Level II
Training Manual

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Goal of the class:

To better equip you to troubleshoot a Teledyne API analyzer, to at least the module level.

PREFACE: T SERIES ADDENDUM

P1. Front Panel, Rear Panel, and Display

P2. Calibration & Update Procedures

P3. Troubleshooting Faults

P4. Diagrams and Schematics

P5. E Series Compatibility

P1. Front Panel, Rear Panel, And Display

P1.1. Getting Started

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

P1.1.1 Front Panel

Figure P1-1 shows the analyzer's front panel layout, followed by a close-up of the display screen in Figure P1-2, which is described in Table P1-1. 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

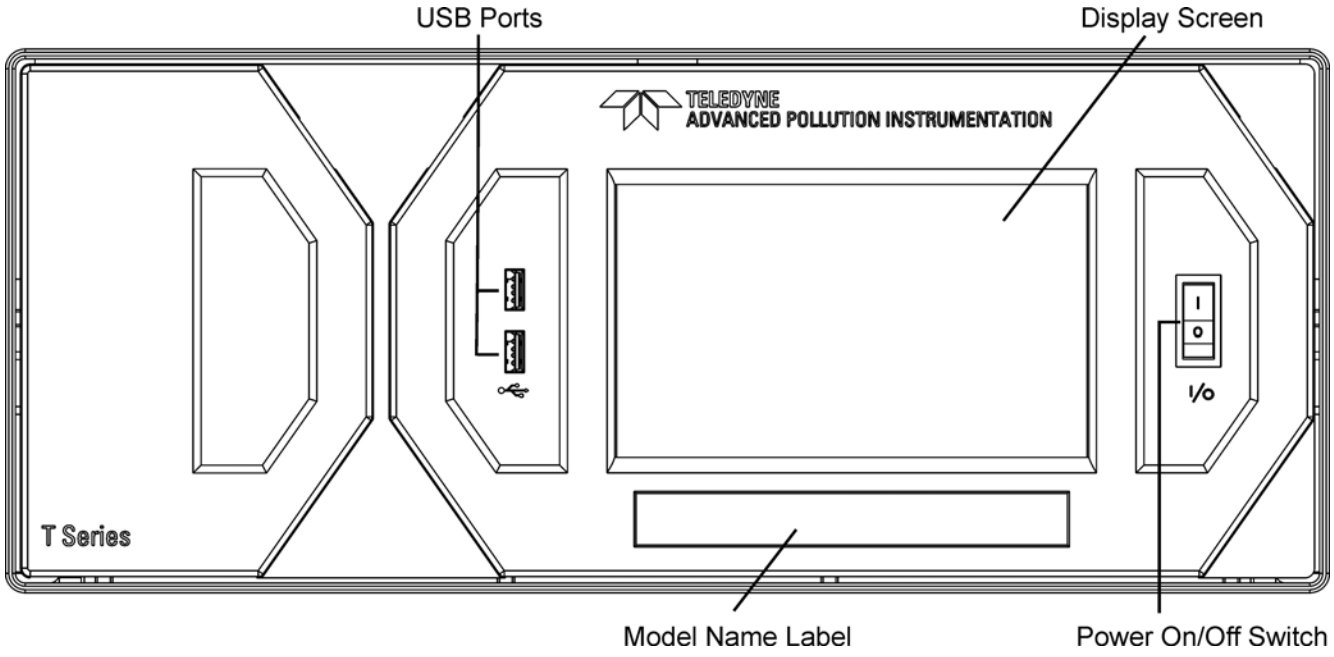


Figure P1-1: Front Panel Layout

Figure P1-2: 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 appear, similar to Figure P1-2 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 P1-1 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 P1-1: 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

Figure P1-3 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.

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.

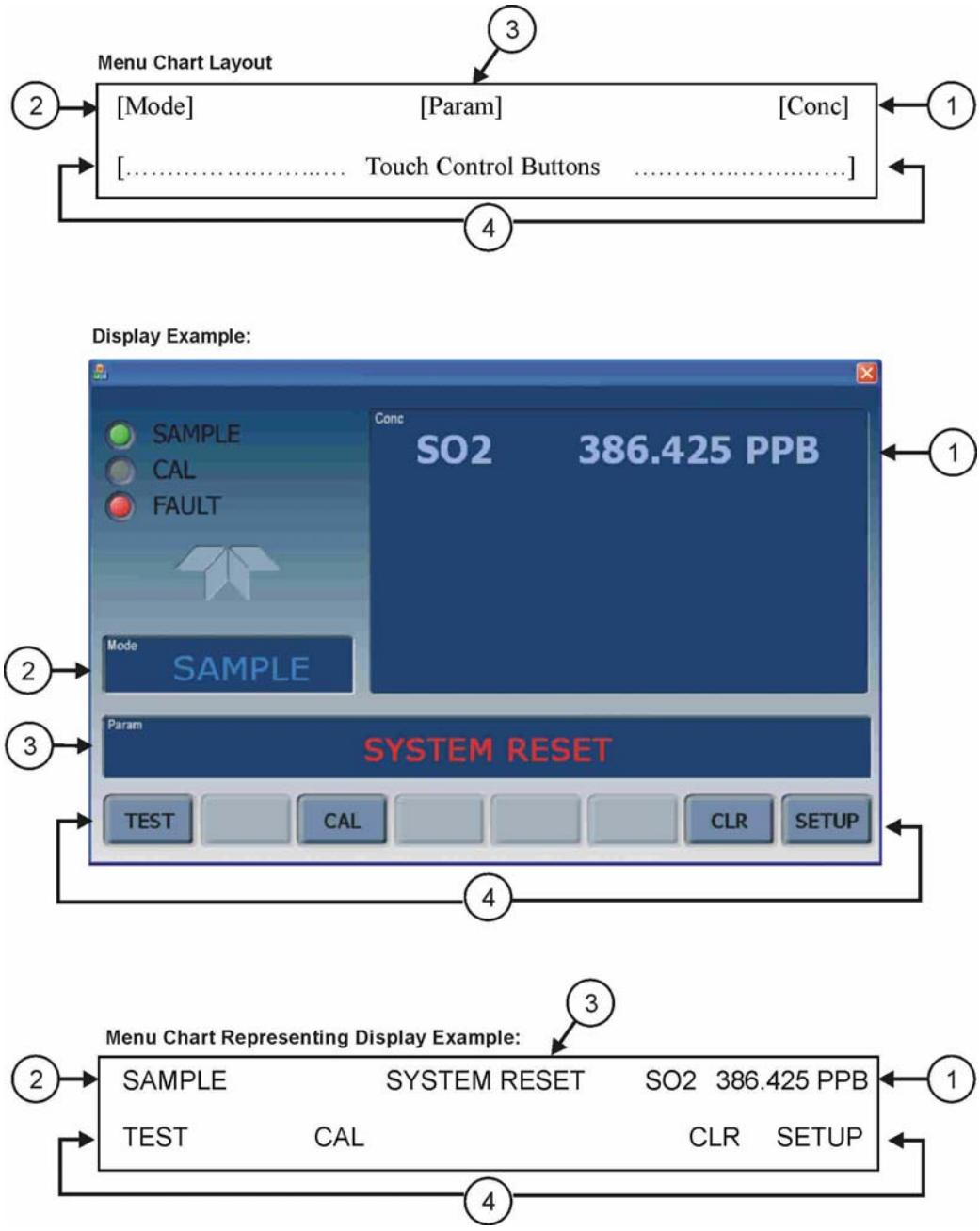


Figure P1-3: Display/Touch Control Screen Mapped to Menu Charts

P1.1.2 Front Panel/Display Interface

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

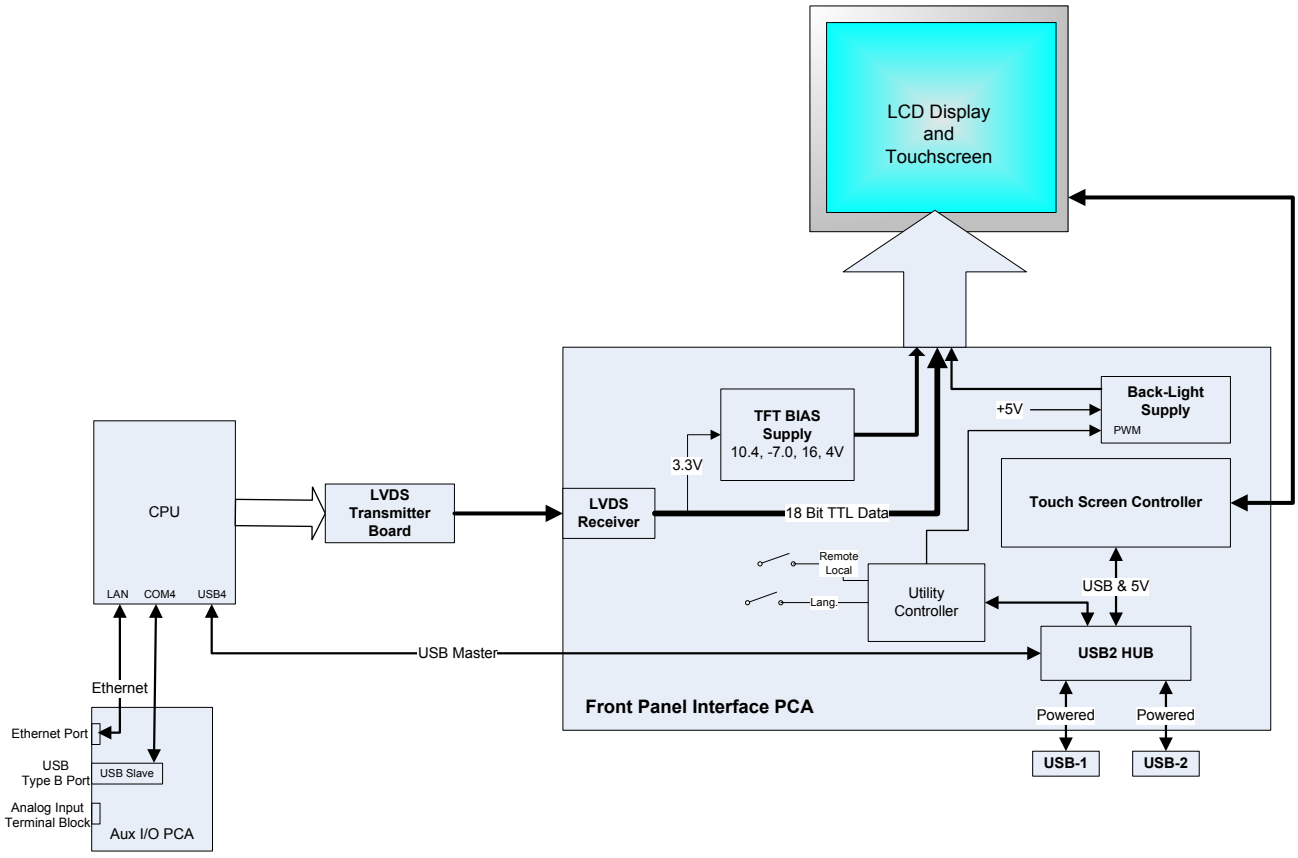


Figure P1-4: Front Panel and Display Interface Block Diagram

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.

The front panel interface PCA controls the various functions of the display and touch screen. 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 touch screen controller and the two front panel USB device ports
- the circuitry for powering the display backlight (current driven)

P1.2. Rear Panel

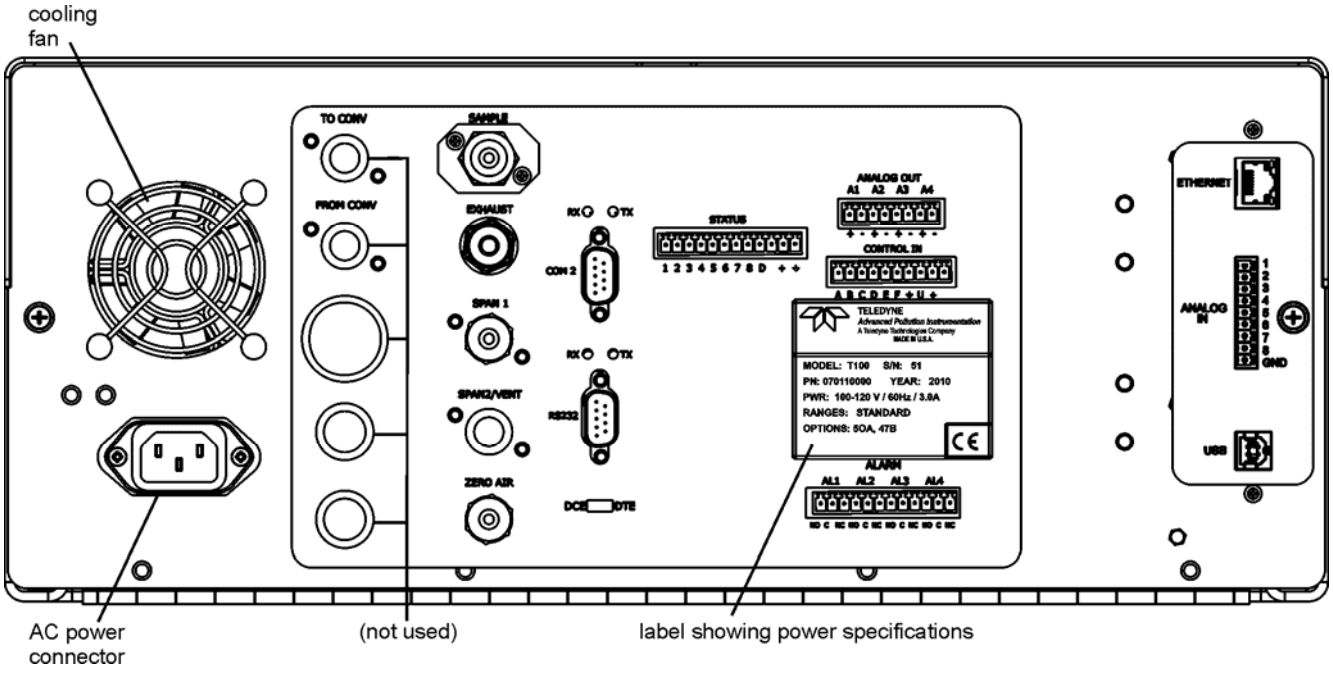


Figure P1-5: Rear Panel Layout

Table P1-2 provides a description of new components on the rear panel.

Table P1-2: 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.

P1.2.1. Connecting Analog Inputs (Option)

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

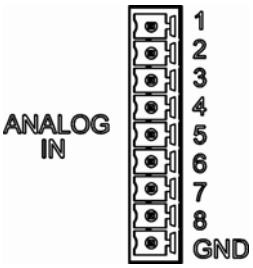


Figure P1-6: Analog In Connector

Pin assignments for the Analog In connector are presented in Table P1-3.

Table P1-3: 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

P1.2.2. USB Connection (Option)

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

P2. CALIBRATION & UPDATE PROCEDURES

P2.1 Display Calibration

The touch screen 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.

P2.2. Analog Input Calibration

Analog I/O Configuration for Analog In

Table P2-1: 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.

P2.2.1. AIN Calibration

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

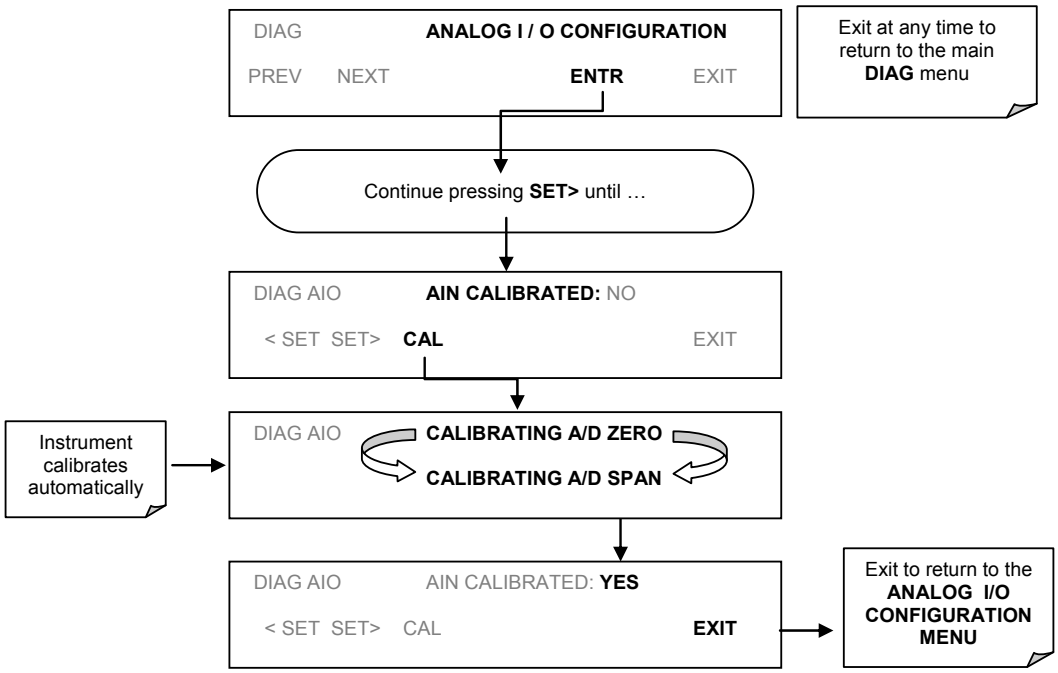


Figure P2-1: DIAG – Analog I/O Configuration – AIN Calibration

P2.2.2. Analog Inputs (XIN1…XIN8) Option Configuration

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

- gain (number of units represented by 1 volt)
- offset (volts)
- engineering units to be represented in volts (each press of the touch screen 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:

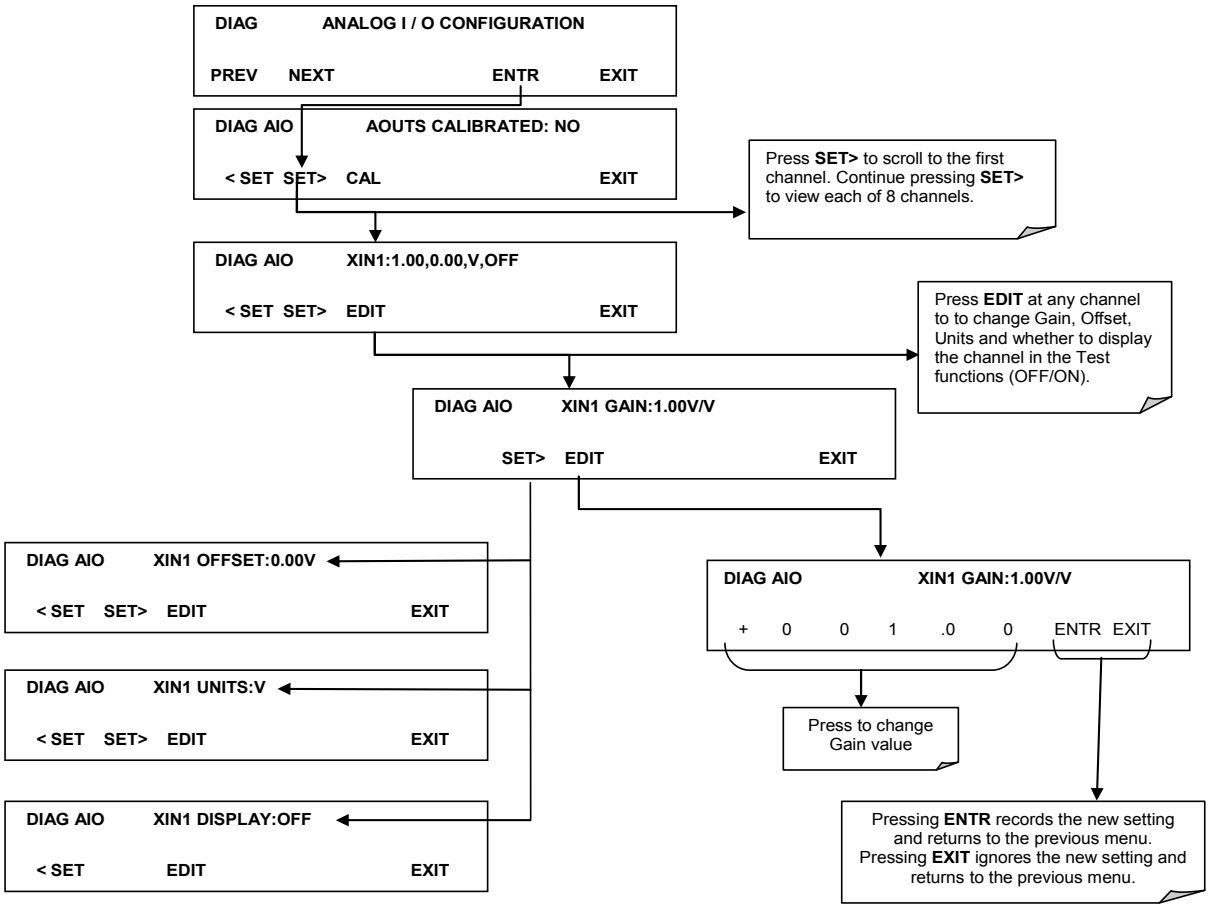


Figure P2-2 DIAG – Analog Inputs (Option) Configuration Menu

P2.3. USB Configuration

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

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

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

P2.4. Firmware Updates via USB

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

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

P3. TROUBLESHOOTING FAULTS

P3.1. Touch Screen Interface

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

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

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

P3.2. LCD Display Module

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

P3.3. Touch-Screen Not Working Correctly

If you experience problems where the display reacts to touch in a different location to where you are pressing, you may need to re-calibrate the touch-screen. Also, if you are in the touch-screen calibration mode and press cancel at the end of the calibration sequence, you will loose the previous calibration and the display will be mis-calibrated. To correct this, follow the calibration procedure in section P2.1.

P4. DIAGRAMS AND SCHEMATICS

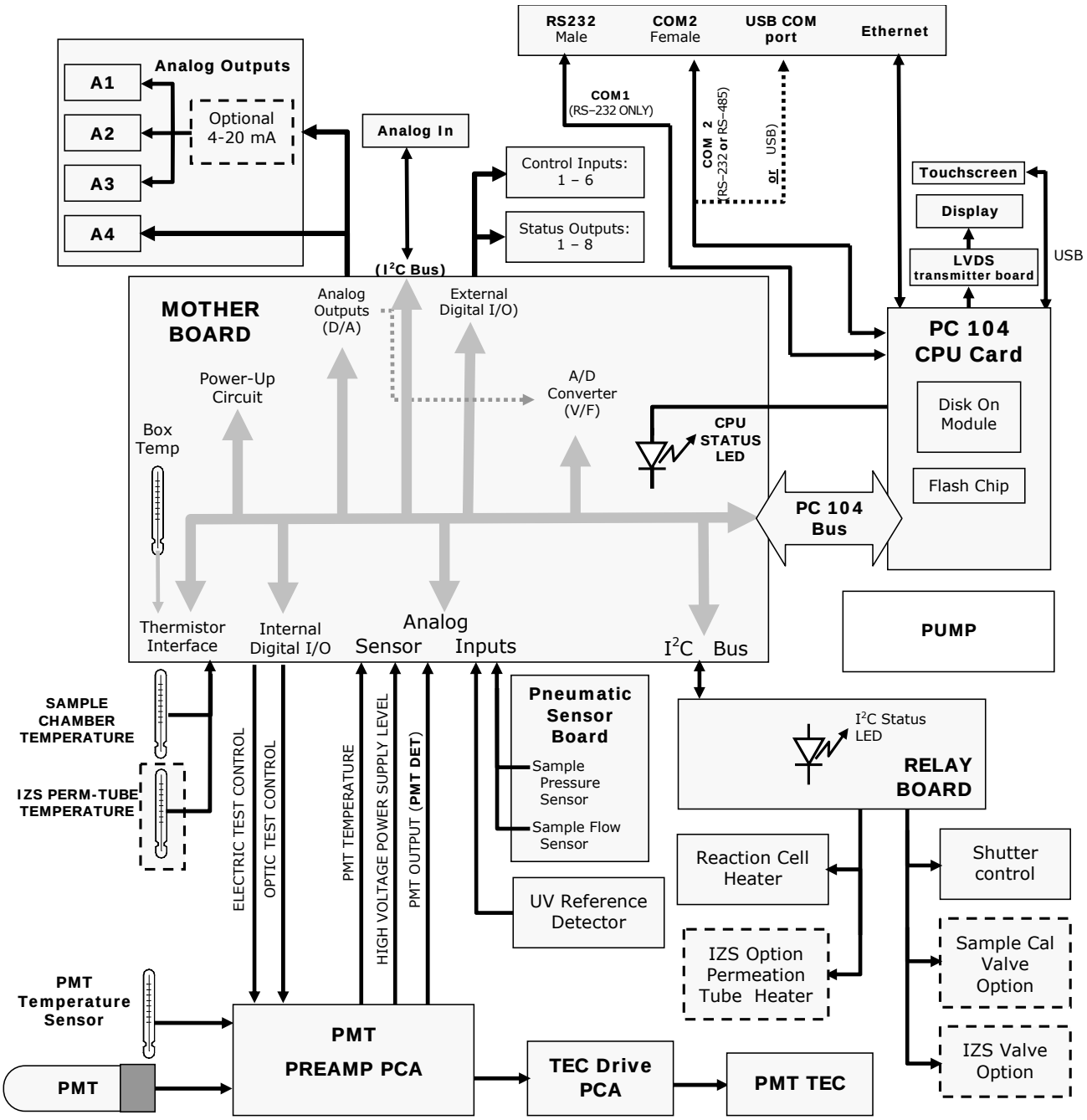


FIGURE P4.1, EXAMPLE OF AN ELECTRONIC BLOCK DIAGRAM (T100)

P5. "E" SERIES COMPATIBILITY

P5.1. Incompatible Components

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

CPU
Multidrop
Display and Keyboard components
Ethernet
USB
Analog Inputs

User notes:

CHAPTER 1: THEORY OF OPERATION

1.1 M100E / T100 - SO_2
- 1.1.1 SO_2 Concentration Equation

1.2 M200E / T200 – NO_x
- 1.2.1 NO_x Concentration Equation

1.3 M300E / T300 – CO
- 1.3.1 M300E General Theory

1.4 M400E / T400 – O_3

1.5 M700E / T700 – Calibrator

1.6 Adaptive filter operation

1.1 The M100E / T100 SO_2 Analyzer

The operation of the Teledyne API SO_2 Analyzer is based upon the well proven technology from the measurement of fluorescence of SO_2 due to absorption of UV energy. Sulfur Dioxide absorbs in the 190 nm - 230 nm region free of quenching by air and relatively free of other interferences. Interferences caused by PNA (poly-nuclear aromatics) are reduced by a "kicker"[1] which removes PNA selectively, through a membrane, without affecting SO_2 sample gas.

The UV lamp emits ultraviolet radiation which passes through a 214.3 nm filter (allowing 214.3 nm light through), exciting the SO_2 molecules and producing fluorescence, approximately 330ηm, which is measured by a PMT through a secondary UV filter. The equations describing the above reactions are as follows:

$$SO_2 + h\nu_1 \xrightarrow{Ia} SO_2^* \qquad (1)$$

The ultraviolet light at any point in the system is given by:

$$Ia = I_0 [1 - \exp (-(\alpha)(x)(SO_2)] \qquad (2)$$

Where I_0 is the UV light intensity, α is the absorption coefficient of SO_2, x the path length, and (SO_2) the concentration of SO_2. The excited SO_2 decays back to the ground state emitting a characteristic fluorescence:

$$SO_2^* \xrightarrow{KF} SO_2 + h\nu_2 \qquad (3)$$

When the SO_2 concentration is relatively low, the path length of exciting light is short, and the background is air, the above expression reduces to:

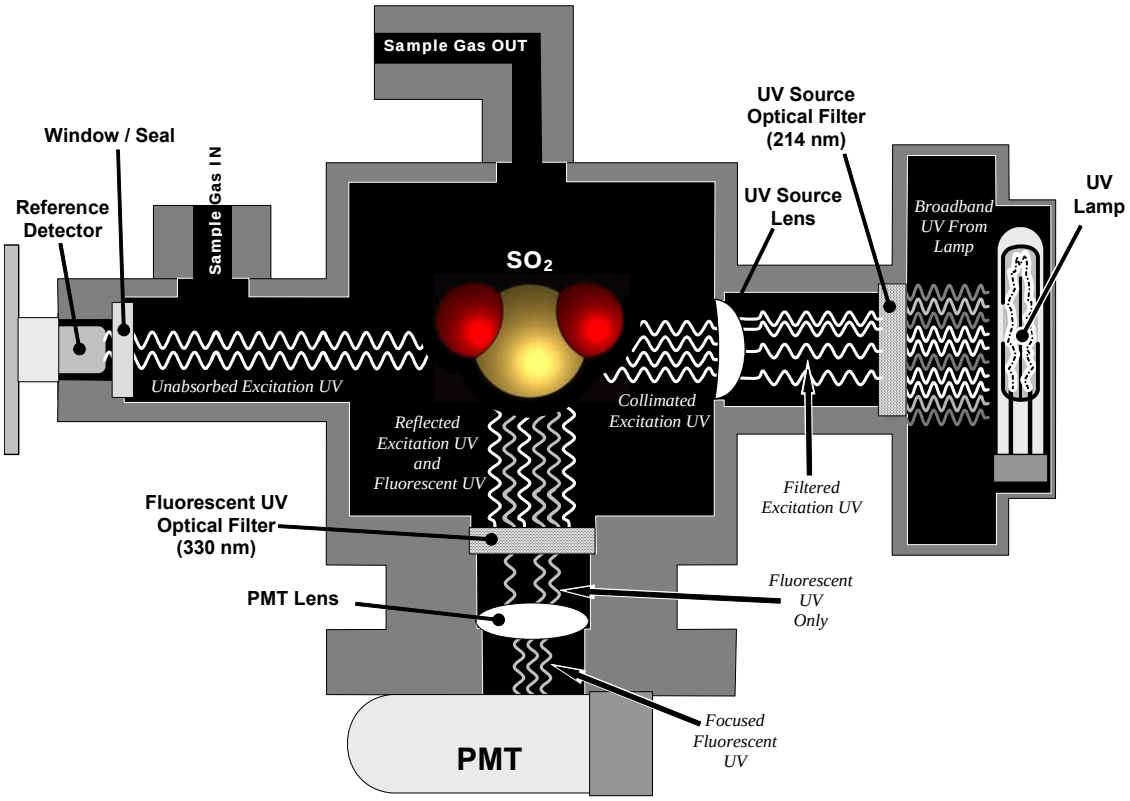
$$F = K(SO_2) \qquad (4)$$

Hence, the fluorescent radiation impinging upon the PMT is directly proportional to the concentration of SO_2

Ultraviolet light is focused through a narrow 214.3 nm band pass filter into the reaction chamber. Here it excites the SO_2 molecules, which give off their characteristic decay radiation. A second filter allows only the decay radiation to fall on the PMT. The PMT transfers the light energy into the electrical signal which is directly proportional to the light energy in the sample stream being analyzed. The preamp board converts this signal into a voltage which is further conditioned by the signal processing electronics.

The UV light source is measured by a UV detector. Software calculates the ratio of the PMT output and the UV detector in order to compensate for variations in the UV light energy. Stray light is the background light produced with zero ppb SO_2. Once this background light is subtracted, the CPU will convert this electrical signal into the SO_2 concentration which is directly proportional to the number of SO_2 molecules.

[1]Developed by Dr. Henk J. Vande Wiel, Laboratory for Inorganic Chemistry, RIVM, National Institute of Public Health and Environmental Protection, Biethoven, The Netherlands.



1.1.1 SO2 Concentration Equation

M100E / T100:

$^{++}$ = numbers made up for this example

Pmt voltage	980 mV^{++}	Direct pmt reading
Slope	1.001^{++}	
Offset	30 mV^{++}	Direct pmt reading (@ zero)
Stray light	10 PPB^{++}	(pmt volt * slope)
Pressure comp	.9525	(samp pres(28.5^{++})/29.92)
Lamp Ratio	99.1%$^{++}$	(Current output of UV Detector) ÷ (last UV lamp calibration value)
Ambient constant	½	

Conc. = { [(pmt mV)·pres comp)·(1 ÷ lamp ratio)·(slope) – (offset)] ÷ 2} – stray light

Conc. = { [(980)·(0.9525)·(1 ÷ 0.991)·(1.001) – 30] ÷ 2 } – 10

= 446.43 ppb

Conc. = NormPMT ÷ 2

1.2 The M200E / T200 NO_x Analyzer

The Teledyne API NO_x Analyzer is designed to measure the concentration of nitric oxide, NO, total oxides of nitrogen, NO_x and, by calculation, nitrogen dioxide, NO_2. The instrument measures the light intensity, as filtered from a 665nM high pass filter, of the chemiluminescence gas phase reaction of nitric oxide NO and ozone O_3 as follows:

$$NO + O_3 \text{ ---> } NO_2^* + O_2$$
$$NO_2^* \text{ ---> } NO_2 + h\nu$$

The reaction of NO with ozone, results in electrically excited NO_2 molecules as shown in the first equation above. The excited NO_2 molecules release their excess energy by emitting a photon of light and dropping to a lower energy level as shown in the second equation. It has been shown that the light intensity produced is directly proportional to the NO concentration present.

The analyzer samples the gas stream and measures the NO concentration by digitizing the signal from the analyzer's photomultiplier tube (PMT). A valve then routes the sample stream through an NO_2 to NO converter. When the valve switches it will allow 1.5 seconds to purge out the old gas in the reaction cell for the NO reading and 2.5 seconds to allow the gas to purge for the NO_x reading. The valve will then stay activated for 1 additional second to take either the NO, or NO_x readings. This makes for a 2.5 second NO time and a 3.5 NO_x time. The converter in the NO_x path contains heated molybdenum to reduce any NO_2 present to NO by the following reaction:

$$@315^oC$$
$$3NO_2 + Mo \text{ ---> } 3NO + MoO_3$$

The analyzer now measures the total NO_x concentration. The NO_x and NO values are subtracted from each other by the built-in computer yielding the NO_2 concentration. The three results NO, NO_x, and NO_2 are then further processed and stored by the computer yielding several instantaneous and long term averages of all three components.

The analyzer has an auto-zero valve that triggers once a minute and stays enabled for 6 seconds. During these 6 seconds, the sample will bypass the reaction cell and be dumped into the exhaust. After the 6 seconds has expired, the analyzer will record the PMT reading and call this the A-Zero value. This value is then subtracted from the normal readings to account for dark PMT drift and contamination in the reaction cell.

The software uses an adaptive filter to accommodate rapid changes in concentration. The algorithm monitors the rate of change in concentration for both the NO and NO_x channels. When a change in concentration is detected, the software changes the sample filters to rapidly respond to the change. The filters are adjusted to minimize the errors introduced by the time delay between the NO_x and NO channel measurements; this assures accurate NO_2 measurements. When the rate of change decreases, the filters are lengthened to provide a good signal to noise ratio. The parameters used to operate the adaptive filter have been tuned to match the electrical and pneumatic characteristics of the M200E.

TPC ENABLE

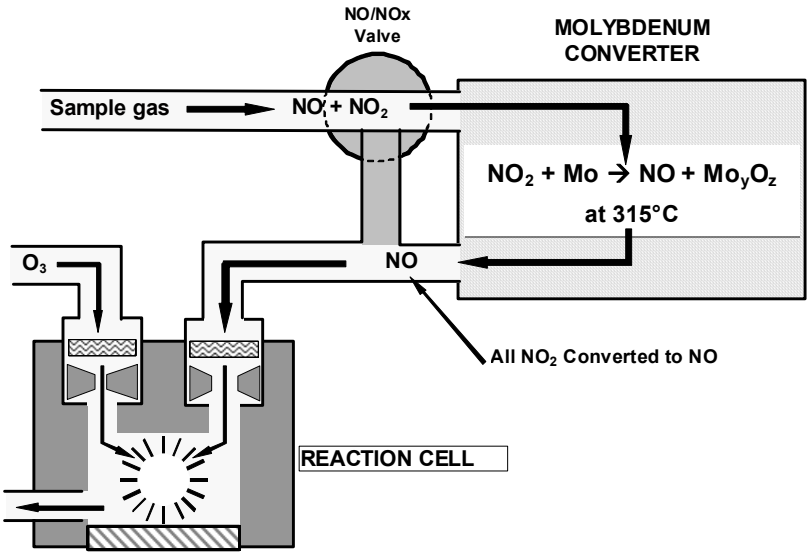
The NO_x Analyzer has temperature and pressure compensation. T/P comp adjusts the output of the instrument for changes in sample temperature, reaction cell pressure, and atmospheric pressure.

The sample temperature is controlled by the temperature of the reaction cell. The set point is 50°C, and the value of the adjustment parameter is equal to 1.0000 when the reaction cell temperature is 50°C. The temperature compensation increases sample concentration with increasing temperature to compensate for the drop in density of gas in the reaction cell.

The reaction cell pressure compensation factor is equal to 1.0000 when the cell pressure is 5"-Hg-A. The compensation factor increases sample concentration with increasing cell pressure to compensate for increased quenching of the chemiluminescence reaction at higher pressures.

The sample pressure compensation factor is equal to 1.0000 at 29.92"-Hg-A. This factor increases sample concentration with decreasing sample pressure to compensate for a lower head pressure on the sample flow orifice.

Taken together, the three factors change the output of the instrument very little. The sample temperature is essentially invariant, and the cell pressure and sample pressure factors tend to cancel each other. The resultant coefficient has no practical variation with pressure changes due to weather fronts. Changes in altitude of 1000 feet usually change the concentration reading of the instrument by about .5% if compensation is turned off, much less if it is turned on.



1.2.1 NO Concentration Equation

M200E / T200:

$^{++}$ = numbers made up for this example

Pmt voltage	980 mV^{++}	Direct pmt reading
Slope	1.001^{++}	
Offset	6.8 mV^{++}	Calculated when the Zero is calibrated
Auto zero	45 mV^{++}	PMT reading during A-Zero cycle
Press comp factor	.75874	({samp pres/29.92}*{5/Rcell}) ({28.15^{++}/29.92}*{5/6.2^{++}})
Ambient constant	½	

$$\text{Conc.} = \frac{\{(\text{pmt mV})*(\text{press comp})*(\text{slope})\} - (\text{offset} + \text{azero})}{2}$$

Conc. = [{(980)*(.75874)*(1.001)} – (6.8 + 45)]/ 2

= 346.25 PPB

Conc. = NormPMT/2 (For both NO_x and NO)

$NO_2 = NO_x - NO$

1.3 The M300E / T300 CO Analyzer

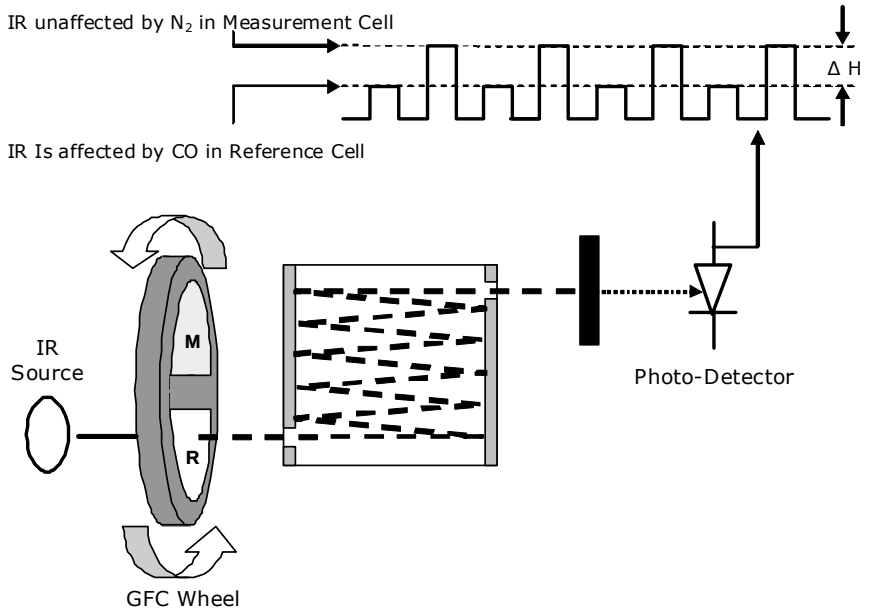
The detection and measurement of carbon monoxide, in the CO Analyzer is based on the absorption of Infra Red (IR) radiation by CO molecules at wave lengths near 4.7µm. In practice, the M300E / T300 uses a high energy heated element to generate broad-band IR light. This light is passed through a rotating gas filter wheel (GFC) which causes the beam to alternately pass through a gas cell filled with nitrogen, N_2, (Measure) and a side filled with a CO and N_2 mixture (Reference). This alternation occurs at a rate of 30 cycles/second, and causes the beam to be modulated into Reference and Measure pulses. During a Reference pulse, the CO in the gas filter wheel effectively strips the beam of all IR energy at wave lengths where CO can absorb. This results in a beam that is hardly affected by any CO in the sample cell. During the Measure pulse, the nitrogen in the filter wheel does not affect the beam which can subsequently be alternated by any CO in the sample cell. The gas filter wheel also incorporates an optical chopping mark which superimposes a 360 cycles/second light/dark modulation on the IR beam. This high frequency modulation is included to maximize detector signal-to-noise performance.

After the gas filter wheel, the IR beam enters the multi-pass sample cell. This sample cell uses folding optics, mirrors, to generate a 14 meter absorption path length in order to achieve maximum sensitivity.

Upon exiting the sample cell, the beam passes through a band-pass interference filter, located inside the detector assembly, to limit the light to the wave length of interest.

Finally, the beam strikes the detector which is a thermoelectrically cooled solid-state photo-conductor.

The detector output is electronically demodulated to generate two DC voltages, CO MEAS and CO REF. These voltages are proportional to the light intensity striking the detector during the Measure pulse and Reference pulse, respectively.



1.3.1 M300E / T300 General Theory

Infrared Absorbance

Beer's Law

$$I=I_o e^{-\alpha cL}$$

Where:

I	= intensity of transmitted light (CO Meas Value)
I_o	= intensity of source light (CO Ref Value)
α	= absorbance coefficient of CO @ 4.7µm
L	= path length ≈ 14m
c	= CO concentration
e	= Natural Exponent ≈ 2.71828

Source Energy Compensation – Gas Filter Correlation

CO MEAS	$I=I_0 e^{-\alpha cL}$
CO REF	$I=I_0 e^{-\alpha cL} \cdot e^{-\alpha c} {}^{c}w {}^{l}w$

where:

^{c}w = conc. of CO in wheel
^{l}w = width of wheel

CO absorbance peak 4680 nm
(Chosen for insensitivity to H_2O and CO_2)

1.4 The M400E / T400 O3 Analyzer

The detection of ozone molecules is based on absorption of 254 ηm UV light due to an internal electronic resonance of the O_3 molecule. The O3 Analyzer uses a mercury lamp constructed so that a large majority of the light emitted is at the 254ηm wavelength. Light from the lamp shines down a hollow glass tube that is alternately filled with sample gas, and then filled with gas scrubbed of all ozone. The ratio of the intensity of light passing through the scrubbed gas to that of the sample forms a ratio I/I_o. This ratio forms the basis for the calculation of the ozone concentration.

The Beer-Lambert equation, shown below, calculates the concentration of ozone from the ratio of light intensities.

$$C_{O_3} = -\frac{10^9}{\alpha \times L} \times \frac{\mathrm{T}}{273^o \mathrm{K}} \times \frac{29.92 in Hg}{\mathrm{P}} \times \ell n \frac{\mathrm{I}}{\mathrm{I}_o}$$

I = Intensity of light passed through the sample
I_o = Intensity of light passed through the sample free of ozone
α = Absorption coefficient
L = Path length
ℓn = Natural Log
C_{O_3} = Concentration of ozone in ppb
T = Sample temperature in degrees Kelvin
P = Pressure in inches of mercury

As can be seen from the equation above, the concentration of ozone depends on more than the intensity ratio. Temperature and pressure influence the density of the sample. The density changes the number of ozone molecules in the absorption tube which impacts the amount of light removed from the light beam. These effects are addressed by directly measuring temperature and pressure and including their actual values in the calculation. The absorption coefficient is a number that reflects the inherent ability of ozone to absorb 254ηm light. Most current measurements place this value at 308 cm^{-1} atm^{-1} at STP. The value of this number reflects the fact that ozone is a very efficient absorber of UV radiation, which is why stratospheric ozone protects the life forms lower in the atmosphere from the harmful effects of solar UV radiation. Lastly, the absorption path length determines how many molecules are present in the column of gas in the absorption tube.

The intensity of light is converted into a voltage by the detector/preamp module. The voltage is converted into a number by a voltage-to-frequency (V/F) converter. The digitized signals, along with the other variables, are used by the CPU to compute the concentration using the above formula.

Every 3 seconds the analyzer completes a measurement cycle. A measurement cycle consists of a 2 second waiting period for the absorption tube to purge, followed by 1 second of measuring the average light intensity to determine I. The sample valve is switched to admit scrubbed sample gas for 2 seconds. This is followed by 1 second measuring the average light intensity to obtain I_o. Every time the analyzer takes an UV detector reading it makes a concentration calculation. Measurement of the I_o every 3 seconds minimizes instrument drift due to changing intensity of the lamp due to aging and dirt.

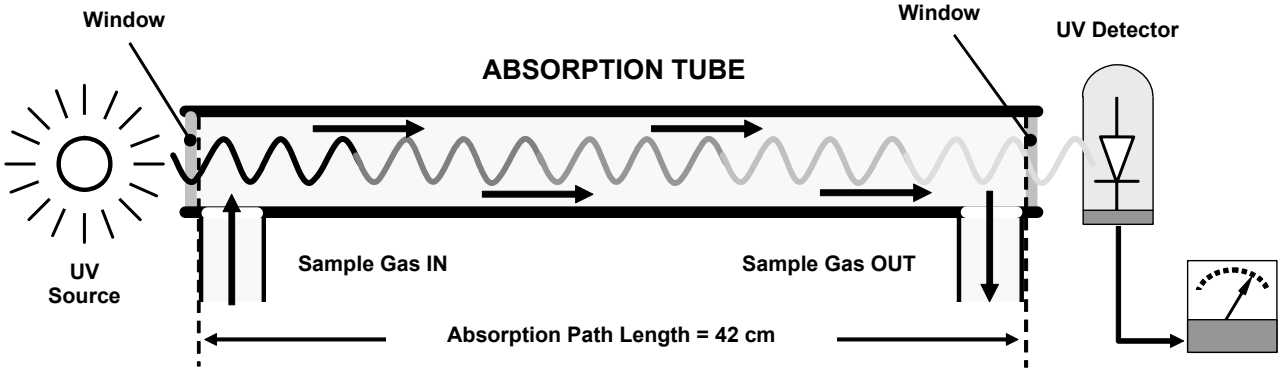
Interferant rejection

It should be noted that the UV absorption method for detecting ozone is subject to interference from a number of sources. The M400E / T400 have been successfully tested for its ability to reject interference from sulfur dioxide, nitrogen dioxide, nitric oxide, water and meta-xylene.

While the instrument rejected interference from the aromatic hydrocarbon meta-xylene, it should be noted that there are a very large number of volatile aromatic hydrocarbons that could potentially interfere with ozone detection. 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 that these compounds may cause.

Ozone generator calibration

When the M400E / T400 are equipped with the ozone generator option, it must be calibrated. The bench in the analyzer is calibrated to a known source of reference gas (usually from a M700E / T700 or M703E / T703). After the bench is calibrated, the ozone generator is calibrated to the bench. To do this the CPU in the analyzer steps the drive voltage from 0mV of drive to the 5000mV maximum. After a settling time period has expired, the CPU will take a concentration reading and a detector reading, (if equipped with a detector). The CPU will store these numbers in tables for future use. The CPU will continue to step the voltage until it gets to 5000mV. The CPU will do 9 calibration points. The tables that the CPU has just generated have 9 more points that are what we call "learned" points. This means that if you ask for a span gas point that is not an exact point in the calibration curve, the analyzer will calculate the correct drive voltage to obtain the conc. After the analyzer gets to this point the CPU will "learn" this point so the next time you ask for that concentration, it will go right to that drive voltage, and your output concentration will be what you are asking for.



1.5 The M700E / T700 Calibrator

The Teledyne API Calibrator can generate diluted calibration gas including ozone, gas phase titration (NO_2) from gas cylinders, or from a permeation tube source gas. Each concentration is generated precisely by mixing the gas with diluent zero air, in which the mixing ratio is controlled by a mass flow controller.

The diluent air mass flow controller has a range of 10 SLPM (20 SLPM option), and the gas mass flow controller has a range of 100 cc/min. (0-50 cc/min., 0-200cc/min. options). The mass flow controllers assure a precise mixing ratio for accurate and precise calibration gas generation using the state-of- the-art electronic closed-loop control. The CPU calculates both the required gas and diluent air flow rate as determined by the following equation and controls the corresponding mass flow controllers accordingly.

$$C_f = C_i \frac{GAS_{flow}}{GAS_{flow} + AIR_{flow} + (O_{3\,flow})}$$

C_f = final concentration of diluted gas
C_i = gas bottle concentration
GAS_{flow} = gas flow rate
AIR_{flow} = diluting air flow rate
$O_{3\,flow}$ = O_3 Generator Flow if GPT/GPTPS

The principle of GPT is based on the rapid gas phase reaction between NO and O_3 which produces stoichiometric quantities of NO_2 as shown by the following equation:

$$NO + O_3 ==> NO_2 + O_2$$

Given that the NO and O_3 concentrations are known for this reaction, the resultant concentration of NO_2 can be determined. The NO concentration must be at least 10% higher then the O_3 concentration. The gasses are mixed in a glass volume creating NO_2, and a NOx analyzer detects the changes in NO concentration. After the addition of O_3, the observed decrease in NO concentration on the NO channel of the NO_x analyzer is equivalent to the concentration of NO_2 produced. The amount of NO_2 generated can be varied by adding varying amounts of O_3 from the O_3 generator.

It has been determined, empirically, that the NO-O_3 reaction goes to completion (<1% residual O_3) if the NO concentration in the reaction chamber (PPM) multiplied by the residence time (min.) of the reactants in the chamber is $\geq$2.75 min-min. The M700E is designed to satisfy the complete reaction based on U.S.E.P.A. guidelines.

The M700E / T700 has a built-in ozone generator, as an option, in order to generate a dynamic range of ozone concentrations. The O_3 generator has up to three different modes of lamp feedback control, depending upon the option installed. If only the O_3 generator is installed, then the constant lamp control mode or the reference detector control mode can be selected by the user. If the photometer option is included, then the bench feedback mode can be used to generate precise ozone concentration.

The first step in doing the ozone generator calibration is to calibrate the bench that is in the calibrator (if this option is installed). Once the bench is calibrated the ozone generator can be calibrated. To do this the computer will start at 0mV of drive to the ozone gen. lamp. It will then step up the drive voltage until it gets to the 5000mV full scale drive voltage. There are 13 calibration points in the M700E calibrator and there are 8 more "learned" points that the calibrator CPU will store when you generate some concentration of ozone while you are using the calibrator.

The "learned" points are a list of points that are generated every time an ozone concentration is requested from the M700E / T700. Once these points are stored in the memory, the calibrator will know what drive voltage to go to when you ask for a concentration of ozone. This makes the calibrator faster to use.

A permeation tube consists of a small container of liquid, with a small membrane outlet made from PTFE. The gas slowly permeates through the PTFE at a rate in the ng/min range. If the tube is kept at constant temperature, usually about 50^{o}C, the device will provide a stable source of gas. The permeation tube concentration is determined by the permeation tube specific output (ppb @ 1 slpm @ 50^{o}C), the permeation tube temperature (^{o}C), and the air flow across it (slpm). The specific output is a fixed function of the permeation tube and is noted on the shipping container.

A standard perm tube will be rated in ηg/min @ 50^{o}C. In order to calculate the actual concentration in ppb, we must know the type of gas that is in the perm tube and the flow rate. The calculations for this are as follows.

Total Flow = Perm Tube flow + Zero Air Flow
(ηg/min ÷ Total Flow)(Gas type modifier)=Cal Gas Out Concentration

Gas Type Modifiers are different for every gas. They are based upon the molecular weight of that particular gas. See the list below for some of the more common types.

NO_2 = 0.532
SO_2 = 0.382
H_2S = 0.719
NH_3 = 1.438

Example

SO_2 Perm tube rating = 1256ηg/m @ 50^{o}C
Perm Tube Flow = 0.105L/min
Dilution Flow = 4.0L/min

Total Flow = 0.105L/min + 4.0Lmin = 4.105L/min
(1256ηg/min÷4.105L/min)(0.382) = 117ppb of SO_2 @ 4L/min

1.6 Adaptive Filter Operation

The Teledyne API analyzers have software filtering for the concentration that is displayed on the front panel and for the concentration that is output on the rear panel of the analyzer. The filter for both the front panel and the analog voltage that goes out the rear panel, is the same filter just applied to two different locations.

The reason for the filtering is that if you were to look at the instantaneous concentration of any analyzer it would look very noisy. There has to be some time constant that the analyzer has in this regard. By using a computer in the analyzer, we can do this in software and that gives us the flexibility to change the filter and change the characteristics of the analyzer.

To implement this into the analyzer, we have created a long software filter and a short software filter. The long filter is called simply "the filter" (FILT). The short software filter is called "the adaptive filter" (or AFILT). Both these filters are moving "boxcar" filters. This means that they will have a set number of readings that they will average. As a new reading is taken and put into the filter it will kick the oldest reading out and recomputed the average.

When the analyzer is normally running, and the concentration is stable, the analyzer puts the instantaneous readings into the long filter (this size is different from analyzer to analyzer) and averages the numbers up by the number of instantaneous values that were put into the filter. This is just a simple first in first out, average.

Now if the analyzer is running and the concentration of gas is changing rapidly the computer will see that and use the short filter. What this means is that the concentration value that is displayed on the front panel is going to change more rapidly because the number of averages that are required to fill up the filter are fewer.

Example of long vs. short filter:

FILT (20 Long)	*AFILT (7 Long)*
451.0	451.0
452.0	452.0
451.1	451.1
451.0	451.0
451.6	451.6
451.9	451.9
451.9	451.9
451.7	**Avg. = 451.5**
451.2	
451.5	
451.2	
451.0	
451.2	
451.6	
451.1	
451.0	
451.6	
451.9	
451.9	
451.7	
451.2	
Avg. = 451.4	

Now we have to be able to differentiate between a stable, and a changing concentration of gas. The way that we do that is by looking at the instantaneous value of concentration and the averaged value. When the instantaneous value changes more than some percentage of the averaged value (this number is different in different analyzers), then the analyzer uses the AFILT filter. When the concentration becomes stable again it will go back into the long filter. Before the analyzer goes back into the long filter it holds off for some period of time (again this is different in different analyzers). This is how we can fine-tune the response time of the analyzer. This parameter is called "FILT_DELAY".

In summary we have several different variables (VARS) that determine what the concentration is that is displayed on the front panel (and on the rear panel). The use of all these variables makes the analyzer more flexible and allows us to get the best response times and the best noise specifications. This method of filtering can be very sensitive and you can dramatically change the characteristics of the analyzer if you change the wrong variable or if you change the variable too much, but when applied right this allows us to fine-tune the analyzer to what we want.

FILT_SIZE	Moving filter size (long filter)
AFILT_SIZE	Moving filter size (short filter or adapt filter)
FILT_DELTA	Absolute change to trigger adaptive filter
FILT_PCT	Percent change to trigger adaptive filter
FILT_DELAY	Delay before leaving adaptive filter mode.
FILT_ADAPT	On enables the adaptive filter mode.

User notes:

CHAPTER 2: BASIC TROUBLESHOOTING TECHNIQUES

2.1 What are the symptoms?

2.1.1 Will not zero

If the analyzer does not zero, you need to look at offsets and concentration readings. The offset or the concentration is too high. This could be caused from a high HVPS on the SO_2 and NO_x analyzers. If your zero source is not really zero, it can cause high offsets in the analyzer. If you have electronic devices such as the PMT or HVPS that have a large dark current, this can also cause the analyzer not to be zeroed.

2.1.2 Will not span

First, leak check and flow check. Try a factory calibration for the SO_2 and NO_x analyzers to bring the slope back in spec. Dirty filters and windows can cause this. Make sure your span gas is correct. Ozone analyzers need to have the M/R valve and ozone scrubber checked. Look at the OT and ET for the NOx and SOx analyzers.

2.1.3 Drifting high

First, leak check all the analyzers. Check the flow rates for the analyzers. An analyzer drifting high is a very rare symptom.

2.1.4 Drifting low

Leak check and flow check. For NOx analyzers, inspect the reaction cell for dirt and contamination. For an O_3 analyzer, check the ozone scrubber for O_3 breakthrough.

2.1.5 Noisy

For all analyzers check the REF_4096 voltage in the Signal I/O for stability. Also make sure that there are no values over 4950mV. The preamp/HVPS typically cause the noise that is seen in NO_x and SO_x analyzers. Detectors, detector boards and misaligned optics are the typical cause of noise in a CO. Check the signals with an O-scope. O_3 noise is normally caused by a bad UV lamp.

2.1.6 Warnings/test functions out of normal range (not at limits)

Warnings are set by the variables. See the manuals to see what the normal TST value should be. If you have any warnings on the front panel, then one of these TST values either went to high or two low.

2.1.7 What is a symptom and what is a cause?

- Is the slope high because the norm pmt voltage is too low?
  Input span gas. What dose the norm pmt read? Does it fit the formula?
- Or is the norm pmt voltage too low because the span gas is too low?
  Make sure your system is correct, verify with another analyzer if possible.
- Or is the slope too high because the window is dirty?
  Inspect the windows; has the slope slowly been increasing over time?
- Or is the norm pmt voltage to low because there is a leak that is diluting the sample?
  As always you must leak check and flow check before performing any other tests on the analyzer.

2.2 What are you expecting the analyzer to do?

2.2.1 Zero

What is zero? Each analyzer has different specs.
Each analyzer has a LDL (lower detectable limit).

2.2.2 Span

Does the span value fit in the specs? Do the linearity checks fall with in 1% of the range?

2.2.3 GPT

What exactly does it read? Does the NO_2 value read approximately what the O_3 value is? If not, why? Reference the service note 04-001 for the exact GPT procedure.

2.2.4 Monitor ambient air

Check zero and span, does it work well on these?

2.3 How is it supposed to work?

2.3.1 Perform a zero check
Does it zero like it should? Is the stability reading low enough?

2.3.2 Perform a span check
Does it span like it should? Is the stability reading low enough?

2.3.3 Perform a GPT
Does the NO_2 read correct? Reference the service note 04-001 for the exact GPT procedure.

2.3.4 Monitoring sample gas.
How close is the reading to your expected values?

2.4 The software is the analyzer.

2.4.1 What does that mean?
There are many different versions of software. What is yours? How is it special?

2.4.2 There are inputs
The CPU/Software reads all the inputs

2.4.3 There are outputs
The CPU/Software controls all outputs

2.4.4 The only thing that the CPU knows is inputs and outputs
If the device is working properly, but the analyzer is not, it's typically false data being sent to the CPU.

2.4.5 An output is a reaction to an input.

2.5 Block Diagrams:

2.5.1 Look at the block diagrams and see if you can figure out if the symptom you are looking at is the cause of the problem or a result of the problem

2.6 Troubleshooting Sources

2.6.1 RMA information – Warranty repair questionnaire
- test function limits

2.6.2 Test function troubleshooting chart
- possible causes

2.6.3 Specifications page – noise, drift, linearity, precision, response time

2.6.4 Warning message chart
- possible causes

2.6.5 Block diagrams

2.6.6 Schematics – test equipment

2.6.7 Signal I/O – command valves / heaters / signals

2.6.8 LED indicators

2.6.9 Setup procedures, performance section in manual

2.6.10 Sub-systems checkouts

2.6.11 Repair procedures in manuals

2.6.12 Computer interface to download data, APICOM, HyperTerminal

2.6.13 Service notes on Customer Service CD
- troubleshooting trees

2.6.14 Website – download manuals –

2.6.15 Customer Service phone support and E-mail support

2.6.16 Training class

Warranty/Repair Questionnaire T100, M100E
(04796F DCN6611)

TELEDYNE
ADVANCED POLLUTION INSTRUMENTATION
Everywhereyoulook™

CUSTOMER:_____ PHONE: _____
CONTACT NAME:_____ FAX NO._____
SITE ADDRESS: _____
MODEL 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)***

*IF OPTION IS INSTALLED

Parameter	Recorded Value	Acceptable Value
RANGE	PPB/PPM	50 PPB to 20 PPM
STABIL	PPB	≤1 PPB WITH ZERO AIR
SAMP PRESS	IN-HG-A	~ 2" < AMBIENT
SAMPLE FLOW	cm^3/MIN	650 ± 10%
PMT WITH ZERO AIR	mV	-20 TO 150 mV
PMT 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 4800 mV
LAMP RATIO	mV	30 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 – 900
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 ± 1000
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.

THANK YOU FOR PROVIDING THIS INFORMATION. YOUR ASSISTANCE ENABLES TELEDYNE API TO RESPOND FASTER TO THE PROBLEM THAT YOU ARE ENCOUNTERING.

M100E / T100 Test Function Troubleshooting Chart from the Operator's Manual

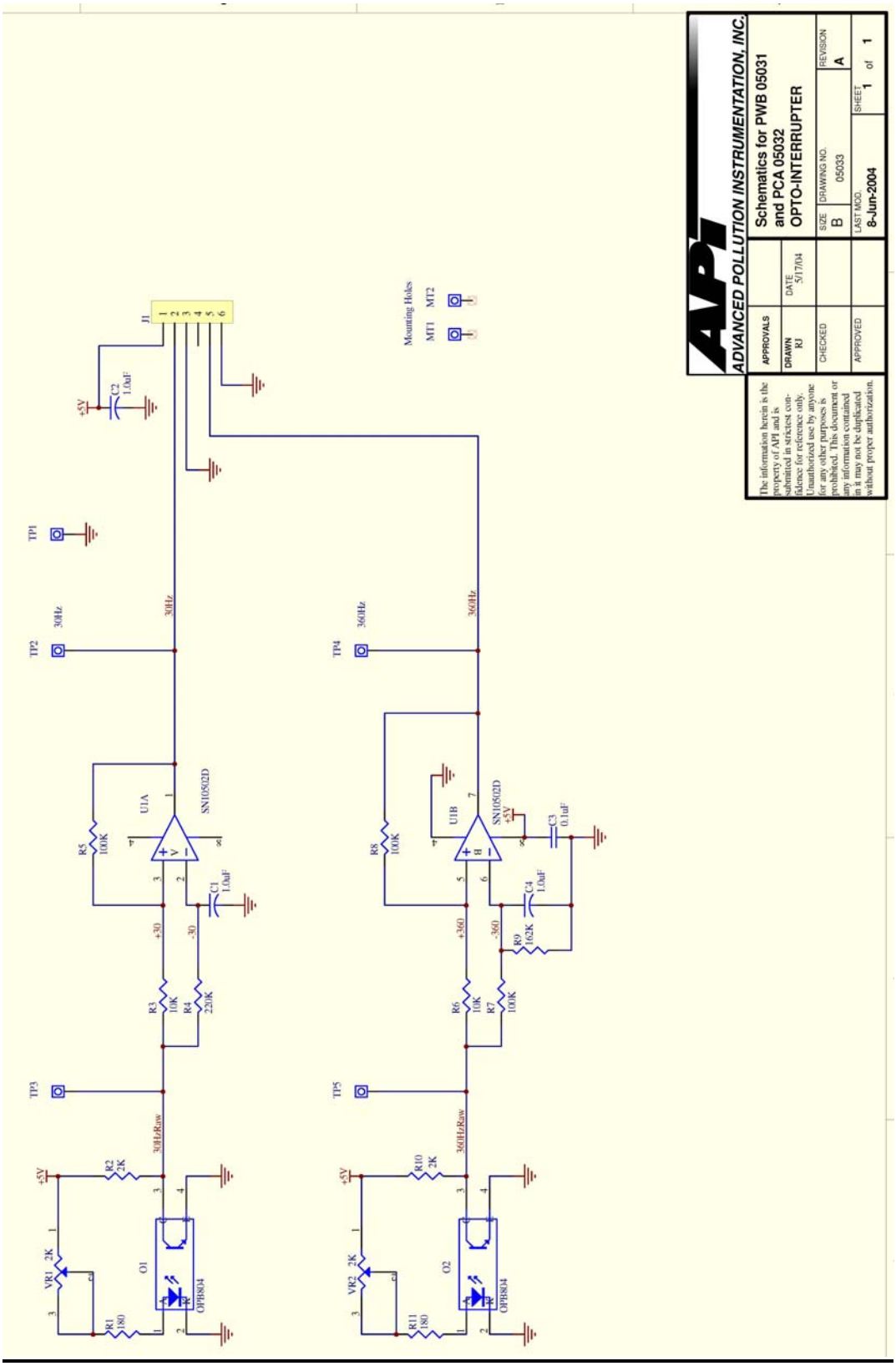
TEST FUNCTION	NOMINAL VALUE(S)	POSSIBLE CAUSE(S)
STABIL	≤1 ppb with zero air	Faults that cause high stability values are: pneumatic leak; low or very unstable UV lamp output; light leak; faulty HVPS; defective preamp board; aging detectors; PMT recently exposed to room light; dirty/contaminated reaction cell.
SAMPLE FL	650 cm^3/min ± 10%	Faults are caused due to: clogged critical flow orifice; pneumatic leak; faulty flow sensor; sample line flow restriction.
PMT	-20 TO 150 mV with zero air	High or noisy readings could be due to: calibration error; pneumatic leak; excessive background light; aging UV filter; low UV lamp output; PMT recently exposed to room light; light leak in reaction cell; reaction cell contaminated HVPS problem. *It takes 24-48 hours for the PMT exposed to ambient light levels to adapt to dim light.*
NORM PMT		Noisy Norm PMT value (assuming unchanging SO_2 concentration of sample gas): Calibration error; HVPS problem; PMT problem.
UV LAMP SIGNAL	3500 mV ± 200mV	This is the instantaneous reading of the UV lamp intensity. Low UV lamp intensity could be due to: aging UV lamp; UV lamp position out of alignment; faulty lamp transformer; aging or faulty UV detector; UV detector needs adjusting; dirty optical components. Intensity lower than 600 mV will cause UV LAMP WARNING. Most likely cause is a UV lamp in need of replacement.
LAMP RATIO	30 TO 120%	The current output of the UV reference detector divided by the reading stored in the CPU's memory from the last time a UV Lamp calibration was performed. Out of range lamp ratio could be due to: malfunctioning UV lamp; UV lamp position out of alignment; faulty lamp transformer; aging or faulty UV detector; dirty optical components; pin holes or scratches in the UV optical filters; light leaks.
STR LGT	40-100 ppb	High stray light could be caused by: aging UV filter; contaminated reaction cell; light leak; pneumatic leak.
DRK PMT	-50 - +200 mV	High dark PMT reading could be due to: light leak; shutter not closing completely; high pmt temperature; high electronic offset.
DRK LMP	-50 - +200 mV	High dark UV detector could be caused by: light leak; shutter not closing completely; high electronic offset.
HVPS	≈ 400 V to 900 V	Incorrect HVPS reading could be caused by; HVPS broken; preamp board circuit problems.
RCELL TEMP	50ºC ± 1ºC	Incorrect temperature reading could be caused by: malfunctioning heater; relay board communication (I^1C bus); relay burnt out
BOX TEMP	ambient + ~ 5ºC	Incorrect temperature reading could be caused by: Environment out of temperature operating range; broken thermistor; runaway heater
PMT TEMP	7ºC ± 2ºC constant	Incorrect temperature reading could be caused by: TEC cooling circuit broken; High chassis temperature; 12V power supply
IZS TEMP (OPTION)	50ºC ± 1ºC	Malfunctioning heater; relay board communication (I^1C bus); relay burnt out
PRESS	ambient ± 2 IN-HG-A	Incorrect sample gas pressure could be due to: pneumatic leak; malfunctioning valve; malfunctioning pump; clogged flow orifices; sample inlet overpressure; faulty pressure sensor
SLOPE	1.0 ± 0.3	Slope out of range could be due to: poor calibration quality; span gas concentration incorrect; leaks; UV Lamp output decay.
OFFSET	< 250 mV	High offset could be due to: incorrect span gas concentration/contaminated zero air/leak; low-level calibration off; light leak; aging UV filter; contaminated reaction cell; pneumatic leak.
TIME OF DAY	Current time	Incorrect time could be caused by: Internal clock drifting; move across time zones; daylight savings time?

M100E / T100 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 Noise1	≤ 0.2 ppb RMS
Span Noise1	≤ 0.5% of reading, above 50 ppb
Lower Detectable Limit2	0.4 ppb
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 reading1
Lag Time1	20 sec
Rise/Fall Time1	95% in <100 sec
Sample Flow Rate	650cc/min. ±10%
Temperature Range	5-40 oC
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 Defined as twice the zero noise level by the USEPA.	

M100E / T100 Warning messages

MESSAGE	MEANING
ANALOG CAL WARNING	The instruments internal A-to-D circuitry (also referred to as "Analog In") or one of its analog outputs is not calibrated.
BOX TEMP WARNING	The temperature inside the M100E chassis is outside the specified limits.
CANNOT DYN SPAN	Remote span calibration failed while the dynamic span feature was set to on
CANNOT DYN ZERO	Remote zero calibration failed while the dynamic zero feature was set to on
CONFIG INITIALIZED	Configuration was reset to factory defaults or was erased.
DARK CAL WARNING	Dark offset above limit specified indicating that too much stray light is present in the sample chamber.
DATA INITIALIZED	iDAS data storage was erased.
FRONT PANEL WARN	Firmware is unable to communicate with the front panel.
HVPS WARNING	High voltage power supply for the PMT is outside of specified limits.
IZS TEMP WARNING	On units with IZS options installed: The permeation tube temperature is outside of specified limits.
PMT DET WARNING	PMT detector >4950mv.
PMT TEMP WARNING	PMT temperature is outside of specified limits.
RCELL TEMP WARNING	Sample chamber temperature is outside of specified limits.
REAR BOARD NOT DET	The CPU is unable to communicate with the motherboard.
RELAY BOARD WARN	The firmware 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	Sample pressure outside of operational parameters.
SYSTEM RESET	The computer was rebooted.
UV LAMP WARNING	The UV lamp intensity measured by the reference detector reading too low or too high.



M300E / T300 Opto-Pickup Schematic

User notes:

CHAPTER 3: PNEUMATICS

3.1 Leak check the analyzer
- 3.1.1 Quick leak check (Vacuum)
- 3.1.2 Center splitting the analyzer until you find all of the leaks.
  Start at the beginning of the analyzer then start cutting it in half. If it does not leak anymore, the leak is in the other part of the analyzer
- 3.1.3 Pressure leak checking
  - 3.1.3.1 Bubble solution for leak checking
  - 3.1.3.2 Using a gas bottle for a pressure source

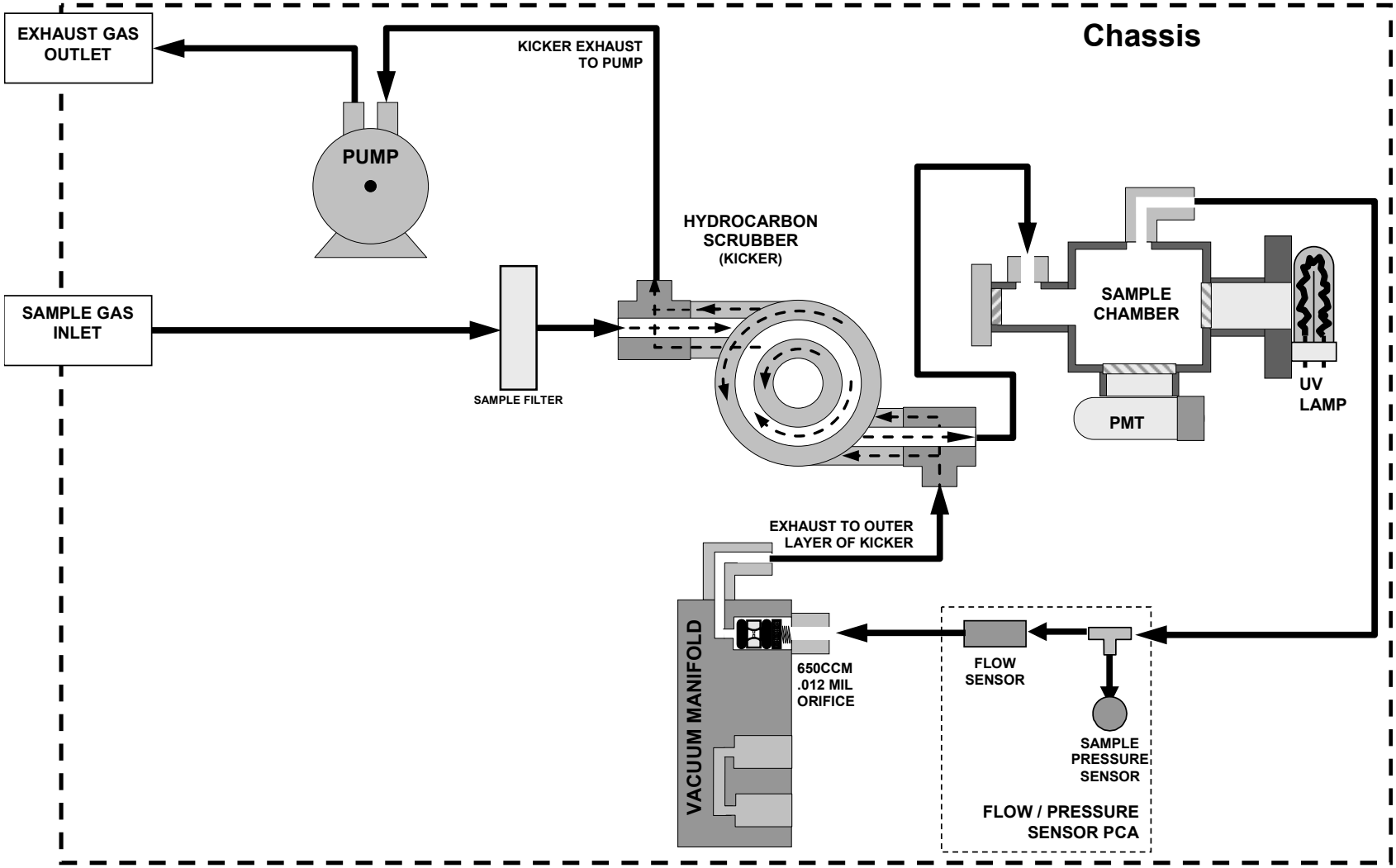
3.2 Flow check the analyzer
- 3.2.1 All the orifices. (bypass, purge, sample, dryer)

- 3.2.2 Replace the sintered filters & O-rings when necessary.

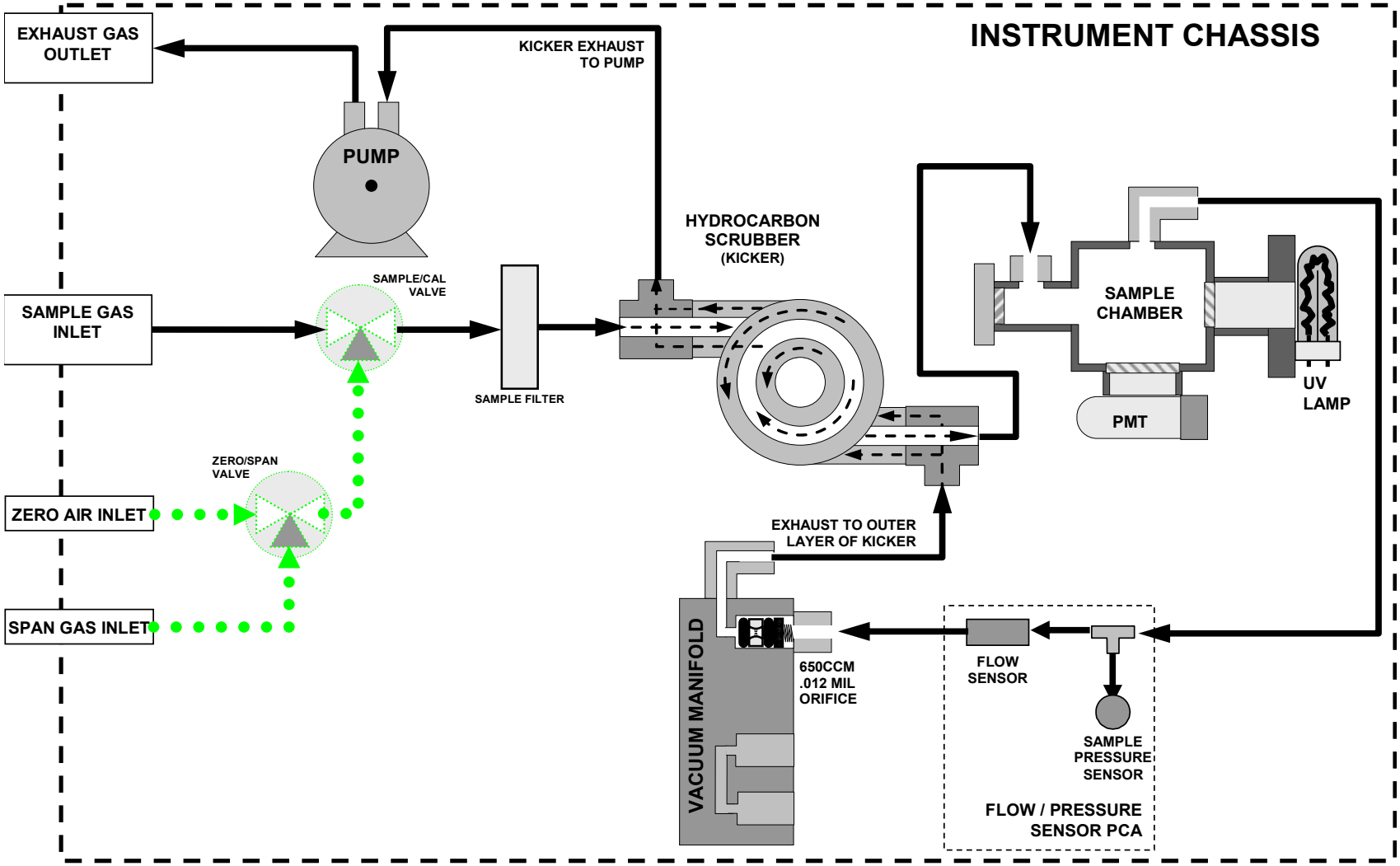
3.3 Leak checkers available from Teledyne API.

3.4 Inspect/clean tubing.

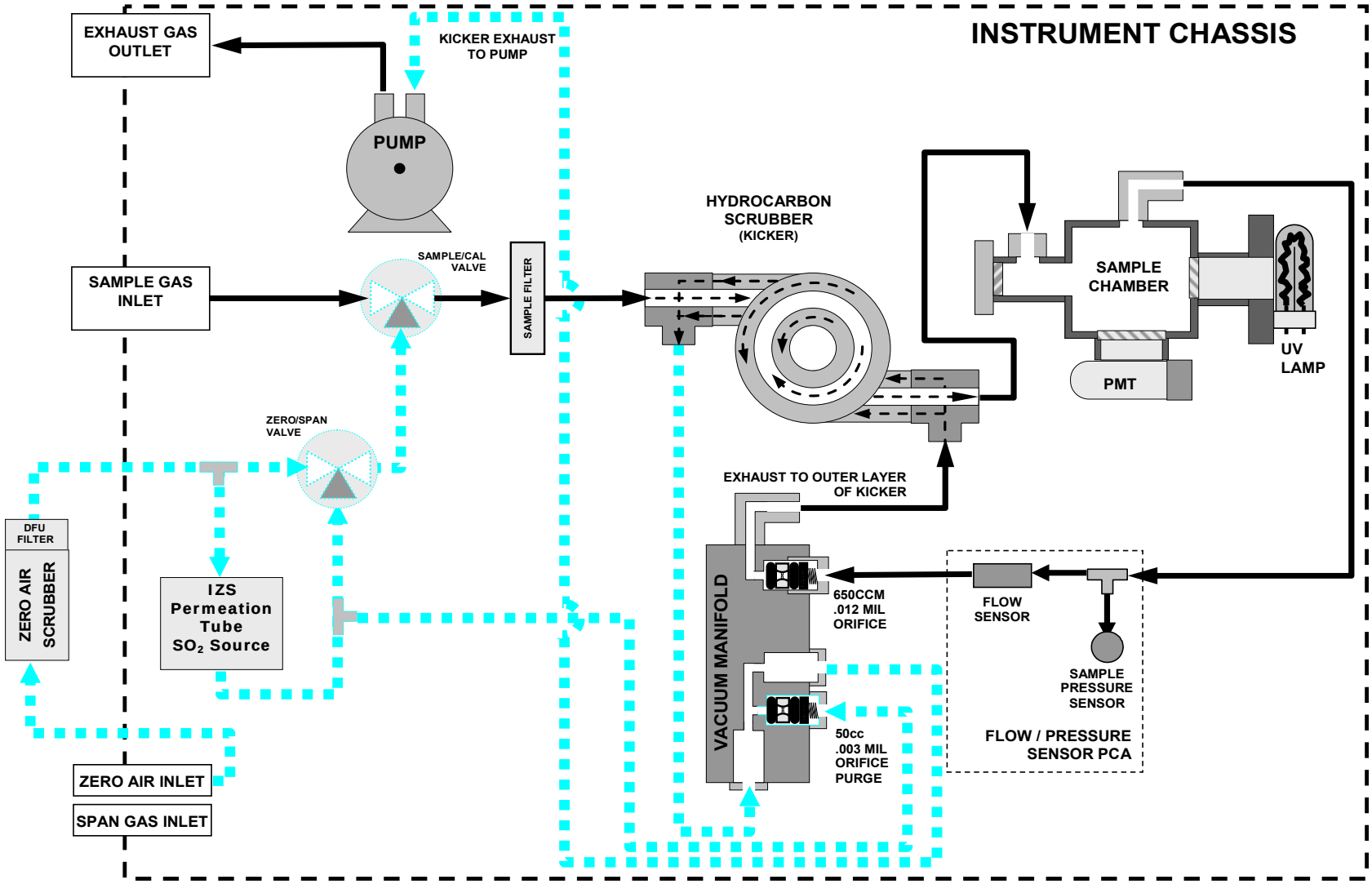
3.5 Pneumatic Schematics



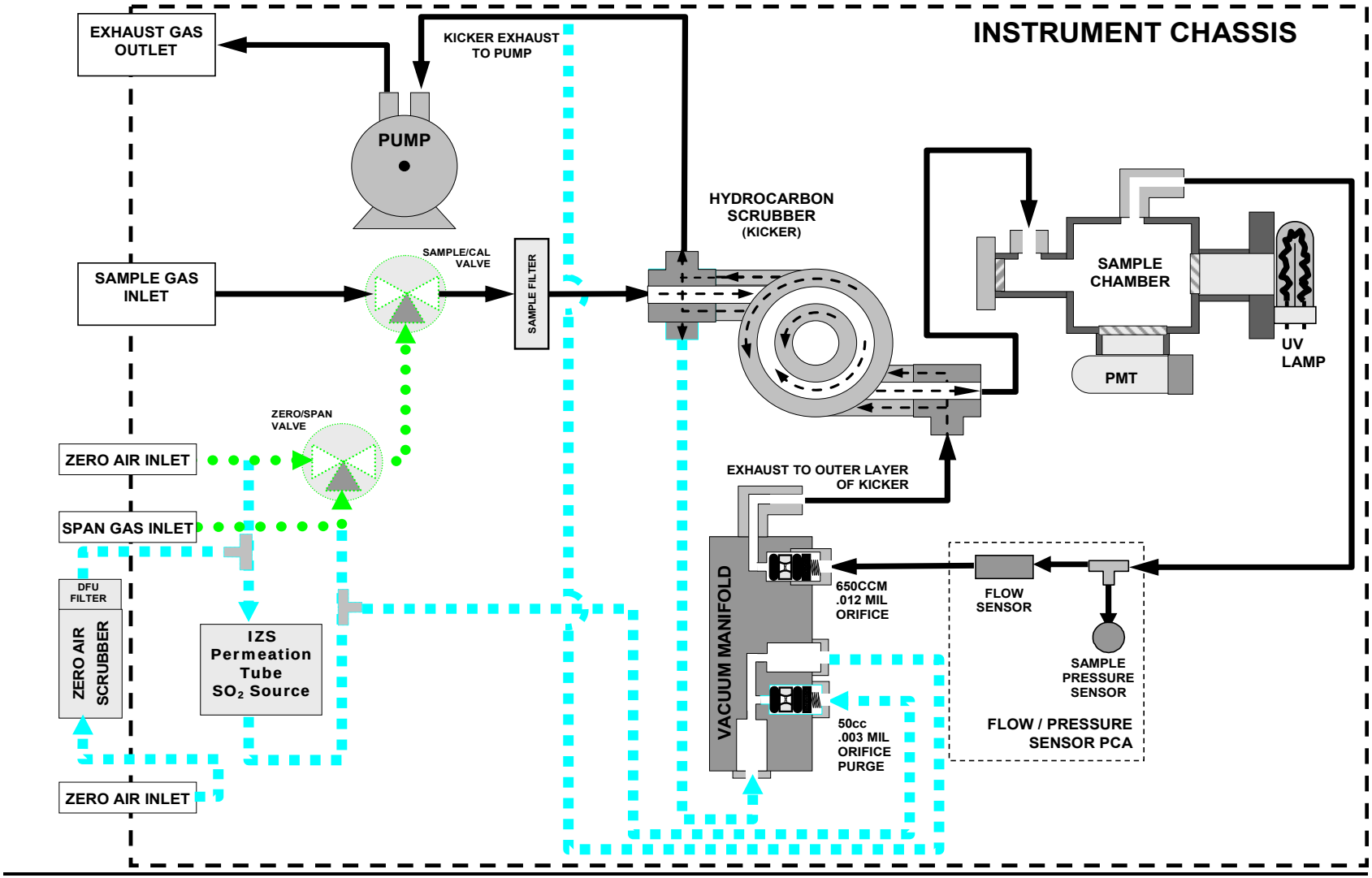
M100E / T100 Standard Configuration



M100E / T100 With Valve Option



M100E / T100 With Internal Span/Zero Option

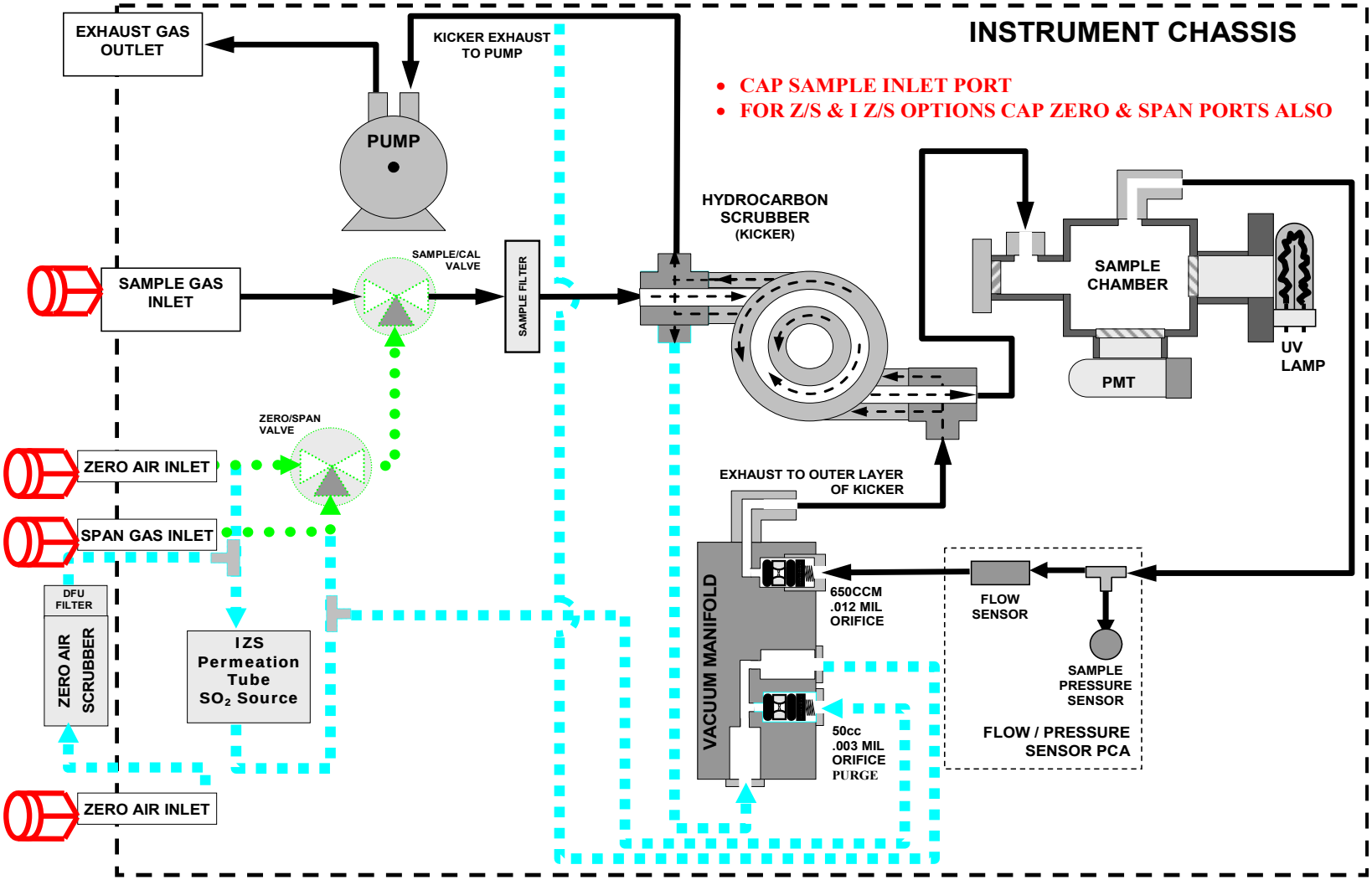


STANDARD

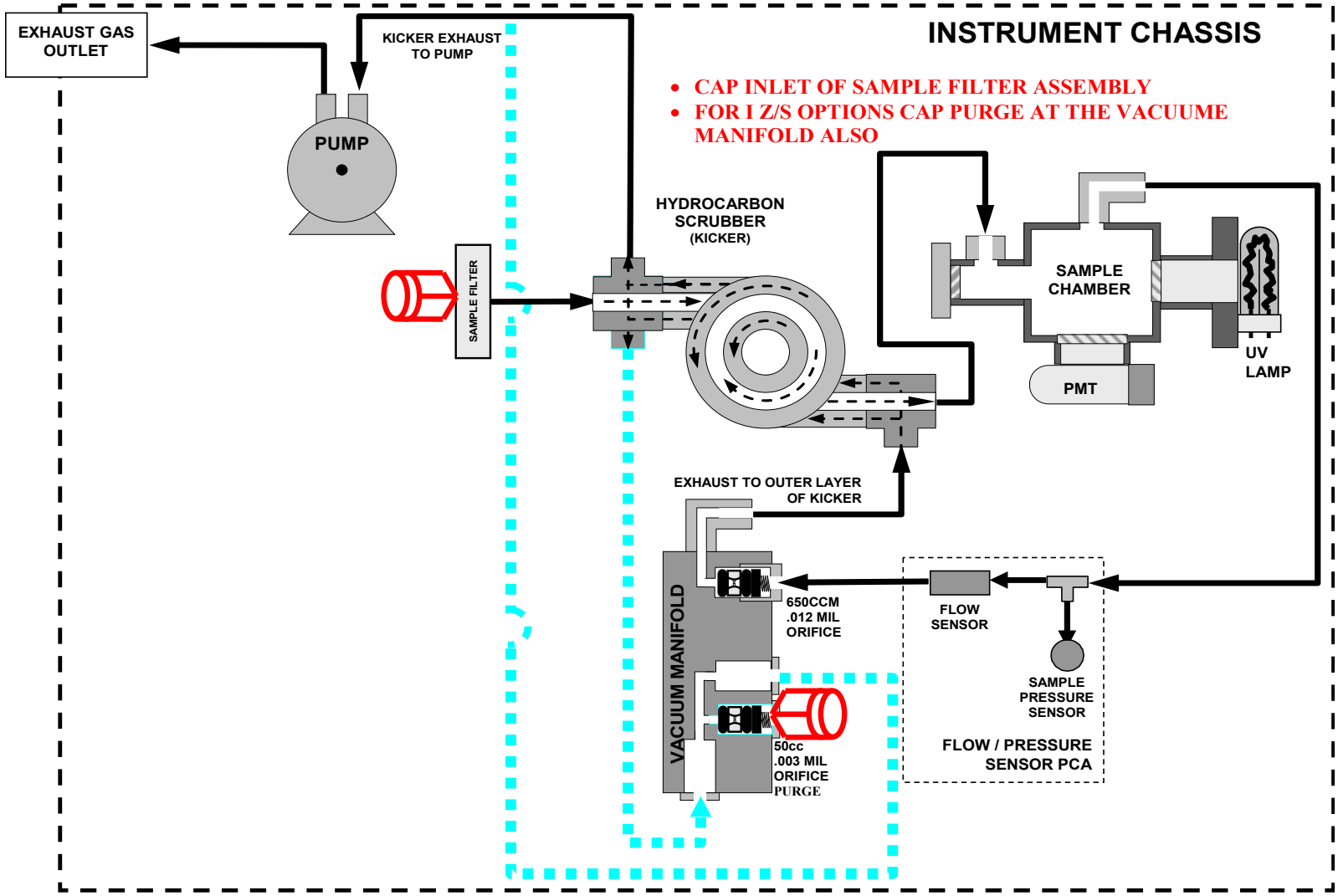
ZERO/SPAN

I Z/S

M100E / T100 Option Breakdown



M100E / T100 Initial Leak Check

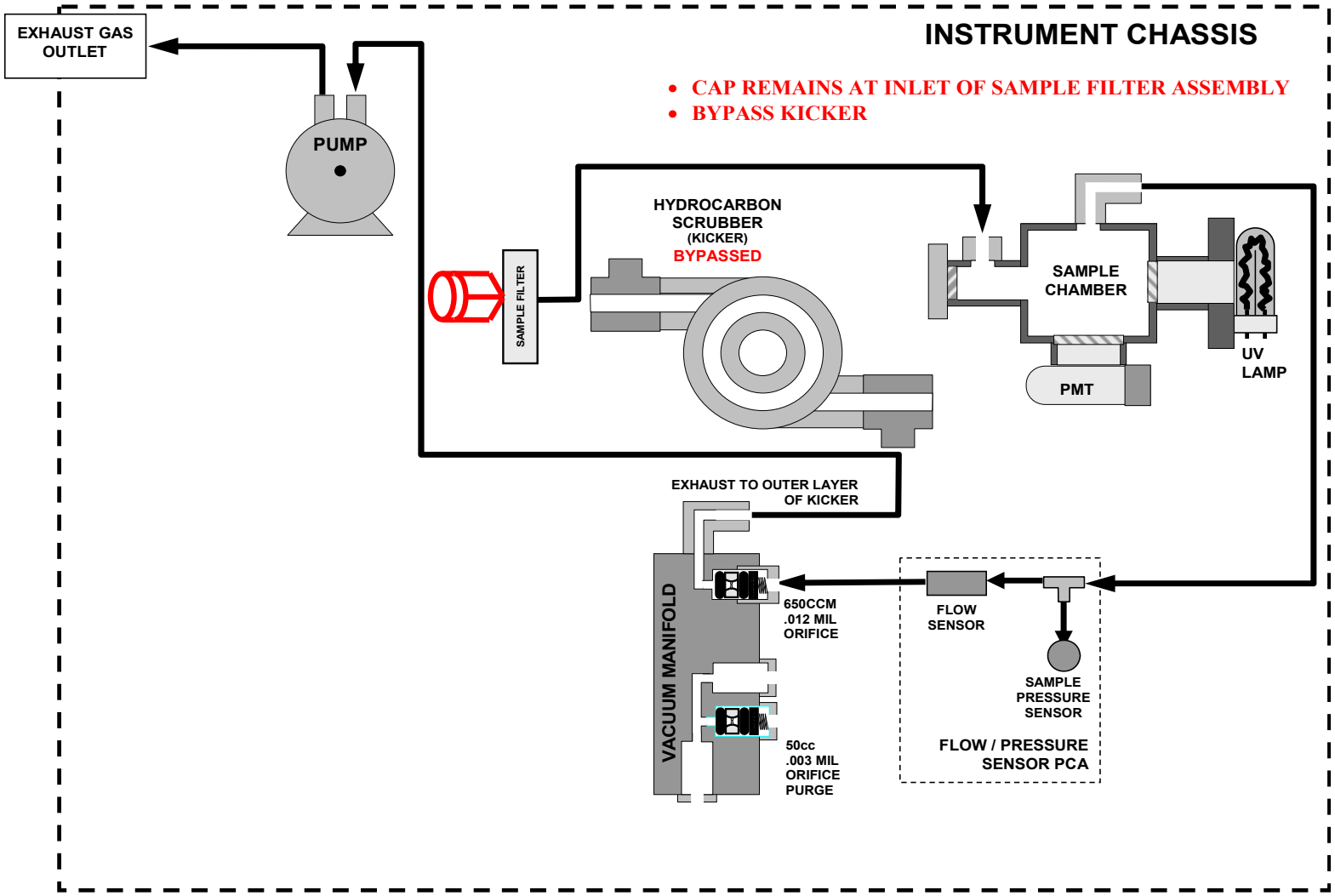


STANDARD

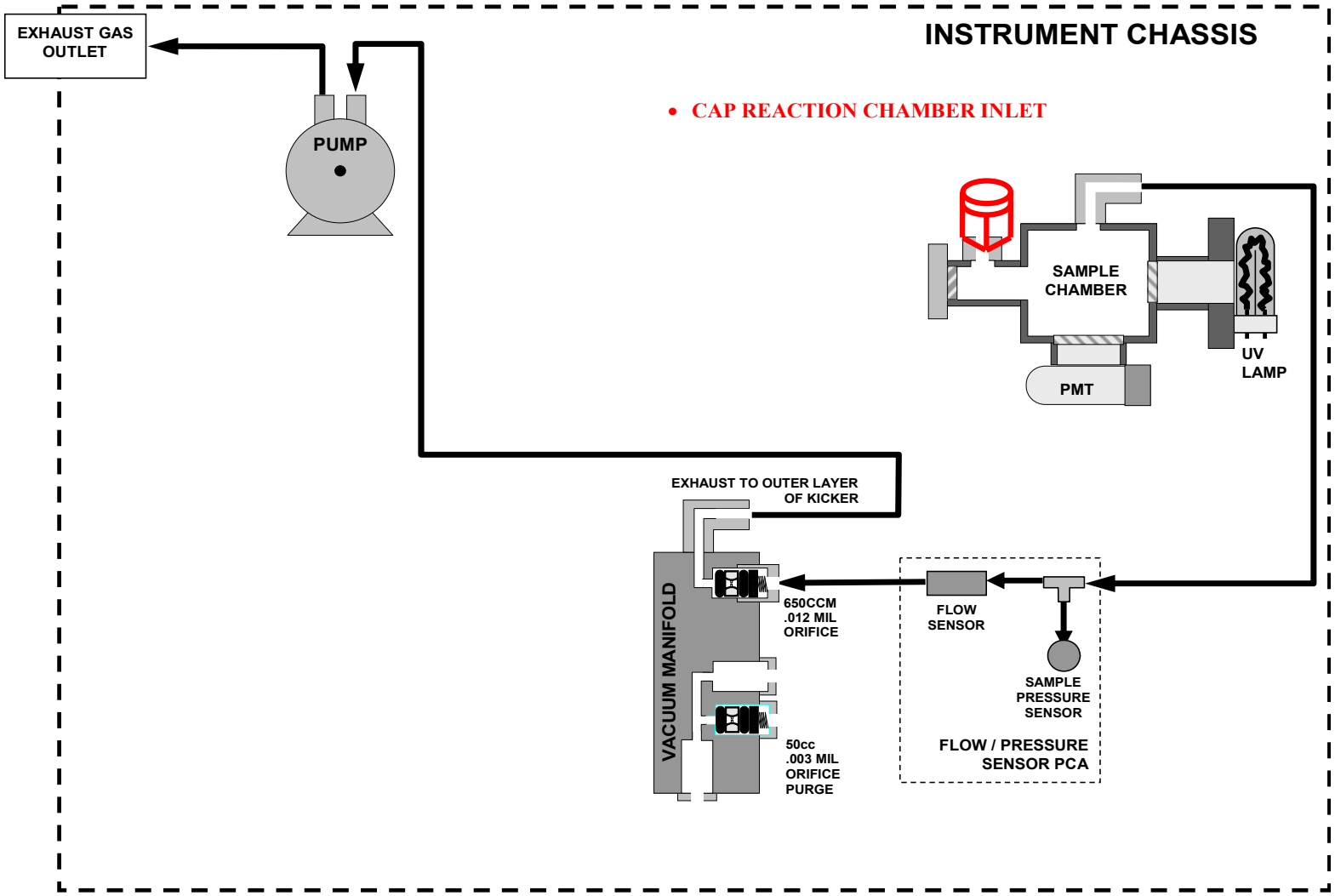
ZERO/SPAN

I Z/S

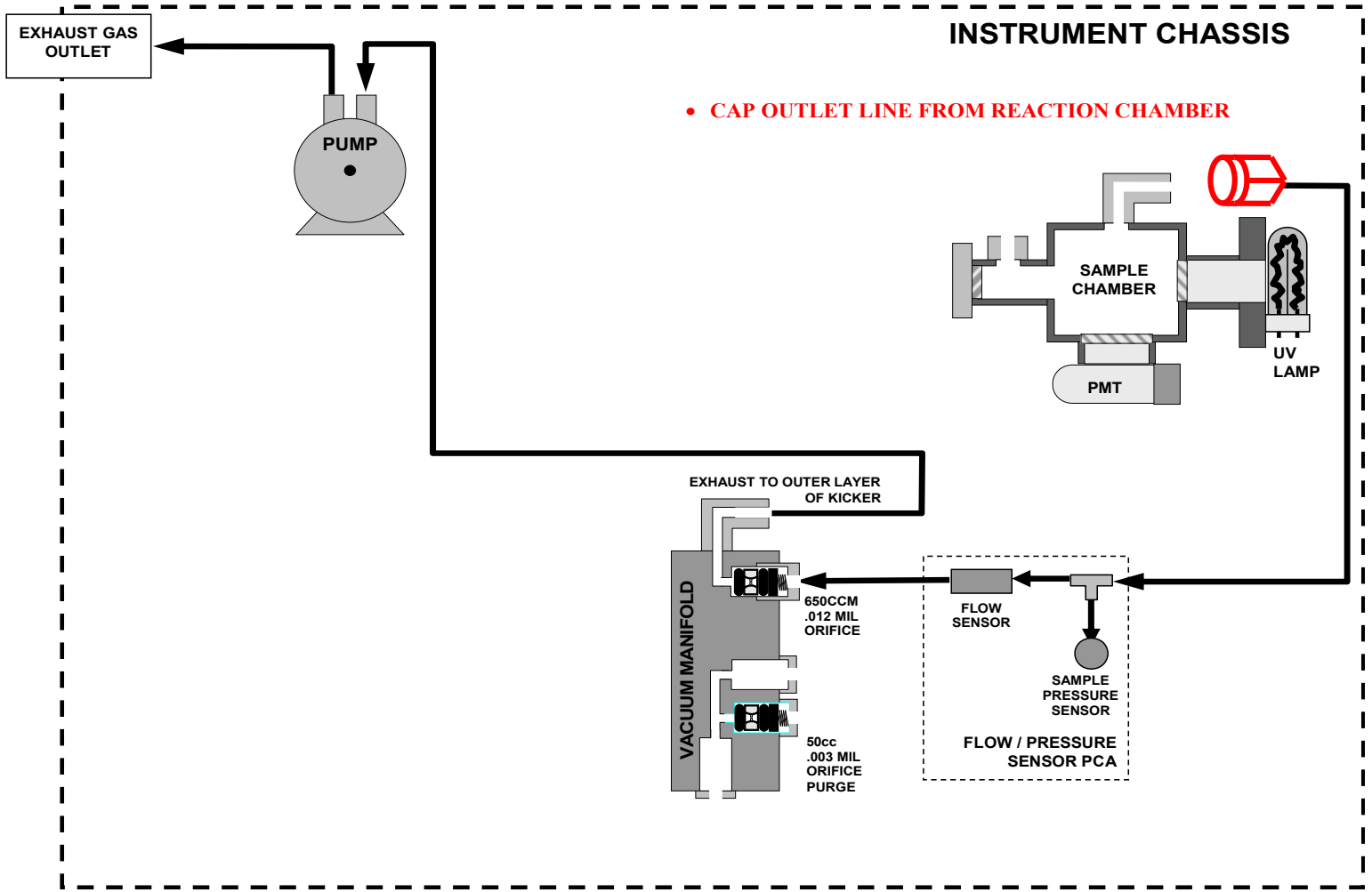
M100E / T100 Valves and IZS Bypassed



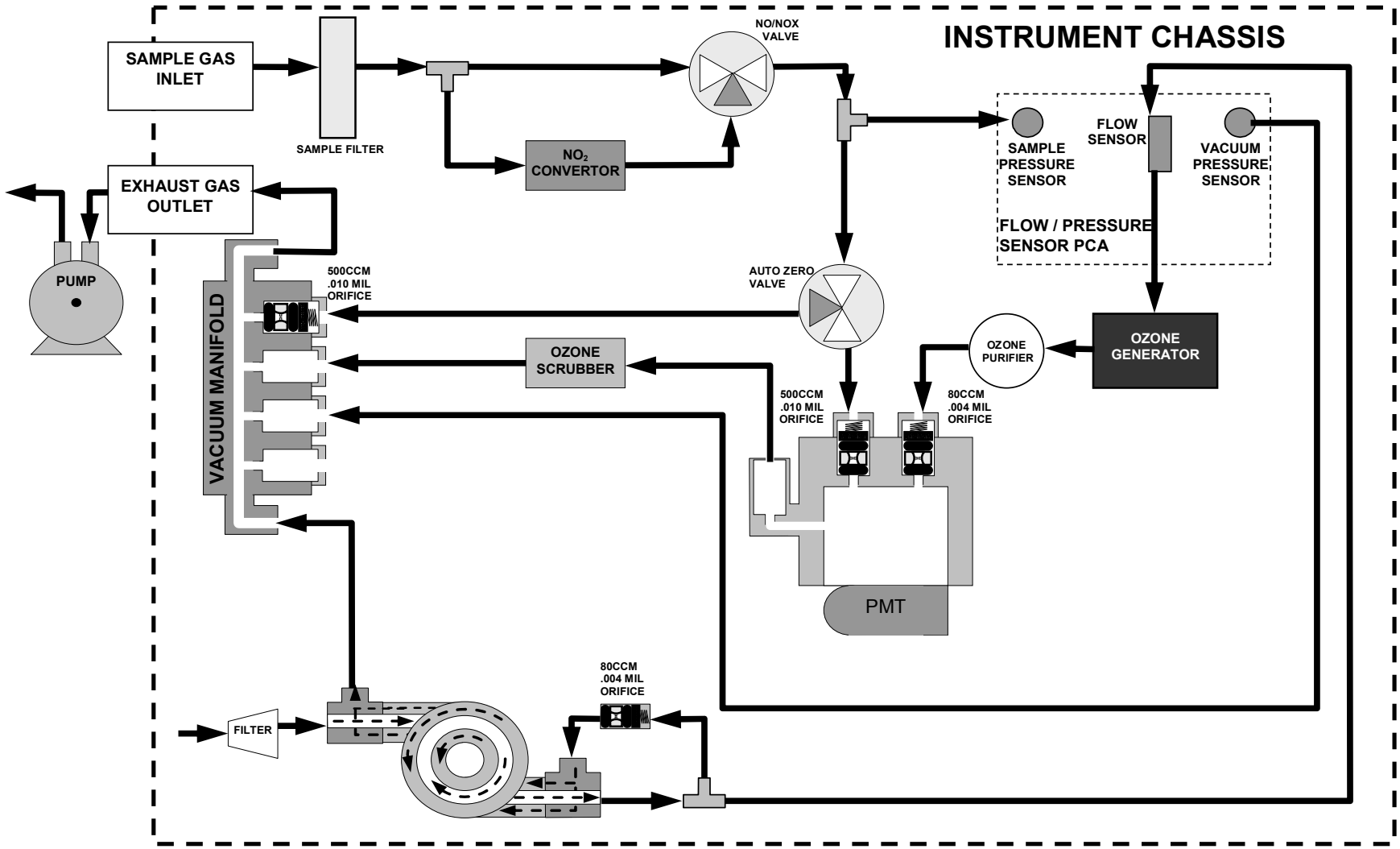
M100E / T100 Kicker Bypassed



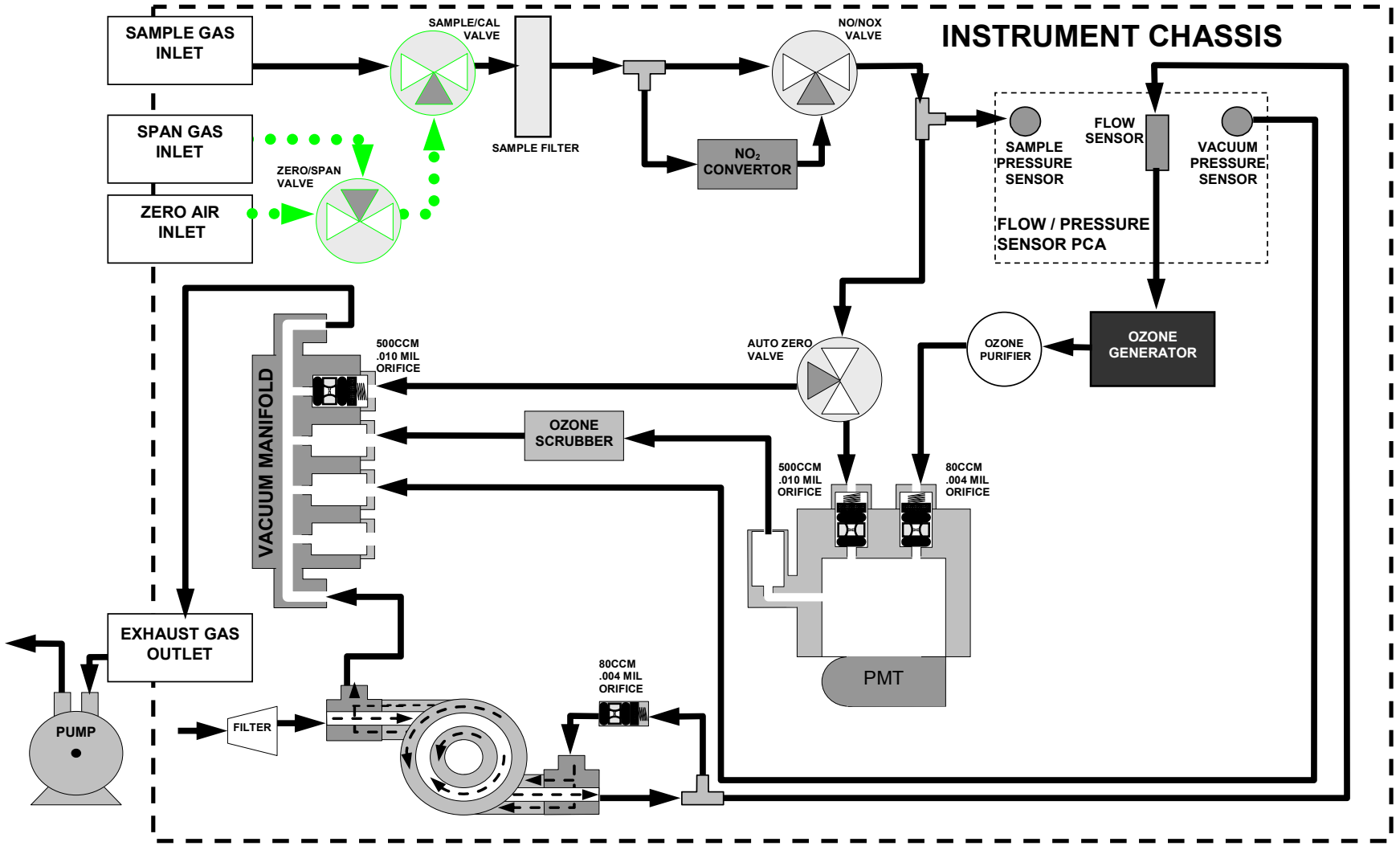
M100E / T100 Kicker and Sample Filter Bypassed



M100E / T100 Sample Chamber Bypass



M200E / T200 Standard Configuration

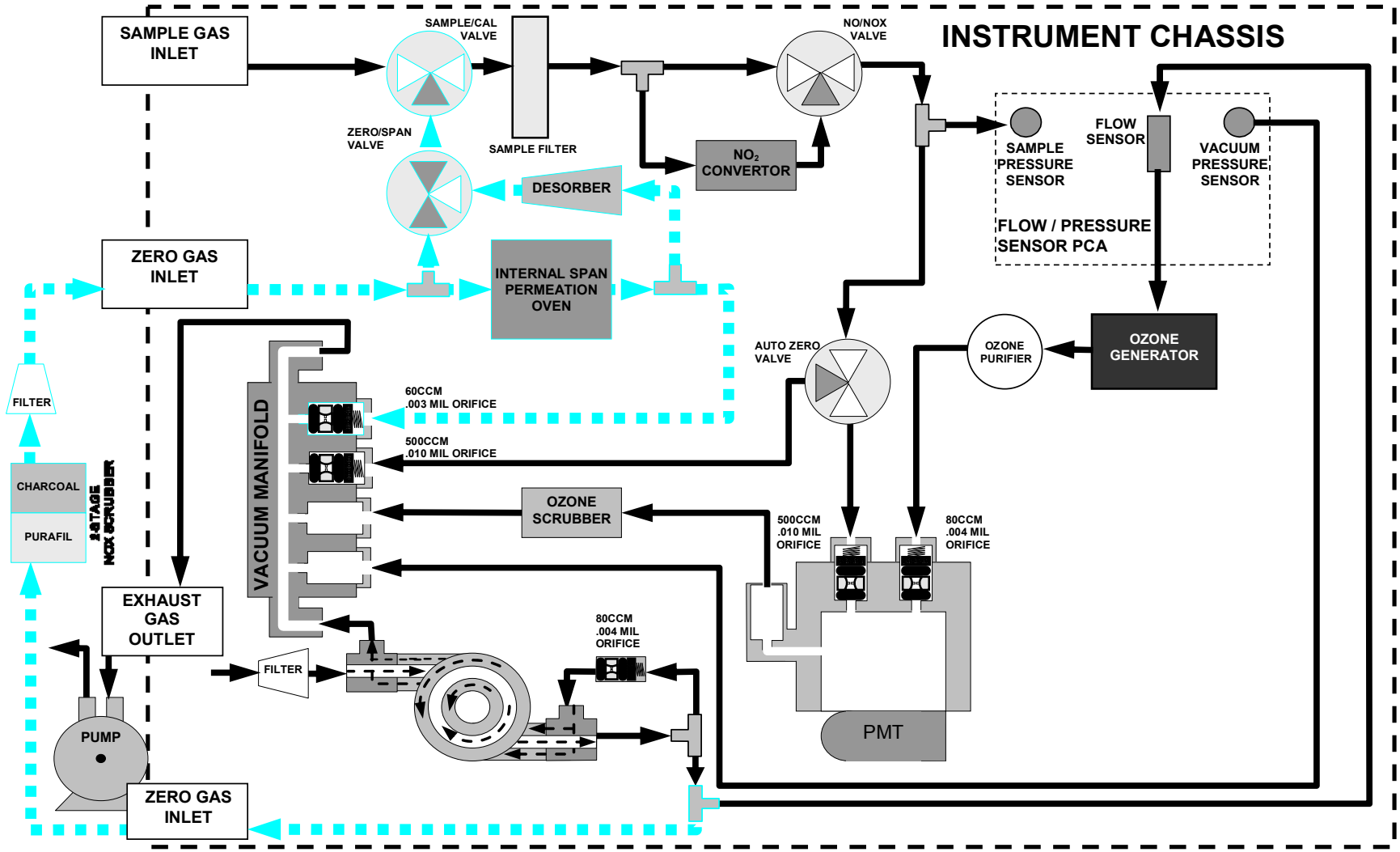


STANDARD

ZERO/SPAN

Z/S & IZ/S

M200E / T200 With Zero/Span Valve Option

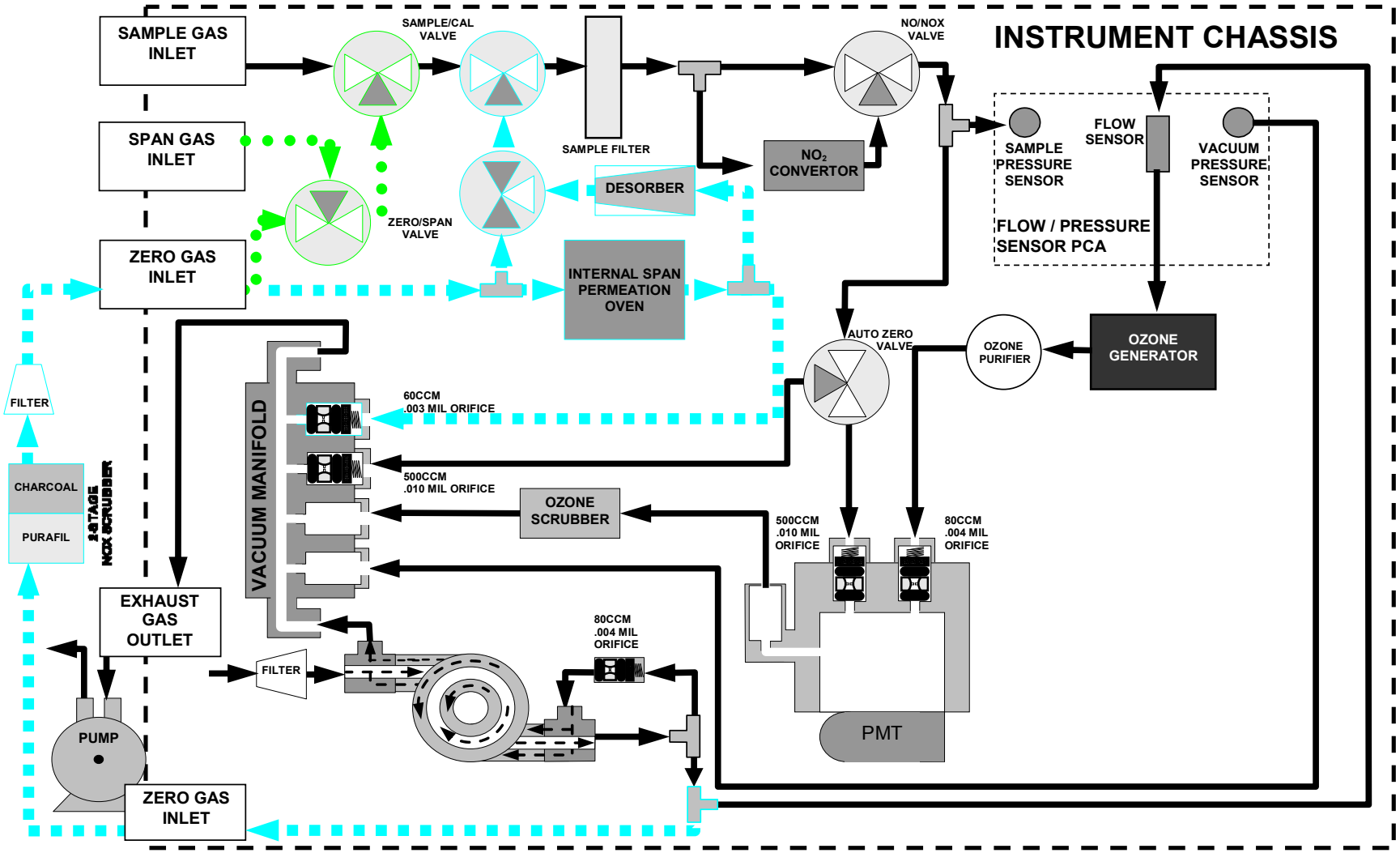


STANDARD

ZERO/SPAN

Z/S & IZ/S

M200E / T200 With Internal Span/Zero Option

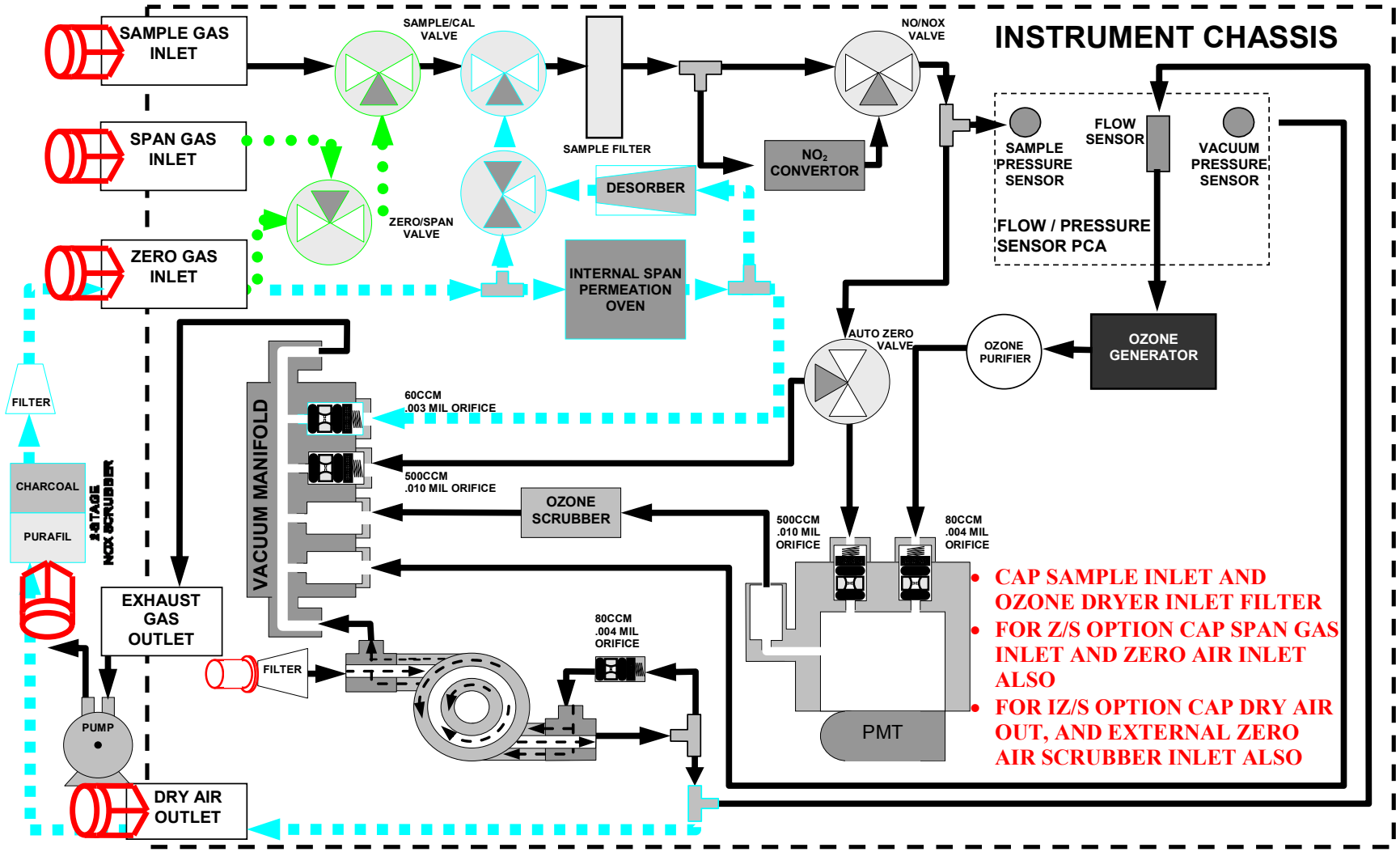


STANDARD

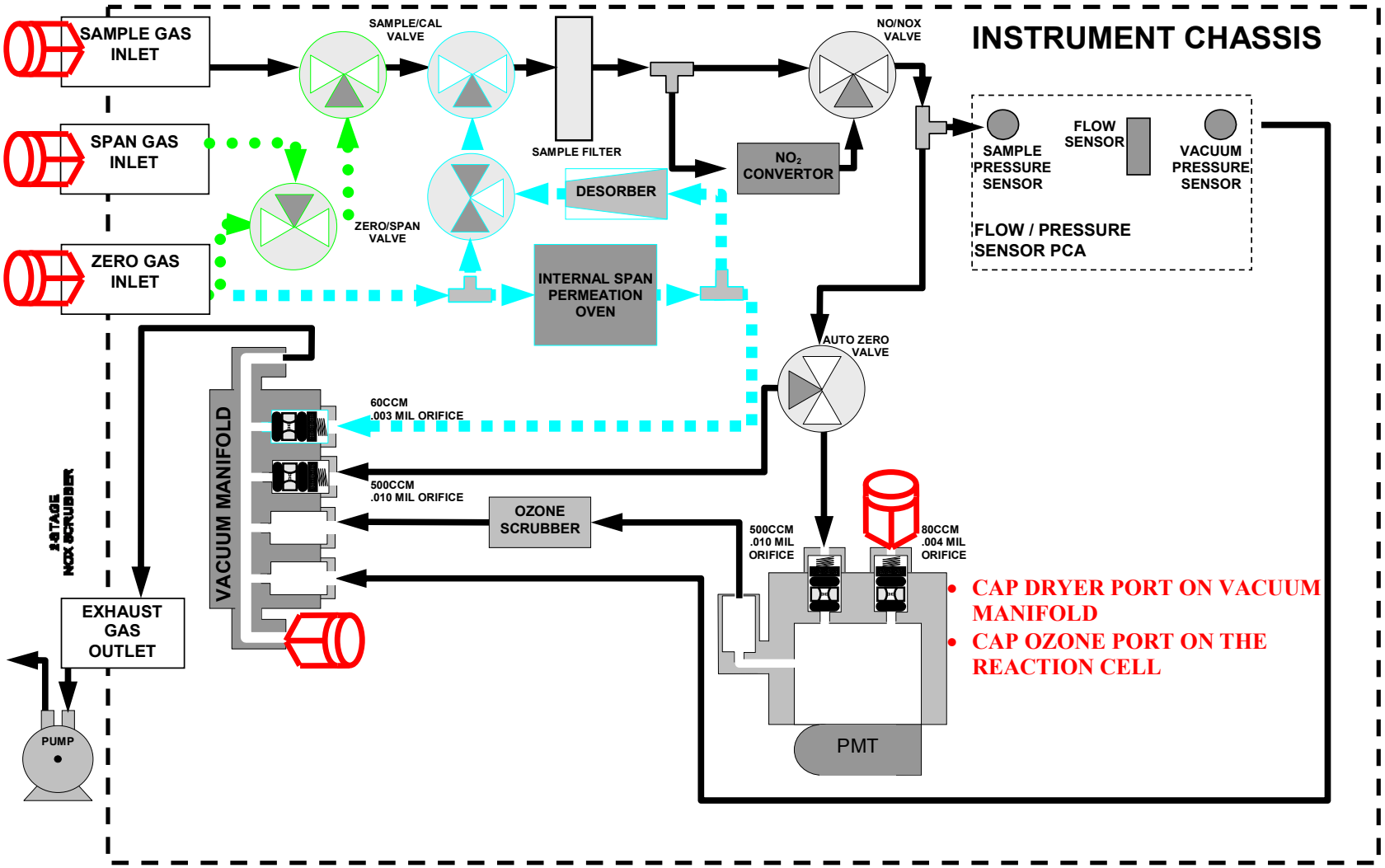
ZERO/SPAN

Z/S & IZ/S

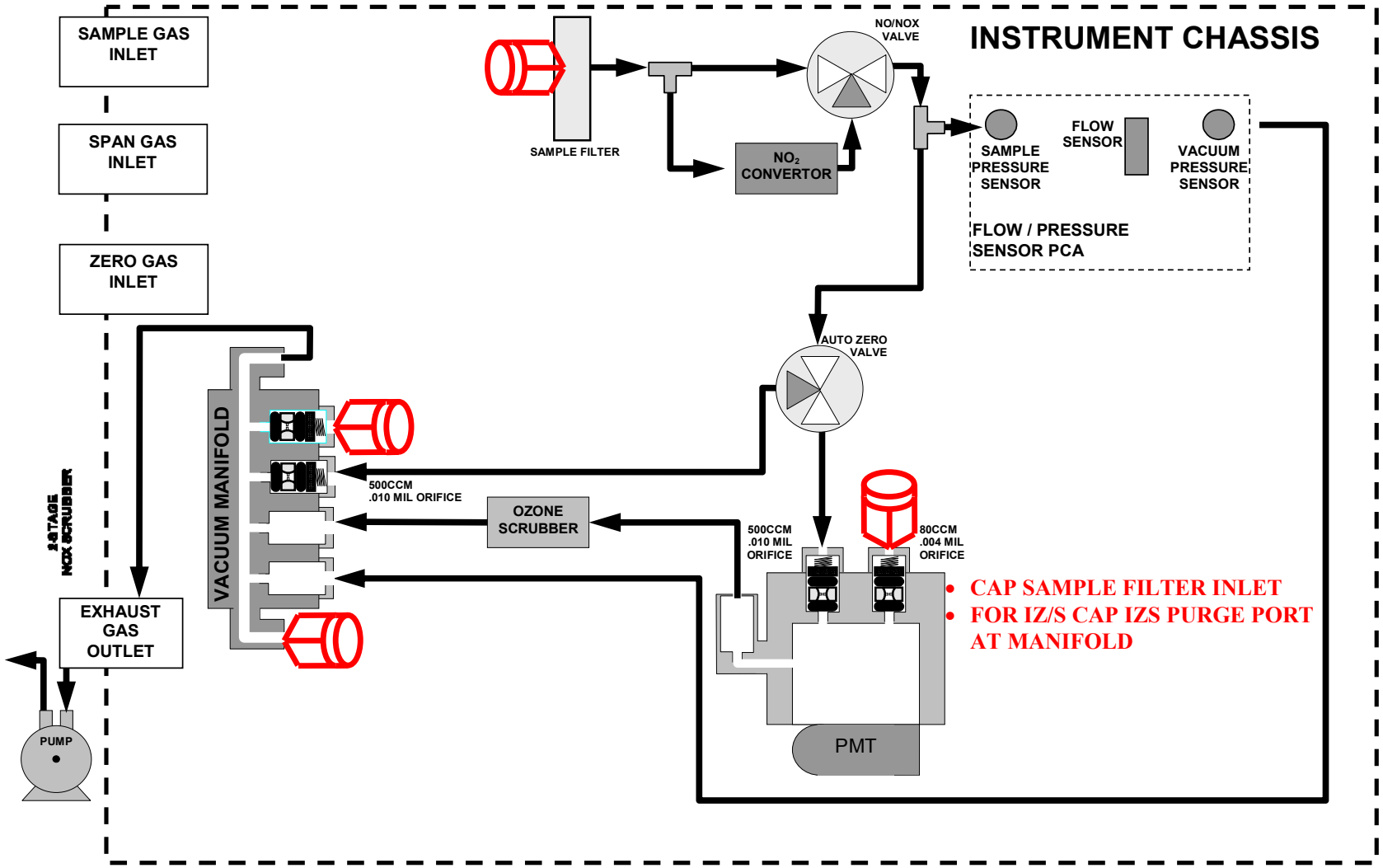
M200E / T200 Option Breakdown



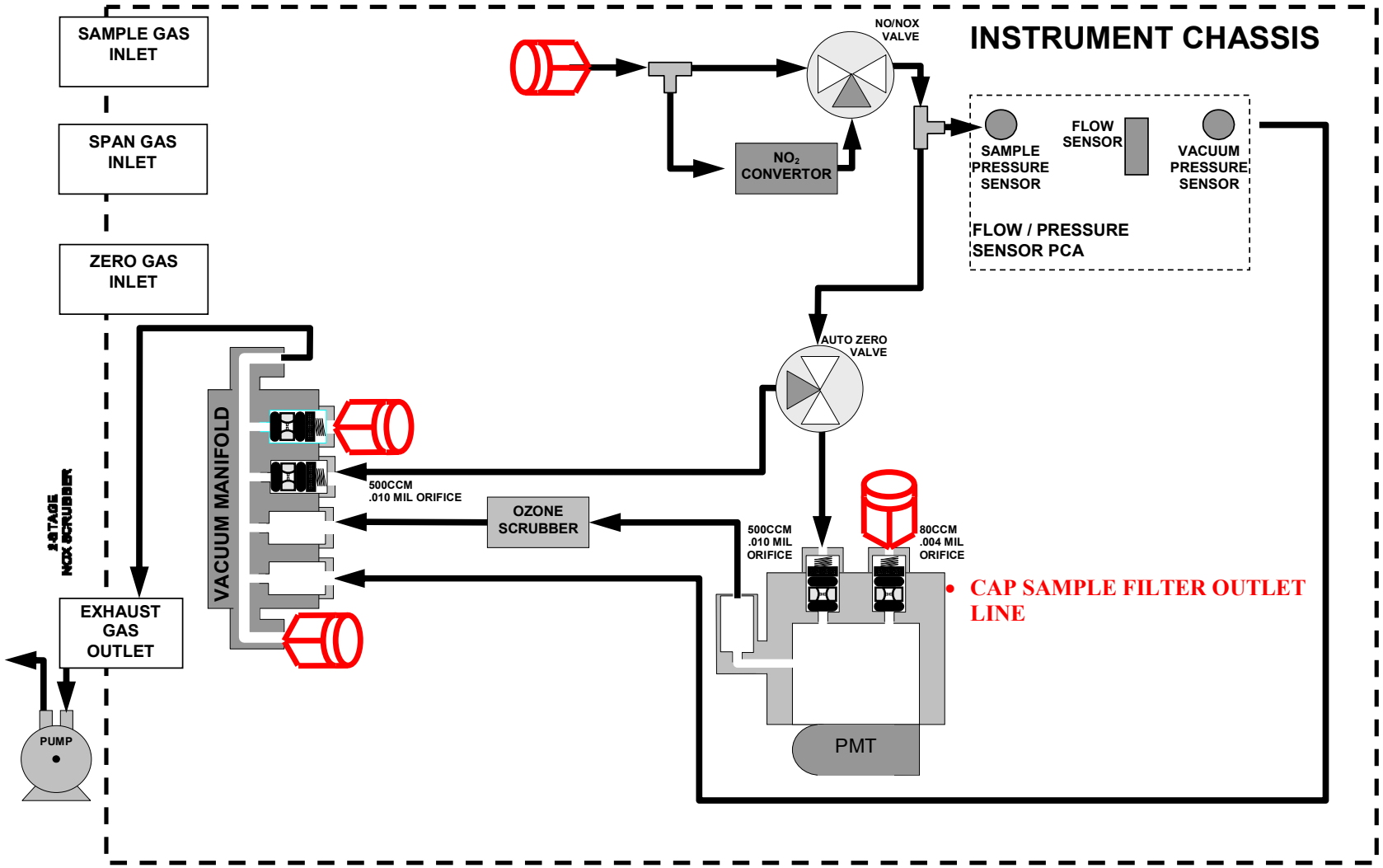
M200E / T200 Initial Leak Check



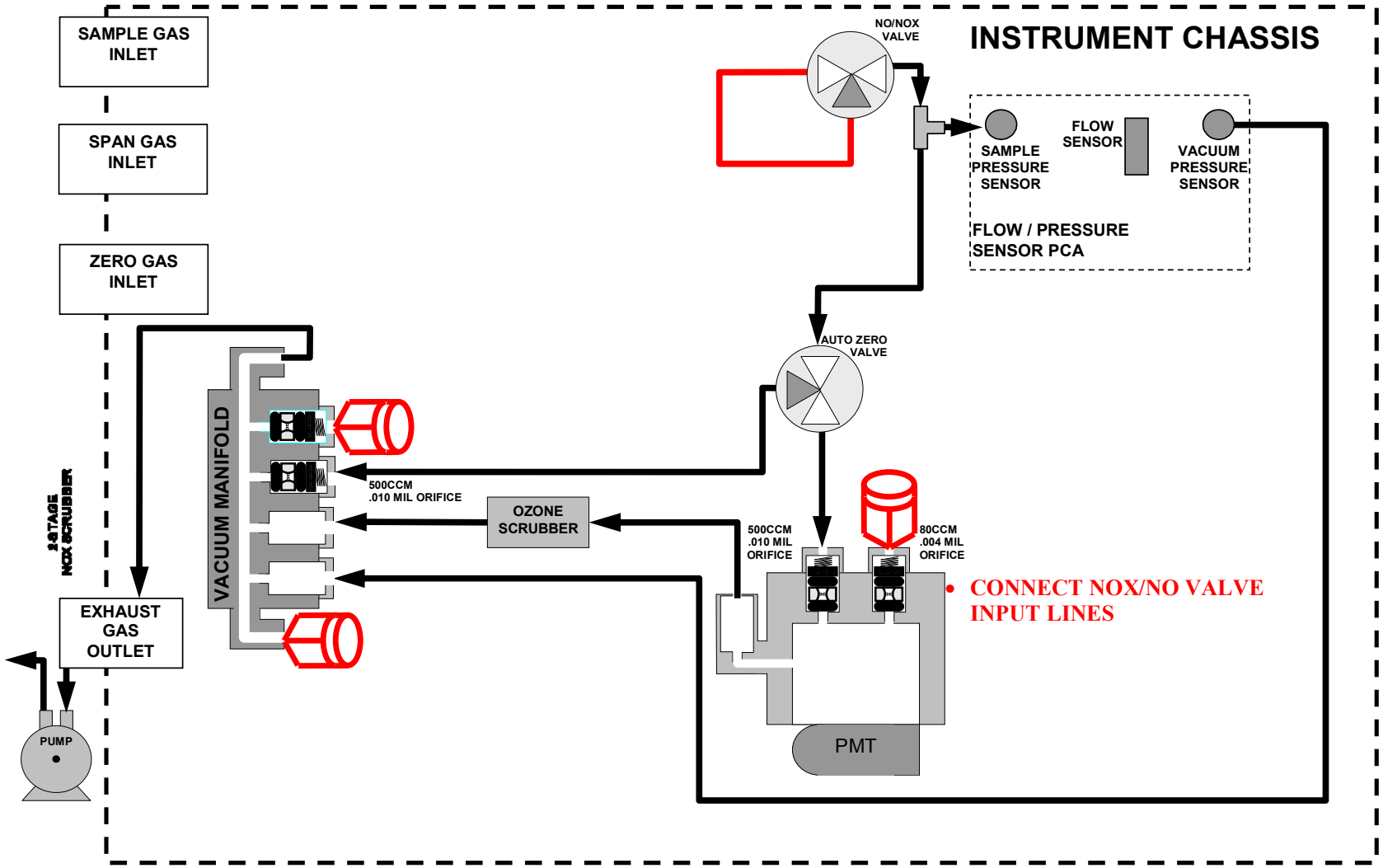
M200E / T200 Ozone Side Bypassed



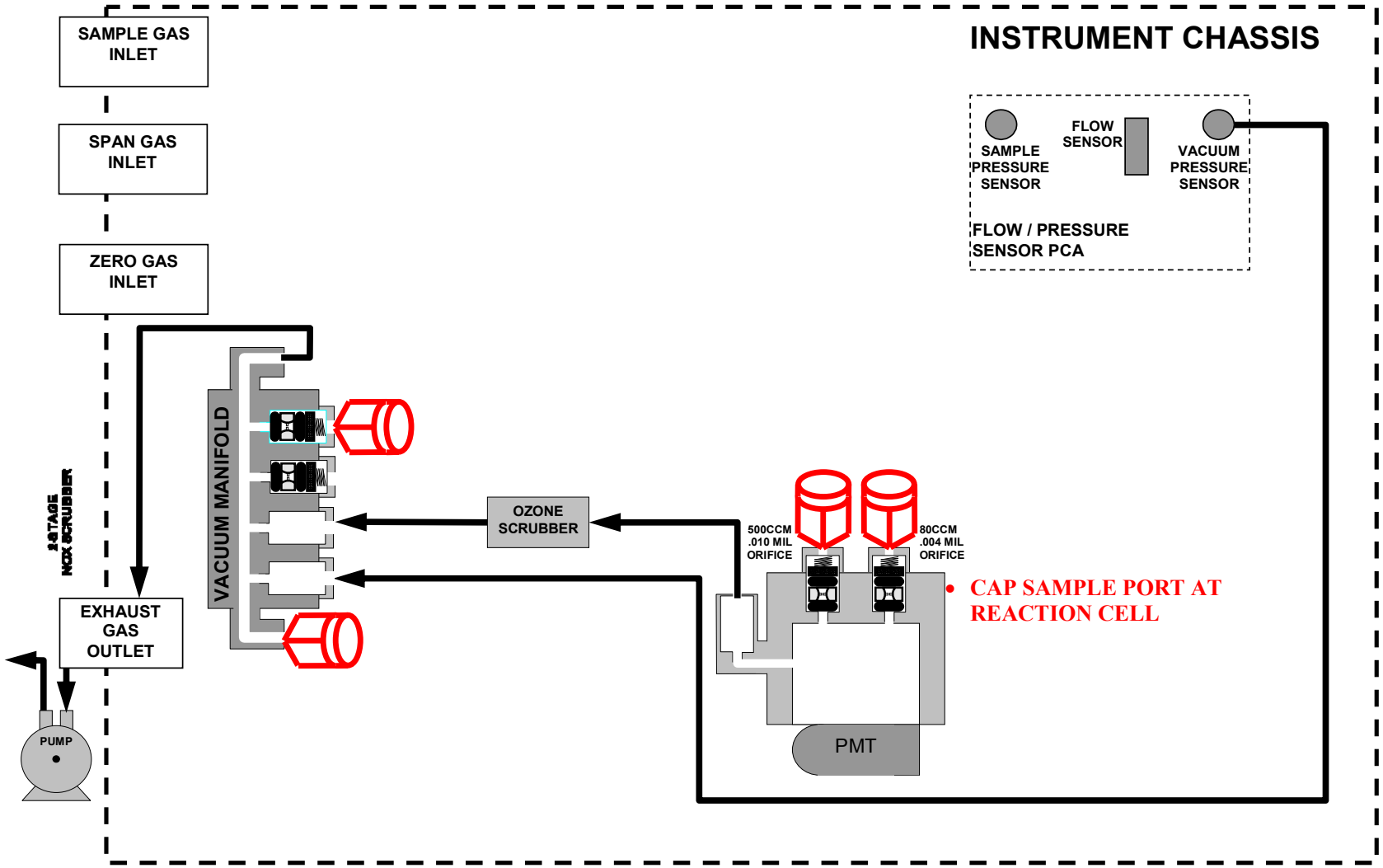
M200E / T200 Zero/Span Valves Bypassed



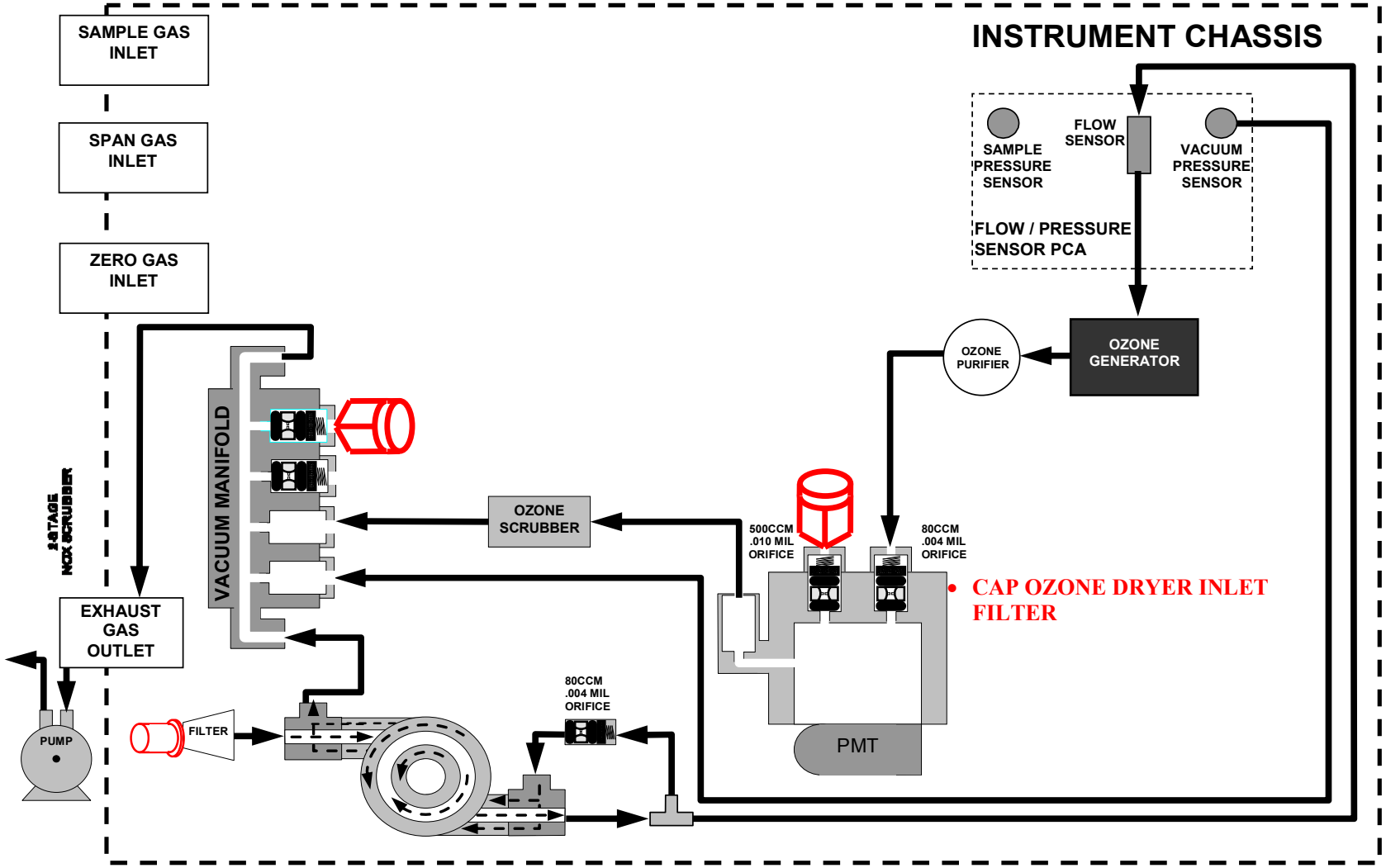
M200E / T200 Sample Filter Bypassed



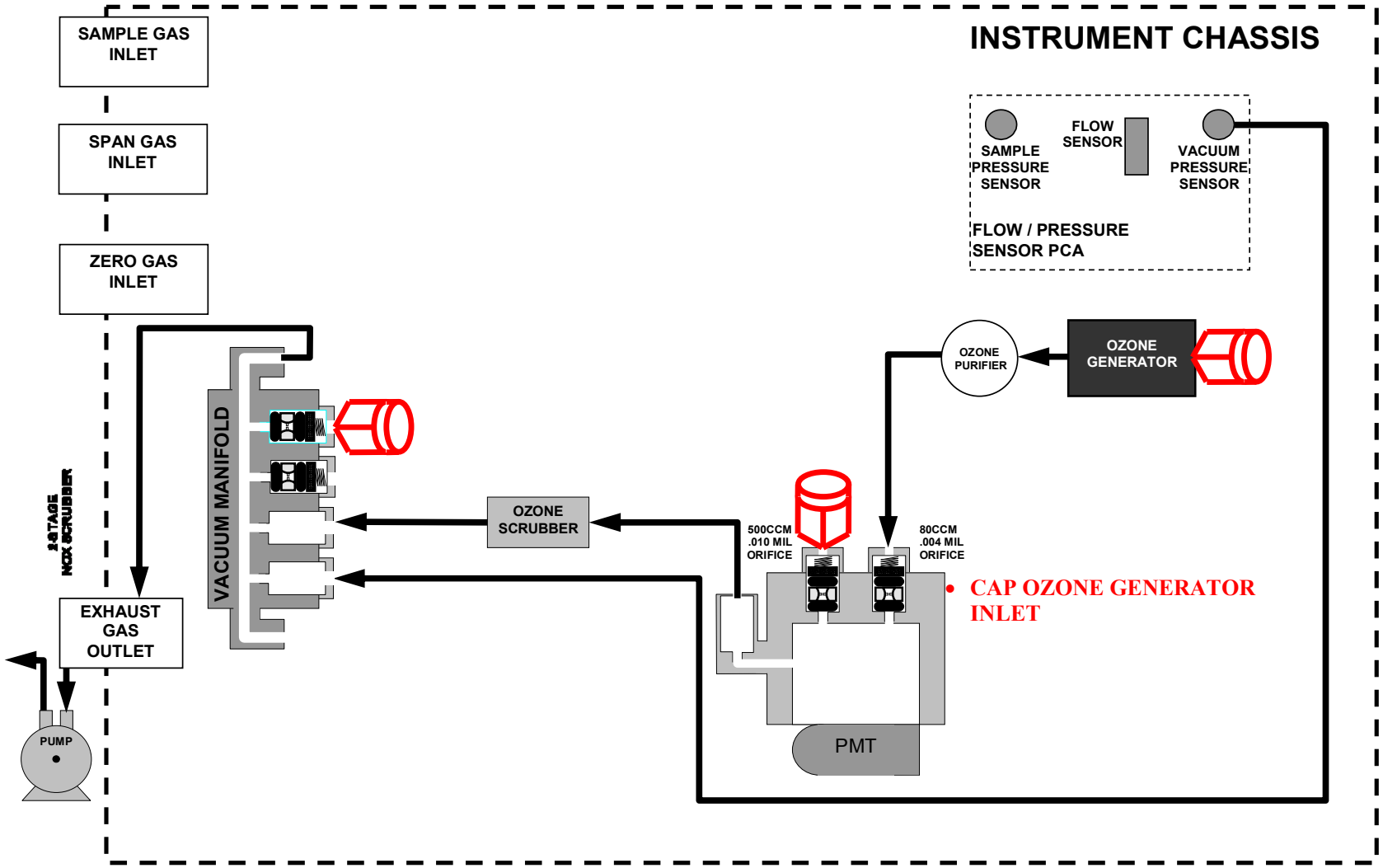
M200E / T200 Convertor Bypassed



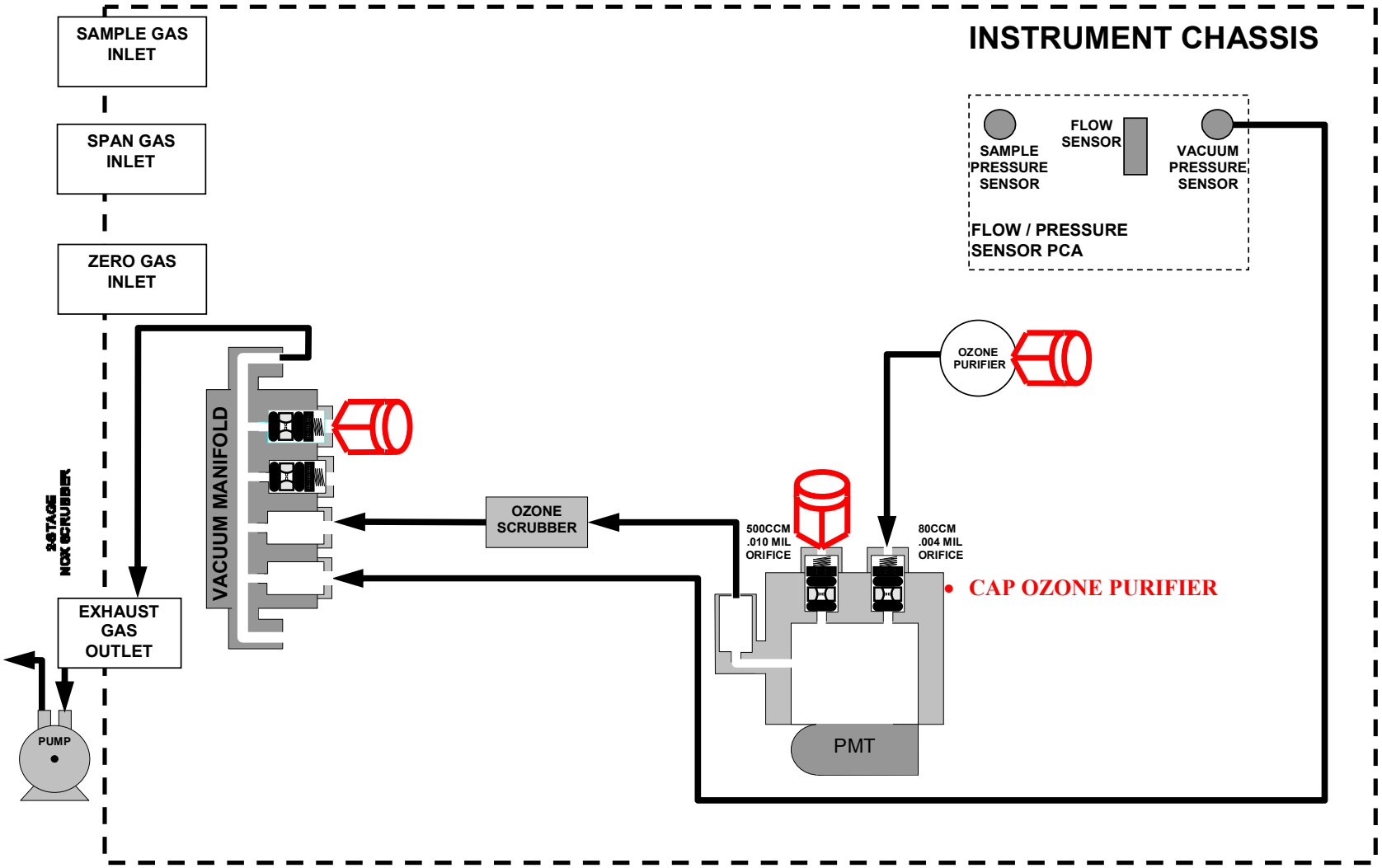
M200E / T200 Valves Bypassed



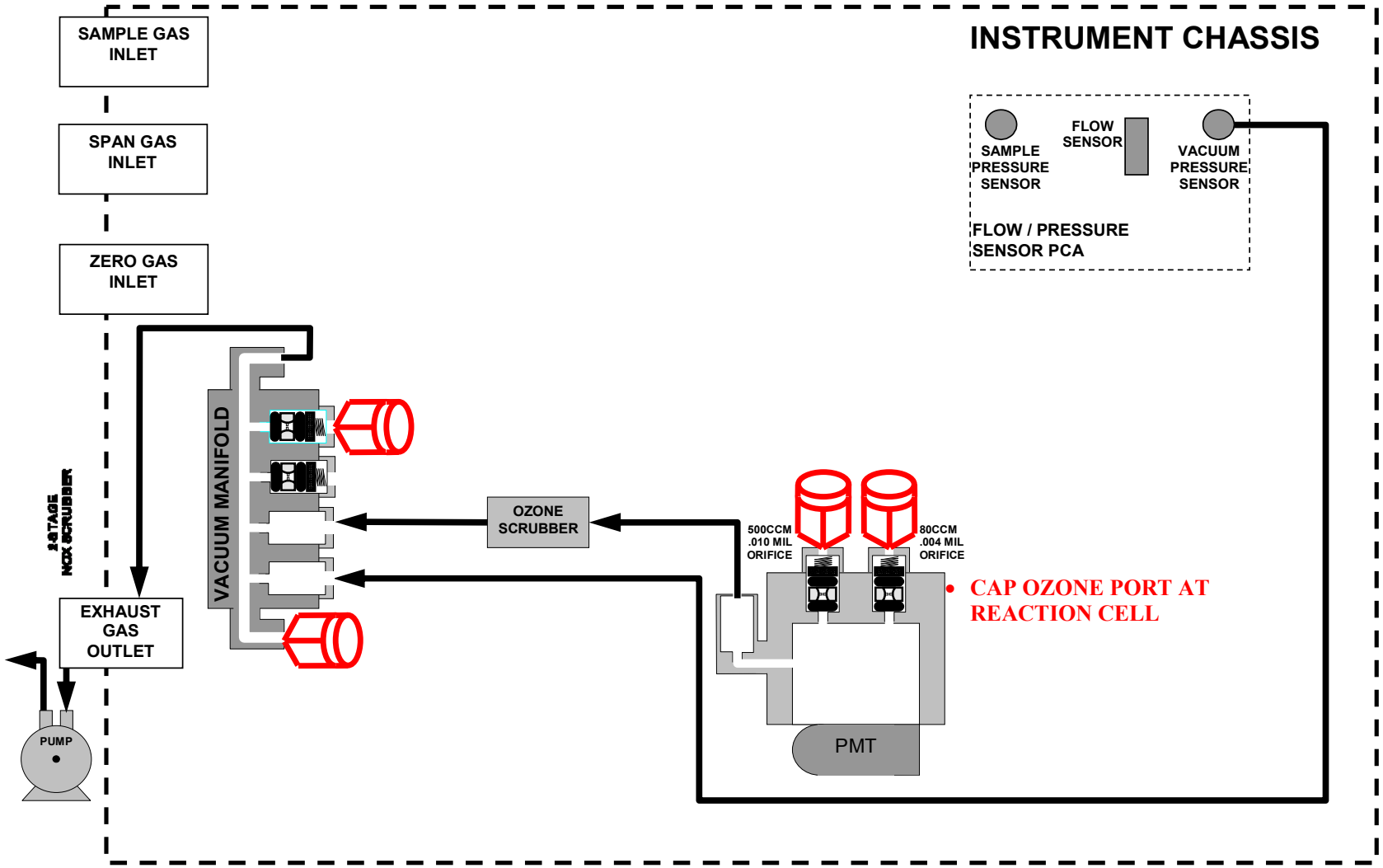
M200E / T200 Sample Side Bypassed (Ozone only)



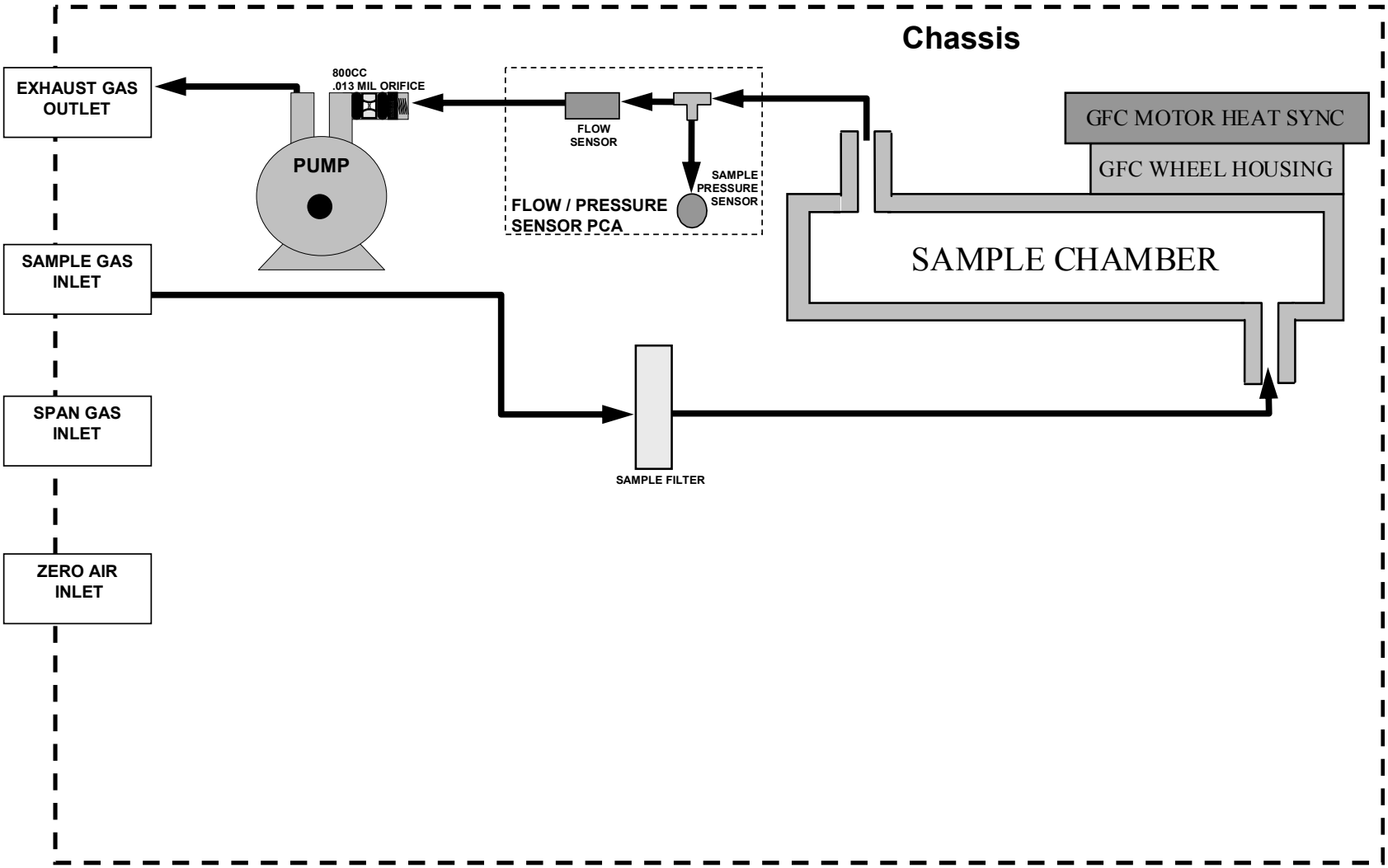
M200E / T200 Drier and Flow Sensor Bypassed



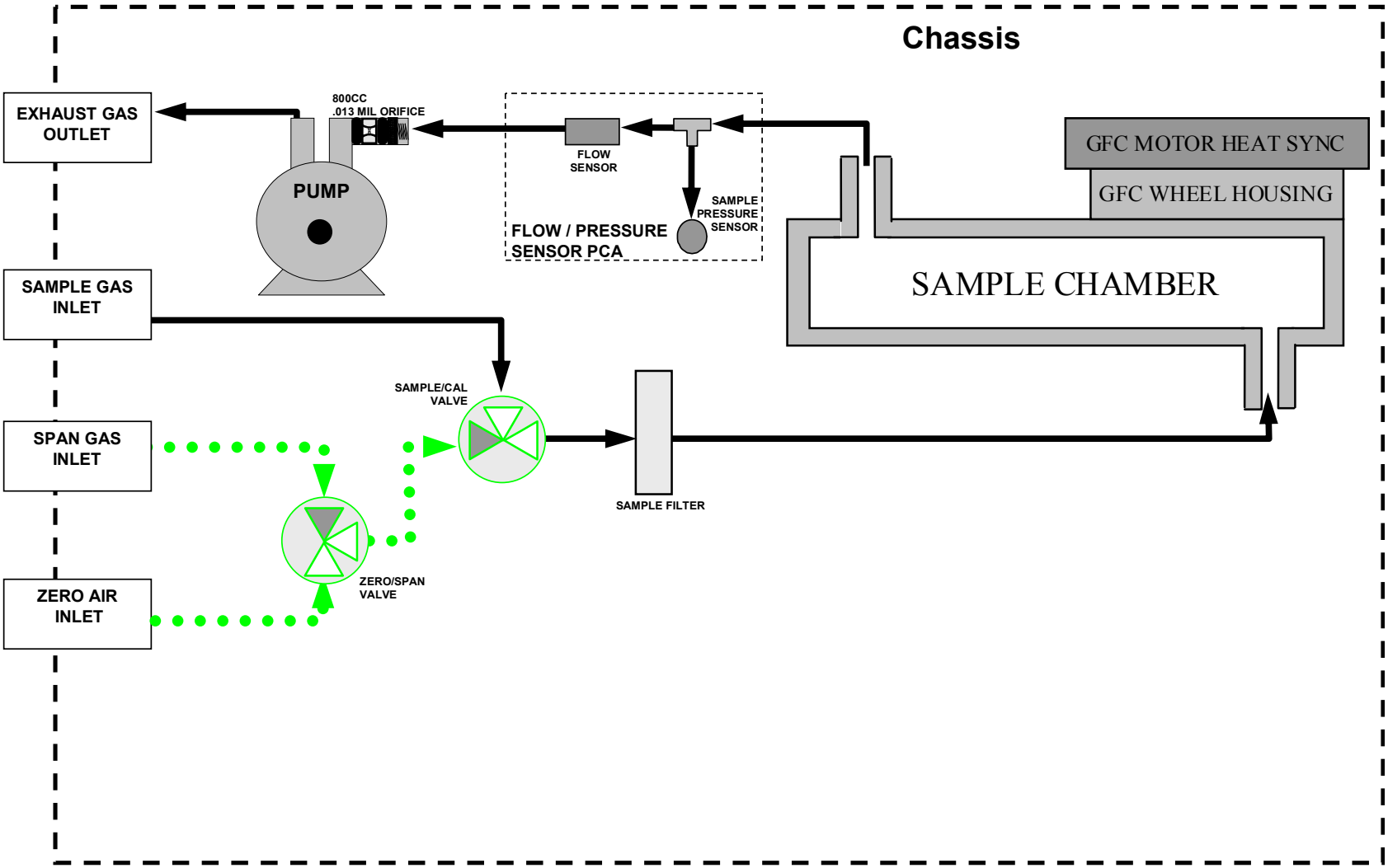
M200E / T200 Ozone Generator Bypass



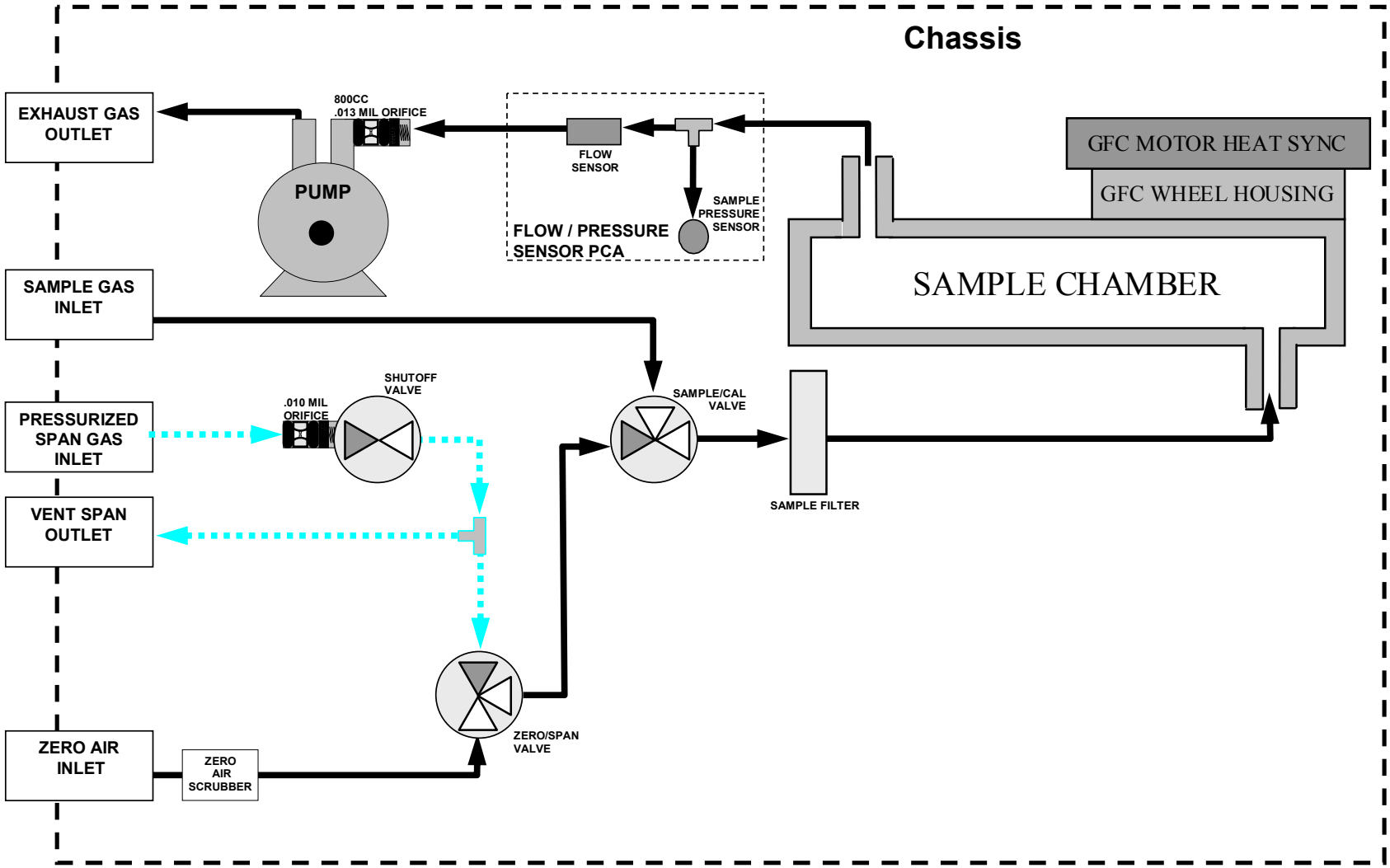
M200E / T200 Ozone Purifier Bypassed



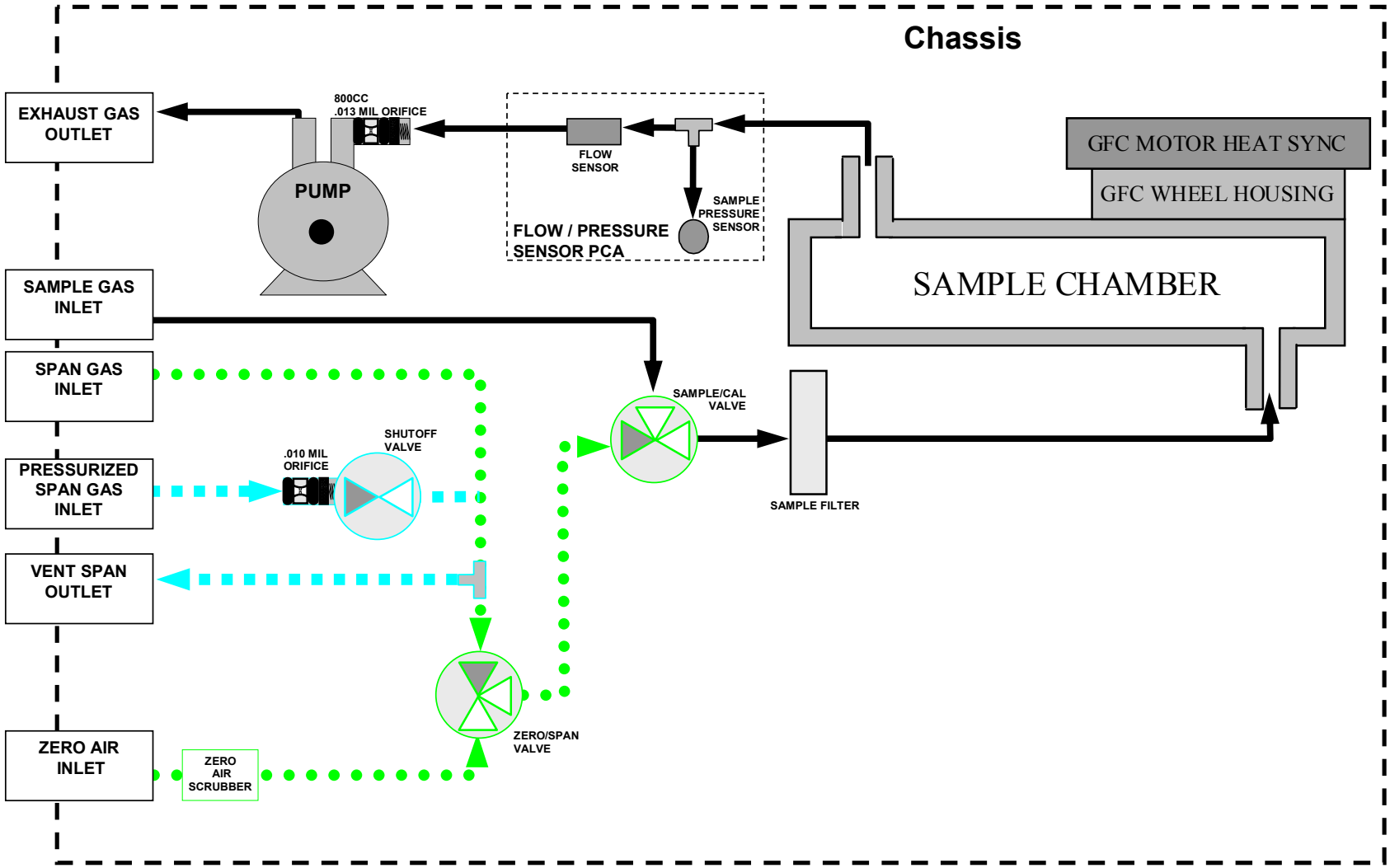
M300E / T300 Standard Configuration



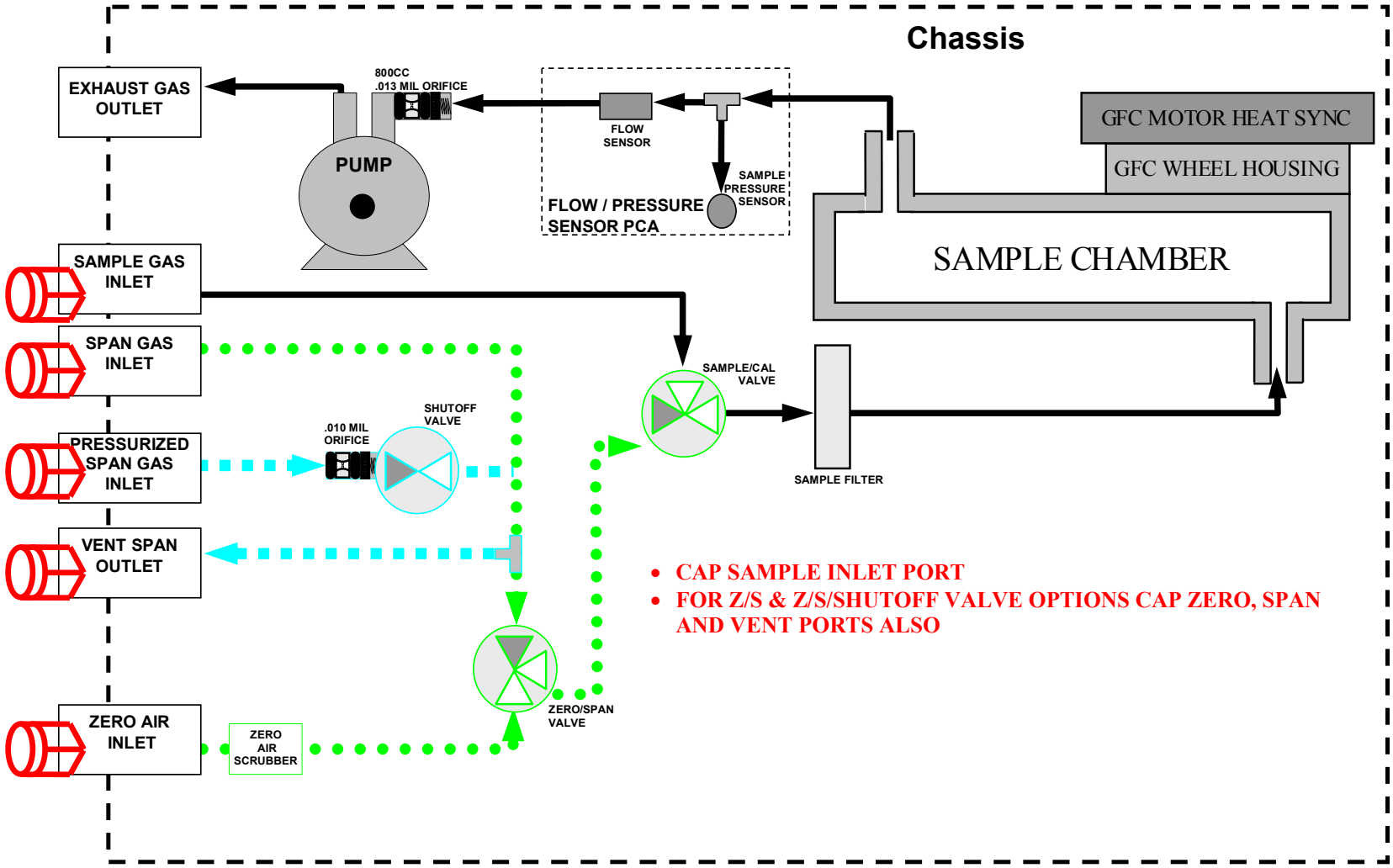
M300E / T300 With Valve Option



M300E / T300 With Internal Span/Zero Option



M300E / T300 Option Breakdown

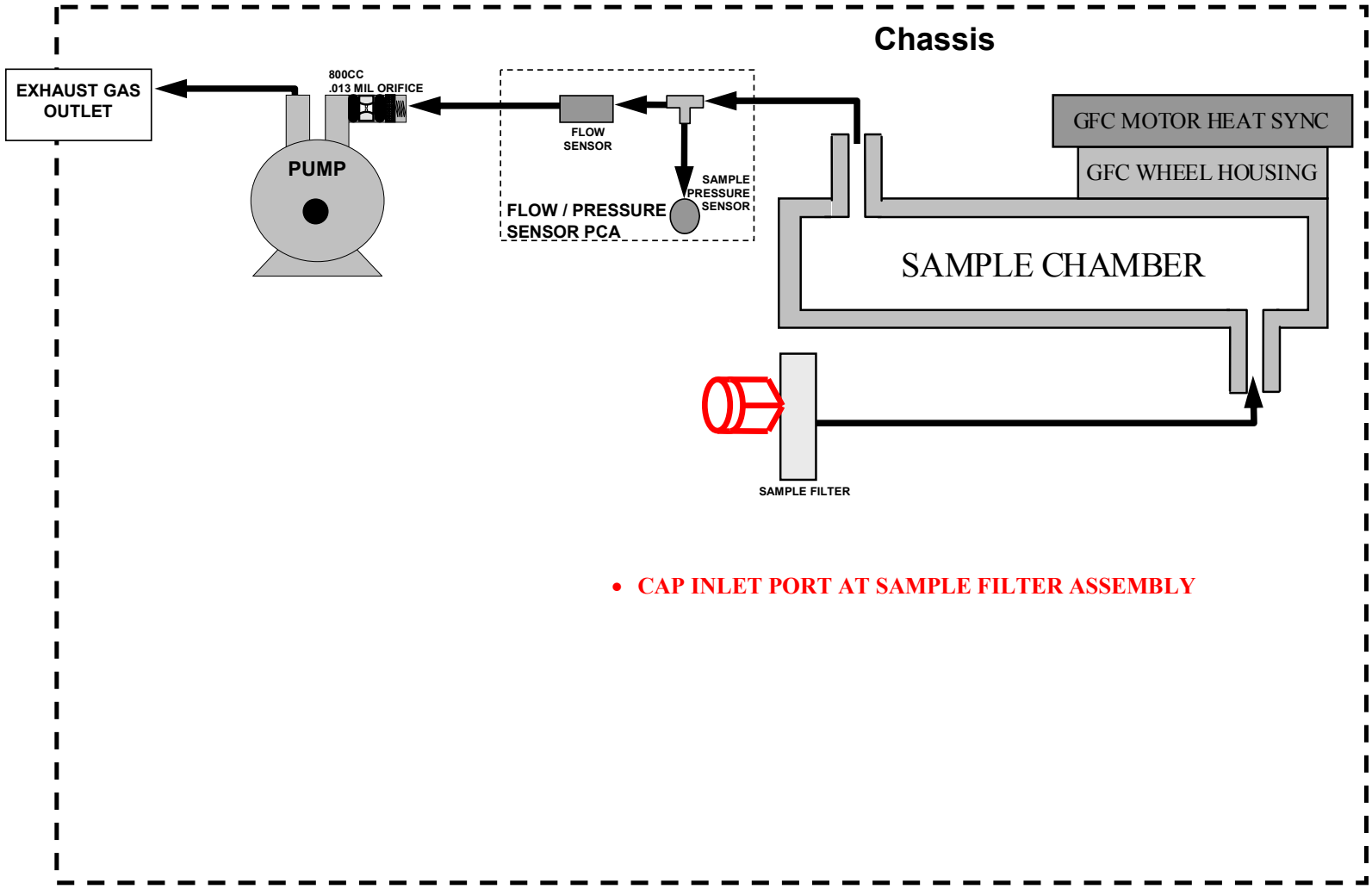


M300E / T300 Initial Leak Check

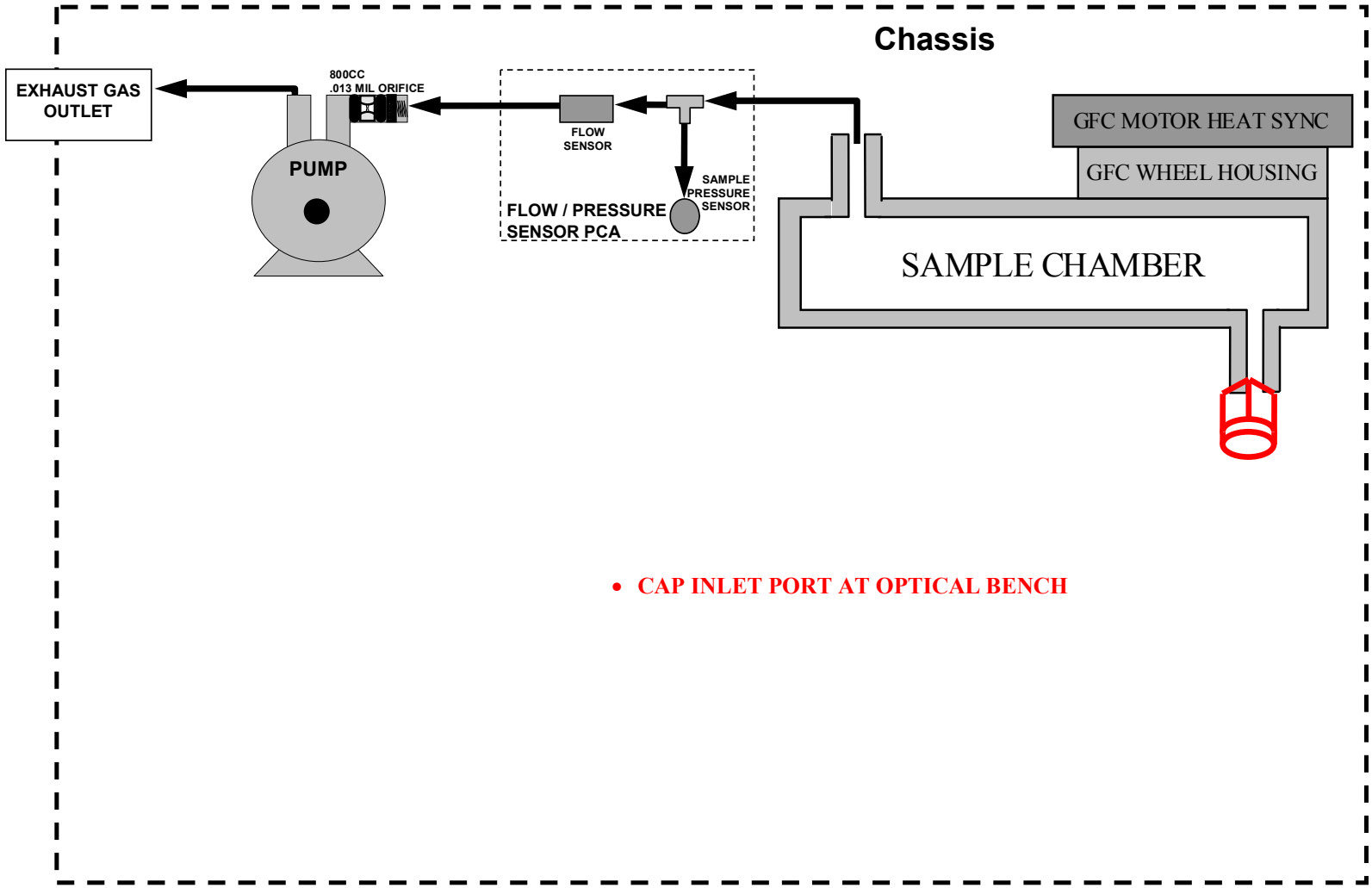
STANDARD

ZERO/SPAN

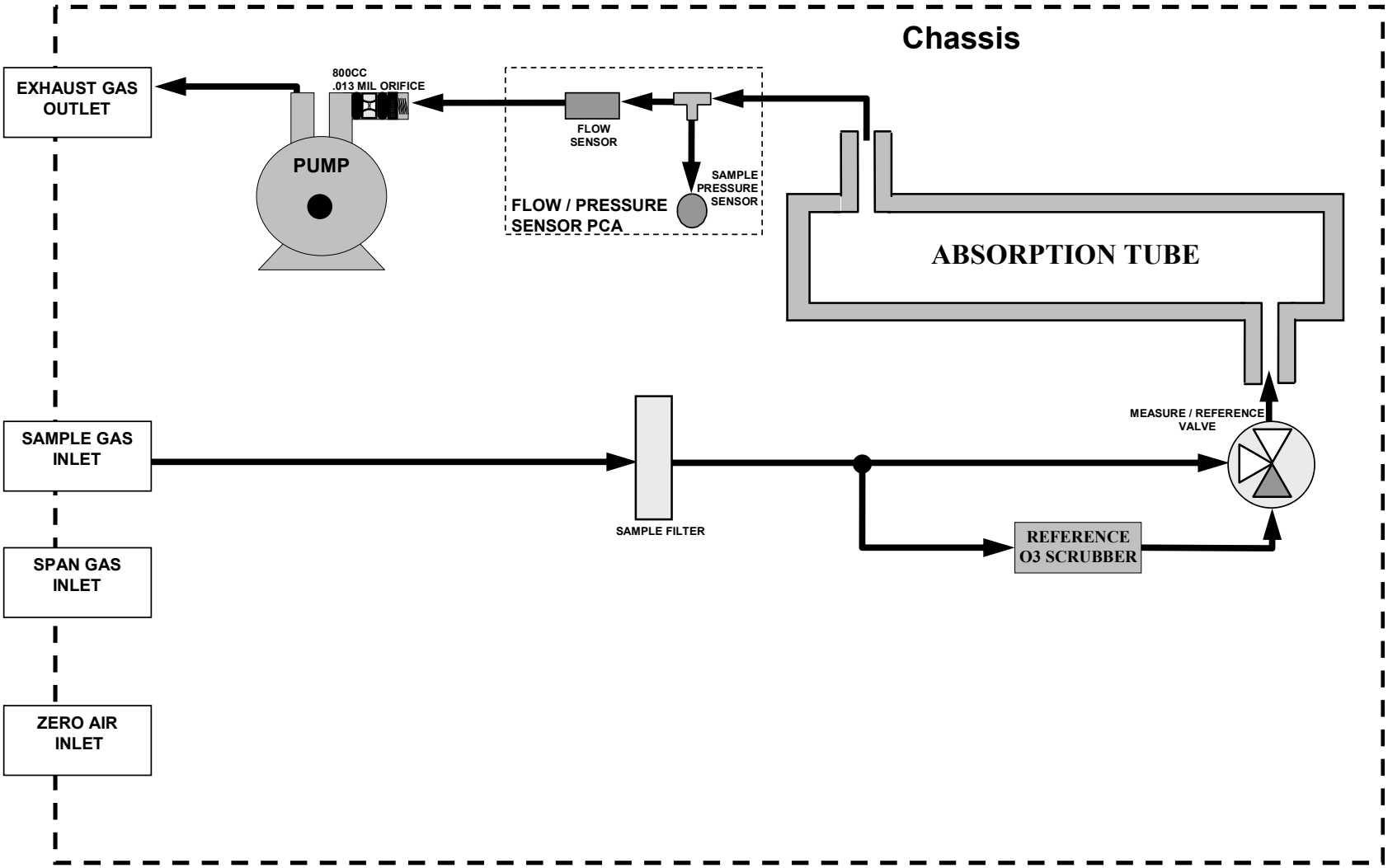
Z/S & SHUTOFF



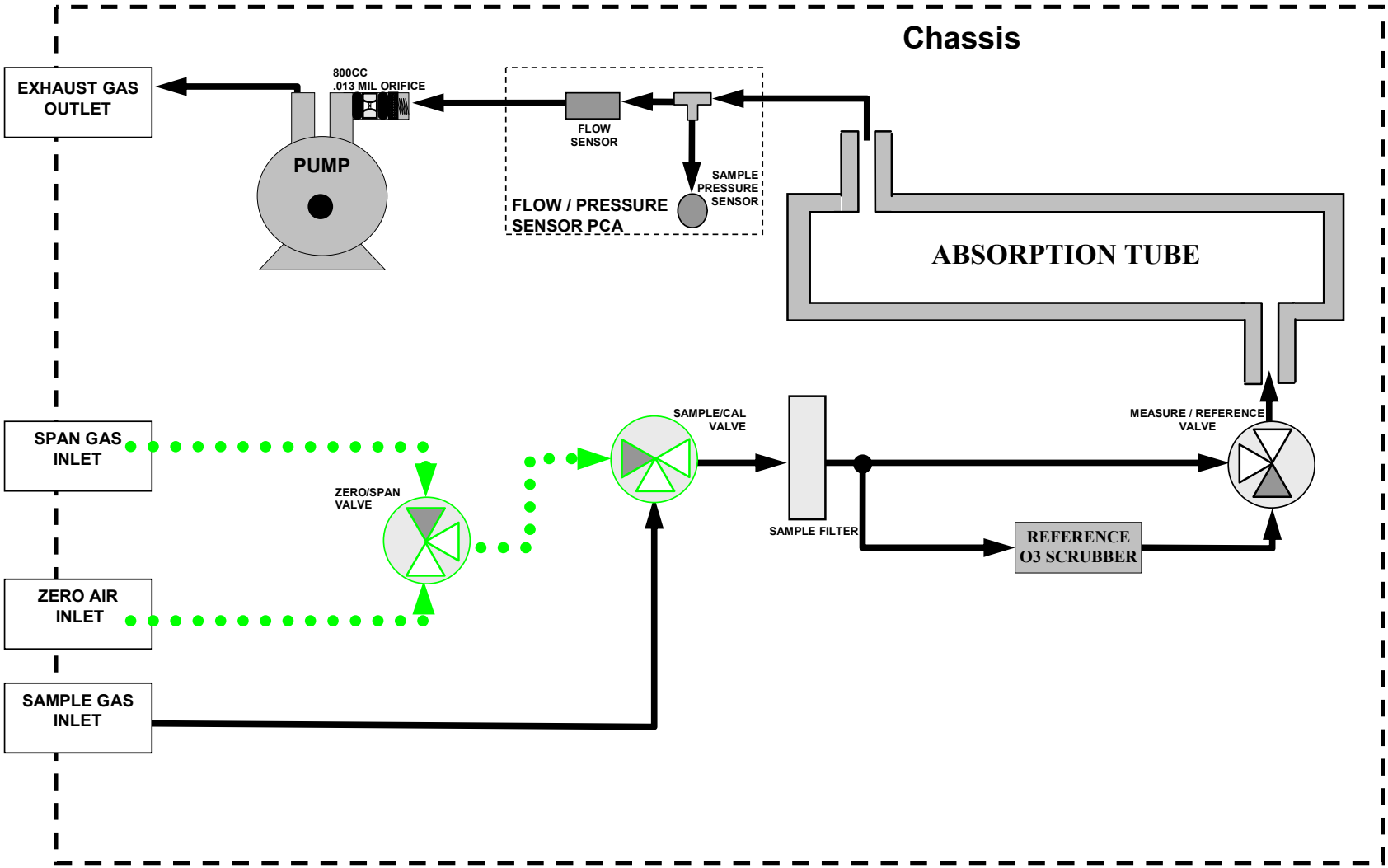
M300E / T300 Valves Bypassed



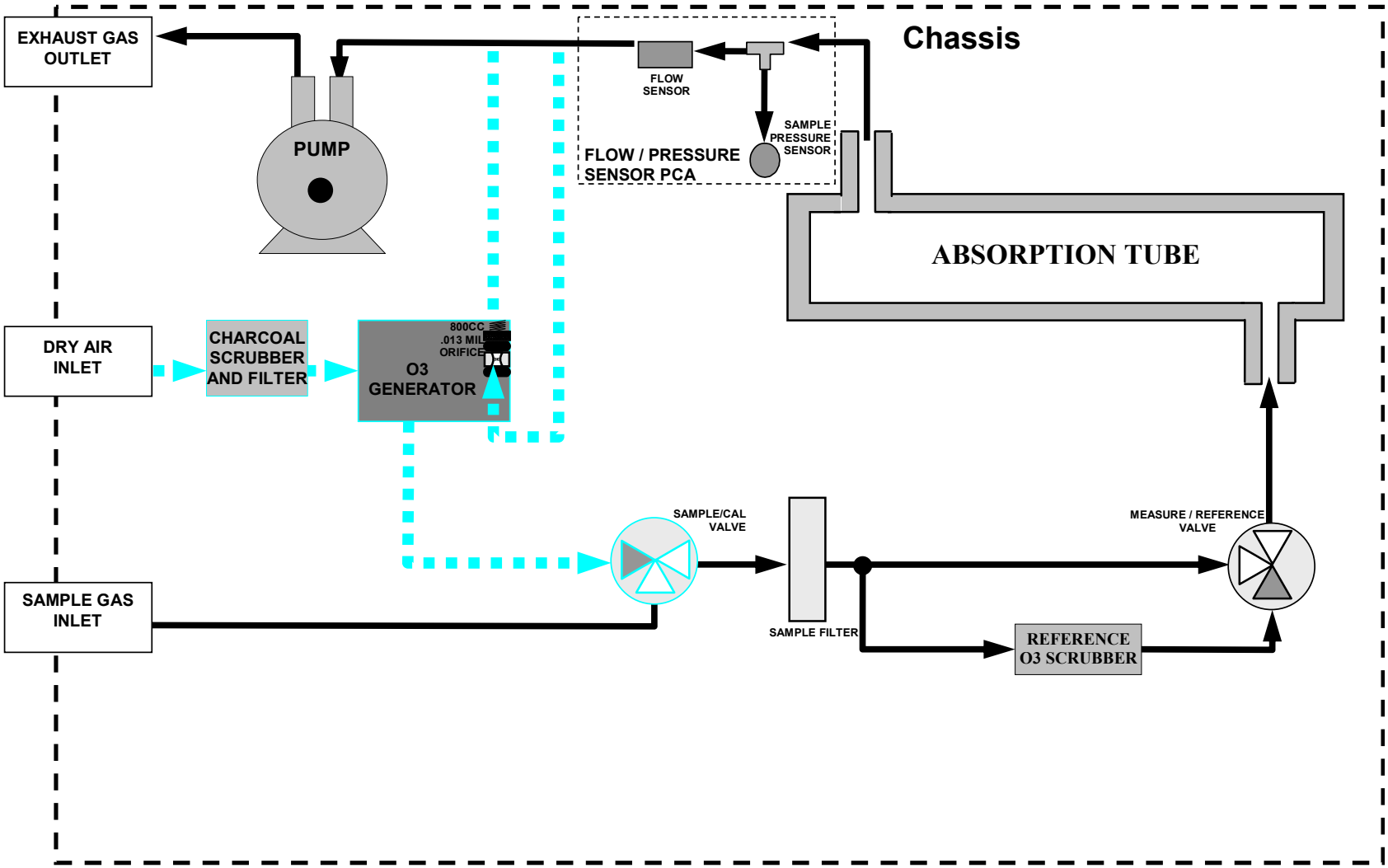
M300E / T300 Sample Filter Bypassed



M400E / T400 Standard Configuration



M400E / T400 With Valve Option

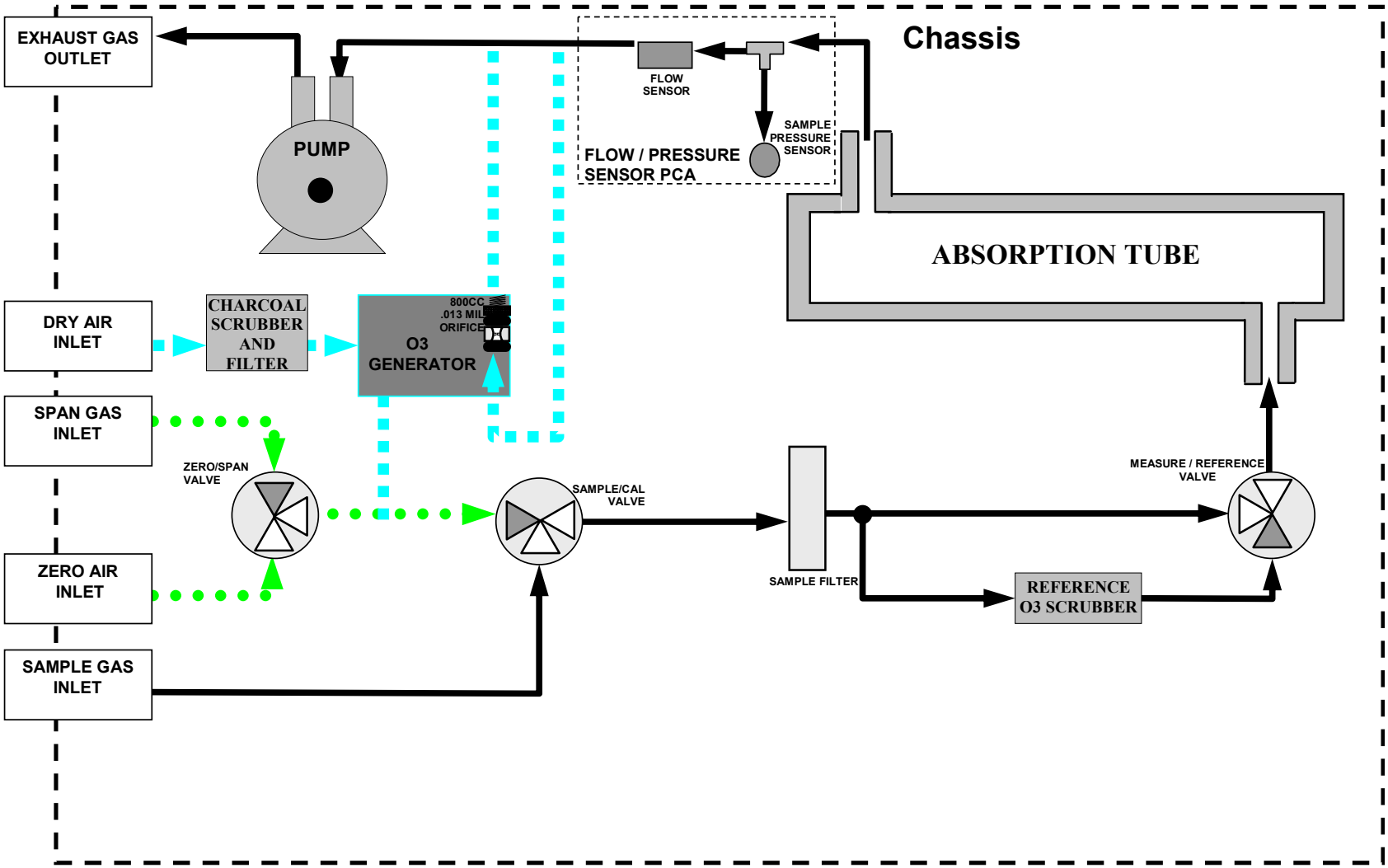


STANDARD

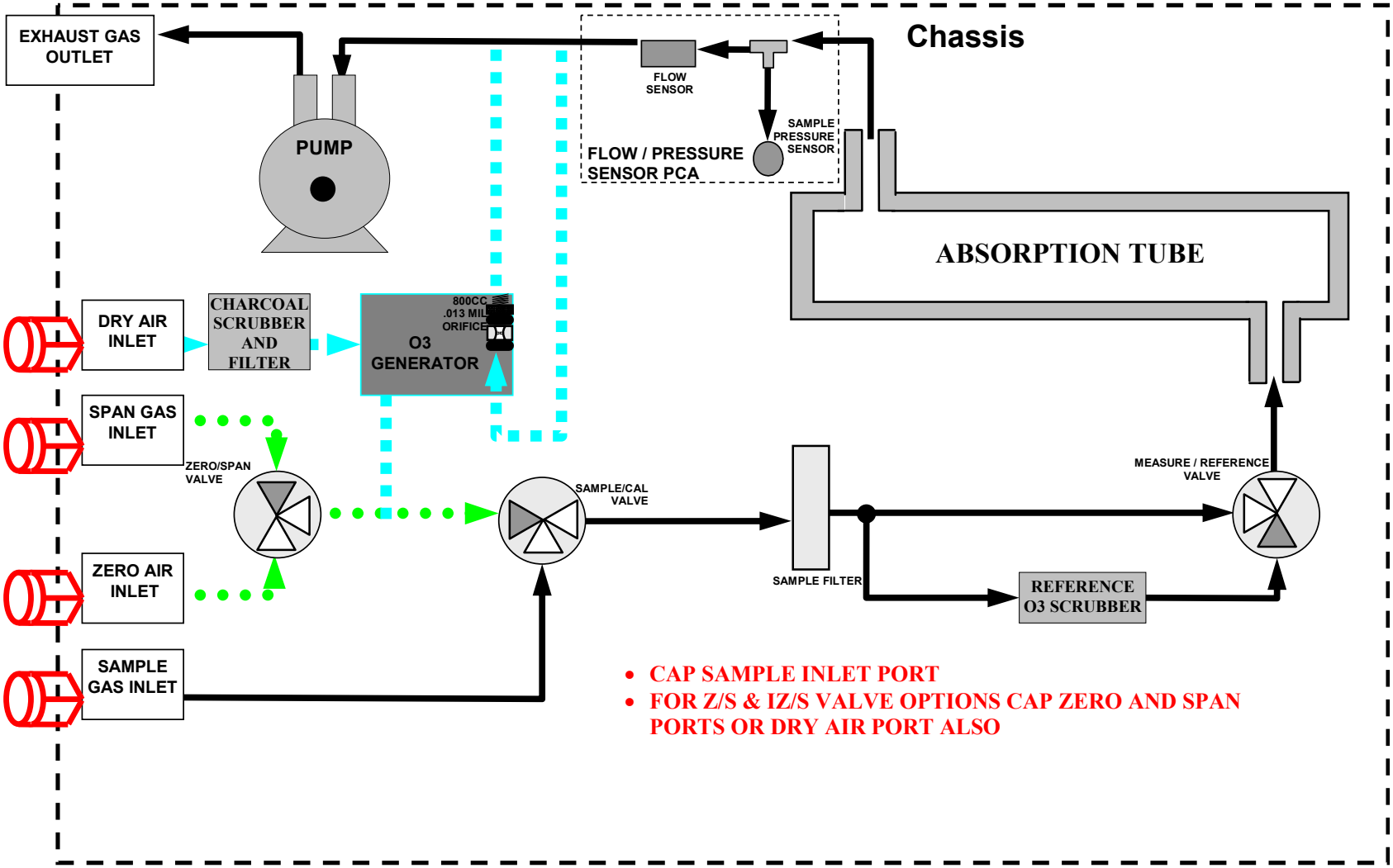
ZERO/SPAN

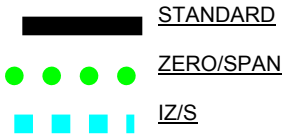
IZ/S

M400E / T400 With Internal Span/Zero Option

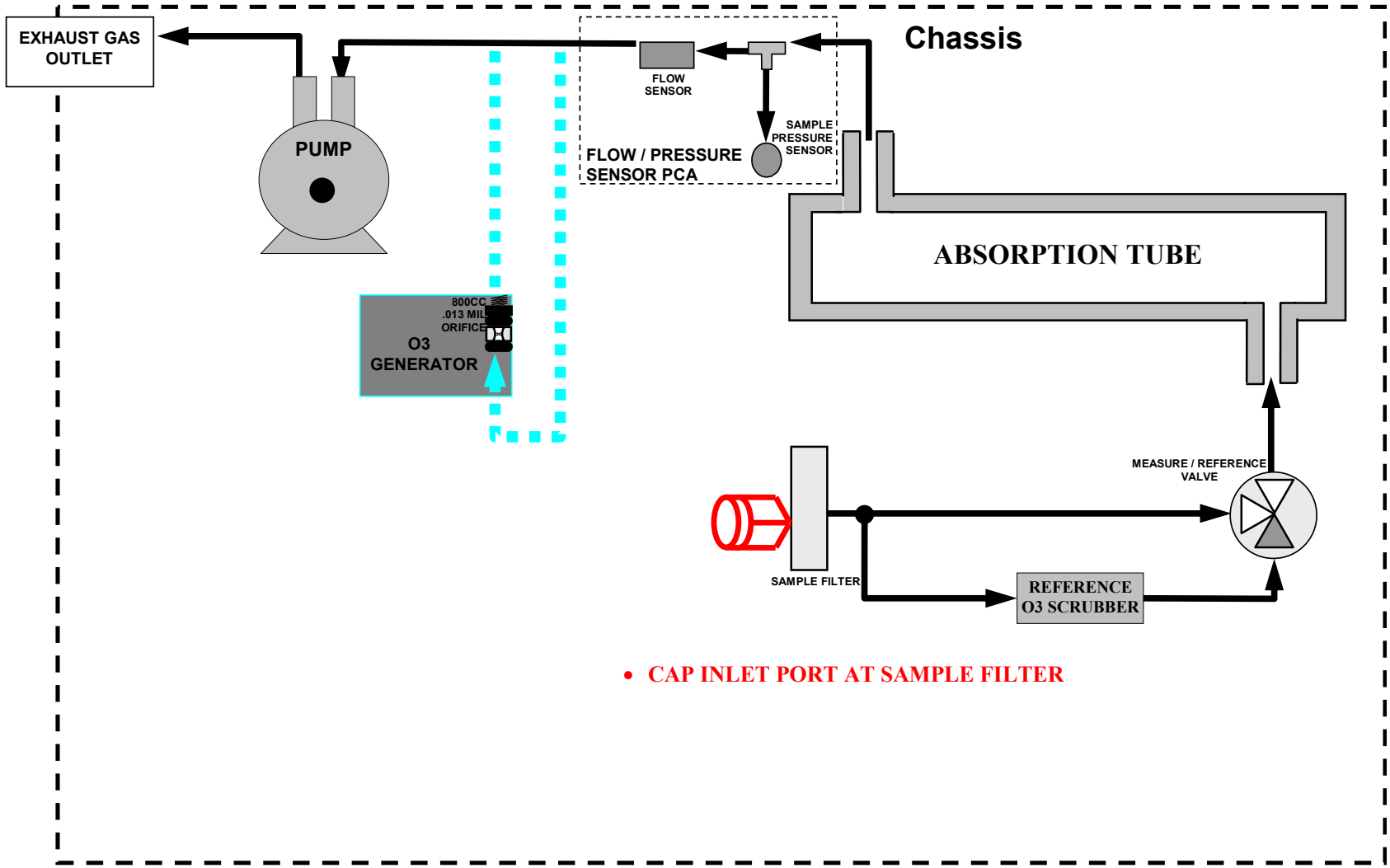


M400E / T400 Option Breakdown





M400E / T400 Initial Leak Check

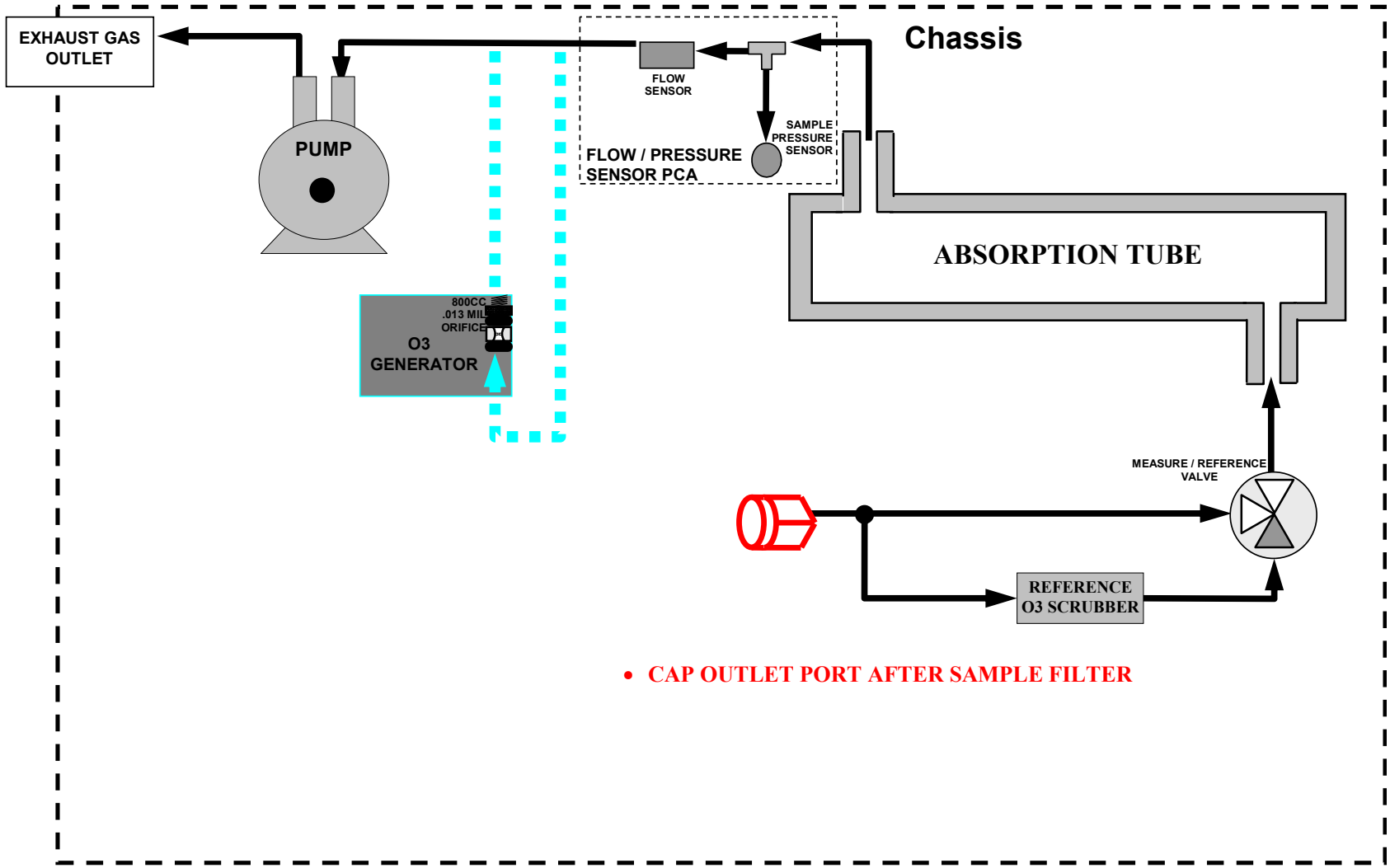


STANDARD

ZERO/SPAN

IZ/S

M400E / T400 Valves Bypassed

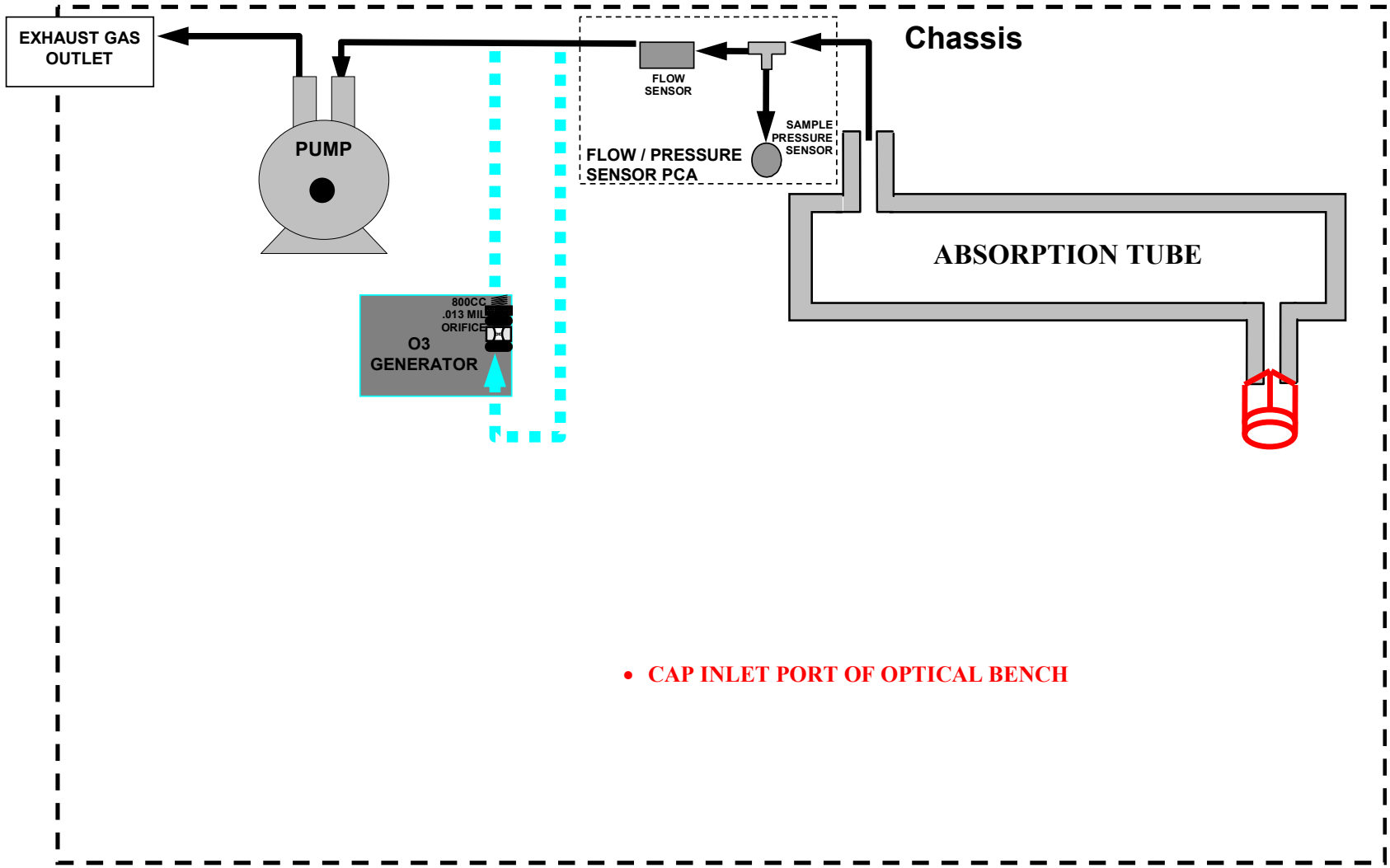


STANDARD

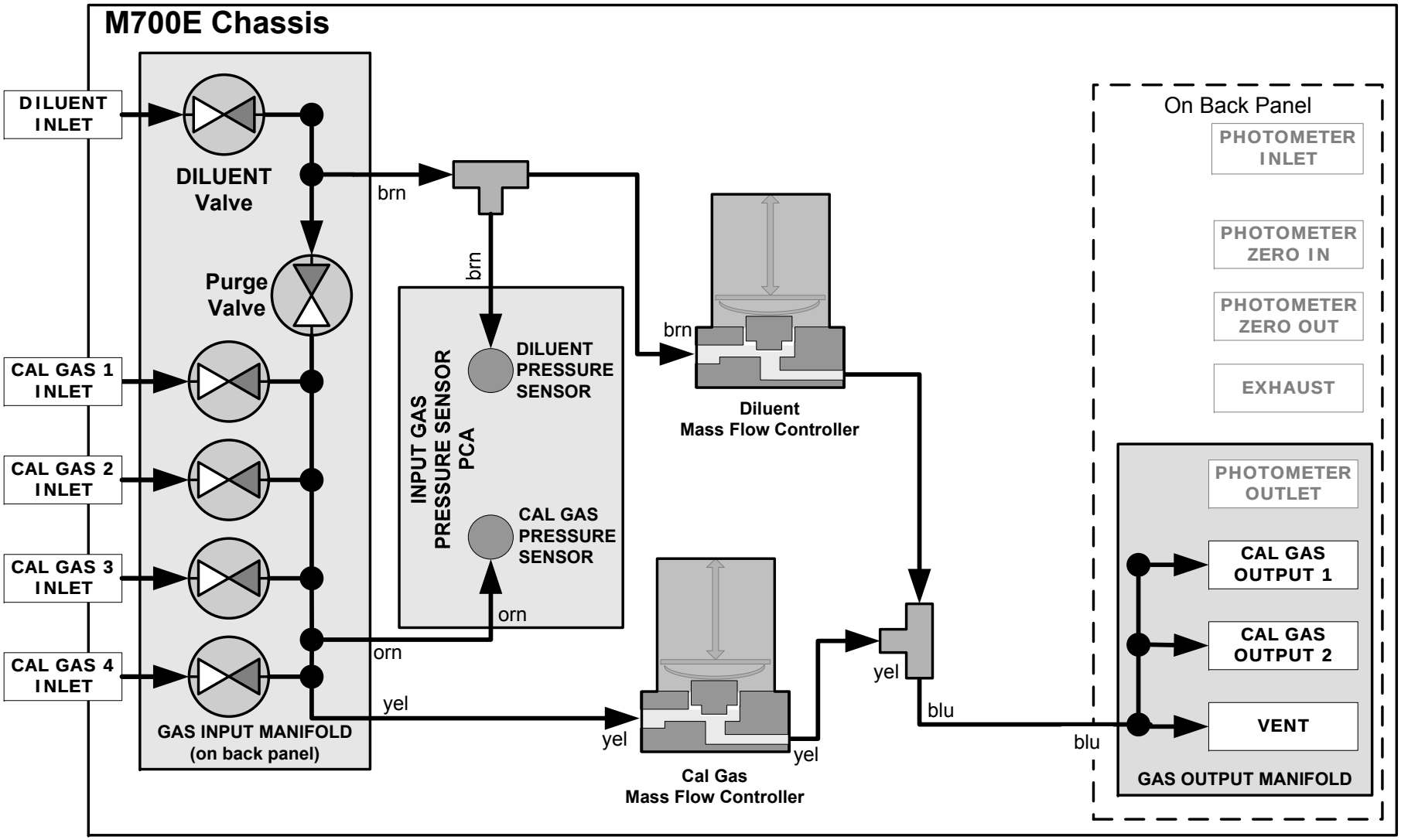
ZERO/SPAN

IZ/S

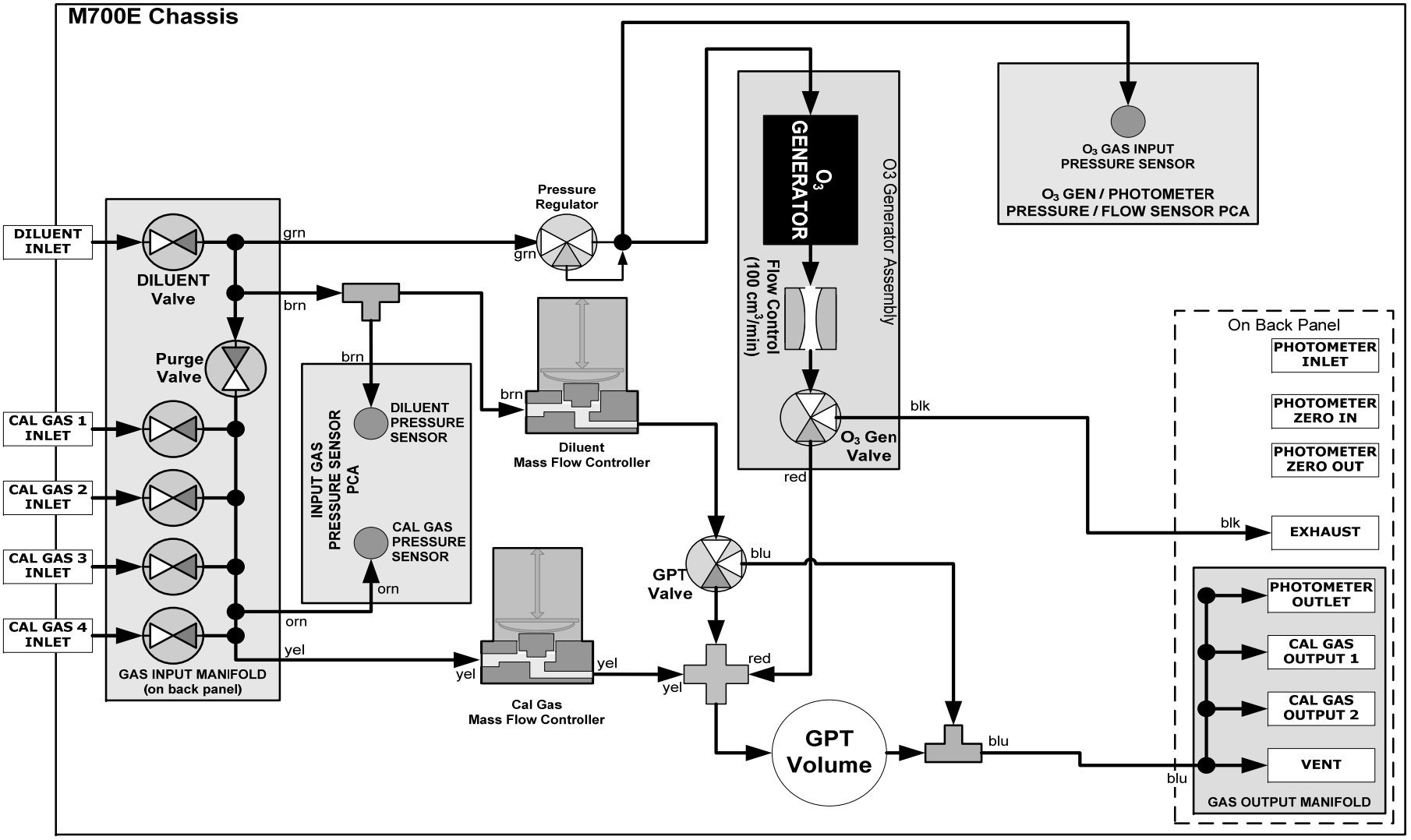
M400E / T400 Sample Filter Bypassed



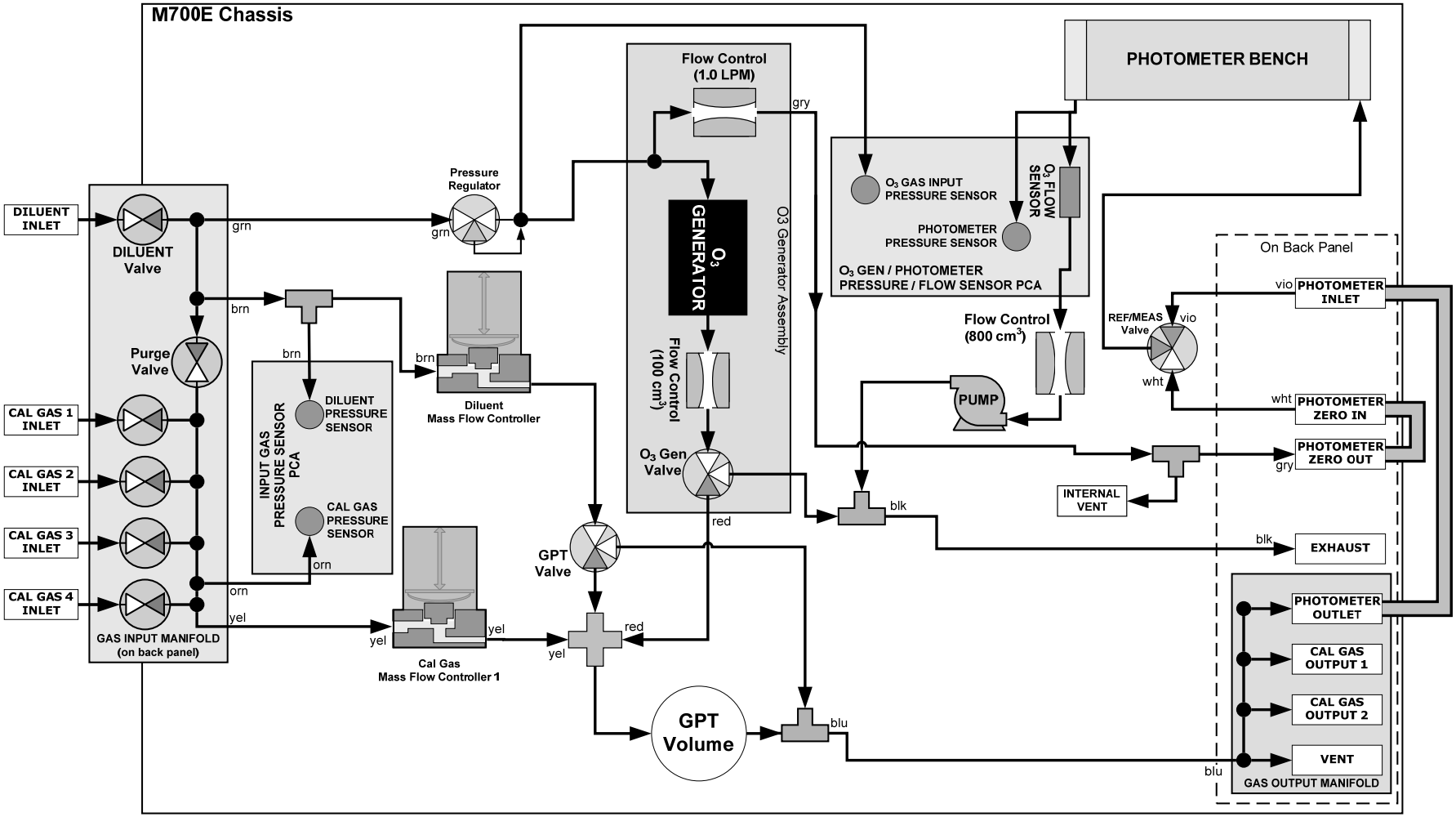
M400E / T400 Meas/Ref Valve and Scrubber Bypass



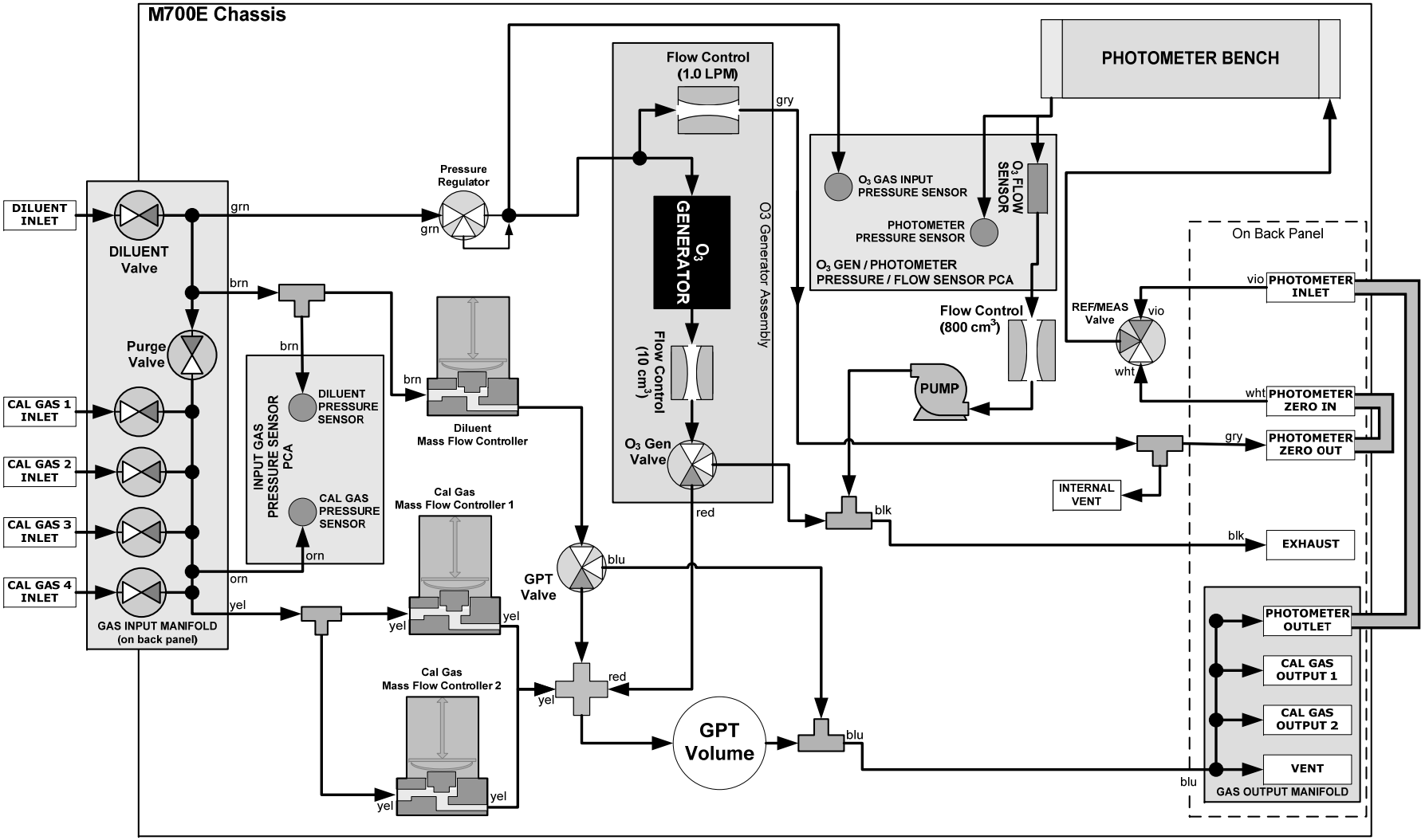
M700E / T700 Standard Configuration



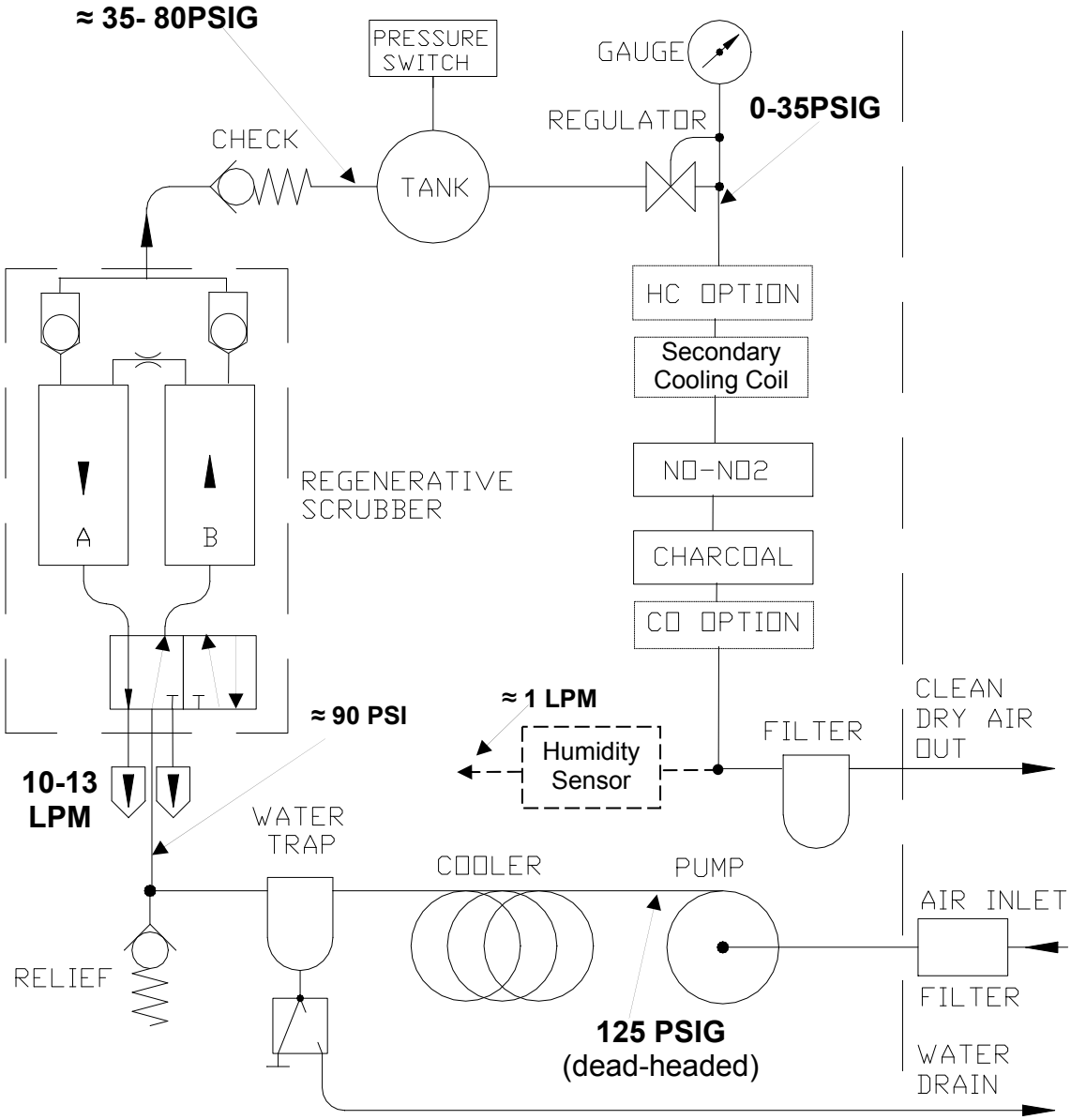
M700E / T700 With Ozone/GPT Option



M700E / T700 With Photometer Option



M700E / T700 With 2nd Cal Gas MFC and Photometer Options



M701 Zero Air Module

TELEDYNE
ADVANCED POLLUTION INSTRUMENTATION
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Service Note

99-027C
2 Nov, 2012

API LEAK CHECKERS

I. SCOPE:

To inform our customers of the availability of purchasing leak checkers from API, for use in troubleshooting your air pollution analyzers.

II. PARTS:

Deluxe leak checker	p/n 019600000 (specify power requirement)
Economy leak checker w/gauge	p/n KIT000058
Economy leak checker w/o gauge	p/n KIT000059
Zero air source t/s tool w/gauge	p/n KIT000060

III. TOOLS:

NONE

IV. PROCEDURE:

1. We have found historically that as much as 50% of the "trouble calls" that we get from customers are related to leaks in the pneumatics of the system. This can be either in the analyzer or in the sample/calibration system. One of the first checks that we do when trying to locate a problem in a system is to leak check the analyzer & the sample system to make sure that it is leak free.
2. We have three leak checkers available for purchase. The first is the deluxe model that comes in a box with a pump, gauge, toggle valve & can do vacuum & pressure. This model comes in 115/220/230 & 240 Vac models; you will have to specify what voltage you need when you purchase your leak checker.
3. The second model is the economy model that has a valve, tubing, fittings & gauge that requires you to use the pump for the instrument to do the leak check.
4. The third model has only valve, fittings & tubing that also requires you to use the pump for the instrument.
5. The fourth unit that we offer is a pressure gauge & valve assy that is vital in trouble shooting a zero air source. This unit is very similar to the construction of the economy model that has a valve, tubing, fittings & a gauge. As you are using it to trouble shoot a zero air source that has a pump, a pump for troubleshooting is not necessary.
6. All of the leak checkers that we offer come with instructions to help you use the tool & how to find leaks in your instrument.
7. If you would like more information about pricing & availability on these leak checkers please contact the API sales department.

User notes:

CHAPTER 4: ELECTRONICS (INPUTS AND OUTPUTS)

4.1 Test functions
- 4.1.1 Does the analyzer have any warnings, if so, fix the warnings first.
- 4.1.2 Are there any specs that are out of normal ranges, if yes, work these issues next.
  - 4.1.2.1 What are the specs and where can you find them. All this information is available in this manual and the main operators manual.
  - 4.1.2.2 What do the test functions do when you go to span or zero. The only ones that should change are the PMT or Measure/Reference values.
- 4.1.3 Signal I/O
  - 4.1.3.1 Turn things on and off to prove or disprove theories.

4.2 Motherboard
- 4.2.1 Inputs
  - 4.2.1.1 Control inputs
- 4.2.2 Outputs
  - 4.2.2.1 Status outputs
  - 4.2.2.2 I^2C bus, what is it?
  - 4.2.2.3 Signal I/O mV values. Ref 4096, Ref, GND, all voltages must be <4950mV.

4.3 Relay board and power supplies
- 4.3.1 Relay board
  - 4.3.1.1 Relays and power distribution
  - 4.3.1.2 Test points and status LEDs
- 4.3.2 Power Supplies
  - 4.3.2.1 Switching power supply 15V, -15V, 5V
  - 4.3.2.2 Switching power supply 12V

4.4 Center splitting
- 4.4.1 What is causing the problem, input or output?
- 4.4.2 Input known value
- 4.4.3 Turn on output on signal I/O
  - 4.4.3.1 Where is problem, (relay, heater, cable)

4.5 Follow the signal.
- 4.5.1 From a thermistor to the CPU
- 4.5.2 From the CPU to the heater.
- 4.5.3 From the TC to the CPU
- 4.5.4 From the pressure transducer to the CPU
- 4.5.5 From the pmt thermistor to the CPU

4.6 ET
- 4.6.1 Do the electric test, (relative test).
- 4.6.2 Does it mean anything? It can help find drift and/or noise in an analyzer.

4.7 OT
- 4.7.1 Do the optic test (relative test).
- 4.7.2 Does it mean anything? It can help find drift and/or noise in an analyzer.

Warranty/Repair Questionnaire T100, M100E
(04796F DCN6611)

TELEDYNE
ADVANCED POLLUTION INSTRUMENTATION
Everywhereyoulook™

CUSTOMER: _____ PHONE: _____
CONTACT NAME: _____ FAX NO. _____
SITE ADDRESS: _____
MODEL 100 SERIAL NO.: _____ FIRMWARE REVISION: _____
1. ARE THERE ANY FAILURE MESSAGES? _____
_____

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

Parameter	Recorded Value	Acceptable Value
RANGE	PPB/PPM	50 PPB to 20 PPM
STABIL	PPB	≤1 PPB WITH ZERO AIR
SAMP PRESS	IN-HG-A	~ 2" < AMBIENT
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 4800 mV
LAMP RATIO	mV	30 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 – 900
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 ± 1000
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

2. WHAT IS THE SAMPLE FLOW & SAMPLE PRESSURE W/SAMPLE INLET ON REAR OF MACHINE CAPPED?
   SAMPLE FLOW -_____CC **SAMPLE PRESS** - _____IN-HG-A
3. WHAT ARE THE FAILURE SYMPTOMS_____
4. WHAT TEST HAVE YOU DONE TRYING TO SOLVE THE PROBLEM? _____
5. IF POSSIBLE, PLEASE INCLUDE A PORTION OF A STRIP CHART PERTAINING TO THE PROBLEM. CIRCLE PERTINENT DATA. THANK YOU FOR PROVIDING THIS INFORMATION. YOUR ASSISTANCE ENABLES TELEDYNE API TO RESPOND FASTER TO THE PROBLEM THAT YOU ARE ENCOUNTERING.

Warranty/Repair Questionnaire
T200 and M200E
(04503E, DCN6611)

TELEDYNE
ADVANCED POLLUTION INSTRUMENTATION
Everywhereyoulook™

CUSTOMER: _____ PHONE: _____
CONTACT NAME: _____ FAX NO. _____
SITE ADDRESS: _____
MODEL 100E SERIAL NO.: _____ FIRMWARE REVISION: _____
1. ARE THERE ANY FAILURE MESSAGES? _____
_____

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

PARAMETER	RECORDED VALUE	ACCEPTABLE VALUE
RANGE	PPB/PPM	50 PPB TO 20 PPM
NOx STAB	PPB/PPM	≤ 1 PPB WITH ZERO AIR
SAMPLE FLOW	CM^3	500 ± 50
OZONE FLOW	CM^3	80 ± 15
PMT SIGNAL WITH ZERO AIR	MV	-20 TO 150
PMT SIGNAL AT SPAN GAS CONC	MV PPB	0-5000MV 0-20,000 PPB
NORM PMT SIGNAL AT SPAN GAS CONC	MV PPB	0-5000MV 0-20000PPB
AZERO	MV	-20 TO 150
HVPS	V	400 – 900
RCELL TEMP	ºC	50 ± 1
BOX TEMP	ºC	AMBIENT ± 5ºC
PMT TEMP	ºC	7 ± 2ºC
IZS TEMP*	ºC	50 ± 1ºC
MOLY TEMP	ºC	315 ± 5ºC
RCEL PRESS	IN-HG-A	<10
SAMP PRESS	IN-HG-A	~ 1" < AMBIENT
NOx SLOPE		1.0 ± 0.3
NOx OFFSET		-50 TO 150
NO SLOPE		1.0 ± 0.3
NO OFFSET		-50 TO 150
ETEST	PMT MV	2000 ± 1000
OTEST	PMT MV	2000 ± 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

2. WHAT IS THE SAMPLE FLOW & SAMPLE PRESSURE W/SAMPLE INLET ON REAR OF MACHINE CAPPED?
SAMPLE FLOW -_____CC **SAMPLE PRESS** - _____IN-HG-A
3. WHAT ARE THE FAILURE SYMPTOMS_____
4. WHAT TEST HAVE YOU DONE TRYING TO SOLVE THE PROBLEM? _____
5. IF POSSIBLE, PLEASE INCLUDE A PORTION OF A STRIP CHART PERTAINING TO THE PROBLEM. CIRCLE PERTINENT DATA. THANK YOU FOR PROVIDING THIS INFORMATION. YOUR ASSISTANCE ENABLES TELEDYNE API TO RESPOND FASTER TO THE PROBLEM THAT YOU ARE ENCOUNTERING.

Warranty/Repair Questionnaire
T300/T300M & M300E/EM
(04305H DCN6611)

TELEDYNE ADVANCED POLLUTION INSTRUMENTATION
Everywhereyoulook™

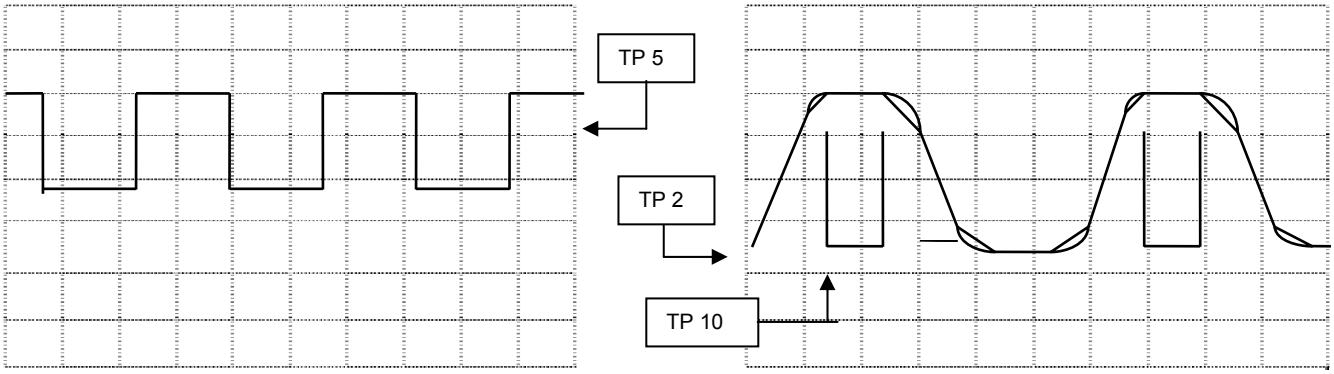
CUSTOMER: _____ PHONE: _____
CONTACT NAME: _____ FAX NO. _____
SITE ADDRESS: _____
MODEL 100E SERIAL NO.: _____ FIRMWARE REVISION: _____
1. ARE THERE ANY FAILURE MESSAGES? _____
PLEASE COMPLETE THE FOLLOWING TABLE: ***(NOTE: DEPENDING ON OPTIONS INSTALLED, NOT ALL TEST PARAMETERS SHOWN BELOW WILL BE AVAILABLE IN YOUR INSTRUMENT)***

PARAMETER	DISPLAYED AS	OBSERVED VALUE	NOMINAL RANGE
Range	Range	PPM, MGM[1,2] PPB, UGM[1]	1 – 1000 PPM[1] 5 – 5000 PPM[2]
Stability	STABIL	PPM	<1.0 PPM @ Zero Air
CO Measure	CO MEAS	mV	2500 – 4800 MV
CO Reference	CO REF	mV	2500 – 4800MV
Measure/Reference Ratio	MR RATIO	–	1.1 – 1.3 W/ Zero Air
Pressure	PRES	In-Hg-A	-2" <Ambient Absolute
Sample Flow	SAMP FL	cm^3/min	800 ± 10%
Sample Temp	SAMPLE TEMP	°C	48 ± 4
Bench Temp	BENCH TEMP	°C	48 ± 2
Wheel Temp	WHEEL TEMP	°C	68 ± 2
Box Temp	BOX TEMP	°C	~ Ambient + 7
Photo Drive	PHT DRIVE	mV	250 mV – 4750 mV
Slope of CO Measurement	CO SLOPE	–	1.0 ± .3
Offset of CO Measurement	CO OFFSET	PPM	0 ± 0.3
Dark Cal Reference signal	REF DARK OFFSET	mV	125 ± 50 mV
Dark Cal Measurement Signal	MEAS DARK OFFSET	mV	125 ± 50 mV
Electric Test		PPM	40 ± 2 PPM

[1] T300, M300E [2] T300M, M300EM

2. WHAT IS THE SAMPLE FLOW & SAMPLE PRESSURE WITH THE SAMPLE IN-LET CAPPED?
SAMPLE FLOW- _____CC **SAMPLE PRESSURE** - _____ IN-HG-A

3. LOOK FOR THE SIGNALS ANNOTATED ON THE DIAGRAM. WHAT ARE THE PEAK-TO-PEAK VOLTAGES?



2v/DIV 10 mS 2v/DIV .5 mS

4. WHAT TEST HAVE YOU DONE TRYING TO SOLVE THE PROBLEM? _____
5. IF POSSIBLE, PLEASE INCLUDE A PORTION OF A STRIP CHART PERTAINING TO THE PROBLEM. CIRCLE PERTINENT DATA. THANK YOU FOR PROVIDING THIS INFORMATION. YOUR ASSISTANCE ENABLE TELEDYNE API TO RESPOND FASTER TO THE PROBLEM THAT YOU ARE ENCOUNTERING.

Warranty/Repair Questionnaire T400, M400E (04404E, DCN6595)	TELEDYNE ADVANCED POLLUTION INSTRUMENTATION Everywhereyoulook™

CUSTOMER: _____ PHONE: _____
CONTACT NAME: _____ FAX NO. _____
SITE ADDRESS: _____
MODEL 100E SERIAL NO.: _____ FIRMWARE REVISION: _____
1. ARE THERE ANY FAILURE MESSAGES? _____
_____

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

PARAMETER	RECORDED VALUE	ACCEPTABLE VALUE
RANGE	PPB/PPM	1 – 10,000 PPB
STABIL		<= 1.0 PPB 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

[1] If IZS valve option installed.

2. WHAT IS THE SAMPLE FLOW AND SAMPLE PRESSURE WITH THE SAMPLE INLET ON REAR OF MACHINE CAPPED?
   SAMPLE FLOW - _____cm^3/MIN **SAMPLE PRESSURE** - _____IN-HG-
3. WHAT ARE THE FAILURE SYMPTOMS?_____
   _____
   _____
   _____
   _____
4. IF POSSIBLE, PLEASE INCLUDE A PORTION OF A STRIP CHART PERTAINING TO THE PROBLEM. CIRCLE THE PERTINENT DATA.
5. THANK YOU FOR PROVIDING THIS INFORMATION. YOUR ASSISTANCE ENABLES TELEDYNE API TO RESPOND FASTER TO THE PROBLEM THAT YOU ARE ENCOUNTERING.

Warranty/Repair Questionnaire
T700, M700E
(05625C DCN6611)

TELEDYNE
ADVANCED POLLUTION INSTRUMENTATION
Everywhereyoulook™

CUSTOMER: _____ PHONE: _____
CONTACT NAME: _____ FAX NO. _____
SITE ADDRESS: _____
MODEL 700E SERIAL NO.: _____ FIRMWARE REVISION: _____
1. ARE THERE ANY FAILURE MESSAGES? _____
PLEASE COMPLETE THE FOLLOWING TABLE: (**NOTE**: ***DEPENDING ON OPTIONS INSTALLED, NOT ALL TESTS PARAMETERS BELOW WILL BE AVAILABLE IN YOUR INSTRUMENT***)

PARAMETER		RECORDED VALUE	ACCEPTABLE VALUE
Name in E-Series software versions prior to v.C.1.	Name in T-Series and in E-Series w/software v. D.3 and higher		
ACT CAL	A-CAL	LPM*	TARG CAL ± 1%
TARG CAL	T-CAL	LPM*	0.001 – 0.100 SLPM
ACT DIL	A-DIL	LPM*	TARG DIL ± 1%
TARG DIL	T-DIL	LPM*	0.01 – 10 SLPM
O3 GEN REF [1]	O3GENREF [1]	mV	0 – 5000mV
O3 FLOW [1]	O3FLOW [1]	LPM*	0.100 ± 0.025 SLPM
O3 GEN DRIVE [1]	O3GENDRV [1]	mV	0 – 5000mV
O3 LAMP TEMP [1]	O3LAMPTMP [1]	ºC	48 ± 1ºC
CAL PRESSURE	CAL PRES	PSI	25 – 35PSI
DIL PRESSURE	DIL PRES	PSI	25 – 35PSI
REG PRESSURE [1]	REG PRES [1]	PSI	20 ± 1PSI
ACT	(n/a)		TARG ± 1%
(n/a)	A-GAS		T-GAS ± 1%
(n/a)	T-GAS		
(n/a)	A-O3 [1]		T-O3 ± 1%
(n/a)	T-O3 [1]		
TARG	(n/a)		
(n/a)	T-FLW	LPM*	
BOX TEMP	BOX TMP	ºC	AMBIENT ± 5ºC
PERM TUBE #1 TEMP [3]	PERM1 TMP [3]	ºC	50 ± 1ºC
PERM FLOW [3]	PERM FLW [3]	LPM*	0.100 ± 0.025 SLPM
PHOTO MEASURE [2]	PH MEAS [2]	mV	2500 – 4800mV
PHOTO REFERENCE [2]	PH REF [2]	mV	2500 – 4800mV
PHOTO FLOW [2]	PH FLW [2]	LPM	0.720 – 0.880LPM
PHOTO LAMP TEMP [2]	PH LTEMP [2]	ºC	58 ± 1ºC
PHOTO SPRESS [2]	PH PRES [2]	IN-HG	~ 1 IN-HG < AMBIENT
PHOTO STEMP [2]	PH STEMP [2]	ºC	AMBIENT ± 3ºC
PHOTO SLOPE [2]	PH SLOPE [2]		0.85-1.15
PHOTO OFFSET [2]	PH OFFST [2]	PPB	0 ±10 PPB

[1] If ozone generator option installed. [2] If photometer option installed. [3] If permeation tube installed. *Standard flow

What is measured photometer flow rate? _____cc/min. What is measured O3 generator flow rate? _____cc/min
What is the pressure change during the AUTO LEAK check procedure? _____psi What are the failure symptoms?

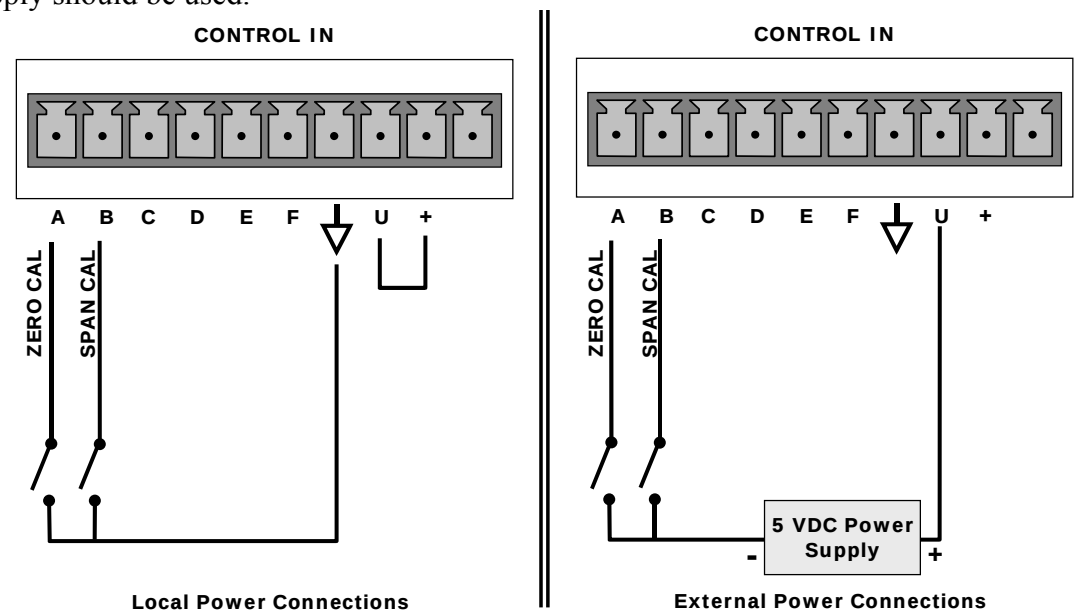
_____
What tests have you done trying to solve the problem? _____
Thank you for providing this information. Your assistance enables Teledyne Instruments to respond faster to the problem that you are encountering.

4.2 Motherboard

4.2.1 Inputs

Connecting the Control Inputs

If you wish to use the analyzer to remotely activate the zero and span calibration modes, several digital control inputs are provided through a 10-pin connector labeled CONTROL IN on the analyzer's rear panel. There are two methods for energizing the control inputs. The internal +5V available from the pin labeled "+" is the most convenient method. However, if full isolation is required, an external 5 VDC power supply should be used.



Control Input Connector Figure

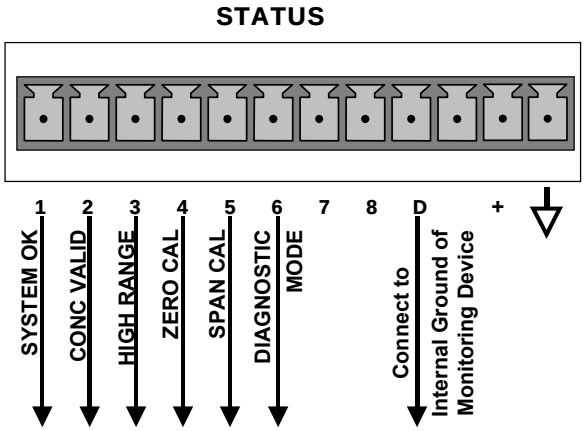
Control Input Signals Table

INPUT #	STATUS DEFINITION	ON CONDITION
A	**REMOTE ZERO CAL**	The analyzer is placed in Zero Calibration mode. The mode field of the display will read ZERO CAL R.
B	**REMOTE SPAN CAL**	The analyzer is placed in span calibration mode as part of performing a low span (midpoint) calibration. The mode field of the display will read LO CAL R.
C, D, E & F	**SPARE**	
⏚	**Digital Ground**	The ground level from the analyzer's internal DC power supplies (same as chassis ground)
U	**External Power input**	Input pin for +5 VDC required to activate pins A – F.
+	**5 VDC output**	Internally generated 5V DC power. To activate inputs A – F, place a jumper between this pin and the "U" pin. The maximum amperage through this port is 300 mA (combined with the analog output supply, if used).

4.2.2 Outputs

Status Outputs

The analyzer's status outputs are accessed through a 12 pin connector on the analyzer's rear panel labeled STATUS. They are used to interface with a device that accepts closed-contact digital inputs, such as programmable logic controllers (PLC's).



Status Output Connector Figure

NOTE

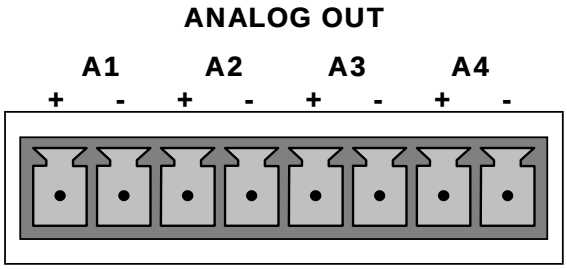
Most PLC's have internal provisions for limiting the current the input will draw. When connecting to a unit that does not have this feature, external resistors must be used to limit the current through the individual transistor outputs to ≤50mA (120 Ω for 5V supply).

Status Output Signals

REAR PANEL LABEL	STATUS DEFINITION	CONDITION
1	**SYSTEM OK**	ON if no faults are present.
2	**CONC VALID**	OFF any time the HOLD OFF feature is active, such as during calibration or when other faults exist possibly invalidating the current concentration measurement (example: sample flow rate is outside of acceptable limits). ON if concentration measurement is valid.
3	**HIGH RANGE**	ON if unit is in high range of the AUTO Range Mode
4	**ZERO CAL**	ON whenever the instrument's ZERO point is being calibrated.
5	**SPAN CAL**	ON whenever the instrument's SPAN point is being calibrated.
6	**DIAG MODE**	ON whenever the instrument is in DIAGNOSTIC mode
7 - 8	**SPARE**	
D	**EMITTER BUS**	The emitters of the transistors on pins 1-8 are bussed together.
	SPARE	
+	**DC POWER**	+ 5 VDC, 300 mA source (combined rating with Control Output, if used).
▽	**Digital Ground**	The ground level from the analyzer's internal DC power supplies

Analog Outputs

A strip chart recorder and/or data-logger can be attached to the appropriate contacts of the analog output connecter on the rear panel of the analyzer. These outputs can be set for 0 to 0.1V, 1V, 5V, or 10V. They can also be set up for 4-20mA.



Analog Output Connector

Analog output Pin Outs

PIN	ANALOG OUTPUT	VOLTAGE OUTPUT	CURRENT LOOP OPTION
1	**A1**	V Out	I Out +
2		Ground	I Out -
3	**A2**	V Out	I Out +
4		Ground	I Out -
5	**A3**	V Out	I Out +
6		Ground	I Out -
7	**A4**	V Out	Current not available on A4
8		Ground	Current not available on A4

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Service Note

03-020C
2 Nov, 2012

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.

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Service Note

03-028E
18 October, 2012

TROUBLESHOOTING THE I^2C BUS

I. PURPOSE:
To go through the analyzer systematically and locate which board is bringing down the I^2C bus

II. TOOLS:
None

III. PARTS:
Service Note 02-032

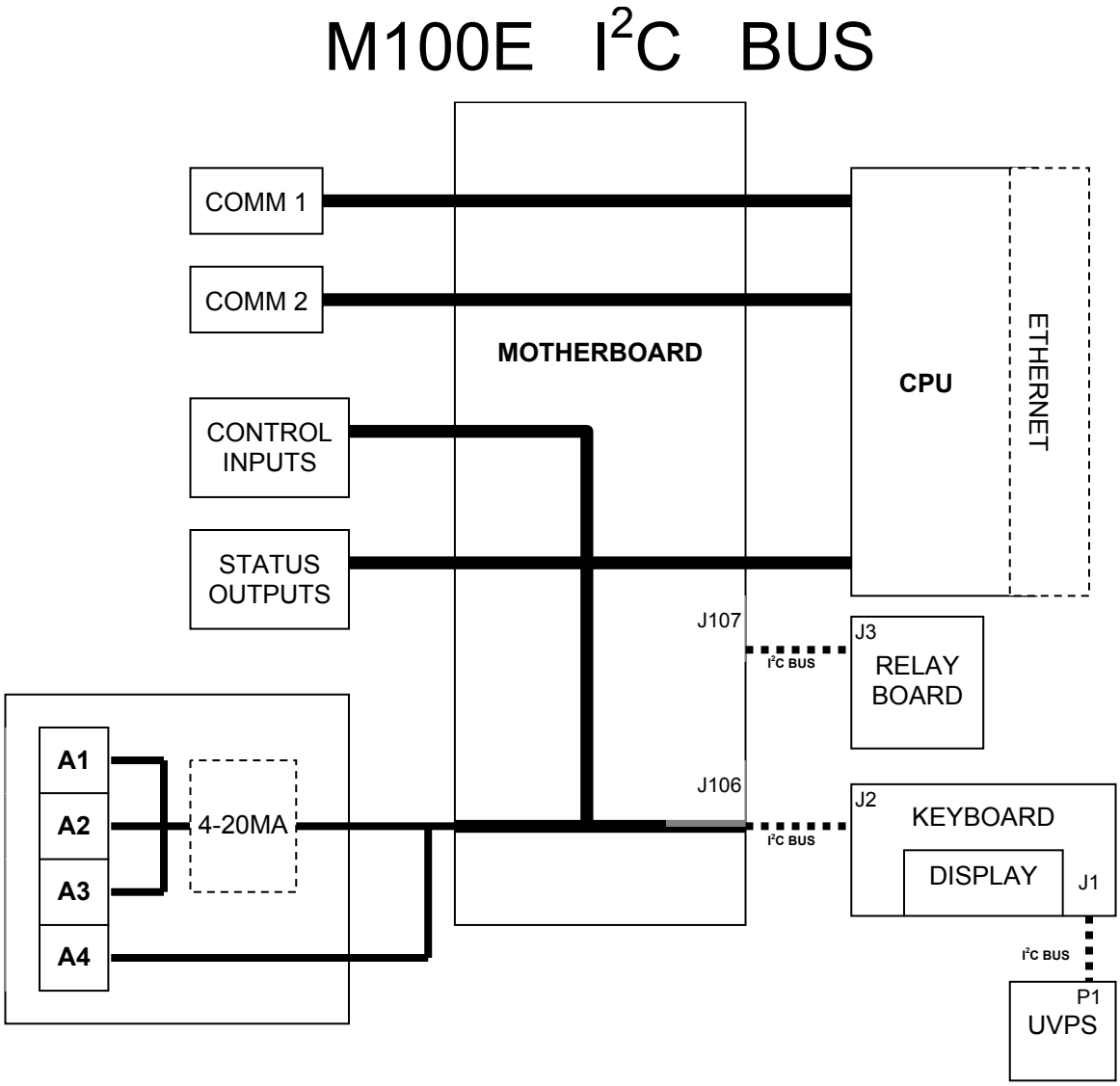
IV. PROCEDURE:

1. If you have an I^2C bus failure you may see the display read invalid characters, it will be locked up, blank, just a cursor in the upper left hand corner and/or the LEDs on the relay board will all be off.
2. Before you get started you will need to check the 5VDC power. To check the 5VDC power, refer to Teledyne API Service Note 02-032A
3. The important part of troubleshooting the I^2C bus is to know where it goes in the analyzer you are working on. The illustrations in the following pages outline the I^2C path for models 100, 200, 300, 400, 700, and 703 E and T Series instruments.
4. Another important part of trouble shooting the I^2C bus is to observe the flashing bright blue SDA LED (DS5) and SCL LED (DS7) on the motherboard. Watch these LED's and make sure that they are blinking at a steady pace. If these LED's are blinking, it means that the CPU is operating correctly. If these LED's are not blinking at a steady constant rate, either the CPU board, motherboard, or cables are bad or there is a problem in the software.
5. If the unit has failed in this manner you first need to turn off power to the unit and reseat all of the cables going to the motherboard. Turn the unit back on and see if it remedies the problem. If it does not, turn the power back off and remove the CPU from the motherboard and wait 2 minutes. Then, reinstall the CPU back onto the motherboard and see if it fixes the problem. If it doesn't, you will need to swap out either the DOC/DOM on the CPU, the entire CPU assembly, or Motherboard to find the problem part.
6. If the DOC/DOM, the CPU or Motherboard isn't the problem, start trouble shooting the I^2C bus by unplugging the connectors in reverse order. Remember to power down the analyzers before connecting / disconnecting any electronics and/or power cables. After each step observe the display and the relay board. If you unplug the faulty board when the I^2C bus is operating, you will see the LEDs on the relay board either go on or flash on and off, or the display will be begin to function normally. The bright red Watchdog LED (D1) on the relay board must be toggling every 5-10 seconds or something is wrong with the I^2C bus.

   The following are the steps to take for each of the analyzers to determine which board is bad.

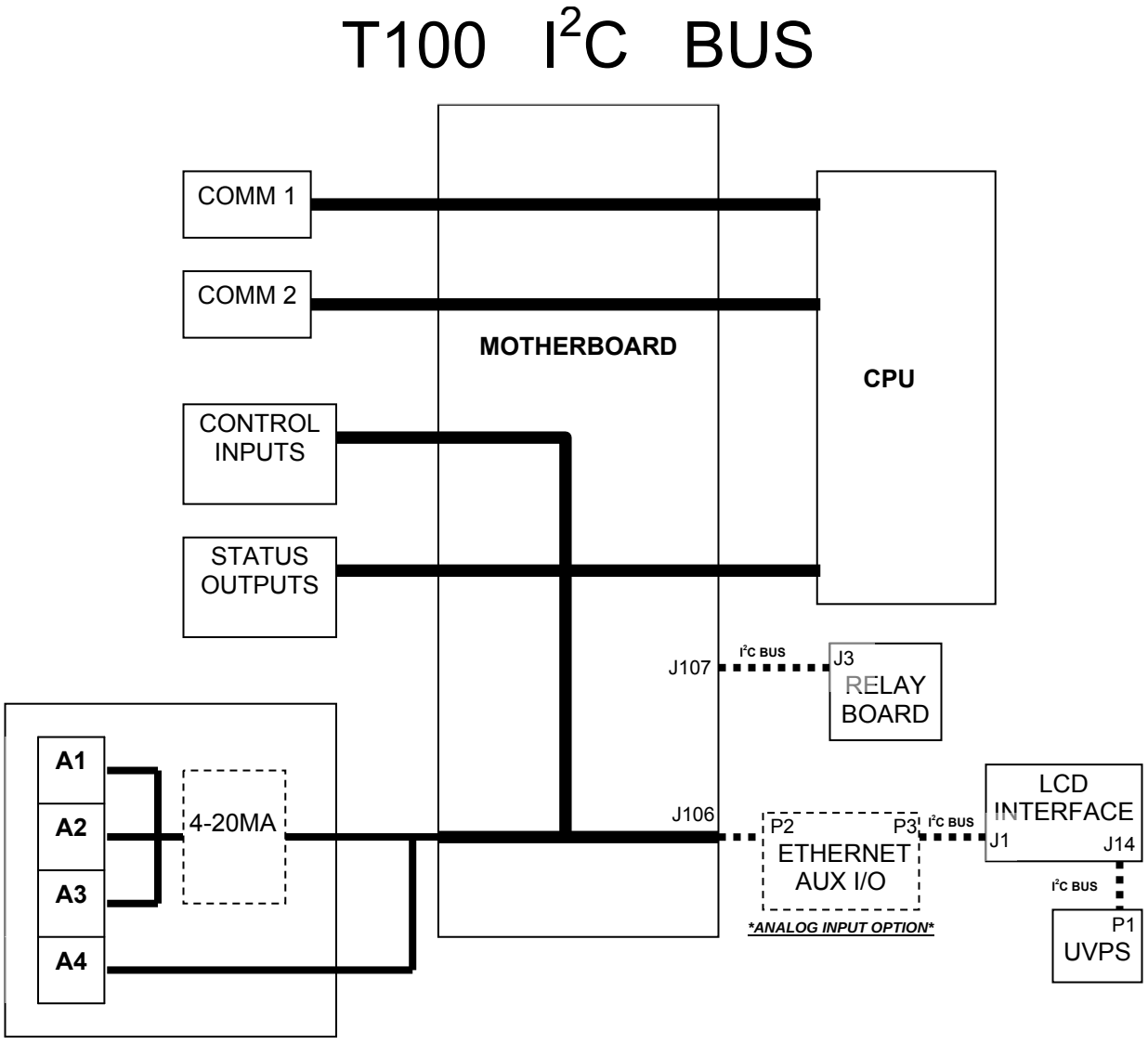
M100E
CPU→Motherboard (J106) →Keyboard (J2) →Keyboard (J1) →UVPS (P1)
CPU→Motherboard (J107) →Relay board (J3)

1. Unplug P1 on the UVPS board, and wait 2 minutes. If the LEDs on the relay board stay off then the UVPS board is not the problem. Plug P1 back in to the UVPS board.
2. Unplug J2 on the Keyboard and wait 2 minutes. If the LEDs on the Relay Board stay off then the keyboard is not the problem. On the Keyboard plug J2 back in.
3. Unplug J3 on the Relay Board and wait 2 minutes. If the front panel does not begin to function normally then the relay board is not bad.
4. The only other components that will pull down the I^2C bus are the Motherboard, or the cables. Replace each in turn with a known good spare to determine which part is the problem.



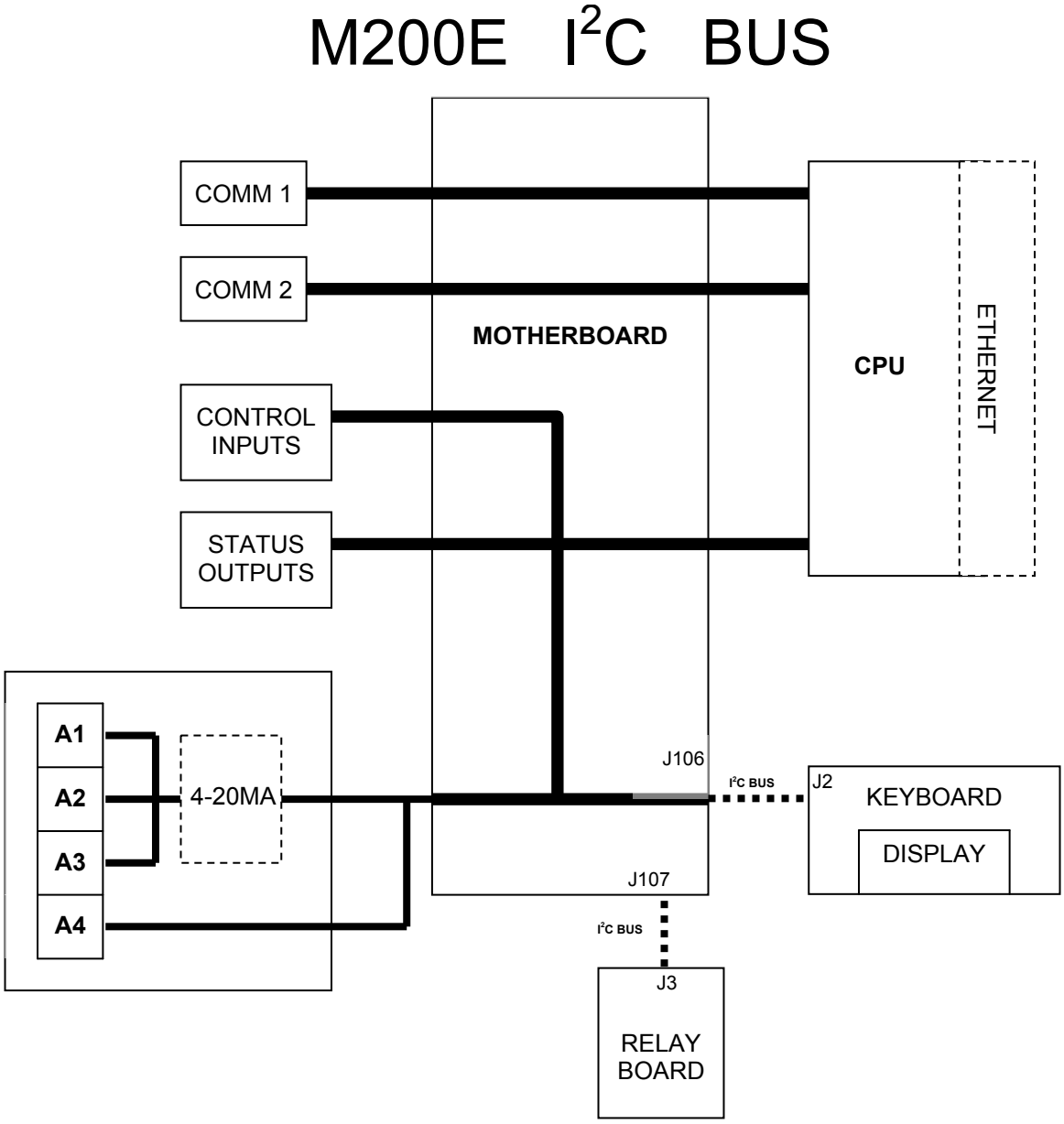
T100
CPU→Motherboard (J106) →*[*Ethernet-Aux I/O board (P2) →Ethernet-Aux I/O board (P3)→]*
LCD Interface (J1) →LCD Interface (J14) →UVPS (P1)
CPU→Motherboard (J107) →Relay board (J3)

1. Unplug P1 on the UVPS board, and wait 2 minutes. If the LEDs on the relay board stay off then the UVPS board is not the problem. On the UVPS board, plug P1 back in.
2. Unplug J1 on the LCD Interface and wait 2 minutes. If the LEDs on the Relay Board stay off then the LCD Interface is not the problem. Plug J1 on the LCD Interface back in.
3. If the Analog Input option is installed unplug P3 on the Ethernet-Aux I/O board and wait 2 minutes. If the LEDs on the relay board stay off then the UVPS board is not the problem and plug P3 back in.
4. Unplug J3 on the Relay Board and wait 2 minutes. If the front panel does not begin to function normally then the relay board is not bad.
5. The only other components that will pull down the I^2C bus are the Motherboard, the cables, or if the Analog Input option is installed the Ethernet-Aux I/O board. Replace each in turn with a known good spare to determine which part is the problem



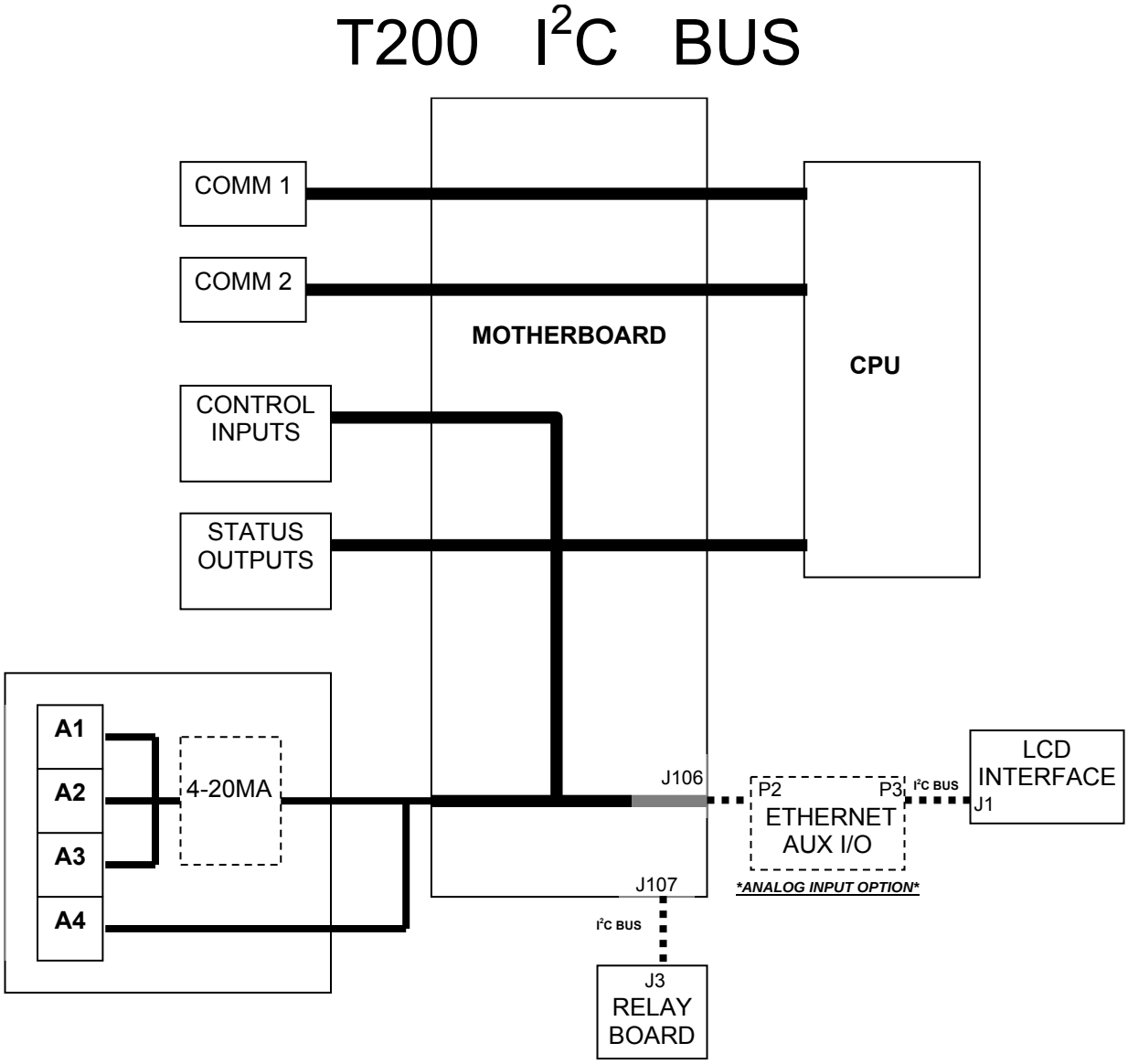
M200E
CPU→Motherboard (J106) →Keyboard (J2)
CPU→Motherboard (J107) →Relay board (J3)

1. Unplug J2 on the Keyboard and wait 2 minutes. If the LEDs on the Relay board stay off then the keyboard is not the problem. On the Keyboard plug J2 back in.
2. Unplug J3 on the relay board and wait 2 minutes. If the front panel does not begin to behave normally then the relay board is not bad.
3. The only other components that will pull down the I^2C bus are the Motherboard, or cables. Replace each in turn with a known good spare to determine which part is the problem.



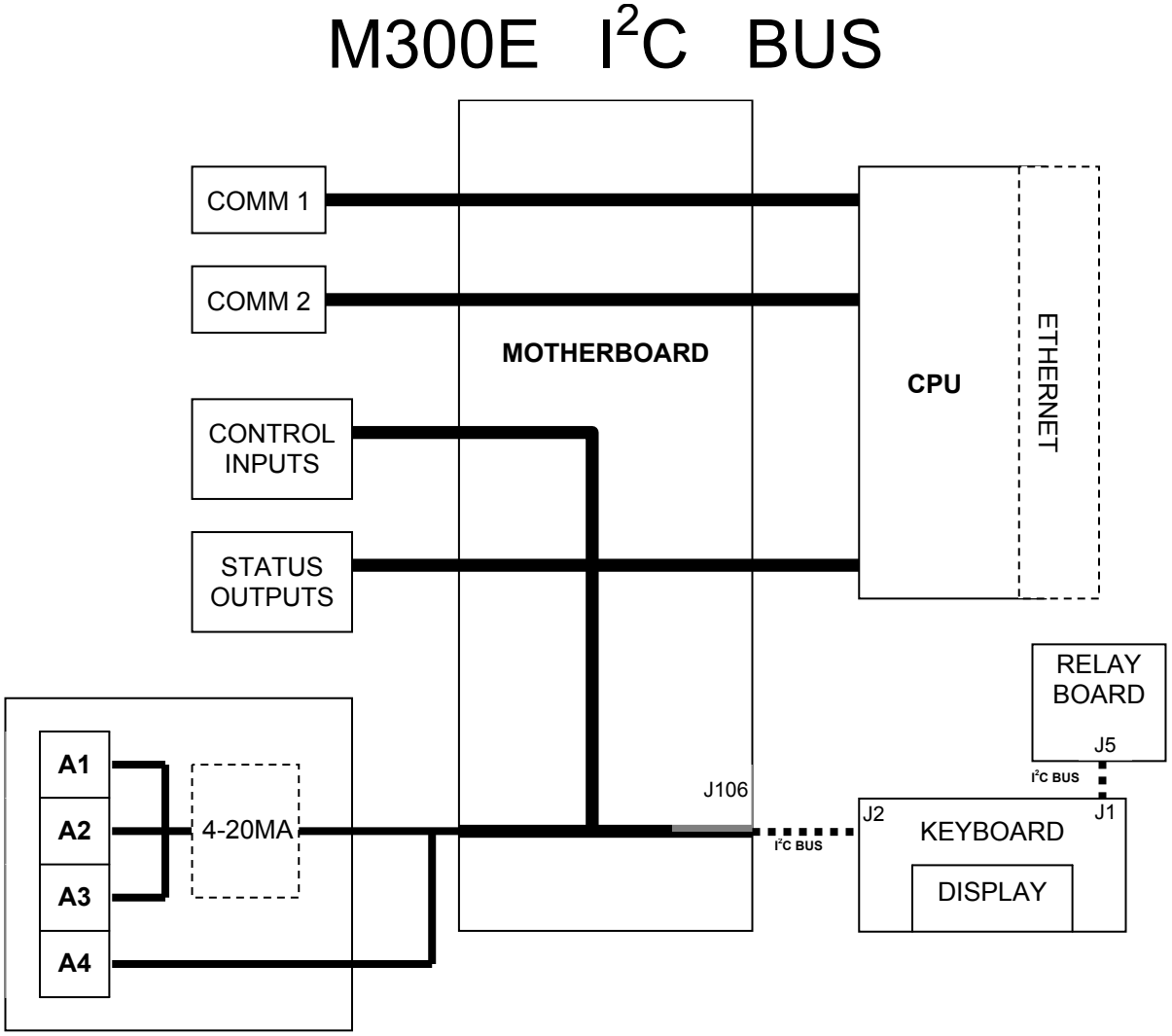
T200
CPU→Motherboard (J106) →*[*Ethernet-Aux I/O board (P2) →Ethernet-Aux I/O board (P3)→]*
LCD Interface (J1)
CPU→Motherboard (J107) →Relay board (J3)

1. Unplug J1 on the LCD Interface and wait 2 minutes. If the LEDs on the Relay Board stay off then the LCD Interface is not the problem. Plug J1 on the LCD Interface back in.
2. If the Analog Input option is installed unplug P3 on the Ethernet-Aux I/O board and wait 2 minutes. If the LEDs on the relay board stay off then the UVPS board is not the problem and plug P3 back in.
3. Unplug J3 on the relay board and wait 2 minutes. If the front panel does not begin to behave normally then the relay board is not bad.
4. The only other components that will pull down the I^2C bus are the Motherboard, the cables, or if the Analog Input option is installed the Ethernet-Aux I/O board. Replace each in turn with a known good spare to determine which part is the problem



M300E
CPU→Motherboard (J106) →Keyboard (J2) →Keyboard (J1) →Relay board (J5)

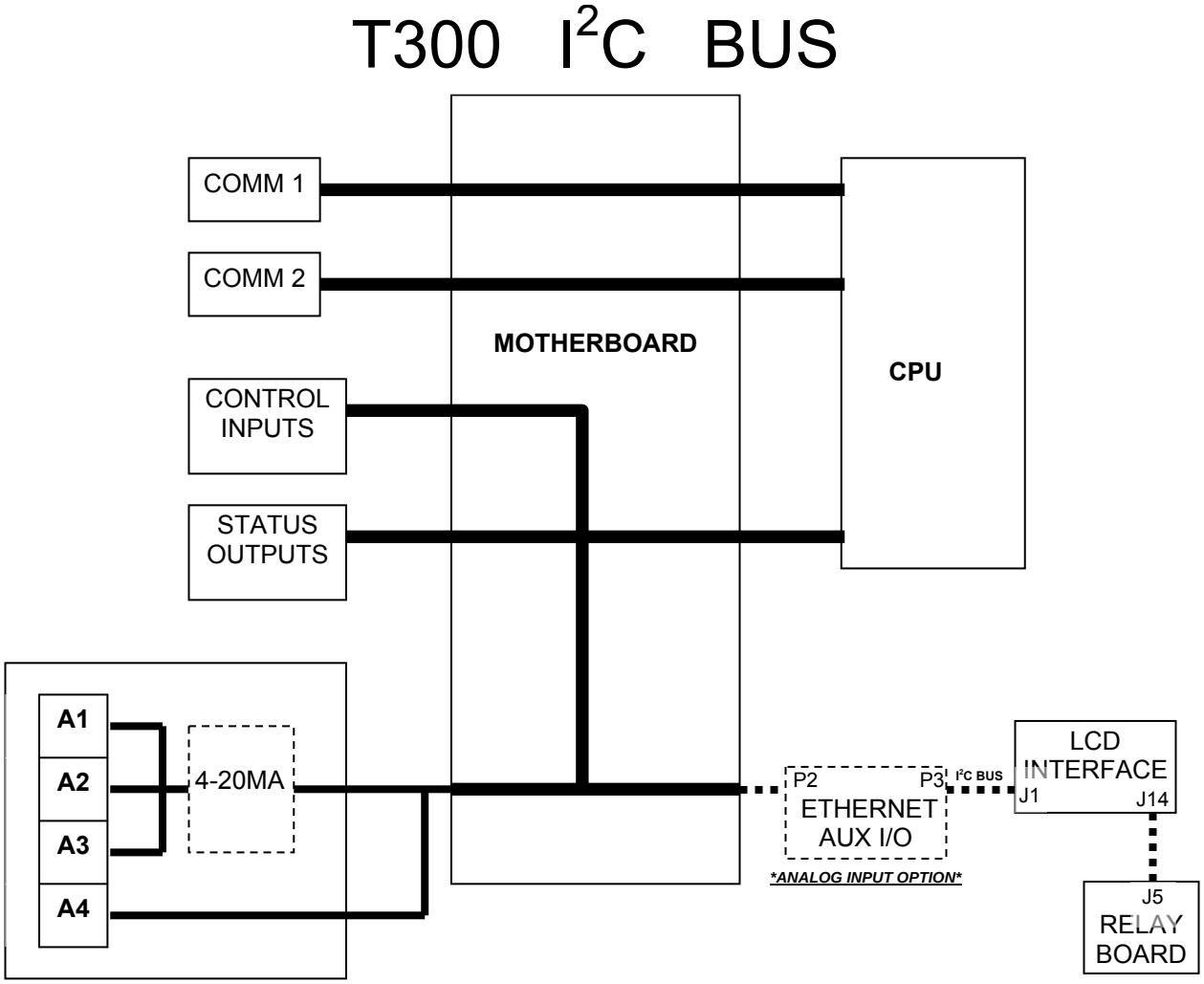
1. The M300E is a little tricky to troubleshoot because of the route that the I^2C bus takes. First unplug J5 on the relay board if the display still doesn't work then the relay board is not the problem, and plug J5 back in.
2. You will now have to turn off the power and swap keyboards with a known good keyboard. Turn the power back on and see if the I^2C bus is still down.
3. The only other components that will pull down the I^2C bus are the Motherboard, or cables. Replace each in turn with a known good spare to determine which part is the problem.



T300

CPU→Motherboard(J106)→*[*Ethernet-Aux I/O board(P2)→Ethernet-Aux I/O board(P3)→]*LCD Interface(J1)→LCD Interface(J14)→ Relay board(J5)

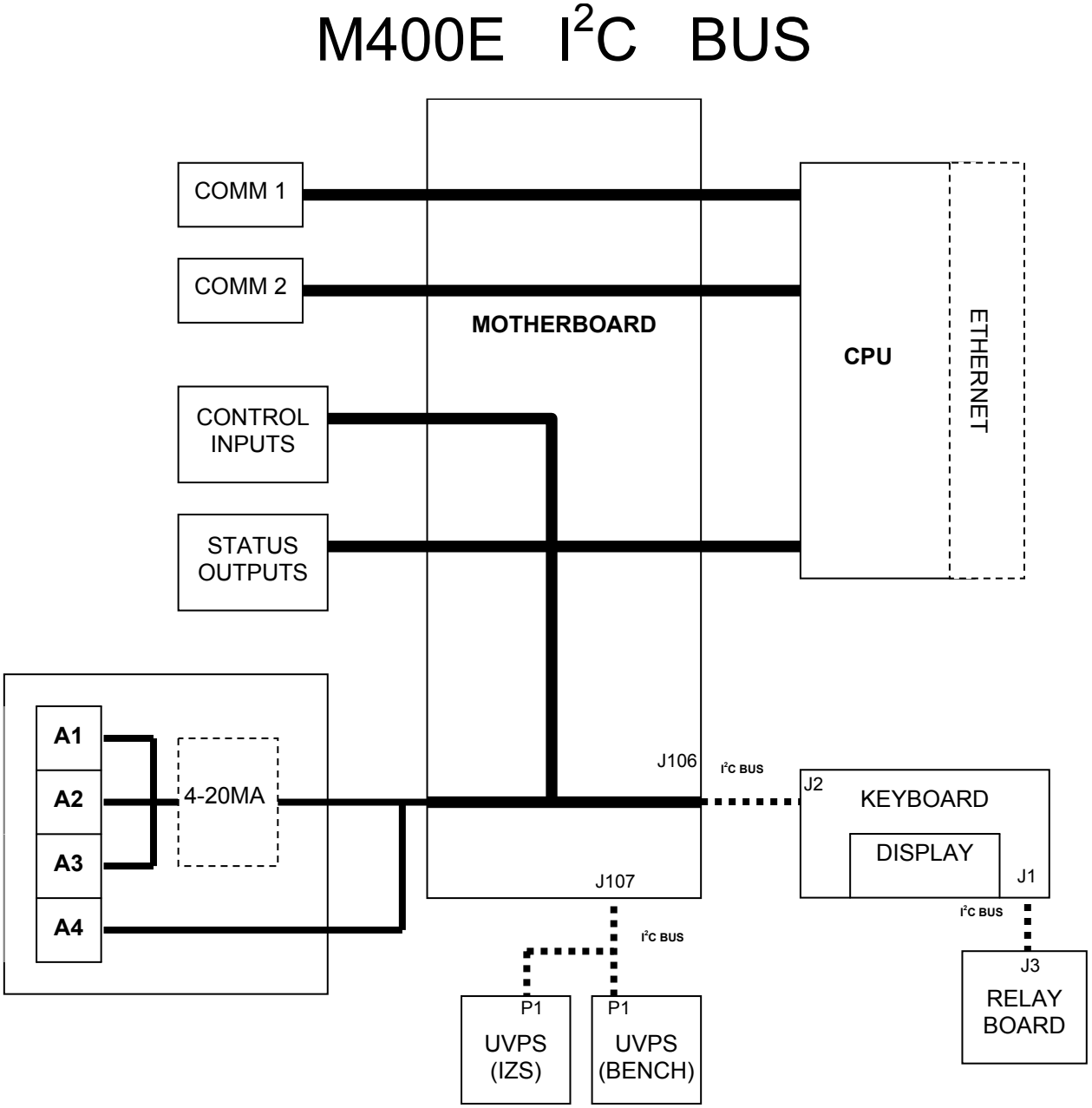
1. The T300 is a little tricky to troubleshoot because of the route that the I^2C bus takes. First unplug J5 on the relay board if the display still doesn't work then the relay board is not the problem, and plug J5 back in.
2. You will now have to turn off the power and swap LCD Interface with a known good spare. Turn the power back on and see if the I^2C bus is still down.
3. The only other components that will pull down the I^2C bus are the Motherboard, the cables, or if the Analog Input option is installed the Ethernet-Aux I/O board. Replace each in turn with a known good spare to determine which part is the problem.



M400E (M700E, M703E)
CPU→Motherboard (J107) →Bench UVPS (P1) →O3UVPS (P1)
CPU→Motherboard (J106) →Keyboard (J2) →Keyboard (J1)→ Relay board (J3)

For the M700E and M703E, please follow the instructions below as the I2C components are identical. *If your M700E does not have the ozone/Photometer option, ignore the steps for disconnecting the UVPS connectors.

1. Unplug J3 on the relay board and wait 2 minutes. If the keyboard does not come back on then they relay board is not bad. Plug J3 back in on the relay board.
2. If you have IZS installed in the analyzer unplug P1 on the UVPS for the Ozone Gen Tower and wait 2 minutes. If the LEDs on the relay board stay off then your UVPS for the Ozone Gen Tower is not the problem. Plug P1 on the UVPS back in. Repeat this step for the UVPS for the bench lamp
3. You will now have to turn off the power and swap keyboards with a known good keyboard. Turn the power back on and see if the I^2C bus is still down.
4. The only other components that will pull down the I^2C bus are the Motherboard, or cables. Replace each in turn with a known good spare.

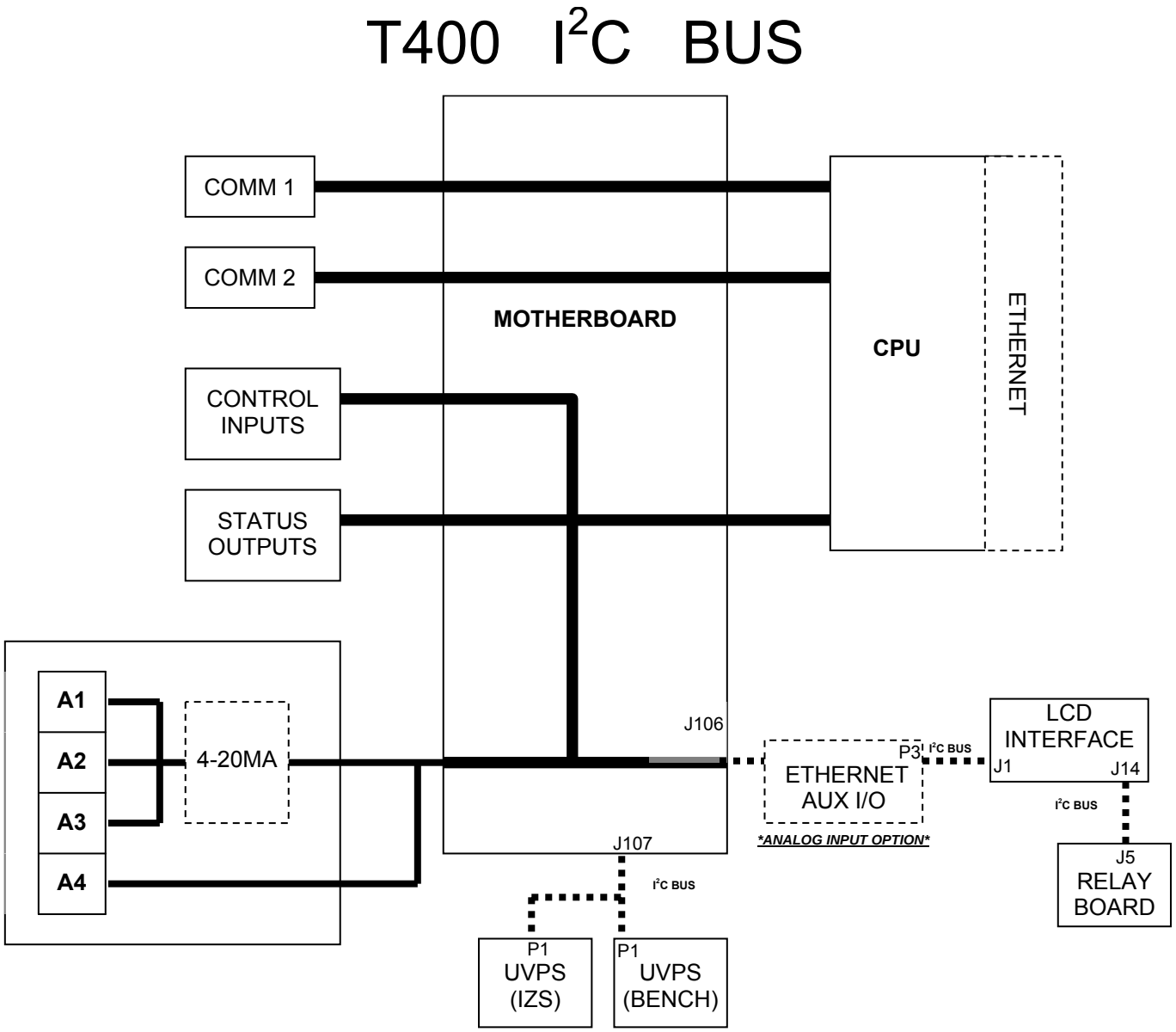


T400 (T700, T703)

CPU→Motherboard (J107) →Bench UVPS (P1) →O3UVPS (P1)
CPU→Motherboard (J106) →*[*Ethernet-Aux I/O board (P2) →Ethernet-Aux I/O board (P3)→]* LCD Interface (J1) →LCD Interface (J14)→ Relay board (J3)

For the T700 and T703, please follow the instructions below as the I2C components are identical. *If your T700 does not have the ozone/Photometer option, ignore the steps for disconnecting the UVPS connectors.

1. Unplug J3 on the relay board and wait 2 minutes. If the keyboard does not come back on then they relay board is not bad. Plug J3 back in on the relay board.
2. If you have IZS installed in the analyzer unplug P1 on the UVPS for the Ozone Gen Tower and wait 2 minutes. If the LEDs on the relay board stay off then your UVPS for the Ozone Gen Tower is not the problem. Plug P1 on the UVPS back in. Repeat this step for the UVPS for the bench lamp
3. You will now have to turn off the power and swap LCD Interface with a known good spare. Turn the power back on and see if the I^2C bus is still down.
4. The only other components that will pull down the I^2C bus are the Motherboard, the cables, or if the Analog Input option is installed the Ethernet-Aux I/O board. Replace each in turn with a known good spare to determine which part is the problem.

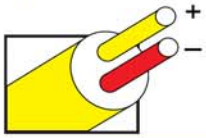


MAXIMUM TEMPERATURE RANGE
Thermocouple Grade
– 328 to 2282°F
– 200 to 1250°C
Extension Grade
32 to 392°F
0 to 200°C
LIMITS OF ERROR
(whichever is greater)
Standard: 2.2°C or 0.75% Above 0°C
2.2°C or 2.0% Below 0°C
Special: 1.1°C or 0.4%
COMMENTS, BARE WIRE ENVIRONMENT:
Clean Oxidizing and Inert; Limited Use in Vacuum or Reducing; Wide Temperature Range; Most Popular Calibration
TEMPERATURE IN DEGREES °C
REFERENCE JUNCTION AT 0°C

Thermocouple Grade

Revised Thermocouple Reference Tables

Nickel-Chromium vs. Nickel-Aluminum



Extension Grade

TYPE K

Reference Tables
N.I.S.T. Monograph 175
Revised to ITS-90

Thermoelectric Voltage in Millivolts

°C	-10	-9	-8	-7	-6	-5	-4	-3	-2	-1	0	°C
-260	-6.458	-6.457	-6.456	-6.455	-6.453	-6.452	-6.450	-6.448	-6.446	-6.444	-6.441	-260
-250	-6.441	-6.438	-6.435	-6.432	-6.429	-6.425	-6.421	-6.417	-6.413	-6.408	-6.404	-250
-240	-6.404	-6.399	-6.393	-6.388	-6.382	-6.377	-6.370	-6.364	-6.358	-6.351	-6.344	-240
-230	-6.344	-6.337	-6.329	-6.322	-6.314	-6.306	-6.297	-6.289	-6.280	-6.271	-6.262	-230
-220	-6.262	-6.252	-6.243	-6.233	-6.223	-6.213	-6.202	-6.192	-6.181	-6.170	-6.158	-220
-210	-6.158	-6.147	-6.135	-6.123	-6.111	-6.099	-6.087	-6.074	-6.061	-6.048	-6.035	-210
-200	-6.035	-6.021	-6.007	-5.994	-5.980	-5.965	-5.951	-5.936	-5.922	-5.907	-5.891	-200
-190	-5.891	-5.876	-5.861	-5.845	-5.829	-5.813	-5.797	-5.780	-5.763	-5.747	-5.730	-190
-180	-5.730	-5.713	-5.695	-5.678	-5.660	-5.642	-5.624	-5.606	-5.588	-5.569	-5.550	-180
-170	-5.550	-5.531	-5.512	-5.493	-5.474	-5.454	-5.435	-5.415	-5.395	-5.374	-5.354	-170
-160	-5.354	-5.333	-5.313	-5.292	-5.271	-5.250	-5.228	-5.207	-5.185	-5.163	-5.141	-160
-150	-5.141	-5.119	-5.097	-5.074	-5.052	-5.029	-5.006	-4.983	-4.960	-4.936	-4.913	-150
-140	-4.913	-4.889	-4.865	-4.841	-4.817	-4.793	-4.768	-4.744	-4.719	-4.694	-4.669	-140
-130	-4.669	-4.644	-4.618	-4.593	-4.567	-4.542	-4.516	-4.490	-4.463	-4.437	-4.411	-130
-120	-4.411	-4.384	-4.357	-4.330	-4.303	-4.276	-4.249	-4.221	-4.194	-4.166	-4.138	-120
-110	-4.138	-4.110	-4.082	-4.054	-4.025	-3.997	-3.968	-3.939	-3.911	-3.882	-3.852	-110
-100	-3.852	-3.823	-3.794	-3.764	-3.734	-3.705	-3.675	-3.645	-3.614	-3.584	-3.554	-100
-90	-3.554	-3.523	-3.492	-3.462	-3.431	-3.400	-3.368	-3.337	-3.306	-3.274	-3.243	-90
-80	-3.243	-3.211	-3.179	-3.147	-3.115	-3.083	-3.050	-3.018	-2.986	-2.953	-2.920	-80
-70	-2.920	-2.887	-2.854	-2.821	-2.788	-2.755	-2.721	-2.688	-2.654	-2.620	-2.587	-70
-60	-2.587	-2.553	-2.519	-2.485	-2.450	-2.416	-2.382	-2.347	-2.312	-2.278	-2.243	-60
-50	-2.243	-2.208	-2.173	-2.138	-2.103	-2.067	-2.032	-1.996	-1.961	-1.925	-1.889	-50
-40	-1.889	-1.854	-1.818	-1.782	-1.745	-1.709	-1.673	-1.637	-1.600	-1.564	-1.527	-40
-30	-1.527	-1.490	-1.453	-1.417	-1.380	-1.343	-1.305	-1.268	-1.231	-1.194	-1.156	-30
-20	-1.156	-1.119	-1.081	-1.043	-1.006	-0.968	-0.930	-0.892	-0.854	-0.816	-0.778	-20
-10	-0.778	-0.739	-0.701	-0.663	-0.624	-0.586	-0.547	-0.508	-0.470	-0.431	-0.392	-10
0	-0.392	-0.353	-0.314	-0.275	-0.236	-0.197	-0.157	-0.118	-0.079	-0.039	0.000	0
0	0.000	0.039	0.079	0.119	0.158	0.198	0.238	0.277	0.317	0.357	0.397	0
10	0.397	0.437	0.477	0.517	0.557	0.597	0.637	0.677	0.718	0.758	0.798	10
20	0.798	0.838	0.879	0.919	0.960	1.000	1.041	1.081	1.122	1.163	1.203	20
30	1.203	1.244	1.285	1.326	1.366	1.407	1.448	1.489	1.530	1.571	1.612	30
40	1.612	1.653	1.694	1.735	1.776	1.817	1.858	1.899	1.941	1.982	2.023	40
50	2.023	2.064	2.106	2.147	2.188	2.230	2.271	2.312	2.354	2.395	2.436	50
60	2.436	2.478	2.519	2.561	2.602	2.644	2.685	2.727	2.768	2.810	2.851	60
70	2.851	2.893	2.934	2.976	3.017	3.059	3.100	3.142	3.184	3.225	3.267	70
80	3.267	3.308	3.350	3.391	3.433	3.474	3.516	3.557	3.599	3.640	3.682	80
90	3.682	3.723	3.765	3.806	3.848	3.889	3.931	3.972	4.013	4.055	4.096	90
100	4.096	4.138	4.179	4.220	4.262	4.303	4.344	4.385	4.427	4.468	4.509	100
110	4.509	4.550	4.591	4.633	4.674	4.715	4.756	4.797	4.838	4.879	4.920	110
120	4.920	4.961	5.002	5.043	5.084	5.124	5.165	5.206	5.247	5.288	5.328	120
130	5.328	5.369	5.410	5.450	5.491	5.532	5.572	5.613	5.653	5.694	5.735	130
140	5.735	5.775	5.815	5.856	5.896	5.937	5.977	6.017	6.058	6.098	6.138	140
150	6.138	6.179	6.219	6.259	6.299	6.339	6.380	6.420	6.460	6.500	6.540	150
160	6.540	6.580	6.620	6.660	6.701	6.741	6.781	6.821	6.861	6.901	6.941	160
170	6.941	6.981	7.021	7.060	7.100	7.140	7.180	7.220	7.260	7.300	7.340	170
180	7.340	7.380	7.420	7.460	7.500	7.540	7.579	7.619	7.659	7.699	7.739	180
190	7.739	7.779	7.819	7.859	7.899	7.939	7.979	8.019	8.059	8.099	8.138	190
200	8.138	8.178	8.218	8.258	8.298	8.338	8.378	8.418	8.458	8.499	8.539	200
210	8.539	8.579	8.619	8.659	8.699	8.739	8.779	8.819	8.860	8.900	8.940	210
220	8.940	8.980	9.020	9.061	9.101	9.141	9.181	9.222	9.262	9.302	9.343	220
230	9.343	9.383	9.423	9.464	9.504	9.545	9.585	9.626	9.666	9.707	9.747	230
240	9.747	9.788	9.828	9.869	9.909	9.950	9.991	10.031	10.072	10.113	10.153	240
°C	0	1	2	3	4	5	6	7	8	9	10	°C

°C	0	1	2	3	4	5	6	7	8	9	10	°C
250	10.153	10.194	10.235	10.276	10.316	10.357	10.398	10.439	10.480	10.520	10.561	250
260	10.561	10.602	10.643	10.684	10.725	10.766	10.807	10.848	10.889	10.930	10.971	260
270	10.971	11.012	11.053	11.094	11.135	11.176	11.217	11.259	11.300	11.341	11.382	270
280	11.382	11.423	11.465	11.506	11.547	11.588	11.630	11.671	11.712	11.753	11.795	280
290	11.795	11.836	11.877	11.919	11.960	12.001	12.043	12.084	12.126	12.167	12.209	290
300	12.209	12.250	12.291	12.333	12.374	12.416	12.457	12.499	12.540	12.582	12.624	300
310	12.624	12.665	12.707	12.748	12.790	12.831	12.873	12.915	12.956	12.998	13.040	310
320	13.040	13.081	13.123	13.165	13.206	13.248	13.290	13.331	13.373	13.415	13.457	320
330	13.457	13.498	13.540	13.582	13.624	13.665	13.707	13.749	13.791	13.833	13.874	330
340	13.874	13.916	13.958	14.000	14.042	14.084	14.126	14.167	14.209	14.251	14.293	340
350	14.293	14.335	14.377	14.419	14.461	14.503	14.545	14.587	14.629	14.671	14.713	350
360	14.713	14.755	14.797	14.839	14.881	14.923	14.965	15.007	15.049	15.091	15.133	360
370	15.133	15.175	15.217	15.259	15.301	15.343	15.385	15.427	15.469	15.511	15.554	370
380	15.554	15.596	15.638	15.680	15.722	15.764	15.806	15.849	15.891	15.933	15.975	380
390	15.975	16.017	16.059	16.102	16.144	16.186	16.228	16.270	16.313	16.355	16.397	390
400	16.397	16.439	16.482	16.524	16.566	16.608	16.651	16.693	16.735	16.778	16.820	400
410	16.820	16.862	16.904	16.947	16.989	17.031	17.074	17.116	17.158	17.201	17.243	410
420	17.243	17.285	17.328	17.370	17.413	17.455	17.497	17.540	17.582	17.624	17.667	420
430	17.667	17.709	17.752	17.794	17.837	17.879	17.921	17.964	18.006	18.049	18.091	430
440	18.091	18.134	18.176	18.218	18.261	18.303	18.346	18.388	18.431	18.473	18.516	440
450	18.516	18.558	18.601	18.643	18.686	18.728	18.771	18.813	18.856	18.898	18.941	450
460	18.941	18.983	19.026	19.068	19.111	19.154	19.196	19.239	19.281	19.324	19.366	460
470	19.366	19.409	19.451	19.494	19.537	19.579	19.622	19.664	19.707	19.750	19.792	470
480	19.792	19.835	19.877	19.920	19.962	20.005	20.048	20.090	20.133	20.175	20.218	480
490	20.218	20.261	20.303	20.346	20.389	20.431	20.474	20.516	20.559	20.602	20.644	490
500	20.644	20.687	20.730	20.772	20.815	20.857	20.900	20.943	20.985	21.028	21.071	500
510	21.071	21.113	21.156	21.199	21.241	21.284	21.326	21.369	21.412	21.454	21.497	510
520	21.497	21.540	21.582	21.625	21.668	21.710	21.753	21.796	21.838	21.881	21.924	520
530	21.924	21.966	22.009	22.052	22.094	22.137	22.179	22.222	22.265	22.307	22.350	530
540	22.350	22.393	22.435	22.478	22.521	22.563	22.606	22.649	22.691	22.734	22.776	540
550	22.776	22.819	22.862	22.904	22.947	22.990	23.032	23.075	23.117	23.160	23.203	550
560	23.203	23.245	23.288	23.331	23.373	23.416	23.458	23.501	23.544	23.586	23.629	560
570	23.629	23.671	23.714	23.757	23.799	23.842	23.884	23.927	23.970	24.012	24.055	570
580	24.055	24.097	24.140	24.182	24.225	24.267	24.310	24.353	24.395	24.438	24.480	580
590	24.480	24.523	24.565	24.608	24.650	24.693	24.735	24.778	24.820	24.863	24.905	590
600	24.905	24.948	24.990	25.033	25.075	25.118	25.160	25.203	25.245	25.288	25.330	600
610	25.330	25.373	25.415	25.458	25.500	25.543	25.585	25.627	25.670	25.712	25.755	610
620	25.755	25.797	25.840	25.882	25.924	25.967	26.009	26.052	26.094	26.136	26.179	620
630	26.179	26.221	26.263	26.306	26.348	26.390	26.433	26.475	26.517	26.560	26.602	630
640	26.602	26.644	26.687	26.729	26.771	26.814	26.856	26.898	26.940	26.983	27.025	640
650	27.025	27.067	27.109	27.152	27.194	27.236	27.278	27.320	27.363	27.405	27.447	650
660	27.447	27.489	27.531	27.574	27.616	27.658	27.700	27.742	27.784	27.826	27.869	660
670	27.869	27.911	27.953	27.995	28.037	28.079	28.121	28.163	28.205	28.247	28.289	670
680	28.289	28.332	28.374	28.416	28.458	28.500	28.542	28.584	28.626	28.668	28.710	680
690	28.710	28.752	28.794	28.835	28.877	28.919	28.961	29.003	29.045	29.087	29.129	690
700	29.129	29.171	29.213	29.255	29.297	29.338	29.380	29.422	29.464	29.506	29.548	700
710	29.548	29.589	29.631	29.673	29.715	29.757	29.798	29.840	29.882	29.924	29.965	710
720	29.965	30.007	30.049	30.090	30.132	30.174	30.216	30.257	30.299	30.341	30.382	720
730	30.382	30.424	30.466	30.507	30.549	30.590	30.632	30.674	30.715	30.757	30.798	730
740	30.798	30.840	30.881	30.923	30.964	31.006	31.047	31.089	31.130	31.172	31.213	740
750	31.213	31.255	31.296	31.338	31.379	31.421	31.462	31.504	31.545	31.586	31.628	750
760	31.628	31.669	31.710	31.752	31.793	31.834	31.876	31.917	31.958	32.000	32.041	760
770	32.041	32.082	32.124	32.165	32.206	32.247	32.289	32.330	32.371	32.412	32.453	770
780	32.453	32.495	32.536	32.577	32.618	32.659	32.700	32.742	32.783	32.824	32.865	780
790	32.865	32.906	32.947	32.988	33.029	33.070	33.111	33.152	33.193	33.234	33.275	790
°C	0	1	2	3	4	5	6	7	8	9	10	°C

THERMISTOR CHART

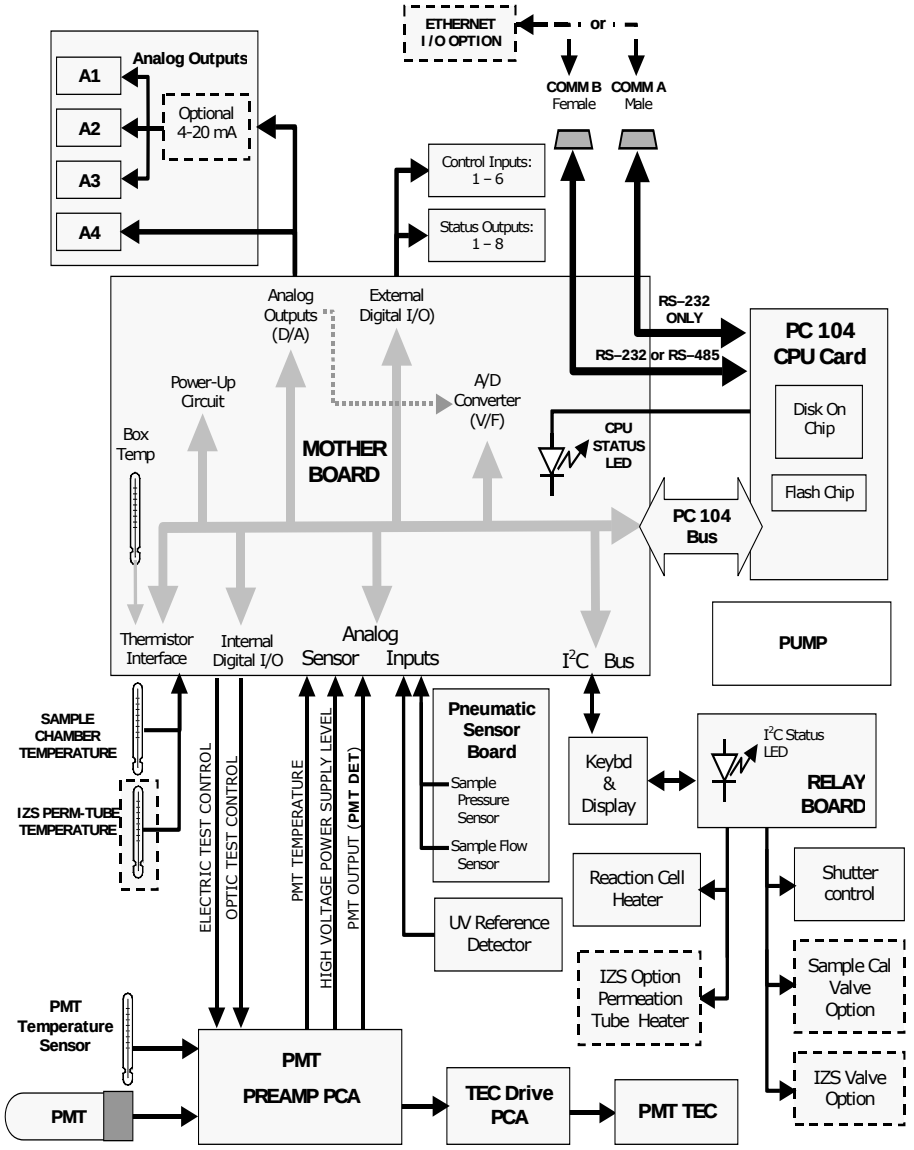
TEMP	RES.	TEMP	RES.	TEMP	RES.	TEMP	RES.	TEMP	RES.
-40°	884.6KΩ	0°	95.0KΩ	40°	16.15KΩ	80°	3.843KΩ	120°	1.176KΩ
-39°	830.9KΩ	1°	90.4KΩ	41°	15.52KΩ	81°	3.720KΩ	121°	1.145KΩ
-38°	780.8KΩ	2°	86.1KΩ	42°	14.92KΩ	82°	3.602KΩ	122°	1.114KΩ
-37°	733.9KΩ	3°	82.0KΩ	43°	14.35KΩ	83°	3.489KΩ	123°	1.085KΩ
-36°	690.2KΩ	4°	78.1KΩ	44°	13.80KΩ	84°	3.379KΩ	124°	1.057KΩ
-35°	649.3KΩ	5°	74.4KΩ	45°	13.28KΩ	85°	3.273KΩ	125°	1.029KΩ
-34°	611.0KΩ	6°	71.0KΩ	46°	12.77KΩ	86°	3.172KΩ	126°	1.002KΩ
-33°	575.2KΩ	7°	67.7KΩ	47°	12.29KΩ	87°	3.073KΩ	127°	976.3Ω
-32°	541.7KΩ	8°	64.5KΩ	48°	11.83KΩ	88°	2.979KΩ	128°	951.1Ω
-31°	510.4KΩ	9°	61.6KΩ	49°	11.39KΩ	89°	2.887KΩ	129°	926.7Ω
-30°	481.0KΩ	10°	58.8KΩ	50°	10.97KΩ	90°	2.799KΩ	130°	903.0Ω
-29°	453.5KΩ	11°	56.1KΩ	51°	10.57KΩ	91°	2.714KΩ	131°	880.0Ω
-28°	427.7KΩ	12°	53.5KΩ	52°	10.18KΩ	92°	2.632KΩ	132°	857.7Ω
-27°	403.5KΩ	13°	51.1KΩ	53°	9.807KΩ	93°	2.552KΩ	133°	836.1Ω
-26°	380.9KΩ	14°	48.8KΩ	54°	9.450KΩ	94°	2.476KΩ	134°	815.0Ω
-25°	359.6KΩ	15°	46.7KΩ	55°	9.109KΩ	95°	2.402KΩ	135°	794.6Ω
-24°	339.6KΩ	16°	44.6KΩ	56°	8.781KΩ	96°	2.331KΩ	136°	774.8Ω
-23°	320.9KΩ	17°	42.6KΩ	57°	8.467KΩ	97°	2.262KΩ	137°	755.6Ω
-22°	303.3KΩ	18°	40.8KΩ	58°	8.166KΩ	98°	2.195KΩ	138°	736.9Ω
-21°	286.7KΩ	19°	39.0KΩ	59°	7.876KΩ	99°	2.131KΩ	139°	718.8Ω
-20°	271.2KΩ	20°	37.3KΩ	60°	7.599KΩ	100°	2.069KΩ	140°	701.2Ω
-19°	256.5KΩ	21°	35.7KΩ	61°	7.332KΩ	101°	2.009KΩ	141°	684.1Ω
-18°	242.8KΩ	22°	34.2KΩ	62°	7.076KΩ	102°	1.950KΩ	142°	667.5Ω
-17°	229.8KΩ	23°	32.7KΩ	63°	6.830KΩ	103°	1.894KΩ	143°	651.3Ω
-16°	217.6KΩ	24°	31.3KΩ	64°	6.594KΩ	104°	1.840KΩ	144°	635.6Ω
-15°	206.2KΩ	25°	30.0KΩ	65°	6.367KΩ	105°	1.788KΩ	145°	620.3Ω
-14°	195.4KΩ	26°	28.7KΩ	66°	6.149KΩ	106°	1.737KΩ	146°	605.5Ω
-13°	185.2KΩ	27°	27.5KΩ	67°	5.940KΩ	107°	1.688KΩ	147°	591.1Ω
-12°	175.6KΩ	28°	26.4KΩ	68°	5.738KΩ	108°	1.640KΩ	148°	577.1Ω
-11°	166.6KΩ	29°	25.3KΩ	69°	5.545KΩ	109°	1.594KΩ	149°	563.5Ω
-10°	158.0KΩ	30°	24.3KΩ	70°	5.359KΩ	110°	1.550KΩ	150°	550.2Ω
-9°	150.0KΩ	31°	23.3KΩ	71°	5.180KΩ	111°	1.507KΩ		
-8°	142.4KΩ	32°	22.3KΩ	72°	5.007KΩ	112°	1.465KΩ		
-7°	135.2KΩ	33°	21.4KΩ	73°	4.842KΩ	113°	1.425KΩ		
-6°	128.5KΩ	34°	20.6KΩ	74°	4.682KΩ	114°	1.386KΩ		
-5°	122.1KΩ	35°	19.7KΩ	75°	4.529KΩ	115°	1.348KΩ		
-4°	116.0KΩ	36°	19.0KΩ	76°	4.381KΩ	116°	1.311KΩ		
-3°	110.3KΩ	37°	18.2KΩ	77°	4.239KΩ	117°	1.276KΩ		
-2°	104.9KΩ	38°	17.5KΩ	78°	4.102KΩ	118°	1.241KΩ		
1°	99.8KΩ	39°	16.8KΩ	79°	3.970KΩ	119°	1.208KΩ		

Resistance

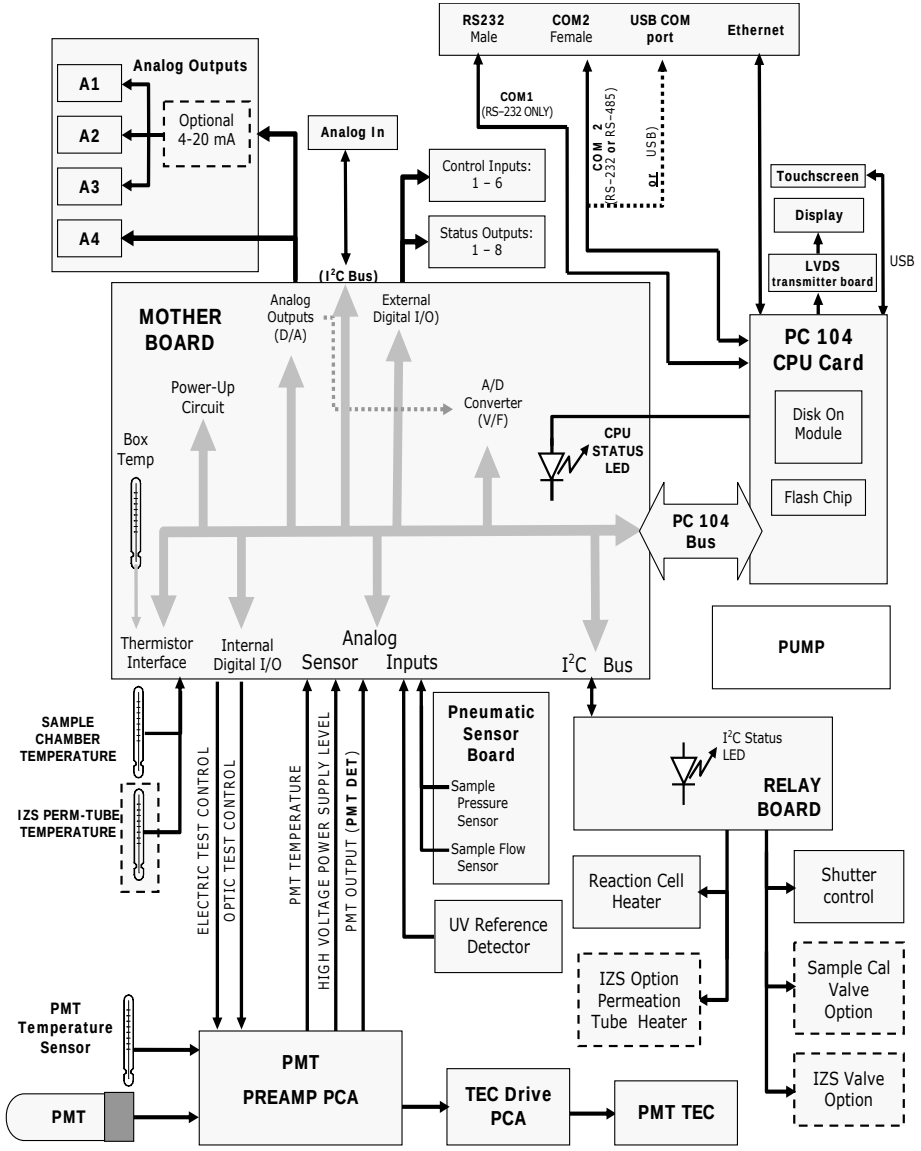
VS.

Temp (Deg. C)

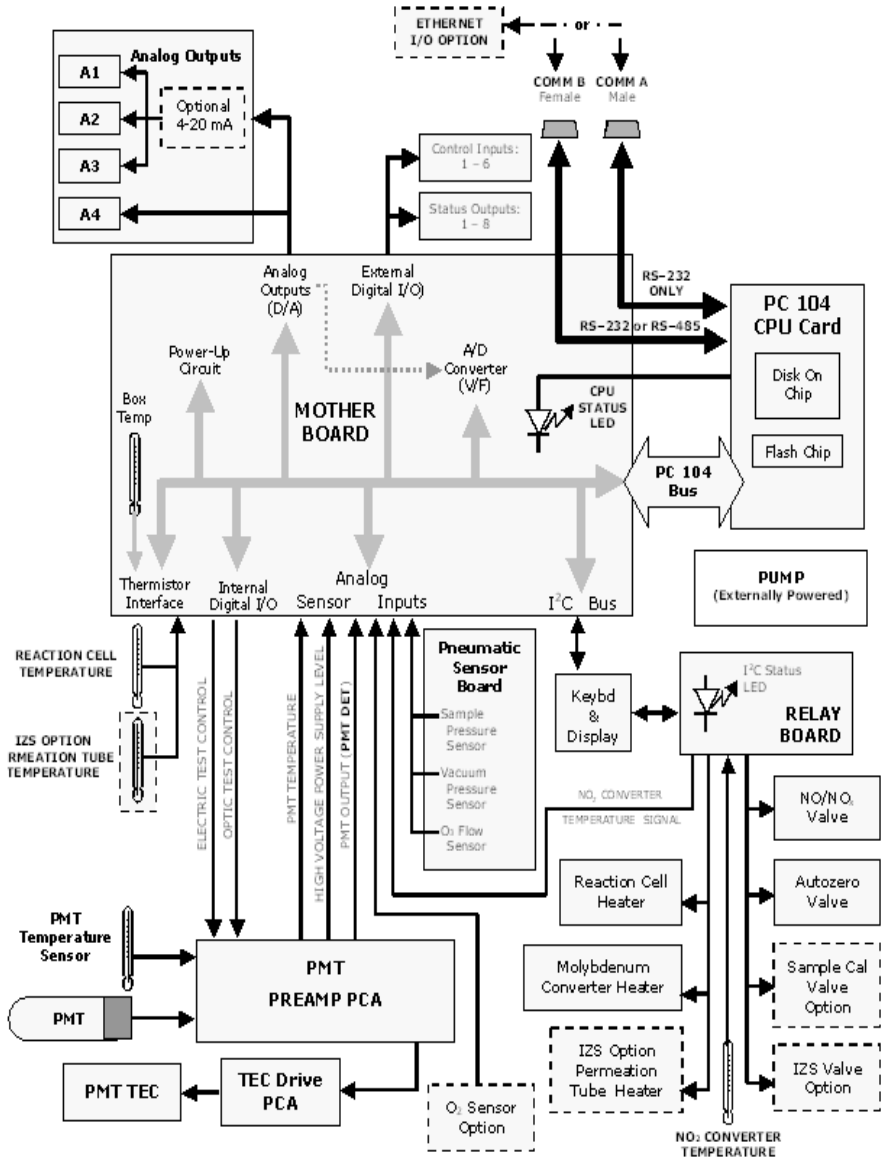
M100E Electronic Block Diagram



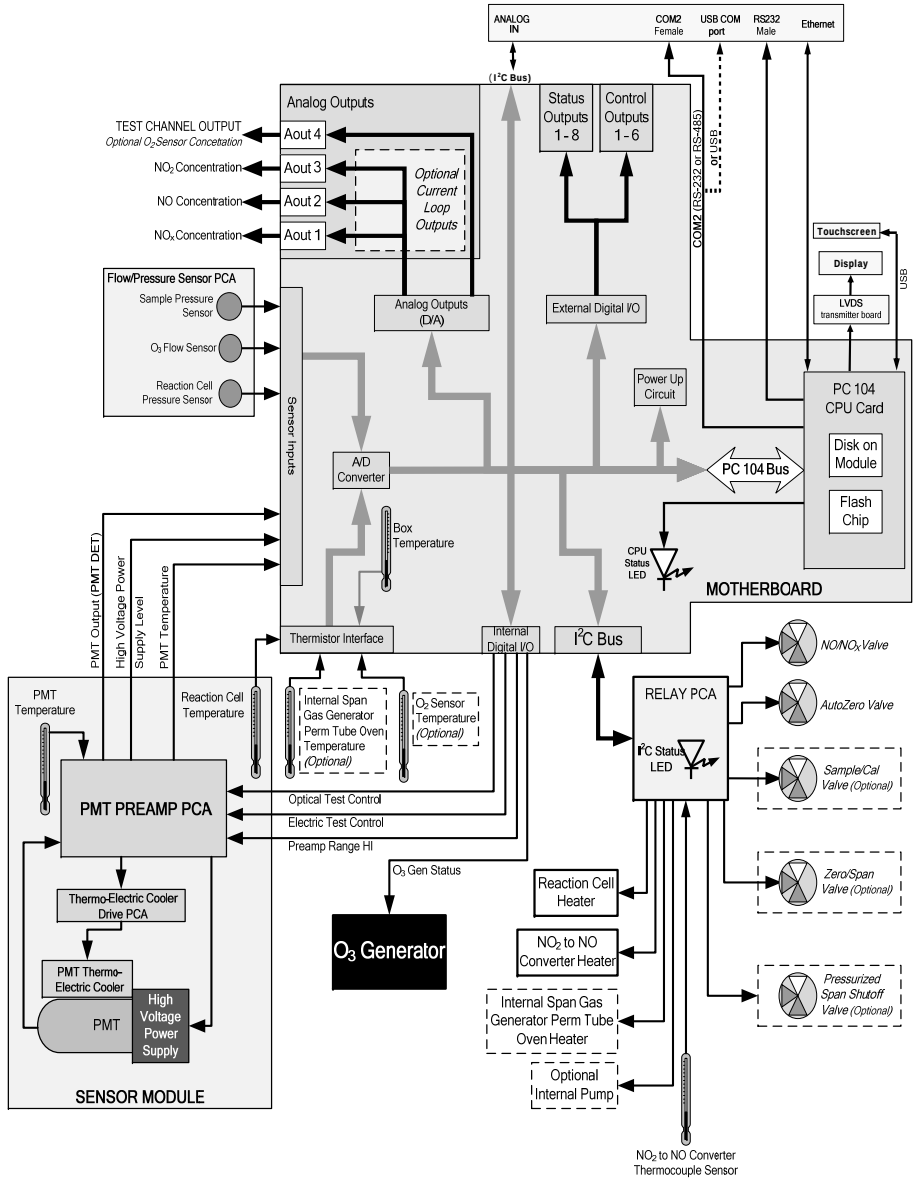
T100 Electronic Block Diagram



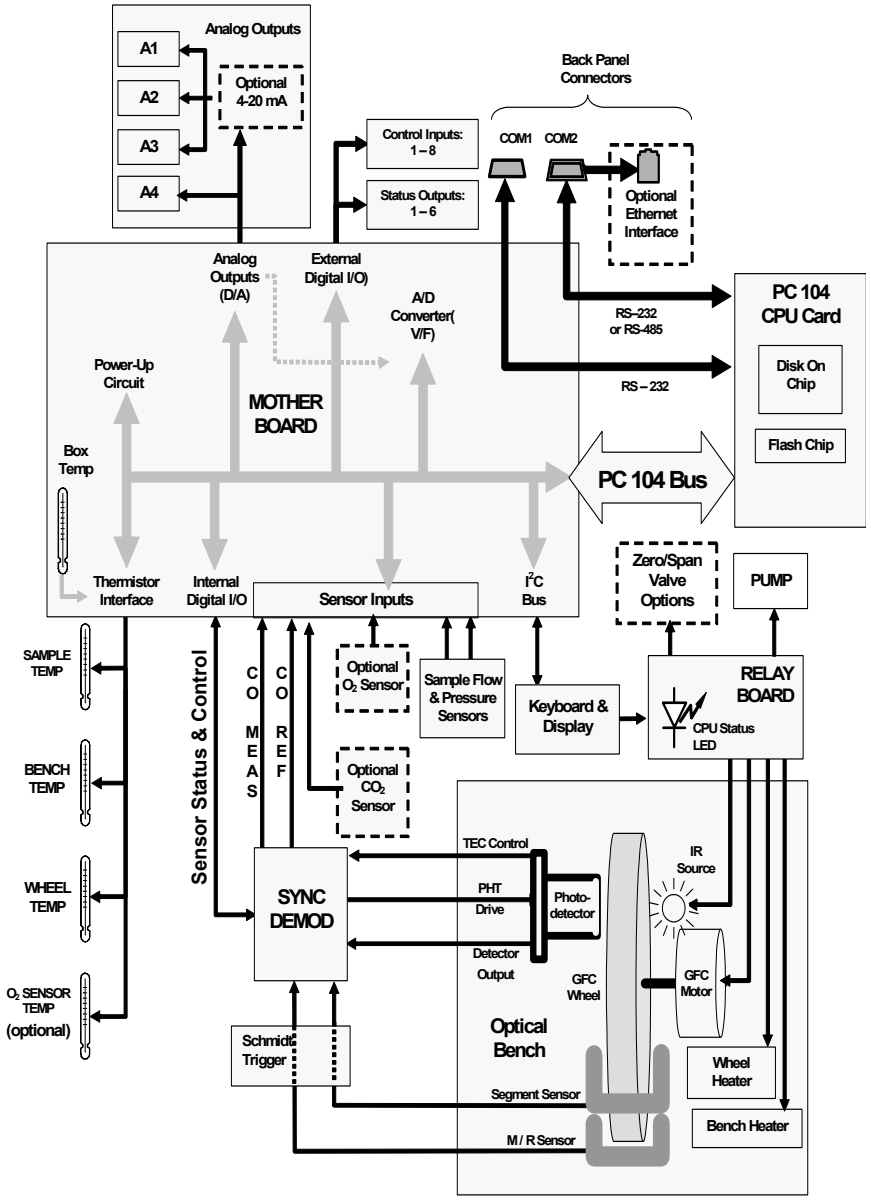
M200E Electronic Block Diagram



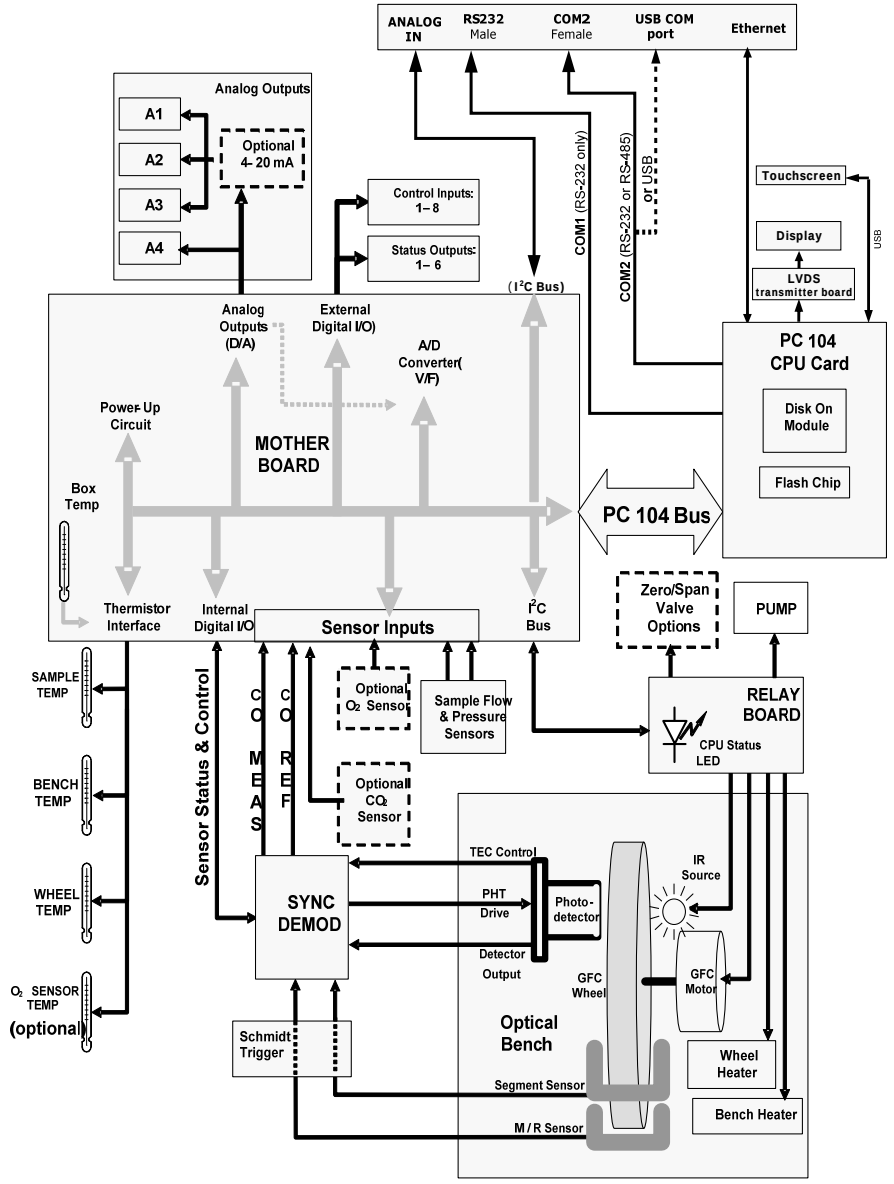
T200 Electronic Block Diagram



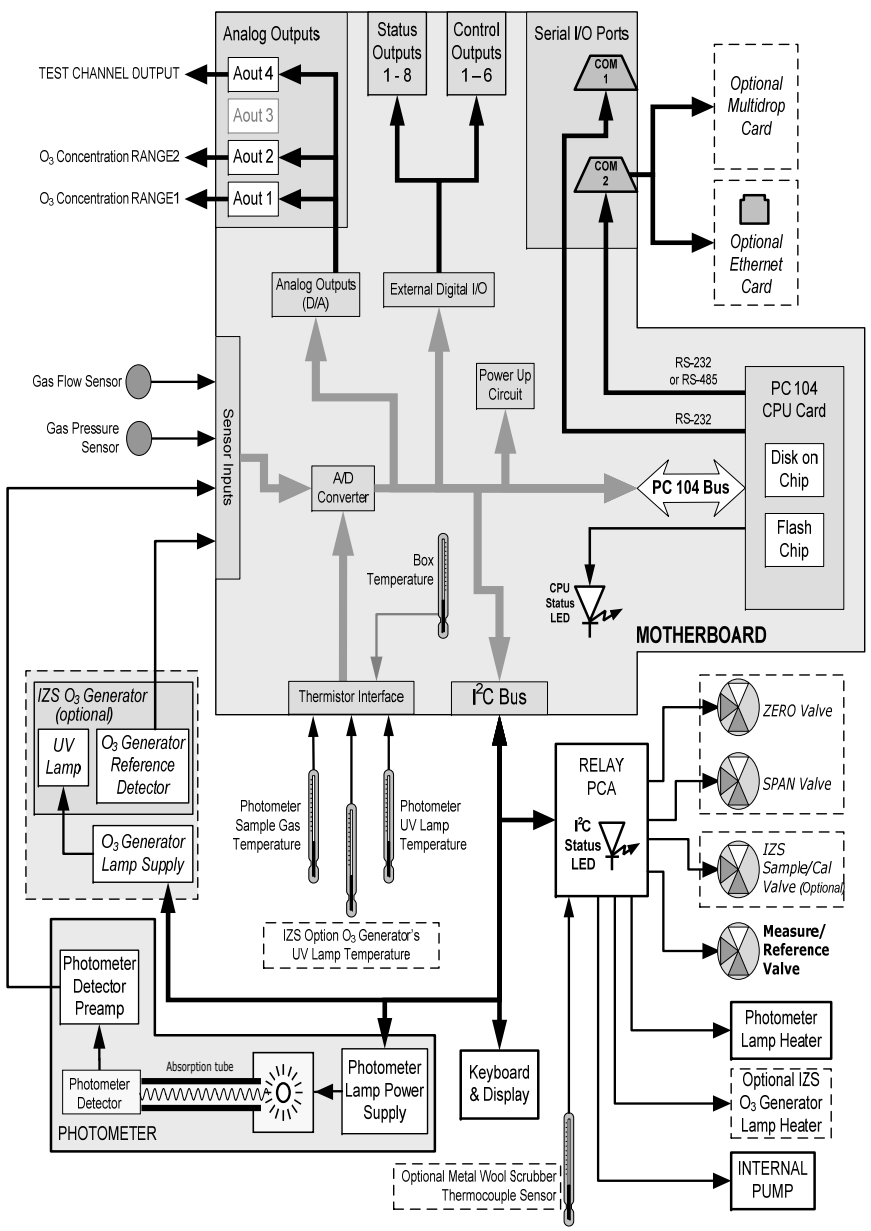
M300E Electronic Block Diagram



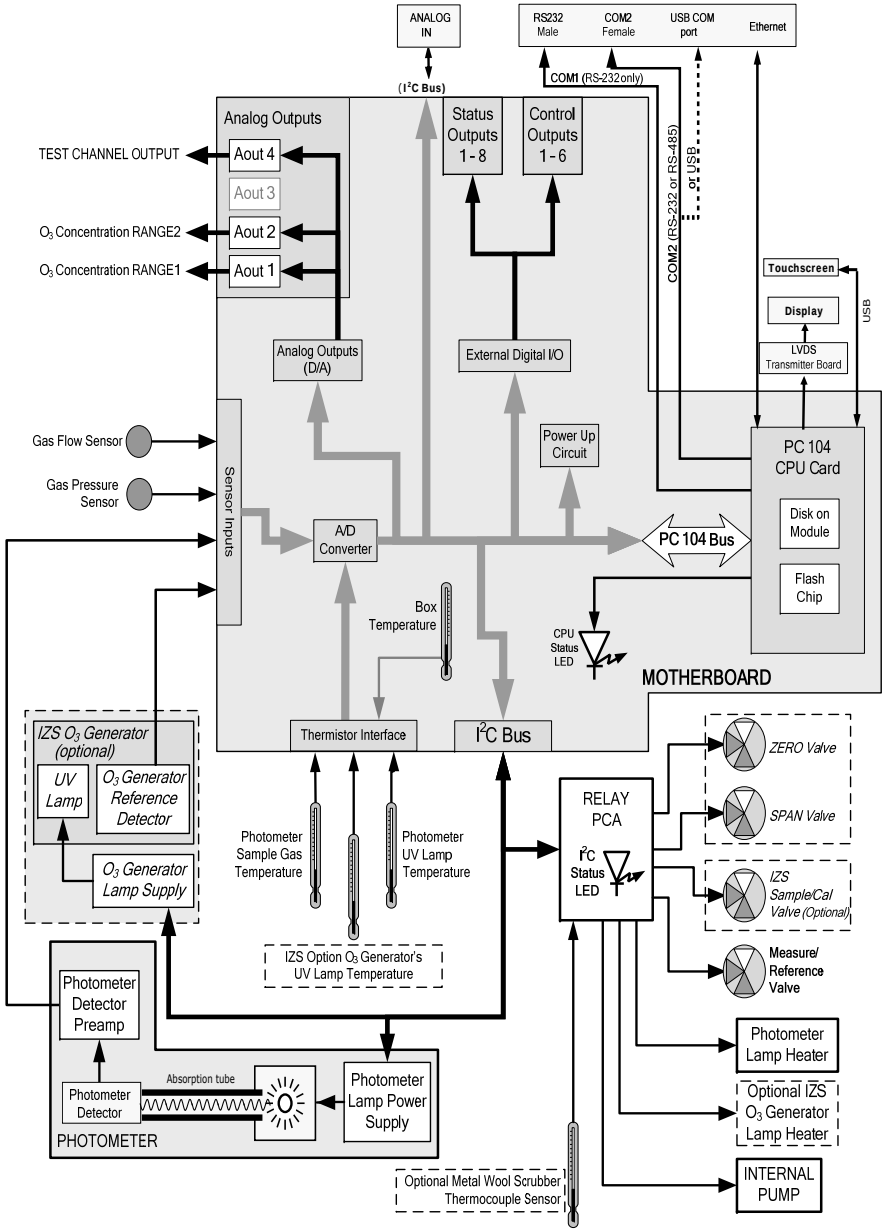
T300 Electronic Block Diagram

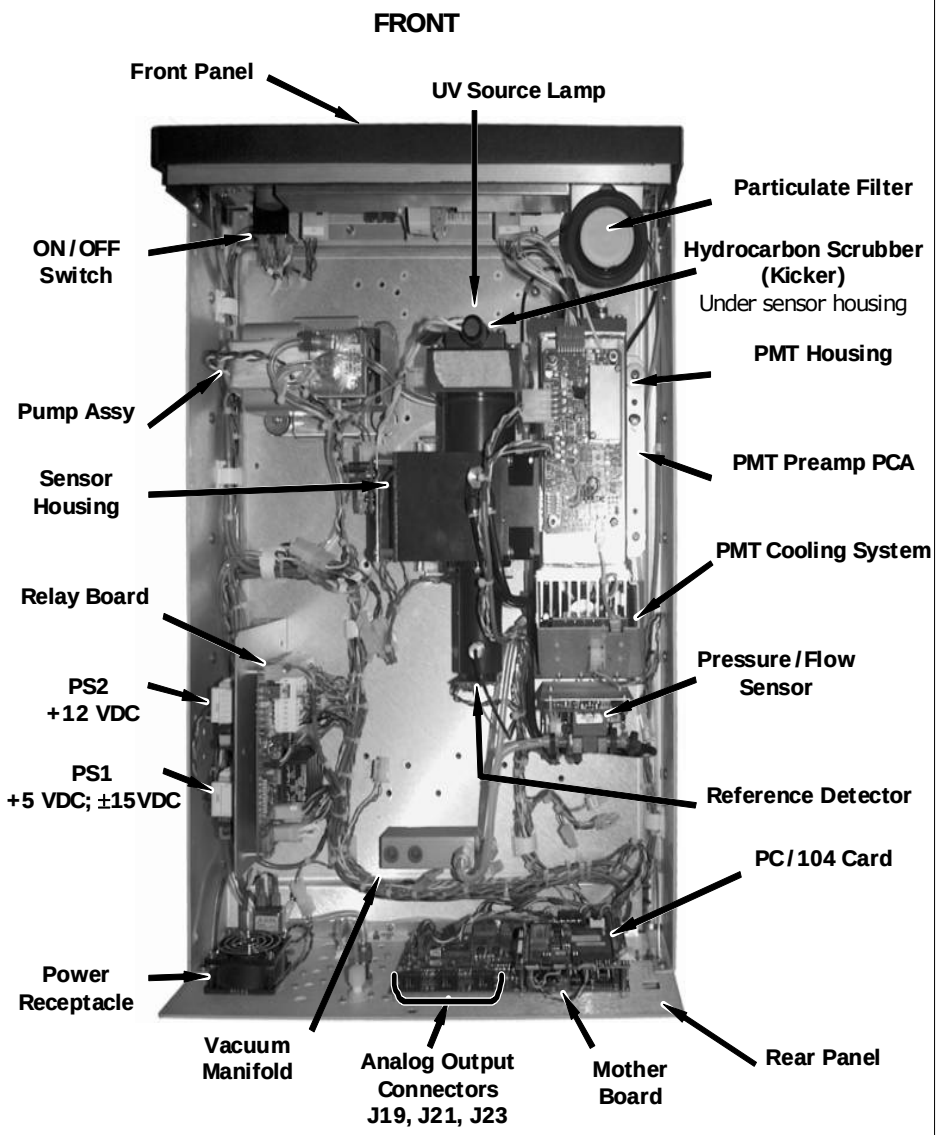


M400E Electronic Block Diagram

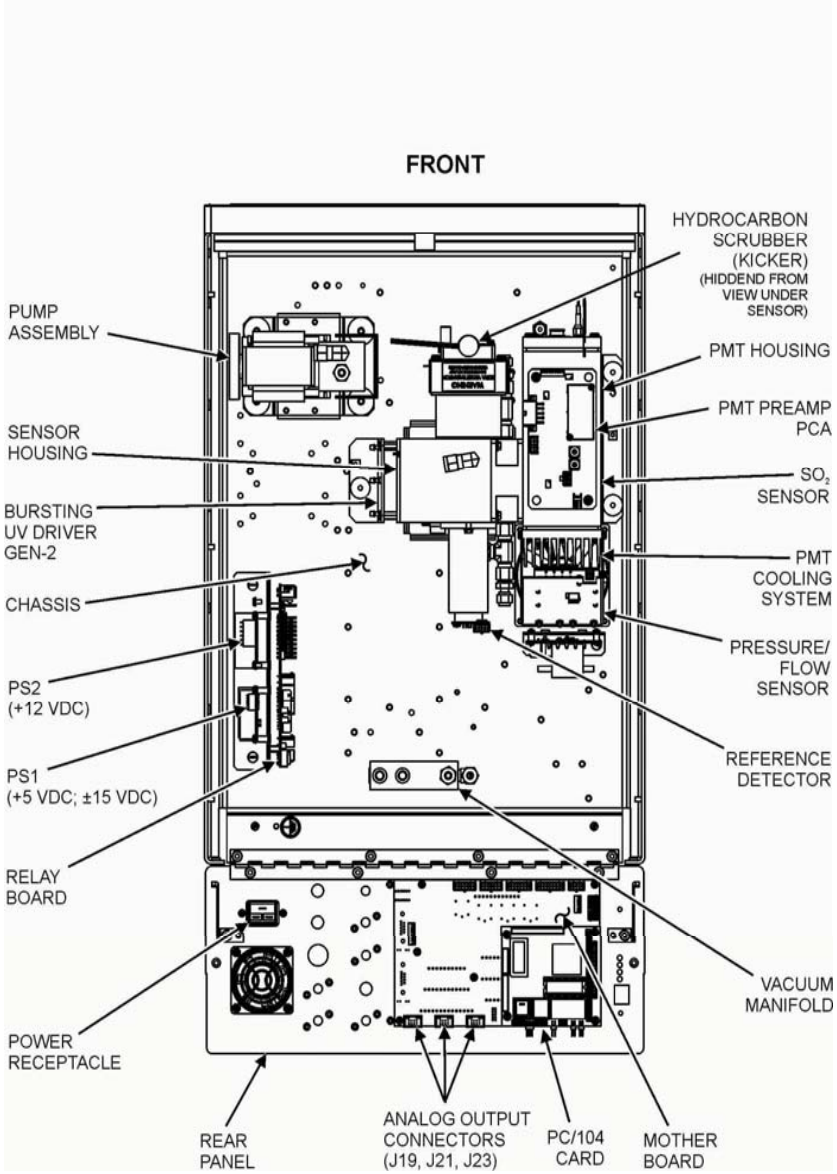


T400 Electronic Block Diagram

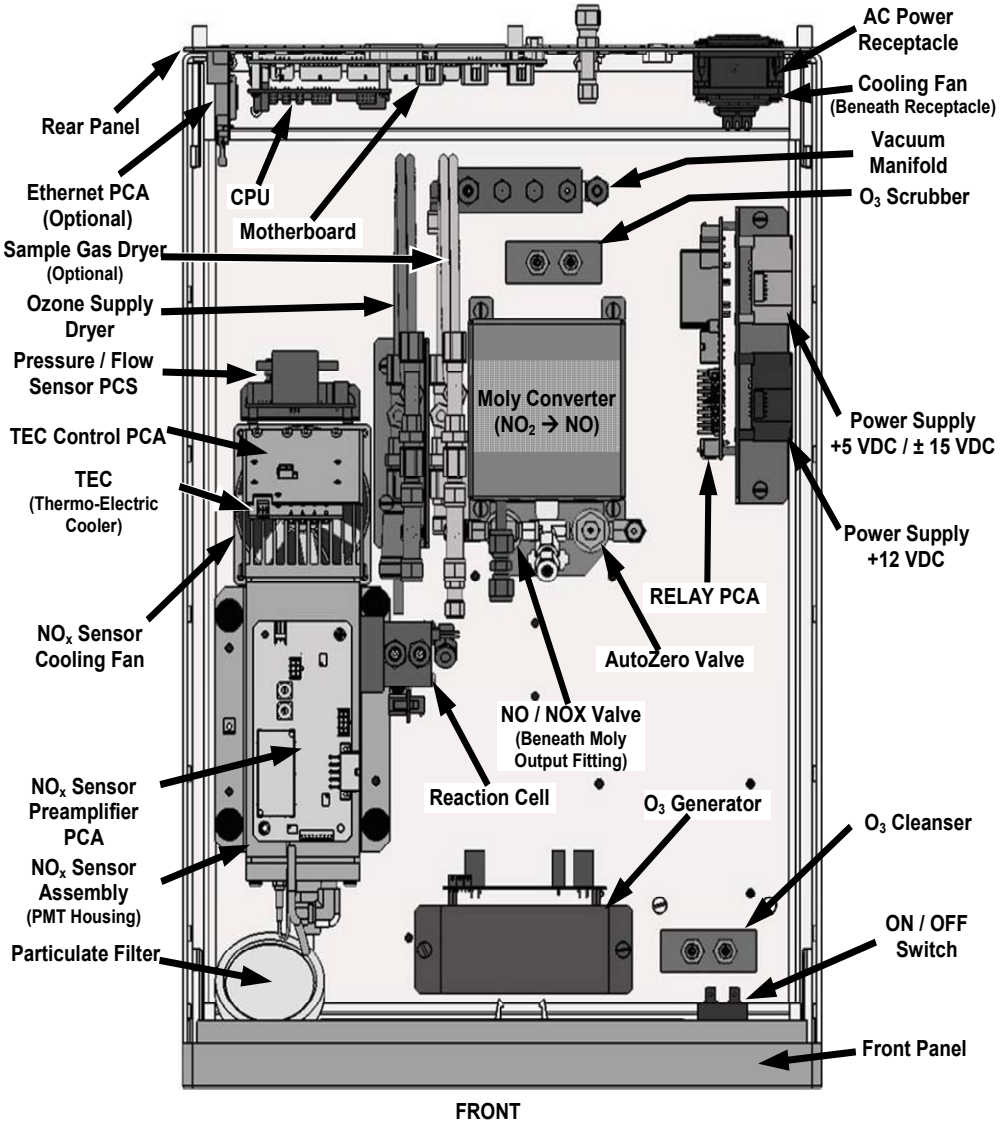




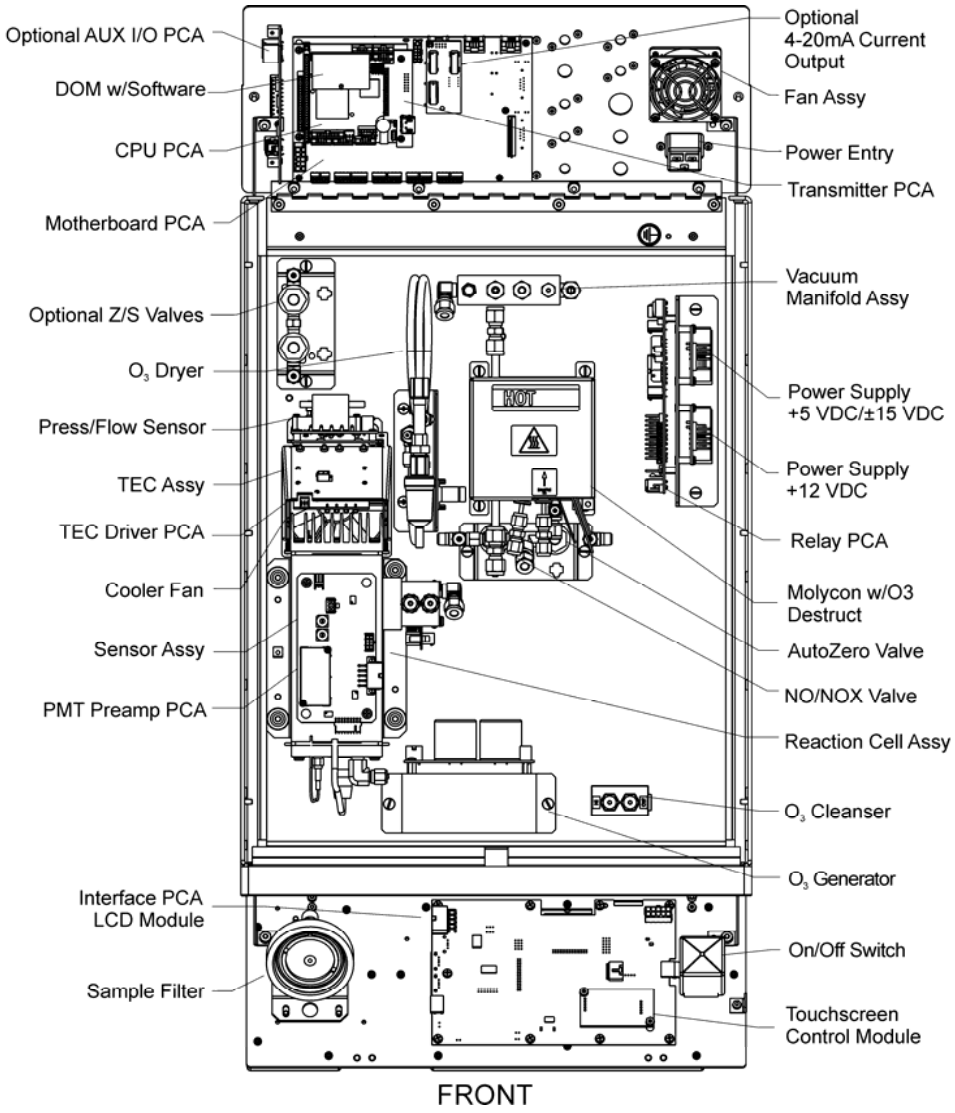
M100E Layout



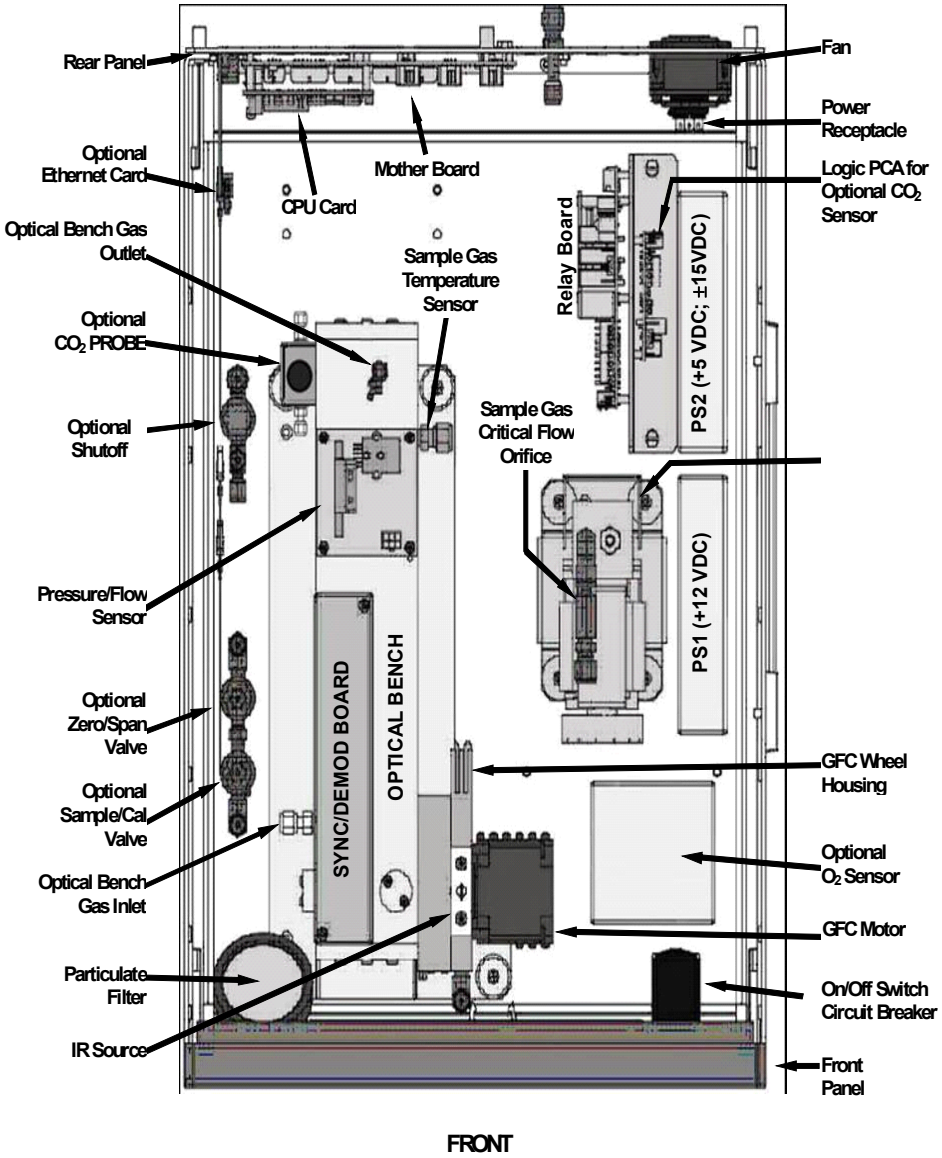
T100 Layout



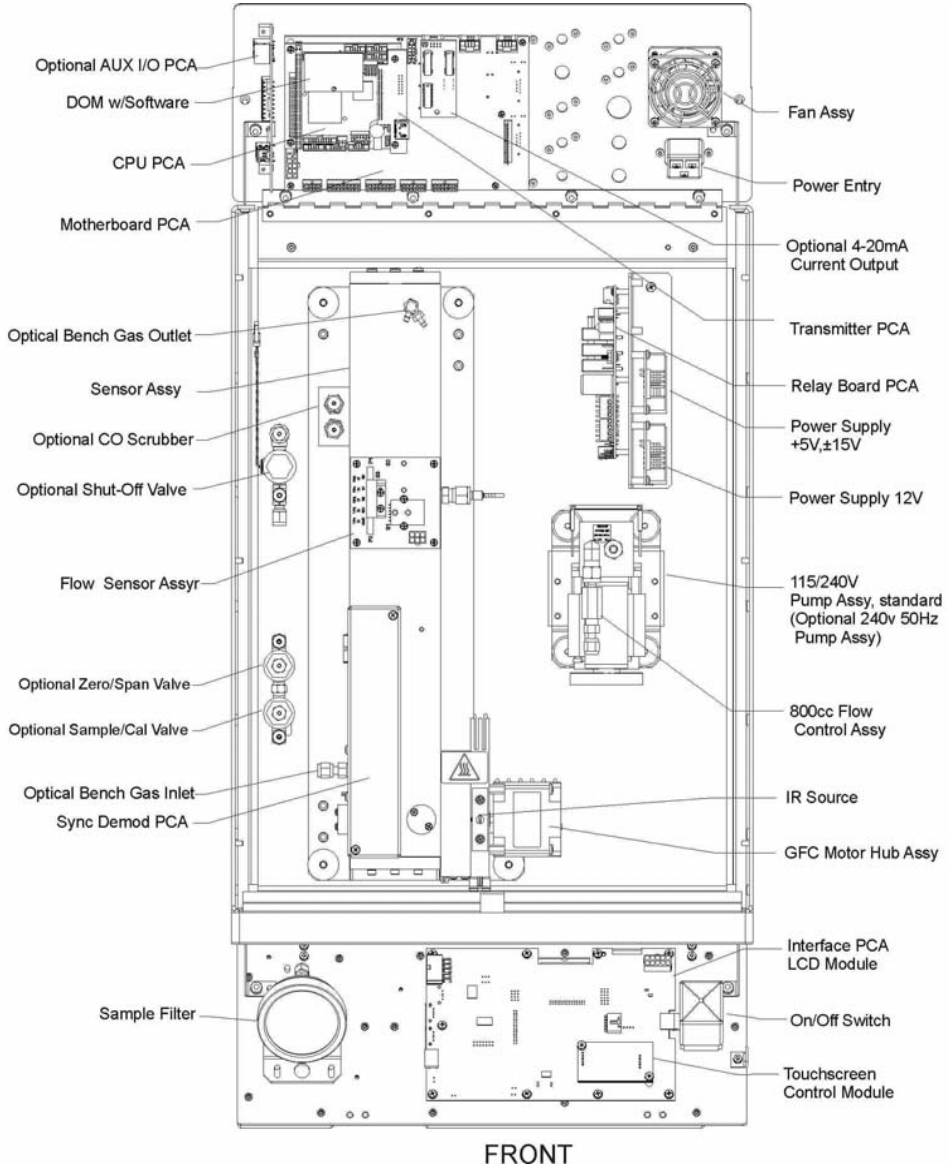
M200E Layout



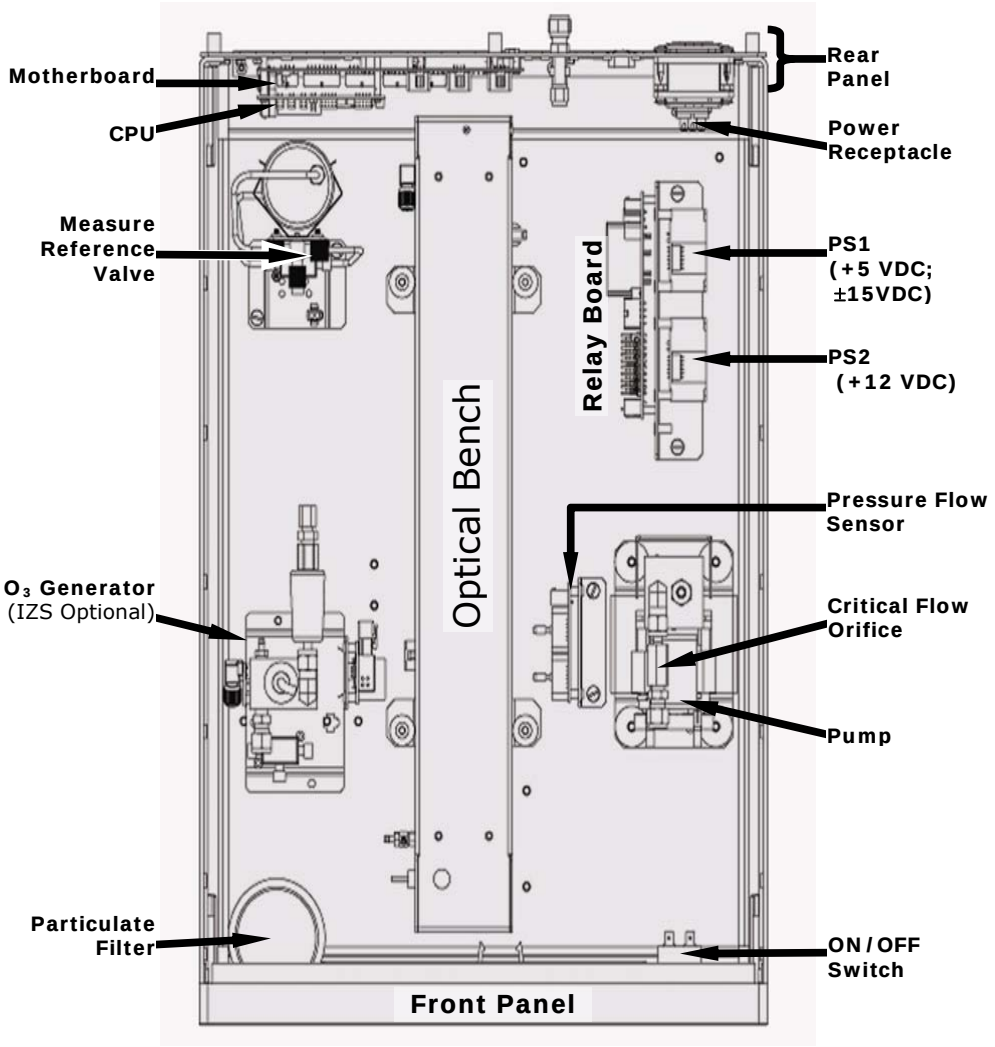
T200 Layout



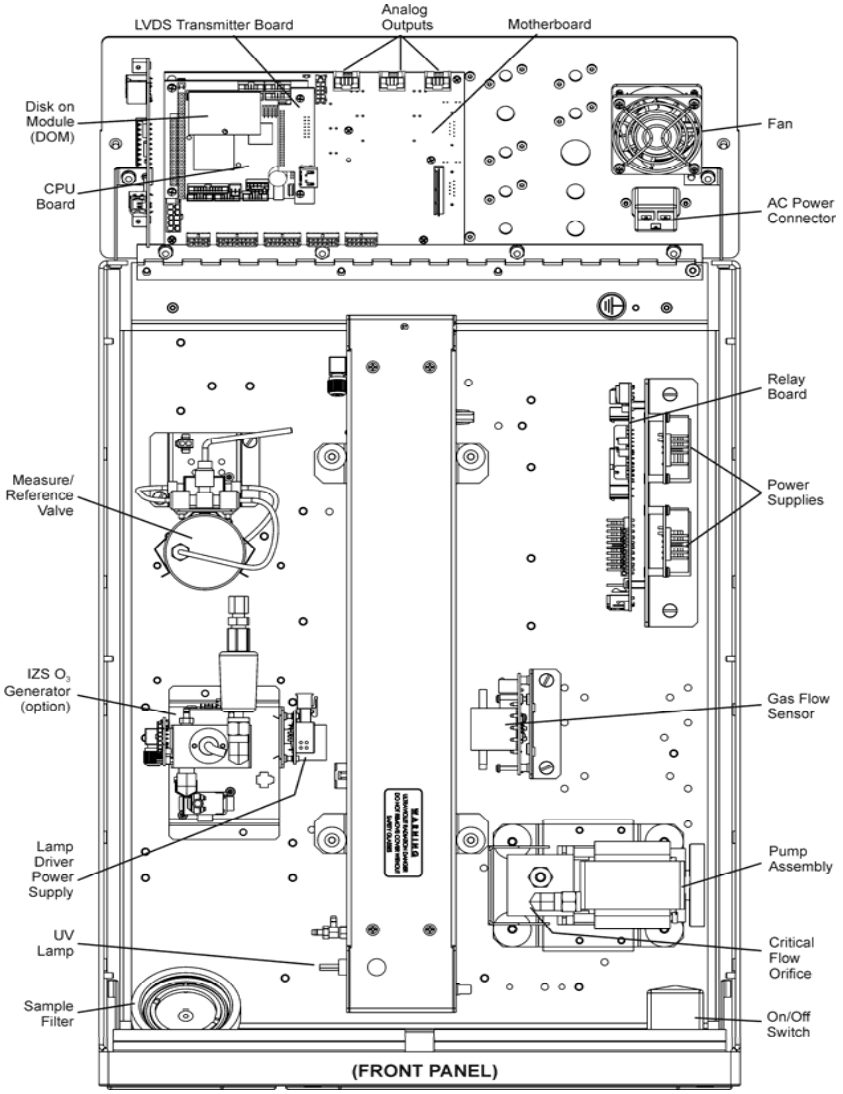
M300E Layout



T300 Layout

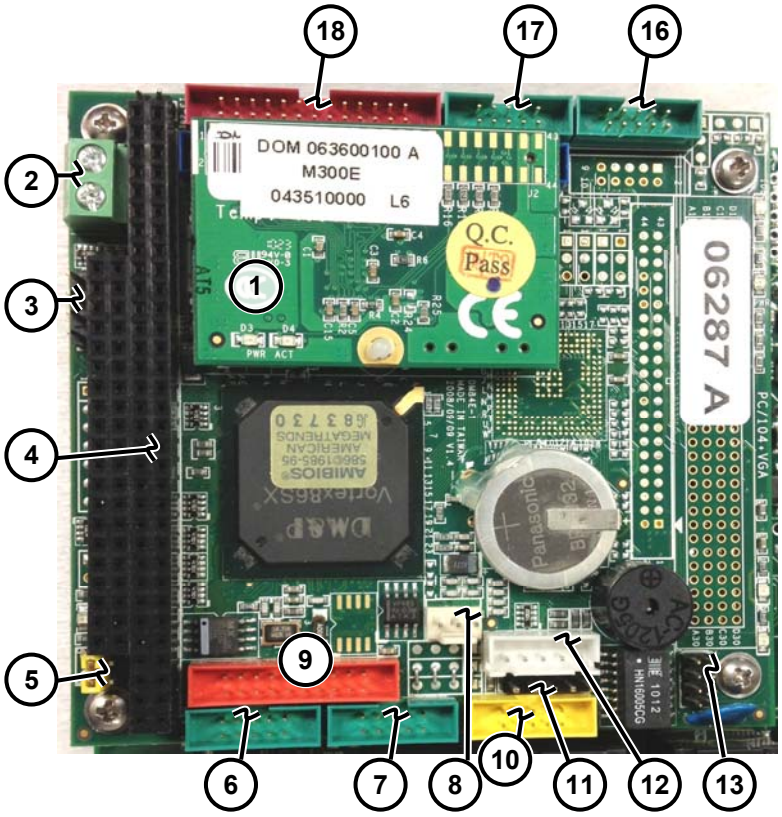


M400E Layout

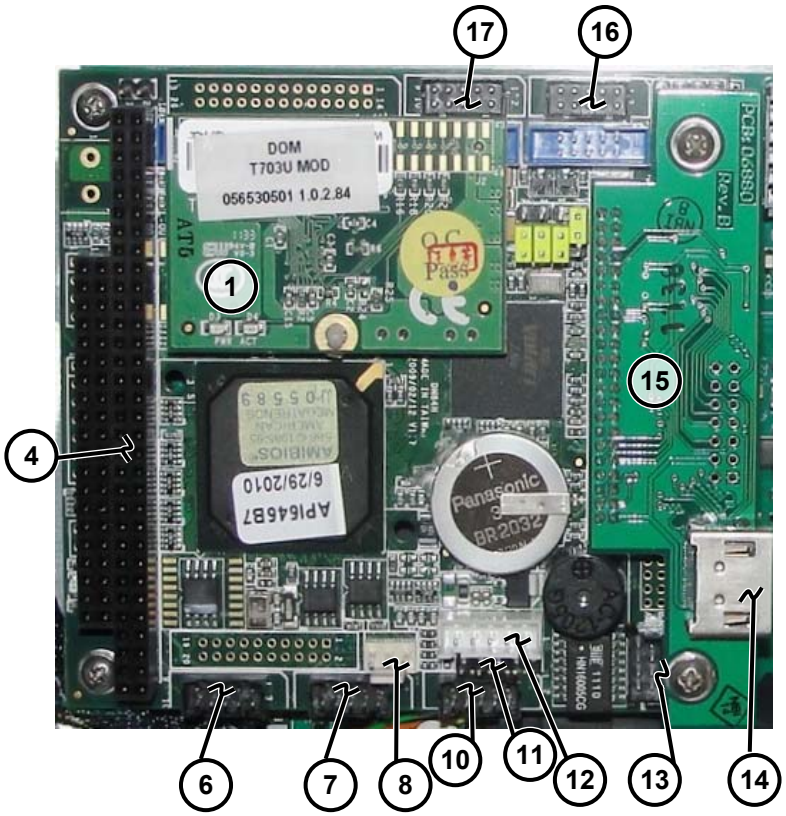


T400 Layout

E Series ICOP CPU Assembly



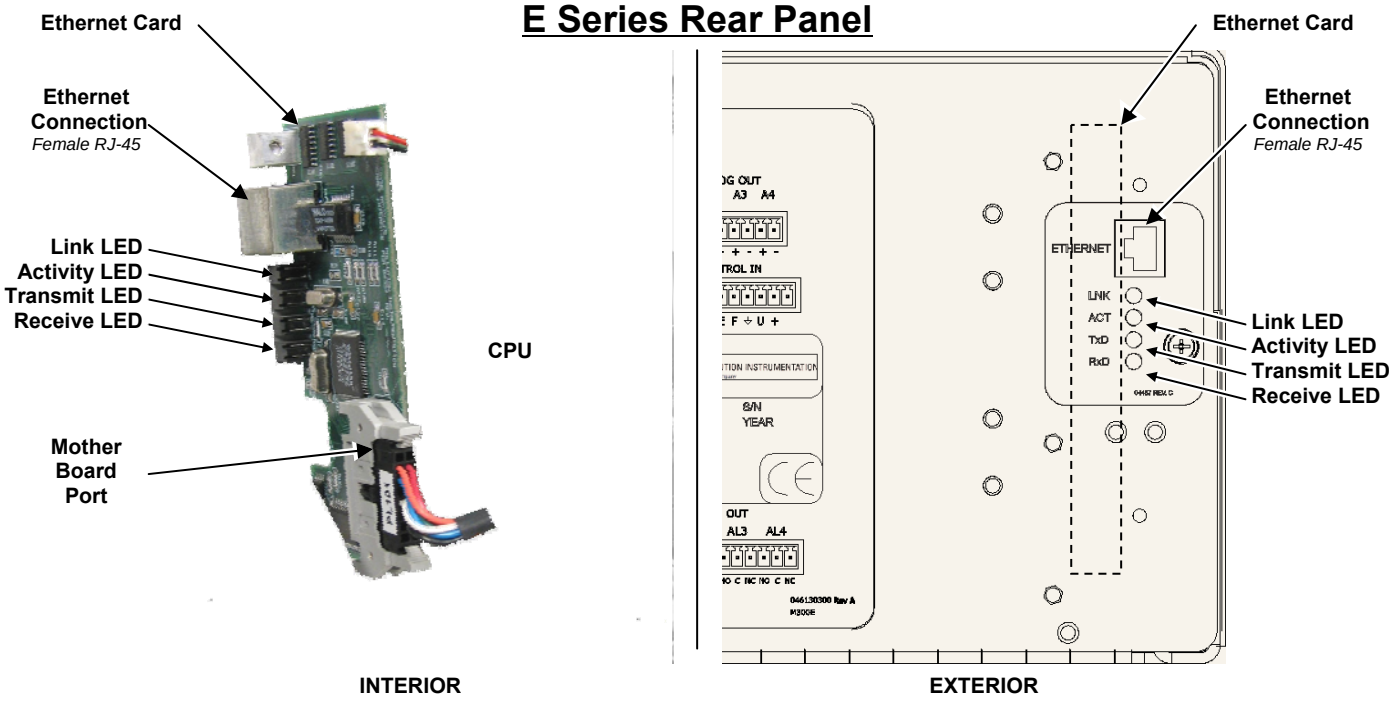
T Series ICOP CPU Assembly



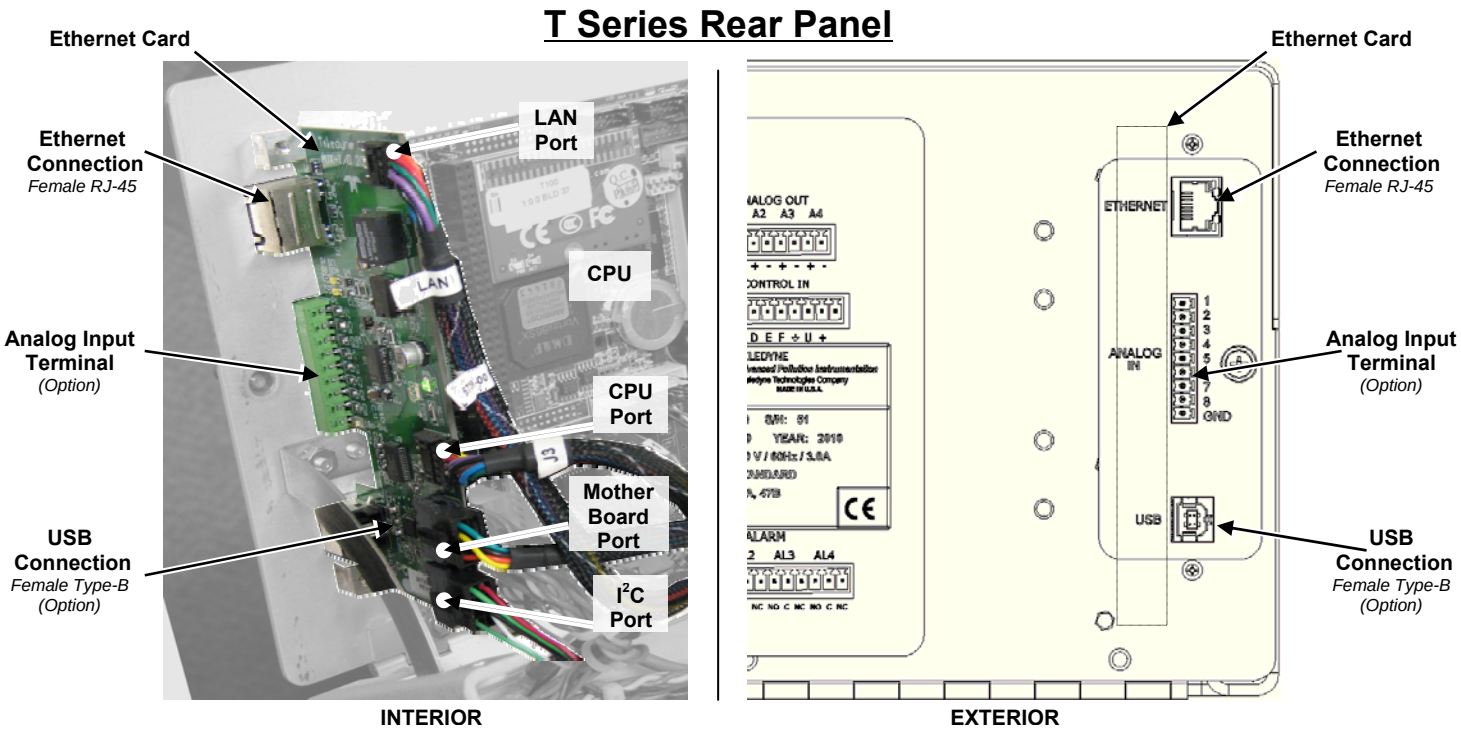
	CPU PORT IDENTIFICATION
1	Disc-On-Memory, model and firmware rev
2	Power Connector *
3	Power Flexible DC Power Connector *
4	PC/104
5	RS-232 / RS-485 Jumper
6	COM1 RS-232 only
7	COM2 RS-232 / RS-485
8	RS-485
9	GPIO *
10	USB Port
11	PS/2 Mouse *
12	PS/2 Keyboard *
13	LAN
14	HDMI Port
15	LVDS Transmitter Board
16	COM4 RS-232 *
17	COM3 RS-232 *
18	Parallel Port *

** Denotes Port / Component is not utilized*

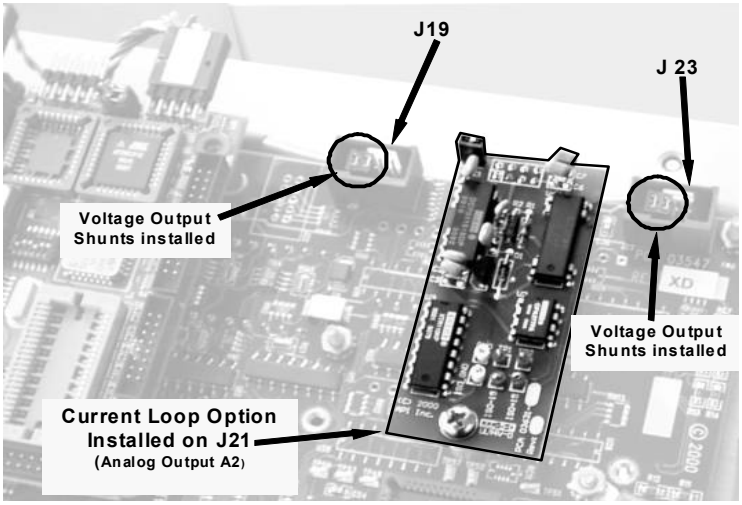
E Series Rear Panel



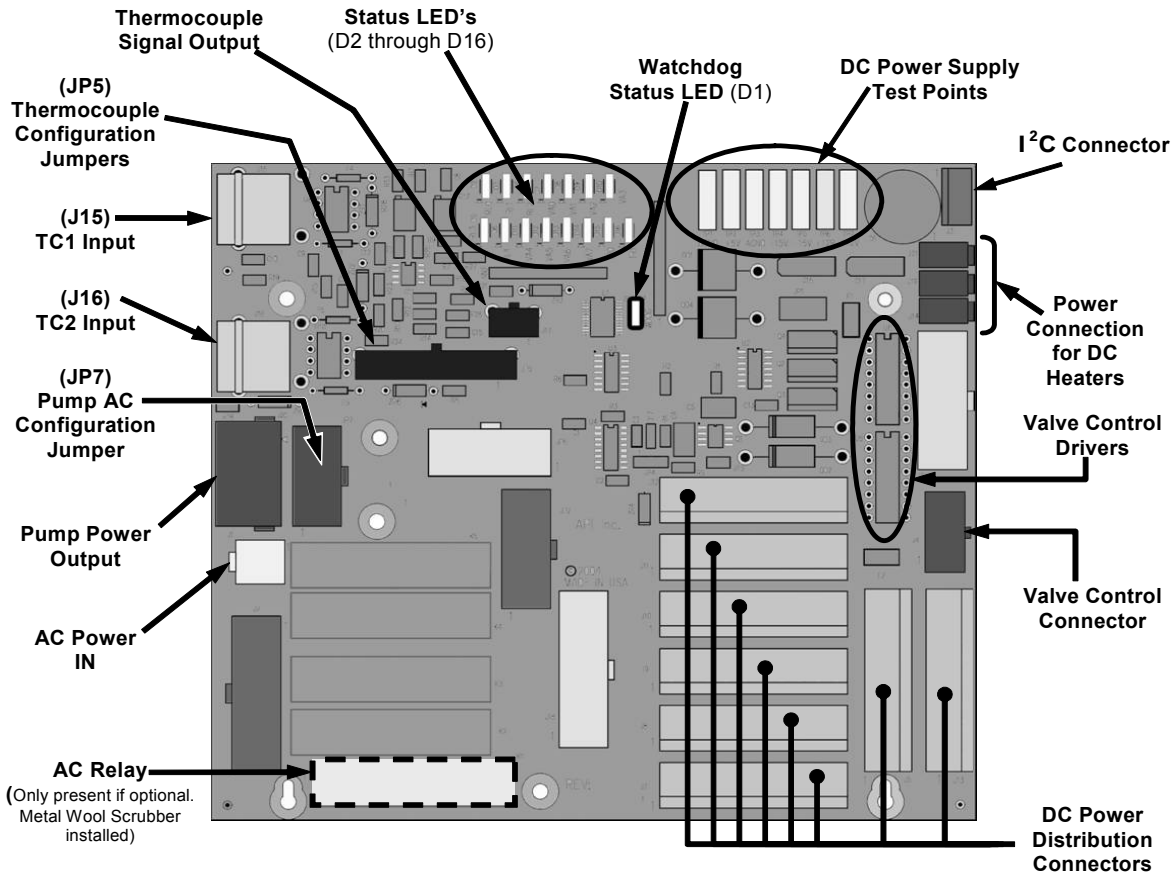
T Series Rear Panel



Current Option Installed on the Motherboard



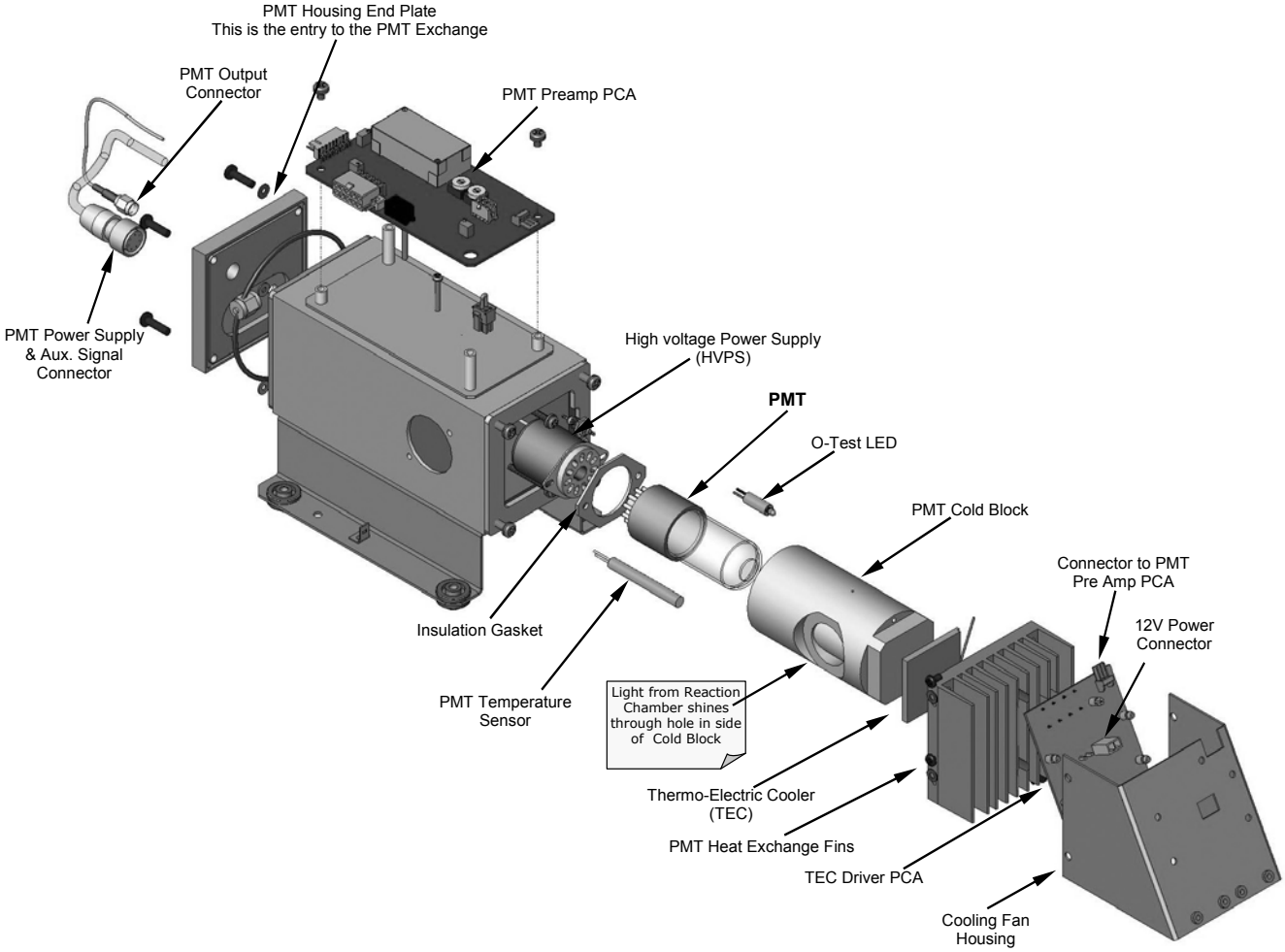
4.3 Relay Board And Power Supplies



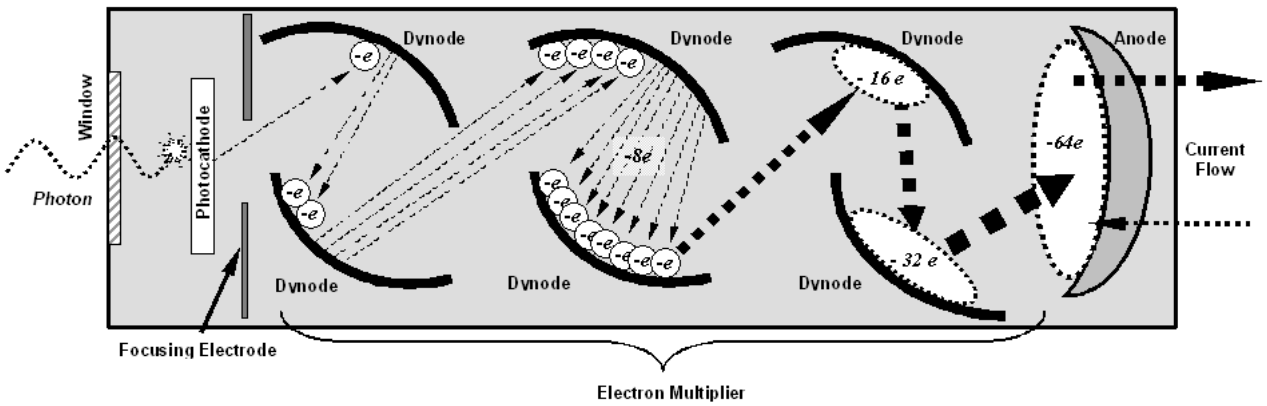
Relay Board Layout

LED	COLOR	100E	200E	200EM/EH	300E / EM	400E	700E
D1	RED	Watchdog	Watchdog	Watchdog	Watchdog	Watchdog	Watchdog
D2	YELLOW	RxCell heater	RxCell heater	RxCell heater	Wheel heater	Metal wool heater	X
D3	YELLOW	X	NO_2 converter heater	NO_2 converter heater	Bench heater	X	X
D4	YELLOW	X	manifold heater	manifold heater	X	X	X
D5	YELLOW	IZS heater	IZS heater	X	S/C valve	X	X
D6	YELLOW	X	O2 sensor heater	O2 sensor heater	Z/S valve	X	X
D7	GREEN	Z/S valve	Z/S valve	Z/S valve	SO valve	Z/S valve	Meas/Ref Valve
D8	GREEN	S/C valve	S/C valve	S/C valve	IR Source	M/R valve	O_3 Gen Valve
D9	GREEN	X	AZ valve	AZ valve	X	S/C valve	Pump
D10	GREEN	X	NO/NOx valve	NO/NOx valve	X	X	X
D11	GREEN	UV shutter	X	X	X	X	X
D12	GREEN	X	X	X	X	X	X
D13	GREEN	X	X	X	X	X	X
D14	GREEN	X	X	X	X	X	X
D15	GREEN	X	X	X	X	Photo lamp heater	Photo lamp heater
D16	GREEN	X	X	X	X	Gen lamp heater	Gen lamp heater

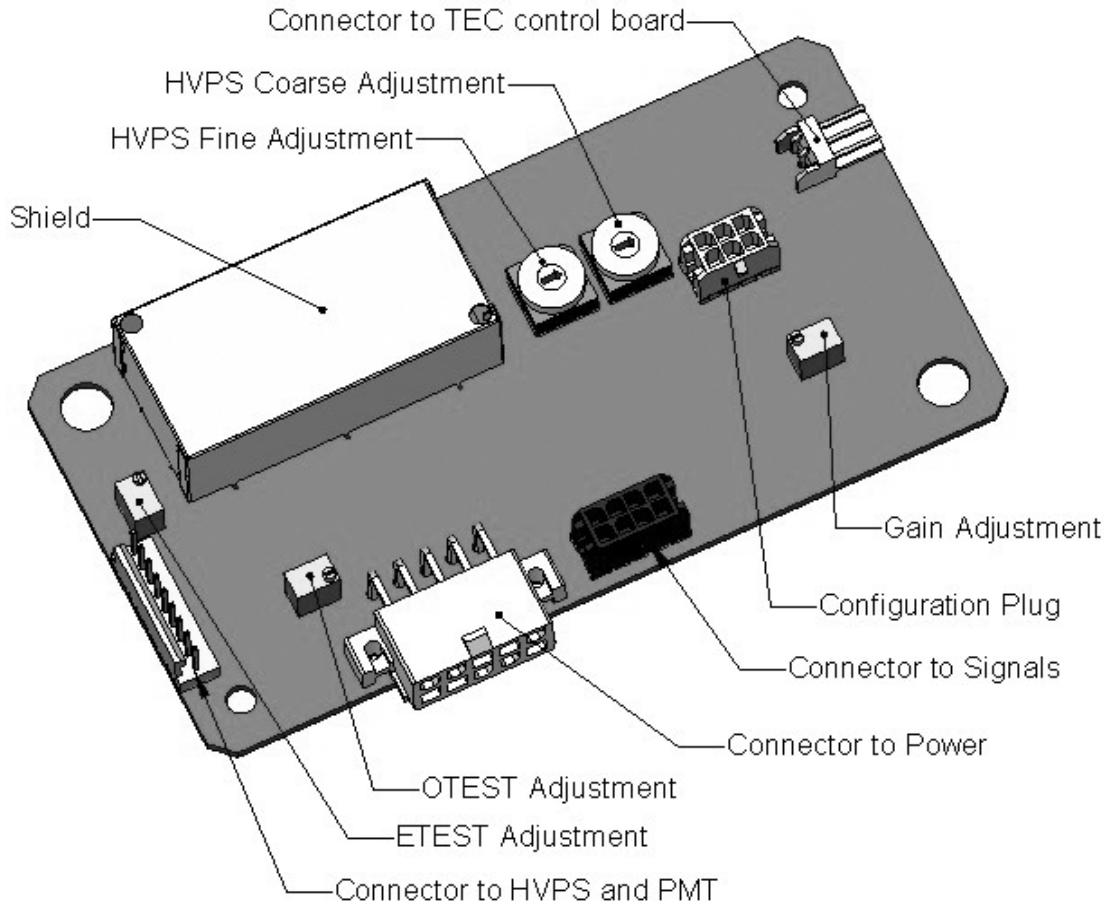
Relay Board Status LEDs



PMT Housing Assembly



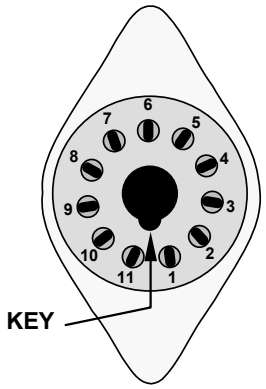
Basic PMT Design



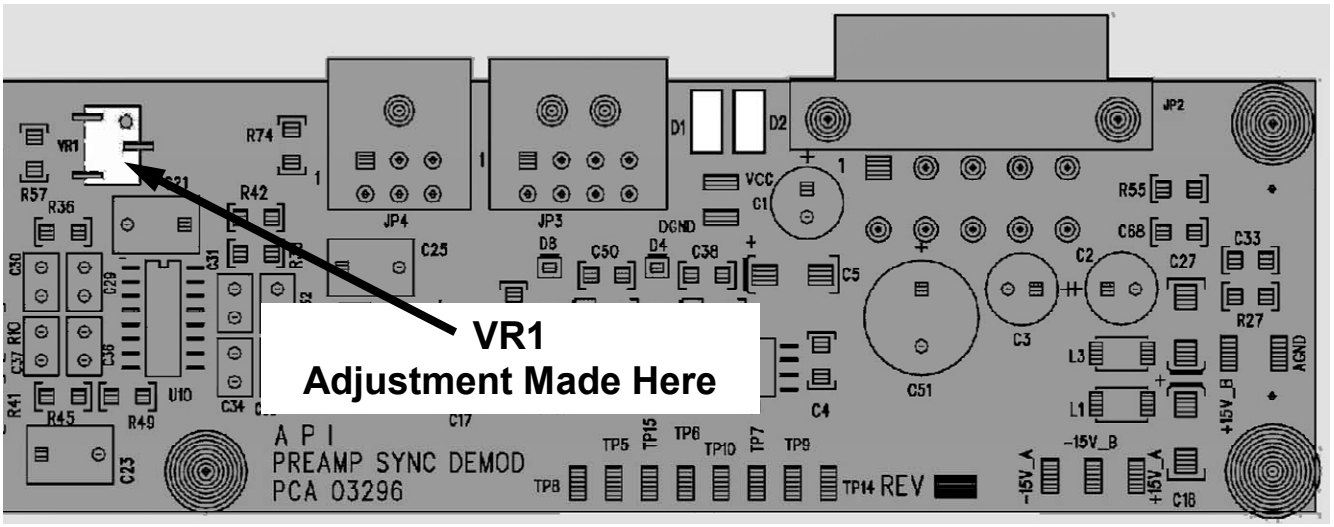
Preamp Board Layout

If **HVPS** reading = 700 VDC

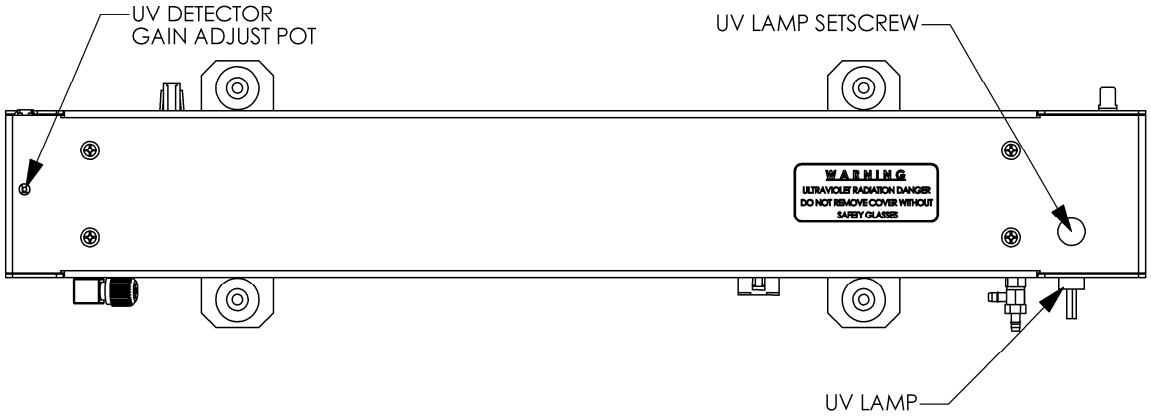
PIN PAIR	NOMINAL READING
1 → 2	70 VDC
2 → 3	70 VDC
3 → 4	70 VDC
4 → 5	70 VDC
5 → 6	70 VDC
6 → 7	70 VDC
7 → 8	70 VDC



HVPS Pin out



Location of M300E / T300, Sync/Demod Gain Potentiometer



Location of M400E/T400 UV gain potentiometer

User notes:

CHAPTER 5: COMMON FAILURE MODES

5.1. M100E/T100
- 5.1.1. Stray Light
- 5.1.2. Lamp Fails Often
- 5.1.3. Shutter Warning
- 5.1.4. High stray light/no zero button

5.2. M200E/T200
- 5.2.1. Drifty
- 5.2.2. Non-Linear Response
- 5.2.3. A-Zero Warning

5.3. M300E/T300
- 5.3.1. Non-linear at top end
- 5.3.2. Drifty
- 5.3.3. Goes Negative
- 5.3.4. Sync or Source Warning
- 5.3.5. Always noisy, span or zero

5.4. M400E/T400
- 5.4.1. Reading too low or no span button
- 5.4.2. IZS drift
- 5.4.3. Noise in the analyzer
- 5.4.4. Troubleshooting Noise in M400E Analyzers Service Note 04-011

5.5. M700E/T700 & M701
- 5.5.1. M700E fails leak check
- 5.5.2. Non Linear
- 5.5.3. O_3 Generation Problems
- 5.5.4. M701 runs all the time

5.6. Top 5 Common Analyzer Problems

5.1. M100E/T100

5.1.1 High Stray Light

5.1.1.1 UV Filter has excessive pinholes (See figure 5.1 and 5.2). Use a flashlight to test. Pinholes allow non-214ηM and visible blue light from lamp into RxCell increasing stray light. Replace UV filter.

5.1.1.2 Contamination of RxCell. Remove end-cap and examine inside of RxCell and PMT filter. Contamination of black TFE surfaces increases reflectivity of RxCell walls, causing increase in stray light. Clean with distilled water and a lint free cloth.

5.1.1.3 Contamination of PMT filters. Typically caused by a leaking PMT housing. Contamination is found on PMT side of PMT filter. Remove RxCell housing from PMT housing. Clean PMT filter. Replace the silica gel in the PMT housing whenever the inspection plate is removed. This is very important as if water gets into the HVPS it will fail.

Figure 5.1
Bad UV Filter (too many pinholes)

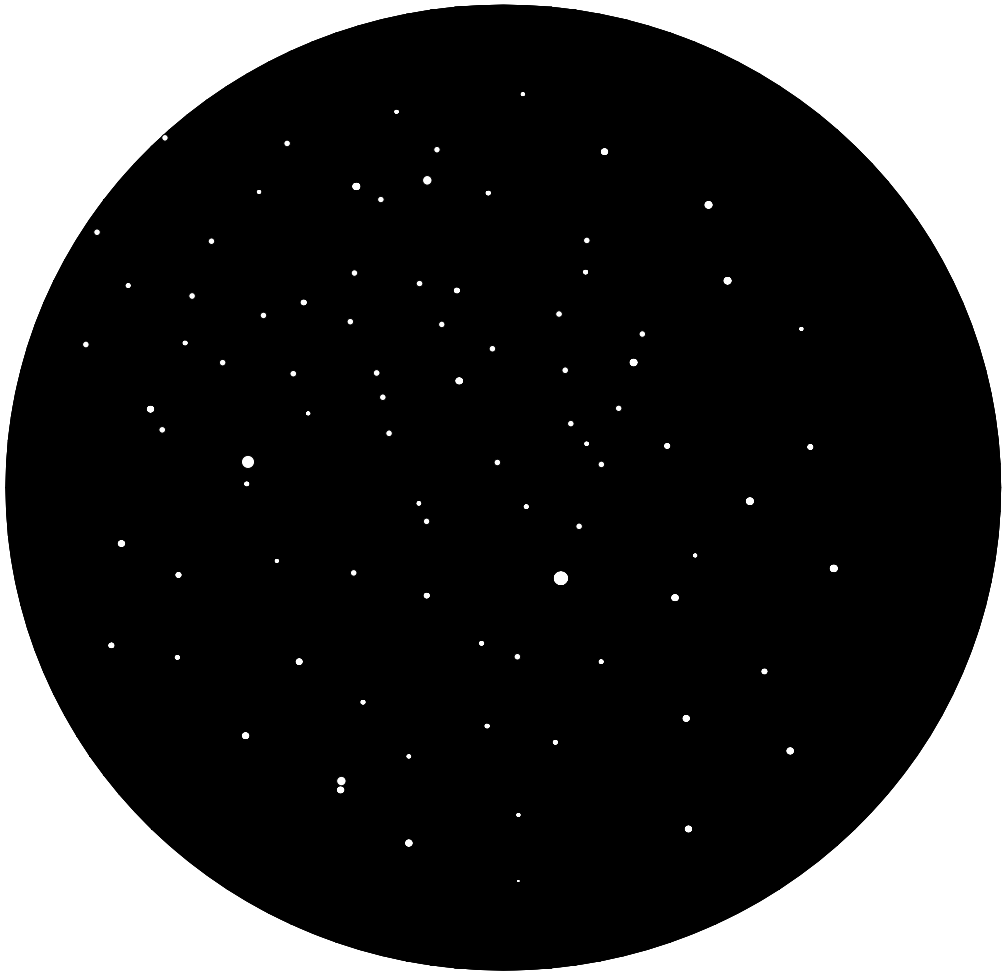
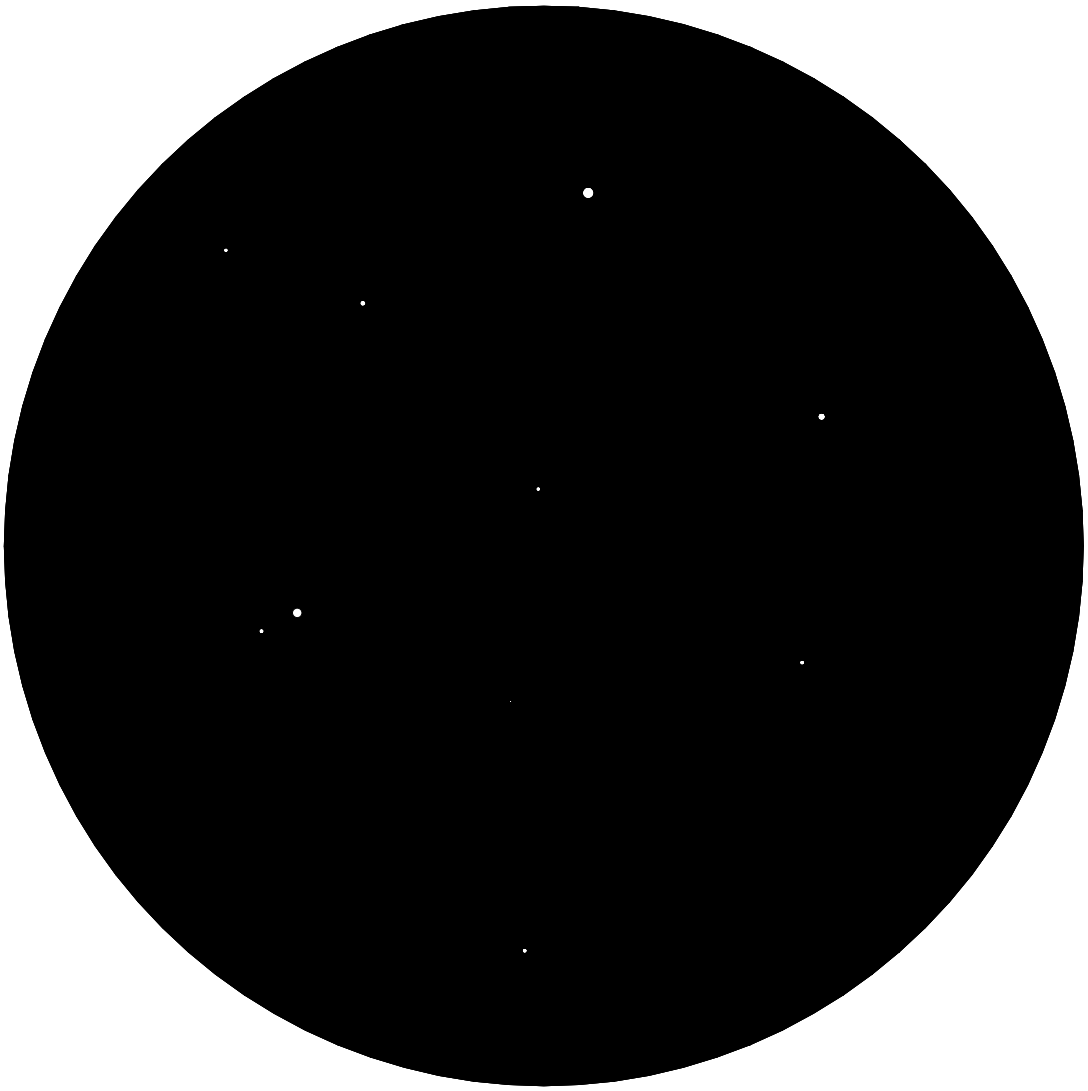


Figure 5.2
Good UV filter (Not too many pinholes)



5.1.2 Lamp Fails Often

5.1.2.1 UV filter has excessive opacity. The UV filter at best only transmits about 15% of the 214ηm energy that hits it. Over a period of years the filter becomes more opaque and less of this energy can pass through. Eventually the transmittance drops so low that even a new lamp cannot provide sufficient energy. Replace UV filter.

5.1.2.2 Failing detector. The detector occasionally will become insensitive to UV light. This is usually seen as a steady decrease in UV energy over time. A new lamp will not achieve sufficient brightness. If a new lamp cannot be adjusted to at least 4000mV, and you have replaced the UV filter, then the detector is likely failing.

5.1.2.3 Incorrect UV driver board. There are a few different versions of UV driver board that were used on the "E" Series of SO_2 analyzers. Make sure there is a yellow dot in the upper left hand corner of the board. If this dot is not there, contact TAPI customer service for a replacement.

5.1.3. Shutter Warning

5.1.3.1 Verify shutter function. Push TST button to view PMT mV on front panel. Manually close the shutter. If the PMT is reading >150mV, the shutter is not the problem. If the PMT is reading <150mV, then go to Signal I/O and turn the shutter on. While in the Signal I/O, scroll to the PMT signal and verify the signal is now <150mV. If the PMT is <150mV when the shutter is manually closed, but >150 when the shutter is closed in Signal I/O, then the shutter is faulty. Replace the solenoid.

5.1.3.2 Excessive HVPS setting. HVPS set to >800Vdc during calibration. This is typically an indication that there is insufficient signal to the PMT. Often caused by a dirty PMT filter (RxCell side or PMT side). Refer to section 5.1.1.2 and 5.1.1.3 above for cleaning instructions. If the filter is unable to be cleaned, it will need to be replaced.

5.1.3.3 Failing PMT or HVPS. Experience tells us that the HVPS is usually the cause when other sources of shutter warning are eliminated. However, if you have a spare PMT handy, it is much easier to swap the PMT and see if that fixes it. If not, or if you do not have a spare PMT, replace the HVPS.

5.1.3.4 Try "Troubleshooting a Dark Cal / Shutter Warning in a SOX Analyzer" Service Note 12-013A

5.1.4 High stray light/no zero button.

5.1.4.1 Perform a factory calibration. The gain may be set too high, and performing a factory calibration will bring the gain back to reasonable levels.

5.1.4.2 A weak signal is forcing the gain of the PMT to be increased too high. Leak check. Flow check. If the H_2S or the TRS analyzer, bypass scrubber and calibrate using SO2.

5.1.4.3 Dirty PMT filter/RxCell. Open the end-cap on the RxCell (Power off) and observe if the PMT filter is clean. A normal filter will appear dull purple/blue. If coated with iridescent sheen or is obviously dirty, clean with de-ionized water and a lint free cloth. Also clean inside of RxCell.

5.2 - M200E/T200

5.2.1 Drift. When the PMT signal is decreased, the analyzer's concentration will drift down.

5.2.1.1 The two main causes of this are:

- A decrease in the amount of light created in the RxCell.
- A decrease in the amount of light reaching the PMT. Often the most difficult part of troubleshooting drifts is in determining which of the two situations is occurring.

In either of these cases the first things to check are leak check and flow check. Next, inspect the reaction cell.

5.2.1.2 Leak check. Verify flows, including AZERO flow. Open the RxCell and examine for any wetness or sticky substances. Normally the RxCell sleeve and window are clean and dry, with only a gray-colored coating on the window and the sleeve.
If you notice any liquid or sticky substances, this could indicate failure of the dryer or the presence of liquid water in the sample. Locate/repair source of water. Clean the RxCell.

5.2.1.3 Crystals in the RxCell. Salt crystals in the RxCell can build up when the sample contains NH_3. Clean the RxCell. If the problem persists you will need to either install a Perma-Pure drier on the sample inlet of the analyzer or a NH_3 Scrubber before the sample inlet on the back of the analyzer.

5.2.2 Non-linear response.

Leak check. Flow check. RxCell Pressure good? Slope? Clean the RxCell. Try a different source of Zero and/or Span gas.

5.2.3 A-zero Warning

5.2.3.1 Leaking A-Zero valve. Input zero air. Wait 5 minutes. Clear the warning. Wait 10 minutes. Record the A-zero value (if still getting the warnings, the valve is not the problem). Input span gas. Wait 15 minutes. Observe the A-Zero value. If the value increases more than 5mV, the valve is leaking and should be replaced.

5.2.3.2 Light Leak. Cover off the analyzer. Wait 10 minutes. Record A-zero.
Cover on the analyzer. Wait 10 minutes. Observe A-zero. If the value changes more than 10mV, the analyzer has light leak.

5.2.3.3 HVPS/PMT. Enter DIAG-SIGNAL I/O. Scroll to AZERO valve and turn it on. Scroll to PMT DETECTOR. If the signal is >150mV then problem is HVPS, PMT or preamp. Next, disconnect the white coax cable that runs from the preamp board to the PMT housing. If the PMT DETECTOR signal is still high, the preamp is the problem. If it drops down close to zero, it is the HVPS or PMT. Experience indicates this is generally the HVPS, but the PMT is easier to swap. If you have spare PMT try that. Otherwise replace the HVPS.

5.2.3.4 Try "Troubleshooting A-Zero Warnings in M200Ex/T200X analyzers"
Service Note 12-003A

5.3- M300E/T300

5.3.1. Non-linear at top end.

If the analyzer is linear and working well between 0 and 100PPM, but not linear above 100PPM, the causes are different from those related to low-end non-linearity. Use the linearity adjust to bring the mid points closer to the target value. Make sure the pressure is properly calibrated to the pressure at the site.

5.3.2 Drifty.

Drift can come from a number of causes. Leak check. Flow check. Upward drift of zero could indicate a leaking wheel.

5.3.3 Goes negative.

Negative readings are often caused by differing CO_2 levels in the gas. Verify that the calibration gas contains CO_2 values close to what is expected in the stack. Failing source. Replace. Failing detector. All IR products will drift slightly negative at zero. As long as the drift is within factory specifications we pronounce it good.

5.3.4 Sync or source warning.

This is usually caused by a failed source, detector, or wheel. Verify that source is lit. If not, measure source voltage, it should be around 11.6V. Replace the source. If source is good then make sure the wheel is spinning. Either look at the two flashing red LEDs on the detector board or put a small tool on the shaft coming out of the motor connecting to the wheel. If the motor is spinning and the source is lit then the detector and detector board should be replaced. If water is sucked into analyzer, mirrors will be damaged and this symptom will appear. Reference service note 05-026 for more information.

5.3.5 Always noisy at span or zero.

Using an oscilloscope, look at the two square waves coming off the opto-pickup board. These two signals can be viewed on TP1 and TP2, or TP2 and TP4, depending on which style opto-pickup board you have. These should be clean square waves with a 50% duty cycle. Verify detector signal has 6 large and 6 small pulses. Verify that tops and bottoms of pulses are flat. If ragged, wheel is dirty. Adjust opto input and output mirrors as needed.

5.4 - M400E/T400

5.4.1 Reading too low or no span button.

Generally caused by leaks, a failed O3 scrubber or a leaking switching valve. It could also be a low sample flow. Leak check and flow check. Input zero air. Record the REFERENCE mV value for 1 minute every time it changes on the front panel. Input span gas. Record the REFERENCE mV value for 1 minute every time it changes on the front panel. Look at the difference between the two sets of readings. If the REFERENCE decreased more than 2mV the analyzer has bad O3 scrubber or leaking switching valve.

5.4.2 IZS drift.

One type of IZS drift is a continually changing, up and down drift over a period of days and weeks. This is most often caused by humidity differences in the ambient air. Install a Dri-rite canister if not already installed.

Another type of IZS drift is a drift that continues in the same direction long term. This type of drift is often associated with a failing UV lamp or a faulty detector in the IZS tower. Place the IZS into CONSTANT mode and run for a period of time. If the drift is gone, then the problem is the detector. If the drift is still present, the lamp is bad.

If the IZS drift is a constantly increasing upward, then perform a flow check on the analyzer. Typically when the analyzer will keep reading the sample gas and any external gas correctly but the IZS span will drift up, the flow rate in the analyzer is starting to decrease.

5.4.3 Noise in the analyzer.

There are a couple of things that can cause noise in the analyzer; from the motherboard to the UV lamp. We have developed a detector simulator board which can be installed in place of the detector. This will apply a very constant 4096mv in place of the detector. This cuts the analyzer in half and lets you know if the noise is from the motherboard or somewhere in the bench. This board, part number 051010000, can be received from TAPI at no cost.

If the UV lamp is suspected to be bad, first make sure that the software version is at least version D.1 or higher. Then look at the step counts in step suppression of the DIAG menu. Replace the UV lamp and look at the step counts again. If they are better, the problem was in the UV lamp.

5.4.4 Try “Troubleshooting Noise in M400E Analyzers” Service Note 04-011

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Service Note

04-011C
2 Nov, 2012

TROUBLESHOOTING NOISE IN M400E ANALYZERS

I. PURPOSE:
This note serves as a guide to troubleshooting noise in M400E analyzers.

II. TOOLS:
None

III. PARTS:
API PN# 05101-0000 "UV detector simulator"

The electronics used in T-API analyzers are sensitive to Electrostatic Discharge (ESD). When working on any T-API device, please ensure that you are properly grounded prior to handling or touching any electronic circuitry in the analyzers! For more information on how to protect sensitive components from ESD during handling, please contact T-API customer service and ask for the ESD Service note number 03-022.

IV. PROCEDURE:

1. Press the TST button until you see O3REF= displayed on the front panel. Watch the voltage for a couple of minutes. It should not change more than .5mV.

2. Remove the cover. At the very end of the bench, toward the back of the analyzer, on the right side, locate the 8 pin connector (it has 4 wires connected to it). Remove this connector. Plug this connector into the 05101-0000 board. This will simulate a detector signal that is equivalent to a normal detector on zero air.

3. Press SETUP-ENTR-MORE-DIAG (on older software it will be SETUP-MORE-DIAG-ENTR). The top line of the display should show SIGNAL I/O. Press ENTR.

4. Press JUMP and enter the number 25. Press ENTR.

5. Press NEXT until you see PHOTO_DETECTOR. Watch this voltage for a few minutes and verify that it does not go above 4950mV. This voltage should not change more than 0.5mV or so.

6. Press NEXT until you see SAMPLE_PRESSURE. Verify that the voltage displayed does not exceed 4950mV (with the pump running). If it is above 4950mV then the pressure/flow board is bad and must be replaced.

7. Press NEXT. You should see SAMPLE_FLOW. Verify that the voltage displayed does not exceed 4950mV (with the pump running). If it is above 4950mV then the pressure/flow board is bad and must be replaced.

8. Press NEXT until you see REF_4096_MV. Watch this voltage. It should not change more than 2mV. If it is moving more than 2mV and the voltages in steps 3-5 are correct then the motherboard is faulty and needs replacement.

9. If the voltage in step 3 is jumping around and exceeding 4950mV, and the voltage in step 6 is changing more than 2mV then you will need to unplug the lamp and check the voltage in step 6 again. If the voltage in step 6 is stable with the lamp unplugged then the lamp is faulty and needs replacement. If the voltage in step 6 is still unstable with the lamp unplugged then the motherboard is faulty and needs replacement.

10. If the analyzer passes the above tests, and is still noisy or spiking, or if you were referred here from step 3, then disconnect the pump. If the analyzer is quiet with the pump off, but noisy with the pump on, then the problem is pneumatic. Leak check, verify flow, test pump or clean the bench tube. If the analyzer is still noisy with the pump on, try connecting a charcoal scrubber to it. If the analyzer is quiet with the charcoal scrubber, then the problem is likely an interferant.

5.5 - M700E/T700 & M701

5.5.1 M700E/T700 fails leak check.

Don't rely on front panel PASS/FAIL indication. If the M700E has no bench or O3 tower, pressure loss > 1 PSI in 5 minutes is a failure. If the M700E has O3 but no bench, press loss > 1.5PSI is failure. If the M700E has an O3 and bench, pressure loss > 2 PSI is failure.

5.5.2 Non Linear.

Using the M700E to generate several concentrations from a single bottle and the response is non-linear. Leak check. Check operation/calibration of MFC's using service note 99-015B.

5.5.3 O_3 Generation Problems.

O3 output is too high. With the bench operating, the output is higher than the analyzer's response. Leak check the bench. At the end of bench, on the front of analyzer, disconnect the tube from the 1/8" TFE fitting on the bench. Plug the fitting with a cap or a finger. Verify SFLOW drops to <10 CC. Verify SPRESS drops to <10"-Hg-A. If the flow is too high, the bench assemble has leak. If the PRESS is too high, the pump needs a rebuild. If all pass, replace the switching valve.

Unstable O3 generation. Place the calibrator into CNST mode. If stable, then the lamp is good. Place the calibrator into the REF mode. If still stable, the problem is in the bench.

5.5.4 M701 runs all the time.

Troubleshoot leaks in 701 using Service Note 98-035. If the M701 has a dew point sensor on it the pump will turn on more frequently, even if the output of the M701 is capped.

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Service Note

99-037F
12 January, 2012

TROUBLESHOOTING M701 PRESSURE PROBLEMS

I. SCOPE:

To guide you through troubleshooting pressure problems in the M701 zero air module. Typically, if you are having a problem with your M701 you are noticing that the pump does not shut off or that the pump is not capable of maintaining 30 PSIG @ the output of the M701.

IMPORTANT NOTE: If you are using about 5 LPM of air at the output of your M701 your pump might not cycle on & off. The reason is that we are using anywhere from 7 to 13 LPM of air for the regenerative dryer. This 7 – 13 LPM of air with the 5 LPM of air that you are using at the output of the M701 means that the pump is continually pumping 12 – 18 LPM of air. This is not a problem, as the M701 can still maintain 30 PSIG @ the output of the output of the M701.

II. PARTS:

NONE

III. TOOLS:

KIT 60 M701 pressure checker OR a 0-150 PSIG gauge with a shutoff valve.
7/16" wrench.
½"wrench.
9/16" wrench.
¼" pipe to ¼" tube fitting.
Phillips screwdriver
Flat tip screwdriver
External Dew Point Sensor

IV. PROCEDURE:

1. Cap the output of the M701 & see if the pump will shut off. If the pump shuts off then generate 10 LPM of zero air from your T700 calibrator & see if the M701 can maintain 30 PSIG. If not already at 30PSI, you can adjust it using the pressure regulator on either the front panel, or just inside the front panel. If it can then your M701 works fine. If the pump does not shut off or you cannot achieve 30PSI when you have the output of the M701 capped off then go to step 2.
2. Put the M701 on a table & remove the cover from the unit.
3. For step 4 & 5 the pressure gauge (see Figure 6) should be hooked directly to the output (pressure) port of the pump as indicated in Figure 1, with the needle valve closed, so that the pump is pumping "dead head" into the gauge.
4. Put the gauge at the output of the pump so that you can measure the dead headed pressure of the pump. This should be greater then 115 PSIG. If it is below 115 PSIG then you are going to have to rebuild the pump, before continuing on with this procedure. (see Figure 1, Point A)
5. To test the relief valve, connect the gauge between the relief valve and the regenerative dryer (see Figure 1, Point B) and close the gate valve. Allow the pump to pressurize the gauge until you feel air pushing out of the vent on the pressure release valve. Note the pressure that the relief valve opens up at.
6. Open your gate valve & bleed the pressure off of the pump & notice the pressure that the valve seats at. The valve should open at about 90 PSIG & it will begin to seat at about 80-85 PSIG.

7. If the pressure relief does not open at the correct pressure, insert your Allen wrench & turn the Allen screw in or out some to set the opening pressure to the correct pressure. The closing pressure is not that critical & as long as it closes within 10 PSIG of the opening pressure then you are ok. This may take a few tries to get correct.
8. Turn the unit off & allow the pressure to drop back to zero. Hook up the pneumatics of the M701 to its original configuration.
9. If you have the new style regenerative dryer it will have two mufflers on it. Follow this step for both mufflers. Put a 10 to 15 LPM flow meter on the exhaust of the four-way valve on the regenerative dryer. You are going to have to remove the "brass" muffler that is on the exhaust of this valve & install a ¼" pipe to ¼" tube fitting (see Figure 1, Point C).
10. Cap the zero air output & turn on the M701 & allow the unit to come up to pressure (or 5 minutes which ever comes first). Measure the flow out of the exhaust of the four-way valve. This must be less than 14 LPM of flow @ full pressure (typically this is about 7-9 LPM @ full pressure or 10-13 LPM if you have a double headed GAST pump installed). Please note that if the pump stops, the regenerative dryer will also stop flowing air. Remove the cap from the zero air outlet to have the pump kick back on.
11. Remove the fitting at the exhaust of the four-way valve & install the muffler back into the exhaust of the valve.
12. Disconnect the output of the tank & put your gauge & shutoff valve there (see Figure 1, Point D). Turn the unit on & monitor the pressure that the pressure switch shuts off the pump. If the pressure goes higher than 80 PSIG then you are going to have to adjust the cutout pressure of the pressure switch. If the unit shuts off the pump at 80 PSIG then open your valve, & bleed off some pressure until the pump turns back on. The pump should turn back on at 35 PSIG.

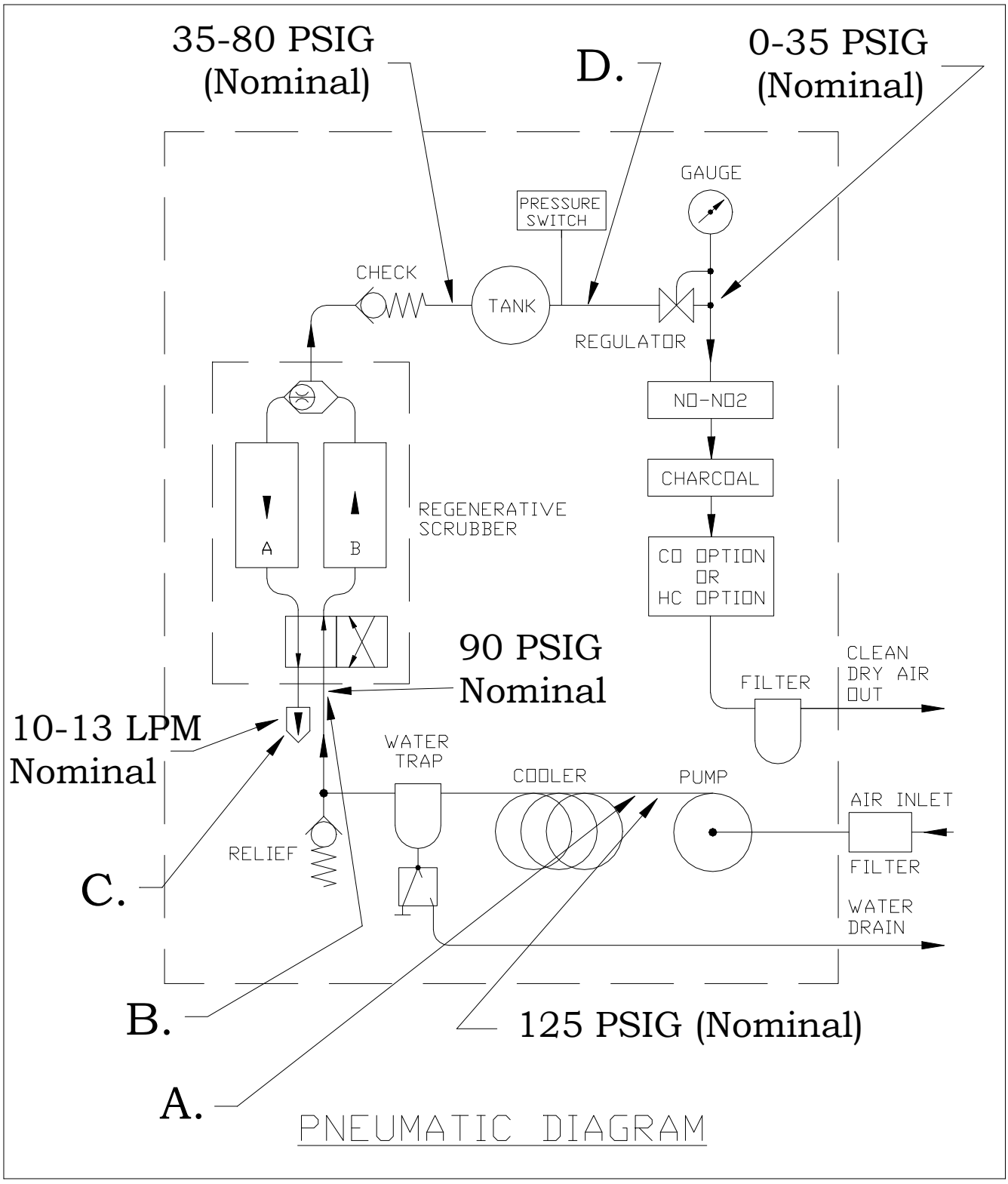
NOTE: IF YOU HAVE THE NEWER STYLE PRESSURE SWITCH YOU WILL ONLY ADJUST THE CUT IN PRESSURE. SEE FIGURE 5.

NOTE: THE HIGH END SHOULD BE SET TO AT LEAST 75 AND NOT MORE THAN 85 PSIG. ONCE THE HIGH END IS SET, THE LOW END SHOULD BE SET TO 35-45. THE LOW END PRESSURE MUST BE AT LEAST 33PSI.

13. To adjust the pressure switch, open your valve & allow the unit to bleed down until the switch cuts in & turns the pump on. If the pressure is too low when the pump turns on then turn the smaller left screw clockwise. If the cut in pressure is too high then turn the screw counter clockwise (see Figure 4). If you have the newer style pressure switch, you will only adjust 1 screw and it will adjust the cut in point.
14. Close the valve & allow the unit to build pressure again. Open your valve & allow the unit to drain down until it cuts in the pump again. If it is still not right then continue to adjust the left screw until you have the cut in pressure correct.
15. To adjust the cut out pressure, allow the unit to pump up to pressure & notice where it cuts out the pump. If the cut out pressure is too high then turn the larger right screw turn the screw counter clockwise. If the cut out pressure is too low turn the screw clockwise (see Figure 4).
16. If your unit has a dew point sensor installed, please measure the flow rate coming out of the Dew Point Sensor located on the main control PCA. This should be 0.6LPM to 1.0LPM.
17. When you get to this point your M701 should be completely adjusted with the exception of your output pressure. To adjust this pressure, hook your M701 to your T700 & generate 5 LPM of zero air. Adjust the output regulator of the M701 to 30 PSIG. We typically use the diluent pressure reading on the TEST functions on the T700 to adjust the output of the M701. If you don't have the M701 hooked to the T700 then adjust the M701 output pressure to 30 PSIG on the gauge on the front of the M701.
18. If your unit has a dew point sensor installed, connect an external dew point sensor to the Zero Air outlet of the unit. Please take care to plumb up your sensor as designed by the manufacture. Set the output of the M701 for approximately 10LPM. The dew point should be <-20degC at 10LPM.

NOTE: WHEN CHANGING THE CHARCOAL AND/OR PURAFIL SCRUBBER MEDIA, IT CAN TAKE UP TO 48 HOURS OF RUNNING FOR THE MATERIAL TO DRY OUT.

19. If you have any questions about this procedure or the any of the API family of analyzers & calibrators please contact the API service department.



5.6 – Top 5 Common Analyzer Problem

5.6.1 M100E/T100

- Pneumatic leak
- Sintered filter/Orifice clogged
- Pump Diaphragm
- UV lamp weak or drifting
- UV filter 214Nm pin holes

5.6.2 M200E/T200

- Pneumatic leak
- Sintered filter/Orifice clogged
- Converter
- Dirty r-cell/PMT filter
- Weak pump

5.6.3 M300E/T300

- Pneumatic leak
- Sintered filter/Orifice clogged
- Pump Diaphragm
- Source age/alignment/Gain adjust
- Chopper motor failure

5.6.4 M400E/T400

- Pneumatic leak
- Sintered filter/Orifice clogged
- UV Lamp
- Software not upgraded
- Pump Diaphragm

5.6.5 M700E/T700

- Pneumatic leak
- Photometer UV Lamp/Software not upgraded
- Noisy MFC
- Inaccurate O_3 gen.-cal
- O_3 gen. lamp

Chapter 6: Other Important Problems

6.1 Time for some hard thinking

- What is it supposed to do?
- What IS it doing?
- What is it NOT doing?
- What is not working that is causing it not to do what it is supposed to do?
- What test can we run to figure out if what is not working is what is causing the problem?

6.2 Cleaning

6.2.1 What to clean

- NO_X & SO_X - Reaction cell and PMT filters
- O_3 - Absorption tube and windows
- CO - Never clean unless water or dirt was sucked into the bench

6.2.2 When to clean it

- Clean optics Annually

6.2.3 What to use to clean it

- When cleaning anything in any analyzer always use de-ionized or distilled water and a lint free cloth. NEVER use any type of alcohol or other cleaning solution.

6.3 Optical problems

6.3.1 Detector gain Issues

- As the gain is increased so is the noise

6.3.2 The 214ηm band pass filter

- Failure modes of the filter: solarized, pin holes, eclipse, oval burn in.

6.3.3 The 330ηm / 360ηm band pass filters

- The 330ηm filter gives you a 50:1 NO_x rejection ratio on the SO_x analyzer.
- The 360ηm filter gives you a 250:1 NO_x rejection ratio on the SO_x analyzer.

6.3.4 The 655ηm high pass filter

- 665ηm is a visible red light. The filter will normally have a light film over it. Heavy corrosion or particulate build up on the filter is bad.

6.3.5 Lamps

- SO_x lamps tend to loose energy over time as the only failure.
- O_3 lamps spike in their output, causing noise.

6.4 Interferents & Quenching

6.4.1 Ammonia nitrate salts (NH_3)

- When a NO_x analyzer has ammonia, NH_3, in the sample stream, it will make ammonia nitrate salts in the reaction cell. These salts build up and cause drifting problems and can clog up the flow in the analyzer. An ammonia scrubber must be installed upstream of the analyzer to prevent the build up of ammonia nitrate salts.

6.4.2 Normal Dirt

- Cleaning the reaction cells with de-ionized water will keep them in good working condition.

6.4.3 Water (H_2O)

- Water is a factor in all of the analyzers, how much and how it affects it, is what changes.

6.4.4 Mercury (Hg)

- Mercury is a large interferent to the O_3 analyzer. Small amounts of mercury will contaminate the instrument causing spiky and erratic concentration readings.
- The reference scrubber will most likely need to be replaced and all of the mercury will need to be cleaned up before the instrument can be run in the same location.

6.4.5 Nitrogen (N_2)

- N_2 can act as an interferent in the SO_x analyzer. This is because oxygen (O_2) is a quencher and must be present in the sample in order to get accurate readings.
- NO_x will also act as an interferent in the SO_x analyzer without the presence of O_2.
- The rejection ratio of NO_x balance N_2 in the SO_x instrument is approximately 4:1
- The rejection ratio of NO_x with >2% of O2 in the SO_x instrument is approximately 50:1

6.4.6 CO_2

- The CO analyzer has a 200,000:1 CO_2 rejection ratio. Remember all interferents in a CO analyzer will be negative interferents.

6.4.7 HC (Hydro-Carbons)

- NO_x - Small interference
- SO_x - Large interference (that is why there is a kicker)
- O_3 - Large interference (if expecting large amounts of HC in the sample, use a Chemiluminescent O_3 analyzer.)

Cleaning the M100E/T100 Sample chamber

NOTE:

The sample chamber should only be opened or cleaned on instructions from the Teledyne Instruments customer service department.

Be careful not to leave thumbprints on the interior of the sample chamber. The various oils that make up fingerprints fluoresce brightly under UV light and will significantly affect the accuracy of the analyzer's SO_2 measurement)

1. Turn off the instrument power.
2. Open the top cover of the instrument:
   - Remove the set screw located in the top, center of the rear panel
   - Remove the screws fastening the top cover to the unit (four per side).
   - Lift the cover straight up.
3. Disconnect the sensor module pneumatic lines.
   - Gas inlet line: 1/8" black Teflon® line with stainless steel fitting.
   - Gas outlet line: 1/4" black Teflon® line with brass fitting.
4. Disconnect all electrical wiring to the Sensor Module:
   - UV lamp power supply wiring.
   - Shutter cabling.
   - Reaction cell thermistor wiring (yellow).
   - Reaction cell heater wiring (red).
   - UV detector wiring.
   - TEC power cable.
   - PMT wiring (connectors J5 & J6 on the PMT preamplifier PCA).
5. Remove the three sensor module mounting screws, and remove the sensor from the chassis of the analyzer.
6. Remove the sample chamber mounting bracket by unscrewing the four bracket screws.
7. Unscrew the 4 hexagonal standoffs
8. Gently remove the chamber cover.
9. Using a lint-free cloth dampened with distilled water, wipe the inside surface of the chamber and the chamber cover.
10. Dry the chamber surfaces with a 2nd lint-free cloth.
11. Re-assemble the chamber and re-install the sensor module

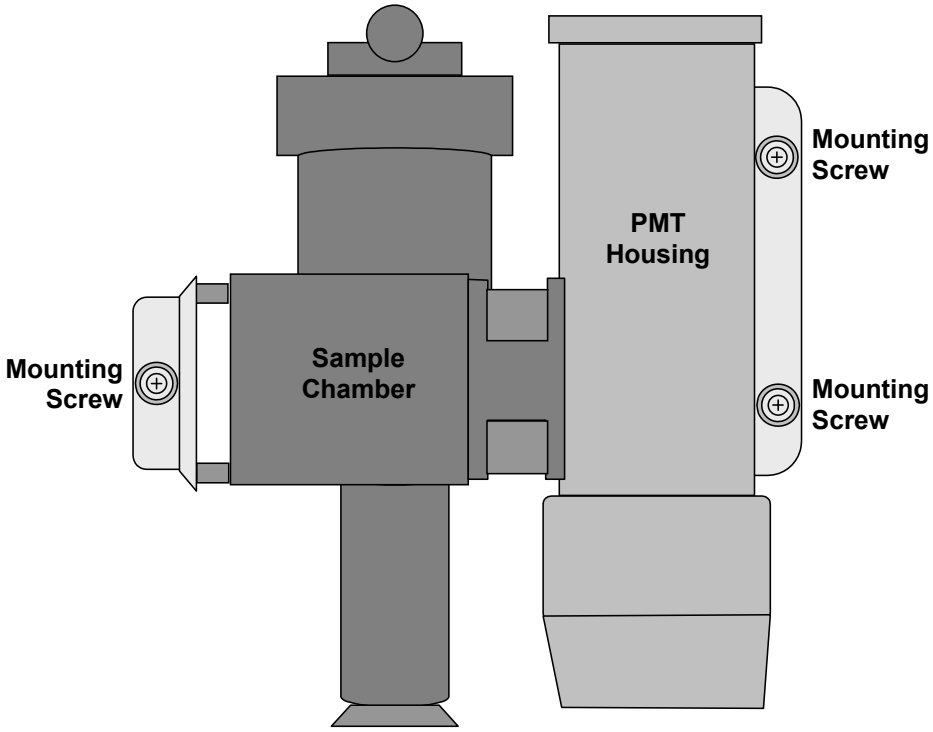


Figure 6-1: Sensor Module Mounting Screws

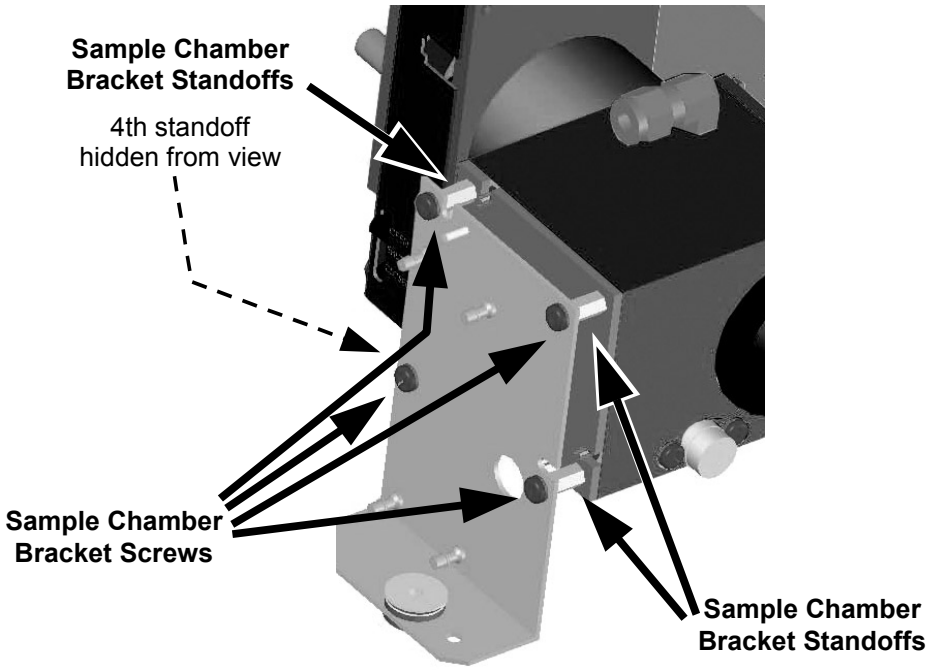


Figure 6-2: Sample Chamber Mounting Bracket

CHAPTER 7: APICOM AND THE DAS SYSTEM

7.1. RS232 connection types & configurations

7.1.1. 06-005B – Extracting parameters readings settings and data using HyperTerminal

7.1.2. 02-039E – Downloading new firmware into "E" Series analyzers

7.2. APICOM and the Internal Data Acquisition System(iDAS)

7.2.1. Benefits

7.2.2. Applications

- 7.2.2.1. Calibration
- 7.2.2.2. Data collection
- 7.2.2.3. Data storage
- 7.2.2.4. Diagnostics
- 7.2.2.5. Demonstrations

7.2.3. Configuration

7.2.4. Summation

7.2.5. APICOM and iDAS Procedure Tutorial

7.2.6. iDAS parameters, setup, and front panel setup.

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Service Note

06-005C
2 Nov, 2012

Extracting Parameters, Readings, Settings, and Data using HyperTerminal

I. PURPOSE:

The following procedure guides you through extracting various parameters and readings from Teledyne-API instruments through HyperTerminal.
It is important to capture these parameters before resetting memory, upgrading firmware, and for periodic monitoring for maintenance or troubleshooting.

Here is a list of commands:

? (displays the Firmware version Help screen and available commands)
t list all (front panel test parameters)
v list ! (VARS parameters: slope, offset, factory options, etc.)
d list (signal I/O parameters and readings)
d print (IDAS channel parameters in analyzers)
c print (sequences for calibrators)
c leveltable print (Dasibi dot command levels for M403, M700, M700E, M703E calibrators with LEADS version firmware)
prnt (printout of MFC calibration tables for M700/ M700E calibrator mass flow controllers)

II. TOOLS and EQUIPMENT:

A computer with HyperTerminal program (HyperTerminal is on all Windows computers).
DB9 to DB9 Female to Female (straight through) RS-232 Serial Communications cable.
If your computer only has a USB serial port, you will need a USB to RS232 adapter

III. PARTS and MATERIALS:

N/A

IV. REFERENCE:

Service Note 05-023 - APICOM and IDAS Procedure Tutorial
Service Note 02-039 - Downloading New Firmware into "E" Series Analyzers

V. PROCEDURE:

1. The HyperTerminal baud rate must match the Analyzer / Calibrator baud rate.
2. Check the baud rate of the instrument.
   a. Check baud rate on "E" Series instrument by pressing SETUP – MORE – COMM – COM1 – SET to view the COM1 BAUD RATE.
   b. Check the baud rate of the "A" Series instrument by pressing SETUP – MORE – COMM – BAUD to view the COM BAUD RATE.
3. Connect computer to instrument directly with a RS-232 cable.
4. Open HyperTerminal and type a name for the connection (such as API Direct), and press OK.
   Depending on your version of Microsoft Windows, HyperTerminal is located at: Start / All Programs / Accessories / Communications / HyperTerminal (Windows XP).

5. Select Connect using COM1 (or your computers active serial / RS232 com port), and press OK. For USB to RS 232 adapters, usually the com port is higher than COM3, (example: COM4).
6. Use the bits per second dropdown and select the Baud rate from step 2.
7. Ensure Data bits = 8, Parity = None, Stop bits = 1, Flow control = Xon / Xoff.
8. Now press OK.

NOTE: If using multi-drop, any command issued needs to have the MACHINE ID included in the command. Examples: ? 0200 or t 0200 list (if 0200 is the machine ID set in VARS)

9. Type a question mark ? (or ? 200) (even if the ? character does not display on the screen) and press Enter (↵).
10. If the instrument does not respond with the help menu, go to the back of the instrument and observe the red / green LEDs on the back panel near the serial com ports. If only one LED is lit, change the position of the DCE/DTE switch on the back of the instrument, then both LEDs should be lit. Now type a question mark again (?) and Enter (↵), the help menu should display.

NOTE: If there is still no response, contact Teledyne-API customer technical service at 1-800-324-5190 or api-customerservice@teledyne.com. There may be some other things that need to be checked, such as a bad cable, other programs running that interfere, host computer problems, or an analyzer problem.

11. If typing characters do not display on the screen, press the “Control” key and the “T” key together (Ctrl + T) to turn on terminal mode, now typing will echo onto the screen.
12. Type t list all (note: there is a space in between t and list and all), and press Enter (↵).
13. The instrument will return with a list of all of the test parameters, just as if you pressed the test button many times on the front panel to view all of the parameters separately.
14. Now on the hyper terminal tool bar, select Transfer, then select Capture Text.
    a. Select the File BROWSE button.
    b. Navigate (by selecting the Save In: dropdown) to the folder that you wish to save the text file that will be created, or use the default location if desired.
    c. Type a file name (example: M300 E s-n 334 2-17-06.txt) and press Save.
15. Press the Start button.
16. All keystrokes and text displays will now be recorded into the text file just created.
17. Type ?, and press Enter (↵). (help menu and commands, software version)
    a. The available commands are listed in the help menu.
18. Type t list all, and press Enter (↵). (front panel test parameters).
19. Type v list !, and press Enter (↵). (VARS parameters: slope, offset, factory options, etc.) (NOTE: be sure to use the exclamation point “ ! ” after “v list” – there should be over 70 parameters returned to the screen).
20. Type d list, and press Enter (↵). (signal I/O parameters and readings).
21. For analyzers, type d print, and press Enter (↵). (iDAS channel parameters).
22. For calibrators, type c print, and press Enter (↵). (sequences).
23. For M403 calibrators, or M700 and M700E calibrators with LEADS version of, type c leveltable print and press Enter (↵). (Dasibi dot command levels).

24. For M700 calibrator MFC tables, on the front panel of the calibrator press STBY – SETUP – MORE - DIAG (use 818 password) – ENTR - NEXT until....MFC CALIBRATION – ENTR - MFC1 – PRNT – EXIT - MFC2 - PRNT. (20 point calibration tables for mass flow controllers). This will output the tables to the HyperTerminal screen.
25. For M700E calibrator MFC tables, on the front panel of the calibrator press STBY – SETUP – MORE - DIAG (use 818 password) – ENTR - NEXT until....MFC CONFIGURATION – ENTR - DIL1 – EDIT - PRNT – EXIT – SET> - CAL1 – EDIT – PRNT – EXIT (if there are 3 MFC'S continue – SET> - CAL2 – EDIT – PRNT - EXIT. (20 point calibration tables for mass flow controllers). This will output the tables to the HyperTerminal screen.
26. Select Transfer, then select Capture Text, and then select Stop.
27. Select File and Save, (or Save As and select a convenient location such as your desk top). This saves the session file so re-connecting to the instrument will be easier next time. Now in the HyperTerminal start menu (or on your desk top) your saved session setup file (with baud rate and other connection information) will easily be recalled by opening this file to start your session.
28. Now navigate to the place where you saved the text file (with all of the collected data) and open the file to make sure everything is there. This file can be used as reference for different settings and to record historical data from the instrument. If just capturing test parameters for periodic monitoring of the front panel test parameters / readings – only perform t list all.
29. Close HyperTerminal if desired, disconnect RS 232 cable.

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Service Note

02-039G
2 Nov, 2012

Downloading New Firmware into "E" Series Analyzers

I. PURPOSE:

This procedure guides you through downloading new firmware into E Series analyzers.

II. TOOLS:

A computer with communications program (HyperTerminal is on all Windows computers).
DB9 to DB9 Female to Female Serial Communications cable.
If your computer only has a USB serial port, you will need a USB to RS232 adapter

III. PARTS and SUPPLIES:

New Firmware file, this file may be e-mailed to you or can be sent by other media

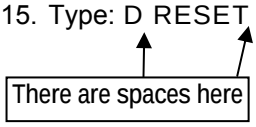
IV. REFERENCE:

Service Note 06-005 - Extracting Parameters, Readings, Settings, and Data using HyperTerminal.
Service Note 05-023 - APICOM and IDAS Procedure Tutorial
Service Note 03-020 - How to Perform a Manual DAC Calibration on "E" Series Machines
APICOM Manual http://www.teledyne-api.com/manuals/man_apicom.pdf
IDAS Manual http://www.teledyne-api.com/manuals/das_02837a.pdf

V. PROCEDURE:

1. Before downloading new firmware, it is recommended to extract and save various important parameters from the instrument, refer to Service Note: 06-005 - Extracting Parameters, Readings, Settings, and Data using HyperTerminal.
2. When the firmware is downloaded, all of the stored data in the IDAS (internal data acquisition system) will be deleted, refer to Service Note 05-023 for instructions on saving this data, or the IDAS Manual available from the Teledyne-API website.
3. Perform this download procedure after you receive the new firmware file and install it to the downloading computer. Usually the firmware file is installed on the desktop.
4. Check current firmware version from the analyzer front panel.
    a. Press SETUP, look at upper-left blinking letter / number, such as C.3; Record on scrap paper, this old version will be used later.
5. Change analyzer baud rate to 115200.
    a. SETUP – MORE - COMM - COM1 – SET> - EDIT – NEXT....until 115200 - ENTR
6. Connect computer com port to analyzer com port with RS-232 cable.
7. Open HyperTerminal and type a name for the connection (such as Direct Download), and press OK. Depending on your version of Microsoft Windows, HyperTerminal is located on your computer at: Start / All Programs / Accessories / Communications / HyperTerminal (example of Windows XP).
8. Select Connect using: COM1 (or use dropdown to select your computers active com port), and press OK.
9. Use bits per second dropdown and select 115200.

10. Ensure Data bits = 8, Parity = None, Stop bits = 1, Flow control = None.
11. Now press OK.
12. Type question mark (?) (even if ? character does not display on the screen) and press Enter (↵).
13. If the analyzer does not respond with the help menu, go to the back of the analyzer and observe the red / green LEDs on the back panel near the serial com ports. If only one LED is lit, change the position of the DCE/DTE switch on the back of the analyzer, then both LEDs should be lit. Now type a question mark again (?) and Enter (↵), the help menu should display.
14. If typing characters do not display on the screen, press the "Control" key and the "T" key together (Ctrl + T) to turn on the terminal mode, now typing will echo onto the screen.
15. Type: D RESET 11 and press (↵),



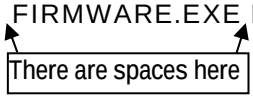
or go to HALT FIRMWARE on front panel of the instrument, and press, Setup – More – Diag – 929 – Entr – Next (until... Halt Firmware) – Entr, push Yes to exit to DOS, then push the (.) period key or choose RCMD (Remote Commands). Now choose baud rate of 115 K or let the timer count down and automatically connect. Rates must match between the instrument and the computer.

16. In the HyperTerminal window, type: DIR (↵) to see all of the files, (DIR = directory) and locate the file called FIRMWARE.EXE.

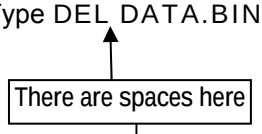
The goal is to rename the file that the instrument uses called FIRMWARE.EXE, then delete the data file that the old firmware wrote into (DATA.BIN), then download a new firmware file and rename it to FIRMWARE.EXE

NOTE: In the following step, type <u>your old version</u> if it is not C.3 (C.3 = current firmware version from example in step 4). By keeping the old file, it is possible to revert to old firmware.

17. Type REN FIRMWARE.EXE FIRMWARE.C3 (↵) (REN = rename)



18. Type DIR (↵) to see that the file was renamed correctly.
19. Type DEL DATA.BIN (↵) (DEL = delete)



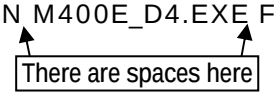
    a. Check to ensure screen displays:
       FILE DATA.BIN DELETED
       1 FILE(S) DELETED

20. Type RECV YMODEM (↵). Immediately after this command, go to step 21, do not wait. The RECV YMODEM command gets the analyzer waiting for you to send the file to it from your computer. Step 21 sends the file from your computer to the analyzer. The analyzer only waits for a short time and then reports a timeout warning. If the receive timeout happens, press OK for the warning and repeat steps 20 - 21.
21. Now on the hyper terminal menu screen, select Transfer, then select Send File.
    a. Select the Filename BROWSE button and go to the firmware version file that you want. Select the file and press Open. This file will be the new firmware that may have been e-mailed to you or installed on a computer drive, (must be the .EXE file).
    b. Select or ensure the PROTOCOL is YMODEM (use dropdown to select).
    c. Press Send to download to the instrument, you should see the "packets" begin counting; when finished, ensure that FILE RECEIVED OK is displayed.
    d. If a timeout error has occurred or data does not transfer, press cancel, then press OK, and start over at RECV YMODEM step 20 – 21 above.

22. Type: DIR (↵) to see the newly installed file. Use this newly installed file name for the next step.

NOTE: In the following step, rename the file that you downloaded – the filename must be typed exactly as displayed from the directory command, (example = M400E_D4.EXE).

23. Type REN M400E_D4.EXE FIRMWARE.EXE (↵)



24. Type DIR (↵) to see that the file was renamed correctly.
25. Type EXIT (↵) and the analyzer will reboot using the new firmware file.
26. The analyzer needs to be power cycled for the upgrade to be complete, but first the factory options need to be reassigned.
    a. Use the data captured from the parameter extraction procedure to reassign the factory options and input to VARS. The v list ! parameter is called:
       V 210:12:35 0200 FACTORY_OPT=513 (0 to 65535) BitFlag.
       In this example, 513 is the parameter, use your parameter for the next step.
    b. Press, SETUP - MORE – VARS – 929 – ENTR – NEXT...until FACT_OPT=0 BitFlag – EDIT – Change to your number and press –ENTR.
    c. If you don't have the VAR number and know what the options are, press, SETUP - MORE - DIAG – 929 – ENTR – NEXT...until FACTORY OPTIONS – ENTR – Change the various options as required and press – ENTR.
27. Power cycling should happen any time the firmware is upgraded, or if factory options or VARS are changed.
28. Turn power off, wait 5 seconds, turn power back on (this is referred to as power cycling).
29. Usually there will be ANALOG CAL WARNING displayed on the analyzer – if this warning is present, you must perform ANALOG I/O CONFIGURATION CALIBRATION (DAC CAL) procedure, refer to Service Note 03-020 - How to Perform a Manual DAC Calibration on "E" Series Machines.
30. You must now recalibrate (zero and span) the analyzer.

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Service Note

10-020

24 March 2011

T SERIES FIRMWARE UPDATE

III. PURPOSE:

To give instruction on installing new operating firmware in a T Series instrument.

IV. TOOLS:

Computer with Ethernet communication or USB flash drive
USB keyboard

V. PARTS:

Teledyne API Instrument Upgrade Utility
Latest revision of Firmware from Teledyne API Customer Service

The electronics used in T-API analyzers are sensitive to Electrostatic Discharge (ESD). When working on any T-API device, please ensure that you are properly grounded prior to handling or touching any electronic circuitry in the analyzers! For more information on how to protect sensitive components from ESD during handling, please contact T-API customer service and ask for the ESD Service note number 03-022A.

VI. PROCEDURE:

- The firmware update can be completed through Ethernet using the Instrument Upgrade Utility, or it can be done with a USB flash drive and the front panel USB ports.

Ethernet

1. Locate the Instrument Upgrade Utility install file**, Setup.msi,** and double click. Follow the onscreen instructions. (Note: Must have the latest windows update of .net framework installed.)
2. Copy down the IP address of the instrument. The IP address can be found by pressing **SETUP** on the instrument's display, **MORE**, **COM** and **INET**. Enter **9-2-9** password and **ENTER**. Press **SET>** till **INST IP:** is displayed and note this number ***.***.***.***.
3. Click the **Start** menu at the lower left-hand of the screen: **All Programs**, **Teledyne API** and **Instrument Upgrade Utility**.
4. The Teledyne API Instrument Upgrade Utility will open on the screen. Click **Next**, **Instrument Application Firmware** and **Next**. Instrument Firmware Image page will appear. Click the square "**…**". This will allow you to search for the new firmware file from your desktop, or your saved file. Select the appropriate **.exe** file. The Select Target Instrument page will now appear. Type in the IP Address of the instrument, which you copied from step 4, and select **Next.** A confirmation page will show up, click **Next** and **Next** again. The Performing Update screen will appear showing the status of the update. When finished, click **Finish,** and at the next screen prompt click **OK**. Power cycle the instrument via the from panel switch.

USB Flash drive

1. Before downloading new firmware, it is recommended to extract and save various important parameters from the instrument, refer to Service Note: 06-005 - Extracting Parameters, Readings, Settings, and Data using HyperTerminal.
2. Transfer the firmware file from your computer to the root directory of a USB flash device (thumbdrive, etc).
    a. The firmware will be delivered to you via e-mail or CD
    b. The filename will look something like this example: 041630901_1.0.0 - T100 MODBUS.exe
3. Re-name the file on the flash device to: update.exe

Do not add the .exe if the file is already an executable. Adding .exe is only necessary if the file was sent to you as a text or a word file in an e-mail. If this is the case, then you will need to open up windows folder options and uncheck the box labeled "hide known file extensions". After doing this, you will see .txt or .doc after the file name. If you see .txt or .doc, change this to .exe.

4. After the file is renamed, safely remove the USB device from your computer.
5. With the instrument booted up all of the way, plug the USB device into one of the USB receptacles on the front panel
    a. Do NOT install the USB device and then turn on power to the analyzer
    b. Do NOT leave a USB device in the receptacle and allow the analyzer to reboot
6. The instrument will scan the USB device and detect the update file and then give instruction for completion of the updating procedure
    a. It will report "A software update is available"
    b. The version that is you have on the USB device will be displayed
    c. It will ask if you want to continue (to install the new firmware from the USB device.
7. Press "YES"
8. Type the password "929", and press "Enter"
9. It will report "Updating the Instrument Software"
10. If you wait long enough, it will report "Waiting for USB drive removal".
11. Remove the USB device
12. Then it will report "Now Restarting the Unit System"
13. After booting up it will report "The Instrument Software has Been Updated."

7.2 APICOM and iDAS (Internal Data Acquisition System)

7.2.1 BENEFITS:

7.2.1.1 Remote operation of analyzers.

- Total control of analyzers remotely, in all aspects.
- Configurable up & down the entire line of API analyzers regardless of age or software version, not just the current version of analyzers.
- Will break down lockout specs, TEI for windows.
- Free to all that ask.

7.2.2 APPLICATION:

7.2.2.1 Calibration

- With APICOM the operator can calibrate any & all the API analyzers remotely, as if the person was standing in the shelter that could be 4 or 5 hours away.

7.2.2.2 Data Collection

- With APICOM the operator can collect the data from the analyzers remotely, with out having to go to the site.
- If the iDAS is configured to collect data you can download any of the iDAS reports for any time period that you would like to.
- All reports in iDAS report
- Certain number of iDAS records
- Date to date (very useful if you are concerned with data from a particular date).
- Configure and modify the iDAS reports & records via intuitive menu.

7.2.2.3 Data storage (useful for data manipulation or data transfer).

- With APICOM you have the ability to save the data to a disk that is recorded in the iDAS system with in the analyzer.
- Open this file with a spread sheet type of program (excel etc)
- Manipulate or transfer the data as you would like.
- Graphing/plotting/trending etc.
- Instant graphing ability for immediate trending.

7.2.2.4 Diagnostics

- Use the iDAS to do predictive diagnostics.
- Set up a iDAS report (basic reports are configured from factory) to trend flows, pressures, temps, pmt voltages, measure reference values etc.
- Allows user to do a diagnostic evaluation of the analyzer remotely.
- Electric test, optic test, signal I/O, test channel configuration

7.2.2.5 Demonstration

- With APICOM you can call up stations that are in service to show potential customers what APICOM can do & how easy it is to get data from the already great API family of analyzers.
- This is a great tool that you can use at your facility or at a potential customers site to demonstrate both APICOM & the analyzers.

7.2.3 CONFIGURATION:

7.2.3.1 Site configuration.

- Allows the user to configure sites to individual configurations.
- When using modem connection input phone number & pass codes (9 to get an outside line, etc).
- When using direct connection input baud rate/Comm port/Comm information (8,1,none).

7.2.3.2 Instrument configuration

- Allows the user to configure the instruments to a particular site.
- Analyzer type, model, instrument id
- Allows the user to enable & enter the switch prefix when using a CAS (Code Activated Switch).

7.2.3.3 Instrument ID's

- Allows the user to specify the ID for each instrument, if the instruments are being used with "API Multi-drop".
- Best method is to use the instrument model numbers but any number can be inputted up to four digits.

7.2.3.4 Auto Update

- Allows the user to update the instrument front panel(s) automatically.
- If auto update is not selected the "pushing" of a button on an analyzer will update all the parameters for that instrument.
- The update frequency is modifiable when "auto update" is selected.
- Allows any frequency from 5 to 60 seconds.
- This frequency is going to be different with different sites.

7.2.3.5 Modems

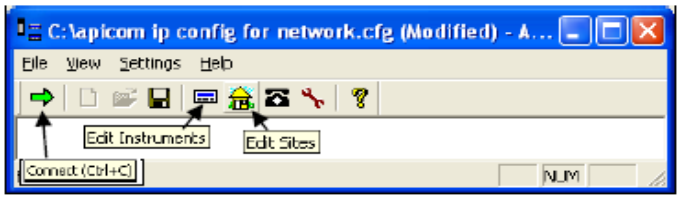
- Allows the modification of the modem parameters.
- Select the windows modem & the APICOM will automatically allow windows to handle all protocol issues for the modem.
- Tone dial, auto answer, modem name, etc.
- The "standard modem" selected from menu works with most Hayes compatible modems.

7.2.4. SUMMATION:

- This is a very powerful tool designed to save you time & money, & also to make you money.
- We have tried to make APICOM as simple to use as the instrument. The idea was that for anyone that has experience with the instruments this will be almost automatic & for the novice user that has not used our instruments that this be as intuitive as possible.
- If you have ideas or suggestions please feel free to contact us at sda_techsupport@teledyne.com with your suggestions.

Quick Reference Checklist for APICOM

1. Install **APICOM** or copy the **APICOM.EXE** file to the computer that is connecting to the Teledyne API instrument.
2. Connect the instrument to the computer with the desired cables. If connecting with Ethernet, refer to service notes 05-006 or 05-007. If connecting direct refer to service notes 95-001, 98-049. If connecting with a phone line modem refer to service notes 98-020, 98-023, 98-030, 98-033, 98-034, 98-049.



3. Ensure that no other communications programs are open from the computer to the analyzer that would use the computer comm port. – such as HyperTerminal**. Open (execute) the APICOM interface program** (APICOM.EXE).

SITE SETUP

4. Press the **Edit Sites** icon. Follow steps 5 – 9 for **Direct Cable setup**, or steps 10 – 12 for **TCP/IP Setup**.

DIRECT CABLE SETUP

5. Setup for Direct cable, Select **New**, On **Connection Type dropdown**, select (for this example) **Direct Cable**, and select **Settings**.
6. Select the com port that is being used (example **COM1**), and select **Settings**.
7. Select the baud rate of the instrument,
   a. Check baud rate on "E" Series instrument by pressing **SETUP – MORE – COMM – COM1 – SET** to view the COM1 BAUD RATE.
   b. Check the baud rate of the "A" Series instrument by pressing **SETUP – MORE – COMM – BAUD** to view the COM BAUD RATE.
8. Then select that rate in the **Bits per second dropdown** menu on the computer (example **19200**). Ensure data bits = **8**, Parity = **none**, stop bits = **1**, and Flow control = **none**.
9. Now press **OK, OK, OK, and Close** for the next windows to get back to the main screen, setup for the direct cable site is complete.

TCP/IP SETUP

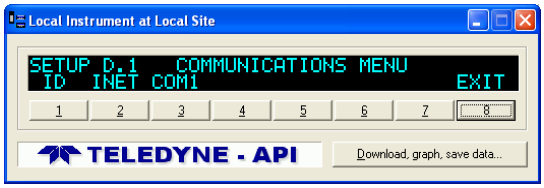
10. Setup of site for TCP/IP (Ethernet). In the New Site Properties window, select **TCP/IP** in the connection dropdown, then select **Settings**.
11. **Type the IP address** of the instrument (example **123.12.12.14**) and type **3000** for the TCP port. Select **OK**.
    a. Refer to Service Note 05-006 or 05-007 for the method of finding / setting IP Addresses.
12. Select **OK, OK, and Close** to exit to the main menu. The Ethernet TCP/IP site setup is complete.

INSTRUMENT SETUP

13. Press the **Edit Instruments** icon. Select **New**.
14. Select the **dropdown arrow** in the Site Name field and select the "Site" you created in previous steps, (in this case "**Local Site**"). Instrument Name field may remain default as "Local Instrument" or if desired, type a name for the instrument such as "M400E" into the Instrument name field. Now select **OK**.
15. Select **Close**.
16. Select the green "**Connect**" arrow.
17. Select the desired instrument, in this case "**Local Instrument**" Select **Connect.**
18. You are now connected to the instrument and can use the computer mouse to press the buttons just as you would press them while in front of the analyzer.
19. Turn on analyzer front panel updating to the computer (so the computer is constantly updated by the instrument), by pressing **Settings** and selecting **Options**.
20. On the Options screen, select the second tab called "**Front Panel**".
21. On the Front panel screen, select the **Update checkbox** and **type 5** for the desired interval of updating (minimum is 5 seconds). Select **OK** and now the computer screen will get updated every 5 seconds.
22. If desired, this setup configuration can be saved and recalled (used again without selecting all of the parameters again). To save the configuration, press **File** and select **Save As**.
23. **Type** a name in the File Name field such as "**laptop apicom ip config**" and select **Save**.
24. (The next 2 steps are only required if loading a new / different configuration).If you want to recall the saved configuration, press the **Open File** icon.
25. Select the desired configuration file and select **Open**.
26. Now select the "**connect**" icon for easy connection again.

Quick Reference Checklist for IDAS

1. Setup of IDAS (Internal Data Acquisition System) through APICOM.
   a. For this example we will set up a configuration to help troubleshoot the analyzer.
   b. Select the **Download, graph, save data**… button.
   c. These actions will delete all data that have been collected by the IDAS, if you wish to keep / save this data, download it first by following steps 1 and 11-13.



1. If the screen is "grayed out", Select Data **Auto On/Off** to get the screen active. Select **Get Config**.
2. Select New Channel (**New Chan**…)
3. Type a Channel name (example "**Troubleshooting**"), type the **sample period to 1** (if not already 1) and type the **report period to 1**, and select **OK**.
   a. If Number of Records is 100 and Sample Period is 1 minute, then 100 minutes of data will be stored. Change Number of Records to a higher value for more run time.
   b. Usually for troubleshooting use the shortest sample time, which is every 1 minute.
   c. Sample, report, and download periods use Julian date format.
4. Select New Parameter (**New Param**…)
5. Use **Parameter dropdown** to select desired measurement parameter (example **PHMEAS**).
6. Usually the Sample Mode will remain at Inst (instantaneous) for troubleshooting purposes; Precision selection will select the number of decimal places for the measurements (example **1**= 4500.1), Select **OK**.
7. Press the **"+"** box next to "Troubleshooting" to see all of the parameters being sampled in this configuration. Select **New Parameter** to add more parameters. Select the "**check box**" next to "Troubleshooting" to select all parameters.
8. Select Save Configuration, use the default name if desired, choose the location desired, and select Save.
9. (This step is only required if loading a new / different configuration), if recalling the saved configuration, select **Load Config..**, select the desired config file (the one that you just created), and select **Open.**

> **WARNING**: If you haven't already pressed "Get Config" and other channels exist in the instrument, the next action will delete the existing configuration, all channels, and all data, and replace it with this new configuration. If you have retrieved the configuration from the instrument (Get Config..), it is safe to load the entire new configuration without erasing the previous configurations / channels; however all data will be lost.

10. Select **Send To Inst** so the instrument will now use this file to start loading measurements into the IDAS, Select **Yes** to the confirmation warning if you wish to discard all data and existing configuration.
11. After at least 2 minutes, check that the data is being streamed into the IDAS by selecting **Get Data**, and select the # of records (usually "**All**"), then select **OK**.
12. Select the **main "troubleshooting" check box** for all of the parameters to be selected, **or** you may choose to not view or graph all of the data by **deselecting** some check boxes. Now select **View Data**.
13. To save this data into a text file, select **Save Data**. Use the default name if desired and select **Save**.
14. You may view a chart of the data, press **Graph Data**.
15. To save the graphic to a file, press and hold the "**Alt**" key on your computer keyboard, then press the "**Print Screen / SysRq**" key on the computer keyboard, then release (**Alt + Print Screen**). NOTE: The screen MUST be active (selected) that you are copying – to make sure that it is active –click your mouse cursor inside of the screen before pressing Alt + Print Screen. Now you will need to open a program such as Microsoft Paint, Microsoft Word, Excel, or PowerPoint.
16. **Open Word, Paint, Excel, or PowerPoint**.
17. Press the "**Ctrl**" and "**V**" keys (**Ctrl + V**). on the computer keyboard simultaneously to paste the screen shot. You may also write other information into the file before saving it (like "**Data from 11-08-2005**").
18. Select **File / Save As**, choose a location and filename and select **Save**.
19. **Open Excel** program and select **File / Open**.
20. You may have to **select the file types to All Files (*.*)** in the Files of Type dropdown to display the text file that was saved before.
21. **Select that file** and press **Open**. Select **Delimited**, then **Next**. Select **Comma** check box, then press **Finish**.
22. Now the data may be manipulated and charted, contact an advanced Excel user for assistance.

User notes:

APPENDIX A: LEVEL II SCHEMATICS

DRAWING	REV	PAGES	DESCRIPTION	MODEL WHERE USED							
				100E	200E	300E	400E	T100	T200	T300	T400
040110000	A	1	Interconnect Drawing	x							
069080000	B	1	Interconnect Drawing					x			
045040000	C	1	Interconnect Drawing		x						
069110000	B	1	Interconnect Drawing						x		
042160000	E	1	Interconnect Drawing			x					
069120000	B	1	Interconnect Drawing							x	
043960000	C	1	Interconnect Drawing				x				
069130000	A	1	Interconnect Drawing								x
066440000	B	1	Ozone Gen Pulse Driver		x				x		
032970000	K	3	Sync Demod Board			x				x	
041360000	B	1	Relay Board			x				x	
041810000	H	3	PMT Preamp	x	x			x	x		
042590000	A	1	Keyboard Interface	x	x	x	x				
066980000	D	4	LCD Touch Screen interface					x	x	x	x
043540000	D	1	Pressure/Flow	x	x	x	x	x	x	x	x
044200000	B	1	UV Detector/Preamp				x				x
044210000	A	1	UV Lamp Driver				x				x
045240000	E	3	Relay Board	x	x		x	x	x		x
049320000	C	1	TEC Amplifier	x	x			x	x		
050330000	A	1	Opto-Interrupter			x				x	
050640000	C	1	UV Detector/Preamp	x				x			
058030000	B	9	Motherboard	x	x	x	x	x	x	x	x
061940000	B	2	Bursting UV Lamp Driver	x				x			