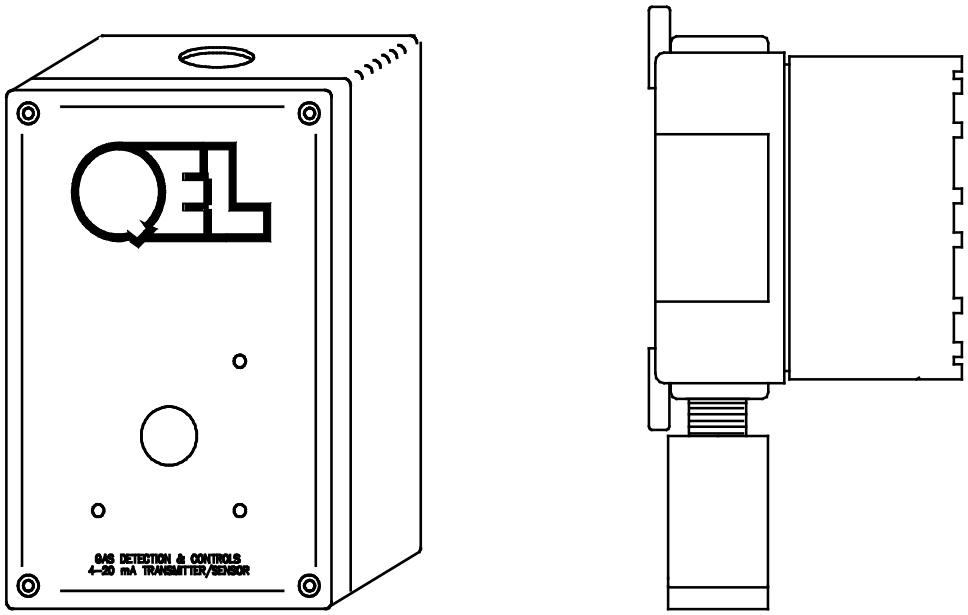
MODEL QTS-6100 SERIES
ANALOG TRANSMITTER/SENSOR



INSTALLATION
OPERATION AND MAINTENANCE
MANUAL

QUATROSENSE ENVIRONMENTAL LTD.
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Web: www.QELsafety.com Email: QEL@QELsafety.com

GENERAL SPECIFICATIONS

DIMENSIONS:

Commercial: 4.2”W x 6”H x 2.6” D (107mm x 152mm x 66mm)

Explosion Proof: 4.9”W x 8.4” Hx 4.8”D (124mm x 213mm x 123mm)

POWER SUPPLY: 24 vdc (12-36 vdc)

SIGNAL: 4 - 20 mA Linear (maximum over scale: 25 mA)

Zero = 4.00 mA ± 0.1 mA

WIRING: 2 - Wire 14 - 24 AWG

SENSOR TYPE: Electrochemical

HUMIDITY: Continuous: 15% - 90% RH Non-Condensing

Intermittent: 0-099% RH Non-Condensing

			Standard	Recommended			
Model	**Gas**	**Gas**	**Measurement**	**Alarm Settings**		**Operating**	**Recommended**
Number	**Code**	**Type**	**Range**	**Warning**	**Alarm**	**Temperature**	**Mtng. Height***
QTS-61110x-	110	H_2S	0-25 ppm	5 ppm	10 ppm	-40° C to + 50° C	Low
QTS-61115x-	115	HCN	0-20 ppm	10 ppm	15 ppm	-20° C to + 50° C	Mid
QTS-61120x-	120	Cl_2	0-3 ppm	0.5 ppm	2 ppm	-20° C to + 50° C	Low
QTS-61123x-	123	ClO_2	0-1 ppm	0.1 ppm	0.3 ppm	-20° C to + 50° C	Low
QTS-61125x-	125	HCL	0-10 ppm	5 ppm	7 ppm	-20°C to + 50° C	Mid
QTS-61140x-	140	SO_2	0-6 ppm	2 ppm	5 ppm	-20°C to + 50° C	Low
QTS-61150x-	150	NO_2	0-6 ppm	1 ppm	3 ppm	-20°C to + 50° C	Low
QTS-61160x-	160	CO	0-250 ppm	10 ppm	100 ppm	-20°C to + 50° C	Mid
QTS-61190x-	190	NO	0-100 ppm	25 ppm	50 ppm	-20°C to + 50° C	Mid
QTS-61211x-	211	H_2	0-2000 ppm	500 ppm	1000 ppm	-20°C to + 50° C	High
QTS-61220x-	220	NH_3	0-50 ppm	25 ppm	35 ppm	-25°C to + 30° C	High
QTS-61230x-	230	C_2H_4O	0-20 ppm	2 ppm	5 ppm	-20°C to + 50° C	Low
QTS-61240x-	240	O_3	0-3 ppm	0.5 ppm	2 ppm	-20°C to + 50° C	Mid

*Low = 9” to 18” (.23 to .45 m) above floor

*Mid = 4ft to 6ft (1.2 to 1.8 m) above floor

*High = 9” to 18” (.23 to .45 m) below ceiling

WARRANTY STATEMENT

The information contained in this manual is based upon data considered accurate; however, no warranty is expressed or implied regarding the accuracy of this data. All QEL equipment is warranted against defects in material and workmanship for a period of two years from date of shipment with the following exceptions:

Electrochemical Sensors (Toxic)	Six Months
Catalytic Sensors (Combustible)	One Year

During the warranty period we will repair or replace, at our discretion, any components or complete units that prove, in our opinion, to be defective. We are not liable for consequential or incidental damage to auxiliary interfaced equipment.

A returned material authorization number should be obtained from the factory prior to returning any goods. All return shipments must be shipped freight prepaid and a copy of the maintenance records should accompany the unit concerned.

Warranty should be considered F.O.B. the factory. Labour and travel time are chargeable for any field site visits required for warranty work.

LIMITED LIABILITY

All QEL systems shall be installed by a qualified technician/electrician and maintained in strict accordance with data provided for individual systems in the form of installation/maintenance manuals. QEL assumes no responsibility for improper installation, maintenance, etc., and stresses the importance of reading all manuals. QEL shall not be responsible for any liability arising from auxiliary interfaced equipment nor any damage resulting from the installation or operation of this equipment.

QEL's total liability is contained as above with no other liability expressed or implied as the purchaser is entirely responsible for installation and maintenance of systems.

This warranty is in lieu of all other warranties, expressed or implied, and no representative or person is authorized to represent or assume for QEL any liability in connection with the sales of our products other than that set forth herein.

NOTE: Due to on-going product development, QEL reserves the right to change specifications without notice and will assume no responsibility for any costs as a result of modifications.

For further information or assistance, contact:

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1. INTRODUCTION

Thank you for purchasing this quality product from Quatrosense Environmental Ltd. (QEL). We want you to enjoy many years of effective use and protection from your QTS-6100 Series Universal Electrochemical Toxic Sensor/Transmitter. This manual is intended to provide you with all of the details you need to properly install, operate, and maintain your equipment.

To properly prepare to install, configure, and start-up your QTS-6100 Series Universal Electrochemical Toxic Sensor/Transmitter we recommend that you read those sections of the manual before beginning the work. The sections at the beginning of the manual covering description, specifications, and theory of operation will provide general background and reference information. Please refer to the sections at the end of the manual on maintenance, calibration, and troubleshooting before performing these tasks.

Throughout this manual your attention will be drawn to certain information in the following manner:

NOTE: This will highlight tasks or information important to the proper operation of the controller

CAUTION This will detail steps that will cause malfunction of the unit if performed improperly

WARNING This will indicate critical actions that could cause harm to personnel or damage to the controller or associated equipment if performed improperly

If you have any questions, or you find any errors or omissions in your manual, please contact our customer service team at **(613) 838-4005** by phone or fax us at **(613) 838-4018**.

2. BASIC DESCRIPTION

The QTS-6100 Series Universal Electrochemical Toxic Sensor/Transmitter is a significant upgrade from our previous electrochemical sensor/transmitters. It features improved performance and the ability to configure the transmitter for any of long list of electrochemical sensor elements offered by QEL. The transmitters operate over a wide tolerance of DC power and provide a 4 to 20 mA DC output in a two-wire connection.

The sensor portion of these units is a City Technology compact electrochemical sensor element, selected specifically for the gas to be measured. These elements are completely sealed and are a non-consuming technology. This means that the electrolyte solution is not consumed by the normal operation of the sensor. Typical life for these sensors is two to three years in normal operation, with recalibration recommended every three months. See Section 4 - "Theory of Operation" for details on how these sensors function.

The transmitter portion of these units uses solid state components on two circuit card assemblies to measure the DC microamp signal from the sensor element and convert it to a 4 to 20 mA DC output. The transmitter electronics can be field configured via solderless shorting links to accept any one of the range of electrochemical sensors offered. Across this range there are differing requirements for battery voltage, gain resistance, a shorting FET, and the polarity of the sensor output. See Section 6 - "Configuration" for details on configuring the transmitter.

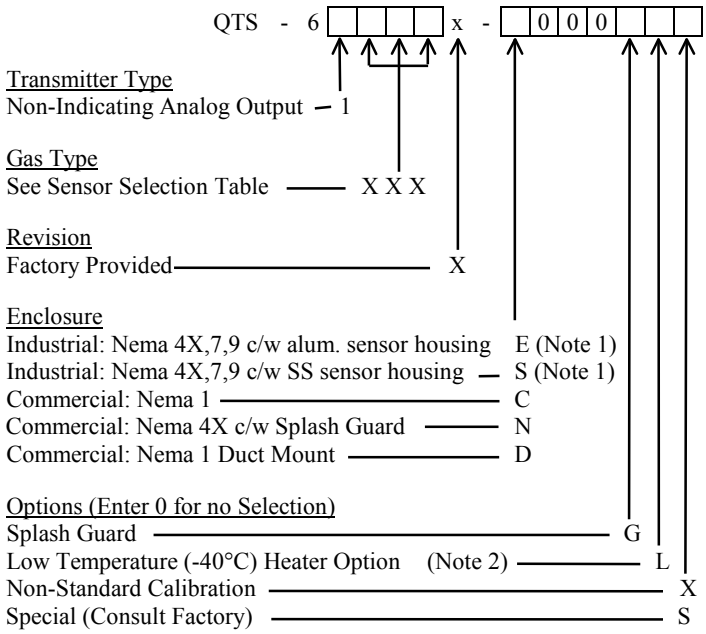
The transmitter electronics are powered with two-wire 24 VDC and transmit the 4 to 20 mA DC output over the same two wires. They have been designed to provide protection from interference caused by Radio Frequency (RFI) and Electro-Magnetic (EMI) sources. The designs have been tested for proper operation under radiated interference of 4 watts at a distance of 1 meter. See Section 5 - "Installation" for details on proper wiring and grounding to ensure proper operation.

Accessible from the top of the transmitter are test jacks that will accept standard digital multimeter test leads. The transmitter 4 to 20 mA DC signal can be monitored from these test points without interrupting the output signal. Two trim potentiometers provide adjustment of zero and span for accurate calibration of the transmitter to specific gas concentrations. No linearization adjustments are required as electrochemical cells are inherently linear.

The sensor/transmitter assemblies are offered in a variety of enclosures. These range from general purpose Nema 1 enclosures through to explosion-proof enclosures listed by CSA, UL, and FM for Class 1, Division 1, Groups B, C, D service. The same transmitter board assembly is used for all enclosure types. The plug-in sensor element connects directly to the transmitter circuit card assembly in the ABS plastic Nema 1 and Nema 4 enclosures. An aluminum or stainless steel sealed sensor assembly is provided for the plug-in sensor element on the explosion-proof enclosures. The sensor connects to the circuit card assembly via a connector at the end of leads extending from the sensor assembly.

3. SPECIFICATIONS AND ORDERING INFORMATION

3.1 Model Number Ordering Code



Note 1: Chlorine sensor assembly not explosion-proof listed
Note 2: Available only in type N or C enclosures

SENSOR SELECTION AND SPECIFICATION TABLE

GAS	SYM	MODEL CODE	STANDARD CAL (PPM)	TEMP RANGE °C (NOTE 3)
Transmitter Only	---	000	None	---
Hydrogen Sulphide	H_2S	110	0 to 25	-40 to +50
Hydrogen Cyanide	HCN	115	0 to 20	-20 to +50
Chlorine	Cl_2	120	0 to 3	-20 to +50
Chlorine Dioxide	ClO_2	123	0 to 1	-20 to +50
Hydrogen Chloride	HCl	125	0 to 10	-20 to +50
Sulphur Dioxide	SO_2	140	0 to 6	-20 to +50
Nitrogen Dioxide	NO_2	150	0 to 6	-20 to +50
Carbon Monoxide	CO	160	0 to 250	-20 to +50
Nitric Oxide	NO	190	0 to 100	-20 to +50
Hydrogen	H_2	211	0 to 2000	-20 to +50
Ammonia	NH_3	220	0 to 50	-25 to +30
Ethylene Oxide	C_2H_4O	230	0 to 20	-20 to +50
Ozone	O_3	240	0 to 0.5	-20 to +50

Note 3: - 40°C = -40° F +30°C = + 86° F
- 25°C = -13° F +50°C = +122° F
- 20°C = - 4° F

3.2 Sensor/Transmitter Specifications

Input Power: 12 to 36 VDC
Fuse: 0.5 Amp socketed pico fuse
Output Signal: 4 to 20 mA DC into 750 ohms at 24 VDC, Two-wire configuration
RFI/EMI Protection: 4.0 Watt at 1 meter radiated
Enclosure Rating: E - NEMA Type 4X Weatherproof, Type 7 and 9 Explosion Proof; Class 1, Div. 1, Groups B, C, D CSA, FM, UL listed; Aluminum Sensor Housing (also Group A rated)
S - Same as E above except with 316 Stainless Steel Sensor Housing
C, D - NEMA Type 1 General Purpose
N - NEMA Type 4X Weatherproof
Encl. Materials: E, S - Cast Aluminum, Epoxy Painted
C, N, D - ABS Plastic
Sensor Technology: Electrochemical, non-consuming
Response Time: Typical less than 60 seconds for 90% response to a step change
Sensor Life: Typical 2 to 3 years
Sensor Gas Types: Field configurable for any sensor from Sensor Selection

Temperature - Sensor: See Sensor Selection Table
Temp. - Transmitter: -40° to +50°C (-40° to +122°F)
Humidity - Sensor: 15 to 90% RH continuous operating, non-condensing.
Humidity - Transmitter: 0 to 99% RH, non-condensing, operating and storage
Pressure: Atmospheric ± 10%
Accuracy: ± 2.5% of Reading
Repeatability: ± 1.0%
Approvals: CSA - C22.2 -30, C22.2-142, C22.2-157 (Pending)

4. THEORY OF OPERATION

4.1 Electrochemical Sensor Elements

The sensor portion of the QTS-6100 is a compact City Technology electrochemical sensor. These sensors are micro-fuel cells that are completely sealed so as to be maintenance free and stable for long periods. The measurement is a gas-in-liquid chemical reaction rather than a surface area measurement. With no surface area to coat, these sensors retain their sensitivity to gases such as H_2S even after prolonged exposure to clean air.

The cell consists of a diffusion barrier, O-ring seal, electrolyte reservoir and three electrodes; Sensing, Counter, and Reference (see Fig. 1). The target gas enters the cell through a diffusion barrier. The chemical process of the measurement is one of oxidation where one molecule of the target gas is exchanged for one molecule of oxygen. The reaction drives the oxygen molecule to the Counter electrode, generating a DC microamp signal between the Sensing and Counter electrodes. This signal is linear to the volume concentration of the sensed gas rather than the partial pressure. These sensors will not respond to normal variations in atmospheric pressure.

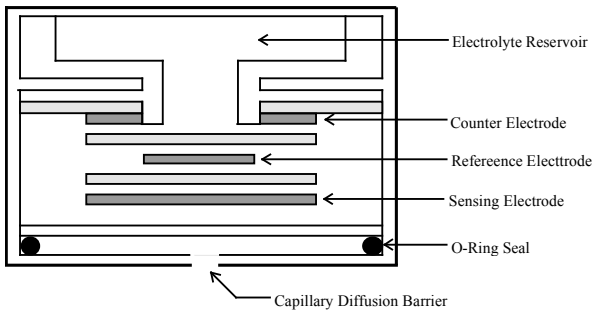


Figure 1 - Toxic Cell Construction
(Schematic Drawing)

In some cases, biasing is required to maintain a voltage differential between the Reference and Sensing electrodes in order to facilitate the necessary reaction in the cell. The transmitter electronics will provide the necessary bias voltage when configured for one of these sensor types. Most sensors produce a small amount of "baseline" current in clean air. This is adjusted out with the zero potentiometer on the transmitter.

This oxidation at the electrodes causes wear, and limits the life of the sensor. Typical life for these sensors is two to three years in normal operation. This will vary somewhat from sensor to sensor, with some working lifetimes exceeding four years. This wear also changes the characteristics of the sensor, requiring regular re-calibration. It is recommended that these sensors be re-calibrated every three months or as necessary.

***CAUTION* Replacement sensor elements which are not bias types are shipped with a tiny spring of wire shorting the Sense and Reference Electrodes. This spring must be removed prior to installing the element to the sensor assembly.**

4.2 Two Wire Transmitters

The standard transmitter output signal is 4 - 20 mA DC. If the current draw required for operation of the transmitter is less than 4 mA DC, then only two wires are needed; for power and signal (See figure 2). The connection to ground is supplied by the monitoring equipment, which measures the voltage developed by the current across a precision resistor. A functioning transmitter will always draw its operating current, so there will always be some output signal in a functioning circuit.

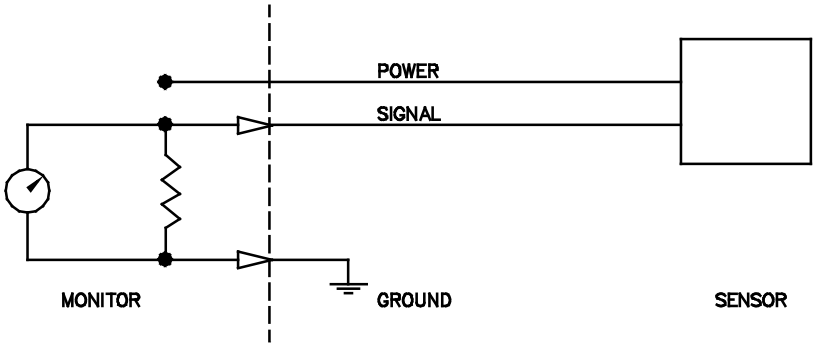


Figure 2 -Two Wire Transmitters

4.3 Intrinsic Safety vs. Explosion Proof Enclosures for Hazardous Locations

Special considerations are necessary in hazardous locations areas where flammable or explosive dusts and/or gases may be present. Such areas are generally classified as either Class 1 (gases) or Class 2 (dusts) and Division 1 (danger is normally present) or Division 2 (danger is present under failure conditions). An additional Group letter code specifies the gases or dusts presenting the hazard. Electrical equipment installed in these areas must be protected from generating a spark of sufficient ignition temperature that an explosion may occur. There are two approaches to these installations.

The first approach is to install the electrical equipment in certified explosion-proof enclosures. When properly installed, these heavy metal enclosures are sealed from the hazardous condition and guaranteed to contain any spark or flame that might occur in the electronics. Unfortunately, access to the contents requires measures to ensure that the area is in a non-hazardous condition.

The second approach is an Intrinsically Safe (IS) installation (See Figure 3). In this approach, voltages and currents into the hazardous area are limited by specially designed IS barriers. The electronic equipment is designed so that energy storage devices (inductive or capacitive) in the electrical device cannot store sufficient energy to cause ignition of the gases to be found in the hazardous area.

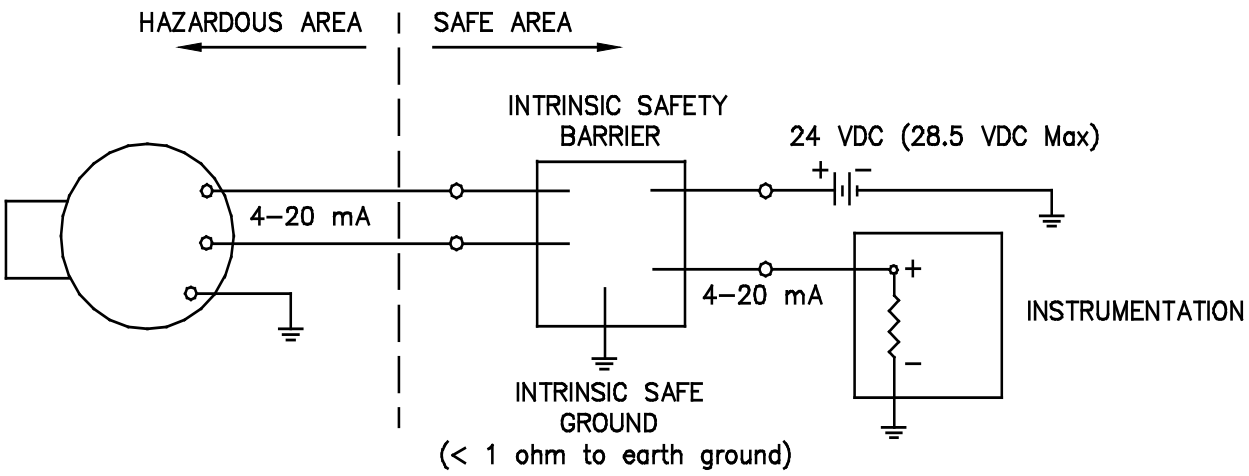


Figure 3 - Intrinsically Safe Installation

For hazardous areas, the QTS-6100 SERIES is available in an explosion proof housing CSA, FM, and UL rated to Class 1 Division 1 Groups B, C, and D. The sensor assembly attached to this enclosure is also rated for Group A (Acetylene). The electronics have been designed to meet intrinsic safety requirements (certification pending).

5. INSTALLATION

WARNING **STATIC ELECTRICITY - Installation, wiring, configuration, or other activity may require handling or disassembly of the transmitter circuit card assemblies (CCA). Handling of a CCA without proper precautions can expose the electronic components to the possible damage from static electricity discharge.**

Try to ensure you are grounded when handling a CCA. If continuous grounding is not practical, touch some metal item, which is known to be grounded. Avoid walking around after this as you can regenerate a static charge. Note that the smallest static discharge, which is noticeable by humans, is 3,000 Volts. A noticeable, significant discharge may be as high as 30,000 Volts

5.1 Mounting

The QTS-6100 Sensor/Transmitter should be mounted where the gas to be measured is most likely to be present. This location will be dependent on the source of the target gas and whether that gas is lighter or heavier than air. Air circulation and mixture should also be taken into account. The following table provides recommended mounting location based on the molecular weight of the gas:

MODEL #	GAS	SYMBOL	MOUNT	LOCATION
QTS-61110	Hydrogen Sulphide	H2S	Low	9 to 18" (230 to 460 mm) above floor
QTS-61115	Hydrogen Cyanide	HCN	Mid	48 to 72" (1200 to 1800 mm) above floor
QTS-61120	Chlorine	Cl2	Low	9 to 18" (230 to 460 mm) above floor
QTS-61123	Chlorine Dioxide	ClO2	Low	9 to 18" (230 to 460 mm) above floor
QTS-61125	Hydrogen Chloride	HCl	Mid	48 to 72" (1200 to 1800 mm) above floor
QTS-61140	Sulphur Dioxide	SO2	Low	9 to 18" (230 to 460 mm) above floor
QTS-61150	Nitrogen Dioxide	NO2	Low	9 to 18" (230 to 460 mm) above floor
QTS-61160	Carbon Monoxide	CO	Mid	48 to 72" (1200 to 1800 mm) above floor
QTS-61190	Nitric Oxide	NO	Mid	48 to 72" (1200 to 1800 mm) above floor
QTS-61211	Hydrogen	H2	High	9 to 18" (230 to 460 mm) below ceiling
QTS-61220	Ammonia	NH3	High	9 to 18" (230 to 460 mm) below ceiling
QTS-61230	Ethylene Oxide	C2H4O	Low	9 to 18" (230 to 460 mm) above floor
QTS-61240	Ozone	O3	Mid	48 to 72" (1200 to 1800 mm) above floor

Table 1 - Sensor/Transmitter Mounting Location

Where possible, the sensor/transmitter should be mounted where it is accessible for the purposes of routine re-calibration and periodic sensor replacement. Sufficient room should be left to allow the enclosure cover to be removed. On units with industrial explosion-proof enclosures; sufficient room should be left to allow the connection of the calibration adapter to the sensor assembly. For sensor element replacement there will need to be enough room to reach into the sensor assembly.

CAUTION **The sensor assemblies on the industrial explosion-proof enclosures are designed for integral mounting only. Remote mounting of the sensor assembly from the transmitter may be possible, but may require special wiring considerations. If you must remote mount the sensor from the transmitter please consult the factory for recommendations.**

NOTE: **Avoid mounting the electronics near 600 VAC switchgear and other sources of radio frequency and/or electromagnetic interference. While RFI/EMI protection is built-in to the electronics, excessive levels of interference may cause instability in the output signal.**

There are two mounting holes in the back of the ABS plastic enclosures for surface mounting. These holes will line up with standard electrical junction boxes. There are two tabbed mounting holes on the exterior of the industrial explosion-proof enclosure for surface mounting. See the appropriate installation drawing for dimensional details.

WARNING **When mounted where the unit will be subjected to rain or other water environments, all conduit connections must be properly sealed with duct seal or equivalent material. Failure to do this could result in water inside the enclosure, which will cause a terminal failure of the electronics.**

5.2 Wiring

The QTS-6100 Series Sensor/Transmitter is a low power consumption transmitter requiring only two wires for power and signal. Terminal block connections are provided for wiring that will accept wire from 14 to 24 AWG. See the appropriate installation drawing for wiring terminal connection details. The transmitter electronics will work over a power range of 12 to 36 VDC. The resistance of the load that the 4 to 20 mA DC output can be driven into is relative to the voltage available at the transmitter (see Figure 4). When calculating power supply requirements, all loads on the transmitter need to be totaled, including wiring and any accessory devices such as intrinsic safety barriers.

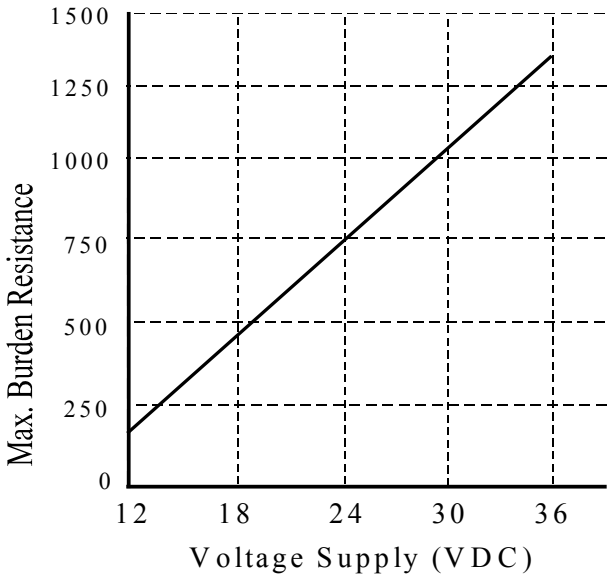


Figure 4 - Maximum Burden Resistance

CAUTION **GROUNDING - The industrial explosion-proof metal enclosure must be connected to a safety ground, either locally or back at the monitor, in order to provide immunity to Electromagnetic Interference.**

6. CONFIGURATION

NOTE: **If you have ordered a complete sensor/transmitter assembly it will come from the factory properly configured and calibrated for the specific sensor element selected. The following configuration information is provided for when a replacement transmitter must be configured or an existing transmitter re-configured to accept a different sensor element type.**

The transmitter electronics package is composed of two circuit card assemblies (CCA) and a top plate (see Figures 6 and 7). Configuration of the transmitter for different sensor elements is performed with a number of solderless shorting links present on each CCA. These shorting links configure the transmitter for biasing, polarity, battery, shorting FET, and proper gain resistance. To change the configuration remove the small plastic shorting link that is plugged over the shorting pins and replace as required in tables 2 and 3 below.

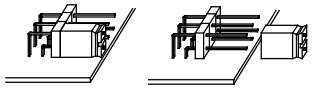


Figure 5 - Jumper Style

			FET		Gain			Polarity	
					Low	Med	High		
Gas	Code	Sensor Part No.	JP11	JP12	JP4	JP5	JP6	JP9	JP10
H2S	110	6300-0006	┃	:	┃	:	:	┃	:
HCN	115	6300-0013	┃	:	:	:	┃	┃	:
Cl2	120	6300-0016	┃	:	:	┃	:	:	┃
ClO2	123	6300-0016	┃	:	:	┃	:	:	┃
HCl	125	6300-0017	:	┃	:	┃	:	┃	:
SO2	140	6300-0018	┃	:	:	:	┃	┃	:
NO2	150	6300-0028	┃	:	┃	:	:	:	┃
CO	160	6300-0003	┃	:	┃	:	:	┃	:
NO	190	6300-0012	:	┃	┃	:	:	┃	:
H2	211	6300-0011	┃	:	┃	:	:	┃	:
NH3	220	6300-0007	┃	:	:	┃	:	┃	:
C2H4O	230	6300-0020	:	┃	┃	:	:	┃	:
O3	240	6300-0023	┃	:	┃	:	:	:	┃

Table 2 - Sensor Type Configuration
Upper Circuit Card Assembly

┃ = Jumper Installed

: = No Jumper

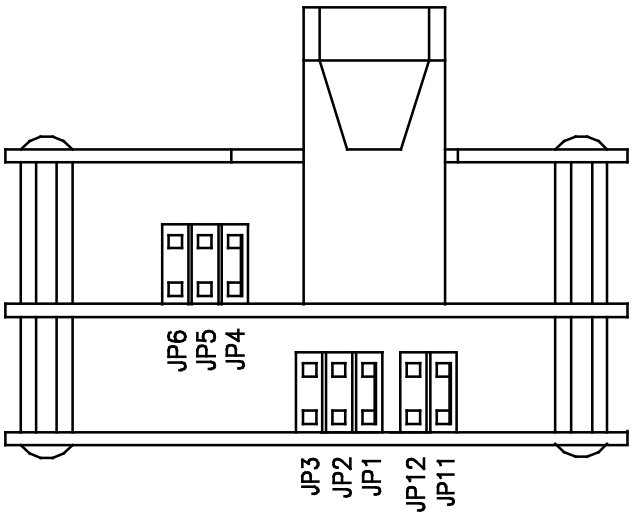


Figure 6 - Configuration Jumpers - Right Side Locations

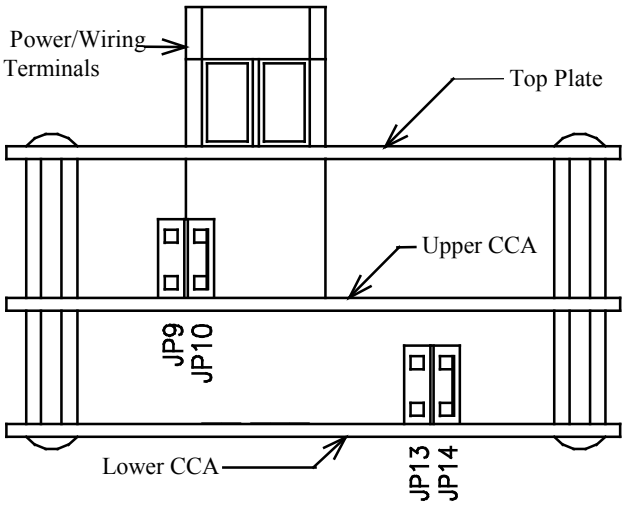


Figure 7 - Configuration Jumpers - Left Side Locations

			Biasing			Battery	
Gas	Code	Sensor Part No.	JP1	JP2	JP3	JP13	JP14
H2S	110	6300-0006	┃	:	:	:	┃
HCN	115	6300-0013	┃	:	:	:	┃
Cl2	120	6300-0016	┃	:	:	:	┃
ClO2	123	6300-0016	┃	:	:	:	┃
HCl	125	6300-0017	:	:	┃	┃	:
SO2	140	6300-0018	┃	:	:	:	┃
NO2	150	6300-0028	┃	:	:	:	┃
CO	160	6300-0003	┃	:	:	:	┃
NO	190	6300-0012	:	:	┃	┃	:
H2	211	6300-0011	┃	:	:	:	┃
NH3	220	6300-0007	┃	:	:	:	┃
C2H40	230	6300-0020	:	:	┃	┃	:
O3	240	6300-0023	┃	:	:	:	┃

Biasing:

JP1 = None
JP2 = Positive
JP3 = Negative

Battery:

JP13 = Enabled
JP14 = Disabled

Table 3- Sensor Type Configuration
Lower Circuit Card Assembly

┃ = Jumper Installed

: = No Jumper

NOTE: **A transmitter that has been reconfigured must always be calibrated with the installed sensor. See Section 8 for details on calibration and replacement of sensor elements.**

7. START-UP AND COMMISSIONING

The QTS-6100 Series Sensor/Transmitter comes from the factory completely configured, tested and calibrated as ordered. Verify the model number is correct and follow the installation instructions in this manual. Check all wiring prior to applying power to the transmitter. Using a digital multimeter (DVOM), check power at the terminals to ensure a nominal 24 VDC is present. Connect the DVOM to the test jacks on the upper CCA with a range selected that will display 20 mA DC. The reading on the test jacks is the actual output from the transmitter.

It is not uncommon for the electrochemical sensor to register a response when first started up, even in clean air. If the sensor was not covered, some gases may have entered the cell and not been cleared by the unpowered unit. Generally the sensor will be fully warmed up and clear of any gases within one hour of power being applied. Under extreme conditions this period may be as long as 24 hours. The exception to this is the ammonia (NH_3) sensor. This sensor will take between three and five days to be fully warmed up and provide a stable output. Calibration of any transmitter should not be performed until the sensor is fully warmed up and stable.

8. ROUTINE MAINTENANCE

8.1 Calibration

Recommended calibration of the QTS-6100 Series Sensor/Transmitter is every 90 days, or as necessary. The user should take into account actual installation environment and the possibilities for failure due to water or corrosive atmospheres. The seriousness of a failure to alarm or the lack of precision in that location should also be considered and calibration periods adjusted accordingly.

8.1.1 EQUIPMENT REQUIRED

- **Digital Multimeter;** Accurate to 0.1 mA maximum.
- **Screwdriver;** Small, for adjusting trim potentiometers.
- **Zero Calibration Gas;** 20.9% Oxygen, balance Nitrogen, or some other source of clean air.
- **Span Calibration Gas;** Should be as close to the span concentration as possible and no less than 50% of the span concentration.
- **Flow Regulator;** For calibration gases; should regulate the gas flow in the range 200 to 1000 ml/min.
- **Calibration Adapter;** As supplied by QEL
- **Tubing;** To connect from the regulator to the calibration adapter

***CAUTION* Some target gases, such as Chlorine (Cl_2) and Hydrogen Sulphide (H_2S) may be absorbed by standard plastic tubing. This absorption will alter the concentration of the calibration gas actually reaching the sensor element and therefore cause erroneous calibration. Teflon tubing should be used for CL_2 and H_2S gas calibrations.**

8.1.2 PROCEDURE

8.1.2.1 Set-Up

Two small jacks are on the upper CCA of the transmitter, accessible through holes on the cover plate (see figure 8). These jacks will accept standard test leads from most hand held multimeters. Set the digital multimeter on a DC milliamp range to read up to 20 mA DC and connect the test leads to the test jacks. The circuit is diode protected, so as to allow measurement without interruption of the transmitter output. Connect the tubing between the flow regulator and the calibration adapter.

NOTE: **Adjustments to the zero potentiometer will effect the span adjustment. Adjustments to the span potentiometer will have a negligible effect on the zero adjustment unless they are major. Ideal calibration will be obtained by repeating the following zero and span adjustments twice.**

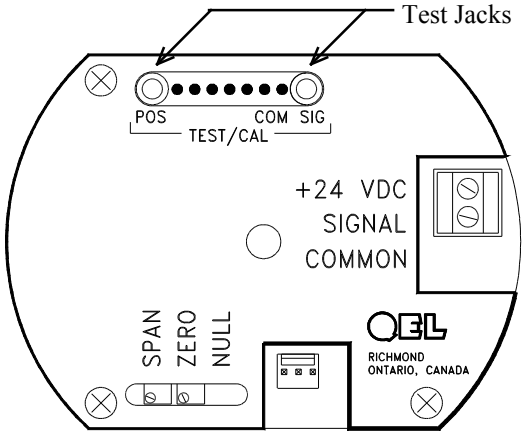


Figure 8 - Calibration Adjustments

8.1.2.2 Zero Adjustment

A) Connect the flow regulator to the zero calibration gas cylinder (or other clean air source).
B) Connect the calibration adapter to a) the sensor assembly cover if the industrial explosion-proof enclosure or b) the sensor opening on the front cover if the ABS plastic enclosure.
C) Apply zero calibration gas while monitoring the output of the sensor. Allow output to stabilize.
D) Adjust the zero potentiometer until the signal is 4.00 mA DC, ± 0.05 mA.
E) Turn off the zero gas and remove from the flow regulator.

8.1.2.3 Span Adjustment

A) Connect the flow regulator to the span gas cylinder (or other span gas source).
B) Apply span calibration gas while monitoring the output of the sensor. Allow output to stabilize.
C) Adjust the span potentiometer until the meter reads the appropriate current ±1.5%.
D) Turn off the span gas and remove from the flow regulator.

NOTE: To determine the appropriate output in mA DC for a given concentration of calibration gas, or to convert current mA DC readings to a specific gas concentration; use the following calculations:

$$\text{Output (mA)} = \left(\frac{\text{Concentration (ppm)}}{\text{Span (ppm)}} \times 16 \right) + 4$$

$$\text{Concentration (ppm)} = \frac{(\text{Output (mA)} - 4)}{16} \times \text{Span (ppm)}$$

8.2 Sensor Element Replacement

As the electrochemical sensor ages, oxidation wears away the measuring electrodes. This reduces the output of the sensor, requiring regular re-calibration. Eventually it will not be possible to adjust the span potentiometer enough to bring the transmitter output to the correct level. When this happens the sensor element must be replaced.

The sensor element is a small, plug-in cell with four pins on the bottom. The cell is shipped from the factory in a sealed plastic cylindrical container. The sealed container prevents contamination of the cell by gases, dirt, and other foreign matter prior to installation.

NOTE: Wherever possible, do not remove the sensor from the sealed container until you are ready to install it. This will maximize the life of the cell and minimize the warm up time.

When you first remove the sensor from the container, a shorting wire will be across the connection pins. This wire prevents degradation of electrodes during storage. When properly installed, the transmitter supports this function whether powered or unpowered.

***CAUTION* Before installing the sensor element, any shorting wires attached to the pins must be removed. The sensor will not operate with these shorting wires connected.**

Newly installed sensor elements should be left powered for at least 24 hours before calibration. Ammonia (NH_3) cells should be left for at least three days, preferably five days before calibration. This will allow the sensor to burn off any gases that may have diffused into the cell before installation and to fully warm-up and stabilize.

8.2.1 INDUSTRIAL EXPLOSION-PROOF ENCLOSURES

A) Remove cap and screen from sensor assembly.
B) Remove old sensor element, including O-ring seal.
C) Install new sensor element, including O-ring seal. Take care to align the pins to the socket.
D) Replace cap and screen on sensor assembly.

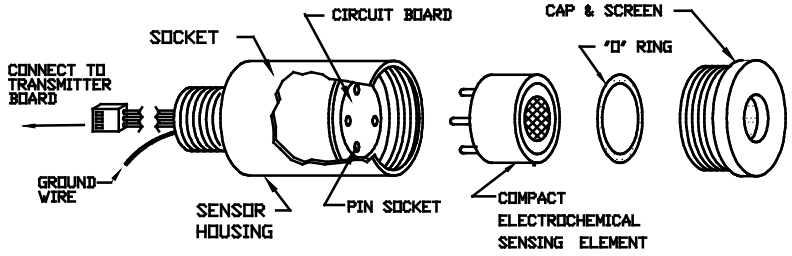


Figure 9 - Sensor Element Installation

8.2.2 ABS PLASTIC COMMERCIAL AND NEMA 4X ENCLOSURES

A) Remove four mounting screws located one at each corner of the front cover.
B) Securing the transmitter assembly from falling, remove the three transmitter mounting screws from the front cover. Transmitter, sensor element, and grounding ring will all come free.
C) Remove old sensor element from transmitter pin sockets.
D) Install new sensor element into transmitter pin sockets. Take care to align the pins to the socket.
E) Remove O-ring from new sensor element.
F) Re-install sensor/transmitter against grounding ring on the inside front cover. Secure with three mounting screws through the front cover.
G) Secure front cover with four cover screws, one on each corner.

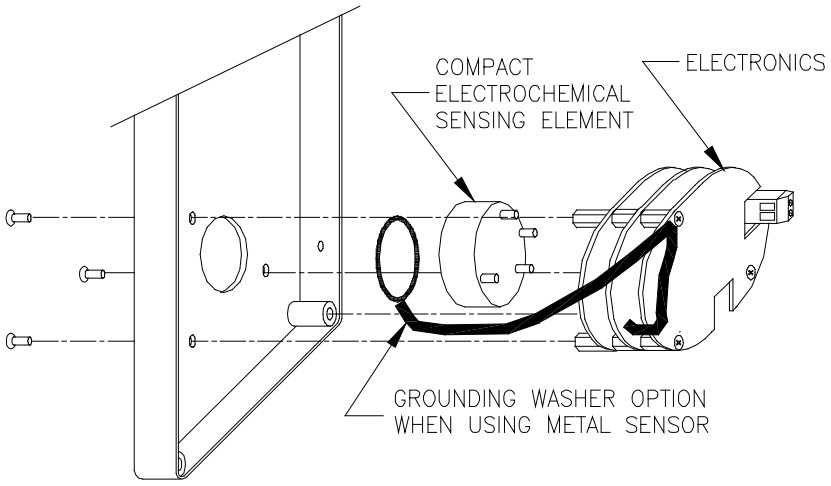


Figure 10 - Sensor Element Installation

ABS Plastic Commercial or Nema 4X Enclosures

9. FIELD TROUBLE SHOOTING

9.1 Sensor Life

The response to gas of electrochemical sensors will reduce with time due to oxidation on the electrodes. The rate of reduction is dependent upon such factors as ambient temperature, humidity, and exposure to gas. In order to compensate for this, the gain of the transmitter can be increased when the unit is calibrated in the field by adjusting the gain (span) potentiometer. If the potentiometer adjustment is insufficient, the gain jumper may be moved to one higher gain position, i.e. JP4 to JP5, or JP5 to JP6.

CAUTION **The gain jumper should not be moved by more than one position, i.e., DO NOT move JP4 to JP6, as this could increase the gain too much causing the amplification of sensor noise, resulting in unacceptable jitter on the 4-20 mA output.**

If the span signal cannot be achieved by adjusting the gain, or the increase in gain results in unacceptable jitter on the output, then the sensor must be replaced.

9.2 Transmitter Electronics

WARNING **STATIC ELECTRICITY - Installation, wiring, configuration, or other activity may require handling or disassembly of the transmitter circuit card assemblies (CCA). Handling of a CCA without proper precautions can expose the electronic components to the possible damage from static electricity discharge.**

Try to ensure you are grounded when handling a CCA. If continuous grounding is not practical, touch some metal item, which is known to be grounded. Avoid walking around after this as you can regenerate a static charge. Note that the smallest static discharge, which is noticeable by humans, is 3,000 Volts. A noticeable, significant discharge may be as high as 30,000 Volts

The two CCAs are the lowest level of field replaceable assembly. These assemblies must be replaced with the power removed from the transmitter. See Figure 11 for an exploded view of the transmitter CCAs and associated hardware, and for details on the disassembly and reassembly procedures.

The only life limited component in the transmitter electronics is a lithium battery. This battery is used to provide a bias voltage to certain types of electrochemical sensors only when the transmitter is unpowered. In the unpowered condition the lithium battery will have a lifetime of at least six months. In the powered condition the lifetime is expected to be at least ten years.

The lithium battery is soldered into the lower CCA, and therefore if it is necessary to replace it in the field the Lower CCA must be replaced.

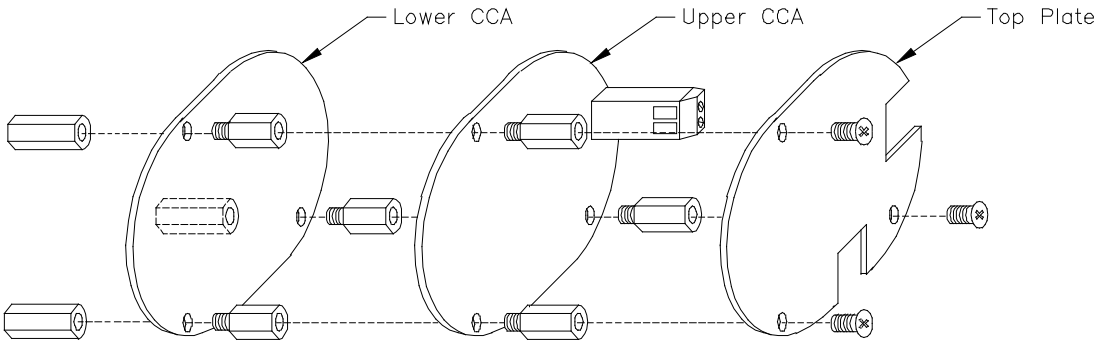


Figure 11 - Circuit Card Assembly

9.3 Installation and Application Problems

Most problems encountered with this equipment are either installation or application related. Some common problems, their symptoms, results, and corrective action are listed below.

9.3.1 SUPPLY AND SIGNAL REVERSED

Symptom: No or excessively high output.

If the supply wire and the signal wire are reversed, then the Fuse may blow (0.5 Amp Pico-fuse, available at most controls suppliers or QEL Pt No 6700-0018-0). The only path for current to flow is through the signal line. Therefore the most likely occurrence will be that the Burden Resistance (monitor input resistance plus wiring resistance plus intrinsic safety barrier if present) will limit the current well below the fuse limit. Approximate readings are given below

24 VDC	250 ohms:	100 mA
	100 ohms:	240 mA

Corrective Action:
1) Measure DC Voltage at the terminals. Ensure sufficient supply voltage is present and the +24 Volt wire is connected to the proper terminal. Correct as necessary.
2) Using the test jacks, check to see if the output of the transmitter is correct.
3) If no output, or high output, turn off power to transmitter (by disconnecting wires, if necessary) and check the fuse. Replace as necessary.
4) If problem still persists there may be associated component damage. Replace upper CCA or contact factory.

9.3.2 OVERVOLTAGE SUPPLY

Symptom: Constant High output.

The input is limited by a Zener diode and fuse. Overvoltage may blow the onboard Pico-fuse. The only path for current to flow is through the signal line. Therefore the most likely occurrence will be that the Burden Resistance (monitor input resistance plus wiring resistance plus intrinsic safety barrier if present) will limit the current well below the fuse limit (see 9.3.1 above). The device will turn on, but the readings will be high in the proportion of excess voltage over the Zener value of 39 VDC.

Corrective Action:
1) Measure DC Voltage at the terminals. Ensure supply voltage between 12 and 36 VDC is present. Correct as necessary.
2) Using the test jacks, check to see if the output of the transmitter is correct.
3) If no output, or high output, turn off power to transmitter (by disconnecting wires, if necessary) and check the fuse. Replace as necessary.
4) If problem still persists there may be associated component damage. Replace upper CCA or contact factory.

9.3.3 EXCESSIVE BURDEN RESISTANCE OR UNDERVOLTAGE SUPPLY

Symptom: Constant Low output or possibly no output.

If the Burden resistance (monitor input resistance plus wiring resistance plus intrinsic safety barrier if present) is greater than that specified for the particular supply voltage (see Figure 4 on page 6) then this will limit the maximum signal output capability to less than full range. If the burden resistance is sufficiently large, then the device may not turn on correctly.

Corrective Action:
1) Measure DC Voltage at the terminals. Ensure supply voltage between 12 and 36 VDC is present. Correct as necessary.
2) Disconnect power to the transmitter power/output current loop.
3) Disconnect wiring at the transmitter and measure resistance across the two wires.
4) If resistance is too high, either reduce the burden or increase the supply voltage.
5) Reconnect wiring and apply power to the transmitter.
6) Using the test jacks, check to see if the output of the transmitter is correct.
7) If problem still persists it may be caused by a cell that needs replacement or has been effected by extensive operation in very low humidity (see 9.3.4 below). There may also be unrelated damage to the CCA. Consult factory.

9.3.4 HUMIDITY PROBLEMS

Symptom: Constant Low output, sluggish response, (Humidity too low).
Constant High output, unstable response, (Humidity too high).

The electrochemical sensor elements are designed to work continuously in an environment with a relative humidity anywhere in the range of 15 to 90% RH non-condensing. The cells will withstand intermittent excursions outside this range, but problems will show up if they are operated for too long at either too low or too high a humidity.

If the humidity is under 15% RH for an extended period of time, the sensor element will give up moisture in the form of water vapor. This will reduce the electrolyte level in the cell and result in sluggish response and readings that may be low.

Corrective Action:

These sensors can be restored to fully functional use by exposing them to a high humidity (90% RH or above) atmosphere for an equal period of time that they were exposed to the low humidity condition.

If the humidity is above 90% RH for an extended period of time, the sensor element will take on moisture in the form of water vapor that condenses inside the cell. As the cell is sealed, this will result in an increase in pressure inside the cell. This increase in pressure will cause the sensor to output a higher than normal signal which will be relatively unstable.

Corrective Action:

These sensors can be restored to fully functional use by exposing them to a low humidity (<15% RH) atmosphere for an equal period of time that they were exposed to the high humidity condition. If the high humidity condition exists for too long a period, the sensor seals may crack rendering them damaged beyond rejuvenation.

9.3.5 RFI/EMI EFFECTS

Symptom: Unstable, wandering output; spikes, drift, possibly false alarms.

The QTS-6100 Series Universal Sensor/Transmitter has been designed to provide protection against Radio Frequency Interference (RFI) and Electro-Magnetic Interference (EMI). The unit has been tested against radiated signals of 4 watts at high frequencies and a distance of 1 meter. This protection can be overwhelmed by interference of higher strengths and/or closer proximity. The transmitter should not be mounted near high voltage, multi-phase switchgear or motors. It should not be mounted near constant sources of radio frequency.

The output signal from the sensor to the transmitter is DC microamps. It is imperative that the industrial explosion-proof sensor assemblies be properly grounded through the enclosure. In the ABS plastic enclosures, a grounding ring is installed between the sensor element and the front cover. This ring is connected to ground (common) on the transmitter board. This ring must be in place for proper operation of the transmitter. When calibrating, avoid placing hands near the sensor opening.

Corrective Action:

RFI/EMI problems are very difficult to troubleshoot. If you suspect a problem of this nature, first check to ensure the transmitter is properly grounded. Then look at all the equipment mounted near the transmitter. Gradually turn off each suspect item to see if it is having an effect on the transmitter output. If you are able to identify a source of interference, relocate the transmitter at a distance from this source so that it is no longer affected.