TRIGARD® Gas Monitor

Instruction Manual

⚠ WARNING

THIS MANUAL MUST BE CAREFULLY READ BY ALL INDIVIDUALS WHO HAVE OR WILL HAVE THE RESPONSIBILITY FOR USING OR SERVICING THE PRODUCT. Like any piece of complex equipment, this instrument will perform as designed only if it is used and serviced in accordance with the manufacturer's instructions. OTHERWISE, IT COULD FAIL TO PERFORM AS DESIGNED AND PERSONS WHO RELY ON THIS PRODUCT FOR THEIR SAFETY COULD SUSTAIN SEVERE PERSONAL INJURY OR LOSS OF LIFE.

The warranties made by Mine Safety Appliances Company with respect to the product are voided if the product is not used and serviced in accordance with the instructions in this manual. Please protect yourself and others by following them. We encourage our customers to write or call regarding this equipment prior to use or for any additional information relative to use or repairs.

In North America, to contact your nearest stocking location, dial toll-free 1-800-MSA-INST
To contact MSA International, dial (724) 776-8626

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

Manufactured by

MSA NORTH AMERICA

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(L) Rev 3 **10072857**

MSA Instrument Warranty

1. Warranty- Seller warrants that this product will be free from mechanical defect or faulty workmanship for a period of eighteen (18) months from date of shipment or one (1) year from installation, whichever occurs first, provided it is maintained and used in accordance with Seller's instructions and/or recommendations. This warranty does not apply to expendable or consumable parts whose normal life expectancy is less than one (1) year such as, but not limited to, non-rechargeable batteries, sensor elements, filter, lamps, fuses etc. The Seller shall be released from all obligations under this warranty in the event repairs or modifications are made by persons other than its own or authorized service personnel or if the warranty claim results from physical abuse or misuse of the product. No agent, employee or representative of the Seller has any authority to bind the Seller to any affirmation, representation or warranty concerning the goods sold under this contract. Seller makes no warranty concerning components or accessories not manufactured by the Seller, but will pass on to the Purchaser all warranties of manufacturers of such components. THIS WARRANTY IS IN LIEU OF ALL OTHER

   WARRANTIES, EXPRESSED, IMPLIED OR STATUTORY, AND IS STRICTLY LIMITED TO THE TERMS HEREOF. SELLER SPECIFICALLY DISCLAIMS ANY WARRANTY OF MERCHANTABILITY OR OF FITNESS FOR A PARTICULAR PURPOSE.

2. Exclusive Remedy- It is expressly agreed that Purchaser's sole and exclusive remedy for breach of the above warranty, for any tortious conduct of Seller, or for any other cause of action, shall be the repair and/or replacement at Seller's option, of any equipment or parts thereof, which after examination by Seller is proven to be defective. Replacement equipment and/or parts will be provided at no cost to Purchaser, F.O.B. Seller's Plant. Failure of Seller to successfully repair any nonconforming product shall not cause the remedy established hereby to fail of its essential purpose.

3. Exclusion of Consequential Damage- Purchaser specifically understands and agrees that under no circumstances will seller be liable to purchaser for economic, special, incidental or consequential damages or losses of any kind whatsoever, including but not limited to, loss of anticipated profits and any other loss caused by reason of nonoperation of the goods. This exclusion is applicable to claims for breach of warranty, tortious conduct or any other cause of action against seller.

General Warnings and Cautions

⚠ WARNING

1. The Trigard Gas Monitors described in this manual must be installed, operated and maintained in strict accordance with their labels, cautions, warnings, instructions, and within the limitations stated.
2. The Trigard Gas Monitor is designed to detect gases or vapors in air. It cannot measure the concentration of gases or vapors in steam or inert or oxygen-deficient atmospheres. The oxygen sensor can measure oxygen-deficient atmospheres.
3. Electrochemical sensors are sealed units which contain a corrosive electrolyte. Should a sensor develop leakage, it must be immediately removed from service; then, remove it from the sensing head and discard it properly. Caution must be exercised so that the electrolyte does not contact skin, eyes, clothing or circuitry; otherwise, serious personal injury (burns) and/or equipment damage may result.
4. Use only genuine MSA replacement parts when performing any maintenance procedures provided in this manual. Failure to do so may seriously impair instrument performance. Repair or alteration of the Trigard Gas Monitor, beyond the scope of these maintenance instructions or by anyone other than an authorized MSA service personnel, could cause the product to fail to perform as designed and persons who rely on this product for their safety could sustain serious personal injury or death.
5. Do not locate the general-purpose enclosure models in an area which may contain a flammable mixture of gas and air; otherwise, an explosion may occur. The general-purpose Trigard Gas Monitors can be a source of ignition and must not be mounted in an area where a flammable mixture of combustible gas and air may become present; otherwise, an explosion may occur.

   Failure to follow the above can result in serious personal injury or death.

⚠ CAUTION

1. As with all gas monitors of these types, high levels of, or long exposure to, certain compounds in the tested atmosphere could contaminate the sensors. In atmospheres where Trigard Gas Monitor may be exposed to such materials, calibration must be performed frequently to ensure that operation is dependable and display indications are accurate.
2. The Trigard Gas Monitor must not be painted. If painting is done in an area where a Monitor is located, care must be exercised to ensure that paint is not deposited on the sintered, metal flashback arrestor in the inlet fitting of the Trigard Gas Monitor, if so equipped. Such paint deposits would interfere with the diffusion process, whereby a sample of the atmosphere being monitored diffuses into the Monitor.
3. The only absolute method to ensure proper overall operation of Trigard Monitor is to check it with a known concentration of the gas for which it has been calibrated. Consequently, calibration checks must be included as part of the routine inspection of the system.
4. Protect the Trigard Gas Monitor from extreme vibration. Do not mount the sensing head in direct sunlight as this may cause overheating of the sensor.

   Failure to follow the above can result in injury, product damage and/or an unsafe condition.

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Chapter 1, Installation

General Description

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

Identifying Your Unit

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

Figure 1-1. TRIGARD Gas Monitor

- The Trigard Gas Monitor comes standard with internal relays, a Cal/Reset pushbutton, and a 95 dB horn. See Chapter 4 for details.
- The gas sensor type and range are located on the sensor module label. Unscrew the sensor assembly to view the label.

Any options ordered, such as Strobes, Battery Backup or Internal AC Power Supply, will be included.

Installing Your Gas Monitor

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

Generally, the Trigard Gas Monitors or remote sensing module should be mounted close to the area where a leak is likely to occur or where the gas is expected. Install the Trigard Gas Monitors or the remote sensor at a high level (ceiling) or low level (floor), depending on the density of the gas most likely to be found. Install the unit so that the front display is not blocked or hidden from view.

⚠ WARNING

Mount the Trigard Gas Monitor or remote sensor with the sensor inlet fitting (FIGURE 1-1) pointed downward; otherwise, the inlet may become clogged with particulate matter or liquids.

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

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

⚠ WARNING

Do not locate the general-purpose enclosure models in an area which may contain a flammable mixture of gas and air; otherwise, an explosion may occur. The general-purpose Trigard Gas Monitors can be a source of ignition and must not be mounted in an area where a flammable mixture of combustible gas and air may become present.

Installing the Trigard Gas Monitor

Remove lid and drill enclosure for power, signal and optional relay cable entry. Use one of the following methods to mount the general-purpose Trigard Gas Monitor.

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

Electrical Connections for Trigard Gas Monitors

⚠ WARNING

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

NOTE: For information on internal relays, see Chapter 4.
For Trigard units with ModBUS, see Chapter 3.

This three-wire assembly is marked to identify power, ground and signal connections for all combustible, toxic, and oxygen models.

Wiring

Install wiring in accordance with the electrical code of the country in use and UL 61010-A1 or CSA C22.2 No. 1010.1, as applicable. In these installations, twisted-pair, instrument quality cable is recommended. Shielded cable is recommended for cable runs where interferences from radio frequency interference (RFI), electromagnetic interference (EMI) or other noise sources exist (such as motors, welding equipment, heaters, etc.).

NOTE: See Installation Outline Drawings for wiring details.

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

Use caution when selecting a cable size. TABLES 1-1 and 1-2 express the maximum cable length when only using the Trigard Gas Monitors. Trigard options may take additional power which requires a heavier cable or a short cable run.

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

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

For Milliamp Output

The Trigard Gas Monitor (three-wire version) may be connected to any device capable of accepting 4 to 20 mA analog signals such as:

- Model 9010/9020 Controller
- GasGard XL Controller
- Programmable controllers
- DCS's, etc.

An external power supply is needed if the optional internal power supply is not ordered. (For power requirements, see Chapter 3, "Specifications".) All connections should be made by following appropriate wire code procedures.

- See TABLES 1-1 through 1-2 for typical cable length and wire size for installation.

⚠ WARNING

When using any of the the Trigard accessories (such as relays) with the 4 to 20 mA output Trigard Gas Monitor, a three-wire connection must be used. Failure to use a three-wire connection could damage the electronics within the Trigard Gas Monitor which can result in serious personal injury or death.

Be sure to install your Trigard Gas Monitor according to National Electrical and local procedural codes. Failure to do so can result in an unsafe condition.

NOTE: See Chapter 3 for ModBUS output.

Table 1-1.
Power Cable Distances for the Trigard Gas Monitor with Internal Relays (4-20 mA Model)

SENSOR TYPE	POWER SUPPLY VOLTAGE	WIRE SIZE	MAXIMUM CABLE LENGTH (IN FEET)	MAXIMUM LOAD RESISTANCE (mA OUTPUT ONLY)
CATALYTIC COMBUSTIBLE	12 VDC	16 AWG	900	300 OHMS
CATALYTIC COMBUSTIBLE	24 VDC	16 AWG	3000	600 OHMS
TOXIC OR OXYGEN	12 VDC	16 AWG	2500	300 OHMS
TOXIC OR OXYGEN	24 VDC	16 AWG	8000	600 OHMS

- See TABLE 1-6 for remote sensor distances.
- In all installations, twisted instrument-quality cable is recommended.
- Shielded cable is recommended in situations where radio frequency interference (RFI), electro-magnetic interference (EMI) or other electrical noise sources exist or are anticipated.

Typical Trigard Gas Monitor Wiring

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

WIRE SIZE	MAXIMUM CABLE LENGTH IN FEET	MAXIMUM LOAD RESISTANCE
22 AWG	12,000	600 Ohms

- Three-wire Trigard Monitors operate in the current source mode (see FIGURE 1-3).

1. Identify the main pc board:
   - It is the round pc board, located inside the lid assembly.

2. Connect 8 to 30 VDC power lead to J8-1 (see FIGURE 1-2).

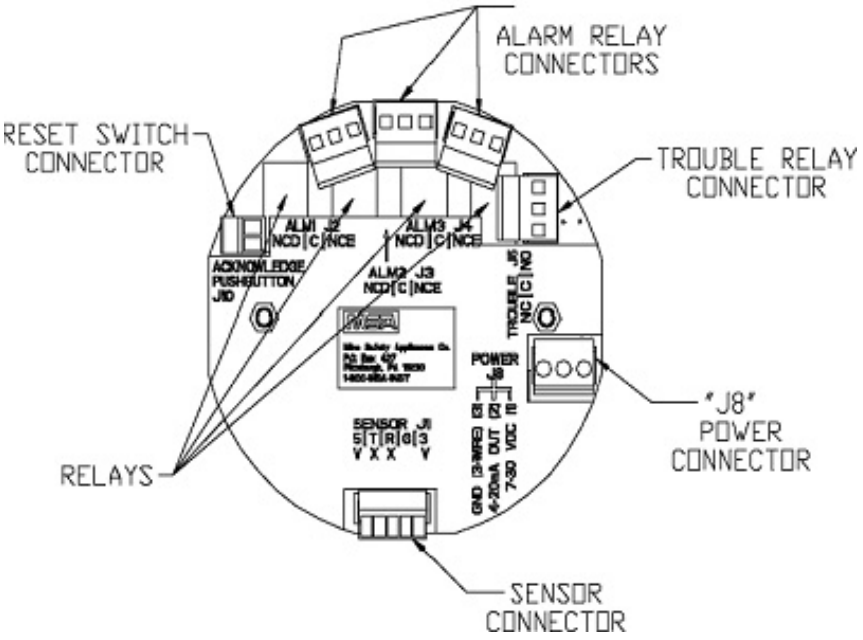


Figure 1-2. Circuit Board (3-Wire Version)

3. Connect J8-2 to 4 to 20 mA input on remote system.
4. Connect the signal ground to J8-3.
5. Connect the sensor module to labeled connector J-1 on the main pc board.
6. Wire for relays (see Chapter 4).
7. Assemble lid on enclosure.

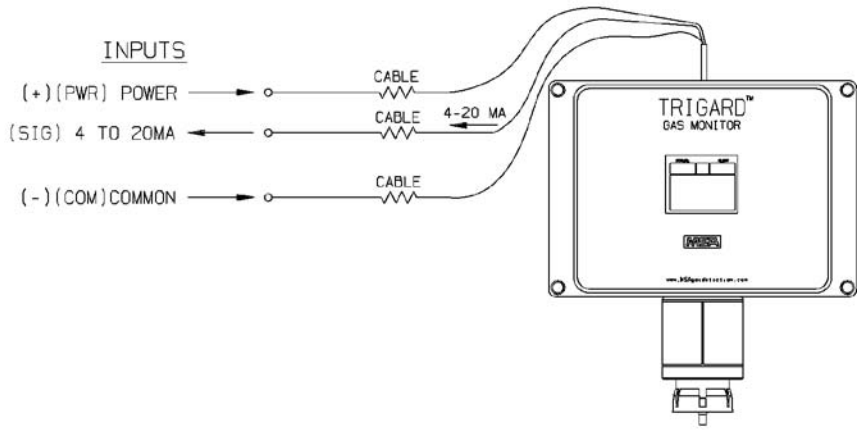


Figure 1-3. Three-Wire 4 to 20 mA Operation

Installing the Trigard Remote Sensor Module

The Remote Sensor Modules are available in a variety of options.

Pre-wired general-purpose sensors are available in lengths of 25, 50 or 100 feet. These remote sensors are not housed in an enclosure, which makes it easier to mount in small places.

Figure 1-4. Remote Sensor Cable Assemblies

Remote sensors can be ordered with general purpose (GP) remote sensor assemblies.

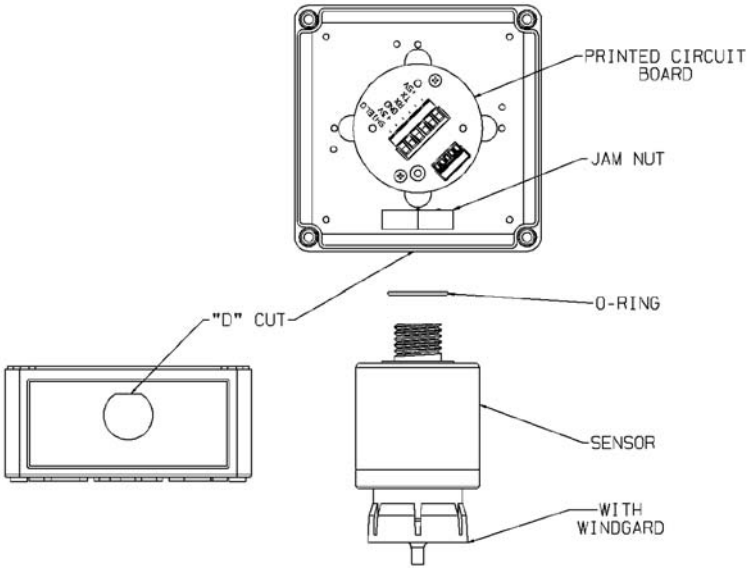


Figure 1-5. General-Purpose Remote Sensor Assemblies

Remote sensors can also be ordered with explosion-proof (XP) remote sensor assemblies.

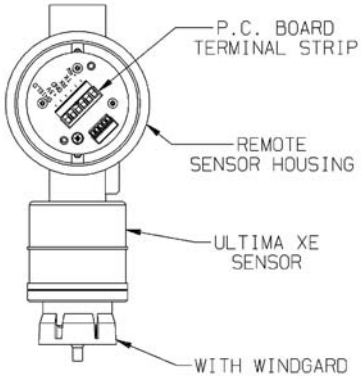


Figure 1-6. Explosion-Proof Remote Sensor Assemblies

The GP or XP Remote Sensor Modules can be mounted in a manner similar to the gas monitor installation in the preceding procedure and at a maximum distance outlined in TABLE 1-3.

Table 1-3. Remote Module Wiring and Placement

GAS TYPE	MINIMUM WIRE SIZE	MAXIMUM DISTANCE
Toxic and Oxygen	20 AWG	100 FEET
Catalytic Combustible	18 AWG	50 FEET
	16 AWG	100 FEET
IR Combustible	16 AWG	50 FEET
	12 AWG	100 FEET

Permanently connect 1/4" ID tubing to the post on the windguard. Route this tubing to the Trigard Gas Monitor, ensuring that there are no kinks, leaks or other obstructions. Secure this tubing near the monitor; it is used to deliver check gas to the sensor module during calibration.

⚠ CAUTION

Tubing used for reactive gases (Cl_2, HCl, ClO_2, HF, NH_3, ETO, F_2, B_2H_6, Br) should be as short as possible (18 inches maximum) to ensure that the gas reaches the sensor. Excessive tubing can result in no gas sensor reading.

Electrical Connections for the Trigard Remote Sensor Module

⚠ WARNING

Before wiring the Trigard Remote Sensor Module, disconnect the power source feeding the Remote Sensor Module and the Trigard Gas Monitor/Less Sensor; otherwise, electrical shock could occur.

⚠ CAUTION

When installing Trigard Remote Sensor Module with its mating Trigard Gas Monitor/Less Sensor, follow National Electrical and local procedural Codes; failure to do so can result in an unsafe condition.

Five conductors are required for the Trigard Remote Sensor Module. The Trigard Monitor has a five-wire terminal to accommodate up to #16 AWG conductors.

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

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

TABLE 1-4 shows suggested cables for Trigard installations; other cables are available which are also adequate.

Table 1-4. Remote Sensor Wiring Cable

SUPPLIER	CATALOG NUMBER	DESCRIPTION
ALPHA WIRE CORP.	5525	5 cond., shielded, 18 AWG
	5535	5 cond., shielded, 16 AWG
	5514	4 cond., shielded, 20 AWG

Table 1-5. Low Temperature Wiring Cable

SUPPLIER	CATALOG NUMBER	DESCRIPTION
ALPHA WIRE CORP.	45525	5 cond., shielded, 18 AWG
	45366	6 cond., shielded, 16 AWG
	45545	5 cond., shielded, 14 AWG

At the Trigard Remote Sensor Location:

1. Open the Trigard Remote Sensor cover by removing lid.
2. Route the cable from the Gas Monitor through a customer-supplied opening in the enclosure and wire it to the terminal block (FIGURE 1-2).
3. Verify the identity of each conductor of the cable and connect the wire to the terminal block.
4. Re-install the cover of the Trigard Remote Sensor

NOTES:

- Incoming power and signal cable shield should be earth grounded at the power source. Connect power and remote sensor cable shields to shield terminals on main pc board. Provide shield terminations inside the sensor housing as indicated on Installation Outline Drawings for Remote Sensor; see Table 5-1 for Installation Outline Drawing document numbers.
- Cables larger than #16 AWG will require a splice of smaller cable to fit the connector.

Chapter 2,
Start-up and Calibration
for 4-20 mA Output

Initial Start-up

- The Trigard Gas Monitors are factory-calibrated. A bump check prior to use is recommended.
- Once power is applied to the unit, the LCD shows a test of all display words. The software version number displays; then, a 30-second (self-check) countdown for sensor stability begins.
- During the 30-second countdown, the output signal is the same as the calibration signal when enabled during a normal calibration. This is described later in this chapter under "Trigard Gas Monitor Calibration Output Signal".
- The Alert red LED will be solid ON during the 30-second countdown.
- After the 30-second countdown, observe that the gas type and gas concentration (ppm, % Gas, or % LEL) alternately flash (FIGURE 2-1).

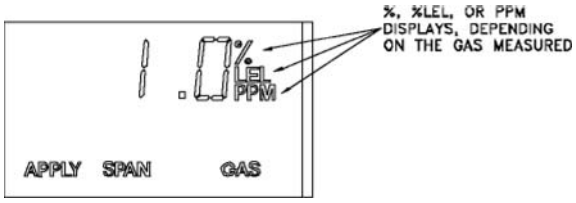


Figure 2-1. LCD Gas Concentration Display

- The Normal green LED will be solid ON after the 30-second countdown.
- A complete listing of instrument operation features can be found in TABLE 2-1.

Table 2-1. Instrument Operation

OPERATION	GREEN LED	RED LED	4 to 20 mA	FAULT RELAY
NORMAL NO. ALARMS	ON steady	OFF	Gas value	Energized
ALARMING	OFF	Flashing	Gas value	Energized
FAULT	OFF	ON steady	3.0 mA	De-energized
POWER UP/ COUNTDOWN	OFF	ON steady	ALERT option[1] disabled: 21.0 mA for O_2; 3.75 mA for others	Energized if ALERT option disabled
			ALERT option[1] enabled: 3.75 mA for all	De-energized if ALERT option enabled[1]
SENSOR MISSING/ COUNTDOWN	OFF	ON steady	3.0 mA if SWAP delay timeout[2] expired, SWAP Delay[3] disabled or FAULT	De-energized if SWAP delay timeout[2] expired, SWAP delay[3] disabled or FAULT
			Previous gas value if SWAP delay[3] enabled and SWAP delay timeout[2] not expired	Energized if swap delay[3] enabled and SWAP delay timeout[2] not expired
SENSOR CAL	OFF	ON steady	3.75 mA if cal signal enabled and ALERT option[1] enabled; gas value if cal signal disabled E	Energized if ALERT option disabled
			21.0 mA for O_2 if cal signal enabled and ALERT option[1] disabled	De-energized if ALERT option enabled[1]
CAL 4-20	OFF	ON steady	4 mA if 4 mA calibration selected	Energized if ALERT option disabled
			20 mA if 20 mA calibration selected	De-energized if ALERT option enabled[1]
CAL FAULT	OFF	ON steady	Gas value	De-energized two seconds every minute
UNDERRANGE	OFF	ON steady	3.0 mA if gas value 0 or less; gas value otherwise	De-energized
OVERRANGE/ LOC	ON steady[4]	OFF[4]	21.0 mA	Energized

NOTES:
1. See Controller/Calibrator manual for ALERT option.
2. Swap Delay timeout is 60 seconds if enabled; 0 seconds otherwise.
3. See Controller/Calibrator manual for SWAP Delay option.
4. Alarming operation will be followed if the alarms are enabled.

During normal operation, the Trigard Monitor displays the gas concentration of the surrounding environment. The corresponding output signal can be transmitted to a controller.

NOTE: The catalytic combustible model of the Trigard Gas Monitors is capable of detecting concentrations of certain combustible gases above 100% LEL. When exposed to these concentrations, the Trigard Gas Monitors will display one of two modes:

- +LOC % LEL - The Trigard Gas Monitor has been exposed to a high concentration of gas (above the LEL) and there is a possibility that the over-range condition may still exist.
- OVER % LEL - The Trigard Gas Monitor has been exposed to a high concentration of gas (above the LEL) and the over-range condition definitely still exists.

⚠ CAUTION

In either mode, correct the condition causing the excessive gas level and vent or purge the area before attempting the following.

- In the +LOC % LEL mode, the output signal will also be locked at full-scale. If this condition occurs, the Trigard Gas Monitor must be unlocked by performing a "Zero Function" with the Trigard Gas Monitor Calibrator or Controller. The Trigard Gas Monitor will not revert to a normal condition until a successful zero operation has been performed. This is an exclusive safety feature of the Trigard Gas Monitor which pre-empts the possibility of ambiguous readings when the sensor is exposed to concentration of gas above 100% LEL
- In the OVER % LEL mode, the combustible gas is over the 100% LEL range. It returns to normal operation when gas concentration level falls below 100% LEL.

Calibration Basics

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

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

then be reduced to the schedule set by the safety officer or plant manager.

Before calibrating, the Trigard Gas Monitor must be powered for a minimum of one hour to allow the sensor to settle into its new environment.

⚠ CAUTION

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

⚠ CAUTION

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

Chemicals that Reduce Catalytic Sensor Sensitivity

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

- Silanes, Silicates, Silicones and Halides (compounds containing Fluorine, Chlorine, Iodine or Bromine)
- TABLE 5-2 in Chapter 5 lists interferants for electrochemical sensors.

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

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

- Ultima Calibrator P/N 809997 (FIGURE 2-2)
- Ultima Controller P/N 809086 (FIGURE 2-3)
- Push-button Calibration (Chapter 4).

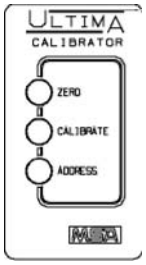


Figure 2-2. Ultima Calibrator

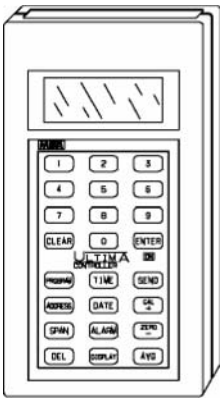


Figure 2-3. Ultima Controller

Ultima Calibrator

The Ultima Calibrator allows the following functions:

- Zero
- Calibration (zero and span)
- Changing address for some models.

Ultima Controller

The Ultima Controller also provides the above functions, plus access to the following features:

- Three levels of alarm and relays
- Date of last successful calibration

- Maximum gas readings over selected time periods
- Average gas readings over selected time periods
- Changing span gas value from factory-set value
- Access to real-time clock for time and date
- Changing of full scale value.

NOTE: See Ultima Controller/Calibrator manual (P/N 813379) for full functionality.

Note on Resetting Latched Alarms with Controller or Calibrator

When Trigard Gas Monitor has an active latched alarm (indicated by a flashing alarm display):

- An infrared (IR) remote device (such as the Ultima Calibrator or Controller) may be used to reset this alarm.
- The next IR command it receives from a calibration device will reset the latched alarm (if it is not beyond the alarm threshold). The intended IR command will be ignored and interpreted as an 'alarm reset.' When the latching alarm function is inactive, other valid IR commands may be used.

Trigard Gas Monitor Calibration Output Signal

The Trigard Gas Monitor is shipped with the calibration output signal disabled so the output signal will track the gas concentration value during the calibration process. In some applications, it may be desirable to disable or lock the output to a pre-determined output value to prevent activation of alarm devices. The calibration signal can be enabled using the Ultima Controller. When the calibration signal is enabled, the output signal is 3.75 milliamps for the 4 to 20 milliamp output models.

NOTE: For the range of 25% oxygen, the calibration signal will be 21 mA. Oxygen can be set to a 3.75 mA calibration signal [see Ultima Controller/Calibrator manual (P/N 813379)].

Calibration Kit

Calibration Kits are available for the Trigard Gas Monitors. For the recommended calibration kit, see Ultima Controller/Calibrator manual (P/N 813379).

Trigard Gas Monitor Calibration Procedure

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

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

INITIAL Calibration

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

The *INITIAL* calibration is accomplished by:

- simultaneously pressing the ZERO and CALIBRATE buttons of the Ultima Calibrator or
- pressing and holding SPAN button on the Ultima Controller or
- using the optional push-button calibration as outlined in Chapter 4, "Optional Push-button Calibration".
- The display should show "APPLY ZERO GAS"
- The word "ICAL" on the display distinguishes an INITIAL Calibration from a regular calibration. If "ICAL" does not appear, abort the calibration; then, retry the above procedure.

NOTE: The zero or calibration process can be aborted at any time simply by pressing any button during the 30-second countdown on the Calibrator while aiming at the unit or by pressing and releasing the push-button if push-button calibration is available.

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

Regular Calibration

A regular calibration includes a "zero" and "span" procedure as described in the following procedures. If the user chooses to only perform a "zero" procedure, they may do so by pressing the ZERO button on the Calibrator or Controller instead of the CALIBRATE button as described as follows, or by using the push-button calibration as outlined in Chapter 4.

Zeroing

1. If Using the zero cap:

   If the ambient air is suitable, with no traces of the gas of interest, place the appropriate Calibration Kit zero cap over the SensorGard inlet and wait two minutes; otherwise, use zero gas.

2. If Using zero gas cylinder:

   a. Locate the zero gas cylinder and the Calibration Kit Flow Controller.

   b. Screw the Flow Controller onto the top of the zero gas cylinder.

   c. Locate the Tube Assembly from the cal kit.

   d. Push the smaller end of the Tube Assembly over the Flow Controller gas outlet and ensure tubing completely covers the gas outlet.

   e. When using Cal Kit 40, connect the other end of the tubing over the SensorGard inlet.

      When using Cal Kit 41, locate the cal cap (with hole for tubing) and push the tubing through the hole in the bottom of the cap. Then, connect the end of the tubing over the sensor inlet and push the calibration cap over the entire sensor inlet.

   f. Turn on the zero gas flow by turning the knob on the flow controller.

3. Point the Calibrator or Controller at the Trigard Monitor display; press the CALIBRATE button.

   NOTE: The zero or calibration process can be aborted at any time during the 30-second countdown interval; simply press any button on the Calibrator or Controller while aiming it at the unit or by pressing and releasing the push-button if push-button calibration is available.

NOTE: The 30-second countdown interval is omitted for oxygen units; it is electronically zeroed.

The display shows:

- A countdown from 30 to 0 seconds
- APPLY ZERO GAS (FIGURE 2-4)

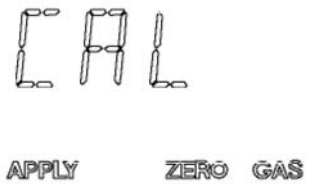


Figure 2-4. Apply Zero Gas Flag

4. After the 30 second countdown:
   - The display alternates between "CAL" and a value. This value is the actual reading of the gas concentration the sensor is detecting.
   - Once the gas value on the display is stable, the alternating display stops. If the calibration is successful, the display will show END.

   a. If using the zero cap: remove it.

   b. If using a zero gas cylinder:

      1) Turn OFF the gas flow by turning the flow controller knob.

      2) Remove the tubing from the SensorGard.

         - If the calibration output signal is enabled during calibration, it will be held at the lockout value for an additional two minutes or until after the span routine if performing a full calibration.

   c. If CAL FAULT appears on the display, this indicates:

      - An unsuccessful attempt to zero or calibrate the Trigard Monitor
      - The Trigard Monitor is operating with the calibration parameters defined before the calibration was attempted.

- See Troubleshooting Guidelines found in Chapter 5.

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

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

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

Spanning

5. During a regular calibration, the Trigard Monitor automatically begins the span countdown after a successful zeroing of the unit. The span countdown is 30 seconds (FIGURE 2-5).

   NOTE: The span process can be aborted at any time during the countdown by simply pressing any button on the Calibrator while aiming it at the unit or by pressing and releasing the push-button.

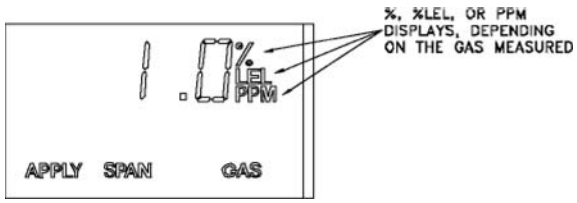


Figure 2-5. Apply SPAN Gas Flag

6. Locate the span gas cylinder and the Calibration Kit Flow Controller.
7. Screw the Flow Controller onto the top of the span gas cylinder.
8. Locate the Tube Assembly from the cal kit.
9. Push the smaller end of the Tube Assembly over the gas outlet of the Flow Controller and ensure that the tubing completely covers the gas outlet.

10. When using Cal Kit 40, connect the other end of the tubing over the SensorGard inlet.

    When using Cal Kit 41, locate the cal cap (with hole for tubing) and push the tubing through the hole in the bottom of the cap. Then, connect the end of the tubing over the sensor inlet and push the calibration cap over the entire sensor inlet.

11. Turn ON the gas flow by turning the flow controller knob.

    - It is good practice to have all calibration components previously assembled.
    - Ensure that any calibration gases are applied during the 30-second count down period.
    - If a CAL FAULT indication is on the Trigard Monitor display before the user is able to apply the gas, a steady state gas condition was reached, causing the unit to use a wrong reading as a span indication.
    - It is necessary to restart the calibration process to clear this condition.

12. After the 30 second countdown:

    - The display alternates between "CAL" and a value. This value is the actual reading of the gas concentration the sensor is detecting.
    - Once the gas value on the display is stable, the alternating display stops. If the calibration is successful, the display will show END for approximately two seconds. (FIGURE 2-6).
    - No user adjustments are necessary.
    - The display will show the span gas value while the span gas is flowing to the unit.

Figure 2-6. Calibration End Display

13. Turn OFF the gas flow by turning the knob on the flow controller.

    - If the calibration output signal is enabled during calibration, it will be held at the lockout value for two additional minutes after END is displayed.
    - When the span gas is removed from the sensor, the sensor reading should change to show an ambient condition.

- If a CAL FAULT appears on the display, this indicates:
  - An unsuccessful attempt to calibrate the Trigard Monitor
  - The Trigard Monitor is operating with the calibration parameters defined before the calibration was attempted.

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

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

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

Calibration Documentation

The Trigard Monitor records the date of the last successful calibration. This date can then be displayed on the front-panel LCD (with the use of the Controller).

Chapter 3,
Start-up and Calibration
for MODBUS output

Typical ModBUS Network Topography (FIGURE 3-1).

Sensors

- A network can consist of up to 31 monitors.
- Each monitor can support up to three sensors.
- Total number of sensors is 93.

Wiring

Power

- Maximum power cable length depends on sensor configuration and wire gauge (TABLES 3-1, 3-2 and 3-3).

RS485 Communications

- Three-wire cable, 22 AWG is labeled:
  - A = Transmit + / Receive +
  - B = Transmit - / Receive -
  - C = Common
- Typical Communications Wiring Scheme (see FIGURE 3-2)
- Maximum RS-485 communications cable length:
  - Trunk: 3000 feet
  - Branch: 60 feet
- Use line termination devices to match communication line characteristics (typically 120 Ohms).

Transmitter Sensor Distance

- Maximum transmitter-sensor distance is 100 feet.

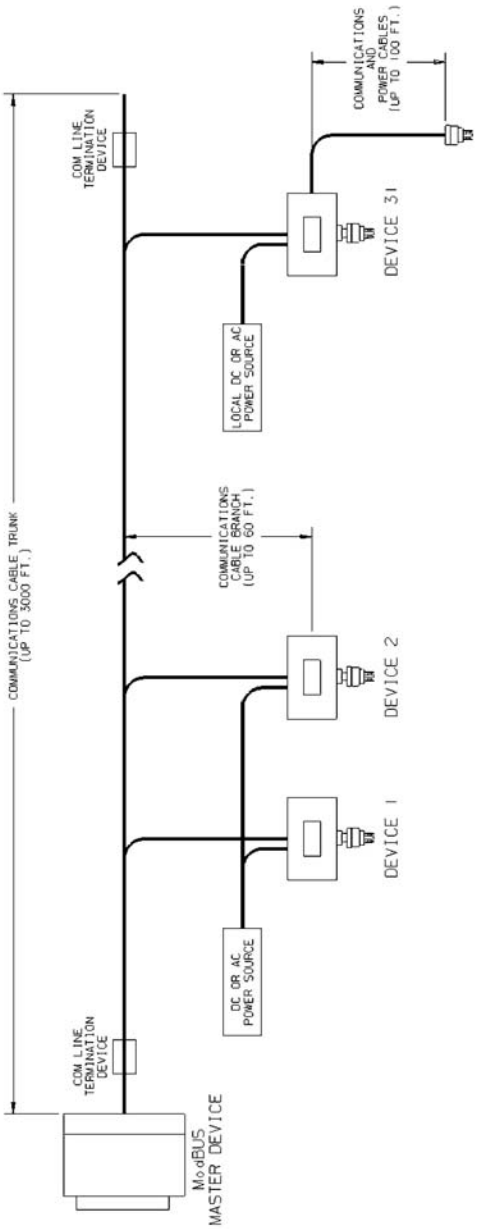


Figure 3-1. Typical ModBUS Network Topography

Table 3-1. Maximum Power Cable Length

CONFIGURATION			MAXIMUM POWER CABLE LENGTH (IN FEET) (WITH NOMINAL 24-VDC TRANSMITTER SUPPLY)					
CATALYTIC	XIR	E-CHEM	16 AWG CABLE [4.2 OHM PER 1K FT.]		14 AWG [2.6 OHM PER 1K FT.]		12 AWG [1.8 OHM PER 1K FT.]	
			NO RELAYS-	RELAY OPTION-	NO RELAYS	RELAY OPTION	NO RELAYS	RELAY OPTION
0	0	3	4500	3500	7500	5500	10,000	7,500
0	2	1	2000	1500	2750	2500	4,000	3,500
0	1	2	3000	2250	4500	3500	6,250	5,000
1	0	2	3500	2750	5500	4250	7,500	6,000
1	1	1	2000	1500	2750	2500	4,000	3,500
2	0	1	2500	1850	3500	3000	5,000	4,000
3	0	0	2000	1500	2750	2500	3,750	3,500

Daisy chaining power to multiple sensors is not recommended.

Table 3-2. Transmitter Power Consumption (7-30 VDC Supply)

CONFIGURATION			MAX. POWER CONSUMPTION WITH RELAYS CLOSED	MAX. POWER CONSUMPTION WITH RELAYS OPEN
CATALYTIC	XIR*	E-CHEM*		
0	0	3	2.5 W	1.5W
0	2	1	9.5 W	8.5W
0	1	2	7.0 W	6.0 W
1	0	2	6.0 W	5.0 W
1	1	1	6.5 W	5.5 W
2	0	1	8.0 W	7.0 W
3	0	0	10.0 W	9.0 W

*Combinations shown represent maximum loads that may be powered from one transmitter without remote power.

NOTE: Only use single catalytic or XIR sensor configuration with 7 W power supply.

If at least one sensor has remote power, any combination is available.

Recommended power supply selection is for operation not to exceed 65% of capacity.

See Installation Outline Drawings for details.

Table 3-3. Remote Sensor Power Consumption (AC or DC Operation)

SENSOR TYPE	MAXIMUM POWER CONSUMPTION
Catalytic	4.5 W
XIR	5.0 W
E-Chem	1.5 W

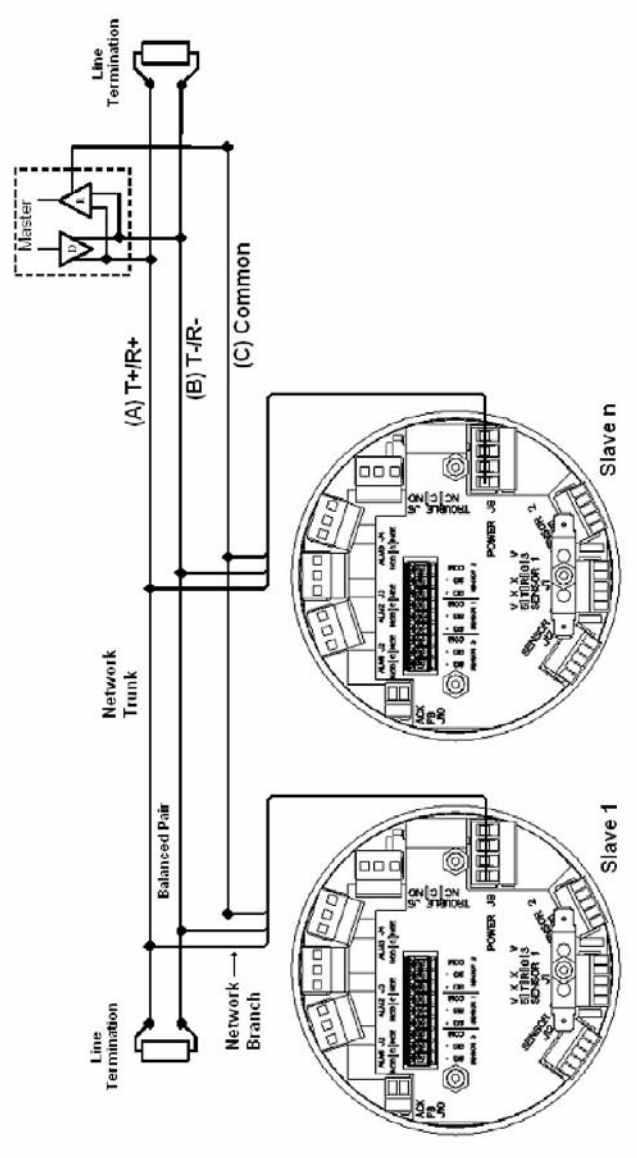


Figure 3-2. Typical Communications Wiring Scheme

Typical Communication Cable Wiring

Operation

Display:

- Displays sensor type and gas level for each sensors
- Cycles through the sensors
- Sensor number graphic identifies sensor number (see FIGURE 3-3)
- Latches on an Alarm or Fault condition and requires user acknowledgment prior to resuming cycling
- If multiple conditions exist, reveals the subsequent alarm/fault condition when one condition is acknowledged
- Resumes cycling through display screens when all conditions are acknowledged.
- Alarm and fault conditions are indicated by alarm and the corresponding number of the alarm level(s) that are activated

Relays:

- Gas processing and alarm activation continues even when a display is locked on a screen
- Are common to all sensors by default
- Can be assigned specifically to a sensor by enabling only one level of alarm for each sensor
    - This may be accomplished through an Ultima Controller (see "Calibration" later in this chapter) consistent with the existing Trigard procedures or through a ModBUS controller
- Form C contacts, 5 A resistive, 30 VDC, 250 VAC
- May be configured as
    - Normally energized/de-energized
    - Increasing/decreasing level alarm
    - Latching/non-latching

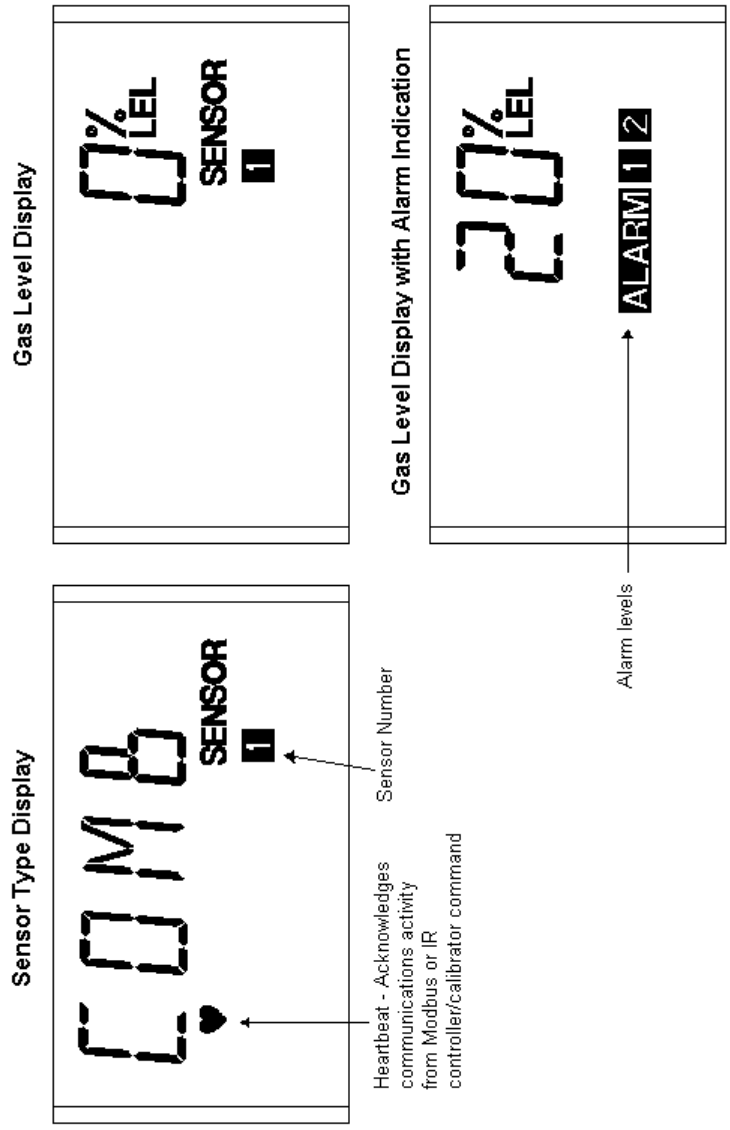


Figure 3-3. Sensor Display Screens

Sensor:

- Automatically recognized when connected to a transmitter
- When removed, causes a "Sensor Missing" fault; this can be corrected by:
  - Reconnecting a sensor to that position or
  - Manually taking the sensor 'off-line' via:
    - Ultima Controller, by sending a sensor disable command
    - ModBUS command write to a control register.
- A missing sensor or unused sensor position returns a gas value of -99.9 in response to a ModBUS request for gas level value starting at address base +207.

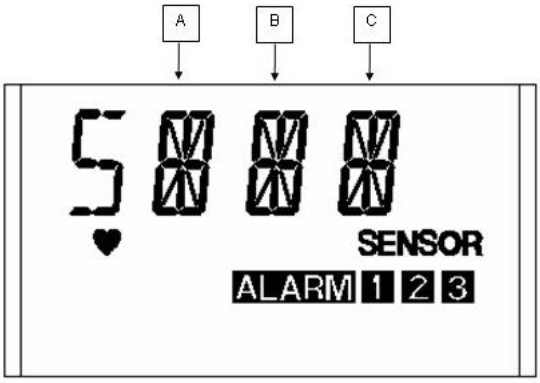
Alarm Status Screen

(FIGURE 3-4)

In the North American version, a screen will appear when a combustible sensor crosses 50%, 60% or 90% of the full-scale range.

- This screen:
  - will override all sensor data or fault screens and will clear when all sensors are below 50% of scale.
  - can be acknowledged by the operator; the:
    - instrument will go back to normal display operation until the sensor or any other sensor crosses 50%, 60% or 90% of scale
    - normal operation status screen will display again.
  - can be acknowledged through the:
    - Ultima Controller
    - Pushbutton or
    - MODBUS interface.

  NOTE: All IR inputs will be functional and appropriate display screens will display for the received IR message.



A. Indicates the status of Sensor #1.
B. Indicates the status of Sensor #2.
C. Indicates the status of Sensor #3.

Figure 3-4. Alarm Status Screen

Table 3-4. Status Indication Codes

CODE	INDICATION
“d”	Sensor position disabled
“F”	Sensor position in a fault state
“N”	Sensor position in normal operation, below 50% of range, and not in alarm
“A”	Sensor position in alarm
“L”	Sensor position at or above 50% of range
“M”	Sensor position at or above 60% of range
“H”	Sensor position at or above 90% of range

- The SENSOR, ALARM #1, #2, #3 indicators will still function as normal cycling though each sensor position. This allows the:
  - use of the IR signal to be received for each sensor position
  - user to see what alarms are active for each sensor when the status screen is displayed.

Ultima Controller or Ultima Calibrator:

- May be used to send commands to display data or set configurations consistent with existing Trigard procedures
- May be sent at any time for transmitter-specific commands, such

as address, baud rate, etc.

- Sensor-specific commands
  (such as calibration initiation or span value) must be sent while the sensor data (sensor type or gas levels) is displayed

Calibration

Calibration is performed via the:

- **Ultima Controller**
  - Sends a zero or span command
  - Sensor calibration depends on the sensor number showing on the display when the command is received.
- **Push-button**
  - Depends on the sensor number showing on the display when the command is received.
  - Press and release push-button to acknowledge any conditions
  - With the desired sensor data (sensor or gas level) on the display, press the push-button to activate a calibration
  - Calibration function depends on length of time that the push-button is pressed
    - 5 seconds: zero calibration
    - 10 seconds: span calibration
    - 20 seconds: factory initial calibration
    - Push-button included.
    - See Installation Outline Drawings for details.

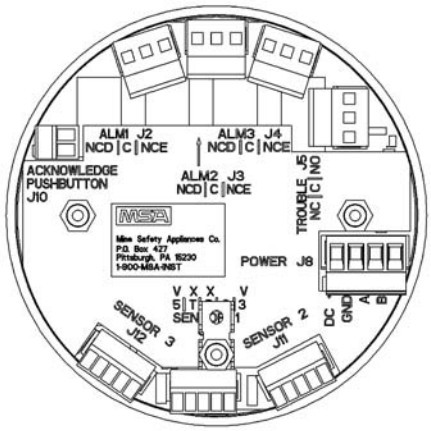


Figure 3-5. ModBus PCB

- **ModBUS Port**
  - See ModBUS data table definition in this addendum.

⚠ WARNING

During the calibration process, the transmitter is in Maintenance mode, all alarming is inhibited for all sensors, and transmitter will not alert user to potential hazardous situations.

- During the calibration of a sensor, a ModBUS request for the gas level returns the actual value. The other sensors on that specific transmitter are not active. A gas level of -99.9 will be returned to indicate that.

ModBUS Communications

Baud rate and data format defaults per data table specification are adjustable by using a:

- Hand-held Controller or
- ModBUS command.

Each transmitter:

- Is a slave on the communications network
- Must have a unique address and serial format compatible with transmitter configuration.

ModBUS Addressing

The ModBUS slave address has a valid range of 1-247.

- 247 is the default value.

This address may be set by:

- The Ultima Controller:
  - Send an address command with the desired value.
- The Ultima Calibrator:
  - Press the ADDRESS button once to display the current setting.
    - The ZERO button increments the address number
    - The SPAN button decrements the address number
    - Range for Calibrator is 1 - 32; use Controller for other addresses

- Press the ADDRESS button again to save the new address.

- A ModBUS controller by writing to the corresponding register in the data table.

ModBUS Communications

- The communications protocol is ModBUS RTU over an RS-485 hardware network.
- The default settings for communications parameters are 19200 baud and even parity.
- The stop bits are fixed at 1 stop bit.
- For data types that are larger than one word, the most significant word is located in the first register (big-endian).

Table 3-5. Supported ModBUS Function Codes

FUNCTION NUMBER	DESCRIPTION
3	Read Holding Registers
5	Write Single Coil
6	Write Single Register
16	Write Multiple Registers

Table 3-6. ModBUS Memory Map Overview

The ModBUS port allows for access to a significant amount of information which may be necessary for your system integration requirements. As a minimum, the gas readings and fault status registers should be polled.

DESCRIPTION	START ADDRESS	END ADDRESS	SIZE IN WORDS	ACCESS
ModBUS Data Table Start Base Address	1000	1000	1	Read/Write
Factory Configuration Data	Base+1	Base+18	18	Read Only
User Configuration Data	Base+101	Base+148	48	Read/Write
Status Information	Base+201	Base+253	53	Read Only
Control Words	Base+301	Base+302	2	Read/Write

ModBUS Base Address (Read/Write)

The ModBUS base address register is located at address 1000 and has a default value of 40,000.

- This may be changed by writing a new value within the permissible range to that address.
- Subsequent addresses must take this new base address into consideration.
- The base address may be changed by writing to address 1000, regardless of its contents.

Table 3-7. ModBUS Bas Address (Read/Write)

DESCRIPTION	ADDRESS	POSSIBLE VALUES
ModBUS Data Table Base Address	1000	1000 - 60,000 (default 40,000)

- For systems that use five-digit addressing, 4XXXX:
  - If the first digit is an internal system requirement and does not appear in the communications packet, write the value 1000 to address 41000. The base address is now 41000 and the first valid address is 41001.
  - If all five digits appear in the communications packet, the default base address is 40000 and the first valid address is 40001.
- For systems that use six-digit addressing, 4XXXXX:
  - The first digit is an internal system requirement and does not appear in the communications packet. The base address is 440000, and the first valid address is 440001.

Table 3-8. ModBUS Factory Configuration Data (Read Only)

DESCRIPTION	ADDRESS	POSSIBLE VALUES
Device Type	Base+1	3(Trigard3 US) 4(Trigard3 Europe)
Firmware Version	Base+2 00.00 to 99.99	0..32767 Integer, divide by 100 for range
Relays Option Installed	Base+3	0-Relays not installed, 1-Relays installed
Reserved for future use	Base+4	
Date of Mfg Year, Sensor 1	Base+5	20XX
Date of Mfg Month, Sensor 1	Base+6	1..12
Date of Mfg Day, Sensor 1	Base+7	1..31
Date of Mfg Year, Sensor 2	Base+8	20XX
Date of Mfg Month, Sensor 2	Base+9	1..12
Date of Mfg Day, Sensor 2	Base+10	1..31
Date of Mfg Year, Sensor 3	Base+11	20XX
Date of Mfg Month, Sensor 3	Base+12	1..12
Date of Mfg Day, Sensor 3	Base+13	1..31
Full Scale Range- Default Sensor 1	Base+14	Single Precision Float
Full Scale Range- Default Sensor 2	Base+16	Single Precision Float
Full Scale Range- Default Sensor 3	Base+18	Single Precision Float

Table 3-9. ModBUS User Configuration Data (Read/Write)

DESCRIPTION	ADDRESS	POSSIBLE VALUES
ModBUS Slave Address	Base+101	1..247
Baud Rate Code	Base+102	0 - 1200, 1 - 2400 2 - 4800, 3 - 9600 4 - 19200 (default)
Parity Code	Base+103	0 - Even (default) 1 - Odd 2 - None
For future use	Base+104	
For future use	Base+105	
For future use	Base+106	
Full Scale Range, Sensor 1	Base+107	Single Precision Float
Full Scale Range, Sensor 2	Base+109	Single Precision Float
Full Scale Range, Sensor 3	Base+111	Single Precision Float
Span Gas Value, Sensor 1	Base+113	Single Precision Float
Span Gas Value, Sensor 2	Base+115	Single Precision Float
Span Gas Value, Sensor 3	Base+117	Single Precision Float
Alarm 1 Setpoint, Sensor 1	Base+119	Single Precision Float
Alarm 1 Setpoint, Sensor 2	Base+121	Single Precision Float
Alarm 1 Setpoint, Sensor 3	Base+123	Single Precision Float
Alarm 2 Setpoint, Sensor 1	Base+125	Single Precision Float
Alarm 2 Setpoint, Sensor 2	Base+127	Single Precision Float
Alarm 2 Setpoint, Sensor 3	Base+129	Single Precision Float
Alarm 3 Setpoint, Sensor 1	Base+131	Single Precision Float
Alarm 3 Setpoint, Sensor 2	Base+133	Single Precision Float
Alarm 3 Setpoint, Sensor 3	Base+135	Single Precision Float
Alarm Function Word 1	Base+137	0..32767, See detail below
Alarm Function Word 2	Base+138	0..32767, See detail below
Average Time Interval	Base+139	1,8 or 24
Current Date - Year	Base+140	20XX
Current Date - Month	Base+141	1..12
Current Date - Day	Base+142	1..31
Current Time -Hour	Base+143	1..24
Current Time - Minute	Base+144	0..59
Current Time - Second	Base+145	Read Only
Gas Table Number Sensor 1 (XIR)	Base+146	1 Methane, 2 Propane 3 Ethane, 4 Butane 5 Pentane, 6 Hexane 7 Cyclopentane, 8 Ethylene
Gas Table Number Sensor 2 (XIR)	Base+147	Same as above
Gas Table Number Sensor 3 (XIR)	Base+148	Same as above

Table 3-10. Alarm Function Codes - Word 1 (Read/Write at Address Base+137)

NAME	BITS	FUNCTION DESCRIPTION
Alarm 1 Enable, Sensor 1	0	1-Enable, 0-Disable
Alarm 1 Enable, Sensor 2	1	1-Enable, 0-Disable
Alarm 1 Enable, Sensor 3	2	1-Enable, 0-Disable
Alarm 2 Enable, Sensor 1	3	1-Enable, 0-Disable
Alarm 2 Enable, Sensor 2	4	1-Enable, 0-Disable
Alarm 2 Enable, Sensor 3	5	1-Enable, 0-Disable
Alarm 3 Enable, Sensor 1	6	1-Enable, 0-Disable
Alarm 3 Enable, Sensor 2	7	1-Enable, 0-Disable
Alarm 3 Enable, Sensor 3	8	1-Enable, 0-Disable
Alarm 1 Direction, Sensor 1	9	1-Increasing, 0-Decreasing
Alarm 1 Direction, Sensor 2	10	1-Increasing, 0-Decreasing
Alarm 1 Direction, Sensor 3	11	1-Increasing, 0-Decreasing
Alarm 2 Direction, Sensor 1	12	1-Increasing, 0-Decreasing
Alarm 2 Direction, Sensor 2	13	1-Increasing, 0-Decreasing
Alarm 2 Direction, Sensor 3	14	1-Increasing, 0-Decreasing
Not used	15	

Table 3-11. Alarm Function Codes - Word 2 (Read/Write at Address Base+138)

NAME	BITS	FUNCTION DESCRIPTION
Alarm 3 Direction, Sensor 1	0	1-Increasing, 0-Decreasing
Alarm 3 Direction, Sensor 2	1	1-Increasing, 0-Decreasing
Alarm 3 Direction, Sensor 3	2	1-Increasing, 0-Decreasing
Alarm 1 Latch Status, Sensor 1	3	0 - Non-Latching, 1 - Latching
Alarm 1 Latch Status, Sensor 2	4	0 - Non-Latching, 1 - Latching
Alarm 1 Latch Status, Sensor 3	5	0 - Non-Latching, 1 - Latching
Alarm 2 Latch Status, Sensor 1	6	0 - Non-Latching, 1 - Latching
Alarm 2 Latch Status, Sensor 2	7	0 - Non-Latching, 1 - Latching
Alarm 2 Latch Status, Sensor 3	8	0 - Non-Latching, 1 - Latching
Alarm 3 Latch Status, Sensor 1	9	0 - Non-Latching, 1 - Latching
Alarm 3 Latch Status, Sensor 2	10	0 - Non-Latching, 1 - Latching
Alarm 3 Latch Status, Sensor 3	11	0 - Non-Latching, 1 - Latching
Relay State-NO Alarm	12	1 - Normally Energized, 0 - Normally De-Energized
Relay State-NO Alarm	13	1 - Normally Energized, 0 - Normally De-Energized
Relay State-NO Alarm	14	1 - Normally Energized, 0 - Normally De-Energized
Not used	15	

Table 3-12. ModBUS Device Status (Read only)

DESCRIPTION	ADDRESS	POSSIBLE VALUES
General Status Bits	Base+201	0..32767, See details below
Fault Status Bits	Base+202	0..32767, See details below
Reserve	Base+203	
Gas Type - Sensor 1	Base+204	See TABLE 17 for details
Gas Type - Sensor 2	Base+205	See TABLE 17 for details
Gas Type - Sensor 3	Base+206	See TABLE 17 for details
Gas Level - Sensor 1	Base+207	Single Precision Float
Gas Level - Sensor 2	Base+209	Single Precision Float
Gas Level - Sensor 3	Base+211	Single Precision Float
Engineering Units - Sensor 1	Base+213	See TABLE 18 for details
Engineering Units - Sensor 2	Base+214	See TABLE 18 for details
Engineering Units - Sensor 3	Base+215	See TABLE 18 for details
Calibration Step	Base+216	0. 30 Sec Countdown to Start Zero 1. Waiting for Zero 2. 30 Sec Countdown to Start SPAN 3. Waiting for SPAN 4. Calibration Aborted 5. Zero Cal Fault 6. Span Cal Fault 7. Calibration Completed Successfully
Temperature - Sensor 1	Base+217	Signed Integer
Temperature - Sensor 2	Base+218	Signed Integer
Temperature - Sensor 3	Base+219	Signed Integer
Min Gas Reading over average Interval - Sensor 1	Base+220	Single Precision Float
Min Gas Reading over average Interval - Sensor 2	Base+222	Single Precision Float
Min Gas Reading over average Interval - Sensor 3	Base+224	Single Precision Float
Max Gas Reading over average Interval - Sensor 1	Base+226	Single Precision Float
Max Gas Reading over average Interval - Sensor 2	Base+228	Single Precision Float
Max Gas Reading over average Interval - Sensor 3	Base+230	Single Precision Float
Avg Gas Reading over average Interval - Sensor 1	Base+232	Single Precision Float
Avg Gas Reading over average Interval - Sensor 2	Base+234	Single Precision Float
Avg Gas Reading over average Interval - Sensor 3	Base+236	Single Precision Float

DESCRIPTION	ADDRESS	POSSIBLE VALUES
Date of Last Cal Year, Sensor 1	Base+238	20XX
Date of Last Cal Month, Sensor 1	Base+239	1..12
Date of Last Cal Day Sensor 1	Base+240	1..31
Date of Last Cal Year, Sensor 2	Base+241	20XX
Date of Last Cal Month, Sensor 2	Base+242	1..12
Date of Last Cal Day, Sensor 2	Base+243	1..31
Date of Last Cal Year, Sensor 3	Base+244	20XX
Date of Last Cal Month, Sensor 3	Base+245	1..12
Date of Last Cal Day, Sensor 3	Base+246	1..31
Drift counter- Sensor 1	Base+247	0..20
Drift counter- Sensor 2	Base+248	0..20
Drift counter- Sensor 3	Base+249	0..20
Internal Error Code - Trigard	Base+250	For future implementation
Internal Error Code - Sensor 1	Base+251	For future implementation
Internal Error Code - Sensor 2	Base+252	For future implementation
Internal Error Code - Sensor 3	Base+253	For future implementation
Information Flags 1	Base+254	See TABLE 3-16
Information Flags 2	Base+255	See TABLE 3-17
Information Flags 3	Base+256	See TABLE 3-18
Information Flags 4	Base+257	See TABLE 3-19
Alternate Gas Reading Sensor 1	Base+258	See TABLE 3-20
Alternate Gas Reading Sensor 2	Base+259	See TABLE 3-20
Alternate Gas Reading Sensor 3	Base+260	See TABLE 3-20

Table 3-13. ModBUS General Status Bits (Read Only at address Base+201)

NAME	BIT	FUNCTION DESCRIPTION
Device Fault (any fault)	0	Set for all fault conditions
Calibration Active - Sensor 1	1	Set during calibration
Calibration Active - Sensor 2	2	Set during calibration
Calibration Active - Sensor 3	3	Set during calibration
Warm up Mode	4	Set during startup
Low Alarm Active	5	Set while alarm relay is active
Mid Alarm Active	6	Set while alarm relay is active
High Alarm Active	7	Set while alarm relay is active
For future use	8	
For future use	9	
For future use	10	
For future use	11	
For future use	12	
For future use	13	
For future use	14	
Not used	15	

Table 3-14. ModBUS Fault Status Bits (Read Only at address Base+202)

NAME	BIT	FUNCTION DESCRIPTION
Fault Relay Active	0	Set when any fault is detected
Sensor Missing - Sensor 1	1	Set when this fault is detected
Sensor Missing - Sensor 2	2	Set when this fault is detected
Sensor Missing - Sensor 3	3	Set when this fault is detected
Calibration Fault - Sensor 1	4	Set when this fault is detected
Calibration Fault - Sensor 2	5	Set when this fault is detected
Calibration Fault - Sensor 3	6	Set when this fault is detected
Power Fail Fault - Sensor 1	7	Set when this fault is detected
Power Fail Fault - Sensor 2	8	Set when this fault is detected
Power Fail Fault - Sensor 3	9	Set when this fault is detected
Power Fail Fault - Main Unit +5VDC	10	Set when this fault is detected
Sensor End of life - Sensor 1	11	Set when this fault is detected
Sensor End of life - Sensor 2	12	Set when this fault is detected
Sensor End of life - Sensor 3	13	Set when this fault is detected
Trigard Configuration Reset	14	Set when a datasheet reset occurs
Not used	15	

Table 3-15. Control Words (Read/Write)

DESCRIPTION	ADDRESS	POSSIBLE VALUES
Command Word 1	Base+301	0 to 32767, See TABLE 3-12
Command Word 2	Base+302	0 to 32767, See TABLE 3-13

Table 3-16. ModBUS Command Word 1 (Read at address Base+301/Write Coils 1 through 16)

NAME	BITS	COIL	FUNCTION DESCRIPTION
Start Full ICAL Calibration - Sensor 1	0	1	Rtn's fault if any Calibration in progress
Start Full ICAL Calibration - Sensor 2	1	2	Rtn's fault if any Calibration in progress
Start Full ICAL Calibration - Sensor 3	2	3	Rtn's fault if any Calibration in progress
Start Standard Full Calibration - Sensor 1	3	4	Rtn's fault if any Calibration in progress
Start Standard Full Calibration - Sensor 2	4	5	Rtn's fault if any Calibration in progress
Start Standard Full Calibration - Sensor 3	5	6	Rtn's fault if any Calibration in progress
Start Standard Zero Calibration Sensor 1	6	7	Rtn's fault if any Calibration in progress
Start Standard Zero Calibration Sensor 2	7	8	Rtn's fault if any Calibration in progress
Start Standard Zero Calibration Sensor 3	8	9	Rtn's fault if any Calibration in progress
Start UCAL Calibration - Sensor 1	9	10	Rtn's fault if any Calibration in progress
Start UCAL Calibration - Sensor 2	10	11	Rtn's fault if any Calibration in progress
Start UCAL Calibration - Sensor 3	11	12	Rtn's fault if any Calibration in progress
Step UCAL	12	13	1 to step
Abort Calibration (any)	13	14	1 to abort
Reserved for future use	14	15	
Not used	15	16	

Table 13-17 ModBUS Command Word 2
(Read at address Base+302/Write Coils 17 through 32)

NAME	BIT	COIL	FUNCTION DESCRIPTION
Sensor Swap Delay	0	17	1-Enable, 0-Disable
Alert Option Enable	1	18	1-Enable, 0-Disable
Acknowledge or Reset Latched Alarms(ACK)	2	19	1 to initiate (same functionality as Push-button or IR command)
Reset Main Board and sensors	3	20	1 to initiate
For future use	4	21	
For future use	5	22	
Reset Data Sheet - Sensor 1	6	23	1 to initiate
Reset Data Sheet - Sensor 2	7	24	1 to initiate
Reset Data Sheet - Sensor 3	8	25	1 to initiate
Disable Sensor 1	9	26	1 to Disable
Disable Sensor 2	10	27	1 to Disable
Disable Sensor 3	11	28	1 to Disable
Reserved for future use	12	29	
Reserved for future use	13	30	
Reserved for future use	14	31	
Not used	15	32	

Table 3-18. Sensor Type

SENSOR TYPE VALUE	SENSOR TYPE
13	COMB-1S 100% LEL, 1% LEL, 25% LEL (0.6% Propane)
257	CO 100 PPM, 1 PPM, MSA 25E/F, 60 PPM
258	CO 500 PPM, 1 PPM, MSA 25E/F, 300 PPM
259	SO_2 25 PPM, 1 PPM, CTL 7ST/F, 10 PPM
260	H_2S 10.0 PPM, 0.1 PPM, MSA HS25B, 5.0 PPM
261	H_2S 50.0 PPM, 0.1 PPM, MSA HS25B, 40 PPM
262	H_2S 100 PPM, 1 PPM, MSA HS25D, 40 PPM
263	NO 100 PPM, 1 PPM, CTL 7NT, 50 PPM
264	NO_2 10.0 PPM, 0.1 PPM, MSA ND25C, 5.0 PPM
265	CL_2 5.0 PPM, 0.1 PPM, MSA CL25B, 2.0 PPM
266	HCN 50 PPM, 1 PPM, MSA HN25C, 10 PPM
267	HCL 50 PPM, 1 PPM, MSA HL25C, 40 PPM
12	O_2 25.0%, 0.1%, MSA 10019727, 20.8%
14	COMB-1S 100%LEL, 1% LEL, 40% LEL
15	COMB-1S 100%LEL, 1% LEL, 55% LEL
16	COMB-1S-NL 100%LEL, 1% LEL, 25% LEL
17	COMB-1S-NL 100%LEL, 1% LEL, 40% LEL
18	COMB-1S-NL 100%LEL, 1% LEL, 55% LEL
19	CLO_2 3.0 PPM, 0.1 PPM, MSA 7CLH, 1.0 PPM
276	NH_3 100 PPM, 1 PPM, SENSORIC, 25 PPM
277	H_2, 1000 PPM, 10 PPM, CTL 7HYT, 300 PPM
279	PHOSPHINE, 2.0 PPM, 0.1 PPM CTL 7SH, 0.5 PPM
280	ARSINE, 2.0 PPM, 0.1 PPM, CTL 7SH, 1.0 PPM
281	SILANE, 25 PPM, 1 PPM, CTL 7SH, 5 PPM
282	GERMANE, 3.0 PPM, 0.1 PPM, CTL 7SH, 2.5 PPM
283	DIBORANE, 50 PPM, 1 PPM, CTL 7SH, 15 PPM
284	FLUORINE, 5.0 PPM, 0.1 PPM, MSA 7CLH, 4.0 PPM
285	HF
286	BROMINE, 5.0 PPM, 0.1 PPM, MSA 7CLH, 2.5 PPM
287	ETO, 10.0 PPM, 0.1 PPM, 5 PPM
288	O_2 10.0%, 0.1% MSA 10019727, 5.0%
2	IRIS
19	COMB-1S-100% LEL, 10% LEL, 31% LEL
20	COMB-1S-100% LEL, 1% LEL, 49% LEL
21	COMB-1S-100% LEL, 1% LEL, 68% LEL

SENSOR TYPE VALUE	SENSOR TYPE
22	Tankerguard
290	CLO_2 0.02 resolution
289	NH_4 1000
291	H_2S 500
3	Custom IRIS 0-10000 PPM
101	IRIS - start
to	IRIS - cont.
150	IRIS - finish

Table 3-19. Sensor Engineering Units

UNIT LABEL VALUE	UNIT LABEL
0	None
1	% LEL
2	%
3	PPM
4	Future Expansion

Table 3-20. Information Flags Word #1 – (Read at address Base+254)

NAME	BITS	FUNCTION DESCRIPTION
Sensor # 1 Disabled	0	0 = enabled, 1 = disabled
Sensor # 2 Disabled	1	0 = enabled, 1 = disabled
Sensor # 3 Disabled	2	0 = enabled, 1 = disabled
Alarm # 1 Sensor # 1	3	0 = clear, 1 = set
Alarm # 2 Sensor # 1	4	0 = clear, 1 = set
Alarm # 3 Sensor # 1	5	0 = clear, 1 = set
Alarm # 1 Sensor # 2	6	0 = clear, 1 = set
Alarm # 2 Sensor # 2	7	0 = clear, 1 = set
Alarm # 3 Sensor # 2	8	0 = clear, 1 = set
Alarm # 1 Sensor # 3	9	0 = clear, 1 = set
Alarm # 2 Sensor # 3	10	0 = clear, 1 = set
Alarm # 3 Sensor # 3	11	0 = clear, 1 = set
Cal Fault Condition Sensor #1	12	0 = Zero, 1 = Span
Cal Fault Condition Sensor #2	13	0 = Zero, 1 = Span
Cal Fault Condition Sensor #3	14	0 = Zero, 1 = Span
Not Used	15	

Table 3-21. Information Flags Word #2 (Read at address Base+255)

NAME	BITS	FUNCTION DESCRIPTION
Configuration Reset	0	Set if TRUE
Fault RAM Main	1	Set if TRUE
FAULT FLASH MAIN	2	Set if TRUE
EEPROM WRITE ERROR	3	Set if TRUE
MUX FAULT	4	Set if TRUE
FAULT INCOMPATIBLE SENSOR #1	5	Set if TRUE
FAULT INCOMPATIBLE SENSOR #2	6	Set if TRUE
FAULT INCOMPATIBLE SENSOR #3	7	Set if TRUE
Quick under range sensor #1	8	Set if TRUE
Quick under range sensor #2	9	Set if TRUE
Quick under range sensor #3	10	Set if TRUE
Under range Sensor #1	11	Set if TRUE
Under range sensor #2	12	Set if TRUE
Under range sensor #3	13	Set if TRUE
Atex Enabled	14	0 = Disabled, 1 = Enabled
Swap Delay	15	0 = Disabled, 1 = Enabled

Table 3-22. Information Flags Word #3 (Read at address Base+26)

NAME	BITS	FUNCTION DESCRIPTION
Overrange Flag sensor #1	0	Set if TRUE
Overrange Flag sensor #21	1	Set if TRUE
Overrange Flag sensor #31	2	Set if TRUE
LOC Flag sensor #1 1	3	Set if TRUE
LOC Flag sensor #2 1	4	Set if TRUE
LOC Flag sensor #3 1	5	Set if TRUE
Parameter Fault Sensor #1	6	Set if TRUE
Parameter Fault Sensor #2	7	Set if TRUE
Parameter Fault Sensor #3	8	Set if TRUE
Warm up Sensor #1 1	9	Set if TRUE
Warm up Sensor #2 1	10	Set if TRUE
Warm up Sensor #3 1	11	Set if TRUE
Sensor Configuration Reset #1	12	Set if TRUE
Sensor Configuration Reset #2	13	Set if TRUE
Sensor Configuration Reset #3	14	Set if TRUE
Not Used	15	

Table 3-23. Information Flags Word #4 (Read at address Base+257)

NAME	BITS	FUNCTION DESCRIPTION
Underrange Average Interval S1	0	Set if TRUE
Underrange Average Interval S2	1	Set if TRUE
Underrange Average Interval S3	2	Set if TRUE
Overrange Average Interval S1	3	Set if TRUE
Overrange Average Interval S2	4	Set if TRUE
Overrange Average Interval S3	5	Set if TRUE
Sensor Warning Sensor #1	6	Set if TRUE
Sensor Warning Sensor #2	7	Set if TRUE
Sensor Warning Sensor #3	8	Set if TRUE
Not Used	9	
Not Used	10	
Not Used	11	
Not Used	12	
Not Used	13	
Not Used	14	
Not Used	15	

Table 3-24. Alternate Gas Readings (Read/Write at address Base+258 to Base+260)

DESCRIPTION	VALUE
Normal Gas Detection	400-2000
Fault	230
Overrange	2110
Suppressed	305
Disabled	0

Chapter 4,
Additional Features

Internal Relays

General Information

The internal relays are designed to enable Trigard Gas Monitors to control other equipment. There are four relays within the Trigard Gas Monitor's module:

- three alarm relays
- one fault relay.

Once configured, the relays activate when the Trigard Gas Monitor detects an alarm condition. Similarly, the fault relay de-energizes when a fault condition is detected.

- The internal relays will be within the read-out module.

The alarm relays are enabled in the non-latching, de-energized mode at the factory.

- To disable or configure the alarms, you need the Ultima Controller (P/N 809086).
- The fault relay is normally-energized so the relay de-activates into a fail-safe condition if a fault or power outage occurs. See "Fault Relay" later in this chapter.

⚠ WARNING

To prevent false alarms in the following instances, alarms/relays are temporarily disabled:
1) During the first minute from power-up
2) During calibration
3) For two minutes after calibration.

Installing the Trigard Gas Monitor with Internal Relays

Unpack, mount and wire the Trigard Gas Monitor according to Chapter 1, "Set-up." All electrical connections to the Trigard Gas Monitor can be made via the clearly marked board-mounted connections.

NOTE: To avoid electrical noise problems, do not run AC lines from relays in the same conduit or cable tray as the DC Signal lines.

Trigard Gas Monitor Internal Relays

Relay Specifications

Table 4-1. Relay Specifications

TEMPERATURE RANGE		-40 to +60°C (-40 to +140°F)	
HUMIDITY		15 to 95% RH, non-condensing	
RELAYS	**3 ALARMS**	SPDT (Single pole, double throw)	
	FAULT (NORMALLY ENERGIZED)	SPDT (Single pole, double throw)	
RELAY RATINGS	**At 125 or 250 VOLTS AC, NON-INDUCTIVE**	5.0 Amps or 5 Amps @ 1/10 Hp	
	AT 30 VOLTS DC, NON-INDUCTIVE	5.0 Amps or 5 Amps @ 1/10 Hp	
POWER CONSUMPTION (TOTAL UNIT WITH RELAYS)	**OXYGEN & TOXICS**	8 VDC	250 mA max
		12 VDC	175 mA max
		24 VDC	100 mA max
	CATALYTIC COMBUSTIBLES	8 VDC	600 mA max
		12 VDC	400 mA max
		24 VDC	290 mA max
	IR COMBUSTIBLES	8 VDC	870 mA max
		12 VDC	550 mA max
		24 VDC	290 mA max

Alarm Relays

There are three alarm relays and one fault relay in the Trigard Gas Monitors. The three alarm relays:

- Activate when the Monitor detects a gas concentration level that exceeds setpoints
  - Alarms 1, 2 and 3 generally default to 10%, 20% and 30% of the full-scale reading and are set when the gas reading is above these values.
  - The Oxygen Model is a special case where:
    - Alarm 1 is set to 19% oxygen and activates below this setpoint

        - Alarm 2 is set to 18% oxygen and activates below this setpoint
        - Alarm 3 is set to 22% oxygen and activates above this setpoint.
    - These default setpoints can be changed or verified via the Controller.
        - See Ultima Controller and Calibrator manual (P/N 813379).
        - The Controller can also enable the latching alarm function.
- Are factory-set to a de-energized position.
    - All relay connections have a normally-open set of contacts and a normally-closed set of contacts. These contacts are labeled as NCD (normally-closed, de-energized) or NCE (normally-closed, energized).
    - The units are shipped with alarm relays factory-set to the de-energized (non-alarm) position and the trouble relay set to the energized (non-fault) position.
    - Upon activation, the relay contacts change state and remain changed for as long as:
        - The alarm condition exists within the Trigard Gas Monitor or
        - The latching mode is selected (see "Note on Resetting Latched alarms with Controller or Calibrator" in Chapter 2).
    - These defaults can be changed or verified via the Ultima Controller.

Fault Relay or Trouble

- It is a normally-energized, single-pole, double-throw (SPDT) relay.
- During normal operation, the relay contacts are normally closed (NC) and normally open (NO) as shown in FIGURE 4-1.
- When a fault is detected or power is cut or turned OFF, these contacts change as follows:
    - normally closed contacts open
    - normally open contacts close.

- Provides an electrical path for fail-safe relay operation. In the event of any failure, including power loss, the relay will change to a fault condition.

The Fault Relay can remain STEADY ON or PULSED. These two different modes can communicate different information to any PLC or DCS connected to the fault relay:

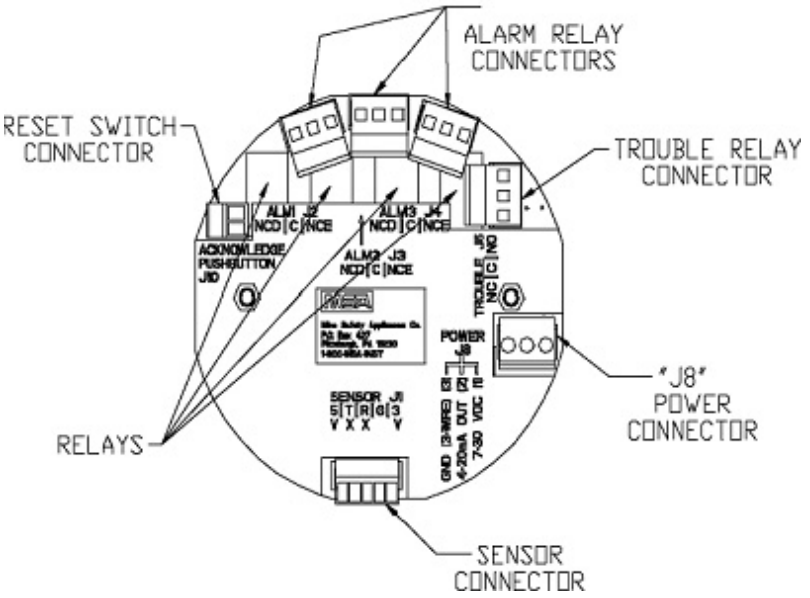


FIGURE 4-1. Relay Contacts

- **Fault Relay STEADY ON indicates:**
  - Trigard sensor is not connected properly or
  - Trigard Gas Monitor internal fault or
  - An inoperative relay.
- **Fault Relay PULSED (once per minute) indicates:**
  - Improper calibration of the Trigard Gas Monitor or
  - Trigard Gas Monitor CHECK CAL or CAL FAULT displayed.

Calibration/RESET Push-button

General

- The RESET button feature is included and allows latching relays to be reset at the sensor location.
- This may silence any alarm horns or turn OFF any equipment connected to the relays.
- Latching relays can be configured on the Trigard Monitor via the Ultima Controller.
    - In a latching configuration:
      when the RESET button is pushed and any alarm is latched and not in its active alarm state, the alarm will reset.
    - In a non-latching configuration: the RESET button has no affect on the alarms.

Push-button Calibration

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

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

Table 4-2. Push-button Calibration

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

- Refer to Chapter 2 or 3, "Startup and Calibration" for more information on calibration.

5. The calibration can be aborted during the 30-second countdown by pressing the push-button until the ♥ is displayed.

- When the push-button is released, the calibration will be aborted.

Relay Connections

All electrical connections to internal relays can be made directly on the pc board (see FIGURE 4-1).

If you are connecting the relays to motors, fluorescent lighting or other inductive loads, it is necessary to suppress any sparks or inductive feedback that may occur at the relay contact. These effects may render the unit inoperative. One way to reduce these effects is to install a *Quencharc® across the load being switched. This device is available from MSA as P/N 630413.

In some cases, if strobes are ordered, the relays are pre-wired.

⚠ WARNING

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

- The Trigard Gas Monitor must be disassembled for relay wiring
- The following procedure must be performed

1. Remove the Trigard Gas Monitor cover.
2. Pull on the wiring plugs to disconnect the connectors on the exposed board.

   NOTE: Observe connector locations for later re-insertion.
3. Route customer-supplied cable into the enclosure and connect to the appropriate wiring plugs.
4. Identify each conductor of the cable to enable proper connection at the control equipment.
5. Re-install the wiring plugs.
   - Ensure that wiring plugs are firmly seated into their mates.
6. Pull the cable away from the unit to relieve any excess slack.
   - It is important not to have excess wire or cable within the module to avoid unwanted AC noise.
7. Re-install the cover of the Trigard Gas Monitor.

Horn Relay Software

The Trigard Gas Monitor comes standard with Horn Relay Software to allow the audible horn to be used with Relay 1. The horn is 95 dB at two feet (P/N 637123). The following describes the use and functionality of this feature.

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

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

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

To Activate the Horn Relay

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

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

To Reset the Horn Relay

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

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

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

Chapter 5, Specifications

Table 5-1. Performance Specifications

GAS TYPES	Combustibles, Oxygen & Toxics		
TEMPERATURE RANGE	**TOXICS & OXYGEN**	**OPERATING RANGE**	0 to 40°C (32 to +104°F)
		***EXTENDED RANGE**	-20 to +50°C (-4 to +122°F)
		OPERATING RANGE NH_3	0 to +30°C (32 to +86°F)
		***EXTENDED RANGE NH_3, CL_2, CLO_2**	-10 to +40°C (+14 to +104 °F)
		Calibrate within operating range	
	CATALYTIC COMBUSTIBLES	**SINGLE & DUAL MODULES**	-40 to +60°C (-40 to +140 °F)
	IR COMBUSTIBLES	**SINGLE & DUAL MODULES**	-40 to +60°C (-40 to +140 °F)
DRIFT	**ZERO DRIFT**	Less than 5%/year, typically	
	SPAN DRIFT	Less than 10%/year, typically	
NOISE		Less than 1% FS	

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

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

STEP CHANGE RESPONSE	**TIME TO REACH 20% OF SCALE-OXYGEN & TOXICS**	Less than 12 seconds (typically 6 seconds) Less than 20 seconds (ETO)		
	TIME TO REACH 50% OF SCALE-OXYGEN & TOXICS	Less than 30 seconds (typically 12 seconds) Less than 45 seconds (ETO)		
	TIME TO REACH 50% OF SCALE-COMBUSTIBLES	Less than 10 seconds		
	TIME TO REACH 90% OF SCALE-COMBUSTIBLES	Less than 30 seconds		
HUMIDITY		15 to 95% RH, non-condensing, 24 hours or less		
		15 to 60% RH (SO2**)		
		35 to 95% RH, long term		
SENSOR LIFE	**CATALYTIC COMBUSTIBLES**	3 years, Typically		
	OXYGEN &TOXICS	2 years, Typically		
	AMMONIA	***		
	FULL REPLACEMENT WARRANTY	1 year; 2 years for IR Combustibles (see "MSA Instrument Warranty" in this manual)		
WIRING REQUIREMENTS	**mA OUTPUT**	**OXYGEN & TOXICS**	3-wire	
		COMBUSTIBLES	3-wire	
POWER CONSUMPTION (Total unit with relays)	**mA VERSIONS**	**OXYGEN & TOXICS**	8 VDC	250 mA max
			12 VDC	175 mA max
			24 VDC	100 mA max
		CATALYTIC COMBUSTIBLES	8 VDC	600 mA max
			12 VDC	400 mA max
			24 VDC	290 mA max
		IR COMBUSTIBLES	8 VDC	870 mA max
			12 VDC	550 mA max
			24 VDC	290 mA max
SIGNAL OUTPUT	**4-20 mA**	**COMBUSTIBLES**	3-wire current source	
		OXYGEN & TOXICS	3-wire current source	
PHYSICAL	**SIZE**	6.89" H x 9.84" W x 5.87" D (239.34 mm x 130 mm x 76 mm)		

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

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

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

INSTALLATION OUTLINE DRAWING NUMBER	MODEL	POWER SUPPLY OUTPUT VOLTAGE	HOUSING DESCRIPTION
SK 3015-1032	Trigard	24 VDC	Plastic

Table 5-2. Sensor Response to Interferants

If your readings are higher or lower than expected, it could be due to the presence of an interferant gas. The gas listed in column 1 is presented to the sensor. Column 2 indicates the concentration of that gas presented to the sensor. The remaining columns indicate the respective responses by the sensors to each particular gas.

For Example: Scan column 1 until you locate "hydrogen". Column 2 shows that 500 ppm of hydrogen was presented to the sensor. Column 3 shows that a CO (filtered) sensor gave an equivalent response of 200 ppm. Column 4 shows that an H_2S sensor gave an equivalent response of 0.5 ppm, etc.

INTER-FERANT	CONCEN-TRATION (PPM)	CO filtered	H_2S	CL_2	SO_2 filtered	NO	NO_2	HCN	HCL
(N/D = NO DATA)									
Acetone	1000	0	0	0	0	N/D	0	N/D	N/D
Acetylene	12000	0	0	0	0	N/D	N/D	N/D	N/D
Ammonia	25	0	0	0	0	N/D	0	0	0
Arsine	1	0	0	0	0	0	N/D	N/D	1
Benzene	20	0	0	0	0	N/D	N/D	0	N/D
Bromine	2	0	0	2.5	N/D	0	0	0	N/D
Carbon Dioxide	5000	0	0	0	0	0	0	0	0
Carbon Disulfide	15	0	0	0	0	0	N/D	0.1	0
Carbon Monoxide	100	100	0.3	0	0.2	N/D	0	0	0
Chlorine	5	0	-3	5	0	0	0	-0.2	0
Diborane	20	0	0	0	0	N/D	N/D	N/D	0
Ethylene	50	100	0.1	0	0	N/D	0	-0.3	N/D
Ethyl Alcohol	100	115	0	0	0	N/D	N/D	0	N/D
Ethylene Oxide	10	N/D	N/D	N/D	0	N/D	N/D	N/D	N/D
Ether	400	3	0	0	0	N/D	0	N/D	N/D
Fluorine	5	0	0	2.5	0	0	N/D	0	0
Freon 12	1000	0	0	0	0	0	0	0	0
Germane	1	0	0	0	0	0	N/D	N/D	1
Hexane	500	0	0	0	0	N/D	0	0	N/D
Hydrogen	500	200	0.5	0	15	N/D	-10	0	0
Hydrogen Chloride	50	0	0	0	0	4	0	N/D	50
Hydrogen Cyanide	10	0	0	0	0	0	0	10	0
Hydrogen Fluoride	10	0	0	0	0	N/D	N/D	N/D	N/D
Hydrogen Sulfide	10	1	10-	0.1	0	1	-8	50	40
MEK	200	0	0	0	0	0	0	N/D	N/D
Mercaptan (Methyl)	5	0	4.5	-0.1	0	1	N/D	6	N/D
Methane	50000	0	0	0	0	0	0	0	0
Nitric Oxide	100	0	2	0	2	100	N/D	-3	40
Nitrogen Dioxide	5 -	1	-4	0.5	-5	1.5	5	N/D	0
Phosphine	0.5	N/D	0	0	N/D	0	N/D	N/D	2
Silane	5	0	0	0	0	0	N/D	N/D	7
Sulfur Dioxide	10	0	0.3	0	10	0.5	N/D	-0.3	0
Tichloroethylene	1000	0	0	0	0	0	N/D	N/D	N/D

INTER-FERANT	CONCEN-TRATION (PPM)	CLO_2	HF	PH_3	ASH_4	SiH_4	GeH_3	B_2H_6	Br_2
(N/D = NO DATA)									
Acetone	1000	0	0	N/D	N/D	N/D	N/D	N/D	0
Acetylene	12000	0	0.1	N/D	N/D	N/D	N/D	0	
Ammonia	25	0	0	N/D	N/D	N/D	N/D	N/D	0
Arsine	1	0	N/D	0.7	1	1	1	5	0
Benzene	20	0	N/D	N/D	N/D	N/D	N/D	N/D	0
Bromine	2	1	N/D	N/D	N/D	N/D	N/D	N/D	2
Carbon Dioxide	5000	0	0	N/D	N/D	N/D	N/D	N/D	0
Carbon Disulfide	15	0	N/D	0	0	0	0	0	0
Carbon Monoxide	100	0	0	0	1	0	0	0	0
Chlorine	5	2.5	5	N/D	N/D	N/D	N/D	N/D	4
Diborane	20	0	N/D	3.5	5	4	5	20	0
Ethylene	50	0	0	0.5	1	1	1	2	0
Ethyl Alcohol	100	0	0	N/D	N/D	N/D	N/D	N/D	0
Ethylene Oxide	10	0	N/D	N/D	N/D	N/D	N/D	N/D	N/D
Ether	400	0	0	N/D	N/D	N/D	N/D	N/D	0
Fluorine	5	1	N/D	N/D	N/D	N/D	N/D	N/D	2
Freon 12	1000	0	0	0	0	0	0	0	0
Germane	1	0	N/D	0.7	1	1	1	5	0
Hexane	500	0	0	N/D	N/D	N/D	N/D	N/D	0
Hydrogen	500	0	0	0	0	0	0	0	0
Hydrogen Chloride	50	0	30	N/D	N/D	N/D	N/D	N/D	0
Hydrogen Cyanide	10	0	0	N/D	N/D	N/D	N/D	N/D	0
Hydrogen Fluoride	10	0	10	N/D	N/D	N/D	N/D	N/D	0
Hydrogen Sulfide	10	0	3	N/D	N/D	N/D	N/D	N/D	0
MEK	200	0	N/D	N/D	N/D	N/D	N/D	N/D	0
Mercaptan (Methyl)	5	0	N/D	N/D	N/D	N/D	N/D	N/D	0
Methane	5000	0	0	N/D	N/D	N/D	N/D	N/D	0
Nitric Oxide	100	0	2	N/D	N/D	N/D	N/D	N/D	0
Nitrogen Dioxide	5	0.2	2.5	N/D	N/D	N/D	0.5	N/D	0.4
Phosphine	0.5	0	0	0.5	1	0.7	1	3	0
Silane	5	0	N/D	0.1	0.2	5	0.2	15	0
Sulfur Dioxide	10	0	8	0.5	1	2	3	6	0
Tichloroethylene	1000	0	0	N/D	N/D	N/D	N/D	N/D	0

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

Chapter 6, Maintenance

General

The Trigard Gas Monitor is constantly performing a self-check. When a problem is found, it displays the appropriate error message. (Table 6-3, "Troubleshooting Guidelines"). When a critical error is detected within the unit, the output signal goes to a fault condition.

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

NOTE: TABLES 6-1 and 6-2 describe the messages that users may see.

Replacing Trigard Sensor

The only routine maintenance item is the sensing element itself, which has a limited lifetime. When the Trigard Gas Monitor's read-out indicates that the sensor must be changed, there is very little sensor lifetime remaining. It is good practice to obtain a replacement sensing element before the sensing element within your unit becomes inoperative. Typically, the Trigard Monitor LCD display shows a maintenance message when the sensor is due for replacement (FIGURE 6-1).

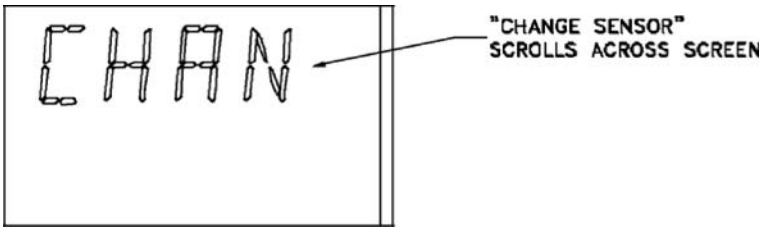


Figure 6-1. "Change Sensor" Scrolls Across the Display

⚠ WARNING

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

⚠ CAUTION

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

1. There is no need to open the main enclosure; simply unscrew the sensor assembly located on the bottom of the Trigard Gas Monitor main assembly (FIGURE 6-2).

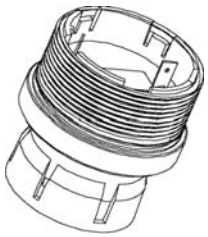


Figure 6-2. Sensor Assembly and Sensor Guard for General Purpose Model

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

   NOTE: Alarm setpoints and relay functions (energized/de-energized, latching/unlatching, and upscale/downscale) will not change when changing a sensor module from its current gas type to the same gas type (e.g., carbon monoxide to carbon monoxide). Alarm setpoints and the upscale/downscale relay function will change to the new sensor's default settings when changing a sensor module from its current gas type to a different gas type (e.g., carbon monoxide to oxygen).

3. The Trigard Gas Monitor is shipped with the Sensor Swap Delay enabled. This means that the 4-20 mA output signal and the FAULT relay will hold off a fault indication for 60 seconds after the sensor missing indication is displayed on the instrument. This setting allows the operator to exchange sensor modules without a FAULT indication.
4. Refer to Chapter 3, "Calibration".

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

Table 6-1. Operational Display Messages

MESSAGE	INDICATES
MM/DD/YY	Format for date scrolling
VER	Software version level will display next
TIME	Time will display next
DATE	Date will display next
MIN	MIN value for this interval will display next
MAX	MAX value for this interval will display next
AVG	AVG value for this interval will display next
Adr	Instrument's address will display next
End	End of calibration cycle
Err	An Error code will display next
HR	Special case indicates hours (two characters or less)
OVER	Gas value is greater than the set range

Table 6-2. Configuration Display Messages

MESSAGE	INDICATES
CAL SIG ON	Instrument will output the calibration signal during calibration
CAL SIG OFF	Instrument will output gas value during calibration
LTCH/	Latching relay operations
UNLTCH/	Non-latching relay operations
INCR/	Increasing Alarm relay operations
DECR/	Decreasing Alarm relay operations
ENER	Energized relay operations
DENER	De-energized relay operations
CAL	Normal calibration or 4-20 calibration cycle
iCAL	Initial calibration cycle
OFF	Alarm is OFF
ON	Alarm is ON
RNGE	Instrument's operational full-scale will display next
PCAL	Instrument's previous calibration date will display next
TBLE	Instrument gas table selection (if applicable)
ALERT OP ON	Instrument output will follow ALERT mode
ALERT OP OFF	Instrument output will not follow ALERT mode
SWAP DELAY ON	60-second delay after sensor missing before fault
SWAP DELAY OFF	Fault occurs at sensor missing condition

Table 6-3. Troubleshooting Guidelines

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

Obtaining Replacement Parts

See TABLE 6-4 for replacement sensor kits. To obtain a replacement sensor, address the order or inquiry to:

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

or call, toll-free, **1-800-MSA-INST**.

⚠ WARNING

Use only genuine MSA replacement parts when performing any maintenance procedures provided in this manual. Failure to do so may seriously impair sensor performance. Repair or alteration of the Trigard Gas Monitor, beyond the scope of these maintenance instructions or by anyone other than authorized MSA service personnel, could cause the product to fail to perform as designed and persons who rely on this product for their safety could sustain serious personal injury or death.

Table 6-4. Replacement Parts

GAS SELECTION	SENSOR KIT PART NO.
	GENERAL-PURPOSE MODELS
Carbon Monoxide, 100 ppm	A-ULTX-SENS-11-0...
Carbon Monoxide, 500 ppm	A-ULTX-SENS-12-0...
Oxygen, 10% - compensated	A-ULTX-SENS-13-0...
Oxygen, 25% - compensated	A-ULTX-SENS-14-0...
Hydrogen Sulfide, 10 ppm	A-ULTX-SENS-15-0...
Hydrogen Sulfide, 50 ppm	A-ULTX-SENS-16-0...
Hydrogen Sulfide, 100 ppm	A-ULTX-SENS-17-0...
Chlorine, 5 ppm	A-ULTX-SENS-18-0...
Sulfur Dioxide, 25 ppm	A-ULTX-SENS-70-0...
Sulfur Dioxide, 100 ppm	A-ULTX-SENS-71-0...
Nitric Oxide, 100 ppm	A-ULTX-SENS-20-0...
Nitrogen Dioxide, 10 ppm	A-ULTX-SENS-72-0...
Hydrogen Cyanide, 50 ppm	A-ULTX-SENS-22-0...
Hydrogen Chloride, 50 ppm	A-ULTX-SENS-23-0...
Chlorine Dioxide, 3 ppm	A-ULTX-SENS-24-0...
Combustible Gas, 100% LEL Natural Gas and H_2, 5% CH_4	A-ULTX-SENS-31-0...
Combustible Gas, 100% LEL Petroleum Vapors, 2.1 % Propane	A-ULTX-SENS-32-0...
Combustible Gas, 100% LEL Solvents, 2.1% Propane	A-ULTX-SENS-33-0...

Comb Gas IR - Methane, 5% CH_4	not available
Comb Gas IR - Non Methane, 2.1 % Propane	not available
Phosphine, 2 ppm	A-ULTX-SENS-41-0...
Arsine, 2 ppm	A-ULTX-SENS-42-0...
Silane, 25 ppm	A-ULTX-SENS-43-0...
Diborane, 50 ppm	A-ULTX-SENS-45-0...
Bromine, 5 ppm	A-ULTX-SENS-46-0...
Fluorine, 5 ppm	A-ULTX-SENS-47-0...
Ammonia, 50 ppm	A-ULTX-SENS-48-0...
Hydrogen, 1000 ppm	A-ULTX-SENS-49-0...
ETO, 10 ppm	A-ULTX-SENS-50-0...
SENSOR GUARD REPLACEMENT PARTS	
All Sensor Types	10028904
STROBES	
Red	634674
Amber	655629
BACKUP BATTERY	10098441
PCBA SELECTION	
3-Wire, 4-20 mA	10100992
ModBUS	10100991

Appendix A, Optional Features

Strobes

Two optional strobes (one red and one amber) are offered with the Trigard Gas Monitor.

If the strobes are selected, they come pre-wired to Relays 2 and 3.

Alarm levels are pre-set to 20 and 30% of full scale, respectively.

- These alarm levels can be modified by using the Ultima Controller (see Chapter 2 for more details).

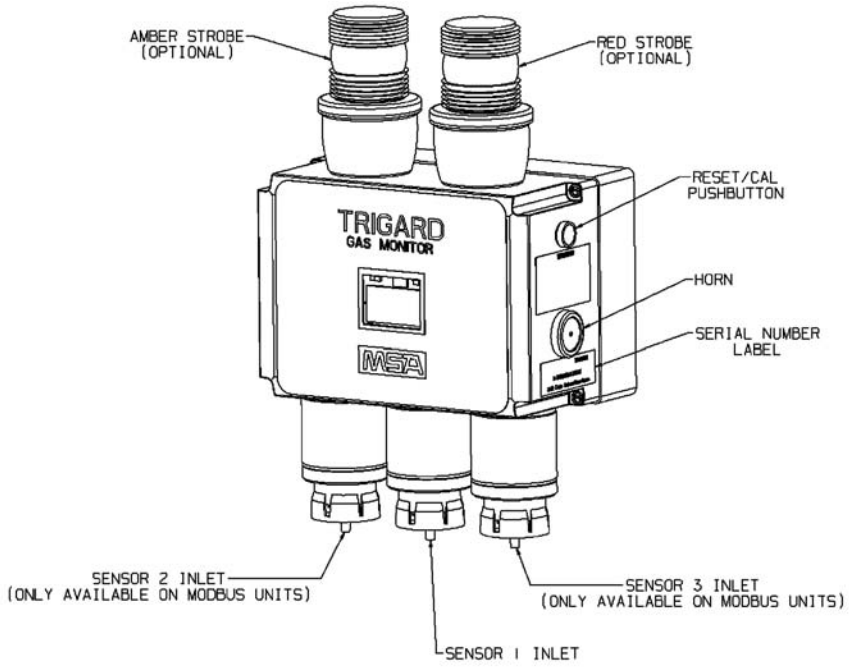


Figure A-1. Trigard Gas Monitor with Additional Options

Internal Power Supply

The optional internal power supply is 24 VDC. An 8 foot AC cord is included with this option for easy power-up (FIGURE A-2).

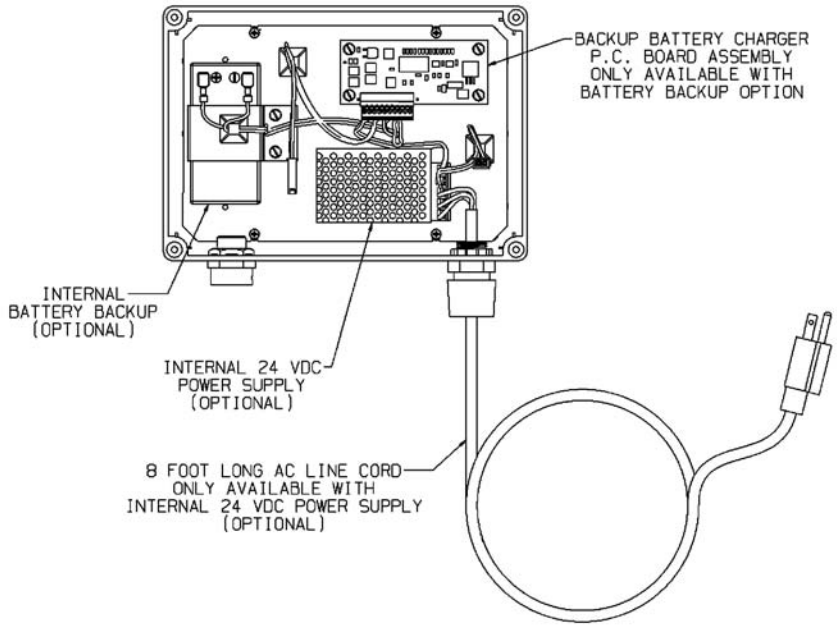


Figure A-2. Trigard Gas Monitor
Power Supply and Battery Backup Options

Backup Battery

The 12 VDC battery backup with additional charger PCB may be ordered as an option for the Trigard Gas Monitor. (See Figure A-2.)

During installation, the blue lead must be connected to the battery to start the charging process.