GENERAL MONITORS

Model TS400

Toxic Gas Detector

Instruction Manual **05/11**

MANTS400

Part No. MANTS400
Revision N-05/11

Introduction

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.

This manual provides instruction for installing and operating the General Monitors Model TS400 Toxic Gas Detector. While the TS400 is easy to install and operate, this manual should be read in full, and the information contained herein understood, before attempting to place the system in service.

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.

Warranty Statement

General Monitors warrants the Model TS400 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.

Special Warning

The TS400 detects many extremely toxic gases and exposure to such gases may result in sickness or death.

The TS400 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 TS400 is rated intrinsically safe as denoted by the symbol "Ex ia" on the instrument label.

Substitution of electrical components within the TS400 may impair intrinsic safety.
Damage to the TS400 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 TS400; however, calibration accuracy and the watertight nature of the TS400 will be compromised.

Do not use a TS400 with a damaged housing in hazardous environments.

IMPORTANT: Each toxic sensor cell is shipped separate from the TS400. This ensures that a fresh sensor cell will be used during initial start-up. DO NOT install the cell into the TS400 until you are ready to apply power to the system. When installing this unit, an initial field calibration must be completed, since the TS400 is not factory calibrated to the specific cell.

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 be 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 specified 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.

Fault/Malfunction circuit operation should be verified.

System verifications should be performed at least annually

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

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.

1.0 Quick Start Guide

1.1 Mount and Wire the Detector (see pages 5 through 14).

The TS400 is shipped without the sensor installed. The sensor must be installed into the detector and calibrated for proper operation. See Section 4.6 for wiring connections and Section 5.3 for calibration instructions.

Once correctly installed, the TS400 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 TS400 (Figure 1) should be used when making installation determinations. Mechanical specifications can be found in the Appendix, Section 6.1.2.

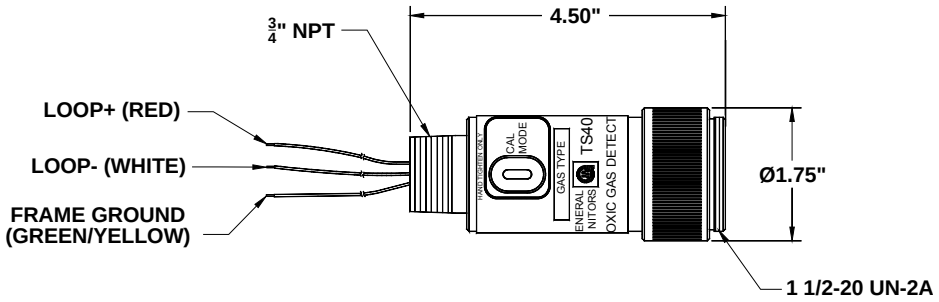

Figure 1: Outline & Dimensional Drawing

In order for the TS400 to be used with classified equipment inside 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 TS400 and the facilities' control room. A list of recommended manufacturers and part numbers follows for Zener and 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.

NOTE: To maintain intrinsic safety, wire length and gauge are limited by the capacitance and inductance of the wire, Ci and Li of the TS400, and the barrier ratings. See Section 6.1.5 for instructions on calculating these values.

Align the TS400 so that the LCD display is easily viewed. Teflon tape may be used on the TS400's threads.

The red and white wires at the base of the TS400 provide for 4-20mA loop-powered operation. The red wire is the "loop +" lead and the white wire is the "loop -" lead (Figure 2). 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 TS400.

Connect the green/yellow frame ground wire to the grounding terminal or lug inside the junction box being used with the TS400.

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, S4100E smart sensor, industrial analog to digital converter, computer-based monitor, PLC, DCS, etc.

Since the TS400 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 TS400 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 6.1.5, for the intrinsically safe system requirements.) In addition, cable length specifications can also be found in the Appendix, Section 6.1.3. In all cases, the cable run should be as short as possible.

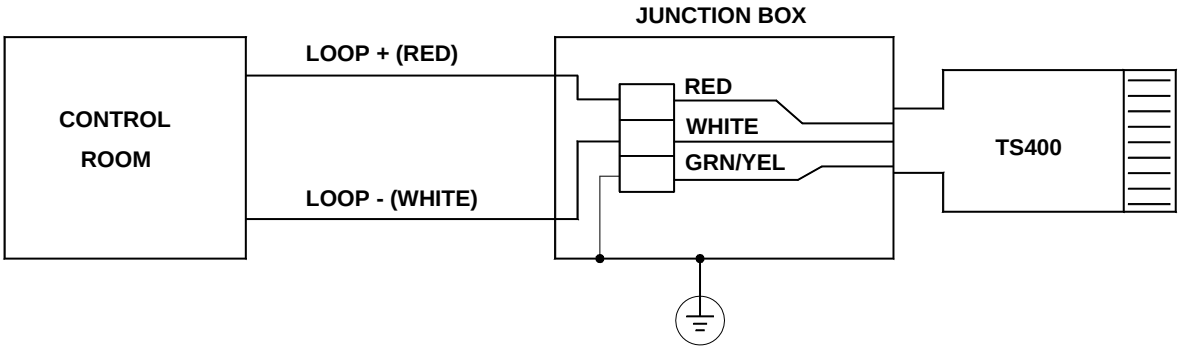

Figure 2: Wiring Diagram

1.2 Apply Power to the Detector

Before applying power to the system for the first time, all wiring connections should be checked. The sensor should be allowed to stabilize prior to calibration. The stabilization time should be twenty-four (24) hours for the Nitric Oxide and Hydrogen Chloride sensors, and one (1) hour for all other sensors.

1.2.1 Initial Power-up

The TS400 is shipped un-calibrated; therefore, the first time power is applied, the TS400 will enter start-up mode (3.6mA) for a short interval, and 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 5.3 for Calibration Procedure).

After calibration is complete, the TS400 will proceed to operate mode (4.0mA) where any detected gas will show as a proportional analog output current between 4 and 20mA. The MODE LCD will be on steady and the CAL LCD off with no gas present and both the MODE and CAL LCD's will flash when gas is detected.

General Monitors recommends the TS400 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 5.3, for more details.)

1.2.2 Power-up After Initial Calibration

When the TS400 is powered up, after it has been previously calibrated, the unit will enter a start-up mode (3.6mA), which allows the sensor to stabilize before proceeding to the operate mode (4.0mA). During start-up, the MODE LCD will flash, the CAL LCD will be off and the analog output current will be 3.6mA.

If the sensor’s “zero” has shifted while it was off power, then the TS400 will stay in start-up mode (3.6mA). This can occur if the sensor was changed, or the sensor drifted due to temperature, humidity, pressure, or electrolyte stability due to power not being applied. Remove the sensor (with power applied to the TS400), wait at least 10 seconds and re-insert the sensor into the TS400. The TS400 will see this as a “new sensor” (3.5mA) and will allow you to enter calibration mode (3.75mA).

OPERATING MODES	INDICATOR CAL	MODE	ANALOG OUTPUT
START-UP	☐	✸	3.6mA
OPERATE			
NO GAS	☐	■	4.0mA
GAS	✸	✸	4.0-22mA
FAULT			
NO POWER	☐	☐	0.0mA
SYSTEM	☐	✸	3.5mA

Table 1: Operating Modes, Indicators and Outputs

Perform a complete zero and calibration and the TS400 will return to operate mode (4.0mA).

NOTE: The TS400 will not allow you to enter calibration mode during start-up mode (3.6mA).

1.2.3 Calibrate the Detector

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

NOTE: The Model TS400 toxic gas detector configured with Nitric Oxide or Hydrogen Chloride sensors may take up to 24 hours to stabilize if power has been removed for more than one (1) hour.

General Monitors recommends that the TS400 be calibrated at the average operating temperature within the first twenty-four (24) hours after initial start-up. Calibration should be checked at least every ninety (90) days to ensure the integrity of the system.

NOTE: A calibration check consists of applying a 50% of full-scale concentration of gas to the sensor and observing the reading on the display device being used.

Calibration checks ensure the integrity of the life protecting equipment, and are recommended for problem environments (i.e. mud collecting on the sensor head, 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.

1.2.4 Calibration Procedure

If it is suspected that toxic gases are present, it will be necessary to purge the sensor with clean air for at least fifteen (15) minutes. The 20.9% O_2 gas cylinder (GMI P/N 1400262-11) can be used.

1. 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.

2. The "**CAL**" LCD indicator will flash while the unit is zeroing the sensor. When the "**CAL**" LCD changes from flashing to solid, it is time to apply the calibration gas.

3. Apply a concentration of toxic gas, equivalent to 50% of full-scale, to the sensor. The display will change from a solid "**CAL**" LCD to a flashing "**CAL**" and "**MODE**" LCD indicating that the sensor is responding to the gas.

4. After three to five minutes the display will change from a flashing "**CAL**" and "**MODE**" LCD to a solid "**CAL**" and "**MODE**" LCD, indicating that the calibration is complete. Remove the calibration gas and allow the sensor to see clean air.

The unit is now calibrated and the new values have been stored in the NOVRAM (non-volatile memory).

Table 2 shows a flow diagram of the codes that will appear in the display window during the calibration procedure.

If the TS400 is placed in "**CAL**" mode and no gas is applied for six (6) minutes, the unit will revert to a fault condition. Placing the magnet over the GMI Logo again will return the unit to the "**CAL**" mode.

If there is a problem and the TS400 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	■	☐
Magnet Removed Zeroing	✸	☐
Zero Finished, Apply Gas[1]	■	☐
Cal Proceeding	✸	✸
Cal Complete, Remove Gas	■	■

1 Depending on age of the sensor and gain setting from a previous calibration, the calibration may proceed from "**zeroing**" to "**Cal Proceeding**". Apply gas during the "**Cal Proceeding**" step in this case.

Table 2: Flow Diagram

NOTE: If the unit fails to calibrate, a flashing "MODE" LCD will be displayed. The calibration gas must be removed from the sensor, and the sensor must see "clean" air for at least fifteen (15) minutes before a second calibration is attempted.

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

Houston, Texas
Phone: +1-281-855-6000
Fax: +1-281-855-3290

Ireland
Phone: 353-91-751175
Fax: 353-91-751317

Singapore
Phone: 656-748-3488
Fax: 656-748-1911

United Arab Emirates
Phone: 971-4-8815751
Fax: 971-4-8817927

United Kingdom
Phone: 44-1625-619-583
Fax: 44-1625-619-098

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2.0 General Description

The Model TS400 is a 4-20mA, loop-powered toxic gas detector used for the detection of various toxic gases. The microprocessor-based electronics process information at the sensor site, and is 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 100% full-scale) provides remote and/or discrete indications of the sensor's operation.

The TS400 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.

NOTE: Intrinsically safe applications require an I/S barrier mounted in a safe area. (See Section 4.4 for guidelines.)

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

2.2 Applications

This is a partial listing of applications:

1. Wastewater Treatment Plants
2. Chemical and Petrochemical Plants
3. Refineries
4. Pulp & Paper Plants
5. Micro-chip Manufacturing
6. Pharmaceuticals
7. Food & Beverage
8. Utilities

Figure 3: Model TS400

3.0 Detector Assembly

3.1 Sensor Assembly

General Monitors uses a three-electrode electrochemical cell mated with a sensor identification board (Figure 4) to provide the most stable and accurate gas detector possible.
Gas diffusing into the electrochemical cell reacts at the sensing electrode by reduction or oxidation depending on the sensor type. The counter electrode acts to balance out the reaction at the sensing electrode. If oxidation occurs at the sensing electrode, oxygen will be reduced to form water at the counter electrode. If the sensing electrode reaction is a reduction, the counter electrode reaction will be reversed (water will be oxidized).

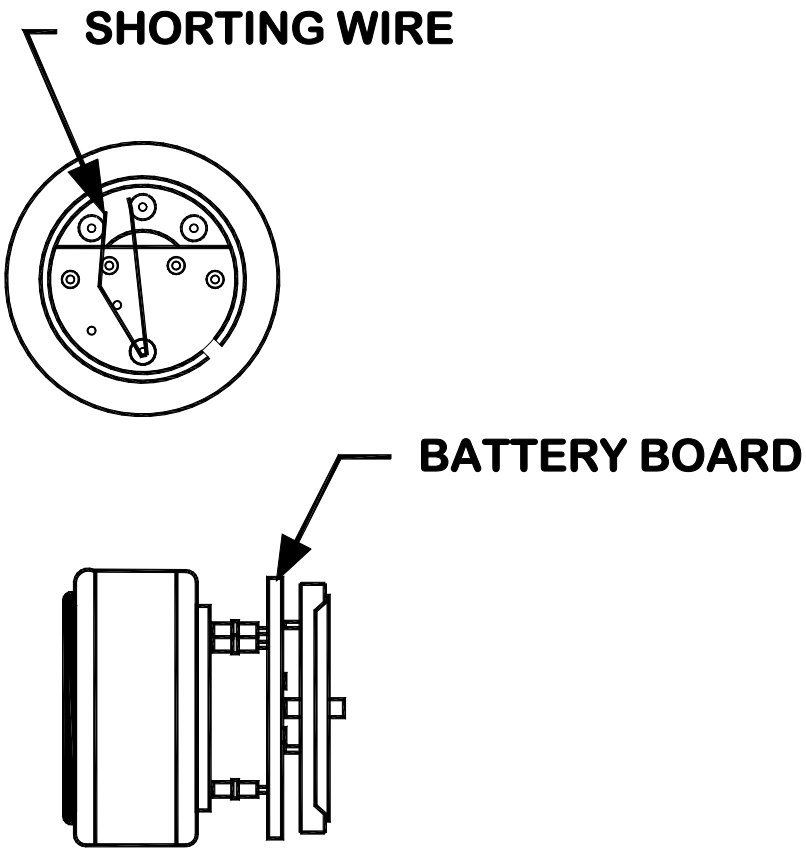

Figure 4: Toxic Sensor Assembly

3.2 Control Electronics

The Model TS400's electronics are contained within a plastic housing so that sensor information can be processed at the point of detection. The Model TS400 provides a 4-20mA-output signal proportional to 0 to 100% full-scale gas concentration at the detector.

The TS400 provides a two-digit LCD (Liquid Crystal Display). This display (Figure 5) provides status of gas present and 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, failure to zero (during calibration) and failure to calibrate.

Engineering specifications covering the sensor cell and control electronics are found in the Appendix, Section 6.1.

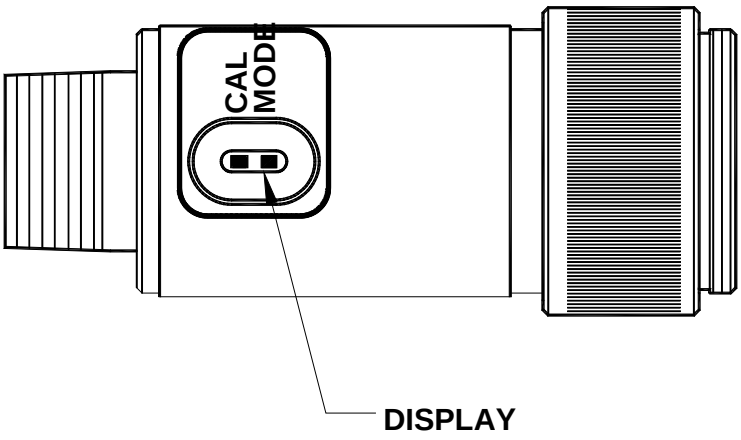

Figure 5: LCD Display Location

4.0 Installation

4.1 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 TS400 is thoroughly checked by the factory. However, a complete inspection and calibration is necessary upon initial installation and start-up to ensure system integrity.

4.2 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 TS400 should be easily accessible for calibration checks. The TS400 should be mounted pointing down to prevent water build-up on the detector head. The detector assembly should not be placed where contaminating substances may coat it. Although the Model TS400 is RFI resistant, it should not be mounted in close proximity to radio transmitters or similar equipment.

Some general guidelines for sensor location:

1. Locate the TS400 where prevailing air currents contain the maximum concentration of gas
2. Locate the TS400 near possible sources of gas leaks
3. Observe the TS400's environmental specifications when locating the unit

The environmental specifications covering the electrochemical cell are found in the Appendix, Section 6.1.4.

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

CAUTION: Operation above or below temperature limits may cause unstable readings, possibly resulting in false alarms or failure to alarm. (See Section 6.1.4 for guidelines.)

Electrochemical sensors may be affected by exposure to certain gases. While General Monitors does use extremely selective cells, some cross-sensitivity does occur. The more important combinations to keep in mind are noted below:

- Carbon Monoxide - Ethylene (75%), Hydrogen (60%) and Nitric Oxide (20%)
- Chlorine - Nitrogen Dioxide (120%)
- Chlorine Dioxide - Nitrogen Dioxide (120%)
- Hydrogen Chloride - Sulfur Dioxide (35%)
- Hydrogen Sulfide – Sulfur Dioxide (20%)
- Nitric Oxide - Hydrogen Sulfide (35%) and Nitrogen Dioxide (25%)
- Nitrogen Dioxide - Chlorine (90%)
- Sulfur Dioxide – Hydrogen Cyanide (50%), Chlorine (-40%) and Nitrogen Dioxide (-100%)

All values are approximations based on experimental data.
Chlorine, Chlorine Dioxide and Hydrogen Chloride cell types may be sensitive to humidity variation (See Section 6.1.4 for Environmental Specifics).

When operating detectors under the above conditions, all parties involved in operating and maintaining the detectors should be notified of the cross-sensitivity issues that are present at the site.

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 TS400 body is painted over, the LCD display cannot be read.

4.3 Installation Instructions

The TS400 is shipped without the sensor installed. The sensor must be installed into the detector and calibrated for proper operation. (See Section 4.6 for wiring connections and Section 5.3 for calibration instructions.)

Once correctly installed, the TS400 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 TS400 (Figure 11) should be used when making installation determinations. Mechanical specifications can be found in the Appendix, Section 6.1.2.

4.4 Intrinsically Safe Barriers

In order for the TS400 to be used with classified equipment inside 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 TS400 and the facilities' control room. A list of recommended manufacturers and part numbers follows for Zener and galvanic barriers:

- Stahl - 9303/11-22-11
- Elcon - mD323 or mD325
- MTL - MTL7206 or MTL5041
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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.

NOTE: To maintain intrinsic safety, wire length and gauge are limited by the capacitance and inductance of the wire, Ci and Li of the TS400, and the barrier ratings. (See Section 6.1.5 for instructions on calculating these values.)

Align the TS400 so that the LCD display is easily viewed. Teflon tape may be used on the TS400's threads.

4.5 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.

4.6 Wiring Connections

The red and white wires at the base of the TS400 provide for 4-20mA loop-powered operative. The red wire is the "loop +" lead and the white wire is the "loop -" lead (Figure 6). 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 TS400.

Connect the green/yellow frame ground wire to the grounding terminal or lug inside the junction box being used with the TS400.

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, S4100E smart sensor, industrial analog to digital converter, computer-based monitor, PLC, DCS, etc.

Since the TS400 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 TS400 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 6.1.5, for the intrinsically safe system requirements.) In addition, cable length specifications can also be found in the Appendix, Section 6.1.3. In all cases, the cable run should be as short as possible.

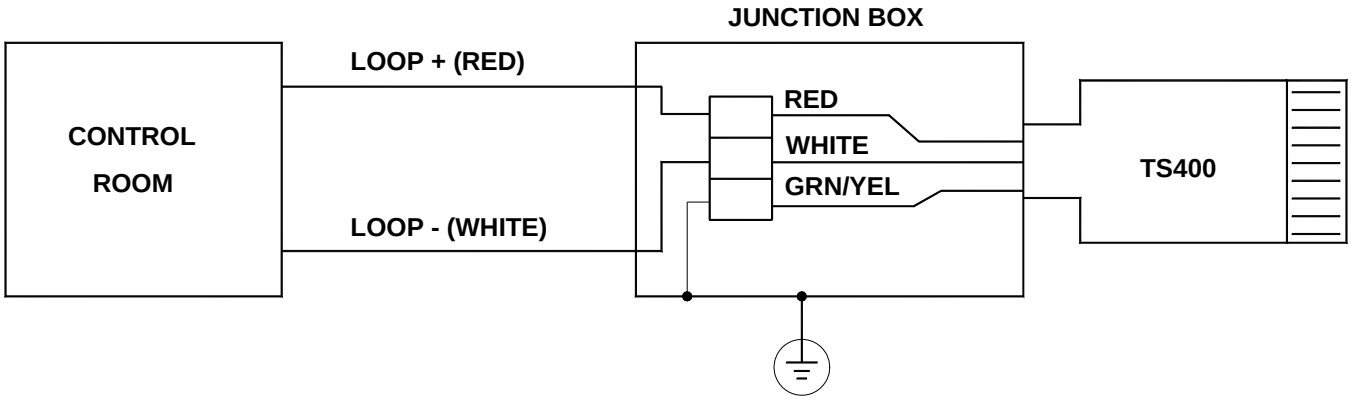


Figure 6: Wiring Diagram

5.0 Operation

5.1 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 twenty-four (24) hours for the Nitric Oxide and Hydrogen Chloride sensors, and one (1) hour for all other sensors.

5.1.1 Initial Power-up

The TS400 is shipped un-calibrated, therefore, the first time power is applied, the TS400 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 5.3 for Calibration Procedure).

After calibration is complete, the TS400 will proceed to Operate mode (4.0mA) where any detected gas will show as a proportional analog output current between 4 and 20mA. The MODE LCD will be on steady and the CAL LCD off with no gas present and both the MODE and CAL LCD's will flash when gas is detected.

General Monitors recommends the TS400 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 5.3, for more details.)

5.1.2 Power-up After Initial Calibration

When the TS400 is powered up, after it has been previously calibrated, the unit will enter a Start-up mode (3.6mA), which allows the sensor to stabilize before proceeding to the Operate mode (4.0mA). During Start-up, the MODE LCD will flash, the CAL LCD will be off and the analog output current will be 3.6mA.

If the sensor’s “zero” has shifted while it was off power, then the TS400 will stay in Start-up mode (3.6mA). This can occur if the sensor was changed, or the sensor drifted due to temperature, humidity, pressure, or electrolyte stability due to power not being applied. Remove the sensor (with power applied to the TS400), wait at least 10 seconds and re-insert the sensor into the TS400. The TS400 will see this as a “new sensor” (3.5mA) and will allow you to enter calibration mode (3.75mA).

OPERATING MODES	INDICATOR CAL	INDICATOR MODE	ANALOG OUTPUT
START-UP	☐	✸	3.6mA
OPERATE			
NO GAS	☐	■	4.0mA
GAS	✸	✸	4.0-22mA
FAULT			
NO POWER	☐	☐	0.0mA
SYSTEM	☐	✸	3.5mA

Table 3: Operating Modes, Indicators and Outputs

Perform a complete zero and calibration and the TS400 will return to operate mode (4.0mA).

NOTE: The TS400 will not allow you to enter calibration mode during Start-up mode (3.6mA).

5.2 Operating Modes

The TS400 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 Tables 3 and 4).

5.3 Calibration

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

NOTE: The Model TS400 toxic gas detector configured with Nitric Oxide or Hydrogen Chloride sensor may take up to 24 hours to stabilize if power has been removed for more than one (1) hour.

General Monitors recommends that the TS400 be calibrated at the average operating temperature within the first twenty-four (24) hours after initial start-up. Calibration should be checked at least every ninety (90) days to ensure the integrity of the system.

NOTE: A calibration check consists of applying a 50% of full-scale concentration of gas to the sensor and observing the reading on the display device being used.

Calibration checks ensure the integrity of the life protecting equipment, and are recommended for problem environments (i.e. mud collecting on the sensor head, sensors accidentally being painted over, etc, see Appendix 6.3).
A calibration schedule should be established and followed. A logbook should also be kept showing calibration dates and dates of sensor replacement.

5.3.1 Calibration Procedure

If it is suspected that toxic gases are present, it will be necessary to purge the sensor with clean air for at least fifteen (15) minutes. The 20.9% O_2 gas cylinder (GMI P/N 1400262-11) can be used.

1. 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.

2. The "**CAL**" LCD indicator will flash while the unit is zeroing the sensor. When the "**CAL**" LCD changes from flashing to solid, it is time to apply the calibration gas.

3. Apply a concentration of toxic gas, equivalent to 50% of full scale, to the sensor. The display will change from a solid "**CAL**" LCD to a flashing "**CAL**" and "**MODE**" LCD indicating that the sensor is responding to the gas.

4. After three to five minutes the display will change from a flashing "**CAL**" and "**MODE**" LCD to a solid "**CAL**" and "**MODE**" LCD, indicating that the calibration is complete. Remove the calibration gas and allow the sensor to see clean air.

The unit is now calibrated and the new values have been stored in the NOVRAM (non-volatile memory).

Table 4 shows a flow diagram of the codes that will appear in the display window during the calibration procedure.

If the TS400 is placed in the "**CAL**" mode and no gas is applied for six (6) minutes, the unit will revert to a fault condition. Placing the magnet over the GMI Logo again will return the unit to the "**CAL**" mode.

If there is a problem and the TS400 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	■	☐
Magnet Removed Zeroing	✷	☐
Zero Finished, Apply Gas_1	■	☐
Cal Proceeding	✷	✷
Cal Complete, Remove Gas	■	■

1 Depending on age of the sensor and gain setting from a previous calibration, the calibration may proceed from "**zeroing**" to "**Cal Proceeding**". Apply gas during the "**Cal Proceeding**" step in this case.

Table 4: Flow Diagram

NOTE: If the unit fails to calibrate, a flashing "MODE" LCD will be displayed. The calibration gas must be removed from the sensor, and the sensor must see "clean" air for at least fifteen (15) minutes before a second calibration is attempted.

5.4 Calibration Equipment

General Monitors offers flow calibration kits as the method of introducing calibration gas to the TS400.

Calibration is performed with 50% of full scale of the gas being monitored.

Use Figure 7 to determine 50% of full scale for the different gases that are monitored.

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.

CAUTION: Do not use a gas cylinder if the regulator gauge shows the cylinder pressure in the black area just above 0 psi. Unstable calibration could result.

Sensor Type	50% of Full-Scale	Recommended Flow Rates (mL/Minute)
Carbon Monoxide	50 ppm, 250 ppm	500
Chlorine	5 ppm	1000
Chlorine Dioxide	1.5 ppm	1000
Hydrogen Chloride	10 ppm	1000
Hydrogen Sulfide	10 ppm, 25 ppm, 50 ppm	500
Nitric Oxide	50 ppm	500
Nitrogen Dioxide	10 ppm	1000
Ozone	0.5 ppm	1000
Sulfur Dioxide	10 ppm	500

Table 5: Sensor Flow Rates

If the TS400 is to be used with the optional Splashguard, all calibrations must be performed using the calibration cup (Figure 7) with the Splashguard installed onto the TS400. In addition, all gas checks must be performed using the calibration cup with the Splashguard 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 Splashguard is not clogged and that gas can get to the sensor.

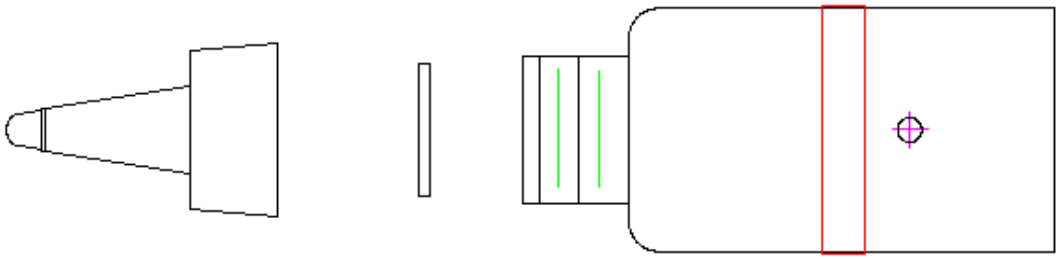


Figure 7: Calibration Cup

If the Splashguard will not be used, the TS400 must be calibrated and gas checked with the calibration plug (Figure 8).

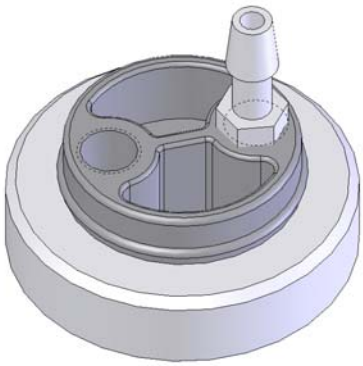


Figure 8: Calibration Plug Assy

5.5 Sensor Replacement Procedure

The following is the procedure to replace a TS400 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 TS400 must be calibrated in the field upon initial installation.

1. Unscrew the TS400 sensor cap.

2. Pull sensor out of the TS400 using your fingers. The sensor is a plug-in type, and the sensor will have a snug fit.

NOTE: The TS400 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.

4. Examine the sensor and ensure that it is the correct gas type for your application.

5. Examine the sensor's gold pins, which are mounted on a green board on the backside of the sensor cell to ensure none of the pins are bent or otherwise damaged. In addition, verify the sensor O-Ring is in place before completing sensor replacement. Failure to do so will compromise the watertight integrity of the TS400.

NOTE: Certain types of sensors are shipped with a shorting wire across (2) two pins. This wire must be removed prior to installing in the TS400. Other sensors are shipped attached to a small circuit board with a button-type battery (the battery board). Remove circuit board prior to installing in TS400. Save both the shorting wire and battery board for later use (Figure 6).

6. Align the arrow on the sensor label with the notch on the TS400 body. Install the sensor by pushing the sensor's pins into the pin sockets on the TS400, (Figure 9).

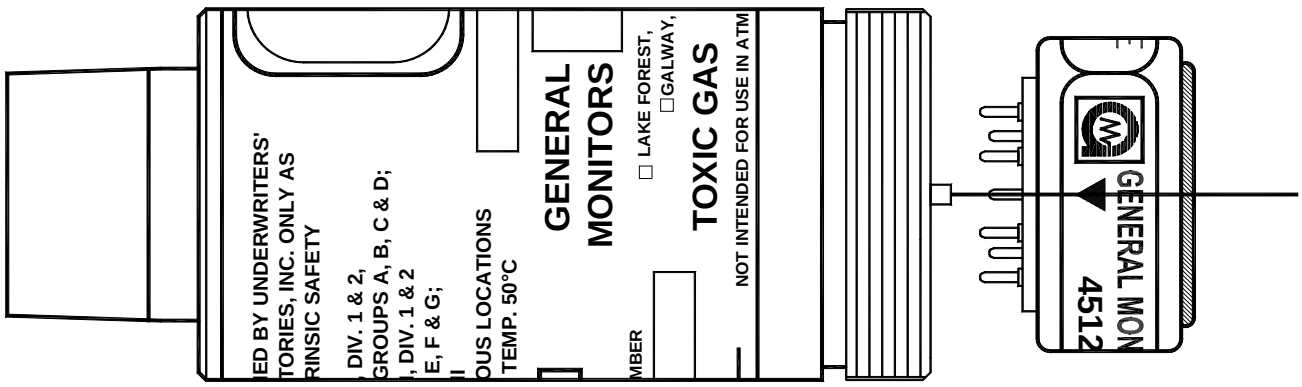


Figure 9: Sensor Alignment

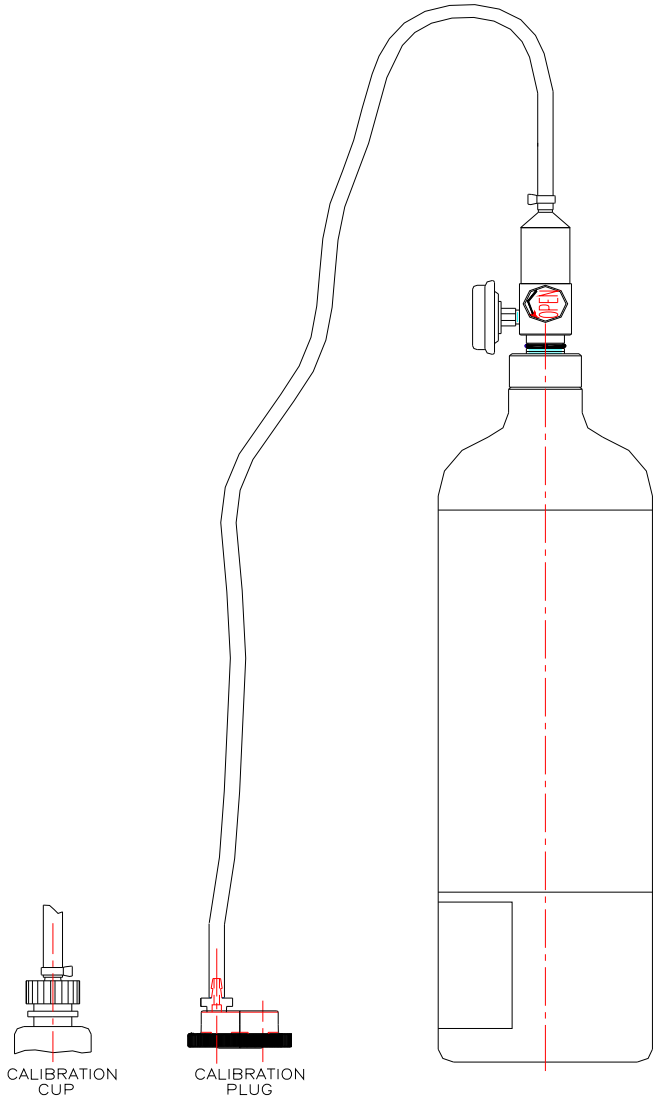


Figure 10: Calibration Kit with Bottle

7. Screw on TS400 sensor cap.

8. 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.

9. Calibrate new sensor (see Section 5.3).

NOTE: The TS400 will stay in fault any time the sensor is removed. Calibration is required to reset the TS400.

5.6 Sensor Care and Maintenance

If power is removed from the TS400 for periods greater than one hour, the sensor should be removed from the TS400 and placed in the original storage container it was shipped in. Storage of the sensor in the original container guards against sensor contamination, such as, solvents, lubricant, humidity, etc. In addition, some sensors are shipped with a shorting wire or battery board, which should be reconnected to the sensor prior to storage in the storage container. (Figure 6) Failure to reconnect the shorting wire or battery board prior to storage can result in very long sensor stabilization after re-installation into the TS400 (stabilization can be as long or greater than a week).

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°C and 20°C.

In all cases, after the sensor has been removed from the TS400, the cap should be replaced on to the TS400 body and the gas port taped off to prevent any corrosion damage to the exposed socket pins.

Table 6 describes the sensor used with the TS400 and whether they require a shorting wire or battery board during storage.

Cell	P/N	Type
Chlorine Dioxide	45123-1	Shorting Wire
Chlorine	45123-2	Shorting Wire
Carbon Monoxide	45123-3	Shorting Wire
Hydrogen Chloride	45123-4	Shorting Wire
Nitric Oxide	45123-7	Battery Board
Nitrogen Dioxide	45123-8	Shorting Wire
Ozone	45123-14	Shorting Wire
Sulfur Dioxide	45123-9	Shorting Wire
Hydrogen Sulfide (low range)	45186-10	Shorting Wire
Hydrogen Sulfide	45186-11	Shorting Wire

Table 6: Sensors Used with the TS400

5.7 Fault Codes & the Remedies

The TS400 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.

5.7.1 The Fault Codes

Fault	Description	Remedy
No Power	Neither LCD will be on. Output signal will be 0.0mA	Check wiring; ensure power is applied to unit
System Fault	The "MODE" LCD will be flashing. Output signal will be 3.5mA	Attempt recalibrating the detector. If the fault persists, replace the sensor and after sensor has stabilized (all sensors one (1) hour minimum). Recalibrate. If fault still persists, contact factory or your sales representative
Start-up Fault (Sensor)	The "MODE" LCD will be flashing. Output signal will be in 3.6mA constantly. (Unit in Start-up for more than 1 minute.)	Remove sensor from model TS400 with power applied. Wait at least 10 seconds and re-insert sensor into Model TS400. The unit should change to an output of 3.5mA. The sensor will need to be re-calibrated

Table 7: Fault Codes

6.0 Appendix

6.1 Specifications

6.1.1 System Specifications

Sensor Type:	Electrochemical cell
Typical Life (sensing element):	2 to 3 years in normal service
Warranty:	Two years for the electronics One year for the sensor
Malfunctions Monitored:	Calibration Errors, Data Memory Errors
Repeatability:	± 2% of full-scale for all gases except +/- 0.1 ppm for O_3 and +/- 0.2 ppm for ClO_2
Zero Drift:	< 5% per year
Approvals:	CSA, C-UL US, ATEX and CE Marking

Measuring Ranges:

Carbon Monoxide:	0-100, 0-500 ppm
Chlorine:	0-10 ppm
Chlorine Dioxide:	0-3 ppm
Hydrogen Chloride:	0-20 ppm
Hydrogen Sulfide:	0-100 ppm, 0-50 ppm, 0-20 ppm
Nitric Oxide:	0-100 ppm
Nitrogen Dioxide:	0-20 ppm
Ozone:	0-1 ppm
Sulfur Dioxide:	0-20 ppm

Response Time (100% FS gas applied):

SO_2, NO - T90	< 10 sec
H_2S, CO, NO_2 - T90	< 30 sec
Cl_2, ClO_2 - T90	< 60 sec
HCl - T90	< 100 sec
O_3 – T90	< 90 sec

6.1.2 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

6.1.3 Electrical Specifications

Recommend:	two wire 14, 16 or 18 AWG shielded cable
General Purpose Installations:	Maximum distance between the TS400 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 µH
Input Power:	10 to 35VDC range; 3.5 to 22mA loop powered
Output Current:	(600 Ω max. @ 24VDC) (120 Ω 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 II, Groups E, F & G, Class III, EEx ia IIC T6, IP67, Type 4X
RFI/EMI Protection:	Complies with EN50081-2, EN50082-2
Status Indicator:	Liquid Crystal Display with Normal, Gas Present, Fault and Calibration cues

6.1.4 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) All cells should be stored in cool area (08C -208C)
Humidity Range:	15 to 90% relative humidity non-condensing
Pressure Range:	Atmosphere ± 10%

NOTE: Chlorine, Chlorine Dioxide and Hydrogen Chloride electrochemical cells are sensitive to changes in humidity, especially at temperatures above 77°F (25°C). To avoid false alarms caused by humidity variations, it is recommended that alarm set points be set above 20% of the full-scale range.

6.1.5 Intrinsically Safe System Requirements

NOTE: Refer to control drawing 45151 Rev B. (Section 5.2.2)

The TS400 is approved as intrinsically safe on its own (entity approved). However, when installing the TS400 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 (TS400) must be less than or equal to U_{MAX} of barrier.
2. I_i/I_{MAX} of the field device (TS400) must be greater than or equal to I_{MAX} of the barrier.
3. The inductance of the cable and the TS400 (L_i) must be less than the barrier's maximum inductance rating (La).
4. The capacitance of the cable and the TS400 (C_i) must be less than the barrier's maximum capacitance rating (Ca).

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

Capacitance:

$$\text{Max. Cable Length} = \frac{C_{MAX}\text{(Barrier)} - C_i\text{(TS400) (ft)}}{\text{Wire Capacitance/Ft}}$$

Inductance:

$$\text{Max. Cable Length} = \frac{L_{MAX}\text{(Barrier} - L_i\text{(TS400) (ft)}}{\text{Wire Inductance/Ft}}$$

6.1.6 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	TS400
C_{MAX} = 0.12 µf	C_i = 0 µf
L_{MAX} = 4.0 mH	L_i = 500 µH
U_i/V_{MAX} = 35V	U_i/V_{MAX} = 35V
I_i/I_{MAX} = 93mA	I_i/I_{MAX} = 100mA

1. U_i/VMAX (TS400) ≤ U_i/VMAX (MTL 7206)
   35VDC ≤ 35VDC
2. Ii/IMAX (TS400) ≥ Ii/IMAX (MTL 7206)
   100mA93mA
3. Cable inductance not available
4. Max. Cable length $= \frac{C_{MAX} \text{ (MTL 7206)} - C_i \text{ (TS400)}}{\text{C/L (Belden 8760)}}$

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

   Max. Cable length = 5000 feet

6.2 Engineering Documentation

6.2.1 Outline & Dimensional Drawing

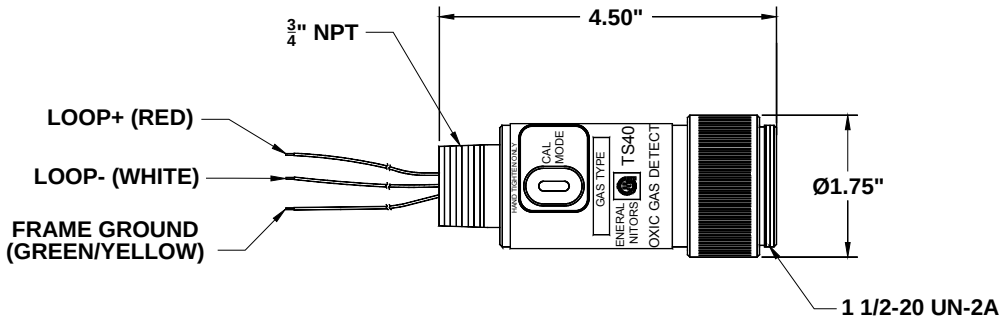


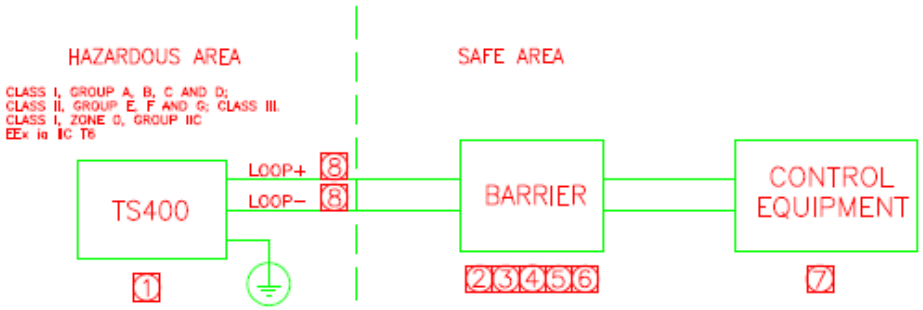
Figure 11: Outline & Dimensional Drawing

6.2.2 Control Drawing

REVISIONS

SYM	RN/ECN NO.	DESCRIPTION	BY	DATE	APPROVER
A	62644	RELEASE TO PRODUCTION	TH	17FEB99	
B	62790	UPDATE NOTES 3, 4, & 5 PER AGENCY REQUIREMENTS	TP	03JUNE99	
C	64488	UPDATE PER AGENCY REQUIREMENTS	TM	13MAY03	
D	66762	UPDATE TO INLCUDE WARNING	LV	09SEP09	

45151 REV. D



10 WARNING: TO PREVENT IGNITION OF FLAMMABLE OR COMBUSTIBLE ATMOSPHERES, DISCONNECT POWER BEFORE SERVICING.

9 INCORPORATE ANY MODIFICATIONS TO THIS DRAWING INTO MANTS400.

8 INTRINSICALLY SAFE WIRING.

7 CONTROL EQUIPMENT MUST NOT USE OR GENERATE MORE THAN 250 V WITH RESPECT TO EARTH.

6 BARRIERS MUST BE INSTALLED IN ACCORDANCE WITH BARRIER MANUFACTURER'S CONTROL DRAWING AND ARTICLE 504 OF THE NATIONAL ELECTRICAL CODE ANSI/NFPA 70, CEC PART 1 OR OTHER LOCAL INSTALLATION CODES, AS APPLICABLE (FOR US ONLY).

5 SELECTED BARRIERS MUST BE THIRD PARTY APPROVED AS INTRINSICALLY SAFE FOR THE APPLICATION AND HAVE Voc NOT EXCEEDING Vmax AND Isc NOT EXCEEDING Imax OF THE INTRINSICALLY SAFE EQUIPMENT, AS SHOWN IN TABLE 1.

TABLE 1:

I.S EQUIPMENT		BARRIER
Ui/Vmax	≥	Voc/Vo
Ii/Imax	≥	Isc/Io
Ci + Ccable	≤	Ca/Co
Li + Lcable	≤	La/Lo

4 CABLE CAPACITANCE PLUS INSTRINSICALLY SAFE EQUIPMENT CAPACITANCE MUST BE LESS THAN THE MARKED CAPACITANCE (Ca) SHOWN ON ANY BARRIER USED, THE SAME APPLIES FOR INDUCTANCE. CAPACITANCE AND INDUCTANCE OF FIELD WIRING FROM THE INTRINSICALLY SAFE EQUIPMENT TO THE BARRIER SHOULD BE CALCULATED AS (Ccable = 60pF/ft AND Lcable = 0.2uH/ft) AND SHOULD BE INCLUDED IN THE SYSTEM CALCULATIONS.

3 BARRIER OUTPUT CURRENT MUST BE LIMITED BY A RESISTOR SUCH THAT THE OUTPUT VOLTAGE–CURRENT PLOT IS A STRAIGHT LINE DRAWN BETWEEN OPEN CIRCUIT VOLTAGE AND SHORT CIRCUIT CURRENT (RESISTIVE TYPE BARRIER).

2 BARRIER MAY BE IN DIVISION 2 LOCATION IF SO APPROVED – FOR US ONLY

1 TS400 ENTITY PARAMETERS:
Ui/Vmax = 35Vdc
Ii/Imax = 100mA
Ci = 0 uF
Li = 500uH

NOTES:

BY	DATE
DRAWN T.H.	17FEB99
CHKD.	
DSNGR. T.H.	17FEB99

USED ON

TITLE: CONTROL DRAWING

GENERAL MONITORS
Lake Forest, CALIFORNIA

MATERIAL

FINISH

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DWG. NO. 45151

SCALE NONE | MODEL TS400 | SHEET 1 OF 1 | REV D

Figure 12: Control Drawing

6.2.3 Sample Installation

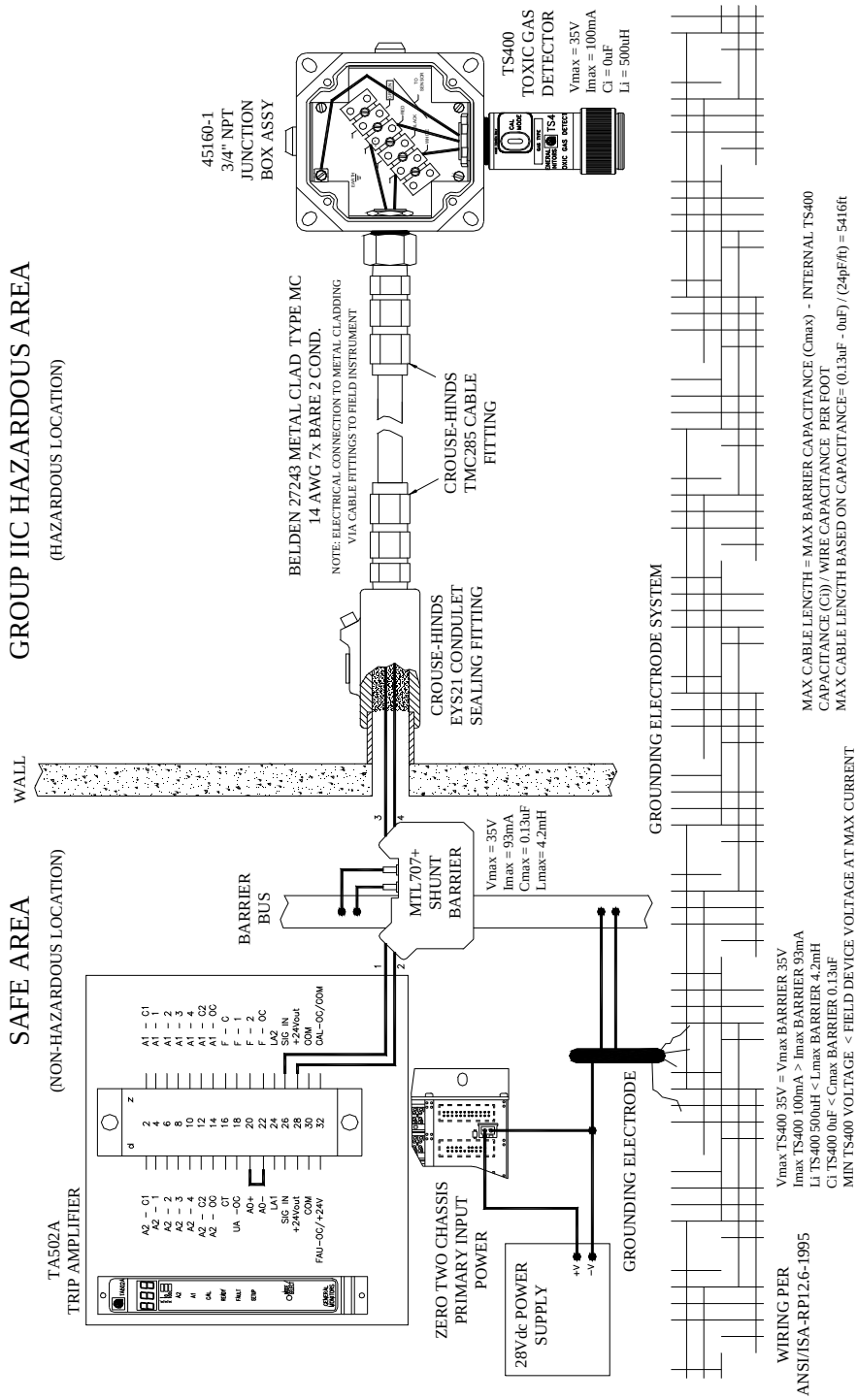

Figure 13: Sample Installation

6.2.4 Junction Boxes

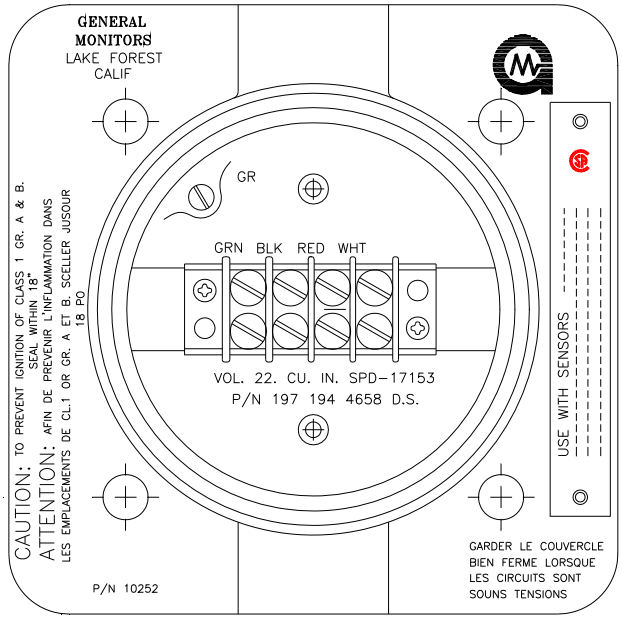

Figure 14: 10252 Round Aluminum Junction Box

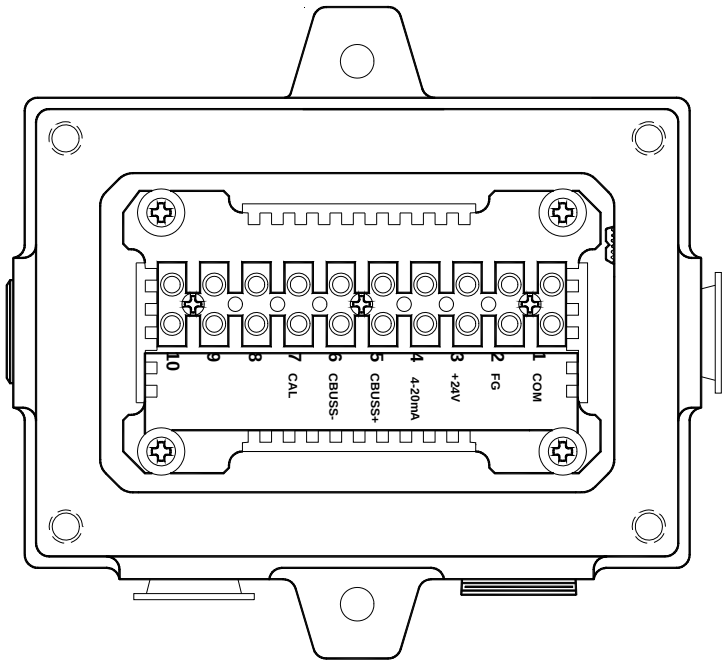

Figure 15: 31305-2 Aluminum Junction Box

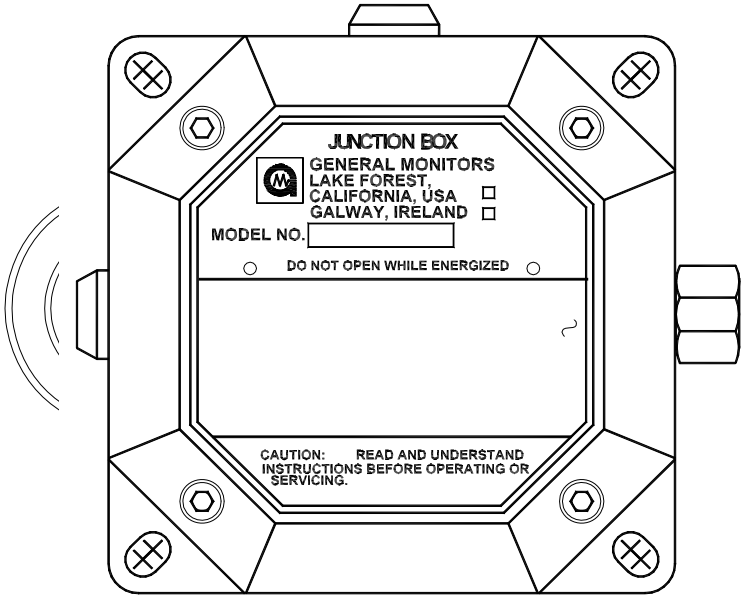

Figure 16: 45160-1 GRP Junction Box, NPT 45160-2 GRP Junction Box, M20

6.2.5 Splashguards

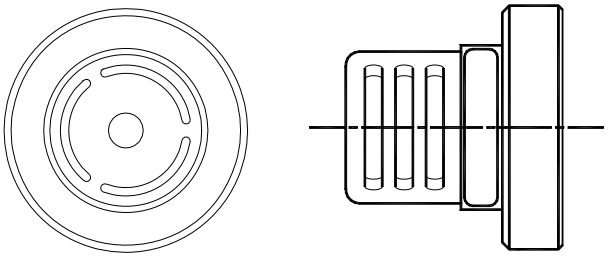

Figure 17: 45167-1 Splashguard Used for Cl_2, ClO_2, and O_3 Gases

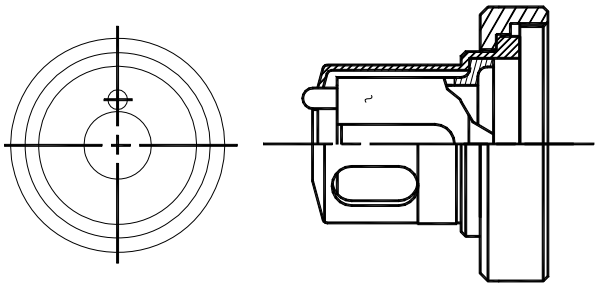

Figure 18: 70631-2 Splashguard

6.2.6 Accessories

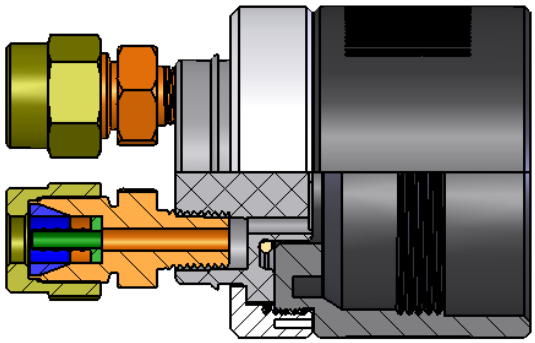

Figure 19: 45170-1 Flow Plug Assy

6.2.7 Calibration Accessories

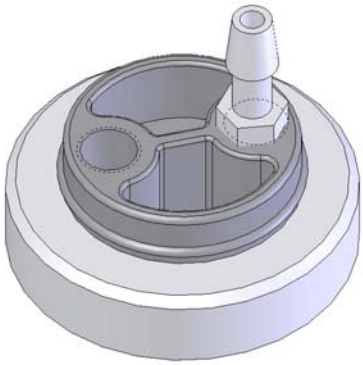

Figure 20: 45172-1 Calibration Plug Assy

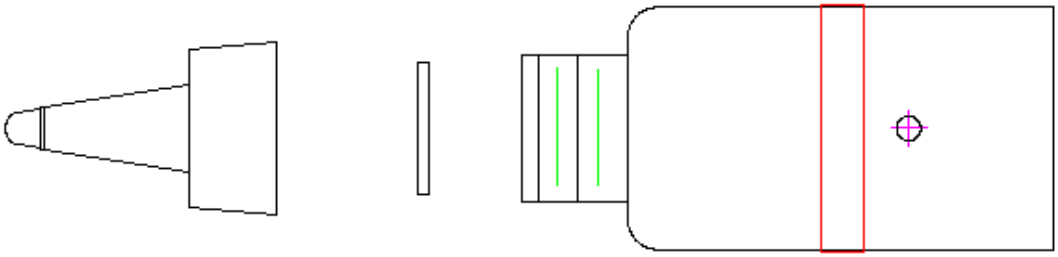

Figure 21: 1400152-1 Calibration Cup

6.3 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 ±20%. 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 ±20%. 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 ±20%. 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 ±20%. Otherwise go to step 7).

Date	Reading	Date	Reading	Date	Reading
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____

7) 90 day calibration check:

Date	Reading	Date	Reading	Date	Reading
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____

6.4 Spare Parts & Accessories

TS400 Spare Parts

The Model TS400 has potted electronics; therefore, there are no replacement boards available for this unit. The part numbers of the TS400 itself are:

TS400

Carbon Monoxide	45100-3
Chlorine	45100-2
Chlorine Dioxide	45100-1
Hydrogen Chloride	45100-4
Hydrogen Sulfide (low range)	45100-10
Hydrogen Sulfide	45100-11
Nitric Oxide	45100-7
Nitrogen Dioxide	45100-8
Ozone	45100-14
Sensor Cap	45103-1
Sulfur Dioxide	45100-9

Replacement Sensors

Carbon Monoxide	45123-3
Chlorine	45123-2
Chlorine Dioxide	45123-1
Hydrogen Chloride	45123-4
Hydrogen Sulfide (low range)	45186-10
Hydrogen Sulfide	45186-11
Nitric Oxide	45123-7
Nitrogen Dioxide	45123-8
Ozone	45123-14
Sulfur Dioxide	45123-9

Replacement O-ring

For Sensor Assembly	925-5043

TS400 Mounting Accessories

¾" NPT, Adapter, Plastic	961-009
¾" NPT Adapter, Steel	961-007
20 mm x ¾" NPT Adapter, Brass	961-006
Alum. Junction Box (Large)	31305-2
Alum. Junction Box (Small)	10252
Cable Grip	961-008
Flow Plug Assembly	45170-1
GRP Junction Box (3/4" NPT)	145160-1
GRP Junction Box (M20)	45160-2
Splash-Guard (Cl_2, ClO_2, O_3)	45167-1
Splash-Guard (Standard)	70631-2

TS400 Calibration Accessories

Calibration Cup	1400152-1
Calibration Plug Assy	45172-1
Case	914-135
Regulator (1000ml/Min) for Cl_2, NO_2, ClO_2, HCl, O_3	922-022
Regulator (500ml/Min) for SO_2, NO, CO, H_2S	922-023
Tubing	931-085

NOTE: Using a different flow rate regulator can cause calibration failure.

Calibration Kits (cylinder, regulator & tubing)

20.9% O_2	1400263-11
Carbon Monoxide, 50 ppm	1400263-9
Carbon Monoxide, 250 ppm	1400263-10
Chlorine, 5 ppm	1400263-3
Chlorine Dioxide	1400263-4
Hydrogen Chloride, 10 ppm	1400263-5
Hydrogen Sulfide, 50 ppm	1400263-33
Hydrogen Sulfide, 25 ppm	1400263-34
Hydrogen Sulfide, 10 ppm	1400263-35
Nitric Oxide, 50 ppm	1400263-6
Nitrogen Dioxide, 10 ppm	1400263-7
Ozone	1400263-15
Sulfur Dioxide, 10 ppm	1400263-8

Spare Cylinders

20.9% O_2	1400262-11
Carbon Monoxide, 50 ppm	1400262-9
Carbon Monoxide, 250 ppm	1400262-10
Chlorine, 5 ppm	1400262-3
Chlorine Dioxide	1400262-4
Hydrogen Chloride, 10 ppm	1400262-5
Hydrogen Sulfide, 50 ppm	1400255-5
Hydrogen Sulfide, 25 ppm	1400255-3
Hydrogen Sulfide, 10 ppm	1400255-1
Nitric Oxide, 50 ppm	1400262-6
Nitrogen Dioxide, 10 ppm	1400262-7
Ozone	1400262-15
Sulfur Dioxide, 10 ppm	1400262-8

ADDENDUM
Product Disposal Considerations

This product may contain hazardous and/or toxic substances.

EU Member states shall dispose according to WEEE regulations. For further General Monitors' product WEEE disposal information please visit:
www.generalmonitors.com/customer_support/faq_general.html

All other countries or states: please dispose of in accordance with existing federal, state and local environmental control regulations.