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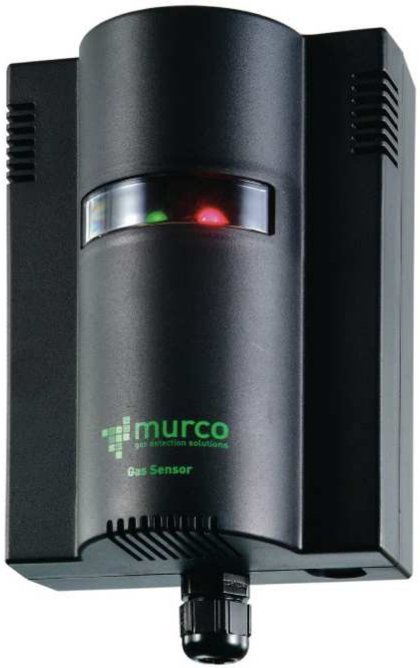
MGS Modbus

Gas Detector

Installation and Operation Manual
Instruction 1000-0693
Revision 0 – June 2013



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CE DECLARATION OF CONFORMITY

The manufacturer of the products covered by this declaration:	Murco Ltd 114a George's Street Lower Dun Laoghaire Ireland
Year(s) conformity is declared:	2012 (IEC/EN61010), 2012 (EN 50270)
Product(s):	MGS
Model(s):	MGS MGS Modbus

The undersigned hereby declares that the above referenced products are in conformity with the provisions of the following standards and is in accordance with the following directive.

Directive(s):

2004/108/EC	EU EMC Directive
2006/95/EC	Low Voltage Directive (LVD)

Standard(s):

IEC 61010-1:2010 EN 61010-1:2010	Safety Standards	Electrical Equipment for Measurement, Control, and Laboratory Use; Part 1: General Requirements
EN 50270:2006	Electromagnetic Compatibility (EMC) Standards	Electrical Apparatus for the Detection and Measurement of Combustible Gases, Toxic Gases, or Oxygen

Signature: ______________________

Name: Philip Hassell
Title: Engineering Manager
Date: 12th March 2013

The technical documentation file required by this directive is maintained at the corporate headquarters of Murco Ltd.

Section 8. Troubleshooting

Symptom	Possible Cause(s)
Green and Red light off	• Check power supply. Check wiring. • MGS Modbus was possibly damaged in transit. Check by installing another MGS Modbus to confirm the fault.
Red light on, green led off (indicates a fault)	• Sensor may be disconnected from printed circuit board. Check to see sensor is properly inserted into board. • The sensor has been damaged or has reached the end of life and needs to be exchanged. Contact Murco for instructions and support.
Alarms in the absence of a leak	• If you experience alarms in the absence of a leak, try setting an alarm delay. • Perform a bump test to ensure proper operation.

MGS Modbus Installation and Operation Manual

REASONS, MURCO HAS A POLICY OF PERFORMING ALL NEEDED REPAIRS TO RESTORE THE INSTRUMENT TO FULL OPERATING CONDITION.

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PACK THE EQUIPMENT WELL (IN ITS ORIGINAL PACKING IF POSSIBLE), AS MURCO CANNOT BE HELD RESPONSIBLE FOR ANY DAMAGE INCURRED DURING SHIPPING TO OUR FACILITY.

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THIS UNIT MUST BE INSTALLED BY A SUITABLY QUALIFIED TECHNICIAN WHO WILL INSTALL THIS UNIT IN ACCORDANCE WITH THESE INSTRUCTIONS AND THE STANDARDS IN THEIR PARTICULAR INDUSTRY/COUNTRY. OPERATORS OF THE UNIT SHOULD BE AWARE OF THE REGULATIONS AND STANDARDS IN THEIR INDUSTRY/COUNTRY FOR THE OPERATION OF THIS UNIT. THESE NOTES ARE ONLY INTENDED AS A GUIDE AND THE MANUFACTURER BEARS NO RESPONSIBILITY FOR THE INSTALLATION OR OPERATION OF THIS UNIT.

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7.5. Input Status Flags

The Register Map specifies the details of storage locations (registers and flags) within the detectors. Input Status Flags are readable (using function code 02).

Reg	Flag	Range	Details
3000	Alarm Flag	0-1	1: Gas concentration ≥ alarm setpoint 0: Gas concentration < alarm setpoint
3001	Relay	0-1	1: Relay is energised 0: Relay is de-energised
3002	Sensor Fault	0-1	1: Sensor absence or circuit fault 0: Sensor in place, no fault detected
3003	Red LED	0-1	1: On (alarm/fault if Green = off) 0: Off (no alarm or fault condition)
3004	Green LED	0-1	1: On (detector is powered on) 0: Off (no power or fault if Red = on)
3005	Saturation	0-1	1: Gas level is beyond full scale 0: Gas level is within zero & full scale
3006	Startup	0-1	1: Unit is in startup mode 0: Unit is in normal operating mode

7.6. Output Status Flags

The Register Map specifies the details of storage locations (registers and flags) within the detectors. Output Status Flags are readable (using function code 01) and writable (using function code 05).

Reg	Flag	Range	Details
4000	Buzzer	0-1	1: Buzzer is on. 0: Buzzer is off.
4001	Test	0-1	1: Sensor needs testing (operating > 1 yr) 0: Sensor does not require testing yet.

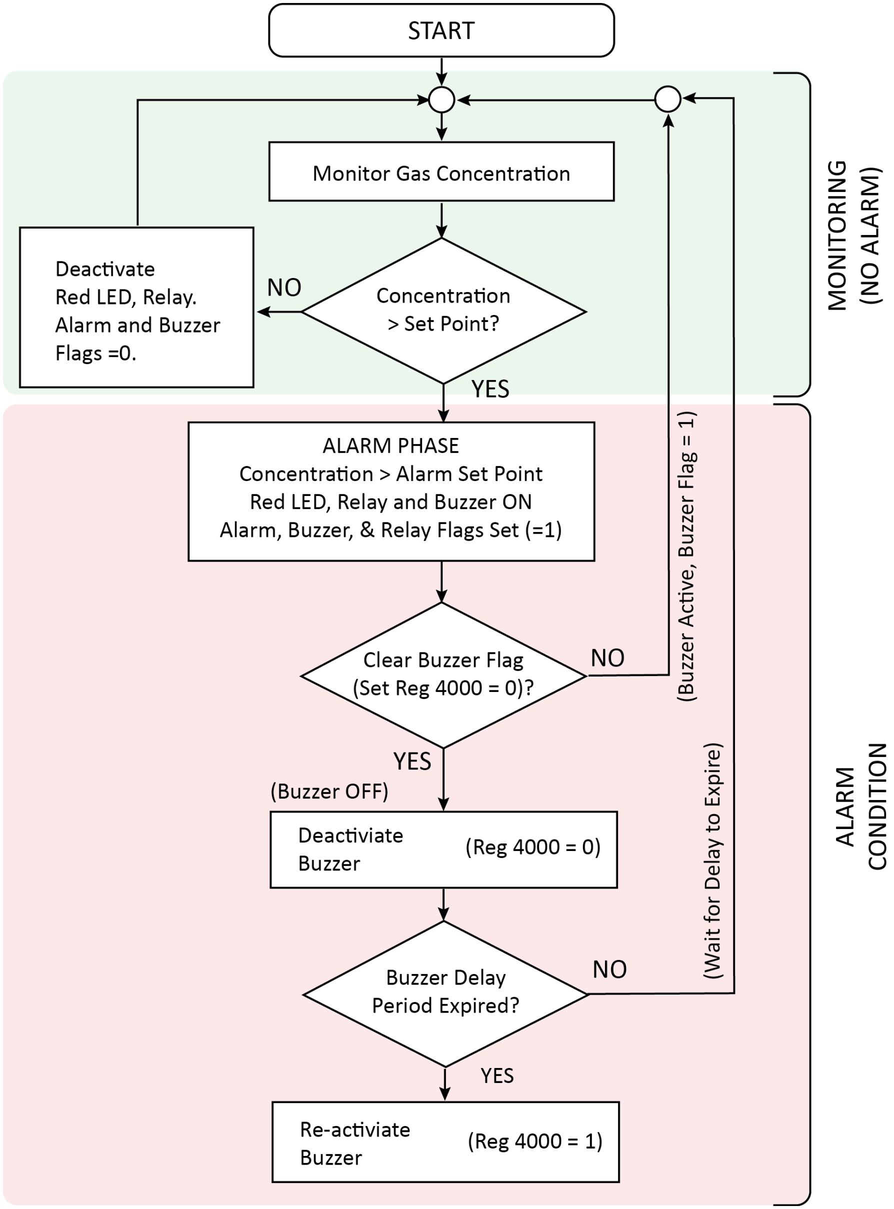

Figure 15. Flowchart of Buzzer Delay Control

MGS Modbus Installation and Operation Manual

Section 1. Overview

1.1. General Information

The MGS Modbus is a state-of-the-art fixed gas detector which can detect a wide range of gases. The MGS Modbus can be used on a stand-alone basis or integrated into Controls or Building Management Systems (BMS).

The MGS Modbus can be used:

- in new buildings/areas that require continuous monitoring.
- to add gas detection solutions to an existing system.

Typical detection applications include the detection of:

- refrigerant gases
- combustible gases
- toxic gases and/or volatile organic compounds.

The MGS Controller is an optional device used to remotely monitor up to six MGS Modbus devices. For more information, refer to the MGS Controller manual (P/N 1000-0694).

1.2. Technical Specifications

Specification	Description
Power Supply	12-24 VDC, 12-24 VAC 50/60 Hz, 2 W max.
Power Monitoring	Green LED
Visual Alarm	Red LED
Audible Alarm	Buzzer, enable/disable
Fault Monitoring	Red LED (on); Green LED (off)
Analog Outputs (2)	Current: 4-20 mA Voltage: 0-5 V; 0-10 V; 1-5 V; 2-10 V (selectable)
Relay	1 relay rated 3 A @ 24 VAC/VDC
RS-485 Communications	Baud rate: 9,600 or 19,200 (selectable) Start bits: 1 Data bits: 8 Parity: none Stop bits: 1 Retry time: 500 ms (min time between retries) End of message: silent 3.5 characters

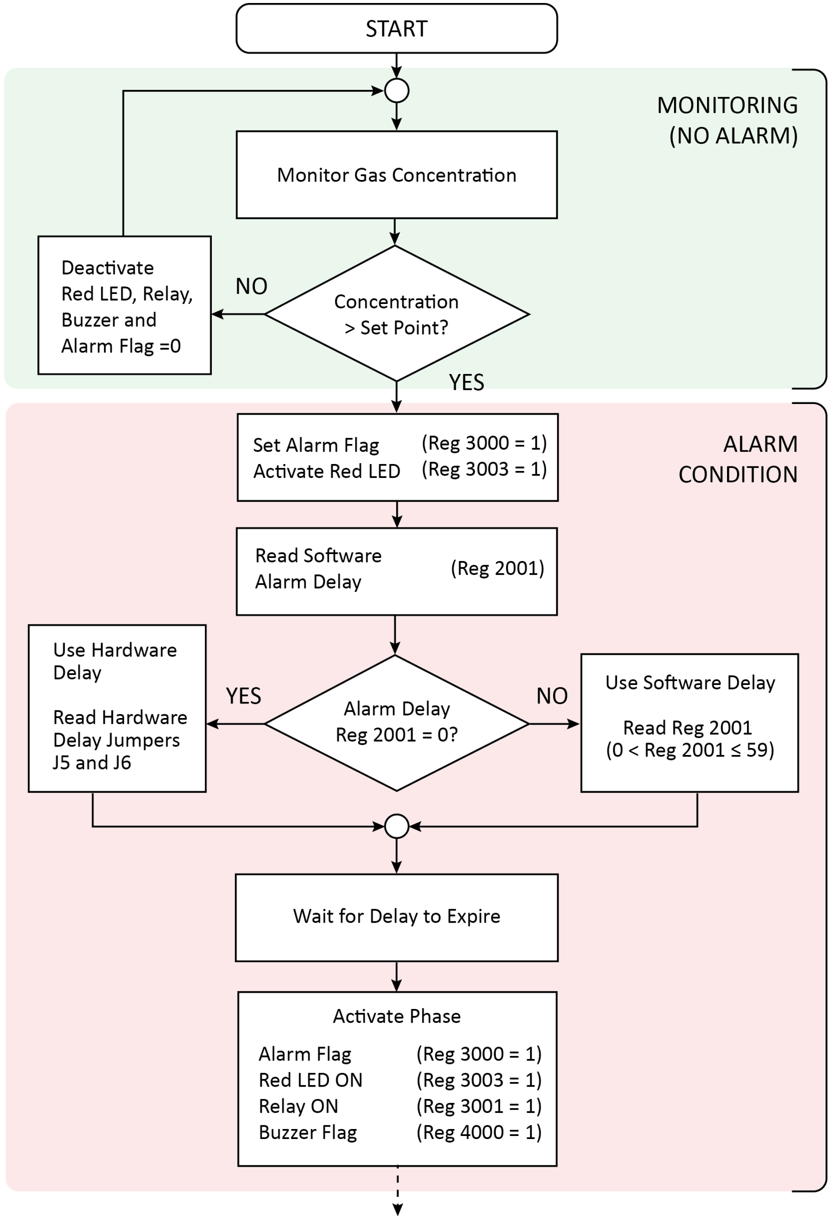

Figure 14. Flowchart of Alarm Delay Control

7.4.2. Alarm Delay Register 2001

The Alarm Delay Register 2001 stores the software alarm delay period up to 59 minutes and the jumpers J5 and J6 set the hardware alarm delay period. The alarm delay is the duration between the unit detecting a gas concentration above the alarm set point and the activation of the relay and the buzzer. If there is a jumper on J5 or J6 or both J5 and J6 have jumpers on connecting the pins, the software value is cleared following a restart whereby the power to the detector is turned off and then turned on again. Following this restart the delay period is determined by the hardware so that the Jumpers J5 and J6 determine the delay period. If there are no jumpers on both J5 and J6 the delay period written into the alarm delay register 2001 is used as the delay and is memorised and reused after a power cycle when the power is turned off and back on.

7.4.3. Buzzer Delay Register 2002

The Buzzer Delay is the time in minutes the buzzer is deactivated for during the alarm phase when the gas concentration has reached or exceeds the alarm set point. The alarm condition will activate the red LED alarm indicator and set the alarm flag to the value 1, the relay and the buzzer will subsequently activate following any delay period and the alarm flag in register 3000, the relay flag in register 3001 and the buzzer flag in register 4000 will all be set to the value 1 to indicate the active alarm state.

Clearing the Sounder Flag, by writing the value zero into register 4000 will deactivate the buzzer for the period defined by the sounder delay register 2002. The sounder delay is in minutes and the maximum value is 59 so for example if the value in register 2002 is 25, then the buzzer will be disabled for 25 minutes during an alarm condition. After this 25 minute mute period, the buzzer will be reactivated if the detector is still detecting gas concentrations at or above the alarm set point, otherwise the buzzer will not be reactivated if the gas concentration has fallen below the alarm set point.

Specification	Description		
Alarm Delay	Selectable; 0, 1, 5, or 10 minutes		
IP Rating	IP41 (standard); IP66 (optional)		
Temperature Ratings	**Housing:**	**Standard**	**IP66**
	IR-RS:	-4° to 122° F -20° to 50° C	N/A N/A
	IR CO_2:	-4° to 122° F -20° to 50° C	-40° to 122° F -40° to 50° C
	SC (all):	-4° to 122° F -20° to 50° C	-40° to 122° F -40° to 50° C
Dimensions/Weights per Enclosure Type (see Note below)	IP41 (Std)	3.35" x 5.59" x 2.09" 86 x 142 x 53 mm	6.3 oz 180 g
	IP66	6.89" x 6.5" x 3.29" 175 x 165 x 82 mm	1 lb 6 oz 629 g
	IP66 w/ Splash Guard	6.89" x 8.9" x 3.29" 175 x 225 x 82 mm	1 lb 9 oz 700 g
	IP66 w/ Remote Sensor	6.89" x 6.1" x 3.29" 175 x 155 x 82 mm	1 lb 11 oz 790 g
	IP66 w/ Exd Sensor Head	6.89" x 6.1" x 3.29" 175 x 155 x 82 mm	2 lb 10 oz 1185 g
	IP66 w/ PRV Sensor Head	6.89" x 6.1" x 3.29" 175 x 155 x 82 mm	2 lb 0.3 oz 916 g
	IP66 Airflow/Duct	6.89" x 4.9" x 3.29" 175 x 125 x 82 mm	1 lb 4 oz 578 g
	Exd (ATEX only)	5.12" x 6.3" x 3.54" 130 x 160 x 90 mm	9 lb 4 oz 4200 g
Approvals	CE; UL/CSA/IEC/EN 61010-1		

NOTE: Enclosures listed above are for all models/configurations *except* IR-RS, which uses the standard IP41 enclosure with a different temperature rating.

NOTE: The hazardous area ***Exd Gas Monitor*** products are designed with individually certified Exd main housing enclosures and certified Exd remote or attached sensor enclosures. The main housing enclosure is also Exd certified, but the final **Exd Gas Monitor** assemblies (main enclosure and/or sensor assembly) are not currently Exd certified, but are pending additional testing.

Supported CFM and Duct Sizes for the Duct Mount Housing

Units	Duct Size				
inches	12 x 12	12 x 24	18 x 18	24 x 24	24 round
feet	1 x 1	1 x 2	1.5 x 1.5	2 x 2	3.14 x 1 x 1
area (ft^2)	1	2	2.25	4	3.14
CFM	**Ft/min (Based on CFM and Duct Size)**				
2800	2800	n/a	n/a	n/a	n/a
3000	3000	n/a	n/a	n/a	n/a
3400	3400	n/a	n/a	n/a	n/a
3800	3800	n/a	n/a	n/a	n/a
4000	4000	n/a	n/a	n/a	n/a
4400	4400	n/a	n/a	n/a	n/a
4800	4800	n/a	n/a	n/a	n/a
5000	5000	2500	n/a	n/a	n/a
5400	5400	2700	n/a	n/a	n/a
5800	5800	2900	2578	n/a	n/a
6000	6000	3000	2667	n/a	n/a
6400	6400	3200	2844	n/a	n/a
6800	6800	3400	3022	n/a	n/a
7000	7000	3500	3111	n/a	n/a
7400	7400	3700	3289	n/a	n/a
7800	7800	3900	3467	n/a	n/a
8000	8000	4000	3556	n/a	2548
8400	8400	4200	3733	n/a	2675
8800	8800	4400	3911	n/a	2803
9000	9000	4500	4000	n/a	2866
9400	9400	4700	4178	n/a	2994
9800	9800	4900	4356	n/a	3121
10000	10000	5000	4444	2500	3185

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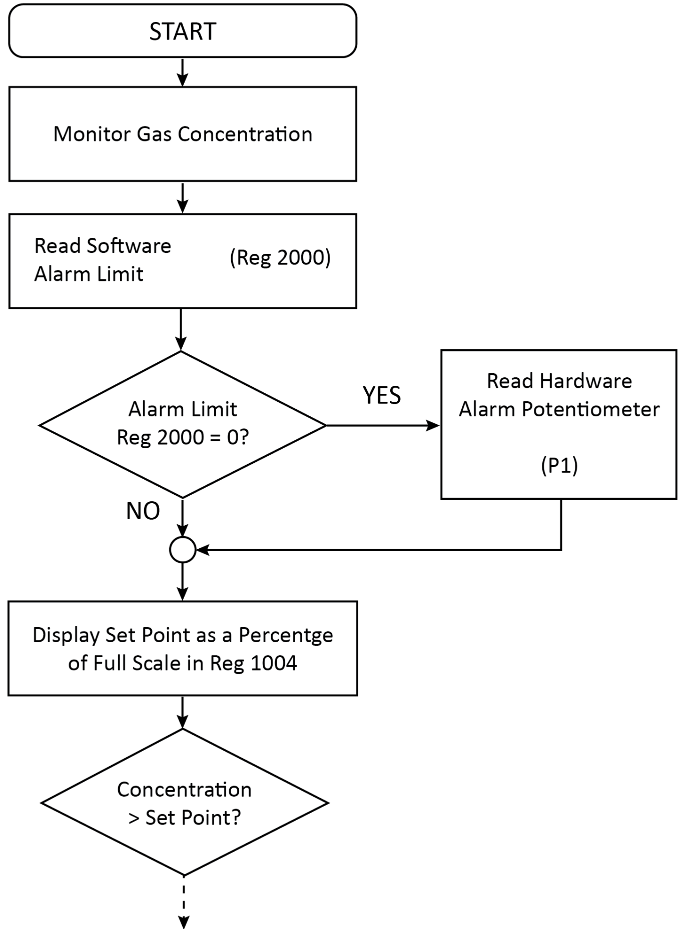


Figure 13. Flowchart of Alarm Set Point Control

7.4. Analog Output Holding Registers

The Register Map specifies the details of storage locations (registers and flags) within the detectors. Analog output holding registers are readable (using function code 03) and writable (using function code 06).

Reg	Description	Range	Details
2000	Alarm Setpoint (ppm)	0-65,535	Alarm set-point / threshold in parts per million
2001	Alarm Delay	0-59	The Alarm Delay is the time in minutes after the gas concentration exceeds the alarm level and the Alarm Flag Register 3000 is set to 1.
2002	Buzzer Delay	0-59	The Buzzer Delay is the time in minutes the buzzer is deactivated for during the alarm phase when the gas concentration exceeds the alarm set point.

7.4.1. Alarm Set Point (in ppm) Register 2000

The Alarm Set Point register 2000 stores the software setting for the alarm set point in parts per million (ppm). Writing the value zero into this register will enable the hardware potentiometer P1 to determine the Alarm Set Point. If a value greater than zero and less then the full scale sensor limit in ppm is written into register 2000 then the hardware potentiometer setting is ignored and the value written into register 2000 determines the alarm set point.

For example, writing the value 500 into the Alarm Set Point register 2000 effectively overrides the hardware alarm set point on the potentiometer P1 and sets the alarm gas concentration threshold to 500 parts per million and will be displayed as 50 in register 1004 to represent 50% for a detector with a full scale range of 1000 ppm.

Section 2. Installation and Wiring

WARNING: Explosion hazard! Do not mount the MGS Modbus in an area that may contain flammable liquids, vapors, or aerosols. Operation of any electrical equipment in such an environment constitutes a safety hazard.

CAUTION: The MGS contains sensitive electronic components that can be easily damaged. Do not touch nor disturb any of these components.

NOTE: The mounting location of the monitor should allow it to be easily accessible for visual monitoring and servicing.

NOTE: The monitor must be connected by a marked, suitably located and easily reached switch or circuit-breaker as means of disconnection.

NOTE: Connect monitor power and signaling terminals using wiring that complies with local electrical codes or regulations for the intended application.

NOTE: This instrument can be equipped with a semiconductor sensor for the detection of refrigerant, combustible or VOC gases. Semiconductor sensors are not gas specific and respond to a variety of other gases including propane exhaust, cleaners, and solvents. Changes in temperature and humidity may also affect the sensor's performance.

2.1. Components and Access Overview

NOTE: The wiring is the same for the semi-conductor and infrared models. The controller wiring is the same for all controllers.

There is a 5-minute power-up delay to allow the sensor to stabilise. Refer to Figure 1 for internal components and wiring.

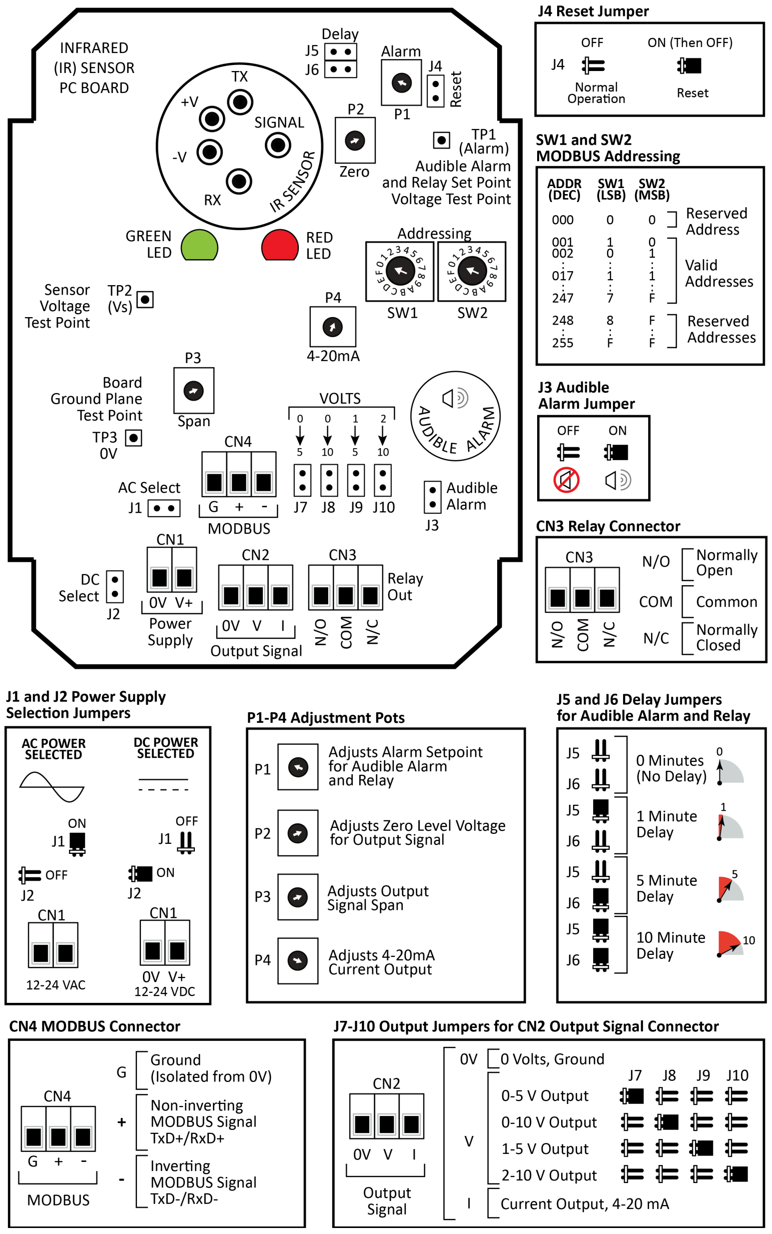


Figure 1a. Sensor Components (IR Sensor)

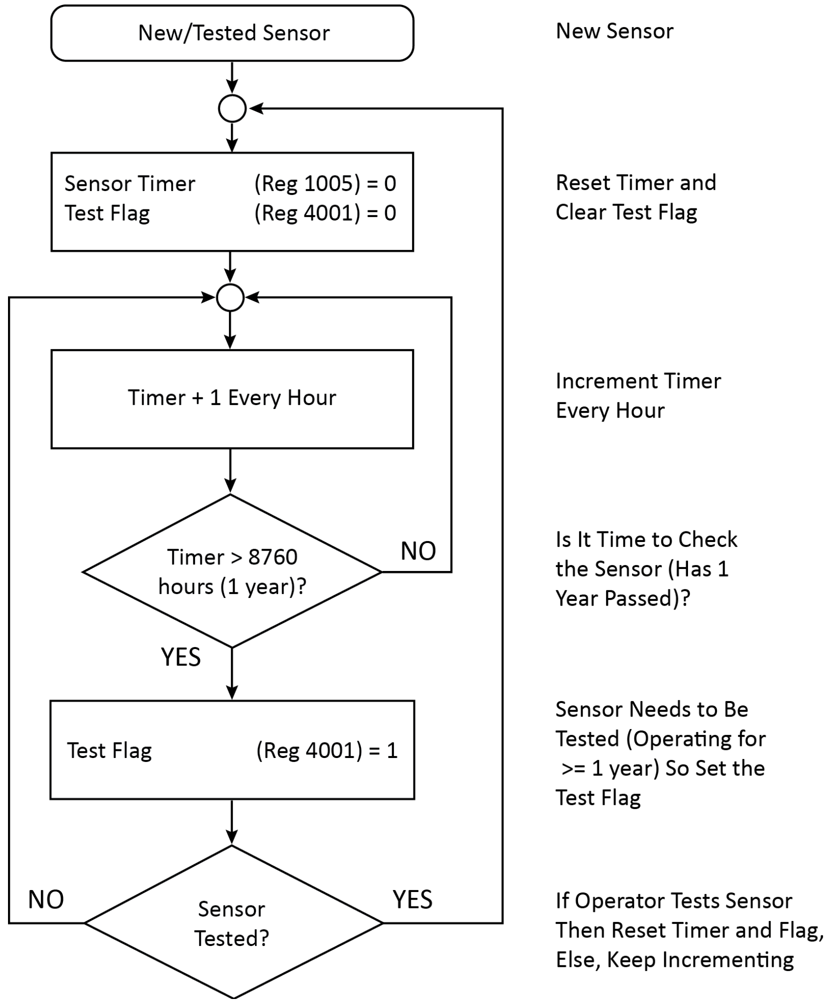


Figure 12. Flowchart of Timer Control

7.3.5. Detector Address 1006

The detector address is the value of address set by the hexadecimal switches.

7.3.6. Software Version 1007

The software version is the revision of firmware operating on the processor of the detector.

and the buzzer is audible. The duration of the delay is measured from the instant when the gas concentration reaches the alarm set point and the red LED and the alarm flag are activated.

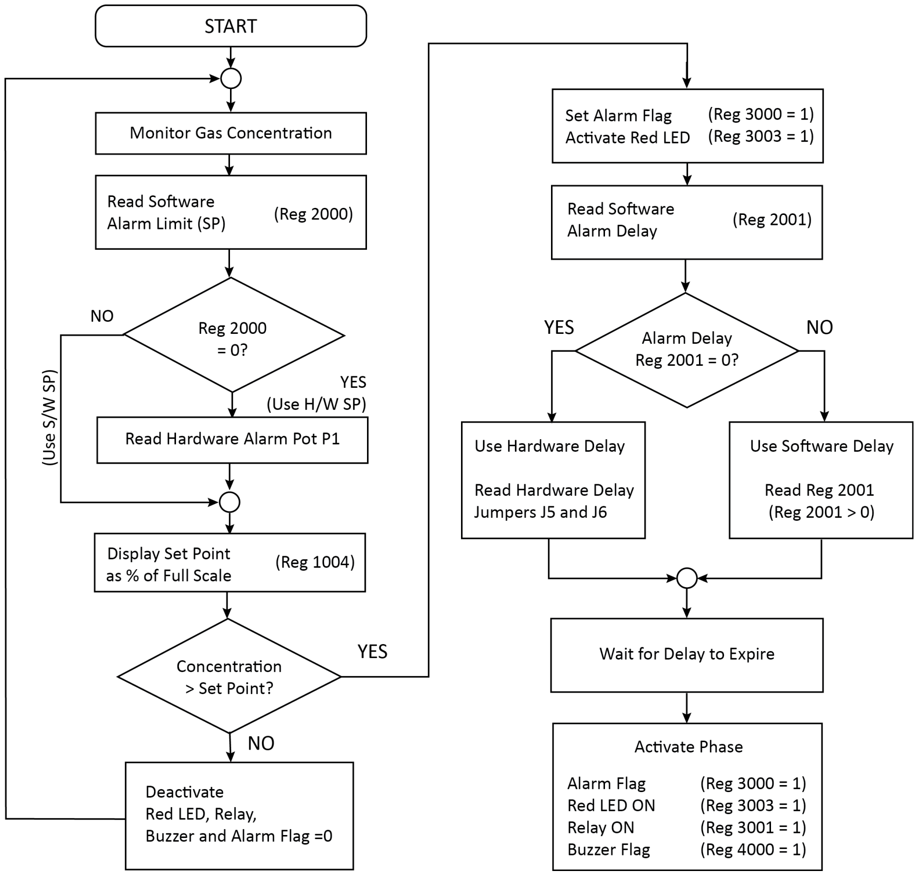


Figure 11. Flowchart of Alarm Control

7.3.4. Sensor Timer Register 1005

The sensor timer register keeps a count of the number of hours the sensor is on. The register is incremented every hour and after one year the register will exceed 8760 hours and the Test Flag will be set to 1 to indicate that the detector requires testing. The Test Flag Register is located at address 4001 and can be cleared to indicate that the sensor and detector have passed the annual test.

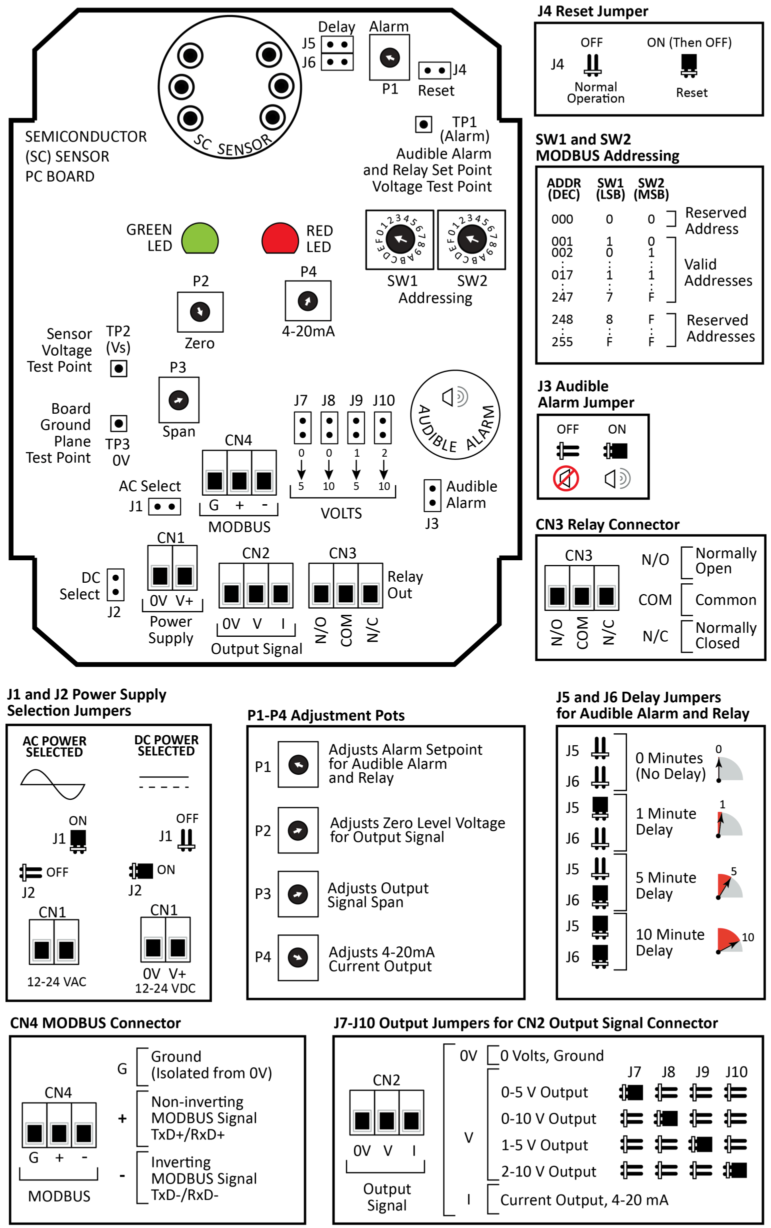


Figure 1b. Sensor Components (SC Sensor)

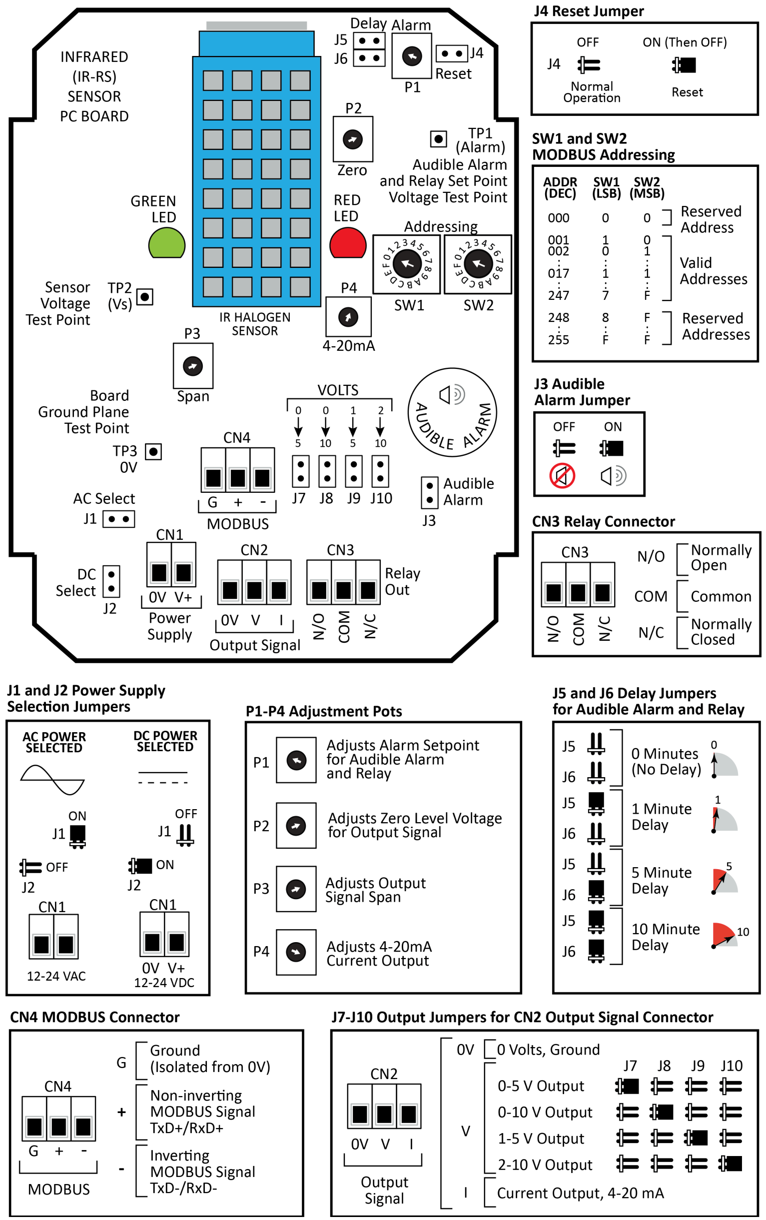


Figure 1c. Sensor Components (IR-RS Sensor)

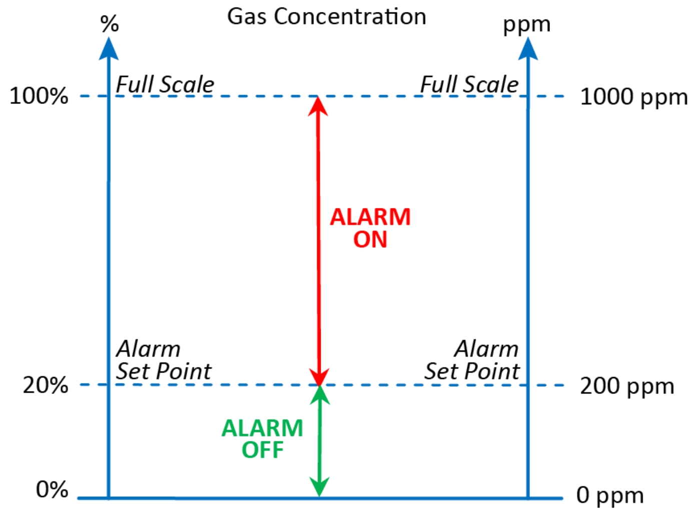


Figure 10. Graphical Example of Registers 1000-1003

7.3.3. Alarm Set Point (% of Full Scale) Register 1004

The Alarm Set Point is the threshold at which the gas concentration has reached a level to warrant the activation of:

- the red LED (alarm indication)
- the relay
- the buzzer
- the alarm flag (by setting a 1 in register 3000).

The Alarm Set Point can be controlled per Section 5.2. Alternatively, a software value can be written into register 2000 to set the alarm level in ppm and override the hardware potentiometer setting until the software value is reset back to zero, so although register 1004 is a read only register, its value can be modified by writing to register 2000.

The Alarm Set Point register 1004 is measured as a percentage of the full scale. For example, 1.0 Volts measured between TP1 and TP3 corresponds to a 20% Alarm Set Point given that the maximum voltage is 5.0 Volts. The Alarm Set Point register 1004 will contain 20 to represent 20% and this corresponds to 200 ppm for a detector with a full scale range of 1000 ppm.

If a delay period (up to 59 minutes) is set in registers 2001, the red LED and the Alarm Flag will be immediately activated, but the relay and the buzzer will wait for the duration of the delay period to expire before the relay switches on

7.3. Analog Input Registers

The Register Map specifies the details of storage locations (registers and flags) within the detectors. Analog input registers are read only and use function code 04.

Register	Description	Range	Unit
1000	Concentration gas level (% of full scale)	0-100	%
1001	Concentration gas level in ppm.	0-65,535	ppm
1003	Full scale sensor level in ppm	0-65,535	ppm
1004	Alarm set-point (% of Full Scale)	0-100	%
1005	Sensor timer	0-65,535	hours
1006	Detector address	1-247	n/a
1007	Software version	100	n/a

7.3.1. Concentration Registers 1000 and 1001

The real-time gas concentration is available in different formats. Register 1000 keeps track of the percentage concentration. Register 1001 maintains the detected concentration in parts per million.

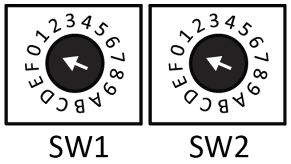
7.3.2. Full Scale Sensor Level (in ppm) Register 1003

The full-scale sensor level is the maximum detectable gas concentration for the detector. This maximum rating is stored in register 1003, so for example, 1003 holds the value 1000 to represent 1000 parts per million (ppm).

Item	Description
Enclosure Access	To open the standard sensor IP41 housing, turn the cable clamp 1/2 turn counter-clockwise to loosen the internal nut, depress the clip on top of the enclosure and open. Reverse to close. (For IP66, use the 4 hex bolts on the cover.)
Power	12-24V AC/DC, connect at positions 0V and +V at connector block CN1. • **For AC:** Jumper J1 is on, J2 is off. • **For DC:** Jumper J1 is off, J2 is on. (Default factory setting is DC.) Use 2 wires, typically 18 AWG (minimum).
Output	Connect two wires to terminal block CN2 positions 0V and V or I for voltage or current, respectively. • Connect 4-20mA at CN2 positions 0V and I • Connect voltage output at CN2 positions 0V and V
Relay Set Point	P1 sets the trip point for the relay and audible alarm using the 0- 5V scale (measure at test points 0V and alarm test point TP1). 2.5V would be equivalent to half the range (500 ppm on a scale of 0-1000 ppm). Default factory setting is typically 50% of the range.
Time Delay	A time delay for the operation of the relay and audible alarm can be selected using jumpers J5 and J6. Default factory setting is zero.
Audible Alarm	The audible alarm can be disabled using jumper J3. Default factory setting is enabled.
Modbus (RS-485)	Modbus connector is CN4. Pin 1 GND Pin 2 + TX/RX non-inverting signals Pin 3 - TX/RX inverting signals The 3-pin connections are designed for a 2-conductor wire with a common drain shield.
Modbus Address and Baud Rate	Hexadecimal Address Switches – Used to set a unique address for the sensor when multiple sensors are connected to a controller. Valid addresses are 0-247. Modbus addressing can be selected by the combined settings on the hexadecimal dial switches SW1 and SW2.

Item	Description
	Addresses 0-15 are selectable with switch SW1 (the least significant portion of the address). SW2 scales the addresses by a factor of 16 (the most significant portion of the address).

ADDR	SW2	SW1
1	0	1
2	0	2
3	0	3
:	:	:
9	0	9
10	0	A
11	0	B
:	:	:
15	0	F
16	1	0
:	:	:
246	6	F
247	7	F



SW1 = Least Significant Hex Character (0-F)

SW2 = Most Significant Hex Character (0-F)

NOTE: Address 0 is reserved to enable the master to broadcast to all of the detector slave devices. Addresses 248-255 (0x8F – 0xFF) are reserved.

Addresses 254 (0xEF) and 255 (0xFF) are reserved for setting the Modbus communications Baud rates.

ADDR	S2	S1	BAUD RATE	
254	F	E	9600	(Default)
255	F	F	19200	

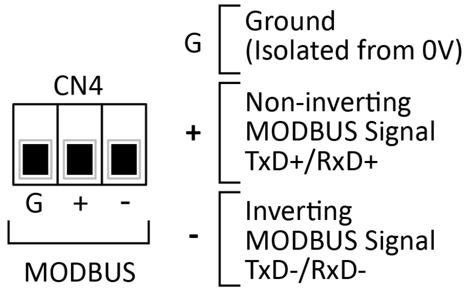
To choose a Baud rate, select the address and reset the gas detector by temporarily shorting jumper J4 (or by cycling the power off and on). After the Baud rate is set, the desired Modbus address (1-247) can be selected by changing the switch settings with a power-cycle or reset operation afterwards.

NOTE: The default Baud rate is 9600.

Section 7. Modbus Communications

7.1. Network Connection

Connector CN4 (labeled G, +, and -) is an RS-485 port for communicating with MGS Modbus gas detectors in Modbus-RTU protocol.



7.2. Communications Settings

There are 256 selections, and the addresses are numbered 0 to 255 inclusive. Addresses are selected by rotating the hexadecimal dial switches SW1 and SW2. Values 1 to 247 are valid / usable addresses providing a unique identity for each gas detector. Addresses 248 to 255 and address 0 are reserved for implementing specific features. Modbus data with a zero in the address field is received by all detectors (irrespective of the address selected by the dial switches) to enable the master device to broadcast simultaneously to all the detectors. Switch SW1 selects addresses 0 to 15 and switch SW2 multiplies the address by a factor of 16.

Refer to page 13 for additional information on Modbus network addressing and Baud rates.

Refer to page 6 for information on RS-485 network communications parameters such as data bits, stop bits, etc.

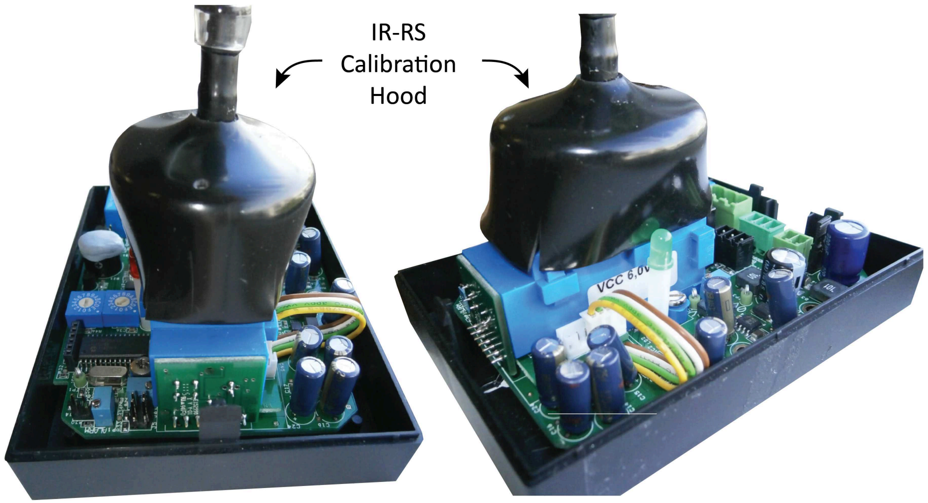


Figure 9. Calibration Hood for IR-RS Sensors

2.2. General Placement Guidelines

NOTE: The MGS Modbus should be installed plumb and level and securely fastened to a rigid mounting surface.

Sensors must be located within the appropriate wire lengths from the central control unit (if used).

In all cases the sensor supplied is designed for maximum sensitivity to a particular gas. However, in certain circumstances false alarms may be caused by the occasional presence of sufficiently high concentrations of other gaseous impurities. Examples of situations where such abnormalities may arise include the following:

- Plant room maintenance activity involving solvent or paint fumes or refrigerant leaks.
- Accidental gas migration in fruit ripening/storage facilities (bananas - ethylene, apples - carbon dioxide).
- Heavy localised exhaust fumes (carbon monoxide, dioxide, propane) from engine-driven forklifts in confined spaces or close to sensors.

Murco recommends setting the alarm delay to minimise false alarms.

2.3. Machinery Rooms

There is no absolute rule in determining the number of sensors and their locations. However, a number of simple guidelines will help to make a decision. Sensors monitor a point as opposed to an area. If the gas leak does not reach the sensor then no alarm will be triggered. Therefore, it is extremely important to carefully select the sensor location. Also consider ease of access for maintenance.

The size and nature of the site will help to decide which method is the most appropriate to use. Locations requiring the most protection in a machinery or plant room would be around compressors, pressurised storage vessels, refrigerant cylinders or storage rooms or pipelines. The most common leak sources are valves, gauges, flanges, joints (brazed or mechanical), filling or draining connections, etc.

- When **mechanical or natural ventilation** is present, mount a sensor in the airflow.

- In machinery rooms where there is **no discernible or strong airflow** then options are:

  Point Detection, where sensors are located as near as possible to the most likely sources of leakage, such as the compressor, expansion valves, mechanical joints or cable duct trenches.
  Perimeter Detection, where sensors completely surround the area or equipment.

- For **heavier-than-air gases** such as halocarbon and hydrocarbon refrigerants such as R404A, propane, and butane sensors should be located near ground level.
- For **lighter-than-air gas** (e.g., ammonia), the sensor needs to be located above the equipment to be monitored on a bracket or high on a wall within 12 in (300 mm) of (or on) the ceiling – provided there is no possibility of a thermal layer trapped under the ceiling preventing gas from reaching the sensor.

NOTE: At very low temperatures (e.g., refrigerated cold store), ammonia gas becomes heavier than air.

- With similar density or miscible gases (e.g., CO_2), sensors should be mounted about head high (about 5 ft [1.5 m]).
- Sensors should be positioned just far enough back from any high-pressure parts to allow gas clouds to form and be detected. Otherwise, a gas leak might pass by in a high-speed jet and not be detected by the sensor.
- Make sure that pits, stairwells and trenches are monitored since they may fill with stagnant pockets of gas.
- If a pressure relief vent (PRV) pipe is fitted to the system, it may be a requirement to mount a sensor to monitor this vent pipe. It could be positioned about 6 feet (2 m) above the PRV to allow gas clouds to form.
- For racks or chillers pre-fitted with refrigerant sensors, these should be mounted so as to monitor the compressors. If extract ducts are fitted the airflow in the duct may be monitored.

6.6. Calibrating Infrared (IR) Sensors

Step	Calibrating Infrared (IR) Sensors
1	Locate P2 which is used to adjust the zero point.
2	Monitor the output between 0V (TP3) and V_S (TP2).
3	Expose the sensor to nitrogen or zero air until output is stable (approximately 3 minutes).
4	Adjust P2 until the voltmeter reads 0 V or slightly positive (0.01 V is acceptable).
5	Locate P3 which is used to calibrate the range (span) of the sensor.
6	Using the appropriate calibration hood for the sensor, expose the sensor to calibration gas and allow to stabilise (approximately 3 minutes).
7	Adjust P3 until the voltmeter equals the voltage calculated in section 6.4 (page 32).

6.7. Calibrating Infrared (IR-RS) Sensors

Step	Calibrating Infrared (IR-RS) Sensors
1	Locate P2 which is used to adjust the zero point.
2	Monitor the output between 0V (TP3) and V_S (TP2).
3	Expose the sensor to nitrogen or zero air until output is stable (approximately 3 minutes).
4	Adjust P2 until the voltmeter reads 0 V or slightly positive (0.01 V is acceptable).
5	Locate P3 which is used to calibrate the range (span) of the sensor.
6	Using the appropriate calibration hood for the sensor, expose the sensor to calibration gas and allow to stabilise (approximately 3 minutes).
7	Adjust P3 until the voltmeter equals the voltage calculated in section 6.4 (page 32).

NOTE: For improved accuracy and response, the instrument should be zeroed and calibrated in the environment in which it is being installed.

6.4. Calculating Calibration Voltage

Sensor outputs are linear. As long as you have a gas cylinder of known concentration you can calibrate to any desired range.

Example: For a sensor range of 0-1000 ppm and a cylinder of the target gas at 800 ppm:

$$\textbf{Voltage} = \textbf{Target Gas Value} \times \frac{\textbf{5 V}}{\textbf{Sensor Range}}$$

$$\textbf{Voltage} = \textbf{800 ppm} \times \frac{\textbf{5 V}}{\textbf{1000 ppm}} = \textbf{4 V}$$

So the output voltage signal should be adjusted to 4V.

6.5. Calibrating Semiconductor (SC) Sensors

Step	Calibrating Semiconductor (SC) Sensors
1	Locate P2 which is used to adjust the zero point.
2	Monitor the output between 0V (TP3) and V_S (TP2).
3	Expose sensor to zero air until output is stable (about 3 minutes).
4	Adjust P2 until the voltmeter reads a slightly positive value (0.01 V is acceptable).
5	Locate P3 which is used to calibrate the range (span) of the sensor.
6	Expose the sensor to calibration gas and allow to stabilise (approximately 3 minutes).
7	Adjust P3 until the voltmeter equals the voltage calculated in section 6.4 (page 32).

NOTE: For semiconductor sensors, you MUST use calibration gas in a balance of air (*not* N_2).

2.4. Refrigerated Spaces

In refrigerated spaces, sensors should be located in the return airflow to the evaporators on a sidewall (below head-high is preferred), or on the ceiling, not directly in front of an evaporator. In large rooms with multiple evaporators, sensors should be mounted on the central line between 2 adjacent evaporators, as turbulence will result in airflows mixing.

2.5. Chillers

In the case of small water- or air-cooled enclosed chiller units mount the sensor so as to monitor airflow to the extract fans. With larger models also place a sensor inside the enclosure under or adjacent to the compressors.

In the case of outdoor units:

- For enclosed air-cooled chillers or the outdoor unit for variable refrigerant volume and variable refrigerant flow (VRV/VRF) systems, mount the sensor so as to monitor airflow to the extract fan. With large units also place a sensor inside the enclosure under or adjacent to the compressors.

In the case of non-enclosed outdoor units:

- If there is an enclosed machinery section locate a sensor there.
- In the case of units with enclosed compressors, mount sensors in the enclosures.
- Where you have protective or acoustic panels mount the sensor low down under the compressors where it is protected by the panels.
- With air-cooled chillers or air-cooled condensers with non-enclosed condenser sections it is difficult to effectively monitor leaks in the coil sections. With some designs it will be possible using an airflow sensor to monitor airflow to the start–up fans in the front or rear sections.
- If there is a possibility of refrigerant leaks into a duct or air-handling unit install a sensor to monitor the airflow.

Weatherproof sensors should be used for unprotected outdoor applications.

2.6. Air Conditioning (Direct Systems VRF/VRV)

For compliance with EN378, at least one detector shall be installed in each occupied space being considered and the location of detectors shall be chosen in relation to the refrigerant and they shall be located where the refrigerant from the leak will collect. In this case refrigerants are heavier than air and detectors should have their sensors mounted low, e.g., at less than bed height in the case of an hotel or other similar Category Class A spaces. Ceilings or other voids if not sealed are part of the occupied space.

CAUTION: Monitoring ceiling voids in a hotel room would not strictly comply with EN378.

Do Mount In-Room Sensors…	Don't Mount Sensors…
…at less than the normal heights of the occupants. E.g., in a hotel room this is less than bed height (between 8 and 20 inches [200 and 500 mm] off the floor).	…under mirrors.
…away from drafts and heat sources like radiators, etc.	…at vanity units.
… to avoid sources of steam.	…in or near bathrooms.

Step	Bump Testing Using Gas Ampoules
1	Make sure that both the ampoules and the calibration beaker are clean and dry.
2	Unscrew the beaker hold screw and place the ampoule so that it sits in the base of the beaker (see Figure 8).
3	Tighten wing-nut screw onto the ampoule without breaking it.
4	Remove the enclosure lid of the gas detector.
5	Connect a voltmeter to monitor sensor response. Monitor response between pins 0V (TP3) and V_S (TP2).
6	Place the beaker over the sensor head using the multi sensor adaptor to fit the sensor, or, if an Exd, IP66 or Remote sensor head version, screw the beaker on the remote sensor head M42 thread or M35 thread adaptor. It should be as tight fitting as possible to allow maximum gas exposure.
7	Tighten the wing-nut screw onto the ampoule until it shatters allowing the gas to diffuse in the beaker. It should be left in place for approximately 5 min.
8	The voltage output will increase. This confirms that the sensor is responding. A response equivalent to at least 50% of the test gas (typical) will confirm that the system is in order.
9	Remove the beaker from the sensor. Carefully remove any ampoule remains from the gas detector and beaker.

6.3. Calibration Overview

There are two adjustments required: zero and span. They are monitored at 0V and VS using a 0-5V scale. If the sensor range is 0-1000 ppm, then 5V=1000 ppm.

Murco offers a calibration kit that consists of a calibration gas cylinder, a flow regulation valve with flexible non-absorbent tubing and vented calibration hood.

Tools required:

- Gas cylinder with the appropriate gas and concentration
- A voltmeter (crocodile clips recommended)
- Screwdriver (depending on housing).

The MGS has three sensor PCB versions: SC, IR, and IR-RS.

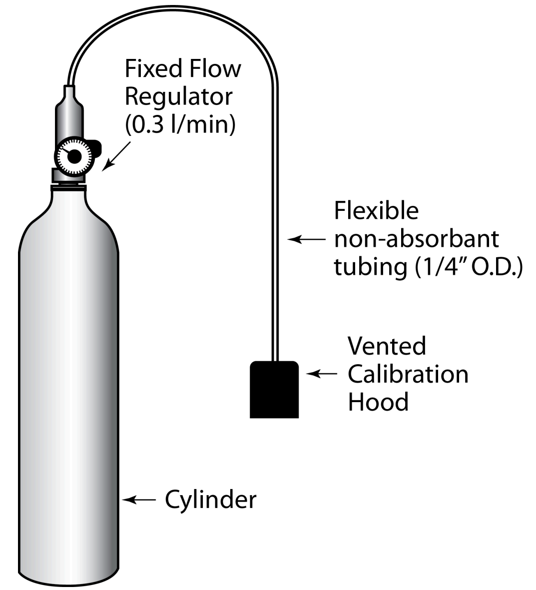


Figure 7. Gas Cylinder and Test Hardware

Gas ampoules are convenient and inexpensive alternatives to using gas cylinders for bump testing.

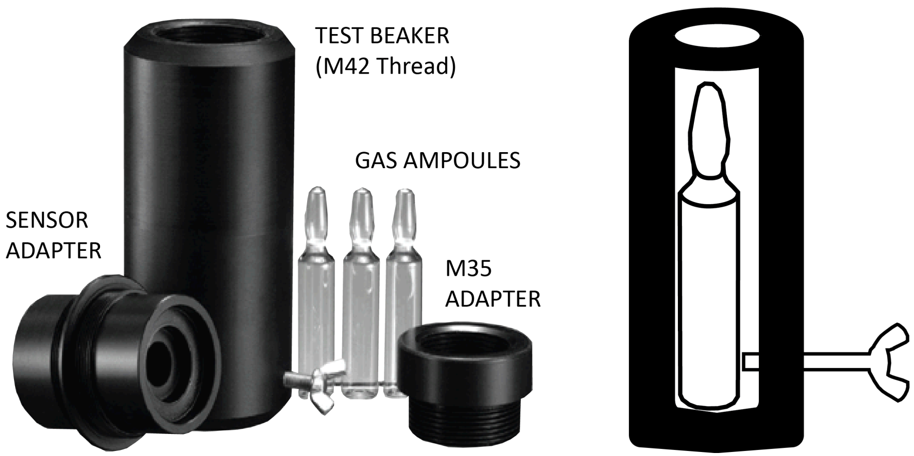


Figure 8. Gas Ampoules for Bump Testing

Section 3. Housing Dimensions

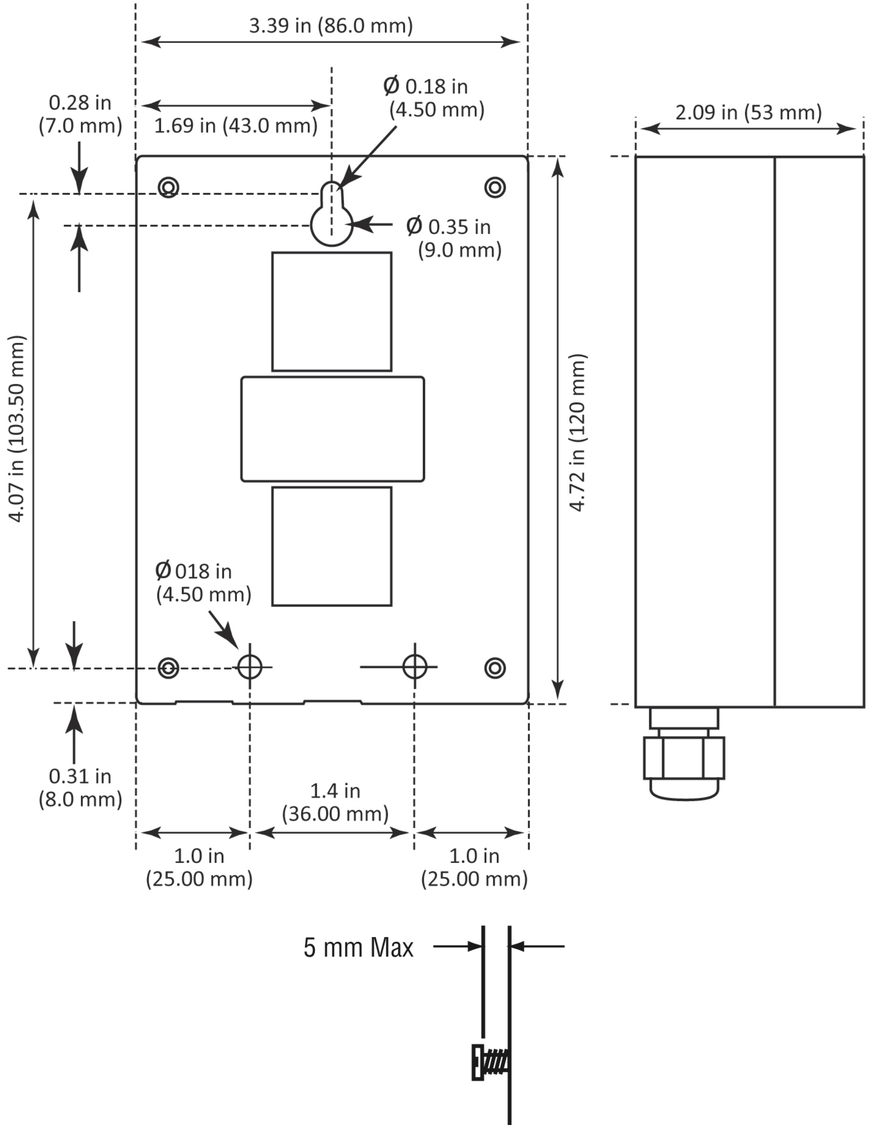


Figure 2. MGS Modbus Standard Housing

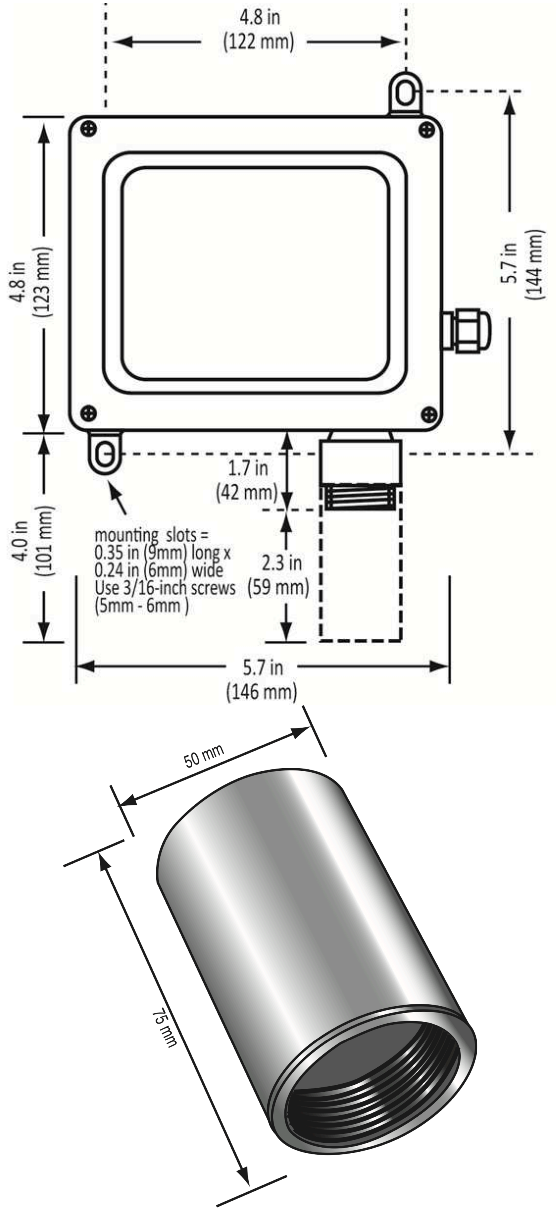


Figure 3. IP66 Housing with Splashguard

NOTE: Prior to carrying out a bump test, check and adjust the zero setting as described in the Calibration section.

NOTE: Procedures for bump test and calibration vary depending on the sensor technology used and the gas in question. The MGS Modbus is available in two sensor versions: Semiconductor (SC) and Infrared (IR).

NOTE: Do not pressurise the sensor.

NOTE: For semiconductor sensors, you MUST use calibration gas in a balance of air (*not* N_2).

IMPORTANT: After a semiconductor sensor is exposed to a substantial gas leak, the sensor should be checked and replaced if necessary.

NOTE: To test the audible alarm and/or relay function, check the delay is set at zero and expose to gas. You can mute the audible alarm by removing jumper J3.

Step	Bump Testing Using Calibration Gas Cylinders
1	Remove the enclosure lid of the gas detector (not in an exhaust area).
2	Connect a voltmeter to monitor sensor response. Monitor response between pins 0V (TP3) and V_S (TP2).
3	Expose the sensor to gas from the cylinder. Use a plastic hose/hood to direct gas to the sensor head. A response of above 80% is acceptable.

NOTE: Gas ampoules are *not* valid for calibration or accuracy checks of the sensor. These require actual gas calibration, *not* bump testing with ampoules.

Bump Test: Exposing the sensor to a gas and observing its response to the gas. The objective is to establish if the sensor is reacting to the gas and all the sensor outputs are working correctly. There are two types of bump test.

Quantified: A known concentration of gas is used.

Non-Quantified: A gas of unknown concentration is used.

Calibration: Exposing the sensor to a calibration gas, setting the "zero" or standby voltage to the span/range, and checking/adjusting all the outputs, to ensure that they are activated at the specified gas concentration.

CAUTION: Before you carry out the test or calibration:

- Advise occupants, plant operators, and supervisors.
- Check if the MGS Modbus is connected to external systems such as sprinkler systems, plant shut down, external sirens and beacons, ventilation, etc. and disconnect as instructed by the customer.
- Deactivate alarm delays if selected at JP5, JP6 as per Figure 1.
- For bump test or calibration the MGS Modbus should be powered up overnight. The instrument should be fully stabilised per Section 4.

6.2. Bump Testing

After installation, the units should be bump tested. Expose the sensors to test gas (NH_3, CO_2, etc.). The gas should put the system into alarm and light the red LED. The delay prevents the audible alarm from sounding and the relay from switching (if delay is set).

With a bump test you can see the functions of the sensor - the red LED will light, the relay and audible alarm will function, and the output (0-10V, for example) will show the gas level.

Ideally bump tests are conducted on site in a clean air atmosphere.

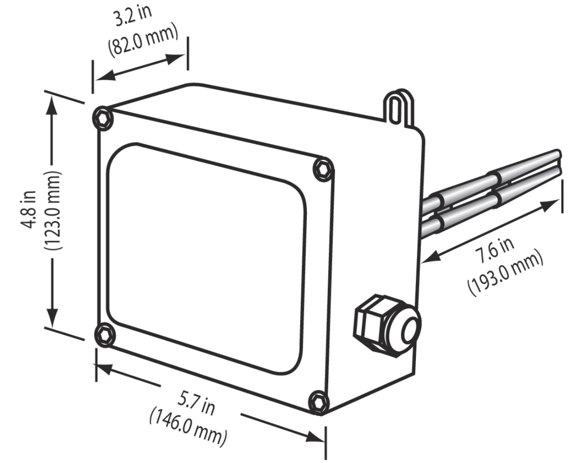


Figure 4. IP66 Airflow Duct Mount Housing

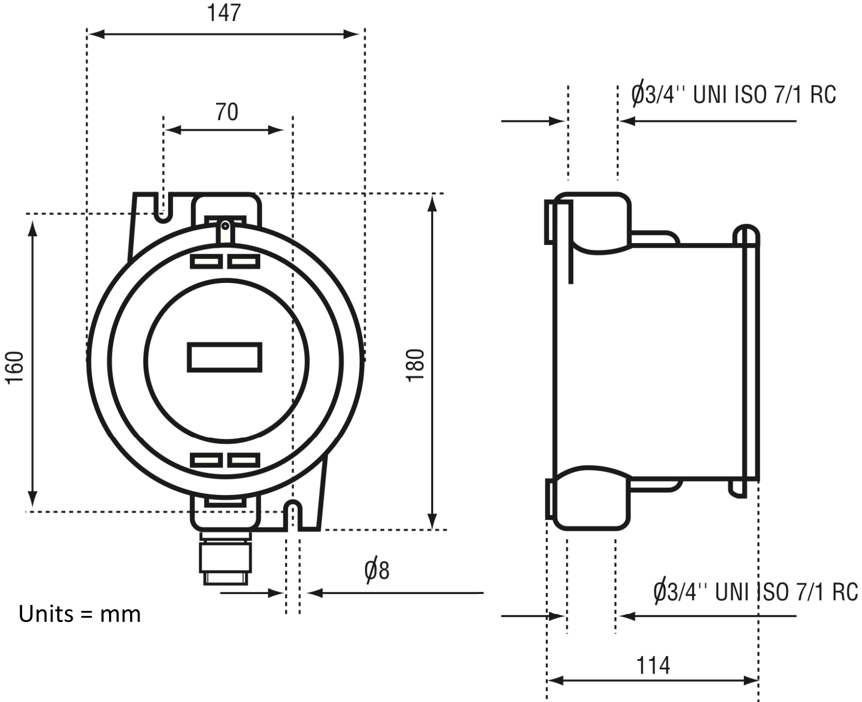
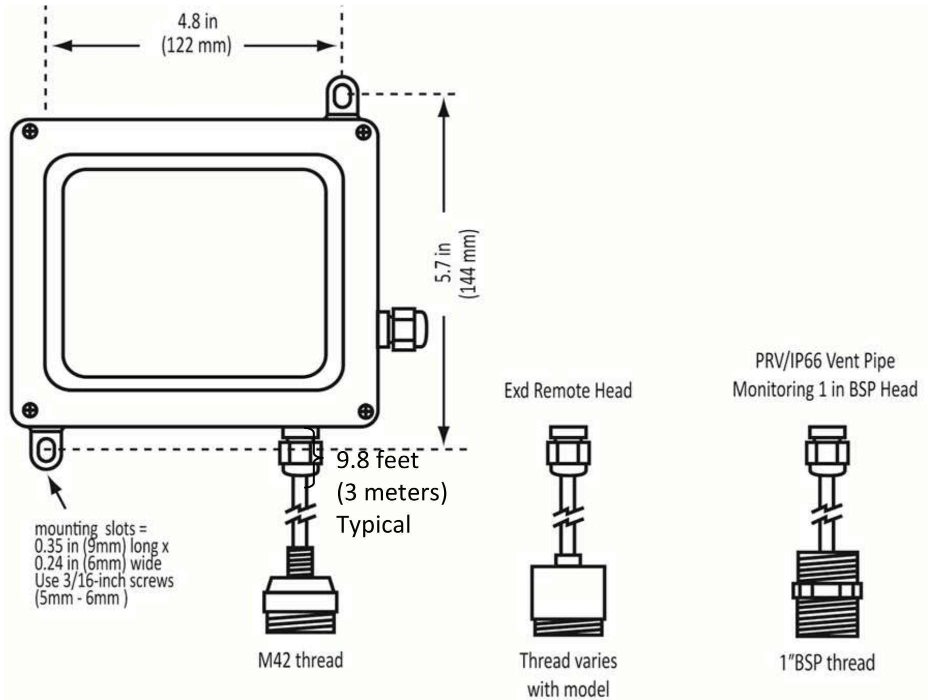


Figure 5. Exd Housing



For Dimensions and Mounting Locations , See Figure 3.

Figure 6. IP66 Housing with Remote Sensor Head

NOTE: For the Exd Remote Head and 16.4 ft (5 m) cable, the thread varies based on the model.

IMPORTANT: Failure to test or calibrate the unit in accordance with applicable instructions and with industry guidelines may result in serious injury or death. The manufacturer is not liable for any loss, injury, or damage arising from improper testing, incorrect calibration, or inappropriate use of the unit.

IMPORTANT: Before testing the sensors on-site, the MGS Modbus must have been powered up and allowed to stabilise.

IMPORTANT: The testing and/or calibration of the unit must be carried out by a suitably qualified technician, and must be done:

- in accordance with this manual
- in compliance with locally applicable guidelines and regulations.

Suitably qualified operators of the unit should be aware of the regulations and standards set down by the industry/country for the testing or calibration of this unit. This manual is only intended as a guide and, insofar as permitted by law, the manufacturer accepts no responsibility for the calibration, testing, or operation of this unit.

The frequency and nature of testing or calibration may be determined by local regulation or standards.

EN378 and the F-GAS Regulation require an annual check in accordance with the manufacturer's recommendation.

There are two concepts that need to be differentiated:

- bump test
- calibration.

Section 6. Functional Tests and Calibration

6.1. Introduction

To comply with the requirements of EN378 and the European F-GAS regulation, sensors must be tested annually. However, local regulations may specify the nature and frequency of this test.

NOTE: The MGS Modbus is calibrated at the factory. After installation, a zero adjustment may be required due to differences in environmental conditions.

CAUTION: Check local regulations on calibration or testing requirements.

CAUTION: The MGS Modbus contains sensitive electronic components that can be easily damaged. Do not touch nor disturb any of these components

IMPORTANT: If the MGS Modbus is exposed to a large leak it should be tested to ensure correct functionality by electrically resetting the zero setting and carrying out a bump test. See procedures below.

IMPORTANT: Murco recommends annual checks and gas calibration. Murco also recommends sensor replacement every 3 years or as required. Calibration frequency may be extended based on application, but should never exceed 2 years.

IMPORTANT: In applications where life safety is critical, calibration should be done quarterly (every 3 months) or on a more frequent basis. Murco is not responsible for setting safety practices and policies. Safe work procedures including calibration policies are best determined by company policy, industry standards, and local codes.

Section 4. Operation and Stabilisation

On powering up, the MGS Modbus will sense for the presence of gas after an initial warm-up delay of 5 minutes. Note that the status of warm-up mode is indicated by Modbus register 3006.

In an alarm condition:

- green LED stays on and the red LED will be on
- audible alarm operates (if not disabled and after delay, if set).
- relay output activates (after a delay, if set)
- V and I output changes proportionally with gas concentration.

In a fault condition:

- green LED will be off and the red LED will be on
- voltage or current fault output will activate:
  - 2mA on the 4-20mA output
  - 0.5V on the 1-5V output
  - 1.0V on the 2-10V output.

The typical time for various sensor types to stabilise is shown below.

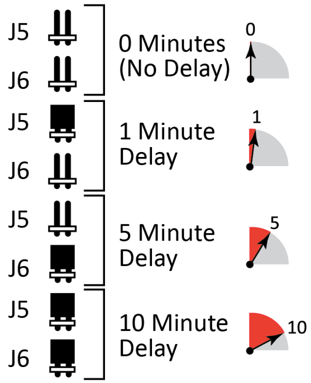
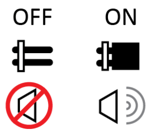
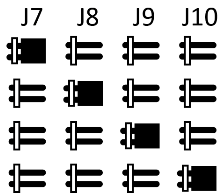
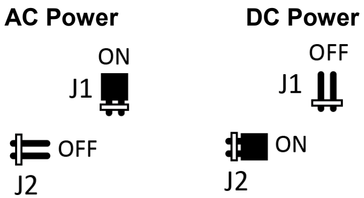
Sensor Type	Stabilisation Time
Semiconductor (SC)	5 minutes
Infrared (IR)	2 minutes
Infrared (IR-RS)	2 minutes

On power up, semiconductor sensors output a signal voltage that is over the + max scale, i.e., > 5V, and move towards zero as they stabilise.

If sensors have been in long-term storage or the detectors have been turned off for a long period, stabilisation is much slower. However, within 1-2 hours sensors should have dropped below the alarm level and be operational. You can monitor progress exactly by monitoring the output (for example, 0-10V, or as otherwise configured). When the output settles around zero the sensor is stabilised. In exceptional circumstances the process can take up to 24 hours or more.

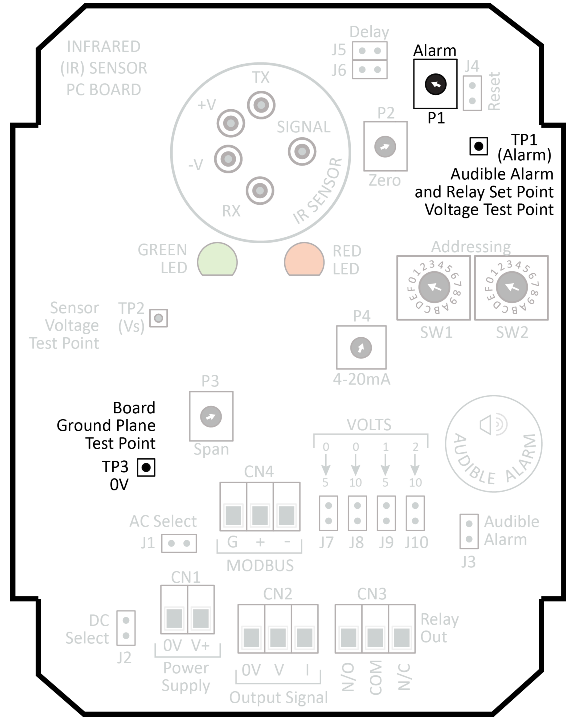
Section 5. Configurations

5.1. Jumper Configurations

Function	Description
Time Delay **(J5, J6)**	Available on the audible alarm and relay to avoid false alarms. This is set with jumpers. **The default delay is 0 minutes.** The max setting via jumpers is 10 minutes. For other settings, use the Modbus interface. You may wish to set to 15 minutes during start up. See Figure 1 for jumper locations and additional configuration details. 
Audible Alarm **(J3)**	The units have an internal audible alarm (see Figure 1). You can disable this alarm using jumper J3, but the **default setting is "enabled"** in compliance with EN378. See Figure 1 for details. 
DC Output Selection **(J7-J10)**	Decide which DC voltage output range is required for the DC output signal on connector CN2. See Figure 1 for jumper locations and configuration details. 
Input Power **(J1, J2)**	Decide whether the device will be powered (via CN1) with an AC source or a DC source. See Figure 1 for jumper locations and additional details. 

5.2. Adjusting the Alarm Setpoint

This process is the same for all versions using P1 and test points 0V (TP3) and ALARM (TP1). See Figure 1 for locations.

Step	Adjusting the Alarm Setpoint	
1	Locate P1 and use it to adjust the set point at which the relay activates. (Example is shown highlighted at the right.)	
2	Using a volt meter, monitor the output between test points 0V (negative) and ALARM (positive) until the correct setting is reached. See formula below for example of how to calculate the desired setpoint.	

Example: For a sensor range of 0-1000 ppm, calculate the voltage to set the alarm point at 100 ppm.

$$\textbf{Voltage} = \textbf{Alarm Value} \times \frac{\textbf{5 V}}{\textbf{Max Range}}$$

$$\textbf{Voltage} = \textbf{100 ppm} \times \frac{\textbf{5 V}}{\textbf{1000 ppm}} = \textbf{0.5 V}$$

So the alarm voltage setting is 0.5 Volts.