EC9811

Ozone Analyser

(with internal zero & span)

User Manual

Revision: B

www.ecotech.com

EC9811
Quick Start Guide.

Step 1 – Installation:

- Inspect analyzer for damage before turning on. ***Service Manual:- 1.1.***
- Select an appropriate location. ***Operation Manual:- 2.1.1.***
- Connect Gas lines. ***Operation Manual:- 2.1.2.2.***
- Connect Analog Output Cables. ***Operation Manual:- 2.1.2.1.***
- Connect RS232 Cables. ***Operation Manual:- 4.2.1.***
- Check the mains power selection switch (115 or 230 VAC). ***Operation Manual:- 2.2.***
- Connect AC Mains Power. ***Operation Manual:- 2.2.***

Step 2 – Start-up:

- Set Service Switches. ***Service Manual:- 1.1.2.***
- Turn On power. ***Operation Manual:- 2.2.***
- The Display should read "9811 O3 Analyzer".
- Adjust the Display Contrast if required. ***Operation Manual:- 2.2.1.***
- Verify that the software is running by observing the Ecotech Globe rotating in the bottom left hand corner of the display.

Step 3. – Operation:

- Verify Instrument warm up and operation mode. ***Service Manual:- 2.2.***
- Set the correct time and date. ***Operation Manual:- 2.3.3.***
- If using RS232, configure the Interface menu. ***Operation Manual:- 2.5.7.***
- Check SYSTEM FAULTS menu. All PASS. ***Operation Manual:- 2.5.15.***
- Verify other menu settings. ***Service Manual:- 4.2.***

Step 4. – Calibration:

- Perform a quick (single point) calibration. ***Operation Manual:- 2.4.***
- Setup and Calibrate the Analog Outputs (if applicable). ***Operation Manual:-2.8.3.***
- If necessary, perform a leak check. ***Service Manual:- 3.3.8.***
- If necessary, perform a flow calibration. ***Service Manual:- 3.5.2***
- If necessary, perform a Multipoint calibration. ***Operation Manual:-3.2.***

Step 5. – Data Validation:

- Verify the results from your data acquisition system agree with the readings of the EC9811 O3 analyzer.
- Verify that the analyzer responds to automatic calibration sequences.

The analyzer is now operating correctly.

Table of Contents

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Manual History

This manual is a newly designed manual to cater for the continuing development of the EC9800 series analyzers. The original manual was:

- ML9811 Operation Manual , PN: 98117600, Rev. F, September 1998.

The scope of this new manual covers the following analyzer:

- EC9811 Ozone Analyzer with internal and External Zero and Span PN: 98111000-100.
- EC9811 Ozone Analyzer with internal and External Zero and Span, Systems PN: 98115000-100

This instrument is manufactured by Ecotech P/L in Australia and supports the new (SMD) Microprocessor Board (Part number 98000063-4). This manual is current for firmware version 1.21 and above.

Ecotech Manual ID:	MAN 0003.
Manual PN:	98117600.
Current Revision:	B.
Date Released:	April 2007.
Description:	EC9811 Ozone Analyzer with Internal Zero and Span, Operation Manual.

Revision History

Rev	Date	Summary	Affected Pages
A	October 2005	New Release for new Microprocessor Board.. Based on original manuals.	All
B	April 2007	Updated specifications, language and links within pdf manual created.	All

NOTE: The photograph on the binder of this manual is of the south coast of Australia during Bushfires in 2003. The photograph is courtesy of Earth Sciences and Image Analysis Laboratory, NASA Johnson Space Center. Photo Reference: ISS006-E-19897.

Notice

The information contained in this manual is subject to change without notice and does not represent a commitment on the part of the Ecotech Pty Ltd. Ecotech reserves the right to make changes in construction, design, specifications, and/or procedures that may not be reflected in this manual.

This manual is furnished on the express condition that the information herein will not be used for second source procurement, or purposes directly or indirectly detrimental to the interests of Ecotech.

MARK DECLARATION

Declaration of Conformity

Ozone Analyzer

Scope of Declaration

This declaration applies to Ozone Analyzers as manufactured by Ecotech Pty Ltd and which may be sold in the following configurations:

Part Number	Description
98101000-100	Ozone Analyzer, B Series
98107000-1	Ozone Analyzer and Ozone Generator
98111000-1	Ozone Analyzer with IZS
98107000-2	

Ecotech certifies that this product operates in compliance with the following standards:

EN 61326-1 Electrical Equipment for measurement, control and laboratory use – EMC Requirements Edition 1.1 with amendment 1 plus amendment 2.

- Immunity Requirements EN61326-1

IEC-61000-4-11	Voltage Interrupts
IEC-61000-4-11	Voltage Dips
IEC-61000-4-3	Radiated RF electromagnetic field immunity test
IEC-61000-4-4	Electrical fast transient/burst immunity test
IEC-61000-4-5	Surge immunity test
IEC-61000-4-6	Immunity to conducted disturbances, induced by radio frequency fields

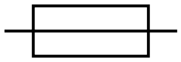
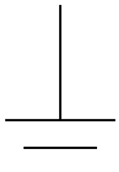
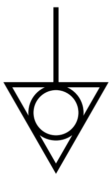
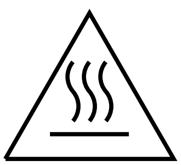
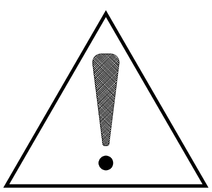
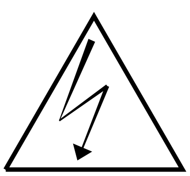
- Electromagnetic compatibility EN61326-1
  Annex A CISPR 22 and CISPR 16-2
  CISPR 16-1 and CISPR 16-2

EN 61010-1 Safety requirements for electrical equipment, control and laboratory use

- Section 19 of EN 60204-1
  Insulation Resistance Check
  Residual Voltage Check
  Earth Continuity

The equipment must be operated as per the directions given by Ecotech P/L in this manual.

Internationally Recognized Symbols Used on Ecotech Equipment

	IEC 60417, No. 5016	Electrical fuse
	IEC 60417, No. 5017	Earth (ground) terminal
	IEC 60417, No. 5021	Equipotentiality
	IEC 60417, No. 5032	Alternating current
	IEC 60417, No. 5041	Caution, hot surface
	ISO 7000-0434	Caution, refer to accompanying documents
	ISO 3864, No. B.3.6	Caution, risk of electric shock

SAFETY REQUIREMENTS

- To reduce risk of personal injury caused by electrical shock, follow all safety notices and warnings in this documentation.
- This equipment should *always* be used with a protective earth installed.
- The EC9811 is compliant with the requirements of EN61010-1 A2:1995, Safety Requirements for Equipment for Measurement, Control, and Laboratory Use.
- If the equipment is used for purposes not specified by the manufacturer, the protection provided by this equipment may be impaired.
- Replacement of any part should only be carried out by qualified personnel, only using parts specified by the manufacturer. Always disconnect power source before removing or replacing any components.

EQUIPMENT RATING

- 100-120/220-240V~ ±10%
- 50/60 Hz
- 250 VA max
- FUSE: 5/3.15A T 250V
- All wiring must be in accordance with local norms and be carried out by experienced personnel.

ENVIRONMENTAL CONDITIONS

RELATIVE HUMIDITY	10% to 80%
Temperature	5 to 40 degrees C
Pollution degree	2
Installation category	II
Maximum altitude	2000m.

Instruments suitable for use in a sheltered environment only.

Never operate this equipment in the presence of flammable liquids or vapors, as this could cause a safety hazard.

Factory Service

We strive to provide efficient and expedient service when an instrument or component is returned for repair. Your assistance can help us to better provide the service you need.

To ensure that we process your factory repairs and returned goods efficiently and expeditiously, we need your help. Before you ship *any* equipment to our factory, please call our Service Response Center at **(+61) 1300 364 946**. This enables us to complete the necessary paperwork and process your equipment correctly when it reaches our facility.

When you call, please be prepared to provide the following information:

1. Your name and telephone number
2. Your company name with shipping address
3. The number of items being returned
4. The part number of each item
5. The model number or a description of each item
6. The serial number of each item, if applicable
7. A description of the problem you are experiencing if factory repair is needed, or the reason you are returning the equipment (e.g. sales return, warranty return, etc)
8. The original sales order number or invoice number related to the equipment
9. Whether repair work is under warranty or is to be billed and a purchase order number for any work to be billed.

When you call in, our Customer Service Representative will assign a Return Material Authorization (RMA) number to your shipment and initiate the necessary paperwork to process your equipment as soon as it reaches us. Please include this RMA number when you return equipment, preferably both inside and outside the shipping container. This will ensure that your equipment receives the most prompt attention possible. ***If the RMA number is not marked on the outside of the shipping container, the shipment will be rejected when it reaches our facility, and returned at your expense.***

Your assistance in this matter will enable us to serve you better. We appreciate your cooperation and support of our products and services.

Claims for Damaged Shipments and Shipping Discrepancies

Damaged Shipment

1. Inspect all instruments thoroughly on receipt. Check material in the container(s) against the enclosed packing list. If the contents are damaged and/or the instrument fails to operate properly, notify the carrier and Ecotech immediately.

2. The following documents are necessary to support claims:

   a. Original freight bill and bill of lading
   b. Original invoice or photocopy of original invoice
   c. Copy of packing list
   d. Photographs of damaged equipment and container

You may want to keep a copy of these documents for your records also.

Refer to the instrument name, model number, serial number, sales order number, and your purchase order number on all claims. Upon receipt of a claim, we will advise you of the disposition of your equipment for repair or replacement.

Shipping Discrepancies

Check all containers against the packing list immediately on receipt. If a shortage or other discrepancy is found, notify the carrier and Ecotech immediately. We will not be responsible for shortages against the packing list unless they are reported promptly.

ECOTECH

Service and Spare Parts

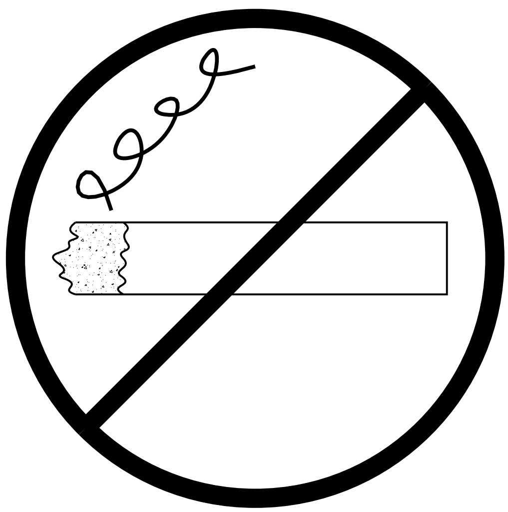
For world wide customer service & spare parts contact ECOTECH:

Address:	**Ecotech Pty Ltd** **1492 Ferntree Gully Road** **Knoxfield** **Australia. VIC 3180**
Phone:	**+61 1300 364 946**
Fax:	**+61 1300 668 763**
Email - Service:	**ecotech@ecotech.com.au**
Email - Spare Parts:	**parts@ecotech.com.au**
Web:	**www.ecotech.com.au**

Our Service Response Center handles product information, application assistance, factory repair, training, service, maintenance agreements, and technical assistance.

WARNING

Avoid smoking in the vicinity of the analyzer. Due to the complex chemical makeup of tobacco smoke, smoke drawn into the sample line may result in incorrect readings. Furthermore, tobacco smoke has been shown to contaminate converter and scrubber materials critical to the accuracy and stability of the analyzer.



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1.0 Description

The EC9811 ozone (O_3) analyzer is a non-dispersive ultraviolet (UV) photometer that may be used as an analyzer or as a calibrated ozone source. Ozone is measured by determining the amount of UV absorbed by the sample. A mercury vapor lamp is used as the light source. Its 254 nm line is close to the center of the ozone absorption band.

When used as an analyzer a selective Ozone scrubber is switched in-and-out of the sample stream. This manganese dioxide (MnO_2) scrubber selectively destroys ozone and passes other common absorbers. The UV intensity with ozone removed is measured on one cycle and compared to the UV intensity with ozone present. The ratio of the two intensities is a measure of ozone concentration alone, since the unwanted absorbers equally affect both measured intensities.

The EC9811 ozone analyzer includes a built-in ozone generator which may be used as a calibrated ozone source for other ozone analyzers or as a source for zero and span checks for the EC9811 when it is used as an analyzer. This ozone generator can supply approximately 1 ppm of ozone at four liters per minute or higher concentrations at reduced flow. Flow is regulated using a variable speed pump and a mass flowmeter.

The system is under the control of the EC9800 series microprocessor module. Software algorithms handle all internal adjustments, continuously perform diagnostics, indicate errors, display status, and make calculations of ozone concentration. The only operator functions are to perform routine maintenance of the pneumatics and periodically verify calibration of the unit.

The microprocessor continuously monitors the source and many other parameters, making adjustments as necessary to ensure stable and accurate operation. In addition to temperature and pressure compensation, the EC9811 analyzer can readjust its span ratio based on a known concentration of gas used to span the analyzer. This feature is not automatically implemented and must be selected by the operator.

Analog and digital outputs are available for data monitoring and the analog output may be selected as either a current output or voltage output. Current ranges are 0-20 mA, 2-20 mA, or 4-20 mA. Voltage outputs are 0-10V, 0-5V, 0-1V, and 0-0.1V.

Data collection and recording is available for either a data acquisition system (such as a datalogger) or a strip chart recorder. A DB50 connector is also included for digital input control and digital output status. The EC9811 also features internal data storage capabilities.

The instrument also includes an over-range feature that, when enabled, automatically switches the analog output to a preselected higher range if the reading exceeds 90% of the nominal range. When the reading returns to 80% of the nominal range, the analyzer automatically returns to that range.

The U.S. EPA has designated the EC9811 ozone analyzer as an Equivalent Method. Section 1.2 includes the operational parameters necessary when using the analyzer in this mode.

1.1 Specifications

Note

All specifications are referenced to STP (standard temperature and pressure).

1.1.1 Range

- Display: Autoranging 0 to 20 ppm. Resolution = 1 ppt (selectable units and decimal places).
- Analog output: 0-full scale from 0-0.05 ppm to 0-20 ppm with 0%, 5%, and 10% offset.
- Autoranging between 2 user-specified full scale values.
- U.S. EPA designated range: Any full scale range between 0 to 0.05 and 0 to 1.0 ppm.

1.1.2 Noise (RMS)

- Measurement process: 0.25 ppb or 0.1% of concentration reading, whichever is greater; with Kalman filter active.
- Analog output: 0.25 ppb or 0.1% of analog output full scale, whichever is greater.

1.1.3 Lower Detectable Limit

- Measurement process: Less than 0.5 ppb or 0.2% of concentration reading, whichever is greater; with Kalman filter active.
- Analog output: 0.5 ppb or 0.2% of analog output full scale, whichever is greater.

1.1.4 Zero Drift

- Temperature dependent, 1.0 ppb/°C.
- Time dependent, at fixed temperature:
  - 24 hours: Less than 1.0 ppb.
  - 30 days: Less than 1.0 ppb.

1.1.5 Span Drift

- Temperature dependent, 0.1% per °C.
- Time dependent, at fixed temperature:
  - 24 hours: 0.5% of reading.
  - 30 days: 0.5% of reading.

1.1.6 Lag Time

Less than 20 seconds.

1.1.7 Rise/Fall Time, 95% of Final Value

Less than 60 seconds (0.5SLPM flow) with Kalman filter active.

1.1.8 Precision

1 ppb or 1% of reading, whichever is greater.

1.1.9 Sample Flow Rate

0.5 slpm.

1.1.10 Sample Pressure Dependence

A 5% change in pressure produces less than a 1% change in reading.

1.1.11 Ozone Generator Flow Rate

- Range: 1 to 5 slpm.
- Accuracy: ±5% of reading.

1.1.12 Ozone Output

- Range: 0.04 to 1 ppm at 4 slpm.
- Stability:

  Feedback ON: 0.001 ppm ±1% of reading.

  Feedback OFF: 0.001 ppm ±3% of reading.
- Repeatability:

  Feedback ON: 0.001 ppm ±1% of reading.

  Feedback OFF: 0.001 ppm ±3% of reading.
- Time stability:

Feedback ON: 0.001 ppm ±1% of reading per 700 hours.

Feedback OFF: 0.001 ppm ±3% of reading per 700 hours.

1.1.13 Temperature Range

- 5° to 40° C (41° to 104° F).
- U.S. EPA designated range: 15° to 35° C.
- Eignungsgeprüft range: 5° to 40° C.

1.1.14 Power

- 99 to 132 VAC, 198 to 264 VAC, 47 to 63 Hz.
- U.S. EPA designated range: 105 to 125 VAC, 60 Hz. or 200 to 240 VAC, 50 Hz.

1.1.15 Weight

25Kg (56 lb)

1.1.16 Analog Output

- Menu selectable current output of 0 to 20 mA, 2 to 20 mA, or 4 to 20 mA.
- Jumper selectable voltage output of 100 mV, 1 V, 5 V, and 10 V, with menu selectable zero offset of 0%, 5%, or 10%.

1.1.17 Digital Output

- Multidrop RS232 port shared between analyzers for data, status, and control.
- Service RS232 port gives front panel access to a local or remote user.
- USB port connection on the rear panel provides data transfer and control.
- DB50 with discrete status, user control and analog output.

1.2 U.S. EPA Equivalent Method

The EC9811 ozone analyzer with IZS has been designated under U.S. EPA regulations as an equivalent method EQOA-0193-091. Use of the EC9811 under U.S. EPA designation as an equivalent method as defined in 40 CFR Part 53 requires operation under the following conditions:

- Range: Any full scale range between 0 to 0.050 ppm and 0 to 1.0 ppm.
- Ambient temperature: 15° to 35° C.
- Line voltage: 105 to 125 VAC, 60 Hz, or 200 to 240 VAC, 50 Hz.
- Flow rate: 0.5 slpm.

- Pump: Internal Pump. (see *Chapter 2, Installation and Operation*).
- Filter: A 5 micron PTFE filter must be installed in front of the sample inlet (Zero and Span gas must pass through this filter).
- If the units in the MEASUREMENT MENU are changed from volumetric to gravimetric (or gravimetric to volumetric), the analyzer must be re calibrated.
- The analyzer must be operated and maintained in accordance with this operation manual.
- The following menu selections must be used:

```
INTERFACE MENU
      ANALOG OUTPUT MENU
            RANGE: 0.05 to 1.0 PPM
            OVER-RANGING: ENABLED or DISABLED

INSTRUMENT MENU
      MEASUREMENT MENU
            FILTER TYPE: KALMAN

CALIBRATION MENU
      CALIBRATION: MANUAL or TIMED
            SPAN COMP: DISABLED

TEST MENU
      PRES/TEMP/FLOW COMP: ON
            DIAGNOSTIC MODE: OPERATE
```

- The Service switch must be positioned to IN.

The EC9811 series analyzers are U.S. EPA equivalent with or without the following options/items:

- rack mount assembly
- 50-pin connector PCA

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2.0 Installation and Operation

2.1 Mechanical Installation

Note

Before installation, the unit should be checked to ensure that the instrument arrived undamaged. The *EC9811 Service Manual* contains initial installation inspection instructions.

2.1.1 Selecting a Location

Select a location for the analyzer where temperature variation, dust, and moisture are minimal. The location should be well ventilated and should allow convenient access to the operator controls and front panel display. The analyzer can operate in a range of 5º to 40º C without risk of damage.

2.1.1.1 Rack Mount or Enclosed Location

The analyzer is supplied as a bench-top version with rubber feet or with the chassis slides to convert it to a rack-mount version. The optional rack-mount version is 24 inches (61 cm) deep and fits into a 19 inch (48.3 cm) RETMA instrumentation rack. The front panel will protrude slightly. Refer to the instructions provided with the rack-mount kit for assembly into a rack.

Caution

The rack-mount version requires a properly ventilated rack enclosure. The temperature inside enclosures that are not properly ventilated may rise as much as 15º C above the ambient air temperature. This may force the analyzer to operate outside of specifications. Optimum operation is obtained at an operating temperature of 20º to 30º C inside the rack enclosure. For ventilation calculations, use a heat dissipation rating of 150 watts or 512 Btu per hour.

After the analyzer has been mounted, make the pneumatic and electrical connections.

2.1.2 Connections

All pneumatic connections must be secure to ensure accurate operation of the analyzer. The following information describes connection techniques for pneumatic and electrical connections. Figure 2-1 shows the rear panel of the analyzer with associated connections. Notice the Network connection is optional

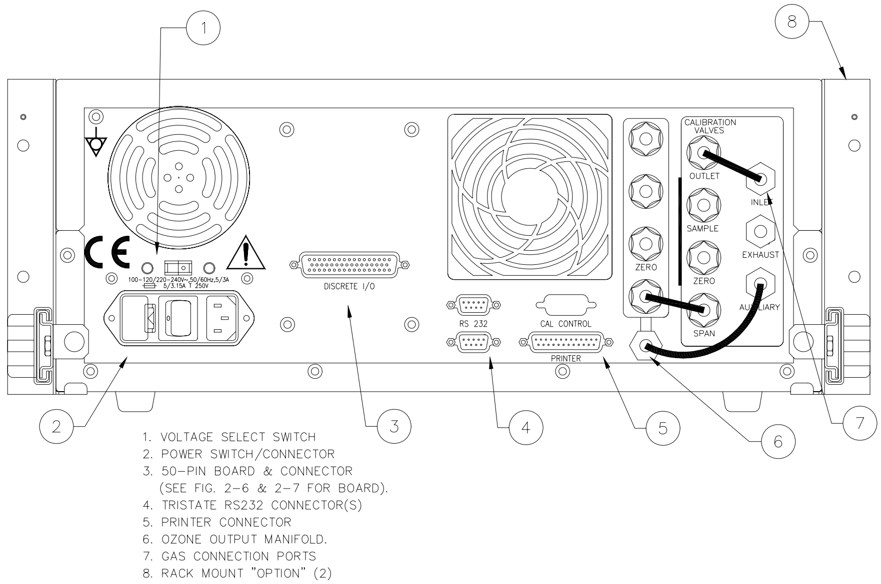

Figure 2-1. Analyzer Rear Panel

2.1.2.1 Recorder and DAS Connections

Caution

The EC9811 electrical ground is isolated from earth ground. To avoid possible ground loops, all electrical devices connected to the analyzer should have floating inputs (not connected to earth ground).

2.1.2.1.1 The 50-Pin I/O PCA

The 50-pin I/O connector board plugs into the discrete I/O connector, and provides voltage and current outputs to drive a strip chart recorder (REC) and a data acquisition system (DAS). The outputs are illustrated in Figure 2-2.

The 50-pin I/O PCA is optional for the EC9811 B series analyzer.

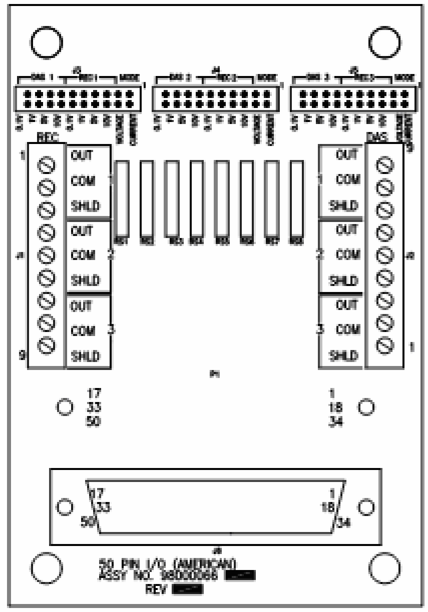

Figure 2-2. 50-Pin Connector Board (Front)

The output is jumper-selectable as:

- Current (see Figure 2-3). Range is set using the menu in a later step.
- Voltage, with selectable ranges of 0 to 0.1 V, 0 to 1 V, 0 to 5 V, and 0 to 10 V. See Figure 2-3.

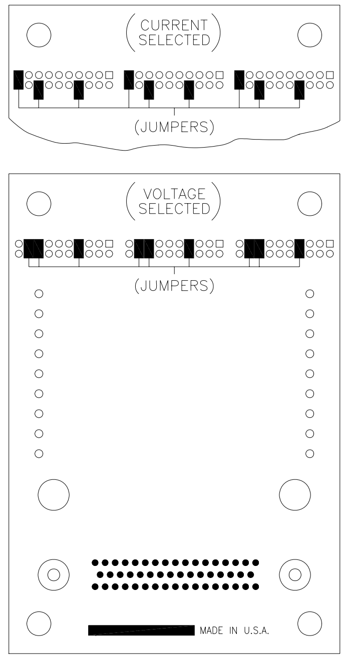

Figure 2-3. 50-Pin Connector Board with Sample Choices (Rear)

Select the output for your application using the following steps.

1. Remove the 50-pin connector board from the rear panel of the analyzer.

2. Place the jumpers on the pins that correspond to the desired printed selections on the front of the board. If current is selected, only the jumpers selecting current make contact with both rows of pins. The other jumpers are offset as shown in Figure 2-3.

   If a current output is selected, the range must also be chosen from the menu when the instrument is operating. The compliance voltage for the current output is 12 V. A terminating resistor of 600 ohms or less should be used for measurement errors no greater than 1%.

   If voltage output is selected, both the REC and DAS outputs are factory-set for 10 volts full scale. Other full scale outputs of 5 V, 1 V, and 0.1 V can be selected. Select the full scale output for REC and DAS. When using voltage output, the source resistance for both REC and DAS outputs is 1000 ohms. The recorder and DAS input resistance should be greater than 500K ohms for a measurement error no greater than 1%.

3. Connect the recorder or DAS wires to the appropriate terminal block. The wire positions are:

   `OUT` = positive or signal
   `COM` = ground or low
   `SHLD` = shielded cable.

Caution

To prevent ground loop problems, connect the shield of the cable at the analyzer only, not at the recorder or DAS.

For additional information regarding output, see section 2.6.

2.1.2.1.2 Current Output Connections

When using the EC9811 without the 50-pin I/O PCA, the analyzer still provides current outputs to drive a strip chart recorder or DAS. These outputs are present on the discrete I/O connector at the following pins:

Function	Pin (Discrete I/O Connector)
Current Out (+)	15
DGND (Gnd)	1,12,14, or 16

If a current output is connected the range must also be chosen from the menu when the instrument is operating. The compliance voltage for the current output is 12 V. A terminating resistor of 600 ohms or less should be used for measurement errors no greater than 1%.

2.1.2.1.3 Voltage Output Connections

The current output mentioned above can be converted to a voltage output by adding a terminating resistor across the output. This resistor must be 50 ohms per full scale voltage desired (50 ohms = 1 V full scale; 500 ohms = 10 v full scale, etc). Following is a list of typical output ranges and required terminating resistance:

Desired Output (Volts)	Terminating Resistance (Ohms)
10 Volts	500 Ohms
5 Volts	250 Ohms
1 Volt	50 Ohms
0.1 Volt	5 Ohms

When using voltage output, the source resistance is 1000 ohms. The recorder or DAS input resistance should be greater than 500K ohms for a measurement error no greater than 1%.

2.1.2.2 Sample Gas Connections

Caution

Sample and zero air connections to the EC9811 should be maintained at ambient pressure, with any excess flow vented to the atmosphere.

The EC9811 requires at least 1.00 slpm (0.5 slpm sample plus 0.5 slpm overflow) of particulate-filtered (<5 micron), dry (non condensing) sample furnished at all times. A 5 micron inlet filter is necessary to meet USEPA requirements which is already installed in the A series analyzer.

Tubing used for sample gas and exhaust connections must be 1/4 inch OD and 1/8 to 3/16 inch ID. The recommended ID is 5/32 inch. A segment of clean Teflon® tubing should be purchased to connect the sample source to the sample inlet. Only use lines and fittings made of Teflon, Kynar®, or glass.

Instructions for tubing connections with Kynar fittings:

- Cut the tubing squarely and remove any burrs.
- Insert the tubing through the back of the nut until it reaches the tube stop in the fitting.
- Tighten the nut finger-tight plus 1-1/2 to 2 turns. A squeaking sound when tightening the nut is normal.
- All nuts should be re-tightened when the system reaches operating temperature.

2.1.2.3 Exhaust Connections

2.1.2.3.1 A Series

When making exhaust connections locate the exhaust outlet away from the sample inlet and occupied enclosed areas. Connect a 1/4 inch OD line from the exhaust port to an exhaust manifold that vents outside of occupied areas. Lines and fittings of materials other than those cited above can be used for these connections.

Note: The ozone output manifold must have one port connected to an exhaust vent.

An optional exhaust pump and exhaust scrubber is available from Ecotech.

2.1.2.4 Manifold Connections

Verify that the ozone output manifold is pneumatically connected to the INLET and AUXILIARY ports see Figure 2-1 on page 2-2.

2.2 AC Power Connection

Verify that the power selection switch on the rear panel and the power cord and fuse are appropriate for your use. Move the switch right or left so the appropriate voltage rating is visible on the switch. Figure 2-1 shows the voltage selection switch.

Warning

Power is supplied to the analyzer through a three-pin power plug. The ground must not be defeated and an adequate ground must be connected to the instrument, both for proper performance and for the safety of operating personnel. The warranty on the analyzer applies only if the analyzer is properly grounded. If it is not properly grounded and electric power is applied in violation of the National Electric Code, Ecotech assumes no responsibility for any injury or damage to personnel or property.

Warning

Be sure to check that the mains power selection switch is at the correct setting before turning the instrument on. Failure to do so may result in damage to the power supply.

Connect the power plug to the power receptacle and press the power switch to the ON position on the rear panel. Also make sure that the DC POWER switch on the front secondary panel is switched to ON.

2.2.1 Display Adjustments

Adjust the display contrast by simultaneously pressing two keys on the front panel (see Figure 2-4).

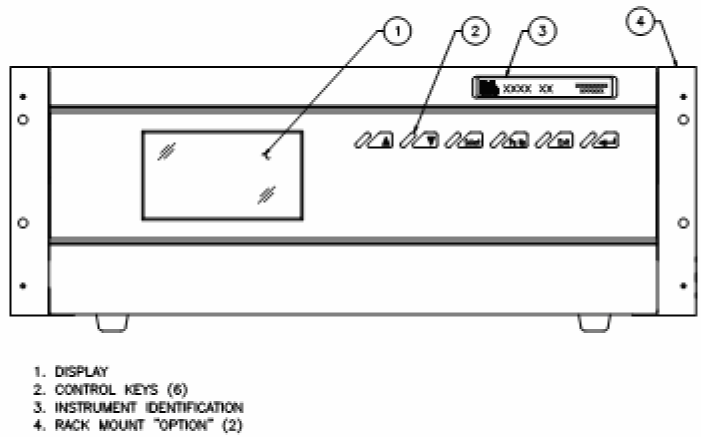

Figure 2-4. Analyzer Front Panel

- *Contrast*
  Up arrow (⮝) and <Select> for darker contrast, Down arrow (⮟) and <Select> for lighter contrast.
- *Backlight*
  The backlight brightness is fixed to maximum and cannot be adjusted.

Hold the key combinations until the desired contrast appears on the display.

Note

Pressing the Up or Down arrow key while not simultaneously pressing the <Select> key when the main screen is displayed causes the screen query, `START MANUAL CALIBRATION?` If this happens while adjusting the display, press the <Exit> key.

Note

The display is sensitive to the ambient air temperature and analyzer temperature. The appearance of the display will vary with changes in these conditions.

2.2.2 Warmup

Upon instrument power-up from a cold condition, heat is applied to the flow block and lamp block. Preset temperatures must be achieved before the instrument begins sample measurement. This automatic process requires up to 30 minutes. Parameters entered during the warm-up period may be changed by the microprocessor returning the parameters to the previous settings. The display reads `0.000 PPM` until actual operation begins; however, all screens can be observed.

Initial Screen Message	Instrument Activity
`O3 LAMP ADJUST`	Adjusting UV lamp current
`O3 REF STABILIZE`	Waiting for reference voltage to stabilize
`O3 ZERO ADJUST`	Adjusts zero voltage
`O3 ZERO STABILIZE`	Stabilization of zero voltage
`BACKGROUND FILL`	Cell filling with zero air.
`BACKGROUND MEASURE`	Zero reading from measurement cell. Final determination of system zero.
`SAMPLE FILL`	Cell filling with sample air.
`SAMPLE MEASURE`	Instrument operational (must be calibrated if this is the first power-up sequence).

The microprocessor continuously adjusts the instrument for lamp warm-up. Once a stable value of 3.9 to 4.0 v has been reached, the analyzer begins measuring ozone. The readings may be noisy at first, but will become quieter with time. You can expect all specifications to be met within four hours of a cold start-up.

Note

The EC9811 will re-run the above start-up routine whenever power has been lost for more than two minutes. If power is lost for less than two minutes, the analyzer will return to its previous settings without the start-up routine.

2.3 Operation

The operation section describes the actions necessary to operate the instrument, first in general, then in specific terms. In section 2.5, the menu headers are shown as they appear on the display screen. The illustration is followed by explanatory information regarding the menu entries or choices. The entire menu tree is shown in Figure 2-6.

2.3.1 General Operation Information

All operator responses needed to operate the EC9811 are performed by pressing the 6 keys available on the front panel to the right of the display screen. The key functions are described below.

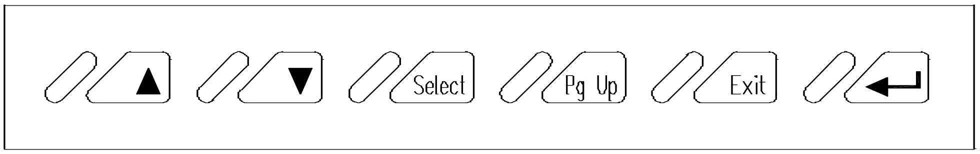

Figure 2-5. Analyzer Keyboard

The key functions are:

- *Up arrow key* (▲)
  Moves the cursor to the previous menu item or, in an input field, moves the cursor to the next choice or increments the digit in a numerical field.
- *Down arrow key* (▼)
  Moves the cursor to the next menu item or, in an input field, moves the cursor to the next choice or decrements the digit in a numerical field.
- *<Select>*
  Selects the menu choice or selects the field for input.
- *<Pg Up>*
  Moves the cursor to the previous page or screen.
- *<Exit>*
  Leaves a field without making a change or returns the cursor to the main screen.
- *<Enter>* (↵)
  Confirms a menu item or a field selection to the microprocessor.

2.3.2 Using the Menu and Making Entries

The EC9811 analyzer is programmed with a series of menus that allow the operator to view parameters, such as those generated by the microprocessor, or to enter digital parameters, when appropriate, or to select from among the choices displayed.

The cursor is displayed as a movable highlighted area of text. (Letters appear as the opposite of the rest of the text on the screen.)

2.3.2.1 Screen Fields

Screen fields that allow input are of two types:

- *Choice fields*
  Contain a fixed series of choices in a wraparound scrolling format.
- *Digit fields*
  Fields of programmable digital parameters in either wraparound scrolling or non-wraparound scrolling format.

To select from among the choices in a choice field, first press the <Select> key to designate the field, then use the Up and Down arrow keys to highlight the desired selection. When the desired selection is displayed, press the <Enter> key to confirm the entry.

To set digits in a digit field, first press the <Select> key to designate the field and to highlight the different digits in the field. When the cursor indicates the digit you wish to change, press the Up or Down arrow key until the desired digit appears. Go to the next digit by pressing <Select>. When all digits of an entry are correct, press the <Enter> key to confirm the entry.

Caution
The <Select> key does not confirm an entry. You *must* press the <Enter> key.

2.3.2.2 Microprocessor-Generated Information

Some fields, such as those on the `INSTRUMENT STATUS` and `SYSTEM TEMPERATURES` screens, contain information generated by the microprocessor. The operator cannot affect the readings in these fields. (If you find that the cursor will not enter a field, the field contains microprocessor-generated information.)

2.3.2.3 Exiting Without Making a Change

If you decide not to make a change during this process, simply press the <Exit> key, and the values will return to the previous entries.

2.3.3 Setting the Date and Time

Before the instrument can be calibrated or collect data for regulatory use, the time and date must be set. Go to the `INSTRUMENT MENU` and select `DATE` and `TIME`. If these are not already set, use a 24-hour clock setting for time and set the date in the day-month-year format. See section 2.5 for instructions on programming menu entries.

2.4 Analyzer Calibration

When the EC9811 analyzer is powered on *for the first time*, the analyzer must be calibrated to ensure accurate O_3 measurements. The analyzer does not require re-calibration after further power interruptions or resets. However if the instrument is transported to a new location, or maintenance work is performed, the instrument may require re-calibration. To determine weather the instrument requires a calibration, a precision check can be performed as discussed in the following sections.

2.4.1 Precision Checks

A precision check is a Level 2 calibration as discussed in section 3.4. This means that the instrument is only checked against a know calibration source and is not adjusted. A precision check can be performed either manually or automatically.

2.4.2 Automatic

Most modern air quality monitoring systems have data acquisition systems which can automatically initiate and record the results of a daily precision check. The means by which the analyzer is externally controlled is via the 50 PIN IO connection, or via the RS232 multidrop connection. Refer to section 4.0 for more details on interfacing to these ports.

2.4.3 Manual

A manual precision check can be initiated as follows:

1. Connect a source of span gas to the analyzer through the Auxiliary port. (see *chapter 3* for instructions on preparing calibration gas).
2. From the `CALIBRATION MENU` set `CALIBRATION` to `MANUAL` and `CAL. MODE` to `SPAN.`
3. Allow the analyzer to sample the span gas until a stable reading is obtained, typically 15 minutes.
4. Verify this stable reading against the know calibration concentration.
5. Typically if it is within 5%, then a calibration is not required.
6. If a calibration is required, continue with the following procedure in section 2.4.4. If not, return the `CAL. MODE` to `MEASURE.`

2.4.4 Analyzer Calibration Instructions

Note

This procedure is a quick guide to single point span calibration of the EC9811 analyzer. For complete gas preparation and multipoint calibration instructions, refer to *Chapter 3, Calibration*.

1. With a stable supply of calibration gas connected to the Auxiliary port of the analyzer, verify that in the `CALIBRATION MENU`, `CALIBRATION` is set to `MANUAL` and `CAL. MODE` to `SPAN`.

2. *From the Primary Screen*, start the calibration sequence by pressing either the Up or Down arrow key (⮝ or ⮟) until the display prompts, `START MANUAL CALIBRATION?` Pressing the <Select> key will allow you to choose from: `NO, SPAN or ZERO`. Confirm that the display reads `SPAN` and press <Enter> (↵). A backlit cursor will be displayed on the O_3 concentration display.

3. Use the <Select> key to move the position of the backlit cursor, and the Up and Down arrow keys to increment and decrement the value of the backlit digit until the span calibration gas concentration value is displayed. When the desired concentration is displayed, press <Enter>.

4. Then move the backlit cursor to the `INSTRUMENT GAIN` field. The instrument gain is automatically calculated by the analyzer. Press <Enter> to confirm this value. Press <Exit> to return to the *primary screen.*

5. The concentration on the *primary screen* should now read the same as the concentration of the calibration gas.

Note

The auto-zero function of the EC9811 eliminates the need for a traditional zero calibration.

This completes the calibration of the EC9811 analyzer.

2.5 Menus and Screens

This section illustrates the various menus and screens for the EC9811 analyzer. A short description of each menu and screen is also provided. The entire menu structure is shown in Figure 2-6 below.

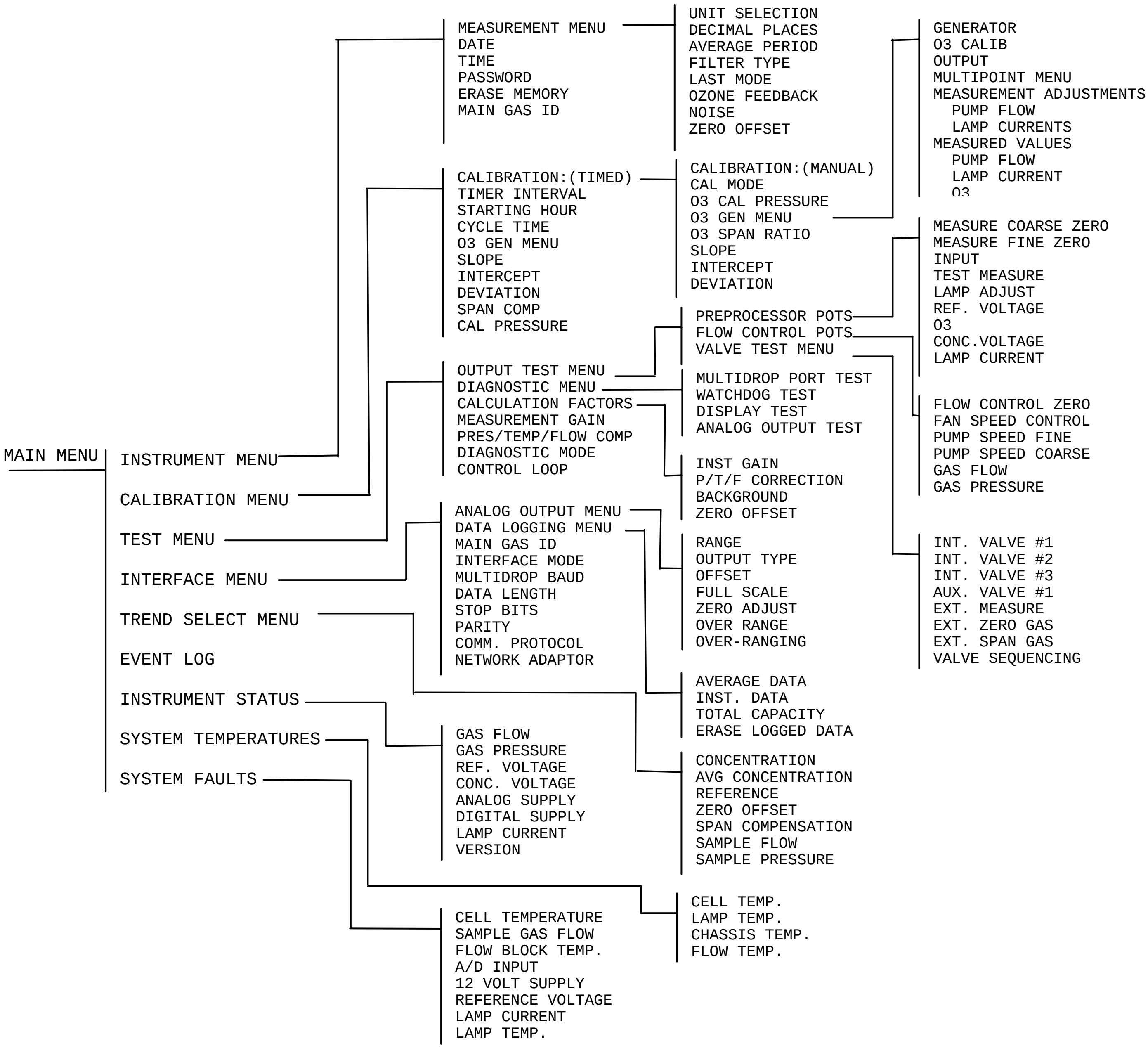

Figure 2-6. Menu Structure

Note

The values shown in the illustrations are examples only. Your display can be affected by the settings you choose.

2.5.1 Primary Screen

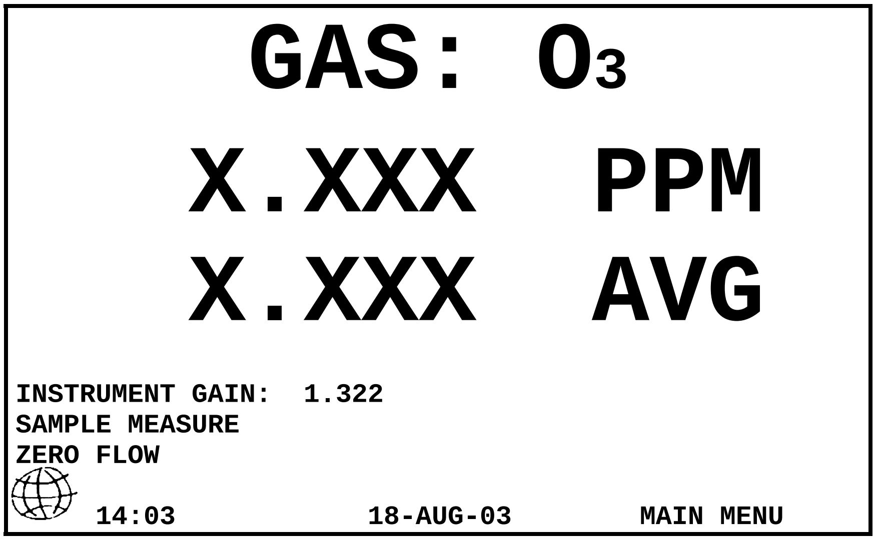

Figure 2-7. Primary Screen

When power is applied, the screen displays the ECOTECH logo for a few seconds. It then identifies the analyzer and the words `MAIN MENU` appear in the lower right corner of the screen. In the lower left hand corner there is the Ecotech Globe rotating, indicating that the program is running. After the warm-up period, the operation mode is displayed at the left of the screen and the current gas measurements for the analyzer are indicated, as shown in Figure 2-7 above.

Instrument faults will be reported on the status line which appears one line below the instrument state display. The following rules govern the information displayed on this line: If there are no failures, the status line is blank. If there is a single failure, that failure is displayed on the status line (i.e., `ZERO FLOW`, `HEATER FAULT`, etc.). The status line will clear when the fault clears. If there are multiple failures, the failure at the top of the failure list will be displayed on the status line. When this failure clears, the next failure on the list will be displayed. The entire list of failures is displayed on the `SYSTEM FAULTS` screen.

Instrument gain (displayed above the operational mode) indicates the relationship between the calibration concentration and a measured gas concentration within the analyzer. It is an essential parameter for the calibration of the analyzer and is an important requirement for system audits.

When the primary screen is displayed and the cursor highlights the words `MAIN MENU`, press the <Select> key to enter the `MAIN MENU`.

2.5.2 Main Menu

```
                    MAIN MENU

      INSTRUMENT MENU
      CALIBRATION MENU
      TEST MENU
      INTERFACE MENU
      TREND SELECT MENU
      EVENT LOG
      INSTRUMENT STATUS
      SYSTEM TEMPERATURES
      SYSTEM FAULTS
```

Figure 2-8. Main Menu

Each of the menus listed in Figure 2-8, except the final four, has one or more levels of menu items contained within the selection.

The `EVENT LOG` is a log created by the microprocessor to indicate deviations in the operating parameters. This screen can be used to determine the cause of system problems.

The `INSTRUMENT STATUS` and `SYSTEM TEMPERATURES` screens constantly update readings that apply to the operation of the instrument.

The `SYSTEM FAULTS` screen provides a pass or fail indication for various parameters which are continually monitored. These parameters must be within acceptable operating ranges in order to display `PASS`.

2.5.3 Instrument Menu

```
                  INSTRUMENT MENU

            MEASUREMENT MENU
            DATE:          15-AUG-03
            TIME:          18:57
            PASSWORD:
            ERASE MEMORY:  NO
            MAIN GAS ID:   011
```

Figure 2-9. Instrument Menu

The items in the `INSTRUMENT MENU` address instrument settings needed to initiate operation.

DATE

The date format is day-month-year.

TIME

Set in 24-hour format. Setting the time resets the seconds (internally) to zero for synchronization with an external clock.

PASSWORD

See section 2.9.

ERASE MEMORY

If YES is selected, the following message is displayed:

```
!THIS WILL ERASE SYSTEM GAINS!
!!!ARE YOU SURE: NO
```

The word NO is highlighted in this warning. Scrolling to YES and pressing <Enter> will erase the memory in the analyzer.

Caution

If the analyzer memory is erased, all user-configured parameters will return to their default values. In addition, all instrument calibration will be lost, so the analyzer will have to be fully recalibrated. This feature is provided for service, and for preliminary configuration purposes. Please do not choose this selection during normal operation.

This feature is provided for service, and for preliminary configuration purposes. Please do not choose this selection during normal operation.

MAIN GAS ID

The ID address of the analyzer when Multidrop RS232 communications is used.

2.5.4 Measurement Menu

```
MEASUREMENT MENU

UNIT SELECTION   : uG/M3
DECIMAL PLACES   : 3
AVERAGE PERIOD   : 1 MINUTE
FILTER TYPE      : KALMAN
INSTRUMENT MODE  : ANALYZER
OZONE FEEDBACK   : DISABLED
NOISE            : 2.032 PPB
ZERO OFFSET      : 0.00 PPB
```

Figure 2-10. Measurement Menu

The MEASUREMENT MENU consists of three items needed for basic operation and data integrity.

UNIT SELECTION

PPM (parts per million), mG/M^3 (milligrams per cubic meter), nG/M^3 (nanograms per cubic meter), uG/M^3 (micrograms per cubic meter), PPT (parts per trillion) or PPB (parts per billion).

Note

If the gravimetric units are selected (mG/M^3, μG/M^3 or nG/M^3), then the conversion factors listed below will apply depending on the CONVERSION TEMP selected.

To convert 1 PPB "Gas" to ug/m^3 @ Multiply by:	0 °C	20 °C	25 °C
O3	2.143	1.997	1.993

Note

If the units in the MEASUREMENT MENU are changed from volumetric to gravimetric (or gravimetric to volumetric), the analyzer must be re calibrated in order to meet U.S. EPA requirements.

DECIMAL PLACES

Set the number of decimal places in which the data is displayed on the screen. (0, 1, 2, 3, 4 or 5).

Note

The screen is able to display up to 7 characters of data including the decimal place for each reading.

AVERAGE PERIOD

Set time in HOURS (1, 4, 8, 12, or 24) or in MINUTES (1, 3, 5, 10, 15, or 30). This establishes the period for average computations. This field is a wraparound field.

FILTER TYPE

Sets the time constant of the digital filter. Choices are NO FILTER, 300 SECONDS, 90 SECONDS, 60 SECONDS, 30 SECONDS, 10 SECONDS or KALMAN (adaptive).

Note

The Kalman filter is the factory default setting and must be used when using the instrument as a U.S. EPA equivalent method. The Kalman filter also gives the best overall performance for this instrument.

INSTRUMENT MODE

Choose between analyzer or photometer mode

OZONE FEEDBACK

Enabling this function sets the analyzer into feedback mode whereby it records the level of O_3 produced by the photometer on the front screen as a reference.

NOISE

The standard deviation of the concentration. The manner in which this is done is as follows: (1) Take a concentration value once every two minutes; (2) Store 25 of these samples in a first-in last-out buffer; (3) Every two minutes, calculate the standard deviation of the current 25 samples. This is a microprocessor-generated field and cannot be set by the operator.

Note

The noise reading is only valid if zero air or a steady concentration of span gas has been supplied to the analyzer for at least one hour.

ZERO OFFSET

ZERO calibration correction factor. User can manually set the offset between ±10.00 PPB.

2.5.5 Calibration Menu

The CALIBRATION MENU contains entries used to set up the instrument calibration. The choice of TIMED or MANUAL calibration creates a slightly different screen. TIMED calibration generates a zero/span check that will occur at the interval chosen, without operator interface. MANUAL calibration allows for operator controlled calibration. Only one choice, TIMED or MANUAL, applies at any given time.

2.5.5.1 Timed Calibration

The following screen appears when `CALIBRATION: TIMED` is selected.

```
                 CALIBRATION MENU

      CALIBRATION       : TIMED
      TIMER INTERVAL    : 24 HOURS
      STARTING HOUR     : 0
      CYCLE TIME        : 15 MINS
      O3 GEN. MENU

      SLOPE             :   0.000
      INTERCEPT         :   0.000
      DEVIATION         :   0.000  PPM
      SPAN COMP.        : REGRESSION

      CAL PRESSURE      : 750.0  TORR
```

Figure 2-11. Timed Calibration Menu

CALIBRATION
Designates TIMED or MANUAL calibration control.

TIMER INTERVAL
The number of hours between the zero/span checks.

STARTING HOUR
The hour when the first zero/span check will be performed.

CYCLE TIME
The period (1 to 59 minutes) of the zero & span steps during a timed calibration.

SLOPE
Computed from linear regression.

INTERCEPT
Computed from linear regression.

DEVIATION
The standard deviation from the linear regression points.

SPAN COMP
Choices are DISABLED and ENABLED. This enables automatic compensation of readings based on the result of a zero/span cycle. For U.S. EPA designated use, this must be set to DISABLED.

CAL PRESSURE
This is the measured ambient pressure during the last O3 calibration.

2.5.5.2 Manual Calibration

The following screen appears when `CALIBRATION: MANUAL` is selected.

```
                   CALIBRATION MENU

      CALIBRATION       : MANUAL
      CAL. MODE         : MEASURE

      O3 GEN. MENU
      O3 SPAN RATIO     : 1.0000
      SLOPE             : 0.000
      INTERCEPT         : 0.000
      DEVIATION         : 0.000  PPM

      CAL PRESSURE   : 750.0  TORR
```

Figure 2-12. Manual Calibration Menu

CALIBRATION
Designates `TIMED` or `MANUAL` calibration control.

CAL. MODE
A choice of `MEASURE` (normal mode), `CYCLE` (zero/span), `SPAN` (span valve), or `ZERO` (zero valve). The choice is based on the valve the operator wants to open.

SPAN COMP.
Choices of `DISABLED, ENABLED,` or `REGRESSION`. For USEPA designated use, this must be set to `DISABLED`. Linear regression uses the method of *least squares* to find the best straight line which fits a series of points. This method minimizes the variance of the error from each point to the line of best fit. Refer to discussion in *Chapter 3*.

CALIBRATION
Choices are `INTERNAL` or `EXTERNAL`. When `INTERNAL` is chosen, zero air during an AZS cycle or manual zero is taken from internal scrubbed air. When `EXTERNAL` is chosen, zero air is taken from the EZS valve manifold zero air port.

O3 GEN. MENU
This choice displays the `O3 GENERATOR MENU` (Figure 2-13).

O3 SPAN RATIO
A microprocessor-generated field that is used to correct the calibration value by multiplying the span reading.

SLOPE
Computed from linear regression.

INTERCEPT
Computed from linear regression.

DEVIATION
The standard deviation from the linear regression points.

O3 CAL PRESSURE
This is the measured ambient pressure during the last O3 calibration.

2.5.5.2.1 O3 Generator Menu

When the O3 GENERATOR MENU item is chosen from the CALIBRATION MENU (Figure 2-11or Figure 2-12), the following screen is displayed. For an explanation of how this menu is used, refer to section 2.6.2.

```
                     O3 GEN. MENU

       GENERATOR          :  ON
       O3 CALIB.          :  START
       OUTPUT             :  1.000  PPM
       MULTIPOINT MENU
       MANUAL ADJUSTMENTS :
         PUMP FLOW        :  4.00 SLPM
         LAMP CURRENT     :  100%
       MEASURED VALUES
         PUMP FLOW        :  4.00 SLPM
         LAMP CURRENT     :  0.05 Ma
         O3               :  0.9821 PPM
```

Figure 2-13. O_3 Generator Menu

GENERATOR
Choices are ON and OFF. When ON is selected, the generator is continuously on. When OFF is selected, the generator is off except when selected by MANUAL CAL or an AZS cycle.

O3 CALIB.
When selected and entered, a self-calibration cycle will start for the ozone generator. Refer to paragraph 2.6.2.4.

OUTPUT

The current programmed output of the ozone generator if the generator is turned on. This number may be changed by the operator.

MANUAL ADJUSTMENTS

PUMP FLOW

Select the desired flow rate of air through the ozone generator in standard liters per minute.

Note

Use the "`PUMP FLOW`" reading below to ensure the reading matches the desired flow entered above. Only confirm the desired flow once this has occurred otherwise pump flow will be offset.

LAMP

The upper limit that the UV lamp will perform at, shown as a percentage.. Recommended to be set at 100.

MEASURED VALUES

PUMP FLOW

The measured air flow through the ozone generator in standard liters per minute.

LAMP CURRENT

The measured current through the ozone producing lamp in milliamps.

O3

The current ozone concentration measured.

2.5.5.2.2 MULTIPOINT MENU

```
                 MULTIPOINT MENU

        POINT #1          :   0.800  PPM
        POINT #2          :   0.600  PPM
        POINT #3          :   0.400  PPM
        POINT #4          :   0.200  PPM
        POINT #5          :   0.000  PPM
```

POINT #1-#5

These are five span points used during an AZS cycle. These points may be any concentration value achievable by the ozone generator with the constraint that values selected must be in decreasing concentration. Refer to Section 3.4.1.

2.5.6 Test Menu

```
                    TEST MENU

   OUTPUT TEST MENU
   DIAGNOSTIC MENU
   CALCULATION FACTORS
   MEASUREMENT GAIN        : 8
   PRES/TEMP/FLOW COMP     : ON
   DIAGNOSTIC MODE         : OPERATE
   CONTROL LOOP            : ENABLED
```

Figure 2-14. Test Menu

The TEST MENU includes a series of submenus containing information and control settings for testing and verifying instrument functions. The operator may make changes to settings; however, when the instrument is returned to normal operation the instrument's automatic control function resumes. Changes made from this menu are for diagnostic and test purposes only.

MEASUREMENT GAIN

Entries are software-controlled settings of 1, 2, 4, 8, 16, 32, 64, and 128.

PRES/TEMP/FLOW COMP

Set either ON or OFF. OFF is used when running diagnostics to see fluctuations in readings. ON is used to compensate for environmental fluctuation that might affect readings.

DIAGNOSTIC MODE

Allows the operator to choose OPERATE, OPTIC, ELECT, or PREAMP. During measurement, set to OPERATE. During diagnostic testing, set to the desired system to be diagnosed.

CONTROL LOOP

Allows the operator to choose ENABLED or DISABLED. When ENABLED is selected, the microprocessor maintains control of the digital pots; when DISABLED is selected, the microprocessor does not control the digital pots and the user can manually adjust the digital pots. When CONTROL LOOP is ENABLED, the microprocessor will take control of the pots at the point at which the pots were last set. **CONTROL LOOP** *will be set to* **ENABLED** *when the primary screen is displayed.*

ZERO SOURCE

Allows the operator to choose STANDARD or CHECK. When STANDARD is selected the instrument is in normal operation. When CHECK is selected the instrument is ready for Ozone scrubber test. *This option is only available in the A series

TEST MEASURE
Software-controlled pot that is used by technicians when troubleshooting, or verifying correct instrument performance. This option only appears when the diagnostic mode is set to `OPTIC, ELECT or PREAMP.`

O3
Gas concentration reading during diagnostics. This option only appears when the diagnostic mode is set to `OPTIC, ELECT or PREAMP.`

2.5.6.1 Output Test Menu

```
                 OUTPUT TEST MENU

      PREPROCESSOR POTS
      FLOW CONTROL POTS
      VALVE TEST MENU
```

Figure 2-15. Output Test Menu

The `OUTPUT TEST MENU` reports readings for digital potentiometers and valves. The `FLOW CONTROL POTS` menu does not appear on the B series analyzer.

2.5.6.1.1 Preprocessor Pots Screen

```
                 PREPROCESSOR POTS

      MEASURE COARSE ZERO     : 61
      MEASURE FINE ZERO       : 47
      INPUT                   : 49
      TEST MEASURE            : 0
      LAMP ADJUST             : 58

      REF. VOLTAGE       3.806 VOLTS
      O3                 0.065 PPM
      CONC. VOLTAGE      1.514 VOLTS
      LAMP CURRENT      10.024 MA
```

Figure 2-16. Preprocessor Pots Menu

Preprocessor pots are electronically controlled digital potentiometers used for adjustments to operations of the preprocessor board. Each pot is set with digits 0 to 99 in a non-wraparound scrolling field.

MEASURE COARSE ZERO
Software-controlled pot for the electronic zero for the measure channel. The pot is updated and controlled by the microprocessor.

MEASURE FINE ZERO
Software-controlled pot for the electronic zero. The pot is updated and controlled by the microprocessor. Used by technicians for troubleshooting.

INPUT
Software-controlled pot that sets input gain on the preprocessor board.

TEST MEASURE
Software-controlled pot that is used by technicians when troubleshooting.

LAMP ADJUST
Software-controlled pot that sets UV lamp current.

REF. VOLTAGE
Reference voltage as measured on the detector PCA. This voltage is indicative of the UV lamp intensity, and absorption by the ozone in the cell.

O3 PPM
Gas concentration reading. Cannot be set; instrument-generated information. Used as reference when setting pots.

CONC. VOLTAGE
Voltage from the preprocessor proportional to the absorption of ozone in the measurement cell. Microprocessor-controlled information used by technicians when troubleshooting.

LAMP CURRENT
Microprocessor displayed value for UV lamp current.

2.5.6.2 Flow Control Pots Screen

FLOW CONTROL POTS are potentiometers used to adjust the functions of the flow control board.

```
                 FLOW CONTROL POTS

         FLOW CONTROL ZERO  : 81
         FAN SPEED CONTROL  : 16
         PUMP SPEED FINE    : 85
         PUMP SPEED COARSE  : 36


         GAS FLOW             0.505  SLPM
         GAS PRESSURE         585.6  TORR
```

Figure 2-17. Flow Control Pots Screen

FLOW CONTROL ZERO

A pot that sets electronic zero for differential flow. The pot value is stored in EEPROM on flow controller board.

FAN SPEED CONTROL

Software-controlled pot that sets chassis fan speed.

PUMP SPEED FINE

Software-controlled pot that controls the pump speed (which controls sample flow rate).

PUMP SPEED COARSE

Software-controlled pot that controls the pump speed (which controls sample flow rate).

GAS FLOW

Instrument-generated information from the flow controller.

GAS PRESSURE

Atmospheric pressure; instrument-generated information.

2.5.6.3 Valve Test Menu

```
                 VALVE TEST MENU

     INT. VALVE #1           : OPEN
     INT. VALVE #2           : CLOSED
     INT. VALVE #3           : CLOSED
     AUX. VALVE #1           : CLOSED
     EXT. MEASURE            : CLOSED
     EXT. ZERO GAS           : CLOSED
     EXT. SPAN GAS           : CLOSED
     VALVE SEQUENCING        : ON
```

Figure 2-18. Valve Test Menu

The VALVE TEST MENU allows the valves to be set to either OPEN or CLOSED according to the operator's choice. To manually operate the valves**,** VALVE SEQUENCING needs to be turned off. See the pneumatic diagram in the EC9811 *Service Manual* for details on plumbing connections.

INT. VALVE #1

Sample stream.

INT. VALVE #2
Scrubbed sample (primary scrubber).

INT. VALVE #3
Not used.

AUX. VALVE #1
Not currently used.

EXT. MEASURE
Externally supplied sample.

EXT. ZERO GAS
Externally supplied zero air.

EXT. SPAN GAS
Externally supplied span gas.

VALVE SEQUENCING
Set to either ON or OFF. ON is used for automatic valve control of reference and sample gas readings; OFF is used for operator control of valves. VALVE SEQUENCING *will automatically be set to* ON *whenever the primary screen is displayed.*

2.5.6.4 Diagnostic Menu

```
                DIAGNOSTIC MENU

      MULTIDROP PORT TEST      : NO
      WATCHDOG TEST            : NO
      DISPLAY TEST             : NO
      ANALOG OUTPUT TEST       : NO
```

Figure 2-19. Diagnostic Menu

The DIAGNOSTIC MENU is information used to diagnose problems or suspected problems. The settings return to the previously set conditions when the operator leaves this menu.

MULTIDROP PORT TEST
Sends test of all printable characters to the Multidrop (rear) serial ports.

WATCHDOG TEST
Disables strobes to the watchdog timer. The system resets when this test is executed.

DISPLAY TEST

A series of 6 tests are available to check the working order of the display screen. Once the test is selected press the <Select> key to verify that the alternate pixels are visible. Press the <Pg Up> key to exit. The available tests are:

STRIPE 1

Causes the screen to show a series of very closely spaced vertical lines.

STRIPE 2

Shows a series of vertical lines in alternate positions to those is **STRIPE 1.**

CLEAR

Clears the screen of all pixels.

FILL

Fills the screen of pixels.

CHECK 1

Causes the screen to show a checkered pattern made up of single pixels.

CHECK 2

Displays a checkered pattern in alternate spaces to **CHECK 1.**

ANALOG OUTPUT TEST

Sends a 0.1 Hz sawtooth waveform to the selected analog output device to test its functionality. There are 6 analog outputs to choose from (`#1 to #6`). Analog outputs `#1 to #3` are available via the 50 PIN IO connector.

2.5.6.5 Calculation factor

```
                CALCULATION FACTOR

INSTRUMENT GAIN         :  0.978
P/T/F CORRECTION        :  0.9877
BACKGROUND              :  0.000
ZERO OFFSET             :  0.000
```

Figure 2-20. Calculation factor

The Calculation factors screen is a non editable screen which provides the values used to calculate different aspects of measurement and calibration.

2.5.7 Interface Menu

```
                    INTERFACE MENU

      ANALOG OUTPUT MENU
      DATA LOGGING MENU
      MAIN GAS ID             :  010
      INTERFACE MODE          :  COMMAND
      MULTIDROP BAUD          :  2400
      DATA LENGTH             :  8 BITS
      STOP BITS               :  1 BIT
      PARITY                  :  NONE
      COMM. PROTOCOL          :  ORIGINAL
      NETWORKING ADAPTOR MENU
```

Figure 2-21. Interface Menu

The INTERFACE MENU is used for interfacing analog recording instruments and programming RS232 parameters.

The following are used only when one or more of the serial ports are to be used. See output connections information in *Chapter 4, Digital Communication*.

MAIN GAS ID
The ID address of the analyzer when Multidrop RS232 communications is used.

INTERFACE MODE
This establishes the RS232 communication mode. Choices are COMMAND and TERMINAL. TERMINAL uses the menu structure, and COMMAND uses the 9800 Serial Command Set.

MULTIDROP BAUD
The communication rate for RS232 (DB9) connectors on the rear panel. The available rates are 1200, 2400, 4800, 9600, 19200 AND 38400.

DATA LENGTH
Sets the number of data bits for the RS232 port. The available choices are 7 BITS and 8 BITS.

STOP BITS
Sets the number of stop bits for the RS232 port. The available choices are 1 BIT and 2 BITS.

PARITY

Sets the parity for the RS232 port. The available choices are NONE, EVEN, and ODD.

COMM. PROTOCOL

Sets the communication protocol for serial transmissions using the 9800 Serial Command Set. The available choices are ORIGINAL, BAVARIAN, and ENHANCED. See the serial communications information in *Chapter 4*.

2.5.8 Analog Output Menu

The ANALOG OUTPUT MENU contains settings that relate to the recording devices. For a detailed explanation of the analog output, see section 0 below. *The setting of analog output ranges has no impact on the measurement range of the analyzer; it only affects the analog output scaling.*

2.5.8.1 O_3 Current Output Menu

```
                ANALOG OUTPUT MENU

      RANGE              : 0.500 PPM
      OUTPUT TYPE        : CURRENT
      CURRENT RANGE      : 0-20 MA
      FULL SCALE         : 0.00 %
      ZERO ADJUST        : 0.00 %
      OVER RANGE         : 20.00 PPM
      OVER-RANGING       : DISABLED
```

Figure 2-22. Analog Output Menu (Current Output)

RANGE

Set upper range limit (in digits) to desired O_3 concentration. This value cannot exceed the OVER RANGE value.

OUTPUT TYPE

Setting must match the choice on the 50-Pin I/O board (if installed), current or voltage.

CURRENT RANGE

Choices are 0-20 MA, 2-20 MA, and 4-20 MA.

FULL SCALE

X.XX%, a correction factor for full scale setting. Used when calibrating the analog outputs.

ZERO ADJ

X.XX%, a correction factor for the zero setting. Used when calibrating the analog outputs.

OVER RANGE
Set to desired over range value. This value cannot be set below the RANGE value. See section 0 below. This is the alternate scale the recorder or DAS indicates when over-ranging is active and enabled. (When 90% of the set range is reached, this auto range is effective. When 80% of the original range is reached, it returns to the original range.)

OVER-RANGING
Set to ENABLED or DISABLED to turn the over-ranging feature on or off.

2.5.8.2 O_3 Voltage Output Menu

```
                 ANALOG OUTPUT MENU

      RANGE              : 0.500 PPM
      OUTPUT TYPE        : VOLTAGE
      OFFSET             : 0    %
      FULL SCALE         : 0.00 %
      ZERO ADJUST        : 0.00 %
      OVER RANGE         : 20.00 PPM
      OVER-RANGING       : DISABLED
```

Figure 2-23. Analog Output Menu (Voltage Output)

RANGE
Set upper range limit (in digits) to desired O_3 concentration. This value cannot exceed the OVER RANGE value.

OUTPUT TYPE
Setting must match the choice on the 50-Pin I/O board (if installed), current or voltage.

OFFSET
Choices are 0%, 5%, and 10%. Recorder or DAS output will reflect this.

FULL SCALE
X.XX%, a correction factor for full scale setting. Used when calibrating the analog outputs.

ZERO ADJ
X.XX%, a correction factor for the zero setting. Used when calibrating the analog outputs.

OVER RANGE
Set to desired over range value. This value cannot be set below the RANGE value. This is the alternate scale the recorder or DAS indicates when over-ranging is active and enabled. (When 90% of the set range is reached, this auto range is

effective. When 80% of the original range is reached, it returns to the original range.)

OVER-RANGING

Set to ENABLED or DISABLED to turn the over-ranging feature on or off.

2.5.9 Data Logging Menu

```
DATA LOGGING MENU

AVERAGE DATA      :  OFF
INST. DATA        :  OFF
TOTAL CAPACITY    :  0.0 DAYS
ERASE LOGGED DATA :  NO
```

Figure 2-24. Data Logging Menu

The DATA LOGGING MENU contains settings that relate to the internal data recording facilities of the EC9811. This data can latter be retrieved using the Ecotech data downloading software mentioned in section 4.6.

AVERAGE DATA

If the average data is set to off, no average data is recorded. If it is set to on, then the average data displayed on the primary screen is recorded. The averaging period of this data is set in the MEASUREMENT MENU.

INST. DATA

The INST. DATA option allows you to select either off (where no data is recorded) or record instantaneous data with the following intervals: 1 HOUR, 30 MINUTES, 10 MINUTES, 5 MINUTES, 3 MINUTES OR 1 MINUTE.

TOTAL CAPACITY

When either of the above are set to on, the amount of free memory available for data logging will be displayed in days. This indicates how much data can be stored, before the earliest data will start to be overwritten.

Inst. Data (min)	*Total Capacity (days)*
1	35
3	106
5	176
10	353
30	1061
60	2123

ERASE LOGGED DATA
When yes is selected and enter is pressed, all the logged data will be erased.

2.5.10 Network Adaptor Menu.

The Network Adaptor Menu allows the user to enter or change the I.P. address, Netmask and Gateway.

```
                  NETWORK ADAPTER MENU


I.P. ADDRESS        0.      0.     0.     0.
NETMASK             0.      0.     0.     0.
GATEWAY             0.      0.     0.     0.
```

2.5.11 Trend Select Menu

TREND SELECT MENU is the graphic display of the parameters listed.

```
                   TREND SELECT MENU

              CONCENTRATION
              AVG CONCENTRATION
              REFERENCE
              ZERO OFFSET
              SPAN COMPENSATION
              SAMPLE FLOW
              SAMPLE PRESSURE
```

Figure 2-25 Trend Select Menu

Each graph is displayed as an x-y plot with the x-axis 0 being the current time and the most distant number being the most historic data.

2.5.12 Event Log Screen

```
                    EVENT LOG

# 1  AZS CYCLE
     OCCURRED AT 00:01  15-AUG-03

# 2  ZERO FLOW
     OCCURRED AT 17:02  08-AUG-03

# 3


# 4
```

Figure 2-26. Event Log Screen

The `EVENT LOG` displays notations of key events such as autozero and calibration or specific error conditions for up to 100 occurrences. This screen is a first in, last out type screen. The first entry is the latest occurrence. You can scroll through the events using the Up or Down arrow keys (⮝ or ⮟).

2.5.13 Instrument Status Screen

```
                INSTRUMENT STATUS

GAS FLOW          : 0.5       SLPM
GAS PRESSURE      : 617.6     TORR
REF. VOLTAGE      : 3.806     VOLTS
CONC. VOLTAGE     : 1.327     VOLTS
ANALOG SUPPLY     : 11.715    VOLTS
DIGITAL SUPPLY    : 4.977     VOLTS

LAMP CURRENT      : 10.214    MA

VERSION 1.03.0002                   EXIT
```

Figure 2-27. Instrument Status Screen

`INSTRUMENT STATUS` is information continuously generated by the microprocessor for various parameters.

GAS FLOW

Calculated gas flow. Will indicate `0.00` if the flow transducer senses flow has gone to zero.

GAS PRESSURE

Current Gas pressure – should be a little below current barometric pressure

REF. VOLTAGE
Reference voltage as measured by the UV Detector PCA. This voltage indicates the UV lamp intensity.

CONC. VOLTAGE
Voltage from the preprocessor proportional to the measurement signal. This voltage is represents the actual measurement of gas.

ANALOG SUPPLY
+12 volt (primary) power supply.

DIGITAL SUPPLY
+5 volt microprocessor power supply.

LAMP CURRENT
UV lamp power supply current.

VERSION
Indicates the current firmware version installed in the Microprocessor.

2.5.14 System Temperature Screen

```
                  SYSTEM TEMPERATURE

      CELL TEMP          : 32.1      DEG C
      LAMP TEMP          : 50.9      DEG C
      CHASSIS TEMP       : 35.1      DEG C
      FLOW TEMP          : 50.0 DEG C

                                              EXIT
```

Figure 2-28. System Temperature Screen

The SYSTEM TEMPERATURES display is information continuously generated by the microprocessor.

CELL TEMP
Temperature of the reaction cell.

LAMP TEMP
Temperature of the heated block surrounding the UV measurement lamp.

CHASSIS TEMP
Temperature of air inside the chassis, measured on the Microprocessor PCA.

FLOW TEMP
Temperature of the flow control/ pressure board.

2.5.15 System Faults Screen

```
                    SYSTEM FAULTS

       CELL TEMPERATURE:        PASS
       SAMPLE GAS FLOW:         PASS
       FLOW BLOCK TEMP:         PASS
       A/D INPUT:               PASS
       12 VOLT SUPPLY:          PASS
       REFERENCE VOLTAGE:       PASS
       LAMP CURRENT:            PASS
       LAMP TEMP:               PASS
                                                  EXIT
```

Figure 2-29. System Faults Screen

The SYSTEM FAULTS display provides a start, pass or fail indication for various parameters which are continually monitored. These parameters must be within acceptable operating ranges in order to display PASS. If the instrument is in startup mode, START will be displayed. Additional information on the SYSTEM FAULTS screen is included in the *EC9811 Service Manual*

2.6 INSTRUMENT SETUP

Instrument setup is divided into two main categories: analyzer setup and ozone generator setup.

2.6.1 Analyzer Setup

Analyzer setup includes setting date and time, selecting the instrument mode, choosing display units, choosing the filter type, choosing the average period, choosing serial interface baud rates, selecting the range and adjusting the analog outputs.

2.6.1.1 Setting the Date and Time

Data stored in instrument memory, such as the EVENT LOG, include time and date. Go to the INSTRUMENT MENU and select DATE and TIME in the day-month-year format. Adjust the current date and time and press enter.

2.6.1.2 Selecting the Instrument Mode

Two modes of operation are available with this instrument. The mode selected determines the source of zero air used as a reference for measurement. In the PHOTOMETER mode reference zero air is drawn from scrubbed ambient air. This is the same air used as a source for the ozone generator. In the ANALYZER mode, reference zero air is drawn from selective scrubbed sample gas.

The PHOTOMETER mode is used when the instrument is used as a calibrated ozone source. The ANALYZER mode is used when the instrument is used to measure ambient ozone for compliance with local regulatory requirements. For USEPA equivalent applications, the instrument must be used in the analyzer mode. In addition, if the instrument is used as an analyzer it cannot be used as a calibrated ozone source unless it is first cleaned and certified.

To select the instrument mode, go to the MEASUREMENT MENU and select INSTR. MODE. Enter either ANALYZER or PHOTOMETER.

2.6.1.3 Choosing Display Units

Two units of display are available ppm or mg/m^3. Parts per million (ppm) is the ratio of ozone to air by volume. Milligrams per cubic meter (mg/m^3) is the mass of the ozone in the sample that would be in one cubic meter if the temperature were 25° C and the pressure were one atmosphere. To select display units go to the MEASUREMENT MENU and select UNIT SELECTION. Enter either ppm or mg/m^3.

2.6.1.4 Choosing the Filter Type

The filter used to establish specifications of the instrument and for data submitted to the USEPA for certification is the Kalman filter. This filter implementation is chosen to optimize noise filtering and instrument response time. This filter adjusts its bandwidth depending upon the history of measured input variations. A steady input is filtered with a long time constant resulting in a quiet signal. A variation in one direction only causes the time constant to shorten resulting in a quick response. A variation in both directions over a long time is signal noise and causes the time constant to lengthen resulting in a quieter signal at the expense of a slower response. The Kalman filter was selected to match the normal fluctuations of ambient gases and is recommended for that application.

To select a filter type enter the `MEASUREMENT MENU`, move the cursor to `FILTER TYPE`, push the <Select> button, increment or decrement through the filter choices, and push the <Enter> button when the desired type is shown.

2.6.1.5 Average Period

Data may be averaged and the average value may be displayed on the instrument trend screen, where the total time displayed is 100 average periods. In addition the average value is shown on the primary screen.

To select an average period enter the `MEASUREMENT MENU`, move the cursor to `AVERAGE PERIOD`, push the <Select> button, increment or decrement through the average choices, and push the <Enter> button when the desired time is shown.

2.6.2 Ozone Generator Setup

Ozone generator setup includes: monitoring the ozone generator, adjusting the ozone generator flow rate, adjusting the full scale current for the ozone producing lamp, self calibrating the ozone generator, setting up the AZS output values, and choosing whether to run the generator open loop or with feedback.

It is recommended that the ozone generator be run overnight before final settings are made for the lamp current, flow rate, and self calibration. This will allow any ozone absorbing surfaces in the generator, distribution manifold, and the analyzer to become passive resulting in stable ozone output and readings.

The output of the ozone generator is directly proportional to lamp current and inversely proportional to flow rate. These two parameters may be adjusted to reach the desired full scale value for the ozone generator. The lamp current for the ozone producing lamp is adjustable from approximately 4 mA to 10 mA. For maximum lamp life and fastest response of the ozone output to lamp current changes, it is best to keep the lamp current at a minimum. Depending on your application requirements, you may be able to set the current to a minimum and adjust the output using generator flow rate. The generator will produce about 1 to 2 ppm at a flow rate of 4 slpm at minimum lamp current. The generator will produce about 2 to 4 ppm at a flow rate of 4 slpm at maximum lamp current. Ozone production varies from lamp to lamp over about a two to one range.

2.6.2.1 Monitoring the Ozone Generator

The analyzer must be monitoring the ozone generator before the generator can be adjusted. To monitor the ozone generator enter the `CALIBRATION MENU` and select `CALIBRATION`. Press the <Select> key and use the increment or decrement keys to find `MANUAL`. Press the <Enter> key to select this function.

Next select `CAL. MODE`. Press the <Select> key and use the increment or decrement keys find `SP1`. Press the <Enter> key to select this function. Next select `O3 GENERATOR MENU` and enter this menu. From this menu select `GENERATOR`. Press the <Select> key and use the increment or decrement keys to find `ON`. Press the <Enter> key to select this function. The ozone generator is now in manual calibration.

2.6.2.2 Adjusting the Ozone Generator Pump Flow

The ozone generator is factory set for a flow rate of 4 slpm. And, the generator output is factory calibrated at this flow rate for a full scale value of 1 ppm. The ozone generator flow rate should not be changed unless required by your application, or instrument repair has been done to the ozone generator. If the ozone generator pump flow is changed it will be necessary to perform an ozone generator self calibration. See paragraph 2.6.2.4.

To set the ozone generator pump flow enter the `CALIBRATION MENU`. From the `CALIBRATION MENU` select the `O3 GENERATOR MENU`. Move the cursor to `PUMP FLOW` and press the <Select> key. Use the select key to choose the digit you wish to change and use the increment and decrement keys to reach the desired digit value. When the desired value is reached push the <Enter> key.

Note

Use the "`PUMP FLOW`" reading below to ensure the reading matches the desired flow entered above. Only confirm the desired flow once this has occurred otherwise pump flow will be offset.

2.6.2.3 Adjusting the O_3 Producing Lamp Current

The current has been factory set for the ozone producing lamp for 1 ppm at a flow rate of 4 slpm. The current should not be readjusted unless required by your application, the ozone producing lamp has been replaced, ozone generator pump flow has been changed, or repair has been done to the ozone generator electronics.

This procedure sets the maximum value of ozone the generator will produce. The ozone generator flow rate should be adjusted, if required, before this procedure is performed. If a record of the analog output is desired to document the lamp adjustment procedure, the analyzer must be set for the ozone range to which the ozone output will be adjusted. This would normally be an analog range of 2 ppm full scale for adjustment of 1 ppm full scale ozone output.

The current to the ozone producing lamp is controlled by two digital to analog converters (DACs) located on the microprocessor board. One DAC controls the maximum lamp current by adjusting the voltage sent to the lamp driver. The other DAC divides this maximum current by duty cycle modulation to produce ozone values from full scale to zero. When either of the adjustment fields are entered, `PUMP FLOW` or `LAMP CURRENT`, the duty cycle DAC is set for maximum current output if the instrument is in `MANUAL` calibration and `CAL MODE` is `SP1` through `SP5`.

The ozone output is determined by the amount of UV light absorbed by oxygen in the ozone producing cell. The cell is designed so the lamp bulb may be screened from some of the oxygen and provide a coarse adjust of ozone output. The procedure for adjusting the O3 generating lamp is given in the *EC9811 Service Manual*.

To set the ozone producing lamp current enter the `CALIBRATION MENU`. From the `CALIBRATION MENU` select the `O3 GENERATOR MENU`. From the `O3 GENERATOR MENU` select the `O3 GEN. SETUP MENU`. Move the cursor to `LAMP CURRENT` and press the <Select> key. The increment or decrement key can be used to change the lamp current. Lamp current is shown as a percentage increase of its nominal value of 4 mA. A percentage display of 0% is nominally 4 mA and a percentage display of 100% is nominally 8 mA.

2.6.2.4 Ozone Generator Self Calibration

Self calibration of the ozone generator is a process where the microprocessor measures the ozone output for equally spaced duty cycle DAC outputs and fits a straight line through the measured values using linear regression. This line is then used to produce selected ozone output values.

When the instrument is programmed to self calibrate the ozone generator, it will automatically go to `SPAN` mode monitor the ozone output. After calibration is complete the instrument will go to `MEASURE` mode.

To self calibrate the ozone generator enter the CALIBRATION MENU. From the CALIBRATION MENU select the CYCLE TIME. Press the <Select> key and then use the increment or decrement keys to change the cycle time. Press the <Enter> key when the desired value is reached. Next select enter the O3 GEN MENU and select O3 CALIB. Press the <Select> key and then the <Enter> key. The instrument will start an ozone generator self calibration. A self calibration in progress can be aborted or the remaining step times can be changed.

- Changing the CYCLE TIME selection will change the time for all steps remaining except the one in progress.

- To abort a self calibration cycle go to the CALIBRATION MENU and change the CALIBRATION MODE from SPAN to MEASURE.

2.6.2.5 Ozone Feedback

When OZONE FEEDBACK is ENABLED, the instrument photometer is used to control the ozone generator output. When OZONE FEEDBACK is DISABLED, the generator output is determined by its most recent calibration values.

When the instrument is used as an analyzer, feedback may be ENABLED or DISABLED depending upon operator preference. In either case the generator is operating as a level two zero/span check, so it may not be used to calibrate the analyzer.

With feedback ENABLED, the instrument photometer is being used to check degradation of the selective scrubber. The ozone generator output is set using the instrument internal zero air source and measured using the selective scrubber. The assumption for this mode of operation is that the photometer and particulate filter degradation due to dirt buildup is slower than the ozone generator degradation due to lamp solarization.

With feedback DISABLED, the ozone generator is being used to check degradation of the ozone scrubber, the particulate filter, and the photometer. The assumption for this mode of operation is that the ozone generator output is degrading slower than the scrubber, particulate filter, and photometer.

Depending upon conditions under which your analyzer is functioning, one mode may be superior to the other. Since the photometer mode of the instrument sends only scrubbed air to the filter and photometer, FEEDBACK: ENABLED is used when the instrument is operated as a calibrated ozone source. The instrument must be put in the PHOTOMETER mode and it must have ozone feedback ENABLED to meet specifications as a calibrated ozone source.

To set ozone feedback enter the INSTRUMENT MENU. From the INSTRUMENT MENU select the MEASUREMENT MENU. From the MEASUREMENT MENU select OZONE FEEDBACK. Press the <Select> key and the use the increment or decrement keys to change the mode. Press the <Enter> key when the desired mode is reached.

2.7 OPERATING THE INSTRUMENT

The instrument may be operated as an analyzer with built-in periodic zero-span checks or as a calibrated ozone source. In both cases you will want to check the ozone generator output and measure ozone from some external source.

2.7.1 Measuring External Ozone

The external ozone source to be measured must have a flow rate of greater than 750 mL per minute to avoid back diffusion. A flow rate of greater than 1000 mL per minute is recommended. The external ozone source is connected to the sample port of the calibration valves. The excess flow of the external ozone source must be connected to a vent.

To measure the external ozone source connected to the sample port, enter the CALIBRATION MENU and select CALIBRATION: MANUAL and CAL MODE: MEASURE. The instrument will now measure the sample gas. At this point you may wish to enter the INTERFACE MENU to rescale the analog RANGE so the measured value is properly scaled for your strip chart recorder or the TREND screen.

2.7.2 Measuring Internal Ozone

The internal ozone generator must be programmed to a flow rate greater than 750 mL per minute. One port of the ozone output manifold must be connected to the valve manifold span port. One port of the ozone output manifold must be connected to a vent.

To measure the internal ozone source connected to the span port enter the CALIBRATION MENU and select CALIBRATION: MANUAL and CAL MODE: SPAN #X (where X is 1 through 5). The instrument will now measure the internal ozone generator. At this point you may wish to turn on the generator or change the generator value. You may also wish to enter the INTERFACE MENU to rescale the analog RANGE so the measured value is properly scaled for your strip chart recorder or the TREND screen.

2.7.3 Changing the Generator Output

The output of the ozone generator, if turned on, is displayed on the O3 GENERATOR MENU. To find this display enter the CALIBRATION MENU. From the CALIBRATION MENU enter the O3 GENERATOR MENU. The generator display is opposite OUTPUT.

To change this output push the <Select> key to enter the numeric field. Push the <Select> key to find the digit you wish to change and use the increment or decrement keys to change the digit. Press <Enter> when the desired ozone output value is reached.

Note

The generator output will not be at the displayed value if the ozone generator has not been self calibrated. Refer to section 2.6.2.

2.7.4 Stepping the Ozone Generator Through the Span Points

The ozone generator may be made to step through the span point values either immediately or at some later time and repeated at a programmed interval.

To cause an immediate output from the ozone generator span points enter the `CALIBRATION MENU`. From the `CALIBRATION MENU` select `CALIBRATION: MANUAL`. Select `CAL MODE` and push the <Select> key, then use the increment or decrement keys to find `CYCLE`. When you push the <Enter> key, the ozone generator will output a sequence of concentrations starting with zero and stepping through the programmed span points. Refer to paragraph 3.4.1.

To set up the ozone generator to perform repeated sequences of span point steps, enter the `CALIBRATION MENU`. From the `CALIBRATION MENU` select `CALIBRATION: TIMED`. Select `TIMER INTERVAL` and push the <Select> key, then use the increment or decrement keys to set the desired interval. Press the <Enter> key to store this value. Select `STARTING HOUR` and push the <Select> key, then use the increment or decrement keys to set the desired hour. Press the <Enter> key to store this value. At the selected starting hour, the ozone generator will output a sequence of concentrations starting with zero and stepping through the programmed span points. The sequence will be repeated at the timed interval. Refer to section 3.4.1.

2.8 Analog Output

Analog output connections are described in section 2.1.2.1 above.

Before setting up the recorder and DAS analog outputs, decide what offset and over-ranging choices to make. A brief explanation of these terms follows, then the setup procedure is given. ***The setting of the analog output and over-range has no impact on the measurement range of the analyzer; it only affects the analog output scaling.***

2.8.1 Offset and Live Zero

At any selected output range, the operator may want to observe negative signal indications. Moving the zero indication up the scale to a specific point creates a live zero, thus allowing the recorder or DAS to show negative as well as positive indications.

The adjustment used to create a live zero is `OFFSET`. For example, a 10% offset moves the zero indication to the point where 10% would normally be indicated. The full reading available on the recorder paper or DAS would then be -10% to +90% of full scale. See Figure 2-30, an illustration of offset on the strip chart recorder.

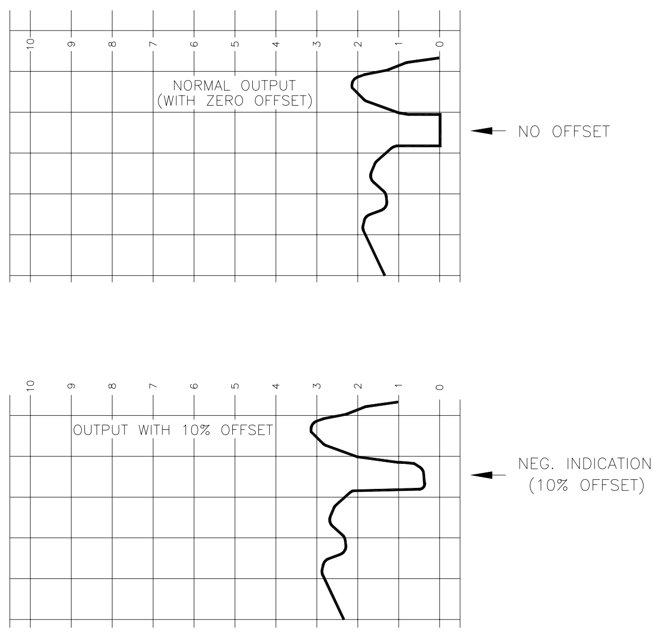

Figure 2-30. Strip Charts Illustrating Offset

Signal adjustments for zero and instrument gain to align the output with the user's recorder or other measurement device can be made in the `ANALOG OUTPUT MENU` in the fields `FULL SCALE` and `ZERO ADJ`. These adjustments may be necessary due to tolerance buildup, power supply variation, etc. in either the analyzer or the measurement device.

2.8.2 Over Range Adjustment

Over-ranging is also enabled from the `ANALOG OUTPUT MENU`. The `OVER RANGE` setting is the auxiliary range the operator chooses to track the data should the data exceed full scale of the original range. *The setting of over-range has no impact on the measurement range of the analyzer; it only affects the analog output scaling.*

With over-ranging enabled, as the concentration reaches 90% of the full scale value for the selected output range, the software generates a positive spike that takes the indicator from the 90% position to the 100% position. The output data is then scaled for the full scale chosen for over range. As the output drops back to 80% of the original full scale, the software generates a negative spike from the displayed value to zero. The output then reverts to the original range. See Figure 2-31 for an example of over range on a typical strip chart recorder.

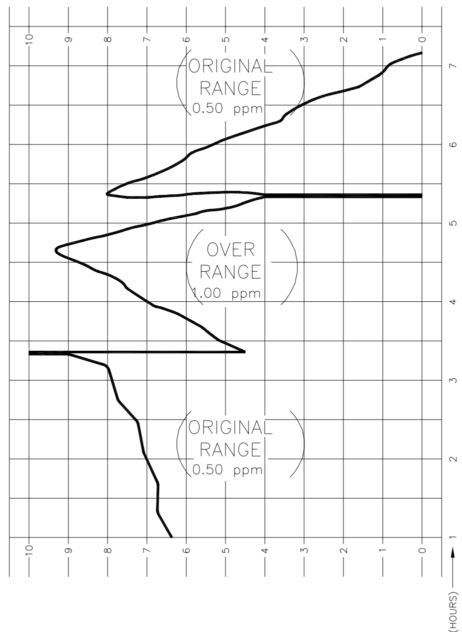

Figure 2-31. Over Range as Seen on a Strip Chart Recorder

The range value should generally be set first. However, because the range value must be less than the currently selected over range value, it may be necessary to increase the over range value to the desired setting first. The over range value is limited to be equal to or greater than the currently selected range value. For practicality, it is recommended that the over range be set to a value between 2 and 5 times the range value. For example, if the desired monitoring range is 0.2 ppm, the over range should be set between 0.4 ppm and 1.0 ppm.

Certain precautions must be taken when over-ranging is enabled to ensure that pollutant concentration measurements are reported correctly. When a data acquisition must interface with the analog output of the instrument, some means must be provided to indicate which range is in effect during all measurements. The user should monitor pin 7 on the 50-pin I/O connector, which is an open collector output indicating `ANALOG OUTPUT #1` is in over-range.

2.8.3 Analog Output Calibration Procedure

This procedure is appropriate for connecting the EC9811 analyzer to a strip cart recorder, Data logger (DAS) or to a Digital voltmeter (DVM).

1. Go to the `INTERFACE MENU` and choose `ANALOG OUTPUT MENU`.

2. Select `RANGE` and enter the desired range by selecting the appropriate digits. Press <Enter> to confirm your choice.

3. Set the output type according to the termination selected for the discrete I/O connector. The choice will be either `CURRENT` or `VOLTAGE`.

4. If current output is desired and the 50-pin board is installed, set the selection jumper to `CURRENT` *and de-select all voltage ranges*. If current output is desired and the 50-pin board is not installed, no hardware change is required.

5. If voltage output is desired and the 50-pin board is installed, set the selection jumper to `VOLTAGE`. If voltage output is desired and the 50-pin board is not installed, an external termination resistor is required. This resistor must be 50 ohms per full scale voltage desired (50 ohms = 1 v full scale; 500 ohms = 10 v full scale, etc).

6. If voltage output type was selected, choose the desired offset and press <Enter>. If current output type was selected, choose the desired output range and press <Enter>.

7. Select `ZERO ADJUST` and adjust the analog output to the selected offset position for zero concentration (i.e., if 10% offset is selected, position the recorder pen or DAS at 10% of full scale). To make the adjustment, watch the recorder paper or DAS while you increment or decrement the zero adjustment correction factor that is displayed. Press <Enter> to confirm your setting.

8. Select `FULL SCALE` and adjust the analog output to 100% on the recorder paper or DAS. To make this adjustment, watch the recorder paper or DAS while you increment or decrement the full scale correction factor that is displayed. Press <Enter> to confirm your setting.

9. Select `OVER RANGE` and set to a range that is higher than the `RANGE` chosen at the top of the screen. When the digits reflect the desired over-range, press <Enter>.

10. Select `OVER-RANGING` and choose either `ENABLED` or `DISABLED`. Press <Enter>.

2.8.4 Calibration Requirements

To make your data acceptable to the regulatory authorities and to pass required periodic audits, you must calibrate the instrument before any data is collected for use in a monitoring program. The calibration procedure is included in *Chapter 3*.

Most regulatory requirements also include establishing a calibration verification program. If your organization does not have the staff to perform this task, Ecotech's Service personnel can provide assistance. See the front of this manual for contact details.

2.9 Password Protection

A password protection option was designed in order to solve the problem of altering the configuration of the machine by the user. This option prevents the user from configuring the EC9800 menus by creating an individual password. This feature allows the user to exclude changes to the front panel menus by locking them through a user-specified password.

2.9.1 Rules of Operation

- The password must be a four-digit number.
- After a memory erasure, the analyzer will default to `UNLOCKED`.
- The user must enter a four-digit number to lock the analyzer. The same four-digit number is used to unlock the analyzer as well.
- Once the analyzer is locked, the user may navigate through the menus, but cannot select a field for data entry.
- Each time the user wishes to lock the analyzer, the password must be entered. The password is only valid while the analyzer remains locked; previous passwords are not remembered.
- On the `INSTRUMENT MENU` there is a new entry labeled `PASSWORD` that displays the status of the menu as either `UNLOCKED` or `LOCKED`.

2.9.2 Sample Session

1. At `INSTRUMENT MENU` there is a field labeled `PASSWORD`. This should display the status `UNLOCKED`.

2. Select the field labeled `PASSWORD`. The status `UNLOCKED` will be replaced by `0000`.

3. Using the select and arrow keys scroll to the desired numbers to represent the password.

4. When the desired password appears, press the <Enter> key. The password will disappear and the `LOCKED` message will take its place. The analyzer is now locked.

5. Scroll through the instrument menus. From this point forward, it is impossible to select any alterable fields.

6. Return to the `INSTRUMENT MENU` and select the `PASSWORD` field.

7. The `LOCKED` message will disappear and `0000` appears in its place.

8. Using the <Select> and arrow keys scroll the numbers of the password entered previously.

9. When the password is displayed, press the <Enter> key. The password will disappear and be replaced by the message `UNLOCKED`.

10. The analyzer is unlocked and the menu configuration can be altered.

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3.0 Calibration

3.1 Overview

The calibration chapter consists of:

- a general discussion of calibration
- a description of the multipoint calibration procedure
- a description of automatic zero/span (AZS) setup
- a discussion of the AZS feature.

The EC9811 ozone analyzer is a precision measuring device which must be calibrated against a known source of ozone. Ozone concentration standards required for calibration may be generated and measured with a UV calibration photometer at the time of use, or they may be obtained by means of a certified ozone transfer standard.

In general terms, the calibration process consists of:

1. Establishing a reliable and stable calibrating source.
2. Providing a satisfactory connection between the calibration source and the analyzer.
3. Calibrating the analyzer against the calibration source.

Multipoint calibration is used to establish the relationship between analyzer response and pollutant concentration over the analyzer's full scale range. Zero and span checks are frequently used to provide a two-point calibration or an indication of analyzer stability and function.

Regulations generally require that the analyzer be recalibrated any time it is moved, serviced, or whenever the analyzer characteristics may have changed. This includes changing the instruments units from volumetric to gravimetric. Regulatory agencies establish the time intervals at which the analyzer must be calibrated to ensure satisfactory data for their purposes.

Important

Use of the EC9811 O_3 analyzer as a U.S. EPA-designated equivalent method requires periodic multipoint calibration in accordance with the procedure described below. In addition, the instrument must be set to the parameters indicated in *Chapter 1, Introduction*.

3.1.1 Analyzer Calibration with external Span

Note

This procedure is a quick guide to single point span calibration of the EC9811 analyzer, intended for operators who are familiar with gas analyzers and preparation of calibration gas. For complete gas preparation and multipoint calibration instructions please refer to the multipoint calibration in section 0 below.

1. Connect a source of span calibration gas to the analyzer through the Inlet port (see *Chapter 3, Calibration*, for instructions on preparing calibration gas).
2. Allow the analyzer to sample the gas until a stable reading is obtained, typically 15 minutes.
3. *From the primary screen*, start the calibration sequence by pressing either the Up or Down arrow key (⮝ or ⮟) until the display prompts `START MANUAL CALIBRATION? SPAN`. Confirm that the display reads `SPAN` and press <Enter> (↵). A backlit cursor will be displayed on the O_3 concentration display.
4. Use the <Select> key to move the position of the backlit cursor, and the Up and Down arrow keys to increment and decrement the value of the backlit digit until the span calibration gas concentration value is displayed. When the desired concentration is displayed, press <Enter>.
5. Then move the backlit cursor to the `INSTRUMENT GAIN` field. The instrument gain is automatically calculated by the analyzer. Press <Enter> to confirm this value. Press <Exit> to return to the *primary screen.*

This completes the span calibration of the EC9811 analyzer.

Note

The auto-zero function of the EC9811 eliminates the need for a traditional zero calibration. In special applications where a zero calibration is required the following procedure can be used:

1. Connect a source of zero air to the analyzer through the Inlet port.

2. Allow the analyzer to sample the gas until a stable reading is obtained, typically 15 minutes.

3. *From the primary screen*, start the calibration sequence by pressing either the Up or Down arrow key (⋏ or ⋎) until the display prompts `START MANUAL CALIBRATION? ZERO`. Confirm that the display reads `ZERO` and press <Enter> (↵). A backlit cursor will be displayed on the O_3 concentration display.

4. Use the <Select> key to move the position of the backlit cursor, and the Up and Down arrow keys to increment and decrement the value of the backlit digit until the zero value is displayed (e.g., 0.000 ppm). The maximum available zero offset is ±0.009 ppm. When the desired concentration is displayed, press <Enter>. Press <Exit> to return to the *primary screen.*

This completes the calibration of the EC9811 analyzer.

3.2 Multipoint Calibration Procedure

The procedure for calibrating the EC9811 ozone analyzer is customized from 40 CFR Part 50, Appendix D. Before beginning a multipoint calibration of the instrument, a qualified service technician must perform the periodic maintenance procedures in the *EC9811 Service Manual*, especially checking the particulate filter. The `INSTRUMENT STATUS` and `SYSTEM TEMPERATURES` screens in the *EC9811 Service Manual* give the ranges for correct operation of the instrument.

Note

Calibration can only be performed correctly when the instrument is stable and has been powered up for at least three hours.

3.2.1 Photometric Analysis Calibration Procedure

3.2.1.1 Principle

The calibration procedure is based on the photometric analysis of ozone (O_3) concentrations in a dynamic flow system. The concentration of O_3 in an absorption cell is determined from a measurement of the amount of 254 nm light absorbed by the sample. This determination requires the knowledge of:

- the absorption coefficient (a) of O_3 at 254 nm
- the optical path length (l) through the sample
- the transmittance of the sample at a wavelength of 254 nm
- the temperature (T) and pressure (P) of the sample.

The transmittance is defined as the ratio I/I_O, where I is the intensity of light which passes through the cell and is sensed by the detector when the cell contains an O_3 sample, and I_O is the intensity of light which passes through the cell and is sensed by the detector when the cell contains zero air. It is assumed that all conditions of the system, except for the contents of the absorption cell, are identical during measurement of I and I_O. The quantities defined above are related by the Beer-Lambert absorption law.

$$\textbf{Transmittance} = \frac{I}{I_O} = e^{-acl}$$

Equation 3-1

where:

a = absorption coefficient of O_3 at 254 nm = 308 ±4 atm^{-1} cm^{-1} at 0° C and 760 torr (760 torr = 101 kPa)
c = O_3 concentration in atmospheres
l = optical path length in cm.

In practice, a stable O_3 generator is used to produce O_3 concentrations over the required range. Each O_3 concentration is determined from the measurement of the transmittance (I/I_O) of the sample at 254 nm with a photometer of path length l and calculated from the following equation:

$$c(atm) = -\frac{1}{al}\left(\ln\frac{I}{I_O}\right)$$

or

$$c(\text{ppm}) = -\frac{10^6}{al}\left(\ln\frac{I}{I_o}\right)$$

Equation 3-2

The calculated O_3 concentrations must be corrected for O_3 losses which may occur in the photometer and for the temperature and pressure of the sample.

3.2.1.2 Applicability

This procedure is applicable to the calibration of ambient air O_3 analyzers, either directly or by means of a transfer standard certified by this procedure. Transfer standards must meet the requirements and specifications set forth in Calibration Reference 2.

3.2.1.3 Apparatus

A complete UV calibration system consists of an ozone generator, an output port or manifold, a photometer, an appropriate source of zero air, and other components as necessary. The configuration must provide a stable ozone concentration at the system output and allow the photometer to accurately analyze the output concentration to the precision specified for the photometer (see section 3.2.1.3.1 below).

Figure 3-1 shows a commonly used configuration and serves to illustrate the calibration procedure which follows. Other configurations may require appropriate variation in the procedural steps. All connections between components in the calibration system downstream of the O_3 generator should be of glass, Teflon®, or other relatively inert materials. Additional information regarding the assembly of a UV photometric calibration apparatus is given in Calibration Reference 1. For certification of transfer standards which provide their own source of O_3, the transfer standard may replace the O_3 generator and possibly other components shown in Figure 3-1; see Reference 2 for guidance.

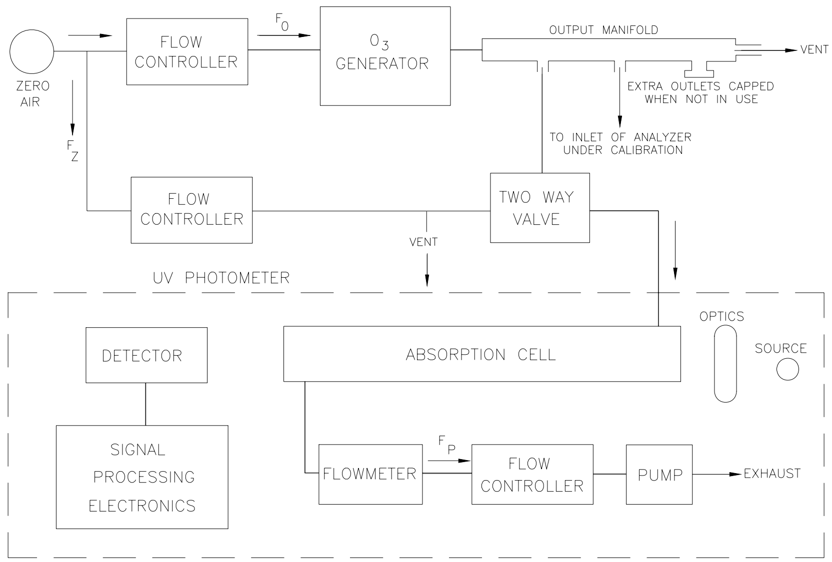

Figure 3-1. Typical UV Photometric Calibration System

3.2.1.3.1 UV Photometer

The photometer consists of a low-pressure mercury discharge lamp, collimation optics (optional), an absorption cell, a detector, and signal-processing electronics, as illustrated in Figure 3-1.

It must be capable of measuring the transmittance, I/I_O, at a wavelength of 254 nm with sufficient precision such that the standard deviation of the concentration measurements does not exceed 0.005 ppm or 3% of the concentration. Because the low-pressure mercury lamp radiates at several wavelengths, the photometer must incorporate suitable means to assure that no O3 is generated in the cell by the lamp, and that at least 99.5% of the radiation sensed by the detector is 254 nm radiation. (This can be readily achieved by prudent selection of optical filter and detector response characteristics.) The length of the light path through the absorption cell must be known with an accuracy of at least 99.5%. In addition, the cell and associated plumbing must be designed to minimize loss of O_3 from contact with cell walls and gas handling components. See Calibration Reference 1 for additional information.

3.2.1.3.2 Air Flow Controllers

Devices capable of regulating air flows as necessary to meet the output stability and photometer precision requirements.

3.2.1.3.3 Ozone Generator

Device capable of generating stable levels of O_3 over the required concentration range.

3.2.1.3.4 Output Manifold

The output manifold should be constructed of glass, Teflon®, or other relatively inert material, and should be of sufficient diameter to insure a negligible pressure drop at the photometer connection and other output ports. The system must have a vent designed to ensure atmospheric pressure in the manifold and to prevent ambient air from entering the manifold.

3.2.1.3.5 Temperature Indicator

Accurate to ±1° C

3.2.1.3.6 Barometer or Pressure Indicator

Accurate to ±2 torr.

3.2.1.4 Reagents

3.2.1.4.1 Zero Air

The zero air must be free of contaminants which would cause a detectable response from the O_3 analyzer, and it should be free of NO, C_2H_4, and other species which react with O_3. A procedure for generating suitable zero air is given in Calibration Reference 1. As shown in Figure 3-1, the zero air supplied to the photometer cell for the I_O reference measure-measurement must be derived from the same source as the zero air used for generation of the ozone concentration to be analyzed (I measurement). When using the photometer to certify a transfer standard having its own source of ozone, see Calibration Reference 2 for guidance on meeting this requirement.

3.2.1.5 Procedure

3.2.1.5.1 General Operation

The calibration photometer must be dedicated exclusively to use as a calibration standard. It should always be used with clean, filtered calibration gases, and never used for ambient air sampling. Consideration should be given to locating the calibration photometer in a clean laboratory where it can be stationary, protected from physical shock, operated by a responsible analyst, and used as a common standard for all field calibrations via transfer standards.

3.2.1.5.2 Preparation

Proper operation of the photometer is of critical importance to the accuracy of this procedure. The following steps will help to verify proper operation.

During the first few months of photometer operation, perform the preparation procedure frequently, and record all quantitative results and indications in a chronological record, in the form of a table or graph. When the performance and stability record of the photometer is established, you may be able to perform the procedure less frequently.

1. *Instruction manual*: Carry out all setup and adjustment procedures or checks as described in the operation or instruction manual associated with the photometer.

2. *System check*: Check the photometer system for integrity, leaks, cleanliness, proper flowrates, etc. Service or replace filters and zero air scrubbers or other consumable materials, as necessary.

3. *Linearity*: Verify that the photometer manufacturer has adequately established that the linearity error of the photometer is less than 3%. Otherwise test the linearity by dilution as follows: Generate and measure an O_3 concentration near the upper range limit of the system (0.5 or 1.0 ppm), then accurately dilute that concentration with zero air and re assess it. Repeat at several different dilution ratios. Compare the analysis of the original concentration with the analysis of the diluted concentration divided by the dilution ratio, as follows.

$$\mathbf{E = \frac{A_1 - A_2 / R}{A_1} * 100\%}$$

Equation 3-3

where:

E = linearity error, percent
A_1 = analysis of the original concentration
A_2 = analysis of the diluted concentration
R = dilution ratio = flow of original concentration divided by the total flow.

The linearity error must be less than 5%. Since the accuracy of the measured flowrates will affect the linearity error as measured this way, the test is not necessarily conclusive. Additional information on verifying linearity is contained in Calibration Reference 1.

4. *Intercomparison:* When possible, the photometer should be occasionally intercompared, either directly or via transfer standards, with calibration photometers used by other agencies or laboratories.

5. *Ozone losses:* Some portion of the O_3 may be lost upon contact with the photometer cell walls and gas handling components. The magnitude of this loss must be determined and used to correct the calculated O_3 concentration. This loss must not exceed 5%. Some guidelines for quantitatively determining this loss are discussed in Calibration Reference 1.

3.2.1.5.3 Certification of Transfer Standards

A transfer standard is certified by relating the output of the transfer standard to one or more ozone standards as determined according to section **Error! Reference source not found.** above. The exact procedure varies depending on the nature and design of the transfer standard. Consult Calibration Reference 2 for guidance.

3.2.1.5.4 Calibration of EC9811 Ozone Analyzer

The analyzer may be calibrated using ozone concentration standards obtained directly as discussed in section **Error! Reference source not found.** above, or by means of a certified ozone transfer standard.

1. Ensure that the analyzer is properly connected to the output recording device, as described in *Chapter 2, Installation and Operation*. If necessary, go to the `INTERFACE MENU`, select the `ANALOG OUTPUT MENU`, and select the appropriate settings for the recording device. Offsetting the analyzer's zero indication (`OFFSET` and `ZERO ADJUST`) to +5% of scale is recommended to facilitate observing negative zero drift. Exit and return to the initial screen.

2. Adjust the calibration system to deliver zero air to the output manifold. The total air flow must exceed the total demand of the analyzer(s) connected to the output manifold by 0.5 lpm to ensure that no ambient air is pulled into the manifold vent. Go to the `CALIBRATION MENU` and select `MANUAL` calibration and `MEASURE` mode. Press the <Exit> key and return to the initial screen.

3. Allow the analyzer to sample zero air until a stable response is obtained. Use the <Select> key to initiate the query, `START MANUAL CALIBRATION?` Use the Up or Down arrow key to choose `ZERO` and confirm by pressing the <Enter> key. The cursor appears in the `ZERO CALIBRATION` field. Use the <Select> key to select the digit to be changed and the Up or Down arrow keys to change the value.

Note

The zero calibration value may be set to any value between -0.009 and +0.009 ppm. However, any zero offset will be reflected in both the display ozone reading and the output recording device. *Set the zero calibration value first, before setting the span value.*

When the value is set, press the <Enter> key to confirm the value. Record the final, stable zero air response and press the <Exit> key twice to return to the initial screen.

4. Generate an O_3 concentration standard of approximately 80% of the analyzer's full scale range. Allow the analyzer to sample this O_3 concentration until a stable response is obtained. Use the <Select> key to initiate the query, `START MANUAL CALIBRATION?` Choose `SPAN` and confirm by pressing the <Enter> key. The cursor now appears in the `SPAN CALIBRATION` field. Use the <Select> and Up and Down arrow keys to input the O_3 span point concentration. Use the <Select> key to select the digit to be changed and the Up or Down arrow key to change the value. Press <Enter> to confirm the input value. Record the O_3 concentration and the analyzer's stable response.

5. Move the cursor to the `INSTRUMENT GAIN` field. Check to see that the displayed value is within the recommended range (0.75 to 1.25), and record for future reference. Press <Enter> to return to the initial screen.

3.2.1.5.5 Option 1

The various O_3 concentrations required when generating ozone to be used in the calibration procedure may be obtained by dilution of the O_3 concentrations generated in step 4 above. With this option, accurate flow measurements are required. The dynamic calibration system may be modified as shown in Figure 3-2 to allow for dilution air to be metered in downstream of the O_3 generator. A mixing chamber between the ozone generator and the output manifold is also required. The flowrate through the O_3 generator (F_O) and the dilution air flowrate (F_D) are measured with a reliable flow or volume standard traceable to NIST. Each O_3 concentration generated by dilution is calculated from:

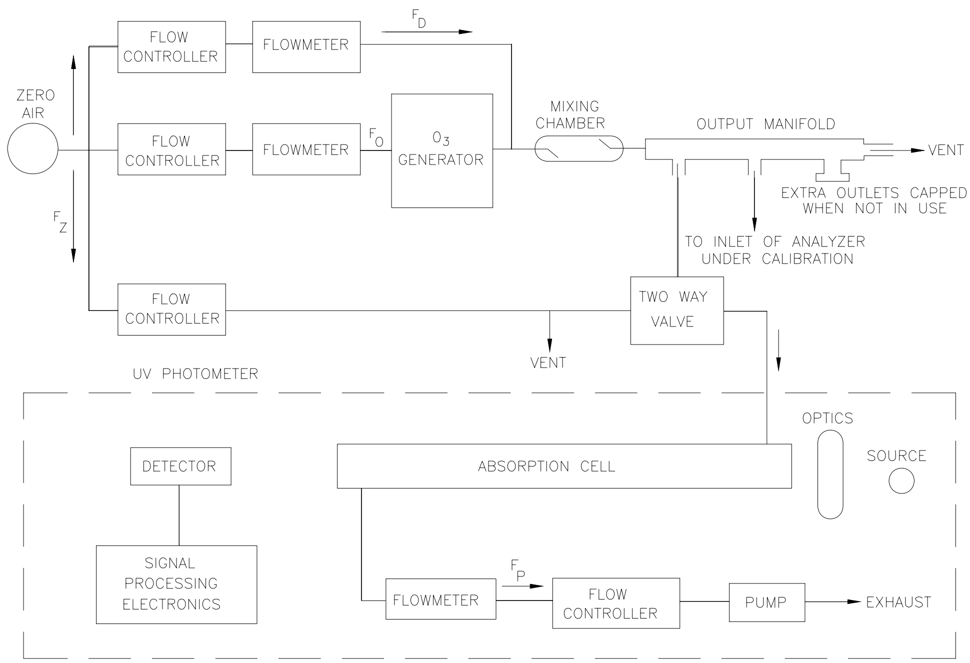

Figure 3-2. Typical UV Photometric Calibration System (Option 1)

$$(O_3)'_{OUT} = (O_3)_{OUT} * \left(\frac{F_O}{F_O + F_D}\right)$$

Equation 3-4

where:

$(O_3)'_{OUT}$ = diluted O_3 concentration, ppm
F_O = flow rate through the O_3 generator, lpm
F_D = diluent air flow rate, lpm.

3.2.2 <u>Procedure For 5 Point Multipoint Calibration with external span</u>

3.2.2.1 Principle

Multipoint calibration consists of five (5) concentrations across the instruments operating range. The concentration levels are derived to determine the accuracy between calculated and expected values of the analyzer using a simple Excel spreadsheet. This procedure is only to be carried out on a 6 monthly basis or after the analyzer has had major repair, as per AS3580.6.1. and U.S.EPA Standards.

3.2.2.2 Apparatus

The apparatus discussed in section 3.2.1.3 above should be used to perform the Multipoint Calibration. In addition to this the following may also be used:

- NATA/NIST Traceable Temperature sensor
- NATA/NIST Traceable Barometric sensor
- Laptop Computer with Microsoft Excel.
- Bios DryCal flow calibrator
- Ecotech portable zero air source
- Ecotech O3 Photometer Calibrator

3.2.2.3 Procedure

1. Connect the flowmeter to the analyzer sample inlet and measure the sample flow reading. Record the average of flow readings and ensure that it meets the specifications of section 1.1.9 ±1%.

2. Setup the O3 photometer to obtain an O_3 gas concentration of 80% of the EC9811's operating range as discussed in section 3.2.1.5. Perform a manual calibration at this point.

Note

Record the analyzer instruments gains before and after the calibration.

4. Setup the O3 photometer to obtain Zero air, and ensure that the EC9811 has a zero reading lower than ±5ppb

Note

Perform a background otherwise and repeat step 2.

Note

Do not make any further span adjustments during the remainder of the calibration. Record the new span values in the spreadsheet.

5. Generate several additional O_3 concentrations (at least 5 others are recommended) over the analyzer's full scale range by adjusting the O_3 source or by referring to option 1 in 3.2.1.5.5. For each O_3 concentration standard, record the concentration and the corresponding analyzer response.

Note

The recommended multipoint span concentrations are: 20, 40, 60, 80, 100% of Full Scale @ minimum of 1LPM.

6. Record the concentration and the analyzer's response for each concentration after a stabilization period of 15 minutes per point.

7. Plot the analyzer responses versus the corresponding O_3 concentrations and draw the analyzer's calibration curve or calculate the appropriate response factor.

3.2.2.4 Calculating Multipoint Calibration Results

3.2.2.4.1 Manual Calculations (Used when Excel not available)

Determine the percent difference between instrument response and the calculated concentration using the following equation.

$$\frac{\text{Instrument Response - Calculated Concentration}}{\text{Calculated Concentration}} \times 100 = \text{Percent Difference}$$

If the difference between values is less than 1% then the instrument is within specifications. Otherwise a Leak Check and or service is required.

3.2.2.4.2 Using Microsoft Excel to Display Multipoint Calibration Results

Produce a X Y scatter plot of the data with the calculated O_3 concentration in the X axis and the instruments response concentration in the Y axis. Right mouse click on any data point to bring up the data formatting menu shown in Figure 3-3.

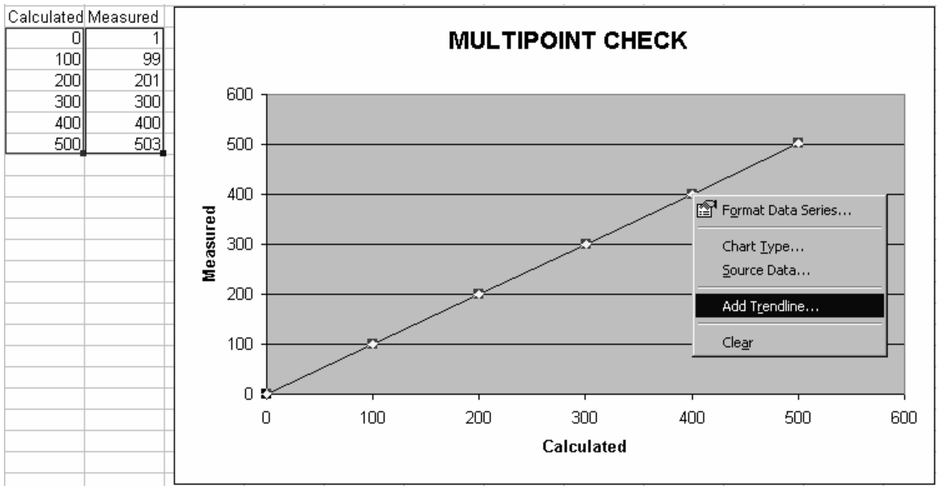

Figure 3-3. Data point formatting menu with Excel chart

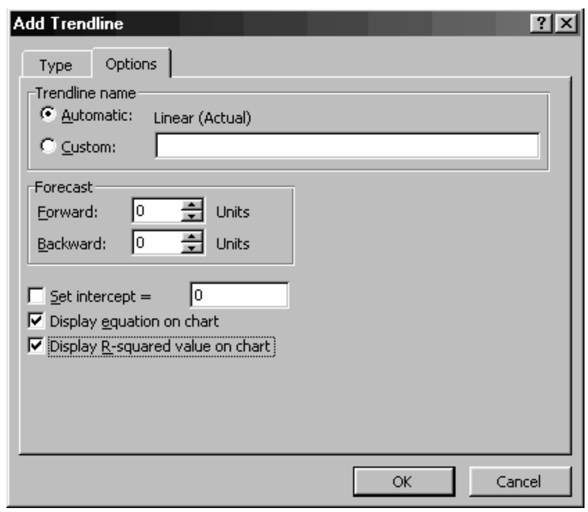

Figure 3-4. Trendline menu in Excel

Select Add Trendline (Linear should be selected under the TYPE tab) and enter Options. Select the tick boxes that will display the equation and the R^2 value on the chart (Figure 3-4). Clicking OK will return to the chart and display the required data necessary to determine the effectiveness of the calibration.

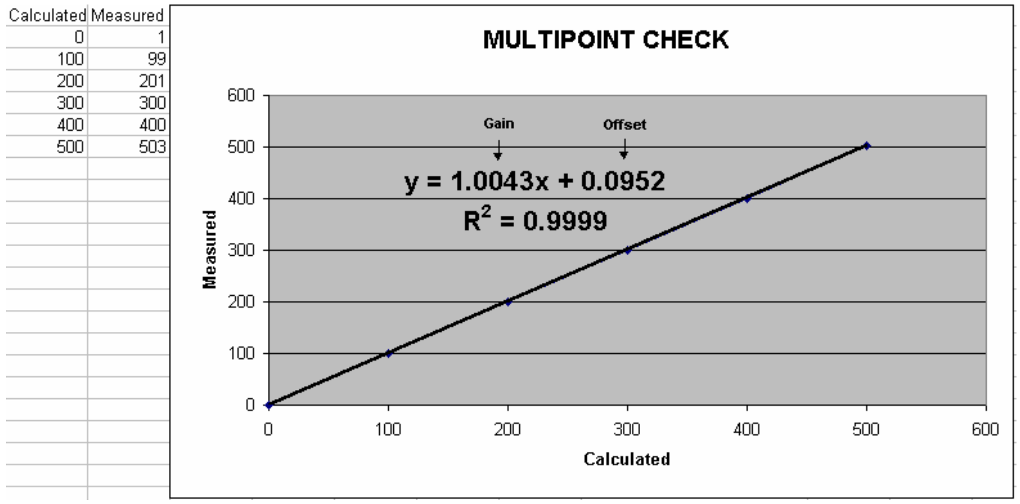

Figure 3-5. Excel chart showing equation with required criteria

Using the linear regression equation y = mx + b from the chart where:

y = instrument concentration (ppm)
x = calculated value (ppm)
m = gradient (gain)
b = y-intercept (offset)

Note

The R^2 value is a correlation factor that relates to the similarity between the data points. Values close to 1 indicate a linear relationship, whereas a value close to zero will show a random distribution of data.

The calibration is accepted if:

- The gradient (m) falls between 0.98 and 1.02
- The intercept (b) lies between ±0.3.
- The correlation (R^2) is greater than 0.9995

Reject the calibration if the above criteria are not met. If the calibration fails perform a leak check, check scrubbers and consult the EC9811 service manual for troubleshooting assistance.

3.3 Calibration Requirements When Over-Ranging Is Employed

If you are utilizing the over-ranging feature of the analog outputs, use the following steps in conjunction with the procedure in section 0 to calibrate the instrument.

1. Choose the desired upper range limit for the normal monitoring range (`RANGE`).
2. Choose and set the desired upper range limit for the higher, over-range (`OVER-RANGE`). A value between 2 and 5 times the `RANGE` value is recommended.
3. Disable over-ranging by setting `OVER-RANGING` to `DISABLED`.
4. Set the `RANGE` value equal to the `OVER-RANGE` value.
5. Adjust the zero and span as described in section 3.2.1.5.
6. Generate several concentration standards and determine the slope, intercept, and linearity of the higher `OVER-RANGE`.
7. Reset `RANGE` to the normal monitoring range.
8. Generate several concentration standards and determine the slope, intercept, and linearity of the `RANGE`.

Note

Once zero and span have been set on the higher range, no further adjustments should be made on the lower, normal monitoring range.

9. Re-enable over-ranging by setting `OVER-RANGING` to `ENABLED`.

3.4 Automatic Zero and Span Checks (AZS)

Over time, the calibration of nearly any sensitive instrument may change slightly (drift), causing error in the measured values. Accordingly, good quality assurance practice requires that the calibration of the EC9811 be checked periodically and, if necessary, that the instrument's zero and span be adjusted to restore accurate calibration.

Section 12 of the Q.A. Handbook for Air Pollution Systems[1] defines two types of calibration checks: a Level 1 zero and span calibration check is an authoritative assessment of the analyzer's calibration, using an O_3 span gas standard that is certified traceable to a UV photometer (primary standard) SRM or CRM. The results of a Level 1 check can be used to adjust the analyzer's zero and span to restore accurate calibration. A Level 2 zero and span check is an informal calibration check, often with an uncertified O_3 standard, used to monitor the day-to-day relative readings of the analyzer. The results of a Level 2 check ***must not*** be used to adjust the analyzer's calibration, but may indicate the immediate need for a more authoritative Level 1 calibration check.

3.4.1 Setting AZS Span Points

When using the internal ozone generator for either zero-span checks or as a calibration source, the instrument can be programmed to step through one to five ozone concentrations in addition to zero air. The sequence is as follows: zero air first, followed by span point #1, span point #2, and so on. A span point selected as 0.000 ppm is treated in a special way. A 0.000 ppm span point is used to indicate the sequence end. The span point preceding 0.000 ppm will be the last output before the analyzer returns to sample gas. For example, suppose you want a two point cycle: a zero point and one span point of 0.400 ppm. Select span point #1 as 0.400 ppm and span point #2 as 0.000 ppm.

It is not necessary to program a point of 0.000 unless you wish to limit the number of points. Also the points must be input in order of decreasing (or equal) concentration. If you enter point #1 as a smaller concentration than the following points, all of the following points will be set to that concentration.

When span compensation is `ENABLED` from the `CALIBRATION MENU`, span point #1 is used as the correct ozone value for span gas. Refer to *Chapter 3*.

To set the AZS span points enter the `CALIBRATION MENU`. From the `CALIBRATION MENU` select the `O3 GENERATOR MENU`. From the `O3 GENERATOR MENU` select `MULTIPOINT MENU` and `POINT #1` within it. Press the <Select> key and then use the increment or decrement keys to change the output. Press the <Enter> key when the desired value is reached. Repeat this procedure for the remaining points. From the previous menu (Calibration:timed) set the time per cycle. Select `CYCLE TIME`. Press the <Select> key and the use the increment or decrement keys to change the cycle time. Press the <Enter> key when the desired value is reached.

3.4.2 Description of AZS Process

The instrument will initiate a full zero/span cycle starting at the prescribed hour. The valve to admit zero air will be opened and the sample valve closed. The instrument will allow the cell to fill with the gas for 10 minutes. During the first 2 minutes, no data is taken but the display and outputs are updated with the actual instrument reading. During the last 8 minutes, the instrument takes readings every second and averages them to yield a value to be stored as the zero calibration value. This value is for user reference only, and is never used by the analyzer to compensate readings.

At the end of 10 minutes, the zero air valve is closed and the span gas valve is opened, admitting the span gas for 10 minutes. During the first 2 minutes, no data is taken but the display and outputs are updated with the actual instrument readings. During the last 8 minutes, the instrument takes readings every second and averages them to yield a value to be stored as the span calibration value. If `SPAN COMP` is set to `ENABLED`, this is the value which is used to correct all subsequent readings to the calibration.

The zero air valve is switched on for 2 minutes to purge the cell of span gas. The sample valve is then activated for an ***additional*** 2 minutes to allow the cell to come back to monitoring concentration.

At the end of 24 minutes, monitoring resumes including putting data in the average, etc. (The data averages are ***not*** updated during zero/span check.)

3.5 Calibration References

1. *Technical Assistance Document for the Calibration of Ambient Ozone Monitors*, EPA-600/4-79-057, U.S. Environmental Protection Agency, Environmental Monitoring Systems Laboratory, Research Triangle Park, NC 27711, 1979.

2. *Transfer Standards for Calibration of Air Monitoring Analyzers for Ozone*, EPA-600/4-79-056, U.S. Environmental Protection Agency, Environmental Monitoring Systems Laboratory, Research Triangle Park, NC 27711,1979.

3. Quality Assurance Handbook for Air Pollution Measurement Systems, Volume II, Part 1 EPA-454/R-98-004, U.S. Environmental Protection Agency, Environmental Monitoring Systems Laboratory, Research Triangle Park, NC 27711, 1998.

4.0 Digital Communication

The EC9811 analyzer has three methods of digital communication, serial communication using RS232 signals, Universal Serial Bus (USB), or discrete control over the 50-pin I/O. Discrete control is limited to lines which either command a specific operation or indicate an operation is in progress. Serial communication allows access to the menu structure using a terminal and also includes a library of other specific operations. USB provides a simple way to monitor the current state of the analyzer, and download data that has been logged to the internal FLASH memory.

4.1 Discrete Control

Two control inputs are available through the 50-pin I/O connector. They are `DOZERO` and `DOSPAN`. These inputs will place the analyzer in either Zero mode or Span mode, respectively, the analyzer will remain in the selected mode while the input is active. When these inputs are made active the analyzer will actuate the valve drivers selected in the `CALIBRATION MENU` for `CALIBRATION INTERNAL/EXTERNAL`. All other discrete connections are status outputs from the analyzer.

4.1.1 50-Pin I/O Functional Specification

The 50-pin connector on the back of the instrument will have functions assigned to pins per the following table (Note 1):

Signal Name	Number	Function
IOUT3	2	Analog current output #3 (*Note 2*)
DOZERO	5	External input to put the instrument into the zero mode.
DOSPAN	6	External input to put the instrument into the span mode.
OVERANGE1	7	Active output indicates that analog output #1 has gone into over-range.
OVERANGE2	8	Active output indicates that analog output #2 has gone into over-range.
OVERANGE3	9	Active output indicates that analog output #3 has gone into over-range.
ANAIN1	10	Unused analog input #1.
ANAIN2	11	Unused analog input #2.
IOUT1	15	Analog current output #1 (*Note 3*).
IOUT2	17	Analog current output #2 (*Note 4*).

Signal Name	Number	Function
SPANCYL	18	Active output indicates that the instrument is in the Span or Span Fill mode.
OUTSERV	19	Active output indicates that the Out of Service switch is in the out-of-service position.
ZEROON	20	Active output indicates that the instrument is in the Zero mode.
SPANON	21	Active output indicates that the instrument is in the Span mode.
ZEROCYL	22	Active output indicates that the instrument is in the Zero or Zero Fill mode.
IZSON	23	Active output indicates that Internal Zero/Span has been selected (*Note 5*).
STARTUP	24	Active output indicates that the startup sequence is active.
PPM/MET	25	Active output indicates that the instrument is in mg/M^3.
USERID1	26	USER ID byte bit 1. Used in conjunction with the PINID serial command.
USERID2	27	USER ID byte bit 2. Used in conjunction with the PINID command.
USERID3	28	USER ID byte bit 3. Used in conjunction with the PINID command.
USERID4	29	USER ID byte bit 4. Used in conjunction with the PINID command.
USERID5	30	USER ID byte bit 5. Used in conjunction with the PINID command.
USERID6	31	USER ID byte bit 6. Used in conjunction with the PINID command.
USERID7	32	USER ID byte bit 7. Used in conjunction with the PINID command.
USERID8	33	USER ID byte bit 8. Used in conjunction with the PINID command.
FLOWFAIL	35	Active output indicates that the sample flow is less than 0.1 slpm.
LAMPFAIL	36	Active output indicates that the lamp has failed (*Note 6*).

Signal Name	Number	Function
CHOPFAIL	37	Active output indicates that the chopper has failed (*Note 7*).
SPAN_OOR	38	Active output indicates that the span ratio is out of range (*Note 8*).
SPAREOC1	39	Spare open collector output #1
HEATERFAIL	40	Active output indicates that a system heater has failed (*Note 9*).
SPAREOC2	41	Spare open collector output #2
OPTEST	42	Active output indicates that the system has been put into the Optic Test mode.
ELECTST	43	Active output indicates that the system has been put into the Electric Test mode.
PS-FAIL	44	Active output indicates that the 12-volt supply voltage has gone out of range (*Note 10*).
HV-FAIL	45	Active output indicates that the PMT high voltage supply has failed (*Note 11*).
SYSFAIL	46	The sum of all failures in the instrument (*Note 12*).
POWER_ON	47	Active output indicates that power to the analyzer is on.
SPDRVR1	48	Spare Driver #1
AGND	1,14,16	Ground reference for analog outputs.
DGND	12	
PGND	13,34	Ground reference for digital inputs or outputs.
CGND	49	Chassis ground.
+12V	50	+12V (50 mA maximum).
	3,4	Unused.

4.1.1.1 Notes

1. All outputs are open collector active LOW.
2. Analog output #3 is unused.
3. Analog output #1 is instantaneous gas concentration.
4. Analog output #2 is unused.

5. Valid for the EC9811.

6. An error is flagged if the lamp current is below 5 mA or above 15 mA.

7. Not valid.

8. Span ratio out of range is defined as calibration gain changing below 75% or above 125% gain change.

9. Unused.

10. An error is flagged if the 12-volt supply voltage is below 11.1 volts or greater than 14.3 volts.

11. Unused.

12. This signal is the logical OR of `FLOWFAIL`, `LAMPFAIL`, `CHOPFAIL`, `CVFAIL`, `COOLERFAIL`, `HEATERFAIL`, `REFFAIL`, `PS-FAIL`, and `HV-FAIL`.

4.1.2 50-Pin I/O Inputs

The `DOZERO` and `DOSPAN` controls (pins 5 and 6) are TTL compatible inputs with internal 4.7K ohm pull-up resistors. These inputs are active low and can be driven to ground by dry contact relays, open collectors or TTL compatible ICs. The logic levels for control inputs are standard TTL levels. They are:

low < 0.8 V 2 V < **high** < 5 V

4.1.3 50-Pin I/O Outputs

The status outputs are active low ULN2003 open collector Darlingtons. The status outputs can be used to drive relays or, with the use of external pull-up resistors, as a voltage indication of on/off conditions. The internal +12 V (pin 50) or an external power supply may used as the relay or indicator power source.

Current through the outputs should be kept as low as possible, ideally around 1 mA. If an external supply is used it should be less than 50 VDC, and the current sunk by each output should be <50 mA. ***If the internal +12 V supply is used the total current drawn must be kept to less than 50 mA or damage to the analyzer will result.***

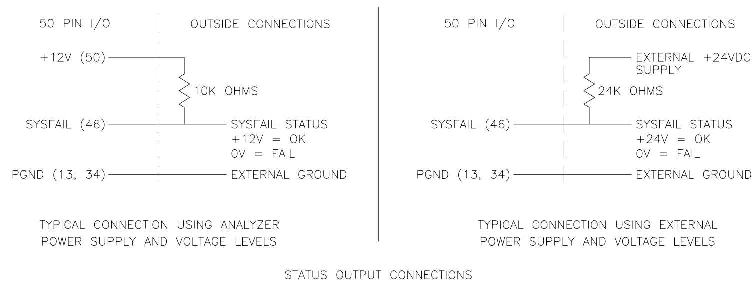

Figure 4-1. Status Output Connections

4.2 Serial Control

Two modes of operation are available using the serial interface. These modes are Terminal and Command. In Command mode, a library of commands becomes available. These are listed at the end of this chapter. In Terminal mode the instrument communication is through the analyzer menu structure.

4.2.1 Serial Connections

The EC9811 has two tristate RS232 ports on the rear of the analyzer. The tristate RS232 causes all instruments not addressed to turn off their transmission capability until the next activation command is received.

Communication among devices is defined in terms of Data Terminal Equipment (DTE) and Data Communication Equipment (DCE) per the EIA standard, RS232.

Communication among devices is defined in terms of Data Terminal Equipment (DTE) and Data Communication Equipment (DCE) per the EIA standard, RS232.

4.2.2 Cable Connections

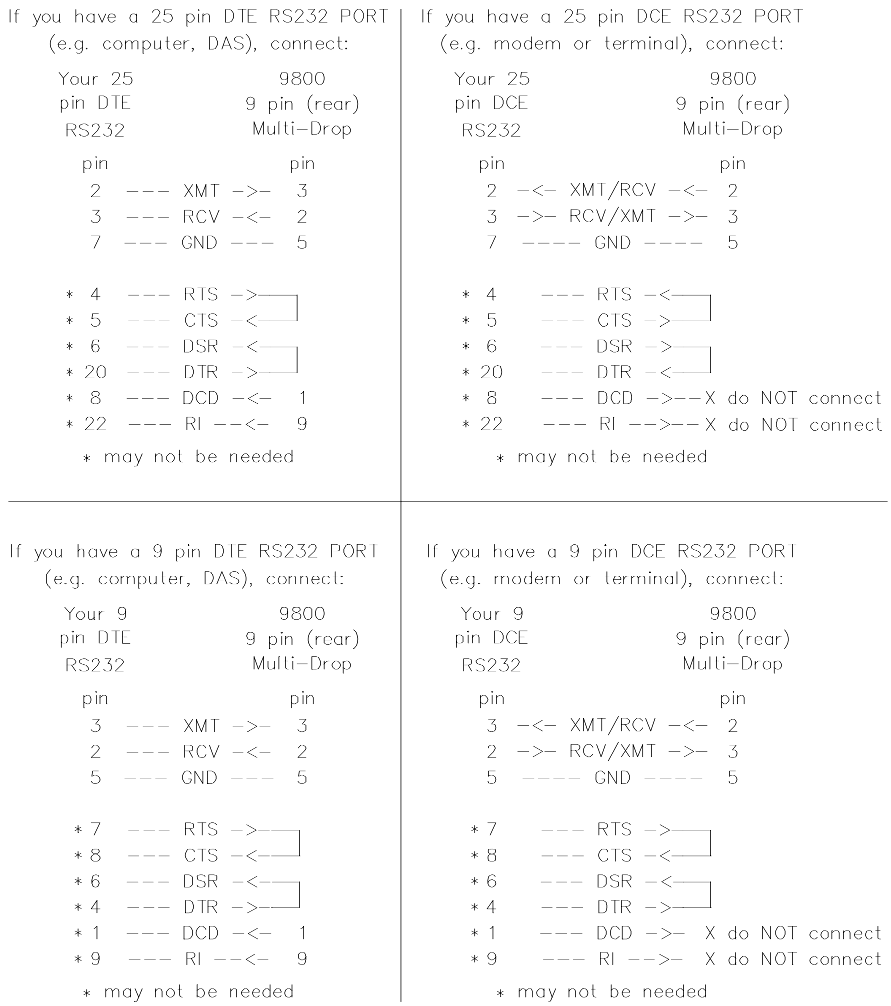

Figure 4-2. Serial Interface Connection Diagrams

4.3 Serial Terminal Control

If the EC9811 is operated in the Terminal mode, a terminal connected to one of the RS232 ports will produce the same results as pressing the six front panel keys with the exception that the same characters sent to the LCD instrument display will also be sent to the terminal. The terminal keys will map into the front panel keys as follows:

Key	Key Label	Function
Enter	ENTER	enter
7	HOME	exit
9	PG UP	page up
8	UP ARROW	up
2	DOWN ARROW	down
6	RT. ARROW	select

The ***Terminal mode must not be used*** if the multidrop port is *daisy-chained* to other instruments.

The mode may be changed using the INTERFACE MENU through the INTERFACE MODE menu selection. When in Terminal mode, this choice may be made manually, or through the serial port. The mode may be changed from Command to Terminal through the serial port using the REMOTE command. For information on required communication parameters refer to the REMOTE command in section 4.4.5.2.

4.4 Serial Command Control

When in the Command mode, two command sets are available. These are the 9800 command set and the Bavarian Network command set. The 9800 command set is recommended for general use. The Bavarian Network command set was set to support a specialized network in Bavaria. Additionally, three communication protocols are provided to allow the user to specify the different handshaking based on their requirements.

4.4.1 9800 Command Set Format

All 9800 commands follow the command format as specified in this section. The specific 9800 commands and their functions are described in section 4.4.5.

9800 Command Format: <CCCCCCCCC>,<III>,<D>,<NN>,<PPPPPPPPPPPP><T>

Where:

<CCCCCCCCC>	= command in ASCII, 1 to 9 characters
<III>	= three-digit instrument ID in ASCII format
<D>	= single digit data type in ASCII (optional)
<NN>	= number of parameters in ASCII, 1 to 9 (optional)

`<PPPPPPPPPPPP>` = parameter in ASCII, 1 to 15 characters (optional)

`<T>` = termination `<CR>` or `<LF>`

For commands that do not have parameters the format is the subset :

```
<CCCCCCCCC>,<III><T>
```

For commands with multiple parameters, the parameters are separated by the comma delimiter and the termination character follows the last parameter :

```
<CCCCCCCCC>, <III>,<D>,<NN>,<PPPPPPPPPPPP>,<PPPPPPPPPPPP><T>
```

4.4.1.1 Examples

An 9800 command with no parameters would be the concentration request, DCONC, used here with an instrument I.D. of 001.

```
DCONC, 001<CR>
```

If no device I.D. is programmed, the I.D. ??? can be used to address any analyzer connected to the RS232 line. An example of this is shown here.

```
DCONC,???<CR>
```

Caution

Using this I.D. will result in a response from *all* analyzers connected to the serial line.

An example of an 9800 command with a parameter would be the trend dump command, DTREND, used here with an instrument I.D. of 134.

```
DTREND,134,1,1,GASAVG<CR>
```

4.4.2 Bavarian Network Command Set Format

All Bavarian Network commands follow the command format as specified in this section. The specific Bavarian commands and their function are described in section 4.4.5.1.

Bavarian Network Command Format: `<STX><TEXT><ETX><BCC1><BCC2>`

Where:

`<STX>` = ASCII Start Of Transmission = 02 hex

`<TEXT>` = ASCII text maximum length of 120 characters

`<ETX>` = ASCII end of transmission = 03 hex

`<BCC1>` = ASCII representation of block check value MSB

`<BCC2>` = ASCII representation of block check value LSB.

The block check algorithm begins with 00 Hex and exclusive-OR each ASCII character from `<STX>` to `<ETX>` inclusive. This block check value is then converted to ASCII format and sent after the `<ETX>` character.

4.4.2.1 Examples

The following is an example of a valid Bavarian data request for an instrument that has an I.D. of 97:

```
<STX>DA097<EXT>3A
```

The block check calculation is best shown by the following table:

Character	Hex Value	Binary	Block Check
<STX>	02	0000 0010	0000 0010
D	44	0100 0100	0100 0110
A	41	0100 0001	0000 0111
0	30	0011 0000	0011 0111
9	39	0011 1001	0000 1110
7	37	0011 0111	0011 1001
<ETX>	03	0000 0011	0011 1010

The binary value 0011 1010 corresponds to the hex value 3A. This value in ASCII forms the last two characters of the data request message. Please note that the I.D. of 97 is sent as the sequence 097. All I.D. strings must have 3 digits and the user should always pad with ASCII zero characters.

This is an example of a valid command to put the unit in the manual span mode if the instrument has an I.D. of 843:

```
<STX>ST843 K<ETX>52
```

The block check operation is best shown with the following table:

Character	Hex Value	Binary	Block Check
<STX>	02	0000 0010	0000 0010
S	53	0101 0011	0101 0001
T	54	0101 0100	0000 0101
8	38	0011 1000	0011 1101
4	34	0011 0100	0000 1001
3	33	0011 0011	0011 1010
	20	0010 0000	0001 1010
K	4B	0100 1011	0101 0001
<ETX>	03	0000 0011	0101 0010

The binary block check value is 0101 0010 which is the hex value 52 as shown at the end of the command string.

4.4.3 Protocol Definition and Selection

There are three protocol selections available for the EC9811 via the `INTERFACE MENU`. These are provided so the user may select the appropriate protocol for their desired application. The first protocol designated original should be used when upgrading software in analyzers that are already in serial networks. The original protocol is provided for back-compatibility as it completely duplicates the protocol already in the field. The second protocol provided is Bavarian. The Bavarian protocol should be used with the Bavarian Network Command Set for any Bavarian network applications. Note specifying the Bavarian protocol still allows the user to access the 9800 command set. The third protocol provided is the enhanced protocol. The enhanced protocol provides a more robust handshaking environment as specified in section 4.4.3.9.

4.4.3.1 Original Protocol

This protocol is provided for back compatibility with pervious versions (before Version 2.05) of 9800B software. There are a number of idiosyncrasies in the original protocol that are preserved to allow existing applications to use upgraded software without modifying their interface.

4.4.3.2 Command Acknowledgment

- For 9800 style commands that provide a data response, the data response itself is the acknowledgment.
- For 9800 style commands that do not provide a data response, the acknowledgment is the returned ASCII string O.K.
- For Bavarian Network commands, no acknowledgment is returned.

4.4.3.3 Negative Command Acknowledgment

- For 9800 commands, if a valid Instrument I.D. is received with an invalid command string the message INVALID COMMAND is sent.
- For Bavarian Network commands, no negative command acknowledgment is sent.

4.4.3.4 Original Protocol Idiosyncrasies

- Block check characters are not checked on Bavarian commands.
- The <STX> character is ignored.
- The <ETX> character is a valid termination for Bavarian commands even in the absence of a <STX> character.
- The DA command will function without a serial I.D.
- The string DA<CR> is a valid command.
- The zero padding on the response to the DA command contains six ASCII zeros instead of the standard ten ASCII zeros.
- The data type must be sent on 9800 style commands but it is not checked against the actual parameters.
- The number of data parameters must be sent on 9800 style commands but it is not checked against the actual parameters.

4.4.3.5 Bavarian Protocol

This protocol is intended to correct the idiosyncrasies in the original protocol, as noted in section 4.4.3.1, as they apply to the Bavarian network. This protocol selection strictly applies the Bavarian network protocol to all commands.

4.4.3.6 Command Acknowledgment

- For 9800 style commands that provide a data response, the response itself is the acknowledgment.
- For 9800 style commands that do not provide a data response, no acknowledgment is returned.
- For Bavarian Network commands no acknowledgment is returned.

4.4.3.7 Negative Acknowledgment

For 9800 commands and for Bavarian Network commands, no negative command acknowledgment is sent.

4.4.3.8 Bavarian Protocol Idiosyncrasies

- The string `DA<CR>` is a valid command.
- The `DA` command will function without an I.D.
- The data type must be sent on 9800 style commands but it is not checked against the actual parameters.
- The number of data parameters must be sent on 9800 style commands but it is not checked against the actual parameters.

4.4.3.9 Enhanced Protocol

This protocol is provided to allow easier and more robust interfacing between the EC9811 and a computer. Every command with a valid I.D. will respond with either `<ACK>` or `<NAK>`. Bavarian commands also respond with either `<ACK>` or `<NAK>`, although this is outside the normal Bavarian Network protocol.

Note

This protocol selection ***should not*** be used in Bavarian network applications.

4.4.3.10 Command Acknowledgment

- For all valid 9800 and Bavarian commands, an ASCII `<ACK>` character is returned.
- For commands that request data, the data will be sent after the `<ACK>` character.

4.4.3.11 Negative Command Acknowledgment

- Any detected error will respond with the ASCII `<NAK>` character followed by an error message.
- Due to the constraints of the multidrop environment the unit I.D. must be received intact for a `<NAK>` response to be sent.
- An invalid command will cause the response `<NAK>UNKNOWN COMMAND<CR><LF>`.
- An invalid command format will cause the response `<NAK> BAD COMMAND FORMAT<CR><LF>`.
- A bad block check on a Bavarian command will cause the response `<NAK>BAD BLOCK CHECK<CR><LF>.`
- If a Bavarian command is sent without a set of matching `<STX>` and `<ETX>` characters it will cause the response `<NAK>BAD STX ETX PAIR<CR><LF>.`

4.4.3.12 Enhanced Protocol Idiosyncrasies

- The string `DA<CR>` is a valid command.
- The `DA` command will function without an I.D.
- The data type must be sent on 9800 style commands but it is not checked against the actual parameters.
- The number of data parameters must be sent on 9800 style commands, but it is not checked against the actual parameters.

4.4.4 Establishing Communications

The first step in establishing communications with the EC9811 is to connect a computer or terminal to one of the instrument's RS232 serial ports as specified in section 4.2.1. The default serial configuration for either serial port is 2400,8,N,1 (2400 baud, 8 bits, no parity, and one stop bit). If you need to change the serial configuration from the default, use the `INTERFACE MENU`.

Once the instrument has been connected, place the instrument in Command mode by entering the `INTERFACE MENU` via the front panel and selecting `COMMAND` as the `INTERFACE MODE`. Then, using a communication package such as HYPER TERMINAL establish communications with the instrument.

To test the communication connection type `DCOMM,???` and press the Enter key. The complete alphanumeric set recognized by the EC9811 should be displayed on the computer followed by `END OF MULTI-DROP PORT TEST`.

4.4.4.1 Multidrop Communications

The term multidrop is an idiomatic contraction of the term *multiple drops*. It is a term used to denote a parallel connection of multiple RS232 transceivers. In this scheme, all receivers share the same receive line that comes from a single master. Likewise, these multiple transceivers share the same transmit line which goes back to a single master. This strategy is a method of attaching multiple slave units (instruments) to a single master (computer).

In the multidrop strategy, each unit is given an identification number (I.D.) which is sent with each command from the master. When a unit recognizes its unique I.D., it processes the command and responds appropriately. The integrity of this method relies on a strict enforcement of the following rules:

- Each unit in the multidrop must have a unique I.D. that is programmed into the unit before attaching to the network.
- After a command is sent by the master, the master must then wait for a response. Only after a reasonable time-out period should the master send another command.

- The multidrop master must include a time-out mechanism in the event that the I.D. sent with the command is garbled. Clearly a `<NAK>` on a bad I.D. is not possible for the units in this scheme.
- The master must correlate the unit response with I.D. sent in the command to know which unit in the multidrop is responding.
- Any command that would cause two units on the multidrop to respond at the same time must be avoided. If more than one unit attempts to respond on the common transmit line, a "data collision" will occur destroying both messages.

4.4.4.2 Programming Instrument Identifiers

Note

The Instrument ID. or Main Gas ID. can be set manually in the Instrument Menu or the Interface Menu. Refer to section 0 for further details. This is this preferred method.

The command `PI` is the only command used to set the Instrument I.D. for a given analyzer. The instrument can then be used standalone or as one of several multidrop (daisy-chain) analyzers. The format of this command is:

```
PIXXX YYY<CR>
```

Where:

`XXX` is the unit I.D.

`YYY` is the unit serial number for all other analyzers.

- The parameter `XXX` is the unit I.D. and must be three characters.
- Unit I.D.'s such as 1 should be programmed as `001`.
- The second parameter `YYY` is an *optional* serial number. This serial number is reported in the response to the Bavarian command but is otherwise unused.
- Only one analyzer at a time may be programmed with an I.D. Do not issue this command with multiple units on a multidrop.

4.4.4.3 Examples

- The string `PI001<CR>` will program a unit to the I.D. of 001.
- The string `PI001 123` will program a unit to the I.D. of 001 with a serial number of 123.
- The string `PI003 004` will program an EC9811 for a main ID of 003 and a secondary ID of 004.

4.4.5 Serial Command Sets

This section describes the Bavarian Network and 9800 command sets available on the EC9811 using the instrument Command mode.

4.4.5.1 Bavarian Protocol Command Set

Command
`{DA}`

Function
Bavarian network command that returns the current instantaneous concentration.

Format
`<STX>{DA}{<DEVICE I.D.>}<EXT><BCC1><BCC2>`

Device response
`<STX>{MD}{01}<SP><kkk><SP><+nnnn+ee><SP><ss><SP><ff><SP><mmm>`
`<SP>{000000[0000]}<SP><ETX><BCC1><BCC2>` where:

`kkk` = instrument ID
`+nnnn+ee` = instantaneous gas concentration in ppb or mg/m3
`ss` = status byte for both channels with the following bit map (positive logic):

`D0` = unused
`D1` = out of service
`D2` = instrument is in zero mode
`D3` = instrument is in span mode
`D4` = unused
`D5` = unused
`D6` = units (1=ppm, 0=mg/m3)
`D7` = unused.

`ff` = failure byte for both channels with the following bit map (positive logic):

`D0` = flow sensor failure
`D1` = instrument failure
`D2` = unused
`D3` = unused
`D4` = lamp failure
`D5` = temperature sensor failure
`D6` = unused
`D7` = unused.

`mmm =` instrument serial number
`[0000] =` 6 pad zeroes if the *original* or *enhanced* protocol is selected; 10 pad zeroes if the *Bavarian* protocol is selected
`BCC1 =` first byte of the block check calculation
`BCC2 =` second byte of the block check calculation.

The block check calculation is performed by clearing the block check number. An iterative `EXCLUSIVE OR` is performed on this number with every character in the message from the `<STX>` to the `<ETX>` (inclusive). The resulting value is converted into a two-digit pseudo hex number and sent out as `BCC1` and `BCC2`.

Command
`{PI}`

Function
Bavarian network command that sets the device ID and serial number of the analyzer.

Format
`<STX>{PI}{<DEVICE I.D.>}<SP>{<INSTRUMENT SERIAL NUMBER>}<ETC>`
`<BCC1><BCC2>`

Command
`{ST}`

Function
Bavarian network command that sets the instrument mode to zero, span, or measure.

Format
`<STX>{ST}{<DEVICE I.D.>}<SP>{COMMAND}<ETX><BCC1><BCC2>` where:

`COMMAND = M` for measure, `N` for zero, `K` for span, `S` to start background cycle.

4.4.5.2 9800 Command Set

Note

The `{TERMINATOR}` can be either a `<CR>` or `<LF>`.
The `{<DEVICE I.D.>}` = Three Digit Instrument I.D. in ASCII Format.

Command
`ABORT`

Function
Commands the addressed device to abort the current mode and return to the measure mode.

Format
`ABORT,{<DEVICE I.D.>}{TERMINATOR}`

Device response
<ACK> if the unit under test is able to perform the command, <NAK> if not.

Command
`DAVGC`

Function
Sends the current average concentration data to the serial port.

Format
`DAVGC,{<DEVICE I.D.>}{TERMINATOR}`

Device response
`{GAS}<SPACE>{STATUS WORD}<CR><LF>`

All numbers are in floating point format. See the `DCONC` command for an explanation of the `STATUS WORD`.

Command
`DAZSC`

Function
Commands the addressed device to perform a zero/span cycle. The system returns to the measure mode when the cycle has completed.

Format
`DAZSC,{<DEVICE I.D.>}{TERMINATOR}`

Device response
<ACK> if the unit under test is able to perform the command, <NAK> if not.

Command
`DCOMM`

Function
Performs a character dump to the serial output when called.

Format
`DCOMM,{<DEVICE I.D.>}{TERMINATOR}`

Device response
<ACK> if the unit under test performs a successful loopback, <NAK> if not.

Command
`DCONC`

Function
Sends the current instantaneous concentration data to the serial port.

Format
`DCONC,{<DEVICE I.D.>}{TERMINATOR}`

Device response
`{GAS}<SPACE>{STATUS WORD}<CR><LF>`

All numbers are in floating point format. The STATUS WORD indicates the instrument status in hex using the following format:

Bit 15 = SYSFAIL (MSB)
Bit 14 = FLOWFAIL
Bit 13 = LAMPFAIL
Bit 12 = CHOPFAIL
Bit 11 = CVFAIL
Bit 10 = COOLERFAIL
Bit 9 = HEATERFAIL
Bit 8 = REFFAIL
Bit 7 = PS-FAIL
Bit 6 = HV-FAIL
Bit 5 = OUT OF SERVICE
Bit 4 = instrument is in zero mode
Bit 3 = instrument is in span mode
Bit 2 = unused
Bit 1 = SET→PPM selected, CLEAR→MG/M3
Bit 0 = reserved (LSB).

Command
`DEVENT`

Function
Dumps the Event Log message buffer to the serial port.

Format
`DEVENT,{<DEVICE I.D.>}{TERMINATOR}`

Device response
`#XX {Message #XX<CR><LF>`
`OCCURRED AT HH:MM DD-MON-YY}<CR><LF>` where:

The last 100 messages are reported. `XX` is the index into the event log message buffer; 99 = oldest point (reported first), 0 = newest point.

The message field is null if no message exists.

Command
`DGAIN`

Function
Dumps instrument gain data and zero offset to the serial port.

Format
`DGAIN,{<DEVICE I.D.>}{TERMINATOR}`

Device response
`{INSTRUMENT GAIN},{ZERO OFFSET}<CR><LF>`

Command
`DINSTR`

Function
Dumps the `INSTRUMENT STATUS MENU` variables to the serial port.

Format
`DSTATUS,{<DEVICE I.D.>}{TERMINATOR}`

Device response
`{STAT1},{STAT2},{STAT3},{STAT4},{STAT5},{STAT6},{STAT7},{STAT8},`
`{STAT9},{STAT10},{STAT11},{STAT12}<CR><LF>` where:

`STAT1` = gas flow
`STAT2` = gas pressure
`STAT3` = reference voltage
`STAT4` = concentration voltage
`STAT5` = analog supply
`STAT6` = digital supply
`STAT7` = ground offset
`STAT8` = ozone generator flow

STAT9 = high voltage
STAT10 = lamp current, mA

STAT11 = ambient pressure
STAT12 = Startup flag (1 = in startup mode).

Startup flag and ground offset are integers; all other numbers are in floating point format. The status field is null if it does not apply to the analyzer type.

Command
DSPAN

Function
Commands the unit under test to enter the span mode and stay there.

Format
DSPAN,{<DEVICE I.D.>}{TERMINATOR}

Device response
<ACK> if the unit under test is able to perform the command, <NAK> if not.

Command
DTEMPS

Function
Dumps the SYSTEM TEMPERATURES MENU variables to the serial port.

Format
DTEMPS,{<DEVICE I.D.>}{TERMINATOR}

Device response
{TEMP1},{TEMP2},{TEMP3},{TEMP4},{TEMP5},{TEMP6},{TEMP7},{TEMP8},{TEMP9},{TEMP10}<CR><LF> where:

TEMP1 = cell temperature
TEMP2 = converter temperature
TEMP3 = chassis temperature
TEMP4 = flow temperature
TEMP5 = cooler temperature
TEMP6 = mirror temperature
TEMP7 = lamp temperature
TEMP8 = ozone generator lamp temperature
TEMP9 = IZS temperature

TEMP10 = manifold temperature.

All temperatures are in floating point format. The temperature field is null if it does not apply to the analyzer type.

Command
DTREND

Function
Dumps the requested trend buffer to the serial port.

Format
DTREND,{<DEVICE I.D.>},1,1,<PARAMETER>{TERMINATOR} where PARAMETER=

GASCONC for the last 100 instantaneous O3 readings
GASAVG for the last 100 averaged O3 readings
PRESSURE for the last 100 cell pressure readings
FLOW for the last 100 flow readings
REF for the last 100 reference readings
SPANCMP for the last 100 span compensation readings from AZS cycles
ZERO for the last 100 zero readings from AZS cycles

Device response
{INDEX}<SPACE>{PARAMETER}<CR><LF> where:

INDEX is the index into the trend buffer. 0 = oldest point. Formatted as an integer.
PARAMETER is the requested data in floating point format.

Command
DZERO

Function
Commands the unit under test to enter the zero mode and stay there.

Format
DZERO,{<DEVICE I.D.>}{TERMINATOR}

Device response
<ACK> if the unit under test is able to perform the command, <NAK> if not.

Command
PINID

Function
Programs the 50-pin device ID.

Format
`PINID,{<DEVICE I.D.>},1,1,BBBBBBBB{TERMINATOR}` where:

`BBBBBBBB` is the desired bit pattern in binary format to be programmed into the device ID. The most significant bit is on the left, least significant bit on the right (for example, `10100101` would correspond to a device ID of `A5` hex or `165` decimal).

Device response
`<ACK>`

Command
`REMOTE`

Function
Puts the instrument in the VT-100 compatible terminal mode. All of the menus become available to a remote controller through the serial port. The remote PC (an ANSI terminal may also be used) should be configured as follows:

Windows: Terminal mode (Hyper Terminal accessory), terminal emulation = VT-100, communications settings = 9600 (or whatever the current instrument host baud rate is), 8 bits, 1 stsop, no parity.

An ANSI terminal should be configured as follows:

WYSE WY-60 or WY-75: VT-100 emulation, full duplex.

WYSE WY-50: Not recommended (no ANSI mode).

Recommended baud rate is at least 4800 baud. The following (remote terminal) keys are now active (using numeric keypad with NUM LOCK enabled on remote terminal).

Key	Key Label	Function
Enter	Enter	Enter
7	Home	Exit
9	Pg Up	Page up
8	Up arrow	Up
2	Down arrow	Down
6	Right arrow	Select

Format
`REMOTE,{<DEVICE I.D.>}{TERMINATOR}`

Device response
<ACK>, then clearscreen, then menu display.

Command
RESET

Function
Reboots the instrument (software reset).

Format
RESET, {<DEVICE I.D.>}{TERMINATOR}

Device response
<ACK>

Command
GETDATA

Function
Used to collect logged data from an analyzer.

Format
This command takes two different formats depending on the transmission state. TO begin with, the following format must be used:

GETDATA,{<DEVICE I.D.>},2,1,<START TIME>,<END TIME>,<DATA TYPE>{TERMINATOR}
Where START TIME is the date/time of the first piece of data to collect, and END TIME is the date/time of the final data to collect. Both must be in the following format:
YY/MM/DD{SPACE}HH:NN
If END TIME is omitted, then all data since START TIME is returned. Year must be 03 or greater.

Where DATA TYPE=
I to only receive instantaneous logged data
A to only receive Averaged logged data
{EMPTY} to receive both instantaneous and averaged logged data.

After the request has been issued, data will be returned in the same packet format as is documented for USB data requests. After each packet, the following command should be issued to request the next packet of data:

GETDATA,{<DEVICE I.D.>},2,1,<REQUEST>{TERMINATOR}

Where `REQUEST=`
`0` to retransmit previous packet logged data
`1` to transmit next block of packet data

Device response
Refer to command 2 in the USB protocol specification. The complete USB packet format is used for the response to this serial command.

4.5 USB Communication

The USB port is located on the rear of the analyzer. This cannot be multidropped with other analyzers, but multiple analyzers can be connected to a single USB port on a computer by using a USB hub. This connection is ideal for collecting data from a standalone analyzer or using a laptop that may not have a serial port.

4.5.1 Installing the driver on a PC

The following are instructions to install the EC9811 analyzer to a computer through the USB connection. It will provide efficient communication between the analyzer and computer with the use of the EC9800 Communicator software described in section 4.6.

Note

Screen shots and instructions below apply to Windows XP, but will be similar for any other Windows operating system.

1. Turn on computer and log in.

2. Connect the analyzer by USB cable to the USB port on the rear of the computer.

3. After 10-20 seconds the dialog box shown in should appear. If no dialog box appears, open the Control Panel and double-click Add New Hardware.

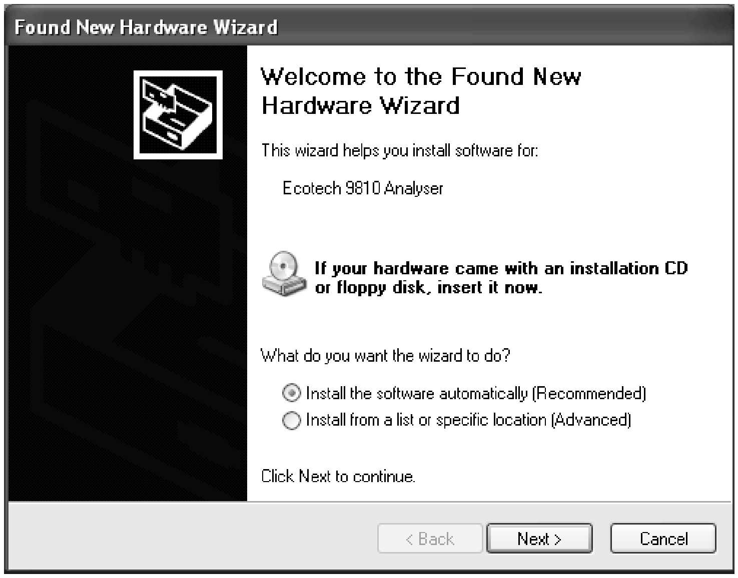

Figure 4-3. Screenshot of menu which appears when USB is connected

4. Insert the CD containing the Ecotech 9800 Analyzer Driver into the CD drive. The computer should recognize the CD and continue with the installation after a few seconds. If it does not, click the Next button after loading the CD.

Note

A dialog box similar to that in Figure 4-4 may appear. If it does, click the Continue Anyway button.

Figure 4-4. Dialog Box, which may appear during installation

5. The installation should now proceed. When complete click the Finish button.

The driver installation is now complete.

4.6 EC9800 Communicator Software

The *EC9800 Communicator* software is supplied on CD with the EC9811 series analyzer and allows the user to communicate with the analyzer by direct serial connection, modem or USB. The two functions of the program are to:

- Download recorded data (Data Acquire mode)
- Remotely access the analyzer's control panel (Remote Terminal mode)

To set the *EC9800 Communicator's* output, connection and analyzer properties use the settings dialog box. Refer to section 4.6.3.

4.6.1 Data Acquire Mode

Data Acquire mode enables the user to download recorded data from the analyzer to a text file

4.6.1.1 Using Data Acquire Mode

1. Ensure that all Settings are correct. Refer to section 4.6.3.
2. Under the **Mode** menu, tick the **Data Acquire** option
3. On the **Comm** menu, select **Start**.
4. In the dialog box that appears, enter the start date/time for the data in dd/mm/yy hh:mm format.
   For example, enter 30/11/2003 14:20 for 2:20PM on 30 November 2003.
5. In the dialog box that next appears, enter the end date/time in the same format.

The *EC9800 Communicator* will now retrieve the data. To stop downloading before all data has been retrieved, select **Stop** on the **Comm** menu.

Note

The analyzer must be in Command mode before the Data Acquire mode can be used. If the program was last used in Remote Terminal mode, the analyzer may still be in Remote mode. See section 4.6.2.2 for further details.

Note

Data Acquire mode only retrieves data already logged by the analyzer. To remotely instruct the analyzer to log data, use the **Remote Terminal mode**.

4.6.1.2 Viewing the Acquired Data

If the communication was successful, a table of data similar to the below will be displayed:

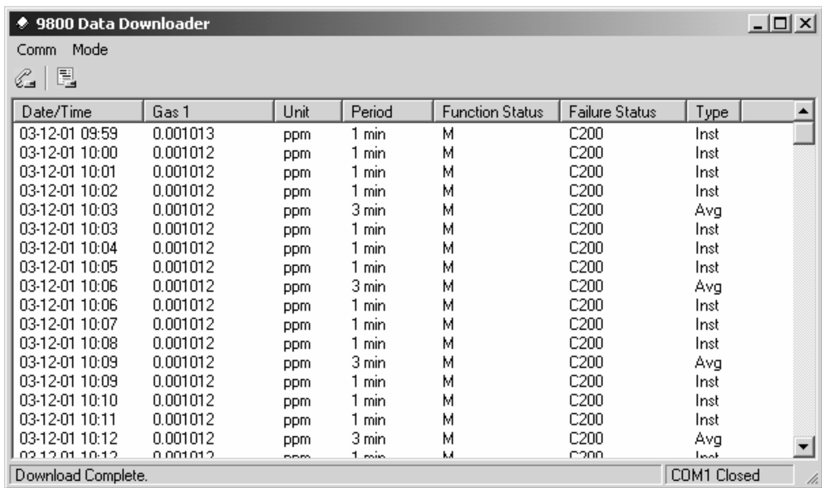

Figure 4-5. Acquired Data completion screenshot

The same data is displayed in the output text file, as set on the Output tab of the **Settings** dialog box, with the fields delimited by commas. A description of each field follows below.

Field	On-screen	In text file
Date/Time	The date/time, in the format selected in the Output tab of the Settings dialog box, when the data in that row were recorded.	As for on-screen
(Data)	Up to three channels of analyzer data, with column headings as set by the analyzer.	As for on-screen
Unit	The unit for the analyzer data.	Codes representing the data units
Period	The repetition period. For averaged data, the repetition period is also the averaging period.	As for on-screen, with the period in minutes

Function status	The function status of the analyzer at the time of measurement.	As for on-screen
Failure status	The failure status of the analyzer at the time of measurement.	As for on-screen
Type	*Inst* = instantaneous data. *Avg* = averaged data.	I = instantaneous data. A = averaged data.

4.6.2 Remote Terminal Mode

Remote Terminal mode can be used to access the analyzer's control panel remotely.

4.6.2.1 Starting a Remote Terminal mode session

1. Ensure that all Settings are correct. Refer to section 4.6.3.

2. Under the **Mode** menu, choose the **Remote Terminal** option.

3. On the **Comm** menu, select **Start**.

4. The screen should replicate the analyzer's display similar to Figure 4-6. The user now has access to the analyzer control panel, with the buttons at the bottom of the screen replicating the buttons on the front panel of the analyzer. If a blank screen appears, terminate the connection as per step 2 below and reconnect.

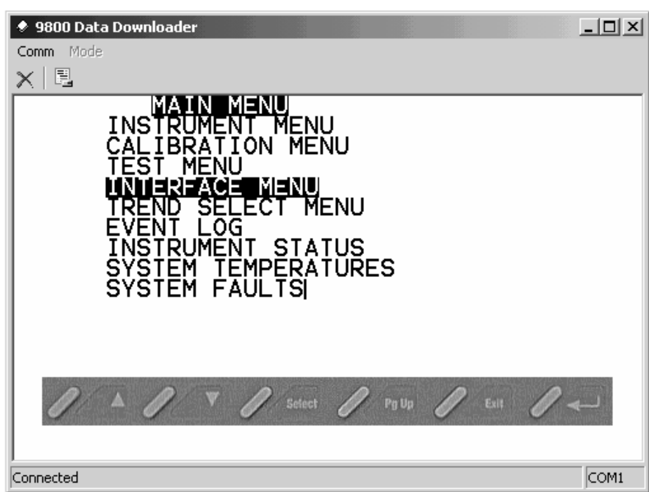

Figure 4-6. Remote Terminal

4.6.2.2 Ending a Remote Terminal mode session

Controlling the analyzer by remote terminal automatically sets the analyzer to **Remote** mode.

Note

It is advisable that the user always returns the analyzer to **Command** mode at the end of the remote terminal session, so that other users may download data.

To end the remote terminal session:

1. Set the **Interface Mode** option on the **Interface Menu** to **Command**. For detailed instructions on how to do this see section 4.6.2.3.

2. Terminate the connection by selecting the **Stop** option on the **Comm** menu.

4.6.2.3 Setting the analyzer to Command mode during a Remote Terminal session

1. Click exit repeatedly to display the analyzer's start-up window. **Main Menu** should be highlighted.

2. Click enter to enter the Main Menu.

3. Click up or down until **Interface Menu** is highlighted.

4. Click enter to enter the Interface Menu.

5. Click up or down until **Interface Mode** is highlighted.

6. Click select

7. Click up or down to change the interface mode to **Command**.

4.6.3 Settings

Open the Settings dialog box by either clicking the button, choosing the **Comm/Settings** menu option or by pressing F2. Click on one of the icons on the left of the dialog box to access that tab.

4.6.3.1 Output Tab

This function sets the options for the text file the program downloads data to.

Output file
Enter the path and filename of the text file that the *EC9800 Communicator* will write acquired data to. Clear the text box if a text file is not required.

If the file exists?

Choose Append to have the data added to the end of an existing file, choose overwrite to have an existing file overwritten, or choose Prompt to have the user prompted before writing to an existing file.

Date format
Choose the date/time format, or the user can select their own, in which to record the date and time of the analyzer data.

4.6.3.2 Connection Tab

This function sets the options for the communication connection between the computer and the direct serial connection, modem connection or USB.

Connection type
Choose the type of connection to communicate with the analyzer. The choice changes the other options available in this tab.

4.6.3.2.1 Direct Serial Connection

Port
Choose the COM port on the computer where the serial cable is connected. Connect the other end of the serial cable to the analyzer.

Baud rate
Choose the baud rate that has been set on the analyzer.

4.6.3.2.2 Modem Connection

Connect using
Choose from the list of modems detected from the computer

Phone
Enter the phone number to which the analyzer is connected.

4.6.3.2.3 USB Connection

Analyzer
Select the analyzer to communicate with from a detected list

4.6.3.3 Analyzer Tab

This function sets the analyzer information for the analyzer being communicated with.

Analyzer ID
If the user has multidropped multiple analyzers onto the one communication line, enter the ID of the analyzer to communicate with.

Average Data
Tick this box to download the averaged data that has been generated by the analyzer.

Instantaneous Data
Tick this box to download the instantaneous data that has been generated by the analyzer.

4.6.4 Keyboard shortcuts

The following are keyboard shortcuts that can be used in general operation of the program.

- F2 - Display the Settings dialog box
- F5 - Start communicating with analyzer
- F6 - Stop communicating with analyzer

4.7 Network Interface (optional)

The EC9800 network interface is an optional feature that can be added to an EC9800 instrument. It adds the possibility to connect the analyser to a network and access directly using a web browser. Within the web browser multiple users have the possibility of seeing current readings, which are updated every 5 seconds, control the analyser remotely, and download data.

4.7.1 Current Readings

The current reading option gives the possibility of seeing current parameter values in the analyser such as temperatures, concentration and status. The values on the screen are auto refreshed every 5 seconds and multiple users are able to view the current values simultaneously.

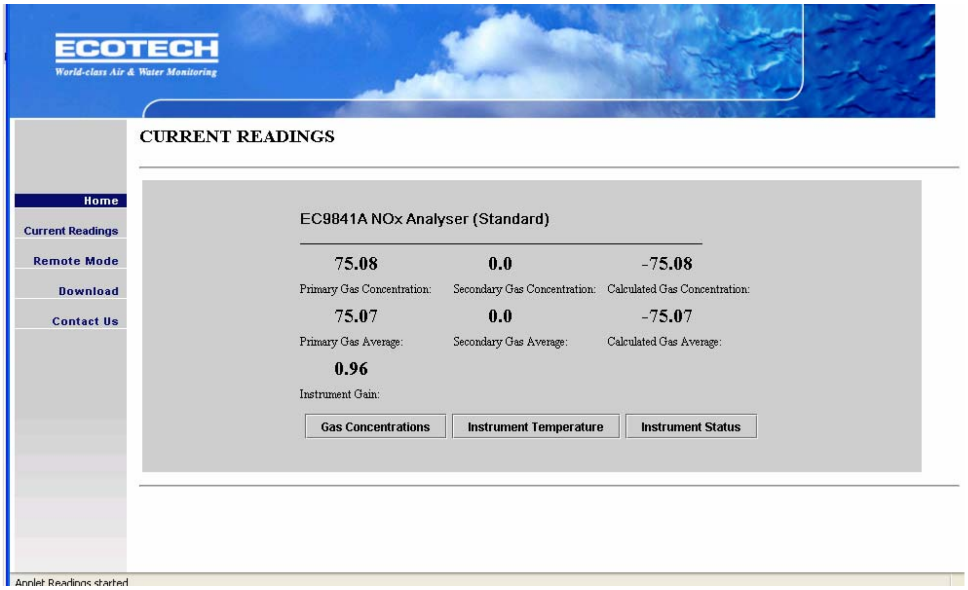

Figure 7 Current Readings window

The parameters are grouped in three main categories, Gas Concentration, Instrument Temperatures and Instrument Status.

- The gas concentrations group shows the current concentration, average concentration and instrument gain.
- The Instrument temperature group shows the relevant current temperatures for the instrument (e.g. the standard EC9841 NO_x analyser would show Cell Temperature, Conversion Temperature, Chassis Temperature, Manifold Temperature and Cooler Temperature).
- Instrument Status is where all the voltage, gas flow, gas pressure and ambient pressure parameters are shown. This group shows all of the parameters of the Instrument Status menu with in the instrument.

4.7.2 Remote Mode

The remote mode allows the user to access the current menu screen in the analyser, and remotely control the analyser through the menus. The buttons on the left substitute the Up, Down, Select, Pg Up, Back, Exit and Enter keys within the analyser.

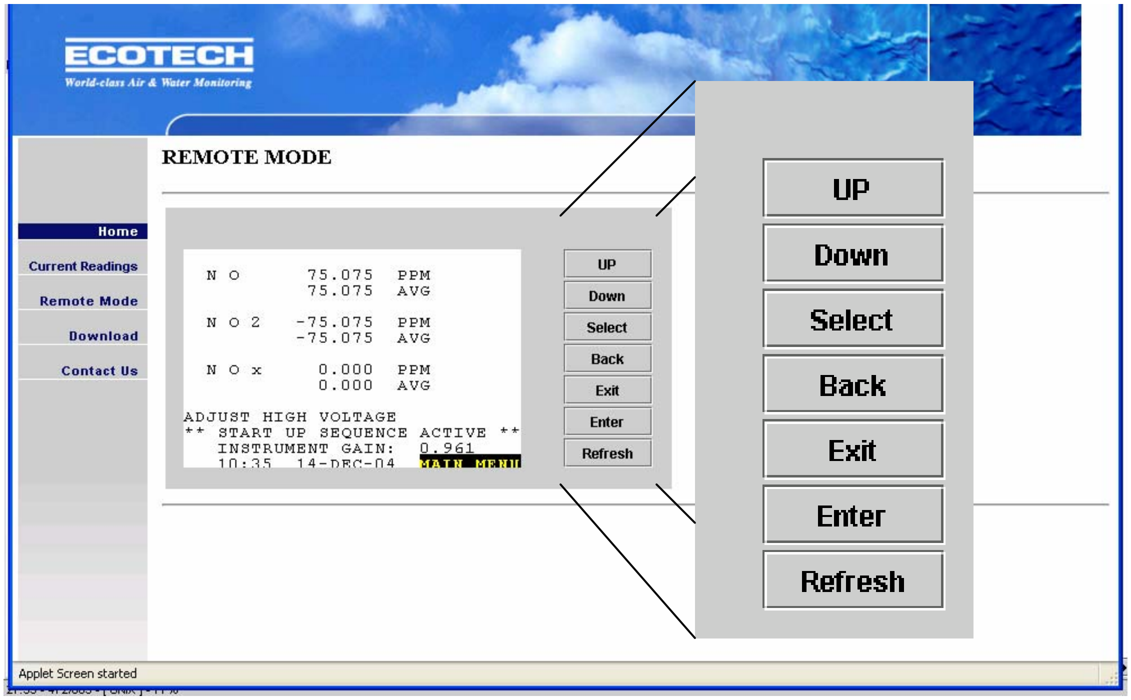

Figure 8 Remote Mode Window

The keyboard can also be used to control the menu with the following keys:

Table 1. Keyboard key and there commands

Keyboard Key	Menu Function
Up Key	Up
Down Key	Down
Left Key	Pg. Up/Back
Right Key	Select
Home Key	Exit
Function Key 5 (F5)	Refresh

IMPORTANT: When the window is left and an another program is used the other program takes control of the keyboard. In this situation when you return to the remote mode window, the keyboard will not work. The keyboard will be reactivated when one of the buttons on the Applet is selected with the mouse.

> **NOTE:** To access the Hidden menu press the H key, then click the refresh button with the mouse immediately.

4.7.3 Download

The download option gives the user the possibility of downloading the logged data to their hard drive.

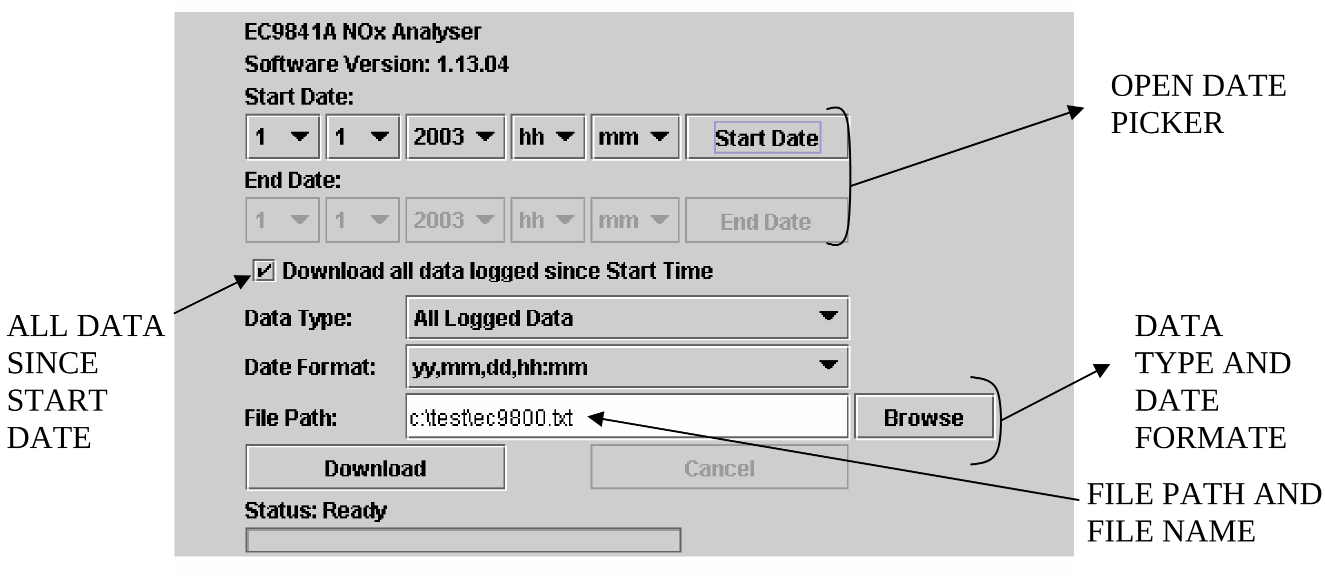

Figure 9 Download Data window

Starting date
The starting date of the data to be downloaded can be selected either using the drop down scrolls in the first two fields, or by using the Start date button to open a date picker.

End date
The end date of the data to be downloaded can be selected either using the drop down scrolls in the first two fields, or by using the Start date button to open a date picker. This option is only possible if the “Download all data logged since Start time” is not ticked.

Download all data since
Tick the box next to “Download all data logged since Start Time” to ensure all data is downloaded from the start date until the last reading.

Data Type
The data type to be downloaded can be selected between Instantaneous data, Average data or all logged data.

Date Format
The Date format can be changed with the order of time, date month and year being interchangeable to your preference.

File Path
In this field the file name and path where the data is to be saved should be specified either by typing the path name or by using the browse button. When typing the file name put the extension either .txt or .csv.

NOTE
By default the path is c:\test\EC9800.txt if you do not have a folder named test and select download this would cause an error.

When all the options are set the download can start by selecting the Download Button. A dialog window will prompt to inform that the download data process may take several minutes, after that the status bar will show the current data being written to the file.

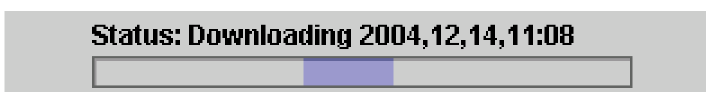

Figure 10 Status Downloading bar

When the downloading process is finished a dialog window pops up to inform that the download has been successfully completed. The file should then be saved in the current directory.

4.7.4 Firmware Update for the Network Interface

The firmware in the network adapter consist of two files the cobox.rom and Ecotech.cob, both of this files need to be loaded into the network adapter, to load the files get into the command window and use the following instruction

tftp –i <instrument IP address> PUT <file path>\cobox.rom X2

Wait for 20 seconds and then use the following instruction to load the .COB file.

tftp –i <instrument IP address> PUT <file path>\Ecotech.cob WEB1

Notice that If you do not have a TFTP client, there is a demo TFTP client application available at www.weird-solutions.com. A Users Guide is included and can be used as reference for using the weird-solutions tftp client.

Use the following parameters:

- Use the instruments IP address for the TFTP server
- Select Upload for the Operation
- Select Binary for the Format
- The path and name of the .cob file
- For the Remote File Name use X2
- Click the Upload Now button to start the operation. Note: Be very careful to set the TFTP application to do a binary transfer when upgrading over the network.

INDEX

APPENDIX A

USB PROTOCOL PARAMETER LIST

Note: parameters are for all EC9800 analyzers and may not be applicable to an individual analyzer.

#	Description	Notes
0	Internal Valve 1	0=Closed, 1=Open
1	Internal Valve 2	0=Closed, 1=Open
2	Internal Valve 3	0=Closed, 1=Open
3	External Measure Valve	0=Closed, 1=Open
4	External Zero Valve	0=Closed, 1=Open
5	External Span Valve	0=Closed, 1=Open
6	Aux Valve 1	0=Closed, 1=Open
7	Aux Valve 2	0=Closed, 1=Open
8	Aux Valve 3	0=Closed, 1=Open
9	Valve Sequencing	0=Off, 1=On
10	LCD Contrast POT	0=Lightest, 99=Darkest
11	PRE POT 1	Measure coarse pot for all analysers except 9841A which is chassis fan speed.
12	PRE POT 2	Measure Fine: 981X, 9820, 9830, 9841, 9842 Bench Fan Speed: 9841A Reference_zero : 9850
13	PRE POT 3	Input for all except 9850 which is measure gain.
14	PRE POT 4	981X, 984X: Test Measure 9820, 9830: test_reference 9850: reference gain
15	PRE POT 5	981X: Lamp Adjust 9820,9830,9850:test measure 984X: high voltage adjust
16	PRE POT 6	9850: high voltage adjust
17	PRE POT 7	9850: lamp adjust
18	VREG POT 1	Flow control zero
19	VREG POT 2	
20	VREG POT 3	
21	VREG POT 4	
22	VREG POT 5	Fan speed control
23	VREG POT 6	Pump speed fine
24	VREG POT 7	Pump speed coarse
25	Analogue input 0	
26	Analogue input 1	
27	Analogue input 2	

28	Analogue input 3	
29	Analogue input 4	
30	Analogue input 5	
31	Analogue input 6	
32	Analogue input 7	
33	Analogue input 8	
34	Analogue input 9	
35	Analogue input 10	
36	Analogue input 11	
37	Analogue input 12	
38	Analogue input 13	
39	Analogue input 14	
40	Analogue input 15	
41	50 PIN IO bits 0-7	BIT 7: Span Out of Range BIT 6: Span On BIT 5: Copper Fail BIT 4: Zero On BIT 3: Lamp Fail BIT 2: Out Of Service BIT 1: Flow Fail BIT 0: Span Cycle
42	50 PIN IO bits 8-15	BIT 7: Pump On BIT 6: Range 1 BIT 5: Startup BIT 4: Heater Fail BIT 3: Range 0 BIT 2: IZS On BIT 1: Spare 1 BIT 0: ZeroCycle
43	50 PIN IO bits 16-23	BIT 7: Power On BIT 6: Sys Fail BIT 5: High Voltage Fail BIT 4: Power Supply Fail BIT 3: Electric Test BIT 2: Optical Test BIT 1: Range 2 BIT 0: PPm / Metric
44	50 PIN IO bits 24-31	Really User ID
45	50 PIN IO bits 32-39	BIT 7: P4 BIT 6: P3 BIT 5: P2 BIT 4: P1 BIT 3: Spare Driver 1 BIT 2: BIT 1:

		BIT 0: Reference Fail
46	50 PIN IO bits 40-47	BIT 7: BIT 6: BIT 5: BIT 4: BIT 3: BIT 2: BIT 1: P6 BIT 0: P5
47	50 PIN IO bits 48-55	BIT 7: Status 2 LED BIT 6: Status 1 LED BIT 5: Sys Fail LED BIT 4: HeartBeat LED BIT 3: BIT 2: BIT 1: BIT 0:
48	50 PIN IO bits 56-63	BIT 7: BIT 6: BIT 5: BIT 4: BIT 3: BIT 2: BIT 1: BIT 0: Status 3 LED
49	PGA Gain	0-7
50	**Primary Gas Concentration**	
51	**Secondary Gas Concentration**	
52	**Calculated Gas Concentration**	
53	**Primary Gas Average**	
54	**Secondary Gas Average**	
55	**Calculated Gas Average**	
56	Instrument Gain	
57	Main Gas ID	
58	Aux Gas ID	
59	Decimal Places	
60	**Noise**	
61	Gas 1 Offset	
62	Gas 3 Offset	
63	Flow Temperature	
64	Lamp Current	
65	Digital Supply	
66	Concentration Voltage	
67	High Voltage	
68	Ozonator	0=Off, 1=On

69	Control Loop	
70	Diagnostic Mode	
71	**Gas Flow**	
72	Gas Pressure	
73	**Ambient Pressure**	
74	Analog Supply	
75	**Cell Temperature**	
76	Converter Temperature	
77	**Chassis Temperature**	
78	Manifold Temperature	
79	Cooler Temperature	
80	Mirror Temperature	
81	Lamp Temperature	
82	O3 Lamp Temperature	
83	Instrument Status	
84	Reference Voltage	
85	Calibration State	0 = MEASURE 1 = CYCLE 2 = ZERO 3 = SPAN
86	Primary Raw Concentration	(before 984X background and gain)
87	Secondary Raw Concentration	(before 984X background and gain)
88	984X Background Concentration	(before gain)
89	Calibration Pressure	
90	Converter Efficiency	
91	Multidrop Baud Rate	
92	Analog Range Gas 1	
93	Analog Range Gas 2	
94	Analog Range Gas 3	
95	Output Type Gas 1	0=Voltage 1=Current
96	Output Type Gas 2	0=Voltage 1=Current
97	Output Type Gas 3	0=Voltage 1=Current
98	Voltage Offset /Current Range Gas1	0=0% or 0-20mA 1=5% or 2-20mA 2=10% or 4-20mA
99	Voltage Offset /Current Range Gas2	0=0% or 0-20mA 1=5% or 2-20mA 2=10% or 4-20mA
100	Voltage Offset /Current Range Gas3	0=0% or 0-20mA 1=5% or 2-20mA 2=10% or 4-20mA
101	Full Scale Gas 1	

102	Full Scale Gas 2	
103	Full Scale Gas 3	
104	Zero Adjust Gas 1	
105	Zero Adjust Gas 2	
106	Zero Adjust Gas 3	
107	Negative 10V Supply	
108	50 Pin IO ANIN1	20mV resolution analog input (0-5V)
109	50 Pin IO ANIN2	20mV resolution analog input (0-5V)
110	Instrument State	
111	CO Linearisation Factor A	
112	CO Linearisation Factor B	
113	CO Linearisation Factor C	
114	CO Linearisation Factor D	
115	CO Linearisation Factor E	
116	Instrument Units	0= PPM 1=PPB 2=PPT 3=mG/M^3 4=µG/M^3 5=nG/M^3
117	Background Measure Time	In seconds
118	Sample Fill Time	In seconds
119	Sample Measure Time	In seconds
120	Aux Measure Time	In seconds
121	Aux Sample Fill Time	In seconds
122	Background Fill Time	In seconds
123	Zero Fill Time	In seconds
124	Zero Measure Time	In seconds
125	Span Fill Time	In seconds
126	Span Measure Time	In seconds
127	Span Purge Time	In seconds
128	Background Pause Time	In seconds
129	Background Interleave Factor	In seconds
130	Calibration Pressure 2	
131	AUX Instrument Gain	
132	Background voltage	
133	AUX Background Voltage	
134	O3 Generator Output	PPM
135	O3 Generator On/Off	
136	Calibration Point 1	PPM
137	Calibration Point 2	PPM
138	Calibration Point 3	PPM
139	Calibration Point 4	PPM
140	Calibration Point 5	PPM

141	Desired Pump Flow	SLPM
142	Actual Pump Flow	SLPM
143	Set Lamp Current	%
144	Lamp Current	mA
145	Cycle Time	Minutes
146	Analog GND Offset	Volts

Appendix B

Failure Status descriptions

The failure status codes provided by the 9800 downloader are described below. Each of the 4 units of the code represent a column below, the description within the box of the corresponding unit explains the failure status of various components, if any, and more detailed descriptions are outlines below the table.

Unit	1st Digit	2nd Digit	3rd Digit	4th Digit
0	NO FAILURE	NO FAILURE	NO FAILURE	GRAV
1	CHOPFAIL	REFFAIL	ZEROON	GRAV
2	LAMPFAIL	HEATERFAIL	OUT OF SERVICE	VOL
3	CHOPFAIL LAMPFAIL	REFFAIL HEATERFAIL	ZEROON OUT OF SERVICE	VOL
4	FLOWFAIL	COOLERFAIL	HV-FAIL	GRAV
5	CHOPFAIL FLOWFAIL	REFFAIL COOLERFAIL	ZEROON HV-FAIL	GRAV
6	LAMPFAIL FLOWFAIL	HEATERFAIL, COOLERFAIL	OUT OF SERVICE HV-FAIL	VOL
7	CHOPFAIL LAMPFAIL FLOWFAIL	REFFAIL HEATERFAIL COOLERFAIL	ZEROON OUT OF SERVICE HV-FAIL	VOL
8	SYSFAIL	CVFAIL	PS-FAIL	GRAV SPANON
9	CHOPFAIL SYSFAIL	REFFAIL CVFAIL	ZEROON PS-FAIL	GRAV SPANON
A	LAMPFAIL SYSFAIL	HEATERFAIL, CVFAIL	OUT OF SERVICE PS-FAIL	VOL SPANON
B	CHOPFAIL LAMPFAIL SYSFAIL	REFFAIL HEATERFAIL CVFAIL	ZEROON OUT OF SERVICE PS-FAIL	VOL SPANON
C	FLOWFAIL SYSFAIL	COOLERFAIL, CVFAIL	HV-FAIL PS-FAIL	GRAV SPANON
D	CHOPFAIL FLOWFAIL SYSFAIL	REFFAIL COOLERFAIL, CVFAIL	ZEROON HV-FAIL PS-FAIL	GRAV SPANON
E	LAMPFAIL FLOWFAIL SYSFAIL	HEATERFAIL, COOLERFAIL, CVFAIL	OUT OF SERVICE HV-FAIL PS-FAIL	VOL SPANON
F	CHOPFAIL LAMPFAIL FLOWFAIL SYSFAIL	REFFAIL HEATERFAIL COOLERFAIL, CVFAIL	ZEROON OUT OF SERVICE HV-FAIL PS-FAIL	VOL SPANON

CHOPFAIL	Indicates that the chopper has failed.
LAMPFAIL	Indicates that the lamp has failed.
FLOWFAIL	Indicates that the sample flow is less than 0.1 slpm.
SYSFAIL	Indicates one or more components have failed.
HEATERFAIL	Indicates that a system heater has failed.
COOLERFAIL	Indicates that a cooler has failed.
CVFAIL	Indicates that a converter has failed.
ZEROON	Indicates that the instrument is in the Zero mode.

OUT OF SERVICE	'Out of service' switch has been activated on analyzer
HV-FAIL	Indicates that the PMT high voltage supply has failed.
PS-FAIL	Indicates that the 12-volt supply voltage has gone out of range.
GRAV	Measuring in gravimetric units i.e. MG/M3
VOL	Measuring in volumetric units i.e. PPM

Example:
If a failure status is received as C022 then the failures of the instrument as determined by this code are:

C= FLOWFAIL — Indicates that the sample flow is less than 0.1 slpm.
SYSFAIL — Indicates one or more components have failed.

0 = No Failure

2 = OUT OF SERVICE — 'Out of service' switch has been activated on analyzer

2 = VOL — Measuring in volumetric units i.e. PPM

Unit	1st Digit	2nd Digit	3rd Digit	4th Digit
0	NO FAILURE	NO FAILURE	NO FAILURE	GRAV
1	CHOPFAIL	REFFAIL	ZEROON	GRAV
2	LAMPFAIL	HEATERFAIL	OUT OF SERVICE	VOL
3	CHOPFAIL LAMPFAIL	REFFAIL HEATERFAIL	ZEROON OUT OF SERVICE	VOL
4	FLOWFAIL	COOLERFAIL	HV-FAIL	GRAV
5	CHOPFAIL FLOWFAIL	REFFAIL COOLERFAIL	ZEROON HV-FAIL	GRAV
6	LAMPFAIL FLOWFAIL	HEATERFAIL, COOLERFAIL	OUT OF SERVICE HV-FAIL	VOL
7	CHOPFAIL LAMPFAIL FLOWFAIL	REFFAIL HEATERFAIL COOLERFAIL	ZEROON OUT OF SERVICE HV-FAIL	VOL
8	SYSFAIL	CVFAIL	PS-FAIL	GRAV SPANON
9	CHOPFAIL SYSFAIL	REFFAIL CVFAIL	ZEROON PS-FAIL	GRAV SPANON
A	LAMPFAIL SYSFAIL	HEATERFAIL, CVFAIL	OUT OF SERVICE PS-FAIL	VOL SPANON
B	CHOPFAIL LAMPFAIL SYSFAIL	REFFAIL HEATERFAIL CVFAIL	ZEROON OUT OF SERVICE PS-FAIL	VOL SPANON
C	FLOWFAIL SYSFAIL	COOLERFAIL, CVFAIL	HV-FAIL PS-FAIL	GRAV SPANON
D	CHOPFAIL FLOWFAIL SYSFAIL	REFFAIL COOLERFAIL, CVFAIL	ZEROON HV-FAIL PS-FAIL	GRAV SPANON
E	LAMPFAIL FLOWFAIL SYSFAIL	HEATERFAIL, COOLERFAIL, CVFAIL	OUT OF SERVICE HV-FAIL PS-FAIL	VOL SPANON
F	CHOPFAIL LAMPFAIL FLOWFAIL SYSFAIL	REFFAIL HEATERFAIL COOLERFAIL, CVFAIL	ZEROON OUT OF SERVICE HV-FAIL PS-FAIL	VOL SPANON

`CHOPFAIL`	Indicates that the chopper has failed.
`LAMPFAIL`	Indicates that the lamp has failed.
`FLOWFAIL`	Indicates that the sample flow is less than 0.1 slpm.
`SYSFAIL`	Indicates one or more components have failed.
`HEATERFAIL`	Indicates that a system heater has failed.
`COOLERFAIL`	Indicates that a cooler has failed.
`CVFAIL`	Indicates that a converter has failed.
`ZEROON`	Indicates that the instrument is in the Zero mode.
`OUT OF SERVICE`	'Out of service' switch has been activated on analyzer
`HV-FAIL`	Indicates that the PMT high voltage supply has failed.
`PS-FAIL`	Indicates that the 12-volt supply voltage has gone out of range.
`GRAV`	Measuring in gravimetric units i.e. MG/M3
`VOL`	Measuring in volumetric units i.e. PPM

Example:
If a failure status is received as C022 then the failures of the instrument as determined by this code are:

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2 =	`OUT OF SERVICE`	'Out of service' switch has been activated on analyzer
2 =	`VOL`	Measuring in volumetric units i.e. PPM