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48iQ
Instruction Manual

Carbon Monoxide Analyzer

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Contents

Contents

Contents

Chapter 1
Introduction

The Thermo Scientific™ 48iQ Carbon Monoxide (CO) Analyzer utilizes gas filter correlation technology to measure the amount of carbon monoxide in the air.

The analyzer is based on the principle that carbon monoxide (CO) absorbs infrared radiation at a wavelength of 4.6 microns. Because infrared absorption is a nonlinear measurement technique, it is necessary for the instrument electronics to transform the basic analyzer signal into a linear output.

The 48iQ Gas Analyzer uses an exact calibration curve to accurately linearize the instrument output over any range up to a concentration of 10,000 ppm.

iQ Series Instrument Platform

The iQ Series Instrument Platform is a smart environmental monitoring solution for ambient and source gas analysis that affords greater control over instrument performance and data availability.

- Distributed Measurement and Control (DMC) module design simplifies serviceability. Each DMC module contains its own microprocessor control enabling functional performance validation at the module level.

- Built-in predictive diagnostics and preventive maintenance schedules identify problems before they occur. The iQ Series platform sends email notifications directly to Thermo Fisher Scientific's world class service support team or locally identified addressees in order to proactively communicate analyzer performance conditions and identify spare parts needs before an operational concern arises.

- The iQ Series platform supports Modbus, streaming and VNC protocols over serial and Ethernet as well as analog and digital I/O for easy integration into most data management systems.

- Three standard USB ports afford convenient data download capability as well as the ability to connect additional hardware, such as a computer keyboard or mouse.

● The iQ Series GUI runs on a 7" color touchscreen display. The GUI is highly flexible and can be customized to enable a tailored experience to simplify daily operations. Custom designed ePort software allows remote access to the analyzer with a PC. The ePort control mirrors the same GUI look and feel as the instrument touchscreen providing a speedy and familiar operational experience.

Figure 1–1. 48iQ Front

48iQ Principle of Operation

The 48iQ operates on the principle that carbon monoxide (CO) absorbs infrared radiation at a wavelength of 4.6 microns. Gas Filter Correlation (GFC) is a particular infrared technique that selectively measures light absorption uniquely due to CO by the ratio of sample-absorbed light to a filtered reference measurement. Light from a broadband infrared source passes through a gas filter wheel alternating between N_2 and CO filled cells and passes through a narrow bandpass interference filter before passing into the volume containing sample gas. Light that passes through the N_2 cell is absorbed by CO in the sample gas normally as the *sample* signal; light that passes through the CO cell is already blocked where CO absorbs, and so is unchanged by sample CO as the *reference*. The ratio of "sample" to "reference" (S/R) is acquired at high speeds and corrects for light intensity and other changes to achieve precision measurement. Because the filtering is achieved with CO gas itself, the GFC technique is specific for CO.

The so-called "spectral resolution" of the technique is such that the measured ratio is partly but not strictly linear as predicted by the well-known "Beer's Law." The 48iQ uses an internally stored calibration curve to accurately linearize the instrument output over any range up to a concentration of 10,000 ppm.

Gas sample is drawn into the 48iQ through the rear panel of the analyzer and through the optical detection system using an embedded intake pump, as shown in Figure 1–2. Gas may be ambient, or it may be delivered from a more distant location using standard tubing connected to the rear panel. The rear panel may be a simple inlet bulkhead, or it could utilize three inlets controlled with solenoid valves: Conventionally, the three inlet configuration is used to conduct independent zero and span reference measurements.

In addition to the inlet configuration, options may be added, such as an oxygen sensor or a "zero scrubber" that catalyzes CO to CO_2 to provide a zero reference. Each of these operate within the basic gas intake pathway described above.

Figure 1–2 shows the simplest case fluid schematic. Gas is introduced into the "SAMPLE" port at near ambient pressures (we describe a flow bypass later on that assures ambient pressure sampling). It is pulled by a single stage pump through the 48 DMC Bench where CO is detected and then through a constriction (a capillary in the "Flow Pressure DMC") which regulates the flow intake to approximately 1 SLPM while monitoring and maintaining ambient pressure on the optical bench side. Note there is also a filter purge that bypasses the sampling but is also drawn by the pump downstream of the constriction. Figure 1–3 shows the example of a three inlet configuration with zero span capabilities and a zero air scrubber.
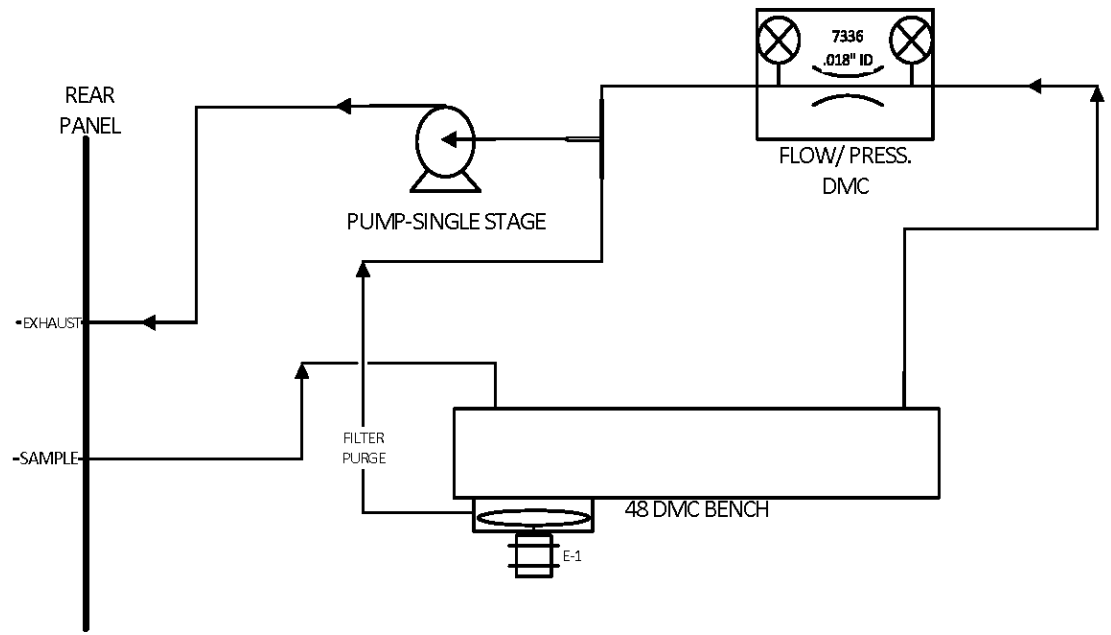
Figure 1–2. 48iQ Flow Schematic
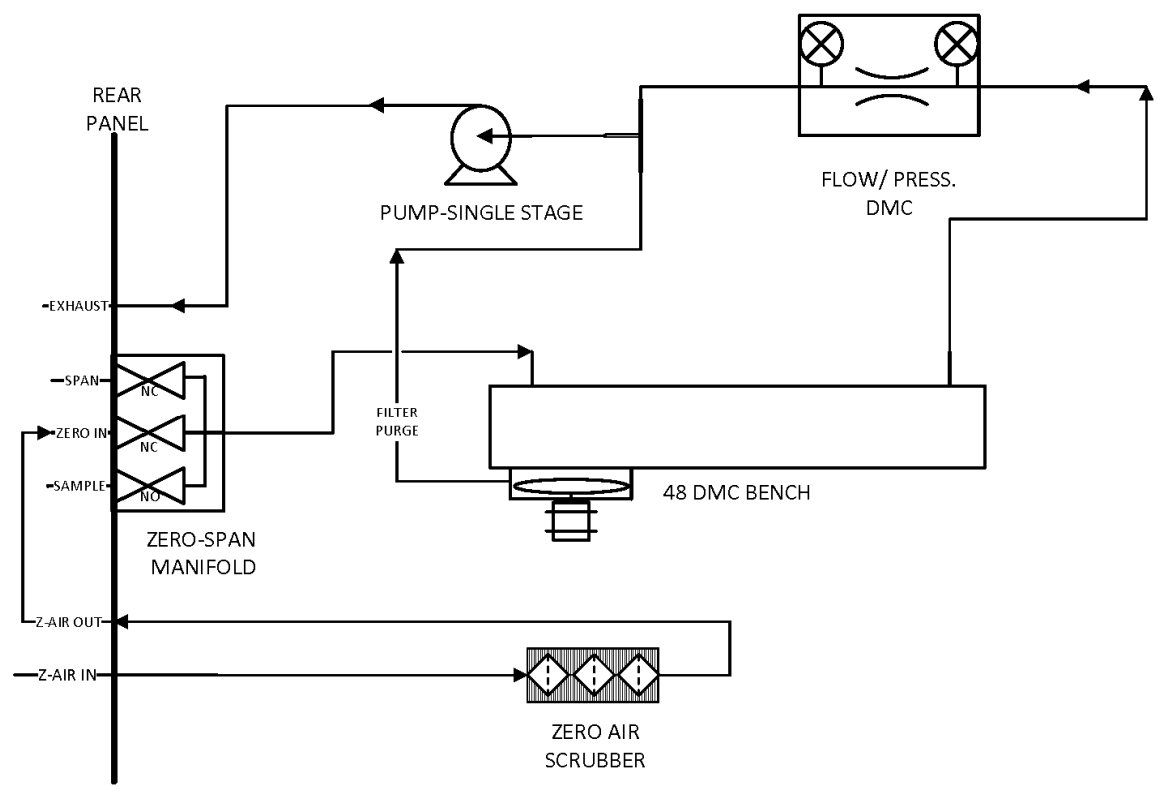
Figure 1–3. 48iQ Flow Schematic with Zero Span and Zero Air Scrubber

Specifications

Table 1–1 lists the specifications for the 48iQ.

Table 1–1. 48iQ Specifications

Range	0-10000 (ppm or mg/m^3)
Zero Noise	0.02 ppm RMS (30 second averaging time)
Detection Limit	0.04 ppm (30 second averaging time)
Zero Drift	<0.1 ppm (24 hour)
Span Drift	±0.5% reading (24 hour)
Response Time	60 seconds (30 second averaging time)
Linearity	±1% full-scale ≤ 1000 ppm
	±2.5% full-scale > 1000 ppm
Flow Rate	1.0 SLPM (1 atm inlet pressure)
Operating Temperature Range	5–45 °C (may be safely operated over the range of 0–45 °C)
Power Requirements	100–240 VAC 50/60 Hz
	275 watts
Physical Dimensions	24 in (D) x 16.75 in (W) x 8.72 in (H) [609 mm (D) 425.45 mm (W) x 221.48 mm (H)]
Weight	34.3 lbs
Analog I/O	4 Isolated Voltage Inputs 0–10 V
	6 Isolated Analog Voltages Outputs, with 4 selectable ranges
	6 Isolated Analog Current Outputs, with 2 selectable ranges
Digital I/O	16 Digital Inputs (TTL)
	8 Solenoid Driver Outputs
	10 Digital Reed Relay Contact Outputs
Serial Ports	1 RS-232/485 port
	1 RS-485 External Accessory port
Other Ports	3 Full Speed USB ports (one in front, two in rear)
	1 Gigabit Ethernet port
Communication Protocols	MODBUS, Streaming, Bayern Hessen
Approvals and Certifications	CE, TUV-SUD Safety, EPA

Table 1–2. 48iQ Optional Internal Oxygen Sensor Specifications

Technology	Paramagnetic
Range	0-100% O_2
Accuracy (Intrinsic error)	<±0.1% O_2
Linearity	<±0.1% O_2
Repeatability	<±0.1% O_2
Zero Drift	<±0.2% O_2 per month (excludes up to 0.1% O_2 in the first 24 hours of operation)
Response Time (T_{10}-T_{90})	<2.5 seconds
Weight	Approximately 2 lbs. (in addition to standard instrument)

Dimensions
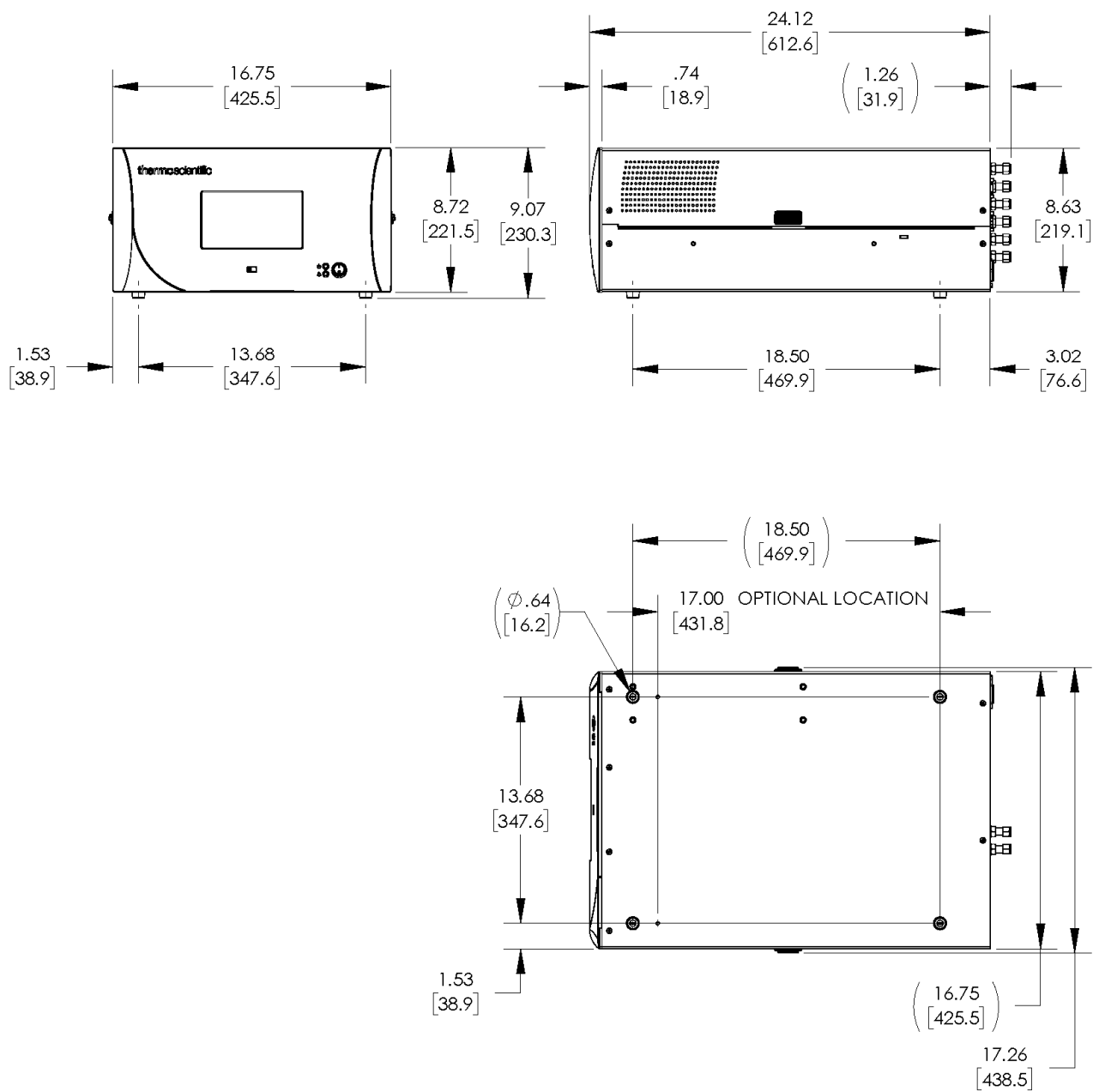
Figure 1–4. Bench Mount Assembly (dimensions in inches [mm])
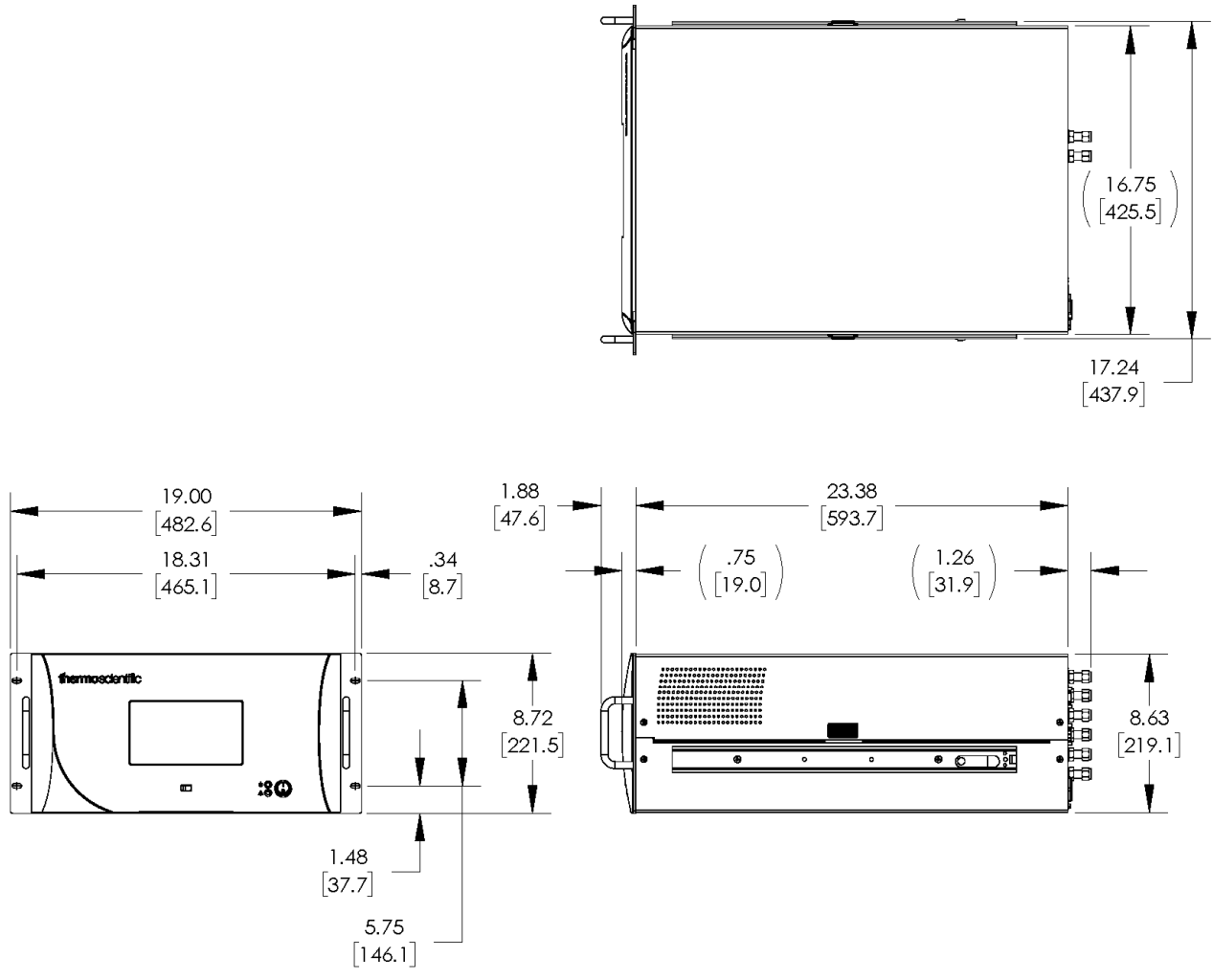
Figure 1–5. Rack Mount Assembly (dimensions in inches [mm])
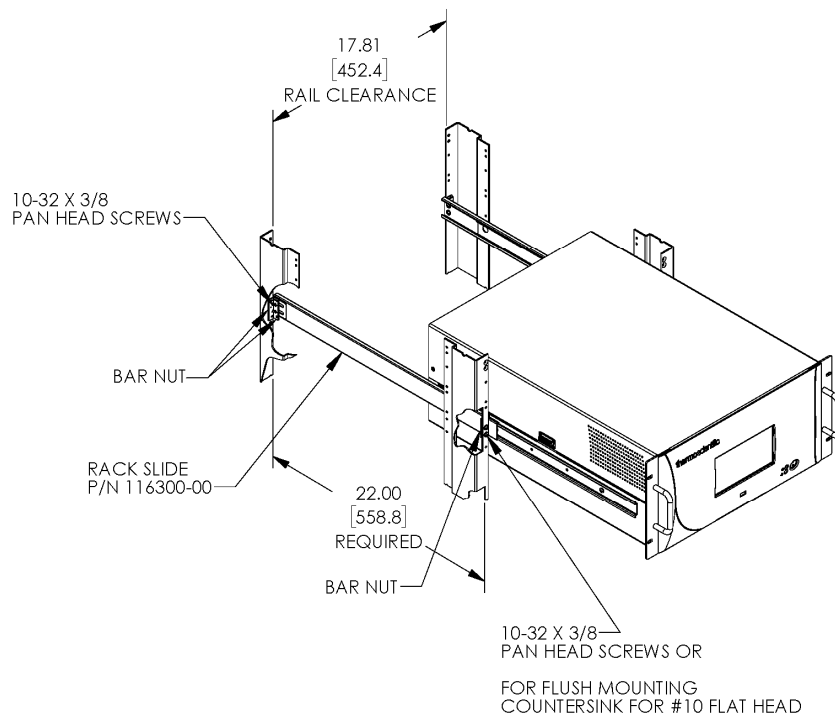
Figure 1–6. Rack Mount Requirements
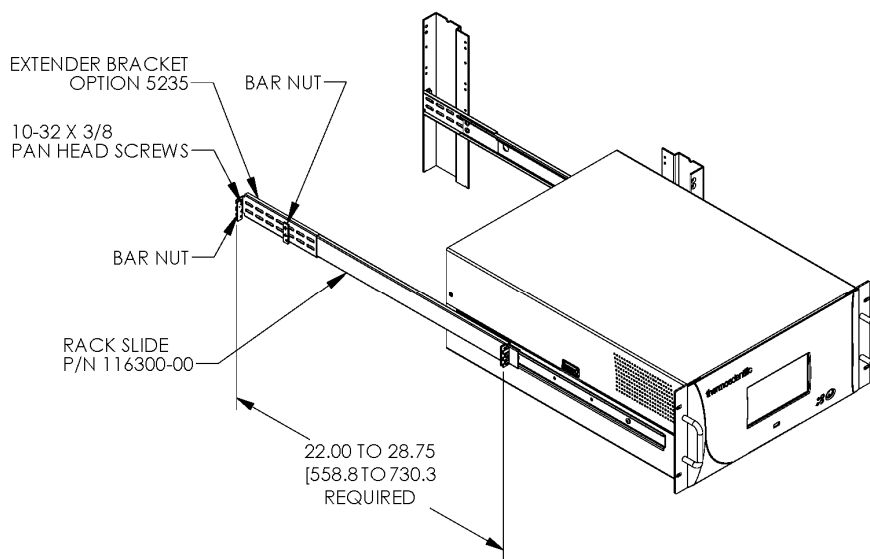
Figure 1–7. Rack Requirements Part 2

Chapter 2
Installation and Setup

Installation and Setup describes how to unpack, setup, and start-up the instrument. The installation should always be followed by instrument calibration as described in the "Calibration" chapter of this manual.

⚠️ **Equipment Damage** Do not attempt to lift the instrument by the cover or other external fittings. ▲

Unpacking and Inspection

The 48iQ is shipped complete in one container. If there is obvious damage to the shipping container when you receive the instrument, notify the carrier immediately and hold for inspection. The carrier is responsible for any damage incurred during shipment.

Use the following procedure to unpack and inspect the instrument.

1. Remove the instrument from the shipping container and set it on a table or bench that allows easy access to both the front and rear.

2. Remove the cover to expose the internal components. (See "Figure 2–1" on page 2-2.)

3. Check for possible damage during shipment.

4. Check that all connectors and circuit boards are firmly attached.

5. Re-install the cover.

6. Remove any protective plastic material from the case exterior.

Cover Removing and Replacing

Use the following procedure to remove and replace the cover.

Equipment required:

Phillips screwdriver, #2

1. Unfasten the four 8-32 screws securing the cover (shipping screws).

2. Press in both latches located on top cover and hold while pulling up to remove. Set upright.

UNFASTEN
4X SCREWS
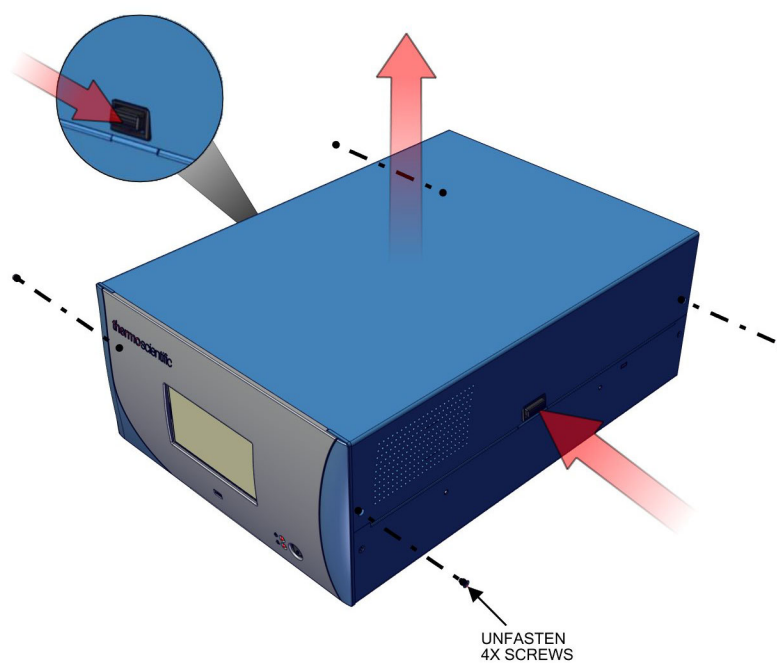
Figure 2–1. Removing the Cover

3. To replace, align cover and drop in. Latches will automatically snap in place.

Mounting Options

The instrument can be installed in the following configurations:

- Bench Mount
- Rack Mount

Bench Mount

Positioned on bench, includes installing feet. See Figure 2–2.

Equipment required:

Slot drive, 5/16-inch

4. Fasten feet in position 1 or 2 to fit to the desired depth.
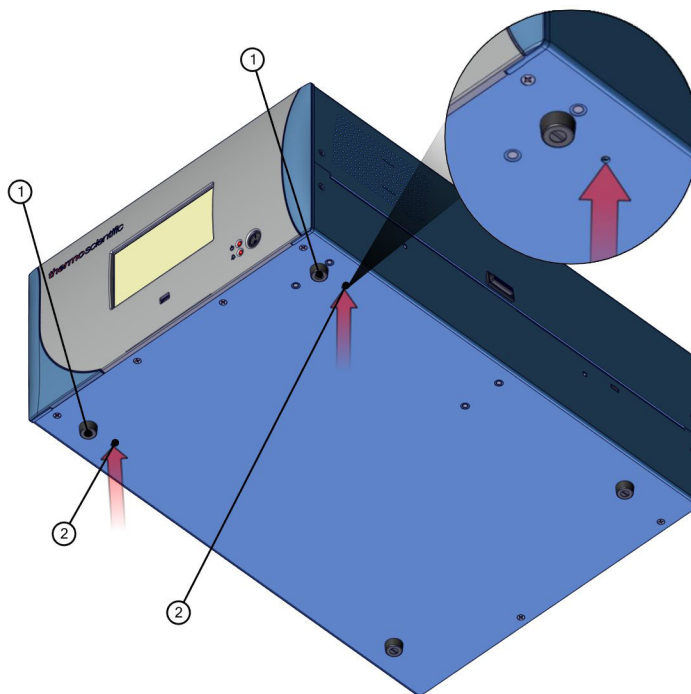
Figure 2–2. Installing Feet

Rack Mount   Mounting in a rack includes removing the front panel and installing ears and handles.

Equipment required:

Phillips drive, #2

1. Start by gripping from the top corners of the front panel and pull outwards. See Figure 2–3.
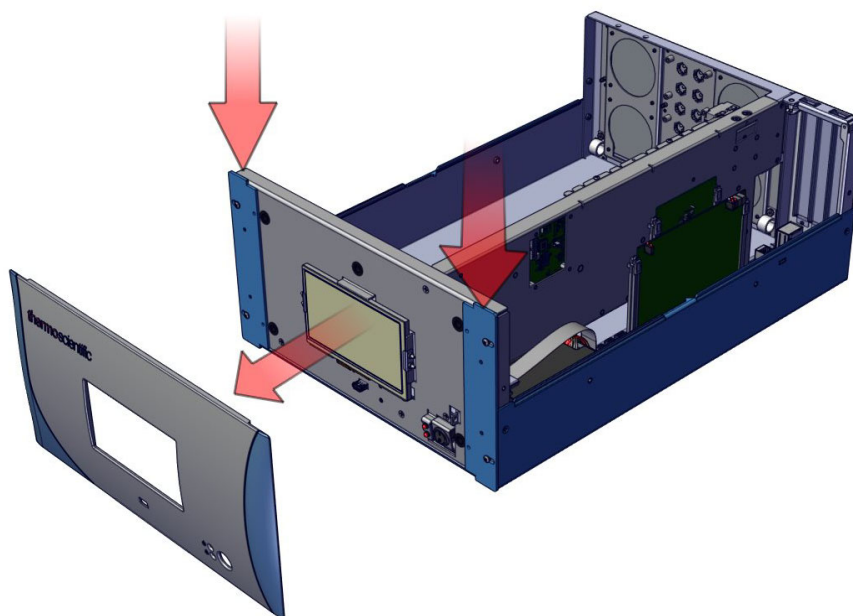
Figure 2–3. Removing the Front Panel

2. Unfasten the four 8-32 pan head screws.

3. Slide ears outwards.

4. Use the same four 8-32 pan head screws to secure it.

5. Install the handles with the four 8-32 flat head screws that came with the handle kit on the backside. See Figure 2–4.

SCREW, 8-32 X 3/16, PAN HEAD, 4X

SCREW, 8-32 X 3/16, FLAT HEAD, 4X
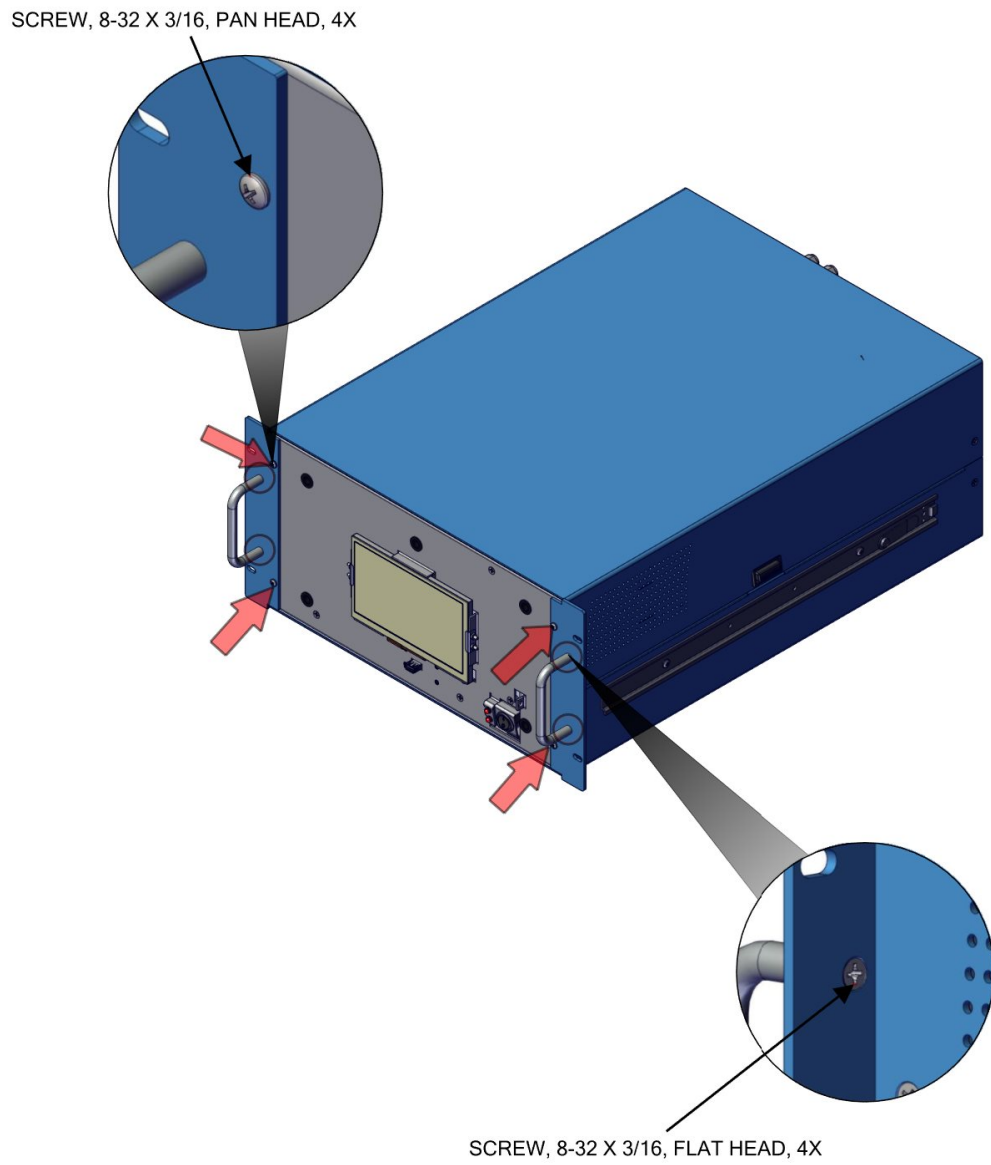
Figure 2–4. Installing Ears and Handles

Setup Procedure

Use the following procedure to setup the instrument:

1. Connect the sample line to the SAMPLE bulkhead on the rear panel (Figure 2–5). Ensure that the sample line is not contaminated by dirty, wet, or incompatible materials. All tubing should be constructed of PTFE, 316 stainless steel, borosilicate glass, or similar tubing with an OD of 1/4-inch and a minimum ID of 1/8-inch. The length of the tubing should be less than 10 feet.

   Note Gas must be delivered to the instrument free of particulates. It may be necessary to use the PTFE particulate filter as described in "PTFE Particulate Filter" on page 9-18. ▲

   Note Gas must be delivered to the instrument at atmospheric pressure. It may be necessary to use an atmospheric bypass plumbing arrangement as shown in Figure 2–6 if gas pressure is greater than atmospheric pressure. ▲

2. Connect the EXHAUST bulkhead to a suitable vent. The exhaust line should be 1/4-inch OD with a minimum ID of 1/8-inch. The length of the exhaust line should be less than 10 feet. Verify that there is no restriction in this line.

3. The analyzer is pre-configured to internally purge the filter wheel. If an external purge is desired, a purge kit is included to allow the user to install the feature. To install plumbing to support the external purge, the following steps need to be implemented.

   a. Pop out the filler late in the 'Purge' position on the rear panel and install the bulkhead fitting circled in red in Figure 2–7.

   b. Detach the connection from the pump to the purge fittings, and use the included tubing to make the connection shown in Figure 2–7.

4. If the external purge feature is installed, connect a source of pressurized clean dry zero air or a non-toxic inert gas at 10 psig to the purge fitting for use as the Filter Wheel Purge gas. The Filter Wheel Purge is described more fully on page 8-2.

5. If the optional zero/span solenoid valves are installed, connect a source of CO-free air to the ZERO IN bulkhead, and connect a source of CO span gas to the SPAN bulkhead.

6. Connect a suitable recording device to the rear panel connector. For detailed information about connecting to the instrument, refer to:

   "Connecting External Devices" on page 9-1

   Communications > "Analog I/O" on page 3-57, and "Digital I/O" on page 3-59.

7. Plug the instrument into an outlet of the appropriate voltage and frequency.

⚠ **WARNING** The 48iQ is supplied with a three-wire grounding cord. Under no circumstances should this grounding system be defeated. ▲
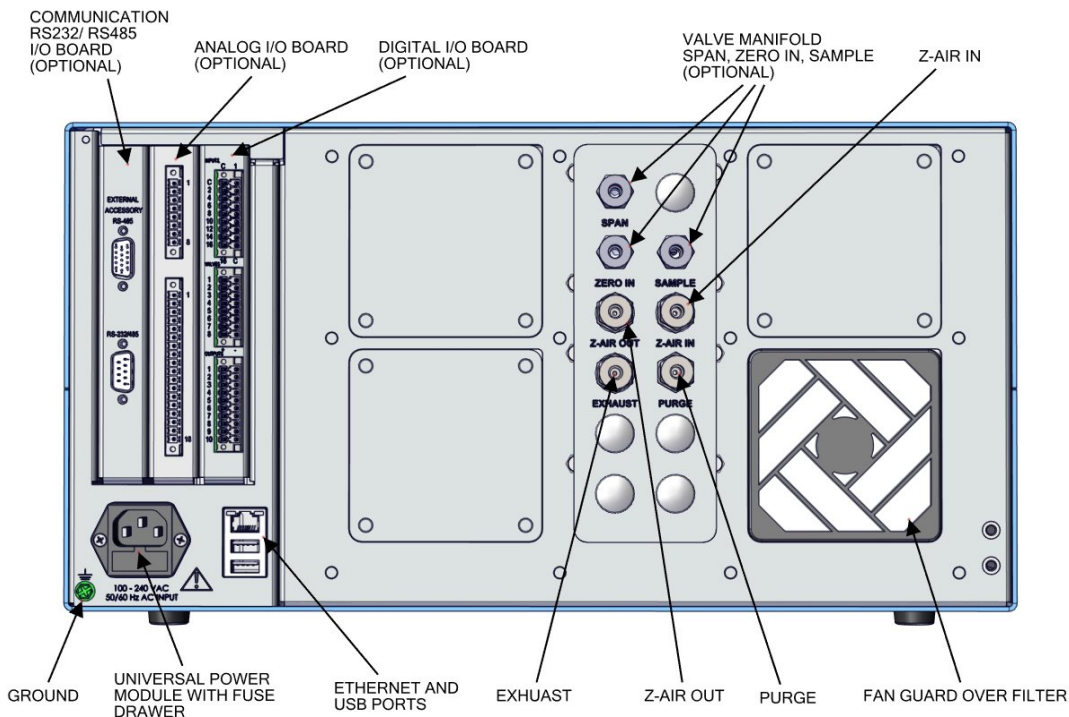
Figure 2–5. 48iQ Rear Panel
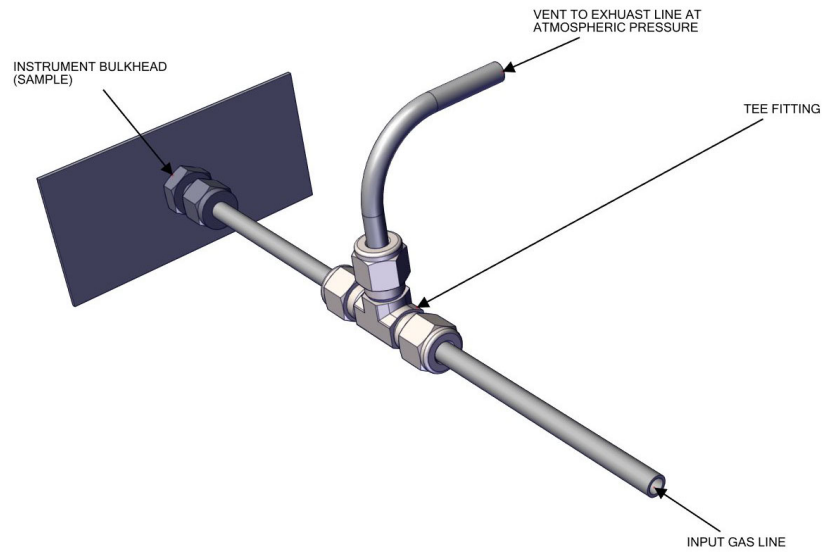
Figure 2–6. Atmospheric Dump Bypass Plumbing
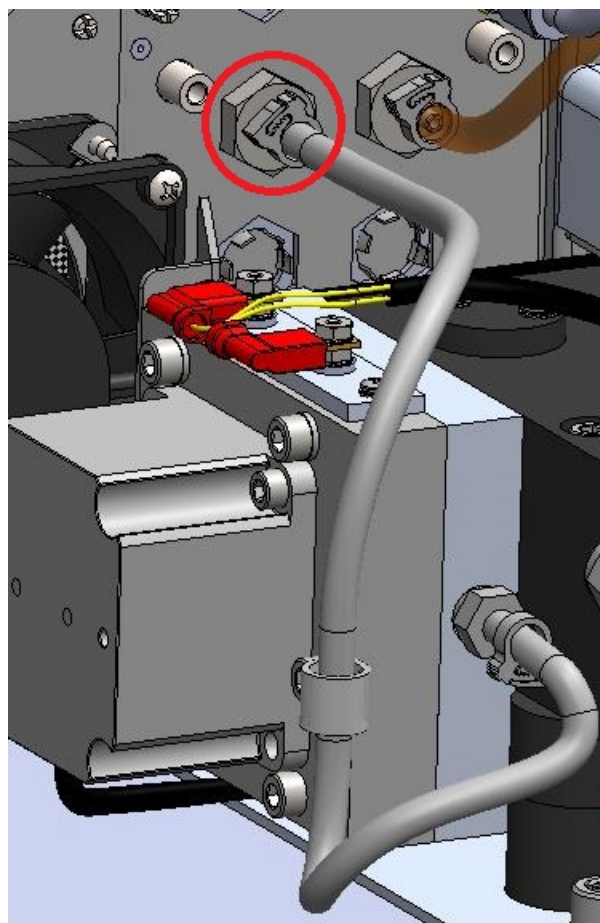
Figure 2–7. External Purge Plumbing

Startup

Use the following procedure when starting the instrument.

1. Turn the power ON.

2. Allow 90–120 minutes for the instrument to stabilize. During the time that the instrument is warming up, the mode "warm up" is displayed on the gas mode button in the title bar, and the concentration calculation is turned off. To disable warm up, go to Settings>**Configuration**.

3. Set instrument parameters such as operating ranges and averaging times to their appropriate settings. For more information about instrument parameters, see the "Operation" chapter.

4. Before beginning the actual monitoring, perform a multipoint calibration as described in the "Calibration" chapter.
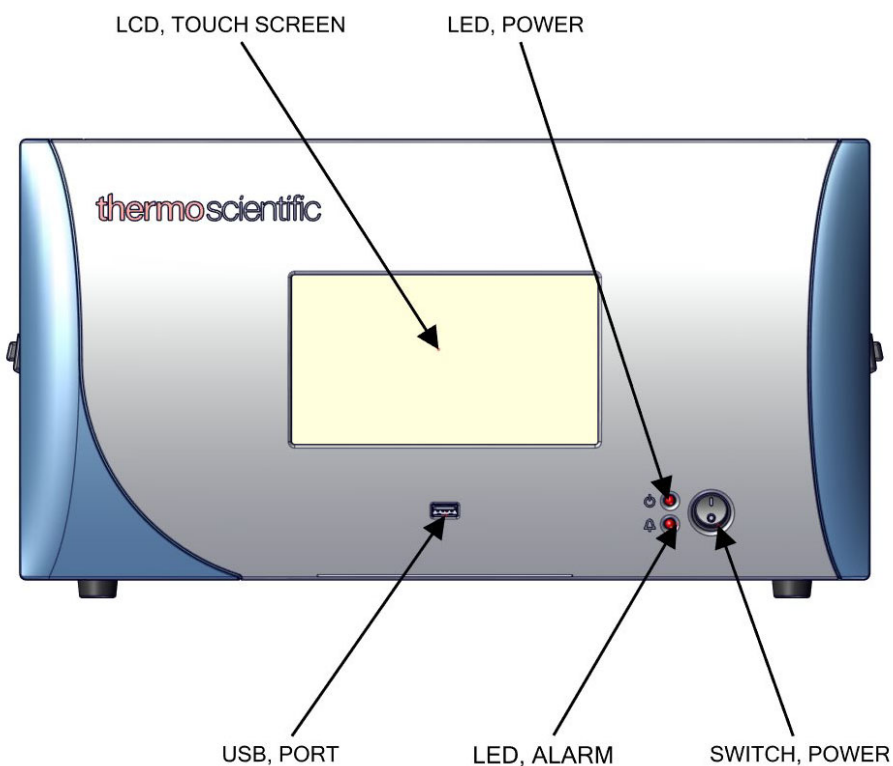
Figure 2–8. Front Panel and Touchscreen Display

Chapter 3
Operation

This chapter describes the functionality of the touchscreen user interface.

Instrument Display

The Instrument Display consists of a Title Bar, a User Interface, and a Status Bar. The Title Bar, located at the top, includes the Home button, instrument name, instrument gas mode, and Help button. The User Interface, located in the middle, is where the Home Screen and all other screens are accessed. The Home Screen has three Main Menu buttons, located on the left side, which include Calibration, Data, and Settings, while the user interface to the right of the buttons displays the chemical name(s), concentration value(s) and unit(s). The Status Bar, located at the bottom, includes the Back button, Access Levels, Health Check, Favorites, Date and Time, and Contact Information.

Home Screen (single range mode with O_2 option)
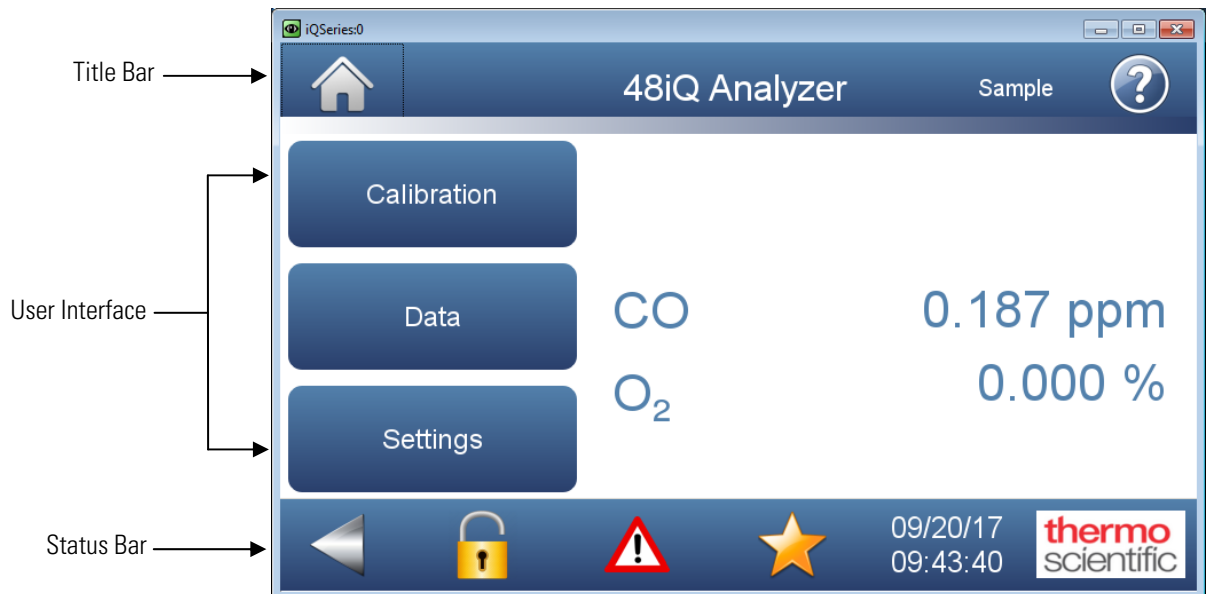
Home Screen (dual or auto range mode with O₂ option)

The Instrument Display contains the following information:

- Title Bar:

  - *Home button:* When pressed, it brings you to the Home Screen.

  - *Title Text:* Displays instrument name when in the Home Screen. Displays the chemical name, current concentration reading and unit when in all other screens. When unit is pressed, it brings you to the gas unit selection screen.

  - *Gas Mode button:* Displays current gas mode of the instrument. When pressed, it brings you to the Gas Mode selection screen.

  - *Help button:* When pressed, it brings you to the help screens.

- User Interface:

  - *Calibration button:* Allows the user to calibrate the instrument, setup automatic calibrations, and view calibration data.

  - *Data button:* Allows the user to view, graph, stream, and analyze data.

  - *Settings button:* Shows real-time status and alarms, also predictive diagnostics and maintenance history. Contains controls for operating the instrument, communications, and sets instrument options.

  - *Concentration*: When in single mode, displays CO concentrations in big, bold characters, depending on operating mode. When in dual or auto mode, displays either high range or low range values based on the range setting.

- Status Bar:

  - *Back button:* When pressed, it displays the previous screen.

  - *Access Levels button:* Allows the user to set security access levels, and allows/restricts access to functionality depending on the selected access level.

  - *Health Check button:* Brings the user to the Health Check screen.

  - *Favorites button:* Allows user-selectable favorite buttons. To add to the favorites screen, user presses the desired screen button for 2 seconds. The user will be directed to the favorites screen where the user chooses the button position. To remove a favorite button from the favorites screen, press and hold button for 2 seconds.

  - *Clock:* Displays current date and time.

● *Thermo Scientific Information button:* Shows contact information.

Main Menus and Keypads

The Main Menu buttons, located on the Home Screen, contains three submenus. Each submenu contains related instrument settings. This chapter describes each submenu and screen in detail. Refer to the appropriate sections for more information.

Calibration	Data	Settings

Calibrate Background

Calibrate Span Coefficient

Zero/Span Schedule

Calibrate O2 Span Coefficient (Optional)

Advanced Calibration
- Manual Calibration
  - Adjust Background
  - Adjust Span Coefficient
  - Reset Bkg and Span Coef
- Mulitpoint Calibration
- Manual O2 Calibration (Optional)
- 2-Point O2 Calibration (Optional)
- Calibration History

View Data Log (Last Hour)
- Graph

View Data Log (Last 24 Hours)
- Graph

View Data (User Defined Time)
- Start Time
  - End Time – View Data
    - Graph

Advanced Data
- Data Logging Setup
- Streaming Data Setup

Health Check
- Status and Alarms
- Predictive Diagnostics
- Maintenance
- File Sharing and Support
- iQ360
- Firmware Version

Measurement Settings
- Averaging Time
- Range Mode Selection
- Range Setting
- Gas Mode
- Gas Units
- Dilution Ratio
- Advanced Measurement
  - Optical Bench Settings
  - Compensation
  - Pressure Calibration

Communications

Instrument Settings
- Display Setup
- Alarm Setpoints
- Language
- Clock
- Pump Power
- Reboot Instrument

Configuration

Security Access Levels

USB Drive
- Firmware Update Via USB Drive
- Download Data to USB Drive
- Change USB Password

User Contact Information

Update Bootloader

Numeric Keypad   User enters a value into the box using the number keypad. When the user needs to change a value, such as for flow rates, temperatures or pressures, the keypad screen will automatically display. Initially, the box above the keypad will display the current value. Enter a new value using the keypad, and then select the **Enter** button to set the new value or press the **Cancel** button to exit the keypad screen and return to the previous screen without saving the value.
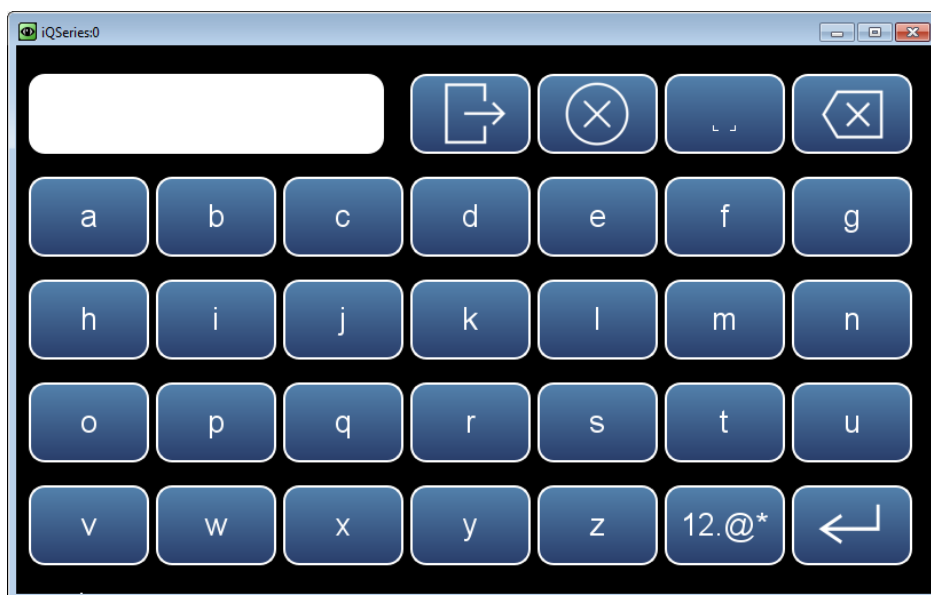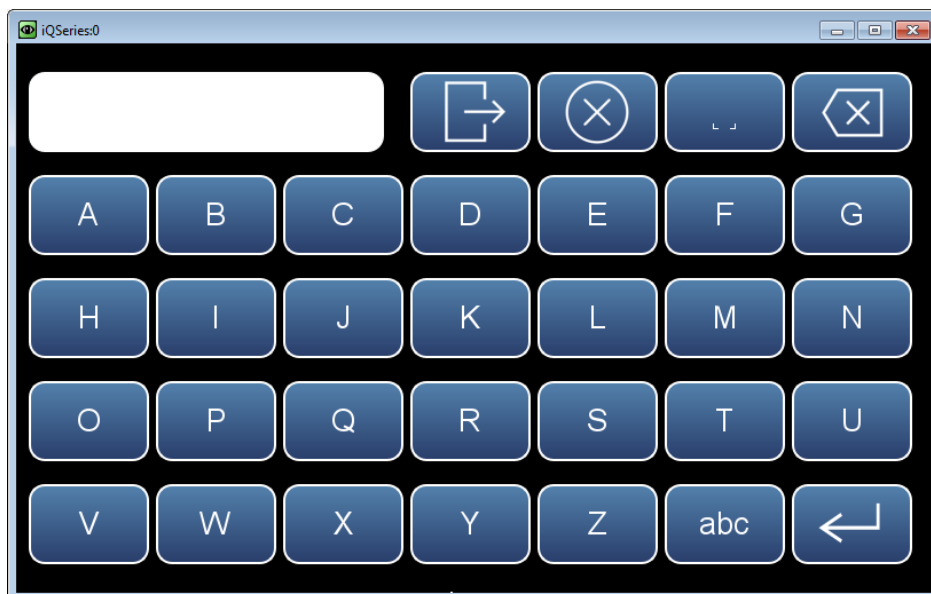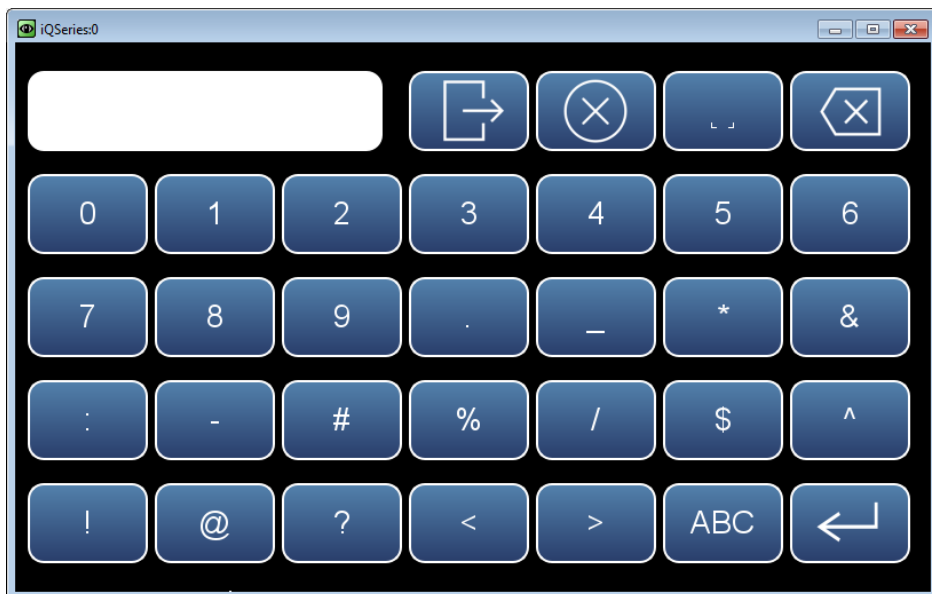
Calibration

The Calibration screen allows the user to calibrate the system, setup automatic calibrations, and view calibration data. See Chapter 4 "Calibration" for further instructions on how to run a calibration.

The following screens show the calibration screens in single range mode and dual or auto range mode. (The only difference between the screens, are the words "High Range" and "Low Range".) The dual and auto range modes have two CO span coefficients (high and low). This allows each range to be calibrated separately. This is necessary if the two ranges used are not close to one another. For example, a low CO range of 50 ppm and a high CO range of 1000 ppm. For more information about range modes, see "Range Mode Selection" on page 3-76.

Home Screen>Calibration (single range mode with O$_2$ option)

Calibrate Background 0.493 ppm	Calibrate Span Coefficient 1.000	Zero / Span Schedule
Calibrate O$_2$ Span Coefficient 1.000		Advanced Calibration

Home Screen>Calibration (dual or auto range mode with O$_2$ option)
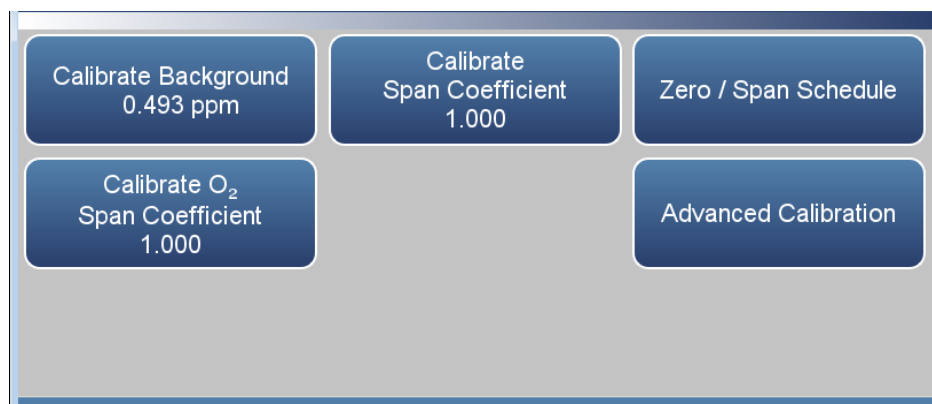
Calibrate Background 0.493 ppm	Calibrate High Range Span Coefficient 1.000	Calibrate Low Range Span Coefficient 1.000
Zero / Span Schedule	Calibrate O$_2$ Span Coefficient 1.000	Advanced Calibration

The Calibration menu contains the following information:

● *Calibrate Background:* Sets the CO reading to zero.

● *Calibrate Span Coefficient:* Sets the span coefficient when in single range mode.

● *Calibrate High Range Span Coefficient:* Sets the high range span coefficient when in dual or auto range mode.

● *Calibrate Low Range Span Coefficient:* Sets the low range span coefficient when in dual or auto range mode.

● *Zero/Span Schedule:* Programs the instrument to perform fully automated zero and span checks or adjustments.

● *Calibrate O$_2$ Span Coefficient:* When the O$_2$ Sensor option is turned on (in the Settings>Configuration screen), this button will appear. It allows an O$_2$ calibration to be performed.

● *Advanced Calibration:* Calibrates the instrument using a manual zero/span calibration, a multipoint calibration and provides calibration history.

Calibrate Background

The Calibrate Background screen is used to calibrate the instrument zero background. Before making an adjustment, be sure the analyzer samples zero air for at least 5 minutes.

It is important to note the averaging time when calibrating. The longer the averaging time the more precise the calibration results. To achieve maximum precision, allow the instrument to stabilize each time input gas is changed and set the averaging time to 300-second averaging. The Averaging Time is located at Settings>Measurement Settings>Averaging Time.

Home Screen>Calibration>Calibrate Background
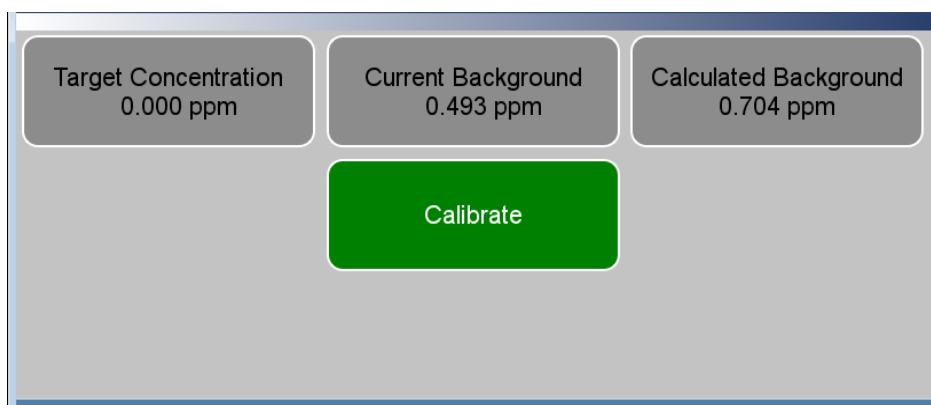
The Calibrate Background menu contains the following information:

● *Target Concentration:* Read only. Displays what the concentration value will become when the calibrate button is pressed.

● *Current Background:* Read only. Displays what the current user-set background is.

● *Calculated Background:* Read only. Displays what the current user-set background will become when the calibrate button is pressed.

● *Calibrate:* When pressed, updates the background, making the concentration go to zero.

Calibrate Span Coefficient

The Calibrate Span Coefficient screen is used to enter the span concentration and calibrate the CO span coefficient. The CO span coefficient is calculated, stored, and used to correct the current reading.

The following screens are shown in single range mode and dual or auto range mode. In dual or auto range modes, "High" or "Low" is displayed to indicate the calibration of the high or low coefficient. The Calibrate High Range Span Coefficient and Calibrate Low Range Span Coefficient screens function the same way.

It is important to note the averaging time when calibrating. The longer the averaging time the more precise the calibration results. To achieve maximum precision, allow the instrument to stabilize each time input gas is changed and set the averaging time to 300-second averaging.

Home Screen>Calibration>Calibrate Span Coefficient (single range mode)

Home Screen>Calibration>Calibrate High Range Span Coefficient (dual or auto range mode)

The Calibrate Span Coefficient menu contains the following information:

- *Edit Span Concentration:* User enters the span concentration when in single range mode.

- *Edit High Range Span Concentration:* User enters the high range span concentration when in dual or auto range mode.

- *Edit Low Range Span Concentration:* User enters the low range span concentration when in dual or auto range mode.

- *Current High Range Concentration:* Read only. Current high range concentration reading when in dual or auto range mode.

- *Current Low Range Concentration:* Read only. Current low range concentration reading when in dual or auto range mode.

- *Current Span Coefficient:* Read only. Displays what the current user-set span coefficient is when in single range mode.

- *Current High Range Span Coefficient:* Displays what the current user-set high range span coefficient is when in dual or auto range mode.

- *Current Low Range Span Coefficient:* Displays what the current user-set low range span coefficient is when in dual or auto range mode.

- *Calculated Span Coefficient:* Read only. After the "Edit Span Concentration" value is entered, the new calculated span coefficient is displayed when in single range mode.

- *Calculated High Range Span Coefficient:* Read only. After the "Edit High Range Span Concentration" value is entered, the new calculated high range span coefficient is displayed when in dual or auto range mode.

- *Calculated Low Range Span Coefficient:* Read only. After the "Edit Low Range Span Concentration" value is entered, the new calculated low range span coefficient is displayed when in dual or auto range mode.

- *Calibrate:* When pressed, updates the coefficient and the concentration should match the span concentration.

Zero/Span Schedule

The Zero/Span Schedule is used to program the instrument to perform fully automated zero and span checks or adjustments.

Home Screen>Calibration>Zero/Span Schedule

Zero / Span Schedule Enabled	Next Time 09/21/2017 09:30	Period 1 hr
Zero Duration 1 min	Span Duration 2 min	Purge Duration 1 min
Total Duration 4 min	Schedule Averaging Time 10 sec	More

Home Screen>Calibration>Zero/Span Schedule>More

Background Calibration Enabled	Span Calibration Enabled	Zero : Span Ratio 1 : 1
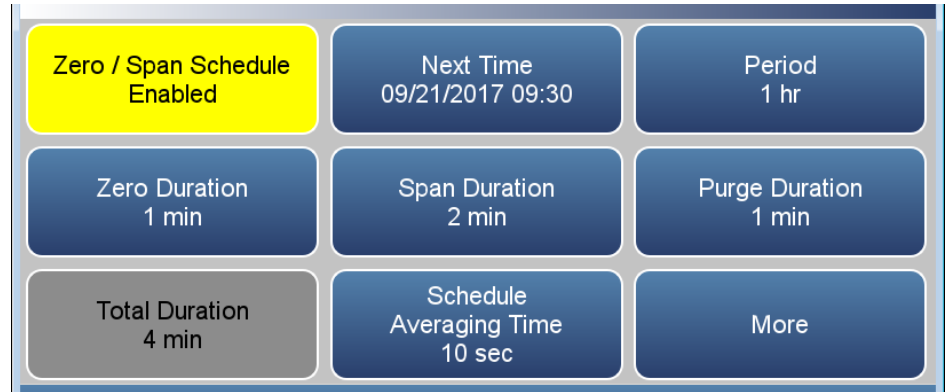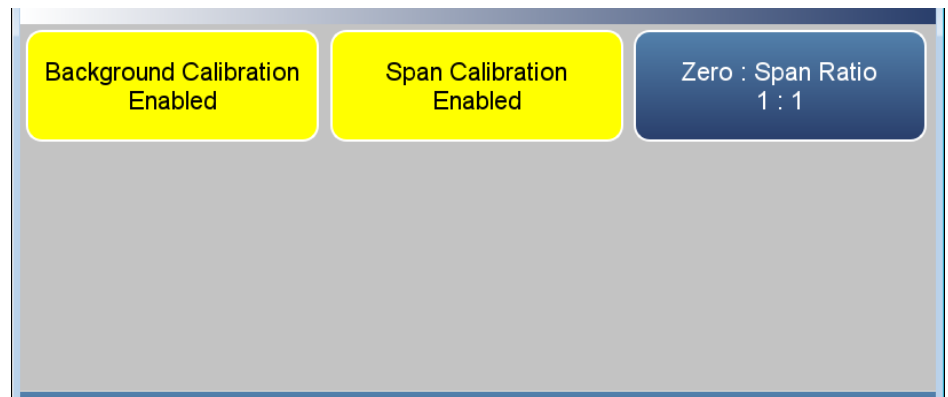
The Zero/Span Schedule contains the following information:

- *Zero/Span Schedule:* Toggles zero/span schedule Enabled or Disabled.

- *Next Time:* Allows the user to view and set the initial date and time (24-hour format) of the zero/span schedule.

- *Period:* Defines the period or interval between zero/span checks or calibrations. If period = 0, the schedule runs continuously.

- *Zero Duration:* Sets how long zero air is sampled by the instrument.

- *Span Duration:* Sets how long span gas is sampled by the instrument.

- *Purge Duration:* Sets how long the purge period will be at the end of the schedule.

- *Total Duration:* Read only. Displays the total time duration of all scheduled events.

- *Schedule Averaging Time:* Allows the user to adjust the zero/span schedule averaging time. This averaging time only affects the zero/span schedule.

- *Background Calibration:* Toggles Enabled/Disabled. If enabled, background value is calibrated. If disabled, schedule runs a background check only and background value is not updated.

- *Span Calibration:* Toggles Enabled/Disabled. If enabled, span coefficient is calibrated. If disabled, schedule runs a calibration check only and span coefficient is not updated.

- *Zero : Span Ratio:* Allows the user to perform more scheduled background calibration checks to span calibration checks. Default is 1 and therefore reads 1:1. (This means that each time the schedule is run, both the zero duration and span duration occurs.) The zero/span ratio is allowable between 1 to 99. If 99 is chosen, the schedule should only perform the Span on the 99th iteration.

Calibrate O$_2$ Span Coefficient

The Calibrate O$_2$ Span Coefficient screen is used to enter the O$_2$ span concentration and calibrate the O$_2$ span coefficient while sampling span gas of known concentration. This button appears if the O$_2$ Sensor option is selected in the configuration screen.

It is important to note the averaging time when calibrating. The longer the averaging time the more precise the calibration results. To achieve maximum precision, allow the instrument to stabilize each time input gas is changed and set the averaging time to 300-second averaging. The O$_2$ Averaging Time is located at Settings>Measurement Settings>Averaging Time.

Home Screen>Calibration>Calibrate O$_2$ Span Coefficient (single range mode)
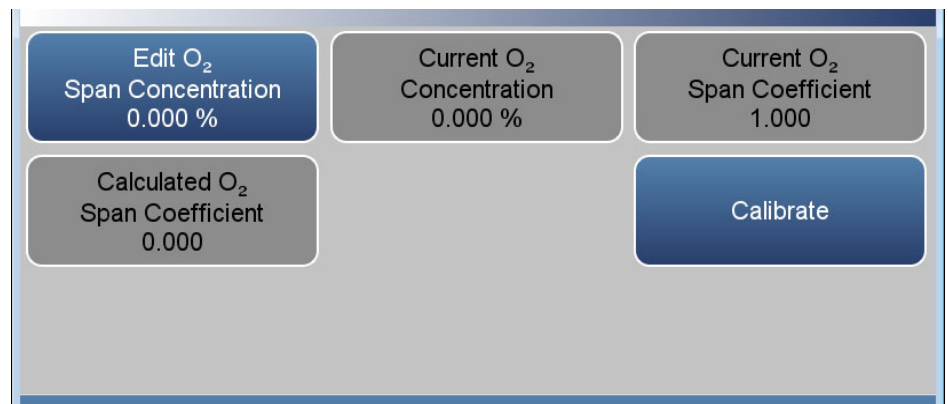
The Calibrate O$_2$ Span Coefficients screen contains the following information:

● *Edit O$_2$ Span Concentration:* User enters the O$_2$ span concentration.

● *Current O$_2$ Concentration:* Read only. Current O$_2$ concentration reading.

● *Current O$_2$ Span Coefficient:* Read only. Current O$_2$ span coefficient value.

● *Calculated O$_2$ Span Coefficient:* Read only. After the "Edit O$_2$ Span Concentration" value is entered, the new calculated O$_2$ span coefficient is displayed.

● *Calibrate:* When pressed, updates the O$_2$ coefficient and the O$_2$ concentration should match the span concentration.

Advanced Calibration

The Advanced Calibration screen provides several additional ways to calibrate the instrument and view the calibration history. See Chapter 4 "Calibration" for further instructions on how to run a calibration.

The following screens show the advanced screens in single range mode and dual or auto range mode. (The only difference between the screens, are the words "High" and "Low".) For more information about range modes, see "Range Mode Selection" on page 3-76.

Home Screen>Calibration>Advanced Calibration (single range mode with O$_2$ option)
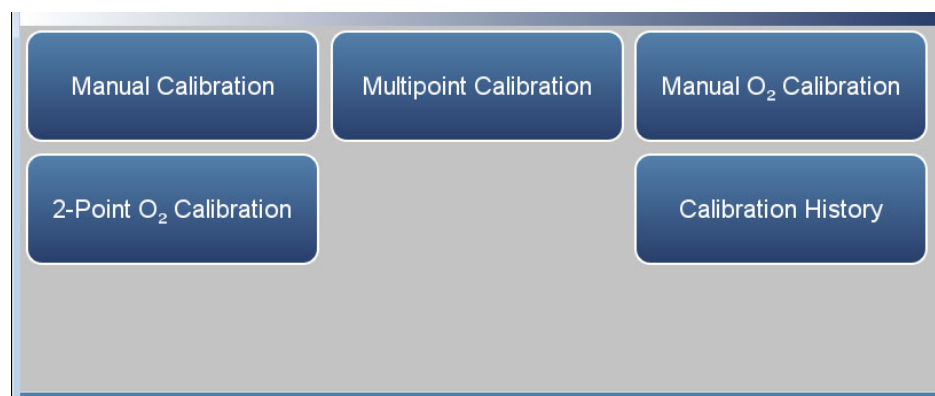
Manual Calibration	Multipoint Calibration	Manual O$_2$ Calibration
2-Point O$_2$ Calibration		Calibration History

Home Screen>Calibration>Advanced Calibration (dual or auto range mode with O$_2$ option)

Manual Calibration	High Range Multipoint Calibration	Low Range Multipoint Calibration
Manual O$_2$ Calibration	2-Point O$_2$ Calibration	Calibration History
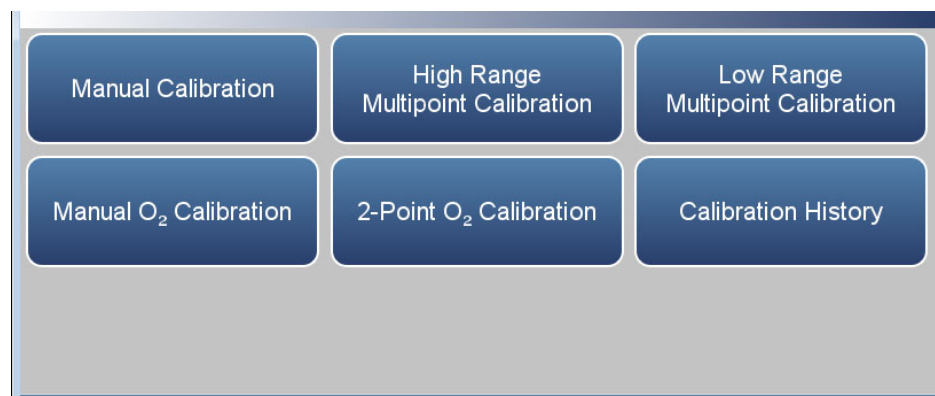
The Advanced Calibration screens contain the following information:

● *Manual Calibration:* The user manually adjusts the background or span coefficient.

● *Multipoint Calibration:* Up to three gas concentrations (cal-points) may be calibrated. Three cal-points will give the most accurate readings over the entire range.

● *High Range Multipoint Calibration:* Up to three gas concentrations (cal-points) for high range may be calibrated. Three cal-points will give the most accurate readings over the entire range.

● *Low Range Multipoint Calibration:* Up to three gas concentrations (cal-points) for low range may be calibrated. Three cal-points will give the most accurate readings over the entire range.

● *Manual O_2 Calibration:* The user manually adjusts the O_2 span coefficient based on the current O_2 concentration value.

● *2-Point O_2 Calibration:* The user manually performs a 2-point calibration of the O_2 sensor.

● *Calibration History:* Lists all calibrations performed and calibration checks.

Manual Calibration   The Manual Calibration screen adjusts the zero background or span coefficient based on a user entered value. See Chapter 4, "Calibration" for instructions on how to run a Manual Calibration.

The following screens show the manual calibration screens in single range mode and dual or auto range mode. In dual or auto range modes, "High Range" or "Low Range" buttons are displayed to indicate the calibration of the high or low coefficient.

Home Screen>Calibration>Advanced Calibration>Manual Calibration (single range mode)

| Adjust Background 0.000 ppm | Adjust Span Coefficient 1.000 | Reset Bkg to 0.000 and Span Coef to 1.000 |

Home Screen>Calibration>Advanced Calibration>Manual Calibration (dual or auto range mode)

| Adjust Background 0.000 ppm | Adjust High Range Span Coefficient 1.000 | Adjust Low Range Span Coefficient 1.000 |

Reset Bkg to 0.000 and Span Coef to 1.000

The Manual Calibration menu contains the following information:

● *Adjust Background:* Allows the user to manually adjust the zero background.

● *Adjust Span Coefficient:* Allows the user to manually adjust the span coefficient when in single range mode.

- *Adjust High Range Span Coefficient:* Allows the user to manually adjust the high range span coefficient when in dual or auto range mode.

- *Adjust Low Range Span Coefficient:* Allows the user to manually adjust the low range span coefficient when in dual or auto range mode.

- *Reset Background to 0.000 and Span Coefficient to 1.000:* Resets all backgrounds and coefficients.

Adjust Background   The Adjust Background screen is used to manually adjust the zero background.

Home Screen>Calibration>Advanced Calibration>Manual Calibration>Adjust Background

Adjust Background 0.491 ppm	Adjusted Concentration 0.227 ppm	Calibrate
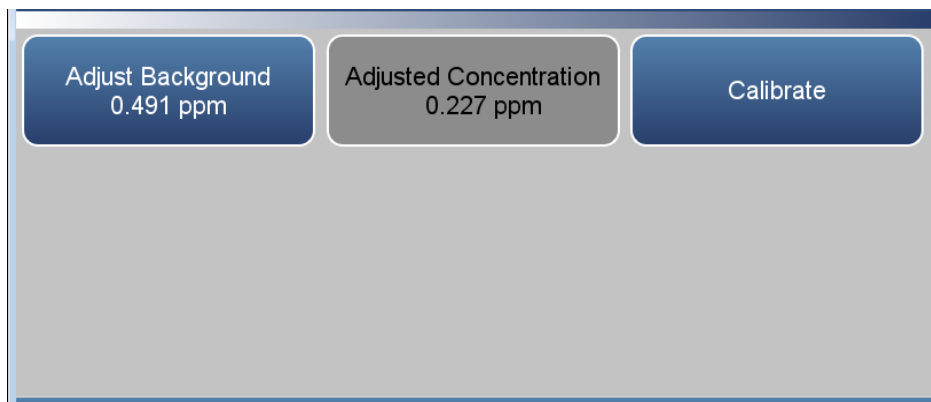
The Adjust Background screen contains the following information:

● *Adjust Background:* User manually adjusts zero background.

● *Adjusted Concentration:* Read only. Shows adjusted concentration based on adjusted zero background.

● *Calibrate:* Calibrates zero background by saving the newly adjusted zero background value.

Adjust Span Coefficient   The Adjust Span Coefficient screen is used to manually adjust the span coefficient.

The following screen is shown in single range mode and dual or auto range mode. In dual or auto range modes, "High Range" or "Low Range" is displayed to indicate the calibration of the high or low coefficient. The Adjust High Range Span Coefficient and Adjust Low Range Span Coefficient screens function the same way.

Home Screen>Calibration>Advanced>Manual Calibration>Adjust Span Coefficient (single range mode)

Adjust Span Coefficient 1.000	Adjusted Concentration 0.291 ppm	Calibrate
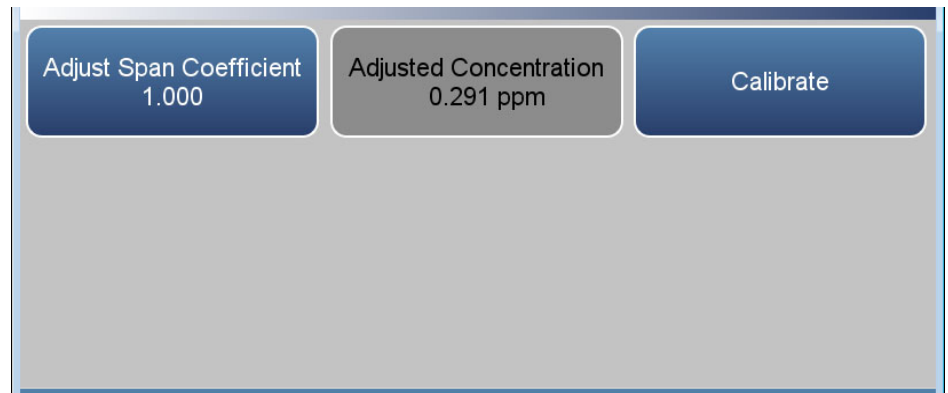
Home Screen>Calibration>Advanced>Manual Calibration>Adjust High Range Span Coefficient (dual or auto range mode)

Adjust High Range Span Coefficient 1.000	Adjusted High Range Concentration 0.285 ppm	Calibrate
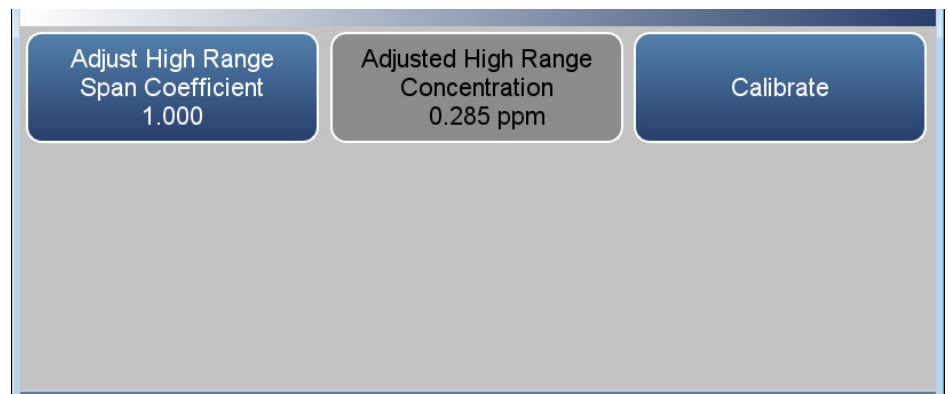
The Adjust Span Coefficient menu contains the following information:

● *Adjust Span Coefficient:* User manually adjusts span coefficient when in single range mode.

● *Adjust High Range Span Coefficient:* User manually adjusts high range span coefficient when in dual or auto range mode.

- *Adjust Low Range Span Coefficient:* User manually adjusts low range span coefficient when in dual or auto range mode.

- *Adjusted Concentration:* Read only. Shows adjusted concentration based on adjusted span coefficient when in single range mode.

- *Adjusted High Range Concentration:* Read only. Shows adjusted high range concentration based on adjusted high range span coefficient when in dual or auto range mode.

- *Adjusted Low Range Concentration:* Read only. Shows adjusted low range concentration based on adjusted low range span coefficient when in dual or auto range mode.

- *Calibrate:* Calibrates span coefficient by saving the newly adjusted span coefficient.

Multipoint Calibration

The Multipoint Calibration screen is used to calibrate the instrument using up to three gas concentrations (cal points) for each range. It is suggested to use three cal-points, as this will give the most accurate readings over the entire range.

The following screen is shown in single range mode. In dual or auto range modes, "High Range" or "Low Range" is displayed to indicate the calibration of the high or low coefficients. The High Range Multipoint Calibration and Low Range Multipoint Calibration screens function the same way.

Note Pressing the Multipoint Calibration button responds with "It is recommended to calibrate all three points" and requires an OK action. ▲

Home Screen>Calibration>Advanced Calibration>Multipoint Calibration (single range mode)

The Multipoint Calibration screen contains the following information:

● *Point 1:* First cal point used in the calibrated multipoint polynomial curve.

● *Point 2:* Second cal point used in the calibrated multipoint polynomial curve.

● *Point 3:* Third cal point used in the calibrated multipoint polynomial curve.

● *First Coefficient:* Read only. Value of the first coefficient in the polynomial curve.

● *Second Coefficient:* Read only. Value of the second coefficient in the polynomial curve.

● *Third Coefficient:* Read only. Value of the third coefficient in the polynomial curve.

● *Reset Points to Default Values:* Resets multipoint coefficients to default values.

Point 1–3   The Point 1 screen allows the user to view and set the selected calibration point. The point 2 and point 3 screens function the same way. Therefore, the following example of point 1 screen applies to point 2 and 3 as well.

The following screen is shown in single range mode. In dual or auto range modes, the High Range Multipoint Calibration and Low Range Multipoint Calibration screens function the same way.

The customer defines the ranges. It is suggested to perform the following calibration points for each range:

Cal point 1: 80% of range

Cal point 2: 50% or range

Cal point 3 20% of range

Home Screen>Calibration>Advanced Calibration>Multipoint Calibration>Point 1
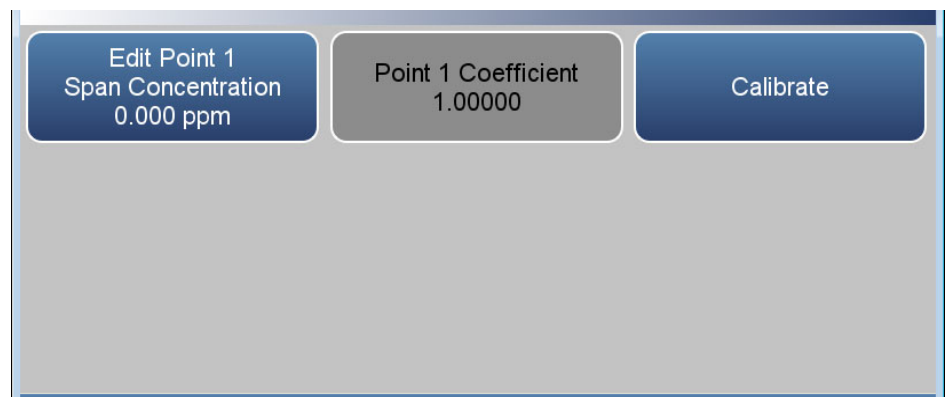
The Point 1 screen contains the following information:

● *Edit Point 1 Span Concentration:* User enters span concentration.

● *Point 1 Coefficient:* Read only. After selecting the value on the Edit Point 1 Span Concentration button and after pressing the Calibrate button, the Point 1 Coefficient value is updated.

● *Calibrate:* Calibrates point 1 coefficient.

Manual O$_2$ Calibration

The Manual O$_2$ Calibration screen allows the O$_2$ span coefficients to be changed manually while sampling span gas of known concentration. This button appears if the O$_2$ Sensor option is selected in the Configuration screen.

Home Screen>Calibration>Advanced Calibration>Manual Calibration (single range mode)
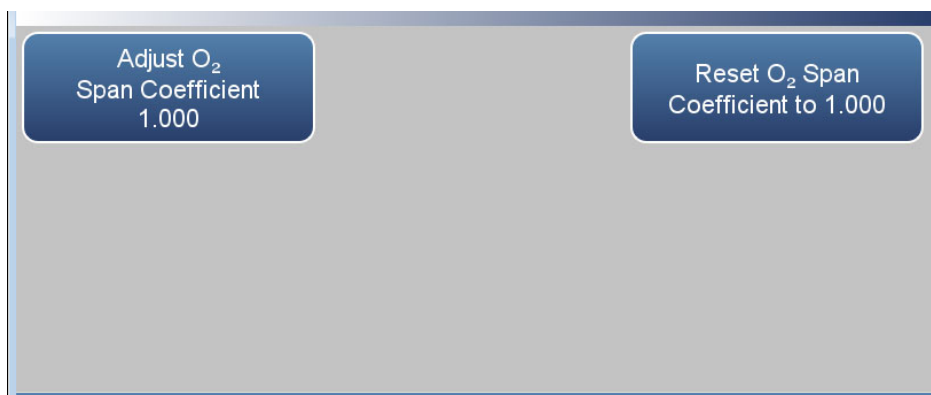
The Manual O$_2$ Calibration screen contains the following information:

● *Adjust O$_2$ Span Coefficient:* Allows the user to manually adjust the O$_2$ span coefficient.

● *Reset O$_2$ Coefficient to 1.000:* Resets coefficient.

Adjust O$_2$ Span Coefficient

The Adjust O$_2$ Span Coefficient screen is used to manually adjust the O$_2$ span coefficient.

Home Screen>Calibration>Advanced>Manual Calibration>Adjust O$_2$ Span Coefficient
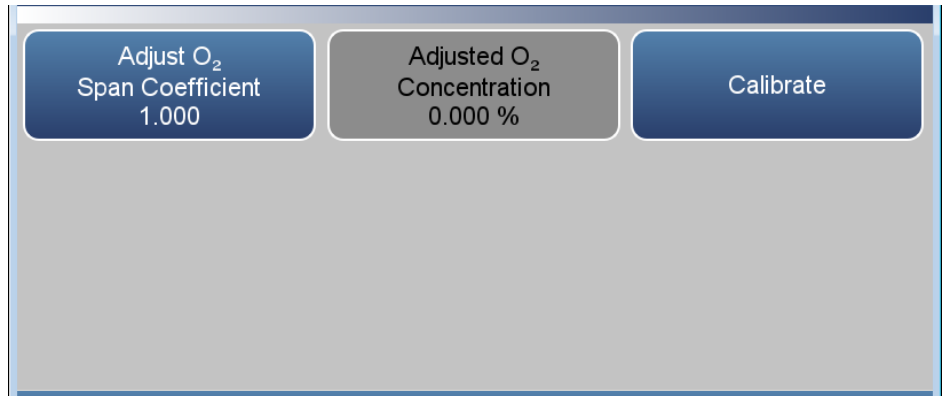
The Adjust O$_2$ Span Coefficient menu contains the following information:

● *Adjust O$_2$ Span Coefficient:* User manually adjusts span coefficient.

● *Adjusted Concentration:* Read only. Shows adjusted O$_2$ concentration based on adjusted O$_2$ span coefficient.

● *Calibrate:* Calibrates span coefficient by saving the newly adjusted O$_2$ span coefficient.

2-Point O₂ Calibration

The 2-Point O_2 Calibration screen is used to calibrate the O2 sensor using 2 different gas concentrations. Both points need to be calibrated for a successful calibration. It is suggested that the two O_2 concentrations used for this calibration be 0% and 20.9%. This button appears if the O_2 Sensor option is selected in the Configuration screen.

Home Screen>Calibration>Advanced Calibration>2-Point O_2 Calibration>

The 2-point O_2 Calibration is performed at the factory and typically is not required in the field. Are you sure you want to proceed to the 2-Point O_2 Calibration?

Continue to 2-Point O_2 Calibration   Return To Previous Screen

Home Screen>Calibration>Advanced Calibration>2-Point O_2 Calibration>Continue to 2-Point O_2 Calibration
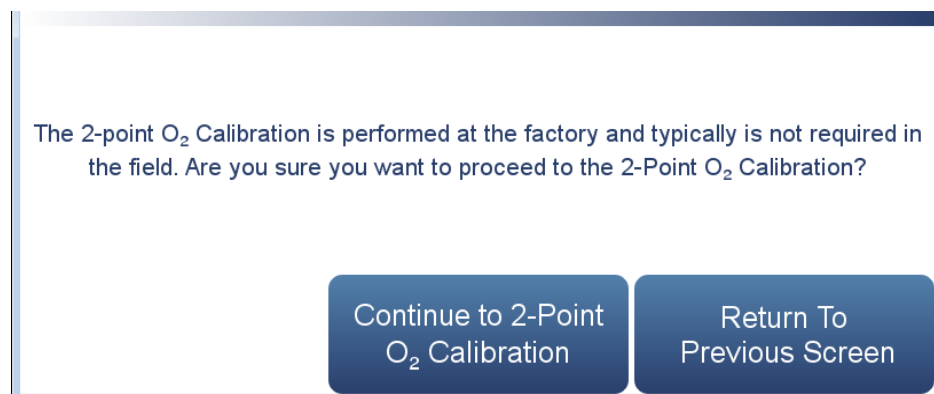
2-Point O_2 Calibration Point 1   2-Point O_2 Calibration Point 2

The 2-Point O_2 Calibration screen contains the following information:

● *2-Point O_2 Calibration Point 1:* First cal point used in the 2 point O_2 calibration. Defaults to 0.000%.

● *2-Point O_2 Calibration Point 2:* Second cal point used in the 2 point O_2 calibration. Defaults to 20.900%.

Point 1–2   The Point 1 screen allows the user to view and set the selected calibration point. The point 2 screen functions the same way. Therefore, the following example of point 1 screen applies to point 2 as well.

Home Screen>Calibration>Advanced Calibration>2-Point O$_2$ Calibration>Continue to 2-Point O$_2$ Calibration>2-Point O$_2$ Calibration Point 1

Edit O$_2$ Concentration 0.000 %	Current O$_2$ Concentration 0.000 %	Calibrate O$_2$ Point 1
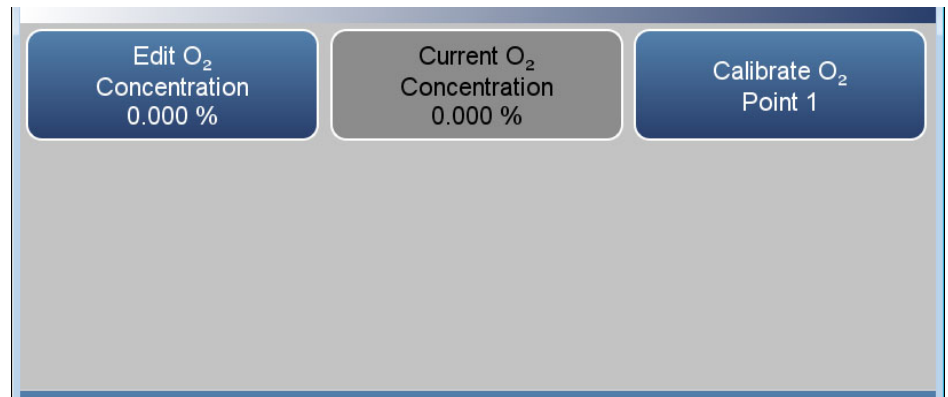
The 2-Point O$_2$ Calibration Point 1 screen contains the following information:

● *Edit O$_2$ Span Concentration:* User enters O$_2$ span concentration.

● *Current O$_2$ Concentration:* Read only. After selecting the value on the Edit O$_2$ Concentration button and after pressing the Calibrate O$_2$ button, the Point 1 Concentration value is updated.

● *Calibrate O$_2$ Point 1:* Calibrates point 1 coefficient.

Note Ensure that the sensor has been sampling the gas for at least 1 minute before pressing the Calibrate O$_2$ Point 1 button. ▲

Calibration History   The Calibration History screen shows the log of calibrations and calibration checks performed.

Use the ▲ and ▼ buttons to move up and down and the ◄ and ► buttons to move left and right.

Home Screen>Calibration>Advanced Calibration>Calibration History

Note Pressing the Calibration History button responds with Retrieving calibration log data, it may take a few seconds... ▲

Time Stamp	Event	Result	Target	Units	Average Time
07/16/2018 16:46:18	Low Span Cal	1.24981	50	ppm	60
07/16/2018 16:39:38	Low Span Cal	1.26427	50	ppm	60
07/16/2018 16:39:27	Low Span Cal	1.26728	50	ppm	60
07/16/2018 16:37:24	Bkg Cal	0.225579	0	ppm	60
07/16/2018 16:36:29	Bkg Cal	0.189574	0	ppm	60
07/16/2018 16:36:13	Bkg Cal	0.197604	0	ppm	60
07/16/2018 16:35:14	Bkg Cal	0.373436	0	ppm	60
07/16/2018 16:25:30	Low Span Cal	1.32877	50	ppm	60
07/16/2018 15:33:19	Bkg Cal	0.441802	0	ppm	300
07/16/2018 15:32:29	Bkg Cal	0.460504	0	ppm	60

The Calibration History screen contains the following information:

● *Time Stamp:* Time of calibration or calibration check.

● *Event:* Lists the type of calibration event.

● *Result:* Concentration result.

● *Target:* Concentration setpoint value.

● *Units:* Displays units for each item.

● *Average Time:* Averaging time used during the calibration or calibration check.

Data

The Data screen is used to view and record concentrations and instrument data. Users can view both tabular data and graphed data.

Home Screen>Data
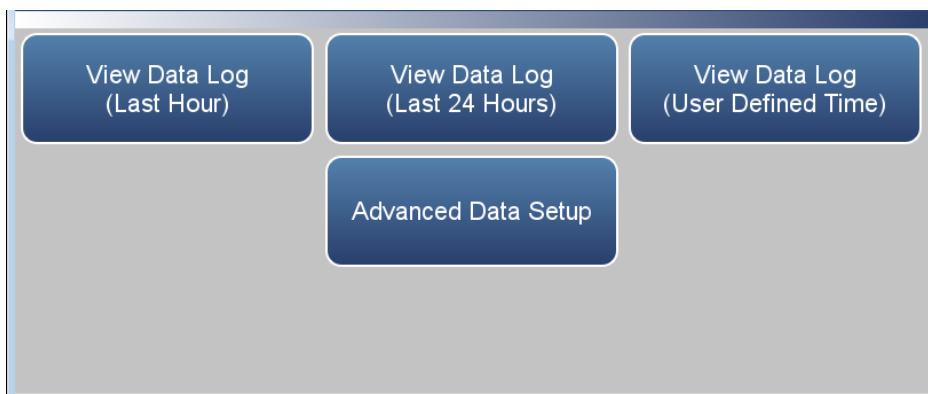
The Data screen contains the following information:

● *View Data Log (Last Hour):* User views last hour of historical data. Table shows most recent data on top.

● *View Data Log (Last 24 Hours):* User views last 24-hour of historical data. Table shows most recent data on top.

● *View Data Log (User Defined Time):* User selects the start and end time for viewing the data. Table shows most recent data on top.

● *Advanced Data Setup:* Allows the user to set up the parameters of how the data is stored and streamed.

View Data Log (Last Hour)

The View Data Log (Last Hour) screen allows the user to instantly view the last hour worth of data in real time.

Use the ▲ and ▼ buttons to move up and down and the ◄ and ► buttons to move left and right.

Home Screen>Data>View Data Log (Last Hour)

Note Pressing the View Data Log (Last Hour) responds with Retrieving user log data, it may take a few seconds... ▲

The View Data Log (Last Hour) screen contains the following options:

● *Graph:* Displays data graph for the column selected. The graph time axis is defined by the data set in the table.
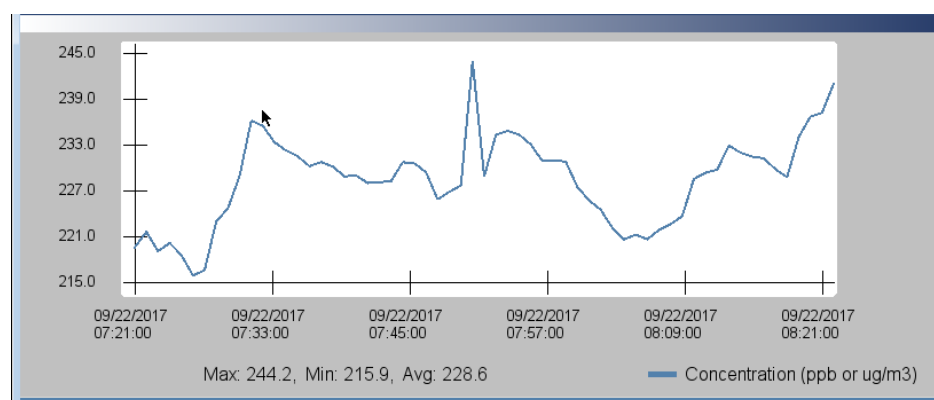
View Data Log (Last 24 Hours)

The View Data Log (Last 24 Hours) screen allows the user to instantly view the last 24 hours worth of data in real time.

Use the ▲ and ▼ buttons to move up and down and the ◄ and ► buttons to move left and right.

Home Screen>Data>View Data Log (Last 24 Hours)

Note Pressing the View Data Log (Last 24 Hours) responds with Retrieving user log data, it may take a few seconds... ▲

Time Stamp	Concentration (ppb or ug/m3)	Bench Pressure (mmHg)	High Concentration (ppb or ug/m3)	Instrument Temperature (degC)	Sample (L/m
	Graph	Graph	Graph	Graph	Graph
09/22/2017 08:21:00	241.241	0	0	0	0
09/22/2017 08:20:00	237.37	0	0	0	0
09/22/2017 08:19:00	236.884	0	0	0	0
09/22/2017 08:18:00	234.178	0	0	0	0
09/22/2017 08:17:00	228.876	0	0	0	0
09/22/2017 08:16:00	229.929	0	0	0	0
09/22/2017 08:15:00	231.378	0	0	0	0
09/22/2017 08:14:00	231.6	0	0	0	0

The View Data Log (Last 24 Hours) screen contains the following options:

● *Graph:* Displays data graph for the column selected. The graph time axis is defined by the data set in the table.
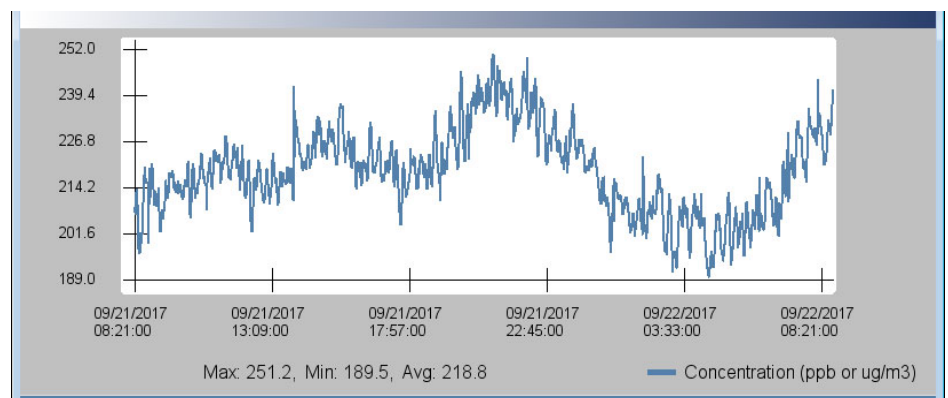
View Data Log (User Defined Time)

The View Data (User Defined Time) screen is used to specify the start and end time for viewing the data logging table.

Home Screen>Data>View Data Log (User Defined Time)

Home Screen>Data>View Data Log (User Defined Time)>Save Data Logging Start Time

The View Data Log (User Defined Time) screen contains the following information:

● *Date:* Sets date of data logging start time.

● *Time:* Sets time of data logging start time.

● *Save Data Logging Start Time:* Pressing this button saves the start time and follows directly to the end time selection for the data logging screen.

The View Data Log (User Defined Time) End Time screen contains the following information:

- *Date:* Sets date of data logging end time.

- *Time:* Sets time of data logging end time.

- *Save Data Logging End Time:* Pressing the Save Data Logging End Time button saves the end time and follows directly to the data logging table.

Note End time should not be greater than 1 year from start time . ▲

Note The datalogging table is limited to 10,000 points. ▲

Advanced Data Setup

The Advanced Data Setup screen allows the user to select variables and set up parameters for data logging and streaming data.

Home Screen>Data>Advanced Data Setup
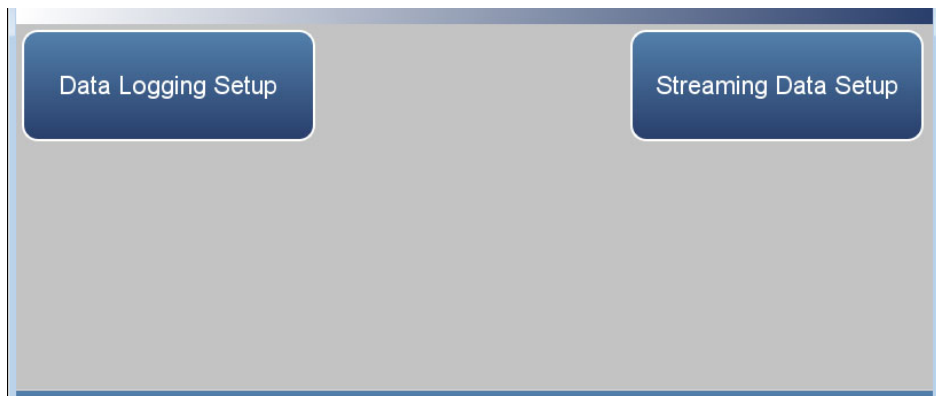
The Advanced Data Setup screen contains the following information:

● *Data Logging Setup:* User selects the parameters for collecting logged data.

● *Streaming Data Setup:* User selects the parameters for streaming data to a computer in real time.

Data Logging Setup   The Data Logging Setup screen allows the user to select data to be stored and how it is stored.

Home Screen>Data>Advanced>Data Logging Setup
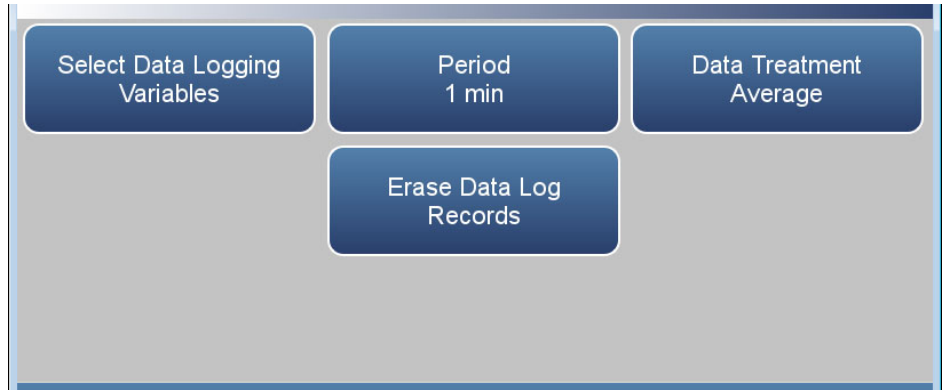
The Data Logging Setup screen contains the following information:

● *Select Data Logging Variables*: User selects instrument variables to log.

● *Period*: User selects how often data is collected by setting the duration between logged data.

● *Data Treatment*: Toggles between Average, Current, Minimum and Maximum. When set to average, the average value during the period will be recorded. When set to current, the latest data will be recorded. When set to minimum or maximum, the minimum or maximum value during the period will be recorded.

● *Erase Data Log Records*: Allows the user to erase all values in the data log and updates the data logging table.

Select Data Logging Variables

The Select Data Logging Variables screen allows the user to select which variables to store. Note: The Data logging and Streaming variable lists are **exclusive** from each other but contain the same variable selections. The list is based on the instrument's configuration.

Use the ▲ and ▼ buttons to scroll through the variables. Select the variables to log by pressing the corresponding cells. Next, press the **Commit Changes** button to save selections. Yellow buttons indicate that the variable is selected.

Home Screen>Data>Advanced>Data Logging Setup>Select Data Logging Variables

Streaming Data Setup   The Streaming Data Setup menu allows the user to stream data to a computer.

Home Screen>Data>Advanced>Streaming Data Setup
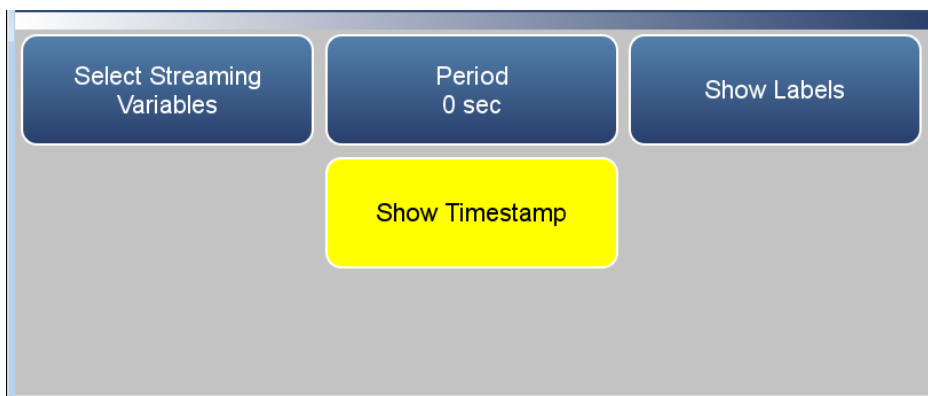
The Streaming Data Setup screen contains the following information:

● *Select Streaming Variables*: User selects which variables to stream.

● *Period*: Sets the time between streamed data.

● *Show Labels*: Toggles on/off. When on, shows variable labels to the left of the variable values.

● *Show Timestamp*: Toggles on/off. When on, shows timestamp at the beginning of each row of data.

Select Streaming Variables

The Select Streaming Variables screen allows the user to select which variables to track. Note: The Data logging and Streaming variable lists are **exclusive** from each other but contain the same variable selections. The list is based on the instrument's configuration.

Use the ▲ and ▼ buttons to scroll through the variables. Select the variables to log by pressing the corresponding cells. Next, press the **Commit Changes** button to save selections. Yellow buttons indicate that the variable is selected.

Home Screen>Data>Advanced>Streaming Data Setup>Select Streaming Variables

Concentration (ppb or ug/m3)	High Concentration (ppb or ug/m3)	corrected Concentration (ppb or ug/m3)	corrected High Concentration (ppb or ug/m3)	▲
Bench Pressure (mmHg)	Instrument Temperature (degC)	Sample Flow (L/min)	Averaging Time (sec)	▼
High Averaging Time (sec)	Concentration Alarm	Pressure Alarm	Flow Alarm	Commit Changes

Settings

The Settings Menu allows the user to view the instrument alarms, set up user preferences, communicate with outside devices and computers, download files to USB, and sets security protocol.

Home Screen>Settings
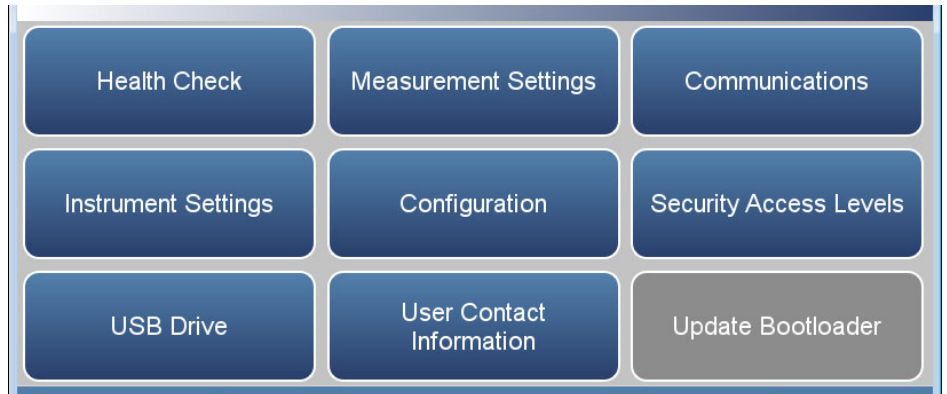
The Settings screen contains the following information:

● *Health Check:* View instrument status and alarms, predictive diagnostics, preventive maintenance alerts, maintenance history, email health check report files, and contact Thermo Fisher Scientific technical support.

● *Measurement Settings:* Allows the user to setup user preferences as related to the concentration readings.

● *Communications:* Allows the user to communicate with outside devices.

● *Instrument Setting:* Allows the user to setup alarm setpoints and user preferences.

● *Configuration:* User selects which options to enable.

● *Security Access Levels:* User selects security protocol. User can also change security passwords.

● *USB Drive:* User can update instrument firmware, download data, and change USB password.

● *User Contact Information:* User sets up their contact information.

● *Update Bootloader:* Used to update bootloader when an update to the bootloader is available.

Health Check

The Health Check screen is used for viewing instrument status and alarms, predictive diagnostics, preventive maintenance schedules, maintenance history, emailing files describing the health/status of the instrument, and viewing the instrument's firmware version.

Note ⚠ This symbol denotes there is an active alarm in the module. ▲

Note ⚙ This symbol denotes there is an active maintenance related warning in the module. ▲

Home Screen>Settings>Health Check

The Health Check screen contains the following information:

● *Status and Alarms:* Allows the user to view the status and alarm menus. Menus are broken down according to modules where the user can view instrument readings, setpoints and alarms.

● *Predictive Diagnostics:* Smart module diagnostics, which shows possible future issues.

● *Maintenance History:* Allows the user to set up a maintenance schedule and track maintenance history.

● *File Sharing and Support:* File sharing via email. Support through Thermo Fisher Scientific technical support.

● *iQ360:* The iQ360 feature is a paid subscription enabling or disabling the instrument to send automated emails to technical support when an alarm or alert is triggered.

● *Firmware Version:* Shows the instrument's firmware version.

Status and Alarms

The Status and Alarms screen provides information with respect to module alarms. In each screen, instrument readings, setpoints, and low/high alarm values are displayed. If applicable, setpoints and alarms are also settable from the Settings>Instrument Settings screen.

Note ⚠ This symbol denotes there is an active alarm in the module. ▲

Home Screen>Settings>Health Check>Status and Alarms

The Status and Alarms menu contains the following information:

● *Concentration:* Displays CO concentrations and alarms.

● *NDIR Bench:* Displays bench module alarms and faults.

● *O_2 Sensor:* Displays O_2 concentrations, sensor alarms and faults (if enabled).

● *Flow and Pressure:* Displays flow and pressure alarms and faults.

● *Peripherals Support:* Displays peripherals support alarms and faults.

● *Valve and Pump Resets:* User can reset valve and pump power.

● *Analog Input/Output:* Displays analog input/output alarms and faults.

● *Digital Input/Output:* Displays digital input/output alarms and faults.

● *Serial Numbers:* Displays all the serial numbers for the instrument.

Concentration   The Concentration screen provides status and alarms for CO concentration, background cal/checks, and span cal/checks. If an item being monitored goes outside the lower or higher alarm limit, an alarm is activated.

Use the ▲ and ▼ buttons to move up and down and the ◄ and ► buttons to move left and right.

Home Screen>Settings>Health Check>Status and Alarms>Concentration

Concentration	Value	Low Alarm	High Alarm	Span Conc	Units	
CO	0.498	0.000	0.000		ppm	▲
Bkg Check Offset	0.000	--	10.000		ppm	▼
Span Check Offset	0.000	--	10.000	0.000	ppm	◄
						►

The Concentration screen contains the following information:

● Across:

   ● *Concentration:* This column lists items associated with the CO and concentrations.

   ● *Value:* Displays the current value for each item.

   ● *Low Alarm:* Displays low alarm status for each item.

   ● *High Alarm:* Displays high alarm status for each item.

   ● *Span Conc:* Span concentration used in the span calibration or span check.

   ● *Units:* Displays units for each item.

● Down:

   ● *CO:* CO concentration.

   ● *Bkg Check Offset:* Displays concentration based on the last attempted background calibration. High alarm shows user defined limit for acceptable background check offset.

● *Span Check Offset:* Displays concentration based on the last attempted span calibration. High alarm shows user defined limit for acceptable span check offset (compared to the span concentration value). Span concentration shows span setpoint.

Note If both the low alarm and high alarms are set to zero, then no alarm will show. ▲

NDIR Bench   The NDIR Bench screen provides status and alarms related to the bench module. If an item being monitored goes outside the lower or higher alarm limit, an alarm is activated.

Use the ▲ and ▼ buttons to move up and down and the ◄ and ►
buttons to move left and right.

Home Screen>Settings>Health Check>Status and Alarms>NDIR Bench

NDIR Bench	Value	Low Alarm	High Alarm	Units
S/R	1.15278			
Sample Intensity	217363			Hz
Reference Intensity	188537			Hz
Bench Pressure	752.559			mmHg
Flow	1.195			L/min
Instrument Temperature	36.8			°C

The NDIR Bench screen contains the following information:

● Across:

  ● *NDIR Bench:* This column lists items associated with the NDIR bench module.

  ● *Value:* Displays the current value for each item.

  ● *Low Alarm:* Displays low alarm status for each item.

  ● *High Alarm:* Displays high alarm status for each item.

  ● *Units:* Displays units for each item.

● Down:

  ● *S/R:* Displays the current sample/reference reading.

  ● *Sample Intensity:* Displays the current sample intensity reading.

  ● *Reference Intensity:* Displays the current reference intensity reading.

  ● *Bench Pressure:* Displays the current bench pressure reading.

  ● *Flow:* Displays the current sample flow reading.

  ● *Instrument Temperature:* Displays the current instrument temperature reading.

- *Bench Temperature:* Displays the current bench temperature reading. User can adjust low and high alarm limits.

- *Bench Temperature too Low:* Displays OK/Fail for bench temperature too low.

- *Bench Temperature too High:* Displays OK/Fail for bench temperature too high.

- *Motor Speed too Low:* Displays OK/Fail for motor speed too low.

- *Motor Speed too High:* Displays OK/Fail for motor speed too high.

- *IR Source Current too Low:* Displays OK/Fail for IR source current too low.

- *IR Source Current too High:* Displays OK/Fail for IR source current too high.

- *IR Detector Bias too Low:* Displays OK/Fail for IR detector bias too low.

- *IR Detector Bias too High:* Displays OK/Fail for IR detector bias too high.

- *Bench Thermistor Open:* Displays OK/Fail for bench thermistor open.

- *Bench Thermistor Short:* Displays OK/Fail for bench thermistor short.

- *Module Thermistor Open:* Displays OK/Fail for module thermistor open.

- *Module Thermistor Short:* Displays OK/Fail for module thermistor short.

- *Board Communication:* Displays OK/Fail for board communication status.

- *Power Supply:* Displays OK/Fail of power supplies. Power supply goes red if any voltages are outside their limits. No voltage rows ever get highlighted.

  - *3.3V Diagnostic:* Displays current voltage readings. Alarm limits are not changeable.

  - *5.0V Diagnostic:* Displays current voltage readings. Alarm limits are not changeable.

  - *15V Diagnostic:* Displays current voltage readings. Alarm limits are not changeable.

  - *24V Diagnostic:* Displays current voltage readings. Alarm limits are not changeable.

- *-15V Diagnostic:* Displays current voltage readings. Alarm limits are not changeable.

- *Bias Voltage:* Displays current voltage readings. Alarm limits are not changeable.

O₂ Sensor

The O_2 Sensor screen provides status and alarms related to the O_2 Sensor. If an item being monitored goes outside the lower or higher alarm limit, an alarm is activated.

Use the ▲ and ▼ buttons to move up and down and the ◄ and ► buttons to move left and right.

Home Screen>Settings>Health Check>Status and Alarms>O₂ Sensor

O₂ Sensor	Value	Low Alarm	High Alarm	Units
Concentration	0.000	3.000	25.000	%
Temperature	0.0			ºC
Temperature Open	OK			
Temperature Short	OK			
Sensor Element Function	OK			
Outside Operational Spec.	OK			

The O_2 Sensor screen contains the following information:

● Across:

  ● *O₂ Sensor:* This column lists items associated with the O_2 sensor.

  ● *Value:* Displays the current value for each item.

  ● *Low Alarm:* Displays low alarm status for each item.

  ● *High Alarm:* Displays high alarm status for each item.

  ● *Units:* Displays units for each item.

● Down:

  ● *Concentration:* Displays the current O_2 sensor concentration reading. User can adjust low and high alarm limits.

  ● *Temperature:* Displays the current module temperature reading.

  ● *Temperature Open:* Displays OK/Fail for temperature open.

  ● *Temperature Short:* Displays OK/Fail for temperature short.

  ● *Sensor Element Function:* Displays OK/Fail for sensor element function.

  ● *Outside Operational Spec.:* Displays OK/Fail for outside operational specification.
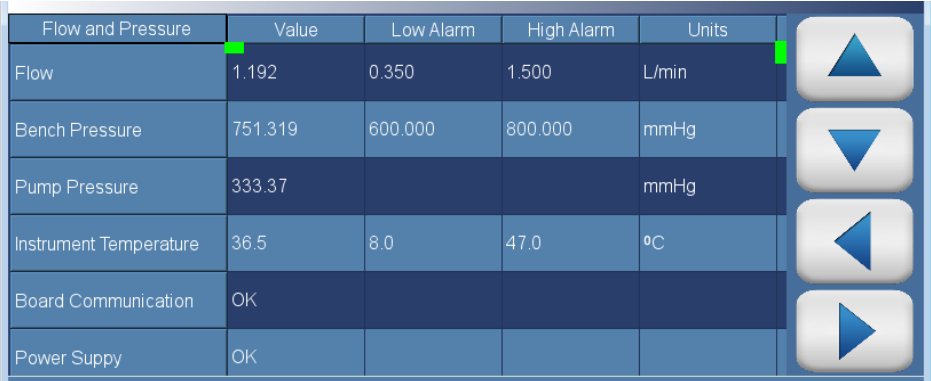
- *Photodiode Current Too Low:* Displays OK/Fail for Photodiode Current Too Low.

- *Sensor Detected:* Displays OK/Fail for sensor detected.

- *Sensor Communication:* Displays OK/Fail for sensor communication.

- *Valid Calibration:* Displays OK/Fail for valid calibration.

- *Board Communication:* Displays OK/Fail for board communication status.

- *Power Supply:* Displays OK/Fail of power supplies. Power supply goes red if any voltages are outside their limits. No voltage rows ever get highlighted.

  - *2.5V Diagnostic:* Displays current voltage readings. Alarm limits are not changeable.

  - *3.3V Diagnostic:* Displays current voltage readings. Alarm limits are not changeable.

  - *5.0V Diagnostic:* Displays current voltage readings. Alarm limits are not changeable.

  - *24V Diagnostic:* Displays current voltage readings. Alarm limits are not changeable.

Flow and Pressure   The Flow and Pressure screen provides status and alarms related to the flow and pressure module. If an item being monitored goes outside the lower or higher alarm limit, an alarm is activated.

Use the ▲ and ▼ buttons to move up and down and the ◀ and ▶ buttons to move left and right.

Home Screen>Settings>Health Check>Status and Alarms>Flow and Pressure

Flow and Pressure	Value	Low Alarm	High Alarm	Units	
Flow	1.192	0.350	1.500	L/min	
Bench Pressure	751.319	600.000	800.000	mmHg	
Pump Pressure	333.37			mmHg	
Instrument Temperature	36.5	8.0	47.0	°C	
Board Communication	OK				
Power Suppy	OK				

The Flow and Pressure screen contains the following information:

- Across:

  - *Flow and Pressure:* This column lists items associated with the flow and pressure module.

  - *Value:* Displays the current value for each item.

  - *Low Alarm:* Displays low alarm status for each item.

  - *High Alarm:* Displays high alarm status for each item.

  - *Units:* Displays units for each item.

- Down:

  - *Flow:* Displays the current sample flow reading. User can adjust low and high alarm limits.

  - *Bench Pressure:* Displays the current bench pressure reading. User can adjust low and high alarm limits.

  - *Pump Pressure:* Displays the current pump pressure reading.

  - *Instrument Temperature:* Displays the current instrument temperature reading. User can adjust low and high alarm limits.

- *Board Communication:* Displays OK/Fail for board communication status.

- *Power Supply:* Displays OK/Fail of power supplies. Power supply goes red if any voltages are outside their limits. No voltage rows ever get highlighted.

  - *2.5V Diagnostic:* Displays current voltage readings. Alarm limits are not changeable.

  - *3.3V Diagnostic:* Displays current voltage readings. Alarm limits are not changeable.

  - *5.0V Diagnostic:* Displays current voltage readings. Alarm limits are not changeable.

  - *24V Diagnostic:* Displays current voltage readings. Alarm limits are not changeable.

Peripherals Support

The Peripherals Support screen provides status and alarms related to the peripherals module. If an item being monitored goes outside the lower or higher alarm limit, an alarm is activated.

Use the ▲ and ▼ buttons to move up and down and the ◀ and ▶ buttons to move left and right.

Home Screen>Settings>Health Check>Status and Alarms>Peripherals Support

Peripherals Support	Value	Low Alarm	High Alarm	Units	
Module Temperature	36.7			°C	
Sample Valve	0.000			mA	
Zero Valve	1.289			mA	
Span Valve	0.000			mA	
Instrument Error	OK				
Board Communication	OK				

The Peripherals Support screen contains the following information:

- Across:
  - *Peripherals Support:* This column lists items associated with the peripherals support module.
  - *Value:* Displays the current value for each item.
  - *Low Alarm:* Displays low alarm status for each item.
  - *High Alarm:* Displays high alarm status for each item.
  - *Units:* Displays units for each item.
- Down:
  - *Module Temperature:* Displays the current module temperature of the module.
  - *Sample Valve:* Displays whether or not the sample valve is activated.
  - *Zero Valve:* Displays whether or not the zero valve is activated.
  - *Span Valve:* Displays whether or not the span valve is activated.
  - *Instrument Error:* Displays OK/Fail for PCP, datalogging, streaming, serial server, and Modbus protocols.

- *Board Communication:* Displays OK/Fail for board communication status.

- *Power Supply:* Displays OK/Fail of power supplies. Power supply goes red if any voltages are outside their limits. No voltage rows ever get highlighted.

  - *2.5V Diagnostic:* Displays current voltage readings. Alarm limits are not changeable.

  - *3.3V Diagnostic:* Displays current voltage readings. Alarm limits are not changeable.

  - *5.0V Diagnostic:* Displays current voltage readings. Alarm limits are not changeable.

  - *24V Diagnostic:* Displays current voltage readings. Alarm limits are not changeable.

  - *5.0V Step Board:* Displays OK/Fail.

  - *24V Step Board:* Displays OK/Fail.

Valve and Pump Resets   The Valve and Pump Resets screen allows the user to reset a valve or pump after a failure due to excessive amperage.

Note ⚠ This symbol denotes that the device needs to be reset. ▲

Note Resetting one valve will reset all valves. ▲

Home Screen>Settings>Health Check>Status and Alarms>Valve and Pump Resets
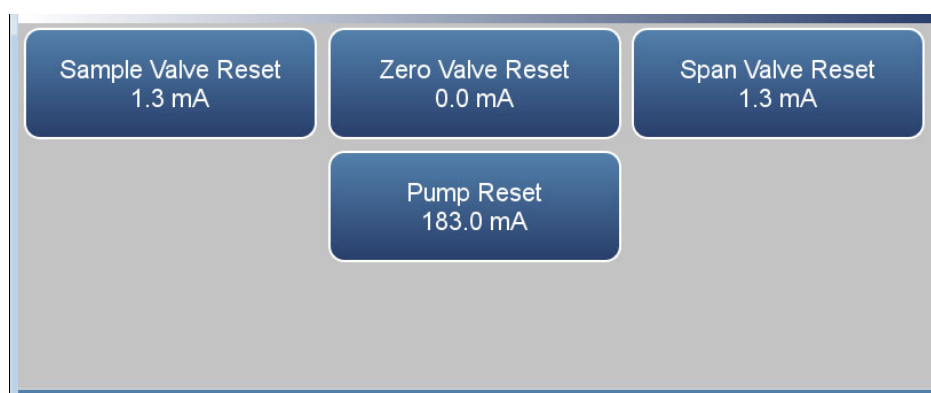
The Valve and Pump Resets screen contains the following information:

● *Sample Valve Reset:* Resets sample valve.

● *Zero Valve Reset:* Resets zero valve.

● *Span Valve Reset:* Resets span valve.

● *Pump Reset:* Resets pump.

Analog I/O   The Analog I/O screen provides status and alarms related to the analog input/output module. If an item being monitored goes outside the lower or higher alarm limit, an alarm is activated.

Use the ▲ and ▼ buttons to move up and down and the ◄ and ► buttons to move left and right.

Home Screen>Settings>Health Check>Status and Alarms>Analog I/O

Analog IO	Value	Low Alarm	High Alarm	Units	
Voltage Output Channel 1	OK				
Voltage Output Channel 2	OK				
Voltage Output Channel 3	OK				
Voltage Output Channel 4	OK				
Voltage Output Channel 5	OK				
Voltage Output Channel 6	OK				

The Analog I/O screen contains the following information:

● Across:

  ● *Analog IO:* This column lists items associated with the analog I/O.

  ● *Value:* Displays the current value for each item.

  ● *Low Alarm:* Displays low alarm status for each item.

  ● *High Alarm:* Displays high alarm status for each item.

  ● *Units:* Displays units for each item.

● Down:

  ● *Voltage Output Channel 1–6:* Displays real-time voltage output for each channel.

  ● *Current Output Channel 1–6:* Displays real-time current output for each channel.

  ● *Chip Temperatures:* Displays OK/Fail for chip temperatures.

  ● *Chip 1–3 Communication:* Displays OK/Fail for each chip communication.

  ● *Test Mode:* Displays test mode on or off.

- *Board Communication:* Displays OK/Fail for board communication status.

- *Power Supply:* Displays OK/Fail of power supplies. Power supply goes red if any voltages are outside their limits. No voltage rows ever get highlighted.

  - *3.3V Diagnostic:* Displays current voltage readings. Alarm limits are not changeable.

  - *5.0V Diagnostic:* Displays current voltage readings. Alarm limits are not changeable.

  - *5.0V Ref Diagnostic:* Displays current voltage readings. Alarm limits are not changeable.

  - *15V Diagnostic:* Displays current voltage readings. Alarm limits are not changeable.

  - *-15V Diagnostic:* Displays current voltage readings. Alarm limits are not changeable.

Digital I/O   The Digital I/O screen provides status and alarms related to the digital input/output module. If an item being monitored goes outside the lower or higher alarm limit, an alarm is activated.

Use the ▲ and ▼ buttons to move up and down and the ◄ and ▶ buttons to move left and right.

Home Screen>Settings>Health Check>Status and Alarms>Digital I/O

Digital IO	Value	Reset	Low Alarm	High Alarm	Units	
Solenoid 1	0.0	Reset	OK	OK	mA	▲
Solenoid 2	0.0	Reset	OK	OK	mA	▼
Solenoid 3	0.0	Reset	OK	OK	mA	◄
Solenoid 4	0.0	Reset	OK	OK	mA	
Solenoid 5	0.0	Reset	OK	OK	mA	▶
Solenoid 6	0.0	Reset	OK	OK	mA	

The Digital I/O screen contains the following information:

● Across:

 ● *Digital IO:* This column lists items associated with the digital I/O.

 ● *Value:* Displays the current value for each item.

 ● *Reset:* Resets item.

 ● *Low Alarm:* Displays low alarm status for each item.

 ● *High Alarm:* Displays high alarm status for each item.

 ● *Units:* Displays units for each item.

● Down:

 ● *Solenoid 1–8:* Displays whether or not the solenoid is activated by showing the current in mA.

 ● *External Alarm 1–3:* Displays OK/Fail for external alarms.

 ● *Relay Test Mode:* Displays relay test mode on or off.

 ● *Solenoid Test Mode:* Displays solenoid test mode on or off.

 ● *Board Communication:* Displays OK/Fail for communication status.

● *Power Supply:* Displays OK/Fail of power supplies. Power supply goes red if any voltages are outside their limits. No voltage rows ever get highlighted.

   ● *3.3V Diagnostic:* Displays current voltage readings. Alarm limits are not changeable.

   ● *5.0V Diagnostic:* Displays current voltage readings. Alarm limits are not changeable.

   ● *24V Diagnostic:* Displays current voltage readings. Alarm limits are not changeable.

Serial Numbers The Serial Numbers screen displays the serial number for each module.

Home Screen>Settings>Health Check>Status and Alarms>Serial Numbers
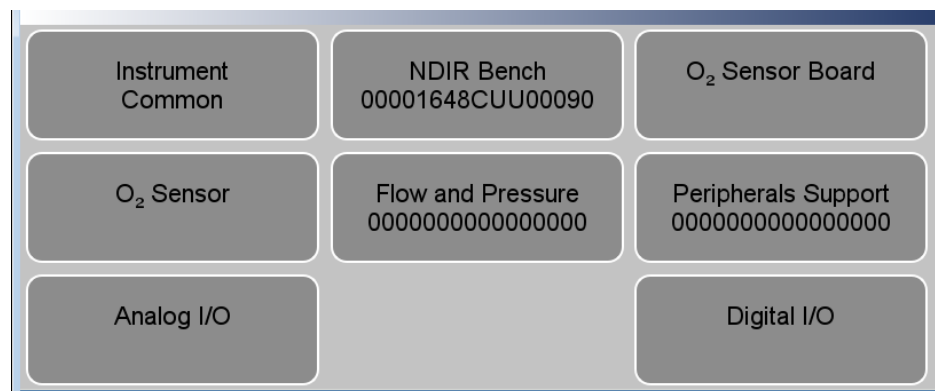
The Serial Numbers screen contains the following information:

- *Instrument:* Instrument serial number.
- *NDIR Bench:* NDIR bench serial number.
- *O₂ Sensor Board:* O$_2$ sensor board serial number.
- *O₂ Sensor:* O$_2$ sensor serial number.
- *Flow and Pressure:* Flow and pressure serial number.
- *Peripherals Support:* Peripherals support serial number.
- *Analog I/O:* Analog I/O serial number.
- *Digital I/O:* Digital I/O serial number.

Predictive Diagnostics   The Predictive Diagnostics screen is a feature for instruments to anticipate maintenance needs, reduce downtime, and reduce troubleshooting time. If button is greyed out, no maintenance is needed. If button is blue, maintenance is suggested.

Note ⚙ This symbol denotes there is an active maintenance related warning in the module. ▲

Home Screen>Settings>Health Check>Predictive Diagnostics
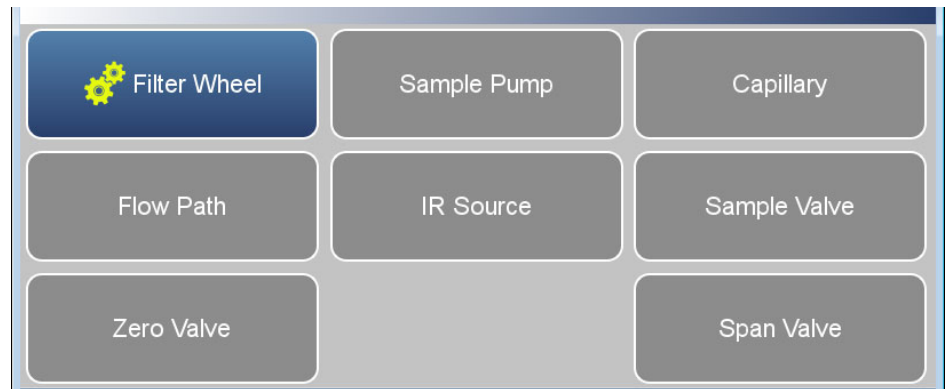
The Predictive Diagnostics screen contains the following information:

● Filter Wheel

● Sample Pump

● Capillary

● Flow Path

● IR Source

● Sample Valve

● Zero Valve

● Span Valve

Maintenance   The Maintenance screen reminds the user when certain instrument
components need to be serviced/replaced.

Note ⚙ This symbol denotes there is an active maintenance related
warning in the module. ▲

Home Screen>Settings>Health Check>Maintenance
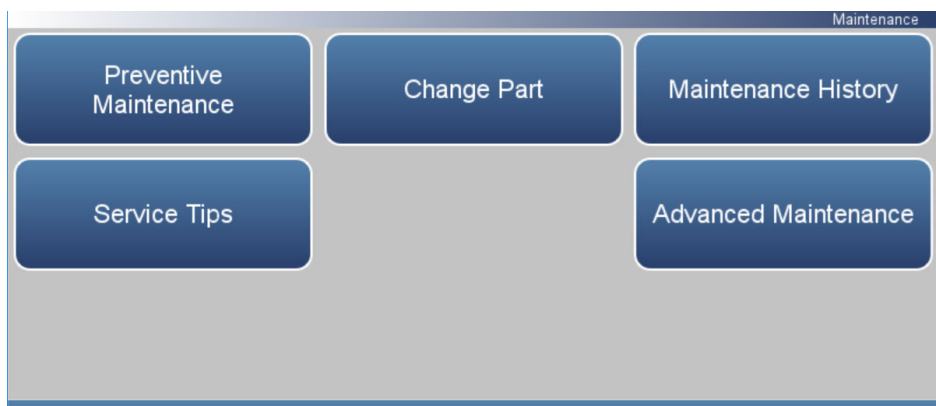
**Home Screen>Settings>Health Check>Maintenance>Advanced
Maintenance**
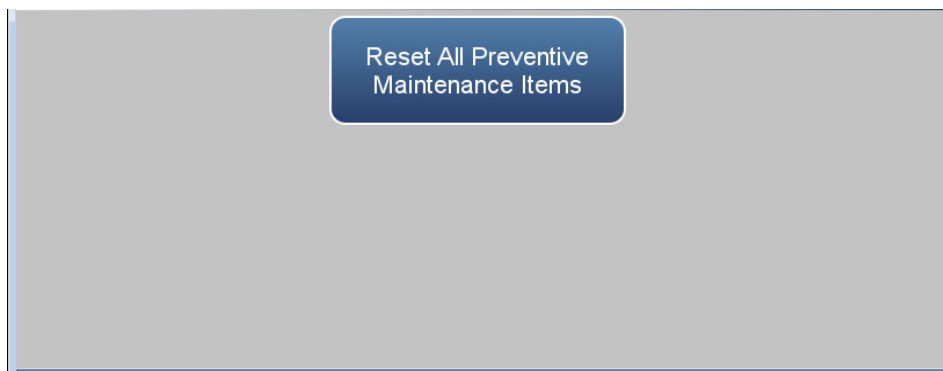
The Maintenance screen contains the following information:

● *Preventive Maintenance:* Shows suggested service interval and time left
for component replacement.

● *Change Part:* User logs component fix.

● *Maintenance History:* Shows the log of all recorded component fixes.

● *Service Tips:* Provides video and procedural service tips.

● *Advanced Maintenance:* Resets all preventive maintenance items.

Preventive Maintenance

The Preventive Maintenance screen reminds the user when certain instrument components need to be serviced/replaced. When the "Months Left" has decreased to 2, the row is highlighted yellow. If the "Months Left" is 1 or less, the row is highlighted red and the maintenance icon (gears) will appear in the status bar located at the bottom of the screen.

Use the ▲ and ▼ buttons to move up and down and the ◀ and ▶ buttons to move left and right.

Home Screen>Settings>Health Check>Maintenance>Preventive Maintenance

Component	Interval in Months	Months Left	Reset	Alert	
Optical Bench Module	48	47	Reset	Enabled	▲
IR Source	12	11	Reset	Enabled	▼
Filter Wheel	48	47	Reset	Enabled	◀
Detector	48	47	Reset	Enabled	
Chopper Motor	48	47	Reset	Enabled	▶
Optical Switch	48	47	Reset	Enabled	

The Preventive Maintenance screen contains the following information:

● Across:

    ● *Component:* Device to be routinely serviced or replaced.

    ● *Interval in Months:* Expected period of time before a component needs to be checked and/or serviced. User settable.

    ● *Months Left:* Count down timer in months. Remaining time since the beginning of the service interval. When the value is 1 or less, the row will be highlighted and it is suggested that the component should be checked and/or serviced.

    ● *Reset:* Once the component is serviced/replaced, the user presses the Reset button and the "Months Left" value resets to the "Service Interval in Months" value.

    ● *Alert:* Allows the user to opt out of receiving preventive maintenance alerts. Displays Enabled/Disabled for each component.

● Down:

   ● *Optical Bench Module:* Service interval for optical bench module components.

      ● *IR Source:* Service interval for IR source.

      ● *Filter Wheel:* Service interval for filter wheel.

      ● *Detector:* Service interval for detector.

      ● *Chopper Motor:* Service interval for chopper motor.

      ● *Optical Switch:* Service interval for optical switch.

   ● *Flow System:* Service interval for the flow system components.

      ● *Capillaries:* Service interval for capillaries.

      ● *Pump:* Service interval for pump.

   ● *DC Power Supply:* Service interval for DC power supply.

   ● *Fan Filter:* Service interval for fan filter.

   ● *System Components:* Service interval for system components.

      ● *Purafil:* Service interval for purafil.

      ● *Charcoal:* Service interval for charcoal.

      ● *Dri-Rite:* Service interval for dri-rite.

Change Part   The Change Part screen allows the user to enter the component being serviced and the type of fix. Pressing commit will update the preventive maintenance table and predictive diagnostics screen when applicable.

Home Screen>Settings>Health Check>Maintenance>Change Part

The Change Part screen contains the following information:

● *Select Part:* User selects part to service from the selection table.

● *Fix:* User chooses from new, rebuilt, cleaned, and unknown.

● *Comment:* User can write a brief comment, which will be saved to the preventive maintenance history table.

● *Commit:* User commits and saves the selected part fix.

Maintenance History   The Maintenance History screen allows the user to view when components were replaced, rebuilt, or cleaned. When a user changes a part in the change part screen, a new row will be automatically created at the top in the maintenance history table.

Use the ▲ and ▼ buttons to move up and down and the ◄ and ► buttons to move left and right.

Home Screen>Settings>Health Check>Maintenance>Maintenance History

Note Pressing the Maintenance History button responds with Retrieving maintenance history data, it may take a few seconds... ▲

Part	Fix	Date	Service Months	Comments
All	Unknown	09/07/2017	0	Reset All
All	Unknown	08/05/2017	1	Reset All
IR Source	New	08/05/2017	1	ABC
All	Unknown	07/31/2017	0	Reset All
IR Source	Rebuilt	07/31/2017	0	
Optical Switch	Rebuilt	07/31/2017	1	
Chopper Motor	Rebuilt	07/31/2017	1	
Detector	Rebuilt	07/31/2017	1	
Filter Wheel	Rebuilt	07/31/2017	1	
IR Source	Rebuilt	07/31/2017	0	

The Maintenance History screen contains the following information:

● *Part:* Component that has been fixed.

● *Fix:* The type of maintenance.

● *Date:* Shows date/time when service was logged.

● *Service Months:* Amount of time in months since last service.

● *Comments:* Shows comments entered from time of change.

File Sharing and Support   The File Sharing and Support screen allows the user to send health check report files to Thermo Fisher Scientific technical support or user emails. The Health Report file includes: Status and Alarms, PM Alerts, Activity Log, Service Database, Cal History, and Data Log (last 24 hours).

Note To create email list, go to Settings>User Contact Information. To configure email, go to Settings>Communications>Email Server (SMTP). ▲

Home Screen>Settings>Health Check>File Sharing and Support
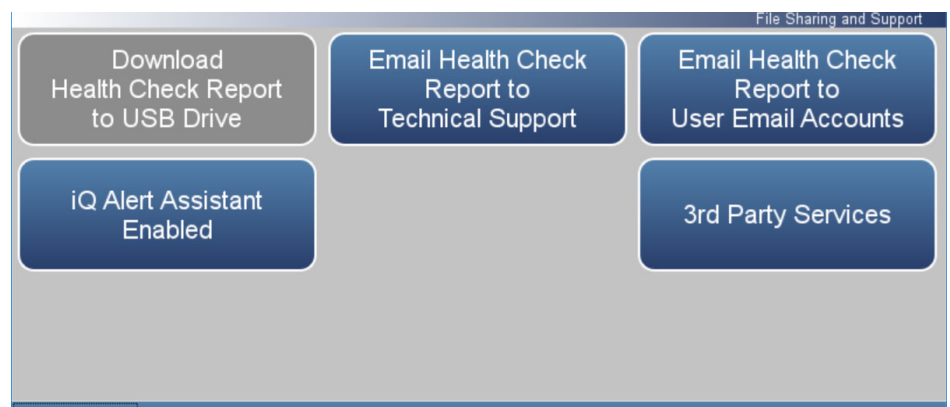
The File Sharing and Support screen contains the following information:

● *Download Health Check Report to USB Drive:* Sends the health report to USB drive.

● *Email Health Check Report File to Technical Support:* Sends the health report file to technical support and the customer email addresses via email.

● *Email Health Check Report to Personal Account:* Sends the health report file to a personal account via email.

● *iQ Alert Assistant:* With the iQ Alert Assistant enabled, the instrument will email Thermo Scientific Technical Support the health check report after each event. After each maintenance alert or predictive diagnostic alert, Customer Service will produce a quote for the components that require service. This quote will get emailed to the email addresses that have been entered into the "User Contact Information" menu.

● *3rd Party Services:* The 3rd party services feature is a paid subscription, which allows a service provider to enable or disable automated email notifications when an alarm or alert is triggered.

iQ360   The iQ360 is a paid subscription enabling or disabling the instrument to send automated emails to technical support when an alarm or alert is triggered.

Home Screen>Settings>Health Check>iQ360 (Get Started)
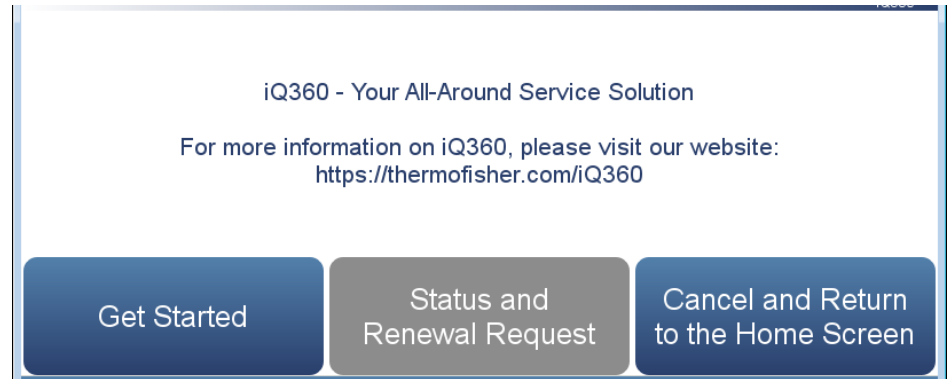
Home Screen>Settings>Health Check>iQ360 (Status and Renewal Request)
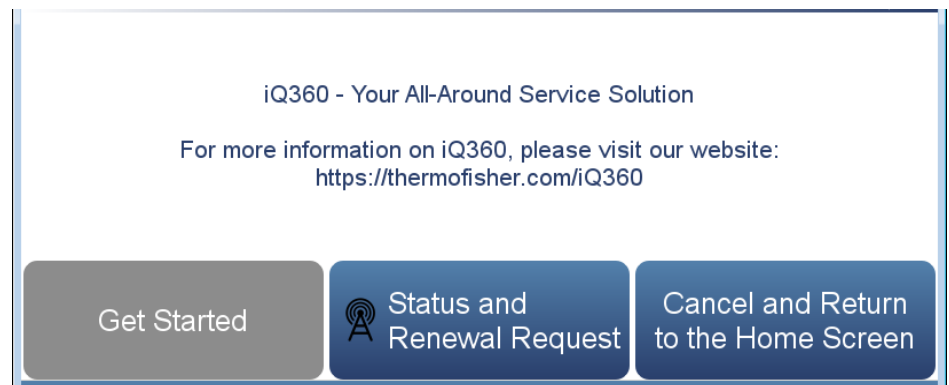
The iQ360 screen contains the following information:

● *Get Started:* Allows the user to access the menu where the subscription passcode is entered.

● *Status and Renewal Request:* Allows the user to access the iQ360 menu once the subscription has been enabled.

● *Cancel and Return to the Home Screen:* Exits screen and returns to the Home Screen.

Get Started

The Get Started screen allows the user to access the menu where the subscription passcode is entered.

Home Screen>Settings>Health Check>iQ360>Get Started
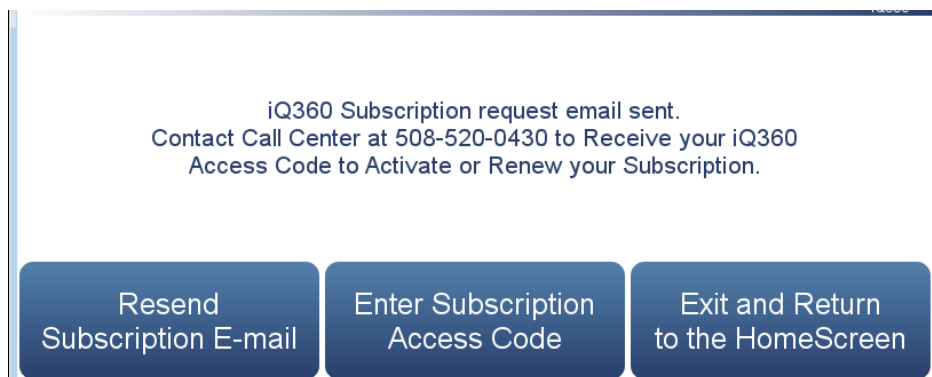
The Get Started screen contains the following information:

● *Resend Subscription E-mail:* Allows the user to request another subscription passcode if the email was never received.

● *Enter Subscription Access Code:* Allows the user to enter the subscription passcode to enable an iQ360 subscription.

● *Exit and Return to the Home Screen:* Exits screen and returns to the Home Screen.

Status and Renewal Request

The Status and Renewal Request screen allows the user to access the iQ360 menu once the subscription has been enabled.

Home Screen>Settings>Health Check>iQ360>Status and Renewal Request

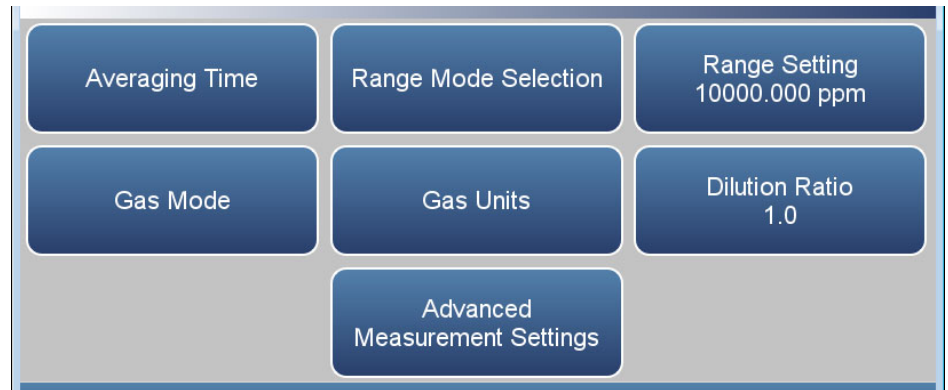The Status and Renewal Request screen contains the following information:

- *iQ360 Status:* Informs the user if the subscription is enabled.

- *iQ360 Subscription Expiration Date:* Informs the user when the subscription will expire.

- *iQ360 Test Connection:* Allows the user to verify the network connection is working.

- *iQ360 Subscription Renewal:* Allows the user to request a subscription renewal via email.

Measurement Settings

The Measurement Settings menu contains a number of submenus where instrument parameters and settings can be read and modified.

The following screens show the measurement settings in single range mode and dual or auto range mode. In the dual and auto range modes, both the "High Range" or "Low Range" buttons averaging buttons will be available.

Home Screen>Settings>Measurement Settings (single range mode)

Averaging Time	Range Mode Selection	Range Setting 10000.000 ppm
Gas Mode	Gas Units	Dilution Ratio 1.0
	Advanced Measurement Settings	

Home Screen>Settings>Measurement Settings (dual or auto range mode)

Averaging Time	Range Mode Selection	High Range Setting 10000.000 ppm
Low Range Setting 10000.000 ppm	Gas Mode	Gas Units
Dilution Ratio 1.0		Advanced Measurement Settings

The Measurement Setting menu contains the following information:

● *Averaging Time:* Sets the averaging time for the CO sample measurement and O_2 sample measurement (if option is enabled).

● *Range Mode Selection:* User can choose between the various range modes: single, dual, or auto. For more information, see "Range Mode Selection" on page 3-76

● *Range Setting:* Sets the concentration range for the analog outputs when in single range mode.

- *High Range Setting:* Sets the high range concentration range for the analog output when in dual or auto range mode.

- *Low Range Setting:* Sets the low range concentration for the analog output when in dual or auto range mode.

- *Gas Mode:* User can manually choose sample, zero or span mode.

- *Gas Units:* Defines the units in which CO concentration reading is expressed.

- *Dilution Ratio:* Serves as a multiplier when dilution gas is utilized.

- *Advanced Measurement Settings:* Advanced settings affecting CO readings.

Averaging Time   The Averaging Time screen allows the user to choose dynamic filtering or a manually selected (static) averaging time.

Averaging Time defines the time period (1 to 300 seconds) during which CO measurements are taken. The average concentration of the readings are calculated for that time period. The front panel display and analog outputs are updated every second if averaging time is greater than 1 second. An averaging time of 10 seconds, for example, means that the average concentration of the last 10 seconds will be displayed at each update. An averaging time of 300 seconds means that the moving average concentration of the last 300 seconds will be the output at each update. Therefore, the lower the averaging time the faster the front panel display and analog outputs respond to concentration changes. Longer averaging times are typically used to smooth output data.

Dynamic Filtering allows for data smoothing without compromising response time. Automatically changes the averaging time giving the user faster response times when conditions are rapidly changing; smoother and stable readings, when conditions aren't changing as rapidly; and as an added bonus, it better processes spikes to minimize their impact on the data. At the same time it will preserve the representative nature of the filtered data to the conditions being sampled.
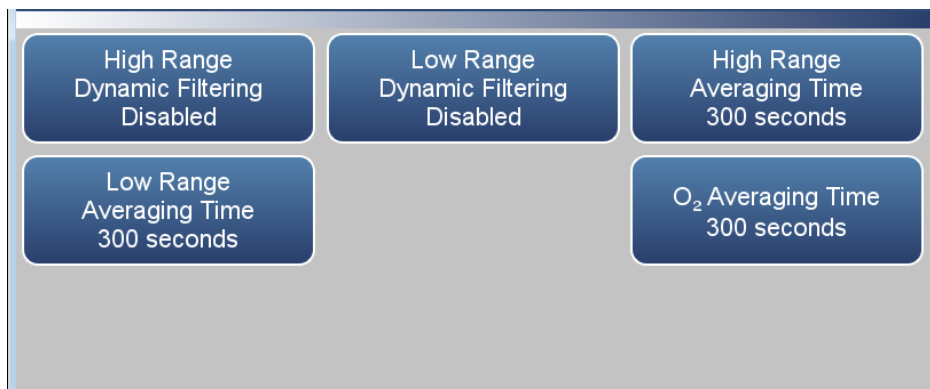
Note When Dynamic Filtering is selected, the user selected Averaging Time button is disabled. ▲

Home Screen>Settings>Measurement Settings>Averaging time (single range mode and O$_2$ option)

Home Screen>Settings>Measurement Settings>Averaging Time (dual or auto range mode and O$_2$ option)

High Range Dynamic Filtering Disabled	Low Range Dynamic Filtering Disabled	High Range Averaging Time 300 seconds
Low Range Averaging Time 300 seconds		O$_2$ Averaging Time 300 seconds

The Averaging Time screen contains the following information:

● *Dynamic Filtering:* Enables/disables dynamic filtering when in single range mode.

● *High Range Dynamic Filtering:* Enables/disables high range dynamic filtering when in dual or auto range mode.

● *Low Range Dynamic Filtering:* Enables/disables low range dynamic filtering when in dual or auto range mode.

● *Averaging Time:* Sets averaging time period in single range mode and when dynamic filtering is disabled.

● *High Range Averaging Time:* Sets high averaging time when in dual or auto range mode and when dynamic filtering is disabled.

● *Low Range Averaging Time:* Sets low averaging time when in dual or auto range mode and when dynamic filtering is disabled.

● *O$_2$ Averaging Time:* Sets O$_2$ averaging time if the O$_2$ sensor is enabled.

Range Mode Selection   The Range Mode Selection screen is used to switch between the various range modes: Single, Dual, and Auto Range.

Home Screen>Settings>Measurement Settings>Range Mode Selection
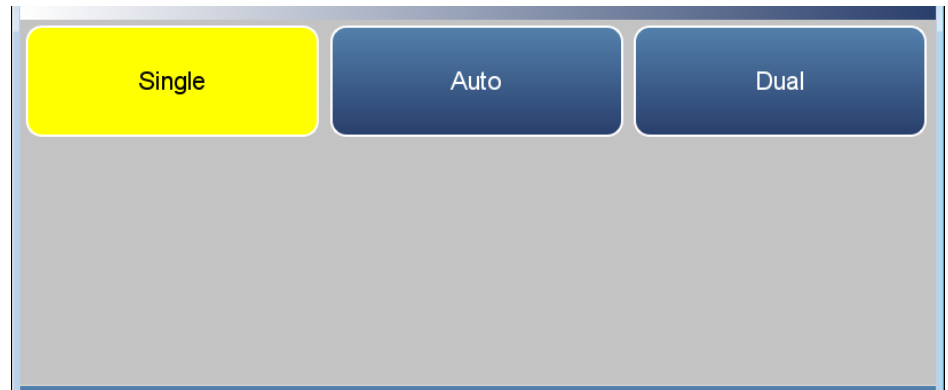
The Range Mode Selection screen contains the following information:

● *Single:* In single range mode, there is one range, one averaging time, and one span coefficient.

● *Dual:* In the dual range mode, there are two independent analog outputs. These are labeled simply as the "High Range" and the "Low Range". Each channel has its own analog output range setting, averaging time, and span coefficient.

   This enables the sample concentration reading to be sent to the analog outputs at two different ranges. For example, the low CO analog output can be set to output concentrations from 0 to 50 ppm and the high CO analog output set to output concentrations from 0 to 100 ppm.

   In addition, when in dual or auto range mode, each CO analog output has a span coefficient so that each range can be calibrated separately. This is especially necessary if the two ranges are not close to one another. For example, the low CO range is set to 0–50 ppm and the high CO range is set to 0–10,000 ppm.

● *Auto:* The auto range mode switches the CO analog outputs between high and low range settings, depending on the concentration level. The high and low ranges are defined in the Range Settings menu.

   For example, suppose the low range is set to 50 ppm and the high range is set to 100 ppm. Sample concentrations below 50 ppm are output based on low range selection and sample concentrations above 50 ppm are output based on high range selection. When the low range

is active, the range mode selection status output is at 0 volts. When the high range is active, the range mode selection status output is at half of full-scale.

When the high range is active, the concentration must drop to 95% of the low CO range for the low range to become active.

In addition, each CO range and analog output has a span coefficient so that each range can be calibrated separately. This is especially necessary if the two ranges are not close to one another. For example, the low CO range is set to 0–50 ppm and the high CO range is set to 0–10000 ppm.

Note When using auto range mode, the high and low ranges should not vary by more than 1 order of magnitude. For instance, if the low range is set to 20 ppm, then the high range should be set to no more than 200 ppm. This is because the concentration response is non-linear and it is possible that the low range readings could become unpredictable above the top of the low range, resulting in a substantial jump in concentration readings when switching between ranges.

One possible fix for this would be to perform the multipoint (3-point) calibration on both ranges and make sure that the low range high point matches or is greater than the high range low point. This will ensure that the high and low range concentration curves will overlap. If both of these methods are unacceptable due to local regulations, then the dual range mode should be used so that the range selection may be evaluated by the user to meet their regulations. ▲
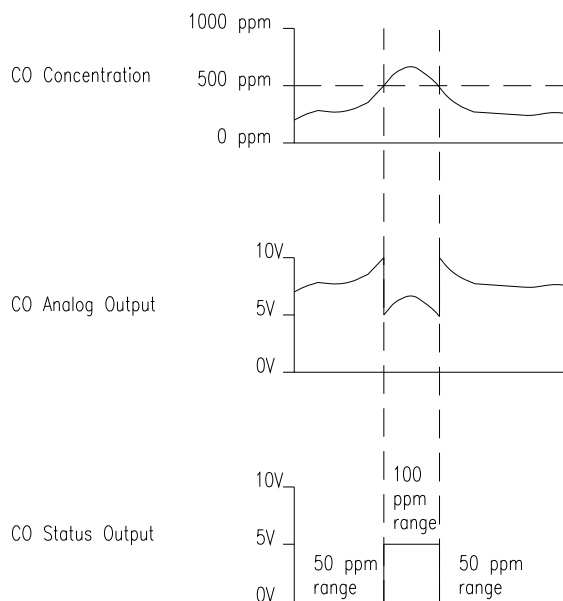
Range Setting   The Range Setting button defines the concentration range of the analog outputs. For example, a CO range of 0–50 ppm restricts the analog output to concentrations between 0 and 50 ppm.

The Range Setting button shows the current CO range. The range setting button is similar for the single, dual, and auto range modes. The only difference are the words "High" or "Low" displayed to indicate which range is displayed. For more information about the dual and auto range modes, see "Range Mode Selection" on page 3-76. Pressing Range Setting, High Range Setting or Low Range Setting, brings up a numeric keypad whereby the user can select a range.

Settable ranges according to unit selection include:

ppb	50–10,000,000 ppb
ppm	1–10,000 ppm
%	5e-6–1 %
$\mu g/m^3$	50–10,000,000 $\mu g/m^3$
mg/m^3	1–10,000 mg/m^3
g/m^3	0.001–10 g/m^3

Gas Mode   The Gas Mode screen defines what gas mode the instrument is set to.

Home Screen>Settings>Measurement Settings>Gas Mode

Sample	Zero	Span
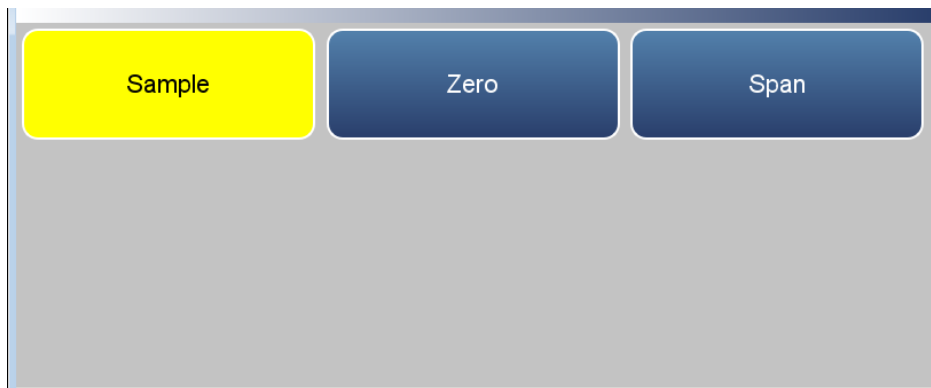
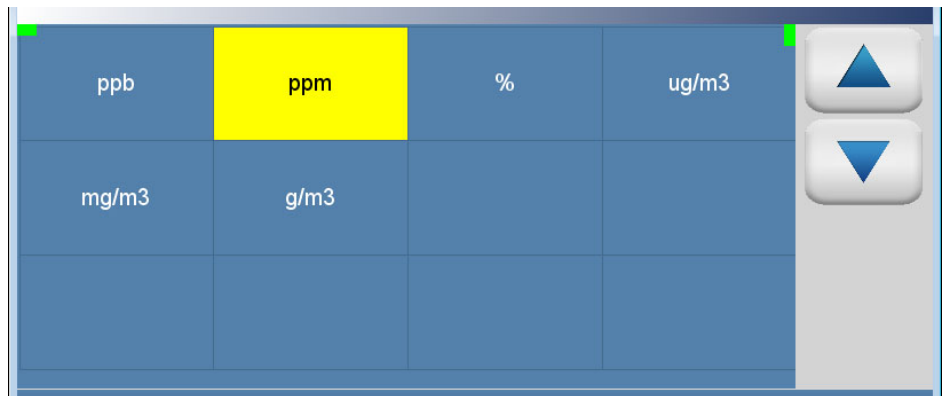The Gas Mode screen contains the following information:

●   *Sample:* Sets the instrument to measure sample gas.

●   *Zero:* Used when calibrating the background of the instrument. When pressed, sets the instrument to zero mode.

●   *Span:* Used when calibrating the span coefficient. When pressed, sets the instrument to span mode.

Gas Units   The Gas Units screen defines how the CO concentration reading is expressed. The $\mu g/m^3$, mg/m^3, and g/m^3 gas concentration modes are calculated using a standard pressure of 760 mmHg and a standard temperature of 0 °C. The temperature can be changed in the compensation screen.

Use the ▲ and ▼ buttons to select.

Home Screen>Settings>Measurement Settings>Gas Units

The Gas Units screen contains the following information:

● *ppb:* parts per billion.

● *ppm:* parts per million.

● *%:* percent.

● *μg/m3:* micrograms per meter cubed.

● *mg/m3:* milligrams per meter cubed.

● *g/m3:* grams per meter cubed.

Advanced Measurement Settings

The Advanced Measurement Settings screen allows the user to calibrate the optical bench and set other advanced settings.

Home Screen>Settings>Measurement Settings>Advanced Measurement Settings

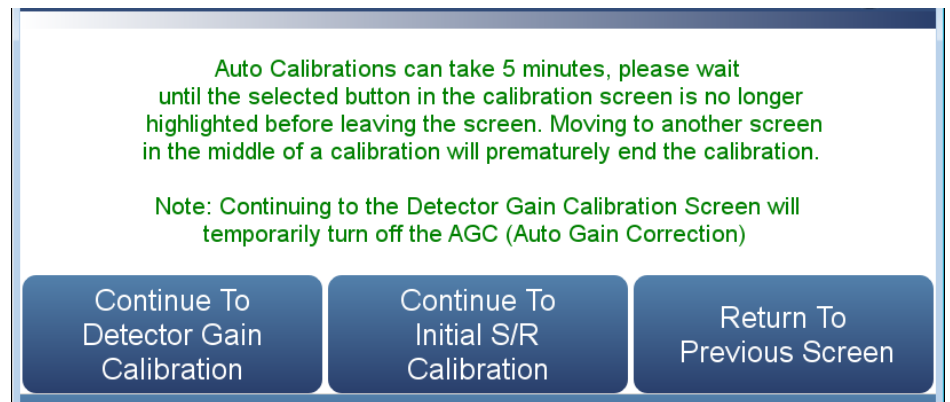The Advanced Measurements Settings menu contains the following information:

● *Optical Bench Settings:* User sets the detector gain and S/R initial value. This can be done manually or automatically.

● *Compensation:* Allows the user to compensate for changes in temperature, pressure, and oxygen concentration (if enabled).

● *Pressure Calibration:* Calibrates pressure.

Optical Bench Settings   The Optical Bench Settings screen allows the user to manually or automatically set the detector gain and initial S/R (sample/reference) value. The S/R value should be calibrated prior to other instrument calibrations. For more information, see Chapter 4, "Calibration".

Use the ▲ and ▼ buttons to move up and down and the ◄ and ► buttons to move left and right.

Home Screen>Settings>Measurement Settings>Advanced Measurement Settings>Optical Bench Settings

Auto Calibrations can take 5 minutes, please wait until the selected button in the calibration screen is no longer highlighted before leaving the screen. Moving to another screen in the middle of a calibration will prematurely end the calibration.

Note: Continuing to the Detector Gain Calibration Screen will temporarily turn off the AGC (Auto Gain Correction)

| Continue To Detector Gain Calibration | Continue To Initial S/R Calibration | Return To Previous Screen |

Home Screen>Settings>Measurement Settings>Advanced Measurement Settings>Optical Bench Settings>Continue to Detector Gain Calibration

Description	Detector Gain	Current Sample Int. (Hz)	Current Reference Int. (Hz)	
Manual Entry	180	165508	143807	
Auto Cal	Start			
End Cal	Stop			
Default Values	Default Gain			

The Detector Gain Calibration screen contains the following information:

● Across:

  ● *Description:* Defines the actions the user can do.

  ● *Detector Gain:* User can manually set or automatically calibrate the detector gain.

- *Current Sample Int. (Hz):* Displays the current sample intensity in Hz.

- *Current Reference Int. (Hz):* Displays the current reference intensity in Hz.

● Down:

- *Manual Entry:* Shows current values. If detector gain cell is pressed, user can manually set the detector gain value.

- *Auto Cal:* When Start is pressed, the auto-calibration process is initiated. Please allow up to 5 minutes for calibration to complete. User can stop calibration by pressing the Stop button.

- *End Cal:* When Stop is pressed, the auto calibration is interrupted and the value does not change.

- *Default Values:* When pressed, the default gain value is saved.

Home Screen>Settings>Measurement Settings>Advanced Measurement Settings>Optical Bench Settings>Continue to Initial S/R Calibration

Description	Initial S/R	Current S/R			
Manual Entry	1.15009	1.15021			
Auto Cal	Start				
End Cal	Stop				
Default Values	Default S/R				

The Initial S/R Calibration screen contains the following information:

● Across:

- *Description:* Defines the actions the user can do.

- *Initial S/R.:* Displays the initial S/R value.

- *Current S/R.:* Displays the current S/R value.

● Down:

- *Manual Entry:* Shows current value. If the initial S/R cell is pressed, user can manually set the initial S/R value. The instrument should be sampling zero gas when changing the S/R.

- *Auto Cal:* When Start is pressed, the auto-calibration process is initiated. Please allow up to 5 minutes for calibration to complete. User can Stop calibration by pressing the Stop button.

- *End Cal:* When pressed, the auto calibration is interrupted and the value does not change.

- *Default Values:* When pressed, the default S/R value is saved.

Compensation   The Compensation screen provides compensation for any changes to the instrument's output signal due to internal instrument temperature, pressure, and oxygen variations (if enabled).

Home Screen>Settings>Measurement Settings>Advanced Measurement Settings>Compensation
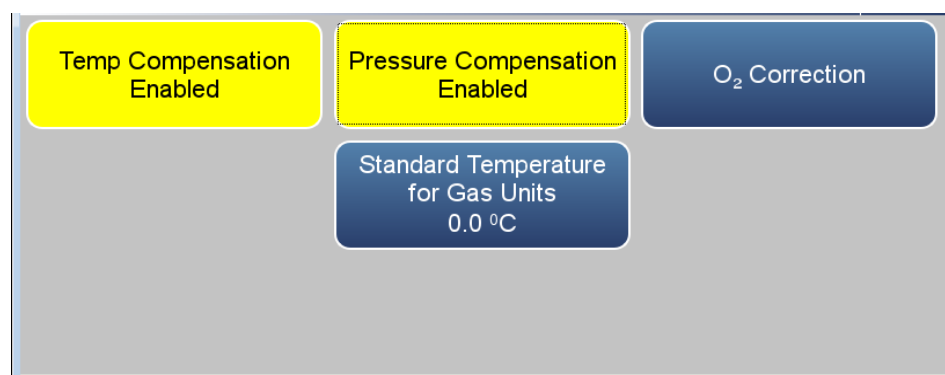
The Compensation screen contains the following information:

● *Temp Compensation:* Toggles temperature compensation enabled or disabled and provides compensation for any changes to the instrument's output signal due to internal instrument temperature variations. The effects of internal instrument temperature changes on the analyzer's subsystems and output have been empirically determined. This empirical data is used to compensate for any changes in temperature.

● *Pressure Compensation:* Toggles pressure compensation enabled or disabled and provides compensation for any changes to the instrument's output signal due to bench pressure variations. The effects of bench pressure changes on the analyzer's subsystems and output have been empirically determined. This empirical data is used to compensate for any change in chamber pressure.

● *O_2 Correction:* Allows for the correction of the CO concentration based on O_2 readings.

● *Standard Temperature for Gas Units:* Allows the user to enter a value between 0 and 30 °C to correct the $\mu g/m^3$, mg/m^3, and g/m^3 concentration calculations.
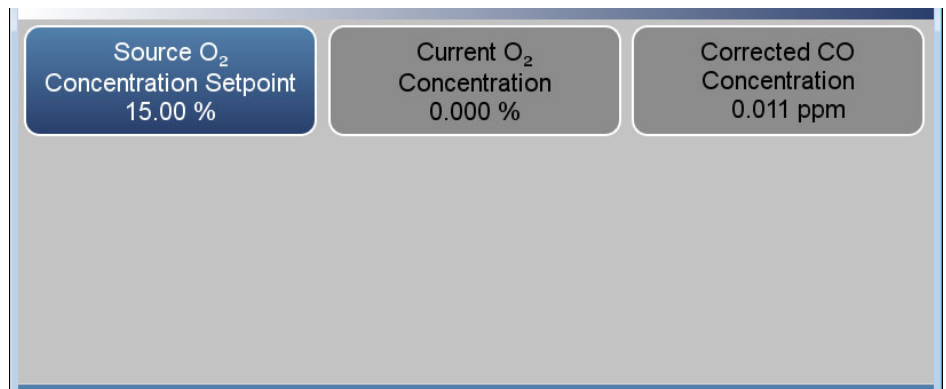
O₂ Correction

When O_2 correction is enabled, the following equation is applied to the concentration value to generate a corrected value. The corrected value may be output on the analog outputs, stored in logging memory, or output as streaming data. The corrected values are not displayed on the Home Screen on the front panel, only the non-corrected values.

$$C_{comp} @ O2_{corr} = C * \left(\frac{20.9 - O2_{corr}}{20.9 - O2_{meas}} \right)$$

Abbreviations: C is the measured concentration, $O2_{corr}$ is the oxygen concentration that C is corrected to (this value is set by the user in the Source O_2 Concentration Setpoint screen and defaults to 15%). $O2_{meas}$ is the measured O_2 concentration, which is clamped at 20.8% to prevent divide-by-zero errors. C_{comp} is the corrected concentration that may be used for analog outputs or datalogging.

Home Screen>Settings>Measurement Settings>Advanced Measurement Settings>Compensation>O₂ Correction (single range mode)

Source O₂ Concentration Setpoint 15.00 %	Current O₂ Concentration 0.000 %	Corrected CO Concentration 0.011 ppm

Home Screen>Settings>Measurement Settings>Advanced Measurement Settings>Compensation>O₂ Correction (dual or auto range mode)
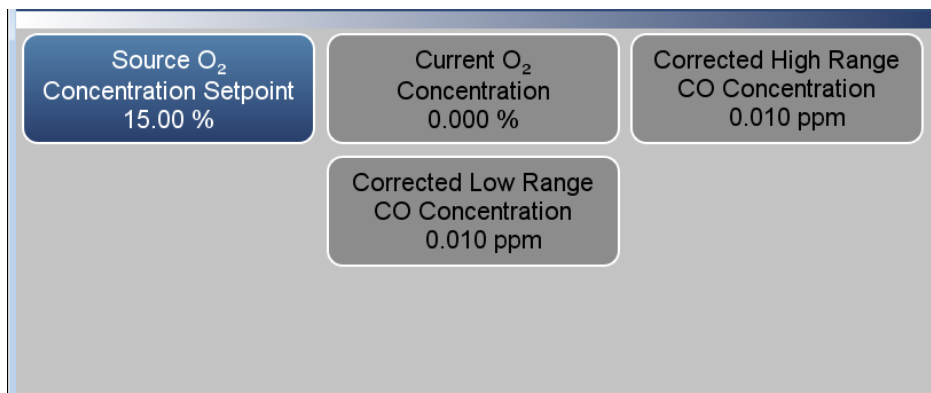
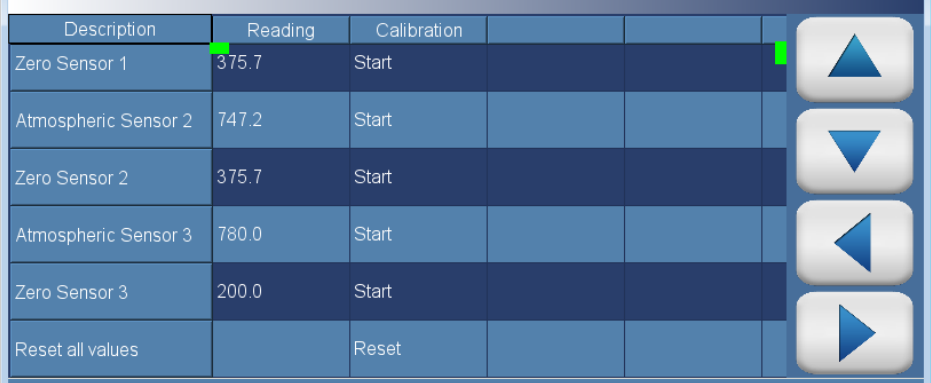The Compensation screen contains the following information:

● *Source O₂ Concentration Setpoint:* User enters expected O_2 concentration.

● *Current O₂ Concentration:* Read only. Displays current O_2 reading.

● *Corrected CO Concentration:* Read only. Displays the corrected CO concentration when in single range mode.

● *Corrected High Range CO Concentration:* Read only. Displays the corrected high range CO concentration when in dual or auto range mode.

● *Corrected Low Range CO Concentration:* Read only. Displays the corrected low range CO concentration when in dual or auto range mode.

Pressure Calibration

The Pressure Calibration screen is used to calibrate the pressure sensor to zero, span, or factory default values.

Use the ▲ and ▼ buttons to move up and down and the ◄ and ► buttons to move left and right.

Home Screen>Settings>Measurement Settings>Advanced Measurement Settings>Pressure Calibration

Description	Reading	Calibration			
Zero Sensor 1	375.7	Start			▲
Atmospheric Sensor 2	747.2	Start			▼
Zero Sensor 2	375.7	Start			◄
Atmospheric Sensor 3	780.0	Start			►
Zero Sensor 3	200.0	Start			
Reset all values		Reset			

The Pressure Calibration screen contains the following information:

● Across:

  ● *Description:* Lists items in table.

  ● *Reading:* Displays reading of each pressure sensor.

  ● *Calibration:* Starts calibration or resets default values.

● Down:

  ● *Sensor 1–3 Reading:* Under the column labeled Reading, current reading of each pressure sensor.

  ● *Atmospheric Sensor 1–3:* Under the column labeled reading, the user enters the current atmospheric pressure in mmHg units. Under the column labelled Calibration, the user presses the Start button to calibrate the high point of the sensor.

  ● *Zero Sensor 1–3:* User should put the pressure sensor under a strong vacuum. Under the column labeled reading, the user enters the pressure in mmHg. Under the column labeled Calibration, the user presses the Start button to calibrate the low point of the sensor.

  ● *Reset all values:* Resets values to default.

Communications   The Communications screen allows the user to set TCP/DHCP parameters, Serial settings, Analog I/O and Digital I/O, Email Server, and Instrument ID. Buttons are grayed out if not selected in Settings>**Configuration**.

Home Screen>Settings>Communications

The Communications screen contains the following information:

● *Wired TCP/DHCP:* Settings for communicating with the instrument through wired Ethernet.

● *Serial RS-232/485:* Settings for communicating with the instrument through RS-232/485 protocol. This is only visible if selected in Settings>Configuration>Communications Board.

● *Analog I/O:* Settings for communicating with the instrument through analog I/O settings. This is only visible if selected in Settings>Configuration>Analog I/O.

● *Digital I/O:* Settings for communicating with the instrument through digital I/O settings. This is only visible if selected in Settings>Configuration>Digital I/O.

● *Email Server (SMTP):* Settings for communication with email.

● *Instrument ID:* Allows the user to edit the instrument identification number (ID). The ID is used to identify the instrument when using protocols to control the instrument or collect data. It may be necessary to edit the ID number if two or more of instruments of the same model are connected to one computer. Valid instrument ID numbers are from 0 to 127. The 48iQ has a default instrument ID of 1.

● *Bayern Hessen Settings:* User selects the registers (measured values) that the instrument should respond with, in response to a valid data query (DA) command.

Note Refer to the "Bayern Hessen Protocol" section in the *Communications Manual* for a detailed description. ▲

● *Ethernet Protocol Selection:* Allows the user to enable Streaming, Modbus, or Bayern Hessen to utilize the mobile app and/or those communication protocols.
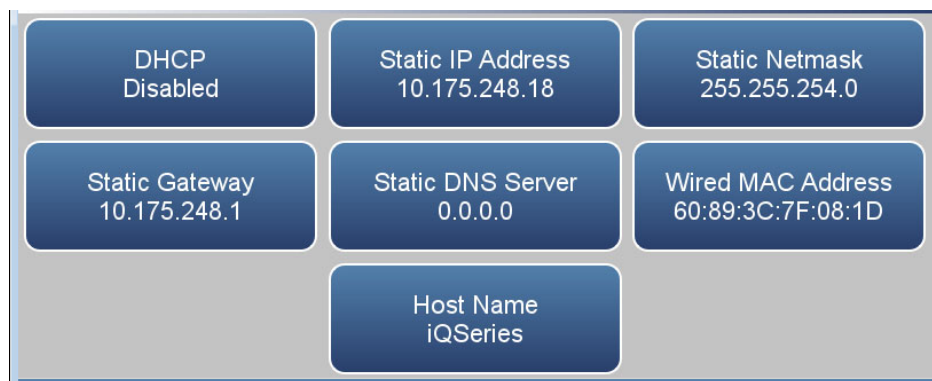
Wired TCP/DHCP   The Wired TCP/DHCP screen allows the user to communicate with the instrument via wired TCP/IP settings.

Note When DHCP is enabled, the dynamic IP address is used. When DHCP is disabled, the static IP address is used. ▲

Home Screen>Settings>Communications>Wired TCP/DHCP (with DHCP enabled)

Home Screen>Settings>Communications>Wired TCP/DHCP (with DHCP disabled)

The Wired TCP/DHCP screen contains the following information:

● *DHCP:* Toggles DHCP enabled/disabled.

● *Dynamic IP Address:* Dynamic IP address of the instrument.

● *Dynamic Netmask:* Dynamic Netmask of instrument.

● *Dynamic Gateway:* Dynamic Gateway of instrument.

- *Static IP Address:* Static IP address of the instrument. This is settable when DHCP is disabled.

- *Static Netmask:* Static Netmask of instrument. This is settable when DHCP is disabled.

- *Static Gateway:* Static Gateway of instrument. This is settable when DHCP is disabled.

- *DNS Server Address:* DNS IP address of instrument. This is settable when DHCP is disabled.

- *Wired MAC Address:* Instrument MAC address.

- *Host Name:* Host name of instrument.

Serial RS-232/485 The Serial RS-232/485 screen allows the user to setup serial communication. This is only visible if selected in Settings>Configuration>**Communications Board**.

Home Screen>Settings>Communications>Serial RS-232/485

The Serial RS-232/485 screen contains the following information:

● *Protocol:* User selects Streaming, Modbus, or Bayern Hessen.

● *Baud Rate:* User selectable baud rates from 1200 to 115200.

● *Bits:* User selectable between 7 and 8.

● *Parity:* User selectable between None, Even, and Odd.

● *Stop Bits:* User selectable between 1 and 2.

● *RS 232/485:* User selectable between RS-232 and RS-485.

Analog I/O
The Analog I/O screen allows for configuring the analog inputs/outputs. This is only visible if selected in Settings>Configuration>**Analog I/O**.

Home Screen>Settings>Communications>Analog I/O
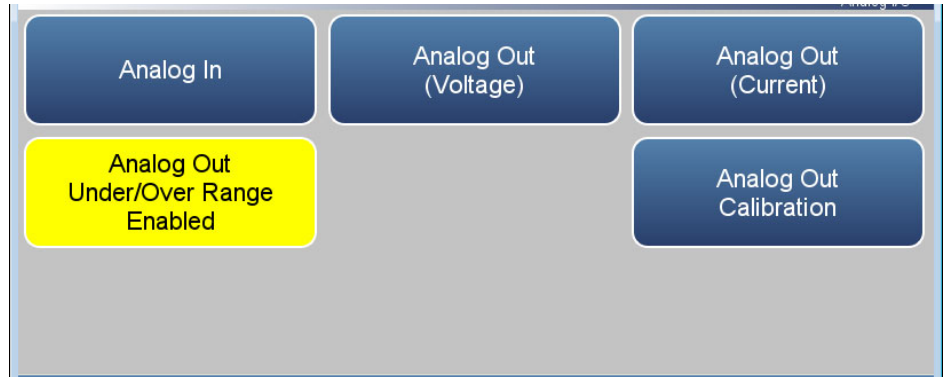
The Analog I/O screen contains the following information:

- *Analog In:* Allows the user to view and calibrate voltage inputs from external devices.

- *Analog Out (Voltage):* Allows the user to view voltage outputs.

- *Analog Out (Current):* Allows the user to view current (mA) outputs.

- *Analog Out Under/Over Range Enabled/Disabled:* Allows the user to select whether or not the analog outputs are allowed to exceed the selected output range.

- *Analog Out Calibration:* Allows the user to calibrate the analog out voltage and current to account for varying loads attached to the terminals.

Digital I/O   The Digital I/O screen allows for configuring the digital inputs/outputs. This is only visible if selected in Settings>Configuration>**Digital I/O**.

Home Screen>Settings>Communications>Digital I/O

The Digital I/O screen contains the following information:

● *Digital In:* Allows the user to view digital inputs from external devices.

● *Digital Out (Relays):* Allows the user to view relay outputs.

● *Digital Out (Solenoids):* Allows the user to view solenoid outputs.

● *Advanced Digital I/O:* Allows user to test the digital out relays and solenoids.

Email Server (SMTP)

The Email Server (SMTP) screen allows the user to configure their email preferences.

Home Screen>Settings>Communications>Email Server (SMTP)

The Email Server (SMTP) screen contains the following information:

● *SMTP Server Address:* Address of the user's email server.

● *From Email Address:* The email address that goes in the From field in emails.

● *SMTP Server Port:* Server port of user's email server.

● *Email Password:* Password for SMTP server.

● *Email UserName:* User name that is authorized to send email through SMTP server.

Bayern Hessen Settings   The Bayern Hessen Settings screen allows the user to select up to 8 registers as the measured values to be logged.

Use the ▲ and ▼ buttons to move up and down and the ◄ and ► buttons to move left and right.

Home Screen>Settings>Communications>Bayern Hessen Settings

	Bayern Hessen Register Selection		
Number	Register	Meter Number	
1	None	101	▲
2	None	102	▼
3	None	103	◄
4	None	104	
5	None	105	►
6	None	106	

The Bayern Hessen Settings screen contains the following information:

- Across:

  - *Number:* Lists up to 8 registers that can selected by the user.

  - *Register:* User selects the measured values to be logged.

  - *Meter Number:* Allows the user to choose the meter/register number (001 to 999) that will preface the measured value in the response to the 'DA' command.

- Down:

  - *1–8:* Displays the register number and the measured values to be logged in the respective register location, in response to a valid query (DA) command.

**Ethernet Protocol
Selection**

The Ethernet Protocol Selection screen allows the user to select the enable Streaming, Modbus, or Bayern Hessen to utilize the mobile app and/or those communication protocols.

Press **Commit changes** button to save selections. Yellow buttons indicate that the selection is enabled. More than one can be chosen.

Home Screen>Settings>Communications>Ethernet Protocol Selection
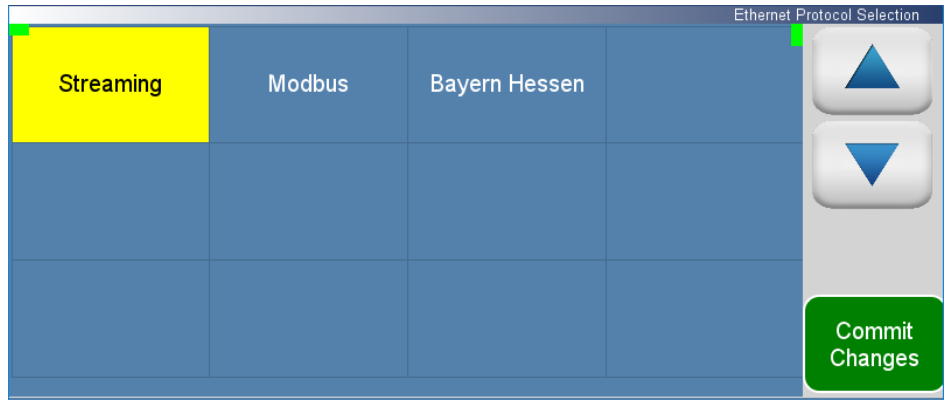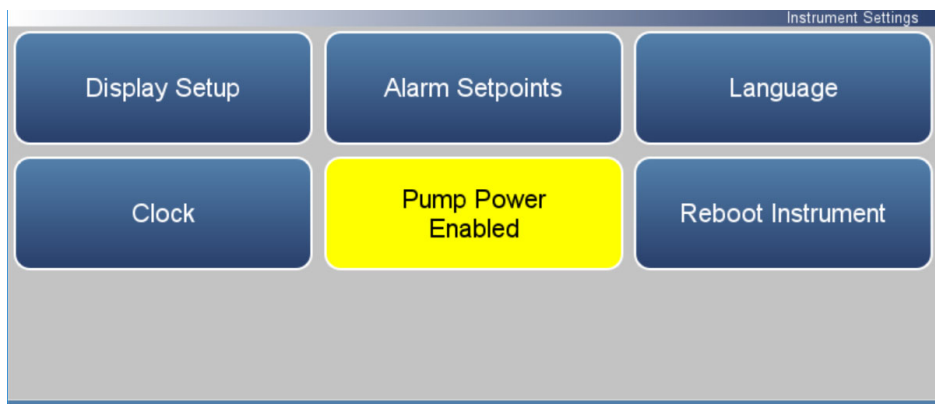

The Ethernet Protocol Selection screen contains the following information:

● Streaming

● Modbus

● Bayern Hessen

Instrument Settings

The Instrument Settings screen allows the user to configure various instrument settings.

Home Screen>Settings>Instrument Settings

The Instrument Settings screen contains the following information:

● *Display Setup:* Sets touch screen display settings.

● *Alarm Setpoints:* View and set all available alarm minimum and maximum values.

● *Language:* Sets language.

● *Clock:* Sets date and time.

● *Pump Power:* Manually enables/disables the pump.

● *Reboot Instrument:* Reboots the instrument.

Display Setup   The Display Setup allows the user to change the brightness of the display and choose power save option.

Home Screen>Settings>Instrument Settings>Display Setup

Power Save Enabled	Power Save Setting 5 min	Brightness 50
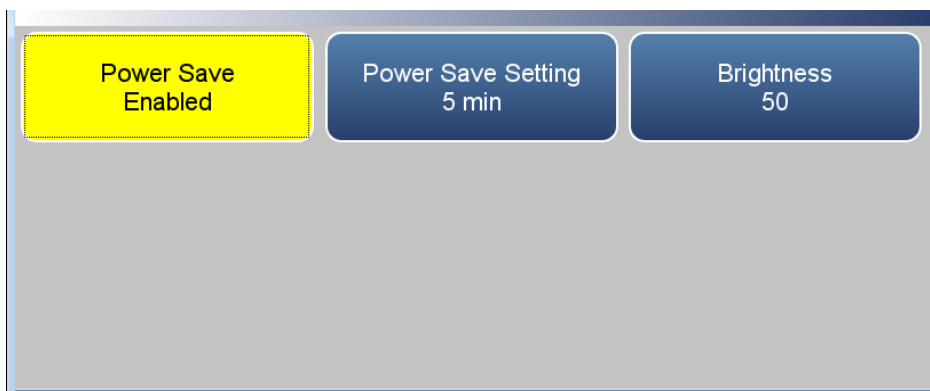
The Display Setup screen contains the following information:

- *Power Save:* Minutes before screen times out. Toggles enable/disable.

- *Power Save Setting:* Option whereby the user can display a black screen after a set amount of inactivity.

- *Brightness:* Sets the brightness of the display.

Alarm Setpoints   The Alarm Setpoints screen allows the user to view and set all settable alarm minimum and maximum values. Alarm setpoints can also be set in Settings>Health Check>Status and Alarms screens.

Note User cannot set alarm limits outside of the acceptable range. The minimum and maximum alarm limit can also be set by pressing on the corresponding buttons located in the Settings>Health Check>Status and Alarms screen. See "Status and Alarms" on page 3-44. ▲

Use the ▲ and ▼ buttons to move up and down and the ◀ and ▶ buttons to move left and right.

Home Screen>Settings>Instrument Settings>Alarm Setpoints

Item	Value	Low Alarm	High Alarm	Units
CO	0.016	0.0	0.0	ppm
Bkg Check Offset	0.000	--	10.0	ppm
Span Check Offset	0.000	--	10.0	ppm
Instrument Temperature	36.6	8.0	47.0	ºC
Bench Pressure	754.819	600.000	800.000	mmHg
Flow	1.197	0.350	1.500	L/min

The Alarm Setpoints screen contains the following information:

● Across:

  ● *Item:* Lists the items that have settable alarm limits.

  ● *Value:* Displays the current value for each item.

  ● *Low Alarm:* User sets low alarm for item.

  ● *High Alarm:* User sets high alarm for item.

  ● *Units:* Units for each item (not settable).

● Down:

  ● *CO:* CO concentration alarm.

  ● *Bkg Check Offset:* User can set the maximum allowable background reading offset for calibration and calibration checks. This is set with the high alarm only.

- *Span Check Offset:* User can set the maximum allowable span reading offset for calibration and calibration checks. This is set with the high alarm only.

- *Instrument Temperature:* Instrument temperature alarm.

- *Bench Pressure:* Bench pressure alarm.

- *Flow:* Flow pressure alarm.

- *O₂ concentration:* O_2 concentration alarm (if enabled).

Language   The Language screen allows the user to choose from the following languages.
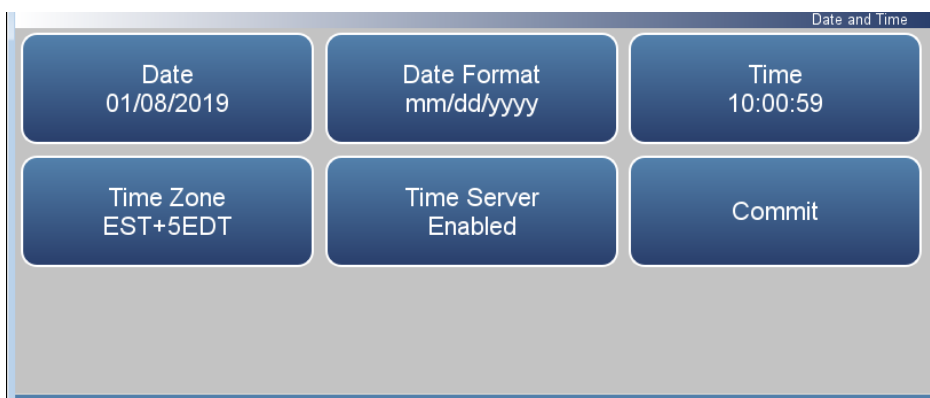
Home Screen>Settings>Instrument Settings>Language

The Language screen contains the following information:

● English

● Chinese

● Spanish

Clock   The Clock screen allows the user to set the instrument's date and time, choose date/time format, time zone, and time server.

Home Screen>Settings>Instrument Settings>Clock

The Clock screen contains the following information:

- *Date:* User sets date.
- *Date Format:* User selects date format.
- *Time:* User sets time.
- *Time Zone:* User chooses time zone.
- *Time Server:* User can enable/disable the time server to get periodic clock updates.
- *Commit:* When pressed, clock settings are saved.

Date   The Date screen allows the user to choose date.

Use the ◀ and ▶ buttons to move left and right to select month and year.

Home Screen>Settings>Instrument Settings>Clock>Date
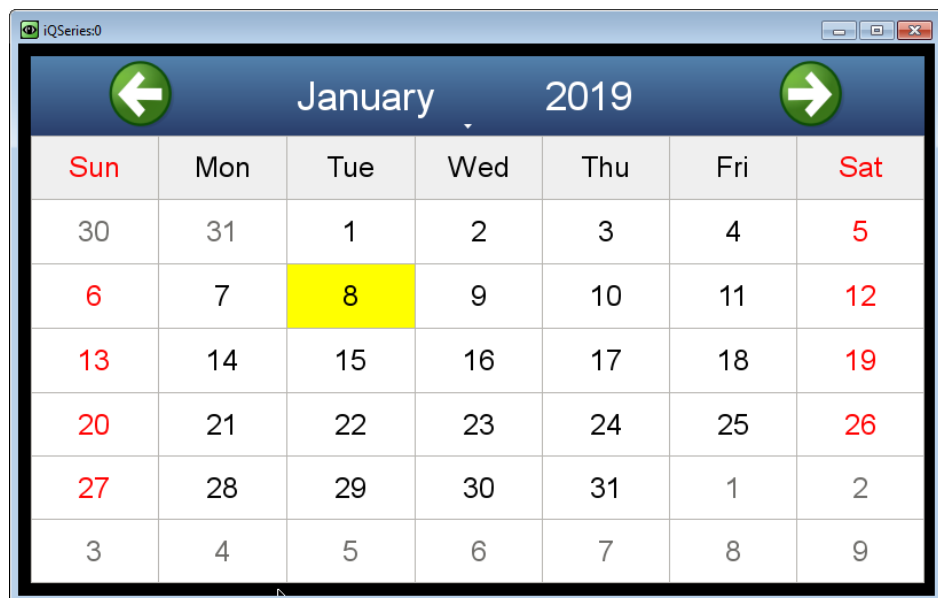
Date Format   The Date Format screen allows the user to choose from the following formats: mm/dd/yyyy or dd/mm/yyyy.

Use the ▲ and ▼ buttons to select.

Home Screen>Settings>Instrument Settings>Clock>Date Format

The Date Format screen contains the following information:

- U.S. Format mm/dd/yyyy

- European Format dd/mm/yyyy

- ISO 8601 yyyy-mm-dd

Time   The Time screen allows the user to choose from the following formats: mm/dd/yyyy or dd/mm/yyyy.

Use the ▲ and ▼ buttons to select.

Home Screen>Settings>Instrument Settings>Clock>Time
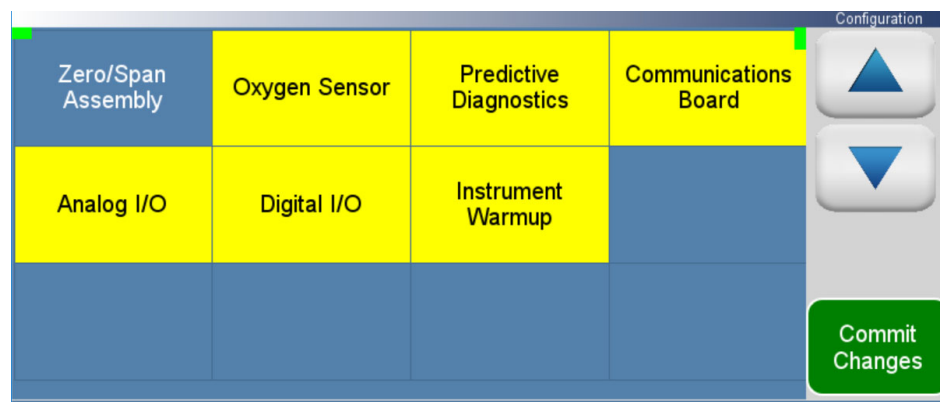

The Time screen contains the following information:

● Hours

● Minutes

● Seconds

Time Zone   The Time Zone screen allows the user to set the time zone for the Network Time Protocol (NTP) server. This should be set to the time zone that the instrument is located in.

Use the ▲ and ▼ buttons to select.

Home Screen>Settings>Instrument Settings>Clock>Time Zone

The Time Zone screen contains the following information:

● Date Line West(UTC-12)

● Samoa Time Zone(UTC-11)

● Aleutian Time Zone(UTC-10)

● Alaskan Time Zone(UTC-9)

● Pacific Time Zone(UTC-8)

● Pacific Daylight Savings(UTC-7)

● Mountain Time Zone(UTC-7)

● Mountain Daylight Savings(UTC-6)

● Central Time Zone(UTC-6)

● Central Daylight Savings((UTC-5)

● Eastern Time Zone(UTC-5)

● Eastern Daylight Savings(UTC-4)

● Atlantic Time Zone(UTC-4)

● Mid-Atlantic(UTC-3)

● South Georgia(UTC-2)

● Cape Verde Time(UTC-1)

- Coordinated Universal Time(UTC-0)

- Central European Time(UTC+1)

- Eastern European Time(UTC+2)

- Further-Eastern European Time(UTC+3)

- Gulf Standard Time(UTC+4)

- Yekaterinburg Time(UTC+5

- Omsk Time(UTC+6)

- Indochina Time(UTC+7)

- ASEAN Common Time(UTC+8)

- Japan Standard Time(UTC+9)

- Chamorro Time Zone(UTC+10)

- Sredmnekolymsk Time(UTC+11)

- New Zealand Standard Time(UTC+12)

Time Server   The Time Server screen allows the user to enable/disable the time server to get periodic clock updates.

Home Screen>Settings>Instrument Settings>Clock>Time Server

The Time Server screen contains the following information:

● *Time Server:* Enables/Disables periodic clock updates from an NTP (Network Time Protocol) source.

● *Set Time Server:* User can choose specific time server.

● *Set Default:* When pressed, default time server will be used.

Configuration

The Configuration screen allows the user to enable optional features. If an option is disabled, the corresponding buttons will be grayed out and the screens will not be available.

Use the ▲ and ▼ buttons to select the variables. Next, press the **Commit Changes** button to save selections. Yellow buttons indicate that the variable is selected. More than one can be chosen.

Home Screen>Settings>Configuration

The Configuration screen contains the following information:

● *Zero/Span Assembly:* Enables zero/span option.

● *Oxygen Sensor:* Enables O_2 sensor option.

● *Predictive Diagnostics:* Enables predictive diagnostics option.

● *Communications Board:* Enables RS-232 or RS-485 communication board option.

● *Analog I/O:* Enables analog I/O option.

● *Digital I/O:* Enables digital I/O option.

● *Instrument Warmup:* Enables instrument warm up option.

Security Access Levels

The Access Levels screen allows the user to set the instrument to either View Only or Full Access. When in Full Access, the user will have access to all screens. When set to View Only, user will not be able to change any values.

Home Screen>Settings>Security Access Levels (Full Access)
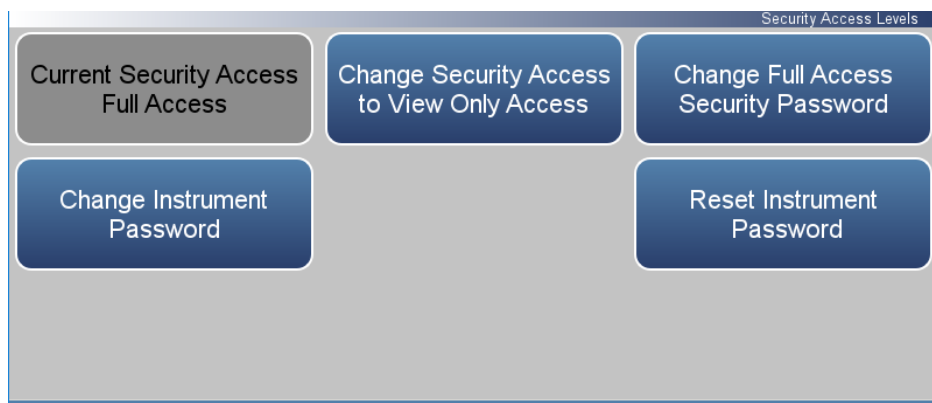
Home Screen>Settings>Security Access Levels (View Only Access)

The Security Access Levels screen contains the following information:

● *Current Security Access Full Access:* Read only. User will be able to change all values. Password is needed for full access.

● *Current Security Access View Only:* Read only. User won't be able to change any values. Password is not needed for view only.

● *Change Security Access to View Only:* User can switch to view only mode. Password not needed to change settings to view only access.

● *Change Security Access to Full Access:* User can switch to full access mode. Password is needed to change settings to full access.

- *Change Full Access Security Password:* Full access password can have a blank value or user selected password.

- *Change Instrument Password:* User can change instrument password.

- *Reset Instrument Password:* User can reset the instrument password.
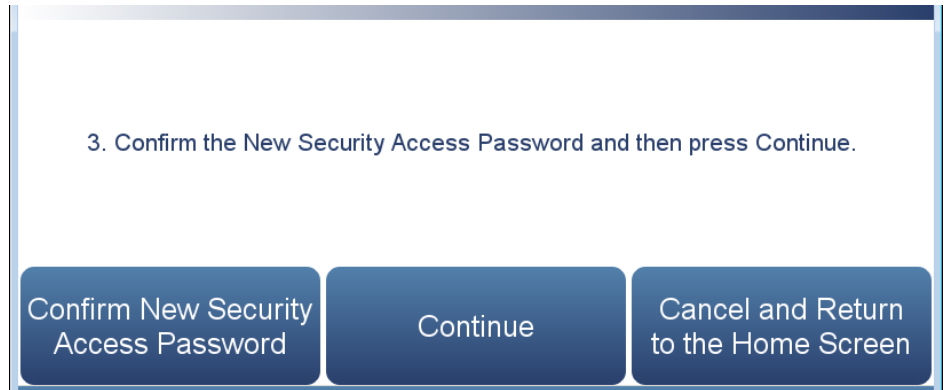
Change Security to View Only Access

The Change Security to View Only Access screen allows the user to set the instrument to view only.

Home Screen>Settings>Security Access Levels>Change Security Access to View Only Access
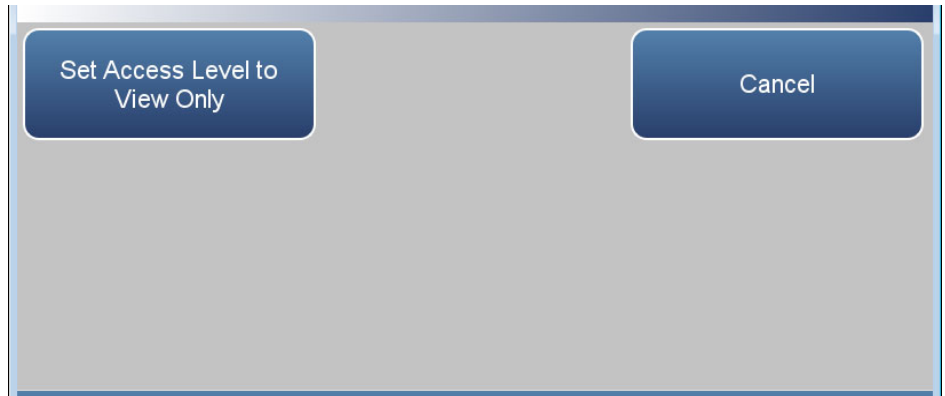
The Change Security to View Only Access screen contains the following information:

● *Set Access Level to View Only:* Programs the instrument to be in the view only access level, where the user won't be able to change any values.

● *Cancel:* Exit screen.

Note To change security access from view only access to full access, a keypad will be displayed where the user can enter full access password. ▲

Change Full Access Security Password

The Change Full Access Security Password screen allows the user to set a new password for allowing full access.

Home Screen>Settings>Security Access Levels>Change Full Access Security Password

To Change the Security Access Password perform the following steps using the graphical user interface only (do not use an external USB keyboard):
1. Enter the Current Security Access Password
2. Enter the New Security Access Password
3. Confirm the New Security Access Password
4. Commit the New Security Access Password Change
Note: To clear the Full Access Password, follow the steps above using blank values for the New Password.

Continue | Cancel and Return to the Home Screen

Home Screen>Settings>Security Access Levels>Change Full Access Security Password>Continue

Security Access Levels

1. Enter the Current Security Access Password and then press Continue.
If there is no Current Full Access Password then press Continue.

Enter Current Security Access Password | Continue | Cancel and Return to the Home Screen

2. Enter the New Security Access Password and then press Continue.

Set New Security Access Password | Continue | Cancel and Return to the Home Screen

3. Confirm the New Security Access Password and then press Continue.

| Confirm New Security Access Password | Continue | Cancel and Return to the Home Screen |

4. Commit the New Security Access Password Change

| Commit New Security Access Password Change | Cancel and Return to the Home Screen |

The Change Full Access Security Password screens contain the following information:

- *Enter Current Security Password:* User enters current security password. Default password is blank.

- *Continue:* Proceeds to next screen.

- *Enter New Security Access Password:* User enters new security password.

- *Confirm New Security Access Password:* User confirms new security password for spelling confirmation.

- *Commit New Security Access Password Change:* Commits new security password.

- *Cancel and Return to the Home Screen:* Exits screen and returns to the Home Screen without changing password.

Change Instrument Password

The Change Instrument Password screen allows the user to change the instrument password.

Home Screen>Settings>Security Access Levels>Change Instrument Password

Home Screen>Settings>Security Access Levels>Change Instrument Password>Continue
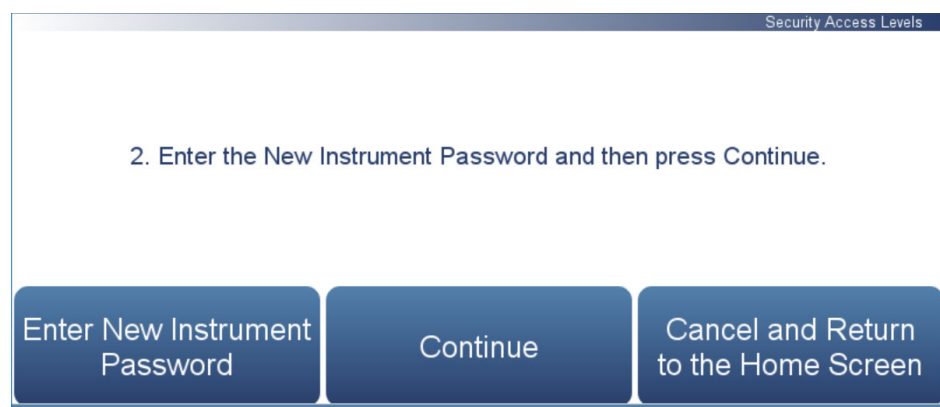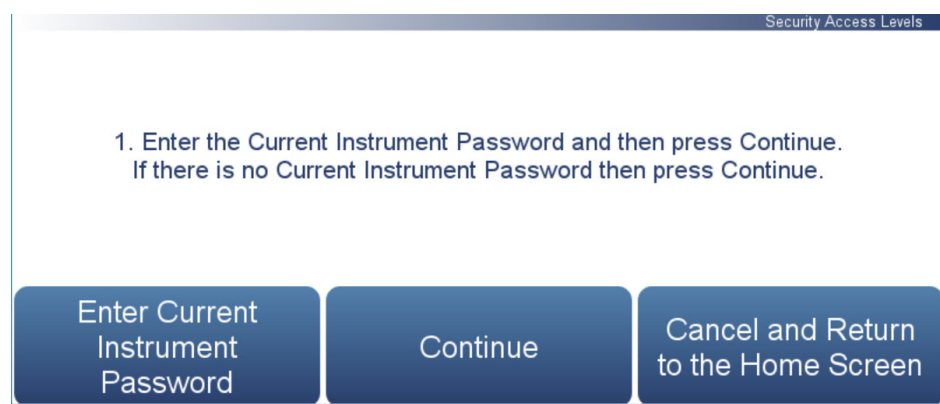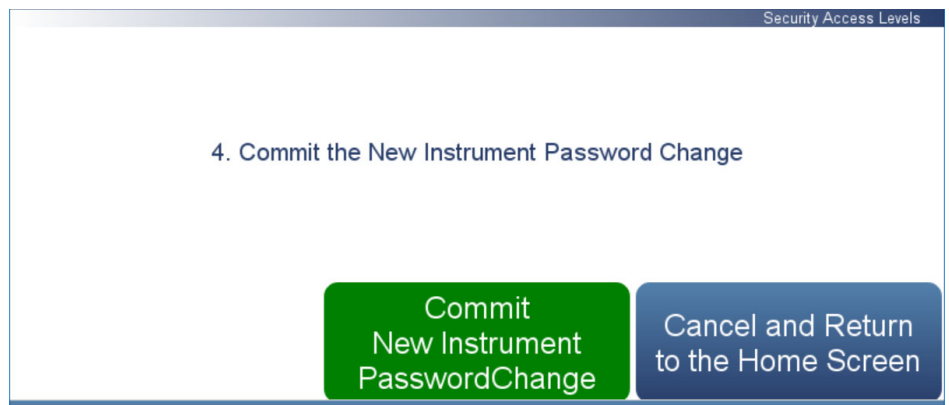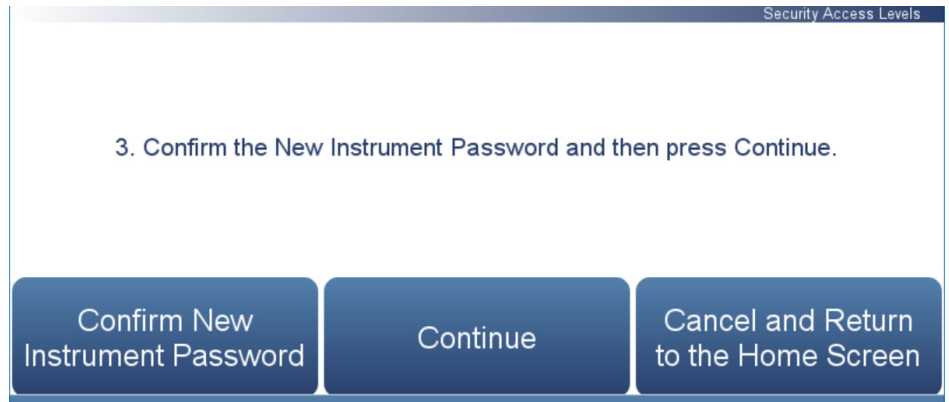
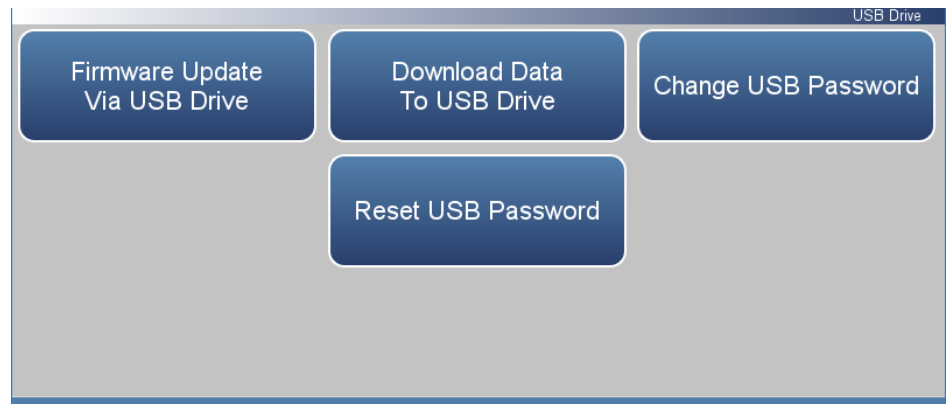The Change Instrument Password screen contains the following information:

● *Enter Current Instrument Password:* User enters current instrument password.

● *Continue:* Proceeds to next screen.

● *Enter New Instrument Password:* User enters new instrument password.

● *Confirm New Instrument Password:* User confirms new instrument password for spelling confirmation.

● *Commit New Instrument Password Change:* Commits new instrument password.

● *Cancel and Return to the Home Screen:* Exits screen and returns to the Home Screen without changing password.

Reset Instrument Password

The Reset Instrument Password screen allows the user to reset the instrument password for Database, SNMP, and VNC.

The default instrument password format is an alternating combination of instrument serial number and installed firmware build number. For example if your instrument serial number is 123456789 and the instrument firmware version is 1.6.8.ABCDE where the last five digits are the build number, then the default instrument password number will be 1A2B3C4D5E6789.

Home Screen>Settings>Security Access Levels>Reset Instrument Password
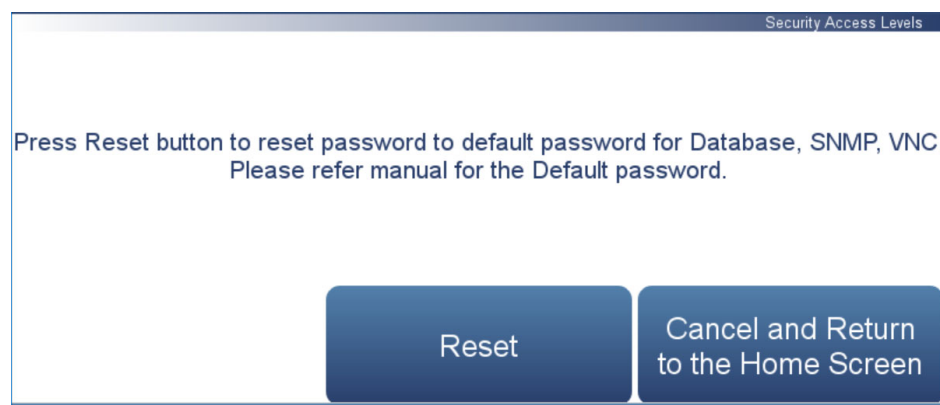
Security Access Levels

Press Reset button to reset password to default password for Database, SNMP, VNC.
Please refer manual for the Default password.

Reset   Cancel and Return to the Home Screen

The Reset Instrument Password screen contains the following information:

● *Reset:* Allows the user to reset the instrument password.

● *Cancel and Return to the Home Screen:* Exits screen and returns to the Home Screen without changing password.

USB Drive

The USB Drive screen allows the user to update firmware, download/upload information, and change the USB password.

Note The USB drive screen only is useable when a USB drive is inserted into the USB port. When a USB drive is inserted, the user is prompted to enter the password if a password has been set. ▲

Home Screen>Settings>USB Drive

The USB Drive screen contains the following information:

● *Firmware Update Via USB Drive:* If USB is mounted, user can update instrument firmware.

● *Download Data To USB Drive:* If USB is mounted, user can download/upload information.

● *Change USB Password:* User can change the USB password.

● *Reset USB Password:* User can reset the USB password.

Firmware Update Via USB Drive

The Firmware Update Via USB Drive screen allows the user to update instrument firmware from the USB drive.

Home Screen>Settings>USB Drive>Firmware Update Via USB Drive

New firmware update is available.
Would you like to update?

Update Firmware   Exit
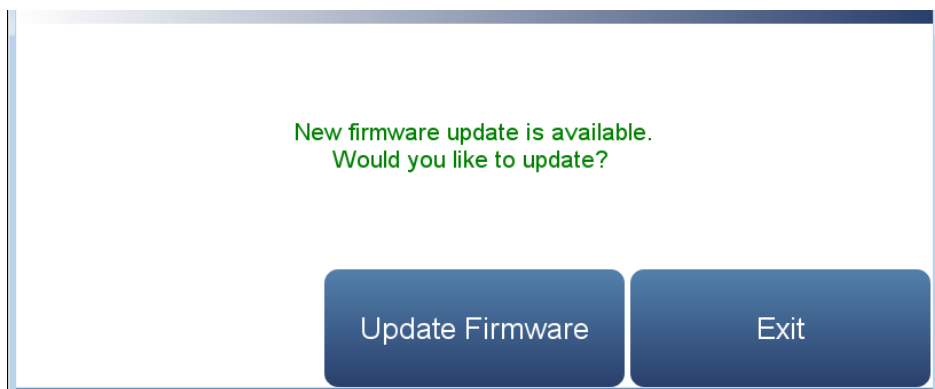
The Firmware Update Via USB Drive screen contains the following information:

● *Update Firmware:* User chooses firmware file from USB and updates instrument firmware. Instrument reboots when update is finished.

● *Exit:* User exits without updating firmware.

Use the following procedure to update firmware using the USB connection.

1. Copy the update*.zip file onto the USB FLASH drive using Windows Explorer or another means. The file must be copied into the root directory of the USB stick's file system otherwise it won't be recognized. Also, make sure the USB stick is formatted using the FAT or FAT32 file system.

2. Plug a USB flash drive into the data port on the front panel of the unit or into one of the USB ports on the side near the power cable. A pop-up box will appear, acknowledging that a flash drive has been detected. If a USB password has been previously set, you will be prompted to enter the USB password to continue. Press **Enter** to continue.


3. Press the OK button on the pop-up box to go to the Firmware Update Via USB Drive screen.

4. Press the **Firmware Update Via USB Drive** button to start the firmware update process.
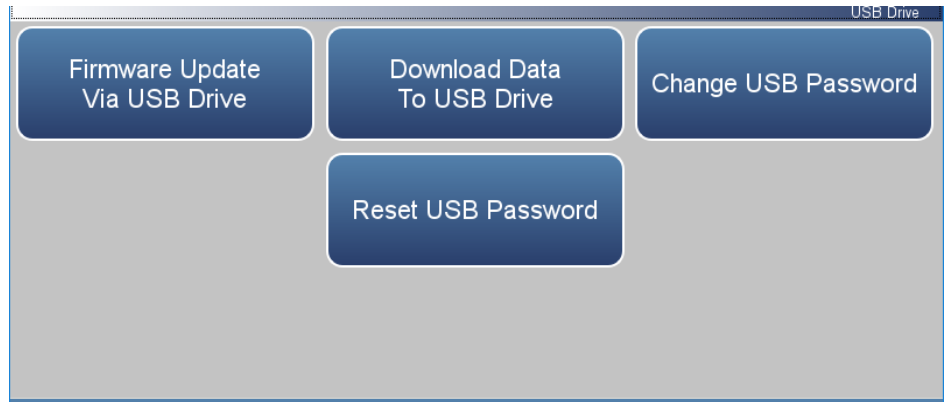
5. Press the **Update Firmware** button.
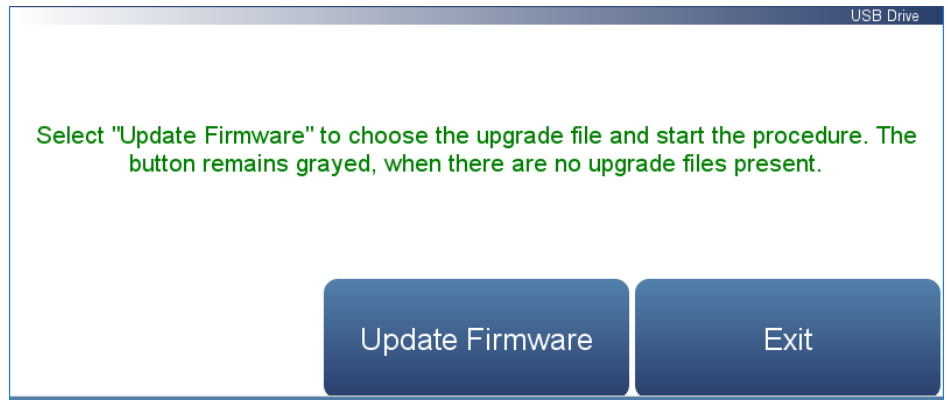
6. The on-screen instructions will prompt the user to select the firmware update file and display what it is doing at each step and some steps may take several minutes to complete.

7. Press **Yes** to confirm and proceed with the firmware upgrade.

Note **Do not power off the instrument while the firmware update is in progress**. ▲

8. The instrument should reboot automatically and should have the new firmware installed. To check that the firmware was installed, go to the **Settings>Health Check** screen and view the Firmware Version button.

Update Firmware

Updates Installed Successfully

System will reboot in 10 seconds ...
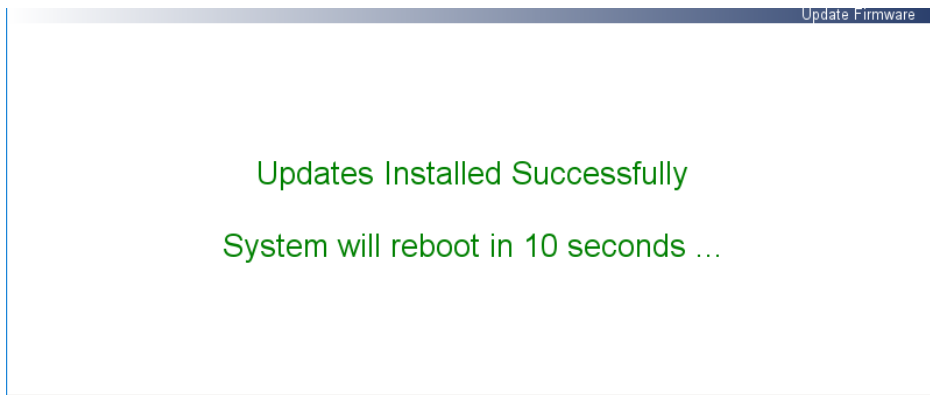
Download Data To USB Drive

The Download Data To USB Drive screen allows the user to download/upload data to/from the USB drive.

Home Screen>Settings>USB Drive>Download Data To USB Drive
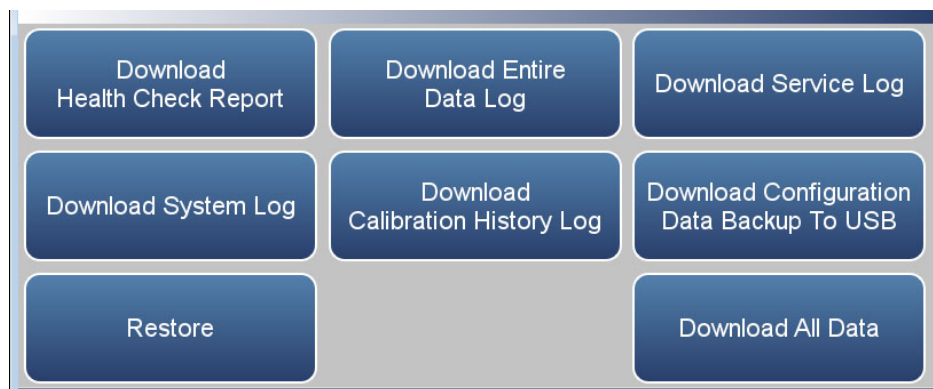
The Download Data to USB Drive screen contains the following information:

- *Download Health Check Report:* Includes status and alarms, preventive maintenance, and maintenance history.

- *Download Entire Data Log:* Includes the entire data log (from data logging).

- *Download Service Log:* Includes a complete listing of data for all variables. This is set at the factory.

- *Download System Log:* Consists of system log text files, which include a listing of system errors.

- *Download Calibration History:* Includes the data in the calibration history screen.

- *Download Configuration Data Backup to USB:* Allows the user to download the configuration file from the instrument to the USB.

- *Restore:* Allows the user to upload the configuration files from the USB to the instrument.

- *Download All Data:* Downloads all reports, logs, histories, and backup information.

Use the following procedure to download data using the USB connection.

1. Plug a USB flash drive into the USB connection on the front of the instrument. If a USB password has been previously set, you will be prompted to enter the USB password to continue. Press **Enter** to continue.

2. To continue, select the **OK** button.

3. The USB Drive will display. Select **Download Data To USB Drive**.
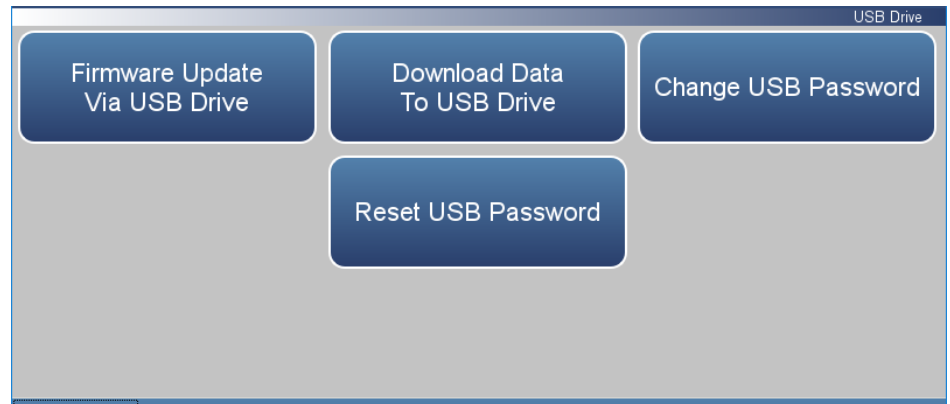
4. The Download Data to USB Drive screen will display. Select from various options to download.
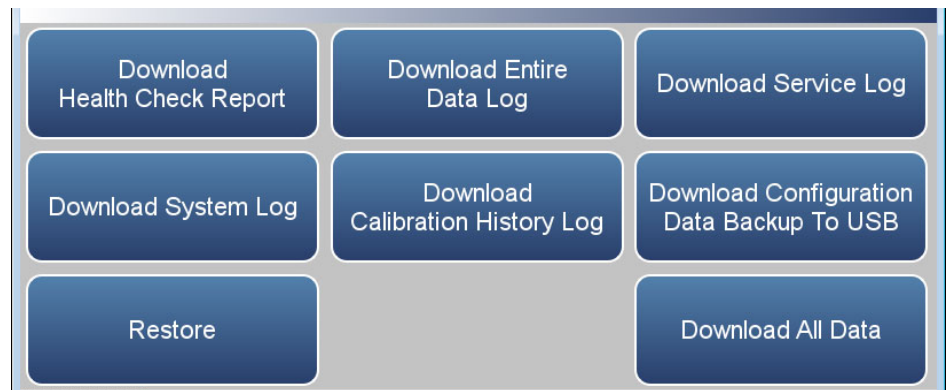
5. The instrument will display a "downloading data" message and begin transferring data to the USB drive.

Note **Do not remove the USB drive from the instrument while the data is downloading**. ▲

6. When the data download is complete, the instrument will display a "Success!" message and display the file name as it is stored on the USB flash drive. (The file name format is the instrument serial number, name of download, followed by a date/time stamp.) Remove the USB flash drive and select the OK button to continue.

Change USB Password

The Change USB Password screen allows the user to set a new password for accessing USB.

Home Screen>Settings>USB Drive>Change USB Password

To Change the USB Access Password perform the following steps using the graphical user interface only (do not use an external USB keyboard):
1. Enter the Current USB Access Password
2. Enter the New USB Access Password
3. Confirm the New USB Access Password
4. Commit the USB Access Password Change
Note: To clear the USB Password, follow the steps above using blank values for the New Password.

Continue   Cancel and Return to the Home Screen

Home Screen>Settings>Security Access Levels>Change Standard Access Password>Continue

1. Enter the Current USB Access Password and then press Continue.
If there is no Current USB Password then press Continue.

Enter Current USB Password   Continue   Cancel and Return to the Home Screen

2. Enter the New USB Access Password and then press Continue.

Enter New USB Password   Continue   Cancel and Return to the Home Screen
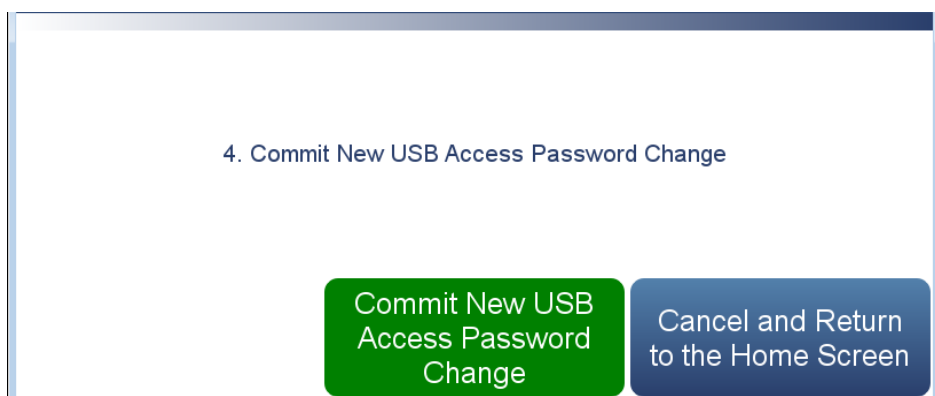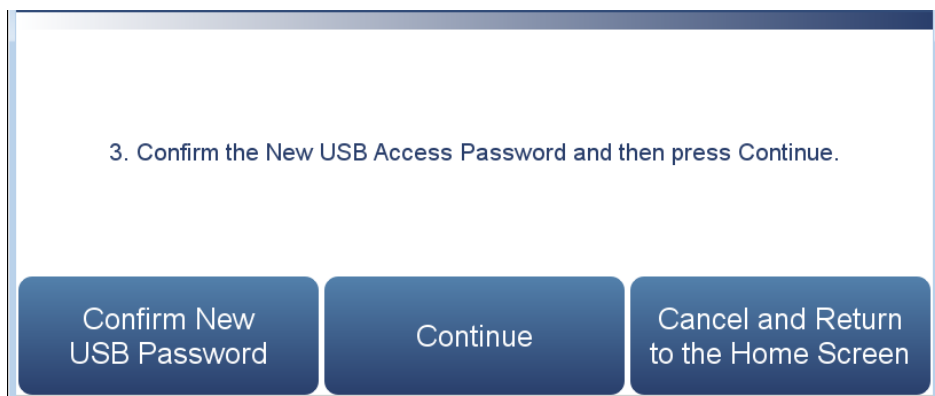
The Change USB Password screens contain the following information:

- *Enter Current USB Password:* User enters current USB password. Default password is blank.

- *Continue:* Proceeds to next screen.

- *Enter New USB Password:* User enters new USB password.

- *Confirm New Security Access Password:* User confirms new security password for spelling confirmation.

- *Commit New USB Password Change:* Commits new USB password.

- *Cancel and Return to the Home Screen:* Exits screen and returns to the Home Screen without changing password.

Reset USB Password   The Reset USB Password screen allows the user to reset the USB password.

The default USB password format is an alternating combination of instrument serial number and installed firmware build number. For example if your instrument serial number is 123456789 and the instrument firmware version is 1.6.8.ABCDE where the last five digits are the build number, then the default USB password number will be 1A2B3C4D5E6789.

Home Screen>Settings>Security Access Levels>Reset USB Password
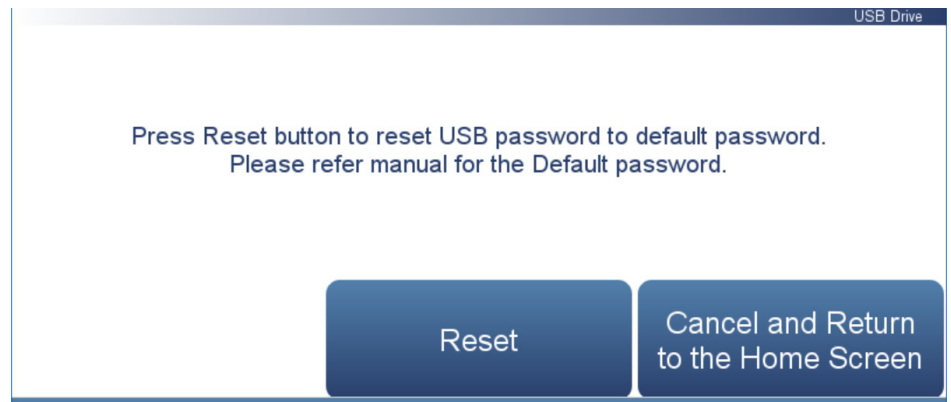
The Reset USB Password screen contains the following information:

● *Reset:* Allows the user to reset the USB password.

● *Cancel and Return to the Home Screen:* Exits screen and returns to the Home Screen without changing password.

User Contact Information

The User Contact Information screen allows the user to enter their contact information. This is useful when contacting technical support through emails found at the screen Health Check>File Sharing and Support.

Home Screen>Settings>User Contact Information

The User Contact Information screen contains the following information:

- Business Name
- User Name
- Alternate User Name
- User ID
- Business Address
- Business Shipping Address
- To: User Email Address
- CC: User Email Address 1–10
- User Phone Number
- Alternate User Phone Number
- Shelter / Lab Phone Number

Update Bootloader

The Update Bootloader screen allows the user to update bootloader and reboot the instrument. The bootloader is a small program that interfaces with our hardware and runs our operating system on power-up. The bootloader may change to optimize hardware settings or if there are changes to the hardware. If the button is blue, an update to the bootloader is available. If button is greyed out, no update is needed.

Home Screen>Settings>Update Bootloader
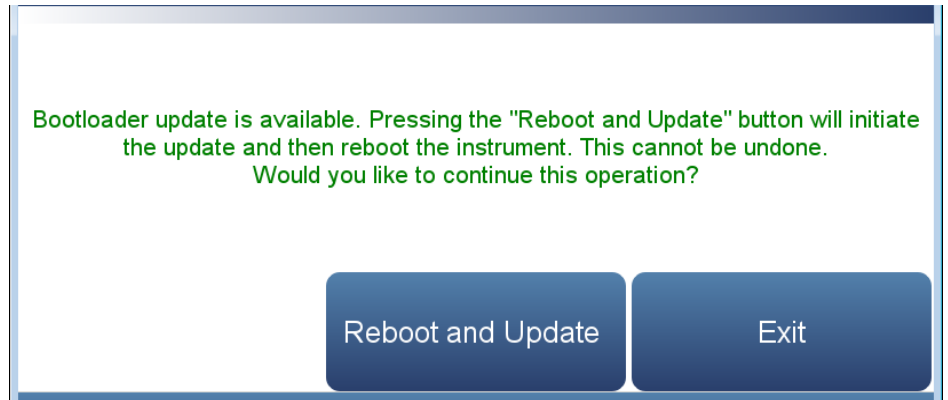
The Update Bootloader screen contains the following information:

● *Reboot and Update:* Update bootloader and reboot instrument.

● *Exit:* Exits screen.

Chapter 4
Calibration

This chapter describes the procedures for performing a standard zero/span calibration and a multipoint calibration of the 48iQ. The information described here is more than adequate to perform the calibration. However, if greater detail is needed, please refer to the *Quality Assurance Handbook for Air Pollution Measurement Systems*[1].

The following sections discuss the required apparatus and procedure for calibrating the instrument.

Equipment Required

The following equipment is required to calibrate the instrument:

CO Concentration Standard

A cylinder of CO in air containing an appropriate concentration of CO suitable for the selected operating range of the analyzer under calibration is necessary. The assay of the cylinder must be traceable either to a National Institute of Standards and Technology (NIST) CO in Air Standard Reference Material (SRM) or an NIST/EPA approved gas manufacturer's Certified Reference Material (CRM).

A recommended protocol for certifying CO gas cylinders against a CO, SRM or CRM is given in the *Quality Assurance Handbook*[1]. The CO gas cylinder should be recertified on a regular basis determined by the local quality control program.

Zero Air Generator

Calibration requires zero air that is free of contaminants which will cause a detectable response on the CO analyzer. The zero air should contain <0.01 ppm CO. Since the 48iQ is virtually interference free, it is only necessary to ensure that CO has been removed.

It should be noted that zero air as supplied in cylinders from commercial suppliers typically contains CO concentrations in the 0.1-0.3 ppm range. So cylinder zero air should be scrubbed of the residual CO prior to its use in the 48iQ as a dilution gas or a zero standard. Room air which has been scrubbed of CO can also be used as the zero air source.

It is not necessary to remove SO_2, NO, NO_2, CO_2, water vapor, or hydrocarbons, since the 48iQ does not respond to these molecules. If water

vapor is not removed, it might be necessary to correct the flow measurement data when calculating the dilution ratio of the span CO reference.

A platinum on alumina catalyst, operated at 250 °C, has been found to be a convenient oxidizer to convert CO to CO_2.

External Flow Meter(s) and Controller(s)

In order to obtain an accurate dilution ratio in the dilution method used for calibration, the flow rates must be regulated to 1%, and be measured to an accuracy of at least 2%. The meter and controller can be two separate devices, or combined in one device. The user's manual for the meter should be consulted for calibration information.

Additional information on the calibration of flow devices can be found in the *Quality Assurance Handbook*[1]. It should be noted that all flows should be corrected to 25 °C and 760 mmHg, and that care should be exercised in correcting for water vapor content.

Pre-Calibration

Prior to calibration, be sure the instrument is operating properly. Turn on the instrument and allow it to stabilize for one hour. Select the operating range and the averaging time of the 48iQ.

● The averaging time should be less than the zero duration and less than the span duration.

● The calibration and calibration check duration times should be long enough to account for the transition (purge) process when switching from sample to zero and from zero to span. This transition time is the time required to purge the existing air.

● Depending on the plumbing configuration and the instrument, data from approximately the first minute of a zero calibration or check should be disregarded because of residual sample air. Also, data from approximately the first minute of a span calibration or check should be disregarded because the span is mixing with the residual zero air.

● If an optional sample line filter is used, the calibration must be performed through this filter. Ensure that the flow rate into the output manifold is greater than the total flow required by the analyzer and any other flow demand connected to the manifold.

Calibration

Use the following procedure to calibrate the instrument.

Connect the Instrument

Connect the instrument and the calibration equipment as shown in Figure 4–1.
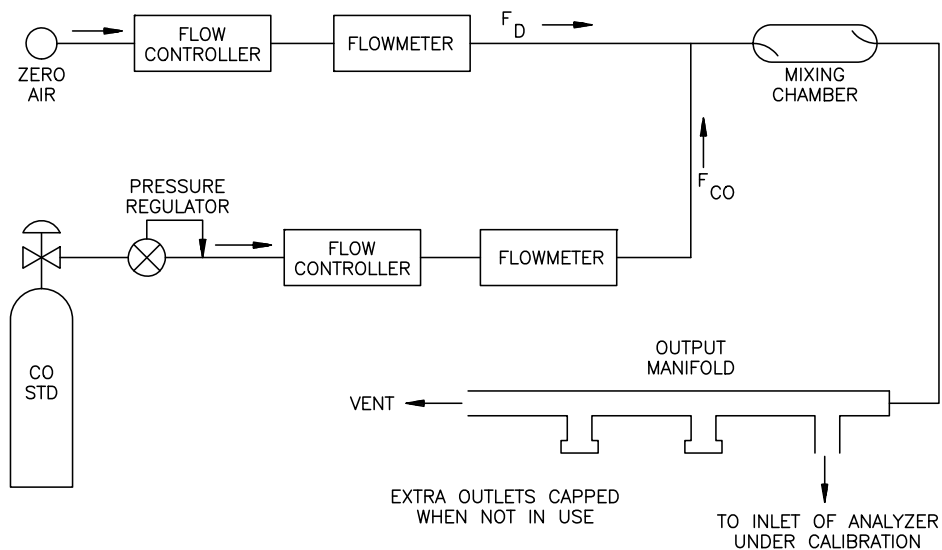
Figure 4–1. Calibration Flow Schematic

Detector Gain

The Detector Gain is determined at the factory and should only be adjusted by a qualified technician. The only time the Detector Gain should be adjusted is if there were changes to the elements that affect the light path or detection. Zero Air should be sampled when calibrating the Detector Gain. There are two ways of calibrating the Detector Gain: From the Home Screen>Settings>Advanced Measurement Settings>Optical Bench Settings>**Continue To Detector Gain Calibration**. The user can manually change the detector gain by clicking on the first cell below the Detector Gain description. The user will be brought to a keypad screen where a new value can be entered.

However, it is suggested to run an Auto Calibration for the Detector Gain. This is done by pressing on the cell labeled Start located in the Detector Gain column. Allow up to 5 minutes for the Detector Gain to be calibrated. The user can Stop the calibration at any time by pressing the Stop button located in the Detector Gain column.

The user can set the Detector Gain to factory defaults by pressing on the cell labeled Default Gain located in the Detector Gain column.

Home Screen>Measurement Settings>Advanced Measurement Settings>Optical Bench Settings>Continue To Detector Gain Calibration

Description	Detector Gain	Current Sample Int. (Hz)	Current Reference Int. (Hz)	
Manual Entry	180	165508	143807	
Auto Cal	Start			
End Cal	Stop			
Default Values	Default Gain			

Initial S/R

The Initial S/R (Sample/Reference Ratio) is determined at the factory and should only be adjusted by a qualified technician. The Initial S/R is used to correct for the slight variations found from one correlation wheel to another. The only time the Initial S/ R ratio should be changed is when the correlation wheel is replaced. Zero Air should be sampled when calibrating the Initial S/R. There are two ways of calibrating the Initial S/R. The user can manually change the Initial S/R by clicking on the first cell below the Initial S/R description. The user will be brought to a keypad screen where a new value can be entered.

However, it is suggested to run an Auto Calibration for the Initial S/R. This is done by pressing on the cell labeled Start located in the Initial S/R column. Allow up to 5 minutes for the Initial S/R to be calibrated. The user can Stop the calibration at any time by pressing the Stop button located in the Initial S/R column.

The user can set the Initial S/R to factory defaults by pressing on the cell labeled Default S/R located in the Initial S/R column.

Home Screen>Settings>Measurement Settings>Advanced Measurement Settings>Optical Bench Settings>Continue To Initial S/R Calibration

Description	Initial S/R	Current S/R				
Manual Entry	1.15009	1.15018				
Auto Cal	Start					
End Cal	Stop					
Default Values	Default S/R					

Multipoint Calibration

The Multipoint Calibration should be performed initially when the instrument is received. The user can choose to calibrate with one, two, or three points. It is suggested to perform a 3-point Multipoint Calibration. The Multipoint Calibration is divided into three calibration points. The range is user definable and the following calibration points are recommended for the user selected range:

● Point 1: 80% of range

● Point 2: 50% of range

● Point 3: 20% or range

Note If performing a multipoint calibration after a "bad" calibration or changing ranges, it is recommended to start off with default values for the Cal point coefficients. ▲

To set default values, from the Home Screen select Calibration>Advanced Calibration>**Multipoint Calibration**. From Multipoint Calibration, select **Reset Points to Default Values**. The instrument will automatically reset to default values.

Use the following procedure to calibrate points 1, 2, and 3:

7. Adjust the zero air flow and the CO flow from the standard CO cylinder to provide a diluted CO concentration of approximately 80% of the upper range limit (URL) of the instrument. The total air flow must exceed the total demand of the analyzer connected to the output manifold to ensure that no ambient air is pulled into the manifold vent. The exact CO concentration is calculated from:

$$[CO]_{OUT} = \frac{([CO]_{STD} \times F_{CO})}{(F_D + F_{CO})}$$

Where:

$[CO]_{OUT}$ = diluted CO concentration at the output manifold, ppm

$[CO]_{STD}$ = concentration of the undiluted CO standard, ppm

F_{CO} = flow rate of CO standard corrected to 25 °C and 760 mmHg, L/min

F_D = flow rate of dilution air corrected to 25 °C and 760 mmHg, L/min

8. Allow the instrument to sample the CO concentration until a stable response is obtained.

9. From the Home Screen press Calibration>Advanced Calibration>Multipoint Calibration>**Point 1**.

Edit Point 1 Span Concentration 0.000 ppm	Point 1 Coefficient 1.00000	Calibrate

10. Enter the span concentration being introduced to the instrument. Press **Calibrate**.

The instrument will perform a series of calculations and save the new parameters.

11. Press the back button to back up a step to the multipoint menu.

12. Introduce a CO concentration 50% of the URL.

13. Select **Point 2**.

14. Enter the span concentration being introduced to the instrument. Press **Calibrate**.

    The instrument will perform a series of calculations and save the new parameters.

15. Press the back button to back up a step to the multipoint menu.

16. Introduce a CO concentration 20% of the URL.

17. Select **Point 3**.

18. Enter the span concentration being introduced to the instrument. Press **Calibrate**.

    The instrument will perform a series of calculations and save the new parameters.

High and Low Multipoint Calibration

The instrument can also be calibrated using a dual three-point calibration. The calibration points are divided into a "high" range and a "low" range consisting of three points each. See "Multipoint Calibration" on page 4-6.

Calibration Frequency

In order to generate data of the highest confidence, it is recommended that a multipoint calibration be performed:

● every three months

● any time any major disassembly of components is performed

**Calibrate
Background**

Use the following procedure to set the CO reading to zero.

1. Allow sufficient time for the instrument to warm up and stabilize.

2. Adjust the dilution system of Figure 4–1 so that zero air alone is present in the manifold.

   Since not all flow controllers have a positive shut off, it might be necessary to disconnect the CO input line and cap it.

3. Allow the instrument to sample zero air until a stable reading is obtained.

4. From the Home Screen, press Calibration>**Calibrate Background**.

   The Target Concentration button will read 0.000. The Calculated Background button will display the background needed to make the current CO concentration go to zero.

5. Press **Calibrate** to set the CO reading to zero and to save the new background.

Target Concentration 0.000 ppm	Current Background 0.565 ppm	Calculated Background 0.484 ppm
	Calibrate	

Periodic Zero and Span Checks

In order to achieve data of the highest confidence, it is suggested that periodic zero air and span checks be performed. These checks can be performed by:

1. Periodically challenging the instrument with zero air. The output of the zero air supply should be greater than the flow demand of the instrument. In addition, an atmospheric dump bypass should be utilized to ensure that the zero air gas flow is being delivered at atmospheric pressure.

    Record the response in percent of scale as A_O. Compute the zero drift from the following equation:

    $$\text{Zero Drift } \% = A_O - Z$$

    Where:

    > Z is the response obtained at the last calibration for zero air, % scale

2. Periodically challenging the instrument with a CO level of approximately 80% of the URL. The 80% URL level may be obtained by dilution of a higher level of CO using a system similar to that of Figure 4–1, or by using a low level cylinder of CO containing CO in air at a concentration of approximately 80% of the URL. In either case the cylinder of CO should be checked against an SRM or CRM. It should also be true for a cylinder of low level CO.

    The *Quality Assurance Handbook*[1] should be referred to for the cylinder checking procedure.

    Compute the span error from the following equation:

    $$\left[\frac{\text{Reported CO Concentration} - \text{Actual CO Concentration}}{\text{Actual CO Concentration}} \right] \bullet 100$$

3. Latest copy of the *Quality Assurance Handbook for Air Pollution Measurement Systems*[1] should be consulted to determine the level of acceptance of zero and span errors.

    For detailed guidance in setting up a quality assurance program, refer to the *Code of Federal Regulations and the EPA Handbook on Quality Assurance*.

Manual Calibration

The Manual Calibration menu allows the user to view and manually adjust the zero background and span coefficient. These are used to correct the CO readings that the instrument generates using its own internal calibration data.

Normally, the zero background and span coefficient are calculated automatically at the Calibrate Background and Calibrate Span Coefficient described earlier in the chapter. However, the calibration factors can also be set manually using the functions as described below.

The following screen is shown in single range mode. In dual or auto range modes, "High Range" or "Low Range" button are displayed to indicate the calibration of the high or low coefficient. The Adjust High Range Span Coefficient and Adjust Low Range Span Coefficient screens function the same way.

Home Screen>Calibration>Advanced Calibration>Manual Calibration (single range mode)

| Adjust Background 0.565 ppm | Adjust Span Coefficient 1.000 | Reset Bkg to 0.000 and Span Coef to 1.000 |

Adjust Background

The CO background is the amount of signal read by the analyzer while sampling zero air.

The Adjust Background screen is used to perform a manual zero background calibration of the instrument. As such, the instrument should sample zero air until stable readings are obtained. The button labeled Adjust Background allows the user to change zero background. The second button called Adjusted Concentration shows what the new CO concentration would be based on the changed zero background. Press the Calibrate button to save the adjusted zero background value.

Home Screen>Calibration>Advanced Calibration>Manual Calibration>Adjust Background
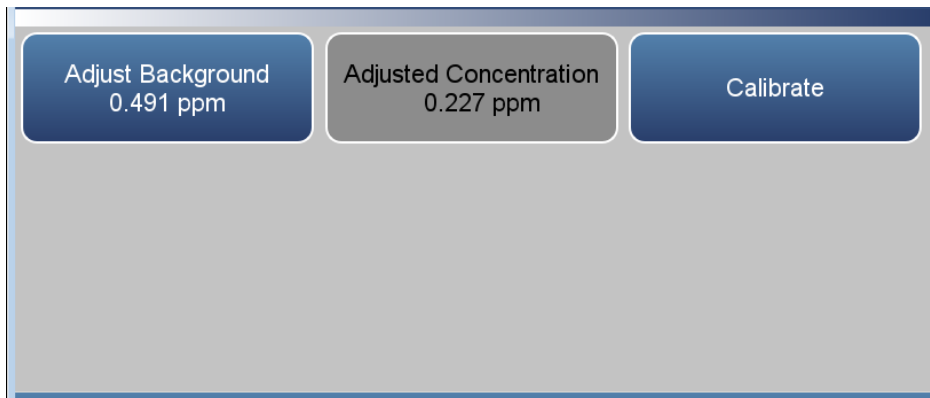
Adjust Span Coefficient

The span coefficients are used to correct the CO readings and normally has a value near 1.000 with minimum/maximum limits of 0.500 and 2.000 respectively.

The user can manually change the span coefficient by entering a value in the Adjust Span Coefficient button. The second button called Adjusted Concentration shows what the new CO concentration would be based on the adjusted span coefficient. Press the Calibrate button to save the adjusted span coefficient value.

Home Screen>Calibration>Advanced>Manual Calibration>Adjust Span Coefficient (single range mode)
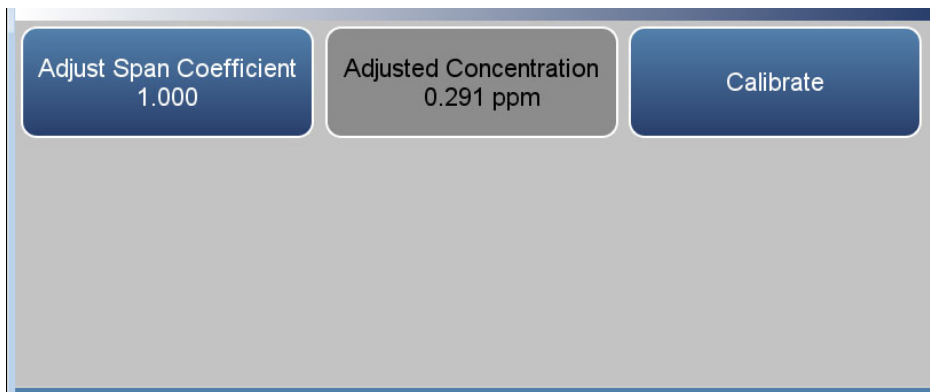
Reset Bkg to 0.000 and Span Coef to 1.000

The Reset Bkg to 0.000 and Span Coef to 1.000 screen allows the user to reset the calibration configuration values to factory defaults.

Zero/Span Schedule

The Zero/Span Schedule is used to program the instrument to perform fully automated zero and span calibration or calibration checks.

Home Screen>Calibration>Zero/Span Schedule

Zero / Span Schedule Enabled	Next Time 09/21/2017 09:30	Period 1 hr
Zero Duration 1 min	Span Duration 2 min	Purge Duration 1 min
Total Duration 4 min	Schedule Averaging Time 10 sec	More

Home Screen>Calibration>Zero/Span Schedule>More

Background Calibration Enabled	Span Calibration Enabled	Zero : Span Ratio 1 : 1
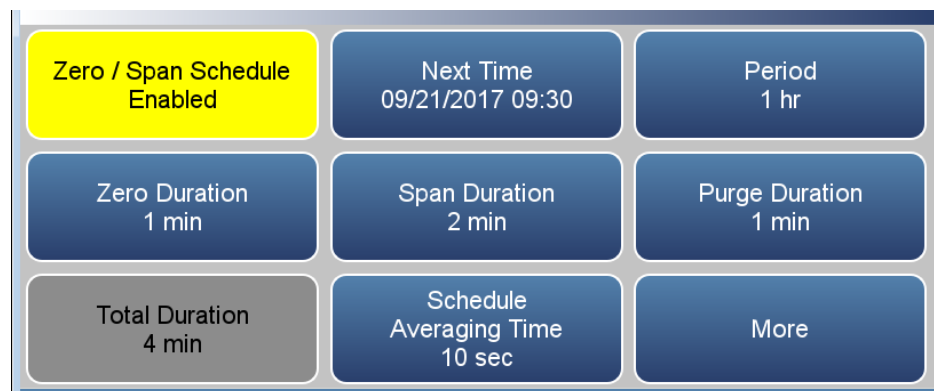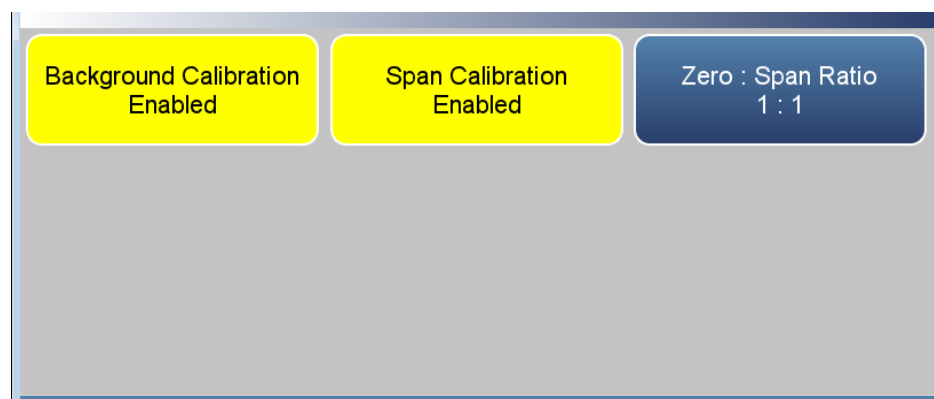
Next Time

The Next Time button is used to view and set the initial date and time (24-hour format) of the zero/span schedule. Once the zero/span schedule begins, the date and time of the next zero/span schedule is calculated and displayed.

Period

The Period button defines the period or interval between zero/span schedule. Periods between 0 and 999 hours are acceptable.

Zero/Span/Purge Duration Minutes

The Zero Duration button defines how long zero air is sampled by the instrument. The Span and Purge Duration buttons look and function the same way as the zero duration button. The span duration button is used to set how long the span gas is sampled by the instrument. The purge duration button is used to set how long the purge period will be after doing

a zero and/or span. This gives the instrument time to flush out the zero and span gas before any meaningful sample data is taken. Logged data is flagged as taken during a purge to show that the data is suspect. Durations between 0 and 99 minutes are acceptable. Each time a zero/span schedule occurs the zero is done first, followed by the span. To perform just a zero, set the span duration to 0 (off). The same applies to perform just a span.

Schedule Averaging Time

The Schedule Averaging Time button allows the user to adjust the schedule averaging time. The schedule averaging time is used by the analyzer only when performing a zero/span schedule. The analyzer's averaging time is used for all other functions. Range is 1–300 seconds.

Background Calibration and Span Calibration

Background Calibration and Span Calibration are toggle buttons that change between enabled or disabled.

If the background calibration is set to enabled, then a zero adjustment is made. If the span calibration is set to enabled, then a span adjustment is made. (This is how to set up a scheduled, recurring auto calibration.)

Zero Calibration and Span Calibration

Zero and Span Calibration Commit are toggle buttons that change between yes or no when selected.

If the zero calibration commit is set to yes, then a zero adjustment is made. If the span calibration commit is set to yes, then a span adjustment is made. (This is how to set up a scheduled, recurring auto calibration.)

Zero/Span Ratio

The Zero/Span Ratio button is used to set the ratio of zero checks or adjustments to span checks or adjustments. For example, if this value is set to 1, a span duration will follow every zero duration. If this value is set to 3, there will be two zero checks between each span check. This value may be set from 1 to 99, with 1 as default.

References

1. Section 12 of EPA *Quality Assurance Handbook for Air Pollution Measurement Systems*, Volume II, available at www.epa.gov.

   Section 12 also provides information on "Calibration of Primary and Secondary Standards for Flow Measurements".

   Specific information on certification of concentration standards is given in EPA *Traceability Protocol for Assay and Certification of Gaseous Calibration Standards*, available at www.epa.gov.

Chapter 5
Maintenance

This chapter describes the periodic maintenance procedures that should be performed on the instrument to ensure proper operation. Since usage and environmental conditions vary greatly, you should inspect the components frequently until an appropriate maintenance schedule is determined.

Safety Precautions

Read the safety precautions before beginning any procedures in this chapter.

⚠ **Equipment Damage** Some internal components can be damaged by small amounts of static electricity. A properly grounded antistatic wrist strap must be worn while handling any internal component. For more information about appropriate safety precautions, see the "Servicing" chapter. ▲

Fan Filter Inspection and Cleaning

Use the following procedure to inspect and clean the fan filter.

1. Remove the fan guard from the fan and remove the filter.

2. Flush the filter with warm water and let dry (a clean, oil-free purge will help the drying process) or blow the filter clean with compressed air.

3. Re-install the filter and fan guard.

Pump Rebuilding

Use the following procedure to rebuild the pump.

Equipment required:

Pump rebuild kit (qty. 1)

Phillips drive, #1 or Torque drive, T10 (depending on pump version)

Pencil or marker
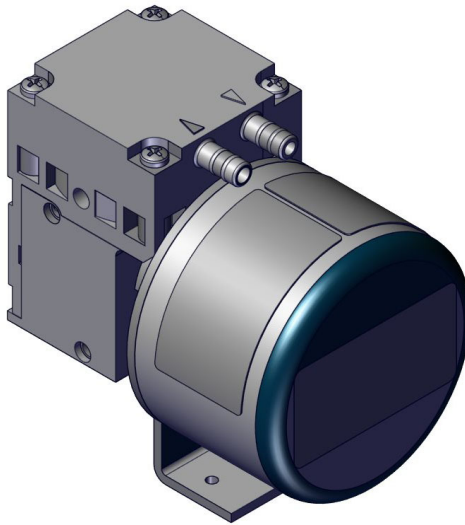
Figure 5–1. Single Stage Pump

1. Turn instrument OFF, unplug the power cord, and remove the cover.

2. Mark the position of head parts relative to each other by drawing a line with a pencil. This helps avoid incorrect assembly later.

3. Undo the four screws in the head.

4. Lift the head plate and the intermediate plate off the housing.

5. Hold the pump with one hand, so that the diaphragm is pointing downwards. Lift the diaphragm by the opposing side edges, grasp it and unscrew it in the counter-clockwise direction.

6. Remove connection rod disc and diaphragm spacers from the threaded pin of the diaphragm.

7. Push the connection rod disc and the diaphragm spacers in this order onto the threaded pin of the new diaphragm.

8. Move the connecting rod to the upper point.

9. Screw the new diaphragm with connection rod disc and spacers clockwise onto the connection rod and tighten hand-tight.

10. Place the intermediate plate on housing, in the position indicated by the drawing line.

11. Place the new valve plate on the intermediate plate.

12. Place the head plate on the intermediate plate, in the position indicated by the drawing line; gently tighten the four screws, evenly and diagonally (if a torque screwdriver is available: torque about 0.30 Nm).

13. Let the pump run.

SCREWS

HEAD PLATE

VALVE PLATE
(ONE PIECE)

INTERMEDIATE PLATE

DIAPHRAGM

CONNECTING ROD DISC

SPACER

CONNECTING ROD
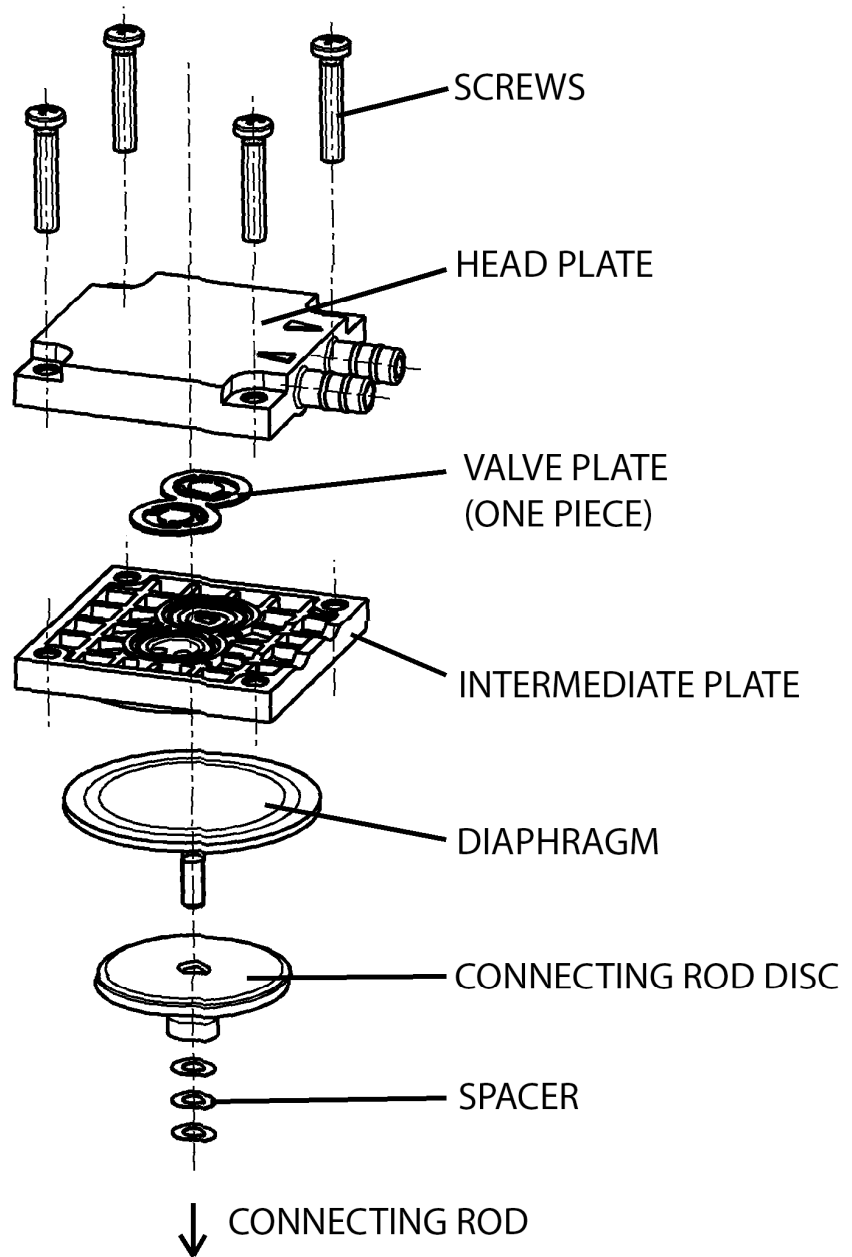
Figure 5–2. Pump Rebuilding

Leak Test

Use the following procedure to perform a leak test.

Equipment Required:

Swage Lock cap (sample port)

Small rubber cap (purge tubing to pump "Y")

Vacuum Tester with Gauge (with a resolution of .5 in Hg or better)

1. Turn instrument OFF, unplug the power cord.

2. Block the SAMPLE bulkhead on the rear panel with a leak-tight cap.

3. Disconnect the tubing from the Filter Wheel purge to the pump at the "Y" fitting and cap the tubing coming from the purge.

4. Connect the vacuum tester tool to the EXHAUST bulkhead on the rear panel.

5. Squeeze trigger until gauge reads to pull in 10 in Hg.

6. Observe vacuum gauge for stable reading for 5 minutes. If reading remains at 10 in Hg, no leak is present.

Note Acceptable leak rate is .5 in Hg over 10 minutes. ▲

Cleaning the Optics

Best results are obtained when the optics are cleaned prior to calibration. The cleanliness of the mirrors should be checked any time the intensity is below 200,000 Hz, since one cause of low output is light attenuation due to dirt on the mirrors.

⚠ **Equipment Damage** Some internal components can be damaged by small amounts of static electricity. A properly grounded antistatic wrist strap must be worn while handling any internal component. For more information about appropriate safety precautions, see the "Servicing" chapter. ▲

Use the following procedure to clean the mirrors.

Equipment Required:

   Hex drive, 9/64

1. Turn off power and disconnect power line.

2. Using 9/64 hex drive, remove the field mirror by removing the four #8-32 socket cap head screws holding it to the main bench.
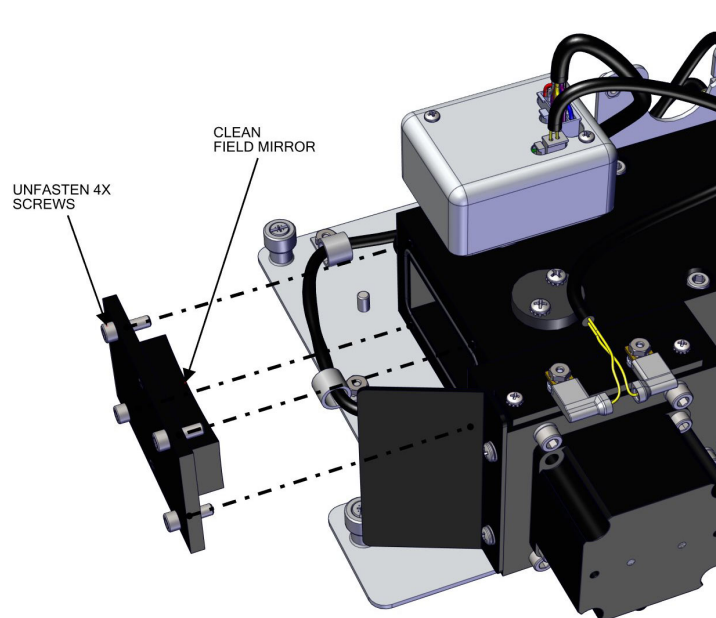
Figure 5–3. Removing the Field Mirror

3. Carefully clean each mirror using methanol. Rinse with distilled or deionized water. Dry by blowing clean dry air over the mirror.

4. Reassemble following the above procedure in reverse. It is not necessary to realign any mirror following cleaning.

5. Calibrate the instrument. See the "Calibration" chapter in this manual.

IR Source Replacement

The IR source control system has been designed to operate the wire wound resistor IR source conservatively in order to increase its life. Nevertheless, the IR source does have a finite life. Since the IR source is relatively inexpensive and easily replaced, it is recommended that the IR source be replaced after one year of continuous use. This will prevent loss of data due to IR source failure. If an IR source is to be replaced on an as needed basis, it should be replaced when:

● There is no light output

● After cleaning the optics, the IR light intensities remain below 100,000 Hz

For more information on replacing the IR Source, see "IR Source Replacement" on page 7-45.

Chapter 6
Troubleshooting

This chapter presents guidelines for diagnosing analyzer failures, isolating faults, and includes recommended actions for restoring proper operation.

Safety Precautions

Read the safety precautions in Appendix A, "Safety" before performing any actions listed in this chapter.

Troubleshooting Guide

Table 6–1 provides general troubleshooting information for the common platform and indicates the checks that you should perform if you experience an instrument problem. It also lists 48iQ specific troubleshooting information and alarm messages you may see on the graphics display and provides recommendations about how to resolve the alarm condition.

Table 6–1. 48iQ Troubleshooting Guide

Problem	Possible Cause	Action
Instrument does not start (LEDs on front panel do not come on and display is blank)	No power	Verify that the power cord is plugged in, power is available and that it matches the voltage and frequency configuration of the instrument.
	Fuse is blown or missing	Disconnect power and check fuses with a volt meter.
	Bad switch or wiring connection to switch	Check for 24V @ J9 on the Backplane board (middle pins). Check all wiring connections.
Front panel display does not start (LEDs on front panel are off)	Disconnected ribbon cable	Power down and evaluate connections of display ribbon cable.
Front panel display does not start (LEDs on front panel are on)	Defective Display	Connect to the instrument using ePort. Select "Remote Interface". If normal GUI is displayed, replace defective display.
Front panel display stays white after power up (LEDs on front panel are on)	Unseated or missing Micro SD card	Power off, re-seat Micro SD or install if missing.

Problem	Possible Cause	Action
	Micro SD Card Programming	If Micro SD card was just replaced, re-install the old one. If the problem is fixed, request a replacement Micro SD card.
Solenoid current out of range (option)	Sticking or damaged solenoid	Reset solenoid via Settings>Health Check>Status and Alarms>Valve and Pump Resets screen. If damaged, replace solenoid valve block.
Pump current out of range	Damaged or dirty pump	Reset pump via Settings>Health Check>Status and Alarms>Valve and Pump Resets. Inspect and refurbish pump. If pump motor is damaged, replace pump.
No output signal (or very low output)	No sample gas reaching the analyzer	Check input sample flow.
	Ruptured pump diaphragm	Rebuild pump head.
	Blocked sample capillary	Unplug power cord. Clean or replace capillary.
Calibration drift	Line voltage fluctuations	Check to see if line voltage is within specifications.
	Defective pump	Rebuild pump.
	Clogged capillaries	Unplug power cord. Clean or replace capillary.
	Clogged sample air filter	Replace filter element.
Non-linear response	Incorrect calibration source	Verify accuracy of multipoint calibration source gas.
	Leak in sample probe line	Check for variable dilution.
Excessive response time	Partially blocked sample capillary	Unplug power cord. Clean or replace capillary.
	Hang up/blockage in sample filter	Change element.
	Low line voltage	Check to see if line voltage is within specifications.
Alarm – Instrument Temperature	Fan failure	Replace fan if not operating properly.
	Dirty fan filter	Clean or replace filter.
	Overheating PCB	Locate defective PCB reporting the error and replace if needed.
Alarm – Bench Temperature	Defective bench	Check 10K ohm thermistor and

Problem	Possible Cause	Action
	heater	replace heater if bad.
Alarm – Pressure	High bench pressure indication	Check the pump for a tear in the diaphragm; replace with pump repair kit if necessary. Refer to "Maintenance" chapter in this manual.
		Check that capillaries are properly installed and o-rings are in good shape. Replace if necessary.
		Check flow system for leaks.
Alarm – Flow	Flow low	Check sample capillary for blockage. Replace as necessary.
		If using sample particulate filter, make sure it is not blocked. Disconnect sample particulate filter from the sample bulkhead. If flow increases, replace the filter.
		Perform a leak test as decribed on page 5-5.
	Flow high	When delivering zero air or gas to the instrument, use an atmospheric dump.
	Flow = 0 LPM	Check that Step POL board #1 has both dip switch settings of SW2 off (both facing the rear of the instrument). Verify the pump is plugged into the Step POL board.
	Worn Diaphragm	Rebuild pump every 12 months or as needed.
Alarm – Board Communication	Cable connection	Check that DMC cable is connected properly. Reseat if needed.
	Defective DMC PCB	Replace DMC board.
Alarm – Power Supply	Cable connection	Check that DMC cable is connected properly. Reseat if needed.
	Defective component	Check for other alarms, as it is possible that another component of that DMC is drawing too much current.
	Defective DMC PCB	Replace DMC board.
Alarm – Module Temperature	Cable connection	Check that DMC cable is connected properly. Reseat if needed.
	Other alarm	Make sure the instrument temperature is not too high or in alarm.

Problem	Possible Cause	Action
	Defective DMC PCB	Replace DMC board.
Alarm – 5V/24V Step Board	Cable connection	Check the cable connections to that Step POL board.
Alarm – Conc.	Concentration has exceeded range limit	Check to ensure range corresponds with expected value. If not, select proper range.
	Concentration low	Check user-defined low set point. Be sure the minimum trigger is set as desired.
Alarm – Analog I/O	Defective PCB	Replace Analog board.
Alarm – Digital I/O	Defective PCB	Replace Digital board.
Alarm – Auto Bkg Cal/Check	Incorrect high alarm limit	Verify the high limit is correct via Settings>Status and Alarms>Concentrations screen.
	Instrument background calibration failed	Recalibrate the instrument.
Alarm – Auto Span Cal/Check	Incorrect high alarm limit	Verify the high limit is correct via Settings>Status and Alarms>Concentrations screen.
	Instrument span calibration failed	Recalibrate the instrument.
Alarm – Bench Temp Thermistor Open	Cable connection	Check connection from heater to DMC board. Reseat if needed.
Alarm – Bench Temp Thermistor Short	Cable connection	Check connection from heater to DMC board. Reseat if needed.
Alarm – Motor Speed too low	Cable connection	Check connection from motor to DMC board. Reseat if needed.
	Defective Heater	Replace motor as needed.
	Defective DMC board	Replace board as needed.
Alarm – Motor Speed too high	Cable connection	Check connection from motor to DMC board. Reseat if needed.
	Defective Heater	Replace motor as needed.
	Defective DMC board	Replace board as needed.
Alarm – Module Thermistor Open	Defective DMC board	Replace board as needed.
Alarm – Module Thermistor Short	Defective DMC board	Replace board as needed.
Alarm – Bench Temp Thermistor Open	Cable connection	Check the cable connection from the thermistor to the DMC board.

Problem	Possible Cause	Action
	Defective Thermistor	Replace Thermistor as needed.
	Defective DMC board	Replace board as needed.
Alarm – Bench Temp Thermistor Short	Cable connection	Check the cable connection from the IR Source to the DMC board.
	Defective IR Source	Replace IR Source as needed.
	Defective DMC board	Replace board as needed.
Alarm – IR Source Current Low	Cable connection	Check the cable connection from the IR Source to the DMC board.
	Defective IR Source	Replace IR Source as needed.
	Defective DMC board	Replace board as needed.
Alarm – IR Source Current High	Cable connection	Check the cable connection from the IR Source to the DMC board.
	Defective IR Source	Replace IR Source as needed.
	Defective DMC board	Replace board as needed.
Alarm – IR Detector Bias Low	Cable connection	Check the cable connection from the IR Source to the DMC board.
	Defective IR Source	Replace IR Source as needed.
	Defective DMC board	Replace board as needed.
Alarm – IR Detector Bias High	Cable connection	Check the cable connection from the IR Source to the DMC board.
	Defective IR Source	Replace IR Source as needed.
	Defective DMC board	Replace board as needed.

Chapter 7
Servicing

This chapter describes the periodic servicing procedures that should be performed on the instrument to ensure proper operation and explains how to replace the 48iQ subassemblies.

Safety Precautions

Read the safety precautions before beginning any procedures in this chapter.

⚠ WARNING The service procedures in this manual are restricted to qualified service representatives. ▲

⚠ WARNING If the equipment is operated in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired. ▲

⚠ CAUTION **CAUTION** If the LCD panel breaks, do not let the liquid crystal contact your skin or clothes. If the liquid crystal contacts your skin or clothes, wash immediately using soap and water. ▲

Do not remove the LCD panel or frame from the LCD module. ▲

The LCD polarizing plate is very fragile, handle it carefully. ▲

Do not wipe the LCD polarizing plate with a dry cloth, as it may easily scratch the plate. ▲

Do not use alcohol, acetone, MEK or other Ketone based or aromatic solvents to clean the LCD module, but rather use a soft cloth moistened with a naphtha cleaning solvent. ▲

Do not place the LCD module near organic solvents or corrosive gases. ▲

Do not shake or jolt the LCD module. ▲

⚠

Equipment Damage Some internal components can be damaged by small amounts of static electricity. A properly grounded antistatic wrist strap must be worn while handling any internal component. For more information about appropriate safety precautions, see "Safety". ▲

Note If an antistatic wrist strap is not available, be sure to touch the instrument chassis before touching any internal components. When the instrument is unplugged, the chassis is not at earth ground. ▲
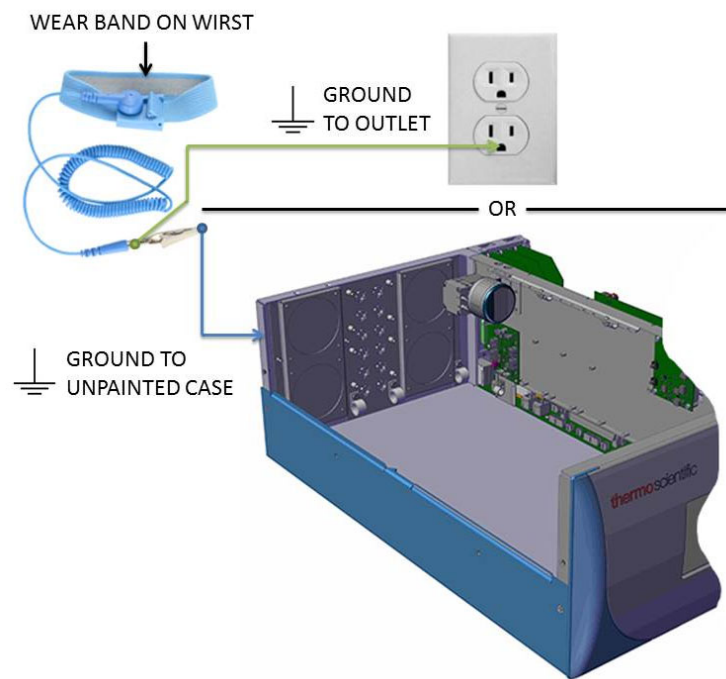
Figure 7–1. Properly Grounded Antistatic Wrist Strap

Note Ground to unpainted case or outlet as shown. ▲

Firmware Updates

New versions of the instrument software are periodically made available over Ethernet, USB flash drive, or company website at:

www.thermofisher.com

For more information on installing new firmware, see "Installing New Firmware" in the *iQ Series Communications* manual.

Replacement Parts List

For a complete list of spare parts, visit the company website at:

www.thermofisher.com/48iQ

Refer to Figure 7–2 and Figure 7–3 to identify the component location.
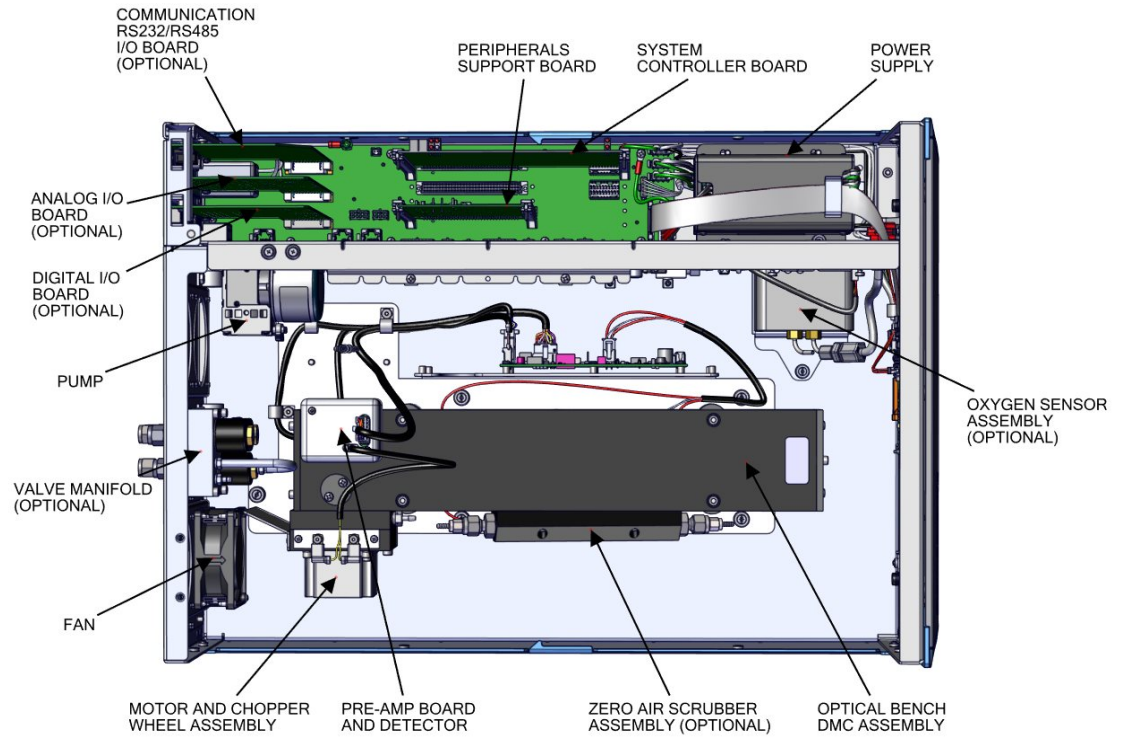
Figure 7–2. 48iQ Component Layout Top View
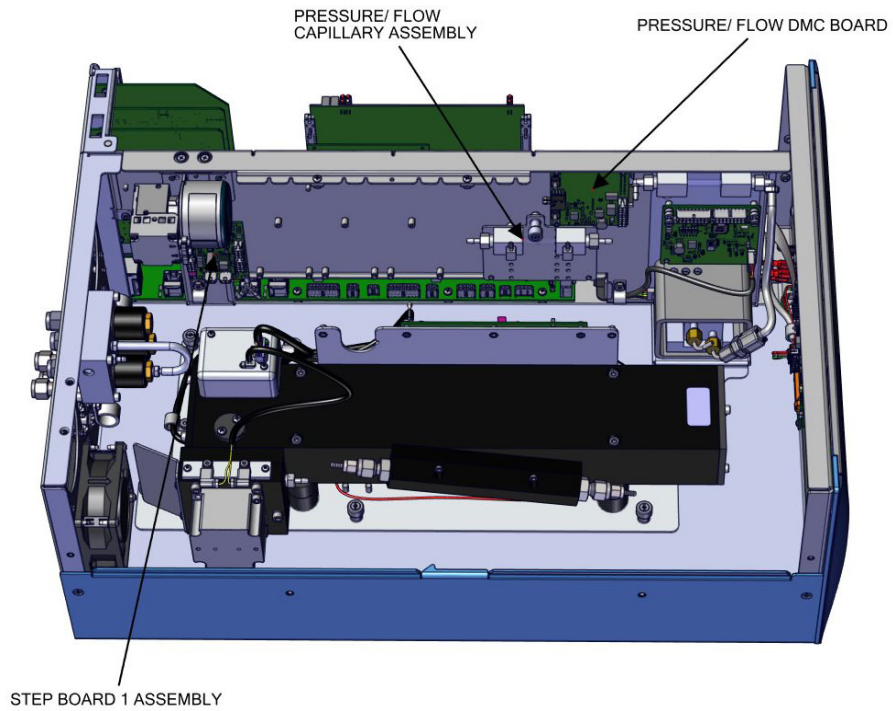
Figure 7–3. 48iQ Component Layout Side View

Fuse Replacement

Use the following procedure to replace the fuses.

1. Turn instrument OFF and unplug the power cord.

2. Remove fuse drawer, located on the AC power connector.

3. If either fuse is blown, replace both fuses.

4. Insert fuse drawer and reconnect power cord.

PULL FUSE TRAY OUT AND REPLACE FUSES
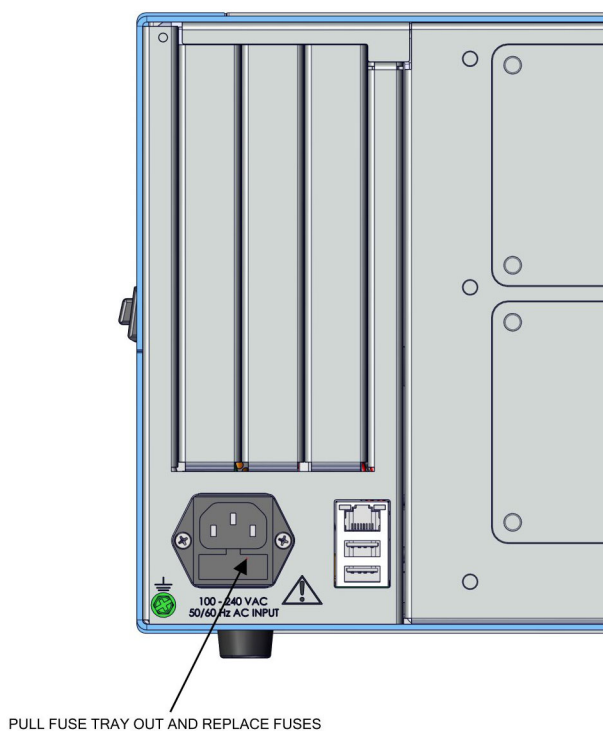
Figure 7–4. Replacing the Fuses

Filter Replacement

Use the following procedure to replace the filter.

1. Turn instrument OFF and unplug the power cord.

2. Starting with top right corner, pull out to remove fan cover.
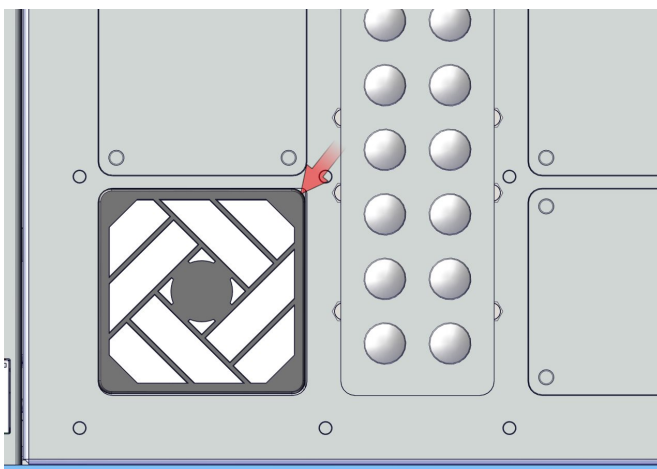
Figure 7–5. Start with Top Right Corner of Fan Cover

3. Replace filter and snap fan cover back in place.

FAN FILTER
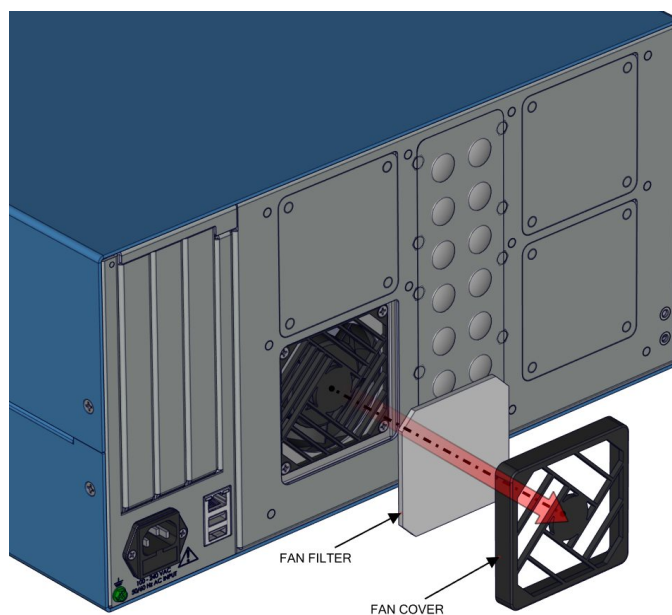
FAN COVER

Figure 7–6. Removing the Fan Cover

Fan Replacement

Use the following procedure to replace the fan.

Equipment required:

Phillips drive, #2

1. Turn instrument OFF, unplug power cord, and remove the cover (Figure 2–1).

2. Unplug the fan cable J18.
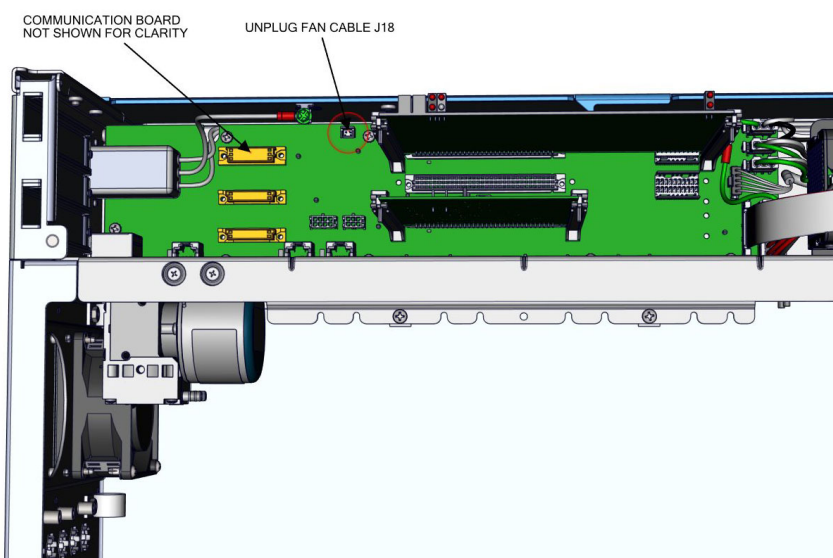
Figure 7–7. Unplugging the Fan Cable

3. Starting with top right corner, pull out to remove fan cover.

4. Unhook the four latches of the fan cover.

5. Unfasten the four 6-32 screws from the fan housing.

6. Replace fan and reassemble in reverse order.
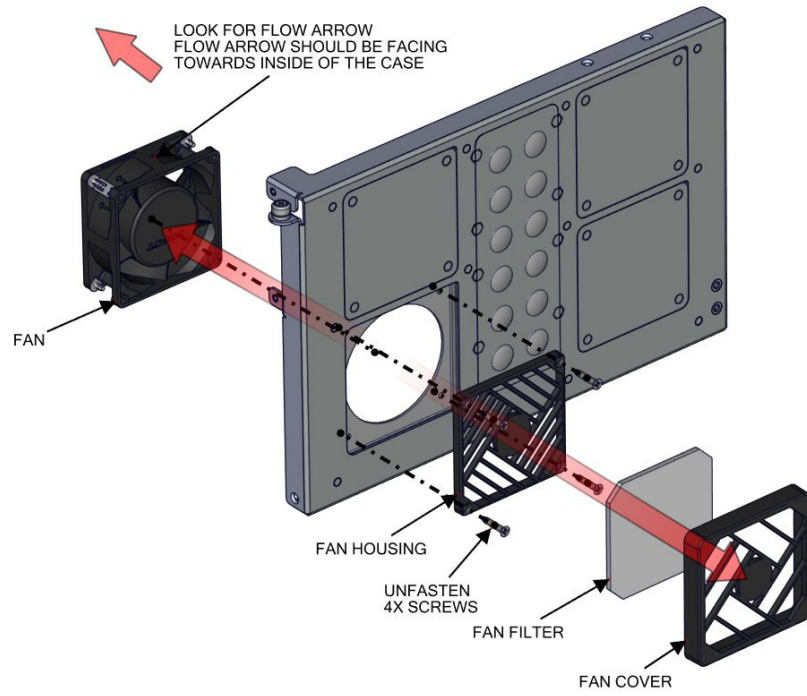
Figure 7–8. Replacing the Fan

Measurement Side Removal

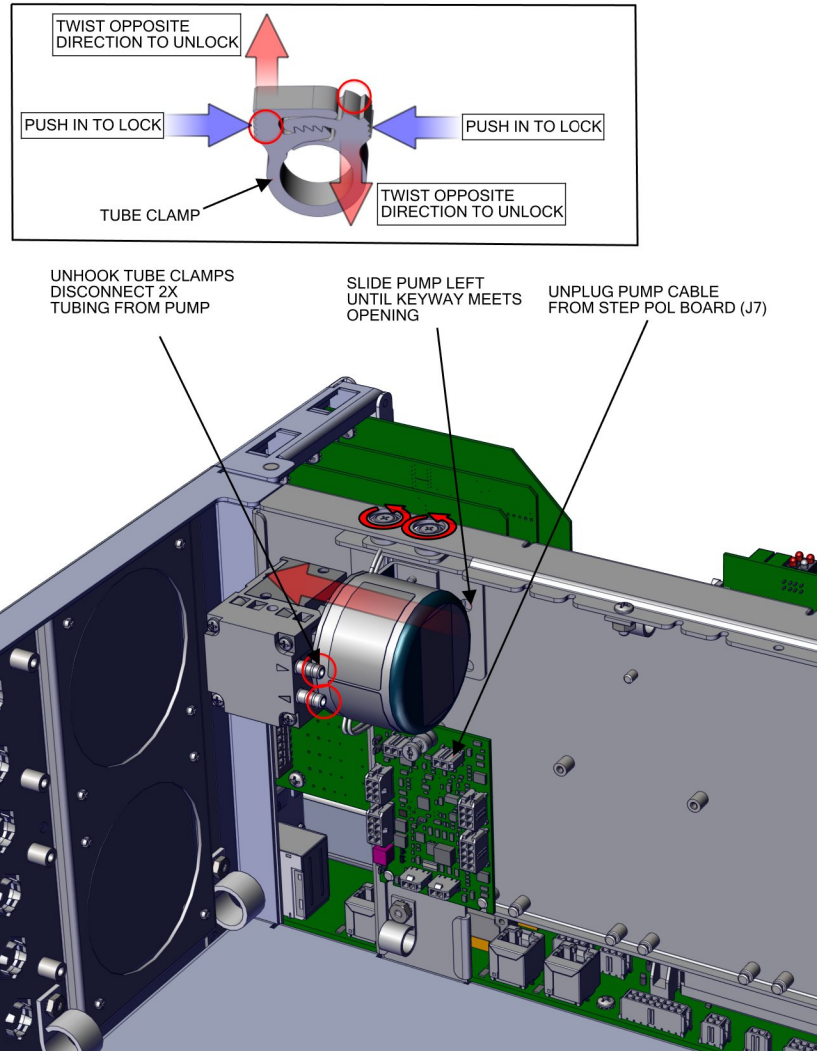Use the following procedure to remove and replace the measurement side if necessary.

Equipment required:

Phillips drive, #2

1. Turn instrument OFF, unplug power cord, and remove the cover (Figure 2–1).

2. Unplug the fan cable J18 (Figure 7–9).
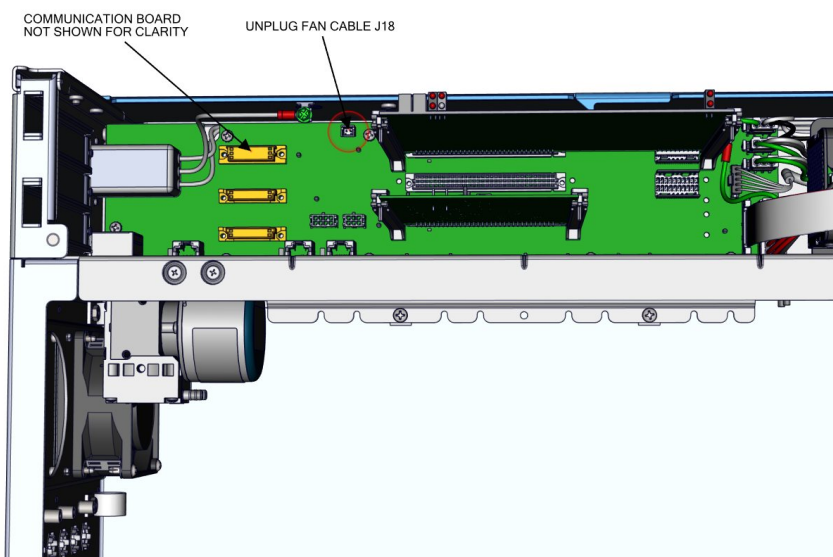
Figure 7–9. Unplugging the Fan Cable

3. Unplug DMC cable (Figure 7–10).

REFERENCE
DMC CABLE CONNECTS HERE
IF REMOVED
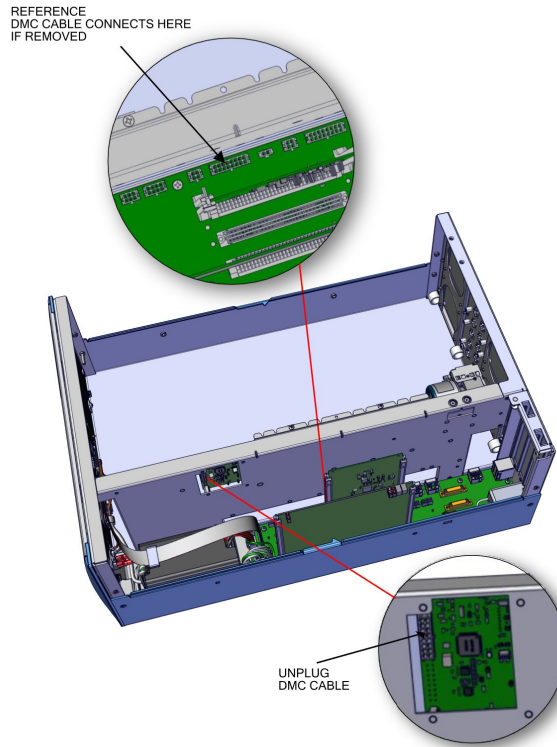
UNPLUG
DMC CABLE

Figure 7–10. Unplugging the DMC Cable

4. Gripping from the top corners of the front panel and pull outwards.

5. Using #2 Phillips drive, remove three 8-32 flat head screws (Figure 7–11).
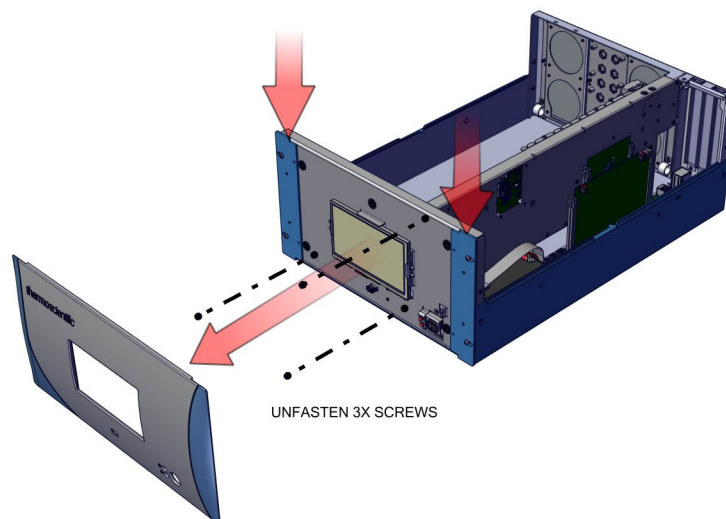
UNFASTEN 3X SCREWS

Figure 7–11. Unfasten Hardware Front for Measurement Side Removal

6. Swing arm open.

7. Unfasten captive hardware.

8. Using #2 Phillips drive, remove two 8-32 flat head screws.

9. Pull measurement side out.

10. Replace in reverse order.

SWING ARM OPEN

UNFASTEN
CAPTIVE HARDWARE
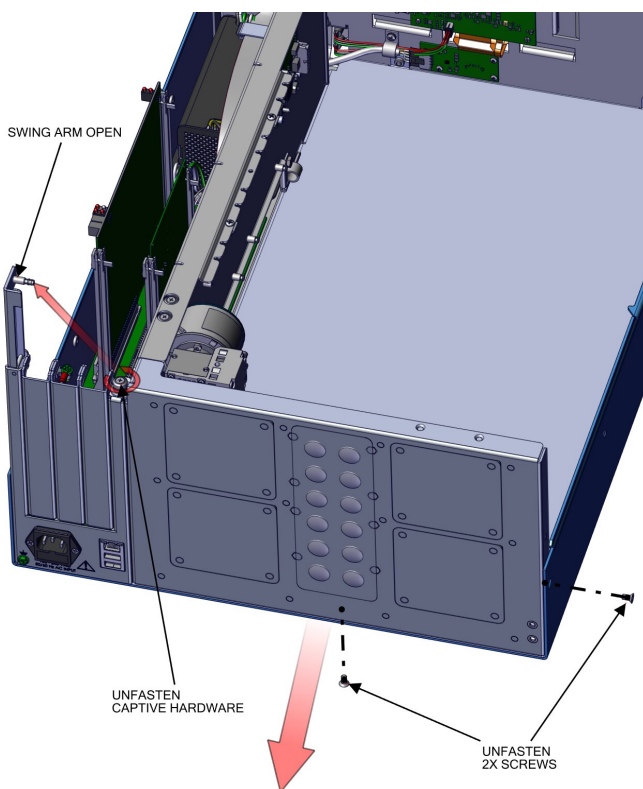
UNFASTEN
2X SCREWS

Figure 7–12. Unfasten Hardware Rear for Measurement Side Removal

LCD Module Replacement

Use the following procedure to replace the LCD module.

Equipment required:

Wrench, 1/4

1. Turn instrument OFF and unplug the power cord.

2. Gripping from the top corners of the front panel and pull outwards.

3. Using 1/4 wrench, unfasten four #4-40 nuts (Figure 7–13).

REMOVE PANEL AND UNFASTEN 4X NUTS
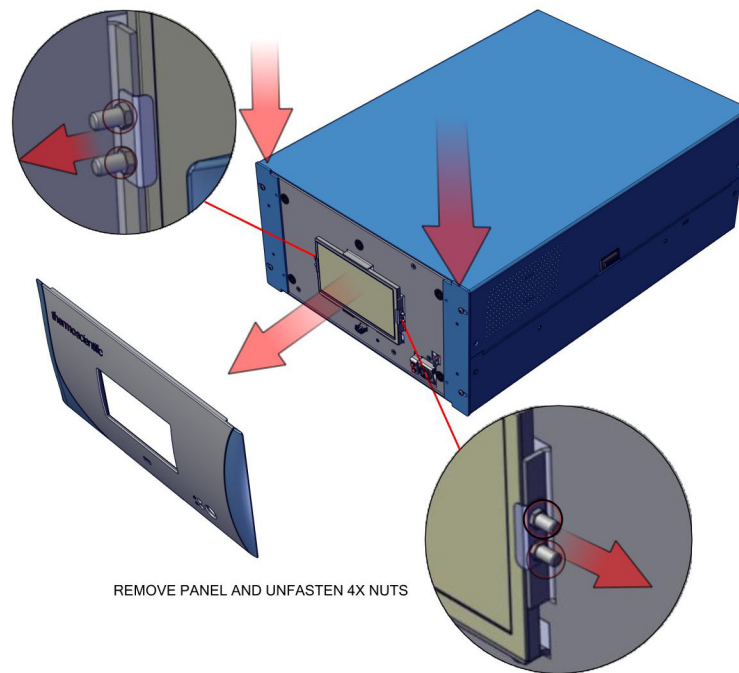
Figure 7–13. Replacing the LCD Module

4. Remove cover.

5. Unplug LCD cables from backside of board.

6. Pull board off the standoffs.

PULL BOARD OFF
THE STANDOFFS

UNPLUG LCD CABLES
FROM BACKSIDE OF BOARD
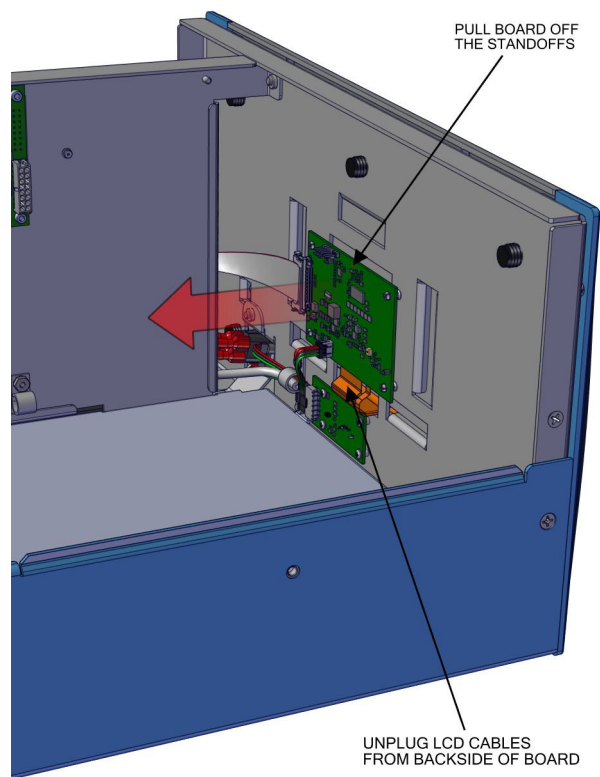
Figure 7–14. Remove Electrical Cables from LCD

7. Replace LCD module and reassemble in reverse order.

I/O Replacement

Use the following procedure to replace the I/O boards.

1. Turn instrument OFF, unplug power cord, and remove the cover (Figure 2–1).

2. Swing arm open.
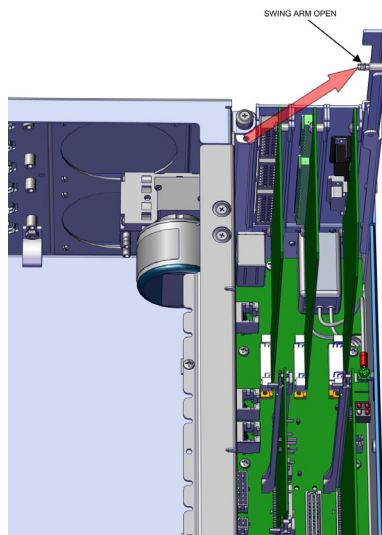
Figure 7–15. I/O Replacement, Arm

3. Pull board upwards.
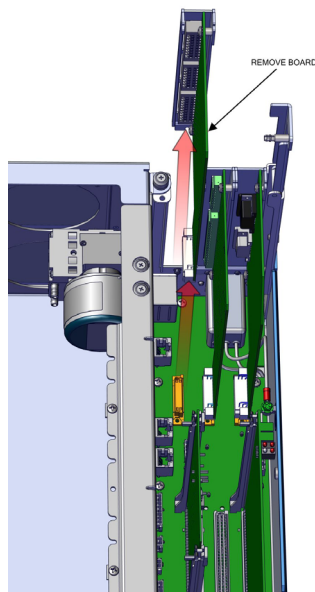
Figure 7–16. I/O Replacement, Remove Board

4. During install, make sure to align cutout circular to keyway.

5. Insert board downwards.
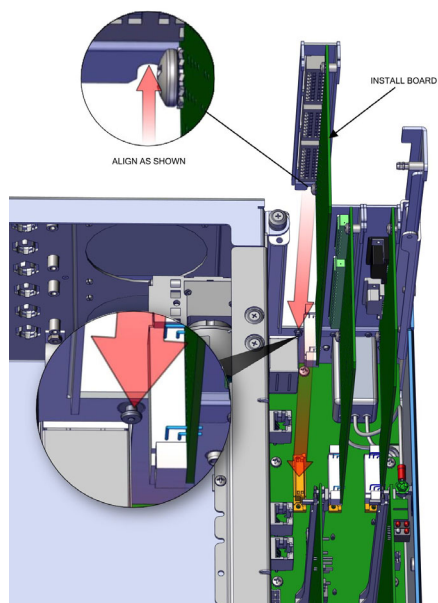
Figure 7–17. I/O Replacement, Install

6. Close arm. Make sure expansion bracket aligns to the inside of the rectangular cutouts.
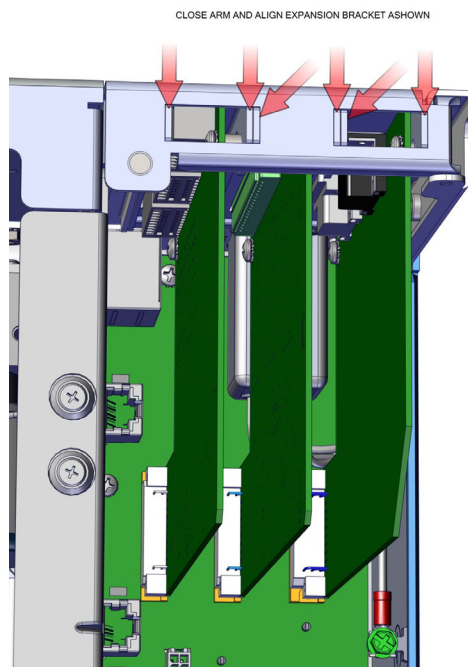
Figure 7–18. I/O Replacement, Close Arm Alignment

Peripherals Support Board and System Controller Board Replacement

Use the following procedure to replace the peripherals support board or system controller board.

1. Turn instrument OFF, unplug power cord, and remove the cover (Figure 2–1).

2. Pull tab out (two per board).

3. Pull board out.
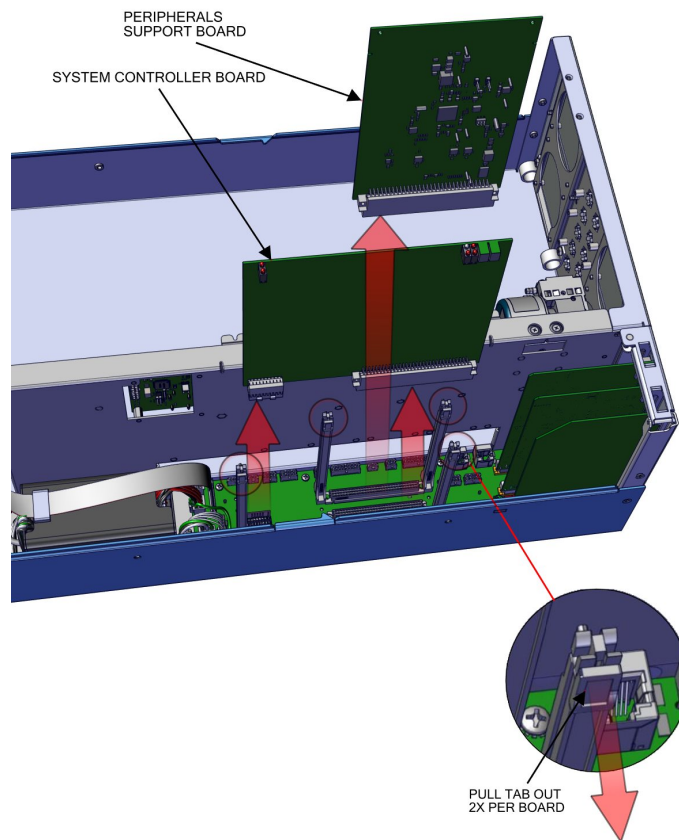
Figure 7–19. Replacing the Peripherals Support Board

4. Replace board and reassemble in reverse order.

DMC Pressure and Flow Board

Use the following to replace the DMC pressure and flow board.

Equipment required:

Hex drive, 7/16

1. Turn instrument OFF, unplug power cord, and remove the cover (Figure 2–1).

2. Unplug cables from the pressure and flow board.
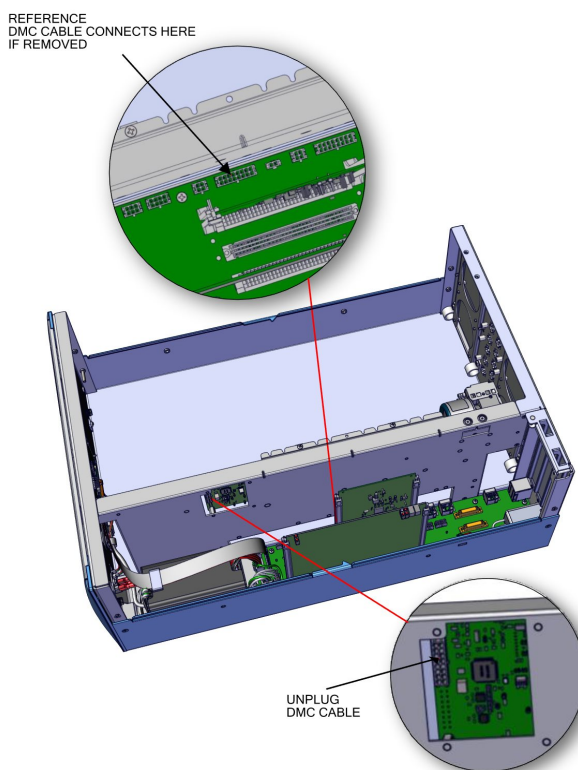
Figure 7–20. Flow Pressure Board, Disconnect DMC Cable

3. Disconnect plumbing.

4. Using 7/16 hex drive, unfasten four #6-32 socket cap head screws.
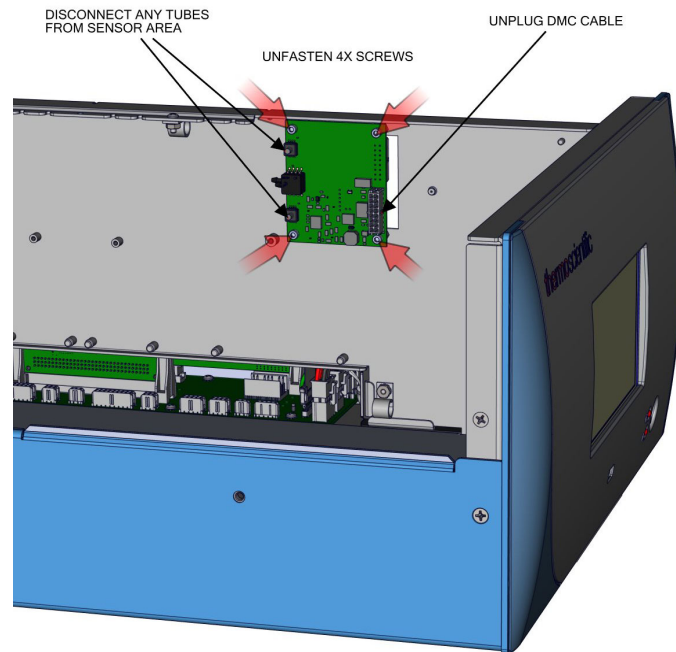
Figure 7–21. Flow Pressure Board, Screws

5. Replace board and reassemble in reverse order.

Pump Replacement

Use the following procedure to replace the pump.

Equipment required:

Phillips drive, #1 and #2

1. Turn instrument OFF, unplug power cord, and remove the cover (Figure 2–1).

2. Unplug pump cable from Step POL board J7.

3. Twist opposite direction to unlock tube clamps.

Note Push in tube clamp to lock. ▲

4. Disconnect tubing from pump.

5. Using #2 Phillips drive, unfasten two captive hardware.

6. Slide pump left until keyway meets opening.

Figure 7–22. Remove Pump, Disconnect and Unfasten

7. Pull pump outwards.

Note When installing pump, make sure the pump keyway opening goes over the keyway. ▲
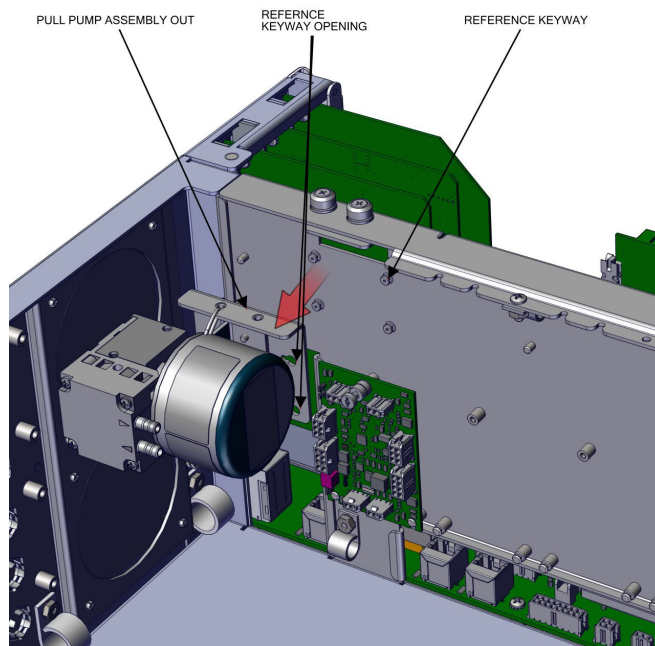
Figure 7–23. Pump Removal, Keyway

8. Using #1 Phillips drive, remove two M3 screws.
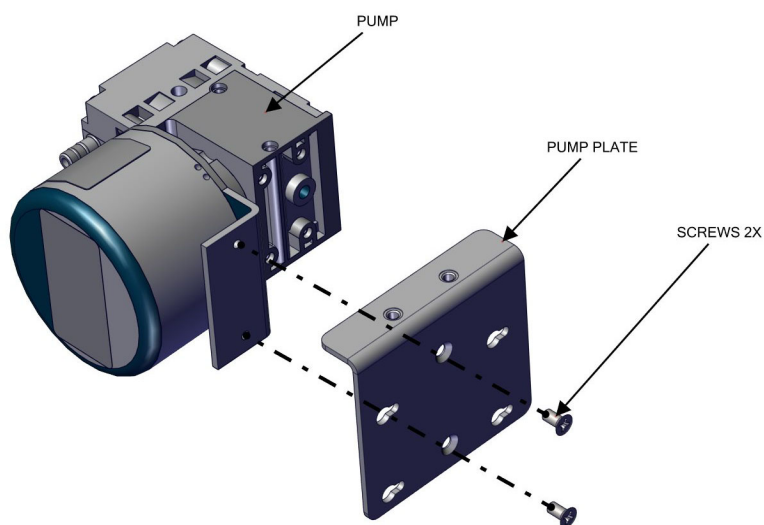
Figure 7–24. Pump replacing, Unfasten Screws

9. Replace pump and reassemble in reverse order.

Capillary Cleaning and/or Replacement

Use the following procedure to clean and/or replace the capillary.

Equipment required:

Phillips drive, #2

Hex drive, 7/64

1. Turn instrument OFF, unplug power cord, and remove the cover (Figure 2–1).

2. Disconnect the plumbing.

3. Using #2 Phillips drive, unfasten captive hardware.
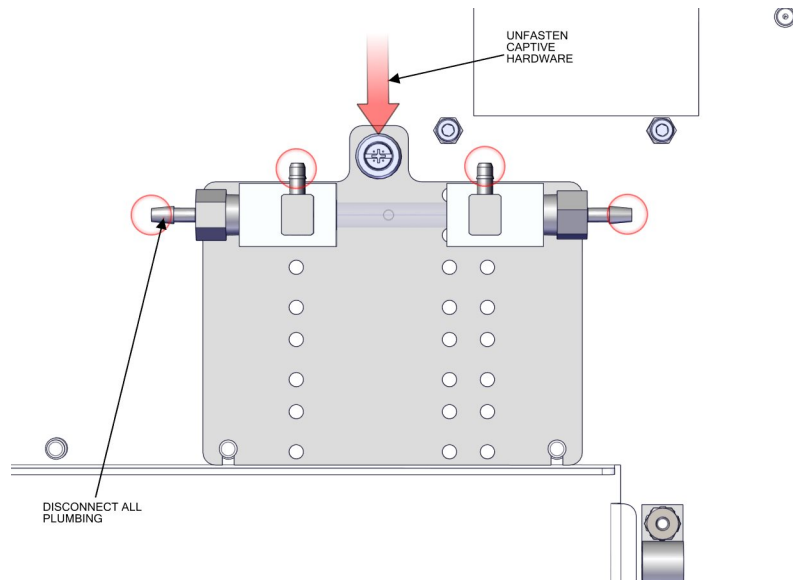
Figure 7–25. Remove Capillary, Disconnect and Unfasten

4. Slide capillary plate upwards clearing the partition panel keyway.
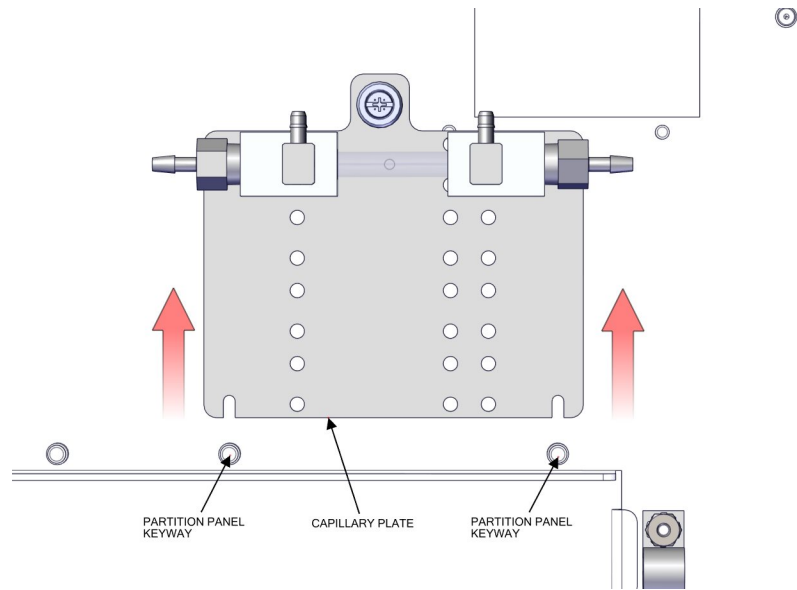
Figure 7–26. Capillary Plate, Keyway

5. Using 7/64 hex drive, remove four #6-32 socket cap head screws.

6. Pull apart the capillary blocks.
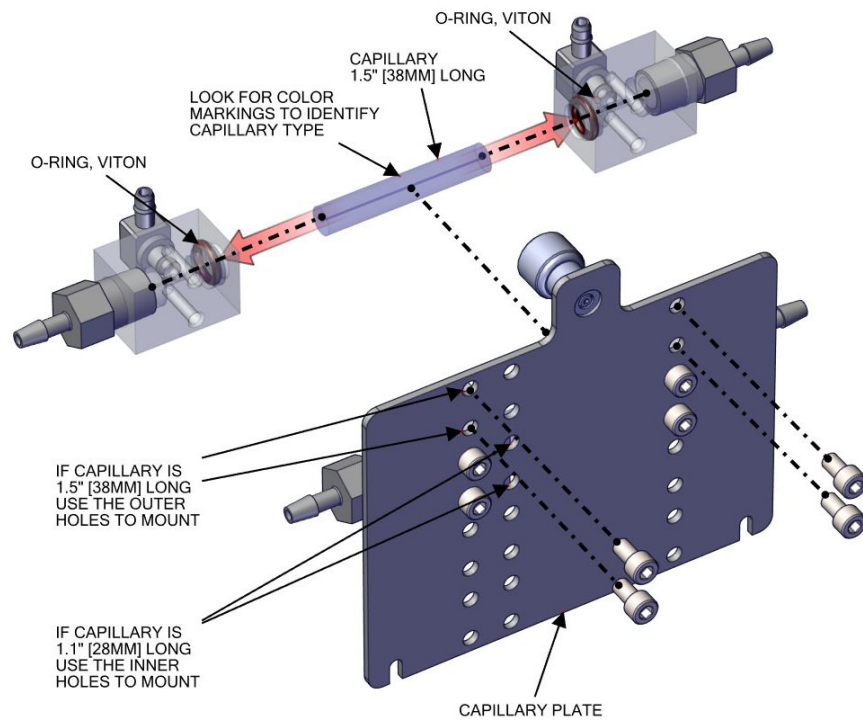
Figure 7–27. Capillary and O-Ring Replace

7. Replace capillary and reassemble in reverse order.

Note Fitting arrangements, number of capillaries and capillary sizes will vary per instrument configuration. ▲

Capillary O-Ring Replacement

Use the following procedure to replace the capillary o-rings.

Equipment required:

O-ring pick tool

1. Using a metal o-ring pick tool, remove the o-ring.

Note Be careful in not damaging the o-ring walls during this process. Refer to Figure 7–27. ▲

Power Supply Replacement

Use the following procedure to replace the power supply.

Equipment required:

Phillips drive, #2

1. Turn instrument OFF, unplug power cord, and remove the cover (Figure 2–1).

2. Unplug all electrical shown J9, J10, J24, J25, J26, and ground.

3. Unfasten captive hardware.

4. Slide power supply left, clearing three case floor plate keyways.
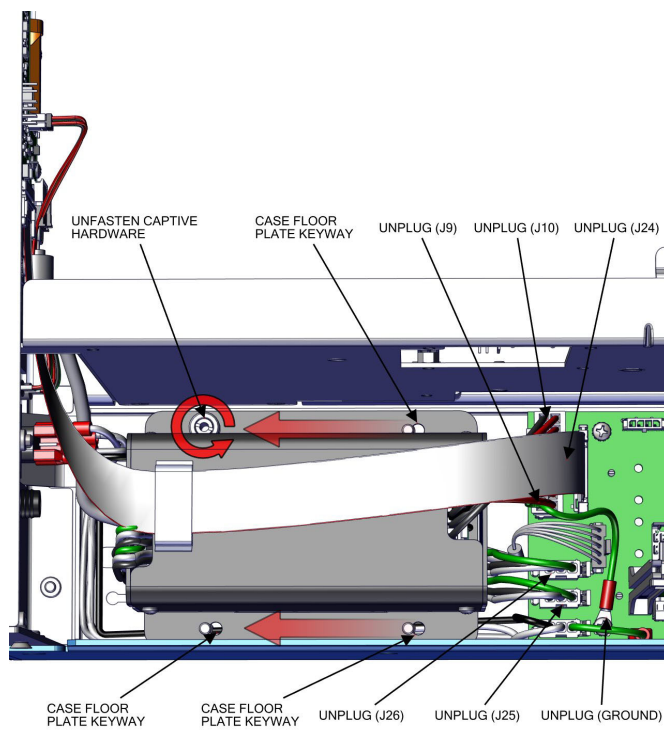
Figure 7–28. Removing Power Supply

5. Pull power supply up.

6. Replace power supply and reassemble in reverse order.
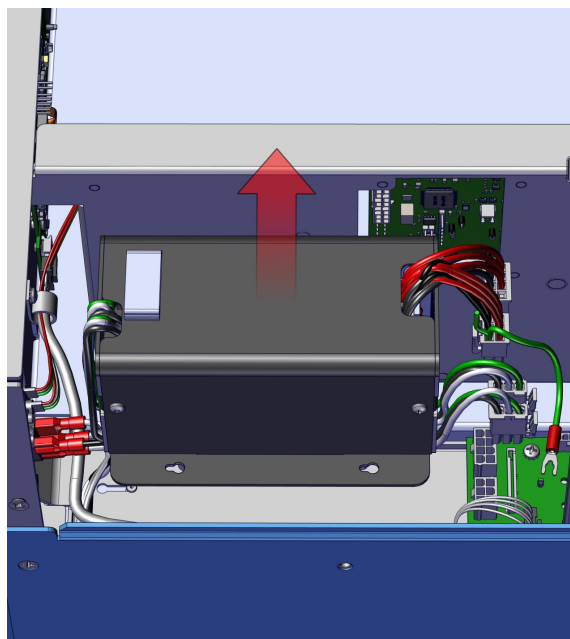
Figure 7–29. Replacing Power Supply

Step POL Board Replacement

Use the following procedure to replace the Step POL board.

Equipment required:

    Torque screwdriver, T15 or Slot screwdriver, 3/16

1. Turn instrument OFF, unplug power cord, and remove the cover (Figure 2–1).

2. Unplug Step POL power cable J4.

3. Unplug Step POL signal cable J2.

4. Unplug pump cable J7.

5. Unfasten captive hardware.
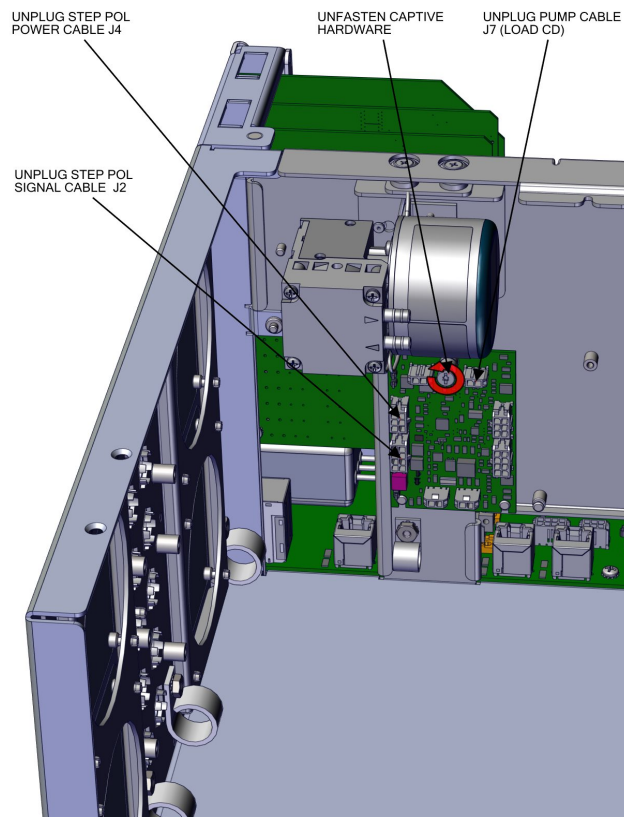
Figure 7–30. Unplug and Unfasten Step POL Board
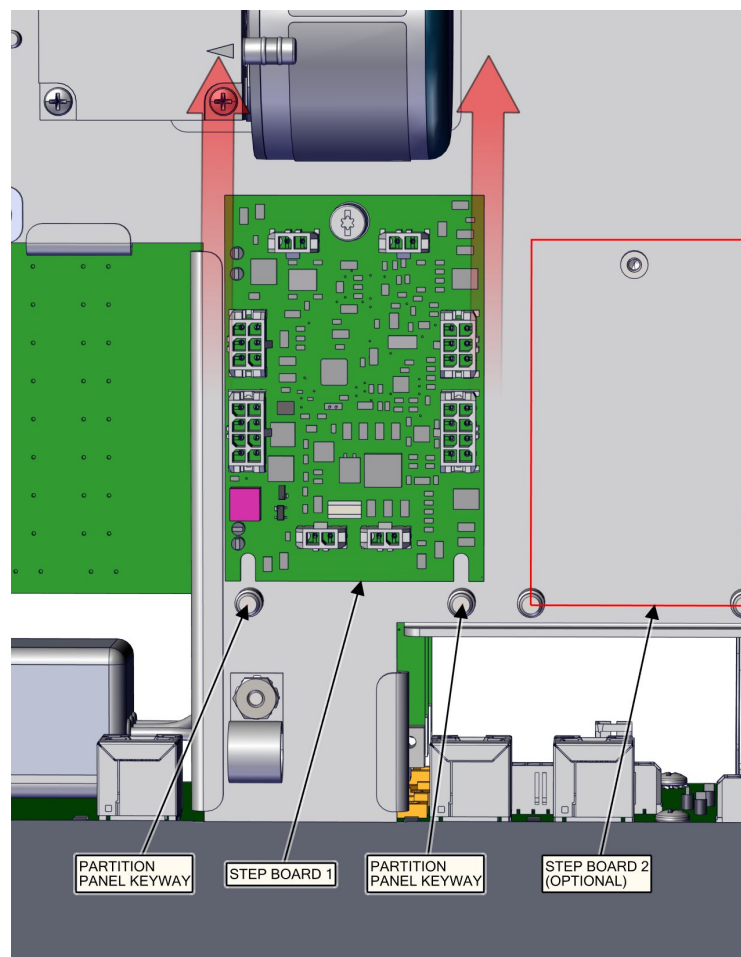
Figure 7–31. Clear Partition Keyway Step POL Board

6. Slide step board 1 upwards clearing the partition panel keyway.

7. If replacing step board 1, make sure switch 1 and 2 are pointed away from ON (Figure 7–32). If replacing optional step board 2, make sure switch 1 is pointed towards ON and switch 2 is pointed away from ON (Figure 7–33).

8. Replace Step POL board and reassemble in reverse order.

MAKE SURE SWITCH 1 AND 2
ARE POINTED AWAY FROM "ON"

LOOK FOR "ON" MARKING

BOARD 1 SETTINGS

LOOK FOR "ON" MARKING

MAKE SURE SWITCH IS POINTED
TOWARDS "ON"
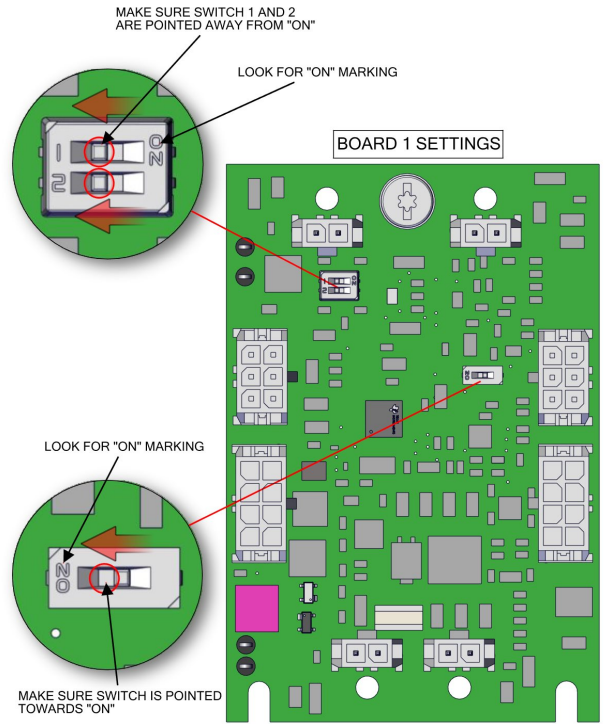
Figure 7–32. Step POL Board 1 Switch Settings

MAKE SURE SWITCH 1
IS POINTED TOWARDS "ON"

LOOK FOR "ON" MARKING

BOARD 2 SETTINGS

MAKE SURE SWITCH 2
IS POINTED AWAY "ON"

LOOK FOR "ON" MARKING

MAKE SURE SWITCH IS POINTED
TOWARDS "ON"
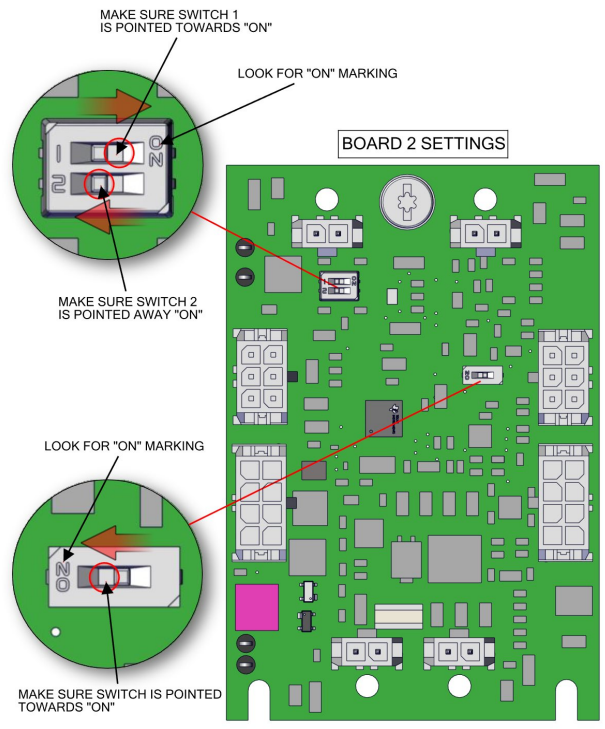
Figure 7–33. Optional Step POL Board 2 Switch Settings

DMC Optical Bench

The DMC Optical Bench consists of an optical bench, a bracket, and a DMC board.
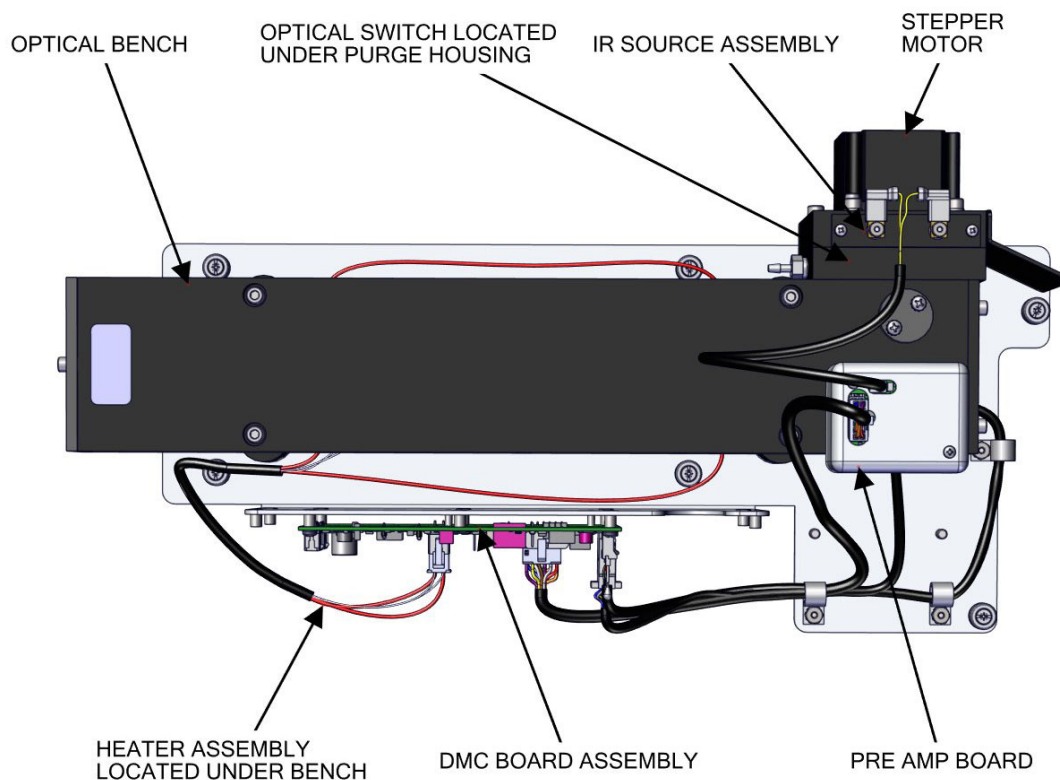
Figure 7–34. DMC Layout

Use the following procedure to remove the DMC from the instrument case. It is easier to do the following by removing the DMC first then remove and replace the following as necessary.

● Optical Bench removal

● Optical switch replacement, purge wheel housing removal, filter wheel replacement, motor replacement, filter wheel and motor alignment

● Heater Assembly removal

● Pre-Amp/Detector Assembly removal

● IR Source removal

Optical Bench Removal

Use the following procedure to remove the optical bench from the instrument case.

Equipment required:

Phillips drive, #2

1. Turn instrument OFF, unplug power cord, and remove the cover (Figure 2–1).

2. Unplug DMC cable J6 (bottom).

3. Disconnect plumbing as shown.

4. Using a #2 Phillips drive, unfasten six captive hardware.
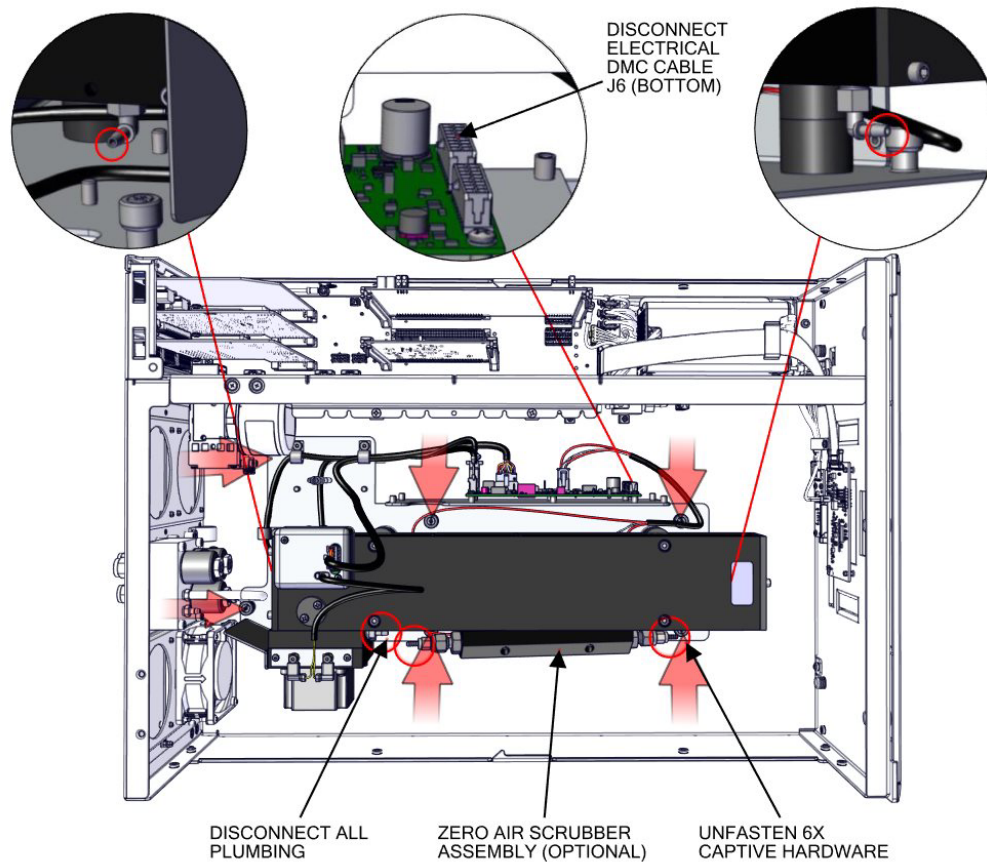
Figure 7–35. DMC Removal from Instrument

Optical Switch Replacement

Use the following procedure to replace the optical switch.

Equipment required:

Hex drive, 5/32

Phillips drive, #1

1. Unplug J8 (motor) and J4 (opt).

2. Unhook motor and opt connections.
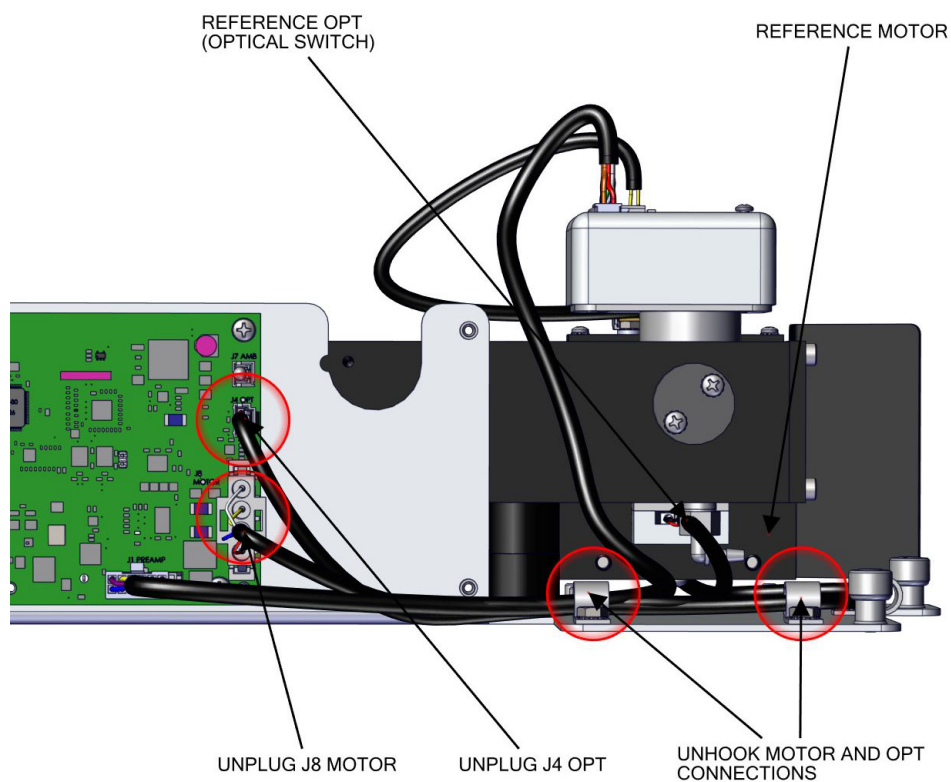
Figure 7–36. Motor and Filter Removal pt 1

3. Unplug electrical connections.

4. Using a 5/32 hex drive, remove three #10-32 socket cap head screws and lockwashers.

UNPLUG 2X ELECTRICAL
CONNECTIONS
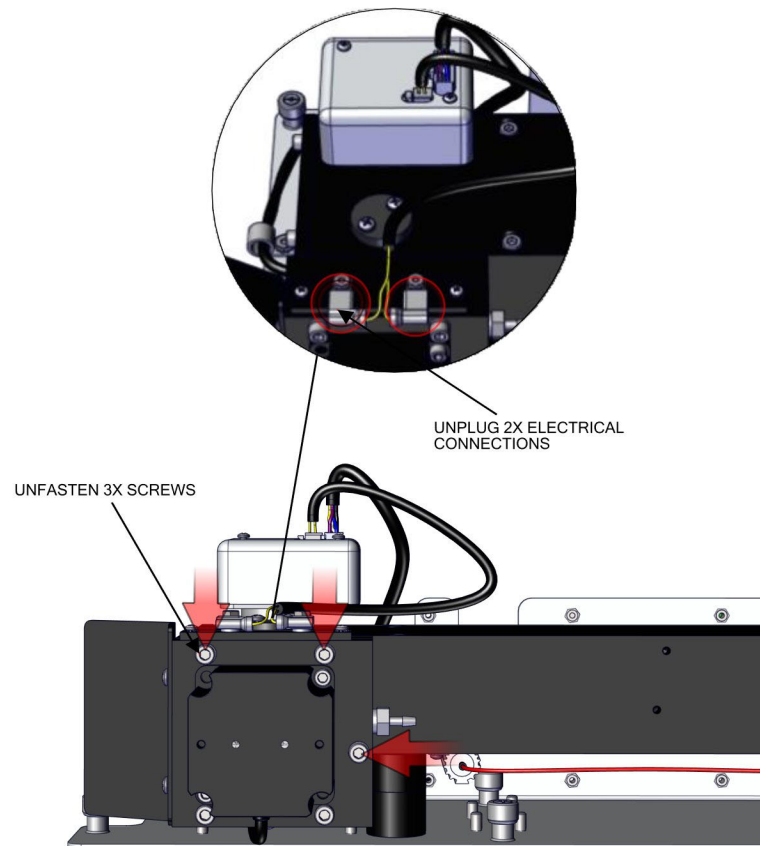
UNFASTEN 3X SCREWS

Figure 7–37. Motor and Filter Removal (pt 2)

Note Replace the optical switch if needed. You don't have to remove the optical switch to replace the motor or filter. ▲

5. Using #1 Phillips drive, unfasten two #4-40 flat head screws to remove the optical cover.

6. Using #1 Phillips drive, unfasten one #2-56 pan head screw to remove the optical switch.
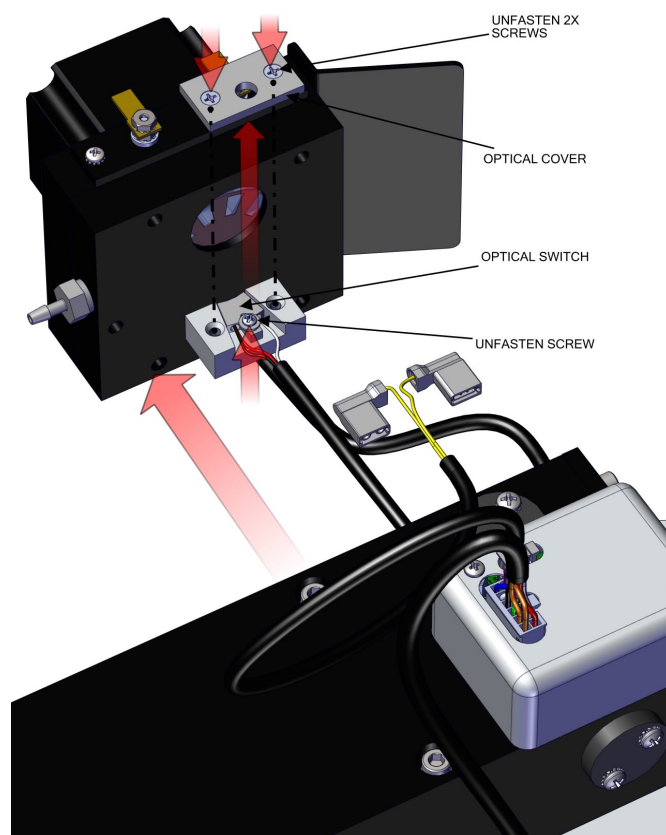
Figure 7–38. Motor and Filter Optical Switch Replacement (pt 3)

Purge Wheel Housing Removal

Use the following procedure to remove the purge housing in order to get to the filter wheel and motor.

Equipment required:

Hex drive, 5/32

1. Using 5/32 hex drive, unfasten two #10-32 socket cap head screws.

2. Carefully pull wheel housing apart.
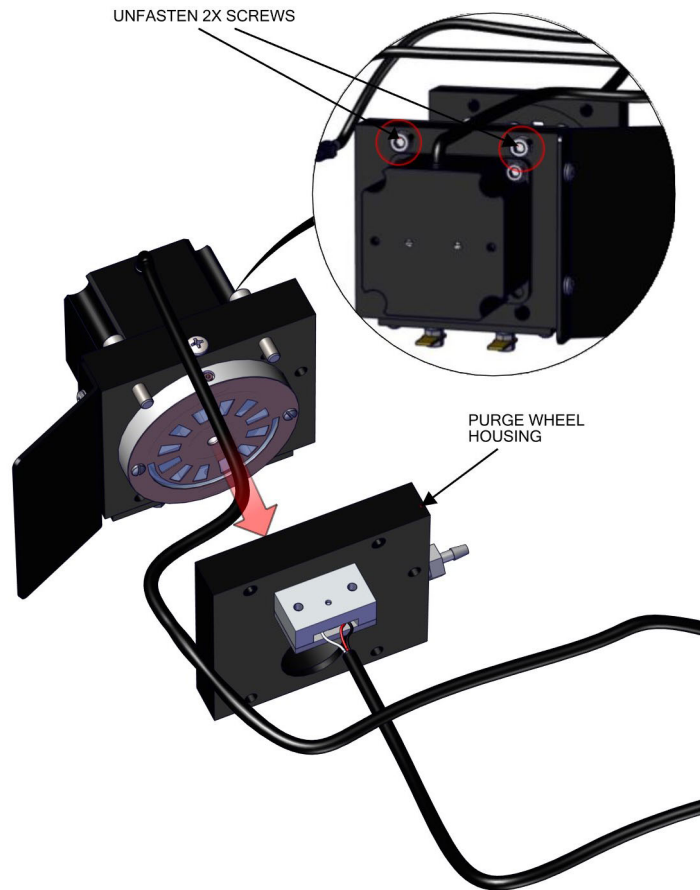
Figure 7–39. Purge Housing Removal from Motor Assembly (pt 4)

Filter Wheel Replacement

Use the following procedure to replace the filter wheel.

Equipment required:

Hex drive, 5/32 and 5/64

Phillips drive, #2

1. Remove optical bench. Refer to "Optical Bench Removal" on page 7-30.

2. Remove purge wheel housing. Refer to "Purge Wheel Housing Removal" on page 7-34.

3. Using 5/32 hex drive, unfasten two #10-32 socket cap head screws.

4. Using #2 Phillips drive, unfasten #8-32 pan head screw to gain access to #8-32 set screw.

5. Using 5/64 hex drive, loosen #8-32 set screw two or three turns only.

6. Carefully slide chopper wheel off motor shaft.

7. Replace filter wheel and align motor and filter wheel. Refer to "Motor and Filter Wheel Alignment" on page 7-39.
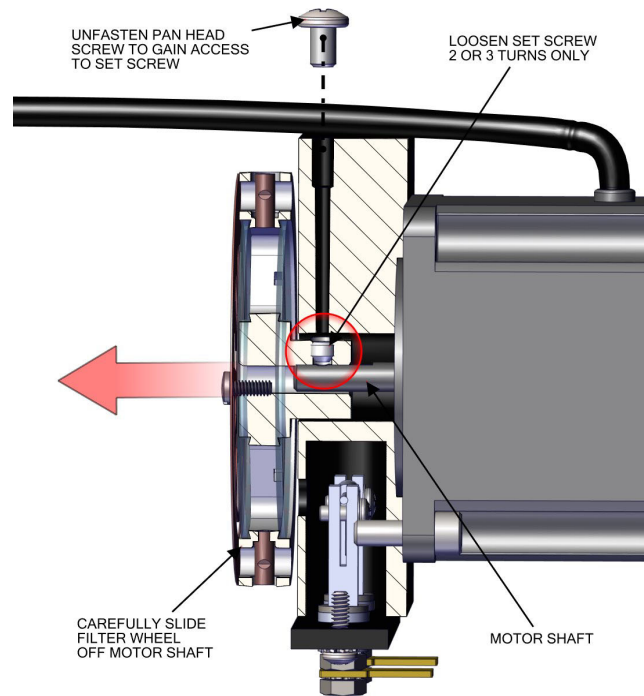
Figure 7–40. Filter Wheel

Motor Replacement   Use the following procedure to replace the motor.

Equipment required:

   Hex drive, 5/32 and 5/64

   Phillips drive, #2

1. Remove optical bench. Refer to "Optical Bench Removal" on page 7-30.

2. Remove purge wheel housing. Refer to "Purge Wheel Housing Removal" on page 7-34.

3. Remove filter wheel. Refer to "Filter Wheel Replacement" on page 7-35.

4. Using 5/64 hex drive, unfasten two #10-32 socket cap head screws.

UNFASTEN 2X SCREWS
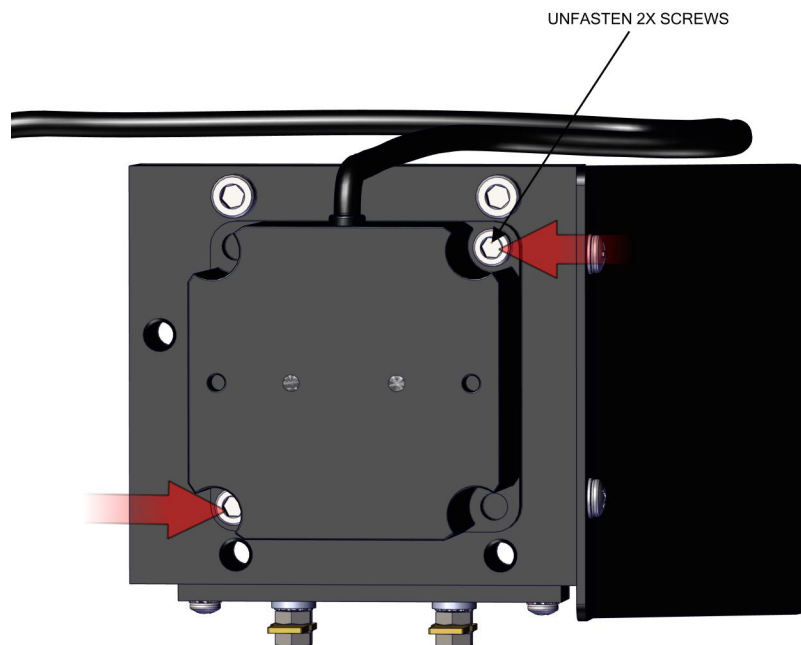
Figure 7–41. Motor Removal from Motor Mount pt 1

5. Using #2 Phillips drive, unfasten #8-32 pan head screw to gain access to #8-32 set screw.

6. Using 5/64 hex drive, loosen #8-32 set screw two or three turns only.

7. Carefully slide motor out.

8. Replace motor and align filter wheel and motor. Refer to "Motor and Filter Wheel Alignment" on page 7-39.
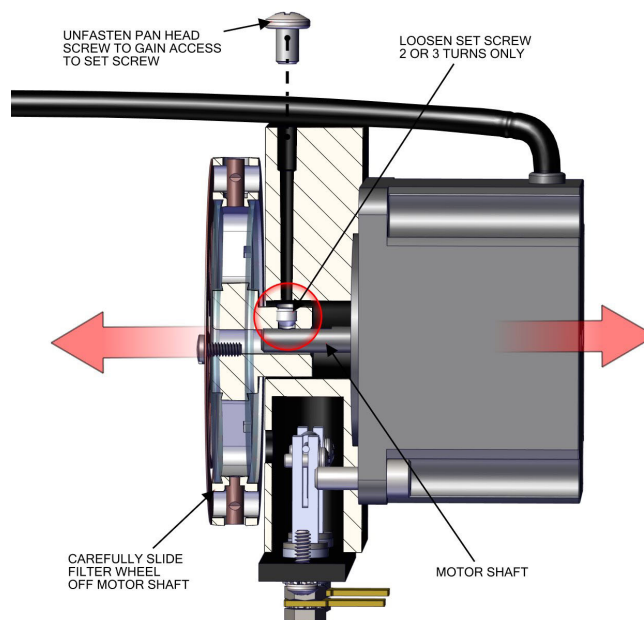
Figure 7–42. Motor Removal

Motor and Filter Wheel Alignment

After installing a new motor or filter wheel, use the following procedure to align the motor and filter wheel.

Equipment required:

Hex drive, 5/32 and 5/64

Thread locker

1. With the "DIMPLE" of the shaft aligned with the access hole, carefully slide chopper wheel over motor shaft until set screw lines up with hole.

2. Apply a light amount of thread locker to #8-32 set screw.

3. Using 5/64 hex drive tighten set screw slowly while gently rotating the chopper wheel back and forth. You should feel the set screw engage with the "DIMPLE" of the shaft. (The set screw for the chopper wheel is located opposite the curved slot.).

4. Make sure 10-32 screws are fastened. If motor is replaced, refer to Figure 7–41.

5. After the filter wheel is installed, spin the wheel and observe that it runs true on the motor shaft.
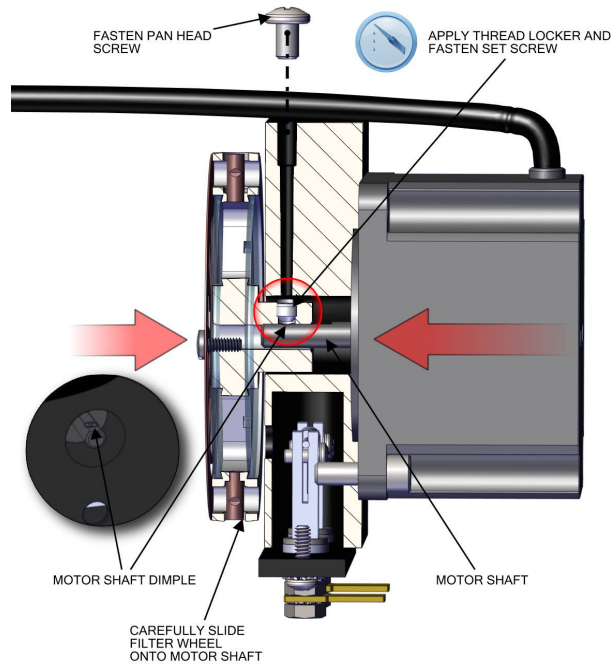
Figure 7–43. Motor Installation Shaft Alignment

6. Let instrument sample zero air for about 90 minutes.

7. From the Home screen, choose Settings>Measurement Settings>Advanced Measurement Settings>Optical Bench Settings>**Continue to Initial S/R Calibration**.

8. Follow steps in Chapter 4, "Calibration" for "Initial S/R".

Optical Bench/Heater Removal

Use the following procedure to remove the optical bench or replace heater assembly.

Equipment required:

Hex drive, 5/32

Phillips drive, #1

⚠ **WARNING**   Allow to cool before handling bottom of optical bench. ▲

1. Unplug electrical connections, J5 heater, J1 preamp, bottom connection J8 motor, and top connection J4 opt.

2. Using a 5/32 hex drive, unfasten four #10-32 socket cap head screws and lockwashers.
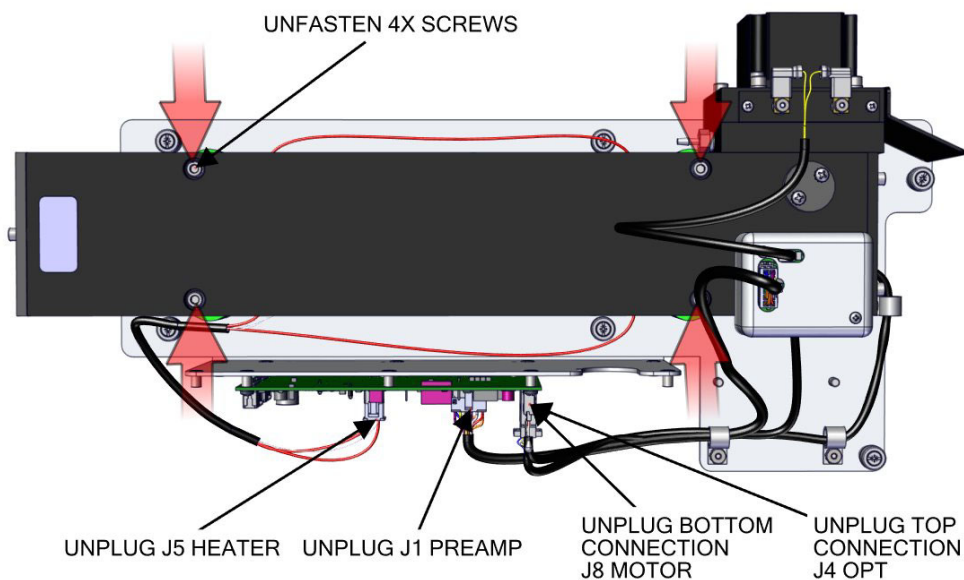
Figure 7–44. Bench Removal pt 1

3. Turn bench over, backside of optical bench.

4. Using #1 Phillips drive, unfasten five #4-40 pan head screws.
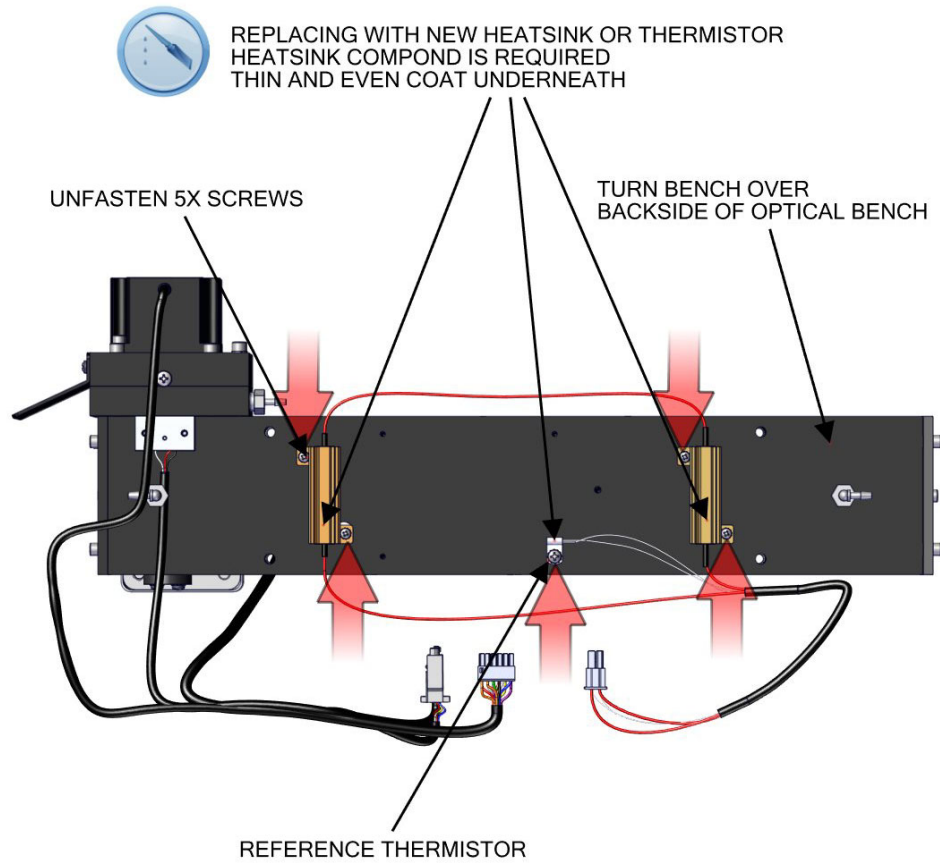
Figure 7–45. Heater Removal

5. When replacing with new heatsink or thermistor, heatsink compound is required. Apply a thin and even coat of heatsink compound underneath.

Pre-Amp/Detector Assembly Removal

Use the following procedure to remove the pre-amplifier/detector assembly.

Equipment required:

Phillips drive, #1

Hex drive, 7/64

1. Turn the instrument OFF, unplug the power cord, and remove the cover.

2. Unplug preamp and source IR cable assembly.

UNPLUG PREAMP CABLE ASSEMBLY   UNPLUG SOURCE IR CABLE
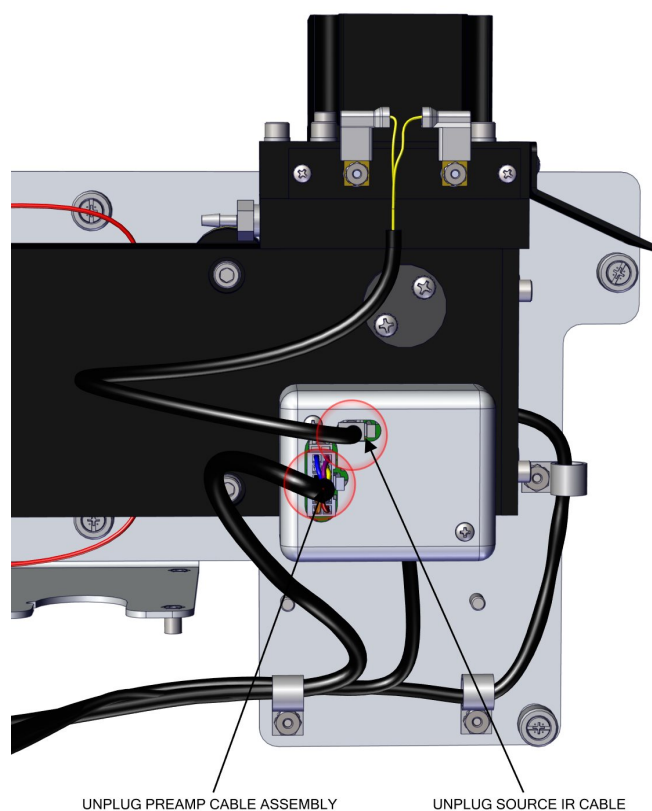
Figure 7–46. Preamp Detector Cover Removal pt 1

3. Using a #1 Phillips drive, unfasten two #4-40 pan head screws.

4. Lift preamp cover up.

5. Using a 7/64 hex drive, unfasten two #6-32 socket cap head screws.

6. Pull preamp board assembly outwards.

UNFASTEN 2X
SCREWS

PREAMP
DETECTOR
COVER

UNFASTEN 2X
SCREWS

PREAMP BOARD
ASSEMBLY

WHEN INSTALLING
MAKE SURE O-RING
IS SEATED PROPERLY
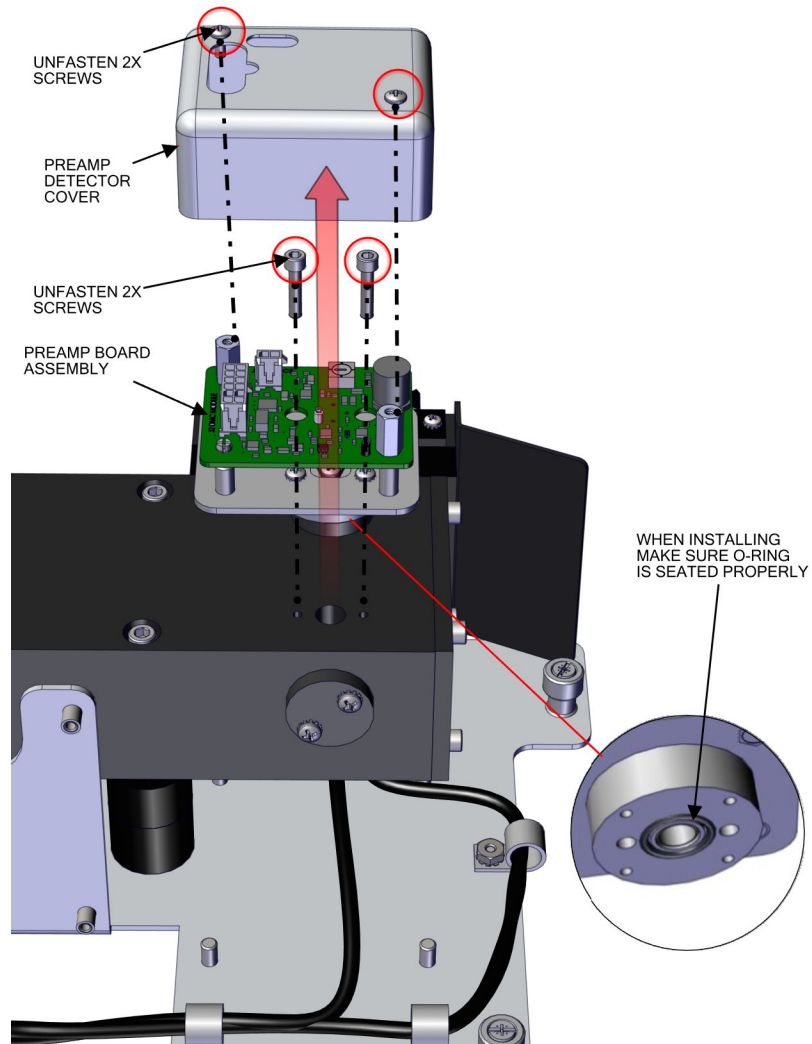
Figure 7–47. Preamp/Detector Removal

7. Replace preamp/detector as needed and assemble in reverse order.

Note When reinstalling preamp board assembly, make sure the o-ring is seated properly. ▲

IR Source Replacement

The IR source control system has been designed to operate the wire wound resistor IR source conservatively in order to increase its life. Nevertheless, the IR source does have a finite life. Since the IR source is relatively inexpensive and easily replaced, it is recommended that the IR source be replaced after one year of continuous use. This will prevent loss of data due to IR source failure. If an IR source is to be replaced on an as needed basis, it should be replaced when:

● There is no light output

● After cleaning the optics, the IR light intensities remain below 100,000 Hz

Use the following procedure to replace the IR source from DMC.

1. Turn the instrument OFF, unplug the power cord, and remove the cover.

2. Disconnect IR source cable as shown.
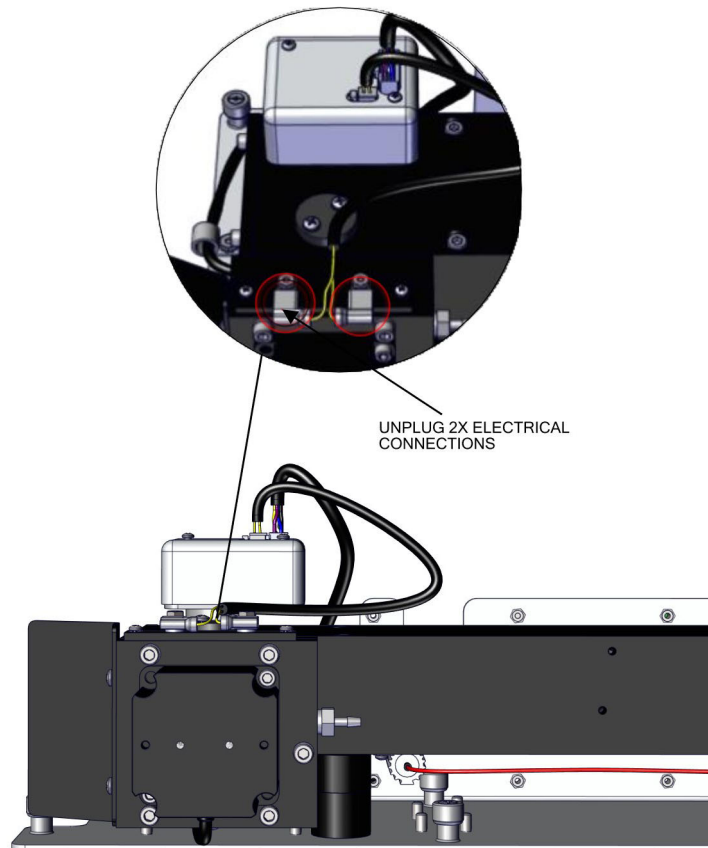
Figure 7–48. IR Source Cable Disconnect

3. Using a #1 Phillips drive, unfasten two #4-40 pan head screws.

4. Pull IR source assembly upwards.
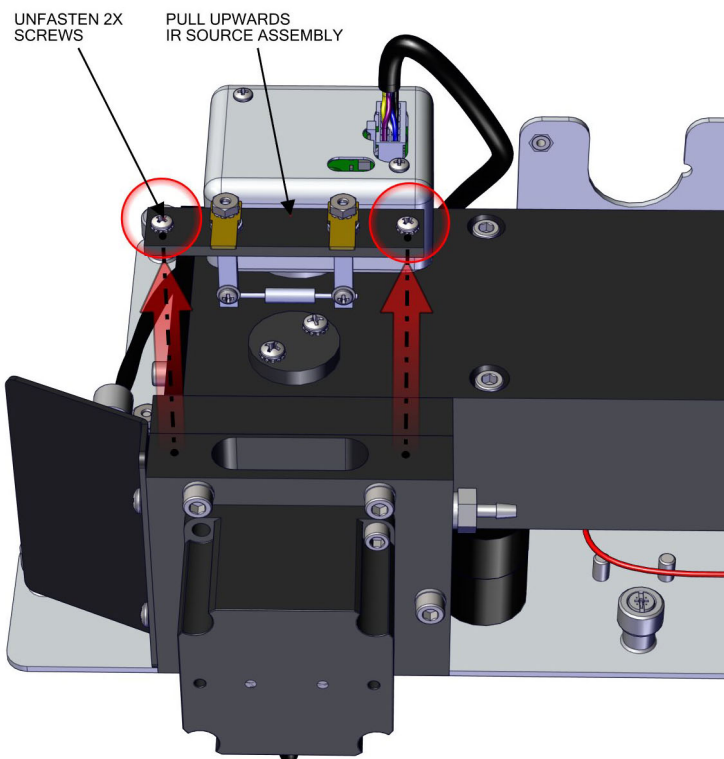
Figure 7–49. IR Source Assembly Removal

5. Reinstall in reverse order.

Optional Manifold Replacement

Use the following procedure to replace the manifold.

Equipment required:
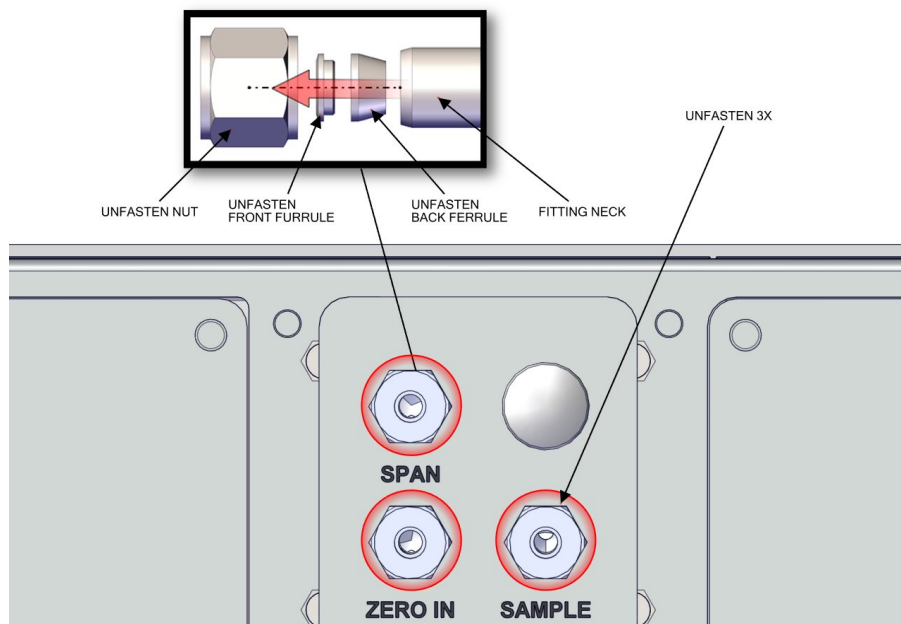
    Hex wrench, 9/16

    Hex drive, 9/64

1. Turn instrument OFF, unplug power cord, and remove the cover (Figure 2–1).

2. Unplug three electrical connections (J5, J6, and J8) from the Step POL board 1.
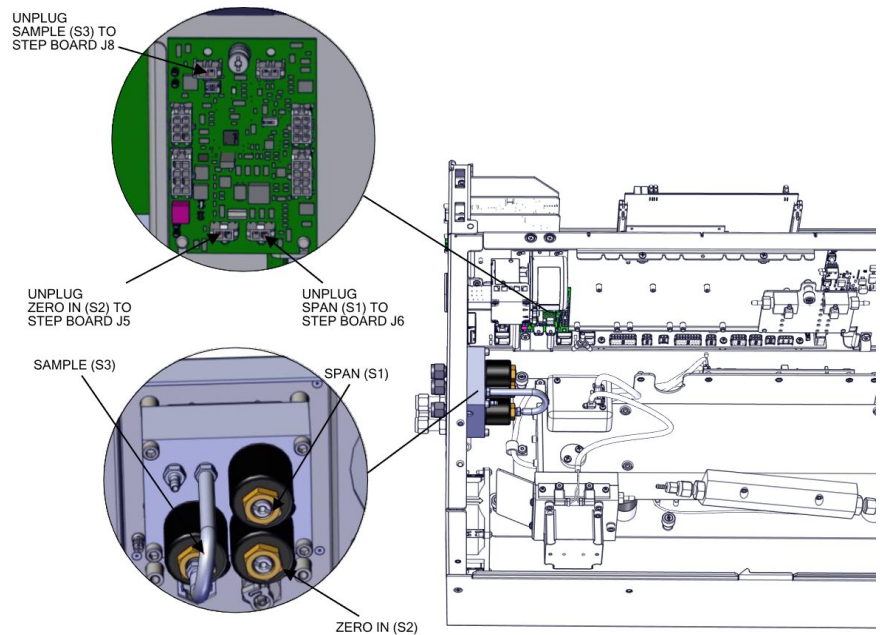
Figure 7–50. Replacing the Manifold pt 1

3. Unfasten three nuts. Remove the nuts, front and back ferrules as shown from span, zero in, sample back panel (Figure 7–51).

Figure 7–51. Replacing the Manifold pt 2

4. Disconnect tubing.

5. Using a 9/64 hex drive, unfasten four #8-32 socket cap head screws.
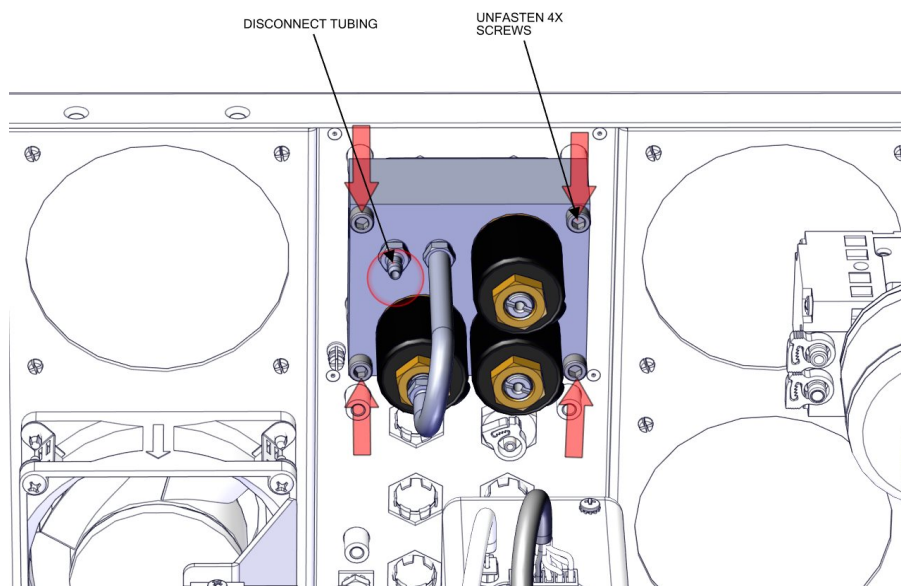
Figure 7–52. Replacing the Manifold pt 3

6. Replace the manifold and assemble in reverse order.

Optional Zero Air Scrubber Replacement

Use the following procedure to replace the zero air scrubber.

Equipment required:

Hex drive, 9/16

1. Turn the instrument OFF, unplug the power cord, and remove the cover (Figure 2–1).

2. Disconnect plumbing.

3. Unfasten four #8-32 socket cap head screws.

ZIR AIR SCRUBBER ASSEMBLY (OPTIONAL)   UNFASTEN 4X SCREWS   DISCONNECT PLUMBING 2X
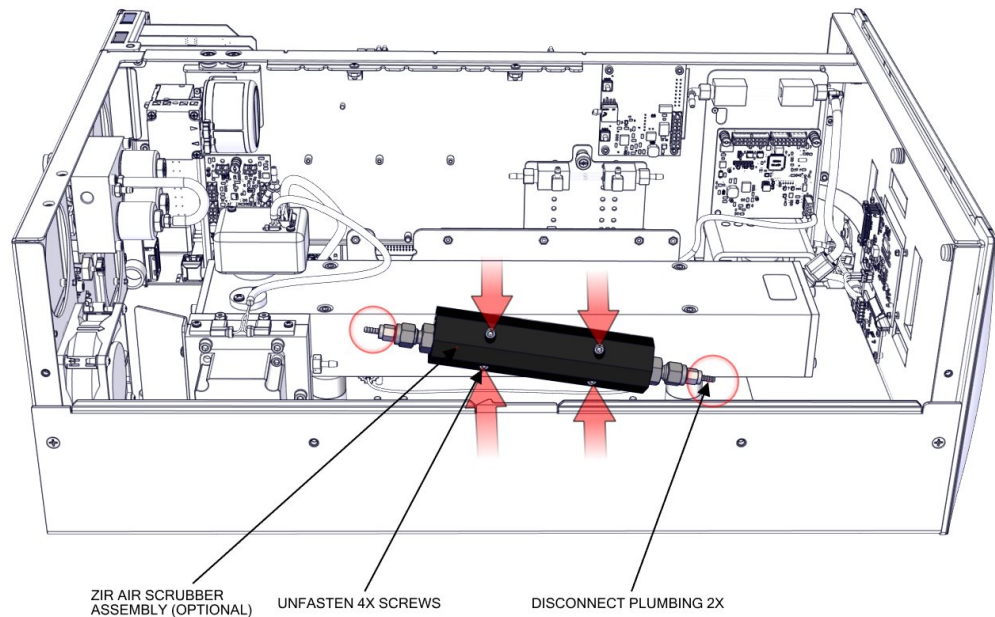
Figure 7–53. Zero Air Scrubber Replacement

4. Replace zero air scrubber and reinstall in reverse order.

Optional DMC Oxygen Sensor

Use the following procedure to remove the oxygen sensor from the instrument case. It is easier to do the following by removing the oxygen sensor first then remove and replace the following as necessary:

- Oxygen Sensor removal
- Oxygen Sensor board replacement
- Oxygen Sensor capillary replacement
- Oxygen Sensor replacement

Oxygen Sensor Removal

Use the following procedure to remove and replace the oxygen sensor.

Equipment required:

Phillips drive, #2

1. Turn instrument OFF, unplug power cord, and remove the cover (Figure 2–1).

2. Unplug electrical, unplug DMC cable to oxygen sensor board DMC (J4).

3. Disconnect 2X plumbing.

4. Using a #2 Phillips drive, unfasten captive hardware.

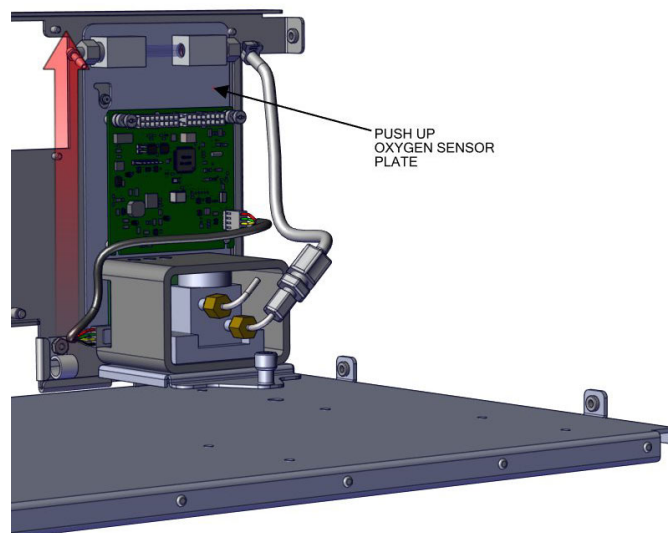**Figure 7–54.** Oxygen Sensor Removal pt 1

5. Slide oxygen sensor assembly left.

Note Make sure oxygen sensor plate clears the edge and stud. ▲
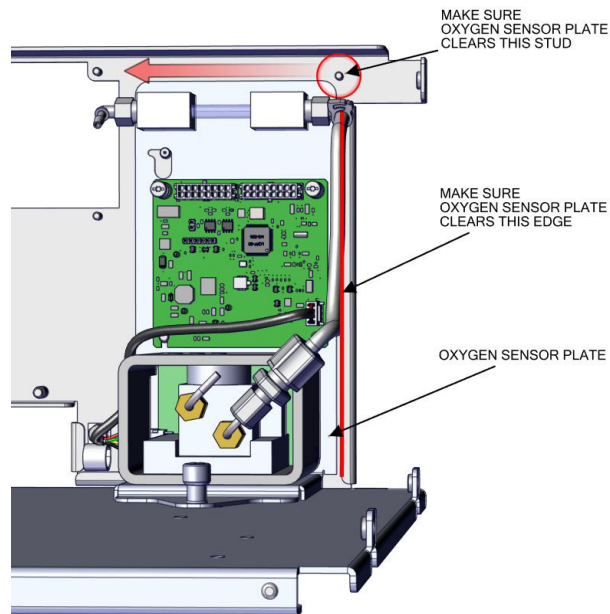
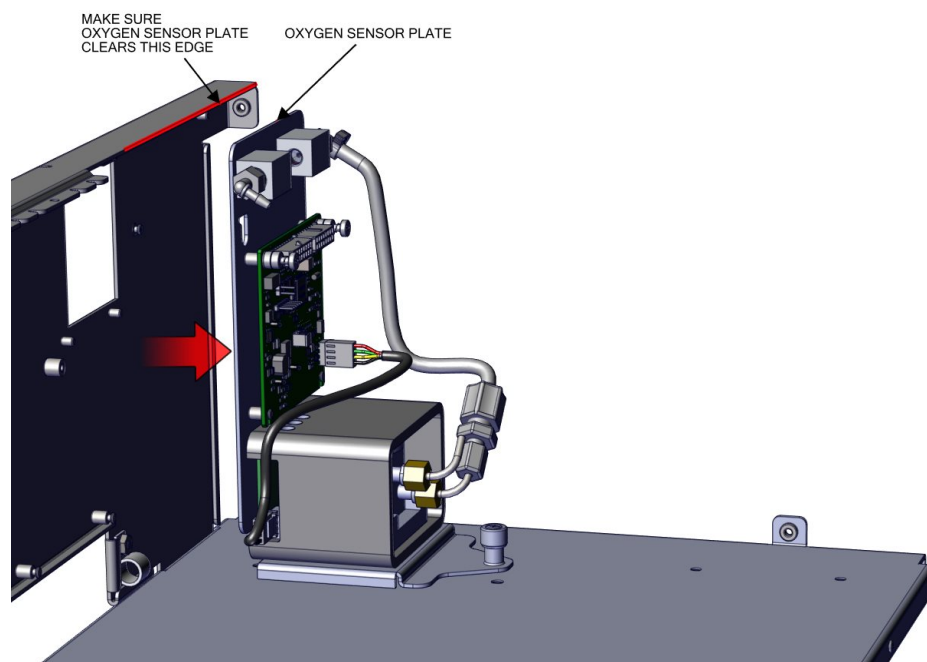**Figure 7–55.** Oxygen Sensor Removal pt 2

6. Slide oxygen sensor assembly upwards.

Figure 7–56. Oxygen Sensor Removal pt 3

7. Pull away from the partition panel.

Note Make sure oxygen sensor plate clears the edge. ▲

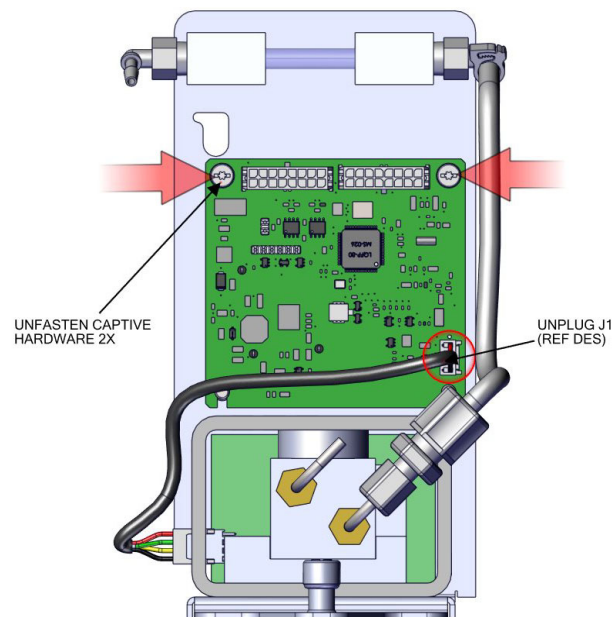**Figure 7–57.** Oxygen Sensor Removal pt 4

Oxygen Sensor Board Replacement

Use the following procedure to replace the oxygen sensor board.
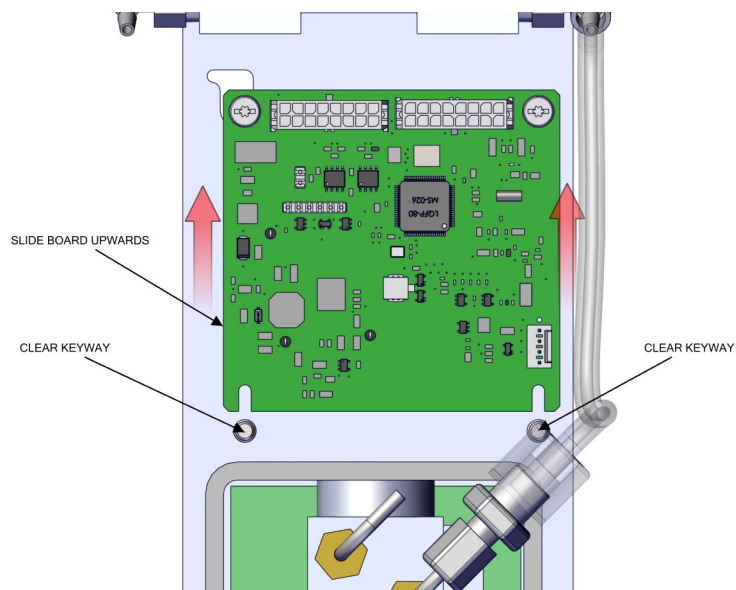
Equipment required:

Phillips drive, #2

1. Remove the oxygen sensor DMC from the instrument. Refer to "Oxygen Sensor Removal" on page 7-51.

2. Unplug J1.

3. Using a #2 Phillips drive, unfasten five #6-32 pan head screws.

Figure 7–58. Replacing the Oxygen Sensor DMC Board

4. Slide board upwards.

Note Clear keyway. ▲

SLIDE BOARD UPWARDS

CLEAR KEYWAY

CLEAR KEYWAY

Figure 7–59. Replacing the Oxygen Sensor DMC Board pt 2

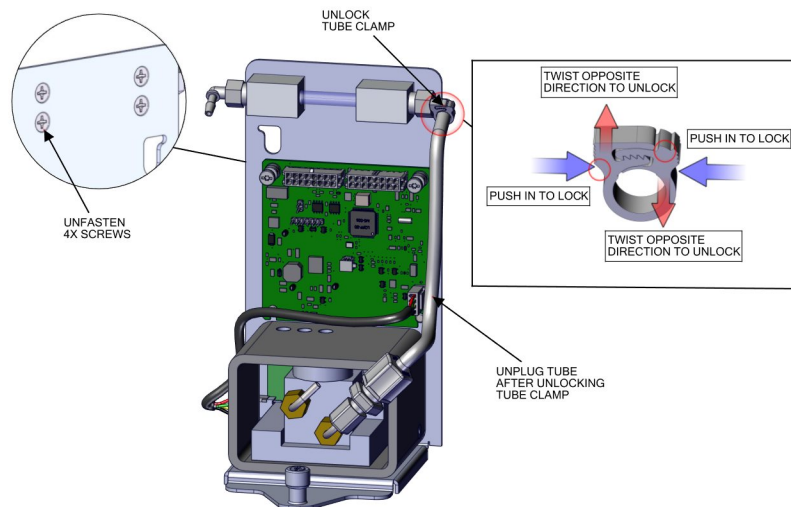5. Replace oxygen sensor board and reassemble in reverse order.

Oxygen Sensor Capillary Replacement

Use the following to replace the oxygen sensor capillary.
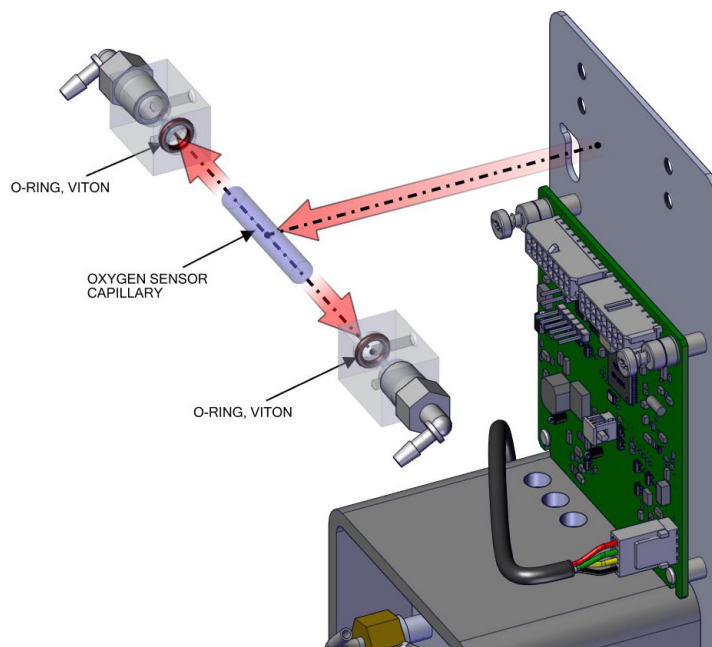
Equipment required:

Ball-end hex drive, 3/32

1. Remove the oxygen sensor DMC from the instrument. Refer to "Oxygen Sensor Removal" on page 7-51.

2. Using a 3/32 ball-end hex drive (angle alignment of screws), unfasten two #4-40 cap screws.

3. Unlock tube clamp.

4. Unplug tube after unlocking tube clamp.

Figure 7–60. Replacing the Oxygen Sensor Capillary

Figure 7–61. Replacing the Capillary pt 2

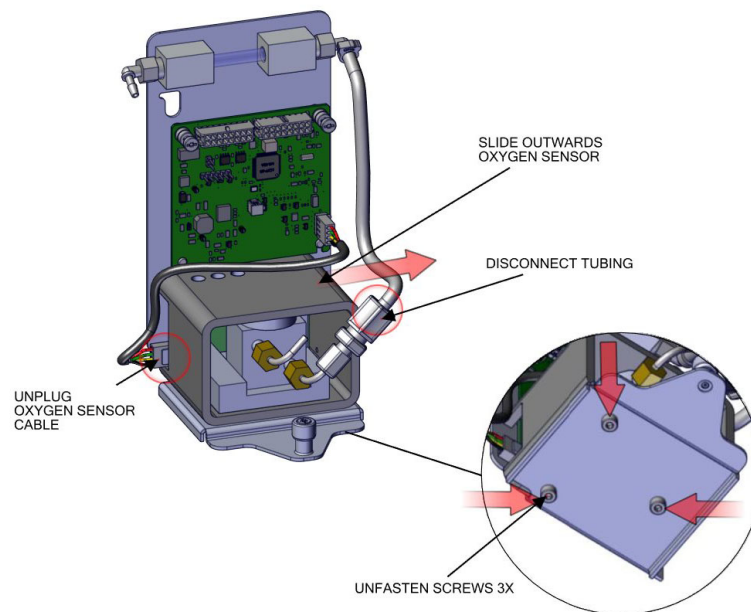5. Replace capillary and reassemble in reverse order.

Oxygen Sensor Replacement

Use the following to replace the oxygen sensor.

Equipment required:

Phillips drive, #2

1. Remove the oxygen sensor DMC from the instrument. Refer to "Oxygen Sensor Removal" on page 7-51.

2. Unplug oxygen sensor cable.

Figure 7–62. Replacing the Oxygen Sensor

3. Using a #2 Phillips drive, unfasten three #6-32 flat head screws.

4. Disconnect tubing.

5. Pull out oxygen sensor

6. Replace oxygen sensor and reassemble in reverse order.

Chapter 8
System Description

The 48iQ deploys a set of modular subsystems that comprise the total instrument function. The core measurements for concentration are contained in Distributed Measurement and Control (DMC) modules. This chapter describes the function and location of the system components in the module framework, including firmware, electronics, and I/O function.

The 48iQ system components include:

- Optical Bench DMC

  - Optical Bench hardware with bandpass filters, mirrors, and heater cable

  - Filter Wheel and Motor sub-assembly

  - Filter Wheel Purge

  - Detector Preamp

  - Infrared source

  - Optical bench DMC board

- Common Electronics

  - Power supply

  - System Control board

  - Backplane board

  - Front panel

  - I/O (optional)

- Peripherals Support System

  - Fan (on rear panel)

  - Step POL board

  - Sample Pump

  - Solenoid valve panel (optional)

- Flow Pressure DMC with flow restricting capillary

- Firmware

● Oxygen Sensor (optional)

Optical Bench DMC

The Optical Bench DMC contains the key components of the optical measurement that eventually results in CO concentration.

Optical Bench Hardware

The optical bench is an airtight bench that contains the sample gas. It also includes the mirrors that reflect infrared light multiple times across the sample path before detection, to maximize absorption. Heaters are used to maintain the optical bench at a constant temperature.

A bandpass filter limits the light entering the optical bench to a narrow band of the infrared within which CO absorbs.
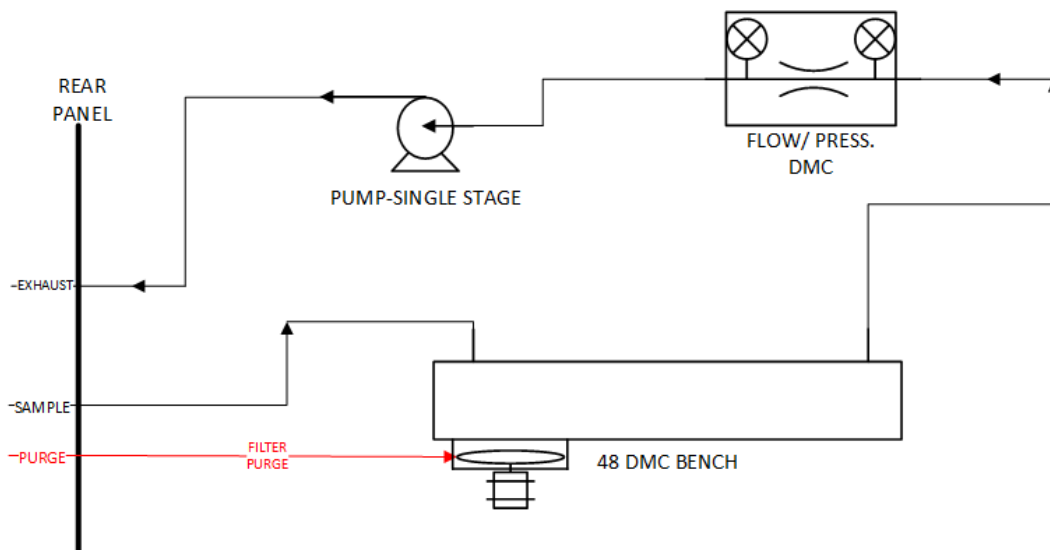
Filter Wheel Motor

A gas filter wheel contains samples of CO and N_2 gas with a chopper disk. The wheel is rotated so that infrared light is periodically interrupted to produce a modulated signal upon detection. Differentiating the light through the CO and N_2 components of the wheel, in the presence of CO in the optical bench, allow the determination of sample CO absorption and concentration.

The chopper motor rotates the gas filter wheel and chopper disk at a uniform speed.

A separate optical switch assembly detects the position of the filter wheel for synchronizing the modulated signal and for checking the chopper motor speed.

Filter Wheel Purge

The filter wheel purge includes a housing attached between the optical bench and the motor plate. It surrounds the gas correlation wheel and allows purging the area around the gas correlation wheel with instrument air or a gas other than that present in the local atmosphere. This increases the reliability of the measurement by removing contaminants in the vicinity of the wheel that would interfere with the analytical process. Figure 8–1 shows how the filter wheel purge is configured within the instrument for an external purge gas supply. The instrument's default configuration allows for active flow of in instrument air through the filter wheel purge.

Figure 8–1. 48iQ Flow Schematic with Filter Wheel Purge

Calibration Note The stability of the purge gas is very important. Since this gas is in the same optical path as the sample, changes in the composition of the purge gas can change the calibration of the instrument. Therefore, either zero air or a non-toxic dry inert gas, such as nitrogen, is required as the purge gas.

A constant purge flow of approximately 140 cc/min is recommended for optimum performance. This is produced by feeding a purge gas to the rear panel bulkhead at a constant pressure of 10 psig. A fitting with a 0.010-inch laser drilled orifice delivers the required 140 cc/min purge flow. Flows greater than this are not recommended due to unstable cooling effects on the IR source. Lower flows are acceptable as long as the purge housing is adequately purged for the application. ▲

Detector Preamp

The detector/preamplifier assembly converts infrared light, carrying modulation and CO sample absorption, into an amplified electrical signal that undergoes processing.

Infrared Source

The infrared light source is a special wire-wound resistor operated at high temperature to generate broadband infrared radiation.

Optical Bench DMC Board

A single PCBA with microprocessor provides active controls for the above elements, performs preliminary data processing, and generates registers that interact with the higher level system controls.

Common Electronics

The common electronics contain the core computational and power routing hardware for the 48iQ, and is replicated throughout other iQ series products (Figure 8–2). It also contains front panel display, the USB ports, the Ethernet port, and the optional I/O interfaces (RS-485, analog, and digital).

Figure 8–3 shows the PCBA interconnect structure for the 48iQ, including options. The modular design of the instrument is conveyed in the architecture. Brief descriptions of the specific PCBAs follow.
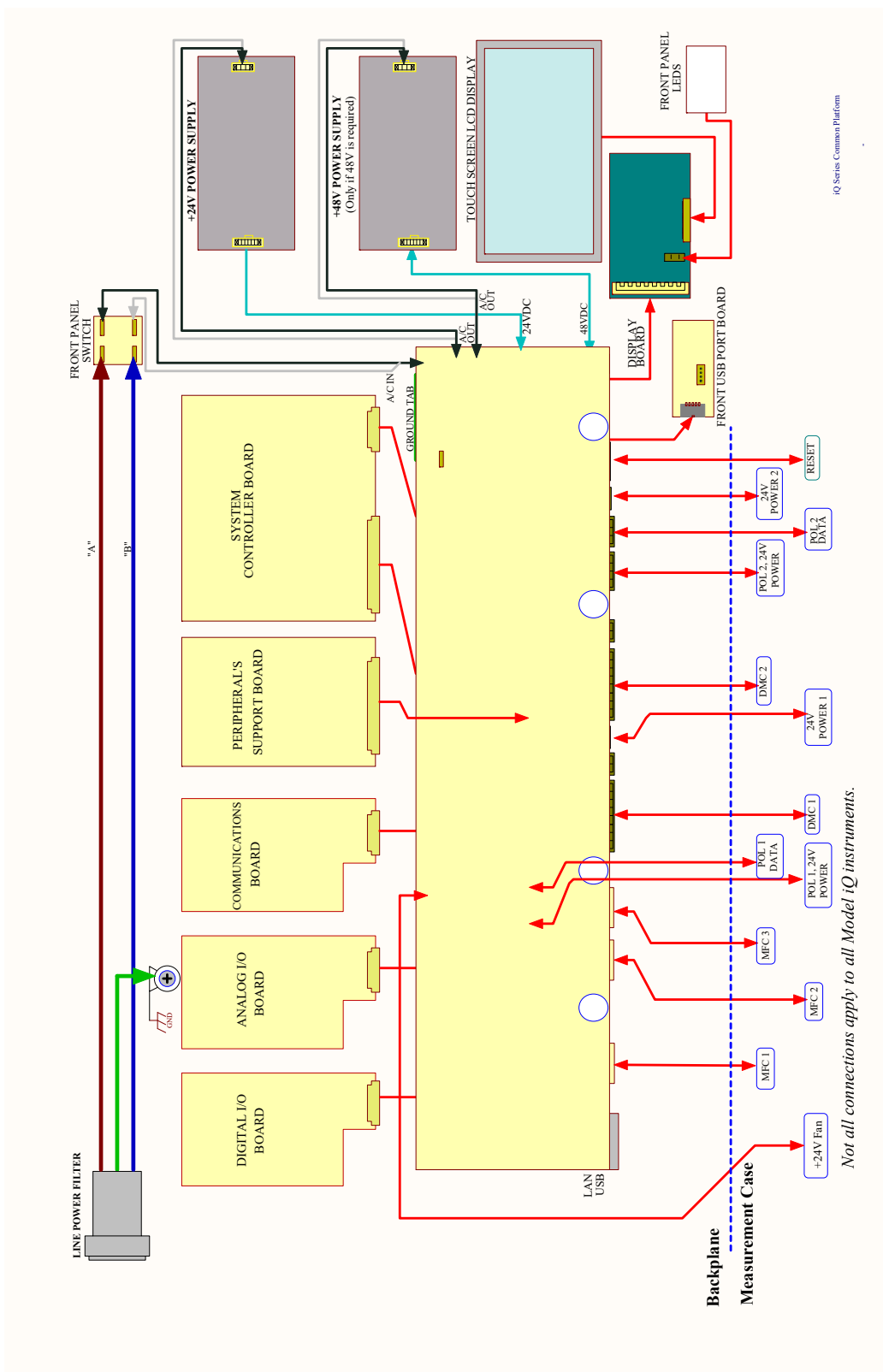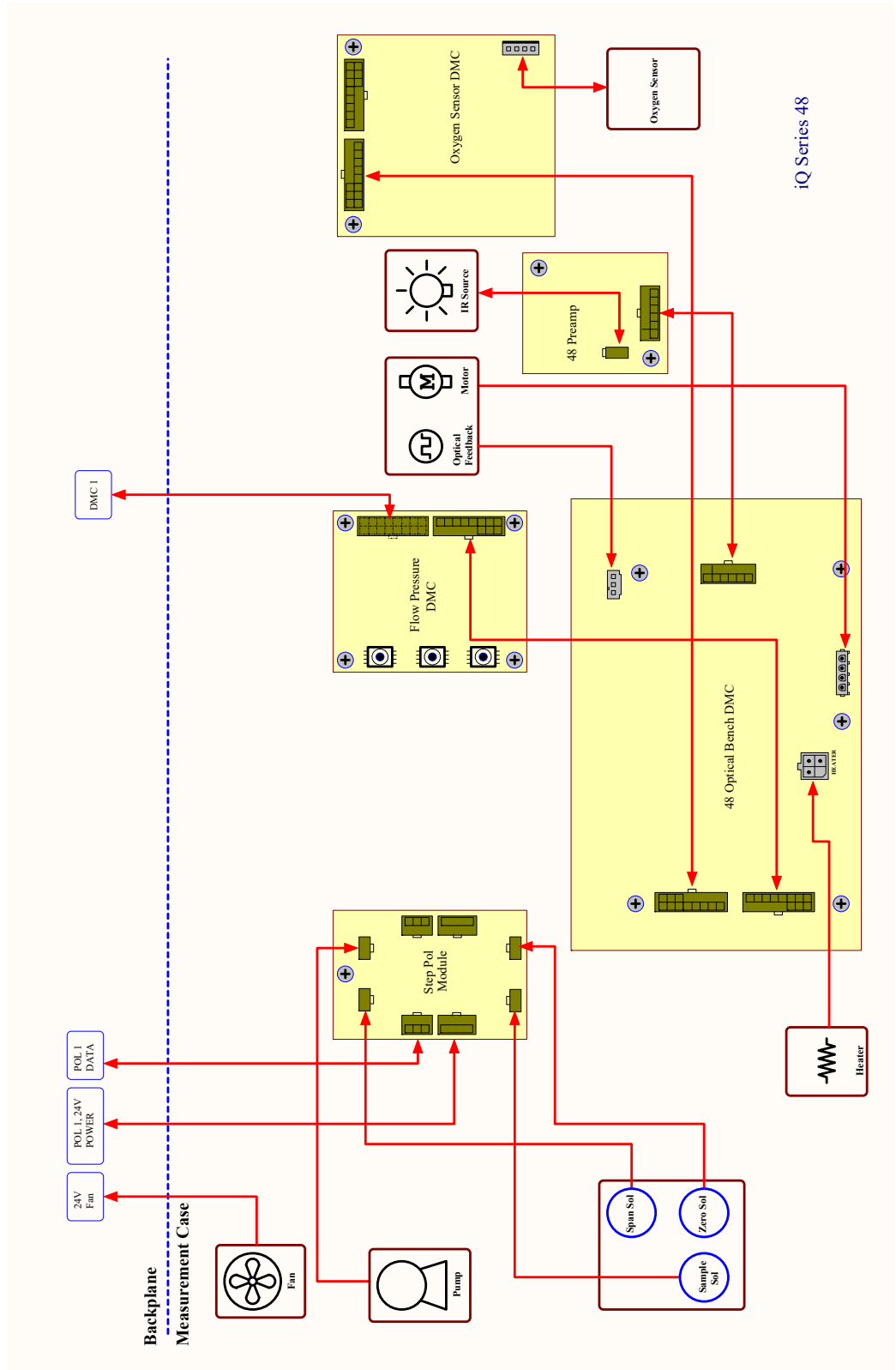
Figure 8–2. Common System Interconnect Diagram

Figure 8–3. 48iQ System Interconnect Diagram

Power Supply

All electronics operate from a universal VDC supply, which is capable of auto-sensing the input voltage and working over all specified operating ranges. The 48iQ contains a 24 VDC channel for most electronics operation, including the pump and fan, and a 48 VDC channel dedicated specifically for optical bench heating.

Front Panel

Front panel electronic components include the touch screen display, the on off switch, and two indicator LEDs for power and alarm status, as described in operational detail in Chapter 2, "Installation and Setup".

I/O and Communication Components

The iQ series instruments provide a number of methods for communicating the instrument results to the operator or external equipment. Every iQ series instrument includes a front panel display, 3 USB ports, and one Ethernet data port as standard equipment.

In addition, optional RS-232/485, analog I/O, and digital I/O ports are available to provide data to external systems as described in Chapter 9, "Connecting External Devices". The front panel GUI allows the operator to configure these output communication channels as described in Chapter 3, "Operation".

System Controller Board

The System Controller Board (SCB) contains the main processor, power supplies, and a sub-processor, and serves as the communication hub for the instrument. The SCB receives operator inputs from the front panel GUI and/or over optional I/O connections on the rear panel. The SCB sends commands to the other boards to control the functions of the instrument and to collect measurement and diagnostic information. The SCB outputs instrument status and measurement data to the GUI, Ethernet/USB, and to the optional rear-panel I/O. The SCB plugs into the backplane via a single connector and has physical retainers to secure placement.

Backplane Board

The backplane board provides the routing and conditioning for +24 VDC (optional +48 VDC) and RS-485 communications within the instrument. It hosts the System Controller Board (SCB) and Peripherals Support Board (PSB) via direct plug ins, and similarly hosts optional I/O (communication, analog, and digital) with rear panel interfaces via direct plug in. It has connections for RS-485 communication with and powering of DMCs and the Step POL Module. It additionally routes the front panel display and driver, external USB and Ethernet.

Peripherals Support System

The peripherals support system operates those additional devices that are needed, but do not require special feedback control or processing. These components are connected to a Peripherals Support Board (PSB).

The PSB microprocessor regulates the timing and health of such devices, and generates registers that interact with the higher level system controls.

Fan

The chassis fan provides air cooling of the active electronic components.

Step POL Board

The Step POL board provides high/low outputs for continuous operation or on/off states. The Step POL board contains the basic circuitry to provide a programmable load to passive devices, either continuously, or on user or automated command. In the iQ Series instruments, the pump, solenoids, etc., are controlled off of the Step POL board from commands generated via the PSB.

Sample Pump

Internal vacuum pump for generating air/sample through the instrument.

Solenoid Valve Panel (optional)

Optional solenoid valves for switching between sample, zero, and span gases, and other optional components.

Flow/Pressure DMC

The Flow/Pressure DMC is used measure instrument pressures that assure proper flow regulation and for sample pressure within the measurement bench for pressure corrections and compensation.

The DMC includes two pressure sensors that read 0–860 mmHg. These sensors are used with the coupled restricting capillary for flow control along with the downstream sample pump. The pressure differential determines the flow through the capillary. The upstream pressure is the measurement bench pressure, while the downstream pressure is at the pump inlet pressure.

Firmware

Like the hardware, the firmware is modular and located within microprocessors distributed throughout the instrument. In the 48iQ, microprocessors containing firmware are located as follows:

- Optical Bench DMC
- Flow/Pressure DMC

- Peripherals Support Board

- Optional I/O (Communications, Analog, and Digital)

- Optional Oxygen Sensor

The firmware contains the active controls for their application, as well as self-identification and configuration for "plug and play" style operation. Each are associated with specific registers of two types:

- Modbus registers that are communicated from each microprocessor to the System Controller Board (SCB) via internal RS-485

- SNMP registers that are maintained in the software and SCB for health and data processing computation

The Modbus communication system operates on 1 second intervals. Within those intervals, data treatment like integration (whether analog or digital) and servo control, are embedded in the module firmware. The SCB receives the 1 second updates for higher level "software" processing and control via SNMP registers, some of which is interfaced with the front panel Graphical User Interface (GUI).

In addition to the operating registers, the 48iQ stores a historical data log in a MySQL database. The memory is provided on the same micro SD card where the operating software resides, for which there is capability to store up to a year of data at 1 minute intervals. Chapter 3, "Operation" describes how this database is accessed and used including external memory downloads.

Oxygen Sensor (optional)

The 48iQ can be configured with an optional DMC based Oxygen (O_2) Sensor. This sensor is a paramagnetic sensor for O_2 concentration measurement and CO correction. This option allows the user to correct the CO readings for the amount of oxygen in the sample. Selectable O_2 concentrations can be used as the correction factor.
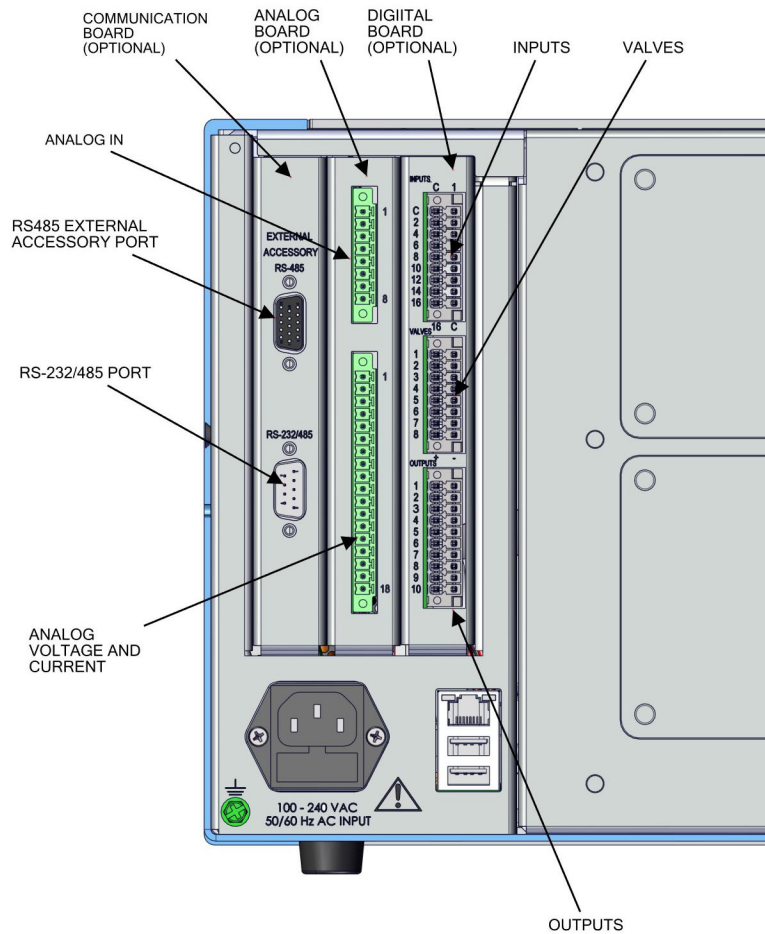
Chapter 9
Optional Equipment

The 48iQ is available with the following options:

Connecting External Devices

Several components are available for connecting external devices. These connection options consist of three plug-in boards:

- Communication Board
- Analog I/O Board
- Digital I/O Board

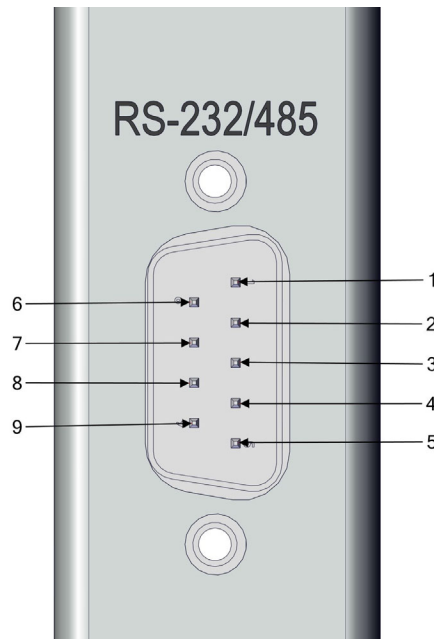**Figure 9–1.** I/O Expansion Replacement Boards

Communication Board

The communication board consists of:

● RS-232/485 Port

● RS-485 External Accessory Port

RS-232/RS-485 Port

The RS-232/RS-485 port uses a 9-pin serial connector with a bi-directional serial interface that can be configured for either RS-232 or RS-485 communication.

Figure 9–2. RS-232/RS-485 Port

Table 9–1. RS-232/RS-485 Port Terminal Assignment

Terminal Number	Signal Name
1	No Connect
2	RX/RS485_RX_P
3	TX/RS485_TX_N
4	No Connect
5	GND
6	No Connect
7	RTS/RS485_TX_P
8	CTS/RS485_RX_N
9	No Connect

RS-485 External Accessory Port

The RS-485 external accessory port uses a 15-pin serial connector for communication with external smart devices.
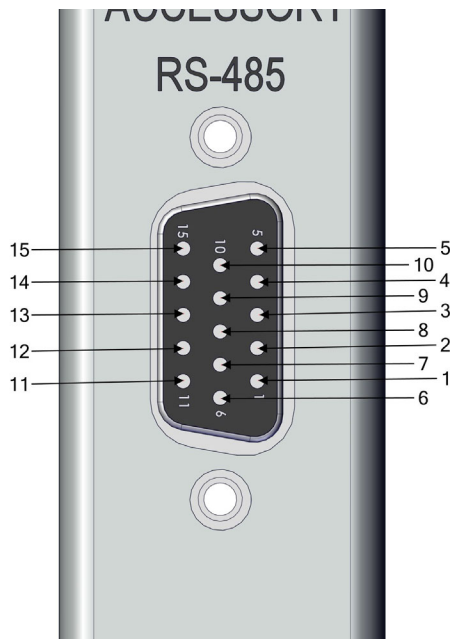
Figure 9–3. RS-485 External Accessory Port

Table 9–2. RS-485 External Accessory Port Terminal Assignment

Terminal Number	Signal Name
1	EXT_RS485_RX_N
2	EXT_RS485_RX_P
3	+5V (Fused @0.4A)
4	+5V (Fused @0.4A)
5	+5V (Fused @0.4A)
6	GND
7	GND
8	GND
9	EXT_RS485_TX_N
10	EXT_RS485_TX_P
11	+24V (Fused @0.4A)
12	+24V (Fused @0.4A)
13	+24V (Fused @0.4A)
14	+24V (Fused @0.4A)
15	+24V (Fused @0.4A)

Analog I/O Board

The Analog I/O Board consists of:

● 4 Isolated Analog Voltage Inputs, Input Voltage Range: 0–10 V

● 6 Isolated Analog Voltage Outputs, Three Ranges: 0–1.0 V, 0–5.0 V, 0–10 V

● 6 Isolated Analog Current Outputs, Two Ranges: 0mA–20mA, 4mA–20mA

Analog Voltage Inputs

Table 9–3 lists the analog voltage inputs are used to monitor four external 0–10V signals.
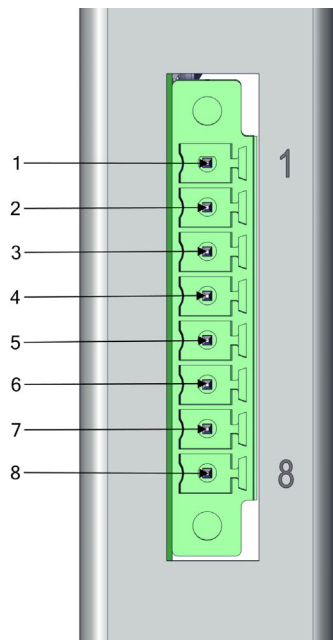
Figure 9–4. Analog Voltage Inputs
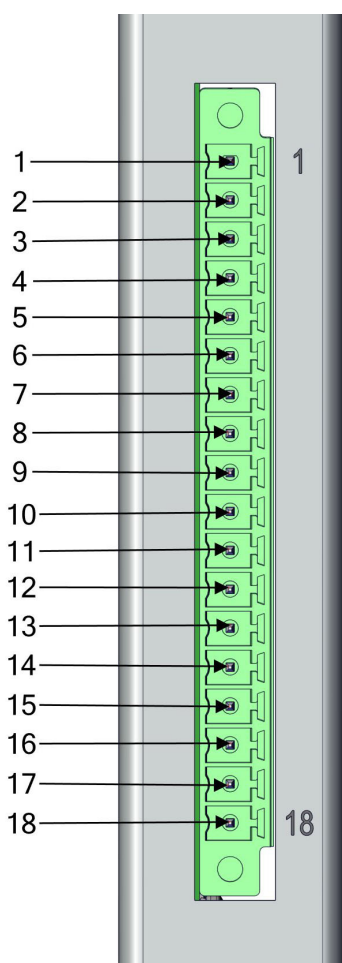
Table 9–3. Analog Voltage Inputs Assignment

Terminal Number	Signal Name
1	Analog In 1
2	Analog GND
3	Analog In 2
4	Analog GND
5	Analog In 3
6	Analog GND
7	Analog In 4
8	Analog GND

Analog Voltage Outputs

There are six globally isolated, 16-bit, Analog Output channels, each with a Voltage Output, a Current Output and a common Return (isolated ground). The Analog Outputs are configured through the software control registers to select Voltage Output ranges 0–1 V, 0–5 V or 0–10 V, as well as Current Output ranges 0–20 mA or 4–20 mA. The maximum allowable load for each Current Output is 1000 Ω. All Voltage Outputs and Current Outputs are continuously monitored separately for accuracy.

The Analog Outputs may be used to control and report parameters pertinent to the analyzers' measured functions.

Figure 9–5. Analog Voltage and Current

Table 9–4. Analog Voltage and Current Assignment

Terminal Number	Signal Name
1	Current Out 1
2	Voltage Out 1
3	C/V Return 1
4	Current Out 2
5	Voltage Out 2
6	C/V Return 2
7	Current Out 3
8	Voltage Out 3
9	C/V Return 3
10	Current Out 4
11	Voltage Out 4
12	C/V Return 4
13	Current Out 5
14	Voltage Out 5
15	C/V Return 5
16	Current Out 6
17	Voltage Out 6
18	C/V Return 6

Analog Output Calibration

The iQ series instruments provide for the ability to calibrate the analog outputs (both voltage and current) of the instruments. The basic procedure for both voltage and current are the same using the following procedure:

● Complete the connections of the recording device to the desired analog output channel. (See page 9-5 for the channel information).

● Calibrate the output channel low level.

Note When calibrating the current output when using the 0-20 mA scale, the low level will be set to 4 mA due to the inability to adjust the actual current output to below zero. ▲

● Calibrate the output channel full scale.

**Analog Output Zero Calibration**

Use the following procedure to calibrate the output channel to low level. This analog output calibration procedure reflects the zero calibration for analog output voltage for demonstration purposes. To calibrate the 4 mA current calibration, follow the same procedure, by selecting the 4 mA current calibration option.

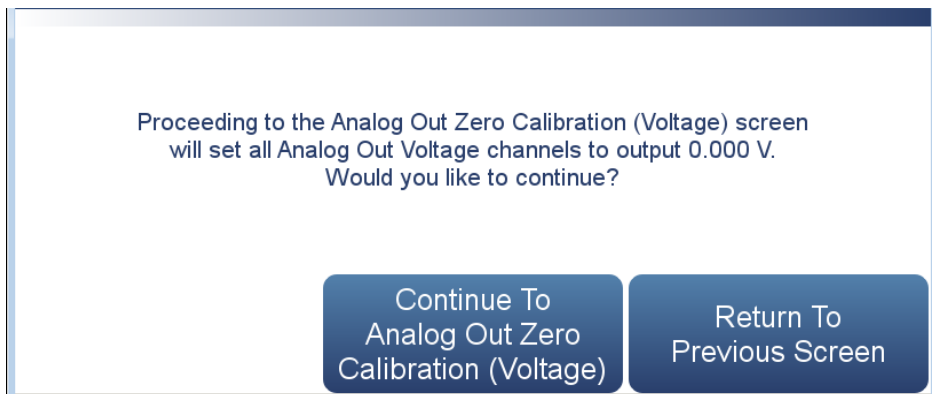**Note** This adjustment should only be performed by an instrument service technician. ▲

1. From the Home screen, choose **Settings>Communications>Analog I/O>Analog Out Calibration.**
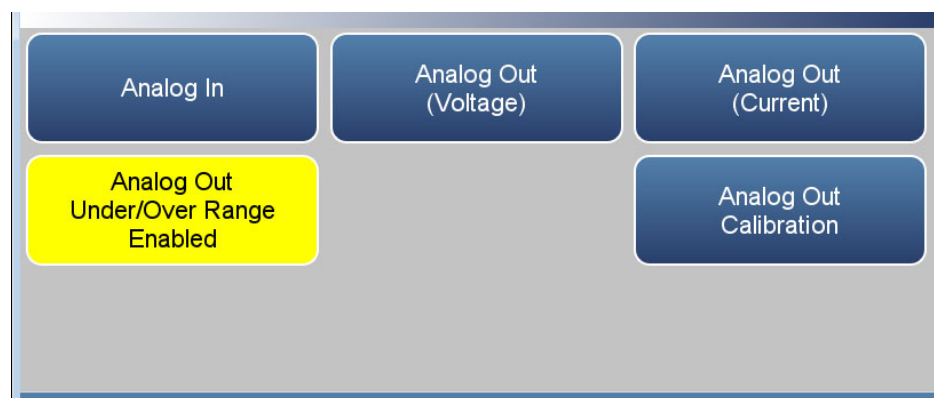
2. Depending on the output type being used, select either Analog Out Zero Calibration (Voltage) or Analog Out 4.000 mA Calibration (Current).
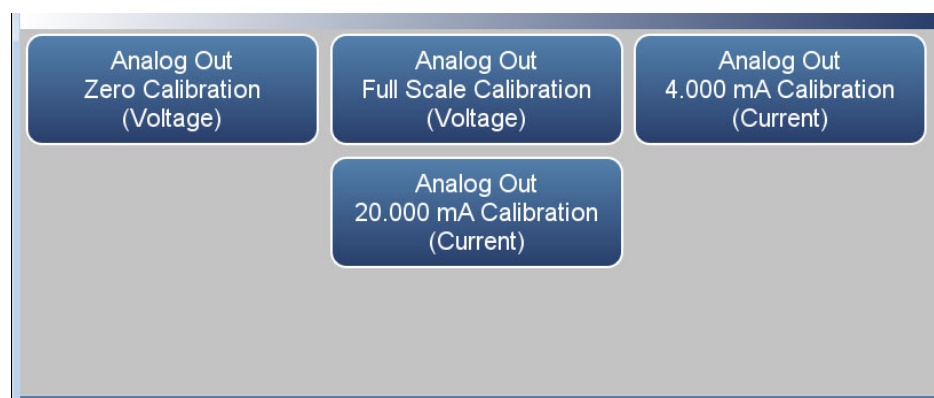
3. A confirmation screen is presented. Select Continue to proceed with the calibration or Return to Previous Screen.

Proceeding to the Analog Out Zero Calibration (Voltage) screen
will set all Analog Out Voltage channels to output 0.000 V.
Would you like to continue?

Continue To
Analog Out Zero
Calibration (Voltage)

Return To
Previous Screen

4. There are six columns for each of the six available output channels:

Channel	Output (V)	Dec	Dec	Dec	Inc	Inc	Inc	Commit
1	0.000	↓↓↓	↓↓	↓	↑	↑↑	↑↑↑	Commit
2	0.000	↓↓↓	↓↓	↓	↑	↑↑	↑↑↑	Commit
3	0.000	↓↓↓	↓↓	↓	↑	↑↑	↑↑↑	Commit
4	0.000	↓↓↓	↓↓	↓	↑	↑↑	↑↑↑	Commit
5	0.000	↓↓↓	↓↓	↓	↑	↑↑	↑↑↑	Commit
6	0.000	↓↓↓	↓↓	↓	↑	↑↑	↑↑↑	Commit

● *Output (V):* Displays the actual output level at the terminal of the analog output board. For analog voltage, this value will default at zero. For analog current, this value will default at 4 mA.

● *Decrease ↓↓↓, Decrease ↓↓, and Decrease ↓:* Decreases the output by coarse, medium, or fine amounts.

● *Increase ↑, Increase ↑↑, and Increase ↑↑↑:* Increases the output by coarse, medium, or fine amounts.

● *Commit:* Accepts the changes to the analog output levels.

5. For the desired analog output channel, increase or decrease the output until the reading on the recording device indicates the proper value.

6. After making changes to the output levels, the commit button will turn green. To accept the changes, press the Commit button. To revert to the previous values, press the back button to return to the previous analog output calibration screen.

**Analog Output Full Scale Calibration**

Use the following procedure to calibrate the output channel to full scale. This analog output calibration procedure reflects the full scale calibration for analog output voltage for demonstration purposes. To calibrate the 20 mA current calibration, follow the same procedure, by selecting the 20 mA current calibration option.

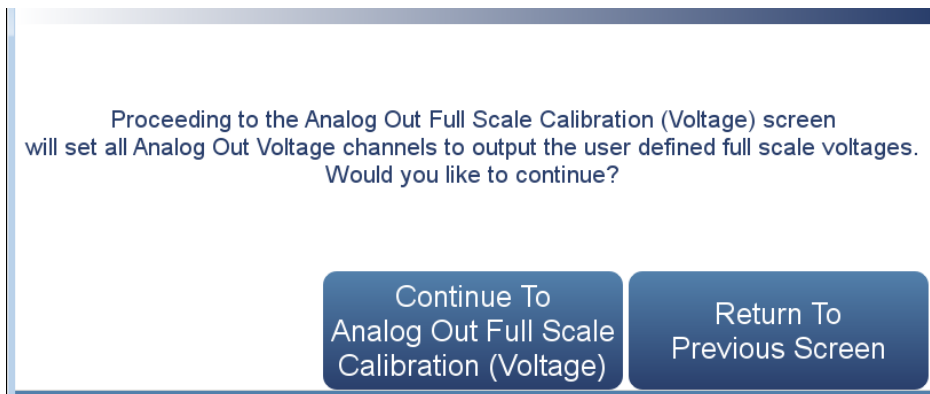**Note** This adjustment should only be performed by an instrument service technician. ▲

1. From the Home screen, choose **Settings>Communications>Analog I/O>Analog Output Calibration.**
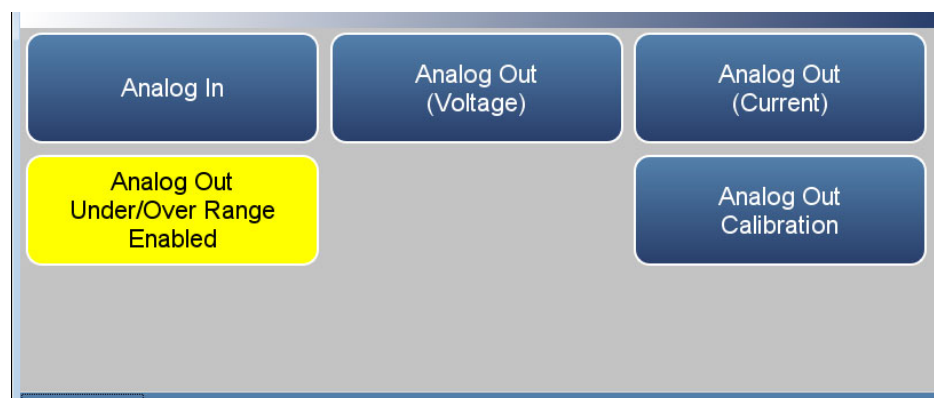
2. Depending on the output type being used, select either Analog Out Full Scale Calibration (Voltage) or Analog Out 20.000 mA Calibration (Current).
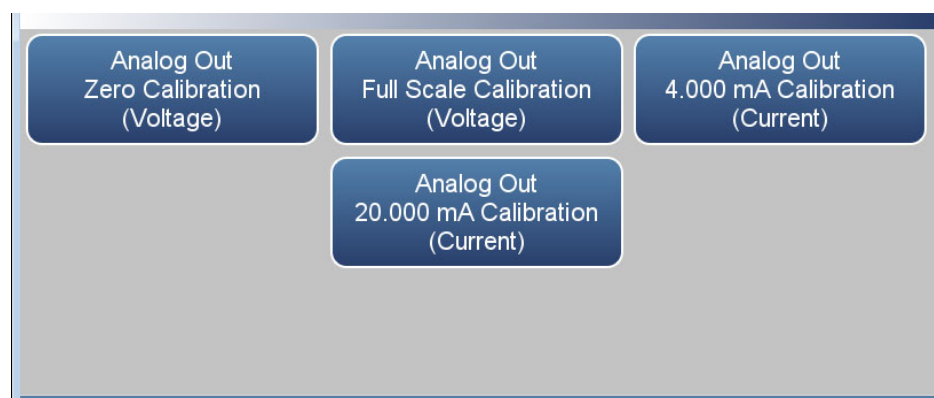
3. A confirmation screen is presented. Select Continue to proceed with the calibration or Return to Previous Screen.

Proceeding to the Analog Out Full Scale Calibration (Voltage) screen
will set all Analog Out Voltage channels to output the user defined full scale voltages.
Would you like to continue?

| Continue To Analog Out Full Scale Calibration (Voltage) | Return To Previous Screen |

4. There are six columns for each of the six available output channels:

Channel	Output (V)	Dec	Dec	Dec	Inc	Inc	Inc	Commit
1	10.000	↓↓↓	↓↓	↓	↑	↑↑	↑↑↑	Commit
2	1.000	↓↓↓	↓↓	↓	↑	↑↑	↑↑↑	Commit
3	1.000	↓↓↓	↓↓	↓	↑	↑↑	↑↑↑	Commit
4	1.000	↓↓↓	↓↓	↓	↑	↑↑	↑↑↑	Commit
5	1.000	↓↓↓	↓↓	↓	↑	↑↑	↑↑↑	Commit
6	10.000	↓↓↓	↓↓	↓	↑	↑↑	↑↑↑	Commit

● *Output (V):* Displays the actual output level at the terminal of the analog output board. For analog voltage, this value will default at the setting of the output channel, 1, 5, or 10 V. For analog current, this value will default at 20 mA.

● *Decrease ↓↓↓, Decrease ↓↓, and Decrease ↓:* Decreases the output by coarse, medium, or fine amounts.

● *Increase ↑, Increase ↑↑, and Increase ↑↑↑:* Increases the output by coarse, medium, or fine amounts.

● *Commit:* Accepts the changes to the analog output levels.

5. For the desired analog output channel, increase or decrease the output until the reading on the recording device indicates the proper value.

6. After making changes to the output levels, the commit button will turn green. To accept the changes, press the Commit button. To revert to the previous values, press the back button to return to the previous analog output calibration screen.

Digital I/O Board

The digital I/O board consists of:

- 16 Digital Inputs (18 pin connector)
- 10 Digital Relay Switches (20 pin connector)
- 8 Valve Driver Outputs (16 pin connector)

Digital Inputs

The digital inputs are TTL (3 V or 5 V) compatible and are pulled high within the instrument. The active state can be user defined in firmware.

- Logic Low Threshold: 0.8 V
- Logic High Threshold: 2.0 V
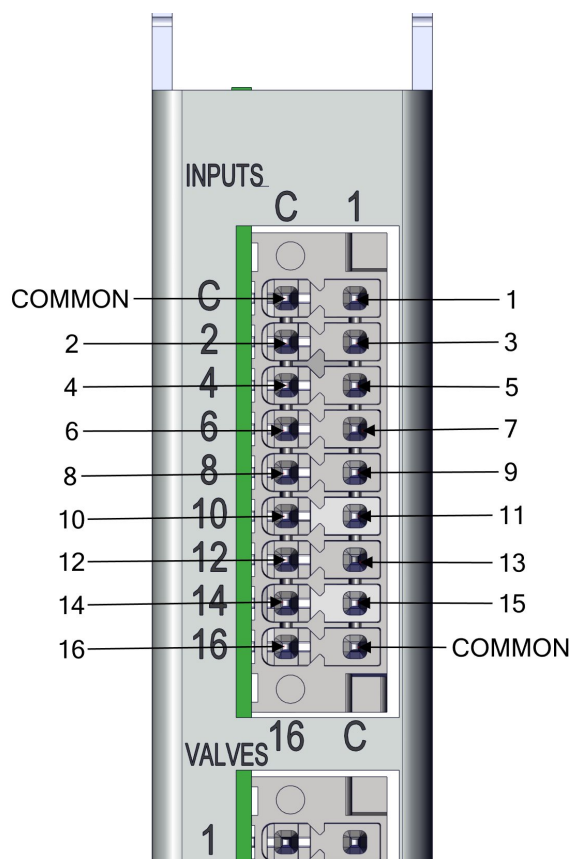- Absolute allowable input voltages: -0.5 to 5.5 V

Figure 9–6. Digital Inputs

Table 9–5. Digital Inputs Terminal Assignment

Terminal Number	Signal Name
COMMON	
1	Digital In 1
2	Digital In 2
3	Digital In 3
4	Digital In 4
5	Digital In 5
6	Digital In 6
7	Digital In 7
8	Digital In 8
9	Digital In 9
10	Digital In 10
11	Digital In 11
12	Digital In 12
13	Digital In 13
14	Digital In 14
15	Digital In 15
16	Digital In 16
COMMON	

Digital Relay Switches   Table 9–6 lists the digital relay switches.

- Maximum Voltage: 300 VDC

- Maximum Current: 500 mA

- Fuse: 800 mA
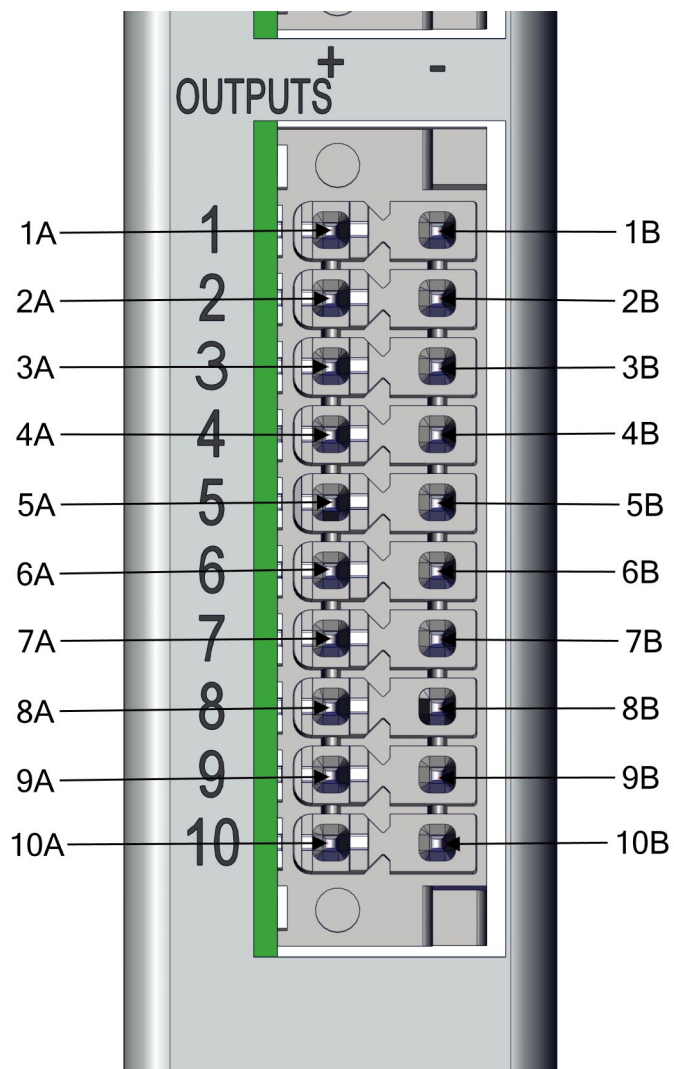
Figure 9–7. Digital Relay Switches

Table 9–6. Digital Relay Switch Assignment

Terminal Number	Signal Name
1A	Relay 1A
1B	Relay 1B
2A	Relay 2A
2B	Relay 2B
3A	Relay 3A
3B	Relay 3B
4A	Relay 4A
4B	Relay 4B
5A	Relay 5A
5B	Relay 5B
6A	Relay 6A
6B	Relay 6B
7A	Relay 7A
7B	Relay 7B
8A	Relay 8A
8B	Relay 8B
9A	Relay 9A
9B	Relay 9B
10A	Relay 10A
10B	Relay 10B

Valve Driver Outputs   Table 9–7 lists the valve driver outputs.

● Actual Output Voltage: 22–24 VDC

● Maximum Current: 300 mA

● Both positive and negative outputs are protected from over voltage and over current by 500 mA fuses.
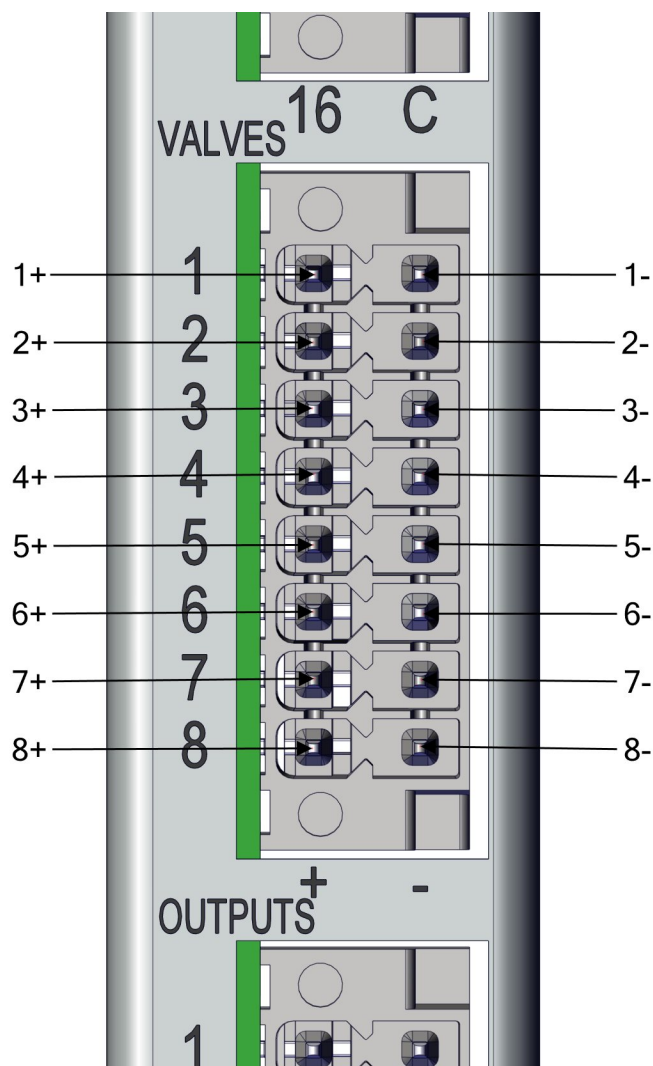
Figure 9–8. Valve Driver Outputs

Table 9–7. Valve Driver Outputs Assignment

Terminal Number	Signal Name
1+	Valve Drive 1+
1-	Valve Drive 1-
2+	Valve Drive 2+
2-	Valve Drive 2-
3+	Valve Drive 3+
3-	Valve Drive 3-
4+	Valve Drive 4+
4-	Valve Drive 4-
5+	Valve Drive 5+
5-	Valve Drive 5-
6+	Valve Drive 6+
6-	Valve Drive 6-
7+	Valve Drive 7+
7-	Valve Drive 7-
8+	Valve Drive 8+
8-	Valve Drive 8-

Note Intended for 24 V valves. These outputs will also drive any DC load of 22–24 VDC, up to 300 mA. ▲

Internal Zero/Span Assembly

With the internal zero/span assembly option, a source of span gas is connected to the SPAN port and a source of zero air is connected to the ZERO port. Zero and span gas should be supplied at atmospheric pressure. It may be necessary to use an atmospheric dump bypass plumbing arrangement to accomplish this. Figure 9–9 shows how this option is integrated with the instrument.
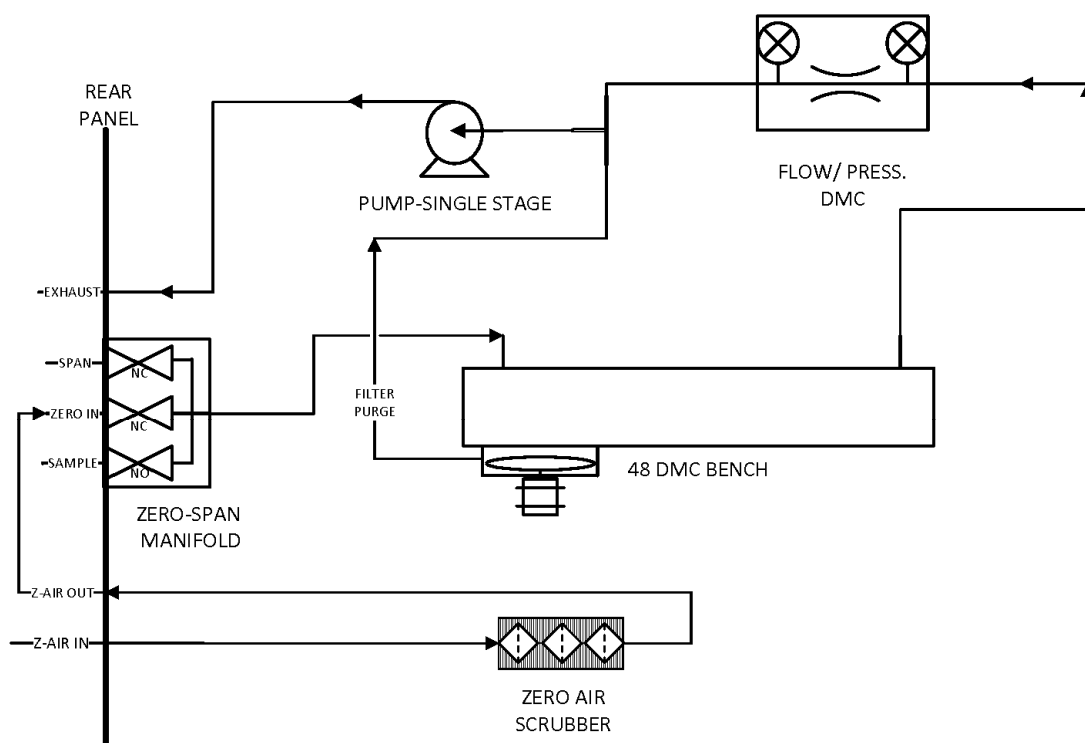
Figure 9–9. 48iQ Flow Schematic with Zero Span and Zero Air Scrubber

Internal Oxygen (O₂) Sensor

The Internal Oxygen (O₂) Sensor option provides a paramagnetic sensor for O₂ concentration measurement and CO correction. This option allows the user to correct the CO readings for the amount of oxygen in the sample. Selectable O₂ concentrations can be used as the correction factor.

Figure 9–10 shows how this option is integrated with the 48iQ.
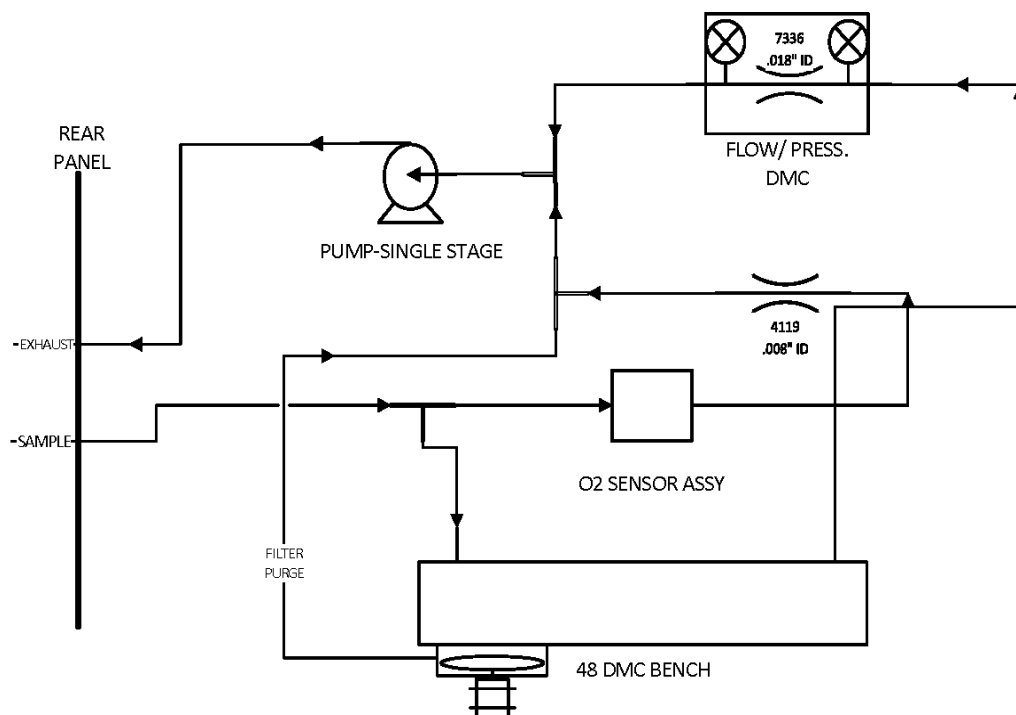
Figure 9–10. 48iQ Flow Schematic with Internal O₂ Sensor

Internal Zero Air Scrubber

The internal air scrubber is mounted inside the instrument and provides a source of zero air. Figure 9–9 shows how this option is integrated with the instrument.

PTFE Particulate Filter

A 5–10 micron pore size, two-inch diameter PTFE element is available for the 48iQ. This filter should be installed just prior to the SAMPLE bulkhead. When using a filter, all calibrations and span checks must be performed through the filter.

Appendix A
Safety, Warranty, and WEEE

Safety

Review the following information carefully before using the instrument. This manual provides specific information on how to operate the instrument, however if the instrument is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired.

Safety and Equipment Damage Alerts

This manual contains important information to alert you to potential safety hazards and risks of equipment damage. Refer to the following types of alerts you may see in this manual.

Safety and Equipment Damage Alert Descriptions

Alert	Description
⚠ DANGER	◂ A hazard is present that will result in death or serious personal injury if the warning is ignored. ▲
⚠ WARNING	◂ A hazard is present or an unsafe practice can result in serious personal injury if the warning is ignored. ▲
⚠ CAUTION	◂ The hazard or unsafe practice could result in minor to moderate personal injury if the warning is ignored. ▲
⚠ **Equipment Damage**	The hazard or unsafe practice could result in property damage if the warning is ignored. ▲

Safety and Equipment Damage Alerts in this Manual

Alert	Description
⚠ WARNING	◂ If the equipment is operated in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired. ▲
	◂ The service procedures in this manual are restricted to qualified service personnel only. ▲
⚠ **Equipment Damage**	Do not attempt to lift the analyzer by the cover or other external fittings. ▲
	This adjustment should only be performed by an instrument service technician. ▲

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WEEE Symbol

The following symbol and description identify the WEEE marking used on the instrument and in the associated documentation.

Symbol	Description
	Marking of electrical and electronic equipment which applies to electrical and electronic equipment falling under the Directive 2002/96/EC (WEEE) and the equipment that has been put on the market after 13 August 2005. ▲

Appendix B
Quick Reference

List of Figures

List of Tables

Appendix C
GNU Lesser General Public License

Version 2.1, February 1999

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Ty Coon, President of Vice

That's all there is to it!

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