TRAINING MANUAL

MODEL 100E / T100
UV FLUORESCENCE SO_2 ANALYZER

Also including the M100EU, M101E, M102E, M108E and M100EH

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1. PRINCIPLE OF OPERATION

Measurement Principle

UV Fluorescence

The M100E UV Fluorescence SO_2 Analyzer is a microprocessor controlled analyzer that determines the concentration of sulfur dioxide, SO_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 sample chamber where the sample gas is exposed to ultraviolet light causing the SO_2 to become excited (SO_2*). As these SO_2* molecules decay into SO_2 they fluoresce. The instrument measures the amount of fluorescence to determine the amount of SO_2 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 SO_2 at various concentrations are supplied and stores these measurements in memory. The microprocessor uses these calibration values along with other performance parameters such as the PMT dark offset, UV lamp ratio and the amount of stray light present, and measurements of the temperature and pressure of the sample gas to compute the final SO_2 concentration.

This concentration value 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, as electronic data via several communication ports, and through analog outputs signals.

SO_2 Ultraviolet Fluorescence

The physical principle of the M100E's measurement method is the fluorescence that occurs when sulfur dioxide (SO_2) is excited by ultraviolet light with wavelengths in the range of 190ηm - 230ηm. This reaction is a two-step process.

The first stage occurs when SO_2 molecules are struck by ultraviolet photons of the appropriate wavelength (190ηm - 230ηm). The SO_2 retains some excess energy that causes one of the electrons of the SO_2 molecule to move to a higher energy orbital state. In the case of the Model 100E, a band pass filter between the source of the UV light and the affected gas limits the wavelength of the UV light to approximately 214ηm.

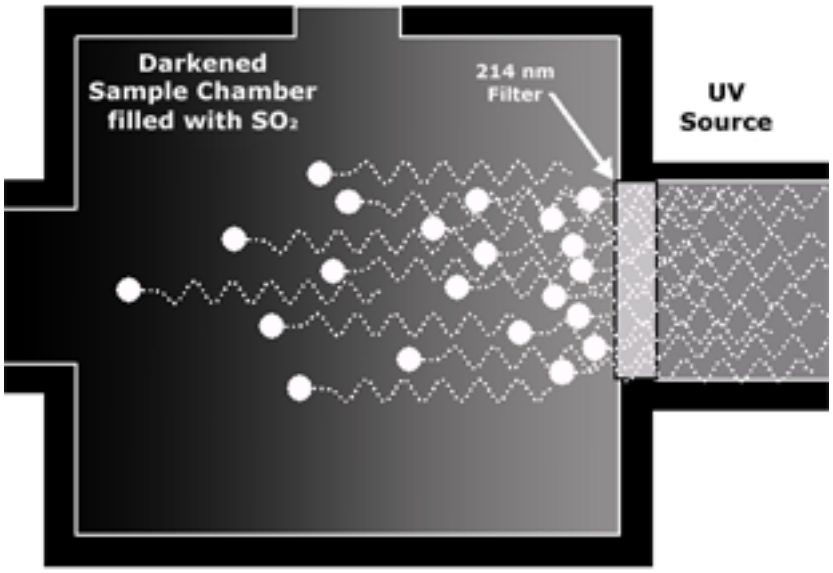
$$SO_2 + h\nu_{214\eta m} \xrightarrow{Ia} SO2*$$

The second stage of this reaction occurs after the SO_2 reaches its excited state (SO_2*). Because the electron will seek the lowest available stable energy state, the SO_2* molecule quickly returns to its ground state by giving off the excess energy in the form of a photon ($h\nu$). The wavelength of this fluoresced light is also in the ultraviolet band but at a longer (lower energy) wavelength centered at 330ηm.

$$SO_2 * \xrightarrow{kF} SO_2 + h\nu_{330nm}$$

Obviously the more SO_2 that is present in the sample gas, the more fluorescence will be detected in the sample chamber. Unfortunately there are several other factors that can also affect the amount of fluorescence detected by the analyzer.

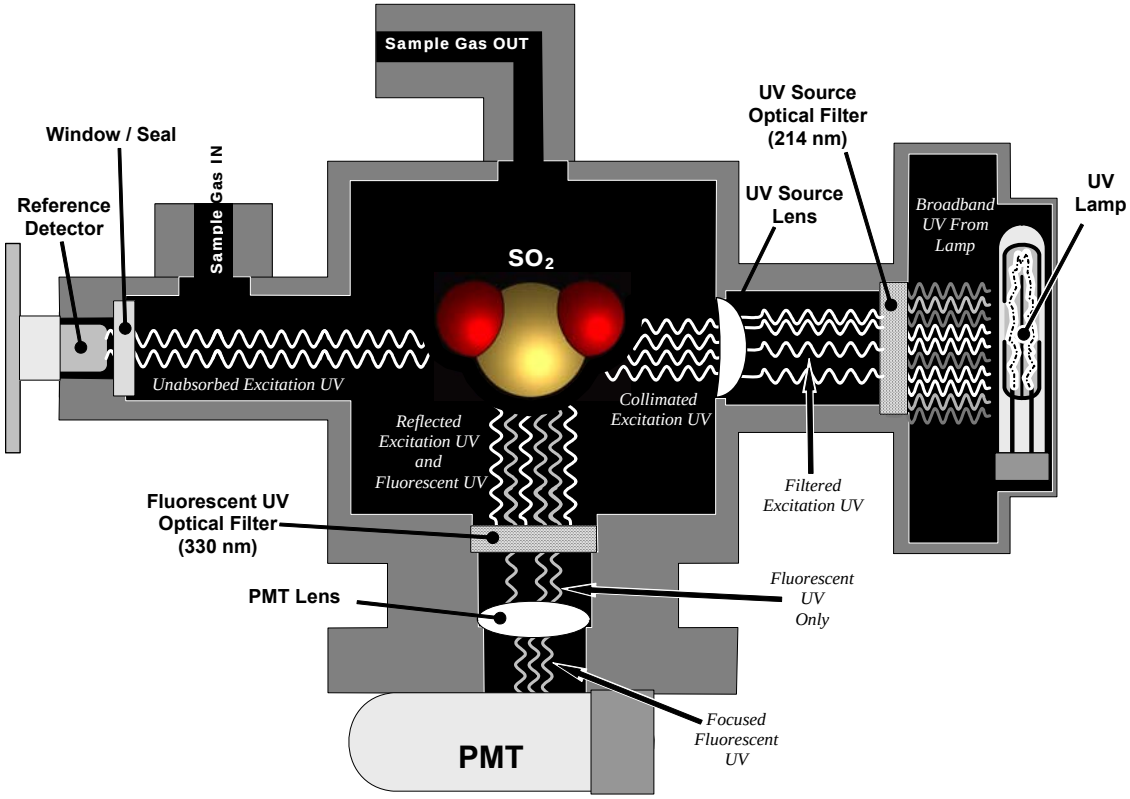
For instance, the amount of SO_2* is dependent on the average intensity of the UV light and not its peak intensity because some of the photons are absorbed by the SO_2 as the light travels through the sample gas.

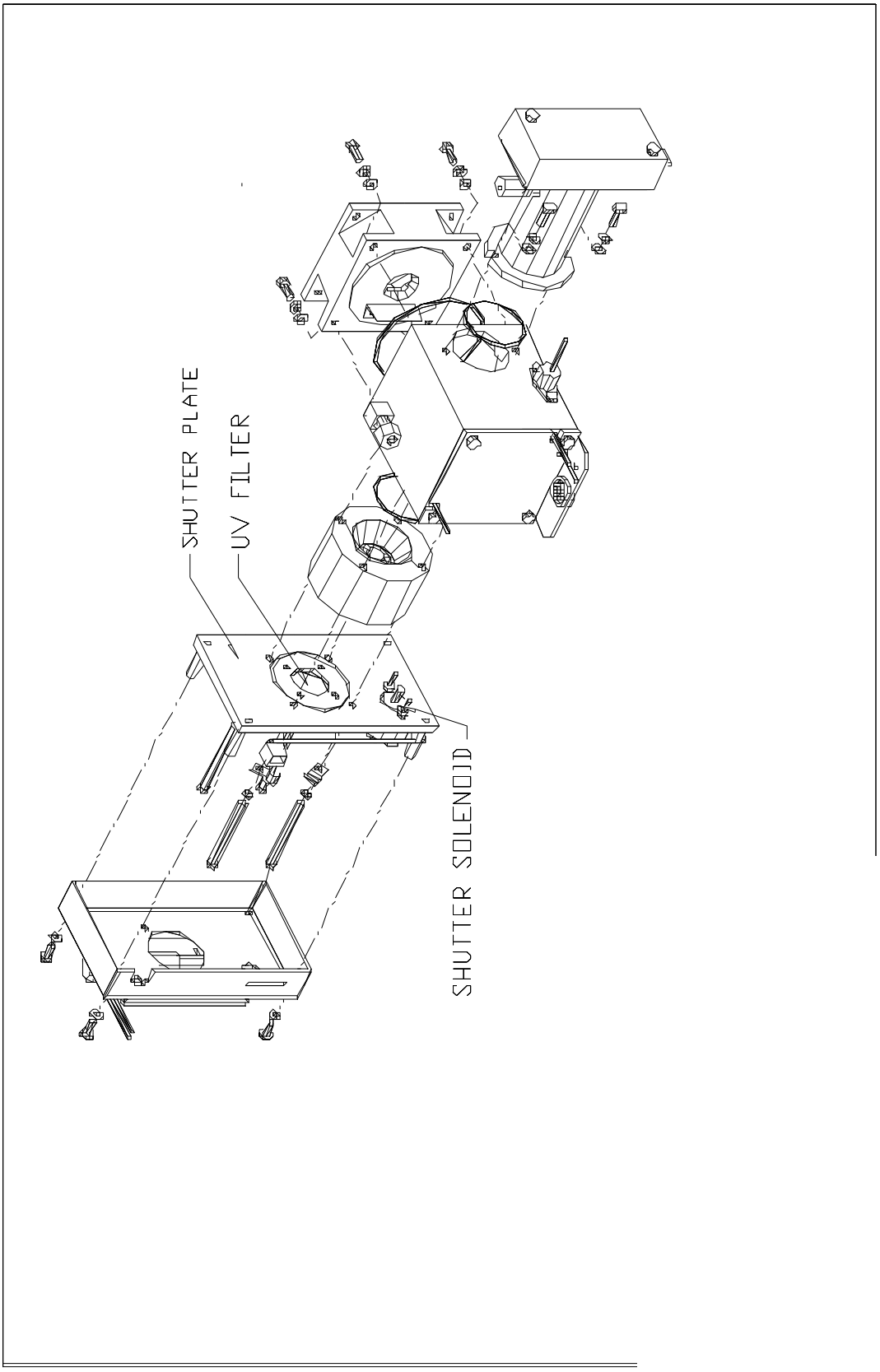


The Reaction Cell

The UV Light Path

The optical design of the Model 100E's sample chamber optimizes the fluorescent reaction between SO_2 and UV Light and assure that only UV light resulting from the decay of SO_2* into SO_2 is sensed by the instruments fluorescence detector, the PMT.
UV radiation is generated by a lamp specifically designed to produce a maximum amount of light of the wavelength needed to excite SO_2 into SO_2* (330ηm) and a special reference detector circuit constantly measures lamp intensity. A Photo Multiplier Tube (PMT) detects the UV given off by the SO_2* decay (330ηm) and outputs an analog signal. Several focusing lenses and optical filters make sure that both detectors are exposed to an optimum amount of only the right wavelengths of UV. To further assure that the PMT only detects light given off by decaying SO_2* the pathway of the excitation UV and field of view of the PMT are perpendicular to each other and the inside surfaces of the sample chamber are coated with a layer of black Teflon® that absorbs stray light.

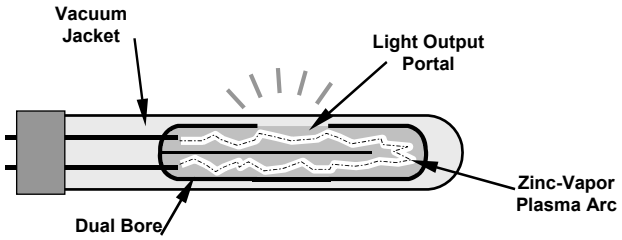




UV Lamp

The source of excitation UV light for the Model 100E is a low pressure zinc-vapor lamp. An AC voltage heats up and vaporizes zinc contained in the lamp element creating a light-producing plasma arc. Zinc-vapor lamps are preferred over the more common mercury-vapor lamps for this application because they produce very strong emission levels at the wavelength required to convert SO_2 to SO_2*, 214ηm.

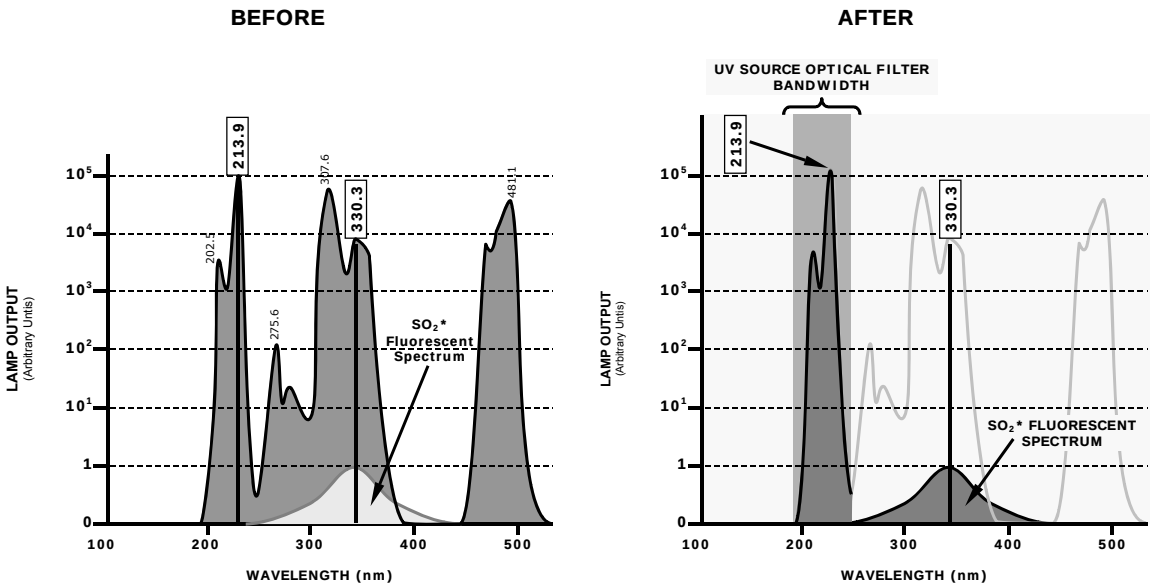
The lamp used in the Model 100E is constructed with a vacuum jacket surrounding a double-bore lamp element. The vacuum jacket isolates the plasma arc from most external temperature fluctuations. The jacket also contains the thermal energy created by the lamps operation thereby helping the lamp heat up to and maintain proper vaporization temperature. Light is emitted through a 20mm x 5mm portal.



UV LAMP

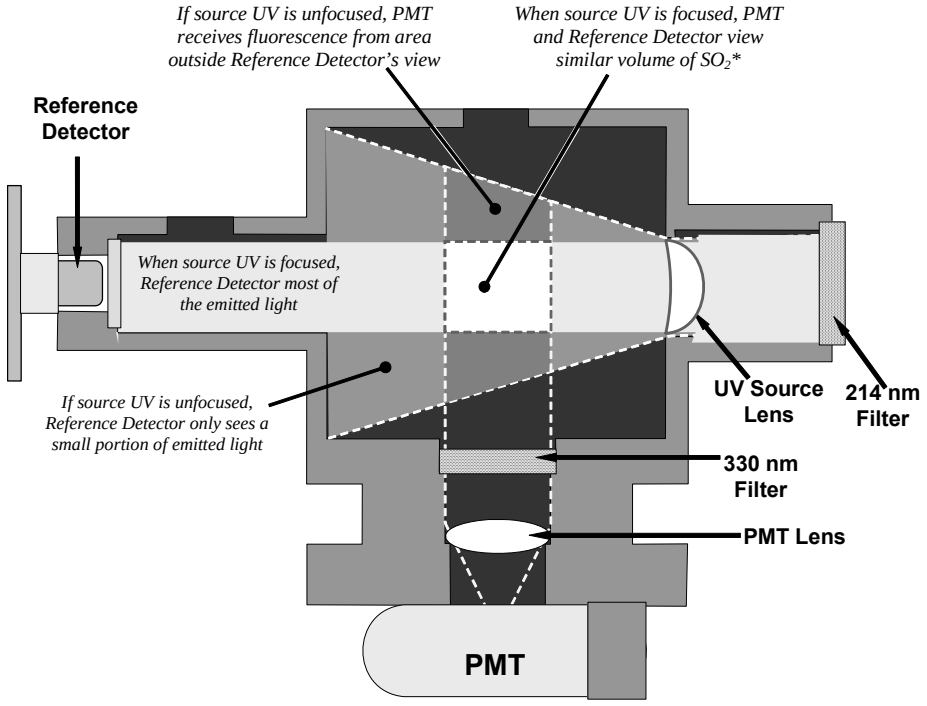
The UV Source Optical Filter

Zinc-vapor lamps output light at other wavelengths beside the 214ηm required for the SO_2 → SO_2* transformation including a relatively bright light of the same wavelength at which SO_2* fluoresces as it returns to its SO_2 ground state (330ηm). In fact, the intensity of the of light emitted by the UV lamp at 330ηm is so bright, nearly five orders of magnitude brighter than that resulting from the SO_2* decay, it would drown out the SO_2* fluorescence. Therefore the 214.3ηm filter is used to let peak UV light at 214ηm to pass into the reaction cell while blocking all other UV frequencies.



Optical Lenses

Two optical lenses are used to focus and optimize the path of light through the sample chamber.



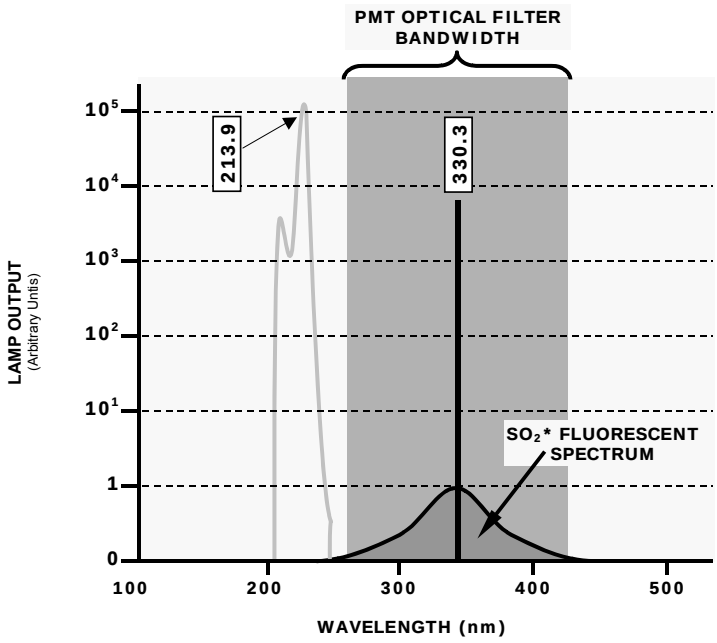
Effects of Focusing Source UV in Sample Chamber

A lens located between PMT and the sample chamber collects as much of the fluoresced UV created there as possible and focuses it on the most sensitive part of the PMT's photo cathode. Another lens located between the excitation UV source lamp and the sample chamber collimates the light emitted by the lamp into a steady, circular beam and focuses that beam directly onto the reference detector. This allows the reference detector to accurately measure the effective intensity of the excitation UV by:

- Eliminating the effect of flickering inherent in the plasma arc that generates the light.
- Making sure that all of the light emitted by the source lamp, passed though the 214ηm filter and not absorbed by the SO_2 reaches the reference detector. Conversely, this also makes sure that the volume of sample gas affected by the excitation beam is similar to the volume of fluorescing SO_2* being measured by the PMT, eliminating a possible source of measurement offset.

PMT Optical Filter

The PMT used in the Model 100E reacts to a wide spectrum of light which includes much of the visible spectrum and most of the UV spectrum. Even though the 214ηm light used to excite the SO_2 is focused away from the PMT, some of it scatters in the direction of the PMT as it interacts with the sample gas. A second optical bandpass filter, placed between the sample chamber and the PMT, strips away light outside of the fluorescence spectrum of decaying SO_2*, including reflected UV from the source lamp and other stray light.



PMT Optical Filter Bandwidth

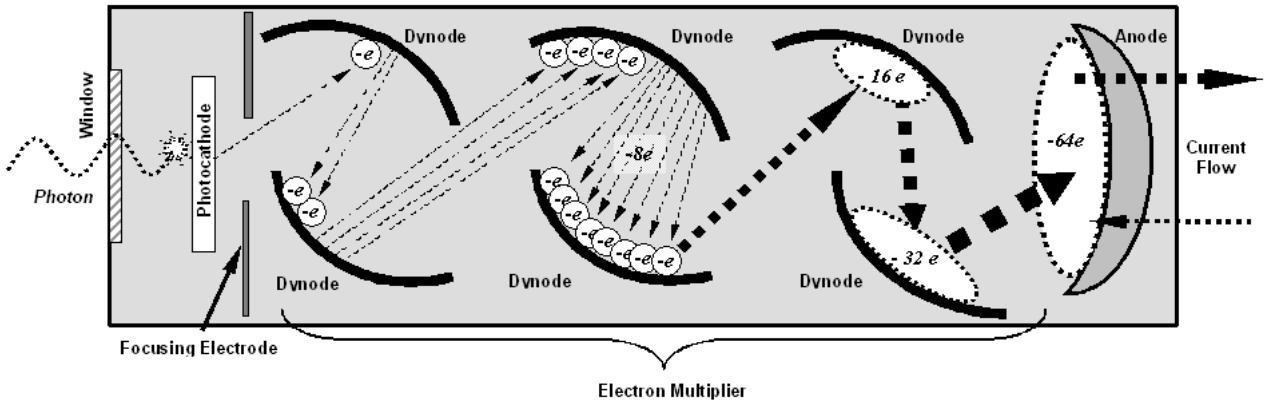
The Reference Detector

A vacuum diode UV detector that converts UV light to a DC current, is used to measure the intensity of the excitation UV source lamp. Its location, directly across from the source lamp at the back of a narrow tube-shaped light trap, places it directly in the path of the excitation UV light. A window transparent to UV light provides an air-proof seal that prevents ambient gas from contaminating the sample chamber. Due to the shape of the light trap and the fact that the detector is blind to wavelengths other than UV, no extra optical filtering is needed.

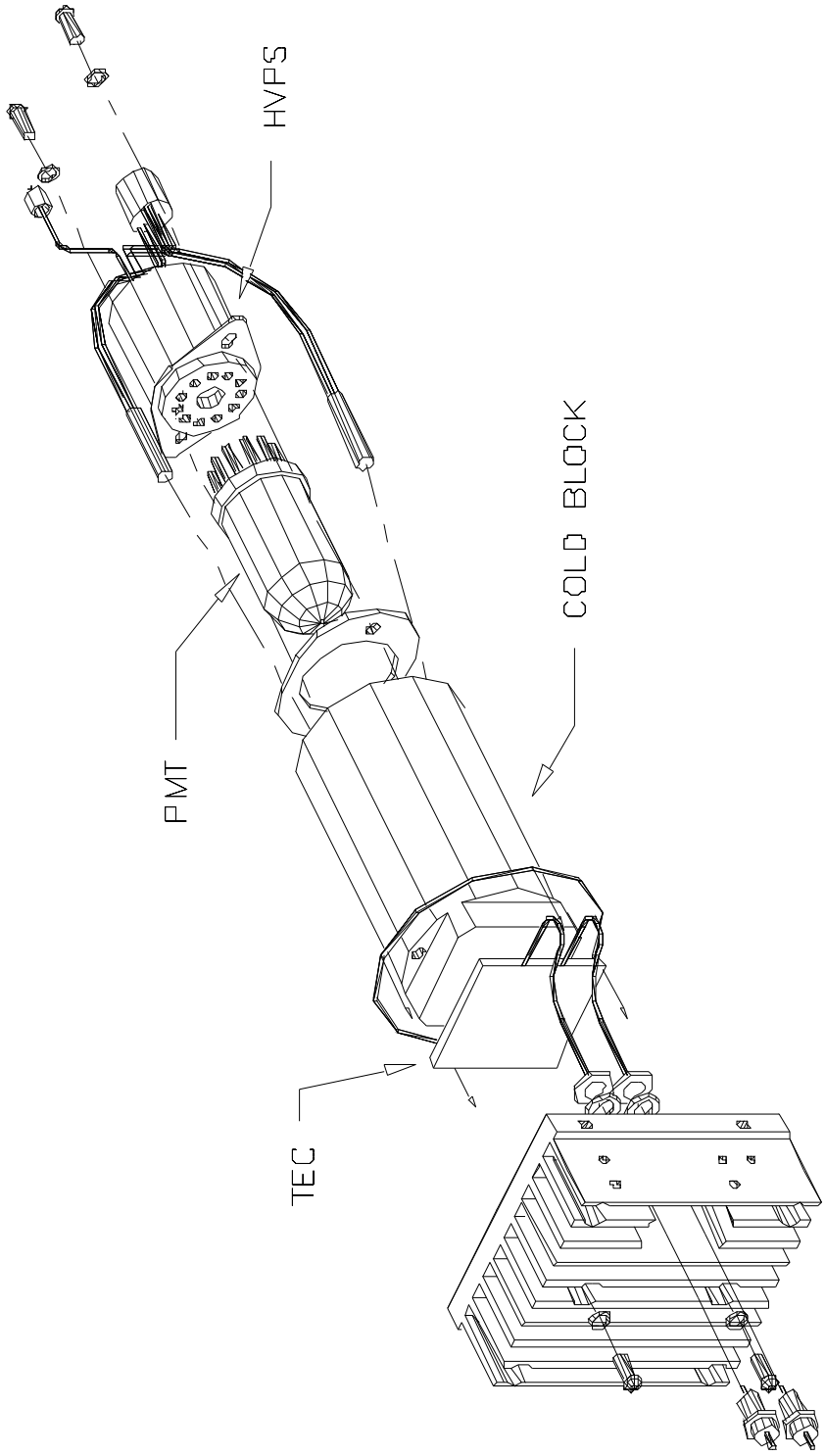
The PMT

The amount of fluoresced UV produced in the sample chamber is much less than the intensity of excitation UV source lamp. Therefore a much more sensitive device is needed to detect this light with enough resolution to be meaningful. The Model 100E uses a Photo Multiplier Tube or PMT for this purpose.

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 a high voltage applied across a series of special electrodes called dynodes that multiply the amount of electrons until a useable current signal is generated. The typical gain is on the order of 1,000,000 to 1. This current increases or decreases with the amount of detected light.



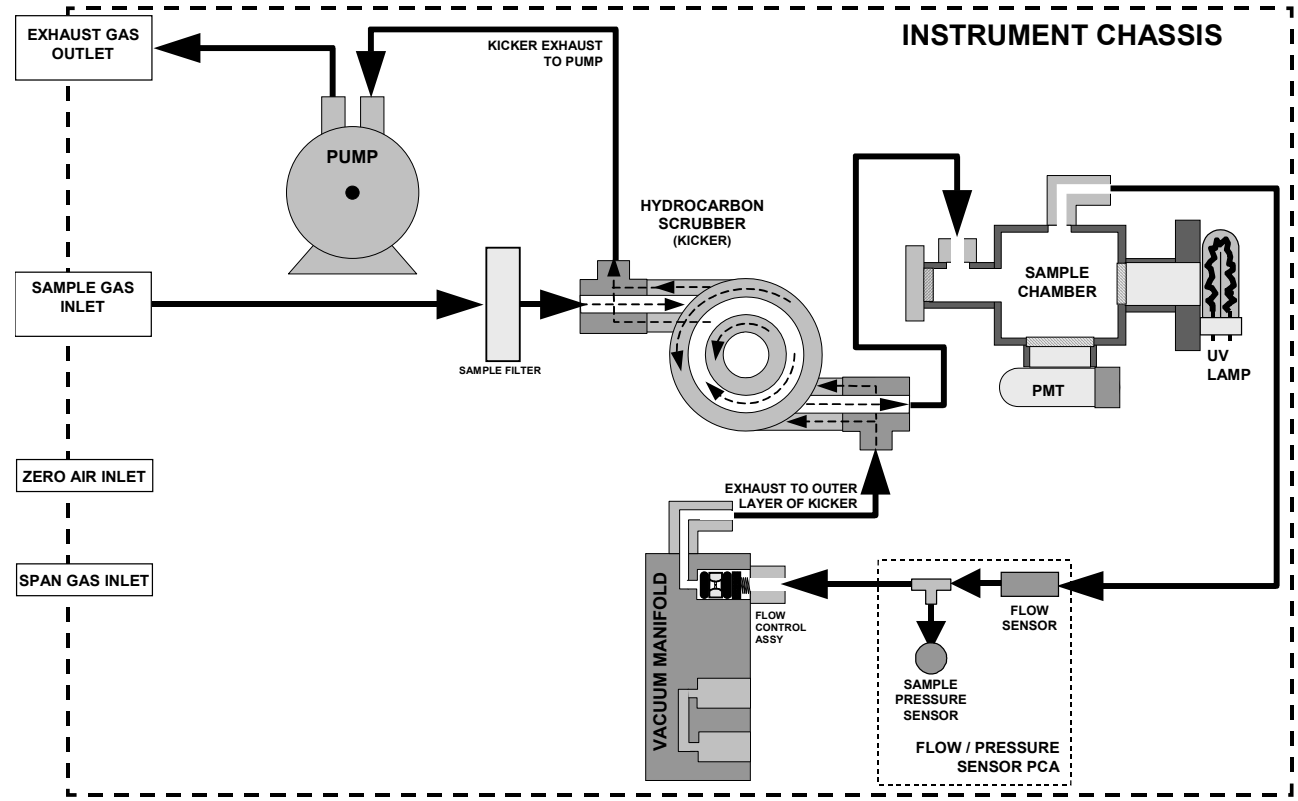
Schematic of Basic PMT Design and Functionality



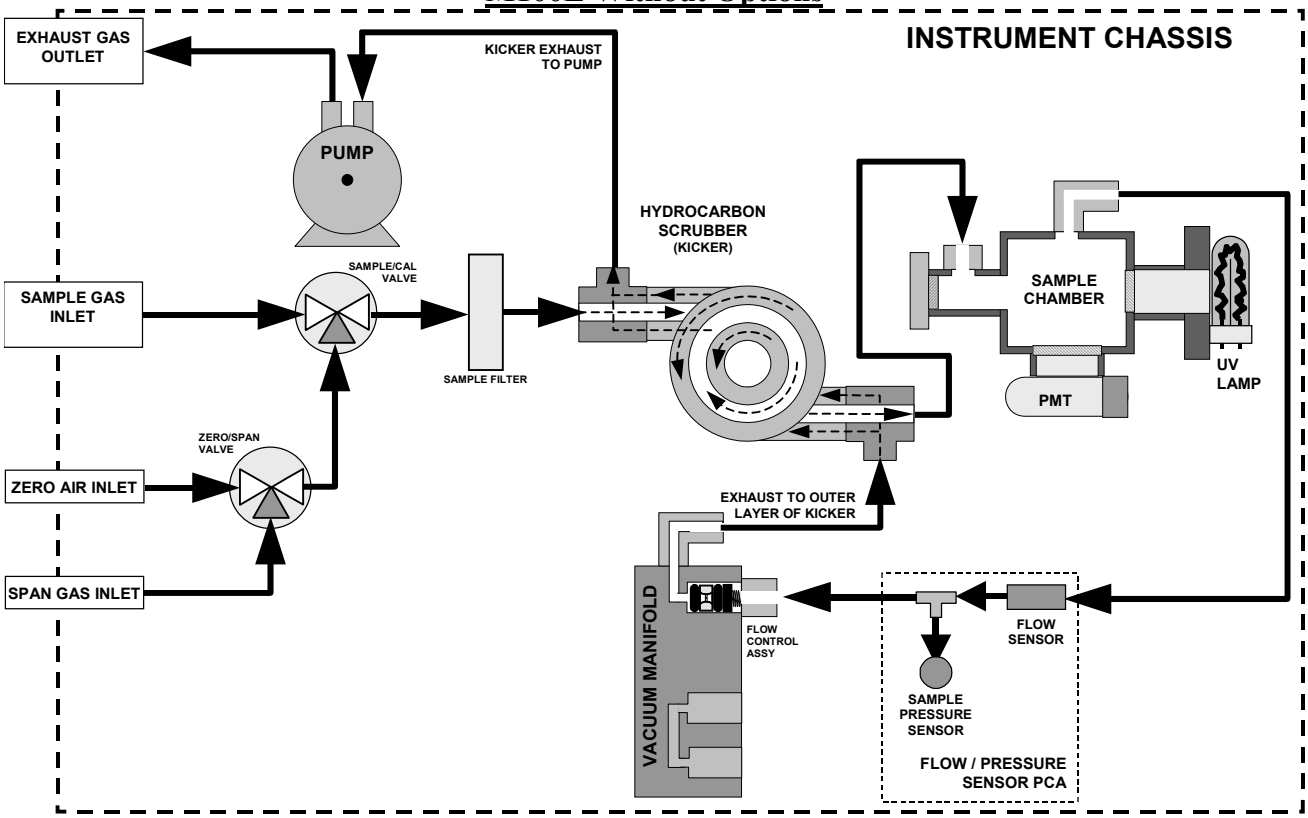
PMT COOLER ASSEMBLY

USER NOTES:

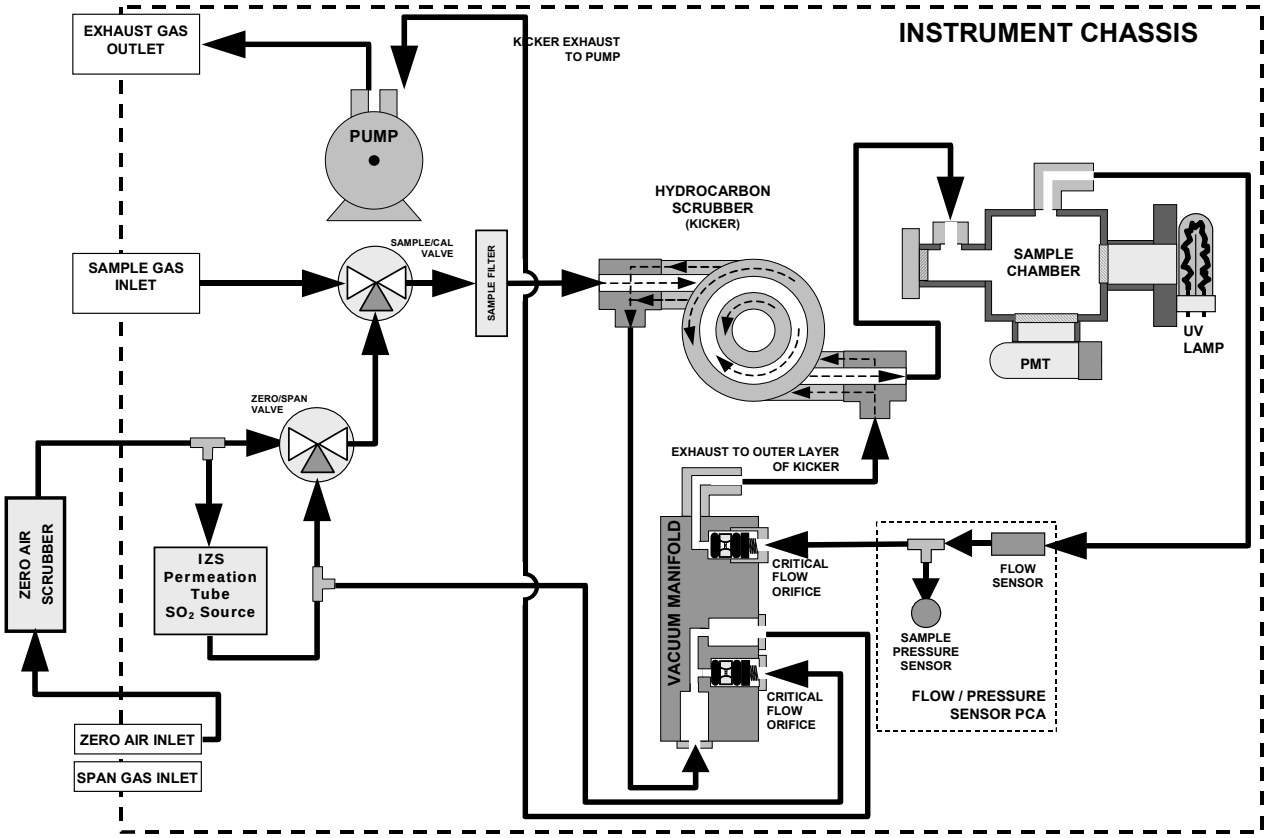
2. PNEUMATICS AND ASSEMBLIES



M100E Without Options



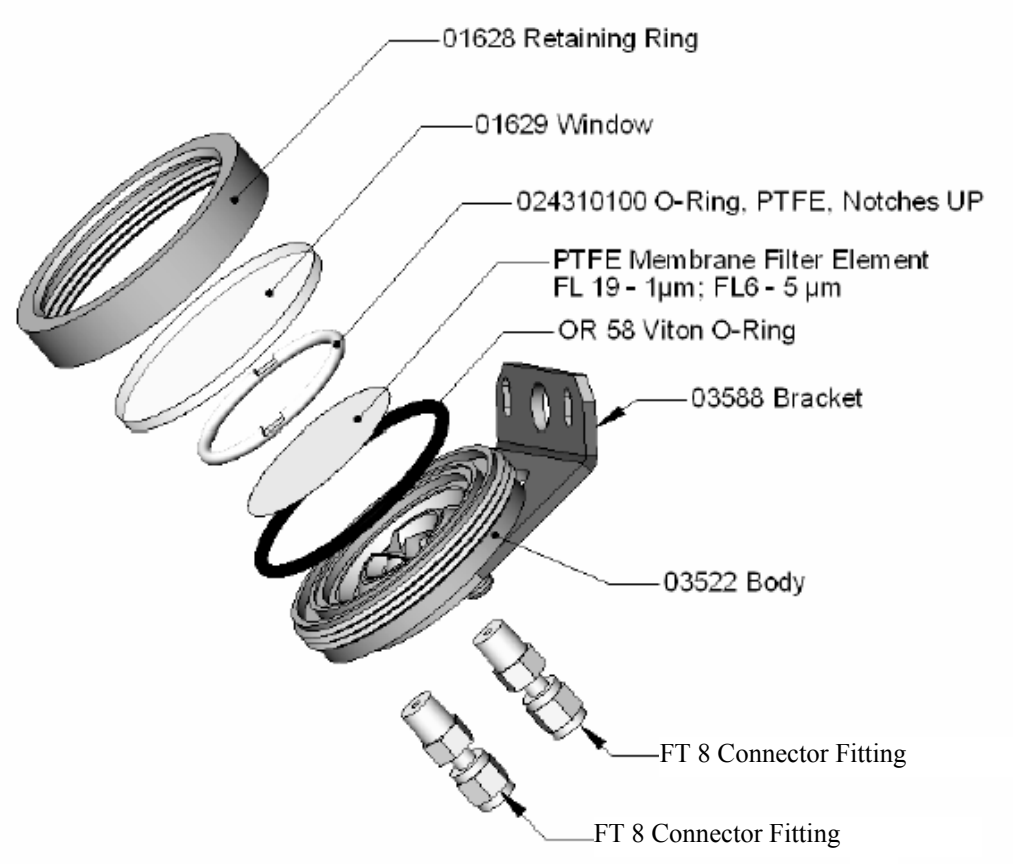
M100E with Valves Option



M100E with IZS Option

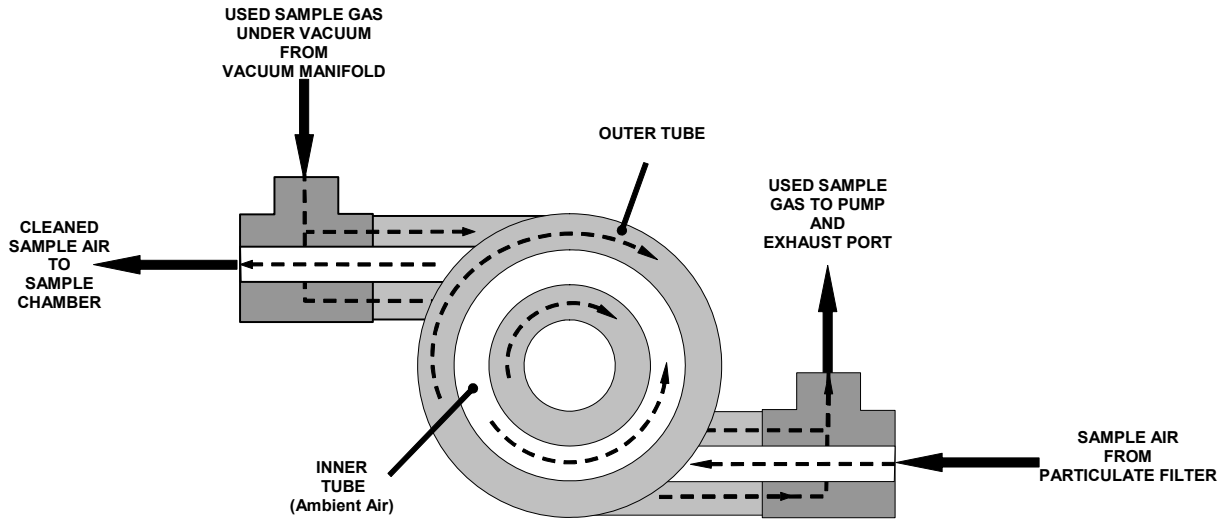
The Sample Particulate Filter

The particulate filter should be inspected often for signs of plugging or excess dirt. It should be replaced regularly even without obvious signs of dirt. Filters with 1µm and 5µm pore size can clog up while retaining a clean look. We recommend handling the filter and the wetted surfaces of the filter housing with gloves and tweezers. We recommend to not touch any part of the housing, filter element, PTFE retaining ring, glass cover or the O-ring with bare hands, as this may cause the pores to clog quicker and surfaces to become dirty due to possible oils from your hands.



The Kicker

It is very important to make sure the air supplied sample chamber is clear of hydrocarbons. To accomplish this task, the M100E uses a single tube permeation scrubber. The scrubber consists of a single tube of a specialized plastic that absorbs hydrocarbons very well. This tube is located within outer flexible plastic tube shell. As gas flows through the inner tube, hydrocarbons are absorbed into the membrane walls and transported through the membrane wall and into the hydrocarbon free, purge gas flowing through the outer tube. This process is driven by the hydrocarbon concentration gradient between the inner and outer of the tubes.



Pneumatic Sensor Board

The flow and pressure sensors of the M100E are located on a printed circuit assembly just behind the PMT sensor. The signals of this board are supplied to the motherboard for further signal processing. All sensors are linearized in the firmware and can be span calibrated from the front panel.

The flow sensor is used as a diagnostics tool only. This measurement has no effect on the analyzers reading. If a flow problem is ever suspected you should measure the flow rate of the analyzer with an external flow meter and not rely on what the analyzer reads off the front panel.

The pressure compensation in the analyzer is extremely important because if the pressure of the sample gas changes (for instance – it doubles), then the amount of SO_2 molecules and diluent molecules will double as well.

If the sample gas is compressed in a fixed volume, and only the pressure changes, the concentration ratio remains the same, as illustrated in the following example:

Example:
5 molecules SO_2 per 1,000,000 molecules air at 15"Hg = 10 molecules SO_2 per 2,000,000 molecules air at 30"Hg.

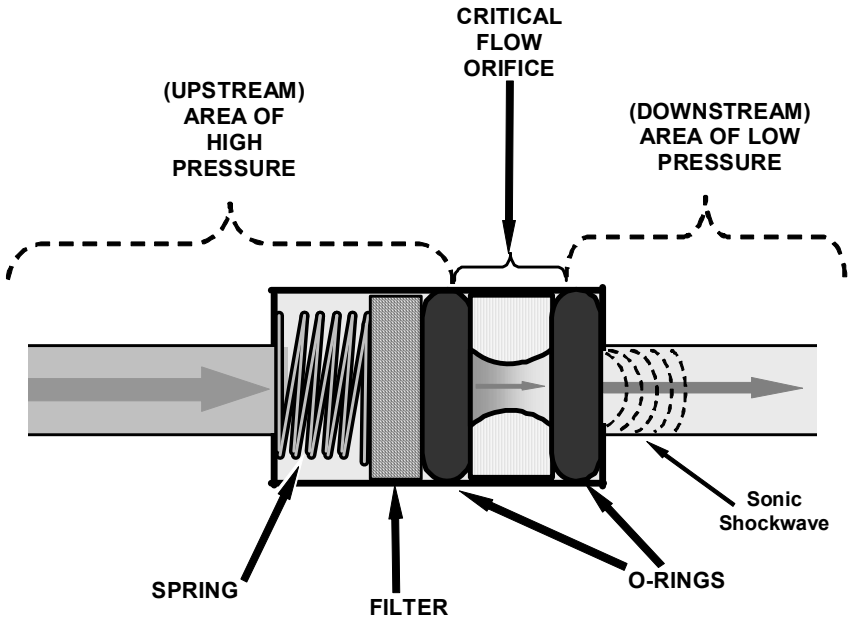
The problem is that without pressure compensation, the PMT would measure 5 molecules fluorescing or 10 molecules fluorescing, but the concentration is actually the same. Therefore the pressure compensation factor would report 5ppm, even though there are more actual molecules fluorescing in the sample chamber.

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

The orifice is made out of a ruby or sapphire gemstone and then a small hole is laser cut to the desired diameter in the center of the gemstone. A gemstone is used due to its high tolerance to thermal expansion.



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 pass 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. This is true until the pump degrades to the point where the 2:1 pressure ratio is no longer maintained, normally around 14"-15". The critical flow orifice used in the Model 100E is designed to provide a flow rate of 650 cm^3/min.

USER NOTES:

3. MENU STRUCTURE

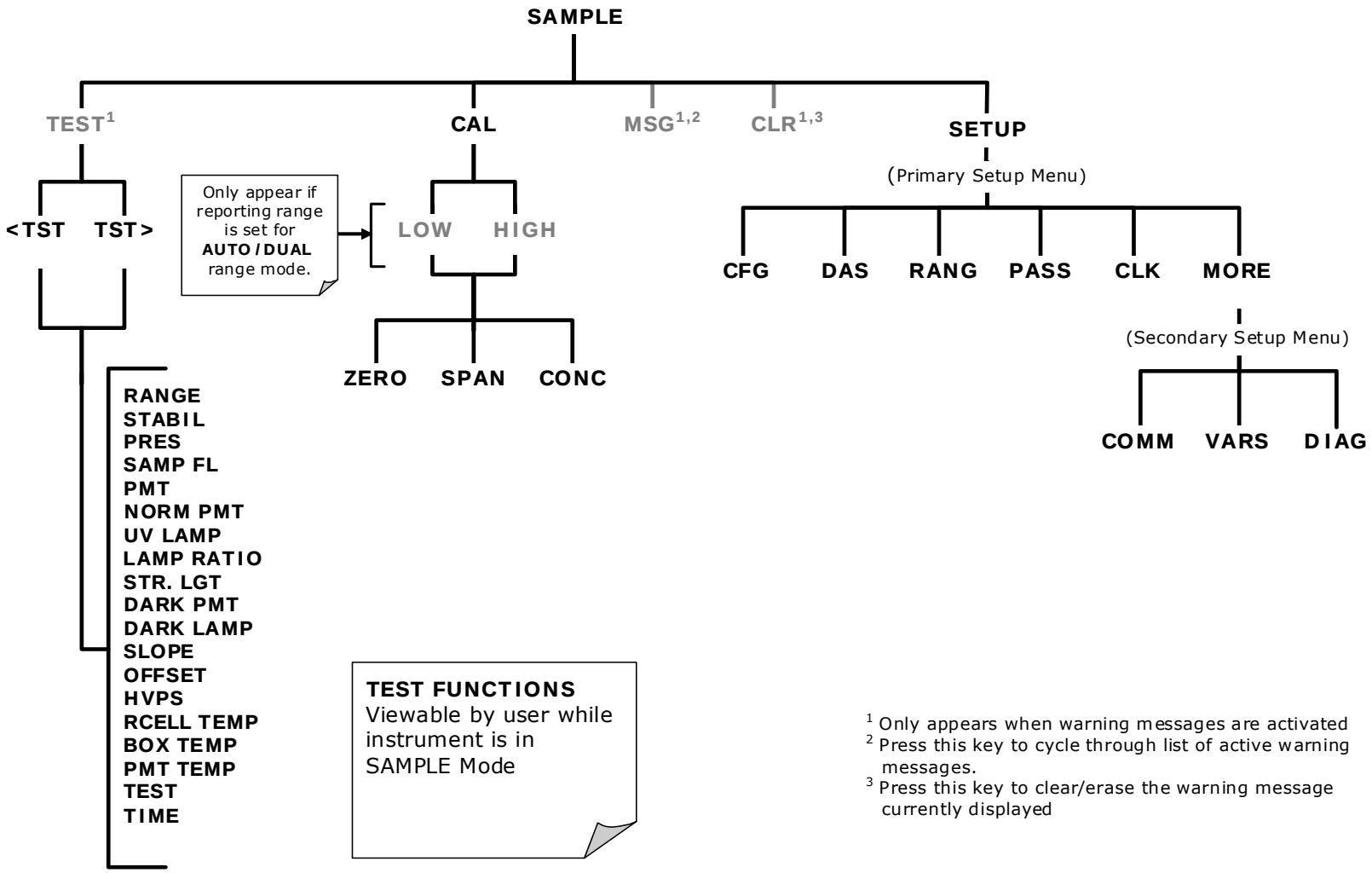


Figure A-1: Basic Sample Display Menu

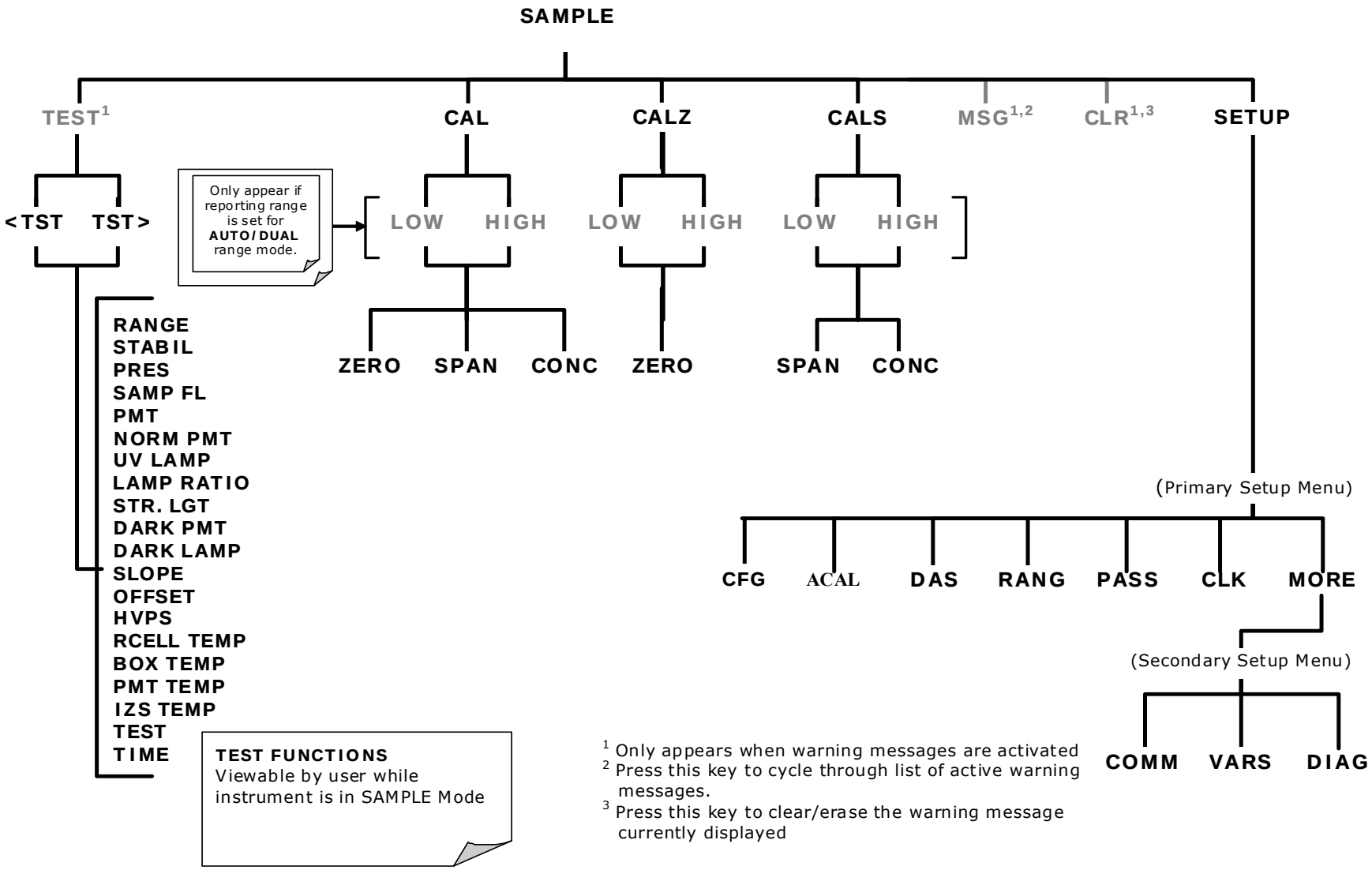


Figure A-2: Sample Display Menu - Units with Z/S Valves or IZS Option installed

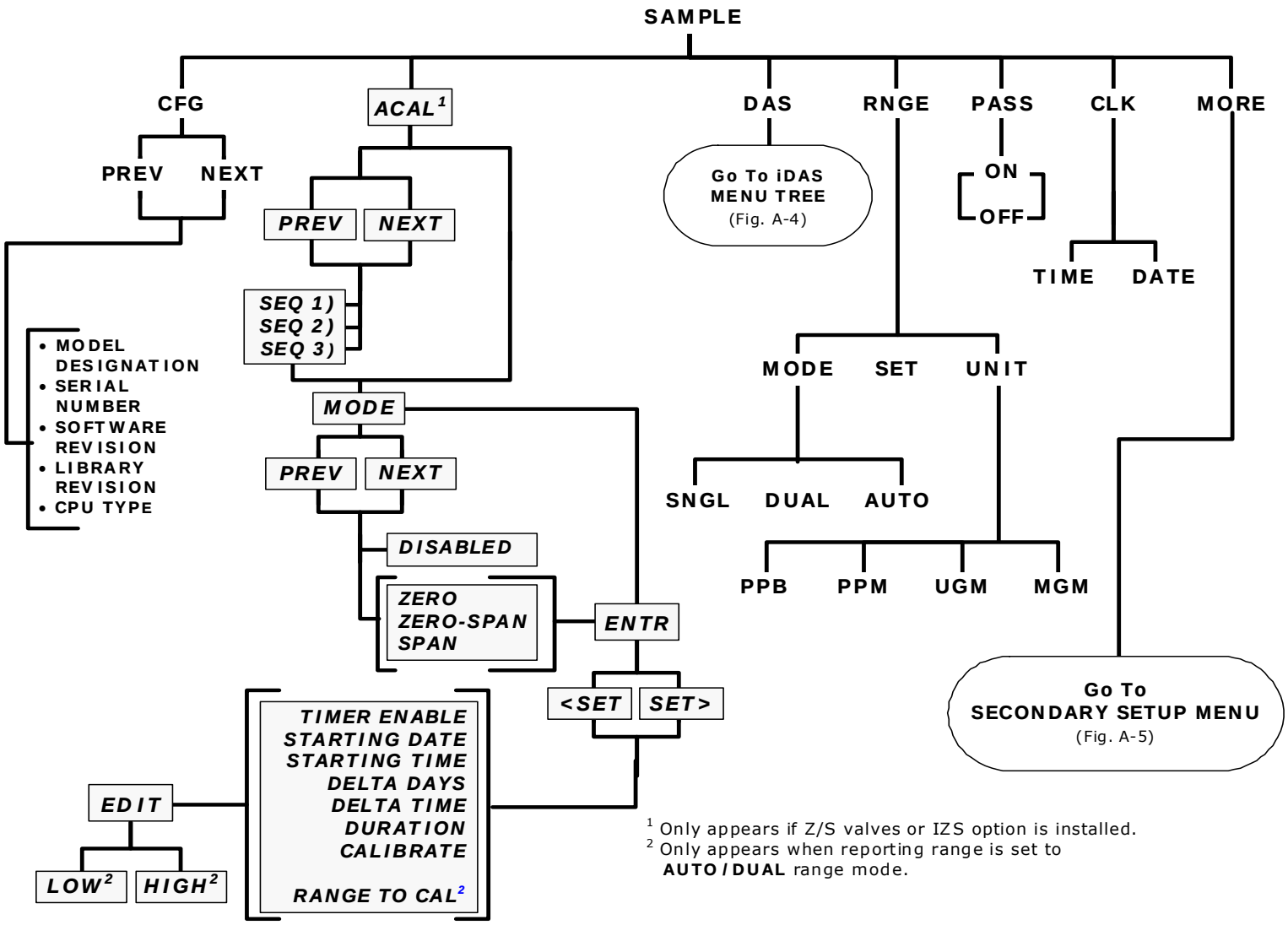


Figure A-3: Primary Setup Menu (Except iDAS)

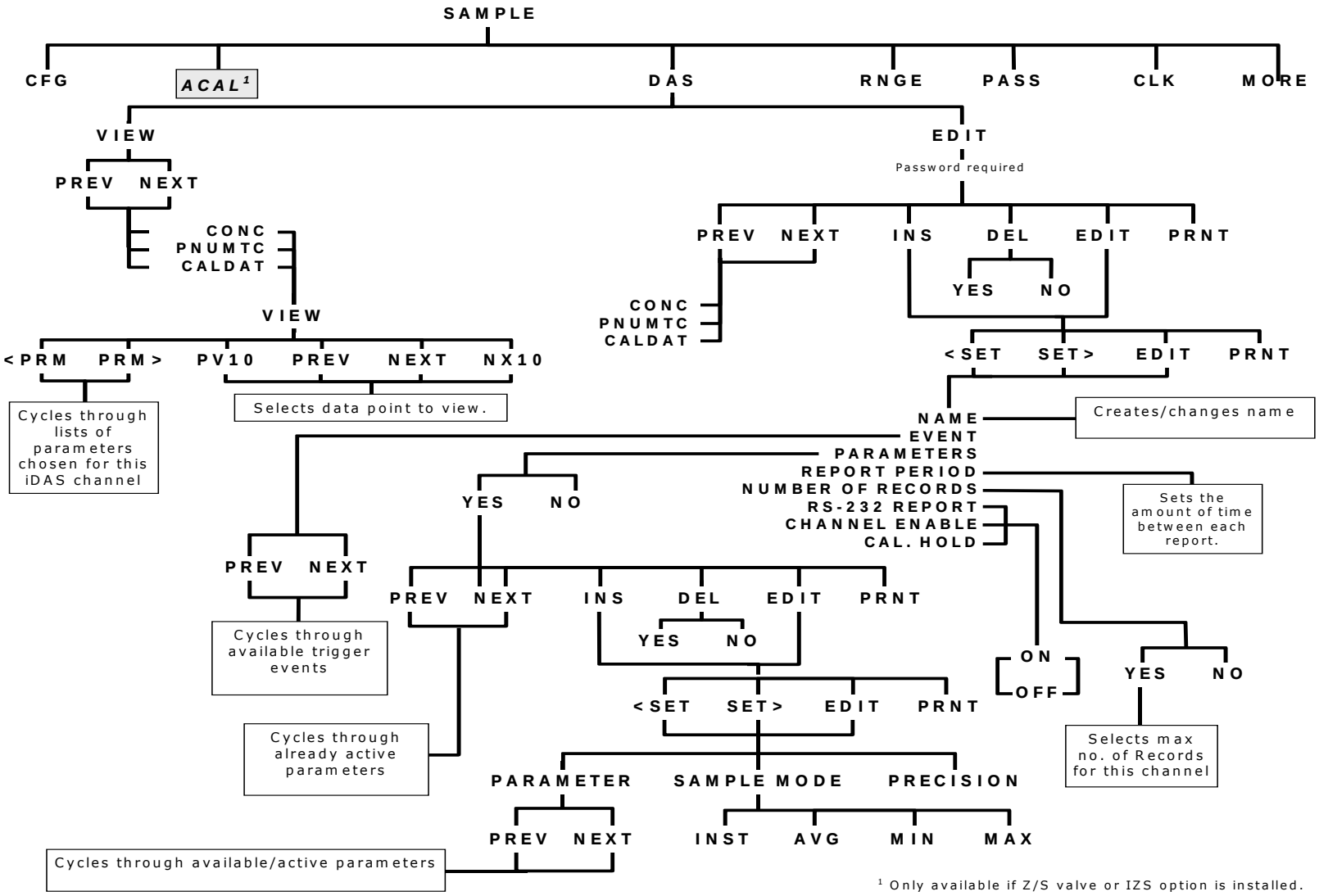
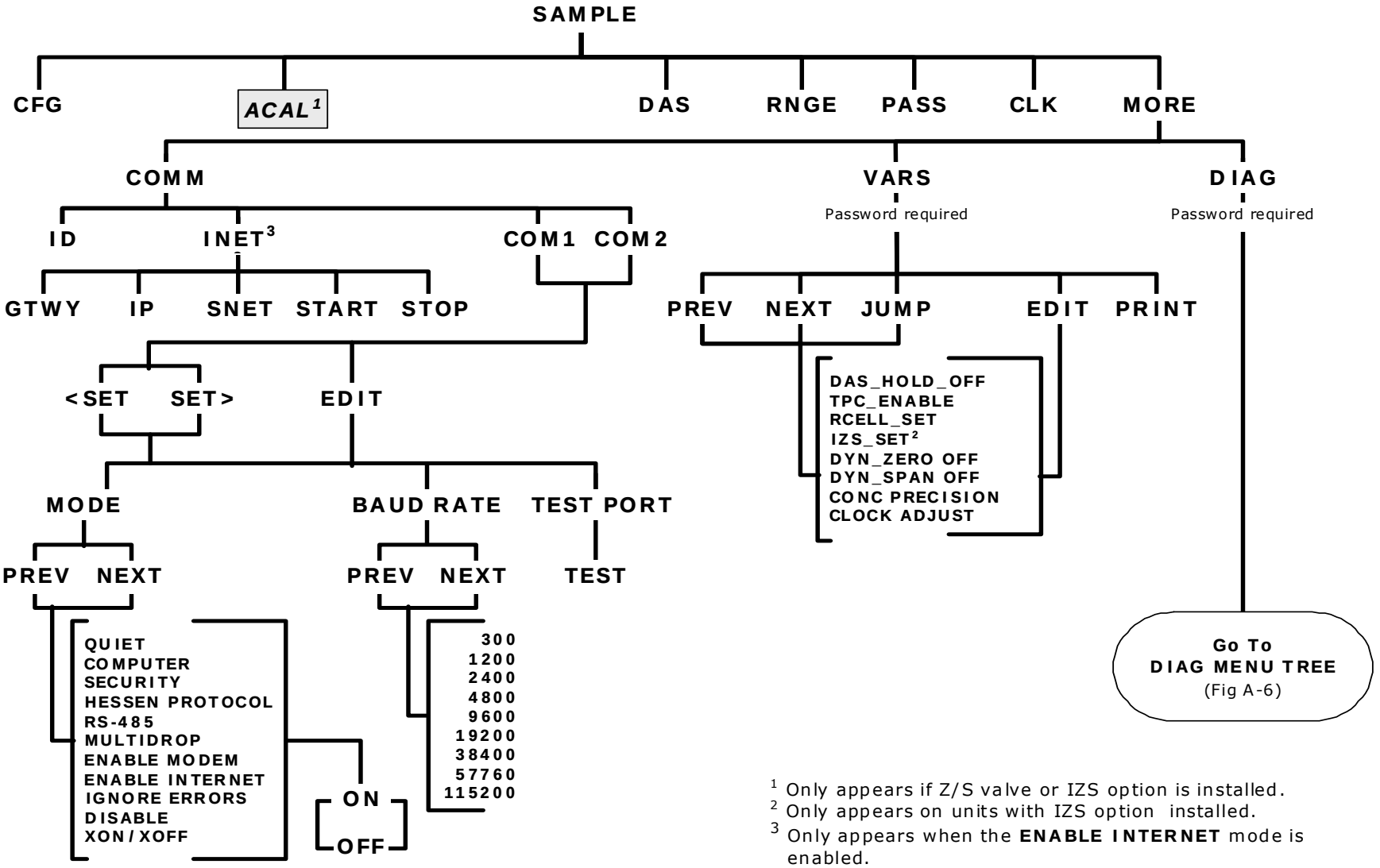


Figure A-4: Primary Setup Menu (iDAS)



[1] Only appears if Z/S valve or IZS option is installed.
[2] Only appears on units with IZS option installed.
[3] Only appears when the **ENABLE INTERNET** mode is enabled.

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

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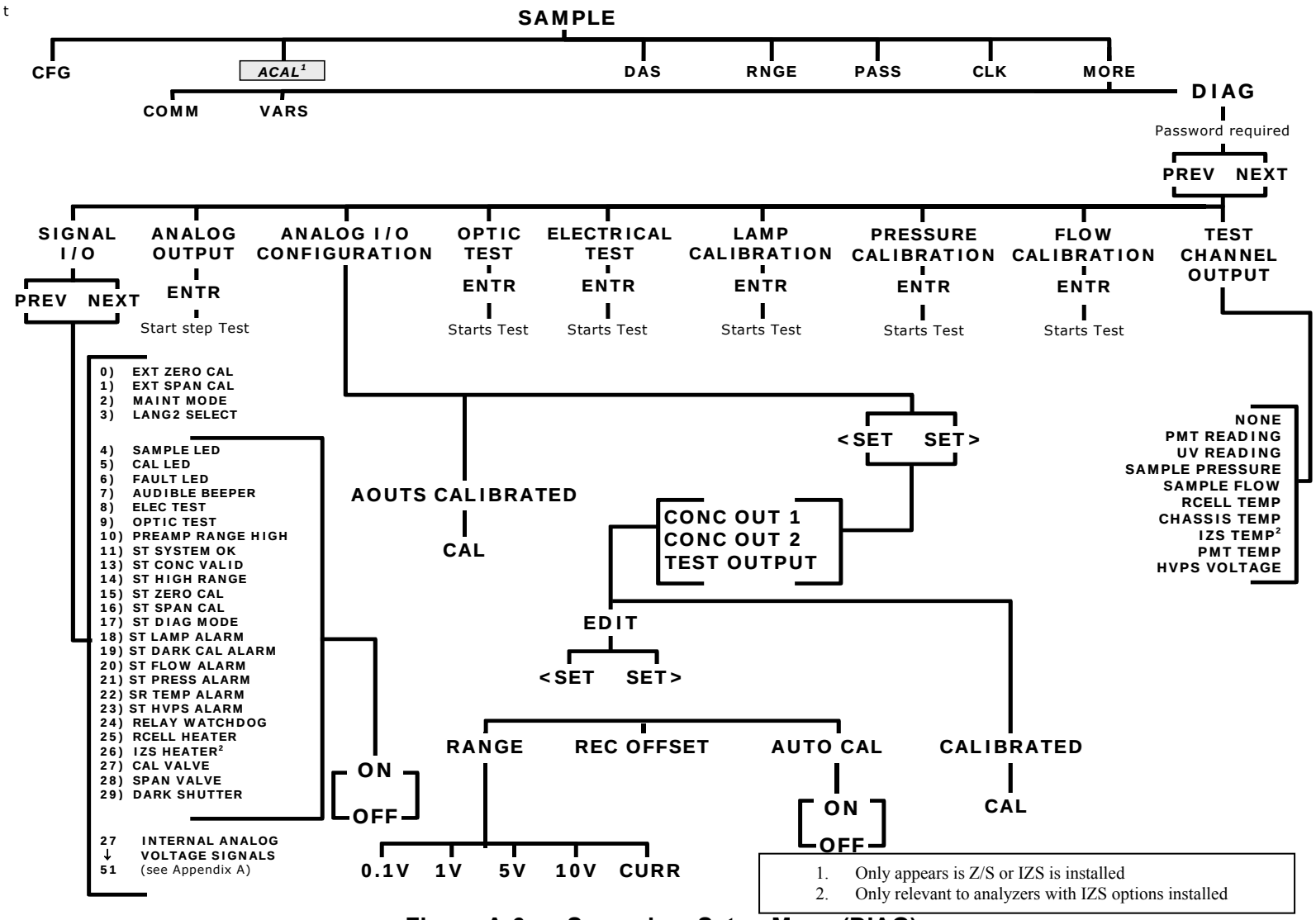

Figure A-6: Secondary Setup Menu (DIAG)

4. CALIBRATION PROCEDURES

TELEDYNE
INSTRUMENTS
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Service Note

04-012B
2 MAY, 2007

UV LAMP REPLACEMENT/ADJUSTMENT PROCEDURE IN "A" AND "E" SERIES ANALYZERS

I. PURPOSE:

To inform the user on the proper steps to replacing and recalibrating a UV lamp in a SO2 analyzer and to deduce when is the proper time to replace a Lamp. This procedure works for all "A" and "E" series Sulfur analyzers.

II. TOOLS:

Potentiometer Trimmer or a small flat head screwdriver
Phillips head screwdriver

III. PARTS:

KIT000236 (A or E series UV Lamp)

IV. PROCEDURE:

With the instrument on for at least 30 minutes, remove the screws holding the cover in place and remove the cover.

1. Use the <TST> buttons on the front panel until the UV LAMP reading is displayed.
2. Adjust the Gain potentiometer on the UV reference preamp until the UV LAMP reading is at its minimum value.
3. Refer to figure 1 for locations of the UV lamp and Gain potentiometer for "E" style instruments. Refer to Figure 2 for location in "A" style instruments.
4. Loosen the thumbscrew to allow the lamp to move freely. When adjusting the UV lamp make sure to hold onto the heat shrink portion of the lamp and not the very top. First, slowly move the UV lamp up and down while monitoring the UV LAMP display to read maximum value. Then slowly rotate the lamp left and right while monitoring the UV LAMP display to read maximum value
5. Finger tight the thumbscrew.
6. Adjust the UV reference POT to approximately 3500 mV.
7. If the UV lamp will not adjust to 3500mv then you should plan on replacing the UV lamp soon. If the UV LAMP display is lower than 1000mV after peak adjustment, it is recommended to have a replacement lamp on hand. Most UV lamps that produce a UV lamp reading above 600 mV are still in good condition and will give correct readings. If the UV LAMP reading is below 600 mV after peaking the lamp it will cause the instrument to read incorrectly and must be replaced.
8. If you have to replace the lamp go to step 9. If the UV lamp is good go to step 13.
9. Turn off power to the analyzer and unplug the power cable.

10. Disconnect the connectors on each wire of the UV lamp for an "A" series analyzer or the single 8pin connector for an "E" series analyzer. Loosen the thumbscrew and pull the UV lamp out of its holder and replace it with the new UV lamp connecting both wires back up (There is no polarity on the UV lamp and it can be wires can be hooked both ways) if you have an "A" or the single 8pin connector if you have an "E".
11. Plug the analyzer back in and turn the power back on. Allow 30 minutes for warm up.
12. Go back to step 2 of this procedure and repeat the UV lamp peaking process.
13. The next step is to calibrate the UV lamp. To do this follow press the following buttons on the front panel. <Setup><More><Diag><Enter> Press <next> until "UV Lamp Calibration" is displayed and Press <Enter>. The analyzer will then display the current UV lamp reading. Press <Enter> and then <exit><exit><exit> to return to the front panel.
14. Replace the Cover to the analyzer and return it to normal operation.
15. After following these steps you will have to perform a factory calibration on the analyzer. Please see your operations manual for instruction on how to perform this procedure.

FIGURE 1
E-SERIES INSTRUMENTS

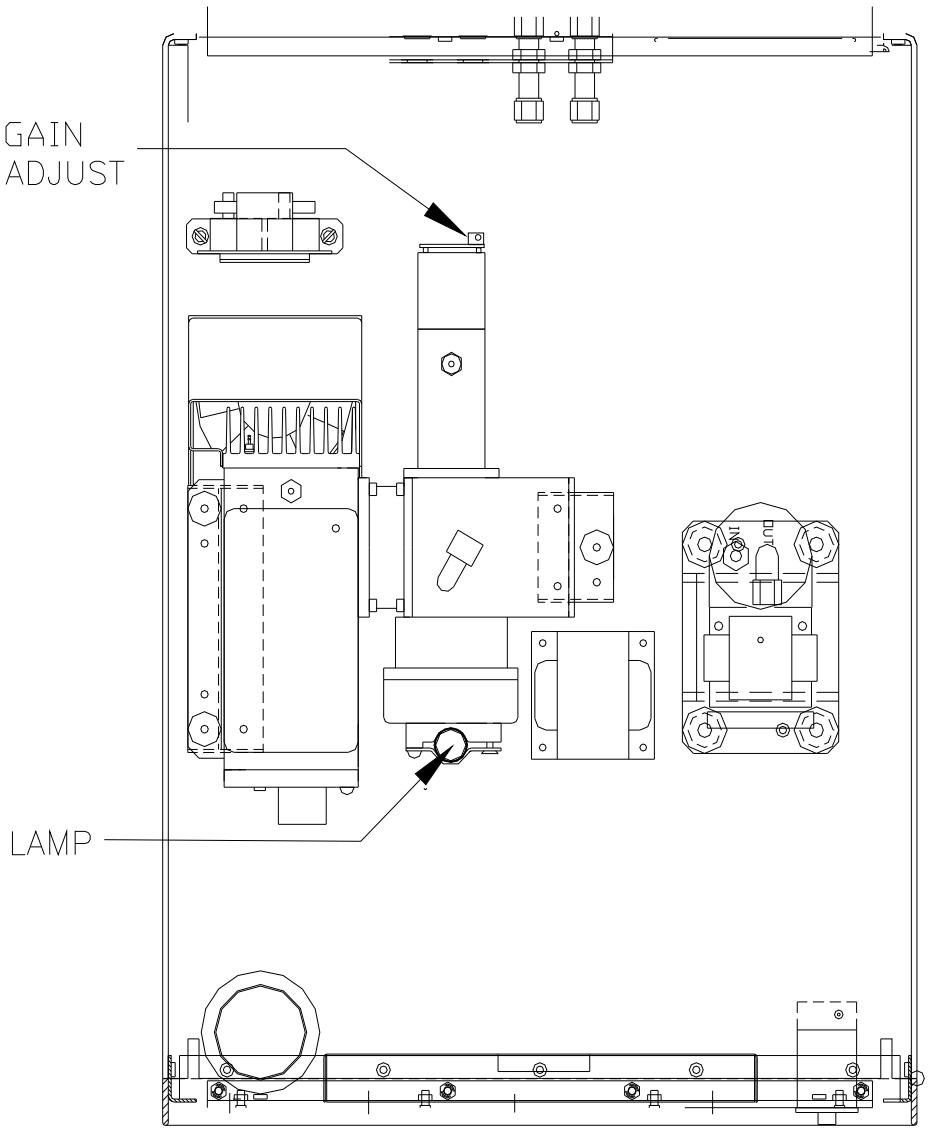
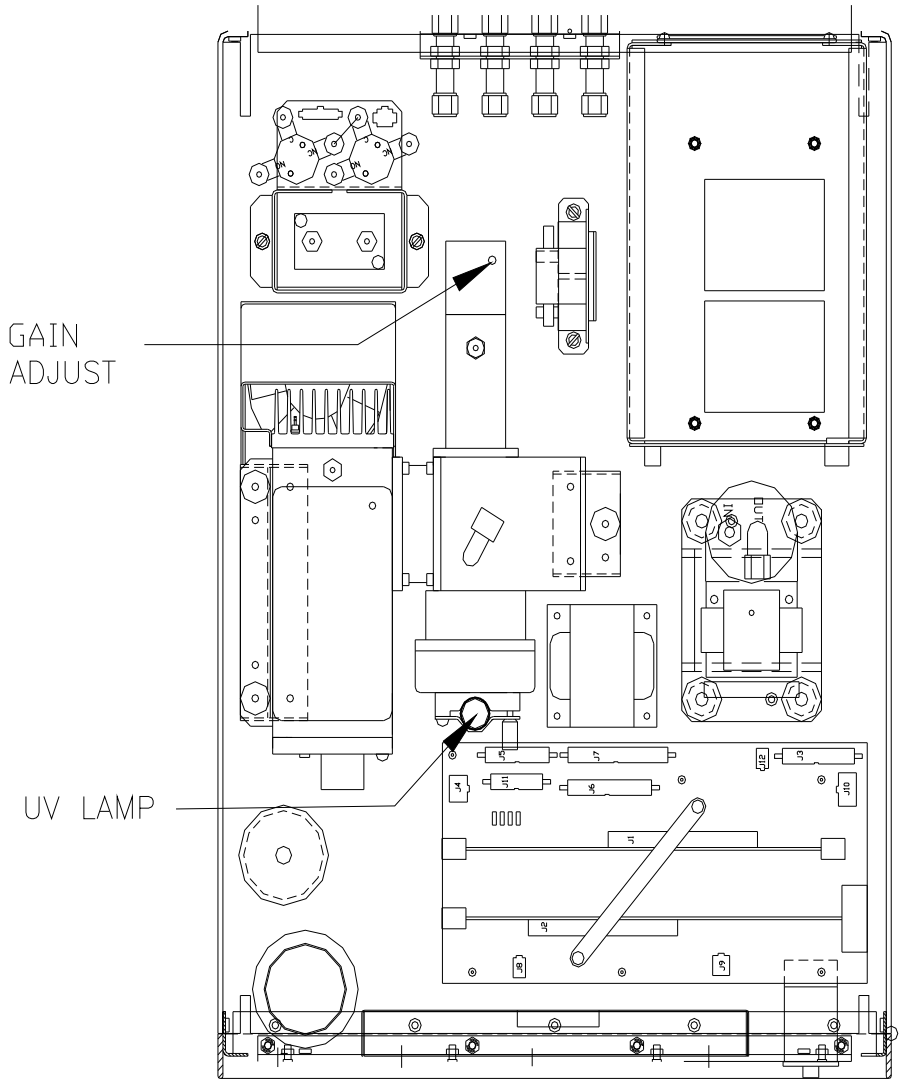


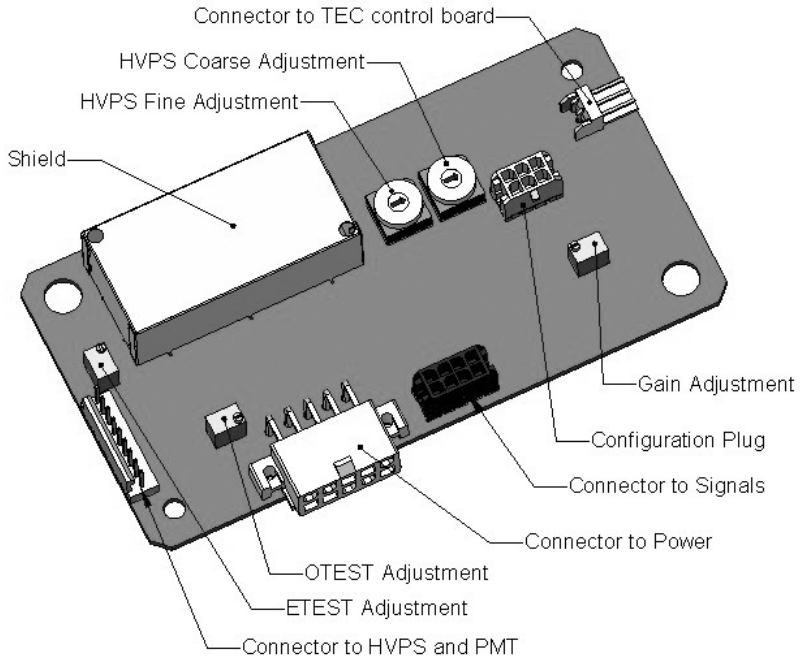
FIGURE 2
A STYLE INSTRUMENTS



Factory Calibration for a M100E

The sensor module hardware calibration adjusts the slope of the PMT output when the Instrument's 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 UV lamp adjustment and calibration, see service note 04-012.
- 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 R29 gain adjustment potentiometer 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)+OFFSET
  Ranges 2000.1 and above
  TARGET NORM PMT=(0.182*CONC)+OFFSET
- Set the HVPS coarse adjustment switch to the lowest setting that will give you more than 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 as possible. 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 to the TARGET NORM PMT value. This is the final very-fine adjustment, and takes a little time to stabilize, re-adjust as necessary.

- 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 mV.

Service Note

9480 Carroll Park Drive, 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

03-020B
2 MAY, 2007

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> until it reads read A/IN CALIBRATED:
3. Press CAL to calibrate the analog inputs.
4. Press <SET until the top line reads CONC_OUT_1 and press EDIT
   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.
5. 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.
6. 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.
7. Press SET>. The top line should read CONC_OUT_1: CALIBRATED: YES
8. Now place your meter on pins 1 and 2 on the rear panel analog output connector and set your meter to read mvDC.
9. Press CAL on the front panel.
10. You should have some DN and UP buttons. And the top line should be say ZERO ADJUST or something similar.

11. 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 12
12. Press ENTR.
13. 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 voltage (i.e. 1V, 5V, 10V) you will have to change the range on the meter to read Volts instead of Mili-volts.
14. Press the DN and UP buttons until the output on the meter reads your full-scale voltage ±1mV.
15. Press ENTR
16. That channel is now calibrated.
17. 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 find out the current atmospheric pressure. This can be found from a barometer or by contacting your local airport or weather station.

Next, disconnect the pump. You can either do this pneumatically or electrically. Also disconnect any tubing connected to the sample inlet or exhaust ports on the back of the analyzer. This will put the analyzer at atmospheric pressure.

From the front panel of the analyzer press <SETUP><MORE><DIAG> and enter 929 for the password whenever it asks for it. Once in the DIAG menu scroll over until you get 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. This should be equal to the atmospheric pressure now. Reconnect the pump and the pressure should drop a few inches. Reconnect the sample inlet and exhaust and the pressure should remain the same +- 0.2”Hg. If the pressure changes more than this when you reconnect the sample and exhaust lines, 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, connect an external flow meter to the sample inlet port on the back of the analyzer. Record the flow rate. 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 scroll over until you get Flow Calibration and hit <ENTER><CAL>. Now enter the value you measured with the external flow meter and hit Enter. This will calibrate the flow meter in the analyzer. Exit back out to the main menu and scroll through the TST values till you get Flow. It should be reading close to the measured value.

5. MAINTENANCE

THE FOLLOWING TABLE IS THE MAINTENANCE SCHEDULE FOR THE M100E. 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.

M100E Preventive Maintenance Schedule

Item	Action	Priority	Frequency	Cal Check	Date Performed								
Particulate filter	Change particle filter	Mandatory	Weekly or As Needed	No									
External zero air scrubber (optional)	Exchange chemical	Mandatory	Annually	No									
Flow controller	Replace sintered filter & O-rings	Mandatory	Annually	Yes									
Particulate filter on Zero air scrubber (Optional)	Replace	Mandatory	Annually or as needed	No									
Pump	Rebuild	Mandatory	Annually or as needed	Yes									
Zero/span calibration	Zero and span calibration	As Needed	Annually or as needed	Yes									
Sample Chamber window	Clean	As Needed	As necessary	Yes									
Zero/span check	Evaluate offset and slope	Recomm-ended	Weekly	Yes									
TEST functions	Review and evaluate	Recomm-ended	Weekly	No									
Pneumatic sub-system	Check for leaks in gas flow paths	Recomm-ended	Annually or after repairs involving pneumatics	Yes on leaks, else no									
PMT Sensor Hardware Calibration	Low-level hardware calibration	Recomm-ended	On PMT or preamp changes	Yes									

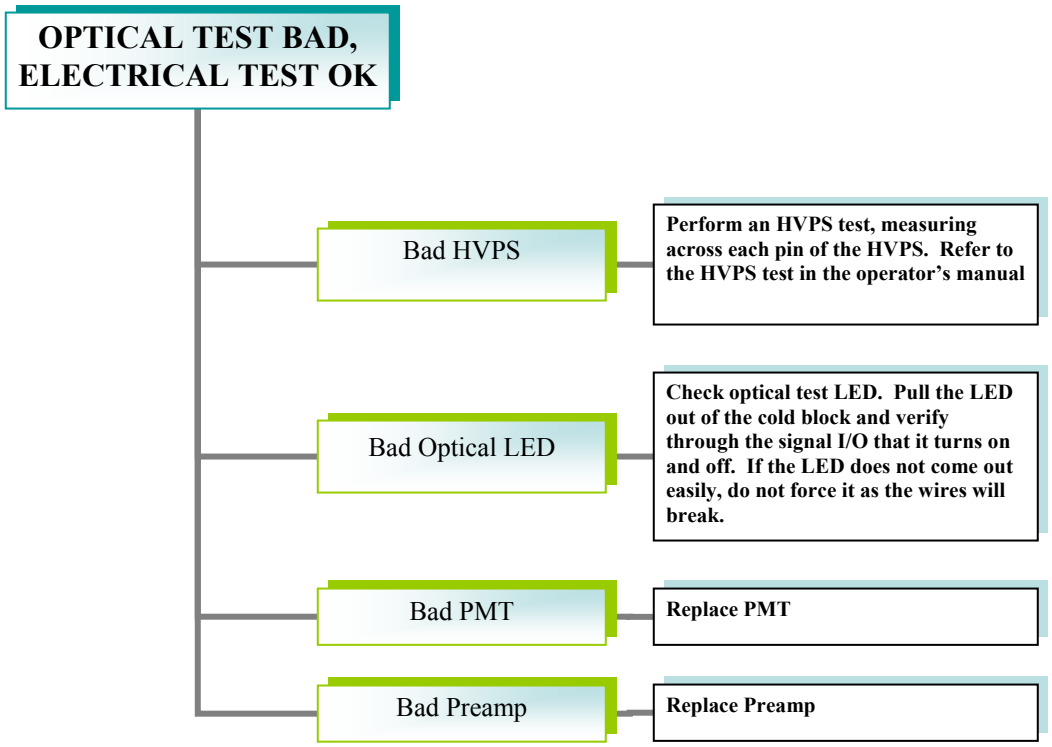
USER NOTES:

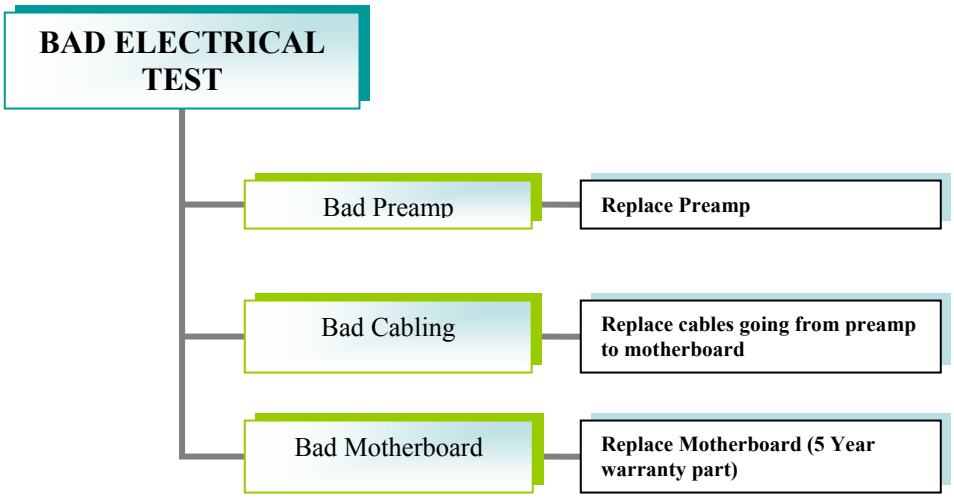
6. TROUBLESHOOTING & FAULTS

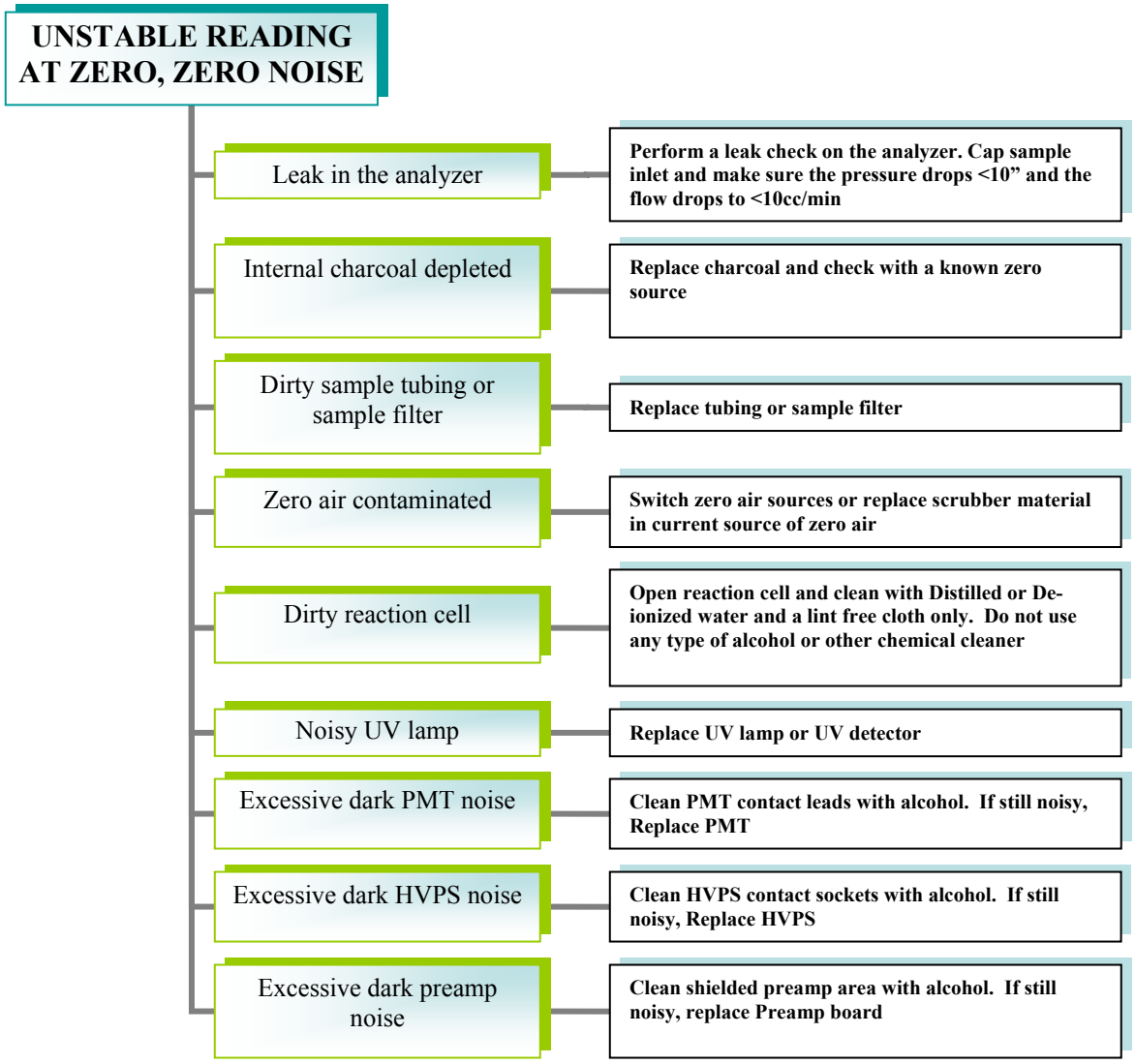
M100E Troubleshooting Tree

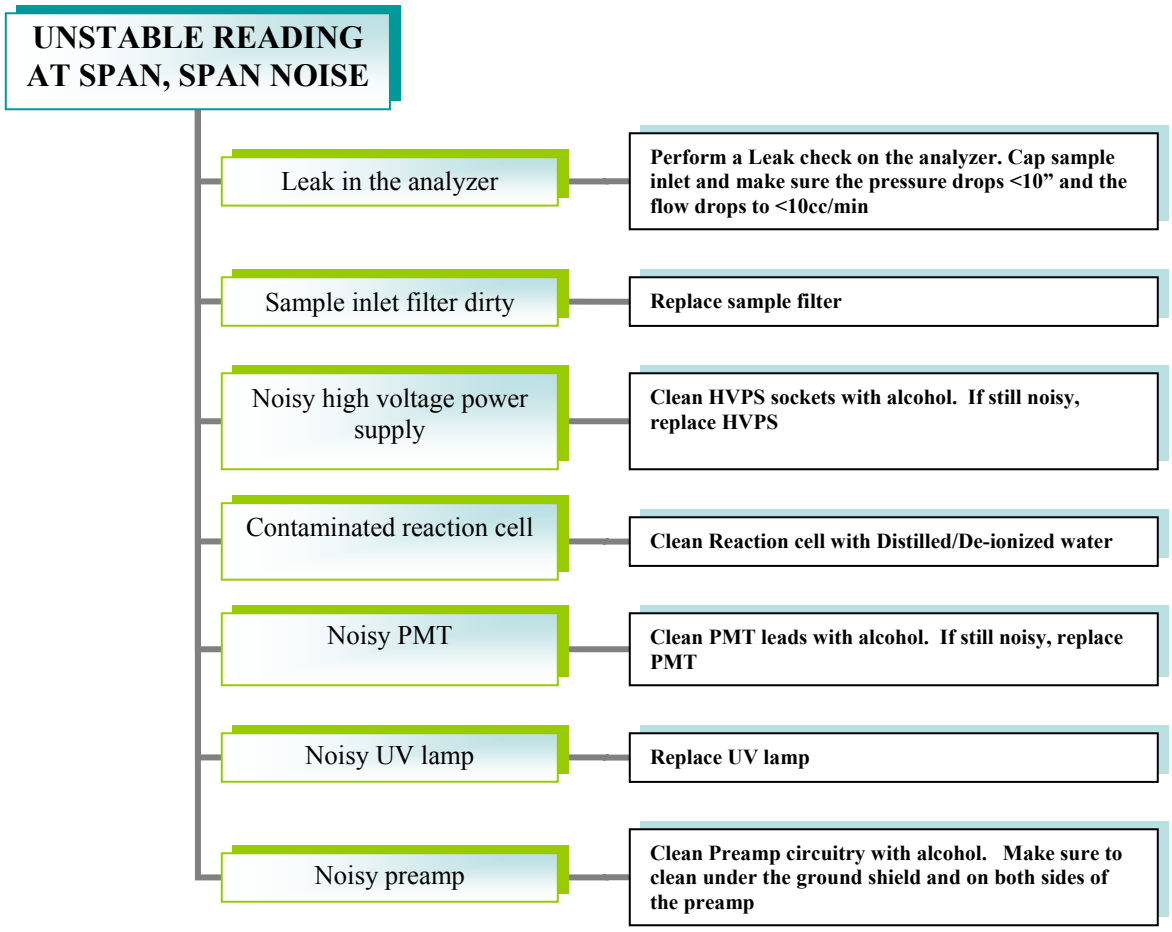
Troubleshooting Trees

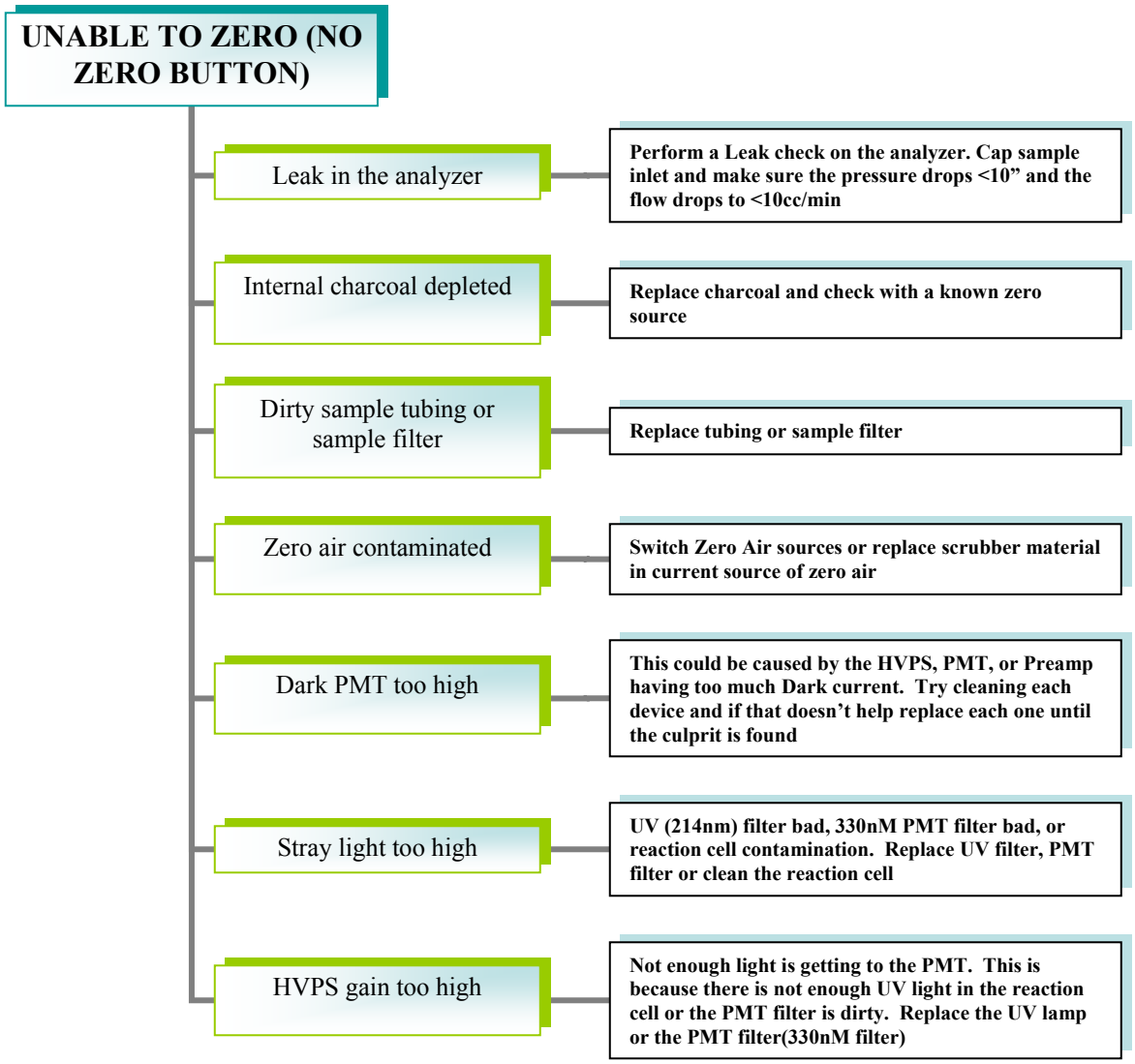
- No Power
- No front panel or locking up Display
- Optical Test bad, Electrical Test OK
- Bad Electrical Test
- Unstable Reading at Zero, Zero noise
- Unstable Reading at Span, Span noise
- Unable to Zero (No Zero Button)
- Unable to Span (No Span button or no response to Span gas)
- Non-Linear Response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

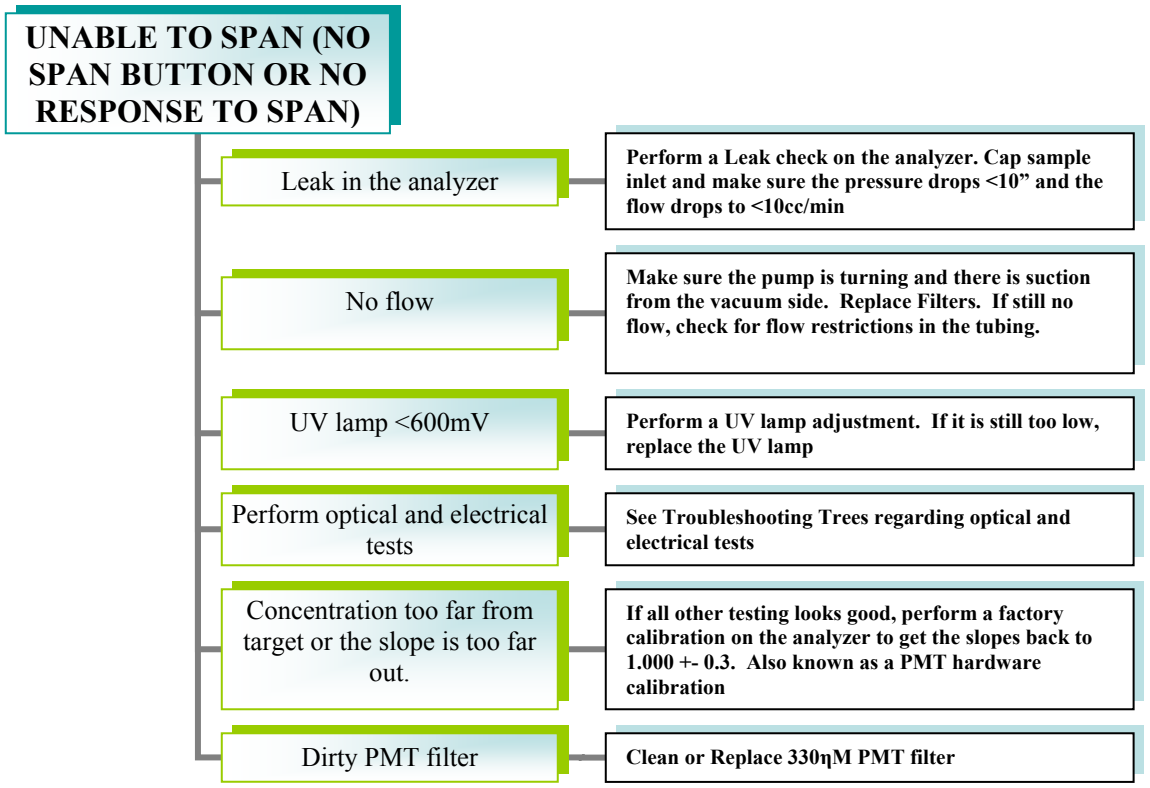


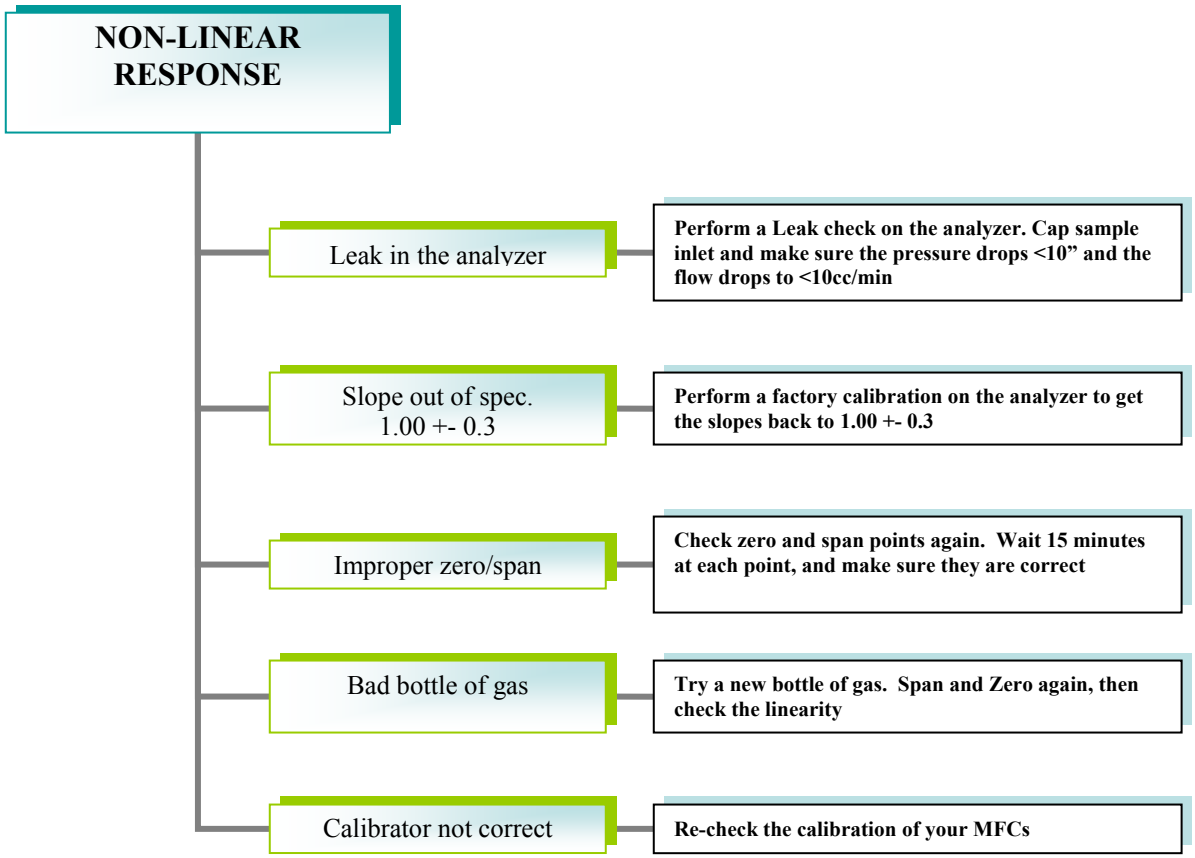


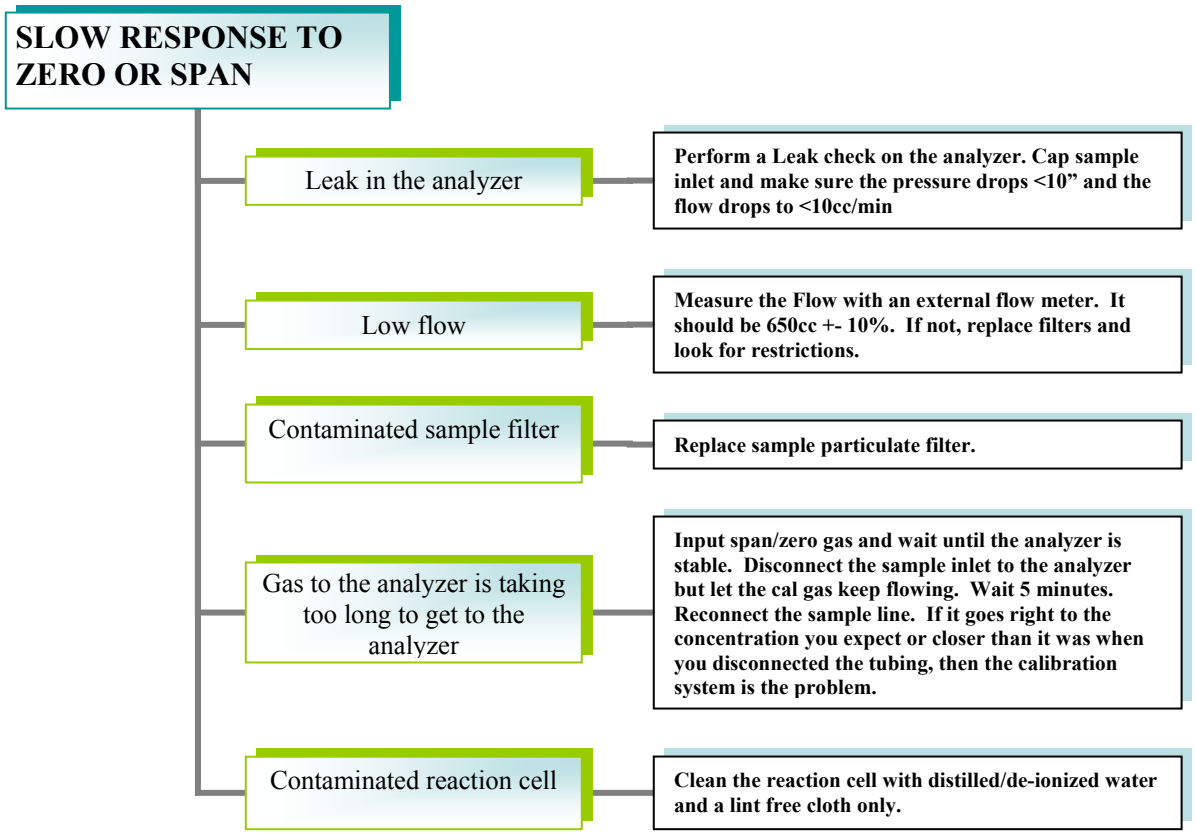


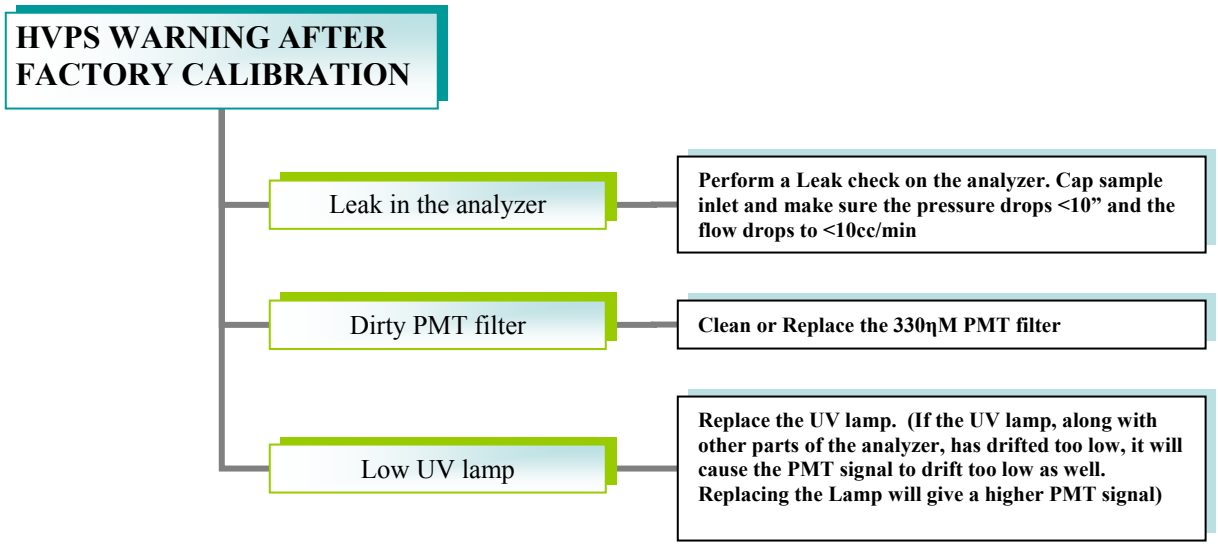


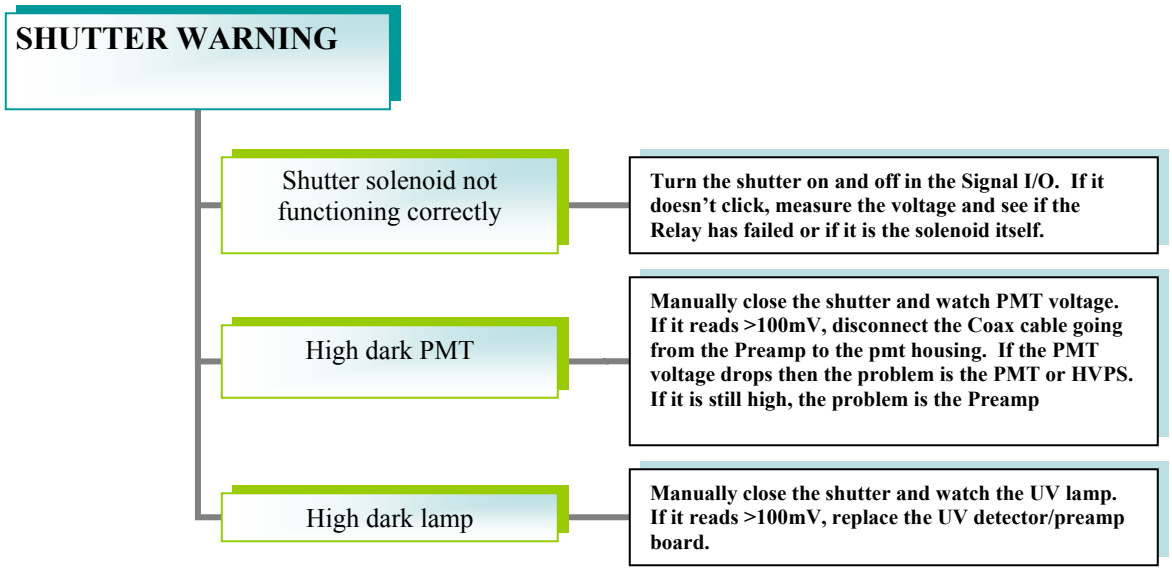


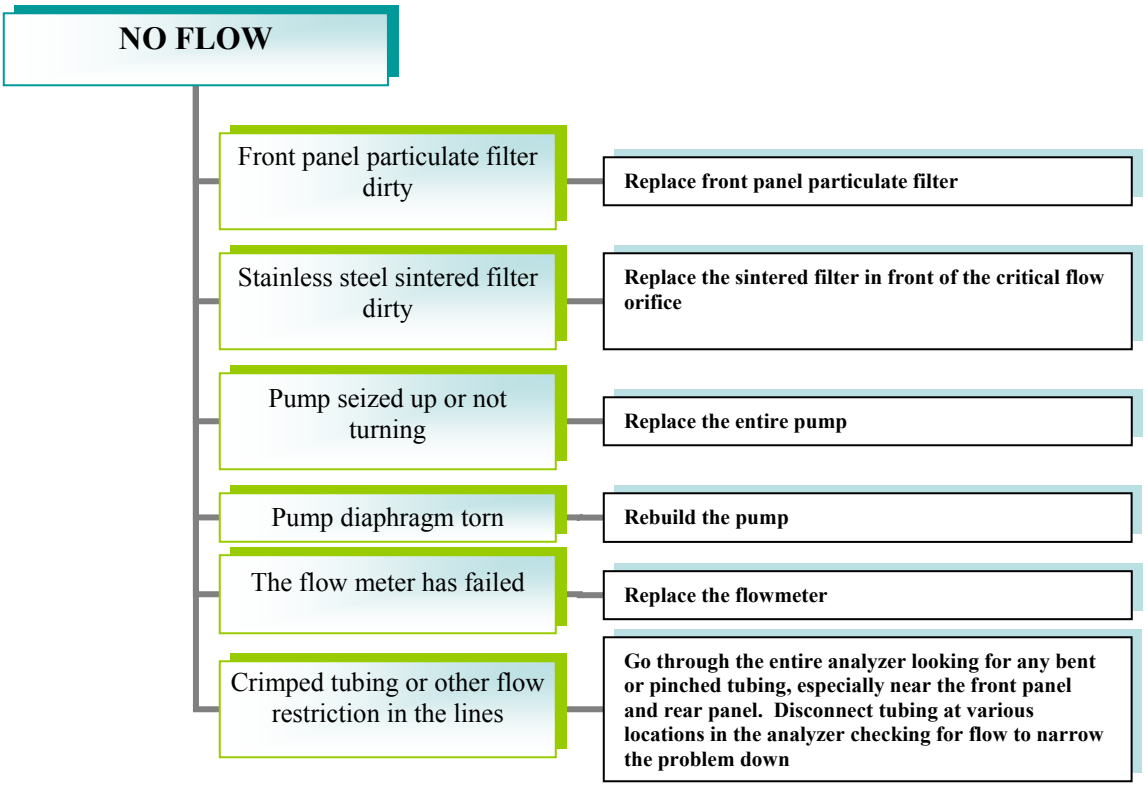


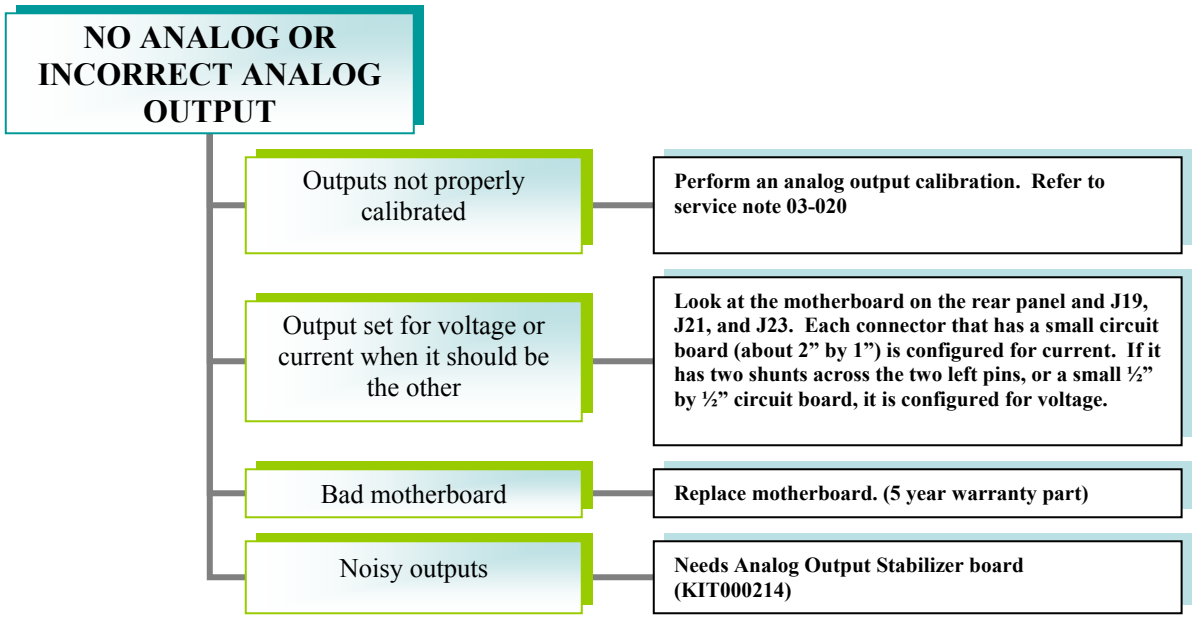


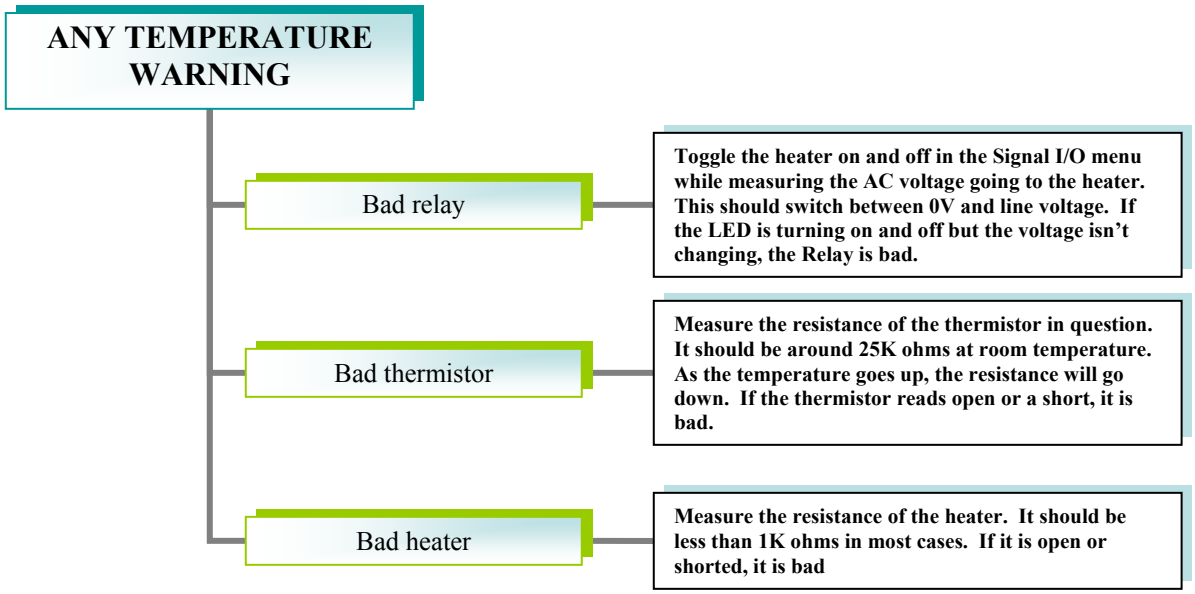




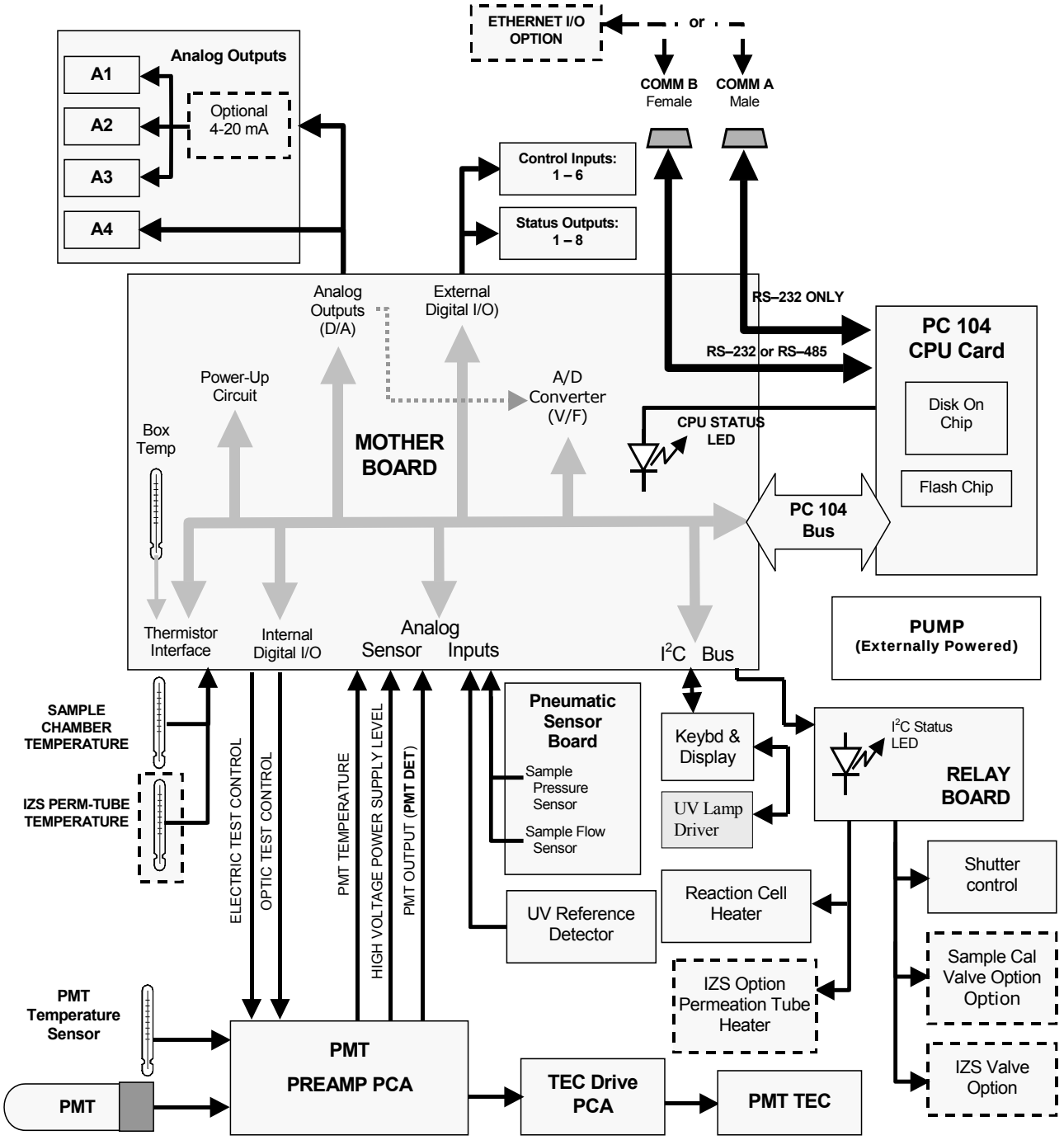








M100E Electronic Interconnect Diagram



Model 100E

Warranty/Repair Questionnaire Model 100E

CUSTOMER: _____ PHONE: _____

CONTACT NAME: _____ FAX NO. _____

SITE ADDRESS: _____

MODEL 100E SERIAL NO.: _____ FIRMWARE REVISION: _____

1. ARE THERE ANY FAILURE MESSAGES? _____

_____

_____

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

Parameter	Recorded Value	Acceptable Value
RANGE	PPB/PPM	
STABIL	PPB	≤1 PPB WITH ZERO AIR
SAMP PRESS	IN-HG-A	AMBIENT ± 2 IN-HG-A
SAMPLE FLOW	CM^3/MIN	650 ± 10%
PMT SIGNAL WITH ZERO AIR	mV	-20 TO 150 mV
PMT SIGNAL AT SPAN GAS CONC	mV PPB/PPM	0-5000 mV 0-20000 PPB
NORM PMT AT SPAN GAS CONC	mV PPB/PPM	0-5000 mV 0-20000 PPB
UV LAMP	mV	1000 TO 4000 mV
LAMP RATIO	mV	25 TO 120%
STR. LGT	PPB	≤ 100 PPB/ ZERO AIR
DARK PMT	mV	-50 TO 200 mV
DARK LAMP	mV	-50 TO 200 mV
SLOPE		1.0 ± 0.3
OFFSET	mV	< 250 mV
HVPS	V	≈ 400 – 800
RCELL TEMP	ºC	50ºC ± 1
BOX TEMP	ºC	AMBIENT + ~ 5
PMT TEMP	ºC	7ºC ± 2º CONSTANT
IZS TEMP*	ºC	50ºC ± 1
ETEST	mV	2000 mV ± 500
OTEST	mV	2000 mV ± 1000
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

3. WHAT IS THE SAMPLE FLOW & SAMPLE PRESSURE WITH THE SAMPLE INLET ON REAR OF MACHINE CAPPED?

   SAMPLE FLOW -_____CC **SAMPLE PRESS -** _____IN-HG-A

4. WHAT ARE THE FAILURE SYMPTOMS?

   _____

   _____

   _____

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.

TELEDYNE API CUSTOMER SERVICE
Email: api-customerservice@teledyne.com
PHONE: (858) 657-9800 TOLL FREE: (800) 324-5190 FAX: (858) 657-9816

USER NOTES:

7. SPECIFICATIONS

Model 100E Basic Unit Specifications

Min/Max Range (Physical Analog Output)	In 1ppb increments from 50ppb to 20,000ppb, dual ranges or auto ranging
Measurement Units	ppb, ppm, µg/m3, mg/m3 (user selectable)
Zero Noise[1]	0.2 ppb RMS
Span Noise[1]	0.5 ppb RMS
Lower Detectable Limit[2]	0.4 ppb RMS
Zero Drift (24 hours)	<0.5 ppb
Zero Drift (7 days)	1 ppb
Span Drift (7 Days)	<0.5% FS
Linearity	1% of full scale
Precision	0.5% of reading[1]
Temperature Coefficient	< 0.1% per ^{o}C
Voltage Coefficient	< 0.05% per V
Lag Time[1]	20 sec
Rise/Fall Time[1]	95% in <100 sec
Sample Flow Rate	650cc/min. ±10%
Temperature Range	5-40°C
Humidity Range	0 - 95% RH, non-condensing
Dimensions H x W x D	7" x 17" x 23.5" (178 mm x 432 mm x 597 mm)
Weight, Analyzer (Basic Configuration)	45 lbs (20.5 kg) w/internal pump
AC Power Rating	100 V, 50/60 Hz (3.25A); 115 V, 60 Hz (3.0 A); 220 – 240 V, 50/60 Hz (2.5 A)
Environmental	Installation category (over-voltage category) II; Pollution degree 2
Analog Outputs	Three (3) Outputs
Analog Output Ranges	100 mV, 1 V, 5 V, 10 V, 2-20 or 4-20 mA isolated current loop. All Ranges with 5% Under/Over Range
Analog Output Resolution	1 part in 4096 of selected full-scale voltage
Status Outputs	8 Status outputs from opto-isolators
Control Inputs	6 Control Inputs, 3 defined, 3 spare
Serial I/O	One (1) RS-232; One (1) RS-485 (2 connecters in parallel) Baud Rate : 300 – 115200: Optional Ethernet Interface
Certifications	USEPA EQSA-0495-100 MCERTS certified Sira MC050067/00 EN14212 Approved, and others.

[1] As defined by the USEPA.
[2] Defined as twice the zero noise level by the USEPA.

8. OTHER SULFUR ANALYZERS

M100EU

Theory of Operation

The M100EU is a modified M100E. The primary differences are the way in which the PMT and UV reference signals are acquired and processed. The M100EU has no shutter but rather employs synchronous demodulation to capture the dark and light PMT and UV reference signals at a frequency of 3.333Hz, or 3 times a second. A printed circuit board, the Sync Demodulator, attached to the end of the PMT housing, on the sensor assembly, includes circuitry that digitizes the PMT and UV reference signals and synchronizes the operation of the UV source with these measurements. This method of signal processing minimizes the error that changing offsets could make in an instrument that is designed to operate near its detection limit.

Sensor Module

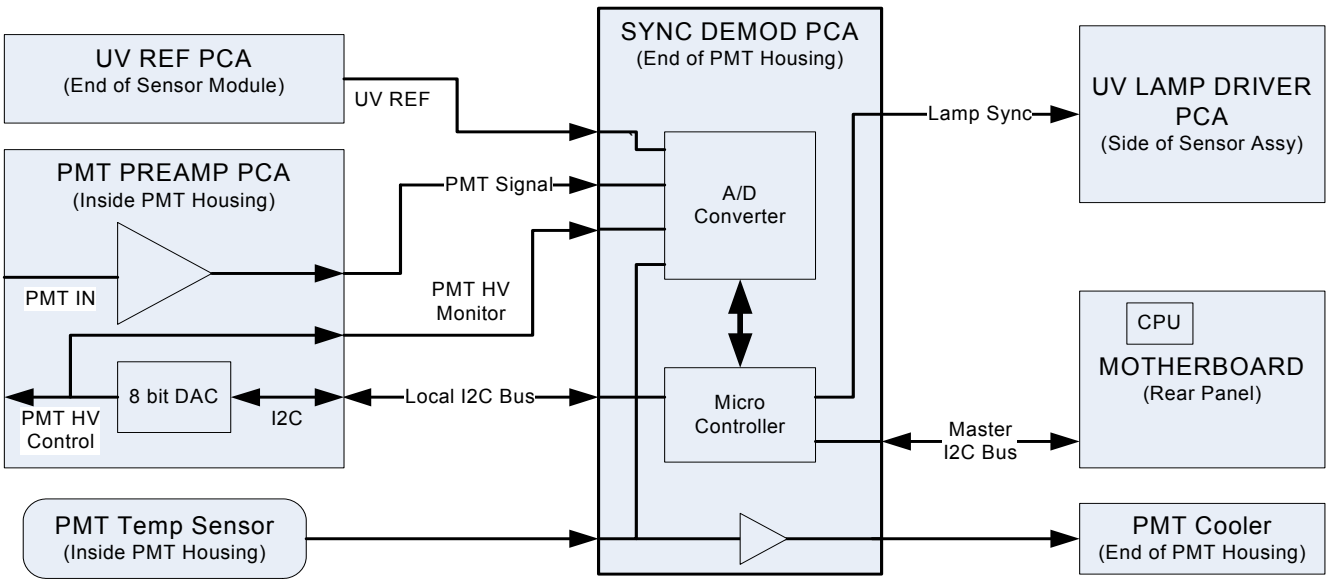
At the heart of the M100EU's signal processing, illustrated on the next page, is the Synchronous Demodulator PCA. The PCA is attached to the end of the PMT housing and serves to seal the end of the PMT housing. This board also contains the PMT preamp and HVPS circuitry. There are no adjustments on this board as everything is controlled by electronic potentiometers. The sync demodulator controls the operation of the 48mA UV Lamp driver, digitizes the analog output signals from the PMT UV reference detector and PMT temperature sensor, controls the PMT cooler (TEC), controls the PMT HV via a local I^2C bus, and communicates with the analyzer's CPU over the master I^2C bus. Digitized and processed data from the UV reference and PMT are passed to the analyzer's CPU over the master I^2C bus and data for control of the PMT HV control DAC is passed from the CPU to the DAC on the PMT preamp via the microcontroller on the Sync Demod board.

The UV lamp signal also has a large averaging filter incorporated into it. The reason for this is to flatten out any spiking or noise that may be in the UV lamp or the UV detector providing a more stable reading. The important thing to know about this is that if you disconnect the UV lamp it may take some time before the UV reading on the front panel starts to drop down. The analyzer uses the same 214.3ηm UV filter as the M100E except that this filter must be changed out annually as it is crucial to the noise level of the analyzer.

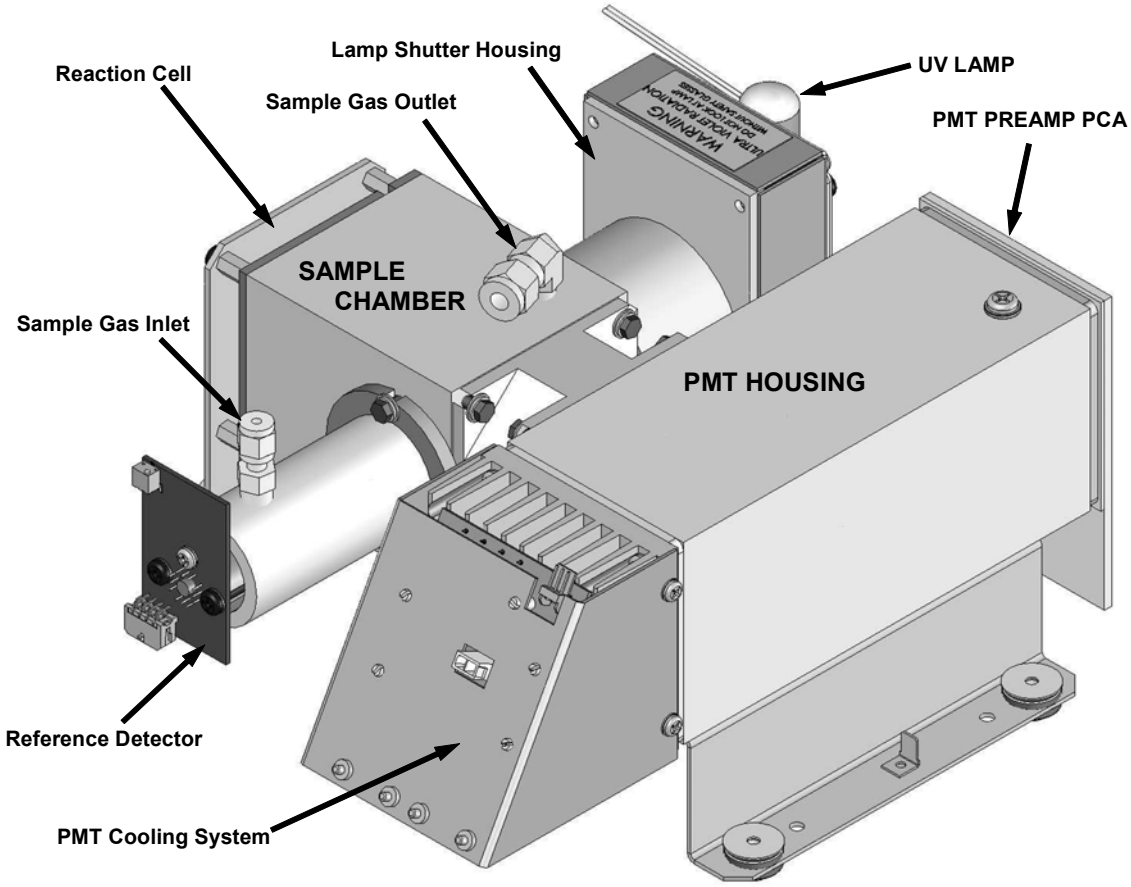
The M100EU can be configured with a 360nm PMT filter instead of the standard 330nm filter covered in the M100E section of this manual. There are pros and cons for using each filter. See the table below to see the differences.

PMT Filter Wavelength	NOx Rejection Ratio	Noise Level	7 Day Zero Drift
330ηm	**50:1**	**25ppt RMS**	**<200ppt**
360ηm	**250:1**	**50-75ppt RMS**	**<400ppt**

As you can see the 360ηm filter does a much better job of removing NOx interference but unfortunately causes the analyzer to become noisier.



Sensor Block Diagram



M100EU Sensor Module Assembly

M100EU SPAN CALIBRATION

Note: The M100EU is very different from the M100E in that there are no potentiometers on the preamp board. It utilizes electronic pots instead and all adjustments to the calibration are performed through the front panel.

1. CHECK THAT THE UV LAMP IS BETWEEN 3450MV AND 4750MV AND THAT THE HVPS IS 400-800 VDC. CHECK THAT THE LAMP RATIO IS CLOSE TO 100%; CALIBRATE THE UV LAMP IF NECESSARY.

2. INPUT SPAN GAS AND ALLOW TO STABILIZE FOR 30 MINUTES.

3. ON THE FRONT PANEL OF THE ANALYZER PRESS SETUP MORE DIAG 929 ENTR. PRESS THE NEXT BUTTON UNTIL YOU GET PMT CALIBRATION AND HIT ENTR. INPUT YOUR SPAN GAS VALUE INTO THIS MENU AND PRESS ENTR. SELECT THE RANGE YOU WITH TO CALIBRATE, MOST OF THE TIME IT WILL BE THE LOW RANGE AND HIT ENTR.

4. THE ANALYZER WILL NOW AUTOMATICALLY BEGIN TO ADJUST THE HVPS. THIS ADJUSTMENT WILL IN TURN AFFECT THE PMT MV READING ON THE FRONT PANEL. AFTER A FEW MINUTES THE CALIBRATION WILL BE COMPLETE.

5. WAIT 10 MINUTES AND PRESS CAL SPAN ENTER. VERIFY THAT THE SLOPE IS 1.0 +-0.5. IF IT ISN'T, YOU WILL NEED TO REPEAT THE CALIBRATION. THIS PROCESS MAY TAKE A FEW CALIBRATIONS IN ORDER TO HAVE THE ANALYZER GET A GOOD CALIBRATION.

6. INPUT A SOURCE OF ZERO AIR TO THE INSTRUMENT AND ALLOW TO STABILIZE FOR 30 MINUTES. PRESS CAL-ZERO TO CALIBRATE THE INSTRUMENT FOR ZERO.

Electric and Optic Test Adjustment

NOTE: Ensure that Zero air is connected to the Sample inlet before making the Electric and Optic Test adjustments.

Electric Test

Enter the VARS Menu using the 929 password and scroll over until you get ELEC_TEST_LEVEL, this is typically around the 70th or 80th var. You will need to set this value at different levels until the Electrical Test reading in the DIAG menu is close to the values below. It may take a few times of going into the VARS to set the values and then into the DIAG to check it before everything looks good.

PMT: 2000 MV *SO_2: 1000 PPB*

OPTIC TEST

Enter the VARS Menu using the 929 password and scroll over until you get OPTIC_TEST_LEVEL, this is typically around the 70th or 80th var. You will need to set this value at different levels until the Optical Test reading in the DIAG menu is close to the values below. It may take a few times of going into the VARS to set the values and then into the DIAG to check it before everything looks good.

PMT: 400 MV *SO_2: 200 PPB*

Model 100EU Basic Unit Specifications

Min/Max Range (Physical Analog Output)	In 1ppb increments from 50ppb to 20 000ppb, dual ranges or auto ranging
Measurement Units	ppb, ppm, µg/m3, mg/m3 (user selectable)
Zero Noise[2]	25 ppt RMS (50 ppt RMS with 360 nM filter installed)
Span Noise[2]	0.5% of reading RMS, above 5 ppb
Lower Detectable Limit[3]	50 ppt RMS
Zero Drift (24 hours)	<200 ppt (<400 ppt with 360 nM filter installed)
Zero Drift (7 days)	<200 ppt (<400 ppt with 360 nM filter installed)
Span Drift (7 Days)	<0.5% FS
Linearity	1% of full scale
Precision	0.5% of reading
Temperature Coefficient	< 0.1% per ^{o}C
Lag Time[1]	30 sec
Rise/Fall Time[1]	95% in <140 sec
Sample Flow Rate	650cc/min. ±10%
Temperature Range	5-40oC
Humidity Range	0 - 95% RH, non-condensing
Dimensions H x W x D	7" x 17" x 23.5" (178 mm x 432 mm x 597 mm)
Weight, Analyzer (Basic Configuration)	45 lbs (20.5 kg) w/internal pump
AC Power Rating	100 V, 50/60 Hz (3.25A); 115 V, 60 Hz (3.0 A); 220 – 240 V, 50/60 Hz (2.5 A)
Environmental	Installation category (over-voltage category) II; Pollution degree 2
Analog Outputs	Three (3) Outputs
Analog Output Ranges	100 mV, 1 V, 5 V, 10 V, 2-20 or 4-20 mA isolated current loop. All Ranges with 5% Under/Over Range
Analog Output Resolution	1 part in 4096 of selected full-scale voltage
Status Outputs	8 Status outputs from opto-isolators
Control Inputs	6 Control Inputs, 3 defined, 3 spare
Serial I/O	One (1) RS-232; One (1) RS-485 (2 connecters in parallel) Baud Rate : 300 – 115200: Optional Ethernet Interface
Certifications	EN61326 (1997 w/A1: 98) Class A, FCC Part 15 Subpart B Section 15.107 Class A, ICES-003 Class A (ANSI C63.4 1992) & AS/NZS 3548 (w/A1 & A2; 97) Class A. IEC 61010-1:90 + A1:92 + A2:95,
1-As defined by the USEPA; **2** – 25 samples taken, 10 sec. interval; **3** – Twice zero noise	

CUSTOMER: _____ PHONE: _____

CONTACT NAME: _____ FAX NO. _____

SITE ADDRESS: _____

MODEL 100EU SERIAL NO.: _____ FIRMWARE REVISION: _____

1. ARE THERE ANY FAILURE MESSAGES? _____

_____

_____

_____

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

Parameter ***IF OPTION IS INSTALLED**	**Recorded Value**	**Acceptable Value**
RANGE	PPB/PPM	
STABIL	PPB	≤0.3 PPB WITH ZERO AIR
STABIL2	PPB	<= 1 PPB WITH ZERO AIR
PRESS	IN-HG-A	AMBIENT (- 2) IN-HG-A
SAMPLE FLOW	cm^3/MIN	650 ± 10%
PMT SIGNAL WITH ZERO AIR	mV	-20 TO 150 mV
PMT SIGNAL AT SPAN GAS CONC	mV PPB/PPM	0-5000 mV 0-20000 PPB
NORM PMT AT SPAN GAS CONC	mV PPB/PPM	0-5000 mV 0-20000 PPB
UV LAMP	mV	2000 TO 4000 mV
UV STAB	mV	< 15mV
LAMP RATIO	mV	30 TO 120%
STR. LGT	PPB	≤ 100 PPB/ ZERO AIR
DARK PMT	mV	200-325
DARK LAMP	mV	-50 TO 200 mV
SLOPE		1.0 ± 0.5
OFFSET	mV	< 250 mV
HVPS	V	≈ 400 – 800
RCELL TEMP	ºC	50ºC ± 1
BOX TEMP	ºC	AMBIENT ± 5
PMT TEMP	ºC	9.5ºC ± 2º CONSTANT
IZS TEMP*	ºC	50ºC ± 1
ETEST	mV	2000 mV ± 500
OTEST	mV	2000 mV ± 1000
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

3. WHAT IS THE SAMPLE FLOW & SAMPLE PRESSURE W/SAMPLE INLET ON REAR OF MACHINE CAPPED?

   SAMPLE FLOW -_____CC **SAMPLE PRESS** - _____IN-HG-A

4. WHAT ARE THE FAILURE SYMPTOMS? _____

_____

_____

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.

M101E

H2S Conversion

The M101E H_2S analyzer is basically a SO_2 analyzer with a $H_2S \rightarrow SO_2$ conversion stage inserted into the gas stream before the sample gas enters the sample chamber.

The H_2S to SO_2 converter receives sample gas from which the SO_2 has been removed by a scrubber. This scrubber is filled with a proprietary material that converts the SO_2 to O_2 and allowing H_2S to pass unaffected. Once the naturally occurring SO_2 is removed from the sample gas, the special converter changes the H_2S in the sample stream to SO_2 using a high-temperature catalytic oxidation.

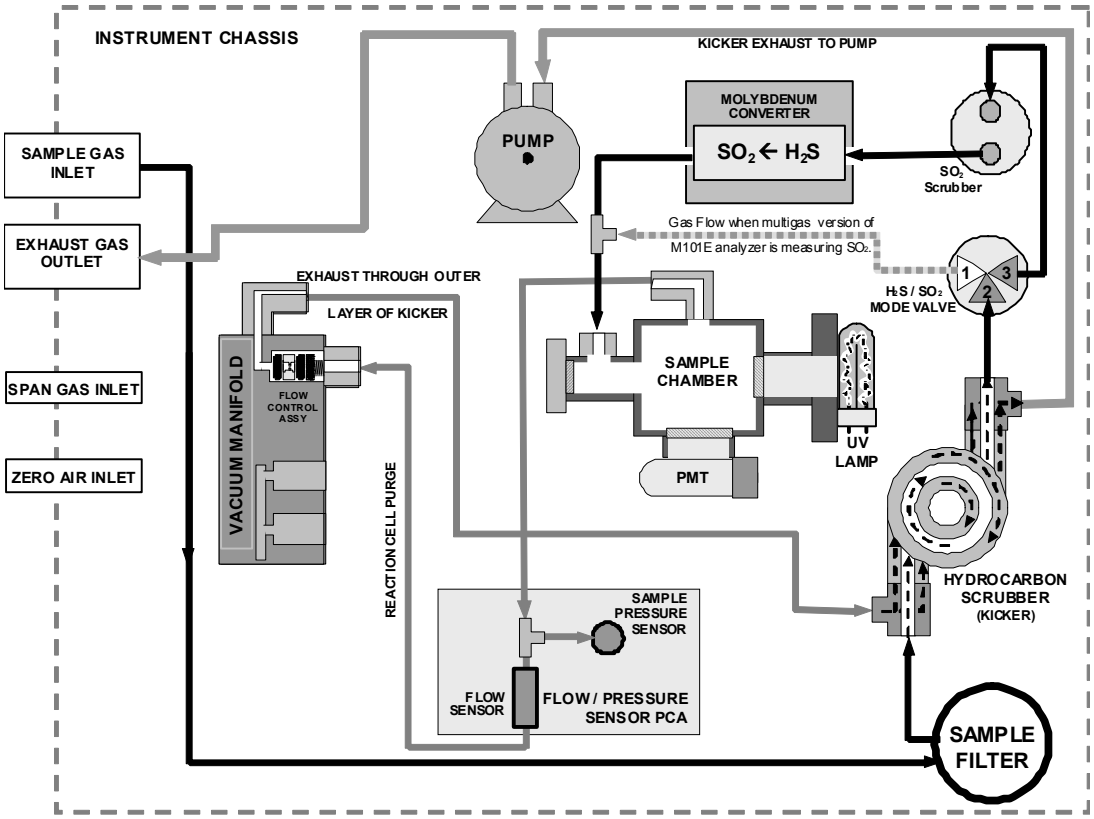
The chemical process is:

$$2H_2S + 3O_2 \longrightarrow 2H_2O + 2SO_2$$

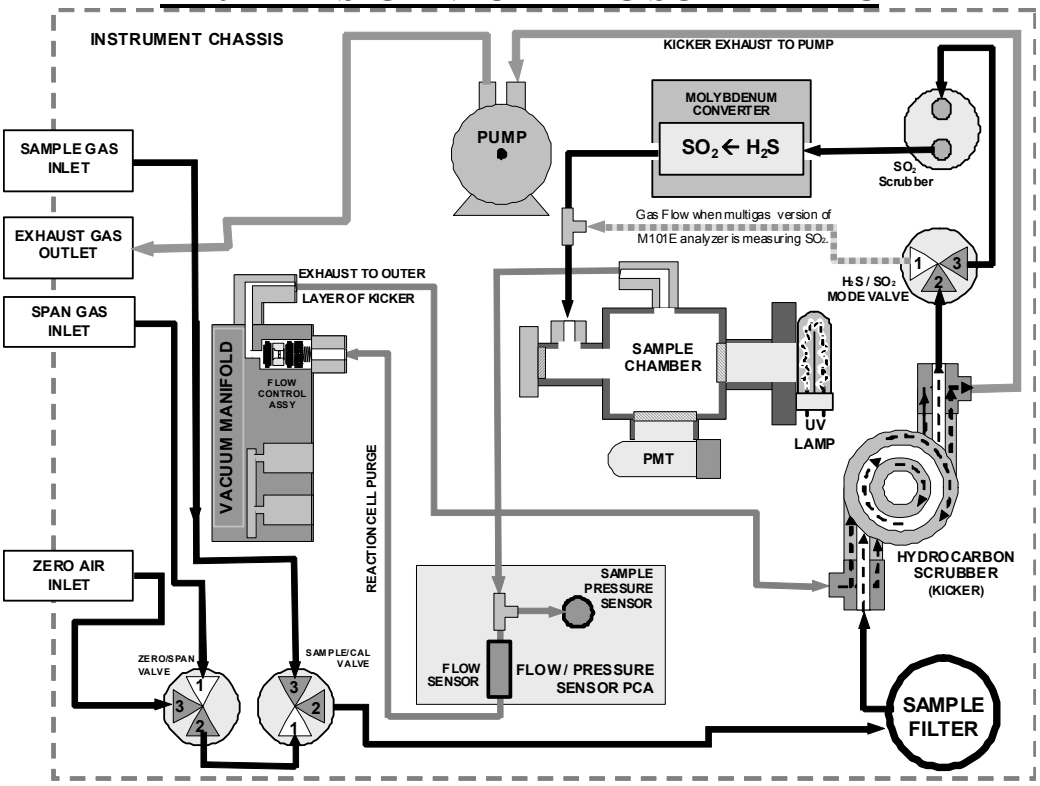
The converter is a heated stainless steel core containing a catalyst across which the sample gas passes just before induction into the reaction cell. The temperature of the converter is maintained by a heater controlled by the CPU via the I^2C bus and the relay card. The converter is enclosed in high-temperature insulation and encased in a stainless steel housing.

The converter is most efficient when it operates at 315°C, converting >96% at check out, of the H_2S into SO_2. Converter temperature is viewable via the front panel as the test function CONV TEMP, and can also be output via the test channel analog output. A warning message, CONV TEMP WARNING will be issued by the CPU if the converter's temperature is below 310°C or above 320°C.

When the converter is operating at peak efficiency there is a nearly 1:1 relationship between the amount of H_2S entering the catalytic converter and the amount of SO_2 leaving it. Therefore, by measuring the amount of SO_2 in the gas after it leaves the converter, the amount of H_2S originally present on the sample gas can be directly inferred. This is accomplished by measuring the ultraviolet fluorescence of the SO_2 in the sample chamber.



M101E BASIC PNEUMATIC SCHEMATIC



M101E WITH VALVES PNEUMATIC SCHEMATIC

Model 101E Basic Unit Specifications

Min/Max Range (Physical Analog Output)	In 1 ppb increments from 50 ppb to 20,000 ppb, independent ranges or auto ranging
Measurement Units	ppb, ppm, µg/m3, mg/m3 (user selectable)
Zero Noise[1]	0.2 ppb RMS
Span Noise[1]	0.2 ppb RMS
Lower Detectable Limit[2]	0.4 ppb RMS
Zero Drift (24 hours)	<0.5 ppb
Zero Drift (7 days)	1 ppb
Span Drift (7 Days)	<0.5% FS
Linearity	1% of full scale
Precision	0.5% of reading[1]
Temperature Coefficient	< 0.1% per °C
Voltage Coefficient	< 0.05% per V
Rise/Fall Time[1]	95% in <100 sec
Sample Flow Rate	650cc/min. ±10%
Temperature Range	5-40°C
Humidity Range	0 - 95% RH, non-condensing
Dimensions H x W x D	7" x 17" x 23.5" (178 mm x 432 mm x 597 mm)
Weight, Analyzer (Basic Configuration)	45 lbs (20.5 kg) w/internal pump
AC Power Rating	100 V, 50/60 Hz (1.7 A / 2.3 A surge); 115 V, 60 Hz (1.5 A / 2.0 A surge); 220 – 240 V, 50/60 Hz (.0.75 A \ 1.0 A surge)
Environmental	Installation category (over-voltage category) II; Pollution degree 2
Analog Outputs	Three (3) Outputs
Analog Output Ranges	100 mV, 1 V, 5 V, 10 V, 2-20 or 4-20 mA isolated current loop. All Ranges with 5% Under/Over Range
Analog Output Resolution	1 part in 4096 of selected full-scale voltage
Status Outputs	8 Status outputs from opto-isolators
Control Inputs	6 Control Inputs, 3 defined, 3 spare
Serial I/O	One (1) RS-232; One (1) RS-485 (2 connecters in parallel) Baud Rate : 300 – 115200: Optional Ethernet Interface
Certifications	EN61326 (1997 w/A1: 98) Class A, FCC Part 15 Subpart B Section 15.107 Class A, ICES-003 Class A (ANSI C63.4 1992) & AS/NZS 3548 (w/A1 & A2; 97) Class A IEC 61010-1:90 + A1:92 + A2:95,
For indoor use at altitudes ≤ 2000m only	
[1] As defined by the USEPA. [2] Defined as twice the zero noise level by the USEPA.	

M102E / M108E TRS

TRS Conversion

The M102E TRS analyzer is basically an SO_2 analyzer with a TRS → SO_2 converter (the M501-TRS) inserted into the gas stream before the sample gas enters the sample chamber.

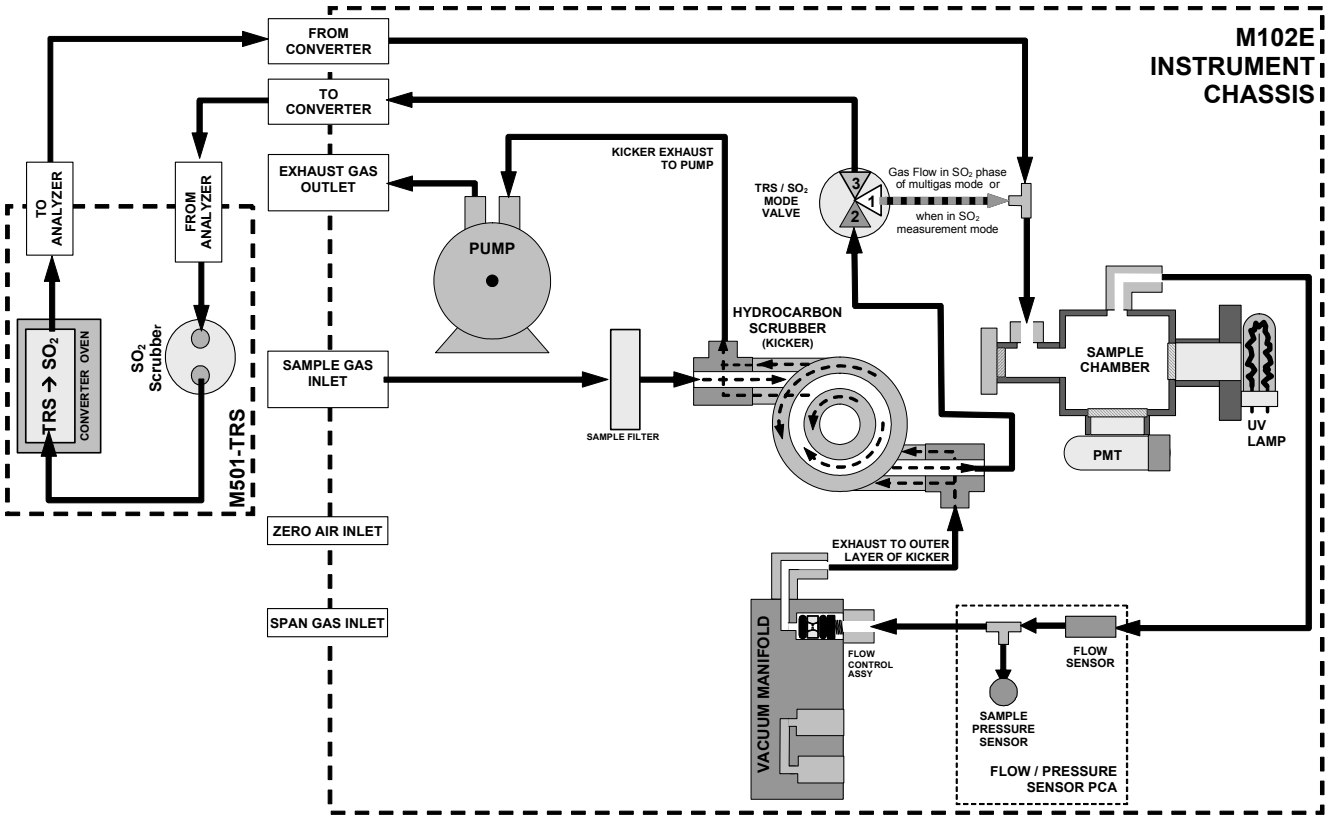
The M501-TRS, receives sample gas from the M102E after it has been passed through a particulate filter and has been scrubbed of hydrocarbon interferents. Once inside the M501-TRS the sample gas is scrubbed of all naturally occurring SO_2, then passed through a special quartz converter which heats the gas to a very high temperature causing it to react with the O_2 present in the sample gas creating SO_2 in the following manner .

$$TRS + O_2 \rightarrow SO_2$$

The converter is most efficient when it operates at 1000°C, converting >95% of the TRS into SO_2. Converter temperature is viewable via the front panel of the M501-TRS

When the converter is operating at peak efficiency there is a nearly 1:1 relationship between the amount of TRS entering the converter and the amount of SO_2 leaving it. Therefore, by measuring the amount of SO_2 in the gas after it leaves the converter, the amount of TRS originally present on the sample gas can be directly inferred.

The M108E analyzer operates in almost exactly the same manner except that it is designed monitor gas with a background of N_2 or CO_2. The problem with this is that if you look at the equation above, we need O_2 in order to convert TRS gasses into SO_2. To solve this we add a dilution manifold that pulls ambient air into a TRS/SO_2 scrubber and then adds the scrubber air to the sample stream. This puts about 5% oxygen into the sample stream and allows the TRS to convert into SO_2.



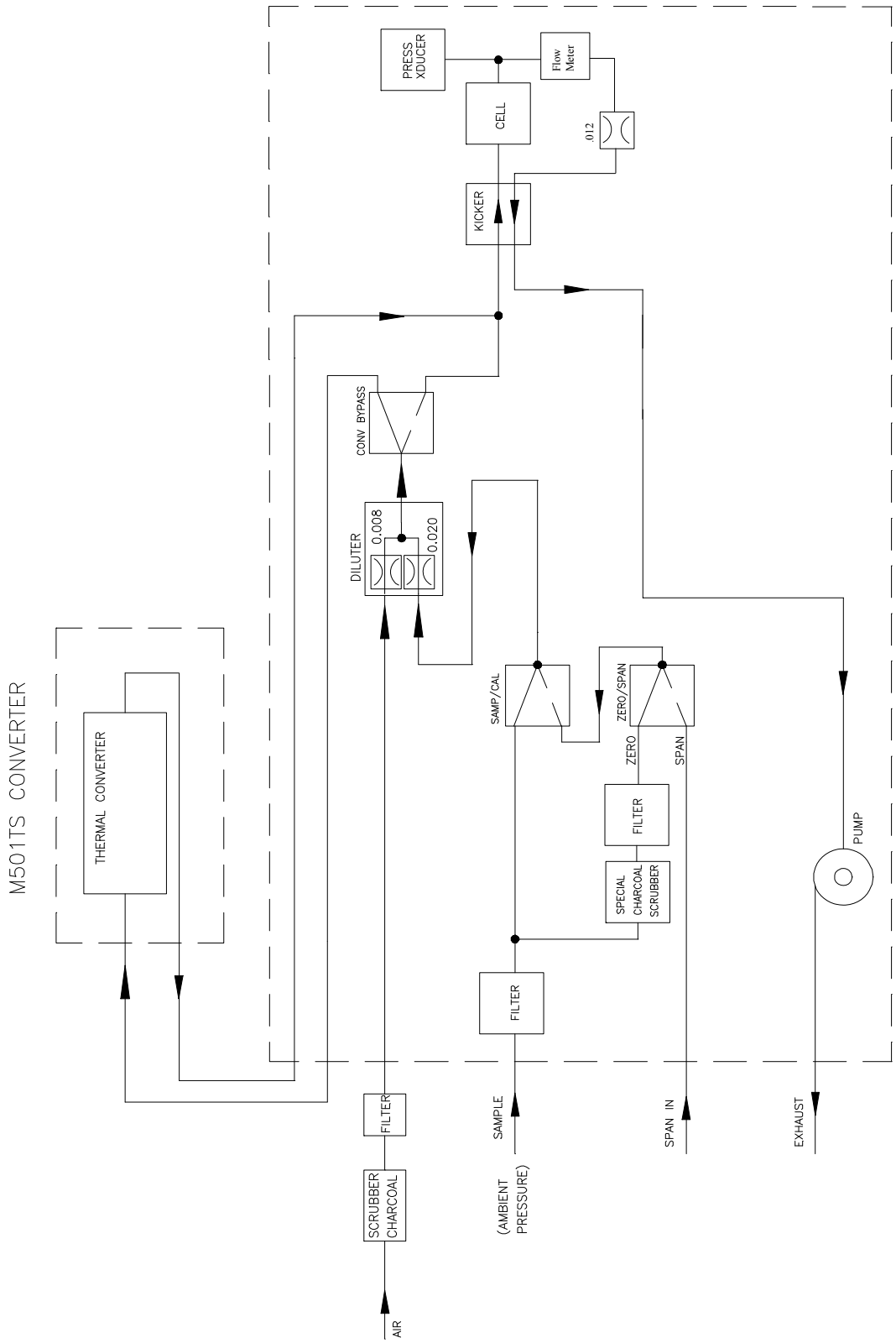
M102E Pneumatic Schematic

Model 102E Basic Unit Specifications

There are no significant differences between the performance specifications for the M102E and the M100E. Below are the specifications for the M501 Converter associated with the M102E.

Minimum Converter Efficiency	H_2S >95% COS >90% CS_2 >90%
Maximum TS Concentration for specified conversion efficiency	20 ppmv
Sample Flow Rate	650cc/min. ±10% - driven by M102E pneumatic system
Optimum Converter Temperature	1000°C (factory setup)
Maximum Converter Temperature	1100°C
Dimensions H x W x D	7" x 17" x 22" (178 mm x 432 mm x 559 mm)
Weight	16 lbs (8 kg) 26 lbs (12 kg) CE version
AC Power Rating	115 V, 50/60 Hz - 400 Watts; 230 V, 50/60 Hz - 575 Watts; CE Version
Internal Alarms	High Alarm Point: 1050°C Low Alarm Point: 950°C
Alarm Output Relay	SPST - 1 point: Alarm output is energized should either the temperature controller's high or low internal alarm set points be activated.
Alarm Output Rating	220V AC/30V DC, 1A (resistive load)
Environmental	Installation category (over-voltage category) II; Pollution degree 2
Certifications	IEC 1010-1 / 61010-1:93 (includes A1) + A2:95,
For indoor use at altitudes ≤ 2000m only	

M108E Pneumatic Schematic



M100EH

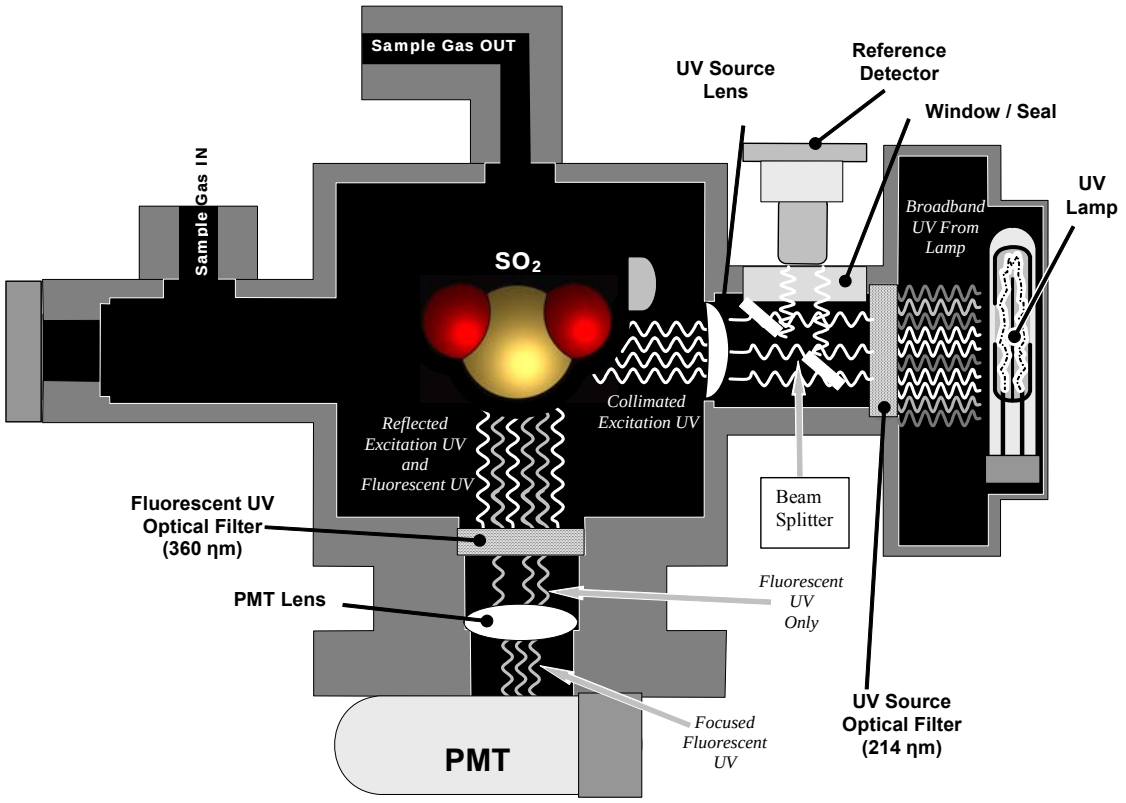
The M100EH is basically a M100E analyzer that has a few modifications to allow it to read higher concentrations of SO_2. The M100EH is a 0ppm-5000ppm SO_2 analyzer.

One of the modifications made to the M100EH analyzer is the kicker has been removed and is now an option. This was to have a cost savings to the end customer. Being that the M100EH analyzer is designed to monitor high levels of SO_2 gas, low levels of hydrocarbons will not interfere with the analyzer. You will need a kicker if you plan on monitoring gas with high levels of hydrocarbons in the sample stream.

Another modification is the physical location of the UV detector. Through the use of a beam splitter, the M100EH can now detect the UV light before the reaction cell to remove the effects of UV shadowing. UV shadowing occurs when the SO_2 concentration in the reaction cell is large enough to actually block the UV light and keep it from hitting the UV reference detector. If the UV detector was in the same location as a M100E, as the SO_2 concentration increased you would start to see the UV lamp value decrease even though the UV lamp output remained the same. Moving the UV reference detector to before the reaction cell prevents this from happening.

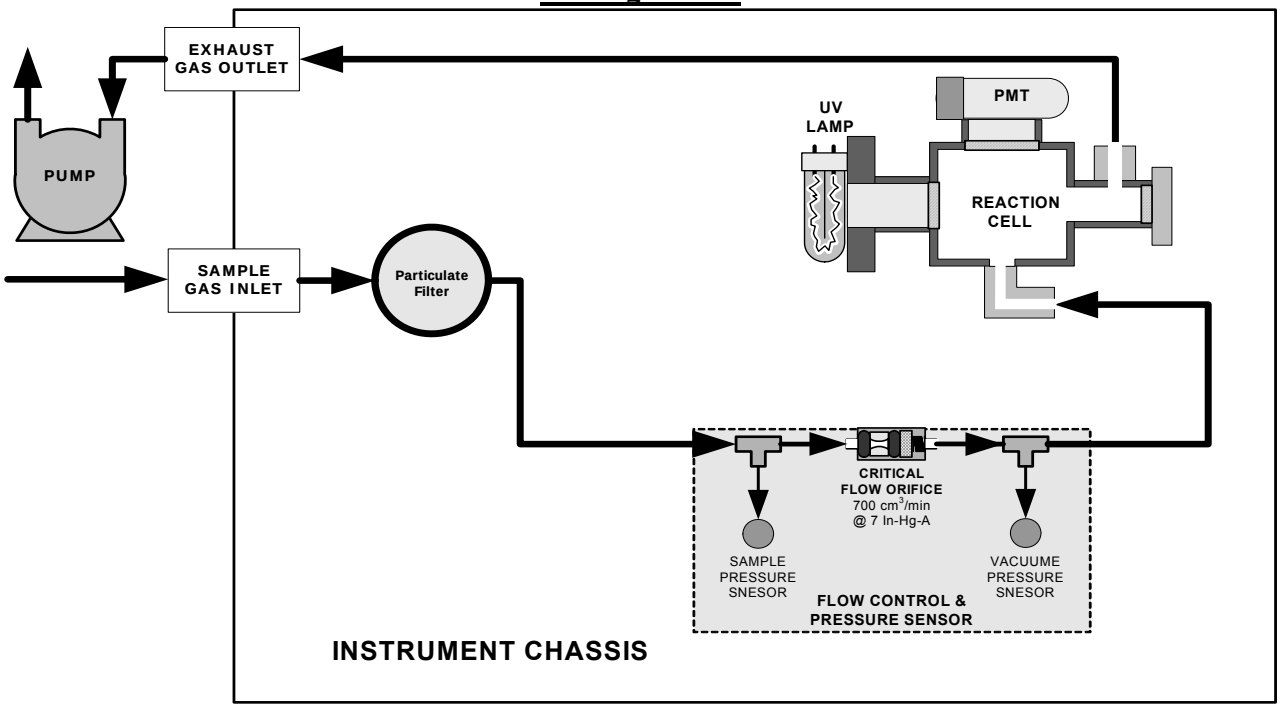
Instead of a 330ηm filter, the M100EH analyzer uses a 360ηm filter. The reason for this is that the sample stream that the analyzer measures will typically have high levels of NOx. The 330ηm filter has about a 50:1 NOx rejection ratio. The 360ηm filter has a 250:1 rejection ratio. So the 360ηm filter does a much better job of filtering out NOx fluorescence, and due to the high levels of SO_2 the HVPS can remain low, decreasing the noise in the analyzer.

The last physical difference is that instead of a flow/pressure sensor, the M100EH uses two pressure sensors. One is monitoring the sample pressure and one is monitoring the vacuum pressure with a critical flow orifice located between the two. If the vacuum reading on the front panel ever rises above 10”, the pump should be rebuilt.



M100EH

UV Light Path



M100EH Pneumatic Schematic

Min/Max Range	In 1ppm increments from 10ppm to 5,000ppm, dual ranges or auto ranging

(Physical Analog Output)	
Measurement Units	ppm, mg/m3 (user selectable)
Zero Noise[1]	0.05 ppm rms
Span Noise[1]	< 0.5% of reading (above 50 ppm)
Lower Detectable Limit[2]	0.1 ppm rms
Zero Drift (24 hours)	< 1 ppm
Zero Drift (7 days)	< 2 ppm
Span Drift (7 Days)	< 0.5% FS
Linearity	1% of full scale
Precision	0.5% of reading[1]
Temperature Coefficient	< 0.1% per ^{o}C
Voltage Coefficient	< 0.05% per V
Lag Time[1]	5 sec
Rise/Fall Time[1]	95% in < 30 sec
Sample Flow Rate	700cc/min. ±10%
Temperature Range	5-40^{o}C
Humidity Range	0 - 95% RH, non-condensing
Dimensions H x W x D	7" x 17" x 23.5" (178 mm x 432 mm x 597 mm)
Weight, Analyzer (Basic Configuration)	35 lbs (16 kg)
Weight, Pump Pack	16 lbs (7 kg)
AC Power Rating	100 V, 50/60 Hz (3.25A); 115 V, 60 Hz (3.0 A); 220 – 240 V, 50/60 Hz (2.5 A)
AC Power Rating, External Pump Pack	110V/60Hz, 220V/50Hz, 240V/50Hz, 295 Watts (230V/50Hz – 2.5A for CE-Mark Rating)
Environmental	Installation category (over-voltage category) II; Pollution degree 2
Analog Outputs	Three (3) Outputs
Analog Output Ranges	100 mV, 1 V, 5 V, 10 V, 2-20 or 4-20 mA isolated current loop. All Ranges with 5% Under/Over Range
Analog Output Resolution	1 part in 4096 of selected full-scale voltage
Status Outputs	8 Status outputs from opto-isolators
Control Inputs	6 Control Inputs, 3 defined, 3 spare
Serial I/O	One (1) RS-232; One (1) RS-485 (2 connecters in parallel) Baud Rate : 300 – 115200: Optional Ethernet Interface
Certifications	USEPA: Reference Method Number EQOA-XXXX-XXX CE: XXNNNNN-N:NN + XN:NN + XN:NN, XXNNNNN - Class A
1 As defined by the USEPA. 2 Defined as twice the zero noise level by the USEPA.	

Model 100EH Basic Unit Specifications

M100EH Factory Calibration

The factory calibration procedure is exactly the same as the M100E except for the equation to calculate your Target NORM PMT voltage. Please use the equations below in order to calculate your Target NORM PMT voltage.

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

Ranges 500.0ppm and below
TARGET NORM PMT=(8.0*CONC)+OFFSET
Ranges 500.1ppm and above
TARGET NORM PMT=(0.8*CONC)+OFFSET

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

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

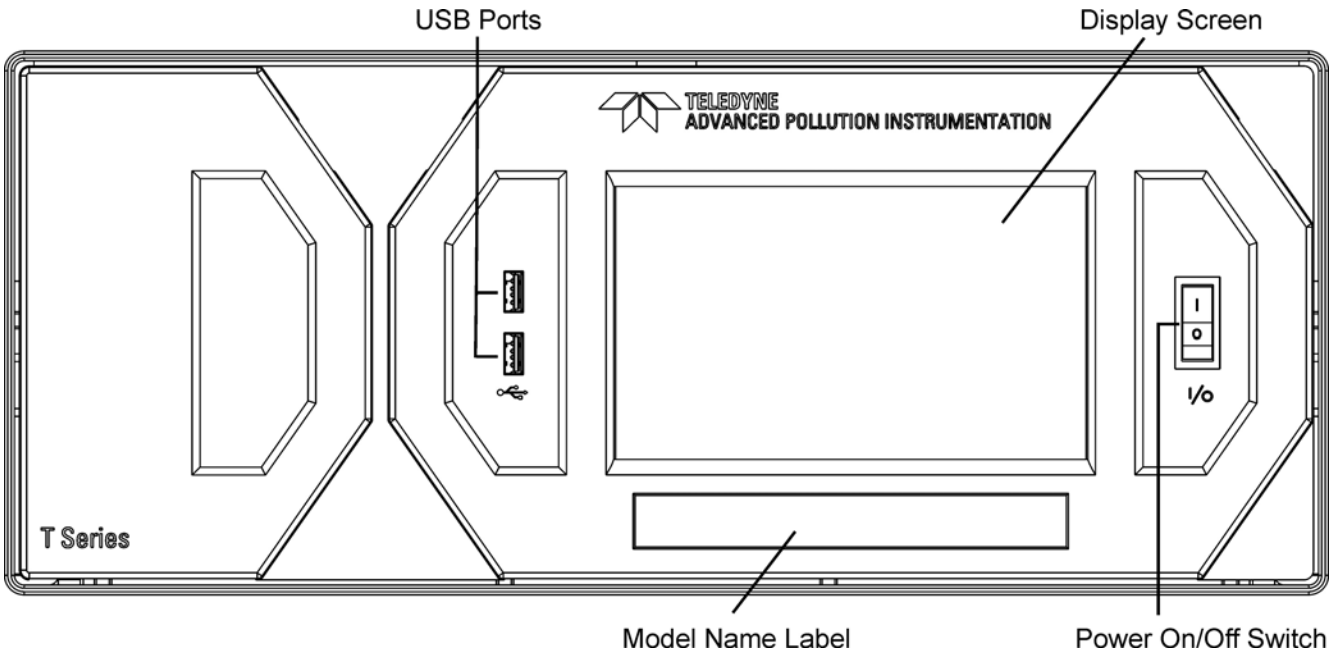


Figure 9-1: Front Panel Layout

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

Field	Description/Function			
Status	Lights indicating the states of Sample, Calibration and Fault, as follows:			
	Name	Color	State	Definition
	SAMPLE	Green	Off On Blinking	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
	CAL	Yellow	Off On Blinking	Auto Cal disabled Auto Cal enabled Unit is in calibration mode
	FAULT	Red	Off Blinking	No warnings exist 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.

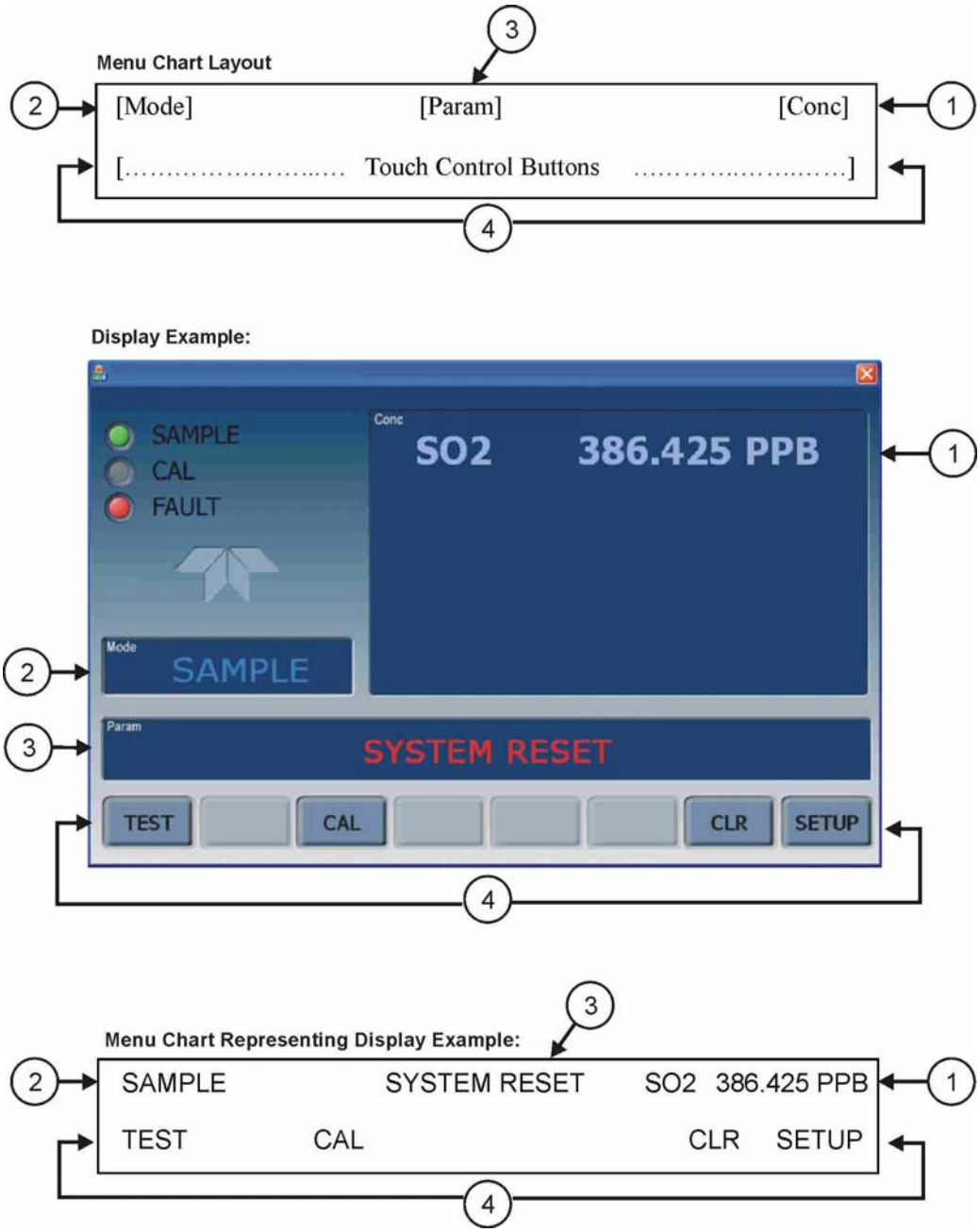


Figure 9-3: Display/Touch Control Screen Mapped to Menu Charts

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.

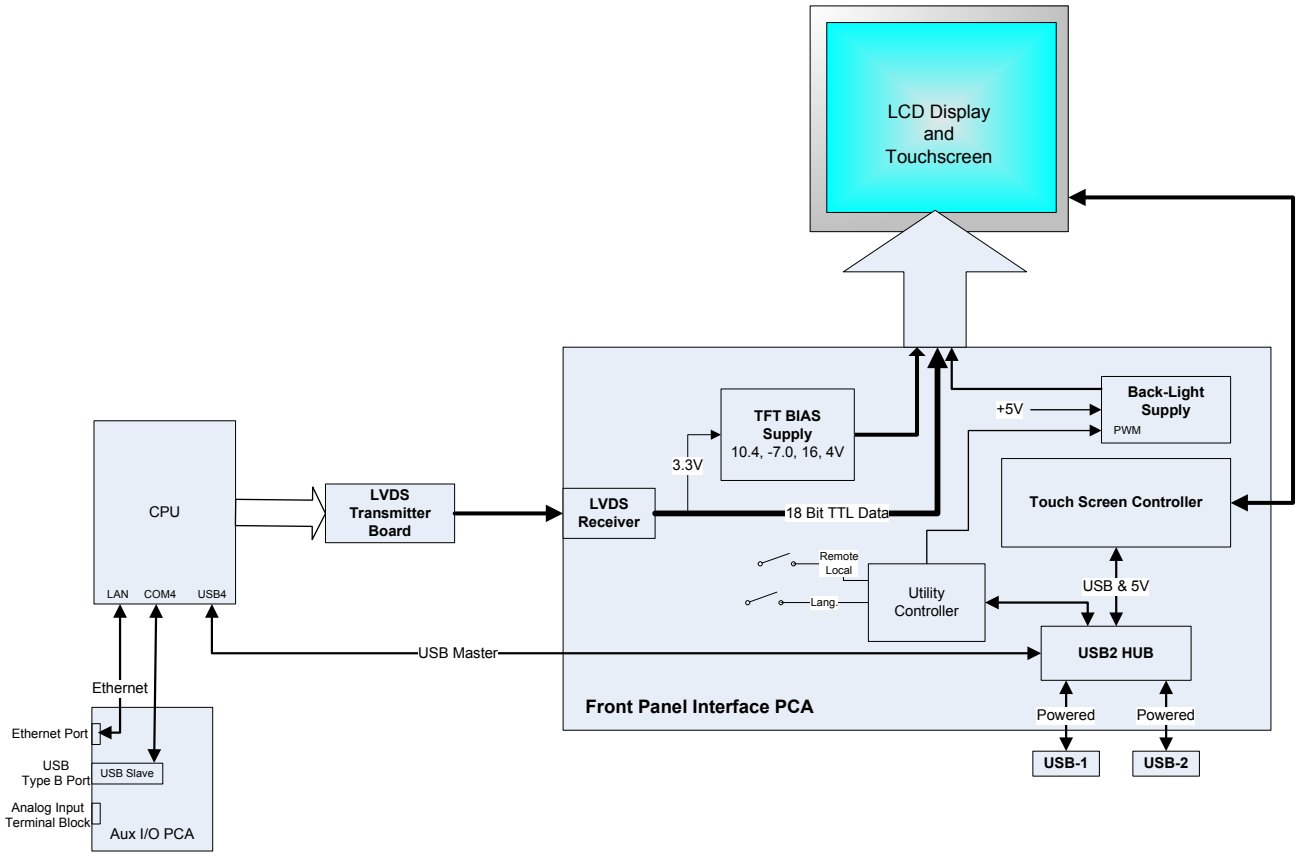


Figure --4: Front Panel and Display Interface Block Diagram

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

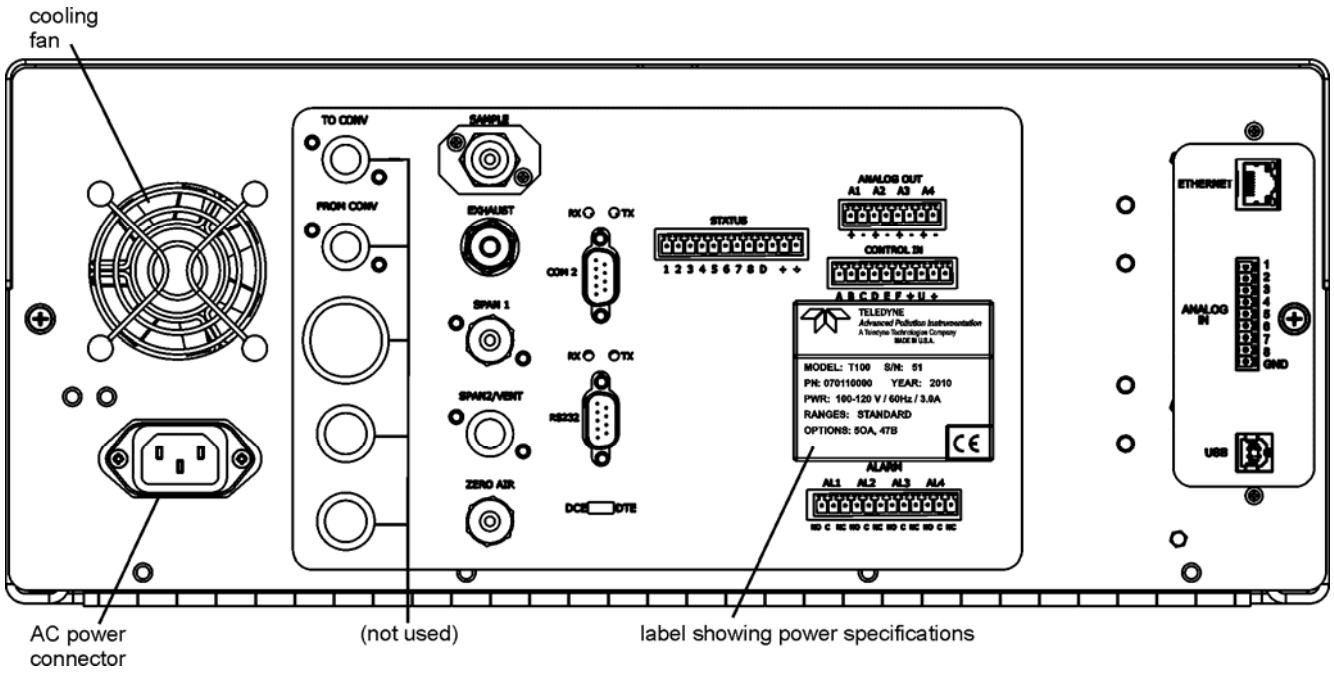


Figure 9-5: Rear Panel Layout

Table 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.

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.

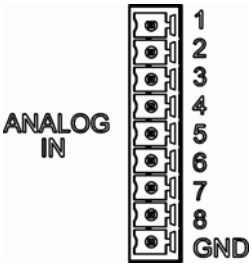


Figure 9-6: Analog In Connector

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

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:

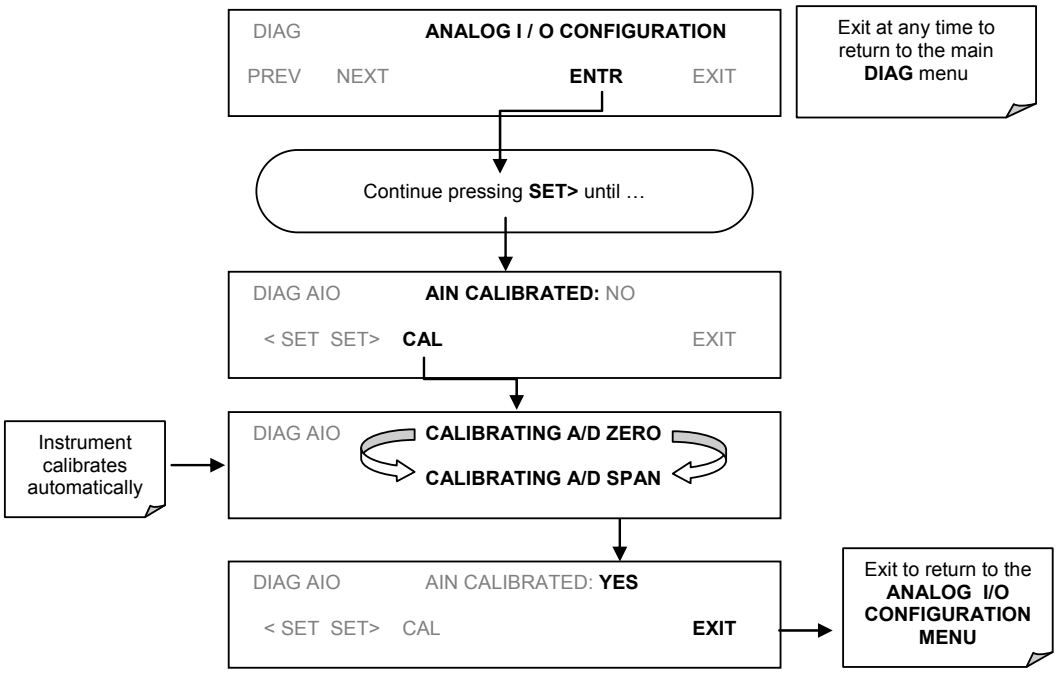


Figure 9-7: DIAG – Analog I/O Configuration – AIN Calibration

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:

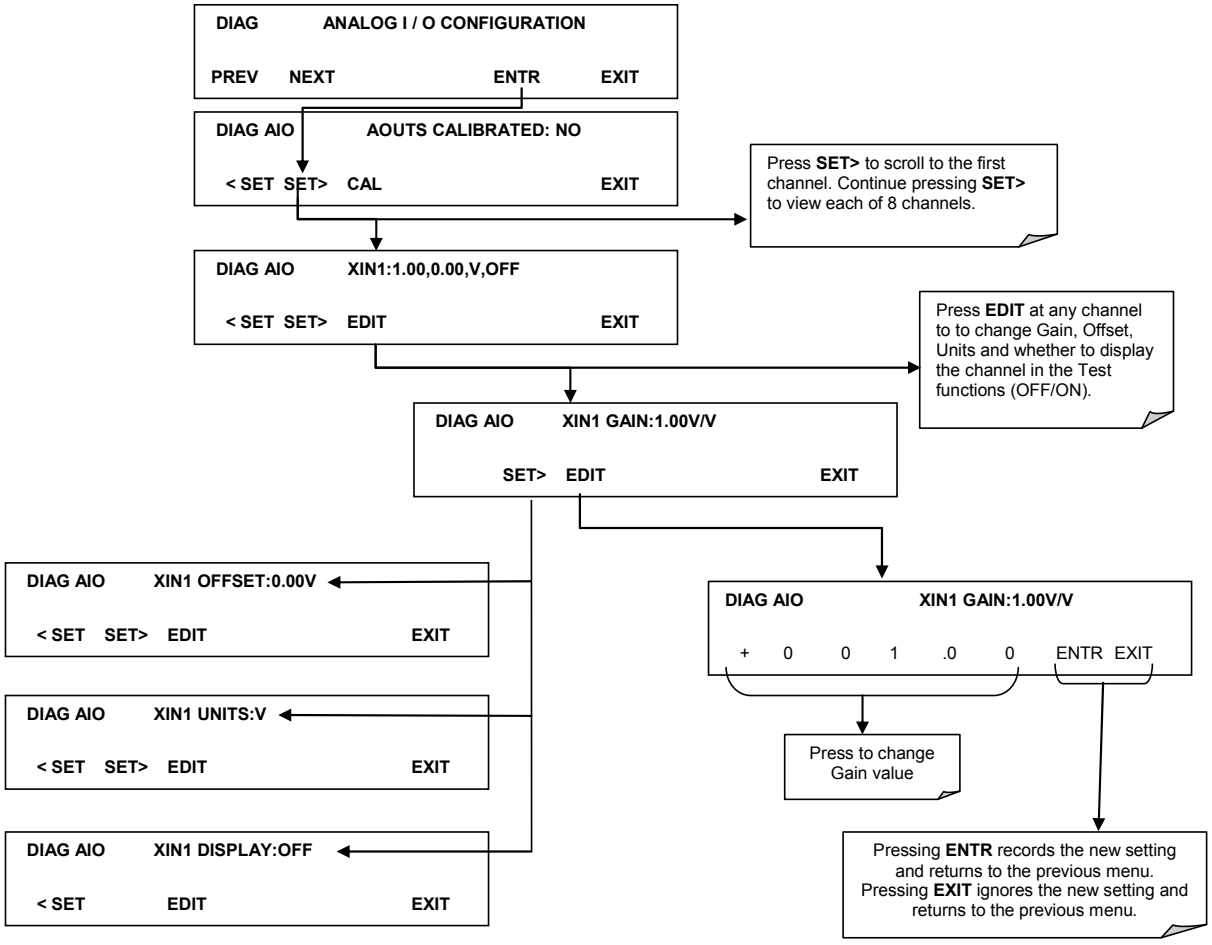


Figure 9-8 DIAG – Analog Inputs (Option) Configuration Menu

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

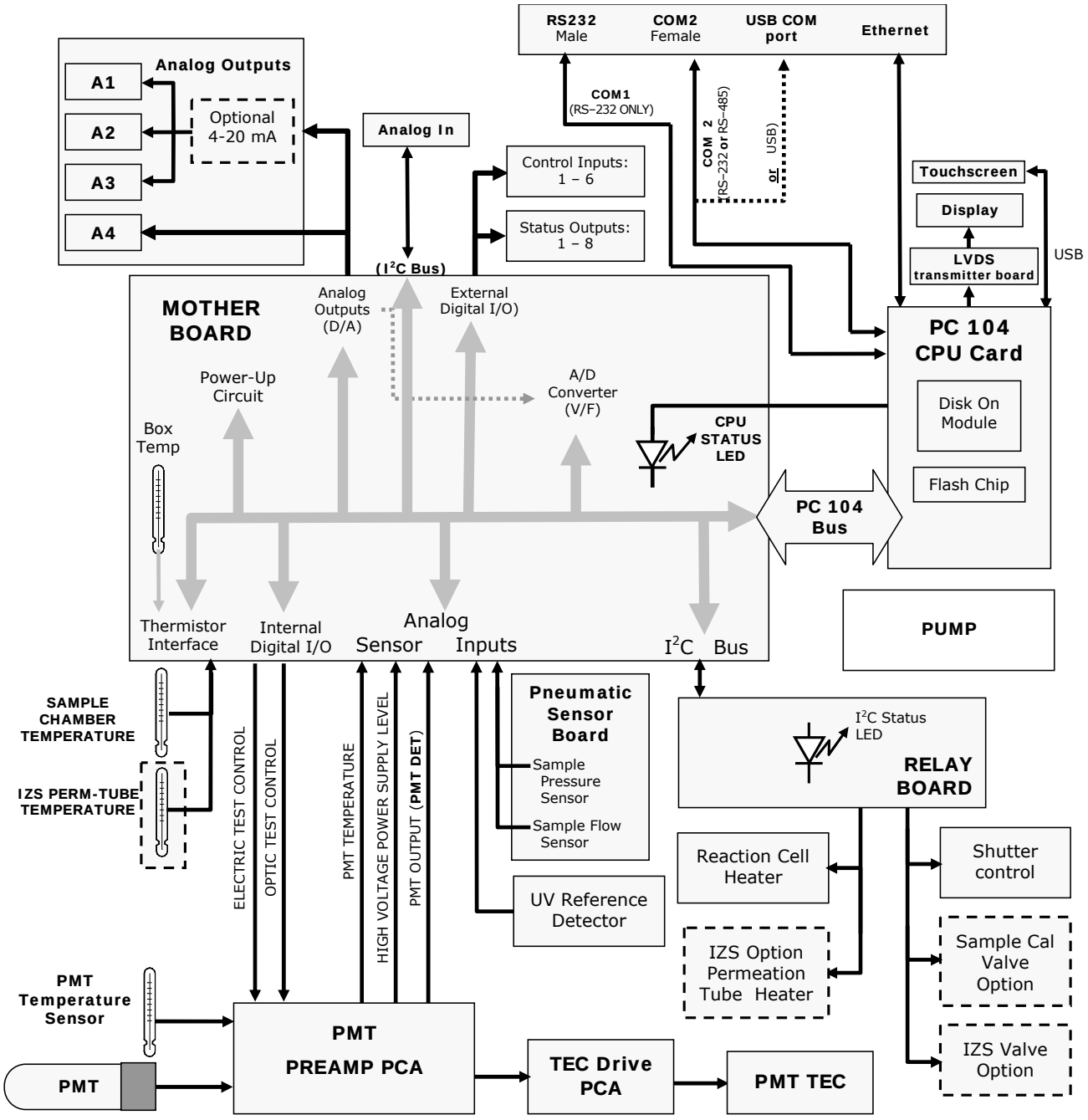


FIGURE 9-9, EXAMPLE OF AN ELECTRONIC BLOCK DIAGRAM (T100)

“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