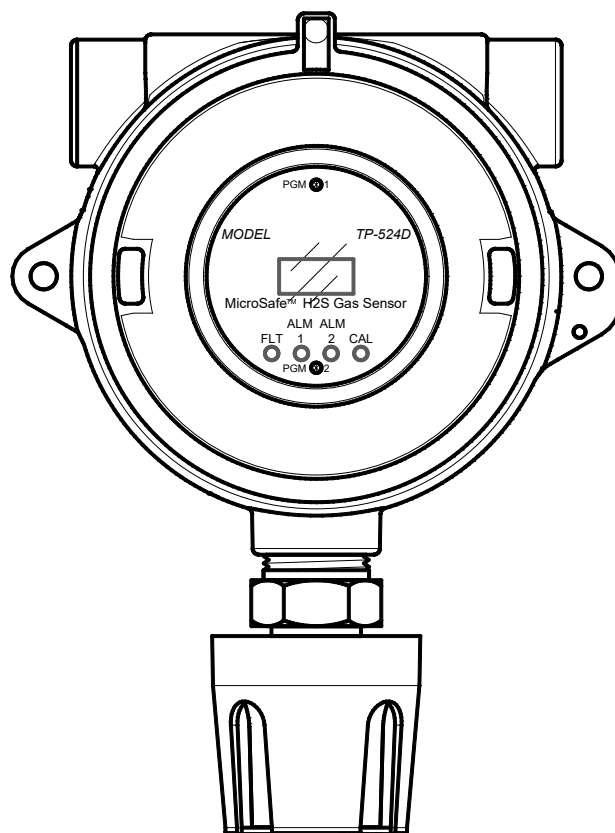


Instruction Manual

Model TP-524D-HRT



TP-524D-HRT Hydrogen Sulfide Sensor

This manual covers the following ranges:
0-20ppm, 0-50ppm, and 0-100ppm



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1. Introduction

1.1 Description

Teledyne Detcon Model TP-524D-HRT hydrogen sulfide sensors are non-intrusive “Smart” sensors designed to detect and monitor H₂S in air. Ranges of detection are 0-20ppm, 0-50ppm, and 0-100ppm. The sensor features an LED display of current reading, fault, and calibration status. The Sensor is equipped with a HRT Bridge Interface, analog 4-20mA output. The HRT Bridge interface provides bi-directional digital communication with HART®-enabled devices. A primary feature of the sensor is its method of automatic calibration, which guides the user through each step via fully scripted instructions displayed on the LED display.

The microprocessor-supervised electronics are packaged as a plug-in replaceable Transmitter Module that is housed in an explosion proof junction box. The Transmitter Module includes a four character alpha/numeric LED used to display sensor readings, and the sensor’s menu driven features when the hand-held programming magnet is used.

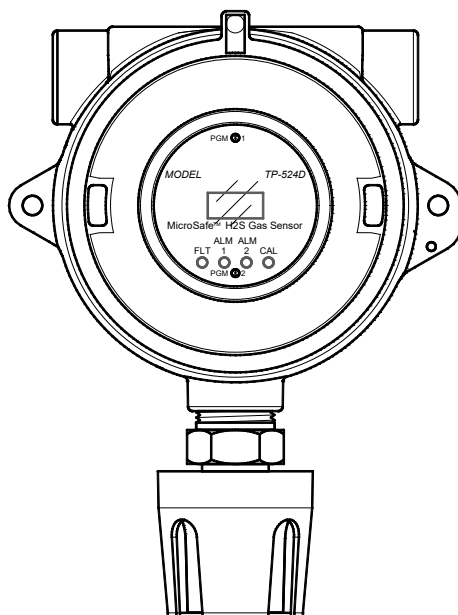
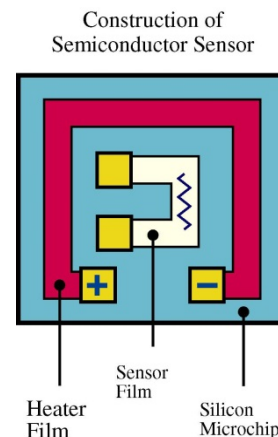


Figure 1 Sensor Assembly Front View

Solid State H₂S Sensor Technology

The sensor technology is a patented solid-state mixed metal oxide semiconductor. The sensor consists of two thin films, a temperature sensitive heater film, and a hydrogen sulfide sensitive sensor film. Both films are deposited on a silicon microchip by vacuum deposition. The heater film elevates the operating temperature of the sensor film to a level where a good sensitivity and response to hydrogen sulfide is achieved. The sensor film is a proprietary mixed metal oxide that shows an extremely stable and dynamic response to hydrogen sulfide gas.

Range of sensitivity is from parts per billion to percent by volume. The rugged sensor is capable of maintaining its operating characteristics for periods of up to 7-10 years in most industrial environments and as such, is supported by a 10-year conditional warranty.



Principle of Operation

Method of detection is by diffusion/adsorption. Air and H₂S diffuse through a sintered stainless steel filter (flame arrestor) and contact the heated surface of the metal oxide sensor film. As hydrogen sulfide gas molecules react with oxygen ions on the film, there is a decrease in electrical resistance proportional to the gas concentration. The heater film elevates the temperature of the sensor film creating convection and promoting a quick response to changing gas concentrations. Electronically, the heater film is used to maintain a constant temperature of the sensor film enhancing stability and repeatability. The sensor response is reversible and results in continuous monitoring of ambient air conditions.

1.2 Modular Mechanical Design

The Model TP-524D-HRT Sensor Assembly is completely modular and is made up of four parts:

- 1) TP-524D with HRT Bridge Plug-in Transmitter
- 2) Field Replaceable H₂S Gas Sensor
- 3) Connector PCB
- 4) Splash Guard.

TP-524D-HRT Plug-in Transmitter

The Plug-in Transmitter Module is a microprocessor-based package that plugs into the connector board located in the explosion proof junction box. Circuit functions include extensive I/O circuit protection, sensor pre-amplifier, sensor temperature control, on-board power supplies, microprocessor, LED display, magnetic programming switches, and a linear 4-20mA DC output. Magnetic program switches located on either side of the LED Display are activated via a hand-held magnetic programming tool, thus allowing non-intrusive operator interface with the Transmitter Module. Calibration can be accomplished without declassifying the area. Electrical classifications are Class I, Division 1, Groups B C D.

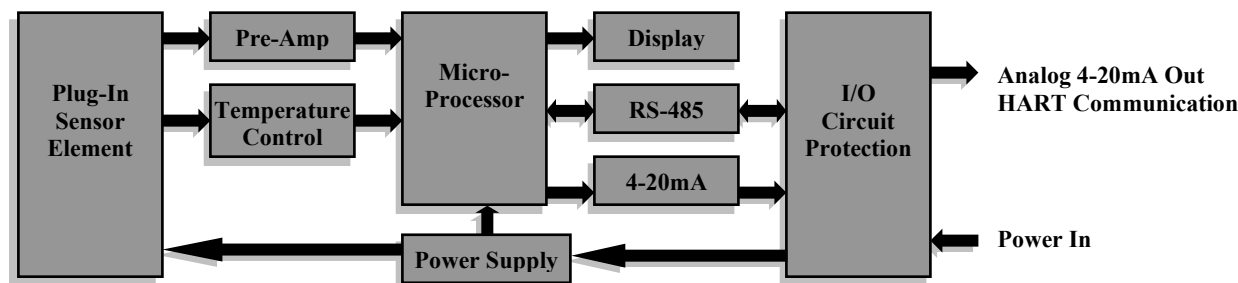


Figure 2 Circuit Functional Block Diagram

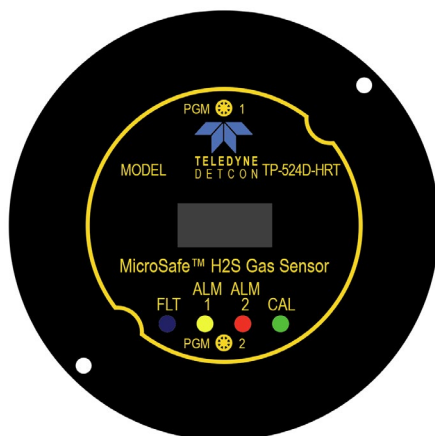


Figure 3 Transmitter Module

Field Replaceable Sensor

The Teledyne Detcon solid-state H₂S gas sensor is a field proven, replaceable type sensor. It can be accessed and replaced in the field by removing the wiring from the connector PCB, and unthreading the Sensor from the junction box. The Teledyne Detcon solid state H₂S sensor has an infinite shelf life and is supported by a 10 year, industry-leading warranty.

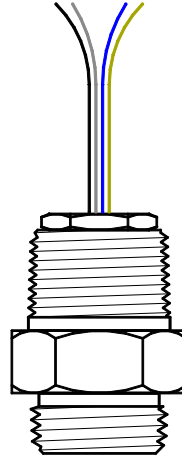


Figure 4 Field Replaceable H₂S Sensor

NOTE: The Field Replaceable H₂S Gas Sensor is constructed from 316 Stainless Steel in order to maximize corrosion resistance in harsh environments.

Base Connector PCB

The base connector board is mounted in the Junction Box. The connector board includes Lug less terminal connections for incoming power and MA output / HART Interface, and connections for the H₂S Replaceable Sensor.

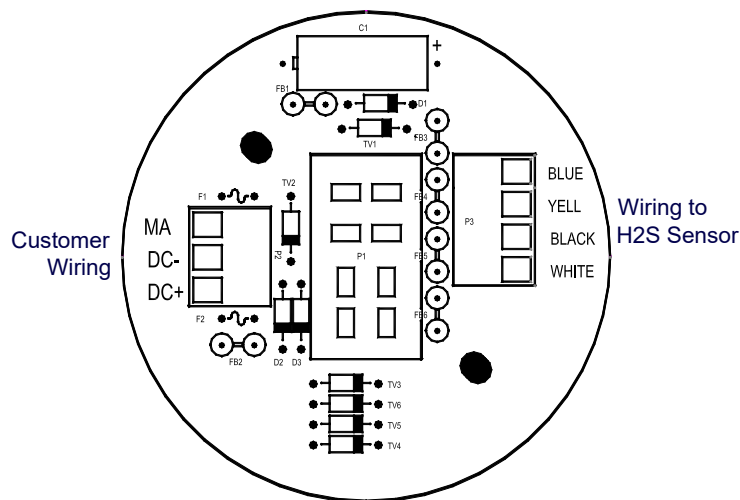


Figure 5 Base Connector Board

2. Installation

2.1 Operational Guidelines for Safe Use

1. Install sensor only in areas with classifications matching with those described on the approval label. Follow all warnings listed on the label.
2. Ensure that the sensor is properly mounted in a vertical orientation with sensor facing down. Avoid use of Teflon Tape, or any type of non-conductive pipe thread coating on the NPT threaded connection.
3. Use ¾" NPT plugs properly rated for hazardous locations to block any unused connections
4. Removal of the Junction box cover or threaded sensor housing (399-800000-000) violates the Ex d protection method and hence power must be removed from the sensor prior its safe removal.
5. Proper precautions should be taken during installation and maintenance to avoid the build-up of static charge on the plastic components of the sensor. These include the splashguard and splashguard adapter.
6. Do not operate the sensor outside of the stated operating temperature limits.
7. Do not operate the sensor outside the stated operating limits for voltage supply.

Calibration/Bump Test Following Ingress Protection Events

Although the Model TP-524D/624D detector models are designed for IP 66 Ingress Protection, it is a mandatory requirement from the ISA 92.00.01-2010 Performance Standard that this device requires that a gas bump test or span calibration is performed shortly after any event where the conditions of IP66 level ingresses have been presented to the detector. An example would be after an extreme wash-down event, or after sustained and concentrated dust exposure event. In these cases, the unit must be confirmed to be reading accurately before safe operation is restored.

NOTE: It is mandatory to bump test or span calibrate the detector following field situations where exposures to IP 66 level ingresses from dust or water have been presented.

2.2 Sensor Placement

Selection of sensor location is critical to the overall safe performance of the product. Five factors play an important role in selection of sensor locations:

- (1) Density of the gas to be detected
- (2) Most probable leak sources within the industrial process
- (3) Ventilation or prevailing wind conditions
- (4) Personnel exposure
- (5) Maintenance access
- (6) Additional Placement Considerations

Density

Placement of sensors relative to the density of the target gas is such that sensors for the detection of heavier than air gases should be located within 4 feet of grade as these heavy gases will tend to settle in low lying areas. For gases lighter than air, sensor placement should be 4-8 feet above grade in open areas or in pitched areas of enclosed spaces.

Note: H₂S is heavier than air.

Leak Sources

The most probable leak sources within an industrial process include flanges, valves, and tubing connections of the sealed type where seals may either fail or wear. Other leak sources are best determined by facility engineers with experience in similar processes.

Ventilation

Normal ventilation or prevailing wind conditions can dictate efficient location of gas sensors in a manner where the migration of gas clouds is quickly detected.

Personnel Exposure

The undetected migration of gas clouds should not be allowed to approach concentrated personnel areas such as control rooms, maintenance or warehouse buildings. A more general and applicable thought toward selecting sensor location is combining leak source and perimeter protection in the best possible configuration.

Maintenance Access

Consideration should be given to providing easy access for maintenance personnel. Consideration should also be given to the consequences of close proximity to contaminants that may foul the sensor prematurely.

NOTE: In all installations the gas sensor should point straight down (refer to Figure 7). Improper sensor orientation may result in false readings and permanent sensor damage.

Additional Placement Considerations

The sensor should not be positioned where it may be sprayed or coated with surface contaminating substances. Painting sensor assemblies is prohibited.

Although the sensor is designed to be RFI resistant, it should not be mounted in close proximity to high-powered radio transmitters or similar RFI generating equipment.

When possible mount in an area void of high wind, accumulating dust, rain, or splashing from hose spray, direct steam releases, and continuous vibration. If the sensor cannot be mounted away from these conditions then make sure the Teledyne Detcon Harsh Location Dust Guard accessory is used.

Do not mount in locations where temperatures will exceed the operating temperature limits of the sensor. Where direct sunlight leads to exceeding the high temperature-operating limit, use a sunshade to help reduce temperature.

2.3 Sensor Contaminants and Interference

Solid State H₂S sensors may be adversely affected by exposure to certain airborne substances. Loss of sensitivity or corrosion may be gradual if such materials are present in sufficient concentrations.

The more common materials that potentially cause problems with the sensors are as follows:

Silicone vapors such as those found in greases and lubricants
Halide Compounds containing Chlorine, Chlorine Dioxide, Fluorine, HF, HCl, and Bromine
Caustic and Acid liquids and concentrated vapors
Heavy metals such as tetraethyl lead
Heavy and complex VOC gasses

The presence of such contaminants in an area does not preclude the use of this H₂S sensor technology, although it is likely that the sensor lifetime will be shorter as a result. Use of this sensor in these environments may require more frequent calibration checks to ensure safe system performance.

Solid State H₂S sensors require O₂ in the background gas and the reading is affected by changing O₂ levels.

Interference Data

There are some gases typically found in industrial environments that can cause a cross-interference response on the sensor. See the Table below for some examples.

Table 1 Cross Interference Gases

GAS	PPM	GAS	PPM
Methane	25,000 = 0	Ammonia	500 = 1
Ethane	5,000 = 0	Diesel Fuel	1000 = 0
Hexane	5,000 = 0	Dimethyl Sulfide	4.4 = 0
Propane	5,000 = 0	Ethylene	200 = 0
Butane	5,000 = 0	Freon 12	1,000 = 0
Carbon Monoxide	1% = 0	Hydrogen	5% = 0
Carbon Dioxide	5,000 = 0	Methyl Mercaptan	10 = 0
Carbon Disulfide	14 = 0	Sulfur Dioxide	300 = 0
Methanol	500 = 5	Toluene	32 = 0
Isopropanol	500 = 3	Ethanol	500 = 5

NOTE: The Teledyne Detcon MOS Sensor Cell can be damaged to the point of non-functioning if the unit is left off power and in the presence normal air levels of moisture for periods exceeding 8 hours.

NOTE: Always protect the sensor cell with the Teledyne Detcon Sealing Cap and a fresh desiccant packet when the sensor is powered off, this will avoid permanent sensor cell damage and help preserve the span calibration.

2.4 Mounting Installation

The TP-524D-HRT should be vertically oriented so that the sensor points straight downward. The explosion-proof enclosure or junction box would then typically be mounted on a wall or pole (See Figure 6). Teledyne Detcon provides a selection of standard junction boxes in both Aluminum and Stainless Steel.

NOTE: Do not use Teflon Tape or any other type of Pipe Thread material on the 3/4" threads unless the unit is mounted in a severe or harsh environment. Metal-on-metal contact must be maintained to provide a solid electrical ground path. If Teflon Tape is used the Sensor *must* be externally grounded using a ground strap.

When mounting on a pole, secure the Junction Box to a suitable mounting plate and attach the mounting plate to the pole using U-Bolts. (Pole-Mounting brackets for Teledyne Detcon Junction Box's are available separately.)

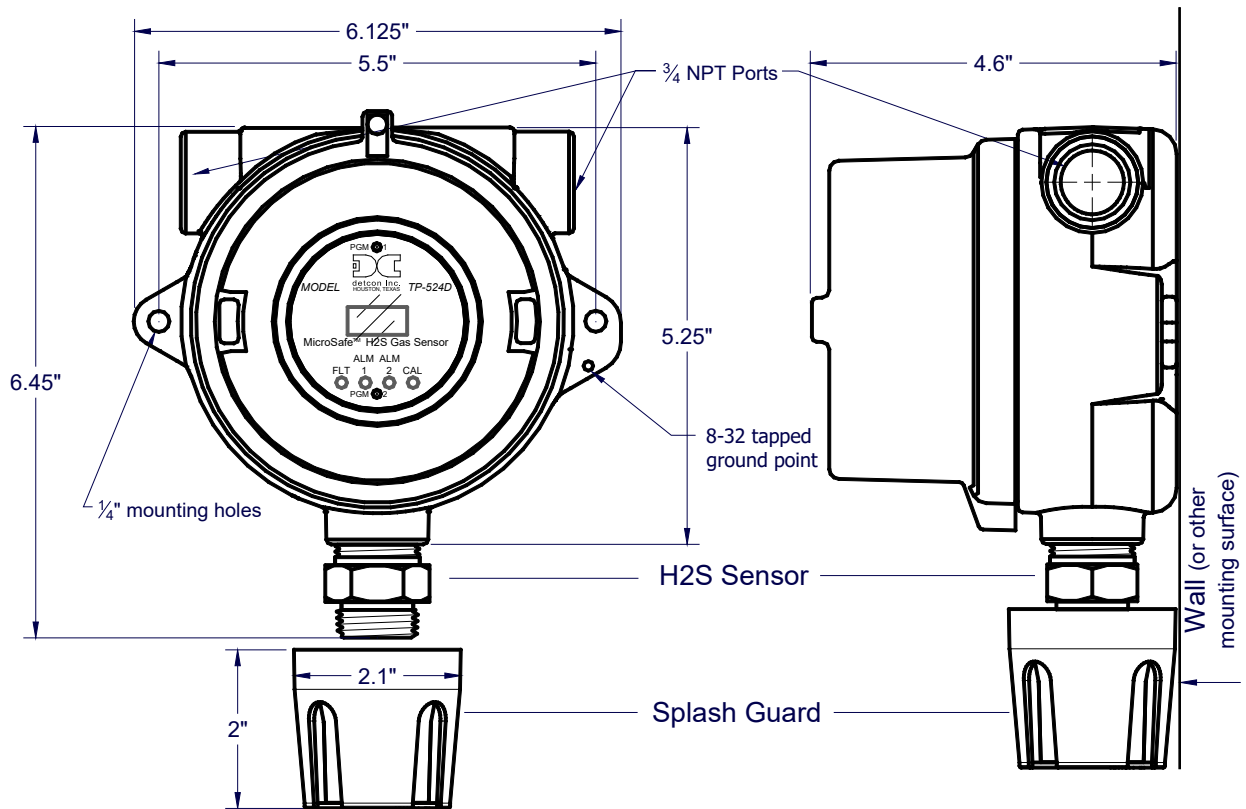


Figure 6 Typical Outline and Mounting Dimensions

2.5 Electrical Installation

The Sensor Assembly should be installed in accordance with local electrical codes. The sensor assemblies are CSA/NRTL approved (US and Canada) for Class I, Division 1, Groups B, C, & D area classifications.

Proper electrical installation of the gas sensor is critical for conformance to Electrical Codes and to avoid damage due to water leakage. Refer to Figure 7 and Figure 8 for proper electrical installation.

NOTE: If a conduit run exits the secondary port, repeat the installation technique shown in Figure 7.

In Figure 7, the drain allows H₂O condensation inside the conduit run to safely drain away from the sensor assembly. The electrical seal fitting is required to meet the National Electrical Code per NEC Article 500-3d (or Canadian Electrical Code Handbook Part 1 Section 18-154). Requirements for locations of electrical seals are covered under NEC Article 501-5. Electrical seals also act as a secondary seal to prevent water from entering the wiring terminal enclosure. However, they are not designed to provide an absolute watertight seal, especially when used in the vertical orientation.

NOTE: For products utilizing the aluminum junction box option, the conduit seal shall be placed at the entry to the junction box (see Figure 7 as an example). For products utilizing the stainless

steel junction box option, the conduit seal shall be placed within 18" of the enclosure. Crouse Hinds type EYS2, EYD2 or equivalent are suitable for this purpose.

NOTE: The Teledyne Detcon Warranty does not cover water damage resulting from water leaking into the enclosure.

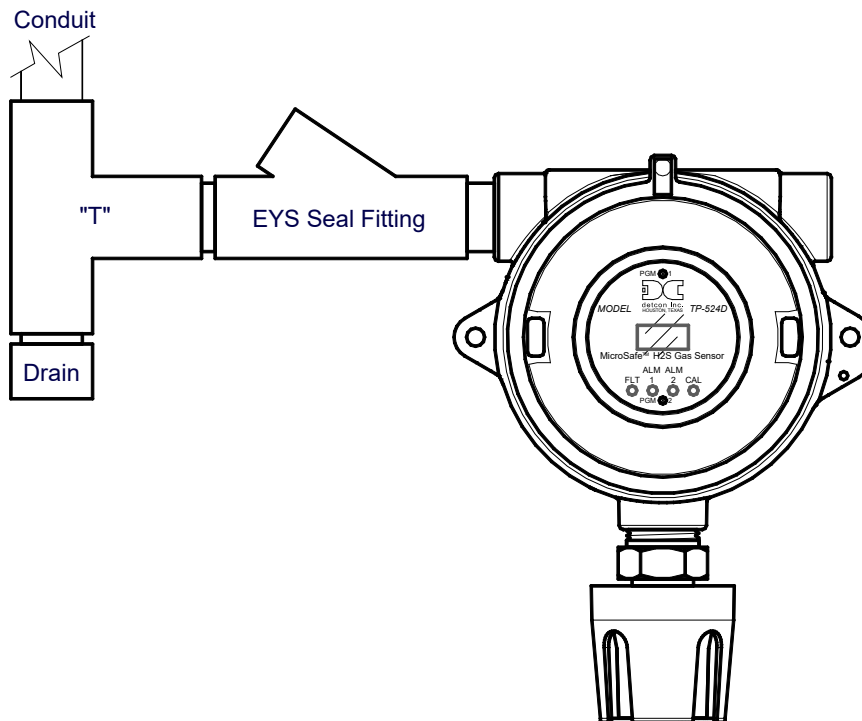


Figure 7 Typical Installation

NOTE: Any unused ports should be blocked with suitable 3/4" male NPT plugs. Teledyne Detcon supplies one 3/4" NPT male plug with each J-box enclosure. If connections are other than 3/4" NPT, use an appropriate male plug of like construction material.

2.6 Field Wiring

Teledyne Detcon Model TP-524D-HRT solid-state H₂S sensor assemblies require three conductor connections between power supplies and host electronic controller's 4-20mA / HART Interface. Wiring designations are DC+, DC-, MA (sensor signal). A 250 ohm load resistor is needed on the 4-20 mA line when it is not being used. The maximum wire length between sensor and 24VDC source is shown in the Table below. The maximum wire size for termination in the Junction Box is 14 AWG.

Table 2 Wire Gauge vs. Distance

AWG	Wire Dia.	Meters	Feet	Over-Current Protection
22	0.723mm	700	2080	3A
20	0.812mm	1120	3350	5A
18	1.024mm	1750	5250	7A
16	1.291mm	2800	8400	10A
14	1.628mm	4480	13,440	20A

NOTE 1: Wiring table is based on stranded tinned copper wire and is designed to serve as a reference only.

NOTE 2: Shielded cable is required for installations where cable trays or conduit runs include high voltage lines or other possible sources of induced interference. Separate conduit runs are highly recommended in these cases.

NOTE 3: The supply of power should be from an isolated source with over-current protection as stipulated in table.

NOTE 4: A 250 ohm load resistor is needed on the 4-20 mA line when it is not being used.

Terminal Connections



CAUTION: Do not apply System power to the sensor until all wiring is properly terminated. Refer to Section 2.7 Initial Start Up

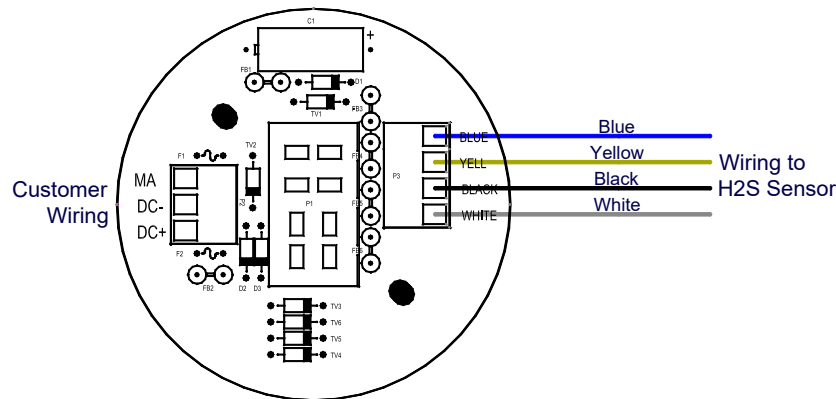


Figure 8 Sensor Connector PCB

- Remove the junction box cover and unplug the Transmitter Module. Identify the terminal blocks for customer wire connections.
- Observing correct polarity, terminate the 3-conductor 4-20mA field wiring (DC+, DC-, and MA) to the sensor assembly wiring in accordance with the detail shown in Figure 8.
- Trim all exposed wire leads if they are not permanently landed in the terminal block.
- Plug the Transmitter Module into the connector PCB and replace the junction box cover.

NOTE: A 6-32 or 8-32 threaded exterior ground point is provided on most junction boxes for an external ground. If the Sensor Assembly is not mechanically grounded, an external ground strap **must** be used to ensure that the sensor is electrically grounded.

2.7 Initial Start Up

Upon completion of all mechanical mounting and termination of all field wiring, apply system power in the range of 12-28VDC (24VDC typical) and observe the following normal conditions:

- TP-524D-HRT display reads "0", and no fault messages are flashing.

- b) A temporary upscale reading may occur as the sensor heats up. This upscale reading will decrease to “0” ppm within 1-2 minutes of power-up, assuming there is no gas in the area of the sensor.

NOTE: The 4-20mA signal is held constant at 4mA for the first two minutes after power up.

- c) Remove the desiccant cap about 10 minutes after applying power to the sensor and install the weatherproof splashguard accessory supplied with the sensor.

NOTE: A desiccant cap with a desiccant packet is attached to the sensor cell housing during storage and shipping. This prevents water from contacting the sensor film, and as a result helps to retain the stability of the factory span calibration.

NOTE: Store the desiccant caps with the desiccant packets in a sealed container (i.e. zip-lock bag) for future use. It is advisable (but not mandatory) to reinstall the desiccant cap and packet during prolonged periods without power (more than 2 days is considered “prolonged”). An active desiccant packet is blue in color and turns pink when consumed. (P/N 960-399800-000 Package of 10)

Initial Operational Tests

After a warm up period of 1 hour, the sensor should be checked to verify sensitivity to H₂S gas.

Material Requirements

- Teledyne Detcon PN 600-610000-000 Splash Guard with integral Cal Port -OR-
- Teledyne Detcon PN 943-000006-038 Threaded Calibration Adapter
- Teledyne Detcon PN 942-010112-025 Span Gas; 25ppm H₂S in balance Air at fixed flow rate between 200 - 500cc/min (10ppm for 0-20ppm range)
- Teledyne Detcon PN 985-241100-321 In-Line Humidifying Tube

NOTE: Do not use H₂S in Nitrogen background gas mixtures. This will cause significant reading inaccuracies.

- a) Connect the In-Line Humidifying Tube between the cal gas cylinder and the sensor. The humidifying tube will introduce the ambient relative humidity into the Cal Gas as it passes through the tube.
- b) Attach the calibration adapter to the threaded sensor housing. Apply the test gas at a controlled flow rate of 200 - 500cc/min (200cc/min is the recommended flow). Allow 1-2 minutes for the reading to stabilize. Observe that during the 1-2 minutes the display increases to a level near that of the applied calibration gas value.
- c) Remove test gas and observe that the display decreases to “0”.

Initial operational tests are complete. Teledyne Detcon H₂S gas sensors are factory calibrated prior to shipment, and should not require significant adjustment on start up. However, it is recommended that a complete calibration test and adjustment be performed 16 to 24 hours after power-up. Refer to span calibration instructions in Section 3.4.

3. Operation

3.1 Programming Magnet Operating Instructions

The Operator Interface of the Model 700 Series gas sensors is accomplished via two internal magnetic switches located above and below the LED display (Figure 10). The two switches, labeled “PGM1” and “PGM2”, allow for complete calibration and configuration, thereby eliminating the need for area de-classification or the use of hot permits.



Figure 9 Magnetic Programming Tool

The magnetic programming tool (Figure 9) is used to operate the magnetic switches. Switch action is defined as momentary contact, 3-second hold, and 10-second hold. (Hold times are defined as the time from the point when the arrow prompt “▶” appears.) For momentary contact use, the programming magnet is briefly held over a switch location. For 3-second hold, the programming magnet is held in place over the switch location for three seconds. For 10-second hold, the programming magnet is held in place over the switch location for 10 seconds. The 3 and 10 second holds are generally used to enter calibration/program menus and save new data. The momentary contact is generally used to move between menu items and to modify set-point values. Arrows (“▶” and “◀”) are used on the LED display to indicate when the magnetic switches are activated. The location of “PGM1” and “PGM2” are shown in Figure 10.

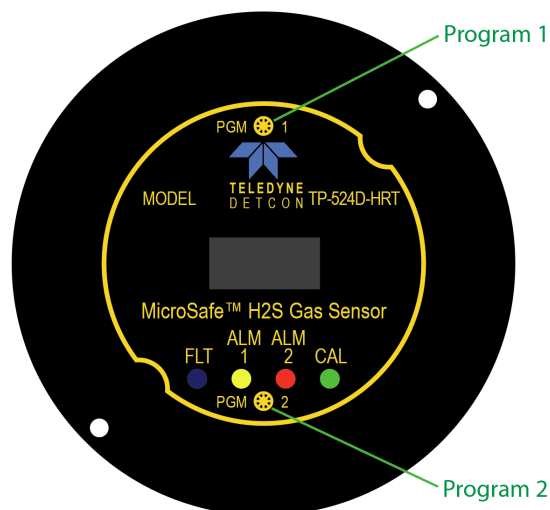


Figure 10 Magnetic Programming Switches

NOTE: While in the Program Mode, if there is no magnetic switch interaction after 4 consecutive menu scrolls, the sensor will automatically revert to normal operating condition. While changing values inside menu items, **if there is no magnet activity after 3-4 seconds the sensor will revert to the menu scroll.**

(Exception to this is with “Signal Output Check” mode.)

3.2 Operator Interface

The operating interface is menu-driven via the two magnetic program switches located under the target marks of the sensor housing. The two switches are referred to as “PGM1” and “PGM2”. The menu list consists of three major items that include sub-menus as indicated below. (Refer to the complete Software Flow Chart.)

Normal Operation

Current Reading and Fault Status

Calibration Mode

AutoSpan

Program Mode

View Sensor Status

- Sensor Model Type
- Current Software Version
- Range of Detection
- AutoSpan Level
- Days Since Last AutoSpan
- Remaining Sensor Life
- Sensor Heater Power
- Sensor Heater Voltage
- Raw Sensor Resistance
- mA Output
- Input Voltage Supply
- Sensor Temperature
- Alarm 1 Level
- Alarm 1 Ascending
- Alarm 1 Latching
- Alarm 2 Level
- Alarm 2 Ascending
- Alarm 2 Latching
- Fault Latching

Set AutoSpan Level

Set Range

Set Heater Power

Signal Output Check

Restore Default Settings

Alarm 1 Settings

Alarm 2 Settings

Fault Settings

Software Flowchart

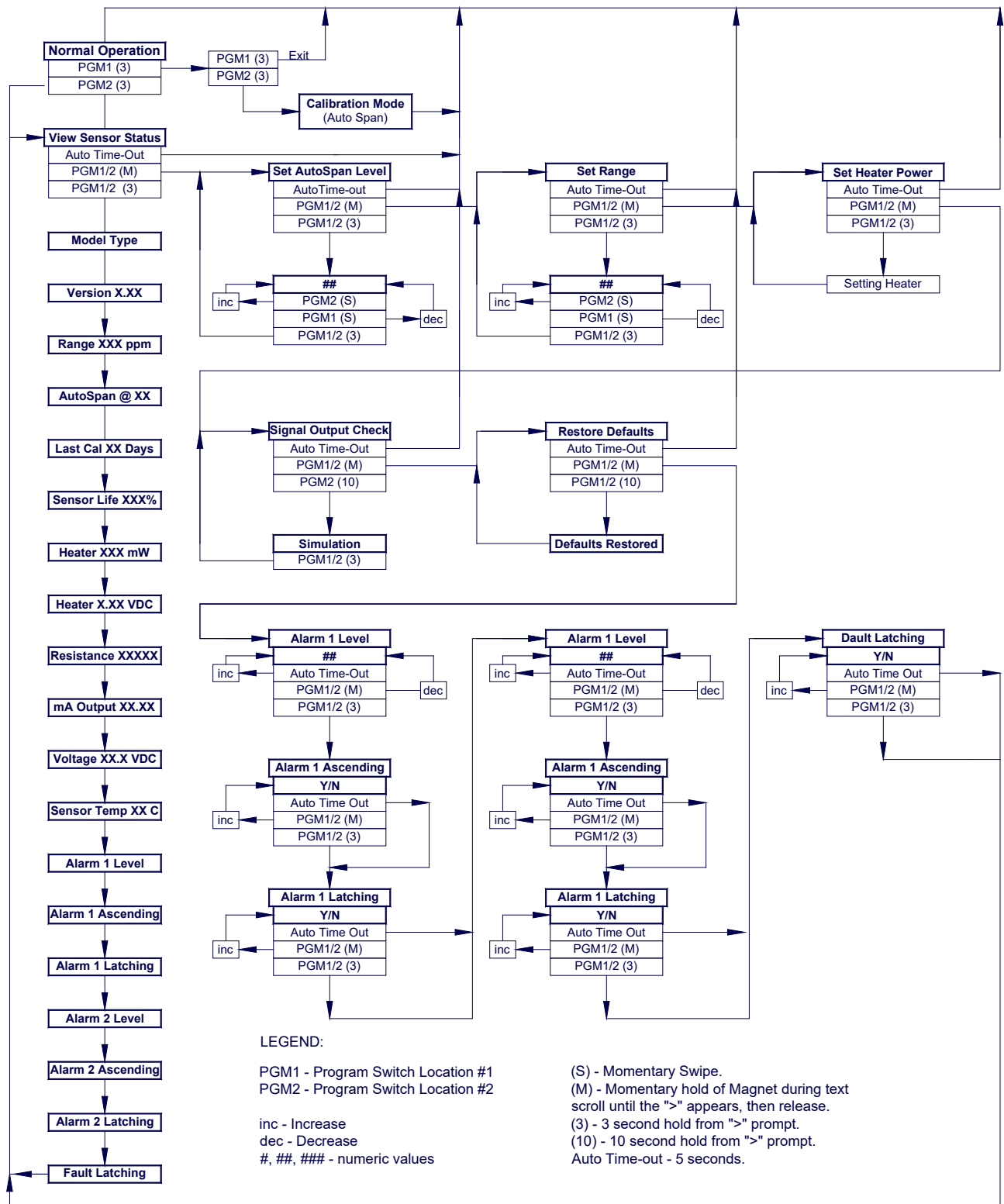


Figure 11 TP-524D-HRT Software Flowchart

3.3 Normal Operation

In normal operation, the display continuously shows the current sensor reading, which will normally appear as “0”. Once every minute, the LED display will flash the sensor’s units of measure and the gas type (i.e. ppm H₂S). If the sensor is actively experiencing any diagnostic faults, a “Fault Detected” message will scroll across the display on the display once every minute instead of the units of measure and the gas type. At any time, while the sensor is in “Fault Detected” mode, PGM1 or PGM2 can be swiped to prompt the sensor to display a list of the active faults.

In normal operation, the 4-20mA current output linearity corresponds with the full-scale range.

3.4 Calibration Mode (AutoSpan)

Calibration Mode allows for sensor span calibration. Span calibration should be performed on a routine basis (quarterly minimum) to ensure reliable performance. If a sensor has been exposed to any de-sensitizing gases or to very high over-range H₂S levels, then a re-calibration should be considered. Unless otherwise specified, span adjustment is recommended at 25ppm for the 0-100 and 0-50ppm ranges (and 10ppm for 0-20ppm range). This function is called “AUTO SPAN.”

Material Requirements:

- Teledyne Detcon PN 327-000000-000 MicroSafe™ Programming Magnet
- Teledyne Detcon PN 600-610000-000 Splash Guard with integral Cal Port -OR-
- Teledyne Detcon PN 943-000006-038 Threaded Calibration Adapter
- Teledyne Detcon PN 985-241100-321 In-Line Humidifying Tube
- Teledyne Detcon PN 942-010112-025 H₂S Span Gas (recommended) or other suitable span gas source containing H₂S gas in air balance. A fixed flow rate of 200-500cc/min is recommended.

NOTE 1: Before performing AutoSpan Calibration, verify that the AutoSpan level matches the span calibration gas concentration as described in Section 3.5.2 Set AutoSpan Level.

NOTE 2: The span gas source must have a normal background concentration of 20.9% O₂ (H₂S balanced with Air). Pure Nitrogen background mixtures are not acceptable! Significant span calibration inaccuracies will result.

NOTE 3: An H₂S gas concentration of 25ppm is strongly recommended for 0-50 and 0-100ppm ranges (10ppm span gas for 0-20ppm range). This should be supplied at a controlled flow rate of 200 to 500cc/min, with 200cc/min being the recommended flow rate. Other concentrations can be used if as they fall within allowable levels.


NOTE 4: Span gas bottles contain 0% humidity and this ultra-low humidity condition will cause inaccurate readings when used to calibrate a sensor. To prevent this error, Teledyne Detcon prescribes the use of a 24” flexible In-Line Humidifying Tube, which adds the relative humidity to the span gas. The humidifying tube is not necessary when using a gas generating calibration device that consists of pumped ambient air and an H₂S generating source.



CAUTION: Verification that the calibration gas level setting matches the calibration span gas concentration is required before executing “AutoSpan” calibration. These two numbers must be equal.

AutoSpan consists of entering Calibration Mode and following the menu-displayed instructions. The display will ask for the application of span gas in a specific concentration. The applied gas concentration must be equal to the calibration gas level setting. The factory default setting and recommendation for span gas concentration

is 10ppm for the 0-20ppm range and 25ppm for the 0-50ppm and 0-100ppm ranges. If a span gas containing the recommended concentration is not available, other concentrations may be used as long as they fall between 10% and 50% of selected full-scale range. However, any alternate span gas concentration value must be programmed into the sensor via the “Set AutoSpan Level” menu before proceeding with AutoSpan calibration. Follow the instructions “a” through “e” below for AutoSpan calibration.

- a) Verify that the AutoSpan Level is equal to the Calibration Span Gas Concentration. (Refer to View Sensor Status in Section 3.5.1.) If the AutoSpan Level is not equal to the Calibration span gas concentration, adjust the AutoSpan Level as instructed in Section 3.5.2 Set AutoSpan Level.
- b) From Normal Operation, enter Calibration Mode by holding the programming magnet over PGM1 for 3 seconds. Note, the “” prompt will show that the magnetic switch is activated during the 3 second hold period. The display will then scroll “PGM1=Exit PGM2=Span”. Hold the programming magnet over PGM2 for 3 seconds to execute AutoSpan (or allow to timeout in 5 seconds if AutoSpan is not intended). The display will then scroll “Apply XX ppm Gas”.

NOTE: Upon entering Calibration Mode, the 4-20mA signal drops to 2mA and is held at this level until the program returns to normal operation.

- c) Apply the span calibration test gas via the In-Line Humidifying Tube at a flow rate of 200-500cc/min (200cc/min is the recommended flow rate). As the sensor signal begins to increase the display will switch to reporting “XX” reading as the display shows the sensor’s “as found” response to the span gas presented. If it fails to meet the minimum in-range signal change criteria within 2½ minutes, the display will report “Range Fault” twice and the sensor will return to normal operation, aborting the AutoSpan sequence. The sensor will continue to report a “Range Fault” and will not clear the fault until a successful AutoSpan is completed.

Assuming acceptable sensor signal change, after 3 minutes the reading will auto-adjust to the programmed AutoSpan level. During the next 30 seconds, the AutoSpan sequence checks the sensor for acceptable reading stability. If the sensor fails the stability check, the reading is re-adjusted back to the AutoSpan level and the cycle repeats until the stability check is passed. Up to three additional, 30-second stability check periods are allowed before the sensor reports a “Stability Fault” and returns to normal operation, aborting the AutoSpan sequence. The sensor will continue to report a “Stability Fault” and will not clear the fault until a successful AutoSpan is completed.

If the sensor passes the stability check, the sensor reports a series of messages:

“AutoSpan Complete”

“Sensor Life XXX%”

“Remove Span Gas”

- d) Remove the span gas and calibration adapter. The display will report a live reading as the sensor clears toward “0”. When the reading clears below 8ppm, the sensor will display “Span Complete” and will revert to normal operation. If the sensor fails to clear to less than 8ppm within 5 minutes, a “Clearing Fault” will be reported and the sensor will return to normal operation, aborting the AutoSpan sequence. The sensor will continue to report a “Clearing Fault” and will not clear the fault until a successful AutoSpan is completed.
- e) AutoSpan calibration is complete.

NOTE 1: If the sensor fails the minimum signal change criteria, a **“Range Fault”** will be declared and a “Fault Detected” message will be displayed alternately with the sensor’s current reading. The 4-20mA output will be taken to 0mA.

NOTE 2: If the sensor fails the stability criteria, a “**Stability Fault**” will be declared and a “Fault Detected” message will be displayed alternately with the sensor’s current reading. The 4-20mA output will be taken to 0mA.

NOTE 3: If the sensor fails the clearing time criteria, a “**Clearing Fault**” will be declared and a “Fault Detected” message will be displayed alternately with the sensor’s current reading. The 4-20mA output will be taken to 0mA.

NOTE 4: The most common cause of “**Range Fault**” and “**Stability Fault**” is the improper storage of the unit / sensor cell. When the sensor power is removed for any period of time, the sensor cell should be protected with a Desiccant Pack (P/N 960-240010-000) and covered by the Dust Cap (P/N 600-003232-000)

Calibration/Bump Test Following Ingress Protection Events

Although the Model TP-524D/624D detector models are designed for IP 66 Ingress Protection, it is a mandatory requirement from the ISA 92.00.01-2010 Performance Standard that this device requires that a gas bump test or span calibration is performed shortly after any event where the conditions of IP66 ingress have been presented to the detector. An example would be after an extreme wash-down event, or after sustained and concentrated dust exposure event. In these cases, the unit must be confirmed to be reading accurately before safe operation is restored.

NOTE: It is mandatory to bump test or span calibrate the detector following field situations where exposures to IP 66 level ingresses from dust or water have been presented.



3.5 Program Mode


Program Mode provides a “View Sensor Status” menu to check operational and configuration parameters. Program Mode provides for adjustment of the AutoSpan Level, Sensor Range, and Heater Power. Additionally, Program Mode includes the diagnostic functions “Signal Output Check” and “Restore Factory Defaults”.




The Program Mode menu items appear in the order presented below:

- View Sensor Status
- Set AutoSpan Level
- Set Range
- Set Heater Power
- Signal Output Check
- Restore Default Settings
- Alarm 1 Settings
- Alarm 2 Settings
- Fault Settings

Navigating Program Mode


From Normal Operation, enter Program Mode by holding the magnet over PGM2 for 4 seconds (until the displays starts to scroll “View Sensor Status”). Note, the “” prompt will show that the magnetic switch is activated during the 4 second hold period. The sensor will enter Program Mode and the display will display the first menu item “View Sensor Status”. To advance to the next menu item, hold the magnet over PGM1 or PGM2 while the current menu item’s text is scrolling. At the conclusion of the text scroll the arrow prompt (“” for

PGM2 or “” for PGM1) will appear, immediately remove the magnet. The display will advance to the next menu item. Repeat this process until the desired menu item is displayed. Note, PGM1 moves the menu items from right to left and PGM2 moves the menu items from left to right.

To enter a menu item, hold the magnet over PGM1 or PGM2 while the menu item is scrolling. At the conclusion of the text scroll the “” prompt (“” for PGM2 or “” for PGM1) will appear, continue to hold the magnet over PGM1 or PGM2 for an additional 3-4 seconds to enter the selected menu item. If there is no magnet activity while the menu item text is scrolling (typically 4 repeated text scrolls), the sensor will automatically revert to Normal Operation.

3.5.1 View Sensor Status

View Sensor Status displays all current configuration and operational parameters including: sensor type, software version number, detection range, AutoSpan level, days since last AutoSpan, estimated remaining sensor life, heater power, heater voltage, raw resistance, mA output, input voltage, and sensor ambient temperature.

From the **View Sensor Status** text scroll, hold the magnet over PGM1 or PGM2 until the “” prompt appears and continue to hold the magnet in place for an additional 3-4 seconds (until the display starts to scroll “Status Is”). The display will scroll the complete list of sensor status parameters sequentially:

Sensor Model Type

The menu item appears as: “TP-524D”

Current Software Version

The menu item appears as: “V X.XXZ”

Range of Detection.

The menu item appears as: “Range XXXppm”

AutoSpan Level.

The menu item appears as: “Auto Span Level XXppm”

Days Since Last AutoSpan.

The menu items appears as: “Last Cal XX days”

Remaining Sensor Life.

The menu item appears as: “Sensor Life 100%”

Sensor Heater Power.

The menu item appears as: “Heater XXXmW”

Sensor Heater Voltage

The menu item appears as: “Heater X.XXVDC

Raw Sensor Resistance

The menu item appears as: “Resistance XXXXX”

mA Output

The menu item appears as: “mA Output XX.XX mA”

Input Voltage Supply

The menu item appears as: “Voltage XX.X VDC”

Operating Temperature

The menu item appears as: “Temp XX C”

Alarm 1 Level

The menu item appears as: “Alarm 1 Level XX”

Alarm 1 Ascending

The menu item appears as: “Alarm 1 Ascending or Descending”

Alarm 1 Latching

The menu item appears as: “Alarm 1 Latching or Non-Latching”

Alarm 2 Level

The menu item appears as: “Alarm 2 Level XX”

Alarm 2 Ascending

The menu item appears as: “Alarm 2 Ascending or Descending”

Alarm 2 Latching

The menu item appears as: “Alarm 2 Latching or Non-Latching”

Fault Latching


The menu item appears as: “Fault Latching or Non-Latching”

When the status list sequence is complete, the display will revert to the “View Sensor Status” text scroll. The user can either: 1) review list again by executing another 3-4 second hold, 2) move to another menu item by executing a momentary hold over PGM1 or PGM2, or 3) return to Normal Operation via automatic timeout of about 15 seconds (the display will scroll “View Sensor Status” 4 times and then return to Normal Operation).

3.5.2 Set AutoSpan Level

Set AutoSpan Level is used to set the span gas concentration level that is being used to calibrate the sensor. This level is adjustable from 10% to 50% of selected full-scale range. The current setting can be viewed in View Program Status.

The menu item appears as: “**Set AutoSpan Level**”.

From the **Set AutoSpan Level** text scroll, hold the magnet over PGM1 or PGM2 until the “” prompt appears and continue to hold the magnet in place for an additional 3-4 seconds (until the display starts to scroll “Set Level”). The display will switch to “XX”(where XX is the current gas level). Swipe the magnet momentarily over PGM2 to increase or PGM1 to decrease the AutoSpan Level until the correct level is displayed. When the


correct level is achieved, hold the magnet over PGM1 or PGM2 for 3-4 seconds to accept the new value. The display will scroll “Level Saved”, and revert to “Set AutoSpan Level” text scroll.

Move to another menu item by executing a momentary hold, or return to Normal Operation via automatic timeout of about 15 seconds (the display will scroll “Set AutoSpan Level” 4 times and then return to Normal Operation).

3.5.3 Set Range

Set Range is used to change full-scale ranges. This is selectable between 0-20, 0-50, and 0-100ppm. The current range can be viewed in View Sensor Status using instruction given in Section 3.5.1 View Sensor Status.

The menu item appears as: **“Set Range”**.

From the **“Set Range”** text scroll, hold the programming magnet over PGM1 or PGM2 until the “” prompt appears and continue to hold the magnet in place for an additional 3-4 seconds (until the display starts to scroll “Set Range”). The display will then switch to “XXX“(where XXX is the current Range). Swipe the magnet momentarily over PGM2 to increase or PGM1 to decrease the range Level until the desired range is displayed. Hold the magnet over PGM1 or PGM2 for 3 seconds to accept the new value. The display will scroll “Range Saved”, and revert to “Set Range” text scroll.

Move to another menu item by executing a momentary hold, or, return to Normal Operation via automatic timeout of about 15 seconds (the display will scroll “Set Range” 7 times and then return to Normal Operation).


NOTE: When switching between ranges, it may be necessary to readjust the AutoSpan Level.

3.5.4 Set Heater Power

Set Heater Power is used to set the each H₂S sensor to the optimum operating temperature. This function is performed during factory calibration of each TP-524D-HRT sensor assembly, and is not necessary during installation. However, it is necessary to perform in the field if the plug-in H₂S sensor is replaced, mounted remotely from the Transmitter Module, or if the Restore Factory Defaults function has been executed.

The menu item appears as: **“Set Heater Power”**.

NOTE: “Set Heater Power” is only necessary after new plug-in H₂S sensor installation, mounted remotely from the Transmitter Module, or after use of the “Restore Factory Defaults” function. A full 3-4 second magnet hold on PGM1 or PGM 2 is required to execute this function.

From the “Set Heater Power” text scroll, hold the programming magnet over PGM1 or PGM2 until the “” prompt appears and continue to hold the magnet in place for an additional 3-4 seconds (until the display starts to scroll “Setting Heater”). After scrolling “Setting Heater”, the sensor will adjust the Heater power. The sequence should require about 2-minutes. When the cycle is complete, the display will revert to the “Set Heater Power” text scroll.

NOTE: If the sensor cannot adjust the heater power within 3 minutes an error message, “Can’t set, Reverting to Default”, will be scrolled. Refer to section 6 Troubleshooting Guide.

Move to another menu item by executing a momentary hold, or, return to Normal Operation via automatic timeout of about 15 seconds (the display will scroll “Set Heater Power” 4 times and then return to Normal Operation).


The current values for heater power and heater voltage can be observed in the “View Sensor Status” menu. The target heater power setting at 25C operating temperature is $240 \pm 5\text{mW}$. At the operating temperature extremes the observed heater power settings will vary according to the data below:

50C	normal heater power range is $210 \pm 5\text{mW}$
0C	normal heater power range is $260 \pm 5\text{mW}$
-20C	normal heater power range is $275 \pm 5\text{mW}$
-40C	normal heater power range is $290 \pm 5\text{mW}$

3.5.5 Signal Output Check

Signal Output Check provides a simulated 4-20mA output. This simulation allows the user to conveniently perform a functional system check of their entire safety system. This signal output simulation also aids the user in performing troubleshooting of signal wiring problems.

The menu item appears as: “**Signal Output Check**”.

From the “Signal Output Check” text scroll, hold the magnet over PGM1 or PGM2 until the “” prompt appears and then hold continuously for an additional 10 seconds. Once initiated, the display will scroll “Simulation Active” until the function is stopped. During simulation mode, the 4-20mA value will be increased from 4.0mA to 20.0mA (in 1% of range increments at about a 1 second update rate) and then decreased from 20.0mA to 4.0mA.

NOTE: Signal Output Check stays active indefinitely until the user stops the function. There is no automatic timeout for this feature.

To end simulation mode, hold magnet over PGM1 or PGM2 for 3 seconds. The display will either move to the prior menu item or move to the next menu item respectively.


Move to another menu item by executing a momentary hold, or, return to Normal Operation via automatic timeout of about 15 seconds.

3.5.6 Restore Factory Defaults

Restore Factory Defaults is used to clear current user configuration and calibration data from memory and revert to factory default values. This may be required if the settings have been configured improperly and a known reference point needs to be re-established to correct the problem.

This menu item appears as: “**Restore Defaults**”.

NOTE: “Restoring Factory Defaults” should only be used when absolutely necessary. All previously existing configuration inputs will have to be re-entered if this function is executed. A full 10-second magnet hold on PGM 1 is required to execute this function.

From the “Restore Defaults” text scroll, hold the programming magnet over PGM1 until the “” prompt appears and continue to hold 10 seconds. The display will scroll “Restoring Defaults”, and then will revert to the “Restore Defaults” text scroll.

Move to another menu item by executing a momentary hold, or, return to Normal Operation via automatic timeout of about 15 seconds (the display will scroll “Restore Defaults” 4 times and then return to Normal Operation).

Following the execution of “**Restore Defaults**”, the TP-524D-HRT will revert to its factory default settings. The default settings are:

NOTE: The following *must* be performed in order before the sensor can be placed back into operation.

- Range = 100ppm. Range must be set appropriately by the operator (3.5.3).
- AutoSpan Level = 25ppm. AutoSpan level must be set appropriately by the operator (3.5.2).
- Heater Power: Heater Power settings are lost and “Set Heater Power” (3.5.4) must be performed before “AutoSpan”.
- AutoSpan: AutoSpan Settings are lost and a successful “AutoSpan” must be performed before placing the Sensor into operation (3.4).

3.5.7 Alarm 1 and 2 Settings

The TP-524D has the ability to set alarm levels that are displayed on the front of the sensor via the LED’s ALM 1 and ALM 2. These alarm LEDs can be set as latching or non-latching. In non-latching mode, the LED is deactivated as soon as the sensor alarm condition is cleared. In latching mode, the LED remains active even after the alarm condition has cleared. Once activated, the LED can only be deactivated by swiping a magnetic programming tool above the PGM1 or PGM2 mark on the TP-524D face plate.

The alarm LEDs can be configured for ascending or descending mode. In ascending mode the LED will be activated when the concentration is *above* the alarm threshold. This is the most common mode of operation for the TP-524D. The alarm LEDs can also be activated in descending mode. In this mode, the alarm LEDs will activate when the concentration is *below* the alarm threshold.

The menu item appears as: “**Alarm X Settings**”

From the “**Alarm X Settings**” text scroll, hold the programming magnet over PGM1 or PGM2 until the “▼” prompt appears and continue to hold the magnet in place for an additional 3-4 seconds (until the display starts to scroll “Set Level”). The display will then switch to “XXX”(where XXX is the current alarm level in ppm). Swipe the magnet momentarily over PGM2 to decrease or PGM1 to increase the alarm level until the desired level is displayed. Hold the magnet over PGM1 or PGM2 for 3 seconds to accept the new value (until the display starts to scroll “Level Saved”).

The display will scroll “Set Ascending”, and then switch to “Yes” or “No”. “Yes” indicates the LED is in ascending mode and “No” indicates the LED is in descending mode. Swipe the magnet momentarily over PGM2 or PGM1 until the correct value is displayed. Hold the magnet over PGM1 or PGM2 for 3 seconds to accept the new value.

The display will scroll “Set Latching”, and then switch to “Yes” or “No”. “No” indicates the LED is non-latching and “Yes” indicates the LED is latching. Swipe the magnet momentarily over PGM2 or PGM1 until the correct value is displayed. Hold the magnet over PGM1 or PGM2 for 3 seconds to accept the new value.

Hold the magnet over PGM1 or PGM2 for 3 seconds to accept the new value (until the display starts to scroll “Saved”). Move to another menu item by executing a momentary hold, or, return to Normal Operation via automatic timeout of about 15 seconds (the display will scroll “Alarm X Settings” 4 times and then return to Normal Operation).

3.5.8 Fault Settings

The TP-524D Fault LED can be configured to change state when the sensor experiences a fault condition. This LED can be configured as either latching or non-latching. In non-latching mode, the LED is deactivated as soon

as the fault condition is cleared. In latching mode, the LED remains active even after the fault condition has cleared. Once activated, the LED can only be deactivated by swiping a magnetic programming tool above the PGM1 or PGM2 mark on the TP-524D face plate.

The menu item appears as: **“Fault Settings”**

From the **“Fault Settings”** text scroll, hold the programming magnet over PGM1 or PGM2 until the “▼” prompt appears and continue to hold the magnet in place for an additional 3-4 seconds. The display will scroll “Set Latching”, and then switch to “Yes” or “No”. “No” indicates the relay is non-latching and “Yes” indicates the relay is latching. Swipe the magnet momentarily over PGM2 or PGM1 until the correct value is displayed. Hold the magnet over PGM1 or PGM2 for 3 seconds to accept the new value.

Hold the magnet over PGM1 or PGM2 for 3 seconds to accept the new value (until the display starts to scroll “Saved”). Move to another menu item by executing a momentary hold, or, return to Normal Operation via automatic timeout of about 15 seconds (the display will scroll “Fault Settings” 4 times and then return to Normal Operation).

3.6 Program Features

Teledyne Detcon TP-524D-HRT H₂S gas sensors incorporate a comprehensive set of diagnostic features to achieve Fail-Safe Operation. These Operational features and Failsafe Diagnostic features are detailed below.

3.6.1 Operational Features

Over-Range

When gas greater than the full-scale range is detected, the sensor display will continuously flash the full-scale reading (20, 50, 100ppm). This designates an over-range condition. The 4-20mA signal will report a 22mA output during this time.

In-Calibration Status

When the sensor is engaged in AutoSpan calibration, the 4-20mA output signal is taken to 2.0mA. This alerts the user that the sensor is not in an active measurement mode. This feature also allows the user to log the AutoSpan events via their master control system.

Sensor Life

Sensor Life is calculated after each AutoSpan calibration and is reported as an indicator of remaining service life. It is reported in the “View Sensor Status” menu. Sensor Life is reported on a scale of 0-100%. When Sensor Life falls below 25%, the sensor cell should be replaced within a reasonable maintenance schedule.

Last AutoSpan Date

This reports the number of days that have elapsed since the last successful AutoSpan. This is reported in the View Sensor Status menu. After 180 days, an AutoSpan Fault will be declared.

3.6.2 Fault Diagnostic/Failsafe Features

Fail-Safe/Fault Supervision

Model TP-524D-HRT MicroSafe™ sensors are designed for Fail-Safe operation. If any of the diagnostic faults listed below are active, the sensor display will scroll the message “Fault Detected” every 60 seconds during

normal operation. At any time during “Fault Detected” mode, holding the programming magnet over PGM1 or PGM2 for 1 second will display the active fault(s). All active faults are reported sequentially.

Most fault conditions result in failed operation of the sensor. In these cases the 4-20mA signal is dropped to the universal fault level of 0mA. These include the AutoSpan Calibration faults, Heater Fault, Sensor Fault, Processor Fault, Memory Fault, Loop Fault, and Input Voltage Fault. (The 0mA fault level is not employed for a Temperature Fault, or during Calibration.)

NOTE: Refer to the Troubleshooting Guide, Section 6, for guidance on fault conditions.

Range Fault – AutoSpan

If the sensor fails the minimum signal change criteria during AutoSpan sequence (Section 3.4), the “Range Fault” will be declared. A “Range Fault” will cause a “Fault Detected” message to scroll once a minute on the sensor display and drop the 4-20mA output to 0mA. The sensor should be considered “Out-of-Service” until a successful AutoSpan calibration is performed.

Stability Fault - AutoSpan

If the sensor fails the signal stability criteria during AutoSpan sequence (Section 3.4), the “Stability Fault” will be declared. A “Stability Fault” will cause a “Fault Detected” message to scroll once a minute on the sensor display and drop the mA output to 0mA. The sensor should be considered as “Out-of-Service” until a successful AutoSpan calibration is performed.

Clearing Fault - AutoSpan

If the sensor fails the signal stability criteria during AutoSpan sequence (Section 3.4), the “Clearing Fault” will be declared. A “Clearing Fault” will cause a “Fault Detected” message to scroll once a minute on the sensor display and drop the mA output to 0mA. The sensor should be considered as “Out-of-Service” until a successful AutoSpan calibration is performed.

Open Heater Fault

If the sensor heater should fail and become electrically open, a “Heater Fault” will be declared. A “Heater Fault” will cause a “Fault Detected” message to scroll once a minute on the sensor display. If a Heater Fault occurs, the 4-20mA signal will be set at 0mA until the fault condition is resolved.

Open Sensor Fault

If the sensor film should fail and become electrically open, a “Sensor Fault” is declared. A “Sensor Fault” will cause a “Fault Detected” message to scroll once a minute on the sensor display. If a Sensor Fault occurs, the 4-20mA signal will be set at 0mA until the fault condition is resolved.

Processor Fault

If the detector has any unrecoverable run-time errors, a “Processor Fault” is declared. A “Processor Fault” will cause a “Fault Detected” message to scroll once a minute on the sensor display. If a Processor Fault occurs, the 4-20mA signal will be set at 0mA until the fault condition is resolved.

Memory Fault

If the detector has a failure in saving new data to memory, a “Memory Fault” is declared. A “Memory Fault” will cause the “Fault Detected” message to scroll once a minute on the sensor display. If a Memory Fault occurs, the 4-20mA signal will be set at 0mA until the fault condition is resolved.

4-20mA Loop Fault

If the sensor detects a condition where the 4-20mA output loop is not functional (high loop resistance or failed circuit function) a “4-20mA Fault” is declared. A “4-20mA Fault” will cause the “Fault Detected” message to scroll once a minute on the ITM display. If a Loop Fault occurs, the 4-20mA signal will be set at 0mA until the fault condition is resolved. If the 4-20mA current loop is still out of tolerance, contact Teledyne Detcon at detcon-service@teledyne.com, or contact Teledyne Detcon customer service.

Input Voltage Fault

If the detector is currently receiving an input voltage that is outside of the 11.5-28VDC range, an “Input Voltage Fault” is declared. An “Input Voltage Fault” will cause the “Fault Detected” message to scroll once a minute on the sensor display. If an Input Voltage Fault occurs, the 4-20mA signal will be set at 0mA until the fault condition is resolved.

Temperature Fault

If the detector is reporting currently an ambient temperature that is outside of the -40°C to $+75^{\circ}\text{C}$ range, a “Temperature Fault” is declared. A “Temperature Fault” will cause the “Fault Detected” message to scroll once a minute on the sensor display. If a Temperature Fault occurs, the 4-20mA signal remains operational.

AutoSpan Fault

If 180 days has elapsed since the last successful AutoSpan, an AutoSpan Fault will be generated. An “AutoSpan Fault” will cause the “Fault Detected” message to scroll once a minute on the sensor display. If an AutoSpan Reminder Fault occurs, the 4-20mA signal remains operational.

4. HRT Bridge

The HRT Bridge interface is an integral part of the Transmitter Module for the TP-524D-HRT. The sensor utilizes the 4-20mA output with the added HART interface information.

4.1 Description

The HRT Bridge PCA is a bi-directional digital communication interface that provides data communication between the Model TP-524D-HRT sensor and HART®-enabled devices. The HART® (Highway Addressable Remote Transducer) Communication Protocol is a standard for sending and receiving digital information across analog wires between smart devices and a control host or monitoring system. A host can be any software application from a technician's hand-held device or laptop to a plant's process control, asset management, safety or other system using any control platform.

The HART Communication Protocol makes use of the Bell 202 Frequency Shift Keying (FSK) Standard to superimpose digital communication signals on the 4-20mA signal utilized by the TP-524D-HRT sensor. This enables two-way communication and makes it possible for additional information to be transferred to and from the sensor. This communication includes the ability for the Host to:

- Configure or re-configure the sensor
- Perform sensor diagnostics
- Troubleshoot the sensor
- Read additional information from the sensor
- Determine the sensor's health and status

4.2 Connecting the HRT Bridge

The HRT Bridge connection to the Host utilizes a 3-wire connection of power, power return, and mA output (Refer to Figure 5 Base Connector Board). Connect the 24VDC to the base connector board terminal labeled 'DC+'. Connect the 24V Return to the terminal labeled 'DC-', and connect the 4-20mA to the terminal labeled 'mA'. The 4-20mA signal from the HRT Bridge must be connected to a load resistor to operate properly. If this signal is not terminated properly, the HRT Bridge, and the HART Interface will fail to work properly.

4.3 Operation

When power is applied to the TP-524D with HRT Bridge, the HRT Bridge will go through a boot up sequence that will last for approximately 30 seconds. During this time, the 4-20mA line will be held at 1mA. After the boot up sequence the HRT Bridge will enter normal operation, and communication with the Host will begin. A red LED (D7) Labeled "HART" on the HRT Bridge PCA will illuminate when the PCA is communicating with the HART Host. (The HRT Bridge is part of the TP-524D-HRT Transmitter assembly.)

The 4-20mA signal from the HRT Bridge must be connected to a load resistor for HART communication to operate properly. If this signal is not terminated properly, the HRT Bridge, and the HART Interface will fail to work. Normal termination for the 4-20mA signal is accomplished by connection to a Host device, which will have the correct load to terminate the signal properly.

If the HRT Bridge senses a fault in the sensor, it will take the 4-20mA signal down to 1mA. This 1mA signal will signify to the Host that a sensor fault has occurred, and the Host should, in turn, flag an error with the associated sensor.

The HRT Bridge communicates with the TP-524D-HRT sensor through Modbus™. The HRT Bridge reads the appropriate Modbus™ register and creates the 4-20mA signal from the register reading. This allows the HRT Bridge complete control of the HART Communications. A red LED Labeled “MODBUS” will blink when communication with the sensor occurs.

The HART interface has the ability to take the sensor into calibration. If the sensor is taken into calibration via the HART interface, the HART Communication Protocol will inform the Host that the sensor is in calibration mode, and will not set a fault. The 4-20mA signal will be set at 2mA. Starting a calibration using the sensor interface and magnetic tool will also cause the 4-20mA to be set to 2mA.

4.4 Operator Interface

The HRT Bridge provides the ability to interface with the sensor via the HART Interface. The HART interface Host can be a PC, a Laptop, or several handheld devices such as the Emerson 375 Field Communicator. Although the displays on each device may be different and the menu names may change, the information provided should be the same. The HART Interface consists of three basic Menus, each with a subset of menus or screens:

- Device Variables Menu
 - Primary Variables
 - Identification
- Diagnostics Menu
 - Device Status
 - Sensor Status
- Device Status Menu
 - Configuration Setup
 - Calibration
 - HART Setup

NOTE: The screen shots shown below are taken from the HART Communication Foundation SDC625 Reference Host. The user's screen appearance may be different depending on the HART host used.

4.4.1 Device Menu

4.4.1.1 Primary Variables

The primary Variable Screen contains the basic information from the sensor and is broken into four basic sections. None of these variables are changeable, and are directly read from the sensor.

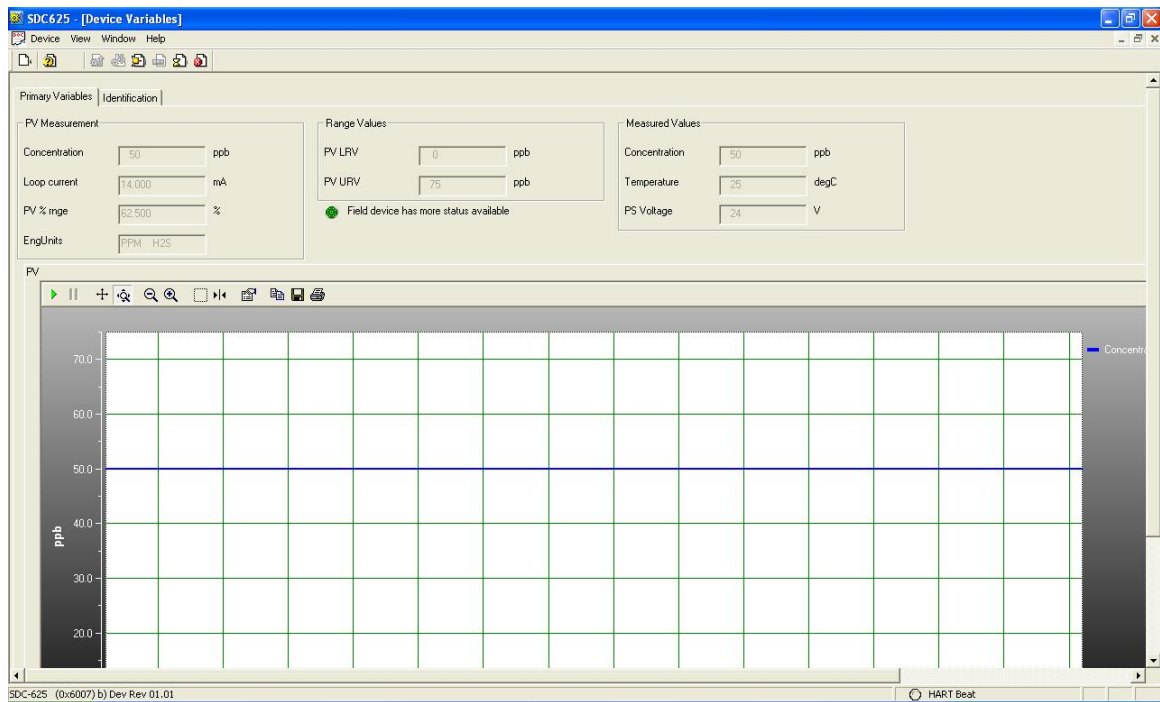


Figure 12 Primary Variables

Primary Variables

- Concentration – the value of the gas concentration measured by the sensor. The units of measurement (ppm, ppb, or %) are shown to the right of the concentration value. This is the HART primary variable.
- Loop Current – the value of the output 4-20mA loop current
- PV %range – Primary variable percent of range
- EngUnits – the measurement units and gas type

Range Variables

- PV LRV – Primary variable lower range value (normally 0 for most sensors)
- PV URV – Primary variable upper range value, or the range of the sensor (i.e. 100ppm, 10ppm, 5%, etc.)

Device Status

- Indicates the device has more status information available. If this icon is green, no additional status information is available. If it is red, refer to Section 4.4.2 Diagnostics for more information.

Measured Values

- Concentration – the value of the gas concentration measured by the sensor. The units of measurement (ppm, ppb, or %) are shown to the right of the concentration value
- Temperature – displayed in degrees Centigrade.
- PS Voltage – power supply voltage. Nominally 24VDC

PV – Graphic display

A graphic display of the sensor concentration reading may also be displayed in this screen. The graph will be a graphic display of concentration verses time.

4.4.1.2 Identification

The Identification screen contains 4 sections that provide some basic HART information as well as some additional sensor information. None of these variables are able to be changed in this screen, although some of these variables may be changed elsewhere.

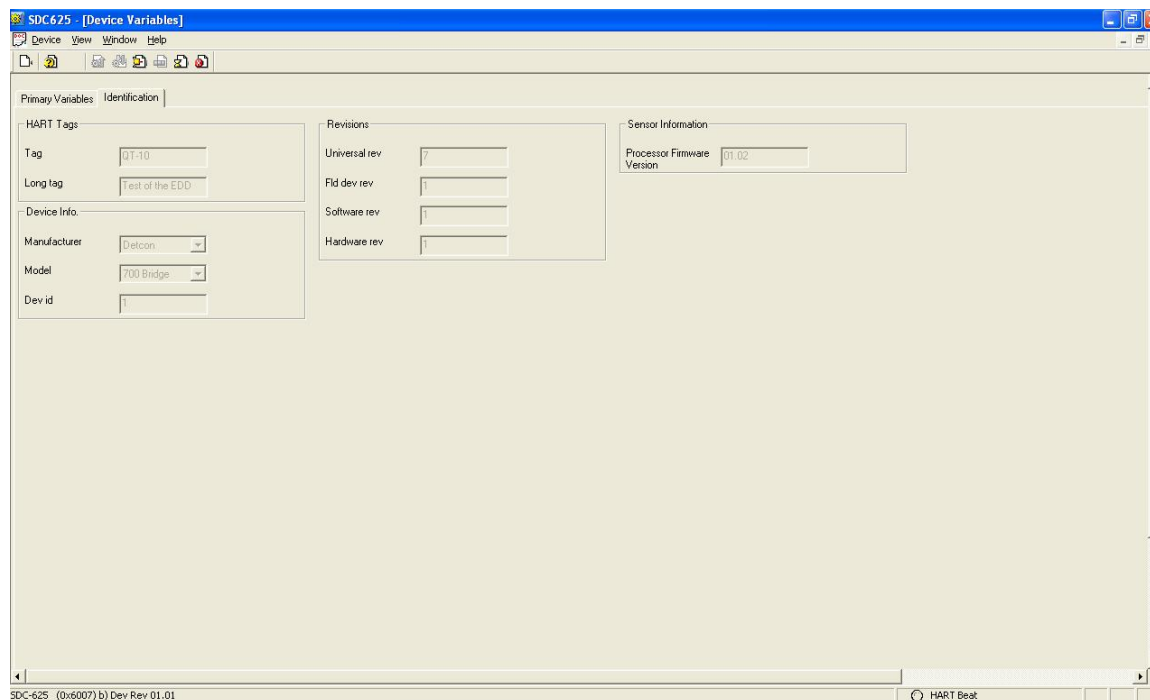


Figure 13 Identification

HART Tags

- Tag – Text that is associated with the field device installation. This text can be used by the user in any way. A recommended use is a unique label that correlates to a field device label: a plant drawing, or on a control system. This variable is also used as a type of data link layer address handle.
- Long Tag – Functions exactly like the Tag except the size is larger (max 32 ISO Latin 1 characters).

Device Info.

- Manufacturer – Device manufacturer – “Teledyne Detcon”
- Model – Device model – “700 Bridge”
- Dev id – Field Device Identification – Uniquely identifies the field device when combined with the Manufacturer and Model.

Revisions

- Universal rev – Revision of the HART Communication Protocol (currently revision 7)
- Fld dev rev – Revision of the Field Device Specific Device Description
- Software rev – Revision of the software embedded in the HRT Bridge PCA
- Hardware rev – Revision of the hardware in the HRT Bridge PCA.

Sensor Information

- Processor Firmware Version – Version of the firmware currently loaded in the TP-524D-HRT sensor.

4.4.2 Diagnostics Menu

The Diagnostics Menu contains two screens; 1) Device Status and 2) Channel Status. Both screens consist of a list of possible device error or status conditions. Next to each status condition is a small icon that will be either green to display the normal status, or red to indicate an abnormal, changed, or a malfunction condition.

4.4.2.1 Device Status

Device Status contains one screen that shows the status of the sensor and the HRT Bridge PCA. The left side of the screen (Device Status) displays the status of the HRT Bridge PCA, with icons that will display either green to indicate normal condition, or red to indicate an error, a change, or a malfunction.

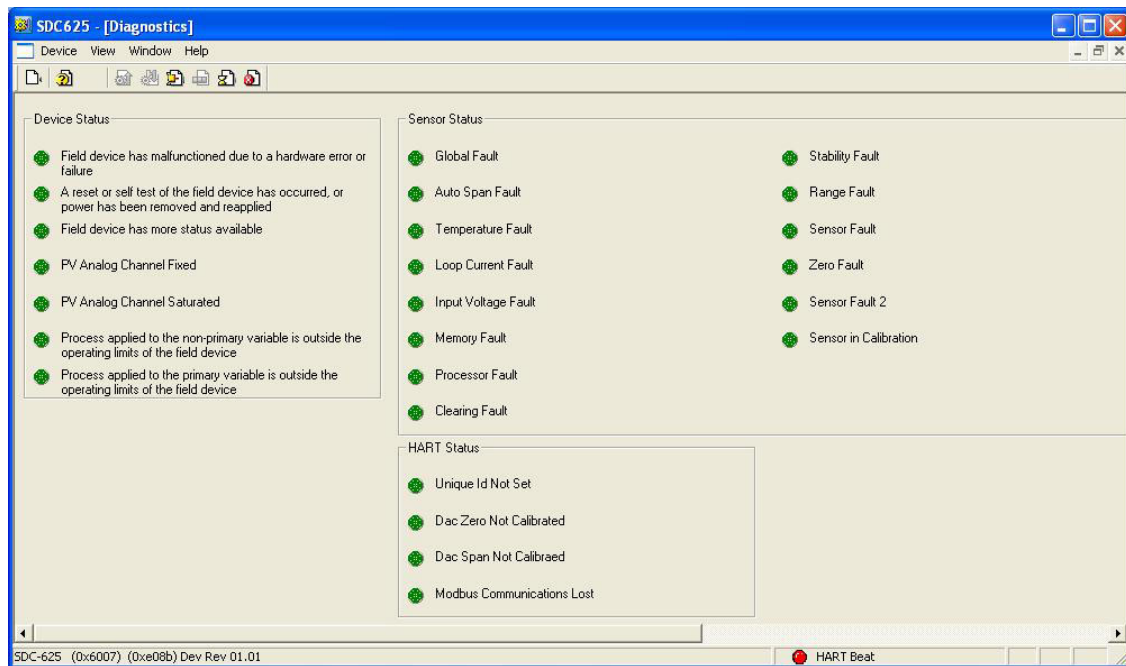


Figure 14 Device Status Screen

- Field device has malfunctioned due to a hardware error or failure
- A reset or self test of the field device has occurred, or power has been removed and reapplied
- Field device has more status available
- PV analog channel fixed
- PV analog channel saturated
- Process applied to the non-primary variable is outside the operating limits of the field device
- Process applied to the primary variable is outside the operating limits of the field device

4.4.2.2 Sensor Status

The Sensor Status section of the screen shows the status of the TP-524D-HRT sensor. Icons are used to display the status of the sensor and display either green to indicate normal condition or red to indicate an error, a change, or a malfunction.

- Global Fault – The TP-524D-HRT sensor has one or more faults.
- Auto span fault – 180 days or more has elapsed since the last successful AutoSpan
- Temperature fault – the detector is currently reporting an ambient temperature that is outside of the – 40C to +75C range
- Loop current fault – The sensor has detected a condition where the 4-20mA output loop is not functional

- Input voltage fault – The sensor is currently receiving an input voltage that is outside of the 12-28VDC range
- Memory fault – The detector has a failure in saving new data to memory
- Processor fault – The detector has an unrecoverable run-time error
- Clearing Fault – The sensor reading failed to clear after removal of span gas during an AutoSpan sequence
- Stability Fault – The sensor reading failed to attain a stable reading when span gas was applied during an AutoSpan sequence
- Range Fault – Sensor fails the minimum signal change criteria during an AutoSpan sequence
- Sensor fault – The sensor cell has failed
- Zero Fault – the sensor drifts below –10% of full range
- Sensor Fault 2 – Wheatstone bridge fault
- Sensor in Calibration – The sensor is currently being calibrated

4.4.2.3 HART Status

The HART status section of the screen shows the status of the HART interface on the HRT Bridge PCA. Icons next to each error description indicate if an error has occurred. A green icon indicates the error condition is not present and a red icon indicates an error has occurred.

- Unique ID Not Set – The unique device ID for the HRT Bridge PCA has not been set. This ID is set at the Teledyne Detcon factory prior to shipping. If this error occurs, please contact Teledyne Detcon technical support.
- DAC Zero Not Calibrated – The 4mA output of the HRT Bridge PCA has not been calibrated. Please see Section 4.4.3.4 for calibration instructions
- DAC Span Not Calibrated – The 20mA output of the HRT Bridge PCA has not been calibrated. Please see Section 4.4.3.4 for calibration instructions
- Modbus Communications Lost – The TP-524D-HRT sensor has failed to respond to more than 3 Modbus poll requests. This error condition can be reset using the “Reset Comm Lost Status” button that appears when this error condition occurs.

4.4.3 Device Setup Menu

The Device Status Menu consists of three sub menus that allow parameters within the HRT Bridge PCA, and within the sensor to be changed or modified, and allows calibration of the sensor.

4.4.3.1 Configuration Setup

The Configuration Screen displays the configuration of the TP-524D-HRT sensor. There are no fields that can be changed on this screen, these fields are read directly from the TP-524D-HRT sensor.

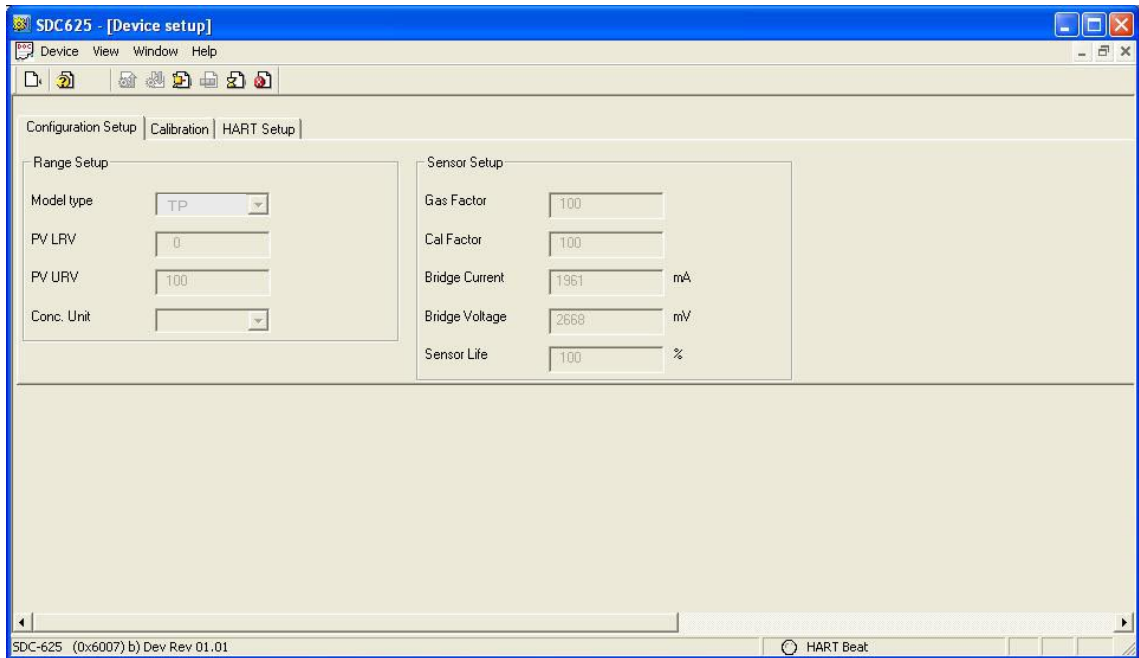


Figure 15 FP Configuration Setup

The Range Set up will display the Model Type of the sensor, followed by the PV LRV (Primary Variable Lower Range Value) and the PV URV (Primary Variable Upper Range Value), and the Conc Units (Concentration Units), the display may also show the Sensor Range. The Sensor Setup portion of the screen will display sensor specific parameters:

- Heater Power
- Heater Voltage
- Sensor Resistance
- Heater Current
- Sensor Life

NOTE: The values above are read when the HRT Bridge boots up and are not updated in real-time.

4.4.3.2 Calibration

The Calibration screen displays the days since the last calibration, and the auto span level. This screen also allows the user to calibrate the sensor by performing an Auto Span Calibration. Calibration of the sensor using this feature also notifies the Host that the sensor is in calibration mode.

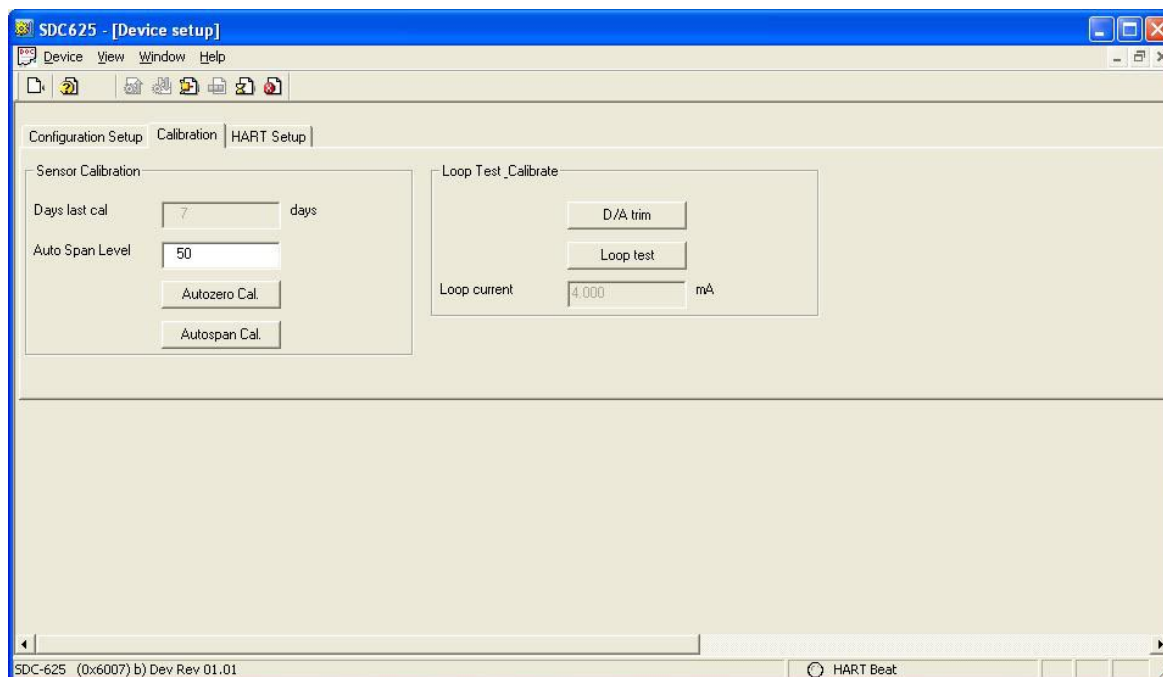


Figure 16 FP Calibration Screen

4.4.3.3 Sensor Calibration using the HRT Bridge

Calibration of a sensor using the HRT Bridge follows the same principle as calibrating the sensor via the magnetic interface. Since most of the calibration information can be found in Section 3.4 Calibration Mode, it is important to have the sensor manual on hand when performing sensor calibration.

Auto Zero

Auto Zero function is not used with the TP-524D-HRT Sensor.

Auto Span

The Auto Span function is used to calibrate the sensor. Unless otherwise specified by the associated sensor manual, span calibration is recommended at 50% of range.

Material Requirements:

- Handheld Communicator or PC and interface for HRT Bridge.
- Teledyne Detcon PN 600-610000-000 Splash Guard with integral Cal Port -OR-
-Teledyne Detcon PN 943-000006-038 Threaded Calibration Adapter
- Teledyne Detcon PN 985-241100-321 In-Line Humidifying Tube
- Teledyne Detcon PN 942-010112-025 H₂S Span Gas (recommended) or other suitable span gas source containing H₂S gas in air balance. A fixed flow rate of 200-500cc/min is recommended.

NOTE: Refer to Section 3.4 Calibration Mode (AutoSpan) for information regarding Span Gas, flow rates, cross interference, or other sensor specific criteria.

Auto Span consists of entering “Autospan Cal” and following the display. The procedure will ask for the application of span gas. The applied gas concentration must be equal to the Autospan gas level setting. The factory default setting and recommendation for span gas concentration is normally 50% of range. If a span gas containing the recommended concentration is not available, other concentrations may be used as long as they

fall between 5% and 100% of range. However, any alternate span gas concentration value must be set in the “**Auto Span Level**” field before proceeding with “Autospan cal”.

NOTE 1: Before performing AutoSpan Calibration, verify that the AutoSpan level matches the span calibration gas concentration as described in Section 3.5.2 Set AutoSpan Level.

NOTE 2: The span gas source must have a normal background concentration of 20.9% O₂ (H₂S balanced with Air). Pure Nitrogen background mixtures are not acceptable! Significant span calibration inaccuracies will result.

NOTE 3: An H₂S gas concentration of 25ppm is strongly recommended for 0-50 and 0-100ppm ranges (10ppm span gas for 0-20ppm range). This should be supplied at a controlled flow rate of 200 to 500cc/min, with 200cc/min being the recommended flow rate. Other concentrations can be used if as they fall within allowable levels.

NOTE 4: Span gas bottles contain 0% humidity and this ultra-low humidity condition will cause inaccurate readings when used to calibrate a sensor. To prevent this error, Teledyne Detcon prescribes the use of a 24” flexible In-Line Humidifying Tube, which adds the relative humidity to the span gas. The humidifying tube is not necessary when using a gas generating calibration device that consists of pumped ambient air and an H₂S generating source.



CAUTION: Verification that the calibration gas level setting matches the calibration span gas concentration is required before executing “Autospan Cal”. These two numbers must be equal. Refer to the appropriate sensor manual for more information.

1. If applicable install the Calibration Adapter or Splash Guard Adapter with integral Cal Port.
2. Verify that the Auto Span Level is equal to the calibration span gas concentration. If the Auto Span Level is not equal to the Calibration span gas concentration, adjust the Auto Span Level.
3. Connect the Cal Gas to the sensor, but do not apply the gas.
4. Select “Autospan Cal” from the Sensor Calibration section of the screen.

NOTE: Upon entering calibration the 4-20mA signal drops to 2mA and is held at this level until the program returns to normal operation.

5. Upon entering the procedure the procedure will prompt to begin Auto Span Calibration.
6. The procedure will prompt to apply span gas. Apply span gas from the attached cal gas cylinder and respond to the prompt.

NOTE: The sensor reading will respond to the gas and will switch to displaying a flashing “XX”.

NOTE: Assuming acceptable sensor signal change, after 3 minute the reading will auto-adjust to the programmed Auto Span level. During the next 30 seconds, the Auto Span sequence checks the sensor for acceptable reading stability. If the sensor fails the stability check, the reading is re-adjusted back to the Auto Span level and the cycle repeats until the stability check is passed. Up to three additional 30-second stability check periods are allowed before the unit reports a “**Stability Fault**” twice and the sensor will return to normal operation, aborting the Auto Span sequence. The sensor will continue to report a “**Stability Fault**” and will not clear the fault until a successful Auto Span is completed.

7. If the sensor passes the stability check, the sensor reports a series of messages:

“AutoSpan Complete”

“Sensor Life XXX%”

“Remove Span Gas”

8. When the sensor passes calibration the procedure will prompt to remove the span gas. Unsuccessful completion of the span calibration will create a Global Fault, and “Autospan Cal” will be aborted with a change to the HART Sensor Status (refer to section 4.4.2.2 Sensor Status).
9. After successfully setting span cal the sensor and the HART Interface will return to Automatic Mode.
10. The Auto Span Calibration is complete
11. Remove the cal gas and calibration adapter if applicable.

NOTE 1: If the sensor fails the minimum signal change criteria, a “**Range Fault**” will be declared and a “**Fault Detected**” message will be displayed alternately on the sensor with the current reading. The HART Sensor Status will change to reflect a Range Fault.

NOTE 2: If the sensor fails the stability criteria, a “**Stability Fault**” will be declared and a “**Fault Detected**” message will be displayed alternately on the sensor with the current reading. The HART Sensor Status will change to reflect a Sensor Fault.

NOTE 3: If the sensor fails the clearing time criteria, a “**Clearing Fault**” will be declared and a “**Fault Detected**” message will be displayed alternately on the sensor with the current reading. The HART Sensor Status will change to reflect a Clearing Fault.

4.4.3.4 Loop Test Calibrate

The Calibration Screen contains a Loop Test Calibration section. This section displays the loop current reading and allows the user to perform D/A trim and Loop Test. D/A trim is used to calibrate the 4mA and 20mA set points in the Digital/Analog converter. Loop test allows the user to set the mA output to any level within range; this can be a good troubleshooting tool for line degradation. A DVM capable of reading milliamps and a 100~250 Ohm resistor are required to perform D/A trim and/or Loop test.

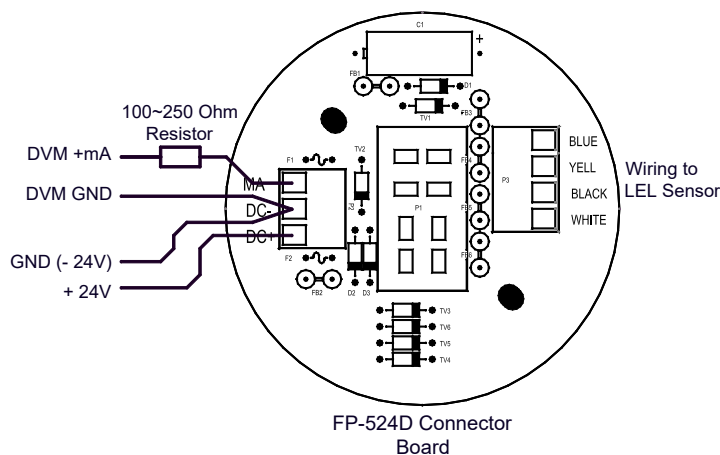


Figure 17 DVM Connection

D/A Trim

- 1) Select “D/A trim” from the Loop test Calibrate section of the screen.
- 2) The procedure will prompt to connect a meter: (Refer to Figure 17.)
 - a) Disconnect the wire from the connector board mA terminal.
 - b) Connect one end of a 100~250Ohm resistor to the mA terminal.

- c) Connect the positive lead of a DVM set to measure milliamps to the other end of the resistor.
- d) Connect the negative lead (-) of the DVM to the 'DC-' terminal of the connector board.
- 3) The procedure will set the output to 4mA, and prompt for the DVM Reading. Input the reading and select "OK".
- 4) The HRT Bridge will readjust the output for 4mA, and inquire if the reading is 4mA on the DVM (select "YES" or "NO").
- 5) If the reading on the DVM is 4mA, select "YES" and "OK" and the HRT Bridge will continue on to 20mA. If the reading is not 4mA, select "NO" and "OK" and the procedure will re-run the 4mA calibration (Step 3).
- 6) The procedure will set the output to 20mA, and prompt for the DVM Reading. Input the reading and select "OK".
- 7) The HRT Bridge will readjust the output for 20mA, and inquire if the reading is 20mA on the DVM (select "YES" or "NO").
- 8) If the reading on the DVM is 20mA, Select "YES" and "OK". If the reading is not 20mA, select "NO" and "OK" and the procedure will re-run the 20mA calibration (Step 6).
- 9) When both the 4mA and the 20mA have been calibrated the procedure will return the HRT Bridge to automatic control.

Loop Test

- 1) Ensure that the DVM is connected as prescribed in Figure 17:
 - a) Disconnect the wire from the Connector Board mA terminal.
 - b) Connect one end of a 100~250Ohm resistor to the mA terminal on the connector board.
 - c) Connect the positive lead of a DVM, set to measure milliamps, to the other end of the resistor.
 - d) Connect the negative lead (-) of the DVM to the 'DC-' terminal of the connectorboard. (Figure 17)
- 2) Select "Loop test" from the Loop test Calibrate section of the screen.
- 3) The procedure will prompt for a setting ("4mA", "20mA", "Other", and "End").
- 4) Select one of the settings or "End" to exit.
- 5) If "Other" is selected, the procedure will prompt for a value. Only valid values will be accepted.
- 6) Select "OK".
- 7) The HRT Bridge will set the output for the selected milliamp value.
- 8) Compare the reading on the DVM to the output displayed. Select "OK" when ready to continue
- 9) The procedure will return to Step 3. If "End" is selected, the HRT Bridge will exit Loop test and return to automatic control.

4.4.3.5 HART Setup

The HART Setup Screen allows parameters of the HRT Bridge to be changed or modified. Changes made on this screen will not be applied until power is cycled on the unit.

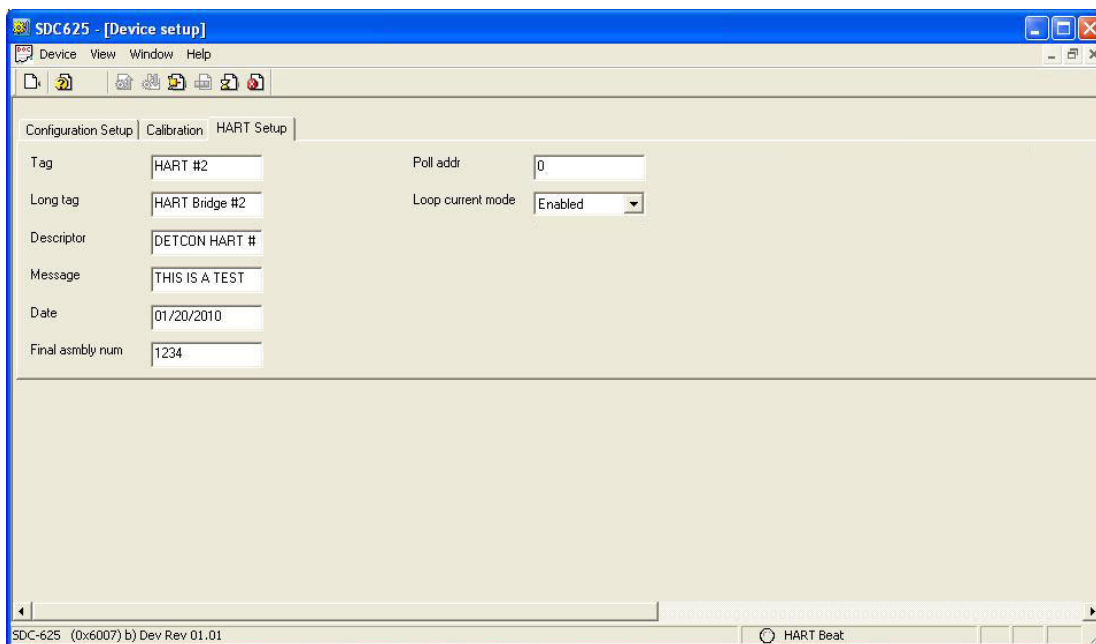


Figure 18 HART Setup

- Tag – Text that is associated with the field device installation. This text can be used by the user in any way. A recommended use is a unique label that correlates to a field device label: a plant drawing, or on a control system. This variable is also used as a type of data link layer address handle.
- Long Tag – Functions exactly like the Tag except the size is larger (max 32 ISO Latin 1 characters).
- Descriptor – Text that is associated with the field device. This text can be used by the user in any way. There is no specific recommended use.
- Message – Text that is associated with the field device. This text can be used by the user in any way. There is no specific recommended use.
- Date – Gregorian calendar date that is stored in the field device. This can be used by the user in any way. There is no specific recommended use. Note: This field is not updated by the HRT Bridge and does not indicate the current date.
- Final assembly num – Number that is used for identification purposes, and is associated with the overall field device.
- Poll addr – This number is the address of the HRT Bridge on a network and must be set to 0.

5. Service and Maintenance

Calibration Frequency

In most applications, monthly to quarterly span calibration intervals will assure reliable detection. However, industrial environments differ. Upon initial installation and commissioning, close frequency tests should be performed, weekly to monthly. Test results should be recorded and reviewed to determine a suitable calibration interval. If, after 180 days, an AutoSpan Calibration is not performed, the sensor will generate an AutoSpan Fault.

Visual Inspection

The Sensor should be inspected annually. Inspect for signs of corrosion, pitting, and water damage. During visual inspection, the Splash Guard should be inspected to insure that it is not blocked. Examine the porous 316SS flame arrestor within the sensor's bottom housing for signs of physical blockage or severe corrosion. Also, inspect inside the Junction Box for signs of water accumulation or Terminal Block corrosion.

Condensation Prevention Packet

A moisture condensation packet should be installed in every explosion proof Junction Box. The moisture condensation prevention packet will prevent the internal volume of the J-Box from condensing and accumulating moisture due to day-night humidity changes. This packet provides a critical function and should be replaced annually. Teledyne Detcon's PN is 960-202200-000.

NOTE: A desiccant cap with a desiccant packet is attached to the sensor cell housing to avoid damage during storage and shipping. This prevents water from contacting the sensor film, and as a result helps to retain the stability of the factory span calibration.

NOTE: Store the desiccant caps with the desiccant packets in a sealed container (i.e. zip-lock bag) for future use. It is advisable (but not mandatory) to reinstall the desiccant cap and packet during prolonged periods without power (more than 1 day is considered "prolonged"). An active desiccant packet is blue in color and turns pink when consumed. (P/N 960-399800-000 Package of 10)

Replacement of H₂S Sensor

NOTE: It is necessary to remove power while changing the H₂S sensor in order to maintain area classification while the junction box cover is removed. Proper "Hot Permits" may apply.

- a) Remove the junction box cover and remove the Transmitter Module from the Connector PCB.
- b) Remove the black, white, blue, and yellow wires coming from the H₂S Sensor from the connector PCB.
- c) Unthread the H₂S Sensor from the junction box and thread the new H₂S Sensor onto the junction box.
- d) Connect the black, white, blue, and yellow wires from the new H₂S sensor to the connector PCB.
- e) Reinstall the Transmitter Module, and the junction box cover.
- f) Perform "Set Heater Power (Section 3.5.4) to match the new H₂S sensor with the Transmitter Module.
- g) Perform a successful AutoSpan to match the new H₂S sensor with the Transmitter Module (Section 3.4).

Replacement of Transmitter Module

- a) Remove the junction box cover and remove the Transmitter Module from the Connector PCB.

NOTE: It is necessary to remove power to the Junction Box while changing the Transmitter Module in order to maintain area classification.

- b) Plug the new Transmitter Module into the connector PCB, and reinstall the junction box cover.
- c) Perform Set Range, Set Heater Power, and Set AutoSpan Level then perform a successful AutoSpan before placing sensor assembly into operation.

Replacement of the Connector PCB

NOTE: It is necessary to remove power to the Junction Box while changing the Transmitter Module in order to maintain area classification.

- a) Remove the junction box cover and remove the Transmitter Module from the Connector PCB.
- b) Remove the black, white, blue, and yellow wires coming from the H₂S Sensor from the connector PCB.
- c) Remove the output wiring from the connector PCB terminals labeled DC+, DC-, and MA.
- d) Remove the two 6-32 screws holding the Connector PCB to the base of the junction box, and remove the Connector PCB.
- e) Install the new Connector PCB using the two 6-32 screws removed in step d.
- f) Re-connect the output wiring to the terminals labeled DC+, DC-, and MA on the connector PCB,
- g) Reconnect the black, white, blue, and yellow wires from the H₂S Sensor to the connector PCB.
- h) Reinstall the Transmitter Module, and the junction box cover.

6. Troubleshooting Guide

Refer to the list of Failsafe Diagnostic features listed in Section 3.6.2 for additional reference in troubleshooting activities. Listed below are some typical trouble conditions and their probable cause and resolution path.

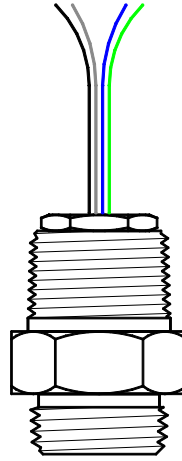


Figure 19 Replaceable H₂S Sensor

Open Heater

Probable Cause: H₂S sensor has failed

Remove H₂S sensor wires from the Connector PCB and verify resistance between the black and white wires using an ohmmeter. At room temperature, the heater film's normal reading should range between 70 and 90 ohms.

Replace the H₂S sensor if open circuit or significantly out-of range readings are found.

Open Sensor

Probable Cause: H₂S sensor has failed

Remove H₂S sensor wires from the Connector PCB and verify resistance between the blue and yellow wires using an ohmmeter. At room temperature, the sensor's normal reading range should be 100 K-ohms to 25 meg-ohms. Failure would be open circuit.

Replace the H₂S sensor if an open circuit is found.

AutoSpan Calibration Faults – (Range, Stability, and Clearing)

To clear any AutoSpan Calibration fault, the AutoSpan process must be completed successfully (Section 3.4).

Range Fault

Probable Causes: Failed Sensor, Cal Gas not applied or not applied at appropriate time, problems w/ cal gas and delivery, no Humidifying Tube used, failure to properly desiccant packet the sensor cell during extended power-off periods.

Check Heater Power Setting (should be $240 \pm 5\text{mW}$ at 25°C ambient temperature).

Verify use of span gas Humidifying Tube.

Check validity of span gas using H₂S pull tube or other means (check MFG date on cal gas cylinder).

Check for obstructions through stainless steel flame arrestor (including being wet, blocked, or corroded).

Replace the H₂S sensor.

Stability Fault

Probable Causes: Failed Sensor, empty or close to empty Cal Gas Cylinder, problems with cal gas and delivery, or no Humidifying Tube used, failure to properly desiccate the sensor cell during extended power-off periods.

Check Heater Power Setting (should be $240 \pm 5\text{mW}$ at 25°C ambient temperature).

Verify use of span gas Humidifying Tube.

Check validity of span gas using H_2S pull tube or other means (check MFG date on cal gas cylinder).

Check for obstructions through stainless steel flame arrestor (including being wet, blocked, or corroded).

Replace the H_2S sensor.

Clearing Fault

Probable Causes: Failed Sensor, Cal Gas not removed at appropriate time or problems with cal gas and delivery, presence of background H_2S , or incorrect Heater Power Setting.

Must recover to $< 8\text{ppm}$ in $< 5\text{ min}$ after AutoSpan is complete

Use bottled air (zero air) if there is a known continuous H_2S background level.

Verify use of span gas Humidifying Tube.

Check validity of span gas using H_2S pull tube or other means (check MFG date on cal cylinder).

Check for obstructions through stainless steel flame arrestor (including being wet, blocked, or corroded).

Perform Heater Power Setting.

Replace the H_2S sensor.

Poor Calibration Repeatability

Probable Causes: Failed Sensor, use of wrong Cal Gas or problems w/ cal gas and delivery, or Interference Gases

Check for adequate Sensor Life.

Check Heater Voltage Setting (should be $240 \pm 5\text{mW}$ at 25°C ambient temperature).

Verify use of span gas Humidifying Tube.

Check validity of cal gas using H_2S pull tube or other means (check MFG date on cal cylinder).

Check for obstructions through stainless steel flame arrestor (including being wet, blocked, or corroded).

Evaluate area for presence of any contaminating gases as listed in Section 2.3.

Note the sensor's serial # and report repetitive problems to Teledyne Detcon's Repair Department.

Replace the H_2S sensor.

Unstable Output/ Sudden spiking

Possible Causes: Unstable power supply, inadequate grounding, or inadequate RFI protection

Verify Power source is stable.

Verify field wiring is properly shielded and grounded.

Contact Teledyne Detcon to optimize shielding and grounding.

Add Teledyne Detcon's RFI Protection Circuit accessory if problem is proven RFI induced.

Nuisance Alarms

Check conduit for accumulated water and abnormal corrosion on terminal blocks.

If nuisance alarms are happening at night, suspect condensation in conduit. Add or replace Teledyne Detcon's Condensation Prevention Packet P/N 960-202200-000.

Investigate the presence of other target gases that are causing cross-interference erroneous readings.

Determine if cause is RFI induced.

Processor and/or Memory Faults

Recycle power in attempt to clear problem

Restore Factory Defaults - This will clear the processor's memory and may correct problem. Remember to re-enter all customer settings for range and cal gas level after Restore Factory Defaults.
If problem persists, replace the Plug-in Transmitter Module.

Unreadable Display

If due to excessive sunlight, install a sunshade to reduce glare.

Nothing Displayed – Transmitter not Responding

Verify conduit has no accumulated water or abnormal corrosion.
Verify required DC power is applied to correct terminals.
Swap with a known-good Transmitter Module to determine if Transmitter Module is faulty.

Faulty 4-20mA Output

If Sensor has a normal reading with no Faults displayed, and the 4-20 mA signal output is 0mA....
Check that wiring is properly connected at terminal blocks and through to controller inputs.
The 4-20mA output loop must be closed (resistance of < 1000 ohms) to avoid the Loop Fault.
Perform a "Signal Output Check" sequence via Section 3.5.5 and verify 4-20mA output with Current Meter.
Swap with a known-good Transmitter Module to determine if the Transmitter Module's 4-20mA output circuit is faulty.
If the 4-20mA current loop is still out of tolerance, contact Teledyne Detcon at detcon-service@teledyne.com, or contact Teledyne Detcon customer service.

7. Customer Support and Service Policy

Teledyne Detcon Headquarters

Shipping Address: 14880 Skinner Road, Cypress, Texas 77429

Phone: 713.559.9200

- www.teledynegasandflamedetcon.com
- detcon-service@teledyne.com
- detcon-sales@teledyne.com

All Technical Service and Repair activities should be handled by the Teledyne Detcon Service Department via phone, fax or email at contact information given above. RMA numbers should be obtained from the Teledyne Detcon Service Department prior to equipment being returned. For on-line technical service, customers should have ready the model number, part number, and serial number of product(s) in question.

All Sales activities (including spare parts purchase) should be handled by the Teledyne Detcon Sales Department via phone, fax or email at contact information given above.

Warranty Notice

Teledyne Detcon Inc. warrants the Model TP-524D-HRT H₂S gas sensor to be free from defects in workmanship of material under normal use and service for two years from the date of shipment on the transmitter electronics and for a 10 year conditional period on the H₂S sensor. See Warranty details in Section 8 TP-524D-HRT Sensor Warranty.

Teledyne Detcon Inc. 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 Teledyne Detcon Inc. personnel.

Defective or damaged equipment must be shipped to the Teledyne Detcon Inc. factory or representative from which the original shipment was made. In all cases, this warranty is limited to the cost of the equipment supplied by Teledyne Detcon Inc. The customer will assume all liability for the misuse of this equipment by its employees or other contracted personnel.

All warranties are contingent upon the proper use in the application for which the product was intended and does not cover products which have been modified or repaired without Teledyne Detcon Inc. 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, Teledyne Detcon Inc. 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 Teledyne Detcon Inc. for damages including, but not limited to, consequential damages arising out of, or in connection with, the performance of the product.

8. TP-524D-HRT Sensor Warranty

H₂S Sensor Warranty

Teledyne Detcon Inc. warrants, under normal intended use, each new H₂S sensor (PN 399-800000-000) for a ten year period under the conditions described as follows: The warranty period begins on the date of shipment to the original purchaser and ends ten years thereafter. The sensor element is warranted to be free of defects in material and workmanship. Should any sensor fail to perform in accordance with published specifications within the warranty period, return the defective part to Teledyne Detcon, Inc., 14880 Skinner Road, Cypress, Texas 77429, for necessary repairs or replacement.

First year	No Charge
2 nd -5 th years	\$ 25.00 handling charge
6th year	\$ 60.00 handling charge
7th year	\$ 90.00 handling charge
8th year	\$120.00 handling charge
9th year	\$150.00 handling charge
10th year	\$180.00 handling charge
Warranty voided	\$200.00 charge
Non-warranty	\$295.00 charge

NOTE: The warranty will not be honored if evidence shows that the sensor cell was damaged by moisture exposure due to improper handling and protection during periods of removed power or storage. The sensor cell must be protected during periods of removed power or storage by use of a Dust Cap (P/N 602-003306-0TP) and a Desiccant Packet (P/N 960-240010-000).

Terms & Conditions

- * The original serial number must be legible on each sensor element base.
- * Shipping point is FOB the Teledyne Detcon factory.
- * Net payment is due within 30 days of invoice.
- * Teledyne Detcon, Inc. reserves the right to refund the original purchase price in lieu of sensor replacement.

Transmitter Module Warranty

Teledyne Detcon Inc. warrants, under intended normal use, each new Transmitter Module to be free from defects in material and workmanship for a period of two years from the date of shipment to the original purchaser. All warranties and service policies are FOB the Teledyne Detcon facility located in Cypress, Texas.

Terms & Conditions

- * The original serial number must be legible on each ITM.
- * Shipping point is FOB the Teledyne Detcon factory.
- * Net payment is due within 30 days of invoice.
- * Teledyne Detcon, Inc. reserves the right to refund the original purchase price in lieu of ITM replacement.

9. Appendix

9.1 Specifications

Sensor Type:	Continuous diffusion/adsorption type CHEMFET Solid State MOS type
Sensor Life:	5-10 years typical
Measuring Ranges:	0-20ppm, 0-50ppm, or 0-100ppm
Accuracy/ Repeatability:	± 2 ppm or $\pm 10\%$ of applied gas (whichever is greater)
Response/Clearing Time:	T50 < 30 seconds, T80 < 60 seconds
Outputs:	Linear 4-20mA HART
Electrical Classification:	Explosion Proof cCSA Class I, Division 1, Groups B, C, D (Tamb= -40°C to +40°C) Class I, Zone 1, Group IIB+H2 CSA _{US} Class I, Division 1, Groups B, C, D (Tamb= -25°C to +40°C) Class I, Zone 1, Group IIB+H2 FM Approvals Class I, Division 1, Groups B, C, D (Tamb= -40°C ≤ Ta ≤ 60°C) ATEX Exd IIB+H2 T4 (Tamb= -40°C ≤ Ta ≤ 60°C)
Performance Approvals:	ISA 92.00.01 Part I-2010; H2S Performance Requirements
Safety Approvals:	cCSA _{US} FM ATEX CE Marking
Ingress Protection:	NEMA 4X, IP66
Applicable Standards	CSA C22.2 No. 30-M1986 CSA C22.2 No. 142-M1987 UL No. 916 UL No.1203 FM 3810 FM 3600 FM 3615 FM 6340
Warranty:	Electronics – 2 years Sensor – 10 year conditional

Environmental Specifications

Operating Temperature:	-40°C to +75°C (-40°F to +167°F)
Storage Temperature:	-35°C to +55°C (-31°F to +131°F)
Operating Humidity:	5-100% RH (Non-condensing)
Operating Pressure:	Ambient \pm 10%
Air Velocity:	0-5 meters/second

Mechanical Specifications

Mechanical Specifications

Dimensions:	10"H (including Splashguard) x 6.1"W x 4.3"D (254mmH x 155mmW x 109mmD) 3 each $\frac{3}{4}$ "NPT Female Input Ports $\frac{1}{4}$ " Mounting Holes (J-box) 5.5" (140mm) Center to Center.
Weight:	6 lbs. (2.72kg) (with aluminum j-box) 9 lbs. (4.08kg) (with Stainless Steel j-box)

Electrical Specifications

Electrical Specifications

Input Voltage:	12-28 VDC
Power Consumption:	Normal operation = 68mA (<1.7 watt); Maximum = 85mA (2 watts)
RFI/EMI Protection:	Complies with ISO 92.0.01
Analog Output:	Linear 4-20mA DC current (1000 ohms maximum loop load @ 24VDC) 0mA All Fault Diagnostics 2mA In-Calibration 4-20mA 0-100% full-scale 22mA Over-range condition
HART Version	7.0
Manufacture ID	0x6007
Device ID	0xE08B
Status Indicators:	4-digit LED Display with gas concentration, full-script menu prompts for AutoSpan, Set-up Options, and Fault Reporting LEDs for Fault and Calibration
Faults Monitored:	Heater Fault, Loop Fault, Input Voltage Fault, Sensor Fault, Processor Fault, Memory Fault, Calibration Fault(s)
Cable Requirements:	Power/Analog – 3-wire shielded cable Maximum distance is 13,300 feet with 14 AWG

9.2 Spare Parts, Sensor Accessories, Calibration Equipment

Part Number	Spare Parts
925-0154DH-100	TP-524D Plug-in Transmitter Module with HRT Bridge
399-800000-000	Replacement H ₂ S sensor
500-005230-000	Standard Connector PCB
960-202200-000	Condensation prevention packet (for J-Box replace annually)
960-240010-000	Desiccant Protection Packet for Cell
960-398800-000	H2S/MOS DRICAP w/desiccant (10 pack)
Sensor Accessories	
897-850800-000	NEMA 7 Aluminum Enclosure less cover – 3 port
897-850400-000	NEMA 7 Aluminum Enclosure Cover (Blank)
897-850801-316	NEMA 7 316SS Enclosure less cover – 3 port
897-850401-316	NEMA 7 316SS Enclosure Cover (Blank)
600-610000-000	Sensor Splashguard with integral Cal-Port
943-002274-000	Harsh Location Dust guard
327-000000-000	Programming Magnet
600-003307-000	Dust Cap 7/8" Thread
960-202200-000	Condensation prevention packet (for J-Box replace annually)
960-240010-000	Desiccant Protection Packet for Cell
960-398800-000	H2S/MOS DRICAP w/desiccant (10 pack)
Calibration Accessories	
985-241100-321	In-Line Humidifying Tube
943-000006-038	Threaded Calibration Adapter
943-020000-000	Span Gas Kit: Includes calibration adapter, In-Line Humidifying Tube, 200cc/min fixed flow regulator, and carrying case. (Does Not include gas).
942-010112-010	Span Gas cylinder: 10ppm H ₂ S in air (for 20ppm range) Contains 58 liters of gas and is good for 80 calibrations
942-010112-025	Span Gas cylinder: 25ppm H ₂ S in air (for 50 and 100ppm ranges). Contains 58 liters of gas and is good for 80 calibrations
943-090005-502	200cc/min Fixed Flow Regulator for span gas bottle
Recommend Spare Parts for 2 Years	
925-0154DH-100	TP-524D Plug-in Transmitter Module with HRT Bridge
399-800000-000	Replacement H ₂ S sensor
500-005065-007	Standard Connector PCB
960-202200-000	Condensation prevention packet (for J-Box replace annually)
960-399800-000	H2S/MOS DRICAP w/desiccant (10 pack)

10. Revision Log

Revision	Date	Changes made	Approval
0.0	12/01/10	Initial Release	LBU
0.1	04/23/12	Updated Section 2.6 Field Wiring, load resistor	LU
0.2	10/31/13	Added setting LED Alarm Levels	LU
0.3	03/10/14	Add notation on use of desiccant pack with sensor cell	BM
0.4	11/07/17	Add IP66 Ingress Protection event cautions and ISA 92.00.01-2010 Performance Test Update	BM
0.5	04/23/18	Specifications Update	MM
0.6	06/05/18	Update conduit seal requirement Section 2.5	MM
0.7	11/09/20	Updated company address	KM

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