BACHARACH®
The Measurable Difference

PCA3®

Portable Combustion Analyzer

Instruction 0024-9472
Operation & Maintenance
Rev. 0 - August 2010

WARRANTY

Bacharach, Inc. warrants to Buyer that at the time of delivery this Product will be free from defects in material and manufacture and will conform substantially to Bacharach Inc.'s applicable specifications. Bacharach's liability and Buyer's remedy under this warranty are limited to the repair or replacement, at Bacharach's option, of this Product or parts thereof returned to Seller at the factory of manufacture and shown to Bacharach Inc.'s reasonable satisfaction to have been defective; provided that written notice of the defect shall have been given by Buyer to Bacharach Inc. within two (2) years after the date of delivery of this Product by Bacharach, Inc. The Oxygen (O_2) sensor has a limited warranty of one (1) year. Routine service and calibration are excluded from this warranty.

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Declaration of Conformity

Manufacturers name & address:	Bacharach, Inc. 621 Hunt Valley Circle New Kensington, PA 15068
Product Name:	PCA®3
CE Mark:	European EMC Directive 2004/108/EC EN 50270:2006 - Electromagnetic Compatibility Standard EN 55011 - Emissions Product Specific Standard

Notice:

Product improvements and enhancements are continuous, therefore the specifications and information contained in this document may change without notice.

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Contents

1.0 Introduction

1.1 About This Manual

Thank you for investing in a Bacharach PCA®3 Combustion Analyzer. To assure operator safety and the proper use of the PCA®3, please read the contents of this manual, which provides important information on the operation and maintenance of the analyzer.

Warning Statements

The use of the word **WARNING** (and the symbol at left) in this manual denotes a potential hazard associated with the use of this equipment. It calls attention to a procedure, practice, or condition, or the like, which if not correctly performed or adhered to, could result in personal injury or death.

Caution Statements

The use of the word **CAUTION** (and the symbol at left) in this manual denotes a potential hazard associated with the use of this equipment. It calls attention to a procedure, practice condition, or the like, which if not correctly performed or adhered to, could result in damage to the equipment

1.1.1 General Warnings and Cautions

CAUTION: *This analyzer is not intended to be used on a continuous basis.*

WARNING: *This analyzer is not intended to be used as a safety device.*

CAUTION: *Except for sensor and battery replacement, this analyzer should only be opened and serviced by authorized Bacharach personnel. Doing so may void the warranty.*

WARNING: *When testing an appliance, a full visual inspection of the appliance should be performed to ensure its safe operation.*

1.2 PCA®3 General Description

The PCA®3 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, boot, Fyrite® User Software, USB cable, and carrying case.

Because of the PCA®3'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 color graphic display shows up to seven combustion test values simultaneously, and includes a zoom capability that provides extra large text.

B-Smart® sensor technology allows a new sensor to be installed in the field without having to calibrate the analyzer with gas before use.

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 for extended periods of time while data logging.

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

1.3 Sales Combo & Model Configurations

Sales Combo	0024-8440	0024-8441	0024-8442
Sales Combo (Kit)	0024-8447	0024-8448	0024-8449
Model Type	225	235	245
PCA®3 Only Part Number	0024-7320	0024-7321	0024-7322
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			

Sales Combo	0024-8443	0024-8444	0024-8445	0024-8446
Sales Combo (Kit)	0024-8450	0024-8451	0024-8452	0024-8453
Model Type	255	265	275	285
PCA®3 Only Part Number	0024-7323	0024-7324	0024-7325	0024-7326
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.

1.4 Features & Benefits

- Powered by 4 'AA' alkaline batteries or NiMH rechargeable batteries. An optional AC adapter provides extended operation.
- O_2 and CO_{Low} measurement standard. Optional measurement of up to two additional gases, including 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.
- B-Smart® sensor technology allows pre-calibrated sensors to be installed in the field. Sensors are provided with data that can be entered through the PCA®3 software, or instrument calibration menus, for easy calibration.
- 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 color graphic LCD with zoom capabilities
- 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 for printing current and stored combustion records, pressure records, calibration data, and diagnostic data
- USB connectivity for downloading data to 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.
- Language options including English, French, and Spanish
- Custom Display Formats
- Calibration Reminders - PCA®3 can be set up to remind the user that calibration is past due.

1.5 Operational Overview

The PCA®3 is powered by either its four 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.

The PCA®3 is controlled by 11 front panel push buttons, while a color graphic LCD (with automatic dimming feature) 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®3 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 instrument will display 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 run/hold screen.

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 display.

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 keypad backlight enables a user to read the keypad in dimly-lit areas. Turn the keypad 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.

1.6 Connector Descriptions

1.6.1 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.

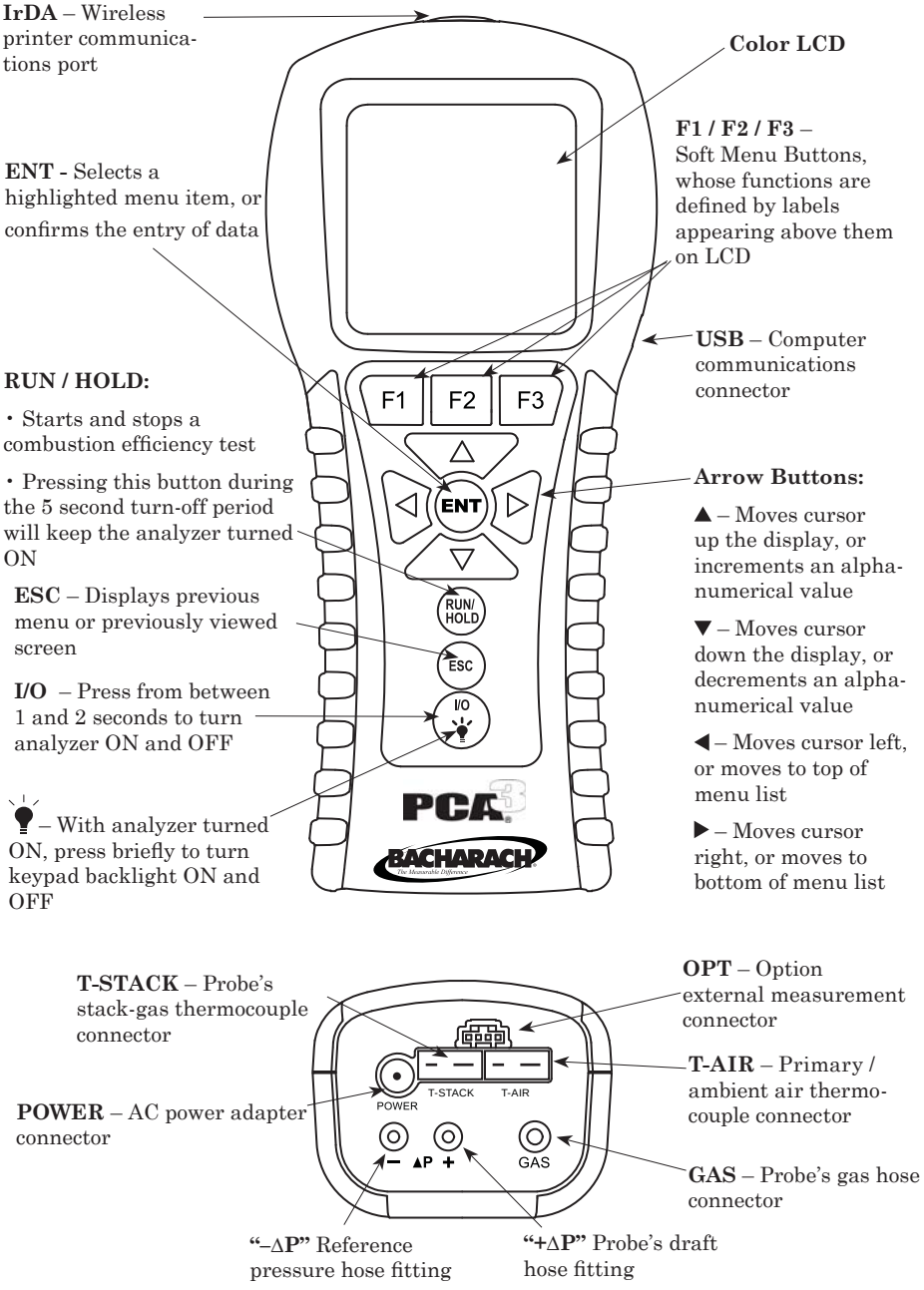


Figure 1-1. PCA®3 Components

1.6.2 T-AIR (Primary Air Thermocouple)

If thermocouple P/N 0104-1797 (10 feet long) or Utility Wand P/N 0104-1799 (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.

1.6.3 POWER (AC Adapter)

The AC power adapter P/N 0024-1254 can be used as an external power supply, which will run the analyzer on a continuous basis.

1.6.4 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 0024-1103 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 where differential pressure is to be measured.

1.6.5 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 0104-4032 between the USB ports of the computer and analyzer.

1.6.6 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.

1.6.7 OPT (Option)

The option connector is used for optional external measurement features.

1.7 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.

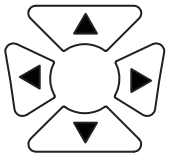
MENU (F2): Displays the Main Menu.

SAVE (F3): Saves the data currently displayed on the LCD in memory. Up to 500 individual Combustion Test, Temperature, and Pressure records can be saved. After 500 records have been saved, the memory must be cleared to continue saving additional data. The analyzer will not overwrite old data.

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

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 through the directory. Holding this button speeds the paging process.



The arrow buttons move the cursor on the LCD. 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 item. 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 keypad LEDs ON and OFF.

NOTE: *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, though it is not recommended.*

2.0 Specifications

The PCA®3 Directly Measures and Displays:
The gases displayed depend on the sensors installed in the analyzer. Refer to Section 1.3.

Oxygen ..... 0.1 to 20.9%
Stack Temperature .....-4 to 2,192 °F (-20 to 1,200 °C)
Primary/Ambient Air Temperature .....-4 to 999 °F (-20 to 537 °C)
Carbon Monoxide (CO) (H_2 compensated) ..... 0 to 4,000 ppm
Pressure/Draft.....±72 "H_2O (±179 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®3 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 °C).

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 referenced to $\%O_2$ ..... 0 to 9,999 ppm
NO_2 referenced to $\%O_2$..... 0 to 9,999 ppm
SO_2 referenced 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
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	±.02 inches from -1 to 1 inwc ±2% of reading from -10 to 10 inwc ±3% of reading from -40 to 40 inwc
System Flow Rate with Probe	200 cc/min minimum

Power Requirements:

Four disposable 'AA' alkaline batteries provide a minimum of 10 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 adaper, 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.

Warm-Up Time:

Warm-up time is 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 2.0 (mini-B connector)

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 and Hose Assembly - 1 lb (0.5 kg)

3.0 Initial Setup

3.1 Scope

Before using the PCA®3, 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 be used to power the analyzer. 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

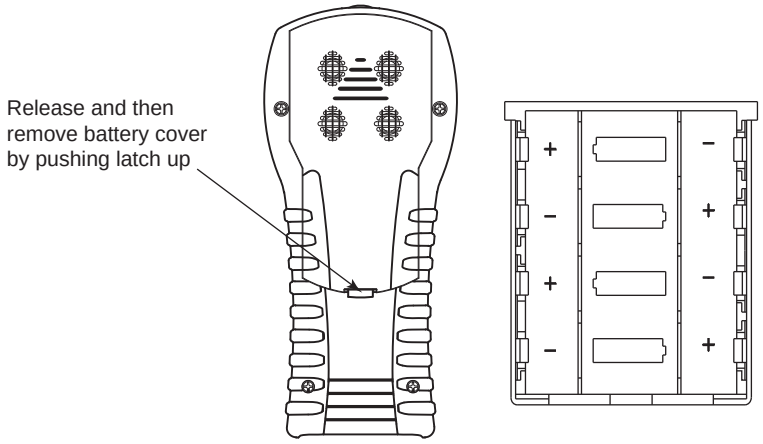


Figure 3-1. Battery Replacement

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 +6 VDC. The adapter's output connector plugs into the analyzer's POWER jack located on the botton of the unit (Figure 3-2).

3.3 Connecting the Probe & Hose Assembly

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 analyzers +ΔP fitting.
3. Push the stack-gas thermocouple connector into the T-STACK jack (connector fits in only one way).
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 the filter is not dirty or saturated with water.

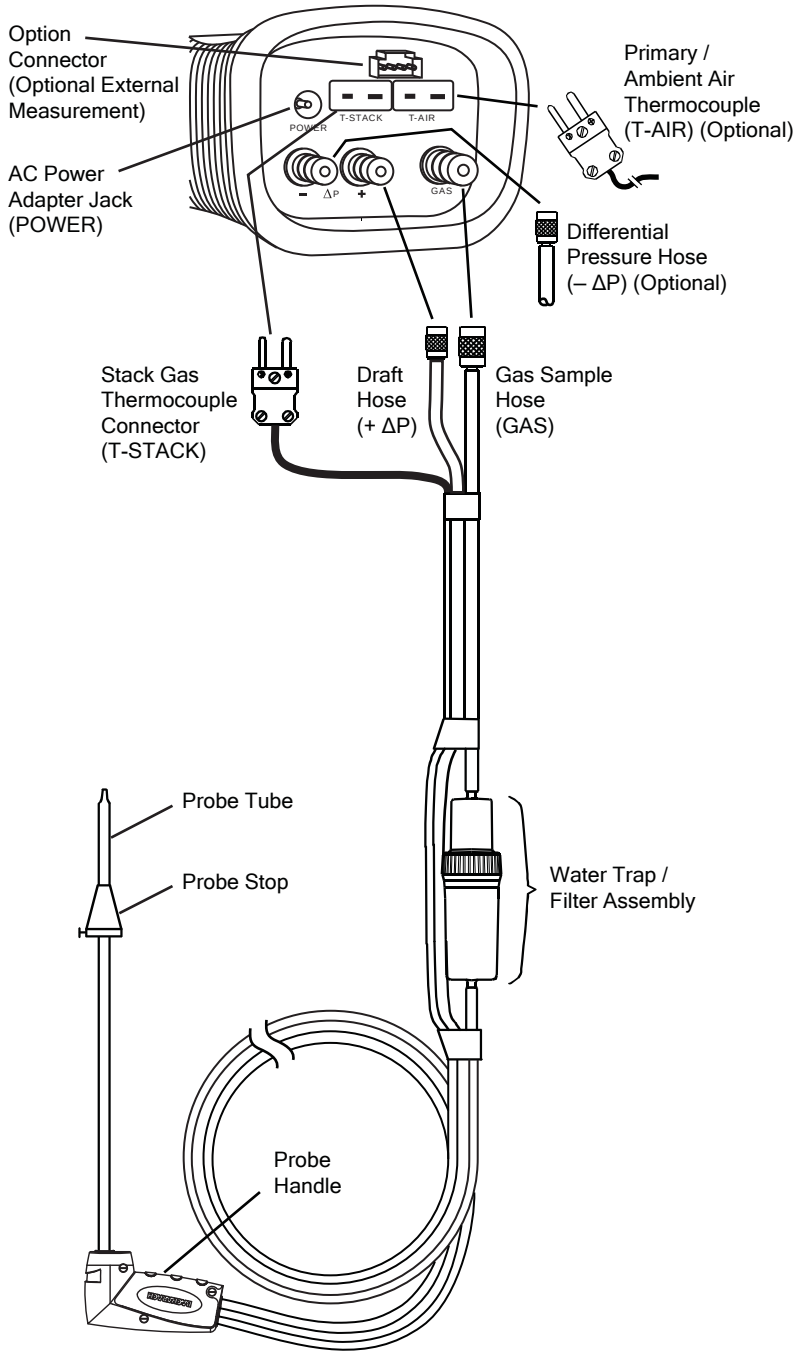


Figure 3-2. Connecting the Probe to the Analyzer

3.4 Operating Parameters

The PCA®3 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.....Standard
Logging .....No
Button Sound .....On
Calibration Reminder .....Never

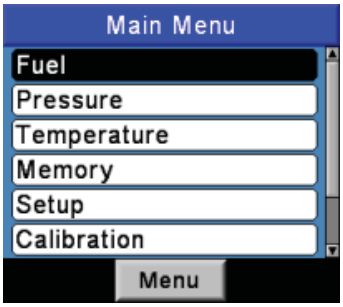
To change any of these parameters, perform the associated procedure provided in Sections 3.5 thru 3.20.

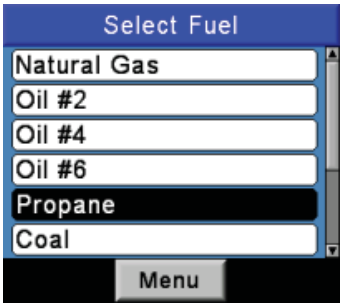
3.5 Fuel Selection

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 (If custom fuels are added, they will be displayed at the bottom of the list).

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





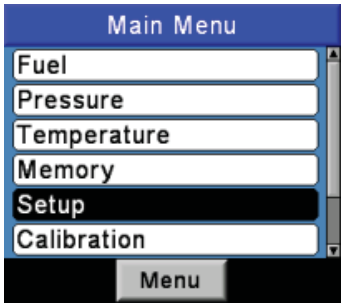
4. Press **ENT** to save the selection and display the Combustion Test HOLD screen. Observe that the name of the selected fuel should now appear at the top of the screen.

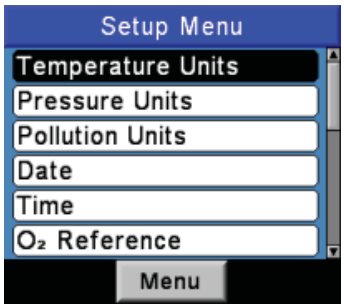
   NOTE: *In addition to the standard fuels programmed into the PCA®3, Bacharach can develop custom fuel codes based on the customers specific needs. The PCA®3 can be programmed with 2 additional fuels which can be added to the instrument using the Fyrite User Software. Consult factory for price and delivery.*

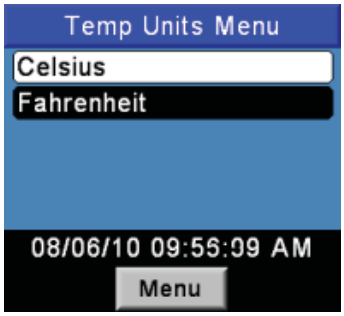
3.6 Temperature Units Selection

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.



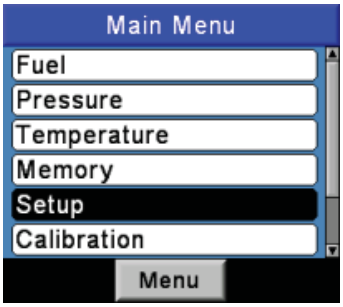


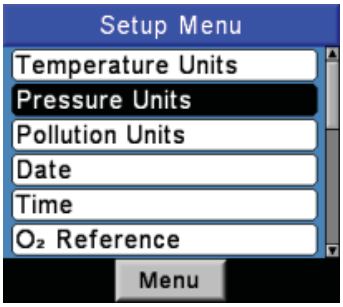


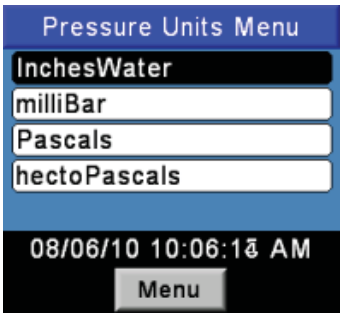
3.7 Pressure Units Selection

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.





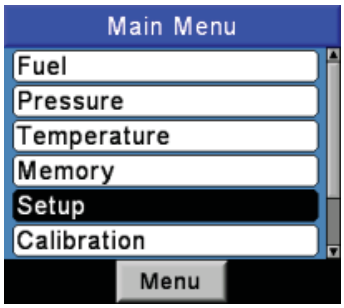


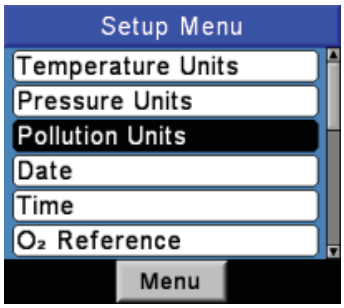
3.8 Pollution Units Selection

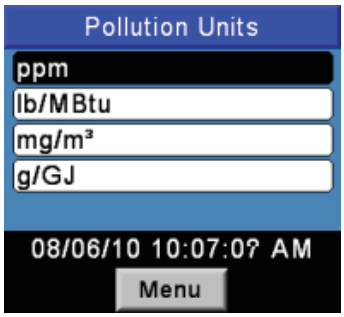
The PCA®3 is capable of converting the measured ppm levels of CO, NO, NO_2, and SO_2 to various pollution units using CFR40 Part 60 emission factors. Note that the pollution-unit conversions for NO, NO_2 and NOx are based on the molecular weight of NO_2.

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.







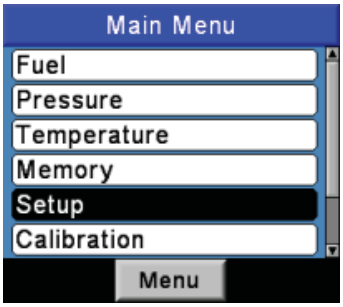
3.9 Date Setup

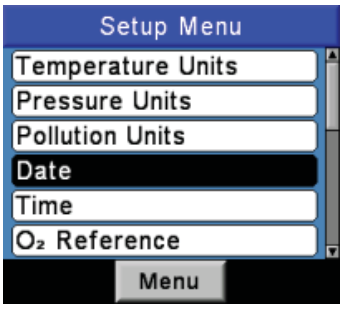
The date is stored in the format: MM/DD/YY. Its value is part of the date and time stamp that is saved along with each combustion test record.

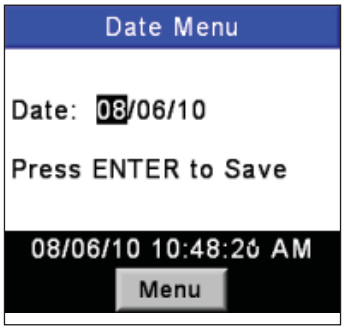
Set the analyzer's internal clock to the current date as follows:

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 change, 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 selection 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 coin cell battery on the Main PCB in the absence of batteries. Bacharach recommends changing the coin cell (P/N 0204-0020) every 5 years.*







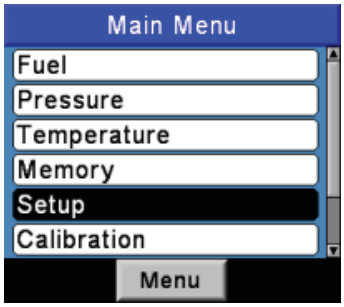
3.10 Time Setup

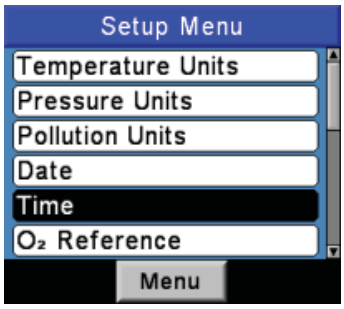
The time is stored in the format: hh:mm:ss AM/PM. Its value is part of the date and time stamp that is save along with each combustion test record.

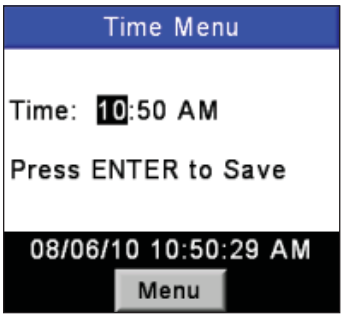
Set the analyzer's internal clock to the current time as follows:

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 change, and then press the ▲▼ buttons until the desired value is displayed
5. Repeat Step 4 until the values for hour, minute, and meridian 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.



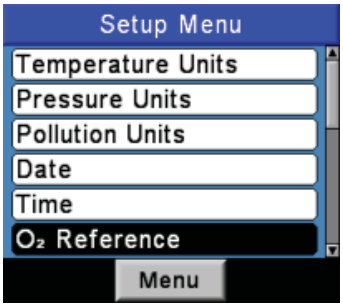


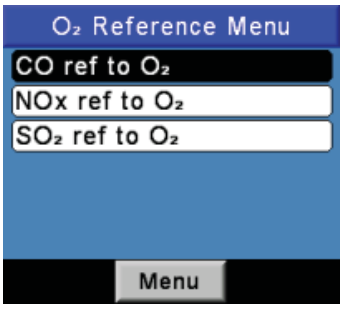


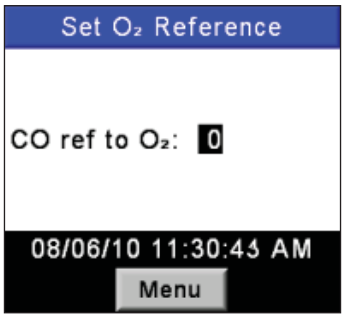
3.11 O_2 Reference Setup

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:





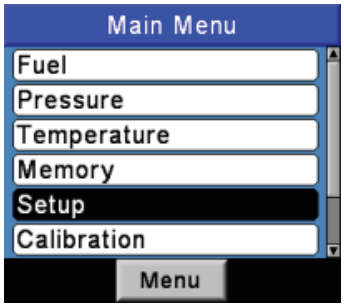


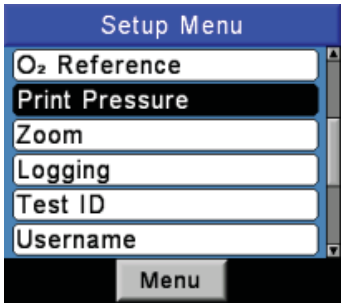
1. Display the MAIN MENU by pressing the **MENU (F2)** button. If necessary, press **ESC** until MENU appears above **F2**.
2. Use the ▲▼ buttons to highlight SETUP, and then press **ENT** to display the SETUP MENU.
3. Use the ▲▼ buttons to highlight O_2 REF, and then press **ENT** to display the O_2 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 re-display 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, repeat Steps 4, 5, and 6 for each measurement.

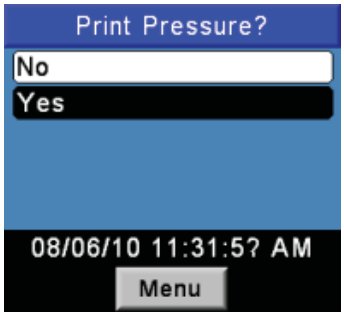
3.12 Print Pressure Selection

Select whether to print or not print the pressure measurement on the combustion test printout as follows:

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.

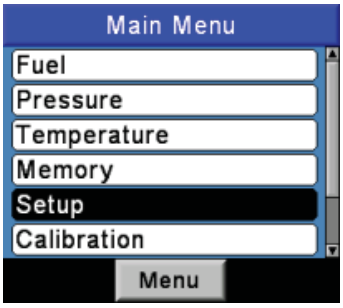


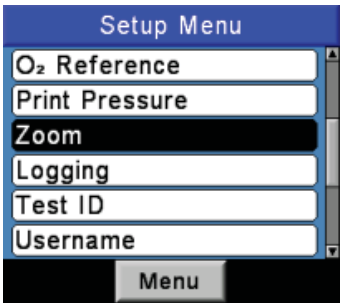


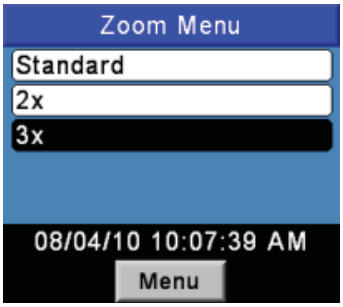


3.13 Zoom-Display Selection

Combustion test data in the Run/Hold screen can be shown with enlarged characters to make viewing easier. The operator can set zoom levels to Standard, 2X, or 3X. The Standard zoom setting will display seven lines of combustion test data at one time, 2X which will display five lines of combustion test data with enlarged characters, and 3X which will display four lines of combustion test data with enlarged characters. The operator can scroll through the complete list of measured and calculated data no matter what zoom level has been selected.

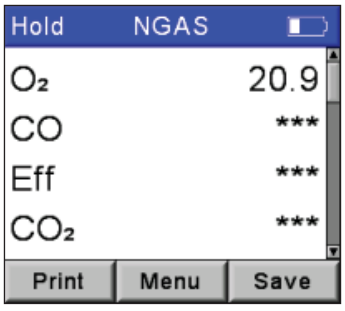






Select desired zoom level as follows:

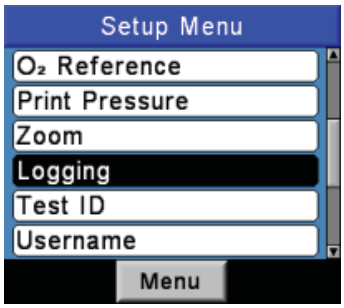
1. Display the MAIN MENU by pressing the **MENU (F2)** button. If necessary, press **ESC** until MENU appears above **F2**.
2. Use the ▲▼ buttons to highlight SETUP, and then press **ENT** to display the SETUP MENU.
3. Use the ▲▼ buttons to highlight ZOOM, and then press **ENT** to display the ZOOM screen.
4. Use the ▲▼ buttons to select the desired Zoom level. Options include STANDARD, 2X, and 3X. Standard will display seven lines of Combustion test data, 2X will display five, and 3X will display four.
5. Press **ENT** to save the selection and re-display the SETUP MENU.



3.14 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 predetermined length of time.

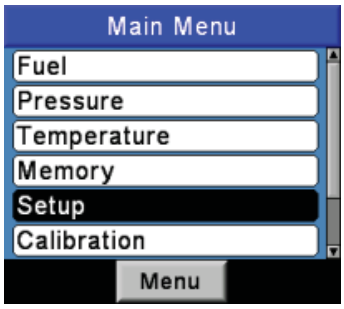
Refer to Section 4.14 for detailed information on how to select the logging function; how to set the interval and duration time periods; and how to view or download the stored data.

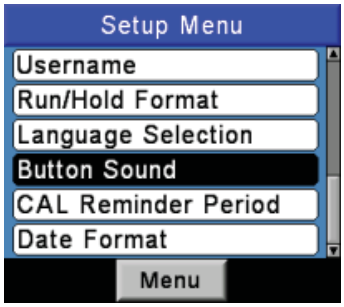


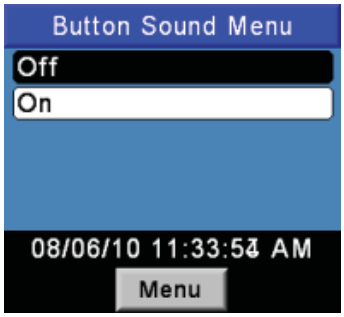
3.15 Button Sound

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 or ON. In the example shown, OFF has been selected.
5. Press **ENT** to save the selection and re-display the SETUP MENU.







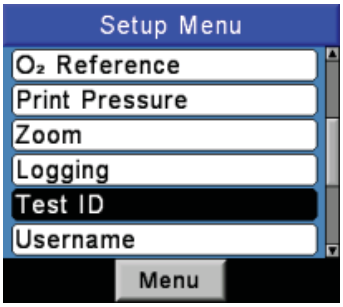
3.16 Test ID Information

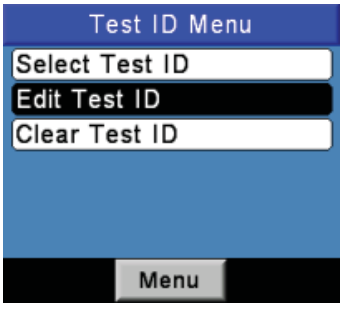
Test records can be identified (e.g. customer's name, burner number, and location) by manually entering up to three lines of text, with each line containing a maximum of 20 alphanumeric characters. When a Test ID is selected this information will be associated with all succeeding test records, and will appear at the top of each test record when printed, and in CSV files when records are downloaded to a PC. The chosen Test ID remains in effect until it is deselected, a new Test ID is selected, or the instrument is turned off. Up to 30 Test ID's can be pre-entered for later retrieval.

> **TIP:** *To save time Test ID information can be entered using the Fyrite User Software.*

To enter or edit a Test ID:

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 TEST ID, and then press **ENT** to display the TEST ID menu
4. Use the ▲▼ buttons to highlight EDIT TEST ID, and then press **ENT** to display the EDIT TEST ID menu, which displays the first line of each Test ID record.
5. Use the ▲▼ buttons to select which Test ID to edit and then press **ENT** to display all three lines of that record. Periods (.....) are used to identify empty lines.

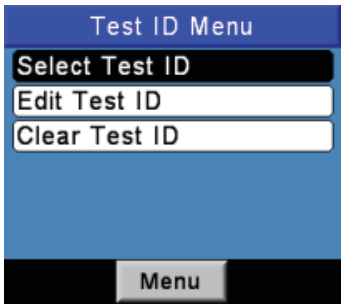




6. Use the ▲▼ buttons to choose which of the three Test ID lines to edit and then press **ENT** to begin editing the chosen line.
7. Use the ▲▼ buttons to enter the desired character and then move to the next character position by pressing the right arrow key. Repeat this step until the line is complete. A maximum of 20 characters can be entered. Press **ENT** to accept the information.

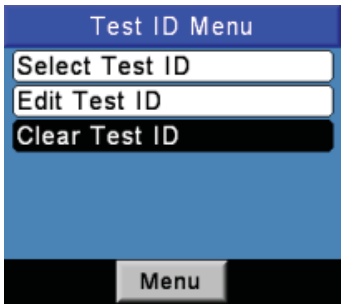
8. At this time, either return to Step 6 to choose another line to edit, or end this procedure by highlighting Edit Complete and pressing the **ENT** key to return to the Edit Test ID Menu.
9. Press **ESC** to go to the Test ID Menu or the **RUN/HOLD** key to return to the Run/Hold screen.

Select a Test ID:



1. From the Test ID menu, use the ▲▼ buttons to highlight SELECT TEST ID, and then press **ENT** to display the SELECT TEST ID menu, which displays the first line of each Test ID record.
2. Use the ▲▼ buttons to choose a pre-entered Test ID or choose NO Test ID (located at bottom of list) to deselect a previously chosen record, then press ENT to make the selection and return to the Test ID menu.
3. Press **ESC** to end the procedure and return to the Setup Menu or press the **RUN/HOLD** key to return to the Run/Hold Screen.

Clear Test ID Information:



1. From the Test ID menu, use the ▲▼ buttons to highlight CLEAR TEST ID, and then press **ENT** to display the CLEAR TEST ID menu.
2. Do one of the following to clear Individual Records or All Records.

   *Individual Records - Use the ▲▼ buttons to highlight Individual Records, then press **ENT** to display the Clear Individual menu. Again use the ▲▼ buttons to highlight the individual record to clear, then press **ENT** to clear the record.

   *All Records - Use the ▲▼ buttons to highlight All Records, then press **ENT** to display the Clear All menu. Again use the ▲▼ buttons to highlight Yes, then press **ENT** to clear all records.
3. Press **ESC** to end this procedure and return to the Test ID menu or press the **RUN/HOLD** key to return to the Run/Hold screen.

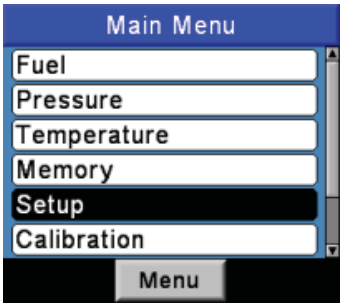
3.17 Username

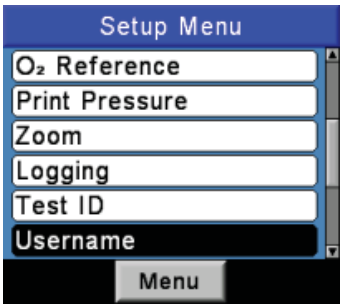
The name of the user or owner of the analyzer (e.g. company name, address, phone number) can be stored in memory by manually entering up to three lines of text, with each line containing up to 20 alphanumeric characters. This information will appear at the top of each printout until new information is entered or cleared.

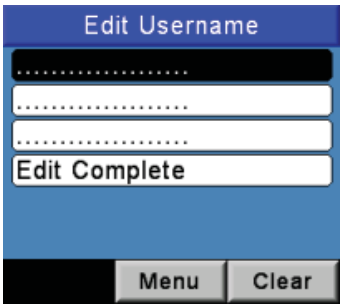
> **TIP:** *To save time Username Information can be entered using the Fyrite® User Software.*

Username Information can be entered 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 USERNAME, and then press **ENT** to display all three lines of the EDIT USERNAME screen. Periods(.....) identify empty lines.
4. Use the ▲▼ buttons to choose which of the three Username lines to edit, then press **ENT** to begin editing the chosen line.
5. Use the ▲▼ buttons to enter the desired character and then move to the next character position by pressing the right arrow key. Repeat this step until the line is complete. A maximum of 20 alphanumeric characters can be entered.
6. Press **ENT** to accept the entered information.
7. At this time, either return to Step 4 to choose another line to edit, or end this procedure by highlighting Edit Complete and pressing the **ENT** key to return to he Setup Menu.



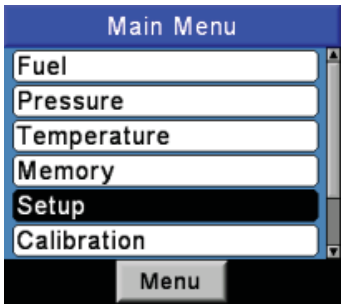


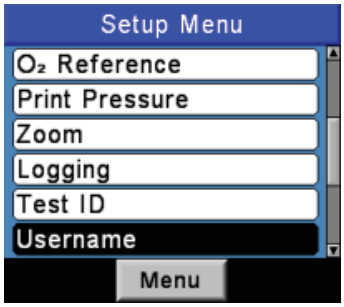


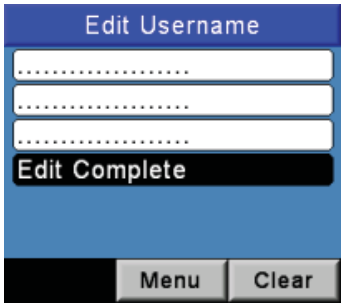
8. Press **ESC** to go to the Main Menu or the RUN/HOLD key to return to the Run/Hold screen.

To Clear a Username proceed 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 USERNAME, and then press **ENT** to display all three lines of the EDIT USERNAME screen. Periods(.....) identify empty lines.
4. Use the ▲▼ buttons to choose which of the three Username lines to clear, then press **CLEAR (F3)** to clear that line.
5. At this time, either return to Step 4 to choose another line to clear, or end this procedure by highlighting EDIT COMPLETE and pressing the **ENT** key to return tot he Setup Menu.
6. Press **ESC** to go to the Main Menu or the **RUN/HOLD** key to return to the Run/Hold screen.



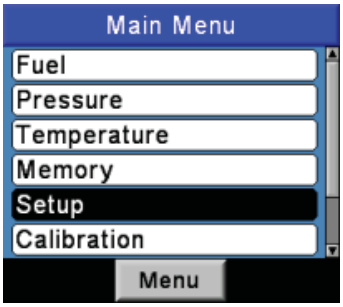


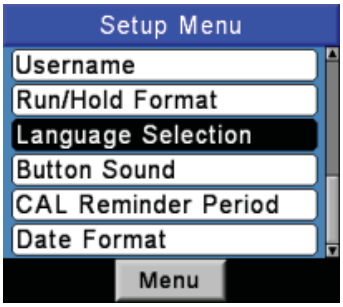


3.18 Language

Information on the display screen can be shown in English, French, or Spanish. Select the desired language 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 LANGUAGE SELECTION, and then press **ENT** to display The Language Selection Menu.
4. Use the ▲▼ buttons to highlight the desired language, then press **ENT** to activate the selection and re-display the Setup Menu.





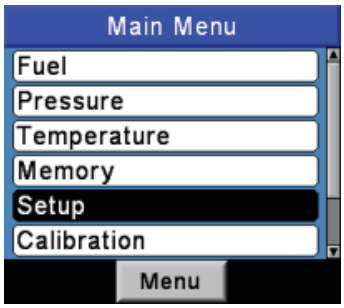
3.19 Cal Reminder Period

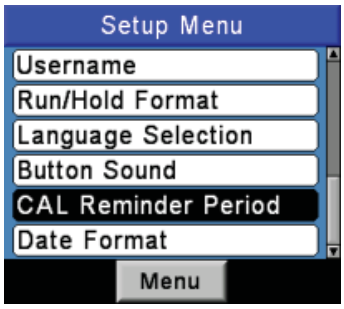
The analyzer can be set to indicate a calibration reminder during the 60 second warm-up period. Calibration reminders can be preset to occur never, 6, 8, 10, 12, or 15 months after the last calibration. When the preset period is exceeded the instrument will display the reminder, and how long since the sensors were last calibrated. The reminder will be displayed at the end of the 60 second warm-up period. If a calibration reminder is displayed the operator can press the RUN/HOLD key to move to the Run/Hold screen for normal operation. Regular calibration periods of 6 months to a year for all gas sensors (except Oxygen) are recommended.

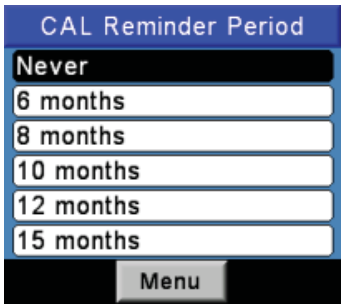
Set the calibration reminder period as follows:

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 CAL REMINDER PERIOD, and then press **ENT** to display CAL Reminder Period Menu.
4. Use the ▲▼ buttons to highlight the desired CAL reminder period, and then press the **ENT** key to activate the selection and re-display the Setup Menu.

NOTE: *The date and time settings must be correct to get accurate cal reminders.*







3.20 Run/Hold Screen Format

PCA®3 test data is located in the Run/Hold screen. By pressing the **RUN/HOLD** key, you should hear the pump running and see the word RUN at the upper-left hand corner of the display. The instrument is continuously measuring and calculating the data that is shown in the Run/Hold screen. Press the **RUN/HOLD** key again, the pump should stop running and the word HOLD should be shown at the upper-left hand corner of the display. The instrument will now show the last measured and calculated data taken before the instrument was placed in HOLD. Use the up and down arrow keys to scroll through the complete list of measured and calculated values when the instrument is running or in the hold mode.

The default order in which data appears in the Run/Hold screen is as follows:

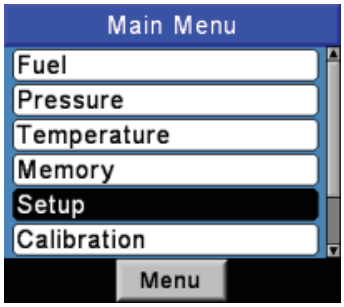
O_2	=	Oxygen
CO	=	Carbon Monoxide
EFF	=	Combustion Efficiency
CO_2	=	Carbon Dioxide
T-STK	=	Stack Temperature
T-AIR	=	Ambient/Primary Air Temperature
EA	=	Excess Air
CO(#)	=	Carbon Monoxide content referenced to an Oxygen percentage
NO	=	Nitric Oxide
NO_2	=	Nitrogen Dioxide
NOx	=	Oxides of Nitrogen (NO and NO_2 combined)
SO_2	=	Sulfur Dioxide
NO(#)	=	Nitric Oxide content referenced to an Oxygen percentage
NO_2(#)	=	Nitrogen Dioxide content referenced to an Oxygen percentage
NOx(#)	=	Oxides of Nitrogen content referenced to an Oxygen percentage
SO_2(#)	=	Sulfur Dioxide content referenced to an Oxygen percentage

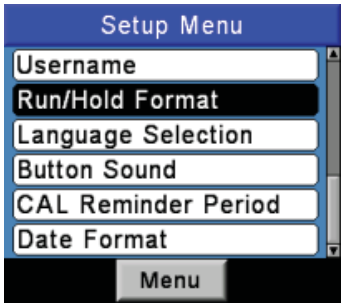
NOTE: *(#) denotes the current O_2 Reference selected.*

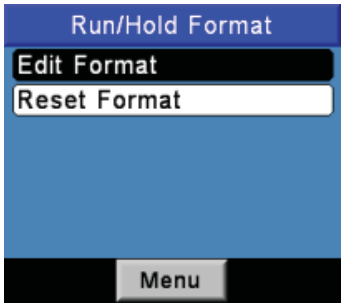
NOTE: *Stars (***) appear in measurement and calculation fields of sensors that are not installed.*

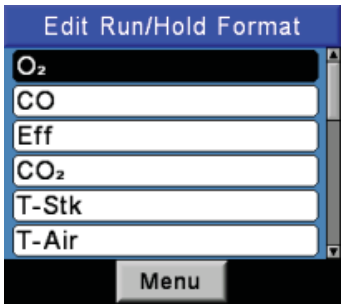
Change the order in which data is displayed as follows:

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 RUN/HOLD FORMAT, and then press **ENT** to display Run/Hold Format Menu.
4. Use the ▲▼ buttons to highlight Edit Format, and then press the **ENT** key to show the Edit Run/Hold Format, where the current order of combustion data is displayed.
5. Change data shown for a particular location by first using the ▲▼ buttons to highlight the location. Then press the **ENT** key to select the location; the cursor will start to flash.
6. Use the ▲▼ buttons to scroll through and select the desired data to appear at that location. Press the **ENT** key to make the selection.
7. Change data displayed at other locations by repeating Steps 5 & 6.
8. When finished, use the ▼ button to highlight Edit complete at the bottom of the list, then press **ENT** to save the new display format and return to the Run/Hold Format screen.



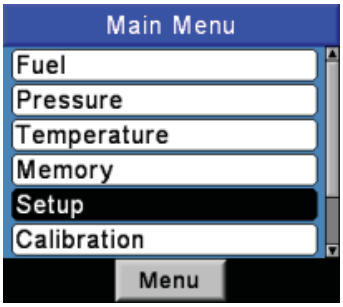


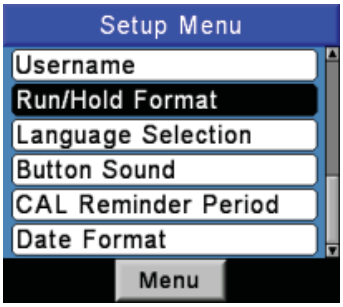


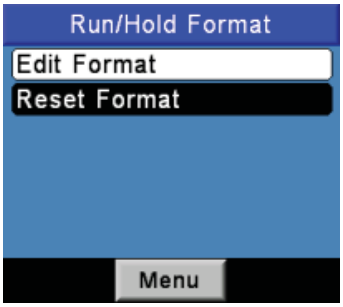


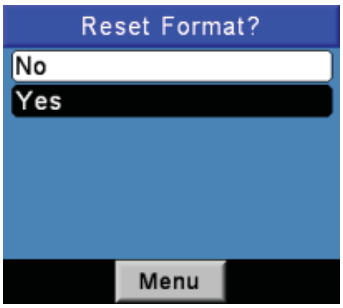
Reset Display format back to factory default settings as follows:

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 RUN/HOLD FORMAT, and then press **ENT** to display Run/Hold Format Menu.
4. Use the ▲▼ buttons to highlight RESET FORMAT, then press **ENT** to display the Reset Format screen.
5. Use the ▲▼ buttons to select YES, then press **ENT** to reset the display and return to the Run/Hold Format screen.









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.

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 ºF and the other sensors at approximately -94 ºF. 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 4.11.
- The analyzer should be purged after performing a combustion test. After removing probe from the stack, let the pump run for at least 10 minutes to remove any 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.

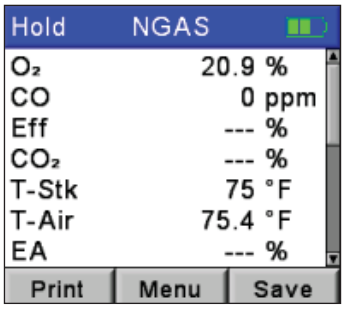
- When storing the analyzer, it's a good idea to empty the water trap and leave it open to further dry it out.
- Calibrate the analyzer every 6 months - 1 year to ensure its accuracy.

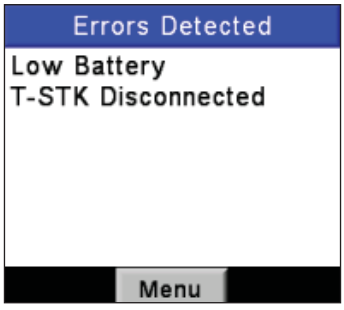
4.2 Turning ON the Analyzer and Warm Up

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

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

1. Place the probe in an area that contains fresh air. This ensures that the sensors will be properly zeroed during the warm-up cycle.
2. 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.
3. Wait for the analyzer to count down its 60 second warm-up period; after which, the instrument will display the Combustion Test HOLD screen.
4. 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.

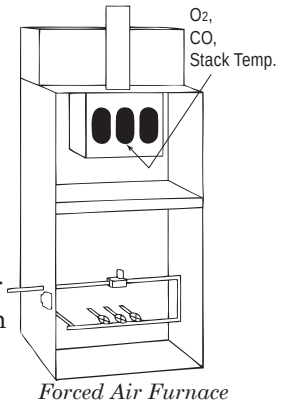




TIP: *If the sensors in error are not critical to the combustion test, then press the* **RUN/HOLD** *button to display the Combustion Test HOLD screen and proceed with the test.*

4.3 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.



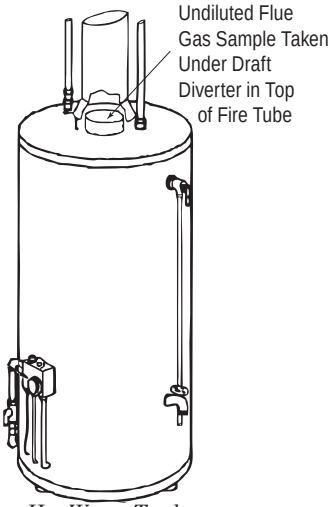
Forced Air Furnace

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.

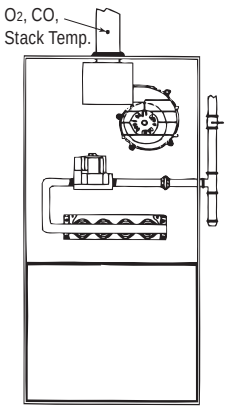
80% EFFICIENCY FAN ASSIST OR POWER VENTED: Combustion testing of fan assist or power vented, furnaces/boilers should be done through a hole drilled in the vent immediately above the inducer fan.

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.

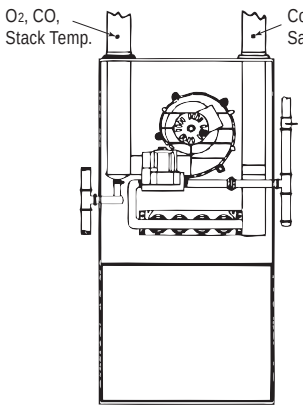
ATMOSPHERIC OR GRAVITY VENTED BOILER: Boilers, which have a 'bell' shaped draft diverter on top, should be tested directly below the diverter through a hole drilled in the vent connector.



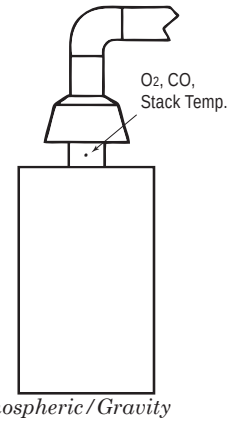
Hot Water Tank



80% Efficiency Fan



90% Efficiency Condensing



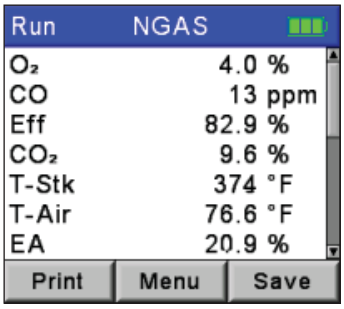
Atmospheric/Gravity Vented Boiler

Figure 4-1. Sampling Points

4.4 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 3.5).
- Inset probe into stack (Section 4.3).
- 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.

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

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

   (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%).

2. Use the up and down arrow keys to scroll to the T-STK reading. Loosen the 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.
3. 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 4.10).*

4. Pressing the **RUN/HOLD** button holds all readings, stops the pump and displays the Combustion-Test HOLD screen. Press the ▲▼ buttons to scroll through all test values. 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(#)	Carbon Monoxide ppm level referenced to a % of oxygen (2)
NO	Nitric Oxide (1)
NO_2	Nitrogen Dioxide (1)
NOx	Oxides of Nitrogen (NO and NO_2 combined) (1)
SO_2	Sulfer Dioxide (1)
NO(#)	Nitric Oxide ppm level referenced to a % of oxygen (2)
NO_2(#)	Nitrogen Dioxide ppm level referenced to a % of oxygen (2)
NOx(#)	Oxides of Nitrogen ppm level referenced to a % of oxygen (2)
SO_2(#)	Sulfur Dioxide ppm level referenced to a % of oxygen (2)
NO-T	Nitric Oxide Sensor Temperature (3)

(1) Pollution unit of measure selected per Section 3.8

(2) The "#" represents the oxygen reference level of between 0 and 15% as selected per Section 3.11

(3) Only shown if selected in the Run/Hold Format menu per Section 3.20

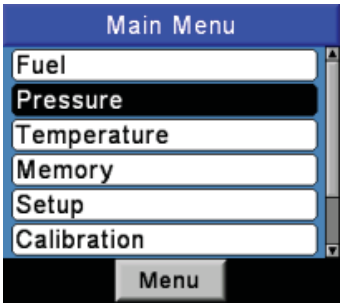
NOTE: *Stars (* * *) appear in measurement and calculation fields of sensors that are not installed.*

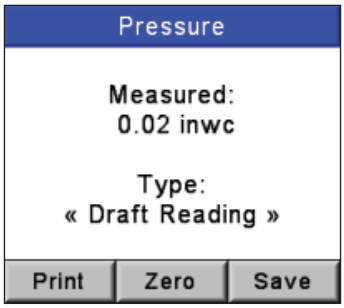
4.5 Pressure Label Selection

The pressure measurement can be labeled with types including, differential across heat exchanger, draft reading, and differential pressure. See Section 4.7 for pressure and draft measurement procedures.

Label data as follows:

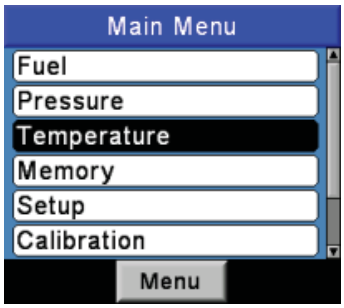
1. Display the MAIN MENU by pressing the **MENU (F2)** button. If necessary, press **ESC** until MENU appears above **F2**.
2. Use the ▲▼ buttons to highlight PRESSURE, and then press **ENT** to display the PRESSURE MENU.
3. Use the ◄► buttons to scroll through the available pressure label types. The current label will be used, saved, and printed with the record



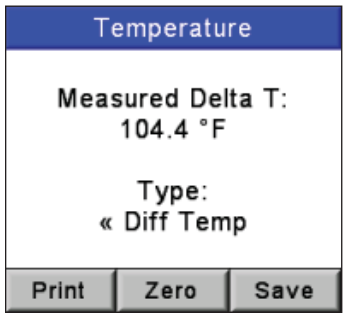


4.6 Temperature Label Selection & Measurement

The difference in temperature between two areas can be measured by using the analyzer's two temperature channels and the Temperature screen. By using the T-Air channel as a reference, the temperature applied to the T-Stack channel will be displayed on the Temperature Measurement screen as differential temperature between the two channels. Additionally, the temperature measurement can be labeled. Label types include differential temperature across heat exchange or differential temperature. Perform a differential temperature measurement 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 TEMPERATURE, and then press **ENT** to display the TEMPERATURE MEASUREMENT screen.
3. Install thermocouples in both temperature channel connectors.



4. Before taking a measurement, the temperature channels may need to be zeroed, if not already displaying zero with both thermocouples exposed to the same condition. Press **ZERO (F2)** if needed.
5. To label the data use the ◄► buttons to scroll through the available temperature label types. The current label will be used, saved, and printed with the record.
6. Press **ENT** to save the selection and re-display the TEMPERATURE MENU or **ESC** to exit back to the Main Menu

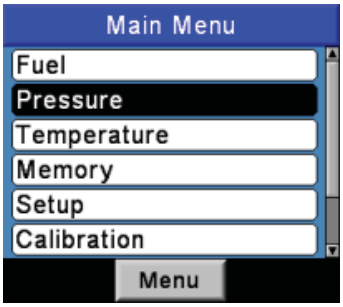
4.7 Making a Draft / Pressure Measurement

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.

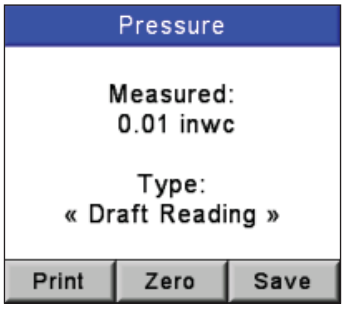
Perform a draft / pressure measurement as follows:

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

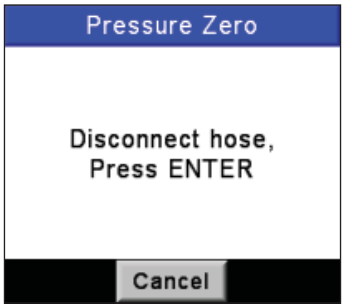
   TIP: *The pressure units of measure is selected per Section 3.7.*



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:
   - Press the **ZERO (F2)** button.
   - Disconnect any hoses connected to the +ΔP and –ΔP ports, and then press **ENT** to zero the pressure sensor.
   - 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 4-2).



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.

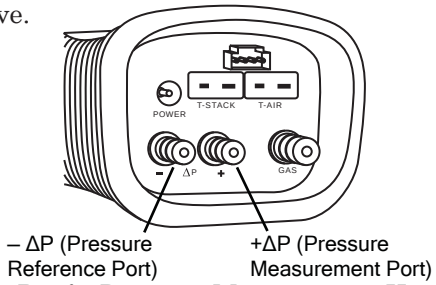


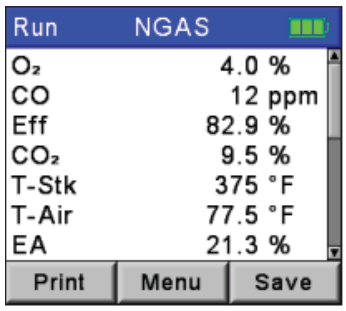
Figure 4-2. Draft/Pressure Measurement Hose Connections

4.8 Saving Test Data

Up to 500 individual sets ("snap shots") of combustion-test, pressure, or temperature data can be saved in memory, which can later be recalled for viewing from the Memory Directory (Section 4.14).

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 will not be saved until space is made available by clearing the data. (See 4.14.3: Clearing Memory)*



4.9 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 with fresh air as indicated by the O_2 reading returning to 20.9%.

4.10 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.*

1. 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.
2. 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.
3. After each combustion test, also check the Water Trap's filter element. If it looks dirty, replace the filter per Section 6.2.

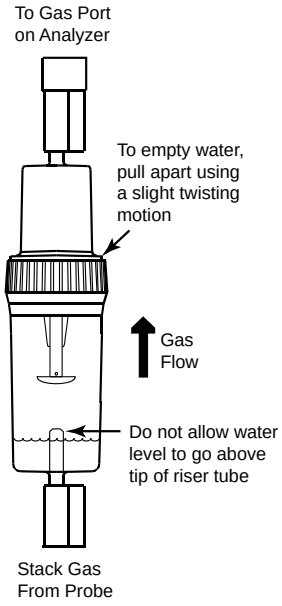


Figure 4-3.

4.11 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®3 was not purged with fresh air as described in Section 4.9, 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.*

4.12 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 keypad backlight being ON or OFF, and the type and condition of the batteries).

4.13 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 4.14), or downloaded to a personal computer using the supplied Fyrite® User Software and USB cable. 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.

4.13.1 Turning ON Data Logging

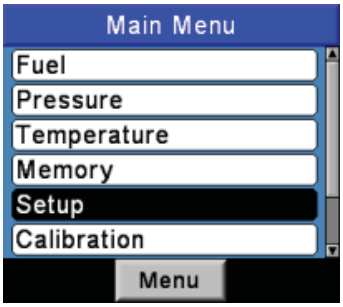
IMPORTANT: *Before turning ON data logging and starting the data logging process, the analyzer should already be set up to perform a combustion test per Section 4.5.*

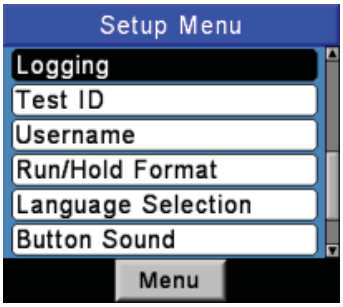
Turn ON data logging as follows:

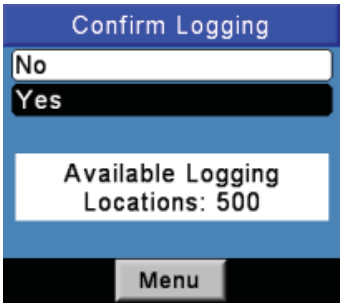
1. Display the MAIN MENU by pressing the **MENU (F2)** button. If necessary, press ESC until MENU appears above **F2**.
2. Use the ▲▼ buttons to highlight SETUP, and then press **ENT** to display the SETUP MENU.
3. Use the ▲▼ buttons to highlight LOGGING, and then press **ENT** to display the LOGGING 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 4.14.3.*

   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.





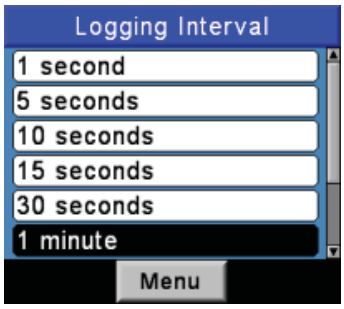


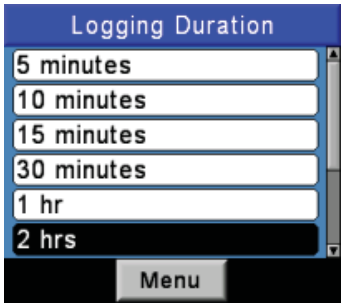
4.13.2 Setting the Logging Interval and Duration

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 4.14.1, 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.

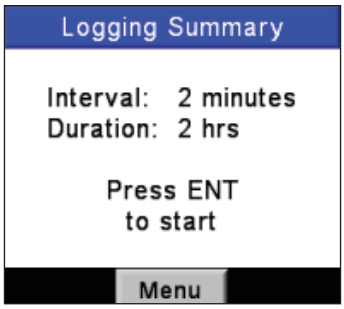




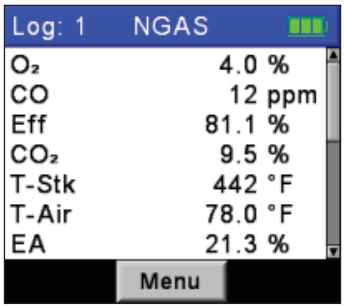
> **NOTE:** *If the selected duration requires more memory than is currently available, the analyzer will automatically select the longest duration possible for the selected interval.*

4.13.3 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 top of the screen, the memory location where the current log entry is being saved is displayed.
- 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.

4.13.4 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.
- If the logging process was stopped by pressing **ESC**, it cannot be resumed without first turning logging back ON per Section 4.13.1.

4.14 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 4.8., while the second bank is used to store logged combustion test data as described in Section 4.13. Each bank is independent of each other, and cannot share data or be combined.

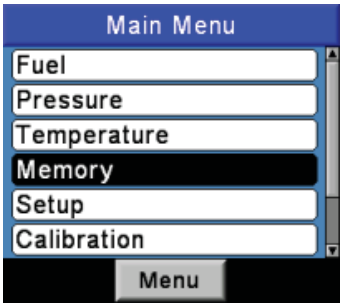
Individual memory locations in each memory bank can be recalled for viewing on the display or printed (refer to Sections 4.15.1 & 4.15.2), or the entire contents of each memory bank can be individually downloaded to a computer and viewed in a spreadsheet program for analysis (refer to Section 4.17).

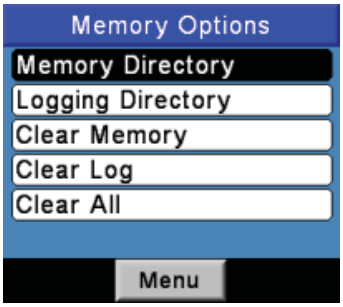
> **TIP:** *When displaying the contents of either memory bank, the operator can quickly page through the screens by pressing the* **PAGE– (F1)** *and* **PAGE+ (F3)** *buttons. Or move to the first or last memory location by pressing the ◄► buttons, respectively.*

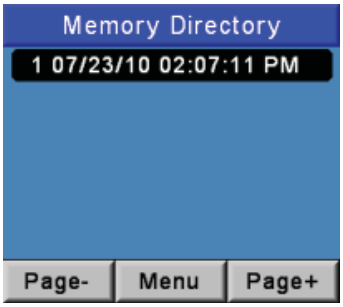
4.14.1 Recalling Combustion Test Data

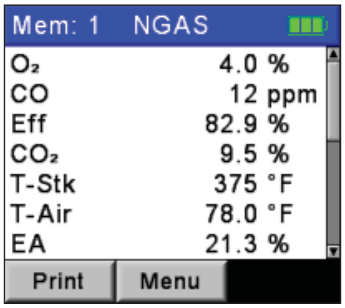
Recall individual combustion test data records as follows:

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.









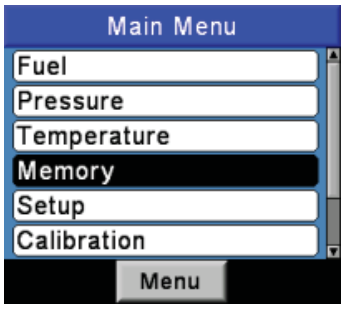
Note the following:

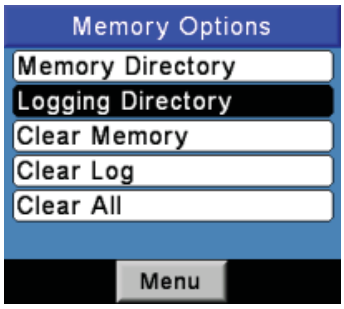
- The top line of the recalled combustion test data screen shows the memory location being viewed. In this example, "MEM: 1" is being displayed
- The recalled combustion test data can be printed by pressing the **PRINT (F1)** button (refer to Section 4.19).

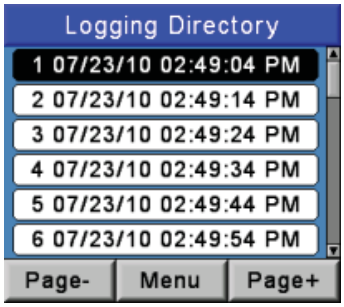
4.14.2 Recalling Logged Test Data

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.

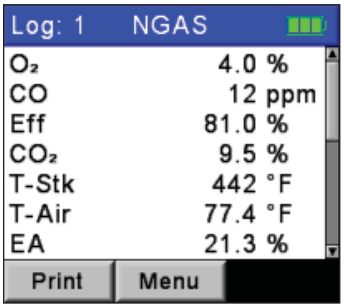




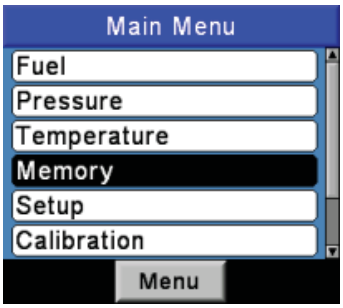


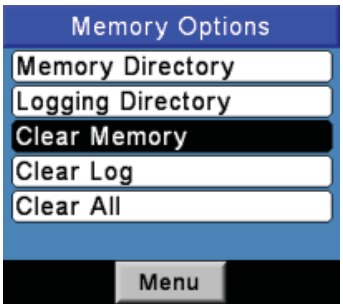
Note the following:

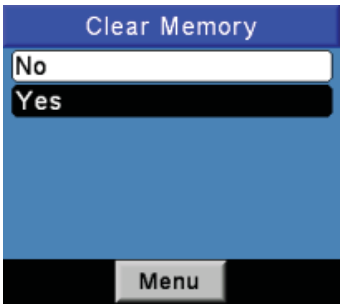
- The top line of the log test data screen shows the log location being viewed. In this example, “Log: 1” is being displayed.
- The recalled logged test data can be printed by pressing the **PRINT (F1)** button (refer to Section 4.18).



4.14.3 Clearing Memory







When all memory locations used to store individual combustion test records have been filled, the next combustion test record saved will not 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.

4.15 Downloading Stored Data to a Computer

The combustion test data that was stored in either the analyzer's Memory Directory (Section 4.8), or Logging Directory (Section 4.14), can be downloaded to a computer using the Fyrite® User Software 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.

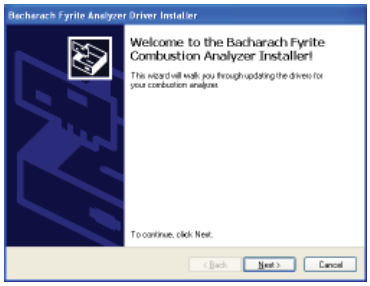
Computer requirements:

- Windows XP or higher
- CD ROM drive
- USB 1.1, USB 2.0, or USB 3.0 port
- 205 MB of hard drive space for the Fyrite® User Software, plus up to an additional 350 KB for each downloaded file

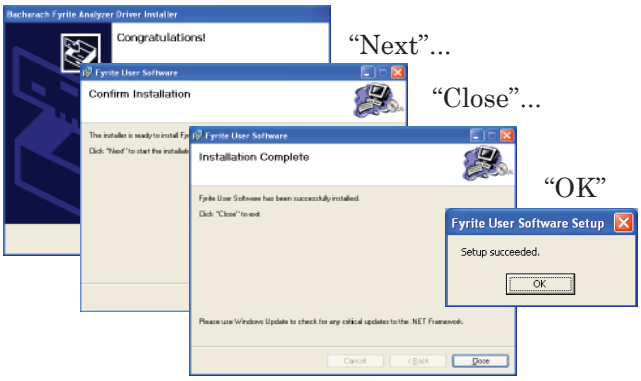
4.15.1 Fyrite® User Software Installation

Windows XP:

1. Insert the Fyrite® User Software CD into the computer's disc drive.
2. After the CD is loaded, the Setup window will be displayed. Click OK. If applicable, wait for the Net 3.5 Framework setup to complete.
3. Click "Next" on the "Welcome" screen to begin the installation.



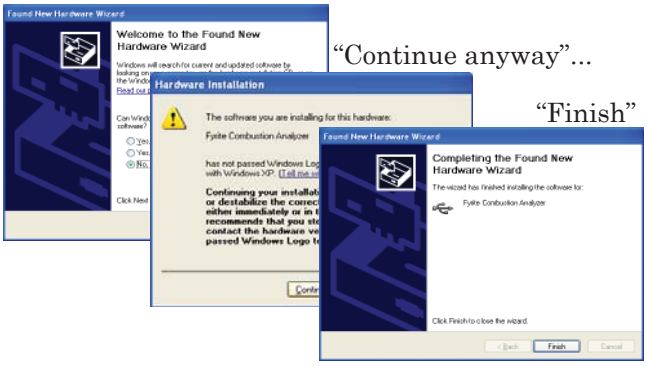
4. Respond to the prompts on the screens that follow.
5. Click "Finish"...



After the installation:

1. Open Fyrite® User Software via the desktop icon.
2. Connect the instrument to the PC with the USB cable (P/N 0104-4032).
3. When first connected, a "Found New Hardware Wizard" screen will be displayed. Again, respond to the prompts to completion.

4. Click “Next”



“Continue anyway”...

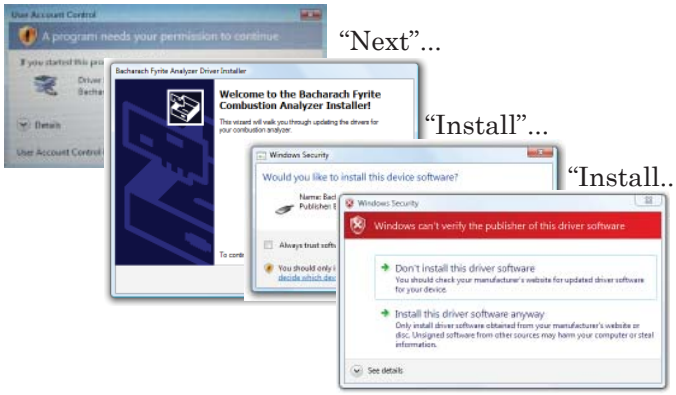
“Finish”

Windows Vista:

1. Insert the Fyrite® User Software CD into the computer’s disc drive.

2. After the CD is loaded, the Security window will be displayed. Click on OK. If applicable, wait for the Net 3.5 Framework setup to complete.

3. Click “Continue”...

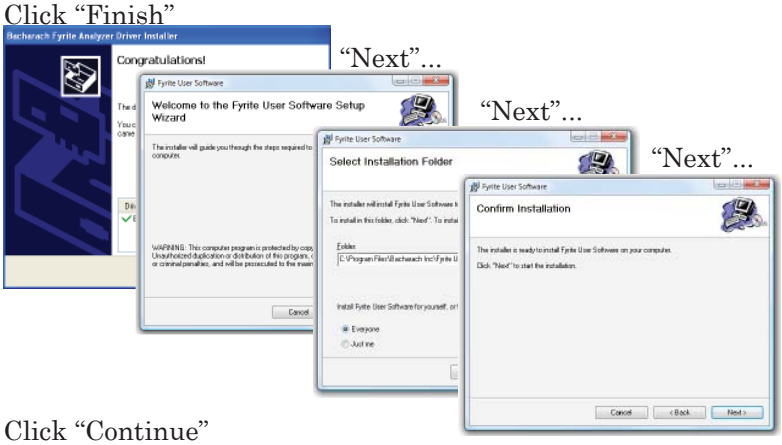


“Next”...

“Install”...

“Install... software anyway”

Click “Finish”

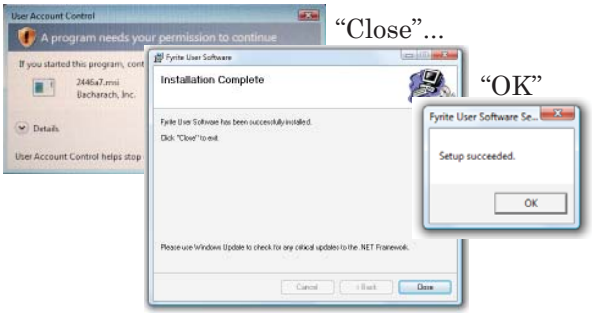


“Next”...

“Next”...

“Next”...

Click “Continue”

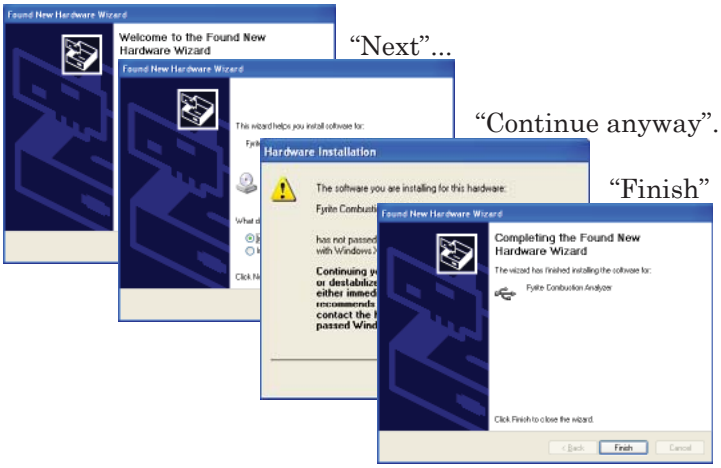


“Close”...

“OK”

After the installation:

1. Open Fyrite® User Software via the desktop icon.
2. Connect instrument to the PC with USB cable (P/N 0104-4032).
3. Click “Next”....



“Next”...

“Continue anyway”...

“Finish”

4.16 Fyrite® User Software Description

Fyrite User Software	
Set Instrument Time	Sync instrument with computers time
Calibration Password	Change 4 digit numeric code
Time Meters	Provides instrument & pump run time
B-Smart	B-Smart calibration code entry
Logged Data	Downloads instrument logged memory to Excel
Saved Measurements	Downloads instrument memory to Excel
Test IDs	Test ID entry
User/Customer ID	User ID entry
Settings	Change instrument set up parameter
Customer Logo set up	Load custom logos for print out. Limited to 384 x 192.
Custom Fuel	Bacharach can supply fuel codes for custom fuel. Consult the factory for more information
Update Instrument Software	Remote upgrade of instrument software

4.17 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 32 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 "***". For example: if the analyzer does not contain an SO_2 sensor, then "***" will appear in data fields 23 and 24.

Table 4-2 — Downloaded Data Fields

Field	Column Name	Data Name or Value
1	Date	Date of Test in mm/dd/yy
2	Time	Time of Test in 12 hour format (AM/PM)
3-5	Test ID	Information Input by User
6	Fuel	Fuel Name
7	%O2	Oxygen Level
8	CO	Carbon Monoxide Level (see field 30)
9	ppm CO(O2)	Carbon Monoxide Level referenced to a % of O_2 (see field 25)
10	% Efficiency	Combustion Efficiency
11	% CO2	Carbon Dioxide Level
12	%EA	Excess Air
13	TStk	Stack Temperature
14	TAir	Primary/Ambient Air Temperature
15	Delta-T	Differential Temperature Value
16	TempUnit	Temperature Units
17	NO	Nitric Oxide Level (see field 30)
18	ppm NO(O2)	Nitric Oxide Level referenced to a % of O_2 (see field 26)
19	NO2	Nitrogen Dioxide Level (see field 30)
20	ppm NO2(O2)	Nitrogen Dioxide Level referenced to a % of O_2 (see field 26)
21	NOx	Nitrogen Oxides ($NO+NO_2$) (see field 30)
22	ppm NOx(O2)	Nitrogen Oxides Level as referenced to a % of O_2 (see field 26)
23	SO2	Sulfur Dioxide (see field 30)
24	ppm SO2(O2)	Sulfur Dioxide Level referenced to a % of O_2 (see field 27)
25	CO_O2Ref	$\%O_2$ Reference for CO (1)
26	NOx_O2Ref	$\%O_2$ Reference for NOx (1)
27	SO2_O2Ref	$\%O_2$ Reference for SO_2 (1)
28	Pressure	Pressure (Draft) Value
29	Pressure Units	Pressure Units of Measure (2)
30	Pollution Units	Pollution Units of Measure (3)
31	PS Voltage	Power Supply Voltage
32	NO Temp	Nitric Oxide Sensor Temperature

(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

4.18 Printing Test Data

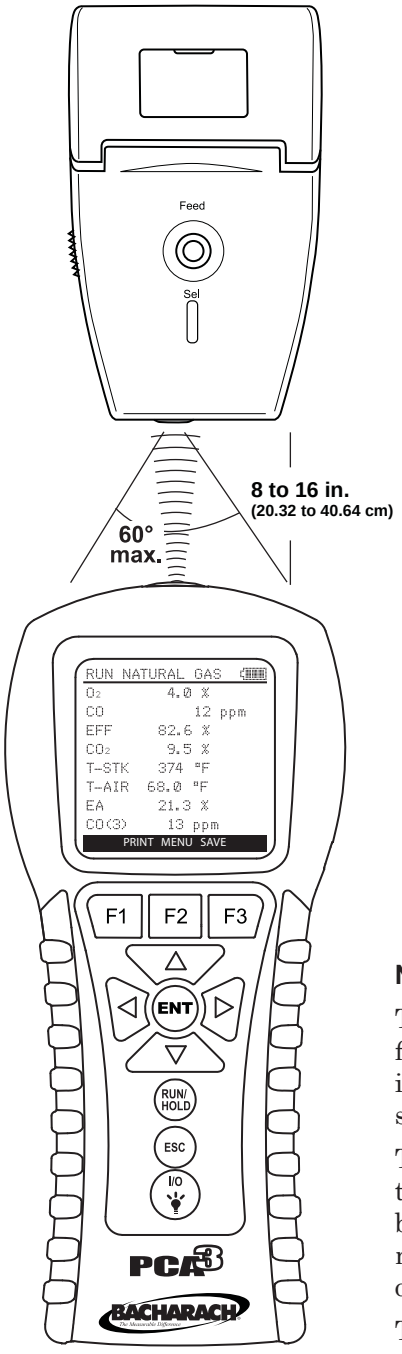
Combustion or pressure data that is currently being displayed can be sent to a printer using IrDA protocol as described below.

Data that is stored in memory can also be printed by first displaying the stored test data as described in Sections 4.14.1 & 4.14.2.

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 4-4.
3. Press the **PRINT (F1)** button to begin printing.

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



BACHARACH, INC.
PCA 3
SN: xxxxxx
==========
TIME 01:00:00 PM
DATE 08/04/10

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
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 –0.02 inwc

COMMENTS:

NOTES:

Three Stars (***) appear in the data field of sensors that are not calibrated or installed, 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 4-4. Printer Alignment & Sample Printout

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 B-Smart Sensors

The PCA®3 uses Bacharach's B-Smart® Sensor technology for CO_{Low}, CO_{High}, NO, NO_2, and SO_2. The B-Smart® Sensor is marked with a 10 or 14 digit calibration code that can be entered in the instruments calibration screen via the keypad, or with the Fyrite® User Software.

Benefits of the B-Smart® Sensors:

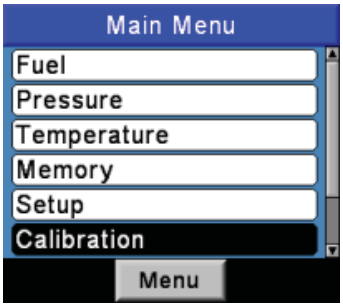
- New sensors can be installed without applying gas for calibration.
- Sensors can be pre-calibrated and installed when needed
- Sensors can be moved from one analyzer to another.
- The analyzer's diagnostics screen shows what sensors are installed, and their current end-of-life condition (Good, Low, Bad).

B-Smart® sensors should be calibrated by an authorized Bacharach Service Center (Section 8.3) every 6 months to 1 year to assure that the analyzer continues to meet its published accuracy specifications. B-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
2. Any errors detected during warm-up will be listed on the display immediately following warm-up. Correct any errors before proceeding. Refer to Section 7.3 for a listing of error messages and their meaning.
3. Display the MAIN MENU by pressing the **MENU (F2)** button. If necessary, press **ESC** until MENU appears above **F2**.
4. Use the ▲▼ buttons to highlight CALIBRATION, and then press **ENT** to display the CALIBRATION PASSWORD screen.
5. Before calibration can begin a 4-place alphanumeric password must be entered. Use the ▲▼ and ◄► buttons to enter the password. (default password is 1111)
6. Press the **ENT** key to accept the password. If the correct password was entered the CALIBRATION LIST Menu will be displayed.
7. 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 B-Smart® Sensor Replacement & Calibration

To replace a B-Smart® sensor and calibrate, do the following:

1. Enter the CALIBRATION MENU per Section 5.2.
2. Use the ▲▼ buttons to select B-SMART®. Press **ENTER** to display the B-Smart code screen
3. Use the ▲▼ buttons to enter the 10 or 14 digit alphanumeric code supplied with the B-Smart® sensor. Use the ◄► buttons to move the cursor across the screen. Press **ENTER.**

   NOTE: *There are two B-Smart® sensor code lengths. 10 digits for CO_{High}, NO, NO_2, and SO_2, and 14 digits for CO_{Low}.*

   NOTE: *If the correct code was entered, the analyzer accepts it and returns to the CALIBRATION MENU. If an incorrect code was entered, the screen will display "Invalid Code". Check to make sure the correct code has been entered. If the problem persist, contact your nearest Bacharach Service Center.*

   TIP: *To save time B-Smart® codes can be entered using the Fyrite User Software.*

Bacharach also offers a convenient Exchange Program that allows the customer to regularly send in old sensors and, as scheduled, receive calibrated replacements. Contact Bacharach customer service for more details about the Exchange Program.

5.4 Pressure Sensor Calibration

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

Material Required:

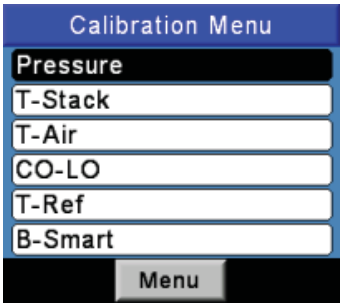
- Bellows
- Manometer
- Range: ±8 in. of water column (±20 mb)
- Accuracy: ±0.01 in. of water column (±0.025 mb)

Procedure:

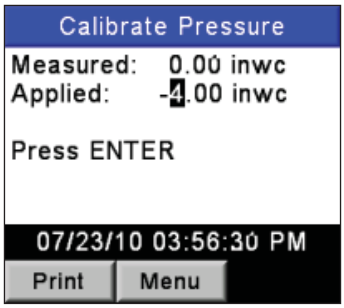
NOTE: *The unit-of-measure for pressure is selected per Section 3.7. In the following procedure inwc is selected, but note that any unit-of-measure can be used for calibration purposes.*

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 display 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 4.8, 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.



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 "Applied Value High" (or Low) to appear at the bottom of the screen.

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.

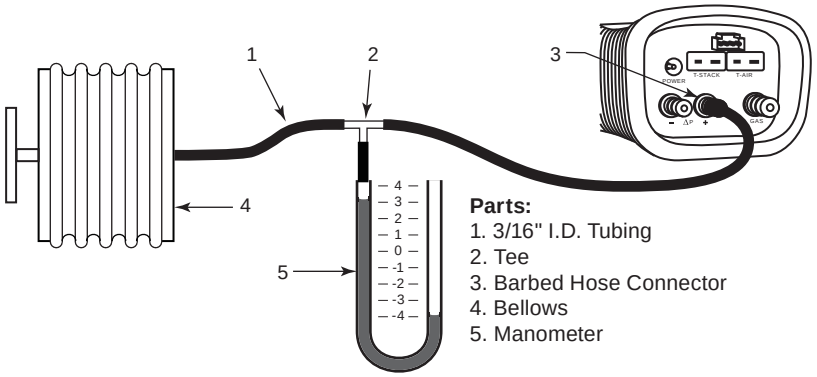


Figure 5-1. Pressure Sensor Calibration Equipment

5.5 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.

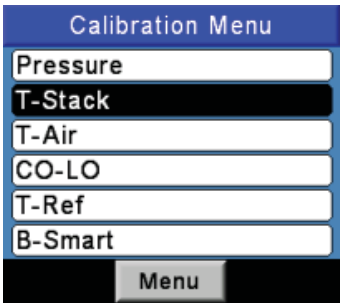
   Alternatively: *Plug the probe's thermocouple into the T-STACK connector located at the bottom of the analyzer.*

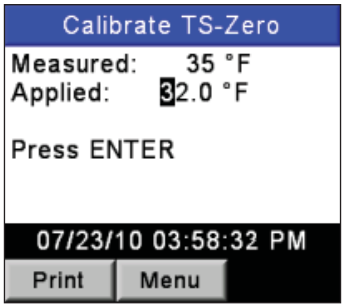
   CAUTION: *DO NOT attach the probe's gas hose to the analyzer's GAS port; otherwise water will be drawn into the analyzer!*

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 "Applied Value High" (or Low) to appear at the bottom of the screen.

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:

1. 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 "Applied Value High" (or Low) to appear at the bottom of the screen.

2. 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.

5.6 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:

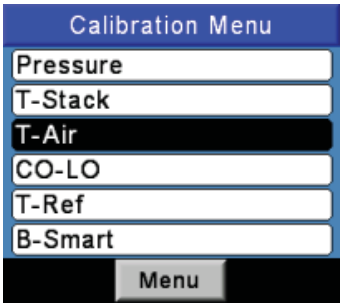
1. Set thermocouple simulator to room temperature and plug its output into the T-AIR connector located at the bottom of the analyzer.

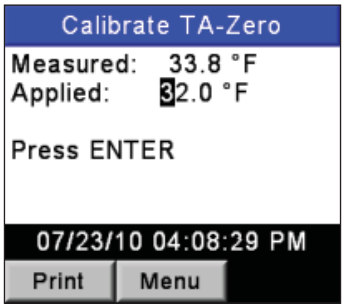
   Alternatively: *Plug the probe's thermocouple into the T-AIR connector located at the bottom of the analyzer. DO NOT attach the probe's gas hose to the analyzer's GAS port; otherwise water will be drawn into the analyzer!*

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.

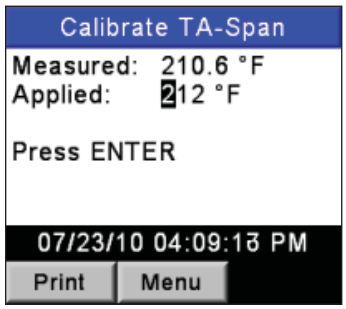
   Alternatively: *Submerge probe tip into an ice-water bath with a thermometer, wait several minutes, and then use the ▲▼ and ◄► buttons to enter an Applied value that exactly equals the thermometer reading.*

   The calibration range is from 32 to 41 °F (0 to 5 °C). An attempt to calibrate outside this range will cause the message "Applied Value High" (or Low) to appear at the bottom of the screen.

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:

1. 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.

2. 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.

5.7 CO_{Low} Sensor Calibration

Note that the CO_{Low} 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_{Low} sensor and, optionally, spans the H_2 part of the sensor to known gas levels.

The user has the option to perform a CO only calibration or a CO/H_2 calibration using the PCA®3 soft keys.

Material Required:

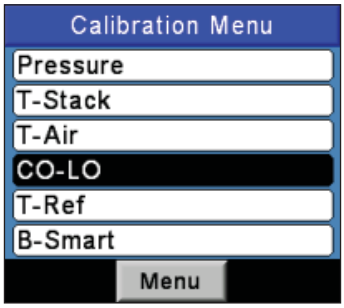
- Calibration Kit, P/N 0024-7059
- Gas Cylinder: 500 ppm CO in air, P/N 0024-0492
- Gas Cylinder: 1,000 ppm CO & 1,000 ppm H_2 in Nitrogen, P/N 0024-0794

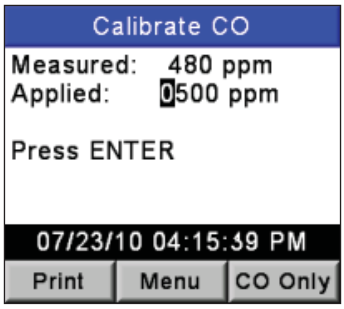
Procedure:

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_{Low}, 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 85.
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 9 to 1,500 ppm. An attempt to calibrate outside this range will cause the message "Applied Value High" (or Low) to appear at the bottom of the screen.



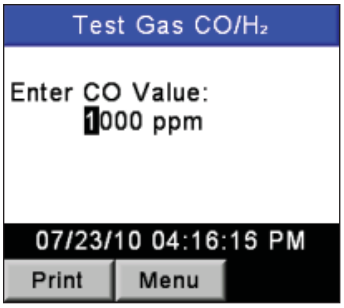


5. Adjust the regulator for a flowmeter indication of approximately 2 SCFH. Wait until the Measured reading stabilizes (approximately 3 minutes), and then press **ENT** to calibrate the CO Measured value to that of the Applied value. The message "Good Calibration" should briefly appear followed by the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

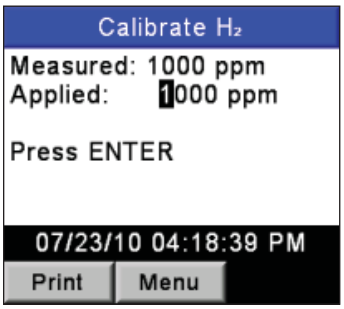
6. Turn OFF the regulator of calibration fixture and remove the CO cylinder.

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. Calibrating 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.

    NOTE: *A CO-only calibration can be done by pressing* **F3** *in Step 5 (instead of* **ENT***).*

5.8 SO_2 Sensor Calibration

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

Material Required:

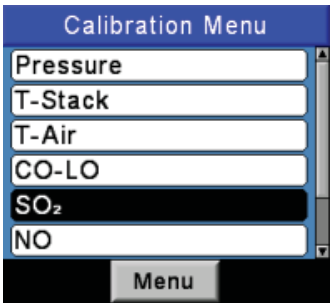
- Calibration Kit, P/N 0024-7059
- Gas Cylinder: 100 ppm SO_2 in Nitrogen, P/N 0024-1158

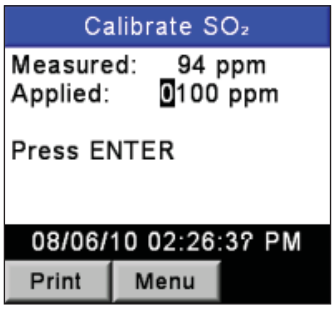
Procedure:

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 85.
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 1,800 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.

5.9 NO Sensor Calibration

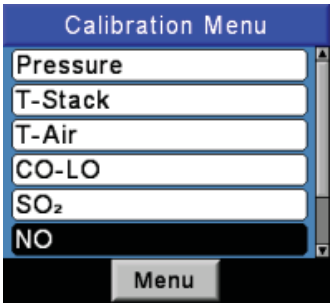
This procedure spans the optional nitric oxide sensor to a known gas level.

Material Required:

- Calibration Kit, P/N 0024-7059
- Gas Cylinder: 250 ppm NO in Nitrogen, P/N 0024-1156

Procedure:

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



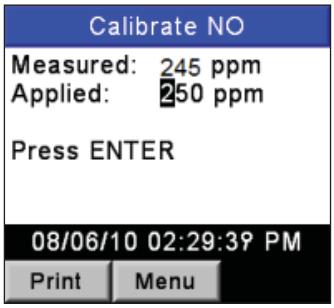
2. Use the ▲▼ buttons to highlight NO, and then press **ENT** to display the CALIBRATE NO screen.

   "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 85.
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 900 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.

5.10 NO_2 Sensor Calibration

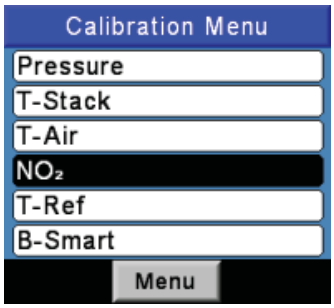
This procedure spans the optional nitrogen dioxide sensor to a known gas level.

Material Required:

- Calibration Kit, P/N 0024-7059
- Gas Cylinder: 100 ppm NO_2 in Nitrogen, P/N 0024-1157

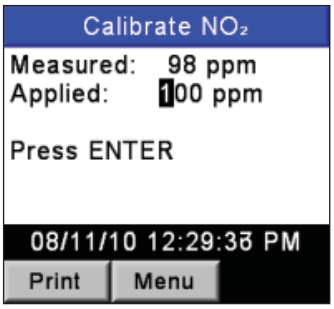
Procedure:

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 85.
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.

5.11 CO_{High} Sensor Calibration

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

Material Required:

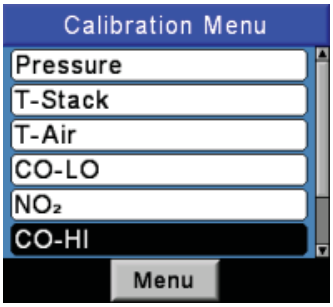
- Calibration Kit, P/N 0024-7059
- Gas Cylinder: 4,000 ppm CO in Air, P/N 0024-1155

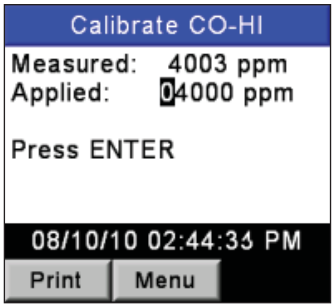
Procedure:

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_{High}, and then press **ENT** to display the CALIBRATE CO_{High} 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 85.
4. Use the ▲▼ and ◄► buttons to enter an Applied value that exactly equals the concentration 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.

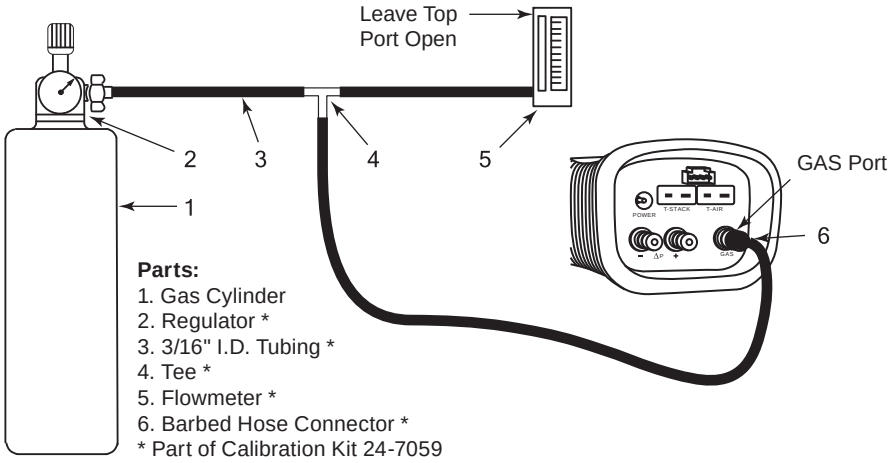


Figure 5-2. Gas Sensor Calibration Equipment

6 Maintenance

Customer maintenance of the PCA®3 is limited to the following:

- Battery replacement (Section 3.2.1)
- Sensor re-calibration (Section 5)
- Water trap / filter assembly maintenance (Section 6.2)
- Sensor replacement (Section 6.3)
- Probe thermocouple replacement (Section 6.5)
- Cleaning the probe (Section 6.6)

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

6.1 PCA®3 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.*
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.

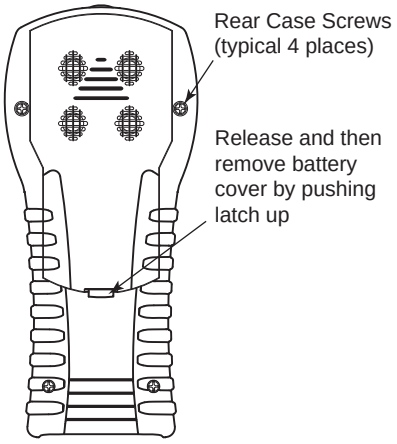


Figure 6-1. Removing the Rear Case

Sensor Positions

Position \ Model	225	235	245	255	265	275
#1	O_2	O_2	O_2	O_2	O_2	O_2
#2	CO_{Low}	CO_{Low}	CO_{Low}	CO_{Low}	CO_{Low}	CO_{Low}
#3				SO_2	NO_2	SO_2
#4		NO	CO_{High}		NO	NO

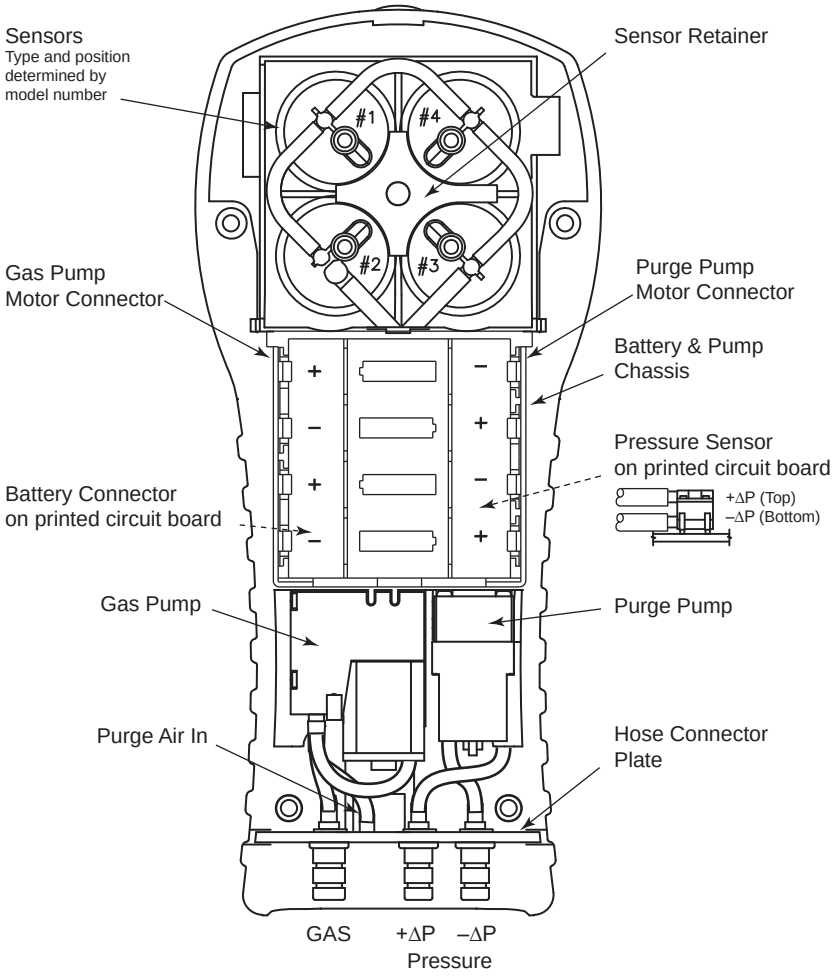
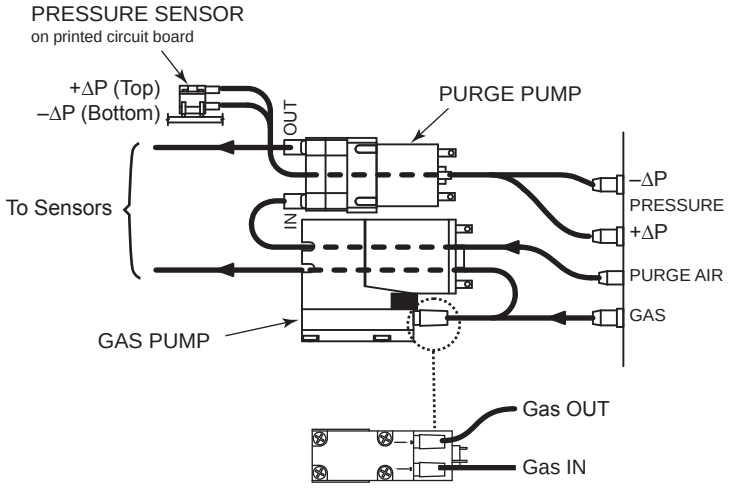


Figure 6-2. Inside View with Rear Case Removed



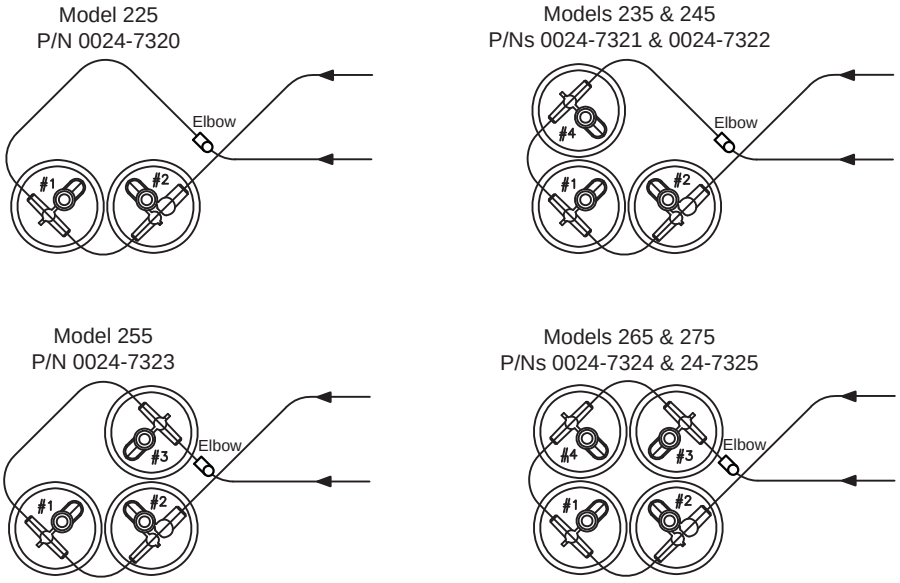


Figure 6-3. Tubing Connection

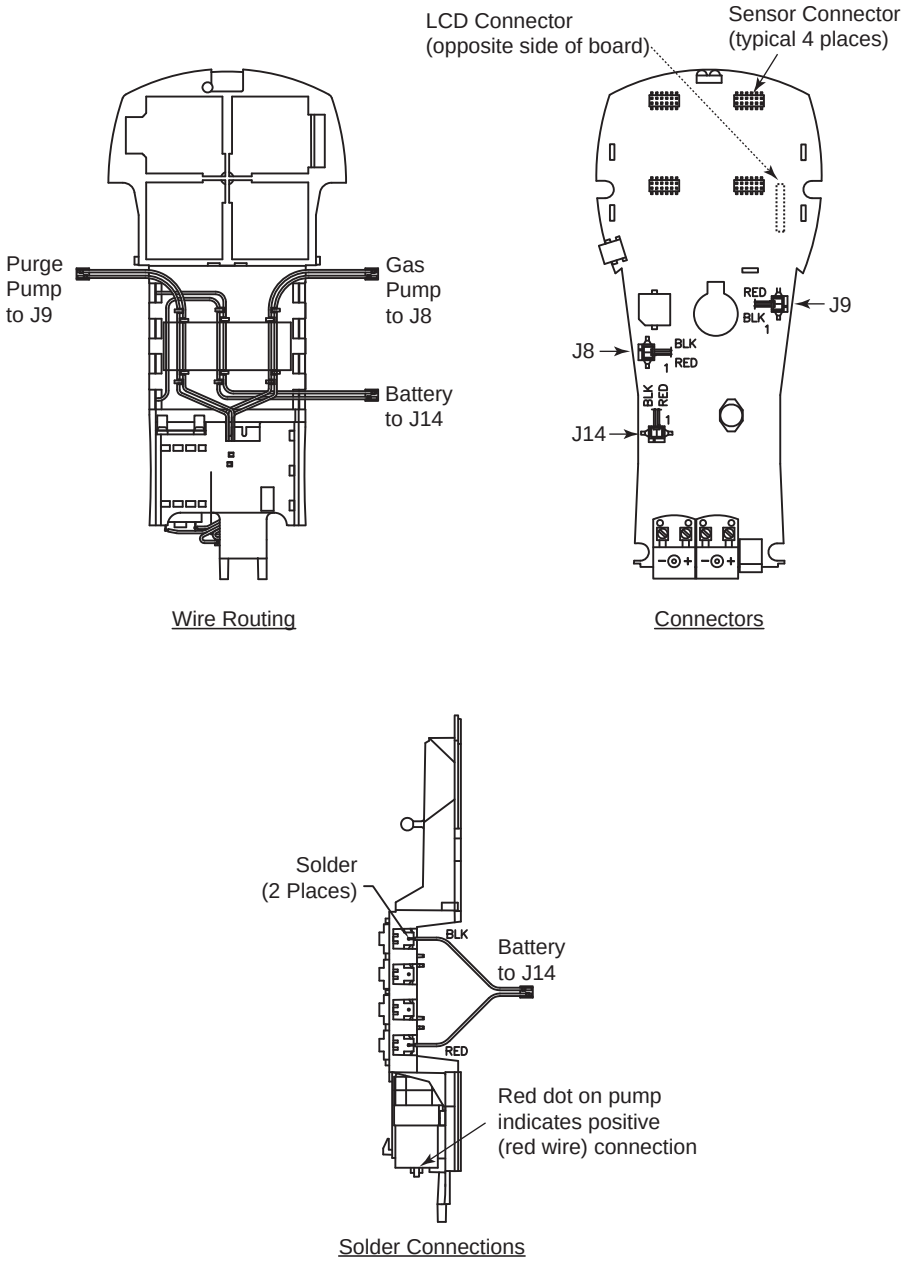


Figure 6-4. Wiring

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.

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 0007-1644
- 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.

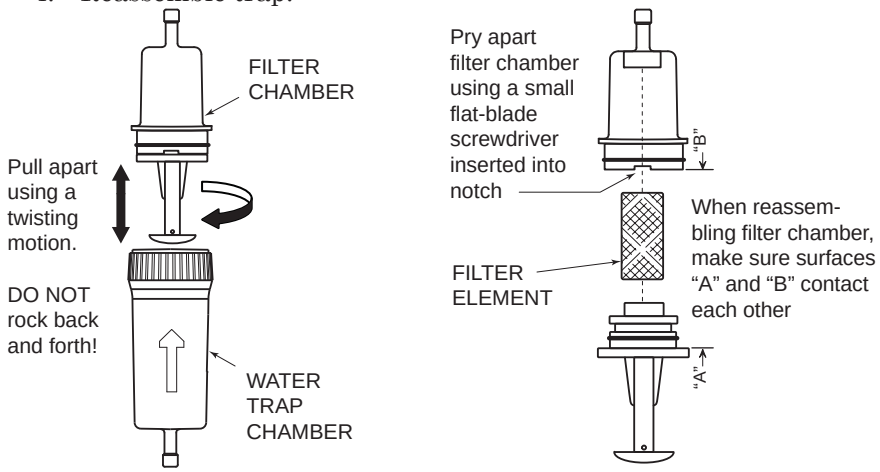


Figure 6-5. Disassembling the Water Trap/Filter Assembly

6.3 Sensor Replacement

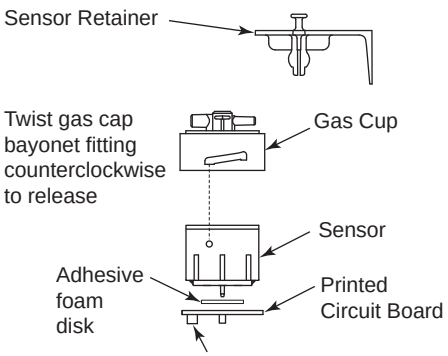
All sensors are replaced in a similar manner. Do the following to replace either the O_2, CO_{Low}, CO_{High}, NO, NO_2, or SO_2 sensor. Refer to Section 8.1 Replacement Parts for list of sensors and part numbers.

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. Carefully remove the old sensor from the B-Smart® sensor PCB, keeping in mind that there is an adhesive foam disk in between the PCB and sensor.

   IMPORTANT: *When replacing the O_2 sensor, be sure that the "+" sensor pin plugs into the PCB socket that is also marked "O_2+".*

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

8. Remove the replacement sensor from its plastic canister. Note that the CO_{Low}, CO_{High}, SO_2, and NO_2 sensors have a shorting-spring installed between two of their pins. Remove and discard this spring before installing the sensor.



CAUTION: *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.*

Figure 6-6. Sensor Assembly

9. 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.
10. Plug the sensor into analyzer; and then reattach tubing to gas cup.
11. 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. Enter the B-Smart® calibration code, or calibrate the new sensor(s) per Section 5 (except the O_2 sensor which does not require calibration).

6.4 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 to remove the 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 toward 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

6.5 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...
0024-8413	6 inches
0024-8414	12 inches
0024-8415	24 inches
0024-8416	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.

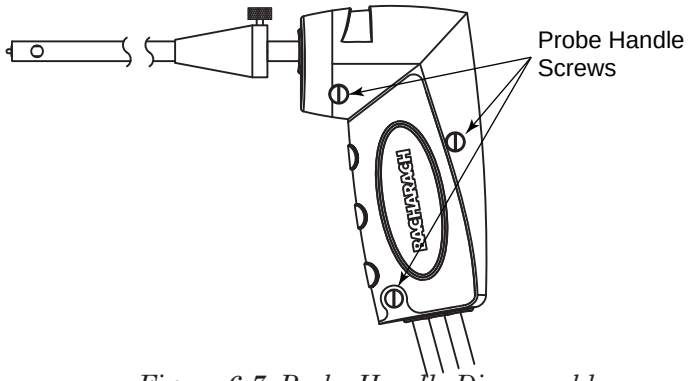


Figure 6-7. Probe Handle Disassembly

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.

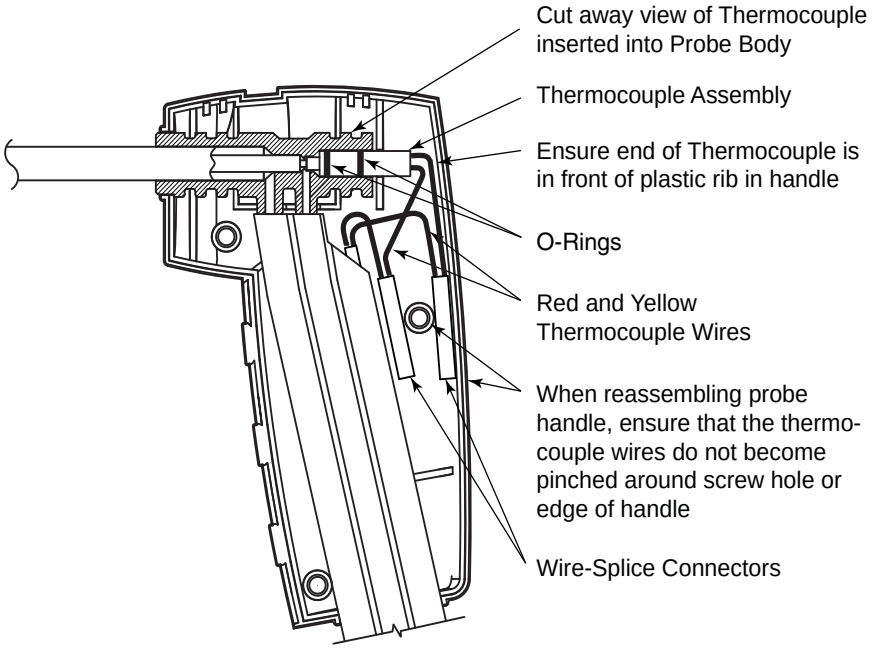


Figure 6-8. Thermocouple Installation and Wiring

6.6 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.

7 Troubleshooting

7.1 Analyzer Repair

It is recommended that field repair of the PCA®3 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

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 error 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 over range.

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. Replace batteries per Section 3.2.
- **O_2 Sensor Missing** – Oxygen sensor not installed. Install oxygen sensor per Section 6.3.
- **BAD Sensors** – The oxygen sensor's output is too low and can not be calibrated in the instrument, signifying that the sensor is depleted and needs replaced. Refer to Section 6.3.
- **No B-Smart Sensors Installed** – There are no B-Smart sensor(s) installed. Install sensors per Section 6.3.
- **Low Sensors** - O_2, CO_{Low}, CO_{High}, NO, NO_2, or SO_2 sensor output(s) were low but still usable. Sensor(s) may need to be replaced in the near future. Message will indicate which sensor(s) are in warning.
- **T-STK Disconnected** – The probe's thermocouple is not connected to the analyzer's T-STACK connector. Plug the probe thermocouple plug into the T-Stack connector at the bottom of the instrument.
- **Warmup Sensor Error** - CO_{Low}, CO_{High}, NO, NO_2, or SO_2 Gas sensor(s) were not zeroed at warmup because of high output. Run instrument on fresh air then restart instrument to re-zero sensor(s). If message persists, sensor(s) may need to be replaced. Message will indicate which sensor(s) are in error.

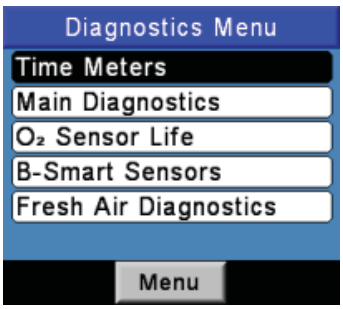
Stack or Air temperature channel is measuring temperature outside the range of -4 to 212 °F at startup. Make sure that the Stack and Air thermocouples are sampling ambient room air within the temperature range at startup. Message will indicate which channel(s) are in error.

Pressure sensor is measuring pressure outside the range of +/ - 3 inches of water column at startup. Ensure that the analyzer is sampling atmospheric pressure and restart.

The analyzer was turned on with the probe sampling flue gas. Move the probe to fresh air and restart the analyzer.

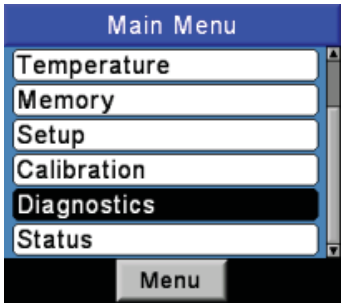
7.4 Diagnostics and Status Screens

The DIAGNOSTICS menu provides information regarding the operation of the analyzer. Information includes the following:



- **Time Meters** - Displays the run time of the analyzer, sample pump and purge pump in hours of operation.
- **Main Diagnostics** - Lists the current status of the Stack and Air Thermocouple channels, Reference Temperature channel, Pressure channel, and Battery.
- **O_2 Sensor Life** - Displays the approximate remaining life of the Oxygen sensor.
- **B-Smart Sensors** - Displays the current status of all B-Smart sensors installed.
- **Fresh Air Diagnostics** - Fresh air diagnostics will cycle the instrument through the 60 second warm-up to check on the status of all sensors. The probe must be in fresh air to perform a valid check.

Access the Diagnostic menu 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 DIAGNOSTICS and then press **ENT** to display the DIAGNOSTICS MENU.
3. Use the ▲▼ buttons to highlight the desired diagnostic topic, and then press **ENT** to display the information under that topic.
4. Press **ESC** key to exit back to the Diagnostic menu or the Menu (F2) key to exit back to the Main Menu.

The Status screen provides a quick reference to key items when troubleshooting.

Access the Status menu 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 STATUS and then press **ENT** to display the DEVICE STATUS screen.
3. Press **ESC** key to exit back to the Main Menu.

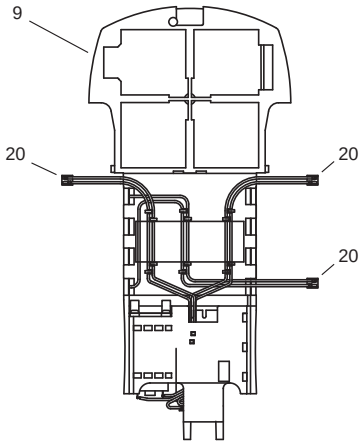
8 Parts & Service

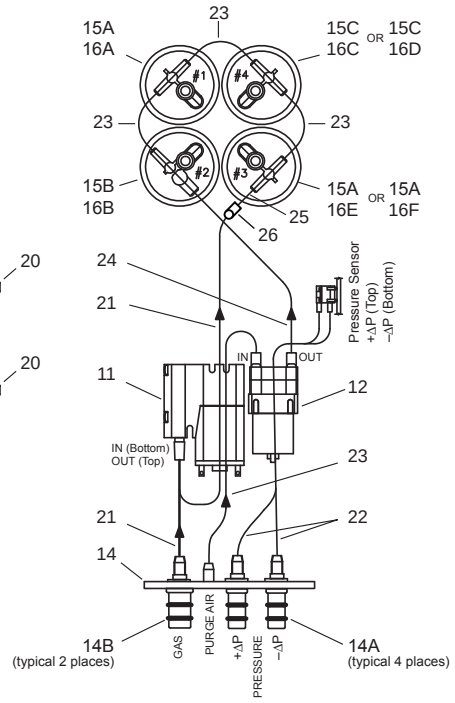
8.1 Replacement Parts

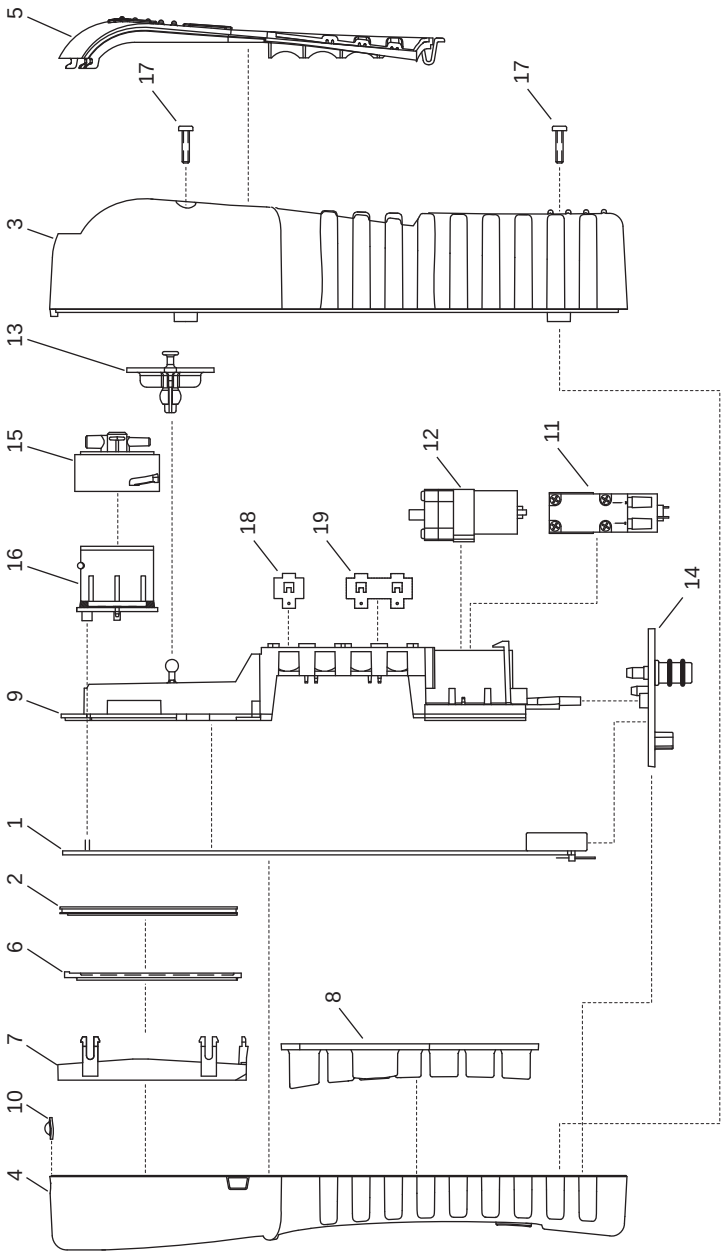
Item	Description	Part No.
1	Main PCB Assembly	0024-1523
2	LCD Module	0024-1520
3	Rear Case	0024-1381
4	Top Case	0024-1524
5	Battery Cover	0024-1383
6	Window	0024-1526
7	LCD Frame	0024-1525
8	Keypad	0024-1387
9	Chassis	0024-1388
10	Lens, Infrared	0024-1391
11	Replacement Pump, Sample Gas	0024-1547
12	Replacement Pump, Purge	0024-1548
13	Sensor Retainer	0024-1418
14	Replacement Hose Connector Plate (complete assembly, including o-rings)	0024-1480
14A	O-Ring, Pressure Fitting	0105-5103
14B	O-Ring, Gas Fitting	0105-5102
15A	Gas Cup, $O_2/SO_2/NO_2$	0024-1421
15B	Gas Cup, CO_{Low}	0024-1422
15C	Gas Cup, NO/CO_{High}	0024-1420
16A	Sensor, O_2	0024-0788
16B	Sensor, B-Smart®, CO_{Low}	0024-1541
16C	Sensor, B-Smart®, CO_{High}	0024-1542
16D	Sensor, B-Smart®, NO	0024-1545
16E	Sensor, B-Smart®, NO_2	0024-1544
16F	B-Smart® Sensor, SO_2	0024-1543
16G	Sensor, NOT-calibrated, CO_{Low}	0024-0789
16H	Sensor, NOT-calibrated, CO_{High}	0024-0997
16J	Sensor, NOT-calibrated, NO	0024-0881

16K	Sensor, NOT-calibrated, NO_2	0024-1027
16L	Sensor, NOT-calibrated, SO_2	0024-0998
17	Screw, #4 x 1/2" LG	0002-2144
18	Battery Clip, Single	0004-1434
19	Battery Clip, Double	0024-1433
20	Cable Assembly	0024-1521
21	Tubing, Vinyl, 1/8 ID x 3/16 OD*	0003-6104
22	Tubing, Silicon, 1/16 ID x 1/8 OD*	00036372
23	Tubing, Silicon, 3/32 ID x 5/32 OD*	0103-6101
24	Tubing, Silicon, 1/8 ID x 3/16 OD*	0103-6102
25	Tubing, 1/8 ID x 1/4 OD*	0003-6105
26	Elbow	0003-6170
- -	Bias Battery	0204-0020
- -	O-Ring Kit (all o-rings included)	0024-1471

* Order tubing by the foot



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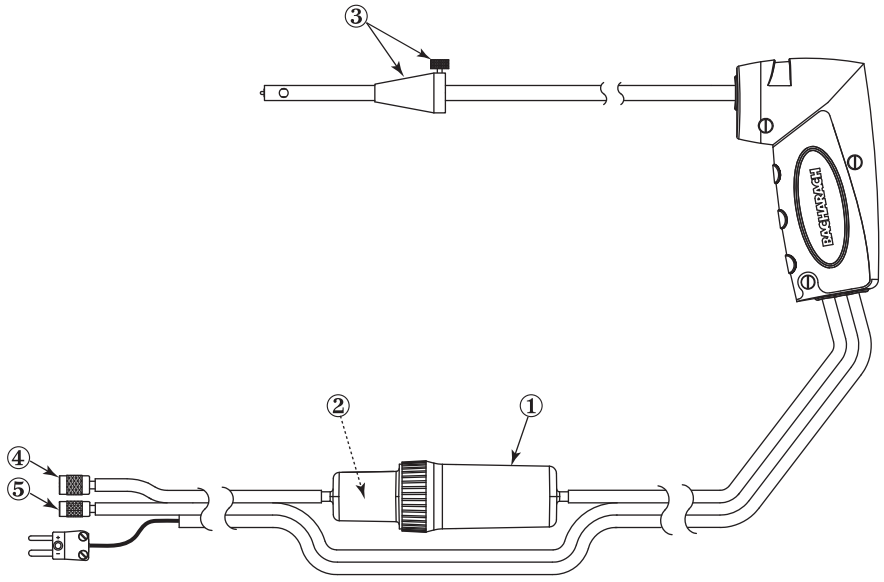
8.2 Accessories

Standard Accessories

Description		Part No.
Carrying Case		0024-0865
Batteries, 'AA' Alkaline		0204-0004
12" Probe, Hose, and Water Trap/Filter Assembly		0024-3004
1	Water Trap/Filter	0019-3265
2	Filter Element (3 pack)	0007-1644
3	Probe Stop	0019-0580
4	Thumb Screw	0102-0875
5	Connector, Gas Sample	0024-0877
6	Connector, Draft	0024-0878
Fyrite® User Software		0024-1470
USB Cable		0104-4032
Instruction Manual		0024-9472



Optional Accessories

Description	Part No.
AC Power Adapter: (Input: 100-240 VAC, 50/60 Hz; Output: 6 VDC @ 1 A)	0024-1254
Ambient Air Thermocouple (T-AIR), K-Type, 10 ft.	0104-1797
Ambient Air Thermocouple (T-AIR), K-Type, 1 inch.	0104-1798
Utility Wand (12 in. rigid probe w/ 5 ft. coiled cable)	0104-1799
Differential Pressure Hose Assembly, 6 ft.	0024-1103
Calibration Kit (includes hoses, adapter, flowmeter; does not include gas cylinders)	0024-7059
Gas Cylinder, 500 ppm CO in air (103 Liter)	0024-0492
Gas Cylinder, 1000 ppm CO & 1000 ppm H_2 in Nitrogen (103 Liter)	0024-0794
IrDA Printer	0024-1400
Printer Paper, 1 Roll	0006-8733
Printer Paper, 5 Pack	0024-1310
Probe, Hose, and Water Trap/Filter Assembly, 6 in. Probe	0024-3002
Probe, Hose, and Water Trap/Filter Assembly, 24 in. Probe	0024-3021
Probe, Hose, and Water Trap/Filter Assembly, 36 in. Probe	0024-3022
Thermocouple Replacement Kit, 6 in.	0024-8413
Thermocouple Replacement Kit, 12 in.	0024-8414
Thermocouple Replacement Kit, 24 in.	0024-8415
Thermocouple Replacement Kit, 36 in.	0024-8416
Sample Conditioning Probe, Compact (recommended when measuring NO_2 and SO_2)	0024-7224

8.3 Service Centers

United States

Bacharach, Inc.
621 Hunt Valley Circle
New Kensington, PA 15068
Phone: 724-334-5051
Fax: 724-334-5723
Email: help@MyBacharach.com

Canada

Bacharach of Canada, Inc.
20 Amber Street Unit #7
Markham, Ontario L3R 5P4
Canada
Phone: 905-470-8985
Fax: 905-470-8963
Email: bachcan@idirect.com

NOTES

World Headquarters
621 Hunt Valley Circle, New Kensington, PA 15068
Ph: 724-334-5000 • Toll Free: 800-736-4666 • Fax: 724-334-5001
Website: www.MyBacharach.com • E-mail: help@MyBacharach.com