INSTRUCTION MANUAL
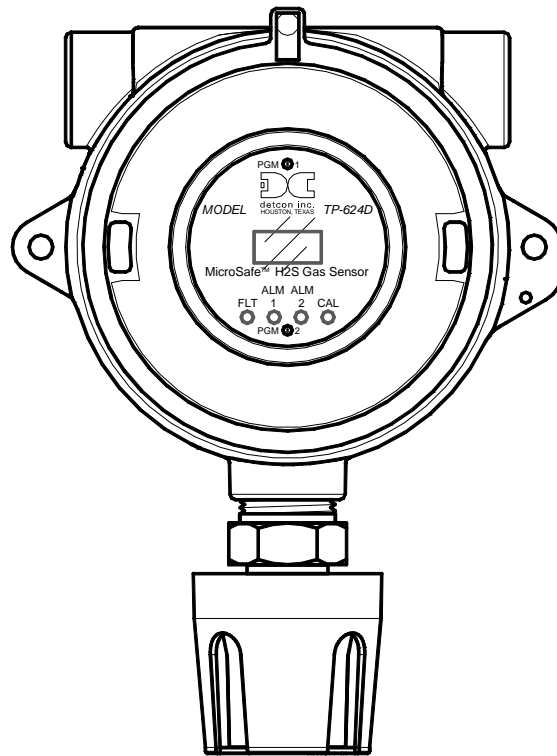# Detcon Model TP-624D

TP-624D 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

Detcon Model TP-624D hydrogen sulfide sensors are non-intrusive "Smart" sensors designed to detect and monitor H_2S 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 standard analog 4-20mA and Modbus[TM] RTU outputs. 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.
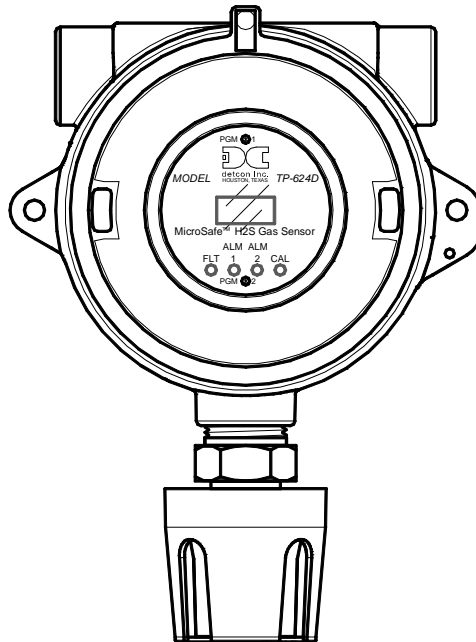
Figure 1 Sensor Assembly Front View

Solid State H_2S 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.

Construction of Semiconductor Sensor

Heater Film
Sensor Film
Silicon Microchip
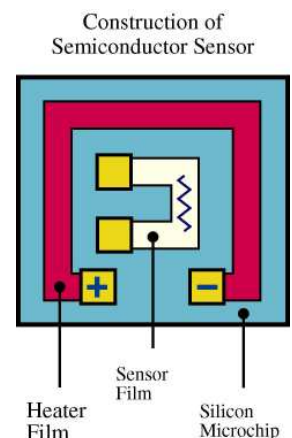
Principle of Operation

Method of detection is by diffusion/adsorption. Air and H$_2$S 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-624D Sensor Assembly is completely modular and is made up of four parts:

1) TP-624D Plug-in Transmitter
2) Field Replaceable H$_2$S Gas Sensor
3) Connector PCB
4) Splash Guard

TP-624D 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, a linear 4-20mA DC output, and a Modbus RTU output. Magnetic program switches located above and below 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.
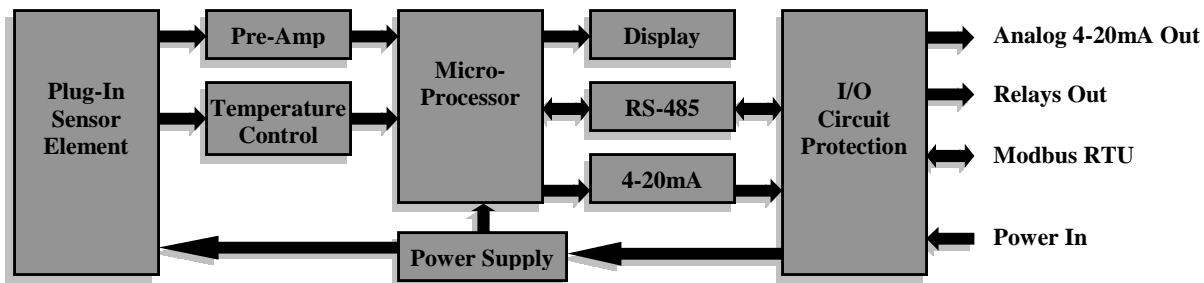
Figure 2 Circuit Functional Block Diagram
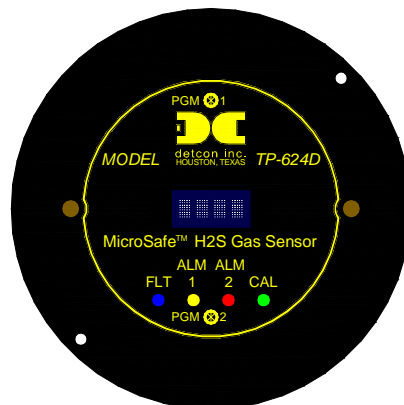
Figure 3 Transmitter Module

The transmitter module includes four LED status indicators (see Figure 3). These indicators are labeled FLT, ALM1, ALM2 and CAL. The ALM1 and ALM2 LEDs are illuminated when the sensor is above the corresponding alarm threshold. The FLT LED is illuminated when the sensor is in fault. The CAL LED is illuminated solid when the sensor is completing an AutoSpan calibration. If the sensor is not being calibrated, the CAL LED will flash each time the sensor answers a poll request from a Modbus master.

Field Replaceable Sensor

The Detcon solid-state H_2S 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 Detcon solid state H_2S sensor has an infinite shelf life and is supported by a 10 year, industry-leading warranty.
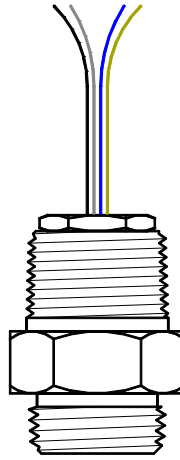
Figure 4 Field Replaceable H_2S Sensor

NOTE: The Field Replaceable H_2S 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, Modbus, and mA output, and connections for the H2S Replaceable Sensor. Terminals for the common and normally open/normally closed relay outputs are also located on the base connector board.
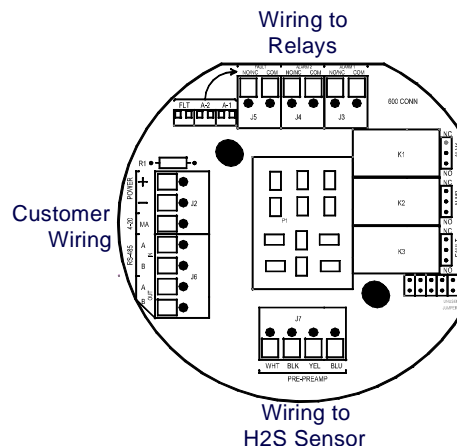
Figure 5 Base Connector Board

1.3   Relay Outputs

The TP-624D includes three 5A Form C relay outputs. Two of these relays are dedicated to alarm outputs, and the third is used to indicate when the sensor is in fault. The common and normally closed contacts on the alarm relays are connected when the gas concentration is below the alarm threshold. If the concentration exceeds the alarm threshold for more than five seconds, then the common and normally open contacts will be connected.

The common and normally closed contacts on the fault relay are connected when the sensor is not in fault. If the sensor experiences a fault condition for more than five seconds, then the common and normally open contacts will be connected.

The common and either the normally open or the normally closed contacts from the alarm and fault relays are connected to terminals on the base connector board. A jumper near each relay is used to select whether the normally open or normally closed contact is connected to the terminal on the base connector board.

The relays can be configured to operate in Energized Mode. In this mode, the common and normally open contacts are connected when the gas is below the alarm threshold (alarm relays) or is not in fault (fault relay). This mode allows for fail-safe operation of the sensor. If the power to the sensor fails or the cable to the sensor I/O is disconnected, then the common and normally open contacts will no longer be connected.

The alarm and fault relays can be configured as either latching or non-latching. In non-latching mode, the relay is deactivated as soon as the sensor alarm or fault condition is cleared. In latching mode, the relay remains active even after the alarm or fault condition has cleared. Once activated, the relay can only be deactivated by swiping a magnetic programming tool above the PGM1 or PGM2 mark on the TP-624D face plate.

The alarm relays can be configured for ascending or descending mode. In ascending mode the relay will be activated when the concentration is *above* the alarm threshold. This is the most common mode of operation for the TP-624D. The alarm relays can also be activated in descending mode. In this mode, the alarm relays will activate when the concentration is *below* the alarm threshold.

> **NOTE**: The relay outputs will not activate during the first 60 seconds after sensor power up. This allows the sensor cell to stabilize and begin outputting an accurate reading.

2. Installation

2.1 ATEX 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.

DETCON, THE WOODLANDS, TEXAS, USA	DETCON, THE WOODLANDS, TEXAS, USA

Detcon Condulets

DETCON, THE WOODLANDS, TEXAS, USA
MODEL TP-624D
RATED: 22-30VDC, 132 mA @ 24VDC

Serial #
Date Code

CE 0035

SIRA 09ATEX1351X
II 2 G Ex d IIB +H2 T4
Tamb = -40°C to +60°C

WARNING:Keep cover tight while circuits are active.
WARNING:Understand manual before operating

Killark Condulets

DETCON, THE WOODLANDS, TEXAS, USA
MODEL TP-624D
RATED: 22-30VDC, 132 mA @ 24VDC

Serial #
Date Code

CE 0035

SIRA 09ATEX1351X
II 2 G Ex d IIB +H2 T4
T amb = -20°C to +60°C

WARNING:Keep cover tight while circuits are active.
WARNING:Understand manual before operating

Figure 6 TP 624D ATEX Approval Labels

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.

8. These sensors meet EN60079-0, EN60079-1.

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: H_2S 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 8). 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 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 H_2S 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 H_2S 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 H_2S sensors require O_2 in the background gas and the reading is affected by changing O_2 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 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 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-624D 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 7). 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 ¾" 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 Detcon Junction Box's are available separately.)
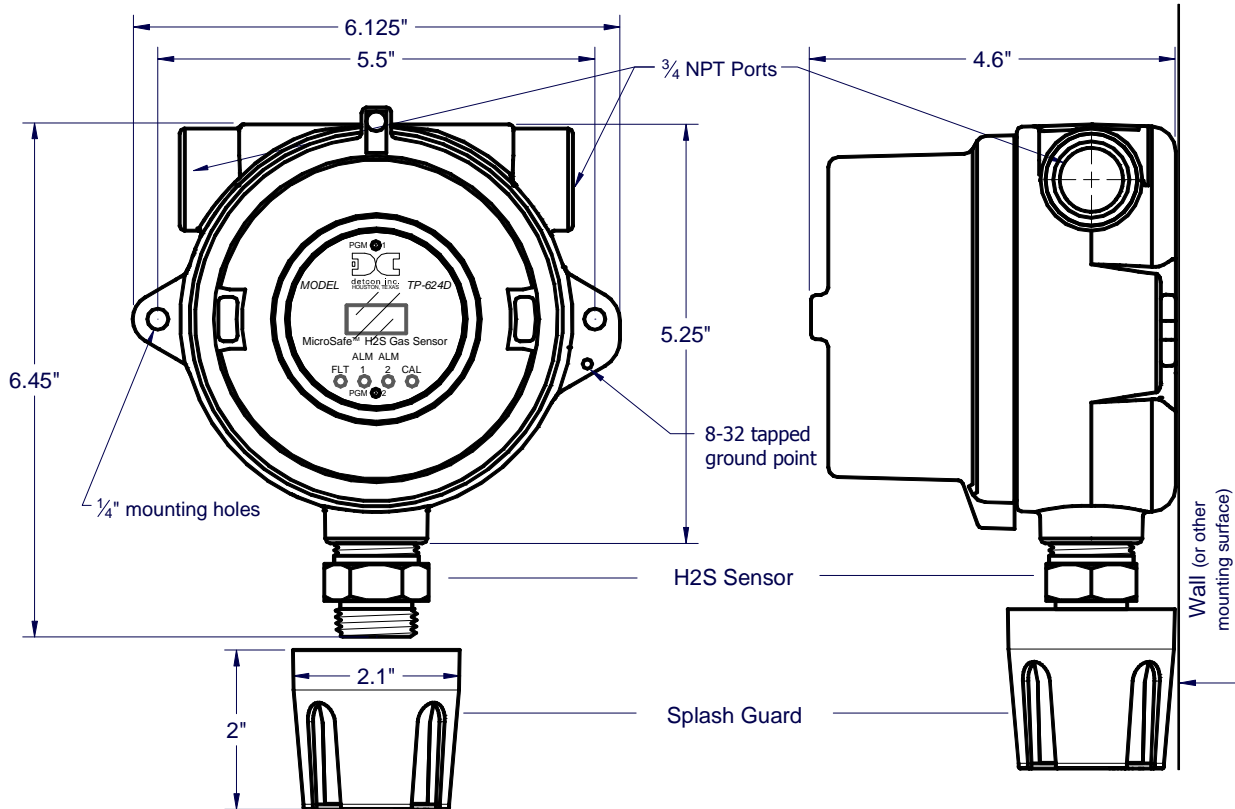
Figure 7 Typical Outline and Mounting Dimensions

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 8 and Figure 9 for proper electrical installation.

> **NOTE:** If a conduit run exits the secondary port, repeat the installation technique shown in Figure 8.

In Figure 8, the drain allows H_2O 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:** A conduit seal is typically required to be located within 18" of the J-Box and Sensor Assembly. Crouse Hinds type EYS2, EYD2 or equivalent are suitable for this purpose.

NOTE: The Detcon Warranty does not cover water damage resulting from water leaking into the enclosure.
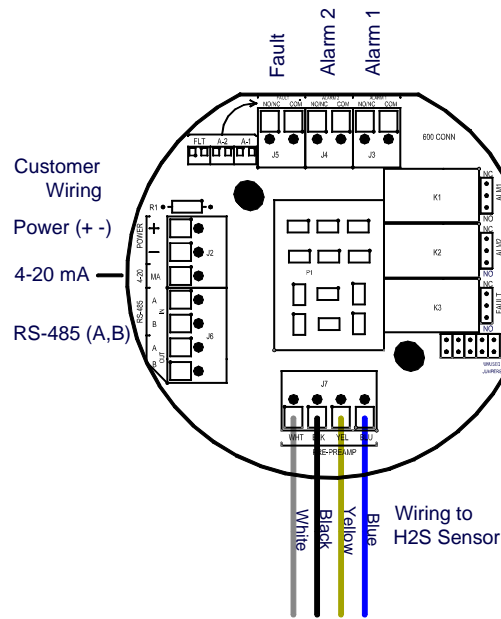
Figure 8 Typical Installation

NOTE: Any unused ports should be blocked with suitable ¾" male NPT plugs. Detcon Supplies one ¾" NPT male plug with each J-box enclosure. If connections are other than ¾" NPT, use an appropriate male plug of like construction material.

2.6 Field Wiring

Detcon Model TP-624D solid-state H$_2$S sensor assemblies require up to five conductor connections between power supplies and host electronic controller. Wiring designations are DC+, DC-, MA (sensor signal), Modbus A and Modbus B. If the MA signal is not needed, its terminal may be left unconnected. If the MA signal is not needed, a 250 ohm load resistor should be connected between the 4-20mA and the Power '-' terminals to properly terminate the signal. 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 between the 4-20 mA and the Power '-' terminals when the 4-20mA signal 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
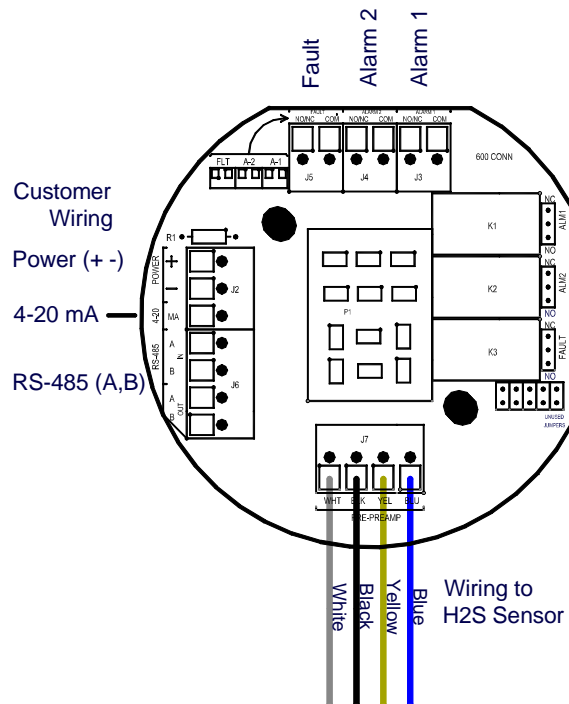
Figure 9 Sensor Connector PCB

a) Remove the junction box cover and unplug the Transmitter Module. Identify the terminal blocks for customer wire connections.

b) Observing correct polarity, terminate the field wiring (DC+, DC-, MA, A, and B) to the sensor assembly wiring in accordance with the detail shown in Figure 9.

c) Trim all exposed wire leads if they are not permanently landed in the terminal block.

d) 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:

a)   TP-624D 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 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.

> *IMPORTANT NOTE: Do not remove the desiccant cap and cover until power is applied to the sensor. Store the desiccant caps with the desiccant packets in a sealed container (i.e. zip-lock Bag) for future use. It is mandatory to reinstall the desiccant cap and packet during any periods without power lasting more than 1 hour. An active desiccant packet is blue in color and turns pink when consumed. (re-order P/N 960-240010-000). Do not use the desiccant packet if it is pink in color, order new packets as required.*

Initial Operational Tests

After a warm up period of 1 hour, the sensor should be checked to verify sensitivity to H_2S gas.

Material Requirements

-Detcon PN 600-610000-000 Splash Guard with integral Cal Port -OR-
    -Detcon PN 943-000006-038 Threaded Calibration Adapter
-Detcon PN 942-010112-025 Span Gas; 25ppm H_2S in balance Air at fixed flow rate between 200 - 500cc/min (10ppm for 0-20ppm range)
-Detcon PN 985-241100-321 In-Line Humidifying Tube

> **NOTE**: Do not use H_2S 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. Detcon H$_2$S 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 TP-624D gas sensors is accomplished via two internal magnetic switches located above and below the LED display (Figure 11). 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 10 Magnetic Programming Tool

The magnetic programming tool (Figure 10) 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 11.
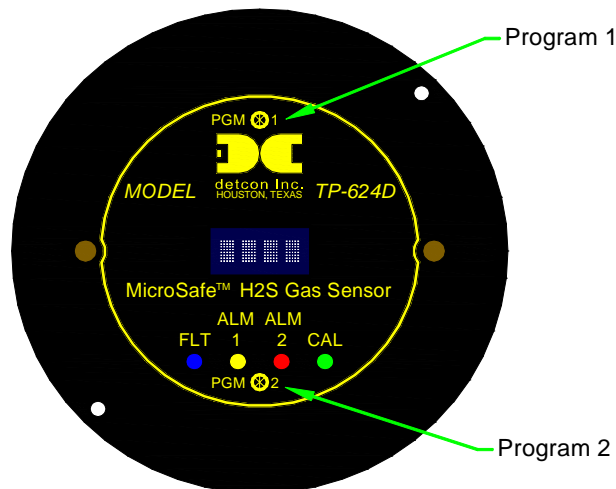
Figure 11 Magnetic Programming Switches

> **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
> > Serial ID
> > Alarm 1 Level
> > Alarm 1 Ascending
> > Alarm 1 Latching
> > Alarm 1 Energized
> > Alarm 2 Level
> > Alarm 2 Ascending
> > Alarm 2 Latching
> > Alarm 2 Energized
> > Fault Latching
> > Fault Energized
>
> Set AutoSpan Level
> Set Range
> Set Heater Power
> Signal Output Check
> Restore Default Settings
> Set Serial ID
> Alarm 1 Settings
> Alarm 2 Settings
> Fault Settings

Software Flowchart
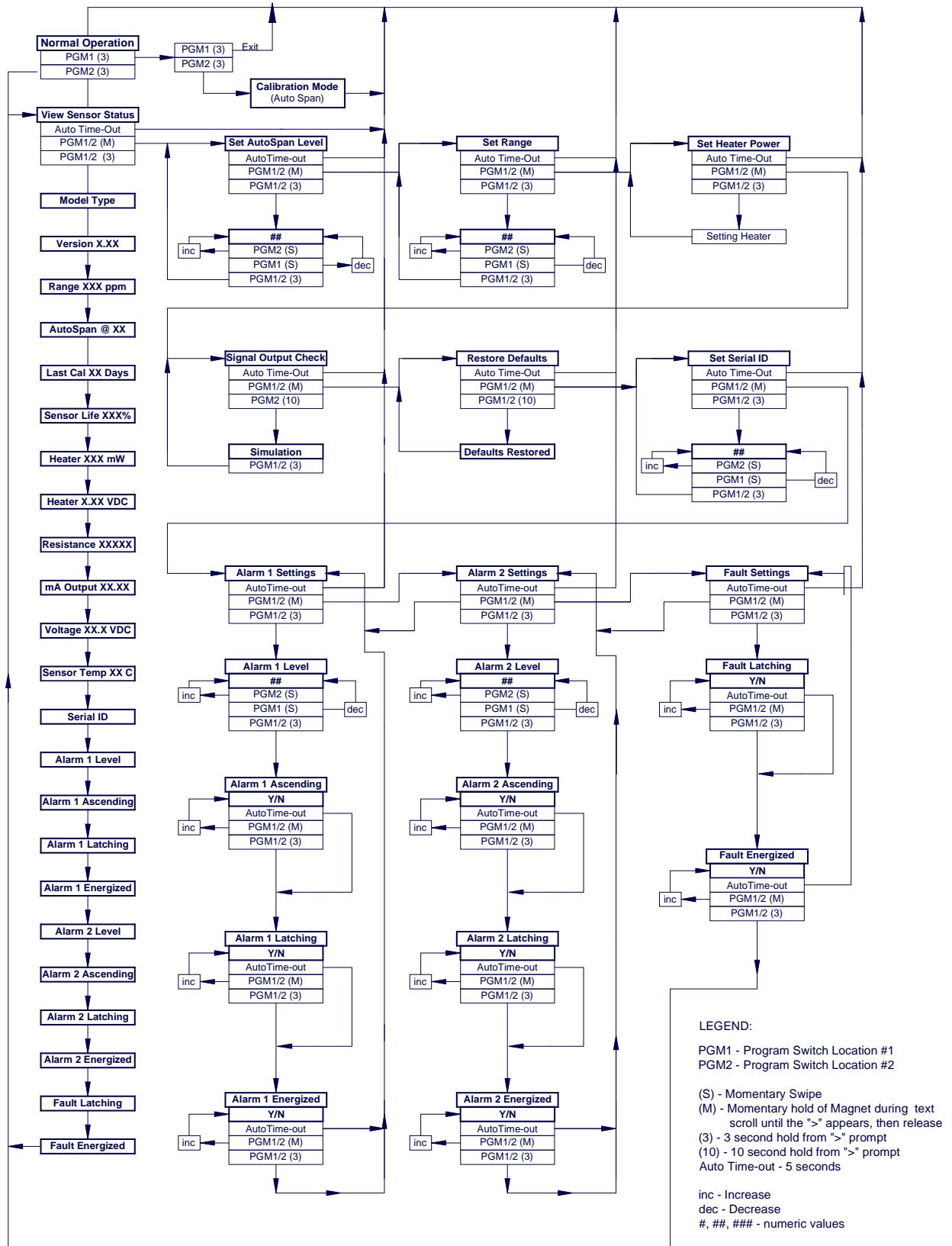
Figure 12 TP-624D Software Flowchart

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 H_2S). If the sensor is actively experiencing any diagnostic faults, a "Fault Detected" message will scroll across 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 H_2S 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:

-Detcon PN 327-000000-000 MicroSafe™ Programming Magnet
-Detcon PN 600-610000-000 Splash Guard with integral Cal Port -OR-
        -Detcon PN 943-000006-038 Threaded Calibration Adapter
-Detcon PN 985-241100-321 In-Line Humidifying Tube
-Detcon PN 942-010112-025 H_2S Span Gas (recommended) or other suitable span gas source containing H_2S 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 (H_2S balanced with Air). Pure Nitrogen background mixtures are not acceptable! Significant span calibration inaccuracies will result.

> **NOTE 3:** An H_2S 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, 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 H_2S 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. The "Range Fault" bit in Modbus register 40005 will be set.

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. The "Stability Fault" bit in Modbus register 40005 will be set.

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. The "Clearing Fault" bit in Modbus register 40005 will be set.

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 600-003307-000)

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, Heater Power, Serial ID, Alarm and Fault Settings. 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
> Set Serial ID
> 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, sensor ambient temperature, serial ID, alarm and fault settings.

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-624D"

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"

Serial ID

> The menu item appears as: "Serial ID XX"

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 1 Energized

> The menu item appears as: "Alarm 1 Energized or Non-Energized"

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"

Alarm 2 Energized

> The menu item appears as: "Alarm 2 Energized or Non-Energized"

Fault Latching

> The menu item appears as: "Fault Latching or Non-Latching"

Fault Energized

> The menu item appears as: "Fault Energized or Non-Energized"

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 PGM1 to increase or PGM2 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 PGM1 to increase or PGM2 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 each H_2S sensor to the optimum operating temperature. This function is performed during factory calibration of each TP-624D sensor assembly, and is not necessary during installation. However, it is necessary to perform in the field if the plug-in H_2S 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 H_2S 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 ± 5mW. At the operating temperature extremes the observed heater power settings will vary according to the data below:

50C   normal heater power range is 210 ± 5mW
0C   normal heater power range is 260 ± 5mW
-20C   normal heater power range is 275 ± 5mW
-40C   normal heater power range is 290 ± 5mW

3.5.5   Signal Output Check

Signal Output Check provides a simulated 4-20mA and Modbus 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. The value of the Modbus concentration register (40002) will also be increased and decreased in the same manner.

> **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).

NOTE: The default settings on the TP-624D are not restored until power is cycled on the sensor.

Following the execution of "**Restore Defaults**" and a power cycle of the sensor, the TP-624D 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).
➢ Serial ID: The Modbus address of the sensor must be set appropriately by the operator (3.5.7).
➢ Alarm and Fault Settings: The alarm levels and relay properties must be set appropriately by the operator (3.5.8 and 3.5.9)

3.5.7   Set Serial ID

Detcon Model TP-624D sensors can be polled serially via RS-485 Modbus™ RTU. Refer to Section 4.0 for details on using the Modbus™ output feature.

Set Serial ID is used to set the Modbus™ serial ID address. It is adjustable from 01 to 256 in hexadecimal format (01-FF hex). The current serial ID can be viewed in View Sensor Status using the instruction given in Section 3.5.1 View Sensor Status.

The menu item appears as: "**Set Serial ID**".

From the "**Set Serial ID"** 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 ID"). The display will then switch to " XX" (where XX is the current ID address). Swipe the magnet momentarily over PGM2 to increase or PGM1 to decrease the hexadecimal number until the desired ID is displayed. Hold the magnet over PGM1 or PGM2 for 3-4 seconds to accept the new value. The display will scroll "ID Saved", and revert to "Set Serial ID" 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 Serial ID" 5 times and then return to Normal Operation).

3.5.8   Alarm 1 and 2 Settings

The TP-624D contains two Form C alarm relay outputs. These relays can be configured to change state when the concentration exceeds a set level. The relays can be configured to operate in either energized or non-energized mode. In non-energized mode, the normally open contact is open if the alarm level has not been reached. In energized mode, the normally open contact is closed if the alarm level has not been reached. Energized mode provides for fail-safe operation since a loss of power or cable failure will cause the contact to be open.

The alarm relays can be configured as either latching or non-latching. In non-latching mode, the relay is deactivated as soon as the sensor alarm condition is cleared. In latching mode, the relay remains active even after the alarm condition has cleared. Once activated, the relay can only be deactivated by swiping a magnetic programming tool above the PGM1 or PGM2 mark on the TP-624D face plate.

The alarm relays can be configured for ascending or descending mode. In ascending mode the relay will be activated when the concentration is *above* the alarm threshold. This is the most common mode of operation for the TP-624D. The alarm relays can also be activated in descending mode. In this mode, the alarm relays 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 relay is in ascending mode and "No" indicates the relay 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 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.

The display will scroll "Set Energized", and then switch to "Yes" or "No". "No" indicates the relay is normally non-energized and "Yes" indicates the relay is normally energized. 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 (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).

3.5.9   Fault Settings

The TP-624D contains a single Form C fault relay output. This relay can be configured to change state when the sensor experiences a fault condition. This relay can be configured to operate in either energized or non-energized mode. In non-energized mode, the normally open contact is open if the sensor is not in fault. In energized mode, the normally open contact is closed if the sensor is not in fault. Energized mode provides for fail-safe operation since a loss of power or cable failure will cause the contact to be open.

The fault relay can be configured as either latching or non-latching. In non-latching mode, the relay is deactivated as soon as the fault condition is cleared. In latching mode, the relay remains active even after the fault condition has cleared. Once activated, the relay can only be deactivated by swiping a magnetic programming tool above the PGM1 or PGM2 mark on the TP-624D 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.

The display will scroll "Set Energized", and then switch to "Yes" or "No". "No" indicates the relay is normally non-energized and "Yes" indicates the relay is normally energized. 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 (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

Detcon TP-624D H_2S 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. The Modbus concentration register will report the measured concentration (up to full scale + 10%).

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. The "In Calibration" bit in the Modbus fault register is set while the sensor is in calibration mode.

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 and in a Modbus register. 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-624D 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. The "Global Fault" bit in the Modbus fault register is also set and the fault relay output is activated. The faults include the AutoSpan Calibration faults, Heater Fault, Sensor Fault, Processor Fault, Memory Fault, Loop Fault, and Input Voltage Fault. (The 0mA fault level and fault relay output 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 "Range Fault" bit in the Modbus fault register will be set. 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 "Stability Fault" bit in the Modbus fault register will be set. 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 "Clearing Fault" bit in the Modbus fault register will be set. 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 and the "Sensor Fault 2" bit will be set 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 and the "Sensor Fault" bit will be set 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 and the "Processor Fault" bit will be set 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 and the "Memory Fault" bit will be set until the fault condition is resolved.

4-20mA Loop Fault

If the detector measures a 4-20mA loop load resistance > 1000 ohms, a "4-20mA Fault" is declared. A "4-20mA Fault" will cause the "Fault Detected" message to scroll once a minute on the sensor display. If a Loop Fault occurs, the 4-20mA signal will be set at 0mA and the "4-20mA Fault" bit will be set until the fault condition is resolved.

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 and the "Input Voltage Fault" bit will be set until the fault condition is resolved.

Temperature Fault

If the detector is currently reporting an ambient temperature that is outside of the –40ºC to +75ºC 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, but the "Temperature Fault" bit will be set.

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, but the "Sensor Fault" bit will be set.

4. RS-485 Modbus^{TM} Protocol

Model TP-624D sensors feature Modbus™ compatible communications protocol output and are addressable via the program mode. Communication is via a two wire, half duplex RS-485, 9600 baud, 8 data bits, 1 stop bit, no parity, with the sensor set up as a slave device. A master controller up to 4000 feet away can poll up to 256 different TP-624D sensors. This number may not be realistic in harsh environments where noise and/or wiring conditions would make it impractical to place so many devices on the same pair of wires. If a multi-point system is being utilized, each sensor should be set for a different address. Typical address settings are: 01, 02, 03, 04, 05, 06, 07, 08, 09, 0A, 0B, 0C, 0D, 0E, 0F, 10, 11…etc.

Sensor Serial ID numbers are factory default to 01. These can be changed in the field via the Operator Interface described in Section 3.5.7.

The following table explains the details of the Modbus™ protocol that the TP-624D sensor supports.

Table 3 Modbus Registers

FC	REG	Content Description	R/W	Content Definition		
				Value	**Meaning**	**Range**
03	40000	Device Type	R	8	700 Sensor	
03 06	40001 40001	Read Detectable Range[1,2] Write Detectable Range	R/W	100 10000	For 0-100 For 0-10000[2]	DM – 0 to 10000 FP – Read only TP – 20, 50, 100, 200 IR – 0 to 10000 PI – 0 to 10000
03	40002	Read Concentration[3,2]	R	1000	Bound by range. If > range, this value is in fault.	
03 06	40003 40003	Read AutoSpan Level[4,2] Write AutoSpan Level	R/W	50	Span gas at 50	DM – 1% to 95% of Range FP – 5% to 95% of Range (40001) TP – 2% to 50% of Range (40001) IR – 5% to 95% of Range (40001) PI – 1% to 95% of Range (40001)
03	40004	Read Sensor Life	R	85	For 85% sensor life	
03	40005	Read Fault Status Bits[5]	R	0x0001 0x0002 0x0004 0x0008 0x0010 0x0020 0x0040 0x0080 0x0100 0x0200 0x0400 0x0800 0x1 000 0x2000 0x4000 0x8000	Global Fault Auto Span Fault Temperature Fault 4-20mA Fault Input Voltage Fault Memory Fault Processor Fault Clearing Fault Stability Fault Range Fault Sensor Fault Zero Fault Sensor Fault 2 <reserved> In Calibration Communication Error	
03	40006	Read Model #	R	1, 2, 3, 4, 5	DM, FP, IR, TP, PID respectively	
03	40007	Read Days Since Cal	R	29	29days	
03	40008	4-20 Current Output	R	400	4.00mA	
03	40009	Read Input Voltage	R	2400	24.00V	
03	40010	Read Temperature	R	28	28 °C	
03/	40011	Special #1	R/W		Function Dependant on Value	
FC	**REG**	**Content Description**	**R/W**	**Content Definition**		
				Value	**Meaning**	**Range**
03/ 06	40012	Special #2	R/W		Function Dependant on Value of 40006 (See Special Register Table)	
03	40013	Special #3	R		Function Dependant on Value of 40006 (See Special Register Table)	

03/06	40014	Special #4	R/W		Function Dependant on Value of 40006 (See Special Register Table)	
03	40015	Calibration Status	R	0x0000 0x0001 0x0002 0x0003 0x0004	Idle Zero Calibration Started Span Calibration Started Span Set Span Calibration Unsuccessful	
06	40015	Calibration Enable	W	0x0001 0x0002 0x0008 0x0009 0x000A 0x000B	Set Zero Set Span Signal simulation mode Set FP Bridge Voltage Set TP Heater Power Set IR Gain	
03	40016	Read Text 1, first char in L	R		Two Char of Gas/Units String[6]	
03	40017	Read Text 2	R		Two Char of Gas/Units String[6]	
03	40018	Read Text 3	R		Two Char of Gas/Units String[6]	
03	40019	Read Text 4	R		Two Char of Gas/Units String[6]	
03	40020	Read Text 5, last char in H	R		Two Char of Gas/Units String[6]	
03	40021	Text null terminator in L	R		Two Char of Gas/Units String[6]	
03	40022	Special #5	R/W		Function Dependant on Value of 40006 (See Special Register Table)	
03	40023	Processor Firmware Version	R	0x0102	Version 01.02	

[1] Units are determined by "units" field in the "notation" string

[2] Span Gas must be less than or equal to Detectable Range and is usually about ½ of it.

[3] Fault status bits self-reset when fault clears

[4] Text in ASCII, in order L byte, H byte, L byte… See field descriptions of notation string.

Table 4 Notation Text String Description

Character #	1	2	3	4	5	6	7	8	9	10	11
Description	Units			0x20	Gas Type						0x00

Units – This field is 'PPM', 'PPB', or '_ _ %' (where ' _ ' is a space, 0x20).
0x20 – The units field is terminated with an ASCII space (0x20)

Gas Type – This field contains the gas type of the cell (typically "H2S _ _ _")
0x00 – The notation string is terminated with an ASCII null character

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. 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 H$_2$S Sensor

> **NOTE:** It is necessary to remove power while changing the H$_2$S 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 H$_2$S Sensor from the connector PCB.

c) Unthread the H$_2$S Sensor from the junction box and thread the new H$_2$S Sensor onto the junction box.

d) Connect the black, white, blue, and yellow wires from the new H$_2$S 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 H$_2$S sensor with the Transmitter Module.

g) Perform a successful AutoSpan to match the new H$_2$S 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 H_2S Sensor from the connector PCB.

c) Remove the output wiring from the power, 4-20mA, RS-485 and relay connector PCB terminals.

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 from the power, 4-20mA, RS-485 and relay connector PCB terminals.

g) Reconnect the black, white, blue, and yellow wires from the H_2S 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.
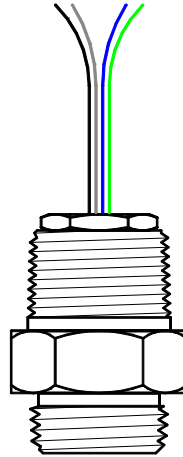

Figure 13 Replaceable H$_2$S Sensor

Open Heater

Probable Cause: H$_2$S sensor has failed
Remove H$_2$S 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 H$_2$S sensor if open circuit or significantly out-of range readings are found.

Open Sensor

Probable Cause: H$_2$S sensor has failed
Remove H$_2$S 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 H$_2$S 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 (Section3.4).

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 ± 5mW at 25ºC ambient temperature).
Verify use of span gas Humidifying Tube.
Check validity of span gas using H$_2$S 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$_2$S 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 desiccant packet the sensor cell during extended power-off periods.
Check Heater Power Setting (should be 240 ± 5mW at 25ºC 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 < 8ppm in < 5 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±5mW at 25ºC 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 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 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 Detcon to optimize shielding and grounding.
Add Detcon's RFI Protection Circuit accessory if problem is proven RFI induced.

Nuisance Alarms

Check condulet for accumulated water and abnormal corrosion on terminal blocks.
If nuisance alarms are happening at night, suspect condensation in condulet. Add or replace 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 condulet 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.

7. Customer Support and Service Policy

Detcon Headquarters
Shipping Address: 4055 Technology Forest Blvd, Suite 100, The Woodlands Texas 77381
Mailing Address: P.O. Box 8067, The Woodlands Texas 77387-8067
Phone: 888.367.4286, or 281.367.4100
Fax: 281.292.2860

• www.detcon.com
• service@detcon.com
• sales@detcon.com

All Technical Service and Repair activities should be handled by the Detcon Service Department via phone, fax or email at contact information given above. RMA numbers should be obtained from the 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 Detcon Sales Department via phone, fax or email at contact information given above.

Warranty Notice

Detcon Inc. warrants the Model TP-624D H_2S 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 H_2S sensor. See Warranty details in Section 8 TP-624D Sensor Warranty.

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 Detcon Inc. personnel.

Defective or damaged equipment must be shipped to the 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 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 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, 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 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-624D Sensor Warranty

H₂S Sensor Warranty

Detcon Inc. warrants, under normal intended use, each new H$_2$S 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 Detcon, Inc., 4055 Technology Forest Blvd, Suite 100, The Woodlands, Texas 77381, for necessary repairs or replacement.

First year   No Charge
2nd-5th 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 600-003307-000) 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 Detcon factory.
* Net payment is due within 30 days of invoice.
* Detcon, Inc. reserves the right to refund the original purchase price in lieu of sensor replacement.

Transmitter Module Warranty

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. From year 2 – 5, a fixed fee repair policy of $65.00 is in effect. All warranties and service policies are FOB the Detcon facility located in The Woodlands, Texas.

Terms & Conditions

* The original serial number must be legible on each Transmitter.
* Shipping point is FOB the Detcon factory.
* Net payment is due within 30 days of invoice.
* Detcon, Inc. reserves the right to refund the original purchase price in lieu of Transmitter 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:	± 2ppm or ±10% of applied gas (whichever is greater)
Response Time:	T50 < 30 seconds, T80 < 60 seconds
Outputs:	Linear 4-20mA DC RS-485 Modbus™ RTU 3 Relays (Alarms 1, 2, and Fault) Dry Contacts rated 5A

Electrical Classification:	Explosion Proof
	CSA and US (NRTL)
	      Class I, Division 1, Groups B, C, D (Tamb= -40°C to 75°C)
	      Class I, Zone 1, Group IIB+H2
	ATEX
	      EExd IIB+H2 T4 (Tamb= -40ºC ≤ Ta ≤ 60ºC)

Performance Approvals:	ISA 92.0.01 Part I-1998; H2S Performance Requirements
Safety Approvals:	$_C$CSA$_{US}$ CSA/NRTL (US OSHA Certified) FM ATEX CW Marking SIL2 FMEDA Rating
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 EN60079-0 (2006) EN60079-1 (2007)
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 ± 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 ¾"NPT Female Input Ports ¼" 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

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
Serial Output:	RS-485 Modbus™ RTU Baud Rate 9600 BPS (9600,N,8,1 Half Duplex)
Status Indicators:	4-digit LED Display with gas concentration, full-script menu prompts for AutoSpan, Set-up Options, and Fault Reporting 4 LEDs for Alarm 1, Alarm 2, Fault, and Calibration
Relay Outputs:	Alarm 1, Alarm 2, and Fault 5A @ 250VAC 5A @ 30VDC
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 Serial Output – 2-wire twisted-pair shielded cable specified for RS-485 use. Maximum distance is 4,000 feet to last sensor
I/O Protection:	Over-voltage, miswiring, EMI/RFI Immunity

9.2 Spare Parts, Sensor Accessories, Calibration Equipment

Part Number	Spare Parts
926-0154D0-100	TP-624D Plug-in Transmitter Module
399-800000-000	Replacement H$_2$S sensor
500-001794-004	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	
897-850800-010	NEMA 7 Aluminum Enclosure less cover – 3 port
897-850400-010	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	
926-0154D0-100	TP-624D Plug-in Transmitter Module
399-800000-000	Replacement H$_2$S sensor
500-001794-004	Standard Connector PCB
960-202200-000	Condensation prevention packet (for J-Box replace annually)
960-399800-000	H2S/MOS DRICAP w/desiccant (10 pack)

9.3 Revision Log

Revision	Date	Changes made	Approval
0.0	6/21/2010	Initial Release	LBU
0.1	6/25/2010	Changed gas/units register definition. Added note about "Restore Defaults"	LBU
0.2	04/23/12	Updated Section 2.6 Field Wiring, load resistor	LU
0.3	08/26/13	Added setting LED Alarm Levels	LU
0.4	03/07/14	Add notation on use of desiccant pack with sensor cell	BM