TRAINING MANUAL

MODEL 80XE / T80X

CO_2 / O_2 ANALYZER

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1.1. CO_2 SENSOR/PROBE – THEORY OF OPERATION

1.1.1. NDIR MEASUREMENT OF CO_2

The CO_2 sensor/probe is a silicon based Non-Dispersive Infrared (NDIR) sensor. It uses a single-beam, dual wavelength measurement method.

An infrared source at one end of the measurement chamber emits IR radiation into the sensor/probe's measurement chamber where light at the 4.3 µm wavelength is partially absorbed by any CO_2 present. A special light filter called a Fabry-Perot Interferometer (FPI) is electronically tuned so that only light at the absorption wavelength of CO_2 is allowed to pass and be detected by the sensor/probe's IR detector.

A reference measurement is made by electronically shifting the filter band pass wavelength so that no IR at the CO_2 absorption wavelength is let through.

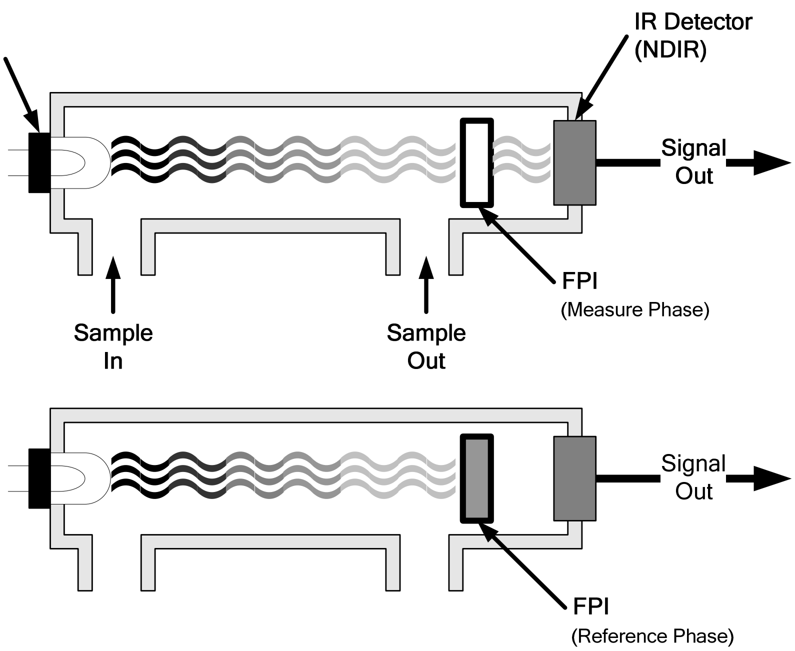


Figure 1-1 CO_2 Sensor/probe Theory of Operation

The sensor/probe computes the ratio between the reference signal and the measurement signal to determine the degree of light absorbed by CO_2 present in the sensor/probe chamber. This dual wavelength method of measuring CO_2 allows the instrument to compensate for ancillary effects like sensor/probe aging and contamination.

1.1.2. OPERATION WITHIN THE M80XE ANALYZER

Operationally, the CO_2 sensor/probe option is transparently integrated into the core analyzer operation. All functions can be viewed or accessed through the front panel, just like the functions for O_2.

The CO_2 concentration is displayed in the upper right-hand corner, alternating with O_2 concentration.

Test functions for CO_2 slope and offset are viewable from the front panel along with the analyzers other test functions.

CO_2 sensor/probe calibration is performed via the front panel **CAL** function and is performed in a nearly identical manner as the standard O_2 calibration.

Stability of the CO_2 sensor/probe can be viewed via the front panel.

The CO_2 concentration range is 0-20%.

1.1.3. ELECTRONIC OPERATION OF THE CO_2 SENSOR/PROBE

The CO_2 PCA is powered by 12 VDC from the analyzer via the relay card, which outputs a 0-5 VDC analog signal to the analyzer's CPU via the motherboard that corresponds to the concentration of CO_2 measured by the probe.

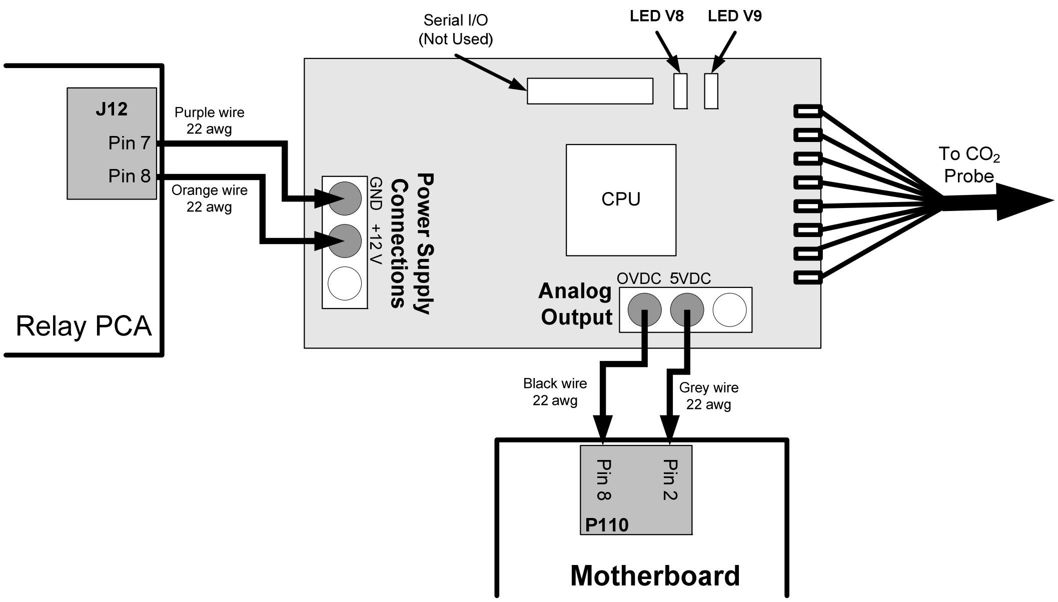


Figure 1-2 CO_2 Sensor/probe Option PCA Layout and Electronic Connections

1.2. O_2 SENSOR – THEORY OF OPERATION

The M80XE parametric oxygen analyzer is a microprocessor-controlled analyzer that determines the percent concentration of molecular oxygen (O_2) in a sample gas drawn through the instrument. It uses a paramagnetic sensor that relies on the relatively high reactivity of O_2 molecules to magnetic fields to generate a current that is proportional to the amount of O_2 present in the sensor chamber.

Calibration of the instrument is performed in software and does not require physical adjustments to the instrument. During calibration the microprocessor measures the current state of the O_2 Sensor output and various other physical parameters of the instrument and stores them in memory. The microprocessor uses these calibration values, measurements made on the sample gas along with data regarding the current temperature and pressure of the gas to calculate a final O_2 concentration.

1.2.1. PARAMAGNETIC OXYGEN MEASUREMENT

1.2.1.1. MAGNETIC PROPERTIES OF O_2 GAS

Molecular oxygen, O_2, displays a particularly strong susceptibility to the effect of magnetic fields. This is due to the behavior of the electrons of the two oxygen atoms that make up the O_2 molecule.

When the electrons in an orbital are paired, they spin in opposite directions from each other thereby canceling any magnetic field effects. On the other hand, unpaired electrons, such as those of an O_2 molecule, spin in the same direction as each other, increasing the aggregate magnetic field.

1.2.1.2. PRINCIPLE OF MEASUREMENT

The type of paramagnetic sensor used in the M80XE analyzer is called a magneto-mechanical sensor. This type of sensor consists of a small dumbbell-shaped body (a sphere on either end) made of glass and filled with a gas of negative paramagnetic characteristic (in this case, N_2). The dumbbell body is suspended on a platinum fiber within the magnetic field of a permanent magnet, in such a way that it is free to rotate. Because the N_2 inside the spheres has a small opposite magnetic charge from the field of the permanent magnet, the dumbbell's resting (neutral) position is slightly deflected away from the strong point of the field.

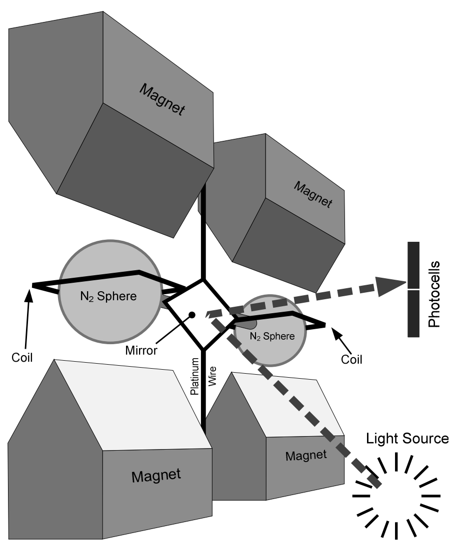


Figure 1-3 Paramagnetic O_2 Sensor Design

When sample gas containing oxygen flows into the magneto-mechanical sensor, the O_2 molecules are drawn toward the strong point of the magnetic field. This causes the N_2 filled spheres to deflect even more so that the suspended dumbbell body pivots on the platinum wire. The more O_2 present the further the dumbbell body is deflected from its neutral position.

The position of the dumbbell is detected by a pair of photocells that receive a light beam reflected from a mirror attached to the center of the dumbbell body. As the dumbbell body pivots, the angle of the reflected light beams on the photocells changes. The resulting potential difference creates a current.

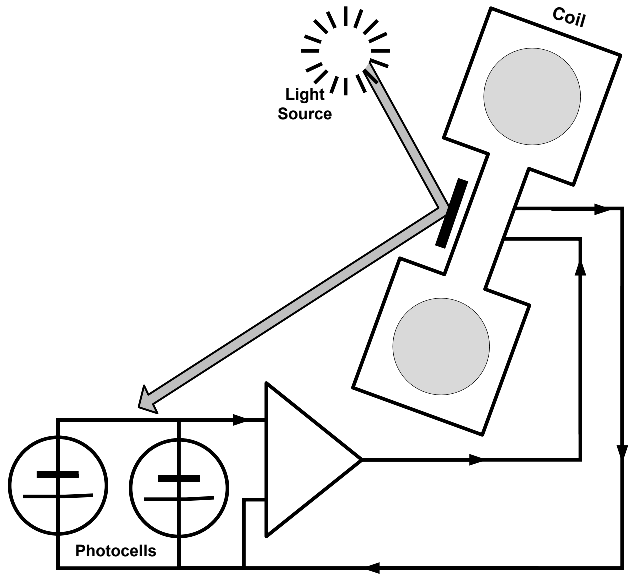


Figure 1-4 Paramagnetic O_2 Sensor Block Diagram

This current is passed to a feedback loop, which generates a second current to a wire winding (in effect, a small DC electric motor) mounted on the suspended mirror. The more O_2 present, the more the dumbbell and its attached mirror moves and the more current is needed to move the dumbbell back to it's zero position. Finally, sensor measures the amount of current generated by the feedback control loop which is directly proportional to the concentration of oxygen within the sample gas mixture.

2. PNEUMATICS

2.1. Layout

Notes:

Flow specifications for the M801E, M802E, and M80XE are 120cc ± 20

- **CAUTION**

GENERAL SAFETY HAZARD

IT IS IMPORTANT THAT THE SAMPLE AIRFLOW SYSTEM IS BOTH LEAK-TIGHT AND NOT PRESSURIZED OVER AMBIENT PRESSURE.

Regular leak checks should be performed on the analyzer as described in the maintenance schedule.

In pneumatic operation an internal pump creates a vacuum that draws sample gas into the analyzer. Normally the analyzer is operated with its inlet near ambient pressure either because the sample is directly drawn at the inlet or a small vent is installed at the inlet when the sample is delivered under pressure. There are several advantages to this "pull through" configuration.

First, the pumping process heats and compresses the sample complicating the measurement process. Both heat and pressure affect the accuracy of gas measurements.

Additionally, certain physical parts of the pump itself are made of materials that might chemically react with the sample gas.

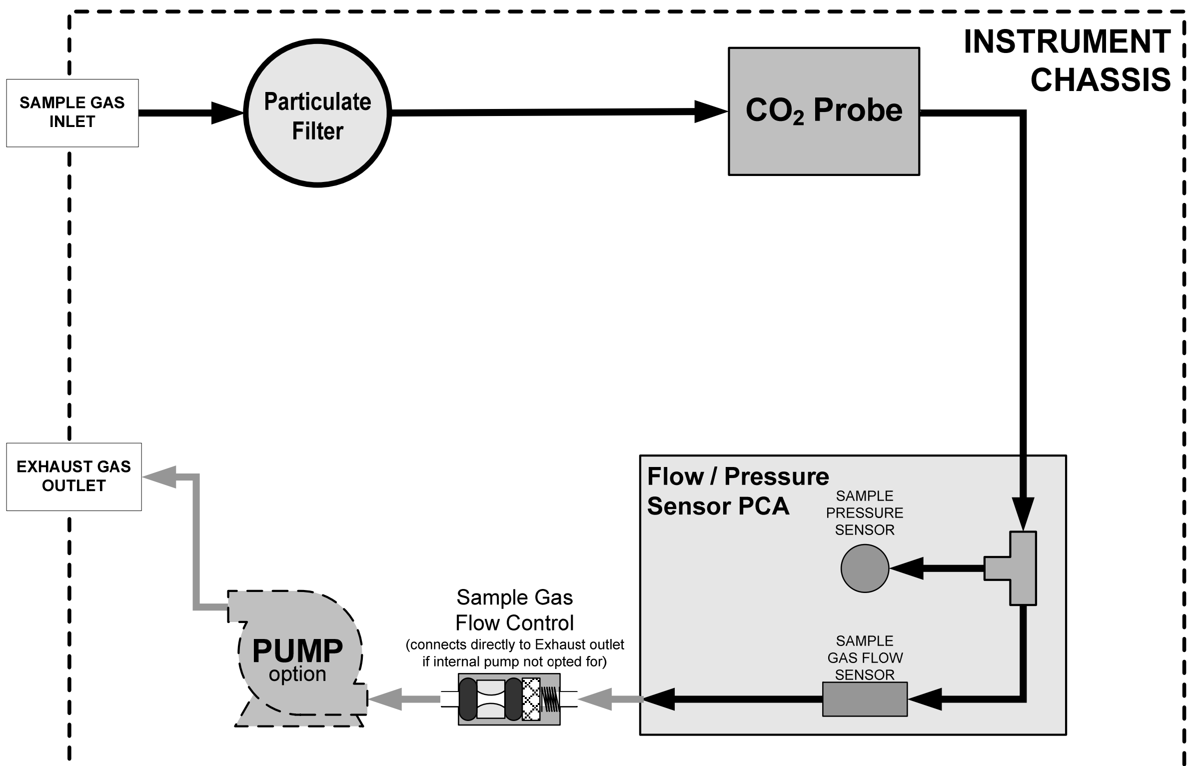


Figure 2-1 Internal Pneumatic Flow M801E

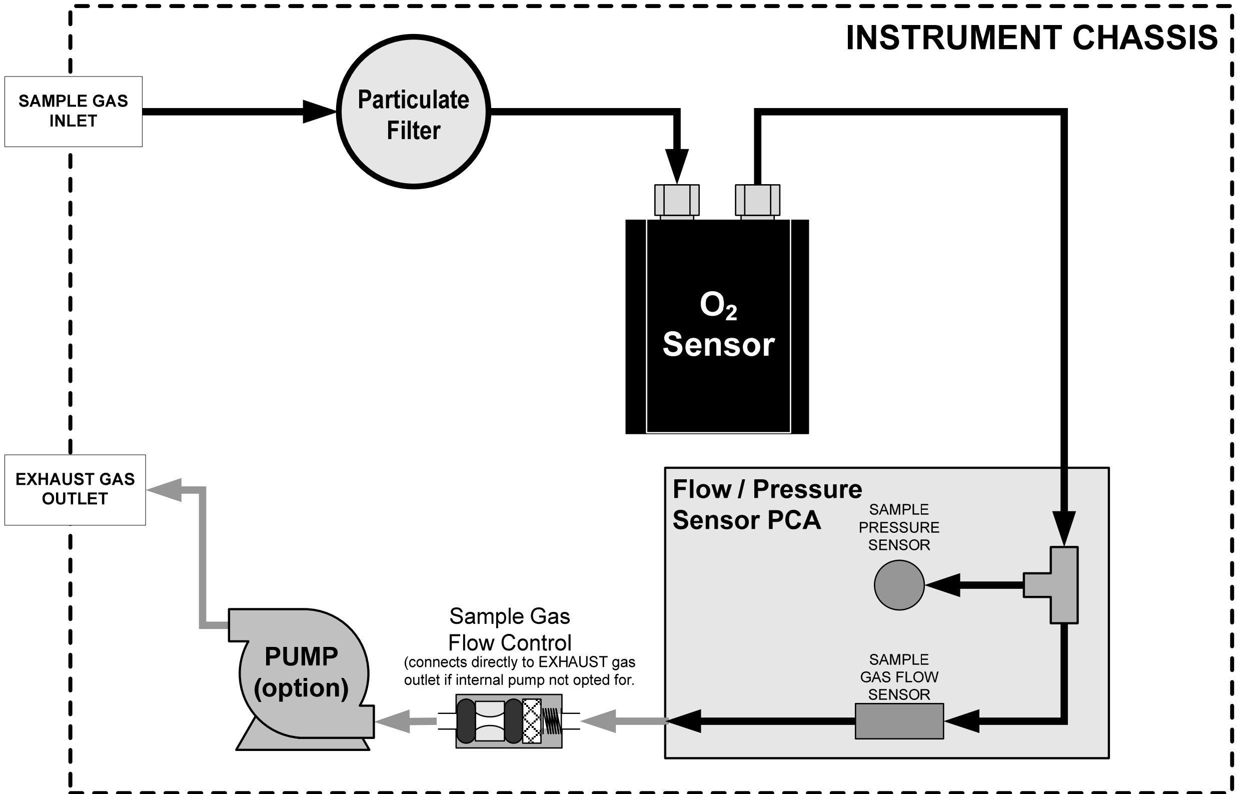


Figure 2-2 Internal Pneumatic Flow M802E

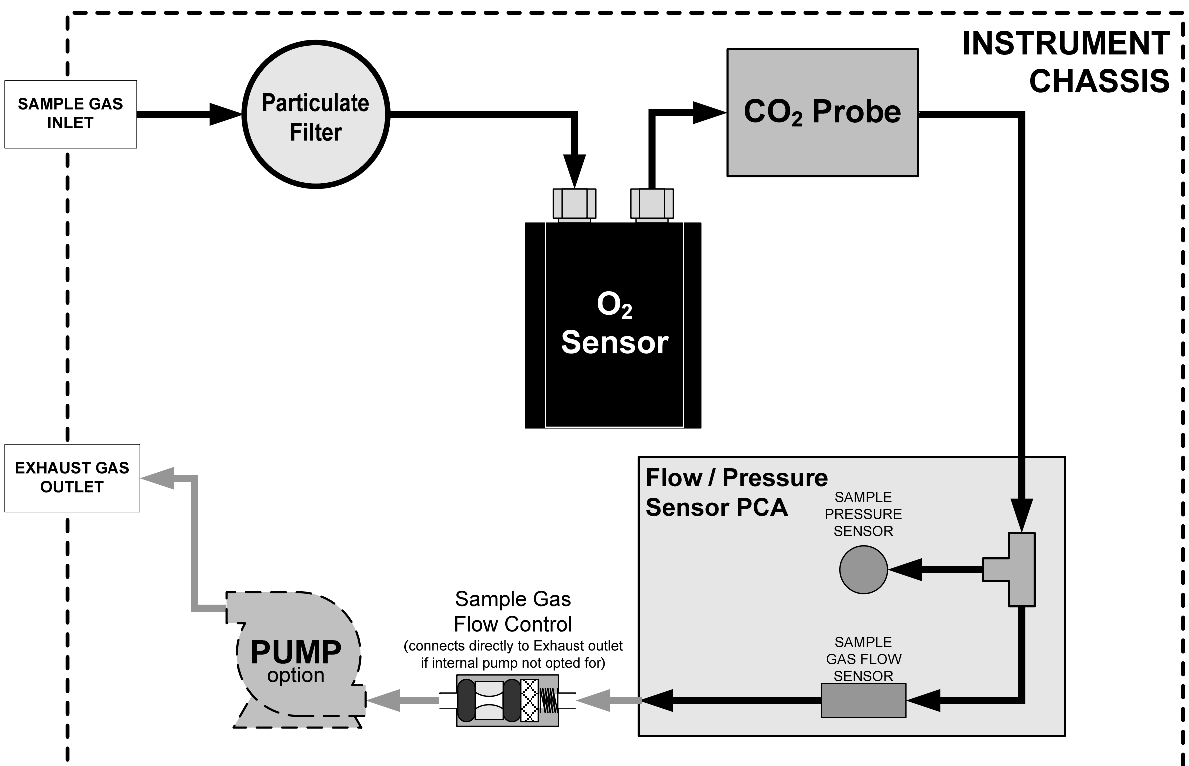


Figure 2-3 Internal Pneumatic Flow M80XE (also M802E /w CO2 option)

2.2 FLOW RATE CONTROL

To maintain a constant flow rate of the sample gas through the instrument, the M80XE uses a special flow control assembly located in the exhaust gas line just before the optional internal pump or connected to the rear panel if using an external pump. These assemblies consist of:

A critical flow orifice.

Two o-rings: Located just before and after the critical flow orifice, the o-rings seal the gap between the walls of assembly housing and the critical flow orifice.

A spring: Applies mechanical force needed to form the seal between the o-rings, the critical flow orifice and the assembly housing.

A sintered filter: Removes particulates to prevent clogging the orifice

2.2.1. CRITICAL FLOW ORIFICE

The most important component of this flow control assembly is the critical flow orifice.

Critical flow orifices are a remarkably simple way to regulate stable gas flow rates. They operate without moving parts by taking advantage of the laws of fluid dynamics. By restricting the flow of gas though the orifice, a pressure differential is created. This pressure differential combined with the action of the analyzer's pump draws the gas through the orifice.

As the pressure on the downstream side of the orifice (the pump side) continues to drop, the speed that the gas flows though the orifice continues to rise. Once the ratio of upstream pressure to downstream pressure is greater than 2:1, the velocity of the gas through the orifice reaches the speed of sound. As long as that ratio stays at least 2:1 the gas flow rate is unaffected by any fluctuations, surges, or changes in downstream pressure because such variations only travel at the speed of sound themselves and are therefore cancelled out by the sonic shockwave at the downstream exit of the critical flow orifice.

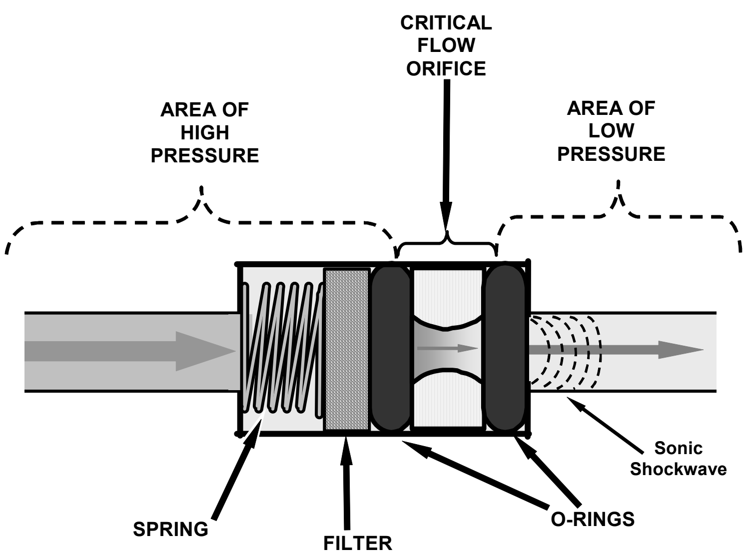


Figure 2-4 Flow Control Assembly & Critical Flow Orifice

The actual flow rate of gas through the orifice (volume of gas per unit of time), depends on the size and shape of the aperture in the orifice. The larger the hole, the more gas molecules moving at the speed of sound passes through the orifice. Because the flow rate of gas through the orifice is only related to the minimum 2:1 pressure differential and not absolute pressure the flow rate of the gas is also unaffected by degradations in pump efficiency due to age.

The critical flow orifice used in the M80XE is designed to provide a flow rate of 120 cm^3/min.

2.2.2. PARTICULATE FILTER

The M80XE Analyzer comes equipped with a 47 mm diameter, Teflon, particulate filter with a 1 micron pore size. The filter is accessible through the front panel, which folds down to allow access, and should be changed according to the suggested maintenance schedule described in the maintenance section.

PNEUMATIC SENSORS

2.2.3. SAMPLE PRESSURE SENSOR

An absolute value pressure transducer plumbed to the outlet of the sample chamber is used to measure sample pressure. The output of the sensor is used to compensate the concentration measurement for changes in ambient air pressure. This sensor is mounted to a printed circuit board with the sample flow sensor on the sample chamber.

2.2.4. SAMPLE FLOW SENSOR

A thermal-mass flow sensor is used to measure the sample flow through the analyzer. The sensor is calibrated at the factory with ambient air or N_2, but can be calibrated to operate with samples consisting of other gases such as O_2. This sensor is mounted to a printed circuit board with the Sample Pressure sensor on the sample chamber.

3. MENU STRUCTURE

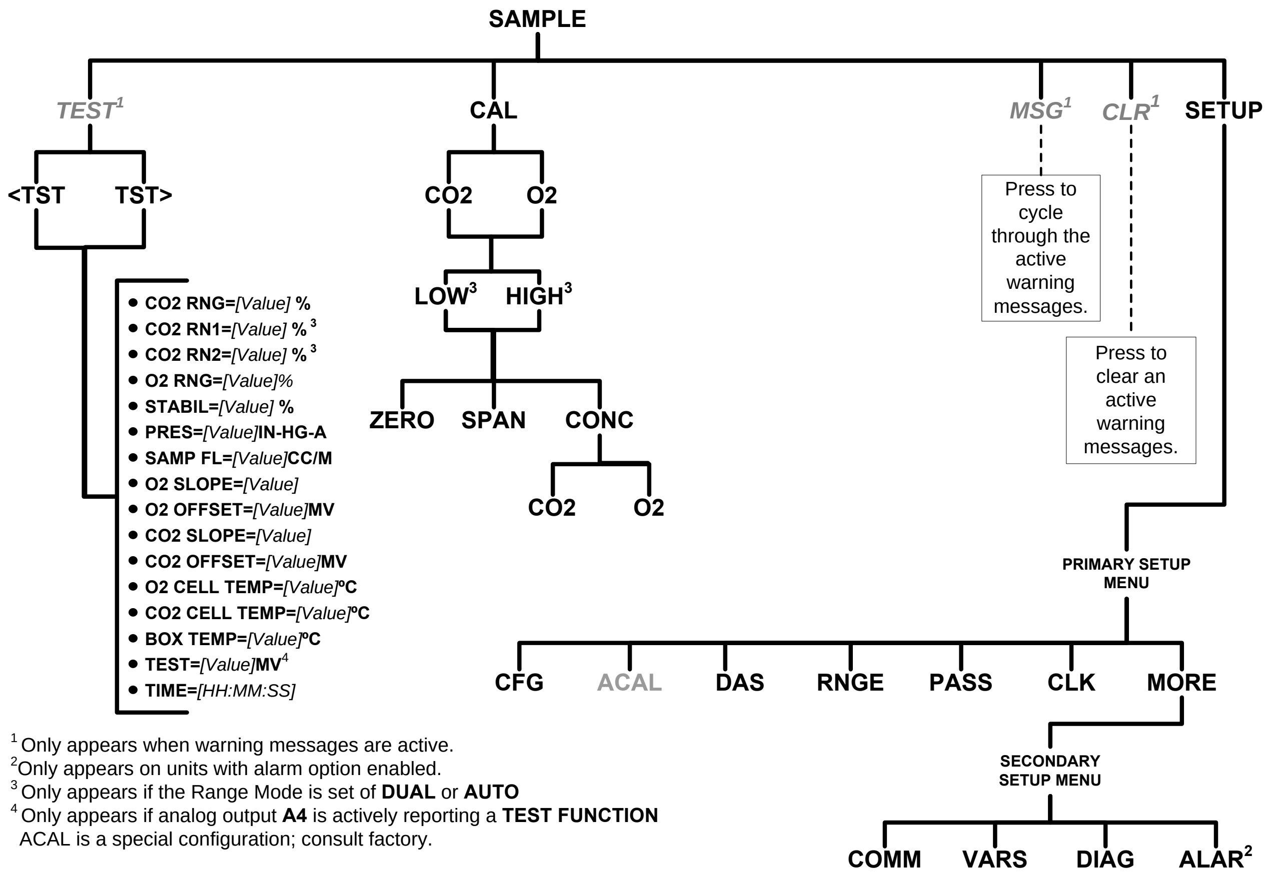
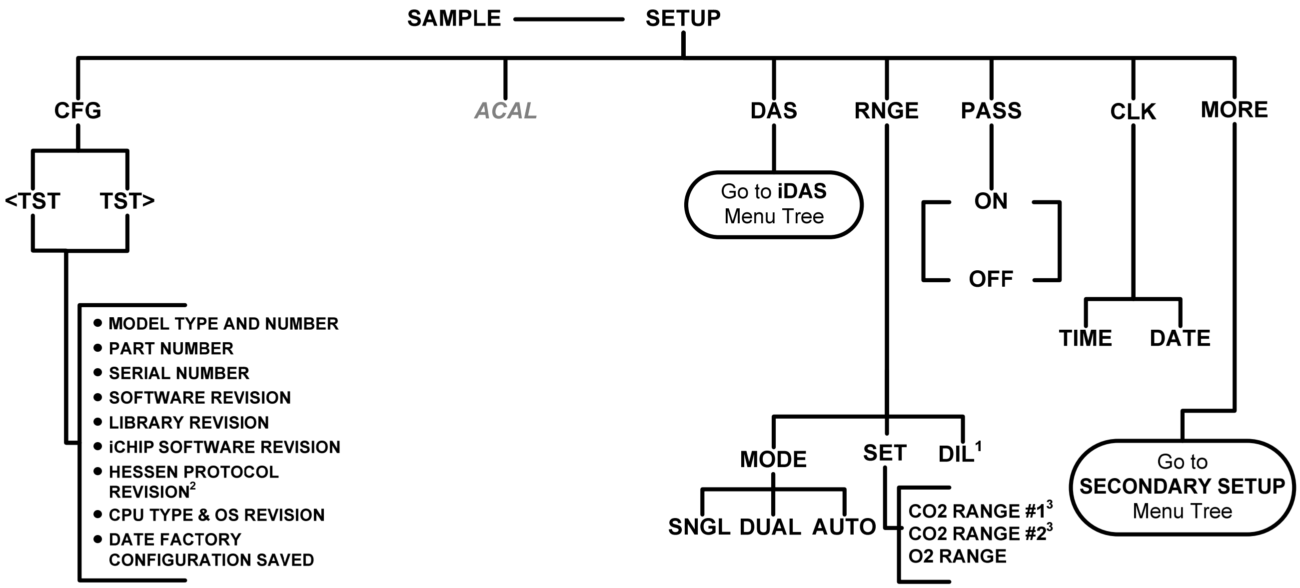


Figure 3-1 Basic Sample Display Menu



[1] Only appears if Dilution option is active.
[2] Only appears if Hessen protocol is active.
[3] Only appears if the **DUAL** or **AUTO** range modes are selected.
ACAL is a special configuration; consult factory.

Figure 3-2 Primary Setup Menu (Except iDAS)

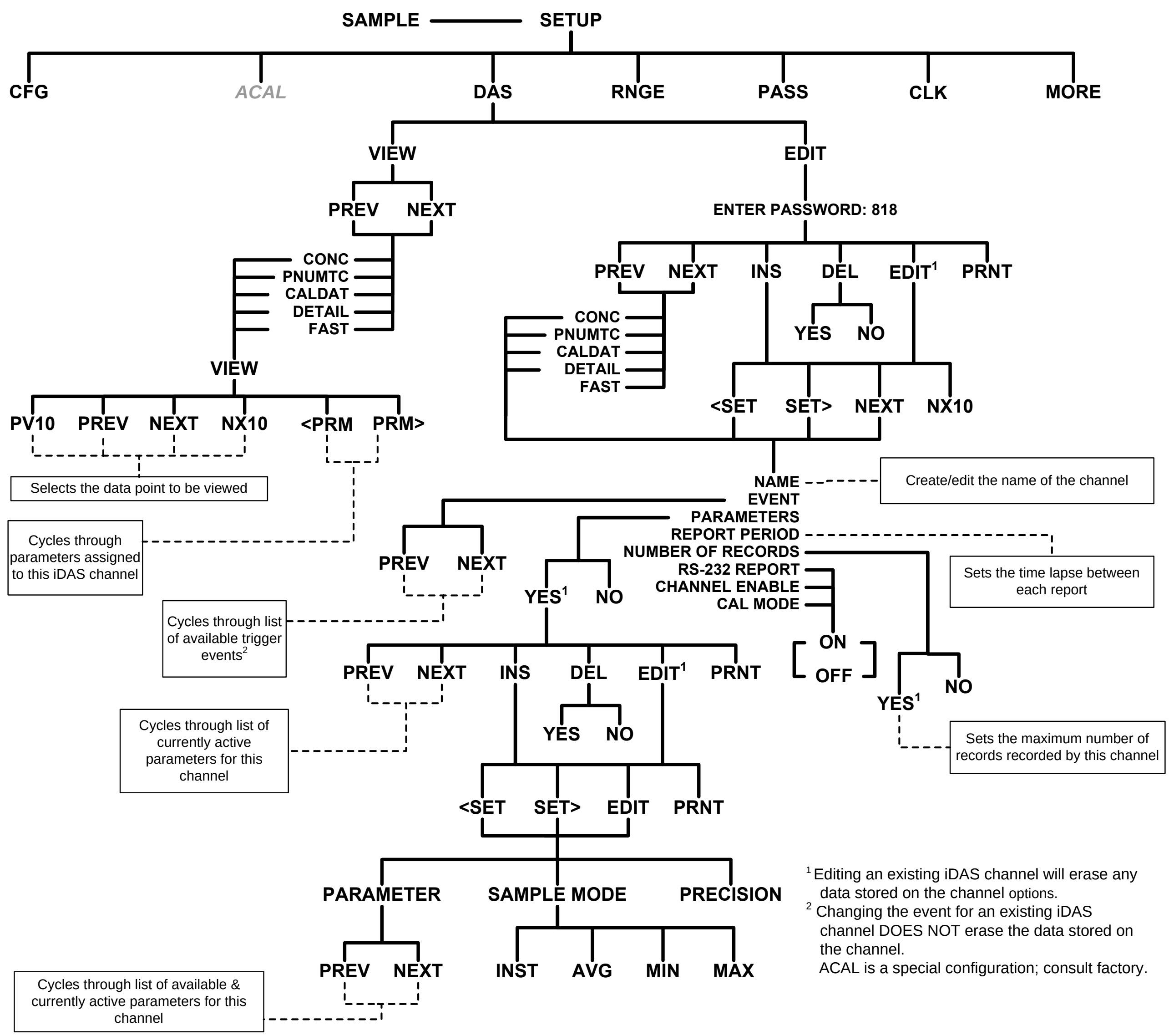


Figure 3-3 Primary Setup Menu (iDAS)

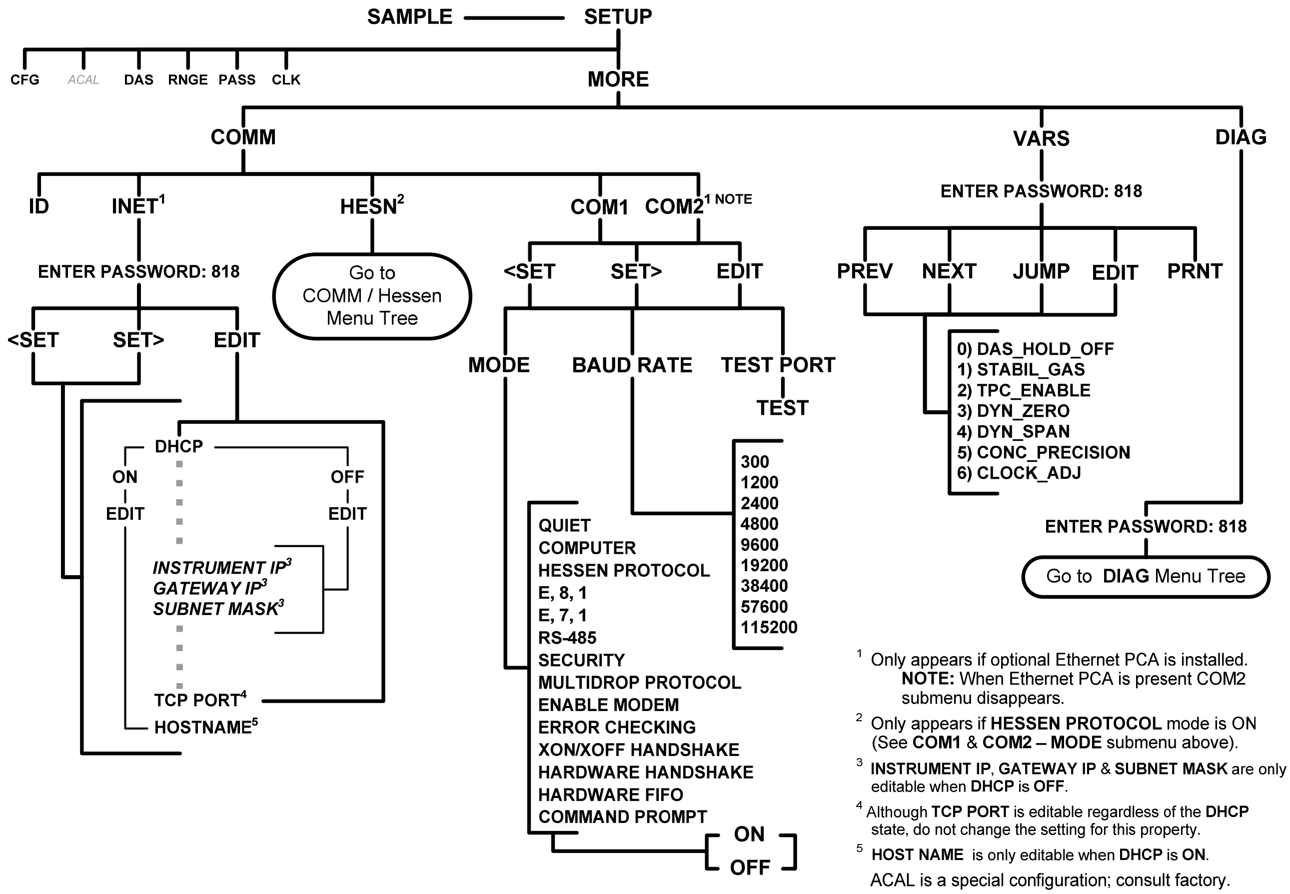


Figure 3-4 Secondary Setup Menu (COMM & VARS)

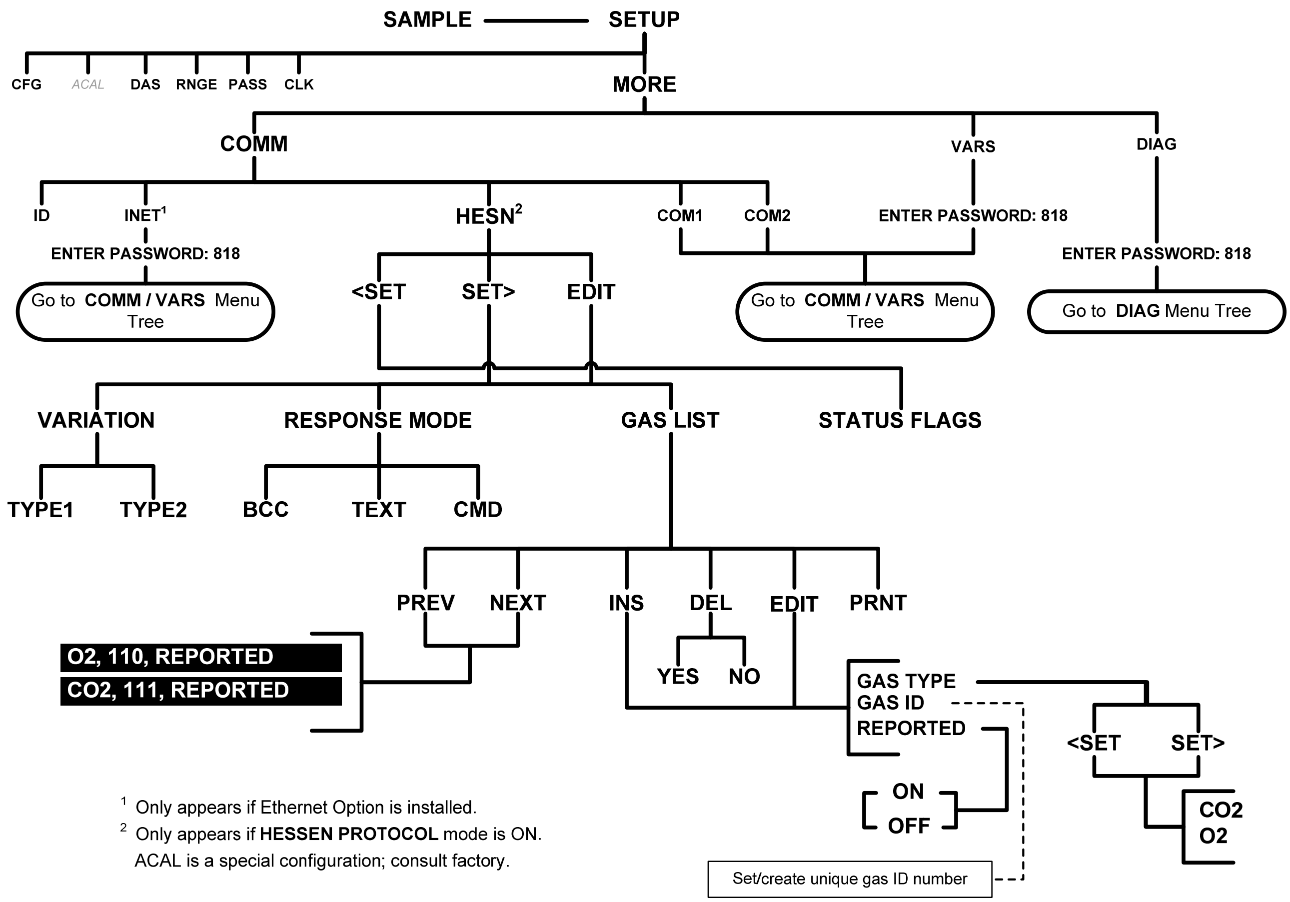


Figure 3-5 Secondary Setup Menu - HESSEN Submenu

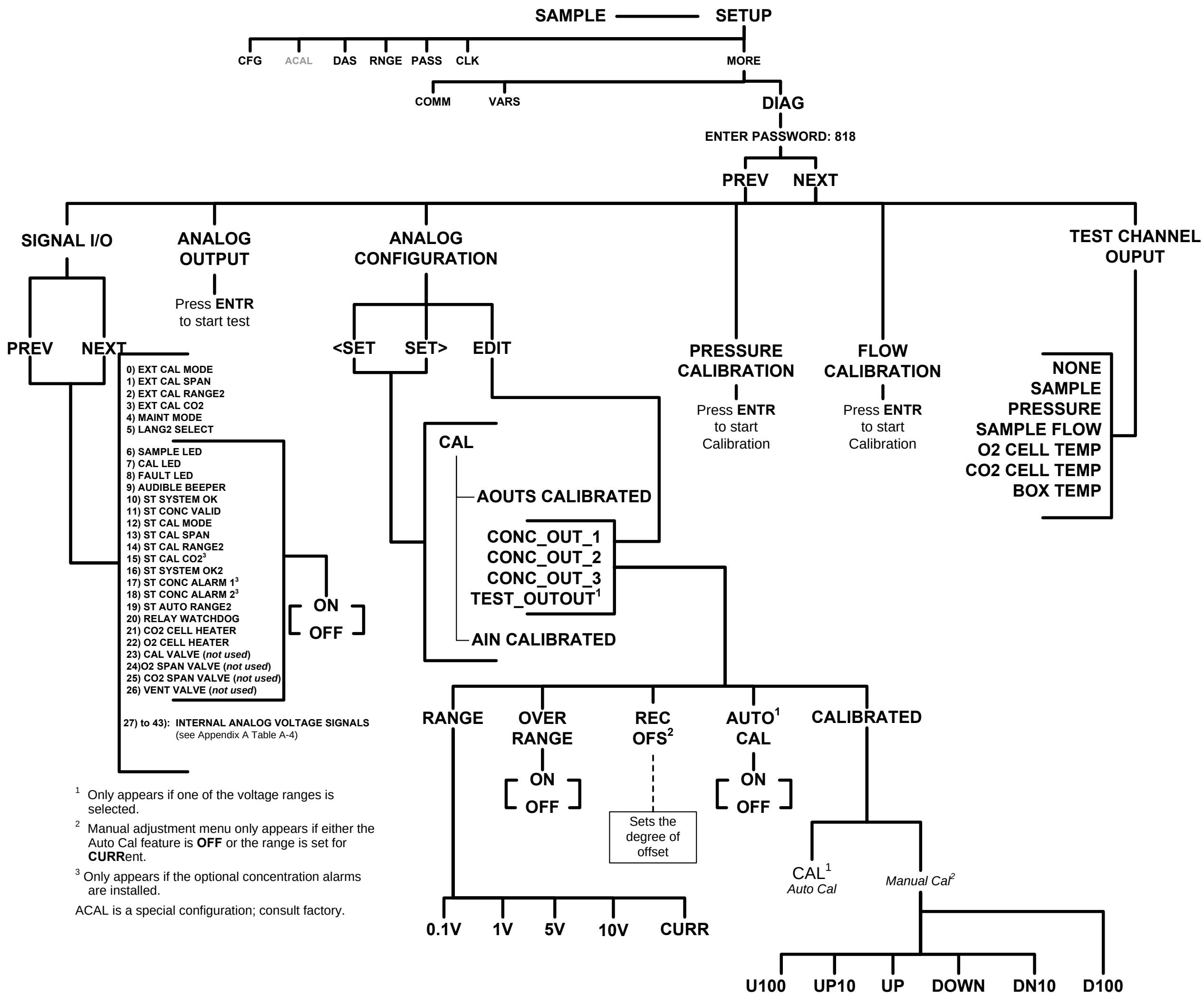


Figure 3-6 Secondary Setup Menu (DIAG)

4. CALIBRATION PROCEDURES

4.1. CALIBRATION OF THE ANALOG OUTPUTS

Analog output calibration should to be carried out on first startup of the analyzer (performed in the factory as part of the configuration process) or whenever re-calibration is required. The analog outputs can be calibrated automatically or adjusted manually.

During automatic calibration, the analyzer tells the output circuitry to generate a zero mV signal and high-scale point signal (usually about 90% of chosen analog signal scale) then measures actual signal of the output. Any error at zero or high-scale is corrected with a slope and offset.

Automatic calibration can be performed via the **CAL** button for the **AOUTS CALIBRATED** menu item. By default, the analyzer is configured so that calibration of analog outputs can be initiated as a group with the **AOUT CALIBRATION** command. The outputs can also be calibrated individually, but this requires the AUTOCAL feature be disabled.

4.1.1. ENABLING OR DISABLING THE AUTOCAL FOR AN INDIVIDUAL ANALOG OUTPUT

To enable or disable the **AutoCal** feature for an individual analog output, select the **ANALOG I/O CONFIGURATION** submenu.

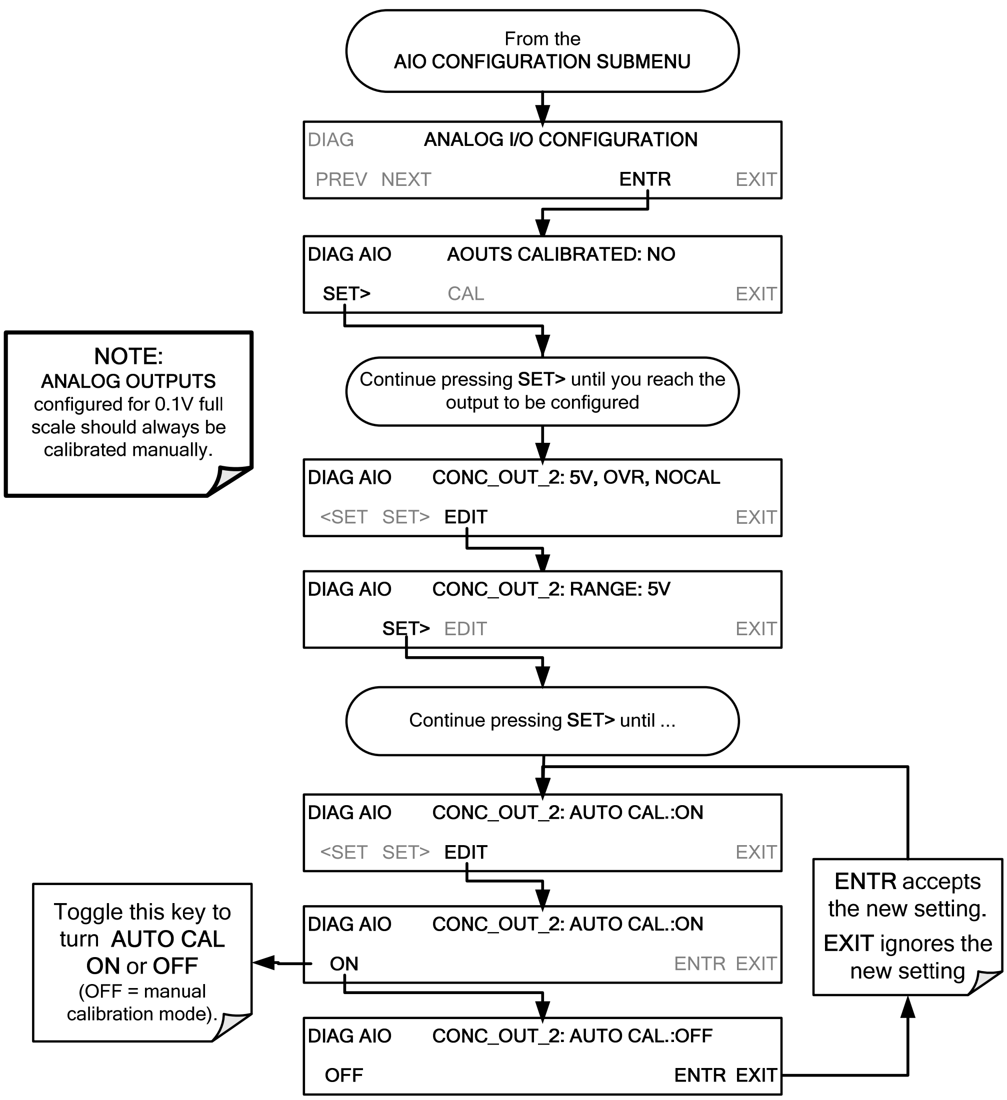


FIGURE 4-1 AUTO CAL ENABLE

4.1.2. AUTOMATIC CALIBRATION OF THE ANALOG OUTPUTS

> **NOTE**
>
> **Before performing this procedure, ensure that the AUTO CAL for each analog output is enabled.**

To calibrate the outputs as a group with the **AOUTS CALIBRATION** command, select the **ANALOG I/O CONFIGURATION** submenu.

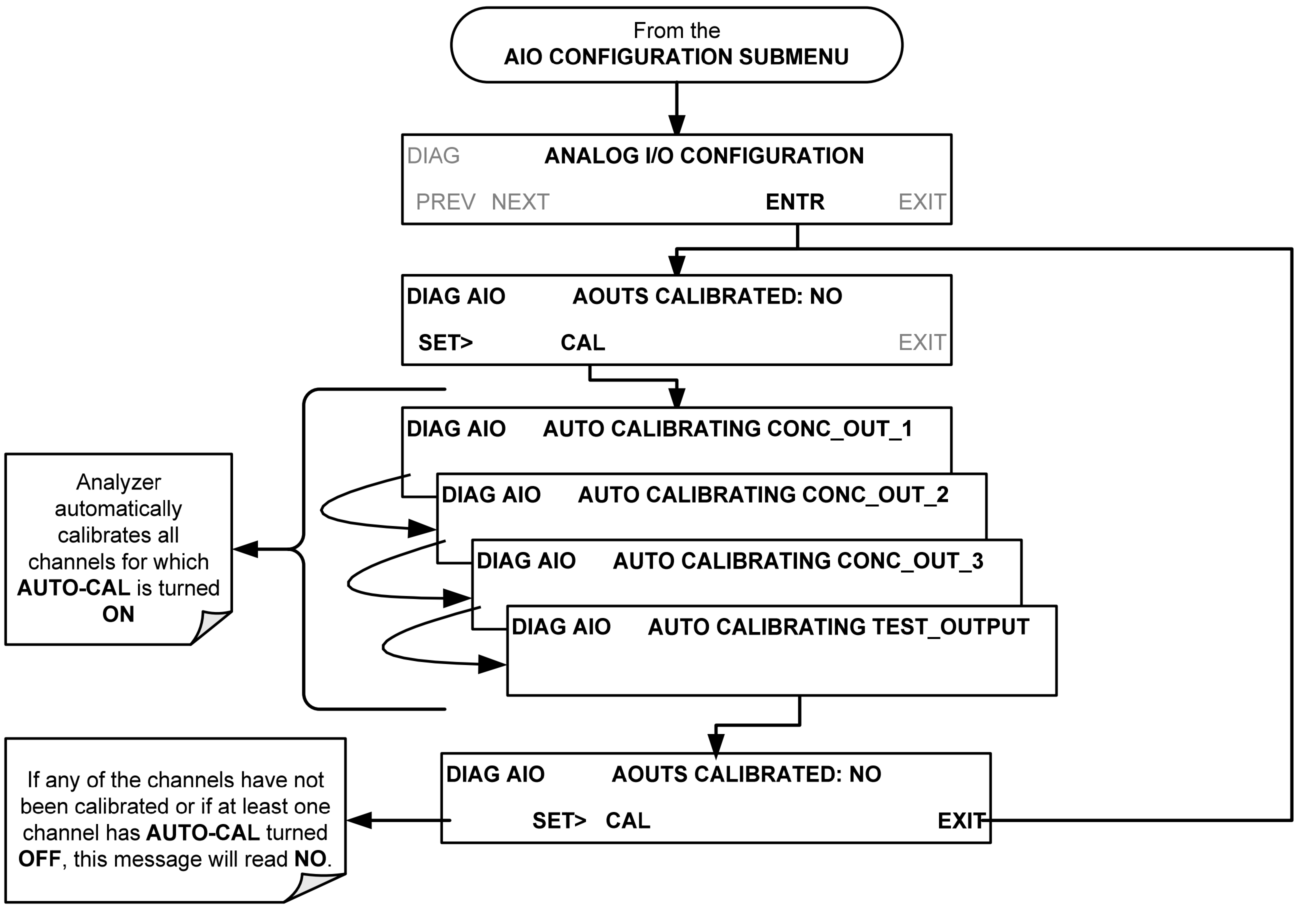


Figure 4-2 Auto Cal Initiate

> **NOTE**
>
> **Manual calibration should be used for any analog output set for a 0.1V output range or in cases where the outputs must be closely matched to the characteristics of the recording device.Individual Calibration of the Analog Outputs**

To use the **AUTO CAL** feature to initiate an automatic calibration for an individual analog output, select the **ANALOG I/O CONFIGURATION** submenu.

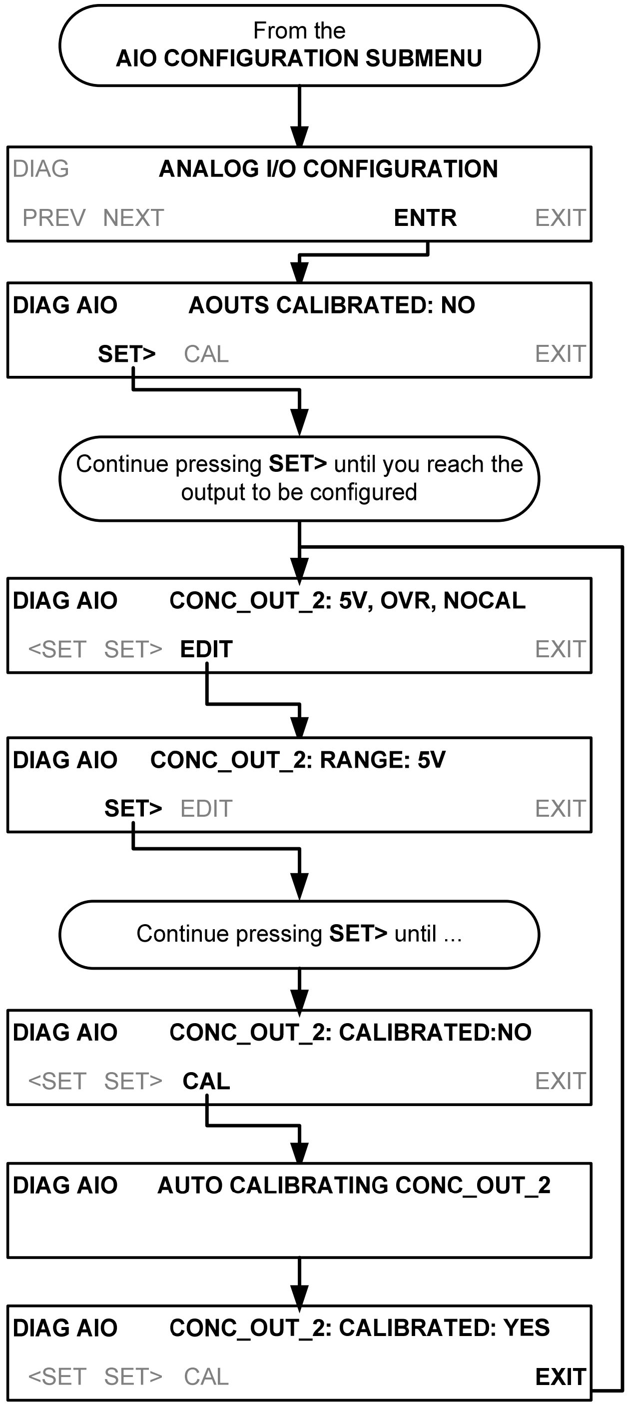


Figure 4-3 Auto Cal Initiate for individual channel

4.1.3. MANUAL CALIBRATION OF THE ANALOG OUTPUTS CONFIGURED FOR VOLTAGE RANGES

For highest accuracy, the voltages of the analog outputs can be manually calibrated.

> **NOTE:**
>
> **The menu for manually adjusting the analog output signal level will only appear if the AUTO-CAL feature is turned off for the channel being adjusted.**

Calibration is performed with a voltmeter connected across the output terminals and by changing the actual output signal level using the front panel keys in 100, 10 or 1 count increments.

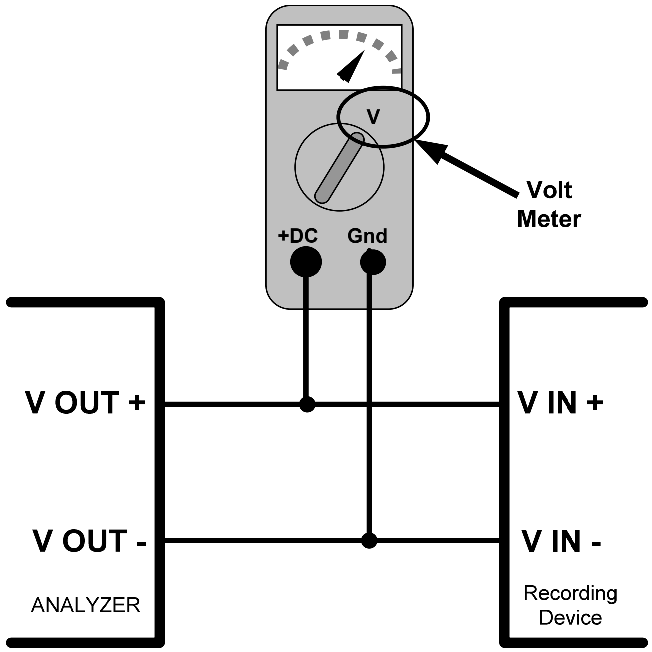


Figure 4-4 Setup for Checking / Calibrating DCV Analog Output Signal Levels

Table 4-1 Voltage Tolerances for the TEST CHANNEL Calibration

FULL SCALE	ZERO TOLERANCE	SPAN VOLTAGE	SPAN TOLERANCE	MINIMUM ADJUSTMENT (1 count)
0.1 VDC	±0.0005V	90 mV	±0.001V	0.02 mV
1 VDC	±0.001V	900 mV	±0.001V	0.24 mV
5 VDC	±0.002V	4500 mV	±0.003V	1.22 mV
10 VDC	±0.004V	4500 mV	±0.006V	2.44 mV

To adjust the signal levels of an analog output channel manually, select the **ANALOG I/O CONFIGURATION** submenu.

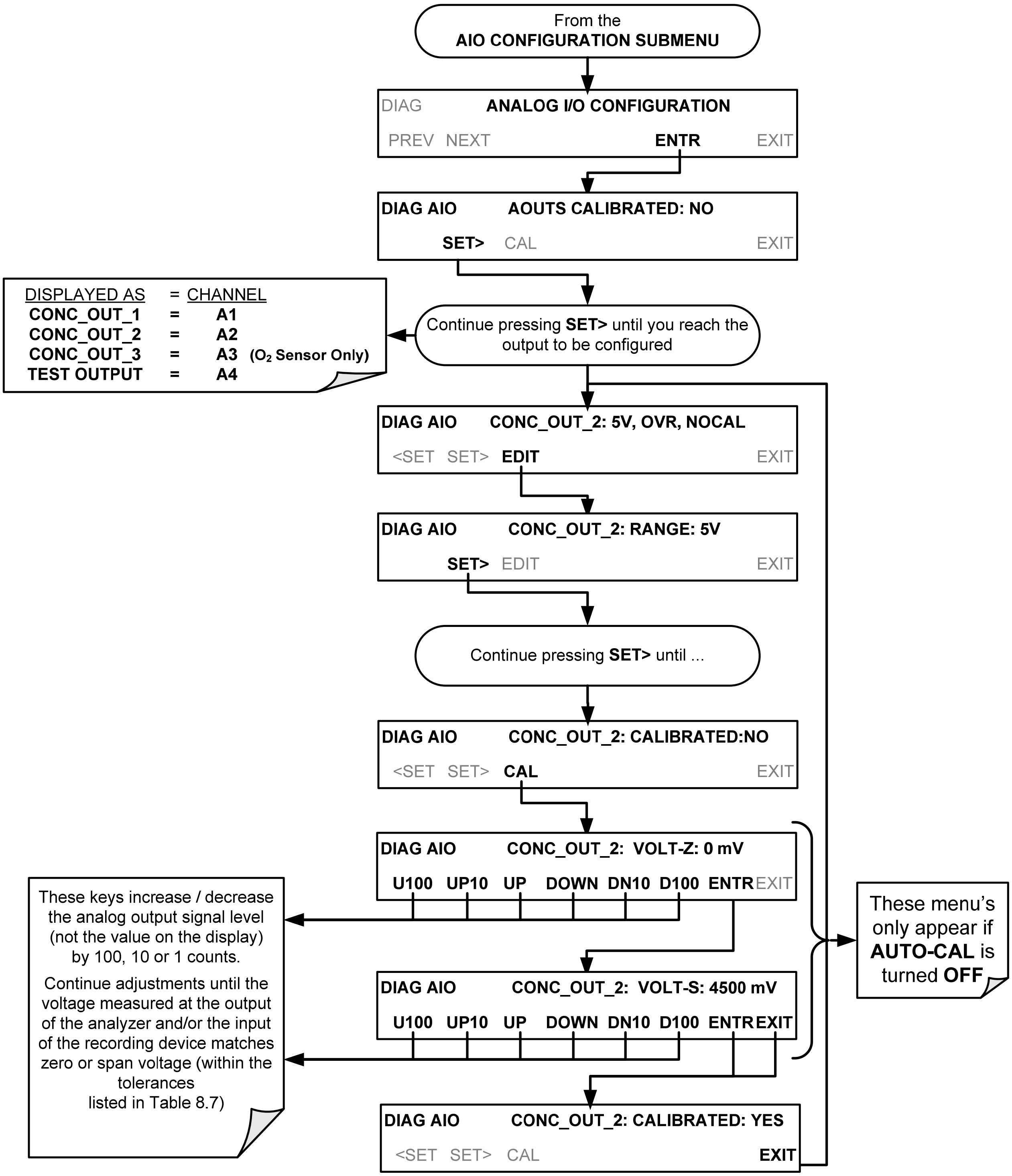


Figure 4-5 Manual Calibration

4.1.4. MANUAL ADJUSTMENT OF CURRENT LOOP OPTION OUTPUT SPAN AND OFFSET

A current loop option may be purchased for the **A1**, **A2** and **A3** analog outputs of the analyzer. This option places circuitry in series with the output of the A-to-D converter on the motherboard that changes the normal DC voltage output to a 0-20 milliamp signal.

The outputs can be ordered scaled to any set of limits within that 0-20 mA range, however most current loop applications call for either 0-20 mA or 4-20 mA range spans.

All current loop outputs have a + 5% over range. Ranges whose lower limit is set above 1 mA also have a 5% under range.

To switch an analog output from voltage to current loop, select **CURR** from the list of options on the "Output Range" menu.

Adjustment of the signal zero and span levels of the current loop output is done by raising or lowering the voltage output of the D-to-A converter circuitry on the analyzer's motherboard. This raises or lowers the signal level produced by the current loop option circuitry.

The software allows this adjustment to be made in 100, 10 or 1 count increments. Since the exact amount by which the current signal is changed per D-to-A count varies from output-to-output and instrument–to–instrument, you will need to measure the change in the signal levels with a separate, current meter placed in series with the output circuit.

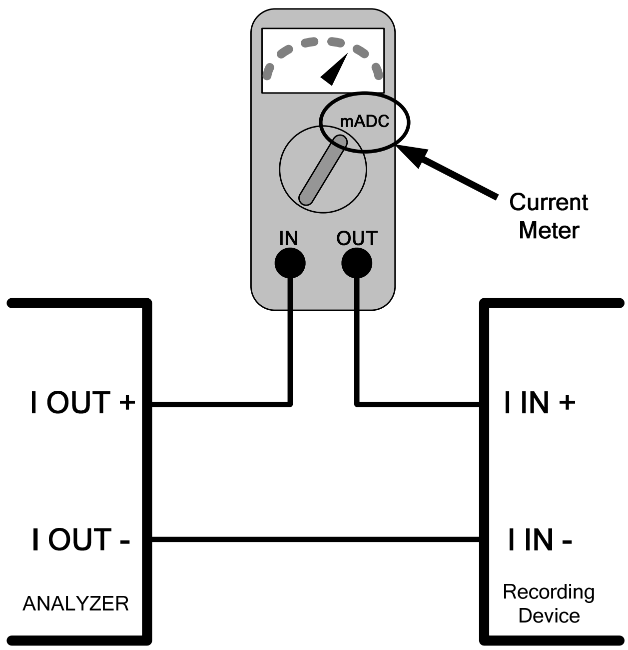


Figure 4-6 Setup for Checking / Calibration Current Output Signal Levels Using an Ammeter

- **CAUTION**

GENERAL SAFETY HAZARD

Do not exceed 60 V peak voltage between current loop outputs and instrument ground.

To adjust the zero and span signal levels of the current outputs, select the **ANALOG I/O CONFIGURATION** submenu.

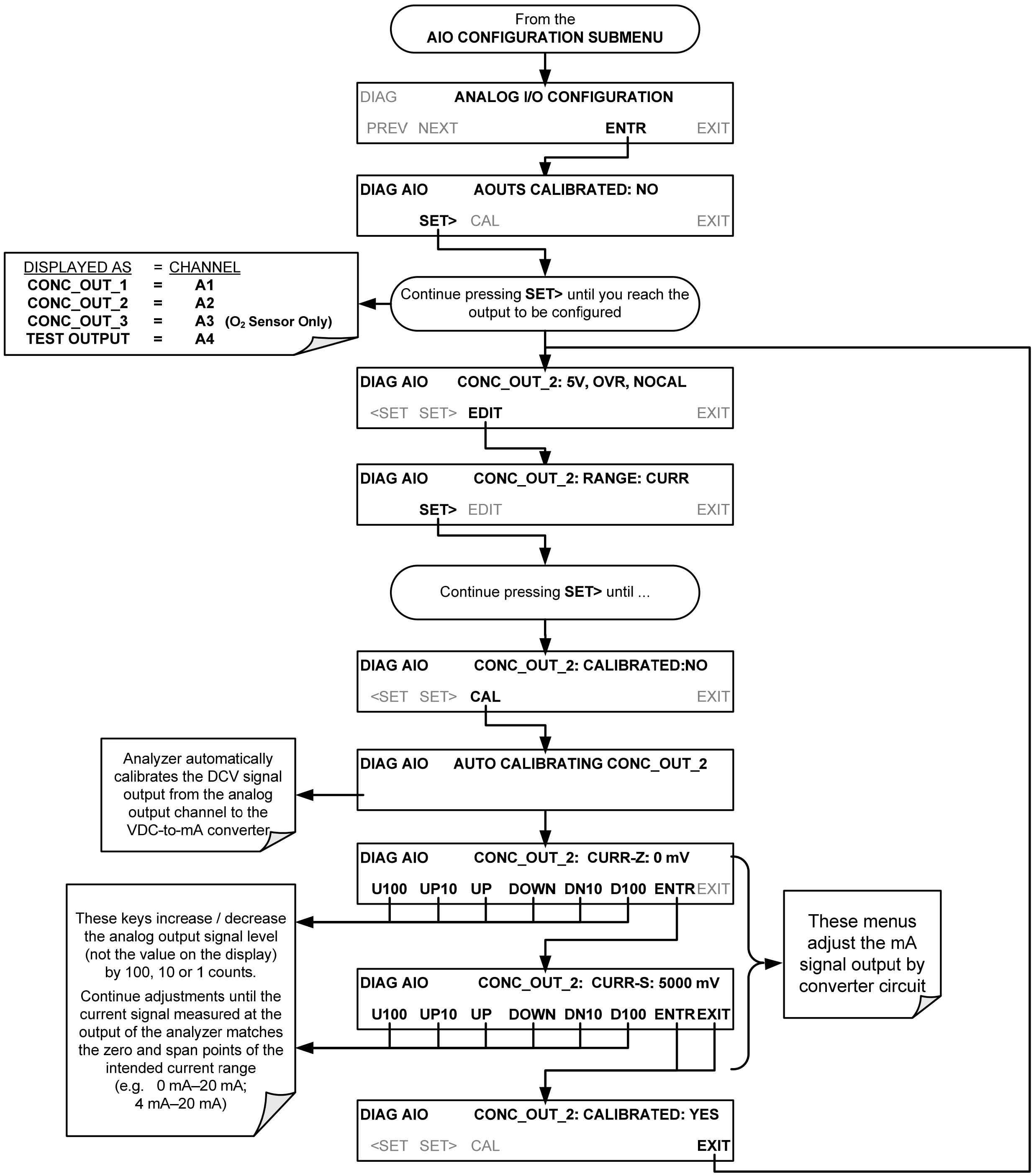


Figure 4-7 Current Calibration

An alternative method for measuring the output of the Current Loop converter is to connect a 250 ohm ±1% resistor across the current loop output in lieu of the current meter. This allows the use of a voltmeter connected across the resistor to measure converter output as VDC or mVDC.

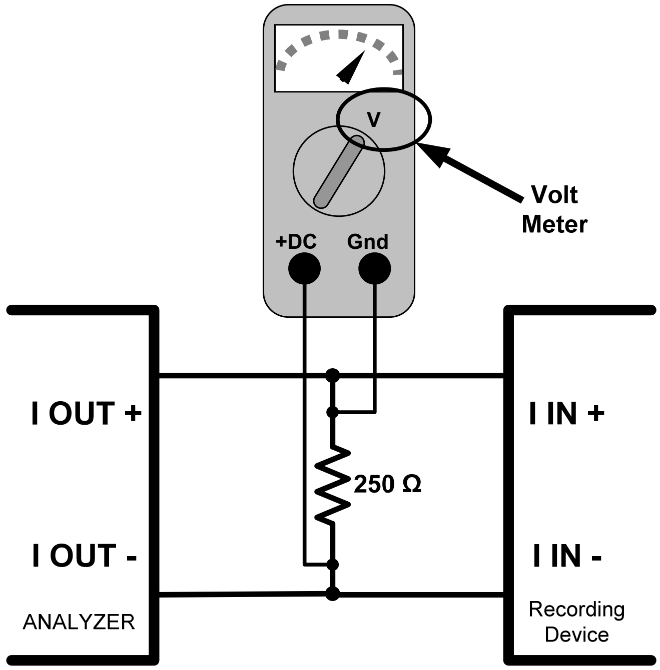


Figure 4-8 Alternative Setup Using 250Ω Resistor for Checking Current Output Signal Levels

In this case, follow the procedure above but adjust the output for the following values:

Table 4-2 Current Loop Output Check

% FS	Voltage across Resistor for 2-20 mA	Voltage across Resistor for 4-20 mA
0	500 mVDC	1000 mVDC
100	5000 mVDC	5000 mVDC

4.1.5. TURNING AN ANALOG OUTPUT OVER-RANGE FEATURE ON/OFF

In its default configuration, a ± 5% over-range is available on each of the M803E's analog outputs. This over-range can be disabled if your recording device is sensitive to excess voltage or current. To turn the over-range feature on or off, select the **ANALOG I/O CONFIGURATION** submenu.

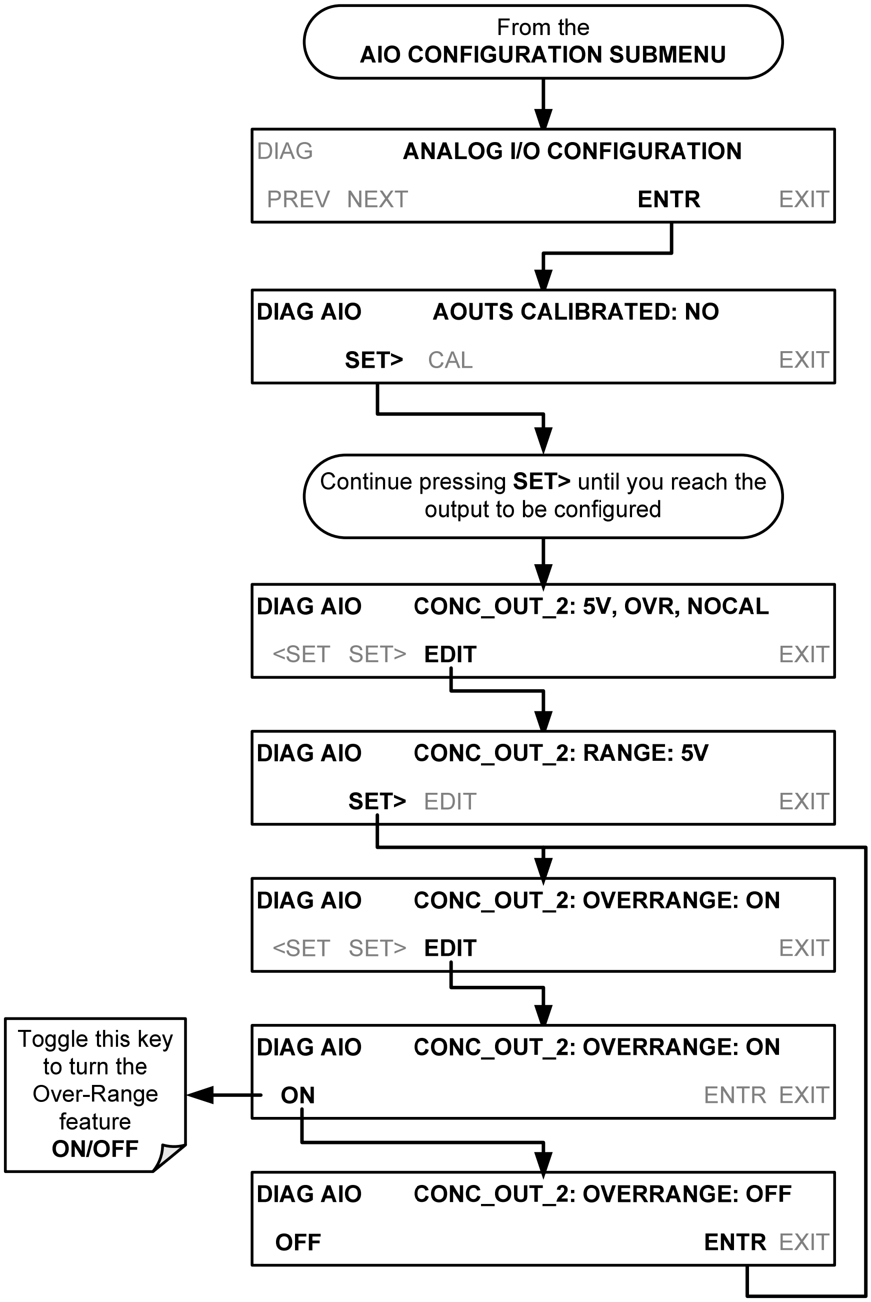


Figure 4-9 Setting Overrange

4.1.6. ADDING A RECORDER OFFSET TO AN ANALOG OUTPUT

Some analog signal recorders require that the zero signal be significantly different from the baseline of the recorder in order to record slightly negative readings from noise around the zero point. This can be achieved in the M803E by defining a zero offset, a small voltage (e.g., 10% of span).

To add a zero offset to a specific analog output channel, select the **ANALOG I/O CONFIGURATION** submenu.

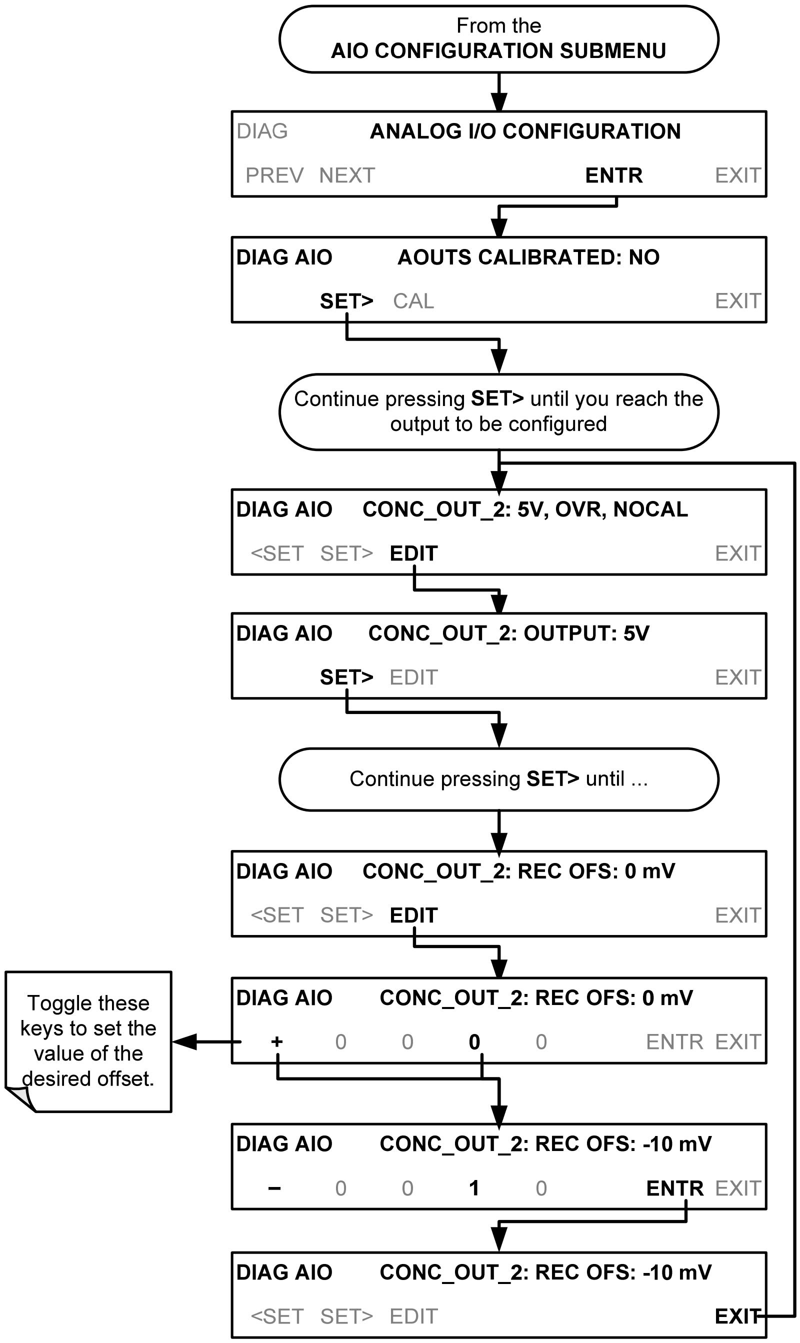


Figure 4-10 Analog Offset

4.1.7. SELECTING A TEST CHANNEL FUNCTION FOR OUTPUT A4

The test functions available to be reported are:

Table 4-3 Test Channels Functions available on the M803E's Analog Output

TEST CHANNEL	DESCRIPTION	ZERO	FULL SCALE
NONE	Test Channel is turned off		
SAMPLE PRESSURE	The absolute pressure of the Sample gas as measured by a pressure sensor located inside the sample chamber.	0 "Hg	40 "Hg
SAMPLE FLOW	Sample mass flow rate as measured by the flow rate sensor in the sample gas stream.	0 cm^3/m	1000 cm^3/m
CO2 CELL TEMP	The temperature of the gas inside the CO_2 sensor sample chamber.	0°C	70°C
O2 CELL TEMP	The temperature of the gas inside the O_2 sensor sample chamber.	0°C	70°C
CHASSIS TEMP	The temperature inside the analyzer chassis.	0°C	70°C

Once a function is selected, the instrument not only begins to output a signal on the analog output, but also adds **TEST** to the list of test functions viewable via the front panel display.

To activate the **TEST** Channel and select a function (in this example **SAMPLE PRESSURE**), press:

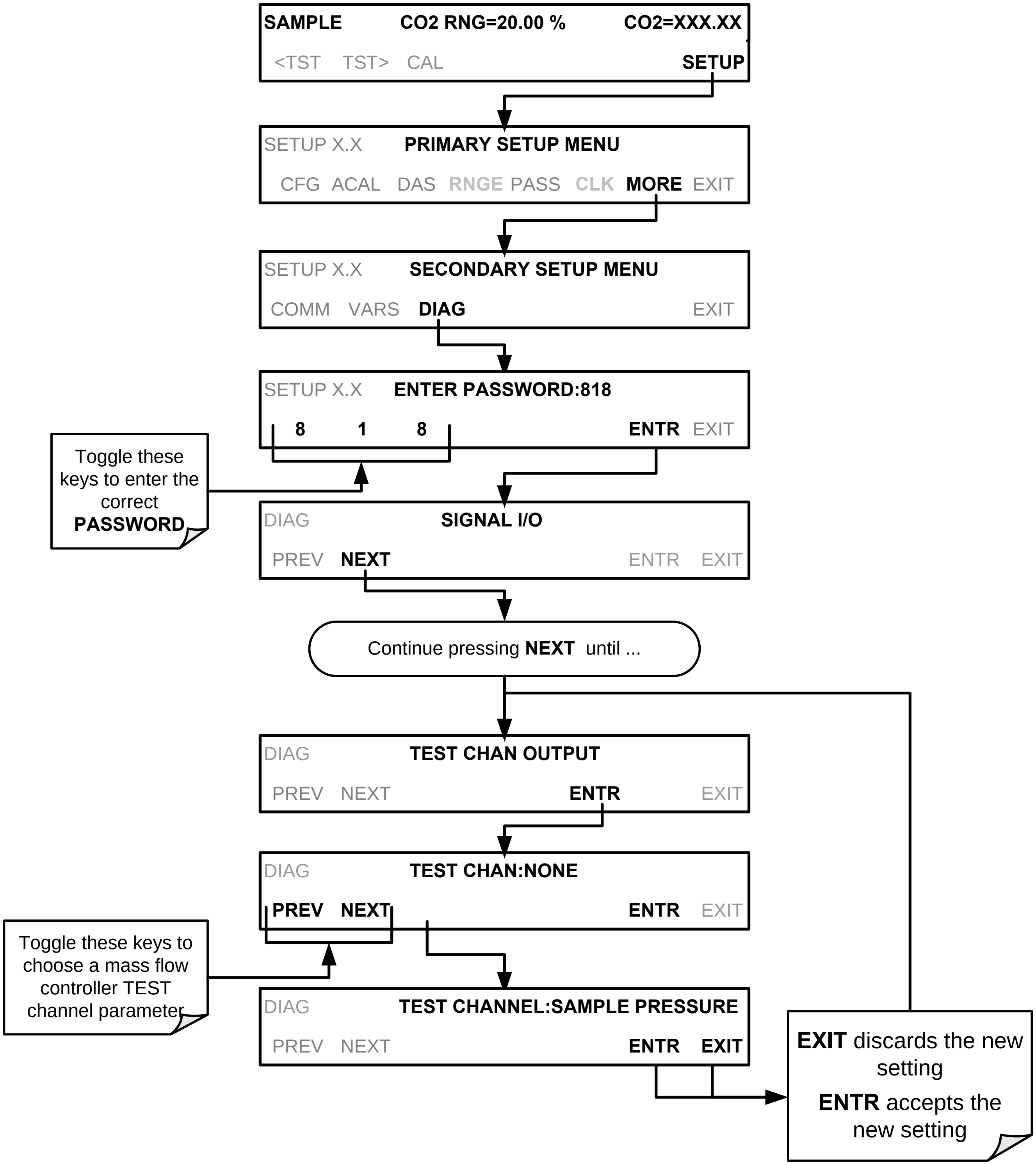


Figure 4-11 Setting Test Channel (The ACAL submenu in the Primary Setup Menu is a special configuration; consult factory).

4.1.8. AIN CALIBRATION

This is the sub-menu to conduct a calibration of the M803E analyzer's analog inputs. This calibration should only be necessary after major repair such as a replacement of CPU, motherboard or power supplies. To perform an analog input calibration, select the ANALOG I/O CONFIGURATION submenu.

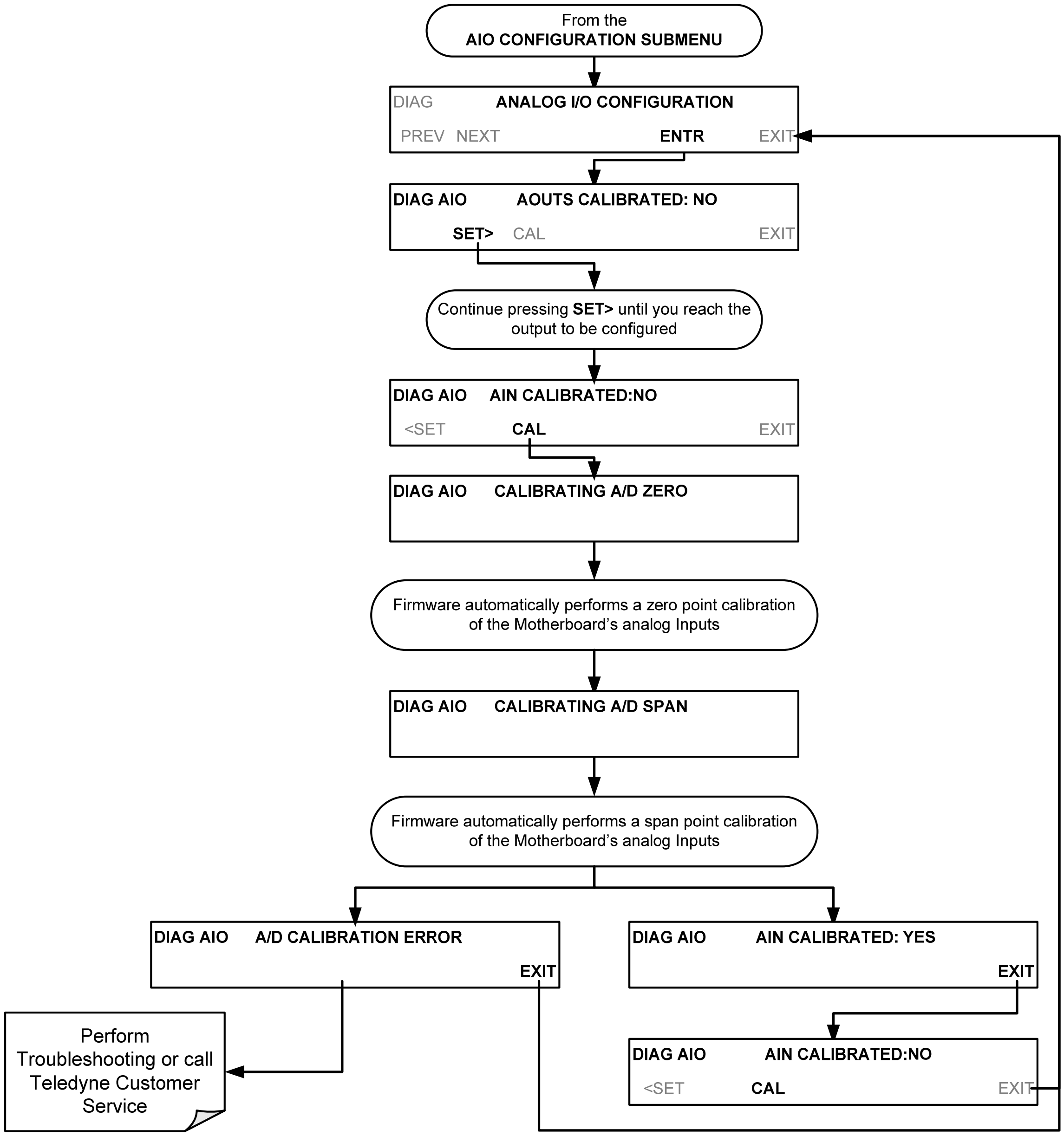


Figure 4-12 AIN Calibration

4.1 M80XE CALIBRATION PROCEDURES

This section contains a variety of information regarding the various methods for calibrating a M80XE as well as other supporting information

This section is organized as follows:

- **BEFORE CALIBRATION**

This section contains general information you should know before calibrating the analyzer.

MANUAL CALIBRATION CHECKS AND CALIBRATION OF THE M80XE ANALYZER

This section describes the procedure for checking the calibration of the M80XE and calibrating the instrument. Also included are instructions for selecting the reporting range to be calibrated when the M80XE analyzer is set to operate in either the DUAL or AUTO reporting range modes.

ASSESSING CALIBRATION QUALITY

This section describes how to judge the effectiveness of a recently performed calibration.

- **CALIBRATION OF THE M80XE'S ELECTRONIC SUBSYSTEMS**

This section describes how to perform calibrations of the M80XE's electronic systems, including:

adjusting the analyzers internal flow sensor

adjusting the analyzers internal pressure sensor

NOTE

Throughout this section are various diagrams showing pneumatic connections between the M80XE and various other pieces of equipment such as calibrators and zero air sources.

These diagrams are only intended to be schematic representations of these connections and do not reflect actual physical locations of equipment and fitting location or orientation.

Contact your regional EPA or other appropriate governing agency for more detailed recommendations.

4.2.1. BEFORE CALIBRATION

The calibration procedures in this section assume that the range mode, analog range and units of measure have already been selected for the analyzer. If this has not been done, please do so before continuing.

> **NOTE**
>
> **If any problems occur while performing the following calibration procedures, refer to Section 6 for troubleshooting tips.**

4.2.1.1. REQUIRED EQUIPMENT, SUPPLIES, AND EXPENDABLES

Calibration of the M80XE analyzer requires a certain amount of equipment and supplies. These include, but are not limited to, the following:

Zero-air source.

Span gas source.

Gas lines - All Gas lines should be Stainless Steel, PTFE (Teflon), and glass or electroless nickel.

A recording device such as a strip-chart recorder and/or data logger (optional). For electronic documentation, the internal data acquisition system can be used.

> **NOTE**
>
> **If any problems occur while performing the following calibration procedures, refer to Section 6 of this manual for troubleshooting tips.**

4.2.1.2. CALIBRATION GASES

4.2.1.2.1. ZERO AIR

A gas that is similar in chemical composition to the earth's atmosphere but scrubbed of all components that might affect the analyzer's readings. Teledyne API recommends using pure N_2 when calibrating the zero point of your CO_2 or O_2 sensor except if known interferents are involved.

> • **CAUTION**
>
> **GENERAL SAFETY HAZARD**
>
> **DO NOT vent calibration gases into enclosed areas. Rapid release of pure N_2 gas into an enclosed space can displace oxygen, and therefore represents an asphyxiation hazard. This may happen with few warning symptoms.**

4.2.1.2.2. SPAN GAS

A gas specifically mixed to match the chemical composition of the type of gas being measured at near full scale of the desired measurement range. In this case, O_2 measurements made with the M80XE analyzer, Teledyne API recommends using 21% O_2 in N_2 when calibrating the span point of the O_2 sensor and 16% CO_2 in N_2 when calibrating the span point of the CO_2 sensor/probe.

Cylinders of both calibrated O_2 and CO_2 gas traceable to NIST-Standard Reference Material specifications (also referred to as SRMs or EPA protocol calibration gases) are commercially available.

Table 4-4 NIST SRM's Available for Traceability of O_2 Calibration Gases

NIST-SRM	Type	Nominal Concentration
2657a	O_2 in N_2	2%
2658a	O_2 in N_2	10 %
2659a	O_2 in N_2	21%
2619a	CO_2 in N_2	0.5%
2620a	CO_2 in N_2	1%
2622a	CO_2 in N_2	2%
2624a	CO_2 in N_2	3%
2744b	CO_2 in N_2	7%
2745[1]	CO_2 in N_2	16%

NOTE

For span point calibration it is generally a good idea to use 80% of the reporting range for that channel.

For instance if the reporting range of the instrument is set for 5%, the proper span gas would be 4%.Data Recording Devices

A strip chart recorder, data acquisition system or digital data acquisition system should be used to record data from the serial or analog outputs of the M80XE.

If analog readings are used, the response of the recording system should be checked against a NIST traceable voltage source or meter.

Data recording devices should be capable of bi-polar operation so that negative readings can be recorded.

For electronic data recording, the M80XE provides an internal data acquisition system (iDAS).

APICOM, a remote control program, is also provided as a convenient and powerful tool for data handling, download, storage, quick check and plotting.

4.2.1.3. ANALOG OUTPUT CONFIGURATIONS

The analog outputs for the M80XE vary per model. The default configurations are as follows:

M801E	**A1**	**A2**	**A3**	**A4**
Standard Firmware	CO2 CNC1	CO2 CNC2 (if dual or auto range selected)	NONE	
Test Configurable	CO2 CNC1	CO2 CNC2	NONE	Test
M802E				
Standard Firmware	O2 CNC1	O2 CNC2	CO2 (if option installed)	
Test Configurable	O2 CNC1	O2 CNC2	CO2 CNC1 (if option installed)	CO2 CNC2 (if option installed)
M803E				
Standard Firmware	CO2 CNC1	CO2 CNC2 (if dual or auto range selected)	O2	
Test Configurable	CO2 CNC1	CO2 CNC2	O2 CNC1	O2 CNC2

4.2.2. Manual Calibration Checks and Calibration of the M80XE Analyzer

ZERO/SPAN CALIBRATION CHECKS VS. ACTUAL ZERO/SPAN CALIBRATION

NEVER press the ENTR key if you are only checking calibration.

Pressing the ENTR key during the following procedure resets the stored values for OFFSET and SLOPE and alters the instrument's Calibration. This should ONLY BE DONE during an actual calibration of the M80XE.

4.2.2.1. SETUP FOR CALIBRATION CHECKS AND CALIBRATION

Connect the Sources of Zero Air and Span Gas as shown below.

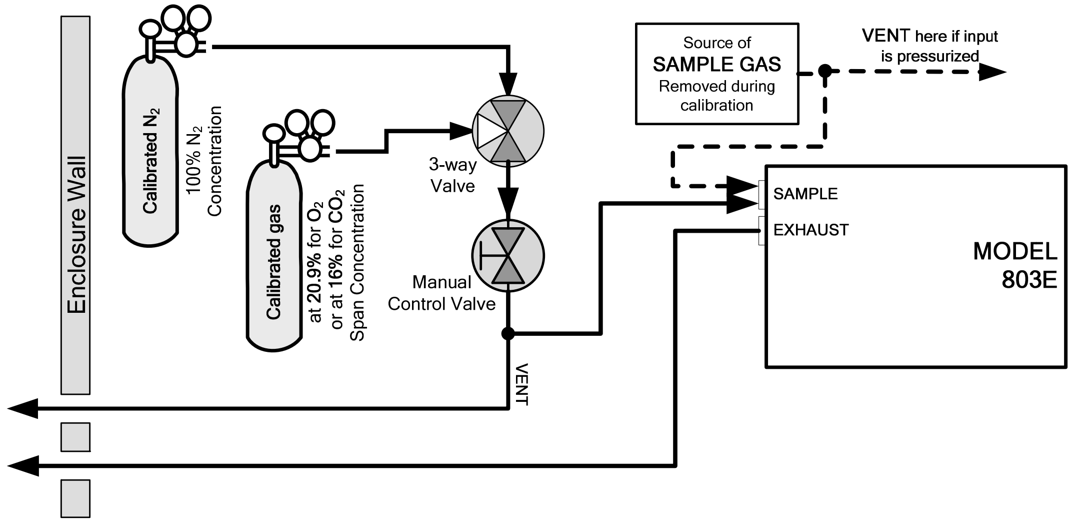


Figure 4-13 Pneumatic Connections Using Bottled Span Gas

4.2.2.2. PERFORMING A MANUAL CALIBRATION CHECK

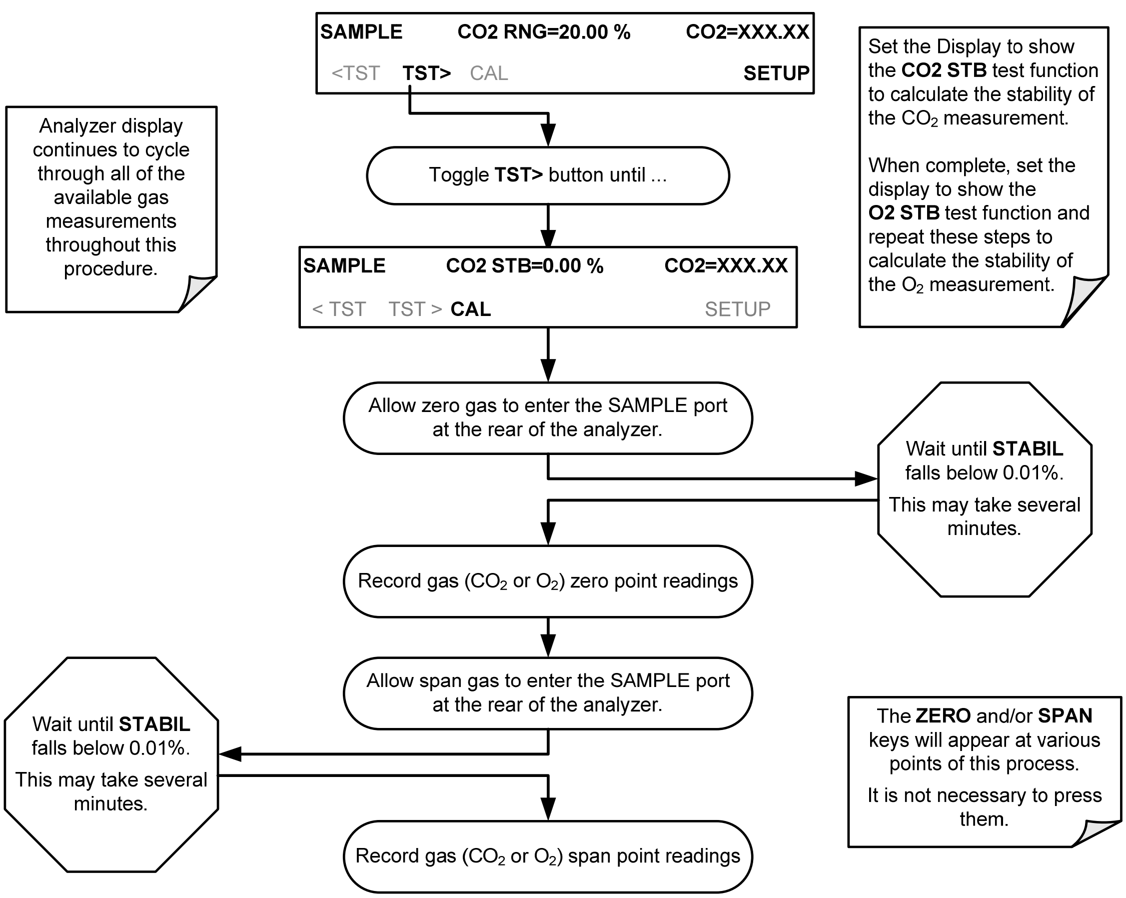


Figure 4-14 Zero and Span Check

> **NOTE**
>
> **If the ZERO or SPAN keys are not displayed, the measurement made during this cal check is out of the allowable range allowed for a reliable calibration. See Section 6 for troubleshooting tips.**

4.2.3. PERFORMING A MANUAL CALIBRATION

The following section describes the basic method for manually calibrating the M80XE.
If the analyzer's reporting range is set for the **DUAL** or **AUTO** range modes, a step will appear for selecting which range is to be calibrated: **RNG1** (LOW) or **RNG2** (HIGH).
Each of these two ranges **MUST** be calibrated separately.

4.2.3.1. SETTING THE EXPECTED SPAN GAS CONCENTRATION

> **NOTE**
> **When setting expected concentration values, consider impurities in your span gas.**

The expected CO_2 span gas concentration should be 80% of the reporting range of the instrument.

The default factory setting is 16% for CO_2 or 20.95 % for O_2. To set the span gas concentration, press:

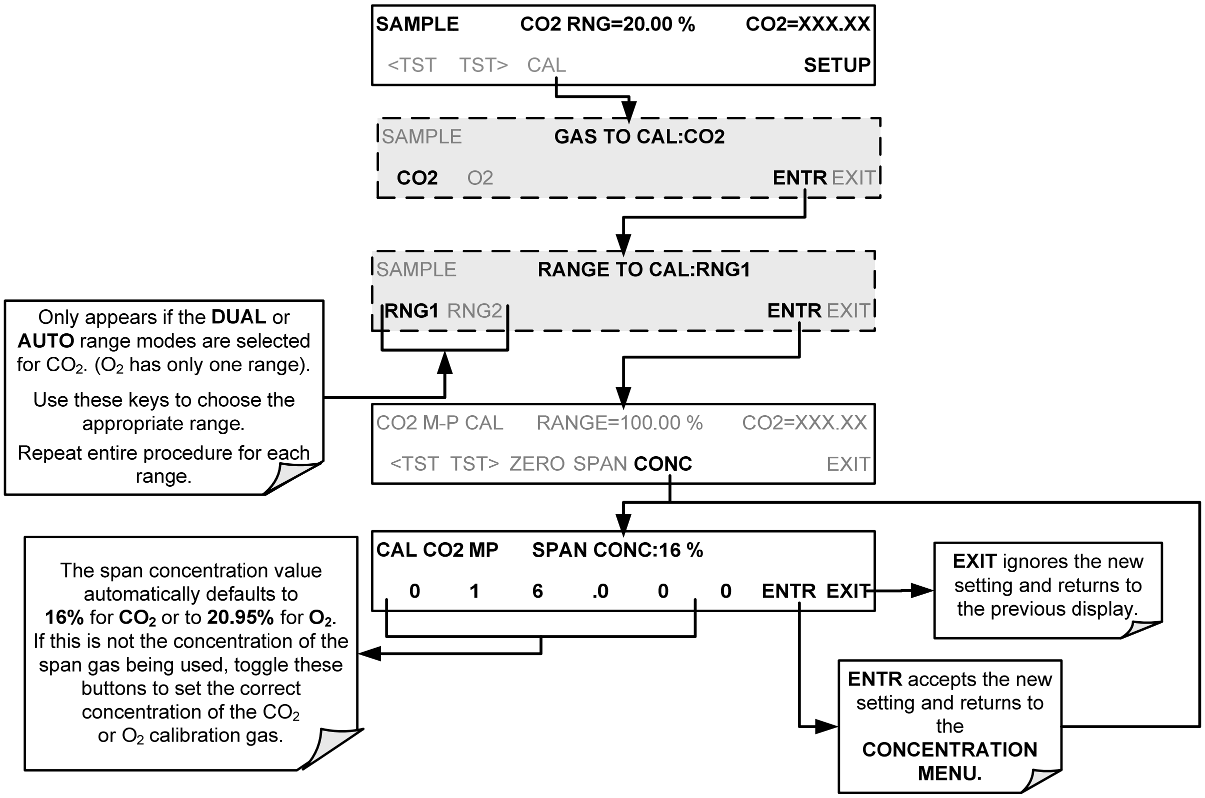


Figure 4-15 Setting Expected Gas Concentration

NOTE

For this Initial Calibration it is important to independently verify the PRECISE Concentration Value of the SPAN gas (CO_2 or O_2).

If the source of the Span Gas is from a calibrated bottle, use the exact concentration value printed on the bottle.

4.2.3.2. ZERO/SPAN POINT CALIBRATION PROCEDURE

To perform the zero/span calibration procedure:

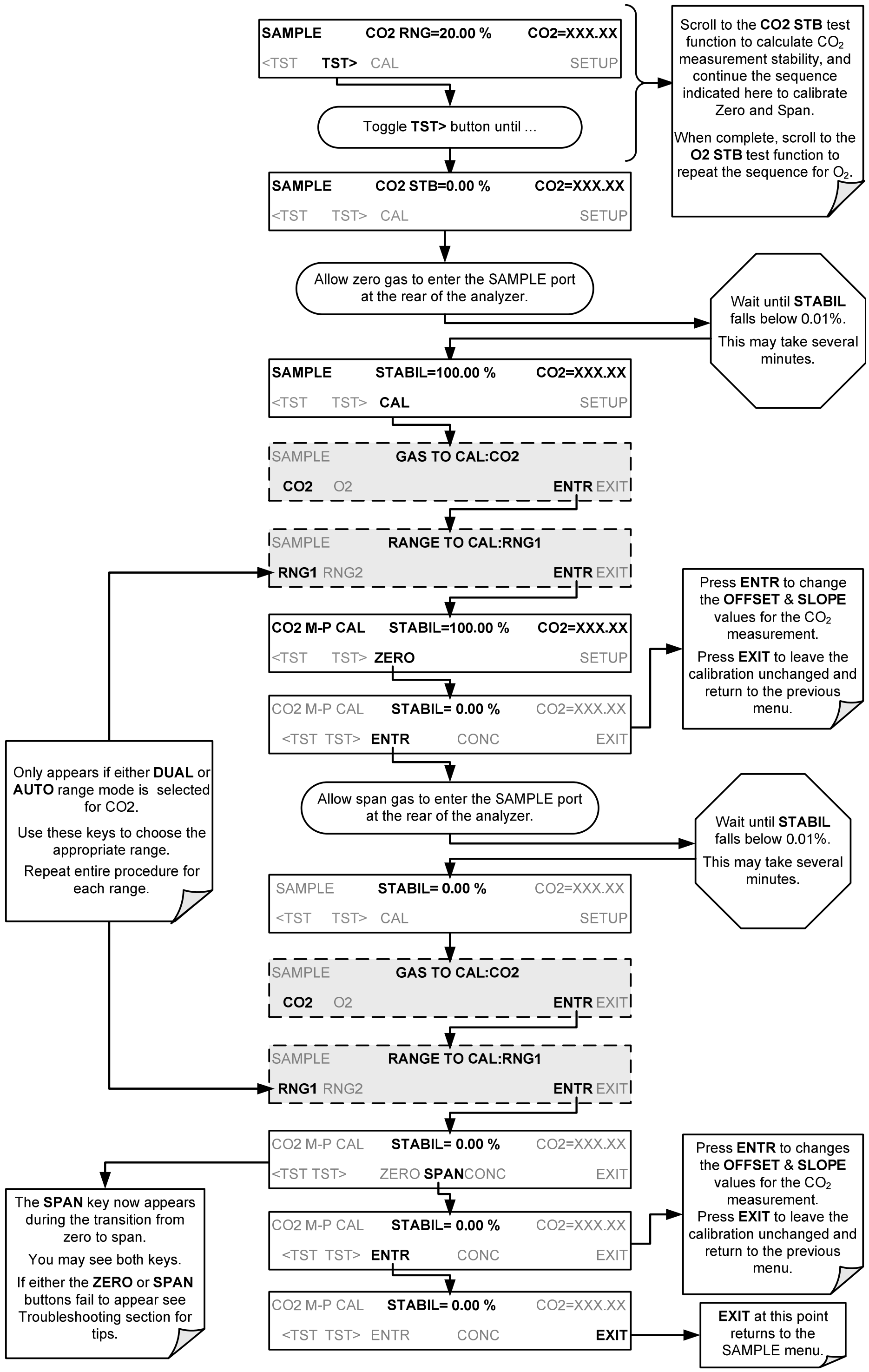


Figure 4-16 Zero/Span Point Calibration

4.2.4.Assessing Calibration Quality

After completing one of the calibration procedures described above, it is important to evaluate the analyzer's calibration **SLOPE** and **OFFSET** parameters. These values describe the linear response curve of the analyzer. The values for these terms, both individually and relative to each other, indicate the quality of the calibration.

To perform this quality evaluation, you will need to record the values of both test functions, all of which are automatically stored in the iDAS channel CALDAT for data analysis, documentation and archival.

Make sure that these parameters are within the limits listed below and frequently compare them to those values on the *Final Test and Checkout Sheet* (P/N 065120000) that came attached to your manual, which should not be significantly different. If they are, refer to troubleshooting in Section 6.

Table 4-5 Calibration Data Quality Evaluation

FUNCTION	MINIMUM VALUE	OPTIMUM VALUE	MAXIMUM VALUE
SLOPE	0.700	1.000	1.300
OFFSET	-0.500	0.000	0.500
These values should not be significantly different from the values recorded on the Teledyne API *Final Test and Validation Data Sheet* that was shipped with your instrument. If they are, refer to troubleshooting in Section 6.			

The default iDAS configuration records all calibration values in channel **CALDAT** as well as all calibration check (zero and span) values in its internal memory.

Up to 200 data points are stored for up 4 years of data (on weekly calibration checks) and a lifetime history of monthly calibrations.

Review these data to see if the zero and span responses change over time.

These channels also store the **STABIL** values (standard deviation of the CO_2 and the O_2 concentrations) to evaluate if the analyzer response has properly leveled off during the calibration procedure.

4.2.4. Calibration of the M80XE's Electronic Subsystems

4.2.4.1. PRESSURE CALIBRATION

A sensor/probe in the sample path continuously measures the pressure of the sample gas. This data is used to compensate the measured CO_2 and O_2 concentrations for changes in atmospheric pressure and is stored in the CPU's memory as the test function PRES (also viewable via the front panel).

To carry out this adjustment, the current ambient atmospheric pressure must be known.

Before performing the following pressure calibration, ensure that the pressure being measured by the analyzer's internal sensor is equal to ambient atmospheric pressure by disconnecting:

The sample gas pump and;

The sample gas-line vent from the sample gas inlet on the instrument's rear panel.

To cause the analyzer to measure and record a value for PRES, press.

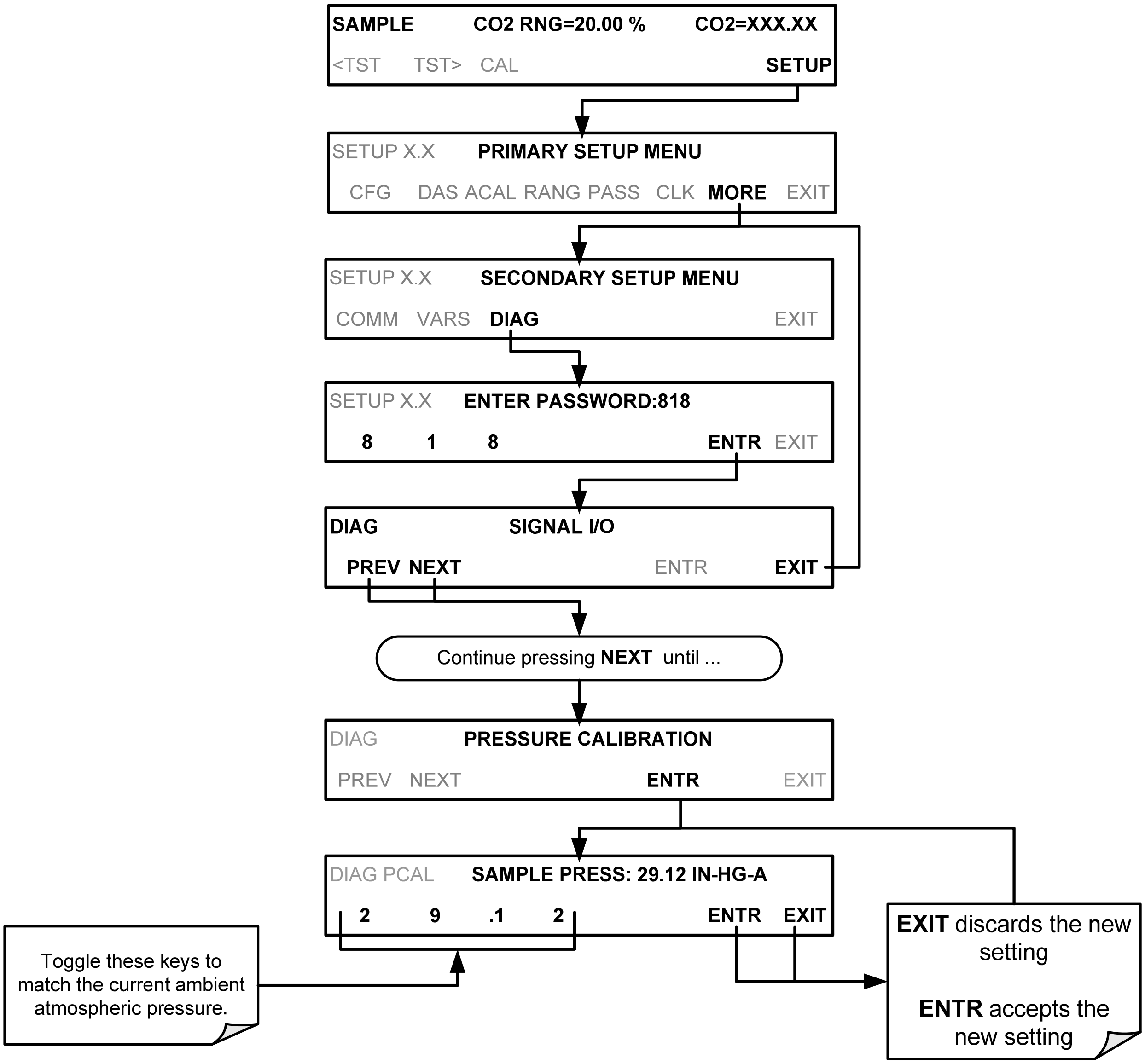


Figure 4-17 Pressure Calibration (The ACAL submenu in the Primary Setup Menu is a special configuration; consult factory).

4.2.4.2. FLOW CALIBRATION

The flow calibration allows the user to adjust the values of the sample flow rates as they are displayed on the front panel and reported through COMM ports to match the actual flow rate measured at the SAMPLE inlet. This does not change the hardware measurement of the flow sensors, only the software-calculated values.

To carry out this adjustment, connect an external, sufficiently accurate flow meter to the sample inlet. Once the flow meter is attached and is measuring actual gas flow, press:

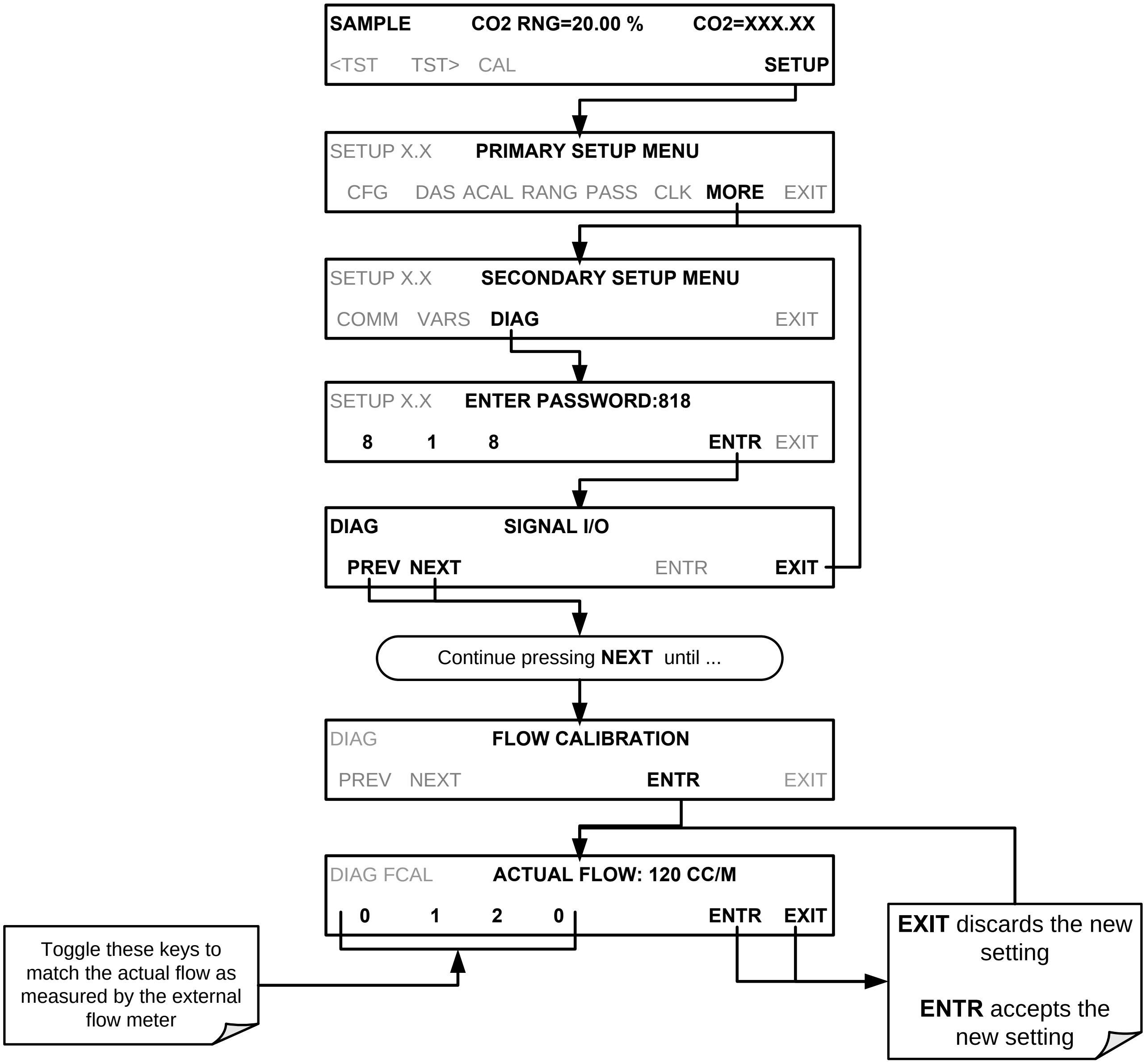


Figure 4-18 Flow Calibration (The ACAL submenu in the Primary Setup Menu is a special configuration; consult factory).

5. MAINTENANCE

Note The M80XE Analyzer utilizes technologies that are non-depleting and require very little maintenance. However, there are a minimal number of simple procedures that when performed regularly will ensure that the analyzer continues to operate accurately and reliably over its lifetime.

5.1. Maintenance Schedule

Please note that in certain environments (i.e. dusty, very high ambient pollutant levels) some maintenance procedures may need to be performed more often than shown.

NOTE

A Span and Zero Calibration Check must be performed following certain of the maintenance procedure listed below.

HAZARD
STRONG OXIDIZER

OXYGEN IS A STRONG OXIDIZER.

Before working with the casing open, be sure to turn off power supply, and perform air or N_2 gas purging of not only the analyzer inside, but also the sample gas line.

In addition, carefully prevent oil and grease from adhering to any piping. Otherwise, poisoning, fire or explosion may be caused due to gas leakage, etc.

- **CAUTION**

GENERAL SAFETY HAZARD

Risk of electrical shock. Disconnect power before performing any of the following operations that require entry into the interior of the analyzer.

- **CAUTION**

QUALIFIED PERSONNEL

The operations outlined in this Section are to be performed by qualified maintenance personnel only.

Table 5-1 M80XE Maintenance Schedule

ITEM	ACTION	FREQ	CAL CHECK REQ'D.	DATE PERFORMED									
Particulate Filter	Replace	Weekly or as needed	No										
Verify Test Functions	Record and analyze	Weekly or after any Maintenance or Repair	No										
Pump Diaphragm	Replace	Annually	Yes										
Sintered Filter	Replace	Annually	Yes										
Perform Flow Check	Check Flow	Annually	No										
Perform Leak Check	Verify Leak Tight	Annually or after any Maintenance or Repair	No										
Pneumatic lines	Examine and clean	As needed	Yes if cleaned										
Cleaning	Clean	As needed	Only if cover removed										

Table 5-2 M80XE Test Function Record

FUNCTION	OPERATING MODE*	DATE RECORDED											
STABIL	O2 ZERO CAL												
STABIL	CO2 ZERO CAL												
PRES	SAMPLE												
FLOW	SAMPLE												
O2 CELL TEMP	SAMPLE												
CO2 CELL TEMP	SAMPLE												
BOX TEMP	SAMPLE												
CO2 SLOPE	SPAN CAL												
CO2 OFFSET	ZERO CAL												
O2 SLOPE	SPAN CAL												
O2 OFFSET	ZERO CAL												

5.2. Using the Test Functions to Predict Failures

The Test Functions can be used to predict failures by looking at how their values change over time. Initially it may be useful to compare the state of these Test Functions to the values recorded on the printed record of the final calibration performed on your instrument at the factory. The below table can be used as a basis for taking action as these values change with time. The internal data acquisition system (iDAS) is a convenient way to record and track these changes. Use APICOM to download and review this data from a remote location.

Table 5-3 Predictive uses for Test Functions

FUNCTION	CONDITION	BEHAVIOR	INTERPRETATION
STABIL	CO_2 Zero Cal O_2 Zero Cal	Increasing	• Pneumatic Leaks – instrument & sample system
PRES	Sample	Increasing > 1”	• Pneumatic Leak between sample inlet and Sample Cell • Change in sampling manifold
		Decreasing > 1”	• Dirty particulate filter • Pneumatic obstruction between sample inlet and sensor/probe • Obstruction in sampling manifold
OFFSET	Zero Cal	Increasing	• Pneumatic Leaks • Contaminated zero gas
		Decreasing	• Contaminated zero gas
SLOPE	Span Cal	Increasing	• Pneumatic Leaks – instrument & sample system • Calibration system deteriorating
		Decreasing	• Calibration system deteriorating

5.3. Maintenance Procedures

The following procedures are to be performed periodically as part of the standard maintenance of the M80XE.

5.3.1. REPLACING THE SAMPLE PARTICULATE FILTER

The particulate filter should be inspected often for signs of plugging or contamination. We recommend that when you change the filter; handle it and the wetted surfaces of the filter housing as little as possible. Do not touch any part of the housing, filter element, PTFE retaining ring, glass cover and the o-ring.

To change the filter:

1. Turn OFF the analyzer to prevent drawing debris into the instrument.
2. Open the M80XE's hinged front panel and unscrew the knurled retaining ring on the filter assembly.

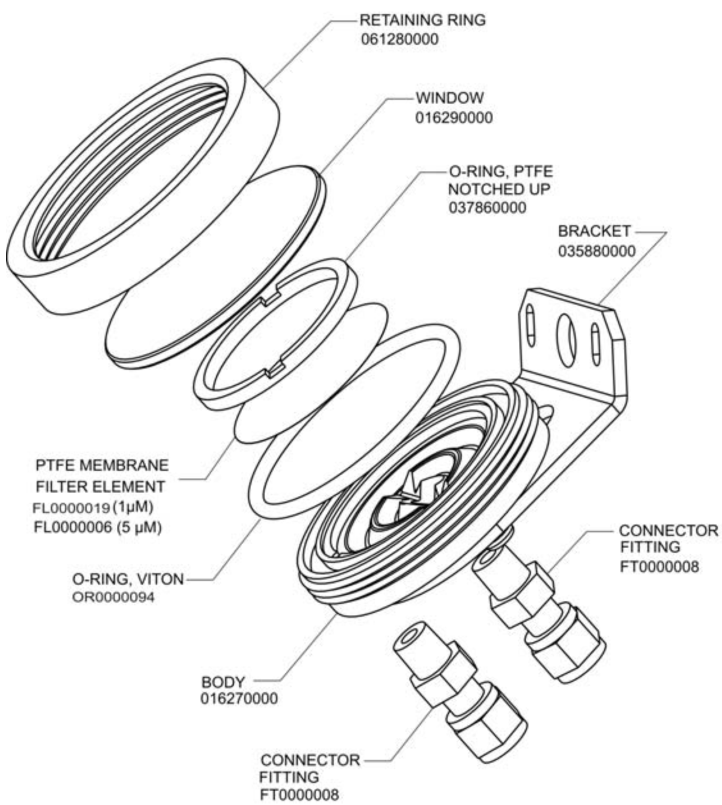


Figure 5-1 Sample Particulate Filter Assembly

3. Carefully remove the retaining ring, PTFE o-ring, glass filter cover and filter element.
4. Replace the filter, being careful that the element is fully seated and centered in the bottom of the holder.
5. Re-install the PTFE o-ring (with the notches up), the glass cover, then screw on the retaining ring and hand tighten. Inspect the seal between the edge of filter and the o-ring to assure a proper seal.
6. Re-start the analyzer.

5.3.2. REBUILDING THE SAMPLE PUMP

The diaphragm in the sample pump periodically wears out and must be replaced. Instructions and diagrams are included with the kit.
Always perform a Flow and Leak Check after rebuilding the Sample Pump.

5.3.3. PERFORMING LEAK CHECKS

HAZARD

STRONG OXIDIZER

OXYGEN IS A STRONG OXIDIZER.

ONLY Perform Leak Checks using N_2 gas and after thoroughly purging the analyzer's internal pneumatics.

Leaks are the most common cause of analyzer malfunction.

5.3.3.1. VACUUM LEAK CHECK AND PUMP CHECK

This method is easy and fast. It detects, but does not locate most leaks. It also verifies that the sample pump is in good condition.

1. Turn the analyzer ON, and allow enough time for flows to stabilize.
2. Cap the SAMPLE inlet port.
3. After several minutes, when the pressures have stabilized, note the following. In the **TEST** menu, note the SAMPLE PRESSURE reading.
4. If the reading is < 10 in-Hg, the pump is in good condition and there are no large leaks.
5. Check the sample gas flow. If the flow is <10 cm^3/min and stable, there are no large leaks in the instrument's pneumatics.

5.3.3.2. PRESSURE LEAK CHECK

If you can't locate the leak by the above procedure, use the following procedure. Obtain a leak checker similar to the Teledyne API P/N 01960, which contains a small pump, shut-off valve and pressure gauge. Alternatively, a convenient source of low-pressure gas is a tank of span gas, with the two-stage regulator adjusted to less than 15 psi with a shutoff valve and pressure gauge.

- **CAUTION**

GENERAL SAFETY HAZARD

Do not use bubble solution with vacuum applied to the analyzer. The solution may contaminate the instrument. Do not exceed 15 PSI pressure.

1. Turn OFF power to the instrument.
2. Install a leak checker or tank of gas as described above on the SAMPLE inlet at the rear panel.
3. Remove the instrument cover and locate the inlet side of the sample pump. Remove the flow assembly from the pump and plug it with the appropriate gas-tight fitting.
4. Pressurize the instrument with the leak checker, allowing enough time to fully pressurize the instrument through the critical flow orifice. Do not exceed 15 psi pressure. Check each fitting with soap bubble solution, looking for bubbles. Once the fittings have been wetted with soap solution, do not re-apply vacuum, as it will suck soap solution into the instrument and contaminate it. Wipe down and thoroughly dry all parts first.
5. Once the leak has been located and repaired, the leak-down rate should be < 1 in-Hg (0.4 psi) in 5 minutes after the pressure is shut off.

5.3.3.3. PERFORMING A SAMPLE FLOW CHECK

- **CAUTION**

GENERAL SAFETY HAZARD

Always use a separate calibrated flow meter capable of measuring flows in the 0 – 1000 cm^3/min range to measure the gas flow rate though the analyzer.

DO NOT use the built in flow measurement viewable from the Front Panel of the instrument. This measurement is only for detecting major flow interruptions such as clogged or plugged gas lines.

1. Attach the Flow Meter to the SAMPLE inlet port on the rear panel. Ensure that the inlet to the Flow Meter is at atmospheric pressure.
2. Sample flow should be 120 cm^3/min ± 10%.
3. Once an accurate measurement has been recorded by the method described above, adjust the analyzer's internal flow sensor. See flow calibration on page 43.

Low flows indicate blockage somewhere in the pneumatic pathway, typically a plugged sintered filter or critical flow orifice in the analyzer's flow control assembly. High flows indicate leaks in the Flow Control Assembly.

5.3.3.4. CLEANING EXTERIOR SURFACES OF THE M80XE

If necessary, the exterior surfaces of the M80XE can be cleaned with a clean damp cloth. Do not submerge any part of the instrument in water or cleaning solution.

6. Troubleshooting & Repair Procedures

Note This section describes a variety of methods for identifying the source of performance problems with the analyzer. Also included here are procedures that are used to repair the instrument.

HAZARD

STRONG OXIDIZER

OXYGEN IS A STRONG OXIDIZER.

Before working with the casing open, be sure to turn off power supply, and perform air or N_2 gas purging of not only the analyzer inside, but also the sample gas line.

In addition, carefully prevent oil and grease from adhering to any piping. Otherwise, poisoning, fire or explosion may be caused due to gas leakage, etc.

- **NOTE**

QUALIFIED PERSONNEL

The operations outlined in this Section must be performed by qualified maintenance personnel only.

- **CAUTION**

RISK OF ELECTRICAL SHOCK

- **Some operations need to be carried out with the instrument open and running.**
- **Exercise caution to avoid electrical shocks and electrostatic or mechanical damage to the analyzer.**
- **Do not drop tools into the analyzer or leave them after your procedures.**
- **Do not shorten or touch electric connections with metallic tools while operating inside the analyzer.**
- **Use common sense when operating inside a running analyzer.**

6.1. General Troubleshooting

The M80XE analyzer has been designed so that problems can be rapidly detected, evaluated and repaired. During operation, it continuously performs diagnostic tests and provides the ability to evaluate its key operating parameters without disturbing monitoring operations.

A systematic approach to troubleshooting will generally consist of the following five steps:

1. Note any **WARNING MESSAGES** and take corrective action as necessary.
2. Examine the values of all TEST functions and compare them to factory values. Note any major deviations from the factory values and take corrective action.
3. Use the internal electronic status LEDs to determine whether the electronic communication channels are operating properly.

   Verify that the DC power supplies are operating properly by checking the voltage test points on the relay PCA.

   Note that the analyzer's DC power wiring is color-coded and these colors match the color of the corresponding test points on the relay PCA.
4. **SUSPECT A LEAK FIRST!**

   Customer service data indicate that the majority of all problems are eventually traced to leaks in the internal pneumatics of the analyzer or the diluent gas and source gases delivery systems.

   Check for gas flow problems such as clogged or blocked internal/external gas lines, damaged seals, punctured gas lines, a damaged / malfunctioning pumps, etc.
5. Follow the procedures defined in this section to confirm that the analyzer's vital functions are working (power supplies, CPU, relay PCA, keyboard, etc.).

   See the wiring interconnect list in the misc diagram section.

6.2. FAULT DIAGNOSIS WITH WARNING MESSAGES

The most common and/or serious instrument failures will result in a warning message being displayed on the front panel. Table 6-1 lists warning messages, along with their meaning and recommended corrective action.

It should be noted that if more than two or three warning messages occur at the same time, it is often an indication that some fundamental analyzer sub-system (power supply, relay board, motherboard) has failed rather than indication of the specific failures referenced by the warnings. In this case, it is recommended that proper operation of power supplies, the relay board, and the A/D Board be confirmed before addressing the specific warning messages.

The analyzer will alert the user that a Warning Message is active by displaying the keypad label MSG on the Front Panel. In this case the Front panel display will look something like the following:

SAMPLE		SYSTEM RESET	CO2 = XX.XX %		
TEST	CAL		MSG	CLR	SETUP

Figure 6-1 Warning Message

The analyzer will also alert the user via the Serial I/O COMM port(s) and cause the FAULT LED on the front panel to blink.

To view or clear the various warning messages press:

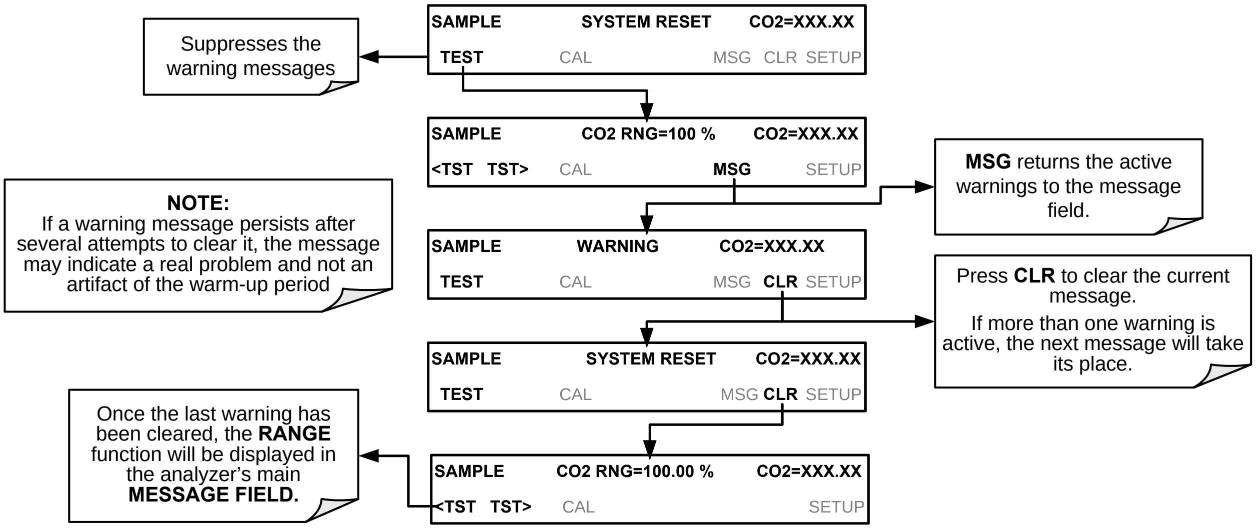


Figure 6-2 Viewing and Clearing Warning Messages

Table 6-1 Warning Messages - Indicated Failures

WARNING MESSAGE	FAULT CONDITION	POSSIBLE CAUSES
O2 CELL TEMP WARN	Sensor cell temperature is outside specified warning limits	Bad heater Bad temperature sensor Bad relay controlling the heater Entire relay board is malfunctioning I^2C bus malfunction
CO2 CELL TEMP WARN	Sensor/probe cell temperature is outside specified warning limits	Bad heater Bad temperature sensor Bad relay controlling the heater Entire relay board is malfunctioning I^2C bus malfunction
BOX TEMP WARNING	Box Temp is < 8 °C or > 50 °C.	NOTE: Box temperature typically runs ~7°c warmer than ambient temperature. Poor/blocked ventilation to the analyzer. Stopped exhaust-fan Ambient temperature outside of specified range
CANNOT DYN SPAN	Dynamic Span operation failed	Measured concentration value is too high or low. Concentration slope value to high or too low
CANNOT DYN ZERO	Dynamic Zero operation failed	Measured concentration value is too high. Concentration offset value to high.
CONFIG INITIALIZED	Configuration and Calibration data reset to original Factory state.	Failed disk on module User erased data
DATA INITIALIZED	Data Storage in iDAS was erased	Failed Disk on Module User cleared data
FRONT PANEL WARN	The CPU is unable to Communicate with the Front Panel Display /Keyboard	Warning only appears on serial I/O COMM port(s) Front panel display will be frozen, blank or will not respond. Failed keyboard I^2C bus failure Loose connector/wiring
REAR BOARD NOT DET	Mother Board not detected on power up.	Warning only appears on serial i/o COMM port(s) Front panel display will be frozen, blank or will not respond. Massive failure of mother board
RELAY BOARD WARN	The CPU cannot communicate with the Relay Board.	I^2C bus failure Failed relay board Loose connectors/wiring
SAMPLE FLOW WARN	Sample flow rate is < 80 cm^3/min or > 180 cm^3/min	Failed sample pump Blocked sample inlet/gas line Dirty particulate filter Leak downstream of critical flow orifice Failed flow sensor/circuitry
SAMPLE PRES WARN	Sample Pressure is <15 in-Hg or > 35 in-Hg Normally 29.92 in-Hg at sea level decreasing at 1 in-Hg per 1000 ft of altitude (with no flow – pump disconnected).	If sample pressure is < 15in-hg: Blocked particulate filter Blocked sample inlet/gas line Failed pressure sensor/circuitry If sample pressure is > 35 in-hg: Pressurized sample gas. Install vent Blocked vent line on pressurized sample/zero/span gas supply Bad pressure sensor/circuitry
SYSTEM RESET	The computer has rebooted.	This message occurs at power on. If you have not cycled the power on your instrument: Failed +5 VDC power, Fatal error caused software to restart Loose connector/wiring

6.3. FAULT DIAGNOSIS WITH TEST FUNCTIONS

In addition to being useful as predictive diagnostic tools, the test functions viewable from the front panel can be used to isolate and identify many operational problems when combined with a thorough understanding of the analyzer's theory of operation.

The acceptable ranges for these test functions are listed in the "Nominal Range" column of the analyzer *Final Test and Validation Data Sheet* (PN 065120000) shipped with the instrument. Values outside these acceptable ranges indicate a failure of one or more of the analyzer's subsystems. Functions whose values are still within the acceptable range but have significantly changed from the measurement recorded on the factory data sheet may also indicate a failure.

The following table contains some of the more common causes for these values to be out of range.

Table 6-2 Test Functions - Indicated Failures

TEST FUNCTIONS (As Displayed)	INDICATED FAILURE(S)
TIME	Time of day clock is too fast or slow Battery in clock chip on CPU board may be dead.
RANGE	Incorrectly configured measurement range(s) could cause response problems with a Data logger or chart recorder attached to one of the analog output. If the Range selected is too small, the recording device will over range. If the Range is too big, the device will show minimal or no apparent change in readings.
STABIL	Indicates noise level of instrument or concentration of sample gas.
PRES	See Table 6-1 for **SAMPLE PRES WARN**
SAMPLE FL	Check for gas flow problems.
O2 CELL TEMP	Temperatures outside of the specified range or oscillating temperatures are cause for concern
BOX TEMP	If the box temperature is out of range, check fan in the power supply module. Areas to the side and rear of instrument should allow adequate ventilation. See Table 6.1 for **BOX TEMP WARNING**.
O2 SLOPE	Values outside range indicate Contamination of the zero air or span gas supply Instrument is miscalibrated Blocked gas flow Bad/incorrect span gas concentration due.
O2 OFFSET	Values outside range indicate contamination of the zero air supply

6.4. DIAG → SIGNAL I/O: USING THE DIAGNOSTIC SIGNAL I/O FUNCTION

The signal I/O diagnostic mode allows access to the digital and analog I/O in the analyzer. Some of the digital signals can be controlled through the keyboard. These signals, combined with a thorough understanding of the instruments Theory of Operation, are useful for troubleshooting in three ways:

The technician can view the raw, unprocessed signal level of the analyzer's critical inputs and outputs.

Many of the components and functions that are normally under algorithmic control of the CPU can be manually exercised.

The technician can directly control the signal level Analog and Digital Output signals.

This allows the technician to observe systematically the effect of directly controlling these signals on the operation of the analyzer. The following flowchart shows an example of how to use the Signal I/O menu to view the raw voltage of an input signal or to control the state of an output voltage or control signal.

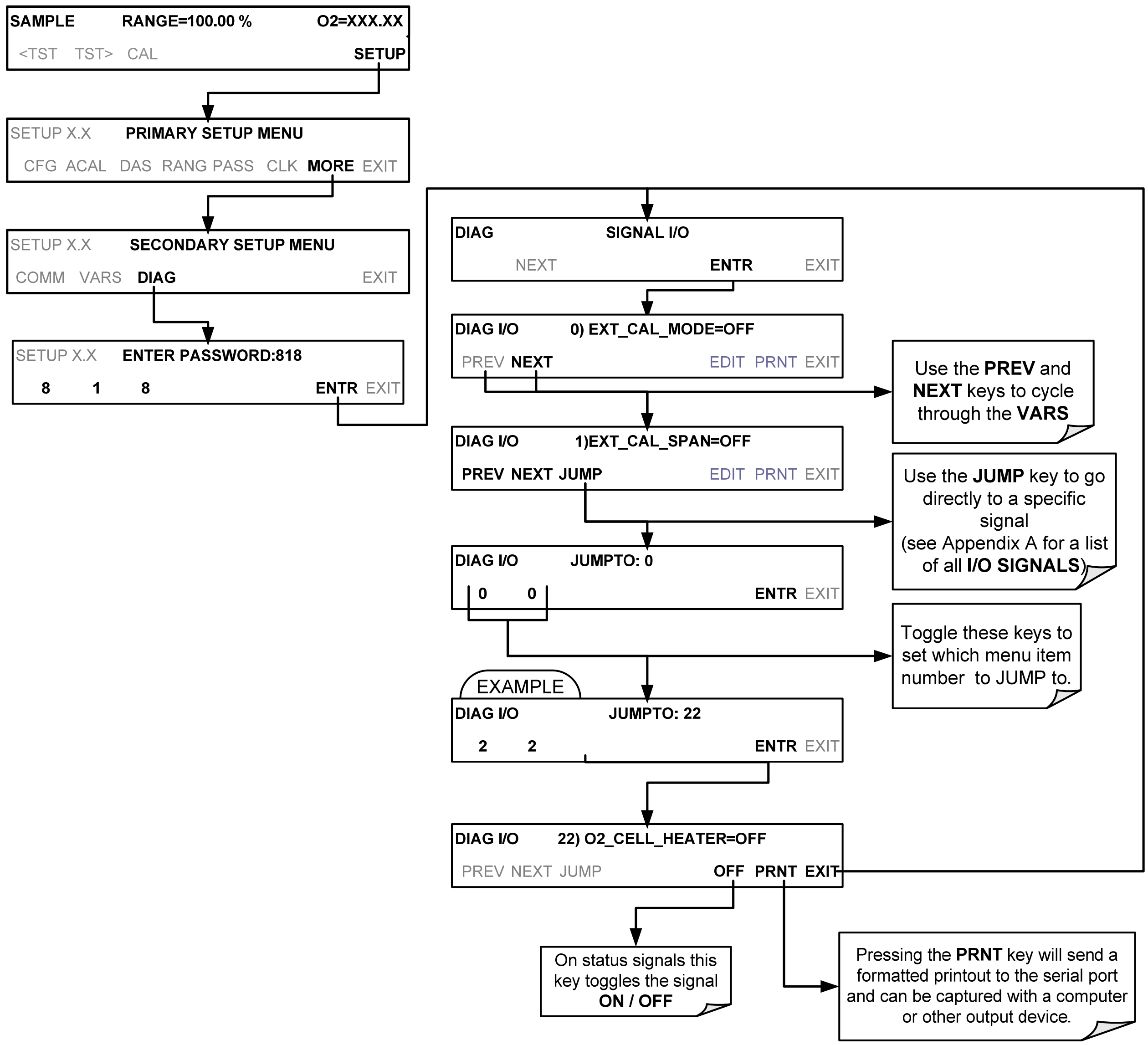


Figure 6-3 Example of Signal I/O Function (The ACAL submenu in the Primary Setup Menu is a special configuration; consult factory).

NOTE

Any I/O signals changed while in the signal I/O menu will remain in effect ONLY until signal I/O menu is exited. The Analyzer regains control of these signals upon exit.

6.5. Using the Internal Electronic Status LEDs

Several LEDs are located inside the instrument to assist in determining if the analyzer's CPU, I^2C bus and relay board are functioning properly.

6.5.1. CPU STATUS INDICATOR

DS5, a red LED, that is located on upper portion of the motherboard, just to the right of the CPU board, flashes when the CPU is running the main program loop. After power-up, approximately 30 to 60 seconds, DS5 should flash on and off. If characters are written to the front panel display but DS5 does not flash, then the program files have become corrupted. If after 30 – 60 seconds neither the DS5 is flashing or no characters have been written to the front panel display, then the CPU is bad and must be replaced.

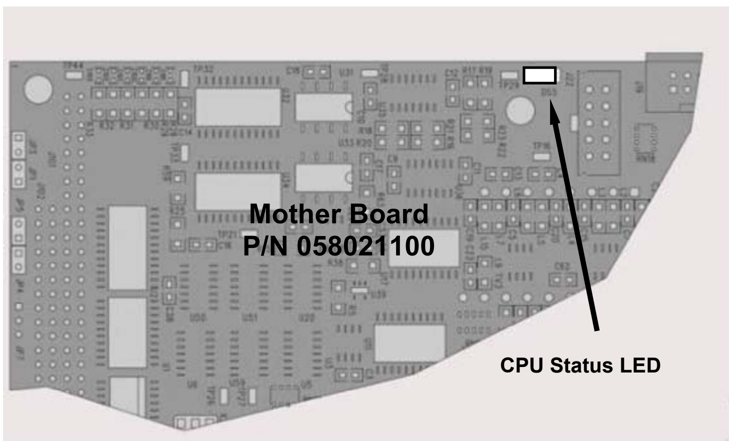


Figure 6-4 CPU Status Indicator

6.5.2. RELAY PCA STATUS INDICATORS

There are sixteen status indicator LEDs located on the Relay PCA. Some are not used on this model.

6.5.3. I^2C BUS WATCHDOG STATUS LEDS

The most important is D1 (which indicates the health of the I^2C bus).

Table 6-3 Relay PCA Watchdog LED Failure Indications

LED	Function	Fault Status	Indicated Failure(s)
D1	I^2C bus Health	Continuously ON	Failed/Halted CPU

(Red)	(Watchdog Circuit)	or Continuously OFF	Faulty Motherboard, Keyboard or Relay PCA Faulty Connectors/Wiring between Motherboard, Keyboard or Relay PCA Failed/Faulty +5 VDC Power Supply (PS1)

If D1 is blinking, then the other LEDs can be used in conjunction with **DIAG** Menu Signal I/O to identify hardware failures of the relays and switches on the Relay PCA.

6.5.4. RELAY PCA STATUS LED S

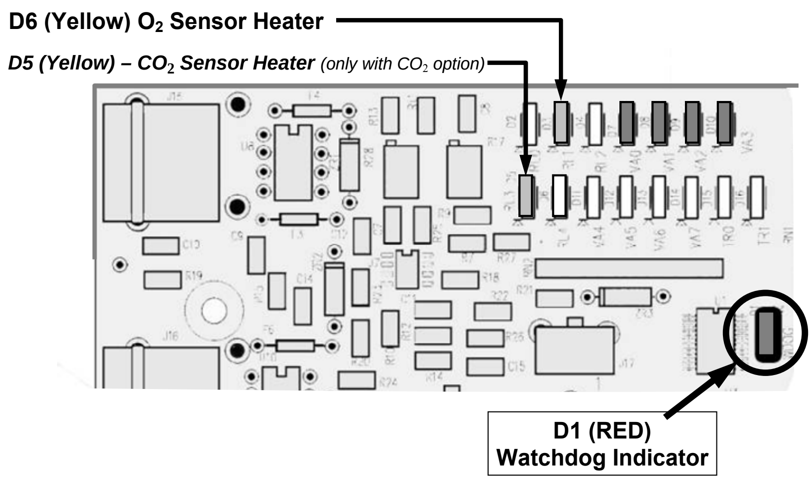


Figure 6-5 Relay PCA Status LEDS Used for Troubleshooting

Table 6-4 Relay PCA Status LED Failure Indications

LED	Color	Function	Status When LED Lit (Energized State)	Status When LED Unlit (Default State)
D1	Red	Watchdog Circuit	Cycles **ON/OFF** every 3 Seconds under direct control of the analyzer's CPU.	
D2-D4	SPARE			
D5	Yellow	CO_2 Sensor/probe Cell heater	Heating	Not Heating

LED	Color	Function	Status When LED Lit (Energized State)	Status When LED Unlit (Default State)
D6	Yellow	O_2 Sensor heater	Heating	Not Heating
D7[2]	Green			
D8[2]	Green			
D9[2]	Green			
D10[2]	Green			
D11 - 16	SPARE			
[2] Not Used				

6.6. Gas Flow Problems

When troubleshooting flow problems, it is a good idea to first confirm that the actual flow and not the analyzer's flow sensor and software are in error, or the flow meter is in error. Use an independent flow meter to perform a flow check. If this test shows the flow to be correct, check the pressure sensors.

In general, flow problems can be divided into three categories:

1. Flow is too high

2. Flow is greater than zero, but is too low, and/or unstable
3. Flow is zero (no flow)

When troubleshooting flow problems, it is crucial to confirm the actual flow rate without relying on the analyzer's flow display. The use of an independent, external flow meter to perform a flow check is essential.

The flow diagrams found in a variety of locations within this manual depicting the M80XE in its standard configuration and with options installed, can help in trouble-shooting flow problems. For your convenience the diagrams are collected here.

6.6.1. M80XE INTERNAL GAS FLOW DIAGRAMS

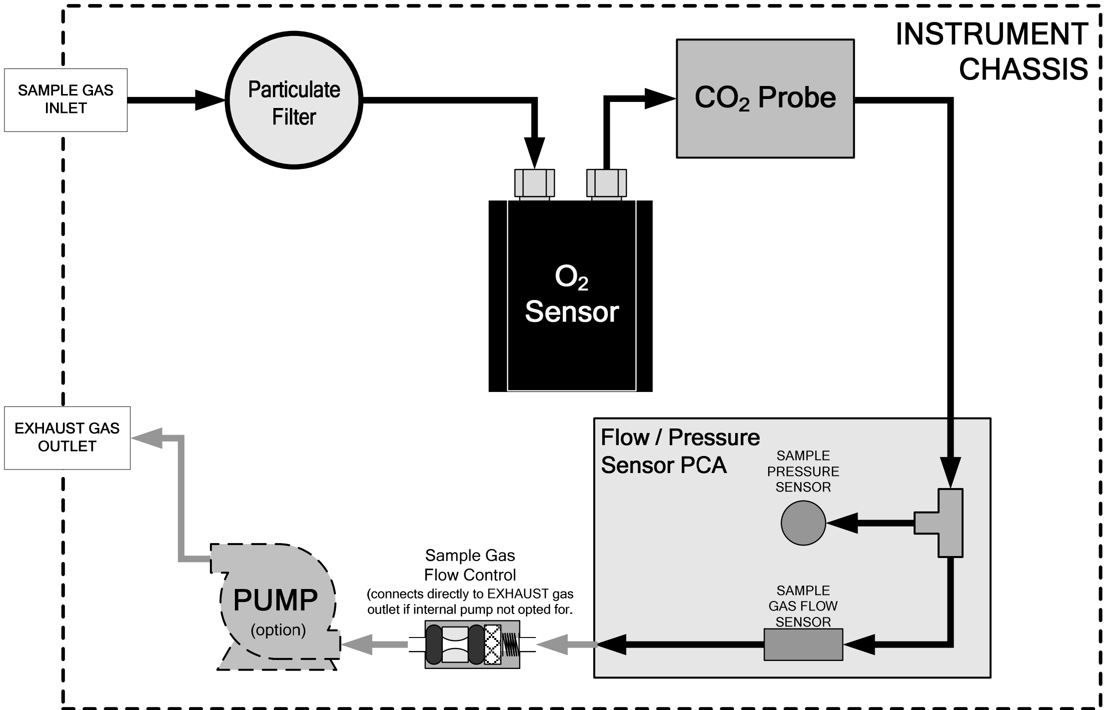


Figure 6-6 M80XE – Internal Gas Flow

6.6.2. TYPICAL SAMPLE GAS FLOW PROBLEMS

6.6.2.1. FLOW IS ZERO

The unit displays a SAMPLE FLOW warning message on the front panel display or the SAMPLE FLOW test function reports a zero or very low flow rate.

Confirm that the sample pump is operating (turning). If not, use an AC voltmeter to make sure that power is being supplied to the pump. If power is present at the electrical leads of the pump, take the following steps:.

1. If AC power is being supplied to the pump, but it is not turning, replace the pump.
2. If the pump is operating but the unit reports no gas flow, perform a flow check.
3. If no independent flow meter is available:
   - Disconnect the gas lines from both the sample inlet and the exhaust outlet on the rear panel of the instrument.
   - Make sure that the unit is in basic SAMPLE Mode.
   - Place a finger over a Sample inlet on the rear panel of the instrument.
   - If gas is flowing through the analyzer, you will feel a vacuum suction at the inlet.
4. If gas flows through the instrument when it is disconnected from its sources of zero air, span gas or sample gas, the flow problem is most likely not internal to the analyzer. Check to ensure that:
   - All calibrators/generators are turned on and working correctly.
   - Gas bottles are not empty or low.
   - Valves, regulators and gas lines are not clogged or dirty.

6.6.2.2. LOW FLOW

1. Check if the pump diaphragm is in good condition. If not, rebuild the pump.
2. Check for leaks. Repair the leaking fitting, line and re-check.
3. Check for the sample filter and the orifice filter for dirt. Replace filters.
4. Check for partially plugged pneumatic lines. Clean or replace them.
5. Check for plugged or dirty critical flow orifices. Replace them.

6.6.2.3. HIGH FLOW

The most common cause of high flow is a leak in the sample flow control. If no leaks or loose connections are found in the fittings or the gas line between the orifice and the pump, replace the critical flow orifice inside the sample flow control assembly.

6.6.2.4. DISPLAYED FLOW WARNINGS

This warning means that there is inadequate gas flow. There are four conditions that might cause this:

1. A leak upstream or downstream of the flow sensor
2. A flow obstruction upstream or downstream of the flow sensor
3. Bad Flow Sensor Board
4. Bad pump

To determine which condition is causing the flow problem, view the sample pressure and sample flow functions on the front panel display. If the sample pressure is reading abnormally low, then the cause is likely a flow obstruction upstream of the flow sensor. First, check the sample filter and make sure it is not plugged and then systematically check all the other components upstream of the orifice to ensure that they are not obstructed.

If the sample pressure is reading normal but the sample flow is reading low, then it is likely that the pump diaphragm is worn or there is an obstruction downstream of the flow sensor.

6.6.2.5. ACTUAL FLOW DOES NOT MATCH DISPLAYED FLOW

If the actual flow measured does not match the displayed flow, but is within the limits of 110-130 cm^3/min, adjust the calibration of the flow measurement. See flow calibration on page 43.

6.6.2.6. SAMPLE PUMP

The sample pump should start immediately after the front panel power switch is turned ON. With the SAMPLE inlet plugged the test function PRES should read < 10”-Hg for a pump in good condition. Readings above 10” Hg indicate that the pump needs rebuilding. If the test function SAMP FL is greater than 10 cm^3/min there is a leak in the pneumatic lines.

6.7. CALIBRATION PROBLEMS

6.7.1. MISCALIBRATED

There are several symptoms that can be caused by the analyzer being miscalibrated. Miscalibration is indicated by out-of-range Slopes and Offsets as displayed through the test functions and is frequently caused by the following:

- **Bad span gas**: This can cause a large error in the slope and a small error in the offset. Delivered from the factory, the M80XE's slope is within ±15% of nominal. Bad span gas will cause the analyzer to be calibrated to the wrong value. If in doubt have the span gas checked by and independent lab.
- **Contaminated zero gas**: Excess H_2O can cause a positive or negative offset and will indirectly affect the slope.
- **Dilution calibrator not set up correctly or is malfunctioning**: This will also cause the slope, but not the zero, to be incorrect. Again the analyzer is being calibrated to the wrong value.
- **Too many analyzers on the manifold**: This can cause either a slope or offset error because ambient gas with its pollutants will dilute the zero or span gas.

6.7.2. NON-REPEATABLE ZERO AND SPAN

As stated earlier, leaks both in the M80XE and in the external system are a common source of unstable and non-repeatable readings.

1. Check for leaks in the pneumatic systems. Don't forget to consider pneumatic components in the gas delivery system outside the M80XE Such as:
   - A change in zero air source such as ambient air leaking into zero air line, or;
   - A change in the span gas concentration due to zero air or ambient air leaking into the span gas line.
2. Once the instrument passes a leak check, do a flow check to make sure adequate sample is being delivered to the sensor/probe assembly.
3. Confirm the sample pressure, sensor/probe temperatures, and sample flow readings are correct and have steady readings.
4. Disconnect the exhaust line from the optical bench near the rear of the instrument and plug this line into the SAMPLE inlet creating a pneumatic loop. The concentration (either zero or span) now must be constant. If readings become quiet, the problem is in the external pneumatics supplies for sample gas, span gas or zero air.

6.7.3. INABILITY TO SPAN – NO SPAN KEY

1. Confirm that the oxygen span gas source is accurate; this can be done by opening the analyzer's SAMPLE inlet to ambient air. If the concentration is not displayed as ~20.9%, there is a problem with the span gas.
2. Check for leaks in the pneumatic systems.
3. Make sure that the expected span gas concentration entered into the instrument during calibration, is the correct span gas concentration and not too different from expected span value. This can be viewed via the CONC submenu of the Sample displays.
4. Check to make sure that there is no ambient air or zero air leaking into span gas line.

6.7.4. INABILITY TO ZERO – NO ZERO KEY

Confirm that there is a good source of zero air. Use zero air from two different sources. If the O_2 concentration of the two measurements is different, there is a problem with one of the sources of zero air.

Check for leaks in the pneumatic systems.

Check to make sure that there is no ambient air leaking into zero air line.

6.8. Other Performance Problems

Dynamic problems i.e. problems which only manifest themselves when the analyzer is monitoring sample gas, can be the most difficult and time consuming to isolate and resolve. The following provides an itemized list of the most common dynamic problems with recommended troubleshooting checks and corrective actions.

6.8.1. TEMPERATURE PROBLEMS

Individual control loops are used to maintain the set point of the temperatures to both sensor/probes. If any of these temperatures are out of range or are poorly controlled, the M80XE will perform poorly.

6.8.1.1. Box Temperature

The box temperature sensor is mounted to the motherboard and cannot be disconnected to check its resistance. Rather check the **BOX TEMP** signal using the SIGNAL I/O function under the **DIAG** Menu. This parameter will vary with ambient temperature, but at ~30^{o}C (6-7° above room temperature) the signal should be ~1450 mV.

6.8.2. Subsystem Checkout

Section 6 discussed a variety of methods for identifying possible sources of failures or performance problems within the analyzer. In most cases this included a list of possible causes. This describes how to determine individually determine if a certain component or subsystem is actually the cause of the problem being investigated.

6.8.2.1. AC MAINS CONFIGURATION

The analyzer is correctly configured for the AC mains voltage in use if:

1. The Sample Pump is running.
2. If incorrect power is suspected, check that the correct voltage and frequency is present at the line input on the rear panel.
   - If the unit is set for 230 VAC and is plugged into 115VAC, or 100VAC the sample pump will not start, and the heaters will not come up to temperature.
   - If the unit is set for 115 or 100 VAC and is plugged into a 230 VAC circuit, the circuit breaker built into the ON/OFF Switch on the Front Panel will trip to the OFF position immediately after power is switched on.

6.8.2.2. DC POWER SUPPLY

If you have determined that the analyzer's AC mains power is working, but the unit is still not operating properly, there may be a problem with one of the instrument's switching power supplies. The supplies can have two faults, namely no DC output, and noisy output.

To assist tracing DC Power Supply problems, the wiring used to connect the various printed circuit assemblies and DC Powered components and the associated test points on the relay board follow a standard color-coding scheme as defined in the following table.

Table 6-5 DC Power Test Point and Wiring Color Codes

NAME	TEST POINT#	TP AND WIRE COLOR
Dgnd	1	Black
+5V	2	Red
Agnd	3	Green
+15V	4	Blue
-15V	5	Yellow
+12V Ret (ground)	6	Purple
+12V	7	Orange

A voltmeter should be used to verify that the DC voltages are correct per the values in the table below, and an oscilloscope, in AC mode, with band limiting turned on, can be used to evaluate if the supplies are producing excessive noise (> 100 mV p-p).

Table 6-6 DC Power Supply Acceptable Levels

POWER SUPPLY ASSY	VOLTAGE	CHECK RELAY BOARD TEST POINTS				MIN V	MAX V
		FROM TEST POINT		TO TEST POINT			
		NAME	#	NAME	#		
PS1	+5	Dgnd	1	+5	2	4.95	5.25
PS1	+15	Agnd	3	+15	4	13.5	16V
PS1	-15	Agnd	3	-15V	5	-13.5V	-16V
PS1	Agnd	Agnd	3	Dgnd	1	-0.05	0.05
PS1	Chassis	Dgnd	1	Chassis	N/A	-0.05	0.05
PS2	+12	+12V Ret	6	+12V	7	11.75	12.5
PS2	Dgnd	+12V Ret	6	Dgnd	1	-0.05	0.05

6.8.2.3. I^2C BUS

Operation of the I^2C bus can be verified by observing the behavior of D1 on the Relay Board in conjunction with the performance of the front panel display. Assuming that the DC power supplies are operating properly and the wiring from the motherboard to the Keyboard, and the wiring from the keyboard to the Relay board, is intact, the I^2C bus is operating properly if:

D1 on the relay board is flashing, or;

D1 is not flashing but pressing a key on the front panel results in a change to the display.

D6 (I2C Serial data line) and D7 (I2C Serial clock) on the motherboard should also be blinking

6.8.2.4. KEYBOARD/DISPLAY INTERFACE

The front panel keyboard, display and Keyboard Display Interface PCA (03975 or 04258) can be verified by observing the operation of the display when power is applied to the instrument and when a key is pressed on the front panel. Assuming that there are no wiring problems and that the DC power supplies are operating properly:

The vacuum fluorescent display is good if on power-up a "-" character is visible on the upper left hand corner of the display.

1. The CPU Status LED, DS5, is flashing.
2. If there is a "-" character on the display at power-up and D1 on the relay board is flashing then the keyboard/display interface PCA is bad.
3. If the analyzer starts operation with a normal display but pressing a key on the front panel does not change the display, then there are three possible problems:
   - One or more of the keys is bad,
   - The interrupt signal between the Keyboard Display interface and the motherboard is broken, or
   - The Keyboard Display Interface PCA is bad.

6.8.2.5. RELAY BOARD

The relay board PCA (04135) can be most easily checked by observing the condition of its status LEDs on the relay board, and the associated output when toggled on and off through signal I/O function in the diagnostic menu.

If the front panel display responds to key presses and D1 on the relay board is NOT flashing then either the wiring between the Keyboard and the relay board is bad, or the relay board is bad.

If D1 on the relay board is flashing and the status indicator for the output in question (heater power etc.) toggles properly using the signal I/O function, then the associated control device on the relay board is bad. (Several of the control devices are in sockets and can be easily replaced).

6.8.2.6. SENSOR/PROBE ASSEMBLY

Both the CO_2 and O_2 sensor/probes have no user serviceable parts.

6.8.2.7. PRESSURE/FLOW SENSOR ASSEMBLY

The pressure/flow sensor PCA can be checked with a Voltmeter using the following procedure which, assumes that the wiring is intact, and that the motherboard and the power supplies are operating properly:

For Pressure related problems:

- Measure the voltage across C1 it should be 5 ± 0.25 VDC.
- If not then the board is bad.
- Measure the voltage across TP4 and TP1.
- With the sample pump disabled it should be 4500 mV ±250 mV at sea level.
- With the pump energized it should be approximately 200 mV less. If not, then S1, the pressure transducer is bad, the board is bad, or there is a pneumatic failure preventing the pressure transducer from sensing the absorption cell pressure properly.

For flow related problems:

- Measure the voltage across TP2 and TP1 it should be 10 ±0.25 VDC.
- If not then the board is bad.
- With flow stopped (sample inlet blocked) the voltage should be approximately 1V.
- If the voltage is incorrect, the flow sensor is bad, the board is bad or there is a leak upstream of the sensor.

6.8.2.8. MOTHERBOARD

6.8.2.8.1. A/D FUNCTIONS

The simplest method to check the operation of the A-to-D converter on the motherboard is to use the Signal I/O function under the **DIAG** menu to check the two A/D reference voltages and input signals that can be easily measured with a voltmeter.

1. Use the Signal I/O function to view the value of REF_4096_MV and REF_GND.
   - If both are within 3 mV of nominal (4096 and 0), and are stable, ±0.2 mV then the basic A/D is functioning properly. If not then the motherboard is bad.
2. Choose a parameter in the Signal I/O function such as SAMPLE_PRESSURE or SAMPLE_FLOW.
   - Compare these voltages at their origin (see interconnect list in the misc diagrams section) with the voltage displayed through the signal I/O function.
   - If the wiring is intact but there is a large difference between the measured and displayed voltage (±10 mV) then the motherboard is bad.

6.8.2.8.2. ANALOG OUTPUTS: CURRENT LOOP

To verify that the analog outputs with the optional current mode output are working properly, connect a 250 ohm resistor across the outputs and use a voltmeter to measure the output.
For each step the output should be within 1% of the nominal value listed in the table below.

Table 6-7 Analog Output Test Function - Nominal Values Current Outputs

	OUTPUT RANGE

		2 -20		4 -20	
		NOMINAL OUTPUT VALUES			
STEP	%	CURRENT	V(250 OHMS)	CURRENT	V(250 OHMS)
1	0	2 mA	0.5V	4	1
2	20	5.6	1.4	7.2	1.8
3	40	9.2	2.3	10.4	2.6
4	60	12.8	3.2	13.6	3.4
5	80	16.4	4.1	16.8	4.2
6	100	20	5	20	5

6.8.2.8.3. STATUS OUTPUTS

The status outputs report analyzer conditions via optically isolated NPN transistors, which sink up to 50 mA of DC current. These outputs can be used to interface with devices that accept logic-level digital inputs, such as programmable logic controllers (PLCs). Each status bit is an open collector output that can withstand up to 40 VDC. All of the emitters of these transistors are tied together and connected at Pin D.

NOTE

Most PLCs have internal provisions for limiting the current that the input will draw from an external device. When connecting to a unit that does not have this feature, an external dropping resistor must be used to limit the current through the transistor output to less than 50 mA.

At 50 mA, the transistor will drop approximately 1.2V from its collector to emitter.

The status outputs are accessed via a 12-pin connector on the analyzer's rear panel labeled STATUS. Pin-outs for this connector are:

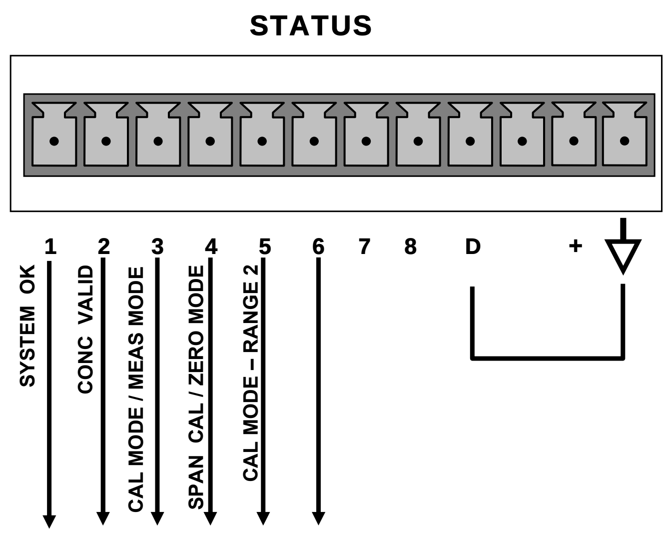


Figure 6-7 Status Output Connector M801E

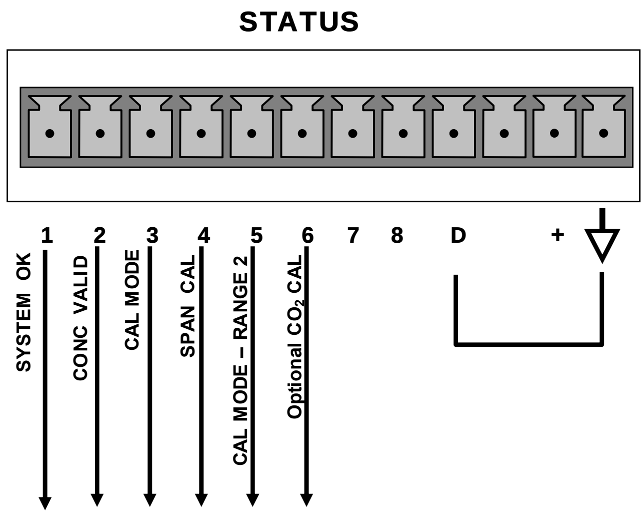


Figure 6-8 Status Output Connector M802E

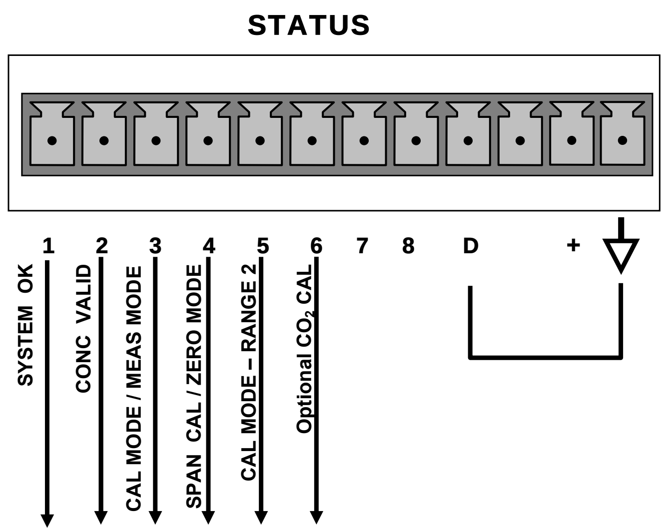


Figure 6-9 Status Output Connector M803E

The procedure below can be used to test the Status outputs:

1. Connect a jumper between the “D“ pin and the “▽” pin on the status output connector.
2. Connect a 1000 ohm resistor between the “+” pin and the pin for the status output that is being tested.
3. Connect a voltmeter between the “▽” pin and the pin of the output being tested (see table below).

Under the **DIAG→** SIGNAL I/O menu, scroll through the inputs and outputs until you get to the output in question. Alternately turn on and off the output noting the voltage on the voltmeter, it should vary between 0 volts for ON and 5 volts for OFF.

Table 6-8 Status Outputs Signals M801E

Rear Panel Label	Status Definition	Condition
1	SYSTEM OK/ALARM	ON if no faults are present. OFF if alarm condition
2	CONC VALID/CONC INVALID	ON if concentration measurement is valid. OFF any time the **HOLD OFF** feature is active, such as during calibration or when any faults exist invalidating the measurement.
3	CAL MODE/ MEAS MODE	ON whenever the instrument is in Calibration Mode OFF when instrument in Measure Mode
4	SPAN/ZERO CAL	ON whenever the instrument's **SPAN** point is being calibrated. OFF whenever the instrument's **ZERO** point is being calibrated.
5	RANGE2 CAL RANGE1 CAL	ON if unit is in high range of either the **DUAL** or **AUTO** range modes. OFF if unit is in default low, single range mode
6	CO_2 Sensor CAL	ON when CO_2 sensor is in calibration mode. OFF when calibration mode is exited.
7 & 8	SPARE	
D	EMITTER BUS	The emitters of the transistors on Pins 1-8 are bussed together.
+	DC POWER	+ 5 VDC, 300 mA source (combined rating with Control Output, if used).
⏚	Digital Ground	The ground level from the analyzer's internal DC power supplies

Table 6-9 Status Output Signals M802E

Rear Panel Label	Status Definition	Condition
1	SYSTEM OK	ON if no faults are present.
2	CONC VALID	OFF any time the **HOLD OFF** feature is active, such as during calibration or when any faults exist invalidating the O_2 measurement. ON if concentration measurement is valid.
3	CAL MODE	ON whenever the instrument is being calibrated. The Mode field
4	SPAN CAL	ON whenever the instrument's **SPAN** point is being calibrated.
5	RANGE2 CAL	ON if unit is in high range of either the **DUAL** or **AUTO** range modes.
6	CO_2 CAL	If this analyzer is equipped with an optional CO_2 sensor, this Output is ON when that sensor is in calibration mode. Otherwise this output us unused.
7 & 8	SPARE	
D	EMITTER BUS	The emitters of the transistors on Pins 1-8 are bussed together.
+	DC POWER	+ 5 VDC, 300 mA source (combined rating with Control Output, if used).
⏚	Digital Ground	The ground level from the analyzer's internal DC power supplies

Table 6-10 Status Output Signals M803E

Rear Panel Label	Status Definition	Condition
1	SYSTEM OK/ALARM	ON if no faults are present. OFF if alarm condition

Rear Panel Label	Status Definition	Condition
2	CONC VALID/CONC INVALID	ON if concentration measurement is valid. OFF any time the **HOLD OFF** feature is active, such as during calibration or when any faults exist invalidating the measurement.
3	CAL MODE/ MEAS MODE	ON whenever the instrument is in Calibration Mode OFF when instrument in Measure Mode
4	SPAN/ZERO CAL	ON whenever the instrument's **SPAN** point is being calibrated. OFF whenever the instrument's **ZERO** point is being calibrated.
5	RANGE2 CAL RANGE1 CAL	ON if unit is in high range of either the **DUAL** or **AUTO** range modes. OFF if unit is in default low, single range mode
6	CO_2/O_2 Sensor CAL	ON when CO_2 sensor is in calibration mode. OFF when O2 sensor is in calibration mode.
7 & 8	SPARE	
D	EMITTER BUS	The emitters of the transistors on Pins 1-8 are bussed together.
+	DC POWER	+ 5 VDC, 300 mA source (combined rating with Control Output, if used).
⏚	Digital Ground	The ground level from the analyzer's internal DC power supplies

6.8.2.9. CPU

There are two major types of failures associated with the CPU board: complete failure and a failure associated with the Disk-On-Module (DOM) on the CPU board. If either of these failures occurs, contact the factory.

1. For complete failures, assuming that the power supplies are operating properly and the wiring is intact, the CPU is bad if on powering the instrument:
    - The vacuum fluorescent display shows a dash in the upper left hand corner.
    - The CPU Status LED, DS5, is not flashing.
    - There is no activity from the primary RS-232 port on the rear panel even if "? <ret>" is pressed.
    - In some rare circumstances this failure may be caused by a bad IC on the motherboard, specifically U57. In this case, call Customer Service.
2. If the analyzer stops part way through initialization (there is a message on the vacuum fluorescent display) then it is likely that the DOM has been corrupted. Call Customer Service.

6.8.2.9.1. New ICOP CPU

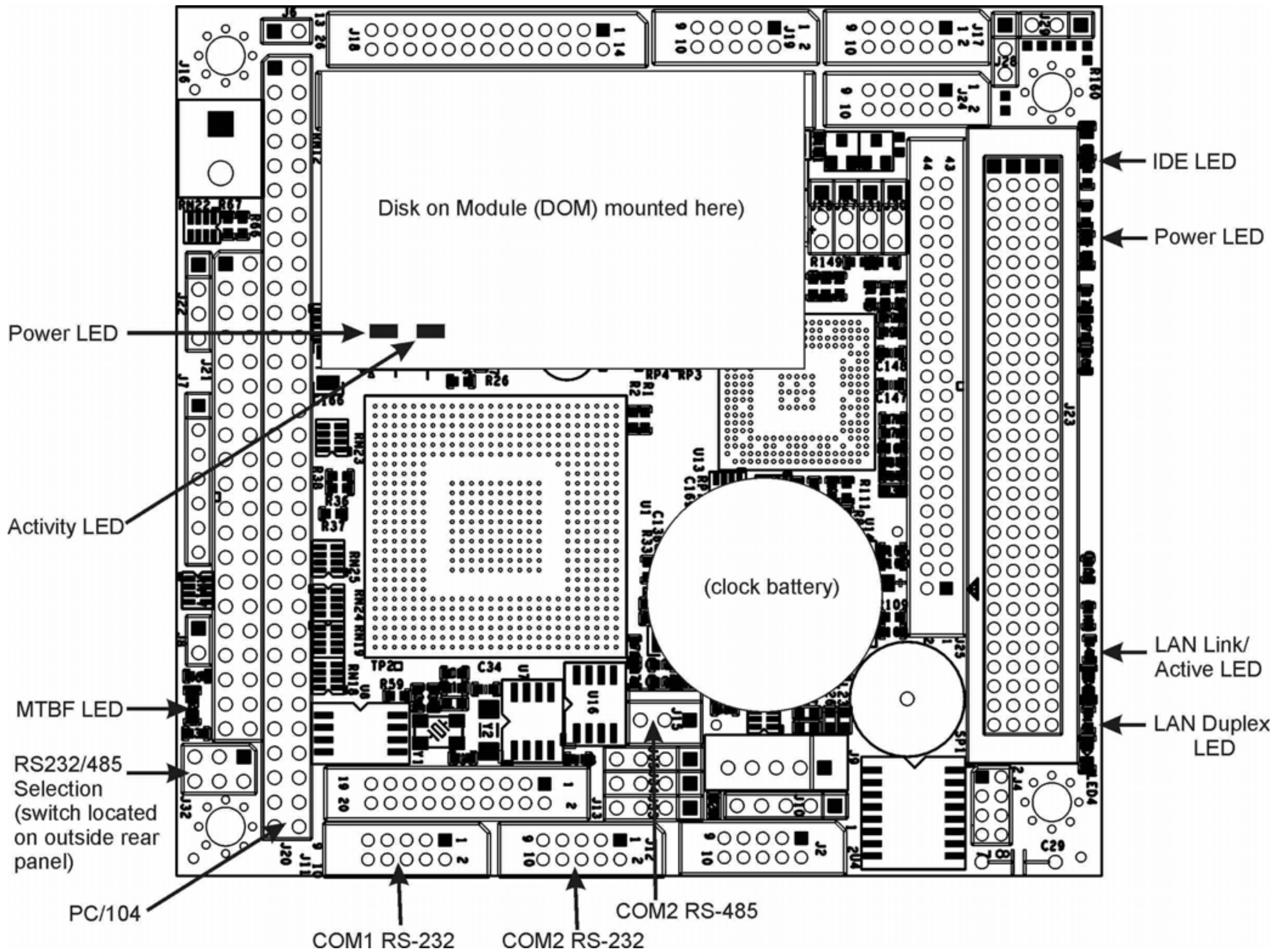


FIGURE 6-10 ICOP CPU

6.8.2.9.2. RS-232 COMMUNICATIONS

6.8.2.9.2.1. GENERAL RS-232 TROUBLESHOOTING

Teledyne API analyzers use the RS-232 communications protocol to allow the instrument to be connected to a variety of computer-based equipment. RS-232 has been used for many years and as equipment has become more advanced, connections between various types of hardware have become increasingly difficult. Generally, every manufacturer observes the signal and timing requirements of the protocol very carefully.

Problems with RS-232 connections usually center around four general areas:

1. Incorrect cabling and connectors.
2. The BAUD rate and protocol are incorrectly configured.
3. If a modem is being used, additional configuration and wiring rules must be observed.

4. Incorrect setting of the DTE – DCE Switch is set correctly. (Should see both a green and a red LED illuminated on the rear panel where the RS-232 goes in)
5. Verify that cable (03596) that connects the serial COMM ports of the CPU to J12 of the motherboard is properly seated

6.8.2.9.2.2. TROUBLESHOOTING ANALYZER/MODEM OR TERMINAL OPERATION

These are the general steps for troubleshooting problems with a modem connected to a Teledyne API analyzer.

1. Check cables for proper connection to the modem, terminal or computer.
2. Check to make sure the DTE-DCE is in the correct position. (Should see both a green and a red LED illuminated on the rear panel where the RS-232 goes in)
3. Check to make sure the set up command is correct.
4. Verify that the Ready to Send (RTS) signal is at logic high. The M80XE sets pin 7 (RTS) to greater than 3 volts to enable modem transmission.
5. Make sure the BAUD rate, word length, and stop bit settings between modem and analyzer match.
6. Use the RS-232 test function to send "w" characters to the modem, terminal or computer.
7. Get your terminal, modem or computer to transmit data to the analyzer (holding down the space bar is one way); the green LED should flicker as the instrument is receiving data.
8. Make sure that the communications software or terminal emulation software is functioning properly.

Further help with serial communications is available in a separate manual "RS-232 Programming Notes" Teledyne API PN 013500000.

6.8.2.10. CO_2 SENSOR/PROBE STATUS LED'S

There are Two LEDs located on the CO_2 sensor/probe PCA.

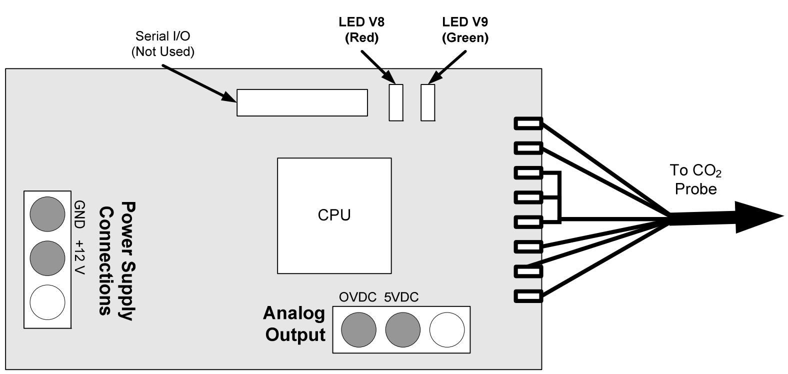


Figure 6-11 Location of Diagnostic LEDs on CO_2 Sensor/probe PCA

Normal Operation: V8 is not lit – V9 is Blinking

Error State: Both LEDs are blinking.

Check to make sure that the cable to the CO_2 sensor/probe is properly connected.

6.9. Repair Procedures

This contains procedures that might need to be performed on rare occasions when a major component of the analyzer requires repair or replacement.

6.9.1. DISK-ON-MODULE REPLACEMENT PROCEDURE

Replacing the Disk-on-Module (DOM), may be necessary in certain rare circumstances or to load new instrument software. This will cause all of the instrument configuration parameters and iDAS data to be lost. However a backup copy of the operating parameters are stored in a second non-volatile memory (a flash chip) and will be loaded into the new the DOM on power-up. To change the DOM:

1. Turn off power to the instrument.
2. Fold down the rear panel by loosening the thumbscrews on each side
3. Locate the DOM in the rightmost socket near the right hand side of the CPU assembly. Using an ESD wrist strap, remove the IC by gently prying it up from the socket.
4. Install the new DOM, making sure the notch in the end of the module is facing upward.
5. Close the rear panel and turn on power to the machine.

6.10. Technical Assistance

If this manual and its troubleshooting / repair sections do not solve your problems, technical assistance may be obtained from:

Teledyne API, Customer Service,
9480 Carroll Park Drive
San Diego, California 92121-5201USA

Phone: 800-324-5190 (toll free in North America)
Phone: 858-657-9800 (direct)
Fax: 858-657-9816
Email: api-customerservice@teledyne.com
Website: http://www.teledyne-api.com/

Before you contact Teledyne API's Customer service, fill out the problem report form in Appendix C, which is also available online for electronic submission at http://www.teledyne-api.com/forms/

7. SPECIFICATIONS

Table 7-1 M80XE Specifications

Parameter	Description
CO_2	
Ranges	0-1% to 0-20% user selectable. Dual ranges and auto-ranging supported.
Zero Noise[1]	<0.02% CO_2
Lower Detectable Limit[2]	<0.04% CO_2
Zero Drift (24 hours)	<± 0.02% CO_2
Zero Drift (7 days)	<± 0.05% CO_2
Span Noise[1]	<± 0.1% CO_2
Span Drift (7 days)	<± 0.1% CO_2
Accuracy	<± (0.02% CO_2 + 2% of reading)
Linearity	<± 0.1% CO_2
Temperature Coefficient	<± 0.01% CO_2 /°C
Rise and Fall Time	<60 seconds to 95%
[1] As defined by the USEPA [2] Defined as twice the zero noise level by the USEPA	
O_2	
Ranges	0-1% to 0-100% user selectable. Dual ranges and auto-ranging supported.
Zero Noise[1]	<0.02% O_2
Lower Detectable Limit[2]	<0.04% O_2
Zero Drift (24 hours) [3]	<± 0.02% O_2
Zero Drift (7 days)	<± 0.05% O_2
Span Noise[1]	<± 0.05% O_2
Span Drift (7 days)	<± 0.1% O_2
Accuracy	(intrinsic error) <± 0.1% O_2
Linearity	<± 0.1 % O_2
Temp Coefficient	<± 0.05% O_2 /°C,
Rise and Fall Time	<60 seconds to 95%
[1] As defined by the USEPA [2] Defined as twice the zero noise level by the USEPA [3] Note: zero drift is typically <± 0.1% O_2 during the first 24 hrs of operation	
Pressure Range	25-31 in•Hg
Temperature Range	5 – 40°C operating
Humidity Range	0-95% RH, Non-Condensing
Sample Flow Rate	120ml ± 20ml
Dimensions (HxWxD)	7" x 17" x 23.5" (178 mm x 432 mm x 597 mm)
Weight	28 lb (12.7 kg)
AC Power	100-120V 50/60 Hz (3.25A), 150 Watts 220- 240V 50/60 Hz (2.5A) , 150 Watts
Analog Outputs	4 user configurable outputs: 10V, 5V, 1V, 100mV
Analog Output Ranges	All Outputs: 0.1 V, 1 V, 5 V or 10 V Three outputs convertible to 4-20 mA isolated current loop.

Parameter	Description
	All Ranges with 5% under/over-range
Recorder Offset	± 10%
Analog Output Resolution	1 part in 4096 of selected full-scale voltage
Digital Status Outputs	8 Status outputs from opto-isolators, 6 Alarm outputs (Optional)
Control Inputs	6 Control Inputs, 2 defined, 4 spare
Serial I/O	One (1) RS-232; One (1) RS-485 (2 connecters in parallel) Baud Rate : 300 – 115200
Alarm outputs (option)	2 opto-isolated alarms outputs with user settable alarm limits

8. MISC DIAGRAMS

Interconnect List

		FROM				TO			
Cable PN	**Signal**	**Assembly**	**PN**	**J/P**	**Pin**	**Assembly**	**PN**	**J/P**	**Pin**
007290000	**CBL, KEYBOARD/DISPLAY**								
	D7	Display	DS0000025	CN1	1	Keyboard/Interface	042580000	J3	1
	D6	Display	DS0000025	CN1	2	Keyboard/Interface	042580000	J3	2
	D5	Display	DS0000025	CN1	3	Keyboard/Interface	042580000	J3	3
	D4	Display	DS0000025	CN1	4	Keyboard/Interface	042580000	J3	4
	D3	Display	DS0000025	CN1	5	Keyboard/Interface	042580000	J3	5
	D2	Display	DS0000025	CN1	6	Keyboard/Interface	042580000	J3	6
	D1	Display	DS0000025	CN1	7	Keyboard/Interface	042580000	J3	7
	D0	Display	DS0000025	CN1	8	Keyboard/Interface	042580000	J3	8
	DISP WRITE	Display	DS0000025	CN1	9	Keyboard/Interface	042580000	J3	9
	DGND	Display	DS0000025	CN1	10	Keyboard/Interface	042580000	J3	10
	Spare	Display	DS0000025	CN1	11	Keyboard/Interface	042580000	J3	11
	DISP_BUSY	Display	DS0000025	CN1	12	Keyboard/Interface	042580000	J3	12
	DISP_RETURN	Display	DS0000025	CN1	13	Keyboard/Interface	042580000	J3	13
	DISP_RETURN	Display	DS0000025	CN1	14	Keyboard/Interface	042580000	J3	14
	DISP_PWR	Display	DS0000025	CN1	15	Keyboard/Interface	042580000	J3	15
	DISP_PWR	Display	DS0000025	CN1	16	Keyboard/Interface	042580000	J3	16
036490100	**CBL ASSY, AC POWER, M300E, SN >=100**								
	AC Line					Power Switch	SW0000051		L
	AC Neutral					Power Switch	SW0000051		N
	Power Grnd	Power Entry	CN0000073			Shield			
	Power Grnd	Power Entry	CN0000073			Chassis			
	AC Line Switched	Power Switch	SW0000051		L	PS2 (+12)	PS0000038	SK2	1
	AC Neu Switched	Power Switch	SW0000051		N	PS2 (+12)	PS0000038	SK2	3
	Power Grnd	Power Entry	CN0000073			PS2 (+12)	PS0000038	SK2	2
	AC Line Switched	PS2 (+12)	PS0000038	SK2	1	PS1 (+5, ±15)	PS0000037	SK2	1
	AC Neu Switched	PS2 (+12)	PS0000038	SK2	3	PS1 (+5, ±15)	PS0000037	SK2	3
	Power Grnd	PS2 (+12)	PS0000038	SK2	2	PS1 (+5, ±15)	PS0000037	SK2	2
	AC Line Switched	PS1 (+5, ±15)	PS0000037	SK2	1	Relay	045230100	J1	1
	AC Neu Switched	PS1 (+5, ±15)	PS0000037	SK2	3	Relay	045230100	J1	3
	Power Grnd	PS1 (+5, ±15)	PS0000037	SK2	2	Relay	045230100	J1	2
038290000	**CBL ASSY, DC POWER TO MOTHERBOARD, E SER**								
	DGND	Relay	045230100	J7	1	Motherboard	057020100	J15	1
	+5V	Relay	045230100	J7	2	Motherboard	057020100	J15	2
	AGND	Relay	045230100	J7	3	Motherboard	057020100	J15	3
	+15V	Relay	045230100	J7	4	Motherboard	057020100	J15	4
	AGND	Relay	045230100	J7	5	Motherboard	057020100	J15	5
	-15V	Relay	045230100	J7	6	Motherboard	057020100	J15	6
	+12V RET	Relay	045230100	J7	7	Motherboard	057020100	J15	7
	+12V	Relay	045230100	J7	8	Motherboard	057020100	J15	8
	Chassis Gnd	Relay	045230100	J7	10	Motherboard	057020100	J15	9
040230000	**CBL, I2C, relay board to motherboard, E-series**								
	I2C Serial Clock	Motherboard	057020100	P107	3	Relay Board	045230100	P3	1
	I2C Serial Data	Motherboard	057020100	P107	5	Relay Board	045230100	P3	2
	I2C Reset	Motherboard	057020100	P107	2	Relay Board	045230100	P3	4
	I2C Shield	Motherboard	057020100	P107	6	Relay Board	045230100	P3	5

041050000	**CBL, KEYBD TO MTHBRD**									
	Kbd Interupt	Keyboard	042580000	J2	7	Motherboard	057020100	J106	1
	DGND	Keyboard	042580000	J2	2	Motherboard	057020100	J106	8
	SDA	Keyboard	042580000	J2	5	Motherboard	057020100	J106	2
	SCL	Keyboard	042580000	J2	6	Motherboard	057020100	J106	6
	Shld	Keyboard	042580000	J2	10	Motherboard	057020100	J106	5
041760000	**CBL, DC power to relay board, E-series**								
	DGND	Relay Board	045230100	P8	1	Power Supply Triple	PS0000037	J1	3
	+5V	Relay Board	045230100	P8	2	Power Supply Triple	PS0000037	J1	1
	+15V	Relay Board	045230100	P8	4	Power Supply Triple	PS0000037	J1	6
	AGND	Relay Board	045230100	P8	5	Power Supply Triple	PS0000037	J1	4
	-15V	Relay Board	045230100	P8	6	Power Supply Triple	PS0000037	J1	5
	+12V RET	Relay Board	045230100	P8	7	Power Supply Single	PS0000038	J1	3
	+12V	Relay Board	045230100	P8	8	Power Supply Single	PS0000038	J1	1
046700000	**CABLE, ICOP CPU TO ETHERNET (WITH MULTIDROP)**								
	txd	Ethernet	043940000	PL101	3	CPU	062870000	COM2	2
	dtr	Ethernet	043940000	PL101	4	CPU	062870000	COM2	6
	rts	Ethernet	043940000	PL101	5	CPU	062870000	COM2	8
	dcd	Ethernet	043940000	PL101	6	CPU	062870000	COM2	1
	rxd	Ethernet	043940000	PL101	8	CPU	062870000	COM2	3
	dsr	Ethernet	043940000	PL101	9	CPU	062870000	COM2	4
	cts	Ethernet	043940000	PL101	10	CPU	062870000	COM2	7
	gnd	Ethernet	043940000	PL101	16	CPU	062870000	COM2	5
046710000	**CABLE, MOTHERBOARD TO MULTIDROP BOARD**								
	rx0	Motherboard	058021100	P12	1	Multidrop Board	062420200	P2	1
	rts0	Motherboard	058021100	P12	2	Multidrop Board	062420200	P2	2
	tx0	Motherboard	058021100	P12	3	Multidrop Board	062420200	P2	3
	cst0	Motherboard	058021100	P12	4	Multidrop Board	062420200	P2	4
	rs-gnd1	Motherboard	058021100	P12	5	Multidrop Board	062420200	P2	5
	cts1/485-	Motherboard	058021100	P12	6	Multidrop Board	062420200	P2	6
	tx1/485+	Motherboard	058021100	P12	7	Multidrop Board	062420200	P2	7
	rts1	Motherboard	058021100	P12	8	Multidrop Board	062420200	P2	8
	rx1	Motherboard	058021100	P12	9	Multidrop Board	062420200	P2	9
	rs-gnd0	Motherboard	058021100	P12	10	Multidrop Board	062420200	P2	10
	cts0	Motherboard	058021100	P12	11	Multidrop Board	062420200	P2	11
	tx0	Motherboard	058021100	P12	12	Multidrop Board	062420200	P2	12
	rts0	Motherboard	058021100	P12	13	Multidrop Board	062420200	P2	13
	rx0	Motherboard	058021100	P12	14	Multidrop Board	062420200	P2	14
059900100	**CABLE, ETHERNET POWER, 80XE**								
	DGND	Relay Board	045230100	P12	1	Ethernet board	043940000	P102	1
	+5V	Relay Board	045230100	P12	2	Ethernet board	043940000	P102	2
062490000	**CABLE, MOTHERBOARD TO CPU, ICOP (USED WITHOUT MULTIDROP)**								
	Shield	Motherboard	058021100	P12	2				
	rs-gnd1	Motherboard	058021100	P12	5	CPU Board	062870000	COM2	5
	cts1/485-	Motherboard	058021100	P12	6	CPU Board	062870000	COM2	8
	tx1/485+	Motherboard	058021100	P12	7	CPU Board	062870000	COM2	3
	rts1	Motherboard	058021100	P12	8	CPU Board	062870000	COM2	7
	rx1	Motherboard	058021100	P12	9	CPU Board	062870000	COM2	2
	rs-gnd0	Motherboard	058021100	P12	10	CPU Board	062870000	COM1	5
	cts0	Motherboard	058021100	P12	11	CPU Board	062870000	COM1	8

	tx0	Motherboard	058021100	P12	12	CPU Board	062870000	COM1	3
	rts0	Motherboard	058021100	P12	13	CPU Board	062870000	COM1	7
	rx0	Motherboard	058021100	P12	14	CPU Board	062870000	COM1	2
	rs-gnd1	Motherboard	058021100	P12	5	CPU Board	062870000	485	1
	tx1/485+	Motherboard	058021100	P12	7	CPU Board	062870000	485	2
	rx1	Motherboard	058021100	P12	9	CPU Board	062870000	485	3
063050000	**CABLE, MOTHERBOARD TO MULTIDROP BOARD**								
	dcd1	Multidrop Board	062420200	P2	1	CPU Board	062870000	COM2	1
	rx1	Multidrop Board	062420200	P2	2	CPU Board	062870000	COM2	2
	tx1	Multidrop Board	062420200	P2	3	CPU Board	062870000	COM2	3
	dtr1	Multidrop Board	062420200	P2	4	CPU Board	062870000	COM2	4
	gnd	Multidrop Board	062420200	P2	5	CPU Board	062870000	COM2	5
	dsr1	Multidrop Board	062420200	P2	6	CPU Board	062870000	COM2	6
	rts1	Multidrop Board	062420200	P2	7	CPU Board	062870000	COM2	7
	cts1	Multidrop Board	062420200	P2	8	CPU Board	062870000	COM2	8
	ri1	Multidrop Board	062420200	P2	9	CPU Board	062870000	COM2	9
	rx0	Multidrop Board	062420200	P2	12	CPU Board	062870000	COM1	2
	txo	Multidrop Board	062420200	P2	13	CPU Board	062870000	COM1	3
	gnd	Multidrop Board	062420200	P2	15	CPU Board	062870000	COM1	5
	rts0	Multidrop Board	062420200	P2	17	CPU Board	062870000	COM1	7
063060000	**CABLE, ICOP CPU TO ETHERNET (USED WITHOUT MULTIDROP)**								
	txd	Ethernet	043940000	PL101	3	CPU	062870000	COM2	2
	dtr	Ethernet	043940000	PL101	4	CPU	062870000	COM2	6
	rts	Ethernet	043940000	PL101	5	CPU	062870000	COM2	8
	dcd	Ethernet	043940000	PL101	6	CPU	062870000	COM2	1
	rxd	Ethernet	043940000	PL101	8	CPU	062870000	COM2	3
	dsr	Ethernet	043940000	PL101	9	CPU	062870000	COM2	4
	cts	Ethernet	043940000	PL101	10	CPU	062870000	COM2	7
	gnd	Ethernet	043940000	PL101	16	CPU	062870000	COM2	5
063750000	**CBL, CO2, O2 SENSOR THERM/HTR, 80XE**								
	O2-L	Relay Board	045230100	P18	9	O2 sensor therm./htr	043420000	P1	4
	O2-N	Relay Board	045230100	P18	10	O2 sensor therm./htr	043420000	P1	2
	Shield	Relay Board	045230100	P18	12	O2 sensor therm./htr	043420000	P1	
	O2TA	O2 sensor therm./htr	043420000	P1	3	Motherboard	057020100	P27	4
	O2TB	O2 sensor therm./htr	043420000	P1	1	Motherboard	057020100	P27	11
	CO2THA	CO2 sensor therm./htr	041920000	P1	2	Motherboard	057020100	P27	6
	CO2THB	CO2 sensor therm./htr	041920000	P1	1	Motherboard	057020100	P27	13
	CO2-11B	Relay Board	045230100	P18	1	CO2 Cell Heater	040400000	P1	4
	CO2-12B	Relay Board	045230100	P18	1	CO2 Cell Heater	040400000	P2	6
	CO2-11A	Relay Board	045230100	P18	2	CO2 Cell Heater	040400000	P3	3
	CO2TS1	Relay Board	045230101	P19	3	CO2 Cell Heater	040400000	P4	1
	CO2TS2	Relay Board	045230102	P20	4	CO2 Cell Heater	040400000	P5	2
	CO2-12A	Relay Board	045230103	P21	5	CO2 Cell Heater	040400000	P6	5
066470000	**CBL, CO2 & O2 SENSORS DC PWR, 80XE**								
	O2 SIGNAL -	Motherboard	057020100	P109	7	O2 Sensor	OP0000030	P1	9
	O2 SIGNAL +	Motherboard	057020100	P109	1	O2 Sensor	OP0000030	P1	10
	Shield	Motherboard	057020100	P109	9				
	DGND	O2 Sensor	OP0000030	P1	5	Relay Board	045230100	P5	1
	+5V	O2 Sensor	OP0000030	P1	6	Relay Board	045230100	P5	2

	+12V RET	CO2 Sensor	OP0000033	P1	GND	Relay Board	045230100	P5	7
	+12V	CO2 Sensor	OP0000033	P1	L	Relay Board	045230100	P5	8
066830000	**CBL, FLOW MODULE, 80XE**								
	DGND	Keyboard	042580000	P1	8	Relay Board	045230100	P10	1
	+5V	Keyboard	042580000	P1	1	Relay Board	045230100	P10	2
	DGND	Keyboard	042580000	P1	2	Relay Board	045230100	P11	1
	+5V	Keyboard	042580000	P1	3	Relay Board	045230100	P11	2
	+12V RET	Relay Board	045230100	P11	7	Chassis fan	040010000	P1	1
	+12V	Relay Board	045230100	P11	8	Chassis fan	040010000	P1	2
	P/Flow Sensor AGND	Relay Board	045230100	P11	3	P/Flow Sensor board	040030800	P1	3
	P/Flow Sensor +15V	Relay Board	045230100	P11	4	P/Flow Sensor board	040030800	P1	6
	Pressure signal 1	P/Flow Sensor board	040030800	P1	2	Motherboard	057020100	P110	6
	Pressure signal 2	P/Flow Sensor board	040030800	P1	4	Motherboard	057020100	P110	5
	Flow signal 1	P/Flow Sensor board	040030800	P1	5	Motherboard	057020100	P110	4
	Shield	P/Flow Sensor board	040030800	P1	S	Motherboard	057020100	P110	12
	CO2+	CO2 Sensor	OP0000033	P1	V	Motherboard	057020100	P110	3
	CO2-	CO2 Sensor	OP0000033	P1	O	Motherboard	057020100	P110	9

9. T SERIES ADDENDUM

9.1 Front panel, rear panel, and display

9.1.1 Getting Started

This section introduces you to the instrument components of the front and rear panel, which are unique to the T series analyzers.

9.1.1.1Front Panel

Figure 9-1 shows the analyzer's front panel layout, followed by a close-up of the display screen in Figure 9-2, which is described in Table 9-1. The two USB ports on the front panel are provided for the connection of peripheral devices:

- plug-in mouse (not included) to be used as an alternative to the touchscreen interface
- thumb drive (not included) to upload new versions of software (contact T-API Customer Service for information).
- plug-in keyboard (not included) to reach the touchscreen display calibration menu

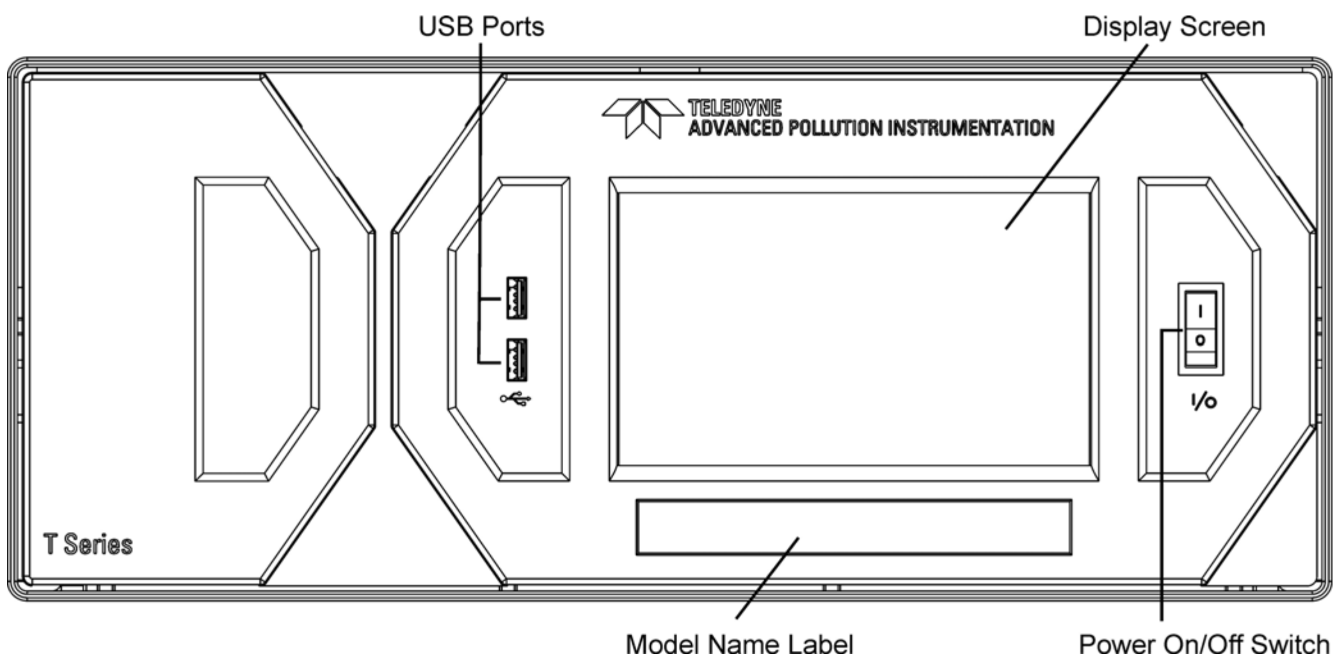


Figure 9-1: Front Panel Layout

Figure 9-2: Display Screen and Touch Control

The front panel liquid crystal display screen includes touch control. Upon analyzer start-up, the screen shows a splash screen and other initialization indicators before the main display appears, similar to Figure 9-2 above (may or may not display a Fault alarm). The lights on the display screen indicate the Sample, Calibration and Fault states; also on the screen is the gas concentration field (Conc), which displays real-time readouts for the primary gas and for the secondary gas if installed. The display screen also shows what mode the analyzer is currently in, as well as messages and data (Param). Along the bottom of the screen is a row of touch control buttons; only those that are currently applicable will have a label. Table 9-1 provides detailed information for each component of the screen.

ATTENTION

COULD DAMAGE INSTRUMENT

Do not use hard-surfaced instruments, such as pens, to touch the control buttons.

Table 9-1: Display Screen and Touch Control Description

<table>
<tr><th>Field</th><th colspan="4">Description/Function</th></tr>
<tr><td rowspan="5">Status</td><td colspan="4">Lights indicating the states of Sample, Calibration and Fault, as follows:</td></tr>
<tr><td>Name</td><td>Color</td><td>State</td><td>Definition</td></tr>
<tr><td>SAMPLE</td><td>Green</td><td>Off
On
Blinking</td><td>Unit is not operating in sample mode, DAS is disabled.
Sample Mode active; Front Panel Display being updated; DAS data being stored.
Unit is operating in sample mode, front panel display being updated, DAS hold-off mode is ON, DAS disabled</td></tr>
<tr><td>CAL</td><td>Yellow</td><td>Off
On
Blinking</td><td>Auto Cal disabled
Auto Cal enabled
Unit is in calibration mode</td></tr>
<tr><td>FAULT</td><td>Red</td><td>Off
Blinking</td><td>No warnings exist
Warnings exist</td></tr>
<tr><td>Conc</td><td colspan="4">Displays the actual concentration of the sample gas currently being measured by the analyzer in the currently selected units of measure</td></tr>
<tr><td>Mode</td><td colspan="4">Displays the name of the analyzer’s current operating mode</td></tr>
<tr><td>Param</td><td colspan="4">Displays a variety of informational messages such as warning messages, operational data, test function values and response messages during interactive tasks.</td></tr>
<tr><td>Control Buttons</td><td colspan="4">Displays dynamic, context sensitive labels on each button, which is blank when inactive until applicable.</td></tr>
</table>

Figure 9-3 shows how the front panel display is mapped to the menu charts illustrated in this manual. The Mode, Param (parameters), and Conc (gas concentration) fields in the display screen are represented across the top row of each menu chart. The eight touch control buttons along the bottom of the display screen are represented in the bottom row of each menu chart.

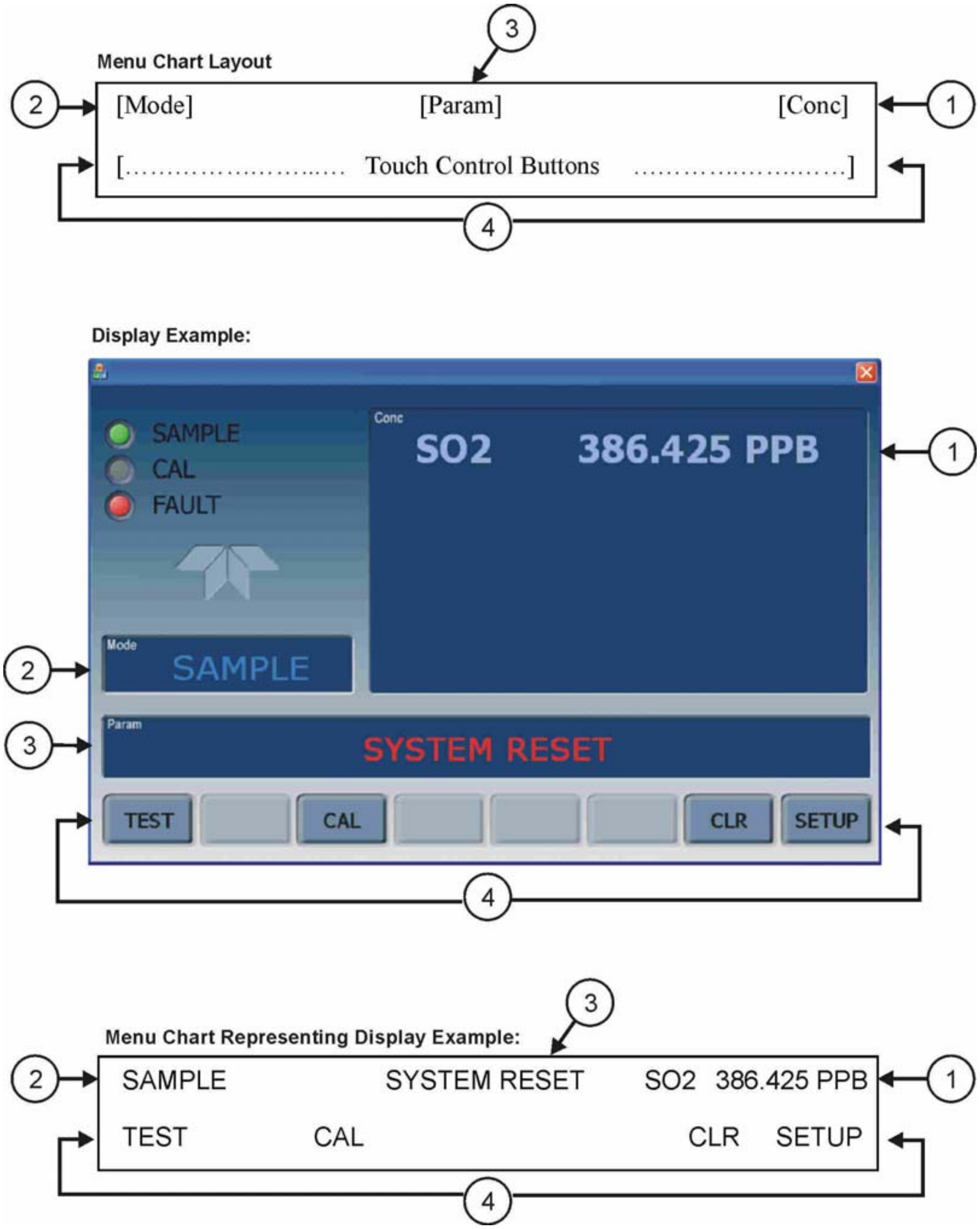


Figure 9-3: Display/Touch Control Screen Mapped to Menu Charts

9.1.1.2 Front Panel/Display Interface

Users can input data and receive information directly through the front panel touch-screen display. The LCD display is controlled directly by the CPU board. The touchscreen is interfaced to the CPU by means of a touchscreen controller that connects to the CPU via the internal USB bus and emulates a computer mouse.

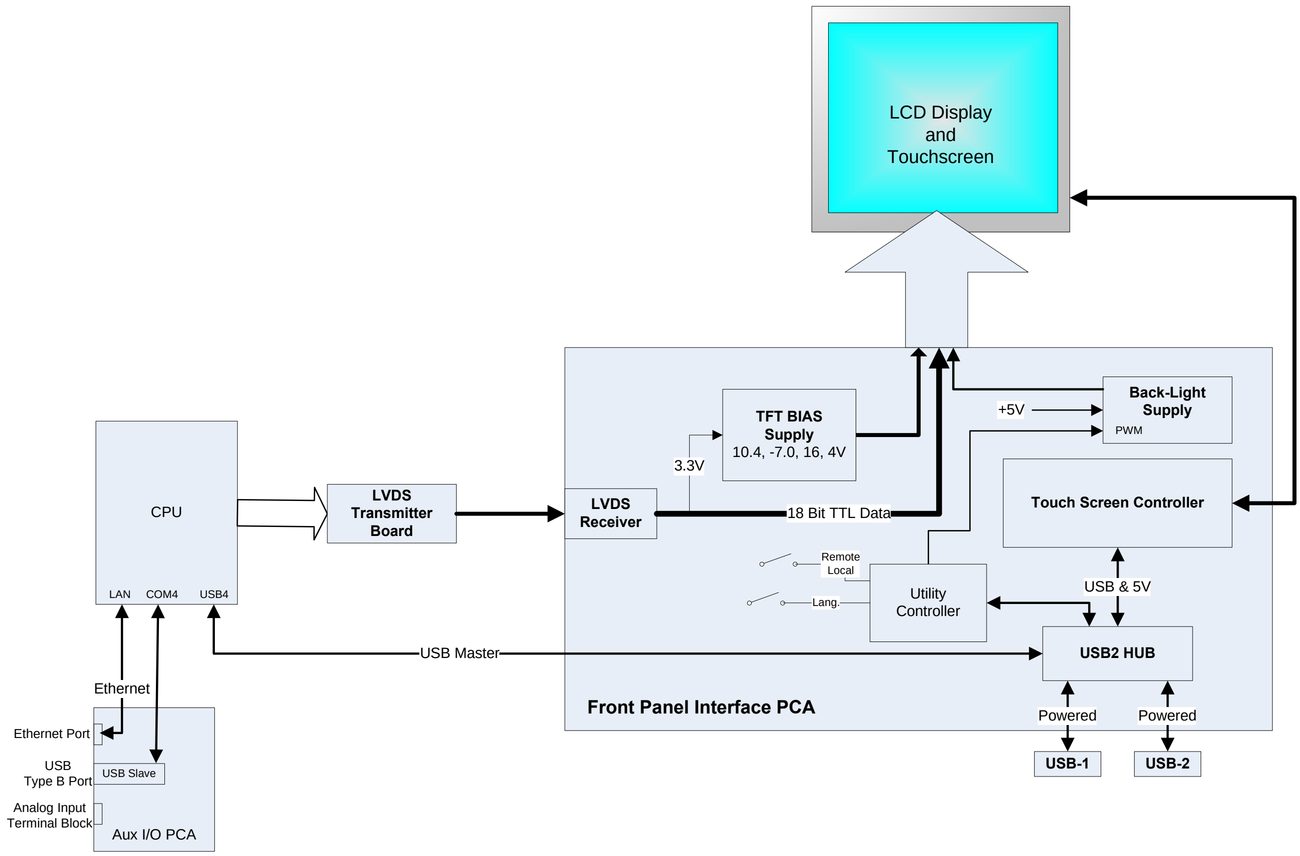


Figure --4: Front Panel and Display Interface Block Diagram

9.1.1.2.1. LVDS Transmitter Board

The LVDS (low voltage differential signaling) transmitter board converts the parallel display bus to a serialized, low voltage, differential signal bus in order to transmit the video signal to the LCD interface PCA.

9.1.1.2.2. Front Panel Interface PCA

The front panel interface PCA controls the various functions of the display and touchscreen. For driving the display it provides connection between the CPU video controller and the LCD display module. This PCA also contains:

- power supply circuitry for the LCD display module
- a USB hub that is used for communications with the touchscreen controller and the two front panel USB device ports
- the circuitry for powering the display backlight (current driven)

9.1.2. Rear panel

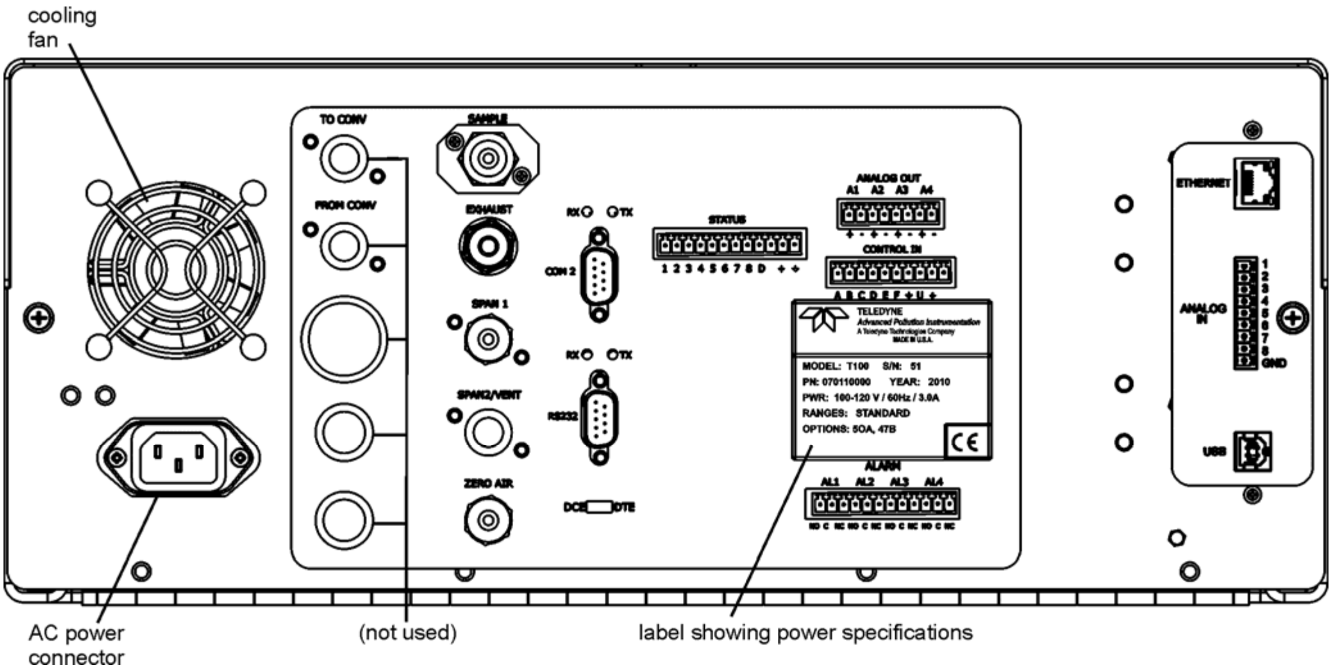


Figure 9-5: Rear Panel Layout

Table 9-2 provides a description of new components on the rear panel.

Table 9-2: Rear Panel Description

Component	Function
ANALOG IN	Option for external voltage signals from other instrumentation and for logging these signals
USB	Connector for direct connection to personal computer, using USB cable.

9.1.2.1. Connecting Analog Inputs (Option)

The Analog In connector is used for connecting external voltage signals from other instrumentation (such as meteorological instruments) and for logging these signals in the analyzer's internal DAS. The input voltage range for each analog input is 0-10 VDC.

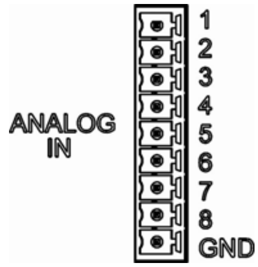


Figure 9-6: Analog In Connector

Pin assignments for the Analog In connector are presented in Table 9-3.

Table 9-3: Analog Input Pin Assignments

PIN	DESCRIPTION	DAS PARAMETER[1]
1	Analog input # 1	AIN 1
2	Analog input # 2	AIN 2
3	Analog input # 3	AIN 3
4	Analog input # 4	AIN 4
5	Analog input # 5	AIN 5
6	Analog input # 6	AIN 6
7	Analog input # 7	AIN 7
8	Analog input # 8	AIN 8
GND	Analog input Ground	N/A

9.1.2.2. USB Connection (Option)

For direct communication between the analyzer and a PC, connect a USB cable between the analyzer and desktop or laptop USB ports. (If this option is installed, the **COM2** port can only be used for Multidrop communication).The baud rate of the PC and the analyzer must match.

9.2. Calibration & update procedures

9.2.1 Display Calibration

The touchscreen display for the T series analyzer can be calibrated for the user's individual touch. To calibrate the display, you will need a USB keyboard. With the keyboard plugged into either USB port on the front panel, power off the instrument and then re-power.

A Teledyne logo will appear and flash, wait until a logo appears again with the words **System Booting** and a loading bar appear below the logo, and hold down the left shift and left control key on the keyboard throughout the rest of the boot up. This may take several minutes to reach the destination screen.

Once the screen becomes solid blue and a mouse curser appears on the center of the display, release the left shift and left control keys. A red and white target will appear near the center of the screen. Press the target to start the calibration. The target will now appear in a different location. Press and hold each target following the instructions on the display until you are asked to hit either ACCEPT or CANCEL. Hit accept to accept the changes or cancel to decline the changes. After you hit accept, remove the keyboard and re-power the instrument.

9.2.2. Analog Input Calibration

Analog I/O Configuration for Analog In

Table 9-4: DIAG - Analog I/O Functions (Example functions for a T100, AOUTS may vary)

SUB MENU	FUNCTION
AOUTS CALIBRATED:	Shows the status of the analog output calibration (YES/NO) and initiates a calibration of all analog output channels.
CONC_OUT_1	Sets the basic electronic configuration of the A1 analog output (SO_2). There are three options: • **RANGE:** Selects the signal type (voltage or current loop) and full scale level of the output. • **REC_OFS:** Allows setting a voltage offset, not available when RANGE is set to Current Loop (**CURR**). • **AUTO_CAL:** Performs the same calibration as AOUT CALIBRATED, but on this one channel only. NOTE: Any change to RANGE or REC_OFS requires recalibration of this output.
CONC_OUT_2	Same as for CONC_OUT_1 but for analog channel 2 (SO_2)
TEST OUTPUT	Same as for CONC_OUT_1 but for analog channel 4 (TEST)
CONC_OUT_3	(Not available in the analyzer's standard configuration; applies when optional sensor installed).
AIN CALIBRATED	Shows the calibration status (YES/NO) and initiates a calibration of the analog input channels.
XIN1 . . . **XIN8**	For each of 8 external analog inputs channels, shows the gain, offset, engineering units, and whether the channel is to show up as a Test function.

9.2.2.1. AIN Calibration

This is the sub-menu to conduct the analog input calibration. This calibration should only be necessary after major repair such as a replacement of CPU, motherboard or power supplies. Navigate to the **ANALOG I/O CONFIGURATION MENU** from the DIAG Menu, then press:

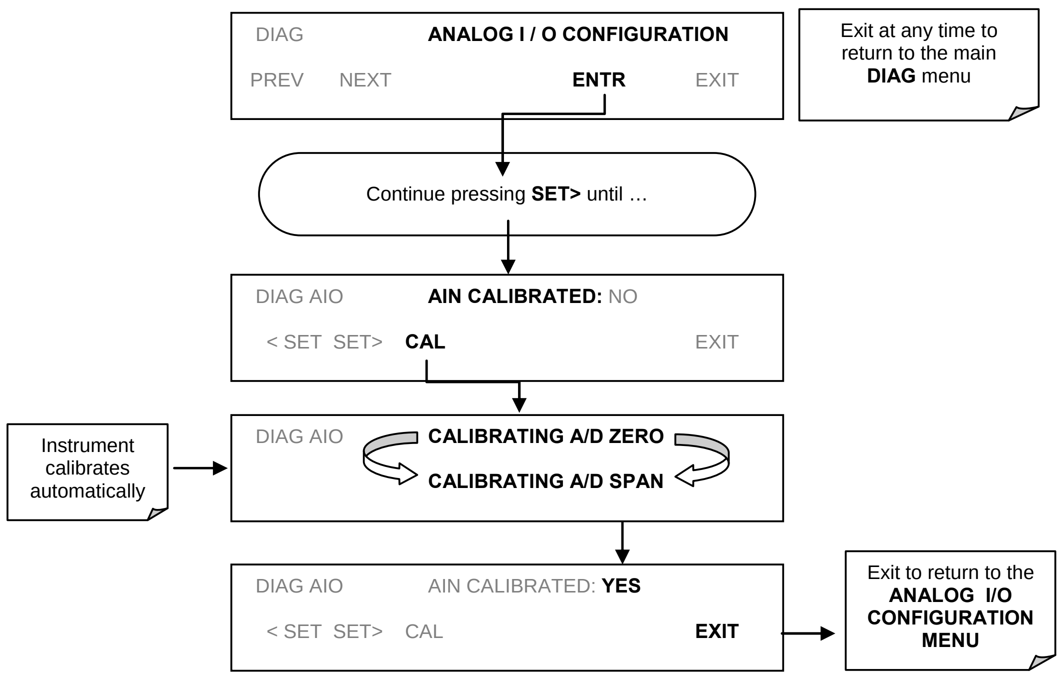


Figure 9-7: DIAG – Analog I/O Configuration – AIN Calibration

9.2.2.2. Analog Inputs (XIN1…XIN8) Option Configuration

To configure the analyzer's optional analog inputs define for each channel:

- gain (number of units represented by 1 volt)
- offset (volts)
- engineering units to be represented in volts (each press of the touchscreen button scrolls the list of alphanumeric characters from A-Z and 0-9)
- whether to display the channel in the Test functions

To adjust settings for the Analog Input option parameters press:

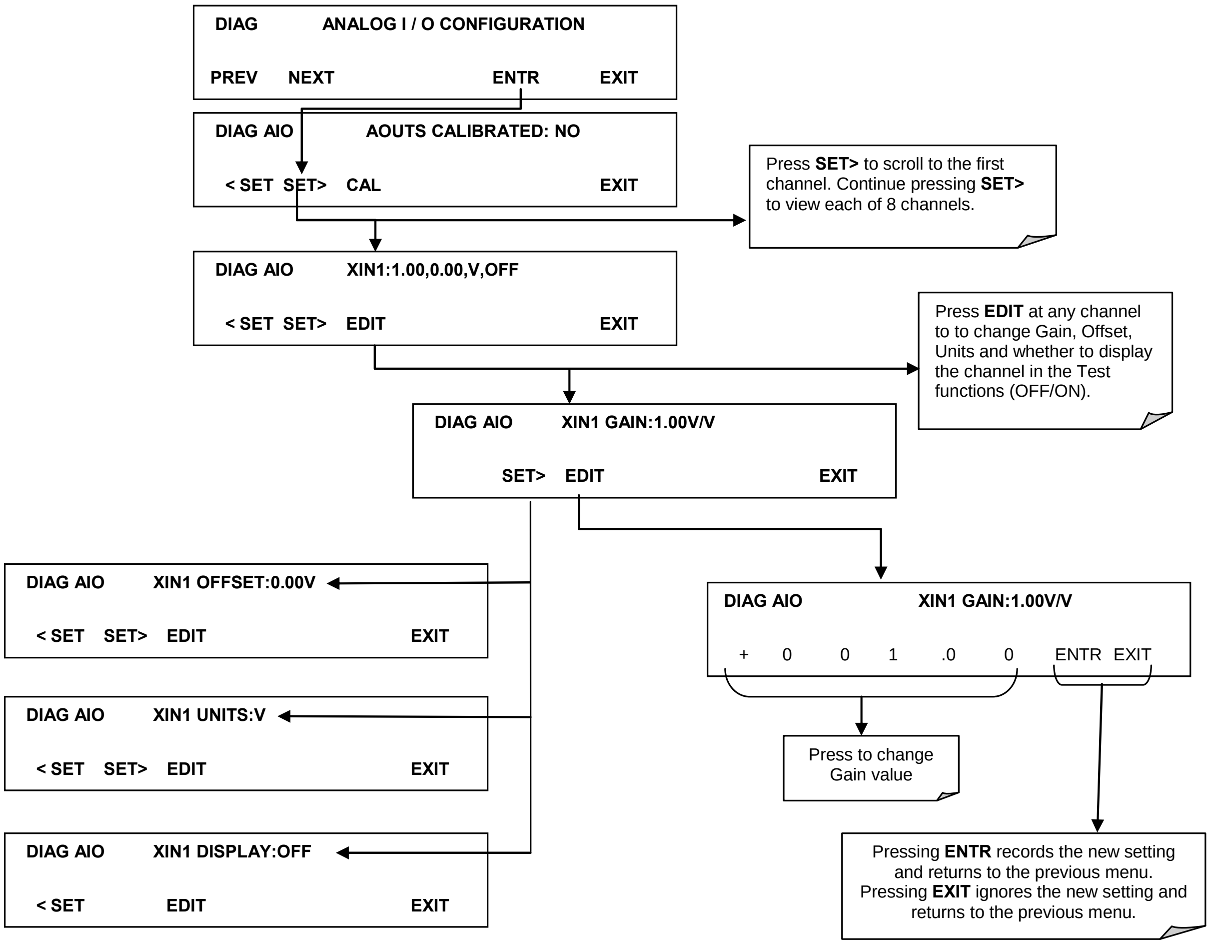


Figure 9-8 DIAG – Analog Inputs (Option) Configuration Menu

9.2.3. USB Configuration

After connecting a USB cable between your PC and the instrument, ensure their baud rates match (change the baud rate setting for either your PC's software or the instrument). COM2 is the default setup menu for USB configuration.

Also, while there are various communication modes available, the default settings are recommended for USB, except to change the baud rate if desired.

Your computer may need the correct drivers in order to communicate via the USB port. These drivers will be available on TAPI's website in the near future. You can contact API customer service if you need the drivers and instructions before then. Once the drivers are installed, the instrument's USB port should work as a standard COM2 port.

9.2.4. Firmware Updates via USB

The T series analyzers can receive firmware updates using a flash drive and the USB ports on the front panel. To update the firmware, locate the file you want to use for the update, and rename it to "update.exe" and copy to the flash drive. This file must not be in a folder on your flash drive in order to be recognized by the T series instrument. Plug in the flash drive and the instrument will give you a popup message with the model the firmware is intended for and the version of firmware, the analyzer will ask if you wish to continue, press yes to continue.

Warning, the instrument will load any recognizable firmware you tell it to regardless of if it is intended for that instrument or not. Double check the firmware model and version before selecting continue.

9.3. Troubleshooting faults

9.3.1. Touch-screen Interface

Verify the functioning of the touch screen by observing the display when pressing a touch-screen control button. Assuming that there are no wiring problems and that the DC power supplies are operating properly, but pressing a control button on the touch screen does not change the display, any of the following may be the problem:

- The touch-screen controller may be malfunctioning.
- The internal USB bus may be malfunctioning.

  You can verify this failure by logging on to the instrument using APICOM or a terminal program. If the analyzer responds to remote commands and the display changes accordingly, the touch-screen interface may be faulty.

9.3.2. LCD Display Module

Verify the functioning of the front panel display by observing it when power is applied to the instrument. Assuming that there are no wiring problems and that the DC power supplies are operating properly, the display screen should light and show the splash screen and other indications of its state as the CPU goes through its initialization

9.3.3. Touch-screen not working correctly

If you experience problems where the display reacts to touch in a different location to where you are pressing, you may need to re-calibrate the touch-screen. Also, if you are in the touch-screen calibration mode and press cancel at the end of the calibration sequence, you will loose the previous calibration and the display will be mis-calibrated. To correct this, follow the calibration procedure in section 9.2.1.

4. Diagrams and schematics

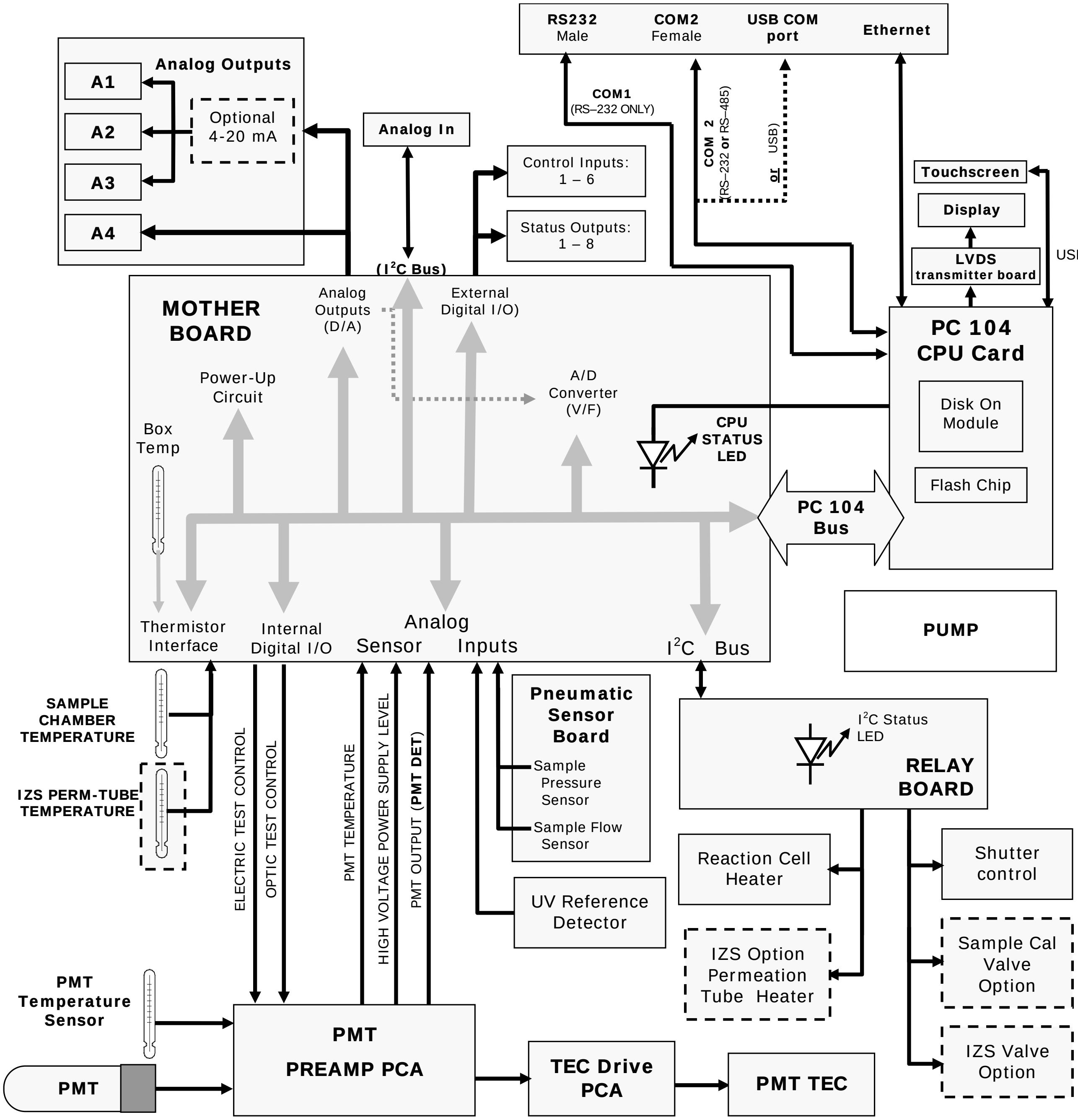


FIGURE 9-9, EXAMPLE OF AN ELECTRONIC BLOCK DIAGRAM (T100)

9.5. “E” series compatibility

9.5.1. Incompatible components

The following components are not compatible between E series and T series analyzers:

CPU
Multidrop
Display and Keyboard components
Ethernet
USB
Analog Inputs