

Model 6000 Series  
CA-CALC™  
Single Gas Monitors

**Operation and Service Manual**

*P/N 1980452 Revision B  
November 2003*



**Model 6000 Series  
CA-CALC™  
Single Gas Monitors**

**Operation and Service  
Manual**

*November 2003  
P/N 1980452, Revision B*

**U.S. and CANADA**

**Sales and Customer Service:**

(800) 874-2811/(651) 490-2811

**Fax:**

(651) 490-3824

**INTERNATIONAL**

**Sales and Customer Service:**

(001 651) 490-2811

**Fax:**

(001 651) 490-3824

**MAIL/SHIP TO:**

TSI Incorporated

ATTN: Customer Service

500 Cardigan Road

Shoreview, MN 55126

USA

**E-Mail**

answers@tsi.com

**WEB SITE**

[www.tsi.com](http://www.tsi.com)

 For current information  
**[www.tsi.com](http://www.tsi.com)**

## Copyright ©

TSI Incorporated / 2003 / All rights reserved.

## Part Number

1980452 / Revision B

## Address

TSI Incorporated / 500 Cardigan Road / Shoreview, MN 55126 / USA

## Fax No.

(651) 490-3824

## LIMITATION OF WARRANTY AND LIABILITY (effective July 2000)

Seller warrants the goods sold hereunder, under normal use and service as described in the operator's manual, shall be free from defects in workmanship and material for twenty-four (24) months, or the length of time specified in the operator's manual, from the date of shipment to the customer. This warranty period is inclusive of any statutory warranty. This limited warranty is subject to the following exclusions:

- a. Batteries are warranted for 90 days from the date of shipment to the customer. Electrochemical gas sensors are warranted for a period of twelve (12) months from the date of shipment to the customer.
- b. Parts repaired or replaced as a result of repair services are warranted to be free from defects in workmanship and material, under normal use, for 90 days from the date of shipment.
- c. Seller does not provide any warranty on finished goods manufactured by others or on any fuses, batteries or other consumable materials. Only the original manufacturer's warranty applies.
- d. Unless specifically authorized in a separate writing by Seller, Seller makes no warranty with respect to, and shall have no liability in connection with, goods which are incorporated into other products or equipment, or which are modified by any person other than Seller.

The foregoing is IN LIEU OF all other warranties and is subject to the LIMITATIONS stated herein. **NO OTHER EXPRESS OR IMPLIED WARRANTY OF FITNESS FOR PARTICULAR PURPOSE OR MERCHANTABILITY IS MADE.**

TO THE EXTENT PERMITTED BY LAW, THE EXCLUSIVE REMEDY OF THE USER OR BUYER, AND THE LIMIT OF SELLER'S LIABILITY FOR ANY AND ALL LOSSES, INJURIES, OR DAMAGES CONCERNING THE GOODS (INCLUDING CLAIMS BASED ON CONTRACT, NEGLIGENCE, TORT, STRICT LIABILITY OR OTHERWISE) SHALL BE THE RETURN OF GOODS TO SELLER AND THE REFUND OF THE PURCHASE PRICE, OR, AT THE OPTION OF SELLER, THE REPAIR OR REPLACEMENT OF THE GOODS. IN NO EVENT SHALL SELLER BE LIABLE FOR ANY SPECIAL, CONSEQUENTIAL OR INCIDENTAL DAMAGES. SELLER SHALL NOT BE RESPONSIBLE FOR INSTALLATION, DISMANTLING OR REINSTALLATION COSTS OR CHARGES. No Action, regardless of form, may be brought against Seller more than 12 months after a cause of action has accrued. The goods returned under warranty to Seller's factory shall be at Buyer's risk of loss, and will be returned, if at all, at Seller's risk of loss.

Buyer and all users are deemed to have accepted this LIMITATION OF WARRANTY AND LIABILITY, which contains the complete and exclusive limited warranty of Seller. This LIMITATION OF WARRANTY AND LIABILITY may not be amended, modified or its terms waived, except by writing signed by an Officer of Seller.

## Service Policy

Knowing that inoperative or defective instruments are as detrimental to TSI as they are to our customers, our service policy is designed to give prompt attention to any problems. If any malfunction is discovered, please contact your nearest sales office or representative, or call TSI's Customer Service department at (800) 874-2811.

# CONTENTS

## Chapters

<b>Introduction .....</b>	<b>1</b>
Manual Purpose .....	1
Using This Manual.....	1
Warnings and Cautions .....	1
<b>1. Instrument Description .....</b>	<b>3</b>
<b>2. Unpacking .....</b>	<b>5</b>
List of Standard Components.....	5
Accessories and Replacement Parts .....	5
<b>3. Component Identification .....</b>	<b>7</b>
The Gas Sensors .....	9
The Sampling Probe.....	9
Diaphragm Pump .....	9
Water-Stop Filter .....	9
Optional Model 802215 Water Trap .....	9
Optional Protective Boot Model 801995.....	10
<b>4. Getting Started .....</b>	<b>11</b>
Assembling the Sampling Probe .....	11
<b>5. Basic Operation .....</b>	<b>13</b>
Buttons and Button Operations .....	13
Startup .....	13
Connecting the Sampling Probe .....	13
Data Display, Viewing the Gas Measurement .....	15
Changing the Gas Measurement Units ( <i>not CA-6020</i> ) .....	15
Making Gas Measurements .....	16
<b>6. Gas Sensor Calibrations.....</b>	<b>17</b>
Calibration Equipment Setups.....	17
CAL MENU Option, Sensor Calibration .....	19
<b>7. Maintenance and Troubleshooting.....</b>	<b>21</b>
Water-Stop Filter Plugging .....	21
Changing the Water-Stop Filter.....	21
Cleaning the Sample Probe .....	21
Adding or Replacing a Gas Sensor.....	22
CAL.F MENU Option—Setting the Calibration Factor for a New Sensor.....	24

**Appendixes**

**A. Error Codes Defined.....25**

**B. Series CA-6000 CA-CALC Single Gas Monitor Detailed Specifications .....27**

# Introduction

---

## Manual Purpose

This manual describes the operation and maintenance of your TSI Series CA-6000 CA-CALC™ Single Gas Monitor.

## Using This Manual

Before using the CA-CALC Single Gas Monitor for the first time, review this manual in its entirety.

Most information in this manual is applicable for all Series CA-6000 instruments. Where information is not applicable to a particular model or additional information is supplied, notation is made.

## Warnings and Cautions

The manual assumes that you have a basic understanding of combustion safety concerns and are thoroughly familiar with the fuel burning equipment being tested. If you are using measurements as the basis for equipment adjustments, rely on your good judgment and experience together with the measured data. This is especially important where safety issues are of concern. Equipment adjustments must always coincide with the fuel burning equipment manufacturer's recommendations.



### W A R N I N G

High temperatures and toxic gases are produced when fossil fuels are burned. Only qualified individuals, thoroughly familiar with operating and adjusting fuel-burning equipment, should use gas measurements for the purpose of making equipment adjustments.



### W A R N I N G

The CA-CALC is not intended for use as a continuous monitor.





# Chapter 1

## Instrument Description

---

The CA-CALC™ 6000 Series Single Gas Monitors are portable instruments designed for measuring key gases associated with the combustion of fossil fuels. The CA-CALC Single Gas Monitor is typically used to evaluate the performance of boilers, furnaces, and hot water tanks, and determine the presence of toxic pollutants for regulatory and safety concerns.

All instruments use electrochemical gas sensors, which for most models provide two or three years of useful service before sensor replacement is necessary. Sensor replacement is easily performed by the operator.

The CA-CALC 6000 Series Analyzers are supplied with a sampling probe consisting of a stainless sample tube, plastic handle, rubber or non-reactive plastic sample line (for NO<sub>2</sub>, SO<sub>2</sub>), and in-line water-stop filter. The sampling probe is used to draw the gas sample at a rate of 0.8 liters per minute from the sampling point to the sensor in the instrument. The sample flow is provided by an internal diaphragm vacuum pump.

The following CA-CALC models are available:

<b>Model Number</b>	<b>Gas Measurement</b>
CA-6010	CO, carbon monoxide 0 – 1000 PPM
CA-6020	O <sub>2</sub> , oxygen 0 – 25%
CA-6030	NO, nitric oxide 0 – 4000 PPM
CA-6040	NO <sub>2</sub> , nitrogen dioxide 0 – 500 PPM
CA-6050	SO <sub>2</sub> , sulfur dioxide 0 – 4000 PPM
CA-6060	CO (high) high concentration CO 0 – 2%
CA-6070	CO (X-high) high concentration CO 0.1% – 8%



# Chapter 2

## Unpacking

---

Carefully unpack your CA-CALC™ Single Gas Monitor and accessories from the carrying case. Check the individual parts against the list of components in the table below. If items are missing or damaged, notify TSI immediately.

### List of Standard Components

Qty.	Item Component	Part/ Model
1	Series CA-6000 CA-CALC single gas monitor	
1	Sample probe with water-stop filter	801993
1	Sample probe with water-stop filter, for Models CA-6040, CA-6050	801998
4	AA cell alkaline batteries	
1	Operation and Service manual	1980452

### Accessories and Replacement Parts

Item	Part/Model	For Model
Boot with magnet and carrying strap	801995	All
Water-stop filter replacement kit	801922	All
Optional Water trap	802215	All
Water trap filters for optional Water Trap	1602309	All
Lithium battery (Model 6030)	1208023	CA-6030
CO replacement sensor	802006	CA-6010
O <sub>2</sub> replacement sensor	802012	CA-6020
NO replacement sensor	802007	CA-6030
NO <sub>2</sub> replacement sensor	802008	CA-6040
SO <sub>2</sub> replacement sensor	802009	CA-6050
CO high concentration replacement sensor	802010	CA-6060
CO x-high replacement sensor to 8%	802013	CA-6070
Replacement pump	801996	All
O <sub>2</sub> sensor zero calibration kit (N <sub>2</sub> gas)	801939	CA-6020
CO sensor calibration kit, 500 ppm CO	801999	CA-6010
NO sensor calibration kit, 200 ppm NO	801937	CA-6030
NO <sub>2</sub> sensor calibration kit, 25 ppm NO <sub>2</sub>	801938	CA-6040
SO <sub>2</sub> sensor calibration kit, 200 ppm SO <sub>2</sub>	801936	CA-6050
CO high concentration calibration kit, 1%	801945	CA-6060/70

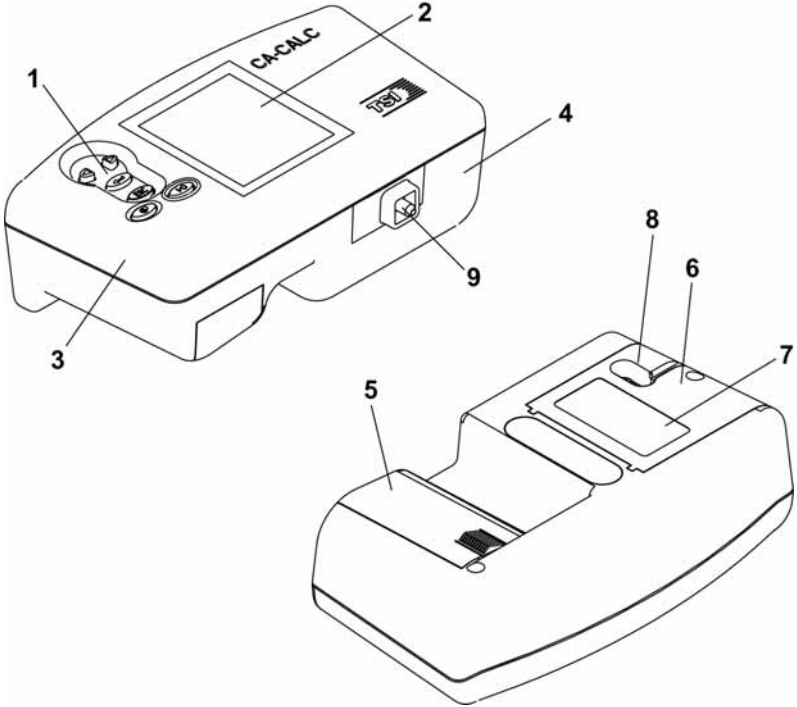


# Chapter 3

## Component Identification

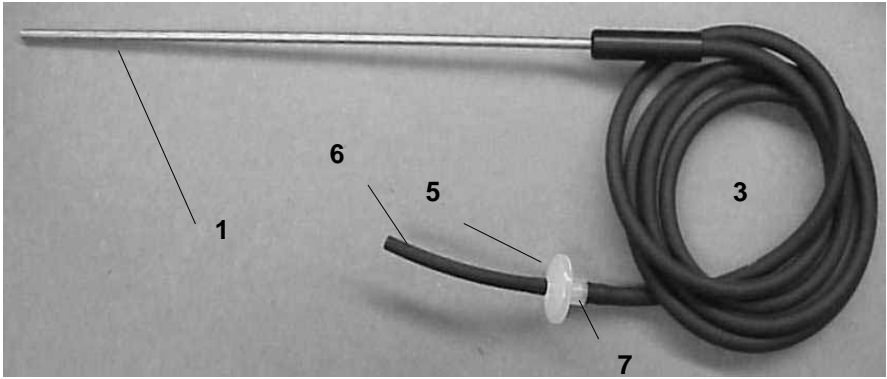
---

Key components of the CA-CALC™ Single Gas Monitor and sampling probe are identified in Figures 1 and 2 and under section headings in the text that follows.

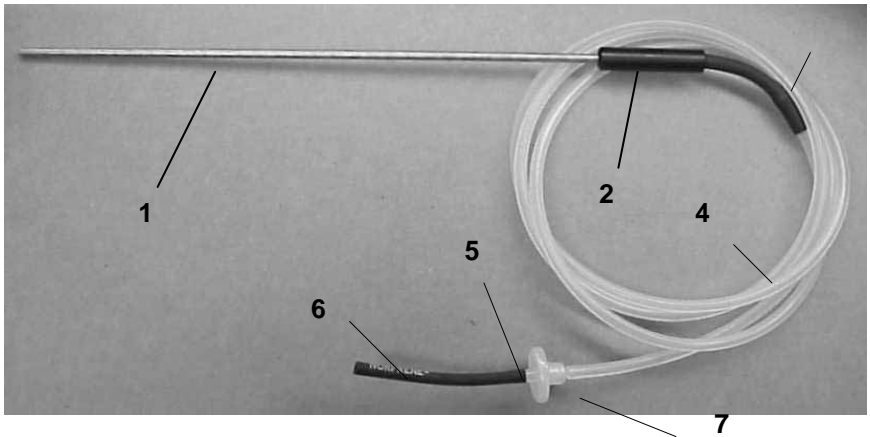


- |                  |                     |
|------------------|---------------------|
| 1. Buttons       | 6. Sensor cover     |
| 2. Display       | 7. Instrument label |
| 3. Top cover     | 8. Gas vent         |
| 4. Case bottom   | 9. Sample port      |
| 5. Battery cover |                     |

**Figure 1: CA-CALC CA- 6000 Series**



Sampling Probe for Models CA-6010,  
CA-6020, CA-6030, CA-6060



Sampling Probe for Models CA-6040, CA-0650

- |   |                      |
|---|----------------------|
| 1. Stainless steel sampling tube                      | 6. Connection tubing |
| 2. Plastic handle                                     | 7. Tube fitting      |
| 3. Rubber sampling tube                               | 8. Adapter tube      |
| 4. Sampling tube (NO <sub>2</sub> , SO <sub>2</sub> ) |                      |
| 5. Water-stop filter                                  |                      |

**Figure 2: CA-CALC Sampling Probe Components**

## The Gas Sensors

Your CA-CALC analyzer uses electrochemical gas sensors for making gas measurements. Electrochemical sensors operate by oxidizing or reducing molecules of the measured gas contacting the sensor's *sensing electrode*. A sensor current develops which is proportional to the reaction rate. The current is detected by the CA-CALC electronics and converted to a gas concentration reading proportional to the current. Gas concentration is displayed in units of PPM or standard  $\text{mg}/\text{m}^3$ , or for oxygen ( $\text{O}_2$ ), displayed as a percent.

## The Sampling Probe

The sampling probe consists of a stainless steel probe tip, plastic handle, sampling tube and water-stop filter. Instrument Models CA-6040 and CA-6050 for measuring  $\text{NO}_2$  and  $\text{SO}_2$ , respectively, use a polypropylene sample tube, which is non-reactive to these gases. Sampling probe types are shown in Figure 2.

## Diaphragm Pump

The CA-CALC analyzer samples exhaust gases from the flue and delivers them to the electrochemical sensors using a diaphragm sampling pump. The pump is accessed through the sensor cover (see Figure 1), and can be removed for cleaning or for replacement. Typical pump life is 1000 hours.

## Water-Stop Filter

Your sample probe is provided with a small, water-impermeable *hydrophobic* filter. This filter protects the pump and gas sensor from water (and soot), which can adversely affect instrument performance. When water is present, the filter plugs, causing the instrument flow to cease. Where water or contamination are present (flue measurements), it is recommended that you purchase a Model 802215 Water Trap. This item is described below.

## Optional Model 802215 Water Trap

The Model 802215 Water Trap, shown in Figure 2, is used to remove moisture that collects in the sample tubing when combustion gases are sampled from the flue. The water trap uses two chambers and a filter to maximize water and particulate removal. Unlike the water-stop filter provided standard, the Water Trap enables extended sampling from a moist, dirty air stream.

### **Optional Protective Boot Model 801995**

An optional protective boot is available for your instrument. The boot provides drop protection for the instrument and is supplied with a magnet, enabling the instrument to be mounted on a flat, vertical metal surface. The boot is equipped with a carrying strap.



# Chapter 4

## Getting Started

---

---

### Installing Batteries

The CA-CALC™ portable Single Gas Monitor operates using 4 AA batteries enabling the instrument to operate for approximately 10 hours with the pump running.

To install the batteries turn the Single Gas Monitor over and remove the battery cover by pushing down on the cover latch tab with your thumb and sliding back, away from the instrument case. Turn the instrument over and shake, allowing the battery holder and batteries to fall out into your hand. Note the orientation of the contacts on the holder and in the instrument.

Replace the used batteries with new batteries, matching the + and – terminals, as indicated on the battery holder. Note the location of the battery contacts. Replace the holder by inserting it straight down into the battery compartment

### Assembling the Sampling Probe

Refer to the photographs in Figure 2. Your probe comes assembled as shown. Should the water-stop filter become separated, reconnect it by attaching the short black rubber tube (1/8" ID) to the smooth "Lure" fitting. Connect the larger black rubber tube (3/16" ID) to the barbed tube fitting attached to the water-stop filter. Where the transparent polypropylene tubing is supplied (probes for NO<sub>2</sub> and SO<sub>2</sub>), reconnect the poly-tubing by sliding it into the rubber tubing as shown in the photos.








## Chapter 5

### Basic Operation

---

---

#### Buttons and Button Operations

	<b>ON-OFF</b> Control Button Turns the instrument <b>on</b> and <b>off</b> .
	The <b>ENTER</b> Control Button Press the <b>ENTER</b> button to execute a command, such as selecting a menu item.
	The <b>ESC</b> Control Button Used to return to the previous menu or cancel a process.
	<b>ARROW</b> Control Buttons Use the arrow buttons to step between items and change values.
	The <b>PUMP</b> On-Off Button Turns the pump on or off.

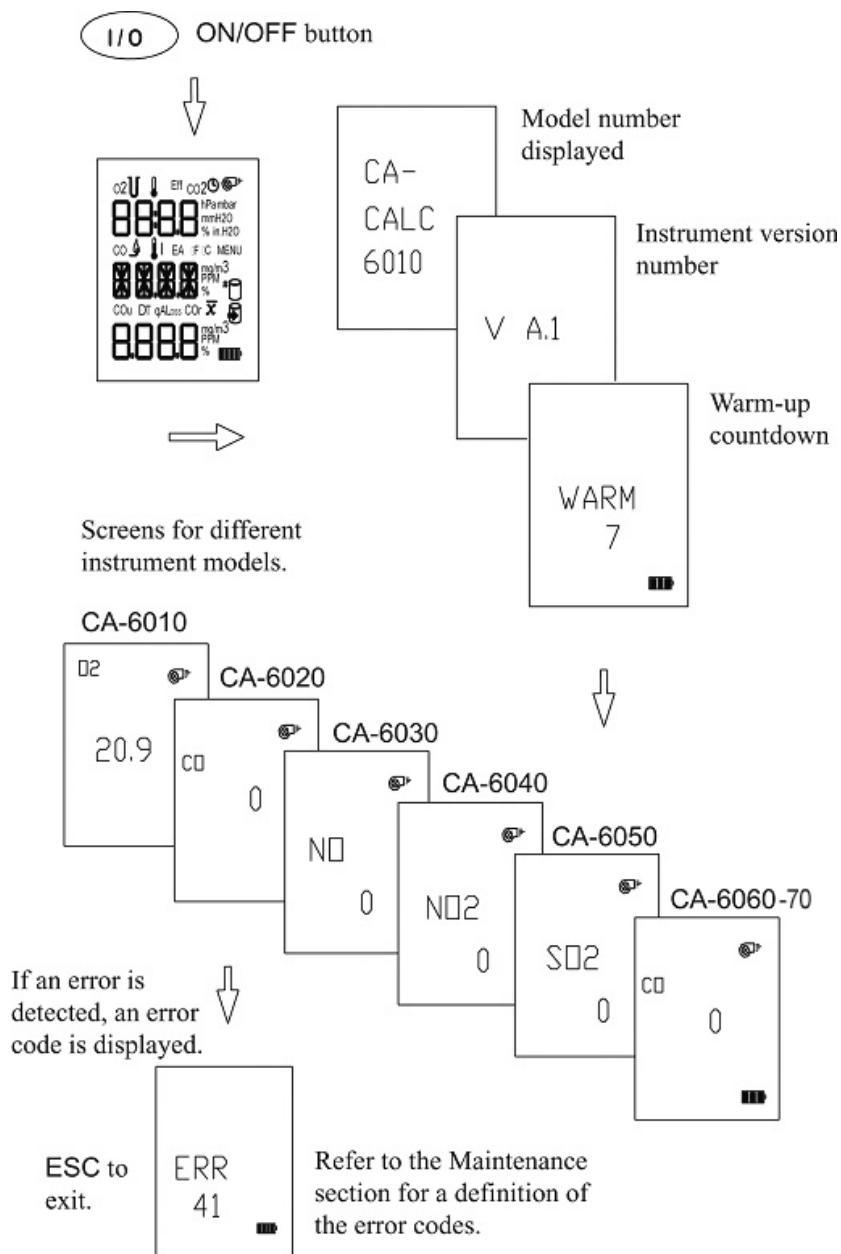
#### Startup

Remove the sampling probe from the flue or disconnect the sample tubing from the sampling port. Press the ON-OFF button. Figure 3 diagrams the start-up sequence and shows screens displayed during startup. If no errors are detected, the Data Display screen appears when the sequence is complete.

While the WARM screen is displayed, the O<sub>2</sub> sensor is calibrated using ambient air, and other gas sensors are zeroed.

#### Connecting the Sampling Probe

The sampling probe is connected to the instrument by pushing the short rubber sample tube completely over the instrument sample port.



**Figure 3. Startup Sequence**

## Data Display, Viewing the Gas Measurement

Measurements and calculations are presented in the Data Display screen. The Data Display appears once the Startup sequence is complete. Except for the Model 6020 (O<sub>2</sub>), gas concentrations are presented in PPM (parts per million) or mg/m<sup>3</sup> (milligrams per cubic meter). Refer to the section below for instructions on changing the units of measurement.

### Changing the Gas Measurement Units (*not* CA-6020, 6070)

Units of gas concentration are changeable. Parts per million, PPM, or milligrams per *standard* cubic meters, mg/m<sup>3</sup> or percent (CA-6060) can be presented on your instrument Data Display. **Note:** mg/m<sup>3</sup> is referenced to 0 deg. C and 760 mm Hg.

To change units, press the ENTER button. Use the ARROW buttons to and scroll to UNITS. Press ENTER. Select either PPM or mg/m<sup>3</sup>. Press ENTER. The figure below outlines steps for changing units.

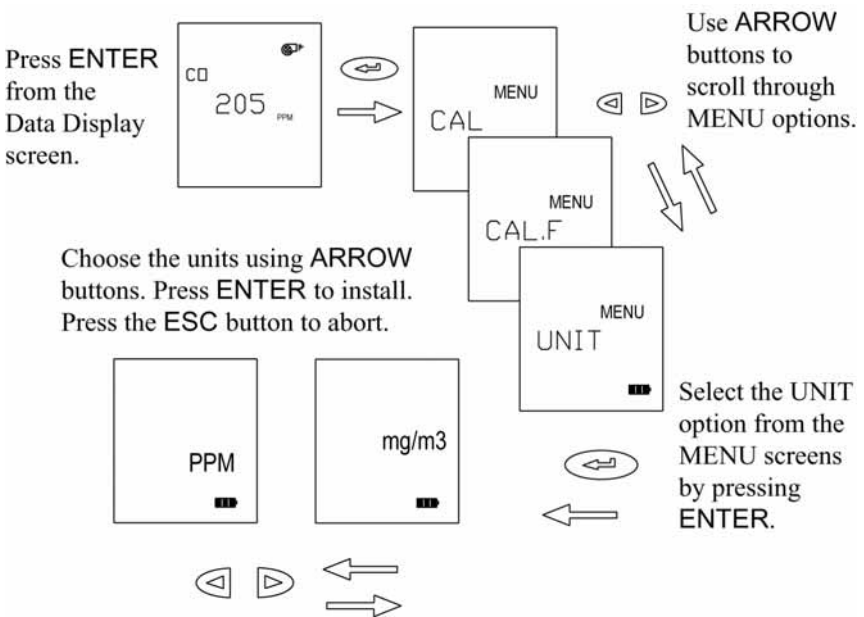


Figure 4. Choosing Display Units

## Making Gas Measurements

Your instrument is ergonomically designed to be held in the left hand. The sampling probe is held in the right, or may be mounted. If you have the protective boot option Model 801995, an attached magnet enables the instrument to be mounted vertically to the metal side of your appliance, for hands-free operation.

### Measurement Interval

When making gas measurements, keep the measurements short. Although the instrument is capable of measurements lasting many minutes, the gas sensors are designed for discrete sampling applications. When high gas concentrations are measured for extended periods, chemical filters in the sensor are used up prematurely. The chemical filters remove *interfering* gases that can cause false readings, influencing the accuracy and lifetime of the sensor. In addition, soot and moisture will plug the water-stop filter, reducing or stopping the gas flow.

*Note: To reduce sensor exposure to gas and to reduce build up of water vapor in the sampling lines and water trap, turn the pump off when not making measurements.*

### Operating Temperature

Best results are obtained if the CA-CALC single gas monitor is allowed to stabilize at the temperature of the test environment before using.

### Plugged Water-Stop Filter

A significant change in the sound of the pump may indicate a plugged water-stop filter. If plugging is suspected, refer to the appropriate heading in the Maintenance section of this manual.

### High Temperature Measurements

When sampling from high temperature, leave at least four inches between the plastic handle of the probe and the outside edge of the flue. The stainless-steel sampling probe is a poor heat conductor, and following the four-inch rule above, temperatures as high as 700 degrees centigrade (1290°F) can be measured without damaging the probe handle.

# Chapter 6

## Gas Sensor Calibrations

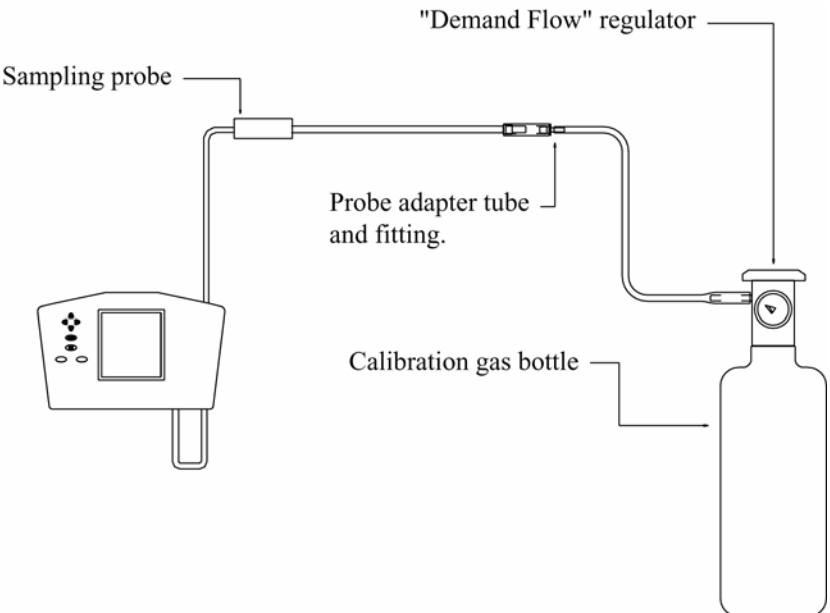
---

### Calibration Equipment Setups

Gas sensors can be calibrated periodically to maintain the best accuracy. Gas sensors do drift over time, depending upon the operating environment and gas sensor's exposure history.

With the proper equipment, such as that shown in Figures 5 and 6 below, it is easy to calibrate your CA-CALC gas sensor. If you wish, you may also return your instrument to TSI for a new *factory* calibration, or purchase a new factory calibrated sensor.

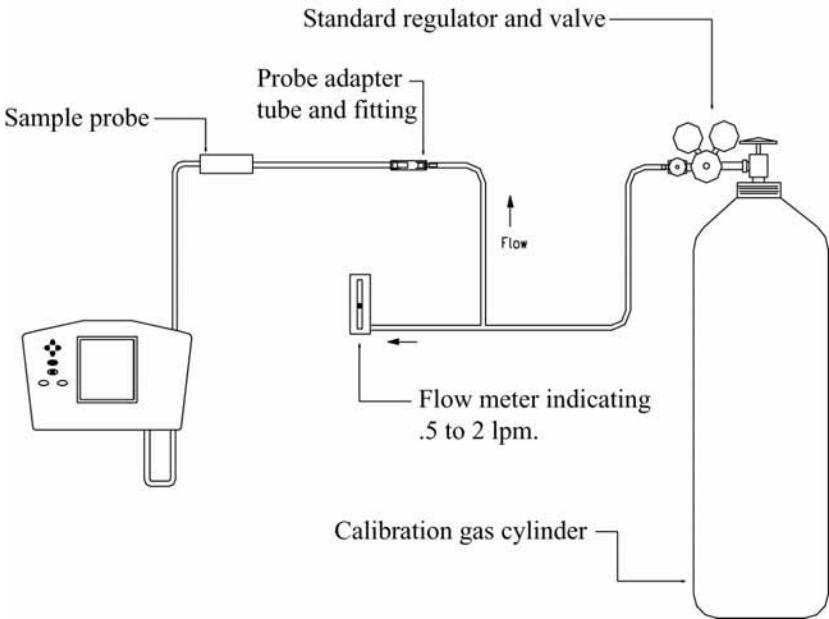
The equipment needed to calibrate individual gas sensors can be purchased from TSI as calibration kits, or you may elect to put together your own calibration system. Model numbers for TSI sensor calibration kits are found in Chapter 2, "Unpacking." Two calibration setups are presented in Figures 5 and 6. A brief discussion of these calibration setups is presented in the following section.



**Figure 5. Calibration with TSI Calibration Kit**

A TSI supplied calibration kit (Figure 5) uses a *Demand Flow* regulator to supply gas to the CA-CALC analyzer in response to the draw of the instrument sampling the pump. If a conventional regulator and valve are used (Figure 6), the setup supplies gas to the instrument using a tee to a vent extra gas. This prevents a forced flow at the instrument inlet. The bead-type flow meter depicted in the figure is used to verify there is extra flow (.5 to 2 LPM recommended). Extra flow is required to prevent room air from being drawn in, diluting the sample.

Once you have assembled the appropriate hardware described, follow the steps in the next section to perform the gas sensor calibration.



**Figure 6. Alternative Calibration Setup**



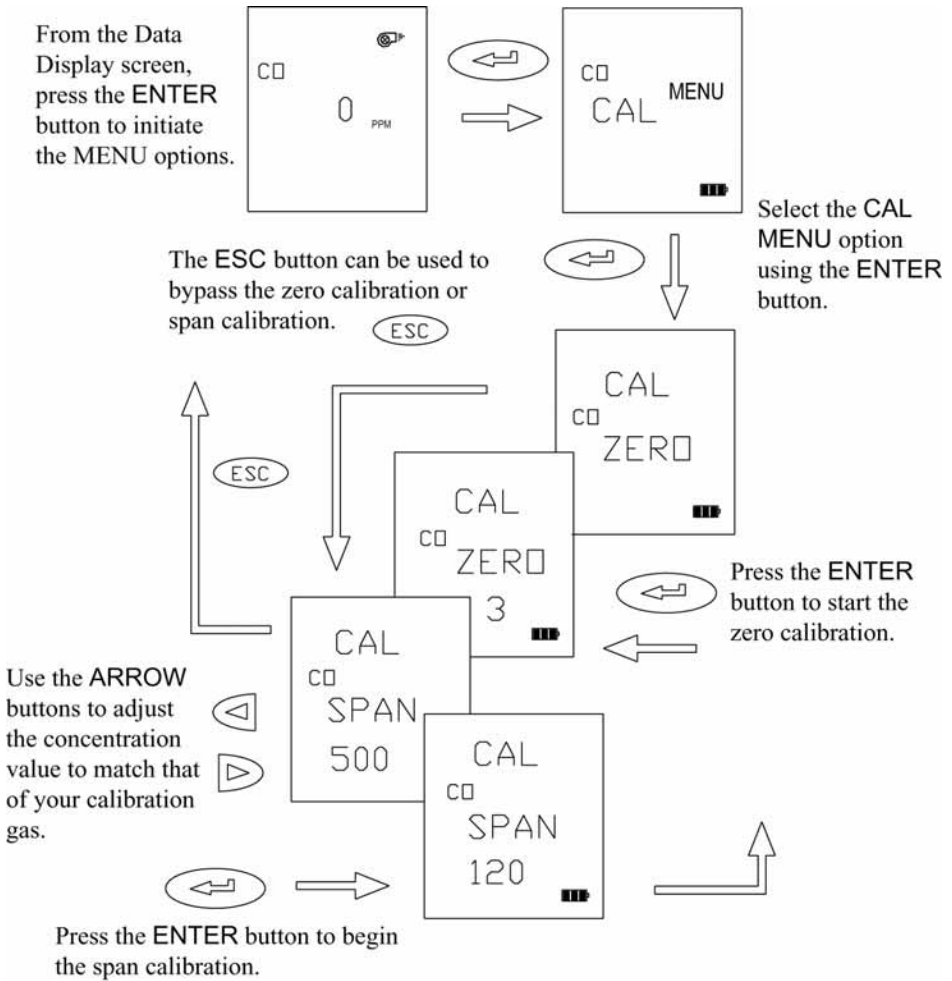
## CAL MENU Option, Sensor Calibration

The CAL option is used for performing calibration of the gas sensor. A schematic showing the button operations and screen displays for sensor calibration is shown in Figure 7. The calibration procedures are also described below.

1. To begin, press the ENTER button from the Data Display screen. The CAL screen appears. CAL is one of three MENU options selectable using the ARROW buttons (reference Figure 4).
2. Press the ENTER button when CAL is displayed. The word ZERO indicates that the sensor voltage is first read, without calibration gas.
3. Unless calibrating an O<sub>2</sub> sensor (Model 6120), disconnect the sampling line so only room air is sampled. If you *are* calibrating an O<sub>2</sub> sensor, connect your N<sub>2</sub> (nitrogen) calibration bottle to the sampling probe (refer to Figures 5 or 6).
4. Press ENTER to start the ZERO calibration. Wait for the countdown to finish.
5. When the zero calibration is complete, SPAN is indicated on the display. SPAN indicates that the voltage will be measured in the presence of your calibration gas. For O<sub>2</sub>, this means the surrounding ambient air.
6. Connect your calibration gas to the sampling probe as shown in Figures 5, and 6 described earlier. If calibrating an O<sub>2</sub> sensor, *disconnect* the N<sub>2</sub> gas bottle.
7. Use the ARROW keys to adjust the SPAN value to match that of your calibration gas. For O<sub>2</sub> this is 20.9%, the ambient air concentration.
8. Press ENTER to start the SPAN calibration. Wait for the countdown to complete.
9. If an error code appears, the initial calibration value will be reinstalled. Refer to Appendix A.

**Notes:** ■ *Pressing the ESC button will bypass either the ZERO or SPAN calibration.*

■ *When the calibration is complete, the calibration factor automatically changes to reflect the new calibration. For more on the calibration factor refer to the CAL.F section in the Maintenance chapter.*



**Figure 7. Gas Calibration Button Sequence. Example, CO Gas Monitor Model 6010.**

# Chapter 7

## Maintenance and Troubleshooting

---

### Water-Stop Filter Plugging

When water comes in contact with the water-stop filter (Figure 2), it reduces or stops flow to the gas sensor. If this occurs, the filter needs to be dried out or replaced.

Check for a plugged flow by blocking the end of the probe with your thumb. Listen for a lowering of the pump frequency. If no change in tone occurs, your filter is probably already plugged. Disconnect the sampling probe from the instrument. The pump sound should change, increasing in frequency. Change the filter, setting the plugged filter aside to dry. If filter plugging is a continuing problem, a TSI Model 801997 Water Trap is recommended.

### Changing the Water-Stop Filter

1. Refer to Figure 2.
2. Remove the sample tubing from the instrument sample port.
3. Remove this tubing from the filter and save.
4. Twist the fitting on the end of the filter counterclockwise to separate the filter from the fitting. Set the filter aside to dry, or discard if clearly dirty.
5. Replace with a new filter. Connect the fitting and replacing the short tubing.

### Cleaning the Sample Probe

Cleaning may be necessary in high-soot environments. Soot accumulates in the steel sampling tube and sampling line and over time may contribute to a blocked flow path. It is assumed that an optional water trap is present. The Water-stop filter supplied standard will not perform in environments where high levels of particulate material (soot) are present.

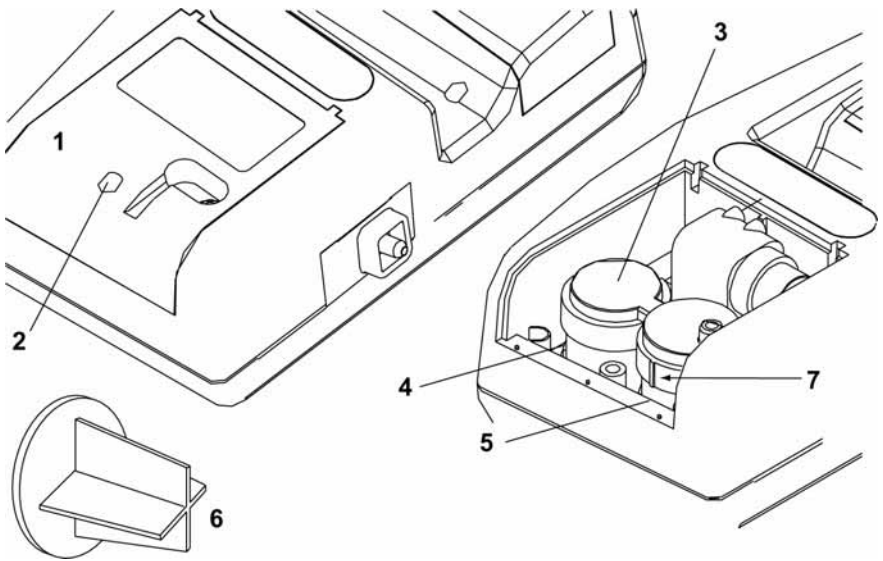
1. Disconnect the sampling probe from the instrument.
2. Remove the water-stop filter or remove the optional Water Trap (if installed) by separating the sample tube from the tube stub on each end of the trap.
3. Rinse the tubing, allowing the water to drain from the probe end. When the water is clear, discontinue the rinse. Orient the probe and tubing so excess water drains from the sample lines.

4. Allow adequate time for the interior of the probe to dry. Replace the water trap making sure the water trap is oriented properly. The filter must be toward the instrument.

## **Adding or Replacing a Gas Sensor**

### **Changing the CO Sensor (Model 6010)**

1. Remove the sensor cover shown in Figure 9, by removing the sensor cover screw (2).
2. Carefully lift the rubber sensor manifold (3) from the sensor and bend it back. *Do not* attempt to remove the rubber manifold from the case!
3. Pull the sensor, together with the foam gasket, out of the instrument.
4. Remove the gasket from the sensor.
5. Replace the gasket in the rubber sensor manifold (3) by aligning the notch in the gasket with the tab on the manifold (7).
6. Install the new sensor by aligning the pins on the sensor with those on the instrument electronics board.
7. Replace the sensor manifold, pushing the foam gasket over the new CO sensor until it is fully seated. Replace the sensor cover and cover screw.
8. Find your calibration factor sheet included with your new sensor. Enter the new calibration factor as described in the section “CAL.F MENU Option” later in this chapter.



- |   |   |
|---|---|
| 1. Sensor Cover                                   | 5. Other sensors                        |
| 2. Sensor retaining screw                         | 6. Dummy sensor plug                    |
| 3. Rubber sensor manifold                         | 7. Manifold Tab for CO gasket alignment |
| 4. O <sub>2</sub> sensor position<br>(Model 6020) |   |

**Figure 9. Removing and Replacing a Gas Sensor**

### Changing Other Sensors

1. Remove the sensor cover shown in the figure above, by removing the sensor cover screw.
2. Carefully lift the rubber sensor manifold from the sensor(s) and bend it back. *Do not* attempt to remove the rubber manifold from the case!
3. Remove sensor from the instrument. Leaving the dummy sensor plug in place.
4. Install the new sensor by aligning the pins on the sensor with those on the instrument electronics board. If you have an oxygen sensor (Model 6020), install the sensor in position number 4 shown in Figure 9. All other sensors are installed in position 5.

*Note: For the oxygen sensor match the + indication on the sensor with the + pin receptacle on the electronics board.*

5. Replace the sensor manifold, pushing the manifold cup over the new sensor, until it is fully seated.

- Find your calibration factor sheet included with your new sensor. Enter the new calibration factor as described in the section “CAL.F MENU Option” which follows.

### CAL.F MENU Option—Setting the Calibration Factor for a New Sensor

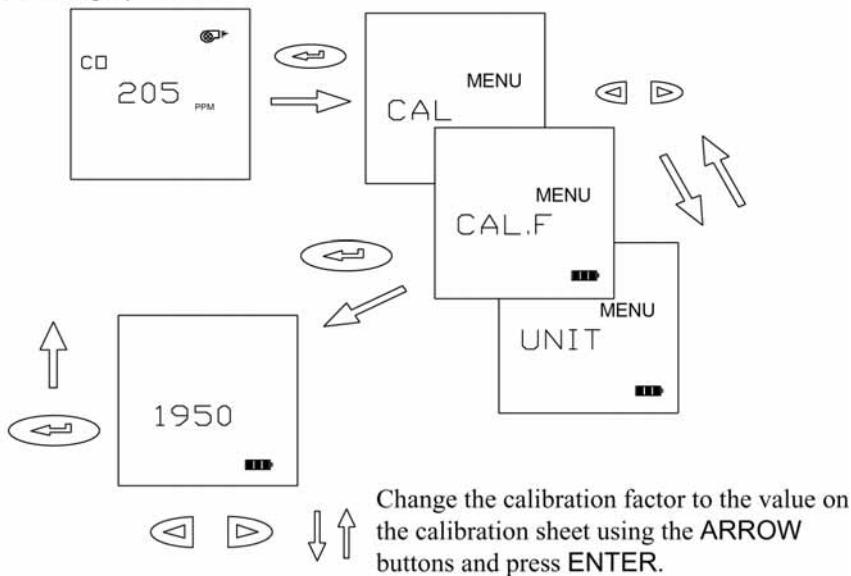
When you install a calibrated replacement sensor from TSI, you must complete the new sensor installation by entering a new calibration factor. This factor is determined by a sensor calibration at the factory.

After installing your new sensor, find the *calibration factor* sheet.

Use the MENU option CAL.F, and enter calibration factor provided. Refer to the details outlined in the schematic below.

Press the ENTER button from the Data Display to access the MENU options. Select CAL.F using the ARROW buttons, then press ENTER.

Data Display screen.



**Figure 10. Setting the Calibration Factor**

# Appendix A

## Error Codes Defined

---

---

Error code by number:

6. Lithium battery low.
9. Can't save data to EEPROM.
12. Model number checksum error.
16. A/D calibration checksum error.
17. Chem sensor checksum error.
30. O<sub>2</sub> zero voltage out of range.
31. CO zero voltage out of range.
32. CO<sub>hi</sub> zero voltage out of range.
33. NO zero voltage out of range.
34. NO<sub>2</sub> zero voltage out of range.
35. SO<sub>2</sub> zero voltage out of range.
36. Instrument temperature out of range.
37. O<sub>2</sub> span voltage out of range.
38. A/D converter calibration factor out of range.
39. A/D converter offset factor out of range.
40. O<sub>2</sub> gain factor out of range.
41. CO gain factor out of range.
42. CO<sub>hi</sub> gain factor out of range.
43. NO gain factor out of range.
44. NO<sub>2</sub> gain factor out of range.
45. SO<sub>2</sub> gain factor out of range.
70. Internal program error—contact TSI.











*TSI Incorporated*  
*500 Cardigan Road, Shoreview, MN 55126 U.S.A.*  
**Web:** [www.tsi.com](http://www.tsi.com)