



**GENERAL MONITORS**

# **SAFETY MANUAL**

## **Intelligent Sensors for H<sub>2</sub>S Gas Applications**



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

**Safety Manual**

**04-09**

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

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

**MANH2SSAFETY**  
**A/04-09**

This manual describes the safety related information for the installation, operation, configuration, and maintenance of the following field devices:

- S4000TH Intelligent Sensor with HART Communication for H<sub>2</sub>S Gas Detection
- S4000T Intelligent Sensor for H<sub>2</sub>S Gas Detection
- S4100T Intelligent Sensor for H<sub>2</sub>S Gas Detection for European Applications

For complete information regarding performance, installation, operation, maintenance and specifications of the above products, please refer to the associated product manual.

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.

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



**WARNING:** TOXIC, COMBUSTIBLE, AND FLAMMABLE GASES AND VAPORS ARE VERY DANGEROUS. USE EXTREME CAUTION WHEN THESE HAZARDS ARE PRESENT.

## INTRODUCTION

### General Description

The Models S4000TH, S4000T, and S4100T Intelligent Sensors for H<sub>2</sub>S gas detection are microprocessor-based transmitters designed for use with General Monitors' metal oxide semiconductor (MOS) sensors. They provide a 4-20 mA signal which is proportional to 0 to 100% of the detection range at the H<sub>2</sub>S sensor. Optional Warn and Alarm relays can be programmed to trip when gas concentrations reach a percentage of the sensor range. All detectors are regarded as Type B field devices per IEC 61508. The S4000TH, S4000T, and S4100T can each connect to Safety Integrity Level (SIL) suitable TA202A Trip Amplifiers and DT210 Eight-Channel Readout/Relay Modules.

The safety function of the S4000TH detector does not include:

- HART communication
- RS-485 Modbus communication

The safety function of the S4000T and S4100T detectors do not include:

- RS-485 Modbus communication

HART and Modbus communication are typically used for field device setup, diagnostics, and troubleshooting. Be sure to observe requirements for interfacing in hazardous locations. HART and Modbus communication are non-interfering functions and do not interrupt the safety critical function of the detectors.

## INSTALLATION

---

**NOTE:** Power should remain disconnected until all other wiring connections are made.

---

For complete installation information for the S4000TH, S4000T, and S4100T, refer to the product instruction manual for each of these field devices.

### Detector Location Considerations

There are no standard rules for detector placement, since the optimum detector location varies with the application. The customer must evaluate conditions at the facility to make this determination. To the greatest extent possible, the Models S4000TH, S4000T, and S4100T detectors should be installed in a manner that provides accessibility to conduct occasional calibration checks.

The sensors used in the Models S4000TH, S4000T, and S4100T should be mounted pointing down to prevent water build-up on the sensor head. Furthermore, the sensor should not be placed where contaminating substances may coat it or where excessive vibration is possible.

Although the S4000TH, S4000T, and S4100T are Radio Frequency Interference (RFI) resistant, the units should not be mounted close to radio transmitters, high magnetic or electrical fields, or in areas with similar interference.

Locate the S4000TH, S4000T, and S4100T where prevailing air currents contain the maximum concentration of gas. Also, locate the detectors as near as possible to the likely source of a gas leak. Observe the temperature range of the field device and locate the unit away from concentrated sources of heat. Do not locate the intelligent sensors in areas that exceed the maximum operating temperature of the unit, such as locations with gas turbine exhaust.

No special or additional mounting, wiring, power, or tool requirements exist beyond the standard installation practices documented in the product instruction manuals for the S4000TH, S4000T, and S4100T.

Sensors may be adversely affected by prolonged exposure to certain materials. Loss of sensitivity or corrosion may be gradual if such materials 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 poisons and contaminants in an area does not necessarily preclude the use of an S4000TH, S4000T, and S4100T 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 two-year warranty would not apply.



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

## OPERATION, CONFIGURATION AND MAINTENANCE

For complete information on the operation, configuration, and maintenance of the S4000TH, S4000T, and S4100T, refer to the product instruction manual for each field device.

General Monitors recommends that the S4000TH, S4000T, and S4100T be calibrated one hour after start-up and again 24 hours after initial start-up, and that the calibration be checked every ninety (90) days to ensure system integrity. More frequent calibration checks are recommended for environments that have a greater likelihood of mud collecting on the sensor head, sensors accidentally being painted over, or other conditions that may adversely impact the sensor.

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.

The S4000TH, S4000T, and S4100T are intelligent sensors performing internal diagnostics on critical faults every second and respond with 0 mA at the Analog Output upon detection of a fault. In addition, depending on configuration, the S4000TH may also respond with a fault signal of 1.25 mA or 3.5 mA at the Analog Output.

Refer to the Troubleshooting Section in the appropriate product instruction manual in the event of a calibration or operational fault. Spare parts should be on-hand as described in the Spare Parts Section of the product instruction manual.

---

**NOTE:** Entering Gas Check or Calibration mode sends a 1.5 mA output signal and disables the Warning and Alarm relay circuits. The S4100T output for these modes is selectable (0 mA, 1.5 mA, or 2 mA) with 1.5 mA as the default.

---



**WARNING:** Disconnect or inhibit external devices such as Trip Amplifiers, Programmable Logic Controllers (PLC), or Distributed Control Systems (DCS) before performing any maintenance.

## SPECIFICATIONS

Table 1 and Table 2 list specifications for the S4000TH, S4000T, and S4100T. For a complete list of specifications, refer to the instruction manual of each respective model.

	S4000TH	S4000T	S4100T
Instruction Manual P/N	MANS4000TH	MANS4000T	MANS4100T-EU
Temp. Range (Electronics)*			
Operating:	CSA/FM: -40°F to 167°F (-40°C to +75°C) ATEX: -40°F to 158°F (-40°C to +70°C)	-40°F to 167°F (-40°C to +75°C)	-50°C to +70°C
Storage:	-58°F to 185°F (-50°C to +85°C)	-58°F to 185°F (-50°C to +85°C)	-50°C to +70°C
Humidity Range:	5% to 100% RH, non-condensing	5% to 100% RH, non-condensing	5% to 100% RH, non-condensing
Atmosphere:	Will not operate in <5% oxygen	Will not operate in <5% oxygen	Will not operate in <5% oxygen
Input Power:			
Absolute min:	20 VDC	20 VDC	18.5 VDC
Nominal:	24 VDC	24 VDC	
Absolute max:	36 VDC	36 VDC	35 VDC

**Table 1 – Environmental/Electrical Specifications**

\* For operating temperature range of sensors see instruction manual.

Mode	S4000TH HART Disabled	S4000TH HART Enabled	S4000T	S4100T
Fault	0 mA	3.5 mA/ 1.25 mA**	0 mA	0 mA
Calibration, Gas Check, Setup Mode	1.5 mA	3.5 mA/ 1.5 mA**	1.5 mA	0 mA, 1.5 mA***, or 2 mA
0 – 100 % LEL	4 – 20 mA	4 – 20 mA	4 – 20 mA	4 – 20 mA
Over range	20-22 mA	20 – 21.7 mA	20 – 22 mA	20.1 – 22 mA

**Table 2 – Analog Output Specifications\***

\* See product instruction manual for analog output signal load resistance specification.

\*\* S4000TH HART Enabled units may have Analog Output modified to output 3.5 mA or 1.25mA for a malfunction and 3.5 mA or 1.5 mA for calibration, gas check and setup modes. The default is 3.5mA.

\*\*\* User selectable on the S4100T for these modes. Default is 1.5 mA.

## CERTIFICATIONS AND FAILURE RATE DATA

The S4000TH, S4000T, and S4100T field devices have gone through rigorous reliability and functional safety assessments, which have resulted in each of these products being certified to IEC 61508 Parts 1, 2, and 3, by FM Approvals. The reliability assessment is a failure rate prediction that assumes an average temperature of 40°C and an environmental factor equivalent to Ground Fixed. It is assumed that the field devices will be installed in a Safety Instrumented System (SIS) operating in a Low Demand environment per IEC 61508. The tables below list the SIL parameters for each field device.

	<b>S4000TH (4-20 mA Output)</b>	<b>S4000TH (Relay Output)</b>	<b>S4000T (4-20 mA Output)</b>
FM Certificate	3034949-S4000TH	3034949-S4000TH	3034949-S4000T
Product Life (Years)*	22	22	23
$\lambda_{DD}$ (Fails per hour)	1.74E-5	1.76E-5	1.7E-5
$\lambda_{DU}$ (Fails per hour)	8.83E-8	3.26E-7	1.2E-7
Safe Failure Fraction (SFF)	>99%	98%	>99%
Safety Integrity Level (SIL)**	3	2	3
Diagnostic Test Interval	1 sec	1 sec	1 sec
Response Time (with full scale gas applied)	<u>Screen</u> $T_{50} < 1$ minute <u>Sintered</u> $T_{50} < 2$ minutes	<u>Screen</u> $T_{50} < 1$ minute <u>Sintered</u> $T_{50} < 2$ minutes	<u>Screen</u> $T_{50} < 1$ minute <u>Sintered</u> $T_{50} < 2$ minutes
Average Probability of Failure on Demand $PFD_{avg} 1001$ ***	1.65E-4	4.2E-4	1.98E-4

**Table 3A – SIL Parameters for S4000TH and S4000T (Clean Environment)**

\* MOS sensor life is typically 3-5 years.

\*\* Hardware Fault Tolerance (HFT) = 0

\*\*\*  $PFD_{avg} 1001$  assumes a 4 hour repair time and 90 day proof test interval.

	<b>S4000TH (4-20 mA Output)</b>	<b>S4000TH (Relay Output)</b>	<b>S4000T (4-20 mA Output)</b>
FM Certificate	3034949-S4000TH	3034949-S4000TH	3034949-S4000T
Product Life (Years)*	22	22	23
$\lambda_{DD}$ (Fails per hour)	2.5E-5	2.5E-5	2.45E-5
$\lambda_{DU}$ (Fails per hour)	2.7E-6	2.9E-6	2.7E-6
Safe Failure Fraction (SFF)	91%	90%	91%
Safety Integrity Level (SIL)**	2	2	2
Diagnostic Test Interval	1 sec	1 sec	1 sec
Response Time (with full scale gas applied)	<u>Screen</u> $T_{50} < 1$ minute <u>Sintered</u> $T_{50} < 2$ minutes	<u>Screen</u> $T_{50} < 1$ minute <u>Sintered</u> $T_{50} < 2$ minutes	<u>Screen</u> $T_{50} < 1$ minute <u>Sintered</u> $T_{50} < 2$ minutes
Average Probability of Failure on Demand $PFD_{avg} 1001^{***}$	3E-3	3.3E-3	3E-3

**Table 3B – SIL Parameters for S4000TH and S4000T (Contaminated Environment)**

\* MOS sensor life is typically 3-5 years

\*\* Hardware Fault Tolerance (HFT) = 0

\*\*\*  $PFD_{avg} 1001$  assumes a 4 hour repair time and 90 day proof test interval.

<b>S4100T (4-20 mA Output)</b>	<b>Clean Environment</b>	<b>Contaminated Environment</b>
FM Certificate	3034949-S4100T	3034949-S4100T
Product Life (Years)*	23	21
$\lambda_{DD}$ (Fails per hour)	1.1E-5	1.63E-5
$\lambda_{DU}$ (Fails per hour)	3.34E-8	1.83E-6
Safe Failure Fraction (SFF)	>99%	92%
Safety Integrity Level (SIL)**	3	2
Diagnostic Test Interval	1 sec	1 sec
Response Time (with full scale gas applied)	<u>Sintered</u> $T_{50} < 2$ minutes	<u>Sintered</u> $T_{50} < 2$ minutes
Average Probability of Failure on Demand $PFD_{avg} 1001^{**}$	3E-4	2.4E-3

**Table 4 – SIL Parameters for S4100T**

\* MOS sensor life is typically 3-5 years.

\*\* Hardware Fault Tolerance (HFT) = 0

\*\*\*  $PFD_{avg} 1001$  assumes a 24 hour repair time and 90 day proof test interval.

### Agency Approvals

The S4000TH, S4000T, and S4100T have the following approvals:

<b>S4000TH</b>	<b>S4000T</b>	<b>S4100T</b>
CSA	CSA	ATEX
FM Approvals	FM Approvals	BV Approval Pending
ATEX	ATEX	Approved for Russia
HART Registered	Approved for Russia	Approved for Kazakhstan
Approval for Russia Pending	IEC 61508 per FM Approvals	IEC 61508 per FM Approvals
IEC 61508 per FM Approvals		

**Table 5 – Approvals**