



**GENERAL MONITORS**

# **Model TS420**

Oxygen Deficiency Detector



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## **Instruction Manual**

**11/00**

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



Part No.  
Revision

MANTS420  
B/11-00

## WARRANTY STATEMENT

General Monitors warrants the Model TS420 to be free from defects in workmanship or material under normal use and service within two (2) years (sensor cells one (1) year) from the date of shipment. General Monitors will repair or replace without charge any equipment found to be defective during the warranty period. Full determination of the nature of, and responsibility for, defective or damaged equipment will be made by General Monitors' personnel. Defective or damaged equipment must be shipped prepaid to General Monitors' plant or the representative from which shipment was made. In all cases this warranty is limited to the cost of the equipment supplied by General Monitors. The customer will assume all liability for the misuse of this equipment by its employees or other personnel. All warranties are contingent upon proper use in the application for which the product was intended and do not cover products which have been modified or repaired without General Monitors' approval or which have been subjected to neglect, accident, improper installation or application, or on which the original identification marks have been removed or altered. Except for the express warranty stated above, General Monitors disclaims all warranties with regard to the products sold, including all implied warranties of merchantability and fitness and the express warranties stated herein are in lieu of all obligations or liabilities on the part of General Monitors for damages including, but not limited to, consequential damages arising out of or in connection with the use or performance of the product.



**WARNING** - THE TS420 DETECTS OXYGEN DEFICIENT ENVIRONMENTS AND EXPOSURE TO OXYGEN DEFICIENT ENVIRONMENTS MAY RESULT IN SICKNESS OR DEATH.

The TS420 Toxic Gas Detector contains components, which can be damaged by static electricity. Special care must be taken when wiring the system to ensure that only the connection points are touched.

The TS420 is rated intrinsically safe as denoted by the symbol "Ex ia" on the instrument label. Substitution of electrical components within the TS420 may impair intrinsic safety.

Damage to the TS420 housing such that any internal components or potting can be or is exposed compromises the intrinsic safety of the device and as such should not be used in a hazardous environment. Such damage includes complete fracture of the plastic housing or cracks that may be opened to expose any internal components or potting. Destruction of the sensor cap will not affect the intrinsic safety of the TS420; however, calibration accuracy and the watertight nature of the TS420 will be compromised.



**WARNING** - DO NOT USE A TS420 WITH A DAMAGED HOUSING IN A HAZARDOUS ENVIRONMENT.

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**IMPORTANT** - Each oxygen sensor cell is shipped separate from the TS420. This ensures that a fresh sensor cell will be used during initial start-up. DO NOT install the cell into the TS420 until you are ready to apply power to the system. When installing this unit, an initial field calibration must be completed, since the TS420 is not factory calibrated to the specific cell.

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## System Integrity Verification

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

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

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

## Commissioning Safety Systems

Before power up, verify wiring, terminal connections and stability of mounting for all integral safety equipment including, but not limited to:

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

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

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

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Fault/Malfunction circuit operation should be verified.

## Periodic Testing/Calibration of Field Devices

Periodic testing/calibrating should be performed per the manufacturers' recommendations and instructions. Testing/Calibrating procedures should include, but not be limited to:

- ! Verify zero reading
- ! Apply a known concentration of gas, or a simulated test device provided by the manufacturer
- ! Verify integrity of all optical surfaces and devices
- ! For flame detectors, use the appropriate test lamp

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

## Periodic System Verification

The following system verifications should be performed at least annually:

Verify wiring, terminal connections and stability of mounting for all integral safety equipment including, but not limited to:

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

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

Fault/Malfunction circuit operation should be verified.

### 1. Mount and Wire the Detector (pages 5 through 9)

There are no standard rules for detector placement since the optimum sensor location is different for each application. The customer must evaluate conditions at the facility to make this determination. Generally, the TS420 should be easily accessible for calibration checks. The TS420 should be mounted pointing down to prevent water build-up on the detector head. The detector assembly should not be placed where it may be coated by contaminating substances. Although the Model TS420 is RFI resistant, it should not be mounted in close proximity to radio transmitters or similar equipment.

Some general guidelines for sensor location:

- ! The TS420 should be used in locations that are tightly enclosed with poor or no ventilation, such as utility tunnels or underground storage areas. These areas are likely to have dangerously low oxygen concentrations.
- ! Observe the TS420's environmental specifications when locating the unit.

The environmental specifications covering the electrochemical cell are found in the Appendix, Section 5.1.4.

Detectors should be mounted in an area that is as free from wind, dust, water, shock and vibration as possible.



**WARNING** - Operation above or below temperature limits will provide unstable readings, which may cause false alarms or failure to alarm. See Section 5.1.4 for guidelines.

General Monitors discourages painting of detector assemblies. If the detector head is painted over, the gas will not be able to diffuse into the sensor. If the TS420 body is painted over, the LCD display cannot be read.

The TS420 is shipped without the sensor installed. The sensor must be installed into the detector and calibrated for proper operation. See Sections 3.3 and 3.4 for installation instructions and Section 4.3 for calibration instructions.

Once correctly installed, the TS420 requires little or no maintenance other than periodic calibration checks to ensure system integrity. General Monitors recommends a calibration check schedule be established and that the complete system, including all alarm circuitry, be tested at least annually.

The overall and mounting dimensions for the TS420 (Figure Q-A) should be used when making installation determinations. Mechanical specifications can be found in the Appendix, Section 5.1.2.

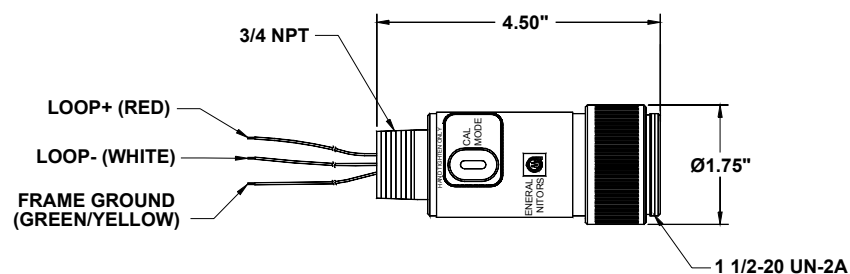


Figure Q-A Outline and Dimensional Drawing

### Intrinsically Safe Barriers

In order for the TS420 to be used with classified equipment inside of the hazardous area, it is necessary for the customer to purchase either a Galvanic or Zener Diode Barrier, which should be mounted in the non-classified area between the TS420 and the facilities' control room. A list of recommended manufacturers and part numbers follows for galvanic barriers:

Stahl - 9303/11-22-11  
 MTL - MTL7206 or MTL5041  
 Pepperl+Fuchs - KFD2-CR-EX1.30-300

Elcon - mD323 or mD325  
 Turck - mk33-Li-ExO

These are recommended active type barriers for intrinsically safe applications. Each application is different and it is the ultimate decision of the user to determine the appropriate I/S barrier for their application.

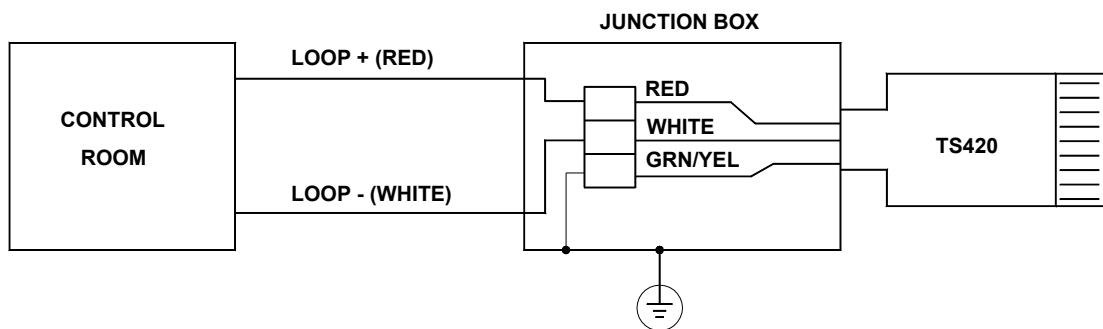
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**NOTE** - To maintain intrinsic safety, wire length and gauge are limited by the capacitance and inductance of the wire,  $C_i$  and  $L_i$  of the TS420, and the barrier ratings. See Section 5.1.5 for instructions on calculating these values.

---

Align the TS420 so that the LCD display is easily viewed. Teflon tape may be used on the TS420's threads.

The two wires at the base of the TS420 provide a 4-20mA loop-powered output. The red wire is the "loop +" lead and the white wire is the "loop -" lead (Figure Q-B). A third green/yellow wire is provided for frame ground.



**Figure Q-B Wiring Diagram**

It is recommended that a two wire, shielded cable be used for making power and output signal connections on the TS420.

Connect the green/yellow frame ground wire to the grounding terminal or lug inside the junction box being used with the TS420.

Ensure the junction box frame is connected to frame ground or connected to the cable shield, which is connected to frame ground at the controller.

Connect the red wire to the +24VDC terminal. Connect the white wire to the signal input terminal on the readout/relay display module, FMD Field Mounted Display, S4100E smart sensor, industrial analog to digital converter, computer-based monitor, PLC, DCS, etc.

Since the TS420 is designed to operate continuously, a power switch is not included, in order to prevent accidental system shutdown.

**NOTE - Power must remain disconnected until all wiring connections are made.**

The absolute maximum distance between the TS420 and the power supply is 8000 feet (2438 meters). Depending on the application, general purpose or intrinsically safe, the cable length will depend on the intrinsically safe barrier chosen and the cable used. See the Appendix, Section 5.1.5, for the intrinsically safe system requirements. In addition, cable length specifications can also be found in the Appendix, Section 5.1.3. In all cases, the cable run should be as short as possible.

**2. Apply power to the detector.**

Before applying power to the system for the first time, all wiring connections should be checked for correctness. The sensor should be allowed to stabilize prior to calibration. The stabilization time should be one (1) hour for all sensors.

**Initial Power-up**

The TS420 has been shipped un-calibrated, therefore, the first time power is applied, the TS420 will enter Start-up mode (3.6mA) for a short interval, then may transition to fault mode (flashing MODE LCD with the CAL LCD off and the analog output current at 3.5mA) until calibrated (See Section 4.3 for Calibration Procedure).

After calibration is complete, the TS420 will proceed to Operate mode (17.38mA = 20.9% V/V O<sub>2</sub>) where any detected oxygen will show as a proportional analog output current between 4 and 20mA (4mA = 0% V/V O<sub>2</sub>, 20mA = 25% V/V O<sub>2</sub>). The MODE LCD will be on steady and the CAL LCD off with normal atmosphere and both the MODE and CAL LCD's will flash when oxygen deficiency is detected. (O<sub>2</sub> level < 19%).

General Monitors recommends the TS420 be calibrated again within the first twenty-four (24) hours after the initial calibration. Calibrations should be performed with new units and units that have been off power for more than one (1) week. See "Calibration", Section 4.3, for more details.

**Power-up After Initial Calibration**

When the TS420 is powered up, after it has been previously calibrated, the unit will enter a Start-up mode (3.6mA) for approximately 50 seconds, which allows the sensor to stabilize before proceeding to the Operate mode (17.38mA). During Start-up, the "MODE" LCD will flash, the "CAL" LCD will be off and the analog output current will be 3.6mA.

| OPERATING MODES   | INDICATOR |      | ANALOG OUTPUT |
|---|-----------|------|---------------|
|   | CAL       | MODE |               |
| START-UP  | □         | *    | 3.6mA         |
| OPERATE   |           |      |               |
| AMBIENT O <sub>2</sub> = 20.9%                          | □         | ■    | 17.38mA       |
| DEFICIENT ATMOSPHERE, O <sub>2</sub> < 19% <sub>1</sub> | *         | *    | 4.0-16.16mA   |
| FAULT   |           |      |               |
| NO POWER  | □         | □    | 0.0mA         |
| SYSTEM  | □         | *    | 3.5mA         |

**Figure Q-C Operating Modes, Indicators and Outputs**

1. Segment may flash Synchronously or alternating.

Perform a calibration and the TS420 will return to operate mode (17.38mA).

**NOTE - The TS420 will not allow you to enter calibration mode during Start-up mode (3.6mA).**

**3. Calibrate the Detector.**

Activating the “**CAL**” switch will automatically disable the external alarm circuits by fixing the analog output current to 3.75mA.

General Monitors recommends that the TS420 be calibrated within the first twenty-four (24) hours after initial start-up, and that calibration be checked at least every ninety (90) days to ensure the integrity of the system.

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**NOTE:** A calibration check consists of applying a 20.9% V/V O<sub>2</sub> (“normal” ambient air) of full-scale concentration of gas to the sensor and observing the reading on the display device being used.

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General Monitors is not implying that the customer should expect problems with sensor life or stability. “Frequent” calibration checks merely ensure the integrity of the life protecting equipment, and are recommended for problem environments (i.e. sensors accidentally being painted over, etc, see Appendix 5.4).

A calibration schedule should be established and followed. A logbook should also be kept showing calibration dates and dates of sensor replacement.

**Calibration Procedure:**

1. If it is suspected that the air is not at “normal” levels (20.9% O<sub>2</sub>), it will be necessary to calibrate the sensor with clean air. The 20.9% O<sub>2</sub> gas cylinder (GMI P/N 1400262-11) can be used. Apply the clean air source prior to entering calibration mode and allow the sensor to stabilize for at least one (1) minute before proceeding.
2. Place the magnet over the GMI Logo on the body of the unit and hold it there until the “**CAL**” LCD indicator appears, then remove the magnet. The analog output current will drop to 3.75mA.
3. The “**CAL**” and “**MODE**” LCD indicator will flash, indicating that the unit is now calibrating.
4. After approximately 30 seconds, the display will change from a flashing “**CAL**” and “**MODE**” LCD to a solid “**MODE**” LCD, indicating that the calibration is complete and the unit has re-entered “**OPERATE**” mode. Remove any calibration gas.
6. The unit is now calibrated and the new values have been stored in the NOVRAM (non-volatile memory).

Figure Q-D shows a flow diagram of the codes that will appear in the display window during the calibration procedure.

If there is a problem and the TS420 cannot complete the calibration sequence, a fault indicator will be displayed, and the analog output current will drop to 3.5mA.

| CALIBRATION       | INDICATOR |      |
|-------------------|-----------|------|
|                   | CAL       | MODE |
| Magnet Applied    | ☐         | ■    |
| Magnet Recognized | ■         | ☐    |
| Cal Proceeding    | ✱         | ✱    |

**Figure Q-D Flow Diagram**



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**NOTE** - If the unit fails to calibrate a flashing “**MODE**” LCD will be displayed. The sensor must see “clean” air for at least fifteen (15) minutes before a second calibration is attempted by reapplying the magnet.

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

If you have any problems in the set-up or testing of the detector, please refer to the “Trouble Shooting Section”, or call the factory direct.

**Worldwide Service is available by calling:**

**Lake Forest, California  
(24 hr. service)**

**Phone: +1-949-581-4464  
Fax: +1-949-581-1151**

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# 1.0 Introduction

## 1.1 General Description

The Model TS420 is a 4-20mA, loop-powered Oxygen Deficiency detector used for monitoring Oxygen levels. The micro-processor based electronics process information at the sensor site and are contained within a corrosion and solvent resistant plastic housing. An LCD display provides status indications that can be viewed through a window in the housing. The analog signal (0 to 25% V/V O<sub>2</sub> full scale) provides remote and/or discrete indications of the sensor's operation.

The TS420 is entity-approved as intrinsically safe for use in Class I, Divisions 1 & 2, Groups A, B, C and D, Class II, Groups E, F and G & Class III hazardous areas. It can also be used in general-purpose (non-hazardous) applications.

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**NOTE** - Intrinsically safe applications require an I/S barrier mounted in a safe area. See Section 3.3.1 for guidelines.

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## 1.2 Features and Benefits

**Microprocessor-Based Electronics:** monitors for fault conditions, processes input signals from the sensor and provides outputs in the form of display codes and an analog signal.

**One Person Adjustment-Free Calibration:** initiate the calibration sequence with a magnet, apply 20.9% V/V O<sub>2</sub>, and wait for the display to indicate that the unit has completed the calibration. No user adjustments are required.

**Two Segment LCD:** indicates gas presence, operational modes, fault codes and calibration cues.

**4 to 20 mA Output:** transmits fault, calibration, and gas concentration levels to a remote display, computer or other device.

## 1.3 Applications

This is a partial listing of applications.

- ! Wastewater Treatment Plants
- ! Chemical and Petrochemical Plants
- ! Refineries
- ! Pulp & Paper Plants
- ! Micro-chip Manufacturing
- ! Pharmaceuticals
- ! Food & Beverage
- ! Utilities



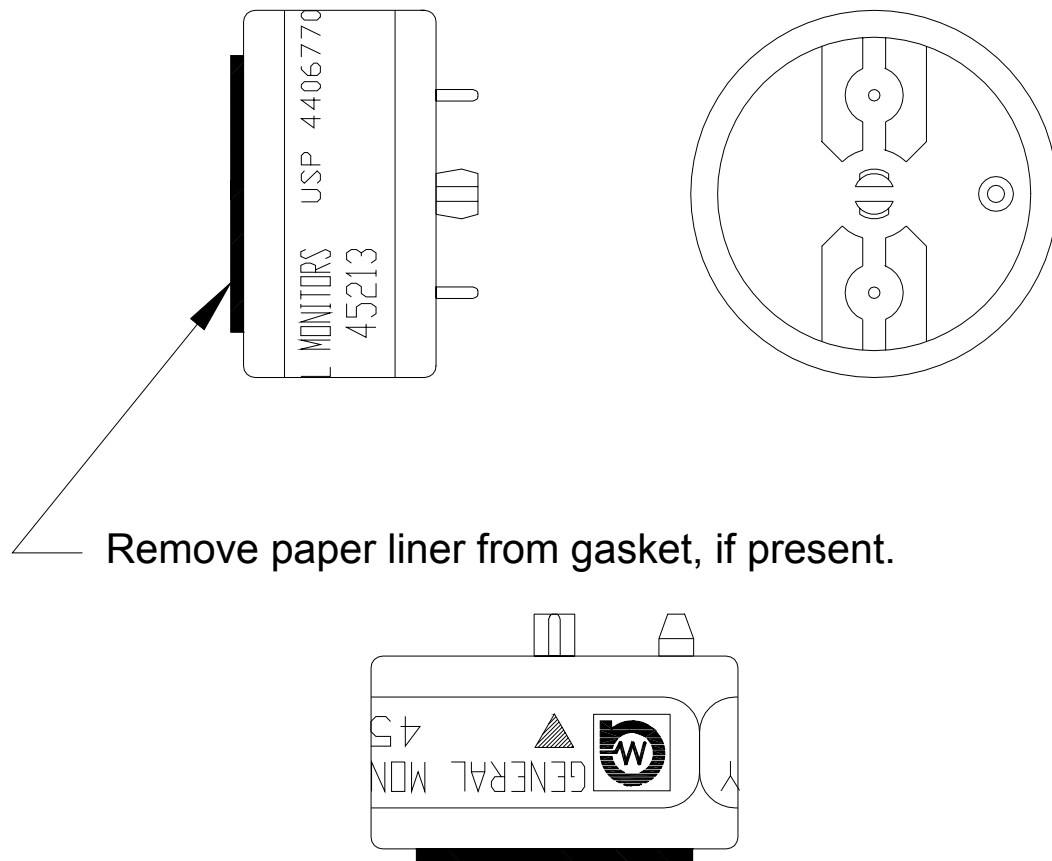
Figure 1 Model TS420

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## 2.0 Detector Assembly

### 2.1 Sensor Assembly

General Monitors uses a two-electrode electrochemical cell (Figure 2) to provide a stable and accurate gas detector.



**Figure 2 Oxygen Deficiency Sensor Assembly**

The oxygen sensor is of the self-powered, diffusion limited, metal air battery type. It contains an anode, electrolyte and an air cathode to which the diffusion of oxygen is severely restricted by a diffusion barrier. At the air cathode, oxygen is reduced to hydroxyl ions, which in turn oxidize the metal anode. This action produces a current that is proportional to the rate of consumption of oxygen.

## 2.2 Control Electronics

The Model TS420's electronics are contained within a plastic housing so that sensor information can be processed at the point of detection. The Model TS420 provides a 4-20 mA output signal proportional to 0 to 25% V/V O<sub>2</sub> full-scale gas concentration at the detector.

Ambient Air is approximate 20.9% V/V O<sub>2</sub>. This level equals 17.38 mA. As the oxygen level decreases the 4-20 mA signal decreases.

The TS420 provides a two-digit LCD (Liquid Crystal Display). This display (Figure 3) provides status such as gas present, fault and calibration cues to the operator. The MODE LCD is on steady during normal operation to show that the sensor is functioning properly.

**Monitored faults are:** data memory failure, failed to calibrate and sensor removed.

Engineering specifications covering the sensor cell and control electronics are found in the Appendix, Section 5.1.

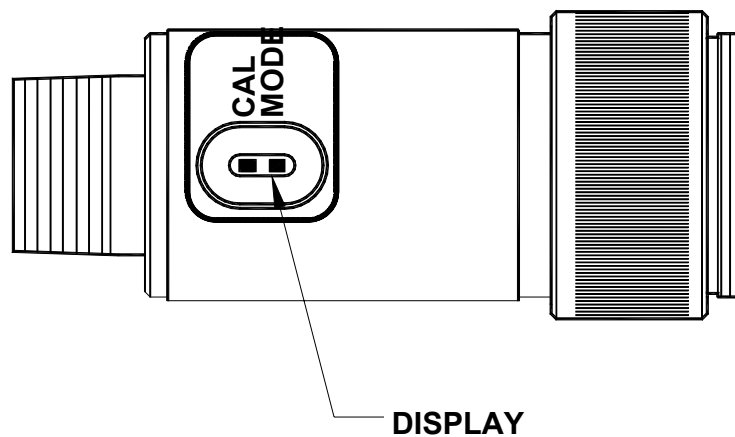


Figure 3 LCD Display Location

## 3.0 Installation

### 3.1 Receipt of Equipment

All equipment shipped by General Monitors is packed in shock absorbing containers, which provide considerable protection against physical damage. The contents should be carefully removed and checked against the packing slip. If any damage has occurred or if there is any discrepancy in the order, notify General Monitors as soon as possible. All subsequent correspondence with General Monitors must specify the equipment part number and serial number.

Each TS420 is thoroughly checked by the factory. However, a complete check-out and initial calibration is necessary upon initial installation and start up to ensure system integrity.

### 3.2 Detector Location Considerations

There are no standard rules for detector placement since the optimum sensor location is different for each application. The customer must evaluate conditions at the facility to make this determination. Generally, the TS420 should be easily accessible for calibration checks. The TS420 should be mounted pointing down to prevent water build-up on the detector head. The detector assembly should not be placed where it may be coated by contaminating substances. Although the Model TS420 is RFI resistant, it should not be mounted in close proximity to radio transmitters or similar equipment.

Some general guidelines for sensor location:

- ! The TS420 should be used in locations that are tightly enclosed with poor or no ventilation, such as utility tunnels or underground storage areas. These areas are likely to have dangerously low oxygen concentrations.
- ! Observe the TS420's environmental specifications when locating the unit.

The environmental specifications covering the electrochemical cell are found in the Appendix, Section 5.1.4.

Detectors should be mounted in an area that is as free from wind, dust, water, shock and vibration as possible.



**WARNING** - Operation above or below temperature limits will provide unstable readings, which may cause false alarms or failure to alarm. See Section 5.1.4 for guidelines.

General Monitors discourages painting of detector assemblies. If the detector head is painted over, the gas will not be able to diffuse into the sensor. If the TS420 body is painted over, the LCD display cannot be read.



### 3.3 Installation Instructions

The TS420 is shipped without the sensor installed. The sensor must be installed into the detector and calibrated for proper operation. See Section 4.5 for installation instructions and Section 4.3 for calibration instructions.

Once correctly installed, the TS420 requires little or no maintenance other than periodic calibration checks to ensure system integrity. General Monitors recommends a calibration check schedule be established and that the complete system, including all alarm circuitry, be tested at least annually.

The overall and mounting dimensions for the TS420 (Figure 12) should be used when making installation determinations. Mechanical specifications can be found in the Appendix, Section 5.1.2.

#### 3.3.1 Intrinsically Safe Barriers

In order for the TS420 to be used with classified equipment inside of the hazardous area, it is necessary for the customer to purchase either a Galvanic or Zener Diode Barrier, which should be mounted in the non-classified area between the TS420 and the facilities' control room. A list of recommended manufacturers and part numbers follows for galvanic barriers:

Stahl - 9303/11-22-11

Elcon - mD323 or mD325

MTL - MTL7206 or MTL5041

Turck - mk33-Li-ExO

Pepperl+Fuchs - KFD2-CR-EX1.30-300

These are recommended active type barriers for intrinsically safe applications. Each application is different and it is the ultimate decision of the user to determine the appropriate I/S barrier for their application.

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**NOTE** - To maintain intrinsic safety, wire length and gauge are limited by the capacitance and inductance of the wire,  $C_i$  and  $L_i$  of the TS420, and the barrier ratings. See Section 5.1.5 for instructions on calculating these values.

---

Align the TS420 so that the LCD display is easily viewed. Teflon tape may be used on the TS420's threads.

#### 3.3.2 Maintenance

The removal of particulate matter from sensor accessories may be done through the use of clean water only. Solvents should not be used. The accessories should be thoroughly dried, with compressed air if necessary, before refitting to the sensor body. Do not apply compressed air directly to the sensor.

Some typical items to check during maintenance examinations are:

- ! The sensor mounting, to see it is secure.
- ! The sensor, to see it is clear of oil, water, dust or paint which might clog it.
- ! The cable connections for tightness and possible damage.
- ! All detector placements are up-to-date with the layout of the plant, e.g. modifications to the plant.
- ! The complete system, to see it has a back up supply for the full-prescribed time.

### 3.4 Wiring Connections

The two wires at the base of the TS420 provide a 4-20mA loop-powered output. The red wire is the “loop +” lead and the white wire is the “loop -” lead (Figure 4). A third green/yellow wire is provided for frame ground.

It is recommended that a two wire, shielded cable be used for making power and output signal connections on the TS420.

Connect the green/yellow frame ground wire to the grounding terminal or lug inside the junction box being used with the TS420.

Ensure the junction box frame is connected to frame ground or connected to the cable shield, which is connected to frame ground at the controller.

Connect the red wire to the +24VDC terminal. Connect the white wire to the signal input terminal on the readout/relay display module, FMD Field Mounted Display, S4100E smart sensor, industrial analog to digital converter, computer-based monitor, PLC, DCS, etc.

Since the TS420 is designed to operate continuously, a power switch is not included, in order to prevent accidental system shutdown.

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**NOTE - Power must remain disconnected until all wiring connections are made.**

---

The absolute maximum distance between the TS420 and the power supply is 8000 feet (2438 meters). Depending on the application, general purpose or intrinsically safe, the cable length will depend on the intrinsically safe barrier chosen and the cable used. See the Appendix, Section 5.1.5, for the intrinsically safe system requirements. In addition, cable length specifications can also be found in the Appendix, Section 5.1.3. In all cases, the cable run should be as short as possible.

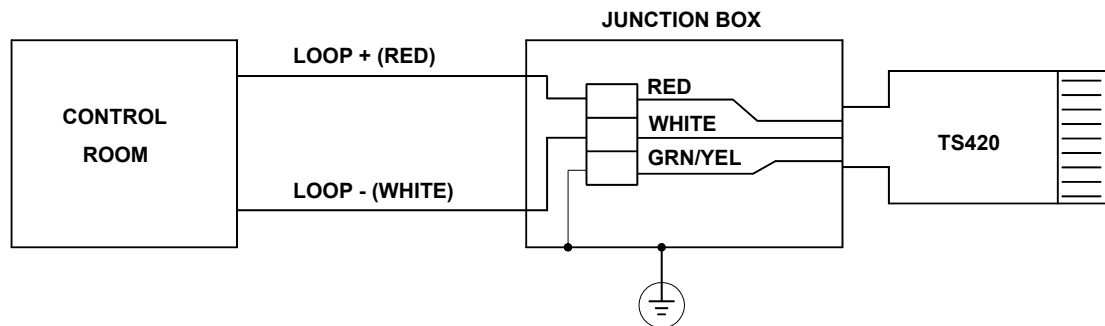


Figure 4 Wiring Diagram

## 4.0 Operation

### 4.1 Applying Power

Before applying power to the system for the first time, all wiring connections should be checked for correctness. The sensor should be allowed to stabilize prior to calibration. The stabilization time should be one (1) hour for all sensors.

#### **Initial Power-up**

The TS420 has been shipped un-calibrated, therefore, the first time power is applied, the TS420 will enter Start-up mode (3.6mA) for a short interval, then may transition to fault mode (flashing MODE LCD with the CAL LCD off and the analog output current at 3.5mA) until calibrated (See Section 4.3 for Calibration Procedure).

After calibration is complete, the TS420 will proceed to Operate mode (17.38mA = 20.9% V/V O<sub>2</sub>) where any detected oxygen will show as a proportional analog output current between 4 and 20mA (4mA = 0% V/V O<sub>2</sub>, 20mA = 25% V/V O<sub>2</sub>). The MODE LCD will be on steady and the CAL LCD off with normal atmosphere and both the MODE and CAL LCD's will flash when oxygen deficiency is detected. (O<sub>2</sub> level < 19%).

General Monitors recommends the TS420 be calibrated again within the first twenty-four (24) hours after the initial calibration. Calibrations should be performed with new units and units that have been off power for more than one (1) week. See "Calibration", Section 4.3, for more details.

#### **Power-up After Initial Calibration**

When the TS420 is powered up, after it has been previously calibrated, the unit will enter a Start-up mode (3.6mA) for approximately 50 seconds, which allows the sensor to stabilize before proceeding to the Operate mode (17.38mA). During Start-up, the MODE LCD will flash, the CAL LCD will be off and the analog output current will be 3.6mA.

| OPERATING MODES   | INDICATOR |      | ANALOG OUTPUT |
|---|-----------|------|---------------|
|   | CAL       | MODE |               |
| START-UP  | □         | *    | 3.6mA         |
| OPERATE   |           |      |               |
| AMBIENT O <sub>2</sub> = 20.9%                          | □         | ■    | 17.38mA       |
| DEFICIENT ATMOSPHERE, O <sub>2</sub> < 19% <sub>1</sub> | *         | *    | 4.0-16.16mA   |
| FAULT   |           |      |               |
| NO POWER  | □         | □    | 0.0mA         |
| SYSTEM  | □         | *    | 3.5mA         |

**Figure 5 Operating Modes, Indicators and Outputs**

1. Segment may flash Synchronously or alternating.

Perform a calibration and the TS420 will return to operate mode (17.38mA).

**NOTE** - The TS420 will not allow you to enter calibration mode during Start-up mode (3.6mA).

## 4.2 Operating Modes

The TS420 has four distinct operating modes: Start-up, Normal Operation, Calibration and Fault. The mode is indicated by both the analog output and the LCD display. See Figures 5 and 6.

## 4.3 Calibration

Activating the “CAL” switch will automatically disable the external alarm circuits by fixing the analog output current to 3.75mA.

General Monitors recommends that the TS420 be calibrated within the first twenty-four (24) hours after initial start-up, and that calibration be checked at least every ninety (90) days to ensure the integrity of the system.

---

**NOTE:** A calibration check consists of applying a 20.9% V/V O<sub>2</sub> (“normal” ambient air) of full-scale concentration of gas to the sensor and observing the reading on the display device being used.

---

General Monitors is not implying that the customer should expect problems with sensor life or stability. “Frequent” calibration checks merely ensure the integrity of the life protecting equipment, and are recommended for problem environments (i.e. sensors accidentally being painted over, etc, see Appendix 5.4).

A calibration schedule should be established and followed. A logbook should also be kept showing calibration dates and dates of sensor replacement.

### Calibration Procedure:

1. If it is suspected that the air is not at “normal” levels (20.9% O<sub>2</sub>), it will be necessary to calibrate the sensor with clean air. The 20.9% O<sub>2</sub> gas cylinder (GMI P/N 1400262-11) can be used. Apply the clean air source prior to entering calibration mode and allow the sensor to stabilize for at least one (1) minute before proceeding.
2. Place the magnet over the GMI Logo on the body of the unit and hold it there until the “CAL” LCD indicator appears, then remove the magnet. The analog output current will drop to 3.75mA.
4. The “CAL” and “MODE” LCD indicator will flash, indicating that the unit is now calibrating.
4. After approximately 30 seconds, the display will change from a flashing “CAL” and “MODE” LCD to a solid “MODE” LCD, indicating that the calibration is complete and the unit has re-entered “OPERATE” mode. Remove any calibration gas.
6. The unit is now calibrated and the new values have been stored in the NOVRAM (non-volatile memory).

Figure 6 shows a flow diagram of the codes that will appear in the display window during the calibration procedure.

If there is a problem and the TS420 cannot complete the calibration sequence, a fault indicator will be displayed, and the analog output current will drop to 3.5mA.

| CALIBRATION       | INDICATOR |      |
|-------------------|-----------|------|
|                   | CAL       | MODE |
| Magnet Applied    | □         | ■    |
| Magnet Recognized | ■         | □    |
| Cal Proceeding    | *         | *    |

Figure 6 Flow Diagram

**NOTE** - If the unit fails to calibrate a flashing "MODE" LCD will be displayed. The sensor must see "clean" air for at least fifteen (15) minutes before a second calibration is attempted by reapplying the magnet.

#### 4.4 Calibration Equipment

General Monitors offers flow calibration kits as the method of introducing calibration gas to the TS420. (See Section 5.5).

Calibration is performed with 20.9% V/V O<sub>2</sub>.

**NOTE** - When removing regulator from gas cylinders, open valve on regulator to ensure that gas is purged and pressure in the regulator is relieved. Be sure to follow this recommendation when switching cylinders.



**WARNING** – Do not use a gas cylinder if the regulator gage shows the cylinder pressure in the black area just above 0 psi. Unstable calibration could result.

If the TS420 is to be used with the optional Splash-Guard, all calibrations must be performed using the calibration cup (Figure 7) with the Splash-Guard installed onto the TS420. In addition, all gas checks must be performed using the calibration cup with the Splash-Guard installed. This performs two functions:

1. It provides a more accurate representation of the amount of gas getting to the sensor.
2. It checks that the Splash-Guard is not clogged and that gas can get to the sensor.

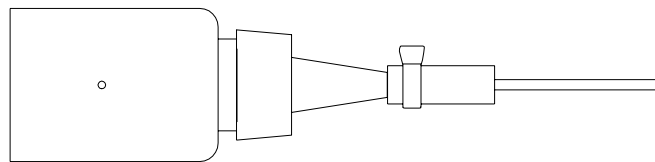


Figure 7 Calibration Cup

If the Splash-Guard will not be used, the TS420 must be calibrated and gas checked with the calibration plug (Figure 8)

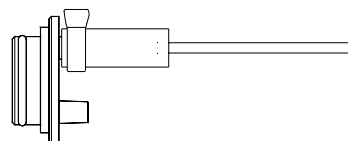


Figure 8 Calibration Plug

**NOTE** – Calibrating the TS420 in normal atmospheric air may introduce a considerable error due to the affects of temperature and humidity. Ambient temperature and humidity can affect the amount of oxygen in the atmosphere (see Figure 9).

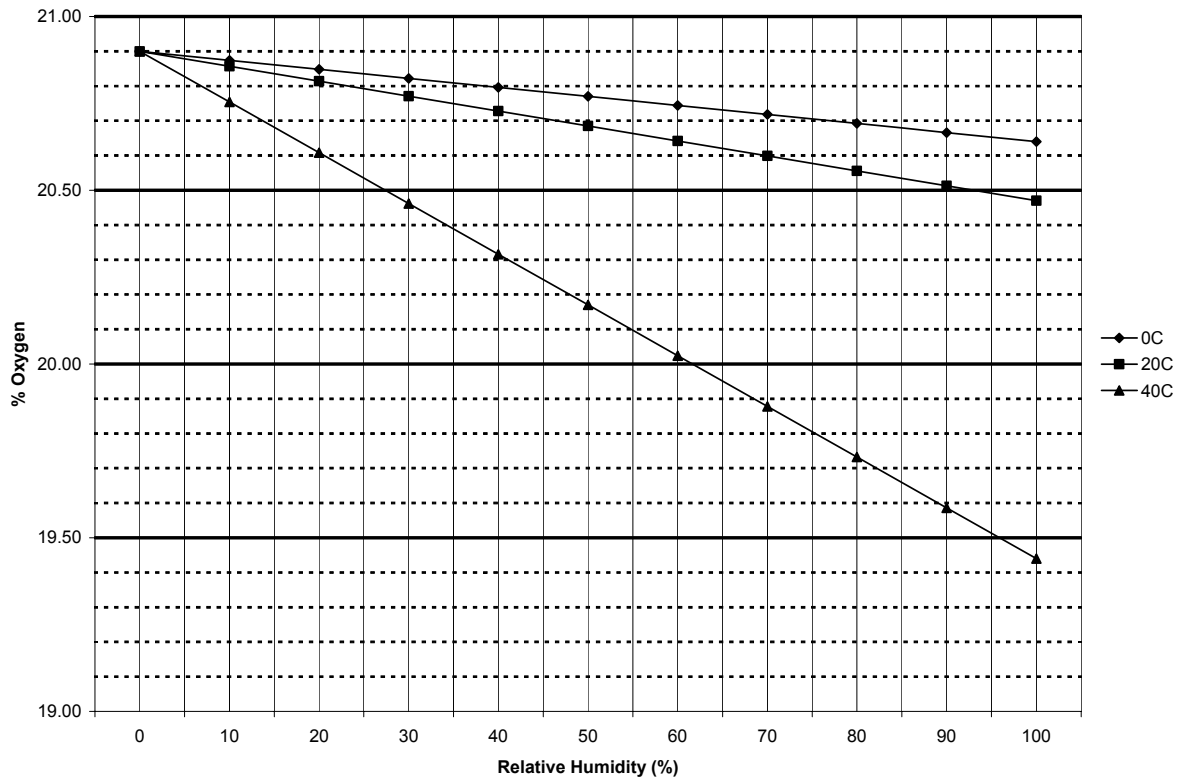


Figure 9 Change in % Oxygen in the atmosphere with Relative Humidity at constant Temperature

## 4.5 Sensor Replacement Procedure

The following is the procedure to replace a TS420 sensor.

**IMPORTANT** - Each sensor is shipped in a plastic bottle. DO NOT remove the sensor until you are ready to apply power to the system. To ensure proper sensor response, each TS420 must be calibrated in the field upon initial installation.

1. Unscrew the TS420 sensor cap.
2. Pull sensor out of the TS420 using your fingers. The sensor is a plug-in type, and the sensor will have a snug fit.

**NOTE** - The TS420 output will drop to 3.5mA when the sensor is removed, indicating a fault condition.

3. If the new sensor is in a plastic storage container, then remove lid ring and uncap jar. Remove the sensor from the container. Save the storage container for later use. Remove paper liner on sensor gasket if present.

4. Examine the sensor and ensure that it is the correct gas type for your application.
5. Align the arrow on the sensor label with the notch on the TS420 body. Install the sensor by pushing sensor's pins into pin sockets on the TS420, see Figure 10.

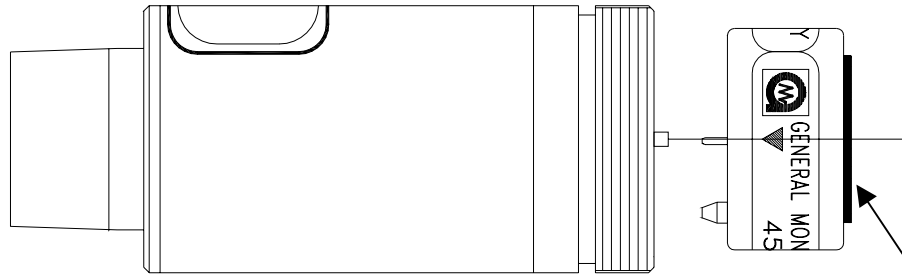
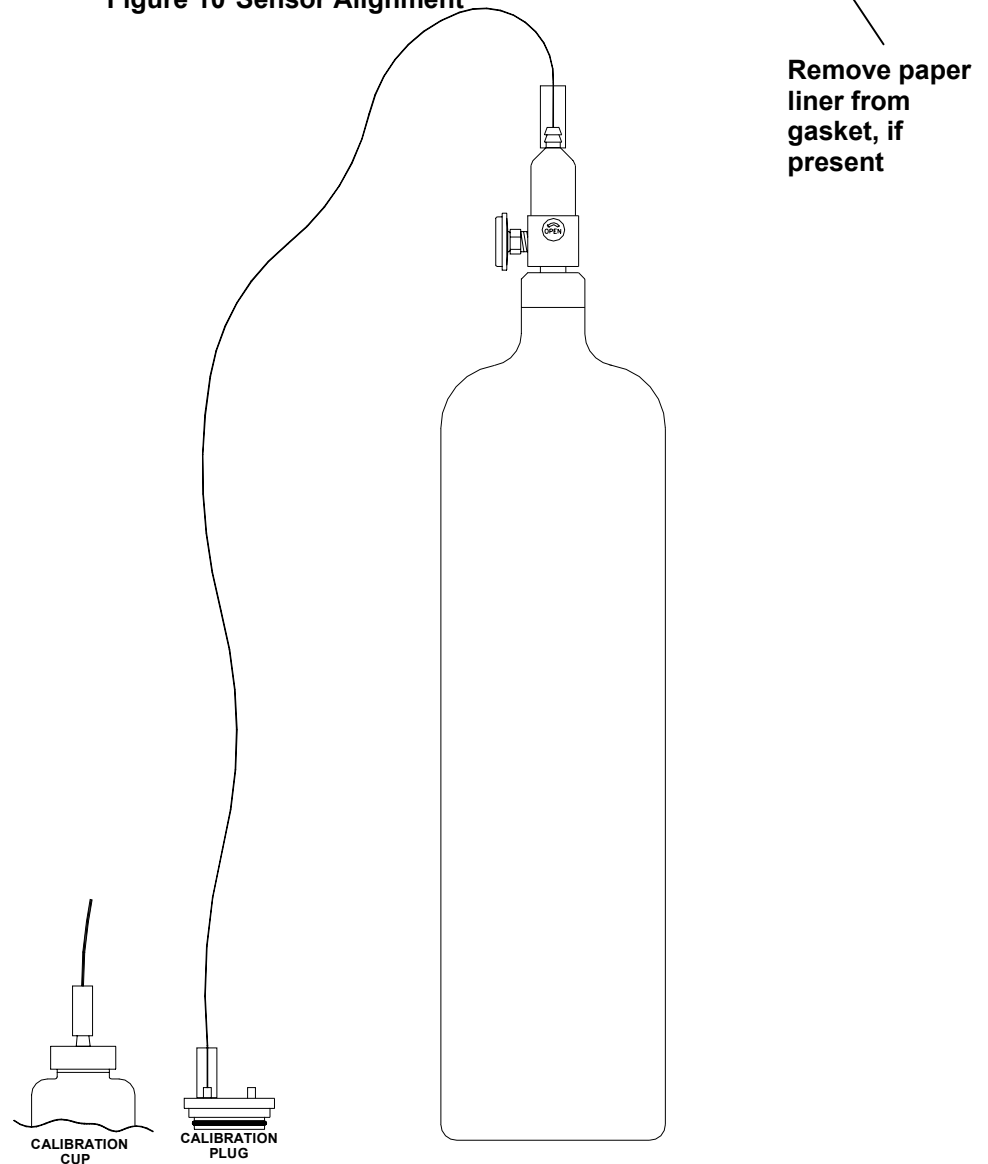


Figure 10 Sensor Alignment



**Figure 11, Calibration Kit with Bottle**

6. Screw on TS420 sensor cap.
7. Apply power to the unit and allow the sensor to stabilize prior to initial calibration. The stabilization time should be at least one (1) hour for all sensors.
8. Calibrate new sensor (see Section 4.3).

---

**NOTE** - The TS420 will stay in fault anytime the sensor is removed. Calibration is required to reset the TS420.

---

## 4.6 Sensor Care and Maintenance

If power is removed from the TS420 for periods greater than one hour, the sensor should be removed from the TS420 and placed in the original storage container shipped with the sensor. Storage of the sensor in the original container guards against sensor contamination from solvents, lubricant humidity, etc.

---

**NOTE** - Do not short the sensor pins.

---

In the case of long intervals of non-use, the sensors should be stored as described above in a cool, dry place, preferably refrigerated between 0 and 20°C.

In all cases, after the sensor has been removed from the TS420, the cap should be replaced on to the TS420 body and the gas port taped off to prevent any corrosion damage to the exposed socket pins.

## 4.7 Fault Codes & The Remedies

The TS420 has self-diagnostics incorporated into the microprocessor program. If a fault is detected, the output signal will drop to 3.5mA and the MODE LCD will be flashing to indicate the fault.

When a calibration fault has occurred and has been corrected, the unit will stay in fault until it has been successfully calibrated.

### **The Fault Codes are:**

**Fault (No Power):** Neither LCD will be on. Output signal will be 0.0mA.

**Remedy:** Check wiring, ensure power is applied to unit.

**Fault (System):** The "MODE" LCD will be flashing. Output signal will be 3.5mA.

**Remedy:** Attempt recalibrating the detector. If the fault persists, replace the sensor and after sensor has stabilized (one (1) hour minimum). Recalibrate. If fault still persists, contact factory or your sales representative.



## 5.0 Appendix

### 5.1 Specifications

#### 5.1.1 System Specifications

**Sensor Type:**

Electrochemical cell

**Typical Life (sensing element):**

2 years in normal air

**Warranty:**

Two years for the electronics

One year for the sensor cell

**Malfunctions Monitored:**

Calibration Errors

Data Memory Errors

**Measuring Range:**

Oxygen 0-25% V/V O<sub>2</sub>

**Response Time:**

T<sub>90</sub> < 15 sec

**Repeatability:**

+ 1 % full scale

**Approvals:**

UL, CUL, CSA, CENELEC and CE approved.

---

**NOTE** - Not approved for use in atmospheres > 21%V/V O<sub>2</sub>.

---

#### 5.1.2 Mechanical Specifications

Weight (approx.): 0.5 lbs. (0.23 kg)

Length: 4.5" (114 mm)

Diameter: 1.75"(44 mm)

Mounting: 3/4" NPT

Housing: Plastic

#### 5.1.3 Electrical Specifications

Recommend two wire 14, 16 or 18 AWG shielded cable.

#### General Purpose Installations

Maximum distance between the TS420 and the power source @ 24VDC nominal (600 Ω load resistor maximum) is 8000 feet (2438 meters).

#### Intrinsically Safe Installations

See Sections 5.1.5 through 5.1.7.

**Intrinsically Safe Parameters**

|                   |             |
|-------------------|-------------|
| $U_i / V_{MAX} =$ | 35VDC       |
| $I_i / I_{MAX} =$ | 100mA       |
| $C_i =$           | 0           |
| $L_i =$           | 500 $\mu$ H |

**Input Power:**

10 to 35VDC range; 3.5 to 22mA loop powered

**Output Current:**

(600  $\Omega$  max. @ 24VDC) (120  $\Omega$  max. @ 10VDC)

|                 |             |
|-----------------|-------------|
| Signal Range    | 3.5 to 22mA |
| Fault           | 3.5mA       |
| Start-up        | 3.6mA       |
| Calibration     | 3.75mA      |
| Detection Range | 4 to 20mA   |
| Over-range      | 22mA        |

**Electrical Classification:**

Class I, Divisions 1 & 2, Groups A, B, C & D;  
Class I, Zone 0, AEx ia IIC T6; EX ia IIC T6; Eex ia IIC T6  
Class II, Groups E, F & G,  
Class III,  
IP67, Type 4X

**RFI/EMI Protection:**

Complies with EN50081-2, EN50082-2

**Status Indicator:**

Liquid Crystal Display with Normal, Fault, and Calibration cues

**5.1.4 Environmental Specifications**

**Operating Temperature Range:**

-4°F to +122°F (-20°C to +50°C)

**Storage Temperature Range:**

-4°F to +122°F (-20°C to +50°C)

**Humidity Range:**

0 to 99% relative humidity non-condensing

**Pressure Range:**

Atmosphere  $\pm$  10%

### 5.1.5 Intrinsically Safe System Requirements

**NOTE** - Refer to control drawing 45217 Rev A. (Section 5.2.2)

The TS420 is approved as intrinsically safe on its own (entity approved). However, when installing the TS420 into a system, there are requirements, which must be strictly followed to maintain the intrinsic safety of the system. These requirements are:

1.  $U_i/V_{MAX}$  of the field device (TS420) must be less than or equal to  $U_{MAX}$  of barrier.
2.  $I_i/I_{MAX}$  of the field device (TS420) must be greater than or equal to  $I_{MAX}$  of the barrier.
3. The inductance of the cable and the TS420 ( $L_i$ ) must be less than the barrier's maximum inductance rating ( $L_a$ ).
4. The capacitance of the cable and the TS420 ( $C_i$ ) must be less than the barrier's maximum capacitance rating ( $C_a$ ).

To calculate maximum cable length, use the following formulas, and use the shorter of the two calculations.

**Capacitance:**

$$\text{Max. Cable Length} = \frac{C_{MAX}(\text{Barrier}) - C_i(\text{TS420}) (\text{ft})}{\text{Wire Capacitance/Ft}}$$

**Inductance:**

$$\text{Max. Cable Length} = \frac{L_{MAX}(\text{Barrier}) - L_i(\text{TS420}) (\text{ft})}{\text{Wire Inductance/Ft}}$$

### 5.1.6 Sample Calculation

What is the maximum allowable cable length when using an MTL 7206 barrier and BELDEN 8760 2-conductor shielded cable?

BELDEN 8760 Parameters: C/ft = 24 pF/ft, L/ft: not available

MTL 7206:

$$C_{MAX} = 0.12 \mu\text{f}$$

$$L_{MAX} = 4.0 \text{ mH}$$

$$U_i/V_{MAX} = 35\text{V}$$

$$I_i/I_{MAX} = 93\text{mA}$$

TS420:

$$C_i = 0 \mu\text{f}$$

$$L_i = 500 \mu\text{H}$$

$$U_i/V_{MAX} = 35\text{V}$$

$$I_i/I_{MAX} = 100\text{mA}$$

1.  $U_i/V_{MAX} (\text{TS420}) \leq U_i/V_{MAX} (\text{MTL 7206})$   
 $35\text{VDC} \leq 35\text{VDC}$
2.  $I_i/I_{MAX} (\text{TS420}) \geq I_i/I_{MAX} (\text{MTL 7206})$   
 $100\text{mA} \geq 93\text{mA}$
3. Cable inductance not available.
4. Max. cable length =  $\frac{C_{MAX}(\text{MTL 7206}) - C_i(\text{TS420})}{C/L (\text{Belden 8760})}$

$$= \frac{0.12\mu\text{f} - 0\mu\text{f}}{24\text{pF/ft}}$$

$$\text{Max. Cable length} = 5000 \text{ feet}$$

## 5.2 Engineering Documentation

### 5.2.1 Outline & Dimensional Drawing

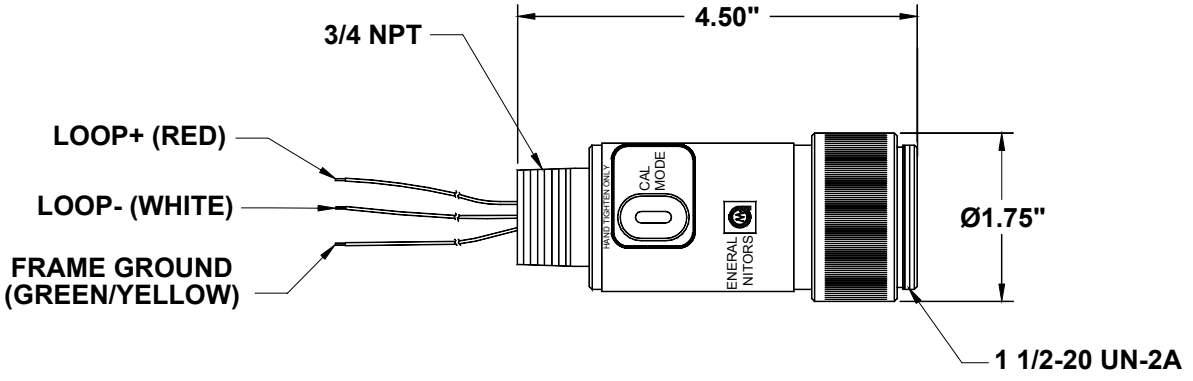
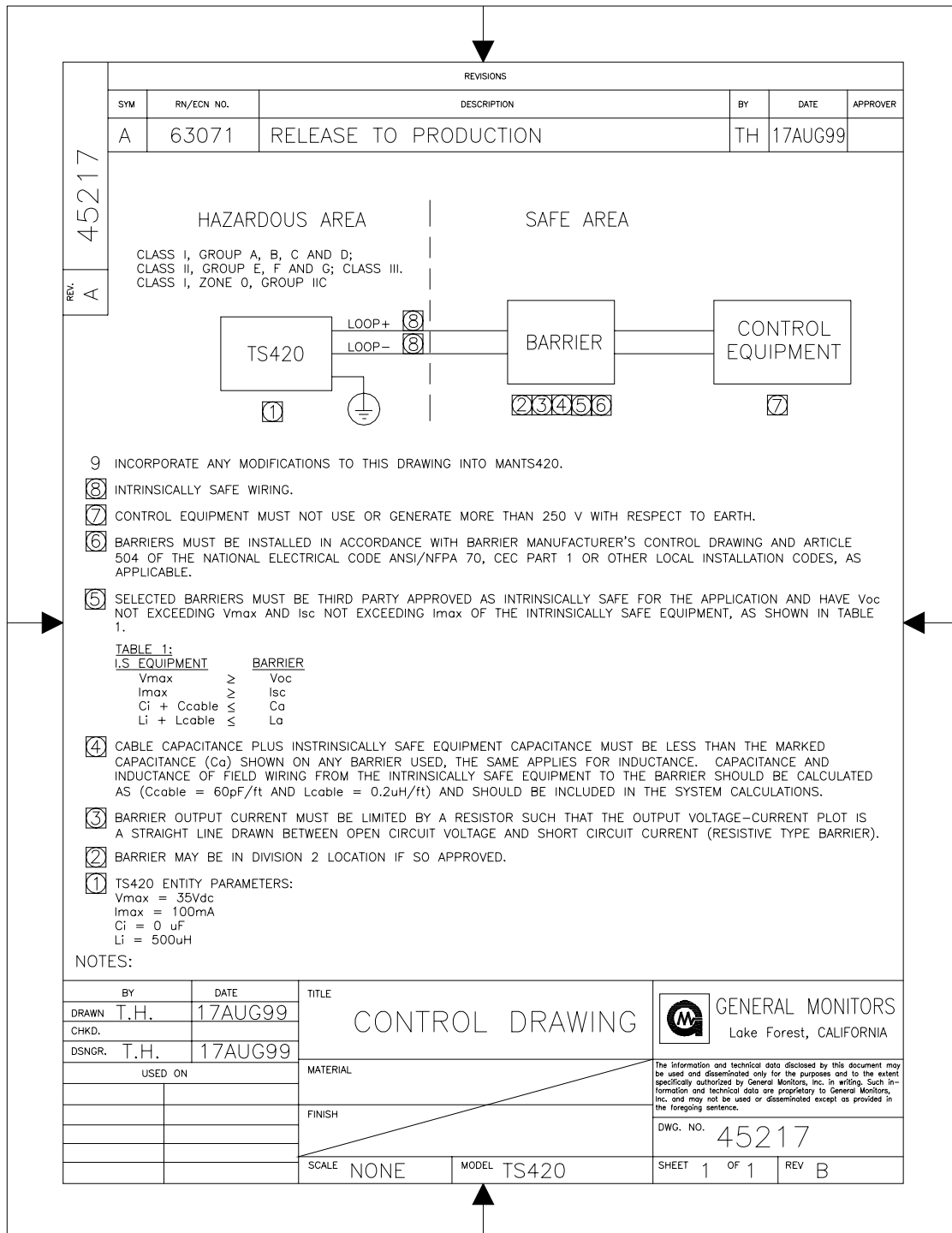


Figure 12 Outline and Dimensional Drawing

**5.2.2 Control Drawing**



**Figure 13 Control Drawing**

5.2.3 Sample Installation

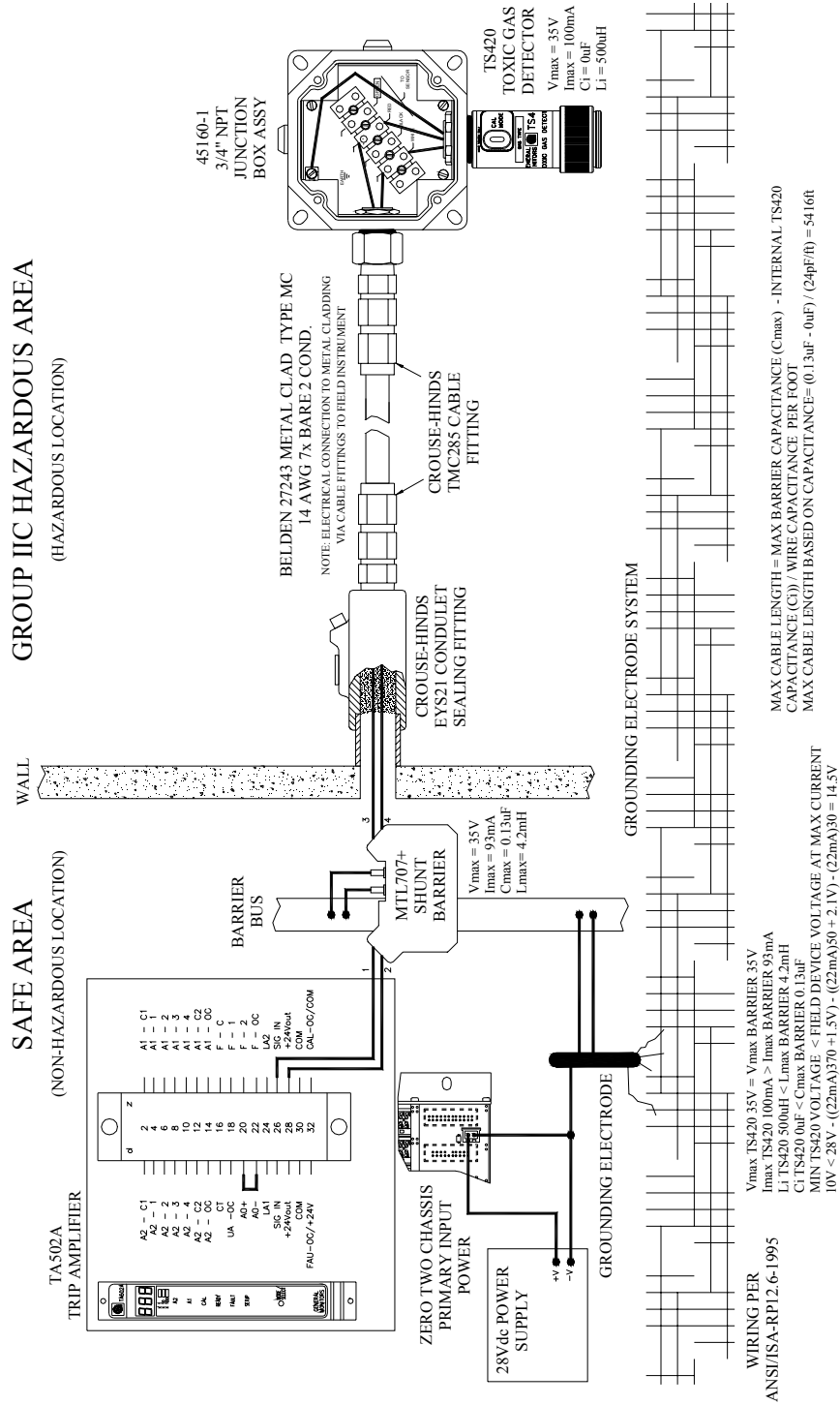
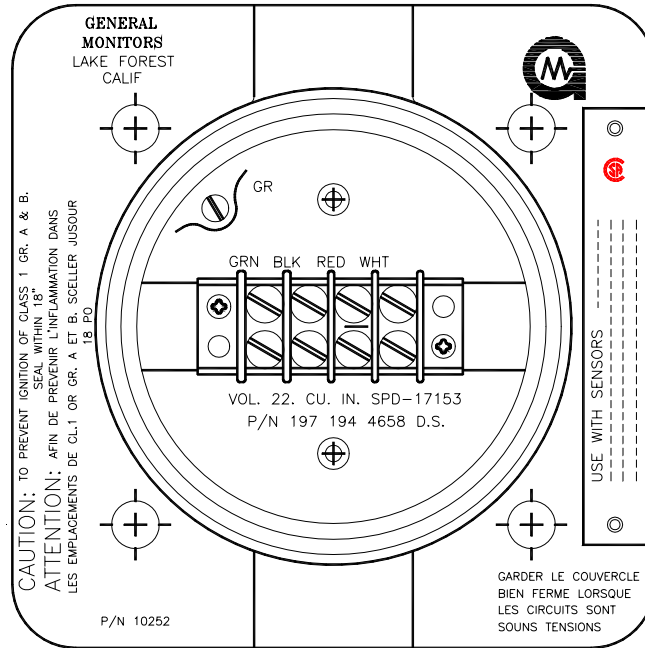
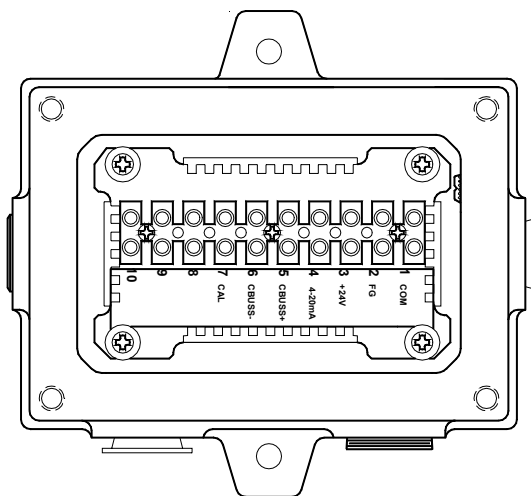


Figure 14 Sample Installation

**5.2.4 Junction Boxes**



**Figure 15 10252 Round Aluminum Junction Box**



**Figure 16 31305-2 Aluminum Junction Box**

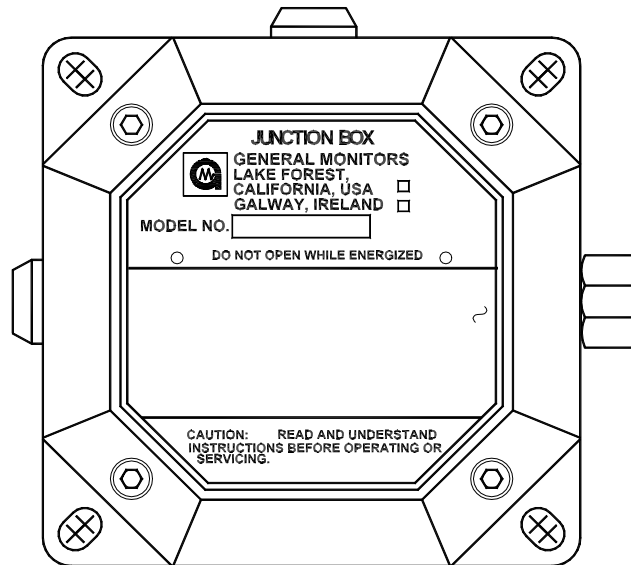


Figure 17 45160-1 Plastic Junction Box, NPT; 45160-2 Plastic Junction Box, M20

### 5.2.5 Splash-Guard

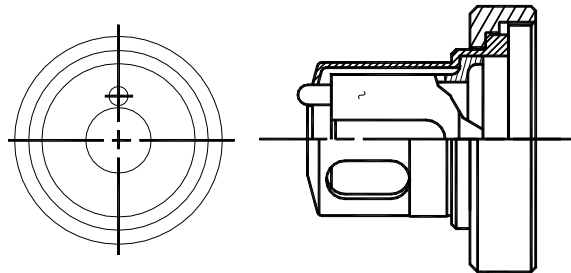


Figure 18 70631-2 Splash - Guard



5.2.6 Accessories

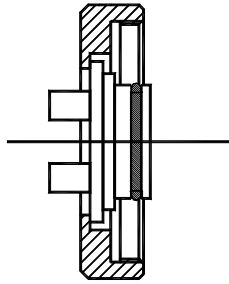


Figure 19 45170-1 Flow Block

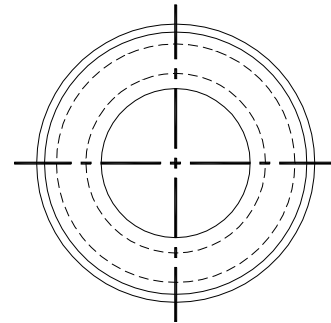
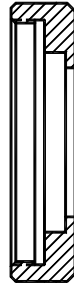


Figure 20 45147-1 Flow Block Retainer

5.2.7 Calibration Accessories

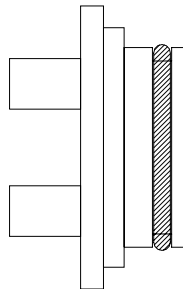


Figure 21 914-152 Calibration Plug

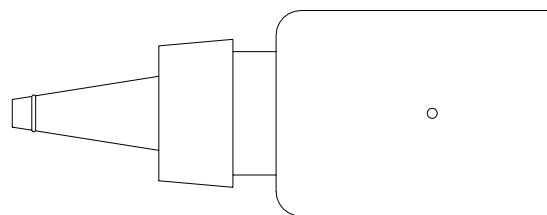
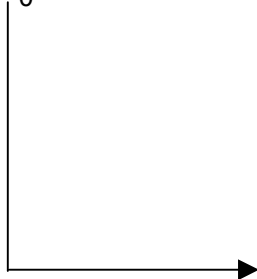


Figure 22 1400152-1 Calibration Cup

### 5.3 Ordering Information

TS420 - 3 0 0 - 101 - 1 0



Junction Box:  
0 = None  
1 = 45160-1 Junction Box – Plastic NPT  
3 = 10252 Junction Box – Round, Aluminum

## 5.4 Calibration Schedule for Problem Environments

Detector Serial Number: \_\_\_\_\_ Location: \_\_\_\_\_

- 1) Installation and preliminary calibration. Record date after preliminary calibration is performed:  
Date: \_\_\_\_\_
  
- 2) 24-hour calibration. Record date after 24-hour calibration is performed:  
Date: \_\_\_\_\_
  
- 3) 7 day calibration check (Record date and reading of calibration check. Repeat after 7 days if reading deviates more than  $\pm 10\%$ . Otherwise go to step 4).  

| Date  | Reading | Date  | Reading | Date  | Reading |
|-------|---------|-------|---------|-------|---------|
| _____ | _____   | _____ | _____   | _____ | _____   |
| _____ | _____   | _____ | _____   | _____ | _____   |
  
- 4) 14 day calibration check (Record date and reading of calibration check. Repeat after 14 days if reading deviates more than  $\pm 10\%$ . Otherwise go to step 5).  

| Date  | Reading | Date  | Reading | Date  | Reading |
|-------|---------|-------|---------|-------|---------|
| _____ | _____   | _____ | _____   | _____ | _____   |
| _____ | _____   | _____ | _____   | _____ | _____   |
  
- 5) 30 day calibration check (Record date and reading of calibration check. Repeat after 30 days if reading deviates more than  $\pm 10\%$ . Otherwise go to step 6).  

| Date  | Reading | Date  | Reading | Date  | Reading |
|-------|---------|-------|---------|-------|---------|
| _____ | _____   | _____ | _____   | _____ | _____   |
| _____ | _____   | _____ | _____   | _____ | _____   |
  
- 6) 60 day calibration check (Record date and reading of calibration check. Repeat after 60 days if reading deviates more than  $\pm 10\%$ . Otherwise go to step 7).  

| Date  | Reading | Date  | Reading | Date  | Reading |
|-------|---------|-------|---------|-------|---------|
| _____ | _____   | _____ | _____   | _____ | _____   |
| _____ | _____   | _____ | _____   | _____ | _____   |
  
- 7) 90 day calibration check:  

| Date  | Reading | Date  | Reading | Date  | Reading |
|-------|---------|-------|---------|-------|---------|
| _____ | _____   | _____ | _____   | _____ | _____   |
| _____ | _____   | _____ | _____   | _____ | _____   |
| _____ | _____   | _____ | _____   | _____ | _____   |
| _____ | _____   | _____ | _____   | _____ | _____   |

## 5.5 Spare Parts & Accessories

### TS420 Spare Parts

The Model TS420 has potted electronics, therefore, there are no replacement boards available for this unit. The part numbers of the TS420 itself are:

#### TS420

|                   |         |
|-------------------|---------|
| Oxygen Deficiency | 45200-1 |
| Sensor Cap        | 45103-1 |

#### Replacement Sensors

|                          |         |
|--------------------------|---------|
| Oxygen Deficiency Sensor | 45213-1 |
|--------------------------|---------|

#### TS420 Mounting Accessories

|                                  |         |
|----------------------------------|---------|
| Splash-Guard (Standard)          | 70631-2 |
| Flow Block (Incl. Ret./Cal Plug) | 45170-1 |
| Retainer, Flow Block             | 45147-1 |
| Alum. Junction Box (Small)       | 10252   |
| Alum. Junction Box (Large)       | 31305-2 |
| Plastic Junction Box (3/4" NPT)  | 45160-1 |
| Plastic Junction Box (M20)       | 45160-2 |
| Cable Grip                       | 961-008 |
| 3/4" NPT, Adapter, Plastic       | 961-009 |
| 3/4" NPT Adapter, Steel          | 961-007 |
| 20 mm x 3/4" NPT Adapter, Brass  | 961-006 |

#### TS420 Calibration Accessories

|                       |           |
|-----------------------|-----------|
| Tubing                | 931-085   |
| Regulator (500ml/Min) | 922-023   |
| Calibration Plug      | 914-152   |
| Calibration Cup       | 1400152-1 |

#### Calibration Kits (cylinder, regulator & tubing)

|                      |            |
|----------------------|------------|
| O <sub>2</sub> 20.9% | 1400263-11 |
|----------------------|------------|

#### Spare Cylinders

|                      |            |
|----------------------|------------|
| O <sub>2</sub> 20.9% | 1400262-11 |
|----------------------|------------|

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