INSTRUCTION MANUAL

MODEL SM8200
SO2/NO MULTI-GAS ANALYZER

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1.0 SAFETY

This manual describes the installation, operation, calibration and routine maintenance of the Teledyne Monitor Labs *SM8200* SO2 and NO Gas Monitor. The *SM8200* Gas Monitor is a 2nd Derivative UV absorption gas monitor that is designed to continuously monitor concentrations of SO2 and NO in combustion exhaust gas streams.

This section describes various safety precautions user and service personnel should be aware of before operation of this product.

FOLLOWING IN THIS SECTION ARE INTERNATIONALLY RECOGNIZED SYMBOLS USED ON THE *SM8200* ALONG WITH SPECIFIC CAUTIONS APPLICABLE TO THE EQUIPMENT.

1.1 ELECTRICAL SAFETY

THIS EQUIPMENT IS INTENDED ONLY FOR THE PURPOSES SPECIFIED IN THIS MANUAL. SAFETY PROTECTIONS INHERENT IN THIS EQUIPMENT MAY BE IMPAIRED IF THE *SM8200* IS USED IN A MANNER DIFFERENT THAN SPECIFIED HEREIN.

Label Standard Number:

ISO 3864 B.3.1

Generic meaning:

CAUTION: RISK OF DANGER. CONSULT MANUFACTURER'S DOCUMENTATION.

Cautions Invoked By This Label for the SM8200:

1. ANALYZER ELECTRONIC BOX AND TRANSCEIVER COVER SCREWS MUST BE TIGHTENED BEYOND FINGER-TIGHT.
2. THE ANALYZER ELECTRONIC BOX AND TRANSCEIVER COVERS ARE TO BE REMOVED ONLY BY TRAINED SERVICE PERSONNEL.
3. THIS EQUIPMENT MUST BE INSTALLED BY A QUALIFIED ELECTRICIAN.

Label Standard Number:

ISO 3864 B.3.6

Meaning:

CAUTION: RISK OF ELECTRIC SHOCK.

Hazardous AC supply inside. Remove power before servicing.

1.2 ULTRAVIOLET RADIATION SAFETY

Label Standard Number:

DIN 4844

Meaning:

CAUTION: The SM8200 contains an ultraviolet (UV) light source. Eye damage can result from looking directly at the UV lamp. Wear protective glasses or do not look directly into the beam.

1.3 CAUTION REGARDING HOT SURFACES

Label Standard Number:

IEC 60417-5041

Meaning:

CAUTION: The SM8200 contains hot surfaces in the area of the optional Cal Gas Heater assembly. To avoid possible skin burns, disconnect mains power and allow the Cal Gas Heater assembly to cool before touching.

1.4 OZONE PRODUCTION

Although design measures have been taken to minimize it, the SM8200 contains an ultraviolet light source that will produce ozone. Ozone is a corrosive gas. Always purge the SM8200 with an adequate supply of clean dry instrument air to prevent accumulation of ozone.

NOTE: *This purge air must be dry and oil free to prevent contamination of optical surfaces and sensitive components.*

2.0 SYSTEM DESCRIPTION

This manual describes the installation, operation, calibration and routine maintenance of the Teledyne Monitor Labs *SM8200* Gas Monitor. The *SM8200* Gas Monitor is a 2^{nd} Derivative UV absorption gas monitor that is designed to continuously monitor concentrations of SO2 and NO in a combustion exhaust gas stream.

2.1 SYSTEM COMPONENTS, STANDARD EQUIPMENT

The *SM8200* utilizes advanced signal processing and dispersive UV optics to produce electrical signals linearly proportional to the concentration of SO2 and NO in gas phase mediums. To accomplish this, several system components are required. The components of a standard system are:

- ❒ Probe
- ❒ Mounting Flange
- ❒ Air Flush Housing
- ❒ Transceiver
- ❒ Mounting Plate and Weather Cover
- ❒ Analyzer Electronics Box (AEB)
- ❒ Enhanced Remote Panel

2.1.1 Probe

The *SM8200* probe includes a ceramic filter, a measurement cavity which is bounded by a quartz window on one end and a retro reflector on the other end and the Stack Temperature probe (see Figure 2-1). Standard probe lengths are 4 and 6 feet. The size of the measurement cavity is factory selected based on gas concentration and stack temperature ranges. The *SM8200* probe is physically joined to the transceiver air flush housing using spring-loaded draw latches to permit easy removal and maintenance.

NOTE: The probe assembly and transceiver air flush housing (forward most hinged transceiver casting) must remain assembled to the probe so that factory optical alignment is maintained.

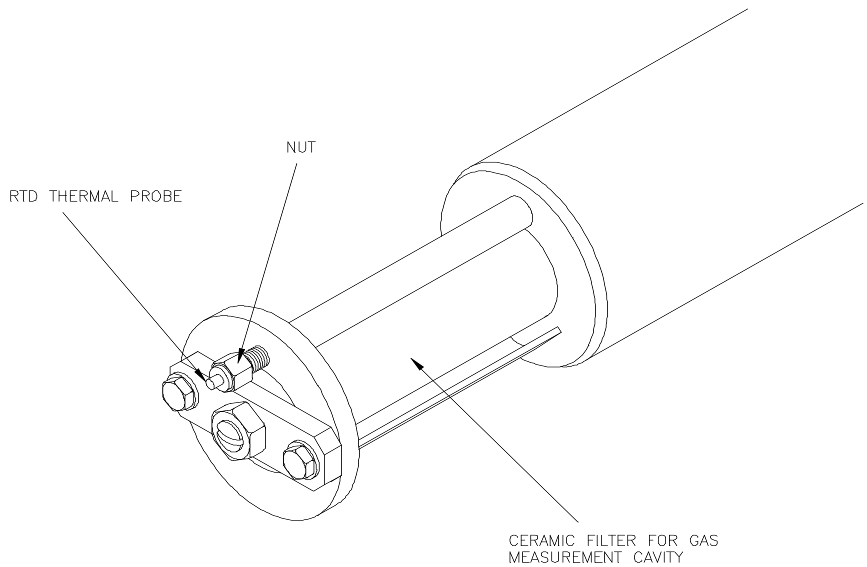

Figure 2-1: Standard SM8200 Probe
for Measurement Cavities of 20 cm or Less

2.1.2 Transceiver

The Transceiver contains most of the optical system (UV lamp, beam splitter, spectrometer, photodiode array (PDA) detector), the Preamp TE Cooler Board, the Bench Temperature Controller and two rotary solenoids, one each for the EO Cal Cell and Dark Shutter. There are no analog potentiometers on the Preamp TE Cooler Board. All adjustments to it can be performed by monitoring test points in the AEB and optimizing digital potentiometer settings via multiple user interfaces.

Figure 2-2 shows the front of the transceiver. The desiccant indicator shows the amount of moisture inside the transceiver. An external span cell can be inserted in the desiccant opening for performing a functional check. The purge tube passes air into the transceiver housing and exits through a hole in the lamp housing to expel ozone gases generated by the lamp. The Stack Temperature probe cable and purge tube connect to the transceiver. The Stack Temperature probe cable originates from an RTD installed near the probe measurement cavity, while the purge tube comes from the AEB.

2.1.2.1 Local User Interface (LUI)

The transceiver is equipped with an LED display and 10 button keypad interface for monitoring of key system data and diagnostics. It also provides access for a limited number of key Transceiver adjustments, as well as manual control of calibration modes for ease of maintenance. However, the Enhanced Remote Panel provides more complete and menu driven access to analyze data and parameters. Consult section 6.0 of this manual for details on LUI operation.

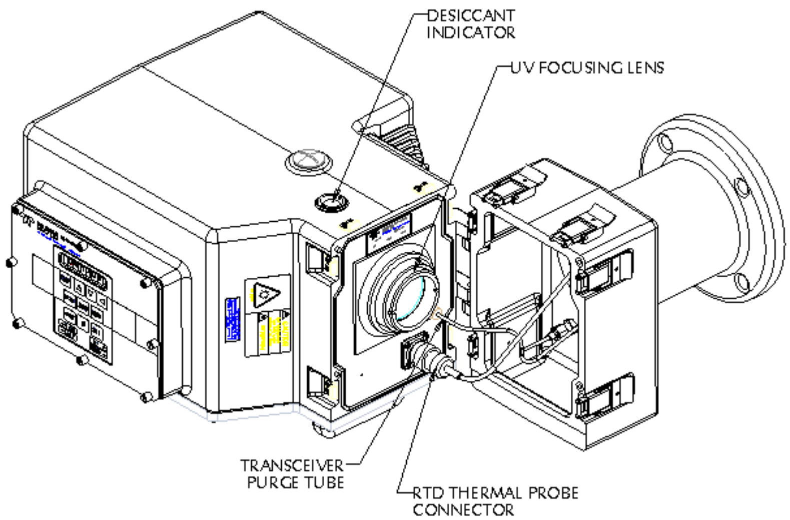

Figure 2-2: SM8200 Transceiver, Front View

2.1.3 Analyzer Electronics Box (AEB)

The Analyzer Electronics Box performs the control and processing of the electrical signals produced by the Transceiver. The heart of the AEB is the AEB Motherboard, which performs the following functions:

- ❐ Processing and control of the amplified PDA video signal and TE cooler controller on the Preamp TE Cooler Board. The amplified video signal is produced from the PDA output as a serial train of analog levels representative of the UV energy signal at discrete wavelengths typically between 200 and 230 nanometers (nm). These discrete wavelength signals (referred to as pixels) are mathematically processed by the AEB Motherboard to calculate gas concentration.

- ❐ Processing of voltages and control of discrete outputs from the Auxiliary IO Board. The Auxiliary IO Board can accept two analog inputs, used for Stack Temperature and Pressure sensing, and produce up to 8 discrete outputs. The discrete outputs are used to control the gas solenoids, the EO Cal solenoid, the Dark Shutter and four relays on the Relay Output Board. The relays are used to control the optional Cylinder Gas Audit Box and the UV Lamp Filament Shutdown signal.

- ❐ Control of the Local User Interface (LUI).

- ❐ Control of the optional Cal Gas Heater Board. The Cal Gas Heater is used in analyzers installed in cold climates that employ bottled gases for calibration span tests.

- ❒ Control (via the Auxiliary IO Board) of the optional O2 IO board, which processes a 4-20mA analog signal from the optional oxygen analyzer. The O2 IO Board also produces 2 contact outputs to drive the zero and span relays of the optional O2 Cal Gas Assembly.

- ❒ Communication via an FFT10A LON WORKS® network with other system elements (see Figure 2-3: System Block Diagram), such as the Enhanced Remote Panel.

Also located in the AEB is the UV Lamp Power Supply. It provides the following voltages to the AEB and Transceiver:

- ❒ +15 VDC for analog circuitry.
- ❒ -15 VDC for analog circuitry.
- ❒ +5 VDC for digital circuitry.
- ❒ Separate +5 VDC power for the PDA TE cooler.
- ❒ +10 VDC filament power for the UV Lamp.
- ❒ UV Lamp Run (+80 VDC nominal) and Strike (approximately +500 VDC) voltages.

Input power is provided to the UV Lamp Power Supply by dual 24 VDC output switching power supplies.

2.1.4 Enhanced Remote Panel

The Enhanced Remote Panel is built with a modular design. It can be mounted in a 19" rack. The software is menu driven and uses a commercial network communications platform to transfer data to and from the AEB. It uses a membrane switch keypad, a 4 ½" LCD display with graphics capability and a key lockout for critical functions.

Included in the Enhanced Remote Panel is the Multi I/O Board, which has eight relay outputs, eight digital inputs, and four individually isolated analog (4 to 20mA) outputs.

The Enhanced Remote Panel also includes one RS232C serial port, one RS422 serial port and an Ethernet 100 BaseT port. Use of these communication ports is outside the scope of this manual. Consult factory for additional documentation.

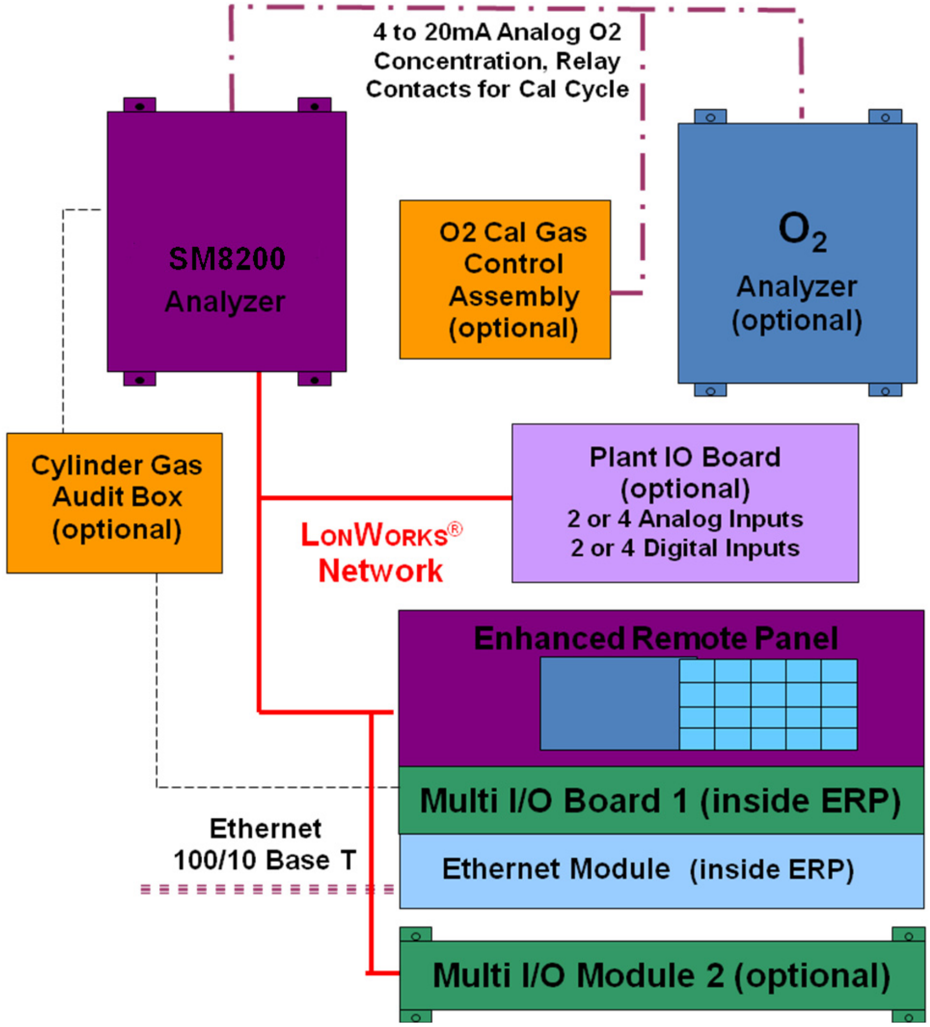

Figure 2-3: System Block Diagram

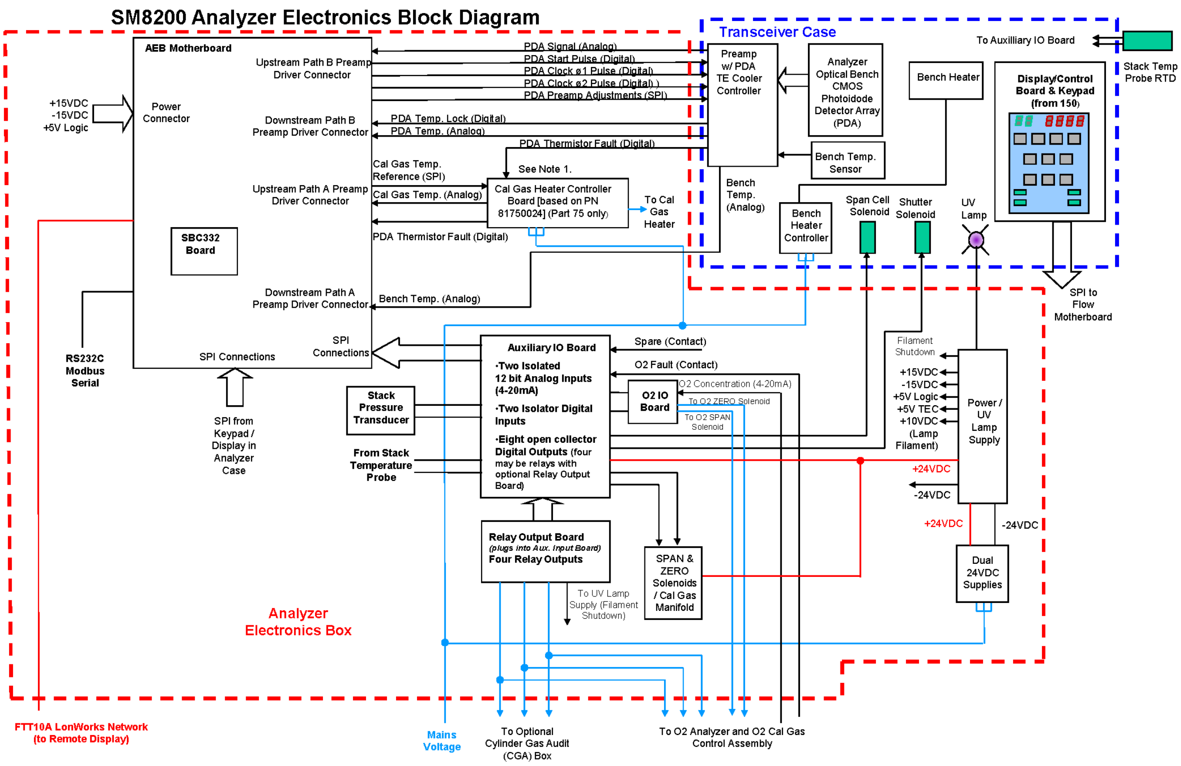

Figure 2-4: Analyzer Electronics Block Diagram

2.2 OPTIONAL EQUIPMENT

2.2.1 Multi I/O Module

A separately packaged, 19" rack mount-able Multi I/O Module is available as optional equipment. This will add eight relay outputs, eight digital inputs, and four individually isolated analog (4 to 20mA) outputs to the system.

2.2.2 Plant IO Module

The Plant IO Module is designed to collect data from up to 4 analog (4 to 20mA or 0 to 5 V)) inputs and 4 contact inputs. It is typically used to provide Continuous Emission Monitor Systems (CEMS) with plant information such as steam flow, megawatts, fuel in use, or other boiler operational parameter status of the plant. The Plant IO Module is designed to mount in a 19" rack for ease of integration with the Enhanced Remote Panel and Multi I/O Module.

2.2.3 Cylinder Gas Audit (CGA) Box

The Cylinder Gas Audit Box is used to automate the operation and collection of 3 point gas audits (low, mid and high concentrations). Since most CEM systems require audits on a quarterly basis, the Cylinder Gas Audit Box provides the customer with a programmable method of automating these tests. This option can reduce the labor required to perform these important test while greatly reducing the possibility of human error during the process.

It consists primarily of a 115 VAC/230VAC input, 24 VDC output power supply, 3 solenoid valves and assorted plumbing. The number of runs is user selectable under menu control by the Enhanced Remote Panel.

2.3 SPECIFICATIONS

PHYSICAL DIMENSIONS

Weather Cover	*36"(914mm)(L) X 20"(508mm)(W) X 31.5"(800mm) Depth*
Probe Dimensions	*Application dependent* *Typical 72"(1829mm) to 96"(2438mm)(L) X 12"(305mm)(W) X 9"(229mm)(H)*
Air Flush Housing	*11"(28cm)L X 7-1/2'(19cm) W X 9"(23cm) D*
Probe Flange Size & Type	*4"(102mm) Schedule 40 pipe (supplied with analyzer)*
Transceiver	14"(35.6 cm) (L) x 13 in.(33 cm.) (W) x 10 in.(25.4 cm.) (H)
Analyzer Electronics Box	*16"(40.6cm) (H) X 14"(35.6cm) (W) X 10"(25.4cm) (D)*
Calibration Gas Heater	*12"(30.5 cm) (L) x 6"(15.4 cm) (W) x 6"(15.4 cm) (H)*
Enhanced Remote Panel	*3U 19"(483mm) Rack Mount 5-1/4"(133mm)(H) X 9" (229mm) Depth*
Multi I/O Module (optional)	*2U 19"(483mm) Rack Mount 3-1/2"(89mm)(H) X 9"(229mm) Depth*
Plant I/O Module (optional)	*2U 19"(483mm) Rack Mount 3-1/2"(89mm)(H) X 9"(229mm) Depth*

PHYSICAL WEIGHTS

Analyzer Electronics Box (w/o Weather Cover)	*46 lbs. Maximum (21 kg)*
Transceiver	*54 lbs. Maximum (24.5 kg)*
Probe (6 foot version including air flush housing)	*44 lbs. Maximum (20.1 kg)*
Calibration Gas Heater	*Approx 15 lbs. (7 Kg)*
Weather Cover with Mounting Plate	*44 lbs. Maximum (22.7 kg)*
Probe Flange	*15 lbs. (7 Kg)*
Enhanced Remote Panel	*8.5 lbs. (4.5 kg)*
Multi I/O Module (optional)	*5.9 lbs. (2.7 kg)*
Plant I/O Module (optional)	*6.3 lbs. (2.9 kg)*

MEASUREMENT RANGES

SO2 and NO	*Minimum 0 to 50 ppm; Maximum 0 to 10,000ppm*
SO2/NO Range Ratio	*Minimum 0.125; Maximum 8*
Stack Temperature Measurement	*Range: 0 to 800°F (-17.8°C to 426.7°C)*

GAS MEASUREMENT CHARACTERISTICS COMMON TO ALL GASES

Response Time	*Adjustable to a minimum of 200 seconds to 95% of value*
Measurement Principle	*2nd Derivative UV Absorption Spectroscopy*
Environmental Regulatory Compliance	*USEPA 40CFR60* ***OR*** *USEPA 40CFR75, dependent on instrument configuration and options*
Calibration Drift, Zero & Span	*± 2.5% of range, or 5 ppm for range <200 ppm, whichever is greater* *(valid from 75°F to 400°F (23.9°C to 204.4 °C)*
Linearity	*±5% of Reference Value from 20 to 100% of range* *(valid from 75°F to 400°F (23.9°C to 204.4 °C)*

POWER & INSTRUMENT AIR REQUIREMENTS

Analyzer Electronics Box	*115 VAC 575 VA Maximum* *230 VAC, 590 VA Maximum* *47-63Hz, Single Phase, Factory Wired*
Analyzer Instrument Air	*Analyzer requires 0.1 CFM to 0.706 CFM (2.8 to 20 LPM) of clean, oil-free dry air or N2 at 69.6 PSI to 101.5 PSI (480 to 700KPa) gauge*
Calibration Gas Heater (Part 75 only)	115/230 VAC 300 VA Maximum
Enhanced Remote Panel Power	*85-245 VAC, 47-63Hz, Single Phase, 30 VA Maximum* *Fuses* *2 Amp Time Delay, 250V, 5x20mm*
Multi I/O Module Power (optional)	*85-245 VAC, 47-63Hz, Single Phase,* *25 VA Maximum* *Fuses* *2 Amp Time Delay, 250V, 5x20mm*
Plant I/O Module Power (optional)	*85-245 VAC, 47-63Hz, Single Phase,* *25 VA Maximum* *Fuses* *2 Amp Time Delay, 250V, 5x20mm*

AMBIENT OPERATING CONDITIONS

Analyzer Electronics Box and Transceiver	*Temperature Range: -30 to +130°F (-34.4 to 54.4°C)* *Relative Humidity Range: 0 to 100% condensing* *Barometric Pressure Range: 18 to 32"Hg (61.1 to 108.6 KPa)* *Enclosure Rating: NEMA4*
Enhanced Remote Panel & (Optional) Multi I/O Module	*Temperature Range: +32 to +104°F(0 to +40°C)* *Relative Humidity Range: 0-95% noncondensing*

MEASUREMENT MEDIUM CONDITIONS FOR GAS MEAUREMENT

Static Pressure Range for Valid Measurement	*±20" H2O (±4.98 KPa) Gauge*
Maximum Particulate Concentration	*4.37 grains/SCF (10,000 mg/Nm^3)*
Humidity	*Standard Probe: Noncondensing*
Temperature Range for Valid Measurement	*75 to 800°F (23.9 to +426.7°C)*

ANALYZER HUMAN/MACHINE INTERFACE (HMI) CHARACTERISTICS

Display Type	*Six 7 Segment LED's*
Indicating LED's	*Fault, Set, In Cal, Power*
User Input Controls	*10-key keypad*

WIRING REQUIREMENTS, ANALYZER TO ENHANCED REMOTE PANEL

Network Transceiver Type	*Free Topology Transceiver (FTT10A)*
Cable Type	*2 conductor shielded twisted pair, 16 AWG (Alpha 5610B1601 or equivalent)*
Termination Style	*Jumper Selectable Double Termination (Internal)*
Maximum Distance Between Analyzer & Enhanced Remote Panel	*3281 feet (1000 meters) [must be Double Terminated]*
Maximum Total Network Length	*3281 feet (1000 meters) [must be Double Terminated]*

ENHANCED REMOTE PANEL HUMAN/MACHINE INTERFACE (HMI) CHARACTERISTICS

Display Type	*Graphics mode liquid crystal with LED backlight*
Display Resolution	*240 X 128*
Indicating LED's	*Fault, Alarm, Power*
User Input Controls	*20-key keypad, security key switch*

ENHANCED REMOTE PANEL SERIAL PORT CHARACTERISTICS

Number	*2 (one RS232C, one RS422 or RS485 [jumper selectable])*
RS232C Port Configuration	
BAUD Rate	*9600*
Data Bits	*8*
Stop Bits	*2*
Parity Type	*No Parity*
Connector Designation & Type	*J16, DB9*
RS422/RS485 Port Configuration	
BAUD Rate	*9600*
Data Bits	*8*
Stop Bits	*2*
Parity Type	*No Parity*
Connector Designation & Type	*J17, DB15*

ENHANCED REMOTE PANEL ETHERNET PORT CHARACTERISTICS

Number	*1*
Physical Layer	*10/100 Base T Ethernet*
IP Addressing Modes	*Static IP or DHCP*
Supported Protocols	*http, Modbus TCP/IP*

MULTI I/O BOARD ANALOG OUTPUTS

Standard Enhanced Remote Panel has one Multi I/O Board,
Optional Multi I/O MODULE Provides a Second Multi I/O Board & Hence Twice the I/O Points

Number	*4*
Isolation Type	*Optical & capacitive barriers; channel to channel, channel to circuit common & earth*
Minimum Isolation Voltage	*500Vpeak*, 500VDC**
Output Type	*4-20mA with live 4mA zero*
Maximum Load Resistance	*900 ohms*
Maximum Offset	*±0.05% of full scale*
Total Output Error	*±0.30% of full scale*

MULTI I/O BOARD DIGITAL INPUTS

Standard Enhanced Remote Panel has one Multi I/O Board,
Optional Multi I/O MODULE Provides a Second Multi I/O Board & Hence Twice the I/O Points

Number	*8*
Modes	*Isolated and Non-isolated*
Isolated Mode Minimum Isolation Voltage	*500Vrms**
Isolated Mode Minimum Actuation Voltage	*5VDC (user supplied)*
Isolated Mode Maximum Actuation Voltage	*24VDC (user supplied)*
Isolated Mode Maximum Input Current	*50mA @ 24VDC*
Non-Isolated Mode Actuation Condition	*Dry contact closure*
Non-Isolated Mode Internal Operating Voltage	*5VDC*

MULTI I/O BOARD RELAY OUTPUTS

Standard Enhanced Remote Panel has one Multi I/O Board,
Optional Multi I/O MODULE Provides a Second Multi I/O Board & Hence Twice the I/O Points

Number	*8 SPST, N.O. (Single Pole Single Throw, Normally Open)*
Minimum Isolation	*500Vrms**
Maximum Contact Voltage	*250VAC*
Maximum Contact Current	*3Amps AC, 3Amps DC*

* I/O wires with respect to earth (common mode).

3.0 INSTALLATION

3.1 SITE PREPARATION

3.1.1 Monitoring Site Selection and Preparation

Select the transceiver/probe site according to procedures established by the appropriate regulatory agencies. The location should be selected where measurements of SO_2 and NO are representative of the total SO_2 and NO concentrations at the stack exit (refer to *40 CFR Part 60, Appendix B, PS-2, paragraph 3*). If the instrument will be exposed to weather conditions, a protective housing is required. Each *SM8200* Gas Analyzer is typically supplied with a fiberglass weather cover and hinge attached mounting plate. See site installation drawing number 82000050, Sheet 1.

Consult Teledyne Monitors Labs Drawing *number 8*2000050 for guidance on electrical installation details for the Monitoring Site. Consult Section 2.0 of this manual for electrical power requirements.

All monitoring site electrical work must be performed by qualified personnel in accordance with local electrical codes (see Section 1.0 of this manual).

3.1.1.1 Instrument Air Purge Requirements

Clean, dry instrument air must be supplied with the following specifications:

- No particulate or liquid contaminates
- 70 psi minimum to 100 psi maximum air pressure
- -40° F maximum dew point
- Less than 0.1 ppm SO2 or NO
- Less than 40 ppm hydrocarbon concentration.

The instrument air tube must be installed near the mounting plate for connection to the Analyzer Electronics Box.

3.1.2 Enhanced Remote Panel Site Preparation

The Enhanced Remote Panel is intended for 19” rack mounted indoor use in a control room or CEM shelter environmental. Consideration should be given to the ability of operators or interested personnel to view the displays and output devices readily. Access to the panel by installation and maintenance personnel should also be considered. Reference Teledyne Monitor Labs Drawing *number 1803-2003 sheet 2,* Enhanced Remote Panel Customer Drawing for mounting dimensions. Reference Teledyne Monitor Labs drawing *number 82000050* for proper electrical connections. Reference Section 2.0 of this manual for the electrical power requirements of the Enhanced Remote Panel.

3.2 SYSTEM INSTALLATION

After completion of site preparation, install the transceiver and probe as described in the following steps. Leave the probe attached to the Air Flush Housing to preserve the factory alignment of the probe and transceiver. Remove transceiver prior to installing probe and Air Flush Housing, then install transceiver once probe and Air Flush housing are in place.

NOTE: *Always cover the probe opening and transceiver lens when transporting the system to the stack.*

3.2.1 Installing the Mounting Flanges and Pipe

If installation is on a metal stack, go to step 2.

1. If installation is on a masonry stack, bolt the stack plate (customer-supplied) to the stack wall using six 1/2-diameter anchor bolts.

   Perform step 2 ***only*** when a protective housing for the SM8200 is being installed. If no housing is to be installed, go to step 3.

2. Fillet weld four 1-1/2" SCH 40 pipe mounting brackets to the stack (Metal Stacks) or stack plate (Masonry Stacks), with dimensions as shown in *drawing 82000050*.

3. Cut a 4½" diameter hole in the stack wall for insertion of the mounting flange pipe (4 inch Schedule 40 pipe).

4. Insert the mounting flange pipe into the hole and position the face of the mounting flange not less than six inches away from the stack wall. One of the small (1/2 in. diameter) holes of the largest diameter bolt circle ***must be*** in the twelve o'clock position. See view A-A on drawing 82000050.

5. Install the mounting tube and flange at a slightly downward angle (approximately 2 – 5 degrees) to prevent the buildup of condensed liquid at the cooler end of the probe.

6. Fillet weld the mounting flange pipe where it meets the stack wall (metal stacks) or stack plate (masonry stacks).

3.2.2 Installing the Protective Housing

If no protective housing is being used, install the Analyzer Electronics Box as described in 3.2.3 below.

Bolt the mounting plate assembly (including the housing and Analyzer Electronics Box) to the four mounting brackets welded to the stack by inserting four 1/2-13 UNC bolts with flat washers and lock washers. Use the four 0.68-diameter clearance holes in the mounting plate.

Secure the cover in the raised position.

3.2.3 Installing the Analyzer Electronics Box

Position the Analyzer Electronics Box with the four conduit inlet holes facing downward. Bolt the Analyzer Electronics Box in place on the enclosure mounting plate.

Cable Installation

1. Open the Analyzer Electronics Box cover.

2. The customer supplied AC power cable (hot, neutral and PE gnd) are to be installed thru the left most conduit connector on the bottom of the Analyzer Electronics Box. Note: The holes allow for the use of ¾-inch conduit fittings. Make connections to TB3 as per the SM8200 Interconnect Diagram, drawing *number 82000050, Sheet-2.*

3. The LONWORKS® network cable is installed thru the 2nd conduit entry from the left to TB4. The recommended cable is Alpha 5610B1601, 16 AWG w/ shield. For details, see the SM8200 Interconnect Diagram, drawing *number 82000050, Sheet-2.*

4. When applicable, install the cables to the optional O2 Analyzer and the Cylinder Gas Audit box assembly thru the remaining 2 conduit openings on the bottom of the AEB to TB4. For details, see the SM8200 Interconnect Diagram, drawing *number 82000050, Sheet-2.*

   NOTE: *If conduit is not used, cord connectors rated NEMA 4 with glands must be used to maintain the NEMA 4 rating of the Analyzer Electronics Box.*

5. Close the Analyzer Electronics Box cover.

Caution: ***Care must be taken when closing the door so that all cables freely clear the hinge and are not pinched in the door.***

3.2.3.1 Plumbing Installation

1. Connect a purge tube from the Analyzer Electronics Box Purge fitting to the transceiver Purge fitting located on the bottom of the probe air flush housing. Connect instrument air to the Analyzer Electronics Box Air In fitting.

2. If the probe has a pressure-sensing port, connect a tube from the Analyzer Electronics Box Pressure fitting to the left Calibration fitting on the probe flange. If the probe port is not installed, point the elbow on the Analyzer Electronics Box pressure bulkhead downward. (There is no elbow on the AEB to point down)

3. Connect a cylinder of mixed NO and SO_2 span calibration gas to the Analyzer Electronics Box Span gas in side of the manual valve. Make sure valve knob is turned to the span gas direction or no gas will flow. Cylinder concentrations must be in compliance with EPA or local agency requirements but not less than 50% of the instrument span.

   NOTE: *The Cal gas outlet must be regulated between 5 to 20 psi. Remember to set the regulator to minimum <u>before</u> turning on the cylinder gas.*

If the optional Cal Gas Heater is used, connect the Analyzer Electronics Box Cal port to Probe fitting to the left side of the heat exchanger. Using the insulated tubing provided, connect the right side of the heat exchanger to the probe Cal fitting (right Calibration fitting on the probe flange). If a Cal Gas Heater is not employed, connect the Analyzer Electronics Box Cal port to the probe Cal fitting.

3.2.4 Installing the Probe

1. Slide the probe (without the transceiver) through the hole at the top of the mounting plate until the probe flange meets the mounting flange.

   NOTE: *Be sure the dynamic calibration fitting slides through the large hole used for zero and gas calibration (in the five o'clock position). One of the small (1/2 in, diameter) holes in the probe flange must be at the twelve o'clock position.*

   From the stack side, insert five 3/8-16 x 1-inch LG hex bolts with split ring lock washers through the mounting flange into the five threaded holes in the probe flange. Tighten the bolts.

3.2.5 Installing the Transceiver

1. Lower the transceiver onto the hinge pins of the probe/air flush housing.

2. Attach the thermal probe connector from the probe to the bulkhead connector just below the transceiver lens. Also, connect the purge tube.

   NOTE: *Ensure that the thermal probe connector and purge tube are not in the light path when making the connection, and when closing the transceiver against the probe.*
3. Remove the lens cover and clamp the transceiver to the probe/air flush housing, ensuring that the pilot pins are properly aligned.

   NOTE: *The pilot pins ensure correct optical alignment between the transceiver and probe.*
4. Connect the three cables between the Transceiver and the Analyzer Electronics Box but ***do not apply power* at this time.** This will be done during checkout and startup by a Teledyne Monitor Labs service engineer.

   Caution: ***Do not attempt to extend the length of these cables. The Analyzer Electronics Box must be mounted within the factory fabricated distance***.

3.2.6 Installing the Enhanced Remote Panel (ERP)

The Enhanced Remote Panel is a 19” rack style chassis that mounts easily to any standard rails with an E.I.A. hole pattern. The ERP occupies 5.25” (3u) of rack space and mounts with standard hardware. Refer to drawing *number 1803-2003 sheet 2,* for mounting details. Refer to Interconnect Diagram, drawing *number 82000050*, sheet 2 for wiring details.

3.2.7 Purge

Significant pollutant gas concentrations can exist in the ambient air surrounding the transceiver and low levels of ozone are produced by the UV lamp, so instrument air must be circulated through the transceiver and probe body to prevent damage. The resulting positive pressure keeps gases, dust, and other contaminants from entering the optical path and prevents ozone accumulation inside the transceiver.

NOTE: *Ozone is highly corrosive. Always operate the transceiver with purge air. Consult Section 1.0 of this manual.*

3.3 SYSTEM COMMISSIONING

3.3.1 Checkout and Startup Service

Teledyne Monitor Labs provides a checkout and startup service at additional cost. This includes a seminar on instrument operation, support, maintenance, and data interpretation. All personnel who will operate or maintain the SM8200 should attend this presentation.

NOTE: *Startup cannot begin until the steps under section 3.2, System Installation, have been completed. Customers are charged at an hourly rate for additional time that Teledyne Monitor Labs' service engineer is required to spend at the site waiting for completion of the installation.*

At startup, the *Transceiver Checklist and Installation/Startup Checklist* are completed by Teledyne Monitor Labs' service representative. Sample checklists are provided at the end of this chapter for your information.

The complete field test and calibration procedure used at startup and whenever instrument test or verification is needed can be found in *Chapter 4, Operation, Calibration & Maintenance*.

3.3.2 Example Transceiver startup Checklist

1. Visually inspect the unit for any apparent damage and record below.

   ____

   ____

   ____

2. Check the mounting interface bolts for tightness. ______

3. Open the transceiver and visually inspect the lens and probe reflector. ______

4. Apply power to the instrument and wait one minute for the lamp to fire.
______ ***Caution: Do not look directly into the front lens of the transceiver***

5. Verify that the UV Lamp has fired (green DS3 LED on the UV Lamp Power Supply Board in the Analyzer Electronics Box is lit). ______

3.3.3 Installation/Startup Checklist

1. Record / verify Enhanced Remote Panel parameter settings and Service Data readings as per below. See Section 5.0 of this manual for help on navigating the menu structure:

SERVICE DATA SM8200
TEMPERATURE & PRESSURE

PDA TEMPERATURE:______________________

BENCH TEMPERATURE: :______________________

CAL GAS TEMP: :______________________

STACK TEMPERATURE: :______________________

STACK PRESSURE: :______________________

SERVICE DATA SM8200
INCREMENTAL & TOTAL ADJUST

	INCREMENTAL	TOTAL
NO ZERO:	____________	_____________
NO SPAN: :	____________	_____________
SO2 ZERO: :	____________	_____________
SO2 SPAN: :	____________	_____________

SERVICE DATA SM8200
GAS AUTO CORRECTION

NO OFFSET: ________________________

SO2 OFFSET: ________________________

NO SLOPE: ________________________

SO2 SLOPE: ________________________

NO & SO2 CONCENTRATIONS

	NO	SO2
CON 1: :	______________	_______________
CON 2: :	______________	_______________
CON 3: :	______________	_______________
CON 4: :	______________	_______________
CON 5: :	______________	_______________
CON 6: :	______________	_______________
CON 7; :	______________	_______________
CON 8: :	______________	_______________
CON 9: :	______________	_______________
CON 10: :	______________	_______________

STACK TEMP & PRESSURE SM8200

	TEMP	PRESS
VAL 1:	______________	_______________
VAL 2:	______________	_______________
VAL 3:	______________	_______________
VAL 4:	______________	_______________
VAL 5:	______________	_______________
VAL 6:	______________	_______________
VAL 7:	______________	_______________
VAL 8:	______________	_______________
VAL 9:	______________	_______________
VAL 10:	______________	_______________

SM8200 ANALYZER PROPERTIES
NO AUTO CORRECTION & ADJUST
AUTO CORRECTION:

ZERO INCR LIMIT: ____________

ZERO TOTAL LIMIT: ____________

SPAN INCR LIMIT: ____________

SPAN TOTAL LIMIT: ____________

SLOPE LIMIT: ____________

SM8200 ANALYZER PROPERTIES
SO2 AUTO CORRECTION & ADJUST
AUTO CORRECTION:

ZERO INCR LIMIT: ____________

ZERO TOTAL LIMIT: ____________

SPAN INCR LIMIT: ____________

SPAN TOTAL LIMIT: ____________

SLOPE LIMIT: ____________

SERVICE DATA SM8200
OTHER DATA 2

FACTORY CAL CRC CHECK RES: ____________

USER SET CRC CHECK RESULT: ____________

MEAN DARK CURRENT: ____________

MEAN REF CURRENT: ____________

CAL CYCLE DURATION

DARK CURRENT IP: ______________________

ZERO ACQUIRE IP's: _____________________

ZERO IP's: _____________________

WAVELENGTH CHECK IP's: _____________________

SPAN ACQUIRE IP's_____________________:

SPAN IP's_____________________:

NORMAL ACQUIRE IP's: _____________________

SM8200 ANALYZER
OTHER CAL CYCLE PROPERTIES

HOUR OF AUTO CAL: ___________________

MINUTE OF AUTO CAL: ___________________

AUTO CAL INTERVAL HOUR: ___________________

BOTTLED CALGAS ENABLE: ___________________

DAILY CAL GAS: ___________________

CGA CYCLES: ___________________

WAVELENGTH CHECK: ___________________

MAN CAL TIMEOUT MINTS: ___________________

SM8200 ANALYZER PROPERTIES
ANALYZER GAINS

PDA VIDEO GAIN: ___________________

PDA TEMP GAIN: ___________________

CAL GAS TEMP GAIN: ___________________

BENCH TEMP GAIN: ___________________

SM8200 ANALYZER PROPERTIES
PRE AMP SETTINGS

ANTI GLITCH SETTING: ____________________

DARK PIXEL SETTING: ____________________

PRE AMP OFFSET: ____________________

SM8200 ANALYZER PROPERTIES
NO SET POINTS

ZERO SET POINT: ____________________

SPAN SET POINT: ____________________

EO CAL SET POINT: ____________________

FULL SCALE: ____________________

CAL TOLERANCE,%FS: ____________________

SM8200 ANALYZER PROPERTIES

NO CURVE TYPE

CURVE TYPE: ____________________

A0 OR X1: ____________________

A1 OR Y1: ____________________

A2 OR X2: ____________________

A3 OR Y2: ____________________

A4 OR X3: ____________________

A5 OR Y3: ____________________

SM8200 ANALYZER PROPERTIES
SO2 CURVE TYPE

CURVE TYPE: ____________________

A0 OR X1: ____________________

A1 OR Y1: ____________________

A2 OR X2: ____________________

A3 OR Y2: ____________________

A4 OR X3: ____________________

A5 OR Y3: ____________________

SM8200 ANALYZER PROPERTIES
NO GAIN,INTERFERENCE COMP

NO GAIN: ___________________

SO2toNO INT COMP: ___________________

NO2toNO INT COMP: ___________________

NH3toNO INT COMP: ___________________

SM8200 ANALYZER PROPERTIES
SO2 GAIN,INTERFERENCE COMP

SO2 GAIN: ___________________

NOtoSO2 INT COMP: ___________________

NO2toSO2 INT COMP: ___________________

NH3toSO2 INT COMP: ___________________

SM8200 ANALYZER PROPERTIES
EO CAL TEMP & PRESS

EO CAL TEMP: ____________________

REFERENCE PRESS: ____________________

CURRENT SOFTWARE VERSIONS
SM8200

REMOTE PANEL 332 VER: ____________________

REMOTE PANEL NEURON VER: ____________________

ANALYZER 332 VER: ____________________

ANALYZER NEURON VER: ____________________

FPGA VER: ____________________

TRAINING SET VER: ____________________

MIO 1 VER: ____________________

MIO 2 VER: ____________________

ETHERNET WEB SERVER VER: ____________________

ETHERNET NEURON VER: ____________________

2. Verify that the transceiver has been on for at least three hours before continuing checkout (warm-up and settling time).

3. Verify that no analyzer faults are active.

4. Using the Enhanced Remote Panel user interface, place the SO2 and NO Auto-correction parameters in the DEFAULT setting, then verify that SO_2 and NO zero and span readings are correct. If the readings are correct, return the Auto-correction parameters to their original settings.

   SO_2 zero ____________________ ppm

   NO zero ____________________ ppm

   SO_2 EO Cal span cell value ____________________ppm

   NO EO Cal span cell value _________________________ppm

   SPAN SO2 _______________ppm reading, ____________bottle concentration

   SPAN NO ________________ ppm reading, ____________bottle concentration

5. Verify the Multi IO Analog Outputs

6. Verify alarm levels according to the application requirements:

   SO2 LOW Level __________ ppm SO2 HIGH Level__________ppm

   NO LOW Level ___________ ppm NO HIGH Level __________ ppm

7. Verify contact closure outputs to any external devices.

8. Verify Ethernet communication to the DAS, as appropriate.

3.3.4 Software Upgrade Policy

Teledyne Monitor Labs reserves the right to modify, alter, or enhance its software at its own discretion.

Periodically, software upgrades are made available for sale; call for standard upgrade price.

Customers who request upgrades accept all responsibility for installation and configuration of the upgrade, including costs and real or consequential damages related to the installation or use of the upgrade.

Factory service software upgrades performed by Teledyne Monitor Labs employees will include a charge for software installation.

In the event of a software upgrade covered by warranty, Teledyne Monitor Labs' liability is limited to provision of the software or firmware component in question on electronic media. Labor, travel costs, incidentals, and all other expenses resulting from the software upgrade are the sole responsibility of the customer.

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4.0 OPERATION, CALIBRATION AND MAINTENANCE

4.1 OPERATION

This section describes the basic operating steps for the SM8200. Operators must understand the operating procedure for the controller before attempting to operate the SM8200. Refer to the Section 5.0 of this manual for details on menus and setup parameters pertaining to SM8200 operation and reporting.

The SM8200 has numerous modes of operation. These modes can be invoked from many points in the system:

- the Transceiver Local User Interface
- the serial port of the Analyzer Electronics Box Motherboard through use of the PMODBUS Tool
- the Enhanced Remote Panel user interface
- the serial ports of the Enhanced Remote Panel
- the Multi I/O Board (both the internal one in the Enhanced Remote Panel and the optional external one)
- the Ethernet Module interface

For all manual mode change commands, the measurement cycle in progress will terminate when a mode change command is received. The last of the above mentioned devices to command a mode change will win control of the analyzer mode. The exceptions to this are:

1. if the analyzer boxcar has finished accumulating and the data calculations are in progress, in which case said calculations will complete before the mode is changed
2. if a CAL_CYCLE in progress, in which case no mode change commands will be honored until the completion of the CAL_CYCLE.

NORMAL mode is the typical operating mode of the instrument. In this mode the instrument samples the stack gas, calculates concentrations and propagates these values throughout the system as emission data.

ZERO mode challenges the analyzer with zero air (typically instrument air) or dry N2 calibration gas. In this mode zero reference gas floods the measurement cavity, thus producing a response at or near zero on all gas measurements.

SPAN mode challenges the analyzer with an upscale calibration gas, typically a blend of NO and SO2 with a N2 balance. In this mode calibration gases floods the measurement cavity.

EO CAL mode places a sealed gas cell containing a known blend of NO and SO2 into the measurement path directly in the optical path of the Photodiode Array (PDA). During this mode zero reference gas floods the measurement cavity so that the only gas in the measurement path is that in the EO CAL cell.

DARK mode places a shutter in the optical path whose purpose is to prevent light from reaching the PDA. A measurement is taken in this condition during every calibration cycle to determine the dark current of the PDA. This new dark current resulting from this measurement is applied after the end of the calibration cycle.

There are several other modes of operation of the instrument. For information on additional modes of operation, consult Table 4-1.

There are other operations of the analyzer that blend several modes, such as the CAL CYCLE. There are two types of cal cycles:

1. one that uses calibration gases (BOTTLED CALIBRATION GAS = ENABLED in the CALIBRATION MENU)
2. one that uses the EO CAL cell for the span portion of the cal cycle (BOTTLED CALIBRATION GAS = DISABLED).

For information on the sequence of modes during the cal cycle, consult Table 4-2 and Table 4-3. Consult Section 5.0 of this manual for more information on calibration cycle control.

To understand the terminology used in Table 4-1, Table 4-2 and Table 4-3, it is necessary to have a fundamental grasp of the data collection process in the analyzer. Briefly put, the Analyzer Electronics Box Motherboard performs box car integration of digitized spectra measured by the Photodiode Array. In the box car integration technique, the absolute values of many measurement events are added together for each wavelength or pixel. This has the effect of separating the synchronous signal from asynchronous random noise, which has particular value in canceling noise.

These data are transferred to the Single Board Computer on the AEB Motherboard for analysis and subsequent conversion to gas concentrations. The process of accumulation of box car averages is programmable but is typically performed once per minute. Each accumulation cycle is called an INTEGRATION PERIOD. The calibration cycle duration is programmable in terms of the number of INTEGRATION PERIOD’s.

Name	Description
UNKNOWN	Default mode of all non analyzer devices when the analyzer node has not yet communicated its mode. The analyzer mode at reset.
DARK CURRENT	See Table 4-2
ZERO ACQUIRE	See Table 4-2
ZERO	See Table 4-2
WAVELENGTH CHECK	See Table 4-2
SPAN ACQUIRE	See Table 4-2
SPAN	See Table 4-2
NORMAL ACQUIRE	See Table 4-2
NORMAL	See Table 4-2
E/O CAL	See Table 4-3
MANUAL DARK	The shutter is deployed and the PDA output is integrated, calculated as per the Procedure for Calculating Concentrations document and placed in the appropriate nvoDataP float array members but the result is not used as the new dark current, but the mean dark current is propagated on the network via nvoDataP.
MANUAL ZERO, INITIAL ZERO, FINAL ZERO	All ZERO mode operations described in Table 4-2 are performed (zero gas flows into the measurement cavity), instantaneous and average ZERO are calculated and propagated on the network, but a new reference is not calculated nor is the data used for auto-correction purposes.
MANUAL WAVELENGTH CHECK	All WAVELENGTH CHECK mode operations from Table 4-2 are performed, the PDA output is integrated, calculated as per the Procedure for Calculating Concentrations document and placed in the appropriate nvoDataP float array members, Pixel Offset is calculated and placed in the Manual Pixel Offset nvoDataP word array variable and propagated on the network, but it is not used and thus is not placed in the Pixel Offset nvoDataP or buffer of 10 float array variables.
MANUAL SPAN	All SPAN mode operations from Table 4-2 are performed with the exception that no auto-correction is performed.
MANUAL E/O CAL	All E/O CAL mode operations from Table 4-3 are performed with the exception that no auto-correction is performed.
CGA LOW1, CGA_LOW2, CGA_LOW3, CGA_LOW4, CGA_LOW5, CGA_LOW6	For manual CGA's. CGA_LOWx (Cylinder Gas Audit Low) mode is similar to SPAN but instead of the SPAN solenoid the CGA_LOW relay is energized, the data is evaluated, averaged and propagated as if it were SPAN data, but no auto-correction is performed nor is SPAN calibration failure fault evaluated. The x indicates in which order the audit was done.
CGA MID1, CGA_MID2, CGA_MID3, CGA_MID4, CGA_MID5, CGA_MID6	For manual CGA's. CGA_LOW. CGA_MIDx (Cylinder Gas Audit Low) mode is similar to SPAN but instead of the SPAN solenoid the CGA_MID relay is energized, the data is evaluated, averaged and propagated as if it were SPAN data, but no auto-correction is performed nor is SPAN calibration failure fault evaluated. The x indicates in which order the audit was done.
CGA HIGH1, CGA_HIGH2, CGA_HIGH3, CGA_HIGH4, CGA_HIGH5, CGA_HIGH6	For manual CGA's. CGA_HIGHx (Cylinder Gas Audit Low) mode is similar to SPAN but instead of the SPAN solenoid the CGA_HIGH relay is energized, the data is evaluated, averaged and propagated as if it were SPAN data, but no auto-correction is performed nor is SPAN calibration failure fault evaluated.
TRAIN_DARK	Used for factory cal. Analyzer shutter is deployed, blocking light to PDA. Analyzer has accumulated one integration period's worth of data in box car and will not collect more data until another command is issued. Analyzer data is presented WITHOUT D2 processing.
TRAIN_CLEAR	Similar to TRAIN_DARK, but shutter is not deployed, zero gas solenoid is energized.
TRAIN_SPAN	Similar to TRAIN_DARK, but shutter is not deployed, span gas solenoid is energized. Also, the data is presented WITH D2 processing.
TRAIN_E/O_CAL	Similar to TRAIN_DARK, but shutter is not deployed, span cell (E/O CAL) solenoid is energized, span and zero gas cell solenoids are de-energized. Also, the data is presented WITH D2 processing.
TRAIN_NORMAL	Similar to TRAIN_DARK, but all solenoids are de-energized. Also, the data is presented WITH D2 processing.
TRAIN_DARK_ACQUIRE	Analyzer is accumulating data in the boxcar prior to processing. See TRAIN DARK.
TRAIN_CLEAR_ACQUIRE	Analyzer is accumulating data in the boxcar prior to processing. See TRAIN CLEAR.
TRAIN_SPAN_ACQUIRE	Analyzer is accumulating data in the boxcar prior to processing. See TRAIN SPAN.
TRAIN_E/O_CAL_ACQUIRE	Analyzer is accumulating data in the boxcar prior to processing. See TRAIN E/O CAL.
TRAIN_NORMAL_ACQUIRE	Analyzer is accumulating data in the boxcar prior to processing. See TRAIN NORMAL.
CGA LOW_ACQUIRE	This mode flags that the audit gas flowing into the measurement cavity is in the process of purging / displacing the prior contents. CGA_LOW gas solenoid is energized.
CGA MID ACQUIRE	This mode flags that the audit gas flowing into the measurement cavity is in the process of purging / displacing the prior contents. CGA_MID gas solenoid is energized.
CGA HIGH_ACQUIRE	This mode flags that the audit gas flowing into the measurement cavity is in the process of purging / displacing the prior contents. CGA_HIGH gas solenoid is energized.
E/O CAL_ACQUIRE	This mode flags that the zero gas flowing into the measurement cavity is in the process of purging / displacing the prior contents and produce a valid E/O CAL. The ZERO solenoid is energized thus zero gas flows into the measurement cavity. The Span Cell solenoid is also energized.

Table 4-1: SM8200 Mode Description

Order	Name	Duration	Description
1st	DARK CURRENT	Number of Integration Periods of Dark Current	Shutter is deployed to block PDA for dark current determination.
2nd	ZERO ACQUIRE	Number of Integration Periods of Zero Acquire	Zero gas flows into measurement cavity. Instrument starts acquiring zero data and performs calculations at the end of each integration period. The data is not yet representative of Zero gas.
3rd	ZERO	Integration Periods of Zero	Zero gas continues to flow into measurement cavity. Averager is filled with data from zero, therefore average output represents true zero performance regardless. Averager contains zero mode data only, but first integration period in, data is an average of one point; 2nd in, data is an average of two points; etc.
4th	WAVE-LENGTH CHECK	Integration Periods of Wavelength Check	Zero gas continues to flow into measurement cavity. Span cell solenoid actuates, thereby placing span cell in optical path inside optical bench. Data is acquired and used to check and calculate the wavelength-pixel offset alignment to be applied after completion of the calibration cycle.
5th	SPAN ACQUIRE	Number of Integration Periods of Span Acquire	Span cell solenoid deactuates, thereby removing the span cell from the optical path. Span gas solenoid energizes, thus span gas flows into measurement cavity. Instrument starts acquiring span data and performs calculations at the end of each integration period. The data is not yet representative of Span gas.
6th	SPAN	Integration Periods of Span	Span gas continues to flow into measurement cavity. Averager is filled with data from span, therefore average output represents true span performance. Averager contains span mode data only, but first integration period in, data is an average of one point; 2nd in, data is an average of two points; etc.
7th	NORMAL ACQUIRE	Number of Integration Periods of Normal Acquire	Span cal gas no longer flows into measurement cavity and stack gas begins to diffuse in. Instrument starts acquiring normal mode data.
8th	NORMAL	Not Applicable	The instrument is back to performing normal mode emission measurements. The Slope and Offset corrections determined during the calibration cycle are now applied after Zero and Span drift are calculated if auto-correction is enabled.

Table 4-2: Calibration Cycle Sequence for BOTTLED CALIBRATION GAS variable = ENABLED

Order	Name	Duration	Description
1st	DARK CURRENT	Number of Integration Periods of Dark Current	Shutter is deployed to block PDA for dark current determination.
2nd	ZERO ACQUIRE	Number of Integration Periods of Zero Acquire	Zero gas flows into measurement cavity. Instrument starts acquiring zero data. Averager contains zero mode data only, but first integration period in, data is an average of one point; 2nd in, data is an average of two points; etc.
3rd	ZERO	Integration Periods of Zero	Zero gas continues to flow into measurement cavity. Averager is filled with data from zero, therefore average output represents true zero performance.
4th	WAVELNGTH CHECK	Number of Integration Periods of Wavelength Check	Zero gas continues to flow into measurement cavity. Span cell solenoid actuates, thereby placing span cell in optical path inside optical bench. Data is acquired and is used for to check and calculate the wavelength-pixel offset alignment to be applied after completion of cal cycle.Averager is not updated in this mode as no concentration data is calculated.
5th	E/O CAL	Integration Periods of Span or E/O	Zero gas continues to flow into measurement cavity. Span cell solenoid is still actuated. Averager is filled with data from E/O Cal, therefore average output represents true span performance.
6th	NORMAL ACQUIRE	Number of Integration Periods of Normal Acquire	Zero cal gas no longer flow into measurement cavity and stack gas begins to diffuse in. Span cell solenoid deactuates. Instrument starts acquiring normal mode data. Averager contains normal mode data only, but first integration period in, data is an average of one point; 2nd in, data is an average of two points; etc.
7th	NORMAL	Not Applicable	The instrument is back to performing normal mode emission measurements. The Wavelength, Slope and Offset corrections determined during the calibration cycle are now applied.

Table 4-3: Calibration Cycle Sequence for BOTTLED CALIBRATION GAS variable = DISABLED (this selection enables EO Cal cell as the daily upscale calibration check device)

4.2 MAINTENANCE

This section provides a guide to scheduled maintenance procedures such as inspection, cleaning, and adjustments. The calibration section includes procedures for the adjustment of parameters used to maintain system operation within desired specifications.

4.2.1 Routine Maintenance

After initial installation, the SM8200 typically provides three months of low-maintenance operation. The table below summarizes the routine maintenance recommended to ensure ongoing trouble-free operation.

Refer to Chapter 8 for component replacement procedures.

Recommended Interval	Description	Materials Required
12 months*	Clean probe.	Ceramic filter and filter gasket (these are probe-dependent). Refer to appropriate probe list of materials for correct part numbers.
6 months	Replace UV lamp.	UV lamp assembly (See Spare Parts List)
12 months	Perform field calibration procedure, section 4.3	Refer to 4.3.1
6 months*	Replace transceiver desiccant cartridge.	Desiccant cartridge (See Spare Parts List)

* If the transceiver desiccant cartridge requires more frequent replacement, the instrument air system may require more thorough drying.

Note
The transceiver optics are sealed from the electronics to prevent optical contamination during checkout, servicing, or calibration.

4.2.2 Analyzer Electronic Box

4.2.2.1 AEB Motherboard Test Points

The following test points on the AEB Motherboard are of primary interest during field troubleshooting and maintenance procedures:

Test Point Number	Description
TP24	Analog to Digital Converter Input
TP21	Diagnostic Output (typically set for Box Car Integrator Output)
TP30	Trigger Signal for TP21 and TP24
TP15	Circuit Common (Ground Reference)

Both TP21 and TP24 are best viewed using a delay triggered digital oscilloscope using a time base of 2.5 milliseconds and vertical sensitivities of 0.5 to 2.0 Volts per division. See Figure 4-1.

TP24 is the last analog test point in the system. It contains the raw, unprocessed spectra along with three other diagnostic voltages. The maximum value of the spectra should always be less than 2.0 VDC peak with a clear optical path (zero gas in measurement cavity). Typically the peak spectra voltage at TP24 is between 0.8 and 1.8 VDC during a zero calibration. For most instruments, the leftmost portion of the TP24 and TP21 spectra waveform represent wavelengths near 200 nm and the rightmost represents wavelengths near 230 nm.

TP21 is a diagnostic output representing the boxcar value and is best used with the oscilloscope in inverted mode. The shape of TP21 should resemble the spectra portion of TP24, but with increasing amplitude that builds as the integration period progresses. At the end of the integration period, TP21 will clear, and then go to a value near zero volts while the Single Board Computer calculates concentration values based on the spectra. After the conclusion of the analysis the process repeats itself and TP21 begins to build again.

The raw spectra are time multiplexed with three other diagnostic DC voltages. These diagnostics are (arranged in order of time sequence following the spectra): PDA Temperature, Cal Gas Heater Temperature and Bench Temperature. In normal operation, the peak value of these voltages should always be less than 2.0 VDC, also.

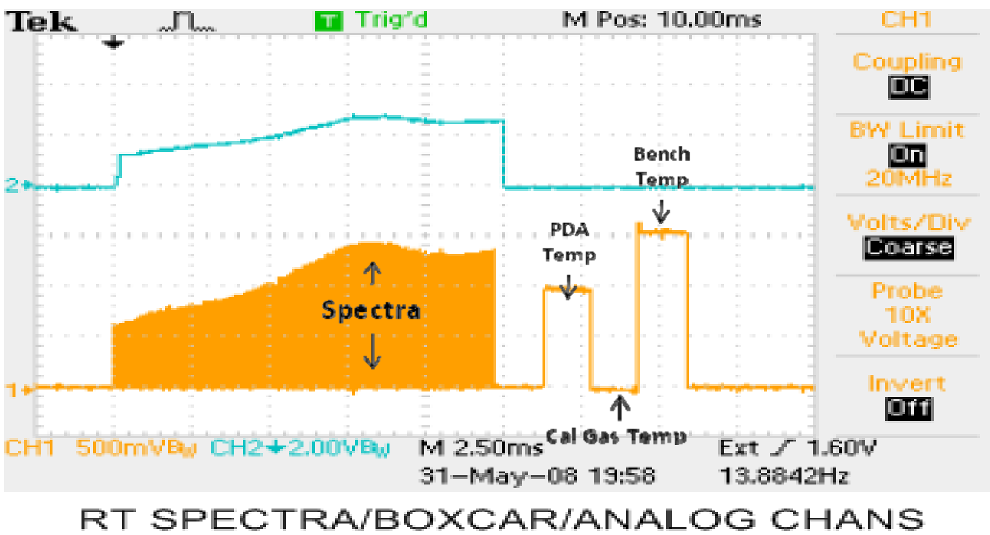

Figure 4-1: AEB Motherboard TP21 (blue, shown inverted) and TP24 (orange) Waveforms

4.2.2.2 UV Lamp Current

On the UV lamp Power Supply Board, set the UV lamp current to 300 mA by adjusting R6 so that TP1 is 0.300 VDC with respect to circuit common (TP11 on the UV Lamp Power Supply Board).

4.2.3 Visual Inspection

1. Release the six latches that secure the transceiver to the probe assembly and swing the transceiver to the side on its hinges.

2. Stand approximately two feet back from the probe assembly and look into the probe cavity. You should see a reflection of your eye at the end of the probe. If no image is visible, remove the probe from the stack and check the probe filter. Replace the filter if it is blocked, using the procedure in Section 8.2

Note
You may need to shine a flashlight down the probe.

Warning
Eye damage can result from looking directly at the UV light exiting the transceiver. Wear protective glasses.

3. Clean the outside surface of the transceiver lens with a clean lens cloth moistened with a 50% alcohol and distilled water solution. Teledyne Monitor Labs recommends the use of reagent grade isopropyl alcohol. Do not use cleaners that contain an anti-fog additive. Commercial lint free lens and glass wipes such as Kimwipes® must be used for cleaning.

Caution: *Do not use solvents on the lens. Do not remove the lens from the transceiver. Do not turn the lens housing, because the focal point will be changed.*

4. Swing the transceiver back into position. Be sure the thermal probe connector and purge tube are out of the light path and connected properly. Ensure that the transceiver is properly aligned on the alignment pins opposite the hinged side. Secure the six latches.

5. Ensure that all mounting bolts at the probe/flange interface are secure.

Note
If the bolts and nuts that face the transceiver are loose, the transceiver/probe may require realignment (refer to the probe replacement procedure in Section 8.8 for alignment instructions). If the bolts can be tightened without changing the previously established alignment, no adjustment is necessary.

6. Check the desiccant indicator on top of the transceiver. The center spot of the desiccant capsule should be blue. If not, replace the desiccant cartridge.

Note
If the transceiver desiccant cartridge requires replacement more frequently than every six months, an air dryer may be required on the instrument air supply. Desiccant capsules are also located inside the air filter in the AEB.

4.2.4 Wiring Check

Inspect the wiring between the AEB and the controller for any irregularity. Verify the AEB number. (Refer to the Instrument # Table in drawing *81750011* for the positions of S6-1 and S6-2 on the SDA board in the AEB.)

4.3 FIELD TEST AND CALIBRATION PROCEDURES

The following procedures can be used for initial instrument startup and any time instrument verification is required. The complexity and interactive nature of the following procedures require that the operator have SM8200 training and experience before proceeding.

Operators must also be familiar with the procedures for entering and changing parameters in the controller. Thoroughly review Section 5.0 of this manual before starting these procedures.

4.3.1 Recommended Equipment

- 4½ digit DVM (digital voltmeter), Fluke 80 Series or equivalent
- Independent temperature monitor capable of measuring the process temperature at the probe sampling point (also required to simulate a 100 ohm RTD)
- Oscilloscope
- Untreated lens cleaning cloth
- Flow meter, 0 to 10 lpm or equivalent (recommended equipment)
- Two-stage gas regulator
- NO single gas, balance N_2
- SO_2/NO blend, balance N_2.

Note

Select calibration gas values per EPA or local agency requirements or to be near the typical process values, or at least 70% of full scale.

4.3.2 Determining Zero Gas Flow

Note

Whenever installing a cold probe into an operating stack, turn on a nominal flow of zero gas until the probe reaches process temperature. This will prevent condensation/fogging on the windows.

1. Connect a digital oscilloscope to TP21 and TP24 on the AEB Motherboard. Use TP30 as an external trigger.

2. Put the SM8200 into continuous zero via the Enhanced Remote Panel, Transceiver Local User Interface or PMODBUS Tool.

3. Set the flow rates for the zero gas by first adjusting the pressure regulator in the AEB for the highest peak spectra value on TP24. TP24 should be free of spectral structure when the proper flow rate is achieved (indicating that the process gas has been evacuated and no absorbing gas species are present in the measurement cavity).

4. Reduce the pressure until the voltage at TP24 starts to decrease or show spectral structure. The SO2 ((Local User Interface) LUI Bank U2) and NO (Bank U0) measurements will begin to increase above zero.

5. Increase the pressure until the highest TP24 voltage is again obtained. The SO2 and NO measurements should be at their minimum values.

6. Increase the pressure by 1 to 2 psi to compensate for any minor changes in the process.

7. Record the pressure shown on the gauge in the AEB for future reference.

4.3.3 Determining Span Gas Flow

Two methods can be used to determine the optimum span gas flow. One method uses a flow meter and the other uses the AEB pressure gauge. The method using a flow meter is preferred over the method using gas regulator adjustment while monitoring AEB pressure. If more purge time is required (as with a 1-meter cavity), increase the purge time using the Enhanced Remote calibration ZERO_ACQUIRE and SPAN_ACQUIRE Integration Periods in the Cal Cycle Duration screen in the Enhanced Remote Panel. See Section 5.0 of this manual.

4.3.4 Using a Flowmeter

1. Connect a span gas bottle through the flow meter to the “Span Gas In” fitting on the AEB.

2. Verify the site barometric pressure versus the stack pressure as displayed on the Enhanced Remote Panel Service Data screen. Alternately, the Transceiver Local User Interface A1 Bank may be used to display the measured stack pressure (see Section 6.0 of this manual for details on LUI operation). Refer to Section 6.4, if stack pressure adjustment is required.

3. Set the calibration gas regulator output pressure to agree with the Zero gas regulator output pressure established in Section 4.3.2 above. For high temperature calibration (above 500° F), establish the gas flow required by slowly increasing the flow rate while monitoring TP24 of the AEB Motherboard and LUI Bank U0 (NO ppm), U2 (SO2 ppm) or both alternately. Place the monitor in MANUAL SPAN using either the transceiver LUI or the ERP Output and Cal Tests screen. Plot the response (ppm or voltage) against flow rate. There will be a plateau in the curve where further increases in gas flow do not increase the measured concentration. Adjust the flow to allow a safe margin above the knee of the curve.

4. Optimum gas flow depends on both probe cavity size and site installation characteristics. Record the flow meter setting for future reference. Note that if a rotameter is used to measure flow, the final flow achieved without the rotameter in-line will be higher than that measured due to the pressure drop in the flow meter.

4.3.5 <u>Probe Tests</u>

4.3.5.1 Light Level Down the Probe

The light level down the probe should not cause an excess of 1.8 V peak in the spectra portion of AE Motherboard TP24 in continuous zero. Check the light level using the following steps.

1. Display the reference level on the Bank SC of the LUI at the transceiver. Monitor TP24 of the AEB Motherboard using an oscilloscope.

2. Put the SM8200 in continuous zero via the Enhanced Remote Panel, LUI or PMODBUS Tool.

Note

The Zero gas flow must be set in accordance with the paragraph titled *Determining Zero Gas Flow*.

3. Verify that the peak TP24 spectra is between 0.8 V and 1.8 V during continuous zero.

4. Return the AEB to the normal operational mode.

If you have a problem with low TP24 spectra voltages, check for the following:

Dirty or damaged window and/or corner cube. Inspect the window and corner cube for damage. Clean the window and all surfaces of the corner cube with an untreated lens cleaning cloth. The rear faceted surfaces of the corner cube must also be cleaned in addition to the front flat surface since the device works on the principle of total internal reflection.

Damaged and/or dirty beam splitter. Inspect and clean or replace the beam splitter if necessary.

Incorrectly adjusted or dirty focusing lens assembly. The proper focus for probes that are four feet long or shorter is two turns counterclockwise from the fully clockwise position. Probes that are six feet long or longer are focused at 3/4 turn counterclockwise from the fully clockwise position.

Note

When cleaning the above optical components use a clean lens cloth moistened with a 50% alcohol and distilled water solution. Teledyne Monitor Labs recommends the use of reagent grade isopropyl alcohol. Do not use cleaners that contain an anti-fog additive. Commercial lint free lens and glass wipes such as Kimwipes® must be used for cleaning.

Incorrect probe alignment. The probe must be removed from the stack for alignment. Position and clasp the probe on the transceiver in a vertical position. Loosen the three flange bolts, then rotate the two flange alignment rings independently and together in order to get the highest spectra voltage at TP24 on the AEB Motherboard. Long probes may be subject to a significant change in alignment because of the effects of heat. In such cases, try alternate positions near the highest voltage.

Incorrect adjusted or worn-out UV Lamp. First try adjusting the position of the UV Lamp housing to maximize light level by monitoring for maximum voltage at TP24. If the light level is still inadequate and probe alignment has been verified, try replacing the UV Lamp and readjusting the position of the lamp housing.

If the TP24 spectra voltage is still too low after all of the above items have been investigated and resolved, it may be necessary to increase the PDA Gain. This can done at either the Enhanced Remote Panel (see Section 5.0 of this manual) or via the F4 Bank of the LUI (see Section 6.0 of this manual). The acceptable range of PDA Video Gain is 60 to 255.

4.3.5.2 Probe Leaks

In some stack conditions, isolating probe leaks can be a challenge. A gas leak at the window in a negative stack can cause low gas readings, while the same leak in a positive stack can fill the probe body and cause high gas readings. A low concentration of stack gas in the probe body will have a much greater effect than if it were present in the measurement cavity due to the much longer optical path length. This is why the body of the probe is continuously purged instrument air to prevent the buildup of stack gas inside the probe body, though it is important to note that small leaks generally have a negligible effect, except in very short measurement cavity installations. Verifying a leak-free probe is therefore very important. Use the following techniques to verify a leak-free probe.

Leak-testing the probe is best performed with the probe removed from the stack. Flow calibration gas into the dynamic calibration fitting ("Span Gas In" on the AEB) at a much higher rate than required and verify that the readings do not continually increase. To verify that no gas leaked into the probe body, flow zero air into the probe and ensure that the reading is zero.

Gas can also leak into the probe body through the purge air system. The air used to purge ozone from the transceiver is vented into the probe body through a small hole in front of the transceiver. Make sure the purge air is clean, dry, oil-free instrument air only.

Keep the transceiver access door and ports closed, especially when the atmosphere around the transceiver is suspected to be contaminated with gases.

If a probe leak is found, remove the probe from the stack and replace the gaskets on both sides of the measurement cavity window. Carefully clean and reassemble the probe optics after gasket replacement.

When installing a probe in the stack, allow sufficient time for the entire probe to stabilize to process temperature (approximately one hour for shirt sleeve ambient conditions: 60° to 90° F).

4.3.6 Transceiver Test and Electronic Alignment

Note

Do not attempt to calibrate the transceiver until it has reached full operating temperature. A cold transceiver requires a minimum of three hours with all access doors and ports sealed to reach a stable temperature. When possible, allow the transceiver to warm up overnight.

When the transceiver temperature has stabilized, use the following procedures to test and calibrate the transceiver.

4.3.6.1 Verify Optics Plate Temperature

The optics plate temperature affects the stability of the optics and the accuracy of readings. To verify this temperature

1. Monitor the Bench Temperature diagnostic variable by navigating to the SERVICE DATA\TEMPERATURE & PRESSURE screen on the ERP or selecting the LUI Bank S1 variable. Alternately, one may connect a thermocouple or other temperature measurement device under the Bench Temperature controller and tighten for good thermal contact

2. By using the temperature measurement device or monitoring the Bench Temperature diagnostic varible, verify that the temperature is 139° ±10° F. If this temperature measurement is outside of this range, call factory Tech Support for specific procedures for adjustment.

3. Close the transceiver housing when the procedure is complete.

4.3.6.2 PDA Temperature

The PDA has an internal and external thermo-electric (TE) cooler for temperature regulation. The external TE cooler is mounted between the PDA and its heat sink and is intended to improve the design margin of the temperature control system. Both TE coolers are controlled by a circuit on the Preamp and TE Cooler Board assembly. The set point for the PDA temperature can be adjusted via the LUI (F0 Bank) or the Enhanced Remote Panel. The typical temperature range of the PDA is 68° -4, +14° F. It is important to perform a CAL CYCLE after adjusting the PDA temperature command because DARK current is affected by PDA Temperature.

4.3.6.3 Stack Temperature Adjustment

1. Disconnect the RTD by removing P3 on the Auxiliary IO Board.

2. Jumper J3 pins 1 and 2 together. This will place a 100 ohm resistor in the RTD measurement circuit.

3. With the resistor in place, record the Stack Temperature RTD Linearized Counts in S8 of the LUI (see Section 6.0 of this manual) or the Stack Temperature screen of the Enhanced Remote Panel ([PATH = ANALYZER PROPERTIES/CHANGE SM8200 PROPERTIES/PRESS & TEMP SCALING/STACK TEMPERATURE] see Section 5.0 of this manual).

4. Enter the counts value into the F8 Bank of the LUI or the Low Counts line of the Stack Temperature screen of the Enhanced Remote Panel.

5. Enter 32 (if using ENGLISH measurement units) or 0 (if using METRIC) into the F9 Bank of the LUI, or alternately, into the Low Value line of the Enhanced Remote Panel Analyzer Properties screen.

6. Reconnect the RTD by first removing the jumper between J3 pins 1 and 2 on the Auxiliary IO Board.

7. Use a temperature probe to monitor the stack temperature. Record this value as the High Value while simultaneously monitoring the Stack Temperature RTD Linearized Counts in S8 of the LUI (see Section 6.0 of this manual) or the Stack Temperature screen of the Enhanced Remote Panel (see Section 5.0 of this manual).

8. Enter the observed counts value into the FA Bank of the LUI or the High Counts line of the Stack Temperature screen of the Enhanced Remote Panel.

9. Next, enter the observed stack temperature (in Fahrenheit if using ENGLISH measurement units, in Celsius if using METRIC) into the FB Bank of the LUI, or alternately, into the High Value line of the Enhanced Remote Panel Analyzer Properties screen.

4.3.6.4 Stack Pressure Adjustment

The SM8200 stack pressure transducer port is connected via tubing to the probe measurement cavity so that a direct measurement of stack pressure, can be made. This approach provides greater accuracy since the static pressure of the stack or duct and any overpressure created when flowing span or zero gas are accounted for as well as the barometric pressure. It is important to note that the stack pressure transducer in this instrument measure absolute (not gauge) pressure.

1. Determine the barometric pressure at the stack site from a reliable source such as a calibrated manometer.

2. Determine the nominal static pressure of the stack either from direct measurement with a differential pressure transducer or from reliable historical data and convert this pressure into units consistent with the barometric pressure measurement.

3. Add together the barometric pressure and static pressure of the stack being careful to observe the sign of the stack static pressure.

4. Record the Stack Pressure Counts in S9 of the LUI (see Section 6.0 of this manual) or the Stack Pressure screen of the Enhanced Remote Panel (see Section 5.0 of this manual).

5. Enter the observed counts value into the FE Bank of the LUI or the High Counts line of the Stack Pressure screen of the Enhanced Remote Panel ([PATH = ANALYZER PROPERTIES/CHANGE SM8200 PROPERTIES/PRESS & TEMP SCALING/STACK TEMPERATURE] see Section 5.0 of this manual).

6. Next, enter the pressure calculated above into the FF Bank of the LUI, or alternately, into the High Value line of the Enhanced Remote Panel Analyzer Properties screen.

7. Verify that the measured pressure in Bank A1 of the LUI or, alternately, the Analyzer Properties screen of the ERP is consistent with the calculated pressure.

4.3.6.5 Verification of Internal EO Span Cell Measurement

1. Find the internal span cell value and E/O TEMP on the SM8200 factory data sheet.

Note

If the internal span value has been revised, refer to the last recorded value.

2. Begin a MANUAL EO CAL via either the LUI (see Section 6.0) or the Enhanced Remote Panel Outputs and Cal Test screen.

3. Allow the sequence to finish.

Note

The ERP or LUI may produce a fault and display SPAN FAIL at this time. It should clear shortly.

4. Record the span values under Service Data / Gas Concentration screens in the ERP.

5. Repeat steps 2 through 4 at least ***five*** times.

6. Enter the SO_2 and NO EO Cal values averaged in step 5 into the EO Cal Set point line of the Enhanced Remote Panel Cal Set Points and Curve Type screen.

7. Repeat steps 2 and 4 to verify that no SPAN FAIL faults occur.

If significant changes have been made to both previous EO Cal Set point values, perform the probe leak test in paragraph 4.3.5.2 above.

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5.0 ENHANCED REMOTE PANEL W / MULTI I/O BOARD

5.1 OVERVIEW

The Enhanced Remote Panel is menu driven. It features a touch sensitive keypad, a 4 ½” (11.4 cm) LCD display, key lockout and RS-232 serial communication capability, and a commercial network communication node. The Multi I/O Board has eight relay outputs, eight isolated digital inputs, and four individually isolated analog outputs.

5.2 MECHANICAL DESCRIPTION

The Enhanced Remote Panel uses a modular design. The components of the display are mounted in a 19” rack mountable enclosure. The enclosure is 5 1/4” (13.3 cm) high, x 8” (20 cm) deep, x 16 9/16” (42.1 cm) wide. There are two #8-32 tapped holes on each side for slides if desired.

All external connections are made from the back panel with pluggable connectors. Access to the inside of the unit is through a removable top panel. The top panel is removed by taking out four screws.

Inside the enclosure there are seven circuit boards, a power entry module, several interconnect cables, and the Liquid Crystal Display (LCD) board. The LCD Driver Board is integral to the display and the keypad is built into the front panel. The Terminal Block PC Board mounts to the back panel. The other five boards mount off of the bottom panel in a stacked arrangement. The Mother Board, Multi I/O Board, and Power Supply Board mount on standoffs and are interconnected by cables. The Computer Module Board and the LONWORKS® network board mount directly into sockets on the Mother Board.

Modules of the Enhanced Remote Panel:

- ❐ Mother Board
- ❐ Computer Module Board (mounts on Mother Board)
- ❐ LONWORKS® LTM- network 10 Board (mounts on Mother Board)
- ❐ Terminal Block PC Board
- ❐ Power Supply Board
- ❐ Multi I/O Board
- ❐ LCD w / Driver Board
- ❐ Power Entry Module
- ❐ Keypad/Front Panel Assembly

5.3 ELECTRICAL DESCRIPTION

5.3.1 Input Power Requirement

The Enhanced Remote Panel has been designed to operate over a wide range of international power supply ranges and frequencies without the need for modifications or adjustments. (*See Section 2.0 of this manual for input power specifications.)* The internal D.C. supply is auto-ranging and automatically adjusts for the power mains voltage.

5.3.1.1 Circuit Description (Overview)

The Enhanced Remote Panel Mother Board with Multi I/O Board are two separate networked devices mounted in a single package: the Enhanced Remote Panel Mother Board node (hereafter referred to as the Enhanced Remote Display) and Multi I/O Board node (hereafter referred to as the Multi I/O Board). Each has independent software and a unique network address. They share a common power supply and chassis. The Enhanced Remote Display acts as the operator interface. The Multi I/O Board is the peripheral hardware interface.

5.3.1.2 Liquid Crystal Display (LCD)

The display is a graphics capable, 240x128 pixel, back-lit LCD. The Display Driver Board is integral with the LCD and communicates to the Mother Board via ribbon cable. The contrast and back-light brightness are adjustable from the keypad.

5.3.1.3 Keypad

The Keypad is a light touch, membrane switch array. It is built into the front panel assembly and connects directly to the Mother Board via a ribbon cable.

5.3.1.4 Front Panel LED’s

The Power, Fault, and Alarm LED’s are also integral to the front panel assembly. They are connected to, and driven by, the Mother Board via a six pin ribbon cable (J_3).

5.3.1.5 Security Key Switch

The Security Key Switch is functionally in parallel with the administrator password. Protected variables can be unlocked with the administrator password or Key Switch.

5.3.1.6 Power Supply Board

The Power Supply Board produces the +5 VDC logic power for the Enhanced Remote Panel. It has two connectors - one for input and one for output. The input wires come from the input power module that contains the line cord connector power switch, and initial filtering. Surge protection and fusing are located on the board.

5.3.1.7 Terminal Block P.C. Board

The Terminal Block PC Board mounts to the rear panel and handles all I/O connections. It has ten connector plugs mounted on the outside that extend through the metal panel. Incoming wires terminate in the female half of the connector with the push of a screwdriver. This type of connector allows the wires to be removed one wire at a time or by connector group.

5.3.1.8 Enhanced Remote Panel Mother Board

The Enhanced Remote Panel Mother Board has two microprocessors, a 68332, and an LTM-10. Each is laid out on a separate Daughter Board that plugs horizontally into the Mother Board. The Mother Board has circuits to perform the following:

- Interface the two processors
- Buffer the data bus
- Adjust contrast and brightness outputs to the display
- Drive and buffer the keypad
- Drive the FTT10A network communication port
- Electrostatic Discharge (ESD) protection for all I/O's
- Drive the front panel LED's for Fault and Alarm
- Communicate with the display
- Provide –20 VDC for the LCD

5.3.1.9 Communication Protocol Support

5.3.1.9.1 RS-232

An RS232 multi-drop addressable Modbus serial communication interface for monitoring of network variables is provided. The communication parameters of both ports are fixed. They are listed in Table 5-1. Contact the factory for a Modbus register map and further information on the operation of this port.

Table 5-1: Communication Parameters

BAUD RATE	DATA BITS	STOP BITS	PARITY
9600	8	1	N

5.3.1.9.2 100 Base T Ethernet

The need for simplified web browser-based remote access, configuration and control of intelligent embedded microprocessor-based devices has led Teledyne Monitor Labs to offer Ethernet connectivity as standard equipment on the SM8200. This interface can provide simultaneous HTML web pages for user interface and fast Modbus TCP access to instrument data and parameters.

Ethernet access is via the popular 100 Base T physical layer. The Ethernet connector is located on the rear of the Enhanced Remote Panel. The Ethernet MAC address for each instrument is located on a label next to the Ethernet connector.

The browser based mode of operation is accessible to users via commercial readily available PC programs and is consequently much simpler than Modbus TCP communication. The latter requires development of a driver program at the PC end and is beyond the scope of this manual.

The Ethernet Module also provides FTP access for factory firmware updates. Description of the use of FTP access to the Ethernet Module is beyond the scope of this manual.

For further information, including a Modbus TCP register map for the SM8200 Ethernet Module, consult the factory.

5.3.2 Multi I/O Board (Hardware)

The Multi I/O Board is a peripheral hardware interface. It communicates with the other devices in the system via a network interface. It gathers information from the AEB and the Enhanced Remote Display node via the network. It processes this information together with its digital inputs and site specific configuration to control its outputs.

The Multi I/O is capable of driving eight digital outputs (dry relay contacts) and four analog outputs. It can read up to eight digital inputs. The digital inputs are jumper configurable to be either dry contacts or 0 – 5 VDC signals. Dry contacts are standard.

The analog output hardware is jumper configurable but must be in the 0 – 20 mA position. Firmware settings control the Digital to Analog (D to A) and create a full range functional 4-20 mA output configuration. The 0-20mA hardware setting allows values less than 4mA to be transferred to a data collection device. This allows the 4mA level to function as a “live zero”. Test points are provided for measuring output current. See Jumper and Test Point Table 5-2 and Table 5-3.

Figure 5-1: Mother Board Block Diagram, 1803-0200/2200

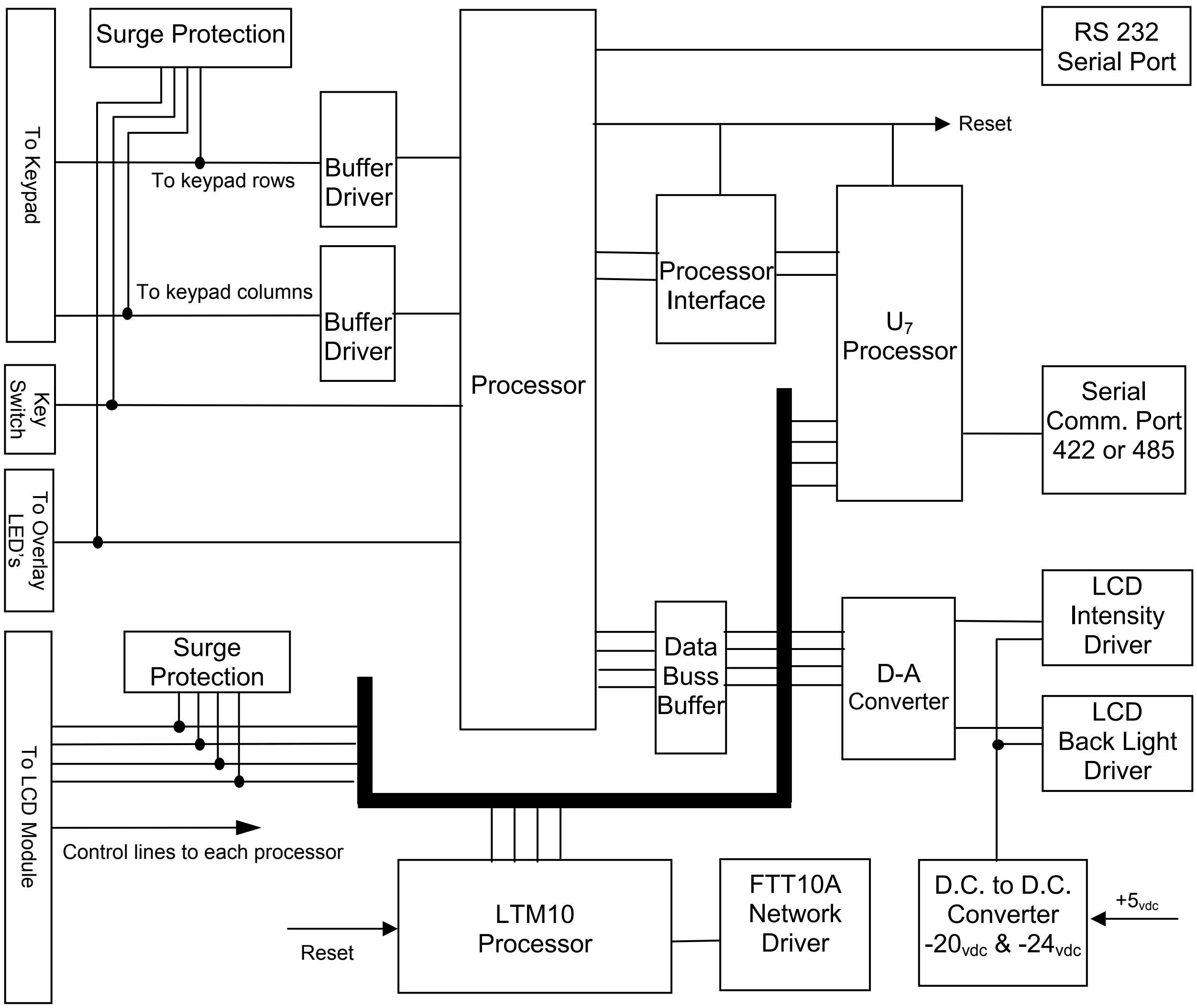


Table 5-2: Enhanced Remote Display Mother Board Jumper Definitions

Jumper #	Selections							Functional Description
JU1	IRQ1	IRQ2	IRQ3	IRQ4	**IRQ5**	IRQ6	Out	Selects IRQ for reset signal
JU2	IRQ1	IRQ2	IRQ3	IRQ4	IRQ5	**IRQ6**	Out	RS422/485 Receive IRQ
JU3	**UART**			TPU				Selects where to send received data
JU4	**UART**			TPU				Selects UART or TPU data for transmit to J_6
JU5	**UART**		TPU			422		Selects handshake signal or full time on
JU6	A – B **= single**			B – C = double				Selects single or double termination of network
JU7	A – B **= terminated**			B – C = not terminated				Selects if network is terminated at remote or not
JU8	**-20V**			-24V				Selects drive voltage for LCD contrast adjustment

Table 5-3: 68332 Processor, SBC332 Board, Jumper Definitions

Jumper #	Selections			Functional Description
J2A	1 -- 2		2 – 3	J2A, through J2F configure the Computer Module Board for the type of memory used. Standard settings are highlighted.
J2B	1 -- 2		2 – 3	
J2C	1 -- 2		2 – 3	
J2D	1 -- 2		2 – 3	
J2E	1 -- 2		2 – 3	
J2F	1 -- 2		2 – 3	
J3	1 -- 2 = Enabled		2 -- 3 = Disabled	J3 enables or disables the 68332's watchdog timer
J9	1 -- 2	2 -- 3	1-2 = 1200_{ms} timeout	J9 selects the length of time the watchdog timer waits
J7	IN		Out	J7 puts in or takes out the RAM super cap for backup
J10	IN		Out	Selects the serial port outputs of the 68332
J12	IN		Out	Selects the serial port outputs of the 68332

NOTES:

1. J1, J4, J5A, J5B, J6, and J11 on the Computer Module Board are actually connectors. **<u>NEVER</u> jumper together any of the pins on these headers.**
2. Bold print or shading indicates the standard selection.

Table 5-4: Multi I/O Jumper Definitions

Jumper #	Selections: *4--20ma (not used)*	0--20ma	*0—24ma (not used)*	Functional Description
JU1	*1*	**0**	*1*	Jumpers JU_1 & JU_2 configure the range of the analog outputs for channel #1.
JU2	*0*	**1**	*1*	
JU3	*1*	**0**	*1*	Configures the range of analog output #2
JU4	*0*	**1**	*1*	
JU5	*1*	**0**	*1*	Configures the range of analog output #3
JU6	*0*	**1**	*1*	
JU7	*1*	**0**	*1*	Configures the range of analog output #4
JU8	*0*	**1**	*1*	

	Dry Contact	5_{vdc} Digital	
JU9	1—2—3	1—2—3	Configures digital input #1 hardware to work with dry contact or 5_{vdc} logic signals
JU10	1—2—3	1—2—3	Configures digital input #2 hardware.
JU11	1—2—3	1—2—3	Configures digital input #3 hardware.
JU12	1—2—3	1—2—3	Configures digital input #4 hardware.
JU13	1—2—3	1—2—3	Configures digital input #5 hardware.
JU14	1—2—3	1—2—3	Configures digital input #6 hardware.
JU15	1—2—3	1—2—3	Configures digital input #7 hardware.
JU16	1—2—3	1—2—3	Configures digital input #8 hardware.

	Ram 128K	Ram 32K	ROM 128K	ROM 64K	ROM 32K	Flash 128K	Flash 64K	Flash 32K	
JU17	1-2	1-2	3-4	3-4	3-4	3-4	**3-4**	3-4	Jumpers JU_{17} & JU_{18} together, select the type of memory chips to be used.
JU18	7-8	7-8	5-6	5-6	3-4	5-6	**5-6**	1-2	

JU19	IN-----OUT **Double terminated**	IN-----OUT Single terminated	Selects whether the network termination will be single or double termination. This is usually done elsewhere
JU20	IN-----OUT **Out = unterminated**	IN-----OUT IN = terminated	Terminates the network if necessary. This is usually done elsewhere.
JU21	1 **2 3**	2 3	K1 Contact: 2 3 = NO 1 2 = NC
JU22	1 **2 3**	2 3	K2 Contact: 2 3 = NO 1 2 = NC
JU23	1 **2 3**	2 3	K3 Contact: 2 3 = NO 1 2 = NC
JU24	1 **2 3**	2 3	K4 Contact: 2 3 = NO 1 2 = NC
JU25	1 **2 3**	2 3	K5 Contact: 2 3 = NO 1 2 = NC
JU26	1 **2 3**	2 3	K6 Contact: 2 3 = NO 1 2 = NC
JU27	1 **2 3**	2 3	K7 Contact: 2 3 = NO 1 2 = NC
JU28	1 **2 3**	2 3	K8 Contact: 2 3 = NO 1 2 = NC

NOTES: 1. Bold print indicates the standard selection.

Table 5-5: Multi I/O Test Point Descriptions

Test Point #	Functional Description	Output
TP1	24_{vdc} isolated drive voltage for analog output #1. Referenced to TP_2	Output #1
TP2	GND reference for TP_1 and all points within #1 output circuit	
TP3 TP4	TP_3 & TP_4 are on opposite sides of a 100Ω resistor that is in series with the output #1 current loop. Measure the DC voltage across these test points and divide by 100 to calculate the actual output current of channel #1.	
TP5	24_{vdc} isolated drive voltage for analog output #2. Referenced to TP_6	Output #2
TP6	GND reference for TP_5 and all points within #2 output circuit	
TP7 TP8	TP_7 & TP_8 are on opposite sides of a 100Ω resistor that is in series with the output #2 current loop. Measure the DC voltage across these test points and divide by 100 to calculate the actual output current of channel #2.	
TP9	24_{vdc} isolated drive voltage for analog output #3. Referenced to TP_{10}	Output #3
TP10	GND reference for TP_9 and all points within #3 output circuit	
TP11 TP12	TP_{11} & TP_{12} are on opposite sides of a 100Ω resistor that is in series with the output #3 current loop. Measure the DC voltage across these test points and divide by 100 to calculate the actual output current of channel #3.	
TP13	24_{vdc} isolated drive voltage for analog output #4. Referenced to TP_{14}	Output #4
TP14	GND reference for TP_{13} and all points within #4 output circuit	
TP15 TP16	TP_{15} & TP_{16} are on opposite sides of a 100Ω resistor that is in series with the output #4 current loop. Measure the DC voltage across these test points and divide by 100 to calculate the actual output current of channel #4.	

5.4 USER INTERFACE DESCRIPTION

The Enhanced Remote Panel is menu driven. Operational and configuration parameters are viewed and changed through the display menu screens. The system configuration parameters are password protected. Protected screens can be accessed with the supervisor password or the Security Key Switch. Operational and test parameters may be viewed and/or changed by scrolling through the menus using the "↑", "↓", "Page Up", "Page Down", "ESC", and "↵" keys. The functions of these keys are described on each menu screen. The ESC key will return you to the previous menu. Password protected screens will prompt for the password before displaying the screen. To use the Security Key Switch it must be in the ON position ***before*** that screen is selected.

5.4.1 Memory Test

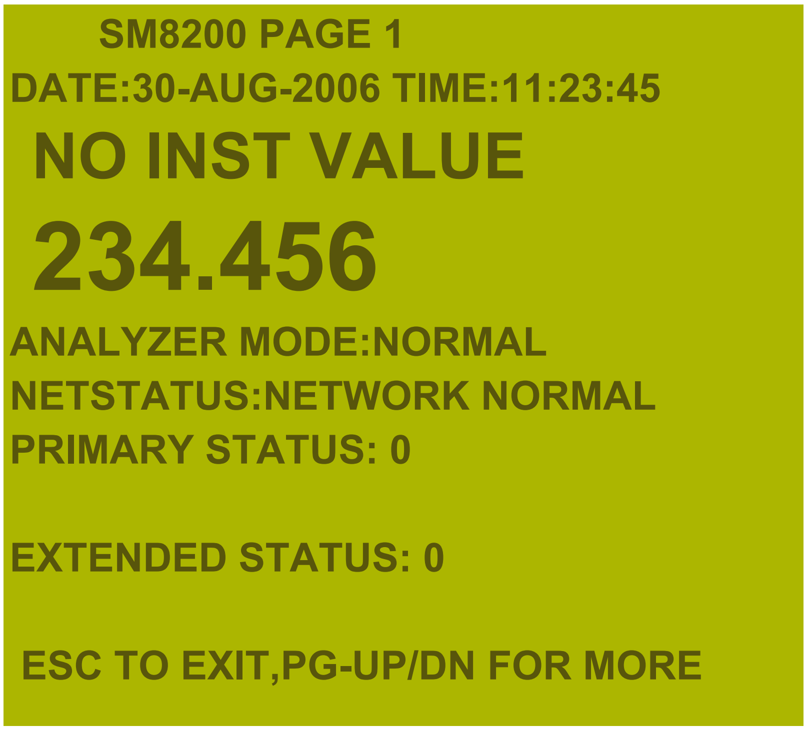
The Memory Test runs at power up before the logo screen is displayed. It tests specific areas of the RAM ICs. If they pass, a message is briefly displayed on the screen before the logo. If either one fails, a message indicating which chip failed remains on the screen and the CPU halts.

5.4.2 Main Display Screens

These screens are typically displayed during normal operation. There are a total of ten display screens accessible by the "Page Up" and "Page Down" keys. There are two pages for each gas species. One of the two pages has large block numbers appropriate for continuous display. The other page has additional data for the gas of interest. *No displayed parameters can be changed from these screens.*

All parameters are updated at the end of each integration period. Instantaneous parameters are updated at the end of each integration period while in the appropriate mode. Average parameters will be updated at the end of the last integration period specified in the average. The STATUS text and STATUS code fields are updated immediately on any change in the monitor status. If multiple malfunctions are indicated, you can scroll through the STATUS text field errors by pressing either arrow button (↓ or ↑) once. After scrolling is completed the STATUS text field will stop and continuously display the most significant error. The NET STATUS field will display the status of network communication between the AEB and the display node. The PRIMARY and EXTENDED STATUS fields display various abnormal status conditions from the Transceiver.

The NO INST (for instantaneous) large character display page is the default on power up and reset. This screen and its pages are at the top of the menu structure. All other screens can be accessed through these pages by moving down through the menu choices from any one of the twelve pages of this display press the "↵" key to view the first level "Main" menu. The ESC key will bring you back up to the Main Display screens.



5.4.3 Main Menu Screen

This is the first level of the menu structure. From this screen you can choose one of the submenus that lead to the information of interest. For a detailed description of the information available under a particular sub menu, refer to the section indicated by the figure above. To select a particular submenu, use the UP and DOWN arrow keys to highlight the selection then press the "↵" key to select. This will bring up the next menu screen as described in the appropriate section. The ESC key will take you back to the previous screen. Pressing the ESC key from the Main Menu screen will take you back to the Main Display, page #1.

MAIN MENU
SERVICE DATA
STATUS CODE HELP
OUTPUT & CAL TESTS
ANALYZER PROPERTIES
OUTPUT MODULE PROPERTIES
DISPLAY PROPERTIES
VIEW STATUS HISTORY
VIEW ALARM STATES
CURRENT SOFTWARE VERSIONS
NUMERICAL DATA
CHANGE PASSWORD
USE AROWS THEN <- TO SELECT
ESC TO EXIT

5.4.4 Service Data Menu

Grouped under the Service Menu are various parameters that are useful in assessing the performance of the analyzer. All data in this menu is read only. It is grouped into three categories, “SM8200”, “NETWORK STATUS”, and “POLL SM8200 NETWORK DATA”. In this case the network referred to is the LONWORKS® network over which the system nodes communicate.

To view the analyzer data, select SERVICE DATA from the main menu by using the arrow keys and press ”↵”, then select SM8200. This will bring up the Service Data selection menu screen. Choose the group you wish to look at and press ”↵”. The parameter names and values will appear on the display. Some of these screens are configured to update live, while others update only when “VIEW LATEST VALUES” is selected. For live update screens, new data is received at the end of the sample integration cycle and posted to the screen.

Within the POLL SM8200 NETWORK DATA screen you can choose different indexed segments of the network variables for display. This information is for factory level troubleshooting only. All information from this screen is available to the operator elsewhere in the menu structure.

```
  SERVICE DATA SM8200
TEMPERATURE & PRESSURE
INCREMENTAL & TOTAL ADJUST
TEMPERATURE & PRESSURE COUNTS
RAW GAS CONCENTRATIONS
GAS AUTO CORRECTION
GAS CONCENTRATIONS
STACK TEMP & PRESSURE
WAVELENGTH CHECK OFFSETS
OTHER DATA 1
OTHER DATA 2

 USE AROWS THEN <- TO SELECT

      ESC TO EXIT
```

5.4.4.1 Service Data Screens

Some of the possible Service Data screens are presented in this section, along with information pertaining to their relevance.

5.4.4.1.1 Temperature and Pressure Screen

This screen displays Stack Temperature and Pressure, along with diagnostic temperatures such as PDA Temperature, Bench Temperature, Cal Gas Heater Temperature and Probe Temperature. The Cal Gas Heater is optional and the Probe Heater is not currently in use. This screen automatically updates results after each Integration Period.

```
SERVICE DATA SM8200
TEMPERATURE & PRESSURE

PDA TEMPERATURE:67.066
BENCH TEMPERATURE:61.367
CAL GAS TEMP:57555
PROBE TEMPERATURE:63.393
STACK TEMPERATURE:516.348
STACK PRESSURE:30.853

ESC TO EXIT
```

5.4.4.1.2 Incremental and Total Adjust Screen

The analyzer is equipped with an Auto Correction feature that can apply a slope and offset correction to the concentration results. The most recent Incremental and Total Adjust values for each gas can be viewed. Incremental Adjust is the difference in the amount of correction applied to either the ZERO or SPAN value as a percentage of Full Scale referenced to the last calibration cycle. Total Adjust is the correction applied versus the baseline values of no correction at all. This screen updates when VIEW LATEST VALUES is highlighted, then "↵" is pressed. A value of "-333" means the Enhanced Remote Panel has not received a value from the AEB since the last time the ERP was reset.

```
  SERVICE DATA SM8200
 INCREMENTAL & TOTAL ADJUST

     INCREMENTAL   TOTAL
 NO ZERO:-333.333   -333.333
 NO SPAN:-333.333   -333.333
SO2 ZERO:-333.333   -333.333
SO2 SPAN:-333.333   -333.333
NO2 ZERO:-333.333   -333.333
NO2 SPAN:-333.333   -333.333
NH3 ZERO:-333.333   -333.333
NH3 SPAN:-333.333   -333.333
     VIEW LATEST VALUES
        ESC TO EXIT
```

5.4.4.1.3 Temperature & Pressure Counts Screen

This screen contains analog-to-digital converter counts for various diagnostics and stack measurement inputs. It can be useful for troubleshooting or field calibration purposes. This screen updates when VIEW LATEST VALUES is highlighted, then "↵" is pressed. A value of "65535" means the Enhanced Remote Panel has not received a value from the AEB since the last time the ERP was reset.

SERVICE DATA SM8200
TEMPERATURE & PRESSURE COUNTS

CAL GAS TEMP COUNTS:65535
PDA TEMP COUNTS:65535
STACK TEMP COUNTS:65535
BENCH TEMP COUNTS:65535
PROBE TEMP COUNTS:65535
AUX INPUT1 COUNTS O2:65535
AUX INPUT2 COUNTS UNDEF:65535
STACK PRESSURE COUNTS:65535

VIEW LATEST VALUES
ESC TO EXIT

5.4.4.1.4 Raw Gas Concentrations Screen

This screen contains the output of the first step in the concentration calculation process and is of use mainly for factory calibration purposes. These values should not be used directly for emission data purposes since they are in terms of column density (ppm-cm) and have not been processed by the numerous subsequent steps of the final concentration algorithm. The most recent result for each mode of operation (NORMAL, ZERO, SPAN) is shown individually. This screen updates when VIEW LATEST VALUES is highlighted, then "↵" is pressed. A value of "-333" means the Enhanced Remote Panel has not received a value from the AEB since the last time the ERP was reset.

```
  SERVICE DATA SM8200
   RAW GAS CONCENTRATIONS
     NO        SO2
  ZERO:-333.333   -333.333
  SPAN:-333.333   -333.333
NORMAL:-333.333   -333.333
     NO2       NH3
  ZERO:-333.333   -333.333
  SPAN:-333.333   -333.333
NORMAL:-333.333   -333.333


    VIEW LATEST VALUES
       ESC TO EXIT
```

5.4.4.1.5 Gas Auto Correction Screen

This screen contains the most recent values of the slope and offset regression equation used in the Auto Correction algorithm. If Auto Correction is set to DISABLE, these values will remain unchanged. This screen updates when VIEW LATEST VALUES is highlighted, then "↵" is pressed. A value of "-333" means the Enhanced Remote Panel has not received a value from the AEB since the last time the ERP was reset.

SERVICE DATA SM8200
GAS AUTO CORRECTION

NO OFFSET:-333.333
SO2 OFFSET:-333.333
NO2 OFFSET:-333.333
NH3 OFFSET:-333.333
NO SLOPE:-333.333
SO2 SLOPE:-333.333
NO2 SLOPE:-333.333
NH3 SLOPE:-333.333

VIEW LATEST VALUES
ESC TO EXIT

5.4.4.1.6 Gas Concentrations Screens

These screens show the last 10 instantaneous final gas concentrations. There are multiple screens showing NORMAL, ZERO and SPAN data. They are grouped 2 gases per screen. This screen is very useful for trending purposes, especially for tuning the ZERO_ACQUIRE, i.e., ZERO flush, SPAN_ACQUIRE and NORMAL_ACQUIRE phases of the calibration cycle, or for checking for stability during Cylinder Gas Audits (CGA's) or Linearity tests. The most recent results are displayed as CON 1, the oldest as CON 10. This screen updates when VIEW LATEST VALUES is highlighted, then "↵" is pressed. A value of "-333" means the Enhanced Remote Panel has not received a value from the AEB since the last time the ERP was reset.

SERVICE DATA SM8200
GAS CONCENTRATIONS

NO & SO2 CONCENTRATIONS
NO2 & NH3 CONCENTRATIONS
NO & SO2 ZERO CONCENTRATIONS
NO2 & NH3 ZERO CONCENTRATIONS
NO & SO2 SPAN CONCENTRATIONS
NO2 & NH3 SPAN CONCENTRATIONS

USE AROWS THEN <- TO SELECT
ESC TO EXIT

```
   NO & SO2 CONCENTRATIONS
       NO        SO2
 CON 1:-333.333   -333.333
 CON 2:-333.333   -333.333
 CON 3:-333.333   -333.333
 CON 4:-333.333   -333.333
 CON 5:-333.333   -333.333
 CON 6:-333.333   -333.333
 CON 7:-333.333   -333.333
 CON 8:-333.333   -333.333
 CON 9:-333.333   -333.333
CON 10:-333.333   -333.333
     VIEW LATEST VALUES
        ESC TO EXIT
```

5.4.4.1.7 Stack Temp & Pressure Screen

This screen shows the last 10 Stack Temperature and Pressures. This screen is useful for trending purposes. The most recent results are displayed as VAL 1, the oldest as VAL 10. This screen updates when VIEW LATEST VALUES is highlighted, then "↵" is pressed. A value of "-333" means the Enhanced Remote Panel has not received a value from the AEB since the last time the ERP was reset.

```
STACK TEMP & PRESSURE SM8200
      TEMP       PRESS
 VAL 1:-333.333   -333.333
 VAL 2:-333.333   -333.333
 VAL 3:-333.333   -333.333
 VAL 4:-333.333   -333.333
 VAL 5:-333.333   -333.333
 VAL 6:-333.333   -333.333
 VAL 7:-333.333   -333.333
 VAL 8:-333.333   -333.333
 VAL 9:-333.333   -333.333
VAL 10:-333.333   -333.333
     VIEW LATEST VALUES
        ESC TO EXIT
```

5.4.4.1.8 Other Data 2 Screen

This screen contains miscellaneous analyzer maintenance data. Three of these can be of importance:

- **FACTORY CAL CRC CHECK:** This is a Cyclic Redundancy Code (CRC) number generated during factory calibration. The factory calibration parameters are continuously checked via CRC verification by the analyzer software to insure they have not been corrupted. If the continuous CRC check does not match this number, a Training Set CRC Check fault will be generated. Consult Technical Support.

- **MEAN DARK CURRENT:** This is the most recent mean value of the Dark Current. It is checked against minimum and maximum fault levels to insure there are no problems with the Dark Shutter, PDA, Preamp TE Cooler Board or various parameters affecting their operation.

- **MEAN REFERENCE CURRENT:** This is the most recent mean value of the Reference. It is checked against minimum and maximum fault levels to insure there are no problems with energy level in the analyzer.

SERVICE DATA SM8200
OTHER DATA 2

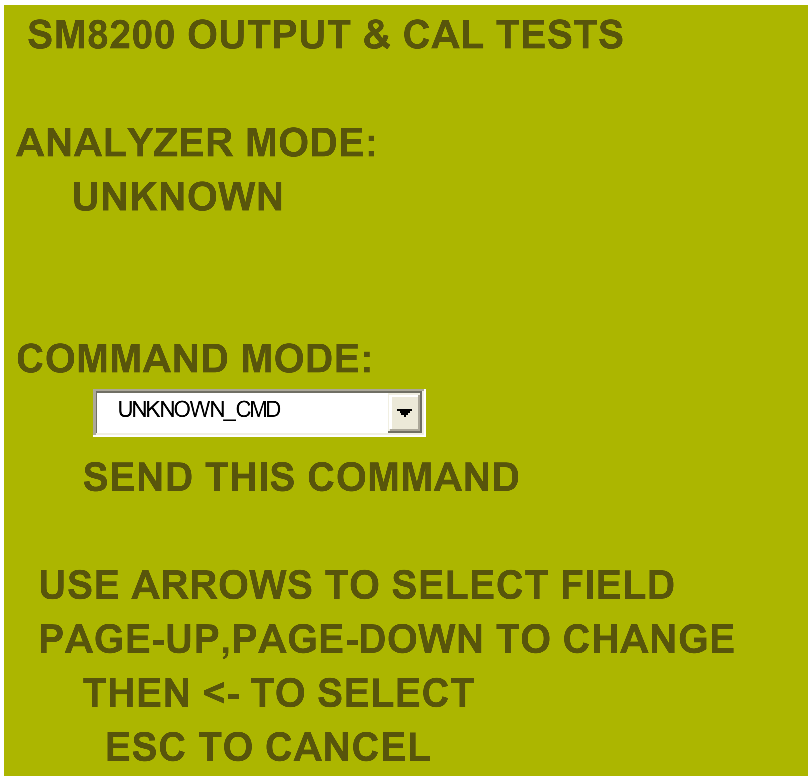
MANUAL PIXEL OFFSET:65535
FACTORY CAL CRC CHECK RES:65535
USER SET CRC CHEK RESULT:65535
PEAK PIXEL NUMBER:65535
MEAN DARK CURRENT:-333.333
MEAN REF CURRENT:-333.333
SIG PEAK WAVELENGTH:-333.333

VIEW LATEST VALUES

ESC TO EXIT

5.4.5 <u>Output & Cal Tests Screens</u>

The Output & Cal Test screens are divided into three separate screens: SM8200, MIO1 and MIO2. The former is of primary interest since it controls the analyzer mode. The latter two allow the user to command values onto the analog outputs of the Multi IO Board inside the ERP (MIO1) and the optional Multi IO Module (MIO2). When the screen comes up, the COMMAND MODE line will be highlighted. Scroll through the modes by pressing the “Page Up” and “Page Down” keys until the desired mode appears. Press ENTER to move the highlight bar to the “SEND THIS COMMAND” line then press “↵” to send the mode change request. The highlight bar will move back to the COMMAND



5.4.6 Analyzer Properties

This menu allows you to choose a group of analyzer properties to view or alter. Monitor calibration is mainly accomplished through use of this group of screens.

The first selection under the Analyzer Properties Menu will permit selection of View or Change for the SM8200 analyzer or the optional Diluent analyzer. Also present in this menu is the Change selection for the ERP RS232 serial port MODBUS properties. *Note that parameters are sent to the AEB as soon as the user hits " ↵". This is unlike the Output Module Configuration screens (see Analog Outputs 5.4.8 Section of this manual).*

Most Change Analyzer Properties screens operate in a similar manner. Numbers may be changed via the numeric keypad. The "E" button is for the exponent of scientific notation numbers. Values on enumerated list parameters may be selected via the "PG UP" "PG DN" buttons. The "↵" will send the new parameter value to the AEB. Some parameter changes will be immediate but most will only take effect on the data at the onset of the next Integration Period.

A full explanation of the significance of all monitor parameters in the Analyzer Properties Menu is outside the scope of this manual. What follows is a concise explanation of the types of parameters in each group of properties and a flavor for their significance.

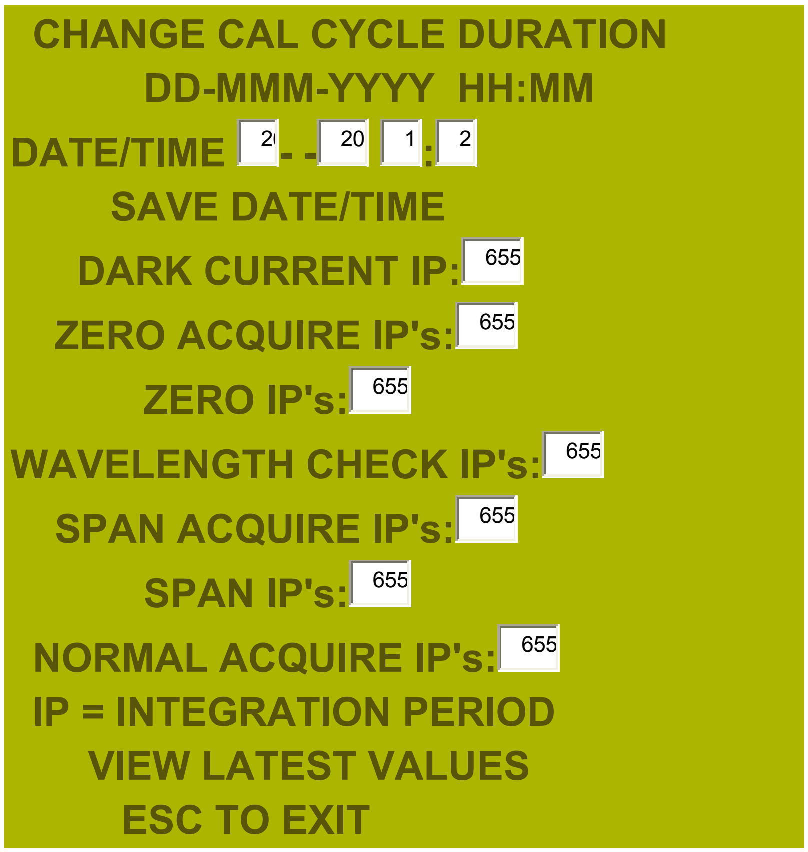
CHANGE SM8200 PROPERTIES
CAL CYCLE PROPERTIES
PRESS & TEMP SCALING
GAS MEASUREMENT PROPERTIES
CAL GAS & PROBE HEATER
PDA PROPERTIES
CAL SET POINTS & CURVE TYPE
OTHER COMPS & CORRECTIONS
ALARM THRESHOLDS
AUX INPUTS
AVERAGING PROPERTIES

USE AROWS THEN <- TO SELECT
ESC TO EXIT

5.4.6.1 Cal Cycle Properties Screens

These screens control the timing of the calibration cycle, i.e., how many Integration Periods the analyzer spends in each phase of the calibration cycle, and other properties pertaining to the calibration cycle and automatic CGA. Refer to the tables in Section 4.0 of this manual for definitions of calibration cycle and CGA modes. ***Also, the SM8200 Analyzer Real Time Clock settings can be changed from these screens.*** There are two submenus: CAL CYCLE DURATION and OTHER CAL CYCLE PROPERTIES.

NOTE: T*he WAVELENGTH CHECK part of the calibration cycle is not in use.* ***This parameter must be set to 0 for proper operation of the analyzer****.*



- **HOUR OF AUTO CAL:** The SM8200 analyzer has an automatic calibration timer triggered by its Real Time Clock. This parameter sets the hour of the day that the self-timed calibration cycle will begin. The hour setting is in military time. To disable the self-timed automatic calibration cycle, set the HOUR OF AUTO CAL to 25.

- **MINUTE OF AUTO CAL:** The SM8200 analyzer has an automatic calibration timer triggered by its Real Time Clock. This parameter sets the minute of the hour set by HOUR OF AUTO CAL that the self-timed calibration cycle will begin.

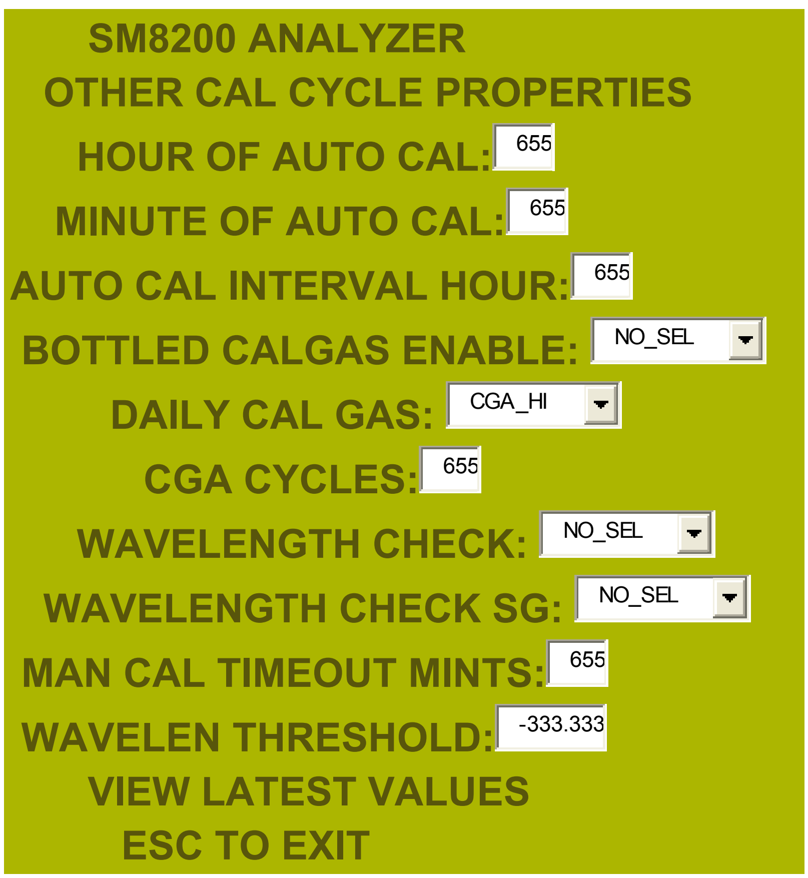
- **BOTTLE CAL GAS ENABLE:** The SM8200 analyzer calibration cycle can employ the internal EO Cal Cell as a span reference or bottled calibration gas. ***Setting BOTTLED CAL GAS ENABLE to DISABLE will make the analyzer use the EO***

Cal Cell during the calibration cycle; setting it to ENABLE will actuate the SPAN gas solenoid during the calibration cycle.

- **DAILY CAL GAS:** This parameter is used if the optional CGA Box is employed. It has three selections: NO SEL (no selection), CGA_HI and CGA_MID. If CGA_HI is selected and BOTTLE CAL GAS ENABLE is set to ENABLE, the high GGA gas bottle solenoid actuates during the SPAN portion of the calibration cycle; and, similarly, the mid CGA gas bottle solenoid will actuate for the CGA_MID setting. The low CGA gas bottle is not a valid selection for daily calibration check use.

- **CGA CYCLES:** This parameter controls how many runs will be used for the automatic CGA cycle. It is typically set to 3, which is the minimum acceptable number under 40CFR75 regulations.

- **MAN CAL TIMEOUT MINTS:** This parameter sets the duration in minutes that the MANUAL_ZERO and MANUAL_SPAN will be allowed to persist, after which the analyzer will return to NORMAL mode. This parameter exists to help prevent accidental calibration gas depletion.



5.4.6.2 Press & Temp Scaling Screens

These screens set the scaling of the pressure and temperature analog channels of the SM8200 analyzer. The Stack Pressure screen is explained as an example.

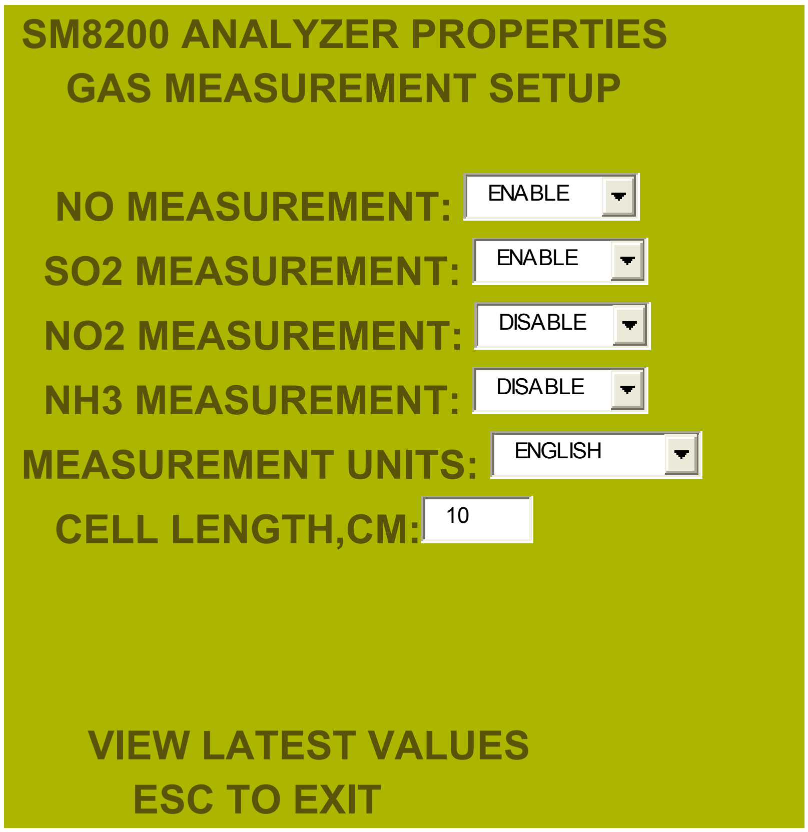
This screen contains the two-point calibration curve for the Stack Pressure transducer, the pressure to which the pressure calibration is referenced. The Counts parameters are analog-to-digital converter values that correspond to the pressures at the two points.

- ❑ **LOW COUNTS:** Counts at Point 1 (X1, or input value 1)
- ❑ **HIGH COUNTS:** Counts at Point 2 (X2, or input value 2)
- ❑ **LOW VALUE:** Pressure at Point 1 (Y1, or output value 1)
- ❑ **HIGH VALUE:** Pressure at Point 2 (Y2, or output value 2)
- ❑ **FAULT MIN:** Pressure threshold below which the Stack Pressure fault will trigger.
- ❑ **FAULT MAX:** Pressure threshold above which the Stack Pressure fault will trigger.
- ❑ **STACK PRESSURE COUNTS:** (View Only) For convenience during calibration, the Stack Pressure counts can be viewed on the same screen as the calibration parameters. Note that one must scroll to “VIEW LATEST VALUES” and hit ”↲” for each update of the counts value.

NOTE: *For the Stack Temperature screen, the Stack Temperature counts values are not raw ADC counts. They are the values after the RTD linearizer.*

5.4.6.3 Gas Measurement Properties Screen

All of the parameters on the Gas Measurement Properties screen are for factory use and must not be altered.



- **MEAUREMENT UNITS:** This parameter has three choices: ENGLISH, METRIC_WGT (Metric Weight) and METRIC_VOL (Metric Volume). See Table 5-6 for the unit types invoked by these settings.

- **CELL LENGTH, CM:** The Cell Length is the physical length in centimeters of the optical measurement cavity from the cavity window to the corner cube retro-reflector.

Table 5-6: Measurement Units

Measurement	English Units	Metric Volume Units	Metric Weight Units
Concentration ***(see note below)***	ppm (by volume)	ppm (by volume)	mg/scm (by weight)
Emission Rate	Lbs/mmBTU (lbs/MBTU)	ng/Joule	ng/Joule
Stack Pressure	Inches Hg	Kilo-Pascals	Kilo-Pascals
Stack Temperature	Deg F	Deg C	Deg C
Bench Temperature	Deg F	Deg C	Deg C
PDA Temperature	Deg F	Deg C	Deg C
Cal Gas Temperature	Deg F	Deg C	Deg C
Probe Temperature	Deg F	Deg C	Deg C

NOTE: *The SM8200's concentration measurements are inherently wet basis. Wet basis measurements cannot be directly compared to or used in calculations with dry basis measurements from extractive systems that employ a gas drier.*

5.4.6.4 PDA Properties Screens

These screens set primary settings for the gas concentration and diagnostic measurements, along with fault settings for the mean Dark and Reference levels.

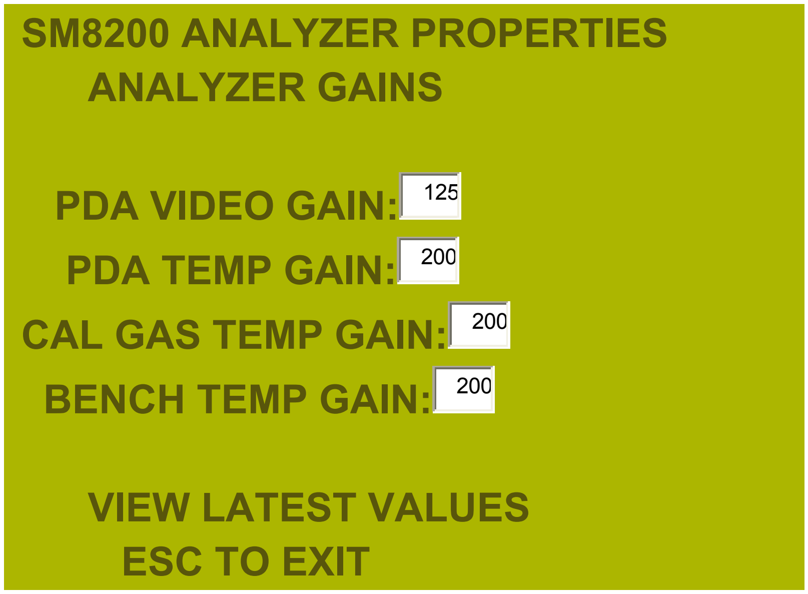
```
SM8200 ANALYZER PROPERTIES
    PDA PROPERTIES

 ANALYZER GAINS
 PDA TEMPERATURE SCALING
 PDA THERMISTER LINEARIZER
 PREAMP SETTINGS
 DARK & REF CURRENT THRESHOLDS
 METRIC CONVERSION

  USE AROWS THEN <- TO SELECT
       ESC TO EXIT
```

- ❑ **PDA VIDEO GAIN:** This parameter sets the gain for the PDA Video signal on the AEB Motherboard. See Section 4.0 of this manual for the valid range for this parameter.

- ❑ **PDA TEMP GAIN:** This parameter sets the gain for the PDA Temperature diagnostic signal on the AEB Motherboard. The maximum value allowed for this parameter is 255. This parameter does not typically require field adjustment.

- ❑ **CAL GAS TEMP GAIN:** This parameter sets the gain for the Cal Gas Heater Temperature diagnostic signal on the AEB Motherboard. The maximum value allowed for this parameter is 255. This parameter does not typically require field adjustment.

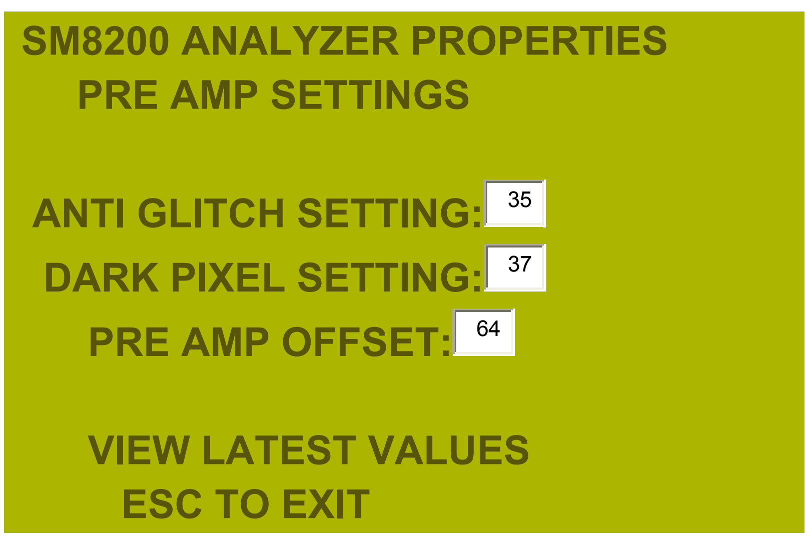
- ❑ **BENCH TEMP GAIN:** This parameter sets the gain for the Transceiver optical Bench Temperature diagnostic signal on the AEB Motherboard. The maximum value allowed for this parameter is 255. This parameter does not typically require field adjustment.



- **ANTI GLITCH SETTING:** This parameter is for setting the anti-glitch circuit on the Preamp TE Cooler Board. The valid range for this parameter is 1 to 127. It should not be adjusted in the field without consulting the factory Technical Support.

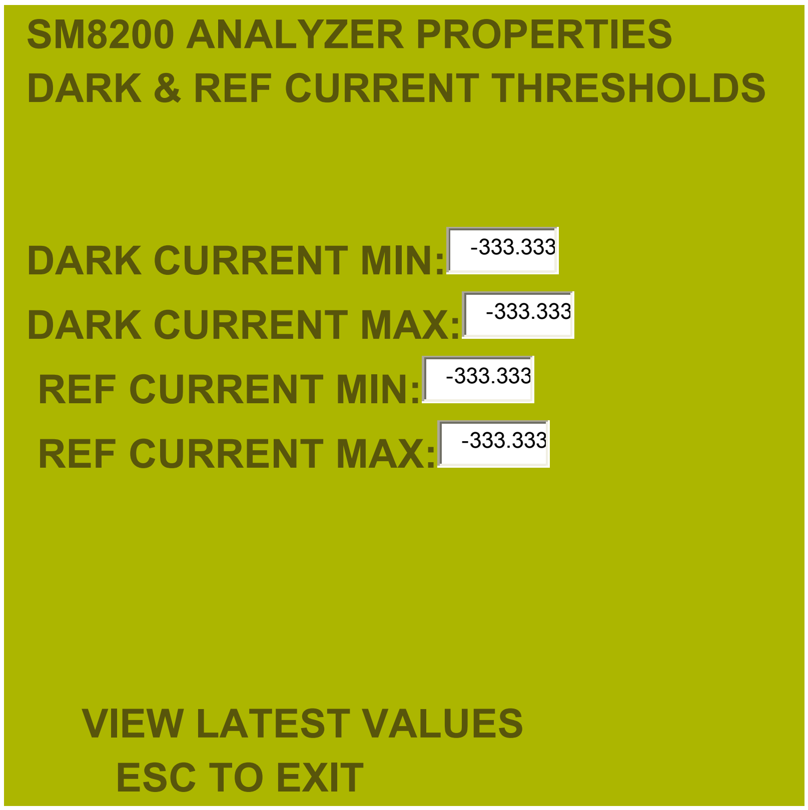
- **DARK PIXEL SETTING:** This parameter establishes the Dark Current level out of the Preamp TE Cooler Board. The valid range for this parameter is 1 to 127. It should not be adjusted in the field without consulting factory Technical Support.

- **PRE AMP OFFSET:** This parameter sets the DC offset of the Preamp TE Cooler Board. The valid range for this parameter is 1 to 127. It should not be adjusted in the field without consulting factory Technical Support.

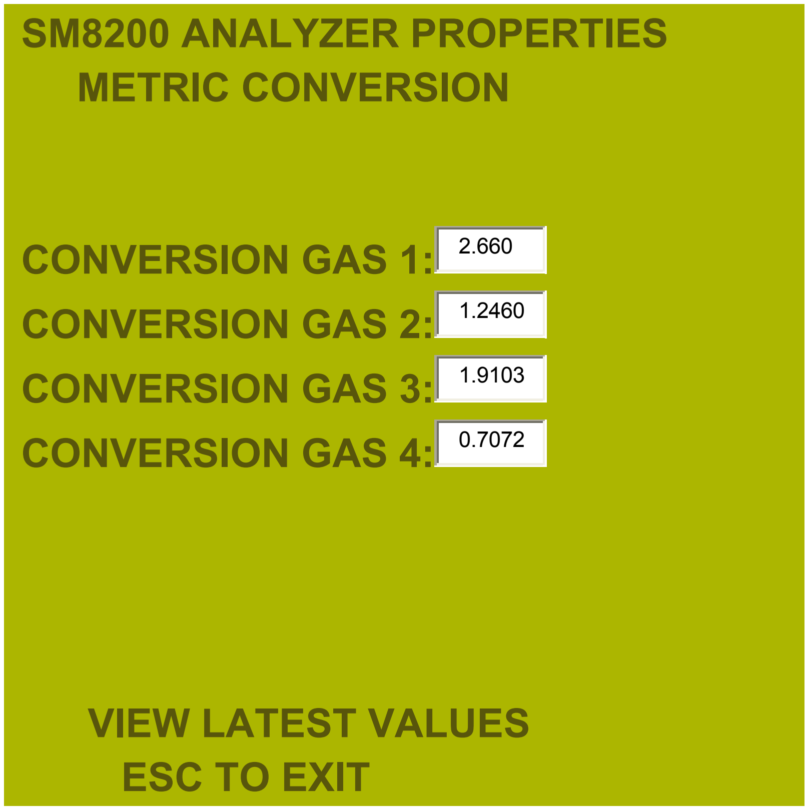


- **DARK CURRENT MIN & MAX:** These parameters establish the fault levels for the mean Dark Current as measured during the DARK phase of the calibration cycle. The light input to the PDA is blocked for this measurement.

- **REF CURRENT MIN & MAX:** These parameters establish the fault levels for the mean Reference Current as measured during the ZERO phase of the calibration cycle. Mean Reference Current is the average of the all of the raw spectra values from the box car over the entire wavelength range of the instrument (typically approximately 200 to 230 nm).



- **CONVERSION GAS 1 thru 4:** These parameters establish the molecular weight based conversion factors used for the METRIC_WGT (Metric Weight) measurement unit selection. Gas 1 is for NO, Gas 2 is for SO2, Gas 3 is not used and Gas 4 is for NH3. See the example Metric Conversion screen for typical parameter values.



NOTE: *USEPA regulations require that NOx, even when measured just as NO, be reported as NO2 for lbs/mmbtu calculations. Refer to 40CFR60 Appendix A Method 19 for further information.*

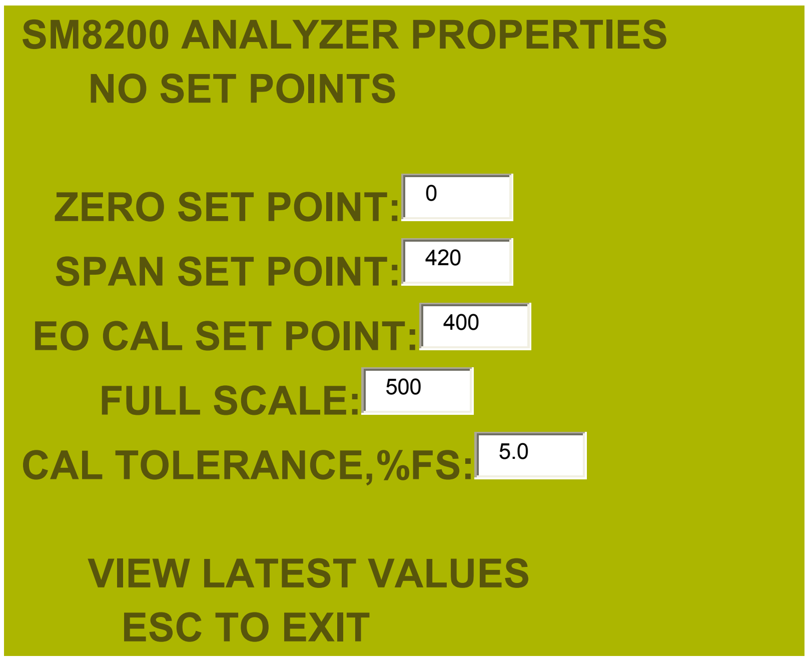
5.4.6.5 Cal Set points & Curve Type

These screens set the calibration reference values and the user concentration linearity (user linearizer) adjustments. To adjust calibration reference values for NO, scroll down to NO SETPOINTS using the arrow keys and press " ↵". To adjust the user linearizer for NO, select NO CURVE TYPE. The other gases in this screen operate in similar fashion.

```
  SM8200 ANALYZER PROPERTIES
CHANGE SET POINTS & CURVE TYPE

   NO SETPOINTS
   NO CURVE TYPE
   SO2 SETPOINTS
   SO2 CURVE TYPE
   NO2 SETPOINTS
   NO2 CURVE TYPE
   NH3 SETPOINTS
   NH3 CURVE TYPE

   USE AROWS THEN <- TO SELECT
          ESC TO EXIT
```

5.4.6.5.1 Set Point Screens for Calibration Gases, Full Scale & Cal Tolerances

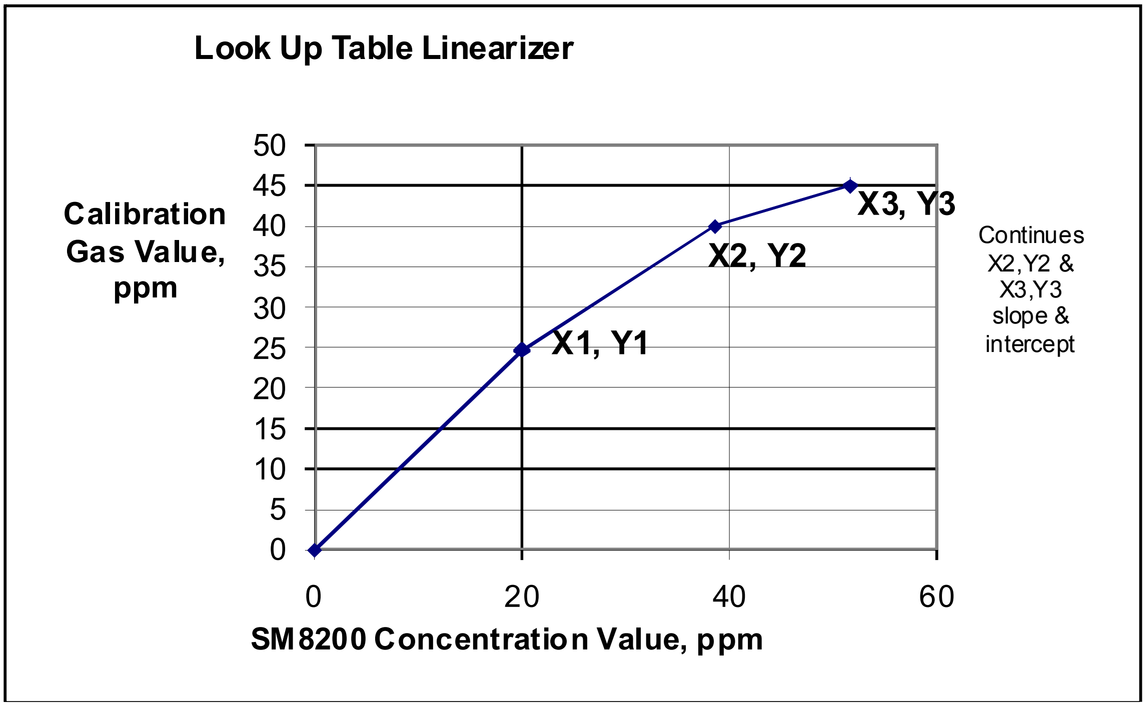
See the NO Set Point screen shown below for typical values for calibration set points, full scale and calibration tolerance as a percentage of full scale. For most US regulatory applications, full scale refers to the span of the instrument. The maximum range of the instrument is greater than or equal to the span.



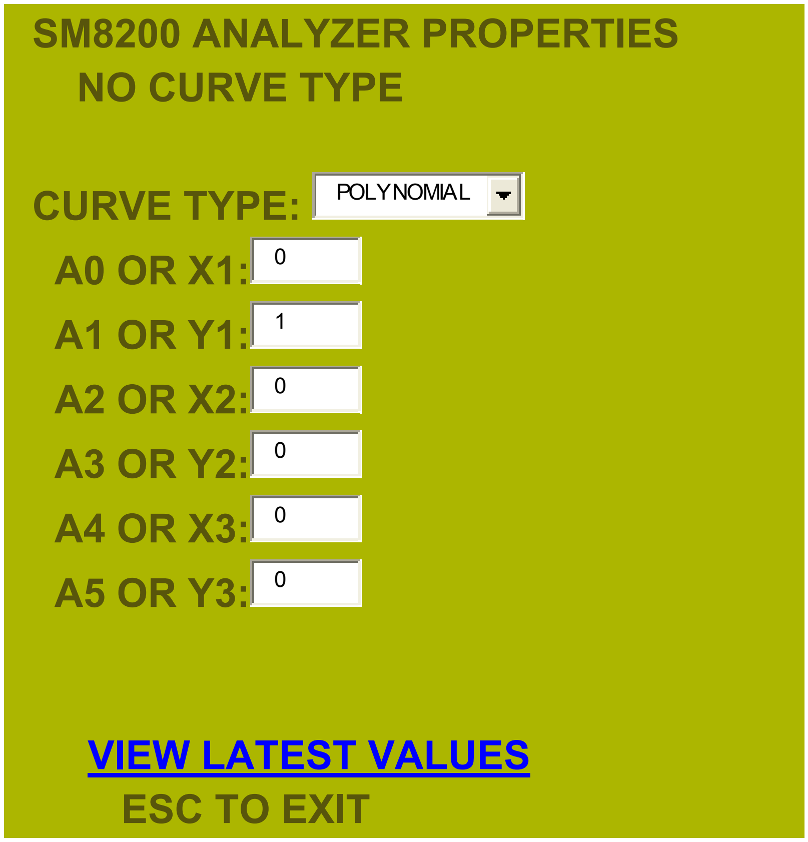
5.4.6.5.2 Curve Type (User Linearizer) Screens

These screens contain the user linearizers (correlation curves) for each gas. The linearizer is a mathematical equation applied to the measured gas concentration in ppm before it is output as the final concentration in digital or analog form. The linearizer is helpful for correcting for system nonlinearities such as differences in calibration gas assay accuracies or other effects. Either a polynomial (POLY) of order one to five or a three-point Look Up Table (LUT) may be used. The Curve Type parameter selects which linearizer form is in use. Note that either the LUT or POLYNOMIAL must be enabled, i.e., the linearizer cannot be bypassed.

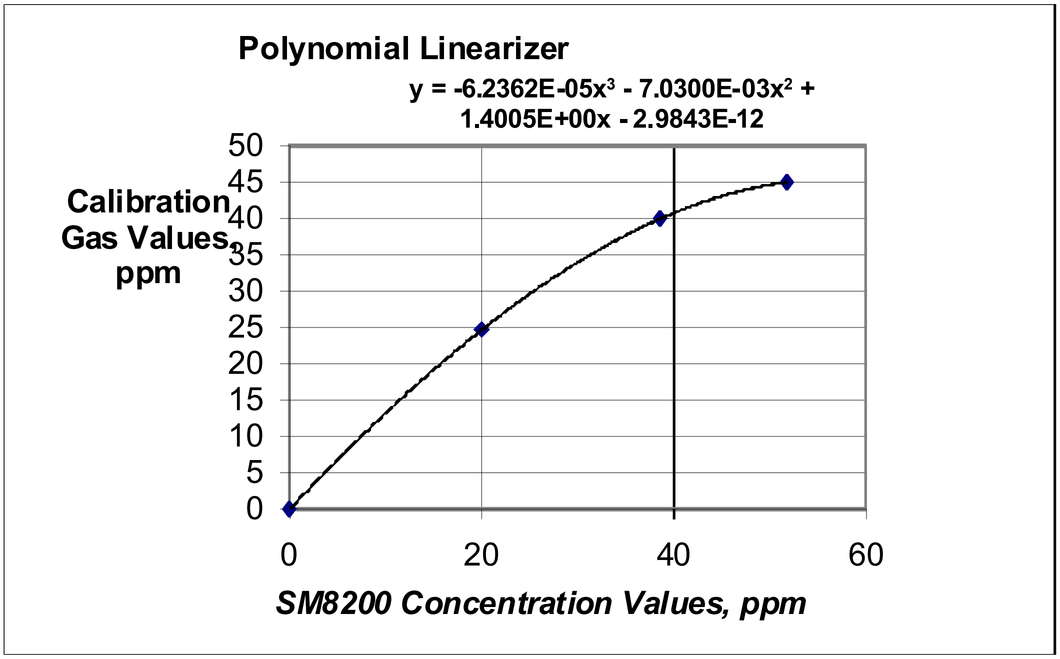
- ❑ **CURVE TYPE:** (POLYNOMIAL or LUT)
- ❑ **X1,Y1,X2,Y2,X3,Y3**: (LUT Points)



The points for the Look Up Table must be derived through testing with reference calibration gases. Each point consists of SM8200 concentration measurement value (X) and an associated reference calibration gas value (Y). The LUT output value is then derived as a straight-line approximation, using up to three line segments. The first segment has zero as its origin and ends at the first SM8200 / reference method pair of numbers entered. The second segment is a line from the first number pair (X1, Y1) to the second SM8200 / reference method pair of numbers (X2, Y2). The third segment runs from the second number pair (X2, Y2) to the third SM8200 / reference method pair of numbers (X3, Y3). If a segment is not used, “-1” must be entered for the terminal point SM8200 value. Thus if “-1” is entered for the last SM8200 point only two lines are used for the curve fit. If the second and third SM8200 points are “-1”, only one line is calculated. If all three points are “-1”, Look Up Table calculations are disabled.


SM8200 ANALYZER PROPERTIES
NO CURVE TYPE
CURVE TYPE: POLYNOMIAL
A0 OR X1: 0
A1 OR Y1: 1
A2 OR X2: 0
A3 OR Y2: 0
A4 OR X3: 0
A5 OR Y3: 0
VIEW LATEST VALUES
ESC TO EXIT

- **A0,A1,A2,A3,A4,A5:** (POLY Points)



The Polynomial A0 through A5 contain the coefficients of a 5th order Polynomial least squares correction curve fit, which may be employed to modify the concentration outputs of the SM8200 to more closely correlate with calibration gases or reference method testing data. <u>Teledyne Monitor Labs Technical Support must be consulted in order to properly employ this curve</u> because the mathematical programs used to determine these coefficients must be evaluated subjectively for anomalies. See Equation 5-1 for the functional form of the polynomial. In analyzers not employing such correction devices A1 = 1. A0, A2, A3, A4, and A5 will be equal to zero.

C = Ac0 + Ac1*Cg + Ac2*Cg^2 + Ac3*Cg^3 + Ac4*Cg^4 + Ac5*Cg^5

Equation 5-1: Polynomial Form of User Linearizer

5.4.6.6 Other Comps & Corrections Screens

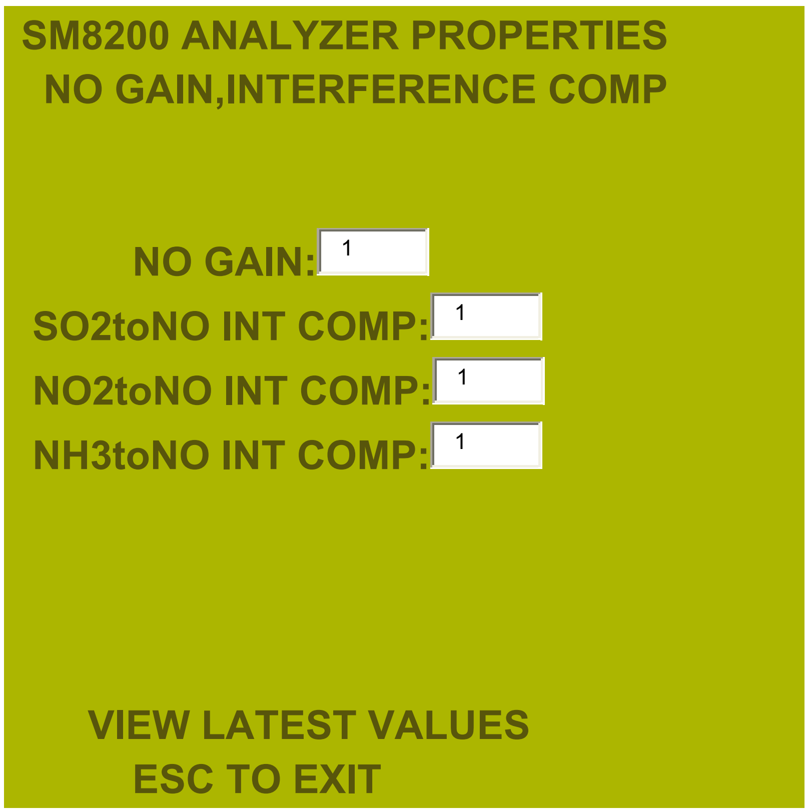
These screens contain several adjustments of note. Note that the Pressure Correction screens are not for field use.

```
SM8200 ANALYZER PROPERTIES
  OTHER COMPS & CORRECTIONS
  NO GAIN,INTERFERENCE COMP
  SO2 GAIN,INTERFERENCE COMP
  NO2 GAIN,INTERFERENCE COMP
  NH3 GAIN,INTERFERENCE COMP
  NO PRESSURE CORRECTION
  SO2 PRESSURE CORRECTION
  NO2 PRESSURE CORRECTION
  NH3 PRESSURE CORRECTION
  EO CAL TEMP & REF PRESSURE
  AUTO CORRECTION & ADJUST
  USE AROWS THEN <- TO SELECT
          ESC TO EXIT
```

5.4.6.6.1 Gain & Interference Comp Screens

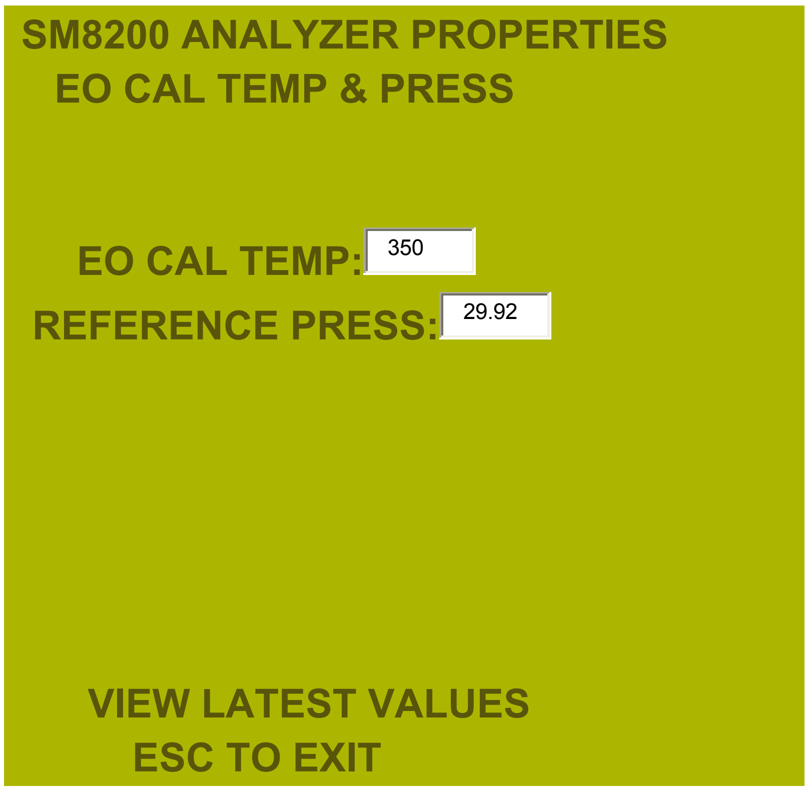
There are four of these screens – one for each gas. The parameters on these screens adjust the overall gain or slope of a gas's response. The gain number entered here will apply to all temperature and pressure ranges of a gas. Interference Comp (INT COMP) adjusts the interference correction magnitude between one gas and another. Default values for all gains and interferences are 1.

NOTE: *Adjustment of Gain and Interference Comp parameters requires a thorough understanding of the operation of the analyzer and should only be attempted by trained service personnel.*



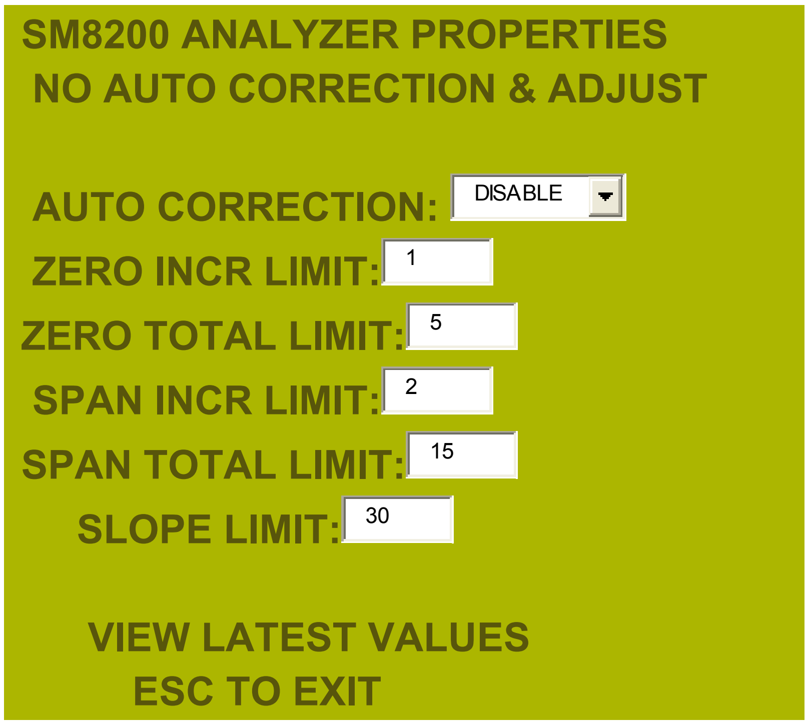
5.4.6.6.2 EO Cal & Ref Pressure Screen

This screen can be used to adjust the temperature used for evaluation of the EO Cal Cell. <u>The Reference Pressure parameter is for factory calibration use only</u> and is typically set to 29.92 inches of Hg, for English measurement unit systems, or 101.35 KPa, for Metric (one atmosphere).



5.4.6.6.3 Auto Correction & Adjust Screens

There are four Auto Correction & Adjust screens – one for each gas. The NO screen is shown as an example. These screens control the Auto Correction algorithm parameters and as a result are of interest to those servicing the analyzer.



- **AUTO CORRECTION:** These parameters enable the Auto Correction algorithm Three settings are possible:

  - **DEFAULT:** This value sets the regression curve slope to 1 and offset to 0, effectively eliminating any automatic correction for the individual gas.

  - **DISABLE:** This value stops further auto corrections, effectively freezing the process while maintaining the current values for the regression curve slope and offset for the individual gas.

  - **ENABLE:** This value enables the Auto Correction algorithm and continues the correction process for the individual gas.

- **ZERO INCR LIMIT:** These parameters limit the difference in the amount of correction that the algorithm applies to the ZERO cal value from one calibration cycle to the next. It is expressed as a percentage of full scale for the individual gas.

- **ZERO TOTAL LIMIT:** These parameters limit the overall amount of correction that the algorithm applies to the ZERO cal value as referenced a baseline of no correction. It is expressed as a percentage of full scale for the individual gas.

- **SPAN INCR LIMIT:** These parameters limit the difference in the amount of correction that the algorithm applies to the SPAN cal value from one calibration cycle to the next. It is expressed as a percentage of full scale for the individual gas.

- **SPAN LIMIT:** These parameters limit the overall amount of correction that the algorithm applies to the SPAN cal value as referenced a baseline of no correction. It is expressed as a percentage of full scale for the individual gas.

- **SLOPE LIMIT:** These parameters limit the slope value of the regression curve for the individual gas. It is expressed as a percentage of reading, i.e., setting SLOPE LIMIT to 30 will limit the slope to values between 0.70 and 1.30.

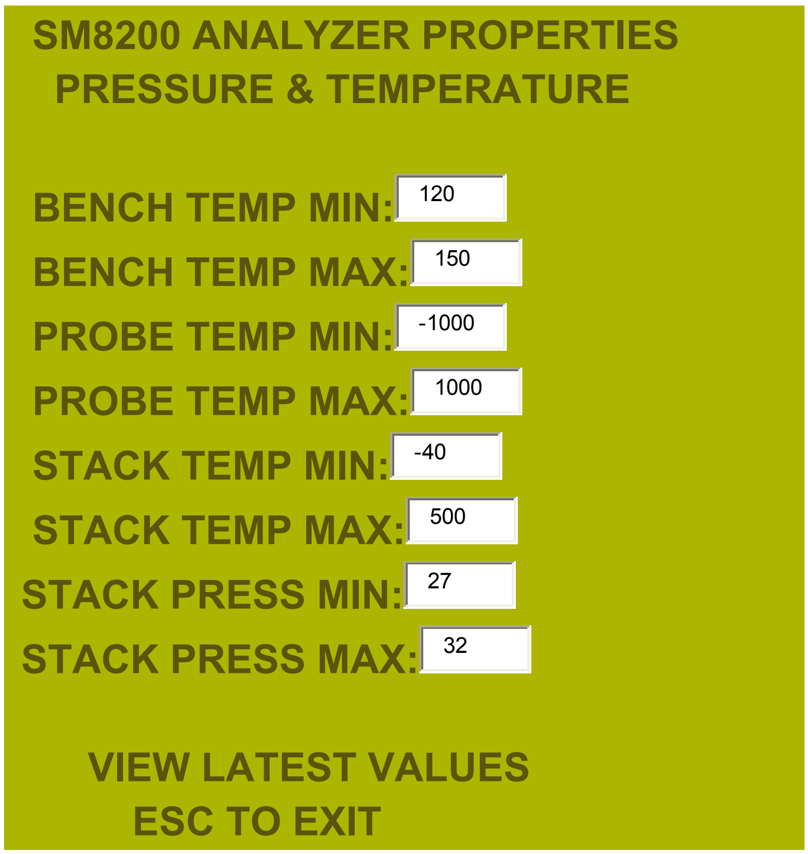
The Auto Correction algorithm adjusts the slope and offset correction terms in an attempt to make the final concentration values equal known concentrations that challenge the analyzer during the calibration cycle. New corrections are applied only after the daily zero and span drift values are computed at the end of the calibration cycle using the correction terms established from the previous calibration cycle. For more information consult Sections 4.0 and 7.0 of this manual.

5.4.6.7 Alarm Thresholds Screens

These screens set concentration alarm thresholds, emission rate (lbs/mm BTU) alarm thresholds and fault thresholds for Bench Temperature, Probe Temperature (not in use), Stack Temperature and Pressure.

5.4.6.7.1 Press & Temp Set Points Screen

This screen sets the thresholds at which the instrument status word will flag Stack Temperature or Pressure as being out of allowable bounds.



5.4.6.8 Averaging Properties

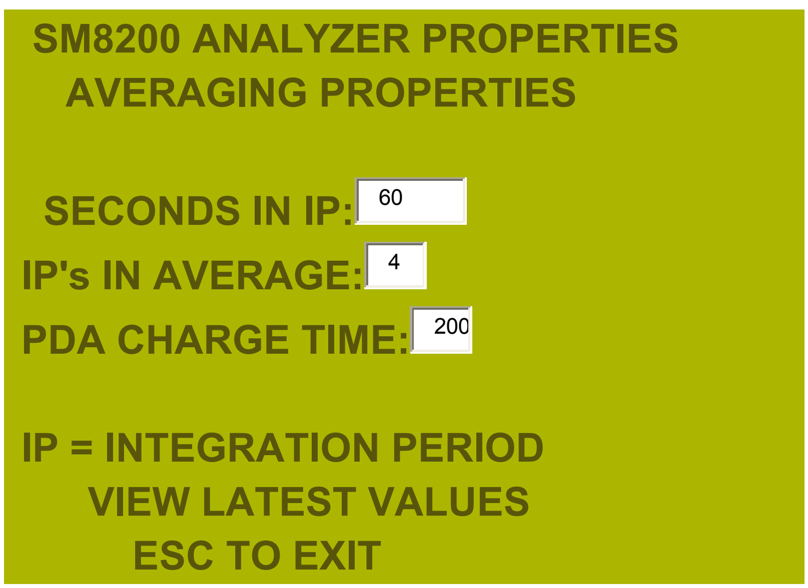
This screen sets the averaging behavior of the analyzer.

- **SECS IN IP:** This parameter establishes the seconds in each Integration Period. It is typically set to between 45 and 60 seconds. Values less than 45 seconds may produce additional scatter in the concentration measurements.

NOTE: *The total time between each measurement is equal to the Integration Period plus the Calculation Time. Since the chemometric evaluation performed by the analyzer is quite complex, between 7 and 13 seconds are consumed performing the concentration evaluation. Actual Calculation Time is related to the number of gases evaluated (typically 2 but this may be 3 for some analyzers). This time adds to the Integration Period to produce the total time between measurements.*

- **IP's IN AVERAGE:** This parameter establishes the number of Integration Periods used to calculate NORMAL, ZERO and SPAN average concentrations. The analyzer calculates averages using moving average filters of a size equal to the value of this parameter.

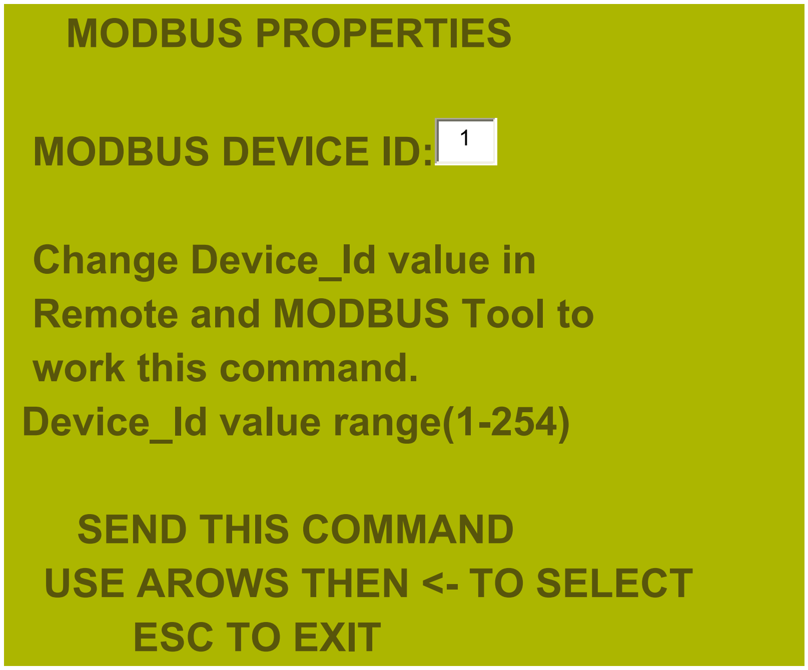
- **PDA CHARGE TIME:** This parameter sets the time that the PDA accumulates charge before it is clocked out for conversion to current and voltage by the Preamp TE Cooler Board. PDA CHARGE TIME is an integer value that is quantized in a format of use for the FPGA's internal registers. The typical value is 2000. It should not be field adjusted without consulting factory Technical Support.



5.4.7 <u>Modbus Properties Screen</u>

This screen sets the Enhanced Remote Panel multi-drop (addressable) RS232 serial Modbus port's ID (identification) number / address.

NOTE: *This screen does NOT have any effect on the Ethernet Modbus TCP settings!*



5.4.8 Output Module Properties Screens

These screens control the setup of the ERP's internal Multi IO Board, the optional external Multi IO Module, the Plant IO Module and some of the TCP/IP properties of the ERP's internal Ethernet port.

```
OUTPUT MODULE PROPERTIES

  MIO 1
  MIO 2
  PLANT I/O
  CONFIG ETHERNET
USE AROWS THEN <- TO SELECT
     ESC TO EXIT
```

5.4.8.1 Output (Multi IO) Properties Screens

To edit or view the ERP's internal Multi IO Board, select MIO 1. For the optional external Multi IO Module, select MIO2.

NOTE: *The Multi IO Properties screens operate in a similar manner to the Analyzer Properties screens with one important difference. In order for changes to take effect, the user must scroll down to the SAVE THIS CONFIG line and hit "↵".*

The four analog outputs of each Multi I/O Board can be configured to display any one of forty parameters. See Table 5-8, Parameters for Analog Output. Scaling for each of these four outputs is configurable and completely independent depending on the parameter selected. Both ZERO and FULL scale may be chosen for each output. Also each output may be configured to allow calibration cycles to appear on it.

- **CAL ENABLE:** The MIO has calibration values available on its analog outputs. The system will allow any analog output selection to be configured for calibration data to be displayed (WITH CAL), even those that are not related to gas concentration, for instance, PDA Temperature, but if the units do not match, the scaling for the calibration parameter will be incorrect and the calibration data will be meaningless. Three calibration options are available for output parameters. They are selectable under the field of the analog output configuration screen. The options are:

  1. **WITH CAL =** Calibration data will be sent to that output when a calibration request is processed. Scaling for the calibration data will be the same as the NORMAL mode scaling entered under VALUE AT ZERO SCALE and VALUE AT FULL SCALE.

  2. **WITHOUT CAL =**The output will not receive or display calibration values.

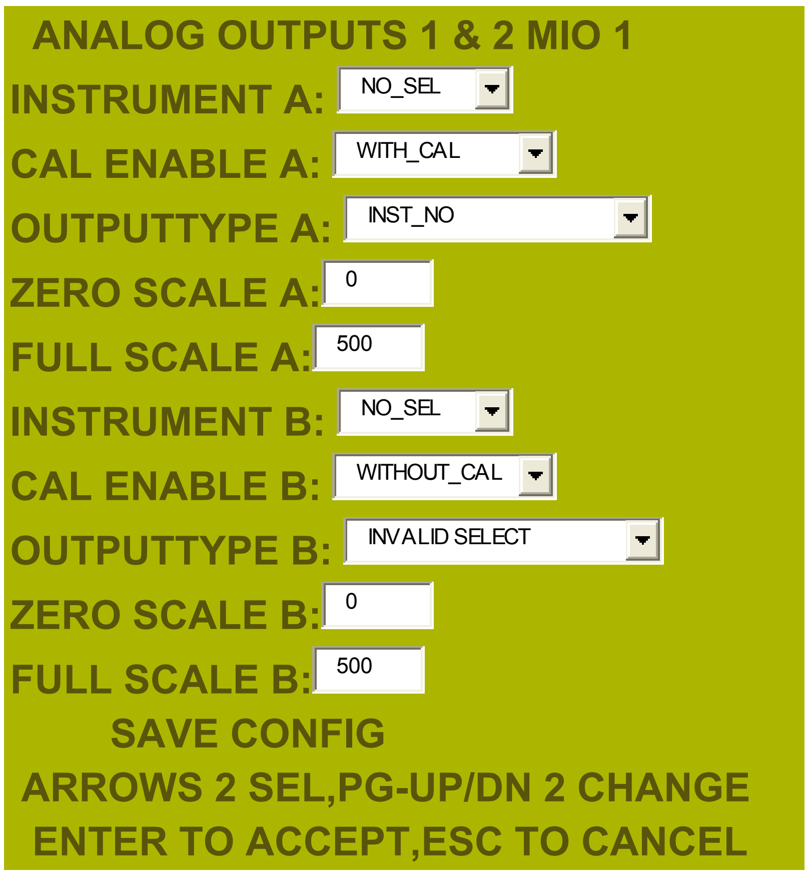
3. **NO SEL =** No selection.

- **INSTRUMENT:** This should always be set to SM8200.

- **OUTPUT TYPE:** This is a list of variables that can be mapped to the analog outputs. Use “PG-UP” and “PG-DN” to select the variable of interest.

- **ZERO SCALE:** This should be set to the value of the variable that corresponds with the low end (4 mA level) of the analog output.

- **FULL SCALE:** This should be set to the value of the variable that corresponds with full scale (20 mA level) of the analog output.



5.4.8.2 Digital Inputs

The Multi I/O can issue mode change commands to the Transceiver based on the status of digital inputs one through six. These are known as the CAL REQUEST inputs. By controlling which input is activated, the operator can construct an “on-demand” calibration cycle to meet the systems needs. There are also inputs that will initiate the automatically timed internal CAL cycle. See Table 5-7, Digital Inputs for Calibration Request.

The Multi I/O analog outputs can be forced to diagnostic status (TEST FULL SCALE, TEST ZERO SCALE, etc.) from two sources: digital inputs seven and eight, and the Enhanced Remote Panel keypad. The operation of the digital inputs is described in

Table 5-10, Digital Inputs for Analog Output Control. The keypad display commands are described in the section on menu structure. If the Multi I/O receives conflicting or overlapping requests for the analog outputs, its priority handler will assign requests from the digital inputs top priority and the keypad requests from the Enhanced Remote Panel second priority.

5.4.8.3 Digital Outputs (Relay Assignment Screen)

The Multi I/O Board's eight digital outputs (relays) can be configured to activate on any one of over eighty parameters. These are listed in Table 5-9, Parameters for Relay Assignment. They fall into four categories:

- ❑ SM8200 Alarm indicators
- ❑ SM8200 Fault indicators
- ❑ SM8200 Output mode indicators
- ❑ O2 Relays

NOTE: *Categories beginning with "CO/CO2" are not currently in use.*

Standard practice is to assign a relay to each of the two CAL modes. These signals will then indicate when and what data is present on the analog outputs for data logging purposes. For more information on software function see the Operational Modes of the system, see Section 4.0 of this manual.

The digital output selections are self-explanatory except for the Data Valid, Fault, and Fatal Fault selections. Data is considered valid in all Multi I/O modes except TEST FULL SCALE, TEST MID SCALE, TEST ZERO SCALE, DIAGNOSTIC, and UNKNOWN when a Fatal Fault is <u>not</u> present. Fatal and Nonfatal Fault conditions are listed in Section 7.0 of this manual.

Data Valid, Fault, and Fatal Fault relays are fail-safe in nature: they are energized during normal operation and de-energized when the appropriate condition arises.

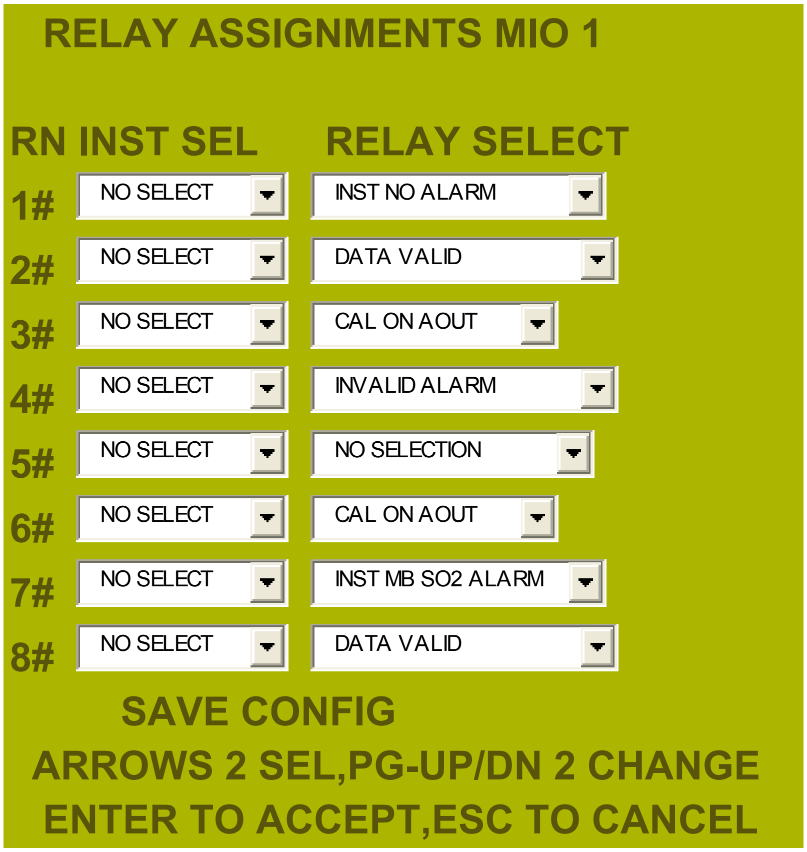


Table 5-7: Digital Inputs for Calibration Request

Input #1	Input #2	Input #3	Input #4	Input #5	Input #6	Command
0	0	0	0	0	0	No action results. No command request recognized.
1	0	0	0	0	0	FORCE_SPAN
0	1	0	0	0	0	FORCE_ZERO
1	1	0	0	0	0	FORCE_EO_CAL
0	0	1	0	0	0	FORCE_CAL_CYCLE
0	0	0	1	0	0	NOT USED
0	0	0	0	1	0	NOT USED
0	0	0	1	1	0	NOT USED
0	0	0	0	0	1	NOT USED
All other combinations of Inputs #1 through #6.						No action results. These are considered invalid command requests.

Note: In the above table, a “1” designates actuation of an Isolator Input and “0” designates de-actuation.

Table 5-8: Parameters for Analog Output

Parameter Name	Functional Description
_INST_NO	Instantaneous NO concentration
_AVE_NO	Average NO concentration
_INST_NO_MBTU	Instantaneous NO lbs/mm BTU
_AVE_NO_MBTU	Average NO lbs/mm BTU
_NO_CAL_ZERO	Continuous NO ZERO calibration
_NO_CAL_ZERO_MBTU	Continuous NO lbs/mm BTU during ZERO calibration
_NO_CAL_SPAN	Continuous NO SPAN calibration
_NO_CAL_SPAN_MBTU	Continuous NO lbs/mm BTU during SPAN calibration
_INST_SO2	Instantaneous SO2 concentration
_AVE_SO2	Average SO2 concentration
_INST_SO2_MBTU	Instantaneous SO2 lbs/mm BTU
_AVE_SO2_MBTU	Average SO2 lbs/mm BTU
_SO2_CAL_ZERO	Continuous SO2 ZERO calibration
_SO2_CAL_ZERO_MBTU	Continuous SO2 lbs/mm BTU during ZERO calibration
_SO2_CAL_SPAN	Continuous SO2 SPAN calibration
_SO2_CAL_SPAN_MBTU	Continuous SO2 lbs/mm BTU during SPAN calibration
_INST_NO2	Instantaneous NO2 concentration (not used)
_AVE_NO2	Average NO2 concentration (not used)
_INST_NO2_MBTU	Instantaneous NO2 lbs/mm BTU (not used)
_AVE_NO2_MBTU	Average NO2 lbs/mm BTU (not used)
_NO2_CAL_ZERO	Continuous NO2 ZERO calibration (not used)
_NO2_CAL_ZERO_MBTU	Continuous NO2 lbs/mm BTU during ZERO calibration (not used)
_NO2_CAL_SPAN	Continuous NO2 SPAN calibration (not used)
_NO2_CAL_SPAN_MBTU	Continuous NO2 lbs/mm BTU during SPAN calibration (not used)
_INST_NH3	Instantaneous NH3 concentration
_AVE_NH3	Average NH3 concentration
_INST_NH3_MBTU	Instantaneous NH3 lbs/mm BTU
_AVE_NH3_MBTU	Average NH3 lbs/mm BTU
_NH3_CAL_ZERO	Continuous NH3 ZERO calibration
_NH3_CAL_ZERO_MBTU	Continuous NH3 lbs/mm BTU during ZERO calibration
_NH3_CAL_SPAN	Continuous NH3 SPAN calibration
_NH3_CAL_SPAN_MBTU	Continuous NH3 lbs/mm BTU during SPAN calibration
_INST_O2_actual	Instantaneous O2 (Diluent) concentration
_AVE_O2_actual	Average O2 (Diluent) concentration
_O2_CAL_ZERO	Continuous O2 (Diluent) ZERO calibration
_O2_CAL_SPAN	Continuous O2 (Diluent) SPAN calibration
_PDA_TEMP	Photodiode Array (PDA) Temperature diagnostic
_BENCH_TEMP	Transceiver Optical Bench Temperature diagnostic
_CAL_GAS_TEMP	Cal Gas Heater Temperature diagnostic
_PROBE_TEMP	Not in use
_STACK_TEMP	Stack Temperature
_STACK_PRESSURE	Stack Pressure

Table 5-9: Parameters for Relay Assignment (Digital Output Closure Conditions)

Alarm Indicators	Output Mode Indicators	Fault Indicators
_INST_NO_ALARM	_UNKNOWN_MODE	_FATAL_FAULT
_AVE_NO_ALARM	_NORM_OR_NORM_ACQ	_NON_FATAL_FAULT
_INST_MBTU_NO_ALARM	_NORMAL_MODE	_ANALYZER_FAULT
_AVE_MBTU_NO_ALARM	_CAL_OR_CAL_ACQ	_DATA_VALID
_INST_SO2_ALARM	_CAL_ON_AOUT	_CAL_FAIL_FAULT
_AVE_SO2_ALARM	_ZERO_OR_ZERO_ACQ	_STACK_TEMP_FAULT
_INST_MBTU_SO2_ALARM	_ZERO_MODE	_STACK_PRESSURE_FAUL
_AVE_MBTU_SO2_ALARM	_SPAN_OR_SPAN_ACQ	_PDA_TEMP_FAULT
_INST_NO2_ALARM	_SPAN_MODE	_BENCH_TEMP_FAULT
_AVE_NO2_ALARM	_CGA_MODE_OR_ACQ	_CAL_GAS_TEMP_FAULT
_INST_MBTU_NO2_ALARM	_CGA_MODE	_PROBE_TEMP_FAULT
_AVE_MBTU_NO2_ALARM	_CGA_LOW_MODE_OR_AC	_OUT_OF_SERVICE
_INST_NH3_ALARM	_CGA_LOW_MODE	O2_ANALYZER_FAULT
_AVE_NH3_ALARM	_CGA_MID_MODE_OR_ACQ	O2_DATA_VALID
_INST_MBTU_NH3_ALARM	_CGA_MID_MODE	
_AVE_MBTU_NH3_ALARM	_CGA_HIGH_MODE_OR_AC	
_INST_O2_ACTUAL_ALARM	_CGA_HIGH_MODE	
_AVE_O2_ACTUAL_ALARM	_SELF_CAL_MODE	
	_TRAIN_MODE	

Table 5-10: Digital Inputs for Analog Output Control

Input #7	Input #8	Command
0	0	No action results. No command request recognized.
1	0	TEST ZERO SCALE
0	1	TEST FULL SCALE
1	1	TEST MID SCALE

Note: In the above table, a “1” designates actuation of an Isolator Input and “0” designates de-actuation.

5.4.9 Display Properties Screen

This screen permits adjustment of the Brightness and Contrast of the LCD Display. Use the "↑" "↓" keys to select the parameter you want to adjust. Then use the "Page-up" and "Page-Down" keys to increase or decrease. The screen should visually change while pressing these keys. When the screen looks the way you want it, return to the main screen by pressing ESC.

An alternate method can be used to adjust the LCD display Contrast and back-light Brightness:

- ❐ To increase display Contrast, press "Page-Up" and hold the "↑" key.
- ❐ To decrease display Contrast, press "Page-Up" and hold the "↓" key.
- ❐ To increase display back-light Brightness, press "Page-Down" and hold the "↑" key. To decrease display back-light Brightness, press "Page-Down" and hold the "↓" key.

5.4.10 Numerical Data Screens

There are three to the Numerical Data screen: one each for SM8200 gas concentrations, diluent gas concentrations and lbs/mm BTU. It is designed to be a place to simultaneously view the most relevant variables for a given type of measurement, i.e., NORMAL, ZERO, SPAN values, primary and extended instrument status and so on. This is a good place to do a daily check of the monitor since all values are updated concurrently. If readings are taken from multiple screens, some differences in the readings may occur due to updates

5.4.11 View Status History Screen

This Screen has up to twelve pages depending on the number of system status changes that have taken place. It stores the previous 100 non-zero status word changes. Consecutive, identical non-zero status words cause only one entry. After one hundred entries the log is first in, first out. The most recent entries are at the top of the list on page one. Each entry consists of a code, the date, and time it occurred. Status words can be decoded as per the STATUS CODE HELP screen.

5.4.12 View Alarm States Screens

These screens allow the user to view the current state of various alarm conditions. Most alarm conditions indicate that a measurement such as gas concentration, lbs/mm BTU, Stack Temperature or Stack Pressure, or a diagnostic such as Bench Temperature has exceeded the threshold or range specified in the Analyzer Properties/Alarm Thresholds screens.

The View Alarm States menu selection triggers a submenu that permits the user to receive help on the meaning of the various alarm codes employed in the system (SM8200 ALARM STATES menu selection). See the example screens for the code descriptions.

ALARM STATES CODE HELP
OCTAL BIT DEFINITIONS SM8200
0001 Inst.Concentration Gas 1
0002 Inst.Concentration Gas 2
0004 Inst.Concentration Gas 3
0010 Inst.Concentration Gas 4
0020 Avg. Concentration Gas 1
0040 Avg. Concentration Gas 2
0100 Avg. Concentration Gas 3
0200 Avg. Concentration Gas 4
0001 Instantaneous MBTU Gas 1
0002 Instantaneous MBTU Gas 2
PAGE-UP, PAGE-DOWN FOR MORE
ESC TO EXIT

ALARM STATES CODE HELP
OCTAL BIT DEFINITIONS SM8200
0004 Instantaneous MBTU Gas 3
0010 Instantaneous MBTU Gas 4
0020 Average MBTU Gas 1
0040 Average MBTU Gas 2
0100 Average MBTU Gas 3
0200 Average MBTU Gas 4
0001 Instantaneous Oxygen
0002 Average Oxygen
0001 Average A/D Input 1
0002 Average A/D Input 2
PAGE-UP, PAGE-DOWN FOR MORE
ESC TO EXIT

Alarm codes are displayed on the SM8200 Alarm States screen in the second column from the left. To view English language text based alarm messages on this screen, use the arrow keys to scroll to the alarm of interest, then hit “ ↵”. An English language alarm message will appear beneath the ALARM STATE TEXT DISPLAY line. If multiple alarms are present, the display line will sequence once through the alarm messages until the end of the alarm list is reached. If no alarms are active, the line will read “NO ALARMS”.

ALARM STATES

CONC LOW:222 VIEW DETAILS
CONC HIGH:333 VIEW DETAILS
MBTU LOW:111 VIEW DETAILS
MBTU HIGH:277 VIEW DETAILS
O2 LOW:464 VIEW DETAILS
O2 HIGH:513 VIEW DETAILS
AUX LOW:321 VIEW DETAILS
AUX HIGH:123 VIEW DETAILS
ALARM STATE TEXT DISPLAY
Inst. Concentration Gas 1

ESC TO EXIT

5.4.13 Current Software Versions Screen

This screen shows the current software versions of the various microprocessors in the system.

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6.0 LOCAL USER INTERFACE DESCRIPTION

This section describes details of the Local User Interface (LUI), an LED and 10 key keypad user interface mounted directly to the SM8200 Transceiver. The intent is to provide maintenance / troubleshooting data through a local LED display at the Transceiver location. Entry and display of a limited number of configuration variables is supported, mainly preamp adjustments, gains and Auxiliary IO Board scaling.

The assembly has a six digit LED display and a ten-button key pad. There are also four LED indicator lights for Fault, In Calibration, Audit and Power on/off. The leftmost two characters of the display are green and indicate the bank or family and the number of the parameter to be displayed. The right hand (red) digits show the alphanumeric value of the displayed parameter.

6.1 BANK CONCEPT

The Local User Interface data and parameter variables are organized into 7 regions called Banks according to their association with one another. The Banks are named:

- ❒ U Bank: (User Data)
- ❒ C Bank: (Calibration Data)
- ❒ S Bank: (Service Data)
- ❒ A Bank: (Auxiliary Data)
- ❒ F Bank: (Fundamental Parameters)
- ❒ E Bank: (Extra Parameters)
- ❒ O Bank: (Oxygen Analyzer Parameters)

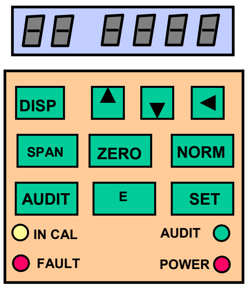
All bank variables can be viewed via the LED display, but only a limited number of these variables can be modified (some of those in the F, E and O Banks).

6.2 KEYPAD OPERATION

The 10 button keypad operates LED display functions and can also command the analyzer into various operational modes (SPAN, EO CAL, ZERO, etc.). Some operations require only that one button be actuated, while others are invoked only by simultaneous actuation of multiple buttons. This subsection is organized by single button functions and multi-button functions.

6.2.1 Individual Button Functions

CODE VALUE



E: When pressed it may cause one of three reactions:

1. No effect.
2. The VALUE digits display the exponent portion of a floating point number. The mantissa of a floating point number is displayed in these digits whenever the E button is not pressed. For example, for the floating point number 1.089 * 10^-4, without E button pressed the VALUE field displays 1.089. With E pressed the VALUE field displays E-04.. This mode of the E button is called EXPONENT in this document.
3. When the E button is pressed, the two CODE digits are used in addition to the VALUE digits to extend the significant display digits of the data. When E is not pressed, VALUE digits alternately display “PUSH” then “---E” and CODE displays the bank code for the variable. For example, in response to the number 31,089, pressing E will cause CODE to display 3 (the most significant digit is blank) and VALUE to display 1089. In response to the number 26,516.4, pressing E will cause CODE to display 26 and VALUE to display 516.4. This mode of the E button is called EXTENDED.

DISPLAY: No effect.

▲ **INC**: No effect.

▼ **DEC**: No effect.

◄ **LEFT**: No effect.

SPAN : Initiates a SPAN calibration.

ZERO : Initiates a calibration ZERO.

NORMAL: Places instrument in NORMAL mode.

AUDIT: When pressed and held by itself, a Cylinder Gas Audit (CGA) will be initiated. The CGA can be aborted by pressing the NORMAL, ZERO or SPAN button or by issuance of a network mode change command for NORMAL, ZERO or SPAN mode.

SET: When pressed by itself while a parameter is currently displayed, causes the four seven segment display value to be entered. When pressed by itself while a data field is currently displayed there is no effect.

6.2.2 Combinations of Buttons

▲ * E: Turns UV Lamp Filament On and NORMAL operation resumes. This combination of buttons has no effect if the UV Lamp Filament is already on.

▼ * E: Turns UV Lamp Filament Off. The four red display LED’s will blink the message FIL followed by OFF followed by the value for the display bank selected. In FILAMENT OFF mode, concentration calculations cease.

ZERO * E: Initiates Dark mode.

SPAN * E: Initiates an EO CAL.

SPAN * ZERO: Initiates a Calibration Cycle.

DISPLAY*LEFT: Toggles the display from User data (U) to Service data (S) and Auxiliary Data (A) banks when pressed and held for about a second. After 10 minutes with no keypad activity, the display defaults back to the User data bank (U). Repeat functions are supported for this combination of buttons.

DISPLAY*INC: Increments the variable number displayed, i.e., U0 becomes U1, F0 becomes F1, etc. Repeat functions are supported for this combination of buttons.

DISPLAY*DEC: Decrements the variable number displayed, i.e., U5 becomes U4, S5 becomes S4 etc. Repeat functions are supported for this combination of buttons.

SET*ZERO*DISP*AUDIT: Initiates LAMP ALIGNMENT MODE. NORMAL mode commands, either from the network or keypad, will terminate LAMP ALIGNMENT MODE.

6.2.3 Exponential Parameter Entry

This section applies only to bank variables F8 through FF and E0 through EF. These parameters are displayed in scientific notation and are subject to editing, thus they require a more complex entry procedure to allow for four significant digits of negative and positive mantissas and exponents.

When the LEFT-ARROW is pressed for the first time the parameter goes into a display mode where the most significant digit of the green LED bank selection is blanked off and the second digit displays either **"P"** for positive numbers or **"-"** for negative numbers. The four (4) digits of display on the right will display the mantissa.

If the display is showing a positive mantissa, then the four-digit display will remain the same and the right digit of the green LED bank selection will change to a **"P"** to indicate that the mantissa is "positive". **(X P #. # # #)**. If the display is showing a negative mantissa, then the four-digit display will shift to the left to show four digits of mantissa and the right digit of the green LED bank selection will change to a **"-"** to indicate that the mantissa is "negative". **(X - #. # # #)**. The **"X"** is used here to represent the left-most LED display is blanked off.

If the LEFT-ARROW is pressed a second time, the keypad will enter the data entry mode. This will be true for either the mantissa or the exponent. All changes made to the mantissa and/or the exponent must be considered to be temporary until the SET button is pressed. This temporary altered value must be maintained for both mantissa and exponent as the display is switched back and forth between the two parts of the display. The actual value used by the analyzer is not altered unless the SET button is pressed.

The right most digit will blink to indicate which digit is being modified. Use the UP-ARROW and DOWN-ARROW to change the value. Each time the UP-ARROW is pressed a value of (0.001) will be added to the displayed value. Likewise a value of (0.001) will be subtracted from the value each time the DOWN-ARROW is pressed. Note that the value will overflow into the upper digits once the value is incremented past a value of **"9"**. Similarly the value will also underflow when it is decremented past **"0"**.

When the LEFT-ARROW is pressed a second time, the second digit from the right will begin to blink and (0.010) will be added or subtracted to the value. In a similar manner, the value of (0.100) and (1.000) will be used for the third digit and fourth LEFT-ARROW selections.

If the LEFT-ARROW is pressed a fifth time the sign-digit will blink. A pressing of either the UP-ARROW or the DOWN-ARROW will cause the sign to alternate between **"P"** and **"-"**.

If the SET button is pressed, the selected value used by the analyzer will be updated with this new value ***AND*** its exponent.

If the **"E"** button is pressed, the display will switch to the exponent display. The green LED bank selection portion of the display will show the register bank currently selected whether in the display mode or the edit mode.

When the LEFT-ARROW is pressed the keypad enters the edit-mode and the right-most digit of the exponent begins to blink. The exponent is edited in a similar manner as the mantissa. At the third pressing of the LEFT-ARROW the sign of the exponent will blink and this sign will toggle between **"P"** and **"-"** when either the UP-ARROW or the DOWN-ARROW is pressed. If the SET button is pressed the analyzer will be updated with both the new mantissa ***AND*** the new exponent that has been entered. If the **"E"** button is pressed the display will go back to the display mode showing the mantissa that was last entered, (not the actual value stored and used by the analyzer.)

If the bank selection is changed before the SET button is pressed, then the parameter value is **NOT** updated and the editing session on the parameter is terminated.

6.3 PASSWORD PROTECTION

Password protection is provided because parameter entry is supported for a limited number of variables in the E, F and O Banks. The password is defined as 0136 and must be entered into Bank A2 to enable parameter editing functions. Password entry enables variable editing for a period of 7200 seconds, after which editing privileges expire but may be renewed by re-entry of the password.

6.4 U BANK (USER DATA BANK)

The U Bank variables are the standard analyzer outputs that most users need to see regularly. The U Bank is referred to as the User Data Bank. It contains the concentration measurements, instrument status words, and other important information.

Code	Description, (Inst/Avg), Units	E Button Action (see Section 6.2.1)
U0	NO Concentration, Instantaneous, ppm	**NO EFFECT**
U1	NO Concentration, Average, ppm	**NO EFFECT**
U2	SO2 Concentration, Instantaneous, ppm	**NO EFFECT**
U3	SO2 Concentration, Average, ppm	**NO EFFECT**
U4	NO2 Concentration, Instantaneous, ppm	**NO EFFECT**
U5	NO2 Concentration, Average, ppm	**NO EFFECT**
U6	NH3 Concentration, Instantaneous, ppm	**NO EFFECT**
U7	NH3 Concentration, Average, ppm	**NO EFFECT**
U8	O2 Concentration, Instantaneous, % (from ML420)	**NO EFFECT**
U9	O2 Concentration, Average, % (from ML420)	**NO EFFECT**
UA	Reserved for future use	**NO EFFECT**
UB	Reserved for future use	**NO EFFECT**
UC	Mode, dimensionless (see Section 4.0)	**NO EFFECT**
UD	Primary Status, dimensionless	**EXTENDED**
UE	Extended Status,dimensionless	**EXTENDED**

6.4.1 Status Word Description

This subsection lists analyzer primary and extended status codes and their English language descriptions. For a more verbose description of the meaning of these faults, consult Section 7.0 of this manual.

6.4.1.1 Primary Status Word

```
Bit_15 = Training Set CRC Fail              CODE LSB+1
// ------------------------------------------------------------------------------------
Bit_14 = Wavelength Check Failure           LED DISPLAY
Bit_13 = NH3 Span Fail CODE LSB
Bit_12 = NH3 Zero Fail
// ------------------------------------------------------------------------------------
Bit_11 = Reference Fault                              LED DISPLAY
Bit_10 = NO2 Span Fail                      VALUE MSB
Bit_09 = NO2 Zero Fail
// ------------------------------------------------------------------------------------
Bit_08 = High Dark Current Fault                      LED DISPLAY
Bit_07 = SO2 Span Fail                      VALUE LSB+2
Bit_06 = SO2 Zero Fail
// ------------------------------------------------------------------------------------
Bit_05 = Low Dark Current Fault             LED DISPLAY
Bit_04 = NO Span Fail                       VALUE LSB+1
```

Bit_03 = NO Zero Fail
// --
Bit_02 = Bench Temperature Fault LED DISPLAY
Bit_01 = PDA Temperature Fault VALUE LSB
Bit_00 = PDA Thermistor Fault

6.4.1.2 Extended Status Word

Bit_15 = Probe Temperature Fault CODE LSB+1
// --
Bit_14 = Cal Gas Temperature Fault LED DISPLAY
Bit_13 = NH3 Total Adjust Fault CODE LSB
Bit_12 = NH3 Incremental Adjust Fault
// --
Bit_11 = Stack Pressure Fault LED DISPLAY
Bit_10 = NO2 Total Adjust Fault VALUE MSB
Bit_09 = NO2 Incremental Adjust Fault
// --
Bit_08 = Stack Temperature Fault LED DISPLAY
Bit_07 = SO2 Total Adjust Fault VALUE LSB+2
Bit_06 = SO2 Incremental Adjust Fault
// --
Bit_05 = O2 Analyzer Fault LED DISPLAY
Bit_04 = NO Total Adjust Fault VALUE LSB+1
Bit_03 = NO Incremental Adjust Fault
// --
Bit_02 = 3 X FPGA Timeout LED DISPLAY
Bit_01 = FPGA Timeout VALUE LSB
Bit_00 = Out of Service

6.5 C BANK (CALIBRATION DATA BANK)

The C Bank (Calibration Bank) displays important calibration data for the analyzer such as the most recent instantaneous and average value for SPAN and ZERO.

Code	Description, (Inst/Avg), Units	E Button Action (see Section 6.2.1)
C0	NO Zero, Instantaneous, ppm	**NO EFFECT**
C1	NO Zero, Average, ppm	**NO EFFECT**
C2	NO Span, Instantaneous, ppm	**NO EFFECT**
C3	NO Span, Average, ppm	**NO EFFECT**
C4	SO2 Zero, Instantaneous, ppm	**NO EFFECT**
C5	SO2 Zero, Average, ppm	**NO EFFECT**
C6	SO2 Span, Instantaneous, ppm	**NO EFFECT**
C7	SO2 Span, Average, ppm	**NO EFFECT**
C8	NO2 Zero, Instantaneous, ppm	**NO EFFECT**
C9	NO2 Zero, Average, ppm	**NO EFFECT**
CA	NO2 Span, Instantaneous, ppm	**NO EFFECT**
CB	NO2 Span, Average, ppm	**NO EFFECT**
CC	NH3 Zero, Instantaneous, ppm	**NO EFFECT**
CD	NH3 Zero, Average, ppm	**NO EFFECT**
CE	NH3 Span, Instantaneous, ppm	**NO EFFECT**
CF	NH3 Span, Average, ppm	**NO EFFECT**

6.6 S BANK (SERVICE DATA BANK)

The S Bank data variables are maintenance-oriented outputs from the analyzer. These variables contain useful information about the condition of the analyzer, such as PDA and Bench Temperatures, mean Reference Level, mean Dark Current. It can also be useful for adjusting the Stack Temperature and Pressure transducers since live updates for pressure transducer ADC counts and linearized RTD counts are displayed in this bank.

The SC, SD and SF bank variables are of utility for UV Lamp replacement or alignment if an oscilloscope is not available. For information on the use of these variables see Section 8.0 of this manual.

Code	Description, (Inst/Avg), Units	E Button Action (see Section 6.2.1)
S0	PDA Temperature, deg. F or C	**NO EFFECT**
S1	Bench Temperature, deg. F or C	**NO EFFECT**
S2	Cal Gas Temperature, deg. F or C	**NO EFFECT**
S3	Probe Temperature, deg. F or C	**NO EFFECT**
S4	PDA Temperature Linearized 4^{th} Root Rth	**NO EFFECT**
S5	Bench Temperature Counts	**NO EFFECT**
S6	Cal Gas Temperature Counts	**NO EFFECT**
S7	Probe Temperature Counts	**NO EFFECT**
S8	Stack Temperature RTD Linearized Counts	**NO EFFECT**
S9	Stack Pressure Counts	**NO EFFECT**
SA	Dark Current Counts	**EXTENDED**
SB	Wavelength Check Offset, most recent	**NO EFFECT**
SC	Reference Level	**EXTENDED**
SD	Lamp Alignment Mode Integration Period, Seconds (XX.XX) (Read/Write) *(Typically 1 second for alignment adjustment)*	**NO EFFECT**
SE	Peak Pixel Number	**NO EFFECT**
SF	Boxcar Saturation Status (Good or CLIP)	**NO EFFECT**

6.7 A BANK (AUXILIARY DATA BANK)

The A Bank contains the most recent Stack Temperature and Pressure readings, emission rates for the various gases (lbs/mm BTU) and software versions. Also of great import in the A Bank is variable A2, the LUI password (see Section 6.3).

Code	Description, (Inst/Avg), Units	E Button Action (see Section 6.2.1)
A0	Stack Temperature, deg. C or F	**NO EFFECT**
A1	Stack Pressure, Kilopascals or inches of Hg	**NO EFFECT**
A2	Password	**NO EFFECT**
A3	NO Instantaneous Emission Rate, ng/J or lbs/MBTU (lbs/mm BTU)	**EXPONENT**
A4	NO Average Emission Rate, ng/J or lbs/MBTU (lbs/mm BTU)	**EXPONENT**
A5	SO2 Instantaneous Emission Rate, ng/J or lbs/MBTU (lbs/mm BTU)	**EXPONENT**
A6	SO2 Average Emission Rate, ng/J or lbs/MBTU (lbs/mm BTU)	**EXPONENT**
A7	NO2 Instantaneous Emission Rate, ng/J or lbs/MBTU (lbs/mm BTU)	**EXPONENT**
A8	NO2 Average Emission Rate, ng/J or lbs/MBTU (lbs/mm BTU)	**EXPONENT**
A9	NH3 Instantaneous Emission Rate, ng/J or lbs/MBTU (lbs/mm BTU)	**EXPONENT**
AA	NH3 Average Emission Rate, ng/J or lbs/MBTU (lbs/mm BTU)	**EXPONENT**
AB	Neuron Version	**NO EFFECT**
AC	68332 Version	**NO EFFECT**
AD	Training Set Version	**NO EFFECT**
AE	FPGA Version	**NO EFFECT**

6.8 F BANK (FUNDAMENTAL PARAMETER BANK)

The F Bank variables are maintenance-oriented parameters for the analyzer such as various Preamp and TE Cooler adjustments and Stack Temperature and Pressure Scaling variables. They may be changed via the LUI keypad if the password bank parameter (A2) is correctly entered prior to parameter editing. See Sections 6.2 (Keypad Operation) and 6.3 (Password Protection) for more information.

Code	Description, (Inst/Avg), Units	E Button Action (see Section 6.2.1)
F0	PDA Temperature Command	**NO EFFECT**
F1	Preamp Anti Glitch	**NO EFFECT**
F2	Preamp Dark Pixel Level	**NO EFFECT**
F3	Preamp Offset	**NO EFFECT**
F4	PDA Video Gain	**NO EFFECT**
F5	PDA Temperature Gain	**NO EFFECT**
F6	Cal Gas Temperature Gain	**NO EFFECT**
F7	Bench Temperature Gain	**NO EFFECT**
F8	Stack Temperature Low, RTD Linearized Counts	**EXPONENT**
F9	Stack Temperature Low Value, deg. C or F	**EXPONENT**
FA	Stack Temperature High, RTD Linearized Counts	**EXPONENT**
FB	Stack Temperature High Value, deg. C or F	**EXPONENT**
FC	Stack Pressure Low Counts	**EXPONENT**
FD	Stack Pressure Low Value, Kilopascals or inches of Hg	**EXPONENT**
FE	Stack Pressure High Counts	**EXPONENT**
FF	Stack Pressure High Value, Kilopascals or inches of Hg	**EXPONENT**

6.9 E BANK (EXTRA PARAMETER BANK)

The E Bank variables are maintenance-oriented parameters for the analyzer. All parameters in the E Bank are involved in scaling of temperature diagnostics and hence do not affect emission calculations. They may be changed via the keypad if the password bank parameter (A2) is correctly entered prior to parameter editing. See Sections 6.2 (Keypad Operation) and 6.3 (Password Protection) for more information.

Code	Description, (Inst/Avg), Units	E Button Action (see Section 6.2.1)
E0	PDA Temperature Low, Linearized 4th Root Rth	**EXPONENT**
E1	PDA Temperature Low, Value, deg. C or F	**EXPONENT**
E2	PDA Temperature High, Linearized 4th Root Rth	**EXPONENT**
E3	PDA Temperature High, Value, deg. C or F	**EXPONENT**
E4	Bench Temperature Low, Counts	**EXPONENT**
E5	Bench Temperature Low, Value, deg. C or F	**EXPONENT**
E6	Bench Temperature High, Counts	**EXPONENT**
E7	Bench Temperature High, Value, deg. C or F	**EXPONENT**
E8	Cal Gas Temperature Low, Counts	**EXPONENT**
E9	Cal Gas Temperature Low, Value, deg. C or F	**EXPONENT**
EA	Cal Gas Temperature High, Counts	**EXPONENT**
EB	Cal Gas Temperature High, Value, deg. C or F	**EXPONENT**
EC	Probe Temperature Low, Counts	**EXPONENT**
ED	Probe Temperature Low, Value, deg. C or F	**EXPONENT**
EE	Probe Temperature High, Counts	**EXPONENT**
EF	Probe Temperature High, Value, deg. C or F	**EXPONENT**

6.10 O BANK (O2 ANALYZER PARAMETER BANK)

The O Bank variables are maintenance-oriented parameters for the external Oxygen (O2) analyzer, with the exception of O4 which is Stack Temperature Counts and is a read-only data variable. All parameters in the O Bank except O4 are involved in scaling the O2 analyzer and hence affect emission calculations. They may be edited (except O4) via the keypad if the password bank parameter is correctly entered prior to parameter editing. See Sections 6.2.1 (Individual Buttons) and 6.3 (Password Protection) for more information.

Code	Description, (Inst/Avg), Units	E Button Action (see Section 6.2.1)
O0	O2 Analyzer Low, Counts	**EXPONENT**
O1	O2 Analyzer Low, Value, %	**EXPONENT**
O2	O2 Analyzer High, Counts	**EXPONENT**
O3	O2 Analyzer High, Value, %	**EXPONENT**
O4	Stack Temperature Counts	**NO EFFECT**

7.0 DIAGNOSTICS AND TROUBLESHOOTING

The SM8200 Gas Analyzer has many diagnostics to aid the troubleshooting process. These divide into two categories:

- ❒ Diagnostic variables with numerical values indicative of analyzer performance
- ❒ Status word variables whose individual bits flag an analyzer condition of note

In addition to these integrated diagnostics, qualified and trained service personnel will find it valuable to the troubleshooting process to possess and be skilled in the use of a delay trigger digital oscilloscope and a Digital Multimeter (DMM).

7.1 ANALYZER DIAGNOSTICS

Several diagnostics are built into the analyzer for maintenance and troubleshooting purposes. Some of these can be displayed on both the ERP and the LUI, while others can only be viewed on the ERP. Diagnostics that are readable at both locations list the LUI Bank variable location in the following descriptions.

- ❒ **Bench Temperature:** (LUI Bank =S1) The Transceiver spectrometer's optical bench is heated to a constant temperature for consistent dispersive properties.

- ❒ **PDA Temperature:** (LUI Bank=S0) The PDA (photodiode array) has internal and external TE coolers for temperature regulation. Constant temperature operation is important so that the PDA's dark current is consistent.

- ❒ **(mean) Reference Level (Current):** (LUI Bank=SC) During each cal cycle the clear path energy of the PDA is measured by monitoring box car output during the ZERO phase of the cal cycle. The mean value of the Reference Level is checked versus the REF CURRENT MAX and MIN levels to insure that it is within bounds.

- ❒ **(mean) Dark Current:** (LUI Bank=SA) During the DARK portion of each cal cycle the dark current level of the PDA is interrogated by placing a shutter at the spectrometer entrance slit, thus blocking the optical path. The mean value of the Dark Current is checked versus the DARK CURRENT MAX and MIN levels to insure that it is within bounds.

- ❒ **Incremental Adjust** (individual values for each gas and for ZERO and SPAN): The analyzer is equipped with an auto-correction algorithm that determines a linear regression model of actual analyzer concentration versus target or desired response. The correction magnitudes from this algorithm are available as diagnostics in terms of full scale corrections to ZERO and SPAN, as opposed to limits to the offset and slope of the linear regression model. The incremental adjustment (the correction applied from one calibration cycle to the next) and total adjustment (correction magnitude referenced to the original targets) are limited individually via parameters.

- ❒ **Total Adjust** (individual values for each gas and for ZERO and SPAN): See Incremental Adjust directly above.

- ❒ **Raw Concentrations:** These concentrations are the base values that result from the chemometrics equations. They precede temperature, pressure, user gain, interference compensation and auto-correction calculations. They are used during factory calibration and are not usually of interest to the end user or service technician.

❒ **Last 10 Final Gas Concentrations (individual values for each gas):** These are useful for tracking trends in stack measurements or the timing of calibration cycle phases.

❒ **Last 10 Stack Temperatures and Pressures:** These are useful for tracking trends in stack measurements.

❒ **ADC Counts for Diagnostics:** These are useful for adjusting the calibration of diagnostics variables since they are readings of the live analog-to-digital converter count values, or are mathematically processed versions of them (for instance, PDA Temperature Linearized 4^{th} Root Rth). However, since these are factory set diagnostics, no field adjustments by the user are typically required.

- **CAL GAS HEATER TEMPERATURE:**
  LUI Bank=S6 (If this option equipment has been provided)

- **PDA TEMPERATURE LINEARIZED 4^{th} ROOT Rth:**
  LUI Bank=S4

- **BENCH TEMPERATURE COUNTS:**
  LUI BANK=S5

❒ **ADC Counts for Stack Measurements:** These are useful for field adjustment of the analyzer since they are readings of the live analog-to-digital converter count values, or are mathematically processed versions of them (for instance, Stack Temperature RTD Linearized Counts). These values are typically those typically entered into the respective Low and High Counts parameters of the LUI or ERP. See Section 4.0 of this manual.

- **STACK TEMPERATURE RTD LINEARIZED COUNTS:**
  LUI Bank=S8

- **STACK PRESSURE COUNTS:**
  LUI Bank=S9

- **AUX INPUT1(O2 ANALYZER) COUNTS:** Used for adjustment of the O2 analyzer 4-20 mA input to the Aux IO Board in the AEB. This is available only on the ERP.

7.2 INSTRUMENT STATUS WORDS

There are two instrument status words: the Primary Status and the Extended Status. Each has 16 bits representative of individual faults. Multiple faults are possible in this system, in which case the individual fault bits “OR” together to create the final status word. There are English language equivalents for each fault that can be viewed on various screens on the Enhanced Remote Panel (see Section 5.0 of this manual). The Transceiver LUI only supports status code display (not English language faults).

It is important to note that all or some of the span failure and zero failure bits in the instrument status words may be overridden in certain cases by calibration drift evaluations performed in the final recording device. For environmental regulatory compliance applications, the final recording device that determines whether an analyzer zero or span check fails to meet the required US EPA specifications is normally a computer based data acquisition and handling system (DAS) associated with the gas analyzer. This device determines when emission data is valid or invalid and provides the official emission reports which are submitted to the regulatory agencies. As a result, the following described analyzer indications of zero and/or span failures are generally only used for a local indication of a problem, unless the fault tolerances have been set in accordance with EPA specifications for that application. For most applications, the daily zero and span drift tolerances are +/- 2.5% of span (full scale), i.e. +/- 12.5 ppm for a 500 ppm span measurement. For low level measurements, the limit may decrease to a fixed ppm value. In some cases, the allowable limits may be twice or four times these values before a measurement channel is judged to be out of control. The DAS must be programmed to accommodate these cases—the analyzer is not.

Analyzer gas measurements are no longer valid emission measurements when an instrument is out of control. In order to calculate the zero and/or span drift the current value of the zero gas and/or span gas must also be entered into the analyzer and DAS. If these gas values and tolerance levels are programmed into the analyzer, then the analyzer zero and/or span failure indications should be consistent with those established by the DAS, outside of special circumstances. If these entries have not been properly set, then the analyzer indications of zero and/or span failures and resultant analyzer status indications of invalid data should be disregarded.

7.2.1 DESCRIPTION OF PRIMARY STATUS FAULT CONDITIONS

7.2.1.1 BIT_00 = PDA THERMISTOR FAULT

7.2.1.1.1 DESCRIPTION OF FAULT

This fault is actuated when the Photo Diode Array (PDA) Thermistor is open or shorted. It is expected that in this condition the PDA temperature will be out of regulation.

7.2.1.1.2 EFFECT ON DATA

This fault invalidates all data since the PDA may no longer be within its temperature tolerance.

7.2.1.2 BIT_01 = PDA TEMPERATURE FAULT

7.2.1.2.1 DESCRIPTION OF FAULT

This fault is actuated when the Photo Diode Array (PDA) temperature is out of regulation by more than -4 to +14 Degrees Fahrenheit from its set-point. The PDA Temperature set-point can be adjusted by modifying the analyzer Local User Interface Keypad bank variable F0 or the equivalent variable in the Enhanced Remote Panel. Nominal PDA Temperature is 68 degrees Fahrenheit.

NOTE: *It is normal for a PDA Temperature Fault to be generated when the analyzer is first powered up since there is a lag in the PDA Temperature control loop.*

7.2.1.2.2 EFFECT ON DATA

This fault invalidates all data since the PDA is no longer within its temperature tolerance.

7.2.1.3 BIT_02 = BENCH TEMPERATURE FAULT

7.2.1.3.1 DESCRIPTION OF FAULT

This fault is actuated when the (optical) Bench Temperature is outside of the window established by the Bench Temperature FAULT MIN and FAULT MAX variables. Nominal Bench Temperature is 139 degrees Fahrenheit.

7.2.1.3.2 EFFECT ON DATA

This fault invalidates all data since the optical bench is no longer within its temperature tolerance and the optical properties of the analyzer spectrometer may no longer be within norms required for valid concentration calculations.

7.2.1.4 BIT_03 = NO ZERO FAIL

7.2.1.4.1 DESCRIPTION OF FAULT

This fault is actuated when the concentration calculation for NO during ZERO mode is not within the calibration tolerance as a percentage of full scale.

7.2.1.4.2 EFFECT ON DATA

This fault invalidates all NO data when properly set-up. ***See Section 7.2 of this manual.***

7.2.1.5 BIT_04 = NO SPAN FAIL

7.2.1.5.1 DESCRIPTION OF FAULT

This fault is actuated when the concentration calculation for NO during SPAN mode is not within the calibration tolerance as a percentage of full scale.

7.2.1.5.2 EFFECT ON DATA

This fault invalidates all NO data when properly set-up. ***See Section 7.2 of this manual.***

7.2.1.6 BIT_05 = LOW DARK CURRENT FAULT

7.2.1.6.1 DESCRIPTION OF FAULT

This fault is actuated when the PDA Dark Current is below the DARK THRESHOLD MIN value during the DARK mode of a CAL CYCLE. PDA Dark Current is measured as an average value of all pixels in the box car integrator during the DARK mode.

7.2.1.6.2 EFFECT ON DATA

This fault invalidates all data because low PDA Dark Current calls into question the behavior of the PDA and / or the Preamp board. The most likely causes of this fault are, in order from most to least probable, incorrect PDA Preamp parameters or the Preamp TE Cooler Board.

7.2.1.7 BIT_06 = SO2 ZERO FAIL

7.2.1.7.1 DESCRIPTION OF FAULT

This fault is actuated when the concentration calculation for SO2 during ZERO mode is not within the calibration tolerance as a percentage of full scale.

7.2.1.7.2 EFFECT ON DATA

This fault invalidates all SO2 data when properly set-up. ***See Section 7.2 of this manual.***

7.2.1.8 BIT_07 = SO2 SPAN FAIL

7.2.1.8.1 DESCRIPTION OF FAULT

This fault is actuated when the concentration calculation for SO2 during SPAN mode is not within the calibration tolerance as a percentage of full scale.

7.2.1.8.2 EFFECT ON DATA

This fault invalidates all SO2 data when properly set-up. ***See Section 7.2 of this manual.***

7.2.1.9 BIT_08 = HIGH DARK CURRENT FAULT

7.2.1.9.1 DESCRIPTION OF FAULT

This fault is actuated when the PDA Dark Current is above the DARK THRESHOLD MAX value during the DARK mode of a CAL CYCLE. PDA Dark Current is measured as an average value of all pixels in the box car integrator during the DARK mode.

7.2.1.9.2 EFFECT ON DATA

This fault invalidates all data because high PDA Dark Current calls into question the behavior of the PDA. It may be caused by, in order from most to least probable, a bad shutter, incorrect PDA Preamp parameters, the Auxiliary IO Board, the Preamp TE Cooler Board, the external TE Cooler and the PDA. If the PDA Temperature is within specifications, the first three are most likely.

7.2.1.10 BIT_09 = NO2 ZERO FAIL

7.2.1.10.1 DESCRIPTION OF FAULT

This fault is actuated when the concentration calculation for NO2 during ZERO mode is not within the calibration tolerance as a percentage of full scale.

7.2.1.11 EFFECT ON DATA

This fault invalidates all NO2 data when properly set-up. ***See Section 7.2 of this manual.***

7.2.1.12 BIT_10 = NO2 SPAN FAIL

7.2.1.12.1 DESCRIPTION OF FAULT

This fault is actuated when the concentration calculation for NO2 during SPAN mode is not within the calibration tolerance as a percentage of full scale. Currently, NO2 calculation is not being performed so this fault should not occur.

7.2.1.12.2 EFFECT ON DATA

This fault invalidates all NO2 data when properly set-up. ***See Section 7.2 of this manual.***

7.2.1.13 BIT_11 = REFERENCE FAULT

7.2.1.13.1 DESCRIPTION OF FAULT

This fault is actuated when the average value of all pixels in the box car integrator during ZERO mode is less than REF THRESHOLD MIN or greater than REF THRESHOLD MAX.

7.2.1.13.2 EFFECT ON DATA

This fault invalidates all data because it may be indicative of, in order of decreasing probability, insufficient UV Lamp energy, a degraded or dirty beam-splitter, a dirty corner cube or cavity window, severe probe or UV Lamp misalignment, incorrect PDA Gain, UV Lamp Power Supply, Preamp or AEB Motherboard failure.

7.2.1.14 BIT_12 = NH3 ZERO FAIL

7.2.1.14.1 DESCRIPTION OF FAULT

This fault is actuated when the concentration calculation for NH3 during ZERO mode is not within the calibration tolerance as a percentage of full scale.

7.2.1.14.2 EFFECT ON DATA

This fault invalidates all NH3 data when properly set-up. ***See Section 7.2 of this manual.***

7.2.1.15 BIT_13 = NH3 SPAN FAIL

7.2.1.15.1 DESCRIPTION OF FAULT

This fault is actuated when the concentration calculation for NH3 during SPAN mode is not within the calibration tolerance as a percentage of full scale.

7.2.1.15.2 EFFECT ON DATA

This fault invalidates all NH3 data when properly set-up. ***See Section 7.2 of this manual.***

7.2.1.16 BIT_14 = WAVELENGTH CHECK FAILURE

7.2.1.16.1 DESCRIPTION OF FAULT

This fault is actuated when the internal EO Cal Span gas cell spectra fail to match the stored values, thus implying that the spectrometer alignment has shifted. This condition is evaluated during the WAVELENGTH CHECK mode of the CAL CYCLE. Currently the WAVELENGTH CHECK feature is not enabled.

7.2.1.16.2 EFFECT ON DATA

This fault invalidates all data because it may be indicative of an optical problem with the spectrometer.

7.2.1.17 BIT_15 = TRAINING SET CRC CHECK

7.2.1.17.1 DESCRIPTION OF FAULT

This fault is actuated when the Cyclic Redundancy Code (CRC) for the Training Set and Supplemental Linearity and Interference parameters fails to equal the stored value established during factory calibration. The Training Set CRC is evaluated continuously by the analyzer 68332 processor as a low priority background task.

7.2.1.17.2 EFFECT ON DATA

This fault invalidates all data because it may be indicative of corruption of factory calibration parameters that are necessary for proper gas concentration calculation behavior.

7.2.2 <u>DESCRIPTION OF EXTENDED STATUS FAULT CONDITIONS</u>

7.2.2.1 BIT_00 = OUT OF SERVICE

7.2.2.1.1 DESCRIPTION OF FAULT

This fault is intended to flag that the analyzer is undergoing a maintenance function. It will occur by setting the COMMAND MODE to OUT OF SERVICE CMD on the ENHANCED REMOTE PANEL [OUTPUT & CAL. TESTS] screen.

7.2.2.1.2 EFFECT ON DATA

This fault invalidates all stack emission data.

7.2.2.2 BIT_01 = FPGA TIMEOUT

7.2.2.2.1 DESCRIPTION OF FAULT

This fault occurs when the FPGA on the AEB Motherboard has not communicated with the 68332 processor in a defined amount of time. If this fault occurs and will not clear with time, first cycle the power on the AEB. If the fault still does not clear, there may be an issue with the analyzer configuration file or a hardware problem on the AEB Motherboard. Contact Teledyne Monitor Labs Technical Support for further information.

7.2.2.2.2 EFFECT ON DATA

This fault invalidates all data since it may be indicative of FPGA failure and the FPGA is necessary for operation of the analyzer.

7.2.2.3 BIT_02 = 3 X FPGA TIMEOUT

7.2.2.3.1 DESCRIPTION OF FAULT

This fault occurs when the FPGA on the analyzer AEB Motherboard has not communicated with the 68332 processor in a defined amount of time for three or more transactions in a row. If this fault occurs and will not clear with time, first cycle the power on the AEB. If the fault does not clear, there may be an issue with the analyzer configuration file or a hardware problem on the AEB Motherboard. Contact Teledyne Monitor Labs Technical Support for further information.

7.2.2.3.2 EFFECT ON DATA

This fault invalidates all data since it may be indicative of FPGA failure and the FPGA is necessary for operation of the analyzer.

7.2.2.4 BIT_03 = NO INCREMENTAL ADJUST FAULT

7.2.2.4.1 DESCRIPTION OF FAULT

This fault occurs when the auto-correction algorithm calculates an incremental correction (the delta in pre (from previous correction) and post corrected (from new correction) values as calculated at the end of a CAL CYCLE) to the NO ZERO value exceeding the ZERO INCR LIMIT (INCR means INCREMENTAL) or a similar correction to the NO SPAN value exceeding the SPAN INCR LIMIT. Note that the auto-correction algorithm will bound corrections to the incremental adjustment limit values. Note also that this evaluation is not based on slope or offset of the correction equation.

7.2.2.4.2 EFFECT ON DATA

This fault does not necessarily invalidate the analyzer data since it is only indicative of daily drift exceeding the settings in the analyzer and does not necessarily indicate that calibration drift is in excess of the calibration tolerance.

7.2.2.5 BIT_04 = NO TOTAL ADJUST FAULT

7.2.2.5.1 DESCRIPTION OF FAULT

This fault occurs when the auto-correction algorithm calculates a total correction (the delta in uncorrected and post corrected values as calculated at the end of a CAL CYCLE) to the NO ZERO value exceeding the ZERO TOTAL LIMIT (INCR means INCREMENTAL) or a similar correction to the NO SPAN value exceeding the SPAN TOTAL LIMIT. Note that the auto-correction algorithm will bound corrections to the total adjustment limit values. Note also that this evaluation is not based on slope or offset of the correction equation.

7.2.2.5.2 EFFECT ON DATA

This fault does not necessarily invalidate the analyzer data since it is only indicative of total drift from the reference value exceeding the settings in the analyzer and does not necessarily indicate that calibration drift is in excess of the calibration tolerance.

7.2.2.6 BIT_05 = O2 ANALYZER FAULT

7.2.2.6.1 DESCRIPTION OF FAULT

This fault occurs via actuation of the external O2 analyzer contact closure input to the Auxiliary I/O Board in the SM8200 Analyzer Electronics Box. If an O2 Analyzer is not employed in the system, AEB Terminal Strip TB4 terminals 35 and 36 should be connected with a jumper wire. If they are not and an O2 Analyzer is not being used, the fault should clear if these terminals are connected together. Otherwise there may a problem with the Auxiliary IO Board in the AEB.

7.2.2.6.2 EFFECT ON DATA

This fault does not invalidate the SM8200 Gas Analyzer concentration results. However, emission rate (lbs/mm BTU) data is invalidated if the diluent source is the O2 analyzer.

7.2.2.7 BIT_06 = SO2 INCREMENTAL ADJUST FAULT

7.2.2.7.1 DESCRIPTION OF FAULT

This fault is the SO2 equivalent to the NO Incremental Adjust Fault.

7.2.2.7.2 EFFECT ON DATA

This fault does not necessarily invalidate the analyzer data since it is only indicative of daily drift exceeding the settings in the analyzer and does not necessarily indicate that calibration drift is in excess of the calibration tolerance.

7.2.2.8 BIT_07 = SO2 TOTAL ADJUST FAULT

7.2.2.8.1 DESCRIPTION OF FAULT

This fault is the SO2 equivalent to the NO Total Adjust Fault.

7.2.2.8.2 EFFECT ON DATA

This fault does not necessarily invalidate the analyzer data since it is only indicative of total drift from the reference value exceeding the settings in the analyzer and does not necessarily indicate that calibration drift is in excess of the calibration tolerance.

7.2.2.9 BIT_08 = STACK TEMPERATURE FAULT

7.2.2.9.1 DESCRIPTION OF FAULT

This fault occurs when the measured stack temperature is less than the STACK TEMPERATURE FAULT MIN value or the greater than the FAULT MAX value. It may be indicative of, in order from lowest to highest probability, an RTD wiring problem, a bad RTD, incorrect stack temperature scaling or limit parameters or a bad Auxiliary IO Board.

7.2.2.9.2 EFFECT ON DATA

This fault invalidates all analyzer data since a valid stack temperature measurement is necessary for proper temperature correction of the concentration data.

7.2.2.10 BIT_09 = NO2 INCREMENTAL ADJUST FAULT

7.2.2.10.1 DESCRIPTION OF FAULT

This fault is the NO2 equivalent to the NO Incremental Adjust Fault.

7.2.2.10.2 EFFECT ON DATA

This fault does not necessarily invalidate the analyzer data since it is only indicative of daily drift exceeding the settings in the analyzer and does not necessarily indicate that calibration drift is in excess of the calibration tolerance.

7.2.2.11 BIT_10 = NO2 TOTAL ADJUST FAULT

7.2.2.11.1 DESCRIPTION OF FAULT

This fault is the NO2 equivalent to the NO Total Adjust Fault.

7.2.2.11.2 EFFECT ON DATA

This fault does not necessarily invalidate the analyzer data since it is only indicative of total drift from the reference value exceeding the settings in the analyzer and does not necessarily indicate that calibration drift is in excess of the calibration tolerance.

7.2.2.12 BIT_11 = STACK PRESSURE FAULT

7.2.2.12.1 DESCRIPTION OF FAULT

This fault occurs when the measured stack pressure is less than the STACK PRESSURE FAULT MIN value or the greater than the FAULT MAX value. It may be indicative of, in order from lowest to highest probability, a pressure transducer wiring problem, incorrect stack pressure scaling or limit parameters, a bad Auxiliary IO Board or a bad pressure transducer.

7.2.2.12.2 EFFECT ON DATA

This fault invalidates all analyzer data since a valid stack pressure measurement is necessary for proper pressure correction of the concentration data.

7.2.2.13 BIT_12 = NH3 INCREMENTAL ADJUST FAULT

7.2.2.13.1 DESCRIPTION OF FAULT

This fault is the NH3 equivalent to the NO Incremental Adjust Fault.

7.2.2.13.2 EFFECT ON DATA

This fault does not necessarily invalidate the analyzer data since it is only indicative of daily drift exceeding the settings in the analyzer and does not necessarily indicate that calibration drift is in excess of the calibration tolerance.

7.2.2.14 BIT_13 = NH3 TOTAL ADJUST FAULT

7.2.2.14.1 DESCRIPTION OF FAULT

This fault is the NH3 equivalent to the NO Total Adjust Fault.

7.2.2.14.2 EFFECT ON DATA

This fault does not necessarily invalidate the analyzer data since it is only indicative of total drift from the reference value exceeding the settings in the analyzer and does not necessarily indicate that calibration drift is in excess of the calibration tolerance.

7.2.2.15 BIT_14 = CAL GAS TEMPERATURE FAULT

7.2.2.15.1 DESCRIPTION OF FAULT

This fault is actuated when the Cal Gas Heater temperature is more than ±(Cal Gas Heater FAULT MAX) degrees Fahrenheit from the measured Stack Temperature.

7.2.2.15.2 EFFECT ON DATA

This fault does not invalidate concentration calculation data since the failure of the Cal Gas Heater only affects the analyzer response to calibration gases. Normal emission measurements are not affected.

7.2.2.16 BIT_15 = PROBE TEMPERATURE FAULT

7.2.2.16.1 DESCRIPTION OF FAULT

This fault is actuated when the Probe Heater temperature is more than ±(Probe Heater FAULT MAX) degrees Fahrenheit from the measured Stack Temperature. ***The Probe Heater option is not available at this time, so this fault should not occur if the analyzer configuration is correct.***

7.2.2.16.2 EFFECT ON DATA

This fault does not invalidate concentration calculation data since the Probe Gas Heater is only to minimize accumulation of condensate and particulate on the probe in wet stack applications. Normal emission measurements and response to calibration gases are not affected.

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8.0 COMPONENT REPLACEMENT

NOTE: *For this section of the manual, probes are categorized into six general groups according to basic cavity size: up to 10cm (standard), up to 20cm or 30cm with extension, 37.5cm, 50cm, and 75cm. Each group may contain several measurement cavity sizes.*

8.1 UV LAMP REPLACEMENT

Caution: *Switch the Transceiver power off (CB1) in the AEB before beginning any Transceiver maintenance or component replacement procedures.*

Caution: *Avoid touching any glass surfaces (lens, window, corner cube reflector, lamp) when cleaning and/or servicing the SM8200 Gas Analyzer.*

1. Switch the Transceiver power off and wait 15 minutes for the lamp to cool.
2. Remove the black-finned lamp housing that is secured to the side of the Transceiver with four captive screws. Loosen the two screws that secure the lamp assembly to the lamp housing and remove the lamp assembly.
3. Remove the new lamp assembly from its container. Avoid touching the quartz envelope of the lamp and handle it only by the wires or by the block at the base of the lamp. Be certain that the envelope is clean.
4. Place the new lamp assembly in the lamp housing and secure it with two screws.
5. Place the lamp housing back in position on the transceiver. Mate the connector on the lamp leads to the fixed connector in the transceiver opening for the lamp housing. The connector is keyed so it can only be installed one way. Verify that the lamp housing is properly aligned on the alignment pins. ***Be sure that the lamp wires are not caught under the housing or near the light exit part of the lamp***. Secure the four captive screws. Ensure that the face of the lamp housing lies flush against the mating Transceiver surface. You may have to adjust the lamp alignment pins to get the lamp housing to lie flat against the transceiver.
6. Turn the Transceiver on. After approximately 20 seconds the lamp should fire. This can be verified by checking that the green LAMP ON LED (DS3) on the UV Lamp Power Supply Board is lit. The lamp does not require further adjustment. If, however, the adjustment locknuts have been changed or if peak performance (maximum light intensity) is desired, proceed to step 7.
7. To adjust the lamp, first notice the two threaded cams secured with locknuts. Using a screwdriver and a small wrench, loosen the locking nut counterclockwise 1/2 turn while keeping the cam from turning with the screwdriver. Loosen the four lamp housing mounting screws a few turns.
8. Use the LUI to initiate a MANUAL ZERO by pressing the ZERO button.

9. There are two ways to align the lamp. One method uses an oscilloscope and the other uses the Local User Interface (LUI) keypad on the Transceiver. Step 10 covers the use of an oscilloscope for lamp alignment, while Steps 11 through 12 are for the LUI.

WITH OSCILLOSCOPE

10. Connect a digital delay trigger oscilloscope to TP24 of the AEB Motherboard. Trigger off of TP30. See Section 4.2.2 of this manual for an example waveform. With the equipment operating, simultaneously rotate both adjustments for the highest peak spectra voltage at TP24 of the AEB Motherboard. Tighten the locking cam and the four captive screws when done. If after optimization, TP24 exceeds 1.8 V peak, the PDA Gain should be reduced. See Section 4.2.2 of this manual.

WITHOUT OSCILLOSCOPE (WITH LUI)

11. Using the LUI, verify that Bank SD (Lamp Alignment Mode Integration Period) is set to 1 (second). If it is not, enter the password into A2, then change SD to 1 (see Section 6.0 of this manual). Next, use the LUI to initiate Lamp Alignment mode by simultaneously pressing and holding the SET*ZERO*DISP*AUDIT buttons of the keypad.

12. Use the LUI to display Bank SC (mean Reference Level). With the equipment operating, simultaneously rotate both adjustments for the highest spectra voltage value in Bank SC. Tighten the locking cam and the four captive screws when done. After optimization, use the LUI to display Bank SF (Boxcar Saturation Status). Bank SF should display Good (Good). If Bank SF instead displays CL IP (Clip), the PDA Gain should be reduced. See Section 4.2.2 of this manual.

8.2 PROBE FILTER REPLACEMENT

NOTE: *This procedure is a guideline based on the standard probe configuration. Steps 3 through 7 are probe-dependent. Refer to the appropriate probe drawings to determine the filter replacement procedure for nonstandard probes.*

1. Release the six latches that secure the Transceiver to the probe. Swing the Transceiver to the side and disconnect the purge tube and thermal probe connector below the Transceiver lens. Lift the Transceiver off the hinge pins and set it aside. Protect the front lens from damage or contamination.

2. Remove the probe by releasing the mounting flange bolts on the ***stack side only***. Leave the probe alignment ring bolts in place. Carefully draw the probe from the sampling port using insulated gloves to prevent burns. Allow the probe to cool to room temperature.

3. For 10cm, 20cm or 30cm with extender use a bladed screwdriver to back off the adjustment cup and screw until the ceramic filter is loose. Remove the two screws securing the adjustment cup support (See Figure 8-4). For 37.5cm, 50cm or 75cm remove the four ¼-20 bolts (See Figure 8-5).

4. Remove the ceramic filter. Use a small screwdriver to remove the filter gasket from its seat in the probe end plate. Scrape seal surface if needed to ensure a clean flat surface.

5. Carefully press a new filter gasket into place.

6. For 10cm, 20cm or 30cm with extender lower the new ceramic filter over the measurement cavity and onto the gasket. Replace the adjustment cup support and tighten the two screws. Make sure the adjustment cup is backed off from contacting the ceramic filter. If too much pressure is applied the ceramic filter will break. Hold the ceramic filter firmly against the gasket and advance the adjustment cup down onto the center of the ceramic filter end until the filter is held firmly against the gasket. DO NOT apply much pressure to the ceramic filter or it will break.

7. For 37.5cm, 50cm or 75cm reinstall the filter assembly and ¼-20 bolts.

8. Carefully insert the probe back into the sampling port and secure it in place with the mounting flange bolts. Tighten the bottom bolts first.

9. Place the Transceiver on the hinge pins. Attach the thermal probe connector and purge tube. Make sure the wiring or tubing will not extend into the light path when closed. Close and latch the Transceiver to the probe.

8.3 TRANSCEIVER LENS REPLACEMENT

1. Release the six latches that secure the Transceiver to the probe. Swing the Transceiver to the side and disconnect the purge tube and thermal probe connector below the Transceiver lens. Lift the Transceiver off the hinge pins and set it aside.

2. With the Transceiver in a vertical position (lens up), remove the lens assembly by rotating it counterclockwise.

   Caution: ***Do not touch any glass surfaces when cleaning or servicing the SM8200. Remove the lens only in a clean, dry environment.***

3. Before inserting the new lens assembly, clean both sides of the Transceiver lens with a clean lens cloth moistened with a 50% alcohol and distilled water solution. Teledyne Monitor Labs recommends the use of reagent grade isopropyl alcohol. Do not use cleaners that contain an anti-fog additive. Commercial lint free lens and glass wipes such as Kimwipes® must be used for cleaning. Ensure that an O-ring is located below the threads on the outside of the lens assembly (refer to the old lens assembly as an example). ***Do not use the new lens assembly without an O-ring*.** Insert the new assembly by rotating it clockwise. Ensure that an O-ring is located below the threads on the outside of the lens assembly (refer to the old lens assembly as an example). ***Do not use the new lens assembly without an O-ring*.** Insert the new assembly by rotating it clockwise.

4. Once the assembly is fully seated, back off the applicable number of turns as follows:

18 inch probe	2 turns out
4 foot probe	2 turns out
6 foot probe	3/4 turn out

5. Place the Transceiver on the hinge pins. Attach the thermal probe connector and purge tube. Make sure the wiring or tubing will not extend into the light path when closed. Close and latch the Transceiver to the probe.

8.4 GRAFOIL RING SEAL AND/OR WINDOW CLEANING OR
8.5 REPLACEMENT

NOTE: *This procedure is a guideline based on the typical probe configuration, which include a cap style corner cube retainer. This type of corner cube holder is used with the following cavities: up to 10cm, up to 20cm or 30cm with a 10cm extender. The 37.5cm, 50cm & 75cm cavities utilize a plug type corner cube retainer. Steps 3 through 6 are probe-dependent. Refer to the appropriate probe drawings to determine the ring/window replacement procedure for nonstandard probes. Whenever the window is replaced, the Grafoil ring must be replaced.*

NOTE: *Any time the probe end is disassembled, the filter gasket must be replaced.*

1. Release the six latches that secure the Transceiver to the probe. Swing the Transceiver to the side and disconnect the purge tube and thermal probe connector below the Transceiver lens. Lift the Transceiver off the hinge pins and set it aside.

2. Remove the probe by releasing the mounting flange bolts on the ***stack side only***. Leave the probe alignment ring bolts in place. Carefully draw the probe from the sampling port using insulated gloves to prevent burns. Allow the probe to cool to room temperature.

3. Steps 3 through 10 are for 10cm, 20cm or 30cm with extender cavity sizes. Remove the ceramic filter (See Figure 8-4). Remove the complete measurement cavity assembly by placing a screwdriver or other strong instrument horizontally through the slots or holes in the measurement cavity for leverage. Turn the complete assembly counterclockwise until it is disengaged.

4. Lift the window assembly out of the probe.

5. Pry the Grafoil ring out of its seat with a small screwdriver and clean the seat.

Caution*: Avoid touching any glass surfaces.*

6. Place the new Grafoil ring in its seat.

7. Clean the window assembly and place it on top of the Grafoil ring.

8. Ensure that the key on the window assembly is aligned with the keyway in the probe body. The key protrusion on the window assembly must face the probe body, not the measurement cavity.

9. Replace the complete measurement cavity by turning it clockwise until solid resistance is felt. Note the portion of the measurement cavity extending from the probe and tighten with a torque wrench until it rotates ¾” (65 deg) to 1-1/2” (135 deg) measured on the circumference of the nut. This distance **IS** **NOT** a compression distance! Do not exceed 40 foot-pounds.

10. Verify that the gasket under the ceramic filter is good. Replace the ceramic filter per section 8.2 above and reinstall the probe.

11. For 37.5cm, 50cm or 75cm cavity sizes remove the entire front-end portion of the probe by removing six ¼-20 hex head bolts (See Figure 8-5).

12. Remove the threaded bushing that holds the window assembly in place.

13. Lift the window assembly out of the probe.

14. Pry the Grafoil ring out of its seat with a small screwdriver and clean the seat.

Caution: ***Avoid touching any glass surfaces***

15. Place the new Grafoil ring in its seat.

16. Clean the window assembly and place it on top of the Grafoil ring.

17. Ensure that the key on the window assembly is aligned with the keyway in the probe body. The key protrusion on the window assembly must face the measurement cavity, not the probe body.

18. Replace the threaded bushing by turning it clockwise until solid resistance is felt. Tighten with a torque wrench until it rotates ¾" (65 deg) to 1-1/2" (135 deg) measured on the circumference of the threaded bushing. This distance **IS NOT** a compression distance! Do not exceed 40 foot-pounds.

19. Reinstall the front end portion of the probe and reinstall the probe assembly.

8.6 RETROREFLECTOR (CORNER CUBE) REPLACEMENT

NOTE: *This procedure is a guideline based on the typical probe configuration, which include a cap style corner cube retainer. This type of corner cube holder is used with the following cavities: up to 10cm, up to 20cm or 30cm with a 10cm extender. The 37.5cm, 50cm & 75cm cavities utilize a plug type corner cube retainer. Steps 3 through 6 are probe-dependent. Refer to the appropriate probe drawings to determine the ring/window replacement procedure for nonstandard probes.*

Caution***: Avoid touching any glass surface when cleaning and/or servicing the SM8200.***

1. Release the six latches that secure the Transceiver to the probe. Swing the Transceiver to the side and disconnect the purge tube and thermal probe connector below the Transceiver lens. Lift the Transceiver off the hinge pins and set it aside.

2. Remove the probe by releasing the mounting flange bolts on the ***stack side only***. Leave the probe alignment ring bolts in place. Carefully draw the probe from the sampling port using insulated gloves to prevent burns. Allow the probe to cool to room temperature.

3. For 10cm, 20cm or 30cm with extender cavities remove the ceramic filter (See Figure 8-4).

4. For 10cm, 20cm or 30cm with extender cavities hold the measurement cavity securely and loosen the jam nut on the back of the measurement cavity. Do not move the main body of the measurement cavity during this procedure.

   NOTE: *If the main body of the measurement cavity does move, perform the Grafoil ring and/or window cleaning or replacement procedure. (See 8.4)*

5. For 37.5cm, 50cm or 75cm cavities loosen the jam nut on the back of the filter holder (See Figure 8-5).

6. Turn the retro reflector cap/holder counterclockwise and remove it.

7. Remove the old retro reflector. Keep the probe level to ensure that the spring and plate remain within the end of the retro reflector housing.

8. Clean the new retro reflector including the front surface and 3 side facets. Insert it in the retro reflector housing.

9. Position the probe with the measurement cavity downward and make sure the spring and plate are correctly positioned in the cap. Then place the retro reflector holder on the end and turn clockwise until there is contact between the spring loaded plate and retro reflector. The point of contact can also be detected when the corner cube no longer rattles when the probe is shook. Turn one turn after contact to preload the retro reflector into position.

   Caution: ***Over tightening will crack the retro reflector.***

10. Tighten the jam nut.

11. For 10cm, 20cm or 30cm with extender verify that the gasket under the ceramic filter is good. Replace the ceramic filter per section 8.2 above.

12. Reinstall the probe.

8.7 STACK TEMPERATURE PROBE REPLACEMENT

NOTE: *This procedure is a guideline based on the standard probe configuration. Steps 3 through 6 are probe-dependent. Refer to the appropriate probe drawings to determine the thermal probe replacement procedure for nonstandard probes.*

NOTE: *Any time the probe end is disassembled, the filter gasket must be replaced.*

1. Release the six latches that secure the Transceiver to the probe. Swing the Transceiver to the side and disconnect the purge tube and thermal probe connector below the Transceiver lens. Lift the Transceiver off the hinge pins and set it aside.

2. Remove the probe by releasing the mounting flange bolts on the ***stack side only***. Leave the probe alignment ring bolts in place. Carefully draw the probe from the sampling port using insulated gloves to prevent burns. Allow the probe to cool to room temperature.

3. With the probe in a horizontal position, remove the thermal probe Swagelok nut. For 10cm, 20cm or 30cm with extender the Swagelok connector is at the stack end of the probe (See Figure 8-4). For 37.5cm, 50cm or 75cm, the Swagelok connector is in the rear of the probe. Remove the ferrule, and pull out the old RTD probe (See Figure 8-5).

4. Insert the new thermal probe. For 10cm, 20cm or 30cm with extender the temperature probe should protrude approximately one inch through the end of the Swagelok fitting.

5. Insert the new ferrule.

6. Replace the Swagelok nut and tighten securely until thermal probe movement is totally restricted. This needs to be a gas tight seal.

7. Reinstall the probe and reattach the Transceiver to the probe.

8. Attach the thermal probe connector at the Transceiver.

8.8 PROBE REPLACEMENT

1. Release the six latches that secure the Transceiver to the probe. Swing the Transceiver to the side and disconnect the purge tube and thermal probe connector below the Transceiver lens. Lift the Transceiver off the hinge pins and set it aside.

2. Remove the probe by releasing the mounting flange bolts on the ***stack side only***. Leave the probe alignment ring bolts in place. Carefully draw the probe from the sampling port using insulated gloves to prevent burns. Allow the probe to cool to room temperature.

3. Align the new probe on the transceiver. The probe must be out of the stack for alignment. Position and clasp the probe with air flush housing on the Transceiver in a vertical position. Loosen the three flange bolts, then rotate the two flange alignment rings independently and together in order to get the highest voltage at TP24 on the AEB Motherboard (see Section 4.2.2 of this manual). Tighten the locking bolts so the rings are locked in position. Long probes require more careful alignment because of the greater sensitivity to the position of the alignment rings.

4. Remove the transceiver and carefully insert the new probe with air flush housing into the sampling port and secure it in place with the 4 mounting flange bolts.

5. Place the Transceiver on the hinge pins. Attach the RTD connector and purge tube. Ensure that the correct type of thermal probe is selected by the jumpers on the Transceiver board. Close and latch the Transceiver to the probe.

8.9 TRANSCEIVER REPLACEMENT

1. Release the six latches that secure the Transceiver to the probe. Swing the Transceiver to the side and disconnect the purge tube and thermocouple connector below the Transceiver lens. Lift the Transceiver off the hinge pins.

2. Disconnect the 3 cables that are connected to the AEB.

3. Place the new Transceiver on the hinge pins. Ensure that the correct type of thermal detector is selected with the Transceiver board jumpers. Attach the thermal probe connector and purge tube. Close and latch the Transceiver to the probe.

4. Reconnect the 3 cables to the AEB.

5. Perform the Transceiver test and calibration procedures.

6. Ensure that the Transceiver lens is focused for the proper probe length (see Section 8.3 above).

8.10 E/O CAL SPAN CELL REPLACEMENT

Caution: ***Switch the transceiver power off (CB1) in the analyzer electronics box before beginning any transceiver maintenance or component replacement procedures.***

Caution: ***Expose optical components only in a clean area.***

Caution: ***Avoid touching any glass surfaces when cleaning and/or servicing the SM8200.***

1. Release the six latches that secure the transceiver to the probe. Disconnect the 3 cables that are attached to the AEB. Swing the transceiver to the side and disconnect the purge tube and thermal probe connector below the transceiver lens. Lift the transceiver off the hinge pins.

2. Position the transceiver on its back, access door handles will be facing up. Loosen the six screws on the transceiver access door and remove the access door. Make sure the working environment is clean and dry.

3. Remove the six #6-32 socket head cap screws that have star washers under the heads. They are located along the edges of the plate (See Figure 8-1).

4. Disconnect connectors P11 from J11 UV Lamp Power, P12 from J12 RTD & P14 from J14 Local User Interface (LUI) cable.

5. Remove the two #10-32 socket head screws that secure the connector bracket to the side of the main housing.

6. Loosen the two #10-32 screws that secure the cable bracket to the optics plate.

7. Carefully lift up the optics plate assembly using the 1” diameter knobs. It may take some force for the registration pins to release. Make sure unplugged wires are held out of the way. Flip the assembly over and set on some edge supports (2X4 boards are OK) so that it is suspended over the work surface. Be sure not to set it on the PC Board A1 or its connectors.

8. Remove the Spectrometer cover. To do this you will need to unplug the dark solenoid and cover heater. Then remove the three 6-32 socket head cap screws that attach the cover to the edge of the base plate. Carefully lift up on the cover till it comes loose. The fit is a snug fit. Be careful that you do not get the dark shutter caught on anything. **CAUTION: The optics under this cover are very delicate. Do not touch any of the optical components.**

9. The E/O cal span cell is attached to the solenoid shaft that is attached to a bracket which is mounted to the side of the PDA heat sink (See Figure 8-2).

10. Loosen the socket head set screw on the span cell hub and remove the span cell.

11. Install a new span cell and loosely tighten the setscrew.

12. Manually flip the E/O cal cell in and out making sure it is free to flip and is landing on the rubber stop pad below.

13. Plug in the 3 cables to the Analyzer Electronics Box. Connect a LUI extension cable (included with instrument) between J14 and P14. Switch the Transceiver power on and allow a few minutes to warm up. On the LUI push ‘SPAN’ ‘E’ in combination and the E/O Cal solenoid should snap the E/O Cal cell into position. Viewing from behind and between the 2 mirrors make sure the cell is directly in front of the PDA face. If not a rotational adjustment will need done to the E/O cal cell. Securely tighten the set screw. Push the ‘Norm’ button on the LUI and the E/O cal cell will drop out of in front of the PDA. Cycle between SPAN ‘E’ and NORM a few times till satisfied that the E/O cal cell is aligned and working properly.

14. Perform steps 1 through 8 in reverse order and reverse action to reassemble the transceiver. Be sure the optics plate drops back on to the registration pins when reassembling.

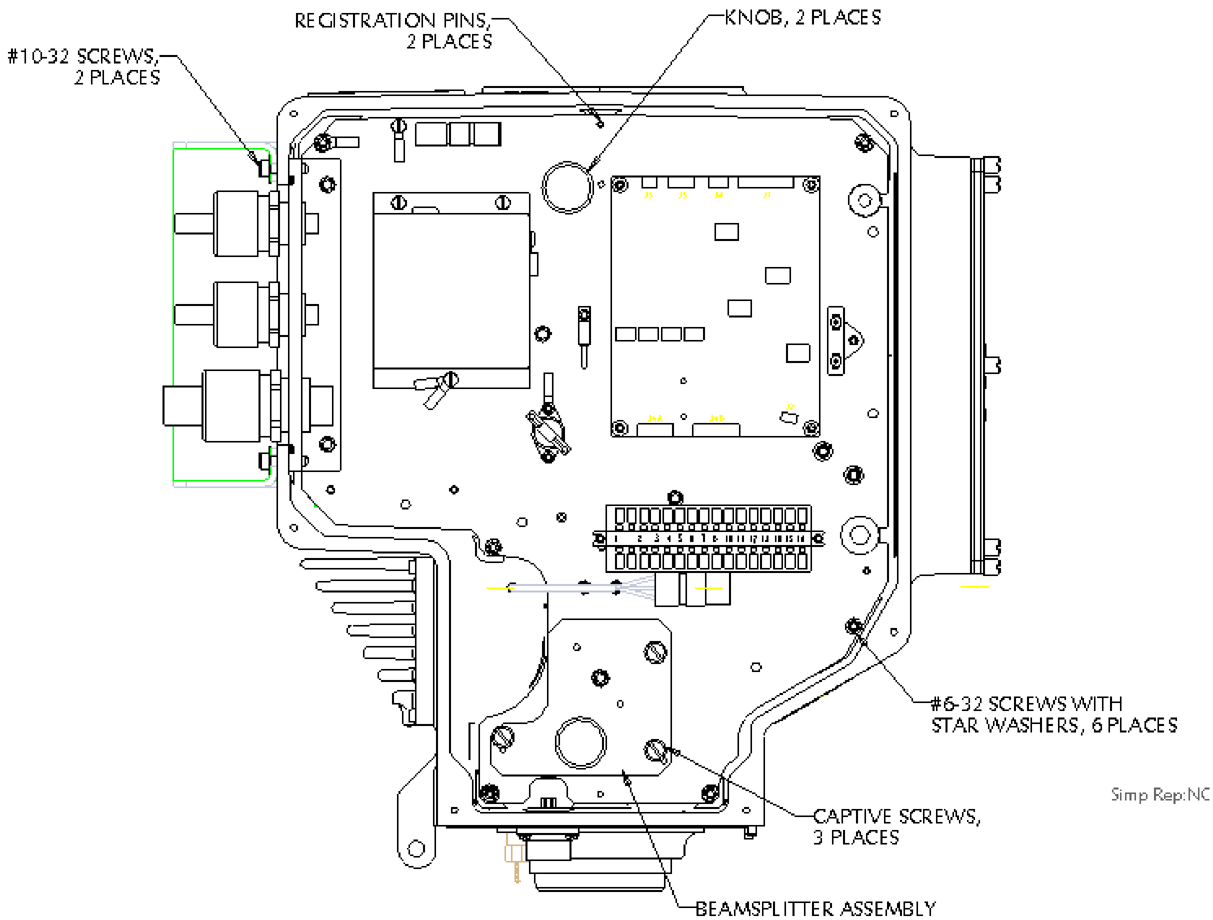

Figure 8-1: Transceiver

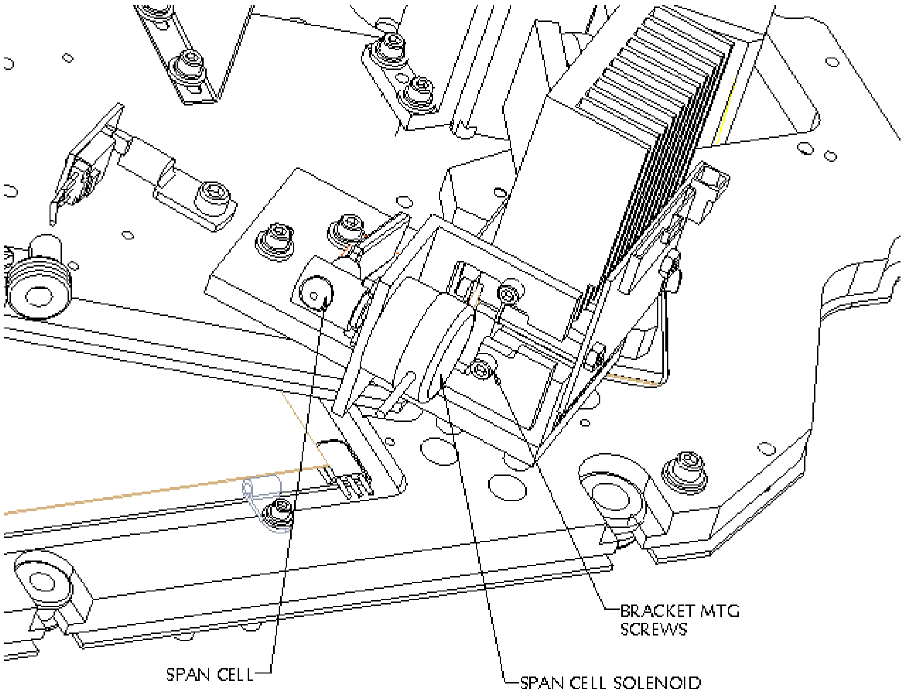

Figure 8-2: Span Cell

8.11 E/O CAL SPAN CELL SOLENOID REPLACEMENT

1. Remove the span cell using the span cell replacement procedure. (Steps 1-14 of section 8.10)

2. Remove the two nuts that hold the span cell solenoid to the bracket. Remove the solenoid and unplug the connector.

3. Remove the connector on the end of the solenoid wires. (You will need a WAGO tool to do this.)

4. On the new solenoid trim the wires to the same length, strip a ¼” and reinstall the connector.

5. Install the new span cell solenoid and plug in the connector.

6. Reinstall the span cell and loosely tighten the set screw.

7. Manually flip the E/O cal cell in and out making sure it is free to flip and is landing on the rubber stop pad below.

8. Plug in the 3 cables to the Analyzer Electronics Box. Connect a LUI extension cable (included with instrument) between J14 and P14. Switch the Transceiver power on and allow a few minutes to warm up. On the LUI push ‘SPAN’ ‘E’ in combination and the E/O Cal solenoid should snap the E/O Cal cell into position. Viewing from behind and between the 2 mirrors make sure the cell is directly in front of the PDA face. If not a rotational adjustment will need done to the E/O cal cell. Securely tighten the set screw. Push the ‘Norm’ button on the LUI and the E/O cal cell will drop out of in front of the PDA. Cycle between SPAN ‘E’ and NORM a few times till satisfied that the E/O cal cell is aligned and working properly.

9. Perform steps 1 through 8 in reverse order and reverse action to reassemble the transceiver. Be sure the optics plate drops back on to the registration pins when reassembling.

8.12 DARK SHUTTER SOLENOID REPLACEMENT

Caution: ***Switch the transceiver power off (CB1) in the analyzer electronics box before beginning any transceiver maintenance or component replacement procedures.***

Caution: ***Expose optical components only in a clean area.***

Caution: ***Avoid touching any glass surfaces when cleaning and/or servicing the SM8200.***

1. Release the six latches that secure the transceiver to the probe. Disconnect the 3 cables that are attached to the AEB. Swing the transceiver to the side and disconnect the purge tube and thermal probe connector below the transceiver lens. Lift the transceiver off the hinge pins.

2. Position the transceiver on its back, access door handles will be facing up. Loosen the six screws on the transceiver access door and remove the access door. Make sure the working environment is clean and dry.

3. Remove the six #6-32 socket head cap screws that have star washers under the heads. They are located along the edges of the plate (See Figure 8-1).

4. Disconnect connectors P11 from J11 UV Lamp Power, P12 from J12 RTD & P14 from J14 Local User Interface (LUI) cable.

5. Remove the two #10-32 socket head screws that secure the connector bracket to the side of the main housing.

6. Loosen the two #10-32 screws that secure the cable bracket to the optics plate.

7. Carefully lift up the optics plate assembly using the 1” diameter knobs. It may take some force for the registration pins to release. Make sure unplugged wires are held out of the way. Flip the assembly over and set on some edge supports (2X4 boards are OK) so that it is suspended over the work surface. Be sure not to set it on the PC Board A1 or it’s connectors.

8. The dark shutter solenoid is located at the corner of the optical bench cover (See Figure 8-3). Remove the 2 socket head cap screws that hold the solenoid bracket to the cover. Be careful not to lose the white pad that is under the bracket. Remove the grommet from the light shield and unplug the connector. Remove the WAGO connector from the end of the solenoid wires. (You will need a WAGO tool to do this.) Slide the grommet off of the wires.

9. Remove the Dark Shutter by loosening the set screw in the shutter hub. Remove the 2 nuts that hold the solenoid in place and remove.

10. On the new solenoid trim the wires to the same length the solenoid wires were, strip a ¼". Slide the grommet over the wires and reinstall the connector.

11. Install the new dark solenoid onto the bracket. Reinstall the dark shutter to the solenoid shaft and reattach the bracket to the top of the cover making sure the white pad is under the bracket. Snap the grommet into the groove in the light shield and plug in the connector.

12. Plug in the 3 main cables to the Analyzer Electronics Box. Connect a LUI extension cable between J14 and P14. Switch the Transceiver power on and allow a few minutes to warm up. On the LUI push 'ZERO' 'E' in combination and the dark shutter solenoid should snap the shutter into position. Make sure the shutter is covering the hole in the cover where the light beam enters. If not a rotational adjustment will need done to the shutter. Push the 'Norm' button on the LUI and the shutter will swing out of in front of hole in the cover. Cycle between ZERO 'E' and NORM a few times till satisfied the new solenoid is working and that the shutter is aligned. The light entrance hole on the spectrometer must be completely clear in the open position and completely blocked in the dark position.

13. Perform steps 1 through 7 in reverse order and reverse action to reassemble the transceiver. Be sure the optics plate drops back on to the registration pins when reassembling.

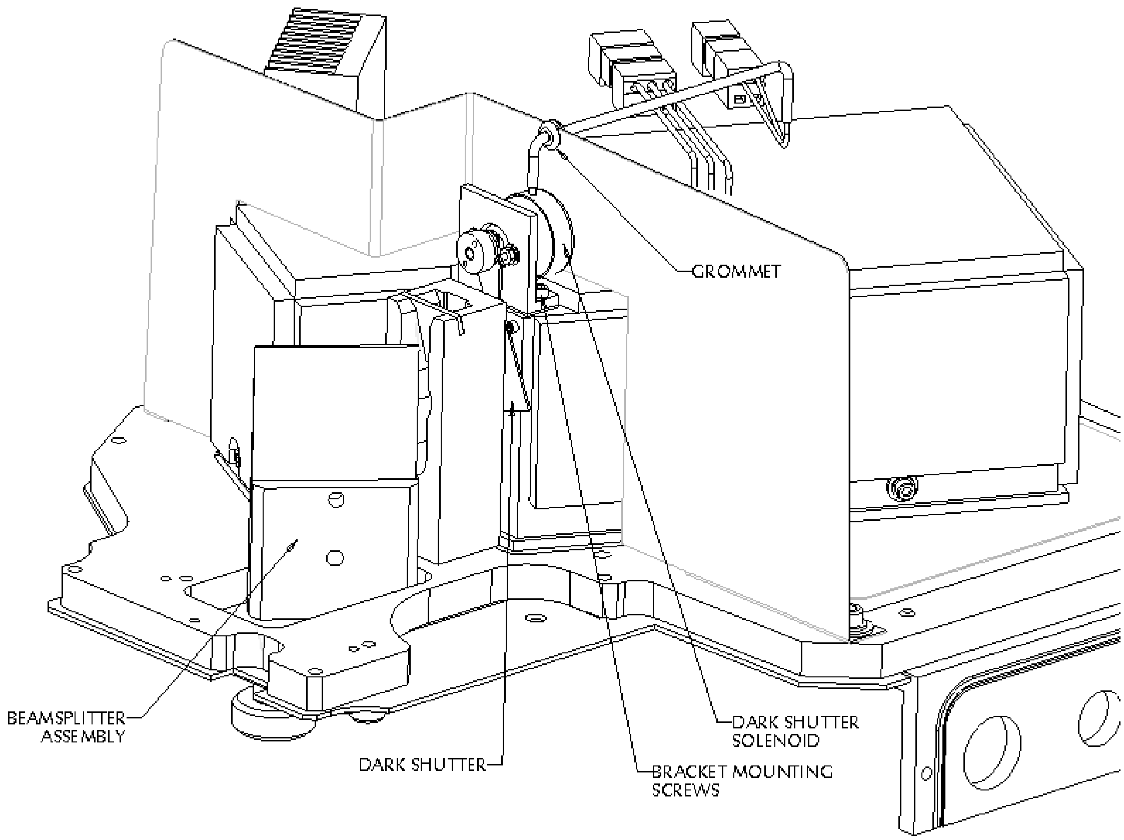

Figure 8-3: Beamsplitter/Shutter

8.13 BEAM SPLITTER CLEANING AND/OR REPLACEMENT

Caution: ***Switch the transceiver power off (CB1) in the analyzer electronics box before beginning any transceiver maintenance or component replacement procedures.***

1. Release the six latches that secure the transceiver to the probe. Swing the transceiver to the side and disconnect the purge tube and thermal probe connector below the transceiver lens. Lift the transceiver off the hinge pins.

2. Position the transceiver on its back, access door handles will be facing up. Loosen the six screws on the transceiver access door and remove the access door. Make sure the working environment is clean and dry.

3. Loosen the three captive screws that hold the beam splitter in place (See Figure 8-1). Gently pull up on the knob located at the approximate center of the assembly. The assembly is pined so it may take a little force to get it to pop off. Remove the assembly being careful not to hit the glass beam splitter against anything.

4. The beam splitter may be cleaned using a clean lens cloth moistened with a 50% alcohol and distilled water solution. Teledyne Monitor Labs recommends the use of reagent grade isopropyl alcohol. Do not use cleaners that contain an anti-fog additive. Commercial lint free lens and glass wipes such as Kimwipes® must be used for cleaning.

5. After cleaning or if replacing the beam splitter assembly, install back into the opening making sure the pins are aligned to their respective holes and that the beam splitter base plate is flat against the optics plate. Tighten the three captive screws.

6. Perform steps 1 and 2 in reverse order and reverse action to reassemble the transceiver.

8.14 TRANSCEIVER LENS CLEANING

Caution: ***Switch the transceiver power off (CB1) in the analyzer electronics box before beginning any transceiver maintenance or component replacement procedures.***

1. Release the six latches that secure the transceiver to the probe. Swing the transceiver to the side and disconnect the purge tube and thermal probe connector below the transceiver lens. Lift the transceiver off the hinge pins.

2. Position the transceiver on its back, access door handles will be facing up. Loosen the six screws on the transceiver access door and remove the access door. Make sure the working environment is clean and dry.

3. The front of the lens is easily accessible for cleaning. The back of the lens can be accessed by removing the beam splitter per the beam splitter cleaning procedure 8.12 above. You should be able to reach the back lens surface through the opening.

4. The lens surfaces may be cleaned using a clean lens cloth moistened with a 50% alcohol and distilled water solution. Teledyne Monitor Labs recommends the use of reagent grade isopropyl alcohol. Do not use cleaners that contain an anti-fog additive. Commercial lint free lens and glass wipes such as Kimwipes® must be used for cleaning.

5. Replace the beam splitter per 8.12 above. Perform steps 1 and 2 in reverse order and reverse action to reassemble the transceiver.

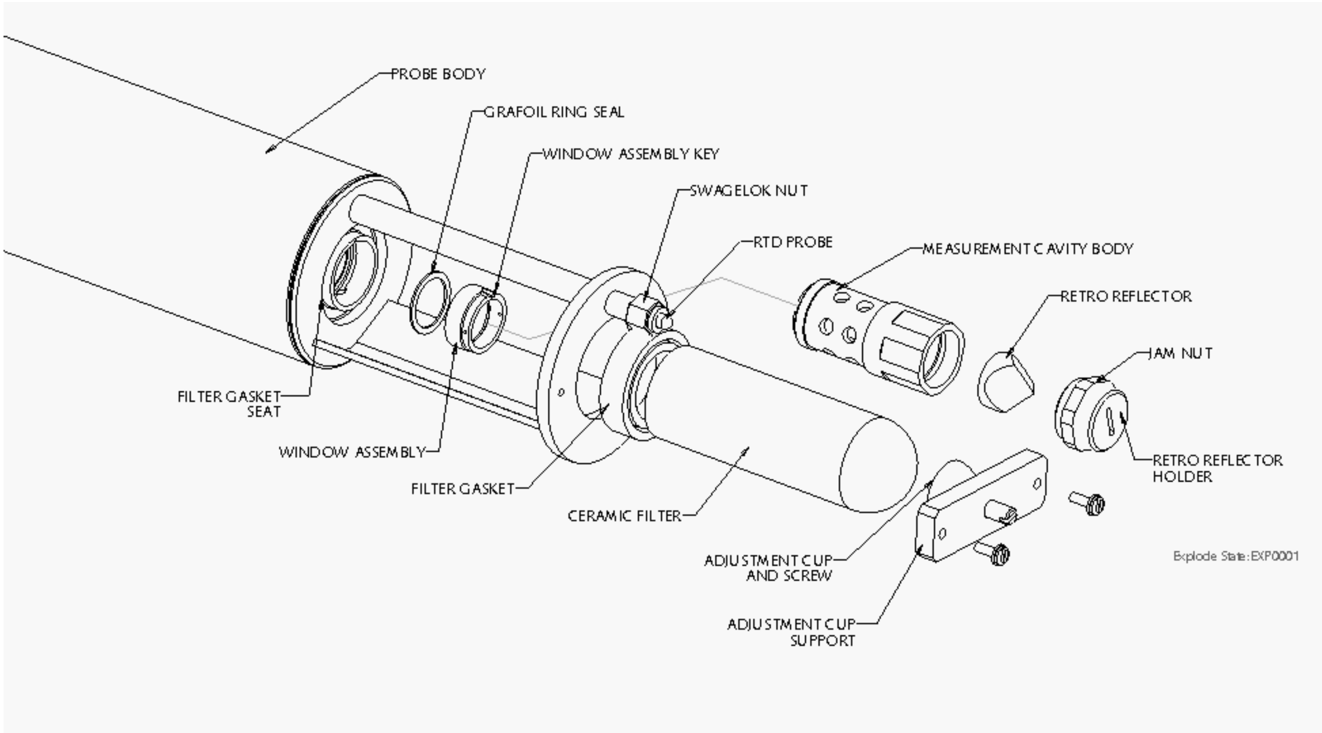

Figure 8-4: Probe Tip Assembly (For 10cm, 20cm or 30cm with extender cavities)

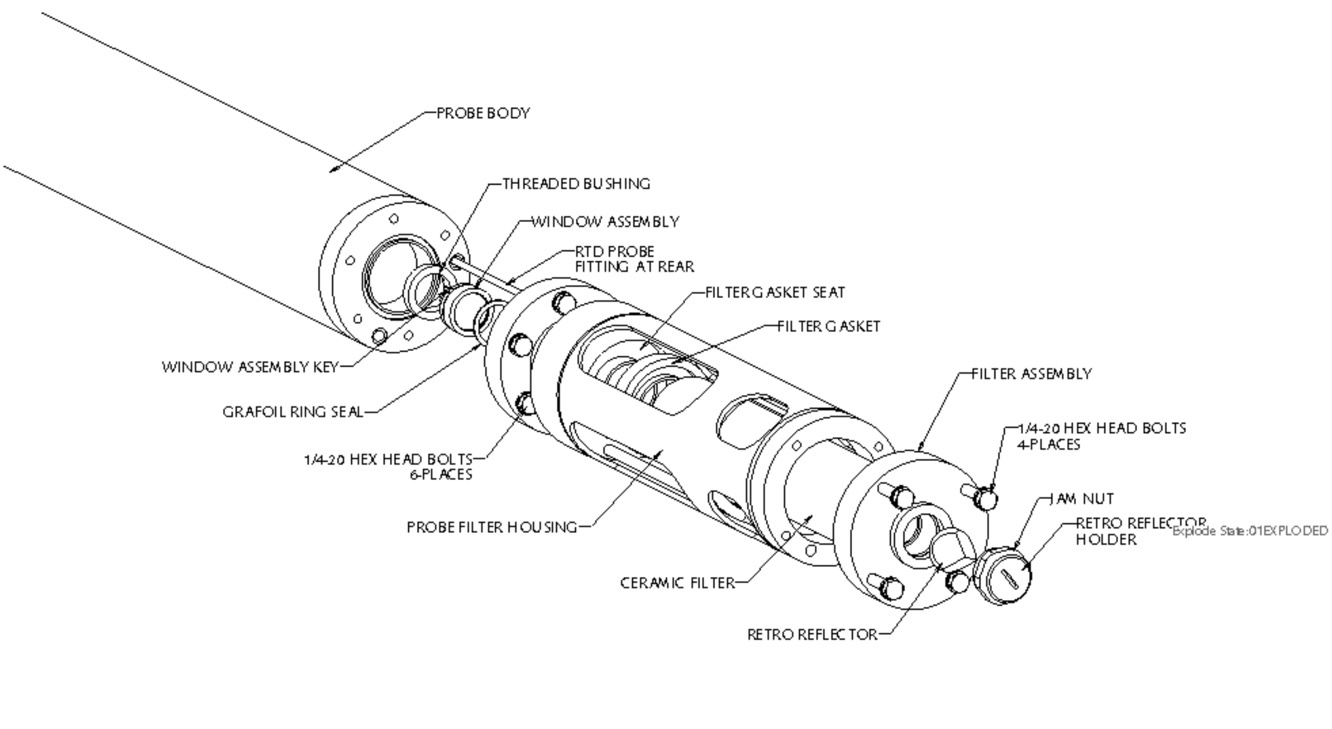

Figure 8-5: Probe Tip Assembly (For 37.5cm, 50cm or 75cm cavities)

9.0 TECHNICAL DESCRIPTION

This section discusses the general theory of operation of the SM8200 gas analyzer, along with the cursory optical, electronic and signal processing basics of the Transceiver and AEB. However, the details of the chemometric techniques involved in the analyzer software are quite complex and outside the scope of this manual.

9.1 SECOND DERIVATIVE ABSORPTION SPECTROSCOPY THEORY

Second-derivative spectroscopy is an optical process that extracts the second derivative $d^2I/d\lambda^2$ of light intensity (I) versus wavelength (λ) from a narrow wavelength region about a peak absorption wavelength (λ_o). It is a powerful technique that can reduce interference from broadband UV absorbers such as SO2, minimize the effects of baseline spectra shifts and provide continuous lamp and detector correction when coupled with the signal processing described in the next section.

9.1.1 Derivation of Second Derivative Signal

In the SM8200 gas measurement cavity, ultraviolet (UV) light traverses through a constant length absorption medium (Figure 9-1). Whenever NO or SO_2 exists in the cavity, absorption of UV light occurs. The ideal theoretical mathematical relationship between these physical quantities is expressed by Beer-Lambert equation:

$$I = I_O e^{-aLc}$$

Equation 9-1

Where:

I_o = initial UV light intensity before traveling through the cavity

$I = I(\lambda)$ = UV light intensity exiting the cavity; I is a function of λ

a = a (λ) = absorption coefficient; a is also a function of pressure and temperature

L = total light path length in the cavity

c = NO or SO_2 gas concentration.

The first derivative of intensity with respect to wavelength is:

$$\frac{dI}{d\lambda} = (\frac{dI_O}{d\lambda})e^{-aLc} - (\frac{da}{d\lambda})LcI_O e^{-aLc}$$

Equation 9-2

Dividing each side of Equation 9-2 by Equation 9-1:

$$\left(\frac{dI}{d\lambda}\right)\left(\frac{1}{I}\right) = (\frac{1}{I_O})(\frac{dI_O}{d\lambda}) - Lc(\frac{da}{d\lambda})$$

Equation 9-3

Where da/dλ is the rate of change of absorption coefficient with wavelength.

The two right-side terms of Equation 9-3 are independent of intensity. The first is a constant indicating the amount of slope in the UV source spectrum. The second term varies linearly with gas concentration.

Taking the second derivative of intensity with respect to wavelength:

$$\left(\frac{d^2 I}{d\lambda^2}\right)\left(\frac{1}{I}\right) = (\frac{1}{I_O})(\frac{d^2 I_O}{d\lambda^2}) + (Lc[\frac{da}{d\lambda}])^2 - (\frac{2}{I_O})(\frac{dI_O}{d\lambda})(\frac{da}{d\lambda}) - Lc(\frac{d^2 a}{d\lambda^2})$$

Equation 9-4

At the point of maximum curvature, which is at the peak absorption wavelength (I_o), the slope da/d I= 0; Equation 9-4 then reduces to:

$$\left(\frac{d^2 I}{d\lambda^2}\right)\left(\frac{1}{I}\right) = \frac{1}{I_O}(\frac{d^2 I_O}{d\lambda^2}) - Lc(\frac{d^2 a}{d\lambda^2})$$

Equation 9-5

The first term on the right side of Equation 9-5 is a constant that measures curvature in the source spectrum. The second term is the curvature in the absorption coefficient.

See Figure 9-2 for a graphic representation of the absorption spectrum and its first and second derivatives.

It is clear from Equation 9-5 that if one subtracts the second derivative of a blank (source) spectrum divided by itself from the continuous ratio of the second derivative and measurement spectrum, the following relationship results.

$$\left(\frac{d^2 I}{d\lambda^2}\right)\left(\frac{1}{I}\right) = -Lc\left(\frac{d^2 a}{d\lambda^2}\right)$$

Equation 9-6

The significance of Equation 9-6 is that when the spectra are processed in this manner, the resulting signal is linear with concentration. Linearity is of value to the chemometric techniques in the analyzer software, since least squares numerical methods are based on linear algebra and thus perform linear matrix operations to establish correlations between the spectra and the concentrations of interest.

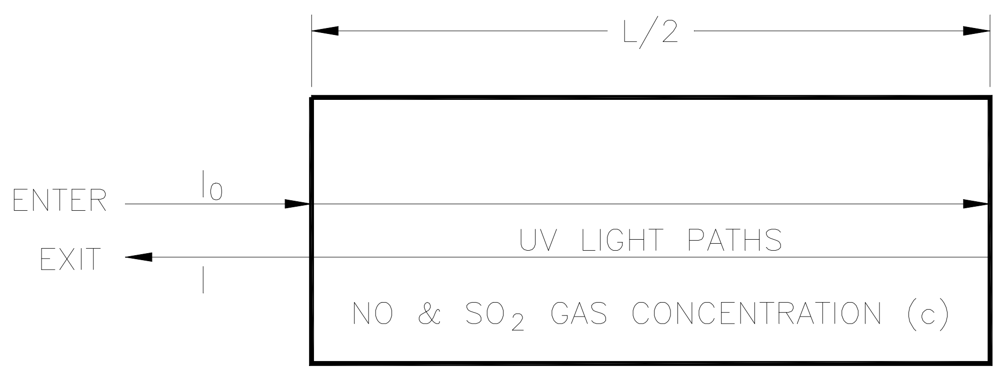

Figure 9-1: Gas Measurement Cavity

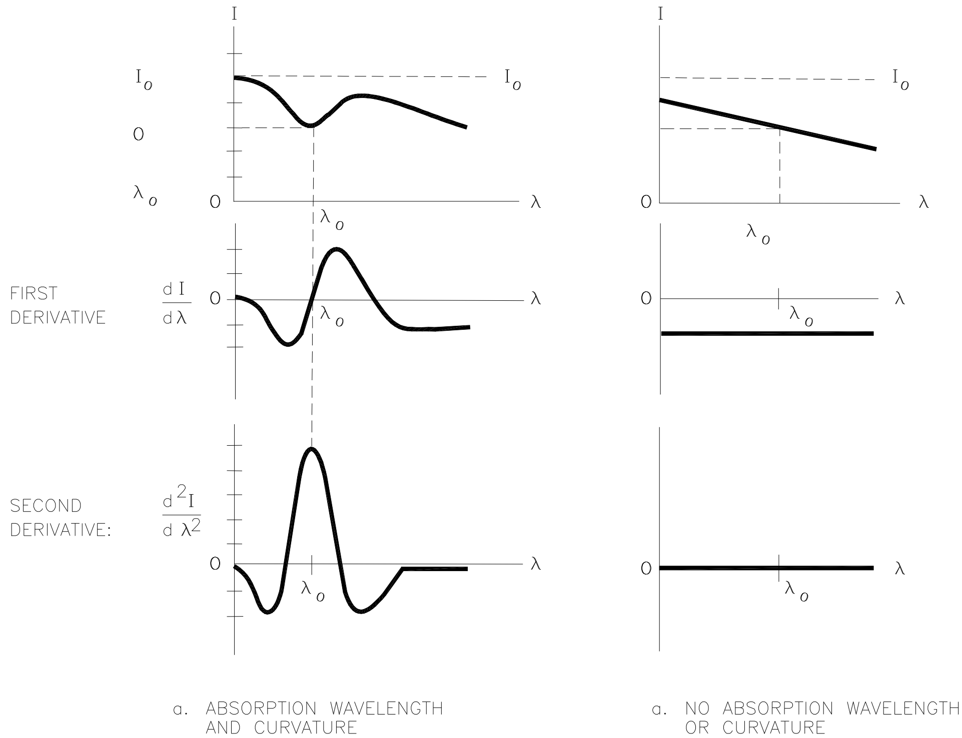

Figure 9-2: Absorption Curves and Their Derivatives

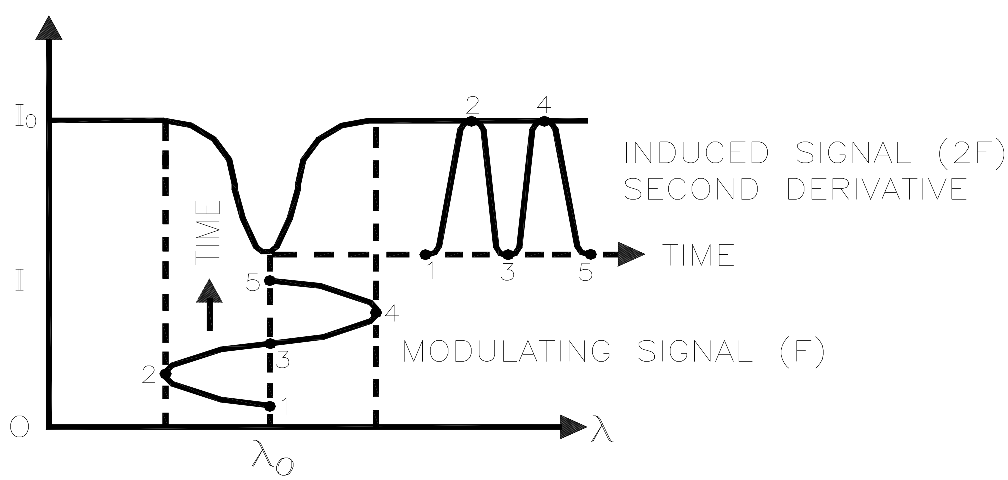

Figure 9-3: Absorption Curve Modulated with Curvature

9.1.2 Savitzky-Golay Smoothing

The analyzer software employs digital signal processing to calculate the second derivative from the 511 discrete wavelength signals from the PDA. Since differentiation typically increases measurement noise, smoothing techniques are essential to a practical implementation. It is of utmost importance that any filtering function applied to this problem not introduce phase shift or significantly alter the peak wavelength location. Savitzky-Golay (SG) filtering, which has had great utility to the fields of spectroscopy and chemometrics for just these reasons, fits this requirement due to its linear phase behavior. SG filter coefficient derivation is quite complex and will not be treated herein, though it is significant to note that a Savitzky-Golay filter is a symmetrical FIR (Finite Impulse Response) filter with an odd number of taps (points) evaluated over an equal number of samples preceding and following the current sample.

SG filters are well suited to calculation of whatever order derivative the application requires. It is only a matter of changing the filter coefficients to change nature of the smoothing and the order of the derivative.

9.1.3 Boxcar Integration

Boxcar integration is a very effective noise mitigation strategy for systems with digital signal processing capabilities such as the SM8200. In this technique, the absolute value of the input data (X(nT) below) from many measurement events are added together for each value of n. This has the effect of separating a synchronous signal, such as the spectra of interest, from asynchronous noise.

Expressing the boxcar integration of X(nT) mathematically as B(nT)

$$B(nT) := \sum_{i=1}^{C} \left| X_i(nT) \right|$$

where

n is the discrete wavelength index (pixel),
i is an index variable representing each individual spectra, and
C is the number of spectrums per integration period
T is the interval between discrete wavelengths

The analyzer uses boxcar integration to take all of it spectral measurements, whether it is the Dark (D) and Reference (R) Spectra taken every calibration cycle, or the normal Input Spectra (I) (see the next subsection).

9.1.4 Fundamental Measurement Formula

The fundamental measurement that the analyzer performs on the boxcar integrator output B(nT) can be summarized as the difference between the Dark and Input or Reference Spectra divided into the 2nd derivative of the difference. This same ratio taken during a blank source measurement (the zero mode of the calibration cycle) is subtracted from every subsequent measurement to improve linearity.

Given the following vector definitions

I – Input Spectra vector [511 x 1]

D – Dark Spectra vector [511 x 1]
R – Reference Spectra vector [511 x 1]
C_{sg} – 2nd Derivative Savitzky-Golay filter coefficients [filter size x 1]

The Dark and Reference spectra are acquired during calibration. They are evaluated at the end of the calibration cycle when a new **d^2R** is calculated as:

$$d^2R = (R - D) * C_{sg} * 2.0) / (R - D)$$

Every sample is Savitzky-Golay filtered and processed further to produce the **S_{out}** vector using the equation

$$S_{out} = ((I - D) * C_{sg} * 2.0) / (I - D)) - d^2R$$

The **S_{out}** output vector is further processed using chemometrics models to produce a Raw Concentration for each gas species of interest. The details of the chemometrics prediction process used in the analyzer are outside of the scope of this manual.

NOTE: *The Raw Concentration results are viewable on the Enhanced Remote Panel for diagnostic purposes but are of limited value to the end user.*

The Raw Concentration results are further processed through a series of complex algorithms to produce the Final Concentrations, which are the calculation results used for emission measurement and calibration assessment purposes.

9.1.5 Example Spectra

The four inorganic species of primary interest to the analyzer are NO, SO2, NH3 and NO2. The UV absorption in the 200 to 230 nm region of the first three of these species is strong while the absorption by NO2 is relatively weak (see Figure 9-4). Note the broadband absorption characteristics of SO2 in this region.

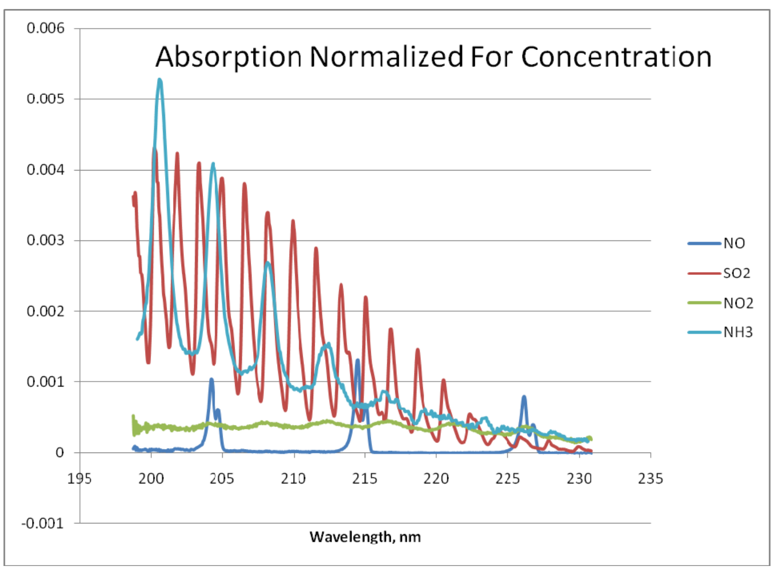

Figure 9-4: Absorption by NO, SO2, NH3 and NO2, 200-230nm

Second derivative processing applied to the absorption spectra for these species can assist in dealing with a broadband absorber such as SO2. Note how 2nd derivative processing changes the sloping, broadband absorption characteristics of SO2 to a series of several narrowband structural features that more closely hug the baseline. See Figure 9-5.

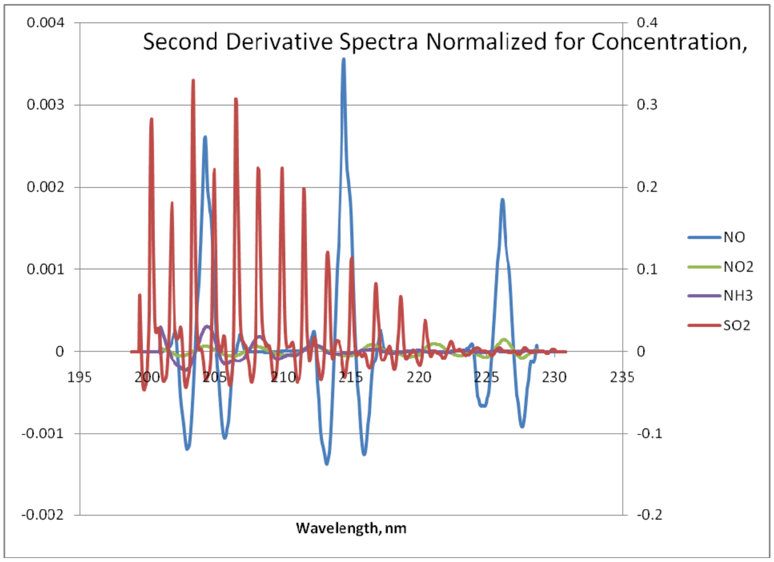

Figure 9-5: NO, SO2, NH3 and NO2 2nd Derivative Spectra, 200-230nm

9.2 OPTICAL SYSTEM

The optical system uses a spectrometer, an instrument that disperses light into the component wavelengths necessary for the measurement of NO or SO2 absorption spectra.

The optical system is contained within the probe and transceiver assemblies and includes a beam splitter, lens, corner cube (retro reflector), mirrors, and a diffraction grating. The functional diagram for this system shows the optical device configuration (see Figure 9-6). Progression of the light path envelopes are indicated by straight lines with arrows, referred to as light rays or beams.

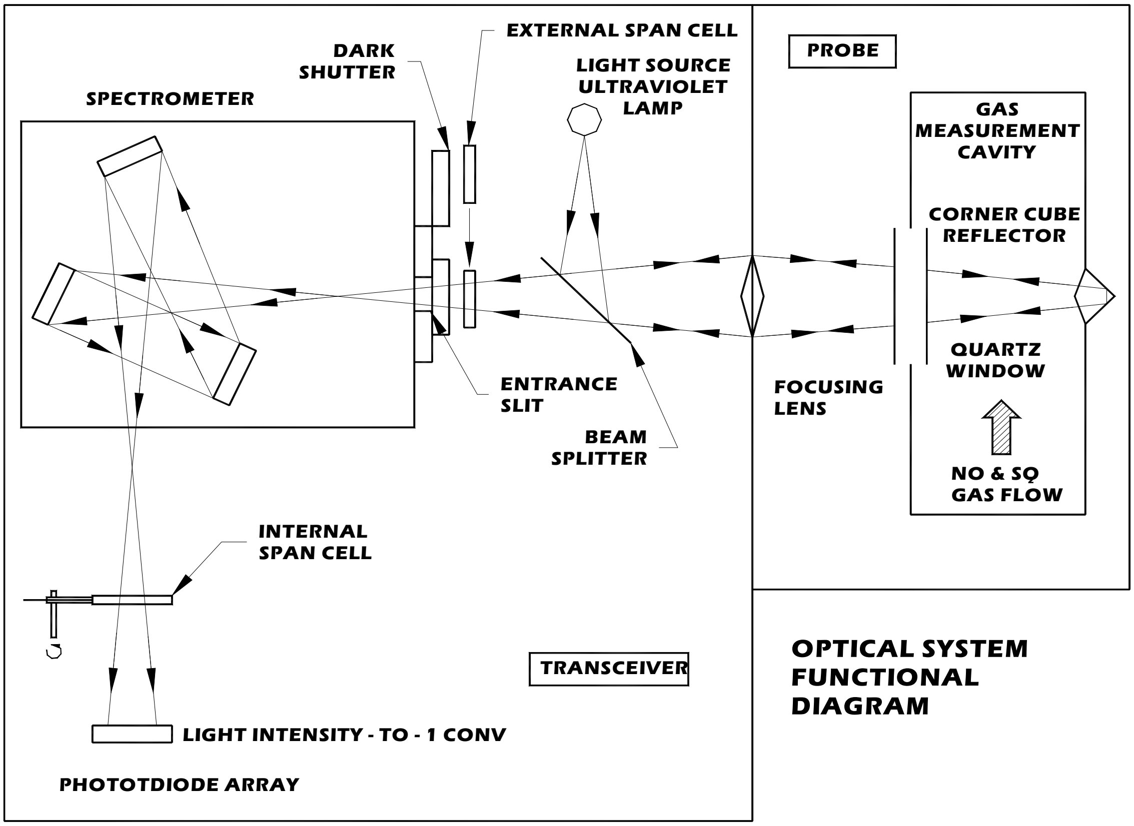

Figure 9-6: Optical System Functional Diagram

9.2.1 Transceiver Optics

The SM8200 contains an electronically-controlled UV lamp that emits a broadband UV light spectrum. The light from the lamp impinges on the partially transparent surface of a beam splitter. The light reflects off the surface of the beam splitter towards a focusing lens located at the probe entrance. The lens converges light rays along the probe length toward the gas measurement cavity. The UV light passes through a quartz window and traverses the cavity. Any NO or SO_2 gas present in the cavity absorbs some UV light, thereby reducing the light intensity at the absorption wavelengths.

A focused corner cube reflector (a prism with a curved front surface to maintain the light beam shape) at the opposite end of the cavity returns the UV light along a different path by the principal of total internal reflection at two prism sides. The reflected light traverses the cavity again, passes back through the quartz window, and travels the probe length to strike the focusing lens, which converges the light towards the beam splitter.

After passing through the beam splitter, the UV light converges to a focal point at the spectrometer entrance slit.

Spectrometer

The spectrometer is a self-contained unit that optically disperses light into the individual wavelengths needed for NO and SO_2 measurement from the focused UV light that passes through the entrance slit.

After the light passes through the entrance slit, it is reflected by a concave, collimating mirror that forms parallel (collimated) rays that impinge on a diffraction grating. The grating is a plane reflection-type with 2360 grooves per millimeter. It is a device that diffracts, or bends, incident light at angles that are a function of the light wavelengths. This is called dispersion. It means that light is angularly separated according to wavelength in a manner similar to a prism separating visible white light into its rainbow of colors.

After dispersion, the light rays are reflected from the grating. The angle of the light rays is determined by their wavelength. They are directed to a concave focusing mirror that reflects and converges the dispersed light into a continuous spectrum across the PDA surface.

Light Intensity-to-Current Converter

A Photodiode Array (PDA) converts the intensity of light exiting the spectrometer to 511 equivalent electrical charges corresponding to individual wavelengths nominally between 200 and 230 nm. At the end of each Charge Time cycle, the PDA charges are clocked out and converted to currents in the Preamp TE Cooler Board. These currents are converted to voltages, amplified and converted to digital codes by the AEB Motherboard, then accumulated in the boxcar integrator. At the end of an Integration Period, the accumulated values for each individual wavelength are processed digitally to produce concentration values.

9.3 ANALYZER ELECTRONICS SYSTEM

9.3.1 Preamp TE Cooler Board

The Photo Diode Array (PDA) is an N-MOS Linear Image Sensor used by the PDA Preamp/TEC Cooler PC Board in the Charge Integration Mode. In the Charge Integration Mode, the signal output is obtained in proportion to the product of light intensity and integration time. The current output type N-MOS Image Sensor consists of a photosensitive section, readout switch section and shift register, integrated into a single chip.

The shift register is comprised of N-Channel FETS. Phase 1, Phase 2 and Phase Start are input pulse pins used to operate the shift register. These external pulses are generated by the FPGA (Field Programmable Gate Array) located on the AEB Motherboard. When an external Phase Start pulse is introduced into the shift register with the two-phase clock pulses Phase 1 and Phase 2, the shift register begins operation and generates a train of address pulses to sequentially turn on the address switch beginning with the first Pixel. When one scan for all Pixels is completed, an END-OF-SCAN (EOS) pulse is output immediately after the last Pixel is read. The readout switch section consists of an address switch array made up of N-channel MOS FETS, with the source of each FET connected to the cathode of a photodiode while the drain and gate are connected to the video line and address pulse input. Each photodiode in the photosensitive section is connected to the video line via the individual address switch. When an address pulse is applied from the shift register the two address switches turn on at the same time, and the output signal is derived from the active video line. (See Figure 9-7).

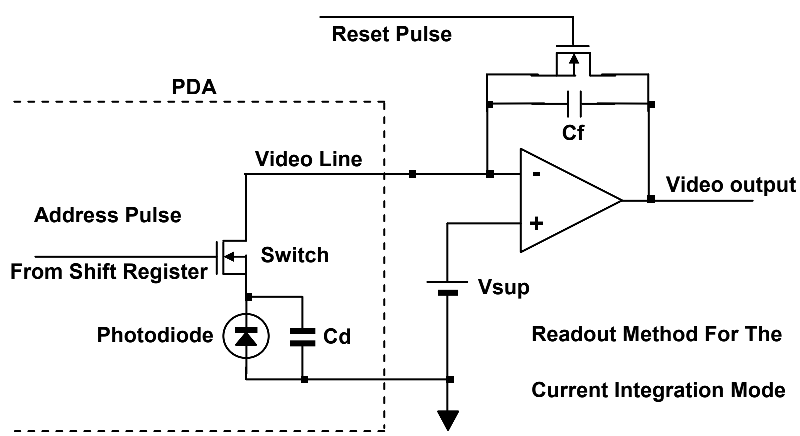

Figure 9-7: Readout Method for Current Integration Mode

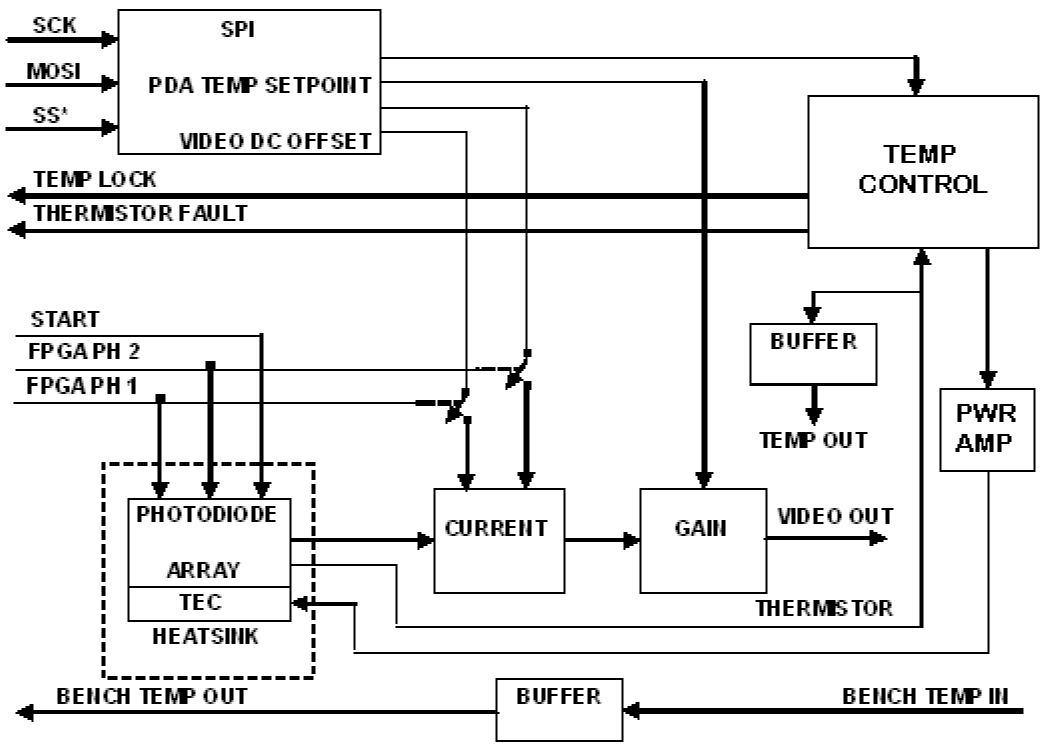

Figure 9-8: Preamp TE Cooler Board Block Diagram

9.3.2 AEB Motherboard

At the heart of the AEB Motherboard are two control devices a Field Programmable Gate Array (FPGA) and a self-contained computer processor module. The FPGA performs all of the low-level control functions of the transducer interface. The computer module is a stand alone, SBC 332 Processor Board that plugs directly into the AEB Motherboard. The computer module handles all calculations and higher level control/timing. Please refer to Figure 9-9.

The AEB Motherboard architecture is complex, as is the custom application software it runs. A detailed description of the board's electronics and software is beyond the scope of this manual. For ease of understanding, the Motherboard's function is described on a block diagram level.

The AEB Motherboard FPGA is SRAM-based; therefore its internal memory is volatile. Consequently, it must be configured each time power is cycled. This is done automatically with an IC known as a Configuration Device. The Configuration Device U5 is a flash memory that contains additional circuitry to control the serial loading of configuration data into the FPGA. The configuration data in U5 programs the gates and registers inside the FPGA to accomplish the board's design functions. It is important to realize this configuration is not the same as the monitor's calibration configuration, i.e. parameters such as PDA Properties, Cal Cycle Properties, etc., which are usually entered by menu selections via the Enhanced Remote Panel software.

Analog signals from various parts of the system enter the 4 channel analog multiplexer on the left of the block diagram. Three out of four of these signals are diagnostics (PDA Temperature, Cal Gas Heater Temperature and Bench Temperature) while the one remaining signal is the Video output corresponding to the spectra from which concentration measurements are made. This latter signal enters the AEB Motherboard via J16 (Upstream Path B). Next all four signals are conditioned by channel A of the dual 8 bit multiplying DAC (TLC7528), which is used in this case as a gain control. Each of the four input voltages to the multiplexer have their own 8 bit gain number, which is fed to the DAC via a gain control bus administered by the FPGA.

After gain control is accomplished, the output current of the DAC is converted back to voltage and fed to a 12 bit analog to digital converter (ADC). The ADC's output is input to the FPGA, whose internal logic controls the boxcar integration process. After completion of an Integration Period, the FPGA interrupts the SBC332 host processor to signal that it is time to read the boxcar results and process the spectra into concentrations.

9.3.2.1 Diagnostic Test Point TP21

The AEB Motherboard has an important built in diagnostic feature. Eight different signals can be viewed from test point 21 (TP21) depending on the configuration of the diagnostic jumpers of JU8. The FPGA places the digital data selected by JU8 (positions A, B or C) on a twelve-bit buss that connects to a digital to analog converter (DAC). The DAC sends an analog representation of the data through a buffer to TP21. This gives the user a way to view complex data such as the integrated spectral data that exists only in the digital realm.

DIAG_2 (JU8C)	**DIAG_1** (JU8B)	**DIAG_0** (JU8A)	**Diagnostic Output**
0	0	0	A/D Output
0	0	1	Boxcar (6--17)
0	1	0	Boxcar (7--18)
0	1	1	Boxcar (8--19)
1	0	0	Boxcar (9--20)
1	0	1	Boxcar (10--21)
1	1	0	Boxcar (11--22)
1	1	1	Boxcar (12--23)

Table 9-1: TP21 Jumper Settings

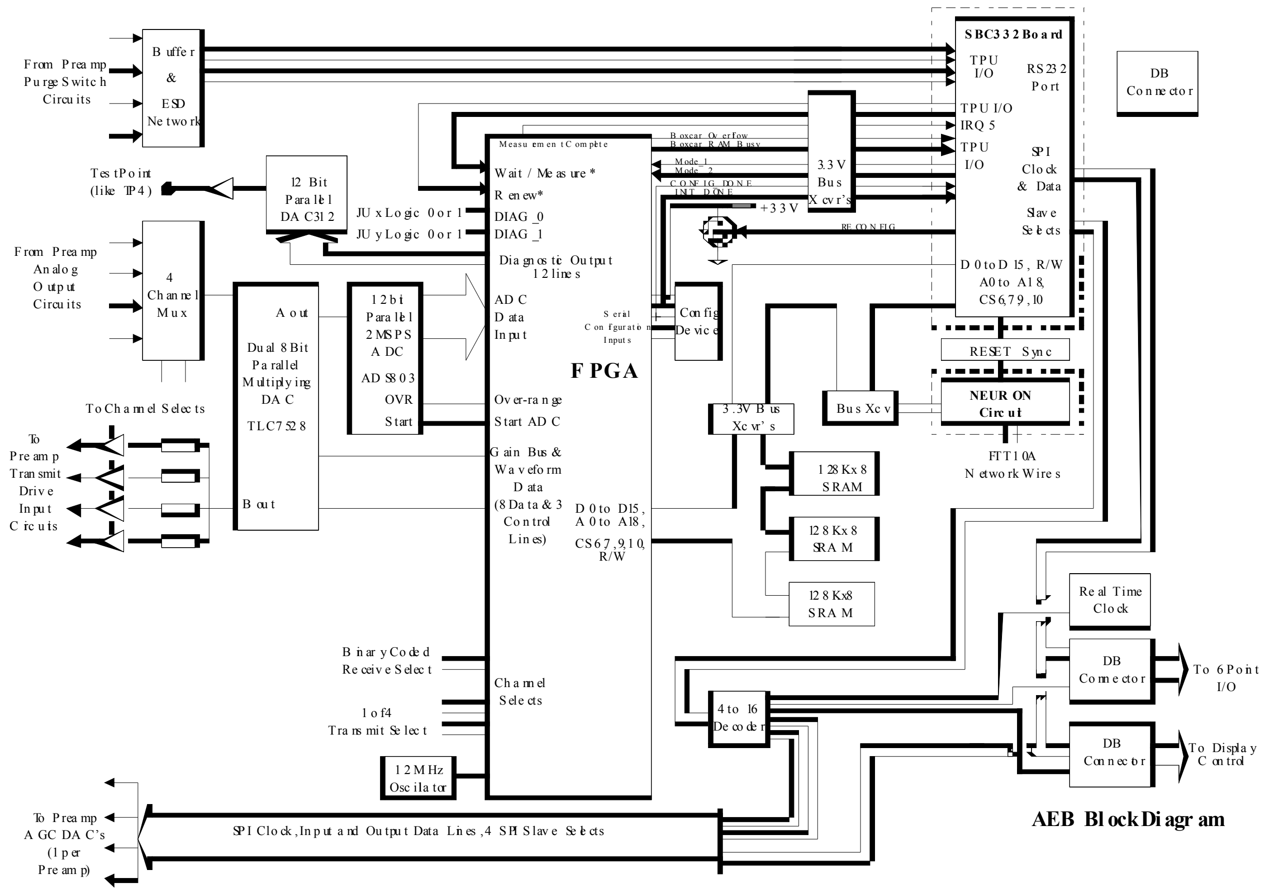

Figure 9-9: AEB Motherboard Block Diagram

9.3.2.2 Bus Transceivers and Logic Level Differences

The digital components of the AEB Motherboard operate with three different logic levels. The FPGA's internal logic uses 2.5 VDC. Its I/O logic requires 3.3 VDC. The SBC 332 Processor and Neuron Circuit use conventional 5.0 VDC logic. Bus transceivers are used to convert logic from one level to another wherever needed.

9.3.2.3 On Board D.C Supplies

The AEB Motherboard has circuits to produce the following D.C. supply voltages:

- +2.5 VDC---Used for FPGA Core functions
- +3.3 VDC---Used for FPGA I/O functions
- +5.0 VDC---Used for analog functions

- -5.0 VDC---Used for analog functions
- +130 VDC---Not used on the SM8200

9.3.2.4 External Serial Data Connections

The AEB Motherboard supports both synchronous and asynchronous serial devices. All synchronous serial devices are for use by SM8200 components, most of which are on AEB circuit boards external to the AEB Motherboard.

The AEB Motherboard supports one RS232C asynchronous serial port for use with Teledyne Monitor Labs' PMODBUS software. This port is accessible through DB9 connector J9.

9.3.2.4.1 Synchronous Serial Devices

The AEB Motherboard employs 11 synchronous serial device channels. The Serial Peripheral Interface (SPI) standard is used to convey data to the I/O devices. The Computer Module Board acts as the master SPI device and hence controls access. All of the devices are on external circuit boards with the exception of the real time clock. The devices are listed below.

0) Preamp TEC Cooler Digital Pot Control
1) Probe Heater Set point Control
2) Cal Gas Heater Set point Control
3) Local User Interface LED Display
4) Local User Interface Keypad
5) Auxiliary I/O Analog Input (Stack Pressure)
6) Auxiliary I/O Analog Input (Stack Temperature)
7) Auxiliary I/O Isolator Inputs
8) Auxiliary I/O Relay Outputs
9) Real Time Clock (Internal to AEB Motherboard)
10) O2 IO Analog Input

9.3.2.4.2 AEB Asynchronous Serial Port

AEB Motherboard DB9 connector J9 is an RS232C serial port. This is a three wire serial port that does not support frame control. Modbus protocol is used to communicate with an optional test and configuration program. The communication port parameters are listed in Table 9-2.

Table 9-2: AEB RS232C Serial Communication Parameters

BAUD RATE	STOP BITS	DATA BITS	PARITY
9600	1	8	NONE

9.3.2.5 Computer Module Board

The Computer Module is a stand-alone Processor Board that plugs horizontally into the AEB Motherboard. The Processor is an MC68332. The application software is loaded into two flash memory chips U1 and U5. Two SRAM's are used for working memory. The Computer Module reads the integrated receive window data from the AEB Motherboard RAM, and performs many spectral processing, concentration, pressure and temperature calculations. It handles all of the calculations except some floating point calculations, which are performed by a coprocessor in the FPGA, and controls all serial communication to and from the AEB. An RS232 serial port is supported by the Computer Module, which speaks a custom "Modbus" protocol. A software tool (PMODBUS) is available that allows the operator to communicate with the AEB through the serial port.

9.3.3 UV Lamp Power Supply

The UV lamp power supply is designed to drive a Deuterium lamp. Initial lamp heating is achieved with lamp filaments (red DS2 LED on) and then maintained by the power dissipated by the arc discharge and a lower idling level of filament power. After the lamp has been warmed up by its filaments (approximately 20 to 30 seconds), the lamp requires a high voltage drive at low current to strike an arc, then a lower voltage drive at the operating current. Lamp start circuit uses a timer circuit to control the application of the starting filament voltage.

During the startup sequence the supply ramps up toward 450 VDC and the lamp fires when its strike voltage potential is reached (about 350 VDC). The current regulation circuit attempts to deliver 300 mA by driving the anode toward ground, so its output holds the lamp cathode near 0 volts. The lamp anode attempts to draw 300 mA, which loads down the lamp start supply, and the lamp anode voltage drops to the level of the lamp run supply (about 80 to 90 VDC). The anode current increases until the lamp current equals the current regulation circuit output. The lamp run supply detects that the cathode voltage is above its set point of 3 volts and decreases the anode voltage until the cathode voltage is at its set point.

The Lamp On detector detects that the lamp cathode is above 1.5 volts and turns off the lamp start supply. Once the lamp is on, the green DS3 LED lights, then the Lamp On detector and the lamp start logic hold off the lamp start supply and the filament switch. If for some reason the lamp goes out, the lamp starting sequence repeats and restarts the lamp.

The current regulation operational amplifier U1 C is configured as a voltage follower driving a MOSFET (Q2). The amplifier turns on the MOSFET until the voltage drop across R4 is equal to the R6 set point. Because little current is drawn through the MOSFET gate, the MOSFET drain current equals the current flowing through R4. The circuit requires that the load be connected to a positive supply. The drain voltage rises toward this supply until the load current equals the current through R4.

The current regulator circuit accurately maintains the current through R4 once it has achieved steady state. However, when the lamp is being fired, the op amp output is at the positive stops of +15 volts, attempting to increase the current through R4. With this gate bias, the MOSFET is fully on and looks like a 2 ohm resistor. When the lamp turns on, the surge current would be approximately several amps until the op amp output could slew to its steady state output. However, transistor Q3 with its base emitter across R4 limits this surge current to 0.7 amps. When the voltage across R4 reaches 0.7 volts, the transistor turns on and stops any further increase in the gate voltage of the MOSFET. This limits the current to 0.7 amps. Under normal running conditions where the drop across R4 is 0.3 volts, this transistor is off.

The filament heater is driven by a MOSFET (Q1). When Q1 is on, the filament runs at its start voltage of 10 VDC. When Q1 is off, R1 limits the filament voltage to the running voltage of approximately 3 VDC. The filament supply voltage is provided by the DC3 DC-DC converter, which takes the -24 VDC input power supply and converts it to +10 VDC.

The lamp start supply uses the energy stored in an inductor to charge capacitor C5 to about 450 volts. Each time the MOSFET Q10 turns on, energy is stored in inductor L2 and transferred to the capacitor due to fly back action. This action pumps up the capacitor voltage until the voltage feedback to the comparator turns off the MOSFET. The maximum output voltage from this circuit is limited by either the rate of change of current through the inductor or the feedback to the comparator. When the output exceeds 450 volts, the comparator turns off the MOSFET, driving the inductor until the output voltage bleeds down below 450 volts.

The lamp run supply uses a pulse-width modulator (PWM) driving two MOSFETs, Q7 and Q8, in a push-pull configuration. The output filter is an LC filter, so the output voltage is the average of the full-wave rectified signal. The period is fixed at about 15 μs and the on time is a variable controlled by the PWM integrated circuit. As the on time increases, the average output voltage increases.

The circuit has two control loops controlled by two different error amplifiers within U3. The amplifier outputs are designed so that the amplifier trying to decrease the output has control. Amplifier U3-5, 16 is normally active and amplifier U3-1, 2 is inactive. Amplifier U3-15, 16 is designed to hold the voltage across the current regulator to 3 volts. A feedback resistor from pin 3 to pin 15 of the PWM U3 reduces the control loop gain, making the loop easier to stabilize. A parallel capacitor decreases the gain with frequency to ensure stabilization.

Current-sensing resistor R16 is in the current return leg of the lamp run circuit output. This resistor limits the short circuit current in the event the lamp anode is shorted to ground. This resistor is 1 ohm and the current-limiting op amp (U3-1, U3-2) is biased to 0.5 volt, so the short circuit current is limited to 0.5 Amps. Note that the voltage fed back from the current-sensing resistor is negative.

9.3.4 Auxiliary IO Board

The Auxiliary IO Board can accept two analog inputs, used for Stack Temperature and Pressure sensing, and produce up to 8 discrete outputs. The discrete outputs are used to control the gas solenoids, the EO Cal solenoid, the Dark Shutter and four relays on the Relay Output Board. The relays are used to control the optional Cylinder Gas Audit Box and the UV Lamp Filament Shutdown signal. The Auxiliary IO Board can also accept up to two discrete inputs.

Stack Temperature Circuit

The Auxiliary IO Board stack temperature measurement circuit is configured for operation with a 100 ohm RTD temperature sensor. Though the circuit design is jumper selectable (JU11) to support 4-20 mA or 0-5 VDC input devices, the software will only support RTD's.

The RTD connects between J3 terminals 2 and 3. These terminals feed a bridge circuit that is fed by a +10VDC voltage reference. Instrumentation amplifier U8 amplifies the bridge circuit resistance difference by a factor of 10. Amplifier circuit U9 provides gain, offset (via R15) and gain (R20) trimming. Isolation amplifier U10 provides galvanic separation between the RTD circuit and the rest of the board. Analog-to-digital converter U11 turns the 0 to 2.5 V voltage at TP9 into a 12 bit binary serial data stream for synchronous serial peripheral interface to the Single Board Computer.

Stack Pressure Circuit

The stack pressure circuit operates in a similar manner to the stack temperature circuit. The major differences are:

- ❑ There is no equivalent to U8 since the pressure circuit only supports 4-20mA and 0-5 VDC inputs so there is no need for an instrumentation amplifier.
- ❑ Since the stack pressure transducer power is supplied by the +15 VDC source on the UV Lamp Power Supply, the galvanic isolation provided by U3 is overridden since the circuits share a common ground point.

Relay and Discrete Output Circuit

Slave select SS12 strobes synchronous serial data from the MOSI (master out slave in) line of the Single Board Computer into shift register U14. Shift register U14 converts the serial stream into parallel outputs that drive open collector transistor circuits Q1 through Q7. The first four open collector outputs drive, respectively, the Dark Shutter, the E/O Cal Solenoid, the Zero Gas Solenoid and the Span Gas Solenoid. The upper four open collector outputs feed the Relay Board, which is used to control the CGA Box solenoids and the UV Filament ON/OFF control.

Discrete Input Circuit

The discrete input circuit of the Auxiliary IO Board employs optical isolators that can be actuated from isolated DC power supplies between 5 and 24 VDC. The circuit is jumper selectable via JU6 and JU7 to operate in a dry contact input mode (DRY position) where the +5VDC supply of the analyzer provides power to operate the isolators. Dry contact is the default mode of operation for the board since the Auxiliary IO Board discrete inputs are designed to interface to an ML O2 analyzer.

Slave select SS10 latches the isolator states into shift register U19 then conveys the serial data via tri-state buffer U6 to the Single Board Computer on the MISO (master in/slave out) data line.

9.3.5 O2 IO Board

The O2 IO Board serves two primary purposes:

- ❑ translation of a linear 4-20 mA analog signal from a diluent analyzer into serial digital codes for synchronous serial interface to the Single Board Computer Board on the AEB Motherboard (the O2 IO Board can also support a 0-5VDC input signal)

- ❑ conversion of the ZERO, SPAN and EO Cal solenoid signals into two signals to properly trigger zero and span gas solenoids in the diluent analyzer so that its calibration cycle can be slaved to the SM8200's

The O2 IO Board mounts on top of the Auxiliary IO Board and plugs into connectors A1J1 and A1J2. It receives its power supply (+5VDC) from the Auxiliary IO Board and manufactures all of its other operating voltages from this supply. DC to DC converters U6 and U7 produce the ±15 VA and ±15 V supply voltages to run the board in manner that provides galvanic isolation between the SM8200 and the diluent analyzer.

The analog 4-20mA circuit on the O2 IO Board is very similar to the Stack Temperature circuit on the Auxiliary IO Board. The principle difference is that the O2 IO Board is not working with a resistive transducer and thus does not have a bridge circuit input and voltage reference.

The diluent analyzer 4-20mA signal enters the board via terminals 3 and 4 (instrumentation amplifier U2 is not currently in use). Jumper JU4 is set to position CUR (3-4) for 4-20mA operation. Amplifier circuit U3 provides gain, offset (via R10) and gain (R12) trimming. Isolation amplifier U4 provides galvanic separation between the diluent analyzer circuit and the rest of the board. Analog-to-digital converter U5 turns the 0 to 2.5 V voltage at TP9 into a 12 bit binary serial data stream for synchronous serial peripheral interface to the Single Board Computer.

Transistors Q1 through Q4 provide the logic and drive relays K1 and K2, which respectively provide contact closures for the ZERO and SPAN gas solenoids of the diluent analyzer. Since the EO Cal control logic in the SM8200 software must energize its own zero gas solenoid to evacuate sample gas from the measurement cavity, additional hardware logic is necessary so that the diluent analyzer cal gas solenoids are controlled in the proper manner. See Table 9-3 for a truth table that illustrates the operation of the O2 IO's transistor logic circuit.

The analog signal sent to the O2 IO Board can be displayed on the ERP page 9 screen. The diluent type must be changed to O2 on the ERP change diluent screen. Scaling is done by noting the Aux input 1 counts O2 on the ERP Temperature & Pressure counts screen. (Note both a high and low count are needed). The O2 counts, high and low values, and faults are set in the ERP Aux inputs 1 screen.

	SM8200 Signal Name			O2 IO K1 Relay (ZERO)	O2 IO K2 Relay (SPAN)
SM8200 MODE	**EO CAL SOLENOID**	**ZERO GAS SOLENOID**	**SPAN GAS SOLENOID**		
NORMAL	OFF	OFF	OFF	OFF	OFF
EO CAL SPAN	ON	ON	OFF	OFF	ON
ZERO	OFF	ON	OFF	ON	OFF
SPAN (with BOTTLED GAS)	OFF	OFF	ON	OFF	ON

Table 9-3: Truth Table

9.3.6 Cal gas heater board

NOTE: *It is important for proper operation of the Cal Gas Temperature diagnostic that jumpers JU2 and JU3 both be in the CG position (pins 2-3 connected).*

The optional Cal Gas Heater Board supplies additional thermal energy to calibration gases to preheat them prior to their entry into the probe. It is typically used when the calibration gases for the analyzer are stored at very low ambient temperatures. There are two indicating LED's on the board that provide visual clues as to the state of the control system. D14, the red LED, lights whenever power is applied to the Cal Gas Heater element; and D13, the green LED, lights whenever temperature lock is achieved.

The Cal Gas Heater Board receives a temperature command from the AEB Motherboard that matches the measured Stack Temperature. This command signal enters the board via the synchronous serial interface signals on connector J3 from J11 of the AEB Motherboard. The 12 bit serial digital-to-analog converter (DAC) U2, along with op amps U3A and U3B convert the digital command to an analog voltage between 0 and +5 VDC. The scaling of the command voltage is 10mV/degree Fahrenheit, thus the maximum command is 5oo degrees Fahrenheit.

Temperature feedback is derived from a 100 ohm RTD that is integral to the Cal Gas Heater assembly. The RTD signal is conditioned by op amps U3C and U3D to a -10mV/degree Fahrenheit signal that can be measured at TP12. The temperature feedback and command signals are compared by error amplifier U5B (U5B is output TP10). Op amps U5C and U5D provide jumper selectable proportional and integral control while op amp U4C sums the proportional and integral error signals.

A low frequency triangular wave oscillator (U8A and U8B) is used to improve control dynamics of the system. Test point TP14 contains the output of the oscillator, which is compared to the controller output (TP16) by comparator U9A. The output of U9A is configured for wired-OR operation with U9B, acting as a high temperature limit shutoff. The parallel outputs of U9A and U9B control the optically isolated zero crossing triac U10, which in turns controls the Q3 power triac that actually modulated power to the Cal Gas Heater element.

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SM8200 SPARE PARTS LIST

REVISION HISTORY

B	See DCN SM82000182B / ECO 6965	10/22/10	CAD	JR
A	Release Per DCN SM82000182A/ECO 6798	12/4/08	CAD	GFM
LTR	DESCRIPTION	DATE	INCORP	APPR

Level 1: Consumables, Level 2: Non-routine Replacements, Level 3: Max Uptime.

SM8200 SO_2/NO Analyzer Spare Parts Analyzer Electronics Box (AEB) Assembly		
Description	**Part Number**	**Level**
Air filter, 23 micron fibre, disposable filter unit (DFU)	036-040180	1
Valve, Solenoid Brass, NC, 24 vdc	45000181-6	2
Valve, Solenoid Stainless Steel, NC, 24 vdc	45000181-7	2
Air Pressure Regulator	28000339	3
Gauge, Pressure, 0 to 30 psig	29000205	3
Gauge, Pressure, 0 to 15 psig	29000226	3
Transducer Assembly, Pressure	82000072	3
Check valve (2 needed)	28001347	3
Printed Circuit Assembly, Relay board	82000006	3
Printed Circuit Assembly, UV Lamp Power Supply	82000012	3
Printed Circuit Assembly, Aux I/O	82000003	3
Printed Circuit Assembly, AEB Motherboard, complete with plug-in computer module	1903-0100-08	3
Printed Circuit Assembly, O2 I/O (option)	82000133	3
Printed Circuit Assembly, Cal Gas Heater(option)	82000015	3
Power Supply, 24 vdc	523888	3

SM8200 SO_2/NO Analyzer Spare Parts Transceiver Assembly		
Description	**Part Number**	**Level**
Cartridge, Desiccant	16000053	1
Lamp Assembly, Ultraviolet (Maintain at least 1 spare)	39000087	1
Beam Splitter/holder Assembly	82000088	1
Fuse, Thermal overtemp cutoff	53000093-2	2
Temperature Controller Assembly, Optical plate	53000033-2	2
Crib sheet, LUI	82000118	2
Solenoid, Dark shutter	22000015-2	2
Solenoid, Span cell	22000015-2	2
Span Cell Assembly, Internal	81000167SP-2	3
Printed Circuit Assembly, PDA Preamp	82000195	3
Keypad assy, LUI	82000080	3
Lens Assembly, Singlet Focusing	81000157-3	3
Lens Assembly, Doublet Focusing	82000126	3

SM8200 SO2/NO Analyzer Spare Parts Probe Assembly		
Description (Select for probe length/material & cavity size)	**Part Number**	**Level**
Filter, Ceramic, 0.625 to 10 cm Cavity	28000262	1
Filter, Ceramic, 15 to 20 cm Cavity	81000935-1	1
Filter, Ceramic, 30 cm Cavity	81751229	1
Filter Assembly, Ceramic, 37.5 cm Cavity	81750105-1	1
Filter Assembly, Ceramic, 50 cm Cavity	81750105-5	1
Filter Assembly, Ceramic, 75 cm Cavity	81750105-2	1
Gasket, Ceramic Filter, 30 cm cavity and smaller	81000205	1
Gasket, Ceramic Filter assy, 37.5, 50,75 cm Cavity	81001137	1
Gasket, Between probe and mounting flange	81750564	1
Ring, Grafoil for window assy	81000790-2	1
Window Assembly, 316SS	81000789-2*	2
C-ring, 1.75 inches for 37.5, 50, 75 cm cavities	28001075-2	2
C-ring, 0.375 inches for 37.5, 50, 75 cm cavities (3 needed)	28001075-1	2
Cube, Corner for cavities less than 1.25 cm	Consult factory	3
Cube, Corner, for 18 Inch Probe	20400-5007-2	3
Cube, Corner, for 4 Foot Probe	20400-5007-3	3
Cube, Corner, for 6 Foot Probe	20400-5007-4	3
Cube, Corner, for 8 Foot Probe	20400-5007-5	3
Probe, RTD, 316SS, for 18 Inch Probe & < 37 cm cavity	53000188-7*	3
Probe, RTD, 316SS, for 4 Foot Probe & < 37 cm cavity	53000188-8*	3
Probe, RTD, 316SS, for 6 Foot Probe & < 37 cm cavity	53000188-9*	3
Probe, RTD, 316SS, for 8 Foot Probe & < 37 cm cavity	53000188-10*	3
Probe, RTD, 316SS, for 4 Foot Probe & 37.5/50 cm cavity	53000216-2*	3
Probe, RTD, 316SS, for 6 Foot Probe & 37.5/50 cm cavity	53000216-4*	3
Probe, RTD, 316SS, for 4 Foot Probe & 75 cm cavity	53000216-1*	3
Probe, RTD, 316SS, for 6 Foot Probe & 75 cm cavity	53000216-3*	3

SM8200 SO_2/NO Analyzer Spare Parts Enhanced Remote Panel (ERP) Assembly		
Description	**Part Number**	**Level**
Printed Circuit Assembly, ERP Motherboard, complete with plug-in computer module	1803-2200-05	3
Printed Circuit Assembly, Multi I/O board (ERP)	1803-2500-07	3
Printed Circuit Assembly, Multi I/O board (MIO Module)	1803-2500-08	3
Printed Circuit Assembly, Power Supply	1803-0300-02	3
Printed Circuit Assembly, Ethernet Module (ERP)	1903-2010-04	3
Front panel assy	1803-0100-03	3

SM8160 SO_2/NO Analyzer Spare Parts Maintenance Kit		
Description	**Part Number**	**Level**
Cloth, Polishing, Lint-Free (for transceiver lens)	25000393	1

* For 316L stainless steel probes/instruments only, call the factory for availability of Hastelloy probe components.

SM8200 Checksheet

TELEDYNE MONITOR LABS
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Date	
Serial#	
Company	
Site	
Zip Code	
Field Engineer	

Contact Email	
Unit ID	

☐ If faults exist prior to PM or in History list below

Cal Type
- ○ Gas
- ○ EO

Data

	As Found	As Left
PDA TEMPERATURE		
BENCH TEMPERATURE		
CAL GAS TEMP		
PROBE TEMPERATURE		
STACK TEMPERATURE		
STACK PRESSURE		
NO offset		
NO slope		
SO2 offset		
SO2 Slope		
Mean dark current		
Mean reference		
PDA VIDEO GAIN		
ZERO SET POINT for NO		
SPAN SET POINT for NO		
EO CAL SET POINT for NO		
NO Curve Type:		
A0 OR X1		
A1 OR Y1		
A2 OR X2		
A3 OR Y2		
A4 OR X3		
A5 OR Y3		
ZERO SET POINT for SO2		
SPAN SET POINT for SO2		
EO CAL SET POINT for SO2		

SM8200 Checksheet

TELEDYNE MONITOR LABS
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Date	
Serial#	
Company	
Site	
Zip Code	
Field Engineer	

Contact Email	
Unit ID	

	As Found	As Left
SO2 Curve Type:		
A0 OR X1		
A1 OR Y1		
A2 OR X2		
A3 OR Y2		
A4 OR X3		
A5 OR Y3		
NO Gain		
SO2 Gain		
EO Cal Temp		
Reference Pressure		
NO ZERO AVERAGE		
NO SPAN AVERAGE		
SO2 ZERO AVERAGE		
SO2 SPAN AVERAGE		
O2 ZERO		
O2 ZERO SET POINT		
O2 SPAN		
O2 SPAN SET POINT		

Gas Flow

Instrument Air PSI Gauge		
Cal Gas Flow Rate in LPM or PSI Gauge		

SM8200 Checksheet

TELEDYNE MONITOR LABS
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Date	
Serial#	
Company	
Site	
Zip Code	
Field Engineer	

Contact Email	
Unit ID	

AEB, Probe and Tranceiver Checks

AEB	corrosion free, wiring & hardware tight	
	Zero and Span solenoids quiet	
	Purge air filter free of oil & water	
	DFU Filters	
	J-Box Gasket	
	Power Supply within tolerances	
Probe	Probe Inspected	
	Cermaic Filter	
	Corner Cube	
	Grafoil Seal	
	Window	
	Alignment Rings	
Transceiver		
	Lamp	
	Beam Splitter	
	Focus Lens	
	Dark Shutter Solinoid	
	EO Cal Solinoid	
	EO Cal Cell	
	Dessicant	

Notes/Work Performed

List Parts Replaced:

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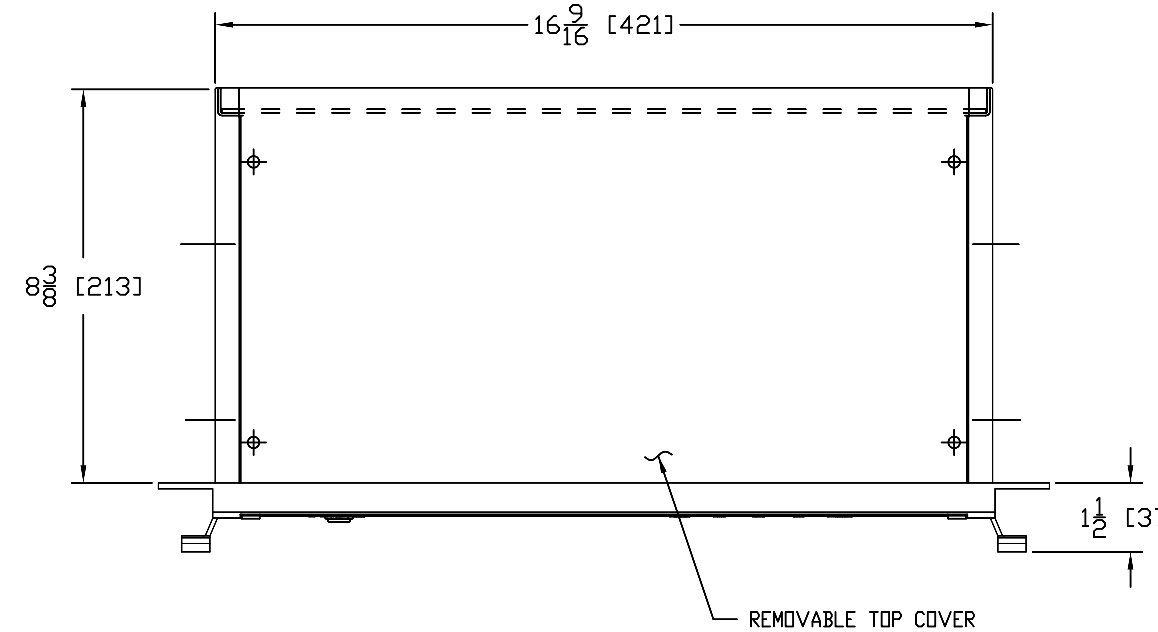
APPENDIX C – SM8200 ENGINEERING DRAWINGS

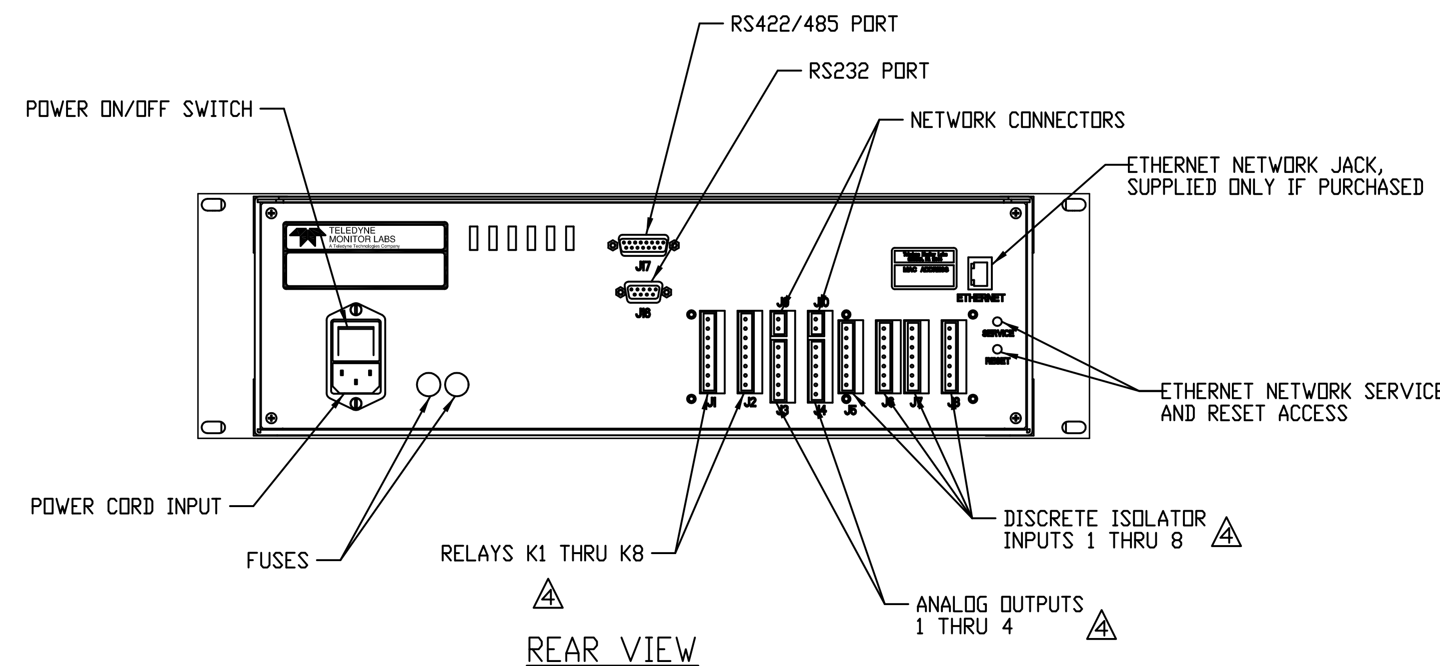
Table C-1: List of Included Engineering Drawings

Document #	Document Title
1803-2003	Enhanced Remote Panel Assembly, W/New Case
1804-1001	Multi I/O Module Assembly, Customer Outline
82000050	Site Installation W/Optional Cal Gas Heater And System Interconnect, SM8200
82000119	Pneumatic Diagram, SM8200
82000134	Plant I/O Assembly, Customer Outline
82000159	Customer Outline Drawing, CGA Box, SM8200

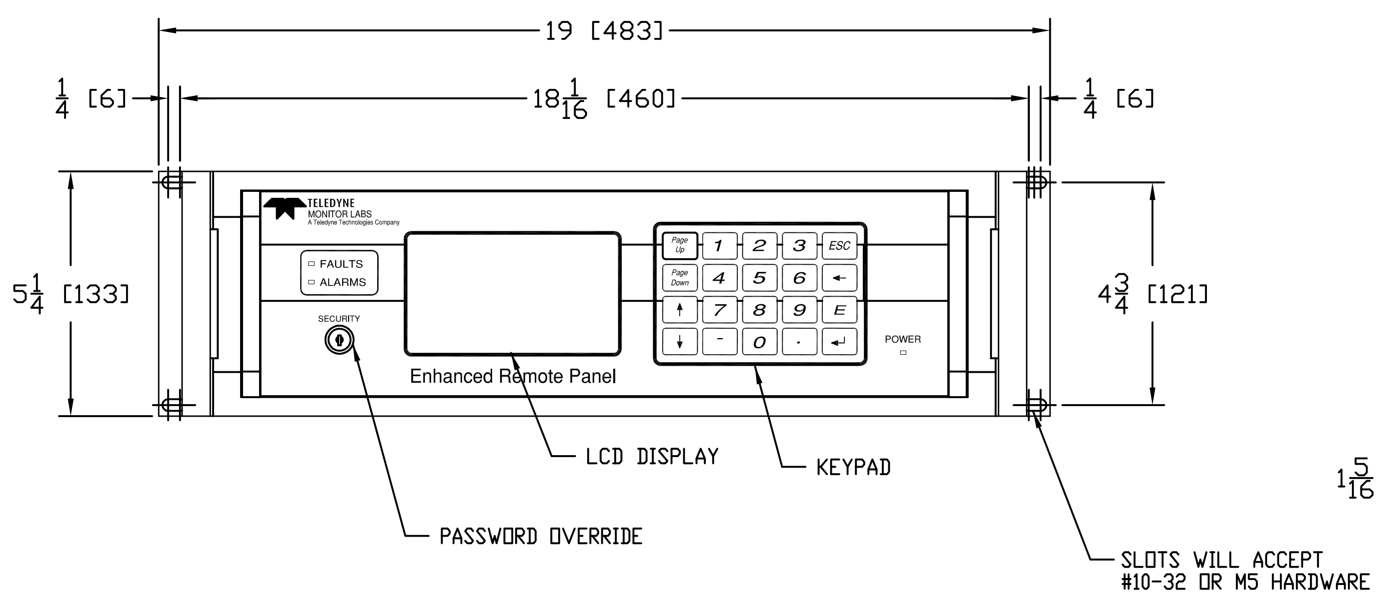
DWG. NO 1803-2003 SH 2

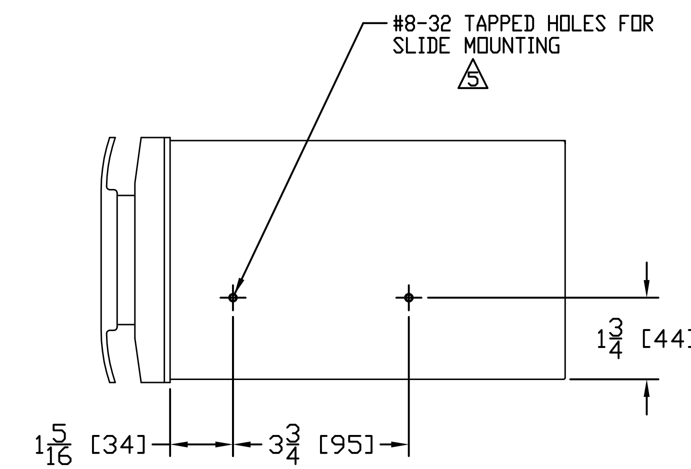
REVISIONS				
ZONE	SYM.	DESCRIPTION	DATE	APPD.
	B	PER DCN #1803-2003B	7-16-02	ELM
	C	PER DCN 1803-2003C	4-1-03	DMB
	D	PER DCN 1803-2003D	12-4-06	DMB
	E	PER DCN 1803-2003E	6-1-07	ELM
	F	PER DCN 1803-2003F	10-7-08	ELM





REAR VIEW





5. SLIDES ARE AVAILABLE AS AN OPTION. CONSULT FACTORY
4. THESE FEATURES ARE FUNCTIONAL ONLY IF INTERNAL I/O PC BOARD IS PURCHASED.
3 MINIMUM REAR CLEARANCE 5"(127mm)
2 DIMENSIONS IN () ARE METRIC
1 DISPLAY FITS IN STANDARD 19"(482.6mm) RACK MOUNT, 5-1/4" (3U) HIGH CHASSIS

NOTE:

CUSTOMER OUTLINE DRAWING

DIMENSIONAL TOLERANCES UNLESS OTHERWISE SPECIFIED
FRACTIONS: 0 TO 4 ±1/32; 4 TO 8 ±1/16; 8 AND UP ±1/8
DECIMALS: .XX ±.01; .XXX ±.005
ANGLES: ±0°30'
RMS FINISH ✓
ALL DIMENSIONS ARE IN INCHES
DO NOT SCALE THIS DRAWING

USED ON

DASH NO	NEXT ASSEMBLY
-02	

AUTHORIZATION	BY	DATE
DRAWN	EAS	16-Jul-02
CHECKED	EAS	7-18-02
DESIGNED	EAS	Jul-02
ENGINEERED	ELM	7-24-02
PRODUCTION	PD	7-24-02
Q.A.	AS	7-24-02

PROJECTION

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TITLE: TML ENHANCED REMOTE PANEL ASSEMBLY, W/NEW CASE

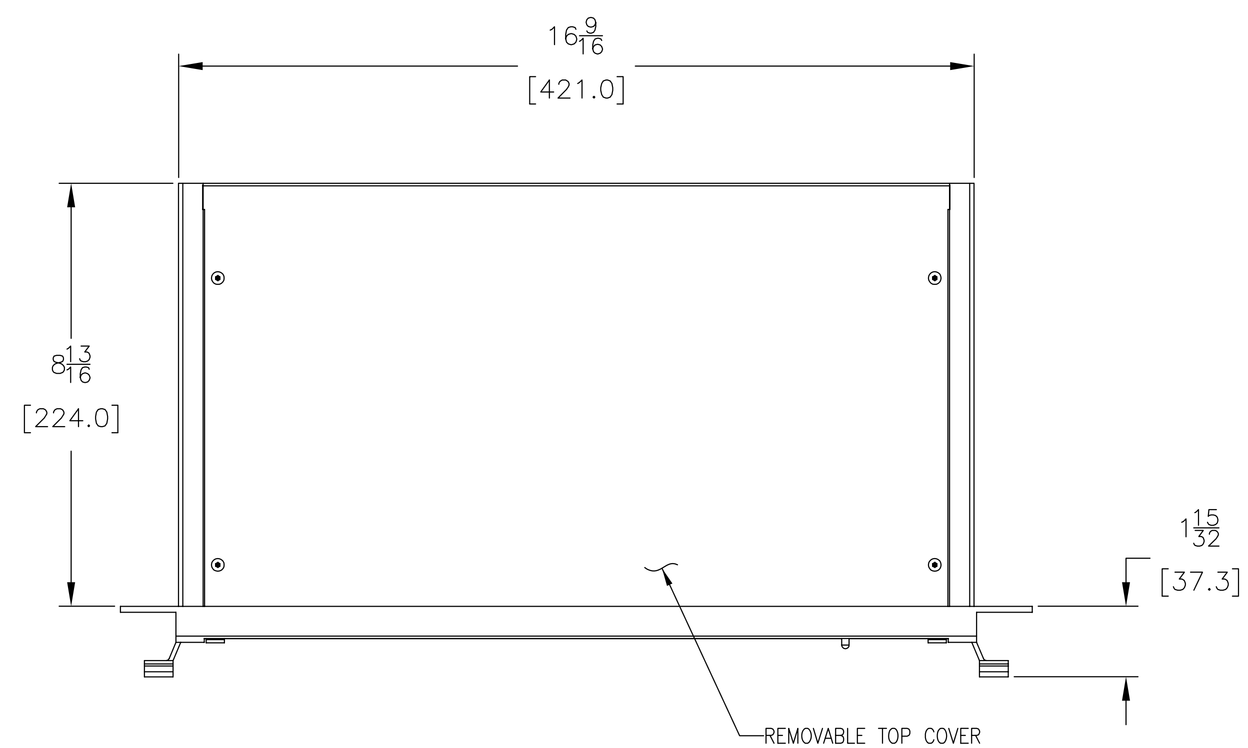
MAT'L.

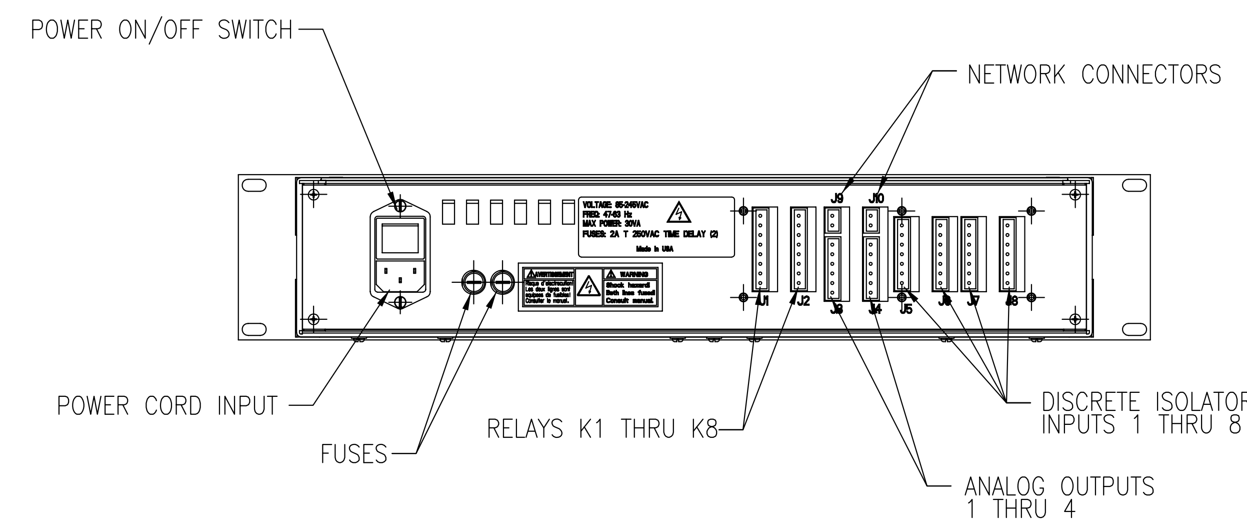
FINISH

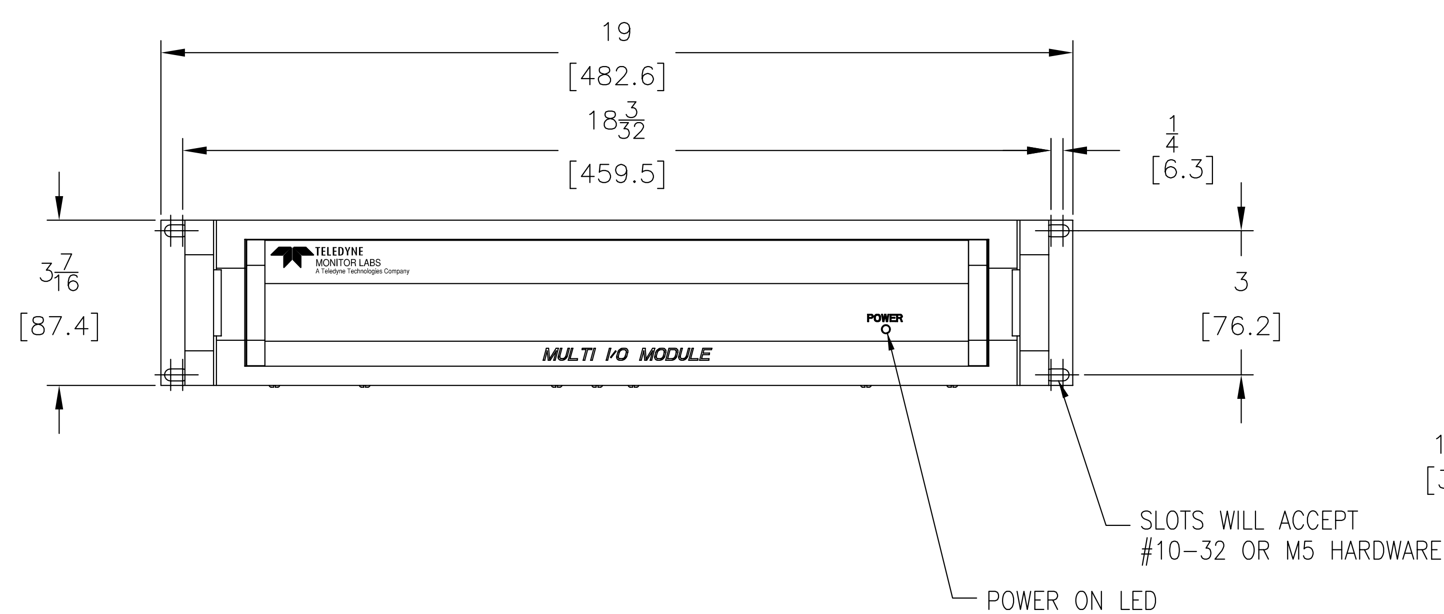
JIG NO.

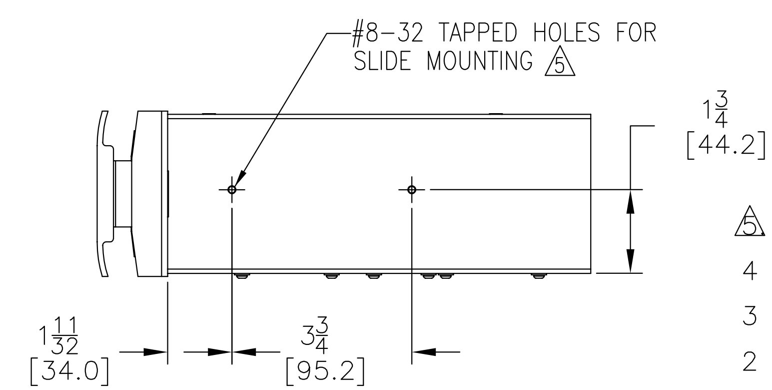
SCALE 1/2 | SHEET 2 OF 2 | D | DRAWING NO. 1803-2003 | LATEST REVISION F

REVISIONS						
REVISED BY: EAS	APPR. BY: ELM	REV. A	2/26/09	SEE DCN	NA	FOR CHANGE DESC. REF ECO# 1017









NOTE:

1. DISPLAY FITS IN STANDARD 19"(482.6mm) RACK MOUNT, 3-1/2" (2U) HIGH CHASSIS
2. DIMENSIONS IN [ ] ARE METRIC
3. MINIMUM REAR CLEARANCE 5"(127mm)
4.
5. SLIDES ARE AVAILABLE AS AN OPTION. CONSULT FACTORY

CUSTOMER OUTLINE DRAWING

NEXT ASSEMBLY	USED ON
FINAL	SM8200

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE INCHES
TOLERANCE ON DECIMALS .X± .1 .XX± .02 .XXX± .010
TOLERANCE ON ANGLES ± 0°30'
DO NOT SCALE DRAWING
MATERIAL

DRAWN BY EAS — DATE 2/22/08
FINISH – BREAK ALL SHARP EDGES 125
THIRD ANGLE PROJECTION
FINISH

TELEDYNE MONITOR LABS
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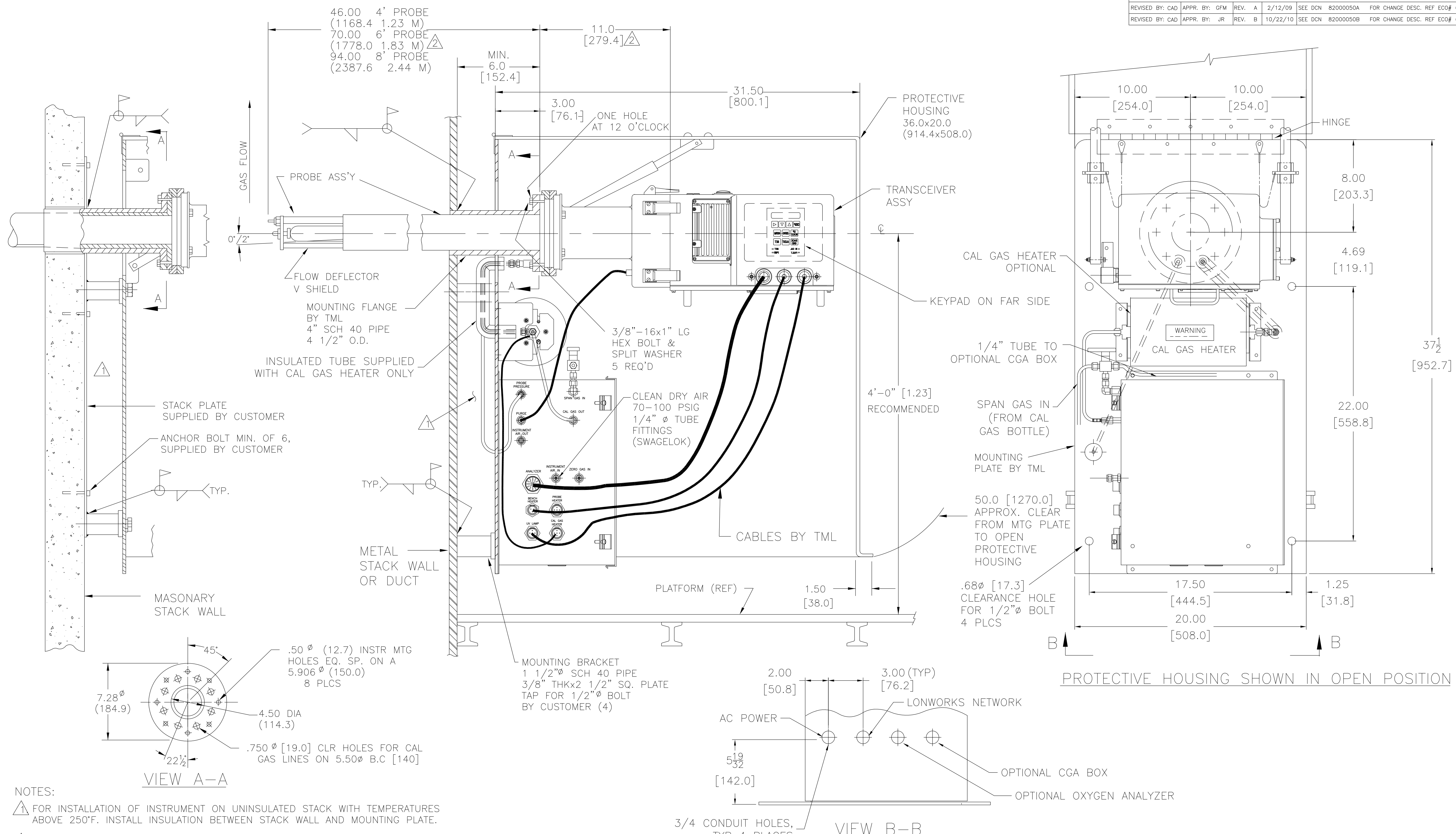
MULTI I/O MODULE ASSY.
CUSTOMER OUTLINE

SIZE	CAGE CODE	DWG NO	REV
B		1804-1001	A
SCALE 1/4		SHEET 1 OF 1	

REVISIONS						
REVISED BY: CAD	APPR. BY: GFM	REV. A	2/12/09	SEE DCN 82000050A	FOR CHANGE DESC. REF ECO# 6807
REVISED BY: CAD	APPR. BY: JR	REV. B	10/22/10	SEE DCN 82000050B	FOR CHANGE DESC. REF ECO# 6965



NOTES:

1. FOR INSTALLATION OF INSTRUMENT ON UNINSULATED STACK WITH TEMPERATURES ABOVE 250°F. INSTALL INSULATION BETWEEN STACK WALL AND MOUNTING PLATE.
2. CLEARANCE REQUIRED FOR PROBE REMOVAL & INSERTION: 11.0"(279.4) PLUS PROBE LENGTH.
3. IT IS RECOMMENDED THAT AN ELECTRICAL OUTLET, 115 VAC BE LOCATED WITHIN 3 FT [.9 M] OF INSTRUMENT FOR USE BY SERVICE PERSONNEL.
4. DIMENSIONS: X.X INCHES, [YY.Y] METRIC.
5. SEE SHEET 2 FOR SYSTEM INTERCONNECT

SM8200 — NEXT ASSEMBLY / USED ON

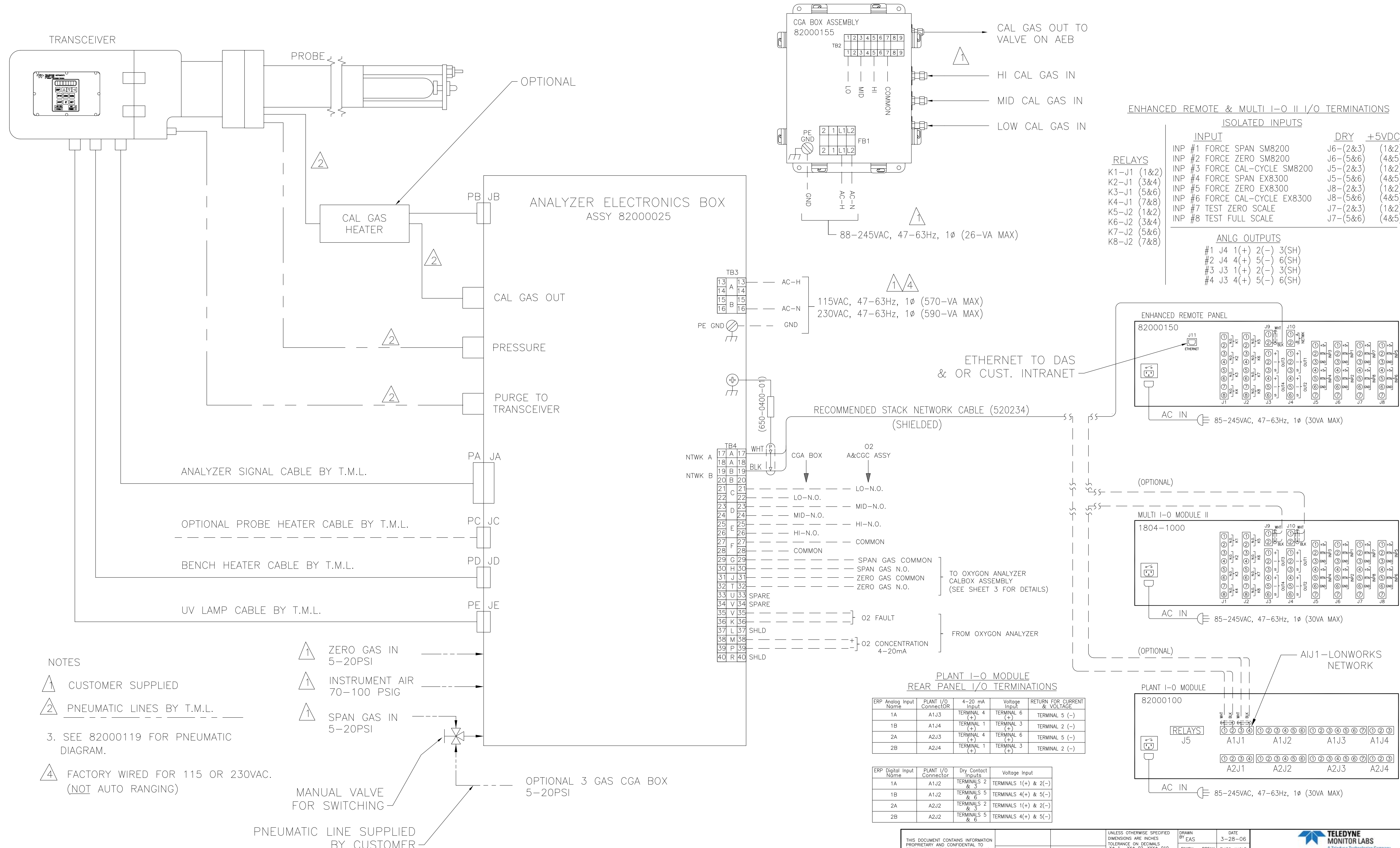
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE INCHES TOLERANCE ON DECIMALS .X± .1 .XX± .02 .XXX± .010 TOLERANCE ON ANGLES ± 0°30'
DO NOT SCALE DRAWING
MATERIAL
FINISH

DRAWN BY EAS — DATE 3-28-06
FINISH - BREAK ALL SHARP EDGES 125
THIRD ANGLE PROJECTION

TELEDYNE MONITOR LABS
A Teledyne Technologies Company

SM8200 SITE INSTALLATION W/OPTIONAL CAL GAS HEATER

SIZE D — CAGE CODE — DWG NO 82000050 — REV B
SCALE 1/4 — SHEET 1 OF 3



PLANT I-O MODULE
REAR PANEL I/O TERMINATIONS

ERP Analog Input Name	PLANT I/O ConnectOR	4-20 mA Input	Voltage Input	RETURN FOR CURRENT & VOLTAGE
1A	A1J3	TERMINAL 4 (+)	TERMINAL 6 (+)	TERMINAL 5 (-)
1B	A1J4	TERMINAL 1 (+)	TERMINAL 3 (+)	TERMINAL 2 (-)
2A	A2J3	TERMINAL 4 (+)	TERMINAL 6 (+)	TERMINAL 5 (-)
2B	A2J4	TERMINAL 1 (+)	TERMINAL 3 (+)	TERMINAL 2 (-)

ERP Digital Input Name	PLANT I/O Connector	Dry Contact Inputs	Voltage Input
1A	A1J2	TERMINALS 2 & 3	TERMINALS 1(+) & 2(-)
1B	A1J2	TERMINALS 5 & 6	TERMINALS 4(+) & 5(-)
2A	A2J2	TERMINALS 2 & 3	TERMINALS 1(+) & 2(-)
2B	A2J2	TERMINALS 5 & 6	TERMINALS 4(+) & 5(-)

NEXT ASSEMBLY	USED ON
	SM8200

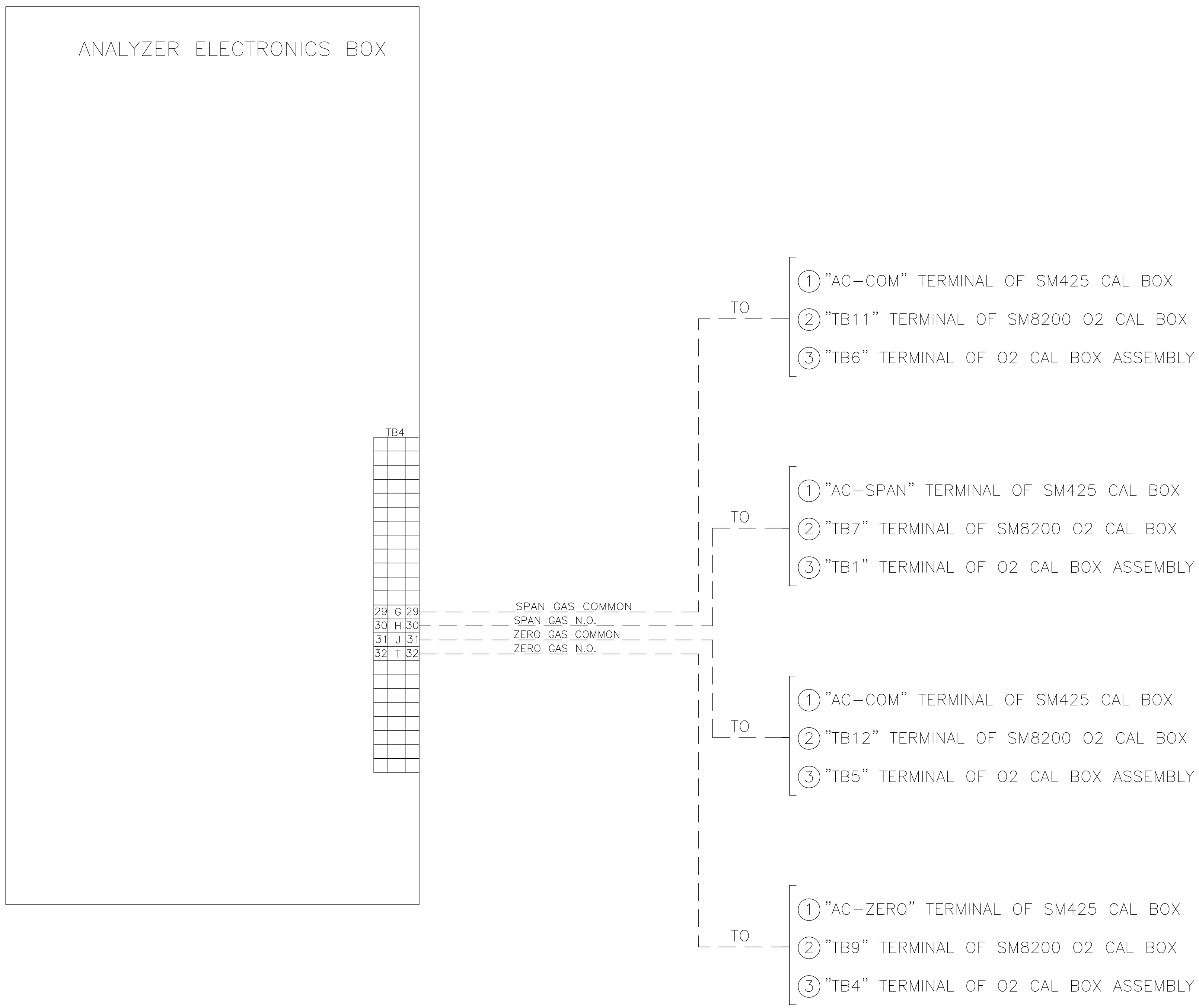
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE INCHES
TOLERANCE ON DECIMALS .X± .1 .XX± .02 .XXX± .010
TOLERANCE ON ANGLES ± 0°30'
DO NOT SCALE DRAWING
MATERIAL
DRAWN BY EAS — DATE 3-28-06
FINISH - BREAK ALL SHARP EDGES 125
THIRD ANGLE PROJECTION
FINISH

TELEDYNE MONITOR LABS
A Teledyne Technologies Company

SYSTEM INTERCONNECT
SM8200

SIZE D | CAGE CODE | DWG NO 82000050 | REV B
SCALE NTS | SHEET 2 OF 3

REVISIONS



AEB TO O2 CAL BOX CONNECTION DETAIL

(3) O2 CAL BOXES ARE AVAILABLE:

① SM425CAL (ASSEMBLY# 42500004)

② SM8200 O2 CAL BOX (ASSEMBLY# 82000168)

③ O2 CAL BOX ASSEMBLY (ASSEMBLY# 96750220)

NEXT ASSEMBLY	USED ON
	SM8200

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE INCHES
TOLERANCE ON DECIMALS .X± .1 .XX± .02 .XXX± .010
TOLERANCE ON ANGLES ± 0°30'
DO NOT SCALE DRAWING
MATERIAL

DRAWN BY CAD — DATE 10–22–10
FINISH – BREAK ALL SHARP EDGES 125
THIRD ANGLE PROJECTION
FINISH

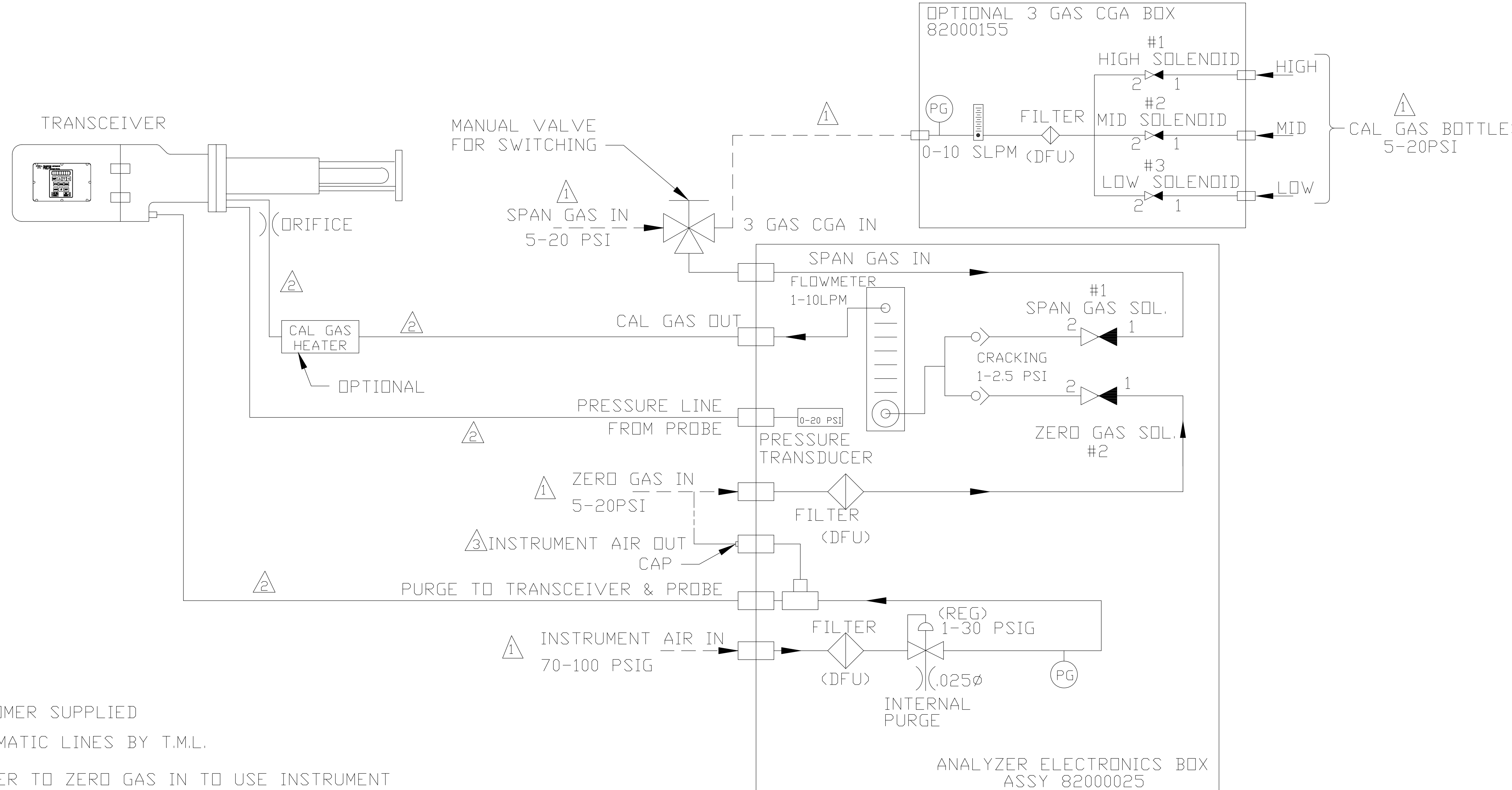
TELEDYNE MONITOR LABS
A Teledyne Technologies Company

SYSTEM INTERCONNECT
SM8200

SIZE	CAGE CODE	DWG NO	REV
D		82000050	B

SCALE NTS — SHEET 3 OF 3

REVISIONS					
REVISED BY: CAD	APPR. BY: GFM	REV. A	2/12/09	SEE DCN 82000119A	FOR CHANGE DESC. REF ECO# 6807
REVISED BY: CAD	APPR. BY: KH	REV. B	10/6/09	SEE DCN 82000119B	FOR CHANGE DESC. REF ECO# 6883



NOTES

1. CUSTOMER SUPPLIED
2. PNEUMATIC LINES BY T.M.L.
3. JUMPER TO ZERO GAS IN TO USE INSTRUMENT AIR AS ZERO CAL GAS. OTHERWISE CAP INSTRUMENT AIR OUT PORT.

NEXT ASSEMBLY	USED ON
	SM8200

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE INCHES
TOLERANCE ON DECIMALS .X± .1 .XX± .02 .XXX± .010
TOLERANCE ON ANGLES ± 0°30'
DO NOT SCALE DRAWING
MATERIAL

DRAWN BY EAS — DATE 9-14-07
FINISH - BREAK ALL SHARP EDGES 125
THIRD ANGLE PROJECTION
FINISH

TELEDYNE MONITOR LABS
A Teledyne Technologies Company

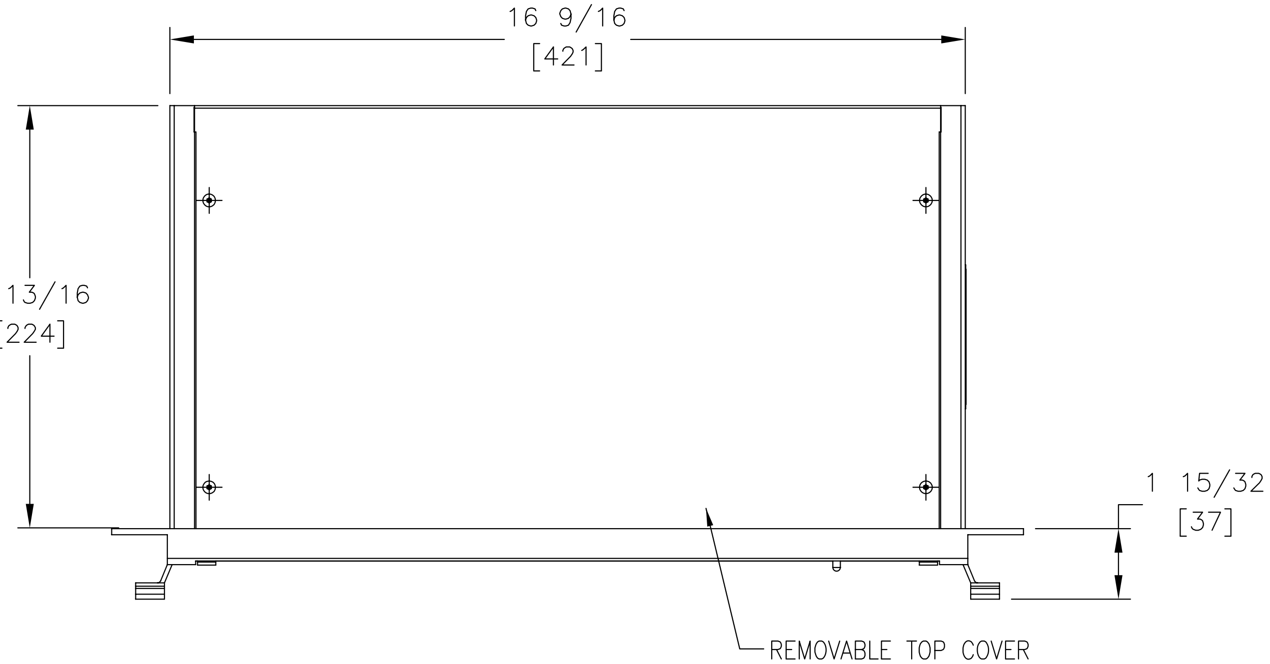
PNEUMATIC DIAGRAM SM8200

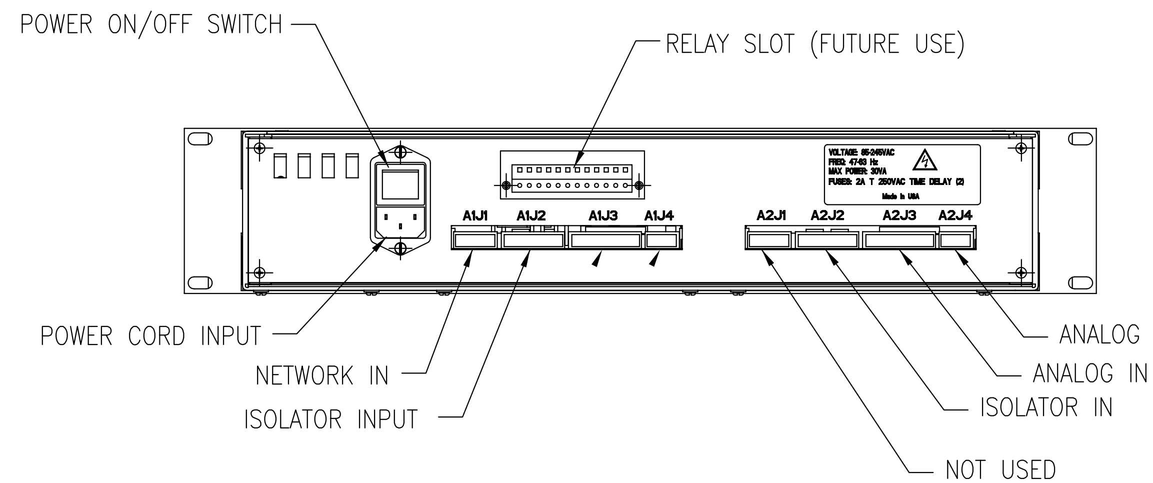
SIZE	CAGE CODE	DWG NO	REV
B		82000119	B

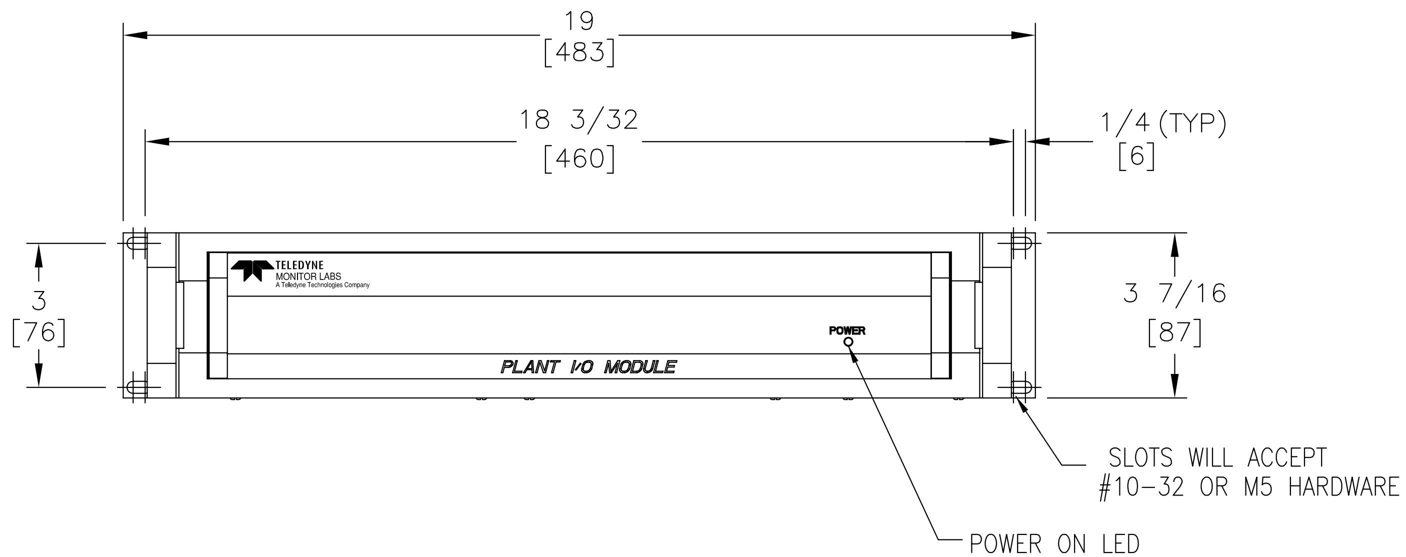
SCALE NONE — SHEET 1 OF 1

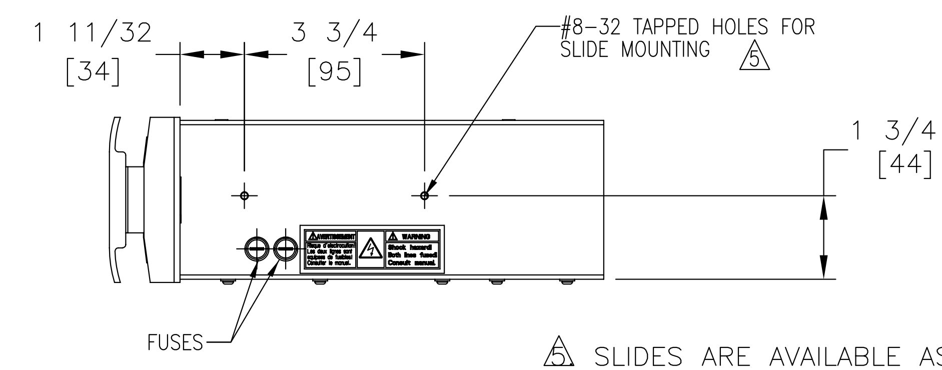
REVISED BY: CAD	APPR. BY: GFM	REV. A	2/12/09	SEE DCN 82000134A FOR CHANGE DESC. REF ECO# 6807

REVISIONS









NOTES:

1. DISPLAY FITS IN STANDARD 19"(482.6mm) RACK MOUNT, 3-1/2" (2U) HIGH CHASSIS
2. DIMENSIONS IN [ ] ARE METRIC
3. MINIMUM REAR CLEARANCE 5"(127mm)
4. PROGRAMMED VIA MIO2
5. SLIDES ARE AVAILABLE AS AN OPTION. CONSULT FACTORY

NEXT ASSEMBLY	USED ON

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE INCHES
TOLERANCE ON DECIMALS .X± .1 .XX± .02 .XXX± .010
TOLERANCE ON ANGLES ± 0°30'

DO NOT SCALE DRAWING

MATERIAL

DRAWN BY EAS — DATE 2-21-08

FINISH – BREAK ALL SHARP EDGES 125

THIRD ANGLE PROJECTION

FINISH

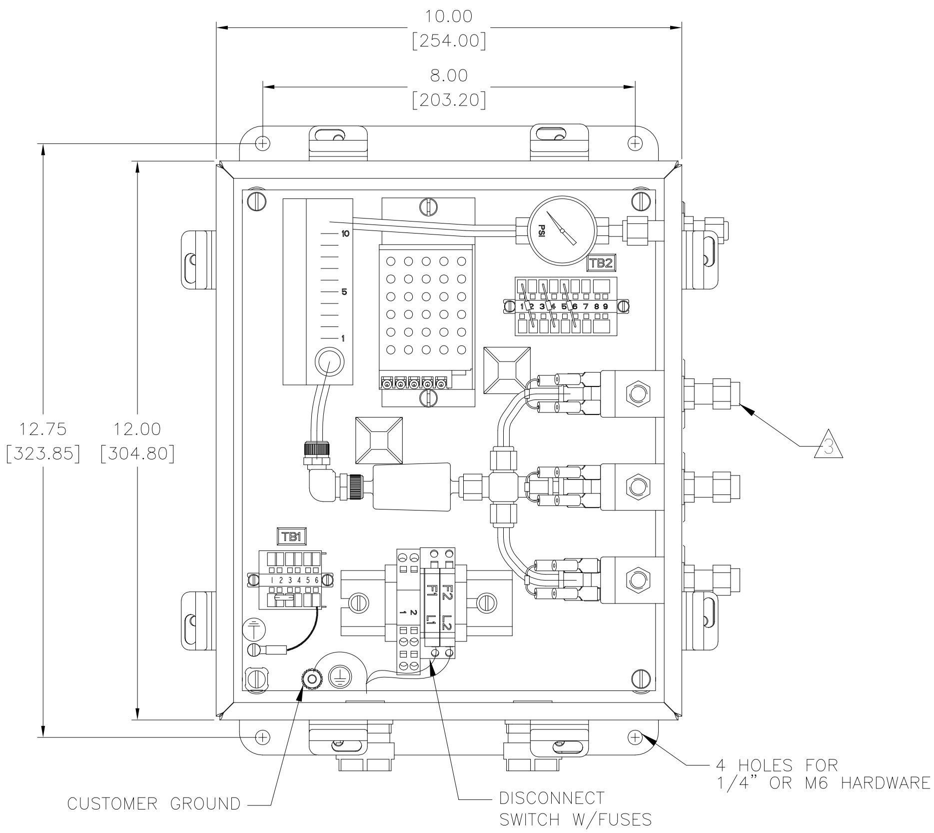
TELEDYNE MONITOR LABS
A Teledyne Technologies Company

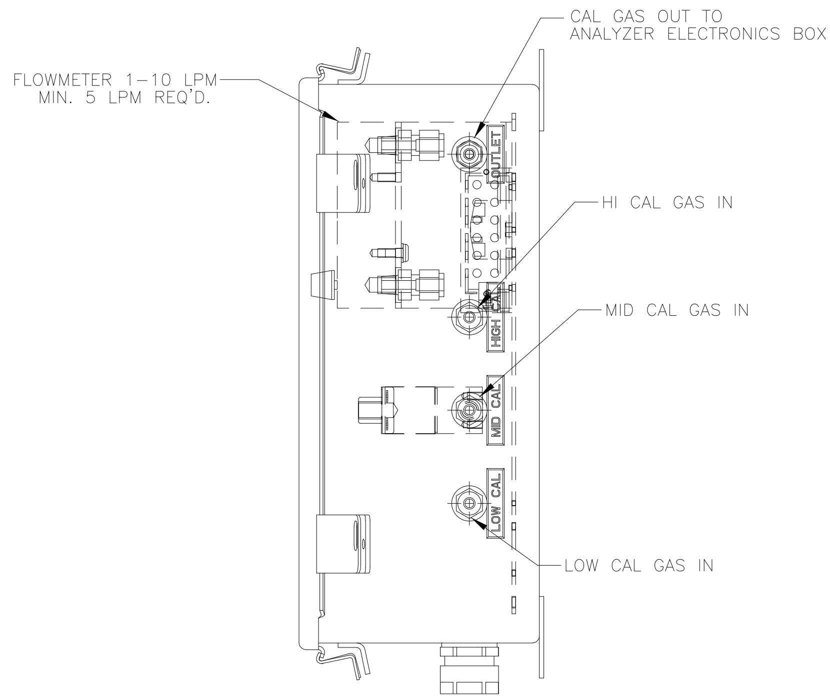
PLANT I/O ASSY. (OPTIONAL) CUSTOMER OUTLINE

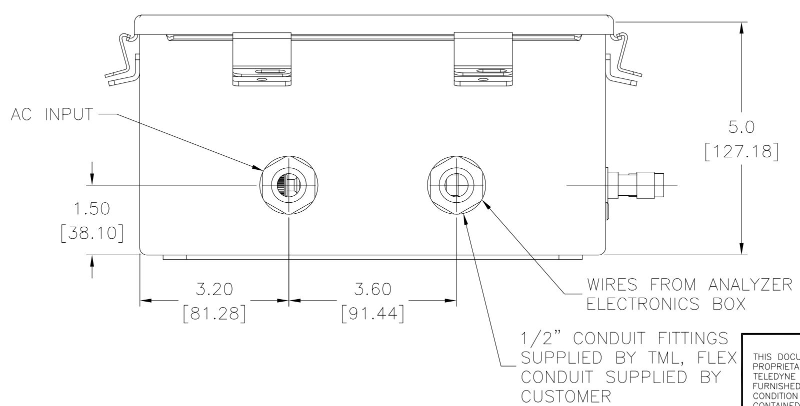
SIZE	CAGE CODE	DWG NO	REV
B		82000134	A

SCALE 1/4 — SHEET 1 OF 1

REVISIONS				
REVISED BY: CAD	APPR. BY: GFM	REV. A	2/13/09	INITIAL RELEASE. REF ECO# 6807







NOTES:

1. FOR INTERCONNECT WIRING SEE DRAWING 82000050 SHT 2.
2. FOR PNEUMATIC DIAGRAM SEE DRAWING 82000119.
3. FITTINGS ON SIDE OF BOX, EXCEPT 1/4" O.D. TUBING.
4. DIMENSIONS IN [ ] ARE METRIC.

NEXT ASSEMBLY	USED ON
FINAL	SM8200

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE INCHES
TOLERANCE ON DECIMALS .X± .1 .XX± .02 .XXX± .010
TOLERANCE ON ANGLES ± 0°30'
DO NOT SCALE DRAWING
MATERIAL

DRAWN BY EAS — DATE 6-6-08
FINISH – BREAK ALL SHARP EDGES 125
THIRD ANGLE PROJECTION
FINISH

TELEDYNE MONITOR LABS
A Teledyne Technologies Company

CUSTOMER OUTLINE DRAWING
CGA BOX, SM8200

SIZE	CAGE CODE	DWG NO	REV
C		82000159	A

SCALE 1/4 — SHEET 1 OF 1