ecotech

environmental monitoring solutions

EC9811

Ozone Analyser

(with internal zero & span)

Service Manual

Revision: B

www.ecotech.com

Table of Contents

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: 98117601, 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 1.03 and above.

This manual should only be used in conjunction with the *EC9811 Ozone Analyzer*, *Operation Manual PN: 98117601* Rev B, *April 2007.*

Ecotech Manual ID:	MAN 0004
Manual PN:	98117601.
Current Revision:	B
Date Released:	April 2007.
Description:	EC9811 Ozone Analyzer with Internal and External Zero and Span, Service 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

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.

Service and Spare Parts

For world wide customer service & spare parts contact ECOTECH:

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

1.0 Installation

1.1 Initial Check

Verify that the serial number label on the documentation and the serial number(s) on the analyzer match.

Check to make certain your instrument arrived undamaged. If you find damage, report it as described in the preface, on the page titled *Claims for Damaged Shipments and Shipping Discrepancies* in the Operation manual.

Analyzers are shipped ready to power up. Occasionally, however, rough handling during shipment causes dislodged PC boards, disconnected cables, or incorrectly positioned switches. Verify that your instrument is in operating condition by performing the following procedure.

1.1.1 Remove the Top Cover

Grasp the front top corners of the front panel and pull forward. The panel will pop loose and pivot forward. See Figure 1. The top cover retaining hardware is then visible as shown in Figure 2. Use a screwdriver to unscrew the two captive screws. When the two captive screws are loosened, slide the cover backward about 4 inches and lift the top cover straight up.

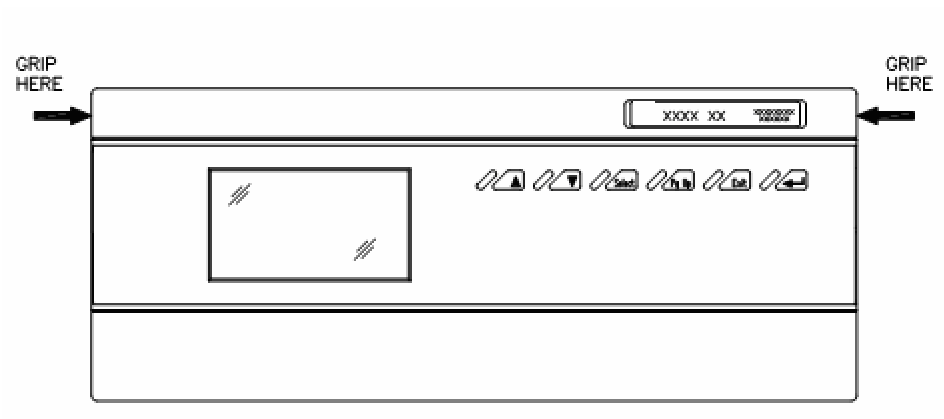

Figure 1. Opening the Front Panel

1.1.2 Service Switch

Opening the front panel allows a view of the secondary panel where four switches are visible. The position of the toggle switches for operating mode is:

DC Power	ON
Pump	ON
Service	IN

The Reset switch is not a toggle switch and is only activated when pressed. It resets the microprocessor. The pump switch is not applicable to the B-line instrumentation because the flow is generated through the use of an external pump.

When in the OUT position, the Service switch sets the `OUT OF SERVICE` bit in the 50-pin I/O interface and in the status word from the serial port. The OUT position has no other effect on the operation or validity of the data obtained from the analyzer. When the Service switch is set from OUT to IN, the instrument returns to the normal operating conditions.

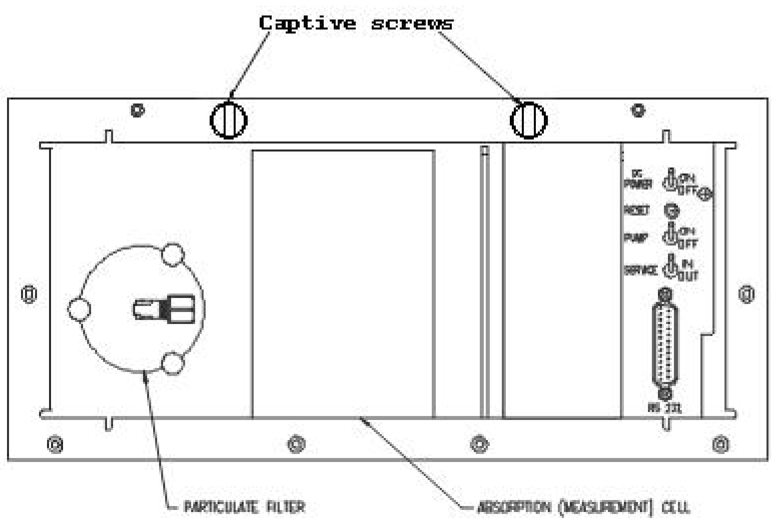

Figure 2 The Secondary Panel

1.1.3 Inspect the Components

Verify that the components were not damaged in shipping. If any PC boards are dislodged or cables disconnected, follow the instructions below.

1.1.4 Reinsert Dislodged Boards

The bottom edge of the boards must be held in place by the guides. The top of the boards must be attached to the metal bulkheads by the plastic or metal studs with spring tips.

1.1.5 Cable Connections

The cable connectors and the board connectors must be matched securely in place for correct connection. The red indicator on each cable must be positioned at the arrowhead mark on the board connector. Make the connection by pressing the cable connector into the mating connector until a click is heard. Then, fold the retainers inward to secure the connection (see Figure 3).

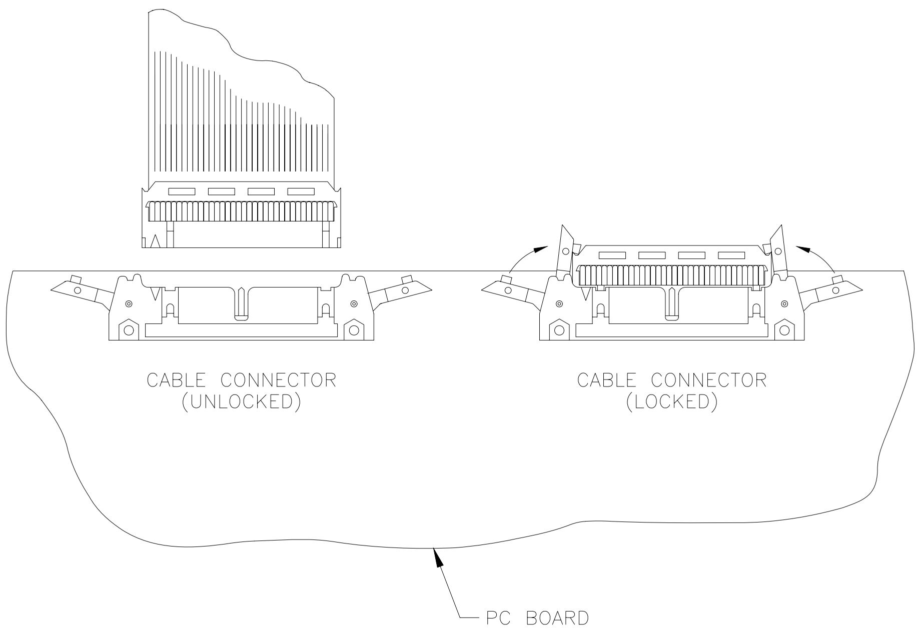

Figure 3. Cable Connections

2.0 Theory of Operation

Ozone exhibits strong absorption in the ultraviolet spectrum around 250 nanometers (nm). The EC9811 ozone analyzer exploits this absorption feature to accurately measure ozone concentrations to less than 0.5 ppb. A stream switched, single beam photometer serves as the basis for the EC9811.

A mercury vapor lamp is used as the source and a solar blind vacuum photodiode is used as the detector. A glass tube serves as the absorption cell. During the *reference cycle* of the stream switching process, air is drawn into the photometer through a scrubber which removes all ozone and the light intensity (I_O) is determined. The valve is then switched to allow ambient air to fill the cell. During this measurement cycle the light intensity (I) is determined. The Beer/Lambert Law gives the relationship between these measurements and the ozone concentration as follows:

$$(O_3)_{OUT} = \left(\frac{-1}{al} \ln \frac{I}{I_o}\right) \left(\frac{T}{273}\right) \left(\frac{760}{P}\right) \left(\frac{10^6}{L}\right)$$

Equation 1

where:

$[O_3]_{OUT}$ = O_3 concentration, ppm

a = absorption coefficient of O_3 at 254 nm = 308 $atm^{-1}cm^{-1}$ at 0° C and 760 torr (760 torr = 101 kPa)

l = optical path length, cm

T = sample temperature, °K

P = sample pressure, torr

L = correction factor for O_3 losses.

A number of compounds absorb at 254 nm, the predominant wavelength emitted by the UV lamp. Such compounds include aromatics, SO_2, and others. The scrubber selectively removes O_3 but passes the interfering compounds. Thus, the intensity ratio described in the previous paragraph is a function of only ozone absorption.

The microprocessor and electronics of the EC9811 control, measure, and correct for all the major external variables to ensure stable and reliable operation. For example, the absorption coefficient is temperature and pressure sensitive. The

EC9811 contains temperature and pressure sensors which are used to correct the coefficient for prevailing conditions. This ensures that an EC9811 analyzer calibrated under one set of conditions will still be accurate when operated in another.

The EC9811 analyzer has no internal mechanical adjustments. The microprocessor monitors all critical variables and makes the necessary adjustments. The algorithms have been designed so that no adjustments affect calibration.

The EC9800 analyzer family uses the advanced digital Kalman filter. This filter provides the best possible compromise between response time and noise reduction for the type of signal and noise present in ambient air analyzers and their applications.

The Ecotech’s implementation of this filter enhances the analyzer's measurement method by making the time constant variable, depending on the change rate of the measured value. If the signal rate is changing rapidly, the instrument is allowed to respond quickly. When the signal is steady, a long integration time is used to reduce noise. The system continuously analyzes the signal and uses the appropriate filtering time. Ecotech’s analyzers have passed USEPA equivalency testing using this advanced signal filtering method.

2.1 Ozone generator theory

Oxygen absorbs ultraviolet light whose wavelength is approximately 185 nanometers (nm). The energy at this wavelength is sufficient to dissociate the oxygen molecule into two atoms. The oxygen atoms then react with oxygen molecules to form ozone.

A mercury vapor lamp is used as the source of 185 nm light. This lamp differs from lamps used for ozone measurement in the type of glass used in the lamp envelope. The envelope of an ozone producing lamp is transparent to 185 nm light. The envelope of an ozone-free lamp is opaque to 185 nm light.

Ambient air is pushed through a scrubber and a particulate filter so that interferant-free air is introduced to the ozone generating cell. The air is passed through a mass flowmeter before entering the cell, so the quantity of air diluting the ozone is known. In the cell, oxygen in the air is irradiated by the mercury vapor lamp and a constant number of ozone molecules per unit time are produced. The power applied to the mercury vapor lamp determines the rate of ozone molecule generation. The concentration of ozone exiting the cell is directly proportional to the lamp current and inversely proportional to air flow rate.

2.2 Instrument Description

The instrument is designed in a modular format consisting of a power/ microprocessor module and a sensor module. The power/microprocessor module contains the power supply, voltage regulators, and the system microprocessor. The sensor module contains all components necessary to measure the pollutant gas. The layout of the EC9811 is illustrated in the system block diagrams (Figure 4) and major component layout diagram (Figure 5).

2.2.1 Power/Microprocessor Module

The power/microprocessor module can be described in three sections: the power supply, the voltage regulator, and the microprocessor.

2.2.1.1 Power Supply

The power supply is a self-contained unit housed in a steel case designed to meet CE requirements. It has an input voltage of 115/230VAC 50/60 Hz (manual switch selectable) and an output voltage of 12 VDC power for distribution within the analyzer. The power supply also furnishes a 250 msec power extension in the event of power failure to allow the computer to store data before the power failure can affect it.

2.2.1.2 Voltage Regulator

The voltage regulator board regulates and distributes the different voltages needed throughout the system: 12 VDC to +5 VDC for the digital circuitry and 12 VDC to ±10 v for analog circuitry. An additional +15 VDC supply is present to power the microprocessor display supplies and analog output circuits. The voltage regulator also furnishes a 300 msec power extension in the event of power failure to allow the computer to store data before the power failure can affect it.

2.2.1.3 Microprocessor

The microprocessor board contains a battery backed clock/calendar and an onboard 16-bit microprocessor (MC68HC12) operating at 16 MHz. The microprocessor board is the control center for input and output apparatus such as the 2 inch by 4 inch liquid crystal display (LCD), keyboard switches, the serial ports, and the 50-pin I/O connector on the rear panel. The 50-pin I/O connector input accepts control lines from the rear panel and sends status and failure signals to solid state relay drivers. Support circuitry for the liquid crystal display includes a -20 V power supply and digitally adjusted potentiometers for contrast level.

All analog voltages from the sensor assembly are digitized by the analog-to-digital (A/D) converter for microprocessor use. Digital-to-analog (D/A) conversion of three channels is used to send 0 to 20 mA analog signals to the 50-pin I/O connector.

The microprocessor has electrically erasable ROMs which store the operating program and internally logged data. Program upgrades can be easily made through the serial port. The Service and Reset switches are located on the front of the board and are accessible when the top is removed or when the front panel is opened. The microprocessor also has provisions for USB and optional TCIP connections through the rare panel.

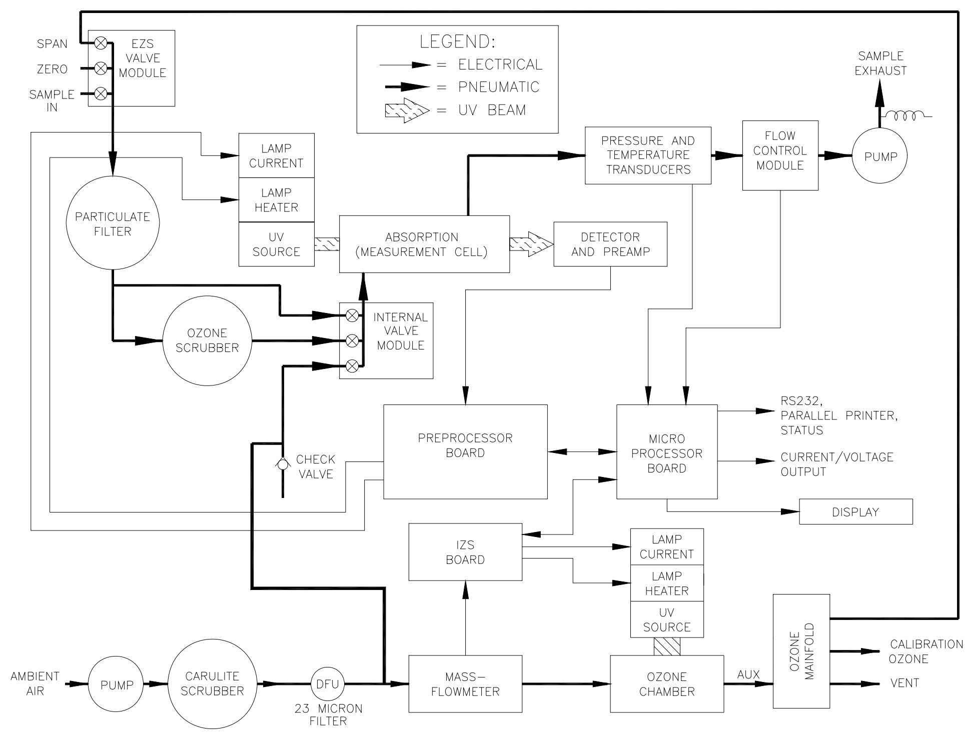

Figure 4. System Block Diagram

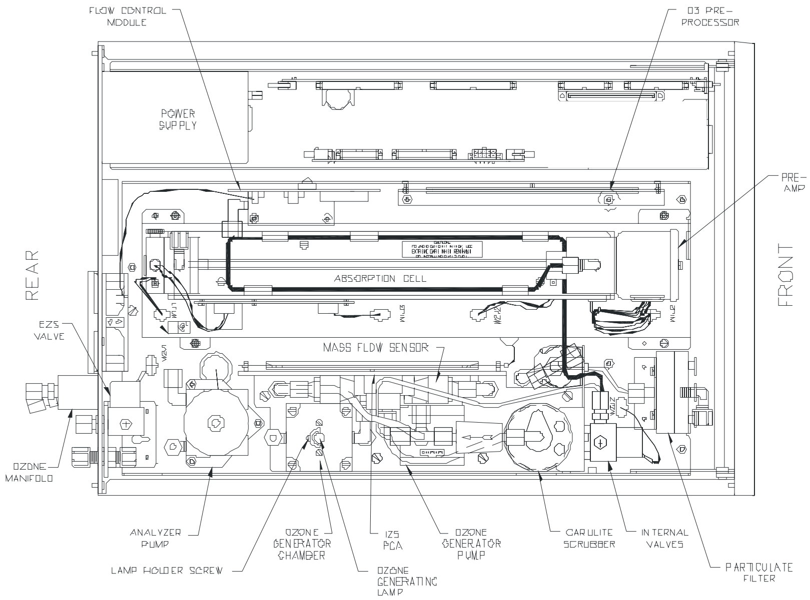

Figure 5 Major Components

2.2.2 Sensor Module

The sensor module can be divided into three areas of description: pneumatics, optics, and electronics.

2.2.2.1 Pneumatics

The pneumatic system continuously supplies particulate-free sample air to the measurement cell at a rate that allows the sample to be measured before exiting the analyzer. The pneumatic system flow is illustrated in Figure 6 The pump causes sample air to be drawn into the sample inlet and through the 5 micron particulate filter.

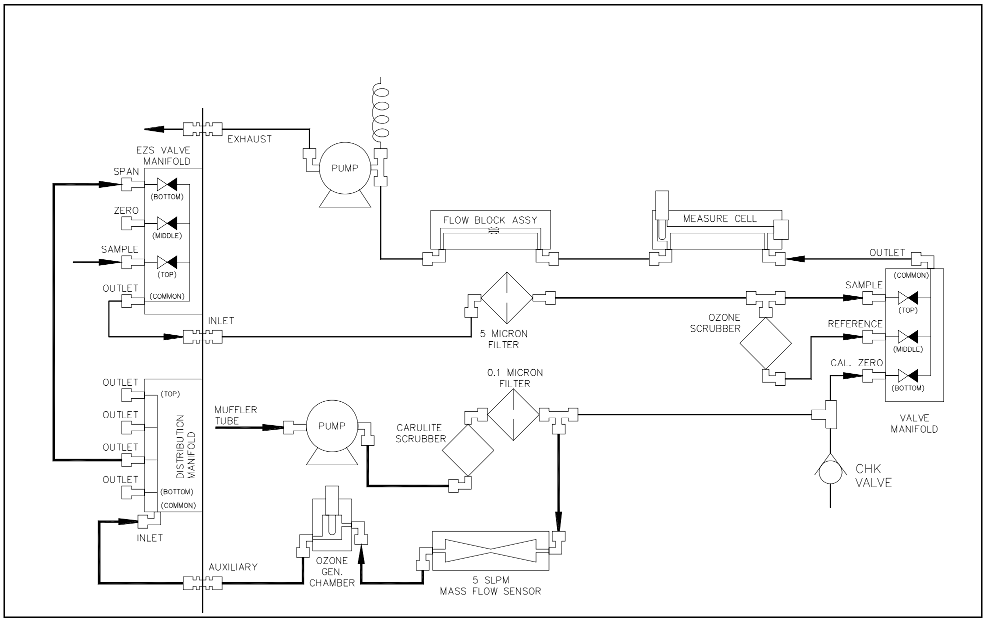

Figure 6. Pneumatic Diagram

- *Particulate Filter*. The particulate filter is designed to remove particles larger than 5 microns and to expose the sample to only inert materials of Kynar, Teflon, and Viton. The filtering agent is a 47 mm diameter, 5 micron filter. This filter is not supplied with the B series analyzer and must be purchased as an option.
- *Ozone Scrubber*. The ozone scrubber uses manganese dioxide-coated screens to remove ***only*** ozone from the air stream. As such, interferences are sampled on both cycles and their effect is canceled, making the instrument selective for O_3.

The copper screens in the scrubber have been carefully coated with manganese dioxide (MnO_2). The performance of the selective scrubber is process-sensitive and the scrubber must be manufactured under strict quality conditions to perform correctly. Incorrectly coated screens will result in unpredictable instrument performance. Use of any scrubber other than those provided by Ecotech is not permitted for monitoring under USEPA regulations without prior approval.

2.2.2.1.1 Flow Control

- *Flow Control Module***.** The sample flow rate is monitored by measuring the pressure drop across a calibrated flow restrictor. The upstream pressure of this restrictor is the sample cell pressure. Mass flow through the restrictor is computed from the upstream and downstream pressures. Since the pressure transducers used are temperature sensitive, they are mounted in a temperature controlled block.

- *Sample Pump.* The rotary vane-type pump is powered by a brushless DC motor. Since the pump is working with a very light load, it rotates very slowly, resulting in very little bearing or vane wear. The estimated pump life is in excess of 5 years. The Pump speed is controlled by a DC input voltage derived from two digital potentiometers under microprocessor control on the flow control board. The pump speed is varied to achieve desired sample flow rate.
- *Rear Fan.* The fan speed is controlled by a variable input voltage derived from a digital potentiometer under microprocessor control on the flow control board. The fan speed is controlled to begin operating at about 30° C chassis temperature and increase its speed in a linear fashion until it is at full operating speed about 50° C chassis temperature.

2.2.2.2 Optics

- *UV Source.* The UV source is a mercury vapor lamp operated at 10 mA by a regulated power supply. The lamp temperature is controlled to approximately 50^o C to ensure stable operation.
- *Measurement Cell.* The measurement cell is a glass tube with the UV source at one end and the UV detector at the other.
- *UV Detector.* The detector is a solar blind vacuum diode sensitive only in the spectral region where O_3 absorbs.

2.2.2.3 Electronics

- *Preamplifier Board.* The preamplifier (preamp) board converts the current from the UV detector to voltage and amplifies it. The microprocessor measures the light intensity during the scrubbed air cycle and during the sampling cycle. The ratio of the intensities is proportional to O_3 concentration.
- *Preprocessor PCA.* This circuit board contains the analog electronics that condition the detector signal, generate the lamp control signals, and generate all the signals required for preamp, optic and electronic test diagnostic functions. It also contains a heater control circuit to heat the UV lamp block to 50° C. The board also contains an EEPROM which contains device identification and stored setup parameters. All circuitry adjustments are made via microprocessor controlled digital potentiometers.
- *Lamp Driver PCA.* The lamp driver contains a high voltage switching supply to start and maintain the UV lamp at a constant intensity. This board is under the control of signals from the preprocessor PCA.

- *Flow Control PCA.* The pressure/flow portion of the board contains an absolute and a gauge pressure transducer to measure cell pressure and control sample flow. This board also controls the pump speed, powers the chassis fan, and has a heater control circuit to heat the flow block. (A series only)
- *Pressure PCA.* The pressure/flow portion of the board contains an absolute and a gauge pressure transducer to measure cell pressure and detect sample flow. This board also powers the chassis fan and has a heater control circuit to heat the flow block.

2.3 Operation Modes

The analyzer operates in a number of different measurement modes. These modes include startup, measurement, and auto-zero modes. Following is a description of each of the operating modes.

2.3.1 Startup Mode

When the instrument is initially powered up several components in the instrument are automatically configured by the microprocessor. This process can require up to 30 minutes to complete. Following is a description of the various adjustments made during the startup routine. All adjustments are automatically performed by the microprocessor and no manual intervention is required.

2.3.1.1 Reference Adjust

Reference adjust allows the input gain of the preprocessor measurement channel to be adjusted for the proper reference voltage level (the reference voltage is proportional to the intensity of the UV lamp). The microprocessor initially adjusts the lamp adjust potentiometer for a lamp current of 10 mA, then the input potentiometer for a reference voltage of 3.0 ±0.2 volts. After the reference voltage is set it is not adjusted again until another auto startup routine is performed or the reference voltage goes below 1 volt or above 4 volts.

After the UV lamp is adjusted the reference voltage is continuously monitored to ensure it is stable during operation. If the reference voltage becomes momentarily unstable, the analyzer will display `REFERENCE STABILIZATION` until the lamp achieves stability.

2.3.1.2 Zero Adjust

After the reference voltage is set the analyzer must adjust the preprocessor to offset the electronic signal present during the zero (background) cycle. The cell is filled with zero air, then the preprocessor measure coarse zero and measure fine zero potentiometers are adjusted until the concentration voltage is just above 0.00 volts (the concentration voltage is a signal proportional to the measurement of gas). After startup this signal level is continuously monitored and adjusted as necessary.

2.3.1.3 Sample Measurement

The EC9811 is a stream switched analyzer. This means that the analyzer is constantly switched between a background (zero) cycle and a measure cycle. These streams are switched approximately every 10 seconds. The difference in detected signal between the two cycles is proportional to the measurement concentration. The current operational mode is displayed on the analyzer main screen: `SAMPLE FILL/MEASURE` or `BACKGROUND FILL/MEASURE.`

2.3.1.4 Quick Start Routine

If the analyzer power is removed for less than two minutes, the full startup routine is replaced by a *quick-up* routine. The analyzer is returned to its last known operating parameters and normal operation is restored. This allows the analyzer to rapidly return to measurement mode and keeps data loss to a minimum. If power is lost for more than two minutes, a full auto-restart is performed.

2.3.2 <u>Measure Modes</u>

2.3.2.1 Sample Measure

Sample measure is the standard operating mode of the EC9811.

2.3.2.2 Zero Measure

Zero measure allows the cell to be filled with zero air either from the internal zero air source with internal valves selected or from an external zero air source with external valves selected. Processing of the signal is identical to measurement processing; the only difference is the source of the sample stream.

2.3.2.3 Span Measure

Span measure allows the cell to be filled with gas from an external span source. Processing of the signal is identical to measurement processing; the only difference is the source of the sample stream.

3.0 Maintenance

3.1 Maintenance Schedule

The following outlines a periodic maintenance schedule for the EC9811 analyzer. This schedule is based on experience under normal operating conditions, and may need to be modified to suit specific operating conditions. It is recommended that this schedule be followed in order to maintain reliable, long-term operation of the analyzer.

Interval[1]	Item	Procedure	Section
Weekly	Inlet Particulate Filter	Check/Replace	Service Manual:- 3.3.1
	Event Log / System Faults	Check	Service Manual:- 4.2.4 & 4.2.7
	Precision Check	Check	Operation Manual:- 2.4
Monthly	Fan Filter	Check/Clean	Service Manual:- 3.3.3
	Zero / Span Calibration	Perform	Operation Manual:- 2.4
	Clock	Check	Operation Manual:-2.3.3
6 Monthly	Ozone Scrubber	Check/Replace	Service Manual:- 3.3.6
	Multi-point Calibration	Perform	Operation Manual:- 3.2
1 Year	Clean Pneumatics	Clean	Service Manual:- 3.3.4
	UV Lamp	Check/Replace	Service Manual:- 3.3.5
	Leak Check	Perform	Service Manual:- 3.3.7
	Flow Calibration	Check / Calibrate	Service Manual:- 3.5

[1] Suggested intervals for normal operation and actual intervals will vary depending upon application. The user can refer to this table as a guideline, but should develop a maintenance schedule to suit their specific requirements.

3.2 Replaceable Parts

EC9811 Analyzer Spare Parts Requirements			
Description	**Series**	**Part Number**	**Level**
O-ring, reaction cell tube (2 required)	A & B	25000430-204	1
Filter element, 5 micron, consumable (50 each)	A & B	98000098-1	1
Scrubber assembly, ozone	A & B	881-025001	2
Lamp assembly, ultraviolet (ozone measuring)	A & B	98100011	2
Lamp, ultraviolet (ozone generating)		98110012	2
Fitting, reducing ferrule	A & B	036-120060	3
Filter, felt, carulite scrubber		002-051300	3
Scrubber material, carulite		016-000370SP	3
O-ring, carulite scrubber		025-030850	3
Nut, Kynar	A & B	036-13440	3
O-ring, quartz window	A & B	25000430-012	3
O-ring, ozone chamber		25000442-012	3
O-ring, ozone chamber		25000442-032	3
Mass flowmeter		29000134-1	3
Window, quartz	A & B	38000083-1	3
Pump	A	58500037	3
Tube, reaction cell	A & B	881-050900	3
PCA, Voltage Regulator	A & B	98000056	3
Display/switch assembly	A & B	98000057SP	3
PCA, Microprocessor (SMD)	A & B	98000063-4	3
PCA, 50-Pin I/O	A	98000066-2	3
Power supply, 115/230 VAC to 12 VDC	A & B	98000142	3
PCA, Preprocessor	A & B	98100021SP1	3
PCA, Lamp Driver	A & B	98100031-2	3
Filter, particulate, sample inlet 5 micron		98000210-1	3
PCA, Internal Zero/Span Control		98100036	3
PCA, Preamplifier/Detector	A & B	98100039	3
Flow control Module	A	98300046-SP1	3
Thermistor assembly	A	98100054	3
Heater and thermistor assembly, internal zero/span		98110013	3
Valve manifold, main	A	98300037	3

EC9811 Analyzer Spare Parts Requirements			
Description	**Series**	**Part Number**	**Level**
PCA USB Board Assembly	A & B	98007502	3
Heater/thermistor assembly	A & B	98300061	3

Level 1: General maintenance supplies and expendables such as filters, O-rings, lamps, etc.

Level 2: Critical items that are known from experience to have a higher failure rate, such as pumps, heaters, converters, valves, and circuit boards.

Level 3: Other miscellaneous items not included in Level 1 or 2. This level includes other spare parts that are not expected to fail over a given time frame.

Components marked with shading are essential components which need to be kept on hand at all times.

EC9810 Analyzer Spare Parts Requirements Options and Accessories		
Description	**Series**	**Part Number**
Rack mount kit with slides	A & B	98000036-2
Battery power option, 12 VDC	A & B	98000115
Filter kit, particulate, sample inlet, 5 micron	A	98000211-1
50-pin connector and shell kit	A & B	98000235-1
EC9811 Operation Manual	A & B	98117600
EC9811 Service Manual	A & B	98117601
Valve manifold kit, external zero/span (EZS)	A & B	98300087
Reaction cell maintenance kit	A & B	98110019-KIT1

3.2.1 Expected Life Span of Consumables

Component	Minimum	Typical
UV lamp (O3 measurement) (98100011)	6 months	1 to 2 years
O_3 scrubber/filter (881-025001)	6 months	1 to 2 years
UV lamp (O3 Generating) (98110012)	6 months	1 - 2 years

3.3 Maintenance Procedures

Following is a list of routine maintenance procedures which may be required through the life of the analyzer.

Recommended equipment to perform maintenance:

- Toolbox
- Oscilloscope
- Digital multimeter (DMM)
- Computer or remote data terminal and connection cable for RS232 communication
- Pressure transducer (absolute) and connection tubing, calibrated in torr
- Flow meter (1 slpm nominal)
- Wire strippers
- Soldering iron
- Minifit extraction tool
- Orifice removal tool
- Assortment of 1/4” and 1/8” tubing and fittings
- Test zero air source
- Test span gas source
- Leak tester

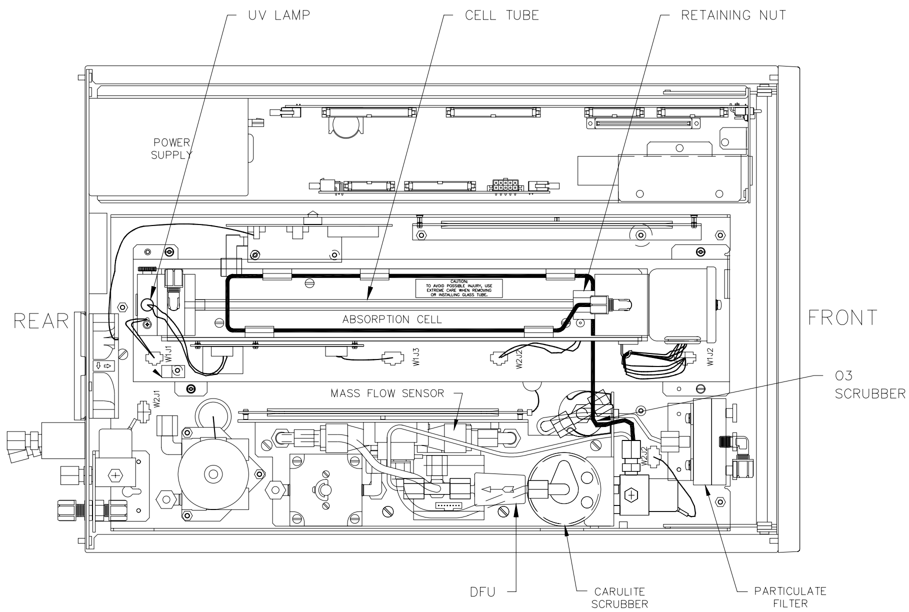

Figure 7. Routine Maintenance Components

3.3.1 Check Particulate Filter

The inlet filter prevents particulates from entering the pneumatic components of the EC9811. Contamination of the filter can result in degraded performance of the EC9811, including slow response time, erroneous readings, temperature drift, and various other problems.

Several factors affect the filter replacement schedule. In the springtime, for example, the filter might accumulate pollens and dust. Man-made environmental changes such as construction dust might indicate more frequent change, or a climate where dry, dusty conditions are normal might dictate more frequent filter replacement than climates with few natural pollutants.

Determining the schedule for changing the filter is best developed by monitoring the filter at weekly intervals for the first few months, then adapting the schedule to fit the specific site.

3.3.2 Particulate Filter Replacement Procedure

Use Figure 8 as reference when performing the filter replacement procedure.

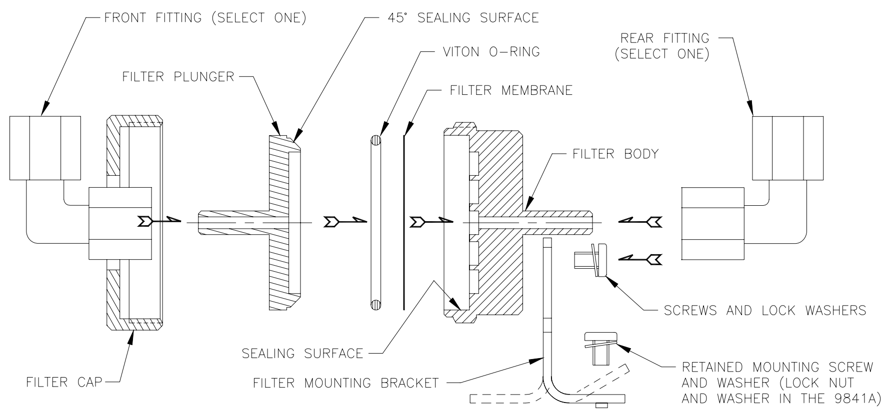

Figure 8. Particulate Filter Replacement

1. Open the front panel to access the service switches and particulate filter. Position the Pump switch in the secondary front panel to OFF.
2. Completely unthread the filter cap by turning it counterclockwise.
3. Pull the filter plunger out of the body, carefully resting it in a secure place. The O-ring and filter membrane are now exposed inside the filter body.
4. Remove, inspect, and wipe down the O-ring. Replace the O-ring only if damaged.
5. Remove, discard, and replace the old filter membrane.
6. Reinstall the O-ring over the new membrane, reinstall the plunger, and **hand-thread** the cap back into place by turning it clockwise. Do not use tools.
7. Return the Pump to ON.
8. Close the front panel.

3.3.3 Clean Fan Filter

The fan filter is located on the rear of the analyzer. If this filter becomes contaminated with dust and dirt it may affect the cooling capacity of the analyzer. The fan screen should be cleaned by removing it from the analyzer and blowing it out with compressed air, or by cleaning it with mild soapy water and air drying.

3.3.4 Pneumatic Cleaning

3.3.4.1 Cleaning the Cell Tube

Cleaning the cell tube requires removal of the glass tube from the two end blocks.

Warning

Apply minimal pressure while installing or removing the tube, as it may fracture and cause serious injury to the operator.

1. Loosen the retaining nut at the end of the tube. Slide the glass tube toward the front of the instrument until it is free of the rear mounting block. Rotating the tube and using both hands will help.

1. Gently raise the rear of the glass tube and slide the tube rearward until it is free of the forward mounting block.

2. Inspect the tube for any particulate matter deposited on the inner walls of the tube. If any residue is detected, the entire pneumatic system should be cleaned. ***Do not clean the ozone scrubber***.

3. Clean the glass tube by swabbing with clean, soapy water in both directions. Rinse in deionized water, then in isopropyl alcohol. Dry in air. Examine by looking down bore to light. No lint, grease, or particulate matter should be present.

4. Replace the clean, dry tube in the blocks by first placing the tube in the front block and sliding it into the rear block. The O-rings on either end of the Rx cell mounting may also be replaced. Tighten the retaining nut.

5. Perform the leak test.

3.3.4.2 Cleaning the Lines

The pneumatic lines (sample and exhaust) may be cleaned by removing and washing with a methanol cotton swab pushed through and dried by blowing with zero air or dry nitrogen. Do ***not*** clean the scrubber.

Note

After tube or cell cleaning the analyzer should be allowed to sample O_3 at approximately 0.400 ppm overnight to recondition the pneumatics prior to calibration.

3.3.5 UV Lamp Check

The UV lamp must be of sufficient intensity to ensure proper operation of the analyzer. A weak UV lamp will cause the analyzer output to become noisy. If the signal becomes extremely weak, measurement will stop completely.

The intensity of the UV lamp is reflected by the gain required to maintain a sufficient signal. This gain can be viewed as the input potentiometer setting in the `PREPROCESSOR POTS MENU`. As the intensity of the UV lamp decreases, the setting of the input potentiometer will increase.

The decrease in lamp intensity is typically very slow, but since the reference voltage is usually only adjusted during a startup cycle, there will sometimes be a dramatic increase in the Input potentiometer setting. As a routine maintenance procedure the operator should maintain a log and record the input pot setting in the `PREPROCESSOR POTS MENU` on a routine basis. As the potentiometer setting approaches 100 (the maximum available gain setting), replacement of the lamp should be considered.

3.3.5.1 UV Lamp Replacement

1. Turn the analyzer off.
2. Remove the analyzer cover and the internal reaction cell cover.
3. Remove the screw securing the green ground wire to the UV lamp block.
4. Loosen the thumb screw securing the UV lamp and slide the lamp out of the block.
5. Install the new UV lamp in reverse order of the above steps. Be sure to insert the lamp completely in the block to achieve maximum signal strength.

3.3.6 Ozone Scrubber

The performance of the ozone scrubber is critical to the EC9811. Although the ozone scrubber will theoretically last forever if exposed to only O_3 and air, exposure to other elements in the atmosphere will adversely affect the life span of the scrubber. A weak or failed scrubber can result in noisy measurement, frequently caused by excessively high gain.

The quickest indicator of ozone scrubber efficiency is the instrument gain of the analyzer. (This is calculated automatically by the analyzer every time it is manually calibrated.) As scrubber efficiency decreases, instrument gain must increase to compensate for it. Since this number is, however, affected by factors such as atmospheric pressure and cell cleanliness, it is only an indicator, not a true test of scrubber efficiency. The operator should maintain a log of the instrument gain at each calibration. Any time this number increases by more than 15% (from a known good calibration point), scrubber efficiency should be checked.

3.3.6.1 Ozone Scrubber Test

This test may be performed on ambient sample gas if the reading is at least 100 ppb ozone. Use of ozone span gas made up in zero air is recommended for full confidence in the result of this test.

1. Generate 400 ppb ozone.
2. Verify that the analyzer reads `400 PPB ±10%`, and record the reading.
3. Select the `TEST MENU` screen from the `MAIN MENU`. Select `ZERO SOURCE: CHECK` and press <Enter>.
4. Move to the `CALIBRATION MENU` and select `CALIBRATION: MANUAL`, then select `CAL. MODE: ZERO` and press <Enter>. Press the <Exit> key to return to the initial screen.
5. The reading should remain at a value between ±1% of the initial reading (e.g., ±4 ppb for a 400 ppb O_3 level). A negative reading indicates that the primary scrubber is less efficient than the secondary scrubber. A positive reading indicates that the secondary scrubber is less efficient. If the reading is outside of this range, replace the appropriate scrubber.
6. Upon completion of the test, return the instrument to normal operation by (1) setting the `CALIBRATION MENU/CAL MODE` to `MEASURE`, and (2) setting the `TEST MENU/ZERO SOURCE` to `STANDARD`. Confirm the selections by pressing <Enter>. Press <Exit> to return to the initial screen.
7. The initial screen ozone reading should return to the original value of `400 PPB ±10%`. If you are running the test on ambient air, the air sample may vary during the time it takes to run the test.

3.3.6.2 Scrubber Replacement

1. Press the Power switch to the OFF position.
2. Unscrew the retaining nut located on the elbow of the scrubber to be changed. Disconnect the tubing from the joint.

3. Remove the scrubber from the retaining clip. See Figure 9.

4. Unscrew the retaining nut on the elbow joint at the bottom of the scrubber. Disconnect the tubing from the joint.

5. Connect the tubing to the new scrubber and tighten the retaining nut at the bottom of the new scrubber.

6. Press the scrubber into the retaining clip and connect the tubing to the top elbow joint. Tighten the retaining nut.

7. Replace the top cover and close the front panel.

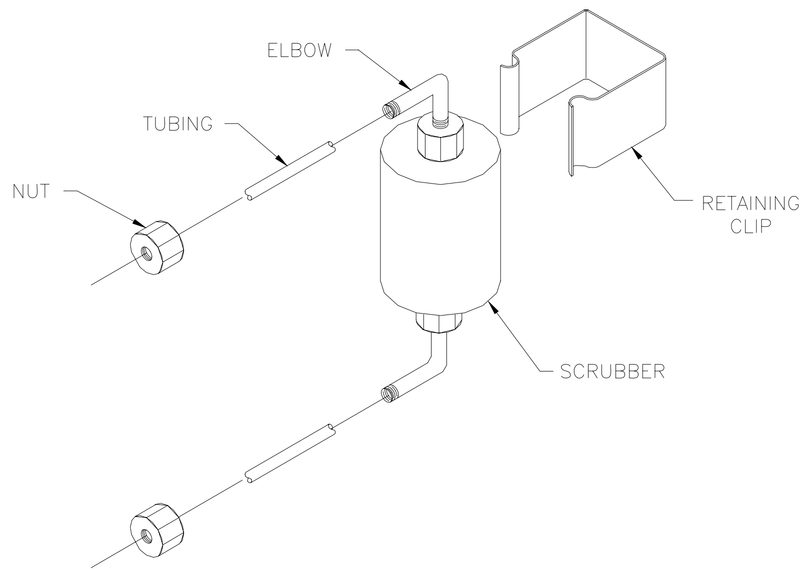

Figure 9. Scrubber Replacement

3.3.7 Leak Test Procedure

This is a test for the pneumatic system of the instrument. The display readings will indicate whether the system is leaking or not.

Note

This procedure applies ***only to the instrument***. It does not include the EZS valve option. The option must be disabled to perform this test.

1. Enter the `TEST MENU` and select `OUTPUT TEST MENU`; then `VALVE TEST MENU`; from these items pick `VALVE SEQUENCING` and set to `OFF`.

2. Set all valves to `CLOSED`.

3. Press <Pg Up> to return to the OUTPUT TEST MENU and choose FLOW CONTROL POTS.

4. Turn the Pump switch on the secondary panel to OFF and verify FLOW: 0.00 SLPM. If it does not read 0.00, the Flow Control PCA requires recalibration. Return the Pump switch to ON.

5. Plug the inlet and auxiliary ports on the rear panel.

6. Verify GAS FLOW in the FLOW CONTROL POTS screen reads 0.00. If the reading is not 0.00, the leak is somewhere between the valves and the flow block.

7. Press <Pg Up> and select the VALVE TEST MENU. Set INT. VALVE #1 to OPEN; return to the FLOW CONTROL POTS screen, and verify GAS FLOW reads 0.00 SLPM. If the reading is not zero, the leak is in the measure/sample line.

8. Return to the VALVE TEST MENU. Close the INT. VALVE #1 and open the INT. VALVE #2. Return to the FLOW CONTROL POTS screen and observe the flow reading. If the reading is not zero, the leak is in the zero air line.

9. Return to the VALVE TEST MENU. Close the INT. VALVE #2 and open the INT. VALVE #3. Return to the FLOW CONTROL POTS screen and observe the GAS FLOW. If the reading is not zero, the leak is in the span gas line.

10. Return to the VALVE TEST MENU. Close INT. VALVE #3 and open INT. VALVE #1 for normal operation.

11. Set VALVE SEQUENCING to ON and press <Exit>. Remove the plugs from the inlet and auxiliary ports.

12. Verify that the flow returns to the original setting by observing the INSTRUMENT STATUS menu.

The actual flow through the analyzer should be checked by turning on the pump and connecting a flow meter to the measure inlet (ensure that the analyzer is in SAMPLE MEASURE). Actual flow through the analyzer should be approximately 0.5 slpm. If flow is too low, perform the flow calibration in section 3.5 below.

3.4 Hidden Menu

The new software features of the Ecotech Microprocessor board (SMD version), provides provisions for a hidden menu. This enables the experienced user to access menus for maintenance purposes. These menus eliminate the need for a portable computer to perform flow & pressure calibrations.

To access the hidden menu, simultaneously press three keys on the front panel from the primary screen as follows:

Up arrow (⮝), <Pg Up> and Enter> (↵)
The following menu will be displayed:

```
                  HIDDEN MENU

SERIES                        A
ANALYZER TYPE              9811
SUB TYPE               STANDARD
FLOW BLOCK TYPE        STANDARD
GAS NAME                    ___
PRESSURE CALIBRATION MENU
FLOW CALIBRATION MENU
```

Figure 10. Hidden Menu

SERIES
Allows the user to choose the correct series of analyzer. The options are `A, B & S.` The selection must reflect the Hardware to which it is being installed. i.e. for an EC9811 analyzer, it must be set to `A.` The `S` option is reserved for special system software.

ANALYZER TYPE
Allows the user to choose the correct analyzer type. The options are `9810, 9811, 9812, 9820, 9830, 9841, 9842 & 9850.` The selection must reflect the Hardware to which it is being installed. i.e. for an EC9810 analyzer, it must be set to `9810` in order to operate correctly. The analyzer type will default to `????` if the device type has not been set or cannot be read from the preprocessor board.

SUB TYPE
Allows the user to set the correct Hardware options for this analyzer. The options for the 9811 are: `STANDARD & WITH IZS.` If the Internal Zero & Span (IZS) option is installed, then `WITH IZS` should be selected.

GAS NAME
Allows the user to set a 3 character name for the primary gas name. The name entered here will be used to replace the primary gas name in all screens. If the first character is a space then O3 will be used as a gas name.

FLOW BLOCK TYPE
Displays the type of flow block installed. If the flow block is not connected or calibrated, then no type will be displayed. For **A** series analyzers the **STANDARD** type is selected.

3.4.1 Pressure & Flow Calibration sub-menus

The pressure and flow calibration menus allow the user to manually calibrate the pressure transducers and calibrate the flow of the flow controllers. The contents of the pressure and flow calibration menus are described below. Note that these parameters will vary depending on which flow block type is selected. Refer to section 3.5 for further details.

`CRITICAL ORIFICE`
Designated flow rate of the critical orifice installed in the ISO-B flow block.

`DESIRED FLOW`
Desired flow rate that the standard flow block will maintain a constant flow at.

Note

If the flow rate is changed within an A series analyzer the instrument must be reset in order for the change to take effect.

`FLOW SPAN POINT`
During the flow calibration of the standard flow block, this is where the externally measured flow rate is entered.

`FLOW ZERO POINT`
During the zero flow calibration of the standard flow block, this option must be set to `set` and enter pressed for the zero calibration to take effect. Select `cancel` to abort this operation.

`FLOW TRANSDUCER DF`
Selecting set, loads the factory default calibration curve into the EEPROM on the standard flow control board.

`PRESSURE 1 HIGH`
Pressure entered during ambient calibration.

`PRESSURE 1 LOW`
Pressure entered during low pressure calibration.

`VALVE SEQUENCING`
Turn the valve sequencing on or off. Same as in the Valve Test Menu. When turned off, the appropriate valve sequence will set ready for pressure calibration.

`CONTROL LOOP`
When `ENABLED`, the microprocessor controls the pump speed (via the flow control pots) to give the desired flow rate. When `DISSABLED`, the user can manually adjust the pump speed using the flow control pots. For the standard flow block only.

FLOW CONTROL ZERO

This flow control pot is used to manually adjust the zero flow offset voltage during the zero calibration of the standard flow block.

PUMP SPEED COARSE/ FINE

The two flow control pots (PUMP SPEED COARSE & PUMP SPEED FINE) are software-controlled pots which control the pumps speed on the standard flow block.

AMBIENT PRESSURE

Current ambient pressure measured from the ISO flow controller.

GAS PRESSURE

Current gas pressure measured from the flow controller.

GAS FLOW

Current gas flow measured from the flow controller.

3.5 Pressure & Flow Calibration

The pressure and flow calibrations should be performed whenever a flow or pressure reading becomes suspect, when a transducer is replaced, or can be performed as an annual maintenance item. The pressure and flow transducer calibration may be performed separately or together. The following procedures cover both the STANDARD and ISO-B flow block types. For both procedures the following equipment is required:

- Digital Volt Meter.
- Pressure transducer (absolute); calibrated in torr.
- Flowmeter, 1 slpm nominal
- ¼” fitting with hose to suit pressure transducer.

3.5.1 Pressure/Flow Calibration (A Series)

3.5.1.1 Setup

Note

The EC9811 analyzer should be left running for at least one hour with the pump switched on before this procedure is attempted. This will allow the flow block temperature to stabilize to 50^{o}C.

From the HIDDEN MENU, set the **FLOW BLOCK TYPE** TO **STANDARD**, and press Enter> (↵). Press Reset on the analyzer secondary panel.

3.5.1.2 Pressure Calibration

1. From the HIDDEN MENU, select the **PRESSURE CALIBRATION MENU**. The menu of Figure 11 should be displayed.

```
                PRESSURE CALIBRATION MENU

       PRESSURE 1 HIGH      743.0 TORR
       PRESSURE 1 LOW       530.0 TORR

       VALVE SEQUENCING     ON
       CONTROL LOOP         ENABLED
       PUMP SPEED COARSE    28


       GAS PRESSURE         710.0 TORR
       GAS FLOW             0.500 SLPM
```

Figure 11. Pressure Calibration Menu for Standard flow block

2. Verify the pump is turned off by setting the pump switch to **OFF** on the secondary panel.

3. Allow 30 seconds for the pressure reading to stabilize to ambient pressure on both the calibrated pressure transducer and the analyzer. This reading (in TORR) should be the ambient pressure. Set this value as **PRESSURE 1 HIGH** in the PRESSURE CALIBRATION MENU and then press Enter> (↵).

Note

To convert from millibar to TORR, multiply the pressure by 0.75.

4. Set the **CONTROL LOOP** TO **DISABLED**, and press Enter> (↵).This will disable the flow control loop.

5. Connect the calibrated pressure transducer to the sample inlet on the rear panel of the analyzer.

6. Turn the pump **ON** from the secondary panel.

7. Set the **PUMP SPEED COARSE** to **99** and press Enter> (↵).

8. Allow approximately 1 minute for the pressure to drop to a stable reading. This reading should be typically 100 to 200 torr lower than the ambient pressure (depending upon the capacity of the pump).

9. Set this reading (in TORR) as **PRESSURE 1 LOW** in the PRESSURE CALIBRATION MENU and press Enter> (↵).

10. Disconnect the pressure transducer from the inlet and turn the pump **OFF**.

11. To verify that the pressure transducers on the standard flow control board are calibrated, view the **`GAS PRESSURE`** reading in the `PRESSURE CALIBRATION MENU`. it should be at ambient pressure +/- 2 TORR.

This completes the pressure transducer calibration procedure.

3.5.1.3 Flow Calibration

1. From the `HIDDEN MENU`, select the **`FLOW CALIBRATION MENU`**. The menu of Figure 12 should be displayed.

```
                 FLOW CALIBRATION MENU

       DESIRED FLOW          0.50 SLPM
       FLOW CONTROL ZERO     81
       FLOW TRANSDUCER DF    CANCEL
       CONTROL LOOP          ENABLED
       VALVE SEQUENCING      ON
       FLOW ZERO POINT       CANCEL
       FLOW SPAN POINT       0.500 SLPM
       PUMP SPEED COARSE     28
       PUMP SPEED FINE       7
       GAS PRESSURE          710.0 TORR
       GAS FLOW              0.500 SLPM
```

Figure 12. Flow Calibration Menu for Standard flow block

2. Verify the pump is turned **OFF** .and the **`CONTROL LOOP`** `is` **`DISABLED`** in the `FLOW CALIBRATION MENU.`

3. Load the linearization table into the flow control board EEPROM by setting **`FLOW TRANSDUCER DF`** to **`SET`** and pressing Enter> (↵). The linearization table contains the following parameters:

   Flow points: 0, 0.5, 1.75, 2.5, 3.25, 3.75.

   Voltage points: 0, 0.13, 0.91, 1.783, 2.5, 3.478.

4. Connect the calibrated flow meter to the sample inlet on the rear panel of the analyzer. With the pump turned off, verify that there is no flow.

5. Connect a Digital Volt Meter (DVM) to the FLOW test point on the Flow Control PCA. TP1 is the 0V connection, and pin 5 of the J2 connector is the FLOW test point. The Digital Volt Meter should be set to the 2V DC range.

6. Adjust the **`FLOW CONTROL ZERO`** pot until the DVM reads slightly positive (0 to 0.5 VDC), then press <Enter>.

7. Set the **FLOW ZERO POINT** to **SET** and press Enter> (↵). The **GAS FLOW** should now read 0.000 SLPM.

8. Disconnect the DVM.

9. Turn the analyzer pump **ON** and verify the **CONTROL LOOP** is still **DISABLED.**

10. From FLOW CALIBRATION MENU use the **PUMP SPEED COARSE** and **PUMP SPEED FINE** pots to adjust the measured flow (external flow meter) to as close as possible to 0.50 SLPM.

Note

If the analyzer attempts to automatically change the pot position during adjustment then repeat step 9.

11. Record the average measured flow from the flow meter and enter it into the **FLOW SPAN POINT** and press Enter> (↵).

12. Set the **DESIRED FLOW** to 0.50 SLPM and press Enter> (↵).

13. Press Reset on the analyzer and allow the flow to stabilize. Verify the flow meter reading is now 0.50 ±0.05 SLPM.

Note

After the instrument startup is complete, verify the gas pressure is slightly below actual ambient pressure (approximately 10 - 20 torr). The gas pressure and gas flow readings may not bet updated during the startup routine.

This completes the flow transducer calibration procedure.

3.6 Preprocessor Device ID Entry

This procedure is only required if the microprocessor is not reading the device ID from the preprocessor board, or if the preprocessor board has been replaced.

1. From the HIDDN MENU set the **SERIES** to **A** or **B** depending on which analyzer it is. Then press Enter> (↵).

2. Set the **ANALYZER TYPE** to **9811** and press Enter> (↵).

3. Press Reset on the analyzer secondary panel. The display should now display `9811 O3 ANALYZER`.

4. You may need to erase memory after this procedure to avoid any problems.

This completes the analyzer device type programming.

3.7 Firmware Update

As improvements are made to the EC9800 series analyzers, these can be easily passed on to the user by updating the firmware (software operating within the Microprocessor board).

To update your EC9800 Analyzer, download the Firmware Updater Software. Install this software on a Windows based computer with a COM port. To do this, run the downloaded file 'setup.exe' by double clicking on it, then follow the installation screens to install.

Next, download the required software version for your 9800 analyzer from those listed at the bottom of this page (e.g. V1.00.0002), by right clicking on the link, and choosing 'Save Target As', and saving the .sx file on your computer. You will need to select save as type 'All Files' in the download window.

To update the firmware on the analyzer:

1. Run 'Firmware Updater' from the 'Start - Programs - Ecotech - Firmware Updater' menu.

2. Connect the 9800 analyzer to the computer using a standard serial cable (you can connect to either the Multidrop port on the back of the analyzer, or the service port on the front of the analyzer).

3. Select 'Serial Port' and the COM Port on the computer from those listed on the Firmware Update screen.

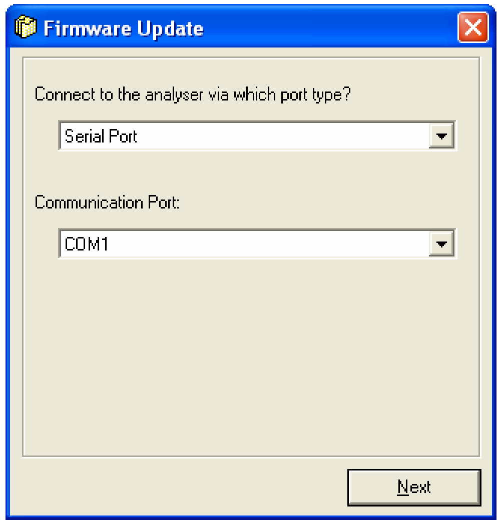

Figure 13 Firmware Update communication settings screenshot

4. Click Next

5. Enter the full path and file name of the firmware (.sx) file you downloaded. e.g. - C:\TEMP\V1.03.0001.SX assuming the file was saved to C:\TEMP.

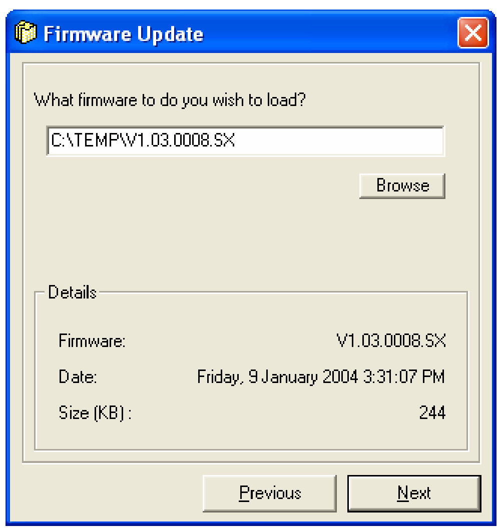

Figure 14. Firmware Update firmware selection screenshot

6. Click Next

7. Tick the boxes as shown in the figure below.

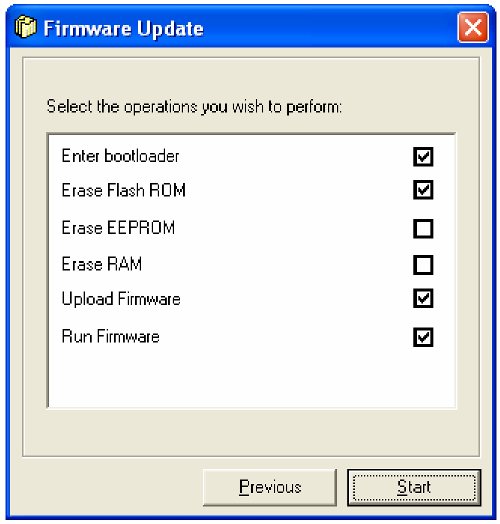

Figure 15. Firmware Update operations screenshot

8. Ensure the analyzer is switched off using the switch under the front panel.
9. Click 'Start'.
10. Switch the analyzer on.
11. The Firmware Updater window will show each step as the firmware is uploaded. DO NOT turn the analyzer off until the 'Close' button is enabled as shown below, and the Analyzer is operating as usual again.

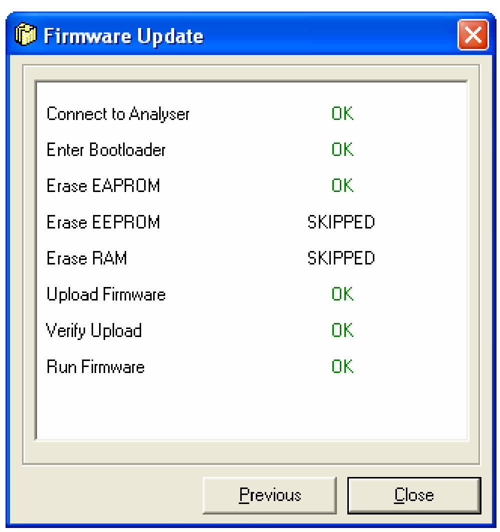

Figure 16. Firmware Update completion screenshot

4.0 Troubleshooting

4.1 DC Power Supply Voltages

Before consulting the troubleshooting section, verify that the DC power supply voltages are present and within the specifications given for each printed circuit board listed in the following table.

Troubleshooting Voltage Table				
PCB	**Supply**	**DVM(-)**	**DVM(+)**	**Response**
Microprocessor	+12V GOOD* -10V -20V	TP1 (PGND)	TP2 TP3 TP4	+5V ±0.5V -10V ±0.5V -20V ±0.5V
Voltage Regulator	+12V +10V -10V +5V	TP7 (AGND)	TP9 TP8 TP6 TP4	+12V ±0.5V +10V ±0.5V -10V ±0.5V +5V ±0.25V
Preprocessor	+12V +5V +10V -10V	TP1 (AGND)	J3-1, J3-6 J3-3 J3-4 J3-5	+12V ±0.5V +5V ±0.25V 10V ±0.5V -10V ±0.5V
Lamp Driver	+12V	TP1 (AGND)	TP5	+12v ±0.5V
Flow Control (A Series)	+5VL +4.5VB +12V	TP1 (AGND)	J2-1 J2-4 J2-8	+5 ±0.25V +4.5 ±0.25V +12 ±0.5V
Flow/Pressure (B Series)	+10V -10V	TP2 (AGND)	J1-4 J1-5	+10V ±0.5V -10V ±0.5V

* The +12V GOOD test point is a 5 volt status output from the power supply to indicate that the Mains supply is within the correct operating range.

4.2 Troubleshooting the EC9811 Analyzer

Because of the sophisticated design of the EC9811 analyzer, a significant amount of information about the condition of the system is available on the front panel display. You can therefore troubleshoot an operating instrument without opening the front cover.

The most useful menus in terms of troubleshooting are:

- PREPROCESSOR POTS
- VALVE TEST MENU
- EVENT LOG

- INSTRUMENT STATUS
- SYSTEM TEMPERATURES
- SYSTEM FAULTS.

These menus provide information that may indicate a failure or an operational problem. If instrument performance appears to have changed dramatically, the component that is causing the problem can possibly be determined, thereby speeding up the corrective process. It may assist the operator to periodically check and record these parameters to establish an operational history of the analyzer. In addition, information from this section may be requested by Ecotech Service support personnel when assistance is required.

4.2.1 Preprocessor Pots Menu

```
                  PREPROCESSOR POTS

MEASURE COARSE ZERO      : 62 (10 – 90)
MEASURE FINE ZERO        : 42 (0 – 99)
INPUT                    : 68 (10 – 90)
TEST MEASURE             : 0
LAMP ADJUST              : 58 (40 – 80)

REF. VOLTAGE             1 – 4 VOLTS
O3                       0 – 20
CONC. VOLTAGE            0.0 – 4.5 VOLTS
LAMP CURRENT             9.5 – 10.5 MA
```

Figure 17. Preprocessor Pots and Ranges

The PREPROCESSOR POTS screen displays the potentiometer settings associated with several components and variables on the preprocessor board. Figure 17 illustrates a typical test screen for an instrument that is operating normally. The values of the potentiometer settings are somewhat arbitrary, so differences in the examples shown here and the values displayed on an operating instrument should not be construed as a definite indicator of a problem. Potentiometer settings of 99 and 0, however, represent the extreme limits of the potentiometer range and may be reason to suspect a problem. The exception is TEST MEASURE, which is zero unless changed by an operator.

4.2.2 Flow Control Pots Menu

The FLOW CONTROL POTS screen displays the potentiometer settings associated with several components, variables, or signals on the A series Flow Control board. Figure 18 illustrates a typical test screen for an instrument that is operating normally. Like PREPROCESSOR POTS, the value of the potentiometer settings is somewhat arbitrary. Potentiometer settings 99 and 0, however, represent the extreme limits of the potentiometer range and may be reason to suspect a problem.

```
                    FLOW CONTROL POTS

         FLOW CONTROL ZERO  : 81 (50 –90)
         FAN SPEED CONTROL  : 16 (0 - 99)
         PUMP SPEED FINE    : 85 (0 - 99)
         PUMP SPEED COARSE  : 36 (20 - 60)


         GAS FLOW            0.505  SLPM
         GAS PRESSURE        585.6  TORR
```

Figure 18. Flow Control Pots Range

4.2.3 Valve Test Menu

```
                    VALVE TEST MENU

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

Figure 19. Valve Test Menu

The `VALVE TEST MENU` displays the current status of each valve in the instrument. This menu can be particularly useful in correcting flow problems in the machine. The valves can be opened and closed from this menu, thus allowing the operator to determine whether valves are operating correctly. `VALVE SEQUENCING` must be `ON` in order for correct gas measurements to be accomplished.

4.2.4 Event Log

Upon noting a possible operational problem, examine the `EVENT LOG` menu to determine whether the microprocessor is reporting a system failure or problem. Should the `EVENT LOG` indicate an error, it will also provide information as to the portion or component of the instrument which is at fault.

Event Log Messages		
Message	**Description**	**Action**
RAM CHECKSUM FAILURE	Checksum of memory at power down differs from checksum at restart.	Battery failure or system software error. If error persists, call Ecotech Customer Service for instructions.

Event Log Messages		
Message	**Description**	**Action**
SERVICE SWITCH ACTIVATED	Unit taken out of service from front panel.	Return analyzer to service using the front panel switch.
LCD DISPLAY BUSY	LCD constantly busy indicates hardware failure in display.	Check display cable connection, Display PCA, and Microprocessor PCA.
A/D CONVERSION ERROR	A/D returned busy status	Normal at startup. If failure persists, replace microprocessor.
SYSTEM POWER FAILURE	Power removed from system.	No action required.
SYSTEM POWER RESTORED	Power applied to system.	No action required.
INPUT POT LIMITED TO 0 OR 99	Input pot adjustment exceeds range.	Check UV lamp or clean Rx cell.
LAMP ADJUST ERROR	Lamp adjust pot reached limit before 10 mA lamp current was achieved.	Check UV lamp, Lamp Driver PCA, or Preprocessor PCA.
ZERO POT LIMITED TO 0 OR 99	Zero voltage controller reached limits before voltage reached set point.	Reset analyzer, check zero air source.
ZERO FLOW	Instrument flow has gone to zero.	The pump has failed or a flow obstruction has occurred. Replace pump, or clear obstruction.
SPAN RATIO <0.75	After AZS cycle, ratio of requested span to measured span is <0.75.	Instrument span has drifted beyond acceptable limits. Recalibrate.
SPAN RATIO >1.25	After AZS cycle, ratio of requested span to measured span is >1.25.	Instrument span has drifted beyond acceptable limits. Recalibrate.
RESET DETECTION	Reset button pressed or watchdog timer caused reset.	Unless the reset was not initiated by the user, no action is required.
AZS CYCLE	AZS cycle started.	No action required.
ELECTRONIC ZERO ADJUST	An analyzer electronic zero cycle was initiated.	Normal after reset or power failure. If not associated with these, check zero air supply.
DATA LOGGING MEM FAIL	Occurs if unable to write to datalogging memory.	Battery failure or system software error. If error persists, call Ecotech Customer Service for instructions.

Event Log Messages		
Message	**Description**	**Action**
CONTROL LOOP RESTARTED	Occurs when Control Loop has been disabled, and then automatically enabled after the main screen has been visible for the last 1 minute.	No action required.
VALVE SEQUENCING RESTARTED	Occurs when valve sequencing has been disabled, and then automatically enabled after the main screen has been visible for the last 1 minute.	No action required.

4.2.5 Instrument Status

```
                  INSTRUMENT STATUS

      GAS FLOW          : 0.375 –  0.625  SLPM
      GAS PRESSURE      : 690   –  760    TORR
      REF. VOLTAGE      : 2.0  –  3.20    VOLTS
      CONC. VOLTAGE     : 0.00  –  4.50   VOLTS
      ANALOG SUPPLY     : 11.6  –  12.2   VOLTS
      DIGITAL SUPPLY    : 4.8   –  5.2    VOLTS
      O3 GEN. FLOW      : 4.17            SLPM
      LAMP CURRENT      : 9.8   –  10.2   mA

      VERSION 1.11.0002                         EXIT
```

Figure 20. Instrument Status Ranges

If any of the parameters displayed on the INSTRUMENT STATUS screen vary significantly from the values shown in Figure 20, the fault or operational problem is probably related. This is also true if one of the parameters is demonstrating a rapid change or is oscillating strongly around the desired setpoint. For more information on the operational limits and fault messages, refer to the table in section 4.2.7 System Faults.

Several of the parameters displayed on the INSTRUMENT STATUS screen are affected by the potentiometer settings on the PREPROCESSOR POTS screen. If a parameter is out of the normal operating range, make note of the parameter value, proceed to the respective menu, and examine the pertinent potentiometer settings.

4.2.6 System Temperatures

```
                  SYSTEM TEMPERATURES

       CELL TEMP.        : 22 – 38   DEG C
       LAMP TEMP.        : 45 – 55   DEG C
       CHASSIS TEMP.     : 25 – 35   DEG C
       FLOW TEMP.        : 45 – 55   DEG C

                                                EXIT
```

Figure 21. System Temperatures and Tolerances

The SYSTEM TEMPERATURES screen provides the temperatures of the lamp, the chassis, and the flow control block. Figure 21 contains the nominal values which should be displayed on this screen. If any of the parameters are outside the acceptable ranges, a significant problem among these components is strongly indicated. For more information on the operational limits and fault messages, refer to the table in section 4.2.7 System Faults.

4.2.7 System Faults

The SYSTEM FAULTS display provides start, pass or fail indications for various parameters which are continually monitored. These parameters must be within acceptable operating ranges in order to display PASS. If FAIL is indicated, this indicates a major failure in that area. If the instrument is in startup mode, START will be displayed.

Note

The SYSTEM FAULTS screen only indicates PASS or FAIL for the various analyzer parameters, and indicates a major failure. Desired operating ranges are indicated in the INSTRUMENT STATUS and SYSTEM TEMPERATURE ranges section. If analyzer readings are not within these ranges, it could indicate deterioration of certain assemblies within the analyzer, or minor failures.

The following table lists the possible SYSTEM FAULTS messages which are displayed on the primary screen if a major failure occurs. If a fault message is displayed, use the troubleshooting guide to find the possible cause of the fault.

System Fault Messages	
Message	**Description/Failure Limits**
OUT OF SERVICE	Indicates the Service switch is in the OUT position. Unless the analyzer is being serviced, this switch should be in the IN position.
ZERO FLOW	Indicates that measured flow has gone below 0.05 SLPM.
LAMP FAILURE	Indicates that the lamp current is not within the acceptable limits. In the EC9811, a fault is indicated if the lamp current is ***below*** 5 mA or ***above*** 15 mA.
REFERENCE VOLTAGE OUT OF RANGE	Indicates that the reference voltage is not within the acceptable limits. In the EC9811 a fault is indicated if the reference voltage is ***below*** 1 volt or ***above*** 4 volts.
12 VOLT SUPPLY FAILURE	Indicates that the 12 volt supply voltage is not within the acceptable limits. A fault is indicated if the 12 volt supply voltage is ***below*** 11.1 volts or ***above*** 14.3 volts.
CELL TEMPERATURE FAILURE	Indicates that the cell temperature is not within the acceptable limits. A fault is indicated if the cell temperature is ***below*** 5° C or ***above*** 60° C.
FLOW BLOCK TEMP	Indicates the flow block temperature is not within acceptable limits. A fault is indicated if the flow temperature is ***below*** 35° C or ***above*** 60° C.
STABILIZATION	Displayed If the reference voltage becomes momentarily unstable. It is displayed until the lamp achieves stability.
START UP SEQUENCE ACTIVE	Indicates that the analyzer is in start-up mode. Usually after power-up or reset.
LAMP TEMPERATURE FAILURE	Indicates the lamp temperature is not within acceptable limits. A fault is indicated if the lamp temperature is ***below*** 35° C or ***above*** 60° C.

4.3 Test Functions

The following diagnostic modes are available in the EC9811 under the TEST MENU:

4.3.1 Optic

Not supported.

4.3.2 Preamp

The preamp test function generates an electronic test signal which is applied to the input of the UV detector preamp. This simulates an input from the detector and is then processed as if it were an actual signal. This test is used to verify the operation of the detector.

4.3.3 Electric

The electric test function generates an electronic test signal which is applied to the input of the preprocessor. This simulates an input to the preprocessor and is then processed as if it were an actual signal. This test is used to verify the operation of the preprocessor PCA reference and measure channels.

4.3.4 Use of Diagnostic Modes

The diagnostic modes are actuated by selecting `DIAGNOSTIC MODE: PREAMP` or `ELECTRIC` and adjusting the `TEST MEASURE` potentiometer until a response (simulated concentration) is noted. Response to tests will vary depending upon individual analyzer parameters. These tests are typically pass/fail. Functional problems can sometimes be isolated to a single component by logical use of the diagnostic modes.

4.4 Troubleshooting Guide

Use this troubleshooting guide to find the symptom, then follow in order the possible causes and fault isolation/solutions until the problem is discovered. Then take the action described.

If you cannot identify the problem, contact Ecotech at the locations given in the front of this manual.

System Troubleshooting Table

Symptom	Possible Cause	Fault Isolation/Solution
1. No display/ instrument dead	AC power	1. Verify that the line cord is connected. 2. Check that the power supply fuse is not open. The fuse should be 5A (115 v) or 3A (230 v). 3. Verify that the Voltage switch is in the proper position.
2. No display	Contrast misadjusted	Set or adjust the display by simultaneously pressing two keys on the front panel as follows: - *Contrast*: Press Up arrow (↑) and <Select> for darker contrast, Down arrow (↓) and <Select> for lighter contrast.

System Troubleshooting Table		
Symptom	**Possible Cause**	**Fault Isolation/Solution**
	DC power	1. Verify the cable connection from the power supply to the Vreg board. 2. Check the Vreg board for correct voltages as listed in the troubleshooting voltages table in section 4.1. If incorrect voltages are found, replace the power supply or Vreg. 3. Check Microprocessor test points listed in the Troubleshooting Voltages table in section 4.1.
	Display	Check the interface cable between the display and J6 on the Microprocessor board.
	Bad display or Microprocessor PCA.	1. Replace the front panel display. 2. Replace the Microprocessor board. 3. A bad cable is unlikely, but if you suspect it, perform a pin-for-pin continuity test using an ohmmeter.
3. Zero flow	Pump failed	Replace the pump.
	Filter	Check the particulate filter. Replace if dirty or plugged.
	Flow control assembly (A Series)	Recalibrate the Flow Control Assembly.
	Pressurized Rx cell	Ensure sample and zero inlets are maintained at ambient pressure.
	Plugged orifice or SS filter (B series)	Clean or replace the orifice and SS filter.
4. Noisy or unstable readings	Leaks	A leak dilutes the sample stream and causes low span readings and noise. See section 3.3.7 above.
	Particulate filter	Replace the particulate filter.
	Rx cell temperature	Ensure the reaction cell and analyzer covers are installed.
	Scrubber	Check ozone scrubber.
	Rx cell dirty	Clean Rx cell.
	UV lamp	Check UV lamp.
	UV detector	Replace UV detector.
5. Low span	Span setting	Adjust the span using the Calibration Procedure in *Chapter 3, Calibration*.
	Scrubber	Check ozone scrubber.
	Rx cell dirty	Clean Rx cell.
	UV lamp	Check UV lamp.
	No flow	See the *Zero flow* symptom in this table.
	Leaks	A leak dilutes the sample stream and causes low span readings and noise. See section 3.3.7 above.
6. No response to	Instrument gain	Verify the instrument gain is not set to 0.000.

System Troubleshooting Table		
Symptom	**Possible Cause**	**Fault Isolation/Solution**
span gas	Leaks	A leak dilutes the sample stream and causes low span readings and noise. See section 3.3.7 above.
	No flow	Check the INSTRUMENT STATUS menu and verify flow.
	Software lockup	1. Observe whether ECOTECH GLOBE on the display is turning. 2. Verify that other menus can be selected. 3. Press the Reset button on the secondary panel. 4. Check that D5 HEART BEAT LED is flashing on the Microprocessor Board.
7. Zero drift	Leak	A leak dilutes the sample stream and causes low span readings and noise. See section 3.3.7 above.
	Zero air source	Replace zero air source.
8. Unstable flow or pressure readings	Failed flow control heater	The flow temperature (SYSTEM TEMPERATURES screen) should be 50° ±5° C.
9. Instrument stuck in reference adjust	Reference voltage (INSTRUMENT STATUS screen) not at 3 volts.	Perform UV lamp check and adjustment.
	Lamp current not at 10 mA.	Replace UV lamp, Lamp Driver PCA, or Preprocessor PCA.
10. Response time not at specified value	Low flow	Check sample flow with flowmeter. It should be 0.4 to 0.6 slpm @ STP. Replace SS filter or orifice if it is not.
11. Analyzer displays BAD I.D. ANALYZER	Preprocessor ID set wrong	1. Check J5 connector on Microprocessor. 2. Check J4 connector on Preprocessor. 3. Reprogram device ID. 4. Replace Preprocessor
12. No Ozone output.	Tubing missing	Verify ozone generator output connected to inlet.
	Ozone lamp not plugged in	Plug in lamp.
	Generator turned off	Instrument must be in MANUAL CAL SPAN or generator must be turned on using O3 GEN MENU.
	Burned out ozone producing lamp	Replace ozone producing lamp.

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