TRAINING MANUAL

MODEL 201E / T201

CHEMILUMINESCENT AMMONIA ANALYZER

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ADVANCED POLLUTION INSTRUMENTATION
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1. PRINCIPLE OF OPERATION

Measurement Principle

The M201E Ammonia Analyzer is a microprocessor controlled instrument that determines the concentration of ammonia (NH_3), nitric oxide (NO), total nitrogen oxides (NO_X, the sum of NO and NO_2) and nitrogen dioxide (NO_2) in a sample gas drawn through the instrument. It requires that sample and calibration gases be supplied at ambient atmospheric pressure in order to establish a constant gas flow through the reaction cell where the sample gas is exposed to ozone (O_3), initiating a chemical reaction that gives off light (chemiluminescence). The instrument measures the amount of chemiluminescence to determine the amount of gas present in the sample gas.
Calibration of the instrument is performed in software and usually does not require physical adjustments to the instrument. During calibration, the microprocessor measures the sensor output signal when gases with known amounts of NH_3, NO, and NO_2 are supplied and stores these results in memory. The microprocessor uses these calibration values along with the signal from the sample gas and data of the current temperature and pressure of the gas to calculate a final concentration.
The concentration values and the original information from which it was calculated are stored in the unit's internal data acquisition system and reported to the user through a vacuum fluorescent display or several communication ports.

Chemiluminescence

The principle of the M201E's measurement method is the detection of chemiluminescence, which occurs when nitrogen oxide (NO) reacts with ozone (O_3). This reaction is a two-step process. In the first step, one molecule of NO and one molecule of O_3 collide and chemically react to produce one molecule of oxygen (O_2) and one molecule of nitrogen dioxide (NO_2). Some of the NO_2 retains a certain amount of excess energy from the collision and, hence, remains in an excited state, which means that one of the electrons of the NO_2 molecule resides in a higher energy state than is normal (denoted by an asterisk in Equation 1).

$$NO + O_3 \rightarrow NO_2^* + O_2 \qquad \textbf{(1)}$$

Because thermodynamics requires that systems will always seek the lowest, stable energy state, the NO_2 molecule quickly returns to its ground state in a subsequent step by giving off the excess energy in form of a quantum of light ($h\nu$) with wavelengths between 600 and 3000ηm, peaking at about 1200ηm (Equation 2, Figure 1).

$$NO_2^* \rightarrow NO_2 + h\nu_{1200\eta m} \qquad \textbf{(2)}$$

NH_3, NOx and NO_2 Determination

The Teledyne API Model M201E Analyzer measures ammonia by converting NH_3 to nitric oxide by the following reaction:

$$4NH_3 + 5O_2 \rightarrow 4NO + 6H_2O \text{ (at } 825°C)$$

The resulting NO is then measured by the Chemiluminescent reaction of NO with ozone.
Two converters are used for the measurement. A high temperature catalytic converter, the M501NH, converts NH_3 and NOx to NO creating the TN_x channel. A second converter, housed in the M201E analyzer and consisting of heated molybdenum converts all of the NO_x in the sample to NO producing the NO_x channel signal. The NO_2 is converted to NO by the follow reaction.

$$xNO_2 + yMo \rightarrow xNO + M_yO_z \quad (at\ 315°C)$$

The NO channel is measured while bypassing both the 501 & molybdenum converter. A Nafion® drier operated in reflux mode, is installed prior to the molybdenum converter and the AutoZero valve, and removes any residual ammonia and water from the switched stream. This location provides the drier with continuous flow, thereby allowing it to stabilize faster.

The individual gas (NH_3, NO_2, NO) concentrations are computed by the difference between the measured channels, as shown in the following equations:

$NH_3 \rightarrow TN_x - NO_X$
$NO_2 \rightarrow NO_X - NO$
$NO \rightarrow$ Measured
$TN_x \rightarrow$ Measured (NH_3, NO_2, NO)
$NO_X \rightarrow$ Measured (NO_2, NO) $\rightarrow NO_x$

The M201A previously measured TN, TN_x & NH_3. The M201E has replaced the TN channel with the NO_x channel. The TN channel in the original version of the 201A consisted of NO_x and converted NH_3 due to the molybdenum converter. Since the addition of the second dryer in the M201E, the TN channel is primarily NO_x as the second dryer scrubs NH_3 during NO_x measurements.

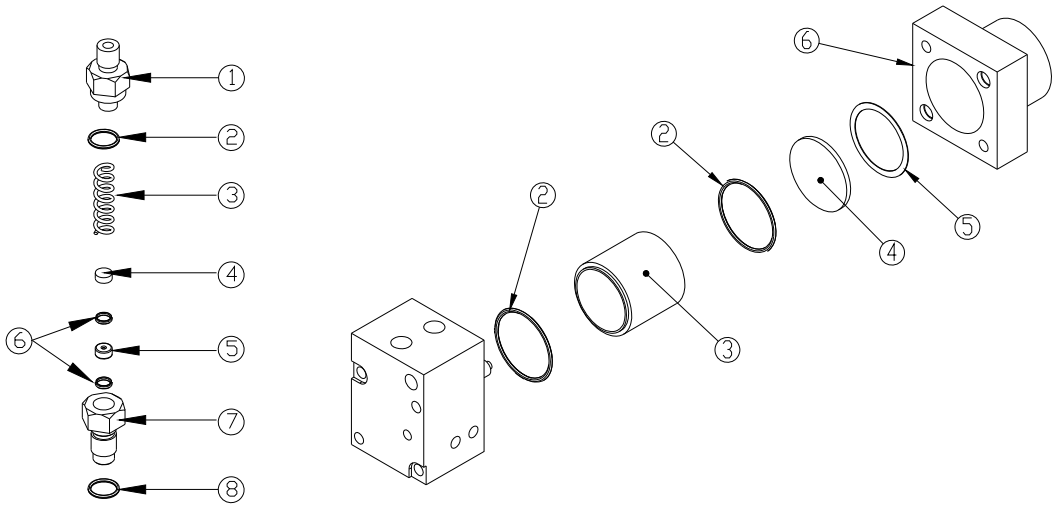
The M501NH NH_3 Converter operates at 825°C. At this high temperature, several reactions occur:

$NO \rightarrow NO$	Loss = ~3%
$NO_x \rightarrow NO$	Efficiency = ~95%
$NH_3 \rightarrow NO$	Efficiency = ~95%
$NH_3 \rightarrow NO_2$	Efficiency = ~5%

As can be seen from the above reactions, the calculation of the ammonia concentration and overall calibration of the instrument must be done carefully if accurate ammonia concentrations are to be measured.

Once the NO_2 in the sample gas has been converted to NO, it is routed to the reaction cell where it undergoes the chemiluminescence reaction described in Equations 1 and 2.

The Reaction Chamber



Orifice Holder Assy

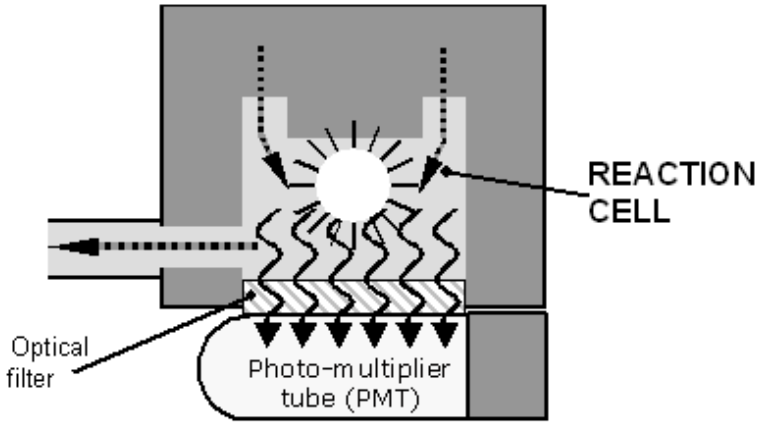
1. FT0000010
2. OR0000034
3. HW0000020
4. FL0000001
5. 000940400 (Ozone)
5. 000940600 (Sample)
6. OR0000001
7. 040900000
8. OR0000039

Reaction Cell Assy

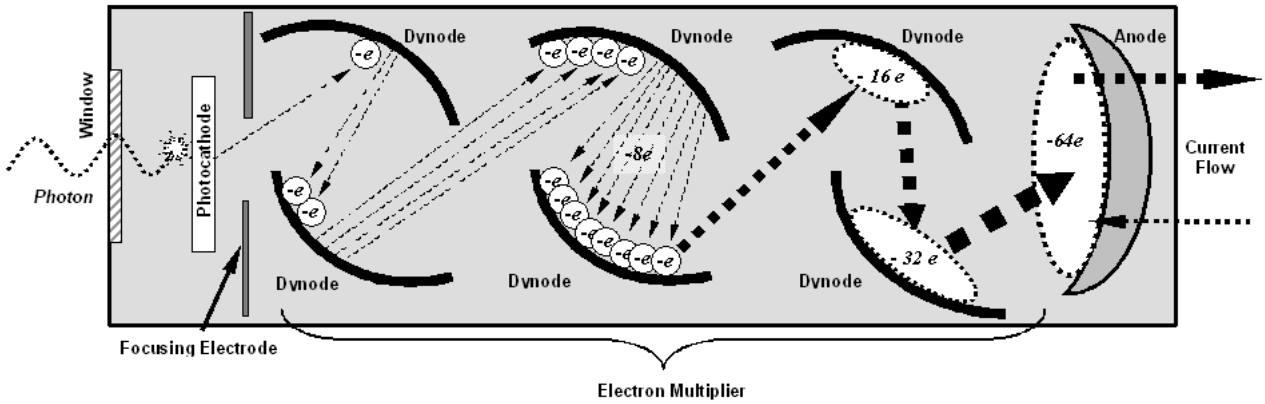
2. OR0000002
3. 001330000
4. 002730000
5. 002270000
6. 008840000

The Photo Multiplier Tube

The M201E uses a photo-multiplier tube (PMT) to detect the amount of light created by the NO and O_3 reaction in the reaction cell.
A PMT is typically a vacuum tube containing a variety of specially designed electrodes. Photons enter the PMT and strike a negatively charged photo cathode causing it to emit electrons. These electrons are accelerated by an applied high voltage and multiply through a sequence of such acceleration steps (dynodes) until a useable current signal is generated. This current increases or decreases with the amount of detected light is converted to a voltage and amplified by the preamplifier board and then reported to the motherboard's analog inputs.



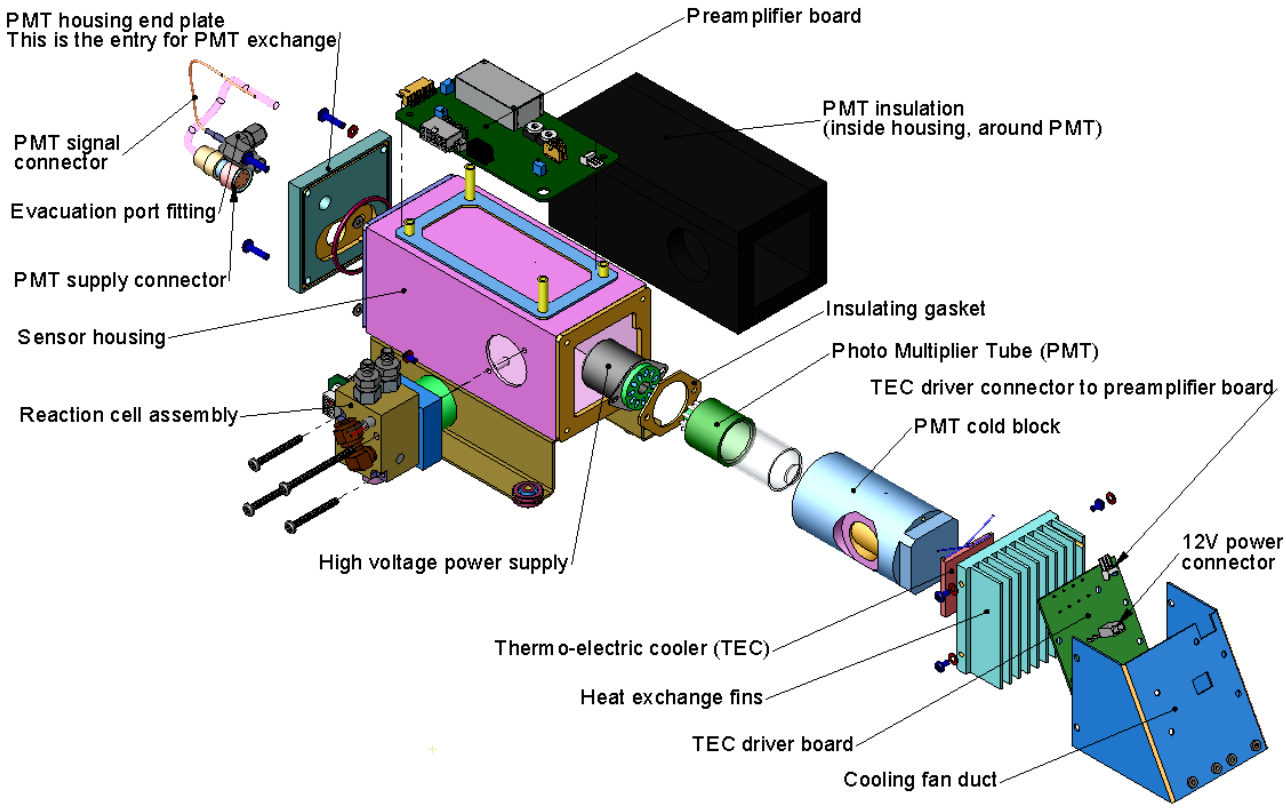
Reaction Cell with PMT Tube



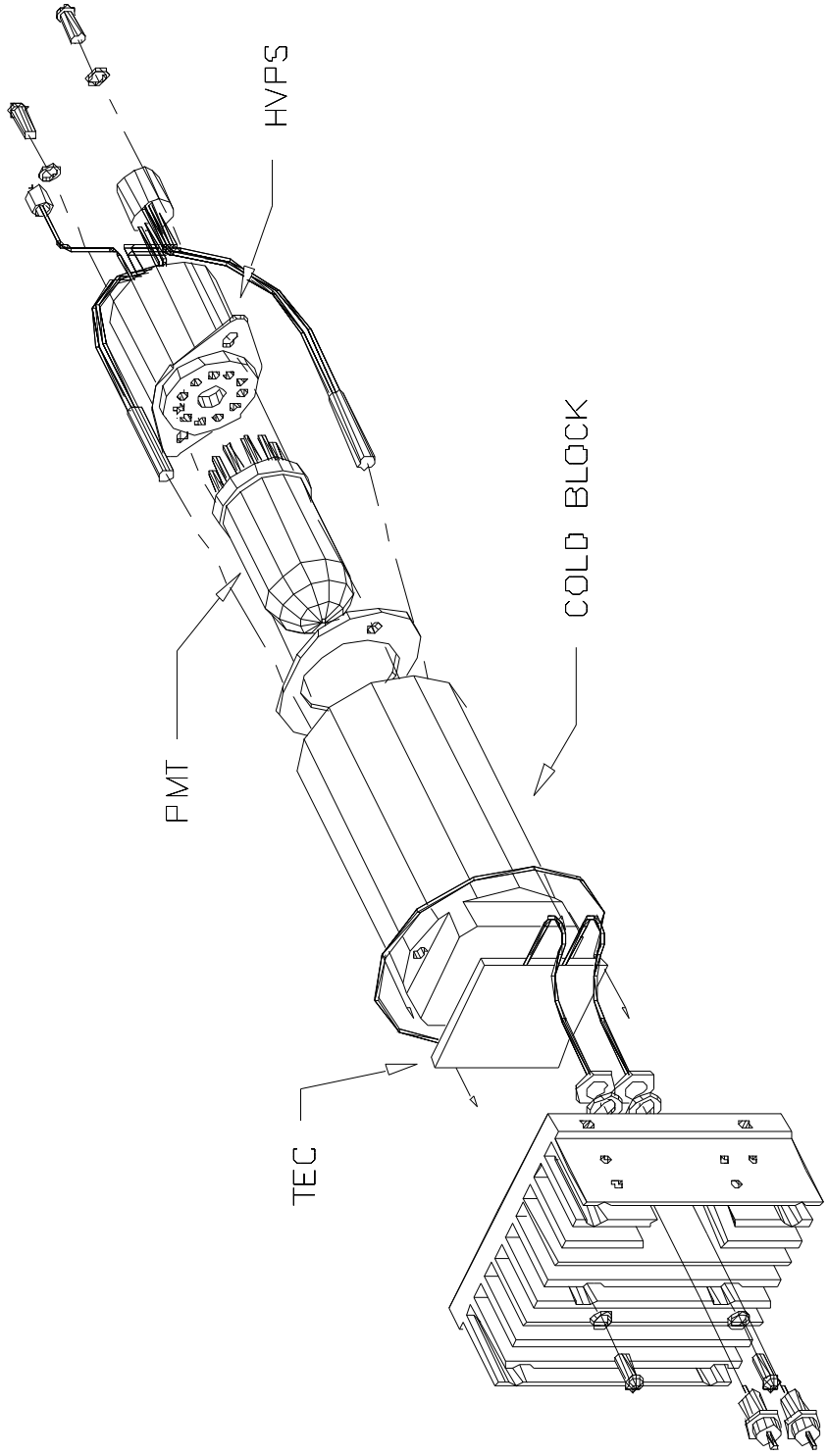
Schematic of Basic PMT Design and Functionality

A significant performance characteristic of the PMT is the voltage potential across the electron multiplier. The higher the voltage, the greater is the number of electrons emitted from each dynode of the electron multiplier, making the PMT more sensitive and responsive to small variations in light intensity but also increases random noise (dark noise). The gain voltage of the PMT used in the M201E is usually set between 450 V and 800 V. This parameter is viewable through the front panel as test function **HVPS** and usually does not need to be changed unless the PMT or the HVPS itself is changed.

The PMT is housed inside the sensor module assembly. This assembly also includes the high voltage power supply required to drive the PMT, an LED used by the instrument's optical test function, a thermistor that measures the temperature of the PMT and various components of the PMT cooling system, including the thermo-electric cooler (TEC).



M201E Sensor Assembly

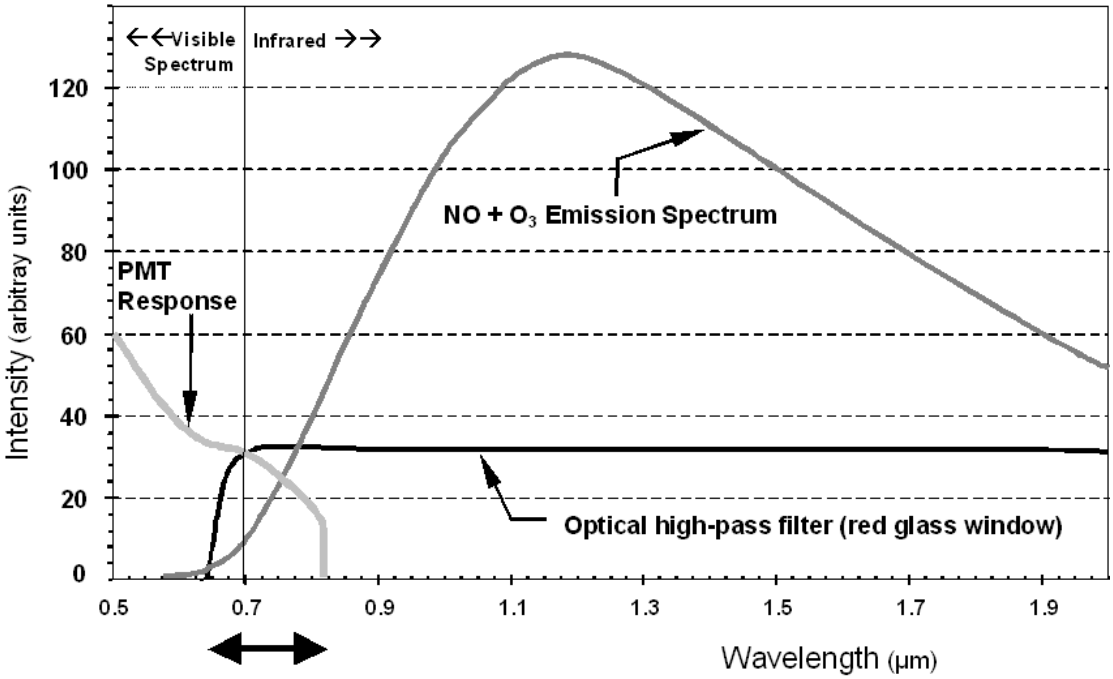


PMT COOLER ASSEMBLY

Optical Filter

Another critical component in the method by which your M201E detects chemiluminescence is the optical filter that lies between the reaction cell and the PMT. This filter is a high pass filter that is only transparent to wavelengths of light above 665nm. In conjunction with the response characteristics of the PMT, this filter creates a very narrow window of wavelengths of light to which the M201E will respond.

THE NARROW BAND OF SENSITIVITY ALLOWS THE M201E TO IGNORE EXTRANEOUS LIGHT AND RADIATION THAT MIGHT INTERFERE WITH THE M201E'S MEASUREMENT. FOR INSTANCE, SOME OXIDES OF SULFUR CAN ALSO UNDERGO CHEMILUMINESCENCE WHEN IN CONTACT WITH O_3 BUT EMIT LIGHT AT SHORTER WAVELENGTHS (USUALLY AROUND 260NM TO 480NM).



M201E Sensitivity Spectrum

Ozone Gas Air Flow

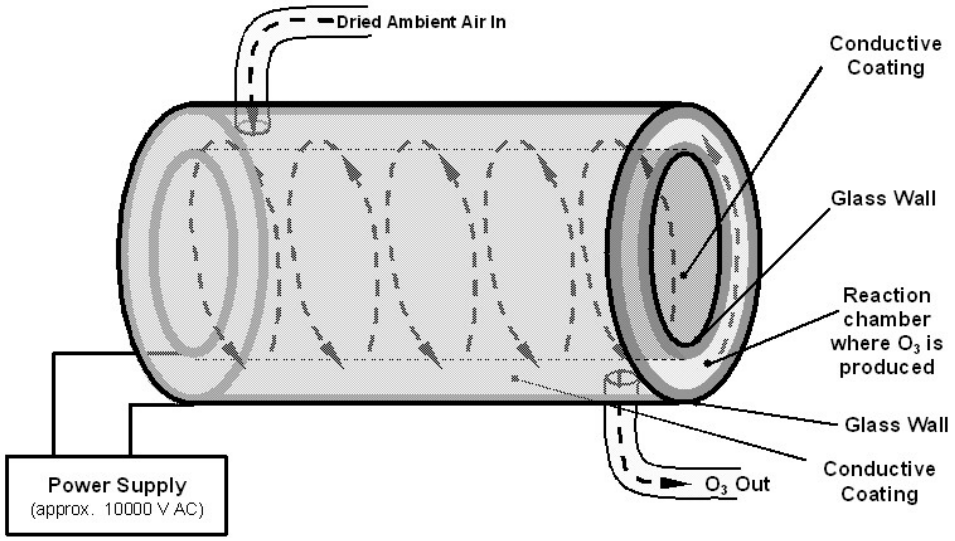
The excess ozone needed for reaction with NO in the reaction cell is generated inside the analyzer because of the instability and toxicity of ozone. Besides the ozone generator itself, this requires a dry air supply and filtering of the gas before it is introduced into the reaction cell. Due to its toxicity and aggressive chemical behavior, O_3 must also be removed from the gas stream before it can be vented through the exhaust outlet.

In contrast to the sample flow, the ozone flow is measured with a mass flow sensor which is mounted on the pneumatic sensor board just behind the PMT sensor assembly. As the flow value displayed on the front panel is an actual measurement (and not a calculated value), the flow variability may be higher than that of the sample flow, which is based on a calculation from (more stable) differential pressures. On the other hand, the drift, i.e. long-term change, in the ozone flow rate may be higher and usually indicates a flow problem. As with all other test parameters, we recommend monitoring the ozone flow over time for predictive diagnostics and maintenance evaluation.

CAUTION
Ozone (O_3) is a toxic gas. Obtain a Material and Safety Data Sheet (MSDS) for this gas. Read and rigorously follow the safety guidelines described there. Always make sure that the plumbing of the O_3 generation and supply system is maintained and leak-free.

O_3 Generator

The M201E uses a corona discharge (CD) tube for creating its O_3. Corona discharge generation is capable of producing high concentrations of ozone efficiently and with low excess heat. Although there are many cell designs, the fundamental principle remains the same.



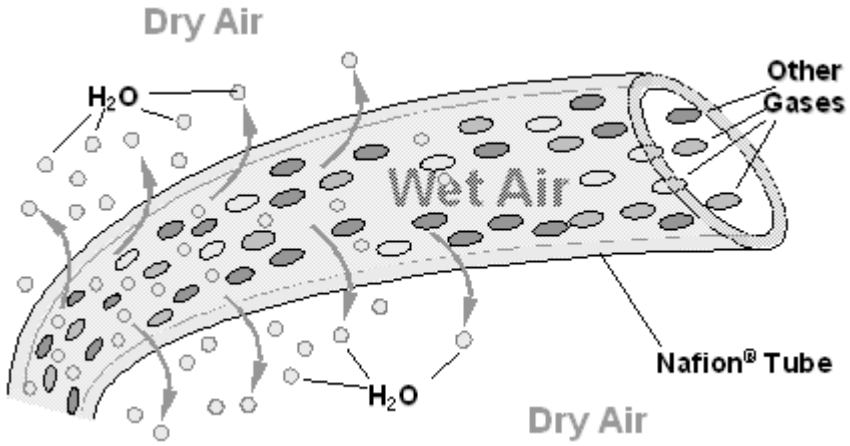
Ozone Generator Principle

The M201E utilizes a dual-dielectric design. This method utilizes a glass tube with hollow walls. The outermost and innermost surfaces are coated with electrically conductive material. The air flows through the glass tube between the two conductive coatings, in effect creating a capacitor with the air and glass acting as the dielectric. The layers of glass also separate the conductive surfaces from the air stream to prevent reaction with the O_3. As the capacitor charges and discharges, electrons are created and accelerated across the air gap and collide with the O_2 molecules in the air stream splitting them into elemental oxygen. Some of these oxygen atoms recombine with O_2 to O_3.
The quantity of ozone produced is dependent on factors such as the voltage and frequency of the alternating current applied to the CD cells. When enough high-energy electrons are produced to ionize the O_2 molecules, a light emitting, gaseous plasma is formed, which is commonly referred to as a corona, hence the name corona discharge generator.

Perma Pure® Dryer

The air supplied to the O_3 generation system needs to be as dry as possible. Normal room air contains a certain amount of water vapor, which greatly diminishes the yield of ozone produced by the ozone generator. Also, water can react with other chemicals inside the O_3 Generator to produce chemicals that damage the optical filter located in the reaction cell such as ammonium sulfate or highly corrosive nitric acid.

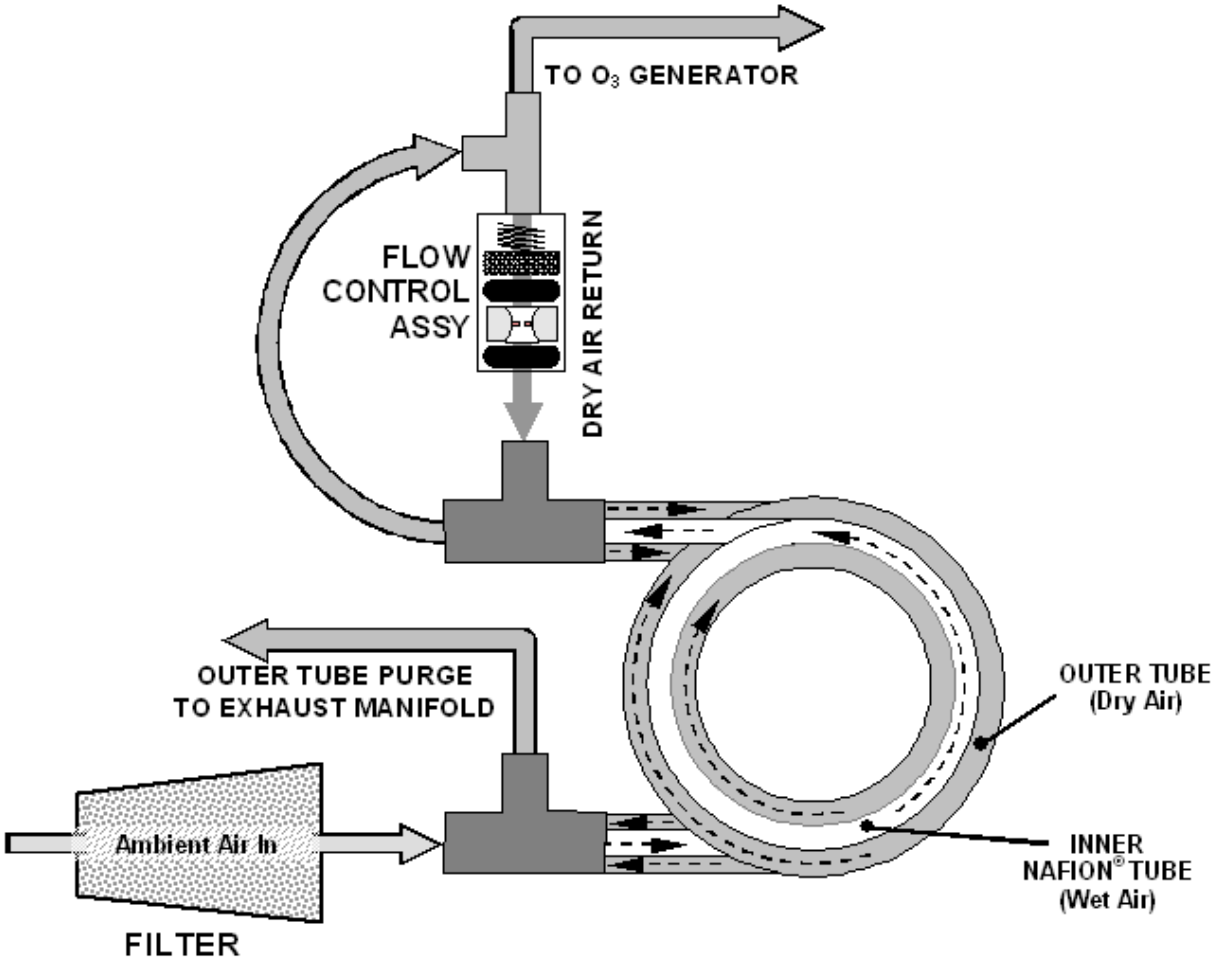
To accomplish this task the M201E uses a Perma Pure® single tube permeation dryer. The dryer consists of a single tube of Nafion®, a co-polymer similar to Teflon® that absorbs water very well but not other chemicals. The Nafion® tube is mounted within an outer, flexible plastic tube. As gas flows through the inner Nafion® tube, water vapor is absorbed into the membrane walls. The absorbed water is transported through the membrane wall and evaporates into the dry, purge gas flowing through the outer tube, countercurrent to the gas in the inner tube.



Semi-Permeable Membrane Drying Process

This process is called per-evaporation and is driven by the humidity gradient between the inner and outer tubes as well as the flow rates and pressure difference between inner and outer tubing. Unlike micro-porous membrane permeation, which transfers water through a relatively slow diffusion process, per-evaporation is a simple kinetic reaction. Therefore, the drying process occurs quickly, typically within milliseconds. The first step in this process is a chemical reaction between the molecules of the Nafion® material and water, other chemical components of the gases to be dried are usually unaffected. The chemical reaction is based on hydrogen bonds between the water molecule and the Nafion material. Other small polar gases that are capable of hydrogen bonds can be absorbed this way, too, such as ammonia (NH_3) and some low molecular amines. The gases of interest, NO and NO_2, do not get absorbed and pass through the dryer unaltered.

To provide a dry purge gas for the outer side of the Nafion tube, the M201E returns some of the dried air from the inner tube to the outer tube. When the analyzer is first started, the humidity gradient between the inner and outer tubes is not very large and the dryer's efficiency is low at first but improves as this cycle reduces the moisture in the sample gas and settles at a minimum humidity.



M201E Perma Pure® Dryer

Just like on startup, if the instrument is turned on after having been off for more than 30 minutes, it takes a certain amount of time for the humidity gradient to become large enough for the Perma Pure® Dryer to adequately dry the air. In this case, called a cold start, the O_3 Generator is not turned on for 30 minutes. When rebooting the instrument within less than 30 minutes of power-down, the generator is turned on immediately.

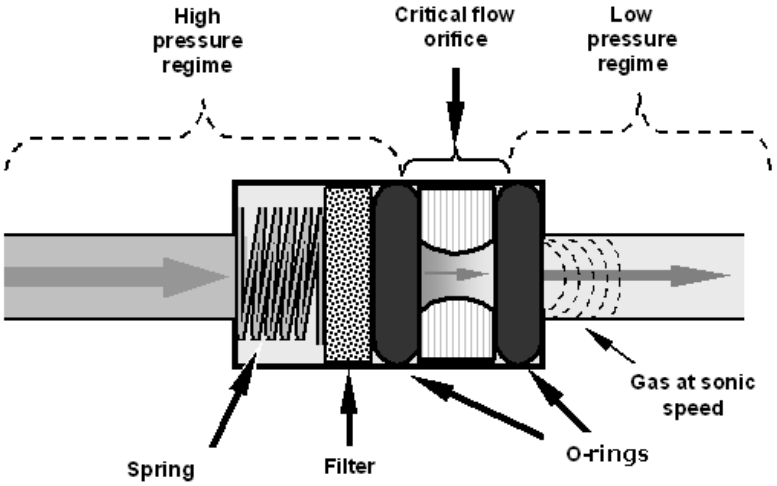
The Perma Pure® Dryer used in the M201E is capable of adequately drying ambient air to a dew point of ≤ -5˚C (~4000 ppm residual H_2O) at a flow rate of 1 standard liter per minute (slpm) or down to ≤ -15˚C (~1600 ppm residual H_2O) at 0.5 slpm. The Perma Pure® Dryer is also capable of removing ammonia from the sample gas up to concentrations of approximately 1 ppm.

Critical Flow Orifices

In order to maintain constant flow rates for both the O_3 supply air and the sample gas, the M201E uses a variety of critical-orifice flow control assemblies located at these places in the pneumatic system of the instrument:

- Reaction cell, sample inlet
- Reaction cell, ozone inlet
- Vacuum manifold, Autozero exit
- TN bypass flow
- Permapure ozone air dryer, purge flow control
- Permapure sample purge flow control

The most important component of each flow control assembly is the critical flow orifice. Critical flow orifices are a simple means 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 through the orifice, a pressure differential is created. This pressure differential, created by the analyzer's external 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 of the gas flowing through 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 and remains constant, regardless of any further pressure difference. As long as that ratio stays at least 2:1, the gas flow rate is unaffected by fluctuations, surges, or changes in downstream pressure because such variations only travel at the speed of sound themselves and are therefore cancelled out at the downstream exit of the critical flow orifice.



Flow Control Assembly & Critical Flow Orifice

The actual flow rate of gas through the orifice depends entirely on the size and shape of the aperture in the orifice and the upstream pressure. The larger the hole or the higher the upstream pressure, the more gas molecules pass through the orifice. The flow rate of the gas is also unaffected by small degradations in pump efficiency due to age as long as the 2:1 pressure difference is maintained.

M201E Gas Flow Rates

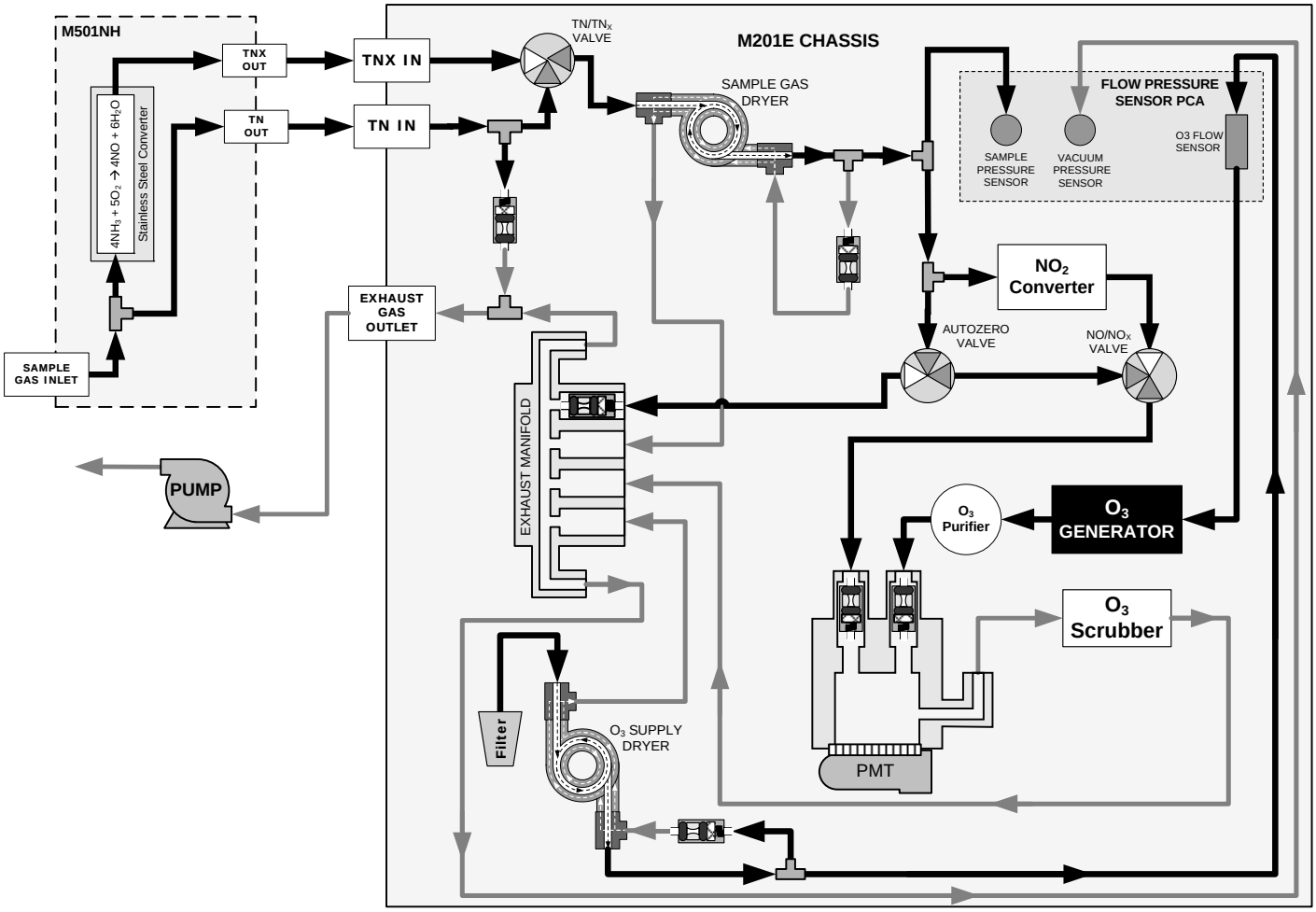
Location	Purpose	Orifice Diameter	Flowrate (nominal)
Sample gas inlet of reaction cell	Controls rate of flow of sample gas into the reaction cell.	0.010" (10mil)	500 cm^3/min
O_3 supply inlet of reaction cell.	Controls rate of flow of ozone gas into the reaction cell.	0.004" (4mil)	80 cm^3/min
Dry air return of Perma Pure® dryer	Controls flow rate of dry air return / purge air of the dryer.	0.004" (4mil)	80 cm^3/min
Vacuum manifold, auto-zero port.	Controls rate of sample gas flow when bypassing the reaction cell during the auto-zero cycle.	0.010" (10mil)	500 cm^3/min
Vacuum manifold, bypass flow port.	Provide a larger flow rate to the inlet of the NH_3 converter for quicker response times.	0.010" (10mil)	500 cm^3/min

Note that the diameter of the critical orifice may change with temperature because of expansion of the orifice material (ruby) and, hence, the most critical flow orifices in the M201E are maintained at a constant temperature inside the reaction cell. These are the sample and O_3 flows. The table above shows the flow rates for each of the critical flow orifices of the M201E.

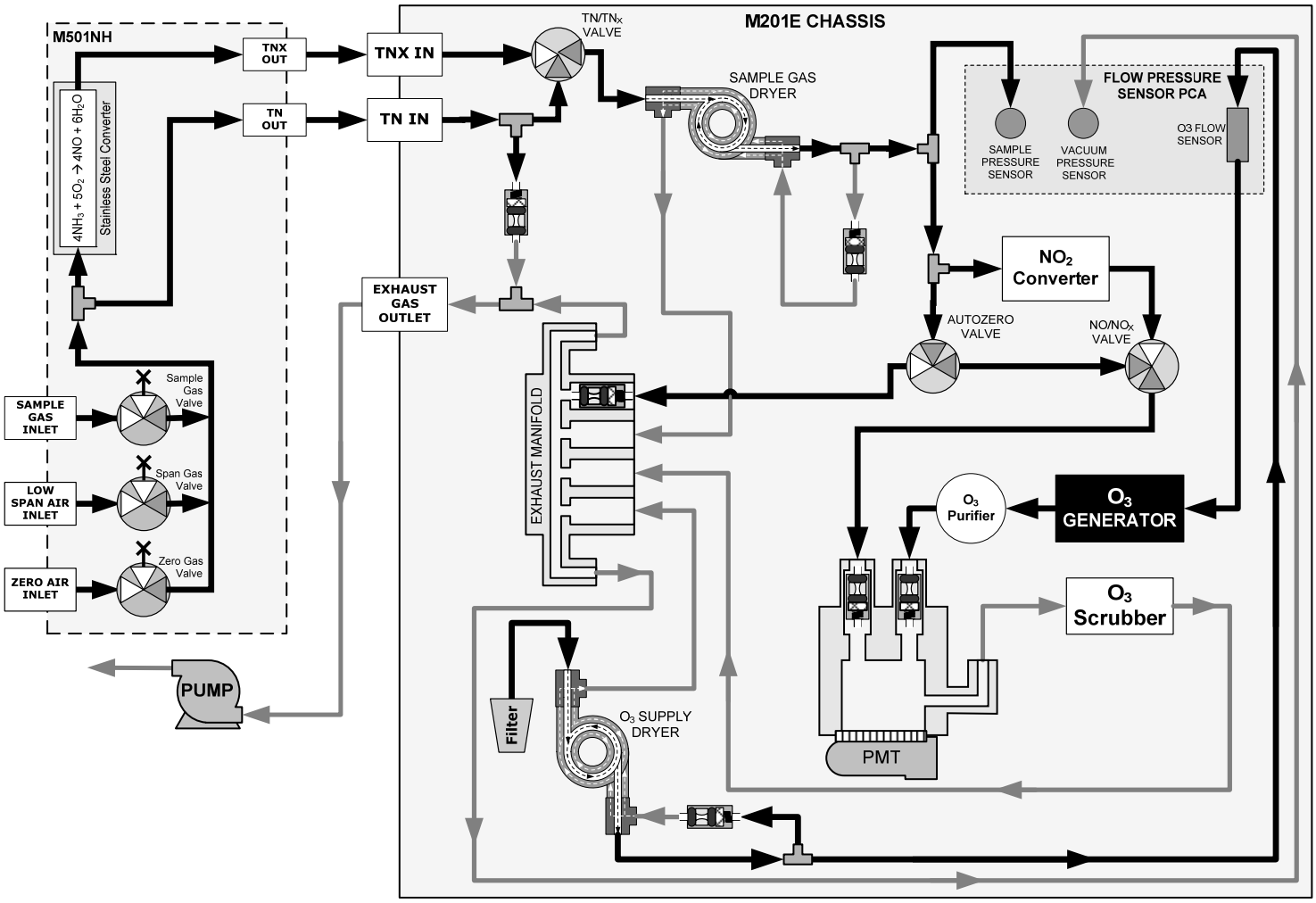
In addition to controlling the gas flows, the two critical flow orifices at the inlets of the reaction cell also maintain a low pressure inside the reaction cell. This effectively reduces the number of molecules in the chamber and therefore increasing the chemiluminescence yield as the likelihood of third body quenching is reduced. The M201E sensitivity reaches a peak at about 2 in-Hg-A, below which the sensitivity drops due to a low number of molecules and decreased yield in the chemiluminescence reaction.
The other components of the flow control assemblies are:

- A sintered stainless steel filter, which prevents particulates from entering the reaction cell and potentially plug the orifice. Note that very fine sub-micron particles may still accumulate on that filter and slowly clog up either the filter or the orifice over time.
- Two O-rings are located before and after the critical flow orifice to seal the gap between the walls of the assembly housing and the critical orifice and force all gas through the orifice opening.
- A spring applies mechanical force to form the seal between the o-rings, the critical flow orifice and the assembly housing and to prevent the components to float up and turn on sudden pressure drops.

2. PNEUMATICS



M201E Pneumatic Diagram, Standard Configuration



M201E Pneumatic Diagram Z/S Option

USER NOTES:

3. MENU STRUCTURE

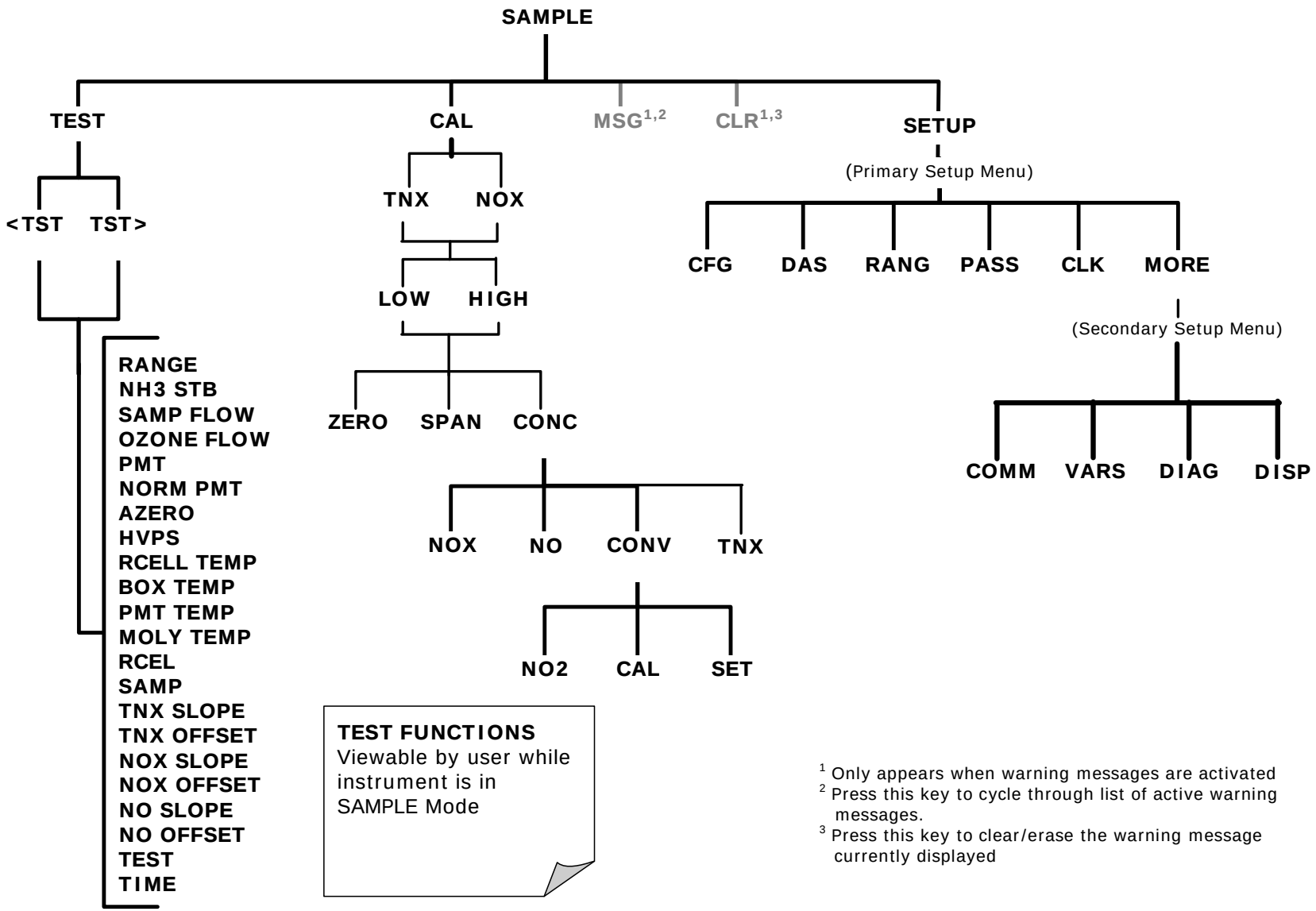


Figure A-1: Basic Sample Display Menu

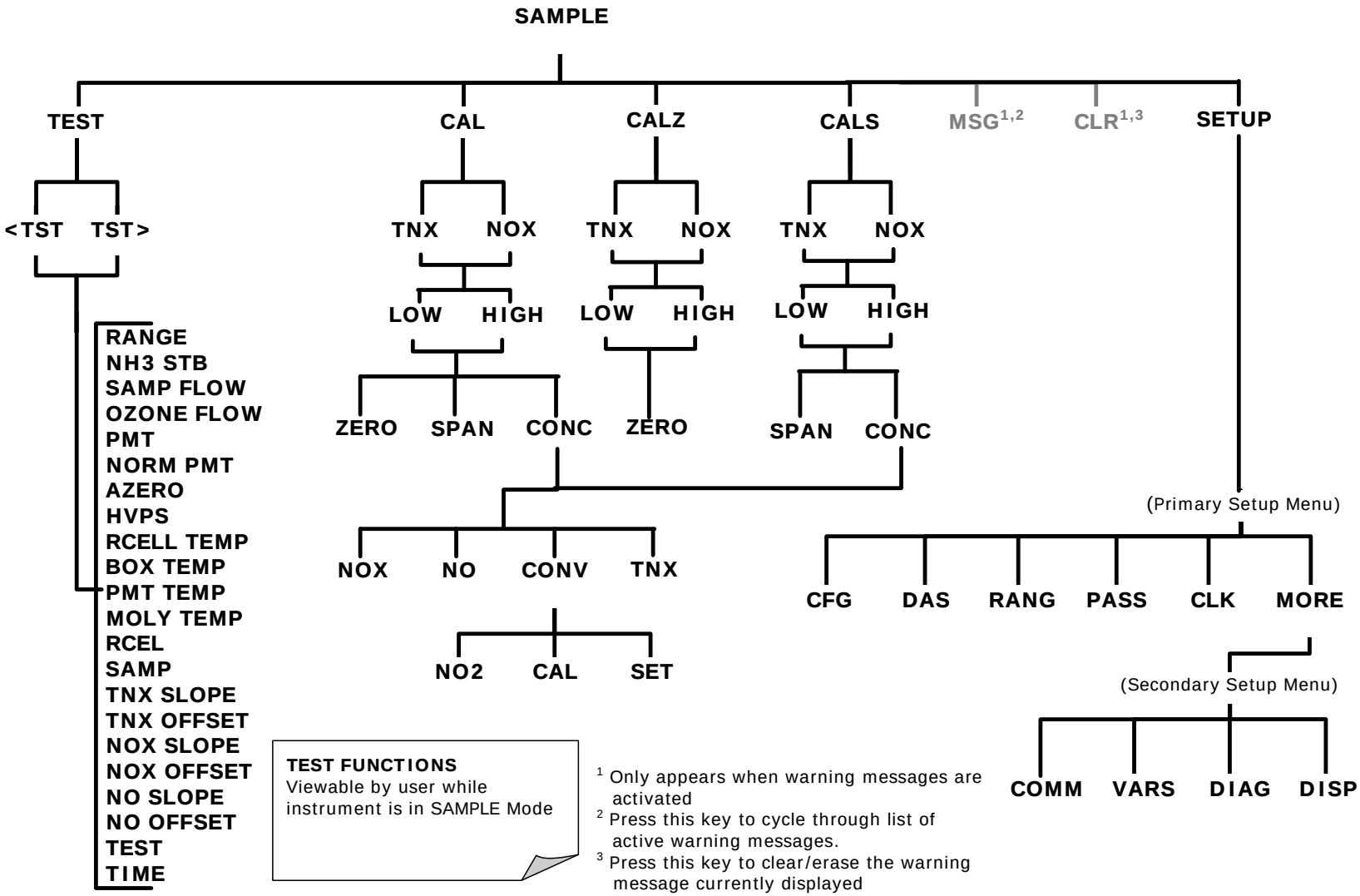


Figure A-2: Sample Display Menu - Units with Z/S Valve Option installed

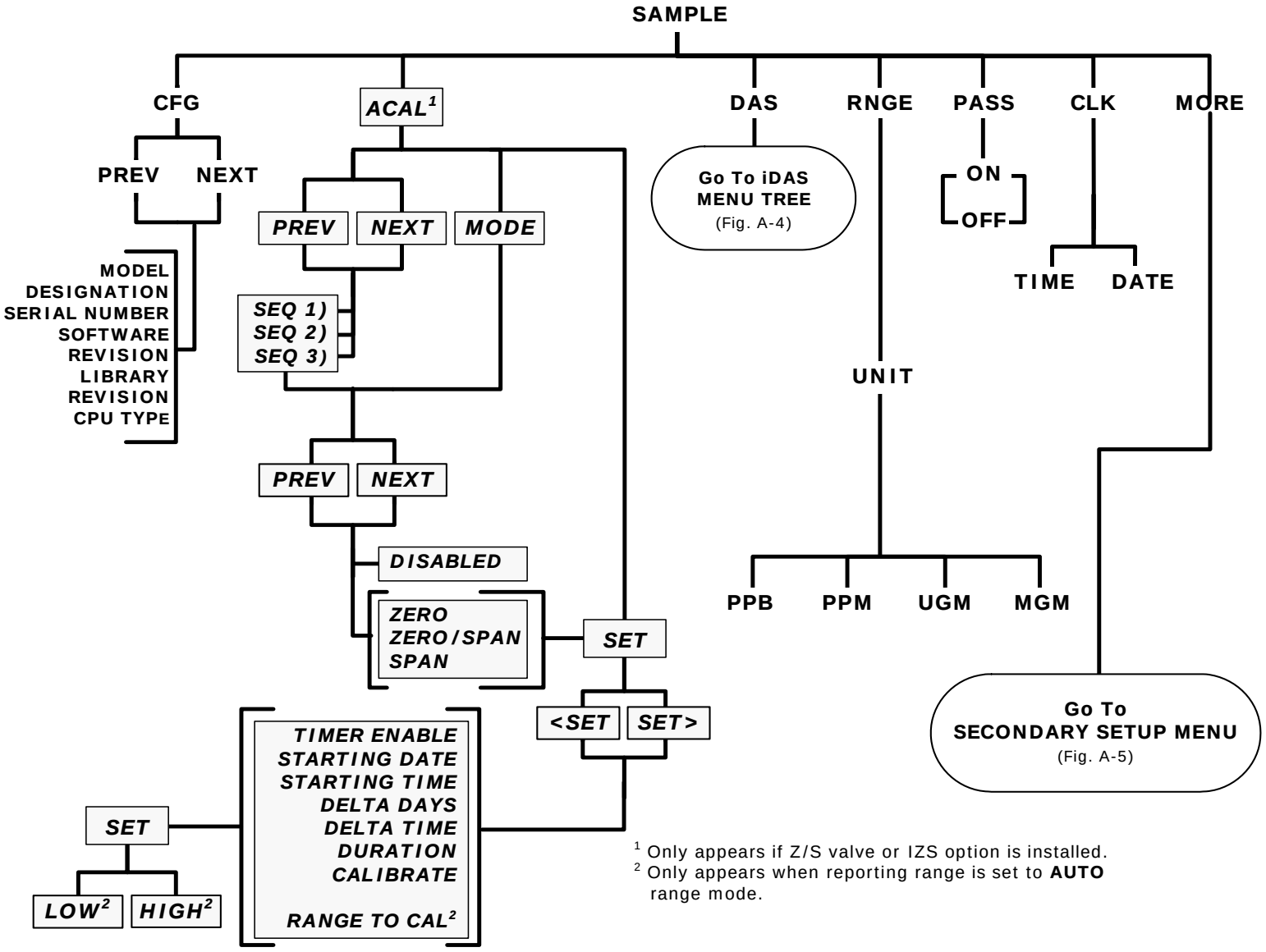


Figure A-3: Primary Setup Menu (Except iDAS)

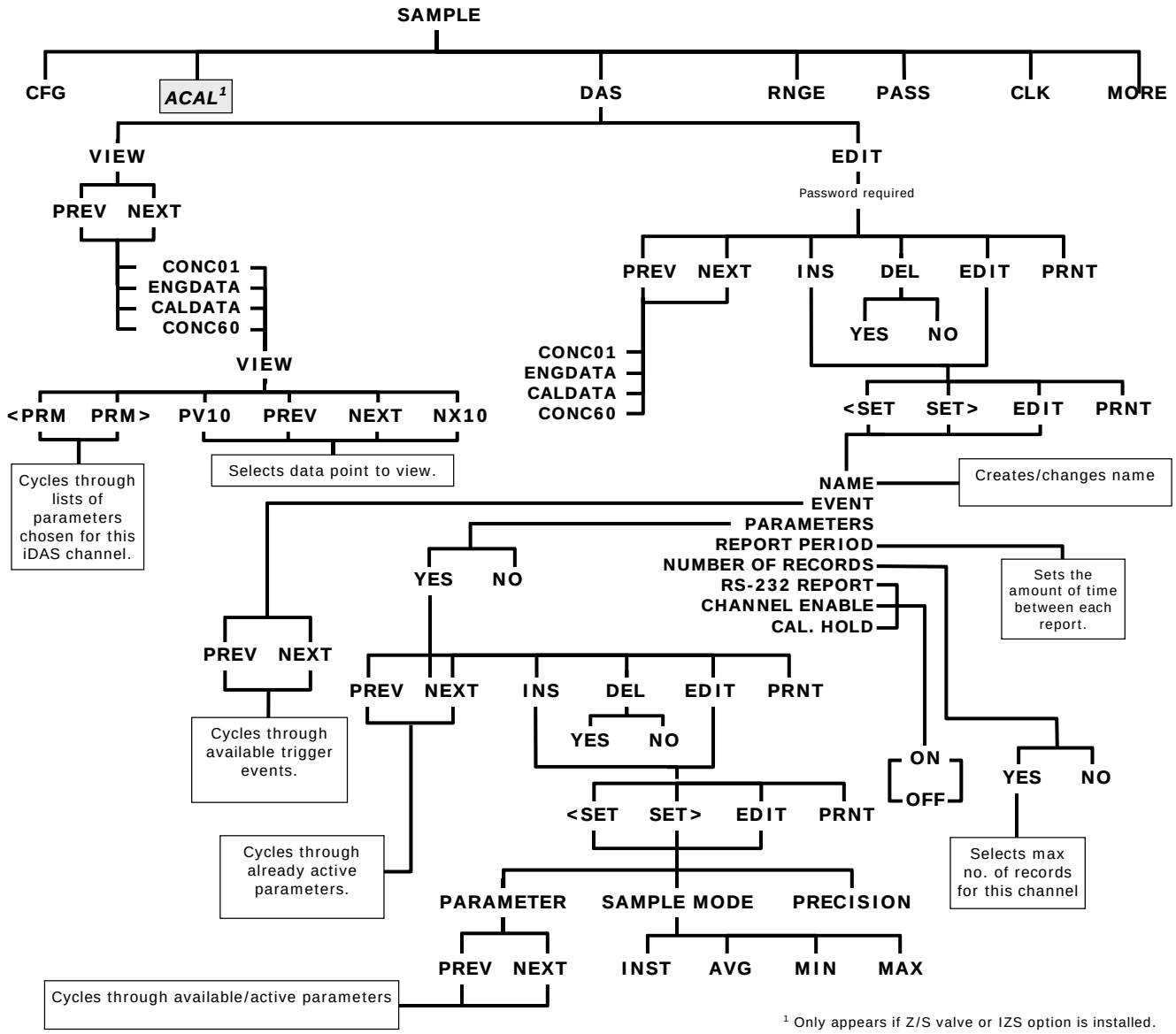


Figure A-4: Primary Setup Menu (iDAS)

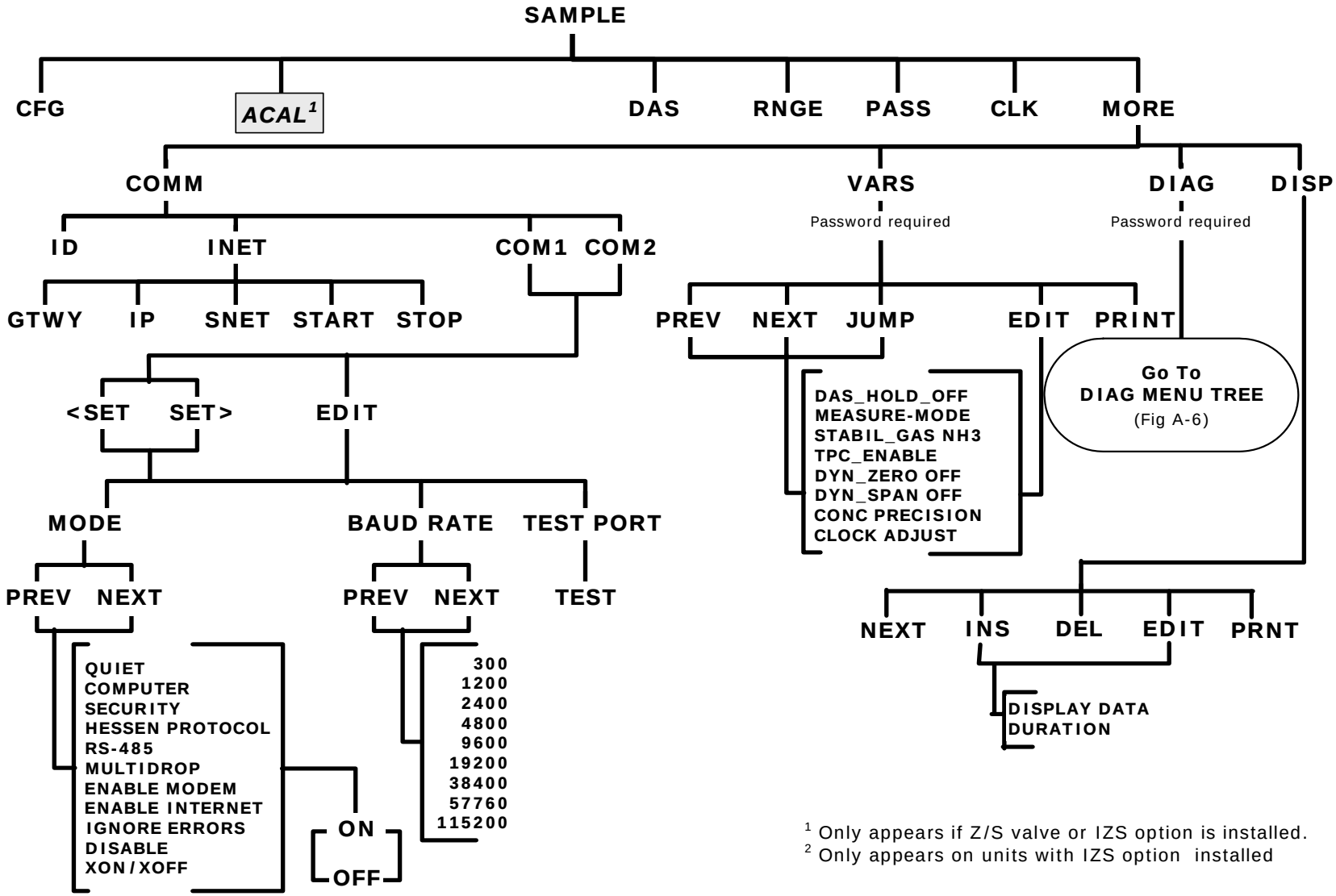
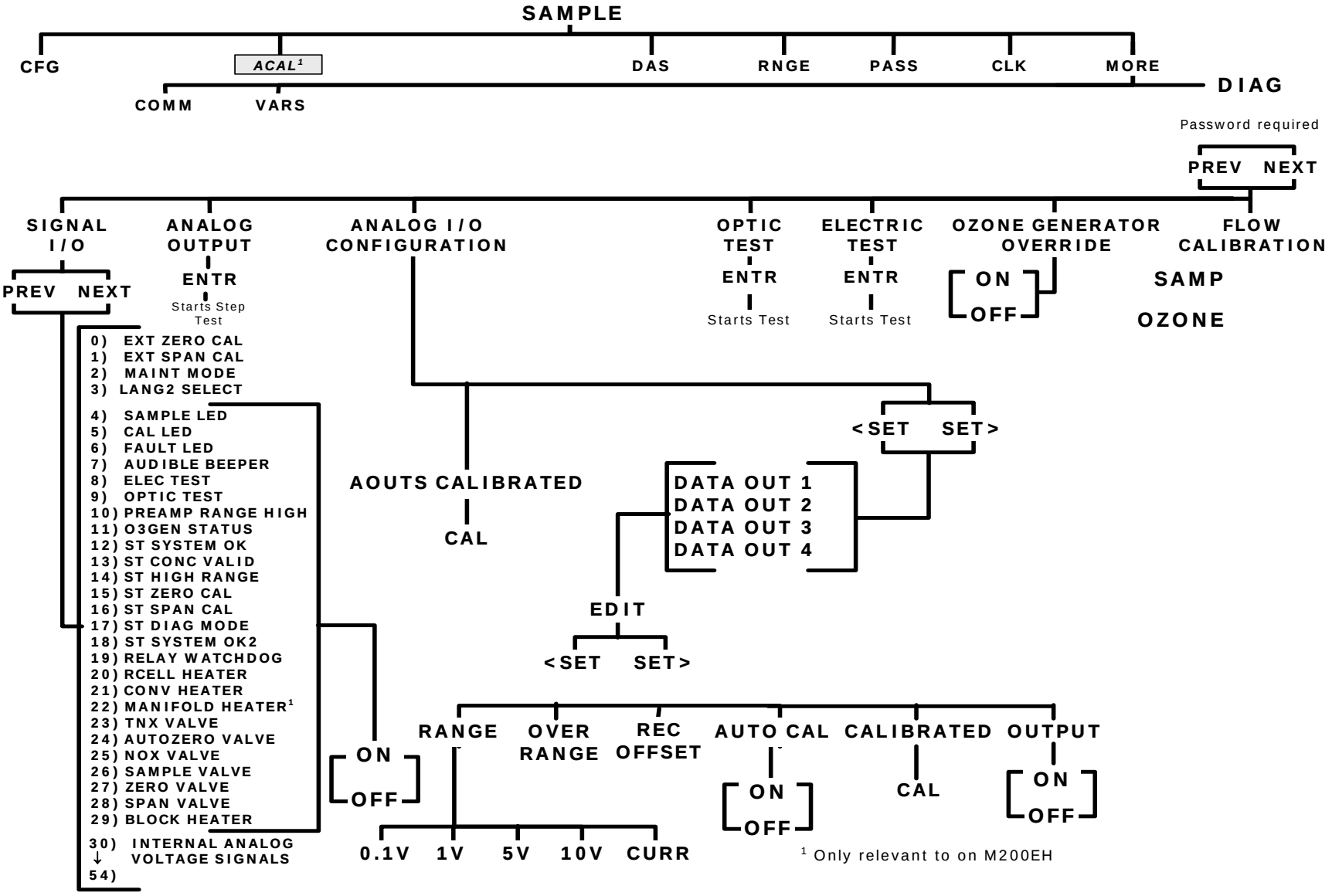


Figure A-5: Secondary Setup Menu (COMM & VARS)



4. CALIBRATION PROCEDURE

Ammonia Calibrations

Ammonia is a difficult gas to measure due to its chemical characteristics. Because of its large dipole moment, the gas tends to adsorb on surfaces and diffuse into many materials. The following precautions should be observed when designing an ammonia sampling system and connecting the M201E analyzer to the system:
Materials:

Do NOT use copper tubing or fittings designed for household plumbing.
Use ONLY Chromatography grade (cleaned, passivated) stainless steel tubing.
Use ONLY Glass tubing for sample inlet manifold.

These rules apply also to your calibrator's internal plumbing. It is highly recommended that you use a M702SS calibrator in conjunction with the M201E. The calibrator has stainless steel plumbing throughout. A standard 700E series calibrator is plumbed using Teflon™ tubing, also the gas mixing is conducted using mass flow controllers, whereas the gas mixing in the M702SS is conducted using critical orifices. Therefore NH_3 response times are slower using the standard 700E series calibrator.
Typical ambient NH_3 levels are < 15 ppb, unless there is some large source of ammonia nearby, so the sampling and analysis system must be carefully designed and well maintained.

Calibration Procedure

Calibration of the M201E is done by first calibrating the NO/NOx and TN_x channels with NO span gas diluted with zero air. The slopes for TN_x, NO_x & NO channels should be very similar following an NO span; large differences could be indications of a potential leak on either channel. Allow the NO_x stability to drop below 1 ppb before pressing the 'SPAN' button. Example with 450 ppb NO calibration:

$(NO)TN_xSlp = 1.0$ $(NO)NO_xSlp = 0.99$ $NOSlp = 0.98$

The TN_x slope is always larger than the NO_x & NO slope for NO & NH_3.

In the second phase of calibration, ammonia span gas is introduced so as to calculate the slope for NH_3 on the TN_x channel. The operator is responsible for calculating the total NO_x (TN_x) at the time of calibration. This value is then entered for TN_x. The process involves knowing the concentration of NH_3 being delivered and adding the NO_x offset value.

Example: 450 ppb of NH_3 being delivered, TNx stability is less then 1.0 and the NO_x channel measures 5 ppb. The operator would then enter 455 ppb for TN_x under the 'CONC' menu. This will calibrate the NH_3 channel to measure 450 ppb NH_3, remember ($NH_3 = TN_X - NO_x$). DO NOT CALIBRATE THE NO_X CHANNEL DURING THIS STEP.

$(NH_3)TN_xSlp = 1.05$ $(NH_3)NO_xSlp = 0.99$ $(NH_3)Slp = 0.98$

The efficiency of the M501 converter is calculated as follows:

M501 efficiency for NH_3 conversion = $(1 - [(NH_3)TN_xSlp - (NO)TN_xSlp]) * 100$
$(1 - [1.05 - 1.0]) * 100 = 95\%$

The procedure for calculating & inputting the NH_3 slope is different than the 201A. In the 201A the operator had to calculate the efficiency of the overall system for NH_3. This value was then entered into

'CONV' location. The M201E automatically calculates the required slope once the 'SPAN' selection is made on the TN_x channel.

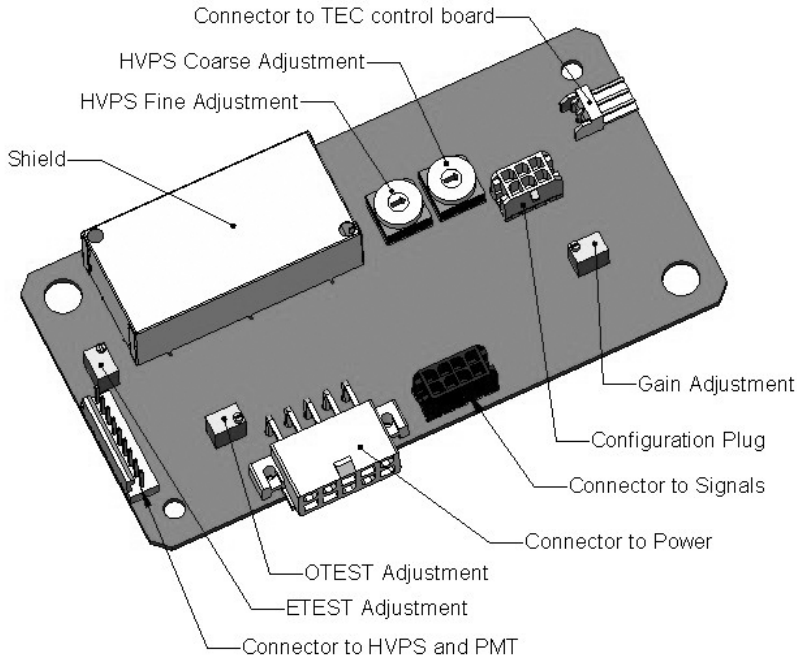
Note:
The molybdenum converter requires oxygen to be present during calibration; therefore some dilute air must be present. The procedure for calibrating the molybdenum converter is outlined in sections 7.1.7 & 7.2 of the 201E operator's manual. It is recommended that the molybdenum & M501 be calibrated at the same time.

If the instrument is configured as a basic model, all zero/span gasses are introduced through the sample port. If the Zero/Span valve option or the ECO option is ordered, the zero/span gas is introduced through the zero/span valves. There are several ways of automating the calibration or span check process; they are covered in Section 7 of the M201E manual.

FACTORY CALIBRATION FOR A M201E

The sensor module hardware calibration adjusts the slope of the PMT output when the Instruments slope and offset values are outside of the acceptable range and all other more obvious causes for this problem have been eliminated.

- Set the instrument reporting range to **SNGL.**
- Perform a full zero calibration using zero air.
- Let the instrument run for one hour to stabilize the lamp and run a lamp calibration from the diagnostic menu. This is required to ensure proper scaling of the **NORM PMT** value.
- Locate the Preamp board.
- Locate the Following Components On the Preamp board
    - HVPS coarse adjustment switch (Range 0-9, then A-F)
    - HVPS fine adjustment switch (Range 0-9, then A-F)
    - Gain adjustment potentiometer (Full scale is 12 turns)



Pre-Amplifier Board Layout

- Turn the gain adjustment potentiometer, R29, 12 turns clockwise to its maximum setting.
- Turn R29, the Gain Adjustment pot, 5 turns counter-clockwise to put it near the center of the potentiometer.

- While feeding span gas to the analyzer and waiting until the STABIL value is below 1.0 ppb, look at the front panel and scroll to the NORM PMT value. This value is what you are going to adjust to get a slope of 1.000. There are two different equations for calculating your TARGET NORM PMT value. If you are on a range 2000 and below you will want to use the first equation, with a range 2000.1 and above you will use the second equation.

  CONC=Span Gas in PPB
  OFFSET=Offset reading from the front panel TST values

  Ranges 2000.0 and below
  TARGET NORM PMT= 2*CONC
  Ranges 2000.1 and above
  TARGET NORM PMT= 0.2*CONC

Set the HVPS coarse adjustment switch to the lowest setting that will give you more then the calculated TARGET NORM PMT voltage.

- Adjust the HVPS fine adjustment such that the NORM PMT value is as close to the TARGET NORM PMT value. It may be necessary to go back and forth between coarse and fine adjustments if the proper value is at the threshold of the min/max coarse setting.

NOTE

Do not overload the PMT by accidentally setting both adjustment switches to their maximum setting. This can cause permanent damage to the PMT.

- Adjust the NORM PMT value with the gain potentiometer down to the TARGET NORM PMT value. This is the final very-fine adjustment.

- Perform software span and zero calibrations to normalize the sensor response to its new PMT sensitivity.

- Review the slope and offset values, the slopes should be 1.000±0.100 and the offset values should be -20 to +150 m

Service Note

9480 Carroll Park Dr., San Diego, CA 92121-2251
Phone (858) 657-9800 Fax: (858) 657-9818 Toll Free 1800 324-5190
E-mail: api-customerservice@teledyne.com http://www.teledyne-api.com

03-020A

9 SEPTEMBER, 2003

HOW TO PERFORM A MANUAL DAC CALIBRATION ON "E" SERIES MACHINES

I. PURPOSE:

The purpose of this service note is to give instructions on how to perform a manual Digital to Analog Calibration (D/A Calibration) on "E" series analyzers.

II. TOOLS:

Digital Voltmeter

III. PARTS:

None

IV. PROCEDURE:

Please follow the appropriate procedure below for either VOLTAGE or CURRENT output.

VOLTAGE OUTPUT

1. From the main menu press SETUP-MORE-DIAG-ENTR-NEXT until ANALOG I/O CONFIGURATION press ENTR.
2. Press SET> 5 times.
3. The top line should read A/IN CALIBRATED: YES
4. Press CAL to calibrate the analog inputs.
5. Press <SET 4 times.
6. The top line should read CONC_OUT_1: RANGE 5V
   a. If this is the output voltage you desire then go to step 7
   b. If this voltage is incorrect press EDIT and change to the output voltage desired, press ENTR and go to step 7.
7. Press EDIT, Press SET>. The top line should read CONC_OUT_1: REC OFFSET: 0mv
   a. If you don't want a recorder offset go to step 8.
   b. If you want a recorder offset press EDIT. Enter the OFFSET value and press ENTR. Go to step 8.
8. Press SET>. The top line should read CONC_OUT_1: AUTO CAL: ON
   a. If this says AUTO CAL ON press EDIT and turn it OFF.
   b. If this says AUTO CALL OFF go to step 9.
9. Press SET>. The top line should read CONC_OUT_1: CALIBRATED: YES
10. Now place your meter on pins 1 and 2 on the rear panel analog output connector and set your meter to read mvDC.

11. Press CAL on the front panel.
12. You should have some DN and UP buttons. And the top line should be say ZERO ADJUST or something similar.
13. The output on the meter should be as close as possible to 0mV ±0.3mV.
    a. If it is not then press DN or UP until the meter reads as close as possible to 0mv
    b. If it does go to step 14
14. Press ENTR.
15. The top line should now say GAIN ADJUST and you should have DN and UP buttons again. The meter should now read 90% of your full-scale voltage (i.e. 1V, 5V, 10V) you will have to change the range on the meter to read Volts instead of Mili-volts. If you are on the 10V scale you will be adjusting to 4.5Vs instead of 90% of full scale.
16. Press the DN and UP buttons until the output on the meter reads 90% of your full-scale voltage ±1mV.
17. Press ENTR
18. That channel is now calibrated.
19. Do this for all channels and ensure that you move the meter on the output connector to the proper pins.

CURRENT OUTPUT

1. From the main menu press SETUP-MORE-DIAG-ENTR-NEXT until ANALOG I/O CONFIGURATION press ENTR.
2. Press SET> 5 times.
3. The top line should read A/IN CALIBRATED: YES
4. Press CAL to calibrate the analog inputs.
5. Press <SET 4 times.
6. The top line should read CONC_OUT_1: CURRENT
    a. If you desire Current output then go to step 7
    b. If you do not desire Current output press EDIT and change to the output voltage desired, press ENTR and follow the steps in the Voltage Output procedure.
7. Press EDIT, Press SET>. The top line should read CONC_OUT_1: AUTO CAL: ON
    a. If this says AUTO CAL ON press EDIT and turn it OFF.
    b. If this says AUTO CALL OFF go to step 8.
8. Press SET>. The top line should read CONC_OUT_1: CALIBRATED: YES
9. Now place your meter on pins 1 and 2 on the rear panel analog output connector and set your meter to read mA.
10. Press CAL on the front panel.
11. You should have some DN and UP buttons. And the top line should be say ZERO ADJUST or something similar.
12. The output on the meter should be as close as possible to 0ma ±0.01ma (if 0-20ma output), 4ma ±0.01ma (if 4-20ma output).
    a. If not then press DN or UP until the meter reads as close as possible to 0ma or 4ma.
    b. If it does go to step 13
13. Press ENTR.
14. The top line should now say GAIN ADJUST and you should have DN and UP buttons again. The meter should now read your full-scale current output 20ma.
15. If it doesn't press the DN and UP buttons until the output on the meter reads your full-scale current output of 20ma ±0.01ma.
16. Press ENTR

17. That channel is now calibrated.
18. Do this for all remaining channels that contain the Current option and ensure that you move the meter on the output connector to the proper pins for that channel.

Pressure Calibration

To calibrate the pressure in the analyzer the first thing you will want to do is disconnect the pump. You can either do this pneumatically or electrically. Also disconnect any tubing connected to the sample inlet port on the back of the analyzer. This will put the analyzer at atmospheric, ambient, pressure.

Next, find out the current atmospheric pressure. This can be found from a barometer or contacting your local airport or weather station.

From the front panel of the analyzer press <SETUP><MORE><DIAG> and enter 929 for the password when ever it asks for it. Once in the DIAG menu, press next until you get to Pressure Calibration and hit ENTER. Now enter the current atmospheric pressure and press ENTER.

Exit back out to the main menu and scroll over to sample pressure and Rcell pressure. These should be equal to the atmospheric pressure now. Reconnect the pump and the pressure should drop about an inch and the Rcell pressure should drop below 10"Hg. Reconnect the sample inlet and the pressure should remain the same +- 0.2"Hg. If the pressure changes more than this when you reconnect the sample line, you will have to troubleshoot the system as the analyzer is being pressurized or being put under a vacuum.

Flow Calibration

With the analyzer on and the pump connected and running, connect an external flow meter to the sample inlet port on the back of the analyzer. Record the flow rate. This should be approximately 900cc-1000cc/min. Next disconnect the $1/8^{th}$ sample line going to the top of the reaction cell and measure the flow going into the cell. This should be approximately 500cc/min, record this value and reconnect the sample line to the reaction cell. Then disconnect the $1/8^{th}$" ozone line going into the top of the reaction cell. This is the tubing going into the fitting marked .004. Measure the flow rate going into the fitting. It should be around 80cc, and record this reading. Then from the front panel hit <SETUP><MORE><DIAG> enter 929 for the password when it asks you for it.

Once in the DIAG menu press Next until you get Flow Calibration and hit <ENTER><SAMP>. Now enter the value you measured with the external flow meter on the sample fitting of the reaction cell and hit Enter. Next, do the same thing for the Ozone flow. This will calibrate the flow meters in the analyzer. Exit back out to the main menu and scroll through the TST values till you get Sample Flow and Ozone Flow. They should be reading close to the measured value.

5. MAINTENANCE

INSTRUMENT MAINTENANCE

Predictive diagnostic functions including data acquisition, failure warnings and alarms built into the analyzer allow the user to determine when repairs are necessary without performing unnecessary, preventative maintenance procedures. There is, however, a minimal number of simple procedures that, when performed regularly, will ensure that the analyzer continues to operate accurately and reliably over its lifetime.

NOTE

A span and zero calibration check must be performed following some of the maintenance procedures listed below. Refer to Chapter 6.

CAUTION

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

NOTE

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

MAINTENANCE SCHEDULE

The table below is the recommended maintenance schedule for the M201E. Please note that in certain environments with high levels of dust, humidity or pollutant levels some maintenance procedures may need to be performed more often than shown.

M201E Preventive Maintenance Schedule

Item	Action	Priority	Frequency	Cal Check?	Date Performed								
Particulate filter	Change particle filter	Mandatory	Weekly	No									
Zero/span calibration	Calibration	Mandatory	Every 3 months	Yes									
NH_3 converter	Check conversion efficiency	Mandatory	Every 3 months	No									
NO_2 converter	Check conversion efficiency	Mandatory	Every 3 months	No									
External zero air scrubber	Exchange chemical	Mandatory	Every 3 months	No									
NH_3 Catalyst	Replace	Mandatory	Annually	Yes									
Ozone filter	Change chemical	Mandatory	Annually	Yes									
Reaction cell window	Clean	Mandatory	Annually or as necessary	Yes									
DFU filter	Change particle filter	Mandatory	Annually	No									
Orifice O-rings and sintered filters	Replace	Mandatory	Annually	Yes									
Pump	Rebuild head	Mandatory	Annually or as necessary	Yes									
TEST functions	Review and evaluate	Recommend	Weekly	No									
Pneumatic sub-system	Check for leaks in gas flow paths	As Needed	Annually or after pneumatics repairs	Yes on leaks, else no									
PMT Sensor Hardware Calibration	Low-level hardware calibration	As Needed	If slope is outside of 1.0±0.3	Yes									
NH_3 converter	Replace converter tube	As Needed	If efficiency is <96%	Yes									
NO_2 converter	Replace converter	As Needed	If efficiency is <96%	Yes									

6. TROUBLESHOOTING & FAULTS

Predictive Diagnostics

The analyzer's test functions can be used to predict failures by looking at trends in their values. Table below 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. APICOM control software can be used to download and review these data even from remote locations.

Predictive Uses for Test Functions

Function	Expected	Actual	Interpretation
RCEL pressure	Constant to within ± 0.5	Fluctuating	Developing leak in pneumatic system
		Slowly Increasing	Pump performance is degrading. Replace pump head when pressure reaches 10 in-Hg-A
SAMPLE pressure	Constant within atmospheric changes	Fluctuating	Developing leak in pneumatic system
		Slowly increasing	Flow path is clogging up. Replace orifice filters
		Slowly decreasing	Developing leak in pneumatic system to vacuum (developing valve failure)
Ozone Flow	Constant to within ± 15	Slowly decreasing	Flow path is clogging up. Replace orifice filters
AZERO	Constant within ±20 of check-out value	Significantly increasing	Developing AZERO valve failure
			PMT cooler failure
			Dirty RxCell window
NO_2 CONC	Constant for constant concentrations	Slowly decreasing signal for same concentration	Conversion efficiency of converter may be degrading. Replace converter
NO CONC	Constant for constant concentration	Decreasing over time	Drift of instrument response; clean RCEL window
NH_3 CONC	Constant for constant concentration	Decreasing over time	Conversion efficiency of the converter may be degrading. Replace tube and catalyst

Non-Linear Response

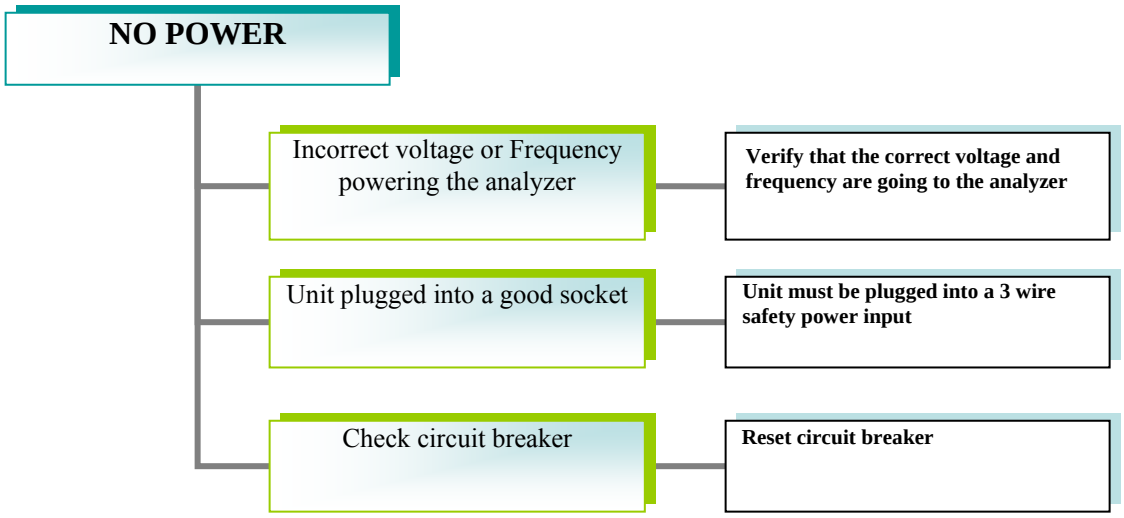
The M201E was factory calibrated to a high level of NO and should be linear to within 1% of full scale. Common causes for non-linearity are:

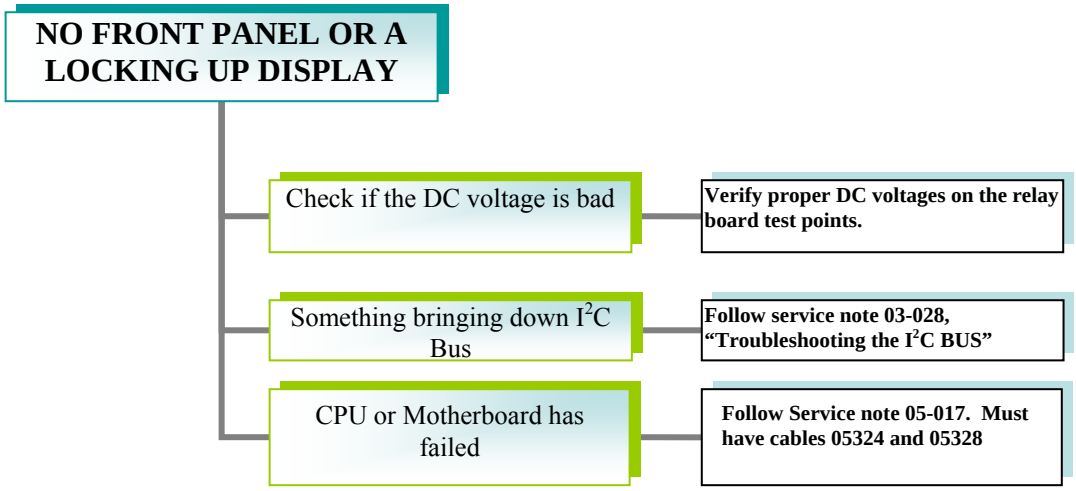
- Leaks in the pneumatic system. Leaks can add a constant of ambient air, zero air or span gas to the current sample gas stream, which may be changing in concentrations as the linearity test is performed. Check for leaks as described in the Operator's Manual.
- The calibration device is in error. Check flow rates and concentrations, particularly when using low concentrations. If a mass flow calibrator is used and the flow is less than 10% of the full scale flow on either flow controller, you may need to purchase lower concentration standards.
- The standard gases may be mislabeled as to type or concentration. Labeled concentrations may be outside the certified tolerance.
- The sample delivery system may be contaminated. Check for dirt in the sample lines or reaction cell.
- Calibration gas source may be contaminated (NO_2 in NO gas is common).
- Dilution air contains sample or span gas.
- Ozone concentration too low because of wet air in the generator. Generator system needs to be cleaned and dried with dry supply air. Check the Perma Pure dryer for leaks. This mostly affects linearity at the low end.
- Ozone stream may be contaminated with impurities. An exhausted ozone filter chemical will let compounds such as HNO_3 and ammonia derivatives break through to the reaction cell. Check the contents of the ozone filter cartridge and replace as necessary. This also will affect linearity mostly at the low level.
- Sample inlet may be contaminated with NO_X exhaust from this or other analyzers. Verify proper venting of the pump exhaust.
- Span gas overflow is not properly vented and creates a back-pressure on the sample inlet port. Also, if the span gas is not vented at all and does not supply enough sample gas, the analyzer may be evacuating the sample line. Make sure to create and properly vent excess span gas.
- Diffusion of oxygen into Teflon-type tubing can happen over long distances. PTFE, or related materials, can cat as permeation devices. In fact, the permeable membrane of NH_3 permeation tubes is made of PTFE. When using very long supply lines (>1m) between high concentration span gases and the dilution system, oxygen from ambient air can diffuse into the line and react with the NO to form NO_2. This reaction is dependent on the NO concentration and accelerates the increasing NO concentration, hence, affects linearity only at high NO levels. Using stainless steel for long span gas supply lines to avoid this problem.

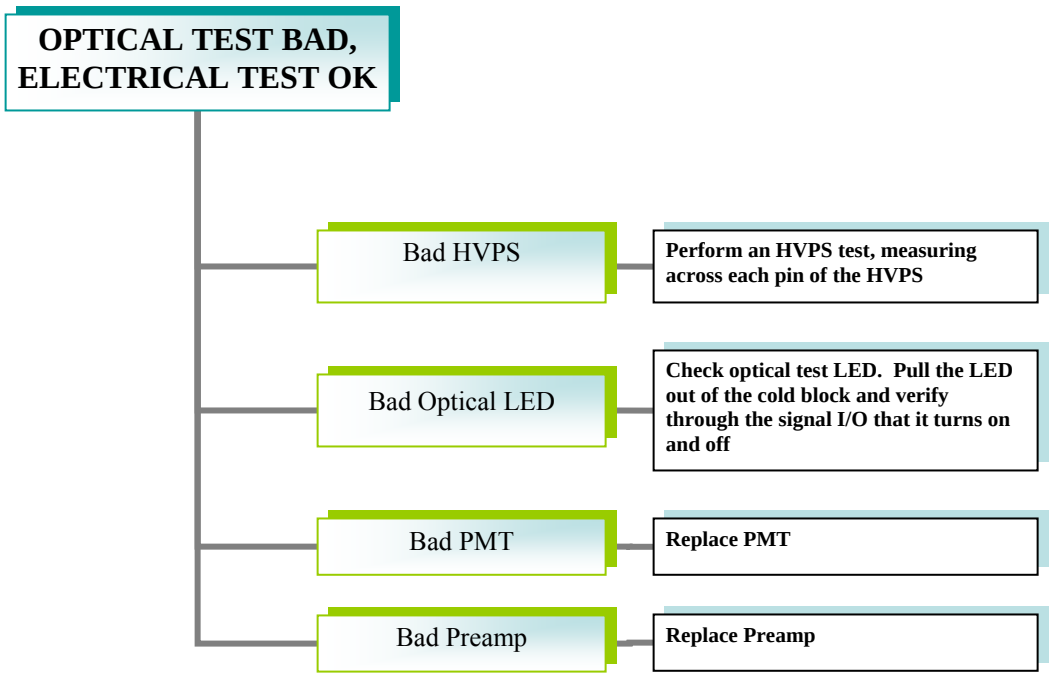
M201E Troubleshooting Tree

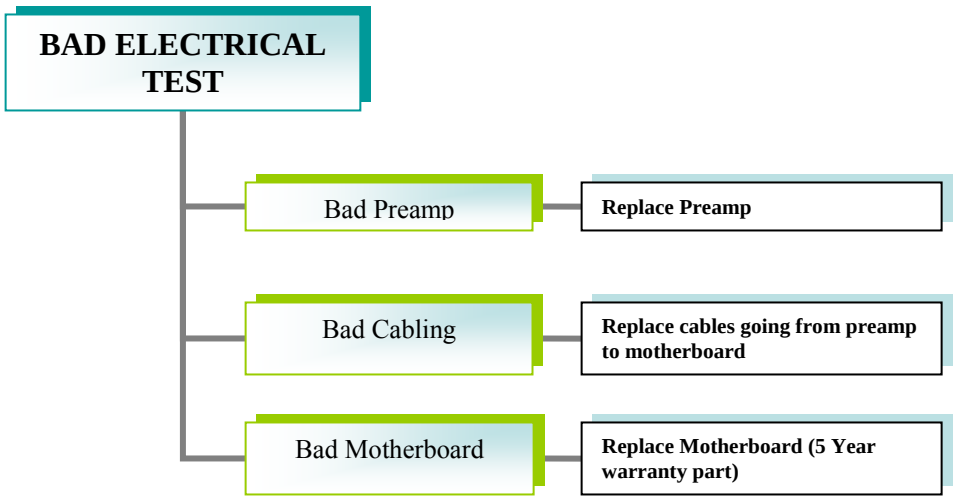
Troubleshooting Trees

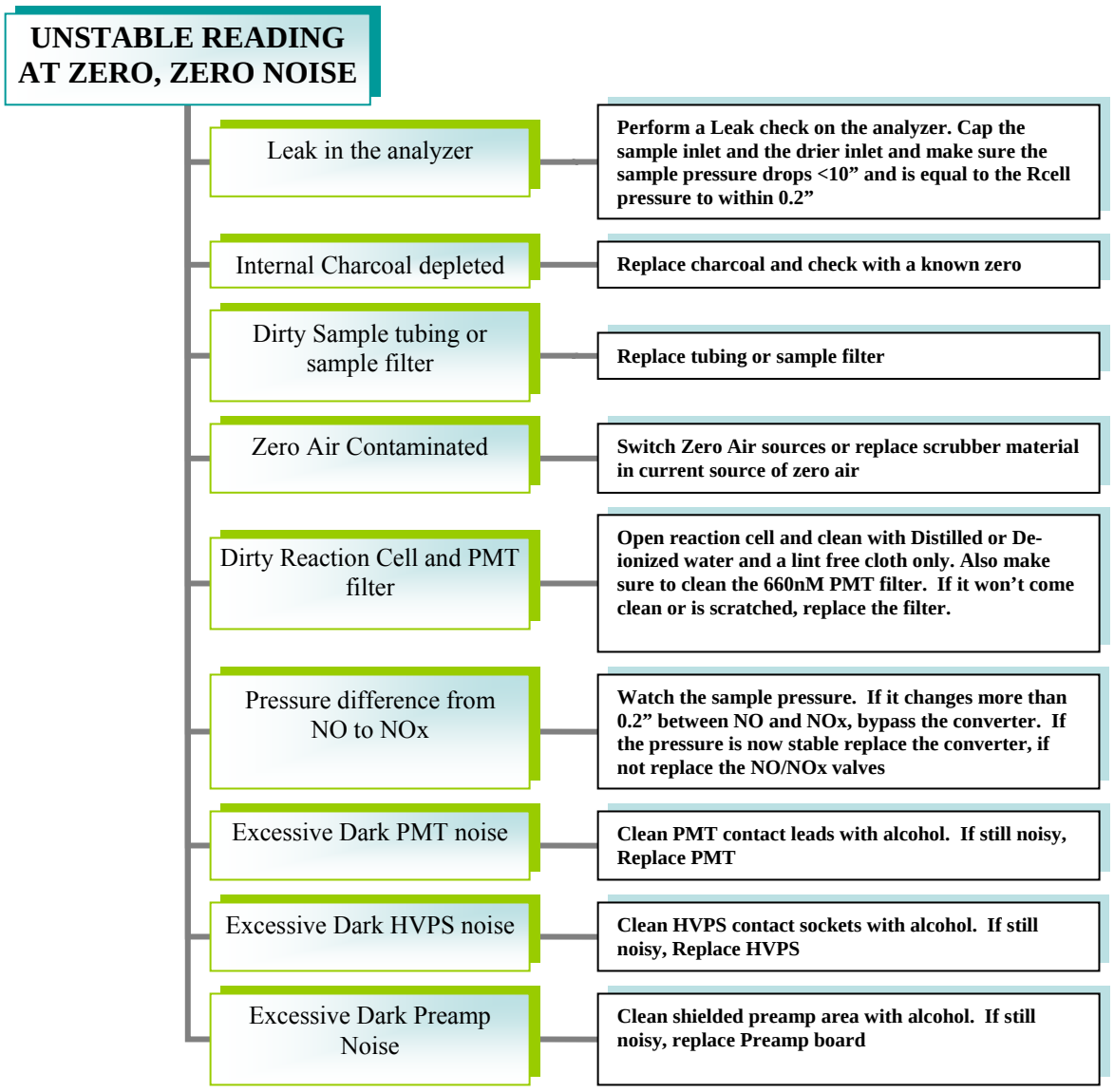
No Power
No front panel or locking up Display
Optical Test bad, Electrical Test OK
Bad Electrical Test
Unstable Reading at Zero, Zero noise
Unstable Reading at Span, Span noise
Unable to Zero (No Zero Button)
Unable to Span (No Span button or no response to Span gas)
Non-Linear Response
Slow Response to Zero or Span
HVPS warning, after factory calibration
Auto-Zero Warning
No Flow
No analog or incorrect analog output
Any Temperature Warning

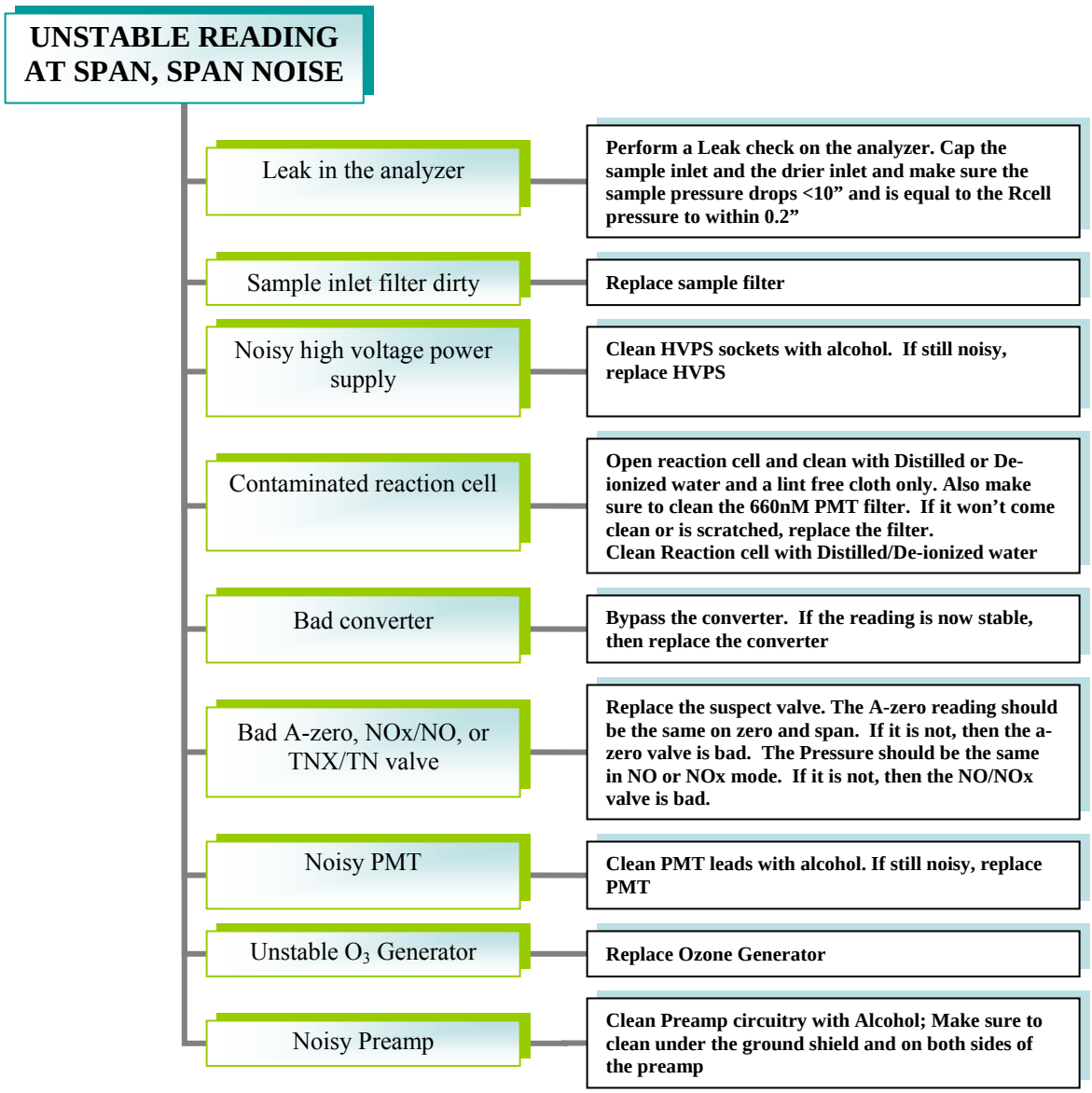


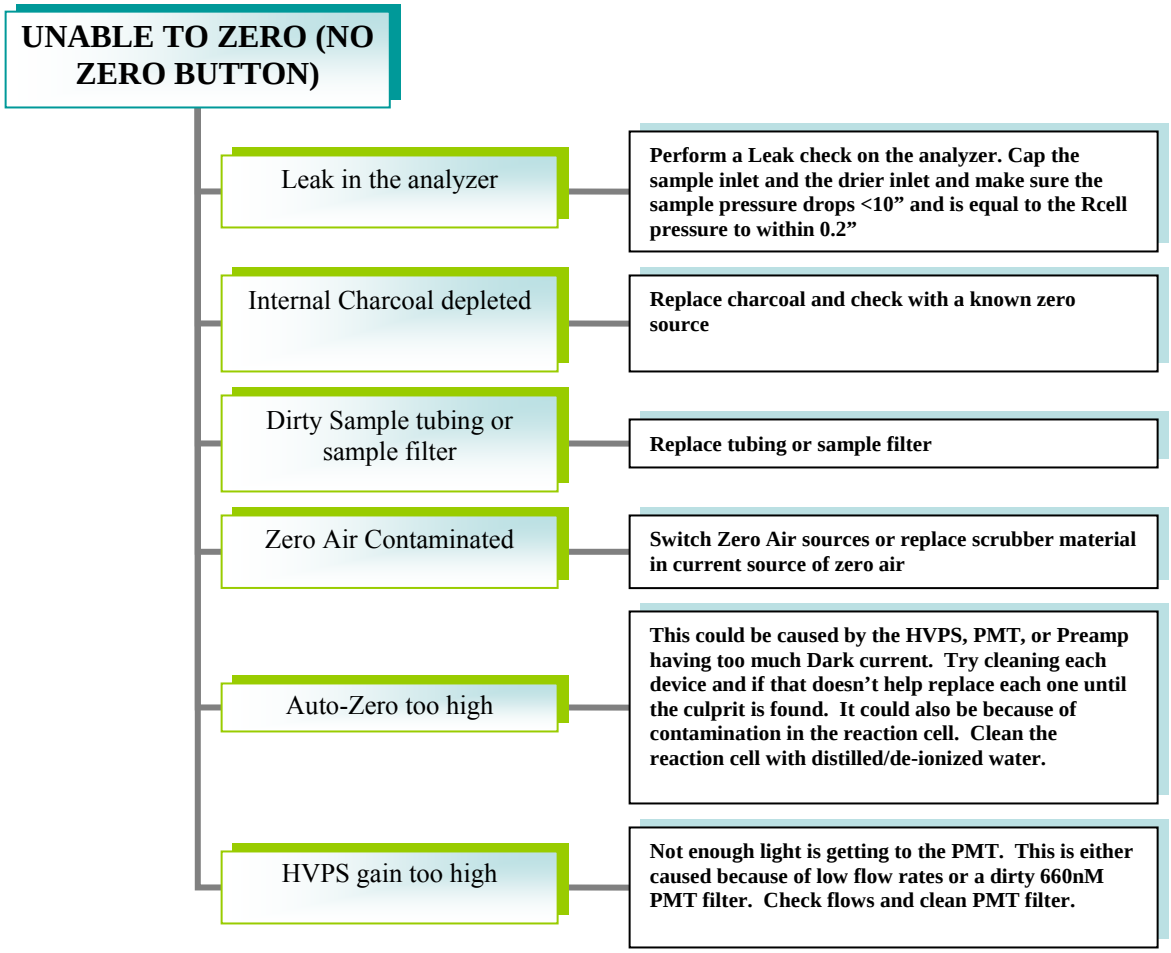


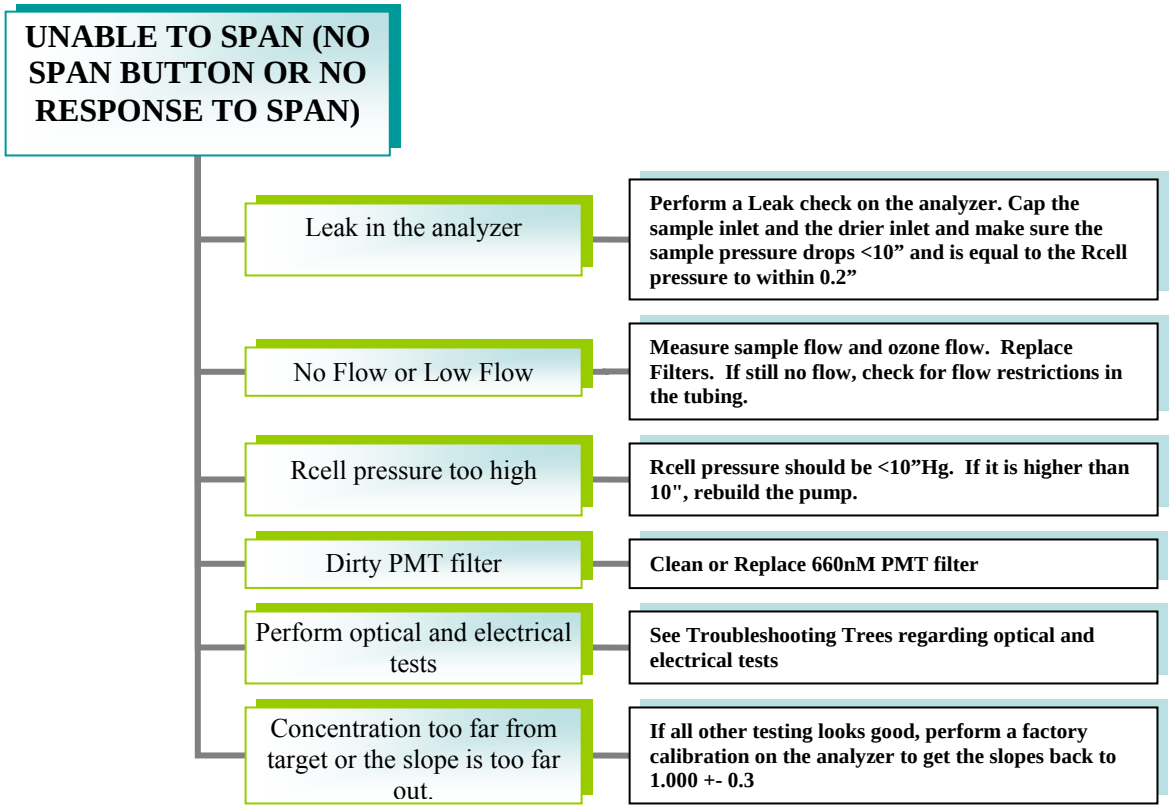


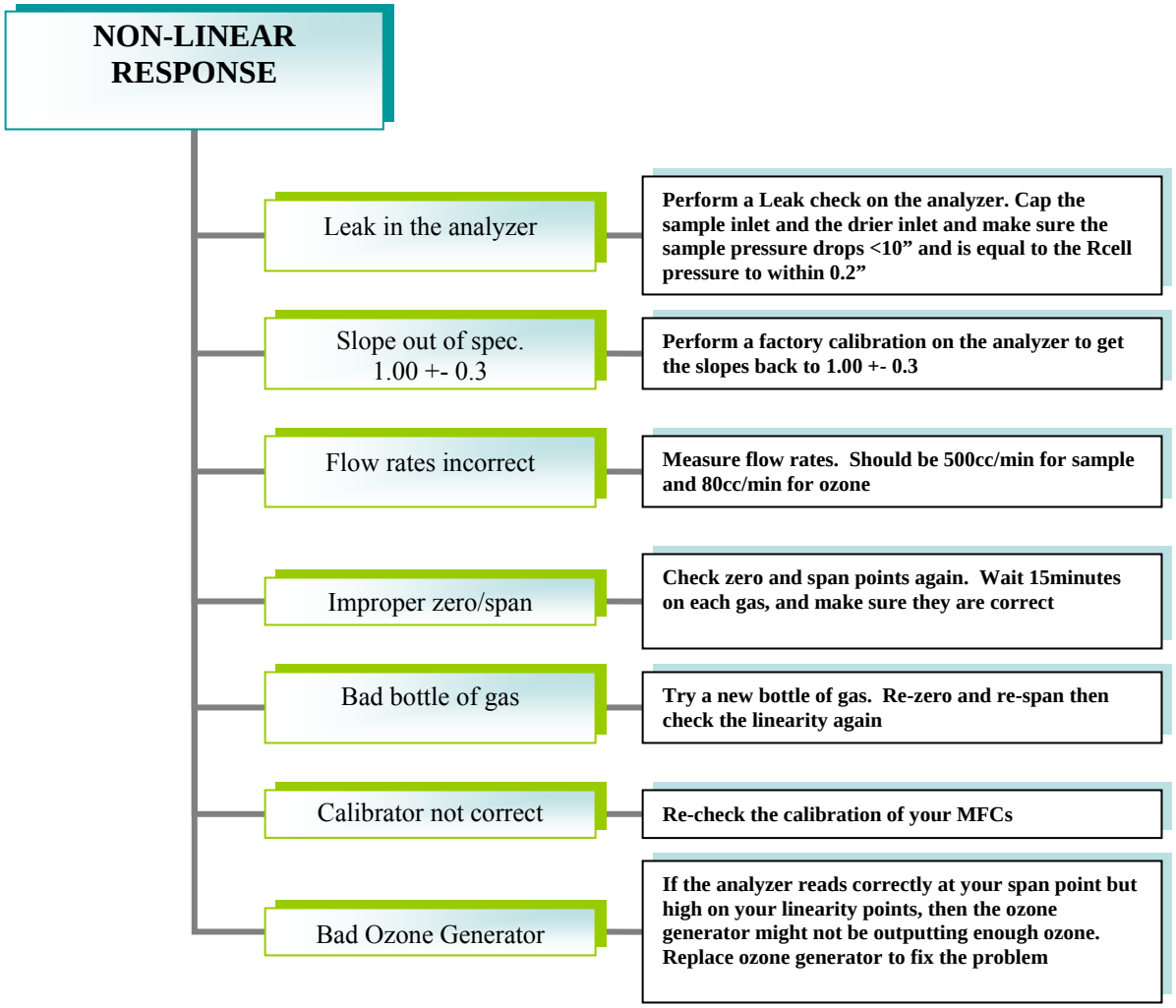


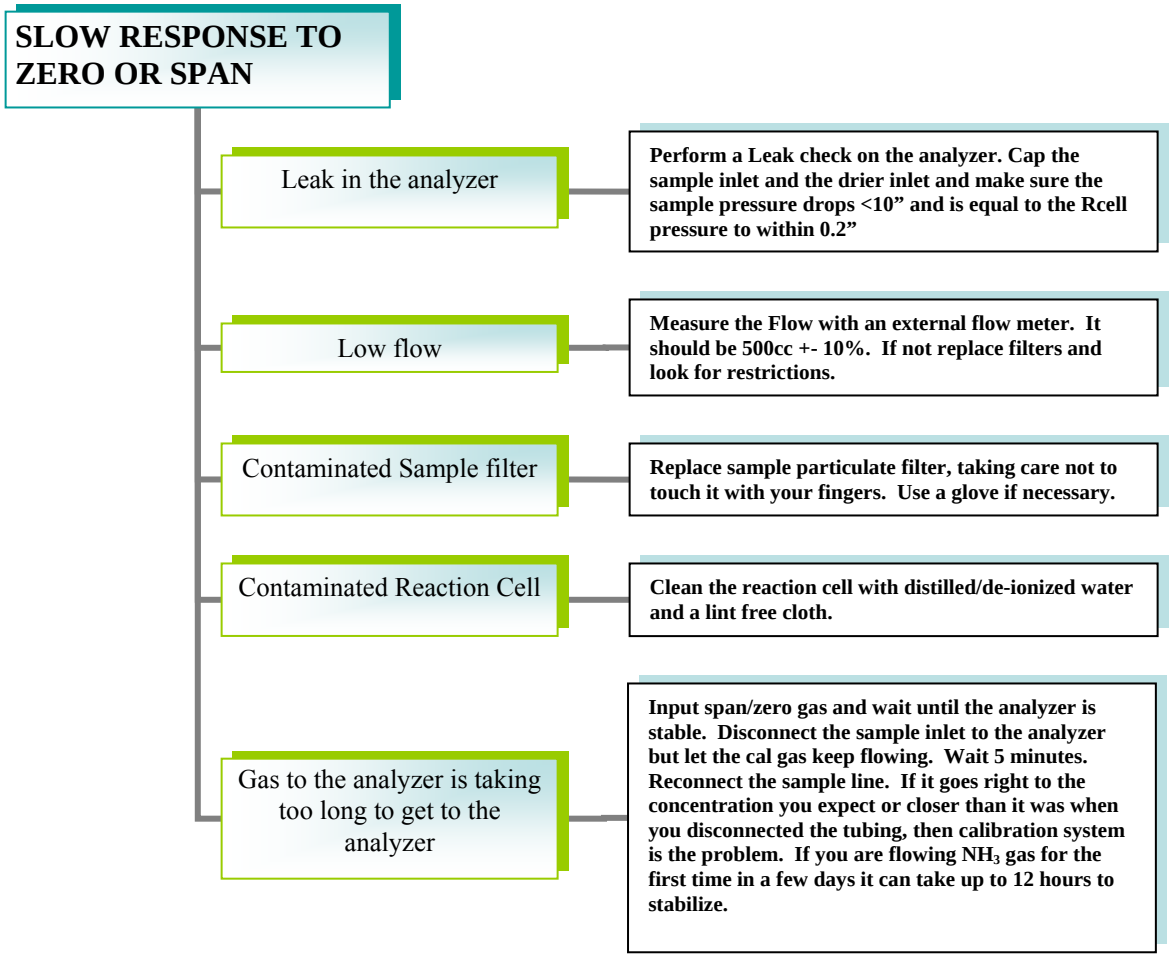


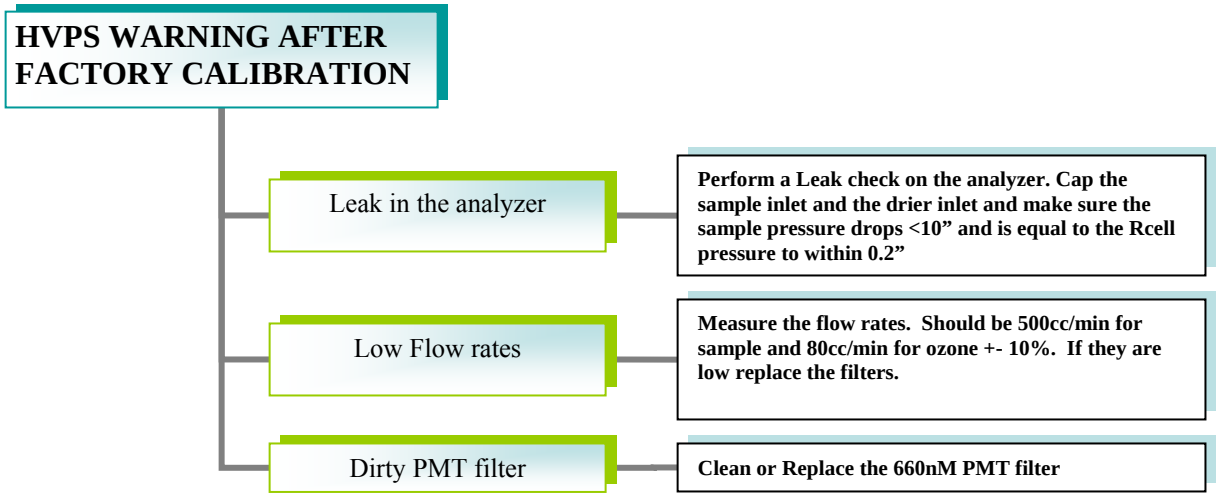


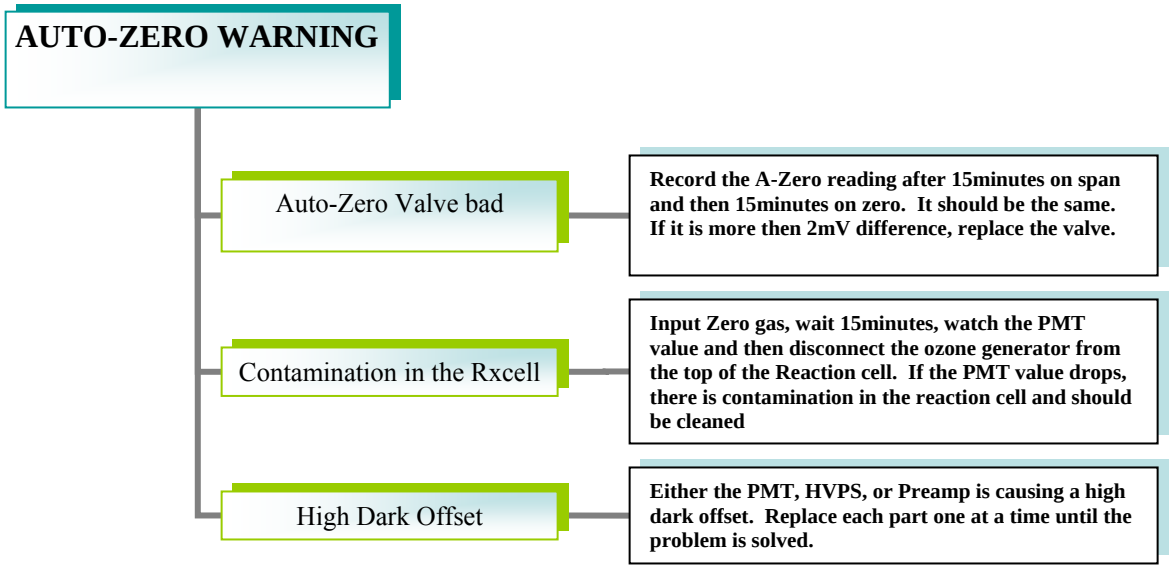


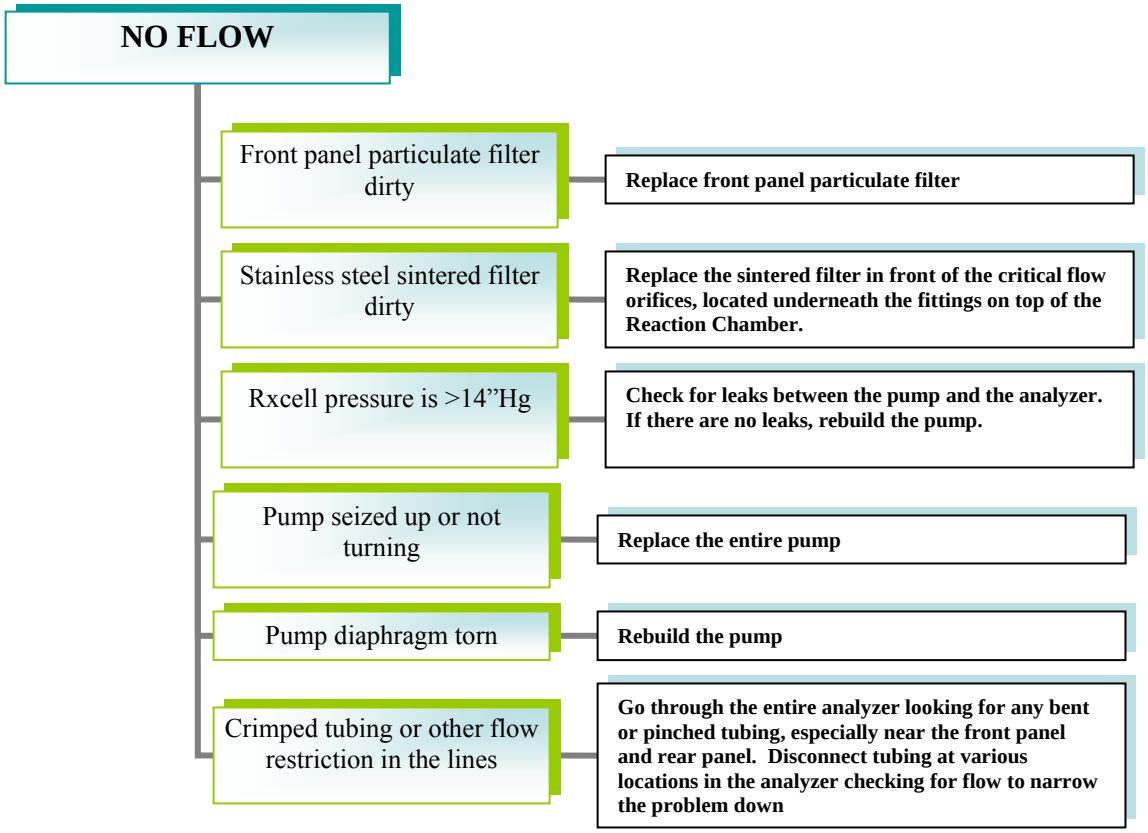


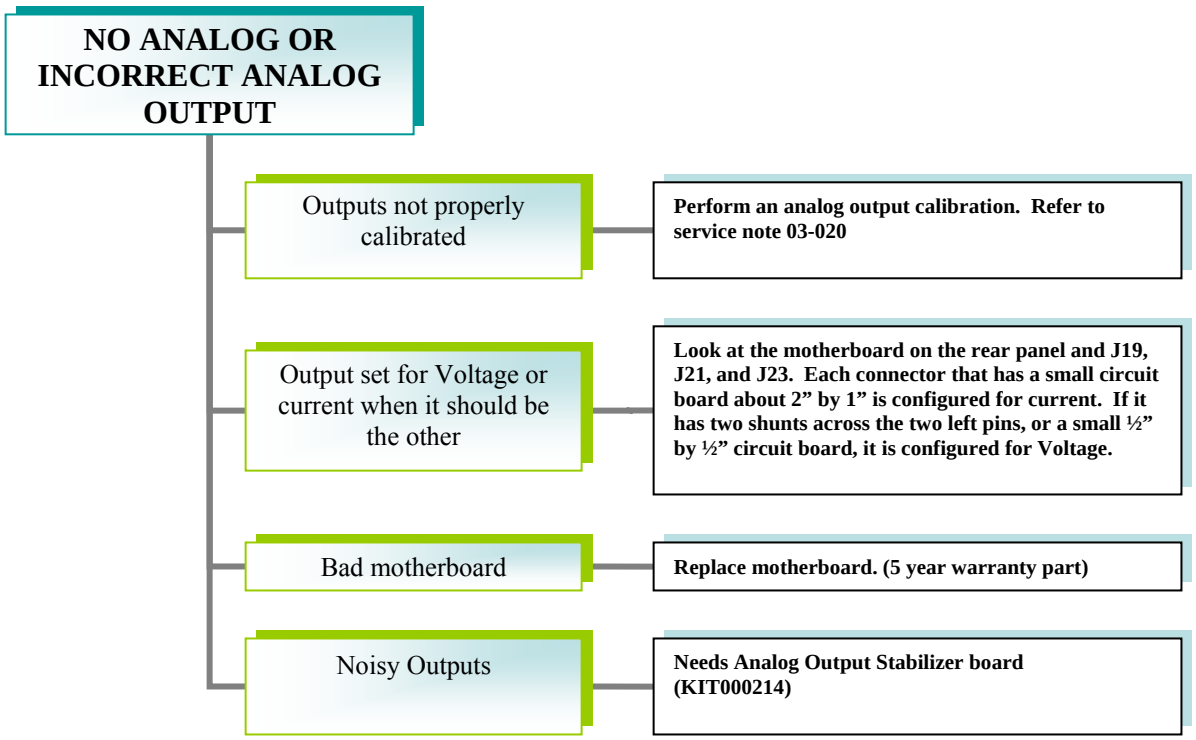


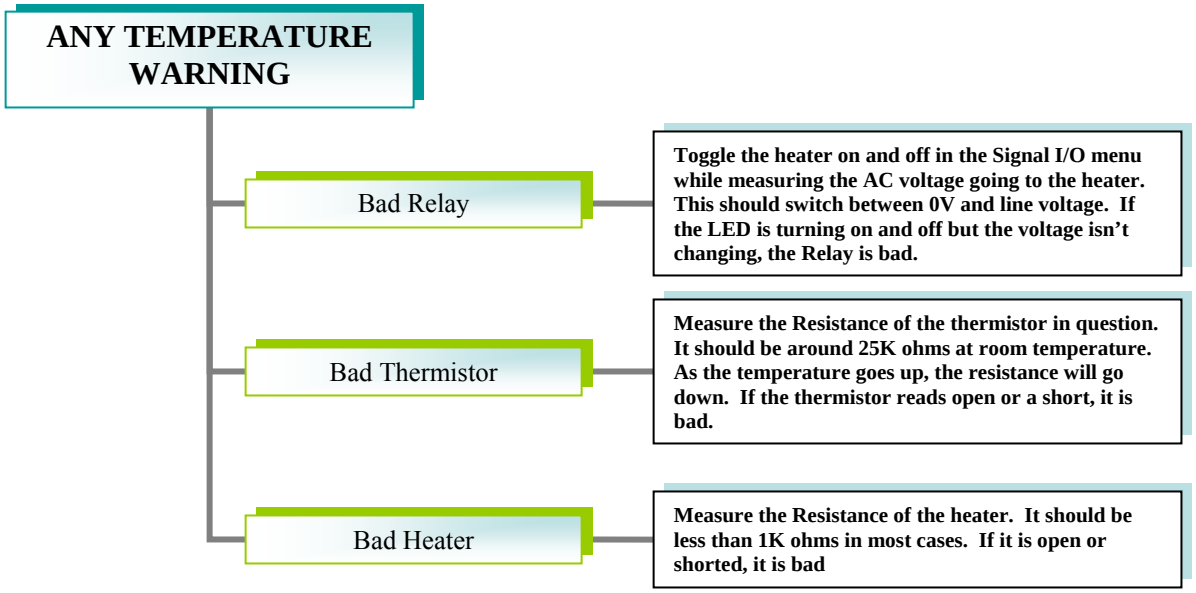












Model 201E Instruction Manual

Warranty/Repair Questionnaire MODEL 201E

TELEDYNE INSTRUMENTS
Advanced Pollution Instrumentation
A Teledyne Technologies Company

CUSTOMER: _____ PHONE: _____

CONTACT NAME: _____ FAX NO. _____

SITE ADDRESS: _____

MODEL 201E SERIAL NO.: _____ FIRMWARE REVISION: _____

1. ARE THERE ANY FAILURE MESSAGES?

_____

_____

_____

_____

PLEASE COMPLETE THE FOLLOWING TABLE: **(NOTE: *DEPENDING ON OPTIONS INSTALLED, NOT ALL TEST PARAMETERS SHOWN BELOW WILL BE AVAILABLE IN YOUR INSTRUMENT*)**

PARAMETER	RECORDED VALUE	ACCEPTABLE VALUE
RANGE	PPB/PPM	50 PPB TO 2,000 PPB
NH_3 STAB	PPB/PPM	≤ 1 PPB WITH ZERO AIR
SAMPLE FLOW	cm^3	500 ± 50
OZONE FLOW	cm^3	80 ± 15
PMT SIGNAL WITH ZERO AIR	mV	-20 TO 150
PMT SIGNAL AT SPAN GAS CONC	mV PPB	0-5,000MV 0-20,000 PPB
NORM PMT SIGNAL AT SPAN GAS CONC	mV PPB	0-5,000MV 0-20,000PPB
AZERO	mV	-20 TO 150
HVPS	V	400 – 900
RCELL TEMP	ºC	50 ± 1
BOX TEMP	ºC	AMBIENT ± 5ºC
PMT TEMP	ºC	7 ± 2ºC
BLOCK TEMP	ºC	50 ± 1
MOLY TEMP	ºC	315 ± 5ºC
RCEL PRESS	IN-HG-A	<10
SAMP PRESS	IN-HG-A	3 to 5 < ”AMBIENT ABSOLUTE
TNx SLOPE		1.0 ± 0.3

TNx OFFSET	mV	-50 TO 150
NOx SLOPE		1.0 ± 0.3
NOx OFFSET	mV	-50 TO 150
NO SLOPE		1.0 ± 0.3
NO OFFSET	mV	-50 TO 150
ETEST	PMT mV	2,000 ± 1,000
OTEST	PMT mV	2,000 ± 1,000
NH3 CONVERTER TEMP	ºC	825 ± 5ºC
Values are in the Signal I/O		
REF_4096_MV	mV	4096mv ±2mv and Must be Stable
REF_GND	mV	0± 0.5 and Must be Stable

2. WHAT IS THE RCELL & SAMPLE PRESSURES WITH THE SAMPLE INLET ON REAR OF MACHINE CAPPED?

RCELL PRESS -_____IN-HG-A **SAMPLE PRESSURE** - _____IN-HG-A

3. WHAT ARE THE FAILURE SYMPTOMS? _____

_____

_____

4. WHAT TEST HAVE YOU DONE TRYING TO SOLVE THE PROBLEM? _____

_____

_____

_____

_____

_____

5. IF POSSIBLE, PLEASE INCLUDE A PORTION OF A STRIP CHART PERTAINING TO THE PROBLEM. CIRCLE PERTINENT DATA.
6. THANK YOU FOR PROVIDING THIS INFORMATION. YOUR ASSISTANCE ENABLES TELEDYNE API TO RESPOND FASTER TO THE PROBLEM THAT YOU ARE ENCOUNTERING.

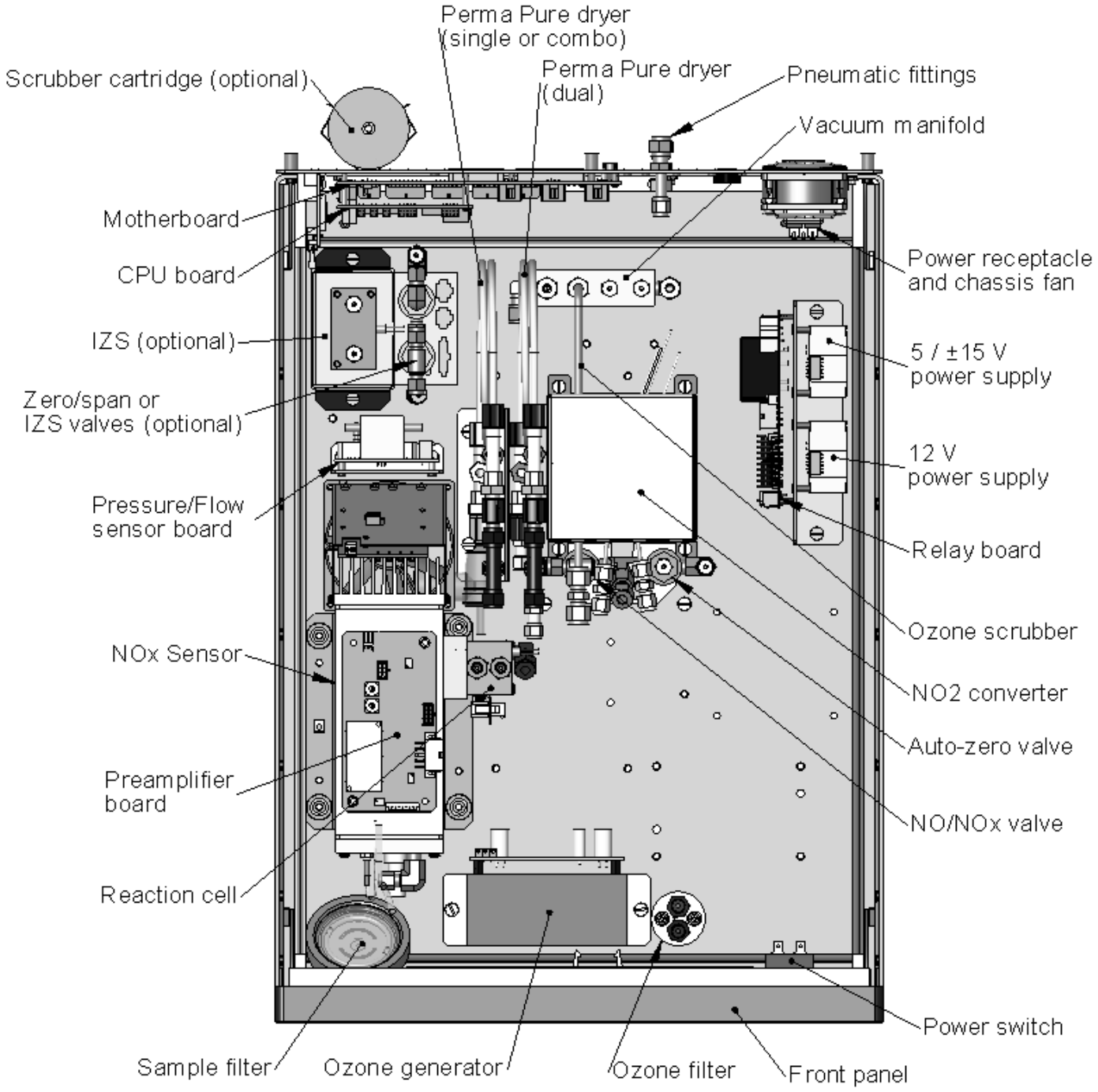
USER NOTES:

7. SPECIFICATIONS

Model 201E

Ranges	0-50 to 0-2000 ppb in 1 ppb increments
Range Modes	Single, Independent, AutoRange
Noise at Zero[1]	0.5 ppb RMS
Noise at Span[1]	< 1.0% of reading above 50 ppb
Lower Detectable Limit[2]	1 ppb RMS
Zero Drift[3]	2 ppb / 24 hours
Span Drift	< 1.0% FS Range / 7 days
Lag Time	40 sec
Rise Time[4]	90% 5 Min
Fall Time	90% 5 Min
Sample Flow Rate	1000 cc/min
Linearity	2% of full scale
Temp Range	15-40^{o}C
Dimensions HxWxD	7” x 17” x 23.6” (18cm x 43cm x 61cm)
Weight, Analyzer	43 lbs (20 kg)
Weight, Converter	24 lbs (11 kg)
Weight, Pump	16 lbs (7 kg)
Power, Analyzer	100V ~50/60 Hz, 120V ~60 Hz, 220V ~50Hz, 240V ~50 Hz, 125 watts
Power, Analyzer[5]	230V ~50 Hz, 125 watts
Power, Pump	110V ~60 Hz, 220V ~50 Hz, 240V ~50 Hz, 295 watts
Power, Pump CEMark[5]	230 V ~50 Hz, 2.5 A peak
Environmental	Installation Category Pollution Degree 2, Over-voltage Category II
Analog Output	0-100 mv, 0-1V, 0-5V, 0-10VDC, 4-20mA isolated
Analog Resolution	1 part in 2048
Status Option	12 Status Outputs
Measurement Units	ppb, µg/m3

8. MISC DIAGRAMS



M201E Layout

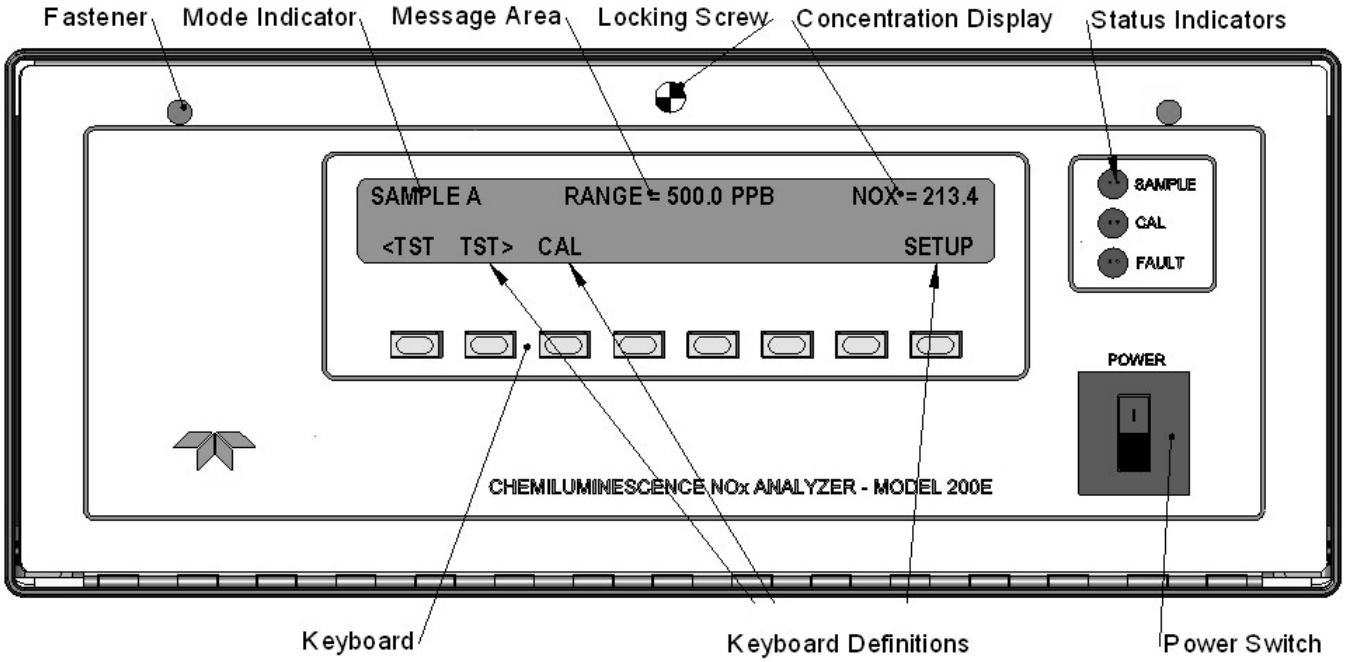
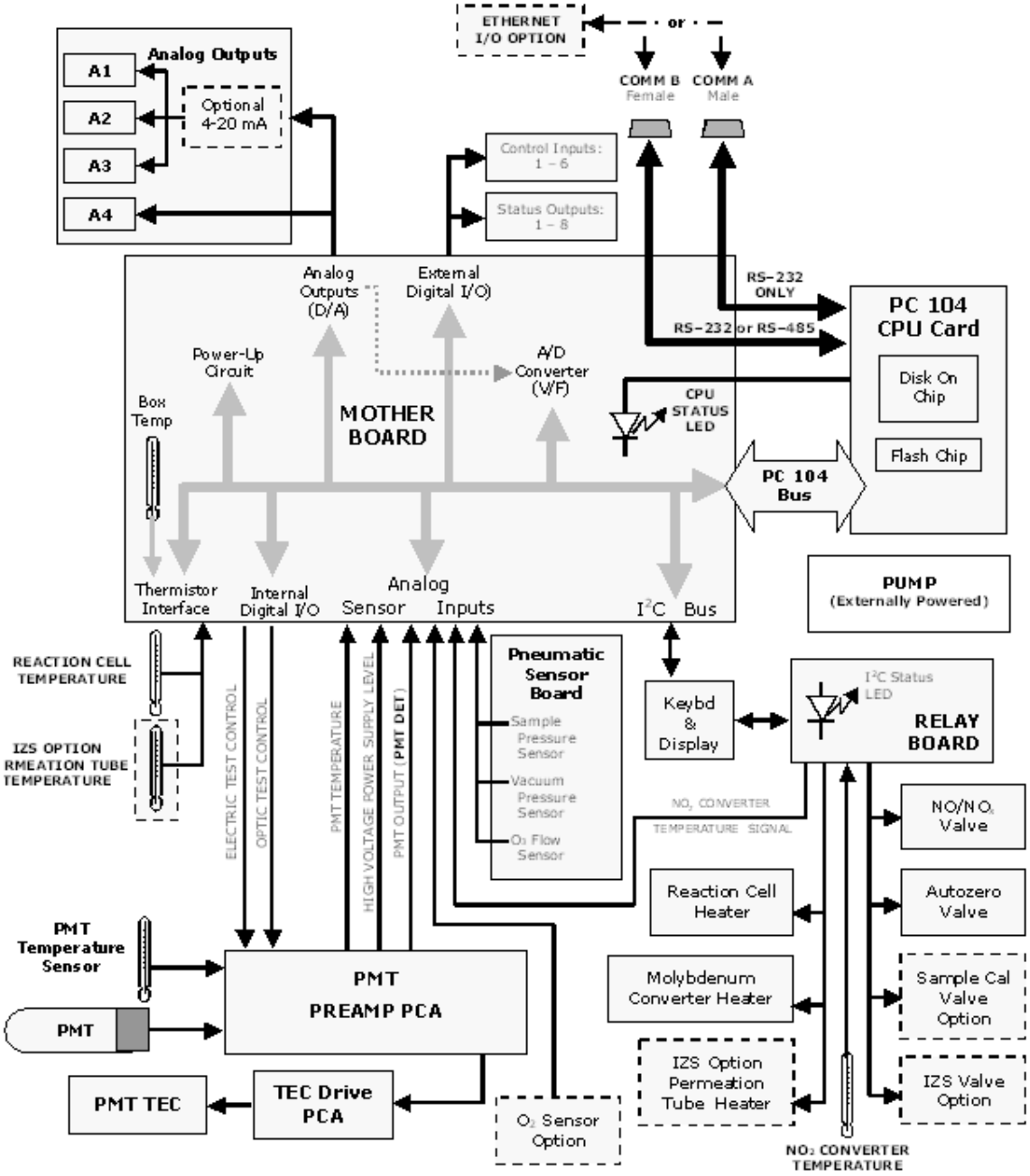


Figure 3-4: M201E Front Panel Layout



M201E Electronic Block Diagram

USER NOTES

USER NOTES

USER NOTES

9. T SERIES ADDENDUM

Front panel, rear panel, and display

Getting Started

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

Front Panel

Figure9-1 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

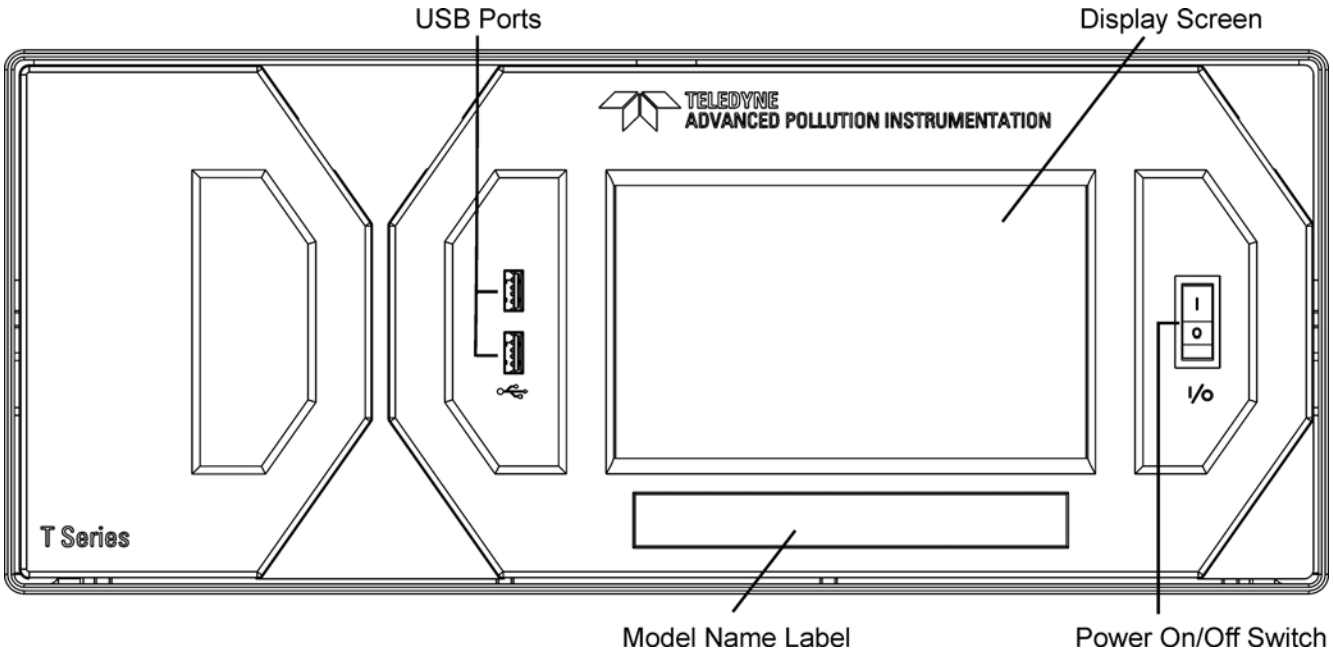


Figure 9-1: Front Panel Layout

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 10-2 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

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

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.

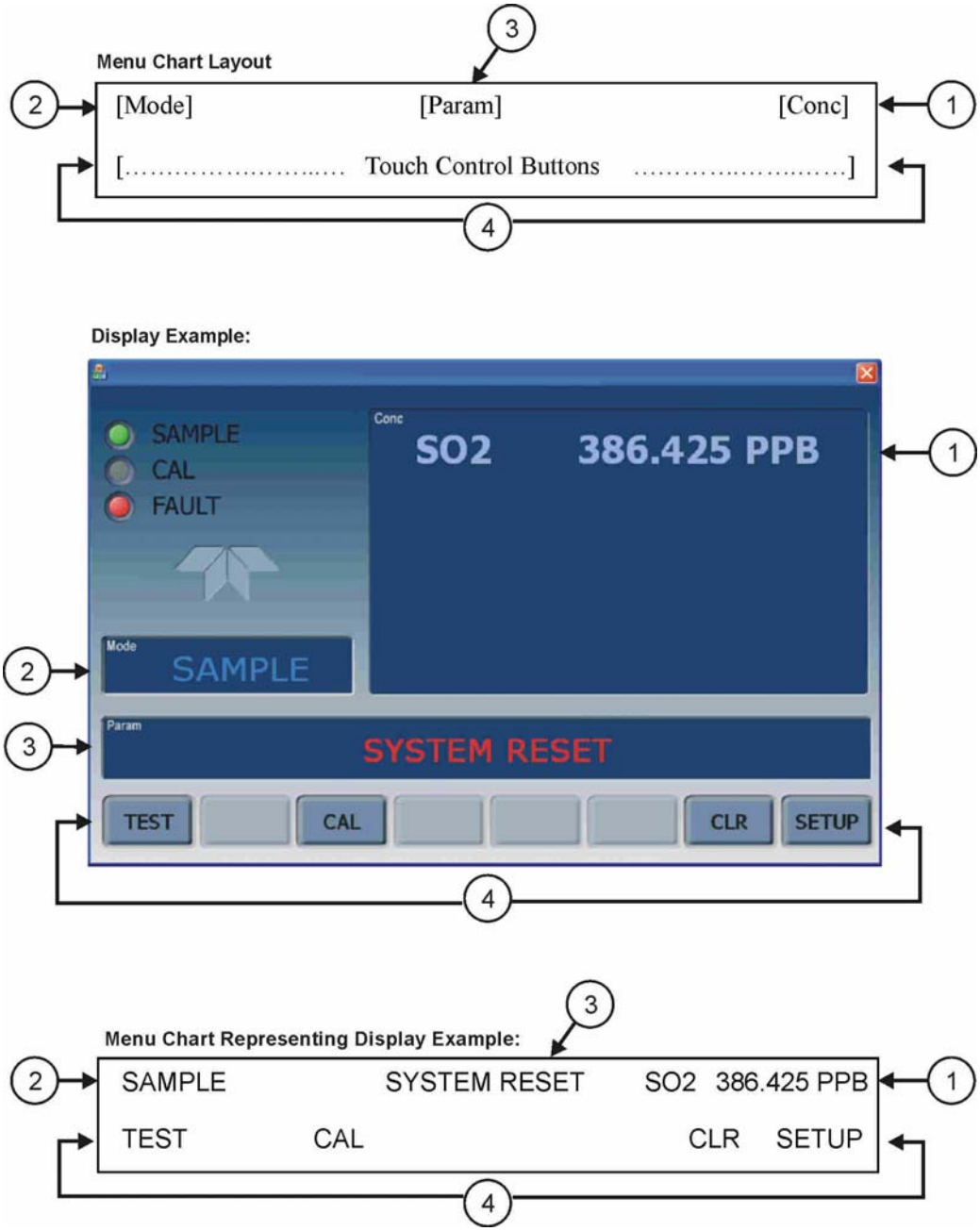


Figure 10-3: Display/Touch Control Screen Mapped to Menu Charts

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.

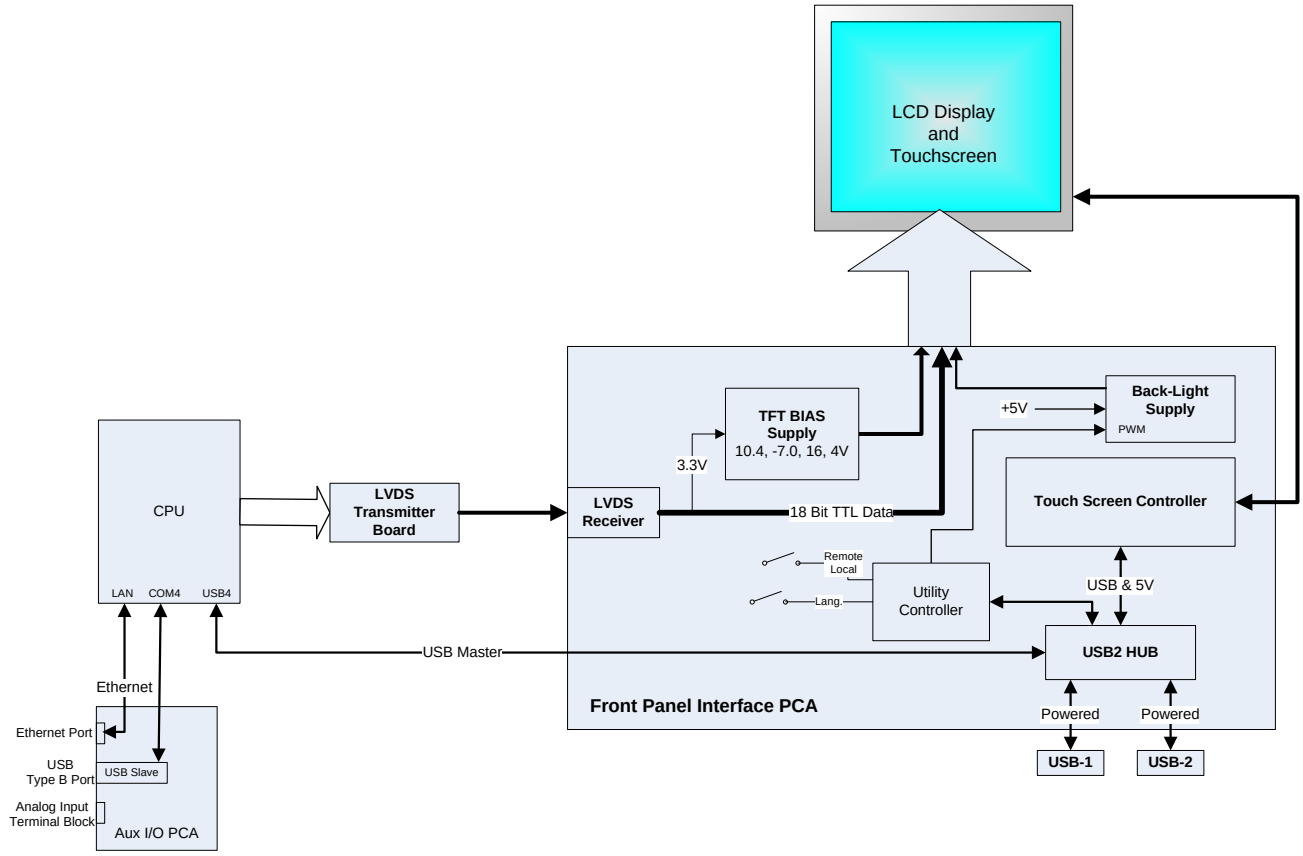


Figure 9-4: Front Panel and Display Interface Block Diagram

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.

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)

Rear panel

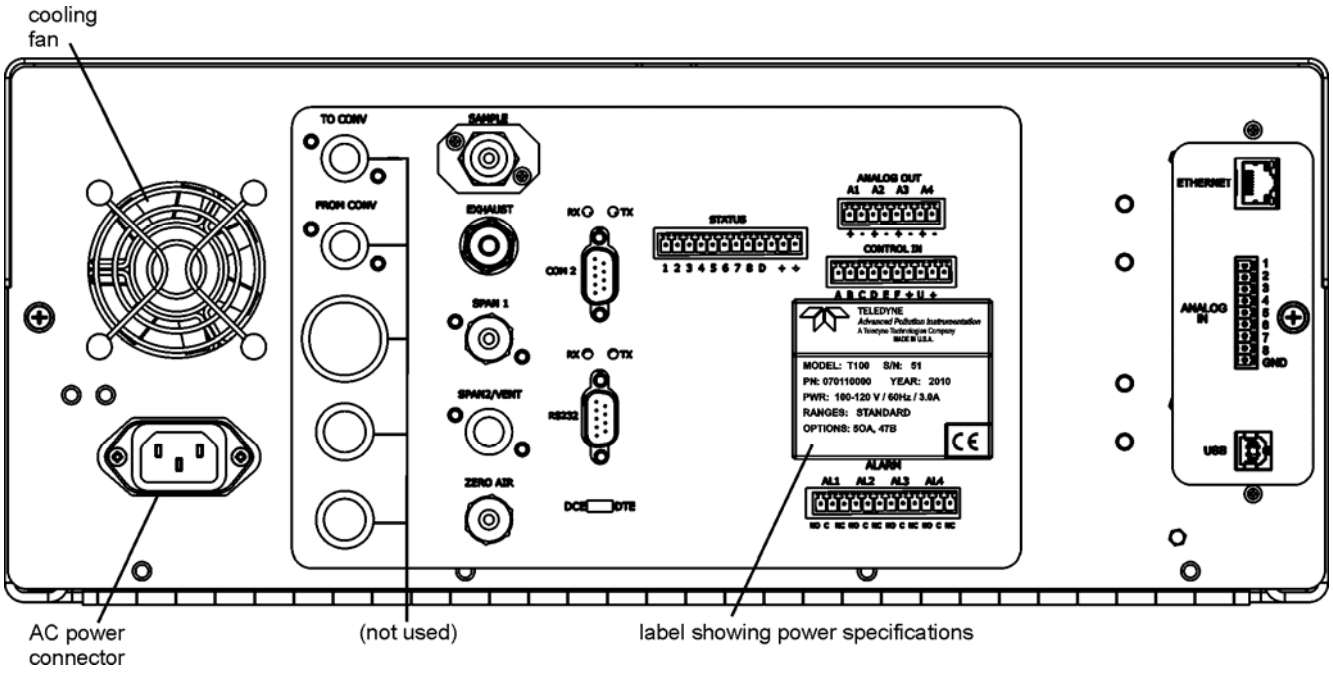


Figure 9-5: Rear Panel Layout

Table 10-2 provides a description of new components on the rear panel.

Table 10-2: 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.

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.

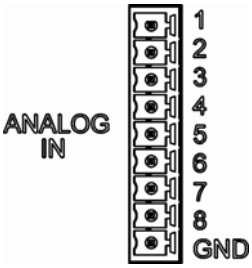


Figure 10-6: Analog In Connector

Pin assignments for the Analog In connector are presented in Table 10-3.

Table 10-3: 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

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.

Calibration & update procedures
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.

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.

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:

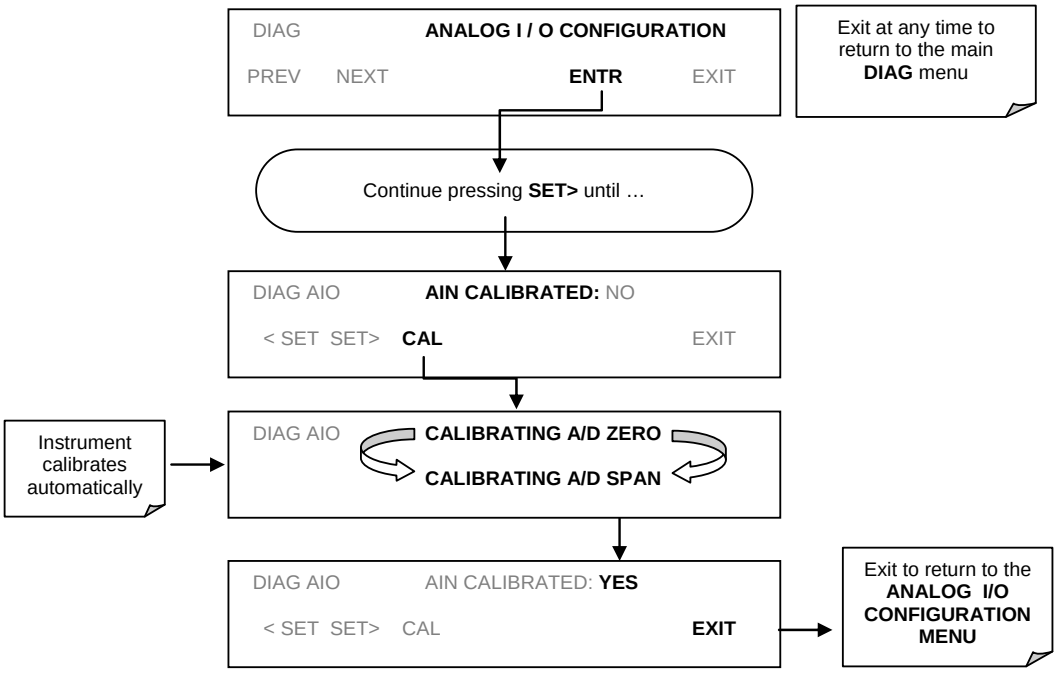


Figure 10-7: DIAG – Analog I/O Configuration – AIN Calibration

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:

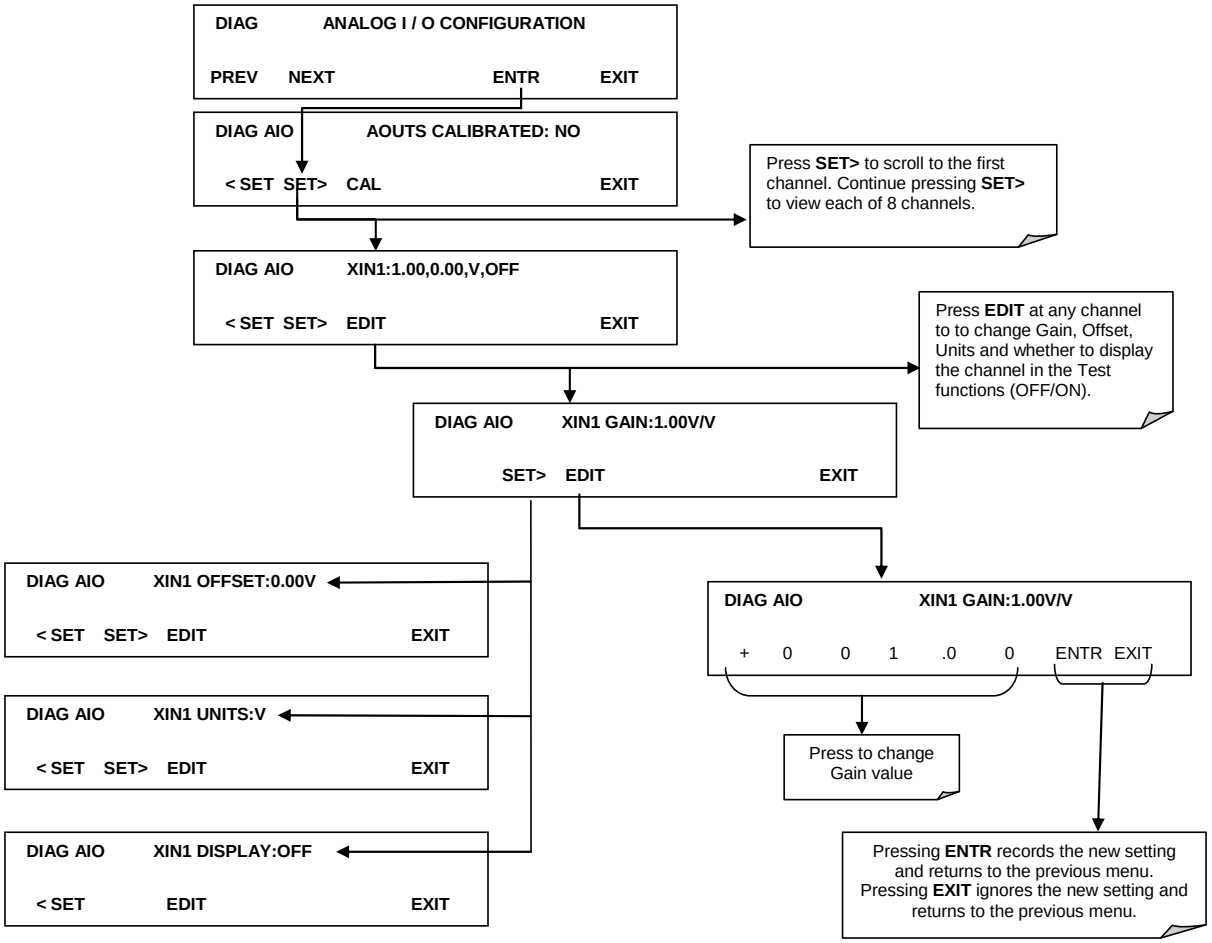


Figure 9-8 DIAG – Analog Inputs (Option) Configuration Menu

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.

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.

Troubleshooting faults

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.

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

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 the Display Calibration section.

Diagrams and schematics

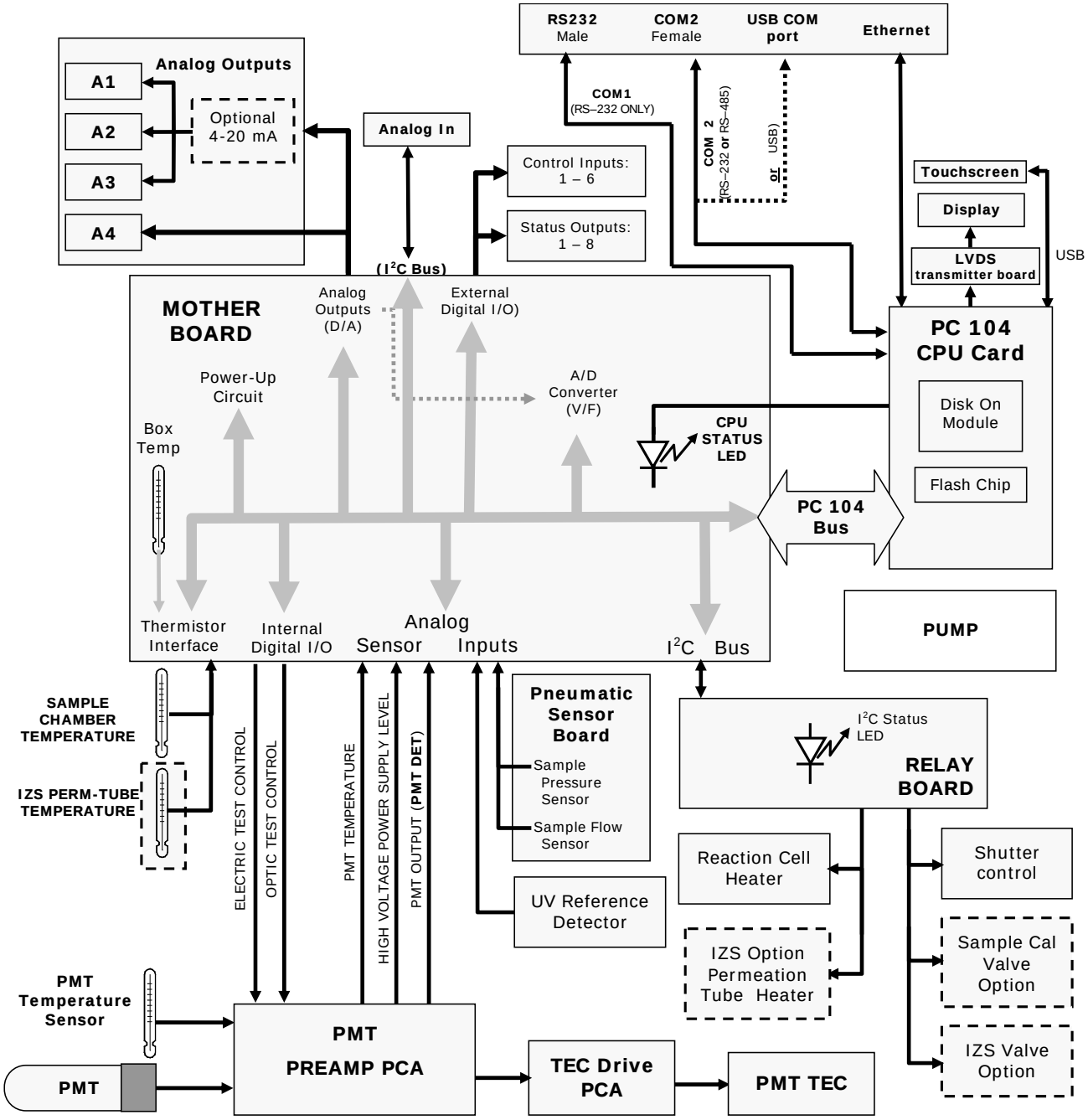


FIGURE 10-9, EXAMPLE OF AN ELECTRONIC BLOCK DIAGRAM (T100)

"E" series compatibility

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