

# **Model 42i NO<sub>x</sub>**

## **Instruction Manual**

Chemiluminescence NO<sub>x</sub> Analyzer

Part Number 102790-00

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# WEEE Compliance

This product is required to comply with the European Union's Waste Electrical & Electronic Equipment (WEEE) Directive 2002/96/EC. It is marked with the following symbol:



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# About This Manual

This manual provides information about operating, maintaining, and servicing the analyzer. It also contains important alerts to ensure safe operation and prevent equipment damage. The manual is organized into the following chapters and appendices to provide direct access to specific operation and service information:

- Chapter 1 “Introduction” provides an overview of product features, describes the principles of operation, and lists the specifications.
- Chapter 2 “Installation” describes how to unpack, setup, and startup the analyzer.
- Chapter 3 “Operation” describes the front panel display, the front panel pushbuttons, and the menu-driven software.
- Chapter 4 “Calibration” provides the procedures for calibrating the analyzer and describes the required equipment.
- Chapter 5 “Preventive Maintenance” provides maintenance procedures to ensure reliable and consistent instrument operation.
- Chapter 6 “Troubleshooting” presents guidelines for diagnosing analyzer failures, isolating faults, and includes recommended actions for restoring proper operation.
- Chapter 7 “Servicing” presents safety alerts for technicians working on the analyzer, step-by-step instructions for repairing and replacing components, and a replacement parts list. It also includes contact information for product support and technical information.
- Chapter 8 “System Description” describes the function and location of the system components, provides an overview of the software structure, and includes a description of the system electronics and input/output connections.
- Chapter 9 “Optional Equipment” describes the optional equipment that can be used with this analyzer.
- Appendix A “Warranty” provides a copy of the warranty statement.

- Appendix B “C-Link Protocol Commands” provides a description of the C-Link protocol commands that can be used to remotely control an analyzer using a host device such as a PC or a datalogger.
- Appendix C “MODBUS Protocol” provides a description of the MODBUS Protocol Interface and is supported both over RS-232/485 (RTU protocol) as well as TCP/IP over Ethernet.





## Safety

Review the following safety information carefully before using the analyzer. This manual provides specific information on how to operate the analyzer, however if the analyzer 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 and the actual alerts that appear in this manual.

### Safety and Equipment Damage Alert Descriptions

Alert	Description
 <b>DANGER</b>	A hazard is present that will result in death or serious personal injury if the warning is ignored. ▲
 <b>WARNING</b>	A hazard is present or an unsafe practice can result in serious personal injury if the warning is ignored. ▲
 <b>CAUTION</b>	The hazard or unsafe practice could result in minor to moderate personal injury if the warning is ignored. ▲
 <b>Equipment Damage</b>	The hazard or unsafe practice could result in property damage if the warning is ignored. ▲


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## Safety and Equipment Damage Alerts in this Manual

Alert	Description
	<p><b>WARNING</b></p> <p>If the equipment is operated in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired. ▲</p> <p>The service procedures in this manual are restricted to qualified service personnel only. ▲</p> <p>The Model 42i is supplied with a three-wire grounding cord. Under no circumstances should this grounding system be defeated. ▲</p>
	<p><b>CAUTION</b></p> <p>If the LCD panel breaks, do not to let the liquid crystal contact your skin or clothes. If the liquid crystal contacts your skin or clothes, wash it off immediately using soap and water. ▲</p> <p>Avoid contact with converter heated components. Allow converter to cool to room temperature before handling converter components. ▲</p>
	<p><b>Equipment Damage</b></p> <p>Do not attempt to lift the instrument by the cover or other external fittings. ▲</p> <p>This adjustment should only be performed by an instrument service technician. ▲</p> <p>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. ▲</p> <p>Handle all printed circuit boards by the edges only. ▲</p> <p>Do not point the photomultiplier tube at a light source. This can permanently damage the tube. ▲</p> <p>Do not remove the panel or frame from the LCD module. ▲</p> <p>The LCD module polarizing plate is very fragile, handle it carefully. ▲</p> <p>Do not wipe the LCD module polarizing plate with a dry cloth, it may easily scratch the plate. ▲</p> <p>Do not use alcohol, acetone, MEK or other Ketone based or aromatic solvents to clean the module, use a soft cloth moistened with a naphtha cleaning solvent. ▲</p> <p>Do not place the LCD module near organic solvents or corrosive gases. ▲</p> <p>Do not shake or jolt the LCD module. ▲</p>

## 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.

## Where to Get Help

Service is available from exclusive distributors worldwide. Contact one of the phone numbers below for product support and technical information or visit us on the web at [www.thermo.com/aqi](http://www.thermo.com/aqi).

1-866-282-0430 Toll Free

1-508-520-0430 International

# Chapter 1 Introduction

The Model 42i NO<sub>x</sub> Chemiluminescence Analyzer combines proven detection technology, easy to use menu-driven software, and advanced diagnostics to offer unsurpassed flexibility and reliability. The Model 42i NO<sub>x</sub> has the following features:

- 320 x 240 graphics display
- Menu-driven software
- Field programmable ranges
- User-selectable single/dual/auto range modes
- Multiple user-defined analog outputs
- Analog input options
- High sensitivity
- Fast response time
- Linearity through all ranges
- Internal sample pump
- Replaceable NO<sub>2</sub> converter cartridge
- User-selectable digital input/output capabilities
- Standard communications features include RS232/485 and Ethernet
- C-Link, MODBUS, and streaming data protocols

For details of the analyzer's principle of operation and product specifications, see the following topics:

- “[Principle of Operation](#)” on [page 1-2](#) describes the principles by which your analyzer operates.

- “Specifications” on [page 1-3](#) is a list of the analyzer’s performance specifications.

Thermo Fisher Scientific is pleased to supply this chemiluminescence NO<sub>x</sub> analyzer. We are committed to the manufacture of instruments exhibiting high standards of quality, performance, and workmanship. Service personnel are available for assistance with any questions or problems that may arise in the use of this analyzer. For more information on servicing, see Chapter 7, “Servicing”.

## Principle of Operation

The Model 42i NO<sub>x</sub> operates on the principle that nitric oxide (NO) and ozone (O<sub>3</sub>) react to produce a characteristic luminescence with an intensity linearly proportional to the NO concentration. Infrared light emission results when electronically excited NO<sub>2</sub> molecules decay to lower energy states. Specifically,

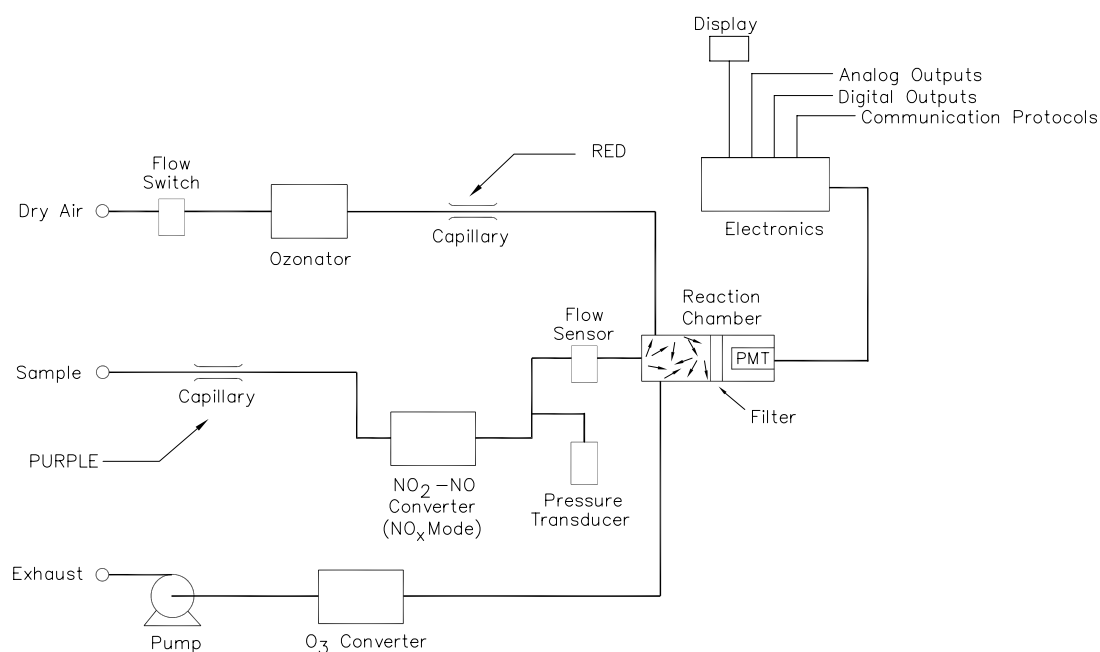


Nitrogen dioxide (NO<sub>2</sub>) must first be transformed into NO before it can be measured using the chemiluminescent reaction. NO<sub>2</sub> is converted to NO by a molybdenum NO<sub>2</sub>-to-NO converter heated to about 325 °C (the optional stainless steel converter is heated to 625 °C).

The ambient air sample is drawn into the Model 42i NO<sub>x</sub> through the *sample* bulkhead, as shown in Figure 1-1. The sample flows through a capillary, to the NO<sub>2</sub>-to-NO converter, and then to the reaction chamber (NO<sub>x</sub> mode). A flow sensor prior to the reaction chamber measures the sample flow.

Dry air enters the Model 42i NO<sub>x</sub> through the *dry air* bulkhead, passes through a flow switch, and then through a silent discharge ozonator. The ozonator generates the ozone needed for the chemiluminescent reaction. At the reaction chamber, the ozone reacts with the NO in the sample to produce excited NO<sub>2</sub> molecules. A photomultiplier tube (PMT) housed in a thermoelectric cooler detects the luminescence generated during this reaction. From the reaction chamber, the exhaust travels through the ozone (O<sub>3</sub>) converter to the pump, and is released through the vent.

The NO<sub>x</sub> concentrations are stored in memory. The Model 42i NO<sub>x</sub> outputs NO<sub>x</sub> concentrations to the front panel display, the analog outputs, and also makes the data available over the serial or ethernet connection.



**Figure 1-1.** Model 42i NO<sub>x</sub> Flow Schematic

## Specifications

**Table 1-1.** Model 42i NO<sub>x</sub> Specifications

Preset ranges	0-0.05, 0.1, 0.2, 0.5, 1, 2, 5, 10, 20 ppm 0-0.1, 0.2, 0.5, 1, 2, 5, 10, 20, 30 mg/m <sup>3</sup>
Extended ranges	0-0.2, 0.5, 1, 2, 5, 10, 20, 50, 100 ppm 0-0.5, 1, 2, 5, 10, 20, 50, 100, 150 mg/m <sup>3</sup>
Custom ranges	0-0.05 to 20 ppm (0-0.02 to 100 ppm in extended ranges) 0-0.1 to 30 mg/m <sup>3</sup> (0-0.05 to 150 mg/m <sup>3</sup> in extended ranges)
Zero noise	0.20 ppb RMS (60 second averaging time)
Lower detectable limit	0.40 ppb (60 second averaging time)
Zero drift (24 hour)	< 0.40 ppb
Span drift	± 1% full-scale
Response time (in automatic mode)	40 sec (10 second averaging time) 80 sec (60 second averaging time) 300 sec (300 second averaging time)
Linearity	± 1% full-scale

Sample flow rate	0.6–0.8 LPM
Operating temperature	15–35 °C (may be safely operated over the range of 0–45 °C)*
Power requirements	100 VAC @ 50/60 Hz 115 VAC @ 50/60 Hz 220–240 VAC @ 50/60 Hz 300 watts
Physical dimensions	16.75" (W) X 8.62" (H) X 23" (D)
Weight	Approximately 55 lbs.
Analog outputs	6 voltage outputs; 0–100 mV, 1, 5, 10 V (User selectable), 5% of full-scale over/under range, 12 bit resolution, user selectable for measurement input
Digital outputs	1 power fail relay Form C, 10 digital relays Form A, user selectable alarm output, relay logic, 100 mA @ 200 VDC
Digital inputs	16 digital inputs, user select programmable, TTL level, pulled high
Serial Ports	1 RS-232 or RS-485 with two connectors, baud rate 1200–115200, data bits, parity, and stop bits, protocols: C-Link, MODBUS, and streaming data (all user selectable)
Ethernet connection	RJ45 connector for 10Mbps Ethernet connection, static or dynamic TCP/IP addressing

\* In non condensing environments. Performance specifications based on operation in 15–35 °C range.



## Chapter 2 Installation

Installing the Model 42i NO<sub>x</sub> includes the following recommendations and procedures:

- “Lifting” on page 2-1
- “Unpacking and Inspection” on page 2-1
- “Setup Procedure” on page 2-3
- “Startup” on page 2-5

### Lifting

When lifting the instrument, use procedure appropriate to lifting a heavy object, such as, bending at the knees while keeping your back straight and upright. Grasp the instrument at the bottom in the front and at the rear of the unit. Although one person can lift the unit, it is desirable to have two persons lifting, one by grasping the bottom in the front and the other by grasping the bottom in the rear.



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

### Unpacking and Inspection

The Model 42i NO<sub>x</sub> 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.

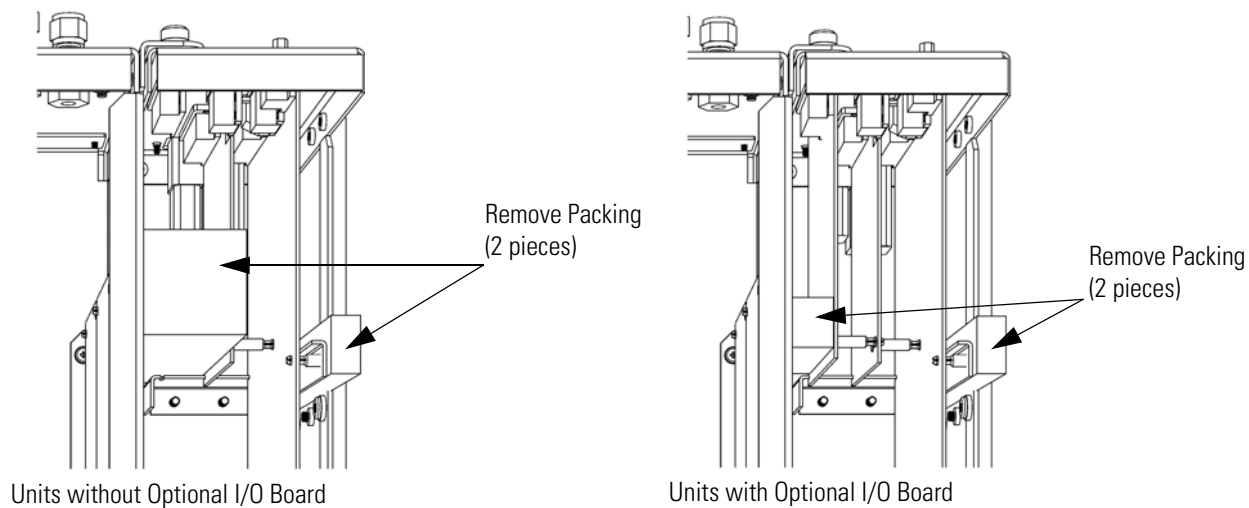
Use the following procedure to unpack and inspect the instrument.

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.

## Installation

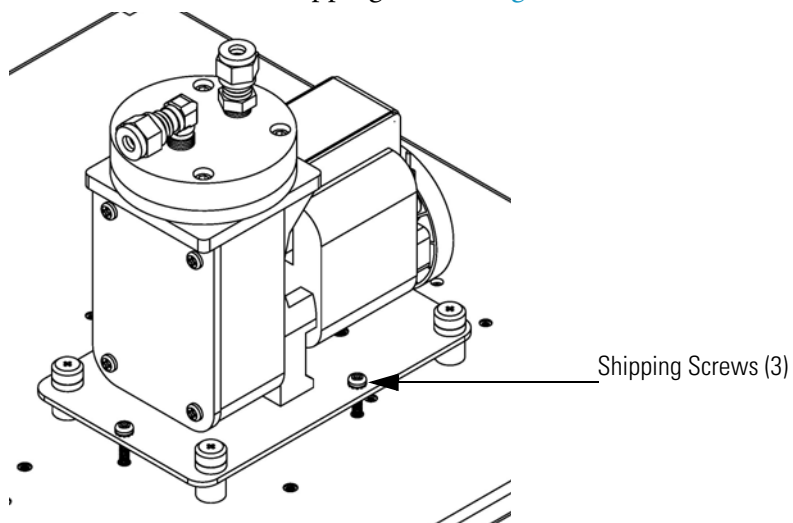
### Unpacking and Inspection

3. Remove the packing material (Figure 2-1).



**Figure 2-1.** Remove the Packing Material

4. Remove the three shipping screws (Figure 2-2).



**Figure 2-2.** Remove the Shipping Screws

5. Check for possible damage during shipment.
6. Check that all connectors and circuit boards are firmly attached.
7. Re-install the cover.

## Setup Procedure

Use the following procedure to setup the instrument.

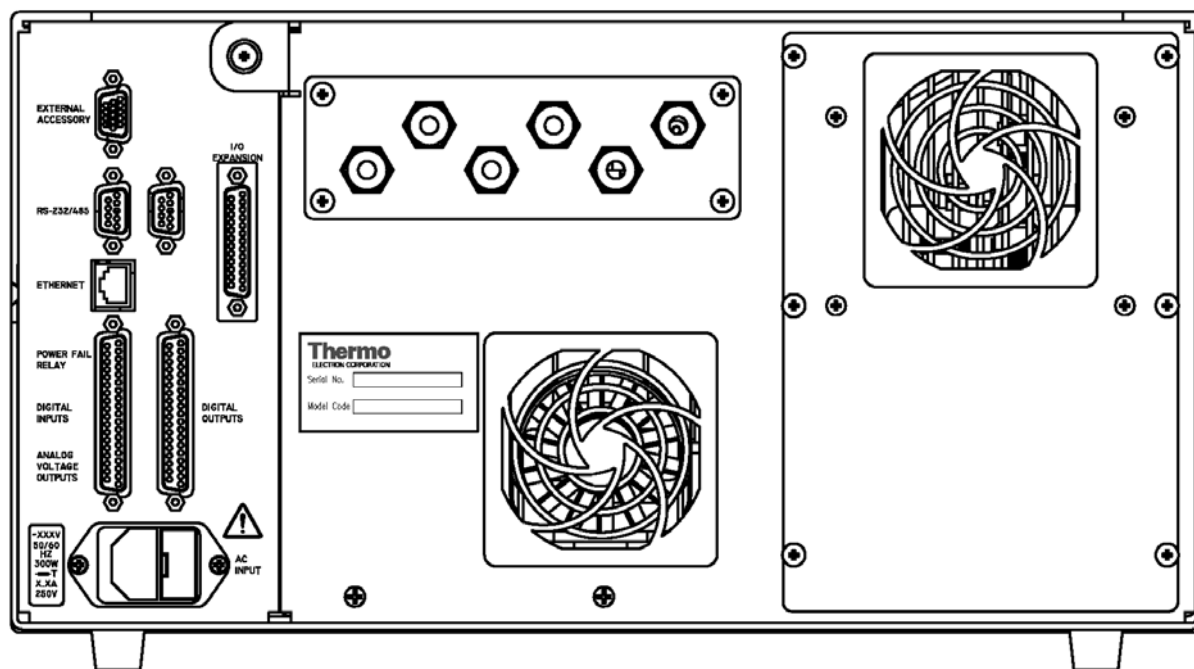
1. Connect the sample line to the SAMPLE bulkhead on the rear panel (Figure 2-3). Ensure that the sample line is not contaminated by dirty, wet, or incompatible materials. All tubing should be constructed of FEP Teflon®, 316 stainless steel, borosilicate glass, or similar tubing with an OD of 1/4-inch 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 at atmospheric pressure. It may be necessary to use an atmospheric bypass plumbing arrangement as shown in Figure 2-4 if gas pressure is greater than atmospheric pressure. ▲

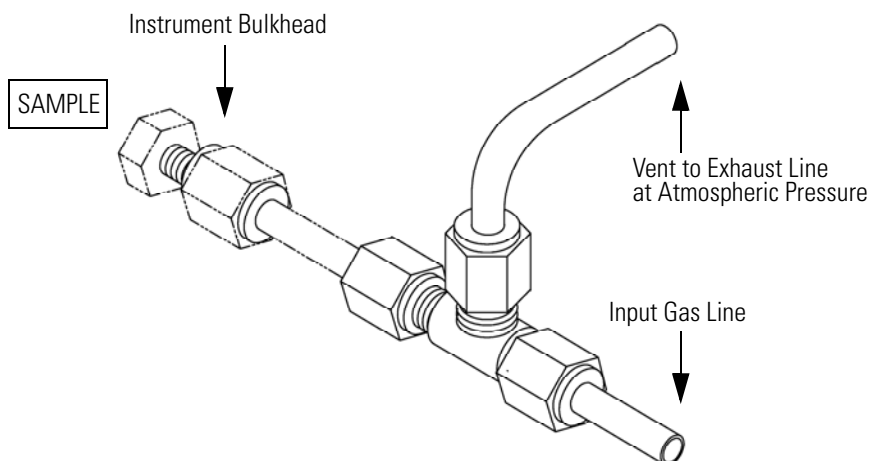
2. Connect the air dryer to the DRY AIR bulkhead.
3. Connect the EXHAUST bulkhead to a suitable vent or ozone scrubber. The exhaust line should be 1/4-inch OD with a minimum ID of 1/8-inch. The length of the exhaust line should be less than 10 feet. Verify that there is no restriction in this line.
4. Connect a suitable recording device to the rear panel connector. See the “Operation” chapter for more information about the rear panel pin-outs.
5. Plug the instrument into an outlet of the appropriate voltage and frequency.



**WARNING** The Model 42i NO<sub>x</sub> is supplied with a three-wire grounding cord. Under no circumstances should this grounding system be defeated. ▲



**Figure 2-3.** Model 42i NO<sub>x</sub> Rear Panel



**Figure 2-4.** Atmospheric Dump Bypass Plumbing

## Startup

Use the following procedure when starting the instrument.

1. Turn the power ON.
2. Allow 90 minutes for the instrument to stabilize.

**Note** It is best to turn the ozonator on and let the instrument run overnight before calibration in order to obtain the most accurate information. ▲

3. Set instrument parameters such as operating ranges and averaging times to appropriate settings. For more information about instrument parameters, see the “Operation” chapter.
4. Before beginning actual instrument monitoring, perform a multipoint calibration as described in the “Calibration” chapter.

## Installation



Startup

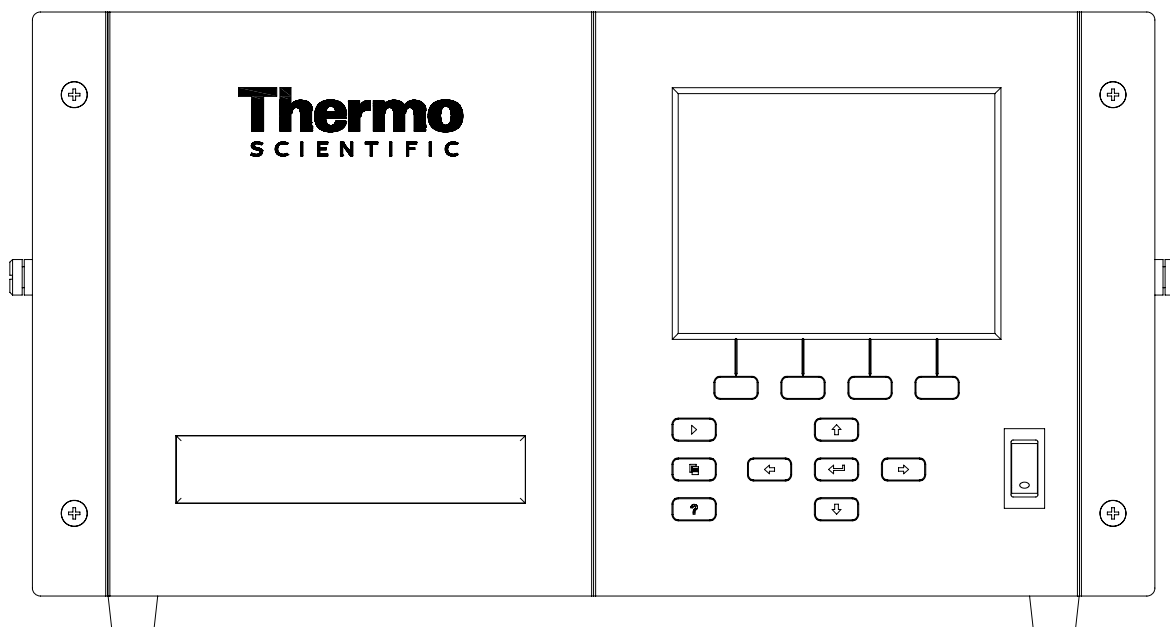
## Chapter 3 Operation

This chapter describes the front panel display, front panel pushbuttons, and menu-driven software.

- “Display” on [page 3-2](#) describes the LCD graphics display.
- “Pushbuttons” on [page 3-3](#) describes the various front panel pushbuttons and the expected key actions for each.
- “Software Overview” on [page 3-4](#) describes the menu-driven software and submenus.
- “Range Menu” on [page 3-8](#) describes the gas units, NO<sub>x</sub> ranges, and custom ranges.
- “Averaging Time” on [page 3-17](#) describes the averaging period applied to NO<sub>x</sub> measurements.
- “Calibration Factors Menu” on [page 3-18](#) describes the calibration factors used to correct NO<sub>x</sub> measurement readings.
- “Calibration Menu” on [page 3-22](#) describes calibration of zero and span.
- “Instrument Controls Menu” on [page 3-28](#) describes the instrument hardware control and configuration.
- “Diagnostics Menu” on [page 3-63](#) describes the diagnostic information and functions.
- “Alarms Menu” on [page 3-71](#) describes a list of items that are monitored by the analyzer.
- “Service Menu” on [page 3-81](#) describes service related menu items.
- “Password” on [page 3-97](#) describes how to enter/change a password, lock and unlock the instrument.

## Display

The 320 x 240 graphics liquid-crystal display (LCD) shows the sample concentrations, instrument parameters, instrument controls, help, and error messages. Some menus contain more items than can be displayed at one time. For these menus, use  and  to move the cursor up and down to each item.



**Figure 3-1.** 42i NO<sub>x</sub> Front Panel Display

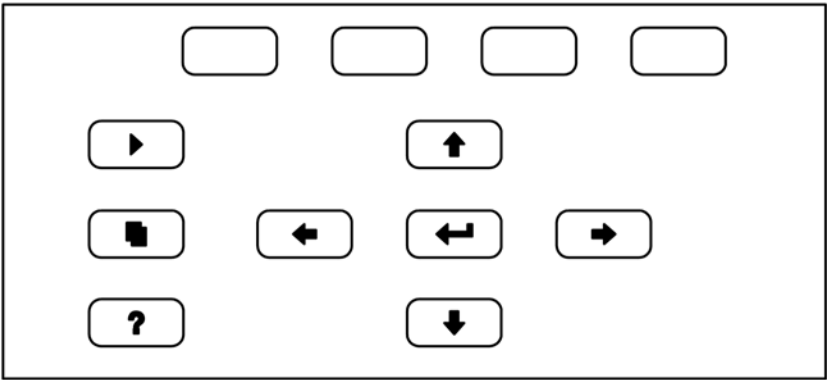


**CAUTION** If the LCD panel breaks, do not let the liquid crystal contact your skin or clothes. If the liquid crystal contacts your skin or clothes, wash it off immediately using soap and water. ▲

























# Pushbuttons

The Pushbuttons allow the user to traverse the various screens/menus.




**Figure 3-2.** Front Panel Pushbuttons

**Table 3-1.** Front Panel Pushbuttons


 = Soft Keys	The  soft keys are used to provide shortcuts that allow the user to jump to user-selectable menu screens. For more information on processing soft keys, see “Soft Keys” below.
 = Run	The  is used to display the Run screen. The Run screen normally displays the NO <sub>x</sub> concentration.
 = Menu	The  is used to display the Main Menu when in the Run screen, or back up one level in the menu system. For more information about the Main Menu, see “Main Menu” later in this chapter.
 = Help	The  is context-sensitive, that is, it provides additional information about the screen that is being displayed. Press  for a brief explanation about the current screen or menu. Help messages are displayed using lower case letters to easily distinguish them from the operating screens. To exit a help screen, press  or  to return to the previous screen, or  to return to the Run screen.
  = Up, Down   = Left, Right	The four arrow pushbuttons (  ,  ,  , and  ) move the cursor up, down, left, and right or change values and states in specific screens.
 = Enter	The  is used to select a menu item, accept/set/save a change, and/or toggle on/off functions.

## Soft Keys

The Soft Keys are multi-functional keys that use part of the display to identify their function at any moment. The function of the soft keys allow immediate access to the menu structure and most often used menus and screens. They are located directly underneath the display and as the keys' functions change this is indicated by user-defined labels in the lower part of the display, so that the user knows what the keys are to be used for.

To change a soft key, place the menu cursor ">" on the item of the selected menu or screen you wish to set. Press  followed by the selected soft key within 1 second of pressing the right-arrow key. The edit soft key prompt will be displayed for configuration for the new label.


**Note** Not all menu items may be assigned to soft keys. If a particular menu or screen item cannot be assigned, the key assignment screen will not come up upon entering right-arrow-soft key combinations. All items under the Service menu (including the menu itself) cannot be assigned soft keys. ▲

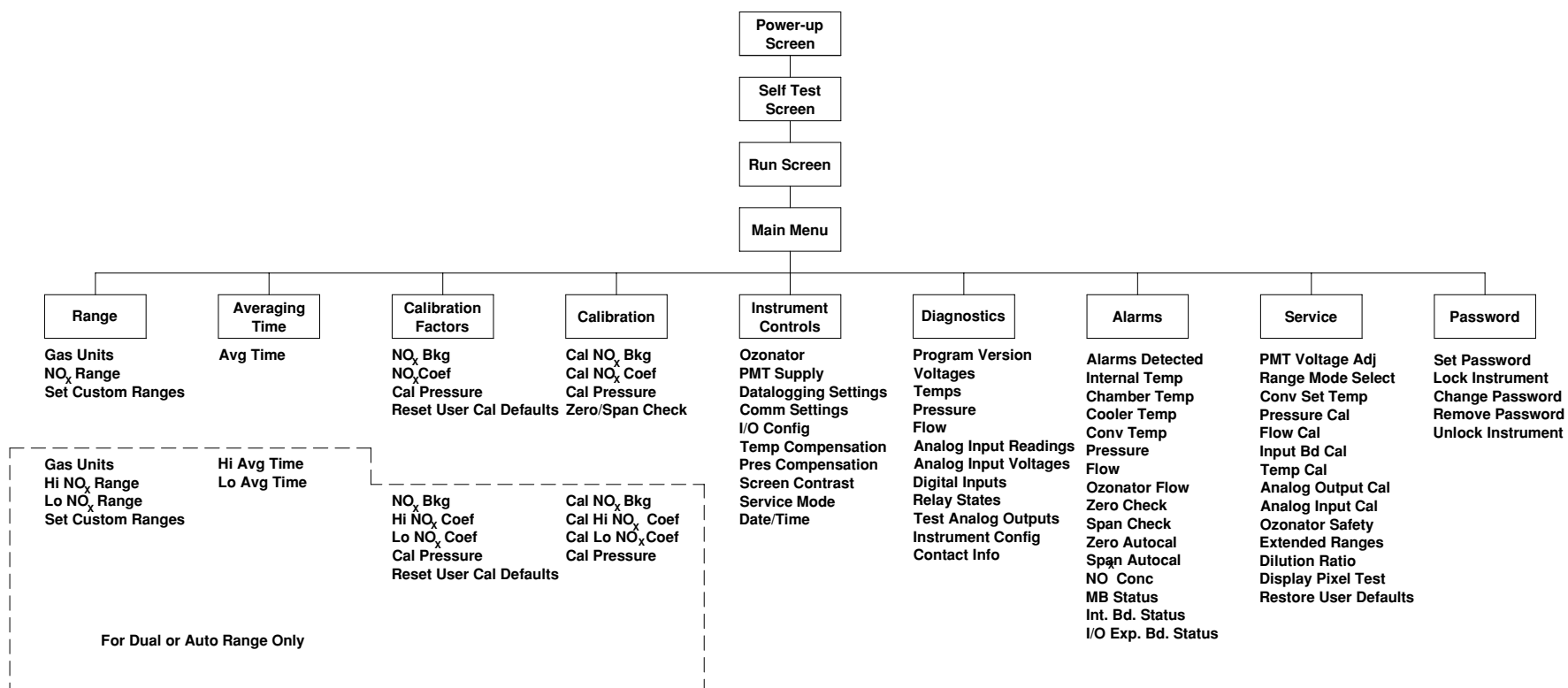


```
EDIT SOFT KEY PROMPT:
CURRENTLY: RANGE
          RANGE
BCDEFGHIJKLMN  BKSP
OPQRSTUVWXYZ   PAGE
0123456789 ./-  SAVE

RANGE  AVG  DIAGS  ALARM
```

## Software Overview

The Model 42i NO<sub>x</sub> utilizes the menu-driven software illustrated by the flowchart in Figure 3-3. The Power-Up screen, shown at the top of the flowchart, is displayed each time the instrument is turned on. This screen is displayed while the instrument is warming up and performing self-checks. After the warm-up period, the Run screen is automatically displayed. The Run screen is the normal operating screen. It displays the NO<sub>x</sub> concentration, depending on operating mode. From the Run screen, the Main Menu can be displayed by pressing . The Main Menu contains a list of submenus. Each submenu contains related instrument parameters and/or functions. This chapter describes each submenu and screen in detail. Refer to the appropriate sections for more information.



**Figure 3-3.** Flowchart of Menu-Driven Software



## Power-Up Screen

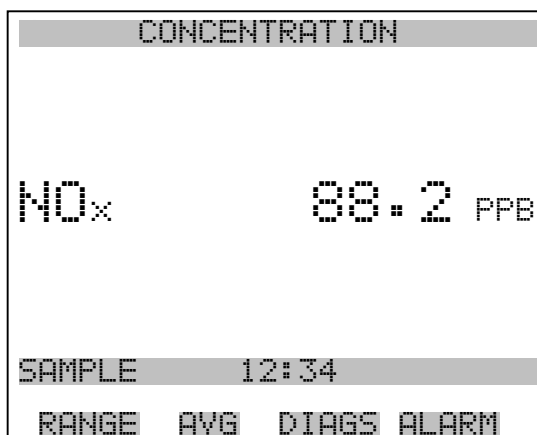
The Power-Up screen is displayed on power up of the Model 42i NO<sub>x</sub>. The Self-Test is displayed while the internal components are warming up and diagnostic checks are performed.



## Run Screen






The Run screen displays the NO<sub>x</sub> concentration. The status bar displays time and the status of the remote control interface, and optional zero/span solenoid valves, if installed. The word "SAMPLE" on the bottom left of the display indicates the analyzer has the span/zero valve option and is in "SAMPLE" mode. Other modes appear in the same area of the display as "ZERO" or "SPAN". For more information about the optional solenoid valves, see Chapter 9, "Optional Equipment".

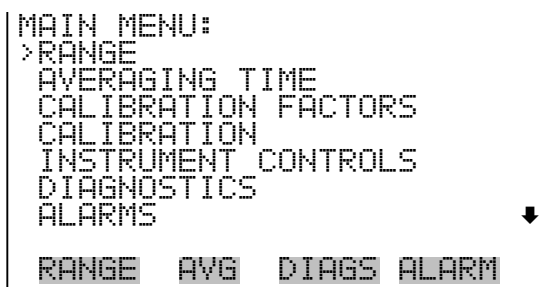
When operating in dual or auto range mode, two sets of coefficients are used to calculate the NO<sub>x</sub> "LOW" and "HIGH" concentrations. Also, two averaging times are used—one for each range. The title bar indicates which range concentrations are displayed. The words "LOW RANGE CONCENTRATION" on the top of the display indicates that the low concentration is displayed. In dual range mode, pressing the  and  arrows will toggle between high and low concentrations. The example below shows the Run screen in single range mode.



## Main Menu

The Main Menu contains a number of submenus. Instrument parameters and features are divided into these submenus according to their function. The concentration appears above the main menu and submenus in every screen, as shown below. The Service menu is visible only when the instrument is in service mode. For more information on the service mode, see “Service Mode” later in this chapter.

- Use  and  to move the cursor up and down.
- Press  to select a choice.
- Press  to return to the Main Menu or  to return to the Run screen.



SERVICE  
PASSWORD

## Range Menu

The Range menu allows the operator to select the gas units, NO<sub>x</sub> range(s), and to set the custom ranges. The screens below show the range menu in single range mode and dual/auto range modes. For more information about the single, dual, and auto range modes, see “Single Range Mode”, “Dual Range Mode”, and “Auto Range Mode” below.

- In the Main Menu, choose **Range**.

```
RANGE:
>GAS UNITS          PPB
NOx RANGE          50
SET CUSTOM RANGES

RANGE  AVG  DIAGS  ALARM
```

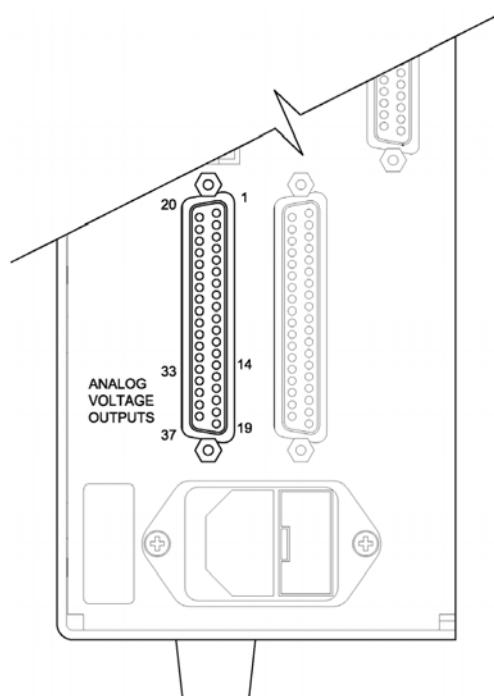
```
RANGE:
>GAS UNITS          PPB
HI NOx RANGE       100
LO NOx RANGE       50
SET CUSTOM RANGES

RANGE  AVG  DIAGS  ALARM
```

## Single Range Mode

In the single range mode, the NO<sub>x</sub> channel has one range, one averaging time, and one span coefficient.

By default, the analog output is arranged on the rear panel connector as shown in Figure 3-4. See Table 3-2 for channel and pin connection. Single range mode may be selected from the “Single/Dual/Auto Select” in the “Service Menu”, later in this chapter.



**Figure 3-4.** Pin-Out of Rear Panel Connector in Single Range Mode

**Table 3-2.** Default Analog Outputs in Single Range Mode

Channel	Pin	Description
1	14	None
2	33	None
3	15	NO <sub>x</sub> Analog Output
4	34	None
5	17	None
6	36	None
Ground	16, 18, 19, 35, 37	Signal Ground

**Note** All channels are user definable. If any customization has been made to the analog output configuration, the default selections may not apply. ▲

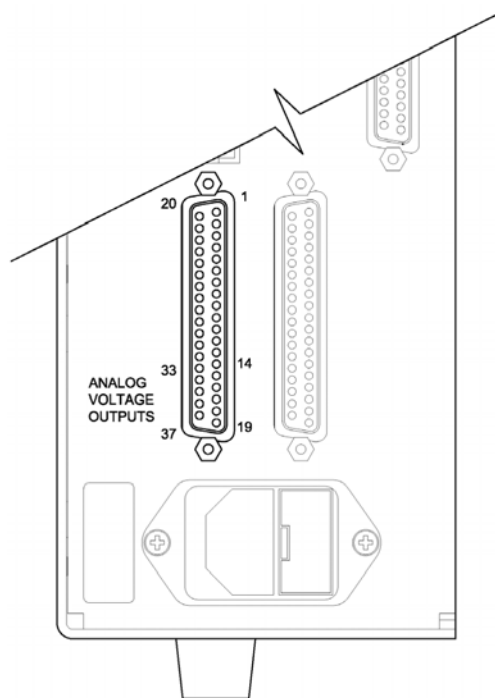
## Dual Range Mode

In the dual range mode, there are two independent channels defined for each compound being measured. These are labeled simply as the “High Range” and the “Low Range”. Each channel has its own analog output range, averaging time and span coefficient.

This enables the sample concentration readings to be sent to the analog outputs using two different ranges. For example, the low NO<sub>x</sub> analog output can be set to output concentrations from 0 to 50 ppb and the high NO<sub>x</sub> analog output set to output concentrations from 0 to 500 ppb.

In addition to each channel having two ranges, each channel has two span coefficients. There are two span coefficients so that each range can be calibrated separately. This is necessary if the two ranges are not close to one another. For example, if the low NO<sub>x</sub> range is set to 0–50 ppb and the high NO<sub>x</sub> range is set to 0–20,000 ppb.

By default, in the dual range mode, the analog outputs are arranged on the rear panel connector as shown in Figure 3-5. See Table 3-3 for channels and pin connections. Dual range mode may be selected from the “Single/Dual/Auto Select” in the “Service Menu”, later in this chapter.



**Figure 3-5.** Pin-Out of Rear Panel Connector in Dual Range Mode



**Table 3-3.** Default Analog Outputs in Dual Range Mode

Channel	Pin	Description
1	14	None
2	33	None
3	15	NO <sub>x</sub> High Range
4	34	None
5	17	None
6	36	NO <sub>x</sub> Low Range
Ground	16, 18, 19, 35, 37	Signal Ground

**Note** All channels are user definable. If any customization has been made to the analog output configuration, the default selections may not apply. ▲

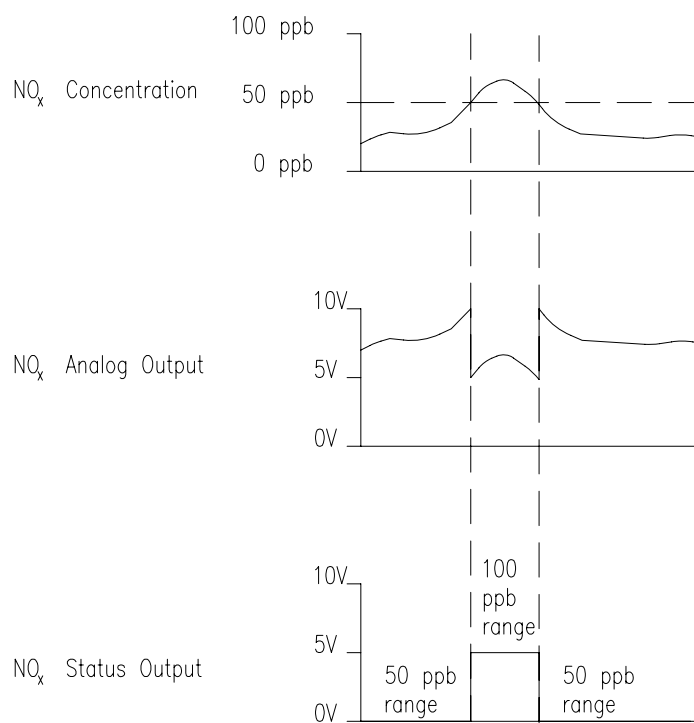
## Auto Range Mode

The auto range mode switches the NO<sub>x</sub> analog outputs between high and low ranges, depending on the concentration level. The high and low ranges are defined in the Range menu.

For example, suppose the low ranges are set to 50 ppb and the high ranges are set to 100 ppb (Figure 3-6). Sample concentrations below 50 ppb are presented to the low ranges analog outputs and sample concentrations above 50 ppb are presented to the high ranges analog outputs. When the low ranges are active, the status output is at 0 volts. When the high ranges are active, the status output is at half of full-scale.

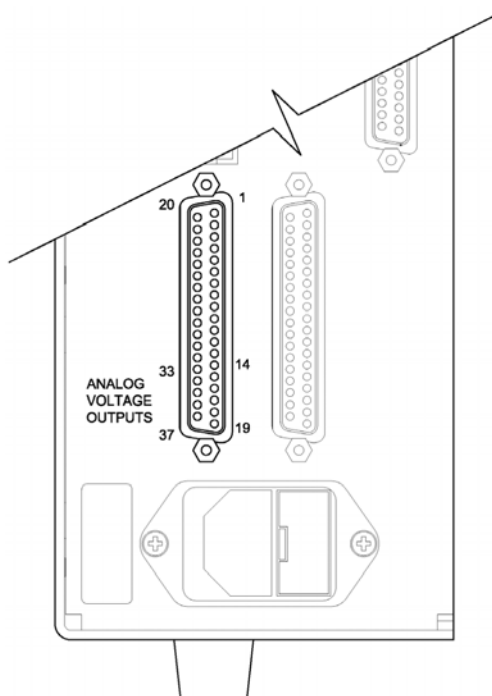
When the high ranges are active, the NO<sub>x</sub> concentration must drop to 95% of the low NO<sub>x</sub> range for the low ranges to become active.

In addition, each NO<sub>x</sub> analog output a span coefficients. There are two span coefficients so that each range can be calibrated separately. This is necessary if the two ranges are not close to one another. For example, if the low NO<sub>x</sub> range is set to 0–50 ppb and the high NO<sub>x</sub> range is set to 0–20,000 ppb.



**Figure 3-6.** Analog Output in Auto Range Mode

By default, in the auto range mode, the analog outputs are arranged on the rear panel connector as shown in Figure 3-7. See Table 3-4 for channels and pin connections. Auto range mode may be selected from the “Single/Dual/Auto Select” in the “Service Menu”, later in this chapter.



**Figure 3-7.** Pin-Out of Rear Panel Connector in Auto Range Mode

**Table 3-4.** Default Analog Outputs in Auto Range Mode




Channel	Pin	Description
1	14	None
2	33	None
3	15	NO <sub>x</sub> Analog Output
4	34	Range Status: half scale = high range zero scale = low range
5	17	None
6	36	None
Ground	16, 18, 19, 35, 37	Signal Ground

**Note** All channels are user definable. If any customization has been made to the analog output configuration, the default selections may not apply. ▲

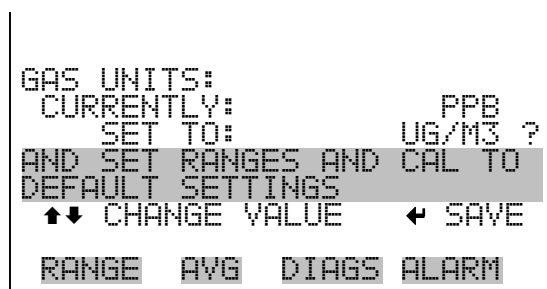
## Gas Units

The Gas Units screen defines how the NO<sub>x</sub> concentration reading is expressed. Gas units of parts per billion (ppb), parts per million (ppm), micrograms per cubic meter (µg/m<sup>3</sup>), or milligrams per cubic meter (mg/m<sup>3</sup>) are available. The µg/m<sup>3</sup> and mg/m<sup>3</sup> gas concentration modes are calculated using a standard pressure of 760 mmHg and a standard temperature of 20 °C.

When switching the selected units from ppb or ppm to µg/m<sup>3</sup> or mg/m<sup>3</sup>, the analog ranges all default to the highest range in that mode. For example, when switching from mg/m<sup>3</sup> to ppm, all the ranges default to 20 ppm. Therefore, whenever you change units, you should also check the range settings.

- In the Main Menu, choose Range > **Gas Units**.
- Use  and  to scroll through a list of choices.
- Press  to save the new units.

**Note** If the units change from ppb/ppm to µg/m<sup>3</sup>/mg/m<sup>3</sup> or vice-versa, the instrument should be recalculated, particularly if the user's standard temperature is different from 20 °C. A display warning will appear that ranges will be defaulted and calibration parameters reset. ▲






## NO<sub>x</sub> Range

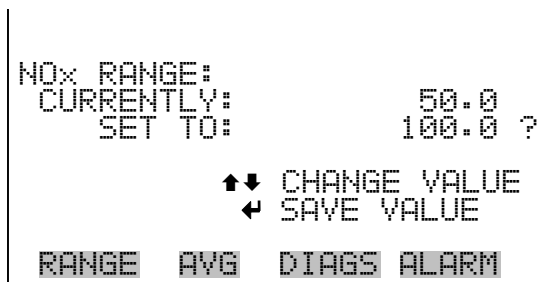
The NO<sub>x</sub> Range defines the concentration range of the analog outputs. For example, an NO<sub>x</sub> range of 0–50 ppb restricts the NO<sub>x</sub> analog output to concentrations between 0 and 50 ppb.

The display shows the current NO<sub>x</sub> range. The next line of the display is used to change the range. The range screen is similar for the single, dual, and auto range modes. The only difference between the screens are the words “High” and “Low” to indicate which range is displayed. The example

below shows the NO<sub>x</sub> range screen in single mode. For more information about the single, dual, and auto range modes, see “Single Range Mode”, “Dual Range Mode”, and “Auto Range Mode” earlier in this chapter.

Table 3-5 lists the standard ranges. Table 3-6 lists the extended ranges. When switching from standard to extended ranges, the PMT voltage must be readjusted. For more information about readjusting the PMT voltage, see Chapter 7, “Servicing”.

- In the Main Menu, choose Range > **NO<sub>x</sub> Range**.
- Use  and  to scroll through a list of choices.
- Press  to save the new range.



**Table 3-5.** Standard Ranges

ppb	ppm	µg/m <sup>3</sup>	mg/m <sup>3</sup>
50	0.05	100	0.1
100	0.10	200	0.2
200	0.20	500	0.5
500	0.50	1,000	1.0
1,000	1.00	2,000	2.0
2,000	2.00	5,000	5.0
5,000	5.00	10,000	10.0
10,000	10.00	20,000	20.0
20,000	20.00	30,000	30.0
C1	C1	C1	C1
C2	C2	C2	C2
C3	C3	C3	C3

**Table 3-6.** Extended Ranges

ppb	ppm	$\mu\text{g}/\text{m}^3$	$\text{mg}/\text{m}^3$
200	0.2	500	0.5
500	0.5	1,000	1
1,000	1	2,000	2
2,000	2	5,000	5
5,000	5	10,000	10
10,000	10	20,000	20
20,000	20	50,000	50
50,000	50	100,000	100
100,000	100	150,000	150
C1	C1	C1	C1
C2	C2	C2	C2
C3	C3	C3	C3

C1, C2, and C3 are custom ranges. For more information about custom ranges, see “Set Custom Ranges” below.

## Set Custom Ranges

The Set Custom Ranges menu lists three custom ranges: C1, C2, and C3. Custom ranges are user-defined ranges. In the standard range mode, any value between 50 ppb (0.05 ppm) and 20,000 ppb (20 ppm) can be specified as a range. In the  $\mu\text{g}/\text{m}^3$ ( $\text{mg}/\text{m}^3$ ) mode, any value between 100  $\mu\text{g}/\text{m}^3$  (0.1  $\text{mg}/\text{m}^3$ ) and 30,000  $\mu\text{g}/\text{m}^3$  (30  $\text{mg}/\text{m}^3$ ) can be specified as a range. In the extended range mode, any value between 200 ppb (0.2 ppm) and 100,000 ppb (100 ppm) can be specified as a range. In the  $\mu\text{g}/\text{m}^3$ ( $\text{mg}/\text{m}^3$ ) mode, any value between 500  $\mu\text{g}/\text{m}^3$  (0.5  $\text{mg}/\text{m}^3$ ) and 150,000  $\mu\text{g}/\text{m}^3$  (150  $\text{mg}/\text{m}^3$ ) can be specified as a range.

- In the Main Menu, choose Range > **Set Custom Ranges**.

```

CUSTOM_RANGES:
>CUSTOM_RANGE 1      55.6
CUSTOM_RANGE 2      75.0
CUSTOM_RANGE 3     125.0




RANGE  AVG  DIAGS  ALARM

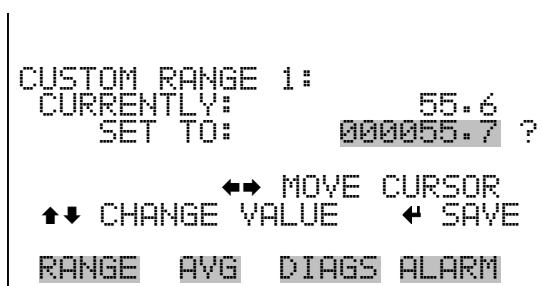
```

## Custom Ranges

The Custom Ranges screen is used to define the custom ranges.

The display shows the current custom range. The next line of the display is used to set the range. To use the custom full-scale range, be sure to select it (Custom range 1, 2, or 3) in the NO<sub>x</sub> Range screen. For more information about selecting ranges, see “NO<sub>x</sub> Ranges” above.




- In the Main Menu, choose Range > Set Custom Ranges > **Custom range 1, 2, or 3.**
- Use  and  to increment or decrement the numeric value.
- Press  to save the new range.



## Averaging Time

The averaging time defines a time period (1 to 300 seconds) over which NO<sub>x</sub> measurements are averaged. The average concentration of the NO<sub>x</sub> reading is calculated for that time period. The front panel display and analog outputs are updated every 10 seconds with the calculated averages. An averaging time of 10 seconds, for example, means that the average concentration of the last 10 seconds will be output at each update. An averaging time of 300 seconds means that the moving average concentration of the last 300 seconds will be output at each 10-second 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.

The Averaging Time screen for the single range mode is shown below. In the dual and auto range modes, an averaging time menu is displayed before the averaging time screen. This additional menu is needed because dual and auto range modes have two averaging times (high and low). The averaging time screens function the same way in the single, dual and auto range modes. The following averaging times are available: 1, 2, 5, 10, 20, 30, 60, 90, 120, 180, 240, and 300 seconds.

- In the Main Menu, choose **Averaging Time**.
- Use  and  to scroll through a list of choices.
- Press  to save the averaging time.

```
AVERAGING TIME:
CURRENTLY:      30 SEC
SET TO:         10 SEC ?

      ↑↓ CHANGE VALUE
      ← SAVE VALUE

RANGE  AVG  DIAGS  ALARM
```

## Calibration Factors Menu

Calibration factors are used to correct the NO<sub>x</sub> concentration reading that the instrument generates using its own internal calibration data. The Calibration Factors menu displays the calibration factors. The screens below show the calibration factors menu in single mode and dual/auto range modes.

Normally, the instrument is calibrated automatically using the commands listed in the Calibration menu described later in this chapter. However, the instrument can also be calibrated manually using the Calibration Factors menu.

To manually calibrate the instrument, see “NO<sub>x</sub> Background”, “NO<sub>x</sub> Span Coefficient”, and “Calibration Pressure” below.

- In the Main Menu, choose **Calibration Factors**.

```
CALIBRATION FACTORS:
>NOx BKG          0.0
NOx COEF          1.000
CAL PRESSURE      150.0 mmHg
RESET USER CAL DEFAULTS

RANGE  AVG  DIAGS  ALARM
```

```
CALIBRATION FACTORS:
>NOx BKG          0.0
HI NOx COEF       1.000
LO NOx COEF       1.000
CAL PRESSURE      150.0 mmHg
RESET USER CAL DEFAULTS

RANGE  AVG  DIAGS  ALARM
```












## NO<sub>x</sub> Background

The NO<sub>x</sub> background correction is determined during zero calibration. The NO<sub>x</sub> background is the amount of signal read by the analyzer in the NO<sub>x</sub> channel while sampling zero air. Although the background is expressed in terms of concentration, the background signal is actually the combination of electrical offsets, PMT dark current, and trace substances undergoing chemiluminescence. Before the analyzer sets the NO<sub>x</sub> reading to zero, it stores this value as the NO<sub>x</sub> background correction. The NO<sub>x</sub> background correction is typically below 15 ppb.

The NO<sub>x</sub> Background screen is used to perform a manual adjustment of the instruments zero background. Before performing a background adjustment, allow the analyzer to sample zero air until stable readings are obtained. The display shows the current NO<sub>x</sub> reading. The next line of the display shows the NO<sub>x</sub> background correction that is stored in memory. The NO<sub>x</sub> background correction is a value, expressed in the current gas units, that is subtracted from the NO<sub>x</sub> reading to produce the NO<sub>x</sub> reading that is displayed.

In the example below, the analyzer is displaying 4.4 ppb of NO<sub>x</sub> while sampling zero air. A background correction of 0.0 ppb means that 0 ppb is being subtracted from the NO<sub>x</sub> concentration being displayed. Therefore, the background correction must be increased to 4.4 ppb in order for the NO<sub>x</sub> reading to be at 0 ppb, i.e., a NO<sub>x</sub> reading of 4.4 ppb minus a NO<sub>x</sub> background reading of 4.4 ppb gives the corrected NO<sub>x</sub> reading of 0 ppb.

To set the NO<sub>x</sub> reading in the example below to zero, use  to increment the NO<sub>x</sub> background correction to 4.4 ppb. As the NO<sub>x</sub> background correction is increased, the NO<sub>x</sub> concentration is decreased. Note that at this point, pressing  and  however, has no affect on the analog outputs or the stored NO<sub>x</sub> background correction of 0.0 ppb. A question mark following both the NO<sub>x</sub> reading and the NO<sub>x</sub> background correction indicates that these are proposed changes as opposed to implemented changes. To escape this screen without saving any changes, press  to return to the Calibration Factors menu or  to return to the Run screen. Press  to actually set the NO<sub>x</sub> reading to 0 ppb and store the new background correction of 4.4 ppb. Then the question mark prompt beside the NO<sub>x</sub> reading disappears.

- In the Main Menu, choose Calibration Factors > NO<sub>x</sub> Background.
- Use  and  to increment or decrement the proposed background value.
- Press  to save the new background.



```
NOx BACKGROUND:
      NOx:      4.4
SET BKG TO:     0.0

      ↑↓ INC/DEC
      ← SAVE VALUE

RANGE  AVG  DIAGS  ALARM
```




## NO<sub>x</sub> Coefficient

The NO<sub>x</sub> span coefficient is usually calculated by the instrument processor during calibration. The span coefficient is used to correct the NO<sub>x</sub> readings, and normally have values near 1.000.

The NO<sub>x</sub> Coefficient screen allows the NO<sub>x</sub> span coefficient to be manually changed while sampling span gas of known concentration. The display shows the current NO<sub>x</sub> concentration reading. The next line of the display shows the NO<sub>x</sub> span coefficient that is stored in memory and is being used to correct the NO<sub>x</sub> concentration. Notice that as the span coefficient value is changed, the current NO<sub>x</sub> concentration reading on the above line also changes. However, no real changes are made to the value stored in memory until  is pressed. Only proposed changes, as indicated by a question mark prompt, are displayed until  is pressed.

In dual or auto range mode, “High” or “Low” is displayed to indicate the calibration of the high or low coefficient. The example below shows the coefficient screen in single mode.

**Note** The concentration value will show ERROR if the measured concentration is not a valid span value (either higher than the selected range, or 0 or lower). ▲

- In the Main Menu, choose Calibration Factors > NO<sub>x</sub> Coef.
- Use  and  to increment or decrement the coefficient value.
- Press  to save the new coefficient.

```

NOx COEFFICIENT:
  NOx:          51.4
SET COEF TO:    1.000

  ↑↓ INC/DEC
  ← SAVE VALUE




RANGE  AVG  DIAGS  ALARM

```

## Calibration Pressure

The Calibration Pressure screen reports the reactor pressure at which current calibration was performed. The screen also allows this value to be edited by the operator. This value should not be changed unless a complete manual calibration is being performed. The calibration pressure is set equal to the reactor pressure at the time of calibration.

**Note** Turning the pressure compensation on and off can produce significant artificial jumps in the apparent sample concentration. If the pressure compensation feature is to be used, the instrument must be calibrated with the pressure compensation feature on. For more information about calibration, see Chapter 4, “Calibration”. ▲

- In the Main Menu, choose Calibration Factors > **Calibration Pressure**.
- Use  and  to increment or decrement the calibration pressure value.
- Press  to save the new calibration pressure.

```

CALIBRATION PRESSURE:
  PRESSURE:    232.5
SET CAL PRES TO: 150.0





  ↑↓ INC/DEC
  ← SAVE VALUE

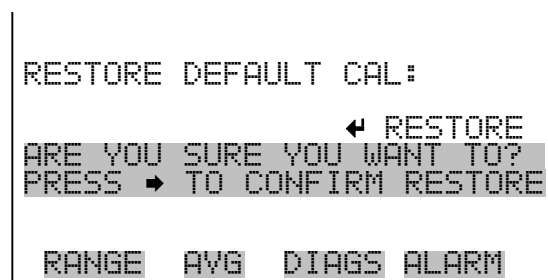
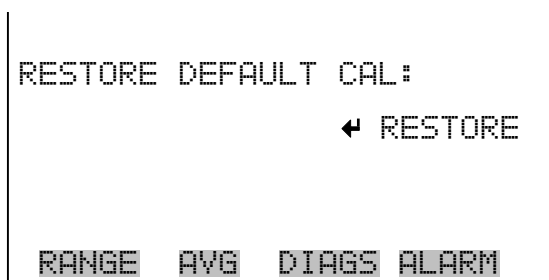
RANGE  AVG  DIAGS  ALARM

```

## Reset User Calibration Default

The Reset User Calibration Default screen allows the user to reset the calibration configuration values to factory defaults.

- In the Main Menu, choose Service > Calibration Factors > **Reset User Cal Defaults**.
- Press  to warn user and enable restore with .
- Use  to reset the calibration pressure reference value when pressed after .



## Calibration Menu

The Calibration menu is used to calibrate the analyzer, including the zero background, the NO<sub>x</sub> coefficient, and calibration pressure.

The calibration procedure is the same in dual, auto, or single range, however, there are two sets of gas coefficients in dual or auto range (i.e. low and high coefficients). This enables each range to be calibrated separately. When calibrating the instrument in dual or auto range, be sure to use a low span gas to calibrate the low range and a high span gas to calibrate the high range.

Whether dual or single range, the first step in calibrating the instrument is to assign the calibration pressure. The calibration pressure is used to account for slight pressure fluctuation brought on by changing weather. The calibration pressure is set equal to the reactor pressure at the time of calibration. For more information about calibration, see Chapter 4, “Calibration”.

- In the Main Menu, choose **Calibration**.

```

CALIBRATION:
>CAL NOx BACKGROUND
CAL NOx COEFFICIENT
CALIBRATE PRESSURE
ZERO/SPAN CHECK

RANGE  AVG  DIAGS  ALARM

```

```

CALIBRATION:
>CAL NOx BACKGROUND
CAL HI NOx COEFFICIENT
CAL LO NOx COEFFICIENT
CALIBRATE PRESSURE


RANGE  AVG  DIAGS  ALARM

```

## Calibrate NO<sub>x</sub> Background

The Calibrate NO<sub>x</sub> Background screen is used to adjust the background, or perform a “zero calibration”. Be sure the analyzer samples zero air until the readings stabilize. The display shows the current NO<sub>x</sub> reading.

It is important to note the averaging time when calibrating. The longer the averaging time, the more precise the calibration will be. For the most precise calibration, use the 300-second averaging time. For more information about calibration, see Chapter 4, “Calibration”.

- In the Main Menu, choose Calibration > **Calibrate NO<sub>x</sub> Background**.
- Press  to set the new reading to zero.

```

NOx BACKGROUND:
  NOx:           3.4
CURRENTLY:       0.0 ?

    ← SET NOx TO ZERO

RANGE  AVG  DIAGS  ALARM






```

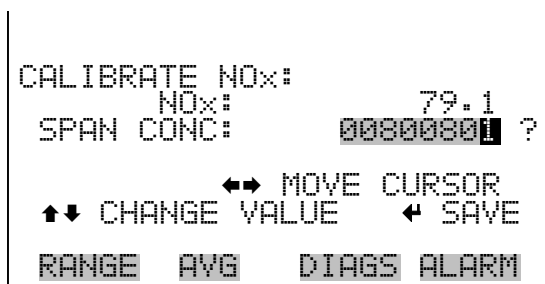
## Calibrate NO<sub>x</sub> Coefficients

The span calibration screens are used to adjust the NO<sub>x</sub> span concentrations while sampling span gas of known concentration.

The display shows the current NO<sub>x</sub> concentration reading and the current NO<sub>x</sub> range. The next line of the display is where the NO<sub>x</sub> calibration gas concentration is entered.

It is important to note the averaging time when calibrating. The longer the averaging time, the more precise the calibration will be. For the most precise calibration, use the 300-second averaging time. For more information about calibration, see Chapter 4, “Calibration”.

- In the Main Menu, choose Calibration > **Cal NO<sub>x</sub> Coefficients**.
- Use  and  pushbuttons to move the cursor left or right.
- Use  and  to increment or decrement the numeric value.
- Press  to calculate and save the new coefficient based on the entered span concentration.



```
CALIBRATE NOx:
  NOx:          79.1
  SPAN CONC:    00800801 ?


  ←→ MOVE CURSOR
  ↑↓ CHANGE VALUE  ← SAVE

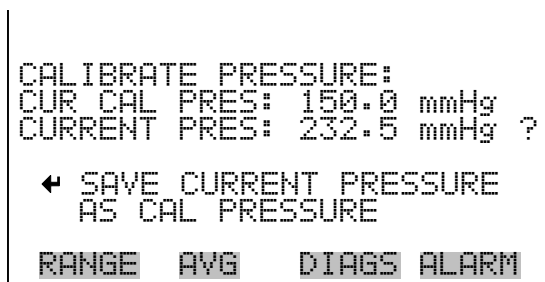
  RANGE  AVG  DIAGS  ALARM
```

## Calibrate Pressure

The Calibrate Pressure screen is used to set the calibration pressure.

The calibration pressure should be set only when calibrating the instrument.

- In the Main Menu, choose Calibration > **Calibrate Pressure**.
- Press  to save the current chamber as the new calibration pressure.



```
CALIBRATE PRESSURE:
CUR CAL PRES: 150.0 mmHg
CURRENT PRES: 232.5 mmHg ?

← SAVE CURRENT PRESSURE
  AS CAL PRESSURE

  RANGE  AVG  DIAGS  ALARM
```

## Zero/Span Check

The Zero/Span Check menu is available with the zero/span valve option. It is used to program the instrument to perform fully automated zero and span check or adjustments. Total Duration Hour is the sum of zero, span, and purge duration minutes. Zero and Span Calibration Reset are toggle items that change between yes or no when selected, and displayed if auto calibration is installed.

- In the Main Menu, choose Calibration > **Zero/Span Check**.






```

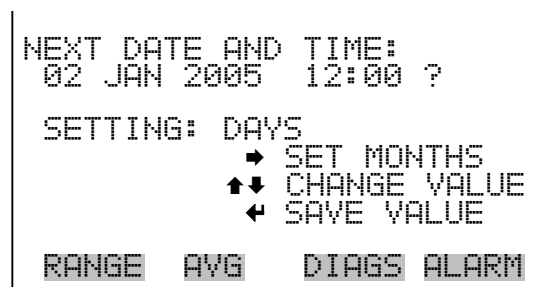
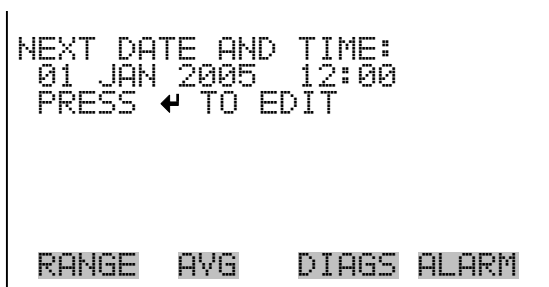
ZERO/SPAN CHECK:
>NEXT TIME 01Jan05 12:00
PERIOD HR      24
TOTAL DURATION HR 1.5
ZERO DURATION MIN 30
SPAN DURATION MIN 30
PURGE DURATION MIN 30
ZERO/SPAN AVG SEC 60 ↓
RANGE  AVG  DIAGS  ALARM

ZERO CAL RESET
SPAN CAL RESET      OFF
ZERO/SPAN RATIO      1
  
```

## Next Time




The Next Time screen is used to view and set the next zero/span check date and time. Once the initial zero/span check is performed, the date and time of the next zero/span check is calculated and displayed.

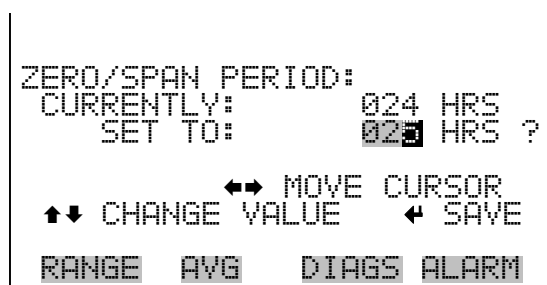
- In the Main Menu, choose Calibration > Zero/Span Check > **Next Time**.
- Use , ,  and  to move and change the value of the date and time.
- Press  to accept a change.



### Period Hours

The Zero/Span Period Hours screen defines the period or interval between zero/span checks. Periods between 0 and 999 hours are acceptable. To turn the zero/span check off, set the period to 0.

- In the Main Menu, choose Calibration > Zero/Span Check > **Period Hours**.
- Use  and  to increment and decrement the numeric value.
- Press  to save the period.






### Zero/Span/Purge Duration Minutes

The Zero Duration Minutes screen defines how long zero air is sampled by the instrument. The span and purge duration screens look and function the same way as the zero duration screen, and are used to set how long the span gas and sample gas are sampled by the instrument. Durations between 0 and 60 minutes are acceptable. Each time a zero/span check occurs the zero check is done first, followed by the span check. To perform just a zero check, set the span and purge duration screen to 0 (off). The same applies to perform just a span or purge check.

- In the Main Menu, choose Calibration > Zero/Span Check > **Zero, Span or Purge Duration Min.**



- Use  and  to increment and decrement the numeric value.
- Press  to save the duration value.

```

ZERO DURATION:
CURRENTLY:      30 MIN
SET TO:         31 MIN ?




      ↔ MOVE CURSOR
↑↓ CHANGE VALUE  ← SAVE

RANGE  AVG  DIAGS  ALARM

```

### Zero/Span Averaging Time

The Zero/Span Averaging Time screen allows the user to adjust the zero/span averaging time. The zero/span averaging time is used by the analyzer only when performing an automatic zero or span check. The analyzer's averaging time is used for all other functions. The following averaging times are available: 1, 2, 5, 10, 20, 30, 60, 90, 120, 180, 240, and 300 seconds.

- In the Main Menu, choose Calibration > Zero/Span Check > Zero/Span Avg Sec.
- Use  and  to scroll through a list of choices.
- Press  to save the averaging time.

```

ZERO/SPAN AVERAGING TIME:
CURRENTLY:      60 SEC
SET TO:         90 SEC ?




      ↑↓ CHANGE VALUE
      ← SAVE VALUE

RANGE  AVG  DIAGS  ALARM

```

### Zero/Span Ratio

The Zero/Span Ratio screen is used to adjust the ratio of zeros to spans. For example, if this value is set to 1, a span check will follow every zero check. If this value is set to 3, there will be two zero checks between each zero/span check. This value may be set from 1 to 10, with 1 as default.

- In the Main Menu, choose Calibration > Zero/Span Check > **Zero/Span Ratio**.
- Use  and  to increment and decrement the numeric value.
- Press  to save the ratio value.

```

ZERO/SPAN RATIO:
CURRENTLY:      1 :1
SET TO:         2 :1 ?

      ↑↓ CHANGE VALUE
      ← SAVE VALUE

RANGE  AVG  DIAGS  ALARM

```

## Instrument Controls Menu

The Instrument Controls menu contains a number of items. The software controls listed in this menu enable control of the listed instrument functions.

- In the Main Menu, choose **Instrument Controls**.

```

INSTRUMENT CONTROLS:
>OZONATOR
PMT SUPPLY
DATALOGGING SETTINGS
COMMUNICATION SETTINGS
I/O CONFIGURATION
TEMPERATURE COMPENSATION
PRESSURE COMPENSATION ↓

RANGE  AVG  DIAGS  ALARM

SCREEN CONTRAST
SERVICE MODE
DATE/TIME

```


## Ozonator

The Ozonator screen is used to turn the internal ozonator on or off. The display shows the status of the control line that turns the ozonator on or off. The next line of the display shows the user-specified ozonator setting. Under most conditions, the control line status and ozonator set status are the same. However, as a safety precaution, the microprocessor can override the user-specified ozonator setting. This occurs only if the ozonator flow doesn't indicate any flow or if the NO<sub>2</sub> converter temperature is below the

minimum alarm limit. In this case, an alarm is activated and the ozonator is turned off. This is done to prevent the ozonator from overheating, which will result in permanent damage to the ozonator, or if the converter temperature drops below the minimum limit, which reduces the effectiveness of the ozone destruct.

It is possible, however, to defeat this feature, by setting the ozonator safety “OFF” in the “Service Menu”.

**Note** The ozonator must be “ON” to obtain NO<sub>x</sub> readings. As an additional safety precaution, a lit LED mounted on the measurement interface board indicates that the ozonator is on. ▲


- In the Main Menu, choose Instrument Controls > **Ozonator**.
- Press  to toggle and set the ozonator on or off.

```

OZONATOR:
CURRENTLY:
SET TO:
                                OFF
                                ON ?
                                ← TOGGLE VALUE
RANGE  AVG  DIAGS  ALARM
  
```

## PMT Supply

The PMT Supply screen is used to turn the PMT power supply on or off. This is useful in a troubleshooting situation.

- In the Main Menu, choose Instrument Controls > **PMT Supply**.
- Press  to toggle and set the PMT supply on or off.

```

PMT SUPPLY:
CURRENTLY:
SET TO:
                                OFF
                                ON ?
                                ← TOGGLE VALUE
RANGE  AVG  DIAGS  ALARM
  
```

## Datalogging Settings

The Datalogging Settings menu deals with datalogging.




- In the Main Menu, choose Instrument Controls > **Datalogging Settings**.

```
DATALOGGING SETTINGS:
>SELECT SREC/LREC      SREC
VIEW LOGGED DATA
ERASE LOG
SELECT CONTENT
COMMIT CONTENT
RESET TO DEFAULT CONTENT
CONFIGURE DATA LOGGING

RANGE  AVG  DIAGS  ALARM
```

### Select SREC/LREC

The Select SREC/LREC is used to select short record or long record format for other operations in this menu.

- In the Main Menu, choose Instrument Controls > Datalogging Settings > **Select SREC/LREC**.
- Use  and  to scroll through a list of choices.
- Press  to set record format.



```
SELECT LOG TYPE:
CURRENTLY:      SREC
SET TO:         LREC ?


      ← TOGGLE VALUE

RANGE  AVG  DIAGS  ALARM
```

### View Logged Data

The View Logged Data screen is used to select the start point to view the logged data by number of records or date and time.

- In the Main Menu, choose Instrument Controls > Datalogging Settings > Select SREC or LREC > **View Logged Data**.
- Use  and  to toggle between number of records or date and time.




- Press  to accept.

```

SELECT START POINT BY:
  SET TO: # OF RECS
    ↑↓ CHANGE      ← ACCEPT
RANGE  AVG  DIAGS ALARM
  
```

### Number of Records





The Number of Records screen is used to select the starting point to display the number of records back to view.

- Use  and  to increment or decrement the numeric value.
- Press  to set the starting record and continue to the record display screen.

```

SET # BACK FROM CURRENT:
TOTAL LRECS:      00000000
                  20
    ↔ MOVE CURSOR
    ↑↓ CHANGE VALUE  ← SAVE
RANGE  AVG  DIAGS ALARM
  
```

The Record Display screen (read only) displays the selected records.

- Use  and  to view all the items in the record.
- Use  and  to view records at different times.





```

time      date      flags
10:00    06/20/05   FC0088900
11:00    06/20/05   FC0088900
12:00    06/20/05   FC0088900
13:00    06/20/05   FC0088900
↑↓ PGUP/DN  ↔ PAN L/R
RANGE  AVG  DIAGS  ALARM

```

### Date and Time

The Date and Time screen is used to set a start date and time for which to view logged data. For example, if “20 JUN 2005 10:00” is entered, then the first logged data record that is displayed is the first record after this time. If set to one minute logging, this would be at “20 JUN 2005 10:01”.





- Use  and  to increment or decrement the selected field.
- Use  to advance to next field.
- Press  to set the date and time of the first record to be displayed and continue to the record display screen.

```

DATE AND TIME:
20 JUN 2005 10:00
↑↓ CHG DAYS
➡ SET CURSOR TO MONTHS
⬅ ACCEPT AS SHOWN
RANGE  AVG  DIAGS  ALARM

```

The Record Display screen (read only) displays the selected records.



- Use  and  to view all the items in the record.
- Use  and  to view records at different times.

```

time      date      flags
10:01 06/20/05 FC0088900
10:02 06/20/05 FC0088900
10:03 06/20/05 FC0088900
10:04 06/20/05 FC0088900
↑↓ FGUP/DN ↔ PAN L/R
RANGE  AVG  DIAGS ALARM

```

**Erase Log** The Erase Log is used to erase all saved data for the selected record type (not all short records and long records).

- In the Main Menu, choose Instrument Controls > Datalogging Settings > **Erase Log**.
- Press  to erase all data.
- Press  to confirm erasure.

```

ERASE LREC LOG FILE DATA?
                        ← ERASE
RANGE  AVG  DIAGS ALARM

```

```

ERASE LREC LOG FILE DATA?
                        ← ERASE
ARE YOU SURE YOU WANT TO?
PRESS → TO CONFIRM ERASURE
RANGE  AVG  DIAGS ALARM

```

**Select Content** The Select Content submenu displays a list of 32 record fields to use and a submenu list of the analog output signal group choices to choose from. Choices are Concentrations, Other Measurements, and Analog Inputs (if the I/O expansion board is installed). This is a temporary list of items for the selected record type that must be committed via the datalogging menu before the changes will apply. Note that committing any changes to this list will erase all currently logged data, as the format of the stored data is changed.

- In the Main Menu, choose Instrument Controls > Datalogging Settings > **Select Content**.

```


LREC FIELDS:
>FIELD 1          NO
FIELD 2          NOX
FIELD 3          PRES
FIELD 4          PMTT
FIELD 5          INTT
FIELD 6          CONV
FIELD 7          NONE
                ↓
RANGE  AVG  DIAGS  ALARM
    
```




```

DATA IN LREC FIELD 1:
>CONCENTRATIONS
OTHER MEASUREMENTS
ANALOG INPUTS

RANGE  AVG  DIAGS  ALARM
    
```

## Concentrations

The Concentrations screen allows the user to select the output signal that is tied to the selected field item. The selected item is shown by “<--” after it. Note that at this point, pressing  indicates that these are proposed changes as opposed to implemented changes. To change the selected record format and erase record log file data, see “Commit Content” below. Range (NO<sub>x</sub>) is visible only in auto range mode.

- In the Main Menu, choose Instrument Controls > Datalogging Settings > Select Content > Select Field > **Concentrations**.
- Use  and  to move the cursor up and down.
- Press  to select a new choice.




```




CONCENTRATIONS:
>NONE
NO
NO2
NOx <--
LO NO
LO NO2
LO NOx
↓
RANGE  AVG  DIAGS  ALARM

HI NO
HI NO2
HI NOx
RANGE (NOX)

```

## Other Measurements

The Other Measurements screen allows the user to select the output signal that is tied to the selected field item. The selected item is shown by “<--” after it. Note that at this point, pressing  indicates that these are proposed changes as opposed to implemented changes. To change the selected record format and erase record log file data, see “Commit Content” below.

- In the Main Menu, choose Instrument Controls > Datalogging Settings > Select Content > Select Field > **Other Measurements**.
- Use  and  to move the cursor up and down.
- Press  to select a new choice.


```




OTHER MEASUREMENTS:
>NONE
INT TEMP
CHAMBER TEMP
COOLER TEMP
NO2 CNV TEMP
CHAMBER PRES
FLOW
↓
RANGE  AVG  DIAGS  ALARM

PMT VOLTS
OZONATOR FLOW

```

## Analog Inputs



The Analog Inputs screen allows the user to select the output signal (none or analog inputs 1-8) that is tied to the selected field item. The selected item is shown by “<--” after it. Note that at this point, pressing  indicates that these are proposed changes as opposed to implemented changes. To change the selected record format and erase record log file data, see “Commit Content” below.

- In the Main Menu, choose Instrument Controls > Datalogging Settings > Select Content > Select Field > **Analog Inputs**.
- Use  and  to move the cursor up and down.
- Press  to select a new choice.

```
ANALOG INPUTS:
>NONE
ANALOG IN 1
ANALOG IN 2
ANALOG IN 3
ANALOG IN 4
ANALOG IN 5
ANALOG IN 6
                                     ↓
RANGE  AVG  DIAGS  ALARM
```

## Commit Content



The Commit Content screen is used to save the selected output signal that is tied to the selected field item. For more information about selecting the analog output signal group choices, see “Select Content” above.

- In the Main Menu, choose Instrument Controls > Datalogging Settings > **Commit Content**.
- Press  to commit changes to selected record format and erase record log file data.
- Press  to confirm changes.



### Reset to Default Content

The Reset to Default Content screen is used to reset all of the datalogging field items to default values. For more information about selecting the analog output signal group choices, see “Select Content” above.

- In the Main Menu, choose Instrument Controls > Datalogging Settings > **Reset to Default Content**.
- Press  to reset selected record format and erase record log file data.
- Press  to reset.



### Configure Datalogging

The Configure Datalogging menu deals with datalogging configuration for the currently selected record type.

- In the Main Menu, choose Instrument Controls > Datalogging Settings > **Configure Datalogging**.

```




DATALOGGING SETTINGS:
>LOGGING PERIOD MIN    OFF
MEMORY ALLOCATION %     50
DATA TREATMENT         AVG

RANGE  AVG  DIAGS ALARM

```

### Logging Period Min

The Logging Period Min screen is used to select the logging period in minutes for the record format (srec or lrec). List of choices include: off, 1, 5, 15, 30, and 60 minutes (default).

- In the Main Menu, choose Instrument Controls > Datalogging Settings > Configure Datalogging > **Logging Period Min**.
- Use  and  to scroll through a list of choices.
- Press  to set the logging period.

```

SET PERIOD FOR SREC:
CURRENTLY:          OFF MIN
SET TO:             60 MIN ?




↑↓ CHANGE VALUE    ← SAVE


RANGE  AVG  DIAGS ALARM

```

### Memory Allocation Percent

The Memory Allocation Percent screen is used to select the percentage of each record type for both short records and long records. Percentages between 0 and 100% are available in increments of 10. Changing this value results in log erasure for both short records and long records.

- In the Main Menu, choose Instrument Controls > Datalogging Settings > Configure Datalogging > **Memory Allocation %**.
- Use  and  to scroll through a list of choices.
- Press  to set the percentage for both record types and proceed to the erasure warning screen.

- Press  to confirm change.

```

SET PERCENT SRECS:
CURRENTLY:      50 %
SET TO:         60 % ?

↓ CHANGE VALUE  ← SAVE

RANGE  AVG  DIAGS  ALARM
  
```




```

SET PERCENT SRECS:
CURRENTLY:      50 %
SET TO:         60 % ?
THIS WILL ERASE ALL LOGS!
PRESS → TO CONFIRM CHANGE

RANGE  AVG  DIAGS  ALARM
  
```

### Data Treatment

The Data Treatment screen is used to select the data type for the selected record: whether the data should be averaged over the interval, the minimum or maximum used, or the current value logged. Data treatment doesn't apply to all data, just to the concentration measurement. All other data points log the current value at the end of the interval.

- In the Main Menu, choose Instrument Controls > Datalogging Settings > Configure Datalogging > **Data Treatment**.
- Use  and  to scroll through a list of choices.
- Press  to set the data type.

```

SET LREC DATA TYPE:
CURRENTLY:      AVG
SET TO:         CUR      ?

↑↓ CHANGE VALUE  ← SAVE

RANGE  AVG  DIAGS  ALARM
  
```

## Communication Settings

The communication Settings menu is used with communications control and configuration.




- In the Main Menu, choose Instrument Controls > **Communication Settings**.

```
COMMUNICATION SETTINGS:
>BAUD RATE
  INSTRUMENT ID
  COMMUNICATION PROTOCOL
  STREAMING DATA CONFIG
  RS-232/RS-485 SELECTION
  TCP/IP SETTINGS

RANGE  AVG  DIAGS  ALARM
```

### Baud Rate

The Baud Rate screen is used to set the RS-232/RS-485 interface baud rate. Baud rates of 1200, 2400, 4800, and 9600, 19200, 38400, 57600, and 115200 are available.

- In the Main Menu, choose Instrument Controls > Communication Settings > **Baud Rate**.
- Use  and  to scroll through a list of choices.
- Press  to save the new baud rate.

```
BAUD RATE:
CURRENTLY:      9600
SET TO:         19200  ?




  ↑↓ CHANGE VALUE
  ← SAVE VALUE

RANGE  AVG  DIAGS  ALARM
```

### Instrument ID

The Instrument ID screen allows the operator to edit the instrument ID. The ID is used to identify the instrument when using the C-Link or MODBUS protocols to control the instrument or collect data. It may be necessary to edit the ID number if two or more of the same instrument are connected to one computer over the serial port. Valid Instrument ID

numbers are from 0 to 127. The Model 42i NO<sub>x</sub> has a default Instrument ID of 42. For more information about the Instrument ID, see Appendix B “C-Link Protocol Commands” or Appendix C “MODBUS Protocol”.

- In the Main Menu, choose Instrument Controls > Communication Settings > **Instrument ID**.
- Use  and  to increment or decrement the ID value.
- Press  to save the new instrument ID.

```

INSTRUMENT ID:
CURRENTLY:      42
SET TO:         50 ?




      ↑↓ CHANGE VALUE
      ← SAVE VALUE

RANGE  AVG  DIAGS  ALARM
  
```

## Communication Protocol

The Communication Protocol screen is used to change the instrument communication protocol for serial communications. This does not affect communications over Ethernet, because the protocols are processed simultaneously on different ports.

In the Main Menu, choose Instrument Controls > Communication Settings > **Communication Protocol**.

- Use  and  to scroll through a list of choices.
- Press  to save the new protocol.

```

COMMUNICATION PROTOCOL:
CURRENTLY:      CLINK
SET TO:         STREAMING ?

      ↑↓ CHANGE VALUE
      ← SAVE VALUE

RANGE  AVG  DIAGS  ALARM
  
```

## Streaming Data Configuration

The Streaming Data Configuration menu is used to allow for configuration of the 18 streaming data output items, streaming interval, current data format, and current time. The Choose Stream Data submenu displays a list of the analog signal group choices to choose from. Choices are Concentrations, Other Measurements, and Analog Inputs (if the I/O expansion board option is installed).

**Note** Add Labels and Prepend Timestamp are toggle items that change between yes or no when selected. ▲



- In the Main Menu, choose Instrument Controls > Communication Settings > **Streaming Data Config.**

```
STREAMING DATA CONFIG:
INTERVAL          10 SEC
ADD LABELS        NO
PREPEND TIMESTAMP YES
>ITEM 1           NO2
ITEM 2            INTT
ITEM 3            PRES
ITEM 4            NONE
RANGE  AVG  DIAGS  ALARM
```


```
CHOOSE STREAM DATA:
>CONCENTRATIONS
OTHER MEASUREMENTS
ANALOG INPUTS
RANGE  AVG  DIAGS  ALARM
```

## Streaming Data Interval

The Streaming Data Interval screen is used to adjust the streaming data interval. The following interval times are available: 1, 2, 5, 10, 20, 30, 60, 90, 120, 180, 240, and 300 seconds.

- In the Main Menu, choose Instrument Controls > Communication Settings > Streaming Data Config > **Interval.**
- Use  and  to scroll through a list of choices.



- Press  to save the new streaming data period.

```

STREAMING DATA INTERVAL:
CURRENTLY:      10 SEC
SET TO:         20 SEC ?




      ↑↓ CHANGE VALUE
      ← SAVE VALUE

RANGE  AVG  DIAGS  ALARM

```

## Concentrations

The Concentrations screen allows the user to select the output signal that is tied to the selected streaming data item. The selected item is shown by “<--” after it. In dual or auto range mode, “High” or “Low” is displayed to indicate high or low concentrations. Range (NO<sub>x</sub>) is visible only in auto range mode.

- In the Main Menu, choose Instrument Controls > Communication Settings > Streaming Data Config > Select Item > **Concentrations**.
- Use  and  to move the cursor up and down.
- Press  to select a new choice.

```

CONCENTRATIONS:
>NONE
NOx
RANGE (NOX)      <--




RANGE  AVG  DIAGS  ALARM

```

## Other Measurements

The Other Measurements screen allows the user to select the output signal that is tied to the selected streaming data item. The selected item is shown by “<--” after it.

- In the Main Menu, choose Instrument Controls > Communication Settings > Streaming Data Config > Select Item > **Other Measurements**.

- Use  and  to move the cursor up and down.
- Press  to select a new choice.




```

OTHER MEASUREMENTS:
>NONE
INT TEMP
CHAMBER TEMP
COOLER TEMP
NO2 CNV TEMP
CHAMBER PRES
FLOW
                                     ↓
RANGE  AVG  DIAGS  ALARM
  
```

PMT VOLTS

### Analog Inputs

The Analog Inputs screen allows the user to select the output signal (none or analog inputs 1-8) that is tied to the selected streaming data item. The selected item is shown by “<--” after it.

- In the Main Menu, choose Instrument Controls > Communication Settings > Streaming Data Config > Select Item > **Analog Inputs**.
- Use  and  to move the cursor up and down.
- Press  to select a new choice.



```

ANALOG INPUTS:
>NONE
ANALOG IN 1
ANALOG IN 2
ANALOG IN 3
ANALOG IN 4
ANALOG IN 5
ANALOG IN 6
                                     ↓
RANGE  AVG  DIAGS  ALARM
  
```

### RS-232/RS-485 Selection

The RS-232/RS-485 Selection screen allows the user to choose between the RS-232 or RS-485 specification for serial communication.

**Note** Disconnect the serial cable before changing RS-232 and RS-485 selection to prevent damage to the connected equipment. ▲

- In the Main Menu, choose Instrument Controls > Communication Settings > **RS-232/RS-485 Selection**.
- Press  to leave the warning screen and move to next screen.
- Use  to confirm and save the new selection change.

```

RS-232/RS-485 SELECTION:
** WARNING **
DISCONNECT THE SERIAL
CABLES BEFORE CHANGING
THE SELECTION!
      ← TO CONTINUE

RANGE  AVG  DIAGS  ALARM
  
```

```

RS-232/RS-485 SELECTION:
CURRENTLY:      RS-232
SET TO:         RS-485 ?
MAKE SURE THAT THE CABLE
IS OFF: PRESS → TO CONFIRM
      ← TOGGLE VALUE

RANGE  AVG  DIAGS  ALARM
  
```

## TCP/IP Settings

The TCP/IP Settings menu is used for defining TCP/IP settings.

- In the Main Menu, choose Instrument Controls > Communication Settings > **TCP/IP Settings**.

```


TCP/IP SETTINGS:
>USE DHCP      OFF
IP ADDRESS     192.168.1.15
NETMASK        255.255.255.0
GATEWAY        192.168.1.1
HOST NAME      Iseries

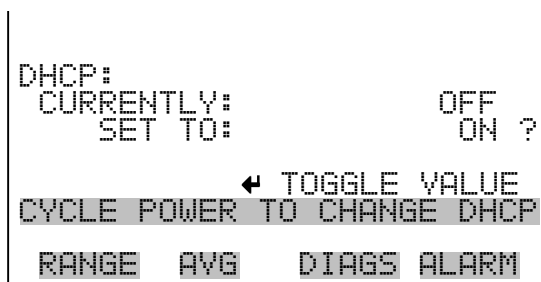
RANGE  AVG  DIAGS  ALARM
  
```

## Use DHCP

The Use DHCP screen is used to specify whether to use DHCP or not.






**Note** The instrument power must be cycled after this parameter has been changed for the change to take effect. ▲

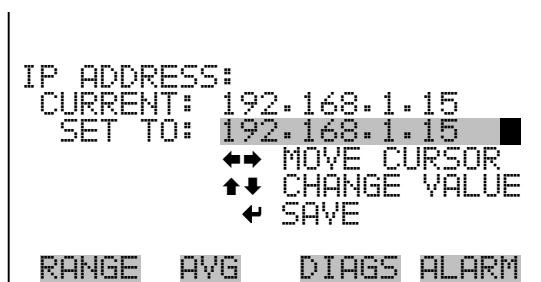
- In the Main Menu, choose Instrument Controls > Communication Settings > TCP/IP Settings > **Use DCHP**.
- Press  to toggle and set DHCP on or off.



## IP Address






The IP Address screen is used to edit the IP address.

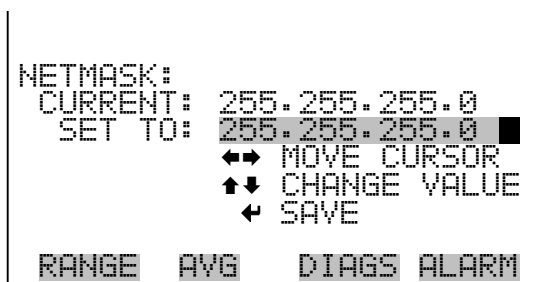
- In the Main Menu, choose Instrument Controls > Communication Settings > TCP/IP Settings > **IP Address**.
- Use , ,  and  to move and change the value of the IP address.
- Press  to save the new address.








## Netmask

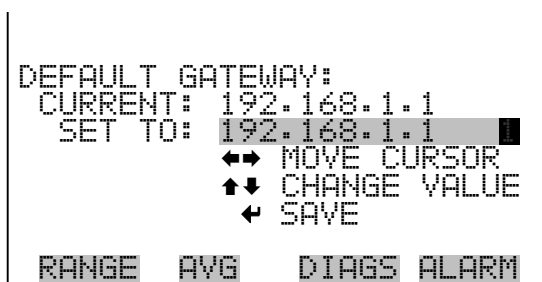
The Netmask screen is used to edit the netmask address.

- In the Main Menu, choose Instrument Controls > Communication Settings > TCP/IP Settings > **Netmask**.
- Use , ,  and  to move and change the value of the netmask.
- Press  to save the new address.








**Gateway** The Gateway screen is used to edit the gateway address.

- In the Main Menu, choose Instrument Controls > Communication Settings > TCP/IP Settings > **Gateway**.
- Use , ,  and  to move and change the value of the gateway address.
- Press  to save the new address.



**Host Name** The host name screen is used to edit the host name. When DHCP is enabled, this name is reported to the DHCP server.

- In the Main Menu, choose Instrument Controls > Communication Settings > TCP/IP Settings > **Host Name**.
- Use , ,  and  to move the cursor or change between the edit field and the alpha page.
- Press  to save the new letter in the alpha table or save the new alpha page.

```

HOST NAME:
CURRENT:  I SERIES
          I SERIES ?
BCDEFGHIJKLMN BKSP
OPQRSTUVWXYZ  PAGE
0123456789 . / - SAVE

RANGE  AVG  DIAGS  ALARM

```

## I/O Configuration

The I/O Configuration menu deals with configuration of the analyzer's I/O system. The analog input configuration is displayed if the I/O expansion board option is installed.

- In the Main Menu, choose Instrument Controls > **I/O Configuration**.

```

I/O CONFIGURATION:
>OUTPUT RELAY SETTINGS
DIGITAL INPUT SETTINGS
ANALOG OUTPUT CONFIG
ANALOG INPUT CONFIG

RANGE  AVG  DIAGS  ALARM

```

## Output Relay Settings

The Output Relay Settings menu displays a list of the 10 analog output relays available, and allows the user to select the logic state or instrument parameter for the relay selected.

**Note** The digital outputs may take up to one second after the assigned state occurs to show up on the outputs. ▲


- In the Main Menu, choose Instrument Controls > I/O Configuration > **Output Relay Settings**.

```

OUTPUT RELAY SETTINGS:
>1  NOP      GEN ALARM
2  NOP      NONE
3  NOP      UNITS
4  NOP      CONC ALARM
5  NOP      NONE
6  NOP      NONE
7  NOP      NO MODE ↓
RANGE  AVG  DIAGS ALARM

```

**Logic State** The Logic State screen is used to change the I/O relay to either normally open or normally closed.

- Press  to toggle and set the logic state between open or closed.

```

OUTPUT RELAY SETUP:
>LOGIC STATE      OPEN
INSTRUMENT STATE
RANGE  AVG  DIAGS ALARM

```

**Instrument State** The Instrument State submenu allows the user to select the instrument state that is tied to the selected relay output. A submenu lists signal types of either alarms or non-alarm to choose from.




- In the Main Menu, choose Instrument Controls > I/O Configuration > Output Relay Settings > Select Relay > **Instrument State**.

```

CHOOSE SIGNAL TYPE:
>ALARMS
NON-ALARM
RANGE  AVG  DIAGS ALARM

```

**Alarms** The Alarms status screen allows the user to select the alarm status for the selected relay output. The selected item is shown by “<--” after it. Items displayed are determined by the options installed.

- In the Main Menu, choose Instrument Controls > I/O Configuration > Output Relay Settings > Select Relay > Instrument State > **Alarms**.
- Use  and  to scroll through a list of choices.
- Press  to save the new selection for the relay.

```

ALARM STATUS ITEMS:
>NONE
GEN ALARM                <--
NOx CONC MAX
NOx CONC MIN
INT TEMP
CHAMB TEMP
COOLER TEMP              ↓
RANGE  AVG  DIAGS  ALARM




```

```

NO2 CV TEMP
PRESSURE
FLOW
OZONE FLOW
MB STATUS
MIB STATUS
I/O BD STATUS
CONC ALARM

```

**Non-Alarm** The Non-Alarm status screen allows the user to select the non-alarm status for the selected relay output. The selected item is shown by “<--” after it. Items displayed are determined by the options installed.

- In the Main Menu, choose Instrument Controls > I/O Configuration > Output Relay Settings > Select Relay > Instrument State > **Non-Alarm**.
- Use  and  to scroll through a list of choices.
- Press  to save the new selection for the relay.



```

NON ALARM STATUS ITEMS:
>NONE
AUTORANGE (NOx)
SERVICE
UNITS
ZERO MODE
SPAN MODE
NO MODE
↓
RANGE  AVG  DIAGS  ALARM

NOX MODE
SAMPLE MODE
PURGE MODE

```

## Digital Input Settings

The Digital Input Settings menu displays a list of the 16 digital inputs available, and allows the user to select the logic state and instrument parameter for the relay selected.

**Note** The digital inputs must be asserted for at least one second for the action to be activated. ▲

- In the Main Menu, choose Instrument Controls > I/O Configuration > **Digital Input Settings**.


```

DIGITAL INPUT SETTINGS:
>1  NOP      NO MODE
2   NOP      NOX MODE
3   NOP      SET BACKGROUND
4   NOP      CAL TO LO SPAN
5   NOP      AOUTS TO ZERO
6   NOP      AOUTS TO FS
7   NOP      NONE
↓
RANGE  AVG  DIAGS  ALARM

```

## Logic State

The Logic State screen is used to change the I/O relay to either normally open or normally closed. The default state is open, which indicates that a relay connected between the digital input pin and ground is normally open and closes to trigger the digital input action. If nothing is connected to the digital input pin, the state should be left at open to prevent the action from being triggered.

- Press  to toggle and set the logic state open or closed.

```




DIGITAL INPUT SETUP:
>LOGIC STATE      OPEN
INSTRUMENT ACTION

RANGE  AVG  DIAGS  ALARM

```

### Instrument Action

The Instrument Action screen allows the user to select the instrument state that is tied to the selected digital input. The selected item is shown by “<--” after it.

- In the Main Menu, choose Instrument Controls > I/O Configuration > Digital Input Settings > Select Relay > **Instrument Action**.
- Use  and  to scroll through a list of choices.
- Press  to save the new selection for the relay.

```

CHOOSE ACTION:
>NONE
ZERO MODE
SPAN MODE
NO MODE      <--
NOX MODE
SET BACKGROUND
CAL TO LO SPAN
              ↓

RANGE  AVG  DIAGS  ALARM

AOUTS TO ZERO
AOUTS TO FS
CAL TO HI SPAN

```

### Analog Output Configuration

The Analog Output Configuration menu displays a list of the analog output channels available for configuration. Channel choices include all voltage channels, all current channels, voltage channels 1-6, and current channels 1-6 (if the I/O expansion board option is installed). Configuration choices include selecting range, setting minimum/maximum values, and choosing signal to output.

- In the Main Menu, choose Instrument Controls > I/O Configuration > **Analog Output Config.**

```




OUTPUT CHANNELS:
>ALL VOLTAGE CHANNELS
  ALL CURRENT CHANNELS
  VOLTAGE CHANNEL 1
  VOLTAGE CHANNEL 2
  VOLTAGE CHANNEL 3
  VOLTAGE CHANNEL 4
  VOLTAGE CHANNEL 5
                                     ↓
  RANGE  AVG  DIAGS  ALARM
  
```

```

ANALOG OUTPUT CONFIG:
>SELECT RANGE
  SET MINIMUM VALUE
  SET MAXIMUM VALUE
  CHOOSE SIGNAL TO OUTPUT
                                     ↓
  RANGE  AVG  DIAGS  ALARM
  
```

### Select Output Range

The Select Output Range screen is used to select the hardware range for the selected analog output channel. Possible ranges for the voltage outputs are: 0-100 mV, 0-1, 0-5, 0-10 V.




- In the Main Menu, choose Instrument Controls > I/O Configuration > Analog Output Config > Select Channel > **Select Range.**
- Use  and  to move the cursor up and down.
- Press  to save the new range.

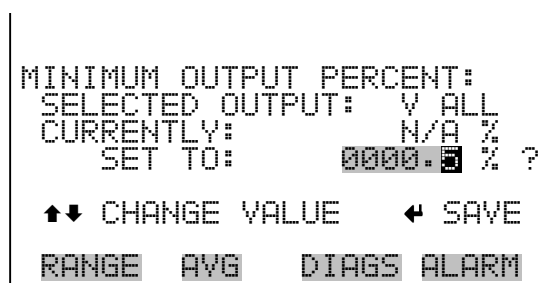
```

SELECT OUTPUT RANGE:
SELECTED OUTPUT:      V ALL
CURRENTLY:            0-10V
SET TO:               0-5V  ?
  ↑↓ CHANGE VALUE    ← SAVE
  RANGE  AVG  DIAGS  ALARM
  
```

## Minimum and Maximum Value

The Minimum Value screen is used to edit the zero (0) to full-scale (100) value in percentages for the selected analog output channel. See Table 3-7 for a list of choices. The minimum and maximum output value screens function the same way. The example below shows the set minimum value screen.

- In the Main Menu, choose Instrument Controls > IO Configuration > Analog Output Config > Select Channel > **Set Minimum** or **Maximum Value**.
- Use  and  to increment or decrement the numeric value.
- Press  to validate and save the new minimum value.






**Table 3-7.** Analog Output Zero to Full-Scale Table

Output	Zero % Value	Full-Scale 100% Value
NO <sub>x</sub>	Zero (0)	Range Setting
LO NO <sub>x</sub>	Zero (0)	Range Setting
HI NO <sub>x</sub>	Zero (0)	Range Setting
Range (NO <sub>x</sub> )	Recommend not to change the setting for this output	
Internal Temp	User-set alarm min value	User-set alarm max value
Chamber Temp	User-set alarm min value	User-set alarm max value
Cooler Temp	User-set alarm min value	User-set alarm max value
NO <sub>2</sub> Converter Temp	User-set alarm min value	User-set alarm max value
Chamber Pressure	User-set alarm min value	User-set alarm max value
Flow	User-set alarm min value	User-set alarm max value
PMT Volts	700 volts	1100 volts
Everything Else	0 units	10 units

## Choose Signal to Output

The Choose Signal to Output screen displays a submenu list of the analog output signal group choices. Group choices are Concentrations, Other Measurements, and Analog Inputs (if the I/O expansion board option is installed). This allows the user to select the output signal to the selected output channel. The Concentrations screen is shown below. See Table 3-8 below for a list of items for each signal group choice.

- In the Main Menu, choose Instrument Controls > I/O Configuration > Analog Output Config > Select Channel > **Choose Signal To Output**.
- Use  and  to move the cursor up and down.
- Press  to select a choice.

```

CHOOSE SIGNAL -      CONC
SELECTED OUTPUT:    V1
CURRENTLY: NONE
SET TO: NONE        ?

↑↓ CHANGE VALUE    ← SAVE

RANGE  AVG  DIAGS  ALARM

```

**Table 3-8.** Signal Type Group Choices

Concentrations	Other Measurements	Analog Inputs
None	None	None
NO <sub>x</sub> (single/auto range mode)	Internal Temp	Analog Input 1
LO NO <sub>x</sub> (dual mode)	Chamber Temp	Analog Input 2
HI NO <sub>x</sub> (dual mode)	Cooler Temp	Analog Input 3
Range (NO <sub>x</sub> ) (auto range mode)	NO <sub>2</sub> Converter Temp	Analog Input 4
	Chamber Pressure	Analog Input 5
	Flow	Analog Input 6
	PMT Volts	Analog Input 7
		Analog Input 8

## Analog Input Configuration


The Analog Input Configuration menu displays a list of the 8 analog input channels available for configuration. This screen is displayed if the I/O expansion board option is installed. Configuration includes entering descriptor, units, decimal places, choice of 1-10 points in the table, and corresponding number of points selected.

- In the Main Menu, choose Instrument Controls > I/O Configuration > **Analog Input Config.**

```
ANALOG INPUT CONFIG:
>CHANNEL 1          IN1
CHANNEL 2          IN2
CHANNEL 3          IN3
CHANNEL 4          IN4
CHANNEL 5          IN5
CHANNEL 6          IN6
CHANNEL 7          IN7↓
RANGE  AVG  DIAGS  ALARM
```

```
ANALOG INPUT 01 CONFIG:
>DESCRIPTOR          IN1
UNITS                V
DECIMAL PLACES       2
TABLE POINTS         2
POINT 1
POINT 2
RANGE  AVG  DIAGS  ALARM
```


**Descriptor** The Descriptor screen allows the user to enter the descriptor for the selected analog input channel. The descriptor is used in datalogging and streaming data to report what data is being sent out. The descriptor may be from 1 to 3 characters in length, and defaults to IN1 to IN8 (user input channel number).

- In the Main Menu, choose Instrument Controls > I/O Configuration > Analog Input Config > Select Channel > **Descriptor**.
- Press  to save the new descriptor.

```

ANALOG INPUT DESCRIPTOR:
CURRENTLY: IN1
          IN1
          ABCDEFGHIJKLMN BKSP
          OPQRSTUVWXYZ  PAGE
          0123456789 ./-  SAVE
          RANGE  AVG   DIAGS ALARM
  
```

**Units** The Units screen allows the user to enter the units for the selected analog input channel. The units are displayed on the diagnostic screen and in datalogging and streaming data. The units may be from 1 to 3 characters in length, and defaults to V (volts).




- In the Main Menu, choose Instrument Controls > I/O Configuration > Analog Input Config > Select Channel > **Units**.
- Press  to save the new value.

```

ANALOG INPUT UNITS:
CURRENTLY: V
          V
          ABCDEFGHIJKLMN BKSP
          OPQRSTUVWXYZ  PAGE
          0123456789 ./-  SAVE
          RANGE  AVG   DIAGS ALARM
  
```




**Decimal Places**

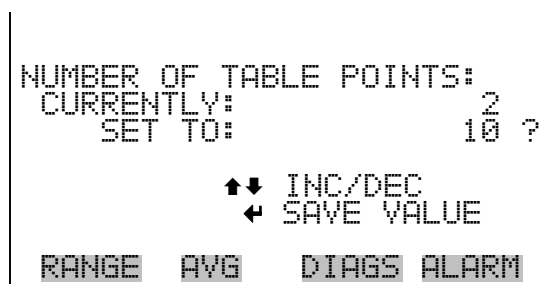
The Decimal Places screen allows the user to select how many digits are displayed to the right of the decimal, from 0 to 6, with a default of 2.

- In the Main Menu, choose Instrument Controls > I/O Configuration > Analog Input Config > Select Channel > **Decimal Places**.
- Use  and  to increment or decrement the value.
- Press  to save the new value.

**Number of Table Points**

The Number of Table Points screen allows the user to select how many points are used in the conversion table. The points range from 2 to 10, with a default of 2.

- In the Main Menu, choose Instrument Controls > I/O Configuration > Analog Input Config > Select Channel > **Table Points**.
- Use  and  to move the cursor up and down.
- Press  to save the new value.








**Table Point** The Table Point submenu allows the user to set up an individual table point.

- In the Main Menu, choose Instrument Controls > I/O Configuration > Analog Input Config > Select Channel > **Point 1-10**.

```
TABLE POINT 01 CONFIG:
>VOLTS          0.00
USER VALUE      0.00

RANGE  AVG  DIAGS  ALARM
```

**Volts** The Volts screen allows the user to set the input voltage for the selected table point in the conversion table from 0.00 to 10.50. The default table is a two-point table with point 1: 0.00 V = 000.0 U and point 2: 10.00 V = 10.0 U.

- In the Main Menu, choose Instrument Controls > I/O Configuration > Analog Input Config > Select Channel > Select Point > **Volts**.
- Use  and  to move the cursor up and down.
- Press  to save the new value.




```
TABLE POINT 01 VOLTS:
CURRENTLY:      0.00
SET TO:         00.00

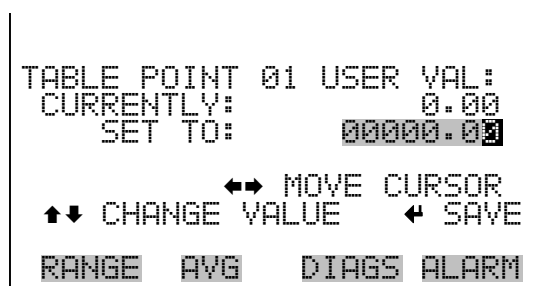
↔ MOVE CURSOR
↑↓ CHANGE VALUE ← SAVE

RANGE  AVG  DIAGS  ALARM
```

## User Value

The User Value screen allows the user to set the output value for the corresponding input voltage for the selected table point in the conversion table from -9999999 to 99999999. The default table is a two-point table with point 1: 0.00 V = 000.0 U and point 2: 10.00 V = 10.0 U.


- In the Main Menu, choose Instrument Controls > I/O Configuration > Analog Input Config > Select Table Point > **User Value**.
- Use  and  to move the cursor up and down.
- Press  to save the new value.



## Temperature Compensation

Temperature compensation 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. This compensation can be used for special applications, or when operating the instrument outside the recommended temperature range, even though the Model 42i NO<sub>x</sub> does not require temperature compensation for EPA equivalency.

When temperature compensation is on, the display shows the current internal instrument temperature (measured by a thermistor on the Interface board). When temperature compensation is off, the display shows the factory standard temperature of 30 °C.

- In the Main Menu, choose Instrument Controls > **Temperature Compensation**.
- Press  to toggle and set the temperature compensation on or off.

```

TEMPERATURE COMPENSATION:
COMP TEMP:      30.0 °C
CURRENTLY:      OFF
SET TO:         ON ?

      ← TOGGLE VALUE


RANGE  AVG  DIAGS  ALARM

```

## Pressure Compensation

Pressure compensation provides compensation for any changes to the instrument's output signal due to reaction chamber pressure variations. The effects of reaction chamber pressure changes on the analyzer's subsystems and output have been empirically determined. This empirical data is used to compensate for any change in reaction chamber pressure. This compensation can be used even though the Model 42i NO<sub>x</sub> does not require pressure compensation for EPA equivalency.

When pressure compensation is on, the first line of the display represents the current pressure in the reaction chamber. When pressure compensation is off, the first line of the display shows the factory standard pressure of 150 mmHg.

- In the Main Menu, choose Instrument Controls > **Pressure Compensation**.
- Press  to toggle and set the pressure compensation on or off.

```

PRESSURE COMPENSATION:
COMP PRES:      150.0 mmHg
CURRENTLY:      OFF
SET TO:         ON ?




      ← TOGGLE VALUE

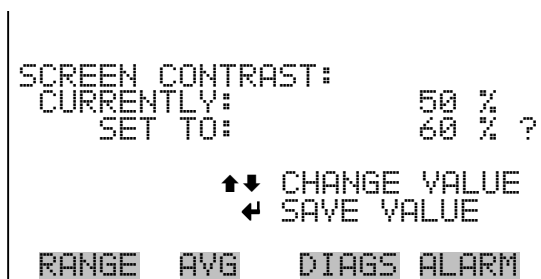
RANGE  AVG  DIAGS  ALARM

```

## Screen Contrast

The Screen Contrast screen is used to change the contrast of the display. Intensities between 0 and 100% in increments of 10 are available. Changing the screen contrast may be necessary if the instrument is operated at extreme temperatures.

- In the Main Menu, choose Instrument Controls > **Screen Contrast**.
- Use  and  to increment or decrement the screen contrast.
- Press  to accept a change.



```
SCREEN CONTRAST:
CURRENTLY:      50 %
SET TO:         60 % ?


      ↑↓ CHANGE VALUE
      ← SAVE VALUE

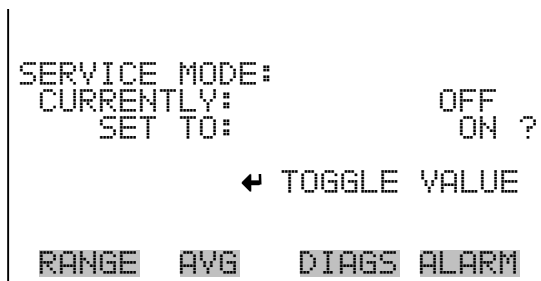
RANGE  AVG  DIAGS  ALARM
```

## Service Mode

The Service Mode screen is used to turn the service mode on or off. The service mode locks out any remote actions and includes parameters and functions that are useful when making adjustments or diagnosing the Model 42i NO<sub>x</sub>. For more information about the service mode, see “Service Menu” later in this chapter.

**Note** The service mode should be turned off when finished, as it prevents remote operation. ▲

- In the Main Menu, choose Instrument Controls > **Service Mode**.
- Press  to toggle and set the service mode on or off.








```
SERVICE MODE:
CURRENTLY:      OFF
SET TO:         ON ?

      ← TOGGLE VALUE

RANGE  AVG  DIAGS  ALARM
```

## Date/Time

The Date/Time screen and allows the user to view and change the system date and time (24-hour format). The internal clock is powered by its own battery when instrument power is off.

- In the Main Menu, choose Instrument Controls > **Date/Time**.
- Use , ,  and  to move and change the value of the date and time.
- Press  to edit and save the new date and time.

```

DATE AND TIME:
19 MAR 2005 12:34:56
PRESS ← TO EDIT

RANGE  AVG  DIAGS  ALARM
  
```

```

DATE AND TIME:
19 MAR 2005 12:34:56  ?
SETTING: DAYS
    → SET MONTHS
    ↑↓ CHANGE VALUE
    ← SAVE VALUE

RANGE  AVG  DIAGS  ALARM
  
```

## Diagnostics Menu

The Diagnostics menu provides access to diagnostic information and functions. This menu is useful when troubleshooting the instrument. The analog input readings and analog input voltages are displayed if the I/O expansion board option is installed.

- In the Main Menu, choose **Diagnostics**.

```

DIAGNOSTICS:
>PROGRAM VERSION
VOLTAGES
TEMPERATURES
PRESSURE
FLOW
ANALOG INPUT READINGS
ANALOG INPUT VOLTAGES  ↓

RANGE  AVG  DIAGS  ALARM
  
```

```

DIGITAL INPUTS
RELAY STATES
TEST ANALOG OUTPUTS
INSTRUMENT CONFIGURATION
CONTACT INFORMATION
  
```

## Program Version

The Program Version screen (read only) shows the version number of the program installed. Prior to contacting the factory with any questions regarding the instrument, please note the program version number.

- In the Main Menu, choose Diagnostics > **Program Version**.

```
PROGRAM VERSION:
PRODUCT:  MODEL 42iD
VERSION:  01.00.01.074

RANGE  AVG  DIAGS  ALARM
```

## Voltages

The Voltages menu displays the current diagnostic voltage readings. This screen enables the power supply to be quickly read for low or fluctuating voltages without having to use a voltage meter. The I/O board is displayed if the I/O expansion board option is installed.

- In the Main Menu, choose Diagnostics > **Voltages**.

```
VOLTAGES:
>MOTHERBOARD
INTERFACE BOARD
I/O BOARD

RANGE  AVG  DIAGS  ALARM
```

## Motherboard Voltages

The Motherboard screen (read only) is used to display the current voltage readings on the motherboard.

- In the Main Menu, choose Diagnostics > Voltages > **Motherboard Voltages**.

MOTHERBOARD VOLTAGES:			
3.3	SUPPLY	3.3	V
5.0	SUPPLY	5.0	V
15.0	SUPPLY	15.0	V
24.0	SUPPLY	24.0	V
-3.3	SUPPLY	-3.3	V
<div> <div>RANGE</div> <div>AVG</div> <div>DIAGS</div> <div>ALARM</div> </div>			

### Interface Board Voltages

The Interface Board screen (read only) is used to display the current voltage readings on the interface board.

- In the Main Menu, choose Diagnostics > Voltages > **Interface Board Voltages**.

INTERFACE BOARD VOLTAGES:			
PMT	SUPPLY	785.5	V
3.3	SUPPLY	3.3	V
5.0	SUPPLY	5.0	V
15.0	SUPPLY	15.0	V
P15.0	SUPPLY	15.0	V
24.0	SUPPLY	24.0	V
-15.0	SUPPLY	-15.0	V
<div> <div>RANGE</div> <div>AVG</div> <div>DIAGS</div> <div>ALARM</div> </div>			

### I/O Board Voltages

The I/O Board screen (read only) is used to display the current voltage readings on the I/O expansion board. This screen is displayed if the I/O expansion board option is installed.

- In the Main Menu, choose Diagnostics > Voltages > **I/O Board Voltages**.

I/O BOARD VOLTAGES:			
3.3	SUPPLY	3.3	V
5.0	SUPPLY	5.0	V
15.0	SUPPLY	15.0	V
24.0	SUPPLY	24.0	V
-3.0	SUPPLY	-3.0	V
<div> <div>RANGE</div> <div>AVG</div> <div>DIAGS</div> <div>ALARM</div> </div>			

## Temperatures

The Temperatures screen (read only) displays the internal temperature, reaction chamber temperature, cooler temperature, and converter temperatures. The internal temperature is the air temperature measured by a sensor located on the interface board.

- In the Main Menu, choose Diagnostics > **Temperatures**.

```
TEMPERATURES:
> INTERNAL      28.6 °C
CHAMBER        49.0 °C
COOLER        -2.8 °C
NO2 CONVERTER  320.7 °C
NO2 CONV SET   325.0 °C

RANGE  AVG  DIAGS  ALARM
```

## Pressure

The Pressure screen (read only) displays the reaction chamber pressure. The pressure is measured by a pressure transducer at the reaction chamber.

- In the Main Menu, choose Diagnostics > **Pressure**.

```
CHAMBER PRES:  232.5 mmHg

RANGE  AVG  DIAGS  ALARM
```

## Flow

The Flow screen (read only) displays the sample and ozonator flow rate. The flows are measured by internal flow sensors. For more information, see Chapter 1, “Introduction”.

- In the Main Menu, choose Diagnostics > **Flow**.



```

FLOW:                0.700 LPM
OZONATOR FLOW        OK

RANGE  AVG  DIAGS  ALARM

```

## Analog Input Readings

The Analog Input Readings screen (read only) displays the 8 current user-scaled analog readings (if the I/O expansion board option is installed).

- In the Main Menu, choose Diagnostics > **Analog Input Readings**.

```

ANALOG INPUT READINGS:
>CO                10.2 PPM
SO2                18.2 PPB
CO2                250 PPM
FL1                20.42 LPM
WND                9.86 V
FL2                1.865 LPM
IO7                0.0 V↓

RANGE  AVG  DIAGS  ALARM

```

## Analog Input Voltages

The Analog Input Voltages screen (read only) displays the 8 raw analog voltage readings (if the I/O expansion board option is installed).

- In the Main Menu, choose Diagnostics > **Analog Input Voltages**.

```

ANALOG INPUT VOLTAGES:
>ANALOG IN 1        6.24 V
ANALOG IN 2         4.28 V
ANALOG IN 3         0.00 V
ANALOG IN 4         0.00 V
ANALOG IN 5         0.00 V
ANALOG IN 6         0.00 V
ANALOG IN 7         0.00 V↓

RANGE  AVG  DIAGS  ALARM

```

## Digital Inputs

The Digital Inputs screen (read only) displays the state of the 16 digital inputs.

- In the Main Menu, choose Diagnostics > **Digital Inputs**.

```
DIGITAL INPUTS:
>INPUT 1      1
INPUT 2      1
INPUT 3      1
INPUT 4      1
INPUT 5      1
INPUT 6      1
INPUT 7      1
              ↓
RANGE  AVG  DIAGS  ALARM
```

## Relay States

The Relay States screen displays the state of the 10 digital outputs and allows toggling of the state to either on (1) or off (0). The relays are restored to their original states upon exiting this screen.

- In the Main Menu, choose Diagnostics > **Relay States**.

```
RELAY STATE:
>OUTPUT 1      0
OUTPUT 2      0
OUTPUT 3      0
OUTPUT 4      1
OUTPUT 5      0
OUTPUT 6      0
OUTPUT 7      0
              ↓
RANGE  AVG  DIAGS  ALARM
```

## Test Analog Outputs

The Test Analog Outputs menu contains a number of digital to analog converter (DAC) calibration items. Channel choices include all analog outputs, 6 voltage channels, and 6 current channels (if the I/O expansion board option is installed).

- In the Main Menu, choose Diagnostics > **Test Analog Outputs**.




```

TEST ANALOG OUTPUTS:
>ALL
VOLTAGE CHANNEL 1
VOLTAGE CHANNEL 2
VOLTAGE CHANNEL 3
VOLTAGE CHANNEL 4
VOLTAGE CHANNEL 5
VOLTAGE CHANNEL 6
↓
RANGE  AVG  DIAGS  ALARM

```

### Set Analog Outputs

The Set Analog Outputs screen contains three choices: Set to full-scale, set to zero, or reset to normal. Full-scale sets the analog outputs to the full-scale voltage, zero sets the analog outputs to 0 volts, and normal operation. The example below shows the selected output state “ALL” is set to normal.

- In the Main Menu, choose Diagnostics > Test Analog Outputs > **ALL**, **Voltage Channel 1-6**, or **Current Channel 1-6**.
- Use  and  to move the cursor up and down.
- Press  to select a choice.


```


SET ANALOG OUTPUTS:
SETTING:                ALL
OUTPUT SET TO:         NORMAL
↑ SET TO FULL SCALE
↓ SET TO ZERO
← RESET TO NORMAL
RANGE  AVG  DIAGS  ALARM

```

## Instrument Configuration

The Instrument Configuration screen displays information on the hardware configuration of the instrument.

**Note** If the analyzer is in service mode, pressing  on the item will toggle it yes or no. ▲

- In the Main Menu, choose Diagnostics > **Instrument Configuration**.
- Press  to toggle instrument configuration (in service mode only).

```
INSTRUMENT CONFIGURATION:
>I/O EXPANSION BOARD  YES
ZERO SPAN VALVES      YES
LAG VOLUME             NO
PERM DRYER             NO
CONVERTER              MOLY
DILUTION               NO
AUTO CALIBRATION       NO

RANGE  AVG  DIAGS  ALARM
```

## Contact Information

The Contact Information screen displays the customer service information.


- In the Main Menu, choose Diagnostics > **Contact Information**.

```
CONTACT INFORMATION:
CALL CENTER: 508-520-0430
WEB:        WWW.THERMO.COM

RANGE  AVG  DIAGS  ALARM
```

## Alarms Menu

The alarms menu displays a list of items that are monitored by the analyzer. If the item being monitored goes outside the lower or upper limit, the status of that item will go from “OK” to either “LOW” or “HIGH”, respectively. If the alarm is not a level alarm, the status will go from “OK” to “FAIL”. The number of alarms detected is displayed to indicate how many alarms have occurred. If no alarms are detected, the number zero is displayed.

To see the actual reading of an item and its minimum and maximum limits, move the cursor to the item and press .

The zero/span check and auto calibration screens are displayed if the zero/span check or auto calibration options are enabled. The motherboard status, interface board status, and I/O expansion board status (if installed) indicates that the power supplies are working and connections are successful. There are no setting screens for these alarms.

- In the Main Menu, choose **Alarms**.

```

ALARMS:
ALARMS DETECTED          0
>INTERNAL TEMP           OK
CHAMBER TEMP             OK
COOLER TEMP              OK
CONVERTER TEMP           OK
PRESSURE                 OK
FLOW                    OK↓
RANGE  AVG  DIAGS  ALARM

OZONATOR FLOW            OK
ZERO CHECK               OK
SPAN CHECK               OK
ZERO AUTOCAL             OK
SPAN AUTOCAL             OK
NOx CONCENTRATION        OK
MOTHERBOARD STATUS       OK
INTERFACE STATUS         OK
I/O EXP STATUS           OK
  
```

## Internal Temperature

The Internal Temperature screen displays the current internal temperature and sets the minimum and maximum alarm limits. Acceptable alarm limits range from 8 to 47 °C. If the internal temperature reading goes beyond either the minimum or maximum alarm limit, an alarm is activated. The word “ALARM” appears in the Run screen and in the Main Menu.




- In the Main Menu, choose Alarms > **Internal Temp.**

```
INTERNAL TEMPERATURE:
  ACTUAL                28.6 °C
>MIN                   15.0 °C
  MAX                   45.0 °C

RANGE  AVG  DIAGS  ALARM
```

### Min and Max Internal Temperature Limits

The Minimum Internal Temperature alarm limit screen is used to change the minimum internal temperature alarm limit. The minimum and maximum internal temperature screens function the same way.

- In the Main Menu, choose Alarms > Internal Temp > **Min** or **Max**.
- Use  and  to increment or decrement the numeric value.
- Press  to save set to value as actual value.

```
INTERNAL TEMPERATURE:
  ACTUAL MIN:           15.0 °C
  SET MIN TO:           16.0 °C ?

      ↑↓ INC/DEC
      ← SAVE VALUE

RANGE  AVG  DIAGS  ALARM
```

## Chamber Temperature

The Chamber Temperature screen displays the current chamber temperature and sets the minimum and maximum alarm limits. Acceptable alarm limits range from 47 to 51 °C. If the chamber temperature reading goes beyond either the minimum or maximum limit, an alarm is activated. The word “ALARM” appears in the Run screen and in the Main Menu.

- In the Main Menu, choose Alarms > **Chamber Temp.**




```

CHAMBER TEMPERATURE:
  ACTUAL                49.0 °C
>MIN                   47.0 °C
MAX                    51.0 °C

RANGE  AVG  DIAGS  ALARM
  
```

## Min and Max Chamber Temperature Limits

The Minimum Chamber Temperature alarm limit screen is used to change the minimum chamber temperature alarm limit. The minimum and maximum internal temperature screens function the same way.

- In the Main Menu, choose Alarms > Chamber Temp > **Min** or **Max**.
- Use  and  to increment or decrement the numeric value.
- Press  to save set to value as actual value.

```

CHAMBER TEMPERATURE:
  ACTUAL MIN:          47.0 °C
  SET MIN TO:         48.0 °C ?

    ↑↓ INC/DEC
    ← SAVE VALUE

RANGE  AVG  DIAGS  ALARM
  
```

## Cooler Temperature

The Cooler Temperature screen displays the current cooler temperature and sets the minimum and maximum alarm limits. Acceptable alarm limits range from -25 to -1 °C. If the cooler temperature reading goes beyond either the minimum or maximum limit, an alarm is activated. The word “ALARM” appears in the Run screen and in the Main Menu.




- In the Main Menu, choose Alarms > **Cooler Temp.**

```
COOLER TEMPERATURE:
  ACTUAL                -2.8 °C
>MIN                   -10.0 °C
  MAX                   -1.0 °C

RANGE  AVG  DIAGS  ALARM
```

### Min and Max Cooler Temperature Limits

The Minimum Cooler Temperature alarm limit screen is used to change the minimum cooler temperature alarm limit. The minimum and maximum cooler temperature screens function the same way.

- In the Main Menu, choose Alarms > Cooler Temp > **Min** or **Max**.
- Use  and  to increment or decrement the numeric value.
- Press  to save set to value as actual value.

```
COOLER TEMPERATURE:
  ACTUAL MIN:          -10.0 °C
  SET MIN TO:          -9.0 °C ?

      ↑↓ INC/DEC
      ← SAVE VALUE

RANGE  AVG  DIAGS  ALARM
```



## Converter Temperature

The Converter Temperature screen displays the current converter temperature and sets the minimum and maximum alarm limits. Acceptable alarm limits range from 300 to 700 °C. The actual alarm setpoints should be set for the installed converter. If the converter temperature reading goes beyond either the minimum or maximum limit, an alarm is activated. The word “ALARM” appears in the Run screen and in the Main Menu.

- In the Main Menu, choose Alarms > **Converter Temp**.

```




CONVERTER TEMPERATURE:
  ACTUAL                320.7 °C
>MIN                   300.0 °C
  MAX                   350.0 °C

RANGE  AVG  DIAGS  ALARM
  
```

## Min and Max Converter Temperature Limits

The Minimum Converter Temperature alarm limit screen is used to change the minimum converter temperature alarm limit. The minimum and maximum converter temperature screens function the same way.

**Note** The ozonator will not turn on if the converter is below alarm limit. ▲

- In the Main Menu, choose Alarms > Converter Temp > **Min** or **Max**.
- Use  and  to increment or decrement the numeric value.
- Press  to save set to value as actual value.

```

CONVERTER TEMPERATURE:
  ACTUAL MIN:          300.0 °C
  SET MIN TO:          310.0 °C ?

      ↑↓ INC/DEC
      ← SAVE VALUE

RANGE  AVG  DIAGS  ALARM
  
```

## Pressure

The Pressure screen displays the current reaction chamber pressure reading and sets the minimum and maximum alarm limits. Acceptable alarm limits range from 50 to 300 mmHg. If the pressure reading goes beyond either the minimum or maximum limit, an alarm is activated. The word “ALARM” appears in the Run screen and in the Main Menu.




- In the Main Menu, choose Alarms > **Pressure**.

```
PRESSURE:
  ACTUAL      232.5 mmHg
>MIN         150.0 mmHg
  MAX         300.0 mmHg

RANGE  AVG  DIAGS  ALARM
```

### Min and Max Pressure Limits

The Minimum Pressure alarm limit screen is used to change the minimum pressure alarm limit. The minimum and maximum pressure screens function the same way.

- In the Main Menu, choose Alarms > Pressure > **Min** or **Max**.
- Use  and  to increment or decrement the numeric value.
- Press  to save set to value as actual value.

```
PRESSURE:
  ACTUAL MIN:  150.0 mmHg
  SET MIN TO:  160.0 mmHg?

      ↑↓ INC/DEC
      ← SAVE VALUE

RANGE  AVG  DIAGS  ALARM
```

## Flow

The Flow screen displays the current sample flow reading and sets the minimum and maximum alarm limits. Acceptable alarm limits range from 0 to 1 LPM. If the sample flow reading goes beyond either the minimum or maximum limit, an alarm is activated. The word “ALARM” appears in the Run screen and in the Main Menu.

- In the Main Menu, choose Alarms > **Flow**.




```

FLOW:
  ACTUAL          0.531 LPM
>MIN             0.350 LPM
MAX              0.900 LPM

RANGE  AVG  DIAGS  ALARM
  
```

## Min and Max Flow Limits

The Minimum Flow alarm limit screen is used to change the minimum sample flow alarm limit. The minimum and maximum sample flow screens function the same way.

- In the Main Menu, choose Alarms > Flow > **Min** or **Max**.
- Use  and  to increment or decrement the numeric value.
- Press  to save set to value as actual value.

```

FLOW:
  ACTUAL MIN:    0.350 LPM
  SET MIN TO:   0.360 LPM ?

      ↑↓ INC/DEC
      ← SAVE VALUE

RANGE  AVG  DIAGS  ALARM
  
```

## Ozonator Flow

The Ozonator Flow screen (read only) is used to display the ozonator flow readings. If the ozonator flow reading is 0.050 LPM (50 cc) or below, an alarm is activated, and an alarm condition screen appears as “LOW”. If the ozonator flow is above 0.050 LPM, the no alarm condition screen is

displayed, indicating that the flow is acceptable. Inadequate ozonator flow will cause the ozonator to overheat, resulting in permanent damage to the ozonator.

- In the Main Menu, choose Alarms > **Ozonator Flow**.

```
OZONATOR FLOW:
ACTUAL          > 0.050 LPM

RANGE  AVG  DIAGS  ALARM
```

## Zero and Span Check

The Zero Span Check screen allows the user to view the status of the most recent zero check and set the maximum zero check offset. The zero and span check screens are displayed if the zero/span check option is enabled and function the same way.




- In the Main Menu, choose Alarms > **Zero** or **Span Check**.

```
ZERO CHECK:
ALARM:      OK
RESPONSE:   0.00
>MAX OFFSET: 10.00

RANGE  AVG  DIAGS  ALARM
```

## Max Zero and Span Offset

The Max Zero Check Offset screen is used to change the maximum zero check offset. The maximum zero and span offset screens function the same way.

- In the Main Menu, choose Alarms > Zero or Span Check > **Max Offset**.
- Use  and  to increment or decrement the numeric value.
- Press  to save set to value as actual value.

```

MAX ZERO CHECK OFFSET:
CURRENTLY:      10.00
SET TO:        11.00 ?

      ↑↓ CHANGE VALUE
      ← SAVE VALUE

RANGE  AVG  DIAGS  ALARM

```

## Zero and Span Auto Calibration

The Zero Auto Calibration screen (read only) allow the user to view the status of the most recent auto background calibration. The zero and span auto calibration screens are displayed if the auto calibration option is installed and function the same way.

- In the Main Menu, choose Alarms > **Zero** or **Span Autocal**.

```

ZERO AUTO CALIBRATION:
  ALARM:      OK
  RESPONSE:   5.00

RANGE  AVG  DIAGS  ALARM

```

## NO<sub>x</sub> Concentration

The NO<sub>x</sub> Concentration screen displays the current NO<sub>x</sub> concentration and sets the minimum and maximum alarm limits. Acceptable alarm limits range from 0 to 100,000 ppb (0 to 100 ppm) and 0 to 150,000 µg/m<sup>3</sup> (0 to 150 mg/m<sup>3</sup>). The minimum alarm may be programmed as a floor trigger (alarm is triggered when the concentration falls below the minimum value) or a ceiling trigger (alarm is triggered when the concentration goes above the minimum value). If the NO<sub>x</sub> concentration goes beyond either the minimum or maximum limit, an alarm is activated. The word “ALARM” appears in the Run screen and in the Main Menu.

- In the Main Menu, choose Alarms > **NO<sub>x</sub> Concentration**.




```

NOx CONCENTRATION:
  ACTUAL          88.2
>MIN              0
  MAX            100000
  MIN TRIGGER     CEILING

  RANGE  AVG  DIAGS  ALARM
  
```

### Min and Max NO<sub>x</sub> Concentration Limits

The Minimum NO<sub>x</sub> Concentration alarm limit screen is used to change the minimum NO<sub>x</sub> concentration alarm limit. The minimum and maximum NO<sub>x</sub> concentration alarm limit screens function the same way.

- In the Main Menu, choose Alarms > Select Concentration > **Min** or **Max**.
- Use  and  to increment or decrement the numeric value.
- Press  to save set to value as actual value.

```


NOx CONCENTRATION:
  ACTUAL MIN:      0
  SET MIN TO:      00000000 ?

  ↔ MOVE CURSOR
  ↑↓ INC/DEC      ← SAVE VALUE

  RANGE  AVG  DIAGS  ALARM
  
```

### Min Trigger

The Minimum Trigger screen allows the user to view and set the NO<sub>x</sub> concentration low alarm trigger type to either floor or ceiling. The minimum alarm may be programmed as a floor trigger (alarm is triggered when the concentration falls below the minimum value) or a ceiling trigger (alarm is triggered when the concentration goes above the minimum value).

- In the Main Menu, choose Alarms > Select Concentration > **MinTrigger**.
- Press  to toggle and set to floor or ceiling.

```

MIN TRIG<CEILING/FLOOR>:
ACTUAL TRIGGER: CEILING
SET TRIGGER TO: FLOOR ?


← TOGGLE AND SAVE VALUE

RANGE  AVG  DIAGS  ALARM

```

## Service Menu

The Service menu appears only when the instrument is in the service mode. To put the instrument into service mode:

- In the Main Menu, choose Instrument Controls > **Service Mode**.
- Press  to toggle and set the service mode on.

Advanced diagnostic functions are included in the service mode. Meaningful data should not be collected when the instrument is in the service mode.

- In the Main Menu, choose **Service**.

```

SERVICE:
>PMT VOLTAGE ADJUSTMENT
  RANGE MODE SELECT
  CONVERTER SET TEMP
  PRESSURE CALIBRATION
  FLOW CALIBRATION
  INPUT BOARD CALIBRATION
  TEMPERATURE CALIBRATION ↓

RANGE  AVG  DIAGS  ALARM

```

```

ANALOG OUT CALIBRATION
ANALOG INPUT CALIBRATION
OZONATOR SAFETY
EXTENDED RANGES
DILUTION RATIO
DISPLAY PIXEL TEST
RESTORE USER DEFAULTS




```

## PMT Voltage Adjustment

The PMT Voltage Adjustment screen is used to manually adjust the PMT supply voltage. The PMT voltage adjustment screen is visible only when the instrument is in service mode. For more information on the service mode, see “Service Mode” earlier in this chapter.



**WARNING** This adjustment should only be performed by an instrument service technician. ▲

- In the Main Menu, choose Service > **PMT Voltage Adjustment**.
- Use  and  to increment or decrement the PMT counts.
- Press  to save the new PMT voltage.




```
SET PMT VOLTAGE:
SET PMT:         750.0 V
COUNTS:        2254 ?

      ↑↓ INC/DEC
      ← SAVE VALUE

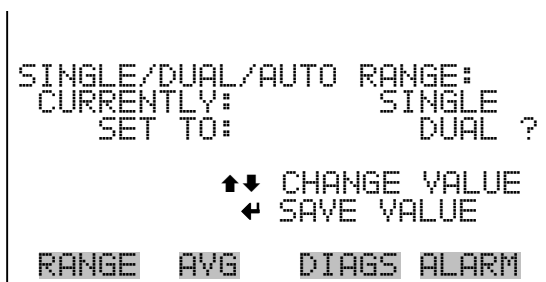
RANGE  AVG  DIAGS  ALARM
```

## Range Mode Select

The Range Mode Select screen is used to switch between the various range modes: single, dual, and auto range. The range mode select screen is visible only when the instrument is in service mode. For more information on the service mode, see “Service Mode” earlier in this chapter.

- In the Main Menu, choose Service > **Range Mode Select**.
- Use  and  to scroll through a list of choices.
- Press  to save the new range mode.








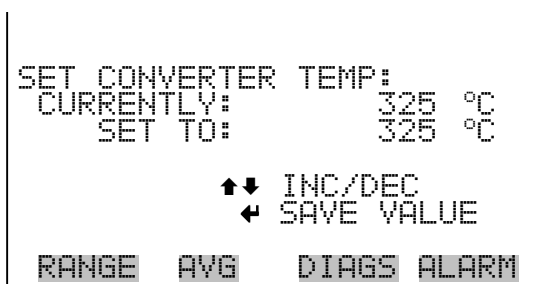
## Converter Set Temperature

The Converter Set Temperature screen is used to change the converter set temperature. The converter set temperature reading is updated every second. The converter set temperature screen is visible only when the instrument is in service mode. For more information on the service mode, see “Service Mode” earlier in this chapter.



**WARNING** This adjustment should only be performed by an instrument service technician. ▲

- In the Main Menu, choose Service > **Converter Set Temperature**.
- Use  and  to increment or decrement the numeric values.
- Press  to save the new set temperature.



## Pressure Calibration

The Pressure Calibration menu is used to calibrate the pressure sensor to zero, span, or restore factory default values. The pressure calibration menu is visible only when the instrument is in service mode. For more information on the service mode, see “Service Mode” earlier in this chapter.

The pressure sensor's zero counts and span slope are displayed on the menu.



**WARNING** This adjustment should only be performed by an instrument service technician. ▲

- In the Main Menu, choose Service > **Pressure Calibration**.


```
PRESSURE SENSOR CAL:
>ZERO              72
SPAN              1.1447
SET DEFAULTS

RANGE  AVG  DIAGS  ALARM
```

### Calibrate Pressure Zero

The Calibrate Pressure Zero screen calibrates the pressure sensor at zero pressure.

**Note** A vacuum pump must be connected to the pressure sensor before performing the zero calibration. ▲

- In the Main Menu, choose Service > Pressure Calibration > **Zero**.
- Press  to save the current pressure reading as the zero reading.

```
CALIBRATE PRESSURE ZERO:
CURRENTLY:  232.5 mmHg
SET TO:     0.0 mmHg ?






CONNECT VACUUM PUMP AND
< SAVE ZERO PRESSURE

RANGE  AVG  DIAGS  ALARM
```

### Calibrate Pressure Span

The Calibrate Pressure Span screen allows the user to view and set the pressure sensor calibration span point.

**Note** The plumbing going to the pressure sensor should be disconnected so the sensor is reading ambient pressure before performing the span calibration. The operator should use an independent barometer to measure the ambient pressure and enter the value on this screen before calibrating. ▲

- In the Main Menu, choose Service > Pressure Calibration > **Span**.
- Use , ,  and  to move and change the value.
- Press  to save set to value as actual value.

```





CALIBRATE PRESSURE SPAN:
CURRENTLY: 232.5 mmHg
SET TO: 760.0 mmHg ?

      ↔ MOVE CURSOR
↑↓ CHANGE VALUE  ← SAVE

RANGE  AVG  DIAGS  ALARM
  
```

### Restore Default Pressure Calibration

The Restore Default Pressure Calibration screen allows the user to reset the pressure calibration configuration values to factory defaults.

- In the Main Menu, choose Service > Pressure Calibration > **Set Defaults**.
- Press  to warn user and enable restore with .
- Use  to overwrite pressure sensor calibration parameters with factory default values when pressed after .

```

RESTORE DEFAULT CAL:

      ← RESTORE

RANGE  AVG  DIAGS  ALARM
  
```

```

RESTORE DEFAULT CAL:

      ← RESTORE
ARE YOU SURE YOU WANT TO?
PRESS → TO CONFIRM RESTORE

RANGE  AVG  DIAGS  ALARM
  
```

## Flow Calibration

The Flow Calibration menu is used to calibrate the flow sensor to zero, span, or restore factory default values. The flow calibration menu is visible only when the instrument is in service mode. For more information on the service mode, see “Service Mode” earlier in the chapter.



**WARNING** This adjustment should only be performed by an instrument service technician. ▲

- In the Main Menu, choose Service > **Flow Calibration**.


```
FLOW SENSOR CAL:
>ZERO                200
SPAN                1.0000
SET DEFAULTS

RANGE  AVG  DIAGS  ALARM
```

### Calibrate Flow Zero

The Calibrate Flow Zero screen calibrates the flow sensor at zero flow.

**Note** The pump must be disconnected before performing the zero calibration. ▲

- In the Main Menu, choose Service > Flow Calibration > **Zero**.
- Press  to save the current flow reading as the zero reading.

```
CALIBRATE FLOW ZERO:
CURRENTLY:    0.004 LPM
SET TO:      0.000 LPM ?






DISCONNECT PUMP AND
← SAVE ZERO PRESSURE

RANGE  AVG  DIAGS  ALARM
```

### Calibrate Flow Span

The Calibrate Flow Span screen allows the user to view and set the flow sensor calibrate span point.

**Note** An independent flow sensor is required to read the flow, then the operator enters the flow value on this screen to perform the calibration. ▲

- In the Main Menu, choose Service > Flow Calibration > **Span**.
- Use , ,  and  to move and change the value.
- Press  to save set to value as actual value.

```

CALIBRATE FLOW SPAN:
CURRENTLY:      1.000 LPM
SET TO:         0.800 LPM ?





      ↔ MOVE CURSOR
↑↓ CHANGE VALUE  ← SAVE

RANGE  AVG  DIAGS  ALARM

```

## Restore Default Flow Calibration

The Restore Default Flow Calibration screen allows the user to reset the flow calibration configuration values to factory defaults.

- In the Main Menu, choose Service > Flow Calibration > **Set Defaults**.
- Press  to warn user and enable restore with .
- Use  to overwrite pressure sensor calibration parameters with factory default values when pressed after .

```

RESTORE DEFAULT CAL:

      ← RESTORE

RANGE  AVG  DIAGS  ALARM

```

```

RESTORE DEFAULT CAL:

      ← RESTORE
ARE YOU SURE YOU WANT TO?
PRESS → TO CONFIRM RESTORE

RANGE  AVG  DIAGS  ALARM

```

## Input Board Calibration

The Input Board Calibration menu is used to initiate a calibration of the input A/D stages. The input board calibration menu is visible only when the instrument is in service mode. For more information on the service mode, see “Service Mode” on page.



**WARNING** This adjustment should only be performed by an instrument service technician. ▲

- In the Main Menu, choose Service > **Input Board Calibration**.

```
INPUT BOARD CALIBRATION:
>MANUAL INPUT CAL
  AUTOMATIC INPUT CAL
  INPUT FREQUENCY DISP

RANGE  AVG  DIAGS  ALARM
```






## Manual Input Calibration

The Manual Input Calibration screen is used to do a manual calibration of the input board A/D stages.



**WARNING** This adjustment should only be performed by an instrument service technician. ▲

**Note** The measurement system and the PMT are both shut off inside this screen. ▲

- In the Main Menu, choose Service > Input Board Calibration > **Manual Input Cal.**
- Press  to leave warning screen.
- Make a note of the frequency at gain of 1.
- Use  and  to change the gain between 10 and 100.
- Use  and  to increment or decrement the D/A counts so the frequency at gain 100 is equal to the frequency at gain 1.

- Press  to save new input board calibration.

```

INPUT BOARD CALIBRATION:
  ← TO CALIBRATE
  ** WARNING **
  THIS ACTION MAY REQUIRE
  RECALIBRATION OF THE
  ENTIRE MEASUREMENT SYSTEM!
RANGE  AVG  DIAGS  ALARM
  
```

```

GAIN 1  - MANUAL:
      FREQ = 4500
      D/A  = N/A  ?
  ↔ CHG GAIN  ← SAVE VALUES
RANGE  AVG  DIAGS  ALARM
  
```


### Automatic Input Calibration

The Automatic Input Calibration screen is used to do a automatic calibration of the input board A/D stages.



**WARNING** This adjustment should only be performed by an instrument service technician. ▲

**Note** The measurement system and the PMT are both shut off inside this screen. ▲

- In the Main Menu, choose Service > Input Board Calibration > **Automatic Input Cal.**
- Press  to leave warning screen and begin automatic calibration.

```






INPUT BOARD CALIBRATION:
  ← TO CALIBRATE
  ** WARNING **
  THIS ACTION MAY REQUIRE
  RECALIBRATION OF THE
  ENTIRE MEASUREMENT SYSTEM!
RANGE  AVG  DIAGS  ALARM
  
```

```

INPUT BOARD CALIBRATION:
  ** IN PROGRESS **
D/A    = 2047
TARGET = 0
FREQ   = 0
ZERO   = 0 CNT = 1
RANGE  AVG  DIAGS  ALARM
  
```

## Input Frequency Display

The Frequency Display screen is used to manually adjust the input board gain. This may be used as a troubleshooting tool for the input board. The gain setting and test mode are reset upon exiting this screen.

- In the Main Menu, choose Service > Input Board Calibration > **Frequency Disp.**
- Press  to leave warning screen.
- Use  and  to toggle the test signal and bypass the PMT.
- Use  and  to change the gain between 1, 10, and 100.

```
INPUT BOARD CALIBRATION:
      ← TO CALIBRATE
** WARNING **
CONCENTRATION CALCULATION
IS HALTED INSIDE
THIS SCREEN!
RANGE  AVG  DIAGS  ALARM
```






```
INPUT BOARD TEST:
GAIN = 1
TEST = OFF
FREQ = 5000
↔ CHG GAIN  ↑↓ TEST MODE
RANGE  AVG  DIAGS  ALARM
```

## Temperature Calibration

The Temperature calibration screen allows the user to view and set the ambient temperature sensor calibration. The temperature calibration screen is visible only when the instrument is in service mode. For more information on the service mode, see “Service Mode” earlier in the chapter.



**WARNING** This adjustment should only be performed by an instrument service technician. ▲

- In the Main Menu, choose Service > **Temperature Calibration.**
- Use , ,  and  to move and change the value.
- Press  to save set to value as actual value.



```

CALIBRATE AMBIENT TEMP:
CURRENTLY:      28.6 °C
SET TO:         25.0 °C ?

      ↔ MOVE CURSOR
↑↓ CHANGE VALUE  ← SAVE

RANGE  AVG  DIAGS  ALARM

```

## Analog Output Calibration

The Analog Output Calibration menu is a selection of 6 voltage channels and 6 current channels (if I/O expansion board option is installed) to calibrate, and allows the user to select the calibration action zero or span. The analog output calibration menu is visible only when the instrument is in service mode. For more information on the service mode, see “Service Mode” earlier in the chapter.



**WARNING** This adjustment should only be performed by an instrument service technician. ▲

- In the Main Menu, choose Service > **Analog Out Calibration**.

```

ANALOG OUTPUT CAL:
>VOLTAGE CHANNEL 1
  VOLTAGE CHANNEL 2
  VOLTAGE CHANNEL 3
  VOLTAGE CHANNEL 4
  VOLTAGE CHANNEL 5
  VOLTAGE CHANNEL 6
  CURRENT CHANNEL 1
                                     ↓

RANGE  AVG  DIAGS  ALARM

```

```




ANALOG OUTPUT CAL:
>CALIBRATE ZERO
  CALIBRATE FULL SCALE

RANGE  AVG  DIAGS  ALARM

```

### Analog Output Calibrate Zero

The Analog Output Calibrate Zero screen allows the user to calibrate the zero state of the selected analog output. The operator must connect a meter to the output and adjust the output until it reads 0.0 V on the meter.




- In the Main Menu, choose Service > Analog Out Calibration > Select Channel > **Calibrate Zero**.
- Use  and  to increment or decrement the numeric value.
- Press  to save the value.

```
ANALOG OUTPUT CAL:  ZERO
CONNECT METER TO OUTPUT!
SELECTED OUTPUT:    V1
SET TO:             101 ?
← SAVE VALUE      ↑↓ INC/DEC
SET OUTPUT TO:     0.0 V

RANGE  AVG  DIAGS  ALARM
```

### Analog Output Calibrate Full-Scale

The Analog Output Calibrate Full-Scale screen allows the user to calibrate the full-scale state of the selected analog output. The operator must connect a meter to the output and adjust output until it reads the value shown in the set output to: field.

- In the Main Menu, choose Service > Analog Out Calibration > Select Channel > **Calibrate Full Scale**.
- Use  and  to increment or decrement the numeric value.
- Press  to save the value.

```
ANALOG OUTPUT CAL:  SPAN
CONNECT METER TO OUTPUT!
SELECTED OUTPUT:    V1
SET TO:             3697 ?
← SAVE VALUE      ↑↓ INC/DEC
SET OUTPUT TO:     10 V

RANGE  AVG  DIAGS  ALARM
```

## Analog Input Calibration

The Analog Input Calibration menu is a selection of 8 analog inputs (if the I/O expansion board option is installed) to calibrate, and allows the user to select the calibration action zero or span. The analog input calibration menu is visible only when the instrument is in service mode. For more information on the service mode, see “Service Mode” earlier in the chapter.



**WARNING** This adjustment should only be performed by an instrument service technician. ▲

- In the Main Menu, choose Service > **Analog Input Calibration**.

```

ANALOG INPUT CAL:
>INPUT CHANNEL 1
  INPUT CHANNEL 2
  INPUT CHANNEL 3
  INPUT CHANNEL 4
  INPUT CHANNEL 5
  INPUT CHANNEL 6
  INPUT CHANNEL 7
                                     ↓
RANGE  AVG  DIAGS ALARM
  
```

```

ANALOG INPUT CAL:
>CALIBRATE ZERO
  CALIBRATE FULL SCALE
                                     ↓
RANGE  AVG  DIAGS ALARM
  
```

### Analog Input Calibrate Zero

The Analog Input Calibrate Zero screen allows the user to calibrate the zero state of the selected analog input.

In the Main Menu, choose Service > Analog Input Calibration > Select Channel > **Calibrate Zero**. (Hook up a voltage source of 0 V to the analog input channel.)

- Press  to save the value.




```
ANALOG INPUT CAL:  ZERO
DISCONNECT SELECTED INPUT!
SELECTED INPUT:  INPUT 1
CURRENTLY:  6.24 V

← CALIBRATE INPUT TO ZERO

RANGE  AVG  DIAGS  ALARM
```

### Analog Input Calibrate Full-Scale

The Analog Input Calibration Full-Scale screen allows the user to calibrate the full-scale state of the selected analog input.


- In the Main Menu, choose Service > Analog Input Calibration > Select Channel > **Calibrate Full Scale**. (Hook up a voltage source of 10 V to the analog input channel.)
- Use  and  to increment or decrement the numeric value.
- Press  to save the value.

```
ANALOG INPUT CAL:  SPAN
PROVIDE VOLTAGE TO INPUT!
SELECTED INPUT:  INPUT 1
CURRENTLY:  6.24 V
SET TO:  10.00 V
← CALIBRATE TO VALUE

RANGE  AVG  DIAGS  ALARM
```

## Ozonator Safety

The Ozonator Safety screen is used to turn the ozonator safety feature on and off. If the ozonator safety is turned off, the ozonator will always be on, even if there is no flow or the converter is not up to temperature. The ozonator safety screen is visible only when the instrument is in service mode. For more information on the service mode, see “Service Mode” earlier in the chapter.


- In the Main Menu, choose Service > **Ozonator Safety**.
- Press  to toggle and set the service mode on or off.

```

OZONATOR SAFETY:
CURRENTLY:          OFF
SET TO:             ON ?
                    ← TOGGLE VALUE
RANGE  AVG  DIAGS  ALARM
  
```

## Extended Ranges

The Extended Ranges screen is used to turn the extended ranges feature on and off. The extended ranges screen is visible only when the instrument is in service mode. For more information on the service mode, see “Service Mode” earlier in the chapter.






- In the Main Menu, choose Service > **Extended Ranges**.
- Press  to toggle and set the extended ranges on or off.

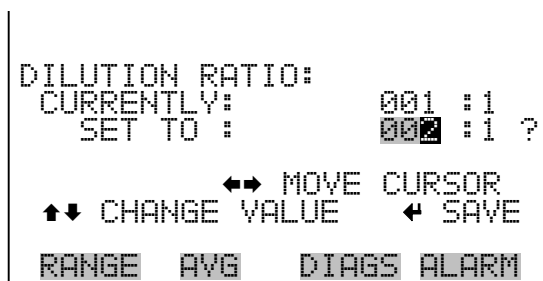
```

EXTENDED RANGES:
CURRENTLY:          OFF
SET TO:             ON ?
                    ← TOGGLE VALUE
RANGE  AVG  DIAGS  ALARM
  
```

## Dilution Ratio

The Dilution Ratio screen allows the user to view and set the dilution ratio. Acceptable values are 1–500: 1. The default is 1:1. When this value is set, the dilution ratio is applied to all concentration measurements. This screen is displayed if the dilution ratio option is installed.

- In the Main Menu, choose Service > **Dilution Ratio**.
- Use , ,  and  to move and change the value.
- Press  to save set to value as actual value.




```
DILUTION RATIO:
CURRENTLY:      001 :1
SET TO :        000 :1 ?

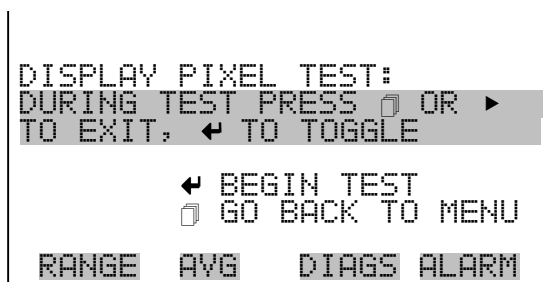
      ←→ MOVE CURSOR
↑↓ CHANGE VALUE  ← SAVE

RANGE  AVG  DIAGS  ALARM
```

## Display Pixel Test

The Display Pixel Test is used to test the LCD display. The display pixel test screen is visible only when the instrument is in service mode. For more information on the service mode, see “Service Mode” earlier in the chapter.

- In the Main Menu, choose Service > **Display Pixel Test**.
- Press  to begin test by turning all pixels on, then toggle between on or off.



```
DISPLAY PIXEL TEST:
DURING TEST PRESS [right arrow] OR [left arrow] TO EXIT,
[left arrow] TO TOGGLE




      ← BEGIN TEST
      → GO BACK TO MENU

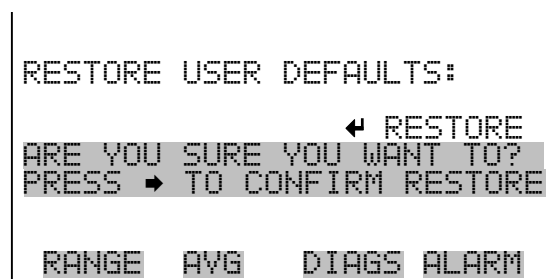
RANGE  AVG  DIAGS  ALARM
```

## Restore User Defaults

The Restore User Defaults screen is used to reset the user calibration and configuration values to factory defaults. The restore user defaults screen is visible only when the instrument is in service mode. For more information on the service mode, see “Service Mode” earlier in the chapter.

**Note** When this item is selected, the instrument will be automatically rebooted after restoring defaults. ▲

- In the Main Menu, choose Service > **Restore User Defaults**.
- Press  to warn and enable restore with .
- Press  to overwrite all user settings with factory default values.



## Password


The Password menu allows the user to configure password protection. If the instrument is locked, none of the settings may be changed via the front panel user interface. The items visible under the password menu are determined by the instrument’s password status.

- In the Main Menu, choose **Password**.



## Set Password


The Set Password screen is used to set the password to unlock the front panel. The set password is shown if the instrument is unlocked and the password not set.

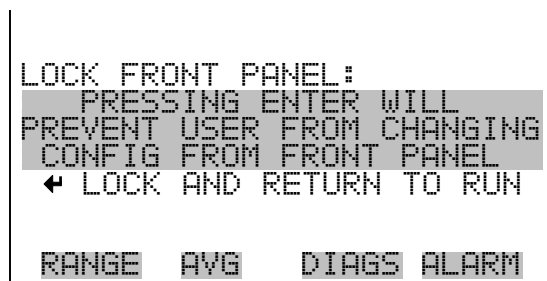
- In the Main Menu, choose Password > **Set Password**.
- Press  to enter password and disable instrument lock.



## Lock Instrument

The Lock Instrument screen is used to lock the instrument's front panel so users can not change any settings from the front panel. The lock instrument is shown if the instrument is unlocked and the password set.


- In the Main Menu, choose Password > **Lock Instrument**.
- Press  to enable instrument lock and returns to main menu.





## Change Password


The Change Password is used to change the password used to unlock the instrument's front panel. The change password is shown if the instrument is unlocked.

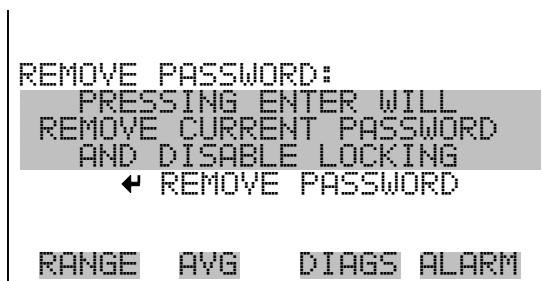
- In the Main Menu, choose Password > **Change Password**.
- Press  to change password.



## Remove Password


The Remove Password screen is used to erase the current password and disable password protection. The remove password is shown if the instrument is unlocked and the password set.

- In the Main Menu, choose Password > **Remove Password**.
- Press  to remove password and returns to main menu.



## Unlock Instrument

The Unlock Instrument screen is used to enter the password to unlock the front panel. The Unlock Instrument is shown if the instrument is locked.

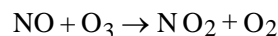
- In the Main Menu, choose Password > **Unlock Instrument**.
- Press  to disable instrument lock and returns to main menu.



## Chapter 4 Calibration

This chapter describes procedures for performing a multipoint calibration of the Model 42i NO<sub>x</sub>. The information described here should be adequate to perform the calibration. However, if greater detail is desired, the user is referred to the Code of Federal Regulations, Title 40, Part 50, Appendix F.

The calibration technique is based on the rapid gas phase reaction between NO and O<sub>3</sub> which produces stoichiometric quantities of NO<sub>2</sub> in accordance with the reaction:



The quantitative nature of this reaction is such that when the NO concentration is known, the concentration of NO<sub>2</sub> can be determined. Ozone is added to excess NO in a dynamic calibration system. Upon the addition of O<sub>3</sub>, the decrease in NO concentration observed on the calibrated NO channel is equivalent to the concentration of NO<sub>2</sub> produced. The amount of NO<sub>2</sub> generated may be changed by adding variable amounts of O<sub>3</sub> from a stable O<sub>3</sub> generator. The following sections discuss the required apparatus and procedure for calibration of the instrument.

### Equipment Required

#### Zero Gas Generator

A zero air source, free of contaminants such as NO, NO<sub>2</sub>, and O<sub>3</sub> is required for dilution, calibration, and gas phase titration.

#### Compression

The zero air source should be at an elevated pressure to allow accurate and reproducible flow control and to aid in subsequent operations such as drying, oxidation, and scrubbing. An air compressor that gives an output of 10 psig is usually sufficient for most applications.

#### Drying

Several drying methods are available. Passing the compressed air through a bed of silica gel, using a heatless air dryer, or removing water vapor with a permeation dryer are three possible approaches.

**Oxidation** NO is usually oxidized to NO<sub>2</sub> in order to ease its scrubbing. Oxidation can be accomplished by either ozonation or chemical contact. During ozonation, the air is passed through an ozone generator. The O<sub>3</sub> that is produced reacts with the NO to form NO<sub>2</sub>. Care must be taken to allow sufficient residence time for the ozonation reaction to go to completion.

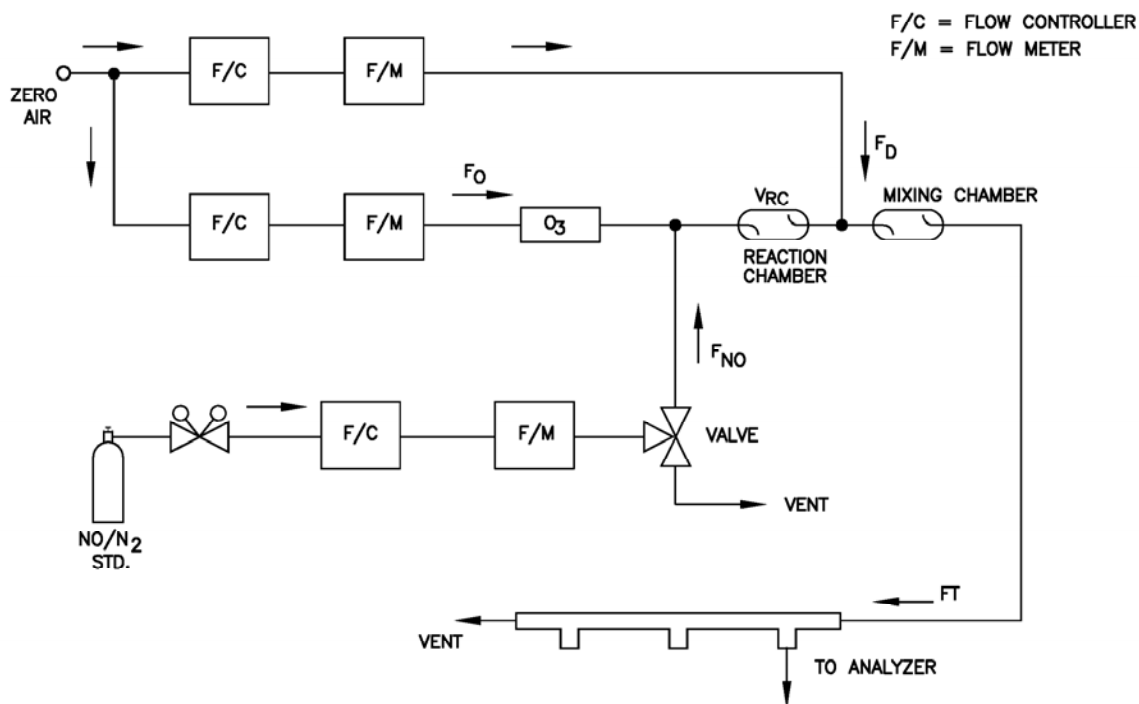
Chemical oxidation is accomplished by passing the air stream through a reacting bed. Such agents as CrO<sub>3</sub> on a alumina support or Purafil<sup>®</sup> are very efficient at oxidizing NO to NO<sub>2</sub>. The chemical contact approach has the advantage of needing no electrical power input for its application.

**Scrubbing** The last step in the generation of the zero air is the removal of the remaining contaminants by either further reaction or absorption. Fixed bed reactors are usually employed. [Table 4-1](#) lists materials that can be effective in removing contaminants.

**Table 4-1.** Scrubbing Materials

To Remove	Use
NO <sub>2</sub>	Soda-Lime (6-12 mesh), Purafil <sup>®</sup>
Hydrocarbons	Molecular Sieve (4A), Activated Charcoal
O <sub>3</sub> and SO <sub>2</sub>	Activated Charcoal

**Gas Phase Titrator** Figure 4-1 shows the suggested placement of the component parts of a gas phase titration apparatus. All connections between components in the system should be made with glass, Teflon<sup>®</sup>, or other nonreactive material.



**Figure 4-1.** GPT System

The air flow controllers should be devices capable of maintaining constant air flows within  $\pm 2\%$  of the required flow rate. The NO flow controller should be capable of maintaining constant NO flows within  $\pm 2\%$  of the required flow rate. Component parts in contact with the NO should be of a nonreactive material.

The pressure regulator for the standard NO cylinder must have a nonreactive diaphragm and internal parts and a suitable delivery pressure.

The ozone generator must be capable of generating sufficient and stable levels of ozone for reaction with NO to generate  $\text{NO}_2$  concentrations in the range required. Ozone generators of the electric discharge type may produce NO and  $\text{NO}_2$  and are not recommended.

A valve used to divert the NO flow when zero air is required at the manifold may be used. The valve should be constructed of glass, Teflon, or other nonreactive material.

The reaction chamber used for the reaction of ozone with excess NO should be constructed of glass, Teflon, or other nonreactive material. The chamber should be of sufficient volume so that the residence time meets the requirements specified further in this chapter. The mixing chamber used to provide thorough mixing of the reaction products and diluent air should also be constructed of glass, Teflon, or other nonreactive material.

The output manifold should be constructed of glass, Teflon, or other nonreactive material and should be of sufficient diameter to insure an insignificant pressure drop at the analyzer connection. The system must have a vent designed to insure atmospheric pressure at the manifold and to prevent ambient air from entering the manifold.

## Reagents

### NO Concentration Standard

A cylinder containing 50 to 100 ppm NO in N<sub>2</sub> with less than 1 ppm NO<sub>2</sub> is usually used as the concentration standard. The cylinder must be traceable to a National Institute of Standards and Technology (NIST) NO in N<sub>2</sub> Standard Reference Material or NO<sub>2</sub> Standard Reference Material. Procedures for certifying the NO cylinder (working standard) against an NIST traceable NO or NO<sub>2</sub> standard and for determining the amount of NO<sub>2</sub> impurity are given in EPA Publication No. EPA-600/4-75-003, "Technical Assistance Document for the Chemiluminescence Measurement of Nitrogen Dioxide." In addition, the procedure for the certification of a NO working standard against an NIST traceable NO standard and determination of the amount of NO<sub>2</sub> impurity in the working standard is reproduced here. The cylinder should be recertified on a regular basis as determined by the local quality control program.

Use the NIST traceable NO standard and the GPT calibration procedure to calibrate the NO, NO<sub>x</sub>, and NO<sub>2</sub> responses of the instrument. Also determine the converter efficiency of the analyzer. Refer to the calibration procedure in this manual and in the Code of Federal Regulations, Title 40, Part 50, Appendix F for exact details. Ignore the recommended zero offset adjustments.

Generate several NO concentrations by dilution of the NO working standard. Use the nominal NO concentration, [NO]<sub>NOM</sub>, to calculate the diluted concentrations. Plot the analyzer NO response (in ppm) versus the nominal diluted NO concentration and determine the slope, S<sub>NOM</sub>. Calculate the [NO] concentration of the working standard, [NO]<sub>STD</sub>, from:

$$[\text{NO}]_{\text{STD}} = [\text{NO}]_{\text{NOM}} \times S_{\text{NOM}}$$

**Zero Air** A source of zero air free of contaminants should be used, as described earlier in this chapter. Contaminants can cause a detectable response on the instrument and may also react with the NO, O<sub>3</sub>, or NO<sub>2</sub> during the gas phase titration.

## Dynamic Parameter Specifications for Gas Phase Titrator

Use the following definitions for the remainder of this chapter.

$P_R$ =	Dynamic parameter specification to ensure complete reaction of the available O <sub>3</sub> , ppm-min
$[NO]_{RC}$ =	NO concentration in the reaction chamber, ppm
$t_R$ =	Residence time of the reactant gases in the reaction chamber, min
$[NO]_{STD}$ =	Concentration of the undiluted NO standard, ppm
$F_{NO}$ =	NO flow rate, sccm
$F_O$ =	O <sub>3</sub> generator air flow rate, sccm
$V_{RC}$ =	Volume of the reaction chamber, cc
$F_T$ =	Analyzer demand plus 10 to 50% excess

The O<sub>3</sub> generator air flow rate and the NO flow rate (Figure 4-1) must be adjusted such that the following relationships hold:

$$P_R = [NO]_{RC} \times t_R \geq 2.75 \text{ ppm} \cdot \text{min}$$

$$[NO]_{RC} = [NO]_{STD} \frac{F_{NO}}{(F_O + F_{NO})}$$

$$t_R = \frac{V_{RC}}{F_O + F_{NO}} < 2 \text{ min}$$

The flow conditions to be used in the GPT system are determined by the following procedure.

1. Determine  $F_T$ , the total flow required at the output manifold, which should be equal to the analyzer demand plus 10 to 50 percent excess.
2. Establish  $[NO]_{OUT}$  as the highest NO concentration that will be required at the output manifold.  $[NO]_{OUT}$  should be about equal to 90% of the upper range limit (URL) of the NO<sub>2</sub> concentration range to be covered.

3. Determine  $F_{NO}$  as:

$$F_{NO} = \frac{[NO]_{OUT} \times F_T}{[NO]_{STD}}$$

4. Select a convenient or available reaction chamber volume. Initially a trial volume may be selected in the range of 200 to 500 cc.

5. Compute  $F_O$  as:

$$F_O = \sqrt{\frac{[NO]_{STD} \times F_{NO} \times V_{RC}}{2.75}} - F_{NO}$$

6. Compute  $t_R$  as:

$$t_R = \frac{V_{RC}}{F_O + F_{NO}}$$

7. Verify that  $t_R < 2$  minutes. If not, select a reaction chamber with a smaller  $V_{RC}$ .

8. Compute the diluent air flow rate as:

$$F_D = F_T - F_O - F_{NO}$$

9. If  $F_O$  turns out to be impractical for the desired system, select a reaction chamber having a different  $V_{RC}$  and re-compute  $F_D$  and  $F_O$ .











## Pre-Calibration

Perform the following pre-calibration procedure before calibrating the instrument. For detailed information about the menu parameters and the icons used in these procedures, see the “Operation” chapter.

**Note** 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. ▲

1. Allow the instrument to warm up and stabilize.
2. Be sure the ozonator is ON. If the ozonator is not ON:
  - a. Press  to display the Main Menu, then choose Instrument Controls > **Ozonator**.
  - b. Press  to toggle the ozonator ON.
  - c. Press   to return to the main menu.
3. Be sure the instrument is in the auto mode. If the instrument is not in auto mode, use the following steps to change to auto mode:
  - a. From the Main Menu, choose Service > **Range Mode Select**. If Service does not appear in the Main Menu, refer to the following note to display it.  
The Single/Dual/Auto Range screen appears.
  - b. Use  or  to change the current selection to Auto and press  to save the selection.
  - c. Press  to return to the Run screen.

**Note** The auto mode is turned ON and OFF via the Range Mode Select function located in the Service menu. If Service does not appear on the Main Menu, use the following procedure to display it. ▲

4. At the Main Menu, press  to scroll to Instrument Controls > press  >  to scroll to **Service Mode** > and press .

The Service Mode screen appears.




- a. Press  to toggle the Service Mode to ON.
- b. Press  >  to return to the Main Menu and continue with Step 3.

5. Select the NO<sub>x</sub> range by selecting the RANGE soft key, if available, or select Range from the Main Menu, and push the AVG soft key to display the Averaging Time screen. It is recommended that a higher averaging time be used for best results. For more information about the ranges or averaging time, see the “Operation” chapter.

**Note** The averaging time should be less than the zero duration and less than the span duration. ▲

6. Set the calibration pressure to the current reactor pressure.
  - a. From the Main Menu, choose > Calibration Factors > **Cal Pressure**.

The Calibrate Pressure screen appears.

- b. Use   to increment/decrement the value to match the current reactor pressure, and press  to save the new calibration pressure value.

7. Verify that any filters used during normal monitoring are also used during calibration.

8. Connect the analog outputs to a strip chart recorder(s).

## Calibration

The following procedure discusses calibration of the instrument using the gas phase titrator and zero gas generator previously described. It is suggested that a calibration curve have at least seven points between the zero and full scale NO concentrations. Although the seven-point curve is optional, two of whatever number of points is chosen should be located at the zero and 90% levels and the remaining points equally spaced between these values.

**Note** When the instrument is equipped with internal zero/span and sample valves, the ZERO and SPAN ports should give identical responses to the SAMPLE port when test gases are introduced. The user should calibrate the instrument using the SAMPLE port to introduce the zero and span gas sources. ▲

After calibration, the zero and span sources should be plumbed to the appropriate ports on the rear panel of the instrument, and then reintroduced to the instrument. The instrument should give identical responses to the test gases whether they are introduced via the SAMPLE port or the ZERO or SPAN ports. If not, the plumbing and/or valves should be serviced.

## Connect GPT Apparatus to the Analyzer

Use the following procedure to connect the GPT apparatus to the instrument.

1. Assemble a dynamic calibration system such as the one shown in [Figure 4-1](#).
2. Ensure that all flow meters are calibrated under the conditions of use against a reliable standard, such as a soap-bubble meter or wet-test meter. All volumetric flow rates should be corrected to 25 °C and 760 mm Hg.
3. Precautions should be taken to remove O<sub>2</sub> and other contaminants from the NO pressure regulator and delivery system prior to the start of calibration to avoid any conversion of NO to NO<sub>2</sub>. Failure to do so can cause significant errors in calibration. This problem can be minimized by:
  - a. Carefully evacuating the regulator after the regulator has been connected to the cylinder and before opening the cylinder valve.
  - b. Thoroughly flushing the regulator and delivery system with NO after opening the cylinder valve.
  - c. Not removing the regulator from the cylinder between calibrations unless absolutely necessary.
4. Connect the analyzer SAMPLE bulkhead input to the output of the GPT system.

## Adjust Instrument Gain

Use the following procedures to adjust the instrument gain. This includes:

- Setting the NO<sub>x</sub> background to zero
- Calibrating the NO<sub>x</sub> channel to the NO calibration gas



The NO<sub>x</sub> background correction is determined during zero calibration. The background signal is the combination of electrical offsets, PMT dark current, and trace substances undergoing chemiluminescence. For more detailed information, see “NO and NO<sub>x</sub> Background Corrections” in the “Operation” chapter.

1. Determine the GPT flow conditions required to meet the dynamic parameter specifications as indicated in “Dynamic Parameter Specifications for Gas Phase Titrator” presented previously in this chapter.
2. Adjust the GPT diluent air and O<sub>3</sub> generator air flows to obtain the flows determined in “Dynamic Parameter Specifications for Gas Phase Titrator” previously in this chapter.

The total GPT air flow must exceed the total demand of the analyzer. The instrument requires approximately 700 cc/min of sample flow and a total GPT air flow of at least 1.5 liters/min is recommended.

3. Allow the instrument to sample zero air until a stable NO<sub>x</sub> response is obtained.
4. After the response has stabilized, from the Main Menu choose Calibration > **Calibrate NO<sub>x</sub> Background**.

The NO<sub>x</sub> Background screen appears.

5. Press  to set the NO<sub>x</sub> reading to zero.
6. Press  to return to the Run screen.
7. Record the stable zero air response as Z<sub>NOX</sub> (recorder response, % scale).

8. Adjust the NO flow from the standard NO cylinder to generate a NO concentration of about 80% of the upper range limit (URL) of the NO<sub>x</sub> range. The exact NO<sub>x</sub> concentration is calculated from:





$$[\text{NO}]_{\text{OUT}} = \frac{F_{\text{NO}} \times \text{NO}_{\text{STD}}}{F_{\text{NO}} + F_{\text{O}} + F_{\text{D}}}$$

Where:

$[\text{NO}]_{\text{OUT}}$  = Diluted NO concentration at the output manifold, ppm

9. Allow the analyzer to sample the NO calibration gas until the NO<sub>x</sub> reading stabilizes.
10. When the response stabilizes, from the Main Menu choose Calibration > **Calibrate NO<sub>x</sub> Coefficient**.

The NO<sub>x</sub> line of the Calibrate NO<sub>x</sub> screen displays the current NO<sub>x</sub> concentration. The Span Conc line of the display is where you enter the NO<sub>x</sub> calibration gas concentration.

Use   to move the cursor left and right and use   to increment and decrement the numeric character at the cursor.

11. Press  to calibrate the NO<sub>x</sub> channel to the NO calibration gas.

The message “SAVING PARAMETER(S)” is briefly displayed to indicate that the NO<sub>x</sub> span coefficient has been calculated, stored, and is being used to correct the NO<sub>x</sub> reading. The NO<sub>x</sub> recorder response will equal:

$$\text{Recorder Response (\% scale)} = \frac{[\text{NO}]_{\text{OUT}}}{\text{URL}} \times 100 + Z_{\text{NO}}$$

Where:

URL = Nominal upper range limit of the NO channel, ppm

12. Record the  $[\text{NO}_x]_{\text{OUT}}$  concentration and the instrument's response as indicated by the recorder response.

## Prepare NO<sub>x</sub> Calibration Curves

Use the following procedure to prepare NO<sub>x</sub> calibration curves.

1. Generate several additional NO<sub>x</sub> concentrations by decreasing  $F_{NO}$  or increasing  $F_D$ .
2. For each concentration generated, calculate the exact NO<sub>x</sub> concentrations using the above equations for  $[NO_x]_{OUT}$ .
3. Record the NO<sub>x</sub> responses.
4. Plot the instrument's responses versus the respective calculated NO and NO<sub>x</sub> concentrations and draw or calculate the respective calibration curves.

For subsequent calibrations where linearity can be assumed, these curves may be checked with a three-point calibration consisting of a zero point and NO<sub>x</sub> concentration of approximately 80% of the URL, and an intermediate concentration.

## Alternative Calibration Procedure Using NO<sub>2</sub> Permeation Tube

Although Thermo Environmental recommends that a GPT system be used to calibrate this instrument, the procedure described in the Code of Federal Regulations, Title 40, Part 50, Appendix F using a NO<sub>2</sub> permeation tube may be used as an alternative procedure for calibration of this instrument.

## Calibration in Dual Range and Autorange Mode

The dual/auto range calibration feature is used to calibrate the analyzer at two different span levels (as opposed to a single span level in the standard mode) generating a "tailored multi-point" calibration curve stored in the analyzer's memory. This feature may be used:



- When widely different gas levels are being monitored, such as a factor of 10 or greater apart
- If precision and span levels are being introduced using separate tanks
- If more than one multi-component cylinder is being used to calibrate the instrument

Properly designed chemiluminescence analyzers are inherently linear over a wide dynamic range; and under normal USEPA compliance situations this feature is not required. Dual calibration may be used for span levels less than

a factor of 10 apart, however if this is done to correct for a significant non-linearity, it may mask the problems causing the effect, such as, bad calibration cylinder, leaks in sampling lines, or low ozonator output.

Use the following procedures to calibrate the instrument in dual or auto range mode.

For detailed information about the menu parameters and the icons used in these procedures, see the “Operation” chapter.





1. Follow the “Pre-Calibration” procedure described previously in this chapter.
  - Be sure the ozonator is ON.
  - Be sure that the instrument is in auto mode.
2. Introduce zero air to the SAMPLE bulkhead and allow the instrument to sample zero air until the NO<sub>x</sub> response stabilizes.
3. When the response stabilizes, from the Main Menu choose Calibration > Calibrate NO<sub>x</sub> Background, and press  to set the NO<sub>x</sub> background to zero.
4. Press  to return to the Run screen.
5. Disconnect the source of zero air from the SAMPLE bulkhead. In its place, connect a source of NO calibration gas of about 80% of the low NO full-scale range.
6. Allow the instrument to sample the low NO calibration gas until the NO<sub>x</sub> reading stabilizes.
7. When the response is stable, from the Main Menu choose Calibration > **Cal Lo NO<sub>x</sub> Coefficient**.


The Calibrate Lo NO<sub>x</sub> screen appears.


## Calibration

### Calibration in Dual Range and Autorange Mode

8. The Lo NO<sub>x</sub> field displays the current NO<sub>x</sub> reading. The Lo Span Conc field is where you enter the low NO<sub>x</sub> calibration gas concentration.

Use   to move the cursor left and right and use   to increment and decrement the numeric character at the cursor.

9. Press  to calculate and save the new low NO<sub>x</sub> coefficient based on the entered span concentration.

10. Press  to return to the Calibration screen.





11. Connect a source of high NO calibration gas of approximately 80% of the high NO<sub>x</sub> fullscale range.


12. Allow the instrument to sample the high NO<sub>x</sub> calibration gas until the NO<sub>x</sub> reading stabilizes.

13. When the response is stable, from the Calibration menu choose **Cal Hi NO<sub>x</sub> Coefficient**.

The Calibrate Hi NO<sub>x</sub> screen appears.

14. The Hi NO<sub>x</sub> field displays the current NO<sub>x</sub> reading. The Hi Span Conc field is where you enter the high NO<sub>x</sub> calibration gas concentration.





Use   to move the cursor left and right and use   to increment and decrement the numeric character at the cursor.


15. Press  to calibrate the NO<sub>x</sub> channel to the NO calibration gas.

16. Press  to return to the Calibration screen and choose **Calibrate Hi NO<sub>x</sub>**.

17. Verify that the high NO<sub>x</sub> calibration gas concentration is the same as the high NO calibration concentration.



Use   to move the cursor left and right and use   to increment and decrement the numeric character at the cursor.

18. Press  to calibrate the NO<sub>x</sub> channel to the NO<sub>x</sub> calibration gas.

You can change the calibration factors by using the Calibration Factors menu. This is often useful in a troubleshooting situation. However, after the preceding calibration procedure is completed, all subsequent data reduction depends on the calibration parameters remaining the same as during the initial calibration.

Therefore never change any calibration factor without first recording the value so that after any troubleshooting procedure is completed, the initial value can be re-entered and the multipoint calibration can be restored.

## Zero and Span Check

The analyzer requires initial and periodic calibration according to the procedures outlined in this manual. Initially, the frequency of the calibration procedure should be determined by the stability of the zero and span checks, which may be run daily. You should generate a new calibration curve when zero and span checks indicate a shift in instrument gain of more than 10 percent from that determined during the most recent multipoint calibration. You can adjust the frequency of calibration and even zero and span checks appropriately as you gain confidence with the instrument.

You should have a quality control plan where the frequency and the number of points required for calibration can be modified on the basis of calibration and zero and span check data collected over a period of time. Note however, that the EPA requires a minimum of one multipoint calibration per calendar quarter. Such a quality control program is essential to ascertain the accuracy and reliability of the air quality data collected and to alert the user if the accuracy or reliability of the data should become unacceptable. A compilation of this kind might include items such as dates of calibration, atmospheric conditions, calibration factors, and other pertinent data.

Use the following procedure to perform a zero and span check.

1. Connect the zero gas to the SAMPLE bulkhead in a standard instrument or to the ZERO bulkhead in an instrument equipped with the zero/span and sample solenoid valve option.
2. Allow the instrument to sample zero gas until a stable reading is obtained on the NO<sub>x</sub> channel then record the zero reading. Unless the zero has changed by more than  $\pm 0.010$  ppm, it is recommended that the

## Calibration

### Zero and Span Check

zero not be adjusted. If an adjustment larger than this is indicated due to a change in zero reading, a new multipoint calibration curve should be generated.

3. Attach a supply of known concentration of NO (usually generated via an NIST traceable NO working standard) to the SAMPLE bulkhead (or SPAN bulkhead for instruments equipped with the zero/span and sample solenoid valve option) on the rear panel.
4. Allow the instrument to sample the calibration gas until a stable reading is obtained on the NO<sub>x</sub> channel. If the calibration has changed by more than  $\pm 10\%$ , a new multipoint calibration curve should be generated.
5. When the calibration check has been completed, record the and NO<sub>x</sub> value(s).
6. Reconnect the analyzer sample line to the SAMPLE bulkhead.

## Chapter 5 Preventive 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.

This chapter includes the following maintenance information and replacement procedures:

- “Safety Precautions” on page 5-1
- “Replacement Parts” on page 5-2
- “Cleaning the Outside Case” on page 5-2
- “Ozonator Air Feed Drying Column Replacement” on page 5-2
- “Capillary Inspection and Replacement” on page 5-2
- “Thermoelectric Cooler Fins Inspection and Cleaning” on page 5-4
- “Fan Filters Inspection and Cleaning” on page 5-4
- “Pump Rebuilding” on page 5-5

### Safety Precautions

Read the safety precautions before beginning any procedures in this chapter.



**WARNING** If the equipment is operated in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired.

▲



**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. ▲

## Replacement Parts

See the “Servicing” chapter for a list of replacement parts.

## Cleaning the Outside Case

Clean the outside case using a damp cloth being careful not to damage the labels on the case.



**Equipment Damage** Do Not use solvents or other cleaning products to clean the outside case.

## Ozonator Air Feed Drying Column Replacement

Use the following procedure to replace the ozonator air feed drying column.

1. Remove the drying column from the connector DRY AIR bulkhead on the rear panel of the instrument.
2. Replace spent absorbent material (indicating Drierite or silica gel) with new or regenerated material.
3. Reinstall the drying column to the DRY AIR bulkhead.
4. Perform a Zero/Span check (see the “Calibration” chapter).

## Capillary Inspection and Replacement

The capillaries normally only require inspection when instrument performance indicates that there may be a flow problem.

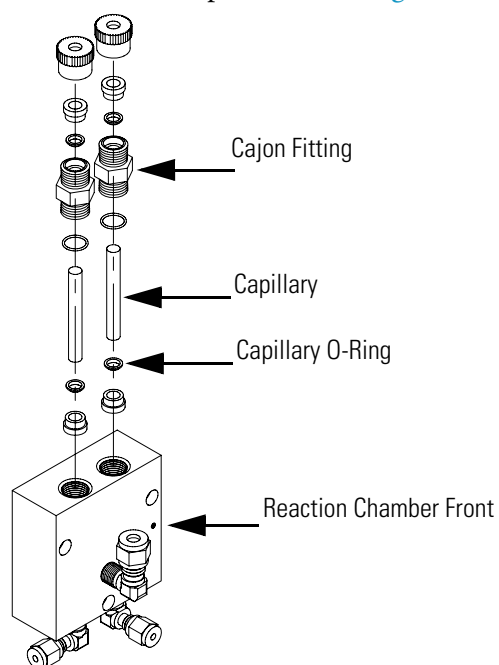


**Equipment Damage** Some internal components can be damaged by small amounts of static electricity. A properly grounded antistatic wrist strap must be worn while handling any internal component. For more information about appropriate safety precautions, see the “Servicing” chapter. ▲

Use the following procedure to inspect and replace the capillaries. This procedure can be used to check any or all of the capillaries.

1. Turn the instrument OFF and unplug the power cord.
2. Remove the instrument cover.

3. Locate the capillaries. See [Figure 5-1](#) and [Figure 7-2](#).



**Figure 5-1.** Inspecting and Replacing the Capillaries

4. Remove the Cajon® fitting(s) from the reaction chamber body using a 5/8-inch wrench being careful not to lose the ferrule or O-ring.
5. Remove the glass capillaries, ferrule, and O-ring. Inspect O-ring for cuts or abrasion, and replace as necessary.
6. Check capillary for particulate deposits. Clean or replace as necessary.
7. Replace capillary in reaction chamber body, making sure the O-ring is around the capillary before inserting it into the body.
8. Replace Cajon® fitting. Note that the Cajon® fitting should be tightened slightly more than hand tight.
9. Reconnect tubing to top of fittings, being careful to insert ferrule and O-ring properly, and tighten knurled nut finger tight.

10. Re-install the cover.

11. Connect the power cord and turn the instrument ON.

## Thermoelectric Cooler Fins Inspection and Cleaning



**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. ▲

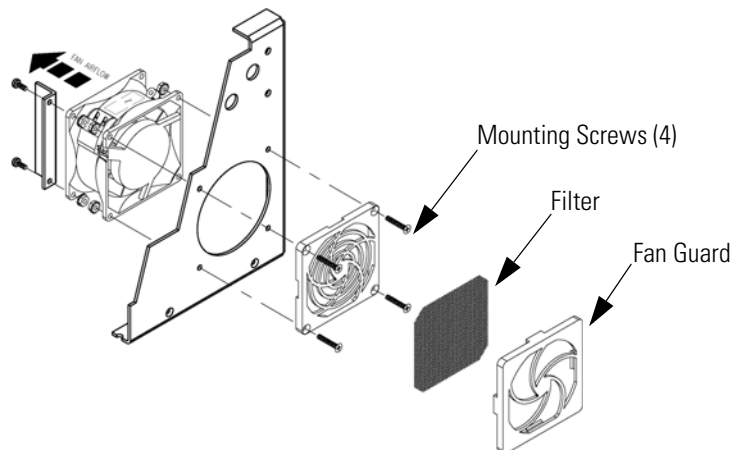
1. Turn the instrument off and unplug the power cord.
2. Remove the instrument cover.
3. Locate the PMT cooler (Figure 7-2 and Figure 7-4).
4. Blow off the cooler fins using clean pressurized air. It may be more convenient to vacuum the cooler fins. In either case, make sure that any particulate accumulation between the fins has been removed.
5. If necessary, use a small brush to remove residual particulate accumulation.
6. Replace the cover.
7. Connect the power cord and turn the instrument ON.

## Fan Filters Inspection and Cleaning

Use the following procedure to inspect and clean the fan filters (Figure 5-2).

1. Remove the two fan guards from the fans and remove the filters.

2. Flush the filters with warm water and let dry (a clean, oil-free purge will help the drying process) or blow the filters clean with compressed air.
3. Re-install the filters and fan guards.



**Figure 5-2.** Inspecting and Cleaning the Fan Filters

## Pump Rebuilding

Use the following procedure to rebuild the pump ([Figure 5-3](#)). To replace the pump. See “Pump Replacement” in the “Servicing” chapter.

Equipment Required:

Pump Repair Kit

Allen Wrench, 3 mm

Wrench, 9/16-inch

Needlenose Pliers



**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. ▲

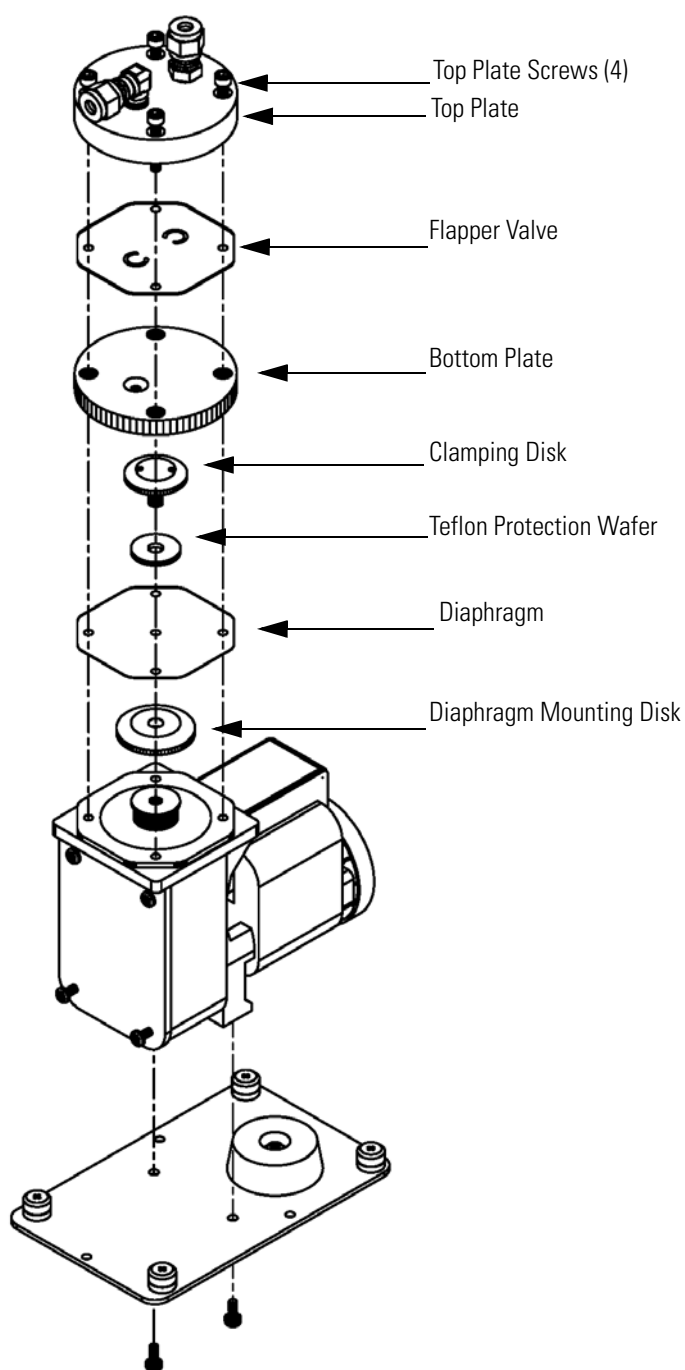
1. Turn instrument off, unplug the power cord, and remove the cover.
2. Loosen fittings and remove both lines going to the pump.

## Preventive Maintenance

### Pump Rebuilding

3. To ensure proper reassembly, mark the position of the pump head by using a pencil or other marker to draw a line from the top plate down across the bottom plate to the pump body. Refer to this reference line when reassembling the pump head.
4. Remove four screws from top plate using the 3 mm Allen wrench.
5. Remove top plate, flapper valve, and bottom plate.
6. Using needlenose pliers, remove clamping disk holding diaphragm and Teflon® protection wafer onto clamping rod, and remove the diaphragm and Teflon® wafer.





**Figure 5-3.** Rebuilding the Pump

7. Assemble pump by following above procedure in reverse. Refer to the marks you made in Step three to position the components. Make sure not to over-tighten clamping disk. Be sure that the Teflon® side of

## Preventive Maintenance

### Pump Rebuilding

diaphragm faces up and that the flapper valves cover the holes of the top and bottom plate.

8. Re-install the cover, reconnect the power cord, and turn instrument ON.
9. Check that the reaction chamber pressure reads between 150 and 250 mm Hg.

## Chapter 6 Troubleshooting

This instrument has been designed to achieve a high level of reliability. In the event of problems or failure, the troubleshooting guidelines, board-level connection diagrams, connector pin descriptions, and testing procedures presented in this chapter should be helpful in isolating and identifying problems.

For additional fault location information refer to the “Preventive Maintenance” chapter in this manual.

The service mode in the “Operation” chapter includes parameters and functions that are useful when making adjustments or diagnosing problems. The service mode includes some of the same information found in the Diagnostic menu, however, readings are updated every second in the service mode compared with every 10 seconds in the Diagnostics menu.

The Technical Support Department at Thermo Fisher Scientific can also be consulted in the event of problems. See “Service Locations” at the end of this chapter for contact information. In any correspondence with the factory, please note both the serial number and program number of the instrument.

This chapter provides the following troubleshooting and service support information:

- “Safety Precautions” on page 6-1
- “Troubleshooting Guides” on page 6-2
- “Board-Level Connection Diagrams” on page 6-6
- “Connector Pin Descriptions” on page 6-8
- “Service Locations” on page 6-22

### Safety Precautions

Read the safety precautions in the Preface and the “Servicing” chapter before performing any actions listed in this chapter.

## Troubleshooting Guides

The troubleshooting guides presented in this chapter are designed to help isolate and identify instrument problems.

[Table 6-1](#) provides general troubleshooting information and indicates the checks that you should perform if you experience an instrument problem.

[Table 6-2](#) lists all the alarm messages you may see on the graphics display and provides recommendations about how to resolve the alarm condition. See “Alarms Menu” in the “Operation” chapter for detailed information.

**Table 6-1.** Troubleshooting - General Guide

Malfunction	Possible Cause	Action
Does not start up	No power	Check that the instrument is plugged into the proper source (115 or 220 VAC, 50 or 60Hz). Check instrument fuses.
	Power supply	Check voltages using a digital voltmeter.
	Digital electronics	Unplug power cord. Check that all boards are seated properly. Unplug power cord. Remove one board. Install known good board. Repeat until faulty board is detected.
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.
	No ozone reaching the reaction chamber	Check the Instrument Control menu to see if the ozonator is ON. If it is ON, check dry air supply.
No output signal	Disconnected or defective input or high voltage supply	Unplug power cord. Check that cables are connected properly. Check cable resistance.
	Analyzer not calibrated	Recalibrate.
	Defective $\pm 15$ volt	Check supply voltages (Diagnostics menu).
Calibration drift	Dryer to ozonator depleted	Replace.

**Table 6-1.** Troubleshooting - General Guide, continued

Malfunction	Possible Cause	Action
	Line voltage fluctuations	Check to see if line voltage is within specifications.
	Defective pump	Rebuild pump.
	Unstable NO or NO <sub>2</sub> source	Replace.
	Clogged capillaries	Unplug power cord. Clean or replace capillary.
	Clogged sample air filter	Replace filter element.
Excessive noise	Defective or low sensitivity PMT	Unplug power cord. Remove PMT. Install known good PMT. Plug in power cord. Check performance.
	Defective input board	Replace board.
	Defective cooler	Check temperature (less than -2 °C at T <sub>amb</sub> = 25 °C).
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.
Improper converter operation	Questionable calibration gas	Verify accuracy.
	Converter temperature too high or too low	Temperature should be approximately 325 °C.
	Low line voltage	Check to see if line voltage is within specifications.
	Molybdenum consumed	Replace Molybdenum converter cartridge.

**Table 6-2.** Troubleshooting - Alarm Messages

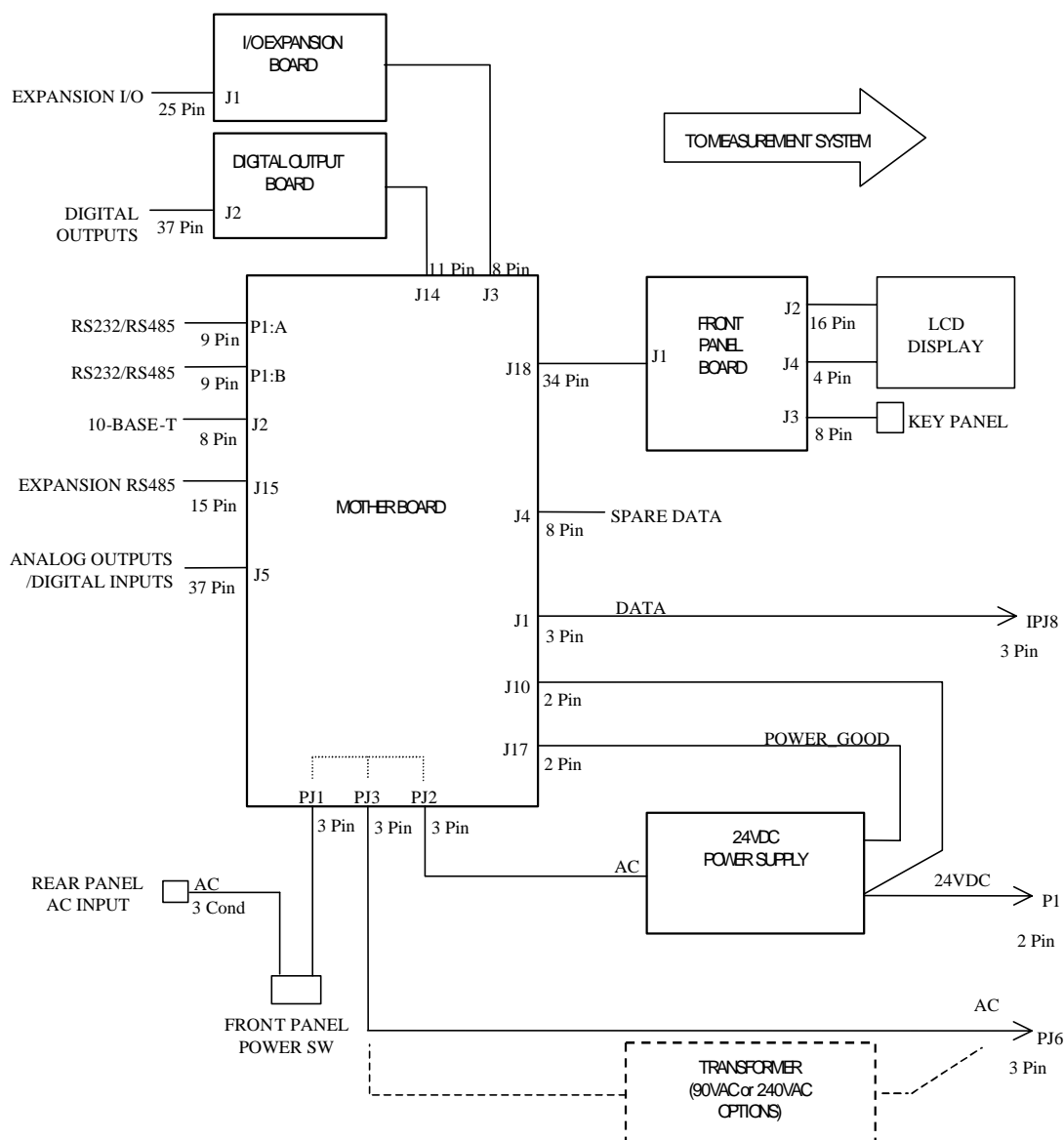
Alarm Message	Possible Cause	Action
Alarm - Internal Temp	Check fan operation	Replace fan if not operating properly.
	Check fan filter	Clean or replace foam filter, refer to "Preventive Maintenance" chapter in this manual.
Alarm - Chamber Temp	Chamber temperature below set point of 50 °C	Check 10K thermistor, replace if bad.
		Check temperature control board to insure the LEDs are coming on. If not, temperature control board could be defective.
Alarm - Cooler Temp  Cooler reads 80 °C	Check fan operation	Replace defective fan.
	Check fan filter	Clean or replace foam filter.
	Bad cooler	Replace cooler.
	Cooler does not hold set point of -3 °C	Replace cooler – thermoelectric module inside cooler failed.
	Cooler reads -20 °C	Replace cooler – thermocouple bad.
Alarm - Converter Temp	Converter temperature low	Molybdenum converter should be hot to the touch, if not the heater may have failed. Check that converter temp. set point is approximately 325 °C. Check that voltage to the heater is 115 VAC.
Alarm - Pressure	High pressure indication	Check the pump for a tear in the diaphragm, replace with pump repair kit if necessary. Refer to "Preventive 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.

**Table 6-2.** Troubleshooting - Alarm Messages, continued

Alarm Message	Possible Cause	Action
Alarm - Flow	Flow low	Check sample capillary (0.015 inch ID) 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.
Alarm - Ozonator Flow	Ozone flow low	Check ozone capillary (0.008 inch ID) for blockage. Replace as necessary.
Alarm - Zero Check Alarm - Span Check	Instrument out of calibration	Recalibrate instrument.
Alarm - Zero Autocal Alarm - Span Autocal		Check gas supply. Perform manual calibration.
Alarm - NO, NO <sub>2</sub> , NO <sub>x</sub> Conc.	Concentration has exceeded range limit	Check to insure range corresponds with expected value. If not select proper range.
	Concentration low	Check user-defined low set point, set to zero.
Alarm - Motherboard Status	Internal cables not connected properly	Check that all internal cables are connected properly.
Alarm - Interface Status	Board is defective	Recycle AC power to instrument. If still alarming, change board.
Alarm - I/O Exp Status		

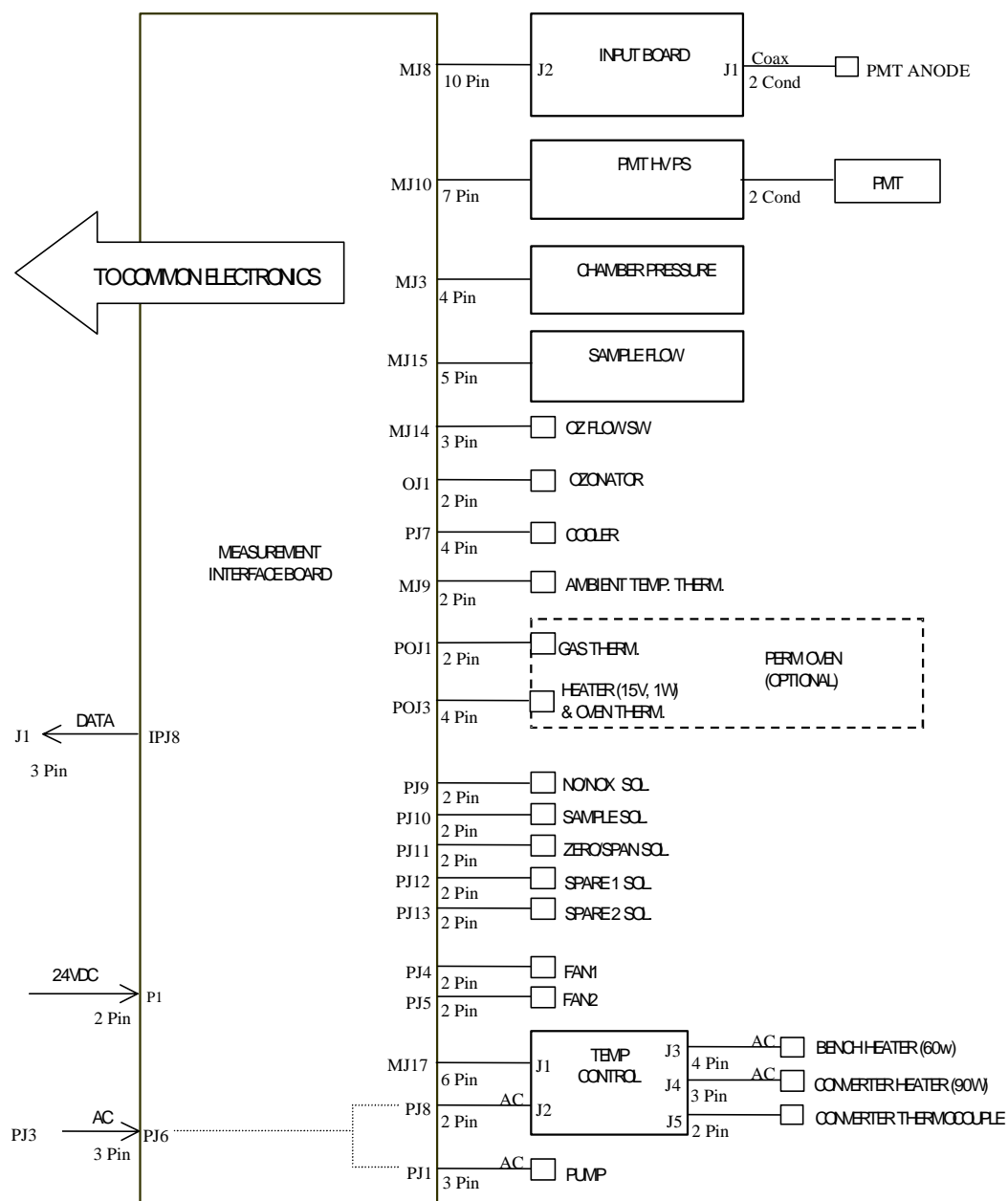
## Board-Level Connection Diagrams

Figure 6-1 and Figure 6-2 are board-level connection diagrams for the common electronics and measurement system. These illustrations can be used along with the connector pin descriptions in Table 6-3 through Table 6-9 to troubleshoot board-level faults.



**Figure 6-1.** Board-Level Connection Diagram - Common Electronics





**Figure 6-2.** Board-Level Connection Diagram - Measurement System

## Connector Pin Descriptions

The connector pin descriptions in [Table 6-3](#) through [Table 6-9](#) can be used along with the board-level connection diagrams to troubleshoot board-level faults.

**Table 6-3.** Motherboard Connector Pin Descriptions

Connector Label	Reference Designator	Pin	Signal Descriptions
INTF DATA	J1	1	Ground
		2	+RS485 to Interface Board
		3	-RS485 to Interface Board
10-BASE-T	J2	1	Ethernet Output (+)
		2	Ethernet Output (-)
		3	Ethernet Input (+)
		4	NC
		5	NC
		6	Ethernet Input (-)
		7	NC
		8	NC
INTF DATA	J1	1	Ground
		2	+RS485 to Interface Board
		3	-RS485 to Interface Board
10-BASE-T	J2	1	Ethernet Output (+)
		2	Ethernet Output (-)
		3	Ethernet Input (+)
		4	NC
		5	NC
		6	Ethernet Input (-)
		7	NC
		8	NC
EXPANSION BD	J3	1	+5V
		2	+24V
		3	+24V
		4	Ground
		5	Ground
		6	Ground
		7	+RS485 to Expansion Board
		8	-RS485 to Expansion Board

**Table 6-3.** Motherboard Connector Pin Descriptions, continued

Connector Label	Reference Designator	Pin	Signal Descriptions
SPARE DATA	J4	1	+5V
		2	+24V
		3	+24V
		4	Ground
		5	Ground
		6	Ground
		7	+RS485 to Spare Board
		8	-RS485 to Spare Board
I/O	J5	1	Power Fail Relay N.C. Contact
		2	Ground
		3	TTL Input 1
		4	TTL Input 2
		5	Ground
		6	TTL Input 5
		7	TTL Input 7
		8	TTL Input 8
		9	TTL Input 10
		10	Ground
		11	TTL Input 13
		12	TTL Input 15
		13	Ground
		14	Analog Voltage Output 1
		15	Analog Voltage Output 3
		16	Ground
		17	Analog Voltage Output 5
		18	Ground
		19	Ground
		20	Power Fail Relay COM
		21	Power Fail Relay N.O. Contact
		22	Ground
		23	TTL Input 3
		24	TTL Input 4
		25	TTL Input 6

**Table 6-3.** Motherboard Connector Pin Descriptions, continued

Connector Label	Reference Designator	Pin	Signal Descriptions
		26	Ground
		27	TTL Input 9
		28	TTL Input 11
		29	TTL Input 12
		30	TTL Input 14
		31	TTL Input 16
		32	Ground
		33	Analog Voltage Output 2
		34	Analog Voltage Output 4
		35	Ground
		36	Analog Voltage Output 6
		37	Ground
SER EN	J7	1	Serial Enable Jumper
		2	+3.3V
24V IN	J10	1	+24V
		2	Ground
DIGITAL I/O	J14	1	+5V
		2	+24V
		3	+24V
		4	Ground
		5	Ground
		6	Ground
		7	SPI Reset
		8	SPI Input
		9	SPI Output
		10	SPI Board Select
		11	SPI Clock
EXT. RS485	J15	1	-RS485 to Rear Panel
		2	+RS485 to Rear Panel
		3	+5V
		4	+5V
		5	+5V
		6	Ground

**Table 6-3.** Motherboard Connector Pin Descriptions, continued

Connector Label	Reference Designator	Pin	Signal Descriptions
		7	Ground
		8	Ground
		9	NC
		10	NC
		11	+24V
		12	+24V
		13	+24V
		14	+24V
		15	+24V
24V MONITOR	J17	1	24V Power Monitor
		2	Ground
FRONT PANEL BD	J18	1	Ground
		2	Ground
		3	LCLK – LCD Signal
		4	Ground
		5	Ground
		6	LLP – LCD Signal
		7	LFLM – LCD Signal
		8	LD4 – LCD Signal
		9	LD0 – LCD Signal
		10	LD5 – LCD Signal
		11	LD1 – LCD Signal
		12	LD6 – LCD Signal
		13	LD2 – LCD Signal
		14	LD7 – LCD Signal
		15	LD3 – LCD Signal
		16	LCD Bias Voltage
		17	+5V
		18	Ground
		19	Ground
		20	LCD_ONOFF – LCD Signal
		21	Keypad Row 2 Input

**Table 6-3.** Motherboard Connector Pin Descriptions, continued

Connector Label	Reference Designator	Pin	Signal Descriptions
		22	Keypad Row 1 Input
		23	Keypad Row 4 Input
		24	Keypad Row 3 Input
		25	Keypad Col 2 Select
		26	Keypad Col 1 Select
		27	Keypad Col 4 Select
		28	Keypad Col 3 Select
		29	Ground
		30	Ground
		31	Ground
		32	Ground
		33	+24V
		34	+24V
RS232/RS485:A	P1:A	1	NC
		2	Serial Port 1 RX (-RS485 IN)
		3	Serial Port 1 TX (-RS485 OUT)
		4	NC
		5	Ground
		6	NC
		7	Serial Port 1 RTS (+RS485 OUT)
		8	Serial Port 1 CTS (+RS485 IN)
		9	NC
RS232/RS485:B	P1:B	1	NC
		2	Serial Port 2 RX (-RS485 IN)
		3	Serial Port 2 TX (-RS485 OUT)
		4	NC
		5	Ground
		6	NC
		7	Serial Port 2 RTS (+RS485 OUT)
		8	Serial Port 2 CTS (+RS485 IN)
		9	NC
AC IN	PJ1	1	AC-HOT
		2	AC-NEUT

**Table 6-3.** Motherboard Connector Pin Descriptions, continued

Connector Label	Reference Designator	Pin	Signal Descriptions
AC 24VPWR	PJ2	3	AC-Ground
		1	AC-HOT
		2	AC-NEUT
		3	AC-Ground
AC INTF BD	PJ3	1	AC-HOT
		2	AC-NEUT
		3	AC-Ground

**Table 6-4.** Measurement Interface Board Connector Pin Descriptions

Connector Label	Reference Designator	Pin	Signal Description
DATA	IPJ8	1	Ground
		2	+RS485 from Motherboard
		3	-RS485 from Motherboard
PRES	MJ3	1	Pressure Sensor Input
		2	Ground
		3	+15V
		4	-15V
INPUT BD	MJ8	1	+15V
		2	Ground
		3	-15V
		4	+5V
		5	Ground
		6	Measurement Frequency Output
		7	Amplifier Zero Adjust Voltage
		8	SPI Output
		9	SPI Clock
		10	SPI Board Select
AMB TEMP	MJ9	1	Ambient Temperature Thermistor
		2	Ground
HVPS	MJ10	1	HV Power Supply Voltage Adjust
		2	Ground

**Table 6-4.** Measurement Interface Board Connector Pin Descriptions, continued

Connector Label	Reference Designator	Pin	Signal Description
		3	HV Power Supply On/Off
		4	Ground
		5	HV Power Supply Voltage Monitor
		6	Ground
		7	Ground
FLOW SW	MJ14	1	NC
		2	Ground
		3	Ozonator Flow OK Switch
FLOW	MJ15	1	Flow Sensor Input
		2	Ground
		3	+15V
		4	-15V
		5	Ground
TEMP CTRL	MJ17	1	Bench Temperature Input
		2	Ground
		3	-15V
		4	Converter Heater On/Off
		5	Converter Temperature Input
		6	+15V_PWR
OZONATOR	OJ1	1	Ozonator Output A
		2	Ozonator Output B
24V IN	P1	1	+24V
		2	Ground
PROV INPUT	P2	1	Spare Voltage Input
		2	Ground
		3	Ground
		4	Ground
		5	Ground
		6	Ground
		7	Spare Frequency Input
		8	Ground
		9	Ground
AC PUMP	PJ1	1	AC-HOT



**Table 6-4.** Measurement Interface Board Connector Pin Descriptions, continued

Connector Label	Reference Designator	Pin	Signal Description
		2	AC-NEUT
		3	AC-Ground
FAN 1	PJ4	1	+24V
		2	Ground
FAN 2	PJ5	1	+24V
		2	Ground
AC IN	PJ6	1	AC-HOT
		2	AC-NEUT
		3	AC-Ground
COOLER	PJ7	1	Cooler Thermistor
		2	Ground
		3	+15V_PWR
		4	Cooler On/Off Control
AC TEMP	PJ8	1	AC-HOT
		2	AC-NEUT
		3	AC-Ground
NO/NOX SOL.	PJ9	1	+24V
		2	NO/NOX Solenoid Control
SAMPLE SOL.	PJ10	1	+24V
		2	Sample Solenoid Control
Z/S SOL.	PJ11	1	+24V
		2	Zero/Span Solenoid Control
SPARE1 SOL.	PJ12	1	+24V
		2	Spare 1 Solenoid Control
SPARE2 SOL.	PJ13	1	+24V
		2	Spare 2 Solenoid Control
PERM OVEN THERM	POJ1	1	Perm Oven Gas Thermistor
		2	Ground
PERM OVEN	POJ3	1	Perm Oven Heater On/Off
		2	+15V_PWR
		3	Perm Oven Thermistor
		4	Ground

**Table 6-5.** Front Panel Board Connector Pin Diagram

Connector Label	Reference Designator	Pin	Signal Description
MOTHER BOARD	J1	1	Ground
		2	Ground
		3	LCLK – LCD Signal
		4	Ground
		5	Ground
		6	LLP – LCD Signal
		7	LFLM – LCD Signal
		8	LD4 – LCD Signal
		9	LD0 – LCD Signal
		10	LD5 – LCD Signal
		11	LD1 – LCD Signal
		12	LD6 – LCD Signal
		13	LD2 – LCD Signal
		14	LD7 – LCD Signal
		15	LD3 – LCD Signal
		16	LCD Bias Voltage
		17	+5V
		18	Ground
		19	Ground
		20	LCD_ONOFF – LCD Signal
		21	Keypad Row 2 Input
		22	Keypad Row 1 Input
		23	Keypad Row 4 Input
		24	Keypad Row 3 Input
		25	Keypad Col 2 Select
		26	Keypad Col 1 Select
		27	Keypad Col 4 Select
		28	Keypad Col 3 Select
		29	Ground
		30	Ground
		31	Ground

**Table 6-5.** Front Panel Board Connector Pin Diagram, continued

Connector Label	Reference Designator	Pin	Signal Description
		32	Ground
		33	+24V
		34	+24V
LCD DATA	J2	1	LFLM_5V – LCD Signal
		2	LLP_5V – LCD Signal
		3	LCLK_5V – LCD Signal
		4	LCD_ONOFF_5V – LCD Signal
		5	+5V
		6	Ground
		7	LCD Bias Voltage
		8	LD0_5V – LCD Signal
		9	LD1_5V – LCD Signal
		10	LD2_5V – LCD Signal
		11	LD3_5V – LCD Signal
		12	LD4_5V – LCD Signal
		13	LD5_5V – LCD Signal
		14	LD6_5V – LCD Signal
		15	LD7_5V – LCD Signal
		16	Ground
KEYBOARD	J3	1	Keypad Row 1 Input
		2	Keypad Row 2 Input
		3	Keypad Row 3 Input
		4	Keypad Row 4 Input
		5	Keypad Col 1 Select
		6	Keypad Col 2 Select
		7	Keypad Col 3 Select
		8	Keypad Col 4 Select
LCD BACKLIGHT	J4	1	LCD Backlight Voltage 1
		2	NC
		3	NC
		4	LCD Backlight Voltage 2

**Table 6-6.** I/O Expansion Board (Optional) Connector Pin Descriptions

Connector Label	Reference Designator	Pin	Signal Description
EXPANSION I/O	J1	1	Analog Voltage Input 1
		2	Analog Voltage Input 2
		3	Analog Voltage Input 3
		4	Ground
		5	Analog Voltage Input 4
		6	Analog Voltage Input 5
		7	Analog Voltage Input 6
		8	Ground
		9	Analog Voltage Input 7
		10	Analog Voltage Input 8
		11	Ground
		12	NC
		13	NC
		14	Ground
		15	Current Output 1
		16	Current Output Return
		17	Current Output 2
		18	Current Output Return
		19	Current Output 3
		20	Current Output Return
		21	Current Output 4
		22	Current Output Return
		23	Current Output 5
		24	Current Output Return
		25	Current Output 6
MOTHER BD	J2	1	+5V
		2	+24V
		3	+24V
		4	Ground
		5	Ground
		6	Ground

**Table 6-6.** I/O Expansion Board (Optional) Connector Pin Descriptions, continued

Connector Label	Reference Designator	Pin	Signal Description
		7	+RS485 to Motherboard
		8	-RS485 to Motherboard

**Table 6-7.** Digital Output Board Connector Pin Descriptions

Connector Label	Reference Designator	Pin	Signal Description
MOTHER BD	J1	1	+5V
		2	+24V
		3	+24V
		4	Ground
		5	Ground
		6	Ground
		7	SPI Reset
		8	SPI Input
		9	SPI Output
		10	SPI Board Select
		11	SPI Clock
DIGITAL OUTPUTS	J2	1	Relay 1 Contact a
		2	Relay 2 Contact a
		3	Relay 3 Contact a
		4	Relay 4 Contact a
		5	Relay 5 Contact a
		6	Relay 6 Contact a
		7	Relay 7 Contact a
		8	Relay 8 Contact a
		9	Relay 9 Contact a
		10	Relay 10 Contact a
		11	NC
		12	Solenoid Drive Output 1
		13	Solenoid Drive Output 2
		14	Solenoid Drive Output 3

**Table 6-7.** Digital Output Board Connector Pin Descriptions, continued

Connector Label	Reference Designator	Pin	Signal Description
		15	Solenoid Drive Output 4
		16	Solenoid Drive Output 5
		17	Solenoid Drive Output 6
		18	Solenoid Drive Output 7
		19	Solenoid Drive Output 8
		20	Relay 1 Contact b
		21	Relay 2 Contact b
		22	Relay 3 Contact b
		23	Relay 4 Contact b
		24	Relay 5 Contact b
		25	Relay 6 Contact b
		26	Relay 7 Contact b
		27	Relay 8 Contact b
		28	Relay 9 Contact b
		29	Relay 10 Contact b
		30	+24V
		31	+24V
		32	+24V
		33	+24V
		34	+24V
		35	+24V
		36	+24V
		37	+24V

**Table 6-8.** Input Board Connector Pin Descriptions

Connector Label	Reference Designator	Pin	Signal Description
PMT IN	J1	1	PMT Input
		2	Ground
INTF BD	J2	1	+15V
		2	Ground
		3	-15V

**Table 6-8.** Input Board Connector Pin Descriptions, continued

Connector Label	Reference Designator	Pin	Signal Description
		4	+5V
		5	Ground
		6	Measurement Frequency Output
		7	Amplifier Zero Adjust Voltage
		8	SPI Input
		9	SPI Clock
		10	SPI Board Select

**Table 6-9.** Temperature Control Board Connector Pin Descriptions

Connector Label	Reference Designator	Pin	Signal Description
INTERFACE	J1	1	Bench Temperature Input
		2	Ground
		3	-15V
		4	Converter Heater On/Off
		5	Converter Temperature Input
		6	+15V_PWR
AC INPUT	J2	1	AC-HOT
		2	AC-NEUT
BENCH	J3	1	Bench Heater AC Output
		2	Bench Heater AC Return
		3	Ground
		4	Bench Thermistor
CONVERTER	J4	1	Ground
		2	Converter Heater AC Output
		3	Converter Heater AC Return
CONV TC	J5	1	Converter Thermocouple TC
		2	Converter Thermocouple TC+
SS TEMP	J6	1	SS Temperature Range Jumper A
		2	SS Temperature Range Jumper B

## **Service Locations**

For additional assistance, service is available from exclusive distributors worldwide. Contact one of the phone numbers below for product support and technical information or visit us on the web at [www.thermo.com/aqi](http://www.thermo.com/aqi).

1-866-282-0430 Toll Free

1-508-520-0430 International



## Chapter 7 Servicing

This chapter explains how to replace the Model 42i NO<sub>x</sub> subassemblies. It assumes that a subassembly has been identified as defective and needs to be replaced.

For fault location information refer to the “Preventive Maintenance” chapter and the “Troubleshooting” chapter in this manual.

The service mode in the “Operation” chapter also includes parameters and functions that are useful when making adjustments or diagnosing problems.

For additional service assistance, see “Service Locations” at the end of this chapter.

This chapter includes the following parts information and component replacement procedures.

- “Safety Precautions” on page 7-3
- “Firmware Updates” on page 7-4
- “Replacement Parts List” on page 7-4
- “Cable List” on page 7-5
- “Removing the Measurement Bench and Lowering the Partition Panel” on page 7-8
- “Pump Replacement” on page 7-9
- “Fan Replacement” on page 7-10
- “PMT Cooler and Reaction Chamber Assembly Replacement” on page 7-11
- “Photomultiplier Tube Replacement” on page 7-13
- “PMT High Voltage Power Supply Replacement” on page 7-15
- “Reaction Chamber Cleaning or Removal” on page 7-17

- “NO<sub>2</sub>-to-NO Converter Replacement” on page 7-19
- “Ozonator Assembly Replacement” on page 7-21
- “Ozonator Transformer Replacement” on page 7-23
- “Input Board Replacement” on page 7-23
- “DC Power Supply Replacement” on page 7-26
- “Analog Output Adjustment” on page 7-29
- “Pressure Transducer Assembly Replacement” on page 7-30
- “Pressure Transducer Calibration ” on page 7-31
- “Temperature Control Board Replacement” on page 7-33
- “Ambient Temperature Calibration” on page 7-34
- “Fuse Replacement” on page 7-35
- “Scrubber Replacement” on page 7-36
- “I/O Expansion Board (Optional) Replacement” on page 7-37
- “Digital Output Board Replacement” on page 7-38
- “Motherboard Replacement” on page 7-39
- “Measurement Interface Board Replacement” on page 7-40
- “Flow Transducer Replacement” on page 7-41
- “Front Panel Board Replacement” on page 7-44
- “LCD Module Replacement” on page 7-45
- “Service Locations” on page 7-47

## 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. ▲

If the equipment is operated in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired. ▲



**CAUTION** Carefully observe the instructions in each procedure. Avoid contact with converter heated components.

Allow converter to cool to room temperature before handling converter components. ▲



**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 ([Figure 7-1](#)). If an antistatic wrist strap is not available, be sure to touch a grounded metal object before touching any internal components. When the instrument is unplugged, the chassis is not at earth ground. ▲

Handle all printed circuit boards by the edges. ▲

Do Not point the photomultiplier tube at a light source. This can permanently damage the tube. ▲

Do not remove the LCD panel or frame from the LCD module. ▲

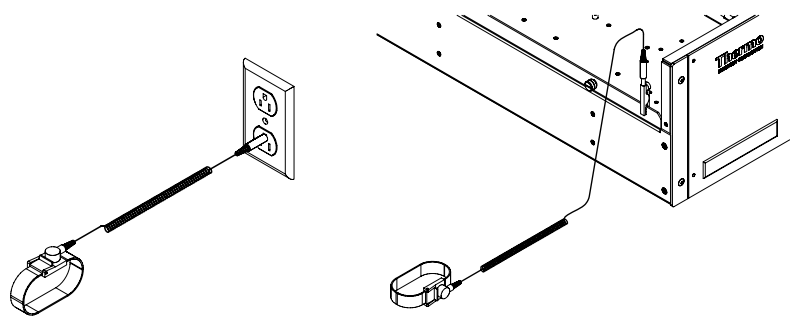
The polarizing plate is very fragile, handle it carefully. ▲

Do not wipe the polarizing plate with a dry cloth, it may easily scratch the plate. ▲

Do not use alcohol, acetone, MEK or other Ketone based or aromatic solvents to clean the LCD module, 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. ▲



**Figure 7-1.** Properly Grounded Antistatic Wrist Strap

## Firmware Updates

The firmware can be updated by the user in the field via the serial port or over the Ethernet. This includes both the main processor firmware and the firmware in all low-level processors. Refer to the *i-Port* manual for the firmware update procedure.

## Replacement Parts List

[Table 7-1](#) lists the replacement parts for the Model 42i NO<sub>x</sub> major subassemblies. Refer to [Figure 7-2](#) to identify the component location.

**Table 7-1.** Model 42i NO<sub>x</sub> Replacement Parts

Part Number	Description
100480-00	Front Panel Pushbutton Board
101491-06	Processor Board
100533-00	Motherboard
100539-00	Digital Output Board
100542-00	I/O Expansion Board (Optional)
102340-00	Front Panel Connector Board
102496-00	Front Panel Display
101399-00	Transformer, 220-240VAC (Optional)
101863-00	Transformer, 100VAC (Optional)
100536-00	Measurement Interface Board
100856-00	Temperature Control Board
101167-00	Input Board Assembly
9973	Ozonator Assembly
9974	Ozonator Transformer
101023-00	Pressure Transducer

**Table 7-1.** Model 42i NO<sub>x</sub> Replacement Parts, continued

Part Number	Description
101021-00	Flow Transducer (Sample)
101620-00	Flow Switch (Ozone)
9367	Photomultiplier Tube (PMT)
101024-00	PMT High Voltage Power Supply
9981	PMT Base Socket Assembly
101020-00	Cooler Assembly
102648-01	Reaction Chamber Assembly
101009-00	NO <sub>2</sub> -to-NO Converter Assembly (Molybdenum 110VAC)
101214-00	NO <sub>2</sub> -to-NO Converter Assembly (Stainless Steel 110VAC)
9269	Molybdenum Converter Cartridge
9467	Stainless Steel Converter Cartridge
101011-00	Pump 110VAC w/Plate and Fittings
9267	Pump Repair Kit (for 101011-00)
101055-00	AC Receptacle Assembly
101681-00	Power Supply Assembly, 24VDC, w/Base Plate and Screws
100907-00	Fan, 24VDC
8630	Fan Filter
101905-00	Fuse, 250VAC, 4.0 Amp, SlowBlow (for 100VAC and 110VAC models)
101904-00	Fuse, 250VAC, 2.0 Amp, SlowBlow (for 220-240VAC models)
101688-00	Ambient Temperature Connector with Thermistor
4119	Capillary 0.008-inch ID
4127	Capillary 0.015-inch ID
6556	Optical Filter Kit (Red Filter, Quartz Window, Rubber Washer)
101562-00	Terminal Block and Cable Kit (DB25)
101556-00	Terminal Block and Cable Kit (DB37)

## Cable List

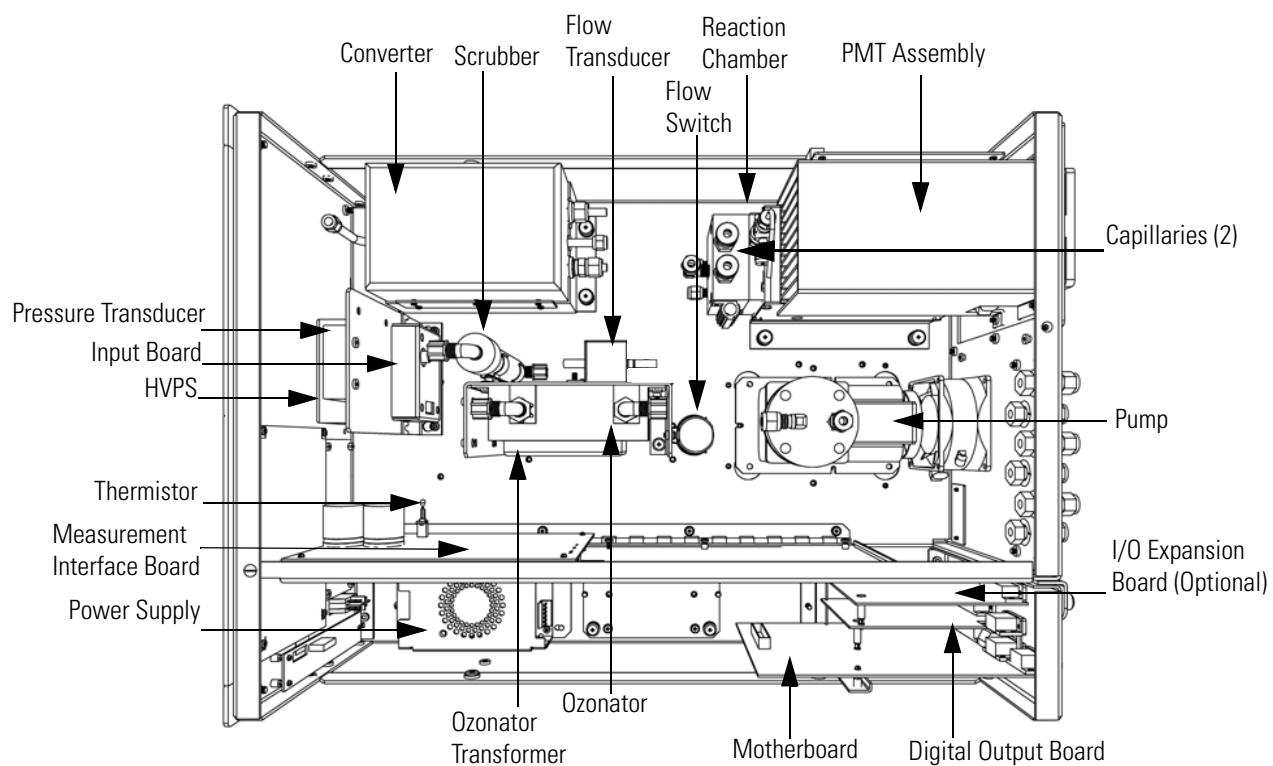
Table 7-2 describes the Model 42i NO<sub>x</sub> spare cables. See the “Troubleshooting” chapter for associated connection diagrams and board connector pin descriptions.

**Table 7-2.** Model 42i NO<sub>x</sub> Cables

Part Number	Description
101036-00	DC Power Supply 24V Output
101037-00	115VAC Supply to Interface Board

**Table 7-2.** Model 42i NO<sub>x</sub> Cables, continued

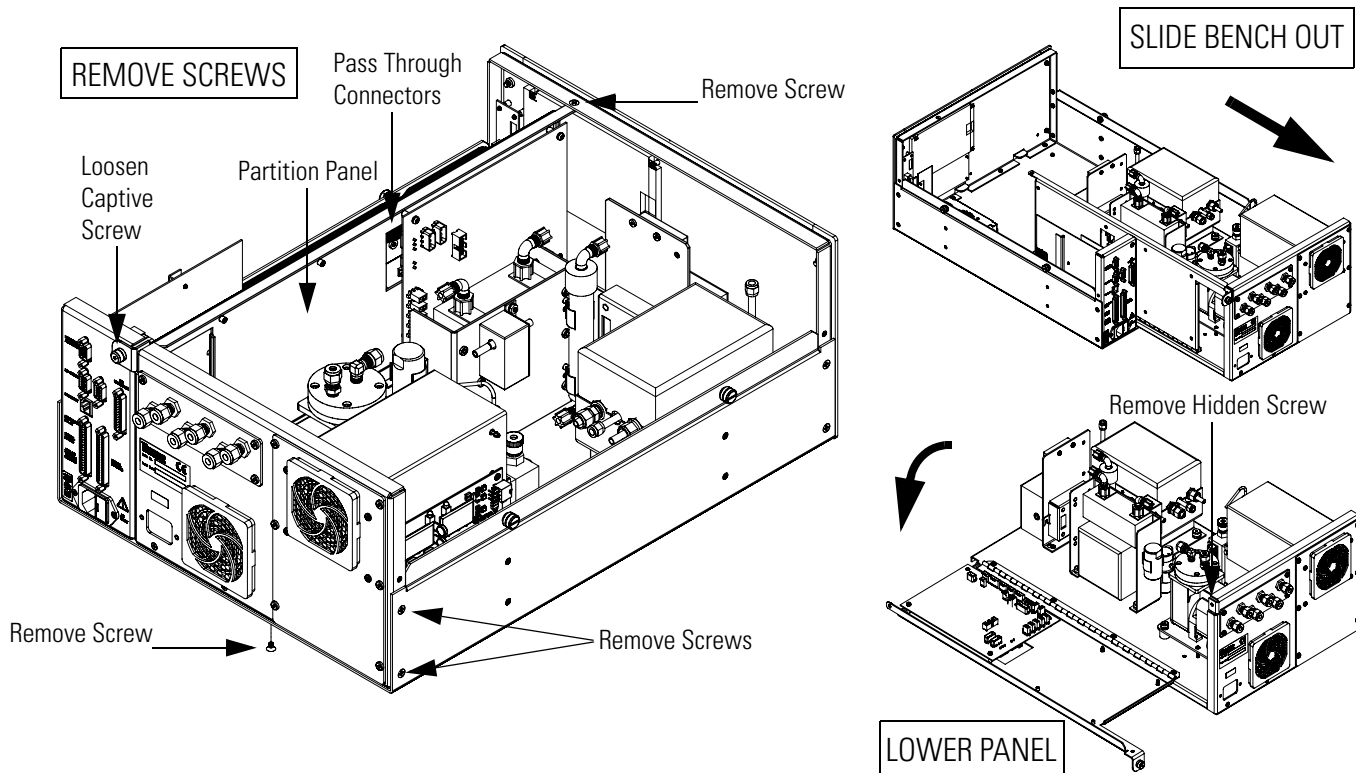
Part Number	Description
101048-00	RS-485/Data
101038-00	Power Switch to Motherboard
101364-00	DC Power Supply Status Monitor
101054-00	Motherboard to Front Panel Board
101035-00	DC Power Supply AC Input
101033-00	AC from Receptacle
101377-00	AC to Power Switch
101267-00	Fan Power Cable
101346-00	Temperature Control
101355-00	Signal Output Ribbon
101695-00	Permeation Oven
101050-00	Heater Power
101055-00	Main AC Receptacle Assembly
102057-00	AC to External Pump



**Figure 7-2.** Component Layout

# Removing the Measurement Bench and Lowering the Partition Panel

The measurement bench can be removed and the partition panel can be lowered to improve access to connectors and components. Refer to the following steps when a procedure requires lowering the partition panel (see [Figure 7-3](#)).



**Figure 7-3.** Removing the Measurement Bench and Lowering the Partition Panel

Equipment Required:

Philips screwdriver



**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. ▲

1. Turn instrument OFF and unplug the power cord.
2. If the instrument is mounted in a rack, remove it from the rack.



3. Remove the cover.
4. Disconnect the plumbing connections at the rear of the measurement bench.
5. Disconnect the three connectors that pass through the center of the partition panel.
6. Remove two screws from the left side of the case (viewed from front).
7. Remove one screw from the bottom front of the case.
8. Remove one screw from the top front of the partition panel.
9. While holding the case securely, loosen the captive screw at the rear of the measurement bench, and pull the measurement bench from the rear of the case.
10. Remove the screw at the top rear of the partition panel securing the top of partition panel to the measurement bench, and lower the panel being careful not to put excessive tension on the cables.
11. Replace the measurement bench by following previous steps in reverse.

## Pump Replacement

Use the following procedure to replace the pump (see [Figure 7-4](#)). To rebuild the pump, see “Pump Rebuilding” in the “Preventive Maintenance” chapter.

Equipment Required:

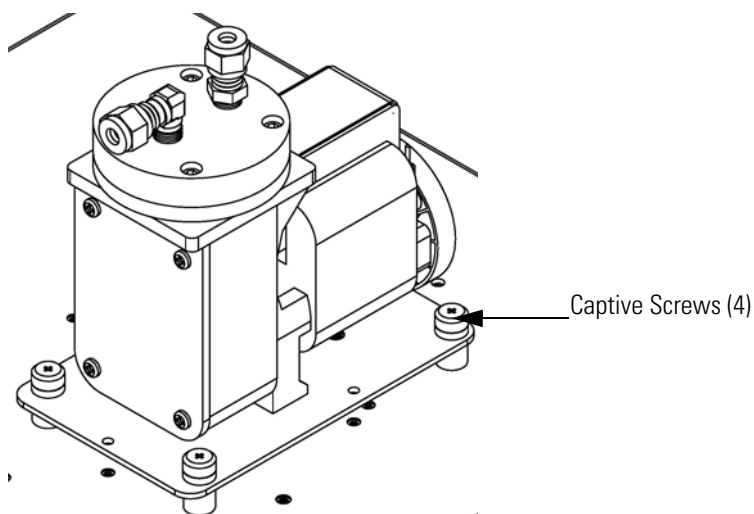
110V pump or 220V pump

Screwdriver



**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. ▲

1. Turn instrument OFF, unplug the power cord, and remove the cover.
2. Disconnect pump power line from AC PUMP connector on the measurement interface board.



**Figure 7-4.** Replacing the Pump

3. Remove both lines from pump.
4. Loosen the four captive screws holding the pump to the mounting plate and remove the pump.
5. Install the new pump by following the previous steps in reverse.

## Fan Replacement

Use the following procedure to replace the fan ([Figure 7-5](#)).

Equipment Required:

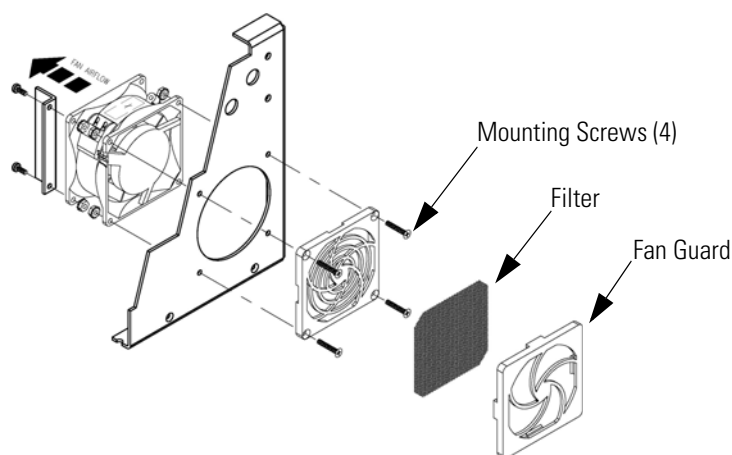
Fan

Philips screwdriver



**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. ▲

1. Turn instrument OFF, unplug the power cord, and remove the cover.
2. Remove the fan guard from the fan and remove the filter.
3. Pull the power connectors off the fan.
4. Remove the four fan mounting screws and remove the fan.
5. Install a new fan following the previous steps in reverse.



**Figure 7-5.** Replacing a Fan

## PMT Cooler and Reaction Chamber Assembly Replacement

Use the following procedure to replace the PMT cooler and reaction chamber assembly (see [Figure 7-6](#)).

Equipment Required:

PMT cooler

Wrenches, 7/16-inch, 9/16-inch

## Servicing

### PMT Cooler and Reaction Chamber Assembly Replacement

Nut driver, 1/4-inch

Philips screwdriver

Wire cutters



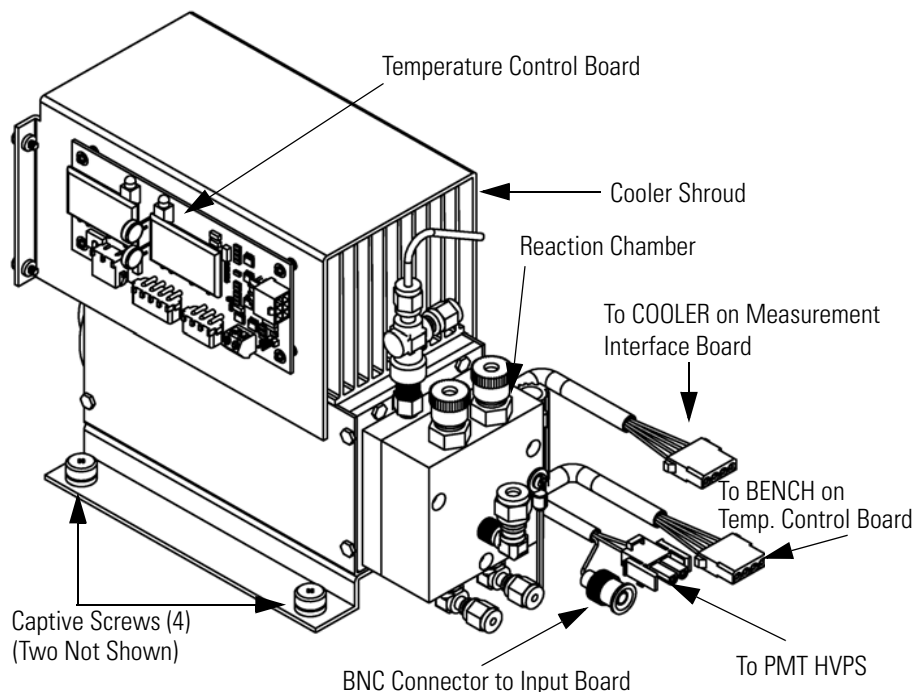
**Equipment Damage** Some internal components can be damaged by small amounts of static electricity. A properly grounded antistatic wrist strap must be worn while handling any internal component. ▲

1. Refer to “Removing the Measurement Bench and Lowering the Partition Panel” in this chapter to lower the partition panel, then proceed to the next step below.
2. Disconnect the reaction chamber connector from the temperature control board.
3. Snap off the temperature control board from the board mounts.
4. Remove the four screws securing the cooler shroud and remove the shroud.
5. Disconnect plumbing connections from the reaction chamber.
6. Disconnect the PMT cooler cables from the PMT high voltage power supply, the input board, and the measurement interface board. Remove all tie-wraps securing the cables.
7. Loosen four captive screws holding cooler to floor plate and remove the cooler assembly with the reaction chamber.

**Note** If only the cooler is being replaced, remove the PMT and reaction chamber from the old cooler and install them on the new cooler. ▲

Fasten knurled fittings on reaction chamber finger tight. ▲

Make sure that the heat shrink covered tubing between the reaction chamber and the converter is light tight at the connections. ▲



**Figure 7-6.** PMT Cooler and Reaction Chamber

8. Install new cooler by following previous steps in reverse.
9. Re-install the measurement bench. Refer to “Removing the Measurement Bench and Lowering the Partition Panel” in this chapter.

## Photomultiplier Tube Replacement

Use the following procedure to replace the PMT tube.

Equipment Required:

Photomultiplier tube and PMT base

Nut driver, 5/16-inch

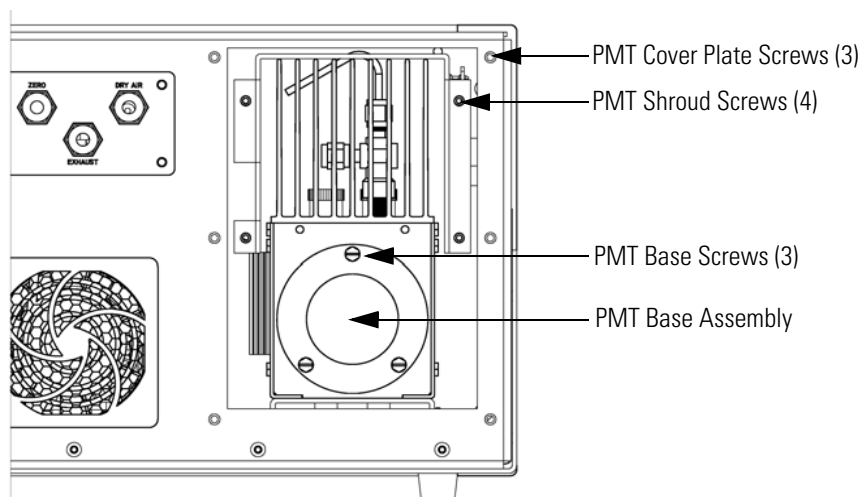
Flat blade screwdriver

Philips screwdriver, small



**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. ▲

1. Turn instrument OFF, unplug the power cord, and remove the cover.
2. Disconnect the high voltage cable from the PMT power supply and unplug the BNC cable from the Input Board.
3. Remove six external screws holding PMT cover plate and the four screws holding the PMT shroud to the panel and remove the PMT cover plate (Figure 7-7). If the cooler fan is attached, unplug the fan power cord if necessary.



**Figure 7-7.** Replacing the PMT

4. Remove the three retaining screws holding PMT base assembly to the cooler using a 5/16-inch nut driver.



**Equipment Damage** Do not point the photomultiplier tube at a light source. This can permanently damage the tube. ▲

5. Pull the PMT and PMT base from cooler assembly by twisting it slightly back and forth.

6. To install PMT, follow previous steps in reverse making sure to backfill the cooler with dry air or nitrogen prior to replacing the PMT.
7. Perform a photomultiplier tube calibration. See “Photomultiplier Tube Calibration” in the “Operation” chapter.

## **PMT High Voltage Power Supply Replacement**

Use the following procedure to replace the PMT high voltage power supply (Figure 7-8).

Equipment Required:

PMT high voltage power supply

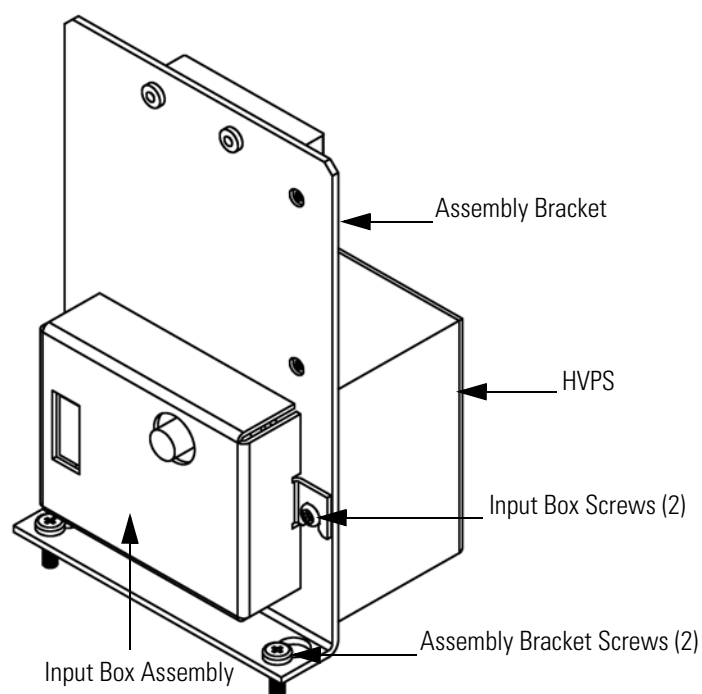
Nut driver, 1/4-inch

Philips screwdriver



**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. ▲

1. Turn instrument OFF, unplug the power cord, and remove the cover.
2. Disconnect the two PMT high voltage supply cables.
3. Loosen the two retaining screws securing the assembly bracket to the floor plate and slide the assembly towards the rear slightly and lift it off the base screws.
4. Loosen two screws on the input box assembly and lift the input box assembly off the power supply.
5. Remove the four screws securing the power supply to the bracket and remove the power supply.



**Figure 7-8.** Replacing the PMT HVPS

6. To install the power supply, follow the previous steps in reverse.
7. Recalibrate the instrument. Refer to the calibration procedures in the “Calibration” chapter.

## PMT Voltage Adjustment





Use the following procedure to adjust the PMT voltage after switching from standard to extended ranges or vice versa.



**WARNING** The service procedures in this manual are restricted to qualified service representatives. ▲





1. Select the NO, NO<sub>2</sub>, and NO<sub>x</sub> ranges. Refer to “Range Menu” in the “Calibration” chapter.
2. Set the NO BKG and NO<sub>x</sub> BKG calibration factors to 0.0. Refer to “Calibration Factors Menu” in the “Calibration” chapter.






3. Set the NO COEF, NO<sub>x</sub> COEF, and NO<sub>2</sub> COEF to 1.000.
4. Set the Averaging Time to 10 seconds. Refer to “Averaging Time” in the “Calibration” chapter.
5. Connect the calibration gas and allow the instrument to sample calibration gas until the reading stabilizes.
6. From the Main Menu, press  to scroll to Service, press   to scroll to **PMT Voltage Adjustment** and press .



The Set PMT Voltage screen appears.

If the Service Mode is not displayed on the Main Menu, use the following procedure to display it.

- a. At the Main Menu, press  to scroll to Instrument Controls, press   to scroll to **Service Mode** and press .

The Service Mode screen appears.

- b. Press  to toggle the Service Mode to ON.
- c. Press   to return to the Main Menu.
- d. Continue the procedure at the beginning of Step 6 to display the Set PMT Voltage screen.

7. At the Set PMT Voltage screen, use   to increment/decrement the counts until the instrument displays the calibration gas concentration value.

## Reaction Chamber Cleaning or Removal

Use the following procedure to clean or remove the reaction chamber (see [Figure 7-9](#)).

Equipment Required:

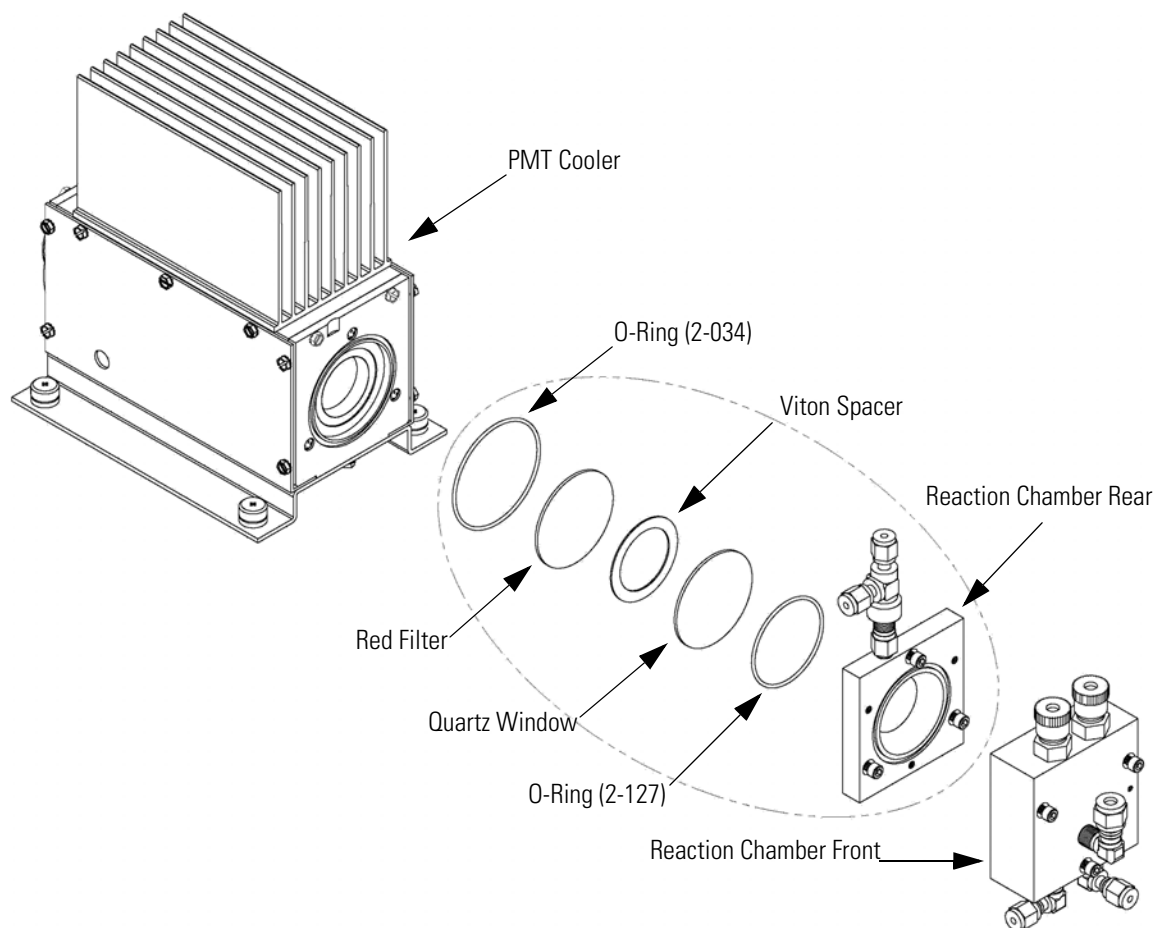
Allen wrench, 9/64-inch

Wrenches, 7/16-inch, 9/16-inch



**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. ▲

1. Remove PMT cooler as described in “PMT Cooler and Reaction Chamber Replacement” in this chapter.
2. Disconnect all plumbing connections from the reaction chamber.
3. Remove the three socket head screws fastening front of reaction chamber to rear (Figure 7-9). This exposes the inner surfaces of both sections of the reaction chamber and the quartz window. To clean these surfaces use cotton swabs and methanol.
4. To continue removing rear of reaction chamber remove the three socket head screws holding it to cooler, being careful to keep quartz window and red filter in cooler body.
5. To reinstall reaction chamber, follow previous steps in reverse, making sure to backfill the cooler with dry air or nitrogen prior to installing reaction chamber.
6. Re-install the measurement bench. Refer to “Removing the Measurement Bench and Lowering the Partition Panel” in this chapter.



**Figure 7-9.** Cleaning or Removing the Reaction Chamber

## NO<sub>2</sub>-to-NO Converter Replacement

Use the following procedure to replace the converter ([Figure 7-10](#)).

Equipment Required:

NO<sub>2</sub>-to-NO Converter

Wrenches, 7/16-inch, 1/2-inch, 9/16-inch, 5/8-inch

Phillips screwdriver

Nut drivers, 1/4-inch, 5/16-inch

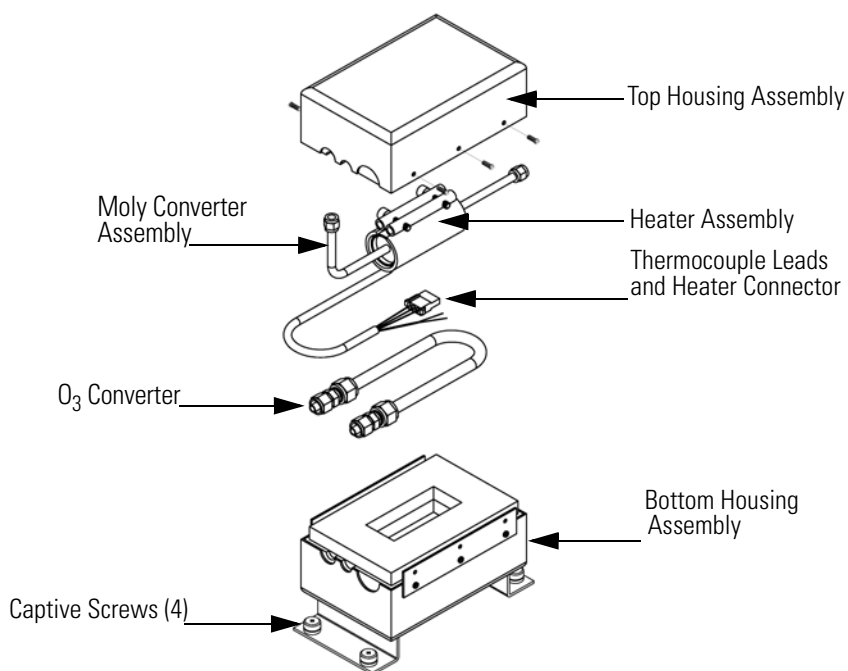


**CAUTION** Avoid contact with converter heated components. Allow converter to cool to room temperature before handling converter components. ▲



**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. ▲

1. Turn instrument OFF, unplug the power cord, and remove the cover.
2. Allow converter to cool to room temperature to prevent contact with heated components.
3. Disconnect plumbing at converter inlet and outlet.
4. Disconnect thermocouple leads and heater connector from temperature control board.
5. Loosen the four captive screws holding converter housing to floor plate.
6. Remove the six screws holding the top housing assembly to the bottom half.
7. Remove the converter cartridge/heater assembly from the bottom housing assembly.
8. Loosen the heater clamp, pry heater apart no wider than necessary and remove the converter cartridge noting the proper orientation of heater wires and thermocouple probe.
9. To replace converter, follow previous steps in reverse. Be sure to wrap the O<sub>3</sub> converter tube snugly around the heater.



**Figure 7-10.** NO<sub>2</sub>-to-NO Moly Converter Assembly

## Ozonator Assembly Replacement

Use the following procedure to replace the ozonator assembly ([Figure 7-11](#)).

Equipment Required:

Ozonator assembly

Wrench, 5/8-inch

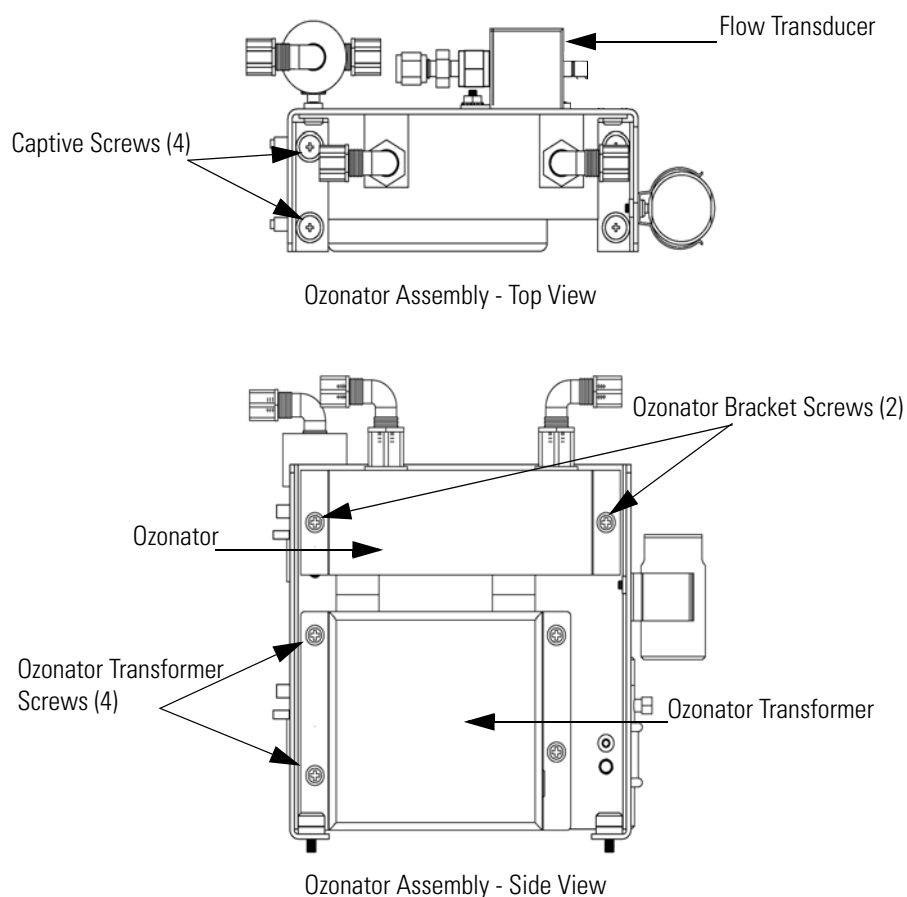
Philips screwdriver



**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. ▲

1. Refer to “Removing the Measurement Bench and Lowering the Partition Panel” in this chapter to lower the partition panel, then proceed to the next step below.
2. Carefully disconnect the plumbing at the glass inlet and outlet of the ozonator.

3. Disconnect the stainless steel tubing from the flow transducer.
4. Loosen the four captive screws securing the ozonator bracket to the floor plate.
5. Remove the two screws securing the ozonator to the ozonator bracket.



**Figure 7-11.** Replacing the Ozonator Assembly

6. Unplug the ozonator from the ozonator transformer by lifting the ozonator straight up.
7. To install the ozonator, follow the previous steps in reverse.
8. Re-install the measurement bench. Refer to “Removing the Measurement Bench and Lowering the Partition Panel” in this chapter.

## Ozonator Transformer Replacement

Use the following procedure to replace the ozonator transformer (Figure 7-11).

Equipment Required:

Ozonator transformer

Philips screwdriver



**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. ▲

1. Turn instrument OFF, unplug the power cord, and remove the cover.
2. Remove the ozonator assembly as described in “Ozonator Assembly Replacement.”
3. Disconnect the plug connecting the ozonator transformer to the measurement interface board (OZONATOR connector).
4. Remove the four screws holding the ozonator transformer to the ozonator bracket and remove the ozonator transformer.
5. To install the ozonator transformer, follow the previous steps in reverse.
6. Re-install the measurement bench. Refer to “Removing the Measurement Bench and Lowering the Partition Panel” in this chapter.

## Input Board Replacement

Use the following procedure to replace the input board (Figure 7-12).

Equipment Required:

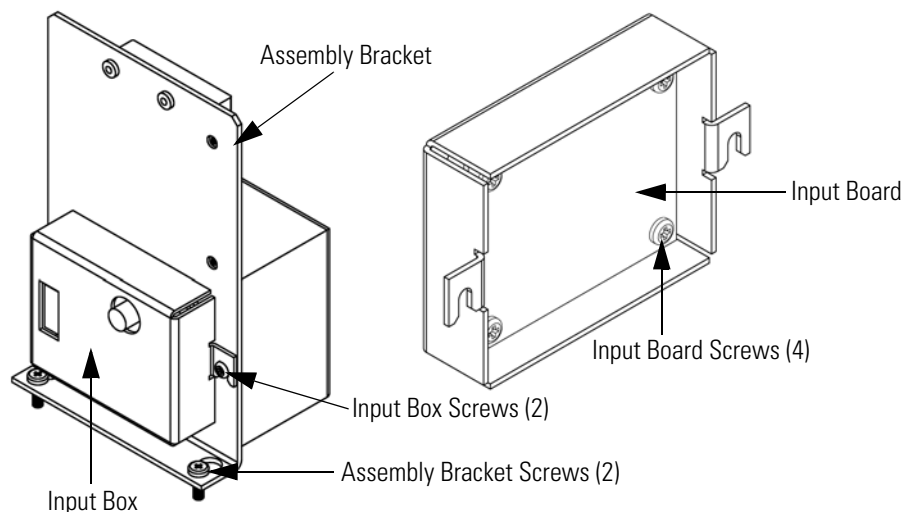
Input board

Philips screwdriver



**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. ▲

1. Refer to “Removing the Measurement Bench and Lowering the Partition Panel” in this chapter to lower the partition panel, then proceed to the next step below.
2. Disconnect the BNC signal and the ribbon cable.
3. Loosen the two screws holding the assembly bracket to the floor plate, move the assembly towards the rear, and lift the assembly off the screws.
4. Loosen the two screws holding the input box to the assembly bracket and lift the input box off the screws.



**Figure 7-12.** Replacing the Input Board

5. Remove the four screws holding the input board to the input box and remove the input board.
6. Install the input board by following the previous steps in reverse.



7. Re-install the measurement bench. Refer to “Removing the Measurement Bench and Lowering the Partition Panel” in this chapter.
8. Perform an input board calibration. See the “Input Board Calibration” procedure that follows.

## Input Board Calibration

After replacing the input board, use the following procedure to calibrate the input board.







**WARNING** The service procedures in this manual are restricted to qualified service representatives. ▲






1. From the Main Menu, press  to scroll to Service, press   to scroll to **Input Board Calibration** and press .

The Input Board Calibration screen appears.



If the Service Mode is not displayed on the Main Menu, use the following procedure to display it.




- a. At the Main Menu, press  to scroll to Instrument Controls, press   to scroll to Service Mode and press .

The Service Mode screen appears.

- b. Press  to toggle the Service Mode to ON.
  - c. Press   to return to the Main Menu.
  - d. Continue the procedure at the beginning of Step 1 to access the Set PMT Voltage screen.
2. At the Input Board Calibration screen, press  to select Manual Input Cal, and press  to calibrate.

The screen displays the frequency at GAIN 1.

3. Make a note of the FREQ value displayed at GAIN 1, then press  or  to change the GAIN to 100.

- At the GAIN 100 screen, use   to increment the D/A counts until the FREQ value matches or is slightly above (within 50 counts) the value noted in the previous step.
- Press  to store the value.

The screen flashes **Calculating - Please Wait!** and **Done - Values Saved!** messages.

## DC Power Supply Replacement

Use the following procedure to replace the DC power supply ([Figure 7-13](#)).

Equipment Required:

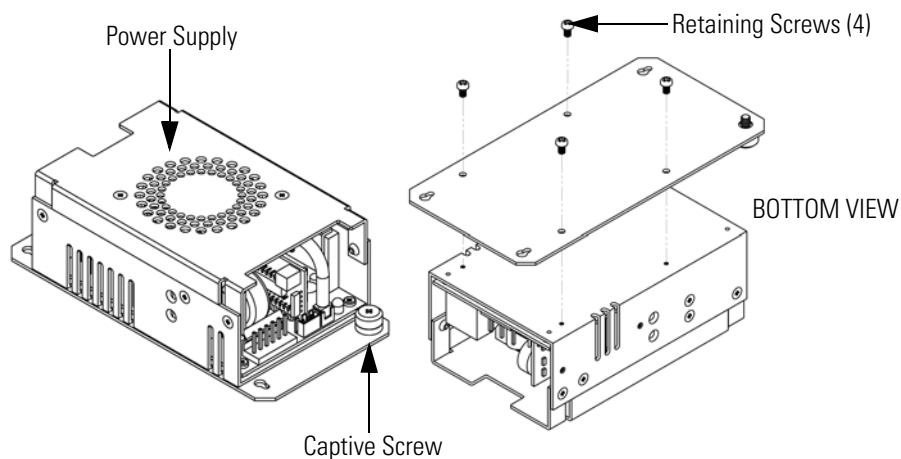
DC power supply

Philips screwdriver



**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. ▲

- Turn instrument OFF, unplug the power cord, and remove the cover.



**Figure 7-13.** Replacing the DC Power Supply

- Disconnect all the power supply electrical connections. Note connector locations to facilitate re-connection.

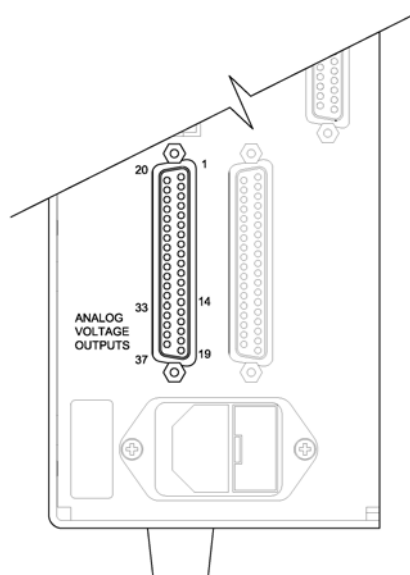
3. Loosen the captive screw securing the power supply to the chassis plate and lift out the power supply.
4. Turn the power supply upside down and remove the four retaining screws securing the power supply to the power supply plate and remove the power supply.
5. To install the DC power supply, follow the previous steps in reverse.

## Analog Output Testing

The analog outputs should be tested if the concentration value on the front panel display disagrees with the analog outputs. To check the analog outputs, you connect a meter to an analog voltage output channel and compare the meter reading with the output value set on the Test Analog Outputs screen.

Use the following procedure to test the analog outputs.





1. Connect a meter to the channel to be tested. [Figure 7-14](#) shows the analog output pins and [Table 7-3](#) identifies the associated channels.





**Figure 7-14.** Rear Panel Analog Voltage Output Pins

**Table 7-3.** Analog Output Channels and Rear Panel Pin Connections


Channel	Pin
1	14
2	33
3	15
4	34
5	17
6	36
Ground	16, 18, 19, 35, 37

2. From the Main Menu, press  to scroll to Diagnostics, press   
 to scroll to Test Analog Outputs, and press .

The Test Analog Outputs screen appears.


3. Press  to scroll to the channel (Voltage Channel 1-6) corresponding to the rear panel terminal pin where the meter is connected, and press .

The Set Analog Outputs screen appears.

4. Press  to set the output to full scale.

The Output Set To: field displays Full Scale.

5. Check that the meter is displaying the full scale value. If the meter reading differs by more than one percent, the analog outputs should be adjusted. Refer to the “Analog Output Adjustment” procedure that follows.

6. Press  to set the output to zero.





The Output Set To: field displays Zero.

7. Check that the meter is displaying a zero value. If the meter reading differs by more than one percent, the analog outputs should be adjusted. Refer to the “Analog Output Adjustment” procedure that follows.

## Analog Output Adjustment





Use the following procedure to adjust the analog voltage outputs if a meter reading in the “Analog Output Testing” procedure differed by more than one percent.

1. Connect a meter to the channel to be adjusted. [Figure 7-14](#) shows the analog output pins and [Table 7-3](#) identifies the associated channels.




2. From the Main Menu, press  to scroll to Service, press   
 to scroll to Analog Output Calibration and press .



The Analog Output Cal screen appears

If the Service Mode is not displayed on the Main Menu, use the following procedure to display it.

- a. At the Main Menu, press  to scroll to Instrument Controls, press   to scroll to Service Mode and press .

The Service Mode screen appears.




- b. Press  to toggle the Service Mode to ON.
- c. Press   to return to the Main Menu.
- d. Continue the procedure at Step 2.


3. At the Analog Output Cal screen, press  to scroll to the channel (Voltage Channel 1-6) corresponding to the rear panel terminal pin where the meter is connected, then press .

The Analog Output Cal: screen appears.



4. With the cursor at Calibrate Zero, press .

The Analog Output Cal: line displays Zero




5. Use   until the meter reads 0V, then press  to save the value.

6. Press  to return to the Analog Output Cal: screen.

The Analog Output Cal: screen appears.

7. Press   to select Calibrate Full Scale.

The Analog Output Cal: Span screen appears.

8. Use   until the meter reads the value shown in the Set Output To: line, then press  to save the value.

## Pressure Transducer Assembly Replacement

Use the following procedure to replace the pressure transducer assembly (Figure 7-15).

Equipment Required:

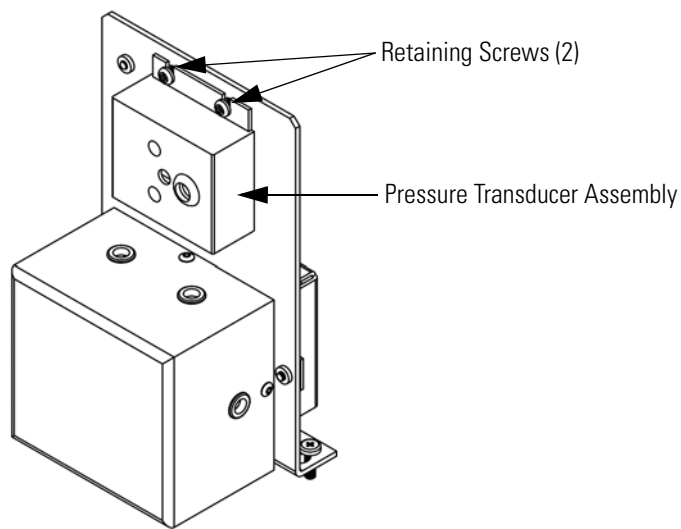
Pressure transducer assembly

Philips screwdriver



**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. ▲

1. Turn instrument OFF, unplug the power cord, and remove the cover.
2. Disconnect plumbing from the pressure transducer assembly. Note the plumbing connections to facilitate reconnection.
3. Disconnect the pressure transducer cable.
4. Remove the two pressure transducer assembly retaining screws and remove the pressure transducer assembly.



**Figure 7-15.** Replacing the Pressure Transducer

5. To install the pressure transducer assembly, follow previous steps in reverse.
6. Calibrate the pressure transducer. Refer to the “Pressure Transducer Calibration” procedure that follows.

## Pressure Transducer Calibration

Use the following procedure to calibrate the pressure transducer.

Equipment Required:

Vacuum pump



**WARNING** The service procedures in this manual are restricted to qualified service representatives. ▲

If the equipment is operated in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired. ▲







**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. ▲

**Note** An error in the zero setting of the pressure transducer does not introduce a measurable error in the output concentration reading. Therefore, if only a barometer is available and not a vacuum pump, only adjust the span setting. ▲





A rough check of the pressure accuracy can be made by obtaining the current barometric pressure from the local weather station or airport and comparing it to the pressure reading. However, since these pressures are usually corrected to sea level, it may be necessary to correct the reading to local pressure by subtracting 0.027 mm Hg per foot of altitude. ▲




Do not try to calibrate the pressure transducer unless the pressure is known accurately. ▲

1. Remove the cover.
2. Disconnect the tubing from the pressure transducer and connect a vacuum pump known to produce a vacuum less than 1 mm Hg.
3. From the Main Menu, press  to scroll to Service, press   to scroll to **Pressure Calibration** and press .











The Pressure Sensor Cal screen appears.

If the Service Mode is not displayed on the Main Menu, use the following procedure to display it.

- a. At the Main Menu, press  to scroll to Instrument Controls, press   to scroll to Service Mode and press .
- The Service Mode screen appears.

- b. Press  to toggle the Service Mode to ON.
- c. Press   to return to the Main Menu.
- d. Continue the procedure at Step 3 to access the Pressure Sensor Cal screen.



4. At the Pressure Sensor Cal screen, press  to select **Zero**.  
The Calibrate Pressure Zero screen appears.
5. Wait at least 10 seconds for the zero reading to stabilize, then press  to save the zero pressure value.
6. Disconnect the pump from the pressure transducer.
7. Press  to return to the Pressure Sensor Cal screen.
8. At the Pressure Sensor Cal screen, press   to select **Span**.  
The Calibrate Pressure Span screen appears.
9. Wait at least 10 seconds for the ambient reading to stabilize, use   and   to enter the known barometric pressure, and press  to save the pressure value.
10. Reconnect the instrument tubing to the pressure transducer.
11. Install the cover.

## Temperature Control Board Replacement

Use the following procedure to replace the temperature control board (Figure 7-6).

### Equipment Required:

Temperature control board

Small flat-blade screwdriver



**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. ▲

1. Turn instrument OFF, unplug the power cord, and remove the cover.

2. Disconnect all connectors from the temperature control board. Use a small flat-blade screwdriver to loosen the two screws securing the CONV TC cable. Note that the red wire is towards the rear and the yellow wire is towards the front.
3. Snap off the board from the board mounts.
4. To install the temperature control board, follow previous steps in reverse.

## Ambient Temperature Calibration

Use the following procedure to calibrate the ambient internal temperature for the instrument.

Equipment Required:

Calibrated thermometer or  $10K \pm 1\%$  Resistor



**WARNING** The service procedures in this manual are restricted to qualified service representatives. ▲

If the equipment is operated in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired. ▲



**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. ▲

1. Remove the instrument cover.
2. Tape the thermistor (plugged into the measurement interface board) to a calibrated thermometer ([Figure 7-2](#)).





**Note** Since the thermistors are interchangeable to an accuracy of  $\pm 0.2^\circ\text{C}$ , and have a value of 10K ohms at  $25^\circ\text{C}$ , an alternate procedure is to connect an accurately known 10K resistor to the thermistor input (AMB TEMP) on the measurement interface board, and enter the temperature reading. ▲

A 1 °C change corresponds to a  $\pm 5\%$  change in resistance, thus this alternative procedure can be quite accurate as a check; however, it clearly is not NIST traceable. ▲




3. From the Main Menu, press  to scroll to Service, press   to scroll to **Temperature Calibration** and press .






The Calibrate Ambient Temperature screen appears.

If the Service Mode is not displayed on the Main Menu, use the following procedure to display it.

- a. At the Main Menu, press  to scroll to Instrument Controls, press   to scroll to Service Mode and press .

The Service Mode screen appears.

- b. Press  to toggle the Service Mode to ON.
- c. Press   to return to the Main Menu.
- d. Continue the procedure at the beginning of Step 3 to access the Calibrate Ambient Temperature screen.

4. Wait at least 10 seconds for the ambient reading to stabilize, use   and   to enter the known temperature, and press  to save the temperature value.

5. Install the cover.

## Fuse Replacement

Use the following procedure to replace the fuse.

Equipment Required:

Replacement fuses:

250VAC, 4 Amp, SlowBlow (for 100VAC and 110VAC models)

250VAC, 2 Amp, SlowBlow (for 220-240VAC models)

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.

## Scrubber Replacement

Use the following procedure to replace the silica scrubber or ammonia scrubber (Figure 7-16).

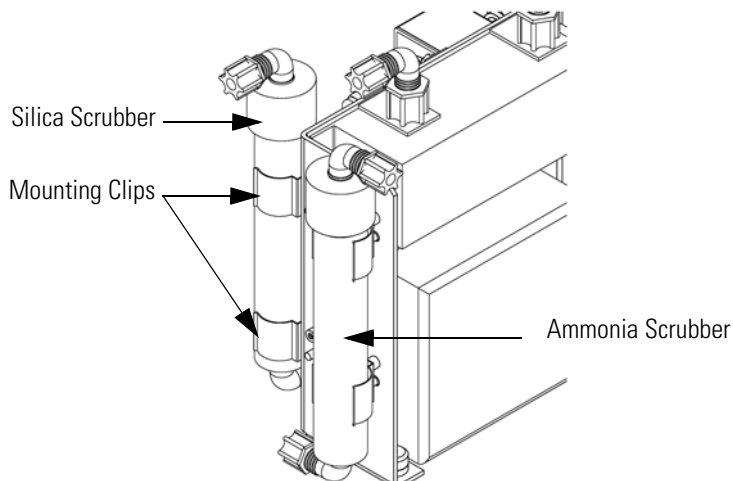
Equipment Required:

Silica scrubber or Ammonia scrubber



**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. ▲

1. Turn instrument OFF, unplug the power cord, and remove the cover.



**Figure 7-16.** Replacing the Scrubber

2. Unscrew the Teflon tubing at both ends of the scrubber.
3. Pull the scrubber off the mounting clips.
4. Push the replacement scrubber into the mounting clips.

5. Attach the Teflon tubing at both ends of the scrubber.
6. Replace the cover.

## I/O Expansion Board (Optional) Replacement

Use the following procedure to replace the optional I/O expansion board (Figure 7-17).

Equipment Required:

I/O expansion board

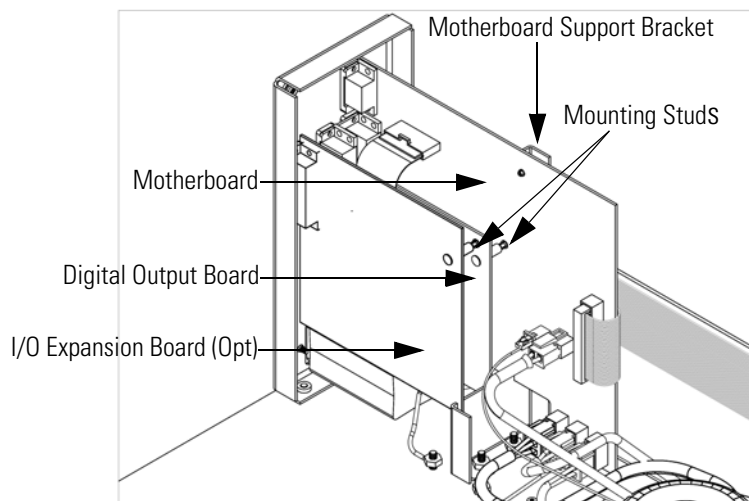
Nut driver, 3/16-inch



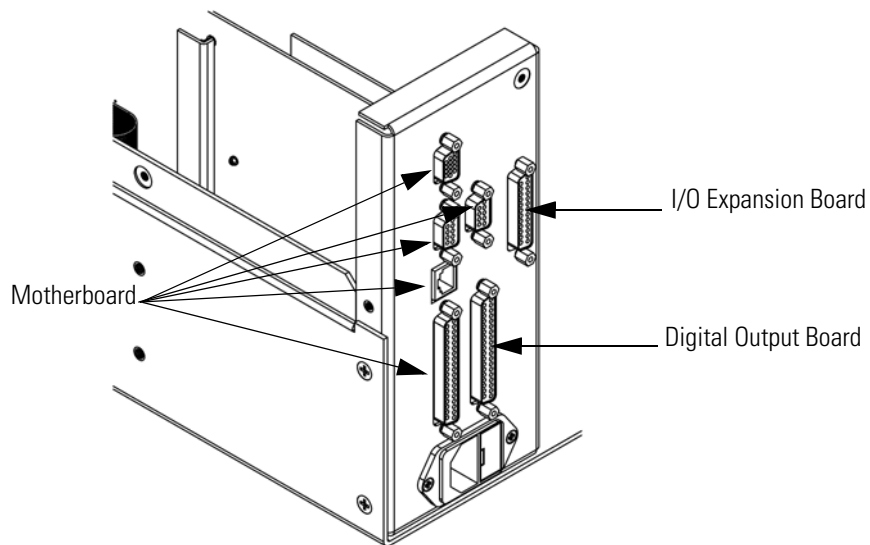
**Equipment Damage** Some internal components can be damaged by small amounts of static electricity. A properly grounded antistatic wrist strap must be worn while handling any internal component. ▲

1. Turn instrument OFF, unplug the power cord, and remove the cover.
2. Unplug the I/O expansion board cable from the EXPANSION BD connector on the motherboard.
3. Remove the two standoffs holding the I/O expansion board connector to the rear panel (Figure 7-18).
4. Pop off the board from the mounting studs and remove the board.

5. To install the I/O expansion board, follow previous steps in reverse.



**Figure 7-17.** Replacing the I/O Expansion Board (Optional)



**Figure 7-18.** Rear Panel Board Connectors

## Digital Output Board Replacement

Use the following procedure to replace the digital output board (Figure 7-17).

Equipment Required:

Digital output board

Nut driver, 3/16-inch



**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. ▲

1. Turn instrument OFF, unplug the power cord, and remove the cover.
2. Remove the I/O expansion board (optional), if used. See the “I/O Expansion Board Replacement” procedure in this chapter.
3. Disconnect the digital output board ribbon cable from the motherboard.
4. Using the nut driver, remove the two standoffs securing the board to the rear panel ([Figure 7-18](#)).
5. Pop off the digital output board from the mounting studs and remove the board.
6. To install the digital output board, follow previous steps in reverse.

## Motherboard Replacement

Use the following procedure to replace the motherboard ([Figure 7-17](#)).

Equipment Required:

Motherboard

Philips screwdriver

Nut driver, 3/16-inch



**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. ▲

1. Turn instrument OFF, unplug the power cord, and remove the cover.

2. Remove the I/O expansion board (optional), if used. See the “I/O Expansion Board Replacement” procedure in this chapter.
3. Remove the digital output board. See the “Digital Output Board Replacement” procedure in this chapter.
4. Unplug all connectors from the motherboard. Note connector locations to facilitate reconnection.
5. Using the nut driver, remove the six standoffs securing the board to the rear panel.
6. Pop off the motherboard from motherboard support bracket, and remove the motherboard.
7. To install the motherboard, follow previous steps in reverse.

## Measurement Interface Board Replacement

Use the following procedure to replace the measurement interface board (Figure 7-19).

### Equipment Required:

Measurement interface board

Philips screwdriver

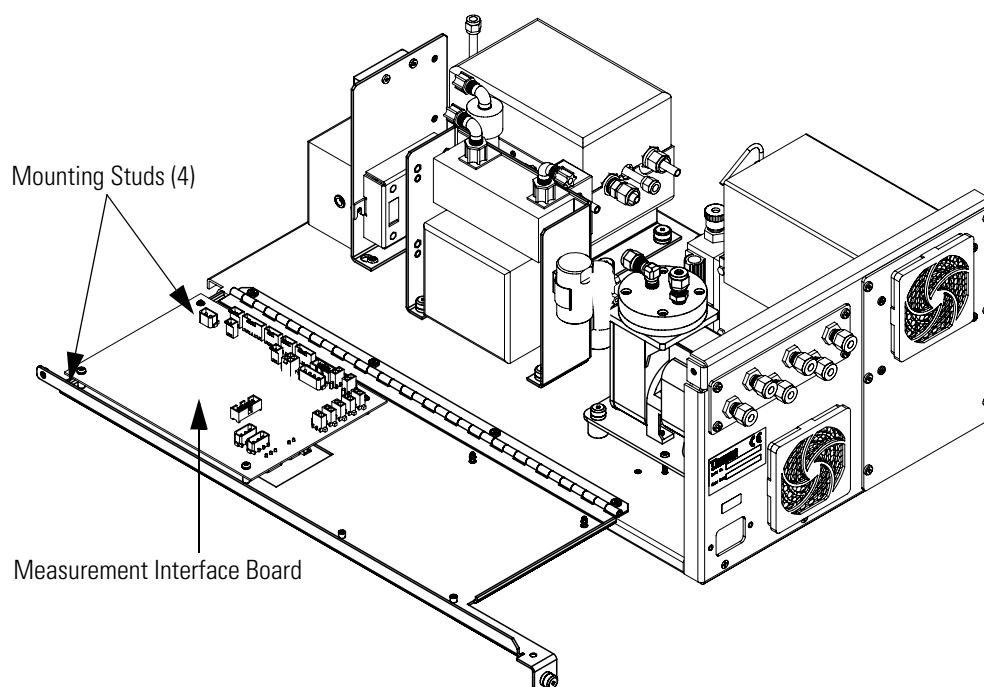


**Equipment Damage** Some internal components can be damaged by small amounts of static electricity. A properly grounded antistatic wrist strap must be worn while handling any internal component. ▲

1. Refer to “Removing the Measurement Bench and Lowering the Partition Panel” in this chapter to lower the partition panel, then proceed to the next step below.
2. Unplug all connectors. Note the locations of the connectors to facilitate reconnection.



3. Pop off the measurement interface board from the four mounting studs and remove the board.
4. To install the measurement interface board, follow previous steps in reverse.
5. Re-install the measurement bench. Refer to “Removing the Measurement Bench and Lowering the Partition Panel” in this chapter.



**Figure 7-19.** Replacing the Measurement Interface Board

## Flow Transducer Replacement

Use the following procedure to replace the flow transducer ([Figure 7-20](#)).

Equipment Required:

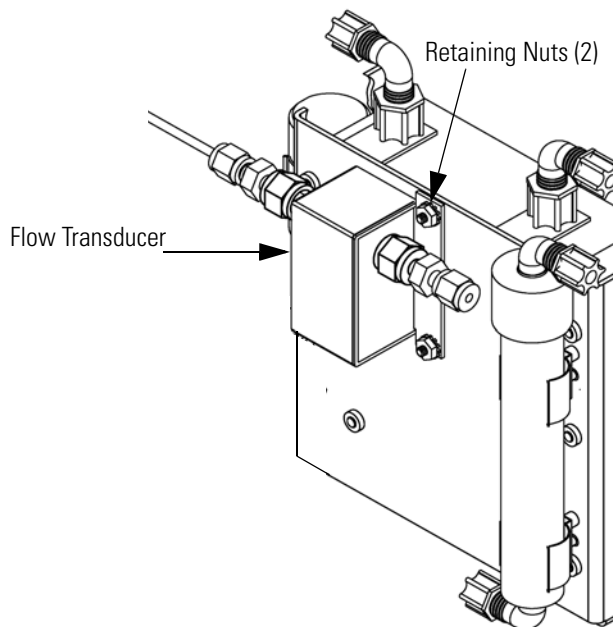
Flow transducer

Philips screwdriver



**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. ▲

1. Turn instrument OFF, unplug the power cord, and remove the cover.
2. Disconnect the plumbing connections from the flow transducer. Note the plumbing connections to facilitate reconnection.



**Figure 7-20.** Replacing the Flow Transducer

3. Disconnect the flow transducer cable from the measurement interface board.
4. Remove the two retaining nuts securing the flow transducer to the ozonator bracket and remove the flow transducer.
5. To install the flow transducer, follow previous steps in reverse.
6. Calibrate the flow transducer. Refer to the “Flow Transducer Calibration” procedure that follows.

## Flow Transducer Calibration

Use the following procedure to calibrate the flow transducer.

Equipment Required:

Calibrated flow sensor







**WARNING** The service procedures in this manual are restricted to qualified service representatives. ▲

If the equipment is operated in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired. ▲







**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. ▲




1. Remove the cover.
2. Disconnect the pump cable from AC PUMP connector on the measurement interface board.
3. From the Main Menu, press  to scroll to Service, press   to scroll to **Flow Calibration** and press .


The Flow Sensor Cal screen appears.

If the Service Mode is not displayed on the Main Menu, use the following procedure to display it.





- a. At the Main Menu, press  to scroll to Instrument Controls, press   to scroll to Service Mode and press .

The Service Mode screen appears.






- b. Press  to toggle the Service Mode to ON.
- c. Press   to return to the Main Menu.
- d. Continue the procedure at Step 2 to access the Flow Sensor Cal screen.

4. At the Flow Sensor Cal screen, press  to select **Zero**.

The Calibrate Flow Zero screen appears.

5. Wait at least 10 seconds for the zero reading to stabilize, then press  to save the zero flow value.
6. Reconnect the pump cable to the AC PUMP connector on the measurement interface board.
7. Connect a calibrated flow sensor at the SAMPLE bulkhead on the rear panel.
8. Press  to return to the Flow Sensor Cal screen.
9. At the Flow Sensor Cal screen, press   to select **Span**.

The Calibrate Flow Span screen appears.

10. Wait at least 10 seconds for the reading to stabilize, use   and   to enter the flow sensor reading, and press  to save the value.
11. Install the cover.

## Front Panel Board Replacement

Use the following procedure to replace the front panel board (Figure 7-21).

Equipment Required:

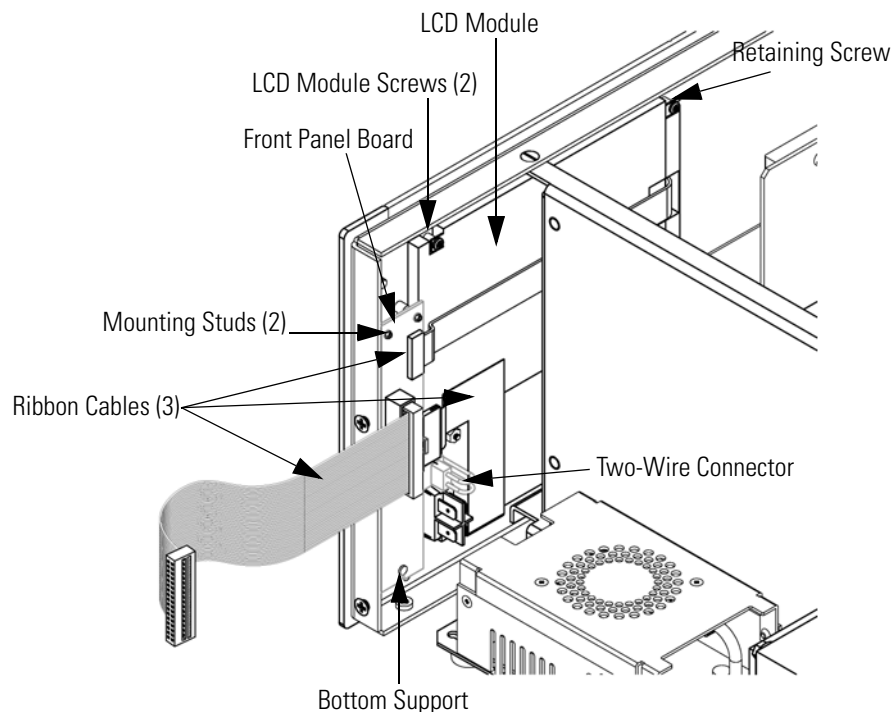
Front panel board



**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. ▲

1. Turn instrument OFF, unplug the power cord, and remove the cover.

2. Remove the three ribbon cables and the two-wire connector from the front panel board.
3. Pop off the board from the two top mounting studs and remove the board by lifting it up and off the slotted bottom support.
4. Replace the front panel board by following previous steps in reverse.



**Figure 7-21.** Replacing the Front Panel Board and the LCD Module

## LCD Module Replacement

Use the following procedure to replace the LCD module ([Figure 7-21](#)).

Equipment Required:

LCD module

Philips screwdriver



**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 it off immediately using soap and water. ▲



**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. ▲

Do not remove the panel or frame from the module. ▲

The polarizing plate is very fragile, handle it carefully. ▲

Do not wipe the polarizing plate with a dry cloth, it may easily scratch the plate. ▲

Do not use alcohol, acetone, MEK or other Ketone based or aromatic solvents to clean the module, use a soft cloth moistened with a naphtha cleaning solvent. ▲

Do not place the module near organic solvents or corrosive gases. ▲

Do not shake or jolt the module. ▲

1. Turn instrument OFF, unplug the power cord, and remove the cover.
2. Remove the two screws from right side of LCD module (viewed front front).
3. Disconnect the ribbon cable and the two-wire connector from the front panel board.
4. Loosen left-side retaining screw (viewed from front) and slide the LCD module out towards the right and rear of the instrument.
5. Replace the LCD module by following previous steps in reverse.

## Service Locations

For additional assistance, service is available from exclusive distributors worldwide. Contact one of the phone numbers below for product support and technical information or visit us on the web at [www.thermo.com/aqi](http://www.thermo.com/aqi).

1-866-282-0430 Toll Free

1-508-520-0430 International





## Chapter 8 System Description

This chapter describes the function and location of the system components, provides an overview of the software structure, and includes a description of the system electronics and input/output connections and functions.

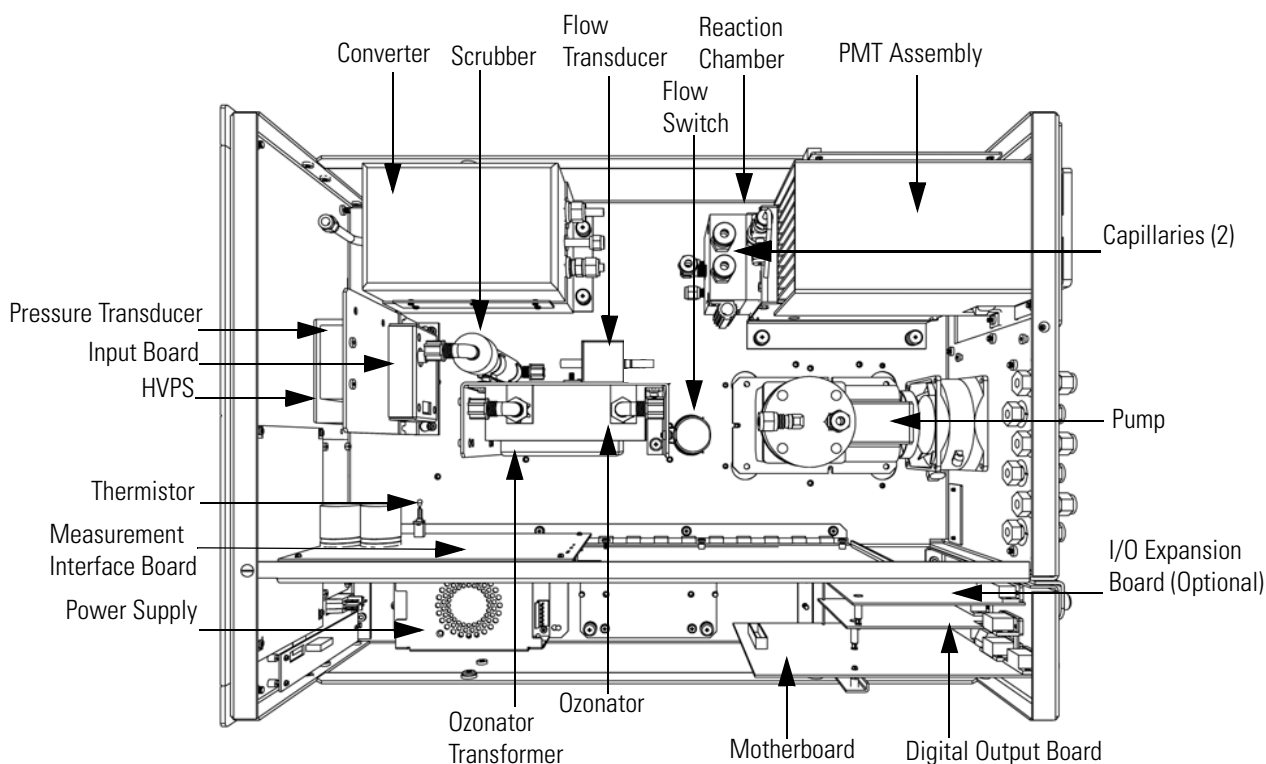
- “Hardware” on [page 8-1](#) describes the analyzer components.
- “Software” on [page 8-4](#) provides an overview of the software organization and detailed information on the software tasks.
- “Electronics” on [page 8-5](#) describes the system boards, assemblies, and connectors.
- “I/O Components” on [page 8-9](#) describes the input and output communication functions and components.

### Hardware

Model 42i hardware components ([Figure 8-1](#)) include:

- NO<sub>2</sub>-to-NO converter
- Reaction chamber
  - Optical filter
  - Pressure transducer
  - Sample flow sensor
- Ozonator
  - Ozone flow switch
- Photomultiplier tube
- Photomultiplier tube cooler
- Pump
  - Sample capillary

- Dry air capillary



**Figure 8-1.** Hardware Components

## NO<sub>2</sub>-to-NO Converter

The NO<sub>2</sub>-to-NO converter heats molybdenum to approximately 325 °C (EPA designated) or stainless steel to 625 °C in order to convert and detect NO<sub>2</sub>. The converter consists of an insulated housing, heater, replaceable cartridge, and a type K thermocouple sensor.

## Reaction Chamber

The reaction chamber is where the sample reacts with ozone and produces excited NO<sub>2</sub> that gives off a photon of energy when it decays.

The reaction chamber is heated and controlled to approximately 50 °C in order to ensure the greatest instrument stability. The sample and ozone flow capillaries and a thermistor sensor are also housed in/on the reaction chamber assembly.

**Optical Filter** The optical filter housed in the reaction chamber limits the spectral region viewed by the detector and eliminates possible interferences due to other chemiluminescent reactions.

**Pressure Transducer** The pressure transducer measures the reaction chamber pressure.

**Sample Flow Sensor** The sample flow sensor located at the reaction chamber inlet measures the sample flow into the reaction chamber.

**Ozonator** The Ozonator generates the necessary ozone concentration required for the chemiluminescent reaction. The ozone reacts with the NO in the ambient air sample to produce the electronically excited NO<sub>2</sub> molecules.

**Ozonator Flow Switch** The ozonator flow switch located at the ozonator inlet completes an electrical safety circuit when air flows through the sensor to the ozonator. If airflow stops, the flow sensor breaks the electrical circuit to the ozonator and shuts it off to prevent the ozonator from overheating.

**Photomultiplier Tube** The Photomultiplier tube (PMT) provides the infrared sensitivity required to detect the NO<sub>2</sub> luminescence resulting from the reaction of the ozone with the ambient air sample.

Optical energy from the reaction is converted to an electrical signal by the PMT and sent to the input board that transmits it to the processor.

**Photomultiplier Tube Cooler** The thermoelectric PMT cooler reduces the PMT temperature to approximately -3 °C to minimize dark current and increase instrument sensitivity. The cooler helps to increase zero and span stability over a wide ambient temperature range. The cooler housing also shields the PMT from external electrical and optical interferences.

**Pump** The vacuum pump draws the reacted gasses out of the reaction chamber.

**Sample Capillary** The sample capillary along with the pump is used to control flow in the sample line.

## **Dry Air Capillary**

The dry air capillary along with the pump is used to control flow in the dry air line.

## **Software**

The processor software tasks are organized into four areas:

- Instrument Control
- Monitoring Signals
- Measurement Calculations
- Output Communication

## **Instrument Control**

Low-level embedded processors are used to control the various functions on the boards, such as analog and digital I/O and heater control. These processors are controlled over a serial interface with a single high-level processor that also controls the front-panel user interface. The low-level processors all run a common piece of firmware that is bundled with the high-level firmware and loaded on power-up if a different version is detected.

Each board has a specific address that is used to identify to the firmware what functions are supported on that board. This address is also used for the communications between the low-level processors and the high-level processor.

Every tenth of a second the frequency counters, analog I/O, and digital I/O are read and written to by the low-level processor. The counters are accumulated over the past second and the analog inputs are averaged over that second. The high-level processor polls the low-level processors once per second to exchange the measurement and control data.

## **Monitoring Signals**

Signals are gathered from the low-level processors once per second, and then processed by the high-level processor to produce the final measurement values. The one-second accumulated counts representing the NO/NO<sub>x</sub> are accumulated and reported for the user-specified averaging time. If this averaging time is greater than ten seconds, the measurement is reported every 10 seconds. The one-second average of the other analog inputs are reported directly (no additional signal conditioning is performed by the high-level processor).

## Measurement Calculations

The calculation of the NO and NO<sub>x</sub> concentrations is lengthy and uses the high-level processor to provide the most accurate readings. The calculation begins by subtracting the appropriate electronic offset from the seven-second count accumulation. Following this correction, the raw accumulated counts are scaled according to the gain setting of the input board.

Next, the uncorrected NO and NO<sub>x</sub> values are determined according to a unique averaging algorithm which minimizes errors resulting from rapidly changing gas concentrations. This algorithm results in NO and NO<sub>x</sub> values which are stored in RAM in a circular buffer that holds all the ten second data from the previous five minutes. This data is averaged over the selected time interval, which can be any multiple of ten between 10 and 300 (the manual modes have additional intervals of 1, 2, and 5 seconds).

The background values for NO and NO<sub>x</sub>, which are corrected for temperature, are subtracted from their respective averages. The NO reading is corrected by the stored span factor and by the temperature factor. The NO<sub>x</sub> reading is partially corrected by the span factor, temperature factor, and balance factor. The corrected NO value is subtracted from the partially corrected NO<sub>x</sub> value to yield an uncorrected NO<sub>2</sub> value. The NO<sub>2</sub> value is then corrected for converter efficiency to give a corrected NO<sub>2</sub> reading. Finally, the corrected NO<sub>2</sub> reading is added to the corrected NO reading to yield a fully corrected NO<sub>x</sub> value.

## Output Communication

The front panel display, serial and Ethernet data ports, and analog outputs are the means of communicating the results of the above calculations. The front panel display presents the NO, NO<sub>2</sub>, and NO<sub>x</sub> concentrations simultaneously. The display is updated every 1-10 seconds, depending on the averaging time.

The analog output ranges are user selectable via software. The analog outputs are defaulted based on the measurement range. The defaults are calculated by dividing the data values by the full-scale range for each of the three parameters and then multiplying each result by the user-selected output range. Negative concentrations can be represented as long as they are within -5% of full-scale. The zero and span values may be set by the user to any desired value.

## Electronics

All electronics operate from a universal switching supply, which is capable of auto-sensing the input voltage and working over the entire operating range.

Internal pumps and heaters all operate on 110VAC. An optional transformer is required if operating on the 210-250VAC or 90-110VAC ranges.

An on/off switch controls all power to the instrument, and is accessible on the front panel.

## **Motherboard**

The motherboard contains the main processor, power supplies, a sub-processor and serves as the communication hub for the instrument. The motherboard receives operator inputs from the front panel mounted function key panel and/or over I/O connections on the rear panel and sends commands to the other boards to control the functions of the instrument and to collect measurement and diagnostic information. The motherboard outputs instrument status and measurement data to the front-panel mounted graphics display and to the rear-panel I/O. The motherboard also contains I/O circuitry and the associated connector to monitor external digital status lines and to output analog voltages that represent the measurement data. Connectors located on the motherboard include:

### **External Connectors**

External connectors include:

- External Accessory
- RS-232/485 Communications (two connectors)
- Ethernet Communications
- I/O connector with Power Fail Relay, 16 Digital Inputs, and 6 Analog Voltage Outputs.

### **Internal Connectors**

Internal connectors include:

- Function key panel and Display
- Measurement Interface Board Data
- I/O Expansion Board Data
- Digital Output Board
- AC distribution

## **Measurement Interface Board**

The measurement interface board serves as a central connection area for all measurement electronics in the instrument. It contains power supplies and interface circuitry for sensors and control devices in the measurement system. It sends status data to the motherboard and receives control signals from the motherboard.

### **Measurement Interface Board Connectors**

Connectors located on the measurement interface board include:

- Data communication with the motherboard
- 24V and 120VAC power supply inputs
- Fans and solenoid outputs
- Cooler control
- 120VAC outputs for the pump and temperature control board
- Ozonator
- Flow and pressure sensors
- Ambient temperature sensor
- Temperature control board
- PMT high voltage supply
- Measurement input board
- Permeation oven option

## **Flow Sensor Assembly**

The flow sensor assembly consists of a board containing an instrumentation amplifier and a flow transducer with input and output gas fittings. The flow transducer output is produced by measuring the pressure difference across a precision orifice. This unit is used for measuring the flow of sample gas in the measurement system.

## **Pressure Sensor Assembly**

The pressure sensor assembly consists of a board containing an instrumentation amplifier and a pressure transducer with a gas input fitting. The pressure transducer output is produced by measuring the pressure difference between the sample gas pressure and ambient air pressure.

## **Temperature Control Board**

The temperature control board regulates and sets the temperature of the reaction chamber and converter.

The reaction chamber temperature is measured with a thermistor. The voltage across the thermistor is fed to the main processor for use in calculating and displaying the reaction chamber temperature. The voltage across the thermistor is also compared to a set-point voltage and used to control that the reaction chamber heaters to maintain a constant temperature of 50 °C. Protective circuitry prevents over heating in the event of broken wires to the thermistor.

The converter temperature is measured by a conditioned thermocouple signal and fed back to the main processor to be used to display and control the converter temperature. The temperature control board receives control signals from the main processor software to control the converter heater to the desired set point. Protective circuitry prevents over heating in the event of broken wires to the thermocouple or processor faults.

## **PMT Power Supply Assembly**

The PMT power supply produces high voltage to operate the photo multiplier tube used in the measurement system. The output voltage is adjustable from approximately 600 to 1200 volts under software control.

## **Input Board Assembly**

The input board accepts the current signal from the PMT and converts it to a voltage, which is scaled by a factor of approximately 1, 10, or 100 depending on the full-scale range of the NO channel. The scaled voltage signal is converted to a frequency and sent to the microprocessor.

The input board includes a test signal that can be activated under software control. The test signal is injected at the first stage of the input board in parallel with the PMT input. This allows the input board and the connection to the processor system to be tested and calibrated without using the PMT.

## **Digital Output Board**

The digital output board connects to the motherboard and provides solenoid driver outputs and relay contact outputs to a connector located on the rear panel of the instrument. Ten relay contacts normally open (with power off) are provided which are electrically isolated from each other. Eight solenoid driver outputs (open collector) are provided along with a corresponding +24VDC supply pin on the connector.



## I/O Expansion Board (Optional)

The I/O expansion board connects to the motherboard and adds the capability to input external analog voltage inputs and to output analog currents via a connector located on the rear panel of the instrument. It contains local power supplies, a DC/DC isolator supply, a sub-processor and analog circuits. Eight analog voltage inputs are provided with an input voltage range of 0V to 10VDC. Six current outputs are provided with a normal operating range of 0 to 20 mA.

## Front Panel Connector Board

The front panel connector board interfaces between the motherboard and the front panel mounted function key panel and Graphics display. It serves as central location to tie the three connectors required for the function key panel, the graphics display control lines, and the graphics display backlight to a single ribbon cable extending back to the motherboard. This board also includes signal buffers for the graphics display control signals and a high voltage power supply for the graphics display backlight.

## I/O Components

External I/O is driven from a generic bus that is capable of controlling the following devices:

- Analog output (voltage and current)
- Analog input (voltage)
- Digital output (TTL levels)
- Digital input (TTL levels)

**Note** The instrument has spare solenoid valve drivers and I/O support for future expansion. ▲

## Analog Voltage Outputs

The instrument provides six analog voltage outputs. Each may be software configured for any one of the following ranges, while maintaining a minimum resolution of 12 bits:

- 0-100mV
- 0-1V
- 0-5V
- 0-10V

The user can calibrate each analog output zero and span point through firmware. At least 5% of full-scale over and under range are also supported.

The analog outputs may be assigned to any measurement or diagnostic channel with a user-defined range in the units of the selected parameter. The voltage outputs are independent of the current outputs.

## **Analog Current Outputs (Optional)**

The optional I/O Expansion board includes six isolated current outputs. These are software configured for any one of the following ranges, while maintaining a minimum resolution of 11 bits:

- 0-20 mA
- 4-20 mA

The user can calibrate each analog output zero and span point through firmware. At least 5% of full-scale over and under range are also supported.

The analog outputs may be assigned to any measurement or diagnostic channel with a user-defined range in the units of the selected parameter. The current outputs are independent of the voltage outputs. The current outputs are isolated from the instrument power and ground, but they share a common return line (Isolated GND).

## **Analog Voltage Inputs (Optional)**

The optional I/O expansion board includes eight analog voltage inputs. These inputs are used to gather measurement data from third-party devices such as meteorological equipment. The user may assign a label, unit, and a voltage to user-defined unit conversion table (up to 16 points). All voltage inputs have a resolution of 12 bits over the range of 0 to 10 volts.

## **Digital Relay Outputs**

The instrument includes one power fail relay on motherboard and ten digital output relays on the digital output board. These are reed relays rated for at least 500 mA @ 200VDC.

The power fail relay is Form C (both normally opened and normally closed contacts). All other relays are Form A (normally opened contacts) and are used to provide alarm status and mode information from the analyzer, as well as remote control to other devices, such as for controlling valves during calibration. The user may select what information is sent out each relay and whether the active state is opened or closed.

## Digital Inputs

Sixteen digital inputs are available which may be programmed to signal instrument modes and special conditions including:

- NO Measure Mode
- NO<sub>x</sub> Measure Mode
- Zero Gas Mode
- Span Gas Mode

The actual use of these inputs will vary based on analyzer configuration.

The digital inputs are TTL level compatible and are pulled up within the analyzer. The active state can be user defined in firmware.

## Serial Ports

Two serial ports allow daisy chaining so that multiple analyzers may be linked using one PC serial port.

The standard bi-directional serial interface can be configured for either RS-232 or RS-485. The serial baud rate is user selectable in firmware for standard speeds from 1200 to 19,200 baud. The user can also set the data bits, parity, and stop bits. The following protocols are supported:

- C-Link
- Streaming Data
- Modbus Slave

The Streaming Data protocol transmits user-selected measurement data via the serial port in real-time for capture by a serial printer, data logger, or PC.

## RS-232 Connection

A null modem (crossed) cable is required when connecting the analyzer to an IBM Compatible PC. However, a straight cable (one to one) may be required when connecting the analyzer to other remote devices. As a general rule, when the connector of the host remote device is female, a straight cable is required and when the connector is male, a null modem cable is required.

Data Format:

1200, 2400, 4800, 9600, 19200, 38400, 57600, or 115200 BAUD

8 data bits

1 stop bit

no parity

All responses are terminated with a carriage return (hex 0D)

Refer to [Table 8-1](#) for the DB9 connector pin configuration.

**Table 8-1.** RS-232 DB Connector Pin Configurations

DB9 Pin	Function
2	RX
3	TX
7	RTS
8	CTS
5	Ground

## RS-485 Connection

The instrument uses a four wire RS-485 configuration with automatic flow control (SD). Refer to [Table 8-2](#) for the DB9 connector pin configuration.

**Table 8-2.** RS-485 DB Connector Pin Configuration

DB9 Pin	Function
2	+ receive
8	- receive
7	+ transmit
3	- transmit
5	ground

## Ethernet Connection

An RJ45 connector is used for the 10Mbps Ethernet connection supporting TCP/IP communications via standard IPV4 addressing. The IP address may be configured for static addressing or dynamic addressing (set using a DHCP server).

Any serial port protocols may be accessed over Ethernet in addition to the serial port.

## **External Accessory Connector**

The external accessory connector is not used in the Model 42*i* analyzer.

This port is used in other models to communicate with smart external devices that may be mounted hundreds of feet from the analyzer using an RS-485 electrical interface.

## System Description

### I/O Components

## Chapter 9 Optional Equipment

The Model 42i NO<sub>x</sub> is available with the following options:

- “Internal Zero/Span and Sample Valves” on page 9-1
- “Ozonator Permeation Dryer” on page 9-1
- “Ozone Particulate Filter” on page 9-2
- “Ammonia Scrubber” on page 9-2
- “NO<sub>2</sub>-to-NO Converters” on page 9-2
- “I/O Expansion Board Assembly” on page 9-2
- “Terminal Block and Cable Kits” on page 9-2
- “Mounting Options” on page 9-3

### Internal Zero/Span and Sample Valves

With the 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.

For more information, refer to the “Installation” chapter. If this option is installed, refer to the “Operation” chapter for more information.

### Ozonator Permeation Dryer

This permeation dryer minimizes routine maintenance procedures by providing a continuous stream of dry air to the ozonator (using the selective water permeation characteristics of the dryer). With the permeation dryer option, it is not necessary to constantly replenish the ozonator air-drying column as in the standard instrument.

If this option is installed, refer to the “Operation” chapter for more information.

## Ozone Particulate Filter

The ozone particulate filter minimizes the potential for contamination of the ozonator by trapping any particulate matter before passing through the ozonator.

## Ammonia Scrubber

The ammonia scrubber is mounted internally and removes ammonia from the sample air.

## NO<sub>2</sub>-to-NO Converters

The Model 42i NO<sub>x</sub> includes a Molybdenum NO<sub>2</sub>-to-NO converter as standard equipment. A stainless steel converter is available as an option.

## I/O Expansion Board Assembly

The I/O expansion board provides six analog current output channels (0-20 mA or 4-20 mA) and eight analog voltage inputs (0-10V). The DB25 connector on the rear panel provides the interface for these inputs and outputs.

## Terminal Block and Cable Kits

The terminal block and cable kit provides a convenient way to connect devices to the analyzer. The kit breaks out the signals on the rear panel connector to individual numbered terminals.

Two types of terminal block and cable kits are available. One kit is for the DB37 connectors and can be used for either the analog output connector or the relay output connector. The other kit is for the DB25 connector and can be used for the optional I/O expansion board. The parts available in these kits can also be purchased separately.

Each kit consists of:

- one six-foot cable
- one terminal block
- one snap track

**Note** Supporting all of the connections on units with the optional I/O expansion board requires:

two DB37 kits

one DB25 kit

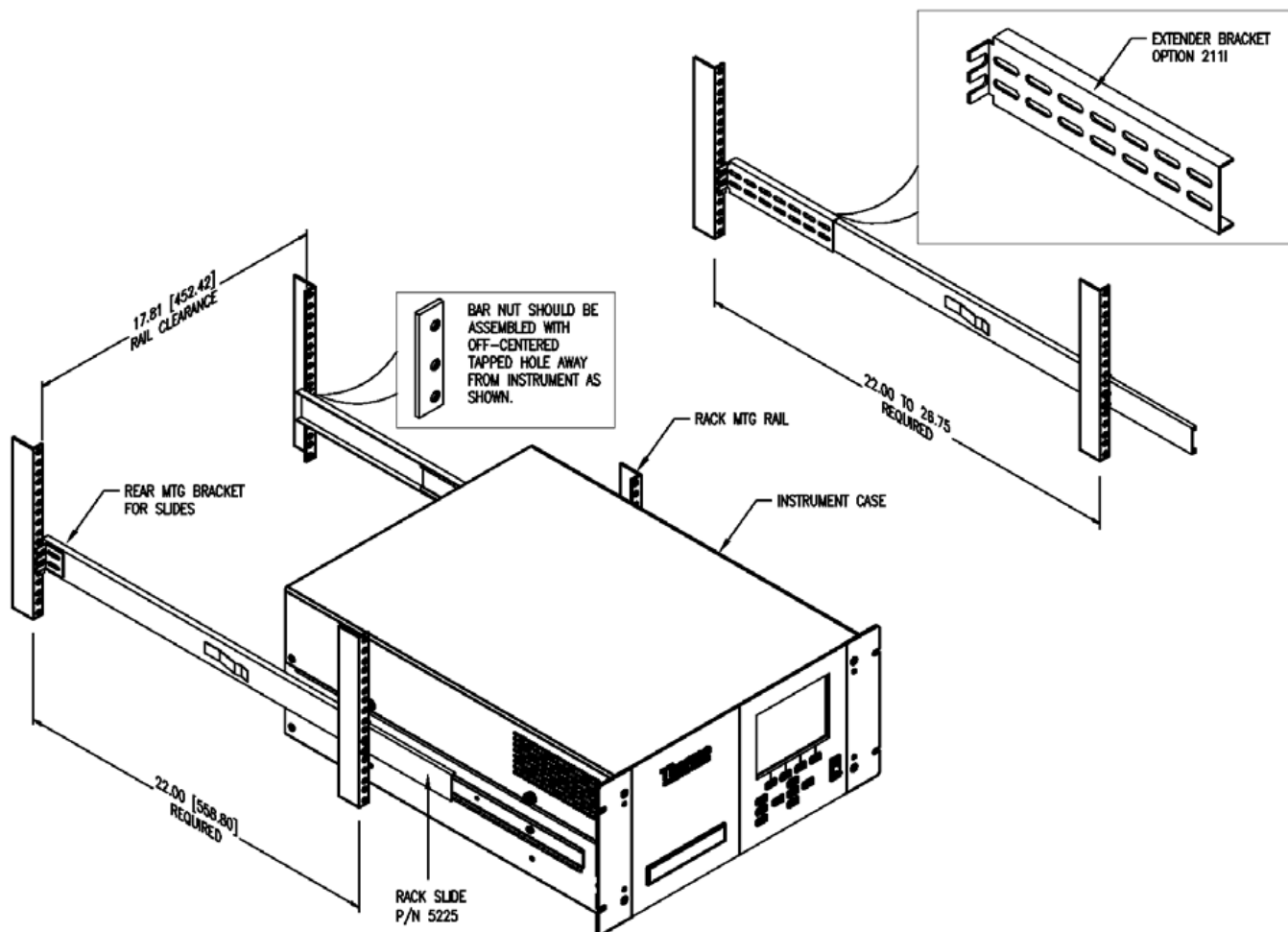


## Mounting Options

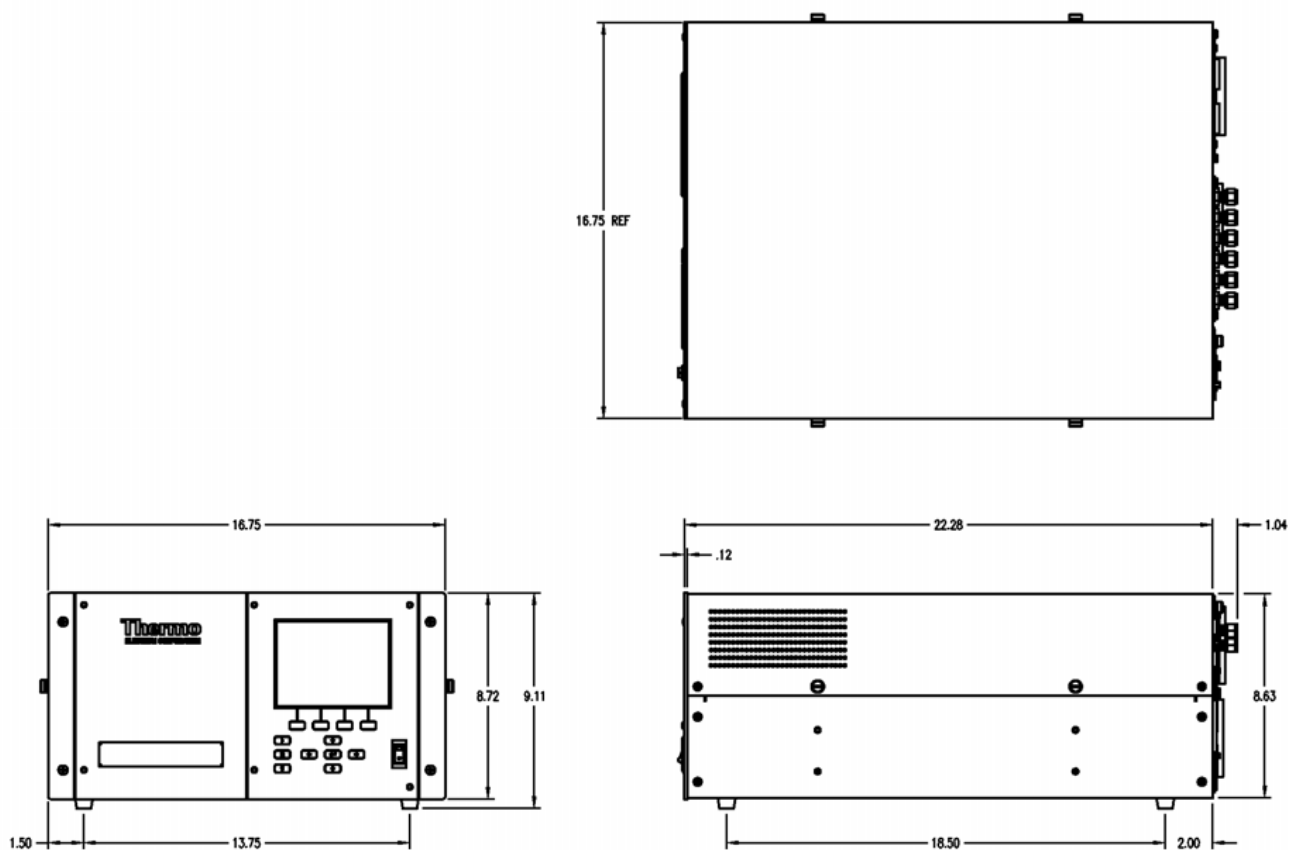
The analyzer can be installed in the configurations described in [Table 9-1](#) and shown in [Figure 9-1](#) through [Figure 9-4](#).

**Table 9-1.** Mounting Options

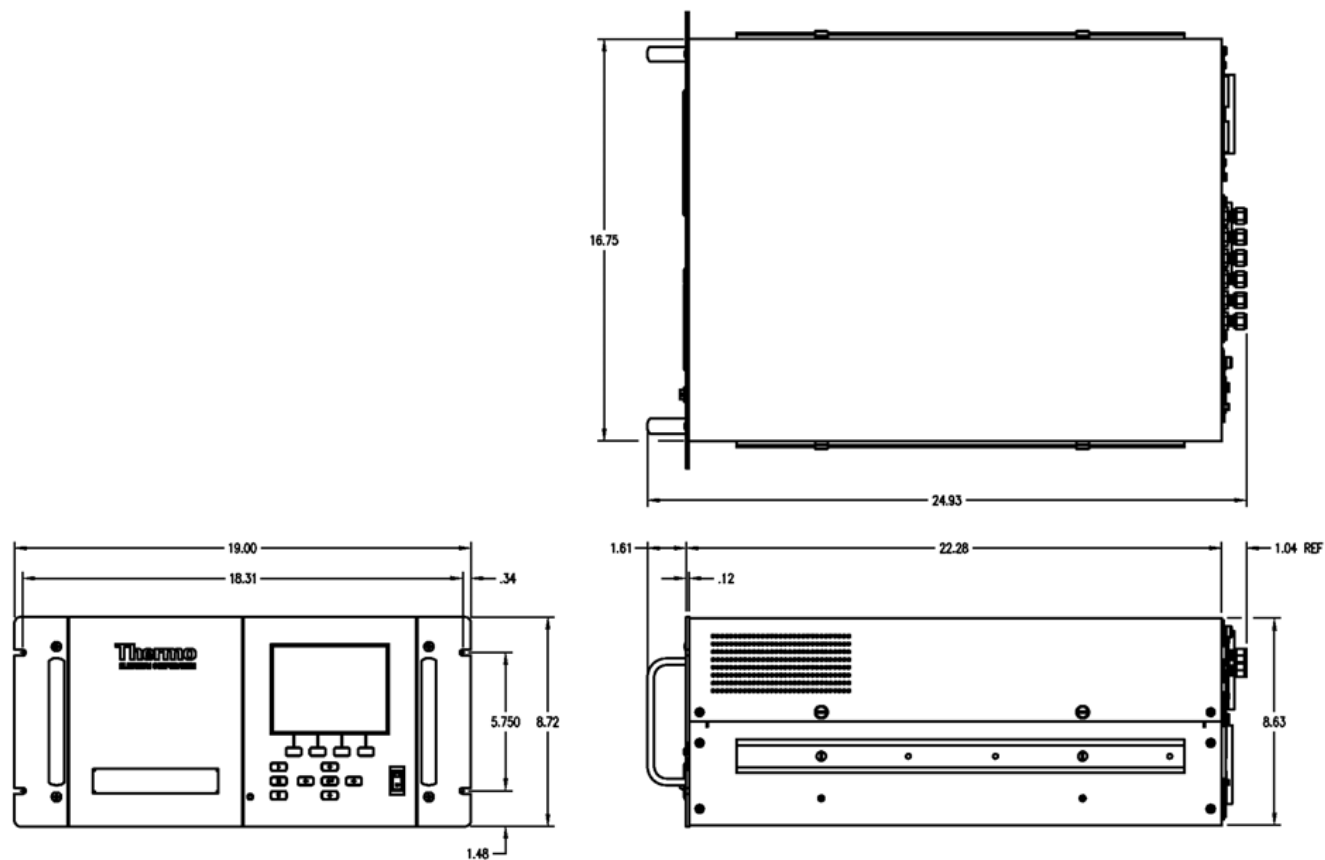
Mounting Type	Description
Bench	Positioned on bench, includes mounting feet, and front panel side-trim ears.
EIA rack	Mounted in an EIA-style rack, includes mounting slides, and front panel EIA-rack mounting ears.
Retrofit rack	Mounted in a Thermo non-EIA rack, includes mounting slides, and retrofit front panel rack-mounting ears.



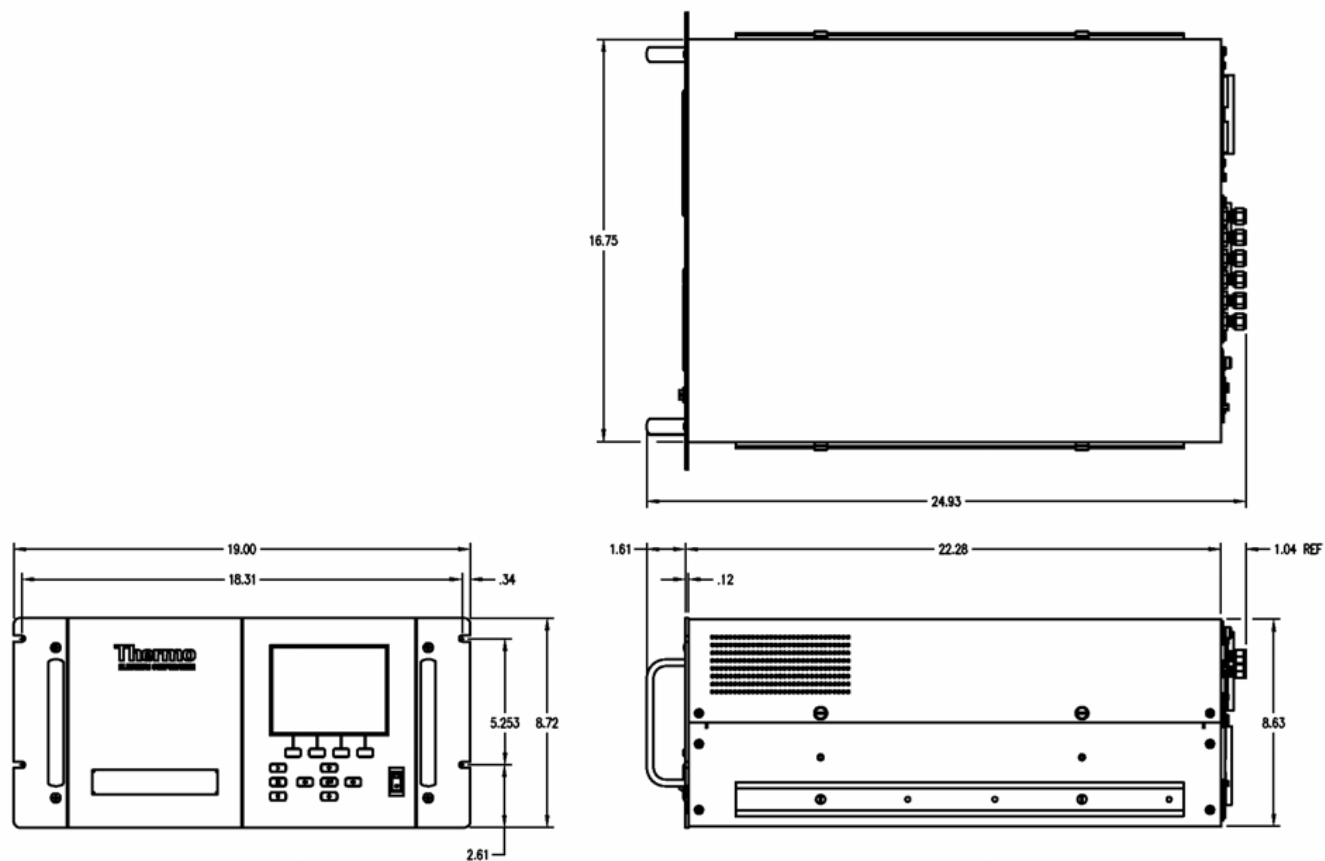
**Figure 9-1.** Rack Mount Option Assembly



**Figure 9-2.** Bench Mounting



**Figure 9-3.** EIA Rack Mounting



**Figure 9-4.** Retrofit Rack Mounting

## Appendix A Warranty

Seller warrants that the Products will operate or perform substantially in conformance with Seller's published specifications and be free from defects in material and workmanship, when subjected to normal, proper and intended usage by properly trained personnel, for the period of time set forth in the product documentation, published specifications or package inserts. If a period of time is not specified in Seller's product documentation, published specifications or package inserts, the warranty period shall be one (1) year from the date of shipment to Buyer for equipment and ninety (90) days for all other products (the "Warranty Period"). Seller agrees during the Warranty Period, to repair or replace, at Seller's option, defective Products so as to cause the same to operate in substantial conformance with said published specifications; provided that (a) Buyer shall promptly notify Seller in writing upon the discovery of any defect, which notice shall include the product model and serial number (if applicable) and details of the warranty claim; (b) after Seller's review, Seller will provide Buyer with service data and/or a Return Material Authorization ("RMA"), which may include biohazard decontamination procedures and other product-specific handling instructions; and (c) then, if applicable, Buyer may return the defective Products to Seller with all costs prepaid by Buyer. Replacement parts may be new or refurbished, at the election of Seller. All replaced parts shall become the property of Seller. Shipment to Buyer of repaired or replacement Products shall be made in accordance with the Delivery provisions of the Seller's Terms and Conditions of Sale. Consumables, including but not limited to lamps, fuses, batteries, bulbs and other such expendable items, are expressly excluded from the warranty under this warranty.

Notwithstanding the foregoing, Products supplied by Seller that are obtained by Seller from an original manufacturer or third party supplier are not warranted by Seller, but Seller agrees to assign to Buyer any warranty rights in such Product that Seller may have from the original manufacturer or third party supplier, to the extent such assignment is allowed by such original manufacturer or third party supplier.

In no event shall Seller have any obligation to make repairs, replacements or corrections required, in whole or in part, as the result of (i) normal wear and tear, (ii) accident, disaster or event of force majeure, (iii) misuse, fault or negligence of or by Buyer, (iv) use of the Products in a manner for which they were not designed, (v) causes external to the Products such as, but not

limited to, power failure or electrical power surges, (vi) improper storage and handling of the Products or (vii) use of the Products in combination with equipment or software not supplied by Seller. If Seller determines that Products for which Buyer has requested warranty services are not covered by the warranty hereunder, Buyer shall pay or reimburse Seller for all costs of investigating and responding to such request at Seller's then prevailing time and materials rates. If Seller provides repair services or replacement parts that are not covered by the warranty provided in this warranty, Buyer shall pay Seller therefor at Seller's then prevailing time and materials rates. ANY INSTALLATION, MAINTENANCE, REPAIR, SERVICE, RELOCATION OR ALTERATION TO OR OF, OR OTHER TAMPERING WITH, THE PRODUCTS PERFORMED BY ANY PERSON OR ENTITY OTHER THAN SELLER WITHOUT SELLER'S PRIOR WRITTEN APPROVAL, OR ANY USE OF REPLACEMENT PARTS NOT SUPPLIED BY SELLER, SHALL IMMEDIATELY VOID AND CANCEL ALL WARRANTIES WITH RESPECT TO THE AFFECTED PRODUCTS.

THE OBLIGATIONS CREATED BY THIS WARRANTY STATEMENT TO REPAIR OR REPLACE A DEFECTIVE PRODUCT SHALL BE THE SOLE REMEDY OF BUYER IN THE EVENT OF A DEFECTIVE PRODUCT. EXCEPT AS EXPRESSLY PROVIDED IN THIS WARRANTY STATEMENT, SELLER DISCLAIMS ALL OTHER WARRANTIES, WHETHER EXPRESS OR IMPLIED, ORAL OR WRITTEN, WITH RESPECT TO THE PRODUCTS, INCLUDING WITHOUT LIMITATION ALL IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR ANY PARTICULAR PURPOSE. SELLER DOES NOT WARRANT THAT THE PRODUCTS ARE ERROR-FREE OR WILL ACCOMPLISH ANY PARTICULAR RESULT.

## Appendix B C-Link Protocol Commands

This appendix provides a description of the C-Link protocol commands that can be used to remotely control a Model 42i NO<sub>x</sub> analyzer using a host device such as a PC or a datalogger. C-Link protocol may be used over RS-232, RS-485, or Ethernet. C-Link functions can be accessed over Ethernet using TCP/IP port 9880.

- “Instrument Identification Number” on [page B-2](#) describes the C-Link command format.
- “Commands” on [page B-2](#) lists all the 42i NO<sub>x</sub> C-Link commands in Table B-1.
- “Measurements” on [page B-7](#) describes and gives examples of the measurement commands.
- “Alarms” on [page B-11](#) describes and gives examples of the alarm commands.
- “Diagnostics” on [page B-14](#) describes and gives examples of the diagnostic commands.
- “Datalogging” on [page B-15](#) describes and gives examples of the datalogging commands.
- “Calibration” on [page B-22](#) describes and gives examples of the calibration commands.
- “Keys/Display” on [page B-24](#) describes and gives examples of the keys and display commands.
- “Measurement Configuration” on [page B-26](#) describes and gives examples of the measurement configuration commands.
- “Hardware Configuration” on [page B-29](#) describes and gives examples of the hardware commands.
- “Communications Configuration” on [page B-33](#) describes and gives examples of the communication commands.

- “I/O Configuration” on page B-37 describes and gives examples of the I/O commands.
- “Record Layout Definition” on page B-41 describes and gives examples of the record layouts.

## Instrument Identification Number

Each command sent to the analyzer must begin with the American Standard Code for Information Interchange (ASCII) symbol or byte value equivalent of the instrument's identification number plus 128. For example, if the instrument ID is set to 25, then each command must begin with the ASCII character code 153 decimal. The analyzer ignores any command that does not begin with its instrument identification number. If the instrument ID is set to 0, then this byte is not required. For more information on changing Instrument ID, see Chapter 3, “Operation”.

## Commands

The analyzer must be in the remote mode in order to change instrument parameters via remote. However, the command “set mode remote” can be sent to the analyzer to put it in the remote mode. Report commands (commands that don't begin with “set”) can be issued either in the remote or local mode. For information on changing modes, see Chapter 3, “Operation.”

The commands can be sent in either uppercase or lowercase characters. Each command must begin with the proper instrument identification number (ASCII) character. The command in the example below begins with the ASCII character code 170 decimal, which directs the command to the Model 42i NO<sub>x</sub>, and is terminated by a carriage return “CR” (ASCII character code 13 decimal).

<ASCII 170>	T	I	M	E	<CR>
-------------	---	---	---	---	------

If an incorrect command is sent, a “bad command” message will be received. The example below sends the incorrect command “set unit ppm” instead of the correct command “set gas unit ppm.”

Send:        set unit ppm  
Receive:    set unit ppm bad cmd

The “save” and “set save params” commands stores parameters in FLASH. It is important that each time instrument parameters are changed, that this command be sent. If changes are not saved, they will be lost in the event of a power failure.



Table B-1 lists the 42i NO<sub>x</sub> C-Link protocol commands. The interface will respond to the command strings outlined below.

**Table B-1.** C-Link Protocol Commands

Command	Description	Page
addr dns	Reports/sets domain name server address	B-33
addr gw	Reports/sets default gateway address	B-33
addr ip	Reports/sets IP address	B-33
addr nm	Reports/sets netmask address	B-33
alarm chamber temp max	Reports/sets chamber temperature alarm maximum value	B-11
alarm chamber temp min	Reports/sets chamber temperature alarm minimum value	B-11
alarm conc nox max	Reports/sets current NO <sub>x</sub> concentration alarm minimum value	B-11
alarm conc nox min	Reports/sets current NO <sub>x</sub> concentration alarm maximum value	B-11
alarm converter temp max	Reports/sets NO <sub>2</sub> converter temperature alarm maximum value	B-11
alarm converter temp min	Reports/sets NO <sub>2</sub> converter temperature alarm minimum value	B-11
alarm cooler temp max	Reports/sets PMT cooler temperature alarm maximum value	B-12
alarm cooler temp min	Reports/sets PMT cooler temperature alarm minimum value	B-12
alarm internal temp max	Reports/sets internal temperature alarm maximum value	B-12
alarm internal temp min	Reports/sets internal temperature alarm minimum value	B-12
alarm pressure max	Reports/sets pressure alarm maximum value	B-13
alarm pressure min	Reports/sets pressure alarm minimum value	B-13
alarm sample flow max	Reports/sets sample flow alarm maximum value	B-13
alarm sample flow min	Reports/sets sample flow alarm minimum value	B-13
alarm trig conc nox	Reports/sets current NO <sub>x</sub> concentration alarm warning value	B-13
analog iout range	Reports analog current output range per channel	B-37
analog vin	Retrieves analog voltage input data per channel	B-37
analog vout range	Reports analog voltage output range per channel	B-37
avg time	Reports/sets averaging time	B-7
baud	Reports/sets current baud rate	B-34
cal high nox coef	Sets/auto-calibrates high range NO <sub>x</sub> coefficient	B-22

**Table B-1.** C-Link Protocol Commands

Command	Description	Page
cal low nox coef	Sets/auto-calibrates low range NO <sub>x</sub> coefficient	B-22
cal nox bkg	Sets/auto-calibrates NO <sub>x</sub> background	B-22
cal nox coef	Sets/auto-calibrates NO <sub>x</sub> coefficient	B-22
cal pres	Sets current measured pressure as pressure during calibration (for pressure compensation)	B-24
clr lrecs	Clears away only long records that have been saved	B-15
clr records	Clears away all logging records that have been saved	B-15
clr srecs	Clears away only short records that have been saved	B-15
contrast	Reports/sets current screen contrast	B-29
conv set temp	Reports/sets temperature setpoint for NO <sub>2</sub> converter	B-30
conv temp	Reports current NO <sub>2</sub> converter temperature	B-8
cooler temp	Reports temperature of PMT cooler (same as PMT temperature)	B-9
copy lrec to sp	Sets/copies current lrec selection into the scratch pad	B-20
copy sp to lrec	Sets/copies current selections in scratch pad into lrec list	B-20
copy sp to srec	Sets/copies current selections in scratch pad into srec list	B-20
copy sp to stream	Sets/copies current selections in scratch pad into stream list	B-20
copy srec to sp	Sets/copies current srec selection into the scratch pad	B-20
copy stream to sp	Sets/copies current streaming data selection into the scratch pad	B-20
custom	Reports/sets defined custom range concentration	B-27
date	Reports/sets current date	B-30
default params	Sets parameters to default values	B-31
dhcp	Reports/sets state of use of DHCP	B-34
diag volt iob	Reports diagnostic voltage level for I/O expansion board	B-14
diag volt mb	Reports diagnostic voltage level for motherboard	B-14
diag volt mib	Reports diagnostic voltage level for measurement interface board	B-14
dig in	Reports status of the digital inputs	B-38
din	Reports/sets digital input channel and active state	B-38
do (down)	Simulates pressing down pushbutton	B-24
dout	Reports/sets digital output channel and active state	B-38
dtoa	Reports outputs of the digital to analog converters per channel	B-39
en (enter)	Simulates pressing enter pushbutton	B-24
er	Returns a brief description of the main operating conditions in the format specified in the commands	B-16

**Table B-1.** C-Link Protocol Commands

<b>Command</b>	<b>Description</b>	<b>Page</b>
erec	Returns a brief description of the main operating conditions in the format specified in the command	B-16
erec format	Reports/sets erec format (ASCII or binary)	B-18
erec layout	Reports current layout of erec data	B-18
flags	Reports 8 hexadecimal digits (or flags) that represent the status of the ozonator, PMT, gas mode, and alarms	B-10
flow	Reports current measured flow	B-9
format	Reports/sets current reply termination format	B-35
gas mode	Reports current mode of sample, zero, or span	B-28
gas unit	Reports/sets current gas units	B-28
he (help)	Simulates pressing help pushbutton	B-24
high avg time	Reports/sets high range averaging time	B-7
high nox	Reports NO <sub>x</sub> concentration calculated with high range coefficients	B-8
high nox coef	Reports/sets high range NO <sub>x</sub> coefficients	B-22
high nox gas	Reports high range NO <sub>x</sub> span gas concentration	B-23
high range nox	Reports/selects current NO <sub>x</sub> high range	B-26
host name	Reports/sets host name string	B-35
instr name	Reports instrument name	B-35
instrument id	Reports/sets instrument id	B-36
internal temp	Reports current internal instrument temperature	B-9
isc (iscreen)	Retrieves framebuffer data used for the display	B-24
layout ack	Disables stale layout/layout changed indicator ("**")	B-36
le (left)	Simulates pressing left pushbutton	B-24
list din	Lists current selection for digital input	B-15
list dout	Lists current selection for digital output	B-15
list lrec	Lists current selection lrec logging data	B-15
list sp	Lists current selection in the scratchpad list	B-15
list srec	Lists current selection srec logging data	B-15
list stream	Lists current selection streaming data output	B-15
list var aout	Reports list of analog output, index numbers, and variables	B-40
list var din	Reports list of digital input, index numbers, and variables	B-40
list var dout	Reports list of digital output, index numbers, and variables	B-40
low avg time	Reports/sets low averaging time	B-7

**Table B-1.** C-Link Protocol Commands

Command	Description	Page
low nox	Reports NO <sub>x</sub> concentrations calculated with low range coefficients	B-8
low nox coef	Reports/sets low range NO <sub>x</sub> coefficient	B-22
low nox gas	Reports/sets low range NO <sub>x</sub> span gas concentration	B-23
low range nox	Reports/sets current NO <sub>x</sub> low range	B-26
lr	Outputs long records in the format specified in the command	B-16
lrec	Outputs long records	B-16
lrec format	Reports/sets output format for long records (ASCII or binary)	B-18
lrec layout	Reports current layout of lrec data	B-18
lrec mem size	Reports maximum number of long records that can be stored	B-19
lrec per	Reports/sets long record logging period	B-19
malloc lrec	Reports/sets memory allocation for long records	B-19
malloc srec	Reports/sets memory allocation for short records	B-19
me (menu)	Simulates pressing menu pushbutton	B-24
mode	Reports operating mode in local, service, or remote	B-36
no of lrec	Reports/sets number of long records stored in memory	B-19
no of srec	Reports/sets number of short records stored in memory	B-19
nox	Reports current NO <sub>x</sub> concentration	B-8
nox bkg	Reports/sets current NO <sub>x</sub> background	B-23
nox coef	Reports/sets current NO <sub>x</sub> coefficient	B-22
nox gas	Reports/sets NO <sub>x</sub> span gas concentration	B-23
ozonator	Reports/sets ozonator on or off	B-31
ozonator flow	Reports current ozonator flow	B-31
ozonator safety	Reports/sets ozonator safety on or off	B-31
ozonator status	Reports status of ozonator and safety	B-32
pmt status	Reports/sets PMT status on or off	B-32
pmt temp	Reports temperature of the PMT cooler (same as cooler temperature)	B-9
pmt voltage	Reports current PMT voltage	B-9
pres	Reports current reaction chamber pressure	B-9
pres cal	Reports/sets pressure used for calibration	B-23
pres comp	Reports/sets pressure compensation on or off	B-29
program no	Reports analyzer program number	B-36
push	Simulates pressing a key on the front panel	B-24

**Table B-1.** C-Link Protocol Commands

Command	Description	Page
range mode	Reports/sets current range mode	B-28
range nox	Reports/sets current NO <sub>x</sub> range	B-26
react temp	Reports current reaction chamber temperature	B-9
relay stat	Reports/sets relay logic status to for the designated relay(s)	B-40
ri (right)	Simulates pressing right pushbutton	B-24
ru (run)	Simulates pressing run pushbutton	B-24
sample	Sets zero/span valves to sample mode	B-28
save	Stores parameters in FLASH	B-32
save params	Stores parameters in FLASH	B-32
sc (screen)	C-series legacy command that reports a generic response (Use iscreen instead)	B-25
sp field	Reports/sets item number and name in scratch pad list	B-20
span	Sets zero/span valves to span mode	B-28
sr	Reports last short record stored	B-16
srec	Reports maximum number of short records	B-16
srec format	Reports/sets output format for short records (ASCII or binary)	B-18
srec layout	Reports current layout of short record data	B-18
srec mem size	Reports maximum number of short records	B-19
srec per	Reports/sets short record logging period	B-19
stream per	Reports/sets current set time interval for streaming data	B-21
stream time	Reports/sets a time stamp to streaming data or not	B-21
temp comp	Reports/sets temperature compensation on or off	B-29
time	Reports/sets current time (24-hour time)	B-32
up	Simulates pressing up pushbutton	B-24
zero	Sets zero/span valves to zero mode	B-28

## Measurements

---

**avg time**

**high avg time**

**low avg time**

These commands report the averaging time in seconds when operating in single range, or averaging time used with the high and low ranges when operating in dual or auto range mode. The example below shows that the averaging time is 300 seconds, according to Table B-2.

Send:        avg time  
 Receive:    avg time 11: 300 sec

**set avg time** *selection*

**set high avg time** *selection*

**set low avg time** *selection*

These commands set the averaging time, high and low averaging times, according to Table B-2. The example below sets the low range averaging time to 120 seconds.

Send: set low avg time 8

Receive: set low avg time 8 ok

**Table B-2.** Averaging Times

<i>Selection</i>	<i>Time, NO<sub>x</sub> Measure Mode</i>
0	1 seconds
1	2
2	5
3	10
4	20
5	30
6	60
7	90
8	120
9	180
10	240
11	300

---

**nox**

**high nox**

**low nox**

These commands report the measured NO<sub>x</sub> concentration when operating in single range, or high and low NO<sub>x</sub> when operating in dual or auto range mode. The example below shows that the NO concentration is 88.2 ppb.

Send: no

Receive: no 8820E-2 ppb

---

**conv temp**

This command reports the current NO<sub>2</sub> converter temperature. The example below reports that the current converter temperature is 320.7 °C.

Send: conv temp

Receive: conv temp 320.7 deg C

---

**cooler temp**

This command reports the PMT cooler temperature. The example below reports that the PMT cooler temperature is -2.8 °C.

Send: pmt temp  
Receive: pmt temp -2.8 deg C

---

**flow**

This command reports the current measured flow. The example below reports that the flow measurement is 0.700 LPM.

Send: flow  
Receive: flow 0.7 l/min

---

**internal temp**

This command reports the current internal instrument temperature. The example below shows that the internal temperature is 28.6 °C.

Send: internal temp  
Receive: internal temp 28.6 deg C, actual 28.6

---

**pmt temp**

This command reports the PMT cooler temperature. The example below reports that the PMT cooler temperature is -2.8 °C.

Send: pmt temp  
Receive: pmt temp -2.8 deg C

---

**pmt voltage**

This command reports the current PMT voltage. The example below reports that the current PMT voltage is -750 volts.

Send: pmt voltage  
Receive: pmt voltage -750

---

**pres**

This command reports the current reaction chamber pressure. The example below shows that the actual reaction chamber pressure is 232.5 mmHg.

Send: pres  
Receive: pres 232.5 mm Hg

---

**react temp**

This command reports the current reaction chamber temperature. The example below reports that the current reaction chamber temperature is 49.0 °C.

Send: react temp  
Receive: react temp 49.0 deg C

**flags**  
This reports 8 hexadecimal digits (or flags) that represent status of the ozonator, PMT, pressure and temperature compensation status, gas units, gas mode, and alarms. To decode the flags, each hexadecimal digit is converted to binary as shown in the Figure B-1. It is the binary digits that define the status of each parameter. In the example below, the instrument is reporting that the ozonator and PMT are both on, that the instrument is in the span gas mode, that at least one of the alarm temperature is activated, and that the NO<sub>x</sub> high concentration alarm is activated.

Send: flags  
Receive: flags C0028020

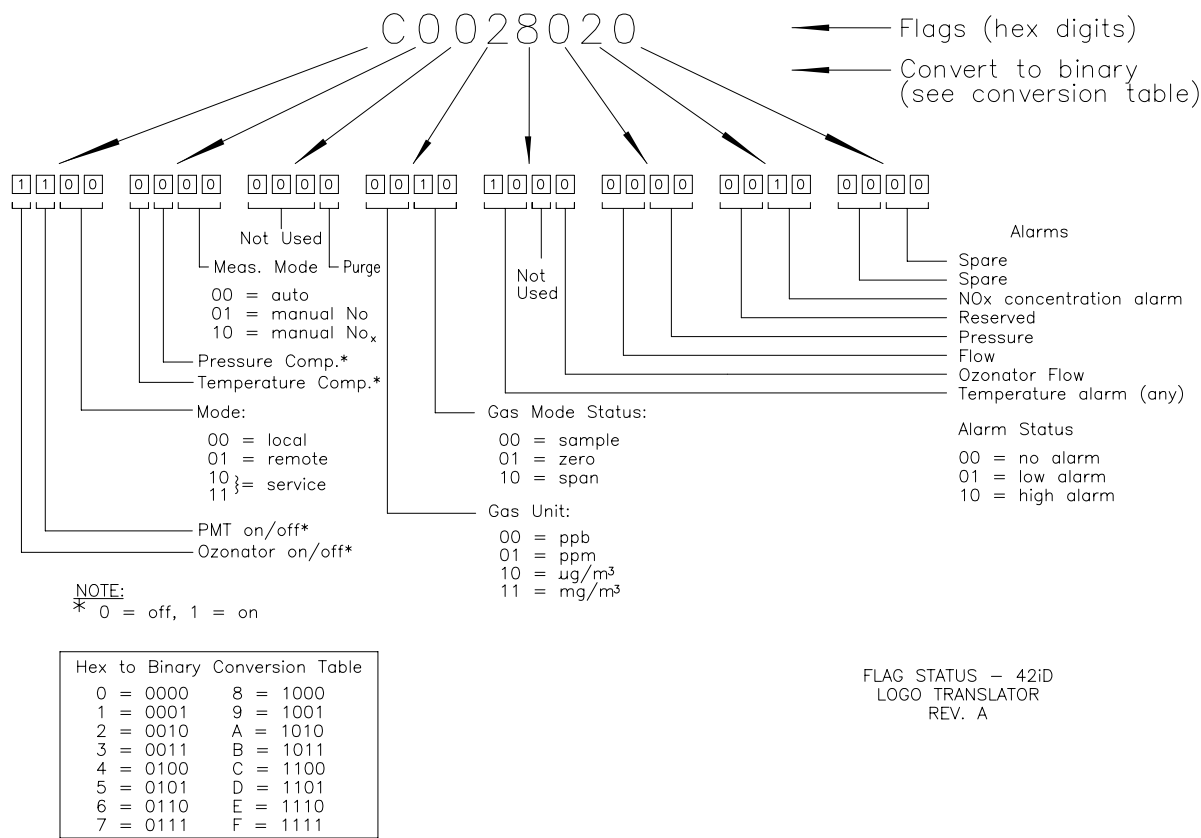


Figure B-1. Flag Status



## Alarms

---

### alarm chamber temp min

### alarm chamber temp max

These commands report the chamber temperature alarm minimum and maximum value current settings. The example below reports that the chamber temperature alarm minimum value is 47.0 °C.

Send: alarm chamber temp min  
Receive: alarm chamber temp min 47.0 deg C

### set alarm chamber temp min *value*

### set alarm chamber temp max *value*

These commands set the chamber temperature alarm minimum and maximum values to *value*, where *value* is a floating-point number representing chamber temperature alarm limits in degrees C. The example below sets the chamber temperature alarm maximum value to 50.0 °C.

Send: set alarm chamber temp max 50.0  
Receive: set alarm chamber temp max 50.0 ok

---

### alarm conc nox min

### alarm conc nox max

These commands report the NO<sub>x</sub> concentration alarm minimum and maximum value current setting. The example below reports that the NO<sub>x</sub> concentration minimum is 5.2 ppb.

Send: alarm conc nox min  
Receive: alarm conc nox min 5.2 ppb

### set alarm conc nox min *value*

### set alarm conc nox max *value*

These commands set the NO<sub>x</sub> concentration alarm minimum and maximum value to *value*, where *value* is a floating-point representation of the concentration alarm limits. Values must be in the units that are currently set for use. The example below sets the NO<sub>x</sub> concentration alarm maximum value to 215.

Send: set alarm conc nox max 215  
Receive: set alarm conc nox max 215 ok

---

### alarm converter temp min

### alarm converter temp max

These commands report the converter temperature alarm minimum and maximum value current settings. The example below reports that the converter temperature alarm minimum value is 300.0 °C.

Send: alarm converter temp min  
Receive: alarm converter temp min 300.0 deg C

**set alarm converter temp min** *value*

**set alarm converter temp max** *value*

These commands set the converter temperature alarm minimum and maximum values to *value*, where *value* is a floating-point number representing converter temperature alarm limits in degrees C. The example below sets the converter temperature alarm maximum value to 340.0 °C.

Send: set alarm converter temp max 340

Receive: set alarm converter temp max 340 ok

---

**alarm cooler temp min**

**alarm cooler temp max**

These commands report the cooler temperature alarm minimum and maximum value current settings. The example below reports that the cooler temperature alarm minimum value is -10.0 °C.

Send: alarm cooler temp min

Receive: alarm cooler temp min -10.0 deg C

**set alarm cooler temp min** *value*

**set alarm cooler temp max** *value*

These commands set the cooler temperature alarm minimum and maximum values to *value*, where *value* is a floating-point number representing cooler temperature alarm limits in degrees C. The example below sets the cooler temperature alarm maximum value to -2.0 °C.

Send: set alarm cooler temp max -2

Receive: set alarm cooler temp max -2 ok

---

**alarm internal temp min**

**alarm internal temp max**

These commands report the internal temperature alarm minimum and maximum value current settings. The example below reports that the internal temperature alarm minimum value is 15.0 °C.

Send: internal temp alarm min

Receive: internal temp alarm min 15.0 deg C

**set internal temp alarm min** *value*

**set internal temp alarm max** *value*

These commands set the internal temperature alarm minimum and maximum values to *value*, where *value* is a floating-point number representing internal temperature alarm limits in degrees C. The example below sets the internal temperature alarm maximum value to 35.0 °C.

Send: set internal temp alarm max 35  
Receive: set internal temp alarm max 35 ok

---

**alarm pressure min****alarm pressure max**

These commands report the pressure alarm minimum and maximum value current settings. The example below reports that the pressure alarm minimum value is 150 mmHg.

Send: pressure alarm min  
Receive: pressure alarm min 150 mmHg

**set alarm pressure min *value*****set alarm pressure max *value***

These commands set the pressure alarm minimum and maximum values to *value*, where *value* is a floating-point number representing pressure alarm limits in millimeters of mercury. The example below sets the pressure alarm maximum value to 290 mmHg.

Send: set alarm pressure max 290  
Receive: set alarm pressure max 290 ok

---

**alarm sample flow min****alarm sample flow max**

These commands report the sample flow alarm minimum and maximum minimum and maximum value current settings. The example below reports that the sample flow alarm minimum value is 0.300 LPM.

Send: alarm sample flow min  
Receive: alarm sample flow min 0.3 l/min

**set alarm sample flow min *value*****set alarm sample flow max *value***

These commands set the sample flow alarm minimum and maximum values to *value*, where *value* is a floating-point number representing sample flow alarm limits in liters per minute. The example below sets the sample flow alarm maximum value to 1 LPM.

Send: set alarm sample flow max 1  
Receive: set alarm sample flow max 1 ok

---

**alarm trig conc nox**

This command reports the NO<sub>x</sub> concentration alarm trigger action for minimum alarm, current setting, to either floor or ceiling. The example below shows the NO<sub>x</sub> concentration minimum alarm trigger to ceiling, according to Table B-3.

Send: alarm trig conc nox  
Receive: alarm trig conc nox 1

#### set alarm trig conc nox *value*

This command sets the NO<sub>x</sub> concentration alarm minimum *value*, where *value* is set to either floor or ceiling, according to Table B-3. The example below sets the NO<sub>x</sub> concentration minimum alarm trigger to ceiling.

Send: set alarm trig conc nox 1  
Receive: set alarm trig conc nox 1 ok

**Table B-3.** Alarm Trigger Values

<i>Value</i>	<b>Alarm Trigger</b>
0	Floor
1	Ceiling

## Diagnostics

---

#### diag volt mb

This command reports the diagnostic voltage measurements on the motherboard. The sequence of voltages is: Positive 24, positive 15, positive 5, positive 3.3, and negative 3.3. Each voltage value is separated by a space.

Send: diag volt mb  
Receive: diag volt mb 24.1 14.9 4.9 3.2 -3.2

---

#### diag volt mib

This command reports the diagnostic voltage measurements on the measurement interface board. The sequence of voltages is: Positive 24, positive 15, negative 15, positive 5, positive 3.3, and positive 15. Each voltage value is separated by a space.

Send: diag volt mib  
Receive: diag volt mib 24.1 14.9 -14.9 4.9 3.2 14.9

---

#### diag volt iob

This command reports the diagnostic voltage measurements on the I/O expansion board. The sequence of voltages is: Positive 24, positive 5, positive 3.3, and negative 3.3. Each voltage value is separated by a space.

Send: diag volt iob  
Receive: diag volt iob 24.1 4.9 3.2 -3.2

## Datalogging

---

### **clr records**

This command will clear all long and short records that have been saved.

Send: clear records  
Receive: clear records ok

### **set clr lrecs**

### **set clr srecs**

These commands will clear only the long records or only the short records that have been saved. The example below clears short records.

Send: set clr srecs  
Receive: set clr srecs ok

---

### **list din**

### **list dout**

These commands report the current selection for the digital outputs in the format. Output no Index number variable name active state. The active state for digital outputs is open or closed. The active state for digital inputs is high or low.

Send: list dout  
Receive: list dout  
output index variable state  
1 35 CONC ALARM open  
3 4 UNITS open  
4 11 GEN ALARM closed  
8 8 NOX MODE open

---

### **list lrec**

### **list srec**

### **list stream**

### **list sp**

These commands report the list of current selections for long record logging data, short record logging data, streaming data output, or the scratch pad (sp) list. The example below shows the list for streaming data output.

Send: list stream  
Receive: list stream  
field index variable  
x x time  
3 3 nox  
4 18 intt  
5 25 pres  
6 26 smplf

---

**er** *xy***lr** *xy***sr** *xy**x* = | 0 | 1 | : Reply termination format (see “set format *format*” command)*y* = | 0 | 1 | 2 | : Output format (see “set errec/lrec/srec format *format*” command)

These commands report the last long and short records stored or the dynamic data record. In the example below, the command requests a long record with no checksum, in ASCII format with text. For details on how to decode the flag fields within these records, see Figure B-1 in the “flags” command.

Send: lr01

Receive: lr01

```
12:31 02-22-03 flags 54089100 no -0000E-1 nox -8485E-1 lono - 0000E-1
lonox -6527E-1 pres 130.9 pmtt 53.2 intt 80.0 rctt 80.0 convt 61 smplf
0.500 ozonf 0.000 pmtv -115
```

---

**errec**

This command returns a brief description of the main operating conditions at the time the command is issued (i.e. dynamic data). The example below shows a typical response. The format is defined by the current settings of “format” and “errec format” commands. For details on how to decode the flag fields within these records, see Figure B-1 in the “flags” command.

Send: errec

Receive: errec

```
10:11 04-06-05 flags DD008000 no 0.000 nox 0.000 no2 0.000 1 lono
147.500 lonox 0.000 lono2 0.000 1 pmtv 805.491 tempal 1 pres 172.278
pcal 150.000 smplf 0.000 ozonf 0.050 hiavgtime 10 loavgtime 10 nobkg
0.000 noxbkg 0.000 nocoef 1.000 noxcoef 1.000 no2coef 1.000 lonocoe
1.000 lonoxcoef 1.000 lono2coef 1.000 norange 100000.000 noxrange
100000.000 no2range 100000.000 lonorange 100000.000 lonoxrange
100000.000 lono2range 100000.000
```

---

**lrec****srec****lrec** *xxxx yy***srec** *xxxx yy***lrec** *aa:bb oo-pp-qq yy***srec** *aa:bb oo-pp-qq yy**xxxx* = the number of past records*yy* = the number of records to return (1 to 10)*aa* = hours (01 to 24)*bb* = minutes (01 to 59)*oo* = month (01 to 12)

*pp* = day (01 to 31)

*qq* = year

These commands output long or short records and dynamic data. The output format is determined by the “set lrec format”, and “set srec format” commands. The logging time is determined by the “set lrec per” and “set srec per” commands. The long records and short records contain the low NO<sub>x</sub> and high NO<sub>x</sub> concentrations. In single range the low NO<sub>x</sub> is set to 0. Since this instrument measures NO<sub>x</sub> only, the NO and low NO concentrations are zero at all times. Concentrations are stored in either ppb or µg/m<sup>3</sup>.

In the following example, there are 740 long records currently stored in memory. When the command lrec 100 5 is sent, the instrument counts back 100 records from the last record collected (record 740), and then returns 5 records: 640, 641, 642, 643, and 644. For details on how to decode the flag fields within these records, see the “flags” command.

```
Send:      lrec 100 5
Receive:   lrec 100 5
11:03 02-22-03  flags 54089100 no 0000E-1 nox 8458E-1 lono 6474E-1
lonox 6506E-1 pres 131.4 pmtt 53.1 intt 80.0 rctt 80.0 convt 61 smplf
0.500 ozonf 0.000 pmtv -116
11:04 02-22-03  flags 54089100 no 0000E-1 nox 8457E-1 lono 6477E-1
lonox 6505E-1 pres 131.5 pmtt 53.1 intt 80.0 rctt 80.0 convt 61 smplf
0.500 ozonf 0.000 pmtv -116
11:05 02-22-03  flags 54089100 no 0000E-1 nox 8456E-1 lono 6492E-1
lonox 6505E-1 pres 131.5 pmtt 53.2 intt 80.0 rctt 80.0 convt 61 smplf
0.500 ozonf 0.000 pmtv -116
11:06 02-22-03  flags 54089100 no 0000E-1 nox 8483E-1 lono 6486E-1
lonox 6525E-1 pres 133.0 pmtt 53.0 intt 80.0 rctt 80.0 convt 61 smplf
0.500 ozonf 0.000 pmtv -116
11:07 02-22-03  flags 54089100 no 0000E-1 nox 8383E-1 lono 6494E-1
lonox 6449E-1 pres 131.5 pmtt 53.1 intt 80.0 rctt 80.0 convt 61 smplf
0.500 ozonf 0.000 pmtv -116
```

where:

pmtv = PMT Voltage

pmtt = PMT Temperature

intt = Internal Temperature

rctt = Reaction Chamber Temperature

convt = NO<sub>2</sub> Converter Temperature

smplf = Sample Flow

ozonf = Ozonator Flow

pres = Pressure

---

**erec format**

**srec format**

**lrec format**

These commands report the output format for long and short records, and dynamic data in various formats such as ASCII without text, ASCII with text, or binary. The example below shows the output format for long records is ASCII with text, according to Table B-4.

```
Send:      lrec format
Receive:   lrec format 1
```

**set erec format *format***

**set lrec format *format***

**set srec format *format***

These commands set the output format for long and short records, and dynamic data, according to Table B-4. The example below sets the long record output format to ASCII with text.

```
Send:      set lrec format 1
Receive:   set lrec format 1 ok
```

**Table B-4.** Record Output Formats

<i>Format</i>	<b>Output Format</b>
0	ASCII no text
1	ASCII with text
2	binary data

---

**erec layout**

**lrec layout**

**srec layout**

These commands reports the layout (string indicating the data formats) for data that is sent out in response to the erec, lrec, srec, and related commands. The example below shows a typical response. For details on how to interpret the strings, see “Record Layout Definition” later in this appendix.

```
Send:      lrec layout
Receive:   lrec layout %s %s %lx %f %f %f %f %f %f %f %f %f %f %f %f
t D L ffffffff
flags no nox hino hinox pres pmtt intt rctt convt smplf ozonf pmtv
```



---

**lrec mem size****srec mem size**

These commands report the long and short records that can be stored with the current settings and the number of blocks reserved for long and short records. To calculate the number of short records per block, add 2 to the number of records, and then divide by the number of blocks. The example below shows that 7 blocks were reserved for long records, and the maximum number of long records that can be stored in memory is 1426.

Send: lrec mem size  
Receive: lrec mem size 1426 recs, 7 blocks

---

**lrec per****srec per**

These commands report the long and short records logging period. The example below shows that the short record logging period is 5 minutes.

Send: srec per  
Receive: srec per 5 min

**set srec per *value*****set lrec per *value***

*value* = | 1 | 5 | 15 | 30 | 60 |

These commands set the long and short records logging period to *value* in minutes. The example below sets the long record logging period to 15 minutes.

Send: set lrec per 15  
Receive: set lrec per 15 ok

---

**no of lrec****no of srec**

These commands report the number of long and short records stored in the long and short records memory. The example below shows that 50 long records have been stored in the memory.

Send: no of lrec  
Receive: no of lrec 50 recs

---

**malloc lrec****malloc srec**

These commands report the currently set memory allocation for long and short records in percent of total memory.

Send: malloc lrec  
Receive: malloc lrec 10%

**set malloc lrec** *value*

**set malloc srec** *value*

*value* = 0 to 100

These commands set the percent of memory space allocated for long and short records to *value*, where *value* is a floating-point number representing percent. The example below sets the memory allocation for long records to 10.

**Note** Issuing these commands will clear all the logging data memory. All the existing records should be retrieved using appropriate commands, if required. ▲

Send: set malloc lrec 10

Receive: set malloc lrec 10 ok

**set copy sp to lrec**

**set copy sp to srec**

**set copy sp to stream**

These commands copy the current selections in scratch pad (sp) into the long record, short record, or streaming data list. The example below copies the current list in scratch pad into the long records list.

Send: set copy sp to lrec

Receive: set copy sp to lrec ok

**set copy lrec to sp**

**set copy srec to sp**

**set copy stream to sp**

These commands copy the current contents of the long record, short record, or streaming data list into the scratch pad (sp). These commands are useful in easy modification of current long record, short record, or streaming data lists. The example below copies the current list of long records into the scratch pad.

Send: set copy lrec to sp

Receive: set copy lrec to sp ok

**sp field** *number*

This command reports the variable *number* and name stored at index in the scratch pad list. The example below shows that the field 5 in the scratch pad is set to index number 13, which is for the variable NO<sub>x</sub> concentration.

Send: sp field 5

Receive: sp field 5 13 pres

**set sp field** *number value*

*number* = 1-32 is the maximum number of fields in long and short record lists.

*number* = 1-18 is for streaming data lists.

This command sets the scratch pad field *number* (item number in scratch pad list) to *value*, where *value* is the index number of a variable in the analog out variable list. Available variables and their corresponding index numbers may be obtained using the command “list var aout”. The “set sp field” command is used to create a list of variables which can then be transferred into the long record, short record, or streaming data lists, using the “set copy sp to lrec”, “set copy sp to srec”, or “set copy sp to stream” commands.

Send:        set sp field 1 34  
Receive:    set sp field 1 34 ok

**stream per**

This command reports the currently set time interval in seconds for streaming data.

Send:        stream per  
Receive:    stream per 10

**set stream per** *number value*

*number value* = | 1 | 2 | 5 | 10 | 20 | 30 | 60 | 90 | 120 | 180 | 240 | 300 |

This command sets the time interval between two consecutive streaming data strings to *number value* in seconds. The example below sets the number value to 10 seconds.

Send:        set stream per 10  
Receive:    set stream per 10 ok

**stream time**

This command reports if the streaming data string will have a time stamp attached to it or not, according to Table B-5.

Send:        stream time  
Receive:    stream time 1

**set stream time** *value*

This command enables *value*, where *value* is to attach or disable time stamp to streaming data string, according to Table B-5. The example below attaches a time stamp to streaming data.

Send: set stream time 0  
Receive: set stream time 0 ok

**Table B-5.** Stream Time Values

<i>Value</i>	<b>Stream Time</b>
0	Attaches time stamp to streaming data string
1	Disables time stamp to streaming data string

## Calibration

---

### **set cal nox coef**

### **set cal high nox coef**

### **set cal low nox coef**

These commands will auto-calibrate the NO<sub>x</sub> coefficient based on the NO<sub>x</sub> span gas concentration. The high and low commands are only available in dual and auto range mode. If the mode is incorrect, the instrument responds with “can’t, wrong settings”. The example below shows a successful auto-calibration of the low NO<sub>x</sub> coefficient.

Send: set cal low nox coef  
Receive: set cal low nox coef ok

---

### **set cal nox bkg**

This command will auto-calibrate the NO<sub>x</sub> background. The example below shows a successful auto-calibration of the NO<sub>x</sub> background.

Send: set cal nox bkg  
Receive: set cal nox bkg ok

---

### **nox coef**

### **high nox coef**

### **low nox coef**

These commands report the NO<sub>x</sub> coefficients in single range mode, or the high and low range coefficients in dual or auto range mode. If the mode is incorrect, the instrument responds with “can’t, wrong settings”. The example below reports that the NO<sub>x</sub> coefficient is 1.000.

Send: nox coef  
Receive: nox coef 1.000

### **set nox coef *value***

### **set high nox coef *value***

### **set low nox coef *value***

These commands set the NO<sub>x</sub> coefficients to user-defined values to *value*, where *value* is a floating-point representation of the coefficient. The example below sets the NO<sub>x</sub> coefficient to 1.005.

Send: set nox coef 1.005  
Receive: set nox coef 1.005 ok

---

**nox gas****high nox gas****low nox gas**

These commands report the NO<sub>x</sub> span gas concentration used to auto-calibrate NO<sub>x</sub> coefficient in single range. The high and low commands are only available in dual and auto range mode. If the mode is incorrect, the instrument responds with “can’t, wrong settings”. The example below shows that the NO<sub>x</sub> low span gas concentration is 240.0 ppm.

Send: low nox gas  
Receive: low nox gas 240E-1 ppm

**set nox gas *value*****set high nox gas *value*****set low nox gas *value***

These commands set the NO<sub>x</sub> span gas concentrations used by the auto-calibration routine to *value*, where *value* is a floating-point representation of the gas concentration in current selected units. The gas units are the same as those chosen by the user. The example below sets the NO span gas concentration to 123.4 ppm.

Send: set no gas 123.4  
Receive: set no gas 123.4 ok

---

**nox bkg**

This command reports the current NO<sub>x</sub> background. The example below reports that the NO<sub>x</sub> background is 5.5 ppb.

Send: nox bkg  
Receive: nox bkg 5.5 ppb

**set nox bkg *value***

This command is used to set NO<sub>x</sub> background to user-defined values to *value*, where *value* is a floating-point representation of the background in current selected units. The example below sets the NO<sub>x</sub> background to 5.5 ppb.

Send: set nox bkg 5.5  
Receive: set nox bkg 5.5 ok

---

**pres cal**

This command reports the pressure recorded at the time of calibration. The example below shows that the pressure at calibration is 85.5 mmHg.

Send:       pres cal  
 Receive:   pres cal 85.5 mmHg

**set pres cal**

This command automatically sets the current pressure as the calibration pressure. The example below successfully sets the calibration pressure to 120.5 mmHg.

Send:       set pres cal 120.5  
 Receive:   set pres cal 120.5 ok

---

**set cal pres**

This command automatically sets the current pressure as the calibration pressure. The example below successfully sets the calibration pressure.

Send:       set cal pres  
 Receive:   set cal pres ok

## Keys/Display

---

**push *button***

*button* = | do | down | en | enter | he | help | le | left | me | menu | ri | right |  
 ru | run | up | 1 | 2 | 3 | 4 |

These commands simulate pressing the front panel pushbuttons. The numbers represent the front-panel soft keys, from left to right.

Send:       push enter  
 Receive:   push enter ok

---

**isc****iscreen**

This command retrieves the framebuffer data used for the display on the iSeries instrument. It is 19200 bytes in size, 2-bits per pixel, 4 pixels per byte arranged as 320 by 240 characters. The data is sent in RLE encoded form to save time in transmission. It is sent as a type '5' binary c\_link response with no checksum.

The RLE encoding consists of a 0 followed by an 8-bit count of consecutive 0xFF bytes. The following 'c' code will expand the incoming data.

```

Void    unpackDisplay ( void far* tdib, unsigned char far* rlescreen )
{
  int i,j,k;
  unsigned char far *sc4bpp, *sc2bpp, *screen, *ptr;

  ptr = screen = (unsigned char far *)malloc(19200);
  //RLE decode the screen
  for (i=0; i<19200 && (ptr - screen) < 19200; i++)
  {
    *(ptr++) = *(rlescreen + i);
    if (*(rlescreen + i) == 0)
    {
      unsigned char rlecount = *(unsigned char *)(rlescreen + ++i);
      while (rlecount)
      {
        *(ptr++) = 0;
        rlecount--;
      }
    }
    else if (*(rlescreen + i) == 0xff)
    {
      unsigned char rlecount = *(unsigned char *)(rlescreen + ++i);
      while (rlecount)
      {
        *(ptr++) = 0xff;
        rlecount--;
      }
    }
  }
}

```

To convert this data into a BMP for use with windows, it needs to be turned into a 4BPP as that is the smallest windows can display. Also note that BMP files are upside down relative to this data, i.e. the top display line is the last line in the BMP.

---

#### sc

#### screen

This command is meant for backward compatibility on the C series. Screen information is reported using the “iScreen” command above.

Send:        screen

Receive:    screen This is an I series Instrument. Screen Information  
not available

## Measurement Configuration

### range nox

#### high range nox

#### low range nox

These commands report the NO<sub>x</sub> ranges in single range mode, or the high and low ranges in dual or auto range mode, according to Table B-6 and B-7. If the mode is incorrect, the instrument responds with “can’t, wrong settings”. The example below reports that the NO<sub>x</sub> range is 50 ppb.

Send: range nox  
Receive: range nox 0: 5000E-2 ppb

### set range nox *selection*

#### set high range nox *selection*

#### set low range nox *selection*

These commands select the NO<sub>x</sub> full-scale ranges, according to Table B-6 and B-7. The example below sets the NO<sub>x</sub> full-scale to 2,000 ppb.

Send: set range nox 5  
Receive: set range nox 5 ok

**Table B-6.** Standard Ranges

<i>Selection</i>	<b>ppb</b>	<b>ppm</b>	<b>µg/m<sup>3</sup></b>	<b>mg/m<sup>3</sup></b>
0	50	0.05	100	0.1
1	100	0.10	200	0.2
2	200	0.20	500	0.5
3	500	0.50	1,000	1.0
4	1,000	1.00	2,000	2.0
5	2,000	2.00	5,000	5.0
6	5,000	5.00	10,000	10.0
7	10,000	10.00	20,000	20.0
8	20,000	20.00	30,000	30.0
9	C1	C1	C1	C1
10	C2	C2	C2	C2
11	C3	C3	C3	C3



**Table B-7.** Extended Ranges

<i>Selection</i>	<i>ppb</i>	<i>ppm</i>	$\mu\text{g}/\text{m}^3$	$\text{mg}/\text{m}^3$
0	200	0.2	500	0.5
1	500	0.5	1,000	1
2	1,000	1	2,000	2
3	2,000	2	5,000	5
4	5,000	5	10,000	10
5	10,000	10	20,000	20
6	20,000	20	50,000	50
7	50,000	50	100,000	100
8	100,000	100	150,000	150
9	C1	C1	C1	C1
10	C2	C2	C2	C2
11	C3	C3	C3	C3

**custom range**

*range* = | 1 | 2 | 3 |

This command reports the user-defined value of custom *range* 1, 2, or 3. The example below reports that custom range 1 is defined to 55.0 ppb.

Send: custom 1  
Receive: custom 1 5500E-2 ppb

**set custom range value**

**set custom 1 value**

**set custom 2 value**

**set custom 3 value**

**set custom 1 range value**

**set custom 2 range value**

**set custom 3 range value**

These commands are used to set the maximum concentration for any of the three custom *ranges* 1, 2, or 3 to range *value*, where *value* is a floating-point number representing concentration in ppb, ppm,  $\mu\text{g}/\text{m}^3$ , or  $\text{mg}/\text{m}^3$ . The example below sets the custom 1 range to 55.5 ppb.

Send: set custom 1 range 55.5  
Receive: set custom 1 range 55.5 ok

---

**range mode**

This command reports the current range mode.

Send: range mode  
Receive: range mode single

**set range mode *mode***

This command sets the current range mode to single, dual, or auto. The example below sets the range mode to single.

Send: set range mode single  
Receive: set range mode single ok

---

**gas mode**

This command reports the current mode of sample, zero, or span. The example below reports that the gas mode is sample.

Send: gas mode  
Receive: gas mode sample

**set sample****set zero****set span**

These commands set the current gas mode to sample, zero, or span. The example below sets the instrument to span mode, that is, the instrument is sampling span gas.

Send: set span  
Receive: set span ok

---

**gas unit**

This command reports the current gas units (ppb, ppm,  $\mu\text{g}/\text{m}^3$ , or  $\text{mg}/\text{m}^3$ ). The example reports that the gas unit is set to ppb.

Send: gas unit  
Receive: gas unit ppb

**set gas *unit***

*unit* = | ppb | ppm |  $\mu\text{g}/\text{m}^3$  |  $\text{mg}/\text{m}^3$  |

This command sets the gas units to ppb, ppm,  $\mu\text{g}/\text{m}^3$ , or  $\text{mg}/\text{m}^3$ . The example below sets the gas units to  $\text{mg}/\text{m}^3$ .

Send: set gas unit  $\text{mg}/\text{m}^3$   
Receive: set gas unit  $\text{mg}/\text{m}^3$  ok

---

**pres comp**

This command reports whether pressure compensation is on or off. The example below shows that pressure compensation is on.

Send:        pres comp  
Receive:    pres comp on

**set pres comp *onoff***

These commands turn the pressure compensation *on* or *off*. The example below turns pressure compensation off.

Send:        set pres comp off  
Receive:    set pres comp off ok

---

**temp comp**

This command reports whether temperature compensation is on or off. The example below shows the temperature compensation is off.

Send:        temp comp  
Receive:    temp comp off

**set temp comp *onoff***

These commands turn the temperature compensation *on* or *off*. The example below turns temperature compensation off.

Send:        set temp comp off  
Receive:    set temp comp off ok

## Hardware Configuration

---

**contrast**

This command reports the screen's level of contrast. The example below shows the screen contrast is 50%, according to Table B-8.

Send:        contrast  
Receive:    contrast 5: 50%

**set contrast *level***

This command sets the screen's *level* of contrast, according to Table B-8. The example below sets the contrast level to 50%.

Send:        set contrast 5  
Receive:    set contrast 5 ok

**Table B-8.** Contrast Levels

<i>Level</i>	<b>Contrast Level</b>
0	0%
1	10%
2	20%
3	30%
4	40%
5	50%
6	60%
7	70%
8	80%
9	90%
10	100%

---

**conv set temp**

This command reports the temperature that the NO<sub>2</sub> converter is set to. The example below reports that the converter temperature is set to 625 °C.

Send: conv set temp  
Receive: conv set temp 625 deg C

**set conv set temp *value***

This command sets the temperature that the NO<sub>2</sub> converter is set to, where *value* is an integer representing degrees C. The example below sets the converter temperature to 625 °C.

Send: set conv set temp  
Receive: set conv set temp 625 deg C ok

---

**date**

This command reports the current date. The example below reports the date as December 1, 2004.

Send: date  
Receive: date 12-01-04

**set date *mm-dd-yy***

*mm* = month

*dd* = day

*yy* = year

This command sets the date of the analyzer's internal clock. The example below sets the date to March 19, 2005.

Send: set date 03-19-05  
Receive: set date 03-19-05 ok

---

**set default params**

This command sets all the parameters to their default values. This does not affect the factory-calibrated parameters.

Send: set default params  
Receive: set default params ok

---

**ozonator**

This command reports the ozonator on or off. The example below reports that the ozonator is on.

Send: ozonator  
Receive: ozonator on

**set ozonator *onoff***

These commands set the ozonator *on* or *off*. The example below sets the ozonator off.

Send: set ozonator off  
Receive: set ozonator off ok

---

**ozonator flow**

This command reports the current ozonator flow. The example below reports that the current ozonator flow is 0.050 LPM.

Send: ozonator flow  
Receive: ozonator flow 0.050 l/m

---

**ozonator safety**

This command reports the status of the ozonator safety on or off. The example below reports that the ozonator safety is on.

Send: ozonator safety  
Receive: ozonator safety on

**set ozonator safety *onoff***

These commands set the ozonator safety *on* or *off*. The example below sets the ozonator off.

Send: set ozonator safety off  
Receive: set ozonator safety off ok

---

**ozonator status**

This command reports the status of the ozonator and safety. The example below reports that the ozonator is off.

Send:        ozonator status  
Receive:    ozonator status off

---

**pmt status**

This command reports the status of the PMT on or off. The example below reports that the PMT is on.

Send:        pmt status  
Receive:    pmt status on

**set pmt *onoff***

These commands set the PMT *on* or *off*. The example below turns the PMT off.

Send:        set pmt off  
Receive:    set pmt off ok

---

**save****set save params**

This command stores all current parameters in FLASH memory. It is important that each time instrument parameters are changed, that this command be sent. If changes are not saved, they will be lost in the event of a power failure. The example below saves the parameters to FLASH memory.

Send:        set save params  
Receive:    set save params ok

---

**time**

This command reports the current time (24-hour time). The example below reports that the internal time is 2:15:30 pm.

Send:        time  
Receive:    time 14:15:30

**set time *hh:mm:ss***

*hh* = hours

*mm* = minutes

*ss* = seconds

This command sets the internal clock (24-hour time). The example below sets the internal time to 2:15 pm.

**Note** if seconds are omitted, the seconds default to 00. ▲

Send: set time 14:15  
Receive: set time 14:15 ok

## Communications Configuration

---

### **addr dns**

This command reports the TCP/IP address for the domain name server.

Send: addr dns  
Receive: addr dns 192.168.1.1

### **set addr dns *address***

This command sets the domain name server *address*, where *address* consists of four numbers ranging from 0-255 inclusive, separated by “.”.

Send: set addr dns 192.168.1.1  
Receive: set addr dns 192.168.1.1 ok

---

### **addr gw**

This command reports the default TCP/IP gateway address.

Send: addr gw  
Receive: addr gw 192.168.1.1

### **set addr gw *address***

This command sets the default gateway *address*, where *address* consists of four numbers ranging from 0-255 inclusive, separated by “.”.

Send: set addr gw 192.168.1.1  
Receive: set addr gw 192.168.1.1 ok

---

### **addr ip**

This command reports the IP address of the analyzer.

Send: addr ip  
Receive: addr ip 192.168.1.15

### **set addr ip *address***

This command sets the analyzer's IP *address*, where *address* consists of four numbers ranging from 0-255 inclusive, separated by “.”.

Send: set addr ip 192.168.1.15  
Receive: set addr ip 192.168.1.15 ok

---

### **addr nm**

This command reports the TCP/IP netmask address.

Send: addr nm  
Receive: addr nm 255.255.255.0

**set addr nm *address***

This command sets the netmask *address*, where *address* consists of four numbers ranging from 0-255 inclusive, separated by “.”.

Send:        set addr nm 255.255.255.0  
Receive:    set addr nm 255.255.255.0 ok

---

**baud**

This command reports the current baud rate for the serial port (RS232/RS485). The example below reports that the current baud rate is 9600.

Send:        baud  
Receive:    baud 9600

**set baud *rate***

*rate* = | 1200 | 2400 | 4800 | 9600 | 19200 | 38400 | 57600 | 115200 |

This command sets the instrument baud *rate*. The example below sets the instrument’s baud rate to 115200.

**Note** After the command is sent, the baud rate of the sending device must be changed to agree with the instrument. ▲

Send:        set baud 115200  
Receive:    set baud 115200 ok

---

**dhcp**

This command reports the current state of use of DHCP on or off. DHCP is used to assign an IP address to the analyzer automatically. The example below shows that DHCP is on.

Send:        dhcp  
Receive:    dhcp on

**set dhcp *onoff***

These commands enables and disables the DHCP service by either *on* or *off*. Changes to this parameter will only take effect when the analyzer is powered up. The example below sets the DHCP service on.

**Note** When DHCP is set to on, the user-supplied addr gw, addr dns, addr ip, and addr nm parameters are not used. ▲

Send:        set dhcp on  
Receive:    set dhcp on ok



---

**format**

This command reports the current reply termination format. The example below shows that the reply format is 00, which means reply with no checksum, according to Table B-9.

Send:       format  
Receive:     format 00

**set format** *format*

This command sets the reply termination *format*, where *format* is set according to Table B-9. The example below sets the reply termination format to checksum.

Send:       set format 01  
Receive:     set format 01 ok

**Table B-9.** Reply Termination Formats

<i>Format</i>	<b>Reply Termination</b>
00	<CR>
01	<NL> sum xxxx <CR>

where xxxx = 4 hexadecimal digits that represent the sum of all the characters (bytes) in the message

---

**host name**

This command reports the host name string.

Send:       host name  
Receive:     host name ISERIES

**set host name** *string*

This command sets the host name *string*, where *string* is 1-13 alphanumeric characters.

Send:       set host name analyzer01  
Receive:     set host name analyzer01 ok

---

**instr name**

This command reports the instrument name.

Send:       instr name  
Receive:     instr name  
NO-NO2-NOx Analyzer  
NO-NO2-NOx Analyzer

---

**instrument id**

This command reports the instrument id.

Send:        instrument id  
Receive:    instrument id 42

**set instrument id *value***

This command sets the instrument id to *value*, where *value* is a decimal number between 0 and 127 inclusive.

**Note** sending this command via RS-232 or RS-485 will require the host to use the new id for subsequent commands. ▲

Send:        set instrument id 50  
Receive:    set instrument id 50 ok

---

**mode**

This command reports what operating mode the instrument is in: local, service, or remote. The example below shows that the instrument is in the remote mode.

Send:        mode  
Receive:    mode remote

**set mode local****set mode remote**

These commands set the instrument to local or remote mode. The example below sets the instrument to the local mode.

Send:        set mode local  
Receive:    set mode local ok

---

**program no**

This command reports the analyzer's model information and program version number, which will be dependant on the current version.

Send:        program no  
Receive:    program no iSeries 42iD 01.00.01.074

---

**set layout ack**

This command disables the stale layout/layout change indicator (“\*”) that is attached to each response if the layout has changed.

Send:        set layout ack  
Receive:    set layout ack ok

## I/O Configuration

---

### **analog iout range** *channel*

This command reports the analog current output range setting for *channels*, where *channel* must be between 1 and 6, inclusive. The example below reports current output channel 4 to the 4-20 mA range, according to Table B-10. This command responds with “feature not enabled” if the I/O expansion board is not detected.

Send:        analog iout range 4  
Receive:    analog iout range 4 2

### **set analog iout range** *channel range*

This command sets analog current output *channel* to the *channel range* where *channel* is between 1 and 6 inclusive, and *range* is set according to Table B-10. The example below sets current output channel 4 to the 0-20 mA range. This command responds with “feature not enabled” if the I/O expansion board is not detected.

Send:        set analog iout range 4 1  
Receive:    set analog iout range 4 1 ok

**Table B-10.** Analog Current Output Range Values

<i>Range</i>	<b>Output Range</b>
1	0-20 mA
2	4-20 mA
0 [cannot be set to this, but may report]	Undefined

---

### **analog vin** *channel*

This command retrieves the analog voltage input *channel* data, both the calculated value and the actual voltage. In the example below, the “calculated” value of channel 1 is 75.325 degrees F, volts are 2.796. This command responds with “feature not enabled” if the I/O expansion board is not detected.

Send:        analog vin 1  
Receive:    analog vin 1 75.325 2.796

---

### **analog vout range** *channel*

This command reports the analog voltage output *channel* range, where *channel* is between 1 and 6 inclusive, according to Table B-11.

Send:        analog vout range 2  
Receive:    analog vout range 2 3

### **set analog vout range** *channel range*

This command sets analog voltage output *channel* to the range, where *channel* is between 1 and 6 inclusive, and *range* is set according to Table B-11. The example below sets channel 2 to the 0-10 V range.

Send: set analog vout range 2 3  
Receive: set analog vout range 2 3 ok

**Table B-11.** Analog Voltage Output Range Values

<i>Range</i>	<b>Output Range</b>
1	0-1 V
2	0-100 mV
3	0-10 V
4	0-5 V
0 [cannot be set to this, but may report]	Undefined

---

### **dig in**

This command reports the status of the digital inputs as a 4-digit hexadecimal string with the most significant bit (MSB) being input 16.

Send: dig in  
Receive: dig in 0xff7f

---

### **din** *channel*

This command reports the action assigned to input *channel* and the corresponding active state. The example below reports the input 5 to be assigned an index number 9 corresponding to action of “analog outputs to zero” with the active state being high.

Send: din 5  
Receive: din 5 9 AOUTS TO ZERO high

### **set din** *channel index state*

This command assigns digital input *channel* (1-16) to activate the action indicated by *index* (1-35), when the input transitions to the designated *state* (high or low). Use “list din var” command to obtain the list of supported *index* values and corresponding actions.

Send: set din 1 3 high  
Receive: set din 1 3 high ok

---

### **dout** *channel*

This command reports the index number and output variable and the active state assigned to output *channel*. The example below reports the input 4 to be assigned an index number 11 corresponding to “general alarm” with the active state being open.

```
Send:      dout 4
Receive:   dout 4 11 GEN ALARM open
```

#### **set dout** *channel index state*

This command assigns digital output *channel* to be assigned to the action associated with *index*, and assigns it an active state of *state* (open or closed).

```
Send:      set dout 4 11 open
Receive:   set dout 4 11 open ok
```

---

#### **dtoa** *channel*

This reports the outputs of the 6 or 12 digital to analog converters, according to Table B-12. The example below shows that the DAC 1 is 97.7% full-scale.

```
Send:      dtoa 1
Receive:   dtoa 1 97.7%
```

**Note** All channel ranges are user definable. If any customization has been made to the analog output configuration, the default selections may not apply. ▲

**Table B-12.** Default Output Assignment

D to A	Function	Single Range	Dual Range	Auto Range
1	Voltage Output	Not Assigned	Not Assigned	Not Assigned
2	Voltage Output	Not Assigned	Not Assigned	Not Assigned
3	Voltage Output	NO <sub>x</sub>	High NO <sub>x</sub>	High/Low NO <sub>x</sub>
4	Voltage Output	Not Assigned	Not Assigned	Range Status
5	Voltage Output	Not Assigned	Not Assigned	Not Assigned
6	Voltage Output	Not Assigned	Low NO <sub>x</sub>	Not Assigned
7	Current Output	Not Assigned	Not Assigned	Not Assigned
8	Current Output	Not Assigned	Not Assigned	Not Assigned
9	Current Output	NO <sub>x</sub>	High NO <sub>x</sub>	High/Low NO <sub>x</sub>
10	Current Output	Not Assigned	Not Assigned	Range Status
11	Current Output	Not Assigned	Not Assigned	Not Assigned
12	Current Output	Not Assigned	Low NO <sub>x</sub>	Not Assigned

---

**list var aout****list var dout****list var din**

These commands report the list of index numbers, and the variables (associated with that index number) available for selection in the current mode (determined by single/dual/auto, gas mode no/no<sub>x</sub> or no/no<sub>x</sub>) for analog output, digital output and digital inputs. The index number is used to insert the variable in a field location in a list using “set sp *field index*”. The example below reports the list of analog output, index numbers, and variables.

```
Send:      list var aout
Receive:   list var aout
index variable
0 none
3 nox
18 intt
19 rctt
20 pmtt
21 convt
25 pres
26 splf
27 pmtv
28 ain1
29 ain2
30 ain3
31 ain4
32 ain5
33 ain6
34 ain7
35 ain8
```

---

**relay stat**

This command reports the current relay logic normally “open” or normally “closed,” if all the relays are set to same state, that is all open or all closed. The example below shows that the status when all the relays logic is set to normally “open”.

```
Send:      relay stat
Receive:   relay stat open
```

**Note** if individual relays have been assigned different logic then the response would be a 4-digit hexadecimal string with the least significant byte (LSB) being relay no 1. ▲

For example:

Receive: relay stat 0x0001 (indicates relay no 1 is set to normally open logic, all others are normally closed)  
Receive: relay stat 0x0005 (indicates relay no 1 and 3 are set to be normally open logic, all others are normally closed)

**set relay open**

**set relay open** *value*

**set relay closed**

**set relay closed** *value*

These commands set the relay logic to normally open or closed for relay number *value*, where *value* is the relay between 1 and 16. The example below sets the relay no 1 logic to normally open.

**Note** if the command is sent without an appended relay number then all the relays are assigned the set logic of normally open/closed. ▲

Send: set relay open 1  
Receive: set relay open 1 ok

## Record Layout Definition

The Erec, Lrec, and Srec Layouts contain the following:

- A format specifier for parsing ASCII responses
- A format specifier for parsing binary responses

In addition to these, the Erec Layout contains:

- A format specifier for producing the front-panel displays

In operation, values are read in using either the ASCII or binary format specifiers and converted to uniform internal representations (32-bit floats or 32-bit integers). These values are converted into text for display on the screen using the format specifier for the front-panel display. Normally, the specifier used to parse a particular datum from the input stream will be strongly related to the specifier used to display it (e.g., all of the floating point inputs will be displayed with an 'f' output specifier, and all of the integer inputs will be displayed with a 'd' specifier).

## Format Specifier for ASCII Responses

The first line of the Layout response is the scanf-like parameter list for parsing the fields from an ASCII ERec response. Parameters are separated by spaces and the line is terminated by a `\n` (the normal line separator character). Valid fields are:

- `%s` - parse a string
- `%d` - parse a decimal number
- `%ld` - parse a long (32-bit) decimal number
- `%f` - parse a floating point number
- `%x` - parse a hexadecimal number
- `%lx` - parse a long (32-bit) hex number
- `%*` - ignore the field

**Note** signed versus unsigned for the integer values does not matter; it is handled automatically.

## Format Specifier for Binary Responses

The second line of the Layout response is the binary parameter list for parsing the fields from a binary response. Parameters **MUST** be separated by spaces, and the line is terminated by a `\n`. Valid fields are:

- `t` - parse a time specifier (2 bytes)
- `D` - parse a date specifier (3 bytes)
- `i` - ignore one 8-bit character (1 byte)
- `e` - parse a 24-bit floating point number (3 bytes: `n/x`)
- `E` - parse a 24-bit floating point number (3 bytes: `N/x`)
- `f` - parse a 32-bit floating point number (4 bytes)

- `c` - parse an 8-bit signed number (1 byte)
- `C` - parse an 8-bit unsigned number (1 byte)
- `n` - parse a 16-bit signed number (2 bytes)
- `N` - parse a 16-bit unsigned number (2 bytes)
- `m` - parse a 24-bit signed number (3 bytes)
- `M` - parse a 24-bit unsigned number (3 bytes)
- `l` - parse a 32-bit signed number (4 bytes)
- `L` - parse a 32-bit unsigned number (4 bytes)

There is an optional single digit *d* which may follow any of the numeric fields which indicates that after the field has been parsed out, the resulting value is to be divided by  $10^d$ . Thus the 16-bit field `0xFFC6` would be interpreted with the format specifier `'n3'` as the number `-0.058`.

## Format Specifier for Front-Panel Layout

The subsequent lines in the ERec Layout response describe the appearance of the full panel. The full instrument panel as it appears on the screen has two columns of lines. Each line is composed of three major components: (1) a text field, (2) a value field, and (3) a button. None of these three components is required. The text field contains statically displayed text.



The value field displays values which are parsed out of the response to a DATA/ERec command. It also displays, though background changes, alarm status. The button, when pressed, triggers input from either a dialog box or a selection list. There are five kinds of buttons, B, I, L, T, and N.

Each line in the layout string corresponds to one line on the display. The layout string describes each of the three major fields as well as translation mechanisms and corresponding commands.

**Text** The first field in the layout string is the text. It is delimited by a ':'. The string up to the first ':' will be read and inserted in the text field of the line.

**Value String** This is followed by a possible string, enclosed in quotes. This is used to place a string into the value field.

**Value Source** The value source, which is the item (or word) number in the DATA/ERec response, appears next. This is followed by an optional bitfield designator. The datum identified by the value source can be printed as a string 's', hexadecimal 'x', decimal 'd', or floating point 'f', or binary 'b' number. Typically, bitfield extractions are only done for decimal or hexadecimal numbers.

Floating-point numbers can be followed with an optional precision specifier which will be used as an argument to printf's %f format (e.g., a field of '4' would be translated into the printf command of '%.3f'). Alternately, the special character '\*' can precede the precision specifier; this causes an indirection on the precision specifier (which now becomes a field number).

This is useful when formatting, for example, numbers which have varying precision depending on the mode of the instrument.

Binary numbers can also have an optional precision specifier which is used to determine how many bits to print. For example, the specifier 'b4' will print the lowest four bits of the parsed number.

There are serious restrictions on where an 's' field may appear: currently sources 1 and 2 must be 's', and no others may be 's'.

**Alarm Information** The value source is followed by optional alarm information, indicated by a commercial at sign '@' with a source indicator and a starting bit indicator. All alarm information is presumed to be two bits long (low and high). The bitfield extraction is performed on the integer part of the source. Typical alarm information would appear as '@6.4'.

**Translation Table** Then, there appears an optional translation table within braces '{}'. This is a string of words separated by spaces. An example translation table would be '{Code\_0 Code\_1 Code\_2 Code\_3}'. The value, once extracted is used as a zero-based index into the translation table to determine the string to display.

**Selection Table** Then there appears an optional selection table within parentheses '(...)'. This is a string of numbers separated by spaces '(0 1)'. The selection table lists the translation table entries which the user may select from when setting the parameter. This is not necessarily the same as the entries which may be displayed.

**Button Designator** Then there appears an optional button designator. This will be one of 'B', 'I', 'L', 'T', or 'N'.

B- Indicates a button which pops up an input dialog prompting the user for a new value using the designated input format. The input format is specified from the 'B' through the subsequent semicolon.

I—Indicates a button which pops up a selection list with input translation. That is, the values read are translated before they are compared to the selection list options.

L—Indicates a button which pops up a selection list without any translation. The output value is number of the selected option.

T—Indicates a button which pops up a selection list with output translation. The number of the option selected is used as an index into the translation table to generate an output string.

N—Indicates a button which only sends the subsequent command to the instrument. No user-prompting happens.

The following string through an optional '|' or the end of the line is the command which is to be sent to the instrument upon the completion of the button selection. The command string should normally contain print-style formatting to include the user input. If a '|' is present, it indicates a command which is sent to the instrument upon successful completion of the button command to update the value field.

This is not currently used.

**Examples** Some examples ('\n' is the C syntax for an end-of-line character):

```
'Concentrations\n'
```

This is a single text-only line.

```
'\n'
```

This is a single blank line.

```
' NO:3s\n'
```

This is a line which appears slightly indented. The text field is 'NO', the value is taken from the third element of the data response, and interpreted as a string.

```
' NO:18sBd.ddd;set no coef %s\n'
```

This is a line which also appears slightly indented. The next field is also 'NO', but the value is taken from the eighteenth element of the data response, again interpreted as a string. A button appears on this line which, when pressed, pops up an input dialog which will state "Please enter a new value for NO using a d.ddd format." The string entered by the user is used to construct the output command. If the user enters, for example, '1.234', the constructed command will be 'set no coef 1.234'.

```
' NO:21f{Code_0 Code_1 Code_2 Code_3 Code_4 Code_5 Code_6 Code_7  
Code_8 Code_9 Code_10 Code_11}Lset range no %d\n'
```

This is a line which appears slightly indented, the title is again 'NO', and the value the twenty-first element of the data response, interpreted as a floating-point number. There is a no-translation button which creates a selection list of twelve "Code nn" options. The number of the user selection is used to create the output command.

```
'Mode:6.12-13x{local remote service service}(0 1)Tset mode %s\n'
```

This is a line which has a title of 'Mode', and value taken from the sixth field of the data response. There is a bitfield extraction of bits 12 through 13 from the source (the value type is not important here because the value is being translated to an output string). Once the bits have been extracted, they are shifted down to the bit-zero position. Thus, the possible values of this example will be 0 through 3. The translation list shows the words which correspond to each input value, the zeroth value appearing first (0 -> local, 1 -> remote, etc.). The selection list shows that only the first two values, in this case, are to be shown to the user when the button is pressed. The 'T' button indicates full translation, input code to string, and user selection number to output string.

```
'\xC'
```

This is a line that starts a new column (the \xC or ^L),

```
' Comp:6.11x{off on}Tset temp comp %s\n'
```

This shows that the bitfield end (the second part of a bitfield specification) is optional. The bitfield will be one bit long, starting in this case at the eleventh bit.

```
'Background:7f*8Bd.ddd;set o3 bkg %s\n'
```

This shows the use of indirect precision specifiers for floating point displays. The background value is taken from the 7th element, and the precision specifier is taken from the 8th. If the asterisk were not present, it would indicate instead that 8 digits after the decimal point should be displayed.

## Appendix C MODBUS Protocol

This appendix provides a description of the MODBUS Protocol Interface and is supported both over RS-232/485 (RTU protocol) as well as TCP/IP over Ethernet.

The MODBUS Commands that are implemented are explained in detail in this document. The MODBUS protocol support for the *i*Series enables the user to perform the functions of reading the various concentrations and other analog values or variables, read the status of the digital outputs of the analyzer, and to trigger or simulate the activation of a digital input to the instrument. This is achieved by using the supported MODBUS commands listed below.

For details of the Model 42i NO<sub>x</sub> MODBUS Protocol specification, see the following topics:

- “Serial Communication Parameters” on page C-2 describes the parameters used to support MODBUS RTU protocol.
- “TCP Communication Parameters” on page C-2 describes the parameters used for TCP connection.
- “Application Data Unit Definition” on page C-2 describes the formats used over serial and TCP/IP.
- “Function Codes” on page C-3 describes the various function codes supported by the instrument.
- “MODBUS Commands Supported” on page C-8 lists the MODBUS commands supported in Table C-1 through Table C-3.

Additional information on the MODBUS protocol can be obtained at <http://www.modbus.org>. References are from MODBUS Application Protocol Specification V1.1a MODBUS-IDA June 4, 2004.

## Serial Communication Parameters

The following are the communication parameters that are used to configure the serial port of the *iSeries* to support MODBUS RTU protocol.

Number of Data bits : 8

Number of Stop bits : 1

Parity : None

Data rate : from 1200-115200 Baud (9600 is default)

## TCP Communication Parameters

*iSeries* Instruments support the MODBUS/TCP protocol. The register definition is the same as for the serial interface.

TCP connection port for MODBUS : 502

## Application Data Unit Definition

Here are the MODBUS ADU (Application Data Unit) formats over serial and TCP/IP:

Serial:	Slave Address	Function Code	Data	Error Check
TCP/IP:	MBAP Header	Function Code	Data	

### Slave Address

The MODBUS slave address is a single byte in length. This is the same as the instrument ID used for C-Link commands and can be between 1 and 127 decimal (i.e. 0x01 hex to 0x7F hex). This address is only used for MODBUS RTU over serial connections.

**Note** Device ID '0' used for broadcast MODBUS commands, is not supported. Device IDs 128 through 247 (i.e. 0x80 hex to 0xF7 hex) are not supported because of limitations imposed by C-Link. ▲

### MBAP Header

In MODBUS over TCP/IP, a MODBUS Application Protocol Header (MBAP) is used to identify the message. This header consists of the following components:

Transaction Identifier	2 Bytes	0x0000 to 0xFFFF (Passed back in response)
Protocol Identifier	2 Bytes	0x00 (MODBUS protocol)
Length	2 Bytes	0x0000 to 0xFFFF (Number of following bytes)
Unit Identifier	1 Byte	0x00 to 0xFF (Passed back in response)

A Slave address is not required in MODBUS over TCP/IP because the higher-level protocols include device addressing. The unit identifier is not used by the instrument.

## Function Code

The function code is a single byte in length. The following function codes are supported by the instrument:

Read Coils	:	0x01
Read Inputs	:	0x02
Read Holding Registers	:	0x03
Read Input Registers	:	0x04
Force (Write) Single Coil	:	0x05
Read Exception Status	:	0x07

If a function code is received that is not in this list, and invalid function exception is returned.

## Data

The data field varies depending on the function. For more description of these data fields, see “Function Codes” below.

## Error Check

In MODBUS over Serial an error check is included in the message. This is not necessary in MODBUS over TCP/IP because the higher-level protocols ensure error-free transmission. The error check is a two-byte (16-bit) CRC value.

## Function Codes

This section describes the various function codes that are supported by the Model 42i NO<sub>x</sub>.

### (0x01/0x02) Read Coils / Read Inputs

Read Coils/Inputs reads the status of the digital outputs (relays) in the instrument. Issuing either of these function codes will generate the same response.

These requests specify the starting address, i.e. the address of the first output specified, and the number of outputs. The outputs are addressed starting at zero. Therefore, outputs numbered 1–16 are addressed as 0–15.

The outputs in the response message are packed as one per bit of the data field. Status is indicated as 1 = Active (on) and 0 = Inactive (off). The LSB of the first data byte contains the output addressed in the query. The other outputs follow toward the high order end of this byte, and from low order to high order in subsequent bytes. If the returned output quantity is not a multiple of eight, the remaining bits in the final data byte will be padded with zeros (toward the high order end of the byte). The Byte Count field specifies the quantity of complete bytes of data.

**Note** The values reported may not reflect the state of the actual relays in the instrument, as the user may program these outputs for either active closed or open. ▲

#### Request

Function code	1 Byte	0x01 or 0x02
Starting Address	2 Bytes	0x0000 to maximum allowed by instrument
Quantity of outputs	2 Bytes	1 to maximum allowed by instrument
Unit Identifier	1 Byte	0x00 to 0xFF (Passed back in response)

#### Response

Function code	1 Byte	0x01 or 0x02
Byte count	1 Byte	N*
Output Status	n Byte	n = N or N+1

\*N = Quantity of Outputs / 8, if the remainder not equal to zero, then N=N+1

#### Error Response

Function code	1 Byte	Function code + 0x80
Exception code	1 Byte	01=Illegal Function, 02=Illegal Address, 03=Illegal Data, 04=Slave Device Failure

Here is an example of a request and response to read outputs 2–15:

#### Request

<i>Field Name</i>	<i>(Hex)</i>
Function	0x01
Starting Address Hi	0x00
Starting Address Lo	0x02
Quantity of Outputs Hi	0x00
Quantity of Outputs Lo	0x0D



### Response

<i>Field Name</i>	<i>(Hex)</i>
Function	0x01
Byte Count	0x03
Outputs status 2-10	0xCD
Outputs status 11-15	0x0A

The status of outputs 2–10 is shown as the byte value 0xCD, or binary 1100 1101. Output 10 is the MSB of this byte, and output 2 is the LSB. By convention, bits within a byte are shown with the MSB to the left, and the LSB to the right. Thus the outputs in the first byte are ‘10 through 2’, from left to right. In the last data byte, the status of outputs 15-11 is shown as the byte value 0x0A, or binary 0000 1010. Output 15 is in the fifth bit position from the left, and output 11 is the LSB of this byte. The four remaining high order bits are zero filled.

## (0x03/0x04) Read Holding Registers / Read Input Registers

Read holding/input registers reads the measurement data from the instrument. Issuing either of these function codes will generate the same response. These functions read the contents of one or more contiguous registers.

These registers are 16 bits each and are organized as shown below. All of the values are reported as 32-bit IEEE standard 754 floating point format. This uses 2 sequential registers, least significant 16 bits first.

The request specifies the starting register address and the number of registers. Registers are addressed starting at zero. Therefore registers numbered 1–16 are addressed as 0–15. The register data in the response message are packed as two bytes per register, with the binary contents right justified within each byte. For each register, the first byte contains the high order bits and the second contains the low order bits.

### Request

Function code	1 Byte	0x03 or 0x04
Starting Address	2 Bytes	0x0000 to maximum allowed by instrument
Quantity of Registers	2 Bytes	1 to maximum allowed by instrument

### Response

Function code	1 Byte	0x03 or 0x04
Byte count	1 Byte	2 x N*
Register value	N* x 2 Bytes	n = N or N+1

\*N = Quantity of Registers

### Error Response

Function code	1 Byte	Function code + 0x80
Exception code	1 Byte	01=Illegal Function, 02=Illegal Address, 03=Illegal Data, 04=Slave Device Failure

Here is an example of a request to read registers 10–13:

### Request

<i>Field Name</i>	<i>(Hex)</i>
Function	0x03
Starting Address Hi	0x00
Starting Address Lo	0x09
No. of Registers Hi	0x00
No. of Registers Lo	0x04

### Response

<i>Field Name</i>	<i>(Hex)</i>
Function	0x03
Byte Count	0x06
Register value Hi (10)	0x02
Register value Lo (10)	0x2B
Register value Hi (11)	0x00
Register value Lo (11)	0x00
Register value Hi (12)	0x00
Register value Lo (12)	0x64
Register value Hi (13)	0x00
Register value Lo (13)	0x64

The contents of register 10 are shown as the two byte values of 0x02 0x2B. The contents of registers 11–13 are 0x00 0x00, 0x00 0x64 and 0x00 0x64, respectively.

## **(0x05) Force (Write) Single Coil**

The force (write) single coil function simulates the activation of the digital inputs in the instrument, which triggers the respective action.

This function code is used to set a single action to either ON or OFF. The request specifies the address of the action to be forced. Actions are addressed starting at zero. Therefore, action number 1 is addressed as 0. The requested ON/OFF state is specified by a constant in the request data field. A value of 0xFF00 requests the action to be ON. A value of 0x0000 requests it to be OFF. All other values are illegal and will not affect the output. The normal response is an echo of the request, returned after the state has been written.

### **Request**

Function code	1 Byte	0x05
Output Address	2 Bytes	0x0000 to maximum allowed by instrument
Output Value	2 Bytes	0x0000 or 0xFF00

### **Response**

Function code	1 Byte	0x05
Output Address	2 Bytes	0x0000 to maximum allowed by instrument
Output Value	2 Bytes	0x0000 or 0xFF00

### **Error Response**

Function code	1 Byte	Function code + 0x80
Exception code	1 Byte	01=Illegal Function, 02=Illegal Address, 03=Illegal Data, 04=Slave Device Failure

Here is an example of a request to write Coil 5 ON:

### **Request**

<i>Field Name</i>	<i>(Hex)</i>
Function	05
Output Address Hi	00
Output Address Lo	05
Output Value Hi	FF
Output Value Lo	00

**Response**

<i>Field Name</i>	<i>(Hex)</i>
Function	05
Output Address Hi	00
Output Address Lo	05
Output Value Hi	FF
Output Value Lo	00

## MODBUS Commands Supported

Table C-1 through table C-3 lists the MODBUS commands supported for the Model 42i NO<sub>x</sub>.

**Table C-1.** Read Coils for 42i NO<sub>x</sub>

<b>Coil Number</b>	<b>Status</b>
1	AUTORANGE (NO <sub>x</sub> )
2	LOCAL/REMOTE
3	SERVICE
4	UNITS
5	ZERO MODE
6	SPAN MODE
7	NO MODE
8	NO <sub>x</sub> MODE
9	NOT USED
10	NOT USED
11	GEN ALARM
12	NOT USED
13	NOT USED
14	NOT USED
15	NOT USED
16	NO <sub>x</sub> CONC MAX ALARM
17	NO <sub>x</sub> CONC MIN ALARM
18	INT TEMP ALARM
19	CHAMB TEMP ALARM
20	COOLER TEMP ALARM
21	NO <sub>2</sub> CONVERTER TEMP ALARM
22	NOT USED

**Table C-1.** Read Coils for 42i NO<sub>x</sub>

Coil Number	Status
23	NOT USED
24	PRESSURE ALARM
25	FLOW ALARM
26	OZONE FLOW ALARM
27	MOTHERBOARD STATUS ALARM
28	INTERFACE BD STATUS ALARM
29	I/O EXP BD STATUS ALARM
30	NOT USED
31	CONC ALARM
32	SAMPLE MODE

**Table C-2.** Read Registers for 42i NO<sub>x</sub>

Register Number	Variable
40001&40002	NOT USED
40003&40004	NOT USED
40005&40006	NO <sub>x</sub>
40007&40008	NOT USED
40009&40010	NOT USED
40011&40012	NOT USED
40013&40014	NOT USED
40015&40016	LO NO <sub>x</sub>
40017&40018	NOT USED
40019&40020	NOT USED
40021&40022	NOT USED
40023&40024	NOT USED
40025&40026	HI NO <sub>x</sub>
40027&40028	NOT USED
40029&40030	NOT USED
40031&40032	RANGE (NO <sub>x</sub> )
40033&40034	NOT USED
40035&40036	INT TEMP
40037&40038	CHAMBER TEMP

**Table C-2.** Read Registers for 42i NO<sub>x</sub>

Register Number	Variable
40039&40040	COOLER TEMP
40041&40042	NO <sub>2</sub> CNV TEMP
40043&40044	NOT USED
40045&40046	NOT USED
40047&40048	NOT USED
40049&40050	CHAMBER PRES
40051&40052	FLOW
40053&40054	PMT VOLTS
40055&40056	ANALOG IN 1
40057&40058	ANALOG IN 2
40059&40060	ANALOG IN 3
40061&40062	ANALOG IN 4
40063&40064	ANALOG IN 5
40065&40066	ANALOG IN 6
40067&40068	ANALOG IN 7
40069&40070	ANALOG IN 8

**Table C-3.** Write Coils for 42i NO<sub>x</sub>

Coil Number	Action Triggered
101	ZERO MODE
102	SPAN MODE
103	NO MODE
104	NO <sub>x</sub> MODE
105	NOT USED
106	NOT USED
107	SET BACKGROUND
108	CAL TO LO SPAN
109	AOUTS TO ZERO
110	AOUTS TO FS
111	CAL TO HI SPAN

## Appendix D

# Geysitech (Bayern-Hessen) Protocol

This appendix provides a description of the Geysitech (Bayern-Hessen or BH) Protocol Interface and is supported both over RS-232/485 as well as TCP/IP over Ethernet.

The Geysitech Commands that are implemented are explained in detail in this document. The Geysitech protocol support for the *iSeries* enables the user to perform the functions of reading the various concentrations and to trigger the instrument to be in sample/zero/span mode if valid for that instrument. This is achieved by using the supported Geysitech commands listed below.

For details of the Model 42i NO<sub>x</sub> Geysitech Protocol specification, see the following topics:

- “[Serial Communication Parameters](#)” on page D-1
- “[TCP Communication Parameters](#)” on page D-2
- “[Instrument Address](#)” on page D-2
- “[Abbreviations Used](#)” on page D-2
- “[Basic Command Structure](#)” on page D-2
- “[Block Checksum](#)” on page D-3
- “[Geysitech Commands](#)” on page D-3

## Serial Communication Parameters

The following are the communication parameters that are used to configure the serial port of the *iSeries* to support Geysitech protocol.

Number of Data bits	: 8
Number of Stop bits	: 1
Parity	: None
Data rate	: from 1200-115200 Baud (9600 is default)

## TCP Communication Parameters

iSeries Instruments support the Geysitech/TCP protocol over TCP/IP. The register definition is the same as for the serial interface.

TCP connection port for Geysitech: 9882

## Instrument Address

The Geysitech instrument address has a value between 0 and 127 and is represented by 3 digit ASCII number with leading zeros or leading spaces if required (e.g. Instrument address of 1 is represented as 001 or <SP><SP>1)

The instrument Address is the same as the Instrument ID used for C-Link and MODBUS commands. This can be set via the front panel.

The Instrument Address is represented by <address> in the examples throughout this document.

**Note** Device IDs 128 through 247 are not supported because of limitations imposed by the C-Link protocol. ▲

## Abbreviations Used

The following is a list of abbreviations used in this document:

<CR> is abbreviation for Carriage Return (ASCII code 0x0D)

<STX> is abbreviation for Start of Text (ASCII code 0x02)

<ETX> is abbreviation for End of Text (ASCII code 0x03)

<SP> is abbreviation for space (ASCII code 0x20)

## Basic Command Structure

The following is the basic structure of a Geysitech command:

<STX>Command text<ETX><BCC>

OR

<STX>Command text<CR>

Each Command is framed by control characters, <STX> at the start and terminated with either <ETX> or <CR>.

If a command is terminated with <ETX> then additional two characters <BCC> is attached after <ETX>, this is the block checksum.



## Block Checksum <BCC>

The block checksum is calculated beginning with a seed value of 00000000, binary (0x00), and bitwise exclusive ORing with each of the characters of the command string (or response) including the framing characters <STX> and <ETX>. The checksum works as an error check. The command terminator determines the presence or absence of <BCC>.

If a command is terminated by <ETX> then the next two characters are the checksum, if the command is terminated with <CR> no checksum is attached

The block checksum is represented by two characters, which represent a 2 digit hex number (1byte). (e.g. 1 byte 0xAB hex checksum will be represented by the two characters 'A' & 'B')

The checksum is referred to as <BCC> throughout this document.

## Geysitech Commands

The following commands are supported by the Geysitech protocol:

- Instrument Control Command (ST)
- Data Sampling/Data Query Command (DA)

### Instrument Control Command (ST)

There are three control commands supported by the Geysitech protocol.

This <control command> is a single letter, which triggers an action in the instrument. These commands are active only when service mode is inactive and the zero/span option is present.

Command 'N' switches the instrument gas mode to Zero mode.

Command 'K' switches the instrument gas mode to Span mode.

Command 'M' switches the instrument gas mode to Sample mode.

The following are the different acceptable formats of the ST command:

<STX>ST<address><control command><ETX><BCC>

OR

<STX>ST<address><control command><CR>

OR

<STX>ST<address><SP><control command><CR>

OR

<STX>ST<address><SP><control command><ETX><BCC>

The <address> is optional, which means it can be left out completely. The <address> if present must match the Instrument Address. Additional space can be present after the <address>.

If the received command does not satisfy the above formats or if the <address> does not match the Instrument Address the command is ignored.

This is a sample command to switch the instrument to zero mode, instrument id 5:

<STX>ST005<SP>N<CR>

## **Data Sampling/Data Query Command (DA)**

This command DA initiates a data transfer from the instrument. The instrument responds with measurement data, which depends on the range mode and is listed in “[Measurements reported in response to DA command](#)” below.

The command structure for a data query command is as follows:

<STX>DA<address><ETX><BCC>

The <address> is optional, which means it can be left out completely. The <address> if present must match the Instrument Address. Additional space can be present after the <address>.

If the <address> is left out then no space is allowed in the query string.

A command with no address is also a valid command.

The following are the different acceptable formats of the DA command with Instrument Address 5:

<STX>DA<CR>

<STX>DA005<CR>

<STX>DA<SP><SP>5<ETX><BCC>

<STX>DA<ETX><BCC>

The data query string is valid and will be answered with data transmission only if the command starts with <STX> which is followed by the characters DA, and the <address> (if present) matches the Instrument Address, and the command is terminated with either <CR> with no checksum or <ETX> followed by the correct checksum <BCC>.

### Sample Data Reply String in response to Data Query Command (DA):

In response to a valid data query command (DA) the instrument responds in the following format:

```
<STX>MD02<SP><address><SP><measured
value1><SP><status><SP><SFKT><SP><address+1><SP><measured
value2><SP><status><SP><SFKT><ETX><BCC>
```

The response uses the same command terminators as used by the received command i.e. if the received command was terminated with a <CR> the response is terminated with <CR> and if the command was terminated with a <ETX><BCC> the response is terminated with <ETX> and the computed checksum <BCC>.

The 02 after the MD indicates, that two measurements are present in the reply string, (a 03 for three measurements and so on, this will also determine the length of the reply string).

<address> is the Instrument Address. Each subsequent measurement attached to the response will have the <address + X> where X keeps incrementing by 1 for each measurement included.

<measured value> is the concentration value in currently selected gas units represented as exponential representation with 4 characters mantissa and 2 characters exponent, each with sign.

Mantissa: sign and 4 digits. The decimal point is assumed to be after the first digit and is not transmitted.

Exponent: sign and 2 digits.

#### Example:

-5384000.0 is represented as -5384+06

+0.04567 is represented as +4567-02

<status>: is formed by < operating status > and < error status > and separated by a space i.e.

```
<operating status><SP><error status>
```

Each of the two (<operating status> and <error status>) are formed by two characters each representing a 2 digit hex number which is one byte (8 Bits) operation status and one byte (8 Bits) error status.

These two bytes contain the information about the main operating conditions of the instrument at that instant. For details on how to interpret the status bytes refer to [Table D-1](#) and [Table D-2](#) below.

<SFKT>: is the space provided for future use for special function, it currently contains a string of ten 0's i.e. <0000000000>.

**Example:**

Geysitech Protocol with transmission of three concentrations (Instrument ID is 1, Operation Status is 03, Error Status is 04):

Data Query String: <STX>DA<CR>

Reply String:

$\text{<STX>MD03}<\text{SP}>001<\text{SP}>+2578+01<\text{SP}>03 \text{ } <\text{SP}>04<\text{SP}>0000000000 \text{ } <\text{SP}>002 \text{ } <\text{SP}>$   
 $\uparrow \qquad \qquad \qquad \uparrow \qquad \qquad \qquad \qquad \qquad \qquad \qquad \qquad \qquad \qquad \qquad \qquad \qquad \qquad \qquad \uparrow$   
 Address      First Concentration(E-format)=25.78      Address+1

+5681+00<SP>03<SP>04<SP>0000000000<SP>003<SP>+1175+01<SP>03<SP>04<SP>

↑                                  ↑        ↑

Second Concentration = 5.681                      Address+2       Third Concentration=11.75

```
0000000000<SP><CR>
```

The attached concentrations are in the selected gas units. The measurements that are attached to the response if not valid in a particular mode then a value of 0.0 will be reported.

### Measurements reported in response to DA command

The following measurements reported in response to DA command are for the Model 42i NO<sub>x</sub>.

## Single Range Mode

The 1 measurement reported in single range mode includes:

- NO<sub>x</sub>

## Dual/Auto Range Mode

The 2 measurements reported in dual or auto range modes include:

- low NO<sub>x</sub>
- high NO<sub>x</sub>

## Operating and Error Status

See [Table D-1](#) for operating status and [Table D-2](#) for error status for the Model 42i NO<sub>x</sub>.

**Table D–1.** Operating Status for Model 42i NO<sub>x</sub>

	D7	D6	D5	D4		D3	D2	D1	D0
→ Bit	8	7	6	5		4	3	2	1
→ Hex-value	80	40	20	10		08	04	02	01
	MSB					LSB			
Operating status:									
Service Mode (On)	0	0	0	0		0	0	0	1
Maintenance (Local)	0	0	0	0		0	0	1	0
Zero gas (On)	0	0	0	0		0	1	0	0
Span gas (On)	0	0	0	0		1	0	0	0
Gas Unit Indication (ppm OR ppb)	0	0	0	1		0	0	0	0
Ozonator (Off)	0	0	1	0		0	0	0	0
PMT (Off)	0	1	0	0		0	0	0	0
Not used	1	0	0	0		0	0	0	0

**Table D–2.** Error Status for Model 42i NO<sub>x</sub>

	D7	D6	D5	D4		D3	D2	D1	D0
→ Bit	8	7	6	5		4	3	2	1
→ Hex-value	80	40	20	10		08	04	02	01
	MSB					LSB			
Error status:									
Not Used	0	0	0	0		0	0	0	1
Not Used	0	0	0	0		0	0	1	0
Not Used	0	0	0	0		0	1	0	0
Any Temperature Alarm	0	0	0	0		1	0	0	0
Pressure Alarm	0	0	0	1		0	0	0	0
Sample Flow Alarm	0	0	1	0		0	0	0	0
Ozonator Flow Alarm	0	1	0	0		0	0	0	0
Not used	1	0	0	0		0	0	0	0

