TRAINING MANUAL

MODEL 400E / T400
UV ABSORPTION OZONE ANALYZER

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TABLE OF CONTENTS

1. PRINCIPLE OF OPERATION

BEER-LAMBERT'S LAW

The basic principle by which the Model 400E Ozone Analyzer works is called Beer's Law (also referred to as the Beer-Lambert equation). It defines the how light of a specific wavelength is absorbed by a particular gas molecule over a certain distance at a given temperature and pressure. The mathematical relationship between these three parameters for gasses at Standard Temperature and Pressure (STP) is:

$$I = I_O \, e^{-\alpha LC} \quad \text{at STP}$$

Where:

I_O is the intensity of the light if there was no absorption.

I is the intensity with absorption.

L is the absorption path, or the distance the light travels as it is being absorbed.

C is the concentration of the absorbing gas. In the case of the Model 400E, Ozone (O_3).

α is the absorption coefficient that tells how well O_3 absorbs light at the specific wavelength of interest.

To solve this equation for **C**, the concentration of the absorbing Gas (in this case O_3), the application of a little algebra is required to rearrange the equation as follows:

$$C = \ln\left(\frac{I_o}{I}\right) \times \left(\frac{1}{\alpha\, L}\right) \quad \text{at STP}$$

Unfortunately, both ambient temperature and pressure influence the density of the sample gas and therefore the number of ozone molecules present in the absorption tube thus changing the amount of light absorbed.

In order to account for this effect the following addition is made to the equation:

$$C = \ln\left(\frac{I_o}{I}\right) \times \left(\frac{1}{\alpha\, L}\right) \times \left(\frac{T}{273^o\, K} \times \frac{29.92\,\mathbf{inHg}}{P}\right)$$

Where:

T = sample temperature in Kelvin

P = sample pressure in inches of mercury

Finally, to convert the result into Parts per Billion (PPB), the following change is made:

$$C = \ln\left(\frac{I_o}{I}\right) \times \left(\frac{10^{-9}}{\alpha L}\right) \times \left(\frac{T}{273^o K} \times \frac{29.92 inHg}{P}\right)$$

In a nutshell the Model 400E Ozone Analyzer:

- Measures each of the above variables: Sample Temperature; Sample Pressure; the Intensity of the UV light beam with and without O_3 present,
- Inserts known values for the Length of the Absorption Path and the Absorption Coefficient, and calculates the concentration of O_3 present in the sample gas.

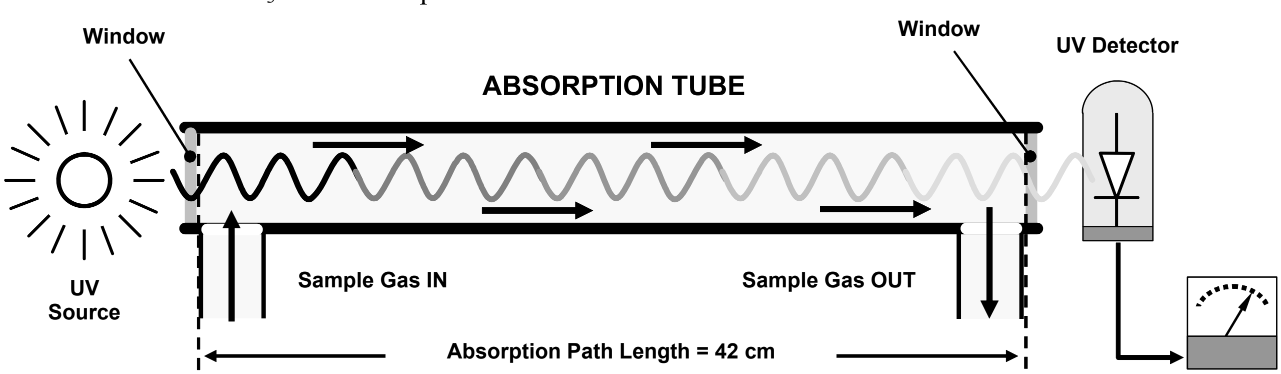
THE ABSORPTION PATH

In the most basic terms, the Model 400E uses a high energy, mercury vapor lamp to generate a beam of UV light. This beam passes through a window of material specifically chosen to be both non-reactive to O_3 and transparent to UV radiation at 254nm and into an absorption tube filled with Sample Gas.

Because ozone is a very efficient absorber of UV radiation the Absorption Path Length required to create a measurable decrease in UV intensity is short enough (approximately 42 cm) that the light beam is only required to make pass through the Absorption Tube. Therefore no complex mirror system is needed to lengthen the effective path by bouncing the beam back and forth.

Finally, the UV then passes through similar window at the other end of the Absorption Tube and is detected by a specially designed vacuum diode that detects radiation at or very near a wavelength of 254nm. The specificity of the detector is high enough that no extra optical filtering of the UV light is needed.

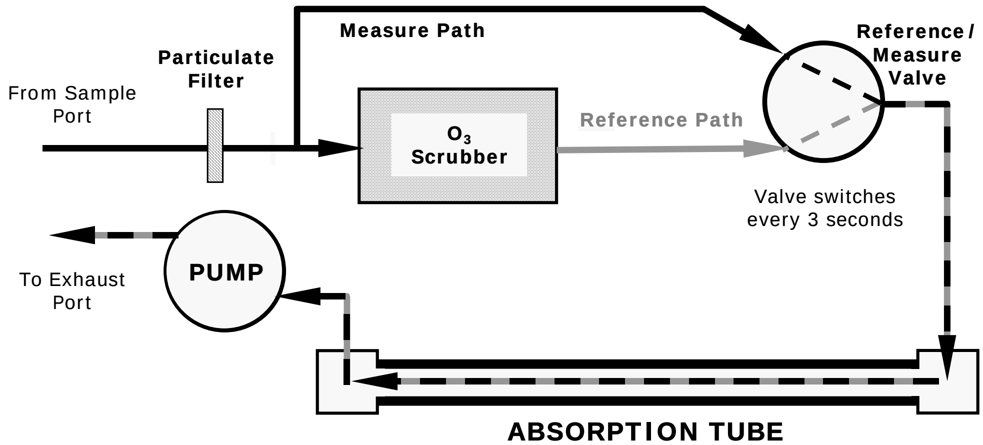
The detector assembly reacts to the UV light and outputs a voltage that varies in direct relationship with the light's intensity. This voltage is digitized and sent to the instrument's CPU to be used in computing the concentration of O_3 in the absorption tube.



O3 Absorption Path

THE REFERENCE / MEASUREMENT CYCLE

In order to solve the Beer-Lambert equation it is necessary to know the intensity of the light passing through the Absorption Path both when O_3 is present and when it is not. The Model 400E accomplishes this by alternately sending the Sample Gas directly to the Absorption tube and passing it through a chemical Scrubber that removes any O_3 present.



Reference / Measurement Gas Cycle

The Measurement / Reference Cycle consists of:

Time Index	Status
0 seconds	Measure/Reference Valve Opens to the Measure Path.
0 – 2 seconds	Wait Period. Ensures that the Absorption tube has been adequately flushed of any previously present gasses.
2 – 3 seconds	Analyzer measures the average UV light intensity of O_3 bearing Sample Gas (**I**) during this period.
3 seconds	Measure/Reference Valve Opens to the Reference Path.
3 – 5 seconds	Wait Period. Ensures that the Absorption tube has been adequately flushed of O_3 b3earing gas.
5 – 6 seconds	Analyzer measures the average UV light intensity of Non-O_3 bearing Sample Gas (**I_0**) during this period.
CYCLE REPEATS EVERY 6 SECONDS	

INTERFERANT REJECTION

The detection of O_3 is subject to interference from a number of sources including, SO_2, NO_2, NO, H_2O, aromatic hydrocarbons such as meta-xylene and Mercury vapor. The Model 400E's basic method or operation successfully rejects interference from most of these interferents. The O_3 Scrubber located on the Reference Path is specifically designed to ONLY remove O_3 from the Sample Gas. Thus the variation in intensities of the UV light detected during the instrument's Measurement Phase versus the Reference Phase is ONLY due to the presence or absence of O_3. Thus the effect of interferents on the detected UV Light intensity is ignored by the instrument.

Even if the concentration of interfering gases were to fluctuate so wildly as to be significantly different during consecutive Reference and Measurement Phases, this would only cause the O_3 concentration reported by the instrument to become noisy. The average of such noisy readings would still be a relatively accurate representation of the O_3 concentration in the Sample Gas.

Interference from SO_2, NO_2, NO and H_2O are very effectively rejected by the model 400E. The two types of interferents that may cause problems for the Model 400E are aromatic hydrocarbons and mercury vapor.

AROMATIC HYDROCARBONS

While the instrument effectively rejected interference from meta-xylene, it should be noted that there are a very large number of volatile aromatic hydrocarbons that could potentially interfere with ozone detection. This is particularly true of hydrocarbons with higher molecular weights. If the Model 400E is installed in an environment where high aromatic hydrocarbon concentrations are suspected, specific tests should be conducted to reveal the amount of interference these compounds may be causing.

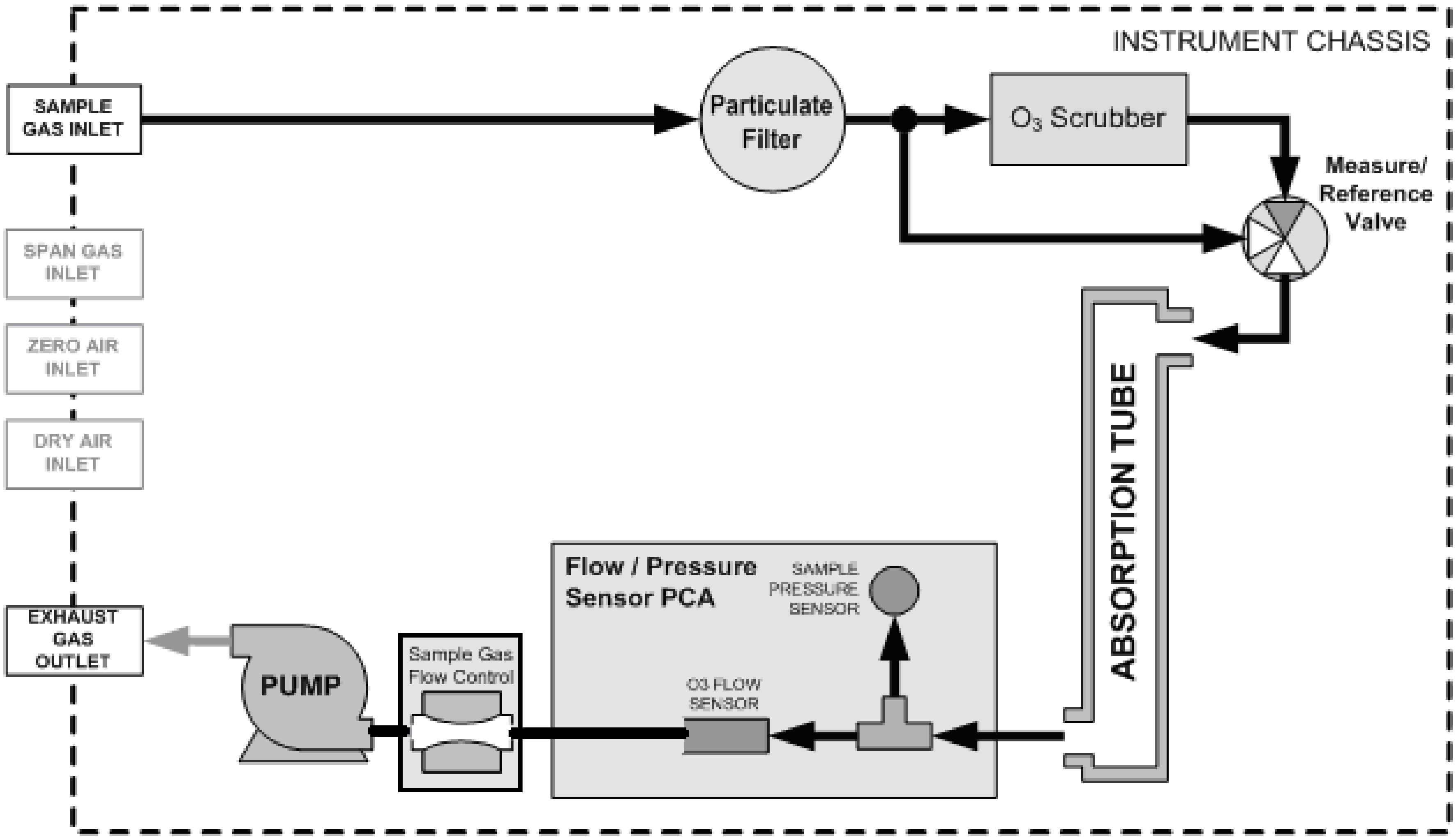
MERCURY VAPOR

Mercury Vapor absorbs radiation in the 254nm wavelength so efficiently that its presence, even in small amounts, will reduce the intensity of UV light to almost zero during both the Measurement and Reference Phases rendering the analyzer useless for detecting O_3.

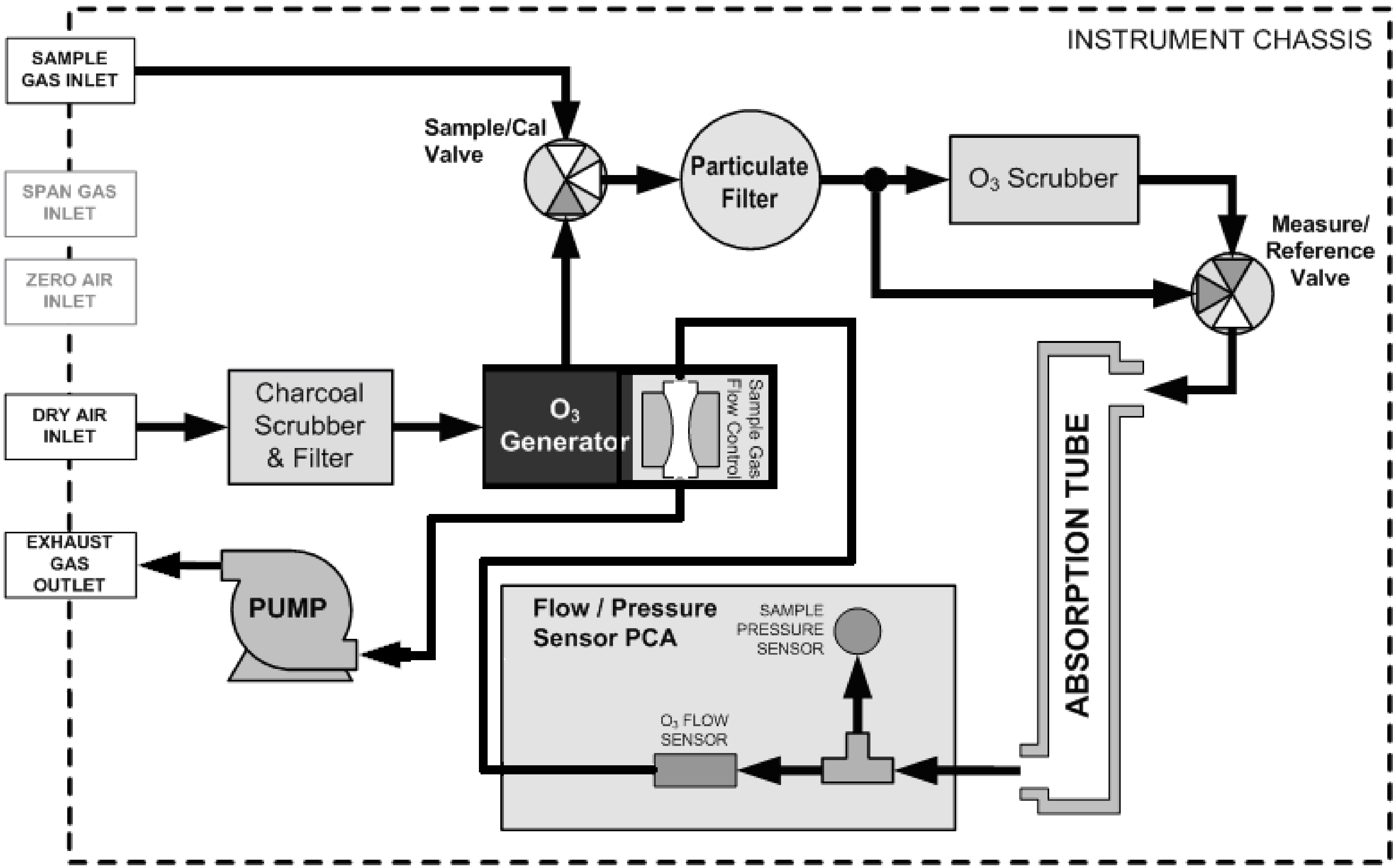
If the Model 400E is installed in an environment where the presence of Mercury vapor is suspected, specific steps MUST be taken to remove the Mercury Vapor from the Sample Gas before it enters the analyzer.

USER NOTES:

2. PNEUMATICS AND SUB-ASSEMBLIES



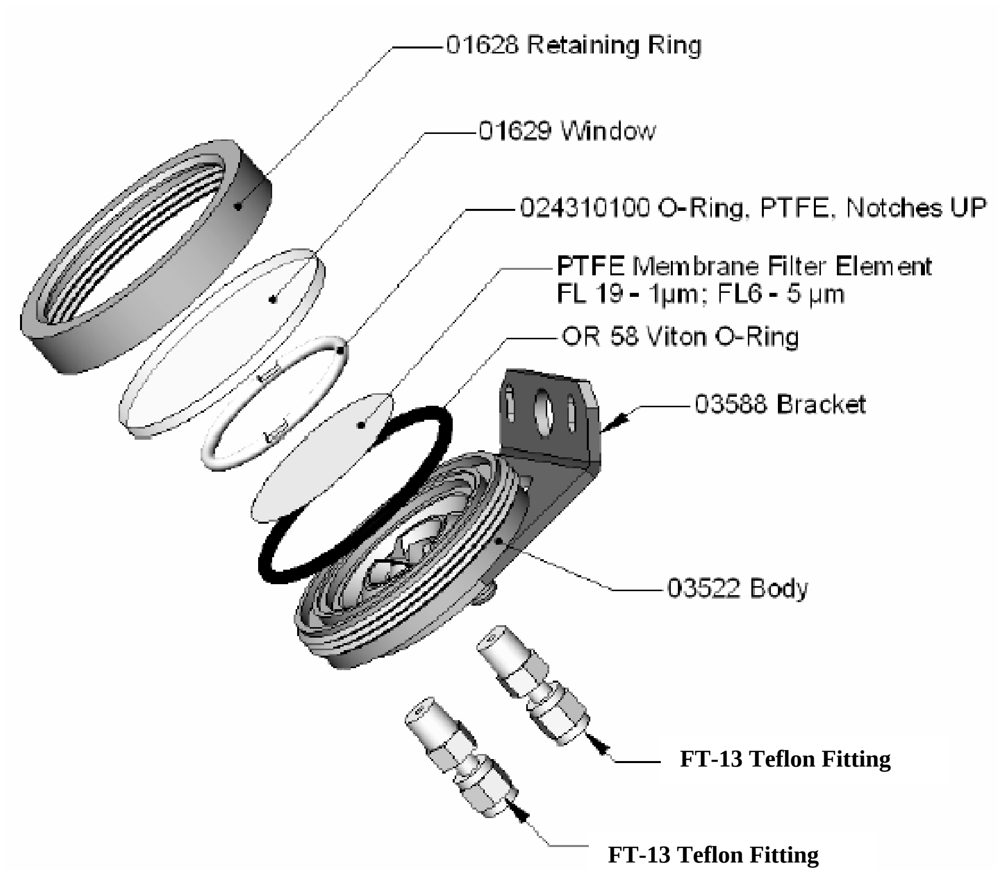
M400E Pneumatic Diagram – Basic Unit



M400E Pneumatic Diagram with Internal Zero/Span (IZS)

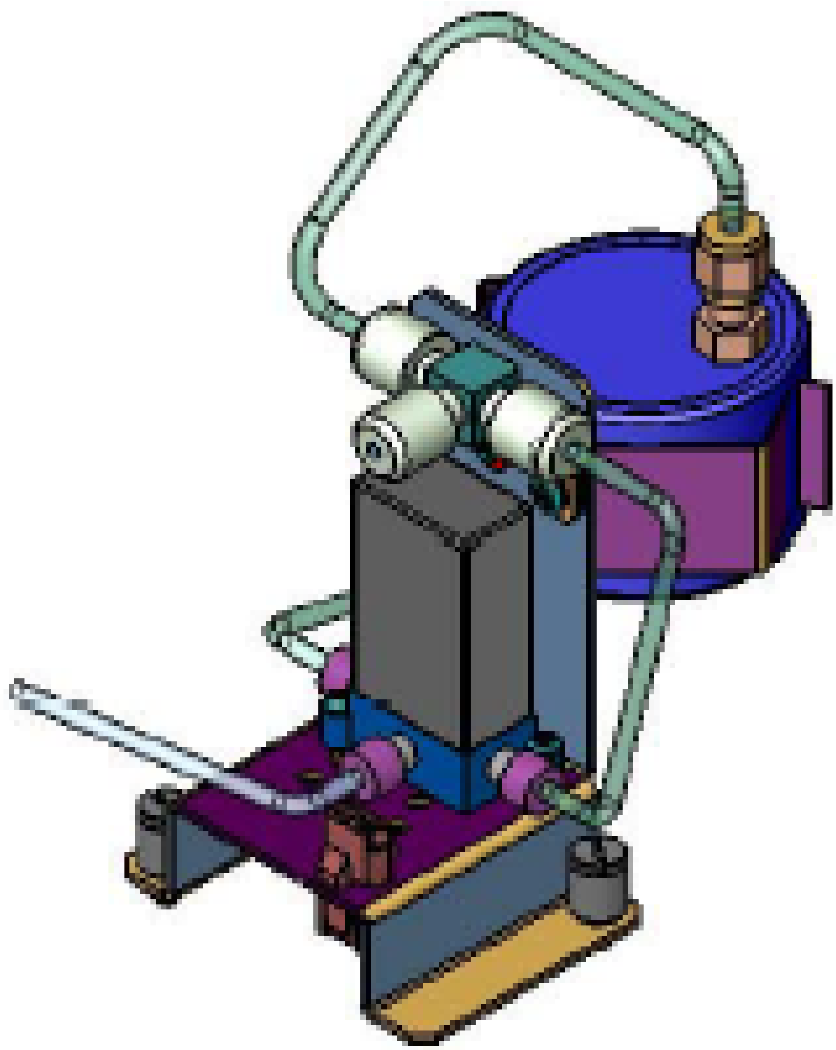
THE SAMPLE PARTICULATE FILTER

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 internal part of the filter 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. This can either cause slow response times as it degrades the ozone going into the unit, or cause a false positive from hydrocarbon interference.



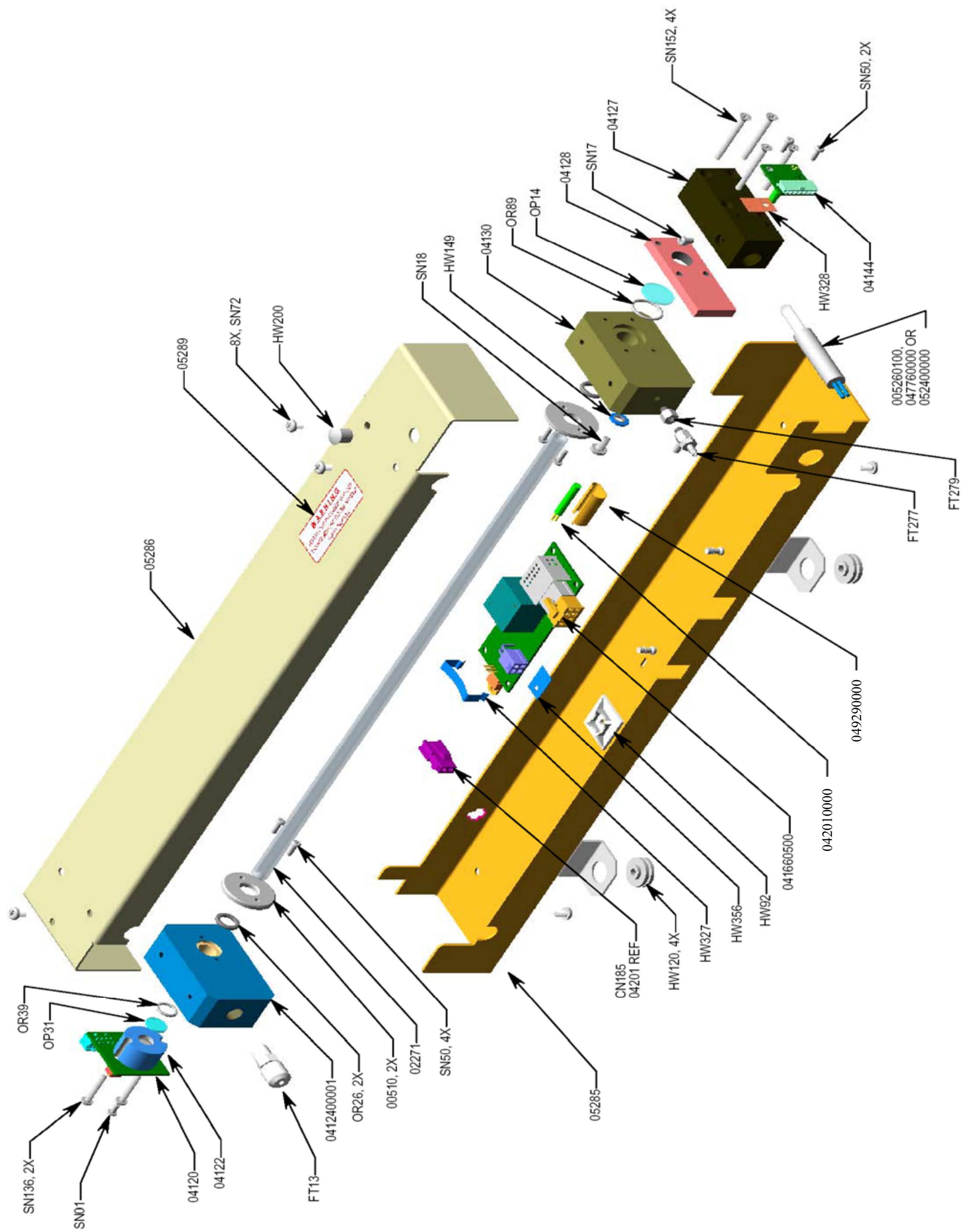
OZONE SCRUBBER AND REFERENCE VALVE

The Ozone Reference scrubber contains Manganese Dioxide screens inside. These screens act as a catalytic converter that react the O_3 into O_2. This chemical equations is $2O_3 \rightarrow 3O_2$. This is an exothermic reaction, meaning it releases heat. Theoretically the scrubber will last forever, but what happens is over time the screens degrade or become dirty. Eventually the scrubber will no longer be able to scrub ozone. There will then be ozone breakthrough and will cause your spans to drop and read lower then they should. This same effect can be seen if the valve develops a cross-port leak. Please see the Unable to Span section in the Troubleshooting Tree s.



O_3 Scrubber and Measure/Reference Switching Valve

M400E Optical Bench Assembly

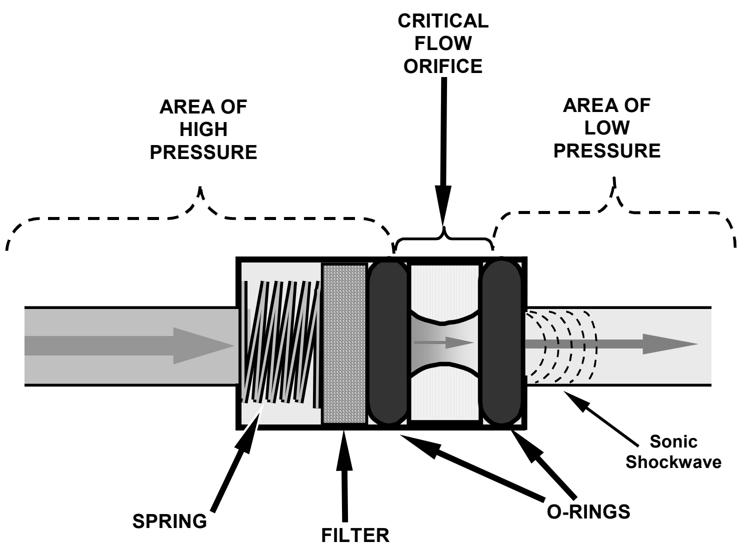


The Critical Flow Orifice

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 itself 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.

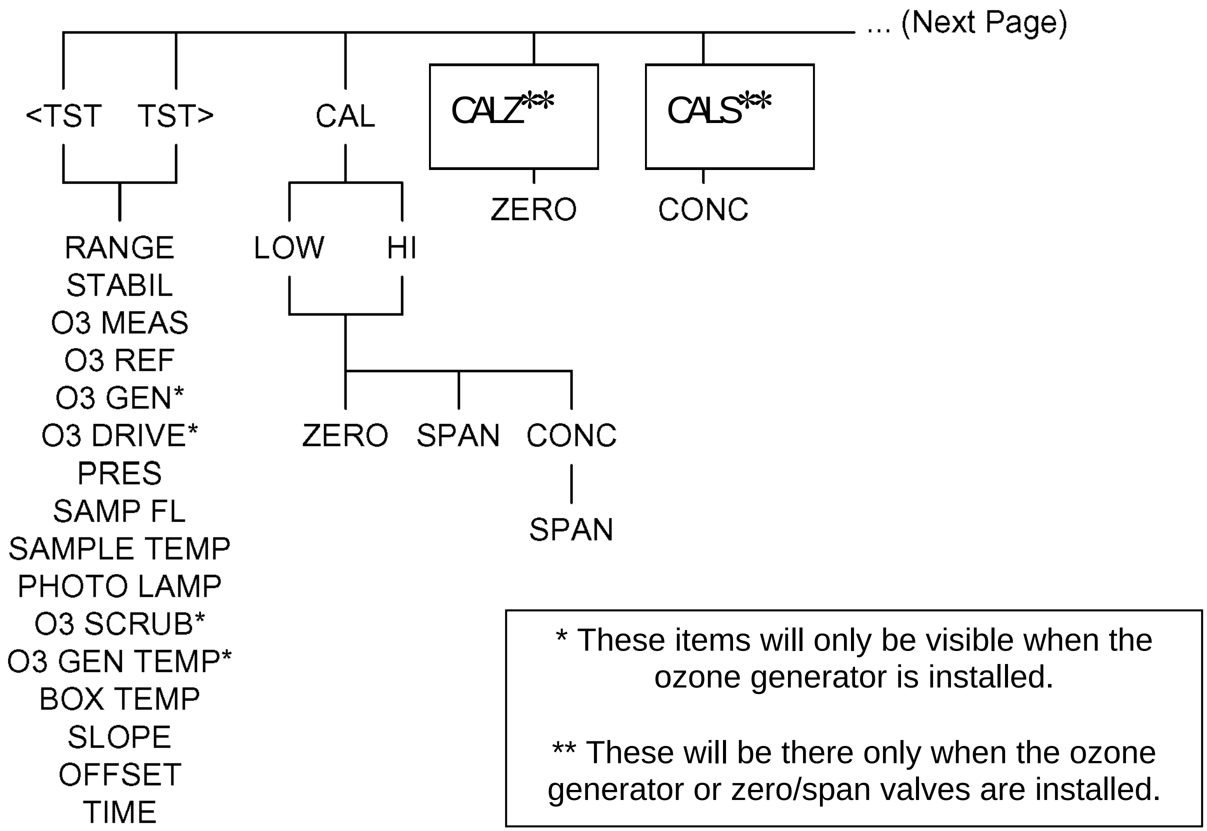


Flow Control Assembly & Critical Flow Orifice

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 400E is designed to provide a flow rate of 800 cm^3/min.

USER NOTES:

3. MENU STRUCTURE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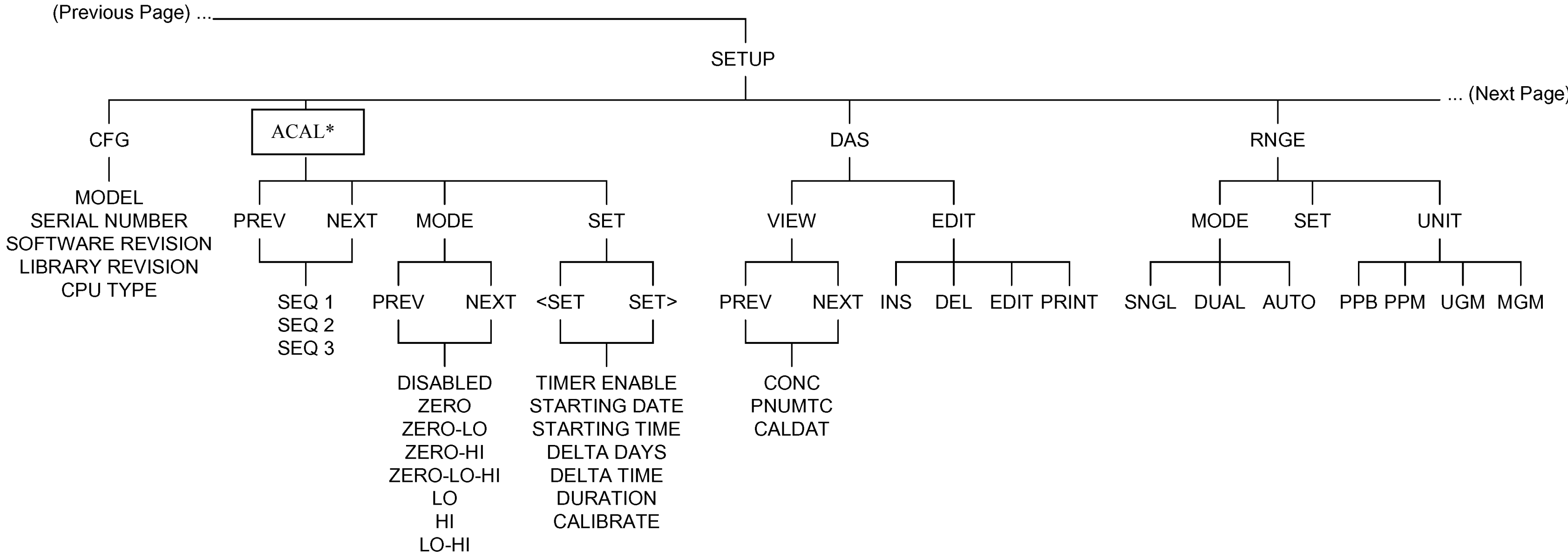
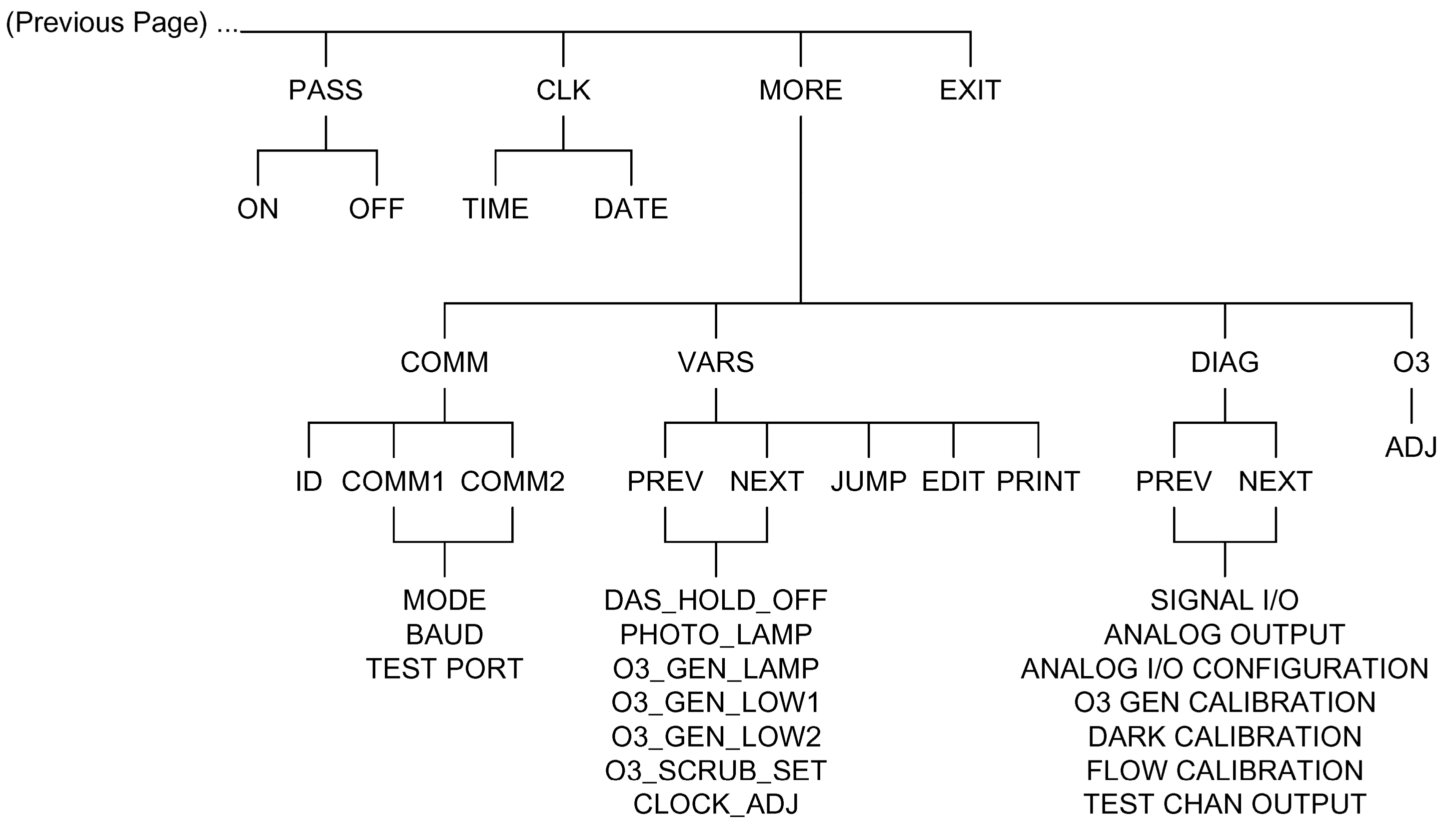
* These items will only be visible when the ozone generator is installed.
** These will be there only when the ozone generator or zero/span valves are installed.



* Only if IZS or span valves are installed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O3_GEN_LOW2
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CLOCK_ADJ
SIGNAL I/O
ANALOG OUTPUT
ANALOG I/O CONFIGURATION
O3 GEN CALIBRATION
DARK CALIBRATION
FLOW CALIBRATION
TEST CHAN OUTPUT

USER NOTES:

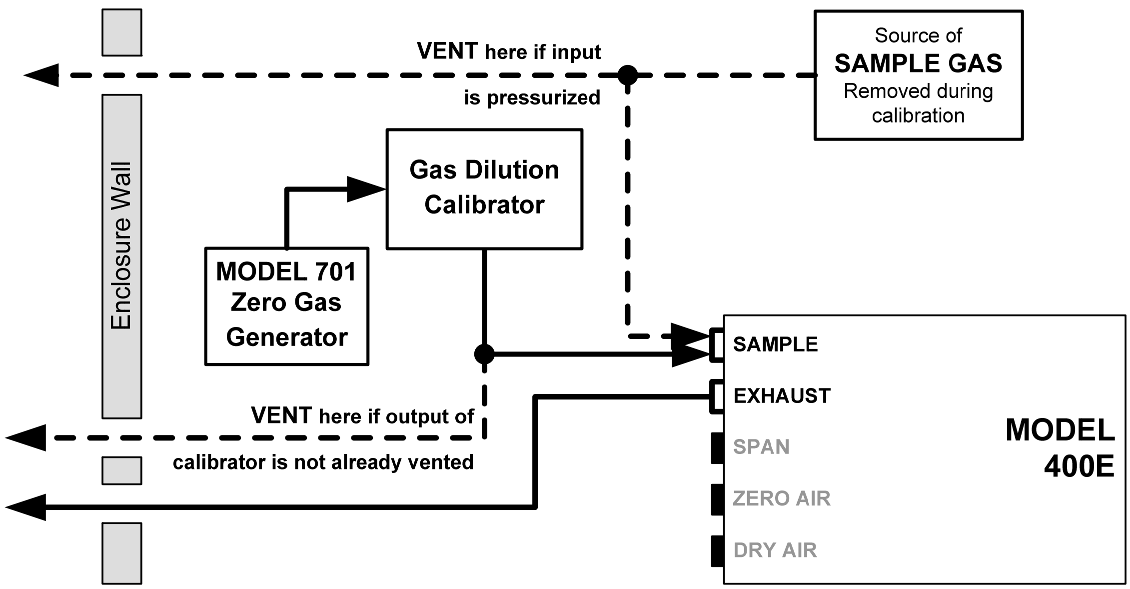
4. CALIBRATION PROCEDURE

MANUAL CALIBRATION & CALIBRATION WITHOUT ZERO/SPAN VALVE OR IZS OPTIONS

This is the basic method for manually calibrating the Model 400E O_3 Analyzer.

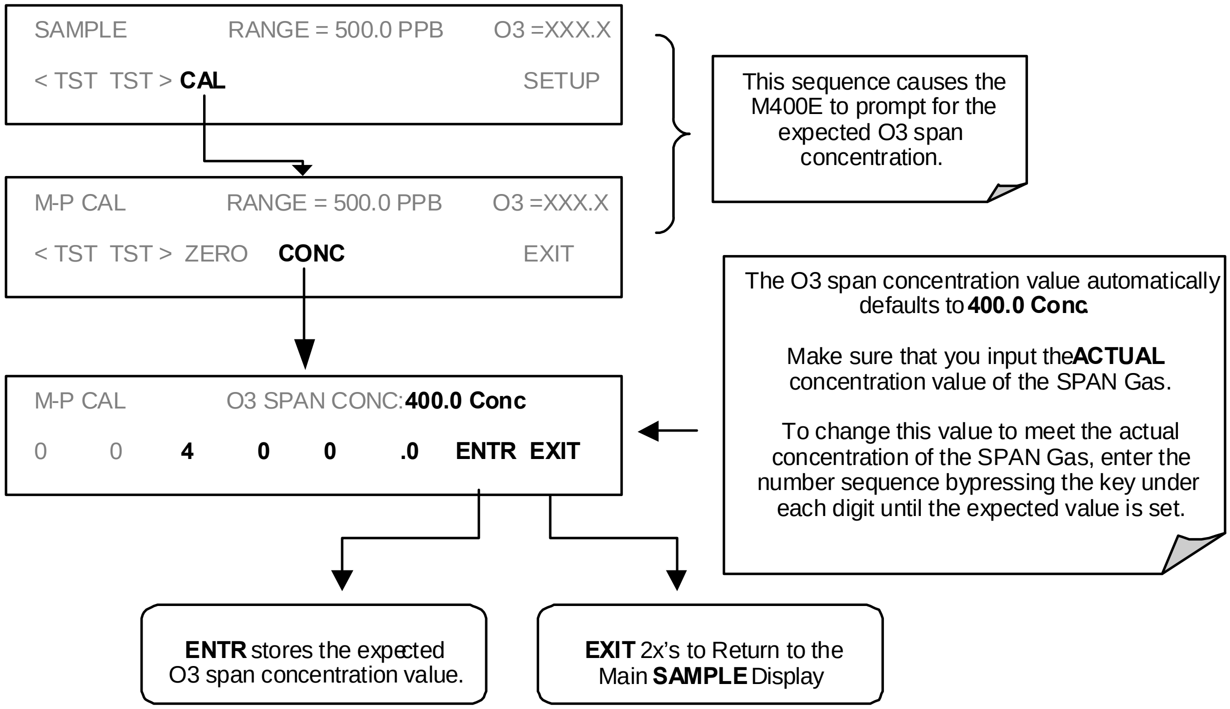
ZERO/SPAN CALIBRATION VS. ZERO/SPAN CHECK
Pressing the ENTR key during the following procedure resets the stored values for OFFSET and SLOPE and alters the instrument's Calibration.

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



Pneumatic Connections for Manual Calibration without Z/S Valve or IZS Options

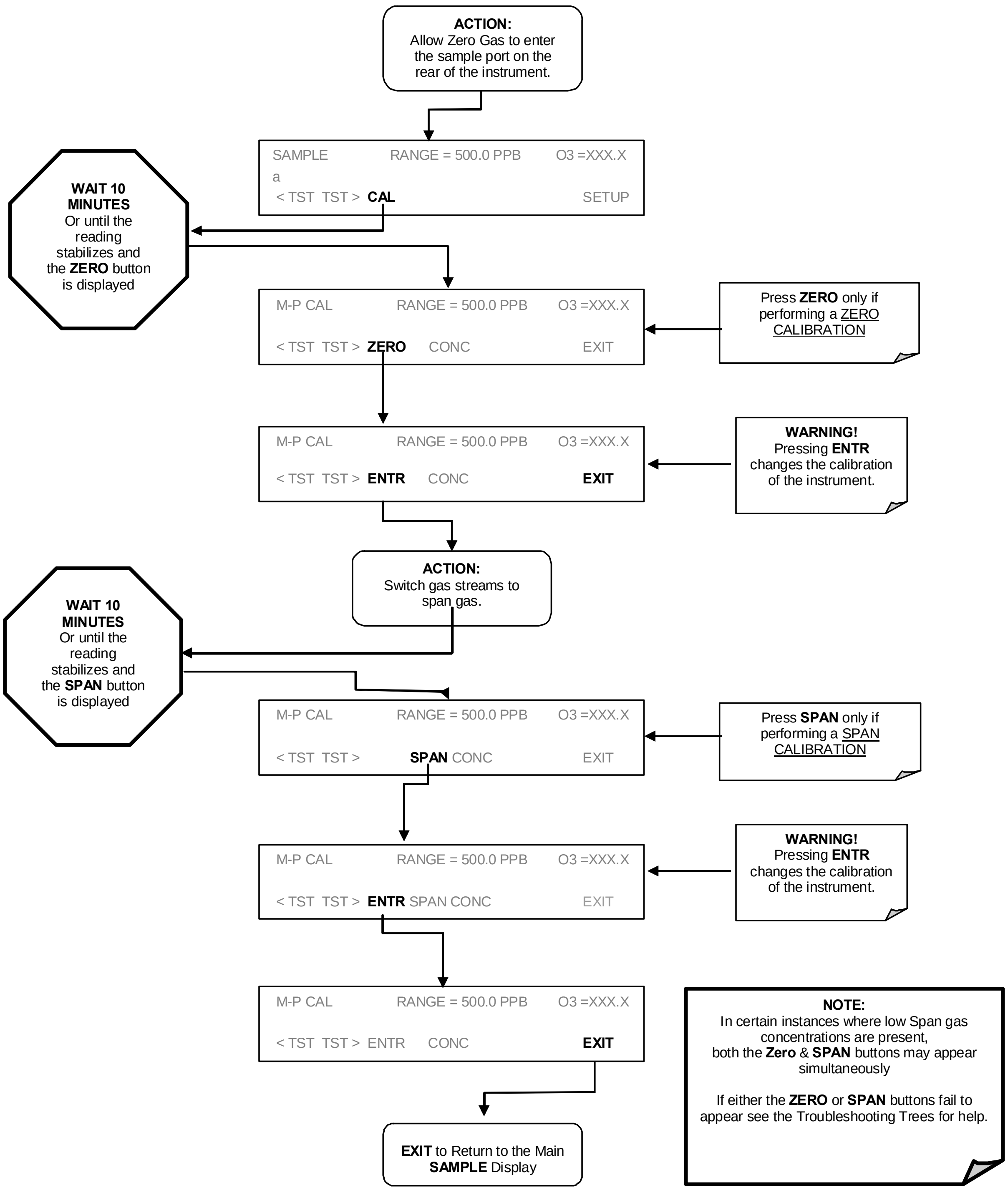
<u>STEP TWO</u>: Set the expected O_3 Span Gas concentration:



NOTE

For this Initial Calibration it is important to independently verify the <u>PRECISE</u> O_3 Concentration Value of the SPAN gas.

STEP THREE: Perform the Zero/Span Calibration Procedure:



If the **ZERO** or **SPAN** keys are not displayed, this means that the measurement made during that part of the procedure is too far out of the allowable range to do allow a reliable calibration. The reason for this must be determined before the analyzer can be calibrated.

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 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 when ever it asks for it. Once in the DIAG menu press next until you get Pressure Calibration and hit ENTER. Now enter the actual 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 press next 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 Sample Flow. It will be reading close to the measured value.

IZS OZONE GENERATOR LAMP

The procedure adjusts the lamp for optimum operation of the IZS and its feedback circuit.

1. Enter the Adjustment menu by pressing SETUP-MORE-O3-ADJ. This causes the lamp drive circuit to output a constant 2.5 V.
2. If you are installing a new lamp, allow approximately 30 min for lamp output to stabilize.
3. Select the "O3 GEN" Test function on the front panel display. Loosen the IZS lamp and rotate until the reading on the display is 2500 mV ± 500 mV.

CAUTION
UV light present. Do not pull the lamp from the IZS assembly.

4. Re-tighten the sealing ring, securing the ozone lamp to the IZS generator assembly.
5. Adjust the reference potentiometer on the IZS UV detector board to refine the front panel reading to 2500 mV ± 25.
6. The IZS lamp and feedback circuit are now set up. Now perform an IZS ozone generator calibration, located in the DIAG menu. This procedure is automated and will take about 1 hour to complete.

Service Note

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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 14
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.

USER NOTES:

5. MAINTENANCE

M400E Preventative Maintenance Schedule

Item	Action	Priority	Frequency	Cal Check	Date Performed								
Particulate Filter	Replace	Mandatory	Weekly or as needed	Yes									
Pump Diaphragm	Replace	Mandatory	Annually	Yes									
IZS zero air scrubber	Replace	Mandatory	Annually	No									
O_3 Scrubber (Ref Scrubber)	Replace	Recommended	Every two years	Yes									
Verify Test Functions	Record & Analyze	Recommended	Weekly or after any maintenance or repair	No									
Perform Flow Check	Check Flow	Recommended	Every 6 months	No									
Verify Leak Tight	Perform Leak Check	Recommended	Annually or after any maintenance or repair	Yes									
Pneumatic Lines	Examine and Replace	Recommended	As needed	Yes if replaced									
Absorption Tube	Clean	Recommended	As needed	Yes									
Bench Calibration	Calibrate	Recommended	Annually as needed	N/A									
IZS Ozone Calibration	Calibrate	Recommended	Annually as needed	N/A									
Orings & Sintered Filters	Replace	As Needed	Annually	Yes									

VACUUM LEAK CHECK AND PUMP CHECK

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

1. Turn the analyzer ON, and allow enough time for flows to stabilize.
2. Cap the sample inlet port.
3. After 2 minutes, when the pressures have stabilized, note the SAMP FL and PRES test function readings on the front panel.
4. If SAMP FL < 10 CC/M then the analyzer is free of any large leaks.
5. If PRES < 10 IN-HG-A then the sample pump diaphragm is in good condition.

PRESSURE LEAK CHECK

If you can't locate the leak by the above procedure, obtain a leak checker similar to the T-API part number 01960, which contains a small pump, shut-off valve, and pressure gauge. Alternatively, a tank of pressurized gas, with the two stage regulator adjusted to ≤ 15 psi; a shutoff valve and pressure gauge may be used.

CAUTION

Once the fittings have been wetted with soap solution, DO NOT apply / re-apply vacuum as this will cause soap solution to be drawn into the instrument, contaminating it.

DO NOT exceed 15 psi pressure.

1. Turn OFF power to the instrument.
2. Install a leak checker or tank of gas as described above on the sample inlet at the rear panel.
3. Install a cap on the Exhaust fitting on the rear panel.
4. Remove the instrument cover and locate the sample pump. Disconnect the two fittings on the sample pump and install a union fitting in place of the pump. The analyzer cannot be leak checked with the pump in line due to internal leakage that normally occurs in the pump.
5. Pressurize the instrument with the leak checker, allowing enough time to fully pressurize the instrument through the critical flow orifice. Check each fitting with soap bubble solution, looking for bubbles. Once the fittings have been wetted with soap solution, do not re-apply vacuum, as it will draw soap solution into the instrument and contaminate it. Do not exceed 15 psi pressure.
6. If the instrument has one of the zero and span valve options, the normally closed ports on each valve should also be separately checked. Connect the leak checker to the normally closed ports and check with soap bubble solution.
7. If the analyzer is equipped with an IZS Option Connect the leak checker to the Dry Air inlet and check with soap bubble solution.
8. Once the leak has been located and repaired, the leak-down rate should be < 1 in-Hg (0.4 psi) in 5 minutes after the pressure is shut off.

CLEANING THE ABSORPTION TUBE

1. Remove the cover from the optical bench.
2. Unscrew the two Philip head screws and remove the retaining brackets from each side of the absorption tube.
3. Using both hands, rotate the tube to free it, and then carefully slide the tube towards the lamp housing. The tube can now be slid past the detector block and out of the instrument.

CAUTION

Do not cause the tube to bind against the metal housings. The tube may break and cause serious injury.

4. Clean the tube with distilled water, then use dry air or nitrogen to dry the tube. Check the cleaning job by looking down the bore of the tube. It should be free from dirt and lint.
5. Inspect the o-rings that seal the ends of the optical tube (these o-rings may stay seated in the manifolds when the tube is removed.) If there is any noticeable damage to these o-rings, they should be replaced.
6. Re-assemble the tube into the lamp housing and leak check the instrument. Note: It is important for proper optical alignment that the tube be pushed all the way towards the detector end of the optical bench when it is re-assembled.
7. Leak check the analyzer. If it leaks check o-rings on tubes.
8. Flow check analyzer.

USER NOTES:

6. TROUBLESHOOTING AND FAULTS

TAPI Service Repair Form

CUSTOMER:______________________________ PHONE: ___________________________________

CONTACT NAME:__________________________ FAX NO. ___________________________________

SITE ADDRESS:____

MODEL TYPE: _____________ SERIAL NO.:________________ FIRMWARE REVISION:____________

Are there any failure messages? ____

____

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____ *(Continue on back if necessary)*

PLEASE COMPLETE THE FOLLOWING TABLE:

PARAMETER	RECORDED VALUE	ACCEPTABLE VALUE
RANGE	PPB/PPM	1 – 10,000 PPB
STABIL		<= 0.3 PPM WITH ZERO AIR
O3 MEAS	mV	2500 – 4800 mV
O3 REF	mV	2500 – 4800 mV
O3 GEN[1]	mV	80 mV. – 5000 mV.
O3 DRIVE[1]	mV	0 – 5000 mV.
PRES	IN-HG-A	~ - 2"AMBIENT ABSOLUTE
SAMPLE FL	CM^3/MIN	800 ± 10%
SAMPLE TEMP	ºC	10 – 50 ºC
PHOTO LAMP	ºC	58 ºC ± 1 ºC
O3 GEN TMP[1]	ºC	48 ºC ± 3 ºC
BOX TEMP	ºC	10 – 50 ºC
SLOPE		1.0 ± .15
OFFSET	PPB	0.0 ± 5.0 PPB
FOLLOWING VALUES ARE UNDER THE SIGNAL I/O SUBMENU		
REF_4096_MV	mV	4096mv±2mv and Must be Stable
REF_GND	mV	0± 0.5 and Must be Stable
Depending on options installed, not all test parameters shown below will be available in your calibrator) [1] If IZS valve option installed.		

Cap the SAMPLE flow inlet and record the flow rate and pressure:

What is sample flow rate _______________ cc/min What is the sample pressure______________ in-Hg-A

What are the failure symptoms? ____

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____

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What tests have you done trying to solve the problem? ____

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Thank you for providing this information. Your assistance enables Teledyne Instruments to respond faster to the problem that you are encountering.

OTHER NOTES: ____

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Warning Messages

Message	Meaning
LAMP DRIVER WARN	CPU is unable to communicate with one of the I2C UV Lamp Drivers.
BOX TEMP WARNING	The temperature inside the M400E chassis is outside the specified limits.
CONFIG INITIALIZED	Configuration storage was reset to factory configuration or erased.
DATA INITIALIZED	iDAS data storage was erased.
FRONT PANEL WARN	CPU is unable to communicate with the front panel.
PHOTO REF WARNING	The O_3 Reference value is outside of specified limits.
PHOTO TEMP WARNING	The UV Lamp Temperature is outside of specified limits.
REAR BOARD NOT DET	Motherboard was not detected during power up.
RELAY BOARD WARN	CPU is unable to communicate with the relay board.
SAMPLE FLOW WARN	The flow rate of the sample gas is outside the specified limits.
SAMPLE PRESS WARN	The pressure of the sample gas is outside the specified limits.
SAMPLE TEMP WARN	The temperature of the sample gas is outside the specified limits.
SYSTEM RESET	The computer has rebooted.
O3 GEN LAMP WARN	The UV Lamp or Detector in the IZS module may be faulty or out of adjustment.
O3 GEN REF WARNING	The UV Lamp or Detector in the IZS module may be faulty or out of adjustment.
O3 GEN TEMP WARN	The UV Lamp Heater or Temperature Sensor in the IZS module may be faulty.
O3 SCRUB TEMP WARN	The Heater or Temperature Sensor of the O_3 Scrubber may be faulty (Optional Metal Wool Scrubber only.)

STATUS LED'S

Some LED's are located on the Analyzer's Relay board to show the current status on the various control functions performed by the Relay Board. They are:

Relay Board Status LED's

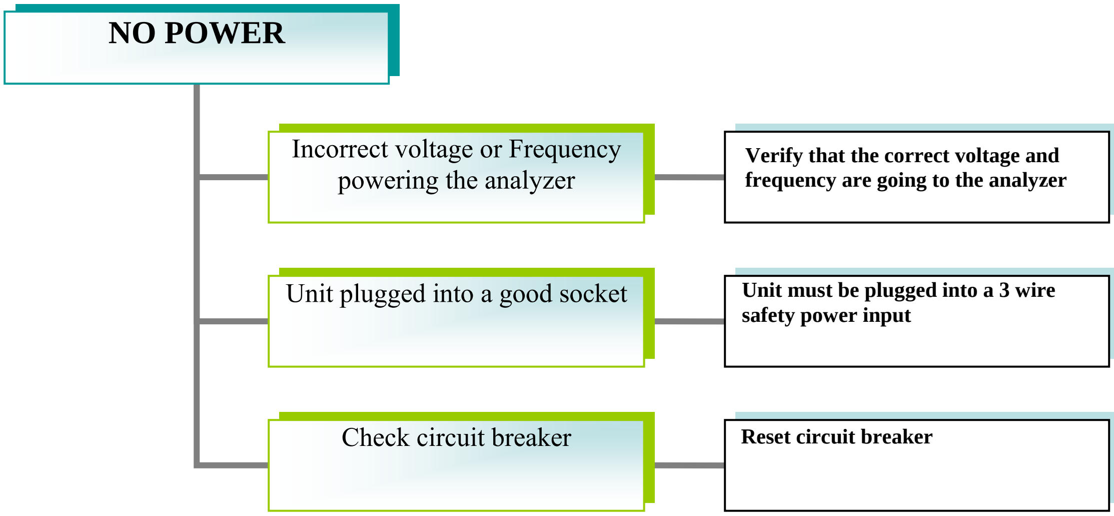
LED	Color	Function	Status When Lit	Status When Unlit
D1	RED	Watchdog Circuit	Cycles On/Off Every 3 Seconds under direct control of the analyzer's CPU.	
D2	YELLOW	Metal Wool Scrubber Heater	HEATING	NOT HEATING
D3	YELLOW	Spare	N/A	N/A
D4	YELLOW	Spare	N/A	N/A
D5	YELLOW	Spare	N/A	N/A
D6	YELLOW	Spare	N/A	N/A
D7	GREEN	Zero/Span Gas Valve	Valve Open to SPAN GAS FLOW	Valve Open to ZERO GAS FLOW
D8	GREEN	Measure/Ref Valve	Valve Open to REFERENCE gas path	Valve Open to MEASURE gas path
D9	GREEN	Sample/Cal Gas Valve	Valve Open to CAL GAS FLOW	Valve Open to SAMPLE GAS FLOW
D10	GREEN	Spare	N/A	N/A
D11	GREEN	Spare	N/A	N/A
D12	GREEN	Spare	N/A	N/A
D13	GREEN	Spare	N/A	N/A
D14	GREEN	Spare	N/A	N/A
D15	GREEN	Photometer UV Lamp Heater	HEATING	NOT HEATING
D16	GREEN	IZS O_3 Generator UV Lamp Heater	HEATING	NOT HEATING

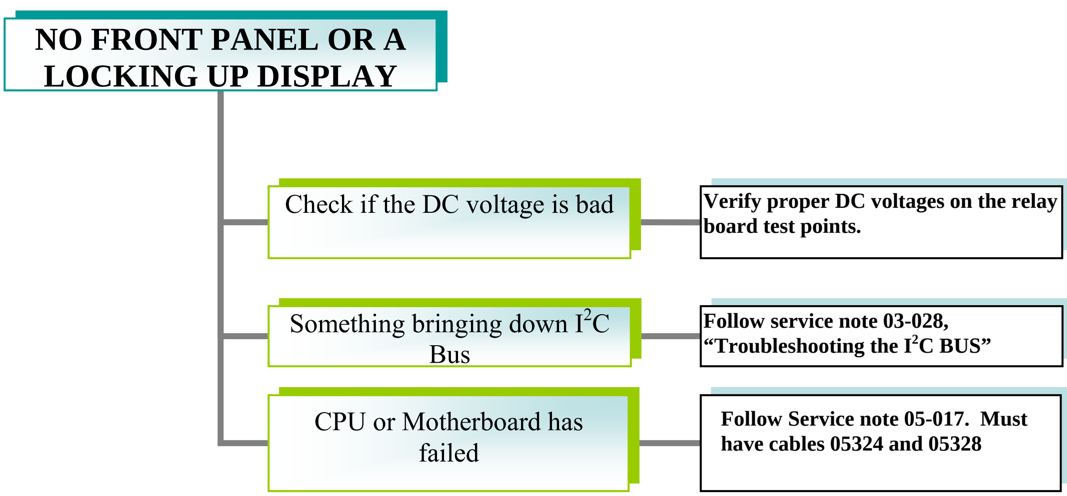
WATCH DOG CIRCUITRY

Special circuitry on the Relay Board watches the status of LED D1. Should this LED ever stay **ON** or **OFF** for 30 seconds, the Watchdog Circuit will automatically shut of all valves as well as turn off the UV Source(s) and all heaters. The Sample Pump will still be running.

M400E TROUBLESHOOTING TREE

Troubleshooting Trees
No Power
No front panel or locking up Display
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
No Flow
No analog or incorrect analog output
Photo Ref Warning
Any Temperature Warning


NO POWER
Incorrect voltage or Frequency powering the analyzer
Verify that the correct voltage and frequency are going to the analyzer
Unit plugged into a good socket
Unit must be plugged into a 3 wire safety power input
Check circuit breaker
Reset circuit breaker


NO FRONT PANEL OR A LOCKING UP DISPLAY
Check if the DC voltage is bad
Verify proper DC voltages on the relay board test points.
Something bringing down I2C Bus
Follow service note 03-028, "Troubleshooting the I2C BUS"
CPU or Motherboard has failed
Follow Service note 05-017. Must have cables 05324 and 05328

UNSTABLE READING AT ZERO, ZERO NOISE

Leak in the analyzer	**Perform a Leak check on the analyzer. Cap sample inlet and make sure the pressure drops <10" and the flow drops to <10cc/min**
Internal Zero source depleted	**Replace scrubber material and check with a known zero source**
Dirty Sample tubing or sample filter	**Replace tubing or sample filter. Make sure not to touch the Sample filter with your hands. Use gloves or soft tweezers**
Zero Air Contaminated	**Switch Zero Air sources or replace scrubber material in current source of zero air**
Bad Motherboard	**Go into the signal I/O menu and find the value Refernce_4096=, Look at the mV reading and make sure it is stable to with in .2mV. If it is moving around more than that, change the motherboard, 5 year warranty part.**
Bad UV lamp	**If both the Measure and Reference are moving around, due to a noisy lamp, then the zero will be unstable. Replace the UV lamp**
Bad detector/UVPS	**If the UV lamp doesn't fix the problem, it is either caused by the UVPS or the Detector. Replace them one at a time to find the problem**
Electronic noise	**Refer to service note 04-011 and Reference detector simulator PN 051010000 to determine if the noise is from the bench or cables/motherboard**

UNSTABLE READING AT SPAN, SPAN NOISE

Leak in the analyzer	**Perform a Leak check on the analyzer. Cap sample inlet and make sure the pressure drops <10" and the flow drops to <10cc/min**
Internal Zero source depleted	**Replace scrubber material and check with a known zero source**
Dirty Sample tubing or sample filter	**Replace tubing or sample filter. Make sure not to touch the Sample filter with your hands. Use gloves or soft tweezers**
Bad Motherboard	**Go into the signal I/O menu and find the value Refernce_4096=, Look at the mV reading and make sure it is stable to with in .2mV. If it is moving around more than that, change the motherboard, 5 year warranty part.**
Bad UV lamp	**If both the Measure and Reference are moving around, due to a noisy lamp, then the span will be unstable. Replace the UV lamp**
Bad detector/UVPS	**If the UV lamp doesn't fix the problem, it is either caused by the UVPS or the Detector. Replace them one at a time to find the problem**
Electronic noise	**Refer to service note 04-011 and Reference detector simulator PN 051010000 to determine if the noise is from the bench or cables/motherboard**

UNABLE TO ZERO (NO ZERO BUTTON)

Leak in the analyzer	**Perform a Leak check on the analyzer. Cap sample inlet and make sure the pressure drops <10” and the flow drops to <10cc/min**
Internal Zero source depleted	**Replace scrubber material and check with a known zero source**
Dirty Sample tubing or sample filter	**Replace tubing or sample filter. Make sure not to touch the Sample filter with your hands. Use gloves or nylon tweezers**
Zero Air Contaminated	**Switch Zero Air sources or replace scrubber material in current source of zero air. A good sign of this is if the offset is slowly increasing**
Pressurizing or vacuuming the sample	**The analyzer can have a high zero offset if you pull a vacuum or pressurize the sample inlet. It should be at ambient pressure**

UNABLE TO SPAN (NO SPAN BUTTON OR NO RESPONSE TO SPAN)

Cause	Remedy
Leak in the analyzer	**Perform a Leak check on the analyzer. Cap sample inlet and make sure the pressure drops <10” and the flow drops to <10cc/min**
No Flow	**Make sure the pump is turning and there is suction from the vacuum side. Replace Filters. If still no flow, check for flow restrictions in the tubing.**
Dirty Sample tubing or sample filter	**Replace tubing or sample filter. Make sure not to touch the Sample filter with your hands. Use gloves or nylon tweezers. Replace tubing or sample filter**
Bad Reference scrubber, or bad M/R valve	**Record the O3 Reference reading on Zero and Span gas. It should not differ more than 1mV. If it drops more than 1mv when you go to span, replace the valve or the scrubber.**
Bad Ozone source	**Check the calibration of your calibrator**
Incorrect span gas in CONC menu	**Check the CONC menu in the calibration mode and ensure it is the correct span gas value**

NON-LINEAR RESPONSE

- **Leak in the analyzer** — **Perform a Leak check on the analyzer. Cap sample inlet and make sure the pressure drops <10" and the flow drops to <10cc/min**
- **Improper zero/span** — **Check zero and span points again. Wait 15minutes and make sure they are correct, this is the most important thing to ensure that the Ozone analyzer is linear**
- **Bad Ozone source** — **Check the calibration of your calibrator**
- **Bad Reference scrubber, or bad M/R valve** — **Record the O3 Reference reading on Zero and Span gas. It should not differ more than 1mV. If it drops more than 1mv when you go to span, replace the valve or the scrubber.**

SLOW RESPONSE TO ZERO OR SPAN

- **Leak in the analyzer** — Perform a Leak check on the analyzer. Cap sample inlet and make sure the pressure drops <10” and the flow drops to <10cc/min
- **Low flow** — Measure the Flow with an external flow meter. It should be 800cc +- 10%. If not replace filters and look for restrictions.
- **Contaminated Sample filter** — Replace sample particulate filter. Make sure not to touch the Sample filter with your hands. Use gloves or soft tweezers
- **Analyzer needs conditioning** — If this is a brand new analyzer, or has been out of service for a while it may need to condition the lines, either in the analyzer or from the calibrator to the analyzer
- **Gas to the analyzer is taking too long to get to the analyzer** — Input span/zero gas and wait until the analyzer is stable. Disconnect the sample inlet to the analyzer but let the cal gas keep flowing. Wait 5 minutes. Reconnect the sample line. If it goes right to the concentration you expect or closer than it was when you disconnected the tubing, the calibration system is the problem, or it just needed to condition itself.

NO FLOW

Cause	Solution
Front panel particulate filter dirty	**Replace front panel particulate filter. Make sure not to touch the Sample filter with your hands. Use gloves or soft tweezers**
Stainless steel sintered filter dirty	**Replace the sintered filter in front of the critical flow orifice**
Pump seized up or not turning	**Replace the entire pump**
Pump diaphragm torn	**Rebuild the pump**
The flow meter has failed	**Replace the flowmeter**
Crimped tubing or other flow restriction in the lines	**Go through the entire analyzer looking for any bent or pinched tubing, especially near the front panel and rear panel. Disconnect tubing at various locations in the analyzer checking for flow to narrow the problem down**

NO ANALOG OR INCORRECT ANALOG OUTPUT

Outputs not properly calibrated	**Perform an analog output calibration. Refer to service note 03-020**
Output set for Voltage or current when it should be the other	**Look at the motherboard on the rear panel and J19, J21, and J23. Each connector that has a small circuit board about 2" by 1" is configured for current. If it has two shunts across the two left pins, or a small ½" by ½" circuit board, it is configured for Voltage.**
Bad motherboard	**Replace motherboard. (5 year warranty part)**
Noisy outputs	**Needs Analog Output Stabilizer board (KIT000214)**

PHOTO REF WARNING

- Reference too high
  - **Look at the Reference value. If it is 4950mV or greater, adjust it back down using the Reference pot or physically adjusting the lamp**
- Reference too low
  - **Adjust UV lamp. If the reference is reading around 100mV, check to see if the lamp is powered on. If it is, replace the detector. If it's not, replace the UVPS or the lamp.**
- Non-spike suppressing software
  - **Make sure you have Version E.0 Software or greater. If you do not, contact API customer service for the newest version**

ANY TEMPERATURE WARNING

Bad Relay

Toggle the heater on and off in the Signal I/O menu while measuring the DC voltage going to the heater. This should switch between 0V and 12V DC. If the LED is turning on and off but the voltage isn't changing, the Relay is bad.

Bad Thermistor

Measure the Resistance of the thermistor in question. It should be around 25K ohms at room temperature. As the temperature goes up the resistance will go down. If the thermistor reads open or a short it is bad.

Bad Heater

Measure the Resistance of the heater. It should be less than 1K ohms in most cases. If it is open or shorted, it is bad

USER NOTES:

7. SPECIFICATIONS

Model 400E Basic Unit Specifications

Min/Max Range (Physical Analog Output)	Min: 0-100 PPB Max: 0-10,000 PPB
Measurement Units	ppb, ppm, µg/m^3, mg/m^3 (user selectable)
Zero Noise	< 0.3 ppb RMS (EPA Definition)
Span Noise	< 0.5% of reading above 100 PPB (EPA Definition)
Lower Detectable Limit	< 0.6 PPB (EPA Definition)
Zero Drift (24 hours)	< 1.0 ppb (at constant temperature and voltage)
Zero Drift (7 days)	< 1.0 ppb (at constant temperature and voltage)
Span Drift (24 hours)	< 1% of reading (at constant temperature and voltage)
Span Drift (7 days)	< 1% of reading (at constant temperature and voltage)
Linearity	< 1% of full scale
Precision	< 0.5% of reading (EPA Definition)
Lag Time	< 10 sec (EPA Definition)
Rise/Fall Time	< 20 sec to 95% (EPA Definition)
Sample Flow Rate	800 ± 80 cc/min
Temperature Range	5 - 40°C
Humidity Range	0-90% RH, Non-Condensing
Pressure Range	25 – 31 "Hg-A
Altitude Range	0-2000m
Temp Coefficient	< 0.05% per deg C
Voltage Coefficient	< 0.05% per Volt AC (RMS) over range of nominal ± 10%
Dimensions (H x W x D)	7" x 17" x 23.5"
Weight	30.6lbs. (13.8Kg) with IZS Option
AC Power	100V 50/60Hz (3.25A), 115V 60Hz (3.0A), 220 – 240 V 50/60 Hz (2.5A)
Environmental Conditions	Installation Category (Over voltage Category) II Pollution Degree 2
Analog Outputs	Four (4) Outputs, Three (3) defined
Analog Output Ranges	All Outputs: 100 mV, 1 V, 5 V, 10 V Two concentration outputs convertible to 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	COM1: RS-232; COM2: RS-232 or RS-485 Baud Rate : 300 – 115200
Certifications	USEPA: Equivalent Method Number EQOA-0992-087 CE Mark

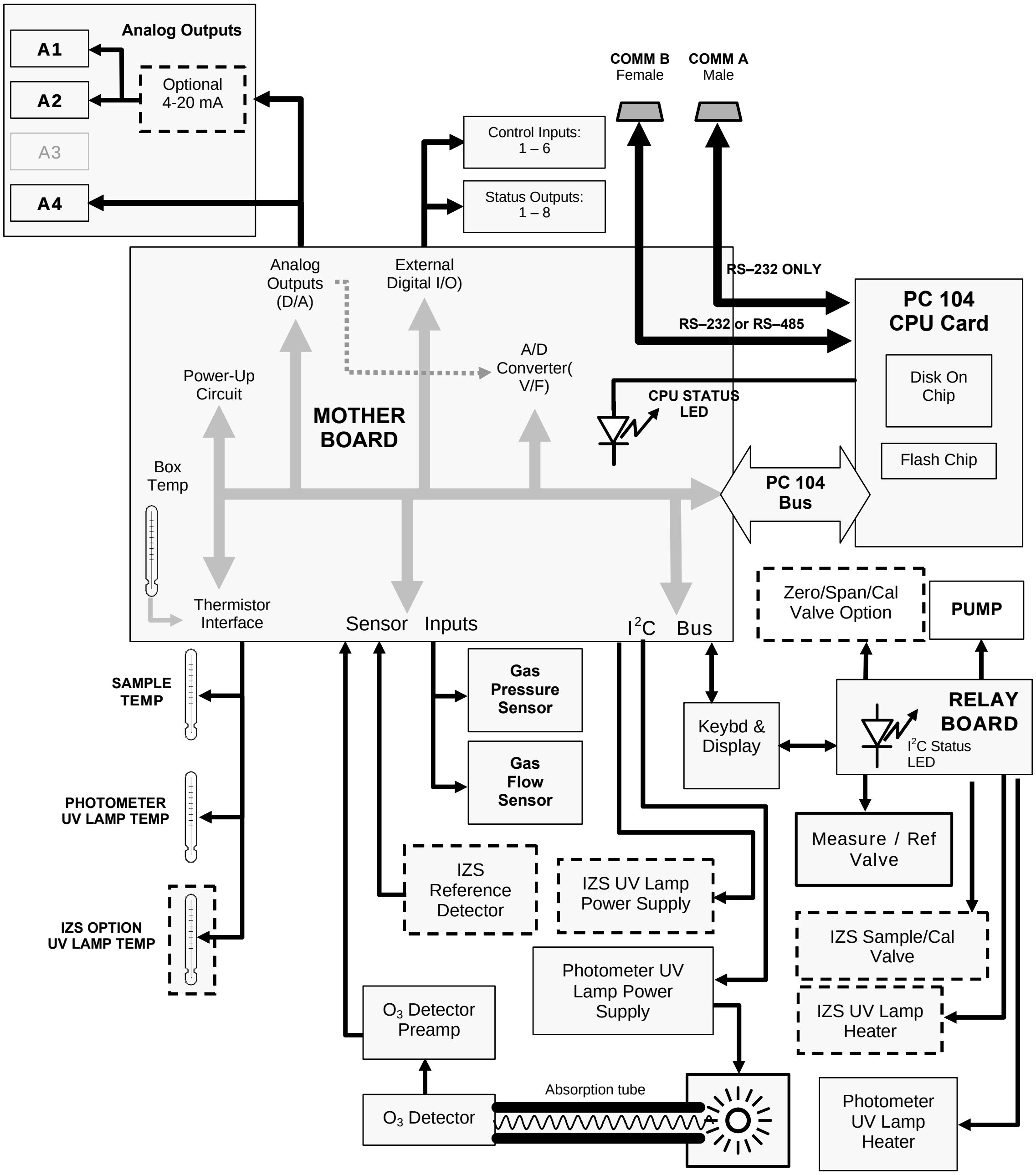
Model 400E IZS Generator Specifications with Reference Feedback Option

Maximum Concentration	1.0 PPM
Minimum Concentration	0.050 PPM
Initial Accuracy	+/- 5% of target concentration
Stability (7 Days)	1% of reading
Repeatability (7 days)	1% of reading
Response Time	< 5 min to 95%
Resolution	0.5 ppb

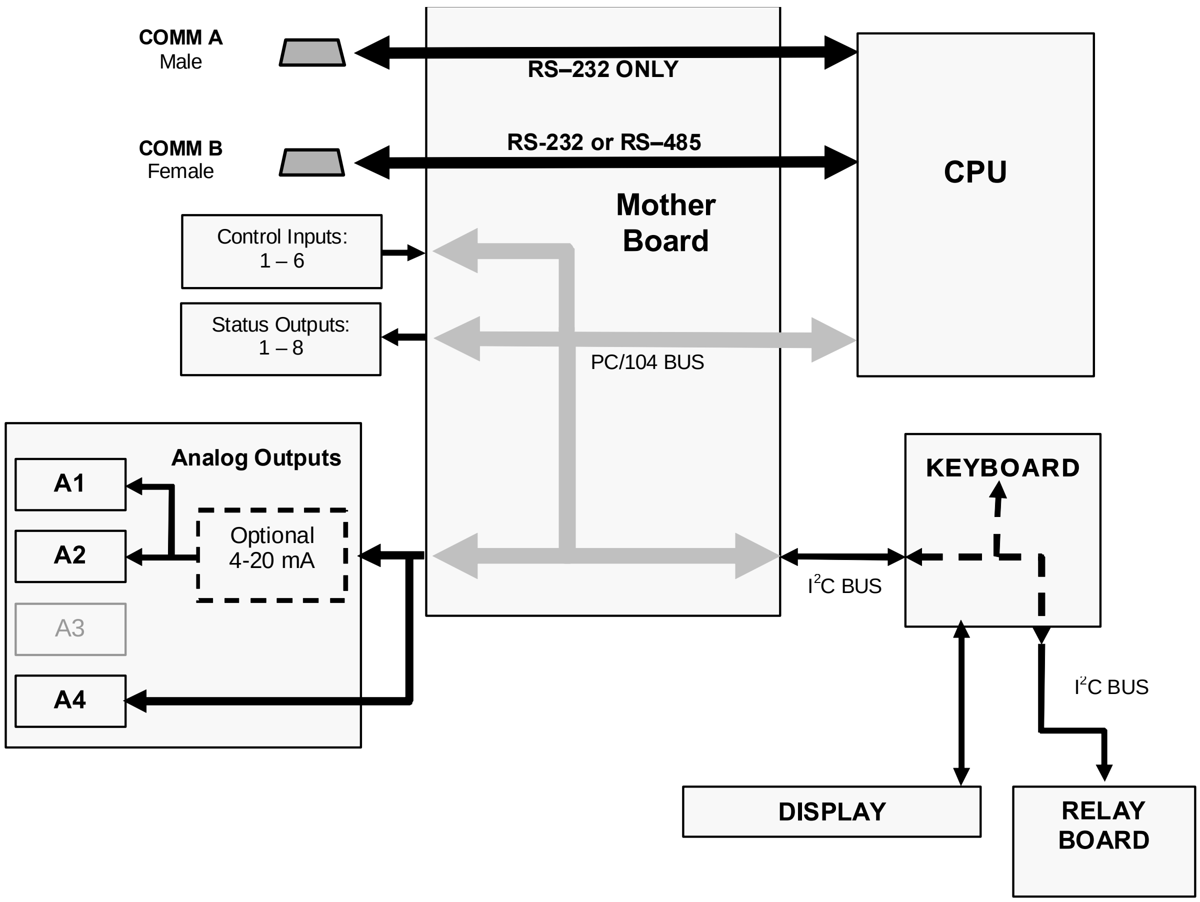
Specifications for Model 400E IZS Generator w/o Reference Feedback Option

Maximum Concentration	1.0 PPM
Minimum Concentration	0.050 PPM
Initial Accuracy	+/- 10% of target concentration
Stability (7 Days)	2% of reading
Repeatability (7 days)	2% of reading
Response Time	< 5 min to 95%
Resolution	0.5 ppb

8. MISC DIAGRAMS



400E Electronic Block Diagram



Basic Electronic Control Circuitry

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

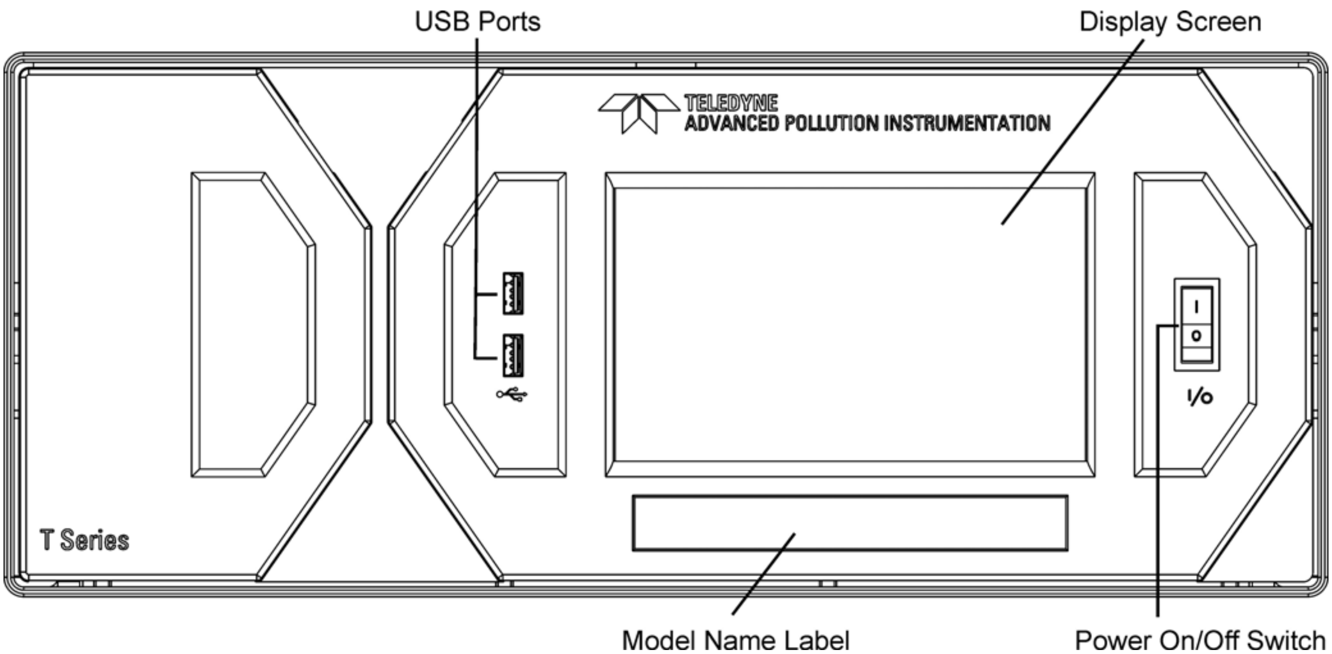


Figure 9-1: Front Panel Layout

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

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

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

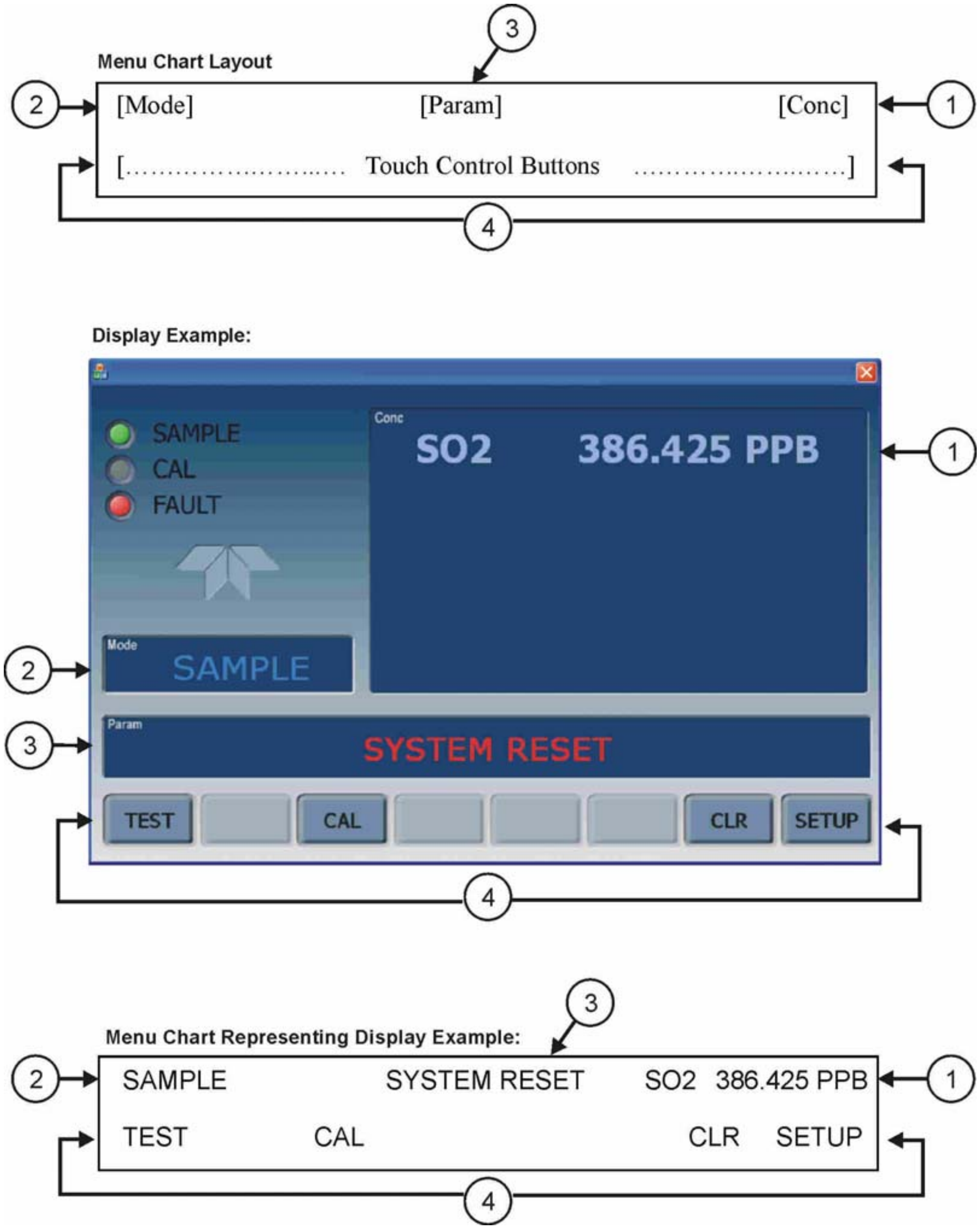


Figure 9-3: Display/Touch Control Screen Mapped to Menu Charts

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.

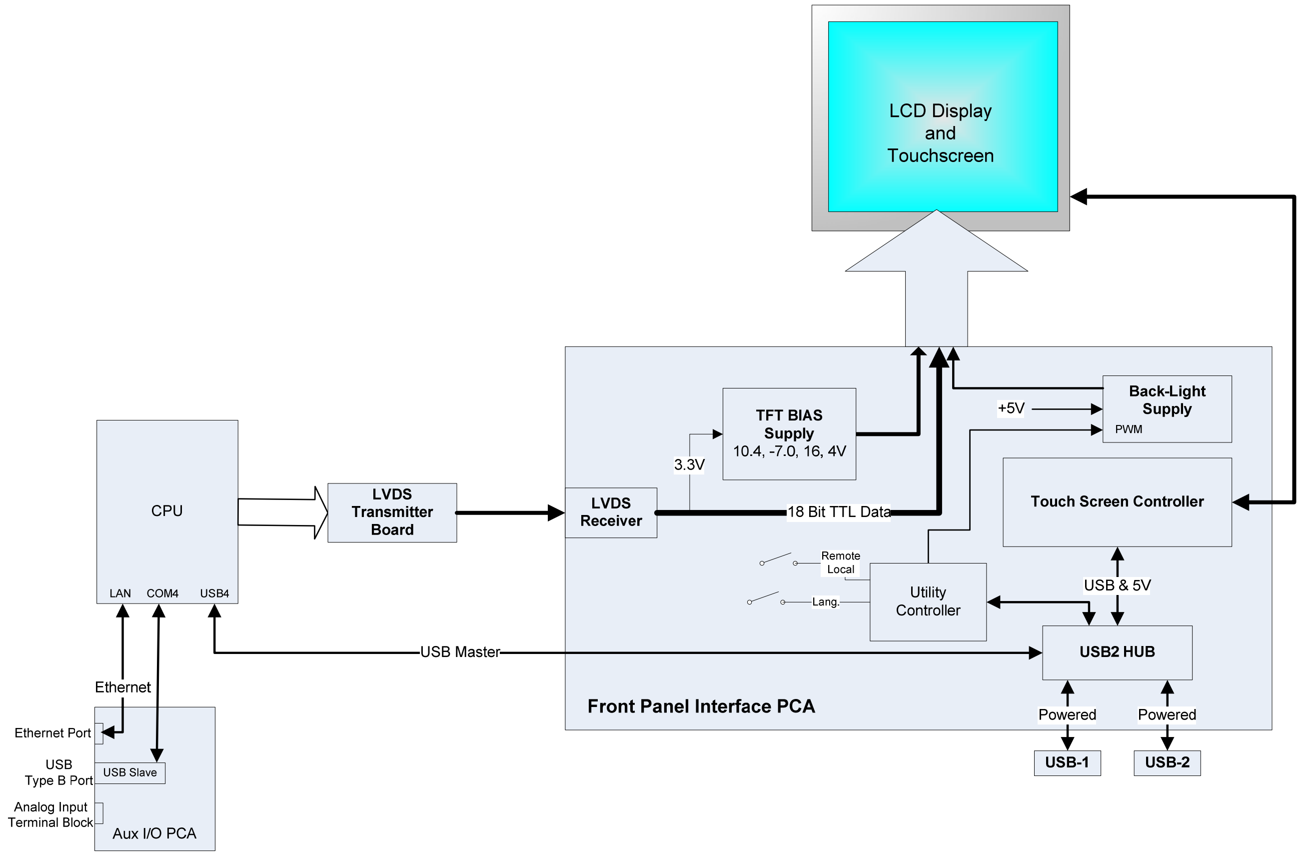


Figure 9-4: Front Panel and Display Interface Block Diagram

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

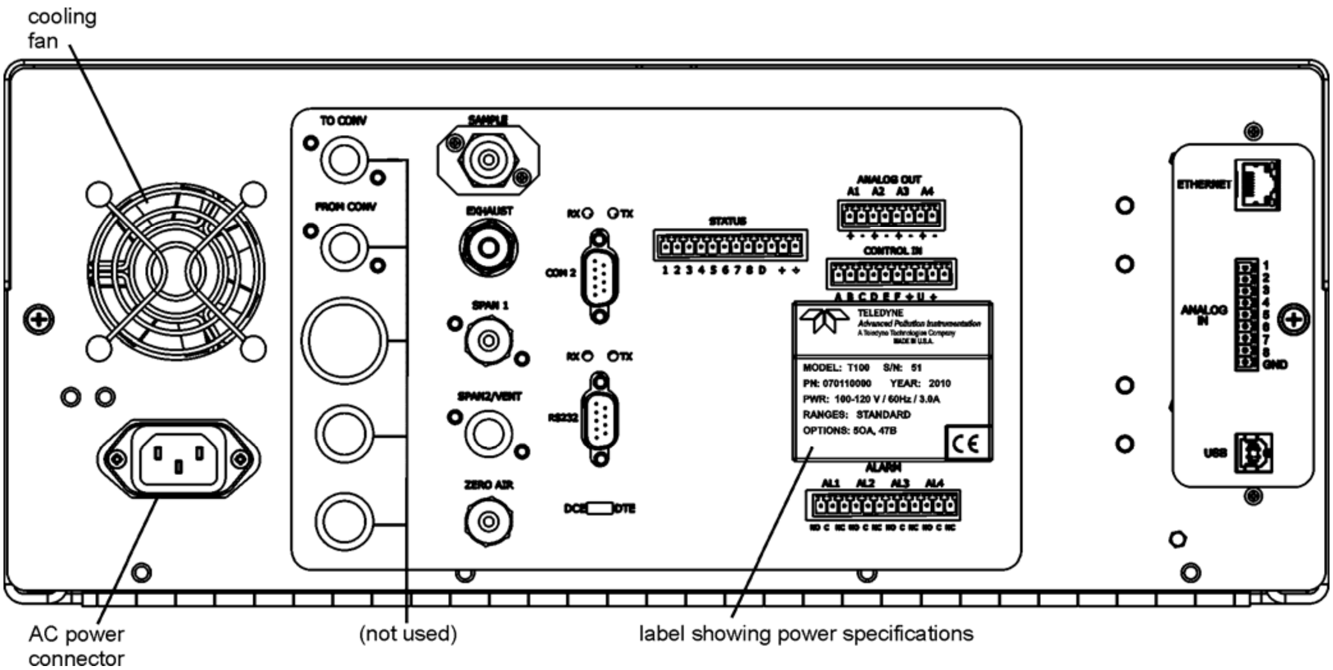


Figure 9-5: Rear Panel Layout

Table 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.

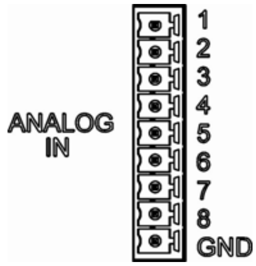


Figure 9-6: Analog In Connector

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:

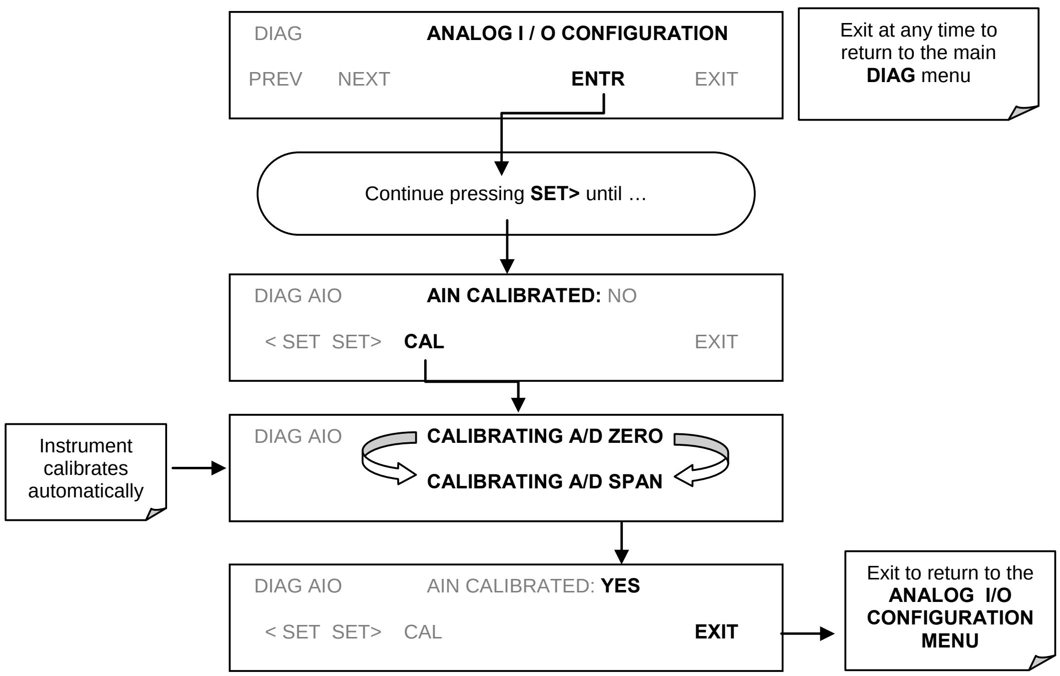


Figure 9-7: DIAG – Analog I/O Configuration – AIN Calibration

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:

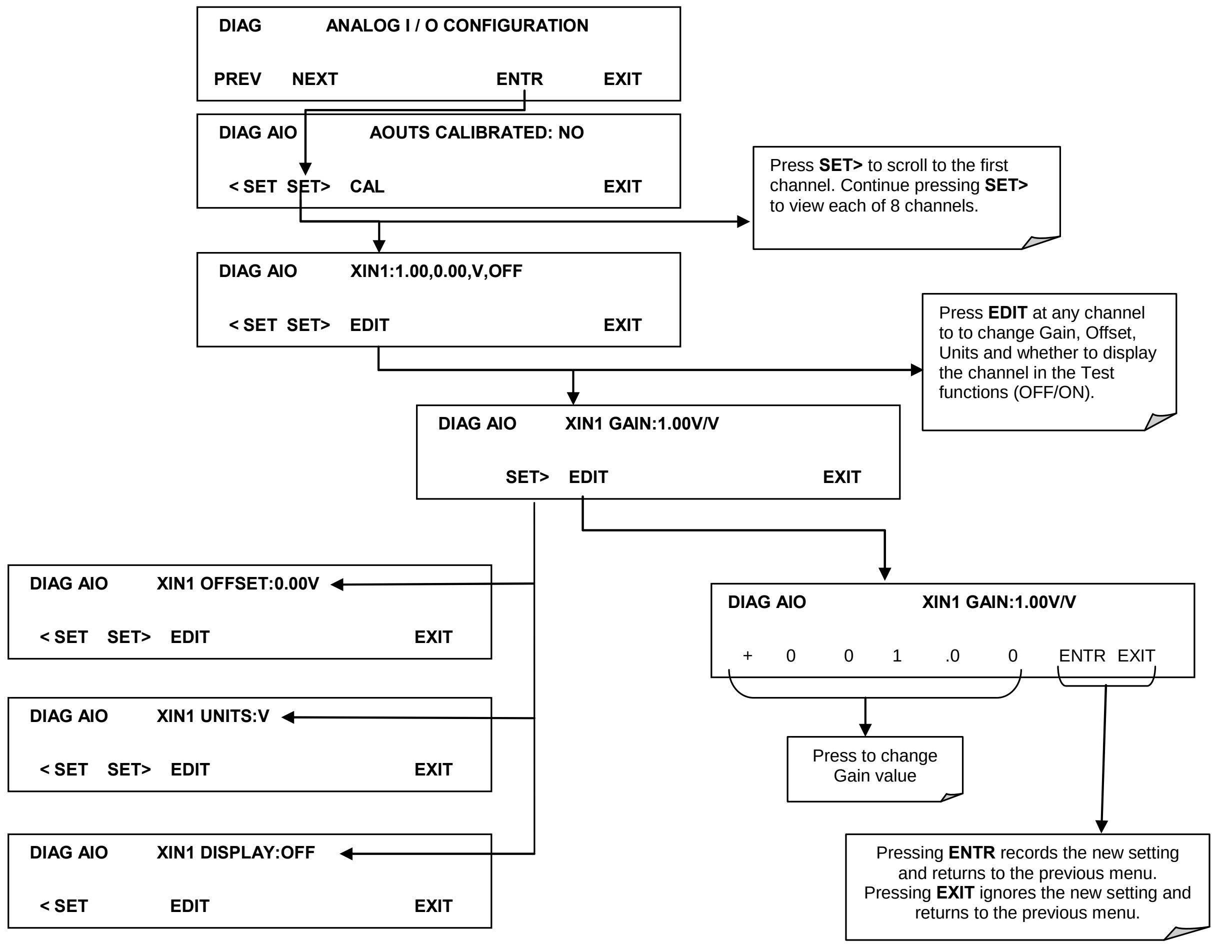


Figure 9-8 DIAG – Analog Inputs (Option) Configuration Menu

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

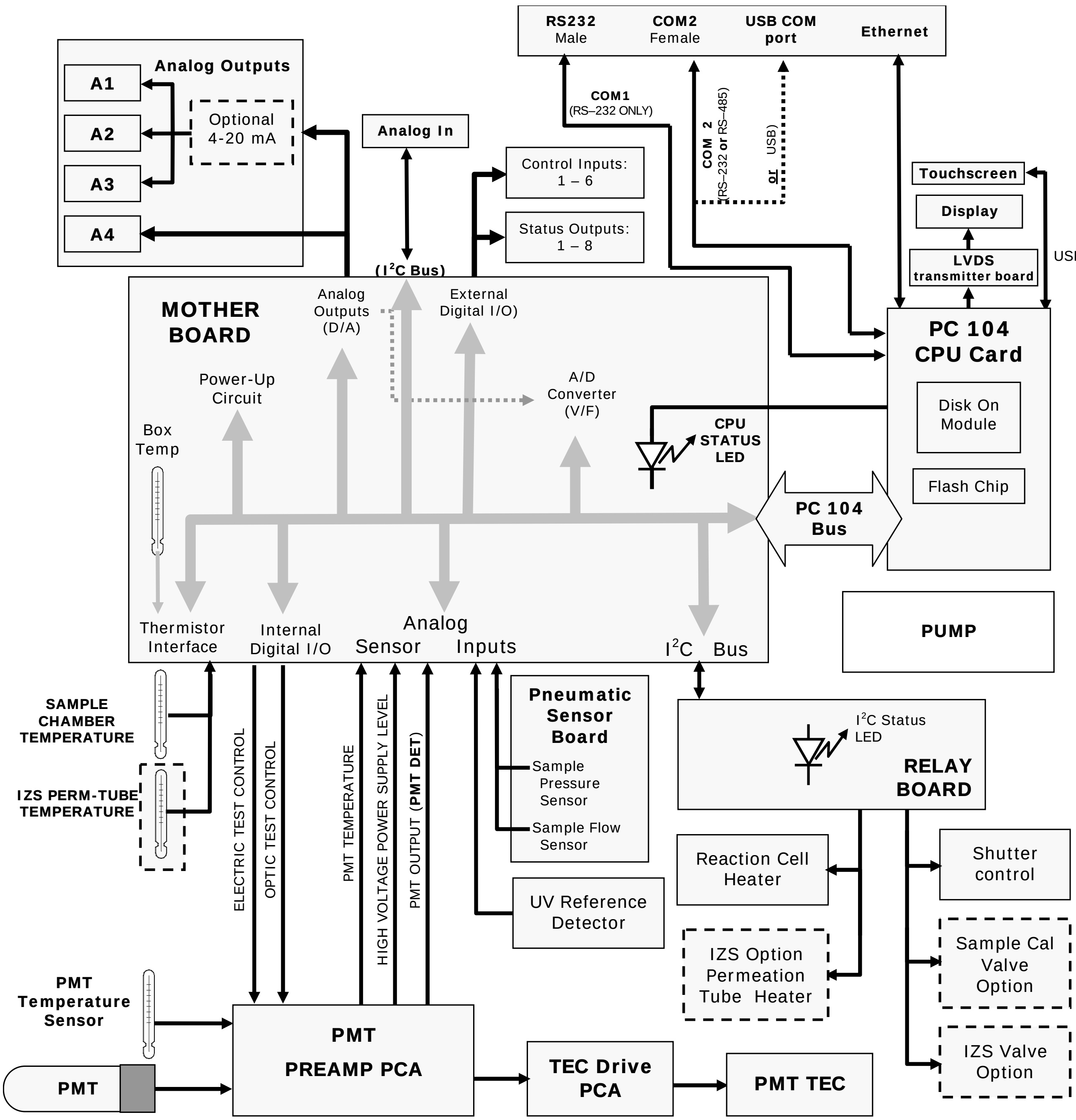


FIGURE 9-9, EXAMPLE OF AN ELECTRONIC BLOCK DIAGRAM (T100)

"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