



General Monitors

by MSA

Model S4000TH

Intelligent Sensor for
Hydrogen Sulfide Gas Detection



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Instruction Manual **10-16**

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Part No.
Revision

MANS4000TH
N/10-16

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Quick Start Guide

Mounting and Wiring

Tools Required

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

The outline and mounting dimensions for the Model S4000TH (Figure 1) should be used when making installation determinations.

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



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

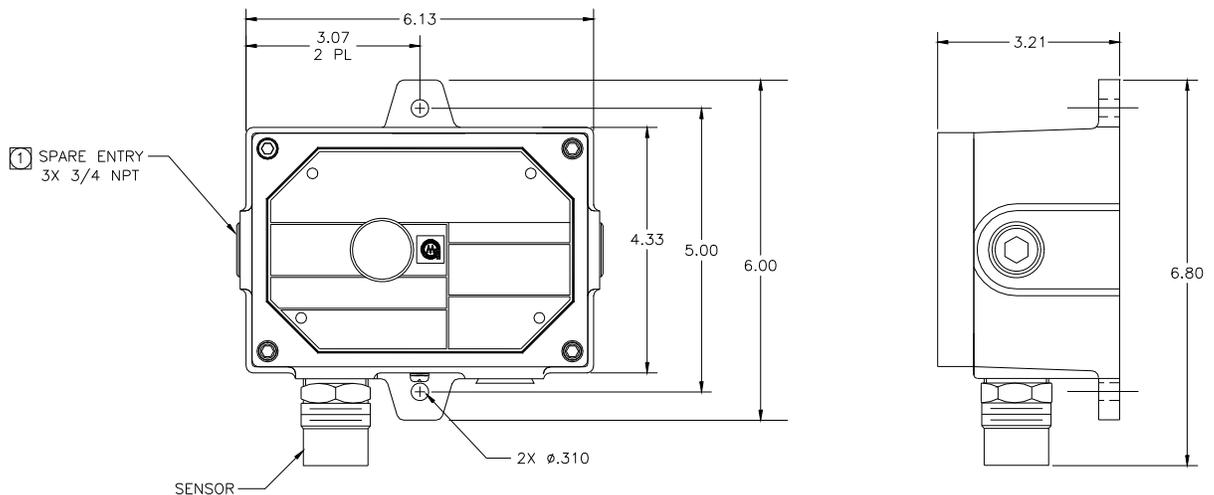


Figure 1: S4000TH Outline and Mounting Dimensions, in inches

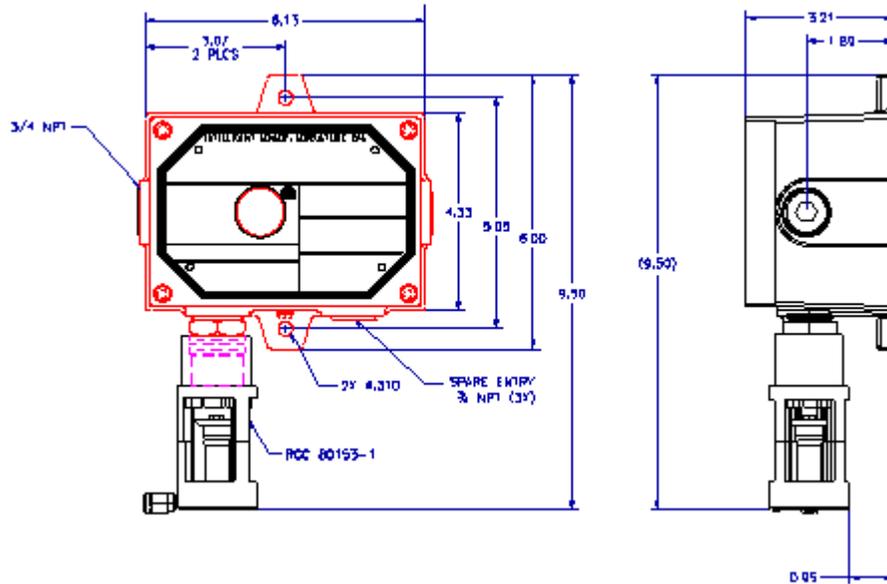


Figure 2: S4000TH with RGC Outline and Mounting Dimensions, in inches

Terminal Connections

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

It is recommended that a minimum three-wire shielded cable be used for making the power and 0-20mA Output connection on TB2 of the S4000TH. It is also recommended that separate two-wire shielded twisted pair cables be used for making the Modbus connections. The spring type terminal block accepts 14 AWG to 20 AWG and the screw type terminal block accepts 12 AWG to 18 AWG stranded or solid wire. Each wire should be stripped before wiring the S4000TH. To connect wiring to the spring type terminal block, insert a screwdriver into the orange tab and press down (Figure 3), opening the terminal. Insert the wire into the terminal and release the orange tab, clamping the wire in the terminal. Check the hold of the wire by gently tugging it to ensure it is locked in.

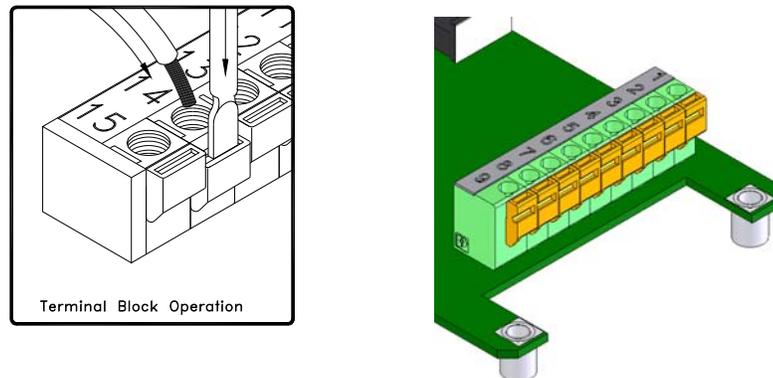


Figure 3: Spring Type Terminal Block Operation

To connect wiring to the screw type terminal block, loosen the top screw counter clock wise (Figure 4). Insert the wire into the terminal and tighten the top screw clockwise.

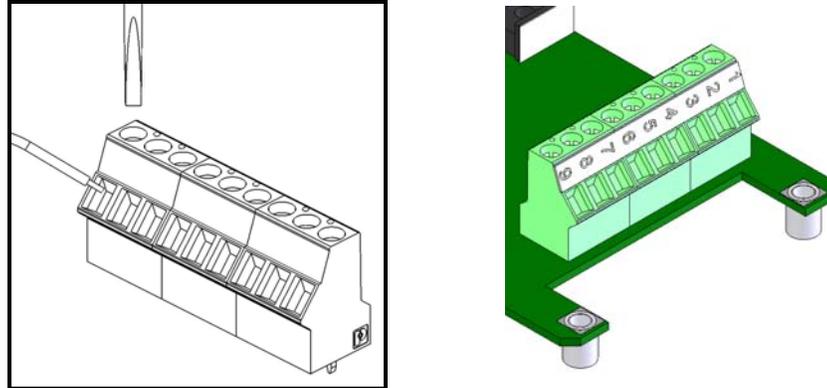


Figure 4: Screw Type Terminal Block Operation

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

The maximum distance between the S4000TH and the power supply is 2,000 feet or 610 meters (each cable run should be as short as possible). See Section 9.3.3 for cable length specifications.

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

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

General Monitors recommends that the S4000TH Intelligent Sensor be calibrated 1 hour after start-up and that the calibration be checked at least every 90 days to ensure system integrity.

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

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

1.0 Introduction

1.1 Protection for Life

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

This manual provides instruction for installing and operating General Monitors' Model S4000TH Intelligent Sensor for hydrogen sulfide gas detection. Although the S4000TH is easy to install and operate, this manual should be read in full and the information contained herein understood before attempting to place the system in service.

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

1.2 Special Warnings

The Model S4000TH Intelligent Sensor contains components, which can be damaged by static electricity. Special care must be taken when wiring the system to ensure that only the connection points are touched.



WARNING: Hydrogen sulfide (H₂S) is an extremely toxic gas, and exposure may result in a loss of consciousness or death.

DO NOT OPEN WHEN AN EXPLOSIVE ATMOSPHERE IS PRESENT. READ AND UNDERSTAND INSTRUCTION MANUAL BEFORE OPERATING OR SERVICING. OPEN CIRCUIT BEFORE REMOVING COVER. POTENTIAL ELECTROSTATIC CHARGING HAZARD – USE ONLY DAMP CLOTH FOR CLEANING.

NE PAS OUVRIR UN PRÉSENCE D'ATMOSPHÈRE EXPLOSIVE. LIRE ET COMPRENDRE MANUEL D'INSTRUCTIONS AVANT D'UTILISER OU SERVICE. OUVRIR LE CIRCUIT AVANT D'ENLEVER LE COUVERCLE. DANGER POTENTIEL ÉLECTROSTATIQUE DE CHARGE – UTILISATION UNIQUEMENT UN CHIFFON HUMIDE POUR LE NETTOYAGE.

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

The S4000TH shall not be used as a Safety Related Device as defined by ATEX Directive 94/9/EC,

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

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

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

The Universal Gas Sensor (51457-XX), when tested in accordance with clause 15.4.2.1 of EN 60079-1, produced a maximum surface rise of 26.3 K. This value should be considered when the component is incorporated into equipment.

The Universal Gas Sensor (51457-XX), utilizing Types 2850FT Cat 11 and 2762 Cat 17 cement shall only be fitted to enclosures having a maximum reference pressure of 9.6 bar.

1.3 System Integrity Verification

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

Commissioning Safety Systems

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

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

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

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

Fault and malfunction circuit operation should be verified.

Periodic Testing/Calibration of Field Devices

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

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

Periodic System Verification

The following system verifications should be performed at least annually:

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

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

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



Figure 6: Model S4000TH Intelligent Sensor with RGC

NOTE: The image in Figure 6 is for reference only. See section 9.3 for actual product specifications.

3.0 Installation

3.1 Receipt of Equipment

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

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

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

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



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



WARNING: The S4000TH Intelligent Sensor contains components, which can be damaged by static electricity. Special care must be taken when wiring the system to ensure that only the connection points are touched.

3.2 Tools Required

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

3.3 Choosing Product Locations

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

- Mount sensor pointing down to prevent water build-up on the sensor head.
- Do not place sensor where contaminating substances may coat it.
- Although the S4000TH is RFI resistant, do not install sensor in close proximity to radio transmitters or similar equipment.
- Locate the S4000TH where prevailing air currents contain the maximum concentration of gas.
- Locate the S4000TH near possible sources of gas leaks.
- Observe the S4000TH's temperature specification and locate the unit away from concentrated sources of heat.
- Install sensor in an area that is as free from wind, dust, water, shock, and vibration as possible. See Section 9.3.4 for the environmental specifications of the unit. If dust and rain cannot be avoided, we recommend the use of our splash guard (GM P/N 10395-1).

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

- Silicones (often contained in greases and aerosols)
- Halides: compounds containing fluorine, chlorine, bromine and iodine

- Heavy metals, e.g. tetraethyl lead
- Caustic and Acidic liquids and vapors
- Glycol

The presence of contaminants in an area does not necessarily preclude the use of a S4000TH Intelligent Sensor. The feasibility of using a sensor in such areas must be determined by an analysis of the specific factors in each application, and General Monitors should be consulted before attempting any such installation.

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

IMPORTANT: Each H₂S sensor is shipped with a red plastic cap fitted over the sensor head. Inside the cap is a desiccant. Do not remove this cap until the system is ready to be powered. Save the cap and re-cap the sensor anytime the system power is off for more than 1 hour.



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

3.3.1 Remote Mounting of the Sensor from the Electronics

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

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

3.4 Mounting and Wiring



WARNING: Unused cable entry holes must be sealed with a suitably certified ATEX or IECEx approved explosion-proof plug. Red caps supplied by General Monitors are for dust protection only and must not be left on the unit when installed.

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

The outline and mounting dimensions for the S4000TH (Figure 5) should be used when making installation determinations. A complete list of the mechanical specifications can be found in Section 9.3.2.

To prevent possible corrosion due to moisture or condensation, it is recommended that the conduit connected to the S4000TH housing, contain a drain loop.

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

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

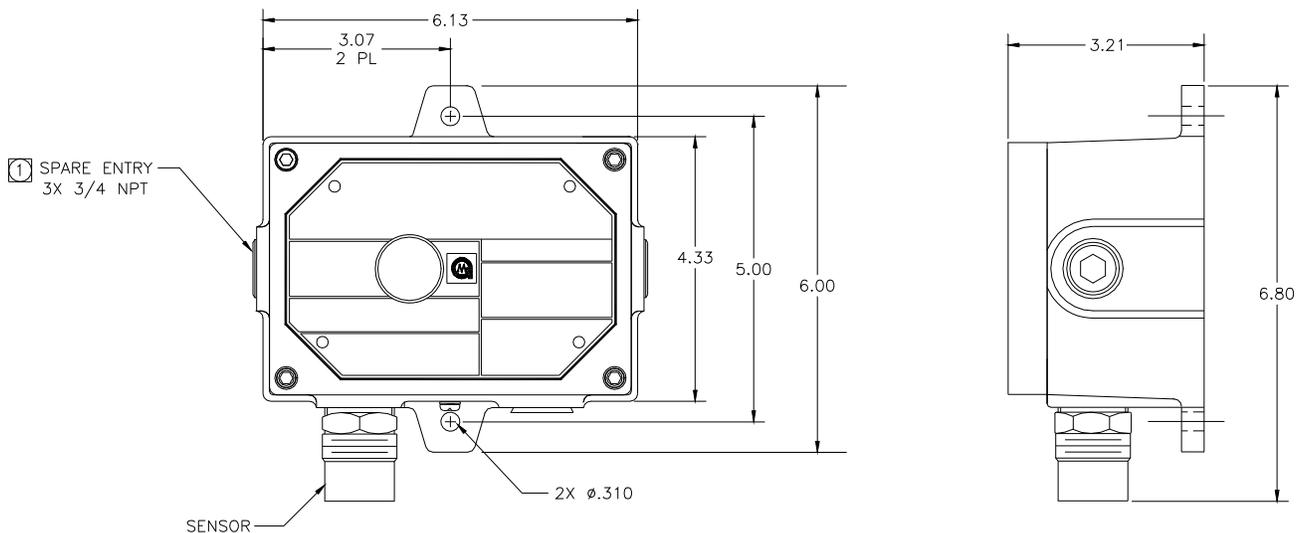


Figure 7: S4000TH Outline and Mounting Dimensions, in inches

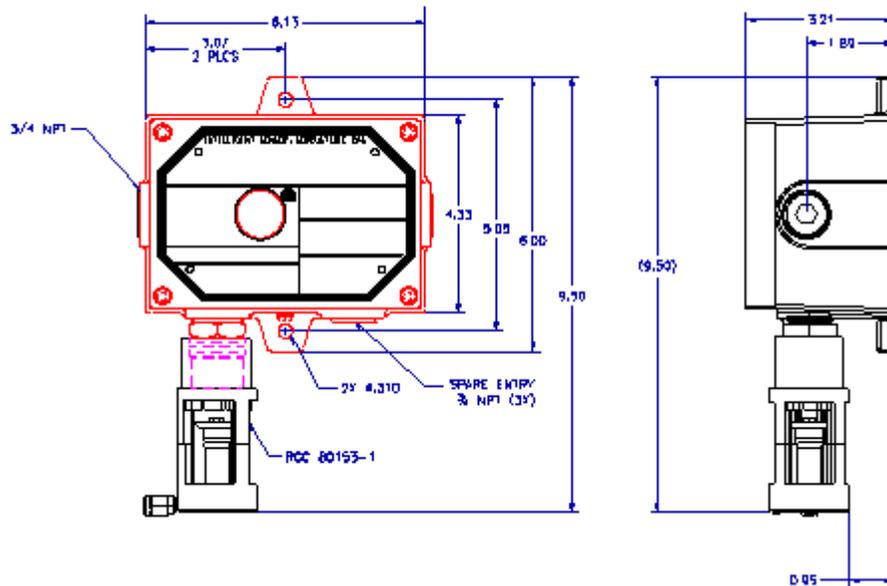


Figure 8: S4000TH with RGC Outline and Mounting Dimensions, in inches



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

Once correctly installed, the S4000TH requires little or no maintenance, other than periodic calibration checks to ensure system integrity. General Monitors recommends that a schedule be established and followed.

NOTE: The S4000TH full 2-year warranty will be voided if customer personnel or third parties damage the S4000TH during repair attempts.

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

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

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

3.5 Terminal Connections

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

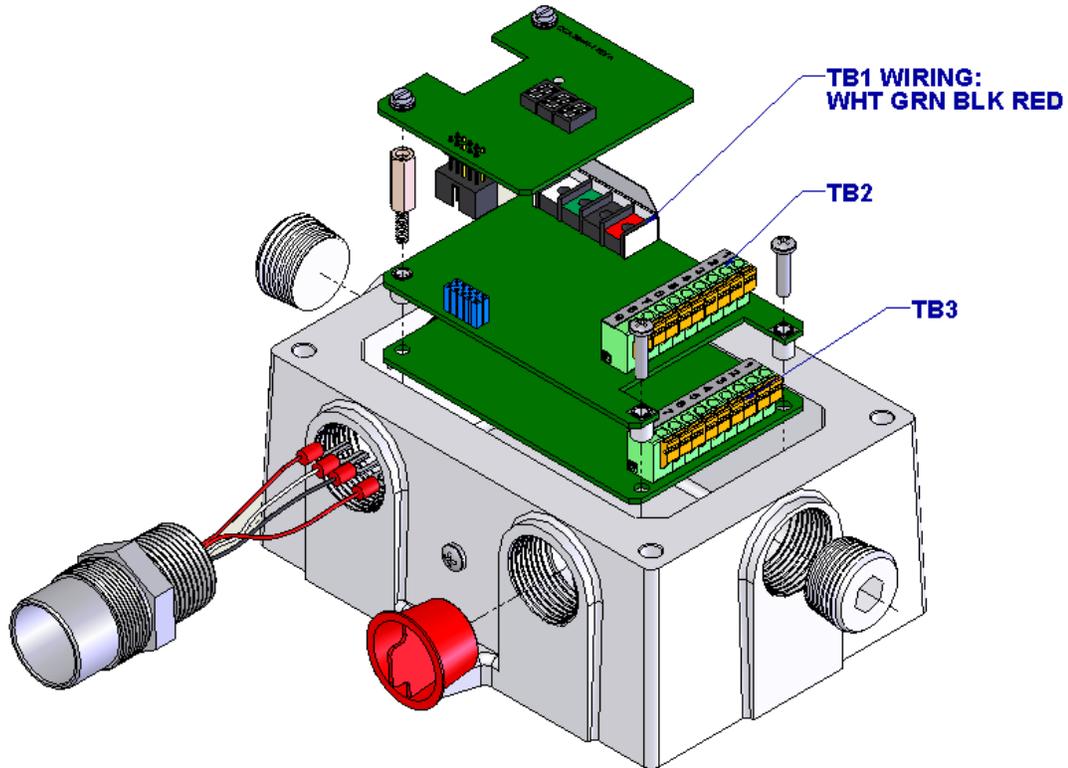


Figure 9: S4000TH Terminal Block Locations

3.5.1 Terminal Block TB1 – Sensor Connections

TB1 contains the four sensor connections, white (W), black (B), red (R) and green (G). Remove the display board by loosening the 2 captive screws on the board and lifting it straight up. Connect the color-coded wires from the sensor to the matching colored terminals on TB1. The label on the inside of the cover can serve as a guide. Replace the display board by pressing it into place and tightening the two captive screws.



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

3.5.2 Terminal Block TB2 – Power and Signal Connections

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

TB2 position	Function
1	0-20 mA Output
2	CH1 Modbus -
3	CH1 Modbus +

4	CH2 Modbus -
5	CH2 Modbus +
6	Remote Calibration
7	Relay Reset
8	Ground
9	+24 VDC Power

Table 1: TB2 Power and Signal Connections

It is recommended that a minimum three-wire shielded cable be used for making the power and 0-20mA Output connection on the S4000TH. It is also recommended that separate two-wire shielded twisted pair cables be used for making the Modbus connections. The spring type terminal block accepts 14 AWG to 20 AWG and the screw type terminal block accepts 12 AWG to 18 AWG stranded or solid wire. Each wire should be stripped before wiring the S4000TH. To connect wiring to the spring type terminal block, insert a screwdriver into the orange tab and press down (Figure 10). Insert the wire into the terminal and release the orange tab, clamping the wire in the terminal. Check the hold of the wire by gently tugging it to ensure it is locked in. To connect wiring to the screw type terminal block, loosen the top screw counterclockwise (Figure 11). Insert the wire into the terminal and tighten the top screw clockwise. Check the hold of the wire by gently tugging it to ensure it is locked in.

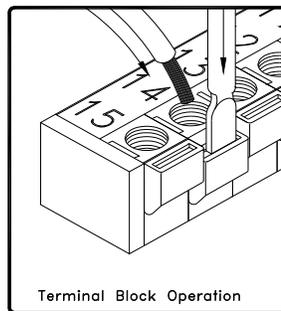


Figure 10: Spring Type Terminal Block Operation

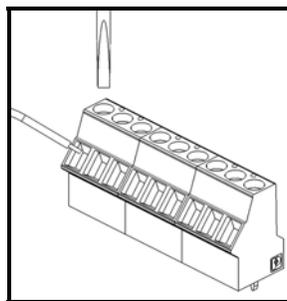
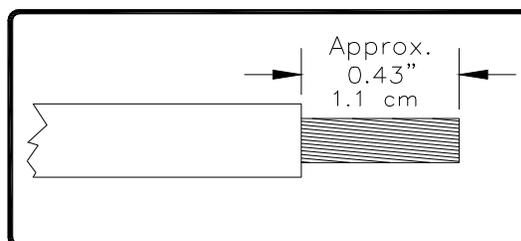


Figure 11: Screw Type Terminal Block Operation



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

3.5.3 DC Power and Ground Connections

The customer must provide primary DC power, unless one of the following General Monitors' Modules is being used with the S4000TH:

- TA202A Trip Amplifier Module with a PS002 Power Supply and Relay Module

The following General Monitors' Modules provide power connections for the S4000TH, but need a customer supplied DC source:

- DT210 Eight-Channel Readout and Relay Display Module
- TA202A Trip Amplifier Module without a PS002

Since the S4000TH is designed to operate continuously, a power switch is not included, in order to prevent accidental system shutdown.

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

See Section 9.3.3 for cable length specifications.

To connect +24 VDC to the S4000TH, connect the red wire (+24 VDC) to TB2, position 9. Connect the ground or common wire to TB2, position 8.

For making power and ground connections to display devices see Table 2 and Table 3.

FROM	TO	
S4000TH	DT210	TA202A
TB2-8 "COM"	Rear COMMON	Rear Pin 30d or 30z

Table 2: Ground or Common Connections

FROM	TO	
S4000TH	DT210	TA202A
TB2-9 "+24 VDC"	Rear CH 1 - 8 24V	Rear Pin 28d or 28z

Table 3: Power Connections

3.5.4 Analog Signal Connections

The S4000TH Intelligent Transmitter provides a 4 to 20 mA output signal. This signal can be sent to a General Monitors readout and relay display module, an industrial analog to digital converter, or logic solver.

The 4 to 20 mA signal provides for control room or other locations remote to the S4000TH to display indications of operation and alarm conditions.

To connect the 4 to 20 mA output signal with another unit, connect the wire into TB2, position 1, labeled 4-20 mA OUT. For making output signal connections to display devices, refer to the specific manual for that device (Table 4).

FROM	TO	
S4000TH	DT210	TA202A
TB2-1 4-20 mA Output	Rear CH 1 – 8 4-20 mA	Rear Pin 26d or 26z

Table 4: Analog Signal Connections

If a device other than a General Monitors readout and relay display module is being used, the DC ground, COM, of both systems must be connected together.

The analog output can also be configured as a HART communication link.

3.5.5 Terminal Block TB3 – Relay Connections

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

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

Table 5: Alarm Relay Connections

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

Table 6: Warn Relay Connections

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

Table 7: Fault Relay Connections

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



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



WARNING: Relay contacts must be protected against transient and over voltage conditions (Figure 13).

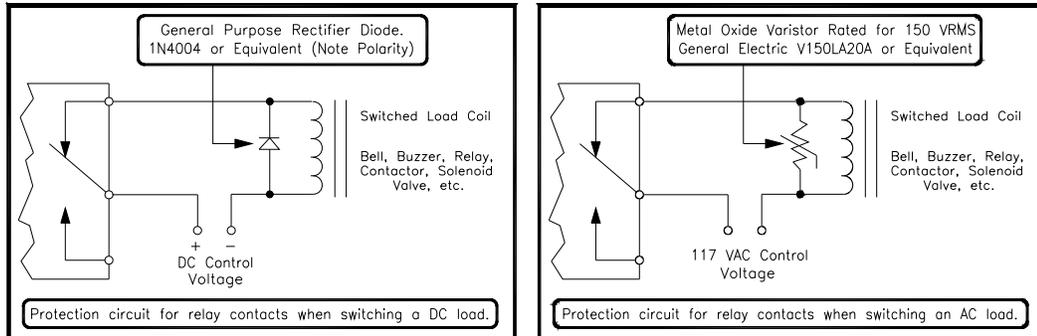


Figure 13: Relay Protection for DC and AC Loads

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

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

3.5.6 European Union (EU) Approved Applications

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

3.5.7 Cable Termination in the Non-hazardous Area

- The cable **armor** must be connected to **safety earth** in the safe area.
- The cable **screen** (drain wire) must be connected to an **instrument earth** in the safe area.
- The power supply **0V return** must be connected to an **instrument earth** in the safe area.
- The interconnecting cables should be segregated from power and other noisy cables. Avoid proximity to cables associated with radio transmitters, welders, switch mode power supplies, inverters, battery chargers, ignition systems, generators, switch gear, arc lights, and other high frequency or high power switching process equipment. In general, a minimum separation of at least 1 meter between instrument and other cables should be maintained. Greater separations are required where long parallel cable runs are unavoidable. Avoid running instrument cable trenches close to lightning conductor earth pits.
- Complete all cable insulation testing before connecting the cable at either end.



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

3.6 Maintaining the X/P Integrity

Some of the factors that influence the explosion-proof integrity of the S4000TH housing are:

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

The acceptable limits for explosion-proof housings that are used in Class I hazardous locations are defined in CSA Standard C22.2 No.30, FM 3615, and EN/IEC 60079-1

Anytime the cover of the S4000TH housing is removed or the cover bolts are loosened, the flame path between the lid and the housing is affected. If power is to be left on while removing the cover or loosening the cover bolts on the Model S4000TH, the area must be declassified.

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

There are four entry holes, one each on the left and right sides, and two on the bottom of the S4000TH housing. These holes are dedicated for the sensor, and conduit/cable. Each hole is tapped for 3/4" NPT threads. If a particular entry hole is not used, it must be plugged during operation in the field. The factory installs plugs in the unused entry holes, except one. A red plastic cap is placed into this remaining hole and must be removed before conduit/cable can be attached to the housing.

The S4000TH will have the following items placed in the four entry holes, at the factory:

- A sensor, if present (otherwise a red plastic cap)
- Two aluminum stopping plugs
- A red plastic cap

The sensor and aluminum stopping plugs have seven threads. Each of these components is screwed into the housing using five to seven turns. If any of these components must be replaced, apply five to seven turns upon replacing the component to ensure the explosion proof integrity of the device is maintained.

4.0 Operation

4.1 Start-Up Checklist

Prior to starting the system, verify the following:

- Inhibit any external devices, such as trip amplifiers, PLC, or DCS systems.
- Verify that the optional settings are set for the desired configuration.
- Verify that the unit is properly mounted. Ensure the conduit/cable gland entries are pointed downward.
- Verify that the signal wiring is correct.
- Verify that the power supply is connected properly. The S4000TH is powered by +24 VDC (20 to 36 VDC voltage range). The detector will output a low voltage fault (F6) at 18.5 VDC or below.
- Make sure the lid is securely installed or the area has been declassified.
- Make sure the HART option is selected if desired.
- Make sure Modbus is properly configured if desired.

4.2 Start-Up

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

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

4.3 Relay Reset

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

- The relays can be reset by using a magnet. To do this, place the magnet over the GM logo on the cover of the unit. After 3 seconds, the display shows “rSt”. After the LED displayed this code, remove the magnet. The relays are now reset (Figure 14).

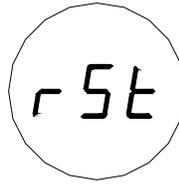


Figure 14: Relay Reset

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

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

4.4 User Selectable Options

The S4000TH includes many selectable options to provide the user with the most flexible H₂S gas detector possible. These options include selectable sensor range, warn and alarm relay set points and configuration, HART communications and Modbus communications settings. These allow the unit to operate with a wide variety of PLC and DCS systems. The following sections explain the available options and how they can be customized.

A flow diagram is included to help the user in understanding the process of reviewing and changing the available options (Figure 15).

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

Modbus

- Dual Redundant Modbus
- Single Modbus and HART

HART

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

RGC

- The Remote Gas Calibrator (RGC) is an accessory that allows remote calibration. With this device, the user turns on and off the calibration gas manually.

4.4.1 Model S4000TH User Menu Structure

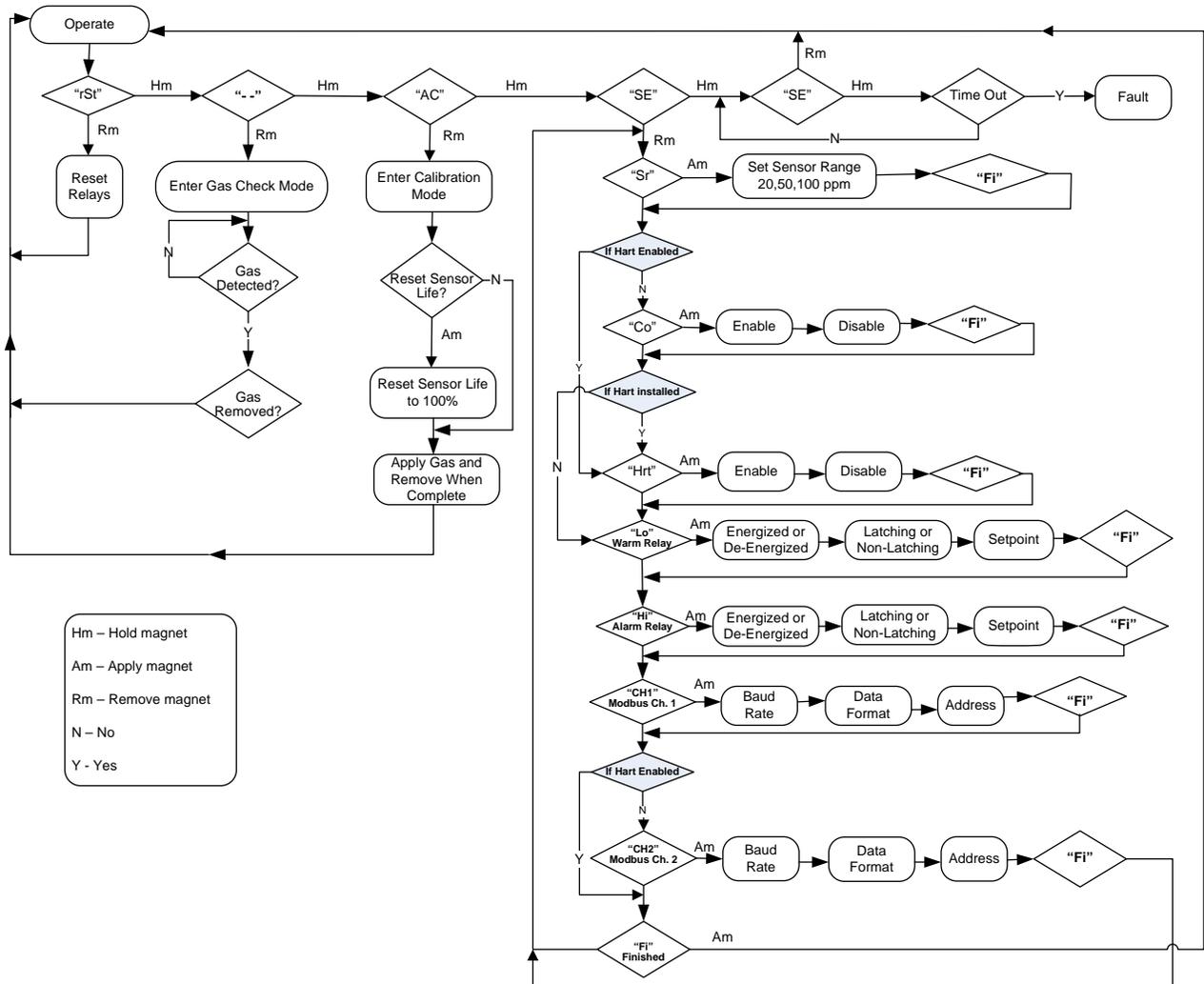


Figure 15: User Menu Structure

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

4.4.2 Sensor Range

The sensor range is selectable between 0-20 ppm, 0-50 ppm, or 0-100 ppm depending on the installed sensor. To adjust the sensor range of the S4000TH, apply the magnet to the GM logo on the cover of the unit until “SE” is displayed, then remove the magnet. This puts the unit into setup mode. After a few seconds “Sr” will be displayed. Apply and remove the magnet to adjust the sensor range. The current sensor range will be displayed. To change the sensor range, apply and remove the magnet repeatedly until the desired range is displayed. Once the desired range is displayed, wait three seconds and “Fi” will be displayed. Apply and remove the

magnet, to return to the next level of the setup menu. When “Fi” is displayed again, apply and remove the magnet, the unit will go to calibration mode. The display will flash the remaining sensor life for a few seconds. Ensure that the sensor is seeing clean air during this time. Apply the calibration gas concentration to the sensor (50% FS of the desired range of H₂S. *See notes section below.). The display will change from “AC” (Automatic Calibration) to “CP” (Calibration in Progress) indicating that the sensor is responding to the calibration gas. **After 3 to 5 minutes, the display will change from “CP” to “CC”, indicating that the calibration is complete.** Remove the gas and wait for the unit to return to normal operation. The unit is now calibrated and the new span value has been stored in the non-volatile memory (EEPROM). ***If a fault occurs during this process, please refer to the notes section below.***

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

It is recommended to go back through the SE mode to confirm range and sensor set-points have been changed correctly. Changing the sensor range will require that the operator change the concentration H₂S previously used for calibrating the unit. It is necessary to use 50% of the "new" full scale reading when changing the scale, as well as after the scale is changed during normal calibration maintenance periods (i.e. 10ppm for a 0-20ppm, 25ppm for a 0-50ppm and 50ppm for a 0-100ppm). **It is important to note that changing a units range may require changing the sensor to match the new sensor range. (-1 sensor for 0-100ppm, -5 sensor for 0-50ppm, and -9 for 0-20ppm).**

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

4.4.3 Calibration Output

To enable the calibration output feature of the S4000TH, apply the magnet to the GM logo on the cover of the unit until “SE” is displayed, then remove the magnet. This puts the unit into setup mode. After a few seconds “Co” will be displayed. Apply and remove the magnet to enter the calibration output setting. The current setting (Enable or Disable) will then be displayed. To change this setting, apply and remove the magnet repeatedly until the desired setting is displayed. Once it is displayed, wait three seconds and “Fi” will be displayed. Apply and remove the magnet to return to the next level of the setup menu. When “Fi” is displayed again, apply and remove the magnet to return to normal operation.

4.4.4 Warning Relay Settings

To adjust the warning relay settings of the S4000TH, apply the magnet to the GM logo on the cover of the unit until “SE” is displayed, then remove the magnet. This puts the unit into setup mode. After a few seconds “Lo” will be displayed. Apply and remove the magnet to change the warning or “low” alarm settings.

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

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

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

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

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

4.4.5 Alarm Relay Settings

To adjust the alarm relay settings of the S4000TH, apply the magnet to the GM logo on the cover of the unit until “SE” is displayed, then remove the magnet. This puts the unit into setup mode. After a few seconds “Hi” will be displayed. Apply and remove the magnet, to change the alarm or “high” alarm settings.

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

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

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

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

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

4.4.6 Modbus Channel 1 Settings

To change the Modbus Channel 1 settings of the S4000TH, apply the magnet to the GM logo on the cover of the unit until “SE” is displayed, then remove the magnet. This puts the unit into setup mode. After a few seconds “CH1” will be displayed. Apply and remove the magnet to change the Modbus Channel 1 settings.

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

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

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

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

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

4.4.7 Modbus Channel 2 Settings

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

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

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

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

4.5 HART

This option is not shown if HART was not purchased for the S4000TH. When HART is selected via setup, the Channel 2 setup is not displayed or available. When Channel 2 is changed from HART to Modbus, the previous settings are used.

To change the HART setting of the S4000TH, apply the magnet to the GM logo on the cover of the unit until “**SE**” is displayed, then remove the magnet. This puts the unit into setup mode. After a few seconds “**Hrt**” will be displayed. Apply and remove the magnet to enter the HART setting. The current setting (Enable or Disable) will then be displayed. To change this setting, apply and remove the magnet repeatedly until the desired setting is displayed. Once it is displayed, wait three seconds and “**Fi**” will be displayed. Apply and remove the magnet to return to the next level of the setup menu. When “**Fi**” is displayed again, apply and remove the magnet to return to normal operation.

The S4000TH has a HART option. The HART option allows the user to get management information and to remotely calibrate the unit. Because HART preserves the 4-20 mA signal, it enables two-way digital communication to occur without disturbing the integrity of the analog connection. The DDL is available at the HART foundation’s website (<http://www.hartcomm2.org/index.html>). If the S4000TH is ordered with the HART option it is in the enabled state. The HART function can also be disabled and then Channel 2 can be used for Modbus.

The S4000TH HART configuration is compatible with the Emerson 375 Field Communicator and AMS Aware. <http://www.emersonprocess.com/> <http://www.emersonprocess.com/ams/>

4.6 Gas Check Mode

The sensor's response can be checked without activating external alarms by placing the S4000TH in Gas Check Mode. In this mode, the alarm relays are inhibited and the analog output is fixed at 1.5 mA. Please see section 9.3.3 for more information on the analog output values.

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

4.6.1 Procedure for Checking the Calibration

Place the magnet over the GM logo on the cover of the S4000TH. Remove the magnet when a flashing pair of bars, "--" appears on the display (about 10 seconds) (Figure 16). Apply the test gas to the sensor. The value of the gas concentration will be indicated by the flashing display and should stabilize in 1 to 2 minutes.

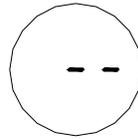


Figure 16: Gas Check

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

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

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

NOTE: The test gas concentration must be at least 10% full-scale before the unit will complete the gas check sequence. If the S4000TH is placed in the gas check mode and no gas is applied for twelve minutes, the unit will revert to a Fault condition. Re-applying the magnet over the GM logo will return the unit to normal operation.

4.7 Calibration

General Monitors recommends that the S4000TH Intelligent Sensor be calibrated 1 hour after start-up, and again 24 hours after initial start-up, and that the calibration be checked at least every 90 days to ensure system integrity of this life protecting equipment.

The above statement is not intended to discourage the customer from checking calibration more frequently. Frequent calibration checks are recommended for environments that have

problems, such as mud collecting on the sensor head, sensors accidentally being painted over, etc.

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

4.7.1 Calibration Procedure

If hydrogen sulfide (H₂S) gas is suspected to be present, it will be necessary to purge the sensor environment with clean air.

Entering Calibration Mode automatically disables the alarm circuits by sending a 1.5 mA output signal and disabling the warn and alarm relays, if present. This will also prevent activation of the remote relay contacts when using a General Monitors readout/relay display module with the Model S4000TH. Please see section 9.3.3 for more information on the analog output values.

To enter Calibration Mode, place the magnet over the GM logo on the cover of the unit (Figure 5) and hold it there until “AC” (Figure 17) appears on the display (about 10 seconds). The display will flash the remaining sensor life (Section 4.7.3) for a few seconds. Ensure that the sensor is seeing clean air during this time.

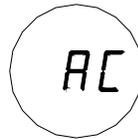


Figure 17: Automatic Calibration Mode

Apply the calibration gas concentration to the sensor (50% FS of the desired range of H₂S). The display will change from “AC” (Automatic Calibration) to “CP” (Calibration in Progress) indicating that the sensor is responding to the calibration gas (Figure 18).



Figure 18: Calibration in Progress Mode

After 3 to 5 minutes, the display will change from “CP” to “CC” indicating that the calibration is complete. (Figure 19).

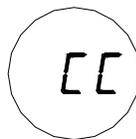


Figure 19: Calibration Complete Mode

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

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

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

4.7.2 Aborting Calibration

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

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

If the S4000TH is placed in the Calibration Mode and no gas is applied for 12 minutes, the unit reverts to a Fault (F2) condition. Re-applying the magnet over the GM logo returns the unit to operational mode with the previous calibration values unchanged.

4.7.3 Remaining Sensor Life

The S4000TH Intelligent Sensor provides an estimate of remaining sensor life, in percent remaining, to provide the user with an early warning of the need for sensor replacement. The remaining sensor life is updated each time the unit is calibrated. The current remaining sensor life estimate is displayed during the zeroing portion of a calibration sequence. It can also be read via the Modbus or HART interface (Section 8.0).

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

4.7.4 Initializing the Remaining Sensor Life

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

4.8 Calibration Equipment

4.8.1 Calibrating with a Breaker Bottle and Ampoules

General Monitors offers ampoules with breaker bottles as a method of reliably introducing calibration gas to the S4000TH. The ampoule is placed inside the breaker bottle into the breaker slot, and the breaker bottle is placed over the sensor. The ampoule should contain

50% FS of H₂S of the sensor range. Follow the calibration procedure in Section 4.7. When the display indicates “AC”, break the ampoule by turning the thumbscrew on the side of the breaker bottle clockwise. The display will change to “CP” indicating that the sensor is seeing the gas. When the display reads “CC”, the calibration is complete. Remove the breaker bottle and allow the sensor to see clean air. It will return to normal operation once the gas at the sensor is below 5% of full-scale. See Section 9.5 for available equipment.



Figure 20: Ampoules with Breaker Bottles

4.8.2 Calibrating with an H₂S Portable Purge Calibrator

An alternate method for introducing calibration or test gas to the S4000TH is available. The H₂S Portable Purge Calibrator is a compact, practical, accurate and safe system for field calibration of H₂S sensors. The bottle is filled with a hydrogen sulfide (H₂S) in air mixture and is available in seven concentrations. The temperature limitation for operation and storage is 0°F to +130°F (-18°C to +54°C).



Figure 21: Portable Purge Calibrator

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

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

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

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

4.8.3 Calibrating with an RGC

The S4000TH has an optional accessory called the Remote Gas Calibrator (RGC). It’s designed for remote or difficult to access locations. The RGC cover the sensor and allow a controlled flow of gas to it. This allows calibration in high wind conditions and can be permanently attached to the sensor. Since it is permanently attached, it is useful for remote locations. The calibrator uses a constant pressure. For calibration using the RGC refer to Section 4.7.1 and MANRGC-S4000TH.



Figure 22: Remote Gas Calibrator (RGC, P/N 80153-1)

5.0 Maintenance

5.1 General Maintenance



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

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

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

5.2 Storage

The S4000TH Intelligent Sensor should be stored in a clean, dry area and within the temperature and humidity ranges quoted in the Appendix under Environmental Specifications. Insert red dust caps into any vacant cable entry holes. See section 9.3.4.

6.0 Troubleshooting



CAUTION: Component level repair must be undertaken either by General Monitors' personnel, or by competent authorized service engineers. SMT PCB repair shall only be performed at a General Monitors' facility. Failure to comply with this requirement will invalidate the warranty.

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

6.1 Fault Codes and Their Remedies

The S4000TH has self-diagnostics incorporated into the microprocessor's program. If a fault is detected, the output signal drops to 0 mA, the fault relay de-energizes and a fault code is displayed. The output signal informs a remote display module that the S4000TH is in the Fault Mode. The display indicates a fault code that can be viewed at the sensor site. Refer to section 9.3.3 for more information on analog output values.

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

6.1.1 F2 - Failed to Complete the Calibration

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

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

6.1.2 F3 Flash Checksum Error

This fault indicates that the contents of the S4000TH's program memory have changed. This usually occurs when powering the unit up after a lightning strike or large voltage transient on the power or signal lines to the unit.

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

6.1.3 F4 - Sensor Heater Open Error or Sensor Amplifier Error

This fault indicates that either one of the remote sensor leads is open or shorted or that the sensor has drifted greater than -10% of the reading. The S4000TH has an additional protection feature. If any of the sensor wires are shorted to ground, the sensor power is turned off. After one minute the power turns back on. If the short is still present, power is quickly turned off.

ACTION - Check the integrity of all sensor connections, and ensure that the cable from the S4000TH to the remote sensor is not damaged. If all sensor leads are connected properly, attempt to re-calibrate the unit. If calibration fails, replace the sensor and re-calibrate.

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

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

6.1.4 F5 - Sensor Heater Shorted Error

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

ACTION - Check the integrity of all sensor connections and ensure that the cable from the S4000TH to the remote sensor is not damaged. If this does not correct the problem, replace the sensor and recalibrate.

NOTE: When the black lead is accidentally shorted to +24 Volts, the S4000TH delays coming out of fault to allow parts to cool down.

6.1.5 F6 - Low Supply Voltage

This fault occurs if the supply voltage at the S4000TH drops below +18.5 VDC.

ACTION - Ensure that the supply voltage is at least +20 VDC at the S4000TH.

NOTE: With long supply leads, a considerable voltage drop may occur due to the electrical resistance of the leads. The maximum cable resistance, which the S4000TH can tolerate, is dependent on the supply voltage.

6.1.6 F7 - EEPROM Verification Failure

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

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

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

6.1.7 F8 - Failure to Complete Setup

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

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

6.1.8 F9 - Gas Check Period Exceeded

If the S4000TH is left in the Gas Check Mode for more than 12 minutes with test gas applied, this fault occurs.

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

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

6.1.9 F10 – Switch Error

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

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

6.1.10 F11 Internal Error

An internal error has occurred.

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

7.0 Customer Support

7.1 General Monitors' Offices

Area	Phone/Email
UNITED STATES 26776 Simpatica Circle Lake Forest, CA 92630	Phone: +1-949-581-4464. 800-446-4872 Email: info.gm@MSAsafety.com
IRELAND Ballybrit Business Park Galway Republic of Ireland, H91 H6P2	Phone: +353-91-751175
SINGAPORE No. 2 Kallang Pudding Rd. #09-16 Mactech Building Singapore 349307	Phone: +65-6-748-3488
MIDDLE EAST PO Box 54910 Dubai Airport Free Zone United Arab Emirates	Phone: +971-4294 3640

Additional locations can be found on our web site, www.MSAsafety.com

Table 8: GM Locations

8.0 Modbus Interface

8.1 Baud Rate

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

8.2 Data Format

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

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

Table 9: Data Format

8.3 Modbus Read Status Protocol (Query/Response)

8.3.1 Modbus Read Query Message

Byte	Modbus	Range	Referenced to S4000TH
1 st	Slave Address	1-247* (Decimal)	S4000TH ID (Address)
2 nd	Function Code	03	Read Holding Registers
3 rd	Starting Address Hi**	00	Not Used by S4000TH
4 th	Starting Address Lo**	00-FF (Hex)	S4000TH Commands
5 th	No. Of Registers Hi	00	Not Used by S4000TH
6 th	No. Of Registers Lo	01	No. Of 16 Bit Registers
7 th	CRC Lo	00-FF (Hex)	CRC Lo Byte
8 th	CRC Hi	00-FF (Hex)	CRC Hi Byte

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

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

8.3.2 Modbus Read Response Message

Byte	Modbus	Range	Referenced to S4000TH
1 st	Slave Address	1-247* (Decimal)	S4000TH ID (Address)
2 nd	Function Code	03	Read Holding Registers
3 rd	Byte Count	02	No. Of Data Bytes
4 th	Data Hi	00-FF (Hex)	S4000TH Hi Byte Status Data
5 th	Data Lo	00-FF (Hex)	S4000TH Lo Byte Status Data
6 th	CRC Lo	00-FF (Hex)	CRC Lo Byte
7 th	CRC Hi	00-FF (Hex)	CRC Hi Byte

8.4 Modbus Write Command Protocol (Query/Response)

8.4.1 Modbus Write Query Message

Byte	Modbus	Range	Referenced to S4000TH
1 st	Slave Address	1-247* (Decimal)	S4000TH ID (Address)
2 nd	Function Code	06	Preset Single Register
3 rd	Register Address Hi	00	Not Used by S4000TH
4 th	Register Address Lo	00-FF (Hex)	S4000TH Commands
5 th	Preset Data Hi	00-FF (Hex)	S4000TH Hi Byte Command Data
6 th	Preset Data Lo	00-FF (Hex)	S4000TH Lo Byte Command Data
7 th	CRC Lo	00-FF (Hex)	CRC Lo Byte
8 th	CRC Hi	00-FF (Hex)	CRC Hi Byte

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

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

8.4.2 Modbus Write Response Message

Byte	Modbus	Range	Referenced to S4000TH
1 st	Slave Address	1-247* (Decimal)	S4000TH ID (Address)
2 nd	Function Code	06	Preset Single Register
3 rd	Register Address Hi	00	Not Used by S4000TH
4 th	Register Address Lo	00-FF (Hex)	S4000TH Commands
5 th	Preset Data Hi	00-FF (Hex)	S4000TH Hi Byte Command Data
6 th	Preset Data Lo	00-FF (Hex)	S4000TH Lo Byte Command Data
7 th	CRC Lo	00-FF (Hex)	CRC Lo Byte
8 th	CRC Hi	00-FF (Hex)	CRC Hi Byte

8.5 Function Codes Supported

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

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

8.6 Exception Responses and Exception Codes

8.6.1 Exception Response

In a normal communications query and response, the master device sends a query to the S4000TH and the S4000TH receives the query without a communications error and handles the query normally within the master device's allowable timeout. The S4000TH then returns a normal response to the master. An abnormal communications produces one of four possible events:

- If the S4000TH does not receive the query due to a communications error, then no response is returned from the S4000TH and the master device eventually processes a timeout condition for the query.
- If the S4000TH receives the query, but detects a communication error (CRC, etc.), then no response is returned from the S4000TH and the master device eventually processes a timeout condition for the query.

- If the S4000TH receives the query without a communications error, but cannot process the response to the master within the master’s timeout setting, then no response is returned from the S4000TH. The master device eventually processes a timeout condition for the query. In order to prevent this condition from occurring, the maximum response time for the S4000TH is 200 milliseconds. Therefore, the master’s timeout setting should be set to 200 milliseconds or greater.
- If the S4000TH receives the query without a communications error, but cannot process it due to reading or writing to a non-existent S4000TH command register, then the S4000TH returns an exception response message informing the master of the error.

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

Byte	Modbus	Range	Referenced to S4000TH
1 st	Slave Address	1-247* (Decimal)	S4000TH ID (Address)
2 nd	Function Code	83 or 86 (Hex)	MSB is set with Function Code
3 rd	Exception Code	01 - 06 (Hex)	Appropriate Exception Code (See Below)
4 th	CRC Lo	00-FF (Hex)	CRC Lo Byte
5 th	CRC Hi	00-FF (Hex)	CRC Hi Byte

8.6.2 Exception Code

Exception Code Field: In a normal response, the S4000TH returns data and status in the data field, which was requested in the query from the master. In an exception response, the S4000TH returns an exception code in the data field, which describes the S4000TH condition that caused the exception. Below is a list of exception codes that are supported by the S4000TH:

Code	Name	Description
01	Illegal Function	The function code received in the query is not an allowable action for the S4000TH
02	Illegal Data Address	The data address received in the query is not an allowable address for the S4000TH.
03	Illegal Data Value	A value contained in the query data field is not an allowable value for the S4000TH.
04	Slave Device Failure	An unrecoverable error occurred while the S4000TH was attempting to perform the requested action.
05	Acknowledge	The S4000TH has accepted the request and is processing it, but a long duration of time will be required to do so. This response is returned to prevent a timeout error from occurring in the master.
06	Device Busy	The S4000TH is engaged in processing a long-duration program command. The master should retransmit the message later when the slave is free.

Table 10: Exception Codes

8.7 S4000TH Command Register Locations

Parameter	Function	Type	Scale	Access	Register Address	Master I/O Address
Analog	0-20 mA Current Output	Value	16-Bit	R	0000	40001
Mode	Indicates and Controls Mode	Bit		R/W	0001	40002
Status/Error	Indicates Errors		Bit	R	0002	40003
Not Used	N/A				0003	40004
Unit Type	Identifies the S4000TH in Decimal	Value	16-Bit	R	0004	40005
Software Rev	Indicates the Software Revision	ASCII	2-Char	R	0005	40006
Status Block	Returns Analog, Mode, Status, Error, and Sensor Life Returns Address 6,7,8	Multi	6-bytes	R	0006	40007
Analog	Analog 2	Value		R	0006	40007
Mode	Mode	Bit		R	0006	40007
Error 2	Error 2	Bit		R	0007	40008
Error 1	Error 1	Bit		R	0007	40008
Sensor Life	Sensor Life	Value		R	0008	40009
Display	Display (LED & MSD)	Bit /ASCII		R	0009	40010
Display	Display (Mid & LSD)	ASCII		R	000A	40011
Serial Number	Upper serial number	Value		R	000B	40012
Serial Number	Lower serial number	32 bit		R	000C	40013
Alarm Settings	Read or change settings for the high alarm	Bit	(0-15)	R/W	000D	40014
Warn Settings	Read or change settings for the low alarm	Bit	(0-15)	R/W	000E	40015
Com1 Addr.	Read or change settings for the Com1 Address	Value	8-Bit	R/W	000F	40016
Com1 Baud	Read or change settings for the Com1 Baud Rate	Bit	(0-7)	R/W	0010	40017
Com1 Data Format	Read or change settings for the Com1 Data Format	Bit	(0-7)	R/W	0011	40018
Com2 Addr.	Read or change settings for the Com2 Address	Value	8-Bit	R/W	0012	40019
Com2 Baud	Read or change settings for the Com2 Baud Rate	Bit	(0-7)	R/W	0013	40020
Com2 Data Format	Read or change settings for the Com2 Data Format	Bit	(0-7)	R/W	0014	40021
Not Used	N/A				0015	40022
Reset Alarms	Reset any latched alarms	Bit	(0)	W	0016	40023
Sensor Life	Read the Remaining Sensor Life	Bit	(0)	R	0017	40024
Sensor Scale	Change the Scale for the H ₂ S sensors on the S4000TH	Value	8-Bit	R/W	0018	40025
Hazard Watch (Co)	Indicates Calibration Success	Value	8-Bit	R/W	0019	40026
Not Used					001A	40027
Not Used					001B	40028

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

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

Table 11: Command Register Locations

8.8 S4000TH Command Register Details

8.8.1 Analog (00H)

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

8.8.2 Mode (01H)

A read returns the present mode of the S4000TH.

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

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

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

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

8.8.3 Status/Error (02H)

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

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

8.8.4 Not Used (03H)

8.8.5 Unit Type (04H)

A read returns the decimal value 4005. This identifies the S4000TH.

8.8.6 Software Revision (05H)

A read returns the software revision of the S4000TH in 2 ASCII characters.

8.8.7 Status Block (06H)

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

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

8.8.8 Analog Value (06H)

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

8.8.9 Mode & Error (07H)

See mode (02)

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

8.8.10 Error Sensor & Sensor Life (08H)

8.8.10.1 Upper Bit for Sensor Errors

Setup error	80
Cal Check error	40
EEPROM Check sum error	20
Flash Check sum	10
Sensor	08
Calibration error	04
Low supply	02
NA	01

8.8.10.2 Lower Bit for Sensor Life

Sensor Life	0-100%
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8.8.11 Display (0x09H & 0x0AH)

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

digit (MID) and the least significant digit (LSD) in ASCII. The upper word represents the MID and the lower word represents the LSD.

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

8.8.12 Serial Number (0BH/0CH)

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

8.8.13 Alarm Settings (0DH)

A read returns the present alarm settings of the S4000TH. A write command changes the settings to the requested values. The set points are programmable in 5% FS steps (1% FS steps for 20 ppm range).

NOTE: The maximum alarm setting for the S4000TH is 60% FS..

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

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

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

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

8.8.14 Warn Settings (0EH)

A read returns the present warn settings of the S4000TH. A write command changes the settings to the requested values. The set points are programmable in 5% FS steps (1% FS steps for 20 ppm range).

NOTE: The maximum alarm setting for the S4000TH is 60% FS.

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

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

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

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

8.8.15 Com1 Address (0FH)

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

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

8.8.16 Com1 Baud Rate (10H)

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

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

Table 12: Com1 Baud Rate

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

8.8.17 Com1 Data Format (11H)

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

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

Table 13: Com1 Data Format

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

8.8.18 Com2 Address (12H)

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

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

8.8.19 Com2 Baud Rate (13H)

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

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

Table 14: Com2 Baud Rate

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

8.8.20 Com2 Data Format (14H)

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

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

Table 15: Com2 Data Format

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

8.8.21 Not Used (15H)

8.8.22 Reset Alarms (16H)

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

8.8.23 Sensor Life (17H)

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

8.8.24 Sensor Scale (18H)

A read returns the current H₂S sensor scale selected: 0-20 ppm, 0-50 ppm, 0-100 ppm. A write changes the scale to the desired scale. If the scale is changed, a calibration fault is generated, forcing the operator to calibrate the unit.

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

Table 16: Sensor Scale

8.8.25 HazardWatch (Co – Calibration Output) (19H)

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

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

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

8.9 HART Enable (1D H)

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

8.9.1 HART Test (1Eh)

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

Code	Results
0	Normal
1	Constant ones
2	Constant zeros

8.9.2 Abort Calibration (1Fh)

Sending a “1” causes a calibration or calibration abort.

8.9.3 Total Receive Errors (20H)

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

8.9.4 Bus Activity Rate % (21H)

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

8.9.5 Function Code Errors (22H)

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

8.9.6 Starting Address Errors (24H)

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

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

8.9.7 RXD CRC Errors Hi (25H)

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

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

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

8.9.9 Parity Errors (27H)

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

8.9.10 Overrun Errors (28H)

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

8.9.11 Framing Errors (29H)

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

8.9.12 Total Software CH1 Errors (2AH)

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

8.9.13 Not Used (2BH)

8.9.14 Clear Hardware Errors (2CH)

Clear parity, framing, and overrun errors.

8.9.15 Clear Communication Errors (2DH)

8.9.15.1 HART Low Current Select (2EH)

Normally in HART mode the low current does not decrease below 3.5 mA. If use of current levels below 3.5mA is required by an application, the S4000TH features an expanded scale that permits faults to be set as low as 1.25 mA. A read returns “1” or “0.”

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

8.9.15.2 Internal Use (2FH)

8.9.15.3 Event Logging (30H to 5FH)

Faults

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

Warning

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

Alarm

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

Calibration

The time a successful zero and calibration occurs is saved in the event log. A counter is increment for each successful calibration. If the unit fails to zero or calibrate, the event is not recorded. If the calibration is aborted the event is also not recorded. Note the zero and calibration are one operation in the S4000TH. There are a total of ten event time stamps stored.

Maintenance

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

Setting structure clock

See table below.

Event Logging Registry Table

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

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

50	Seconds Time Low	lamp test event log entries	Numeric value	0 – 65535	Maintenance
51	Structure time Hi	Hi byte – year, low byte – month for lamp test event log entries	Numeric value	0 – 65535	Maintenance
52	Structure time Mid	Hi byte – day, low byte – hour lamp test event log entries	Numeric value	0 – 65535	Maintenance
53	Structure time Low	Hi byte – min, low byte – sec for lamp test event log entries	Numeric value	0 – 65535	Maintenance
54	Maintenance code	Cal check	Numeric value	0	Maintenance
55	Reserved	Reserved	Numeric value	0	
56	Maintenance Count	Maintenance Count	Numeric value	0 – 65535	Maintenance
57	Calibrate Seconds Time Hi	Seconds Time Hi for lamp test event log entries	Numeric value	0 – 65535	Calibrate
58	Seconds Time Low	Seconds Time Low for lamp test event log entries	Numeric value	0 – 65535	Calibrate
59	Structure time Hi	Hi byte – year, low byte – month for lamp test event log entries	Numeric value	0 – 65535	Calibrate
5A	Structure time Mid	Hi byte – day, low byte – hour lamp test event log entries	Numeric value	0 – 65535	Calibrate
5B	Structure time Low	Hi byte – min, low byte – sec for lamp test event log entries	Numeric value	0 – 65535	Calibrate
5C	Calibrate code	Cal	Numeric value	0	Calibrate
5D	Reserved	Reserved	Numeric value	0	
5E	Calibrate Count	Calibrate Count	Numeric value	0 – 65535	Calibrate
5F	Reset Event Counters	Reset Event Counters	Numeric value	1	Reset

8.9.16 User Information (60H to 6FH)

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

8.9.17 CH2 Total Receive Errors (70H)

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

8.9.18 CH2 Bus Activity Rate % (71H)

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

8.9.19 CH2 Function Code Errors (72H)

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

8.9.20 CH2 Starting Address Errors (73H)

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

8.9.21 CH2 Number of Register Errors (74H)

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

8.9.22 CH2 RXD CRC Errors Hi (75H)

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

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

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

8.9.24 CH2 Parity Errors (77H)

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

8.9.25 CH2 Overrun Errors (78H)

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

8.9.26 CH2 Framing Errors (79H)

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

8.9.27 CH2 Total Software CH1 Errors (7AH)

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

8.9.28 Not Used (7BH)

8.9.29 CH2 Clear UART Errors (7CH)

8.9.30 CH2 Clear Stats (7DH)

9.0 Appendix

9.1 Warranty

General Monitors warrants the S4000TH to be free from defects in workmanship or material under normal use and service within two years from the date of shipment.

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

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

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

Except for the express warranty stated above, General Monitors disclaims all warranties with regard to the products sold, including all implied warranties of merchantability and fitness and the express warranties stated herein are in lieu of all obligations or liabilities on the part of General Monitors for damages including, but not limited to, consequential damages arising out of, or in connection with, the performance of the product.

9.2 Principle of Operation

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

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

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

9.3 Specifications

9.3.1 System Specifications

Sensor Type:	Continuous diffusion, adsorption type metal oxide semiconductor (MOS)
Sensor Life:	3 to 5 years typical
Repeatability:	± 2 ppm or 10% of the applied gas, whichever is greater
Long Term Drift:	± 2 ppm or 10% of reading, whichever value provides the wider tolerance (as defined per ISA-92.0.01)
Response Time (Typical):	$T_{50} < 14$ seconds (screen); $T_{50} < 30$ seconds (sintered) with full scale gas applied according to ISA 92.0.01
Measuring Ranges:	0-20 ppm, 0-50 ppm, 0-100 ppm
Modes:	Calibration, gas check, setup
Approvals:	CSA/FM: Class I, Division 1, Groups B, C, D T6; $T_{amb} = -40^{\circ}\text{C}$ to $+60^{\circ}\text{C}$ (FM); -40°C to $+75^{\circ}\text{C}$ (CSA) CSA: Ex db IIB + H ₂ T4 Gb ($T_{amb} = -40^{\circ}\text{C}$ to $+70^{\circ}\text{C}$) Ex tb IIIC T135°C Db ATEX/IECEX: II 2 GD Ex db IIB+H ₂ T4 Gb, Ex tb IIIC T135°C Db ($T_{amb} = -40^{\circ}\text{C}$ to $+70^{\circ}\text{C}$)
Warranty:	Two years

9.3.2 Mechanical Specifications

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

9.3.3 Electrical Specifications

Input Power:	24 VDC nominal, 20 to 36 VDC, 350 mA max.
Power Consumption	Start-up 270 mA, Normal Operation 120 mA
Relay Ratings:	8 A @ 250 VAC / 8 A @ 30 VDC resistive max. (3x) SPDT - Warning, Alarm & Fault

Analog Signal:

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

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

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

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

HART: RX 100K CX 5nF

Cable Requirements: 3-wire shielded cable. Maximum distance between S4000TH and power source @ 24 VDC nominal with warn & alarm relay energized. If no relays are used the distance can be increased by 10%.

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

Table 17: 24 VDC Cable Lengths

Based on 20 Ohm cable resistance the recommended analog output cable length is shown in Table 18. The total resistance should not exceed 600 Ohms @ 24 Volts.

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

Table 18: Analog Output Cable Lengths

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

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

Table 19: Sensor Cable Lengths

9.3.4 Environmental Specifications

Operating Temperature Range	CSA	FM	ATEX/IECEX
Electronics	Division Classification -40°F to 167°F (-40°C to 75°C) Zone Classification -40°F to 158°F (-40°C to 70°C)	-40°F to 140°F (-40°C to 60°C)	-40°F to 158°F (-40°C to 70°C)
Storage Temperature Range	-58°F to 185°F (-50°C to +85°C)		
Operating Humidity Range	0% to 95% RH, non-condensing		

9.4 Approvals

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

HART:

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

9.5 Spare Parts and Accessories

To order spare parts and/or accessories, please contact the nearest General Monitors representative or, General Monitors directly, and give the following information:

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

9.5.1 Sensors

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

9.5.2 Sensor Housing

10252-1	Universal Housing
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9.5.3 Sensor Accessories

10041-1 Duct Mounting Plate

9.5.4 Calibration Equipment

50000 Breaker Bottle, Single

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

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

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

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

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

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

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

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

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

1400250-1 10 ppm H₂S Portable Purge Calibration Assembly

1400250-3 25 ppm H₂S Portable Purge Calibration Assembly

1400250-5 50 ppm H₂S Portable Purge Calibration Assembly

1400255-1 10 ppm H₂S Replacement Cylinder

1400255-3 25 ppm H₂S Replacement Cylinder

1400255-5 50 ppm H₂S Replacement Cylinder

80153-1 Remote Gas Calibrator (RGC)

Case for Portable Purge Assembly

922-016 Replacement Regulator (0.2 L/min)

Replacement Hose

960-345 Hose Clamp, 5/16"

960-346 Hose Clamp, 1/4"

1400152-1 Calibration Cup

9.5.5 Intelligent Sensor (S4000TH) Replacement Parts

32471-1,-2,-3,-4 Control Board Electronics

32451-1,-2 Output Board Electronics

32441-1 Display Board Electronics

32424-2 Enclosure Cover Assembly with Window

31195-2 Enclosure Base Assembly

30060-1 Calibration Magnet

925-5007 Cover Assembly O-Ring

9.5.6 Recommended Spare Parts for One Year

30060-1 Extra Calibration Magnet (Qty. 1)

9.6 FM Approval

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

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

The following sensors have been FMRC approved for use with the Model S4000TH:

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

The following apparatus have been FMRC approved (although they have not been verified as part of a Model S4000TH system):

- Model DT210 Eight-Channel Readout/Relay Display Module with Power Supply and Relay Module



ADDENDUM
Product Disposal Considerations

This product may contain hazardous and/or toxic substances.

EU Member states shall dispose according to WEEE regulations. For further General Monitors' product WEEE disposal information please visit: www.MSAafety.com

All other countries or states: please dispose of in accordance with existing federal, state and local environmental control regulations.