

SAFETY MANUAL

SIL 2 Certified Model TP-700 H2S Gas Sensor

Version 6.0

1 SAFETY CERTIFIED MODEL TP-700 H2S GAS DETECTOR

This manual addresses the specific requirements and recommendations applicable to the proper installation, operation, and maintenance of all Safety-Certified (SIL-Certified). For complete information regarding performance, installation, operation, maintenance and specifications of the Model TP-700, refer to Instruction Manual Document #3150.

2 SAFETY MESSAGES

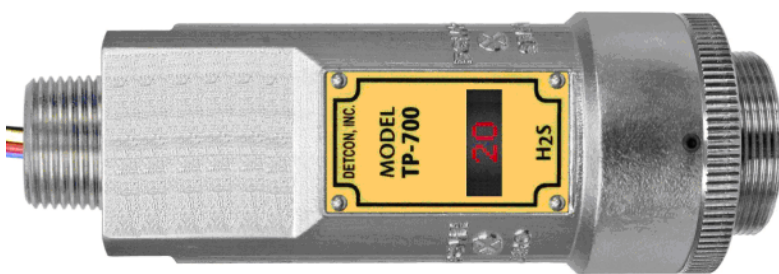
Procedures and instructions in this section may require special precautions to ensure the safety of personnel performing the operations. Information that raises potential safety issues is indicated by the word “Warning.” Always read and understand these safety messages.

Warning:

The TP-700 Gas Detector is intended for use in hazardous environments that may include dangerous levels of toxic H2S gas vapors. This product must be properly installed, operated, and maintained. Improper installation or use could result in death or serious injury.

Do not remove the XP Junction box cover and/or do not remove the sensor bottom housing (required to change out the plugin MOS H2S sensor) in explosive environments when device power is on and circuits are live.

Detector must be properly installed, and XP junction box cover and sensor bottom housing must be fully engaged to meet hazardous area explosion-proof / non-incendive requirements.



3 DESIGN

The Model TP-700 is a mixed metal oxide semiconductor type H2S gas detector that is classified as Type B smart device according to IEC61508. The TP-700 sensor provides a 4-20 mA output that is proportional to H2S vapor concentrations in the ranges of 0-20 ppm, 0-50 ppm, 0-100 ppm, and 0-200 ppm. The TP-700 contains extensive self-diagnostics and is programmed to send the current output to a specified failure state (0 mA) upon internal detection of a failure. A Modbus RS-485 serial output is available in addition to the analog signal output. The Safety Certification for the TP-700 Gas Detector only covers the use of the standard analog 4-20 mA output.

Safety-Certification of the TP-700 includes

The 4-20 mA output

The RS-485 Modbus signal output is **NOT** part of the SIL Certification.

Note: Proper analog signal loop resistance must be installed as documented in the instruction manual to enable proper 4-20 mA signal function. The end user must perform span calibration after any significant configuration changes or repair events. These events include: restore defaults, change of range, replacing plugin MOS H2S sensor, and replacing ITM module.

3.1 Accessories

The TP-700 may be used with the optional HRT Bridge Module, which interfaces with a 700 Series detector to provide HART® (Highway Addressable Remote Transducer) Communication Protocol as well as an analog 4-20 mA output. For complete information regarding performance, installation, operation, maintenance and specifications of the HRT Bridge Module, refer to Instruction Manual Document #3150.

The HRT Bridge is classified as a Type A element, having HFT (Hardware Fault Tolerance) = 0. While the HRT Bridge meets the hardware architectural constraints for up to SIL 2 as a single device, the application-specific restrictions must be met (see Section 8, Constraints) and the HRT Bridge specific failure rates must be considered in any SIL calculations.

4 VALID INPUT RANGE

TP-700 fault annunciation is provided on the 4-20 mA signal output loop by signaling to 0 mA current output level for at least 5 seconds. The receiving device must be programmed to indicate an over-range condition when current levels reach overcurrent (>21 mA) or undercurrent (0 mA).

Note: The TP-700 analog signal output is not safety-rated during detector warm-up, configuration mode, calibration mode, and during signal output loop testing. Alternative means should be used at the jobsite to ensure facility safety during these activities.

5 DIAGNOSTIC RESPONSE TIME

The TP-700 will perform all critical diagnostic functions within 1 hour. This is the worst case diagnostic detection time.

6 CERTIFICATION

The TP-700 Safety-Certified version is certified by exida® to IEC 61508 for single input use in low and high demand, SIL 2 Safety Instrumented Systems. The TP-700 sensor is SIL2 certified as an individual component, but it can be used as part of a larger Safety Instrumented Systems, as long as it is applied per the guidelines of this Safety Manual.

The TP-700 is SIL2 certified per IEC 61508-2010 with an HFT=0.

The revision levels of this SIL 2 certified TP-700 sensor is noted as Main PCB Rev 1, Amplifier PCB Rev 5, and Firmware V5.14N.

7 SAFETY – CERTIFIED PRODUCT IDENTIFICATION

The model number printed on the label will include the character “S” in the model number string, indicating exida® approval for SIL 2 standard. Example: Model TP-700 S.

8 CONSTRAINTS

The safety function of the Detcon Model TP-700 Hydrogen Sulfide Gas Sensor is limited by the following constraints:

- Shall not be used in continuous mode applications
- The maximum load on the 4-20 mA output of the TP-700 is 1 K Ω with 24 VDC input power and 500 Ω with 12 VDC input power
- Shall be span calibrated every 90 days using a calibrated gas standard and humidifier tubing. After calibration, the sensor shall be proof tested by applying the calibration gas and checking for the proper response of the 4-20 mA output.
- After the TP-700 has been off power for more than 24 hours, it shall be allowed a 24 hour start-up period before performing its safety function
- When the TP-700 detects a fault condition it will drive the output to 0 mA for at least 5 seconds. Any PLC, DCS, or other control system used to monitor the TP-700 shall indicate a fault when the output from the sensor drops below 1.3 mA for more than 4 seconds
- Any PLC, DCS, or other control system used to monitor the TP-700 shall indicate that the sensor is in calibration mode when the output is greater the 1.3 mA, but less than 3 mA. When in calibration mode, the TP-700 cannot perform its safety function.
- Any PLC, DCS, or other control system used to monitor the TP-700 shall indicate an over-range condition when the output from the sensor is above 21 mA. When the TP-700 is over-range, the actual gas concentration may be higher than what is being reported by the 4-20 mA output.
- The sensor shall not be installed in applications where it will be exposed to known poisons. The poisons include (but are not limited to):
 - o Silicone vapors such as those found in greases and lubricants
 - o Halide compounds containing chlorine, chlorine dioxide, fluorine, HF, HCl, and bromine
 - o Caustic and acidic liquids and concentrated vapors
 - o Heavy metals such as tetraethyl lead
- At least 10% O₂ in the background gas is required for the TP-700 to operate correctly. The reading is affected by changing O₂ levels.
- Shall be operated with an input power of 11 VDC – 30 VDC
- Shall be installed oriented vertically and mounted more than 1 foot above the ground
- If the TP-700 is powered down for long periods of time, it the sensor cell shall be protected with a desiccant pouch and sealing cap
- Shall not be operated, stored, or transported outside the temperature range of -40° C to 75° C
- The TP-700 enclosure and connected cabling shall be properly grounded and shielded
- The Modbus interface shall not be connected when the TP-700 is used in SIL2 applications
- The magnetic switches on the TP-700 shall not be used while the TP-700 is performing its safety function
- The user shall validate the initial configuration and any subsequent configuration changes of the TP-700 before using it for its safety function. This validation shall be accomplished by performing a proof test after all configurations are complete.
- No online software tools are needed or are to be used when the TP-700 is performing its safety function.
- When used with the HRT Bridge Module, the DC loop resistance must be 250 ohms or less. If this resistance is exceeded, the maximum current delivered to the logic solver will be limited by the HRT Bridge.
- When used with the HRT Bridge Module, the TP-700 shall be configured such that its safety parameters cannot be altered by MODBUS communication while performing the safety function.
- When used with the TP-700, HART data writes via the HRT Bridge Module are disabled while performing the safety function.

9 INSTALLATION

NOTE: For complete information regarding performance, installation, operation, maintenance, and specifications of Model TP-700, refer to Instruction Manual document number 3150.

No specific or additional detector installation requirements exist above and beyond the standard installation practices documented in the Model TP-700 Instruction Manual Document number 3150.

Environmental operating specifications are applicable as published in the general specifications section in the Model TP- 700 Instruction Manual Document number 3150.

The TP-700 operating power distribution system should be designed and installed so the terminal voltage does not drop below 11 VDC when measured at any specific location. The maximum current limit must be less than 0.5 amperes. The over-voltage protection on the power distribution system must be set for 30 VDC.

10 START-UP AND COMMISSIONING

The Safety Certified TP-700 gas detector can be commissioned by any qualified person with knowledge of gas detection instruments and the configuration device being used. Refer to the Start-Up and Commissioning sections provided in the TP-700 Instruction Manual.

11 OPERATION, MAINTENANCE, INSPECTION AND PROOF TESTING

All normal installation, start-up, and full field calibration recommendations as documented in the TP-700 Instruction Manual are applicable to the Safety Certified TP-700 gas detector.

Safety – Certified TP-700 gas detectors require additional Proof Testing to be performed in all cases.

Personnel performing Proof Test procedures shall be competent to perform the task. All proof test results must be recorded and analyzed. Any corrective actions taken must be documented in the event that an error is found in the safety functionality. The proof tests must be performed at a frequency shown in Table 1.

TP-700 Proof Test Name	Commissioning	Frequency per year
Visual Field Inspection Proof Test	Yes	4 (Quarterly)
Gas Response Proof Test	Yes	4 (Quarterly)
Output Response Proof Test	Yes	1

Table 1: Frequency for Performing Proof Tests

Warning: Failure to perform the specified testing and inspection may lower or void the SIL rating for the product or system.

12 VISUAL FIELD INSPECTION PROOF TEST

Tools Required: Programming magnet

Visual inspection of all Safety-Certified TP-700 Gas Detectors shall be conducted quarterly to confirm that no external blockage of gas/vapor path into the sensing chamber exists. Examples include: debris, trash, snow, mud, external equipment, etc.

Corrective action shall include removal of such impediments should they exist. All gas detectors must be inspected to ensure that they are capable of providing expected performance and protection. The Model TP-700 provides a scrolling LED display that indicates fault messages when operational parameters are abnormal. A momentary magnetic swipe across either programming magnet will visually indicate any scrolling Fault Messages should any be present.

Completion of Visual Field Inspection Proof test will be recorded and documented in the SIS logbook.

13 GAS RESPONSE PROOF TEST

Tools Required:

- Span Calibration Gas Cylinder (50 ppm H₂S/balance Air or mid-scale of range used)
- Calibration Kit provided by Detcon

This proof test, commonly referred to as a “gas bump test” and requires the application of high accuracy compressed calibration gas to the detector while in NORMAL operational mode and inspecting the 4-20 mA signal output level to ensure that the signal output is accurately indicative of the applied test gas concentration.

Warning: Any external alarm equipment, systems, or signaling devices that could be automatically initiated by performing this test must be disabled or bypassed before performing this test!

When test gas is flowing into the detector, inspection of proper analog signal level output can be made by reading the analog signal output displayed on the control device. The criteria used for inspection pass is a stabilized response signal within $\pm 10\%$ of applied gas level or ± 2 ppm (the greater of). Use a test gas value that is 50% of selected range. If response test is not within acceptable limits, then a Full Calibration procedure must be performed and the Gas Response Proof Test re-performed.

13.1 FULL CALIBRATION

Tools Required:

- Span Calibration Gas Cylinder - H₂S/background Air (50% of selected range)
- Calibration Kit provided by Detcon
- Programming magnet

Full Calibration shall be conducted when required. The procedure for performing the Full Calibration is in the Calibration section of the TP-700 Instruction Manual. In all cases, the model TP-700 gas detector should be allowed to warm up for 24 hours minimum before conducting a Full Calibration.

Warning: The 4-20 mA output from the TP-700 will drop to 2 mA during the Full Calibration

Successful completion of the Gas Response Proof Test must be recorded and documented in the SIS logbook. If the Full Calibration is performed, it should also be documented in the SIS logbook.

14 OUTPUT RESPONSE PROOF TEST

Tools Required:

- Span Calibration Gas Cylinder (50 ppm H₂S / balance Air or mid-scale of range used)
- Calibration Kit provided by Detcon

The Output Proof Test is performed as follows:

1. Inhibit alarm response at the control device.
2. Apply test gas (50% of FS Range of H₂S ppm/balance Air) to the detector.
3. Verify correct 4-20 mA output signal at the control device.
4. Re-activate alarm response at the control device.

15 FAULT/FAILURE ACTION PLAN

In the event that a Full Calibration does not result in acceptable Gas Response Proof test, then the Standard Maintenance, Troubleshooting, and Device Repair and Return Procedures are listed in the TP-700 Instruction Manual must be followed. Any failure to successfully complete the Gas Response Proof Test must be recorded and documented in the SIS logbook.

16 PRODUCT REPAIR

The TP-700 is partially field repairable. Follow the TP-700 Instruction Manual for proper guidance in executing the allowable field repair / replacement actions. No firmware changes are permitted or authorized. All failures detected by the transmitter diagnostics or by the Proof Test must be reported.

17 OPERATING, ENVIRONMENTAL, AND PERFORMANCE SPECIFICATIONS

The Safety-Certified TP-700 product versions fully comply with, and must be operated in accordance with the functional, environmental, and performance specifications provided in the TP-700 Instruction Manual. A 24 hour mean time to repair should be assumed for safety availability calculations. All TP-700 diagnostics have a maximum 1 hour test interval.

18 SPARE PARTS

Refer to “Spare Parts” in the TP-700 Instruction Manual. Safety Certification is based on having a sufficient number of spares to achieve a 24 hour mean time to repair.

19 CERTIFICATION AND FAILURE RATE DATA

All Safety-Certified TP-700 models are certified compliant to:

IEC61508:2010

SIL 2 Certified

PFDavg @ 1 year is 3.3% of the SIL2 range.

Safe Failure Fraction (SFF): 90.1%

Safety Accuracy: +/-20% FS Range

Safety Response Time for H2S: < 120 seconds to T80

Product Life: 10 years, based on manufacturer data.

20 CERTIFICATIONS

cCSAus, ATEX, CE Marking (Refer to the Model TP-700 Instruction Manual for details).

FMEDA Report available for both TP-700 and optional HRT Bridge Module.

For complete information regarding performance, installation, operation, maintenance, and specifications of Model TP-700, refer to the Instruction Manual Document number 3150.

21 **REVISION LOG**

Revision	Date	Changes made	Approval
1.0	1/11/13	Initial Release	RJM
2.0	5/13/13	Added Constraints section	RJM
3.0	5/15/13	Changes after final review	RJM
4.0	5/22/13	Clarified Section 6, added constraint on online tools to Section 8	RJM
5.0	6/7/13	Added duration to 0mA fault constraint in Section 8. Changed SFF and PFDavg values in Section 19	RJM
6.0	8/25/20	Updated company name to Teledyne Detcon. Added references to the HRT Bridge and its instruction manual and FMEDA report.	KCM