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The Measurable Difference

PCA 2

Portable Combustion Analyzer

Instruction 24-9448
Operation & Maintenance

Rev. 1 - October 2006

Product Leadership • Training • Service • Reliability

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Contents

Notes:

1 Introduction

1.1 PCA 2 General Description

The PCA 2 is a commercial-grade hand-held combustion and emissions analyzer designed for on-demand sampling of light industrial, institutional, commercial and residential furnaces, appliances, and boilers. The basic instrument is supplied with a probe and hose assembly, instruction manual, factory calibrated smart sensors, 4 'AA' alkaline batteries, Data Download Software with USB cable and carrying case.

Because of the PCA 2's ability to measure up to four gases simultaneously, it is the perfect tool for service technicians, inspectors and boiler contractors who need to determine combustion efficiency, excess air, stack gas O_2 and CO levels, stack temperature, draft, and differential pressure. The analyzer can also directly measure and display NO, NO_2 and SO_2 with the installation of the appropriate sensors. Combustion efficiency calculations can be conducted for the following fuels: natural gas, oil #2, oil #4, oil #6, propane, coal, wood, kerosene, bagasse, and digester gas. A large backlit graphical display shows up to eight combustion test values simultaneously, and includes a zoom capability that provides an extra large display of just the O_2, CO, and combustion efficiency values.

Smart sensor technology allows a new sensor to be installed in the field without having to calibrate the analyzer before use. New and innovative probe and analyzer designs allow the PCA 2 to be easily serviced, thus lowering the cost of ownership.

Advanced data storage and communication features allow the operator to store up to 500 individual combustion test records, which can later be recalled for viewing, printing, or downloading to a personal computer. In its data logging mode, the analyzer can store an additional 500 data logged records.

An optional AC power adapter allows the analyzer to run continuously for data logging purposes.

The optional sample conditioning probe is recommended when measuring NO_2 and SO_2 to ensure the highest degree of measurement accuracy.

1.2 Sales Combo & Model Configurations

Sales Combo	24-8350	24-8351	24-8352
Sales Combo (Kit)	24-8370	24-8371	24-8372
Model Type	225	235	245
PCA2 Only Part Number	24-7301	24-7302	24-7303
Measurements			
Oxygen (O_2)	✓	✓	✓
Stack Temperature	✓	✓	✓
Primary / Ambient Air Temperature	✓	✓	✓
Carbon Monoxide Low (CO_{Low})	✓	✓	✓
Pressure / Draft	✓	✓	✓
Carbon Monoxide High (CO_{High})			✓
Nitric Oxide (NO)		✓	
Nitrogen Dioxide (NO_2)			
Sulfur Dioxide (SO_2)			
Calculations			
Combustion Efficiency	✓	✓	✓
Excess Air	✓	✓	✓
Carbon Dioxide (CO_2)	✓	✓	✓
NOx (NOx = NO + NO_2)			
NOx referenced to $\%O_2$			
CO referenced to $\%O_2$	✓	✓	✓
NO referenced to $\%O_2$		✓	
NO_2 referenced to $\%O_2$			
SO_2 referenced to $\%O_2$			

Refer to Section 8.2 for a listing of standard and optional accessories.

Sales Combo	24-8353	24-8354	24-8355
Sales Combo (Kit)	24-8373	24-8374	24-8375
Model Type	255	265	275
PCA2 Only Part Number	24-7304	24-7305	24-7306
Measurements			
Oxygen (O_2)	✓	✓	✓
Stack Temperature	✓	✓	✓
Primary / Ambient Air Temperature	✓	✓	✓
Carbon Monoxide Low (CO_{Low})	✓	✓	✓
Pressure / Draft	✓	✓	✓
Carbon Monoxide High (CO_{High})			
Nitric Oxide (NO)		✓	✓
Nitrogen Dioxide (NO_2)		✓	
Sulfur Dioxide (SO_2)	✓		✓
Calculations			
Combustion Efficiency	✓	✓	✓
Excess Air	✓	✓	✓
Carbon Dioxide (CO_2)	✓	✓	✓
NOx ($NOx = NO + NO_2$)		✓	
NOx referenced to $\%O_2$		✓	
CO referenced to $\%O_2$	✓	✓	✓
NO referenced to $\%O_2$		✓	✓
NO_2 referenced to $\%O_2$		✓	
SO_2 referenced to $\%O_2$	✓		✓

1.3 Features & Benefits

- Powered by 4 'AA' alkaline batteries, or NiMH rechargeable batteries. An optional AC power adapter provides continuous operation.
- Internal charging circuit allows rechargeable batteries to be charged inside the analyzer with the use of the optional AC power adapter.
- O_2 and CO_{Low} measurement standard. Optional measurement of up to two additional gases: CO_{High}, NO, NO_2, or SO_2.
- With the appropriate sensors installed, the analyzer optionally displays pollution conversions for CO, NO, NO_2, and SO_2. Pollution conversions include ppm, #/MBTU, mg/m^3, and g/GJ.
- Smart sensor technology allows pre-calibrated sensors to be installed in the field.
- Automatic zero of all sensing channels on ambient air when the analyzer is first turned ON.
- Automatic flushing of the CO_{Low} sensor with fresh air if the CO level exceeds 4,000 ppm, thus protecting the CO_{Low} sensor from high CO levels. To measure CO levels above 4,000 ppm, the analyzer automatically switches to its CO_{High} sensor, if installed.
- Automatic purging of the gas-sample system if the detected gas levels are abnormally high when the analyzer is turned OFF.
- Displays temperatures in either °F or °C.
- Displays pressure in either inwc, mb, Pa, or hPa.
- Backlit LCD and push buttons.
- Low battery alarm.
- Stores 500 individual combustion records, which can later be recalled for viewing, printing, or downloading to a personal computer. Stores an additional 500 data logged records.
- Wireless IrDA link used for printing current and stored combustion records, pressure records, sensor calibration data, and diagnostic data.
- USB connectivity for downloading stored data to a personal computer.
- Field replaceable sensors and thermocouple.
- Two year warranty on analyzer and all gas sensors except the O_2 sensor which has a one (1) year warranty.

1.4 Operational Overview

The PCA 2 is powered by either its 4 internal batteries, or by an optional AC power adapter that operates from any convenient source of 100–240 VAC, 50/60 Hz power. The type of batteries used can be either disposable alkaline or rechargeable NiMH. Note that rechargeable batteries can be charged inside the analyzer using the optional AC power adapter.

The PCA 2 is controlled by 11 front panel push buttons, while a graphical LCD is used to display all combustion and emission test data and analyzer parameters.

A probe and hose assembly, with an integral thermocouple and filter/water-trap connect to the bottom of the analyzer, thus providing the means of drawing in gas samples, and for measuring stack temperature and draft.

The PCA 2 is turned ON by pressing its red **I/O** button. A warm-up period of 60 seconds then begins, during which time the analyzer performs self diagnostics. At the end of the warm-up period, if no errors were detected the message "NO ERRORS DETECTED" is briefly displayed followed by the display of the Combustion Test HOLD screen. If errors were detected, the message "ERRORS DETECTED" is displayed along with a list of the errors. These errors must be corrected before proceeding with the combustion test.

Before starting a test be sure to select the fuel being burned. The default fuel selected is Natural Gas. Note that the name of the fuel being burned is indicated at the top of the display. To change the fuel: first, press the **MENU** (**F2**) button; next, select **FUEL** from the menu; then use the ▲▼ buttons to highlight the fuel being burned; and finally, press the green **ENT** button to select the highlighted fuel.

To assure correct combustion-efficiency calculations, the analyzer must know the burner's primary-air temperature. The analyzer normally uses its internal temperature sensor for the primary-air temperature value, but this method is only acceptable if the burner is using ambient room air. If the burner is drawing in cold outside air, we recommend that the optional T-AIR thermocouple be used. This thermocouple plugs into the bottom of the analyzer and is placed in the burner's primary-air stream.

Begin the combustion test by first inserting the analyzer's probe tube into the stack-gas stream of the appliance under test, and then pressing the **RUN/HOLD** button to display the Combustion Test RUN screen. The analyzer will begin to continuously monitor the stack temperature, $\%O_2$ and

emission levels in the stack gas and then display measured and calculated values on its LCD. Values are listed in Section 2 Specifications.

During a test, the CO_{Low} sensor is protected from high CO levels by being automatically flushed with fresh air when the detected CO level exceeds 4,000 ppm. The analyzer will automatically start using its optional CO_{High} sensor, if installed, at CO levels starting at 4,001 ppm, thus providing continuous CO readings up to 20,000 ppm.

A backlight enables a user to read the display in dimly-lit areas. Turn the backlight ON and OFF by briefly pressing the **I/O** button.

The analyzer is turned OFF by pressing and holding down the **I/O** button for at least 2 seconds. Note that there is a 5-second delay before the analyzer actually turns OFF, during which time the analyzer can be turned back ON by pressing the **RUN/HOLD** button. In addition, there is a gas-purge feature that keeps the analyzer's pump running if the gas level inside the sensor chambers is abnormally high at shutdown. With the probe removed from the stack and sampling fresh air, the analyzer purges itself until the detected gas concentrations drop below predetermined levels.

1.5 Connector Descriptions

1.5.1 Probe Connections (Gas, Pressure, T-Stack)

Attach the probe and hose assembly to the analyzer by connecting its . . .

- stack-gas thermocouple to the analyzer's T-STACK connector,
- stack-gas hose to the analyzer's GAS connector,
- draft hose to the analyzer's +ΔP connector.

Observe that the probe connectors are of different sizes and shapes, which prevent incorrect connection to their associated connectors on the analyzer.

1.5.2 T-AIR (Primary Air Thermocouple)

If thermocouple P/N 104-1797 (10 feet long) or Utility Wand P/N 104-1799 (12 inch ridged probe with handle and 5 foot coiled cable) is to be used to measure the burner's primary air temperature, then connect either of these thermocouples to the analyzer's T-AIR connector.

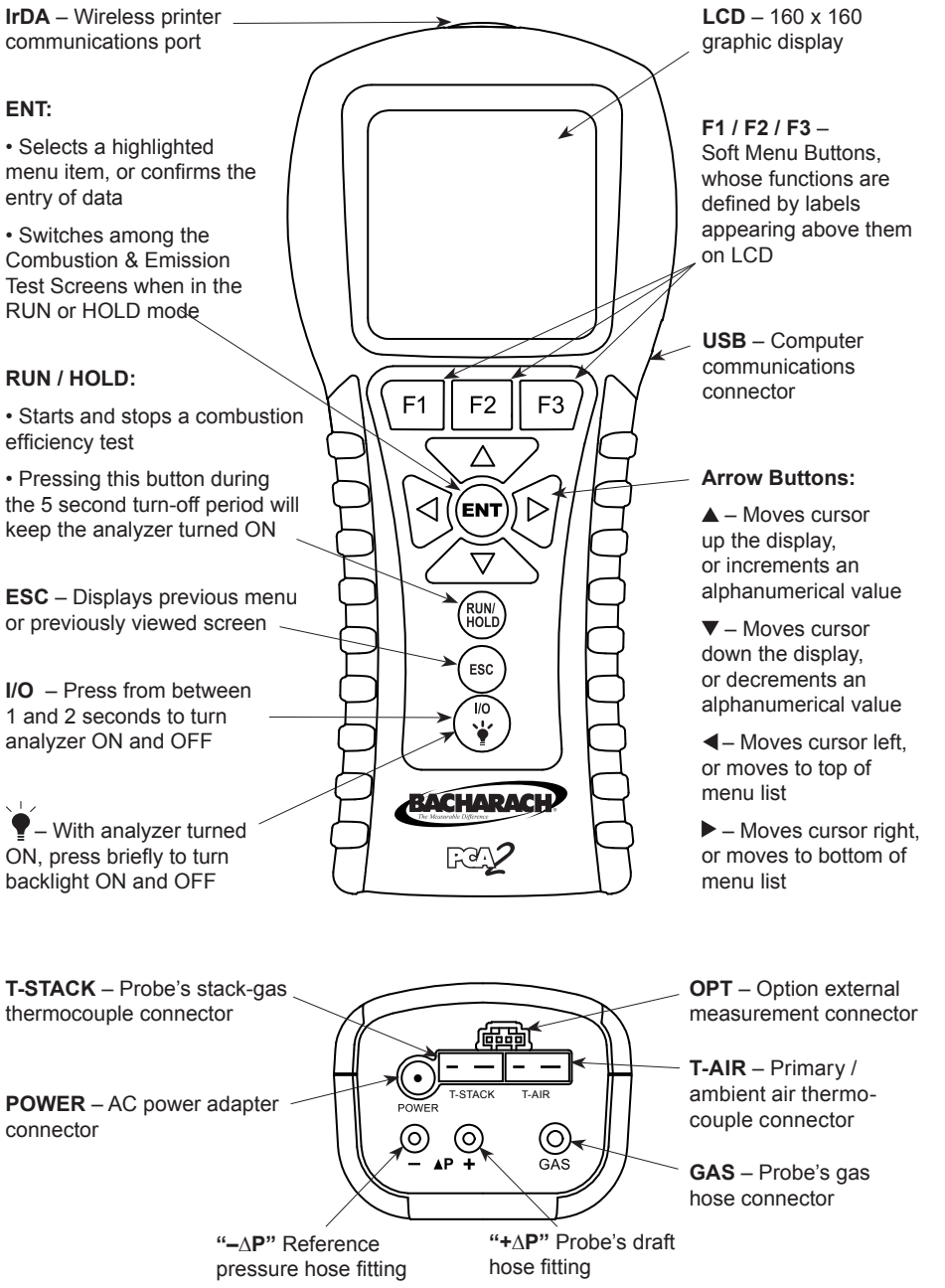


Figure 1-1. PCA 2 Components

1.5.3 POWER (AC Adapter)

The AC power adapter P/N 24-1404 can be used as an external power supply, which will run the analyzer on a continuous basis.

When using rechargeable NiMH batteries, the AC power adapter can also be used to charge the batteries while inside the analyzer. The analyzer's rapid-charger circuit, however, must first be turned ON per Section 3.14. The rapid charger will charge a set of depleted batteries in approximately 2 - 3 hours.

When disposable alkaline batteries are used, the analyzer's battery charger circuit must be OFF to prevent the batteries from overheating. As a precaution, the charger circuit is automatically toggled back to its OFF state when the analyzer is turned OFF.

1.5.4 ΔP (Differential Pressure)

Draft is measured by connecting the probe's draft hose to the +ΔP fitting, while leaving the –ΔP fitting open to the atmosphere.

In addition to measuring draft, the "+" and "–" ΔP fittings can also be used to measure the differential pressure between two areas by first connecting a hose P/N 24-1103 to the –ΔP fitting, and then inserting the open end of this hose into the area being used as the reference pressure. The analyzer's probe is then inserted into the area who's differential pressure is to be measured. Refer to Section 4.6.

1.5.5 USB (Computer Interface)

Data that has been stored in the analyzer's memory can be downloaded to a personal computer by connecting USB data cable P/N 104-4032 between the USB ports of the computer and analyzer. Refer to Section 4.14.2.

1.5.6 IrDA (Printer Interface)

Data that has been stored in the analyzer's memory can be printed on a compatible IrDA wireless printer by aligning their IrDA communication ports. Refer to Section 4.16.

1.5.7 OPT (Option)

The option connector is used for optional external measurement features.

1.6 Front Panel Buttons

Descriptions of the front panel buttons are given below. Note that a control may perform multiple functions as determined by what screen is being displayed at the time.

The functions of these buttons are defined by labels appearing above them on the LCD. The labels that appear depend on the functions that can be performed in the particular screen being displayed.

PRINT (F1): Transmits the data displayed on the screen to a printer through the IrDA communications port.

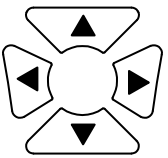
MENU (F2): Displays the Main Menu.

SAVE (F3): Saves the data currently displayed on the LCD in memory. Up to 500 individual Combustion Test and Pressure records can be saved. After which, the oldest data will be overwritten.

ZERO (F2): When viewing the Pressure screen, this button zeros the pressure sensor to current atmospheric conditions.

PAGE– (F1): When viewing the Memory or Logging Directory, each press of this button pages *down* through the directory. Holding this button down speeds up the paging process.

PAGE+ (F3): When viewing the Memory or Logging Directory, each press of this button pages *up* through the directory. Holding this button down speeds up the paging process.



The arrow buttons move the cursor on the LCD in the direction of the arrow. In screens that require the entry of alphanumerical data, use the ◄► buttons to move cursor across the screen and then use the ▲▼ buttons to increment and decrement the data. When viewing a menu, use the ◄► buttons to quickly move to the top and bottom of the menu.

Selects a highlighted menu. In addition, if changes were made to one of the analyzer's operating parameters (e.g., date, time, O_2 reference, etc.), pressing this button confirms those changes and saves them in memory.

Starts and stops a combustion test when the Combustion Test screen is displayed. Pressing this button in any other screen returns the analyzer to the Combustion Test HOLD screen. Pressing this button during the 5 second turn-off-delay period will abort the turn-off process and also return the analyzer to the Combustion Test HOLD screen.

Displays a previously viewed screen. In addition, if changes were made to one of the analyzer's operating parameters (e.g., date, time, O_2 reference, etc.), pressing this button aborts those changes, restores the old values, and then displays the previously viewed screen.

Turns the analyzer ON and OFF, and is also used to turn the backlight and button LEDs ON and OFF.

Note that when the analyzer is turned OFF, there is a 5 second delay, during which time an operator can keep the analyzer turned ON by pressing the **RUN / HOLD** button. Also note that if the measured emission levels are above predetermined limits at the time the instrument is turned OFF, the pump is automatically started and purges the sensor compartment with fresh air until the gas levels inside the analyzer are reduced. If desired, the purging process can be aborted by again pressing the **I/O** button.

2 Specifications

The PCA 2 Directly Measures and Displays:

The gases displayed depend on the analyzer's model number.
Refer to Section 1.2.

Oxygen . . . . . 0 to 20.9%
Stack Temperature. . . . . –4 to 2,192 ºF (–20 to 1,200 ºC)
Primary / Ambient Air Temperature . . . . . –4 to 999 ºF (–20 to 537 ºC)
Carbon Monoxide (CO) (H_2 compensated). . . . . 0 to 4,000 ppm
Pressure / Draft . . . . . ±72 "H_2O (±180 mb)
CO High Range . . . . . 4,001 to 20,000 ppm
Nitric Oxide (NO). . . . . 0 to 3,000 ppm
Nitrogen Dioxide (NO_2) . . . . . 0 to 500 ppm
Sulfur Dioxide (SO_2) . . . . . 0 to 5,000 ppm

The PCA 2 Calculates and Displays:

Calculations are performed only when the measured oxygen level is below 16.0%, and the stack temperature is below 2,000 °F (1,093 ºC).

Combustion Efficiency . . . . . .0.1 to 100%
Excess Air. . . . . 1 to 250%
Carbon Dioxide (dry basis). . . . . 0.1 to fuel dependent maximum in %
NOx (NOx = NO + NO_2). . . . . 0 to 3,500 ppm
NOx referenced to %O_2 . . . . . 0 to 9,999 ppm
CO referenced to %O_2. . . . . 0 to 9,999 ppm
NO reference to %O_2 . . . . . 0 to 9,999 ppm
NO_2 reference to %O_2. . . . . 0 to 9,999 ppm
SO_2 reference to %O_2 . . . . . 0 to 9,999 ppm

Fuels Available for Combustion Calculations:

- Natural Gas
- Oil #2
- Oil #4
- Oil #6
- Propane
- Coal
- Wood
- Kerosene
- Bagasse
- Digester Gas

Normal Operating Conditions:

Temperature:
- Analyzer . . . . . 32 to 104 °F (0 to 40 °C)
- Probe Tip . . . . . .1,472 °F (800 °C) Max.

Humidity:
- Analyzer . . . . . .15 to 90% Relative Humidity, non-condensing

Air Pressure:
- Analyzer . . . . . .Atmospheric
- Probe . . . . . 10" H_2O (25 mb) draft max. at probe tip

Performance:

Accuracy:

O_2	±0.3% O_2 on practical concentrations of stack gas (mix of O_2, CO_2 and N_2)
CO	±5% of reading or ±10 ppm, whichever is greater between 0–2,000 ppm, and ±10% of reading between 2,001–20,000 ppm.
NO	±5% of reading or ±5 ppm, whichever is greater between 0–2,000 ppm
NO_2	±5% of reading or ±5 ppm, whichever is greater between 0–500 ppm
SO_2	±5% of reading or ±10 ppm, whichever is greater between 0–2,000 ppm
Stack Gas Temp.	±4 °F between 32 and 255 °F (±2 °C between 0 and 124 °C) ±6 °F between 256 and 480 °F (±3 °C between 125 and 249 °C) ±8 °F between 481 and 752 °F (±4 °C between 250 and 400 °C)
Primary / Ambient Air Temp..	±2 °F between 32 and 212 °F (±1 °C between 0 and 100 °C)
Pressure / Draft.	±2% of reading or ±0.02 "H_2O (±0.05 mb), whichever is greater

System Flow Rate with Probe . . . . . 200 cc/min minimum

Power Requirements:

Four disposable 'AA' alkaline batteries provide at least 15 hours of continuous operation. NiMH rechargeable batteries can also be used, with the operating time dependent on battery type and condition.

An optional AC power adapter, which runs from any convenient source of 100–240 VAC, 50/60 Hz power, can be used to power the analyzer on a continuous basis. If using rechargeable batteries, the AC power adapter can also be used to charge the batteries while inside the analyzer.

Warm-Up Time:

60 seconds. Sensors are checked and auto zeroed during warm-up.

Memory:

- 500 complete combustion test records
- 500 complete logged combustion test records

Interfaces:

- Printer – Infrared (IrDA) communications
- Computer – USB

Dimensions:

9H x 3W x 2.5D inches (22.9 x 7.6 x 6.3 cm)

Weight:

- Analyzer – 1.4 lb (0.6 kg) w/ batteries
- Probe & Hose Assembly – 1 lb (0.5 kg)

Notes:

3 Initial Setup

3.1 Scope

Before using the PCA 2, you MUST:

- Install batteries, or plug in the optional AC power adapter (Section 3.2)
- Connect the probe and hose assembly (Section 3.3)
- Check, and if necessary, make changes to the analyzer's configuration (Section 3.4)

3.2 Power

3.2.1 Installing or Replacing Batteries

Either alkaline or NiMH rechargeable batteries can used to power the analyzer. Note that if rechargeable batteries are used, they can be recharged while installed inside the analyzer using the optional AC power adapter (refer to Section 3.2.2).

Install or replace the batteries as described below:

1. Remove battery cover from back of unit (Figure 3-1.)
2. Remove (and properly dispose of) any old batteries.
3. Install a set of four 'AA' alkaline or NiMH batteries, per the "+" and "–" markings inside the battery compartment.
4. Replace battery cover.

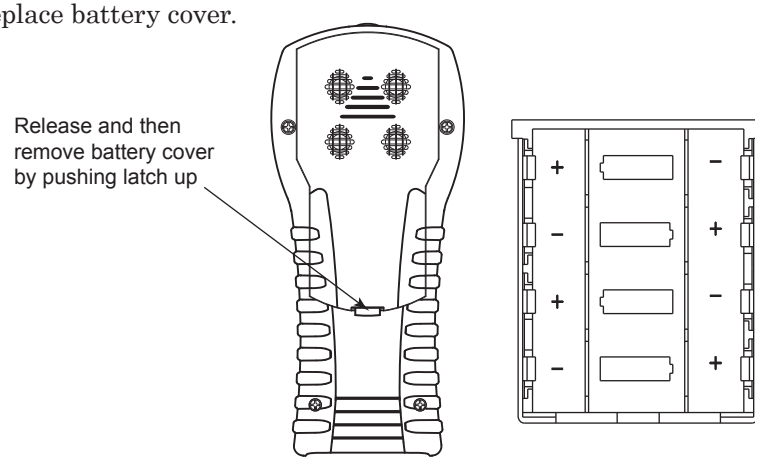


Figure 3-1. Installing Batteries

3.2.2 Using the AC Power Adapter

The AC power adapter is capable of powering the analyzer on a continuous basis. The adapter plugs into an appropriate 100–240 VAC, 50/60 Hz wall outlet, and produces an output of +9 VDC. The adapter's output connector plugs into the analyzer's POWER jack located on the bottom of the unit (Figure 3-2).

If NiMH rechargeable batteries are used, the adapter can also rapid charge these batteries in approximately 2 - 3 hours while still inside the analyzer. For the batteries to be charged, however, the analyzer's battery charger circuit must be turned ON per Section 3.14.

3.3 Connecting the Probe and Hose Assembly

Do the following to attach the probe and hose assembly to the analyzer (Figure 3-2):

1. Push the gas-sample hose connector, the larger of the two connectors (giving a slight twist), onto the analyzer's GAS fitting.

2. Push the draft-hose connector, the smaller connector (giving a slight twist), onto the analyzer's +ΔP fitting.

3. Push the stack-gas thermocouple connector into the T-STACK jack (connector fits in only one way).

   NOTE: *The analyzer has a built-in temperature sensor for measuring ambient temperature. Perform Step 4 only if the optional primary / ambient air thermocouple is used.*

4. Push the optional primary / ambient air thermocouple into the T-AIR jack (connector fits in only one way).

   IMPORTANT: *To assure the accurate calculation of combustion efficiency, the optional primary / ambient air thermocouple must be used when the burner's primary-air temperature is* ***not*** *the same as the room temperature.*

5. Inspect all hoses for cracks. If any hose is found to be defective, replace the entire probe and hose assembly. Check that the water trap is empty, and that the filter is not dirty or saturated with water.

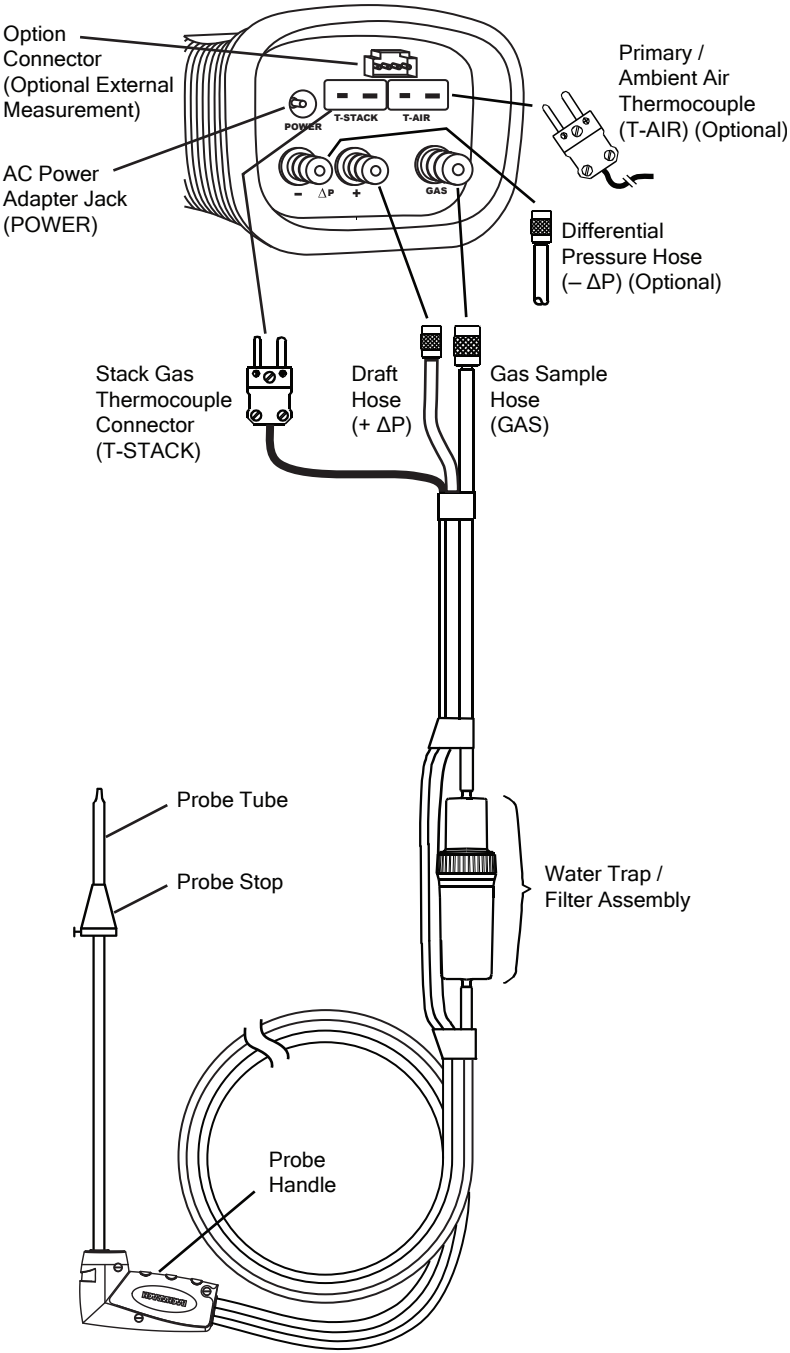


Figure 3-2. Connecting the Probe and Hose Assembly to the PCA 2

3.4 Operating Parameters

The PCA 2 is set up at the factory for the following operating parameters:

Fuel . . . . . Natural Gas
Temperature Units . . . . . °F
Pressure Units . . . . . Inches of Water Column (inwc)
Pollution Units . . . . . ppm
Date . . . . . Current MM/DD/YY
Time . . . . . Current EST HH:MM AM/PM
O_2 Reference 0%
Print Pressure . . . . . No
Zoom . . . . . No
Battery Charger . . . . . OFF
Logging . . . . . No
Button Sound . . . . . ON

To change any of these parameters, perform the associated procedure provided in Sections 3.5 thru 3.16.

3.5 Fuel Selection

To assure the accurate calculation of combustion efficiency, select the fuel being burned as follows:

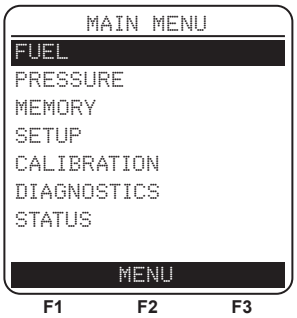
1. Display the MAIN MENU by pressing the **MENU (F2)** button. If necessary, press **ESC** until MENU appears above **F2**.

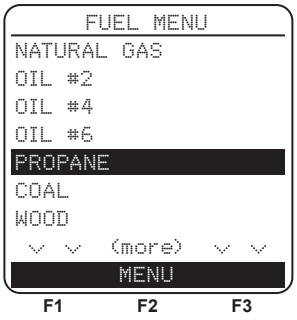
2. Use the ▲▼ buttons to highlight FUEL, and then press **ENT** to display the FUEL MENU.

3. Use the ▲▼ buttons to scroll through the list of available fuels until the desired fuel is highlighted. In the example shown, PROPANE has been selected.

   TIP: *Use the ◄► buttons to quickly scroll to the bottom and top of the list.*

4. Press **ENT** to save the selection and display the Combustion Test HOLD screen. Observe that the name of the selected fuel should now appear at the top of the screen.





3.6 Temperature Units Selection

Select to display temperature in either °F or °C as follows:

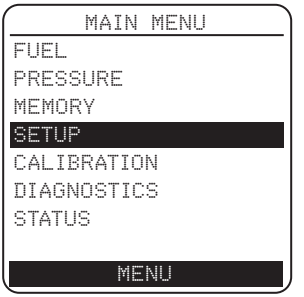
1. Display the MAIN MENU by pressing the **MENU (F2)** button. If necessary, press **ESC** until MENU appears above **F2**.

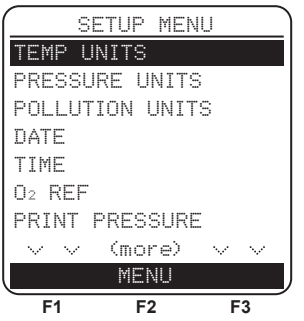
2. Use the ▲▼ buttons to highlight SETUP, and then press **ENT** to display the SETUP MENU.

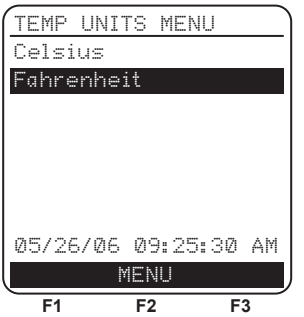
3. Use the ▲▼ buttons to highlight TEMP UNITS, and then press **ENT** to display the TEMP UNITS MENU.

4. Use the ▲▼ buttons to highlight the desired temperature units. In the example shown, Fahrenheit has been selected.

5. Press **ENT** to save the selection and re-display the SETUP MENU.







3.7 Pressure Units Selection

Select to display pressure in Inches of Water Column (inwc), millibar (mb), Pascals (Pa), or hectoPascals (hPa) as follows:

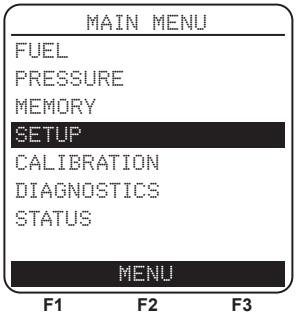
1. Display the MAIN MENU by pressing the **MENU (F2)** button. If necessary, press **ESC** until MENU appears above **F2**.

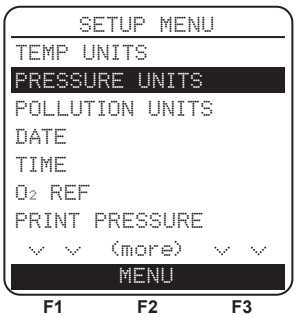
2. Use the ▲▼ buttons to highlight SETUP, and then press **ENT** to display the SETUP MENU.

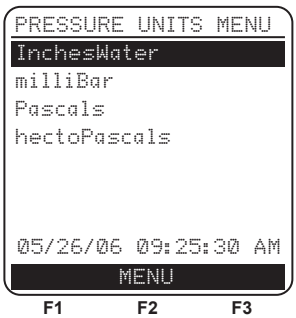
3. Use the ▲▼ buttons to highlight PRESSURE UNITS, and then press **ENT** to display the PRESSURE UNITS MENU.

4. Use the ▲▼ buttons to highlight the desired pressure units. In the example shown, InchesWater has been selected.

5. Press **ENT** to save the selection and re-display the SETUP MENU.







3.8 Pollution Units Selection

The PCA 2 is capable of converting the measured ppm levels of CO, NO, NO_2, and SO_2 to various pollution units using CFR40 Part 60 emission factors. Note that the pollution-unit conversions for NO, NO_2 and NOx are based on the molecular weight of NO_2.

Select to display pollution units in parts per million (ppm), pounds of pollutant per million BTU (#/Mbtu), milligrams of pollutant per cubic meter of gas (mg/m^3), or grams of pollutant per gigajoule (g/GJ) as follows:

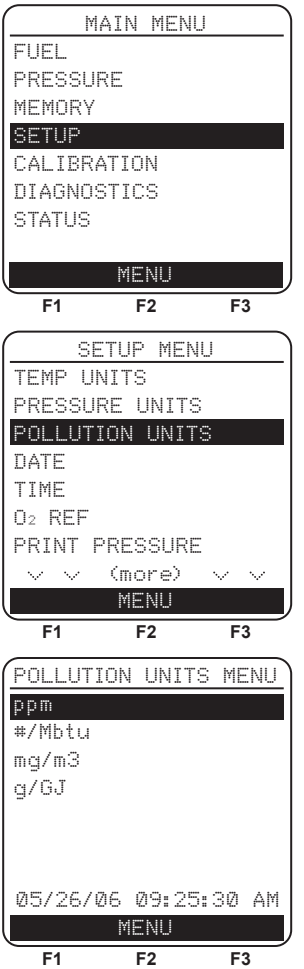
1. Display the MAIN MENU by pressing the **MENU (F2)** button. If necessary, press **ESC** until MENU appears above **F2**.

2. Use the ▲▼ buttons to highlight SETUP, and then press **ENT** to display the SETUP MENU.

3. Use the ▲▼ buttons to highlight POLLUTION UNITS, and then press **ENT** to display the POLLUTION UNITS MENU.

4. Use the ▲▼ buttons to highlight the desired pollution units. In the example shown, ppm has been selected.

5. Press **ENT** to save the selection and re-display the SETUP MENU.



3.9 Date Setup

The date is stored in the format: MM/DD/YY. Its value is part of the date and time stamp that is saved along with each combustion test record.

Set the analyzer's internal clock to the current date as follows:

1. Display the MAIN MENU by pressing the **MENU (F2)** button. If necessary, press **ESC** until MENU appears above **F2**.

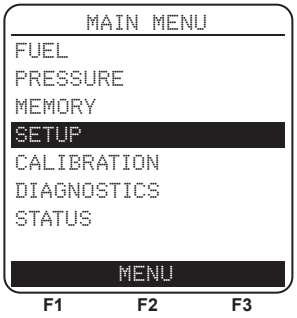
2. Use the ▲▼ buttons to highlight SETUP, and then press **ENT** to display the SETUP MENU.

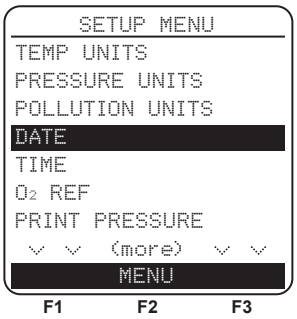
3. Use the ▲▼ buttons to highlight DATE, and then press **ENT** to display the DATE MENU.

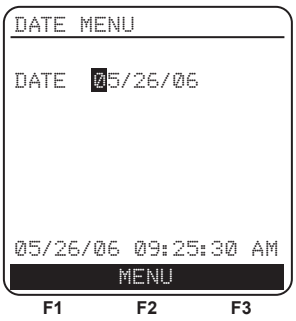
4. First use the ◄► buttons to move the cursor across the screen until it is over the digit to be changed, and then press the ▲▼ buttons until the desired value is displayed.

5. Repeat Step 4 until the values for month, day, and year have been set.

6. Press **ENT** to save the displayed date values and re-display the SETUP MENU, or press **ESC** to abort this procedure and retain the old date values.







Note: The Date and Time real time clock is powered by the main batteries and is maintained by a supercap on the Main PCB for approximately 1-2 days in the absence of batteries. The supercap is intended to maintain the real time clock when the batteries are changed when exhausted. If the batteries are removed for extended periods of time such as when the PCA2 is not in use (off-season storage), simply reset the time and date after fresh batteries are installed when it is placed back in service.

3.10 Time Setup

The time is stored in the format: hh:mm:ss AM/PM. Its value is part of the date and time stamp that is saved along with each combustion test record.

Set the analyzer's internal clock to the current time as follows:

1. Display the MAIN MENU by pressing the **MENU (F2)** button. If necessary, press **ESC** until MENU appears above **F2**.

2. Use the ▲▼ buttons to highlight SETUP, and then press **ENT** to display the SETUP MENU.

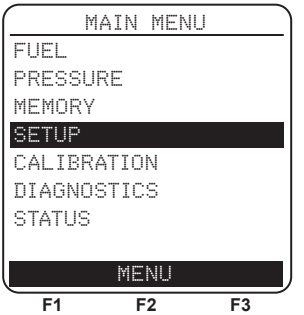
3. Use the ▲▼ buttons to highlight TIME, and then press **ENT** to display the TIME MENU.

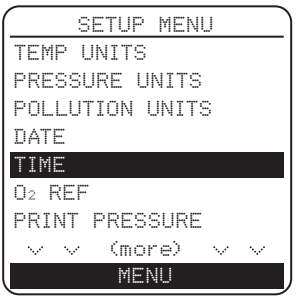
4. First use the ◄► buttons to move the cursor across the screen until it is over the digit to be changed, and then press the ▲▼ buttons until the desired value is displayed.

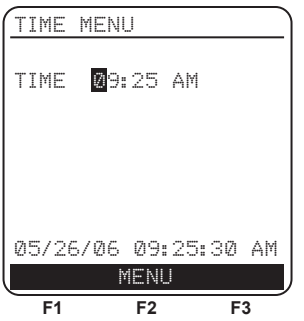
5. Repeat Step 4 until the values for hour, minute, and meridiem have been set.

   NOTE: *The value for seconds cannot be entered, but are displayed and stored as part of the combustion test record.*

6. Press **ENT** to save the displayed time values and re-display the SETUP MENU, or press **ESC** to abort this procedure and retain the old time values.





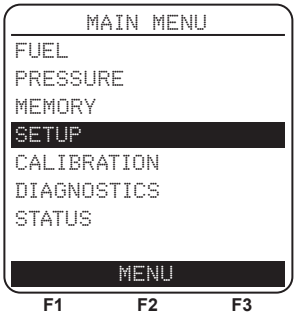


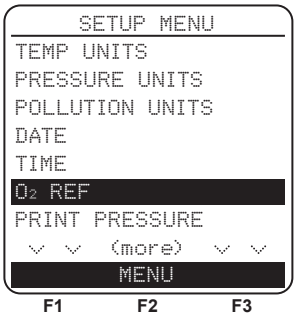
3.11 O_2 Reference Setup

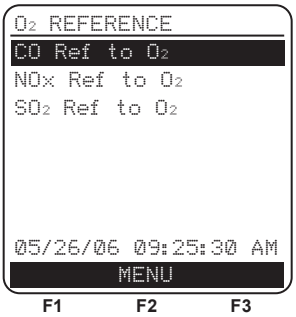
The measured values of CO, NOx, and SO_2 can be individually referenced to a specific O_2 percentage of between 0 and 15%.

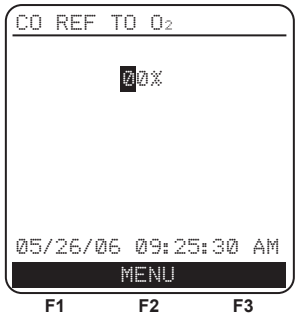
Individually set up the O_2 reference value for each of the above gases as follows:

1. Display the MAIN MENU by pressing the **MENU (F2)** button. If necessary, press **ESC** until MENU appears above **F2**.
2. Use the ▲▼ buttons to highlight SETUP, and then press **ENT** to display the SETUP MENU.
3. Use the ▲▼ buttons to highlight O_2 REF, and then press **ENT** to display the O_2 REFERENCE screen.
4. Use the ▲▼ buttons to highlight the desired measurement, and then press **ENT** to display the REF TO O_2 screen for that measurement. In the example shown, CO has been selected.
5. First use the ◄► buttons to move the cursor across the screen until it is over the digit to be changed, and then press the ▲▼ buttons until the desired value is displayed.
6. Press **ENT** to save the displayed value and redisplay the O_2 REFERENCE screen, or press **ESC** to abort this procedure and retain the old O_2 reference value.
7. If the O_2 reference value for more than one gas is being set, then repeat Steps 4, 5, and 6 for each measurement.





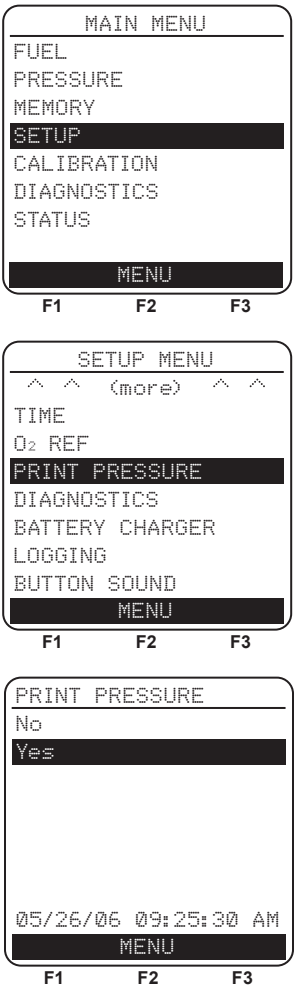




3.12 Print Pressure Selection

Select whether to print or not print the pressure measurement on the combustion test printout as follows (see Figure 4-3 on Page 4-31):

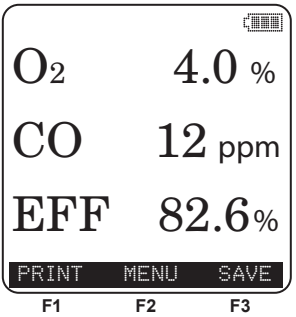
1. Display the MAIN MENU by pressing the **MENU (F2)** button. If necessary, press **ESC** until MENU appears above **F2**.
2. Use the ▲▼ buttons to highlight SETUP, and then press **ENT** to display the SETUP MENU.
3. Use the ▲▼ buttons to highlight PRINT PRESSURE, and then press **ENT** to display the PRINT PRESSURE screen.
4. Use the ▲▼ buttons to highlight either No (do not print pressure) or Yes (print pressure). In the example shown, Yes has been selected.
5. Press **ENT** to save the selection and re-display the SETUP MENU.



3.13 Zoom-Display Selection

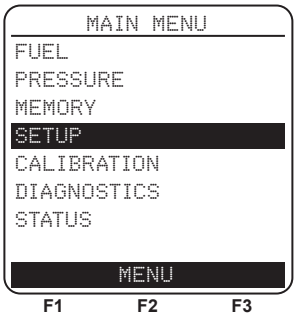
Zoom-display provides an additional combustion test screen that shows the test values of O_2, CO, and efficiency in extra large characters, thus allowing the operator to view the display of these values from a longer distance.

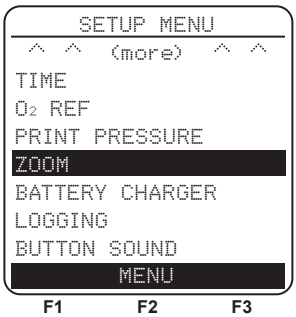
Pressing the **ENT** button while performing a combustion efficiency test will now show the zoom-display. Refer to Section 4.5.

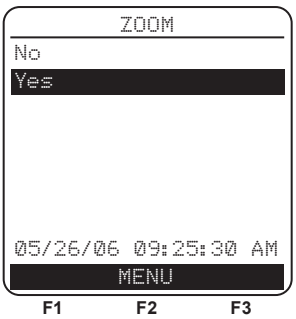


Turn zoom-display ON and OFF as follows:

1. Display the MAIN MENU by pressing the **MENU (F2)** button. If necessary, press **ESC** until MENU appears above **F2**.
2. Use the ▲▼ buttons to highlight SETUP, and then press **ENT** to display the SETUP MENU.
3. Use the ▲▼ buttons to highlight ZOOM, and then press **ENT** to display the ZOOM screen.
4. Use the ▲▼ buttons to highlight either No (turn zoom OFF) or Yes (turn zoom ON). In the example shown, Yes has been selected.
5. Press **ENT** to save the selection and re-display the SETUP MENU.

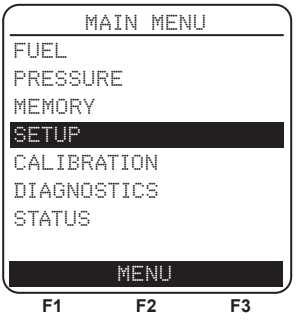






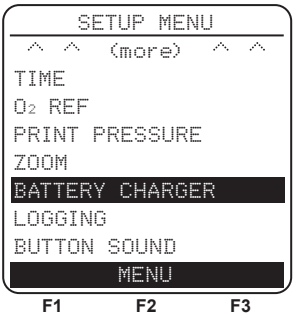
3.14 Battery Charger Selection

When using rechargeable NiMH batteries, the AC power adapter can be used to charge the batteries while inside the analyzer. The analyzer's rapid-charger circuit, however, must be first turned ON.



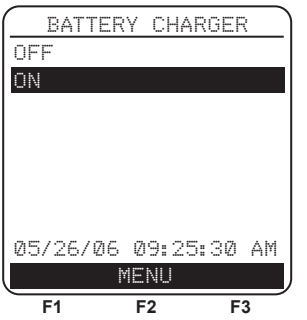
> **IMPORTANT:** *When using disposable alkaline batteries, the analyzer's battery charger circuit should be OFF to prevent the batteries from overheating.*

As a precaution, the charger circuit is automatically toggled to its OFF state when the analyzer is turned OFF, thus requiring the operator to turn the charger back ON when needed.



> *Note: The PCA2 must be left turned ON to charge the batteries.*

Turn the battery charger circuit ON and OFF as follows:

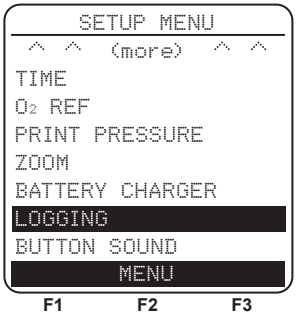


1. Display the MAIN MENU by pressing the **MENU (F2)** button. If necessary, press **ESC** until MENU appears above **F2**.
2. Use the ▲▼ buttons to highlight SETUP, and then press **ENT** to display the SETUP MENU.
3. Use the ▲▼ buttons to highlight BATTERY CHARGER, and then press **ENT** to display the BATTERY CHARGER screen.
4. Use the ▲▼ buttons to highlight either OFF (turn charger OFF) or ON (turn charger ON). In the example shown, ON has been selected.
5. Press **ENT** to save the selection and re-display the SETUP MENU.

3.15 Logging Selection

When the logging function is activated, up to 500 combustion test records will be automatically stored in memory at a preset interval over a pre-determined length of time.

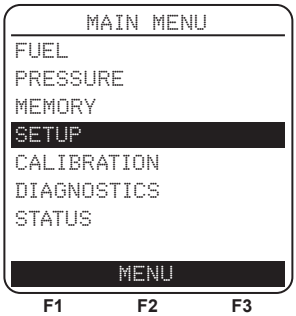
Refer to Section 4.12 for detailed information on how to select the logging function; how to set the interval and duration time periods; and how to view or download the stored data.

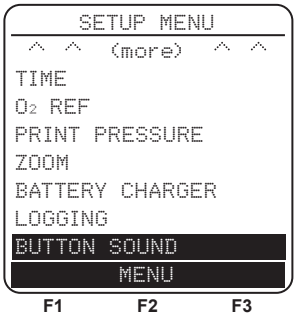


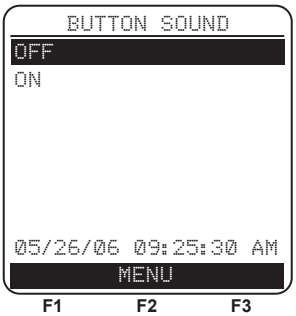
3.16 Button Sound

The audible sound used to signal when a button is pressed can be turned OFF and ON as follows:

1. Display the MAIN MENU by pressing the **MENU (F2)** button. If necessary, press **ESC** until MENU appears above **F2**.
2. Use the ▲▼ buttons to highlight SETUP, and then press **ENT** to display the SETUP MENU.
3. Use the ▲▼ buttons to highlight BUTTON SOUND, and then press **ENT** to display the BUTTON SOUND screen.
4. Use the ▲▼ buttons to highlight either OFF (turn sound OFF) or ON (turn sound ON). In the example shown, OFF has been selected.
5. Press **ENT** to save the selection and re-display the SETUP MENU.







4 Operation

4.1 Operating Tips

- When an analyzer is brought in from a cold vehicle, let it warm up slowly to minimize condensation. Temperatures below freezing will not damage the analyzer; however, bringing a cold analyzer into a warm, humid environment may cause condensate to form inside the case.

  CAUTION: Although the analyzer itself is not damaged by an extremely cold environment, the electrochemical sensors may be damaged. The O_2 sensor's electrolyte will freeze at approximately -20 °F and the other sensors at approximately -94 °F. If the analyzer is exposed to an extremely cold condition, it is strongly suggested that the sensor housings be examined for hairline cracks. Be aware that a leaking sensor can cause chemical burns to the skin and possibly damage the PCB assemblies.

- Ensure that the analyzer is sampling fresh air when turned ON. Pulling a stack-gas sample through the analyzer during its warm-up period will not damage the analyzer, but it will result in incorrect sensor readings, and may result in sensor error messages appearing after the warm-up cycle completes.
- Note that flue-gas condensate is acidic and very corrosive. It is important not to allow the analyzer's internal components to come in contact with condensate for long periods of time.
- Before each use, inspect the filter element of the water-trap / filter assembly. Replace the filter if it looks dirty. Refer to Section 6.2.
- When sampling flue-gas, keep the analyzer above the water-trap, and keep the trap in a vertical position. This will maximize the effectiveness of the trap and keep liquid condensate from being drawn directly into the analyzer.
- When liquid condensate is seen inside the water trap, empty the trap before it becomes full. Refer to Section 4.9.
- It is recommended that the analyzer be purged after performing a combustion test. Once the probe is removed from the stack, let the pump run for 10 minutes or so to completely remove any remaining stack gases and dry any condensate from inside the sensor chamber and probe assembly. If the analyzer is turned OFF with high levels of flue gas remaining in the analyzer, then the pump will continue to run and the message "PURGING SENSORS" will appear on the display until all flue gas levels fall below predetermined levels.
- When storing the analyzer, it's a good idea to empty the water trap and leave it open to further dry it out.
- Calibrate the analyzer every *6 months* to assure its accuracy.

4.2 Turning ON the Analyzer and Warm Up

1. Connect the probe and hose assembly, and make sure that the analyzer is properly set up per Section *3 Initial Setup.*

   IMPORTANT: *DO NOT insert probe into stack before turning ON the analyzer!*

2. Place the probe in an area that contains fresh air. This ensures that the sensors will be properly zeroed during the warm-up cycle.

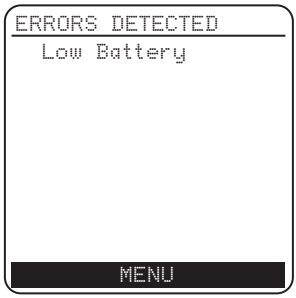
3. Turn ON the analyzer by pressing the **I/O** button for at least 1 second, or until a single beep is heard. Observe that the analyzer's firmware version, model and serial numbers are briefly displayed followed by the Warm Up screen.

4. Wait for the analyzer to count down its 60 second warm-up period; after which, the message "NO ERRORS DETECTED" along with the oxygen sensor's output voltage is briefly displayed followed by the display of the Combustion Test HOLD screen.

   TIP: *The O_2 value at the end of warm-up is reported as "Good, Low or BAD". Consider replacing the oxygen sensor when its value is reported as "Low".*

   If problems were detected during warm up, the message "ERRORS DETECTED" is displayed along with a list of those errors. As an example, the screen to the right shows that the battery is low. Refer to Section 7.3 for a listing and possible remedy for the errors displayed.

   TIP: *If the sensors in error are not critical to the combustion test, then press the* **RUN/HOLD** *button to display the Combustion Test HOLD screen and proceed with the test.*

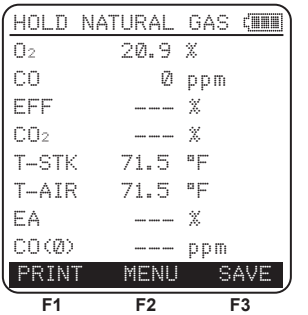


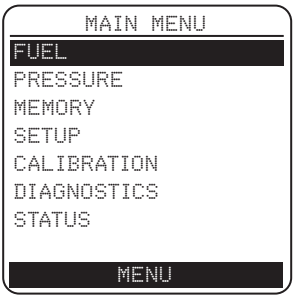
4.3 Selecting a Fuel

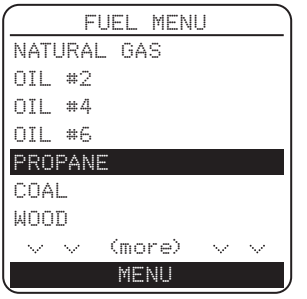
The top line of the Combustion Test HOLD screen shows the fuel currently selected. In the example shown, the current fuel is NATURAL GAS. If necessary, change the fuel as follows:

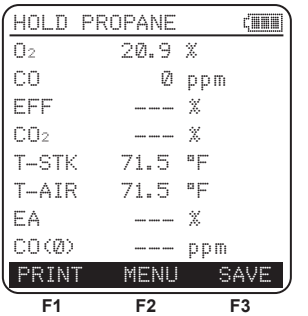
1. Display the MAIN MENU by pressing the **MENU (F2)** button.
2. Use the ▲▼ buttons to highlight FUEL, and then press **ENT** to display the FUEL MENU.
3. Use the ▲▼ buttons to scroll through the list of available fuels until the desired fuel is highlighted. In the example shown, PROPANE has been selected.

   TIP: *Use the ◄► buttons to quickly scroll to the bottom and top of the list.*
4. Press **ENT** to save the selection and return to the Combustion Test HOLD screen. The newly selected fuel should now appear in the top line of the display.



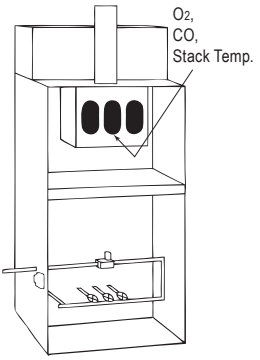






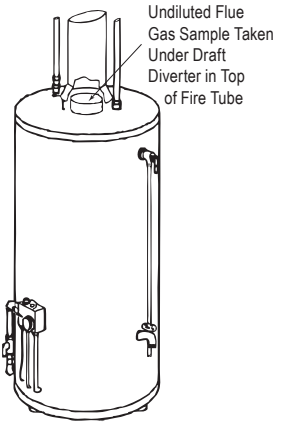
4.4 Sampling Point

FORCED AIR FURNACE – For atmospheric burner or gravity vented, forced air heating equipment with a clamshell or sectional heat exchanger design, test each of the exhaust ports at the top of the heat exchanger. The probe should be inserted back into each of the exhaust ports to obtain a flue-gas sample, before any dilution air is mixed in.



Forced Air Furnace

HOT WATER TANK – Domestic hot water tanks with the 'bell' shaped draft diverter can be accurately tested by inserting the probe tip directly into the top of the fire tube below the diverter.

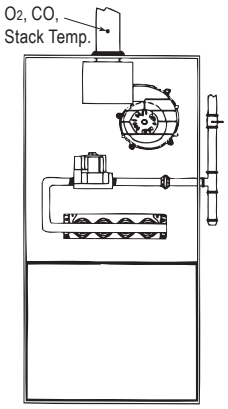


Hot Water Tank

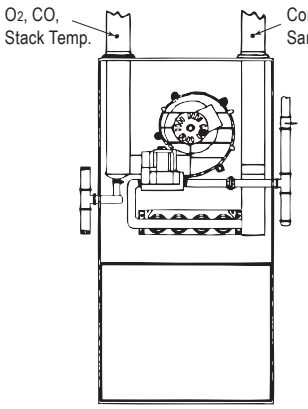
80% EFFICIENCY FAN ASSIST OR POWER VENTED – Combustion testing of fan assist or power vented, furnaces/boilers should be done through a hole drilled in the vent immediately above the inducer fan.

90% EFFICIENCY CONDENSING – Condensing furnaces/boilers can be tested through a hole drilled in the plastic vent pipe (when allowed by the manufacturer or local authority of jurisdiction) or taken from the exhaust termination.

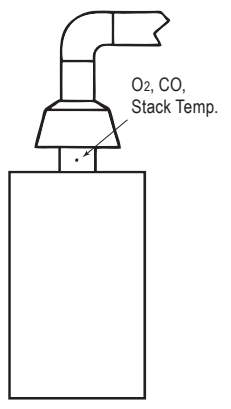
ATMOSPHERIC OR GRAVITY VENTED BOILER – Boilers, which have a 'bell' shaped draft diverter on top, should be tested directly below the diverter through a hole drilled in the vent connector.



80% Eff. Fan Assist or Power Vented



90% Eff. Condensing



Atmospheric or Gravity Vented Boiler

4.5 Performing a Combustion Test

Ensure that the following has been completed, and then proceed with the combustion test as described below:

- Turn ON analyzer and allow it to warm up (Section 4.2).
- Select fuel being burned (Section 4.3).
- Inset probe into stack (Section 4.4).
- If necessary, insert optional primary air thermocouple into combustion-air stream of burners that use an outside source of combustion air.

1. Press the **RUN/HOLD** button to start the test. You should hear the pump start running and see the word RUN appear at the top of the Combustion Test screen.

2. Press the **ENT** button to view the various combustion test screens that contain the data listed in Table 4-1 on Page 4-6.

   The screens to the right show typical combustion test data for an analyzer equipped with O_2, CO_{LOW}, NO and NO_2 sensors.

   TIP: *Use the zoom-display to show only the values of O_2, CO, and efficiency in large characters. Refer to Section 3.13.*

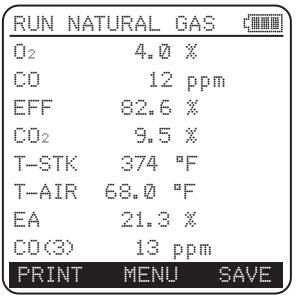
   Sensor Indicators: The following indicators appear in the sensor's data field depending on certain conditions:

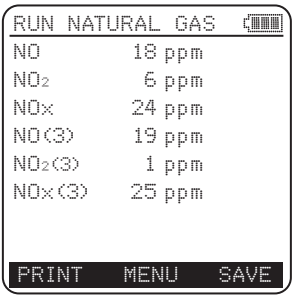
   (* * *) Sensor that is not calibrated or defective.

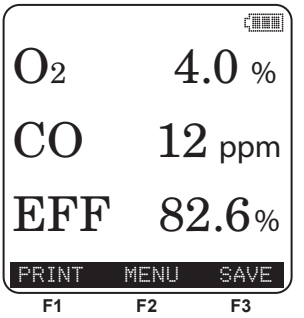
   (XXX) Sensor overrange

   (- - -) The calculated data cannot be displayed because the measured data necessary to make the calculation is out of range (i.e., oxygen level above 16%).

3. Press **ENT** until T-STK is displayed. Loosen thumbscrew on probe stop and move probe in and out of the stack until the stack's core temperature (**hot spot**) is located as indicated by the highest T-STK reading; then tighten thumbscrew to prevent further probe movement. *Locating the highest stack temperature is very important for accurate efficiency calculations.*







4. You can now begin burner-service procedures. The analyzer readings will change quickly to show changes in burner performance.

   CAUTION: *Position the Water Trap with its gas-flow arrow pointing upward. Do not let water condensate go above the tip of the riser tube. The sensors could be damaged if water would enter the analyzer. Empty the Water Trap after every combustion test (refer to Section 4.9)*

5. Pressing the **RUN/HOLD** button freezes all readings, stops the pump and displays the Combustion-Test HOLD screen. Press the **ENT** button to view all test values at the moment the **RUN/HOLD** button was pressed. Pressing **RUN/HOLD** again restarts the pump and resumes testing.

TABLE 4-1. LIST OF COMBUSTION TEST DATA

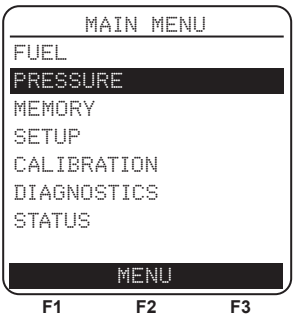
Display Name	Description of Measurement or Calculation
O_2	% Oxygen
CO	Carbon Monoxide (1)
EFF	% Combustion Efficiency
CO_2	% Carbon Dioxide
T-STK	Stack Temperature
T-AIR	Primary / Ambient Air Temperature as measured either internally or by an optional external thermocouple plugged into the analyzer's T-AIR connector
EA	% Excess Air
CO(n)	Carbon Monoxide ppm level referenced to a % of oxygen (2)
NO	Nitric Oxide (1)
NO_2	Nitrogen Dioxide (1)
NOx	Oxides of Nitrogen (combination of NO and NO_2) (1)
SO_2	Sulfur Dioxide (1)
NO(n)	Nitric Oxide ppm level referenced to a % of oxygen (2)
NO_2(n)	Nitrogen Dioxide ppm level referenced to a % of oxygen (2)
NOx(n)	Oxides of Nitrogen ppm level referenced to a % of oxygen (2)
SO_2(n)	Sulfur Dioxide ppm level referenced to a % of oxygen (2)
NO Temp	Nitric Oxide Sensor Temperature (3)

(1) Pollution unit of measure selected per Section 3.8
(2) The letter "n" represents the oxygen reference level of between 0 and 15% as selected per section 3.11
(3) Shown only on printout, not on LCD display.

4.6 Making a Draft / Pressure Measurement

The difference in pressure (ΔP) between two areas can be measured by using the analyzer's two pressure ports and the PRESSURE screen. By using the –ΔP port as the reference, the pressure applied to the +ΔP port will be displayed on the PRESSURE screen as the differential pressure between the two ports.

Perform a draft / pressure measurement as follows:

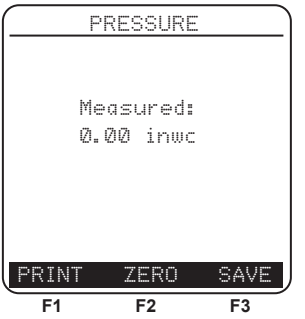


1. Turn ON the analyzer and allow it to complete its warm-up cycle (Section 4.2).

   TIP: *The pressure units of measure is selected per Section 3.7.*

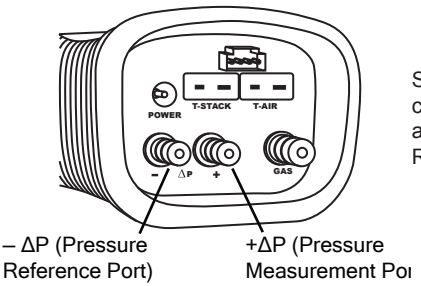
2. Display the MAIN MENU by pressing the **MENU (F2)** button. If necessary, press **ESC** until MENU appears above **F2**.

3. Use the ▲▼ buttons to highlight PRESSURE, and then press **ENT** to display the PRESSURE screen.



4. Before taking a measurement, the pressure sensor may need to be re-zeroed if it is not already displaying zero with both pressure ports open to the atmosphere. If necessary, zero the pressure sensor as follows:

   a. Press the **ZERO (F2)** button.

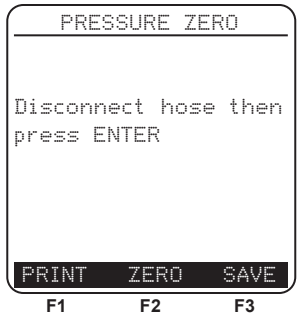


Sampling Hoses with quick connect fittings are available as an optional accessory. Refer to Section 8.2.

Figure 4-1. Draft / Pressure Measurement Hose Connections

b. Disconnect any hoses connected to the +ΔP and –ΔP ports, and then press **ENT** to zero the pressure sensor.

c. Reconnect any hoses. When measuring draft, simply leave the –ΔP port open to the atmosphere and connect the probe's draft hose to the +ΔP port (see Figure 3-2 on Page 3-3).



5. Do one of the following to measure draft or differential pressure:

   - To measure draft, simply insert the probe into the stack and observe the draft reading on the PRESSURE screen.

   - To measure differential pressure, connect two sampling hoses to the +ΔP and –ΔP ports, and place the open end of each hose into the areas being measured. The differential pressure between the two areas is now displayed on the PRESSURE screen.

   If the pressure at the +ΔP port is higher than the –ΔP port, then the pressure reading will be *positive*. If it is lower, then the reading will be *negative*.

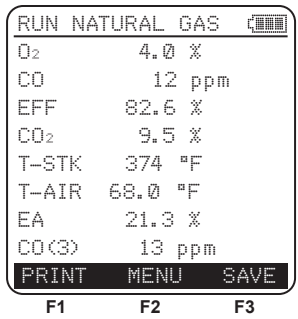
4.7 Saving Test Data

Up to 500 individual sets ("snap shots") of combustion-test or pressure data can be saved in memory, which can later be recalled for viewing from the Memory Directory (Section 4.13.1).

1. First display the screen that contains the data to be saved. In the example to the right, all data associated with the Combustion Test RUN screen will be saved.

2. Press the **SAVE (F3)** button to save the test data in the next available memory location.

   NOTE: *When memory is full, the next reading saved will overwrite the oldest reading.*



4.8 Ending a Combustion Test

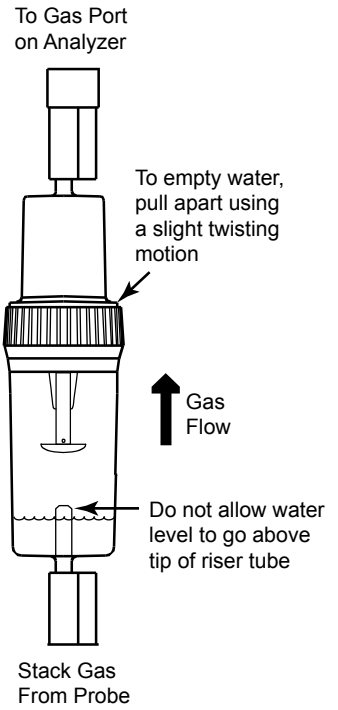
WARNING! *Burn Hazard. Do not touch the probe after removing it from the stack. Allow the probe to cool before handling (about 5 minutes).*

1. Remove probe from stack.
2. Allow the pump to run until all combustion gases have been flushed from the analyzer as indicated by the O_2 reading returning to 20.9%.

4.9 Emptying the Water Trap

The Water Trap / Filter Assembly removes stack-gas condensate, and also prevents soot from contaminating the internal components of the analyzer.

IMPORTANT: *Use the Water Trap / Filter Assembly in a vertical position with the gas-flow arrow pointing up as shown in the illustration to the right.*



Empty the water trap chamber after each combustion test, or stop the test and empty the chamber if the liquid condensate level approaches the tip of the riser tube.

To empty the trap, first pull apart the two halves of the Water Trap using a slight twisting motion; empty the water trap chamber; and then reassemble the trap.

After each combustion test, also check the Water Trap's filter element. If it looks dirty, replace the filter per Section 6.2.

4.10 Turning OFF the Analyzer & Purging

Turn OFF the analyzer by pressing the **I/O** button for at least 2 seconds, or until two beeps are heard. The unit will count down 5 seconds before shutting down, giving the operator an opportunity to keep the analyzer turned ON by pressing the **RUN/HOLD** button.

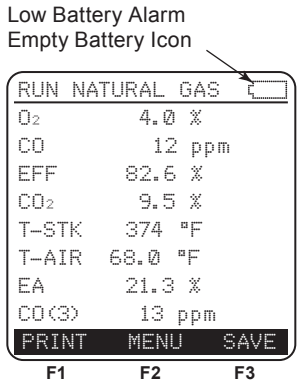
If the PCA 2 was not purged with fresh air as described in Section 4.8, then the analyzer may remain ON with its pump running and display the message "PURGING SENSORS" as the result of combustion gases still being present inside the analyzer. At this time the operator should ensure that the probe is removed from the stack, allowing the analyzer to purge itself with fresh air. The 5-second-shutdown sequence will not begin until the gas levels inside the analyzer drop below predetermined levels:

> **TIP:** *Although not recommended, the purging process can be bypassed by pressing the* **I/O** *button a second time.*

4.11 Low Battery Alarm

When the batteries are nearly depleted, an empty battery icon appears in the upper-right corner of the display, and a short beep is sounded every 10 seconds.

After a low battery alarm occurs, the analyzer will continue to operate for only a few minutes. The amount of operating time that remains depends on many factors (e.g., pump and backlight being ON or OFF, and the type and condition of the batteries).



4.12 Data Logging

When the logging function is activated, up to 500 combustion test records will be automatically stored in memory at a preset interval (1, 5, 10, 15, 30 seconds, 1, 2, 5, 10 minutes) over a predetermined duration (5, 10, 15, 30 minutes, 1, 2, 5, 10, 24, 48 hours).

The maximum duration that data can be collected is determined by the interval. For example, if the interval is set to 10 seconds, then the maximum selectable length of time in which data can be collected to fill 500 memory locations would be 1 hour (500 x 10 seconds = 5000 seconds or 83 minutes). If the operator chooses a duration that is longer than possible for the interval chosen, then the analyzer automatically selects the highest duration possible for the selected interval.

The stored logged data can either be viewed on the display using the analyzer's memory function (refer to Section 4.13), or downloaded to a personal computer using the supplied PCA 2 data recovery software and USB cable (refer to Section 4.14). Downloaded data is stored on the computer's hard drive as a comma-separated-value ASCII text file with a CSV extension, which can be opened by most spreadsheet programs for analysis.

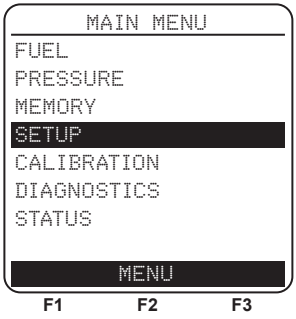
> **TIP:** *The latest PCA 2 data recovery software can be downloaded from http://www.bacharach-inc.com/downloads.*

4.12.1 Turning ON Data Logging

IMPORTANT: *Before turning ON data logging and starting the data logging process, the analyzer should already be set up to perform a combustion test per Section 4.5.*

Turn ON data logging as follows:

1. Display the MAIN MENU by pressing the **MENU (F2)** button. If necessary, press **ESC** until MENU appears above **F2**.



2. Use the ▲▼ buttons to highlight SETUP, and then press **ENT** to display the SETUP MENU.

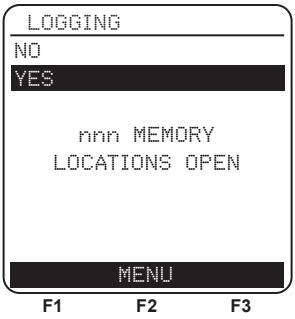
3. Use the ▲▼ buttons to highlight LOGGING, and then press **ENT** to display the LOGGING screen.

TIP: *The amount of memory available for storing new data is displayed in the LOGGING screen (maximum of 500 locations). If previous logging sessions are stored, and additional memory is needed, clear the logging memory per Section 4.13.3.*

NOTE: *At no time will new logging data over write old data.*

4. Use the ▲▼ buttons to highlight YES (turn logging ON).

5. Press **ENT** to make the selection and display the LOGGING INTERVAL screen.



Where: “nnn” is the number of memory locations available to store data.

4.12.2 Setting the Logging Interval and Duration

The logging interval is the length of time between measurements, while the logging duration is the time allocated to the logging process. Set the logging interval and duration as follows:

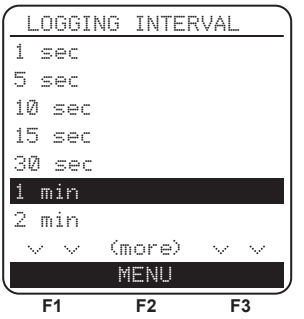
> **TIP:** *If the duration is set for more than 10 hours, we recommend using the optional AC power adapter to power the analyzer.*

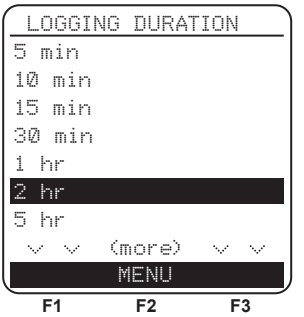
1. As soon as logging is turned ON as described in Section 4.12.1, the LOGGING INTERVAL screen appears.

2. Use the ▲▼ buttons to highlight the desired interval, and then press **ENT** to make the selection and display the LOGGING DURATION screen. In this example, 1 minute has been selected

3. Use the ▲▼ buttons to highlight the desired duration, and then press **ENT** to make the selection and display the LOGGING SUMMARY screen. In this example, 2 hours has been selected.

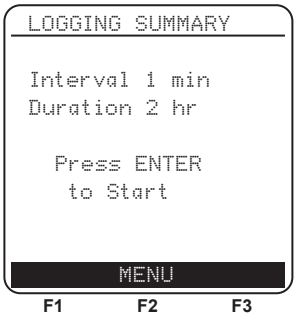
   NOTE: *If the selected duration requires more memory than is currently available, then the analyzer will automatically select the longest duration possible for the selected interval.*





4.12.3 Starting the Data Logging Process

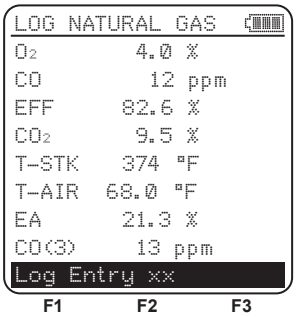
After turning ON data logging and setting the interval and duration, the analyzer will pause at the LOGGING SUMMARY screen, where the currently selected interval and duration time periods are displayed.



Press **ENT** to start the combustion test and logging process. At this time the Combustion Test LOG screen will appear, indicating that the analyzer is now performing a combustion test and the data is being stored in memory.

Note the following:

- At the bottom of the screen, the memory location where the current log entry is being saved is displayed. This number also represents the *total* number of test records that are stored in memory.
- If there were previously stored log entries, each new logging session will start to store data in the next available memory location.
- At no time will new data overwrite old data.



Where: “xx” is the memory location where the current log entry is being saved.

- The **ENT** button can be pressed while logging to view the other Combustion Test screens.

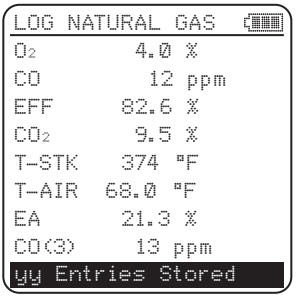
4.12.4 Ending the Data Logging Process

Data logging will stop and the pump will turn OFF after the prescribed duration, or after all 500 memory locations are filled.

To exit the Combustion Test LOG screen, press the **RUN/HOLD** button *twice* to display the Combustion Test HOLD screen.

Note the following:

- To end the logging process at any time, press the **ESC** button.
- At the end of the logging period, or if the **ESC** button was pressed, the total number of log entries that were stored during that period appear at the bottom of the screen.



Where: “yy” is the number of log entries stored during the last logging session.

- If the logging process was stopped by pressing **ESC**, it cannot be resumed without first turning logging back ON per Section 4.12.1.

4.13 Memory

There are two memory banks, each containing 500 memory locations. The first bank is used to store combustion test data as described in Section 4.7., while the second bank is used to store logged combustion test data as described in Section 4.12. Each bank is independent of each other, and cannot share data or be combined.

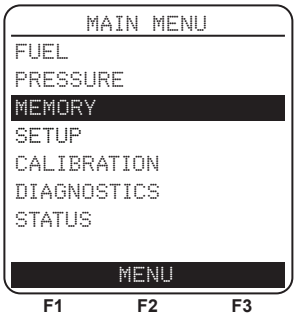
Individual memory locations in each memory bank can be recalled for viewing on the display or printed (refer to Sections 4.13.1 & 4.13.2), or the entire contents of each memory bank can be individually downloaded to a computer and viewed in a spreadsheet program for analysis (refer to Section 4.14).

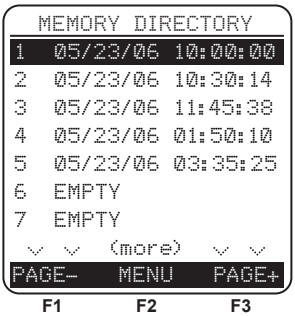
> **TIP:** *When displaying the contents of either memory bank, the operator can quickly page through the screens by pressing the* **PAGE– (F1)** *and* **PAGE+ (F3)** *buttons. Or move to the first or last memory location by pressing the ◄► buttons, respectively.*

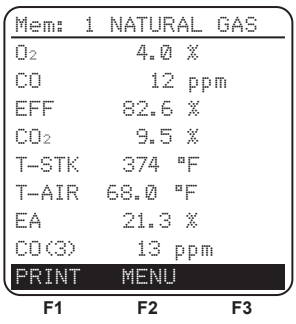
4.13.1 Recalling Combustion Test Data

Recall individual combustion test data records as follows:

1. Display the MAIN MENU by pressing the **MENU (F2)** button. If necessary, press **ESC** until MENU appears above **F2**.
2. Use the ▲▼ buttons to highlight MEMORY, and then press **ENT** to display the MEMORY MENU.
3. Use the ▲▼ buttons to highlight MEMORY DIRECTORY, and then press **ENT** to display the MEMORY DIRECTORY screen.
4. Use the ▲▼ buttons to highlight the desired memory location to be recalled. Each memory location is identified by the date and time at which data was saved. The word EMPTY signifies that the memory location does not contain data.
5. Press **ENT** to display the data contained in the selected memory location.







Note the following:

- The top line of the recalled combustion test data screen shows the memory location being viewed. In this example, “MEM: 1” is being displayed
- The **ENT** button can be pressed to view other memory test data screens.
- The recalled combustion test data can be printed by pressing the **PRINT (F1)** button (refer to Section 4.16).

4.13.2 Recalling Logged Test Data

Recall individual logged combustion test data records as follows:

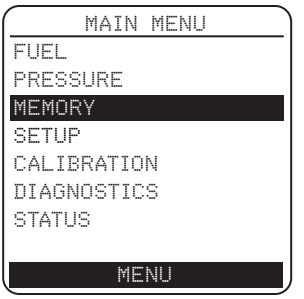
1. Display the MAIN MENU by pressing the **MENU (F2)** button. If necessary, press **ESC** until MENU appears above **F2**.

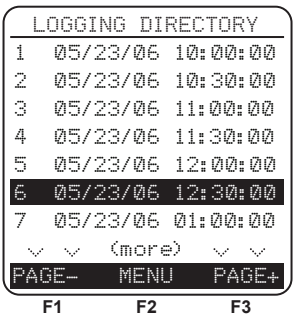
2. Use the ▲▼ buttons to highlight MEMORY, and then press **ENT** to display the MEMORY MENU.

3. Use the ▲▼ buttons to highlight LOGGING DIRECTORY, and then press **ENT** to display the LOGGING DIRECTORY screen.

4. Use the ▲▼ buttons to highlight the desired data logging location to be recalled. Each logging location is identified by the date and time at which the data was saved. The word EMPTY signifies that the logging location does not contain data.

5. Press **ENT** to display the logging data contained in the selected memory location.



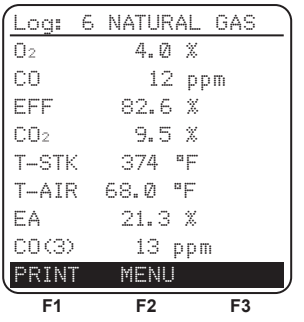


Note the following:

- The top line of the log test data screen shows the log location being viewed. In this example, “Log: 6” is being displayed.

- The **ENT** button can be pressed to view other log test data screens.

- The recalled logged test data can be printed by pressing the **PRINT (F1)** button (refer to Section 4.16).



4.13.3 Clearing Memory

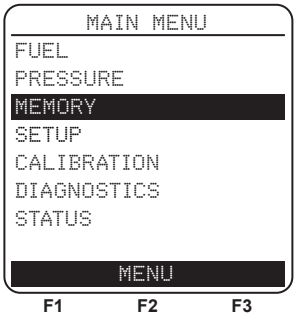
When all memory ("snap shot") locations used to store individual combustion test records have been filled, the *next* combustion test record saved will overwrite the oldest.

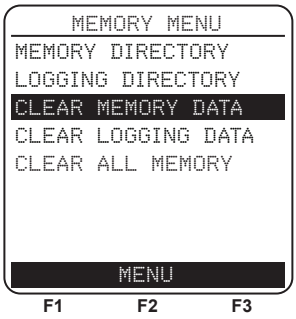
When all logging memory locations in the logging directory are full, they must be manually cleared in order to store new data. At no time will the logging process overwrite older data.

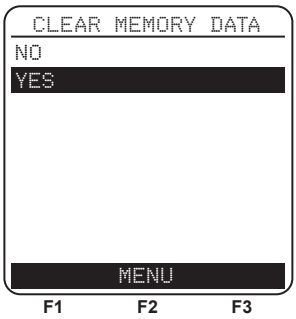
Each memory bank can be individually cleared, or all memory locations in both banks can be cleared simultaneously.

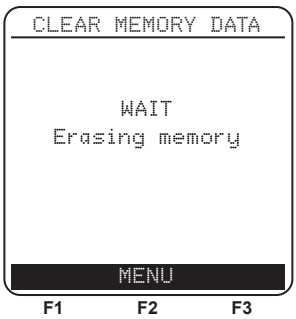
Do the following to clear memory:

1. Display the MAIN MENU by pressing the **MENU (F2)** button. If necessary, press **ESC** until MENU appears above **F2**.
2. Use the ▲▼ buttons to highlight MEMORY, and then press **ENT** to display the MEMORY MENU.
3. Use the ▲▼ buttons to highlight one of the following:
   - CLEAR MEMORY DATA clears only the individual saved combustion test records.
   - CLEAR LOGGING DATA clears only the combustion test records that were saved during the logging process.
   - CLEAR ALL MEMORY clears all memory locations in both memory banks.
4. Press **ENT** to display the CLEAR MEMORY, LOGGING, or ALL DATA conformation screen. Highlight YES to confirm that memory is to be cleared, and then press **ENT** to actually clear memory as evidenced by the display of the "WAIT Erasing memory" screen.









4.14 Downloading Stored Data to a Computer

The combustion test data that was stored in either the analyzer's Memory Directory (Section 4.7), or Logging Directory (Section 4.12), can be downloaded to a computer using the PCA 2 Data Recovery Program and USB cable that are supplied with the analyzer.

The following procedures assume that the operator is familiar with creating folders and navigating the file structure of the Windows operating system. If necessary, consult the Windows help files for instructions on how to perform these procedures.

The downloaded data is stored on the computer's hard drive – or removable media of the operator's choosing – as a comma-separated-value ASCII text file with a CSV extension. This type of file can be opened by most spreadsheet programs for analysis.

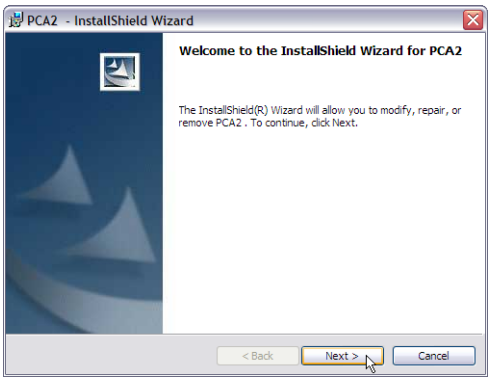
Computer requirements:

- Windows 98SE or higher
- CD ROM drive
- USB 1.1 or USB 2.0 port
- 12 MB of hard drive space for the PCA 2 data recovery program, plus up to an additional 350 KB for each download

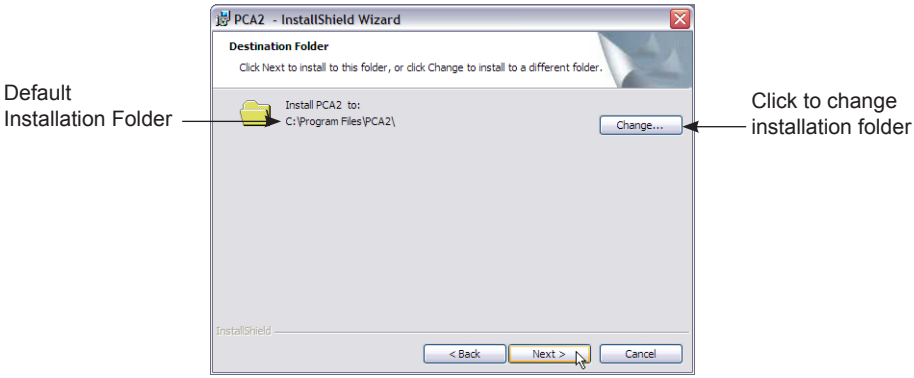
4.14.1 PCA 2 Data Recovery Program Installation

The PCA 2 Data Recovery Program is supplied with the analyzer on a CD (P/N 24-1425). Install this program as follows:

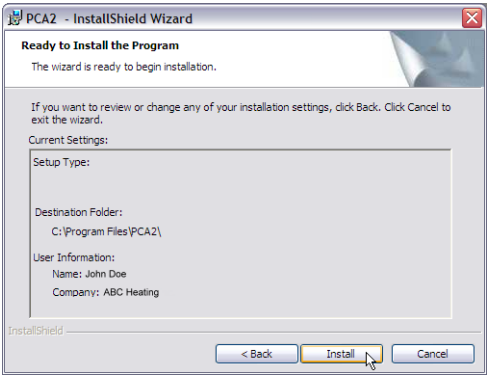
1. Insert the PCA 2 CD into the computer's CD-ROM drive.
2. Locate the CD-ROM drive in Windows Explorer and open the PCA2 folder. Double-click the Setup.exe program to start the installation process.
3. Click Next on the "Welcome to the InstallShield Wizard for PCA2" window.



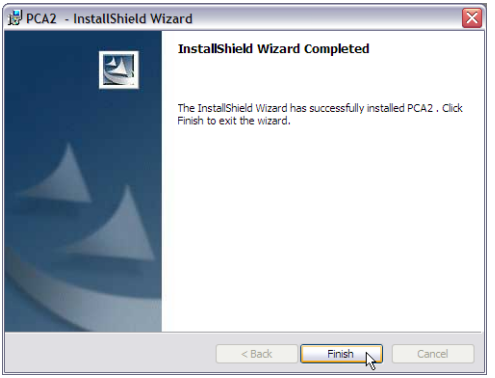
4. Click Next to accept the default destination folder, or click Change to install to a different folder.



5. Click Install to confirm the destination folder and user information.



6. Click Finish after all files have been copied into the destination folder.



7. At this time the PCA2 Data Recovery Program icon should appear under "Start All Programs menu.

8. This completes the installation of the software. Remove CD from drive.

4.14.2 Computer to PCA 2 Connection & USB Device Driver Installation

Connect the USB cable (P/N 104-4032) that was supplied with the PCA 2, and, if necessary, install the analyzer's USB device driver as follows:

1. With both the PCA 2 and computer turned ON, insert the appropriate ends of the USB cable into the USB connectors on the PCA 2 and computer as shown in Figure 4-2.

2. If this is the first time the PCA 2 is being connected to the computer, then the "Found New Hardware Wizard" should shortly appear. Select "No, not this time" and click Next>.

NOTE: *The USB device driver only needs to be installed once. It does not require to be re-installed each time the PCA 2 is connected to the computer.*

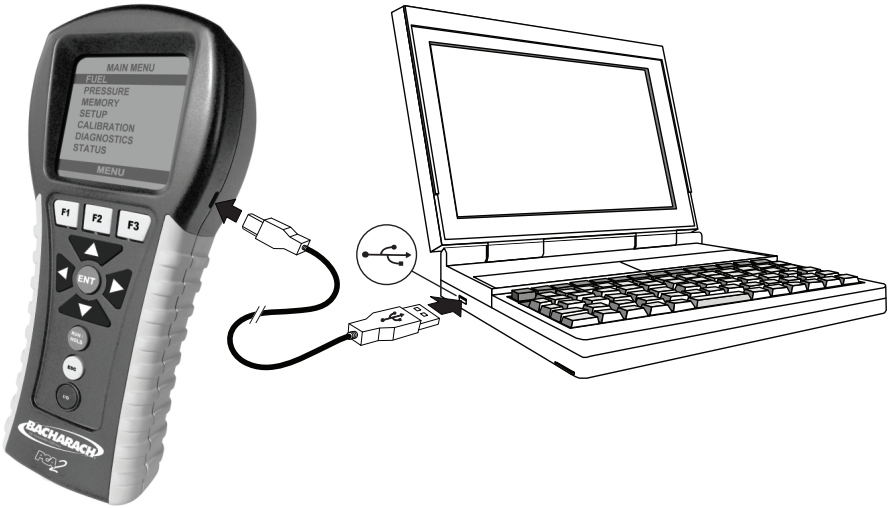
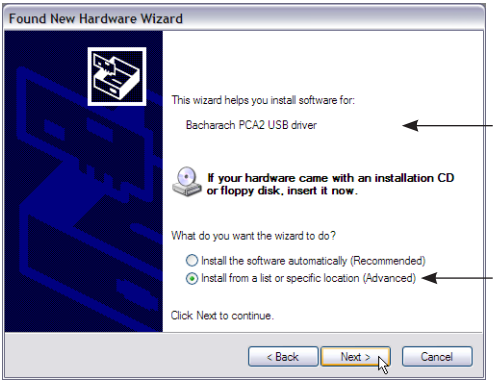
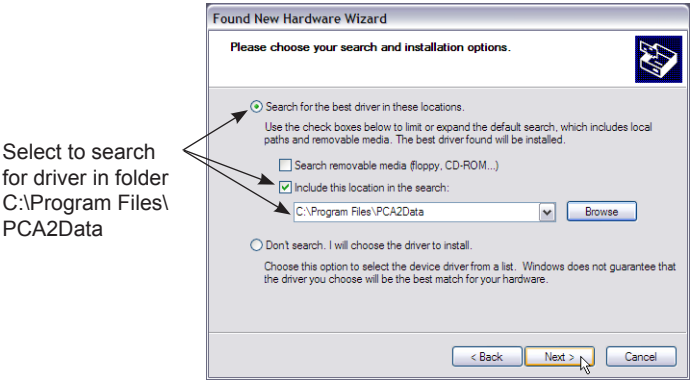


Figure 4-2. Computer to PCA 2 Connection

3. Select “Install from a list or specific location (Advanced)” and click Next>.

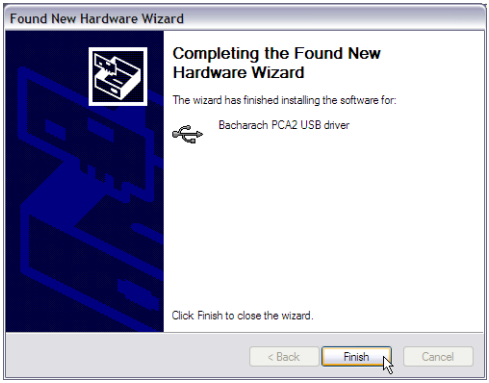


4. Select to search for the best driver and then browse to folder C:\Program Files\PCA2Data. Click Next>.



5. At the Hardware Installation window, click Continue Anyway.
Our driver has been thoroughly tested in Windows for stability. This message appears because Microsoft has not tested this product through WHQL certification.

6. After the Found New Hardware Wizard has finished installing the software, click Finish to close the Wizard.



4.14.3 Recovering Data

Before data can be recovered from the analyzer, install the PCA 2 Data Recovery Program, USB cable, and USB device driver as described in Sections 4.14.1 and 4.14.2.

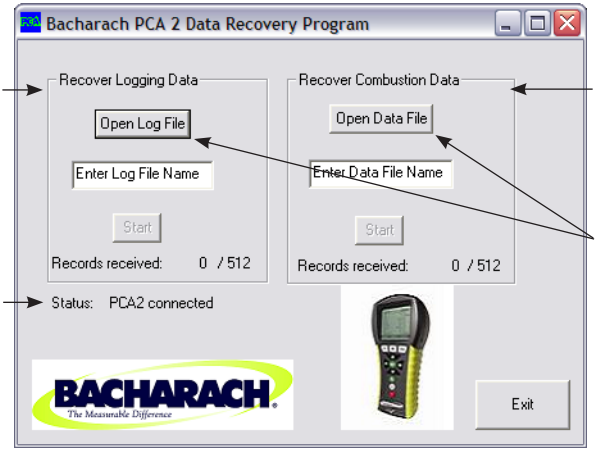
Recover either the logging or combustion data as follows:

1. Start the program by either double-clicking the PCA2 icon on the Windows desktop, or clicking the PCA2 shortcut in start menu. The “Bacharach PCA 2 Data Recovery Program” window should appear.

   Observe that the window is divided into two sections. The left-hand section is used to recover logging data, while combustion data is recovered from the right-hand section.

   In the following steps, the logging data will be recovered. The same procedure can be used to recover combustion data using the right-hand section of the window.

2. Select where the downloaded file containing the recovered data will be located and give it a filename by clicking the Open Log File button. The following example screens show that the downloaded file will be placed into a pre-existing *PCA2 Logging Data* folder and given the filename *Customer XYZ*.

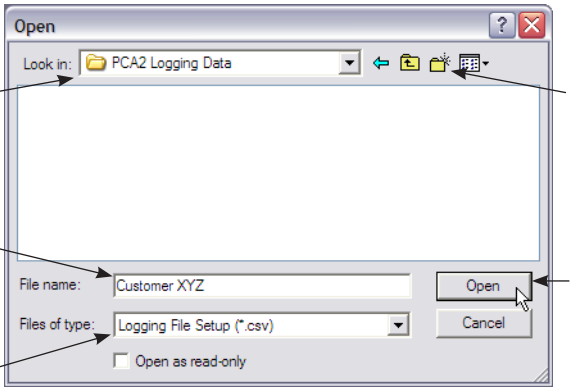


Use this section of window to Recover Logging Data

Use this section of window to Recover Combustion Data

Start the download process by clicking the desired **Open Log / Data File** button

Status line showing PCA 2 is successfully connected to the computer



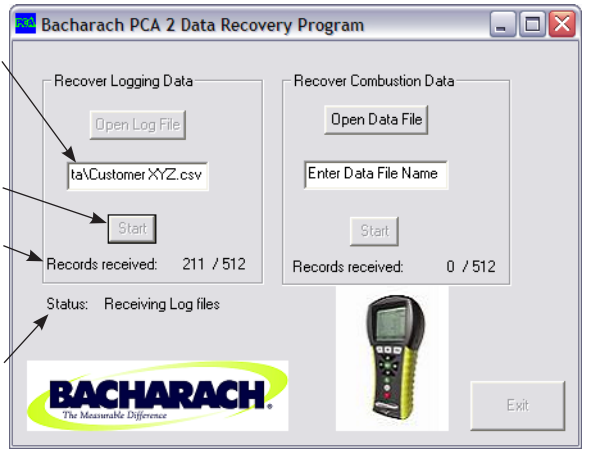
Select a pre-existing folder or create a new folder to store the downloaded file

Click here to create a new folder

Enter filename

Click **Open** after selecting a folder and entering a filename

File type preset to *.cvs



Location of downloaded file

Click **Start** to begin the download process

Total number of records received out of 512 total

Status line showing files are currently being received

NOTE: *The filename is automatically given a CSV (Comma Separated Value) extension, allowing the file to be directly opened by most spreadsheet programs for analysis.*

3. After selecting a folder and entering the filename, click Open and then click Start to begin the download process.

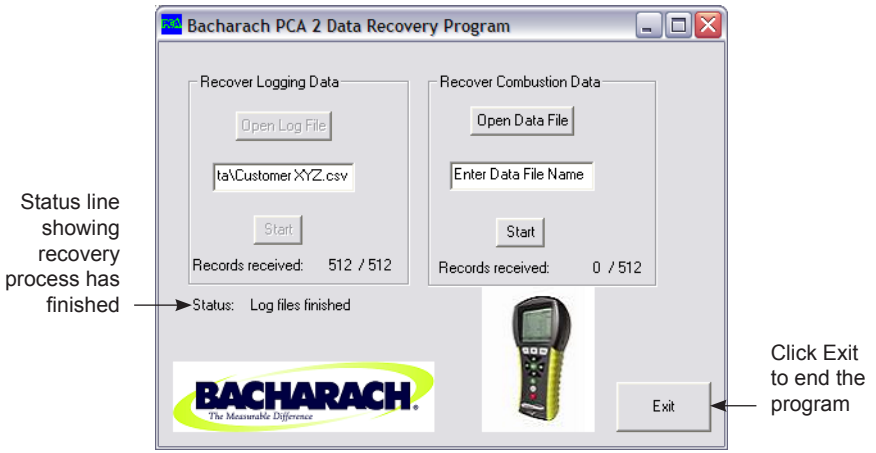
   While recovering the stored data, observe that the "Records received" line displays the total number of records currently downloaded. And after all records have been received, the Status line will read "Log files finished."

   NOTE: *The "Records received" line will shown that 512 files have been received, regardless of how many memory locations actually contained data. This occurs because the program checks for data in all 500 memory locations, including 12 additional locations that contain sensor calibration data.*

   Note that the 12 files that contain sensor calibration data are saved in a separate "CalibrationData.csv" file. This file is automatically created and placed in the same folder that was selected in Step 2.

4. This completes the process of recovering logging data. Either click Exit to close the program, or proceed to recover the combustion data by starting over at Step 2, but this time using the right-hand section of the "Bacharach PCA 2 Data Recovery Program" window.

   NOTE: *Once either the logging data or combustion data has been recovered, that portion of the recovery program's window will turn gray.*

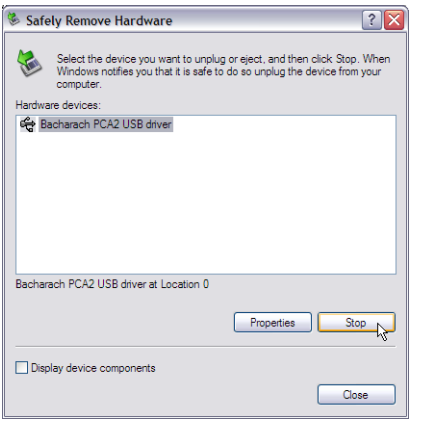


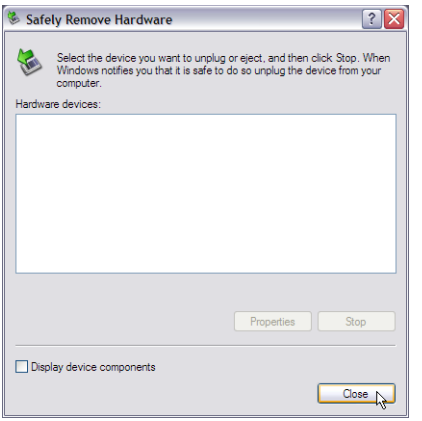
4.14.4 Unplugging the USB Cable

CAUTION: *To avoid possible electronic damage to the analyzer, it is **not** advisable to unplug the USB cable without first turning OFF the PCA 2 USB connection using the "Safely Remove Hardware" icon in the Windows XP system tray.*

Do the following before unplugging the USB cable:

1. Double-click the "Safely Remove Hardware" icon in the Windows XP system tray.
2. If more than one USB device is plugged into the computer, select the device labeled "Bacharach PCA2 USB driver" and then click Stop.
3. Click OK to confirm that the device is to be stopped.
4. Wait until "Bacharach PCA2 USB driver" is removed from the screen, and then click Close.
5. The USB cable can now be safely unplugged.





4.15 Importing Saved Data Into a Spreadsheet

Data that was recovered and saved as an ASCII text file with a "CSV" extension, as described in Section 4.14, can easily be opened for viewing in most spreadsheet programs by simply double-clicking the filename. For example: double-clicking the filename *Customer XYZ.csv* should automatically open the spreadsheet program and display the contents of the file.

If the spreadsheet program does not recognize the "CSV" file extension, then refer to the spreadsheet's documentation for information on how to manually import comma-delimited text files.

Table 4-2 contains a listing and description of the 27 data fields that are downloaded with each data record. Note that for sensors that are not installed, all related data fields for those sensors will be marked as "N/A" (Not Applicable). For example: if the analyzer does not contain an SO_2 sensor, then "N/A" will appear in data fields 19 and 20.

TABLE 4-2. DOWNLOADED DATA FIELDS

Field	Column Name	Data Name or Value
1	Time	Time of Test in 12 hour format (AM / PM)
2	Date	Date of Test in mm/dd/yy
3	Fuel	Fuel Name
4	%O2	Oxygen Level
5	CO	Carbon Monoxide Level (see field 26)
6	ppm CO(O2)	Carbon Monoxide Level referenced to a % of O_2 (see field 21)
7	%Efficiency	Combustion Efficiency
8	%CO2	Carbon Dioxide Level
9	TStk	Stack Temperature
10	TAir	Primary / Ambient Air Temperature
11	TempUnit	Temperature Units
12	%EA	Excess Air
13	NO	Nitric Oxide Level (see field 26)
14	ppm NO(O2)	Nitric Oxide Level referenced to a % of O_2 (see field 22)
15	NO2	Nitrogen Dioxide Level (see field 26)
16	ppm NO2(O2)	Nitrogen Dioxide Level referenced to a % of O_2 (see field 22)
17	NOx	Nitrogen Oxides (NO + NO_2) (see field 26)
18	ppm NOx(O2)	Nitrogen Oxides Level referenced to a % of O_2 (see field 22)
19	SO2	Sulfur Dioxide (see field 26)
20	ppm SO2(O2)	Sulfur Dioxide Level referenced to a % of O_2 (see field 23)
21	CO_O2Ref	$\%O_2$ Reference for CO (1)
22	NOx_O2Ref	$\%O_2$ Reference for NOx (1)
23	SO2_O2Ref	$\%O_2$ Reference for SO_2 (1)
24	Pressure	Pressure (Draft) Value
25	Pressure Units	Pressure Units of Measure (2)
26	Pollution Units	Pollution Units of Measure (3)
27	PS Voltage	Power Supply Voltage
28	NO Temp	Nitric Oxide Sensor Temperature (4)

(1) $\%O_2$ reference as selected per Section 3.11
(2) Pressure units as selected per Section 3.7
(3) Pollution units as selected per Section 3.8
(4) Shown only on printout, not on LCD display.

4.16 Printing Test Data

Combustion or pressure data that is currently being displayed can be sent to a printer using IrDA protocol as described below.

Data that is stored in memory can also be printed by first displaying the stored test data as described in Sections 4.13.1 & 4.13.2.

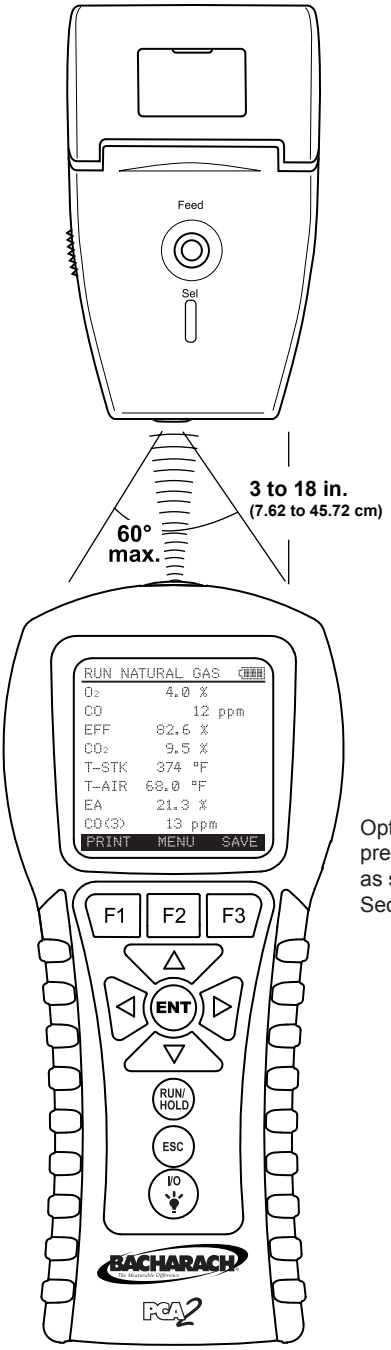
In addition to printing combustion and pressure data, the contents of any screen that shows the label "PRINT" above the **F1** button can be printed. For example, the information shown in the DIAGNOSTIC screen can be printed.

1. Turn ON printer. Refer to the printer's instruction manual for detailed operating information. If not already done, set up the printer for:
   - 8 bit
   - No parity
   - 9600 baud
   - IrDA is set to IrDA-SIR
   - DTR handshaking

2. Align the printer with the top of the analyzer as shown in Figure 4-6.

3. Press the **PRINT (F1)** button to begin printing.

   The printout shown in Figure 4-6 shows typical combustion-test results of an analyzer containing O_2, CO_{LOW}, NO, and NO_2 sensors. Note that since the CO_{HIGH} and SO_2 sensors are not installed, three stars (***) appear in their data fields.



Optional pressure printout as selected per Section 3.12.

BACHARACH, INC.
PCA 2
SN: xxxxxx
==========
TIME 01:00:00 PM
DATE 10/06/06

FUEL
NATURAL GAS

O2	4.0	%
CO	12	ppm
EFF	82.6	%
CO2	9.5	%
T-STACK	374	°F
T-AIR	68.0	°F
EA	21	%
NO	18	ppm
NO Temp	70.5	°F
NO2	6	ppm
NOX	24	ppm
SO2	***	ppm
CO(3)	13	ppm
NO(3)	19	ppm
NO2(3)	6	ppm
NOX(3)	25	ppm
SO2(3)	***	ppm

PRESSURE –0.25 inwc

COMMENTS:

NOTES:

Three stars (***) appear in the data field of sensors that are not calibrated or defective, and in the data fields of that sensor's related calculated values.

Three hyphens or dashes (---) indicate that the calculated data cannot be displayed because the measured data necessary to make the calculation is out of range (i.e., oxygen level above 16%).

Three (XXX) indicate sensor over-range.

Figure 4-3. Printer Alignment & Sample Printout

Notes:

5 Calibration

IMPORTANT: *Before performing any calibration procedure, ensure that fresh batteries are installed or use the optional AC power adapter. Also ensure that the analyzer is at room temperature and will be sampling fresh air when turned ON.*

5.1 Smart Sensors

The PCA 2 uses Bacharach's new "Smart Sensor" technology, meaning that the calibration data for each sensor is stored in nonvolatile memory on the sensor's printed circuit board.

Benefits of Smart Sensors:

- New sensors can be installed without needing to be calibrated.
- Sensors can be pre-calibrated and installed when needed.
- Sensors can be moved from one analyzer to another.
- The analyzer's diagnostics screen shows what sensors are installed, and their current end-of-life condition (Good, Low, Bad).
- Each sensor stores its calibration history and operating parameters, which can be downloaded to a computer and analyzed. This information is useful in determining when the sensor was last calibrated, and predicting its end-of-life.

The smart sensors should be calibrated by an authorized Bacharach Service Center (Section 8.3) every 6 months to assure that the analyzer continues to meet its published accuracy specifications. The smart sensors, however, can be calibrated in the field if your facility has the necessary equipment and qualified personnel to perform the procedures described in the following sections of this instruction manual.

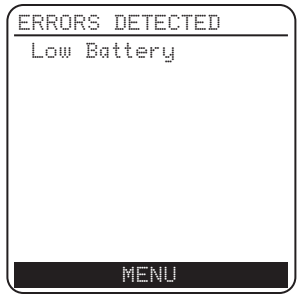
5.2 Starting a Calibration

Start any calibration procedure by doing the following:

1. Place the probe in an area of fresh air, turn ON the analyzer, allowing it to cycle through its 60 second warm-up period. During warm-up, the analyzer's operation is checked and the sensors are set to the following ambient conditions:

   - Oxygen sensor spanned to 20.9%
   - All gas sensors are zeroed
   - The pressure sensor is zeroed

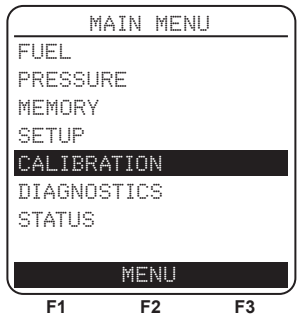
Any errors detected during warm-up will be listed on the display immediately following warm-up. For example, the screen to the right shows that the battery is low. Correct any errors before proceeding. Refer to Section 7.3 for a listing of error messages and their meaning.



2. Display the MAIN MENU by pressing the **MENU (F2)** button. If necessary, press **ESC** until MENU appears above **F2**.

3. Use the ▲▼ buttons to highlight CALIBRATION, and then press **ENT** to display the CALIBRATION LIST screen.

4. Use the ▲▼ buttons to highlight the sensor to be calibrated, and then perform the calibration procedure for that sensor as described in the following sections.



5.3 Pressure Sensor Calibration

This procedure calibrates the pressure sensor to a known pressure value.

Material Required:

- Bellows
- Manometer
  - Range: ±8 in. of water column (±20 mb)
  - Accuracy: ±0.01 in. of water column (±0.025 mb)

Procedure:

NOTE: *The unit-of-measure for pressure is selected per Section 3.7. In the following procedure inwc is selected, but note that any unit-of-measure can be used for calibration purposes.*

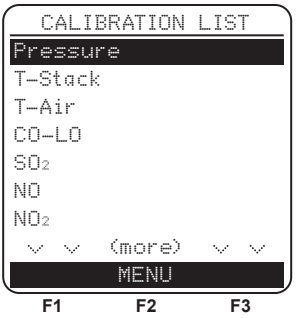
1. Assemble the pressure sensor calibration equipment as shown in Figure 5-1, but **DO NOT** connect the analyzer to the calibration equipment at this time.

2. If not already done, turn ON the analyzer and display the CALIBRATION LIST screen per Section 5.2.

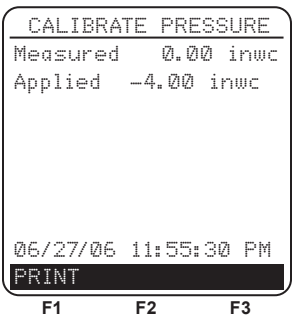
3. Use the ▲▼ buttons to highlight Pressure, and then press **ENT** to dis-

play the CALIBRATE PRESSURE screen.

"Measured" is the pressure value currently being detected by the pressure sensor, while "Applied" is a known value of pressure that will be applied for calibration purposes.



4. With both the –ΔP and +ΔP ports open to the atmosphere, observe that the current Measured pressure reading should be 0 ±0.01 inwc. If necessary, zero the pressure sensor per Section 4.6, and repeating Steps 2 thru 4.



5. Connect the hose from the manometer to the +ΔP port and apply a *negative* pressure to this port by adjusting the bellows for a manometer reading of –4.00 ±2.00 inwc.

6. Use the ▲▼ and ◄► buttons to enter an Applied value that exactly equals the manometer reading.

   The calibration range is from –6 to –2 inwc (–15 to –5 mb). An attempt to calibrate outside this range will cause the message "Bad Calibration Wrong CAL Entry" to appear in the following step.

7. Wait until the Measured reading stabilizes, and then press **ENT** to calibrate the pressure sensor's Measured value to that of the Applied value; after which the message "Good Calibration" should briefly appear followed by the CALIBRATION LIST screen being re-displayed.

8. Remove calibration equipment.

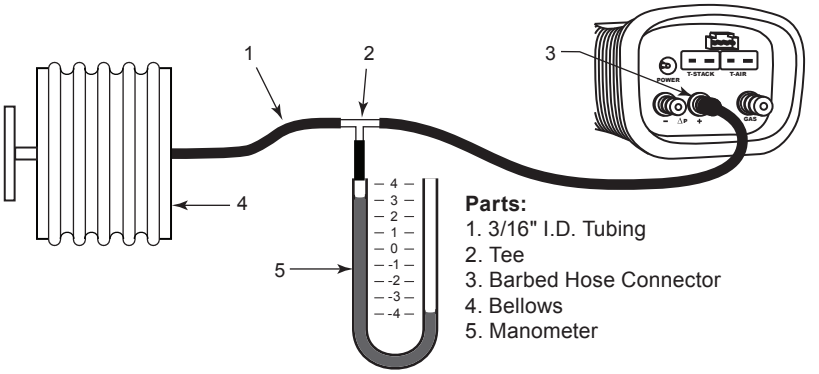


Figure 5-1. Pressure Sensor Calibration Equipment

5.4 T-Stack Calibration

This procedure first *zeros* and then *spans* the stack-temperature channel to known temperature values.

The use of an electronic thermocouple simulator is the preferred method of producing the desired calibration temperatures. Alternatively, containers of ice water and boiling water can be used.

Material Required:

- Thermocouple Simulator (K-type)
  - Range: 0 to 600 °F
  - Accuracy: ±0.5 °F
- (Alternatively) Ice-Water, Boiling Water, Thermometer

TS-Zero Procedure:

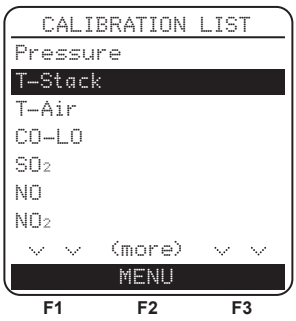
1. Set thermocouple simulator to room temperature and plug its output into the T-STACK connector located at the bottom of the analyzer.

   Alternatively: Plug the probe's thermocouple into the T-STACK connector located at the bottom of the analyzer. **DO NOT attach the probe's gas hose to the analyzer's GAS port; otherwise water will be drawn into the analyzer!**

2. If not already done, turn ON the analyzer and display the CALIBRATION LIST screen per Section 5.2.

3. Use the ▲▼ buttons to highlight T-Stack, and then press **ENT** to display the CALIBRATE TS-ZERO screen.

   "Measured" is the current temperature reading, while "Applied" is a known temperature that will be applied for calibration purposes.

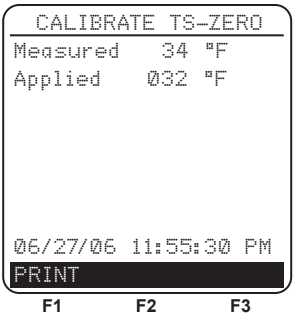


4. Set thermocouple simulator to 32 °F (0 °C), and then use the ▲▼ and ◄► buttons to enter an Applied value that exactly equals the setting of the simulator.

   Alternatively: Submerge probe tip into an ice-water bath with a thermometer, wait several minutes, and then use the ▲▼ and ◄► buttons to enter an Applied value that exactly equals the thermometer reading.

   The calibration range is from 32 to 41 °F (0 to 5 °C). An attempt to calibrate outside this range will cause the message "Bad Calibration Wrong CAL Entry" to appear in the following step.

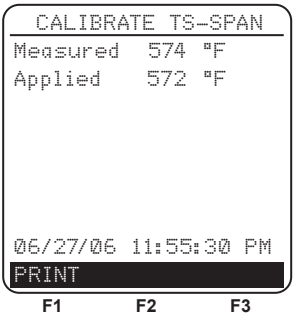
5. Wait until the Measured reading stabilizes, and then press **ENT** to calibrate the TS-Zero Measured value to that of the Applied value; after which the message "Good Calibration" should briefly appear followed by the CALIBRATE TS-SPAN screen.



TS-Span Procedure:

6. Set thermocouple simulator to 572 °F (300 °C), and then use the ▲▼ and ◄► buttons to enter an Applied value that exactly equals the setting of the simulator.

   Alternatively: Submerge probe tip into a container of boiling water with a thermometer, wait several minutes, and then use the ▲▼ and ◄► buttons to enter an Applied value that exactly equals the thermometer reading.



   The calibration range is from 175 to 625 °F (80 to 330 °C). An attempt to calibrate outside this range will cause the message "Bad Calibration Wrong CAL Entry" to appear in the following step.

7. Wait until the Measured reading stabilizes, and then press **ENT** to calibrate the TS-Span Measured value to that of the Applied value; after which the message "Good Calibration" should briefly appear followed by the CALIBRATION LIST screen being re-displayed.

5.5 T-Air Calibration

This procedure first *zeros* and then *spans* the ambient-temperature channel to known temperature values.

The use of an electronic thermocouple simulator is the preferred method of producing the desired calibration temperatures. Alternatively, containers of ice water and boiling water can be used.

Material Required:

- Thermocouple Simulator (K-type)
  - Range: 0 to 600 °F
  - Accuracy: ±0.5 °F
- (Alternatively) Ice-Water, Boiling Water, Thermometer

TA-Zero Procedure:

1. Set thermocouple simulator to room temperature and plug its output into the T-AIR connector located at the bottom of the analyzer.

   Alternatively: Plug the probe's thermocouple into the T-AIR connector located at the bottom of the analyzer. **DO NOT attach the probe's gas hose to the analyzer's GAS port; otherwise water will be drawn into the analyzer!**

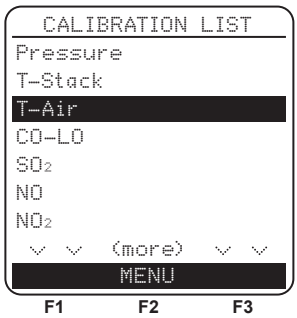
2. If not already done, turn ON the analyzer and display the CALIBRATION LIST screen per Section 5.2.

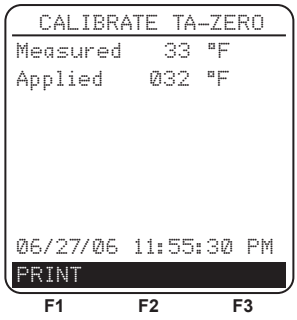
3. Use the ▲▼ buttons to highlight T-Air, and then press **ENT** to display the CALIBRATE TA-ZERO screen.

   "Measured" is the current temperature reading, while "Applied" is a known temperature that will be applied for calibration purposes.

4. Set thermocouple simulator to 32 °F (0 °C), and then use the▲▼ and ◄► buttons to enter an Applied value that exactly equals the setting of the simulator.

   Alternatively: Submerge probe tip into an ice-water bath with a thermometer, wait several minutes, and then use the ▲▼ and ◄► buttons to enter an Applied value that exactly equals the thermometer reading.





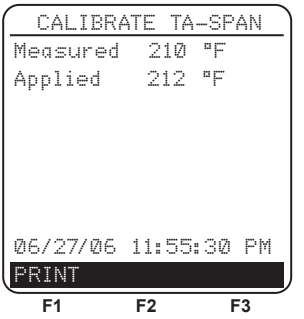
The calibration range is from 32 to 41 °F (0 to 5 °C). An attempt to calibrate outside this range will cause the message "Bad Calibration Wrong CAL Entry" to appear in the following step.

5. Wait until the Measured reading stabilizes, and then press **ENT** to calibrate the TA-Zero Measured value to that of the Applied value; after which the message "Good Calibration" should briefly appear followed by the CALIBRATE TA-SPAN screen.

TA-Span Procedure:

6. Set thermocouple simulator to 212 °F (100 °C), and then use the ▲▼ and ◄► buttons to enter an Applied value that exactly equals the setting of the simulator.

   Alternatively: Submerge probe tip into a container of boiling water with a thermometer, wait several minutes, and then use the ▲▼ and ◄► buttons to enter an Applied value that exactly equals the thermometer reading.



   The calibration range is from 194 to 230 °F (90 to 110 °C). An attempt to calibrate outside this range will cause the message "Bad Calibration Wrong CAL Entry" to appear in the following step.

7. Wait until the Measured reading stabilizes, and then press **ENT** to calibrate the TA-Span Measured value to that of the Applied value; after which the message "Good Calibration" should briefly appear followed by the CALIBRATION LIST screen being re-displayed.

5.6 CO-LO Sensor Calibration

Note that the CO-LO sensor also measures H_2 for the purpose of compensating the CO reading for the presence of H_2 in the gas sample. This procedure first spans the CO-LO sensor and, optionally, spans the H_2 part of the sensor to known gas levels.

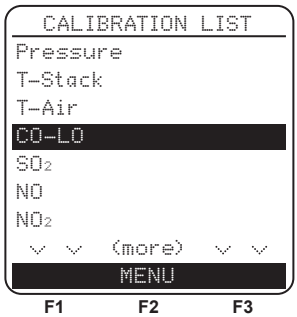
Material Required:

- Calibration Kit, P/N 24-7059
- Gas Cylinder: 500 ppm CO in air, P/N 24-0492
- Gas Cylinder: 1,000 ppm CO & 1,000 ppm H_2 in Nitrogen, P/N 24-0794

Procedure:

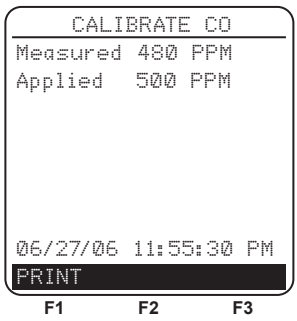
1. If not already done, turn ON the analyzer and display the CALIBRATION LIST screen per Section 5.2.
2. Use the ▲▼ buttons to highlight CO-LO, and then press **ENT** to display the CALIBRATE CO screen.

   "Measured" is the current CO reading, while "Applied" is a known CO level that will be applied for calibration purposes.



3. Attach a 500 ppm CO cylinder to the regulator of the calibration fixture shown in Figure 5-2 on Page 5-14.
4. Use the ▲▼ and ◄► buttons to enter an Applied value that exactly equals the concentration stamped on the CO cylinder.

   The calibration range is from 250 to 1,000 ppm. An attempt to calibrate outside this range will cause the message "Bad Calibration Wrong CAL Entry" to appear in the following step.



5. Adjust the regulator for a flowmeter indication of approximately 2 SCFH. Wait until the Measured reading stabilizes (approximately 3 minutes), and then press **ENT** to calibrate the CO Measured value to that of the Applied value. The message "Good Calibration" should briefly appear followed by the TEST GAS CO/H_2 screen.

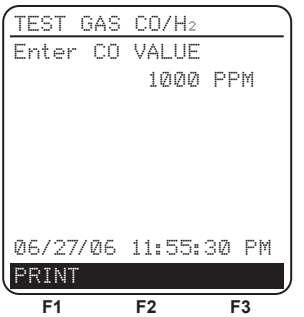
   *If the sensor's output is low, but still usable, then the message "Good Calibration WARNING Low Sensor" will appear. The sensor will now be marked as being **Low** in the DIAGNOSTICS screen.*

*If the sensor's output is too low to be usable, then the message "Bad Calibration Sensor End of Life, Entry Not Saved" will appear. The sensor will now be marked as being **BAD** in the DIAGNOSTICS screen.*

NOTE: *H_2 calibration can be bypassed by pressing the* **ESC** *button, after which the CALIBRATION LIST screen is re-displayed. Skip to Step 10 if the* **ESC** *button was pressed.*

6. Turn OFF the regulator of calibration fixture and remove the CO cylinder.

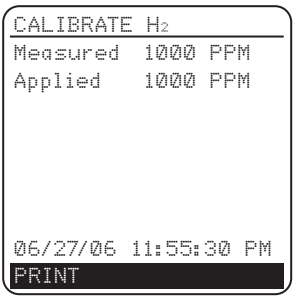
7. Attach a combination 1,000 ppm CO and 1,000 ppm H_2 cylinder to the regulator of the calibration fixture, and then use the ▲▼ and ◄► buttons to enter an Applied value that exactly equals the CO concentration stamped on the cylinder.



8. Adjust the regulator for a flowmeter indication of approximately 2 SCFH, and then press **ENT** to display the CALIBRATE H_2 screen.

The calibration range is from 400 to 1,500 ppm. An attempt to calibrate outside this range will cause the message "Bad Calibration Wrong CAL Entry" to appear in the following step.

9. Wait until the Measured reading stabilizes (approximately 3 minutes), and then press **ENT** to calibrate the H_2 Measured value to that of the Applied value; after which the message "Good Calibration" should briefly appear followed by the CALIBRATION LIST screen being re-displayed.



*If the sensor's output is low, but still usable, then the message "Good Calibration WARNING Low Sensor" will appear. The sensor will now be marked as being **Low** in the DIAGNOSTICS screen.*

*If the sensor's output is too low to be usable, then the message "Bad Calibration Sensor End of Life" will appear followed by the CALIBRATION LIST screen being re-displayed. The sensor will now be marked as being **BAD** in the DIAGNOSTICS screen.*

10. Turn OFF the regulator and remove the gas cylinder.

5.7 SO_2 Sensor Calibration

This procedure spans the optional sulfur dioxide sensor to a known gas level.

Material Required:

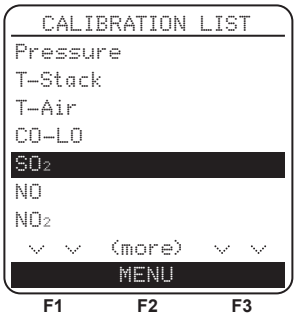
- Calibration Kit, P/N 24-7059
- Gas Cylinder: 100 ppm SO_2 in Nitrogen, P/N 24-1158

Procedure:

1. If not already done, turn ON the analyzer and display the CALIBRATION LIST screen per Section 5.2.

2. Use the ▲▼ buttons to highlight SO_2, and then press **ENT** to display the CALIBRATE SO_2 screen.

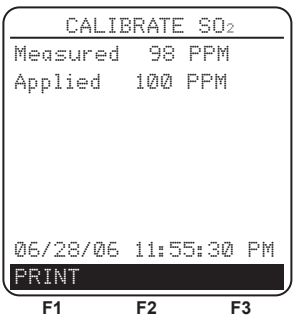
   "Measured" is the current SO_2 *reading, while "Applied" is a known* SO_2 *level that will be applied for calibration purposes.*



3. Attach a 100 ppm SO_2 cylinder to the regulator of the calibration fixture shown in Figure 5-2 on Page 5-14.

4. Use the ▲▼ and ◄► buttons to enter an Applied value that exactly equals the concentration stamped on the SO_2 cylinder.

   The calibration range is from 9 to 150 ppm. An attempt to calibrate outside this range will cause the message "Bad Calibration Wrong CAL Entry" to appear in the following step.



5. Adjust regulator for a flowmeter indication of approximately 2 SCFH. Wait until the Measured reading stabilizes (approximately 3 minutes), and then press **ENT** to calibrate the SO_2 Measured value to that of the Applied value. The message "Good Calibration" should briefly appear followed by the CALIBRATION LIST screen being re-displayed.

   If the sensor's output is low, but still usable, then the message "Good Calibration WARNING Low Sensor" will appear. The sensor will now be marked as being ***Low*** *in the DIAGNOSTICS screen.*

If the sensor's output is too low to be usable, then the message "Bad Calibration Sensor End of Life, Entry Not Saved" will appear followed by the CALIBRATION LIST screen being re-displayed. The sensor will now be marked as being ***BAD*** *in the DIAGNOSTICS screen.*

6. Turn OFF regulator and remove gas cylinder.

5.8 NO Sensor Calibration

This procedure spans the optional nitric oxide sensor to a known gas level.

Material Required:

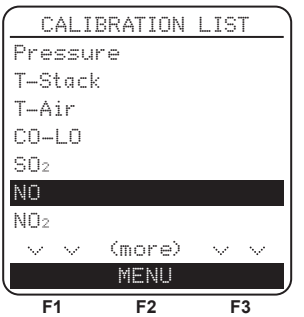
- Calibration Kit, P/N 24-7059
- Gas Cylinder: 250 ppm NO in Nitrogen, P/N 24-1156

Procedure:

1. If not already done, turn ON the analyzer and display the CALIBRATION LIST screen per Section 5.2.

2. Use the ▲▼ buttons to highlight NO, and then press **ENT** to display the CALIBRATE NO screen.

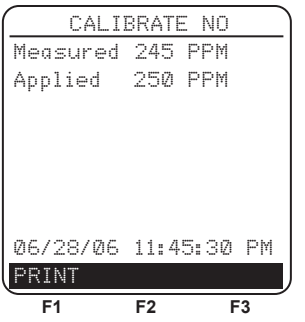
   "Measured" is the current NO *reading, while "Applied" is a known* NO *level that will be applied for calibration purposes.*



3. Attach a 250 ppm NO cylinder to the regulator of the calibration fixture shown in Figure 5-2 on Page 5-14.

4. Use the ▲▼ and ◄► buttons to enter an Applied value that exactly equals the concentration stamped on the NO cylinder.

   The calibration range is from 9 to 550 ppm. An attempt to calibrate outside this range will cause the message "Bad Calibration Wrong CAL Entry" to appear in the following step.



5. Adjust regulator for a flowmeter indication of approximately 2 SCFH. Wait until the Measured reading stabilizes (approximately 3 minutes), and then press **ENT** to calibrate the NO Measured value to that of the Applied value. The message "Good Calibration" should

briefly appear followed by the CALIBRATION LIST screen being re-displayed.

If the sensor's output is low, but still usable, then the message "Good Calibration WARNING Low Sensor" will appear. The sensor will now be marked as being ***Low*** *in the DIAGNOSTICS screen.*

If the sensor's output is too low to be usable, then the message "Bad Calibration Sensor End of Life, Entry Not Saved" will appear followed by the CALIBRATION LIST screen being re-displayed. The sensor will now be marked as being ***BAD*** *in the DIAGNOSTICS screen.*

6. Turn OFF regulator and remove gas cylinder.

5.9 NO_2 Sensor Calibration

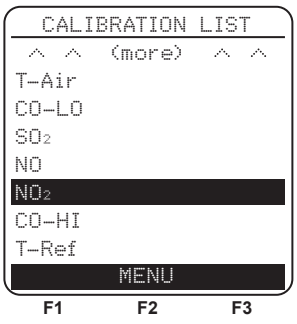
This procedure spans the optional nitrogen dioxide sensor to a known gas level.

Material Required:

- Calibration Kit, P/N 24-7059
- Gas Cylinder: 100 ppm NO_2 in Nitrogen, P/N 24-1157

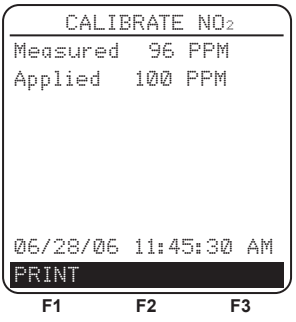
Procedure:

1. If not already done, turn ON the analyzer and display the CALIBRATION LIST screen per Section 5.2.



2. Use the ▲▼ buttons to highlight NO_2, and then press **ENT** to display the CALIBRATE NO_2 screen.

   "Measured" is the current NO_2 *reading, while "Applied" is a known* NO_2 *level that will be applied for calibration purposes.*



3. Attach a 100 ppm NO_2 cylinder to the regulator of the calibration fixture shown in Figure 5-2 on Page 5-14.

4. Use the ▲▼ and ◀▶ buttons to enter an Applied value that exactly equals the concentration stamped on the NO_2 cylinder.

   The calibration range is from 9 to 150 ppm. An attempt to calibrate outside this range will

cause the message "Bad Calibration Wrong CAL Entry" to appear in the following step.

5. Adjust regulator for a flowmeter indication of approximately 2 SCFH. Wait until the Measured reading stabilizes (approximately 3 minutes), and then press **ENT** to calibrate the NO_2 Measured value to that of the Applied value. The message "Good Calibration" should briefly appear followed by the CALIBRATION LIST screen being re-displayed.

   If the sensor's output is low, but still usable, then the message "Good Calibration WARNING Low Sensor" will appear. The sensor will now be marked as being ***Low*** *in the DIAGNOSTICS screen.*

   If the sensor's output is too low to be usable, then the message "Bad Calibration Sensor End of Life, Entry Not Saved" will appear followed by the CALIBRATION LIST screen being re-displayed. The sensor will now be marked as being ***BAD*** *in the DIAGNOSTICS screen.*

6. Turn OFF regulator and remove gas cylinder.

5.10 CO-HI Sensor Calibration

This procedure spans the optional carbon monoxide high sensor (4,001 to 20,000 ppm) to a known gas level.

Material Required:

- Calibration Kit, P/N 24-7059
- Gas Cylinder: 4,000 ppm CO in Air, P/N 24-1155

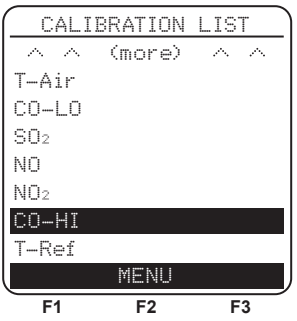
Procedure:

1. If not already done, turn ON the analyzer and display the CALIBRATION LIST screen per Section 5.2.

2. Use the ▲▼ buttons to highlight CO-HI, and then press **ENT** to display the CALIBRATE CO-HI screen.

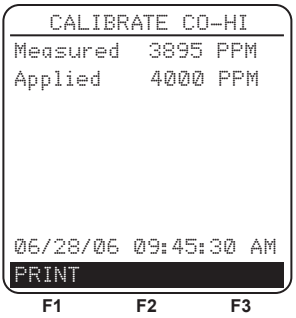
   "Measured" is the current CO *reading, while "Applied" is a known* CO *level that will be applied for calibration purposes.*

3. Attach a 4,000 ppm CO cylinder to the regulator of the calibration fixture shown in Figure 5-2 on Page 5-14.



4. Use the ▲▼ and ◄► buttons to enter an Applied value that exactly equals the concentration stamped on the CO cylinder.

   The calibration range is from 250 to 11,000 ppm. An attempt to calibrate outside this range will cause the message "Bad Calibration Wrong CAL Entry" to appear in the following step.



5. Adjust regulator for a flowmeter indication of approximately 2 SCFH. Wait until the Measured reading stabilizes (approximately 3 minutes), and then press **ENT** to calibrate the CO Measured value to that of the Applied value. The message "Good Calibration" should briefly appear followed by the CALIBRATION LIST screen being re-displayed.

   *If the sensor's output is low, but still usable, then the message "Good Calibration WARNING Low Sensor" will appear. The sensor will now be marked as being **Low** in the DIAGNOSTICS screen.*

   *If the sensor's output is too low to be usable, then the message "Bad Calibration Sensor End of Life, Entry Not Saved" will appear followed by the CALIBRATION LIST screen being re-displayed. The sensor will now be marked as being **BAD** in the DIAGNOSTICS screen.*

6. Turn OFF regulator and remove gas cylinder.

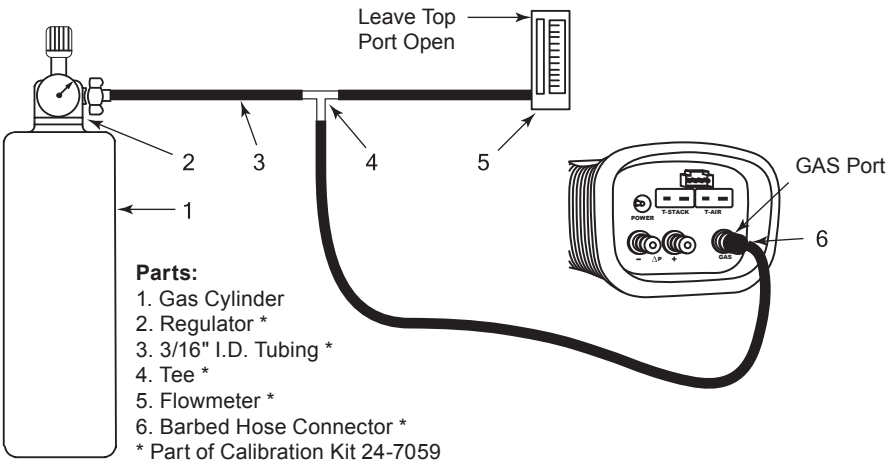


Figure 5-2. Gas Sensor Calibration Equipment

6 Maintenance

Customer maintenance of the PCA 2 is limited to the following:

- Battery replacement or charging using AC power adapter (Section 3.2)
- Sensor re-calibration (Section 5)
- Water trap / filter assembly maintenance (Section 6.2)
- Sensor replacement (Section 6.3)
- Probe thermocouple replacement (Section 6.6)
- Pump (gas or purge) replacement (Section 6.7)
- Cleaning the probe (Section 6.8)

All other maintenance should be performed by an authorized Bacharach Service Center. Refer to Section 8.3.

6.1 PCA 2 Disassembly

The following procedure describes how to disassemble the analyzer, while Figures 6-1 thru 6-4 illustrate how the analyzer is put together.

Tools Required:

- Medium Phillips Screwdriver

Procedure:

1. Unplug all thermocouples from bottom of analyzer.
2. Remove battery cover and then remove batteries.

   TIP: In Step 3, if the sensors are not being replaced, leave the tubing connected to each sensor's gas cap, being careful not to put unnecessary strain on the tubing during the disassembly process.

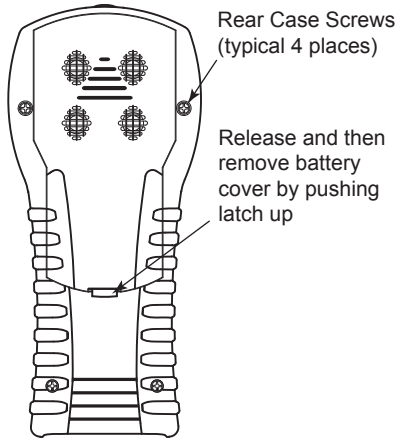


Figure 6-1. Removing Rear Case

3. Pull off sensor retainer; and then unplug all sensors.
4. Lay analyzer face down on a padded work surface; and then using a medium Phillips screwdriver, remove the unit's four rear-case screws.
5. Lift rear case from analyzer and set aside.
6. Unplug electrical connectors J8, J9, and J14 from printed circuit board.

   CAUTION: In Step 7, note that there is tubing connected between the bottom hose-connector plate and the pressure sensor on the printed circuit board. Do not put unnecessary strain on this tubing during the disassembly process.

7. Carefully lift battery-and-pump chassis, along with the bottom hose-connector plate, from analyzer.
8. Lift printed circuit board from analyzer.

Sensor Positions

Position \ Model P/N	225 24-7301	235 24-7302	245 24-7303	255 24-7304	265 24-7305	275 24-7306
#1	O_2	O_2	O_2	O_2	O_2	O_2
#2	CO_{LO}	CO_{LO}	CO_{LO}	CO_{LO}	CO_{LO}	CO_{LO}
#3				SO_2	NO_2	SO_2
#4		NO	CO_{HI}		NO	NO

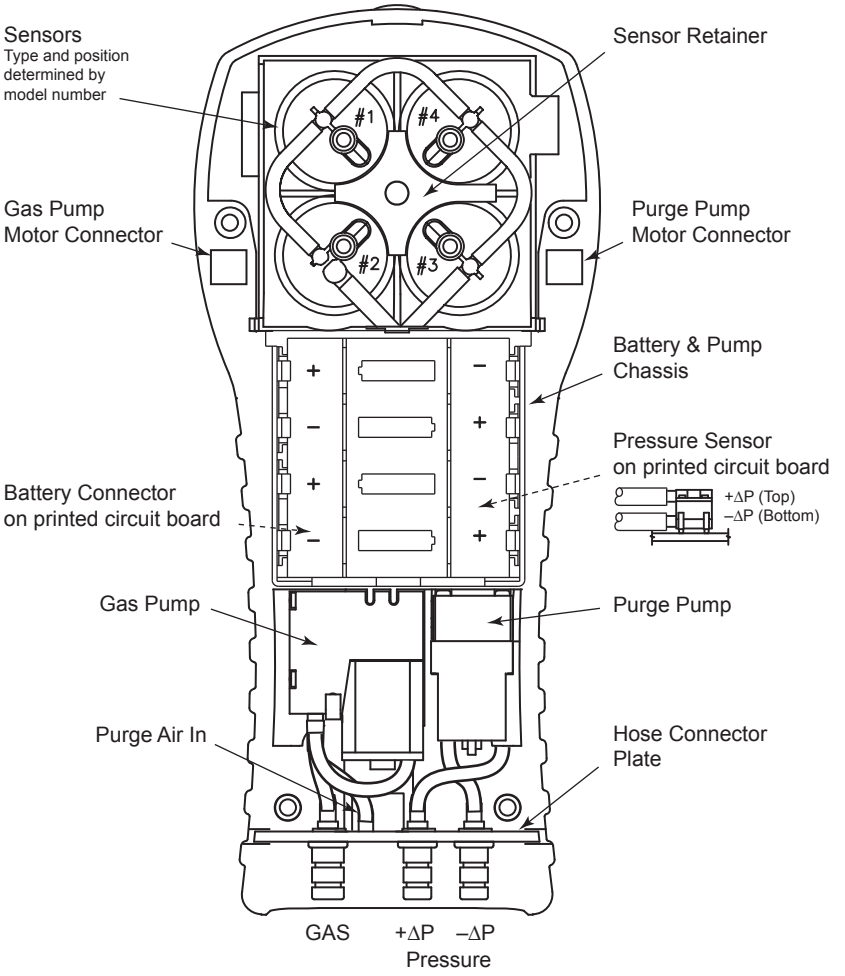
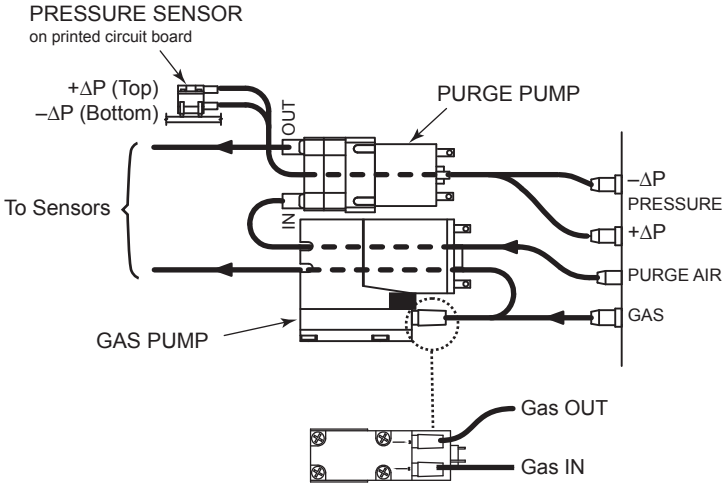
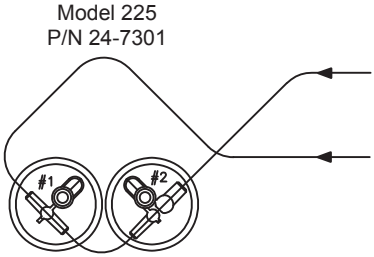
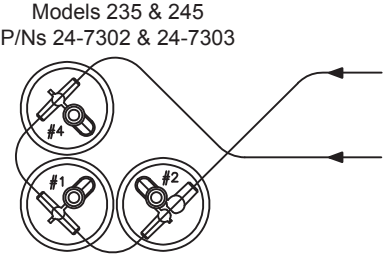
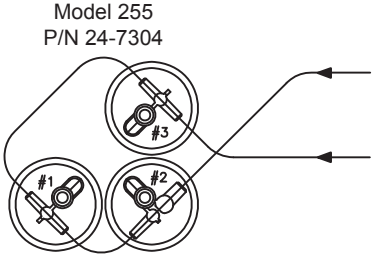


Figure 6-2. Inside View with Rear Case Removed









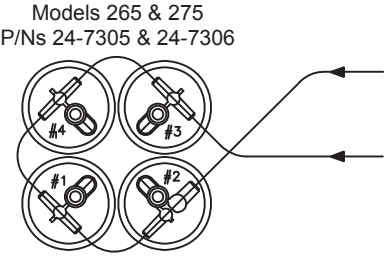


Figure 6-3. Tubing Connections

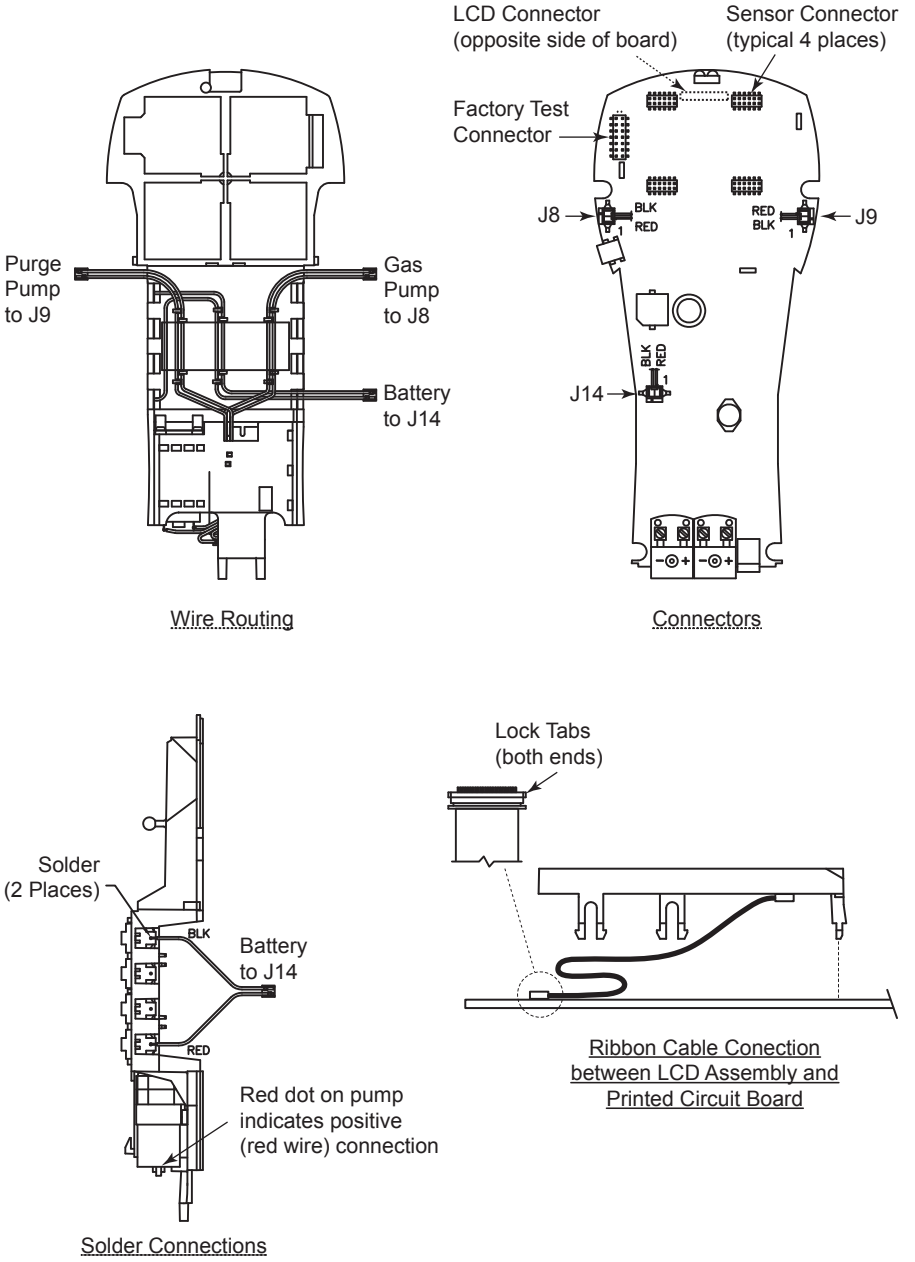


Figure 6-4. Wiring

6.2 Water Trap / Filter Maintenance

6.2.1 Emptying the Water Trap Chamber

The water trap chamber should be emptied after every test, or when the water condensate approaches the tip of the riser tube (refer to Section 4.9).

1. Remove water trap chamber per Figure 6-5.
2. Pour out liquid condensate, and then reassemble trap.

6.2.2 Replacing the Filter Element

Replace the filter element when it becomes visibly dirty or becomes saturated with water.

Material Required:
- Filter Element, P/N 07-1644
- Small Flat Blade Screwdriver

1. Remove water trap chamber per Figure 6-5.
2. Pry apart filter chamber using a small flat-blade screwdriver. Remove and discard old filter.
3. Install new filter and reassemble filter chamber, making sure that surfaces “A” and “B” contact each other.
4. Reassemble trap.

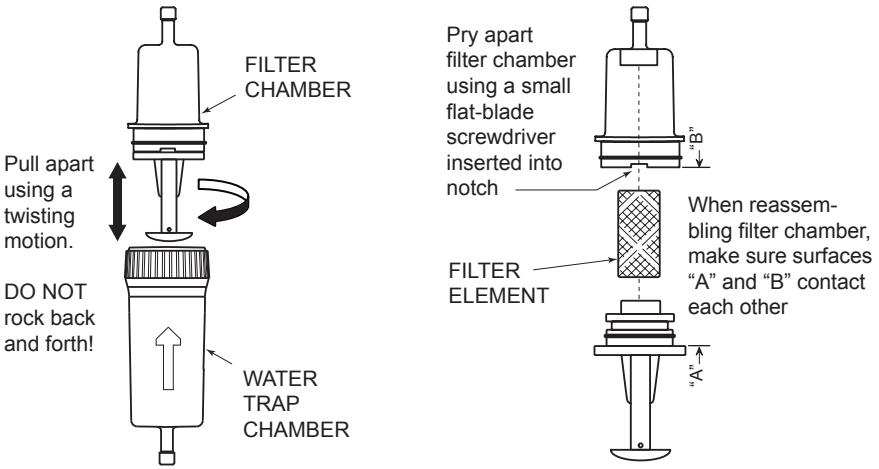


Figure 6-5. Disassembling the Water Trap / Filter Assembly

6.3 Smart Sensor Replacement

Bacharach's Smart sensor technology allows new sensors to be installed without needing to be calibrated inside the analyzer.

NOTE: Sensors may be purchased with and without the Smart sensor technology PCB. See Section 6.4 on how to change just the sensor itself. Calibration must be performed if the sensor is purchased without the Smart technology PCB. Refer to Section 8.1 Replacement Parts for list of sensors and part numbers of both types.

Replace the oxygen sensor when its automatic calibration fails and the analyzer displays an O_2 sensor error at the end of warm up. Refer to Section 4.2.

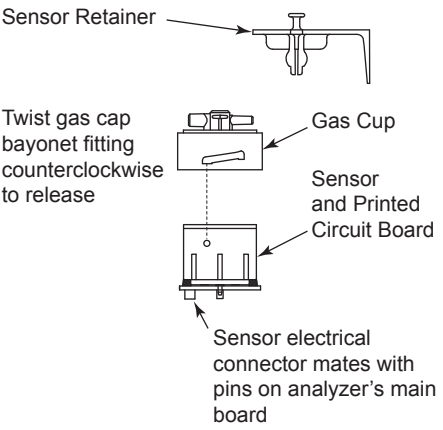
NOTE: The O2 sensor and PCB is not Smart sensor technology. Only the sensor itself, not the PCB, needs to be purchased when the sensor needs replaced.

Replace a gas sensor when it can no longer be calibrated, as evidenced by "Bad Calibration Sensor End of Life" being displayed during its calibration procedure. Refer to Sections 5.6 thru 5.10.

Refer to Section 8.1 for a listing of sensor part numbers. Also, see Figure 6-2 on page 6-3 for sensor positions.

Do the following to replace a Smart sensor:

1. Turn OFF the analyzer.
2. Remove the battery cover.
3. Remove the sensor retainer.
4. Remove the tubing from the gas cup of sensor being replaced.
5. Unplug the sensor along with its printed circuit board from the analyzer's main board.
6. Remove the sensor's gas cup by twisting its bayonet fitting counterclockwise, and then pulling the cup straight up.



7. Attach the gas cup to new sensor, making sure that when the sensor is plugged into analyzer's main board, the tubing connections on top of gas cup are aligned as shown in Figure 6-3 on page 6-4.
8. Plug the sensor into analyzer; and then reattach tubing to gas cup.
9. Install the sensor retainer and battery cover.
10. Turn ON the analyzer and confirm that no sensor errors occur during warm up.

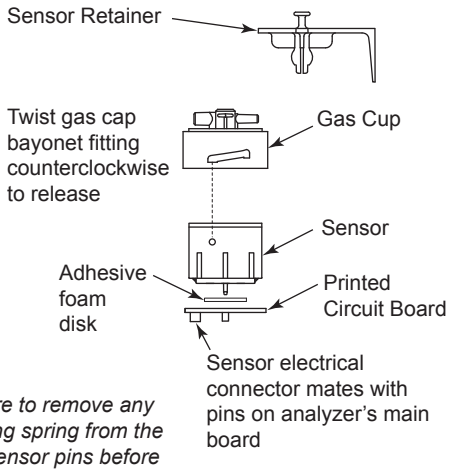
6.4 Sensor Only Replacement

1. All sensors are replaced in a similar manner. Do the following to replace either the O2, CO-LO, CO-HI, NO, NO2, or SO2 sensor. Refer to Section 8.1 Replacement Parts for list of sensors and part numbers.
2. Turn OFF the analyzer.
3. Remove the battery cover.
4. Remove the sensor retainer.
5. Remove the tubing from the gas cup of sensor being replaced.
6. Unplug the sensor along with its printed circuit board from the analyzer's main board.
7. Remove the sensor's gas cup by twisting its bayonet fitting counterclockwise, and then pulling the cup straight up.
8. Carefully remove the old sensor from the Smart sensor PCB, keeping in mind that there is an adhesive foam disk in between the PCB and sensor. Gently remove any adhesive from from the PCB.

   Important! When replacing the O2 sensor, be sure that the "+" sensor pin plugs into the PCB socket that is also marked "O2+".

   When replacing an NO sensor, also replace the bias battery.

9. Remove the replacement sensor from its plastic canister. Note that the CO-LO, CO-HI, SO2, and NO2 sensors have a shorting-spring installed between two of their pins. Remove and discard this spring before installing the sensor.
10. Place the adhesive disk on the bottom of the new sensor and plug the new sensor into the sensor PCB.
11. Attach the gas cup to new sensor, making sure that when the sensor assembly is plugged into the analyzer's main board, the tubing connections on top of gas cup are aligned as shown in Figure 6-3 on page 6-4.



Be sure to remove any shorting spring from the new sensor pins before installing! There is no shorting spring on the O2 or NO sensors.

12. Plug the sensor into analyzer; and then reattach tubing to gas cup.
13. Install the sensor retainer and battery cover.
12. Allow the sensor that was just installed time to stabilize in the circuit before continuing with this procedure. Stabilization time for all sensors (except for the NO sensor) is about 1 hour. The NO sensor baseline technically requires several days to stabilize but should be sufficiently stabilized for use in approximately 4 hours.
13. Turn ON the analyzer and confirm that no sensor errors occur during warm up.

    Note: Discard an old sensor in accordance with local and federal hazardous waste disposal laws.

14. Calibrate the new sensor(s) per Section 5 (except the O2 sensor which does not require calibration).

6.5 Nitric Oxide Sensor Battery Replacement

A single lithium battery, located on the NO Smart Sensor assembly, applies a bias voltage to the NO sensor to prevent the sensor from destabilizing when the analyzer is turned off. The NO bias battery is expected to last at least the life of the NO sensor.

Note: It is recommended that the bias battery be replaced whenever the NO sensor is replaced.

Material Required:

- Bias battery (refer to Section 8.1 Replacement Parts)

Procedure:

1. Follow the instructions in Section 6.3 Smart Sensor Replacement to remove the Smart Sensor assembly from position 4.
2. Remove the old battery from its holder on the Nitric Oxide printed circuit board.
3. Insert the new battery with the positive side facing away from the sensor (the battery contact is stamped with a + symbol) .
4. Re-install the Smart Sensor assembly.
5. Before powering up and using the analyzer, allow the Nitric Oxide sensor to stabilize as described below. Note that recalibration of the Nitric Oxide sensor is not required after replacing its bias battery. Depending on how long the Nitric Oxide sensor was without bias voltage, the time required for the sensor to completely stabilize varies from less than a minute to several days. Typical stabilization times are shown below. Generally, however, the sensor is sufficiently stable after 4 hours for measurement purposes.

Bias battery removed for . . .	**Stabilization time**
Less than 15 minutes	Less than 1 minute
Less than 1 hour	Less than 5 minutes
Less than 2 days	Less than 4 hours
Greater than 2 days	Up to 2 days

6.6 Thermocouple Replacement

Using the appropriate thermocouple replacement kit listed below, replace the probe's thermocouple as follows:

Thermocouple Replacement Kits:

Part Number	Replaces Thermocouple in a Probe with a Tube Length of . . .
24-8413	6 inches
24-8414	12 inches
24-8415	24 inches
24-8416	36 inches

Each kit contains a thermocouple assembly, two O-rings, and two wire-splice connectors.

Tools Required:

- Small Flat Blade Screwdriver
- Wire Cutter
- Wire Stripper
- Slip Joint Pliers

Procedure:

1. Gain access to the thermocouple connections by first removing three screws from probe handle, and then separating the two handle pieces.

2. Cut wires attached to old crimp connectors, leaving behind as much of the probe's thermocouple-connector wire as possible.

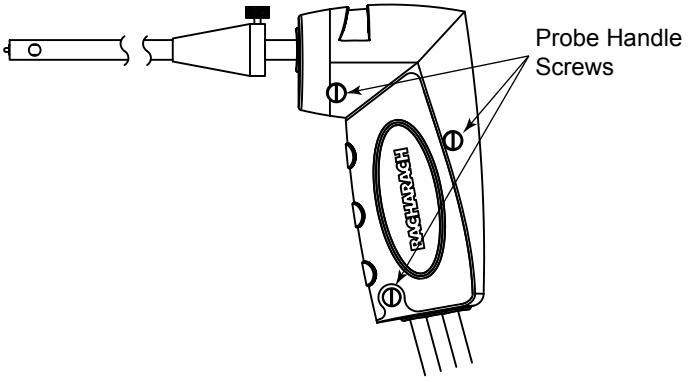


Figure 6-6. Probe Handle Disassembly

3. Pull old thermocouple from probe body and discard.

4. The new thermocouple has been coiled for shipping purposes. Straighten the thermocouple using your thumb and index finger.

5. If not already done, install supplied O-Rings onto thermocouple.

6. Insert thermocouple into probe body until it "bottoms out."

7. Strip 1/4 inch of insulation from each of the probe's thermocouple connector wires.

   IMPORTANT: *In Step 8, the thermocouple wires must first be twisted together and then crimped.*

8. ***Twist*** both red thermocouple wires together; insert them into the supplied wire-splice connector; and then crimp the connector using a pair of pliers. Repeat this step for the yellow thermocouple wires.

9. Reassemble the probe handle, being careful not to pinch the thermocouple wires between the handle pieces. In addition, ensure that the end of the thermocouple is in front of the rib molded into the bottom handle piece; otherwise, the handle pieces will not fit tightly together.

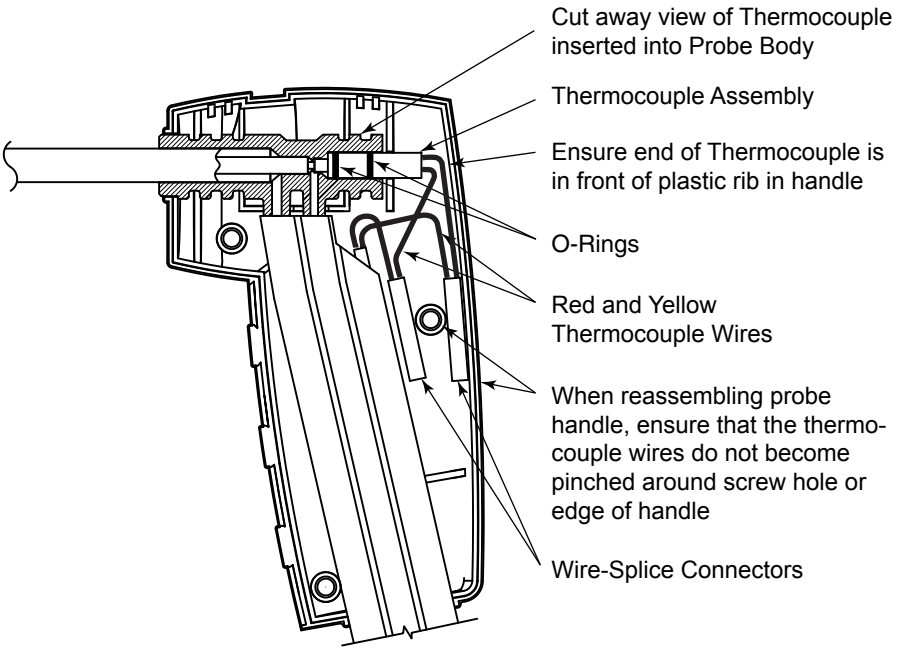


Figure 6-7. Thermocouple Installation and Wiring

6.7 Pump Replacement

Parts & Tools Required:

- Replacement Pump:
  - Gas Pump P/N 24-1393
  - Purge Pump P/N 3015-1716
- Soldering Iron and Solder
- Medium Phillips Screwdriver
- Small Flat Blade Screwdriver

Procedure:

1. Gain access to both the gas and purge pumps by removing the rear case. Refer to Section 6.1.

2. Unsolder the red and black wires from pump being replaced. Note that during installation of the new pump, the ***red*** dot on the pump motor indicates the positive (red wire) connection.

3. Do one of the following:
   - **Gas Pump Removal:** Push pump latch toward bottom of analyzer and lift gas pump out from its mounting location.
   - **Purge Pump Removal:** Insert a small flat blade screwdriver between the purge pump motor and the pump chassis, and then pry the pump out from its mounting location.

4. Remove tubing from pump.

3. Install new pump by reversing this procedure.

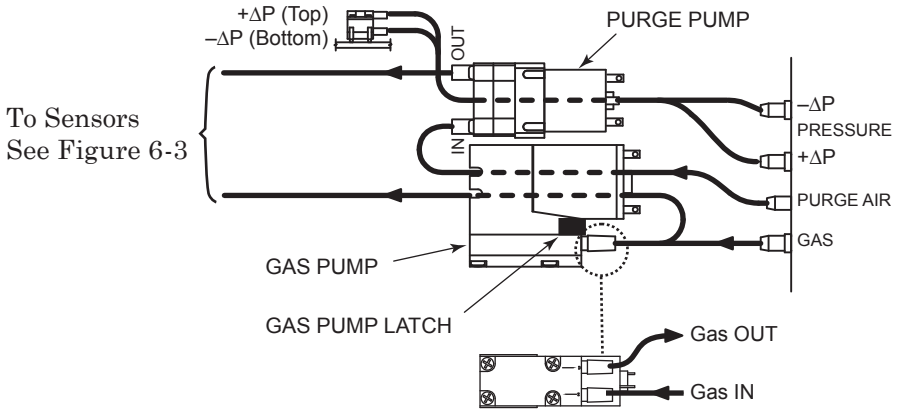


Figure 6-8. Pump Tubing Connections

6.8 Cleaning the Probe

The probe tube and gas-sample hose will become dirty under normal use. Note that the water trap's filter element should prevent soot from reaching the analyzer's internal components. If the probe is not kept clean, it could become clogged and restrict the flow of gas into the analyzer, resulting in incorrect combustion test readings and calculations.

> **NOTE:** *An analyzer that is used to test natural gas furnaces normally requires less frequent cleaning than an analyzer used for testing coal or oil fired furnaces.*

Equipment Required:

- Alcohol
- Aerosol Can of Automotive Carburetor Cleaner
- Clean Rag
- Source of Compressed Air (optional)

Procedure:

1. Remove gas-sample hose from top of water trap.

   CAUTION: *Carburetor cleaner attacks plastic components! Take precautions not to spray cleaner onto the probe handle or analyzer.*

2. Insert the plastic-spray tube of the carburetor cleaner into the gas-sample hose, and then liberally spray carburetor cleaner through the hose and out the probe tube.

3. After spraying, remove all the residual cleaner by repeatedly flushing the gas hose and probe tube with alcohol.

4. Wipe off the surfaces of the probe and tubing with a clean rag.

5. Allow the parts to dry completely. If available, blow compressed air through the probe to expedite the drying process.

6. Reconnect gas-sample hose to top of water trap.

Notes:

7 Troubleshooting

7.1 Analyzer Repair

It is recommended that field repair of the PCA 2 be limited to:

- Checks of printed circuit board connectors
- Replacing the probe assembly
- Replacing the filter element in the water trap / filter assembly
- Replacing sensors
- Replacing either the gas or purge pump

Information on how to perform these repairs is provided in Section 6.

All other repairs should be performed by an authorized Bacharach Service Center (refer to Section 8.3). Any repairs performed by an *unauthorized* service organization will void the analyzer's warranty and release Bacharach, Inc. of any implied or written product liability.

7.2 Error Symbols

Error symbols are shown in the data fields of the Combustion Test screens and on the printout to indicate the following:

"**- - -**" Three hyphens or dashes indicates that the *calculated* data cannot be displayed because the *measured* data necessary to make the calculation is out of range. For calculations to occur, the oxygen level must be below 16% and the stack temperature must be below 2,000 °F (1,093 °C).

"*** * ***" Three stars appear in the data field of sensors that are not installed, defective, or found to be in overrange during warm-up, and also in the data fields of that sensor's related calculated values. For example, if the data field of either the NO or NO_2 sensor contains three stars, then the NOx data field will also contain three stars.

"X X X" Indicates sensor overrange.

7.3 Error Messages Displayed After Warm-Up

If there were problems detected during warm-up, error messages that describe the nature of the problems are displayed immediately following the analyzer's 60 second warm-up period.

If problems were detected, the analyzer will *not* automatically switch to the Combustion Test HOLD screen after warm-up. The analyzer, however, can still be used to perform any test that does not depend on the sensor that is in error. Press the **RUN** button to manually display the Combustion Test HOLD screen, and then continue using the analyzer.

The following is a list of the error messages that may appear following warm-up and their suggested remedies:

Low Battery – Battery voltage is low. Only several minutes of operating time remain. Replace or charge batteries per Section 3.2.

O_2 No Sensor – Oxygen sensor not installed, or has become unplugged from its electrical connector. Install oxygen sensor per Figure 6-2 on Page 6-3.

O_2 BAD Sensor – The oxygen sensor's output is below 24 mV, signifying that the sensor is depleted and needs replaced. Refer to Section 6.3.

No Smart Sensors – No gas sensors are installed. Install sensors per Section 6.3.

Pressure Overrange – Pressure sensor measured a pressure that was outside the range of ±3 inwc during warm-up. Ensure that probe tip is open to the atmosphere during warm-up.

Ts Error – The probe's thermocouple is not connected to the analyzer's T-STACK connector.

Ts Overrange – The temperature measured during warm-up was outside the range of –4 to 2,192 °F (–20 to 1,200 °C). Ensure that the probe is correctly connected to the analyzer per Figure 3-2 on Page 3-3, and that the probe is at room temperature during warm-up.

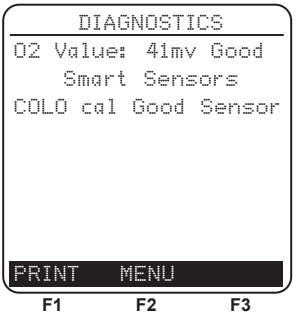
Ta Overrange – The temperature measured during warm-up by the optional primary / ambient air thermocouple plugged into the analyzer's T-AIR connector was outside the range of –4 to 212 °F (–20 to 100 °C). Ensure that this thermocouple is at room temperature during warm-up.

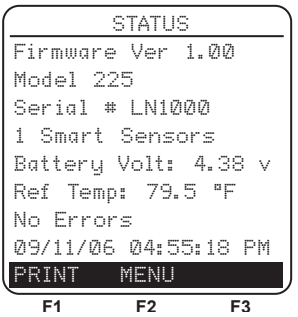
UNCALIBRATED SENSORS – List of sensors that do not have a calibration history stored on their printed circuit board. Calibrate each of the sensors listed per Section 5.

7.4 Diagnostics and Status Screens

The DIAGNOSTICS screen lists the current status of all the SMART gas sensors installed and the O_2 sensor status and mV output.

The STATUS screen provides a quick reference of key items when troubleshooting.





Notes:

8 Parts & Service

8.1 Replacement Parts

Item (Fig. 8-1)	Description	Part No.
1	Main PCB Assembly	24-1371
2	LCD Module	24-1374
3	Rear Case	24-1381
4	Top Case	24-1382
5	Battery Cover	24-1383
6	Window	24-1385
7	LCD Frame	24-1386
8	Keypad	24-1387
9	Chassis, Battery & Pump	24-1388
10	Lens, Infrared	24-1391
11	Pump, Sample Gas	24-1393
12	Pump, Purge	3015-1716
13	Sensor Retainer	24-1418
14	Hose Connector Plate (complete assembly)	24-1419
14A	Gas Fitting	24-1416
14B	Pressure Fitting	24-1415
14C	Retaining ring	02-2886
15	O-Ring, Gas Fitting	105-5102
16	O-Ring, Pressure Fitting	105-5103
17	Gas Covers:	
17A	O_2 / SO_2 / NO_2	24-1421
17B	CO-H_2	24-1422
17C	NO / CO_{HI}	24-1420
18	Smart Sensors (pre-calibrated):	
18B	CO-H_2	24-1395
18C	CO_{HI}	24-1397
18D	NO	24-1401
18E	NO_2	24-1399
18F	SO_2	24-1398

Item (Fig. 8-1)	Description	Part No.
18	Sensors (NOT-calibrated):	
18A	O_2	24-0788
	O_2 sensor PCB only *	24-1364
18B	CO-H_2	24-0789
18C	CO_{HI}	24-0997
18D	NO	24-0881
	Bias battery for NO sensor **	204-0020
18E	NO_2	24-1027
18F	SO_2	24-0998
19	Screw, #4 x 1/2 LG	02-2144
20	Battery Clip, Single	04-1434
21	Battery Clip, Double	04-1433
22	Cable Assembly	24-1410
23	Tubing, Vinyl, 1/8 ID x 3/16 OD ***	03-6104
24	Tubing, Silicon, 1/16 ID x 1/8 OD ***	03-6372
25	Tubing, Silicon, 3/32 ID x 5/32 OD ***	103-6101
26	Tubing, Silicon, 1/8 ID x 3/16 OD ***	103-6102

* A replacement O2 PCB is only required if it is damaged.

** When replacing the NO sensor it is good practice to replace the bias battery at the same time. Also, see Section 6.4 for required baseline stability period required when the NO sensor is replaced and bias battery is installed.

*** Order tubing by the foot

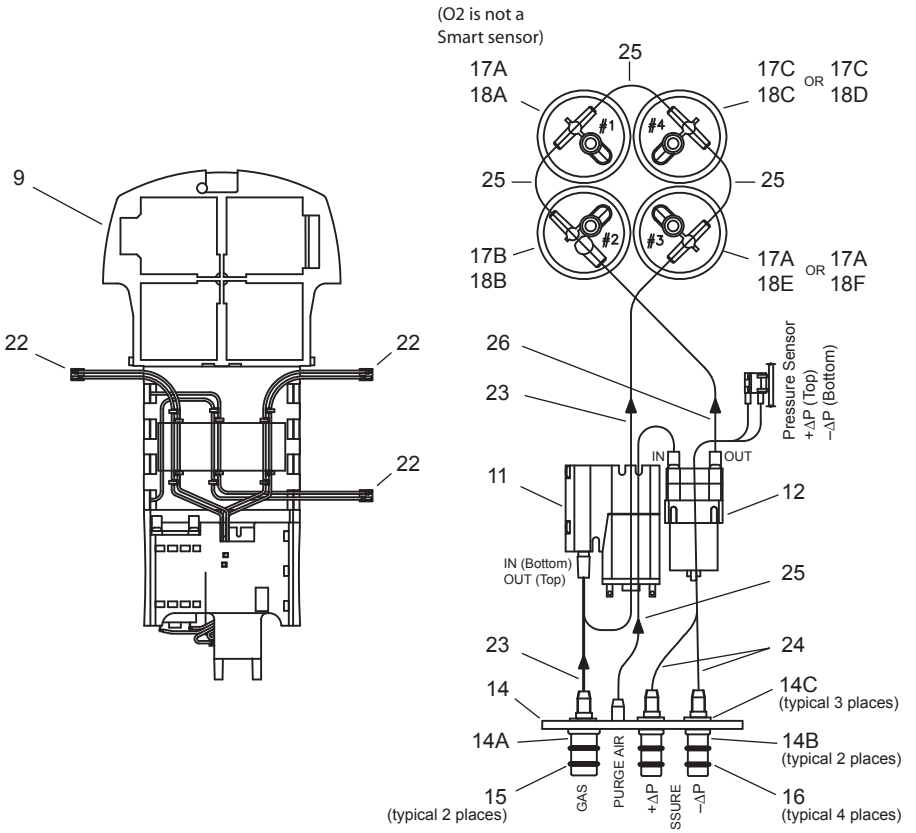


Figure 8-1. Parts (1 of 2)

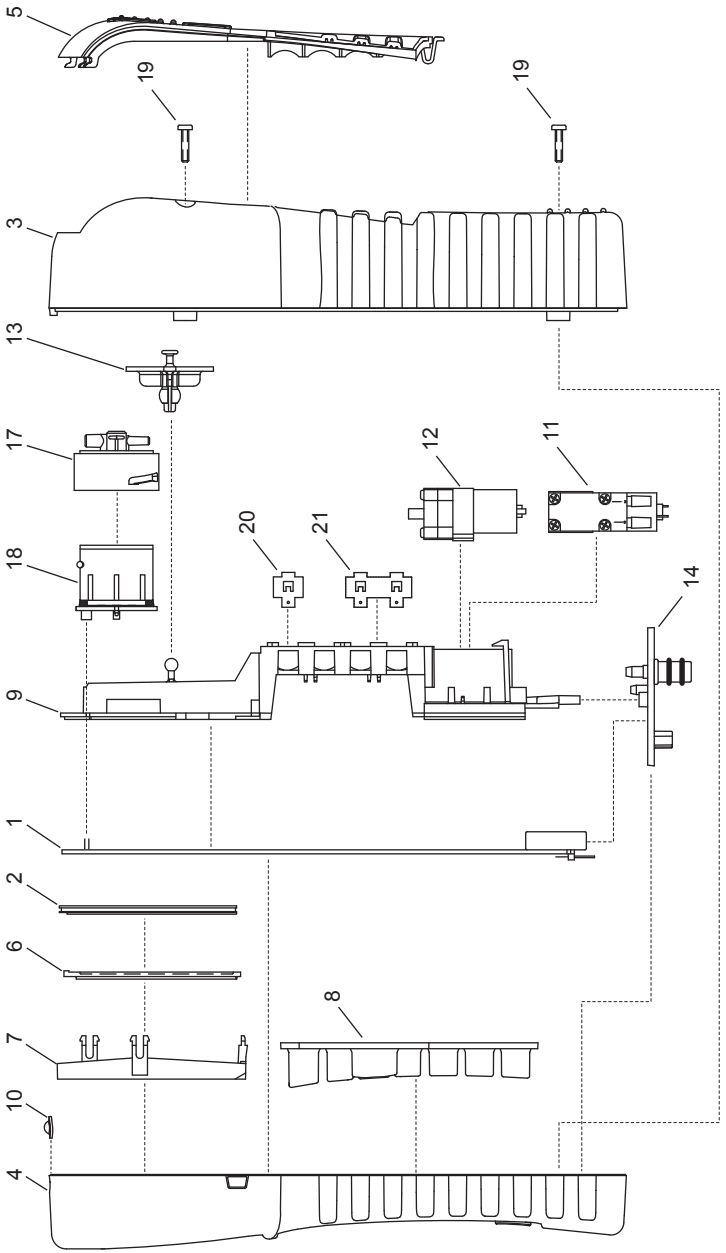


Figure 8-1. Parts (2 of 2)

8.2 Accessories

Standard Accessories	Part No.
Carrying Case	24-0865
Batteries, 'AA' Alkaline (4 required)	204-0004
12" Probe, Hose, and Water Trap / Filter Assembly (Fig. 8-2)	24-3004
① Water Trap / Filter	19-3265
② Filter Element (3 pack)	07-1644
③ Thermocouple Replacement Kit, 12"	24-8414
④ Probe Stop with Thumb Screw	19-3037
⑤ Connector, Gas Sample	24-0877
⑥ Connector, Draft	24-0878
PCA 2 Data Recovery Software Disk	24-1425
USB Cable	104-4032
Instruction Manual	24-9448

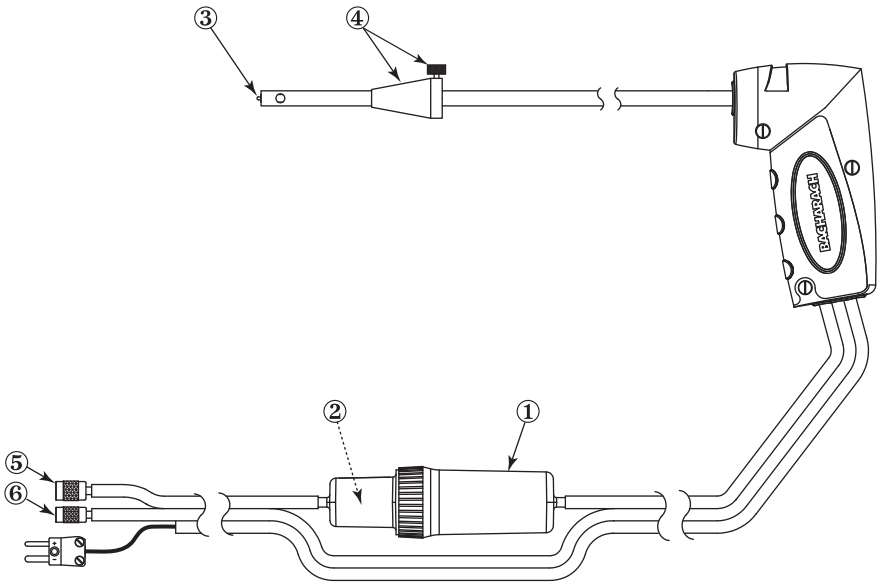


Figure 8-2. Probe, Hose, and Water Trap / Filter Assembly

Optional Accessories — Part No.

AC Power Adapter
(Input: 100–240 VAC, 50/60 Hz; Output: 9 VDC @ 1 A) 24-1404
PCA 2 Protective Boot with magnet 24-1409
Ambient Air Thermocouples (T-AIR), K-Type:
10 ft. 104-1797
1 inch 104-1798
Utility Wand (12 in. ridged probe w/ 5 ft coiled cable). 104-1799
Differential Pressure Hose Assembly, 6 ft 24-1103
Calibration Kit
(Includes hoses, adapters, flowmeter; does not include gas cylinders) . .24-7059
Gas Cylinders (103 Liter):
500 ppm CO in air. 24-0492
1000 ppm CO & 1000 ppm H_2 in Nitrogen. 24-0794
4,000 ppm CO in air 24-1155
250 ppm NO in Nitrogen. 24-1156
100 ppm NO_2 in Nitrogen 24-1157
100 ppm SO_2 in Nitrogen 24-1158
IrDA Printer. 24-1400
Printer Paper :
1 Roll 06-8733
5 Roll Pack. 24-1310
Probe, Hose, and Water Trap / Filter Assemblies:
6 in. Probe 24-3002
24 in. Probe 24-3021
36 in. Probe 24-3022
Thermocouple Replacement Kits:
6 in. 24-8413
12 in. 24-8414
24 in. 24-8415
36 in. 24-8416
Extended hose assembly:
20 ft. 24-1124
Sample Conditioning Probes:
(Recommended when measuring NO_2 and SO_2)
Heavy Duty (EPA/ETV test verified performance) *. 24-7223
Compact *. 24-7224

* Connection and operating instructions supplied with the Sample Conditioning Probes

8.3 Service Centers

United States
Bacharach Inc.
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New Kensington, PA 15068
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Printed in U.S.A.