

# **EC9850**

## **A & B Series**

# **Sulfur Dioxide Analyser**

**User Manual**

**Revision: D**



# EC 9850

## Quick Start Guide.

### Step 1 – Installation:

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

### Step 2 – Start-up:

---

- |  |                                  |
|--|----------------------------------|
| • Set Service Switches.  | <i>Service Manual:- 1.1.2.</i>   |
| • Turn On power.   | <i>Operation Manual:- 2.2.</i>   |
| • The Display should read “9850 SO2 Analyzer”.   |                                  |
| • Adjust the Display Contrast if required.   | <i>Operation Manual:- 2.2.1.</i> |
| • Verify that the software is running by observing the Ecotech Globe rotating in the bottom left hand corner of the display. |                                  |

### Step 3. – Operation:

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- |   |                                   |
|---|-----------------------------------|
| • Verify Instrument warm up and operation mode. | <i>Service Manual:- 2.2.</i>      |
| • Set the correct time and date.                | <i>Operation Manual:- 2.3.3.</i>  |
| • If using RS232, configure the Interface menu. | <i>Operation Manual:- 2.5.12.</i> |
| • Check SYSTEM FAULTS menu. All PASS.           | <i>Operation Manual:- 2.5.21.</i> |
| • Verify other menu settings.                   | <i>Service Manual:- 4.2.</i>      |

### Step 4. – Calibration:

---

- |   |                                  |
|---|----------------------------------|
| • Perform a quick (single point) calibration.             | <i>Operation Manual:- 2.4.</i>   |
| • Setup and Calibrate the Analog Outputs (if applicable). | <i>Operation Manual:- 2.6.3.</i> |
| • If necessary, perform a leak check.                     | <i>Service Manual:- 3.3.13.</i>  |
| • If necessary, perform a flow calibration.               | <i>Service Manual:- 3.5.</i>     |
| • If necessary, perform a Multipoint calibration.         | <i>Operation Manual:- 3.2.</i>   |

### Step 5. – Data Validation:

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- Verify the results from your data acquisition system agree with the readings of the EC 9850 SO2 analyzer.
- Verify that the analyzer responds to automatic calibration sequences.

**The analyzer is now operating correctly.**

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## Manual History

This manual is the combination of two previous versions which have now been merged into one document to cater for the continuing development of the EC9800 series analyzers. The original manuals were:

- ML9850 Operation Manual , PN: 98500022, Rev. V, December 1998.
- ML9850B Operation Manual , PN: 98507005, Rev. P, July 1999.

The scope of this new manual covers the following analyzers:

- EC9850 Sulfur Dioxide Analyzer, (A-Series), PN: 98501000-100.
- EC9850B Sulfur Dioxide Analyzer, (B-Series), PN: 98507000-1.

Both of the instruments are Manufactured by Ecotech P/L in Australia and support the new (SMD) Microprocessor Board (Part number 98000063-4). This manual is current for firmware version 1.33 and above.

**Ecotech Manual ID:** MAN 0022.  
**Manual PN:** 98507600.  
**Current Revision:** D  
**Date Released:** April 2007.  
**Description:** EC9850 Sulfur Dioxide Analyzer, Operation Manual, A & B Series.

## Revision History

Rev	Date	Summary	Affected Pages
A	Jan 2004	New Release for new Microprocessor Board. A & B series Combined. Based on original manuals.	All
B	Feb 2004	Changes to menu options and structure.	All
C	June 2005	Changed to updated EC manual, format and updated safety information.	All
C-1	November 2005	Added Calculation factors menu	2-30
		Added C-tick information, updated CE information	3
D	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.

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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*



## Sulfur Dioxide Analyzer

### Scope of Declaration

The declaration applies to Sulfur Dioxide Analyzers as manufactured by Ecotech P/L, and which may be sold in the following configurations:

Part Number	Description
98501000-100	Sulfur Dioxide Analyzer
98507000-T	Sulfur Dioxide Analyzer Trace
98507000-1	Sulfur Dioxide Analyzer, B Series
98507000-H1	Sulfur Dioxide Analyzer High Level
98507000-2	Sulfur Dioxide Analyzer with IZS

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.**

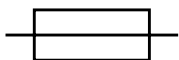
- Immunity Requirements EN61326-1
  - IEC-61000-4-11 Voltage Interrupts
  - IEC-61000-4-11 Voltage Dips
  - IEC-61000-4-3 Radiated RF electromagnetic field immunity test
  - IEC-61000-4-4 Electrical fast transient/burst immunity test
  - IEC-61000-4-5 Surge immunity test
  - IEC-61000-4-6 Immunity to 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

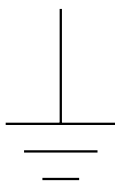
The equipment must be operated as per the directions given by Ecotech P/L in this manual.

## 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



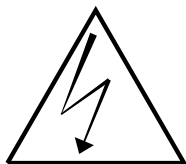
IEC 60417, No. 5041

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 EC9850 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~  $\pm 10\%$
- 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 Centre 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 (eg, 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.



### **Service and Spare Parts**

**For world wide customer service & spare parts contact ECOTECH:**

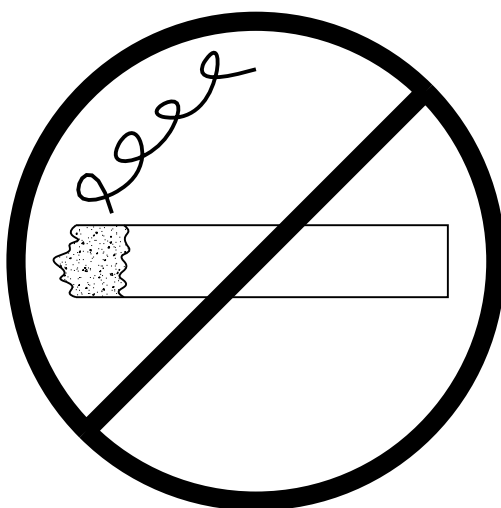
<b>Address:</b>	<b>Ecotech Pty Ltd 1492 Ferntree Gully Rd Knoxfield Australia. VIC 3180</b>
<b>Phone:</b>	<b>+61 1300 364 946</b>
<b>Fax:</b>	<b>+61 1300 668 763</b>
<b>Email - Service:</b>	<b>ecotech@ecotech.com.au</b>
<b>Email - Spare Parts:</b>	<b>parts@ecotech.com.au</b>
<b>Web:</b>	<b>www.ecotech.com.au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

**Our Service Response Centre 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

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The EC9850 sulfur dioxide (SO<sub>2</sub>) analyzer is an ultraviolet (UV) fluorescence spectrometer designed to continuously measure low concentrations of SO<sub>2</sub> in ambient air. The 9850 analyzer comprises an optical sensor assembly, an analog electronic signal preprocessor module, microprocessor-based control and computation electronics, and a pneumatic system that samples ambient air by point monitoring.

The EC9850 A series has a built in charcoal scrubber that provides SO<sub>2</sub>-free zero air to the analyzer, the instrument is designed to monitor the fluorescence background signal by periodically sampling SO<sub>2</sub> scrubbed air. This results in the virtual elimination of zero drift. This feature is an optional extra in the 9850 B series, where an external scrubber is normally used.

In addition to temperature and pressure compensation, the analyzer adjusts the 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. The operator can select analog output as either current or voltage output. Current ranges are 0 to 20 mA, 2 to 20 mA, or 4 to 20 mA. Voltage outputs with the 50-pin I/O board include 0 to 10 V, 0 to 5 V, 0 to 1 V, and 0 to 0.1 V. (The 50-pin I/O board is optional in the EC9850 B series).

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 EC9850 also features internal data storage capabilities.

The instrument 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 US.EPA has designated the EC9850 sulfur dioxide analyzer as an *Equivalent Method*. Included in section 1.2 are 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 0-0.05 ppm and 0-1.0 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, 0.1 ppb per °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 120 seconds with Kalman filter active.

### **1.1.8 Linearity Error**

±1% of full scale (from best straight-line fit).

### **1.1.9 Precision**

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

### **1.1.10 Sample Flow Rate**

0.50 slpm (A series)

0.60 slpm (B series)

### **1.1.11 Sample Pressure Dependence**

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

### **1.1.12 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.

### **1.1.13 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.

### **1.1.14 Weight**

25 kg (55.1 lb) (A series)

21.3 kg (47 lb) (B series)

### **1.1.15 Analog Output**

- Menu selectable current output of 0-20 mA, 2-20 mA, and 4-20 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%. The 9850B requires an optional 50-pin I/O board to enable voltage output.

#### **1.1.16 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 EC9850 series sulfur dioxide analyzers are designated under U.S. EPA regulations as equivalent method EQSA-0193-092. Using the EC9850 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 from 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: 0.50 SLPM. (A series)
- Flow rate: 0.65 SLPM (B series)
- Pump: Internal Pump (A Series), Ecotech external pump or equivalent (B Series) (see section 2.1.2.3).
- Filter: A 5 micron PTFE filter must be installed in front of the sample inlet (Zero and Span gas must pass through this filter).
- EC9850B series analyzer must be fitted with a zero air scrubber.
- 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 PPM 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
  BACKGROUND: not DISABLED

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

- ❑ The Service switch must be positioned to IN.

The EC9850 series analyzers are U.S. EPA equivalent with or without the following options/items:

- ❑ valve assembly for external zero/span (EVS)
- ❑ rack mount assembly
- ❑ 50-pin connector PCA
- ❑ exhaust scrubber
- ❑ internal zero/span assembly (IZS)

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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 *EC9850 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 5° to 40° 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" (61 cm) deep and fits into a 19" (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**

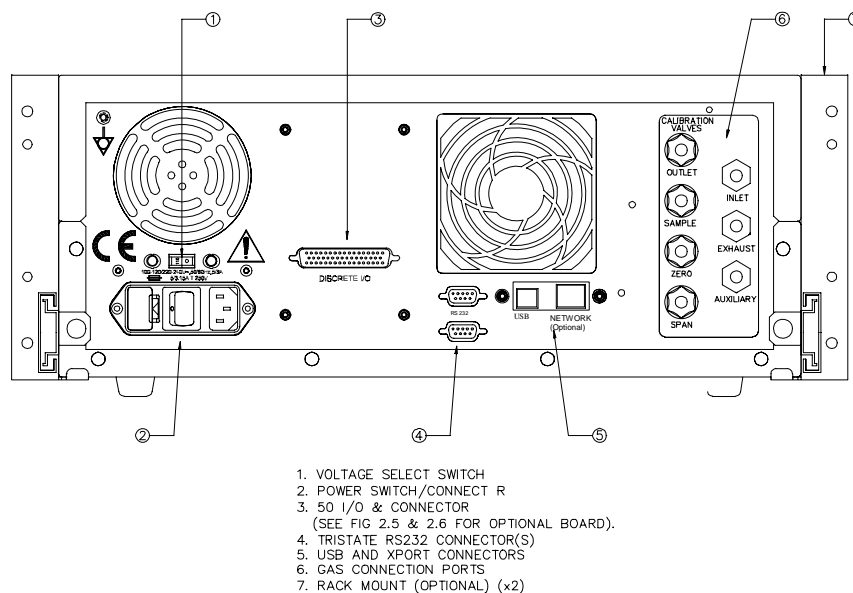
**The rack-mount version requires a properly ventilated rack enclosure. The temperature inside enclosures that are not properly ventilated may rise as much as 15° C above the ambient air temperature. This may force the analyzer to operate outside of specifications. Optimum operation is obtained at an operating temperature of 20° to 30° 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 below 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

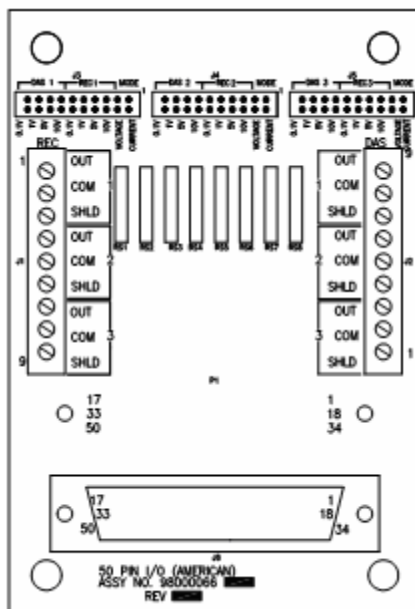
#### Caution

The EC9850 analyzer 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.

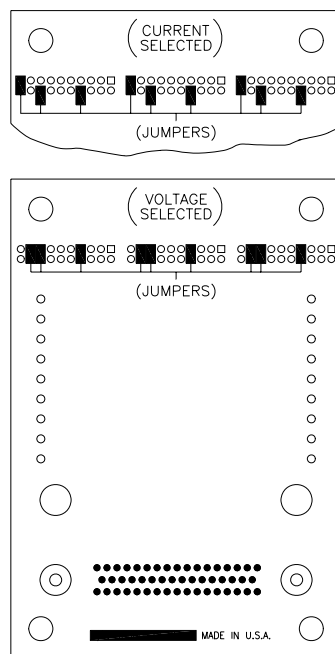
The 50-pin I/O PCA is optional for the EC9850 B series analyzer.



**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 EC9850 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 EC9850 should be maintained at ambient pressure, with any excess flow vented to the atmosphere.**

The EC9850 requires at least 1.00 slpm (0.65 slpm sample plus 50% overflow) of particulate-filtered (<5 micron), dry (noncondensing) 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 stainless steel, 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.

#### 2.1.2.3.2 B Series

Connect the exhaust port of the analyzer to a vacuum pump capable of 4 slpm at 15" Hg (50 kPa) vacuum (minimum capacity). The exhaust of the pump should be connected to a manifold to vent the exhaust gas away from occupied areas. If desired, a charcoal exhaust scrubber may be placed in the exhaust line to remove SO<sub>2</sub>.

Optional exhaust pump and exhaust scrubber are available from Ecotech.

#### **Caution**

**Flow in the EC9850B is calculated assuming critical pressure across an orifice, thus the exhaust vacuum must be maintained at less than 1/2 atmosphere (approximately 15" Hg (50 kPa) at sea level) to keep the orifice critical. It is advisable that the user install a vacuum gauge on the exhaust line and periodically check that sufficient vacuum is being maintained. If pump performance deteriorates below this level, flow indications from the analyzer will no longer be valid.**

#### 2.1.2.4 Zero Air Connection – B Series only

#### **Caution**

**Sample and zero air connections to the EC9850B should be maintained at ambient pressure, with any excess flow vented to the atmosphere.**

Ecotech recommend that only a charcoal scrubber be connected to the aux port. This optional zero air scrubber is available from Ecotech **Pty. Ltd.**

## 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**

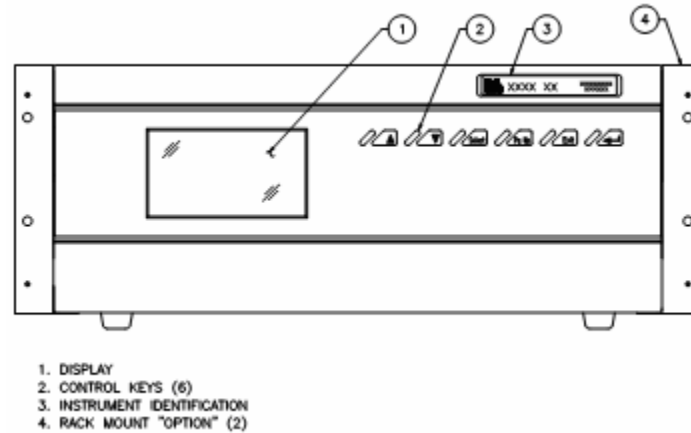
**Be sure to check that the mains power selection switch is at the correct setting before turning the instrument on. Failure to do so may result in damage to the power supply.**

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**

When the instrument is initially powered up, several components in the instrument are automatically configured by the microprocessor and an automatic zero is run. This process requires about 30 minutes. During the startup period, several messages are displayed on the initial screen. These indicate the progression toward normal operation.

Initial Screen Message	Instrument Activity
REFERENCE ADJUST	Lamp turned on and allowed to stabilize. PMT high voltage set.
AUTO ZERO ADJUST / ELECTRONIC ZERO ADJUST	Coarse zero of measurement channel with zero air flowing.
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).

**Note**

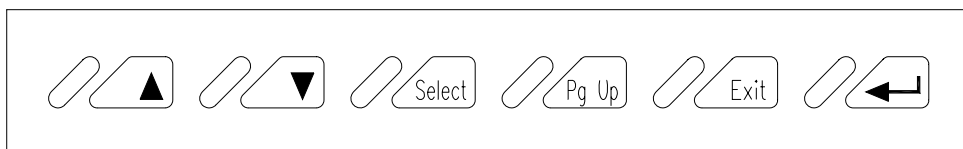
The EC9850 will re-run the above startup routine whenever power has been lost for greater than two minutes. If power is lost for less than two minutes the analyzer will return to its previous settings without the startup routine.

## 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 EC9850 are performed by pressing the 6 keys available on the front panel to the right of the display screen. The key functions are described on the following page.



**Figure 2-5. Analyzer Keyboard**

The key functions are listed below:

- *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 EC9850 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 arrows 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 the 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 EC9850 analyzer is powered on *for the first time*, the analyzer must be calibrated to ensure accurate SO<sub>2</sub> measurements. The analyzer does not require recalibration 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 whether 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 known 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 *chapter3* 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 known 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 EC9850 analyzer. For complete gas preparation and multipoint calibration instructions please refer to the multipoint calibration information in *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 (▲ 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 SO<sub>2</sub> 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.

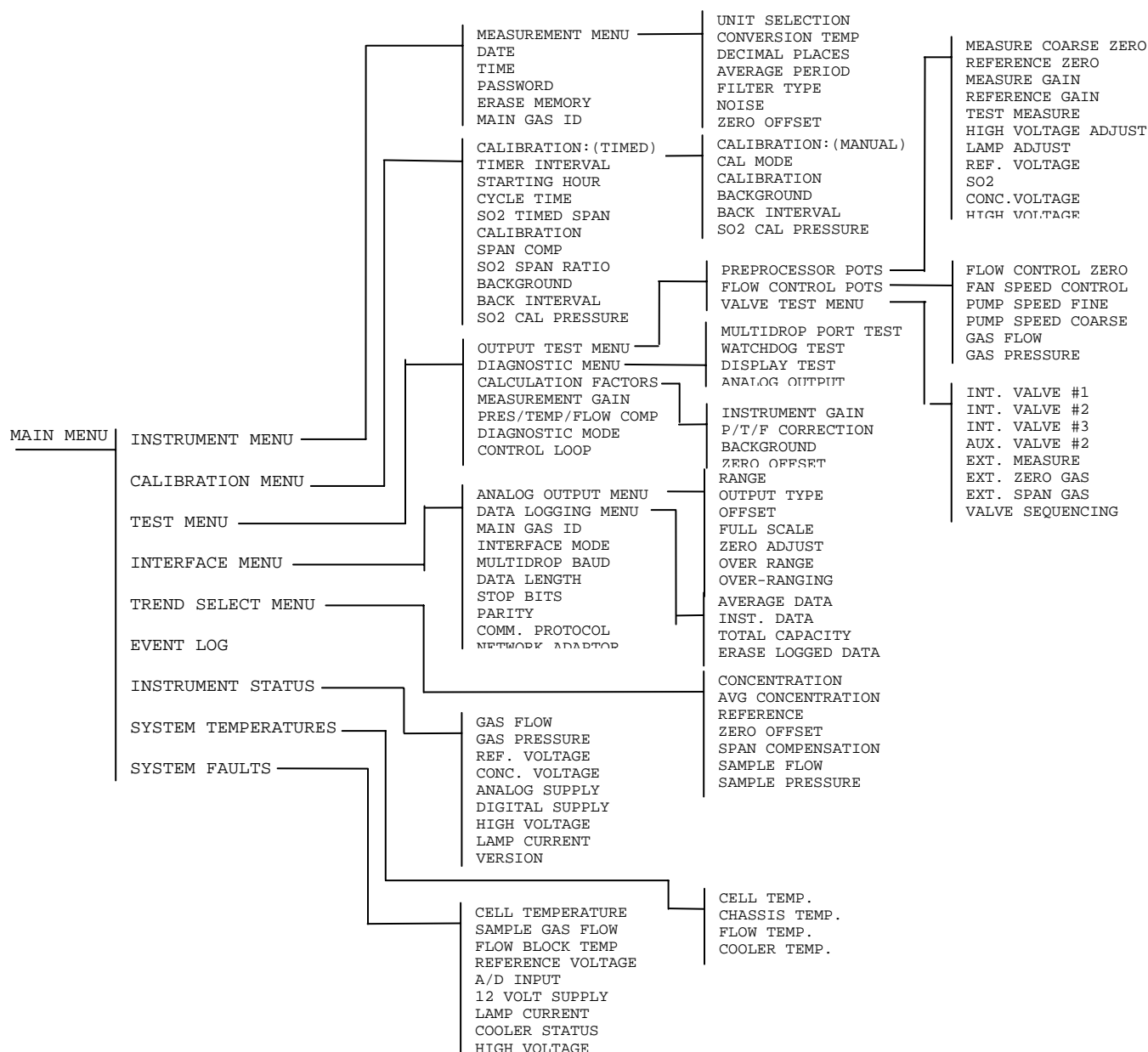
##### **Note**

The auto-zero function of the EC9850 eliminates the need for a traditional zero calibration.

This completes the span calibration of the EC9850 analyzer.

## 2.5 Menus and Screens

This section illustrates the various menus and screens for the EC9850 A series analyzer. The B series menu structure will be very similar in structure yet will not have some of the options that are available in the A series (These will be made clear throughout the relevant sections). A short description of each menu and screen is provided. The entire menu structure is shown in Figure 2-6 below.

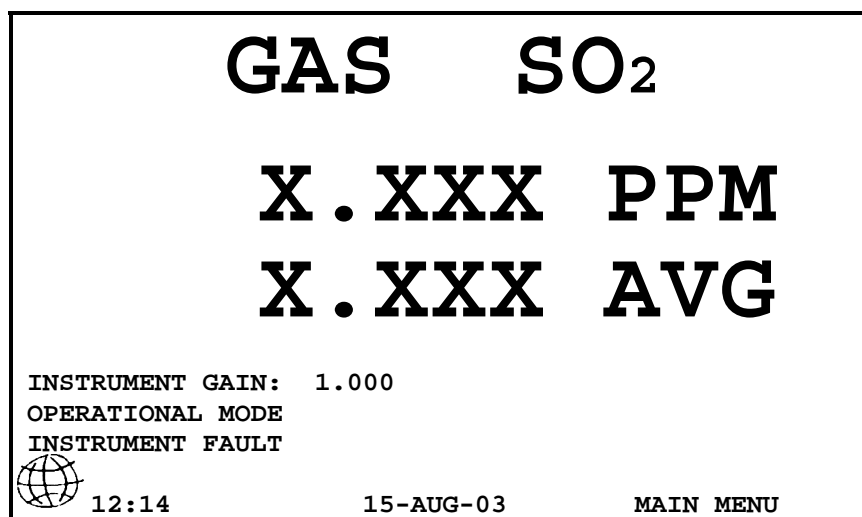


**Figure 2-6. Menu Structure**



**Note**

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

**2.5.1 Primary Screen****Figure 2-7. Primary Screen**

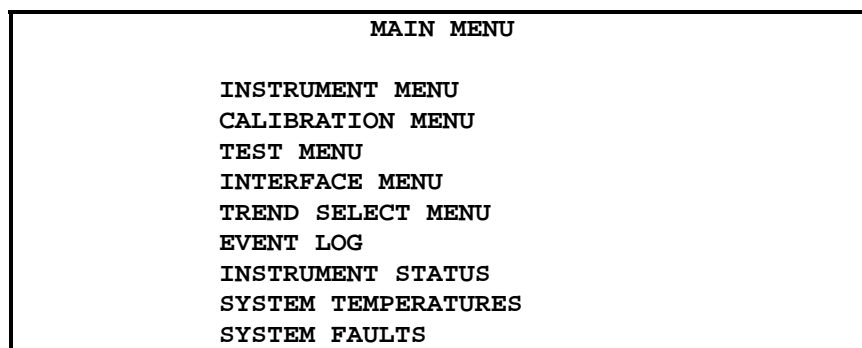
When power is applied, the screen displays the Ecotech logo for a few seconds. It then identifies the analyzer and the notation **MAIN MENU** appears in the lower right corner. In the lower left hand corner there is the Ecotech Globe rotating, indicating that the program is running. After the warmup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

Instrument faults will be reported on the status line which appears one line below the instrument state display. The following rules apply governing 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> or <Enter> key to enter the MAIN MENU.

### 2.5.2 Main Menu



**Figure 2-8. Main Menu**

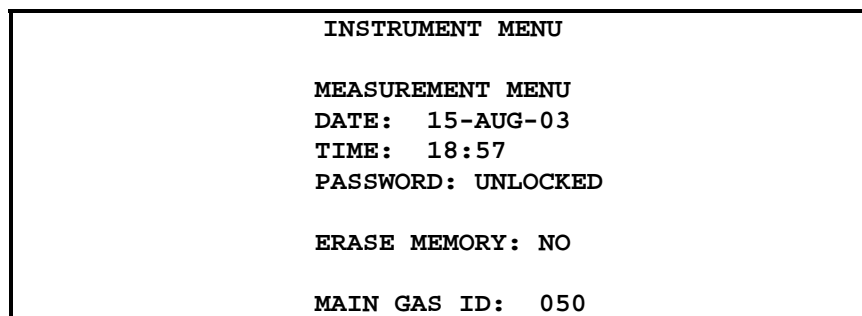
Except for the last four menus, each of the menus listed in Figure 2-8 has one or more levels of menu items contained within the selection.

The EVENT LOG is a log created by the microprocessor to indicate deviations in the operating parameters. This item 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 is a pass/fail indication of various parameters which are continually monitored. These parameters must be within acceptable operating ranges in order to display PASS.

### 2.5.3 Instrument Menu



**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 2.7.

**ERASE MEMORY**

Memory can be erased in two different ways, either `RAM` which does not wipe some settings or `SETTINGS` which will erase everything and reset all settings to default. If you do not wish to erase all setting select `NO` when, 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.**

**MAIN GAS ID**

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

## 2.5.4 Measurement Menu

MEASUREMENT MENU	
UNIT SELECTION	: $\mu\text{G}/\text{M}^3$
CONVERSION TEMP	: 0 DEG C*
DECIMAL PLACES	: 3
AVERAGE PERIOD	: 1 MINUTE
FILTER TYPE	: KALMAN
NOISE	: 0.204 PPB
ZERO OFFSET	: 0.00 PPB

Figure 2-10. Measurement Menu

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

### UNIT SELECTION

PPM (parts per million),  $\text{mG}/\text{M}^3$  (milligrams per cubic meter),  $\text{nG}/\text{M}^3$  (nanograms per cubic meter),  $\mu\text{G}/\text{M}^3$  (micrograms per cubic meter), PPT (parts per trillion) or PPB (parts per billion).

### Note

If the gravimetric units are selected ( $\text{mG}/\text{M}^3$ ,  $\mu\text{G}/\text{M}^3$  or  $\text{nG}/\text{M}^3$ ), then the conversion factors listed below will apply depending on the CONVERSION TEMP selected.

To convert 1 PPB "Gas" to $\mu\text{g}/\text{m}^3$ @	0 °C	20 °C	25 °C
<b>Multiply by:</b>			
SO <sub>2</sub>	2.860	2.664	2.620

### 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.**

### CONVERSION TEMP

Sets the temperature that should be used in internal calculations to convert the concentration from volumetric units (ppm, ppb, ppt) into gravimetric units ( $\text{mG}/\text{M}^3$ ,  $\mu\text{G}/\text{M}^3$  or  $\text{nG}/\text{M}^3$ ) in DEGREES CELCIUS (0, 20, 25). \*This menu option is only displayed when the gravimetric units are selected.

**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 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.

**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  $\pm 10.00$  PPB.

**2.5.5 Calibration Menu**

The CALIBRATION MENU contains entries used to choose calibration gases or to perform automatic zero-span cycles. The choice of TIMED or MANUAL calibration displays a slightly different screen. TIMED calibration generates a zero/span check

that occurs at a chosen interval without operator intervention. **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
SO2 TIMED SPAN	:	10.000 PPM
CALIBRATION	:	INTERNAL
SPAN COMP	:	ENABLED
SO2 SPAN RATIO	:	1.0000
BACKGROUND	:	ENABLED
BACK INTERVAL	:	24 HOURS
SO2 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.

#### **SO2 TIMED SPAN**

Digital setting of the span concentration the operator expects the instrument to read during an AZS cycle. An entry is required only if **SPAN COMP** is **ENABLED**.

#### **CALIBRATION**

The choice of **INTERNAL** or **EXTERNAL** valves that will operate during a zero/span check. (The EZS valve option must be installed to use **EXTERNAL**.)

**SPAN COMP**

A choice of **ENABLED** or **DISABLED**. This function automatically corrects span readings to the expected value. See *Chapter 3* for additional information.

**Note**

For U.S. EPA designated use, **SPAN COMP** must be set to **DISABLED**.

**SO2 SPAN RATIO**

A microprocessor-generated field that displays the value by which the span reading is multiplied to correct it to the calibration value. This value is only applied if **SPAN COMP** is **ENABLED**.

**BACKGROUND**

A choice of **START**, **DISABLED** or **ENABLED**. If **START** is selected, then when <Enter> is pressed the instrument begins an auto-zero (background) cycle. If **DISABLED** is selected, then the instrument will not run the normal auto-zero (background) cycle. If **ENABLED** is selected, then the instrument will run the normal auto-zero (background) cycle.

**Note**

For U.S. EPA-designated use, the background cycle must *not* be disabled.

**BACK INTERVAL**

Set time in **HOURS** (2, 4, 6, 8, 12, 24). A microprocessor-controlled field that indicates when an autozero cycle will begin. The results of the background are stored in the **EVENT LOG**.

**SO2 CAL PRESSURE**

This is the measured ambient pressure during the last **SO2** calibration.

### 2.5.5.2 Manual Calibration

The following screen appears when CALIBRATION: MANUAL is selected.

CALIBRATION MENU	
CALIBRATION	: MANUAL
CAL.MODE	: MEASURE
CALIBRATION	: EXTERNAL
BACKGROUND	: ENABLED
BACK INTERVAL	: 24 HOURS
SO2 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. Selecting CYCLE starts an AZS cycle, which is discussed in *Chapter 3*.

#### CALIBRATION

The choice of INTERNAL or EXTERNAL valves that will operate during a zero/span check. (The EZS valve option must be installed to use EXTERNAL.)

#### BACKGROUND

A choice of START, DISABLED or ENABLED. If START is selected, then when <Enter> is pressed the instrument begins an auto-zero (background) cycle. If DISABLED is selected, then the instrument will not run the normal auto-zero (background) cycle. If ENABLED is selected, then the instrument will run the normal auto-zero (background) cycle.

#### Note

For U.S. EPA-designated use the background cycle must *not* be disabled.

#### BACK INTERVAL

Set time in HOURS(2, 4, 6, 8, 12, 24). A microprocessor-controlled field that indicates when an autozero cycle will begin.. The results of the background are stored in the EVENT LOG.



**SO<sub>2</sub> CAL PRESSURE**

This is the measured ambient pressure during the last SO<sub>2</sub> calibration.

**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
TEST MEASURE	: 0
SO <sub>2</sub>	: 0.00000 PPM

**Figure 2-13. 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 microprocessor controlled settings of 1, 2, 4, 8, 16, 32, 64, or 128.

**PRES/TEMP/FLOW COMP**

Either ON or OFF. OFF is used when running diagnostics to see fluctuations in readings; ON is used to compensate for environmental fluctuations 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 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 LOOPS will be set to ENABLED when the primary screen is displayed.*

**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.

**SO<sub>2</sub>**

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

**2.5.7 Output Test Menu**

OUTPUT TEST MENU	
PREPROCESSOR POTS	
FLOW CONTROL POTS	
VALVE TEST MENU	

**Figure 2-14. 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.

**2.5.8 Preprocessor Pots Screen**

PREPROCESSOR POTS	
MEASURE COARSE ZERO	: 42
REFERENCE ZERO	: 50
MEASURE GAIN	: 50
REFERENCE GAIN	: 39
TEST MEASURE	: 0
HIGH VOLTAGE ADJUST	: 61
LAMP ADJUST	: 83
REF. VOLTAGE	4.016 VOLTS
SO <sub>2</sub>	0.400 PPM
CONC. VOLTAGE	2.327 VOLTS
HIGH VOLTAGE	700 VOLTS

**Figure 2-15. Preprocessor Pots Screen**

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

**MEASURE COARSE ZERO**

Software-controlled pot for the electronic zero of the measure channel.

**REFERENCE ZERO**

Sets the zero for the reference channel and is controlled by the microprocessor.

**MEASURE GAIN**

Sets gain for the measure channel and is controlled by the microprocessor board.

**REFERENCE GAIN**

Software controlled pot for the gain of the reference channel.

**TEST MEASURE**

Software-controlled pot that is used by technicians when troubleshooting, or verifying correct instrument performance.

**HIGH VOLTAGE ADJUST**

Software controlled pot to adjust the PMT high voltage.

**LAMP ADJUST**

Software-controlled pot that sets UV lamp current.

**REF. VOLTAGE**

Reference voltage as measured on the detector PCA in the A series and the pressure /preamp PCA in the B series. This voltage is indicative of the UV lamp intensity.

**SO2**

PPM: Gas concentration reading.

**CONC. VOLTAGE**

Voltage from the preprocessor proportional to the fluorescent signal from the reaction cell. This voltage represents actual gas measurement.

**HIGH VOLTAGE**

PMT power supply high voltage reading.

### 2.5.9 Flow Control Pots Screen (A series only)

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	:	6
PUMP SPEED FINE	:	0
PUMP SPEED COARSE	:	62
GAS FLOW	0.48	SLPM
GAS PRESSURE	585.6	TORR

**Figure 2-16. 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.

**2.5.10 Valve Test Menu**

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

**Figure 2-17. Valve Test Menu**

The VALVE TEST MENU allows the valves to be set 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 *EC9850 Service Manual* for details on plumbing connections.

**INT. VALVE #1**

Sample stream.

**INT. VALVE #2**

Zero air.

**INT. VALVE #3**

Span gas.

**AUX. VALVE #2**

Not used at this time.

**EXT. MEASURE**

Externally supplied sample stream.

**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 zero/span cycles. OFF is used for operator control of valves. VALVE SEQUENCING will automatically be set to ON whenever the primary screen is displayed.

### 2.5.11 Diagnostic Menu

DIAGNOSTIC MENU	
MULTIDROP PORT TEST	: NO
WATCHDOG TEST	: NO
DISPLAY TEST	: NO
ANALOG OUTPUT TEST	: NO

**Figure 2-18. 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.

### 2.5.12 Calculation factors

CALCULATION FACTORS	
INSTRUMENT GAIN	: 1.0592
P/T/F CORRECTION	: 1.0390
BACKGROUND	: 0.0012
ZERO OFFSET	: 0.0000 PPB
EXIT	

**Figure 2-19. Calculation Factors Menu**

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

### 2.5.13 Interface Menu

INTERFACE MENU	
ANALOG OUTPUT MENU	
DATA LOGGING MENU	
MAIN GAS ID	: 050
INTERFACE MODE	: COMMAND
MULTIDROP BAUD	: 2400
DATA LENGTH	: 8 BITS
STOP BITS	: 1 BIT
PARITY	: NONE
COMM. PROTOCOL	: ORIGINAL
NETWORK ADAPTOR MENU	

**Figure 2-20. 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*.

#### 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*.

## 2.5.14 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 2.6. *The setting of analog output ranges has no impact on the measurement range of the analyzer, it only affects the analog output scaling.*

### 2.5.14.1 SO<sub>2</sub> Current Output Menu

SO2 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 2-21. Analog Output Menu (Current Output)**



**RANGE**

Set upper range limit (in digits) to desired SO<sub>2</sub> concentration. This value cannot exceed the OVER RANGE value.

**OUTPUT TYPE**

Setting must match the jumper settings on the 50-pin I/O board (if installed); CURRENT OR VOLTAGE.

**CURRENT RANGE**

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

**FULL SCALE**

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

**ZERO ADJUST**

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 2.6. 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.

**2.5.14.2 SO<sub>2</sub> Voltage Output Menu**

SO2 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 2-22. Analog Output Menu (Voltage Output)**

**RANGE**

Set upper range limit (in digits) to desired SO<sub>2</sub> concentration. See section 2.6. This value cannot exceed the OVER RANGE value.

**OUTPUT TYPE**

Setting must match the jumper settings 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 ADJUST**

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 2.6. 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.

**2.5.15 Data Logging Menu**

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

**Figure 2-23. Data Logging Menu**

The DATA LOGGING MENU contains settings that relate to the internal data recording facilities of the EC9850. 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.

<i>Inst. Data (min)</i>	<i>Total Capacity (days)</i>
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.

**2.5.16 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.

**2.5.17 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 2-24 Trend Select Menu**

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

### 2.5.18 Event Log Screen

EVENT LOG		
# 1	BACKGROUND CYCLE	
	OCCURRED AT 00:01	15-AUG-03
# 2	ZERO FLOW	
	OCCURRED AT 17:02	08-AUG-03
# 3	BACKGROUND CYCLE	
	OCCURRED AT 17:02	07-AUG-03
# 4		

**Figure 2-25. 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 ▼).

### 2.5.19 Instrument Status Screen

INSTRUMENT STATUS		
GAS FLOW	: 0.65	SLPM
GAS PRESSURE	: 586.6	TORR
REF. VOLTAGE	: 2.501	VOLTS
CONC. VOLTAGE	: 2.237	VOLTS
ANALOG SUPPLY	: 11.909	VOLTS
DIGITAL SUPPLY	: 4.977	VOLTS
HIGH VOLTAGE	: 700	VOLTS
LAMP CURRENT	: 34.794	MA
VERSION 1.03.0005		EXIT

**Figure 2-26. 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 on the detector PCA in the A series and the pressure /preamp PCA in the B series. This voltage is indicative of the UV lamp intensity.

**CONC. VOLTAGE**

Voltage from the preprocessor proportional to the fluorescent signal from the reaction cell. This voltage represents the actual measurement of gas.

**ANALOG SUPPLY**

+12 volt (primary) power supply.

**DIGITAL SUPPLY**

+5 volt microprocessor power supply.

**HIGH VOLTAGE**

PMT power supply high voltage reading.

**LAMP CURRENT**

UV lamp power supply current.

**VERSION**

Indicates the current firmware version installed in the Microprocessor.

Additional information on the INSTRUMENT STATUS screen is included in the *EC9850 Service Manual*.

### **2.5.20 System Temperatures Screen**

SYSTEM TEMPERATURES			
CELL TEMP.	:	50.7	DEG C
CHASSIS TEMP.	:	28.1	DEG C
FLOW TEMP.	:	49.9	DEG C
COOLER TEMP.	:	10.3	DEG C

**Figure 2-27. System Temperatures Screen**

The SYSTEM TEMPERATURES screen displays information continuously generated by the microprocessor.

**CELL TEMP.**

Temperature of the reaction cell.

**CHASSIS TEMP.**

Temperature of air inside the chassis, measured on the microprocessor PCA.

**FLOW TEMP. (ONLY IN A SERIES)**

Temperature of the Flow Control Block.

**COOLER TEMP.**

Temperature of the cooled PMT block.

Additional information on the SYSTEM TEMPERATURES screen is included in the *EC9850 Service Manual*.

**2.5.21 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
COOLER STATUS:	PASS
HIGH VOLTAGE:	PASS
EXIT	

**Figure 2-28. 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 *EC9850 Service Manual*.

**2.6 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.*

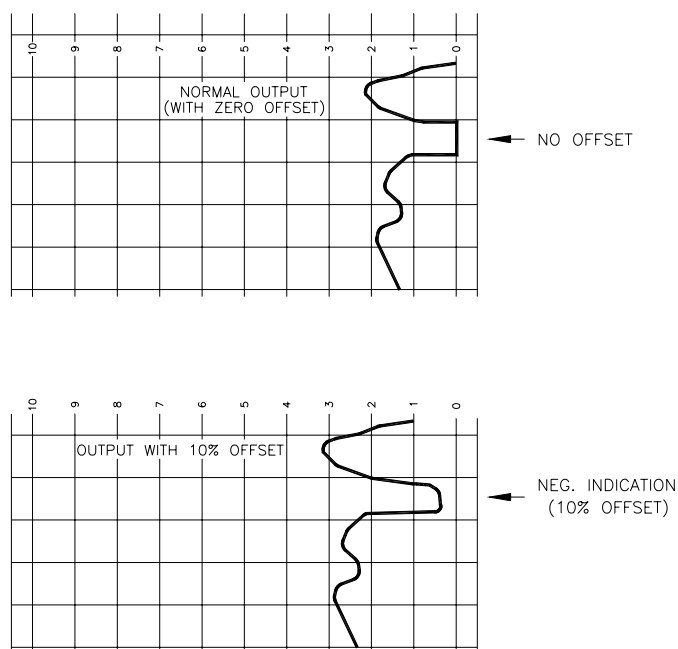
---

\*The flow block temp is only present in the A series analyzer.

### 2.6.1 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 2-29.



**Figure 2-29. Strip Charts Illustrating Offset**

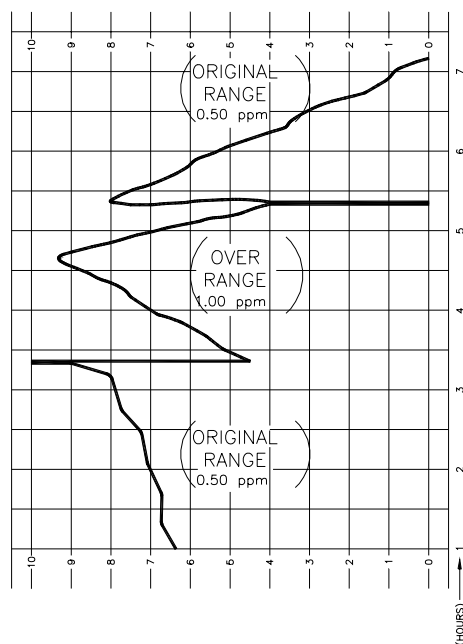
Signal adjustments for zero and instrument gain to align the output with the user's recorder or other measurement device can be made in the **ANALOG OUTPUT MENU** in the **FULL SCALE** and **ZERO ADJ** fields. These adjustments may be necessary due to tolerance buildup, power supply variation, etc in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

### 2.6.2 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 2-30 for an example of over range on a typical strip chart recorder.



**Figure 2-30. 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 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.

### **2.6.3 Analog Output Calibration Procedure**

This procedure is appropriate for connecting the EC9850 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`.

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.

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).

4. 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>`.
5. 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.
6. 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.
7. 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>`.
8. Select `OVER-RANGING` and choose either `ENABLED` or `DISABLED`. Press `<Enter>`.

### **2.6.4 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* of this manual.

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.

## 2.7 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.

### 2.7.1 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.

### 2.7.2 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.

## 3.0 Calibration

---

### 3.1 Overview

This chapter consists of the following:

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

The EC9850 sulfur dioxide analyzer is a precision measuring device that must be calibrated against a known source of sulfur dioxide that is traceable to a National Institute of Standards and Technology (NIST) standard. (Formerly NIST was the National Bureau of Standards, or NBS.)

In general terms, the calibration process consists of the following steps:

1. Establish a reliable and stable calibrating source.
2. Provide a satisfactory connection between the calibration source and the analyzer.
3. Calibrate 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 required that the analyzer be recalibrated any time it is moved or 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 EC9850 SO<sub>2</sub> 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*.

### 3.1.1 Analyzer Calibration Instructions

#### **Note**

This procedure is a quick guide to span calibration of the EC9850 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 section 3.2.

1. Connect a source of span calibration gas to the analyzer through the Inlet port (see the remainder of this section 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 (▲ 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 SO<sub>2</sub> 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 calibration 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*.

#### **Note**

The auto-zero function of the EC9850 eliminates the need for a traditional zero calibration.

This completes the span calibration of the EC9850 analyzer.

## 3.2 Multipoint Calibration

Either of the two procedures described in this chapter may be used to calibrate the EC9850 SO<sub>2</sub> analyzer.

Before beginning a multipoint calibration of the instrument, a qualified service technician must perform the periodic maintenance procedures in the EC9850 Service Manual, especially checking the particulate filter. The INSTRUMENT STATUS and SYSTEM TEMPERATURES screens in the EC9850 Service Manual give the ranges for correct operation of the instrument.

### **Note**

Calibration should only be performed when the instrument is stable and has been powered up for at least two hours.

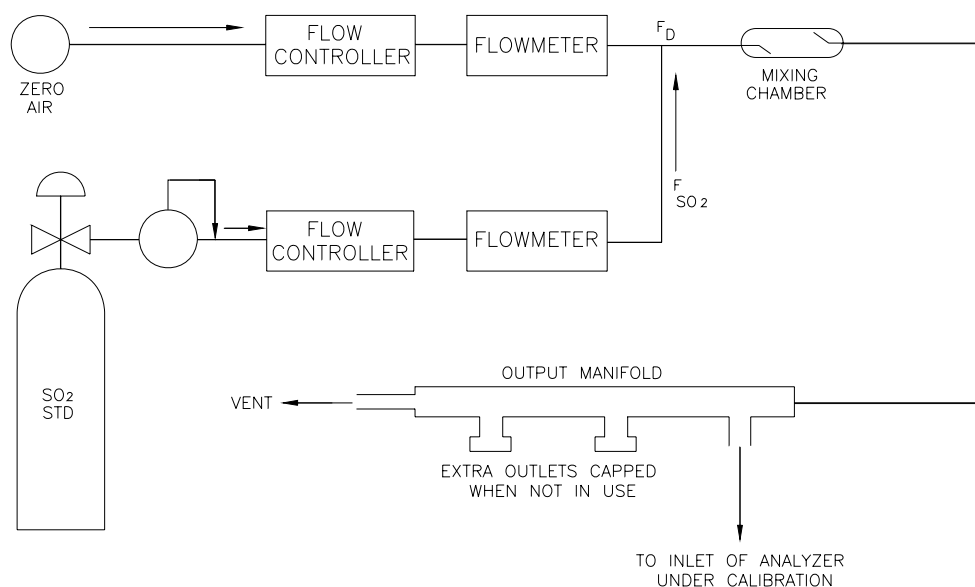
### **3.2.1 Procedure Using Cylinder Gas Dilution Method**

#### **3.2.1.1 Principle**

A certified standard cylinder of SO<sub>2</sub>, diluted as necessary with zero air, is used to obtain the various calibration concentrations needed.

#### **3.2.1.2 Apparatus**

The major components and configuration of a typical calibration system are shown in Figure 3-1.



**Figure 3-1. SO<sub>2</sub> Analyzer Calibration Using Cylinder Gas Dilution**

#### 3.2.1.2.1 Flow Controllers

A device capable of adjusting and regulating flow rates. Flow rates must be regulated to  $\pm 1\%$ .

#### 3.2.1.2.2 Flowmeters

A calibrated flowmeter capable of measuring and monitoring flow rates with an accuracy of  $\pm 2\%$  of the measured value.

#### 3.2.1.2.3 Pressure Regulator for Standard SO<sub>2</sub> Cylinder

The regulator must have a nonreactive diaphragm and internal parts, and a suitable delivery pressure.

#### 3.2.1.2.4 Mixing Chamber

A chamber designed to provide thorough mixing of SO<sub>2</sub> and diluent air.

#### 3.2.1.2.5 Output Manifold



The output manifold should be of sufficient diameter to ensure an insignificant pressure drop at the analyzer connection. The system must have a vent designed to ensure atmospheric pressure at the manifold and enough inlet flow to prevent ambient air from entering the manifold.

### 3.2.1.3 Reagents

#### 3.2.1.3.1 *SO<sub>2</sub> Concentration Standard*

The cylinder of SO<sub>2</sub> in air or nitrogen must contain the appropriate concentration of SO<sub>2</sub> suitable for the selected operating range of the analyzer under calibration. Typical concentration standards are in the range of 20 to 100 ppm for dilution to the analyzer's concentration range. The assay of the cylinder must be traceable either to a National Institute of Standards and Technology (NIST) SO<sub>2</sub> in air Standard Reference Material (SRM) or to an NIST/EPA-approved commercially available Certified Reference Material (CRM). A recommended protocol for certifying SO<sub>2</sub> gas cylinders against either an SO<sub>2</sub> SRM or a CRM is given in Section 12 of Calibration Reference 1. SO<sub>2</sub> gas cylinders should be recertified on a regular basis as determined by the local quality control program.

#### 3.2.1.3.2 *Dilution Gas (Zero Air)*

Zero air is described as air free of contaminants which will cause a detectable response in the SO<sub>2</sub> analyzer. The zero air should contain <0.1 ppb SO<sub>2</sub>. A procedure for generating SO<sub>2</sub>-free air is given in Calibration Reference 1. The Ecotech GasCal 1000 calibrator and 8301 Zero Air source has SO<sub>2</sub>-free air capability sufficient for this operation.

### 3.2.1.4 Procedure

1. Assemble a dynamic calibration system such as the one shown in Figure 3-1. All calibration gases, including zero air, must be introduced into the sample inlet of the analyzer system. The EC9850 instrument sample inlet is labeled Inlet and is located on the rear panel.
2. Ensure that all flowmeters are properly calibrated under the conditions of use, if appropriate, against an authoritative standard such as a soap-bubble meter or wet-test meter. All volumetric flow rates should be corrected to 25° C and 760 torr (760 torr = 101 kPa). A discussion of calibration of flowmeters is given in Calibration Reference 1.

3. Ensure that the analyzer is properly connected to the output recording device, as described in *Chapter 2*. If necessary, go to the `INTERFACE MENU`, select the `ANALOG OUTPUT MENU` field, and select the appropriate settings for the recording device. Offsetting the analyzer's zero indication (`OFFSET` and `ZERO ADJ`) to +5% of scale is recommended to facilitate observing negative zero drift. Exit and return to the primary screen.
4. 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 slpm to ensure that no ambient air is pulled into the manifold vent. Enter the `CALIBRATION MENU` and select `MANUAL` calibration and `MEASURE` mode. Check the optional external zero scrubber by initiating an auto-zero (`BACKGROUND`) cycle. Exit and return to the primary screen. Following the auto-zero cycle, allow the analyzer to sample zero air until a stable response is obtained. If the response goes negative by more than 0.5% of full scale, the zero scrubber may need to be replaced. Record the final, stable zero air response as  $Z_{SO_2}$ .

#### Note

The EC9800 analyzer family does not have zero and span pots that are physically like those on traditional instruments. Zero is set automatically on all units. Span can be set manually by adjusting the instrument readings or by adjusting the instrument gain.

5. Adjust the zero air flow and the SO<sub>2</sub> flow from this standard SO<sub>2</sub> cylinder to provide a diluted SO<sub>2</sub> concentration of approximately 80% of the full scale range of the analyzer. Ensure that the total air flow at the output manifold exceeds the demand by at least 0.5 slpm to ensure that no ambient air is pulled into the manifold vent. The exact SO<sub>2</sub> concentration is calculated from:

$$[SO_2]_{OUT} = \frac{[SO_2]_{STD} \times F_{SO_2}}{F_D + F_{SO_2}}$$

#### Equation 3-1

Where:

$[SO_2]_{OUT}$  = diluted SO<sub>2</sub> concentration at the output manifold, ppm  
 $[SO_2]_{STD}$  = concentration of the undiluted SO<sub>2</sub> standard, ppm  
 $F_{SO_2}$  = flow rate of the SO<sub>2</sub> standard corrected to 25° C and 760 Torr (760 Torr = 101 kPa), slpm

$F_D$  = flow rate of the dilution air corrected to 25° C and 760 Torr, slpm.

6. Sample the SO<sub>2</sub> concentration until a stable response is obtained.
7. *From the primary screen* press the Up or Down arrow key. Respond *SPAN* to the screen query *START MANUAL CALIBRATION?* by pressing the Up or Down arrow key, then <Enter>. The cursor now appears in the first digit of the concentration field.
8. Use the <Select> and arrow keys to input the SO<sub>2</sub> span point concentration calculated in step 5. Use the <Select> key to select the digit to be changed and the Up or Down arrow keys to change the value.
9. Press <Enter> to confirm the input value. Record the SO<sub>2</sub> concentration and the analyzer's stable response.
10. Then move the cursor to the *INSTRUMENT GAIN* field. Record the instrument gain value for future reference. Press <Exit> to return to the primary screen.

### **3.2.2 Procedure For 5 Point Multipoint Calibration**

#### **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 AS3580.4.1. and U.S. EPA Standards.

#### **3.2.2.2 Apparatus**

The apparatus discussed in section 3.2.1.2 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
- ❑ NATA/NIST Traceable SO<sub>2</sub> Gas cylinder with dual stage regulator.
- ❑ Laptop Computer with Microsoft Excel.
- ❑ Bios DryCal flow calibrator
- ❑ Ecotech portable zero air source
- ❑ Ecotech portable Dilution Gas 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 1.1.10  $\pm 1\%$ .
2. Setup the dilution gas calibrator to obtain a SO<sub>2</sub> gas concentration of 80% of the EC9850's operating range as discussed in section 3.2.1.4. Perform a manual calibration at this point.

#### Note

Record the analyzer instruments gains before and after the calibration.

3. Setup the dilution gas calibrator to obtain Zero air, and ensure that the EC9850 has a zero reading lower than  $\pm 5$ ppb 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.

4. Generate 5 additional concentrations by decreasing  $F_{SO_2}$  or increasing  $F_D$ . Be sure the total flow exceeds the analyzer's total flow demand. For each concentration generated, calculate the exact SO<sub>2</sub> concentration using Equation 3-1.

#### Note

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

5. Record the concentration and the analyzer's response for each concentration after a stabilization period of 15 minutes per point.
6. Plot the analyzer's responses versus the corresponding SO<sub>2</sub> concentrations and draw or calculate the calibration curve as discussed in the following section.

### 3.2.2.4 Calculating Multipoint Calibration Results

#### 3.2.2.4.1 Manual Calculations (Used when Excel not available)

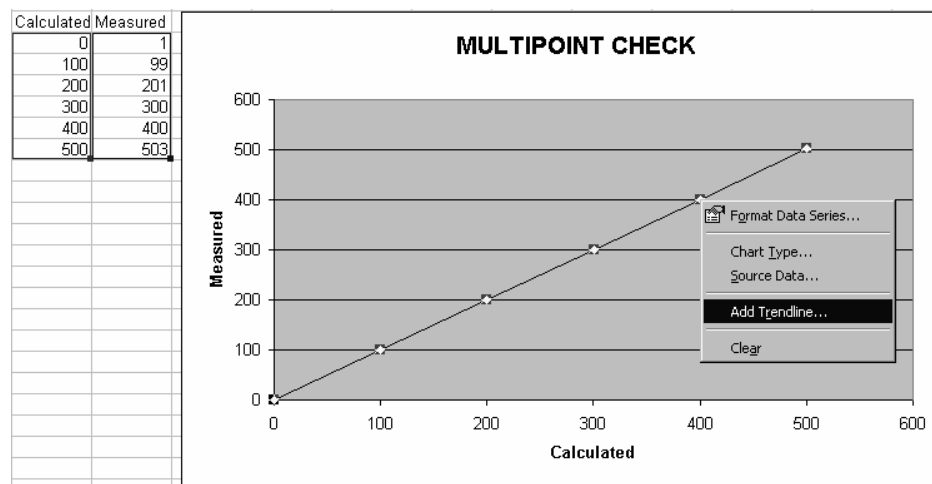
Determine the percent difference between instrument response and the calculated concentration using the following equation.

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

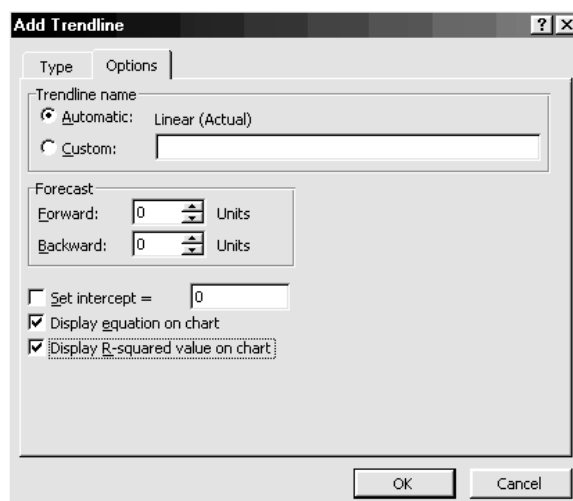
If the difference between values is less than 1% then the instrument is within specifications. Otherwise a Leak Check and or service is required.

### 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 SO<sub>2</sub> 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 3-2.

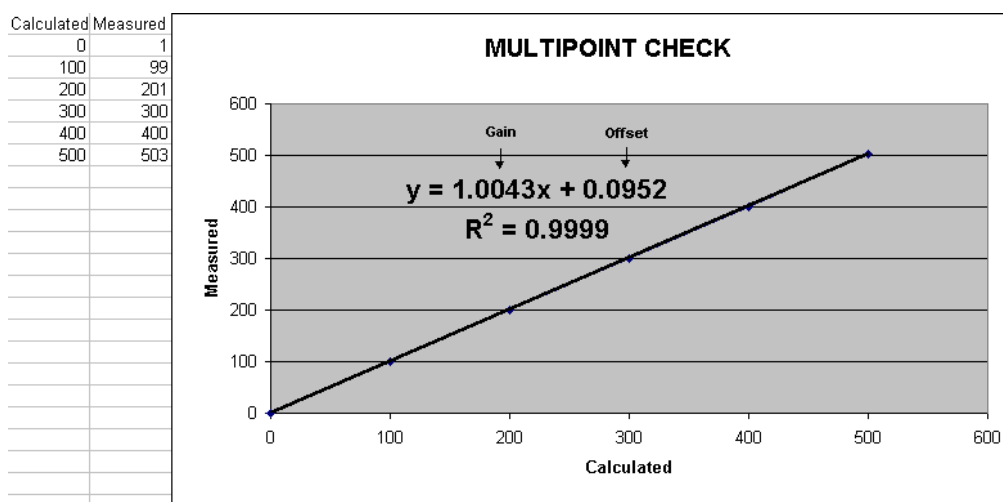


**Figure 3-2. Data point formatting menu with Excel chart**



**Figure 3-3. 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 3-3). Clicking OK will return to the chart and display the required data necessary to determine the effectiveness of the calibration.



**Figure 3-4. 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  $\pm 0.3$ .
- 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 zero air scrubbers and consult the EC9850 service manual for troubleshooting assistance.

### **3.2.3 Procedure Using the Internal Permeation Device**

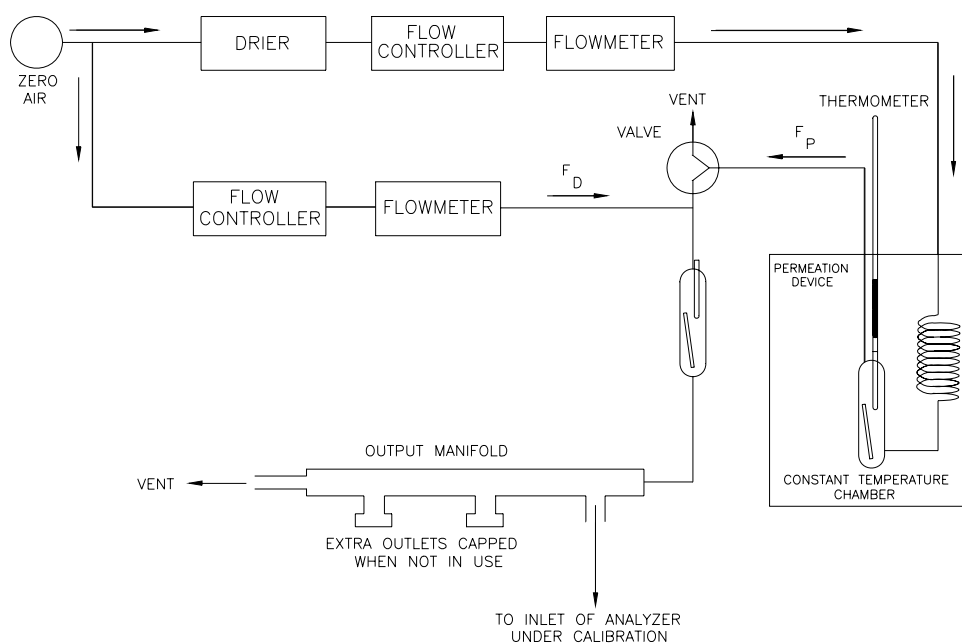
#### **3.2.3.1 Principle**

In a permeation device, an easily liquefied gas such as  $\text{SO}_2$  is condensed inside an inert container, all or part of which is constructed from a polymeric material, often Teflon<sup>®</sup>. Gas escapes from the container by dissolving in and permeating through the polymer walls at a temperature-dependent rate. The rate of gas effusion (in  $\mu\text{g}/\text{minute}$ ) at a constant temperature can be established by gravimetric determination of the weight loss of the permeation device over a known period of time.

In this calibration procedure, accurately known concentrations of  $\text{SO}_2$  are produced dynamically by diluting the effusion from an  $\text{SO}_2$  permeation device with various flow rates of zero air.

#### **3.2.3.2 Apparatus**

A diagram of a typical permeation calibration system is seen in Figure 3-5. In addition to the components used in the cylinder gas dilution method, a permeation calibration system uses a constant temperature chamber, a controlled-temperature housing that contains the  $\text{SO}_2$  permeation device. The chamber is flushed continuously with purified, dry zero air or nitrogen.



**Figure 3-5. SO<sub>2</sub> Calibration Using a Permeation Tube**

Temperature control is the primary concern in using an SO<sub>2</sub> permeation device as a standard SO<sub>2</sub> source. For example, a change in temperature of about 0.5° C effects a change in the permeation rate of the device of about 4%. For this reason, it is important that the temperature of the device be maintained at a constant value within  $\pm 0.1^\circ$  C, and that it be closely monitored when the device is in use.

Generally, the SO<sub>2</sub> permeation device is housed in a temperature-controlled glass container that has an entrance and exit port at opposite ends; a glass thermometer accurate to  $\pm 0.05^\circ$  C can be placed beside the device to monitor its temperature. A small fixed zero air or nitrogen flow (about 100 SCCM) that is maintained at the same temperature as the permeation device flushes the SO<sub>2</sub> out of the device housing into a mixing chamber where the SO<sub>2</sub> is diluted with clean dry zero air. A valve (e.g. a three-way stopcock) placed at the exit of the device housing may be used to divert the SO<sub>2</sub> stream to a vent when clean air is required at the manifold for making the necessary zero adjustments to the analyzer.

To maintain the temperature of the permeation device within 0.1° C of the desired value, the device and housing may be placed either physically inside a constant temperature chamber as shown in Figure 3-5, or they can be located outside the constant temperature chamber with the heat transfer medium circulated around the device housing (eg, a jacketed condenser; West or Liebig type). The flushing zero air or nitrogen passes through a heat exchanger (e.g. a coil of copper tubing)



contained in the constant temperature chamber before passing over the device to adjust its temperature to that of the device.

### 3.2.3.3 Reagents

#### 3.2.3.3.1 Dilution Gas (Zero Air)

A regulated source of clean, dry zero air for diluting the SO<sub>2</sub> gas effluent from the permeation device. Use a source that is capable of providing air flow up to approximately 20 slpm.

#### 3.2.3.3.2 SO<sub>2</sub> Permeation Device

The permeation device should be traceable to an SRM or CRM. An SRM SO<sub>2</sub> permeation device such as SRM 1626 from NIST is suitable for the 0.500 ppm range of this analyzer.

The SO<sub>2</sub> from a permeation device is used as calibration source according to the following formulas.

$$[\text{SO}_2]_{\text{OUT}} = \frac{P \times K_M}{F_T} = \frac{0.382P}{F_T}$$

**Equation 3-2**

Where:

$K_M = 0.382 \mu\text{l}/\mu\text{g}$  for SO<sub>2</sub> (at 25° C and 760 Torr)

$F_T$  = total flow rate of gas after the mixing chamber =  $F_P + F_D$ , in slpm

$P$  = permeation rate of device, in  $\mu\text{g}/\text{minute}$

$[\text{SO}_2]_{\text{OUT}}$  = concentration in total flow rate stream, in ppm.

The information is used in the following example:

$P = 0.820 \mu\text{g}/\text{minute}$  at 30° C

If you want a concentration of 400 ppb = 0.400 ppm, then solve the following:

$$F_T = \frac{0.382 \times P}{[\text{SO}_2]_{\text{OUT}}} = \frac{(0.382)(0.820)}{0.400} = 0.783 \text{ slpm}$$

**Equation 3-3**

A total flow rate of 0.783 slpm is required. Always be sure that the required flow rate exceeds the analyzer demand at the output manifold.

Consult the permeation device distributor for further details.

**3.2.3.4 Procedure**

Follow the procedure given in section 3.2.1, using the permeation system to generate the SO<sub>2</sub> concentrations required in steps 5 and 11.

**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 3.2 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. Set OVER-RANGING to DISABLED to deactivate the over-ranging feature.
4. Temporarily set the range to equal the chosen over range.
5. Check the zero and set the span as described in section 3.2.
6. Generate several concentration standards and determine the slope, intercept, and linearity of the higher over range.
7. Reset the range to the normal monitoring range.
8. Generate several concentration standards (including zero air) and determine the slope, intercept, and linearity of the lower range.

**Note**

Once the span has been set on the higher range, no further adjustments should be made on the lower (normal) monitoring range.

9. Reset OVER-RANGING to ENABLED to reactivate the over-ranging feature.

### 3.4 Automatic Zero/Span Checks(AZS)

Over time, the calibration of the instrument may change slightly (drift), causing error in the measured values. Accordingly, good quality assurance practice requires that the calibration of the EC9850 be checked periodically and, if necessary, that the instrument's zero and span be adjusted to restore accurate calibration.

#### 3.4.1 U.S. EPA Definitions

Section 12 of the QA Handbook for Air Pollution Measurement Systems defines two types of calibration checks: a Level 1 check and a Level 2 check.

A Level 1 zero and span calibration check is an authoritative assessment of the analyzer calibration, using an SO<sub>2</sub> span gas standard that is certified traceable to an SRM or CRM, and the results of the Level 1 check can be used to adjust the analyzer zero and span to restore accurate calibration.

A Level 2 zero and span check is an informal calibration check, often with an uncertified SO<sub>2</sub> 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 calibration, but may indicate the immediate need for a more authoritative Level 1 calibration check.

#### 3.4.2 AZS Outline

When used with a certified traceable SO<sub>2</sub> span standard and external zero standard, the EC9850 automatic zero/span (AZS) feature may be used to automatically carry out a Level 1 calibration check on a periodic basis. Further, when the SPAN COMP in the instrument is ENABLED, the EC9850 automatically and continually compensates subsequent concentration measurements for any minor calibration drift as follows:

$$[\text{SO}_2]_{\text{READ}} = f_{\text{azs}} \times [\text{SO}_2]_{\text{UNCOMP}}$$

**Equation 3-4**

Where:

$[\text{SO}_2]_{\text{READ}}$  = the corrected instrument concentration reading based on the span compensation ratio obtained during the previous AZS cycle

$[\text{SO}_2]_{\text{UNCOMP}}$  = the instrument concentration reading without compensation

$f_{AZS}$  = the span compensation ratio determined during the previous AZS cycle (the default value of  $f_{AZS}$  is 1.000 until the first AZS cycle is carried out).

During an AZS cycle, the EC9850 measures the concentration of the span gas provided to the span gas port. This measurement reading should equal the actual concentration of the span gas standard. If it does not, the instrument sets  $[SO_2]_{READ} = [SO_2]_{STD}$  and calculates a new  $f_{AZS}$  as follows:

$$f_{AZS} = \frac{[SO_2]_{STD}}{[SO_2]_{UNCOMP}}$$

### Equation 3-5

Where  $[SO_2]_{STD}$  = the certified concentration of the span gas standard at the span gas port.

The new value of  $f_{AZS}$  is then used to compensate subsequent measurement readings until the next AZS cycle.

The zero gas reading during an AZS cycle is used for reference purposes only. The reading is not used to compensate future values, regardless of whether COMPENSATION is ENABLED or DISABLED. The analyzer automatically runs a zero cycle (background) at midnight using the external zero air, and compensates future readings based on this value.

Use of a Level 1 span calibration (with SPAN COMP: ENABLED *and* CALIBRATION: TIMED OR CAL MODE: CYCLE) adjusts the instrument gain so the output of the instrument agrees with the concentration expected for span gas. The previously determined multipoint calibration curve is used to verify that the analyzer output is linear. Note that a Level 1 span calibration requires external zero and span standards connected via the EZS valve assembly.

It is recommended that the SO<sub>2</sub> gas cylinder or permeation device be checked against the previous instrument calibration curve immediately after the generation of the calibration curve (refer to section 12 of Calibration Reference 1). It is also recommended that the concentration of this pollutant source be between 70% and 90% of the upper range limit of the analyzer and previous calibration curve. Subsequent use of this pollutant source, with AZS and compensation enabled, adjusts the span of the instrument to agree with the previous calibration line. Specific guidelines are contained in Calibration Reference 1 for use of Level 1 span checks (section 12) and certification of gas cylinders or permeation devices to SRM/CRM sources (section 12).

**Note**

Use of `SPAN COMP: ENABLED` is not allowed under U.S. EPA designation at this time.

A Level 2 span check (with `SPAN COMP: DISABLED`) does not require certification of the span gas used during AZS, and the result of such a check may not be used to correct the data, but merely serves to indicate that the analyzer is functioning properly. If the AZS is used for a Level 2 span check, *the `SPAN COMP` must be set to `DISABLED`*. A Level 2 AZS cycle should be initiated immediately after multipoint calibration so that a valid reference point can be determined.

As described in this section, two modes of operation are possible. In the Internal mode, the zero air scrubber is used as the source of zero air. In the External mode, the user must supply zero air through the `ZERO` inlet of the optional EZS valve. In the External mode, the Outlet port is connected with a short piece of tubing to the Inlet port.

In either mode, the user must supply the span gas. In the Internal mode, the span gas must be connected through the analyzer to the Span port (bottom port) of the internal valve manifold. In the External mode, the span gas is connected to the Span port of the optional EZS valve manifold. These gases (zero and span) must be provided to the analyzer at atmospheric pressure, such as through a manifold as shown in Figure 3-1.

**3.4.3 AZS Setup****Note**

In the `CALIBRATION MENU` the second (lower) `CALIBRATION` prompt requires the designation of `INTERNAL` or `EXTERNAL`. This choice should be `EXTERNAL` only if the optional EZS valve assembly is installed and gas is attached to the Zero and Span ports.

1. Enter the `CALIBRATION MENU`.
2. At the first (upper) `CALIBRATION` prompt, select `TIMED`.
3. At the `TIMER INTERVAL` prompt, set the number of hours between timed calibrations. Typical settings are 23 or 24 hours.

4. At the `STARTING HOUR` prompt, enter the hour of the day when AZS is to commence.
5. At the prompt `CYCLE TIME`, enter the number of minutes required for the span and zero steps to run.
6. At the `SO2 TIMED SPAN` prompt, enter the concentration value of the span gas to be used.
7. At the second (lower) `CALIBRATION` prompt choose `INTERNAL` (unless the EZS valve option is installed and you want to use the external calibrator gas). Using the `INTERNAL` choice, the span gas is connected through the Span (bottom) port of the internal valve manifold and the output of the zero air scrubber is used for zero air. If `EXTERNAL` is chosen, the span is connected to the Span port of the EZS valve manifold and user-supplied zero air is connected to the Zero port of the EZS valve manifold.
8. At the `SPAN COMP` prompt, select `ENABLED` if you want the instrument span adjusted to agree with the span gas after each AZS cycle.

#### **Note**

Use of `SPAN COMP: ENABLED` is not allowed under U.S. EPA designation at this time.

#### **Caution**

**Setting an incorrect `SO2 TIMED SPAN` value with `SPAN COMP: ENABLED` will cause all subsequent readings to be incorrect.**

A built-in check verifies that the observed value is not different from the calibration value by more than  $\pm 25\%$ . If the difference is greater than  $\pm 25\%$ , no updated correction will be made and a message is sent to the `EVENT LOG`, setting the `CALIBRATION ERROR` flag.

#### **Note**

The zero value is a reference value only. Regardless of the state of the `SPAN COMP` option, the analyzer does not correct for shifts in the zero.

The number displayed after `SO2 SPAN RATIO` is the factor by which the instrument gain is multiplied to cause the display and output to agree with the span gas, and will always be between 0.75 and 1.25. You cannot set this number. ***This value is reset to 1.000 any time that the span is set manually via the front panel.*** (The assumption is that front panel adjustment is an instrument calibration, thus preventing compound adjustments.)

### **3.4.4 Description of the 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 8 minutes. During the first 3 minutes no data is taken. During the last 5 minutes, the instrument takes readings every second and averages them to yield a value to be stored as the zero calibration value.

At the end of 8 minutes, the zero air valve is closed and the span gas valve is opened, admitting span gas for 8 minutes. During the first 3 minutes no data is taken. During the last 5 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 `ENABLED`, this is the value which is used to correct all subsequent readings to the calibration.

The zero air valve is switched on for 1 minute to purge the cell of span gas. The Sample valve is then activated for an additional 6 minutes to allow the cell to come back to monitoring concentration.

At the end of 25 minutes, monitoring resumes, including putting data in the average, etc. (The data averages are *not* updated during calibration.)

## **3.5 Calibration References**

1. 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.

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## 4.0 Digital Communication

The EC9850 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):

<b><u>Signal Name</u></b>	<b><u>Number</u></b>	<b><u>Function</u></b>
IOUT3	2	Analog current output #3 ( <i>Note 2</i> )
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 ( <i>Note 3</i> ).
IOUT2	17	Analog current output #2 ( <i>Note 4</i> ).

<b><u>Signal Name</u></b>	<b><u>Number</u></b>	<b><u>Function</u></b>
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 <sup>3</sup> .
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).

<b><u>Signal Name</u></b>	<b><u>Number</u></b>	<b><u>Function</u></b>
CHOPFAIL	37	Active output indicates that the chopper has failed ( <i>Note 7</i> ).
SPAN_OOR	38	Active output indicates that the span ratio is out of range ( <i>Note 8</i> ).
SPAREOC1	39	Spare open collector output #1
HEATERFAIL	40	Active output indicates that a system heater has failed ( <i>Note 9</i> ).
SPAREOC2	41	Spare open collector output #2
OPTTEST	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 ( <i>Note 10</i> ).
HV-FAIL	45	Active output indicates that the PMT high voltage supply has failed ( <i>Note 11</i> ).
SYSFAIL	46	The sum of all failures in the instrument ( <i>Note 12</i> ).
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. Not valid.

6. An error is flagged if the lamp current is below 20 mA or above 50 mA.
7. Not valid.
8. Span ratio out of range is defined as calibration gain changing below 75% or above 125% gain change.
9. Not used.
10. An error is flagged if the 12-volt supply voltage is below 11.1 volts or greater than 14.3 volts.
11. An error is flagged if the high voltage reading differs by more than 25% of the expected value as determined from the high voltage pot setting.
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:

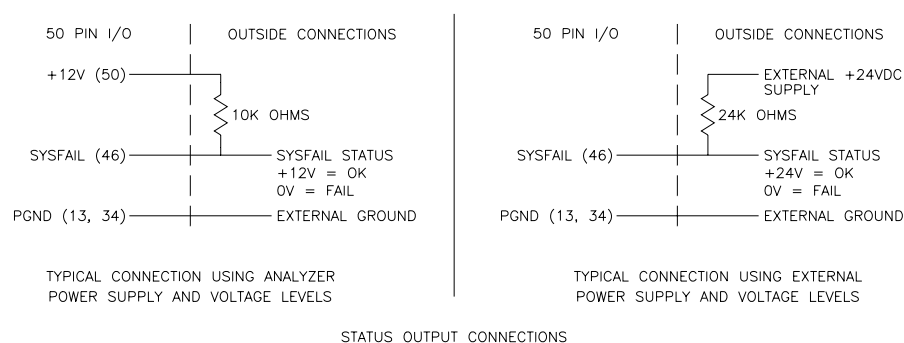
**low** < 0.8 V

2 V < **high** < 5 V

#### **4.1.3 50-Pin I/O Outputs**

The status outputs are active low open collector Darlington. 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 be 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 EC9850 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.

## 4.2.2 Cable Connections

<p>If you have a 25 pin DTE RS232 PORT (e.g. computer, DAS), connect:</p> <table><tr><td>Your 25 pin DTE RS232</td><td>9800 9 pin (rear) Multi-Drop</td></tr><tr><td>pin</td><td>pin</td></tr><tr><td>2 --- XMT --&gt;--</td><td>3</td></tr><tr><td>3 --- RCV --&lt;--</td><td>2</td></tr><tr><td>7 --- GND ----</td><td>5</td></tr></table> <table><tr><td>* 4 --- RTS --&gt;--</td><td></td></tr><tr><td>* 5 --- CTS --&lt;--</td><td></td></tr><tr><td>* 6 --- DSR --&lt;--</td><td></td></tr><tr><td>* 20 --- DTR --&gt;--</td><td></td></tr><tr><td>* 8 --- DCD --&lt;--</td><td>1</td></tr><tr><td>* 22 --- RI --&lt;--</td><td>9</td></tr></table> <p>* may not be needed</p>	Your 25 pin DTE RS232	9800 9 pin (rear) Multi-Drop	pin	pin	2 --- XMT -->--	3	3 --- RCV --<--	2	7 --- GND ----	5	* 4 --- RTS -->--		* 5 --- CTS --<--		* 6 --- DSR --<--		* 20 --- DTR -->--		* 8 --- DCD --<--	1	* 22 --- RI --<--	9	<p>If you have a 25 pin DCE RS232 PORT (e.g. modem or terminal), connect:</p> <table><tr><td>Your 25 pin DCE RS232</td><td>9800 9 pin (rear) Multi-Drop</td></tr><tr><td>pin</td><td>pin</td></tr><tr><td>2 --&lt;-- XMT/RCV --&lt;--</td><td>2</td></tr><tr><td>3 --&gt;-- RCV/XMT --&gt;--</td><td>3</td></tr><tr><td>7 ----- GND -----</td><td>5</td></tr></table> <table><tr><td>* 4 --- RTS --&lt;--</td><td></td></tr><tr><td>* 5 --- CTS --&gt;--</td><td></td></tr><tr><td>* 6 --- DSR --&gt;--</td><td></td></tr><tr><td>* 20 --- DTR --&lt;--</td><td></td></tr><tr><td>* 8 --- DCD --&gt;--</td><td>X do NOT connect</td></tr><tr><td>* 22 --- RI --&gt;--</td><td>X do NOT connect</td></tr></table> <p>* may not be needed</p>	Your 25 pin DCE RS232	9800 9 pin (rear) Multi-Drop	pin	pin	2 --<-- XMT/RCV --<--	2	3 -->-- RCV/XMT -->--	3	7 ----- GND -----	5	* 4 --- RTS --<--		* 5 --- CTS -->--		* 6 --- DSR -->--		* 20 --- DTR --<--		* 8 --- DCD -->--	X do NOT connect	* 22 --- RI -->--	X do NOT connect
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* 1 --- DCD -->--	X do NOT connect																																												
* 9 --- RI -->--	X do NOT connect																																												

**Figure 4-2. Serial Interface Connection Diagrams**

### 4.3 Serial Terminal Control

If the EC9850 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:

<u>Key</u>	<u>Key Label</u>	<u>Function</u>
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: <CCCCCCCC> , <III> , <D> , <NN> , <PPPPPPPPPPPP><T>

Where:

<CCCCCCCC>	= 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 :

<CCCCCCCC>,<III><T>

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

<CCCCCCCC>,<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<ETX>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 EC9850 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 previous 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 0 . 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 9800B instruments 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 EC9850 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 EC9850 should be displayed on the computer followed by `END OF MULTI-DROP PORT TEST`.

##### **4.4.4.1 Multidrop Communications**

The term multidrop is a 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 Main Gas ID. can be set manually in the Instrument Menu or the Interface Menu. Refer to section 2.5.3 or 2.5.12 for further details. This is the 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.

- 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 EC9850 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 EC9850 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.>}<ETX><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/m<sup>3</sup>

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/m<sup>3</sup>)

D7 = instrument is performing a background cycle.

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] = the response will be 6 pad zeroes if the *original* or *enhanced* protocol

is selected. If the *Bavarian* protocol is selected, the response will be 10 pad zeroes.

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>}<ETX>  
<BCC1><BCC2>

---

### Command

{ST}

### Function

Bavarian network command that sets the instrument mode to zero, span, or measure, or runs a background cycle.

### 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**

D<sub>COMM</sub>, { <DEVICE I.D.> } { TERMINATOR }

**Device response**

<ACK> if the unit under test performs a successful loopback; <NAK> if not.

**Command**

D<sub>CONC</sub>

**Function**

Sends the current instantaneous concentration data to the serial port.

**Format**

D<sub>CONC</sub>, { <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 (MSB)	=	SYSFAIL
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	=	instrument is performing a background
Bit 1	=	SET→PPM selected, CLEAR→MG/M3
Bit 0 (LSB)	=	reserved.

**Command**

D<sub>EVENT</sub>

**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>

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

The message field is null if no message exists.

---

**Command**

DGAIN

**Function**

Dumps instrument gain data to the serial port.

**Format**

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

**Device response**

{INSTRUMENT GAIN} <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 SO<sub>2</sub> readings

GASAVG for the last 100 averaged SO<sub>2</sub> 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 stop, 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 clears screen, then menu display.

---

**Command**

RESET

**Function**

Reboots the instrument (software reset).

**Format**

RESET, {&lt;DEVICE I.D.&gt;} {TERMINATOR}

Device response

&lt;ACK&gt;

---

**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 EC9850 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 EC9850 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**

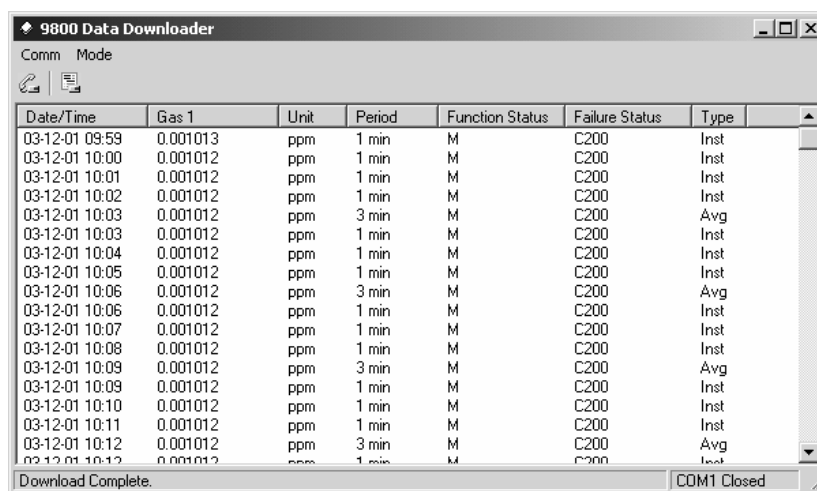
The analyzer must be in **Command** mode before the Data Acquire mode can be used. If the program was last used in Remote Terminal mode, the analyzer may still be in **Remote** mode. See section 4.6.2.2 for further details.

**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:



Date/Time	Gas 1	Unit	Period	Function Status	Failure Status	Type
03-12-01 09:59	0.001013	ppm	1 min	M	C200	Inst
03-12-01 10:00	0.001012	ppm	1 min	M	C200	Inst
03-12-01 10:01	0.001012	ppm	1 min	M	C200	Inst
03-12-01 10:02	0.001012	ppm	1 min	M	C200	Inst
03-12-01 10:03	0.001012	ppm	3 min	M	C200	Avg
03-12-01 10:03	0.001012	ppm	1 min	M	C200	Inst
03-12-01 10:04	0.001012	ppm	1 min	M	C200	Inst
03-12-01 10:05	0.001012	ppm	1 min	M	C200	Inst
03-12-01 10:06	0.001012	ppm	3 min	M	C200	Avg
03-12-01 10:06	0.001012	ppm	1 min	M	C200	Inst
03-12-01 10:07	0.001012	ppm	1 min	M	C200	Inst
03-12-01 10:08	0.001012	ppm	1 min	M	C200	Inst
03-12-01 10:09	0.001012	ppm	3 min	M	C200	Avg
03-12-01 10:09	0.001012	ppm	1 min	M	C200	Inst
03-12-01 10:10	0.001012	ppm	1 min	M	C200	Inst
03-12-01 10:11	0.001012	ppm	1 min	M	C200	Inst
03-12-01 10:12	0.001012	ppm	3 min	M	C200	Avg
03-12-01 10:12	0.001012	ppm	1 min	M	C200	Inst

**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.

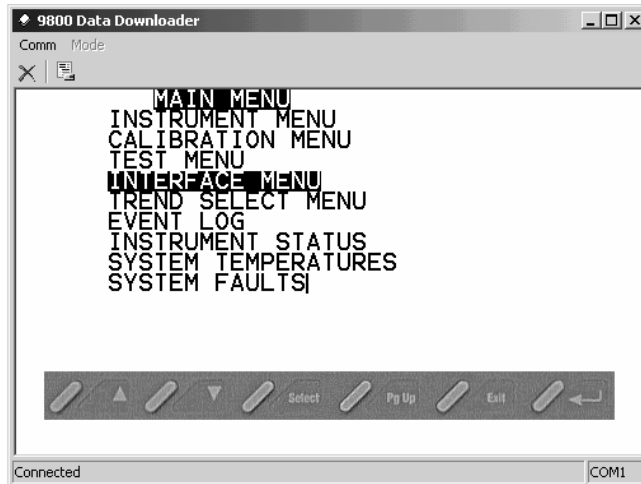
Field	On-screen	In text file
<b>Date/Time</b>	The date/time, in the format selected in the Output tab of the Settings dialog box, when the data in that row were recorded.	As for on-screen
<b>(Data)</b>	Up to three channels of analyzer data, with column headings as set by the analyzer.	As for on-screen
<b>Unit</b>	The unit for the analyzer data.	<u>C</u> odes representing the data units
<b>Period</b>	The repetition period. For averaged data, the repetition period is also the averaging period.	As for on-screen, with the period in minutes
<b>Function status</b>	The <u>function status</u> of the analyzer at the time of measurement.	As for on-screen
<b>Failure status</b>	The <u>failure status</u> of the analyzer at the time of measurement.	As for on-screen
<b>Type</b>	<i>Inst</i> = <u>instantaneous</u> data. <i>Avg</i> = <u>averaged</u> data.	<i>I</i> = <u>instantaneous</u> data. <i>A</i> = <u>averaged</u> 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 6 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 analyzer.

##### **Connection type**

Choose the type of connection to communicate with the Direct Serial Connection or Modem Connection or USB. 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 4-7 Current Readings window**

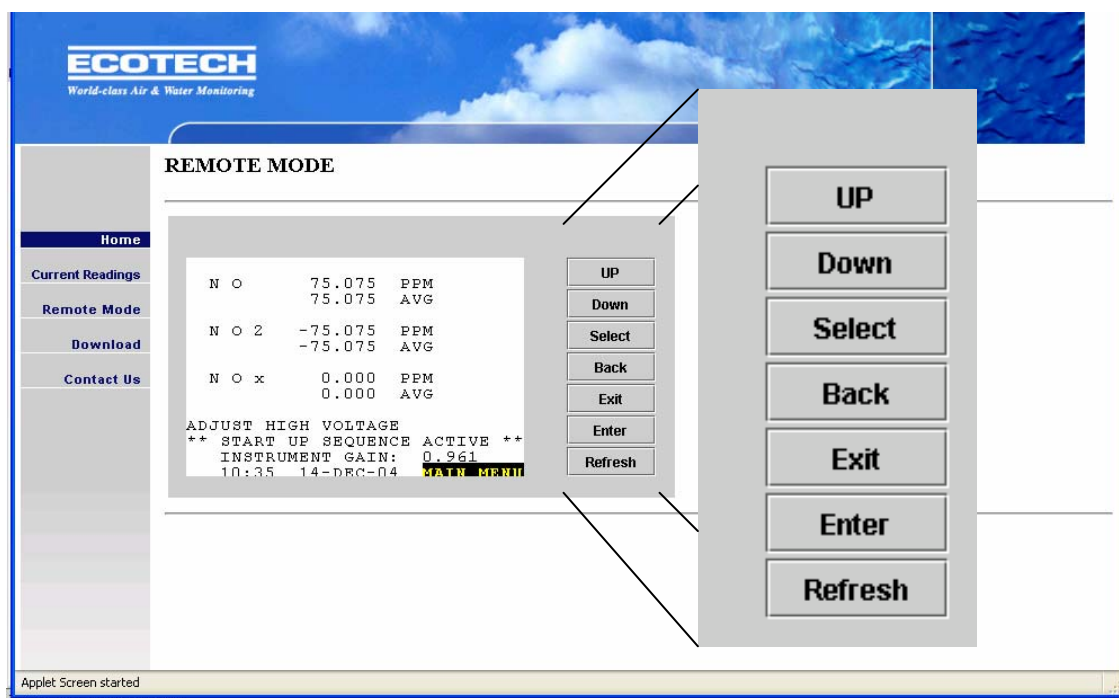
The parameters are grouped in three main categories, Gas Concentration, Instrument Temperatures and Instrument Status.

- 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<sub>x</sub> 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 4-8 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

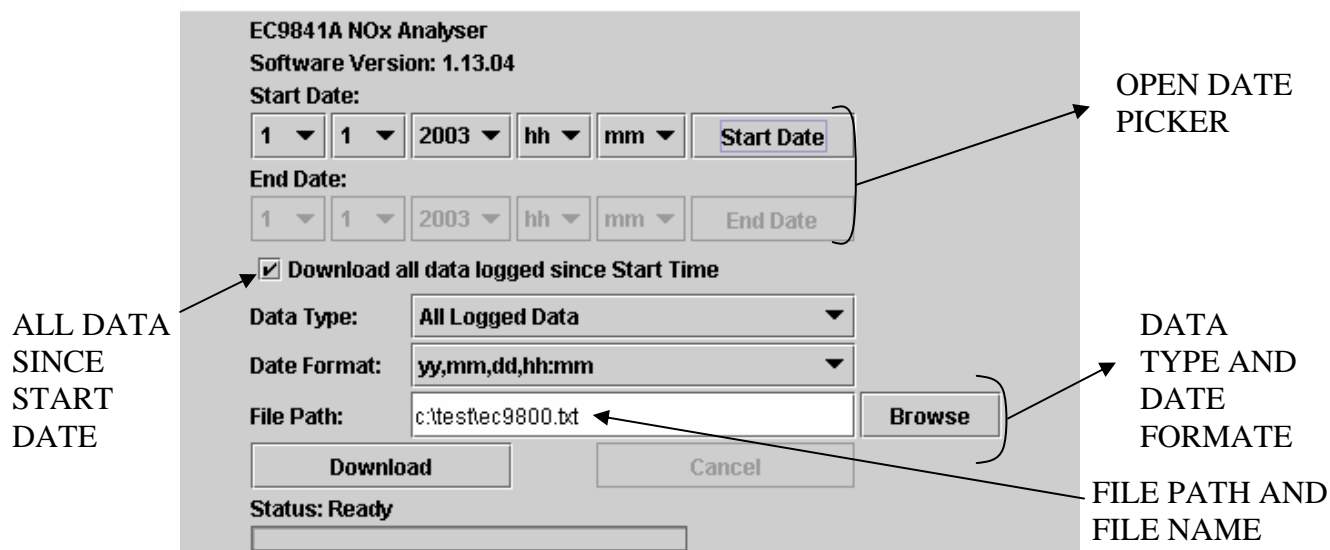
Home Key	Exit
Function Key 5 (F5)	Refresh

**IMPORTANT:** When the window is left and 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 4-9 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 4-10 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](http://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.

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## 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
<b>50</b>	<b>Primary Gas Concentration</b>	
<b>51</b>	<b>Secondary Gas Concentration</b>	
<b>52</b>	<b>Calculated Gas Concentration</b>	
<b>53</b>	<b>Primary Gas Average</b>	
<b>54</b>	<b>Secondary Gas Average</b>	
<b>55</b>	<b>Calculated Gas Average</b>	
56	Instrument Gain	
57	Main Gas ID	
58	Aux Gas ID	
59	Decimal Places	
<b>60</b>	<b>Noise</b>	
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	
<b>71</b>	<b>Gas Flow</b>	
72	Gas Pressure	
<b>73</b>	<b>Ambient Pressure</b>	
74	Analog Supply	
<b>75</b>	<b>Cell Temperature</b>	
76	Converter Temperature	
<b>77</b>	<b>Chassis Temperature</b>	
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 <sup>3</sup> 4=μG/M <sup>3</sup> 5=nG/M <sup>3</sup>
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	1 <sup>st</sup> Digit	2 <sup>nd</sup> Digit	3 <sup>rd</sup> Digit	4 <sup>th</sup> 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:

<b>C=</b>	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