	leave unconnected*	orange
A1	6	Alarm 1 open collector output	leave unconnected*	violet
FLT	7	Fault open collector output	leave unconnected*	green/black
MA	8	Modbus 1 serial interface line A	leave unconnected*	red/black
MB	9	Modbus 1 serial interface line B	leave unconnected*	red/green
GA	10	Modbus 2 serial interface line A	leave unconnected*	red/brown
GB	11	Modbus 2 serial interface line B	leave unconnected*	red/blue
SCREEN	12	Terminate all cable screens (drain wires) at this connection		NA

Signal Name	4-Way Terminal	Function	Module Fly lead colour
WHT	1	Sensor heater supply	white
BLK	2	Sensor heater return	black
RED	3	Sensor Bias supply	red
GRN	4	Sensor Bias Return	green

* Ensure conductor ends have been cut back so that bare conductors do not cause shorts.

NOTE: If remote calibration is required, connect the Remote Calibration Input to Power Supply Return via a momentary action-NO-switch in the Safe Area. The switch should be rated 5V, 5mA or better.

NOTE: For Smart Transmitter Interconnection Cable details consult Appendix A.

3.8 Power up Routine (see also Section 4.5 and 4.6)

When all wiring has been completed and checked, the instrument may be powered up. Remove the red cap after power up. Replace the cap and desiccant if the sensor is to be left off-power for long periods of time.

Immediately following power-up, the instrument will carry out “Display Test”, then blank the display for 1 second, display “Software Revision” and then display “Power up in progress”, followed by normal operation. The analogue output will be at 4.0mA and the Fault open collector output energised.

The Smart Transmitter should then be allowed to stabilise for 24 hours. The display should read “0” if no Hydrogen Sulphide gas is present at the sensor.

If the instrument indicates differently from the above, refer to Section 6, Trouble Shooting.

4.0 Operating Instructions

WARNING – Installation and Maintenance must be carried out by suitably skilled and competent personnel only.

4.1 Menu Operation and Display Codes

Note: See Table 1 and Table 2 for Display Codes

Menu operation starts at Level 1. To enter the menu, the magnet is applied to the MSA Logo on the Nameplate and held in place. The instrument will display "- - -" indicating magnet present. After 5 seconds delay the instrument will start scrolling through Table 1, Level 1 at the rate of 1 step per 2 seconds, the magnet may now be removed. In the presence of (latched) Alarms, the delay time will increase to 90 seconds. The scrolling will continue until a selection is made by briefly applying the magnet. The display will rapid-flash the selection for one second to acknowledge. The operation will then move to the next level corresponding to that selection, which can be scrolled in a similar fashion, etc.

At all menu levels, the instrument will start "10 second menu timeout", 30 seconds after the last selection was made, allowing the user to re-enter the menu while the analogue output is still at cal level (0.0, 1.5 or 2.0mA). Once "10 second menu timeout" has expired, menu data is written to EEPROM, following which the instrument returns to normal operation.

Calibration and Check Calibration mode will be terminated upon completion of the corresponding calibration or calibration check procedure. The unit expects to "see" calibration gas within 6 minutes following selection and will display the appropriate fault code if no gas has been applied and exit the menu. Similar action occurs if the calibration gas supply is interrupted during "Calibration in progress" or if the calibration gas is not removed within 6 minutes following "Calibration completed."

While in Check Calibration mode, Calibration mode may be activated by entering the menu as normal.

When A1 alarm trip level, A2 alarm trip level or Calibration is selected, the current value is shown on the display. The most significant digit will scroll and the desired value is acknowledged by briefly applying the magnet, following which the next lower significant digit will scroll and is acknowledged in similar fashion. The display will rapid-flash each selection for one second to acknowledge. If the current value is acceptable, two subsequent "acknowledge" commands, (one for each digit) will allow the user to continue.

Setting A1 alarm trip level higher than the current A2 alarm trip level causes the A2 alarm trip level to be set to the same level as A1 alarm trip level and following acknowledge of A1 alarm trip level the menu automatically jumps to "A2 alarm set up" to alert the user and allow re-adjustment of A2 alarm trip level. Similar action occurs if A2 alarm trip level is set lower than the current A1 alarm trip level.

Change of Option causes the instrument to enter Calibration mode immediately and Alarm trip levels to change to default levels corresponding to the new Option, alleviating the necessity of a password option.

Faults and Alarm status and ppm level determine which Level 1 menu selections are available. Any Fault inhibits menu operation.

Menu Selection Availability:

Faults?	Alarms?	Latched Alarms?	ppm<min Trip level?	Level 1 menu selections available	Menu entry delay
No	No	No	Yes	ACA, CCA, ASU, CSU & ncl	5 sec
No	No	No	No	ACA, ASU, CSU & ncl	5 sec
No	No	Yes	Yes	ACA & CCA	90 sec
No	No	Yes	No	ACA & ncl	90 sec
No	Yes	No	NA	ACA & ncl	90 sec
No	Yes	Yes	NA	ACA & ncl	90 sec
Yes	NA	NA	NA	None	NA

Note: Minimum trip level is 1ppm for –9 option, 5ppm for –5 option and 10ppm for –1 option.

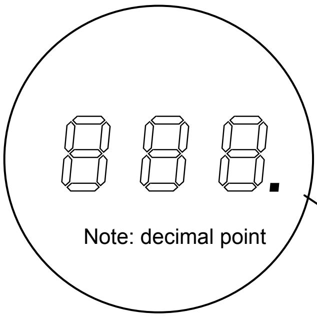
4.2 Tables

TABLE 1 – MENU DISPLAY CODES

Level 1		Level 2		Level 3		Level 4	
ACA	Activate calibration mode	AC	Activate calibration, Apply calibration gas				
		CP	Calibration in progress				
		CC	Calibration completed, Remove calibration gas				
CCA	Check calibration mode	ACA	Activate calibration mode				
ASU	Activate setup mode	‾A1	A1 alarm setup	‾En	Open collector output normally energized		
				‾dE	Open collector output normally de-energized		
				‾LA	Open collector output latching		
				‾nL	Open collector output non-latching		
				‾tP	Trip level setup	‾88	Trip level adjustable ppm 10-60/5-45/1-19
				=A2	A2 alarm setup		
				rtn	Return to level 2		
		=A2	A2 alarm setup	=En	Open collector output normally energized		
				=dE	Open collector output normally de-energized		
				=LA	Open collector output latching		
				=nL	Open collector output non-latching		
				=tP	Trip level setup	=88	Trip level adjustable ppm 10-95/5-45/1-19
				c--	Analog output setup		
				rtn	Return to level 2		
		c--	Analogue output setup	c 0.0	Analogue output 0mA during calibration		
				c 1.5	Analogue output 1.5mA during calibration		
				c 2.0	Analogue output 2.0mA during calibration		
				o--	Option setup		
				rtn	Return to level 2		
		o--	Option setup	o-1	Gas sensor type 100 ppm FSD		
				o-5	Gas sensor type 50 ppm FSD		
				o-9	Gas sensor type 20 ppm FSD		
				‾A1	A1 alarm setup		
				rtn	Return to level 2		
		rtn	Return to level 1				

TABLE 1 – MENU DISPLAY CODES

Level 1		Level 2		Level 3		Level 4
CSU	Check setup mode	o-8	Gas sensor type 100, 50, 20 ppm FSD			
		-88	A1 open collector output norm. (de)-energized			
		-88	A1 open collector output (non)-latching			
		-88	A1 alarm triplevel ppm			
		=88	A2 open collector output norm. (de)-energized			
		=88	A2 open collector output (non)-latching			
		=88	A2 alarm triplevel ppm			
		c 8.8	Analogue output current during calibration in mA			
		888.	Nr. of successful calibrations			
		888	Modbus port 1 & 2 node address			
		rtn	Return to level 1			
ncL	New sensor calibration	ncL	New sensor calibration	AC	Activate calibration, Apply calibration gas	Note: This operation sets nr. of calibrations to 1 when successful
				CP	Calibration in progress	
				CC	Calibration completed, Remove calibration gas	
		rtn	Return to level 1			
tEr	Terminate menu					



tEr Slow Flash (2/sec)

"10 sec Menu Timeout in progress". This timeout starts 30 sec after the last menu selection was made.
Apply magnet to re-enter at Level 1. The analogue output remains at calibration level in this mode.
If magnet not applied, the instrument will write menu parameters to EEPROM,
exit menu and revert to normal operation following timeout.

TABLE 2 – DISPLAY CODES

8.8.8.	Display Test (1 sec)
r 88	Software Revision (1 sec)
SU	Power up in progress (58 sec)
-88	Gas measurement with A1 alarm condition present, or latched A1 alarm pending
=88	Gas measurement with A2 alarm condition present, or latched A2 alarm pending
888	Slow Flash (2/sec) "Overrange" if display > 99% FSD or "Check Calibration Mode active"
888	Rapid Flash (8/sec) "Acknowledgement of menu selection" or "Magnet present" during alarm or fault indication
EE	EEPROM write activity
F88	Fault Codes
- - -	"Magnet present"

4.3 Calibration

Calibration may be carried out as follows:

- Ensure that the instrument has stabilised for at least 24 hours and that there is no Hydrogen Sulphide gas present at the sensor. If background levels of gas are suspected, the sensor should be purged with clean air before calibrating the unit. It is possible to perform a rough calibration 15 minutes after powering up a new sensor (useful where a loss of detection cannot be tolerated), **but a full calibration must be preformed 24 hours later.**

  Some sensors may take a while to stabilise and it is recommended that a weekly check is made on recently installed sensors until satisfied that stability is attained.

- Place the magnet on the MSA Logo on the Nameplate. The instrument will display “---“ for 5 seconds and then enter the menu routine. Remove the magnet. Select “ACA” by briefly re-applying the magnet when the display scrolls around. The instrument will acknowledge the selection by rapid flashing “ACA” for 1 second and display “AC”.

  NOTE: Calibration mode may be terminated at this point by briefly re-applying the magnet.

- Insert an ampoule corresponding to 50% FSD Hydrogen Sulphide into a MSA field calibrator and place the calibrator over the sensor. Ensure a snug fit. Tighten the breaker until the ampoule shatters. When the instrument detects the gas it will display “CP”.

  Alternatively, a MSA Portable Purge Calibrator (see 8.8) containing the specified ppm value of H_2S may be used.

- When the instrument displays “CC”, remove the field calibrator and discard all glass fragments safely.

- As the remaining gas in the sensor disperses, the instrument will exit Calibration mode and return to normal operation. The display should read “0”.

- If the above procedure is unsuccessful, refer to the Trouble Shooting section in this manual.

4.4 New Sensor Calibration

New sensor calibration may be carried out as follows:

- Ensure that the instrument has stabilised for at least 24 hours and that there is no Hydrogen Sulphide gas present at the sensor. If background levels of gas are suspected, the sensor should be purged with clean air before calibrating the unit. It is possible to perform a rough calibration 15 minutes after powering up a new sensor (useful where a loss of detection cannot be tolerated), **but a full calibration must be preformed 24 hours later.**

- Some sensors may take a while to stabilise and it is recommended that a weekly check is made on recently installed sensors until satisfied that stability is attained.

- Place the magnet on the MSA Logo on the Nameplate. The instrument will display " - - -" for 5 seconds and then enter the menu routine. Remove the magnet. Select "ncl" by briefly re-applying the magnet when the display scrolls around. The instrument will acknowledge the selection by rapid flashing "ncl" for 1 second. Re-confirm by briefly re-applying the magnet when the display shows "ncl" or return to the previous level by briefly applying the magnet when the display shows "rtn". The unit will display "AC" following confirmation.

  NOTE: Calibration mode may be terminated at this point by briefly re-applying the magnet.

- Insert an ampoule corresponding to 50% FSD Hydrogen Sulphide into a MSA field calibrator and place the calibrator over the sensor. Ensure a snug fit. Tighten the breaker until the ampoule shatters. When the instrument detects the gas it will display "CP".

  Alternatively, a MSA Portable Purge Calibrator (see 8.8) containing the specified ppm value of H_2S may be used.

- When the instrument displays "CC", remove the field calibrator and discard all glass fragments safely.

- As the remaining gas in the sensor disperses, the instrument will exit Calibration mode and return to normal operation. The display should read "0".

- This calibration procedure resets "number of calibrations" to 1.

- If the above procedure is unsuccessful, refer to the Trouble Shooting section in this manual.

4.5 Calibration Check

- Place the magnet on the MSA Logo on the Nameplate. The instrument will display " - - -" for 5 seconds and then enter the menu routine. Remove the magnet. Select "CCA" by briefly reapplying the magnet when the display scrolls around. The instrument will acknowledge the selection by rapid flashing "CCA" for 1 second and the display will then slow-flash the gas concentration. The analogue output will remain at calibration level.

  NOTE: Calibration Check mode may be terminated at this point by briefly re-applying the magnet.

- Insert an ampoule corresponding to 50% FSD Hydrogen Sulphide into a MSA field calibrator and place the calibrator over the sensor. Ensure a snug fit. Tighten the breaker until the ampoule shatters. The instrument will measure and display gas concentration. Observe the gas reading settles at the required level, normally within 2 to 4 minutes. Should the final reading fall outside the required limits (±10% FSD + ampoule tolerance ±1.5ppm) a full calibration is advisable. If so, proceed as follows, **with the test ampoule still in place:**

  Place the magnet on the MSA logo on the Nameplate. The instrument will display "- - -" for 5 seconds and then show "ACA". Select by briefly re-applying the magnet. The instrument will acknowledge the selection by rapid flashing "ACA" for 1 second. The instrument will then display "AC", followed shortly by "CP". Continue as described in Calibration.

- The display will continue to slow-flash the reading and the analogue output remains at calibration level until the gas has been removed and the concentration at the sensor has dropped below 5% FSD, when the instrument will exit Calibration Check mode and return to normal operation.

- If the above procedure is unsuccessful, refer to the Trouble Shooting section in this manual.

Important:
The Smart Transmitters should be checked regularly by applying gas. This is the only way to ensure the system is fully operational and a schedule should be established to make certain such a check is carried out. MSA recommend that this should be done at least every 90 days, even in ideal conditions and much more frequently when the risk is high, in the early days of an installation, or where conditions are adverse.

4.6 Power up Routine

Immediately following power-up, the instrument will carry out "Display Test", then blank the display for 1 second, display "Software Revision" and then display "Power up in progress" followed by normal operation. The analogue output will be at 4.0mA and the Fault open collector output energised.

4.7 Special Power up Routine

If the instrument is powered up with the magnet present it will display “EEPROM write activity” for 1 second, followed by “Power up in progress” as above. The magnet present will cause the Modbus Parameters to be reset to factory default. The magnet may be removed immediately.

If the instrument is powered up with the magnet Present AND the Remote Calibration input active it will display “EEPROM write activity” for 1 second, followed by “Power up in progress” as above. This condition will cause the Power-up EEPROM CRC check to be bypassed and the Modbus Parameters, all calibration and menu Parameters to be reset to factory default. On exit from Power up, the instrument will enter Calibration mode. This feature is available to allow recovery in the field, should the EEPROM contents have been corrupted due to a power failure coinciding with an EEPROM write cycle. The magnet may be removed and the Remote Calibration input de-activated immediately.

5.0 Maintenance

WARNING - Installation and Maintenance must be carried out by suitably skilled and competent personnel only.

5.1 Maintenance

Once correctly installed, systems require very little maintenance other than Routine Re-calibration (see section 4) and periodic inspection.

Sensors exposed to the elements may require a little grease on the accessory mounting threads. The grease must be free from silicones (Refer to Sensor Poisons) and have a high melting point. Alternatively PTFE. tape may be used.

The removal of particulate matter from sensor accessories may be facilitated by the use of an appropriate halogen-free solvent. Water or Ethanol are suitable. The accessories should be thoroughly dried, with compressed air if necessary, before refitting to the sensor body.

MSA strongly recommends that the complete system, including all alarm circuitry be tested at least annually and that the following checks be carried out:

- All Smart Transmitter assemblies for suitability of mounting positions so that modifications to plant layout have not affected these.
- Security of mounting
- Sensor flame arrestors for clogging due to water, oil, dust, paint or other contaminants.
- Sensor accessories where fitted.
- Condition of fastening of cables.
- Air filters, where fitted. Ensure that replacement filters are clean and dry.
- Operation of complete system on stand-by supplies, where fitted, for the full prescribed time.

5.2 Storage

Electronic modules should be stored in a clean dry area and within the temperature range quoted in the Specification (see Section 2).

When prolonged storage is anticipated, modules should be sealed, together with a desiccant, into plastic bags and double wrapped for protection.

Hydrogen Sulphide sensors should be stored as above, but note that the red cap and desiccant supplied with the sensor should be in position throughout the storage period or when the sensor is off power for long periods.

6 Marking, Certificates and Approvals

6.1 Directive 94/9/EC [ATEX]

Manufacturer	:	Mine Safety Appliances Company 1000 Cranberry Township, PA 16066 USA
Product	:	ULTIMA MOS-5E
Type of protection	:	EN 50014:1997 (amendments A1 and A2) EN 50019:1994 EN 50028: 1987
Measuring function for explosion protection	:	None
Marking	: :	II 2G EEx emd IIC T5 (Ta = -40°C to +55°C) EEx emd IIC T4 (Ta = -40°C to +70°C) when the sensors are fitted to the ULTIMA MOS 5-E unit only
Options:		
EC-Type Examination Certificate	:	SIRA 11ATEX3129
Quality Assurance Notification	:	0518
Year of Manufacture	:	see label
Serial No.	:	see label
Special Conditions for safe use		None
EMC Conformance (89/336/EC)	:	EN 50270, EN 50081-2

6.2 Safety Integrity Level

The ULTIMA MOS-5E field device has gone through rigorous reliability and functional safety assessments, which have resulted in this product being certified to IEC 61508 Parts 1, 2, and 3, by FM Approval. The reliability assessment is a failure rate prediction that assumes an average temperature of 40ºC and an environmental factor equivalent to Ground Fixed. It is assumed that the field device will be installed in a Safety Instrumented System (SIS) operating in a Low Demand environment per IEC 61508. The tables below list the SIL parameters for field device.

ULTIMA MOS-5E (4-20 mA Output)	Clean Environment	Contaminated Environment
FM Certificate	3042476	3042476
Product Life (Years)*	23	21
λ_{DD} (Fails per hour)	1.1E-5	1.63E-5
λ_{DU} (Fails per hour)	3.34E-8	1.83E-6
Safe Failure Fraction (SFF)	>99%	92%
Safety Integrity Level (SIL)**	3	2
Diagnostic Test Interval	1 sec	1 sec
Response Time (with full scale gas applied)	Sintered T_{50} < 2 minutes	Sintered T_{50} < 2 minutes
Average Probability of Failure on Demand PFD_{avg}1oo1**	3E-4	2.4E-3

Table 4 – SIL Parameters for ULTIMA MOS-5E

* MOS sensor life is typically 3-5 years.
** Hardware Fault Tolerance (HFT) = 0
*** PFD_{avg}1oo1 assumes a 24 hour repair time and 90 day proof test interval.

7.0 Trouble Shooting

7.1 Fault codes and Remedies

Faults are stacked according to priority, i.e.: if more than one Fault exists at a particular time, the display will show the Fault with the highest priority (lowest number in priority column). As the Faults are being cleared, the Fault with the next highest priority will be displayed, until all Faults have been cleared.

Latching Faults, except for F07, may be cleared by briefly applying the magnet to the MSA Logo on the Nameplate if the Fault condition no longer exists. Non-latching Faults will clear automatically once the Fault condition ceases to exist.

Recovery from F04, F05, F06 and F08 will cause the unit to enter Power up mode as the sensor may have been disconnected or insufficiently biased during the fault condition.

Fault Code	Function	Priority	Mode	Remedy
F01	Analogue output open circuit	6	non-latching	Check wiring and fuse.
F02	Fail to calibration	9	latching	Ensure calibration gas supply is adequate. Re-calibrate. If persistent, replace sensor.
F03	Low response	8	latching	Ensure calibration gas supply is adequate. Re-calibrate. If persistent replace sensor.
F04	Sensor heater open circuit	5	non-latching	Check wiring and sensor. Replace sensor if necessary.
F05	Sensor heater short circuit	4	non-latching	Check wiring and sensor. Replace sensor if necessary.
F06	Power low	2	non-latching	Ensure power supply voltage at the instrument's terminal block is within specification.
F07	EEPROM CRC error	1	latching	Ensure 50% FSD calibration gas is available. Power down the instrument. Activate the Remote Cal input and place the magnet on the MSA Logo on the Nameplate. Re-apply power, remove the magnet and de-activate Remote Cal. Wait for the instrument to complete its power-up routine. The instrument will automatically enter calibration mode. Calibrate as normal. All user selectable parameters will have returned to their factory default settings and must be re-programmed as required. If F07 persists, the fault condition is terminal and requires the instrument to be returned to MSA.
F08	Sensor short circuit	3	non-latching	Check wiring and sensor, Replace sensor if necessary.
F09	Calibration (check) time-out	7	latching	Ensure calibration gas supply is adequate. Re-calibrate and apply or remove calibration gas in timely fashion as prompted by the display. If persistent, replace sensor.

7.2 Alarms

Alarms are stacked below Faults according to priority i.e.: if a Fault and (latched) Alarm(s) exist at a particular time, the display will show the Fault. As the Fault is cleared, the Alarm with the next highest priority will be displayed.

Latched Alarms may be cleared by briefly applying the magnet to the MSA Logo on the Nameplate if the Alarm condition no longer exists. Non-latching Alarms will clear automatically once the Alarm condition ceases to exist.

7.3 Modbus RTU Serial Interface problems

If the Modbus Node Address or any other Modbus parameter of the instrument is unknown, proceed as follows:

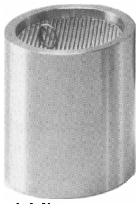
Power down the instrument. Place the magnet on the MSA Logo on the Nameplate. Ensure the Remote Cal input is NOT activated. Re-apply power and remove the magnet. Wait for the instrument to complete its power up routine. All user selectable Modbus parameters will have returned to their factory default settings and may be re-programmed as required.

Safety Warning

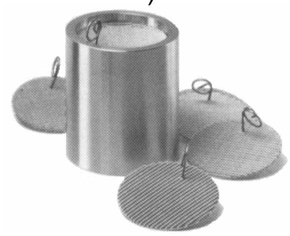
Installation and Maintenance must be carried out by suitably skilled and competent personnel only.

8.0 Ancillary Equipment

8.1 Dust Guard Assembly (P/N 10110)

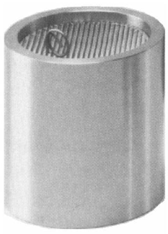


Dust Guard Kit (with 12 replaceable screens)



The dust guard is a simple, threaded (1 3/16-18 UNEF 2B) stainless steel cylinder with a wire screen at one end. It is easily unscrewed for cleaning and/or replacement of the disposable screen. The screen material is stainless steel with a nominal 40 micron mesh. This MSA accessory is specially designed to prevent dust and particulate matter from reaching the sensor flame arrestor. Such debris can plug the sinter and limit the amount of gas reaching the active surface of the sensor, thereby creating a potentially hazardous situation. When the dust guard is installed, this problem is eliminated and sensor response is virtually unchanged. The dust guard is also available in a kit (PIN 10044) with twelve replaceable screens. It can be used as an effective windscreen, and is recommended for corrosive, windy or high temperature environments. A typical application would be in the area surrounding a drying oven.

8.2 Sintered Stainless Steel Dust Guard (P/N 1800822-1)



The construction of this accessory is similar to P/N 10110, but with 3mm (1/8") thick sintered stainless steel disc at one end. The body material is stainless steel with an internal 3/16 UNEF 2B thread for installation on the sensor body. This dust guard provides protection from fine particulates and windy environments. It should be used only in dry locations because of the tendency of the sintered disc to absorb water which will then act as a gas diffusion barrier until the disc has dried out again. Sensor response time is affected by the dust guard. It should not be removed during sensor calibration.

8.3 Splash Guard (P/N 10395-1)

The Splash Guard is a rugged thermoplastic polyester (Valox) plastic cylinder which screws into place over the sensor body. It contains a series of internal baffles which are designed to deflect water spray away from the sensor flame arrestor. The splash guard is recommended for areas where heavy rain or frequent equipment hosedowns occur. It also makes an effective barrier against high winds. Sensor response time is affected by the splash guard. It should not be removed during sensor calibration.

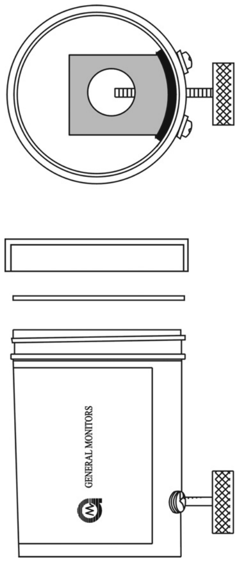
8.4 Sensor Flow Chamber (P/N 10066)

The MSA Sensor Flow Chamber is constructed of 2024T aluminium (optional stainless steel type 316, P/N 10066-SS). The chamber has an internal thread 1 3/16-18 UNEF 2B, into which a sensor may be screwed, and two threaded ports (1/8 27 NPT L1 NOM) which accept 1/4" tube fittings (P/N 925-029). The chamber is designed for insertion into a sampling system and the recommended flow rate is 0.47 litres per minute (1 cu. ft/hr.)

8.5 Duct Mounting Plate (P/N 10041-1 or -2)

The Duct Mounting Plate is a rectangular plate measuring 73 x 116mm (2.88” x 4.56”) containing four captive mounting screws (6-32 UNC), and fitted with a Neoprene O-ring seal. The sensor is mounted in a 1 3/16-18 UNEF threaded hole in the centre of the plate. The assembly is ideally suited to the monitoring of ducted air for living quarters in large offshore modules. Note that the sensor should be mounted **pointing down**, protected for excessive air velocity and in a position to facilitate recalibration.

8.6 Field Calibrator (P/N 50000)



The MSA Field Calibrator provides a simple and efficient means of calibrating H_2S sensors in the field.

It consists of a plastic jar fitted with a removable lid and a seal which fits snugly over the sensor cap. An integral aluminium block with external thumb screw performs the dual functions of retaining and breaking replaceable glass ampoules.

Operating Instructions

a) Ensure that the calibrator is clean and dry and that all fragments of broken glass have been removed.

b) Insert an ampoule of the desired concentration into the hole in the aluminium block, with its base resting on the bottom of the jar. Replace lid and seal.

c) Place calibrator in position on sensor. If a background gas level is suspected! Purge the calibrator with clean air and seal the opening in the lid until just before the calibrator is slipped onto the sensor.

d) Screw thumb screw until ampoule shatters.

e) Leave the calibrator in position until display shows code as per calibration instructions.

f) Remove the calibrator and dispose of the glass fragments safely.

8.7 Ampoules of Hydrogen Sulphide (P/N 50004)

These glass ampoules are manufactured under strict control procedures for use with the Field Calibrator (P/N 50000). They are marked with a gas concentration in ppm H_2S which corresponds to the concentration when released within the Field Calibrator.

Ampoules may start to lose concentration after a specified period. The Ampoule will state: "EXP (date)". Please adhere to this cut-off date.

Out-of-date ampoules should therefore be regarded with suspicion, particularly if erratic results are obtained in calibration.

Ampoules are manufactured in various concentrations and distinguished by the addition of a suffix to the part No. See table for details.

Part Number	Suffix	Concentration ppm H_2S
50004	-25	4
50004	-11	5
50004	-3	10
50004	-9	20
50004	-21	25
50004	-13	50
50004	-5	100

8.8 Calibration by using a H_2S Portable Purge Calibrator

An alternate method for introducing calibration or test gas to the ULTIMA MOS-5E Intelligent
Sensor is available. The H_2S Portable Purge Calibrator is a compact, practical, accurate and
safe system for field calibration of H_2S sensors. The bottle is filled with a hydrogen sulfide (H_2S)
in air mixture and is available in several concentrations. It is performed for sensors located in high humidity environments. The maintenance staff use gas bottles filled with known concentrations of H_2S in dry air. Spare gas bottles are not reffilable .

Refer to the table below for the respective part numbers for ordering accessories for calibration:

Description	**Part No.**
Case (holds two cylinders)	914-135
Teflon Tubing	925-430
Cup with Screen	1400152
Cable Tie	060-331
Gas Can [34 l] 100% vol. Synthetic Air	10029510
Gas Can [34 l] 10ppm H_2S in air	10120482
Gas Can [34 l] 25ppm H_2S in air	10120483
Gas Can [34 l] 50ppm H_2S in air	10120484
Flow Regulator (0,25 l/min)	478359

Operating Instructions

1. Securely fasten the regulator to the gas cylinder and ensure that the tubing and cup are undamaged and securely attached to the regulator outlet.
2. Turn the main valve on the cylinder counter clockwise until the pressure is indicated on the gauge. Gas flow is now controlled by the low pressure ON/OFF valve.

CAUTION: Do not readjust the factory setting of the regulator.

3. With the control module in Calibration Mode, place the cup securely over the sensor (or sensor accessory where relevant) and turn the gas on.
4. Calibrate the channel in the usual manner
   (Refer to Section 4 – Operating Instructions).
5. Switch off the gas and close the main valve by rotating the knob in a clockwise direction (finger tight only) so as to avoid leakage during storage.

9.0 Modbus RTU Serial Interface

See Modbus Specifications for detailed information on Modbus RTU protocol.

10.0 Appendix A

10.1 Maximum Smart Transmitter Cable Length

Cables to be screened and armoured to BS5308 Part 2 or equivalent. References to Sq. mm and AWG are not to be taken as direct equivalents.

Maximum Sensor Transmitter Cable length for various conductor sizes and power supply voltages with a 100mA load on each of the three open collector outputs

Note: When open collector outputs are not connected, use values in parenthesis.

Conductor Size		Maximum Cable Length				Power Supply Rating			Cable Drop
sq mm	AWG	metres		feet		VDC	mA max avg		total VDC
0.75	20	120	(195)	325	(530)	35.0	430	(130)	5.0
1.0	18	160	(255)	500	(820)		775pk	(475pk)	
1.5	16	240	(390)	650	(1050)				
2.0	14	320	(510)	1020	(1670)				
2.5	12	400	(635)	1550	(2550)				
0.75	20	260	(450)	700	(1220)	35.0	465	(165)	10.0
1.0	18	340	(600)	1050	(1890)		715pk	(415pk)	
1.5	16	520	(900)	1400	(2420)				
2.0	14	680	(1200)	2220	(3820)				
2.5	12	850	(1500)	3400	(5870)				
0.75	20	415	(750)	1120	(2020)	35.0	495	(195)	15.0
1.0	18	550	(1000)	1740	(3140)		675pk	(375pk)	
1.5	16	830	(1500)	2230	(4020)				
2.0	14	1100	(2000)	3530	(6350)				
2.5	12	1375	(2500)	5410	(9750)				
0.75	20	260	(450)	700	(1220)	30.0	465	(165)	5.0
1.0	18	340	(600)	1050	(1890)		715pk	(415pk)	
1.5	16	520	(900)	1400	(2420)				
2.0	14	680	(1200)	2220	(3820)				
2.5	12	850	(1500)	3400	(5870)				
0.75	20	415	(750)	1120	(2020)	30.0	495	(195)	10.0
1.0	18	550	(1000)	1740	(3140)		675pk	(375pk)	
1.5	16	830	(1500)	2230	(4020)				
2.0	14	1100	(2000)	3530	(6350)				
2.5	12	1375	(2500)	5410	(9750)				
0.75	20	540	(960)	1475	(2620)	30.0	565	(265)	15.0
1.0	18	725	(1285)	2285	(4065)		685pk	(385pk)	
1.5	16	1080	(1920)	2930	(5210)				
2.0	14	1450	(2575)	4630	(8235)				
2.5	12	1800	(3200)	7120	(12660)				

Conductor Size		Maximum Cable Length				Power Supply Rating			Cable Drop
sq mm	AWG	metres		feet		VDC	mA max avg		total VDC
0.75 1.0 1.5 2.0 2.5	20 18 16 14 12	135 185 270 370 430	(245) (335) (490) (670) (830)	380 585 750 1185 1825	(690) (1065) (1365) (2150) (3325)	24.0	495 665pk	(195) (365pk)	5.0
0.75 1.0 1.5 2.0 2.5	20 18 16 14 12	270 360 540 720 900	(480) (640) (960) (1280) (1600)	740 1145 1470 2320 3550	(1310) (2030) (2615) (4125) (6315)	24.0	570 685pk	(270) (385pk)	10.0

MSA in Europe

[***www.MSAsafety.com***]

Northern Europe

Netherlands
MSA Nederland
Kernweg 20
1627 LH Hoorn
Phone +31 [229] 25 03 03
Fax +31 [229] 21 13 40
info.nl@MSAsafety.com

Belgium
MSA Belgium N.V.
Duwijckstraat 17
2500 Lier
Phone +32 [3] 491 91 50
Fax +32 [3] 491 91 51
info.be@MSAsafety.com

Great Britain
MSA (Britain) Limited
Lochard House
Linnet Way
Strathclyde Business Park
BELLSHILL ML4 3RA
Scotland
Phone +44 [16 98] 57 33 57
Fax +44 [16 98] 74 01 41
info.gb@MSAsafety.com

Sweden
MSA NORDIC
Kopparbergsgatan 29
214 44 Malmö
Phone +46 [40] 699 07 70
Fax +46 [40] 699 07 77
info.se@MSAsafety.com

MSA SORDIN
Rörläggarvägen 8
33153 Värnamo
Phone +46 [370] 69 35 50
Fax +46 [370] 69 35 55
info.se@MSAsafety.com

Southern Europe

France
MSA GALLET
Zone Industrielle Sud
01400 Châtillon sur Chalaronne
Phone +33 [474] 55 01 55
Fax +33 [474] 55 47 99
info.fr@MSAsafety.com

Italy
MSA Italiana S.p.A.
Via Po 13/17
20089 Rozzano [MI]
Phone +39 [02] 89 217 1
Fax +39 [02] 82 59 228
info.it@MSAsafety.com

Spain
MSA Española, S.A.U.
Narcís Monturiol, 7
Pol. Ind. del Sudoeste
08960 Sant-Just Desvern [Barcelona]
Phone +34 [93] 372 51 62
Fax +34 [93] 372 66 57
info.es@MSAsafety.com

Eastern Europe

Poland
MSA Safety Poland Sp. z o.o.
Ul. Wschodnia 5A
05-090 Raszyn k/Warszawy
Phone +48 [22] 711 50 00
Fax +48 [22] 711 50 19
info.pl@MSAsafety.com

Czech republic
MSA Safety Czech s.r.o.
Dolnojircanska 270/22b
142 00 Praha 4 - Kamyk
Phone +420 241440 537
Fax +420 241440 537
info.cz@MSAsafety.com

Hungary
MSA Safety Hungaria
Francia út 10
1143 Budapest
Phone +36 [1] 251 34 88
Fax +36 [1] 251 46 51
info.hu@MSAsafety.com

Romania
MSA Safety Romania S.R.L.
Str. Virgil Madgearu, Nr. 5
Ap. 2, Sector 1
014135 Bucuresti
Phone +40 [21] 232 62 45
Fax +40 [21] 232 87 23
info.ro@MSAsafety.com

Russia
MSA Safety Russia
Походный проезд д.14.
125373 Москва
Phone +7 [495] 921 1370
Fax +7 [495] 921 1368
info.ru@MSAsafety.com

Central Europe

Germany
MSA AUER GmbH
Thiemannstrasse 1
12059 Berlin
Phone +49 [30] 68 86 0
Fax +49 [30] 68 86 15 17
info.de@MSAsafety.com

Austria
MSA AUER Austria Vertriebs GmbH
Modecenterstrasse 22
MGC Office 4, Top 601
1030 Wien
Phone +43 [0] 1 / 796 04 96
Fax +43 [0] 1 / 796 04 96 - 20
info.at@MSAsafety.com

Switzerland
MSA Schweiz
Eichweg 6
8154 Oberglatt
Phone +41 [43] 255 89 00
Fax +41 [43] 255 99 90
info.ch@MSAsafety.com

European International Sales
[Africa, Asia, Australia, Latin America, Middle East]
MSA Europe
Thiemannstrasse 1
12059 Berlin
Phone +49 [30] 68 86 0
Fax +49 [30] 68 86 15 58
info.de@MSAsafety.com

MSA
The Safety Company