MODEL 49C
Primary Standard

UV PHOTOMETRIC O_3 CALIBRATOR

INSTRUCTION MANUAL
P/N 9994

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CHAPTER 1
INTRODUCTION

The Model 49C Primary Standard UV photometric ozone calibrator combines proven technology, easy to use menu-driven software, and advanced diagnostics to provide unsurpassed flexibility and reliability. The Model 49C Primary Standard offers the following features:

- Multi-line alphanumeric display
- Menu-driven software
- Fast internal ozonator
- Fast response time
- Short lag time
- RS-232 communication
- Automatic temperature and pressure correction
- EPA specified method of calibration

Thermo Environmental Instruments is pleased to supply this ultraviolet (UV) photometric ozone calibrator. We are committed to the manufacture of instruments exhibiting high standards of quality, performance, and workmanship. Service personnel are available to assist with any questions or problems that may arise in the use of this calibrator.

PRINCIPLE OF OPERATION

The Model 49C Primary Standard is based on the principle that ozone (O_3) molecules absorb UV light at a wavelength of 254 nm. The degree to which the UV light is absorbed is directly related to the ozone concentration as described by the Beer-Lambert Law:

$$\frac{I}{I_o} = e^{-KLC}$$

where:

K = molecular absorption coefficient, 308 cm^{-1} (at 0°C and 1 atmosphere)
L = length of cell, 38 cm
C = ozone concentration in parts per million (ppm)
I = UV light intensity of sample with ozone (sample gas)
I_o = UV light intensity of sample without ozone (reference gas)

Zero air is supplied to the Model 49C Primary Standard through the **ZERO AIR** bulkhead and is split into two gas streams, as shown in Figure 1-1. One gas stream flows through a pressure regulator to the reference solenoid valve to become the reference gas (I_o). The second zero air stream flows through a pressure regulator, ozonator, and manifold to the sample solenoid valve to become the sample gas (I). Ozone from the manifold is delivered to the **OZONE** bulkhead. The solenoid valves alternate the reference and sample gas streams between cells A and B every 10 seconds. When cell A contains reference gas, cell B contains sample gas and vice versa.

The UV light intensities of each cell are measured by detectors A and B. When the solenoid valves switch the reference and sample gas streams to opposite cells, the light intensities are ignored for several seconds to allow the cells to be flushed. The Model 49C Primary Standard calculates the ozone concentration for each cell and outputs the average concentration to both the front panel display and the analog outputs.

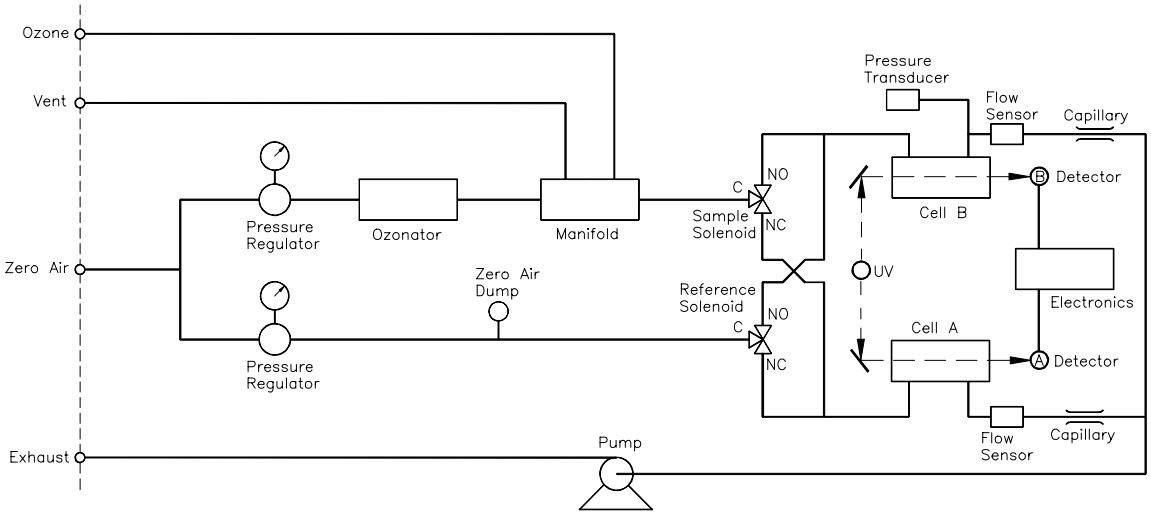

Figure 1-1. Model 49C Primary Standard Flow Schematic

SPECIFICATIONS

Photometer

Range	50, 100, 200, 500, 1000, 2000, 5000 ppb 100, 200, 500, 1000, 2000, 5000, 10000 $\mu g/m^3$
Zero noise	0.5 ppb RMS
Lower detectable limit	1 ppb
Response time	20 seconds (0-95%)
Lag time	10 seconds
Precision	1 ppb
Linearity	± 1% Fullscale
Flow rate	1-3 liters/min
Operating temperature	0-50°C
Power requirements	90-110 VAC @ 50/60 Hz 105-125 VAC @ 50/60 Hz 210-250 VAC @ 50/60 Hz 150 Watts
Physical dimensions	16.75" (W) X 8.62" (H) X 23"(D)
Weight	35 lbs.
Outputs	selectable voltage 4-20 mA, RS-232, RS-485

Ozonator

Output	0.025-1.000 ppm at 3-4 liters/min
Response (to 99% or 4 ppb of final value, whichever is greater)	1 minute
Stability	± 4 ppb or ± 1% of reading, whichever is greater

CHAPTER 2
INSTALLATION

The installation of the Model 49C Primary Standard includes lifting and unpacking the calibrator, connecting zero air, exhaust lines, and attaching the analog outputs to a recording device. To install optional equipment, see Chapter 9, "Optional Equipment."

LIFTING

A procedure appropriate to lifting a heavy object should be used when lifting the calibrator. This procedure consists of bending at the knees while keeping your back straight and upright. The calibrator should be grasped at the bottom, in the front and at the rear of the unit. Do not attempt to lift the calibrator by the cover or other external fittings. While one person may 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.

UNPACKING

The Model 49C Primary Standard is shipped complete in one container. If, upon receipt of the calibrator, there is obvious damage to the shipping container, notify the carrier immediately and hold for inspection. The carrier, and not Thermo Environmental Instruments Inc., is responsible for any damage incurred during shipment. Follow the procedure below to unpack and inspect the instrument.

1. Remove the calibrator from the shipping container and set on a table or bench which will allow easy access to both the front and rear of the calibrator.
2. Remove the calibrator cover to expose the internal components.
3. Remove any packing material.
4. Check for possible damage during shipment.
5. Check that all connectors and printed circuit boards are firmly attached.
6. Reinstall the calibrator cover.

SETUP PROCEDURE

1. Connect the zero air supply to the **ZERO AIR** bulkhead on the rear panel (see Figure 2-1). All tubing should be constructed of FEP Teflon□, 316 stainless steel, borosilicate glass, or similar tubing with an OD of 1/4" and a minimum ID of 1/8" for all lines and components. The length of the tubing should be less than 10 feet.
2. Connect the **EXHAUST** bulkhead to a suitable vent. The exhaust line should be 1/4" OD with a minimum ID of 1/8". The length of the exhaust line should be less than 10 feet. Verify that there is no restriction in this line.
3. Connect a suitable recording device to the rear panel terminals. See Chapter 3, "Operation" for more information about the pin-out of the rear panel terminal.
4. Plug the calibrator into an outlet of the appropriate voltage and frequency.

CAUTION: The Model 49C Primary Standard is supplied with a three-wire grounding cord. Under no circumstances should this grounding system be defeated.

5. Connect the instrument to be calibrated to the **OZONE** bulkhead. The total flow through the ozonator should be set to at least 1 LPM.

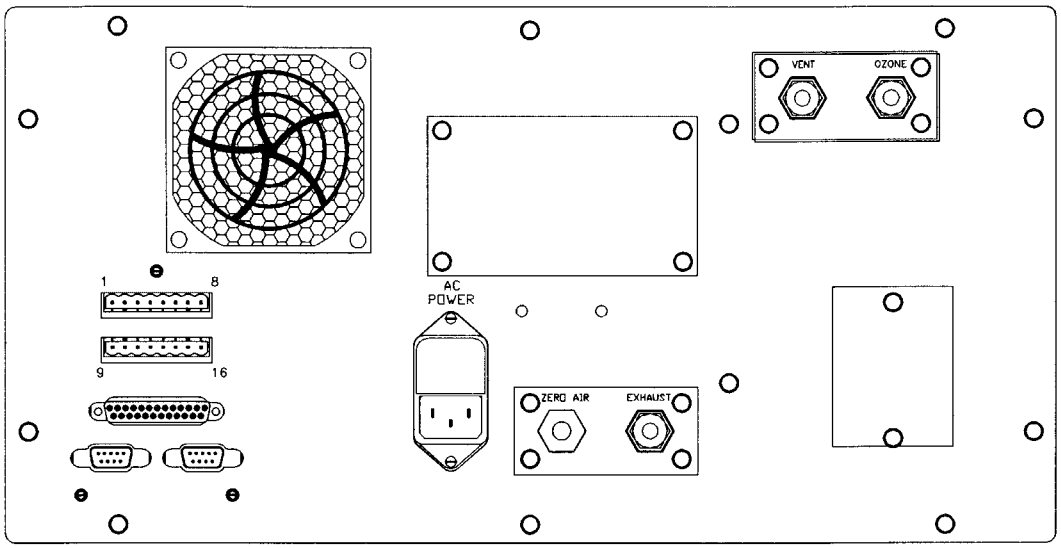

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Figure 2-1. Model 49C Primary Standard Rear Panel

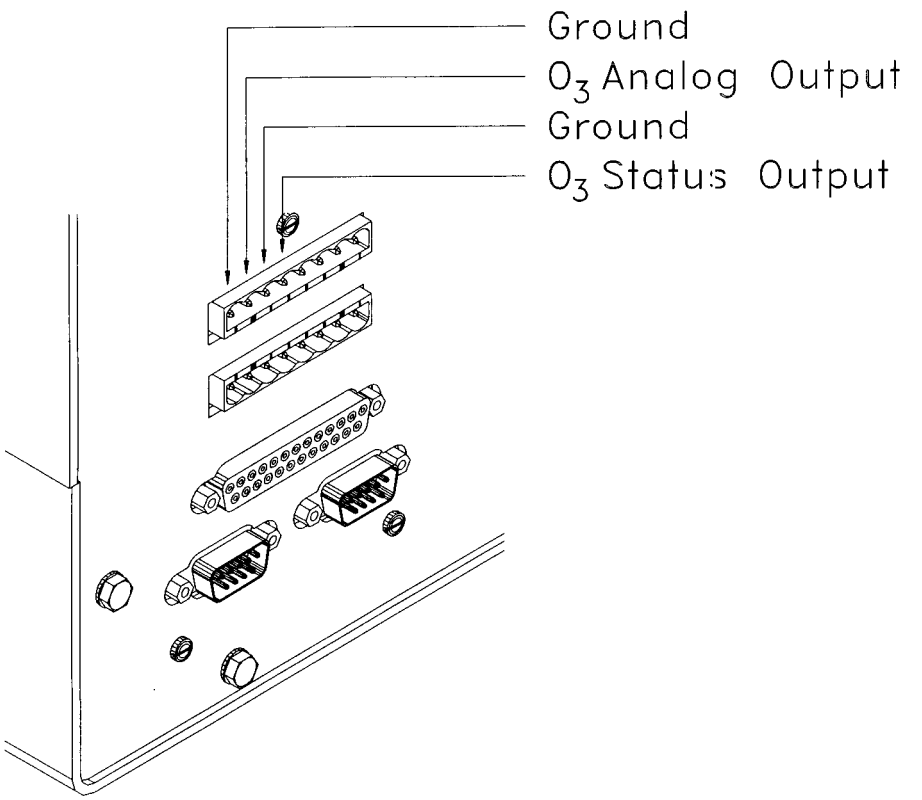


Figure 2-2. Pin-Out of Rear Panel Terminal Strip

Analog Output Cover Installation

This analog output cover must be mounted over the analog outputs to comply with 89/336/EEC Directive. This procedure describes how to install the user-supplied analog output cable in the instrument's analog output cover. The following shielded cables or their equivalent are recommended:

Cable	Gauge	No. of Conductors
Alpha #1741C	20	2
Alpha #1746C	18	2
Alpha #5320/2C *	20	2
Alpha #51 52C *	20	2
Alpha #5162C *	18	2
Alpha #1743C	20	4
Alpha 1747/4C	18	4
Alpha #5320/4C	20	4
Alpha #5154C	20	4
Alpha #5164C	18	4
Belden #8208	18	2

* Maximum shielding. Under harsh environments, maximum shielding may be required.

The following tools are required:

Small screwdriver
Wire stripper
Electrical tape or heat shrink tubing

The user-supplied shielded analog output cable must be properly grounded by coming into full contact with the cable clamp (mounted to the analog output cover). To ensure full contact, the shielding must be exposed and folded back over the cable as shown in Figure 2-3.

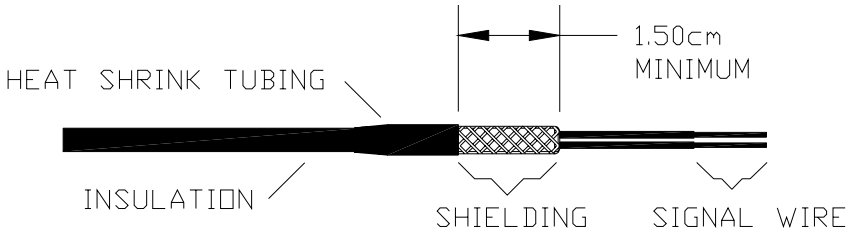


Figure 2-3. Shielded Cable with Shielding Pulled Back

Follow the procedure below to prepare the shielded cable:

1. Remove about 1.8 cm of insulation from the cable.
2. Fold back the shielding.
3. Use electrical tape or shrink tubing to hold the shielding in place. Be sure at least 1.5 cm of shielding is exposed.
4. Strip each signal wire.

Follow the procedure below to connect the shielded cable to the 8-position header:

1. Pass the shielded cable through the cable clamp on the analog output cover, as shown in Figure 2-4.

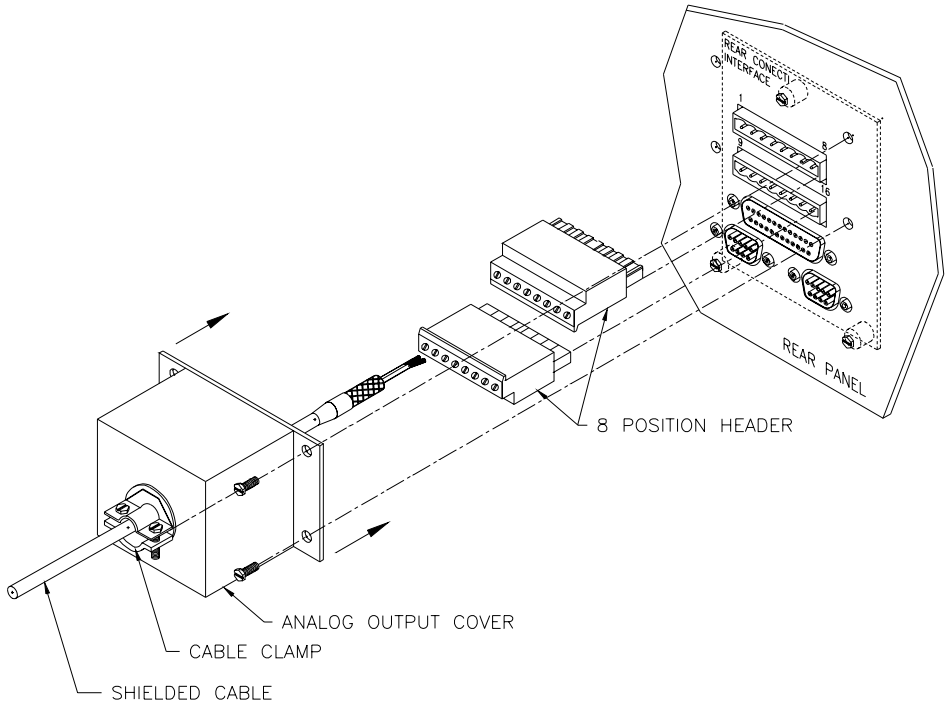


Figure 2-4. Exploded View of Analog Output Cover Installation

2. Insert the bare signal wire into the slot of the header.
3. Tighten down the corresponding set screw.
4. Repeat steps 2 and 3 for each signal wire.
5. Plug the header(s) into the analog output connectors.
6. Install the analog output cover using the four #6 screws with star lockwashers.
7. Position the cable shielding so that it. comes in contact with the cable clamp.
8. Tighten down the cable clamp onto the shielding, as shown in Figure 2-5.

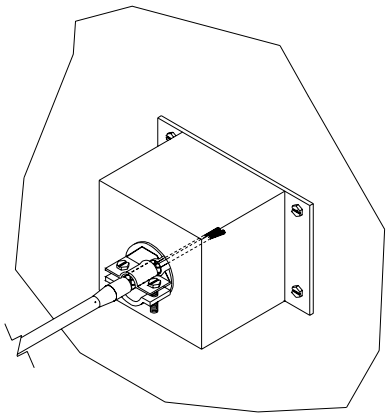


Figure 2-5. Properly Installed Shield Cable

1. Install cable clamp into shield cover and secure. Be sure there is good electrical conductivity between clamp and shield cover.

The following is a parts list of components in the analog output cover assembly:

Part No.	Description	Qty.
7592	Analog output cover	1
11519	8-Position header	2
5889	#6 Star lock washers	4
5820	6-32X3/8” screw	4
14549	Cable clamp	1

STARTUP

1. Turn the power on.
2. Allow 30 minutes for the calibrator to stabilize.
3. Set parameters such as operating ranges and averaging times to appropriate settings. For more information about parameters, see Chapter 3, “Operation.”

CHAPTER 3
OPERATION

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

DISPLAY

The 4 line by 20 character alphanumeric display shows the sample concentrations, instrument parameters, instrument controls, and help messages. Some menus contain more items than can be displayed at one time. For these menus, use the ↑ and ↓ pushbuttons to move the cursor up and down to each choice.

PUSHBUTTONS

Run Pushbutton

The **RUN** pushbutton, shown below, is used to display the Run screen. The Run screen displays the O_3 output concentration.

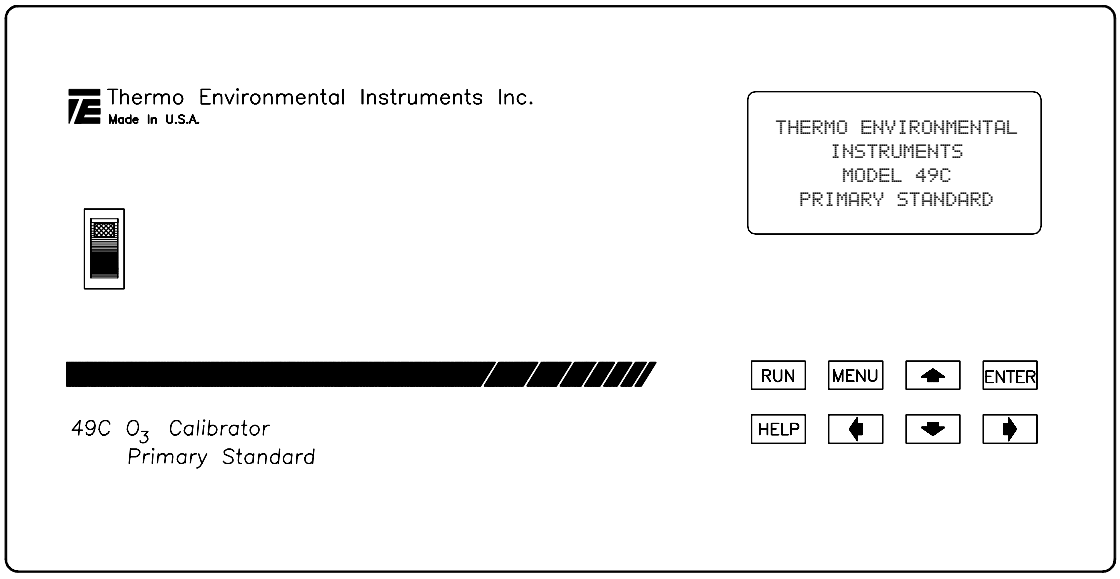


Figure 3-1. Model 49C Primary Standard Front Panel

Menu Pushbutton

The **MENU** pushbutton is used to display the Main Menu and to display submenus. When in the Run screen, this pushbutton displays the Main Menu. When in any other screen, a submenu is displayed. For more information about the Main Menu, see "Main Menu" later in this chapter.

Enter Pushbutton

The **ENTER** pushbutton is used to choose a menu item, complete an entry, and toggle on/off functions. In addition, the **ENTER** pushbutton is used to switch between local and remote mode, when the remote interface is enabled.

Help Pushbutton

The **HELP** pushbutton is context-sensitive, that is it provides additional information about the screen that is being displayed. Press the **HELP** pushbutton for a concise 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 **MENU** to return to the previous screen or **RUN** to return to the Run screen.

↑, ↓, ←, → Pushbuttons

The four arrow pushbuttons (↑, ↓, ←, and →) move the cursor up, down, right, and left.

SOFTWARE OVERVIEW

The Model 49C Primary Standard is based on menu-driven software as illustrated by the flowchart in Figure 3-2. The Power-Up and Self-Test screens, shown at the top of the flowchart, are displayed each time the instrument is turned on. These screens are 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 is where the O_3 output concentration is displayed. From the Run screen, the Main Menu can be displayed by pressing the **MENU** pushbutton. The Main Menu contains a list of submenus. Each submenu contains related parameters and/or functions. This chapter describes each submenu and screen in detail. Refer to the appropriate sections for more information.

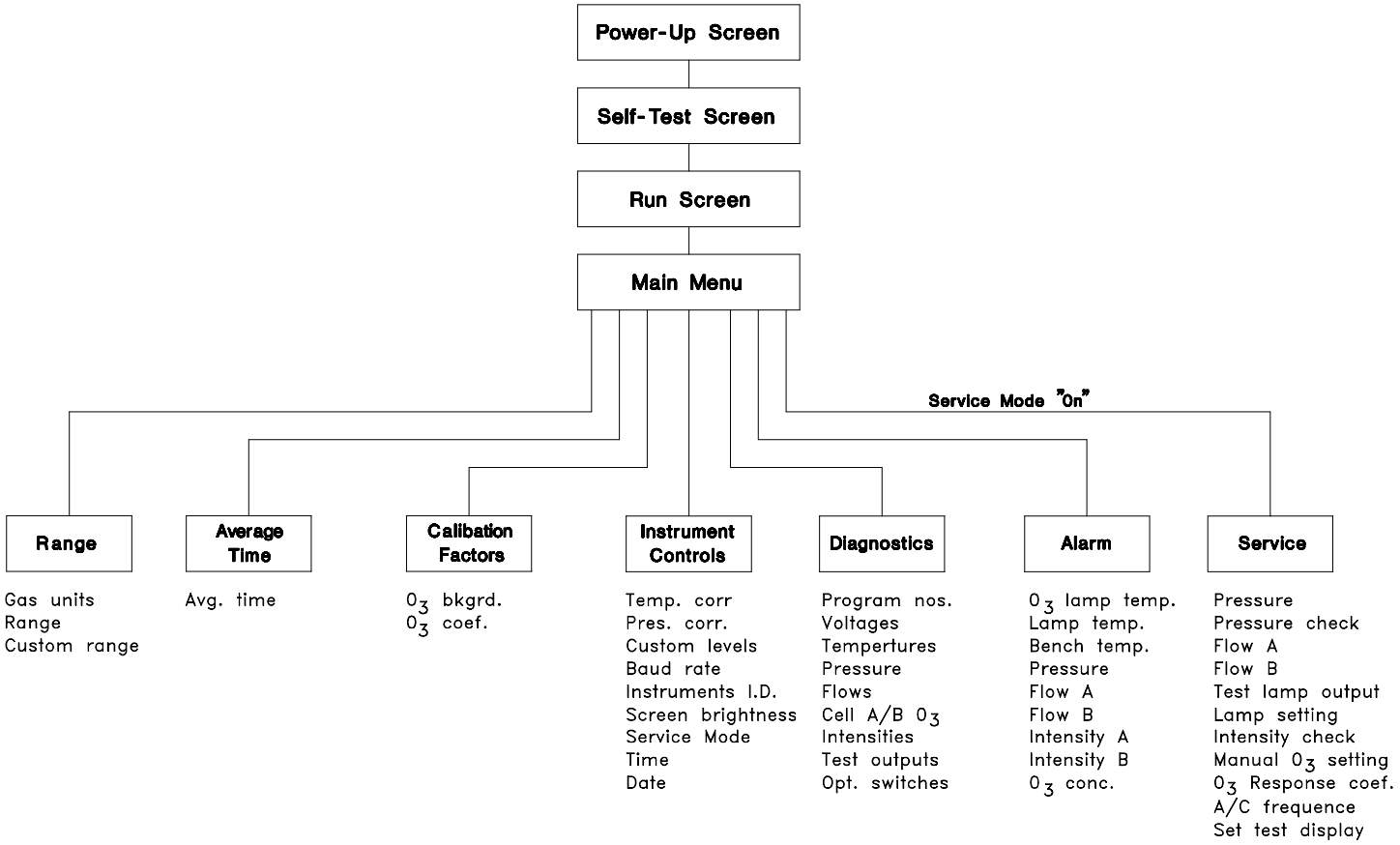
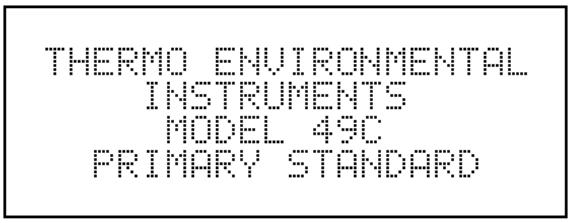


Figure 3-2. Flowchart of Menu-Driven Software

Power-Up Screen

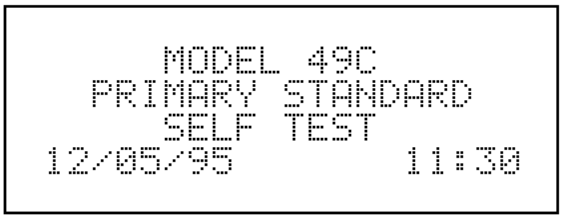
The Power-Up screen, as shown below, is displayed on power up of the Model 49C Primary Standard.



Power-Up Screen

Self-Test Screen

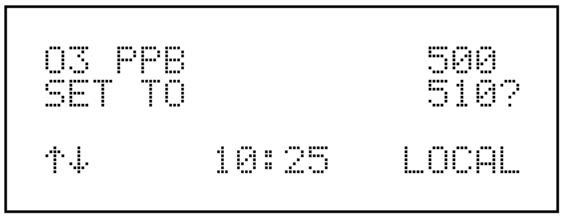
The Self-Test Screen, as shown below, is displayed while the internal components are warming up and a diagnostic check is performed.



Self Test Screen

Run Screen

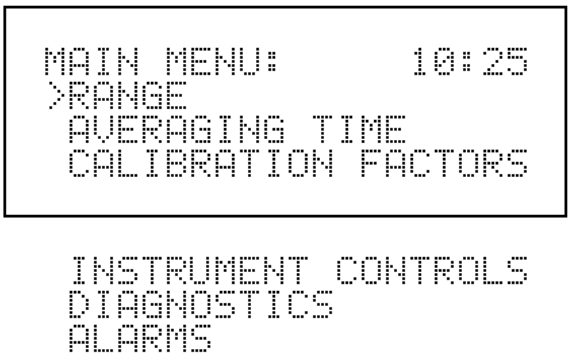
The Run screen, shown below, displays the O_3 output concentration and the time. Use the ↑ and ↓ pushbuttons to increase and decrease the O_3 output concentration.



Run Screen

Main Menu

The Main Menu contains several submenus as shown below. Parameters and features are divided into these submenus according to their function. Use the ↑ and ↓ pushbuttons to move the cursor to each submenu. When the Main Menu is entered directly from the Run screen, the ← pushbutton may be used to jump to the most recently displayed submenu screen. Use the **ENTER** pushbutton to select a submenu.



Main Menu

RANGE MENU

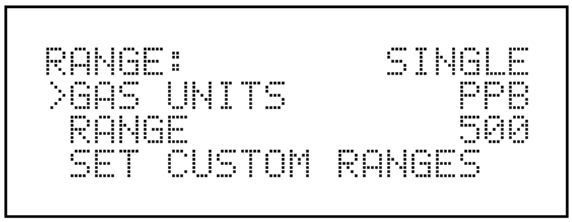
The Range menu appears as shown below.

To display the Range Menu:

- From the Main Menu choose Range

To use the Range Menu:

- Press the ↑ and ↓ pushbuttons to move the cursor to each choice
- Press **ENTER** to select a choice
- Press **MENU** to return to the Main Menu
- Press **RUN** to return to the Run screen



Range Menu

Gas Units

The Gas Units screen, shown below, defines how the O_3 output concentration reading is expressed. Gas units of parts per billion (ppb), parts per million (ppm), micrograms per cubic meter ($\mu g/m^3$), or milligrams per cubic meter (mg/m^3) are available. The $\mu g/m^3$ and mg/m^3 gas concentration modes are calculated using a factory standard pressure of 760 mm Hg and a factory standard temperature of 20°C.

When switching from ppb or ppm to $\mu g/m^3$ or mg/m^3, the O_3 range and custom ranges are set to default to the highest range in that mode. For example, when switching from mg/m^3 to ppm, all ranges will be set to 5 ppm.

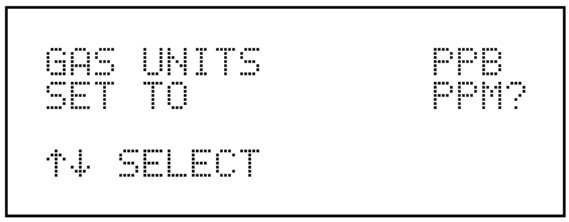
The current gas units are shown on the first line of the display. The gas units are selected on the second line of the display.

To display the Gas Units screen:

- From the Main Menu choose Range
- From the Range Menu choose Gas Units

To use the Gas Units screen:

- Use the ↑ and ↓ pushbuttons to select the gas units
- Press **ENTER** to accept the choice
- Press **MENU** to return to the Range menu
- Press **RUN** to return to the Run screen.



Gas Units Screen

Range

The Range defines the concentration range of the analog outputs. For example, a range of 0-500 ppb restricts the analog output to concentrations between 0 and 500 ppb.

The second line of the display shows the current range. The third line of the display is used to change the range.

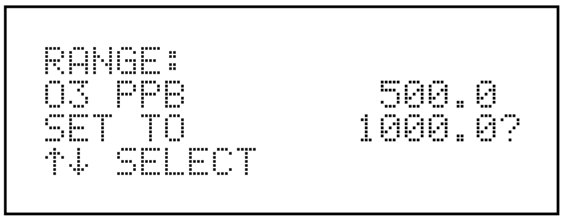
Table 3-1 below lists the available preset ranges. The analog outputs are arranged in the rear panel terminal strip as shown in Figure 3-3.

To display the Range screen:

- From the Main Menu choose Range
- From the Range menu choose Range

To use the Range screen:

- Use the ↑ and ↓ pushbuttons to scroll through the preset ranges
- Press **ENTER** to accept a range
- Press **MENU** to return to the Range menu
- Press **RUN** to return to the Run screen



Range Screen

ppb	ppm	µg/m^3	mg/m^3
50	0.05	100	0.1
100	0.10	200	0.2
200	0.20	500	0.5
500	0.50	1,000	1
1,000	1	2,000	2
2,000	2	5,000	5
5,000	5	10,000	10
C1	C1	C1	C1
C2	C2	C2	C2
C3	C3	C3	C3

Table 3-1. Available Operating Ranges

C1, C2, and C3 are custom ranges. For more information about custom ranges, see "Custom Ranges Menu" below.

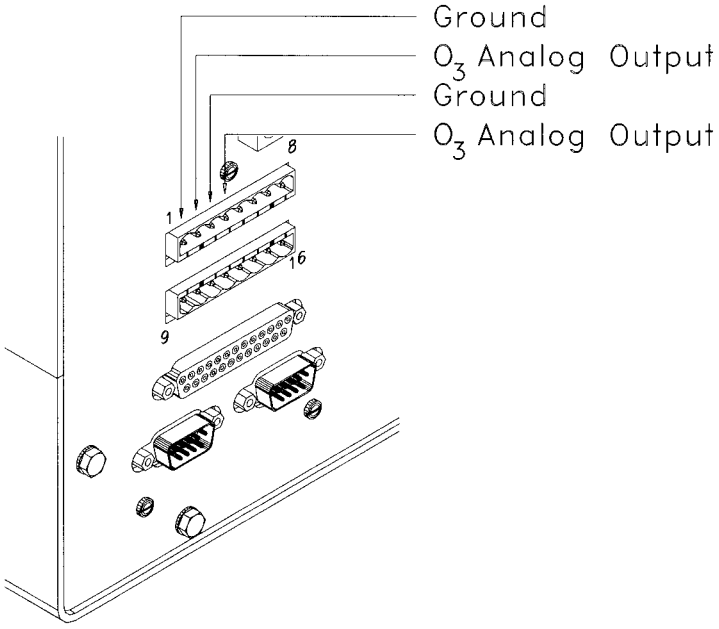


Figure 3-3. Pin-Out of Rear Panel Terminal Strip

Custom Ranges Menu

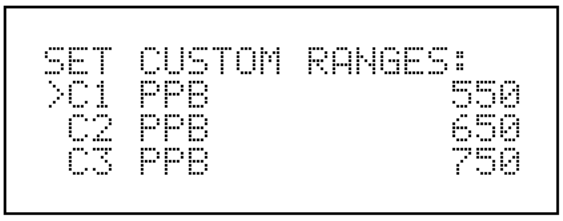
The Custom Ranges menu, shown below, lists three custom ranges: C1, C2, and C3. Custom ranges are user-defined ranges. In the ppm (ppb) mode, any value between 0.05 ppm (50 ppb) and 5 ppm (5,000 ppb) can be specified as a range. In the mg/m^3 (µg/m^3) mode, any value between 0.1 mg/m^3 (100 µg/m^3) and 10 mg/m^3 (10,000 µg/m^3) can be specified. See "Custom Range Screen" below for more information about defining the custom ranges.

To display the Set Custom Ranges screen:

- From the Main Menu choose Range
- From the Range menu choose Set Custom Ranges

To use the Set Custom Ranges menu:

- Use the ↑ and ↓ pushbutton to move the cursor between each custom range
- Press **ENTER** to select the custom range to define
- Press **MENU** to return to the Range menu
- Press **RUN** to return to the Run screen



Set Custom Ranges Menu

Custom Range Screen. The Custom Range screen, shown below, is used to define the custom range.

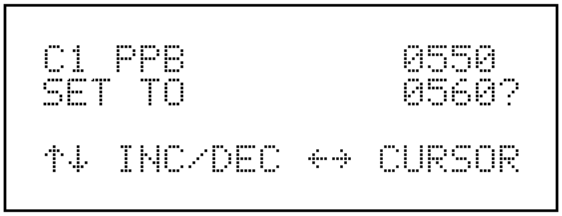
The first line of the display shows the current custom range. The second line of the display is used to set the range. To use the custom fullscale range, be sure to select either C1, C2, or C3 in the O_3 Range screen. See "Range" above for more information.

To display the Custom Range screen:

- From the Main Menu choose Range
- From the Range menu choose Set Custom Ranges
- From the Set Custom Range menu choose C1, C2, or C3

To use the Custom Range screen:

- Use the ↑ and ↓ pushbutton to increment and decrement each digit
- Use the ← and → pushbutton to move the cursor left and right
- Press **ENTER** to accept the custom range
- Press **MENU** to return to the Set Custom Ranges menu
- Press **RUN** to return to the run screen



Set Custom Range 1 Screen

AVERAGING TIME

The averaging time defines a time period (10 to 300 seconds) during which O_3 measurements are taken. The average concentration of the readings are calculated for that time period. The front panel display and analog outputs are updated every 10 seconds for averaging times between 10 and 300 seconds. 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 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.

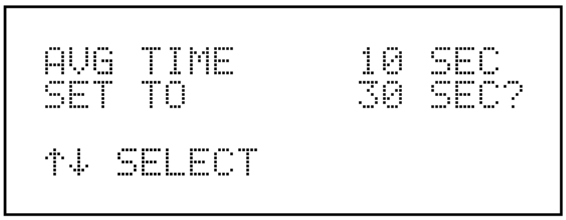
The following averaging times are available: 10, 20, 30, 60, 90, 120, 180, 240, and 300 seconds.

To display the Averaging Time menu/screen:

- From the Main Menu Choose Averaging Time

To use the Averaging Time screen:

- Use the ↑ and ↓ pushbuttons to select the averaging time
- Press **ENTER** to accept the averaging time
- Press **MENU** to return to the Main Menu
- Press **RUN** to return to the Run screen



Averaging Time Screen

CALIBRATION FACTORS MENU

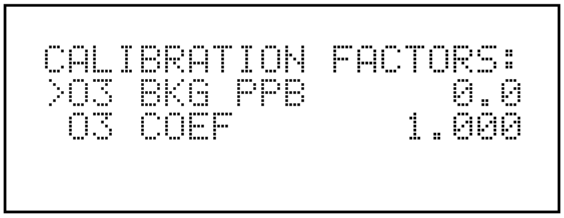
Calibration factors are used to make minor corrections to the O_3 output concentration, when the Model 49C Primary Standard is being precisely matched to a NIST traceable O_3 calibrator. The Calibration Factors menu displays the calibration factors as shown below.

To display the Calibration Factors Menu:

- From the Main Menu choose Calibration Factors:

To use the Calibration Factors menu:

- Use the ↑ and ↓ pushbuttons to move the cursor up and down
- Press **ENTER** to go to the Calibration Factor screen
- Press **MENU** to return to the Main Menu
- Press **RUN** to return to the Run Screen



Calibration Factors Menu

O_3 Background Correction

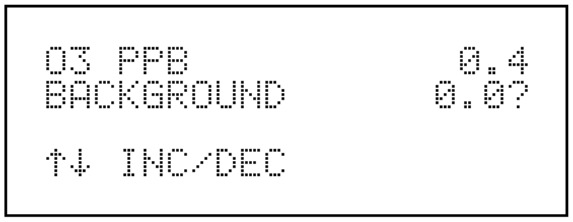
The O_3 Background Correction is used to make small adjustments to the zero level. This adjustment should only be made when the Model 49C Primary Standard is being precisely matched to a NIST traceable O_3 calibrator. Normally, the Model 49C Primary Standard does not require any background correction.

To display the O_3 Background screen:

- From the Main Menu choose Calibration Factors
- From the Calibration Factors menu choose O_3 Background

To use the O_3 Background screen:

- Use the ↑ and ↓ pushbuttons to increment/decrement the O_3 background
- Press **ENTER** to accept a change in the background
- Press **MENU** to return to the Calibration Factors menu
- Press **RUN** to return to the Run screen



O_3 Background Screen

O_3 Coefficient

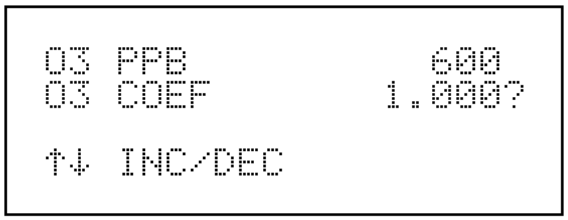
The O_3 Coefficient is used to make small adjustments to the O_3 output level. This adjustment should only be made when the Model 49C Primary Standard is being precisely matched to a NIST traceable O_3 calibrator. Normally, the Model 49C Primary Standard does not require any correction.

To display the O_3 Coefficient screen:

- From the Main Menu choose Calibration Factors
- From the Calibration Factors menu choose O_3 Coef

To use the O_3 Coefficient Screen:

- Use the ↑ and ↓ pushbuttons to increment/decrement the coefficient
- Press **ENTER** to accept a change
- Press **MENU** to return to the Calibration Factors menu
- Press **RUN** to return to the Run screen



O_3 Span Coefficient Screen

INSTRUMENT CONTROLS MENU

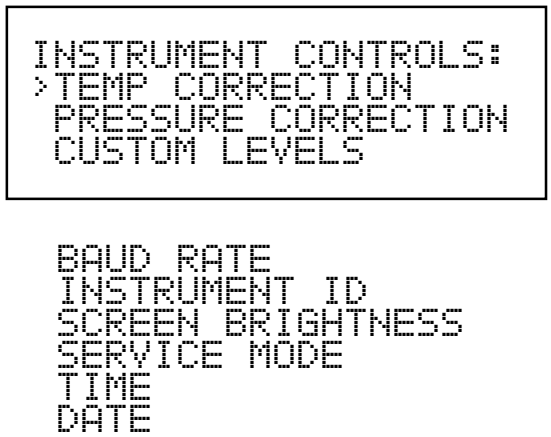
The Instrument Controls menu, shown below, contains items that control the calibrator.

To display the Instrument Controls Menu:

- From the Main Menu choose Instrument Controls

To use the Instrument Controls Menu:

- Use the ↑ and ↓ pushbuttons to scroll through the choices
- Press **ENTER** to select a choice
- Press **MENU** to return to the Main Menu
- Press **RUN** to return to the Run screen



Instrument Controls Menu

Temperature Correction

Temperature correction provides compensation for any changes to the instrument's output signal due to variations in sample gas temperature. The Model 49C Primary Standard can be operated with or without temperature correction.

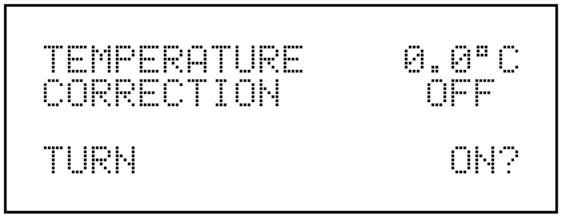
The temperature correction screen is shown below. When temperature correction is on, the first line of the display shows the sample gas temperature (measured by a thermistor on the optical bench). When temperature correction is off, the first line of the display shows the standard temperature of 0.0°C.

To display the Temperature Correction screen:

- From the Main Menu choose Instrument Controls
- From the Instrument Controls menu choose Temperature Correction

To use the Temperature Correction screen:

- Press **ENTER** to toggle temperature correction on and off
- Press **MENU** to return to the Instrument Controls menu
- Press **RUN** to return to the Run screen



Temperature Correction Screen

Pressure Correction

Pressure correction provides compensation for any changes to the instrument's output signal due to variations of sample pressure. The Model 49C Primary Standard can be operated with or without pressure correction.

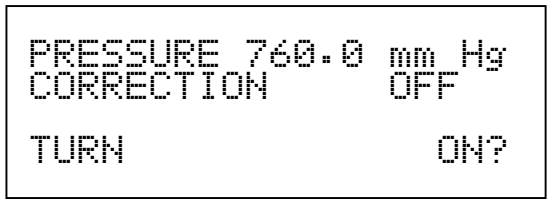
The pressure correction screen is shown below. When pressure correction is on, the first line of the display represents the current sample pressure. When pressure correction is off, the first line of the display shows the standard pressure of 760 mm Hg.

To display the Pressure Correction screen:

- From the Main Menu choose Instrument Controls
- From the Instrument Controls menu choose Pressure Correction

To use the Pressure Correction screen:

- Press **ENTER** to toggle pressure correction on and off
- Press **MENU** to return to the Instrument Controls menu
- Press **RUN** to return to the Run screen



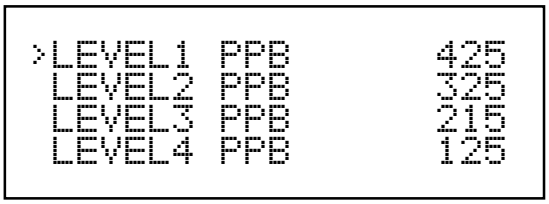
Pressure Correction Screen

Custom Levels

The Custom Levels menu contains for choices as shown below. These levels provide preset concentrations.

To display the Custom Levels screen:

- From the Main Menu choose Instrument Controls
- From the Instrument Controls menu choose Custom Levels

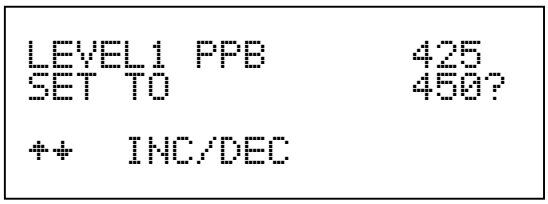


Custom Levels Screen

To use the Custom Levels screen:

- Press the ↑ or ↓ pushbuttons to move the cursor
- Press **ENTER** to accept a choice
- Press **MENU** to return to the Automatic Settings screen
- Press **RUN** to return to the Run screen

Level. When a custom level is selected, the screen similar to that shown below is displayed:



Level Screen

To use the Set Custom Level screen:

- Press the ↑ or ↓ pushbuttons to increment or decrement the concentration level
- Press **ENTER** to accept the revised level
- Press **MENU** to return to the Custom Levels screen

Baud Rate

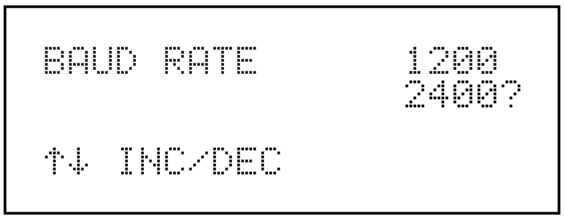
The Baud Rate screen, shown below, is used to set the RS-232 interface baud rate. Baud rates of 1200, 2400, 4800, and 9600 are available.

To display the Baud Rate screen:

- From the Main Menu choose Instrument Controls
- From the Instrument Controls menu choose Baud Rate

To use the Baud Rate screen:

- Use the ↑ and ↓ pushbuttons to increment/decrement the baud rate
- Press **ENTER** to accept a change
- Press **MENU** to return to the Instrument Controls menu
- Press **RUN** to return to the Run screen



Baud Rate Screen

Instrument ID

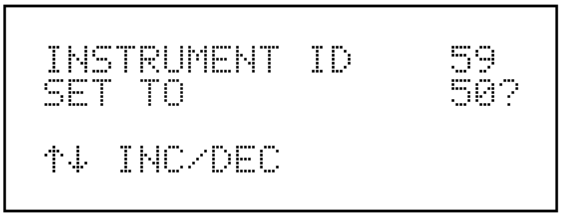
The Instrument ID screen, shown below, enables the Instrument ID to be user-defined. This is useful if two or more of the same instrument are connected to one computer. Valid Instrument ID numbers are from 0 to 99. The Model 49C Primary Standard has a default Instrument ID of 59. For more information about the Instrument ID, see Appendix B, "RS-232 Commands."

To display the Instrument ID screen:

- From the Main Menu choose Instrument Controls
- From the Instrument Controls menu choose Instrument ID

To use the Instrument ID screen:

- Use the ↑ and ↓ pushbuttons to increment/decrement the ID number
- Press **ENTER** to accept a change
- Press **MENU** to return to the Instrument Controls menu
- Press **RUN** to return to the Run screen



Instrument ID Screen

Screen Brightness

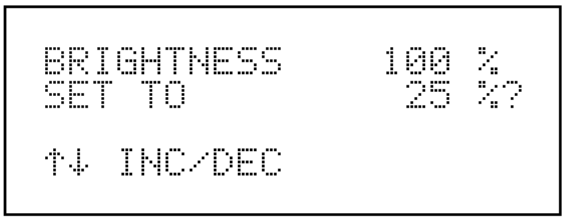
The Screen Brightness screen, shown below, is used to change the screen brightness. Intensities of 25%, 50%, 75%, and 100% are available. Changing the screen brightness to a lower intensity will extend the life of the display.

To display the Screen Brightness screen:

- From the Main Menu choose Instrument Controls
- From the Instrument Controls menu choose Screen Brightness

To use the Screen Brightness screen:

- Use the ↑ and ↓ pushbuttons to increment/decrement the screen brightness
- Press **ENTER** to accept a change
- Press **MENU** to return to the Instrument Controls menu
- Press **RUN** to return to the Run screen



Screen Brightness Screen

Service Mode

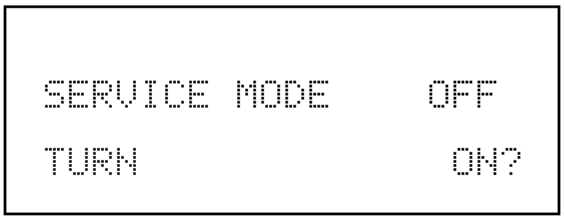
The Service Mode screen, shown below, is used to turn the service mode on and off. When the service mode is on, the Main Menu extends to include the Service Mode menu. The service mode includes parameters and functions that are useful when making adjustments or servicing the Model 49C Primary Standard. For more information about the service mode, see "Service Mode Menu," later in this chapter.

To display the Service Mode screen:

- From the Main Menu choose Instrument Controls
- From the Instrument Controls menu choose Service Mode

To use the Service Mode screen:

- Press **ENTER** to toggle service mode on and off
- Press **MENU** to return to the Instrument Controls menu
- Press **RUN** to return to the Run screen



Service Mode Screen

Time

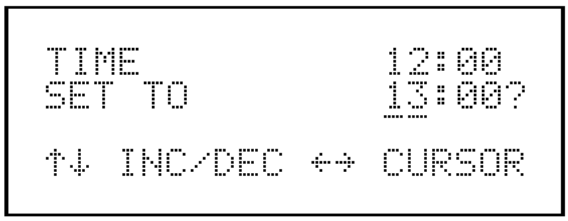
The internal clock is set by the Time screen as shown below. The first line of the display shows the current time (military). The second line of the display is used to change the time. The internal clock is powered by its own battery when instrument power is off.

To display the Time screen:

- From the Main Menu choose Instrument Controls
- From the Instrument Controls menu choose Time

To use the Time screen:

- Use the ↑ and ↓ pushbuttons to increment/decrement the hours and minutes
- Use the ← and → pushbuttons to move the cursor left and right
- Press **ENTER** to accept a change
- Press **MENU** to return to the Instrument Controls menu
- Press **RUN** to return to the Run screen



Time Screen

Date

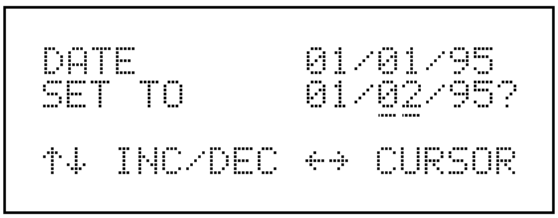
The date is set by the Date screen as shown below. The first line of the display shows the current date. The second line of the display is used to change the date. The date is updated by the internal clock.

To display the Date screen:

- From the Main Menu choose Instrument Controls
- From the Instrument Controls menu choose Date

To use the Date screen:

- Use the ↑ and ↓ pushbuttons to increment/decrement the month, day, and year
- Use the ← and →pushbutton to move the cursor left and right
- Press **ENTER** to accept a change
- Press **MENU** to return to the Instrument Controls menu
- Press **RUN** to return to the Run screen



Date Screen

DIAGNOSTICS MENU

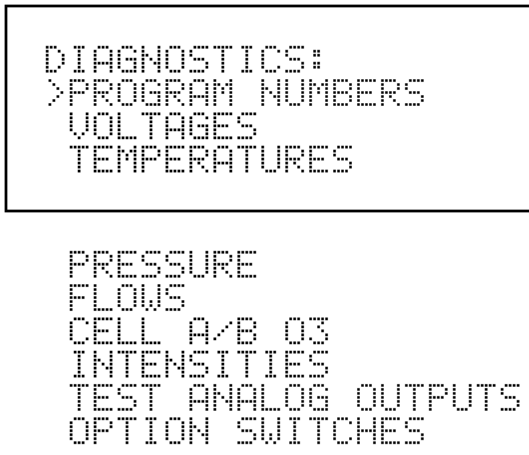
The Diagnostics menu, shown below, provides access to diagnostic information and functions. This menu is useful when troubleshooting the instrument.

To display the Diagnostics menu:

- From the Main Menu choose Diagnostics

To use the Diagnostics menu:

- Use the ↑ and ↓ pushbuttons move the cursor up and down
- Press **MENU** to return to the Main Menu
- Press **RUN** to return to the Run screen



Diagnostics Menu

Program Numbers

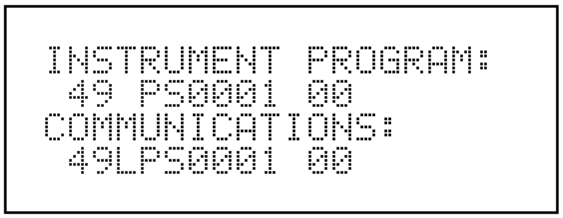
The Program Numbers screen, shown below, shows the version number of the programs installed. Prior to contacting the factory with any questions regarding the instrument, please note the program numbers.

To display the Program Numbers screen:

- From the Main Menu choose Diagnostics
- From the Diagnostics menu choose Program Numbers

To use the Program Numbers screen:

- This is a view only screen
- Press **MENU** to return to the Diagnostics menu
- Press **RUN** to return to the Run screen



Program Number Screen

Voltages

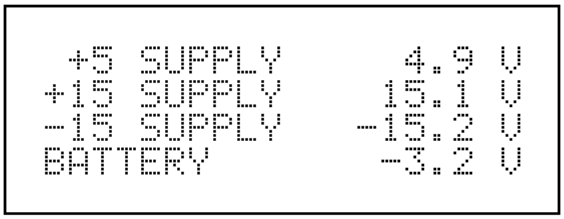
The Voltages screen as shown below, displays the current dc power supply and battery voltages. This allows the power supplies to be quickly tested for low or fluctuating voltages without having to use a voltage meter.

To display the Voltages screen:

- From the Main Menu choose Diagnostics
- From the Diagnostics menu choose Voltages

To use the Voltages screen:

- This is a view only screen
- Press **MENU** to return to the Diagnostics menu
- Press **RUN** to return to the Run screen



Voltages Screen

Temperatures

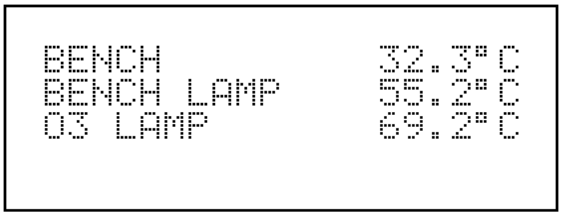
The Temperatures screen, as shown below, displays the current bench temperature and bench lamp temperature.

To display the Temperatures screen:

- From the Main Menu choose Diagnostics
- From the Diagnostics menu choose Temperatures

To use the Temperatures screen:

- This is a view only screen
- Press **MENU** to return to the Diagnostics menu
- Press **RUN** to return to the Run screen



Temperatures Screen

Pressure

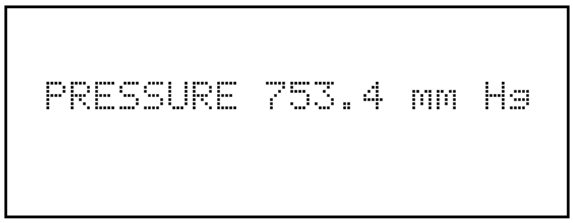
The Pressure screen, shown below, displays the current bench pressure. The pressure is measured by a pressure transducer mounted on the divider panel.

To display the Pressure screen:

- From the Main Menu choose Diagnostics
- From the Diagnostics menu choose Pressure

To use the Pressure screen:

- This is a view only screen
- Press **MENU** to return to the Diagnostics menu
- Press **RUN** to return to the Run screen



Pressure Screen

Flows

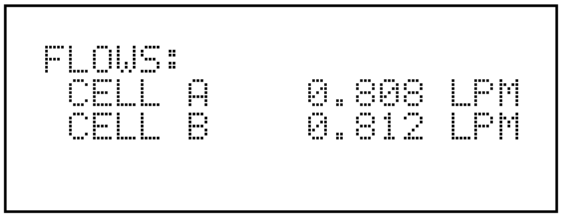
The Flow screen, shown below, displays the current flow rate through Cell A and Cell B. These flows are measured by internal flow sensors (see Figure 1-1).

To display the Flows Screen:

- From the Main Menu choose Diagnostics
- From the Diagnostics menu choose Flows

To use the Flows screen:

- This is a view only screen
- Press **MENU** to return to the Diagnostics menu
- Press **RUN** to return to the Run screen



Flows Screen

Cell A/B O_3

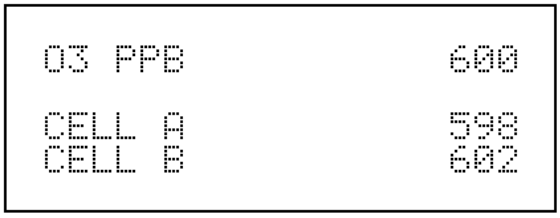
The Cell A/B O_3 screen, shown below, displays the current O_3 concentration in each cell, as well as the O_3 reading displayed in the Run screen (the average of the two cells).

To display the Cell A/B O_3 Screen:

- From the Main Menu choose Diagnostics
- From the Diagnostics menu Cell A/B O_3

To use the Cell A/B O_3 screen:

- This is a view only screen
- Press **MENU** to return to the Diagnostics menu
- Press **RUN** to return to the Run screen



Cell A/B O_3 Screen

Intensities

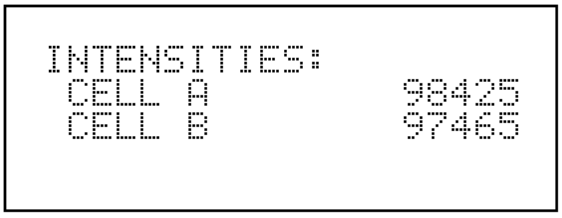
The Intensities screen, shown below, displays the current intensity in Cell A and Cell B in Hertz. The intensities are read by detectors A and B, respectively.

To display the Intensities Screen:

- From the Main Menu choose Diagnostics
- From the Diagnostics menu choose Intensities

To use the Intensities screen:

- This is a view only screen
- Press **MENU** to return to the Diagnostics menu
- Press **RUN** to return to the Run screen



Intensities Screen

Test Analog Outputs

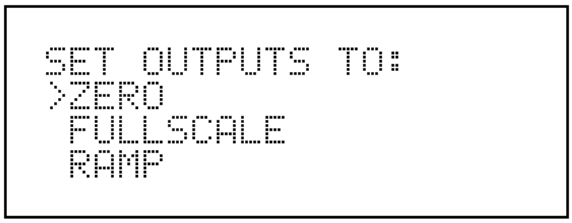
The Test Analog Outputs menu contains three choices as shown below. These functions enable the analog outputs to be set to zero and fullscale in order to adjust the analog outputs to agree with the front panel display. In addition, a digital to analog (DAC) ramp can be generated to fully test the analog outputs.

To display the Test Analog Outputs Menu:

- From the Main Menu choose Diagnostics
- From the Diagnostics menu choose Test Analog Outputs

To use the Test Analog Output menu:

- Use the ↑ and ↓ pushbuttons to move the cursor up and down
- Press **ENTER** to select a choice
- Press **MENU** to return to the Diagnostics menu
- Press **RUN** to return to the Run screen



Test Analog Outputs Menu

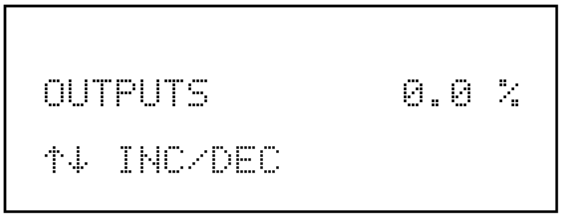
Zero. The Zero screen, as shown below, sets the analog outputs to zero volts. Use the ↑ and ↓ pushbuttons to increment/decrement the output level. For example, to set the analog outputs to 10% of fullscale (1 volt with a 10 volt output), use the ↑ pushbutton to increment the 0.0% to 10%.

To display the Zero screen:

- From the Main Menu choose Diagnostics
- From the Diagnostics menu choose Test Analog Outputs
- From the Test Analog Outputs menu choose Zero

To use the Zero screen:

- Use the ↑ and ↓ pushbuttons to increment/decrement the output level
- Press **MENU** to return to the Diagnostics menu and cancel the zero output
- Press **RUN** to return to the Run screen and cancel the zero output



Zero Analog Outputs Screen

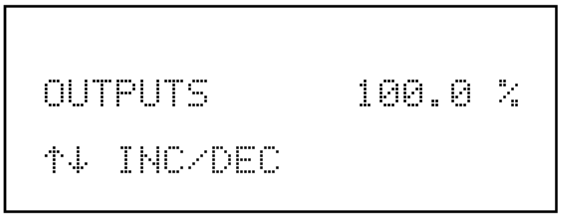
Fullscale. The Fullscale screen, as shown below, sets the analog outputs to fullscale. Use the ↑ and ↓ pushbuttons to increment/decrement the output level. For example, to set the analog outputs to 95% of fullscale (9.5 volts with a 10 volt output), use the ↓ pushbutton to decrement the 100.0% to 95.0%.

To display the Fullscale screen:

- From the Main Menu choose Diagnostics
- From the Diagnostics menu choose Test Analog Outputs
- From the Test Analog Outputs menu choose Fullscale

To use the Fullscale screen:

- Use the ↑ and ↓ pushbuttons to increment/decrement the output level
- Press **MENU** to return to the Diagnostics menu and cancel the fullscale output
- Press **RUN** to return to the Run screen and cancel the fullscale output



Fullscale Analog Outputs Screen

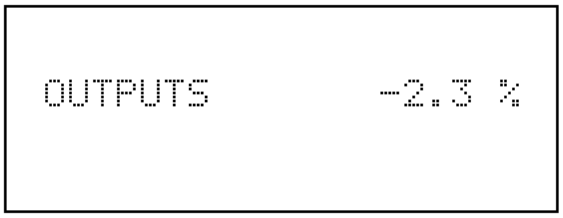
Ramp. The digital to analog (DAC) ramp is used to fully test the analog outputs. The analog outputs start at -2.3% and then increments by 0.1% every second until it reaches 100.0%. A linear output indicates a that the analog outputs are operating correctly.

To display the Ramp screen:

- From the Main Menu choose Diagnostics
- From the Diagnostics menu choose Test Analog Outputs
- From the Test Analog Outputs menu choose Ramp

To use the Ramp screen:

- This is a view only screen
- Press **MENU** to return to the Diagnostics menu and cancel the ramp output
- Press **RUN** to return to the Run screen and cancel the ramp output



Ramp Analog Outputs Screen

Option Switches

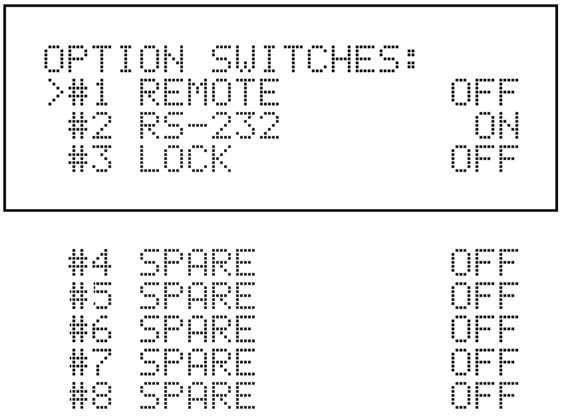
The Option Switches screen, shown below, enables the settings of the internal option switches to be viewed. Option switch settings cannot be changed through the software. For more information about the internal option switches, see "Internal Option Switches" later in this chapter.

To display the Option Switches screen:

- From the Main Menu choose Diagnostics
- From the Diagnostics menu choose Option Switches

To use the Option Switches screen:

- This is a view only screen
- Use the ↑ and ↓ pushbuttons to move up and down
- Press **MENU** to return to the Diagnostics menu
- Press **RUN** to return to the Run screen



Option Switch Status Screen

ALARMS

The Alarms menu, shown below, 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. The number in the upper right-hand corner of the display indicates how many alarms have occurred. If no alarms are detected, the number zero is displayed.

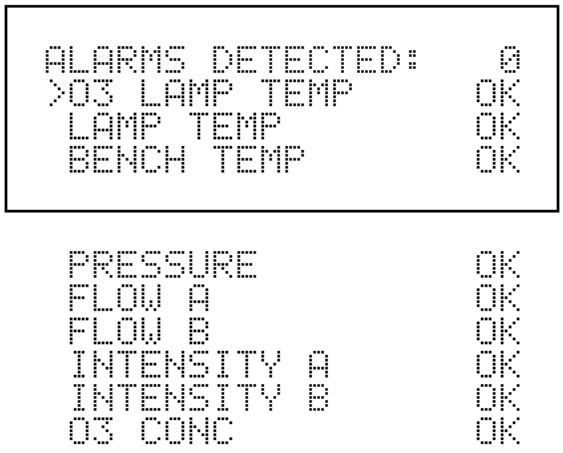
To see the actual reading of an item and its minimum and maximum limits, move the cursor to the item and press **ENTER**.

To display the Alarms menu:

- From the Main Menu choose Alarm

To use the Alarms menu:

- Use the ↑ and ↓ pushbuttons to move up and down
- Press **ENTER** to see the actual reading and the min and max limits
- Press **MENU** to return to the Main Menu
- Press **RUN** to return to the Run screen



Alarm Menu

O3 Lamp Temp

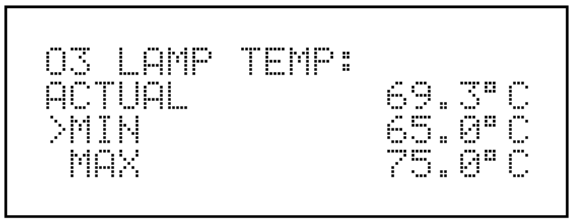
The O_3 Lamp Temperature screen, shown below, displays the current ozonator lamp temperature and the factory-set min and max alarm limits. The min and max alarm limits can be changed when the instrument is in the service mode. Acceptable alarm limits range from 65 to 75°C. If the internal temperature reading goes beyond either the min or max alarm limit, an alarm is activated. The word "Alarm" appears in the Run screen and in the Main Menu.

To display the O_3 Lamp Temp screen:

- From the Main Menu choose Alarm
- From the Alarm menu choose O_3 Lamp Temp

To use the O3 Lamp Temp screen:

- Use the ↑ and ↓ pushbuttons to move up and down (service mode on)
- Press **ENTER** to select a choice (service mode on)
- Press **MENU** to return to the Alarm menu
- Press **RUN** to return to the Run screen



O3 Lamp Temperature Screen

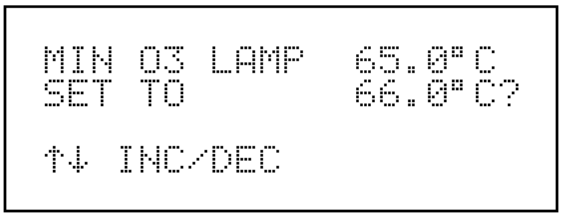
Min and Max O_3 Lamp Temperature Limits. The Min O_3 Lamp Temperature alarm limit screen, shown below, is accessible only when the calibrator is in the service mode. It is used to change the min O_3 lamp temperature alarm limit. The min and max O_3 lamp Temperature screens function the same way.

To display the Min or Max O_3 Lamp Temperature limit screens (service mode on):

- From the Main Menu choose Alarm
- From the Alarm menu choose O_3 Lamp Temp
- From the Bench Temperature menu choose Min or Max

To use the Min or Max O_3 Lamp Temperature limit screens (service mode on):

- Use the ↑ and ↓ pushbuttons to increment/decrement the value
- Press **ENTER** to accept the change
- Press **MENU** to return to the O_3 Lamp Temperature menu
- Press **RUN** to return to the Run screen



Set Min O_3 Lamp Temperature Screen

Lamp Temp

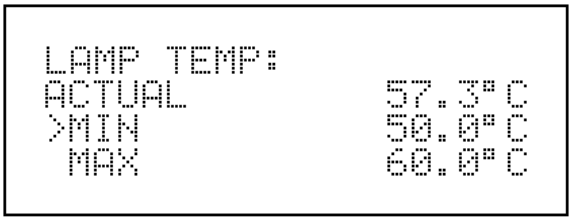
The Lamp Temperature screen, shown below, displays the current bench lamp temperature and the factory-set min and max alarm limits. The min and max alarm limits can be changed when the calibrator is in the service mode. Acceptable alarm limits range from 50 to 60°C. If the internal temperature reading goes beyond either the min or max alarm limit, an alarm is activated. The word "Alarm" appears in the Run screen and in the Main Menu.

To display the Lamp Temp screen:

- From the Main Menu choose Alarm
- From the Alarm menu choose Lamp Temp

To use the Lamp Temp screen:

- Use the ↑ and ↓ pushbuttons to move up and down (service mode on)
- Press **ENTER** to select a choice (service mode on)
- Press **MENU** to return to the Alarm menu
- Press **RUN** to return to the Run screen



Lamp Temperature Screen

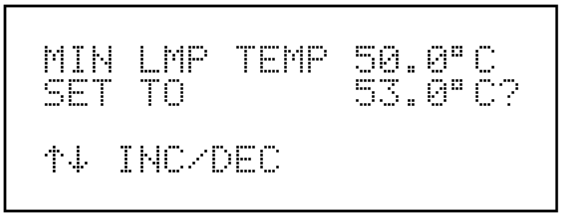
Min and Max Lamp Temperature Limits. The Min Lamp Temperature alarm limit screen, shown below, is accessible only when the calibrator is in the service mode. It is used to change the min lamp temperature alarm limit. The min and max lamp Temperature screens function the same way.

To display the Min or Max Lamp Temperature limit screens (service mode on):

- From the Main Menu choose Alarm
- From the Alarm menu choose Lamp Temp
- From the Bench Temperature menu choose Min or Max

To use the Min or Max Lamp Temperature limit screens (service mode on):

- Use the ↑ and ↓ pushbuttons to increment/decrement the value
- Press **ENTER** to accept the change
- Press **MENU** to return to the Lamp Temperature menu
- Press **RUN** to return to the Run screen



Set Min Lamp Temperature Screen

Bench Temperature

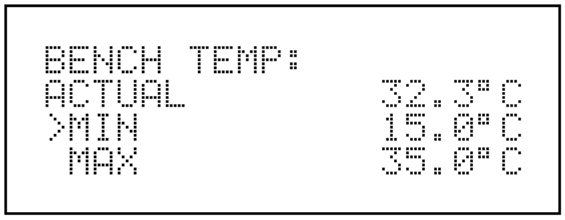
The Bench Temperature screen, shown below, displays the current bench temperature and the factory-set min and max alarm limits. The min and max alarm limits can be changed when the instrument is in the service mode. Acceptable alarm limits range from 5 to 50°C. If the internal temperature reading goes beyond either the min or max alarm limit, an alarm is activated. The word "Alarm" appears in the Run screen and in the Main Menu.

To display the Bench Temperature screen:

- From the Main Menu choose Alarm
- From the Alarm menu choose Bench Temperature

To use the Bench Temperature screen:

- Use the ↑ and ↓ pushbuttons to move up and down (service mode on)
- Press **ENTER** to select a choice (service mode on)
- Press **MENU** to return to the Alarm menu
- Press **RUN** to return to the Run screen



Bench Temperature Screen

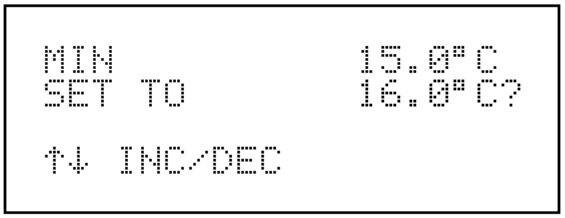
Min and Max Bench Temperature Limits. The Min Bench Temperature alarm limit screen, shown below, is accessible only when the instrument is in the service mode. It is used to change the min bench temperature alarm limit. The min and max Bench Temperature screens function the same way.

To display the Min or Max Bench Temperature limit screens (service mode on):

- From the Main Menu choose Alarm
- From the Alarm menu choose Bench Temperature
- From the Bench Temperature menu choose Min or Max

To use the Min or Max Bench Temperature limit screens (service mode on):

- Use the ↑ and ↓ pushbuttons to increment/decrement the value
- Press **ENTER** to accept the change
- Press **MENU** to return to the Bench Temperature menu
- Press **RUN** to return to the Run screen



Set Min Bench Temperature Screen

Pressure

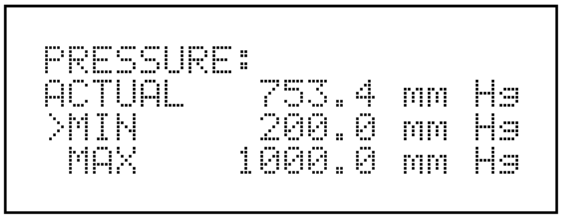
The Pressure screen, shown below, displays the current bench pressure reading and the factory-set min max alarm limits. The min and max alarm limits can be changed when the instrument is in the service mode. Acceptable alarm limits range from 200 to 1,000 mm Hg. If the pressure reading goes beyond either the min or max alarm limit, an alarm is activated. The word "Alarm" appears in the Run screen and in the Main Menu.

To display the Pressure screen:

- From the Main Menu choose Alarm
- From the Alarm menu choose Pressure

To use the Pressure screen:

- Use the ↑ and ↓ pushbuttons to move up and down (service mode on)
- Press **ENTER** to select a choice (service mode on)
- Press **MENU** to return to the Alarm menu
- Press **RUN** to return to the Run screen



Pressure Screen

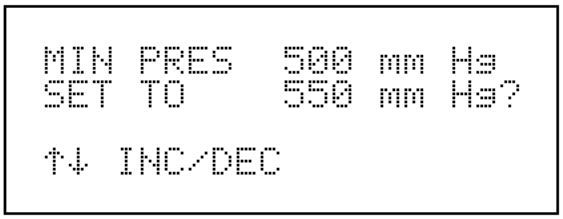
Min and Max Pressure Limits. The Min Pressure limit screen, shown below, is accessible only when the instrument is in the service mode. It is used to change the min pressure alarm limit. The min and max Pressure screens function the same way.

To display the Min or Max Pressure limit screens (service mode on):

- From the Main Menu choose Alarm
- From the Alarm menu choose Pressure
- From the Pressure menu choose Min or Max

To use the Min or Max Pressure limit screens (service mode on):

- Use the ↑ and ↓ pushbuttons to increment/decrement the value
- Press **ENTER** to accept the change
- Press **MENU** to return to the Pressure menu
- Press **RUN** to return to the Run screen



Set Min Pressure Screen

Flow A and B

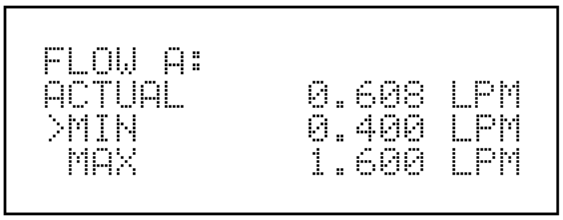
The Flow A screen, shown below, displays the current sample flow reading in Cell A and the factory-set min and max alarm limits. The min and max alarm limits can be changed when the instrument is in the service mode. Acceptable alarm limits range from 0.4 to 1.6 LPM. If the sample flow reading goes beyond either the min or max alarm limit, an alarm is activated. The word "Alarm" appears in the Run screen and in the Main Menu. The Flow B screen functions the same way as the Flow A screen.

To display the Flow A or Flow B screen:

- From the Main Menu choose Alarm
- From the Alarm menu choose Flow A or Flow B

To use the Flow A or Flow B screen:

- Use the ↑ and ↓ pushbuttons to move the cursor up and down (service mode)
- Press **ENTER** to select a choice (service mode)
- Press **MENU** to return to the Alarm menu
- Press **RUN** to return to the Run screen



Flow A Screen

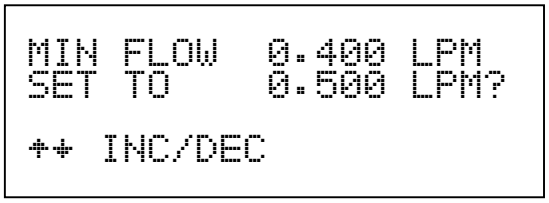
Min and Max Flow Limits. The Min Flow A limit screen, shown below, is accessible only when the instrument is in the service mode. It is used to change the min Flow A alarm limit. The min and max Flow A and Flow B screens function the same way.

To display the Min or Max Flow A or Flow B limit screen (service mode on):

- From the Main Menu choose Alarm
- From the Alarm menu choose Flow A or Flow B
- From the Flow menu choose Min or Max

To use the Min or Max Flow A or Flow B limit screen (service mode on):

- Use the ↑ and ↓ pushbuttons to increment/decrement the value
- Press **ENTER** to accept the change
- Press **MENU** to return to the Flow menu
- Press **RUN** to return to the Run screen



Set Min Flow A Screen

Intensity A and B

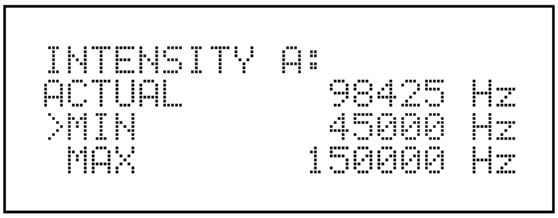
The Intensity A screen, shown below, displays the current lamp intensity reading in Cell A and the factory-set min and max alarm limits. The min and max alarm limits can be changed when the instrument is in the service mode. Acceptable alarm limits range from 45,000 to 150,000 Hz. If the Cell A lamp intensity reading goes beyond either the min or max alarm limit, an alarm is activated. The word "Alarm" appears in the Run screen and in the Main Menu. The Intensity A and Intensity B screens function the same way.

To display the Intensity A or Intensity B screen:

- From the Main Menu choose Alarm
- From the Alarm menu choose Intensity A or Intensity B

To use the Intensity A or Intensity B screen:

- Use the ↑ and ↓ pushbuttons to move up and down (service mode on)
- Press the **ENTER** pushbutton to select a choice (service mode on)
- Press **MENU** to return to the Alarm menu
- Press **RUN** to return to the Run screen



Lamp Intensity Screen

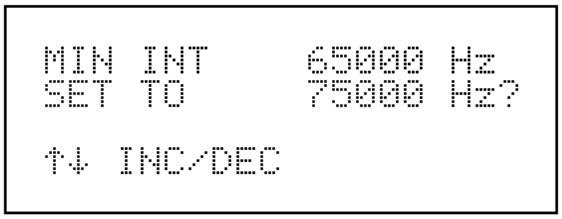
Min and Max Lamp Intensity Limits. The Min Intensity A limit screen, shown below, is accessible only when the instrument is in the service mode. It is used to change the min intensity alarm limit. The min and max Intensity A and Intensity B screens function the same way.

To display the Min or Max Intensity A or Intensity B limit screens (service mode on):

- From the Main Menu choose Alarm
- From the Alarm menu choose Intensity A or Intensity B
- From the Intensity menu choose Min or Max

To use the Min or Max Intensity A or Intensity B limit screens (service mode on):

- Use the ↑ and ↓ pushbuttons to increment/decrement the value
- Press **ENTER** to accept the change
- Press **MENU** to return to the Intensity menu
- Press **RUN** to return to the Run screen



Set Min Lamp Intensity Screen

O_3 Concentration

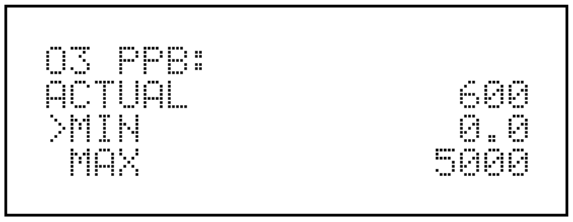
The O_3 Concentration screen, shown below, displays the current O_3 concentration and the factory-set min and max alarm limits. The min and max alarm limits can be changed when the instrument is in the service mode. Acceptable alarm limits range from 0 to 5000 ppb. If the O_3 concentration reading goes beyond either the min or max alarm limit, an alarm is activated. The word "Alarm" appears in the Run screen and in the Main Menu.

To display the O_3 Concentration screen:

- From the Main Menu choose Alarm
- From the Alarm menu choose O_3 Concentration

To use the O_3 Concentration screen:

- Use the ↑ and ↓ pushbuttons to move up and down (service mode on)
- Press the **ENTER** pushbutton to select a choice (service mode on)
- Press **MENU** to return to the Alarm menu
- Press **RUN** to return to the Run screen



O_3 Concentration Screen

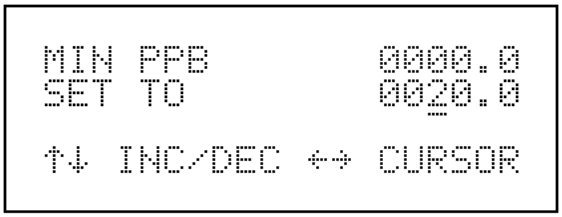
Min and Max O_3 Concentration Limits. The O_3 min and max concentration limit screens are accessible only when the instrument is in the service mode. They are used to change the min and max concentration alarm limits. The min O_3 concentration screen is shown below.

To display the Min or Max O_3 Concentration limit screens (service mode on):

- From the Main Menu choose Alarm
- From the Alarm menu choose O_3 Concentration
- From the O_3 Concentration menu choose Min or Max

To use the Min or Max O_3 Concentration limit screens (service mode on):

- Use the ↑ and ↓ pushbuttons to increment/decrement the value
- Press **ENTER** to accept the change
- Press **MENU** to return to the O_3 Concentration menu
- Press **RUN** to return to the Run screen



Set Min O_3 Concentration Screen

SERVICE MODE MENU

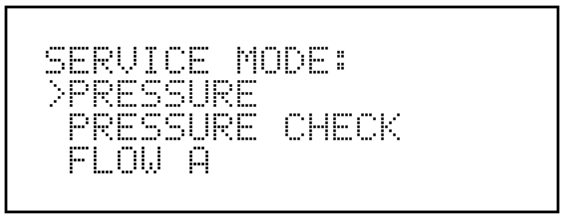
The Service Mode menu, shown below, appears only when the calibrator is in the service mode. To put the calibrator into the service mode, select Instrument Controls from the Main Menu, then from the Instrument Controls menu select Service Mode. When the calibrator is in the service mode, the Main Menu extends to include the Service Mode menu. The service mode includes some of the same information found in the Diagnostic menu. However, items such as Flow A, Flow B , and pressure are updated every second as opposed to every 10 seconds. The faster update time enables the readings on the display to respond faster to adjustment. In addition, advanced diagnostic functions are included in the service mode. Meaningful data should not be collected when the instrument is in the service mode.

To display the Service Mode menu:

- From the Main Menu choose Service Mode

To use the Service Mode menu:

- Use the ↑ and ↓ pushbuttons to move the cursor up and down
- Press **ENTER** to select a choice
- Press **MENU** to return to the Main Menu
- Press **RUN** to return to the Run screen



FLOW B
TEST LAMP OUTPUTS
LAMP SETTING
INTENSITY CHECK
MANUAL O3 SETTING
O3 RESPOSE COEF
A/D FREQUENCY
SET TEST DISPLAY

Service Mode Menu

Pressure

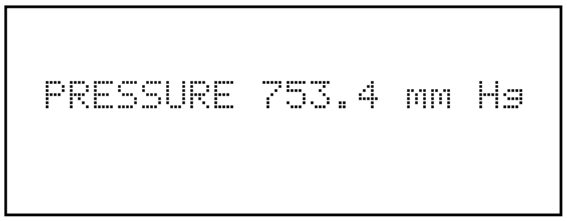
The Pressure screen, shown below, shows the optical bench pressure. The bench pressure is updated every second. This screen is used while adjusting the pressure transducer potentiometers.

To display the Pressure screen:

- From the Main Menu choose Service Mode
- From the Service Mode menu choose Pressure

To use the Pressure screen:

- This is a view only screen
- Press **MENU** to return to the Service Mode menu
- Press **RUN** to return to the Run screen



Pressure Screen

Pressure Check

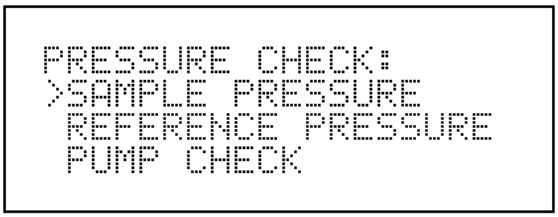
The Pressure Check menu, shown below, is used to manually control the flow of reference or sample gas through Cell B. This enables the pressure reading of Cell B, with either sample or reference gas, to be determined. Pump Check is used to test the pump. Selecting any of these menu choices will disturb the analog outputs.

To display the Pressure Check menu:

- From the Main Menu choose Service Mode
- From the Service Mode menu choose Pressure Check

To use the Pressure Check menu:

- Use the ↑ and ↓ pushbuttons to move the cursor up and down
- Press **ENTER** to select a choice
- Press **MENU** to return to the Service Mode menu
- Press **RUN** to return to the Run screen



Pressure Check Menu

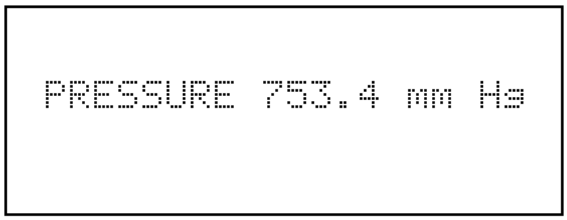
Sample and Reference Pressure. The Sample Pressure screen, shown below, displays the pressure of the sample gas in Cell B. The Reference Pressure screen displays the pressure of the reference gas in Cell B.

To display the Sample or Reference Pressure screens (service mode on):

- From the Main Menu choose Service Mode
- From the Service Mode menu choose Pressure Check
- From the Pressure Check screen choose Sample or Reference Pressure

To use the selected screen (service mode on):

- This is a view only screen
- Press **MENU** to return to the Pressure check menu
- Press **RUN** to return to the Run screen



Sample Pressure Screen

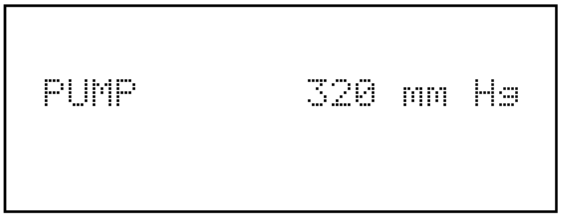
Pump Check. The Pump Check screen, shown below, is used to test the pump. The solenoids are energized such that there is no flow in Cell B. The flow rate for Cell B drops to zero and the pressure reading should drop below 390 mm Hg in less then 20 seconds. This indicates the effectiveness of the internal pump.

To display the Pump Check screen (service mode on):

- From the Main Menu choose Service Mode
- From the Service Mode menu choose Pressure Check
- From the Pressure Check screen choose Pump Check

To use the Pump Check screen (service mode on):

- This is a view only screen
- Press **MENU** to return to the Pressure check menu
- Press **RUN** to return to the Run screen



Pump Check Screen

Flow A and B

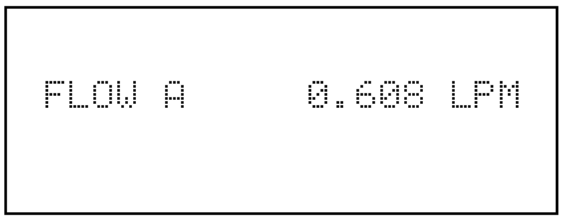
The Flow A screen, shown below, shows the flow in Cell A. The flow reading is updated every second. This screen is used while the Cell A flow sensor potentiometers are adjusted. The potentiometer closest to the mounting flange is the zero adjust potentiometer and the potentiometer farthest from the mounting flange is the span potentiometer. The Flow A and Flow B screens function the same way.

To display the Flow A or Flow B screen:

- From the Main Menu choose Service Mode
- From the Service Mode menu choose Flow A or Flow B

To use the Flow A or Flow B screen:

- This is a view only screen
- Press **MENU** to return to the Service Mode menu
- Press **RUN** to return to the Run screen



Flow A Screen

Test Lamp Outputs

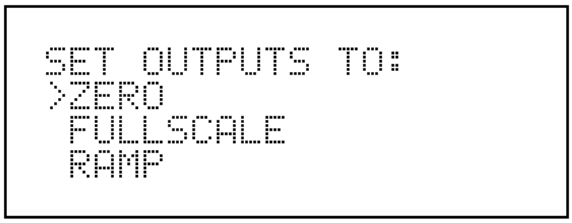
The Test Lamp Outputs menu contains three choices as shown below. These functions enable the lamp outputs to be set to zero and fullscale. Although these signals are brought out to the rear panel terminal strip for ease of service, they are used internally by the calibrator to control both the bench and ozonator lamps. In addition, a digital to analog (DAC) ramp can be generated to fully test the digital to analog converters.

To display the Test Lamp Outputs Menu (service mode on):

- From the Main Menu choose Service
- From the Service menu choose Test Lamp Outputs

To use the Test Lamp Outputs menu (service mode on):

- Use the ↑ and ↓ pushbuttons to move the cursor up and down
- Press **ENTER** to select a choice
- Press **MENU** to return to the Service menu
- Press **RUN** to return to the Run screen



Test Lamp Outputs Menu

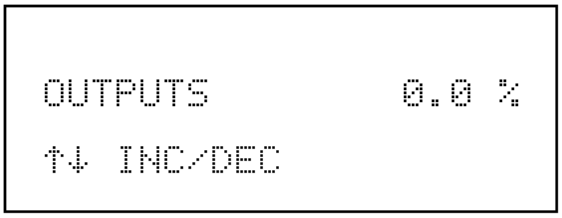
Zero. The Zero screen, as shown below, sets the lamp outputs to zero volts. Use the ↑ and ↓ pushbuttons to increment/decrement the output level. For example, to set the lamp outputs to 10% of fullscale (1 volt with a 10 volt output), use the ↑ pushbutton to increment the 0.0% to 10%.

To display the Zero screen (service mode on):

- From the Main Menu choose Service
- From the Diagnostics menu choose Test Lamp Outputs
- From the Test Lamp Outputs menu choose Zero

To use the Zero screen (service mode on):

- Use the ↑ and ↓ pushbuttons to increment/decrement the output level
- Press **MENU** to return to the Test Lamp Outputs menu and cancel the zero output
- Press **RUN** to return to the Run screen and cancel the zero output



Zero Lamp Outputs Screen

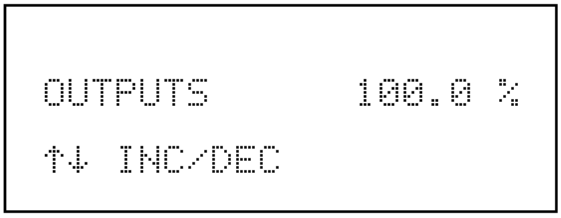
Fullscale. The Fullscale screen, as shown below, sets the lamp outputs to fullscale. Use the ↑ and ↓ pushbuttons to increment/decrement the output level. For example, to set the lamp outputs to 95% of fullscale (9.5 volts with a 10 volt output), use the ↓ pushbutton to decrement the 100.0% to 95.0%.

To display the Fullscale screen (service mode on):

- From the Main Menu choose Service
- From the Diagnostics menu choose Test Lamp Outputs
- From the Test Lamp Outputs menu choose Fullscale

To use the Fullscale screen (service mode on):

- Use the ↑ and ↓ pushbuttons to increment/decrement the output level
- Press **MENU** to return to the Test Lamp Outputs menu and cancel the fullscale output
- Press **RUN** to return to the Run screen and cancel the fullscale output



Fullscale Lamp Outputs Screen

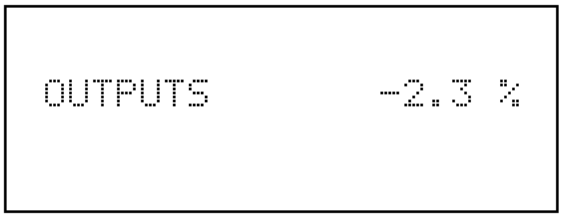
Ramp. The digital to analog (DAC) ramp is used to fully test the lamp outputs. The lamp outputs start at -2.3% and then increments by 0.1% every second until it reaches 100.0%. A linear output indicates a that the lamp outputs are operating correctly.

To display the Ramp screen (service mode on):

- From the Main Menu choose Service
- From the Diagnostics menu choose Test Lamp Outputs
- From the Test Lamp Outputs menu choose Ramp

To use the Ramp screen (service mode on):

- This is a view only screen
- Press **MENU** to return to the Test Lamp Outputs menu and cancel the ramp output
- Press **RUN** to return to the Run screen and cancel the ramp output



Ramp Lamp Outputs Screen

Lamp Setting

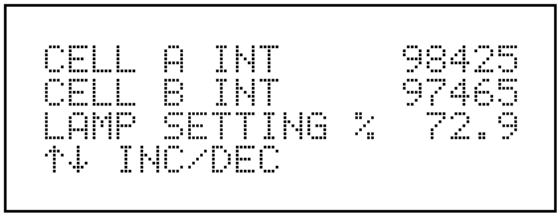
The Lamp Setting screen, shown below, is used to adjust the detector intensities. The first and second line of the display shows the intensities of Cell A and Cell B. The third line of the display shows the current lamp setting. Adjust the lamp setting until the intensities are about 100 kHz.

To display the Lamp Setting screen (service mode on):

- From the Main Menu choose Service
- From the Service Mode menu choose Lamp Setting

To use the Lamp Setting screen (service mode on):

- Use the ↑ and ↓ pushbuttons to increment/decrement the lamp setting
- Press **MENU** to return to the Service Mode menu
- Press **RUN** to return to the Run screen



Lamp Setting Screen

Intensity Check

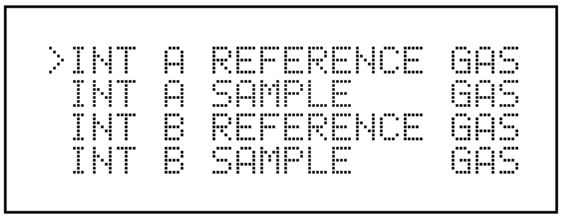
The Intensity Check menu, shown below, is used to manually control the flow of reference or sample gas through either Cell A or Cell B. This enables the intensity and noise reading of each detector to be determined with either reference or sample gas flow. Selecting any of these menu choices will disturb the analog outputs.

To display the Intensity Check menu (service mode on):

- From the Main Menu choose Service
- From the Service Mode menu choose Intensity Check

To use the Intensity Check menu (service mode on):

- Use the ↑ and ↓ pushbuttons to move the cursor up and down
- Press **ENTER** to select a choice
- Press **MENU** to return to the Service Mode menu
- Press **RUN** to return to the Run screen



Intensity Check Menu

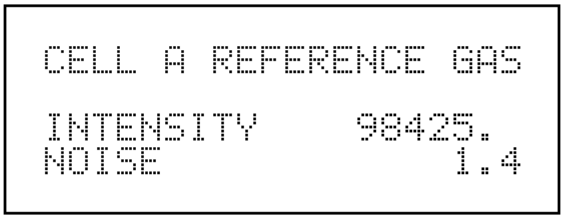
Intensity A Reference Gas. The Intensity A Reference Gas screen, shown below, switches the solenoid valves so that reference gas is flowing through Cell A. The intensity and noise reading are displayed. The Intensity B Reference Gas screen functions the same way. Also, the Intensity A and Intensity B Sample Gas screens function the same way (only with sample gas instead of reference gas).

To display the Int A or B Ref or Sample screens (service mode on):

- From the Main Menu choose Service Mode
- From the Service Mode menu choose Intensity Check
- From the Intensity Check screen choose Int A or B Ref or Sample

To use the selected screen (service mode on):

- This is a view only screen
- Press **MENU** to return to the Intensity check menu
- Press **RUN** to return to the Run screen



Cell A Reference Gas Screen

Manual O_3 Setting

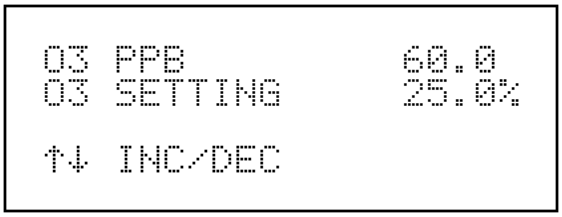
The Manual O_3 Setting screen, shown below, is used to manually control the O_3 output concentration by adjusting the ozonator lamp intensity. In this mode, the automatic feedback control of the ozonator is defeated. This is useful to determine how much ozone is produced at a certain percentage of lamp intensity.

To display the Manual O_3 Setting screen (service mode on):

- From the Main Menu choose Service
- From the Service Mode menu choose Manual O_3 Setting

To use the Manual O_3 Setting screen (service mode on):

- Use the ↑ and ↓ pushbuttons to move the cursor up and down
- Press **ENTER** to select a choice
- Press **MENU** to return to the Service Mode menu
- Press **RUN** to return to the Run screen



Manual O_3 Setting Screen

O_3 Response Coef

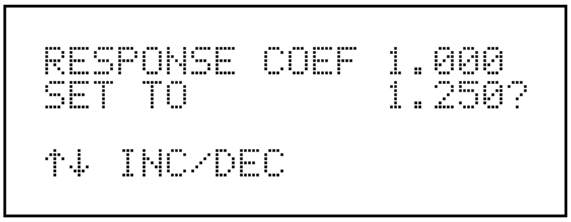
The O_3 Response Coefficient screen, shown below, is used to change the response of the ozonator lamp feedback circuit. The larger the number, the more rapid the response and the higher the noise. Smaller numbers have slower response times and less noise. Normally, this coefficient should be set to 1.0. Valid coefficients range from 0.5 to 1.5.

To display the O_3 Response Coef screen (service mode on):

- From the Main Menu choose Service
- From the Service Mode menu choose O_3 Response Coef

To use the O_3 Response Coef screen (service mode on):

- Use the ↑ and ↓ pushbuttons to move the cursor up and down
- Press **ENTER** to select a choice
- Press **MENU** to return to the Service Mode menu
- Press **RUN** to return to the Run screen



O3 Response Coef Screen

A/D Frequency

The A/D Frequency screen, shown below, displays the frequency of each of the 12 analog to digital (A/D) converters located on the A/D Board. Each A/D has a frequency range between 0 and 100,000 Hertz. This frequency range corresponds to a voltage range of 0 to -10 volts dc. See Appendix C, "Schematics" for the A/D Board schematic. The A/D converters are assigned as follows:

A/D Converter	Function
AN0	Spare
AN1	Spare
AN2	Spare
AN3	Flow Cell B
AN4	Spare
AN5	Flow Cell A
AN6	Spare
AN7	Pressure
AN8	Ozonator Lamp Temperature
AN9	Lamp Temperature
AN10	Spare
AN11	Bench Temperature

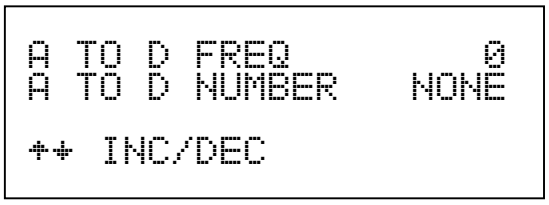
Table 3-2. A/D Converters

To display the A/D Frequency screen:

- From the Main Menu choose Service Mode
- From the Service Mode menu choose A/D Frequency

To use the A/D Frequency screen:

- Use the ↑ and ↓ pushbuttons to increment/decrement the A to D number
- Press **MENU** to return to the Service Mode menu
- Press **RUN** to return to the Run screen



A/D Frequency Screen

Set Test Display

The Set Test Display screen, shown below, displays the contents of a given memory location. This screen is useful to TEI service personnel and should only be used when consulting the factory.

To display the Set Test Display screen:

- From the Main Menu choose Service Mode
- From the Service Mode menu choose Set Test Display

To use the Set Test Display screen:

- Use the ↑ and ↓ pushbuttons to change the display mode
- Press **MENU** to return to the Service Mode menu
- Press **RUN** to return to the Run screen

Set Test Display

INTERNAL OPTION SWITCHES

The internal option switches are located on the Motherboard (near front panel), as shown in Figure 3-4 below. The function of each option switch is given in Table 3-3. These switches are used to activate hardware and software options.

CAUTION: 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 Chapter 6, "Servicing."

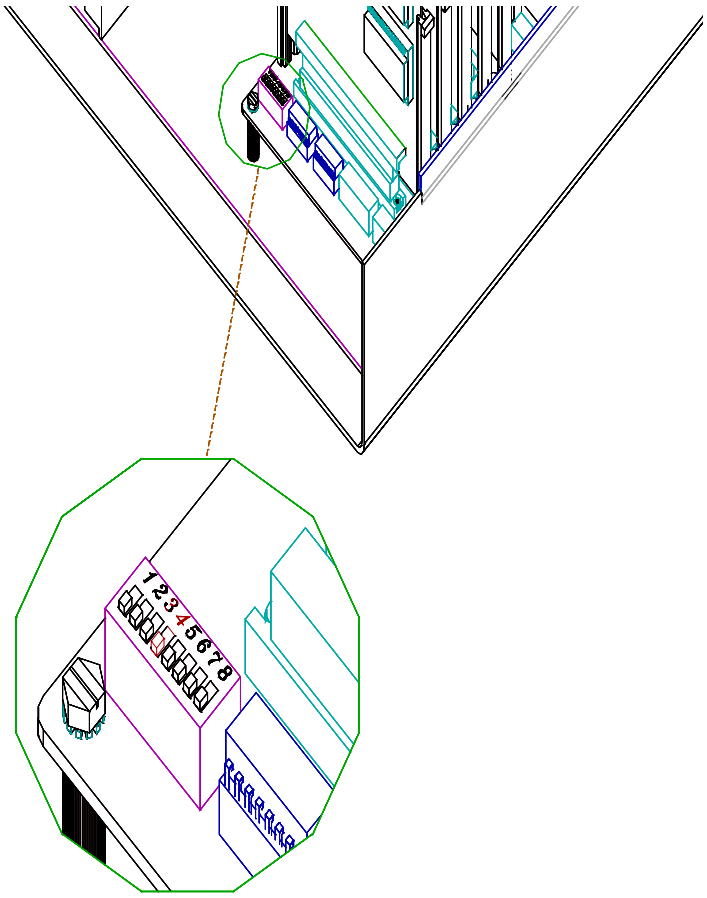


Figure 3-4. Location of Internal Option Switches

Option Switch	Function
1	Remote
2	RS-232
3	Lock
4	Spare
5	Spare
6	Spare
7	Spare
8	Spare

Table 3-3. Option Switch Functions

Remote

Option switch 1 is on when a remote interface is installed, such as RS-232 or I/O activation.

RS-232

Option switch 2 is used to select between RS-232 and I/O activation. When option switch 2 is on, RS-232 is selected. When it is off, I/O activation is selected.

Lock

When option switch 6 is on, instrument parameters are □locked□ and can not be changed. This prevents any erroneous entry of instrument parameters. When option switch 6 is off, instrument parameters can be changed.

Spare

This option switch is currently not used.

CHAPTER 4
PREVENTIVE MAINTENANCE

This chapter describes the periodic maintenance procedures that should be performed on the instrument to ensure proper, uninterrupted operation. Certain components such as the sample pump, solenoid valve, and lamp, have a limited life and should be replaced or at least checked on a regular calendar basis. Other operations, such as cleaning the optical bench and calibration check of the pressure and temperature transducers, should also be performed on a regular basis. What follows is a check and/or cleaning procedure for these elements. Replacement procedures for components found to be defective by these checks are given in Chapter 6, "Servicing."

SPARE PARTS

Table 4-1 lists recommended spare parts.

Part Number	Description
8540	Photometer Lamp
8573	Solenoid Valve
4124	Capillary - 15 mil
4111	Capillary - 28 mil
8606	Pump Rebuild Kit
4509	Fuse – 115V T, 2A, 250V
14009	Fuse - 220V T, 1.25A, 250V
8645	Ozonator Lamp
9994	Model 49C Primary Standard Instruction Manual

Table 4-1. Recommended Spare Parts

CLEANING OF OPTICAL BENCH

Best results are obtained when the optical bench is clean. The cleanliness of the bench should be checked any time the detector frequencies drop below 65 kHz, since one source of low output is light attenuation due to dirt in the cell. Dirt particulates are usually effective ozone removers.

To clean the optical bench, follow the procedure below:

CAUTION: 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 Chapter 6, "Servicing."

1. Turn off the calibrator and unplug the power cord.
2. Remove the calibrator cover.
3. Loosen the knurled nut around the tube and carefully slide out tube.
4. Push a piece of lens paper down the tube using a ¼" piece of Teflon® tubing so as not to damage the tube. Use a cotton swab to clean the window surfaces through the holes that the tube fits into.
5. Both absorption tubes are identical, so they can be replaced in either position. Replacement of absorption cells is opposite to that of removal.
6. Replace the calibrator cover.

If the windows are severely contaminated, they are best cleaned by removing the windows from the bench. The windows on the detector side can be removed by removing the detector block and carefully removing the windows. The windows on the source side can be removed by removing the source block to gain access to the windows. Always leak-check the system after any component removal.

LAMP REPLACEMENT

The lamp control system of the Model 49C Primary Standard has been designed to operate the lamp conservatively to increase its life. However, the lamp should be replaced when any one of the following conditions hold:

- No light output.
- Inability to adjust lamp position to obtain an output detection frequency of 65 kHz.
- Noisy output signal, which has been traced to an unstable lamp (see Troubleshooting Section).

DETECTOR FREQUENCIES AND NOISE

The Model 49C Primary Standard measures intensity ratios and not absolute values. Therefore, a large range of detector frequencies are acceptable for proper operation of the instrument. The nominal values are 65 to 120 kHz. These frequencies can be monitored from the Intensities screen in the Diagnostics menu.

Degradation of detector frequencies to below 65 kHz indicates either a dirty cell or low lamp output. In addition to degrading the measured detector frequency, dirt in the cells can decompose the ozone and give erroneous readings. Therefore, the cells should first be cleaned and the frequency remeasured. If the frequencies are still low, the light output can be increased by using the Lamp Setting screen in the service mode. If the frequency cannot be set above 65 kHz, replace the lamp. To monitor the lamp noise, choose Intensity Check from the Service Mode menu. The noise value displayed after 20 seconds should be below 4.0 Hz for a fully warmed-up lamp (see Chapter 6, "Troubleshooting" if the noise is excessive).

SYSTEM LEAKS AND PUMP

There are two types of leaks: external leaks and internal leaks.

External Leaks

To test for the presence of leaks around the fittings, disconnect the ozone output line and plug the ozone fitting. Disconnect the vent line and plug. Disconnect the zero air supply and plug the zero air fitting. The flows as displayed in the Flows screen of the Diagnostics menu should slowly decrease to zero. The pressure as displayed in the Pressure screen should drop to below 250 mm Hg. If the pump diaphragm is in good condition and the capillary not blocked, it should take less than 20 seconds from the time the inlet is plugged to the time of reading below 250 mm Hg is achieved. Leaks can best be detected by carefully tightening each fitting until the leak is found.

Leaks Through Solenoid

Leaks across the solenoid valve can be caused by cold-flowing of the Teflon® across the seat, or by particulates on the seat.

To check for leaks through the solenoid, generate an ozone concentration of about 0.5 ppm. From the Main Menu choose Diagnostics. From the Diagnostics menu choose Cell A/B O3. This displays the concentration as determined in each cell individually. If the calibrator has stabilized, the average of 10 successive simultaneous readings should agree to within ∀3% percent. A balance measurement of better than 3% indicates that there is no leak across the solenoid. A constant low reading from one cell indicates an imbalance. The imbalance can be caused either by one cell or lines to that cell being extremely dirty, or by a leaky valve. If cleaning the cells and lines does not correct the imbalance, a leaky valve is indicated. To check if the imbalance is caused by an absorption cell, interchange cells. If imbalanced side switches, imbalance is due to cell, if not, it is independent of cell and due to other causes as noted below.

Confirmation of Leak Through Solenoid

An independent direct check of the solenoid valve can be performed as follows:

1. Remove the suspect solenoid valve following directions given in Chapter 6 "Servicing."
2. Connect the pump directly to the common port of the solenoid.
3. Connect the pressure transducer to the normally open port of the solenoid.
4. From the Main Menu choose Diagnostics. From the Diagnostics menu choose Pressure. Note the pressure as P_{NO}.
5. Connect the pressure transducer to the normally closed port of the solenoid.
6. Plug the solenoid power line into the solenoid position on the Power Supply Board. Make sure the solenoid is activated by choosing Pressure from the Diagnostics menu.
7. Note the pressure as P_{NC}.
8. If either P_{NC} or P_{NO} is greater than the pressure determined in the "External Leaks" section above, the solenoid is faulty.

DIGITAL TO ANALOG CONVERTER TEST AND ADJUSTMENT

The digital to analog converter test is used to fully test the analog outputs. It is normally performed only when a problem with the analog outputs is suspected. From the Main Menu choose Diagnostics. From the Diagnostics menu choose Test Analog Outputs. From the Test Analog Output menu choose Ramp. The analog outputs start at -2.3% (-23) and then increment by one every second until it reaches 100.0% (1000). A linear output indicates that the analog outputs are operating correctly.

CHAPTER 5

TROUBLESHOOTING

The Model 49C Primary Standard has been designed to achieve a high level of reliability. Only premium components are used, thus complete failure is rare. In the event of problems or failure, the troubleshooting guidelines presented in this chapter should be helpful in isolating the fault(s). The Service Department at Thermo Environmental can also be consulted in the event of problems at (508) 520-0430. In any correspondence with the factory please note both the serial number and program number of the instrument.

TROUBLESHOOTING GUIDE

MALFUNCTION	POSSIBLE CAUSE	ACTION
Does not start up	No power	Check that the instrument is plugged into the proper source
		Check instrument fuse
	Power supply	Check voltages from power supply
	Digital electronics	Check that all boards are seated properly
		Replace boards one at a time with spare boards to isolate the faulty board.

MALFUNCTION	POSSIBLE CAUSE	ACTION
Cell A or B frequency high	Light adjustment	Readjust Lamp Setting. From the Service Mode menu choose Lamp Setting.
	Defective detector	Interchange detectors at Motherboard connectors to determine if detector is defective.
	Lamp supply	Check for 1.7 volt peak to peak waveform at lamp current check point on Lamp Power Supply Board
	Digital electronics defective	Replace one board at a time with a spare board to isolate defective board.
Cell A or B frequency low or zero	Light adjustment	Readjust lamp setting. From the Service Mode menu choose Lamp Setting.
	Dirty cell	Clean cell
	Defective detector	Interchange detectors at Motherboard connectors to determine if detector is defective.

MALFUNCTION	POSSIBLE CAUSE	ACTION
Cell A or B frequency low or zero (continued)	Digital electronics defective	Replace one board at a time with a spare board to isolate defective board.
Cell A and B frequency low or zero	Dirty cells	Clean cells
	Light adjustment	Check for 1.7 volt peak to peak waveform at lamp current check point on Lamp Power Supply Board.
	Lamp	Remove one cell and look for blue light in hole of input block.
	Lamp heater	Check lamp temperature. From the Diagnostics menu choose Temperatures.
	∀15 volt power supply	Check ∀15 volts. From the Diagnostics menu choose Voltages.
	Digital electronics defective	Replace one board at a time with a spare board to isolate defective board.

MALFUNCTION	POSSIBLE CAUSE	ACTION
Cell A or B noise excessive	Foreign material in one cell	Clean cell.
	Defective detector	Interchange detectors at Motherboard connectors to determine if detector is defective.
	Digital electronics defective	Replace one board at a time with a spare board to isolate defective board.
	Lamp failure	Check for 1.7 volt peak to peak waveform at lamp current check point on Lamp Power Supply Board.
	∀15 volt power supply	Check ∀15 volts. From the Diagnostics menu choose Voltages.
	Digital electronics defective	Replace one board at a time with a spare board to isolate defective board.
Pressure transducer does not hold calibration	Pressure transducer	Replace pressure transducer
	Digital electronics	Replace one board at a time with a spare board to isolate defective board.

MALFUNCTION	POSSIBLE CAUSE	ACTION
Output signal noisy	Recorder	Replace or repair recorder
	Foreign material in cell	Clean cell
	Sticky solenoid valve	Replace with known good solenoid valve.
	Digital electronics defective	Replace one board at a time with a spare board to isolate defective board.
Slow response	Averaging time	Verify averaging time is set properly
	Contaminated optical bench	Clean bench and then condition system overnight

CHAPTER 6
SERVICING

This chapter explains how to replace the Model 49C Primary Standard subassemblies. Fault location is accomplished in the preceding chapters of "Preventive Maintenance" and "Troubleshooting." This chapter assumes that a subassembly has been identified as defective and needs to be replaced. These service procedures should be performed by an instrument service technician. For additional service assistance, see "Servicing Locations" later in this chapter.

SAFETY PRECAUTIONS

Some internal components can be damaged by the discharge of static electricity. To avoid damaging internal components, follow these precautions when performing any service procedure:

- Wear an antistatic wrist strap that is properly connected to earth ground (note that when the calibrator is unplugged, the chassis is not an earth ground)
- If an antistatic wrist strap is not available, be sure to touch a grounded metal object before touching any internal components
- Handle all printed circuit boards by the edges
- Carefully observe the instructions in each procedure

NOTE: Power should be removed from the instrument before any servicing is performed.

REPLACEMENT PARTS LIST

Table 6-1 lists the part numbers of the major subassemblies in the Model 49C Primary Standard.

Part Number	Description
9837	Processor Board
10761	Analog to Digital Board
9839	Digital to Analog Board
9956	Optional I/O Board
9843	C-Link Board
9833	Motherboard
9847	Power Supply Board
10758	Lamp Power Supply Board
8592	Detector System
10763	Lamp Block Heater
8540	Source Lamp (ozone free)
4124	Capillary - 15 mil (short purple)
9877	Pressure Transducer
9934	Flow Sensor
4509	Fuse - 2 amp slo-blo
8573	Solenoid Valve
8606	Pump Rebuild Kit
8550	Pump 110V
8551	Pump 220V

Table 6-1. Replacement Parts

SOURCE LAMP REPLACEMENT

Equipment required:

New Lamp (Part No. 8540)
Allen Wrench - 7/64" and 3/32"
Screwdriver - flat - medium size

1. Wear an antistatic wrist strap, see “Safety Precautions” earlier in this chapter for more information.
2. Turn the instrument off and unplug the power cord.
3. Remove the cover.
4. Disconnect the lamp from the lamp power supply.
5. Remove access hole cover on the rear panel
6. Loosen Allen screw on lamp clamp.
7. Loosen two screws holding the clamp to the base.
8. Carefully slide lamp out of bench and instrument case through access hole.
9. Carefully slide new lamp into bench until it bottoms. Loosely tighten the Allen screw on clamp. Tighten two screws holding clamp to bench. Pull lamp out approximately 1/32" to 1/16" to allow for expansion when the lamp warms up; tighten Allen screw.
10. Plug new lamp into lamp power supply.
11. Replace access hold cover.
12. Re-install the cover.
13. Plug in the power cord and turn on the instrument.
14. After lamp has stabilized (approximately 15 minutes), adjust the lamp voltage in the Service Mode menu until the output from each detector is about 100 kHz.

OPTICAL BENCH SOLENOID REPLACEMENT

Equipment required:

Solenoid (Part No. 8573)
Screwdriver
5/8" Open-End Wrench

1. Wear an antistatic wrist strap, see “Safety Precautions” earlier in this chapter for more information.
2. Turn the instrument off and unplug the power cord.
3. Remove the cover.
4. Disconnect electrical connections of solenoids from Power Supply Board.

5. Loosen and remove two fittings from solenoid assembly to bench and the fitting from solenoid assembly to sample inlet.
6. Remove solenoid bracket from floor plate.
7. Remove solenoid bracket.
8. Replace solenoid by following the above procedure in reverse, making sure all fittings are tight.
9. Re-install the cover.
10. Plug in the power cord and turn on the instrument.
11. Perform a leak test.

REBUILDING PUMP

Equipment Required:

Screwdriver
Pump Repair Kit (Part No. 8606)

1. Wear an antistatic wrist strap, see “Safety Precautions” earlier in this chapter for more information.
2. Turn the instrument off and unplug the power cord.
3. Remove the cover.
4. Loosen fittings and remove all 1/4" Teflon ® lines.
5. Remove four screws from top plate, remove plate-flapper valve and bottom plate (see Figure 6-1).
6. Remove screw holding diaphragm onto piston.
7. Assemble pump by following the above procedure in the reverse; make sure Teflon (white) side of diaphragm is facing up and that the flapper valves cover holes.
8. Re-install the cover.
9. Plug in the power cord and turn on the instrument.
10. Perform a leak test.

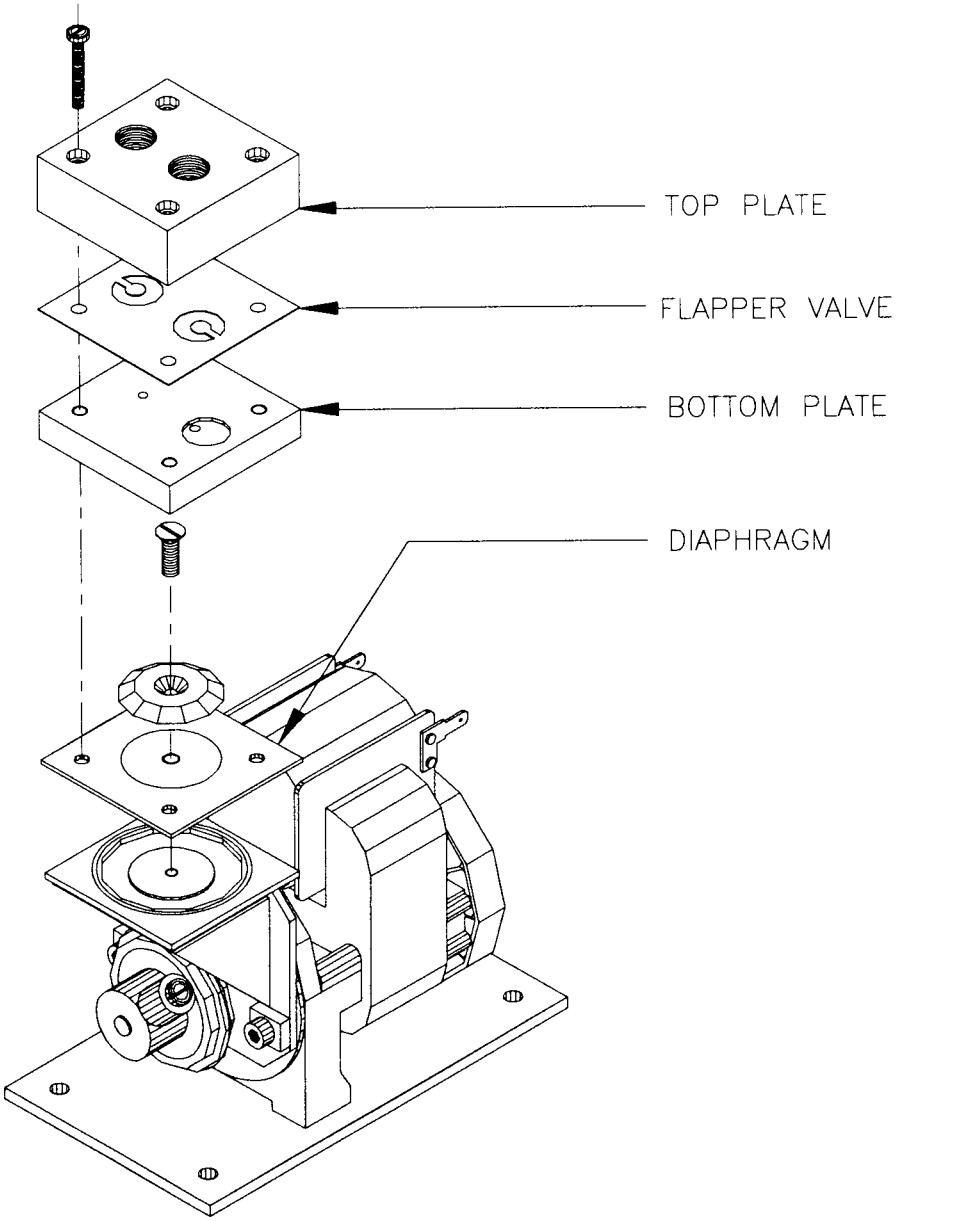


Figure 6-1. Pump Assembly

REPLACEMENT OF PUMP

Equipment Required:

Screwdriver
110V Pump (Part No. 8550)
220V Pump (Part No. 8551)

1. Wear an antistatic wrist strap, see “Safety Precautions” earlier in this chapter for more information.
2. Turn the instrument off and unplug the power cord.
3. Remove the cover.
4. Unplug power line of pump from Power Supply Board.
5. Loosen fittings, remove all ¼" Teflon® lines, remove fittings from pump.
6. Remove four screw holding pump bracket to shock mounts.
7. Remove two screws holding pump to pump bracket.
8. Install new pump by following the above procedure in reverse.
9. Re-install the cover.
10. Plug in the power cord and turn on the instrument.
11. Perform a leak test.

DETECTOR REPLACEMENT

Equipment Required:

New Detector Assembly (Part No. 8592)
Allen Wrench - 1/16"
Allen Wrench - 9/64"

1. Wear an antistatic wrist strap, see “Safety Precautions” earlier in this chapter for more information.
2. Turn the instrument off and unplug the power cord.
3. Remove the cover.
4. Unplug faulty detector from Motherboard.
5. Loosen both 9/64" Allen screws holding detector block.
6. Loosen 1/16" Allen screw to remove detector.
7. Install new detector by following the above procedure in reverse.
8. Re-install the cover.
9. Plug in the power cord and turn on the instrument.

PRESSURE TRANSDUCER

Equipment Required:

New Pressure Transducer (Part No. 9936)
Nut Driver

1. Wear an antistatic wrist strap, see “Safety Precautions” earlier in this chapter for more information.
2. Turn the instrument off and unplug the power cord.
3. Remove the cover.
4. Disconnect pressure transducer from Motherboard.
5. Disconnect the tube connecting the pressure transducer to the optical bench.
6. Remove screws holding pressure transducer to divider panel.
7. Install new pressure transducer by following the above procedure in reverse.
8. Re-install the cover.
9. Plug in the power cord and turn on the instrument.
10. Check calibration of pressure transducer.

DC AND LAMP POWER SUPPLY BOARD REPLACEMENT

Equipment Required:

Nut Driver – 1/4"
Screwdriver
Lamp Power Supply Board (Part No. 8596)
DC Power Supply Board (Part No. 9847)

1. Wear an antistatic wrist strap, see “Safety Precautions” earlier in this chapter for more information.
2. Turn the instrument off and unplug the power cord.
3. Remove the cover.
4. Disconnect all plug-in connections from power supply board being replaced.
5. Remove screws holding board to chassis and remove board.
6. On power supply board, check that transformer is wired for proper voltage.
7. Install new board by following the above directions in reverse. Care should be exercised to assure that the voltage regulators fit into the plug on the board.
8. Re-install the cover.
9. Plug in the power cord and turn on the instrument.

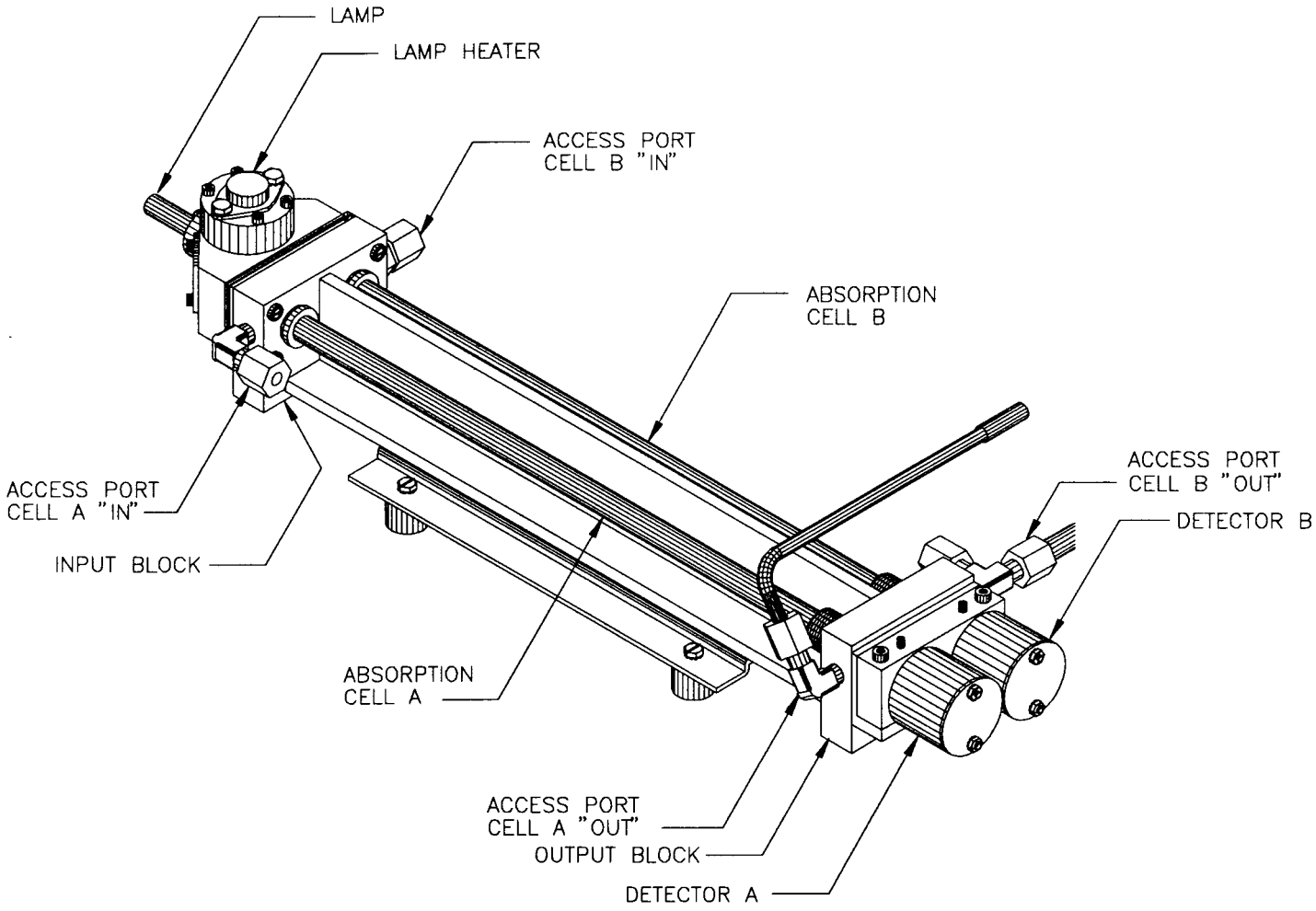


Figure 6-2. Assembly Drawing of Optical Bench 45P740

CAPILLARY SERVICE

Equipment Required:

Capillary (Part No. 4124)
Wire to Clean Old Capillary

1. Wear an antistatic wrist strap, see “Safety Precautions” earlier in this chapter for more information.
2. Turn the instrument off and unplug the power cord.
3. Remove the cover.
4. Remove capillary and clear blockage with wire or replace capillary.
5. Replace capillary by following the above directions in reverse.
6. Re-install the cover.
7. Plug in the power cord and turn on the instrument.

OZONATOR LAMP REPLACEMENT

Equipment Required:

Replacement Lamp (Part No. 8645)
Allen Wrench 7/64"

1. Wear an antistatic wrist strap, see “Safety Precautions” earlier in this chapter for more information.
2. Turn the instrument off and unplug the power cord.
3. Remove the cover.
4. Unplug lamp from Ozonator Power Supply Board.
5. Slide insulation off the lamp handle onto the lamp cord.
6. Loosen both Allen screws down lamp clamp.
7. Carefully slide lamp out of ozonator housing.
8. Slide insulation off of old lamp and slide onto new lamp.
9. Carefully slide new lamp into ozonator housing until it bottoms. Pull lamp out approximately 1/16" to allow for expansion when the lamp warms up, tighten Allen screws.
10. Plug lamp into ozonator power supply.
11. Re-install the cover.
12. Plug in the power cord and turn on the instrument.

OZONATOR HEATER REPLACEMENT

Equipment Required:
New Heater (Part No. 8593)
Allen Wrench - 7/64"
Screwdriver
Heat Conductive Compound

1. Wear an antistatic wrist strap, see “Safety Precautions” earlier in this chapter for more information.
2. Turn the instrument off and unplug the power cord.
3. Remove the cover.
4. Unplug heater from ozonator power supply.
5. Remove top flange of ozonator housing.
6. Remove ozonator heater block from ozonator by removing four (4) Allen screws.
7. Coat new heater block with thin film of heat conductive compound.
8. Install new ozonator heater block by following the above procedure in reverse.
9. Re-install the cover.
10. Plug in the power cord and turn on the instrument.

OZONATOR POWER SUPPLY REPLACEMENT

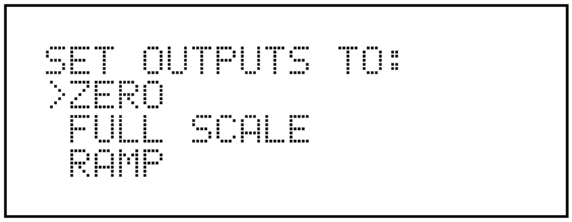
Equipment Required:
New Ozonator Power Supply (Part No. 8515)
Screwdriver
Nut Driver – 1/4"

1. Wear an antistatic wrist strap, see “Safety Precautions” earlier in this chapter for more information.
2. Turn the instrument off and unplug the power cord.
3. Remove the cover.
4. Unplug lamp, heater and cable to main power supply.
5. Remove seven screws holding ozonator power supply board to bracket and remove board with a gently, but firm upwards pull.
6. Check that transformer is wired for proper voltage.
7. If regulators are being replaced, make sure orientation is correct. Compare to PC board.
8. Install new ozonator power supply by reversing the above procedure. Care should be exercised to assure that the voltage regulators fit into the plugs or the board.
9. Re-install the cover.
10. Plug in the power cord and turn on the instrument.

ANALOG OUTPUT ADJUSTMENT

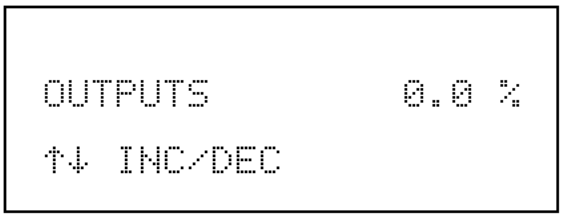
The analog outputs need only be adjusted if the concentration value on the front panel display disagrees with the analog outputs. To see if the analog outputs need to be adjusted, compare the front panel display to the analog output voltage. If they differ by more than 1%, then the analog outputs should be adjusted. This procedure should only be performed by an instrument service technician.

1. Wear an antistatic wrist strap that is properly connected to earth ground, see "Safety Precautions," earlier in this chapter for more information.
2. Remove the instrument cover.
3. From the Run screen, press the **MENU** pushbutton to display the Main Menu. Use the ↓ pushbutton to move the cursor to Diagnostics, and press **ENTER** to display the Diagnostics menu. Use the ↓ pushbutton to move the cursor to Test Analog Outputs, and press **ENTER**. The Test Analog Output screen appears as shown below.



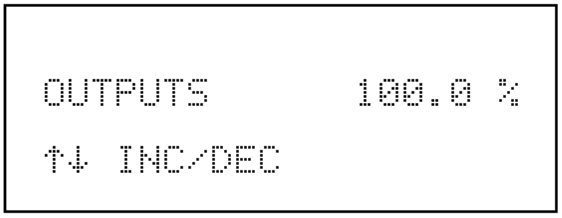
Test Analog Outputs Menu

4. Press **ENTER** to select Zero. The zero screen appears as shown below. Using a small screwdriver, adjust potentiometer R1 and R3 on the D/A board until the analog outputs read 0 volts. Press the **MENU** pushbutton to return to the Test Analog Outputs menu.



Zero Analog Outputs Screen

5. Press the ↓ pushbutton to move the cursor to Fullscale and press **ENTER**. The fullscale screen appears as shown below. Using a small screwdriver, adjust potentiometer R2 and R4 on the D/A board until the analog outputs read 10 volts (standard instrument). Press the **MENU** pushbutton to return to the Test Analog Outputs menu.



Fullscale Analog Outputs Screen

6. Repeat the above steps to ensure the adjustments are accurate.
7. Re-install the instrument cover.

PRESSURE TRANSDUCER ADJUSTMENT

This procedure should only be performed by an instrument service technician.

Equipment Required:
Vacuum Pump
Screwdriver

1. Wear an antistatic wrist strap that is properly connected to earth ground, see "Safety Precautions," earlier in this chapter for more information.
2. Remove the instrument cover.
3. Disconnect the tubing from the pressure transducer and connect a vacuum pump known to produce a vacuum less than 1 mm Hg.
4. From the Run screen, press **MENU** to display the Main Menu. Use the ↓ pushbutton to move the cursor to Instrument Control. Press **ENTER** to display the Instrument Control menu. Use the ↓ pushbutton to move the cursor to Pressure Correction. Press **ENTER** to display the pressure reading.
5. Adjust the zero potentiometer on the pressure transducer for a reading of zero mm Hg.
6. Disconnect the vacuum pump. The display should read the current local barometric pressure. If this value does not agree with a known accurate barometer, adjust the span potentiometer.
7. Re-install the instrument cover.

If the expected pressure changes are small (i.e., the only changes expected are barometric weather changes and not altitude changes) an error in the zero setting will not introduce a measurable error if the span is adjusted correctly. Thus if only a barometer is available, and not a vacuum pump, only adjust the span. If a barometer is not available, a rough check can be made by obtaining the current barometric pressure from the local weather station or airport.

Since these barometric pressures are usually reported corrected to sea level, it might be necessary to correct 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. It is possible for the atmospheric barometric pressure from room to room or in a building to be different from the outside atmospheric pressure as a result of the positive pressure developed by the air-conditioning and/or heating systems.

TEMPERATURE SENSOR ADJUSTMENT

This procedure should only be performed by an instrument service technician.

Equipment Required:

Calibrated Thermometer or 10KΩ ± 1% Resistor
Screwdriver

1. Wear an antistatic wrist strap that is properly connected to earth ground, see "Safety Precautions," earlier in this chapter for more information.
2. Remove the instrument cover.
3. Tape the thermistor plugged into the Motherboard to a calibrated thermometer.
4. Adjust the **GAIN** potentiometer on the Analog to Digital Board until the internal temperature reading agrees with the value on the calibrated thermometer. Since the thermistors used in the calibrator are interchangeable to an accuracy of ± 0.2°C, and have a value of 10K ohms at 25°C, an alternate procedure is to connect an accurately known 10K resistor to the thermistor input on the Motherboard, and adjust the **GAIN** potentiometer for an internal temperature reading of 25°C. Note that a 1°C change corresponds to a ± 5% change in resistance, thus this alternative procedure can be quite accurate as a check; however, it clearly is not NIST traceable.
5. Re-install the instrument cover.

FUSE REPLACEMENT

Equipment Required:

115V T, 2A, 250V (Part No. 4509)
220V T, 1.25A, 250V (Part No. 14009)

1. Disconnect power to instrument.
2. Remove fuse drawer, located on the AC power connector.
3. Replace both fuses, if either is blown.
4. Insert fuse drawer and reconnect power cord.

SERVICE LOCATIONS

For additional assistance, Thermo Environmental Instruments provides customer service from the following locations:

Thermo Environmental Instruments Inc.
8 West Forge Parkway
Franklin, Massachusetts 02038
Telephone: (508) 520-0430
Facsimile: (508) 520-1460

Thermo Environmental Instruments Inc.
325 E. Arrow Hwy. #506
San Dimas, California 91773
Telephone: (909) 394-2373
Facsimile: (909) 394-2367

Thermo Environmental Instruments has additional service personnel located throughout the country. Contact either of the above service centers for more information.

If equipment must be returned, obtain an authorization number from the service center to speed response. This number must appear on the outside of the shipping carton.

CHAPTER 7

THEORY OF OPERATION

In order to understand the operation of the Model 49C Primary Standard, a general knowledge of the electronics, software, and subassemblies is necessary.

ELECTRONICS

The electronics can be broken down into the following subassemblies:

- DC Power Supply
- Lamp Power Supply
- Ozonator Power Supply
- Detector System
- Microprocessor System

A brief description of each follows. Note that all the electrical schematics are given in Appendix C, "Schematics."

DC Power Supply

The DC Power Supply outputs the regulated and unregulated dc voltages necessary to operate the analog and digital electronics. It outputs +24 volts unregulated and ∀15 volts and +5 volts regulated. The power supply board also contains the circuitry for driving the solenoid valves.

Lamp Power Supply

The lamp is driven by a square wave signal at approximately 15 kHz. The square wave is generated by a monolithic pulse width modulation control circuit (U2). The square wave feeds two switching transistors (Q2 & Q3) which drive the primary of the lamp transformer (T1).

The secondary circuit includes the secondary winding, a 50K ohm resistor (R3), the lamp, and a 100 ohm resistor (R5) in series. One end of the transformer is at ground potential. The 50K ohm resistor acts as a current limiting resistor to limit the current to the lamp. The 100 ohm resistor can be used to check the wave form and the current through the lamp.

In addition to driving the lamp, the lamp power supply also includes the lamp block heating circuit (U1 and associated circuitry). The lamp block is heated by a power transistor. The temperature is measured by a thermistor. The current, and thus the heat into the transistor, is controlled by the operational amplifier integrated circuit (U1). As long as the temperature as determined by the thermistor is low, the lamp power supply is off. When the temperature is above about 50EC, the lamp ignites. If the temperature of the lamp block should ever fall below its set point, the lamp will be turned off. The lamp is turned off and on by turning the pulsed width modulator (U2) on or off as controlled by the line between Pins 15 of U2 and the output of the temperature controlling op amp, Pin 8 of U1. The Lamp Power Supply Board also contains circuitry for adjusting the lamp amplitude and sensing the lamp temperature.

Ozonator Power Supply

The Ozonator Power Supply includes a rectifier and dc power supply circuit, and a heater control circuit identical to the lamp power supply. The generation of the 15 kHz square wave is identical to that of the lamp power supply. The ozonator power supply includes the span/zero solenoid driving circuitry and also the control circuitry for adjusting the lamp amplitude and sensing the lamp temperature.

Detector System

The detector system consists of a solar blind vacuum photo-diode which feeds an electrometer operational amplifier (IC-111). since the sensitivity of the detector varies from tube to tube, the gain of the electrometer is matched for each tube by choice of R 112. The output of the electrometer is fed into a V-F (voltage-to-frequency) converter (IC-112). Thus the frequency output of the detector system is proportional to the light intensity reaching the detector. The whole system is mounted in a small, well shielded holder.

The Microprocessor System

The microprocessor system consists of P.C. boards which plug into a motherboard, connecting them to each other and to the rest of the instrument. These boards are as follows:

- Display Module
- Processor Board
- Analog to Digital Board
- Digital to Analog Board

Display Module. The vacuum fluorescent display module shows O_3 concentration, instrument parameters, and help messages. The single board display module consists of 80 characters (4 line by 20 column), refresh memory, character generator, dc/dc converter and all necessary control logic. The display module is powered by +5 volts dc.

Processor Board. The Processor Board contains a Motorola M68HC11F1 microprocessor (U4), RAM (U5), and EPROM (U2). In addition, this high-performance, nonmultiplexed 68-pin microprocessor contains 512 bytes of EEPROM and 1K of RAM. It is operated at a frequency of 2 MHz, which is generated by crystal X1.

Digital/Analog Board. The Digital to Analog Board contains four D/A converters. Each is addressed by the processor via signals from PA0-PA7 and PG0 and PG1. The D/A converters are zeroed using potentiometers R1, R3, R5, and R7 and span is set using potentiometers R2, R4, R6, and R8. The fullscale output of the four D/A converters is set by jumpers on switches SW1-SW4 on the D/A board. Fullscale voltages of 10, 5, 1, and 0.1 volts are available.

Analog to Digital Board. The Analog to Digital Board acts as an interface between all the signals monitored by the processor system and the microprocessor itself. Up to 12 analog inputs are available. The bench temperature, bench lamp temperature, pressure, power supply voltages, lamp voltage, and flow rates are examples of analog signals converted to digital signals used by the microprocessor.

SUBASSEMBLIES

Optical Bench

The optical bench is a dual cell device, with each cell having a length of 37.84 cm. It has been designed for easy disassembly for cleaning. All internal surfaces have been coated with polyvinylidine fluoride to ensure that ozone undergoes no decomposition upon exposure to the internal surface of the bench. Both the source and detectors mount rigidly onto the bench. The optical bench is very rigid and needs no optical alignment.

Lamp and Lamp Power Supply

The lamp is a low pressure mercury vapor lamp with an expected lifetime in excess of one year. The lamp is driven by a precisely regulated power supply with a square wave at about 15 kHz to ensure a high level of stability. In order to achieve the highest level of stability of light output, the lamp itself is mounted in a temperature controlled, insulated aluminum block that provides the necessary thermal stability.

Flow Components

The Model 49C Primary Standard operates at nominal atmospheric pressure. A downstream pump and two capillaries control sample flow through the cells which is monitored by two flow sensors. Total flows of less than 1 LPM (2 scfh) should be avoided since the flush time would be excessive. Total flows of greater than 3 LPM should also be avoided since there would not be enough residence time in the converter to ensure greater than 99% conversion of the ozone. The solenoid valves operating under computer control allow sample gas to pass through Cell A and reference gas through Cell B, or vise versa, depending upon which cycle the instrument is performing.

Ozonator

The internal ozonator operates on the photolytic principle. The ozone level produced is a function of light intensity at 185 nm and gas flow. The light intensity is varied by changing the current into the lamp. The gas flow is held constant by a pressure regulator followed by a capillary. The distribution manifold is all Teflon®.

CHAPTER 8
OPTIONAL EQUIPMENT

This chapter describes optional equipment available for the Model 49C Primary Standard.

RACK MOUNTS WITH SLIDES

Rack mounts with slides for standard 19-inch relay racks are available. Figures 8-1 and 8-2 illustrate the installation of the rack mount option. Also available, as Option 209, are the handle mounting brackets and handles without the rack mounts.

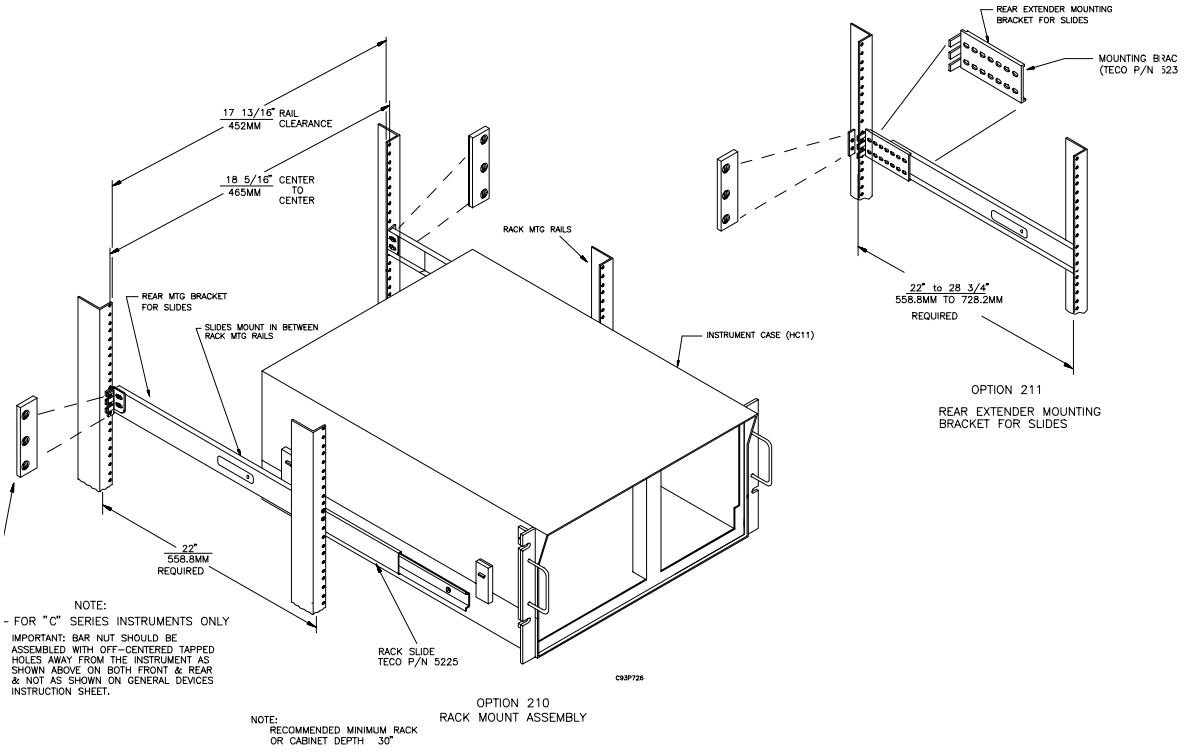


Figure 8-1. Rack Mount Option Assembly

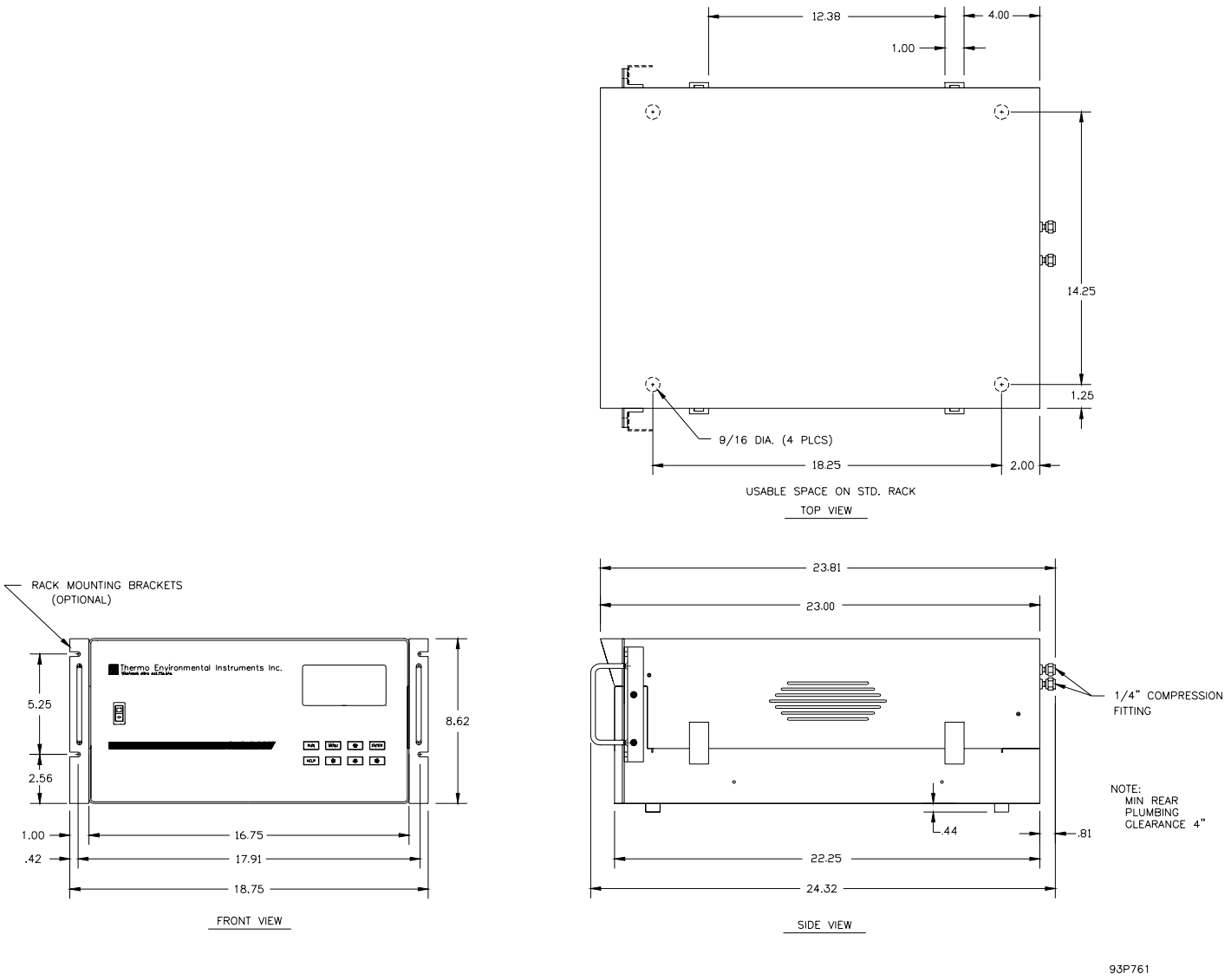
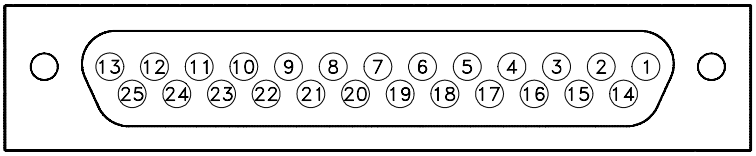


Figure 8-2. Model 49C Primary Standard Dimensional Outline

REMOTE ACTIVATION OF ZERO/SPAN AND SAMPLE VALVES

The rear panel I/O (DB25) connector, shown in Figure 8-3, enables the zero gas and ozonator levels 1 through 4 to be remotely selected via contact closure. In addition, the connector has several instrument status outputs. Option switch 1 must be on and option switch 2 off in order to enable the remote I/O connector.



Pin Out

(1) Ground
(2) INPUT – Level 1
(3) INPUT – Level 2
(4) INPUT – Level 3
(5) INPUT – Level 4
(6) Ground
(7) Relay Common
(8) STATUS - Concentration Alarm
(9) STATUS - Local or Service Mode
(10) STATUS – Zero Gas
(11) STATUS - General Alarm
(12) Relay Common
(13) NC
(14) Ground
(15) NC
(16) NC
(17) NC
(18) INPUT - Zero Gas
(19) Ground
(20) Relay Common
(21) STATUS – Level 1
(22) STATUS – Level 2
(23) STATUS – Level 3
(24) STATUS – Level 4
(25) Relay Common

Figure 8-3. Rear Panel I/O Connector

64P947-5

Input Pins

To activate the zero gas mode, connect pin 1, 6, 14, or 19 (ground) to pin 5 (zero gas mode), as shown in Figure 8-4. To deactivate the zero gas mode, disconnect ground from the zero gas mode input.

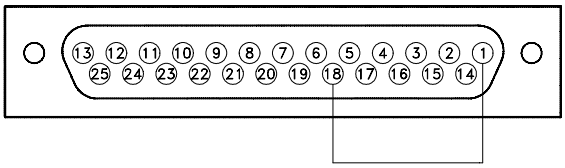


Figure 8-4. Remote I/O Zero Gas Mode Activation 64P947-7

To activate the span gas mode, connect pin 1, 6, 14, or 19 (ground) to pin 18 (Level 4), as shown in Figure 8-5. To deactivate the span gas mode, disconnect ground from the span gas mode input.

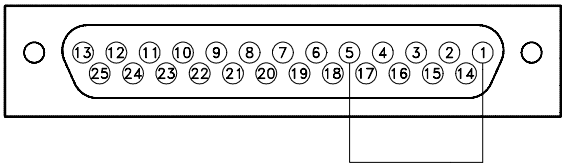


Figure 8-5. Remote I/O O_3 Level 4 Concentration Activation 64P947-6

Instrument Status Outputs

Several instrument status outputs are available on the rear panel I/O (DB25) connector via reed relays on the I/O Board. The reed relays are arranged as shown below in Figure 8-6. In the instrument status output truth tables, each pin is referred to as open or closed (based on the physical position of the corresponding relay). The Relay Common line is common to each of the relays.

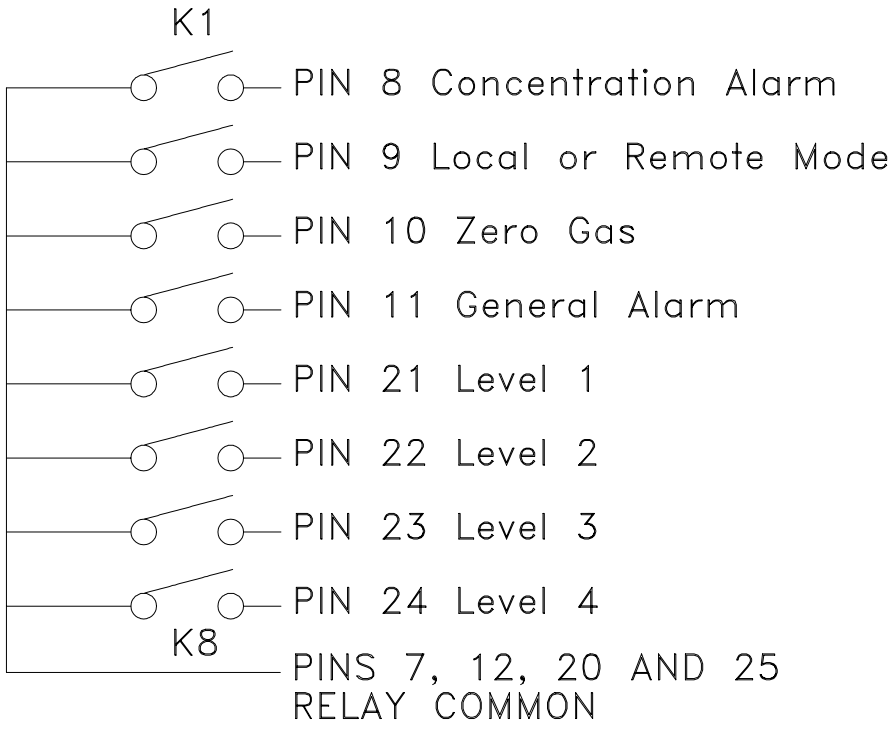


Figure 8-6. Instrument Status Output Relays

45-953-2

Status	Pin	Relay Closed	Relay Open
Concentration Alarm	8	Alarm	No Alarm
Local or Remote Mode	9	Local or Service Mode	Remote Mode
General Alarm	11	Alarm	No Alarm

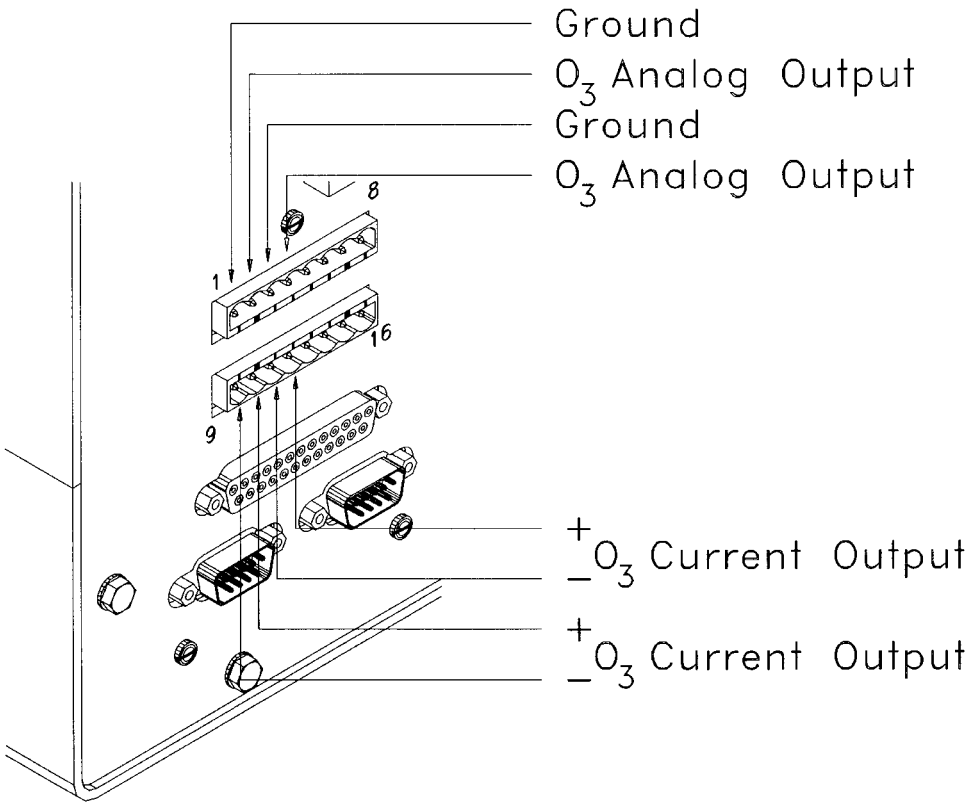
The Instrument Controls menu contains the Custom Levels submenu. This submenu is used for setting four user-defined levels: Level 1, Level 2, Level 3, and Level 4.

In the Run Screen, use the Run pushbutton to scroll through Zero, Level 1, Level 2, Level 3, and Level 4. Press Enter to select a custom level or zero.

Local/Remote Modes	Zero	Level 1	Level 2	Level 3	Level 4	↑↓ = 0	↑↓ ≠ 0
Zero Status (Pin #10)	Relay Closed	Relay Closed	Relay Closed	Relay Closed	Relay Closed	Relay Open	Relay Closed
Level 1 Status (Pin #21)	Relay Open	Relay Closed	Relay Open	Relay Open	Relay Open	Relay Open	Relay Open
Level 2 Status (Pin #22)	Relay Open	Relay Open	Relay Closed	Relay Open	Relay Open	Relay Open	Relay Open
Level 3 Status (Pin #23)	Relay Open	Relay Open	Relay Open	Relay Closed	Relay Open	Relay Open	Relay Open
Level 4 Status (Pin #24)	Relay Open	Relay Open	Relay Open	Relay Open	Relay Closed	Relay Open	Relay Open

4-20 mA ISOLATED CURRENT OUTPUT

A 4-20 mA Isolated Current Output enables the O_3 concentration to be output at 4-20 mA as shown in Figure 8-7.



45P951-4

Figure 8-7. Pin-Out of Rear Panel Terminal Strip with Optional Current Output

INSTRUMENT HANDLE

An instrument handle is available to aid in carrying the instrument. It also enables the instrument to be slightly elevated while resting on a table or bench, to increase visibility of the display. Figure 8-8 shows the installation of the instrument handle.

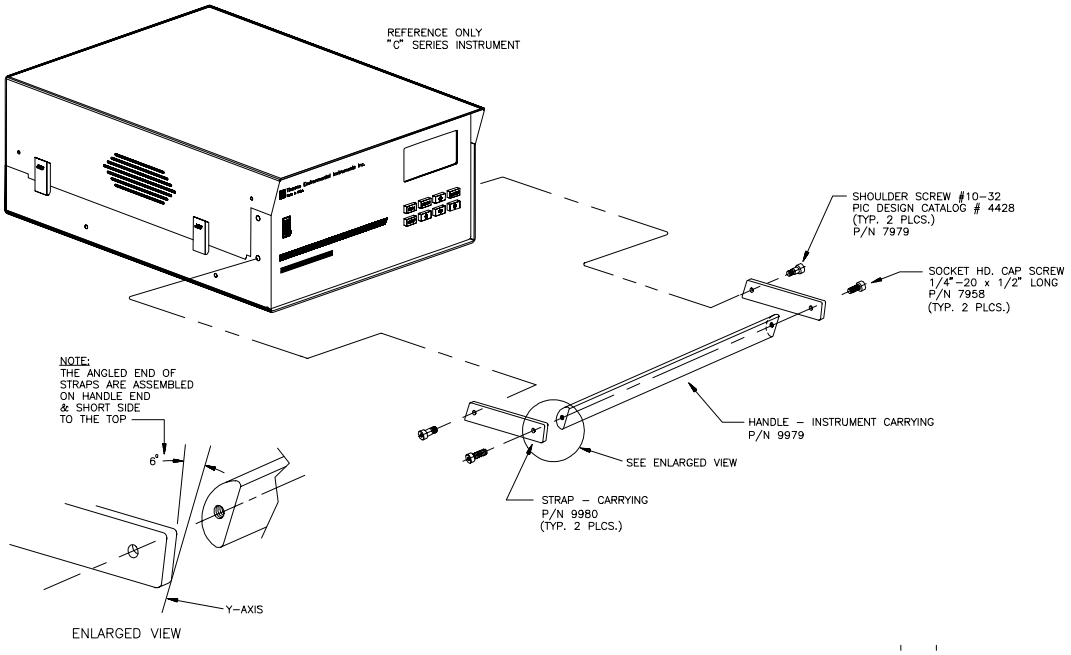


Figure 8-8. Instrument Handle Assembly

APPENDIX A
WARRANTY

Subject to the exceptions stated below, Thermo Environmental Instruments Inc. agrees to correct either by repair or at our option, by replacement, any defects in materials or workmanship which develop within one year from the date of delivery not to exceed eighteen (18) months from date of shipment, parts and labor supplied free of charge.

The exception mentioned above are: (1) All items defective must be returned to Thermo Environmental Instruments Inc., transportation charges prepaid, and will be shipped prepaid and charged to the customer unless the item is found to be defective and covered by the warranty in which case Thermo Environmental Instruments Inc will pay all surface transportation charges; (2) Thermo Environmental Instruments Inc. agrees to extend to the customer whatever warranty is given to Thermo Environmental Instruments Inc. by suppliers of component items purchased by Thermo Environmental Instruments Inc. and incorporated into products sold to the customer; (3) Thermo Environmental Instruments Inc. shall be released from all obligations under this warranty in the event repairs or modification are made by persons other than its own authorized service personnel, or service personnel from an authorized representative, unless such repair is minor, merely the installation of a new plug-in component; (4) if any model or sample was shown to Purchaser, such model or sample was shown merely to illustrate the article and not to represent that any article delivered hereunder would conform to the model or sample, and (5) Spare parts are warranted for ninety (90) days.

THE FOREGOING WARRANTY IS EXCLUSIVE AND IN LIEU OF ALL OTHER WARRANTIES, WHETHER WRITTEN, ORAL, IMPLIED, OR STATUTORY. SELLER DOES NOT WARRANT MERCHANTABILITY OR FITNESS FOR ANY PARTICULAR PURPOSE, OR MAKE ANY OTHER WARRANTY OR AGREEMENT EXPRESSED OR IMPLIED WITH RESPECT TO ANY ARTICLES COVERED HEREUNDER. THERE ARE NO WARRANTIES WHICH EXTEND BEYOND THOSE EXPRESSLY STATED IN THIS CONTRACT.

APPENDIX B

RS-232 COMMANDS

The RS-232 interface enables the Model 49C Primary Standard to be remotely controlled by a host RS-232 device such as, a PC, PLC, or datalogger.

CONNECTIONS

On the rear panel of the Model 49C Primary Standard there are two male DB9 connectors. One connector (it doesn't matter which one) connects to the host RS-232 device. The second DB9 connector is used to connect another C Series analyzer, such as a Model 49C. Several analyzers can be chained together to be controlled by a single host RS-232 device. Cable lengths, however, should be kept under 50N.

A null modem (crossed) cable is required when connecting the Model 49C Primary Standard to an IBM Compatible PC. However, a straight cable (one to one) may be required when connecting the calibrator to other host RS-232 devices. As a general rule, when the connector of the host RS-232 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, or 9600 baud
8 data bits
1 stop bit
no parity
All responses are terminated with a carriage return (hex 0D)

INSTRUMENT IDENTIFICATION NUMBER

When using commercial or custom software to control the Model 49C Primary Standard, it is necessary to send an instrument identification number with each command. This is necessary because several C Series analyzers can be connected to a single host RS-232 device. The instrument identification number directs the command to a specific analyzer. The Model 49C Primary Standard ignores any command that does not begin with its instrument identification number (hex BB). The instrument identification number for each analyzer is given in Table B-1.

Model	Hex	Decimal	ASCII Character
42C	AA	170	5
43C	AB	171	□
48C	B0	176	▒
49C	B1	177	▓
49C P.S.	BB	187	╗

Table B-1. Instrument Identification Numbers

When using a PC with a commercial communications program, such as Procomm Plus, each command must begin with the proper instrument identification number (ASCII character). The command in the example below begins with the ASCII character "╗" which directs the command to the Model 49C Primary Standard.

Send: "╗o3"
Receive: "o3 0090E+0 ppb"

COMMANDS

The analyzer must be in the remote mode in order to change instrument parameters (using set commands) via RS-232. However, the command "set mode remote" can be sent to the Model 49C Primary Standard to put it in the remote mode. Report commands can be issued either in the remote or local mode.

The RS-232 commands can be sent in either uppercase or lowercase characters. In the examples below, only the characters between the quotation marks ("") are sent and received. If an incorrect command is sent, a "bad cmd" message will be received. The example below sends the incorrect command "set time avg" instead of the correct command "set avg time".

Send: "set time avg"
Receive: "set time avg bad cmd"

---

o3

This command reports the current O_3 output concentration. The example below reports that the current O_3 output concentration is 505.7 ppb.

Send: "o3"
Receive: "o3 5057E-1 ppb"

---

set o3 conc

This command is used to set the O_3 concentration to a user defined value. The example below sets the O_3 concentration to 500 ppb.

Send: "set o3 conc 500"
Receive: "set o3 conc 500 ok"

mode

This reports what operating mode the instrument is in: local, remote, or service. 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"

gas unit

This reports the current gas units (ppb, ppm, $\Phi g/m^3$, or mg/m^3). The example reports that the gas unit is set to ppb.

Send: "gas unit"
Receive: "gas unit ppb"

---

set gas unit *unit*

unit = | ppb | ppm | mg/m3 | Φg/m3 |

This command sets the gas units to ppb, ppm, mg/m^3, or Φg/m^3. The example below sets the gas units mg/m^3.

Send: "set gas unit mg/m3"
Receive: "set gas unit mg/m3 ok"

---

range

This command reports the current range. The example below reports that the range is set to 500 ppb.

Send: "range"
Receive: "range 5: 5000E-1 ppb"

---

set range *d*

d = Code in table below

This command selects the fullscale range according to the table below. The example below sets the fullscale range to 100 ppb.

Send: "set range 1"
Receive: "set range 1 ok"

Code	ppb	ppm	Φg/m^3	mg/m^3
0	50	0.05	100	0.1
1	100	0.1	200	0.2
2	200	0.2	500	0.5
3	500	0.5	1,000	1
4	1,000	1	2,000	2
5	2,000	2	5,000	5
6	5,000	5	10,000	10
7	C1	C1	C1	C1
8	C2	C2	C2	C2
9	C3	C3	C3	C3

---

custom *d*

d = | 1 | 2 | 3 |

This reports the user-defined value of custom range 1, 2, or 3. The example below reports that custom range 1 is defined to 2500 ppb.

Send: "custom 1"
Receive: "custom 1 2500E+0 ppb"

---

set custom 1 range *ddddd.d*
set custom 2 range *ddddd.d*
set custom 3 range *ddddd.d*

These commands are used to define the custom ranges. To use the custom range, select it using the set range command. The example below defines custom range 1 to 455.0 ppb.

Send: "set custom 1 range 455.0"
Receive: "set custom 1 range 455.0 ok"

---

avg time

This reports the averaging time setting. The example below reports that the averaging time is set to 60 seconds.

Send: "avg time"
Receive: "avg time 060 sec"

set avg time *d*

d = Code in table below

Sets the averaging time according to the following Table. The example below sets the averaging time to 60 seconds.

Send: "set avg time 3"
Receive: "set avg time 3 ok"

Code	Averaging time (seconds)
0	10
1	20
2	30
3	60
4	90
5	120
6	180
7	240
8	300

o3 bkg

This command reports the current O_3 background. The example below reports that the O_3 background is 0.0 ppb.

Send: "o3 bkg"
Receive: "03 bkg 0.0 ppb"

set o3 bkg *dd.d*

This command is used to set the O_3 background to a user-defined value. The example below sets the O_3 background to 1.4 ppb.

Send: "set o3 bkg 1.4"
Receive: "set 03 bkg 1.4 ok"

o3 setting

This command reports what ozone concentration the calibrator is set to output. The example below reports that the calibrator is set to output 500 ppb.

Send: "o3 setting"
Receive: "o3 setting 0500"

l1 conc
l2 conc
l3 conc
l4 conc

These commands report the four custom level settings. The example below reports that custom level 1 is 125 ppb.

Send: "11 conc"
Receive: "l1 conc 0125 ppb"

---

set l1 conc *dddd*
set l2 conc *dddd*
set l3 conc *dddd*
set l4 conc *dddd*

These commands set the custom levels. The example below sets custom level 1 to 325 ppb.

Send: "set l1 conc 325"
Receive: "set l1 conc 325 ok"

---

gas mode

This command reports the present ozone setting.

Send: "gas mode"
Receive: "gas mode sample
"gas mode zero"
"gas mode level 1"
"gas mode level 2"
"gas mode level 3"
"gas mode level 4"

---

set sample

This command sets the instrument to sample mode.

Send: "set sample"
Receive: "set sample ok"

set zero

This command sets the instrument to zero mode.

Send: "set zero"
Receive: "set zero ok"

set level

This command sets the instrument in custom levels 1, 2, 3, or 4 . The example below sets the custom level 1.

Send: "set level 1"
Receive: "set level 1 ok"

o3 coef

This command reports the current O_3 coefficient. The example below reports that the O_3 coefficient is 1.000.

Send: "o3 coef"
Receive: "o3 coef 1.000"

set o3 coef *d.ddd*

This command sets the O_3 coefficient to a user-defined value. The example below sets the O_3 coefficient to 1.005.

Send: "set o3 coef 1.005"
Receive: "set o3 coef 1.005 ok"

temp comp

This reports whether temperature compensation is on or off. The example below shows a typical response to this command.

Send: "temp comp"
Receive: "temp comp off"

set temp comp on
set temp comp off

This command turns the temperature compensation on and off. The example below turns temperature compensation off.

Send: "set temp comp off"
Receive: "set temp comp off ok"

pres comp

This 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 on
set pres comp off

These commands turn the pressure compensation on and off. The example below turns pressure compensation off.

Send: "set pres comp off"
Receive: "set pres comp off ok"

---

time

This reports the current time (military 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

Sets the internal clock (military time). The example below sets the internal time to 2:15 pm. Note that if seconds are omitted, the seconds default to 00.

Send: "set time 14:15"
Receive: "set time 14:15 ok"

---

date

This reports the current date. The example reports the date as December 1, 1994.

Send: "date"
Receive: "date 12-01-94"

---

set date *mm-dd-yy*

mm = month
dd = day
yy = year

Sets the internal date. The example below sets the internal date to December 1, 1994.

Send: "set date 12-01-94"
Receive: "set date 12-01-94 ok"

---

bench temp

This reports the current bench temperature. The first temperature reading is the temperature being used in instrument calculations. The second temperature is the actual temperature being measured. If temperature compensation is on, then both temperature readings are the same. If temperature compensation is off, a temperature of 0EC is used as the default temperature even though the actual bench temperature is 32.3EC. The example below shows that temperature compensation is on and that the bench temperature is 32.3EC.

Send: "bench temp"
Receive: "bench temp 032.3 deg C, actual 032.3"

---

lamp temp

This reports the current bench lamp temperature. The example below reports that the current bench temperature is 55.2 ^{o}C.

Send: "lamp temp"
Receive: "lamp temp 055.2 deg C"

---

cell a int
cell b int

These commands report the current lamp intensity. The example below reports that the lamp intensity in Cell A is 98,425 Hz.

Send: "cell a int"
Receive: "cell a int 98425 Hz"

lamp setting

This command reports the current photometer lamp setting. The example below reports that the lamp setting is 72.9%.

Send: "lamp setting"
Receive: "lamp setting 72.9%"

set lamp *ddd.d*

This command sets the photometer lamp setting. The example below sets the photometer lamp to 75.5%.

Send: "set lamp 75.0"
Receive: "set lamp 75.0 ok"

pres

This reports the current reaction chamber pressure. The first pressure reading is the pressure reading being used in instrument calculations. The second pressure is the actual pressure reading being measured. If pressure compensation is on, then both pressure readings are the same. If pressure compensation is off, a pressure of 760 mm Hg is used as the default pressure even though the actual pressure is 753.4 mm Hg. The example below shows that actual reaction chamber pressure is 753.4 mm Hg.

Send: "pres"
Receive: "pres 760.0 mm Hg, actual 753.4"

flow a
flow b

These commands report the sample flow in Cell A and Cell B. The example below reports that the current sample flow in Cell A is 0.608 liters/minute.

Send: "flow a"
Receive: "flow a 0.608 l/m"

dtoa *d*

d = DTOA in table below

This reports the outputs of the 7 Digital to Analog converters (0000 = 0.0% FS, 1000 = 100.0% fullscale). The example below shows that the D/A for the O_3 voltage Out is 97.7% fullscale.

Send: "dtoa 1"
Receive: "dtoa 1 0977"

DTOA	Function
1	O_3 Voltage Output
2	O_3 Voltage Output
3	O_3 Lamp Output Voltage
4	Photometer Lamp Output Voltage
5	O_3 Current Output
6	O_3 Current Output
7	Not Used

option switches

This reports the status (on/off) of the 8 option switches. For example, a return of 11100000, means that option switches 1, 2, and 3 are on and the others are off (see Internal Option Switches in Chapter 3 Operation, for more information about option switches). The example below shows that option switches 1, 2, and 3 are on.

Send: "option switches"
Receive: "option switches 11100000"

program no

This reports the calibrator's program number and the Link (communications) program number. The example below shows that the installed processor program is 49 00000100 and the installed communication program (link) is 49L 00000100.

Send: "program no"
Receive: "program no processor 49 PS0001 00 link 49L PS0001 00"

set save params

This command stores parameters in the EEPROM. 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 EEPROM.

Send: "set save params"
Receive: "set save params ok"

screen

This reports the information currently being displayed on the instrument's front panel display. The example below shows a typical response to this command.

Send: "screen"
Receive: "
O3 PPB 600
SET TO 600
89 14:25 REMOTE"

bright

This command reports the current screen brightness setting. The example below reports that screen brightness is set to 100%.

Send: "bright"
Receive: "bright 100%"

set bright *d*

d = Code in table below

This command sets the screen brightness. The example below sets the screen brightness to 50%.

Send: "set bright 1"
Receive: "set bright 1 ok"

Code	brightness %
0	25
1	50
2	75
3	100

battery

This command reports the voltage of the battery on the C-Link Board. The example below reports the battery voltage of 2.9 volts.

Send: "battery"
Receive: "battery 2.9 volts"

o3 lamp temp

This reports the current ozonator lamp temperature. The example below reports that the current ozonator lamp temperature is 69.2 ^{o}C.

Send: "o3 lamp temp"
Receive: "o3 lamp temp 069.2 deg C"

resp coef

This command reports the current ozone response coefficient. The example below reports that the ozone response coefficient is 1.000".

Send: "resp coef"
Receive: "resp coef 1.000"

set resp coef *d.ddd*

This command sets the ozone response coefficient. The example below sets the ozone response coefficient to 1.500"

Send: "set resp coef 1.500"
Receive: "set resp coef 1.500 ok"

button

button = | run | menu | enter | help | up | down | left | right |

This command is used to simulate pressing the Model 49C Primary Standard front panel pushbuttons. In the example below, this command is used in conjunction with the screen command to view the Main Menu. Note that the instrument is in the Run screen initially.

Send: "menu"
Receive: "menu ok"

Send: "screen
Receive: MAIN MENU: 10:25
>RANGE
AVERAGING TIME
CALIBRATION FACTORS"

format

This command reports the current reply termination format as shown below:

Send: "format"
Receive: "format 00"

Code	Reply Termination
00	<CR>
01	0x80 xxxx <CR>

where xxxx = the sum of all characters in the message

set format *dd*

dd = | 00 | 01 |

This command sets the reply termination format. The example below sets the reply termination format to checksum.

Send: "format 01"
Receive: "format 01 ok"
"sum 0570"

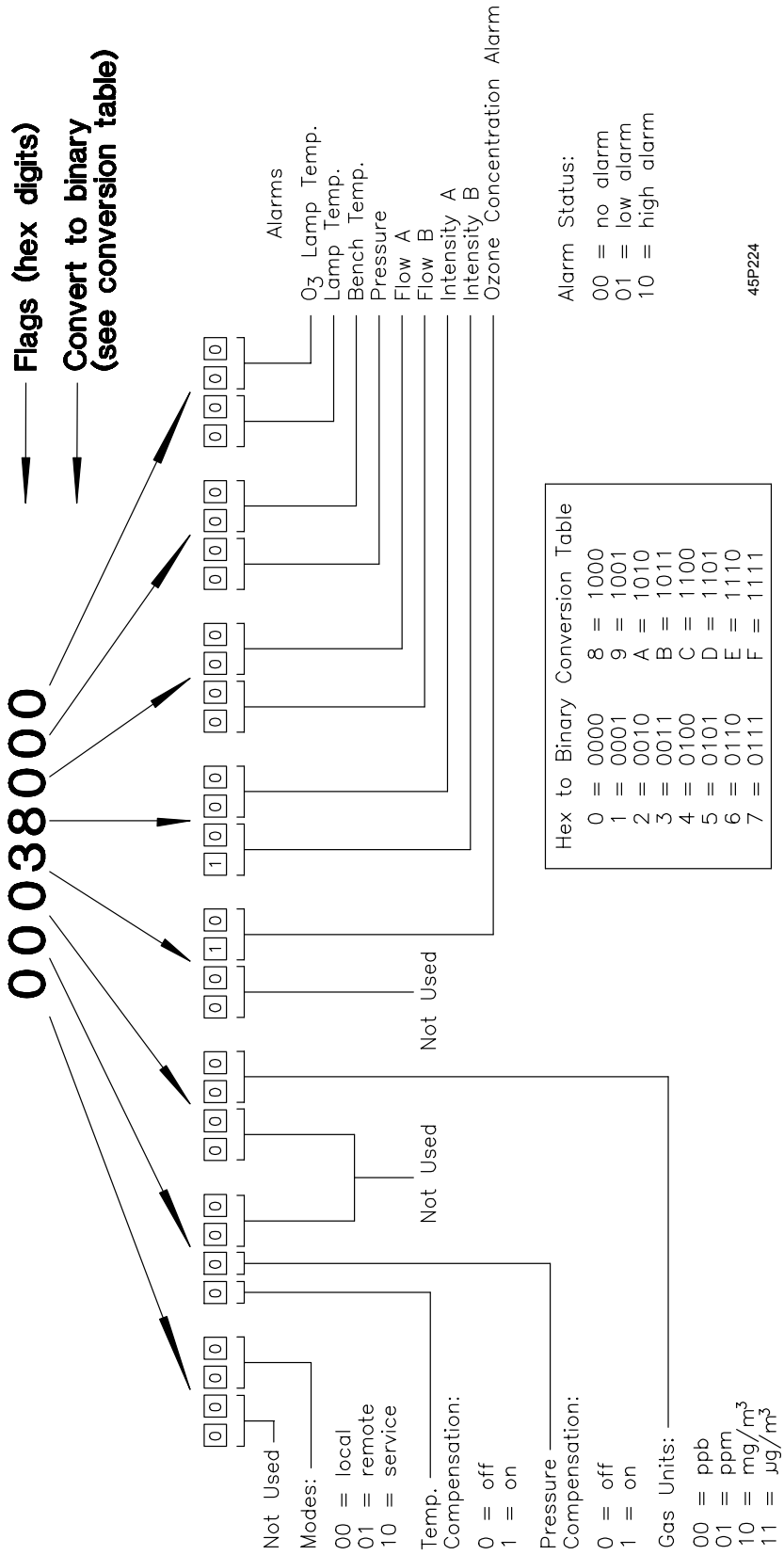
Code	Reply Termination
00	<CR>
01	<nl>sum xxxx<CR>

where xxxx = 4 hexadecimal digits that represent the sum of all the characters in the message

flags

This reports 8 hexadecimal digits (or flags) that represent the status of the calibrator. To decode the flags, each hexadecimal digit is converted to binary as shown in the figure below. The binary digits define the status of each parameter. In the example below, the instrument is reporting that the O_3 high concentration alarm is activated.

Send: "flags"
Receive: "flags 00038000"


Flags (hex digits)
Convert to binary (see conversion table)
0 0 0 3 8 0 0 0
Alarms
O3 Lamp Temp.
Lamp Temp.
Bench Temp.
Pressure
Flow A
Flow B
Intensity A
Intensity B
Ozone Concentration Alarm
Alarm Status:
00 = no alarm
01 = low alarm
10 = high alarm
Hex to Binary Conversion Table
0 = 0000 8 = 1000
1 = 0001 9 = 1001
2 = 0010 A = 1010
3 = 0011 B = 1011
4 = 0100 C = 1100
5 = 0101 D = 1101
6 = 0110 E = 1110
7 = 0111 F = 1111
Not Used
Not Used
Not Used
Modes:
00 = local
01 = remote
10 = service
Temp. Compensation:
0 = off
1 = on
Pressure Compensation:
0 = off
1 = on
Gas Units:
00 = ppb
01 = ppm
10 = mg/m3
11 = µg/m3
45P224

set lrec format *tt ff*
set srec format *tt xx*

tt = | 00 | 01 | 02 | 03 | 04 |
ff = | 00 | 01 | 02 | 03 |
xx = | 00 | 01|

There are two types of records that the internal data logger stores: long records and short records. Both records contain the time, date, O_3 average, and the instrument status flags. The O_3 average is taken over the logging interval. For example, if the long record (or lrec) logging time is set to 30 minutes, then the O_3 reading is the average O_3 reading during the last 30 minutes. In addition, the long record contains the following data: Cell A intensity, Cell B intensity, bench temperature, bench lamp temperature, flow A, flow B, and pressure readings. These readings are instantaneous measurements. The data logger can store about 1,800 long records and 4,000 short records.

The logging time for each record is defined as follows:

Time	Logging Time (minutes)
00	1
01	5
02	15
03	30
04	60

The records may be output several ways:

Reply	Output Format
00	Short reply (no temps, flows, etc.) with no text
01	Short reply (no temps, flows, etc.) with text
02	Long reply (temps, flows, etc.) with no text
03	Long reply (temps, flows, etc.) with text

The example below sets the lrec logging time to 5 minutes and the output format to long reply with text.

Send: "set lrec format 01 03"
Receive: "set lrec format 01 03 ok"

---

lrec *xxxx yy*
srec *xxxx yy*

xxxx = number of records back
yy = the number of records to return (0 to 10)

These commands output the contents of the data logger's records. If the lrec or srec command is issued without either of the *xxxx* or *yy* variables, only the last record stored will be returned. The output format and logging time are determined by the set lrec format and set srec format commands as described above. In the example below, the instrument reports the contents of 5 long records, starting with the 100th previous record. The logging time is set to 5 minutes and the text is being displayed.

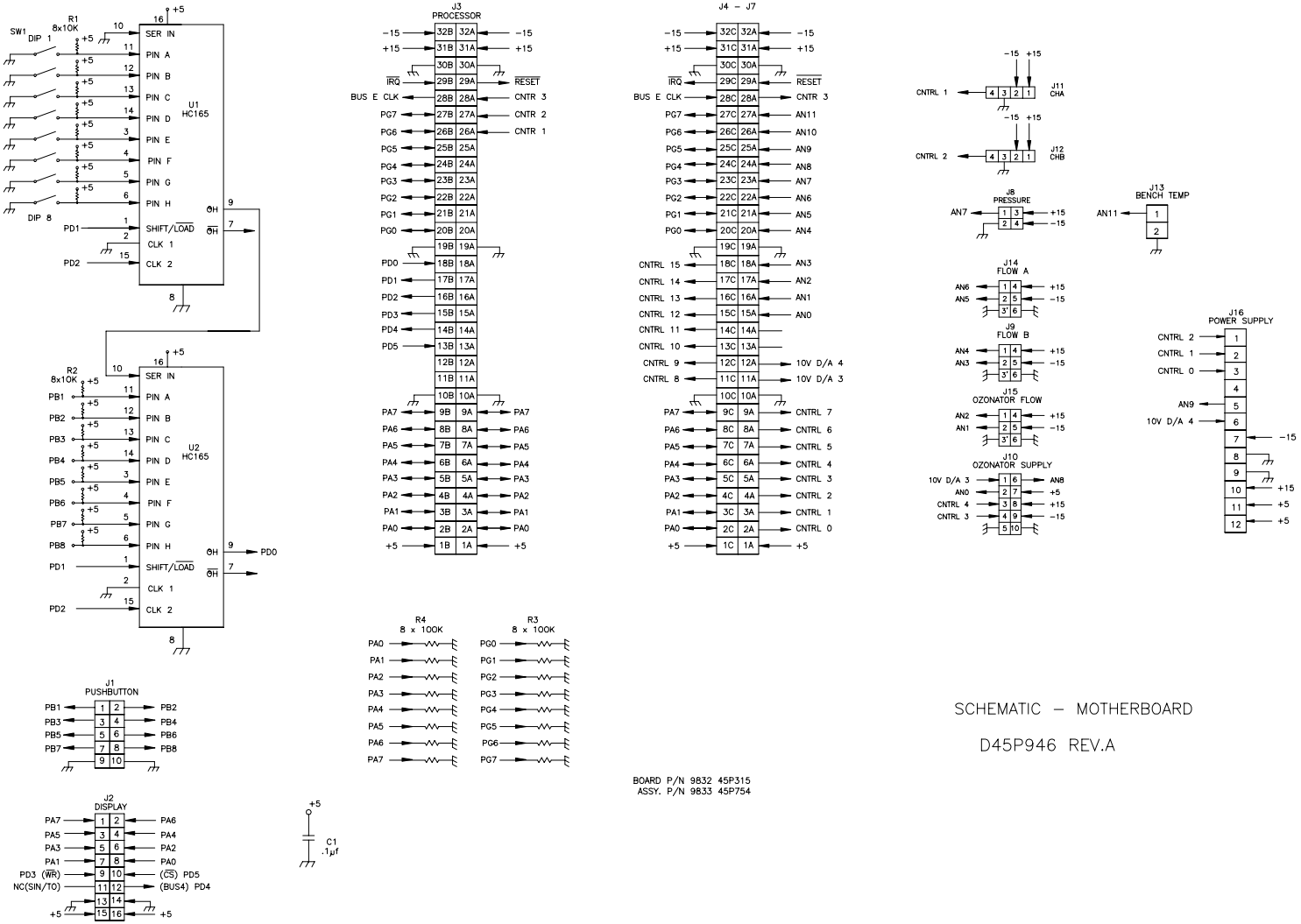
Send: "lrec 100 5"
Receive:

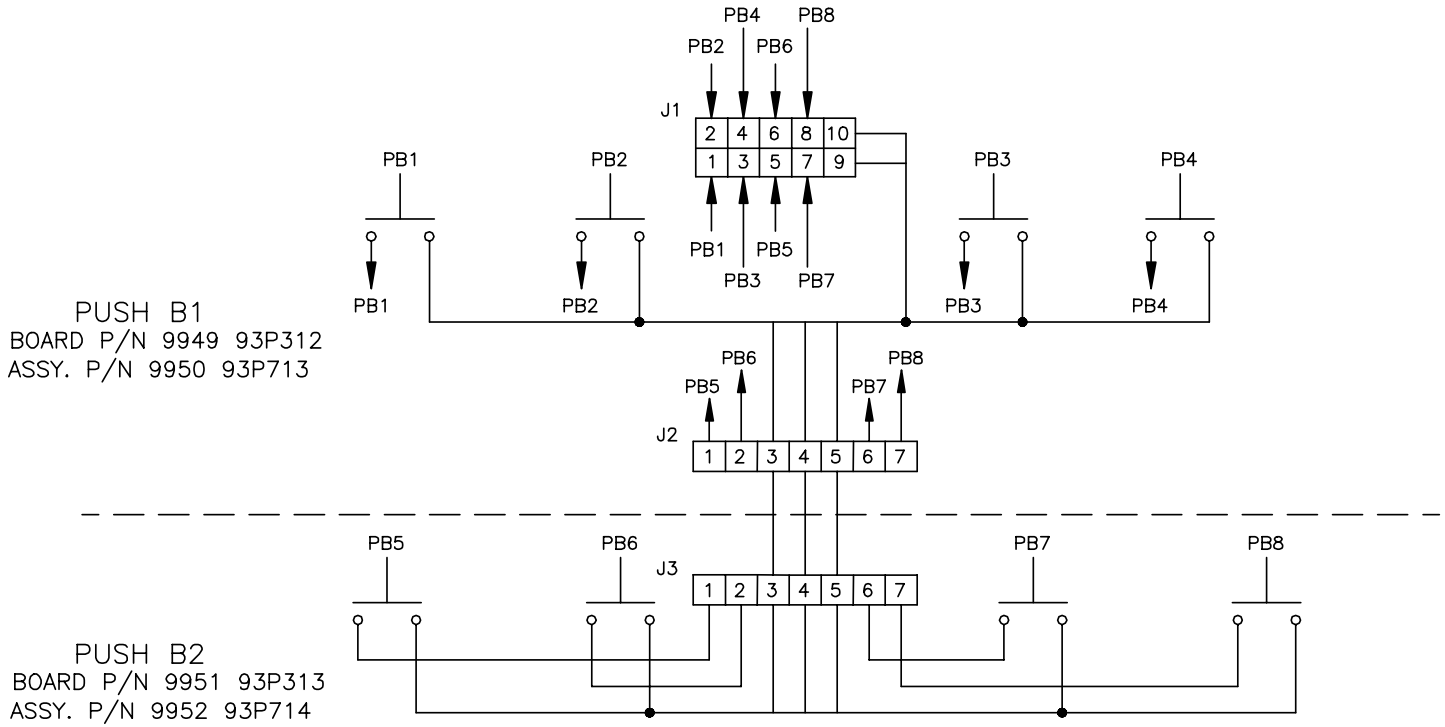
"10:15 10-28 o3 0561E+0 ppb flags 00000000 cella 99342 cellbi 98645 bencht 33.6 lmpt 57.6 o3lt 69.2 flowa 0.804 flowb 0.815 pres 759.9
10:20 10-28 o3 0560E+0 ppb flags 00000000 cella 99542 cellbi 98643 bencht 33.6 lmpt 57.6 o3lt 69.2 flowa 0.804 flowb 0.815 pres 759.9
10:25 10-28 o3 0561E+0 ppb flags 00000000 cella 99362 cellbi 98745 bencht 33.6 lmpt 57.6 o3lt 69.2 flowa 0.804 flowb 0.815 pres 759.9
10:30 10-28 o3 0561E+0 ppb flags 00000000 cella 99342 cellbi 98655 bencht 33.6 lmpt 57.6 o3lt 69.2 flowa 0.804 flowb 0.815 pres 759.9
10:35 10-28 o3 0560E+0 ppb flags 00000000 cella 99442 cellbi 98645 bencht 33.6 lmpt 57.6 o3lt 69.2 flowa 0.804 flowb 0.815 pres 759.9

where:
cellai = Cell A Intensity
cellbi = Cell B Intensity
bncht = Bench Temperature
lmpt = Lamp Temperature
o3lt = Ozonator Lamp Temperature
flowa = Flow A
flow b = Flow B
pres = Pressure0

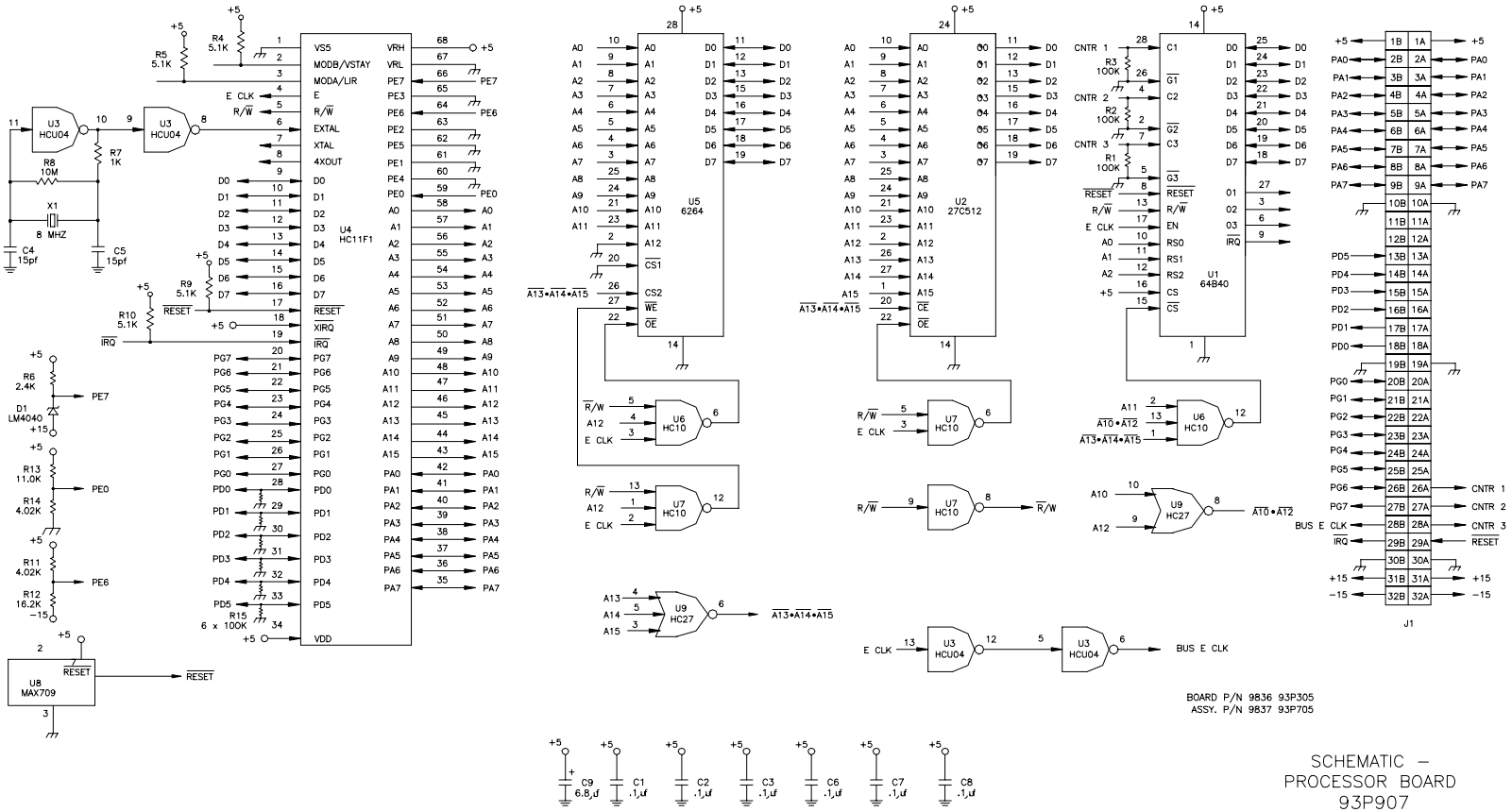
APPENDIX C
SCHEMATICS

This appendix contains the schematics for the standard and optional printed circuit boards contained in the Model 49C Primary Standard. Always turn off the instrument and unplug the power cord before removing any printed circuit board. For more information about appropriate safety precautions, see Chapter 6, "Servicing." A description of each board can be found in Chapter 7, "Theory of Operation."

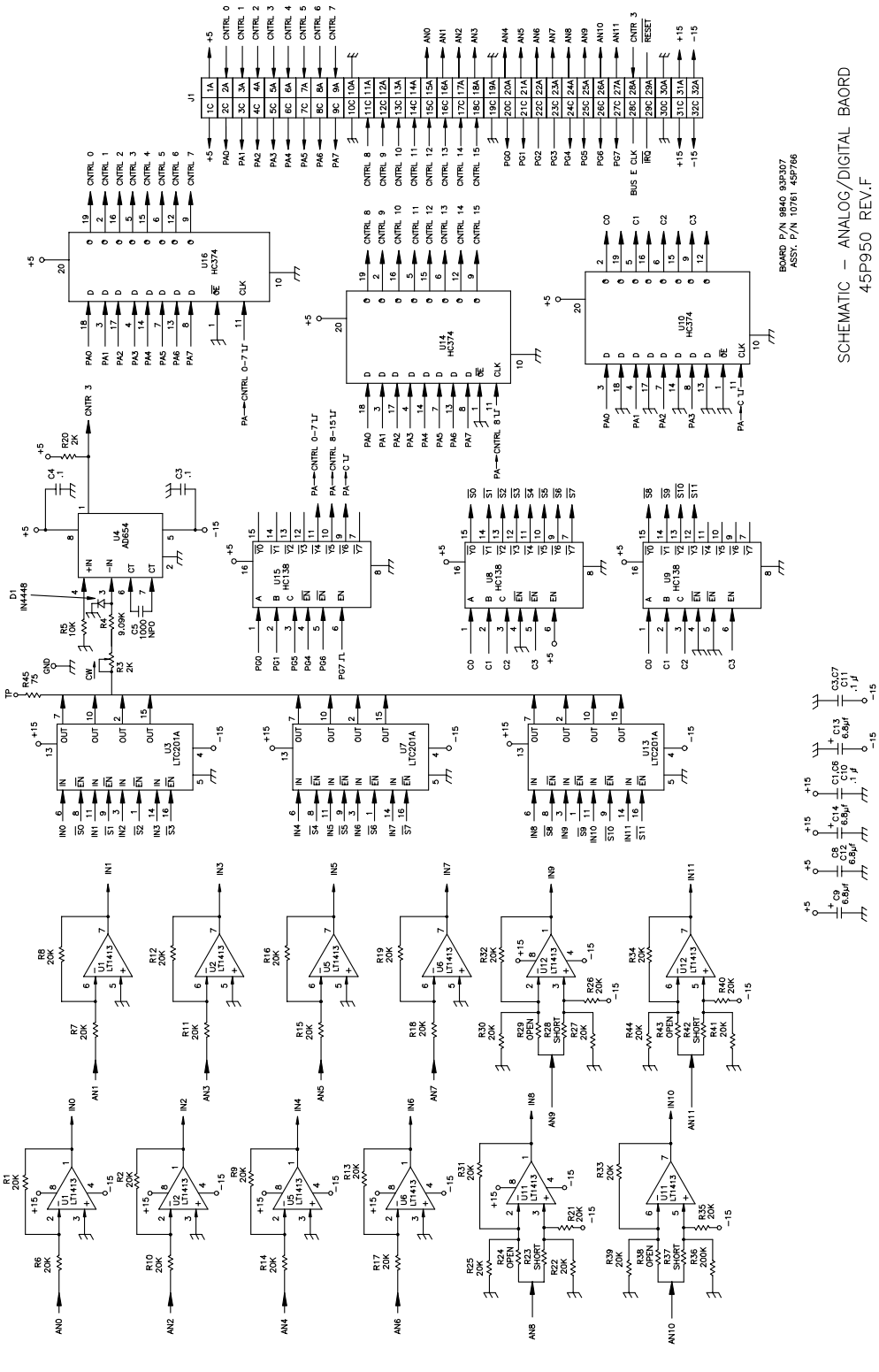

SCHEMATIC – MOTHERBOARD
D45P946 REV.A
BOARD P/N 9832 45P315
ASSY. P/N 9833 45P754
U1 HC165
U2 HC165
R1 8x10K
R2 8x10K
R3 8 x 100K
R4 8 x 100K
J1 PUSHBUTTON
J2 DISPLAY
J3 PROCESSOR
J4 – J7
J8 PRESSURE
J9 FLOW B
J10 OZONATOR SUPPLY
J11 CHA
J12 CHB
J13 BENCH TEMP
J14 FLOW A
J15 OZONATOR FLOW
J16 POWER SUPPLY
C1 .1µf
SER IN
PIN A
PIN B
PIN C
PIN D
PIN E
PIN F
PIN G
PIN H
SHIFT/LOAD
CLK 1
CLK 2
RESET
CNTR 3
CNTR 2
CNTR 1
AN11
AN10
AN9
AN8
AN7
AN6
AN5
AN4
AN3
AN2
AN1
AN0
CNTRL 15
CNTRL 14
CNTRL 13
CNTRL 12
CNTRL 11
CNTRL 10
CNTRL 9
CNTRL 8
CNTRL 7
CNTRL 6
CNTRL 5
CNTRL 4
CNTRL 3
CNTRL 2
CNTRL 1
CNTRL 0
10V D/A 4
10V D/A 3
+15
-15
+5

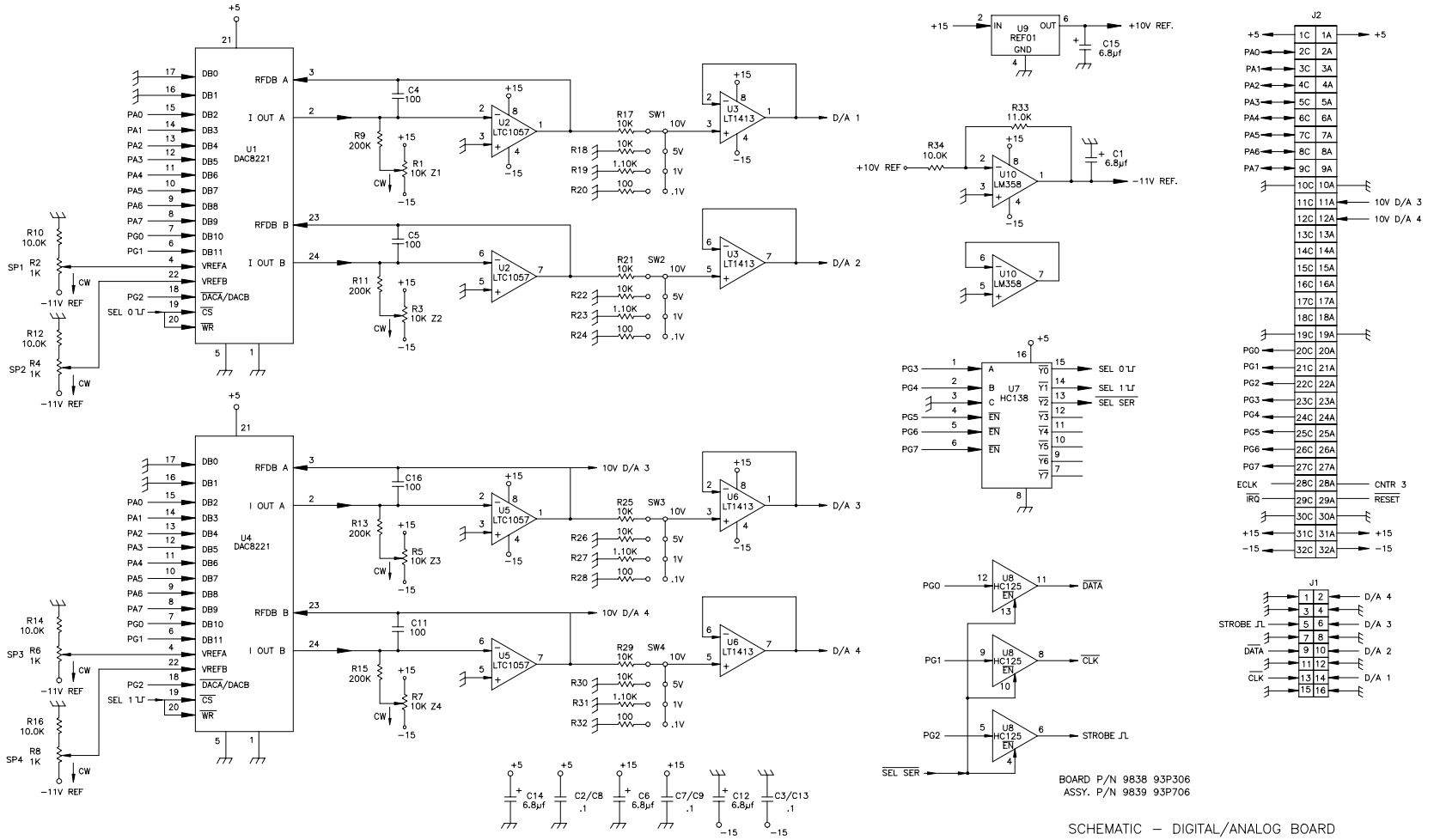


PUSHBUTTON B1 & B2
93P906



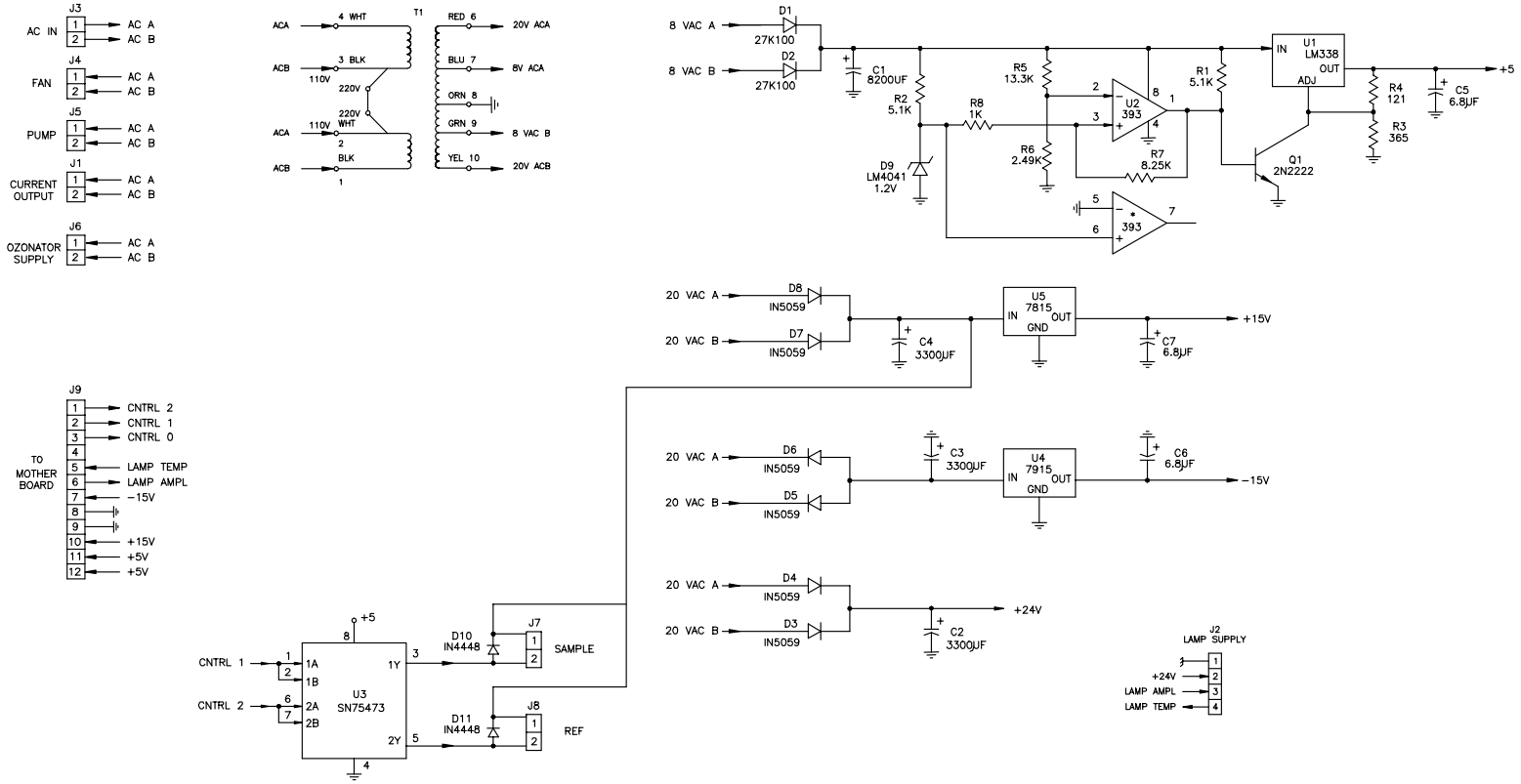
SCHEMATIC –
PROCESSOR BOARD
93P907


SCHEMATIC – ANALOG/DIGITAL BAORD
45P950 REV.F
BOARD P/N 9840 93P307
ASSY. P/N 10761 45P766



BOARD P/N 9838 93P306
ASSY. P/N 9839 93P706

SCHEMATIC – DIGITAL/ANALOG BOARD
93P908

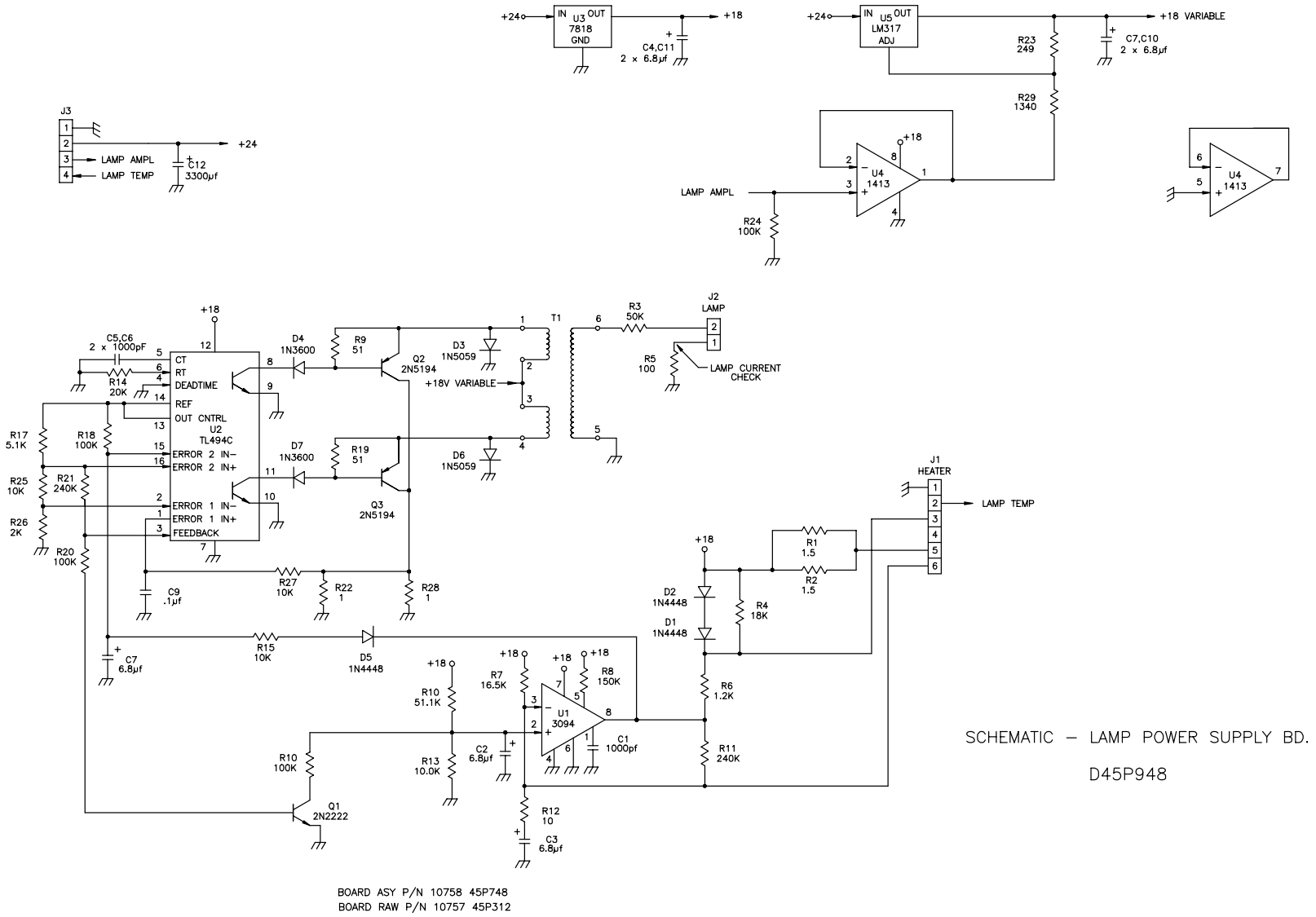


1. ALL RESISTORS 1/4W (UNLESS OTHERWISE SPECIFIED)

BOARD P/N 9846 45P314
ASSY. P/N 9847 45P753

SCHEMATIC – POWER SUPPLY BD.

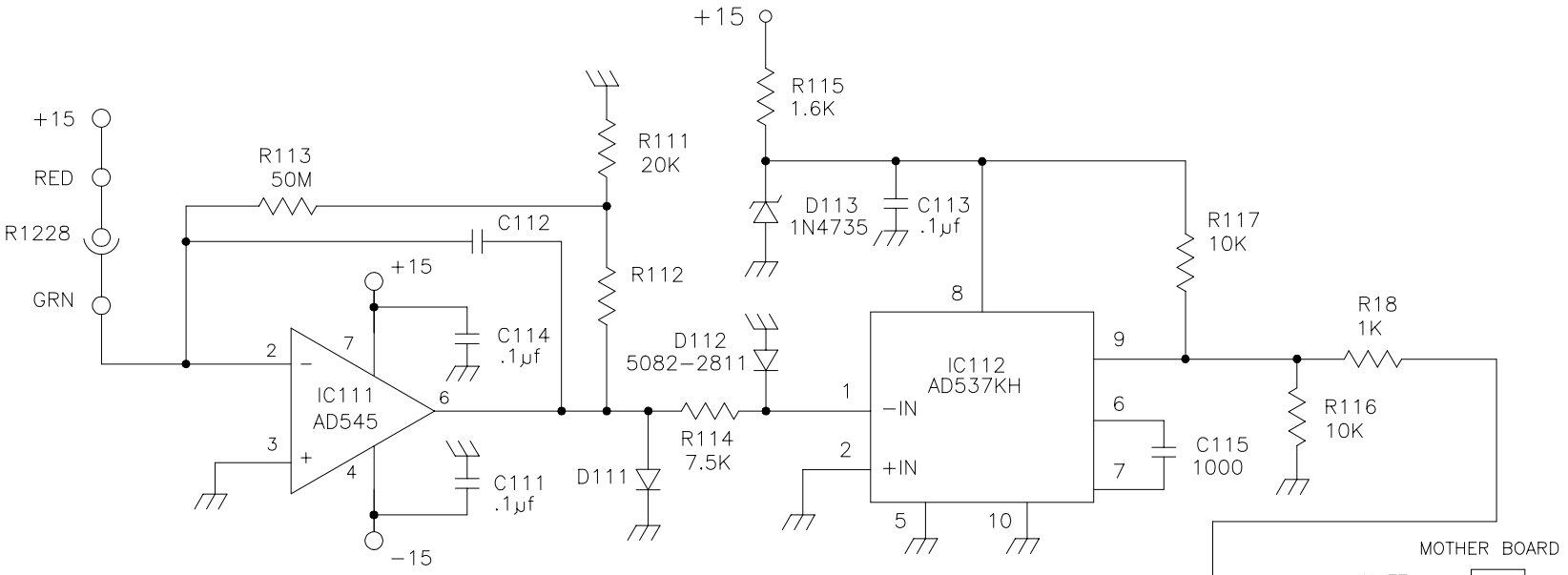
D45P947 REV.A



BOARD ASY P/N 10758 45P748
BOARD RAW P/N 10757 45P312

SCHEMATIC – LAMP POWER SUPPLY BD.

D45P948

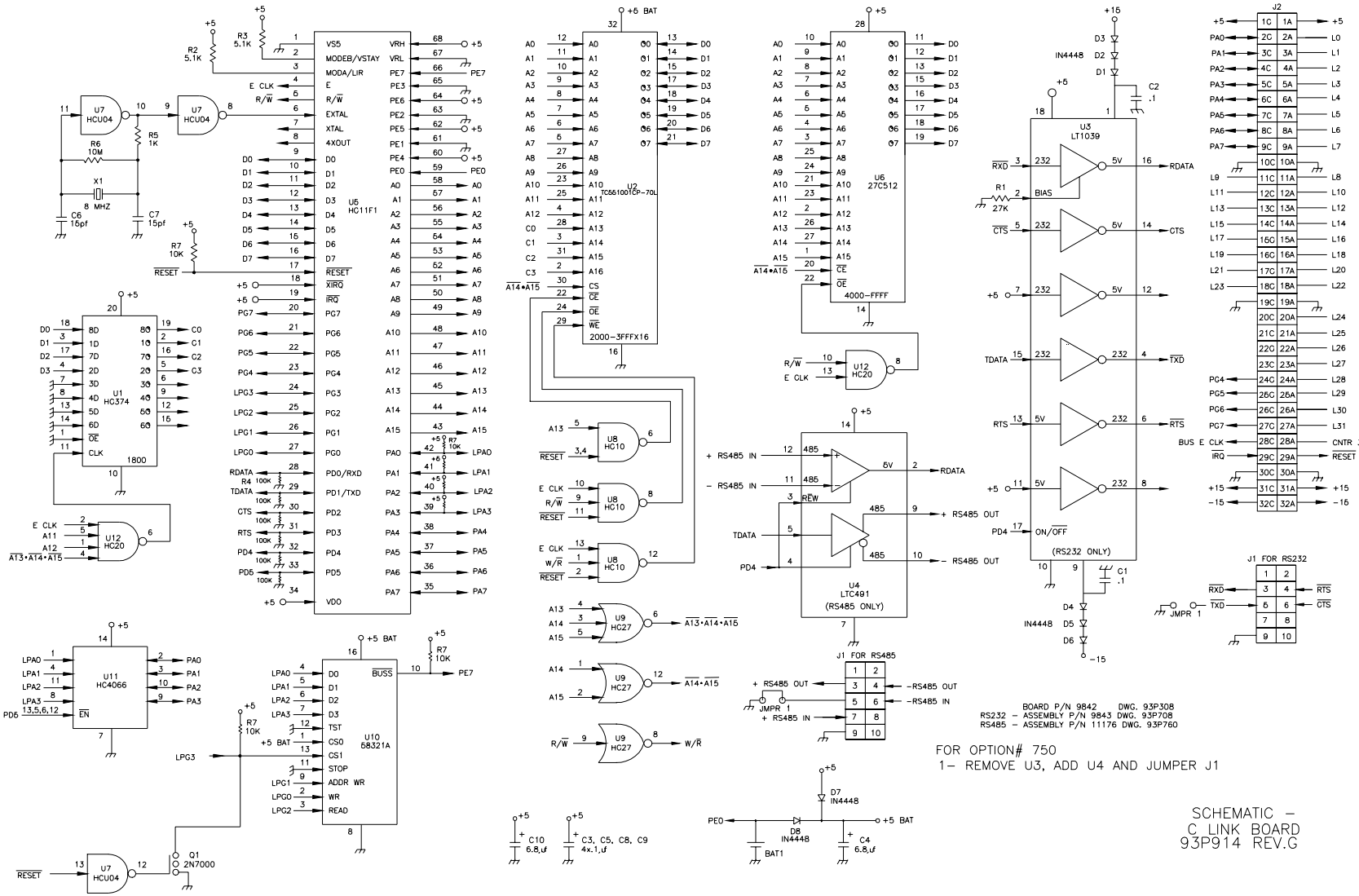


R1228 SENSITIVITY: R112:

≧ 20nA/µW	100Ω
19	1K
18	2.2K
17	3.6K
16	5.1K
15	6.8K
14	8.2K
13	11K
12	13K
11	16K
10	20K
9	24K

BOARD ASSY. P/N 8592
BOARD P/N 8635

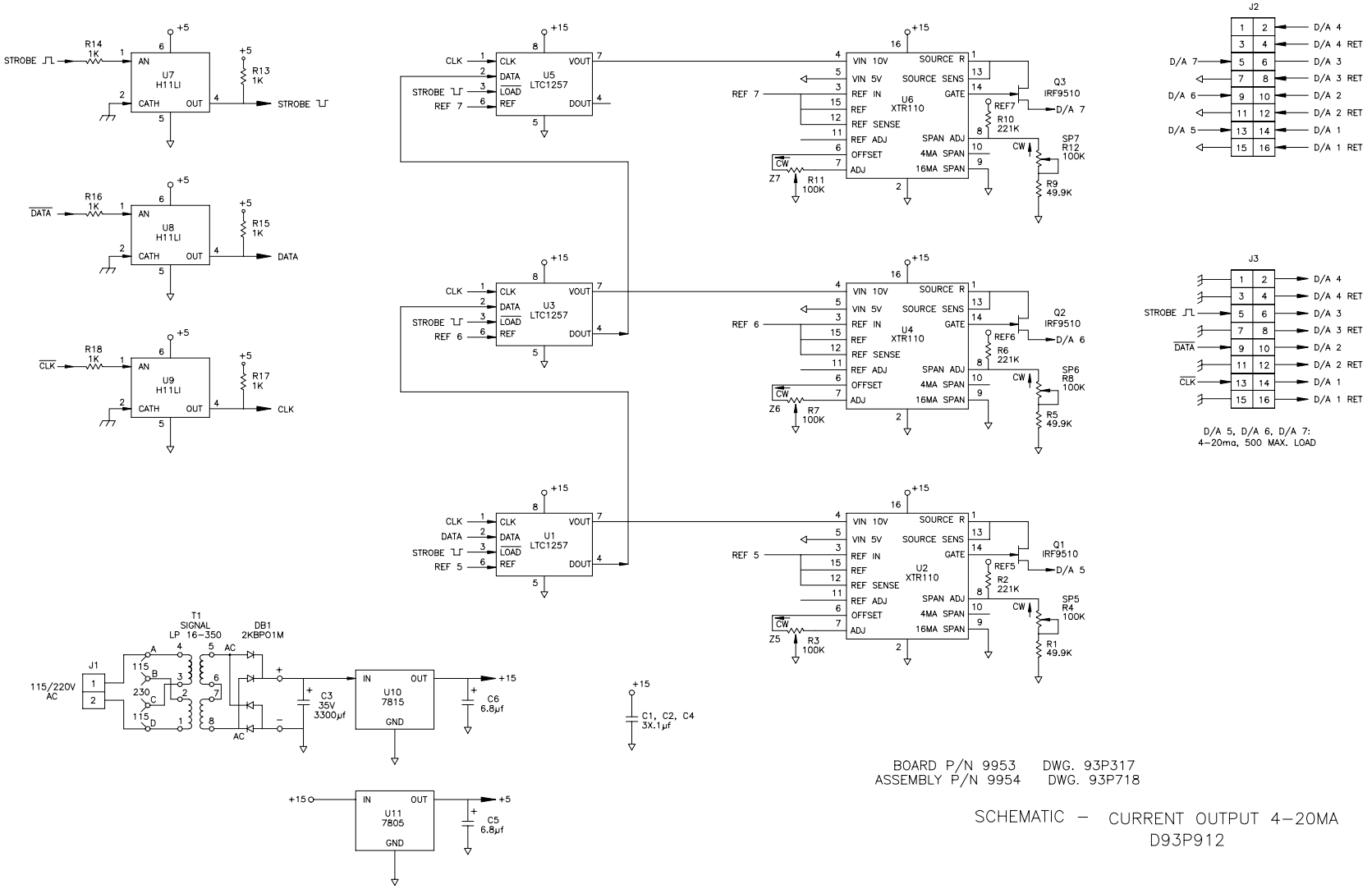
I/F DETECTOR SYSTEM SCHEMATIC (49−11)
B45P911 REV.A



FOR OPTION# 750
1- REMOVE U3, ADD U4 AND JUMPER J1

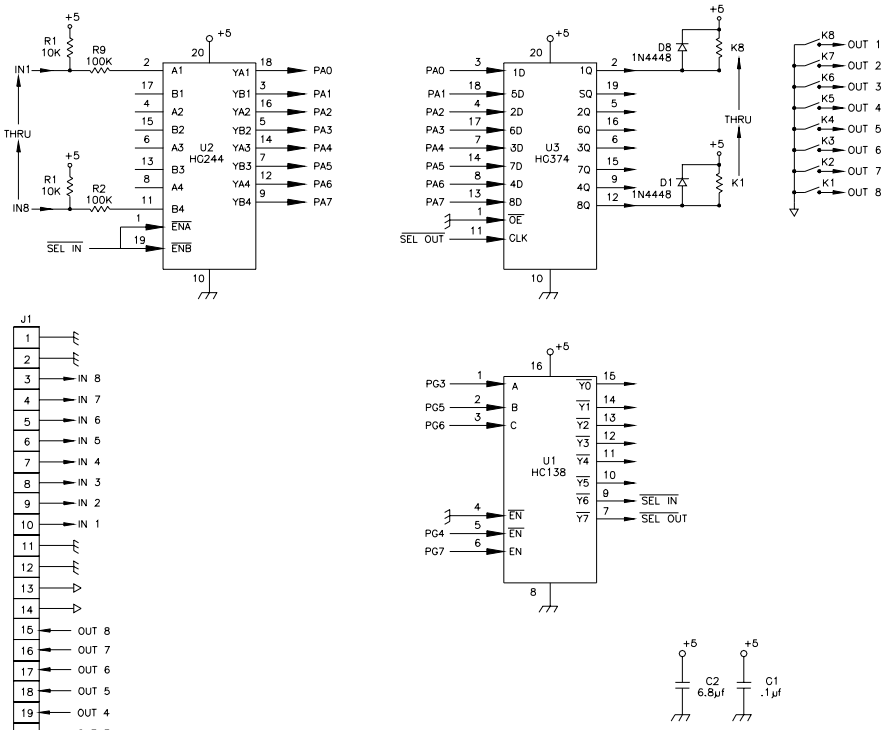
BOARD P/N 9842 DWG. 93P308
RS232 - ASSEMBLY P/N 9843 DWG. 93P708
RS485 - ASSEMBLY P/N 11176 DWG. 93P760

SCHEMATIC -
C LINK BOARD
93P914 REV.G

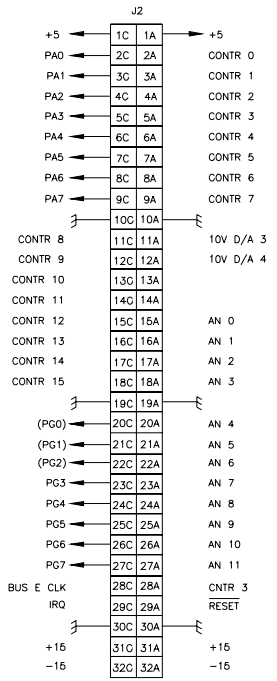


BOARD P/N 9953 DWG. 93P317
ASSEMBLY P/N 9954 DWG. 93P718

SCHEMATIC – CURRENT OUTPUT 4–20MA
D93P912

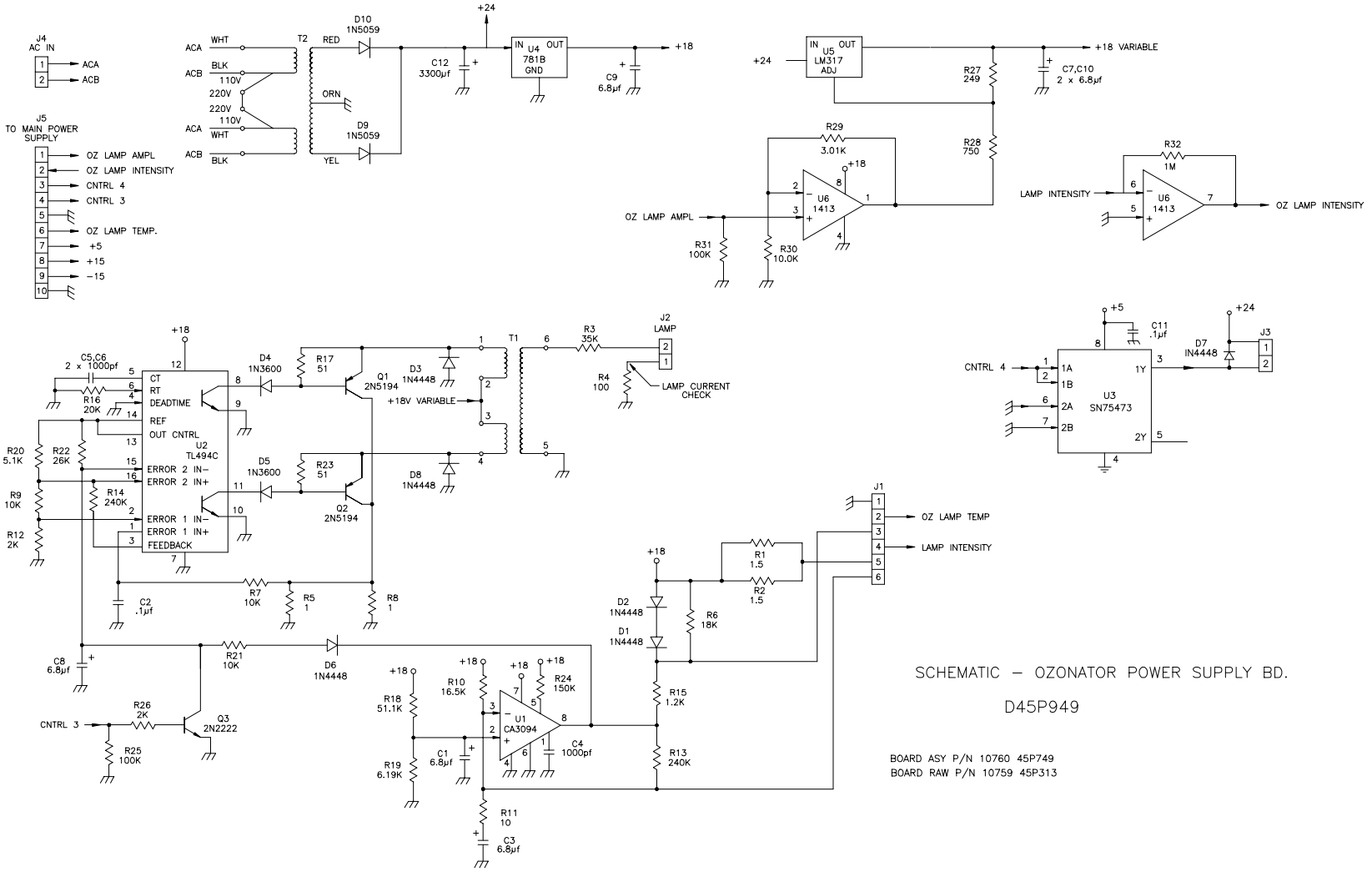


NOTE: SYSTEM GROUND ⏚
SIGNAL GROUND ⏚



BOARD RAW P/N 9955 93P318
BOARD ASY P/N 9956 93P719

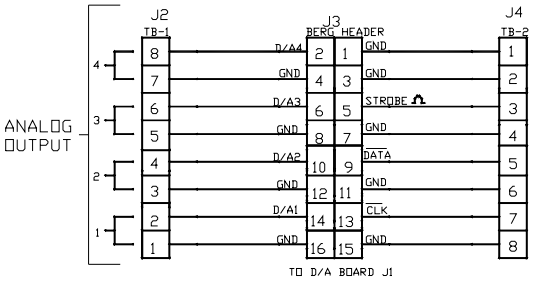
SCHEMATIC –
INPUT/OUTPUT
BOARD
93P913 REV. C

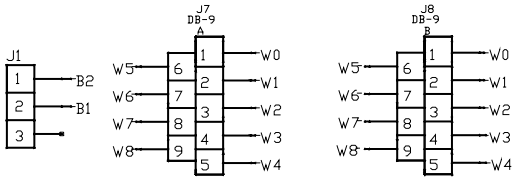


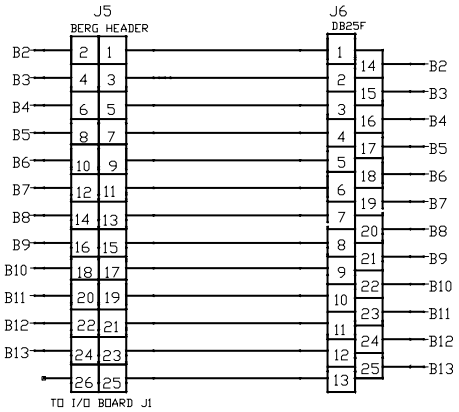
SCHEMATIC – OZONATOR POWER SUPPLY BD.

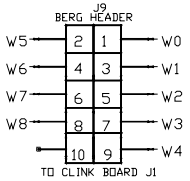
D45P949

BOARD ASY P/N 10760 45P749
BOARD RAW P/N 10759 45P313









DB25	J5	FUNCTION
1	1	GROUND
2	3	IN #8
3	5	IN #6
4	7	IN #4
5	9	IN #2
6	11	GROUND
7	13	SIG GND
8	15	OUT #8
9	17	OUT #6
10	19	OUT #4
11	21	OUT #2
12	23	SIG GND
13	25	N/U
14	2	GROUND
15	4	IN #7
16	6	IN #5
17	8	IN #3
18	10	IN #1
19	12	GROUND
20	14	SIG GND
21	16	OUT #7
22	18	OUT #5
23	20	OUT #5
24	22	OUT #1
25	24	SIG GND
*	26	N/U

P/N 9903 DWG 93P319
ASY 9904 DWG 93P738

REAR CONNECTOR INTERFACE BOARD 93P915 REV.E

APPENDIX D

PUMP MAINTENANCE

Thermo Environmental Instruments

8 West Forge Parkway
Franklin, MA 02038
(508) 520-0430
Fax: (508) 520-1460
Telex: 200205 THEMO UR

Operating and Maintenance Instructions

Diaphragm Vacuum Pump Models: 8550, 8551, 8706

Operating Instructions

Note: The following guidelines should be observed to promote safe and reliable operation of your TEI pump.

1. TEI units are all 100% oil-free. No maintenance at all is necessary for the bearings and NO lubrication should be done. All bearings are sealed and permanently lubricated. For repair service, call TEI Customer Service.
2. Be sure that the available electric power matches specifications marked on the motor. Serious damage may occur to the motor if connected to an improper voltage. All TEI units should be grounded using the provided brass screw. In the event of an electrical short circuit, grounding reduces the risk of electric shock by providing an escape wire for the electric current.
3. The pump should be placed where the surrounding temperature remains between 40°F and 104°F (5°C and 41°C). This is particularly important when the unit is installed in a confined space where heat may build up during operation.
4. Standard models are designed to *start against atmospheric pressure only, not under load (Pressure or vacuum).* Care must be taken to eliminate load when pump is turned off for any reason.
5. Use this pump only to pump air or gas, not liquids or particulates. *Damage to the pump or loss of performance can occur if liquids or particulates enter the system.* In the event that corrosive gases are to be pumped, be certain that a corrosion-resistant model is used. *The life of the pump can be prolonged if the formation of condensate within the pump is avoided.*
6. Always install the pump in such a location that it is protected from direct (or indirect) moisture contact.
7. Avoid operating the pump in very dusty conditions. If this cannot be prevented, then be sure to install an inlet filter and inspect and change it frequently.
8. If flow is throttled or restricted for any reason, care must be taken to avoid exceeding the maximum continuous operating design pressure of the unit.
9. Be sure that the pump is installed at the highest point within the system to prevent possible condensate from entering the unit.
10. Please remove any protective plastic plugs supplied in the intake or outlet ports of your pump prior to applying power to the motor.

Troubleshooting

WARNING! AC motors are thermally protected and will automatically restart unexpectedly when the overload device resets. Don't pump flammable or explosive gases or operate this pump in an atmosphere containing flammable or explosive gases.

Your TEI Pump should perform to specifications for years if the simple operating instructions and precautions are observed .

If you experience a problem and suspect the pump, try these simple checks prior to calling for assistance:

1. Check that all system interconnections are gas-tight.
2. Remove the head assembly as described in "Changing the Diaphragm and Valves". Look for any foreign matter; usually bits of Teflon® tape or particulates carried into the valving system or crystallized material from previously pumped vapors. All of the above must be cleared out and the pump reassembled with clean parts.
3. If pitting of the pump parts or tearing of the diaphragm is observed, it is possible that the gas/vapor being pumped is capable of attacking the wetted parts of the pump.

Chemical resistance charts should be consulted if you are in doubt. Generally, replacing the diaphragm and valves will restore the pump to operating specifications if the valve plate is not pitted in the valve seat area.

Limited Warranty

THERMO ENVIRONMENTAL INSTRUMENTS, INC. (TEI) warrants to buyer that its products will be free from defects in material and workmanship under normal and appropriate use, and agrees to repair or replace any of its products without charge for parts or labor within one year from the date of shipment to the original purchaser.

Products to be evaluated for warranty coverage:

Determination of coverage under this warranty is the sole responsibility of the manufacturing engineering representative of TEI. This determination will frequently require the return of the product to TEI. All product returns will be handled in accordance with TEI's product return policy. TEI reserves the right to inspect custom installations and devices that use TEI products as part of the warranty evaluation process. This warranty does not cover any misuse, negligence, deterioration by chemical action, unauthorized repair or alteration in any way, inappropriate handling or storage that in our judgement caused the product failure. TEI shall not be liable for any inconvenience, loss of use, or any consequential loss, damage or injury arising from any cause whatsoever. No employee, agent or representative of TEI shall have any right or authority to vary or alter the terms of this warranty. This warranty gives you specific legal rights, and you may have other rights which vary from state to state.

Important Note

TEI offers engineering and technical assistance to support the application and selection of our products. We strongly suggest that you ensure that the product you have purchased from us is suitable for the use that you intend; we cannot be responsible for any problems or inconveniences that result from the incorrect application or use of our products. If you provide enough information to us, we will work with you to optimize the performance of our products in your application.

Please call our Technical Sales Department for further information.

Return Requests / Inquiries

Direct all warranty and repair requests to TEI Customer Service Department for instructions before returning any unit for repair or evaluation. We will fax you a "Return Instruction Sheet" for guidance on the proper marking, packing and documentation requirements.

Important information conforming to the "Right To Know" act, such as a Material Safety Data Sheet may be required.

Products shipped to TEI must have a Return Materials Authorization Number (RMA) file number marked on the outside of the package, otherwise they will be refused by our receiving department.

Spare Parts Kits

For TEI Pump 8550
115V/60Hz
Kit Part Number: 8606

For TEI Pump 8551
220/240V/50/60Hz
Kit Part Number: 8606

For TEI Pump 8706
110V/50-60Hz 220V/50-60Hz
Kit Part Number: 8606

Changing the Diaphragm and Valve Plate

During normal use, the diaphragm and valve plate are the only parts of the pump that need to be replaced. Changing them is a simple process when the following steps are taken.

If you run into a problem or have a question regarding the following procedure, please call the TEI Service Department for assistance.

Materials/Tools needed:
The proper replacement kit(s)
Marking Pencil
Slotted-head screwdriver

1. Disconnect the pump from electrical power.

2. Mark the relative positions of the head plate **A** intermediate plate **B** and crankcase housing **C** with a line using a marker for ease of reassembly later.

3. Undo the 4 slotted-head cap screws **D** and lift off the head plate **A,** valve plate **E** and intermediate plate **B**.

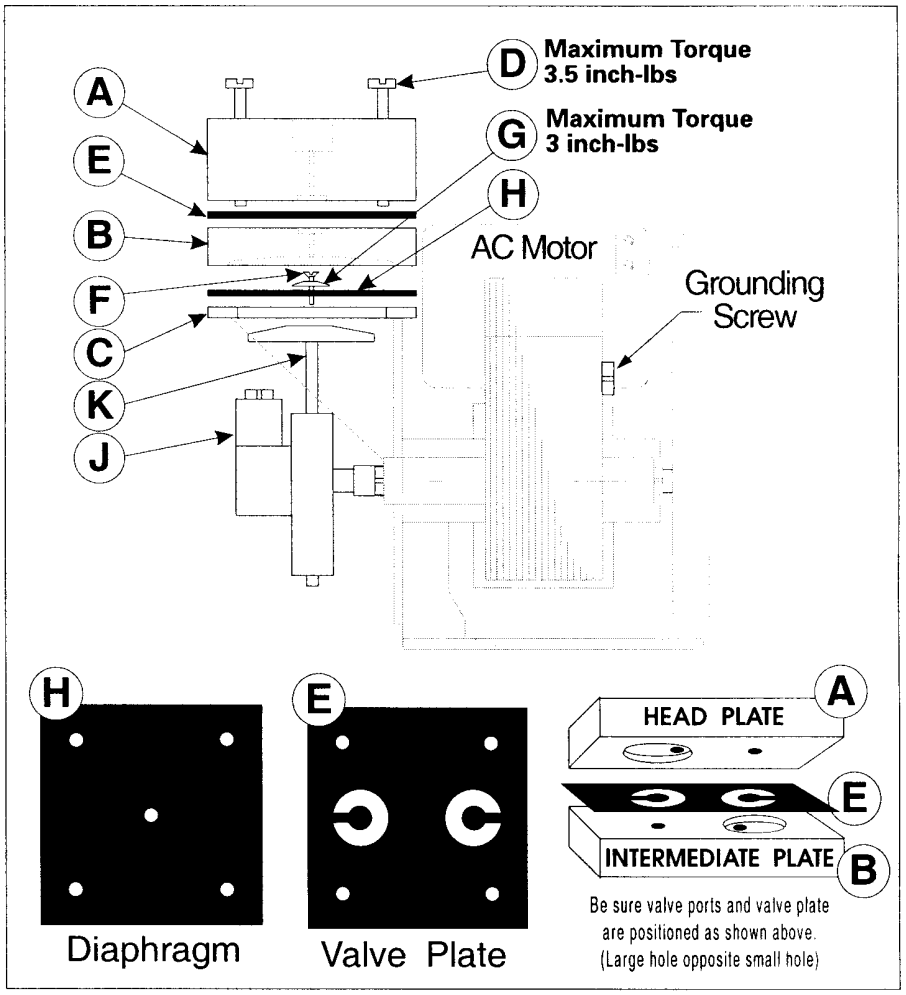
4. Lightly clean the valve seat area of the head plate **A** and intermediate plate **B** of any debris or deposits with fine steel wool. This area must be clean and smooth, without pits or scratches.

5. Loosen the countersunk clamping disc screw **F** and remove the clamping disc **G**, and the diaphragm **H**.

6. Turn the counterweight **J** until the connecting rod **K** is at mid-stroke, and place the new diaphragm **H** (Teflon (white) side up on AT or ST models) on the housing **C,** lining it up with the screw holes.

7. Place the clamping disc **G** (bevel side up).on top of the new diaphragm **H**. Tighten the assembly using the countersunk clamping disc screw **F** to a maximum torque of 3 inch-lbs. **DO NOT OVERTIGHTEN!**

8. Place the intermediate plate **B** over the diaphragm, lining up the marks made previously in step 2.



9. Place the valve plate **E** on top of the intermediate plate **B**, orienting the valve flaps with the holes. There is no top or bottom of the valve plate.

10. Place the head plate **A** on top of the valve plate **E**, lining it up with the markings you made in step 2. Note orientation of the valve ports in the diagram

11. Be sure that all components are centered, then tighten the 4 slotted-head cap screws **C** uniformly to a maximum torque of 3.5 inch-lbs. in a criss-cross pattern. **DO NOT OVERTIGHTEN!**

12. Check that the pump runs freely by turning the counterweight **J** by hand. Check all mechanical and electrical connections for tightness.

13. Apply power to the pump. Listen for a possible "knocking sound." If it is present, equally loosen the four head screws slightly until the sound just disappears. This step is to be sure that the clamping disc does not touch the intermediate plate during operation.

Please Note:
Excessive tightening of the clamping disc screw and the four head screws will cause premature wear on the diaphragm and bearings and must be avoided. Observe stated torque specifications.

For service or parts CONTACT:

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Fax: (508) 520-1460
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