TELEDYNE API
Everywhereyoulook™

User Manual

Model N101
UV Fluorescence Analyzer

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NOTICE OF COPYRIGHT

TRADEMARKS

SAFETY MESSAGES

Important safety messages are provided throughout this manual for the purpose of avoiding personal injury or instrument damage. Please read these messages carefully. Each safety message is associated with a safety alert symbol and is placed throughout this manual; the safety symbols are also located inside the instrument. It is imperative that you pay close attention to these messages, the descriptions of which are as follows:

WARNING: Electrical Shock Hazard

HAZARD: Strong oxidizer

GENERAL WARNING/CAUTION: Read the accompanying message for specific information.

CAUTION: Hot Surface Warning

Do Not Touch: Touching some parts of the instrument without protection or proper tools could result in damage to the part(s) and/or the instrument.

Technician Symbol: All operations marked with this symbol are to be performed by qualified maintenance personnel only.

Electrical Ground: This symbol inside the instrument marks the central safety grounding point for the instrument.

CAUTION

This product should only be installed, commissioned, and used strictly for the purpose and in the manner described in this manual. If you improperly install, commission, or use this instrument in any manner other than as instructed in this manual or by our Technical Support team, unpredictable behavior could ensue with possible hazardous consequences.

Such risks, whether during installation and commission or caused by improper installation/commissioning/use, and their possible hazardous outcomes include but are not limited to:

RISK	HAZARD
Liquid or dust/debris ingress	Electrical shock hazard
Improper or worn power cable	Electrical shock or fire hazard
Excessive pressure from improper gas bottle connections	Explosion and projectile hazard
Sampling combustible gas(es)	Explosion and fire hazard
Improper lift & carry techniques	Personal injury

Note that the safety of a system that may incorporate this product is the end user's responsibility.

For Technical Assistance regarding the use and maintenance of this instrument or any other Teledyne API product, contact Teledyne API's Technical Support Department:

Telephone: 800-324-5190
Email: api-techsupport@teledyne.com

or access any of the service options on our website at http://www.teledyne-api.com/

CONSIGNES DE SÉCURITÉ

Des consignes de sécurité importantes sont fournies tout au long du présent manuel dans le but d'éviter des blessures corporelles ou d'endommager les instruments. Veuillez lire attentivement ces consignes. Chaque consigne de sécurité est représentée par un pictogramme d'alerte de sécurité; ces pictogrammes se retrouvent dans ce manuel et à l'intérieur des instruments. Les symboles correspondent aux consignes suivantes :

AVERTISSEMENT : Risque de choc électrique

DANGER : Oxydant puissant

AVERTISSEMENT GÉNÉRAL / MISE EN GARDE : Lire la consigne complémentaire pour des renseignements spécifiques

MISE EN GARDE : Surface chaude

Ne pas toucher : Toucher à certaines parties de l'instrument sans protection ou sans les outils appropriés pourrait entraîner des dommages aux pièces ou à l'instrument.

Pictogramme « technicien » : Toutes les opérations portant ce symbole doivent être effectuées uniquement par du personnel de maintenance qualifié.

Mise à la terre : Ce symbole à l'intérieur de l'instrument détermine le point central de la mise à la terre sécuritaire de l'instrument.

MISE EN GARDE

Ce produit ne doit être installé, mis en service et utilisé qu'aux fins et de la manière décrites dans le présent manuel. Si vous installez, mettez en service ou utilisez cet instrument de manière incorrecte autre que celle indiquée dans ce manuel ou sous la direction de notre équipe de soutien technique, un comportement imprévisible pourrait entraîner des conséquences potentiellement dangereuses.

Ce qui suit est une liste, non exhaustive, des risques et résultats dangereux possibles associés avec une mauvaise utilisation, une mise en service incorrecte, ou causés mauvaise commission.

RISQUE	DANGER
Pénétration de liquide ou de poussière/débris	Risque de choc électrique
Câble d'alimentation incorrect, endommagés ou usé	Choc électrique ou risque d'incendie
Pression excessive due à des connexions de bouteilles de gaz incorrectes	Risque d'explosion et d'émission de projectile
Échantillonnage de gaz combustibles	Risque d'explosion et d'incendie
Techniques de manutention, soulevage et de transport inappropriées	Blessure corporelle

Notez que la sécurité d'un système qui peut incorporer ce produit est la responsabilité de l'utilisateur final.

WARRANTY

WARRANTY POLICY (02024J)

Teledyne API (TAPI), a business unit of Teledyne Instruments, Inc., provides that:

Prior to shipment, TAPI equipment is thoroughly inspected and tested. Should equipment failure occur, TAPI assures its customers that prompt service and support will be available. (For the instrument-specific warranty period, please refer to the "Limited Warranty" section in the Terms and Conditions of Sale on our website at www.teledyne-api.com).

COVERAGE

After the warranty period and throughout the equipment lifetime, TAPI stands ready to provide on-site or in-plant service at reasonable rates similar to those of other manufacturers in the industry. All maintenance and the first level of field troubleshooting are to be performed by the customer.

NON-TAPI MANUFACTURED EQUIPMENT

Equipment provided but not manufactured by TAPI is warranted and will be repaired to the extent and according to the current terms and conditions of the respective equipment manufacturer's warranty.

PRODUCT RETURN

All units or components returned to Teledyne API should be properly packed for handling and returned freight prepaid to the nearest designated Service Center. After the repair, the equipment will be returned, freight prepaid.

The complete Terms and Conditions of Sale can be reviewed on our website.

CAUTION – Avoid Warranty Invalidation

Failure to comply with proper anti-Electro-Static Discharge (ESD) handling and packing instructions and Return Merchandise Authorization (RMA) procedures when returning parts for repair or calibration may void your warranty. For anti-ESD handling and packing instructions please refer to the manual, Fundamentals of ESD, PN 04786, in its "Packing Components for Return to Teledyne API's Customer Service" section. The manual can be downloaded from our website at http://www.teledyne-api.com. RMA procedures can also be found on our website.

ABOUT THIS MANUAL

We recommend that all users read this manual in its entirety before operating the instrument. Support manuals, such as Fundamentals of Electro-Static Discharge (ESD), PN 04786, and NumaView™ Remote, PN 04892, are available on the TAPI website http://www.teledyne-api.com.

CONVENTIONS USED

In addition to the safety symbols as presented in the *Safety Messages* page, this manual provides *special notices* related to the careful and effective use of the instrument and related, pertinent information.

ATTENTION — **COULD DAMAGE INSTRUMENT AND VOID WARRANTY**
This special notice provides information to avoid damage to your instrument and possibly invalidate the warranty.

Important — **IMPACT ON READINGS OR DATA**
Provides information about that which could either affect accuracy of instrument readings or cause loss of data.

Note — **Provides information pertinent to the proper care, operation or maintenance of the instrument or its parts.**

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1. INTRODUCTION, SPECIFICATIONS, & COMPLIANCE

Teledyne API's Model N101 Analyzer is a microprocessor-controlled instrument that use fluorescence technology to measure SO_2 concentrations for ambient air monitoring. The N101 converts hydrogen sulfide (H_2S) gas into SO_2, using an internal catalytic converter.

Proprietary software allows configurable data acquisition capability that can be triggered conditionally or periodically, enabling operators to perform predictive diagnostics and enhanced data analysis by tracking parameter trends. Reports can be downloaded onto a USB flash drive or via the I/O ports. Operators can also view real-time graphing with one touch of the interface screen.

1.1. SPECIFICATIONS

Table 1-1. Analyzer Specifications

PARAMETER	SPECIFICATION
Min/Max Range (Physical Analog Output)	H_2S: Min: 0-50 ppb full Scale Max: 0-10,000 ppb full Scale SO_2: Up to 0-20,000 ppb full scale (selectable, dual range supported)
Measurement Units	ppb, ppm, µg/m^3, mg/m^3 (selectable)
Zero Noise	< 0.2 ppb (RMS)
Span Noise	< 0.5% of reading (RMS) above 50 ppb
Lower Detectable Limit	< 0.4 ppb
Zero Drift	< 0.5 ppb (at constant temperature and voltage) /24 hours
Span Drift	< 0.5% of Full Scale (at constant temperature and voltage) /24 hours
Response Time	< 140 seconds to 95%
Linearity	1% of full scale / 24 hours
Precision	0.5% of reading above 50 ppb
Sample Flow Rate	650 cc/min ± 10%
AC Power	Rating: 100V - 240V, 50/60 Hz, Typical consumption 70W
Standard I/O	1 Ethernet: TCP/IP 1 RS-232 2 front panel USB device ports
Optional I/O	Universal Analog Output Board (all user-definable): 4 isolated voltage outputs (5 V, 10 V) 3 individually isolated current outputs (4-20mA) Digital I/O Expansion Board includes: 3 x isolated digital input controls (fixed) 5 x isolated digital output controls (user-definable) 3 x form C relay alarm outputs (user-definable)
Dimensions H x W x D	7" x 17" x 24.3" (178mm x 432 mm x 617 mm)
Weight	35 lbs (15.9 kg)
Operating Temperature Range	5 - 40 °C
Humidity Range	0-95% RH non-condensing
Environmental Conditions	Installation Category (Over voltage Category) II Pollution Degree 2 Intended for Indoor Use Only at Altitudes ≤ 2000m
All specifications are based on constant conditions.	

1.2. COMPLIANCE AND CERTIFICATIONS

This product is CE compliant and adheres to the Low Voltage and ElectroMagnetic Compatibility directives.

For any other certifications, please refer to this product's specifications sheet on our website.

2. GETTING STARTED

This section addresses unpacking, connecting, and initializing the instrument, getting an overview of the menu system, and setting up/configuring the functions.

2.1. UNPACKING

CAUTION - GENERAL SAFETY HAZARD

To avoid personal injury, always use two persons and proper lift and carry techniques to move/relocate each instrument.

ATTENTION

COULD DAMAGE INSTRUMENT AND VOID WARRANTY

Printed Circuit Assemblies (PCAs) are sensitive to electro-static discharges too small to be felt by the human nervous system. Failure to use Electro-Static Discharge (ESD) protection when working with electronic assemblies will void the instrument warranty. Refer to the manual, Fundamentals of ESD, PN 04786, which can be downloaded from our website at http://www.teledyne-api.com.

ATTENTION

COULD DAMAGE INSTRUMENT AND VOID WARRANTY

Do not operate this instrument without first removing dust plugs from SAMPLE and EXHAUST ports on the rear panel.

Note

Teledyne API recommends that you store shipping containers and materials for future use if/when the instrument should be returned to the factory for repair and/or calibration service. See Warranty statement in this manual and Return Merchandise Authorization (RMA) on our Website at http://www.teledyne-api.com.

Verify that there is no apparent external shipping damage. If damage has occurred, please advise the shipper first, then Teledyne API.

Included with your instrument is a printed record of the final performance characterization performed on your instrument at the factory. This record, titled Final Test and Validation Data Sheet, is an important quality assurance and calibration record and should be placed in the quality records file for this instrument.

With no power to the unit, carefully remove the top cover of each instrument and check for internal shipping damage by carrying out the following steps:

1. Carefully remove the top cover and check for internal shipping damage.
   a. Remove the side-panel screws that hold the cover in place.
   b. Slide the cover backward until it clears the instrument's front bezel.
   c. Lift the cover straight up.
2. Inspect the interior of the instrument to ensure all circuit boards and other components are intact and securely seated.
3. Check the connectors of the various internal wiring harnesses and pneumatic hoses to ensure they are firmly and securely seated.
4. Verify that all (if any) optional hardware ordered with the unit has been installed. These are listed on the paperwork accompanying the instrument.
5. Return cover and refasten with original screws/fasteners.

WARNING – ELECTRICAL SHOCK HAZARD

Never disconnect or reconnect PCAs, wiring harnesses or electronic subassemblies while instrument is under power.

2.1.1. VENTILATION CLEARANCE

Whether the instrument is set up on a bench or installed in a rack, be sure to leave sufficient ventilation clearance.

Table 2-1. Ventilation Clearance

AREA	MINIMUM REQUIRED CLEARANCE
Back of instrument	10 cm / 4 in
Sides of instrument	2.5 cm / 1 in
Above and below instrument	2.5 cm / 1 in

Note **Failure to provide proper ventilation can result in ambient temperature exceeding the maximum operating temperature specifications.**

2.2. INSTRUMENT LAYOUT

This section illustrates the front and rear panels and the internal chassis layout.

2.2.1. FRONT PANEL

The analyzer front panel (Figure **2-1**) includes two USB ports for peripheral device connections, which can be used with mouse and keyboard as alternatives to the touchscreen interface, or with flash drive for uploads/downloads (devices not included).

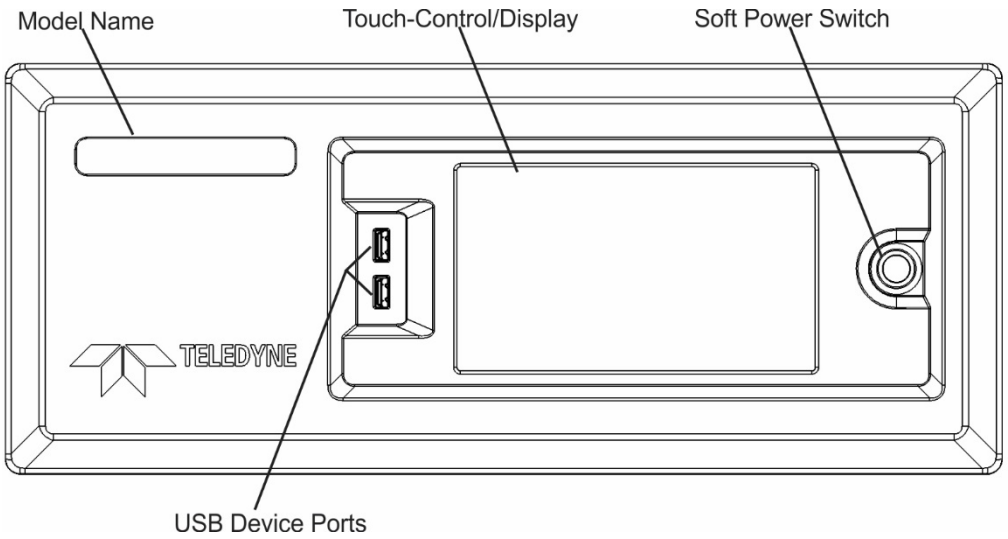


Figure 2-1**. Analyzer Front Panel Layout**

2.2.2. REAR PANEL

Figure 2-2 shows the N101 rear panel layout, and Table 2-2 describes its components.

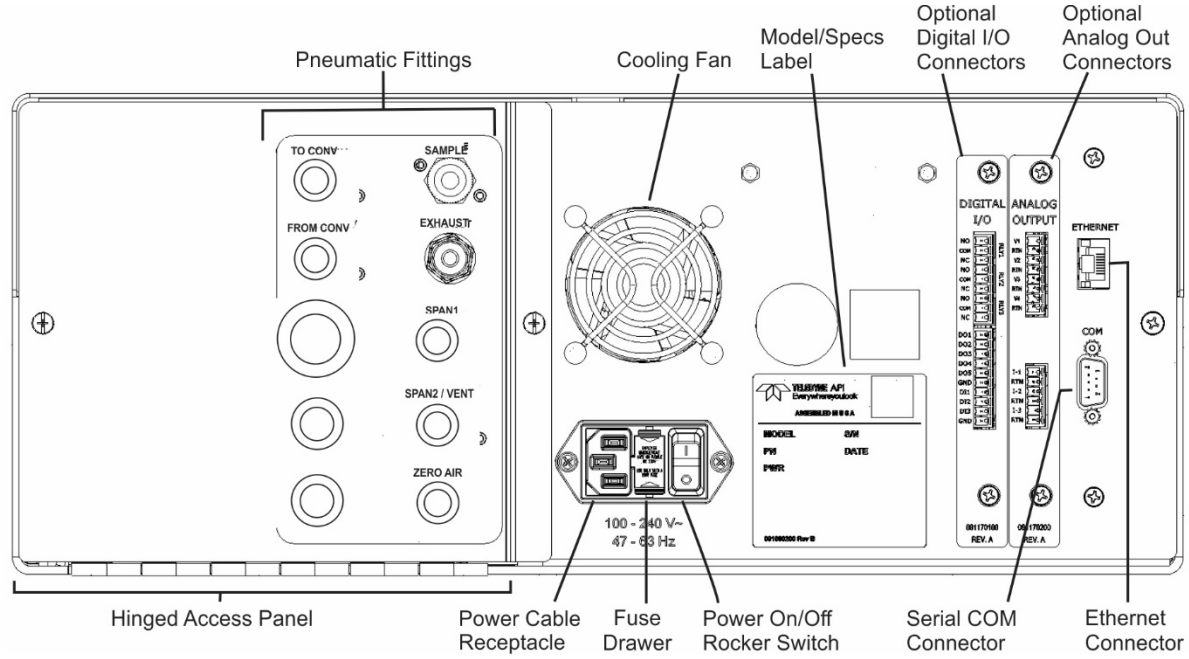


Figure 2-2. Analyzer Rear Panel Layout

Table 2-2. Analyzer Rear Panel Description

COMPONENT	FUNCTION
cooling fan	Pulls ambient air into chassis through side vents and exhausts through rear (software-controlled to Box Temp setpoint).
 AC power connector	Connector for three-prong cord to apply AC power to the analyzer. **CAUTION! The cord's power specifications (specs) MUST comply with the power specs on the analyzer's rear panel label.**
Model/specs label	Identifies the analyzer model number and provides power specs
SAMPLE	Connect a gas line from the source of sample gas here. Calibration gases can also enter here on units without zero/span/shutoff valve options installed.
EXHAUST	Connect an exhaust gas line of not more than 10 meters long here that leads outside the shelter or immediate area surrounding the instrument. The line must be ¼" tubing or greater.
SPAN 1	On units with zero/span/shutoff valves option installed, connect a gas line to the source of calibrated span gas here.
SPAN2/VENT	Used as a second cal gas input line when instrument is configured with zero/span valves and a dual gas option, or as a cal gas vent line when instrument is configured with a pressurized span option *(Call factory for details)*.
ZERO AIR	N101: On units with zero/span/shutoff valves option installed but no internal zero air scrubber, attach a gas line to the source of zero air here.
COM	Serial communications port for RS-232.
DIGITAL I/O Option	For remotely activating the zero and span calibration modes.
ANALOG OUT Option	For voltage or current loop outputs to a strip chart recorder and/or a data logger.
ETHERNET	Connector for network or Internet remote communication, using Ethernet cable.
Model label	Includes voltage and frequency specifications.

2.2.3. INTERNAL CHASSIS

This section shows the internal chassis configuration for the N101 in Figure 2-3.

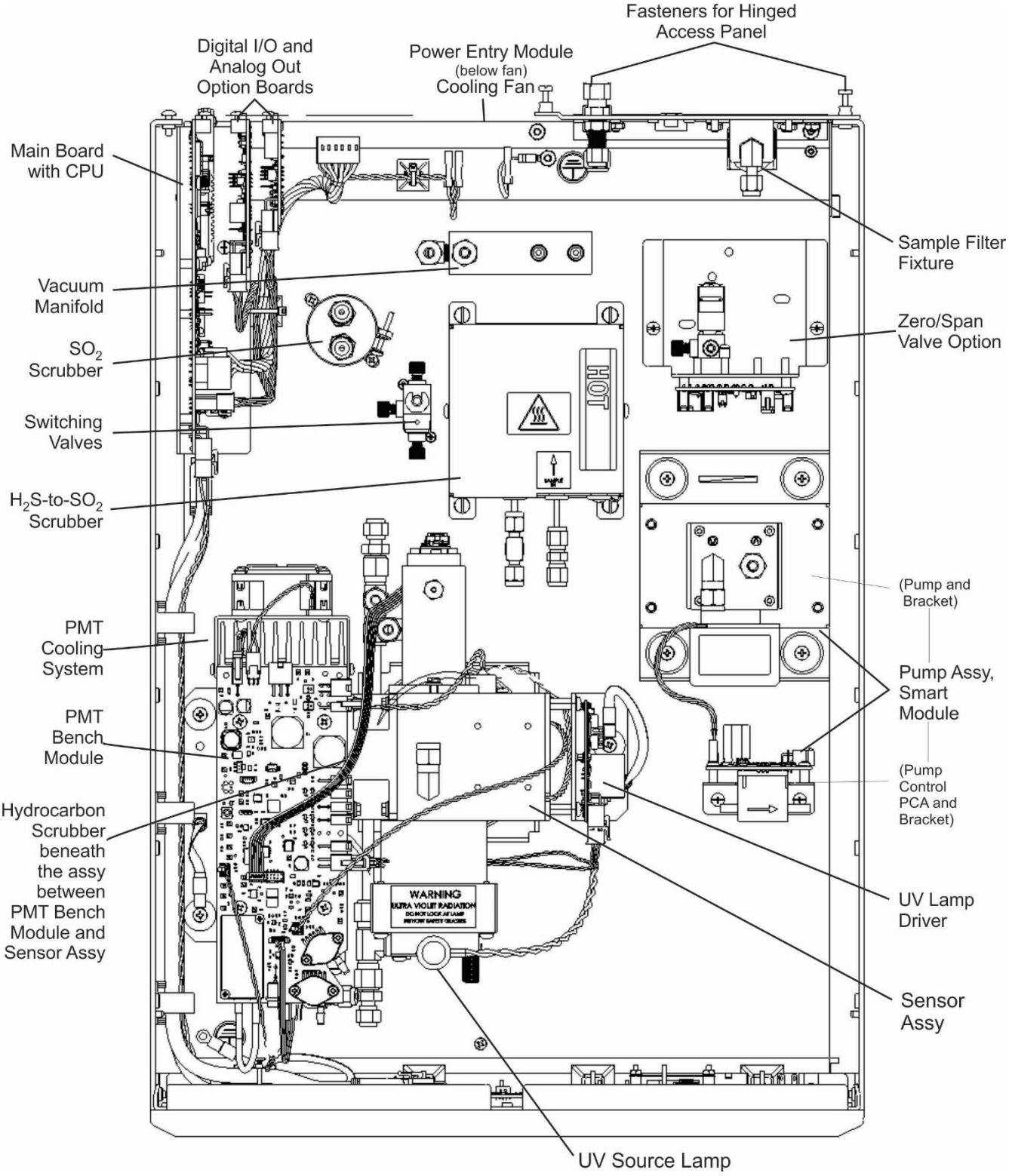


Figure 2-3. N101 Internal Chassis Layout

2.3. CONNECTIONS AND STARTUP

This section presents the electrical (Section 2.3.1) and pneumatic (Section 2.3.2) connections for setting up and preparing the instrument for operation (Section 2.3.3).

ATTENTION **COULD DAMAGE INSTRUMENT AND VOID WARRANTY**

Do not operate analyzer without first removing rear panel dust plugs from SAMPLE and EXHAUST port, and do not operate the converter without first properly connecting the ports to the instrument(s) per the instructions for pneumatic connections.

Note **Do not operate converter without top cover in place: otherwise, the thermal cutout may overheat and shut off the heating element. The air cooling required to stabilize the temperature of the converter tube is dependent on air flow patterns that exist only with the top cover in place.**

2.3.1. ELECTRICAL CONNECTIONS

Note **To maintain compliance with EMC standards, cable length must be no greater than 3 meters for all I/O connections. Ensure that there is enough space to easily disconnect this instrument from the power source if necessary.**

Teledyne API recommends that you store shipping containers and materials for future use if/when the instrument should be returned to the factory for repair and/or calibration service.

WARNING – Electrical Shock Hazard

- **High Voltages are present inside the instrument's case.**
- **Never connect or disconnect electronic circuit boards, wiring, harnesses, or electronic subassemblies while unit is powered up.**
- **Power connection must have functioning ground connection.**
- **Do not defeat the ground wire on power plug.**
- **Do not operate with cover off.**

CAUTION – Avoid Damage to the Instrument

Ensure that the AC power voltage matches the voltage indicated on the instrument's model/specs label before plugging it into line power.

2.3.1.1. CONNECTING POWER

Important

COULD CAUSE LOSS OR CORRUPTION OF DATA

Never power off the instrument from the rear panel Hard Power switch before using the front panel Soft Power switch, which triggers the Supervisory chip to safely shut down the internal computerized components and preserve data. Press and hold the front panel Soft Power switch until the instrument stops running; the LED state then changes from solid lit to blinking, at which time either the rear panel Hard Power switch can be used to finish powering off the instrument if needed, or the Soft Power switch can be pressed again later to restart the instrument.

Attach the power cord between the instrument's AC power connector and a power outlet capable of carrying at least the rated current at your AC voltage range. It is important to adhere to all safety and cautionary messages, and ensure that the outlet is equipped with a functioning earth ground.

2.3.1.2. CONNECTING ANALOG OUTPUTS

The optional rear panel Analog Output board offers several channels that can be mapped to reflect various operating values in the analyzer, including concentration values, temperatures, pressures, etc. These mappings are not configured by default and must be set by the user.

The four **voltage** outputs (0-5 V or 0-10 V) are isolated from the instrument but share a common ground. The three **current** outputs are individually isolated from each other and from the instrument.

To access these signals, attach a strip chart recorder and/or data-logger to the appropriate analog output connections, and configure through the Setup>Analog Outputs menu.

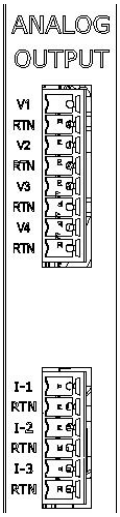


Figure 2-4. Analog Outputs Connectors Panel Option

Table 2-3. Analog Output Pin Assignments

Pin	Output	Description
Isolated Voltage Outputs		
V1	V +	User definable through the Setup>Analog Outputs menu.
RTN	Ground	
V2	V +	
RTN	Ground	
V3	V +	
RTN	Ground	
V4	V +	
RTN	Ground	
Isolated Current Outputs		
I-1	I Out +	User definable through the Setup>Analog Outputs menu.
RTN	I Out -	
I-2	I Out +	
RTN	I Out -	
I-3	I Out +	
RTN	I Out -	

2.3.1.3. Connecting the Digital I/O Expansion Board Option

The connections on this board include three relay alarms, five digital outputs, and three isolated digital input controls. The **Relays** can be mapped to reflect various internal instrument conditions and states. The **Outputs** are isolated from the instrument and consist of open collector transistors with a common ground; they can be mapped to reflect various internal instrument conditions and states; they can be used to interface with devices that accept logic-level digital inputs, such as Programmable Logic Controllers (PLCs). The **Inputs** are also isolated but share the same ground as the Outputs; they will work with relays, open collectors, or 3.3 V – 24 V logic. Pull low to activate. DI1 and DI2 are fixed (not mappable) for remote zero and span calibrations.

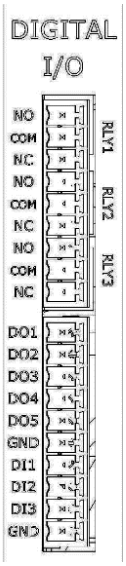


Figure 2-5. Digital I/O Connector Panel Option

Table 2-4. Digital Input/Output Pin Assignments

Pin	Description	
Relays		
NO	RLY1	Relay Alarms, user-configurable through the Setup>Digital Outputs menu.
COM		
NC		
NO	RLY 2	
COM		
NC		
NO	RLY 3	
COM		
NC		
Digital Outputs and Inputs		
DO1	Digital Outputs mappable in the Setup>Digital Outputs menu, and viewable in the Utilities>Diagnostics>Digital Outputs menu	
DO2		
DO3		
DO4		
DO5		
GND	Ground	
DI1	Digital Input1 = Remote Zero Cal Digital Input2 = Remote Span Cal (Digital Input3 not used) View status in Utilities>Diagnostics>Digital Inputs menu	
DI2		
DI3		
GND	Ground	

2.3.1.4. Connecting Communications Interfaces

Ethernet Connection

For network or Internet communication with the analyzer, connect an Ethernet cable from the analyzer's rear panel Ethernet interface connector to an Ethernet port. Although the analyzer is shipped with DHCP enabled by default, it should be manually configured with a static IP address (recommended).

Serial Connection

Received from the factory, the analyzer COM port is set up for RS-232 communications with data communication equipment (DCE). This port can be reconfigured for RS-232 communications with data terminal equipment (DTE) by jumpering the pins on JP1 as indicated in Table 2-5 (view/edit software settings Table 2-14).

WARNING – ELECTRICAL SHOCK HAZARD

Disconnect all power before performing any operation that requires entry into the interior of the analyzer. Contact Technical Support (Section 5.9) before reconfiguring the internal serial communications connector.

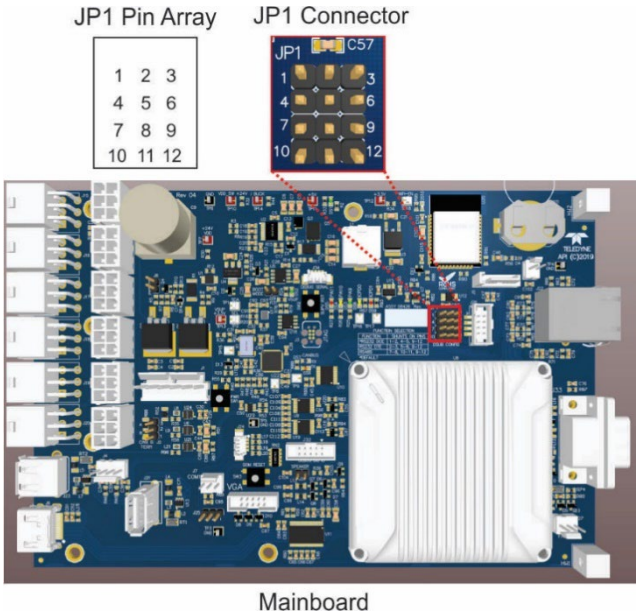


Figure 2-6. Mainboard JP1 Location and Pin Arrangements

Table 2-5. JP1 Configurations for Serial Communication

Function	Jumpers	DSub Pins	
		2	3
DCE RS232 (default)	1-2, 4-5, 9-12	232Tx	232Rx
DTE RS232	2-3, 5-6, 9-12	232Rx	232Tx

View/edit the Communications parameters in the Setup>Comm>COM1 menu.

RS-232

- **Baud rate**: 115200 bits per second (baud)
- **Data Bits**: 8 data bits with 1 stop bit
- **Parity**: None

2.3.2. PNEUMATIC CONNECTIONS

This section provides pneumatic connection and setup instructions for basic and optional configurations. Pneumatic flow diagrams are shown in Section 2.3.3. Calibration instructions are provided in Section 4.

Before making the pneumatic connections, carefully note the following cautionary and special messages:

CAUTION – General Safety Hazard

- **Sulfur Dioxide (SO2) and Hydrogen Sulfide are toxic gases. Obtain a Safety Data Sheet (SDS) for these materials, and rigorously follow the safety guidelines described there.**
- **Vent the exhaust from the analyzer's internal pump to outside the immediate area or shelter surrounding the instrument.**
- **Do not vent calibration gas or sample gas into enclosed areas.**
- **Sample and calibration gases should only come into contact with PTFE (Teflon) or glass tubes and fixtures.**
- **Do not allow sample and calibration gases to come into contact with brass or stainless steel fittings prior to the reaction cell.**
- **In units with a permeation tube option installed, vacuum pump must be connected and powered on to maintain constant gas flow though the analyzer at all times. Insufficient gas flow allows gas to build up to levels that will contaminate the instrument or present a safety hazard to personnel.**
- **Remove the permeation tube when taking the analyzer out of operation and store in sealed container (use the original shipping packaging).**

(See Section 5.6.2 for instructions on how to remove the permeation tube when the unit is not in operation).

ATTENTION

COULD DAMAGE INSTRUMENT AND VOID WARRANTY

Vent Pressurized Gas:

When any gas (span, zero air, sample) is received from a pressurized manifold, always provide a vent to equalize the pressure with the ambient atmosphere before it enters the instrument to ensure that the gases input do not exceed the instrument's maximum inlet pressure, as well as to prevent back diffusion and pressure effects

Remove Dust Plugs:

Remove dust plugs from rear panel exhaust and supply line fittings before powering on the instrument.

Keep dust plugs for reuse in future storage or shipping to prevent debris from entering the pneumatics.

Important

IMPACT ON READINGS OR DATA

Sample and calibration gases should only come into contact with PTFE tubing.

Run a leak check once the appropriate pneumatic connections have been made; check all pneumatic fittings for leaks per Section 5.4.12.1 (or Section 5.4.12.2 for detailed check if any leaking is suspected).

2.3.2.1. Critical Tubing, Pressure, Venting and Exhaust Requirements

The requirements presented in this section apply to all pneumatic connection instructions. All other connection instructions are provided with their respective instrument configurations in Sections 2.3.2.2 through 2.3.2.5.

Tubing:

- PTFE or glass material (do not use FEP or stainless steel materials)
- Outer diameter (OD) minimum ¼" .
- Min/max length 2 meters to 10 meters.

Pressure:

- All Sample gas pressure must be at ambient atmospheric pressure, no greater than 1.0 psig.

Venting (to prevent back diffusion and pressure effects):

- Run tubing outside the enclosure or at least away from immediate area surrounding the instrument.

Exhaust Outlet:

- Run tubing outside the enclosure.

2.3.2.2. Basic Connections Using Gas Dilution Calibrator

Figure 2-7 and Figure 2-8 illustrate pneumatic connections for two of the possible basic configurations.

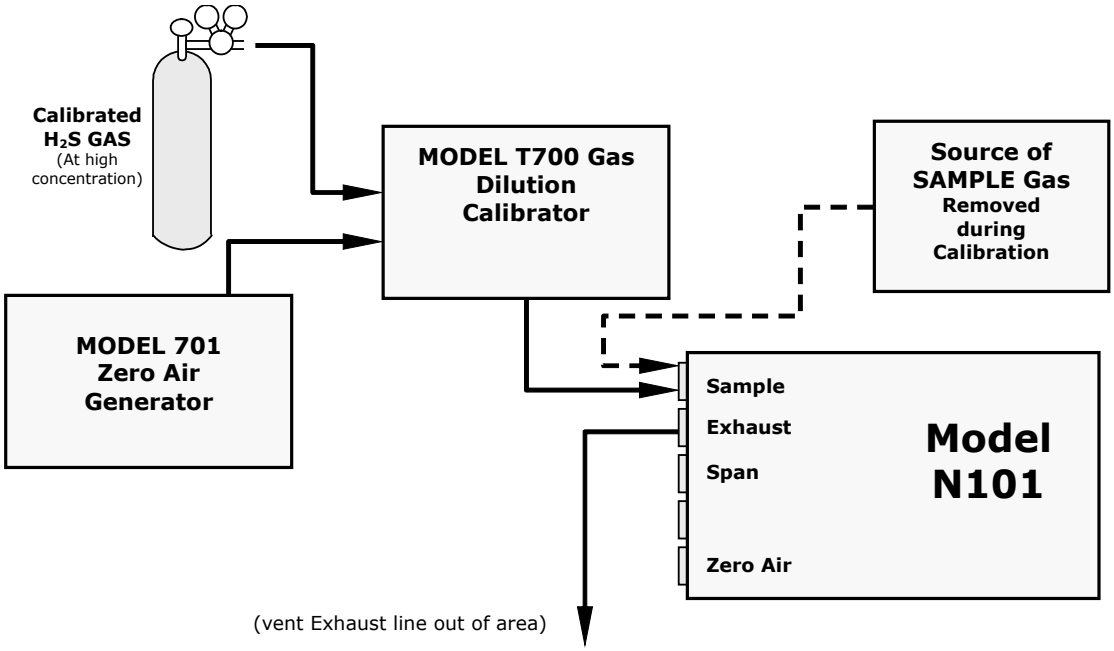


Figure 2-7. N101 Pneumatic Connections from Gas Dilution Calibrator – Basic Configuration

2.3.2.3. Basic Connections Using Bottled Span Gas

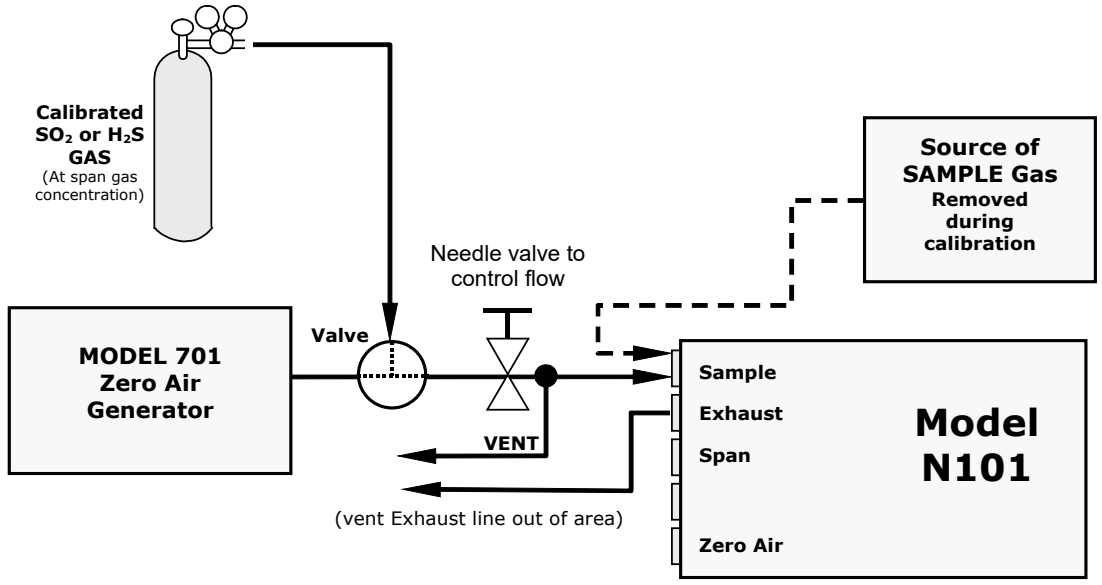


Figure 2-8. N101 Pneumatic Connections from Bottled Span Gas – Basic Configuration

For the analyzer's basic configuration, in addition to tubing, pressure, venting, and exhaust requirements set out in Section 2.3.2.1, ensure the following:

SAMPLE INLET

Connect ¼" gas line not more than 2 m long, from sample gas source to this inlet.

When no zero/span/shutoff valve options, also connect line from calibration gas source to this inlet, but only when a calibration operation is actually being performed.

EXHAUST OUTLET

Connect exhaust line made of PTFE tubing; minimum O.D ¼", to this fitting. The exhaust line should be no longer than 10 meters and should lead outside the shelter or immediate area surrounding the instrument.

CALIBRATOR VENTING

Vent the output of the calibrator if calibrator not already vented.

2.3.2.4. CONNECTIONS W/AMBIENT ZERO/AMBIENT SPAN (Z/S) VALVES OPTION

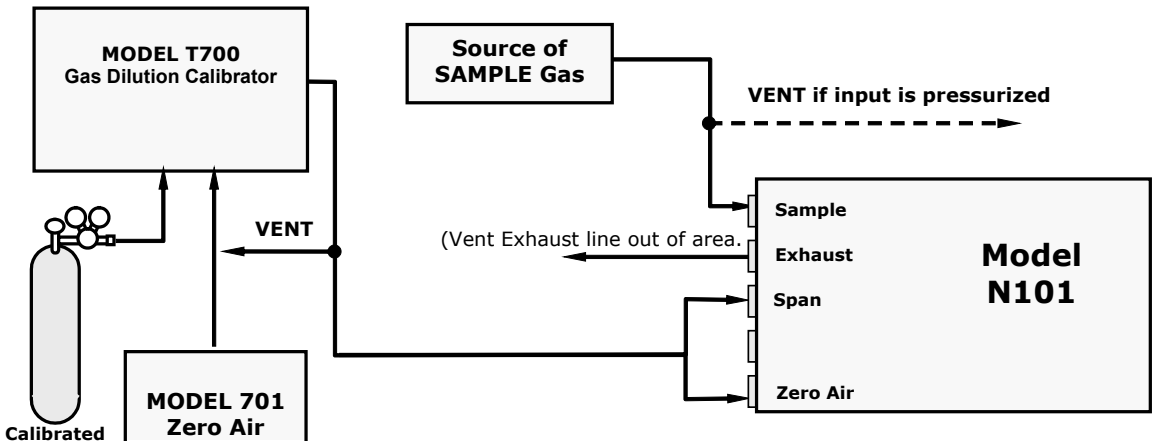


Figure 2-9. N101 Connections with Ambient Zero, Ambient Span Valves Option

In addition to tubing, pressure, venting, and exhaust requirements set out in Section 2.3.2.1, attach the following pneumatic lines:

SAMPLE GAS SOURCE

Attach a sample inlet line to the SAMPLE inlet fitting.

- In applications where the sample gas is received from a pressurized manifold, vent the sample gas line.

CALIBRATION GAS SOURCES

SPAN GAS Attach a gas line from the source of calibration gas (e.g. a Teledyne API T700 Dynamic Dilution Calibrator) to the SPAN1 inlet.

ZERO AIR Zero air is supplied by the zero air generator such as a Teledyne API 701. Attach a gas line from the source of zero air to the ZERO AIR inlet.

VENTING

Vent both the span gas and zero air supply lines.

2.3.2.5. ZERO SCRUBBER AND INTERNAL SPAN SOURCE (IZS) (OPT 50G)

ATTENTION

COULD DAMAGE INSTRUMENT AND VOID WARRANTY

Gas flow must be maintained at all times for units with IZS Options installed. The IZS option requires a permeation tube (customer supplied) which emits H_2S. Insufficient gas flow can build up H_2S to levels that will damage the instrument.

Remove the permeation device when taking the analyzer out of operation.

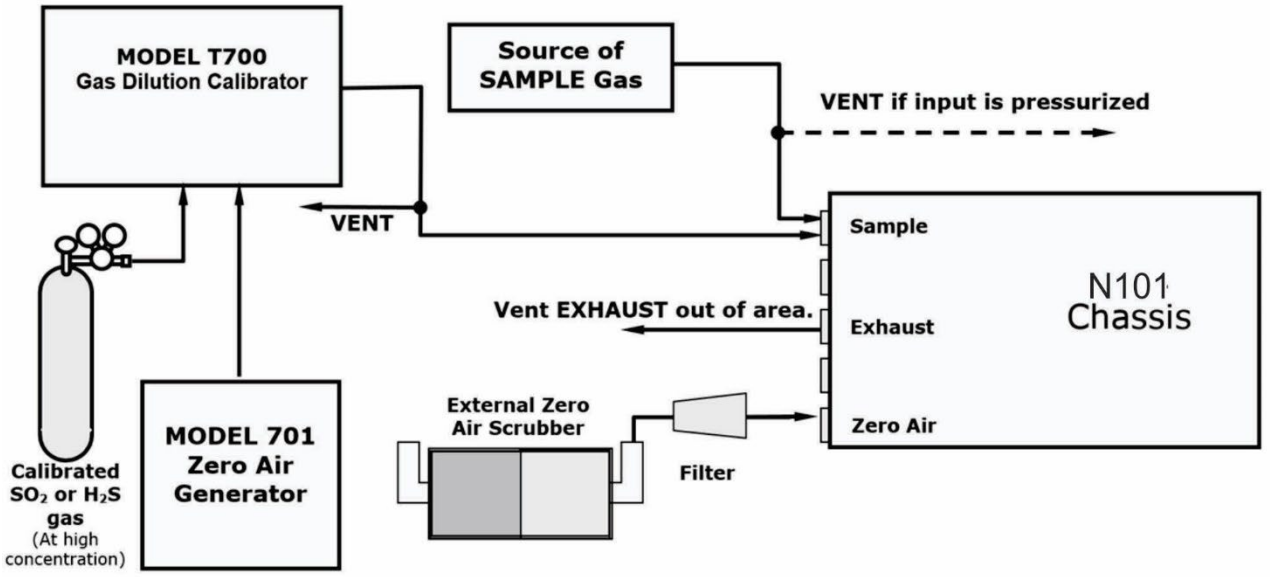


Figure 2-10. N101 Connections with Zero Scrubber and Internal Span Source (IZS) Option

2.3.3. PNEUMATIC FLOW DIAGRAMS

This section shows the pneumatic flow diagrams, each followed by a table showing the respective valve operating states.

2.3.3.1. PNEUMATIC FLOW FOR BASIC CONFIGURATION

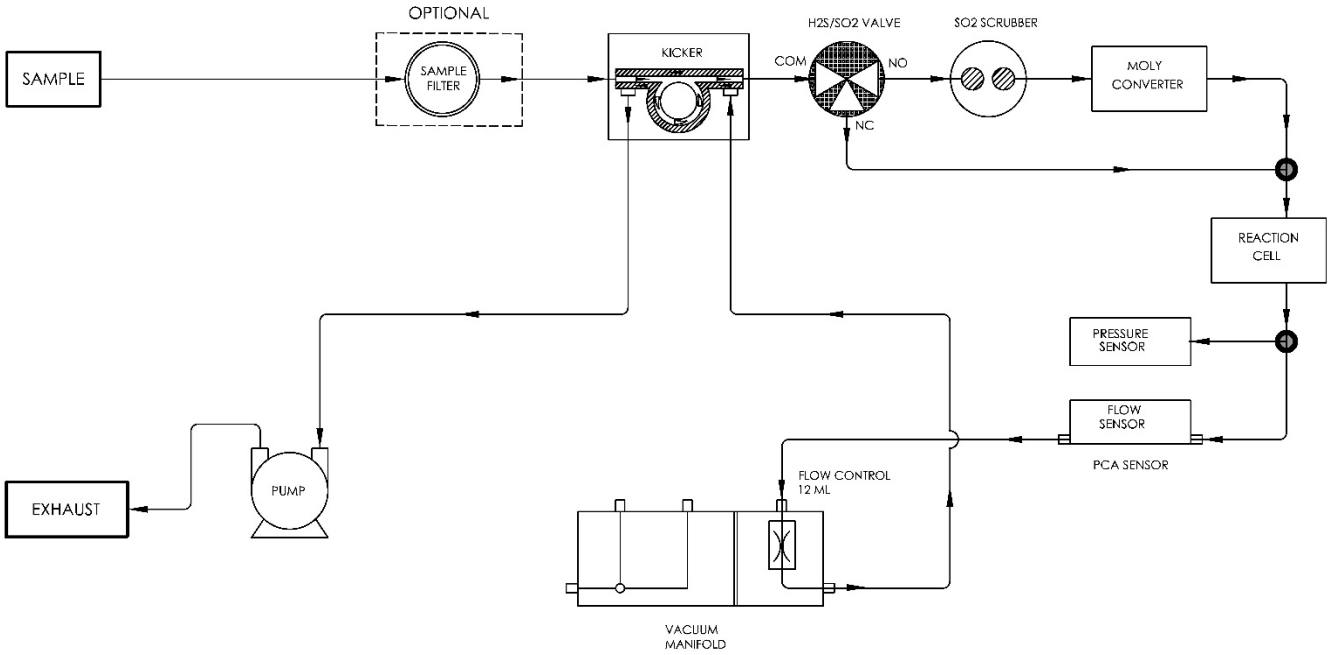


Figure 2-11. N101 Pneumatics, Basic Configuration

Table 2-6. N101 Basic Valve Operating States

GAS MODE	CONDITION OF H2S–SO2 SWITCHING VALVE	VALVE PORT CONNECTION
H_2S	Open to SO_2 Scrubber and Molybdenum Converter	COM → NO
SO_2	Open to directly to Sample Chamber. Bypasses SO_2 Scrubber and Molybdenum Converter	COM → NC
H_2S –SO_2	Switches between above two states every 10 minutes.	- -

2.3.3.2. PNEUMATIC FLOW FOR ZERO/SPAN VALVES OPTION

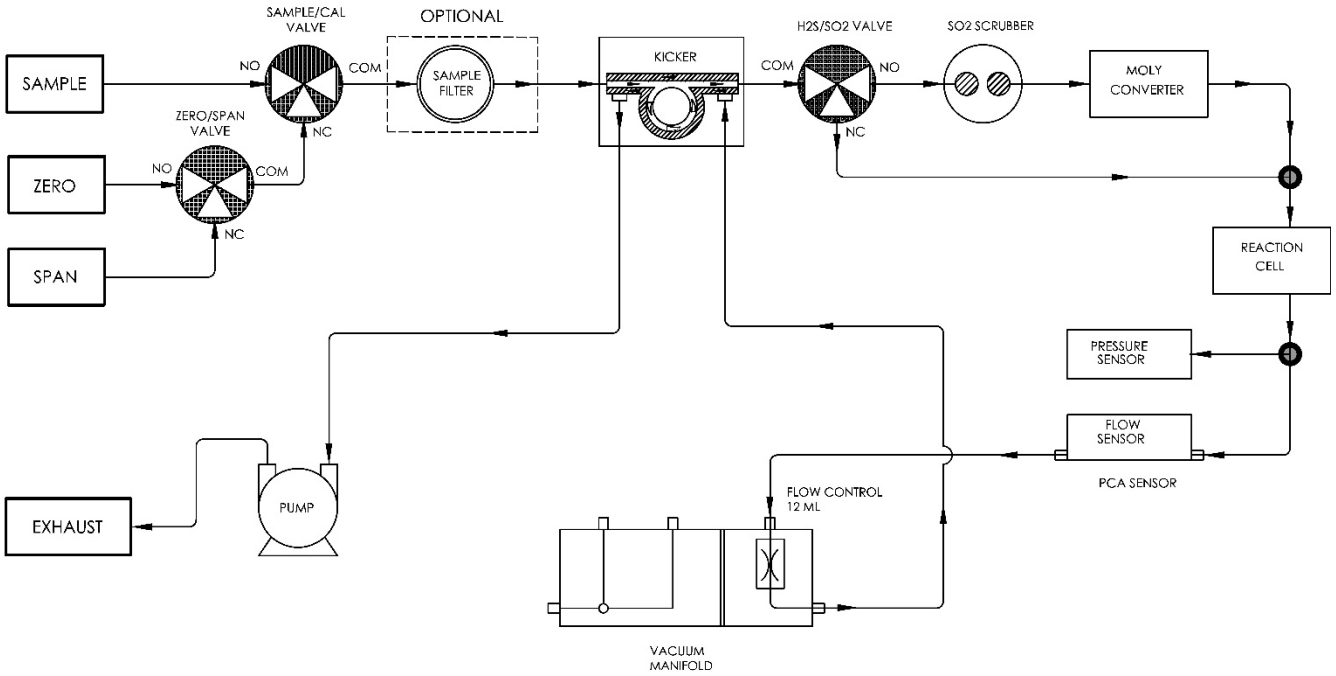


Figure 2-12. N101 Pneumatics with Zero/Span Valves Option

Table 2-7. Zero/Span and Sample/Cal Valve Operating States

MODE	VALVE	STATE	VALVE PORT STATUS
SAMPLE	Sample/Cal	Open to SAMPLE inlet	NO → COM
	Zero/Span	Open to ZERO AIR inlet	NO → COM
ZERO CAL	Sample/Cal	Open to ZERO/SPAN valve	NC → COM
	Zero/Span	Open to ZERO AIR inlet	NO → COM
SPAN CAL	Sample/Cal	Open to ZERO/SPAN valve	NC → COM
	Zero/Span	Open to SPAN GAS inlet	NC → COM

2.3.3.3. PNEUMATIC FLOW FOR INTERNAL ZERO/SPAN (IZS) GAS GENERATOR OPTION

Note **The permeation tube is not included in the IZS Option and must be ordered separately.**

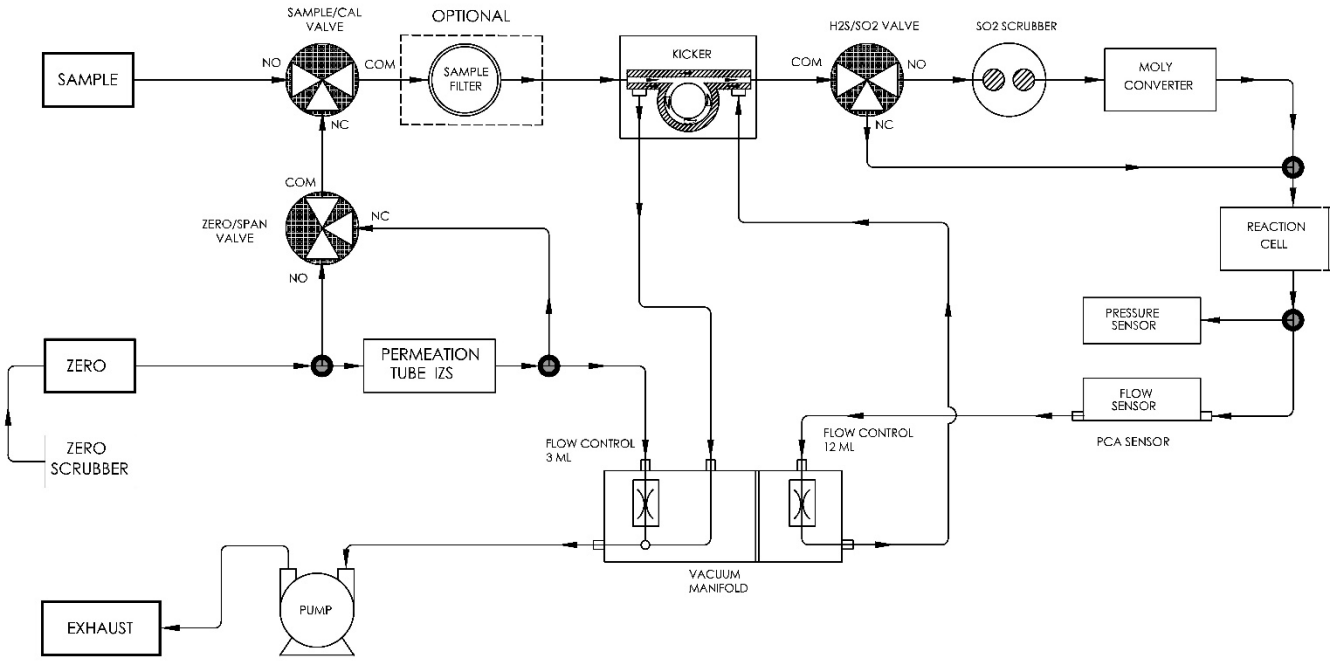


Figure 2-13. N101 Pneumatics with IZS Option

Table 2-8. IZS Valve Option Operating States

MODE	VALVE	STATE	VALVE PORT STATUS
SAMPLE	Sample/Cal	Open to SAMPLE inlet	NO → COM
	Zero/Span	Open to ZERO AIR inlet	NO → COM
ZERO CAL	Sample/Cal	Open to ZERO/SPAN valve	NC → COM
	Zero/Span	Open to ZERO AIR inlet	NO → COM
SPAN CAL	Sample/Cal	Open to ZERO/SPAN valve	NC → COM
	Zero/Span	Open to SPAN GAS inlet	NC → COM

2.3.4. STARTUP, FUNCTIONAL CHECKS AND CALIBRATION

We recommend reading Section 6 to become familiar with the principles of operation.

When the instrument is first started (Section 2.3.4.1), check its functionality (Section 2.3.4.3) and run an initial calibration (Section 2.3.4.4). Section 2.4 introduces the menu system, and Section 2.5 provides setup/customization instructions.

2.3.4.1. STARTUP

Upon initial startup of analyzers, a sequence of status screens (Figure 2-14) appear prior to the Home page appearing (Figure 2-15).

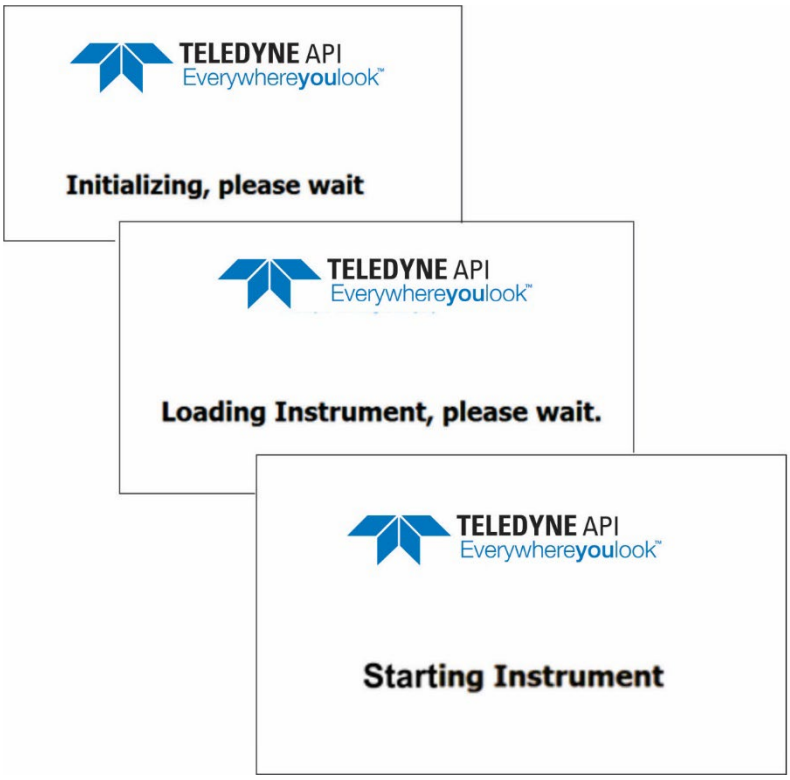


Figure 2-14. Status Screens at Startup

Upon any startup, this instrument should warm up for approximately one hour before reliable measurements can be taken.

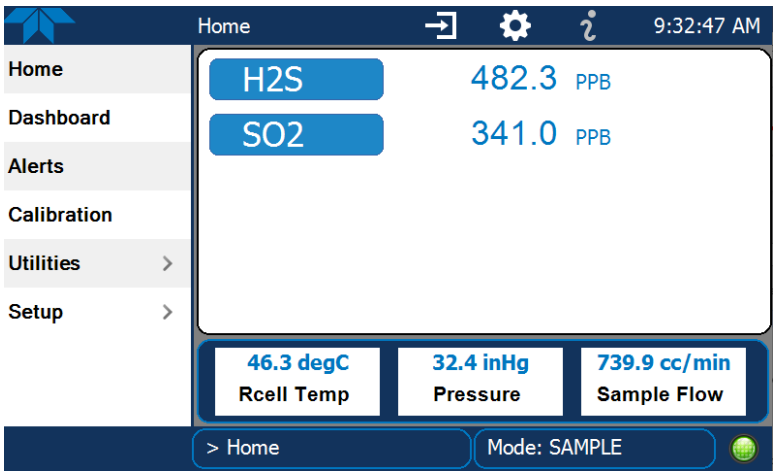


Figure 2-15. N101 Typical Home Page

2.3.4.2. ALERTS: WARNINGS AND OTHER MESSAGES

Because internal temperatures and other conditions may be outside the specified limits during the warm-up period, the software will suppress most Alerts for 30 minutes after power up. The Alerts page (Figure 2-16) shows the status of any active warning conditions or user-configured Events. (Section 2.4.3 provides more detailed information about Alerts, and Section 2.5.2 addresses Events).

Alerts can be viewed and cleared via either the Alerts menu or the Alerts shortcut (Caution symbol, bottom right corner of the screen). Although these alerts can be cleared from the Active Alerts page, a history of all alerts remains in the Utilities>Alerts Log page.

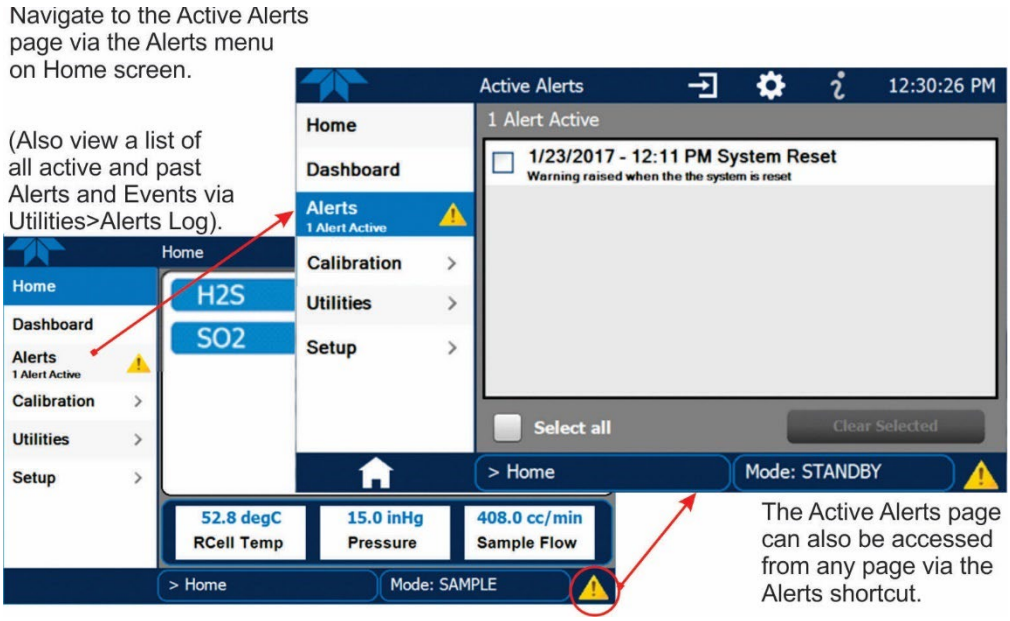


Figure 2-16. Viewing Active Alerts Page

If alerts of warning conditions persist after the warm up period or after being cleared, investigate their cause using the troubleshooting guidelines in Section 5.7.

2.3.4.3. FUNCTIONAL CHECKS

After warm-up, verify that the software properly supports any hardware options that are installed (Setup>Instrument menu), and that the instrument is functioning within allowable operating parameters. Check the Dashboard page against the instrument's *Final Test and Validation Data sheet*, which lists these values as they appeared before the instrument left the factory. (If any functional parameters are not displayed, configure the Dashboard through the Setup>Dashboard menu to add them; see Section 2.4.2).

These functions are also useful tools for diagnosing problems (information provided in Section 5.7.2).

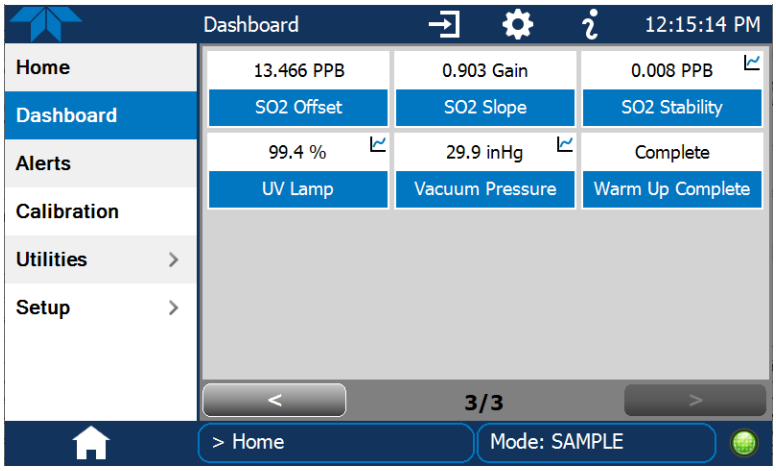


Figure 2-17. Sample Dashboard Page

2.3.4.4. CALIBRATION

Before operation begins, the analyzer requires zero and span calibrations, and possibly HVPS adjustment. Also, any time an analyzer is moved or its configuration changed, it must be calibrated. The method for performing a calibration differs slightly depending on whether or not any of the available internal zero air or valve options are installed. Follow the appropriate calibration instructions presented in Section 4.

2.4. MENU OVERVIEW

Table 2-9 describes the main menus and provides cross-references to the respective sections with configuration details.

Table 2-9. Menu Overview

MENU		DESCRIPTION	LOCATION
Home		View and plot concentration readings and other selectable parameter values (Figure 2-19).	Section 2.4.1
Dashboard		View user-selected parameters and their values, some of which can be displayed in a live-plot graph (Figure 2-20).	Section 2.4.2
Alerts		View and clear active Alerts that were triggered by factory-defined Events as well as user-defined Events. (Active and past Alerts are recorded in the Utilities>Alerts Log).	Section 2.4.3
Calibration		Run calibrations or calibration checks on the SO_2 channel (and second gas sensor if installed).	Sections 2.4.4 and 4
Utilities		View logs, download data and firmware updates, copy configurations between instruments, and run diagnostics.	Section 2.4.5
Setup		Configure a variety of features and functions through these submenus for customized operation.	Section 2.5
	Datalogging	Track and record concentration and calibration data and selectable diagnostic parameters, the reports for which can be viewed in the Utilities>Datalog View menu (Section 2.4.5) and downloaded to a flash drive via the Utilities>USB Utilities menu (Section 2.4.5). Also, select configured Events (Section 2.5.2) and create customized triggers for data logging functions.	Section 2.5.1
	Events	Select parameters and define the conditions by which they are to be flagged and recorded in the Alerts log (Section 2.4.3) when they are triggered. Once configured, Events can be used to trigger Datalogs. (Section 2.5.1). Note that some Events are predefined and are not editable.	Section 2.5.2
	Dashboard	Monitor instrument functionality (Figure 2-17) via selectable parameters.	Section 2.5.3
	Auto Cal (with valve options)	When zero/span valve options installed, configure sequences for automatic calibration checks.	Section 4.3
	Vars	Manually adjust several software variables that define specific operational parameters.	Section 2.5.5
	Homescreen	Select up to three parameters to be displayed in the meters (Figure 2-18).	Section 2.5.6
	Digital Outputs (option)	Map the rear-panel digital outputs to a variety of signals present in the instrument to monitor the status of operating conditions or custom Events.	Section 2.5.7
	Analog Outputs (option)	Send user-selected parameter readings in the form of user-defined voltage or current loop signals as outputs to a strip chart recorder and/or the data logger.	Section 2.5.8
	Instrument	View product and system information, including list of options, if any; view network settings; view/adjust Date and Time settings*; and check for firmware updates when connected to a network that is connected to the Internet. *Time Zone change requires special procedures (Section 5.5).	Section 2.5.9
	Comm	View and configure network and serial communications.	Section 2.5.10

2.4.1. HOME PAGE

Figure 2-18 presents an orientation to the main display screen; Figure 2-19 shows that pressing the gas name or its concentration value or a meter below displays a live plot of their respective readings. Section 2.5.6 provides configuration instructions.

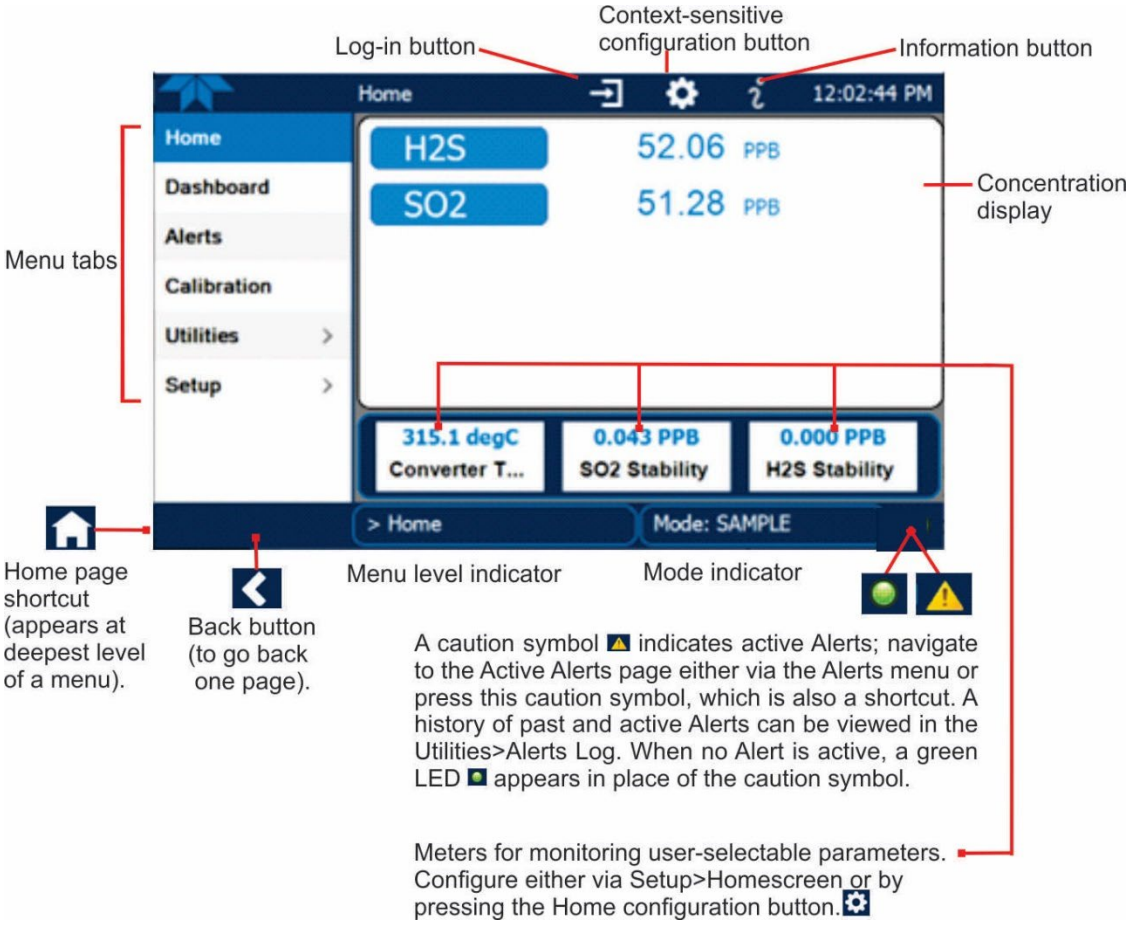


Figure 2-18. User Interface Orientation

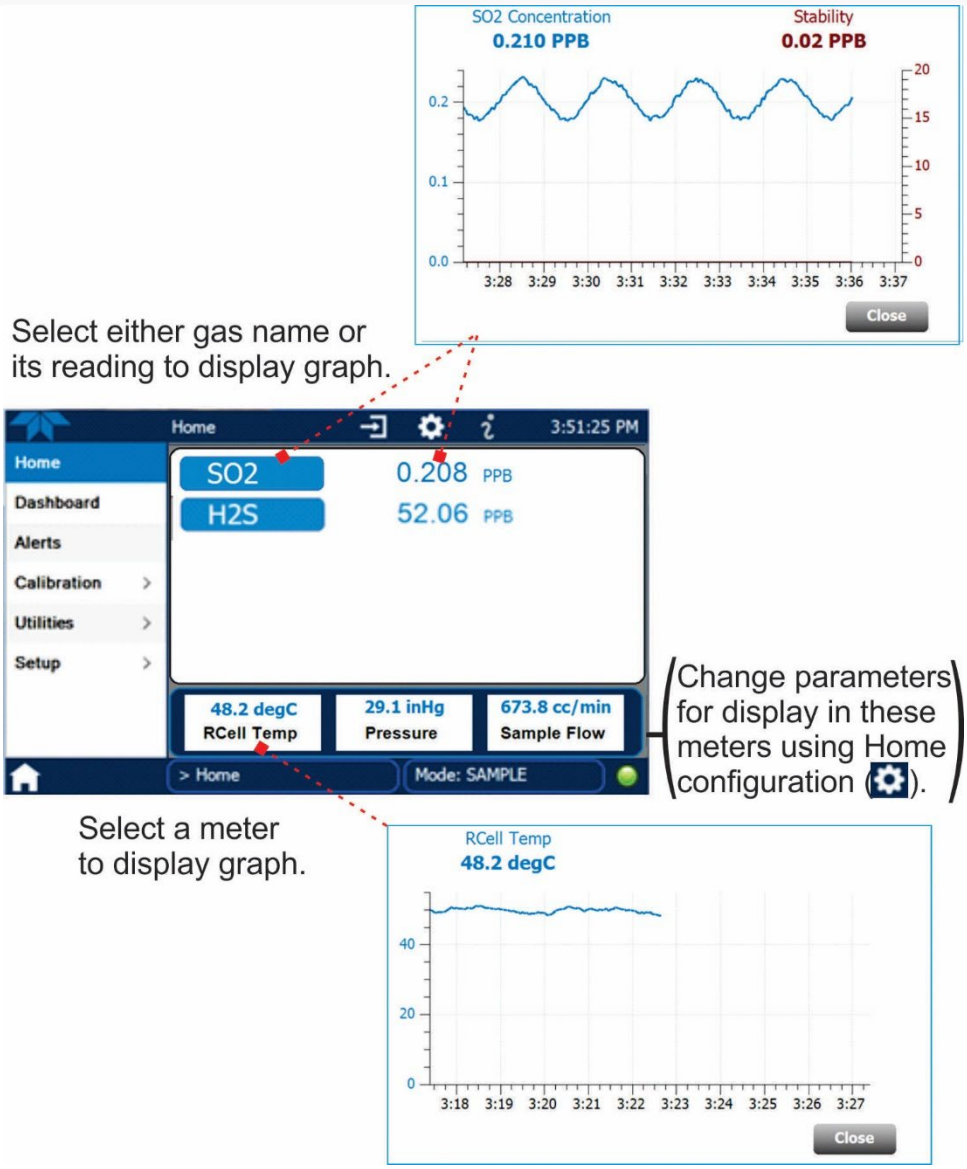


Figure 2-19. Concentration and Stability Graph (top) and Meter Graph (bottom)

2.4.2. DASHBOARD

The Dashboard displays an array of user-selectable parameters and their values (Section 2.5.3 provides configuration instructions). If there is a graphing icon in the upper right corner of a parameter, pressing that parameter displays a live plot of its readings as in Figure 2-20.

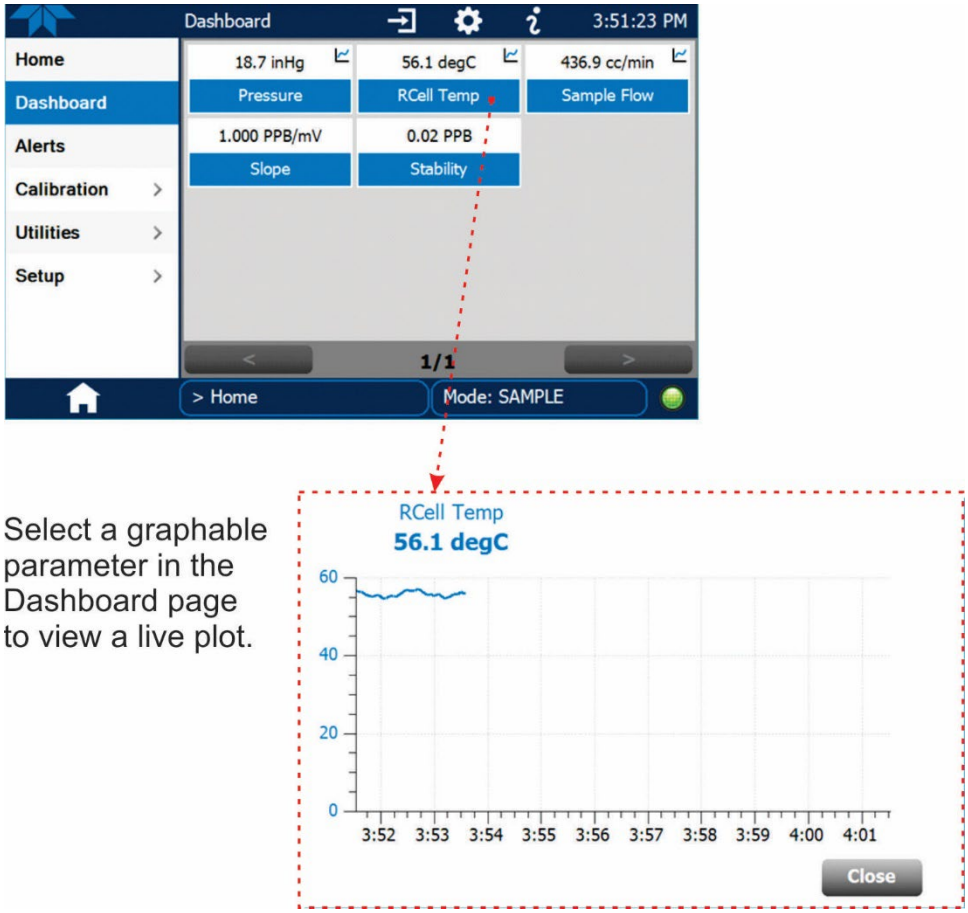


Figure 2-20. Dashboard Page

2.4.3. ALERTS

Alerts are notifications triggered by specific criteria having been met by either factory-defined conditions (standard and not editable) or user-defined Events (Section 2.5.2). The Active Alerts page shows the status of any active warning conditions or Events that have been triggered.

When Alerts are triggered, a caution symbol appears in both the Alerts menu tab and in the bottom right corner of the software interface, which serves as a shortcut to the Alerts page from any other page. View a list of currently active Alerts by pressing either the Alerts menu on the Home screen or by pressing the Alerts shortcut (Figure 2-21).

While Alerts can be cleared from the Active Alerts page, they remain recorded in the Utilities>Alerts Log menu.

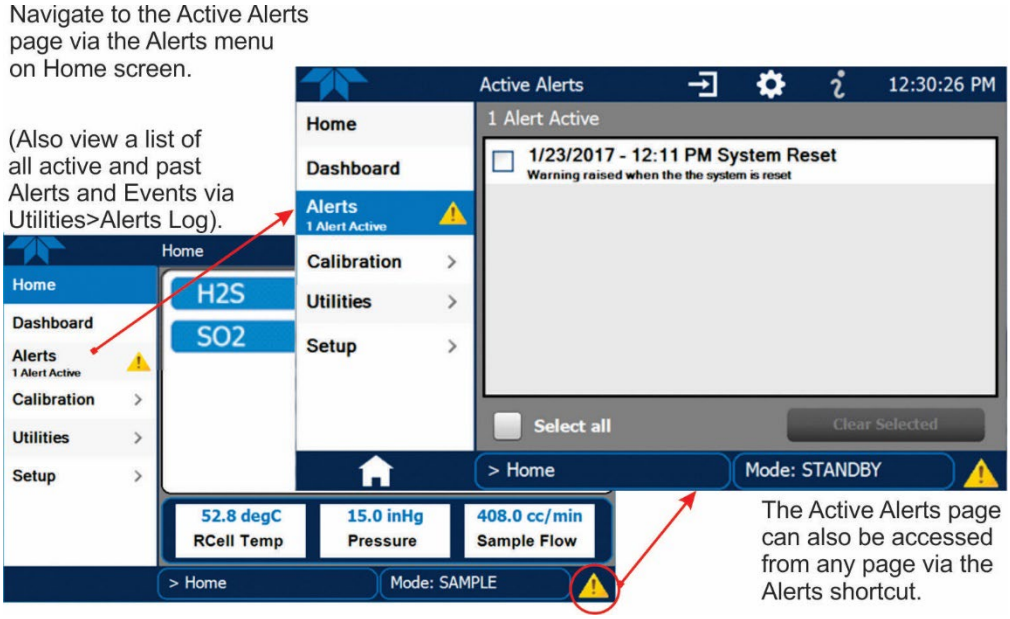


Figure 2-21. Navigating to the Active Alerts Page

Alerts can be configured as either latching (appears in Active Alerts screen when Event is triggered and must be cleared by the user) or non-latching (Active Alerts screen continuously updates based on the Event criteria, clearing on its own). See Section 2.5.2.

To clear Alerts from the Active Alerts page, either check individual boxes to choose specific Alerts, or check the Select All box to choose all Alerts, then press the Clear Selected button.

When all Alerts are cleared, the Alerts menu tab no longer shows the caution symbol, and a green LED replaces the caution symbol in the bottom right corner of the interface (Figure 2-22). However, Alerts can reappear if the conditions causing them are not resolved. For troubleshooting guidance, refer to Section 5.7.

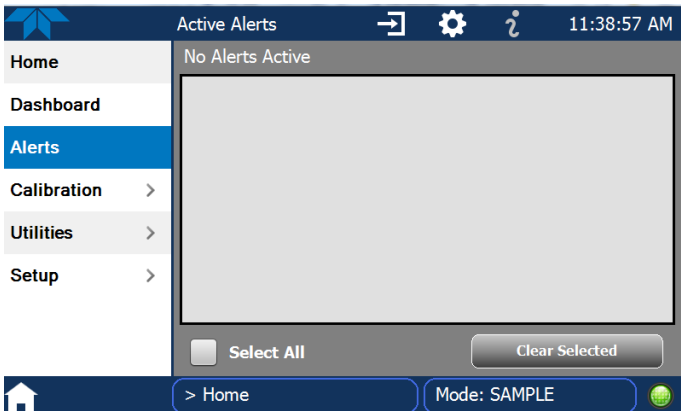


Figure 2-22. Active Alerts Cleared

Alerts and Events remain recorded in the Utilities>Alerts Log (Figure 2-23).

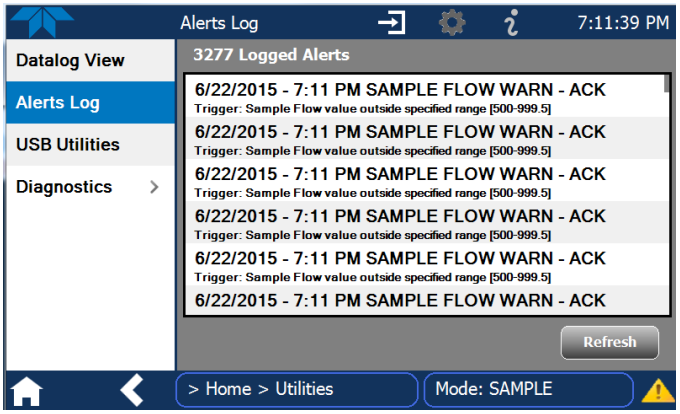


Figure 2-23. Utilities>Alerts Log of Active and Past Alerts and Events

2.4.4. CALIBRATION

The Calibration menu is used for multipoint calibrations and for external calibration with valve options installed. Calibration procedures are presented in Section 4.

2.4.5. UTILITIES

The Utilities menu has a variety of functions as described next in Table 2-10.

Table 2-10. Utilities Submenu Descriptions

UTILITIES MENU	DESCRIPTION	
Datalog View	Displays the data logs that were configured via the Setup>Data Logging menu. From this list a log can be selected and filters applied to view the desired data. (For details on setting up and running the Data Logger, see Section 2.5.1).	
Alerts Log	Displays a history of alerts that are triggered by factory-defined and user-defined Events, such as warnings and alarms (See Section 2.5.2 for Events configuration).	
USB Utilities	Serves multiple purposes using a flash drive connected to the instrument's front panel USB port: • download data from the instrument's Data Acquisition System (DAS), the Data Logger, to a flash drive (Section 2.5.1.3) • update firmware (Section 5.3) • transfer instrument configuration from/to other same-model instruments (Section 2.6) • download a basic operation functionality report (Section 5.3).	
Diagnostics	Provides access to various pages that facilitate troubleshooting.	
	Analog Inputs	Measure voltage signals of several analog input parameters. These can be logged in the internal data acquisition system (DAS), by configuring the Data Logger in the Setup>Data Logging menu (Section 2.5.1).
	Analog Outputs	Show the voltage signals for the functions selected and configured in the Setup>Analog Outputs menu (Section 2.5.8).
	Digital Inputs	Show whether specific available features are turned ON or OFF; for example, whether or not Maintenance Mode input or Language selection can be controlled through the front panel, or whether a zero or span calibration can be activated remotely when an external source is connected to the rear panel Control In connector.
	Digital Outputs	Show the function of user-specified parameters configured in the Setup>Digital Outputs menu (Section 2.5.7).
	Flow Cal	Used to calibrate the sample gas flow reading with actual flow measured by an external device. (See Section 5.6.8.3).
	Lamp Cal	Calibrate UV lamp.
	HVPS	Adjust high voltage power supply.

2.4.6. SETUP

The Setup menu is used to configure the instrument's software features, gather information on the instrument's performance, and configure and access data from the Datalogger, the instrument's internal data acquisition system (DAS). Section 2.5 provides details for the menus under Setup.

2.5. SETUP MENU: FEATURES/FUNCTIONS CONFIGURATION

Use the Setup menu to configure the instrument's software features, to gather information on the instrument's performance, and to configure and access data from the Datalogger, the instrument's internal data acquisition system (DAS). Once the setups are complete, the saved configurations can be downloaded to a USB drive through the Utilities>USB Utilities menu and uploaded to other instruments of the same model (Section 2.6).

2.5.1. SETUP>DATA LOGGING (DATA ACQUISITION SYSTEM, DAS)

The Datalogger can be configured to capture and store user-defined data, which then can be viewed in the Alerts page, if elected, as well as downloaded from the instrument to a USB flash drive for examination and analysis.

Figure 2-24 shows a new log; Figure 2-25 shows a sample existing log, which can be edited or deleted, and Figure 2-26 provides illustrated instructions for setting up a new log, with Sections 2.5.1.1 and 2.5.1.2 providing additional details.

To transfer captured instrument data to a flash drive see Section 2.5.1.3.

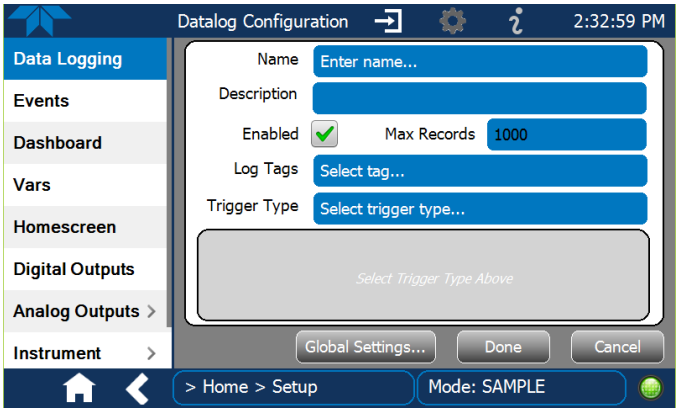


Figure 2-24. Datalog Configuration, New Log Page

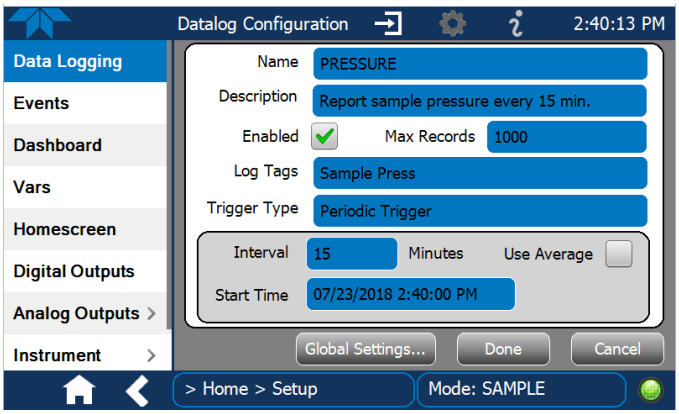


Figure 2-25. Datalog Configuration, Existing Log

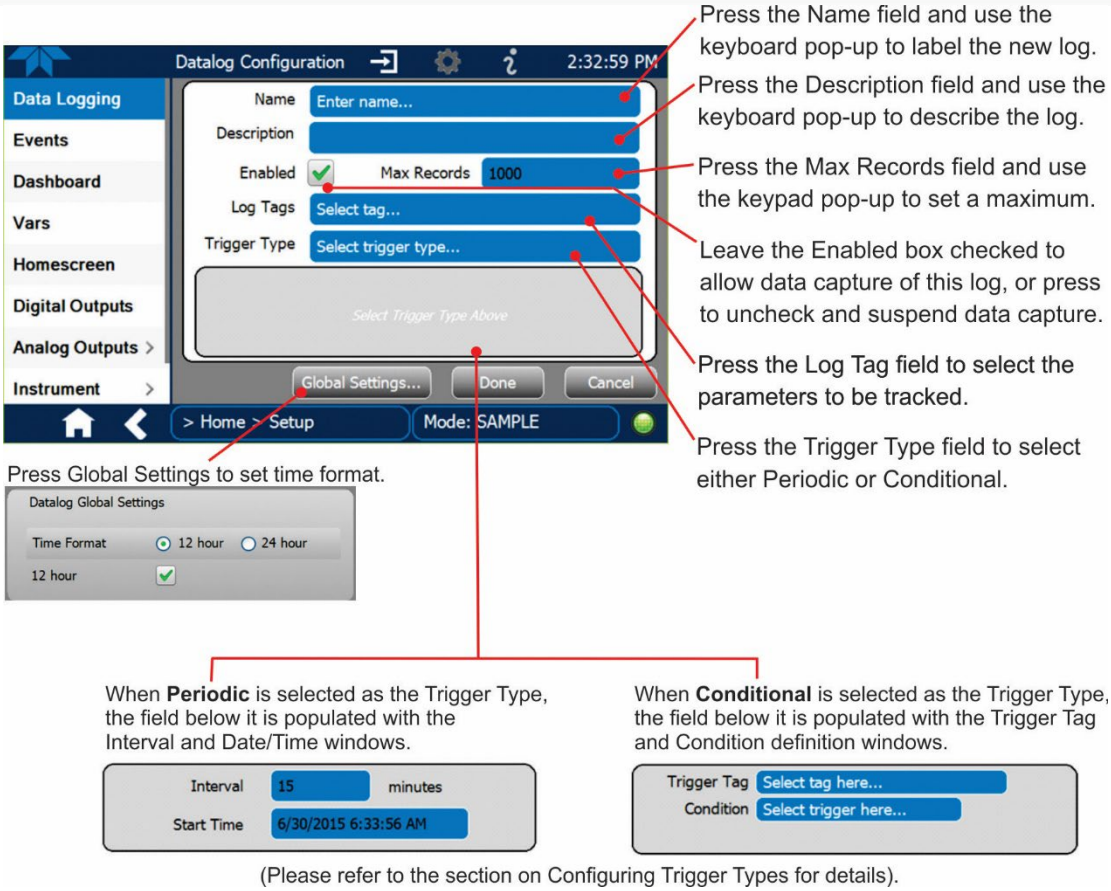


Figure 2-26. Creating a New Data Log

The parameters available in the list of Log Tags include the names of Events configured in the Events page (Section 2.5.2).

2.5.1.1. CONFIGURING TRIGGER TYPES: PERIODIC

The Periodic trigger is a timer-based trigger that is used to log data at a specific time interval. Periodic Trigger requires an interval that is set to number of minutes and a start time that is set to date and clock time.

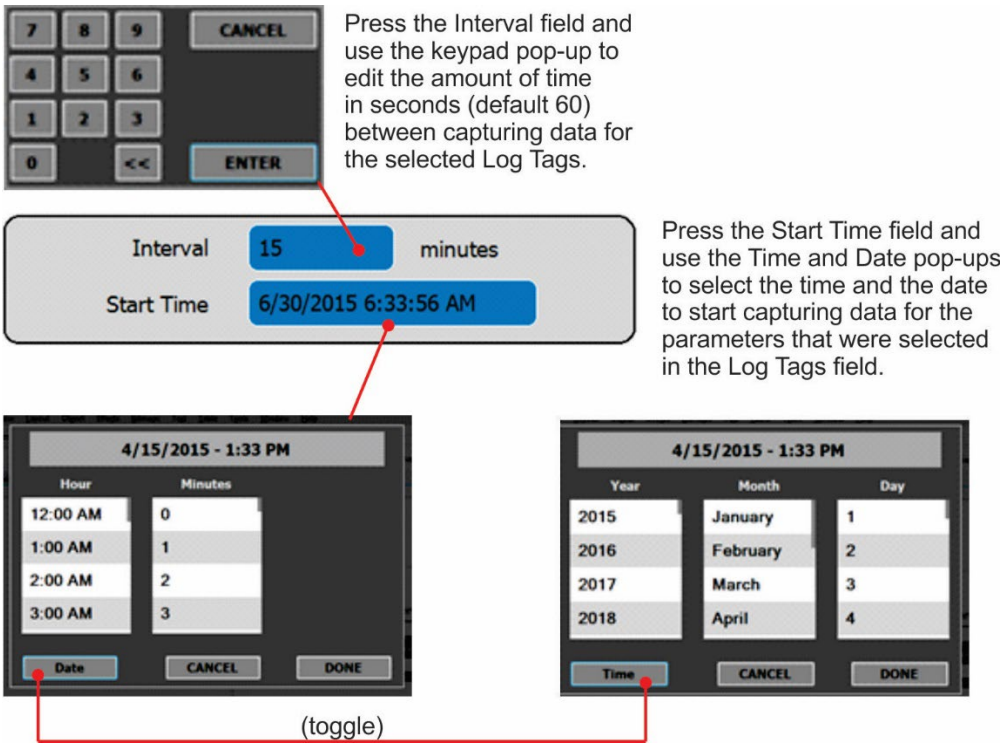


Figure 2-27. Datalog Periodic Trigger Configuration

2.5.1.2. CONFIGURING TRIGGER TYPES: CONDITIONAL

Conditional Trigger tracks/records data for user-selected parameters that meet specified conditions.

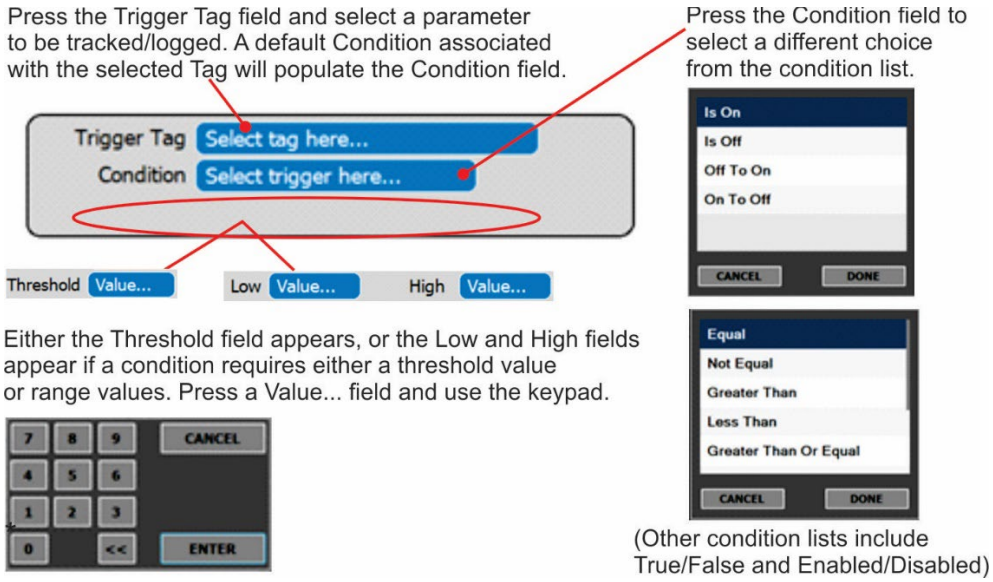


Figure 2-28. Datalog - Conditional Trigger Configuration

2.5.1.3. DOWNLOADING DAS (DATA ACQUISITION SYSTEM) DATA

To download DAS data collected by the Datalogger from the instrument to a flash drive, navigate to the Utilities>USB Utilities>DAS Download menu.

1. Insert a flash drive into a front panel USB port and wait for the Status field to indicate that the drive has been detected; available buttons will be enabled.

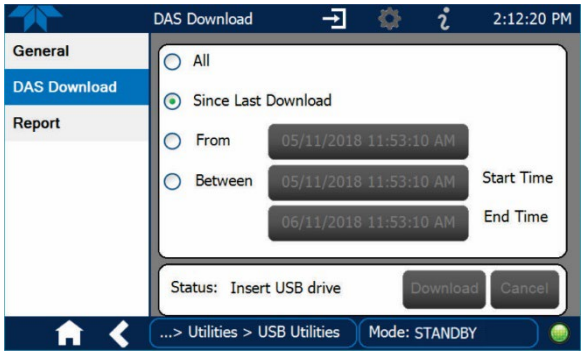


Figure 2-29. DAS Download Page

2. Select all or define a period from which to download the collected data.
3. Press the Download button, and when complete, as indicated in the Status field, press the Done button (changed from “Cancel”) and remove the flash drive.

2.5.2. SETUP>EVENTS

Events are occurrences that relate to any operating function, and are used to define the conditions that can be set to trigger Alerts (Section 2.4.3). Events can provide diagnostic information about the instrument, typically referred to as "Warnings", or they can provide other information on instrument functionality, such as concentration alarms. Some Events are standard and not editable while others are user-configurable, described here. Existing Events are listed in the Events page (Figure 2-30) under the Setup menu.

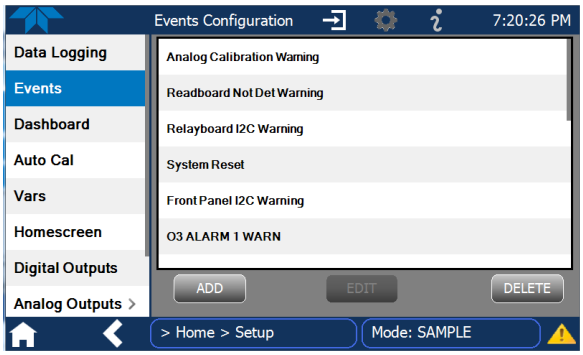


Figure 2-30. Events List

Access the Events Configuration page either from the Active Alerts page (Alerts Menu) by pressing the configuration button, or through the Home>Setup>Events menu (Figure 2-30). Press ADD to create a new Event (refer to Figure 2-31 for details), or select an existing Event to either Edit or Delete it (Figure 2-33).

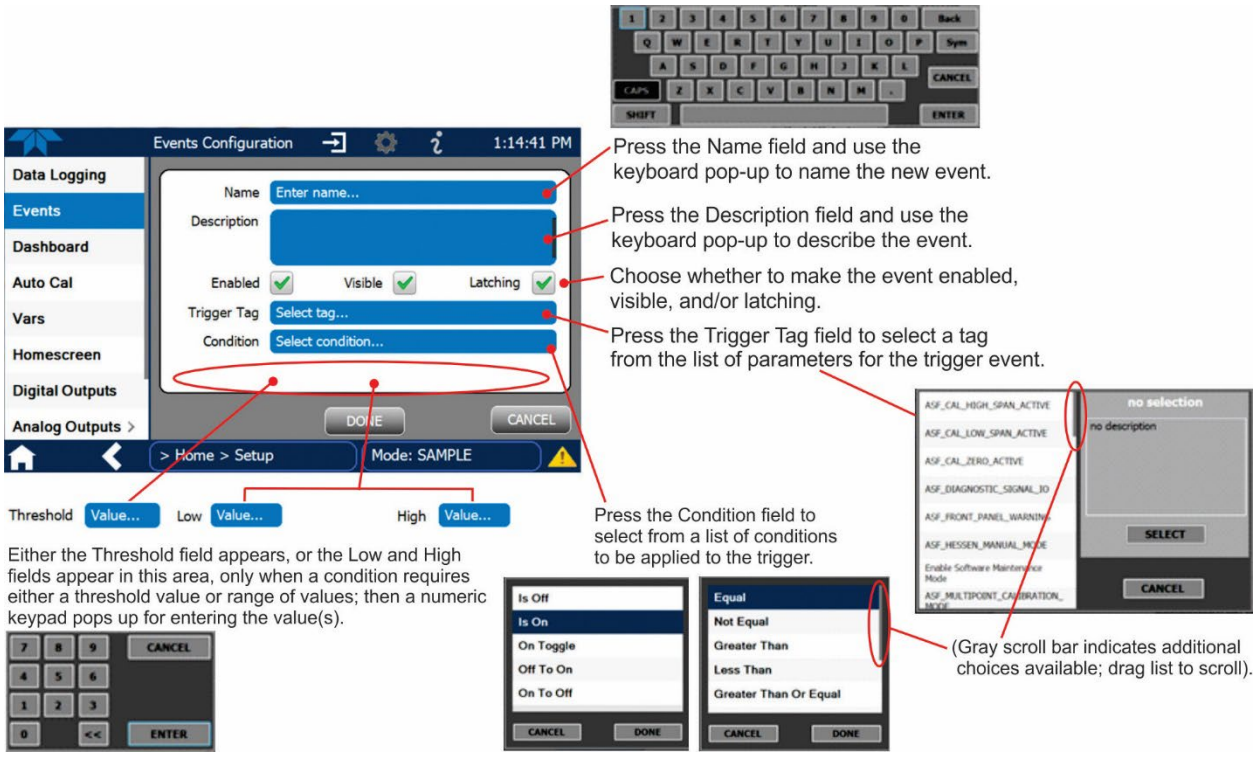


Figure 2-31. Event Configuration

- Enabled allows the choice of whether to track and record the Event (uncheck this box to “turn off” or deactivate the Event without deleting it). An Event must be enabled in order to use the Visible and the Latching options.
- Visible allows the choice of whether or not to display the Event in the Alerts page when it is triggered (it will still be recorded and can be viewed in the Utilities>Alerts Log).To use this option, the Event must be enabled.
- Latching allows the choice of whether or not to keep an Event visible even if the conditions that triggered it were to correct themselves. (Latching requires that the user interact with the Active Alerts screen to manually clear the Alert and internal Event state. Non-latching allows the entry in the Active Alerts screen and the internal Event state to continuously update based on the Event criteria, requiring no user interaction to clear the Alert or Event state).

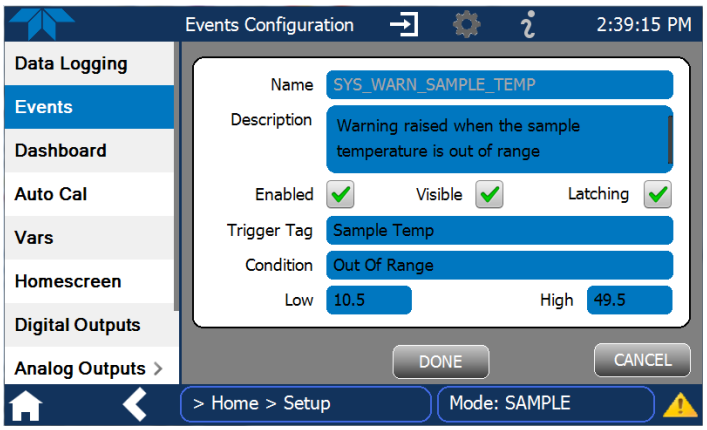


Figure 2-32. Configured Event Sample

2.5.2.1. EDITING OR DELETING EVENTS

Select an Event from the list (Figure 2-30) and press the Edit button to view or edit the details (Figure 2-32), or press the Delete button to delete the Event.

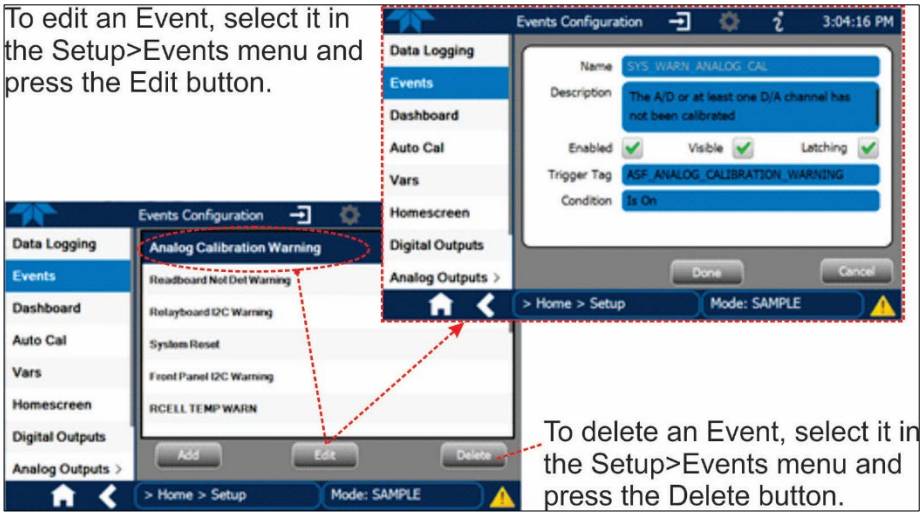


Figure 2-33. Edit or Delete an Event

2.5.2.2. USING EVENTS AS TRIGGERS FOR DATA LOGGING

Events can also be used to create customized triggers for data logging functions. The name entered in the Name field of the Events Configuration page will appear in the list of Log Tags of the Datalog Configuration page. The Data Logger is presented in Section 2.5.1.

2.5.3. SETUP>DASHBOARD

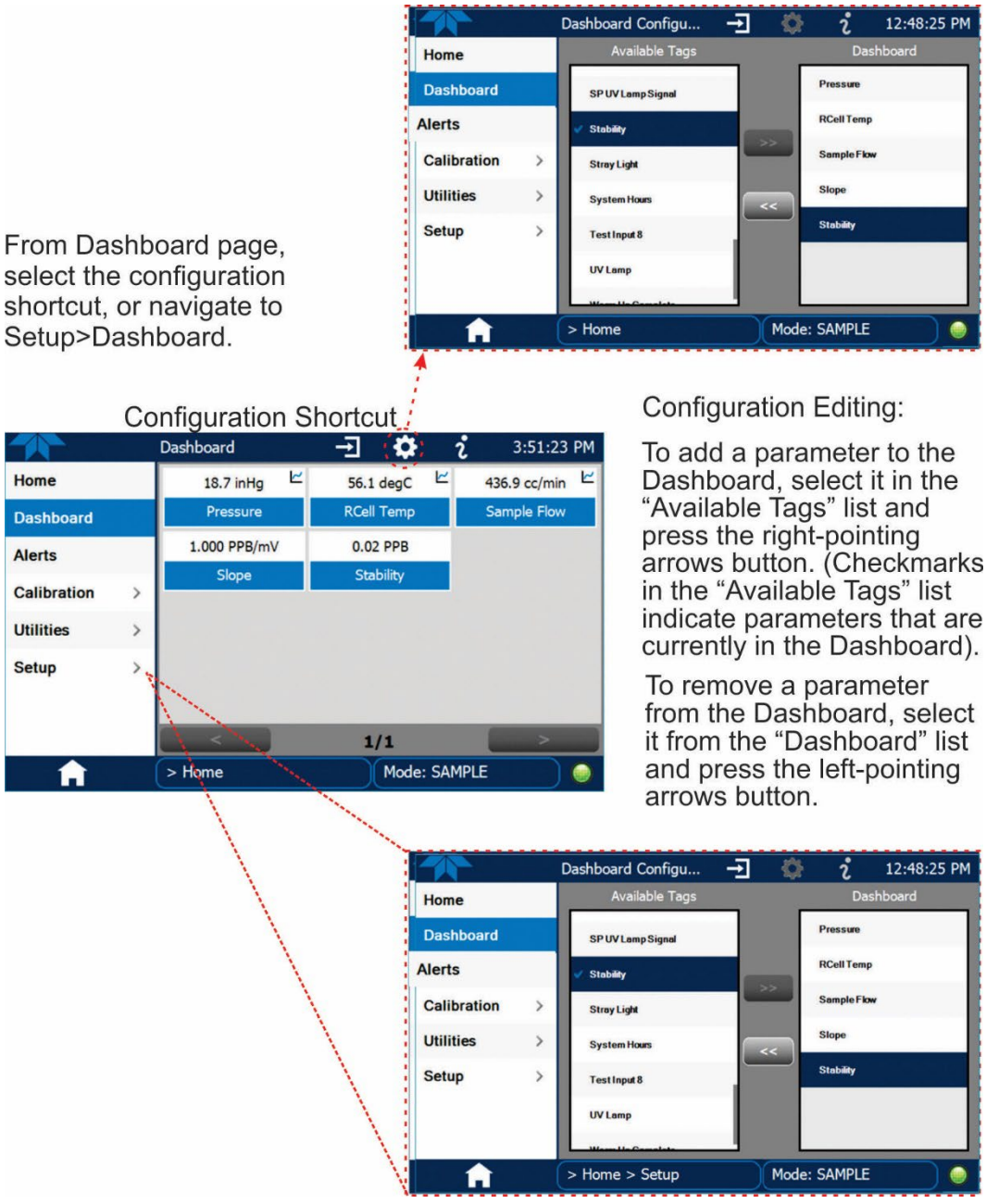


Figure 2-34. Dashboard Display and Configuration

2.5.4. SETUP>AUTOCAL (WITH VALVE OPTION)

Auto Cal is available for running automated calibration checks with installed valve options (see Section 4.3).

2.5.5. SETUP>VARS

Vars are software variables that define operational parameters automatically set by the instrument's firmware, and are user-adjustable through this menu. Access the menu to see the list of variables (Vars); select a Var to view its description; touch the Edit button to change its setting(s). Table 2-11 describes some of the Vars.

Table 2-11. Typical Variables with Descriptions

VARIABLE	DESCRIPTION
NOTE: THIS LIST INCLUDES SEVERAL OF THE MOST COMMON VARS; SELECTING ANY VAR IN THE NUMAVIEW™ SOFTWARE INTERFACE WILL DISPLAY ITS DESCRIPTION IN THE INFORMATION FIELD TO ITS RIGHT. DEPENDING ON CONFIGURATION, SOME, ALL, OR MORE OF THESE VARIABLES APPEAR IN YOUR INSTRUMENT'S VARS MENU.	
Background Periodic Report Upload	Allow a periodic report to be automatically uploaded to cloud service at a frequency (in hours) set in the Report Upload Interval var.
Daylight Savings Enable	Enable or disable Daylight Savings Time (also see Setup>Instrument>Date/Time Settings)
Dilution Factor Option	Sets the instrument to compensate for diluted sample gas, such as in continuous emission monitoring (CEM) where the quality of gas in a smoke stack is being tested and the sampling method used to remove the gas from the stack dilutes the gas. Once the degree of dilution is known, this feature allows the user to add an appropriate scaling factor to the analyzer's SO_2 concentration calculations so that the undiluted values for measurement range and concentration are shown on the instrument's front panel display and reported via the instrument's various outputs. 1. Set the appropriate units of measure (Setup>Vars>User Units). 2. Select the reporting range mode (Setup>Vars>Range Mode) and set the reporting range upper limit (Setup>Analog Output). Ensure that the upper span limit entered for the reporting range is the maximum expected concentration of the undiluted gas. 3. Set the dilution factor as a gain, e.g., a value of 20 means 20 parts diluent and 1 part sample gas (Setup>Vars>Dilution Factor). 4. Calibrate the analyzer; ensure that the calibration span gas is either supplied through the same dilution system as the sample gas or has an appropriately lower actual concentration.
Enable Software Maintenance Mode	Set instrument to continue sampling, while ignoring calibration, diagnostic, and reset instrument commands. This feature is of particular use for instruments connected to Multidrop (2.3.1.4) or Hessen protocol networks.
Instrument ID	Set unique identifier number for the instrument when it is connected with other instruments in multidrop configuration or on the same Ethernet LAN, or when applying MODBUS or Hessen protocols (see Setup>Comm).
Max Concentration Range	Set the highest concentration expected, as this is used by the CPU to adjust Preamp physical ranges. (Section 4.1.4 provides more information).

VARIABLE	DESCRIPTION
PRIGAS Precision	Sets the number of significant digits to the right of the decimal point display of primary gas concentration and stability values. (**SECGAS Precision** for secondary gas)
Range Mode	Controls range mode, single (SNGL) or dual (DUAL). (When set to DUAL, ensure that Max Concentration Range has been set).
System Hours	Total system runtime hours
TPC Enable	Enables or disables the Temperature and Pressure Compensation (TPC) feature (For information on TPC, see Section 6.4.3).
User Conc Units	Change the concentration units of measure.

2.5.6. SETUP>HOMESCREEN

To select a parameter ("tag") for display in each of the three meters at the bottom of the Home page, navigate to the Homescreen configuration page through either the Setup>Homescreen menu or from Home page using the configuration icon (Figure 2-35).

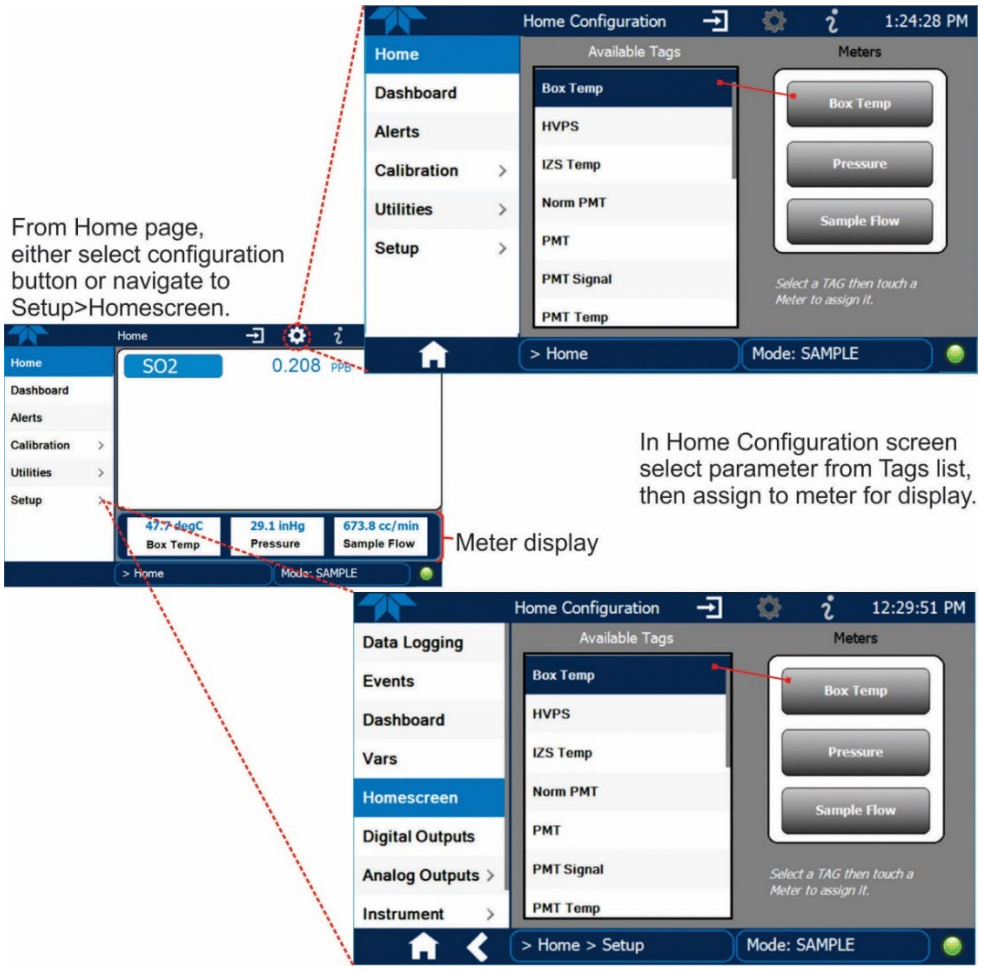


Figure 2-35. Homescreen Configuration

An orientation to the Homescreen was presented in Section 2.4.1, including Figure 2-18 and Figure 2-19.

2.5.7. SETUP>DIGITAL OUTPUTS

Specify the function of each digital output (connected through the rear panel STATUS connector) by mapping the output to a selection of "Signals" present in the instrument. Create custom "Signals" in the Setup>Events menu (Section 2.5.2).

To map Digital Outputs to Signals, select a pin in the Outputs list, then make a selection from the Signals list and press the Map button; if/as needed, change the polarity by pressing the Polarity button. Save any changes by pressing the Apply button, or discard the changes by pressing the Home or the back button (a pop-up provides a warning that the changes will be lost, and will prompt for confirmation to apply changes or not).

Go to the Utilities>Diagnostics>Digital Outputs menu to change the state (ON/OFF) of individual digital outputs.

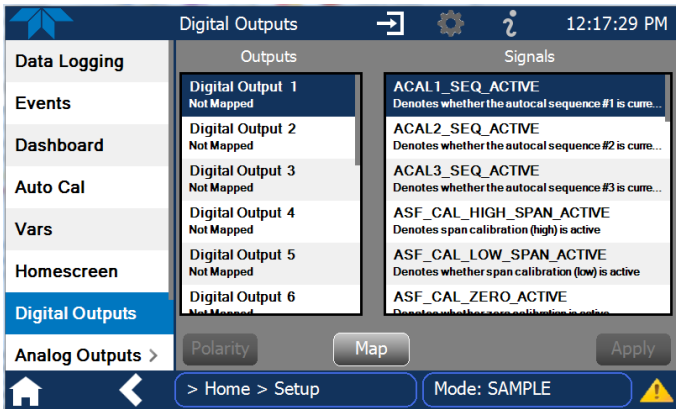


Figure 2-36. Digital Outputs Setup

2.5.8. SETUP>ANALOG OUTPUTS OPTION

Map the user-configurable Analog Outputs (either four Voltage or three Current) to any of a wide variety of "Signals" present in the instrument and customize their respective configurations.

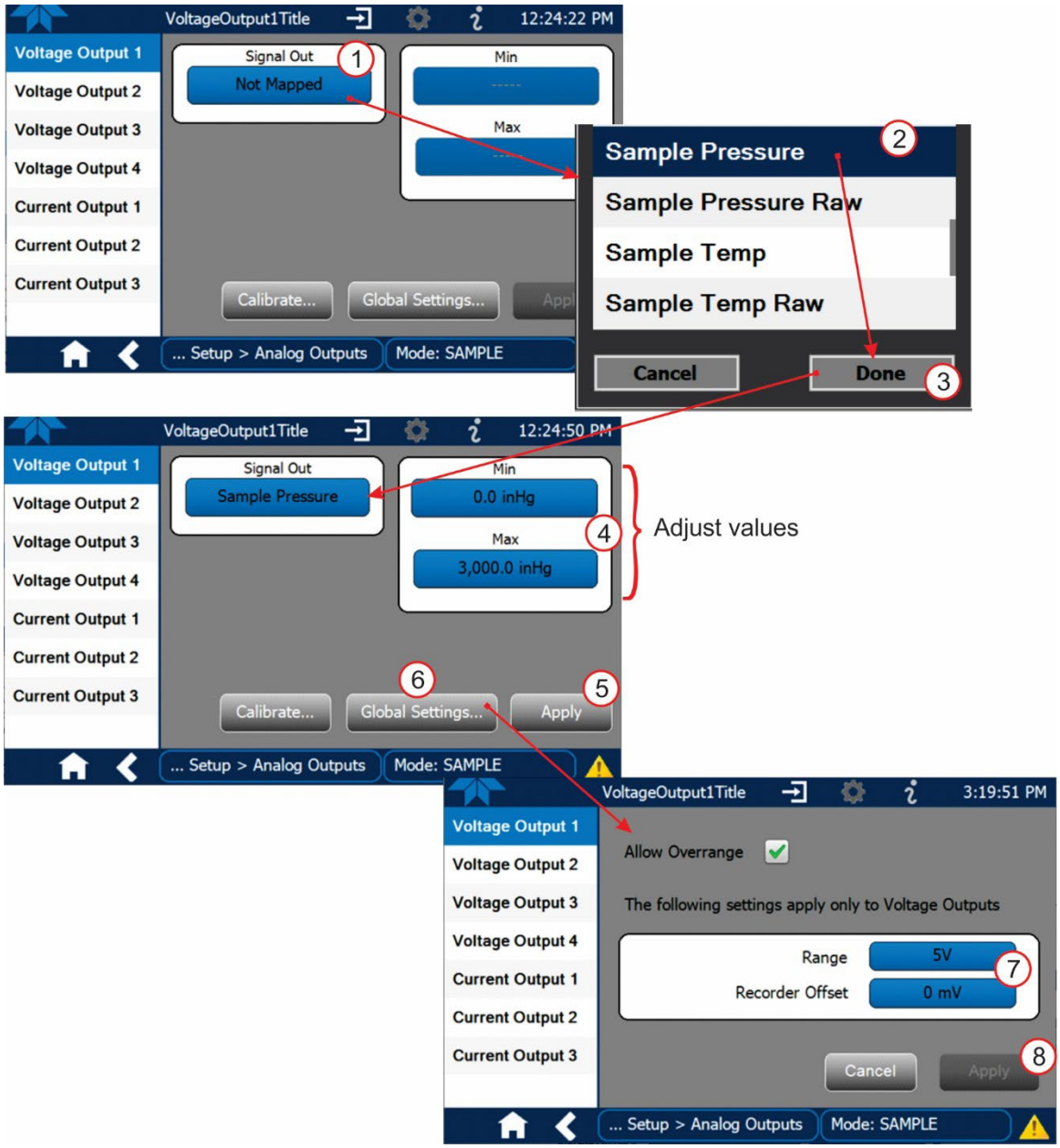


Figure 2-37. Analog Output Configuration for Voltage Output, Example

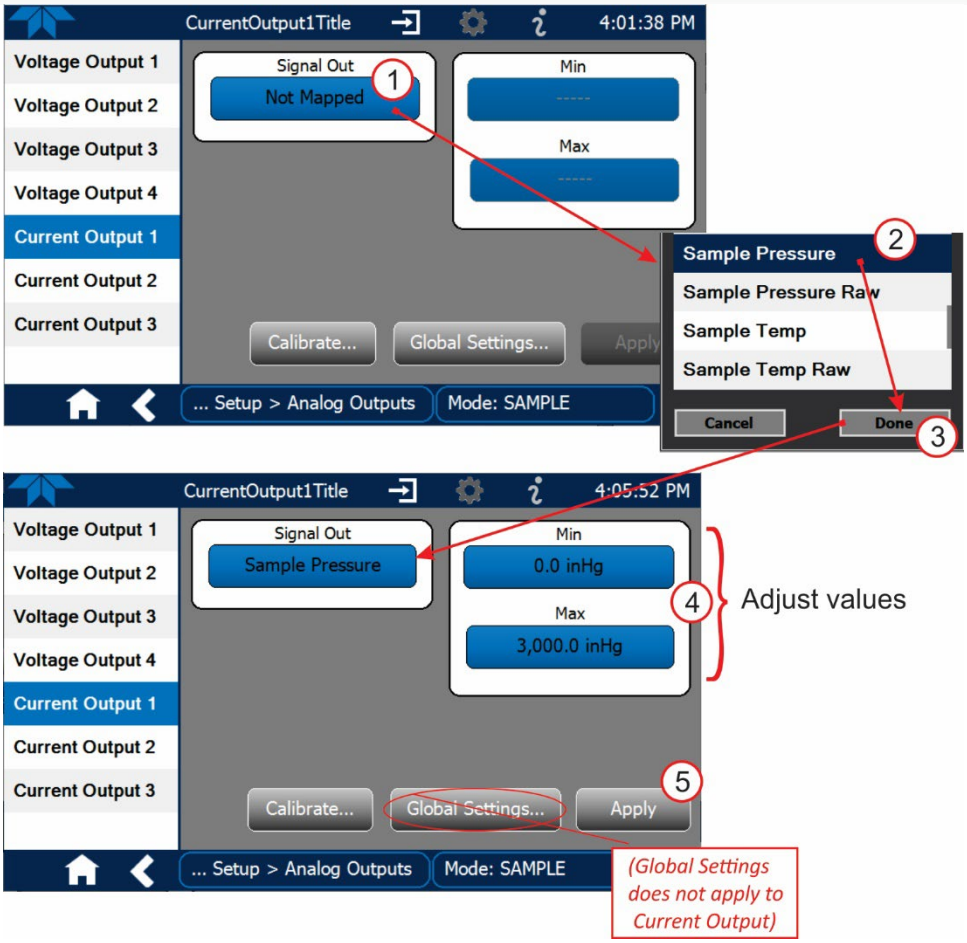


Figure 2-38. Analog Output Configuration for Current Output, Example

Refer to Figure 2-37 (Voltage output) or to Figure 2-38 (Current output), and to Table 2-12 for the following:

1. Signal Out: select a Signal for the output (typically the gas concentration).
2. Min/Max: edit Min and Max fields with realistic values for the selected Signal.
3. Global Settings:
   - For Voltage output, select a Range, and in the Recorder Offset field, add a zero offset for recording slightly negative readings from noise around the zero point. Either check “Allow Overrange” to allow a ± 5% over-range, or uncheck to disable over-range if the recording device is sensitive to excess voltage, and assign a maximum voltage.
   - For Current output, Global Settings does not apply.
4. After completing the configurations, press the (Apply or Accept) button.
5. To calibrate, press the Start button to see the reading, and use the buttons in the Manual Adjust field to make incremental adjustments as needed, noting the range and the minimum/maximum outputs shown in (Table 2-12).
   - For Current output, press the +100 button several times to get the setting close to 4mA.
6. Press the Accept button when adjustment reached.

Table 2-12. Analog Output Voltage/Current Range

Range[1]	Range Span	Minimum Output	Maximum Output
5V	0-5 VDC	-1 VDC	6 VDC
10V	0-10 VDC	- 2 VDC	12 VDC
Current[2]	4-20 mA	3 mA	21 mA

[1] Each range is usable from -5% to +5% of the rated span.

For manual calibration adjustments, see Section 2.5.8.1 for voltage and Section 2.5.8.2 for current.

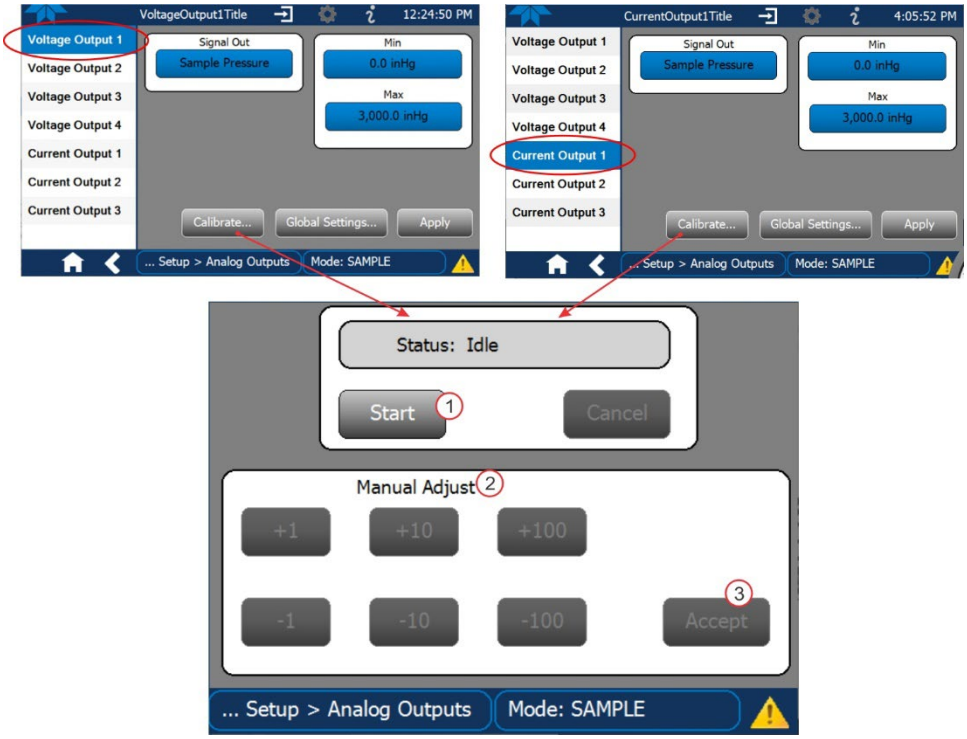


Figure 2-39. Analog Output Calibration, Voltage or Current

2.5.8.1. MANUAL CALIBRATION OF VOLTAGE RANGE ANALOG OUTPUTS

It is possible to manually calibrate the voltages by using a voltmeter connected across the output terminals (Figure 2-40) and changing the output signal level in the Manual Adjust field of the Analog Outputs Calibration screen (Figure 2-19).

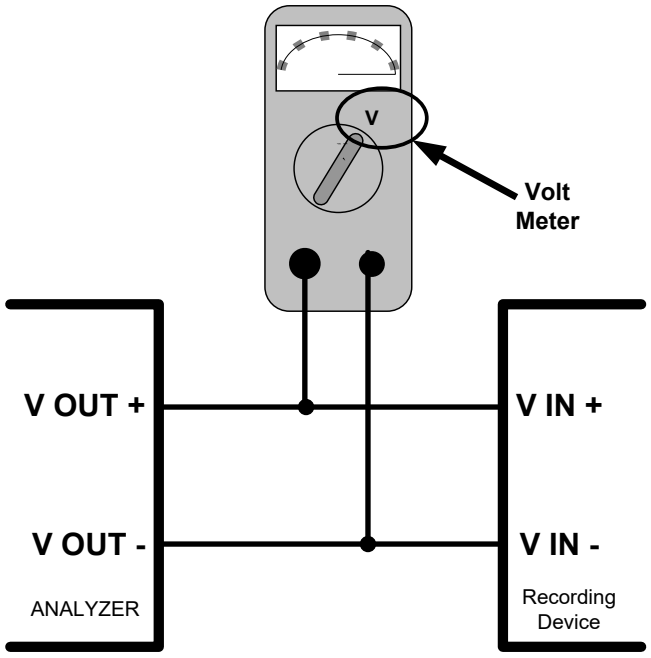


Figure 2-40. Setup for Checking / Calibrating DCV Analog Output Signal Levels

2.5.8.2. MANUAL ADJUSTMENT OF CURRENT RANGE ANALOG OUTPUTS

To manually calibrate the current signals, use an amp meter (Figure 2-41) connected across the Current output terminals (see Figure 2-4 for pin assignments and diagram of the analog output connector) and changing the output signal level in the Manual Adjust field of the Analog Outputs Current Output Calibration screen. While the software allows this adjustment to be made in 100, 10 or 1 count increments, the adjustments here would need several presses of the +100 button to arrive at a realistic starting point for 4mA.

CAUTION!

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

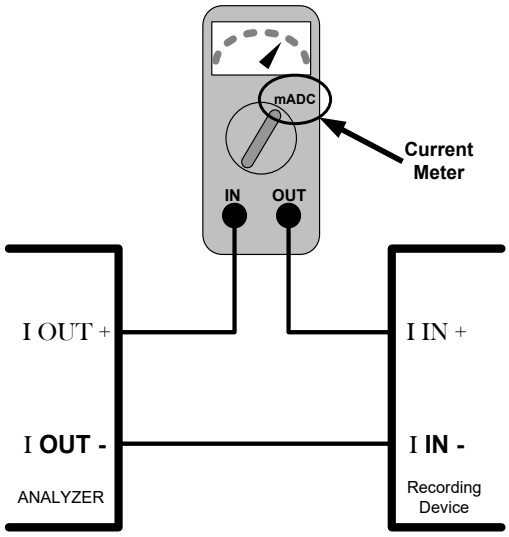


Figure 2-41. Setup for Checking / Calibration Current Output Signal Levels

2.5.9. SETUP>INSTRUMENT

As presented in Table 2-13, view product and system information and network settings, edit network settings, and perform certain maintenance tasks.

Table 2-13. Setup>Instrument Menu

MENU	DESCRIPTION
Product Info	View Model, Part, and Serial Numbers and Package and Driver Versions, and options information.
System Info	View Windows and RAM information.
Network Settings	View the network settings (configurable through the Setup>Comm>Network Settings menu).
Module Info	Provides part and revision numbers of the modules that are installed
Date/Time Settings	Adjust date, hour, and minutes, select a time zone*, and set the system clock to automatically adjust for Daylight Savings Time or not. (Also see Setup>Vars>Daylight Savings Enable). *Time Zone change requires a special procedure; see Maintenance Section 5.5.
NTP Time Settings	Configure Network Time Protocol settings for clock synchronization.
Language	Select an available language.
Remote Update	When an instrument is connected to a network that is connected to the Internet, follow the instructions on this Remote Update page to check for and activate software/firmware updates. (Also refer to Section 5.3).

2.5.10. SETUP>COMM (COMMUNICATIONS)

This menu is for specifying the various communications configurations.

2.5.10.1. COM2

Configure the instrument's COM port to operate in modes listed in Table 2-14.

Table 2-14. COM Port Configuration

MODE	DESCRIPTION
Baud Rate	Set the baud rate for the COM1 or COM2 port being configured.
Command Prompt Display	Enable/disable a command prompt to be displayed when in terminal mode.
Data Bits	Set the data bits to 7 or 8 (typically set in conjunction with Parity and Stop bits).
Echo and Line Editing	Enable/disable character echoing and line editing.
Handshaking Mode	Choose SOFTWARE handshaking for data flow control (do NOT use SOFTWARE handshaking mode when using MODBUS RTU for Protocol mode; select only HARDWARE or OFF for MODBUS RTU), or HARDWARE for CTS/RTS style hardwired transmission handshaking. (This style of data transmission handshaking is commonly used with modems or terminal emulation protocols). Or choose to turn OFF handshaking.
Hardware Error Checking	Enable/disable hardware error checking.
Hardware FIFO	Enable/disable the hardware First In – First Out (FIFO) for improving data transfer rate for that COM port.
Modem Connection	Select either a modem connection or a direct cable connection.
Modem Init String	Input an initialization string to enable the modem to communicate.
Parity	Select odd, or even, or no parity (typically set in conjunction with Data Bits and Stop Bits).
Protocol	Select among the communications protocols: MODBUS RTU, MODBUS ASCII. (Section 3.1.1), Hessen (Section 3.1.2), REST (Section 3.1.3). If selecting a MODBUS protocol, see Handshaking Mode, this table; MODBUS Registers are presented in Appendix A, this manual. Also see www.modbus.org
Quiet Mode	Enable/disable Quiet mode, which suppresses any feedback from the analyzer (such as Alerts) to the remote device and is typically used when the port is communicating with a computer program where such intermittent messages might cause communication problems. Such feedback is still available, but a command must be issued to receive them.
Security	Enable/disable the requirement for a password for this serial port to respond. The only command that is active is the request-for-help command (? CR).
Stop bits	Select either 0 or 1 stop bit (typically set in conjunction with Parity and Data bits).

2.5.10.2. TCP PORT2

This menu is configured with the port number for MODBUS (Section 3.1.1).

2.5.10.3. NETWORK SETTINGS

The Setup>Comm>Network Settings menu is for Ethernet configuration. The address settings default to automatic configuration by Dynamic Host Configuration Protocol (DHCP). Most users will want to configure the instrument with a static IP address: click the Static radio button to manually assign a static IP address (consult your network administrator, and see Table 2-15 for information).

Figure 2-42. Communications Configuration, Network Settings

Table 2-15. LAN/Ethernet Configuration Properties

PROPERTY	DESCRIPTION
IP address	A string of four packets of 1 to 3 numbers each (e.g. 192.168.76.55.) is the internet protocol address of the instrument itself.
Subnet Mask	A string of four packets of 1 to 3 numbers each (e.g. 255.255.252.0) number that masks an IP address, and divides the IP address into network address and host address and identifies the LAN to which the device is connected. All addressable devices and computers on a LAN must have the same subnet mask. Any transmissions sent to devices with different subnets are assumed to be outside of the LAN and are routed through the gateway computer onto the Internet.
Default Gateway	A string of numbers very similar to the Instrument IP address (e.g. 192.168.76.1.) that is the address of the computer used by your LAN and serves as a router to access the Internet or another network.

2.5.10.4. HESSEN

Configure Hessen Settings and Gas List (see Section3.1.2).

2.6. TRANSFERRING CONFIGURATION TO OTHER INSTRUMENTS

Once an instrument is configured, the same configuration can be copied to other instruments of the same Model. This encompasses essentially anything the user can configure and does not apply to instrument-specific settings such as those that are configured at the factory for calibration.

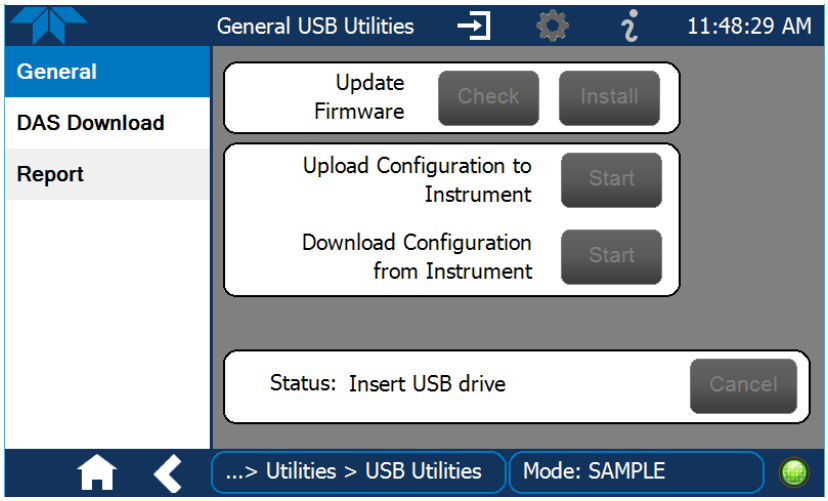


Figure 2-43. Configuration Transfer

1. In the source instrument, go to the Home>Utilities>USB Utilities>General page.
2. Insert a flash drive into either of the two front panel USB ports.
3. When the Status field indicates that the USB drive has been detected, press the “Download Configuration from Instrument” Start button.
4. When the Status field indicates that the download is complete, remove the flash drive.
5. In the target instrument, go to the Home>Utilities>USB Utilities>General page.
6. Insert a flash drive into either of the two front panel USB ports.
7. When the Status field indicates that the USB drive has been detected, press the “Upload Configuration to Instrument” Start button.
8. When the Status field indicates that the upload is complete, remove the flash drive.

3. COMMUNICATIONS AND REMOTE OPERATION

This instrument's standard rear panel connections include an Ethernet port and a serial communications port. Connection instructions were provided in Section 2.3.1.4, and configuration information is provided in Section 2.5.10.

Data acquisition is set up through the Datalogger (Section 2.5.1).

3.1. SERIAL COMMUNICATION

The rear panel COM port operates on the RS-232 protocol (default configuration is DCE RS-232), or it can be configured for DTE RS-232 (more common for PLCs) (Section 2.3.1.4).

Referring to Table 2-14, use the SETUP>COMM menu to view/edit the communications settings for the COM port.

3.1.1. MODBUS

MODBUS communications can be configured through the Setup>Comm>COM2 menu for transmission over Ethernet (Section 3.1) or serial communications.

1. Make the appropriate cable connections between the instrument and a PC.
2. Check the instrument's Modbus Units selection in the Setup>Vars menu and edit if needed.
3. Select the communication protocol for either MODBUS RTU or MODBUS ASCII transmission mode.

Important **When using MODBUS RTU, ensure that the Handshaking Mode is set to either Hardware or OFF. Do NOT set it to Software.**

4. Set other parameters as needed (see descriptions in Table 2-14).
5. Press the Accept button to apply the settings.

The Setup>Comm>TCP Port2 is set to 502 for MODBUS by default.

See Appendix A for MODBUS Registers.

3.1.2. HESSEN

Hessen protocol is supported through serial communications. The Hessen protocol is not strictly defined; therefore, while Teledyne API's application is completely compatible with the protocol itself, it may be different from implementations by other companies. Configure the COM2 port for Hessen protocol through the Setup>Comm>COM2 menu: select COM2 Protocol and press Edit to select HESSEN, then press Accept.

Hessen configuration includes settings for alarms, version, response mode, status flags and gas list. Locate the alarms in the Hessen Settings list (Setup>Comm>Hessen>Hessen Settings) and edit as desired.

HESSEN PROTOCOL RESPONSE MODE

Set the response mode, referring to Table 3-1 for descriptions.

Table 3-1. Teledyne API's Hessen Protocol Response Modes

Mode ID	Mode Description
CMD	This is the default setting. Reponses from the instrument are encoded as the traditional command format. Style and format of responses depend on exact coding of the initiating command.
BCC	Responses from the instrument are always delimited with <STX> (at the beginning of the response, <ETX> (at the end of the response followed by a 2-digit Block Check Code (checksum), regardless of the command encoding.
TEXT	Responses from the instrument are always delimited with <CR> at the beginning and the end of the string, regardless of the command encoding.

HESSEN VARIATION

For the Hessen Variation setting, there are two versions.

- TYPE 1 is the original implementation.
- TYPE 2 has more flexibility when operating with instruments that can measure more than one type of gas. For more specific information about the difference between the two versions, download the *Manual Addendum for Hessen Protocol* from the Teledyne API's web site.

HESSEN STATUS FLAGS

Locate the various status flags in the Hessen Settings list and edit as needed. They are listed by status flag name with their default bit assignments. (Those with unassigned flags are listed as "0x0000").

- The status bits are included in the instrument's responses to inform the host computer of its condition. Each bit can be assigned to one operational and warning message flag.
- It is possible to assign more than one flag to the same Hessen status bit. This allows the grouping of similar flags, such as all temperature warnings, under the same status bit.
- Assigning conflicting flags to the same bit will cause each status bit to be triggered if any of the assigned flags is active.

HESSEN GAS LIST

Table 3-2 describes the Hessen List (Setup>Comm>Hessen menu).

Table 3-2. Hessen List Configuration Summary

Item	Definition
Parameter	gas or non-gas parameter: either Add new or Edit existing.
Range	concentration range to be reported (when Reported box is checked)
0	currently active range
1	only when range 1 or low range is active
2	only when range 2 or high range is active
3	not applicable
Id	Create unique identification for parameter being added or edited
Reported	check to report when polled by the Hessen network

3.1.3. REST

The REST protocol can be used to collect data, change parameters, extract data logs, poll groups of parameter values, and trigger calibration functions.

The user needs to be familiar with REST principles and underlying network technologies. The REST API service is on port 8180, using HTTP verbs (GET, PUT) and REST Resources in JSON format. Tag names and command strings are case sensitive. The Resources are defined in Table 3-3.

The Teledyne API REST guide is a tutorial in the form of Service Note 22-002, accessible on our website under this product page's Downloads tab.

Important

EXTERNAL DATALOGGER BEST FOR REST PROTOCOL

Frequent polling of the instrument's datalogger with REST can slow not only its software routines and tasks, but also the response to the external datalogger polling request.

We recommend polling the live Tag values directly for external datalogger use with REST protocol.

Table 3-3. REST Resource Descriptions

RESOURCE	DESCRIPTION	OPERATION
Tag	Maps to an instrument tag, allowing direct access to parameter properties/attributes	Read/Write (GET/PUT)
Tag.value	Maps to an instrument tag value separately from its properties for direct/fast access due to dynamic characteristics	Read/Write (GET/PUT)
Tag-list	Queries for instrument's available tags and their properties; query can be filtered for specific tag group	Read only (GET)
Tag-list.value	Retrieves specified group of tag values as a batch; groups include: PRIGAS, LOG, TRIG, AOUTMAP, HIST, TRACK_ALL_UPDATES	Read/Write (GET/PUT)
Datalog-list	Retrieves list of the instrument's available data logs	Read only (GET)
Datalog	Retrieves specified data log, based on a defined page number and number of records per page, or on a defined time range that includes start & end date, hour (24-hr format), minute, and seconds (where blank = default, no seconds)	Read only (GET)

3.2. ETHERNET

When using the Ethernet interface, the analyzer can be connected to any standard 10BaseT or 100BaseT Ethernet network via low-cost network hubs, switches or routers. The interface operates as a standard TCP/IP device on port 3000. This allows a remote computer to connect through the network to the analyzer using NumaView™ Remote, terminal emulators or other programs.

The Ethernet connector has two LEDs that are on the connector itself, indicating its current operating status.

Table 3-4. Ethernet Status Indicators

LED	FUNCTION
amber (link)	On when connection to the LAN is valid.
green (activity	Flickers during any activity on the LAN.

The analyzer is shipped with DHCP enabled by default. This allows the instrument to be connected to a network or router with a DHCP server; however, it should be configured with a Static IP address as soon as practical. See Section 2.5.10.3 for configuration details.

For MODBUS communications configuration, see Section 3.1.1.

3.3. NUMAVIEW™ REMOTE

For remote operation and data capture through an Ethernet connection, please refer to the NumaView™ Remote Software User Guide, PN 08492, available on our website.

4. CALIBRATION

This section provides important pre-calibration information, calibration and check procedures, and how to evaluate the quality of each calibration.

4.1. IMPORTANT PRECALIBRATION INFORMATION

Note **A start-up period of 4-5 hours is recommended prior to calibrating the analyzer.**

4.1.1. CALIBRATION REQUIREMENTS

The following equipment, supplies, and expendables are required for calibration:

- Zero-air source
- Span gas source
- Gas lines - all gas line materials should be Teflon-type or glass.
- Traceability Standards

Optional equipment: A recording device such as a strip-chart recorder and/or data logger should be used to record data from the analyzer's serial or analog outputs. If analog readings are used, the response of the recording system should be checked against a NIST traceable voltage source or meter. Data recording device should be capable of bi-polar operation so that negative readings can be recorded. For electronic documentation, the internal data acquisition system (DAS) can be used by configuring the Datalogger through the Setup>Data Logging menu; Section 2.5.1).

The method for performing an initial calibration for the analyzer differs between the standard instrument and those with options.

- See Section 4.2.1 for instructions for initial calibration of the analyzer in its base configuration.
- See Section 4.2.2 for information regarding setup and calibration of the analyzer with Z/S Valve option.

Note **Zero air and span gases must be supplied at 1.5 to 2 times the instrument's specified gas flow rate (Specifications Table 1-1).**

4.1.2. ZERO AIR

Zero air is similar in chemical composition to the Earth's atmosphere but scrubbed of all components that might affect the analyzer's readings. If your analyzer is equipped with an IZS option, it is capable of creating zero air that is adequate for performing informal calibration checks. However, a zero air generator such as the TAPI Model 701 is still recommended for performing formal calibration operations, as it conditions ambient air by drying and removing pollutants.

For the N101 analyzer, the Zero Air must be scrubbed of Hydrogen sulfide (H_2S).

4.1.3. CALIBRATION (SPAN) GAS

Cylinders of calibrated H_2S and/or SO_2 gas traceable to NIST-Standard Reference Material specifications (also referred to as SRM's or EPA protocol calibration gases) are commercially available.

Span gas is specifically mixed to match the chemical composition of the type of gas being measured at near full scale of the desired measurement range. In the case of H_2S, measurements made with the Model N101 UV Fluorescence H_2S Analyzer it is recommended that you use a span gas with a H_2S concentration equal to 90% of the measurement range for your application. The same goes for measuring SO_2 with the N101.

Some applications require a multipoint calibration procedure where span gases of different concentrations are needed. We recommend using a bottle of calibrated H_2S gas of higher concentration in conjunction with a gas dilution calibrator such as a Teledyne API Model T700. This type of calibrator precisely mixes a high concentration gas from zero air (both supplied externally) to accurately produce span gas of the correct concentration. Linearity profiles can be automated with this model and run unattended overnight.

4.1.4. PHYSICAL RANGE MEASUREMENTS

The analyzer has a wide total range of concentrations, butost applications use only a small part of the analyzer's full measurement range, which then becomes a data resolution challenge where the reported measurement may be barely perceptible. The software rectifies this challenge when the user defines the portion of the physical range relevant to the specific application, which the software then uses to scale the reporting range and accurately display the concentration(s).

The analyzer's CPU chooses the appropriate physical range, based on the configuration of the PMT Range variable in the Setup>Vars>PMT Range menu (see Table 2-11).

4.1.5. INTERFERENTS

The fluorescence method for detecting H_2S is subject to interference from a number of sources. However, the analyzer has been designed to reject most of these interferences, including a chemical scrubber to remove the interferents from the sample stream.

4.1.6. PERMEATION TUBE OPTIONS

Teledyne API offers an optional internal span gas generator that utilizes a permeation tube as a span gas source (see Section 2.3.2.5). The accuracy of these devices is only about ±5%. Whereas this may be sufficient for quick, daily calibration checks, we recommend using certified H_2S span gas for accurate calibration.

CAUTION!

Insufficient gas flow allows gas to build up to levels that will contaminate the instrument or present a safety hazard to personnel.

In units with a permeation tube installed, either the tube must be removed and stored in a sealed container (use original container that tube was shipped in) during periods of non-operation, or a vacuum pump must be connected and powered on to maintain constant gas flow though the analyzer at all times.

4.1.7. DATA RECORDING DEVICES

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

- If analog readings are used, the response of the recording system should be checked against an NIST traceable voltage source or meter.
- Data recording devices should be capable of bi-polar operation so that negative readings can be recorded.

For electronic data recording, the analyzers provide an internal data logger, which is configured through the Setup>Data Logger menu (Section 2.5.1).

NumaView™ Remote (Section 3.3) is a remote control program, which is also available as a convenient and powerful tool for data handling, download, storage, quick check and plotting.

4.2. CALIBRATION PROCEDURES

First verify/change (if needed) the settings in the Setup>Vars menu as follows:

- User Units (unit of Measure): PPB
- PMT Range (Low for Min Range spec; High for Max Range spec)
- Range Mode: SNGL

4.2.1. CALIBRATION AND CHECK PROCEDURES FOR BASIC CONFIGURATION

Although this section uses the Calibration menu for both check and actual calibration, a check does not require the Calibration menu. Instead, while in Home page, simply flow the zero air or the span gas through the Sample port, and check the reading after the Stability falls below 1.0 PPB (either in the gas graph or in the Dashboard). Otherwise, follow the steps presented in Sections 4.2.1.1 and 4.2.1.2. after connecting the sources of zero air and span gas as shown in Section 2.3.2.

4.2.1.1. ZERO CALIBRATION CHECK AND ACTUAL CALIBRATION, BASIC

Figure 4-1. Calibration, Basic, Select Gas and PMT Range

1. Go to the Calibration menu and select the Gas.
2. Input Zero air through the Sample port and press the Start button.
3. Either check or calibrate as follows:

Check Only:

a. Wait for reading to stabilize.
b. Press Stop and check the reading.

Actual Calibration:

a. Press the Zero button.
b. Press Stop and check the reading.

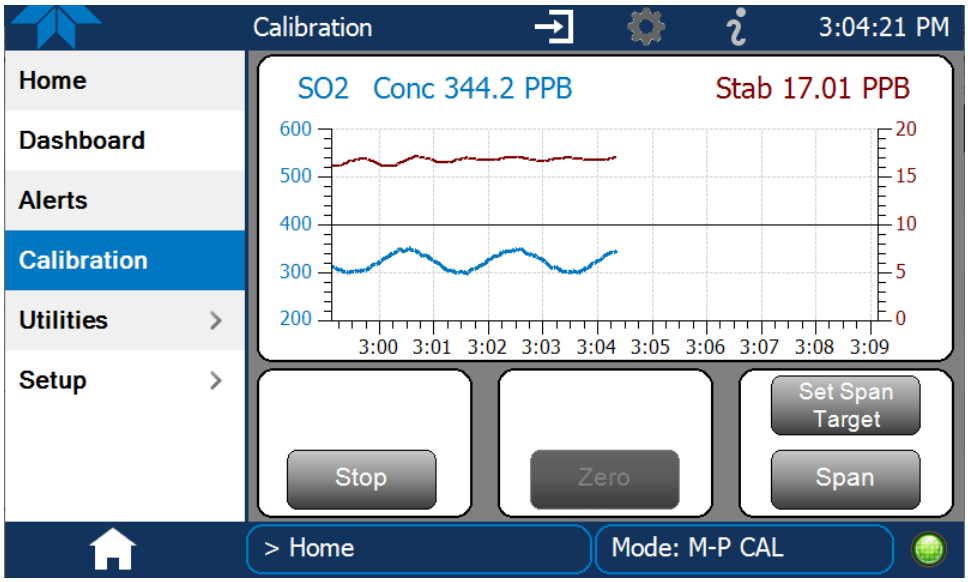


Figure 4-2. Multi-Point Calibration Page

4.2.1.2. SPAN CALIBRATION CHECK AND ACTUAL CALIBRATION

1. While still in the Calibration menu, input Span gas through the Sample port and press the Start button.
2. Either check or calibrate as follows:

Check Only:

a. Wait to reach stability, then press Stop.
b. Record the reading(s).

Actual Calibration:

a. Press the Set Span Target button and enter the gas concentration (Figure 4-3).
b. Verify the concentration reading is the same as the concentration being supplied.
c. If correct, wait to reach stability, then press the Span button.
d. In the Cal Result window, press OK.

3. Press the Stop button and return to Home screen.
4. In the Dashboard, check and record the Slope(s) and the Offset(s). (See Table 4-2 in Section 4.4, Calibration Quality Analysis, for expected/acceptable values).

Figure 4-3. Span Calibration Set Target

4.2.2. CALIBRATION AND CHECK PROCEDURES WITH VALVE OPTIONS INSTALLED

On units with an IZS option installed, zero air and span gas are supplied to the analyzer through the zero gas inlet and from ambient air.

On units with a zero/span valve option installed, zero air and span gas are supplied to the analyzer through the zero gas and span gas inlets from two different sources.

Navigate to the Calibration>Zero menu for Zero cal and to the Calibration>Span menu for Span cal (see Figure 4-4) and follow the instructions in Sections 4.2.1.1 and 4.2.1.2

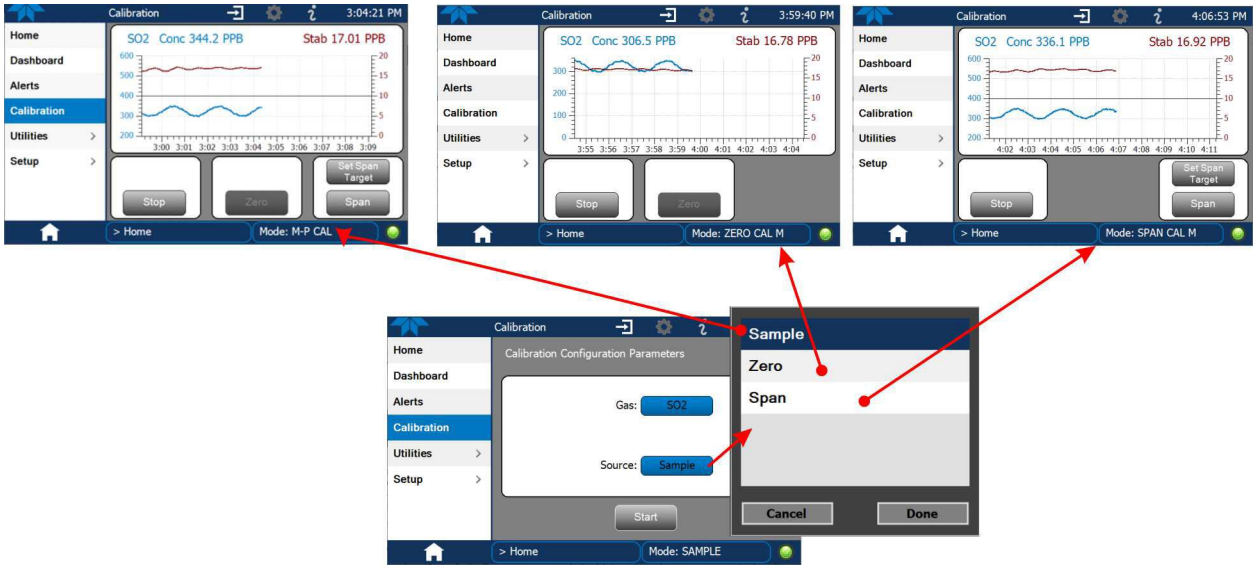


Figure 4-4. Calibration Screens for Valve Options

4.2.2.1. USE OF ZERO/SPAN VALVE WITH DIGITAL EXPANSION BOARD OPTION

Digital Inputs are available for controlling calibration checks Instructions for setup and use of this option are in Section 2.3.1.2.

4.3. AUTOMATIC ZERO/SPAN CAL CHECK (AUTO CAL)

The Auto Cal feature allows unattended periodic calibration checks of the ZERO/SPAN valve options by executing up to three preprogrammed sequences (labeled # **1**, **2** and **3**). Each calibration check can operate in either Zero mode or Span mode. The Auto Cal feature requires that the instrument remain in Calibration mode after the values reset to ambient, in order to continue flagging the data until purging is complete. This is accomplished with the Auto Cal Purge VAR.

To continue calibration until the system is purged, navigate to Setup>Vars>AutoCal Purge and use the Edit button to select the number of minutes for the purge duration.

To program the calibration checks for future execution (Figure 4-5), in the numbered sequence row (#1, #2, #3), click the Zero box or the Span box to select the valve to be switched open, then input the Start, Interval, and Duration parameters (refer to Table 4-1) in the active field for that sequence (identified by the matching number in its upper left corner). Checking the Enabled box for that sequence allows the program to execute once the Apply button is clicked.

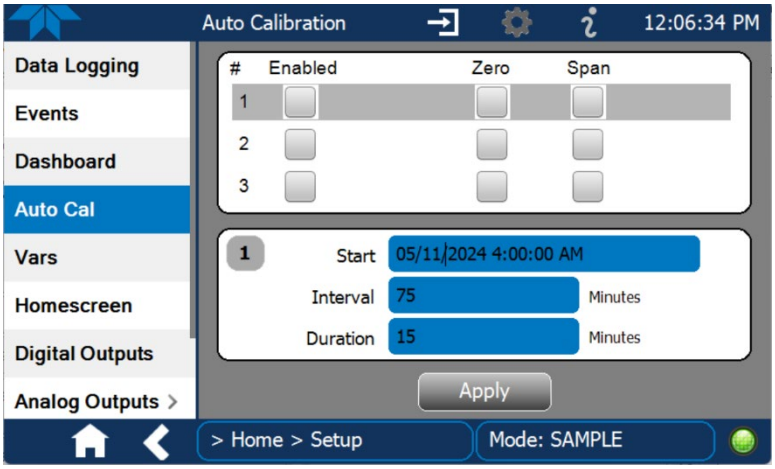


Figure 4-5. Auto Cal Page

Table 4-1. Auto Cal Programming Sequence Execution

ATTRIBUTE	ACTION
Start	For each sequence (identified by its number) that is enabled (Enabled box is checked ☑), the calibration check begins on the date and time shown in the configurable Start field. (Click the field for the pop-up window and toggle between the Time (Hour/Minutes) and the Date (Year/Month/Day) attributes to edit as needed).
Interval	Number of minutes to skip between each Sequence execution. (Click the field to input the number of minutes in the pop-up window).
Duration	Number of minutes that each Sequence execution is to run. (Click the field to input the number of minutes in the pop-up window).

Important

IMPACT ON READINGS OR DATA

- **The programmed Start time must be a minimum of 5 minutes later than the instrument's real time clock (Setup>Instrument>Date/Time Settings, Section 2.5.9).**
- **Avoid setting two or more sequences at the same time of the day.**
- **Any user-initiated calibration or calibration check that overlaps or coincides with a preprogrammed AutoCal check will override the AutoCal check.**
- **It is recommended that calibration checks be performed using external sources of Zero Air and Span Gas whose accuracy is traceable to EPA standards.**

4.4. CALIBRATION QUALITY ANALYSIS

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

Set up the Data Logger with a Periodic trigger (see Section 2.5.1) to record the values of the [Gas] Norm Offset and [Gas] Slope parameters.

Ensure that these parameters are within the limits listed in Table 4-2 and frequently compare them to those values on the *Final Test and Validation Data Sheet* that came with your instrument, which should not be significantly different. Otherwise, refer to the troubleshooting Section 5.7.6.

Table 4-2. Calibration Data Quality Evaluation

FUNCTION	MINIMUM VALUE	OPTIMUM VALUE	MAXIMUM VALUE
SO_2 SLOPE	-0.700	1.000	1.300
SO_2 Norm Offset	50.0 mV	<100	250.0 mV
H_2S SLOPE	-0.700	1.000	1.300
H_2S Norm Offset	50.0 mV	<100	250.0 mV

5. MAINTENANCE AND SERVICE

Follow the maintenance schedule set forth in Section 5.1. Service and troubleshooting are covered in Section 5.7. To support your understanding of the technical details of maintenance and service, the principles of operation in Section 6 provides information about how the instrument works.

WARNING – ELECTRICAL SHOCK HAZARD

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

CAUTION – QUALIFIED PERSONNEL

These maintenance procedures must be performed by qualified technicians only.

ATTENTION

COULD DAMAGE INSTRUMENT AND VOID WARRANTY

Always power off the instrument before disconnecting or reconnecting internal electrical assemblies. Failure to do so can cause damage to instrument.

Also, when cleaning (or any time), avoid spraying anything directly onto any part of the analyzer.

5.1. MAINTENANCE SCHEDULE

Table 5-1 shows a typical maintenance schedule for the N101.

In certain environments (e.g., dusty, very high ambient pollutant levels) some maintenance procedures may need to be performed more often than shown.

Important

IMPACT ON READINGS OR DATA

A span and zero calibration check (see CAL CHECK REQ'D Column of Table 5-1) must be performed following some of the maintenance procedures listed herein. To perform a CHECK of the instrument's Zero or Span Calibration, refer to Sections 4.2.1.1 and 4.2.1.2, respectively.

When running a "check" only, DO NOT press the Zero or Span buttons at the end of each operation (actual calibration), as this will reset the stored values for OFFSET and SLOPE and alter the instrument's calibration.

Alternatively, use the Auto Cal feature (Section 4.3).

Table 5-1. N101 Maintenance Schedule

ITEM	ACTION	FREQUENCY	CAL CHECK	DATE PERFORMED					
SO_2 scrubber	Replace	As required	Yes						
$H_2S \rightarrow SO_2$ Converter Catalyst	Replace	As required	Yes						
Particulate filter option	Change filter element membrane	As needed	No						
Zero/span check	Evaluate offset and slope	Weekly	--						
Zero/span calibration	Zero and span calibration	Every 3 months	--						
External zero air scrubber (optional)	Exchange chemical	Every 3 months	No						
Perform flow check	Check Flow	Every 6 Months	No						
Critical flow orifice & sintered filters	Replace	Annually	Yes						
Internal IZS Permeation Tube	Replace	As required	YES						
Perform pneumatic leak check	Verify Leak Tight	Annually or after repairs involving pneumatics	Yes						
Pump diaphragm	Replace	At least Every 2 years or if **PRES** is ≥ 33.00 in-Hg-A	Yes						
PMT sensor hardware calibration	Low-level hardware calibration	On PMT/ preamp changes if 0.7 < **SLOPE** or **SLOPE** >1.3	Yes						

5.2. PREDICTIVE DIAGNOSTICS

Predictive diagnostic functions, including failure warnings and alarms built into the analyzer's firmware, aid in determining whether and when repairs are necessary.

Dashboard Functions can also be used to predict failures by looking at how their values change over time, compared to the values recorded on the printed record of the *Final Test and Validation Data Sheet*. The internal data logger is a convenient way to record and track these changes (set up through the Data Logger, Section 2.5.1). Use NumaView™ Remote (Section 3.3) to download and review this data from a remote location.

The following table, checked weekly, can be used as a basis for taking action as these values change with time.

Table 5-2. Predictive Uses for Dashboard Functions

DASHBOARD FUNCTION	CONDITION	BEHAVIOR		INTERPRETATION
		EXPECTED	ACTUAL	
H2S OR SO2 STB[1]	Zero Gas	≤ 1 ppb with zero air	Increasing	• Pneumatic Leaks – instrument & sample system • Detector deteriorating
PRES	sample gas	Constant within atmospheric changes	Fluctuating	• Developing leak in pneumatic system
			Slowly increasing	• Flow path is clogging up. • Developing leak in pneumatic system to vacuum - Check critical flow orifice & sintered filter.
			Slowly decreasing	• Replace particulate filter
DRK PMT	PMT output when UV Lamp shutter closed	Constant within ±20 of check-out value	Significantly increasing	• PMT cooler failure • Lamp board pulse drive failure
SO_2 Concentration / H_2S Concentration	At span with IZS option installed	Constant response from day to day	Decreasing over time	• Change in instrument response
				• Degradation of IZS permeation tube
	Standard configuration at span	stable for constant concentration	Decreasing over time	• Drift of instrument response; UV Lamp output is excessively low; clean RCEL window
SAMP FL	Standard Operation	Stable	Slowly Decreasing	• Flow path is clogging up. - Check critical flow orifice & sintered filter. - Replace particulate filter
			Fluctuating	• Leak in gas flow path.
LAMP RATIO	Standard Operation	Stable and near 100%	Fluctuating or Slowly increasing	• UV detector wearing out • UV source Filter developing pin holes
			Slowly decreasing	• UV detector wearing out • Opaque oxides building up on UV source Filter • UV lamp aging
H2S OR SO2 OFFS[1]	During Zero Cal	Stable	Slowly increasing or decreasing	• Bad PMT • Failed HVPS • Leak in sample gas flow • Contamination in zero gas source.
H2S OR SO2 SLOPE[1]	During Span Cal	Stable	Slowly increasing or decreasing	• UV lamp aging • UV detector wearing out • Leak in Sample gas or calibration gas flow path • Deterioration / contamination of calibration gas source(s)

5.3. OPERATIONAL HEALTH CHECKS

Navigate to the Utilities>USB Utilities>Report menu (Figure 5-1) to download a report on the basic operations of the instrument. The report is generated every 24 hours to a Web services "cloud" where it is available for viewing by Teledyne API technical support personnel. To download the report for your own viewing on a computer or to send to others, insert a flash drive into a front panel USB port and press the Download button, which is enabled when the instrument detects the flash drive.

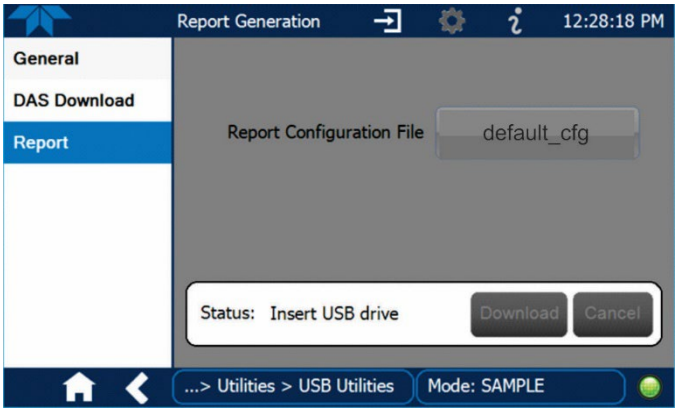


Figure 5-1. Report Generation Page

5.4. SOFTWARE/FIRMWARE UPDATES

An automatic weekly check for updates can be enabled in the Setup>Vars>Periodically Check for Updates menu, and/or a check for updates can be prompted at any time in the Setup>Instrument>Remote Update page. Downloading updates can be performed either remotely (5.4.1) or manually (5.4.2).

5.4.1. REMOTE UPDATES

The instrument must be connected to a network that is connected to the Internet. In the Setup>Instrument menu, select the Remote Update menu and press the Check for Updates button (Figure 5-2). If an update is available, the Update button will be enabled.

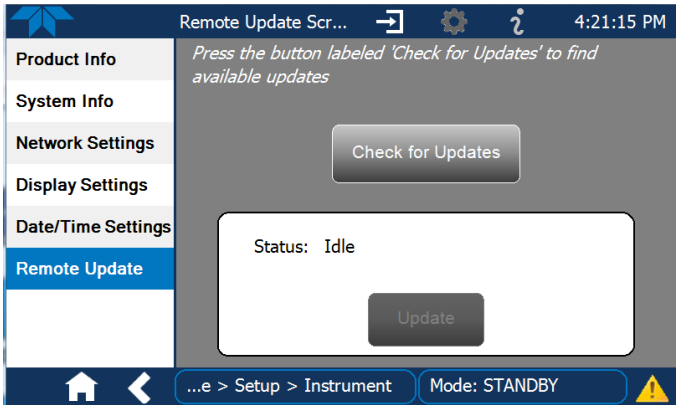


Figure 5-2. Remote Update Page

5.4.2. MANUAL RELOAD/UPDATE PROCEDURES

To reload or update firmware, first contact Technical Support to obtain the applicable file(s): api-techsupport@teledyne.com / 800-324-5190.

1. Follow Technical Support's instructions for copying the firmware files to a flash drive.
2. Go to the Utilities>USB Utilities>General menu.

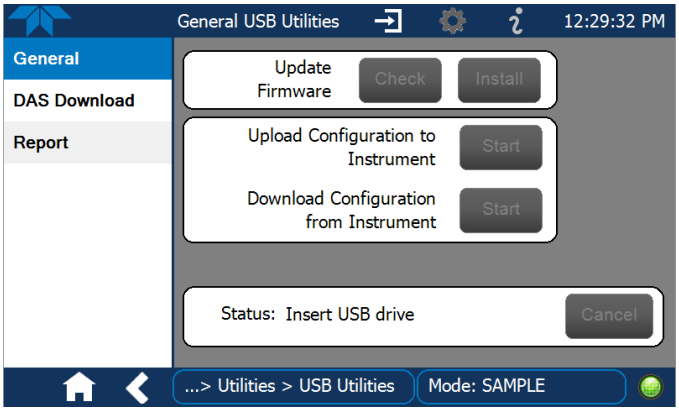


Figure 5-3. Manual Update Page (and other utilities)

3. Insert a flash drive into a front panel USB port and wait for the Status field to indicate that the drive has been detected.
4. In the Update Firmware field, press the Check button for the instrument to determine whether the firmware on the flash drive is more recent than what is currently installed. Once it's been determined that the firmware is new, the Install button will be enabled; if the firmware version on the flash drive is the same as or older than the current firmware of the instrument, the Install button will not be enabled.
5. Press the Install button and note the messages in the Status field at the bottom of the page. Use the Cancel button if necessary.
6. When complete, as indicated in the Status field, press the Done button, which replaces the Cancel button, and remove the flash drive.
7. Power off and restart the instrument to complete the new firmware installation.

5.5. TIME ZONE CHANGES

There is an option to change between 12-hour and 24-hour format in the Setup>Vars menu (System Time Format). Effectively changing the Time Zone requires a specific procedure as follows:

1. In Setup>Instrument>Date/Time Settings select the applicable Time Zone.
2. Allow adequate time for the selected Time Zone to be properly accepted.
3. Verify: return to Home page then back to the Date/Time Settings page, and check that the selected Time Zone is now highlighted.
4. **Without making any other changes, power OFF the instrument and power ON again.**
5. Once restarted, return to the Date/Time Settings page where the newly selected Time Zone should be highlighted. (If not, it means that not enough time had passed for the instrument to accept the change before the power was cycled OFF).
6. After the Time Zone is implemented first (Steps 1 through 5), then other changes to the date and/or time can be made, and recycling the power is not necessary.

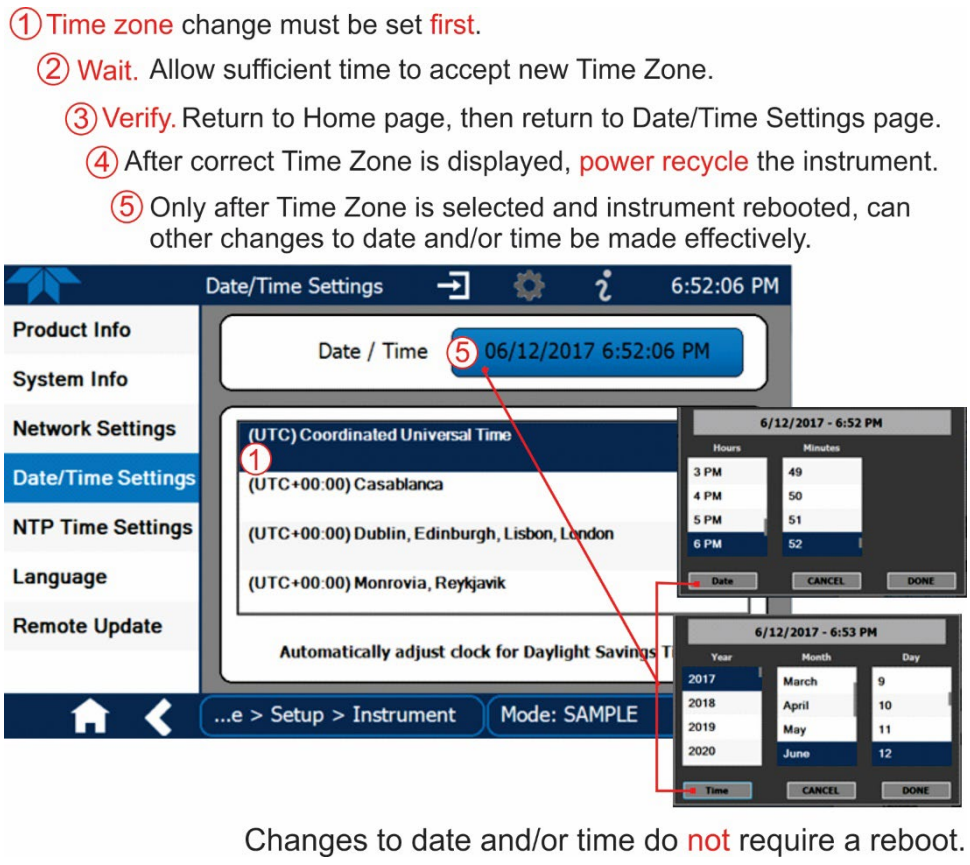


Figure 5-4. Time Zone Change Requirements

5.6. HARDWARE MAINTENANCE PROCEDURES

Perform the following procedures as standard maintenance per Table 5-1.

5.6.1. CHANGING THE PARTICULATE FILTER ELEMENT

If the instrument is fitted with the 47mm particulate sample filter, please follow these procedures for changing the particulate filter element. Inspect the particulate filter often for signs of plugging or contamination. It should be replaced according to the service interval schedule even without obvious signs of dirt, as filters with 1 and 5 µm pore size can clog up while retaining a clean look.

Important

IMPACT ON READINGS OR DATA

Use gloves or PTFE coated tweezers or similar handling to avoid contamination of the sample filter assembly. Do not touch any part of the housing, filter element, PTFE retaining ring, glass cover and the o-ring with bare hands, as contamination can negatively impact accuracy of readings.

To change the filter element:

1. Turn OFF the analyzer to prevent drawing debris into the instrument.
2. Open the hinged rear panel and unscrew the Retaining Ring on the filter assembly (Figure 5-5).

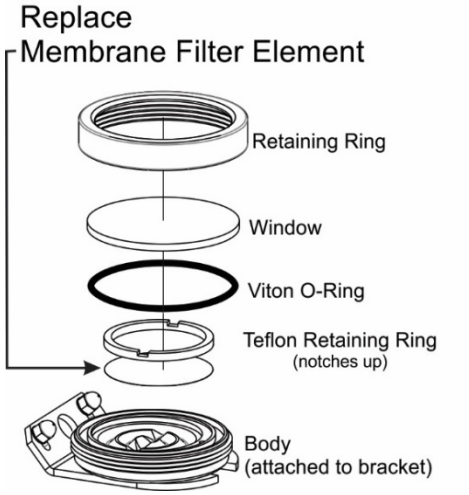


Figure 5-5. Replacing the Particulate Filter Option's Membrane Filter Element

3. Carefully remove the Retaining Ring, the glass Window, the notched Teflon Retaining Ring, and the used Membrane Filter Element (the Viton O-Ring may come up with the Window or it may remain nested in the Body).
4. Insert the new Membrane Filter Element, being careful that it is fully seated and centered in the bottom of the Body.
5. Ensuring that the Viton O-Ring is nested in the Body, reinsert the Teflon Retaining Ring with the notches up, then the glass Window, and finally, screw on the Retaining Ring and finger tighten.
6. Inspect and ensure that the Viton O-Ring is creating a proper seal all around.
7. Close the panel and restart the analyzer.

5.6.2. CHANGING/REMOVING THE IZS PERMEATION TUBE

1. Turn off the analyzer, unplug the power cord and remove the cover.
2. Locate the IZS oven in the rear left of the analyzer.
3. Remove the top layer of insulation if necessary.
4. Unscrew the black aluminum cover of the IZS oven (3 screws) using a medium Phillips-head screw driver.
   - Leave the fittings and tubing connected to the cover.
5. Remove the old permeation tube and replace it with the new tube (or store the permeation tube in its original container if the instrument will not be operated for several or more hours).
   - Ensure that the tube is placed into the larger of two holes and that the open permeation end of the tube (Teflon) is facing up.
6. With the sealing O-ring properly in place, re-attach the cover with three screws.
   - Ensure that the three screws are tightened evenly.
7. Replace the analyzer cover, plug the power cord back in and turn on the analyzer.
8. Carry out an IZS span check to verify that the new permeation device works properly (see Section 4.3).
   - The permeation rate may need several days to stabilize.

ATTENTION

COULD DAMAGE INSTRUMENT AND VOID WARRANTY

Do not leave instrument turned off for more than 8 hours without removing the permeation tube. Do not ship the instrument without removing the permeation tube. The tube continues to emit gas, even at room temperature and will contaminate the entire instrument.

5.6.3. MAINTAINING THE SO_2 SCRUBBER

The SO_2 scrubber (located inside the chassis utilizes a consumable compound to absorb SO_2 from the sample gas that must be replaced periodically in order for the analyzer to continue measuring the desired gas accurately and reliably.

This material is capable of efficiently scrubbing SO_2 for up to 1000 ppm/hours. This means that if the SO_2 content of the sample gas is typically around 100 ppb, the scrubber will function for approximately 10,000 hours, a little over 13 months. However, if the typical ambient SO_2 level of the sample gas is higher, the scrubber will last a shorter time; e.g., an ambient SO_2 level of 250 ppb would shorten the duration of the scrubber's efficiency to approximately 4000 hours or about 5 ½ months.

5.6.3.1. DETERMINING LIFE OF SO_2 SCRUBBER AND WHEN TO REPLACE

To determine how long the SO_2 scrubber will operate efficiently:

1. Ensure that the Setup>Vars>Gas Measure Mode is set to SO2 only (not multiple).
2. Let the analyzer operate in Sample Mode for 30 minutes, then note the SO2 concentration.
3. Divide 1,000 by the SO_2 ppm concentration or 1,000,000 by the SO_2 ppb concentration.

   EXAMPLE: If the SO_2 concentration is 0.125 ppm or 125 ppb:

   1000 ppm/hr ÷ 0.125 ppm

   1,000,000 ppb/hr ÷ 125 ppb

   Operational hours = 8000 hrs

5.6.3.2. CHECKING THE FUNCTION OF THE SO_2 SCRUBBER

To check to see if your SO_2 scrubber is operating properly:

1. With the Measure Mode var set to H_2S, introduce gas mixture into the sample gas stream that includes SO_2 at a concentration of at least 20% of the reporting range currently selected. For example, if the analyzer is set for a Single Range & 500 ppb, a concentration of 1000 ppb would be appropriate.
2. Note the gas concentration: An increase of more than 2% in the gas reading is an indication that the efficiency of the scrubber is decreasing to the point that the absorbing material should be replaced.

5.6.3.3. CHANGING THE SO_2 SCRUBBER MATERIAL

1. Input zero air for 5 minutes.
2. Turn off instrument(s).
3. Locate the scrubber cartridge (white cylinder) respective to the instrument (refer to Figure 2-3).
4. Disconnect the two fittings on the top of the scrubber.
5. Remove the two screws holding the scrubber to the instrument and remove the scrubber.
6. Take the two Teflon fittings off the instrument.
7. Empty the SO_2 scrubbing material into a hazmat bin.
8. Fill each side of the scrubber with new SO_2 scrubber material until it is ½ an inch from the bottom of the thread lines so about ½ inches from the top of the scrubber,

   Important **Do not fill it too high or the fitting will compact the material, causing gas flow restriction.**

9. Remove the Teflon tape from both of the removed fittings, and rewrap them with new Teflon tape.
10. Install both fittings back onto the scrubber.
11. Put the scrubber back into its instrument and replace the two screws on the bottom.
12. Screw the two fittings back onto the top of the scrubber (either fitting can fit the inlet or the outlet).
13. Return instrument(s) to normal operation.

5.6.4. CHANGING THE EXTERNAL ZERO AIR SCRUBBER

The chemicals in the external scrubber need to be replaced periodically according to the maintenance schedule or more frequently as needed. This procedure can be carried out while the instrument is running. Ensure that the analyzer is not in either the ZERO or SPAN calibration modes.

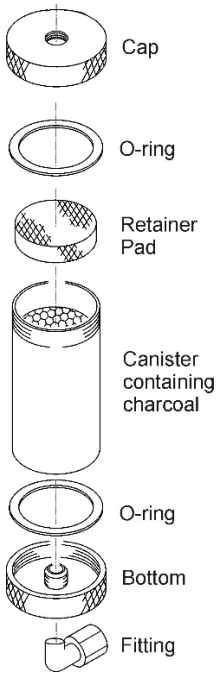


Figure 5-6. Charcoal Canister Assembly

1. Locate the scrubber on the outside rear panel.
2. Remove the old scrubber by disconnecting the 1/4” plastic tubing from the particle filter using 9/16” and 1/2" wrenches.
3. Remove the particle filter from the cartridge using 9/16” wrenches.
4. Unscrew the top of the scrubber canister and discard charcoal contents in accordance with local laws for discarding these chemicals. The rebuild kit comes with a Material and Safety Data Sheet, which contains more information on these chemicals.
5. Refill the scrubber with charcoal at the bottom.
6. Tighten the cap on the scrubber - hand-tight only.
7. Replace the DFU filter, if required, with a new unit and discard the old.
8. Replace the scrubber assembly into its clips on the rear panel.
9. Reconnect the plastic tubing to the fitting of the particle filter.
10. Adjust the scrubber cartridge such that it does not protrude above or below the analyzer in case the instrument is mounted in a rack. If necessary, squeeze the clips for a tighter grip on the cartridge.

5.6.5. MAINTAINING THE N101's $H_2S \rightarrow SO_2$ CONVERTER

The catalyst contained in the $H_2S \rightarrow SO_2$ converter of your N101 must be replaced periodically in order for the analyzer to continue measuring H_2S accurately and reliably.

This material is capable of efficiently converting H_2S into SO_2 for up to 6000 ppm/hours. This means that if the H_2S content of the sample gas is typically around 600 ppb, the scrubber will function for approximately 10,000 hours, a little over 13 months. However, if the typical ambient H_2S level of the sample gas is higher, the duration of the converter's efficiency would be shorter; e.g., if the ambient H_2S level of the sample gas is 1000 ppb, the efficiency of the converter would be shortened to about 6000 hours or about 8 months.

5.6.5.1. DETERMINING LIFE OF CONVERTER CATALYST AND WHEN TO REPLACE

To determine how long the $H_2S \rightarrow SO_2$ converter will operate efficiently:

1. Measure the amount of H_2S in the sample gas.
2. Divide 6000 by the H_2S concentration in ppm or 6,000,000 by the H_2S concentration in ppb.

   EXAMPLE: If the H_2S concentration is 750 ppb:

   6000 ppm/hr ÷ 0.75 ppm

   6,000,000 ppb/hr ÷ 750 ppb

   Operational hours = 8000 hrs

5.6.5.2. CHECKING THE EFFICIENCY OF THE $H_2S \rightarrow SO_2$ CONVERTER

To check whether the $H_2S \rightarrow SO_2$ converter is operating properly:

1. Set the analyzer to SO_2 measurement mode (Setup>Vars>Measure Mode).
2. Supply a gas with a known concentration of SO_2 to the sample gas inlet of the analyzer.
3. Wait until the analyzer's SO_2 concentration measurement stabilizes (should be 0.5 ppb or less before proceeding).
4. Record the stable SO_2 concentration
5. Set the analyzer to H_2S measurement mode (Setup>Vars>Measure Mode).
6. Supply a gas with a known concentration of H_2S, equal to that of the SO_2 gas used in steps 2-4 above, to the sample gas inlet of the analyzer.
7. Wait until the analyzer's concentration measurement stabilizes (should be 0.5 ppb or less before proceeding).
8. Record the stable H_2S concentration

9. Divide the H_2S concentration by the SO_2 concentration

   EXAMPLE: If the SO_2 and H_2S concentration of the two test gases used is 500 ppb:

   Measured SO_2 concentration = 499.1 ppb

   Measured H_2S concentration = 490.3 ppb

   Converter Efficiency= 490.3 ÷ 499.1

   Converter Efficiency= 0.982 (98.2%)

10. It is recommended that the H_2S → SO_2 converter catalyst material be replaced if the converter efficiency falls below 96% or whatever efficiency rating is specified by local regulatory requirements.

5.6.5.3. CHANGING THE H_2S → SO_2 CONVERTER CATALYST MATERIAL

The H_2S → SO_2 converter is located in the center of the instrument. The converter (see Figure 5-7 for the assembly) is designed for replacement of the cartridge only; the heater with built-in thermocouple can be reused.

- Turn off the analyzer power, remove the cover and allow the converter to cool.
- Remove the top lid of the converter as well as the top layers of the insulation until the converter cartridge can be seen.

CAUTION

The converter operates at 315º C. Severe burns can result if the assembly is not allowed to cool. Do not handle the assembly until it is at room temperature. This may take several hours..

- Remove the tube fittings from the converter.
- Disconnect the power and the thermocouple of the converter. Unscrew the grounding clamp of the power leads with a Phillips-head screw driver.
- Remove the converter assembly (cartridge and band heater) from the can. Make a note of the orientation of the tubes relative to the heater cartridge.
- Unscrew the band heater and loosen it, take out the old converter cartridge.

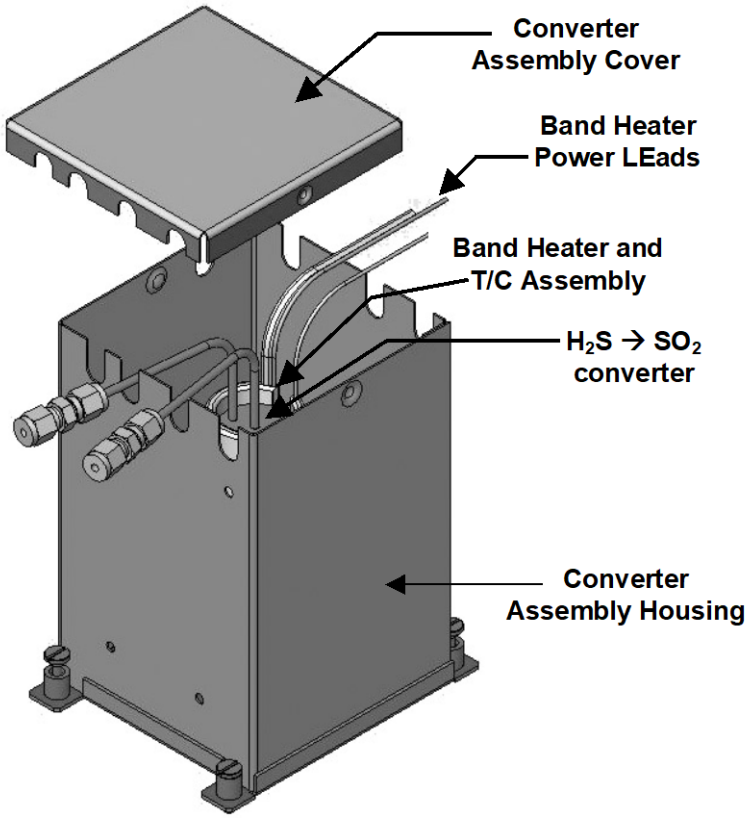


Figure 5-7. H_2S - SO_2 Converter Assembly

- Wrap the band heater around the new replacement cartridge and tighten the screws using a high-temperature anti-seize agent such as copper paste. Make sure to use proper alignment of the heater with respect to the converter tubes.
- Replace the converter assembly, route the cables through the holes in the housing and reconnect them properly. Reconnect the grounding clamp around the heater leads for safe operation.
- Re-attach the tube fittings to the converter and replace the insulation and cover.
- Replace the instrument cover and power up the analyzer.

5.6.6. SERVICING CRITICAL FLOW ORIFICES

A critical flow orifice, located on the exhaust manifold maintains the proper flow rate of gas through the analyzer. Despite the fact that these flow restrictors are protected by sintered stainless steel filters, they can, on occasion, clog up, particularly if the instrument is operated without a sample filter or in an environment with very fine, sub-micron particle-size dust.

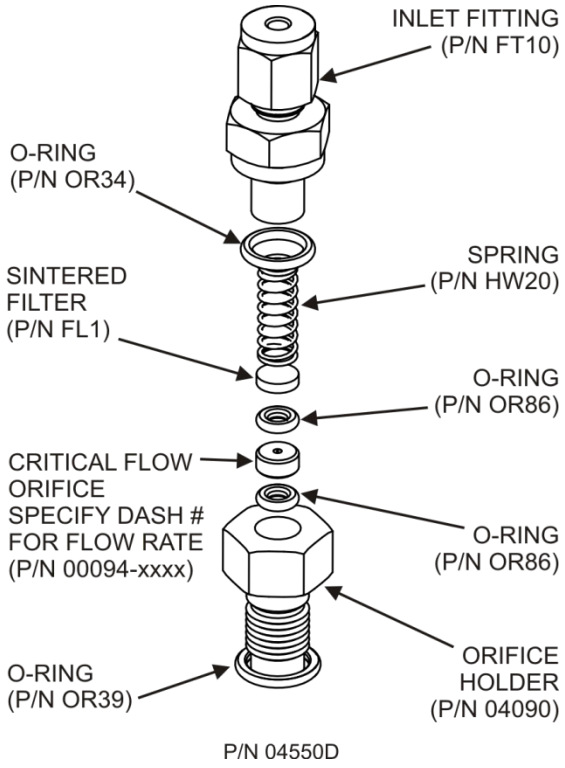


Figure 5-8. Critical Flow Orifice Assembly

To clean or replace a critical flow orifice:

1. Turn off power to the instrument and vacuum pump.
2. Locate the critical flow orifice on the pressure sensor assembly.
3. Disconnect the pneumatic line.
4. Unscrew the NPT fitting.

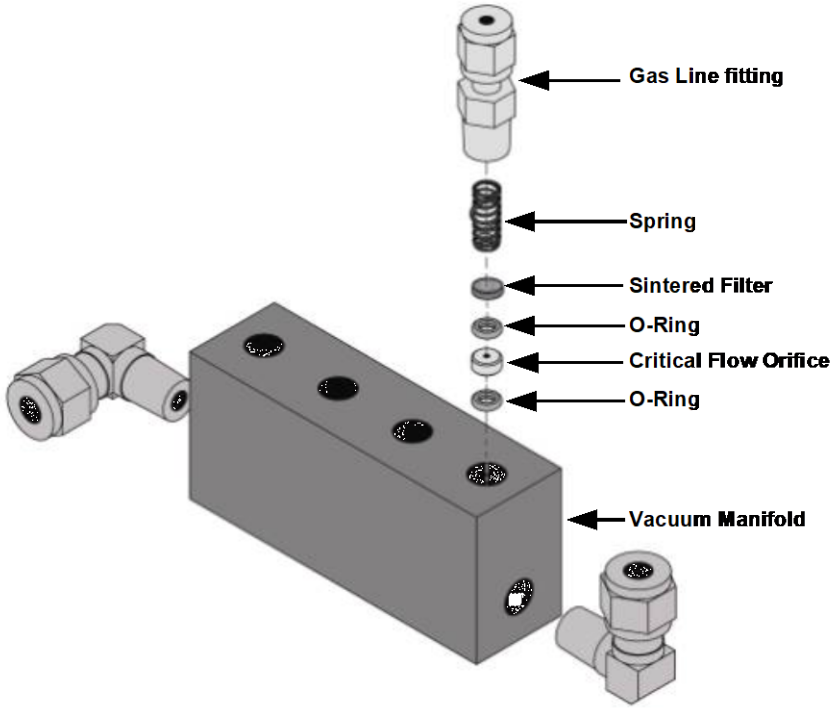


Figure 5-9. Critical Flow Orifice Assembly

5. Take out the components of the assembly: a spring, a sintered filter, two O-rings and the critical flow orifice.

Note **You may need to use a scribe or pressure from the vacuum port to get the parts out of the manifold.**

6. Discard the two O-rings and the sintered filter.
7. Replace the critical flow orifice and let the part dry.
8. Using a new sintered filter and O-rings, reassemble the parts as shown in Figure 5-8.
9. Reinstall the NPT fitting and connect all tubing
10. Power up the analyzer and allow it to warm up for 60 minutes.
11. Perform a leak check.

5.6.7. CHECKING FOR LIGHT LEAKS AFTER MAINTENANCE OR REPAIR

When re-assembled after maintenance or repair, or if operated improperly, the PMT assembly can develop small gaps, allowing stray light from the analyzer surroundings into the PMT housing. To find such light leaks, follow the procedures below.

CAUTION – QUALIFIED PERSONNEL ONLY

This procedure is carried out with the analyzer running and its cover removed.

1. In the Dashboard view the **PMT Signal** (if not visible, configure the Dashboard to add; see Section 2.5.3).
2. Supply zero gas to the analyzer.
3. With the instrument still running, carefully remove the analyzer cover.

WARNING – ELECTRICAL SHOCK HAZARD

Do NOT touch any of the inside wiring with the metal cover or with your body.

Do NOT drop screws or tools into a running analyzer.

4. Shine a powerful flashlight or portable incandescent light at the inlet and outlet fittings and at all of the joints of the reaction cell as well as around the PMT housing.
   - The PMT value should not respond to the light; the PMT signal should remain steady within its usual noise performance.
5. If there is a PMT response to the external light, symmetrically tighten the sample chamber mounting screws or replace the 1/4” vacuum tubing with new, black PTFE tubing (this tubing will fade with time and become transparent).

Note **Often, light leaks are also caused by O-rings being left out of the assembly.**

6. If, during this procedure, the black PMT housing end plate for the Sensor Assembly is removed, ensure to replace the 5 desiccant bags inside the housing.
7. Carefully replace the analyzer cover. If tubing was changed, carry out a pneumatic leak check (Section 5.6.8).

5.6.8. CHECKING FOR PNEUMATIC LEAKS

This section covers a simple leak check and a detailed leak check.

CAUTION - TECHNICAL INFORMATION

Do not exceed 15 psi when pressurizing the system during either Simple or Detailed checks.

5.6.8.1. SIMPLE VACUUM LEAK AND PUMP CHECK

Leaks are the most common cause of analyzer malfunction. This section presents a simple leak check, whereas the next section details a more thorough procedure. The method described here is easy, fast and detects, but does not locate, most leaks. It also verifies the sample pump condition.

1. If not already running, turn the analyzer ON, and allow at least 30 minutes for flows to stabilize.
2. Cap the sample inlet port (cap must be wrench-tight).
3. After several minutes, when the pressures have stabilized, note the Sample Pressure reading.
   - If equal to within 10% and less than 10 in-Hg-A, the instrument is free of large leaks.
   - It is still possible that the instrument has minor leaks.
   - If the reading greater than 10 in-Hg-A, the pump is in good condition.
   - A new pump will create a pressure reading of about 4 in-Hg-A (at sea level).
4. When finished, switch off the pump and open the cap to the sample inlet port slowly to minimize inrush flow.

5.6.8.2. DETAILED PRESSURE LEAK CHECK

Obtain a leak checker that contains a small pump, shut-off valve, and pressure gauge to create both over-pressure and vacuum. Alternatively, a tank of pressurized gas, with the two-stage regulator adjusted to ≤ 15 psi, a shutoff valve and a pressure gauge may be used.

ATTENTION

COULD DAMAGE INSTRUMENT AND VOID WARRANTY

Once tube fittings have been wetted with soap solution under a pressurized system, do not apply or reapply vacuum as this will cause soap solution to be sucked into the instrument, contaminating inside surfaces.

Also, do not exceed 15 psi when pressurizing the system.

1. Turn OFF power to the instrument and remove the instrument cover.
2. Install a leak checker or a tank of gas (compressed, oil-free air or nitrogen) as described above on the sample inlet at the rear panel.
3. Pressurize the instrument with the leak checker or tank gas, allowing enough time to fully pressurize the instrument through the critical flow orifice.

4. Check each tube connection (fittings, hose clamps) with soap bubble solution, looking for fine bubbles.
   - Once the fittings have been wetted with soap solution, do not reapply vacuum as it will draw soap solution into the instrument and contaminate it.
   - Do not exceed 15 psi pressure.
5. If the instrument has the zero and span valve option, the normally closed ports on each valve should also be separately checked.
   - Connect the leak checker to the normally closed ports and check with soap bubble solution.
6. If the analyzer is equipped with an IZS Option, connect the leak checker to the Dry Air inlet and check with soap bubble solution.
7. Once the leak has been located and repaired, the leak-down rate of the indicated pressure should be less than 1 in-Hg-A (0.4 psi) in 5 minutes after the pressure is turned off.
8. Clean surfaces from soap solution, reconnect the sample and pump lines and replace the instrument cover.
9. Restart the analyzer.

5.6.8.3. Performing Flow Checks/Calibrations

Important

IMPACT ON READINGS OR DATA

For accurate measurements use a separate, calibrated flow meter capable of measuring the instrument's flow specifications. Do not use the built in flow measurement viewable in the Dashboard as this value is only calculated, not measured.

The sample gas flow rate through the analyzer is a key part of the gas concentration reading, but the reading is only a calculated value derived by the CPU. The Flow Cal feature under the Utilities>Diagnostics menu is used to check and to calibrate/adjust the calculations.

Sample flow checks, using an external flow meter, are useful for monitoring the actual flow of the instrument to detect drift of the internal flow measurement. A decreasing, actual sample flow may point to slowly clogging pneumatic paths, most likely critical flow orifices or sintered filters (Section 5.6.5).

Flow Check

Low flows indicate blockage somewhere in the pneumatic pathway.

To check the Sample flow with the external flow meter:

1. Disconnect the sample inlet tubing from the rear panel SAMPLE port.
2. Attach the outlet port of a suitable flow meter to the rear panel SAMPLE port.
   - Ensure that the inlet to the flow meter is at atmospheric pressure.
3. The sample flow measured with the external flow meter should be within ± 10% of the analyzer's Flow specification (Table 1-1).

FLOW CALIBRATION

To calibrate the Sample flow (Flow Cal):

1. In the Utilities>Diagnostics>Flow Cal menu (Figure 5-10), edit the Actual Flow value by inputting the reading from the external flow meter obtained in the corresponding check of the flow to be calibrated.
2. Press the Calibrate button.

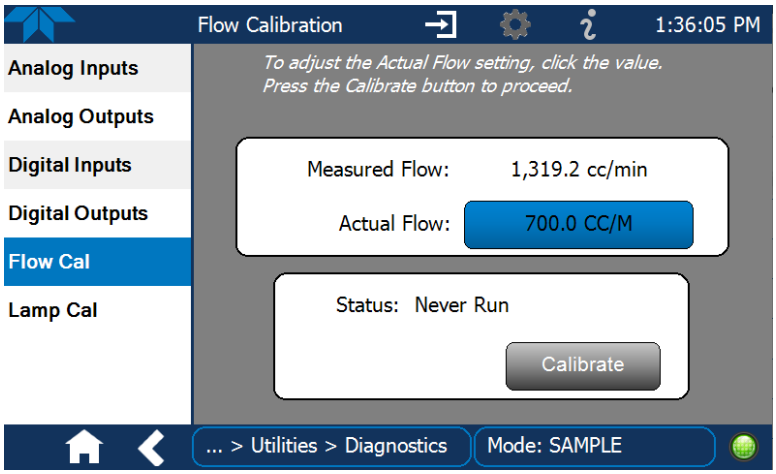


Figure 5-10. Flow Calibration Menu

5.6.9. CHECKING THE HYDROCARBON SCRUBBER (*KICKER*)

There are two possible types of problems that can occur with the scrubber: pneumatic leaks and contamination that ruins the inner tube's ability to absorb hydrocarbons.

5.6.9.1. CHECKING THE SCRUBBER FOR LEAKS

Leaks in the outer tubing of the scrubber can be found using the procedure described in Section 5.6.8.2. Use the following method to determine if a leak exists in the inner tubing of the scrubber.

This procedure requires a pressurized source of air (chemical composition is unimportant) capable of supplying up to 15 psiA and a leak checking fixture such as the one illustrated in Figure 5-11.

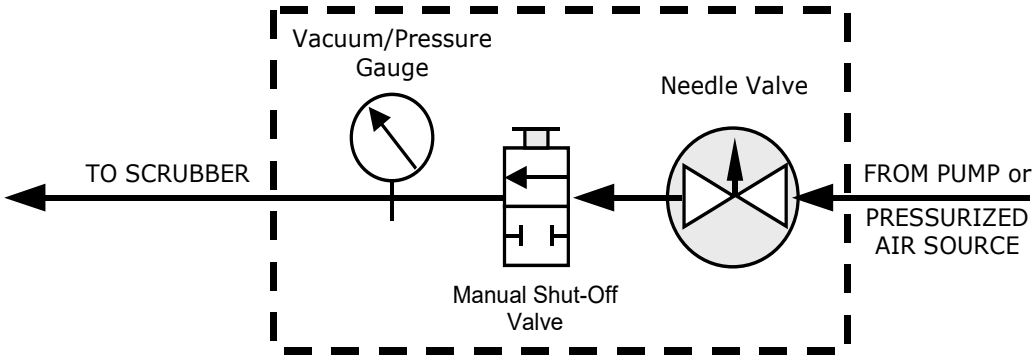


Figure 5-11. Simple Leak Check Fixture

1. Turn off the analyzer.
2. Disconnect the pneumatic tubing attached to both ends of the scrubber's inner tubing.
3. One end is connected to the sample particulate filter assembly and the other end is connected to the reaction cell assembly.
4. Both ends are made of the 1/8" black Teflon tubing.
5. Cap one end of the hydrocarbon scrubber.
6. Attach the pressurized air source to the other end of the scrubber inner tubing with the leak check fixture in line.

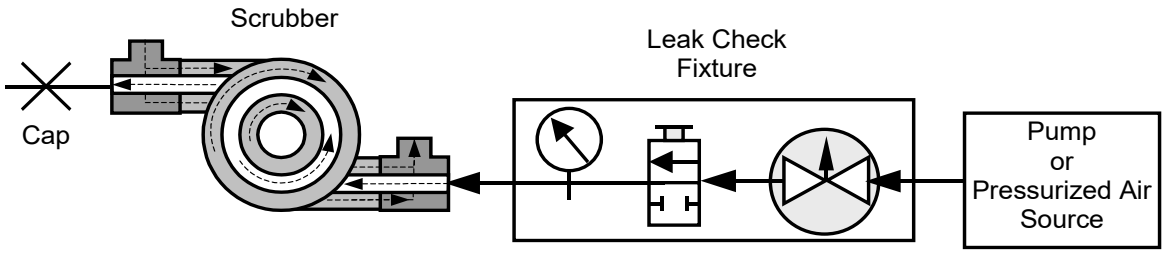


Figure 5-12. Hydrocarbon Scrubber Leak Check Setup

7. Use the needle valve to adjust the air input until the gauge reads 15 psiA.

ATTENTION **COULD DAMAGE INSTRUMENT AND VOID WARRANTY**
Ensure the pressure does not exceed 15 psia.
Do not pull vacuum through the scrubber.

8. Close the shut-off valve.
9. Wait 5 minutes.

If the gauge pressure drops >1 psi within 5 minutes, then the hydrocarbon scrubber has an internal leak and must be replaced. Contact Teledyne API's Technical Support (Section 5.9).

5.7. SERVICE AND TROUBLESHOOTING

This section contains methods to identify the source of performance problems with the analyzer and procedures to service the instrument.

Note **Section 6, Principles of Operation, provides information about how the instrument works, to support your understanding of the technical details of maintenance.**

CAUTION

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

WARNING – RISK OF ELECTRICAL SHOCK

Some operations need to be carried out with the analyzer open and running.

Exercise caution to avoid electrical shocks and electrostatic or mechanical damage to the analyzer.

Do not drop tools into the analyzer or leave them after your procedures.

Do not short or touch electric connections with metallic tools while operating inside the analyzer.

Use common sense when operating inside a running analyzer.

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

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

1. Note any Alerts and take corrective action as necessary (see Table 5-3).
2. Examine the values of all basic functions in the Dashboard and compare them to factory values. Note any major deviations from the factory values and take corrective action.
3. Use the internal electronic status LEDs to determine whether the electronic communication channels are operating properly.
4. Suspect a leak first!
   - Customer service data indicate that the majority of all problems are eventually traced to leaks in the internal pneumatics of the analyzer or the diluent gas and source gases delivery systems.
   - Check for gas flow problems such as clogged or blocked internal/external gas lines, damaged seals, punctured gas lines, damaged / malfunctioning pumps, etc.
5. Follow the procedures defined in Section 2.3.4.3 to confirm that the analyzer's vital functions are working (power supplies, CPU, PMT cooler, etc.).

5.7.1. FAULT DIAGNOSIS WITH ALERTS

Table 5-3 lists brief descriptions of warning Alerts that may occur during start up and describes their possible causes for diagnosis and troubleshooting.

Note that if more than two or three warning Alerts occur at the same time, it is often an indication that some fundamental sub-system has failed, rather than an indication of the specific failures referenced by the warnings.

Table 5-3. Warning Alerts, Fault Conditions and Possible Causes

WARNING	FAULT CONDITION	POSSIBLE CAUSES
ANALOG CAL WARNING	The instrument's A/D circuitry or one of its analog outputs is not calibrated	• A parameter for one of the analog outputs, even one not currently being used, has been changed and the analog output calibration routine was not re-run
BOX TEMP WARNING	Temperature of chassis is outside specified limits. (typically < 7°C or > 48°C)	• Box Temperature typically runs ~7°C warmer than ambient temperature • Poor/blocked ventilation to the analyzer • Stopped Exhaust Fan • Ambient Temperature outside of specified range
CONFIG INITIALIZED	Configuration and Calibration data reset to original Factory state or erased.	• User erased data
CONVERTER TEMPERATURE WARNING	Temperature of converter outside its limits	• Converter heater not plugged in • Converter temperature sensor not plugged in or loose connection • Failed converter heater • Failed converter temperature sensor
DARK PMT WARNING	Dark PMT signal is too high Dark offset above limit specified	• Light leak in reaction cell • Loose connector/wiring • PMT bench module board not functioning properly
DATA INITIALIZED	Data Storage in DAS was erased before the last power up occurred.	• User cleared data.
HVPS WARNING	High voltage power supply output is too high or too low for proper operation of the PMT. (Outside of allowable limits).	• High voltage power supply is bad • High voltage power supply is out of cal
IZS TEMP WARNING [3]	Permeation tube temperature is outside specified limits.	• Bad IZS heater • Bad IZS temperature sensor
PMT TEMP WARNING	PMT temperature outside of warning limits.	PMT fan not operating • Failed PMT Temperature Sensor • Failed PMT TEC • Failed PMT TEC driver circuit • Failed PMT bench module board • Loose connection to/from PMT temperature sensor
PMT DET WARNING	PMT detector output is outside of operational limits.	• Failed PMT • Malfunctioning PMT bench module board
RCELL TEMP WARN	Sample chamber temperature is out of range.	• Failed reaction cell heater • Failed reaction cell temperature sensor

WARNING	FAULT CONDITION	POSSIBLE CAUSES
SAMPLE FLOW WARN	The flow rate of the sample gas is outside the specified limits.	• Failed Sample Pump • Blocked Sample Inlet/Gas Line • Dirty Particulate Filter • Leak downstream of Critical Flow Orifice • Failed flow sensor circuitry
SAMPLE PRES WARN	Sample Pressure is <10 in-Hg or > 35 in-H Note: Normally 29.92 in-Hg at sea level decreasing at 1 in-Hg per 1000 ft of altitude (with no flow – pump disconnected)	If sample pressure is < 10 in-hg: • Blocked particulate filter • Blocked sample inlet/gas line • Failed pressure sensor/circuitry If sample pressure is > 35 in-hg: • Blocked vent line on pressurized sample/zero/span gas supply • Bad pressure sensor/circuitry
SYSTEM RESET	The computer has rebooted.	This message occurs at power on. If it is confirmed that power has not been interrupted: • Fatal Error caused software to restart • Loose connector/wiring
UV LAMP WARNING	The UV lamp intensity measured by the reference is outside of specified limits.	• UV lamp is bad • Reference detector is bad or out of adjustment. • Analog sensor input circuitry has failed. • Fogged or damaged lenses/filters in UV light path • A/D converter circuitry failure • Light leak in reaction cell

[1] Clears the next time successful span calibration is performed.
[2] Clears the next time successful zero calibration is performed.
[3] Only appears if the IZS option is installed.

5.7.2. FAULT DIAGNOSIS WITH DASHBOARD FUNCTIONS

In addition to being useful as predictive diagnostic tools, the functions viewable in the Dashboard can be used to isolate and identify many operational problems when combined with a thorough understanding of the analyzer's principles of operation (see Section 6).

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

Make note of these values for reference in troubleshooting.

Note

Sample Pressure measurements are represented in terms of "Absolute Atmospheric Pressure" because this is the least ambiguous method for reporting gas pressure.

Absolute atmospheric pressure is about 29.92 in-Hg-A at sea level. It decreases about 1 in-Hg per 1000 ft gain in altitude. A variety of factors such as air conditioning systems, passing storms, and air temperature, can also cause changes in the absolute atmospheric pressure.

Table 5-4. Dashboard Functions - Possible Causes for Out-of-Range Values

DASHBOARD FUNCTION	NOMINAL VALUES	POSSIBLE OUT-OF-RANGE CAUSE(S)
Stability	≤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 Flow	650 cm^3/min ± 10%	Faults are caused due to: clogged critical flow orifice; pneumatic leak; faulty flow sensor; sample line flow restriction.
PMT	Range is 0-2300mV	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.*
UV Lamp	200 - 1000 mV	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.
Dark PMT	-150 to +150 mV	High dark PMT reading could be due to: light leak; failure of pulse drive on lamp board; high PMT temperature; 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 reaction cell heater or temperature sensor
Box Temp	Ambient + ≈ 5ºC	Incorrect temperature reading could be caused by: Environment out of temperature operating range; malfunctioning temperature sensor or heater
PMT Temp	7ºC ± 2ºC Constant	Incorrect temperature reading could be caused by: malfunctioning TEC circuit or temperature sensor; high chassis temperature; power supply
IZS (option) Temp	50ºC ± 1ºC	Malfunctioning IZS heater or temperature sensor
Pressure	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.

5.7.3. USING THE DIAGNOSTIC SIGNAL I/O FUNCTIONS

The signal I/O functions in the Utilities>Diagnostics menu allows access to the digital and analog I/O in the analyzer. Some of the digital signals can be controlled through the Setup menu. These signals, combined with a thorough understanding of the instrument's principles of operation (Section 6), are useful for troubleshooting in three ways:

- The technician can view the raw, unprocessed signal level of the analyzer's critical inputs and outputs.
- Many of the components and functions that are normally under algorithmic control of the CPU can be manually exercised.
- The technician can directly control the signal level Analog and Digital Output signals.

This allows the technician to observe systematically the effect of directly controlling these signals on the operation of the analyzer. Use the Utilities>Diagnostics menu to view the raw voltage of an input signal or the Setup menu to control the state of an output voltage or control signal.

5.7.4. FAULT DIAGNOSIS WITH LEDS

The following illustrations show connectors and LEDs that can indicate where issues may lie. Figure 5-13 shows the layout for the mainboard, and Figure 5-14 through Figure 5-16 show the board layouts for the PMT Bench Module, the Lamp Driver, and the Pump Control, respectively.

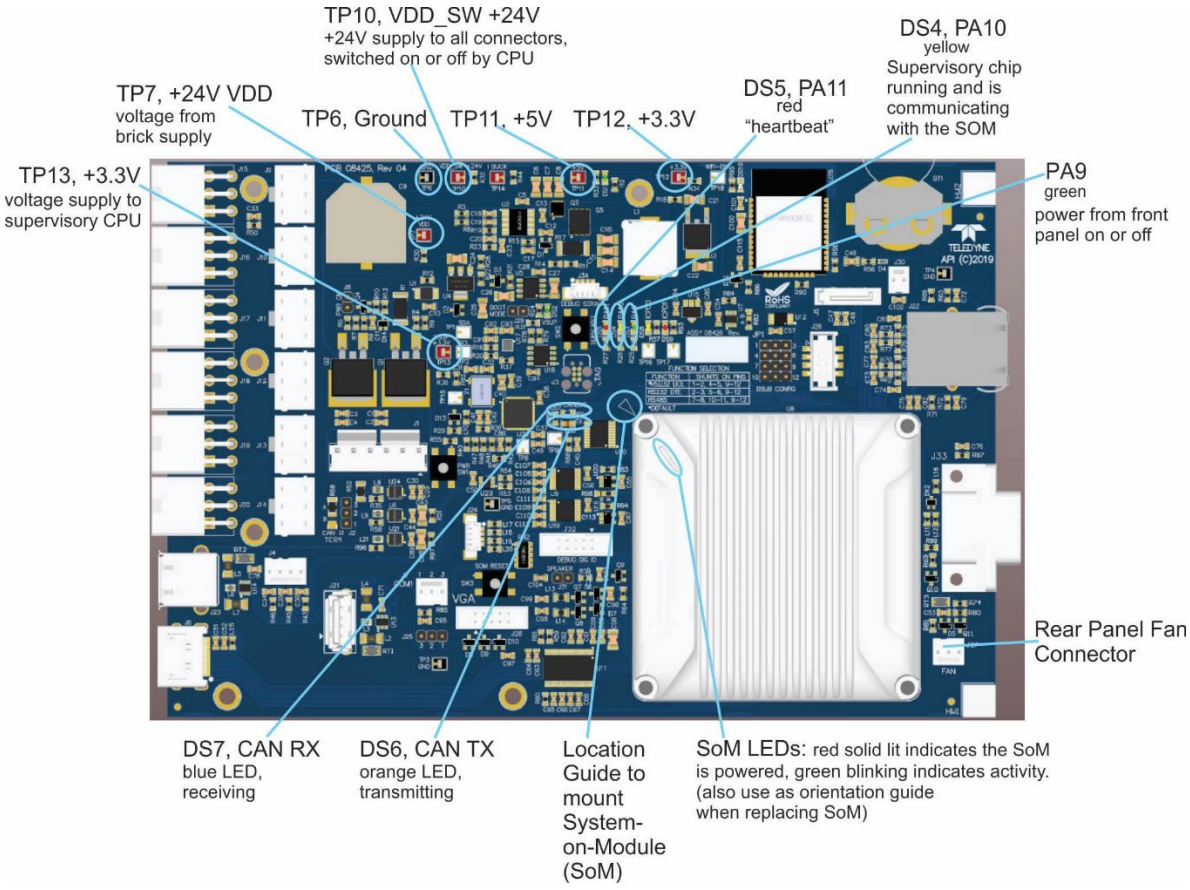


Figure 5-13. Mainboard

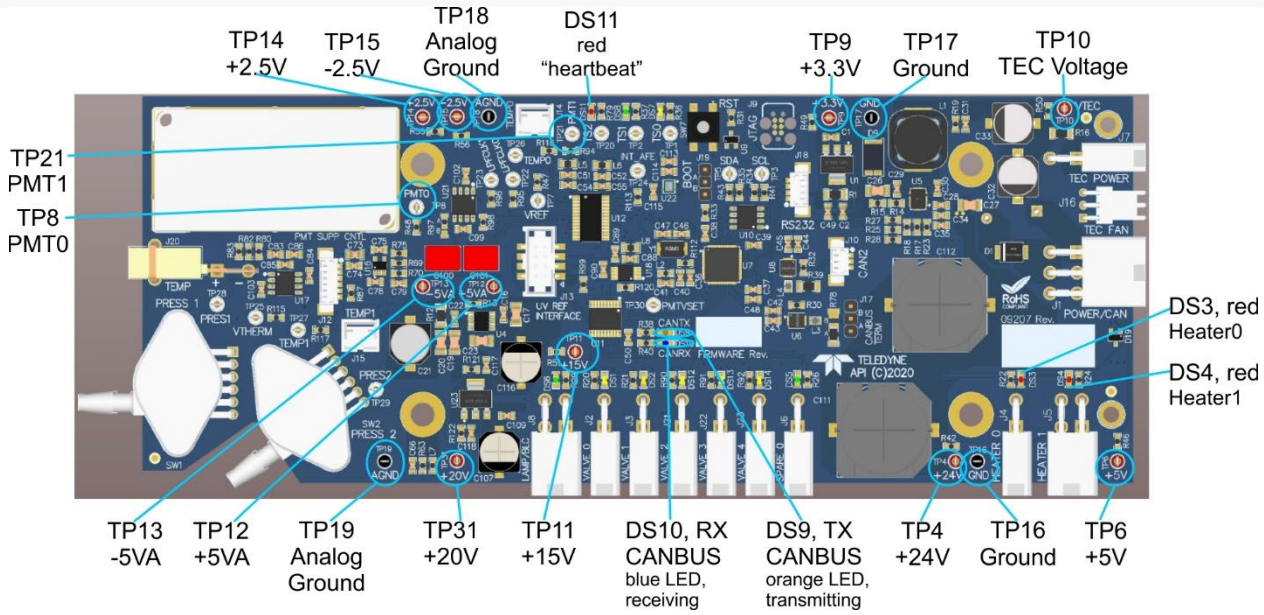


Figure 5-14. PMT Bench Module Board – Test Points and Indicator LEDs

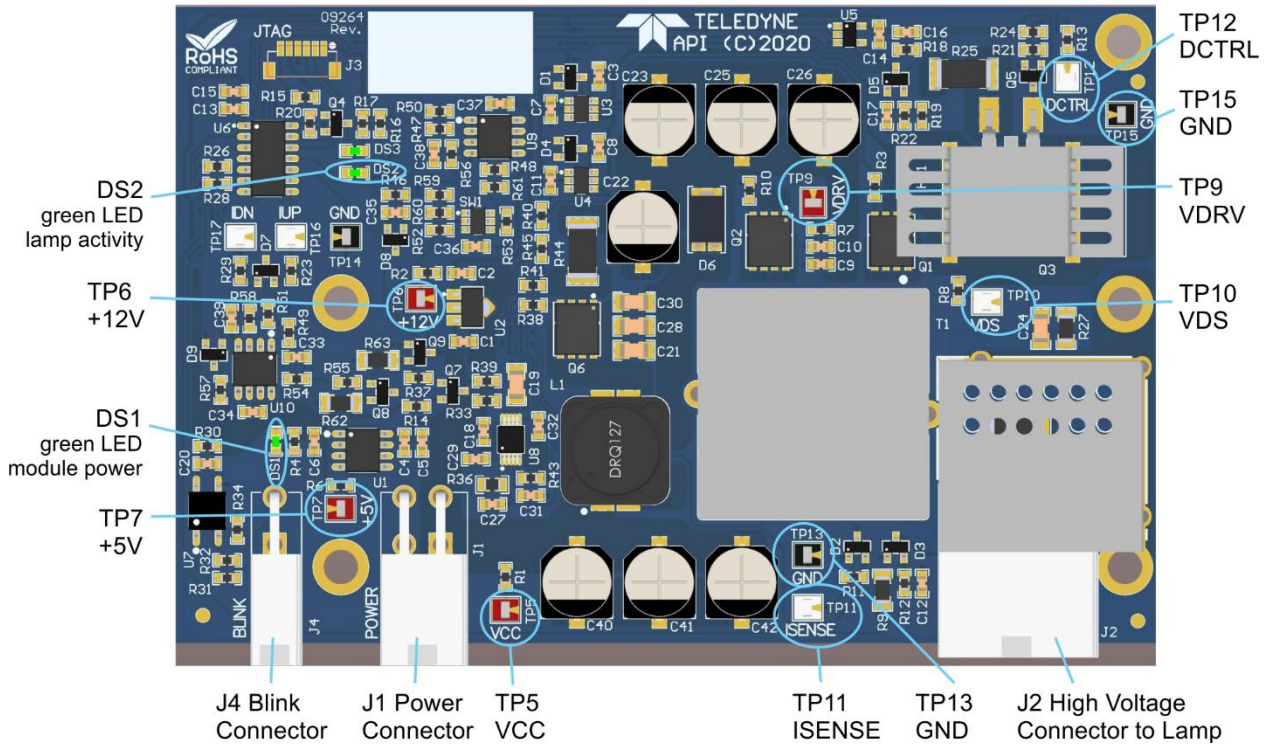


Figure 5-15. Lamp Driver Board – Test Points and Indicator LEDs

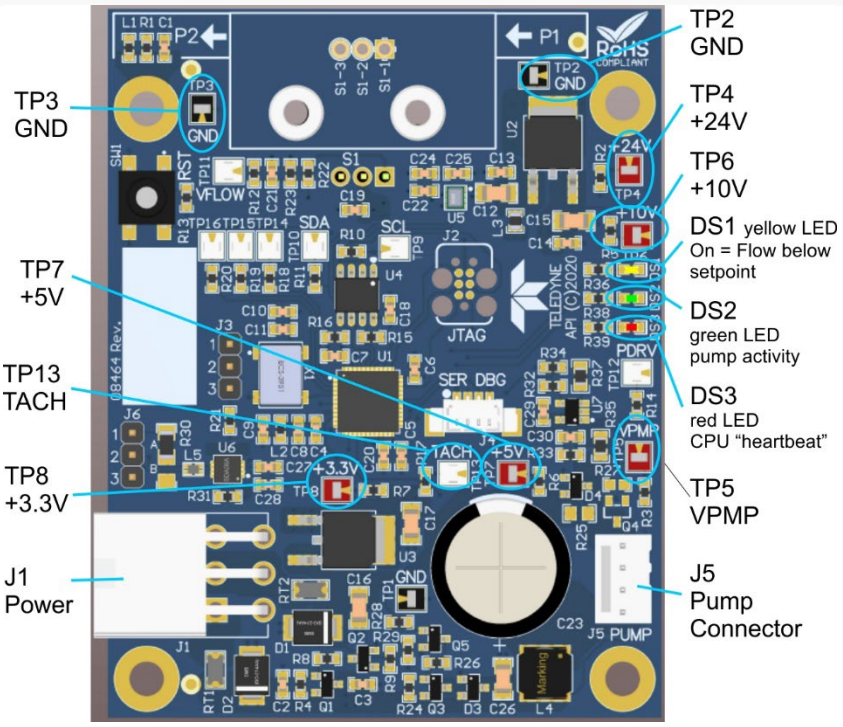


Figure 5-16. DC Pump Control Board – Test Points and Indicator LEDs

5.7.5. FLOW PROBLEMS

The standard analyzer has one main flow path. With the IZS option installed, there is a second flow path through the IZS oven that runs whenever the IZS is on standby to purge H_2S from the oven chamber. The IZS flow is not measured so there is no reading for it on the front panel display. Refer to the flow diagrams (Section 2.3.3) for help in troubleshooting flow problems. In general, flow problems can be divided into three categories:

- Flow is too high
- Flow is greater than zero, but is too low, and/or unstable
- Flow is zero (no flow)

When troubleshooting flow problems, it is essential to confirm the actual flow rate without relying on the analyzer's flow display. The use of an independent, external flow meter to perform a flow check as described in Section 5.6.8.3 is essential. Refer to the pneumatic flow diagrams as needed for reference.

5.7.5.1. SAMPLE FLOW IS ZERO OR LOW

On flow failure, the unit will display a SAMPLE FLOW WARNING in the Active Alerts page, and the respective function (Dashboard or Home Meter, if configured to display) reports a zero or very low flow rate. The instrument has an HD pump running at 100% with a critical flow orifice.

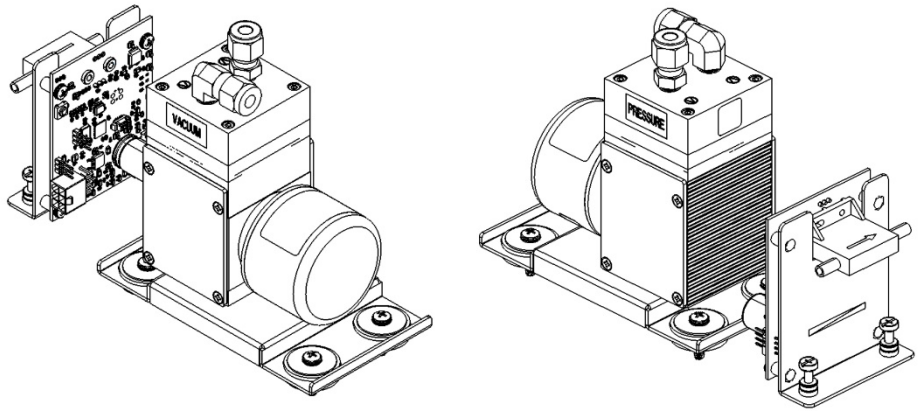


Figure 5-17. HD Pump

Note **Sample and vacuum pressures mentioned in this chapter refer to operation of the analyzer at sea level. Pressure values need to be adjusted for elevated locations, as the ambient pressure decreases by about 1 in-Hg per 300 m / 1000 ft.**

If the pump is not running, use a DC voltmeter to ensure that power is being supplied to the pump. If power is supplied properly but the pump is not running, replace the pump.

If the pump is operating but the unit is not reporting gas flow value, take the following three steps:

1. Check for actual sample flow:
   - Disconnect the sample tube from the sample inlet on the rear panel of the instrument.
   - Ensure that the unit is in basic SAMPLE mode.
   - Place a finger over the inlet and feel for suction by the vacuum or, more properly, use a flow meter to measure the actual flow.
   - If there is proper flow (within spec), contact Technical Support.
   - If there is no flow or low flow, continue with the next step.
2. Check pressures:
   - Check that the sample pressure is at or around 28 in-Hg-A at sea level (adjust as necessary when in elevated location, the pressure should be about 1" below ambient atmospheric pressure) and that the Rx Cell pressure is below 10 in-Hg-A.
   - The analyzer will calculate a sample flow up to about 14 in-Hg-A RCEL pressure but a good pump should always provide less than 10 in-Hg-A.

- If both pressures are the same and around atmospheric pressure, the pump does not operate properly or is not connected properly. The instrument does not get any vacuum.
- If both pressures are about the same and low (probably under 10 in-Hg-A, or ~20" on sample and 15" on vacuum), there is a cross-leak between sample flow path and vacuum, most likely through the dryer flow paths. See troubleshooting the dryer later in this chapter.
- If the sample and vacuum pressures are around their nominal values (28 and <10 in-Hg-A, respectively) and the flow still displays no numerical value, carry out a leak check as described in Section 5.6.8.
- If gas flows through the instrument during the above tests but goes to zero or is low when it is connected to zero air or span gas, the flow problem is not internal to the analyzer but likely caused by the gas source such as calibrators/generators, empty gas tanks, clogged valves, regulators and gas lines.
- If an IZS or Zero/Span valve option is installed in the instrument, press Start in the Calibration>Zero and Span menus. If the sample flow increases, suspect a bad Sample/Cal valve.

3. If none of these suggestions help, carry out a detailed leak check of the analyzer as described in Section 5.6.8.2.

5.7.5.2. HIGH FLOW

Flow readings that are significantly higher than the allowed operating range (typically ±10-11% of the nominal flow) should not occur in the analyzer unless a pressurized sample, zero or span gas is supplied to the inlet ports.

- Ensure to vent excess pressure and flow just before the analyzer inlet ports.
- When supplying sample, zero or span gas at ambient pressure, a high flow could indicate a broken critical flow orifice (very unlikely case), allowing more than nominal flow, or were replaced with an orifice of wrong specifications.
- If the flows are within 15% above normal, we recommend measuring and recalibrating the flow electronically (Section 5.6.8.3), followed by a regular review of these flows over time to see if the new setting is retained properly.
- Also, check the flow assembly o-rings and replace as needed.

5.7.5.3. SAMPLE FLOW IS ZERO OR LOW BUT ANALYZER REPORTS CORRECT FLOW

The analyzer can report a correct flow rate even if there is no or a low actual sample flow through the reaction cell.

- The sample flow is only calculated from the sample pressure and critical flow condition is verified from the difference between sample pressure and vacuum pressure.
- If the critical flow orifice assembly is partially or completely clogged, both the sample and vacuum pressures are still within their nominal ranges (the pump keeps pumping, the sample port is open to the atmosphere), but there is no flow possible through the reaction cell.

Although measuring the actual flow is the best method, in most cases, this fault can also be diagnosed by evaluating the sample pressure value.

- Since there is no longer any flow, the sample pressure should be equal to ambient pressure, which is about 1 in-Hg-A higher than the sample pressure under normal operation.
- Taken together with a zero or low actual flow, this could indicate a clogged sample orifice.

Again, monitoring the pressures and flows regularly will reveal such problems, because the pressures would slowly or suddenly change from their nominal, mean values. Teledyne API recommends reviewing all test data once per week and to do an exhaustive data analysis for test and concentration values once per month, paying particular attention to sudden or gradual changes in all parameters that are supposed to remain constant, such as the flow rates.

5.7.6. CALIBRATION PROBLEMS

This section describes possible causes of calibration problems.

5.7.6.1. NEGATIVE CONCENTRATIONS

Negative concentration values can be caused by:

- A slight, negative signal is normal when the analyzer is operating under zero gas and the signal is drifting around the zero calibration point. This is caused by the analyzer's zero noise and may cause reported concentrations to be negative for a few seconds at a time down to -5 ppb, but should alternate with similarly high, positive values.
- Miscalibration is the most likely explanation for negative concentration values. If the zero air contained some H_2S gas (contaminated zero air or a worn-out zero air scrubber) and the analyzer was calibrated to that concentration as "zero", the analyzer may report negative values when measuring air that contains little or no H_2S. The same problem occurs, if the analyzer was zero-calibrated using ambient air or span gas.
- If the response Offset function for H_2S is greater than 150 mV, a failed PMT or high voltage supply, or sample chamber contamination, could be the cause.

5.7.6.2. NO RESPONSE

If the instrument shows no response (display value is near zero) even though sample gas is supplied properly and the instrument seems to perform correctly.

1. Run an optical test, located in the Utilities>Diagnostics>Digital Outputs menu. See Optic Test (OTest) in Section 5.7.8.2.
   - If this test results in a concentration signal, then the PMT sensor and the electronic signal path are operating properly.
   - If the analyzer passes the OTest, it is capable of detecting light and processing the signal to produce a reading.
   - Therefore, the problem must be in the pneumatics, optics, or the UV lamp/lamp driver.
2. Confirm the lack of response by supplying H_2S span gas of about 80% of the range value to the analyzer
3. Check the sample flow for proper value.
4. Check for disconnected cables to the sensor module.

5.7.6.3. UNSTABLE ZERO AND SPAN

Leaks in the external gas supply and vacuum systems are the most common source of unstable and non-repeatable concentration readings.

1. Check for leaks in the pneumatic systems as described in Section 5.6.8.
2. Consider examining pneumatic components in the gas delivery system outside the analyzer such as a change in zero air source (ambient air leaking into zero air line or a worn-out zero air scrubber) or a change in the span gas concentration due to zero air or ambient air leaking into the span gas line.
3. Once the instrument passes a leak check, do a flow check (Section 5.6.8.3) to ensure that the instrument is supplied with adequate sample gas
4. Confirm the sample pressure, sample temperature, and UV lamp readings are correct and steady.
5. Verify that the sample filter element is clean and does not need to be replaced.

5.7.6.4. INABILITY TO SPAN - DEACTIVATED SPAN BUTTON

In general, the analyzer will deactivate certain buttons whenever the actual value of a parameter is outside of the expected range for that parameter. If the Span button is grayed out, the actual concentration must be outside of the range of the expected span gas concentration, which can have several reasons.

1. Verify that the expected concentration is set properly to the actual span gas concentration.
2. Confirm that the H_2S span gas source is accurate.

    - This can be done by comparing the source with another calibrated analyzer, or by having the H_2S source verified by an independent traceable photometer.

3. Check for leaks in the pneumatic systems as described in Section 5.6.8.

    - Leaks can dilute the span gas and, hence, the concentration that the analyzer measures may fall short of the expected concentration.

4. If the physical, low-level, hardware calibration has drifted (changed PMT response) or was accidentally altered by the user, a low-level calibration may be necessary to get the analyzer back into its proper range of expected values.

    - One possible indicator of this scenario is a slope or offset value that is outside of its allowed range (0.7-1.3 for slope, -20 to 150 for offsets). See Section 0 on how to carry out a low-level hardware calibration.

5.7.6.5. Inability to Zero - Deactivated ZERO Button

In general, the analyzer will deactivate certain buttons whenever the actual value of a parameter is outside of the expected range for that parameter. If the Zero button is grayed out, the actual gas concentration must be significantly different from the actual zero point (as per last calibration), which may be for any of several reasons.

1. Confirm that there is a good source of zero air. If the IZS option is installed, compare the zero reading from the IZS zero air source to a zero air source using H_2S and SO_2-free air. Check any zero air scrubber for performance. It may need to be replaced (Section 5.6.3).
2. Check to ensure that there is no ambient air leaking into zero air line. Check for leaks in the pneumatic systems as described in Section 5.6.8.

5.7.6.6. Non-Linear Response

The analyzer was factory calibrated and should be linear to within 1% of full scale. Common causes for non-linearity are:

- Leaks in the pneumatic system. Leaks can add a constant of ambient air, zero air or span gas to the current sample gas stream, which may be changing in concentrations as the linearity test is performed. Check for leaks as described in Section 5.6.8.
- The calibration device is in error. Check flow rates and concentrations, particularly when using low concentrations. If a mass flow calibrator is used and the flow is less than 10% of the full scale flow on either flow controller, you may need to purchase lower concentration standards.
- The standard gases may be mislabeled as to type or concentration. Labeled concentrations may be outside the certified tolerance.
- The sample delivery system may be contaminated. Check for dirt in the sample lines or sample chamber.
- Calibration gas source may be contaminated.
- Dilution air contains sample or span gas.
- Sample inlet may be contaminated with SO_2 exhaust from this or other analyzers. Verify proper venting of the analyzer's exhaust.
- Span gas overflow is not properly vented and creates a back-pressure on the sample inlet port. Also, if the span gas is not vented at all and does not supply enough sample gas, the analyzer may be evacuating the sample line. Ensure to create and properly vent excess span gas.
- If the instrument is equipped with an internal IZS valve option and the H_2S span value is continuously trending downward, the IZS permeation tube may require replacement.

5.7.6.7. Discrepancy Between Analog Output and Display

If the concentration reported through the analog outputs does not agree with the value reported on the front panel, you may need to re-calibrate the analog outputs. This becomes more likely when using a low concentration or low analog output range. Analog outputs running at 0.1 V full scale should always be calibrated manually. See Section 2.5.8.1 for a detailed description of this procedure.

5.7.7. OTHER PERFORMANCE PROBLEMS

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

5.7.7.1. EXCESSIVE NOISE

Excessive noise levels under normal operation usually indicate leaks in the sample supply or the analyzer itself.

- Ensure that the sample or span gas supply is leak-free and carry out a detailed leak check as described under Section 5.6.8.

Another possibility of excessive signal noise may be the preamplifier board, the high voltage power supply and/or the PMT detector itself.

- Contact the factory on troubleshooting these components.

5.7.7.2. SLOW RESPONSE

If the analyzer starts responding too slow to any changes in sample, zero or span gas, check for the following:

- Dirty or plugged sample filter or sample lines.
- Sample inlet line is too long.
- Dirty or plugged critical flow orifices. Check flows, pressures and, if necessary, change orifices (Section 5.6.5).
- Wrong materials in contact with sample - use glass or Teflon materials only. Porous materials, in particular, will cause memory effects and slow changes in response.
- Sample vent line is located too far from the instrument sample inlet causing a long mixing and purge time. Locate sample inlet (overflow) vent as close as possible to the analyzer's sample inlet port.
- Dirty sample cell.
- Insufficient time allowed for purging of lines upstream of the analyzer. Wait until stability is low.
- Insufficient time allowed for H_2S calibration gas source to become stable. Wait until stability is low.

5.7.8. SUBSYSTEM CHECK FOR TROUBLESHOOTING

The preceding sections of this manual discussed a variety of methods for identifying possible sources of failures or performance problems with possible causes and, in some cases, quick solutions or cross-references to the subsections that may help.. This section describes how to determine if a certain component or subsystem is actually the cause of the problem being investigated.

5.7.8.1. AC MAIN POWER

ATTENTION

COULD DAMAGE INSTRUMENT AND VOID WARRANTY

Plugging the analyzer into a power supply that is too high a voltage or frequency can damage the pump and the AC Heaters.

Plugging the analyzer into a power supply that is too low a voltage or frequency will cause these components to not operate properly.

The analyzer's electronic systems will operate with any of the specified power regimes. As long as system is connected to 100-120 VAC or 220-240 VAC at either 50 or 60 Hz it will turn on and after about 30 seconds show a front panel display. Internally, the status LEDs located on the Mainboard should turn on as soon as the power is supplied. If not, look into the following possible causes and possible solutions:

- Check the power cord for damage, such as whether it's cut or burned.
- Check that the power cord is adequately rated for the instrument's specified power rating.
- Check that the power source is of the proper voltage for the instrument's specified power rating.
- If there are no findings in the preceding steps, then note whether the instrument had been opened for maintenance; if so, place the rear panel Hard Power switch in the OFF position, and disconnect the power cord; then reopen the instrument and check that no wiring had been dislodged, and no tools were left inside.
- If no other reason can be found for the instrument not powering on, then check the fuse with an ohmmeter to determine its viability: carefully follow the instructions in Section 5.7.9.1 to remove the fuse for testing.
  - If the fuse is blown, replace it with a fuse of the correct specifications as instructed in Section 5.7.9.1.
- If the fuse is not blown, or if the replacement fuse blows, then call Technical Support (Section 5.9).

WARNING – ELECTRICAL SHOCK HAZARD

Should the AC power circuit breaker trip, investigate and correct the condition causing this situation before turning the analyzer back on.

If the pump and the heaters are not working correctly and incorrect power configuration is suspected, check the serial number label located on the instrument's rear panel to ensure that the instrument was configured for the same voltage and frequency being supplied.

5.7.8.2. PHOTOMULTIPLIER TUBE (PMT) SENSOR MODULE

The PMT detects the light emitted by the UV-excited fluorescence of SO_2 (see Principles of Operation, Section 6). It has a gain of about 500,000 to 1,000,000. It is not possible to test the detector outside of the instrument in the field. The basic method to diagnose a PMT fault is to eliminate the other components using ETEST, OTEST and specific tests for other sub-assemblies.

OPTIC TEST (OTEST)

The optic test function tests the response of the PMT sensor by turning on an LED located in the cooling block of the PMT (see Figure 5-34). The analyzer uses the light emitted from the LED to test its photo-electronic subsystem, including the PMT and the current to voltage converter on the pre-amplifier board.

- To ensure that the analyzer measures only the light coming from the LED, the analyzer should be supplied with zero air.
- The optic test should produce a PMT response.

To activate the optics test, go to the Utilities>Diagnostics>Digital Outputs menu.

Note **This is a coarse test for functionality and not an accurate calibration tool. The resulting PMT signal can vary significantly over time and also changes with low-level calibration.**

HIGH VOLTAGE POWER SUPPLY (HVPS)

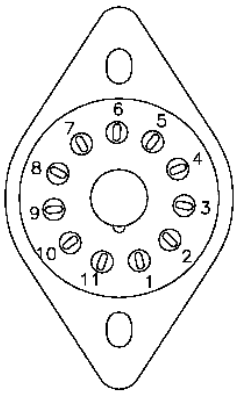
The HVPS is located in the interior of the sensor module and is plugged into the PMT tube (refer to Figure 5-34). It requires 2 voltage inputs.

- The first is +15 V, which powers the supply.
- The second is the programming voltage which is generated on the preamplifier board.
- Adjustment of the HVPS is covered in the factory calibration procedure in Section 0.

This power supply has 10 independent power supply steps, one to each pin of the PMT. The following test procedure below allows you to test each step.

1. Turn off the instrument.
2. Remove the cover and disconnect the 2 connectors at the front of the PMT housing.
3. Remove the end plate from the sensor (4 screws).
4. Remove the HVPS/PMT assembly from the cold block inside the sensor (2 plastic screws).
5. Unplug the PMT from the HVPS.
6. Re-connect the 7 pin connector to the sensor end cap, and power-up the instrument.
7. Navigate to the HVPS parameter in the Dashboard (if not shown, configure the Dashboard to display HVPS, Section 2.5.3).
8. Divide the displayed HVPS voltage by 10 and test the pairs of connector points as shown in the Figure below, which uses 700 V as an example.
9. Check the overall voltage (should be equal to the HVPS value displayed in the Dashboard and the voltages between each pair of pins of the supply.

EXAMPLE: if the HVPS signal is 700 V the pin-to-pin voltages should be 70 V.



HVPS PINS	VOLTAGE
11–1	70
1–2	70
2–3	70
3–4	70
4–5	70
5–6	70
6–7	70
7–8	70
8–9	70

10. Turn off the instrument power, and reconnect the PMT tube, and then reassemble the sensor, including desiccant bag replacement per the Maintenance Schedule requirements (Section 5.1).

    - If any faults are found in the test, you must obtain a new HVPS as there are no user serviceable parts inside the supply.

5.7.8.3. Internal Span Gas (IZS) Generator and Valve Options

If purchased, the zero/span valves and internal span gas generator options should be enabled. Check if the option is listed in the Setup>Instrument>Product Info page, and also check if the Span and Zero are in the Calibration menu. (Otherwise, contact the factory).

The semi-permeable PTFE membrane of the permeation tube is severely affected by humidity. Variations in humidity between day and night are usually enough to yield very variable output results. If the instrument is installed in an air-conditioned shelter, the air is usually dry enough to produce good results. If the instrument is installed in an environment with variable or high humidity, variations in the permeation tube output will be significant. In this case, a dryer for the supply air is recommended (dewpoint should be –20° C or less).

The permeation tube of the internal span gas generator option is heated with a proportional heater circuit and the temperature is maintained at 50°C ±1°C. Check the IZS Temp in the Dashboard or the IZS Temp Raw signal in the Utilities>Diagnostics>Analog Inputs menu. At 50° C, the temperature signal from the IZS thermistor should be around 2500 mV.

5.7.9. SERVICE PROCEDURES

This section contains some procedures that may need to be performed when a major component of the analyzer requires repair or replacement.

Note

Regular maintenance procedures are discussed in Section 5.5 and are not listed here).

Also, there may be more detailed service notes for some of the below procedures. Contact Teledyne API's Technical Support Department.

WARNING – ELECTRICAL SHOCK HAZARD

Unless the procedure being performed requires the instrument to be operating, turn it off and disconnect power before opening the analyzer and removing, adjusting or repairing any of its components or subsystems.

CAUTION – QUALIFIED TECHNICIAN

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

5.7.9.1. FUSE REPLACEMENT PROCEDURE

ATTENTION

COULD DAMAGE INSTRUMENT AND VOID WARRANTY

Fuses do not typically fail without definite cause. Do not attempt to replace until after all measures to detect the cause of a power failure per Section 5.7.8.1 have been carried out, including Soft Power switch LED not lit (neither solid nor blinking), but Hard Power switch is in ON position and instrument's power cord properly connected at both ends. If an ohmmeter shows that the fuse is good, or if a new fuse blows, call Technical Support (Section 5.9).

WARNING – ELECTRICAL SHOCK HAZARD

Never pull out fuse drawer without ensuring that the Hard Power switch is in OFF position and power cord disconnected, to ensure there is no power to the instrument before checking/changing fuse.

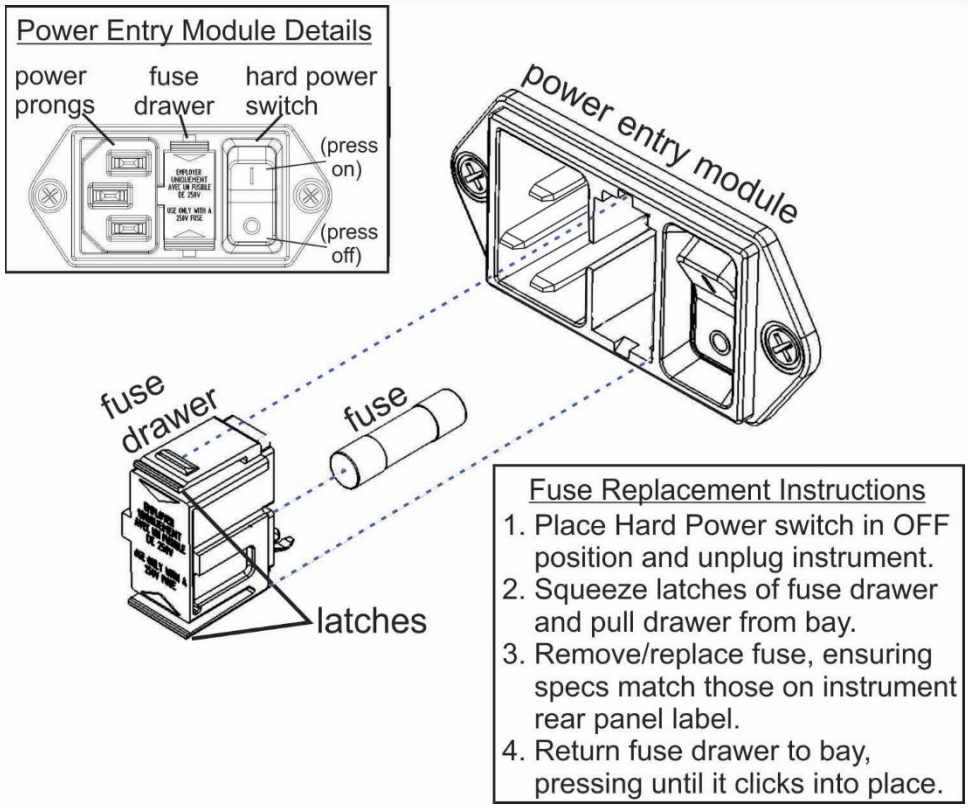


Figure 5-18. Fuse Access

5.7.9.2. MODULE REPLACEMENT

Each smart module has its own printed circuit board mounted to it so that the entire assembly can be quickly and efficiently swapped out.

ATTENTION **COULD DAMAGE INSTRUMENT AND VOID WARRANTY**

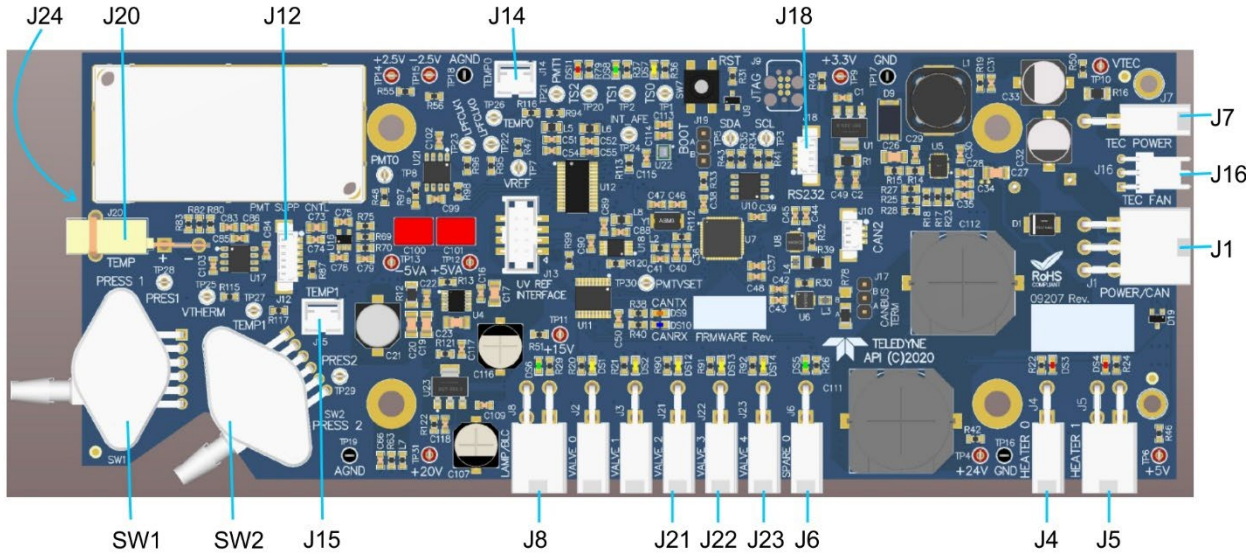
Always power off the instrument before disconnecting or reconnecting any wiring when uninstalling/installing modules. Failure to do so will damage certain PCAs.

1. Turn off the analyzer power (noting that the front panel switch LED should either be blinking or solid off before powering down via the rear panel switch).
2. Remove the power cord and the analyzer cover.
3. Disconnect tubing connected to the module.
4. Unplug the electrical connection(s) to the module.
5. Unscrew the mounting screws that attach the module to the chassis and lift out the entire assembly.
6. If you received a complete replacement module with circuit board and mounting bracket attached, simply reverse the above steps to install. For connector information, refer to the illustrations that follow.

Note **Ensure to carry out a leak check (Section 5.6.8) and a recalibration after the analyzer has warmed up for about 60 minutes.**

The following illustrations provide connector information for module boards:

J24: PMT Signal (back side of PCA)
J20: Moly/Hicon/O3 Destruct
J12: PMT HVPS Drive Control
J14: PMT Temp
J18: RS232 Comm
J7: TEC Cooler Power
J16: TEC Cooler Fan
J1: Power and CAN Bus



SW1: Sample Pressure
SW2: RCell Pressure
J15: RCell Temp
J8: Power for Lamp PCA
J21: Sample/Cal Valve (Not used for IZS option which uses external CAN Bus PCA)
J22: Span Valve (Not used for IZS option which uses external CAN Bus PCA)
J23: Spare
J6: Spare
J4: RCell Heater Power

Figure 5-19. PMT Bench Module Board Connectors

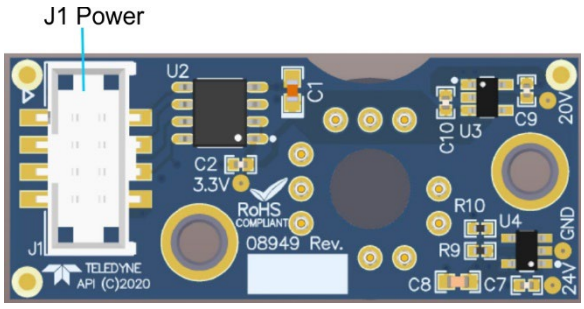


Figure 5-20. UV Detector Board Connector

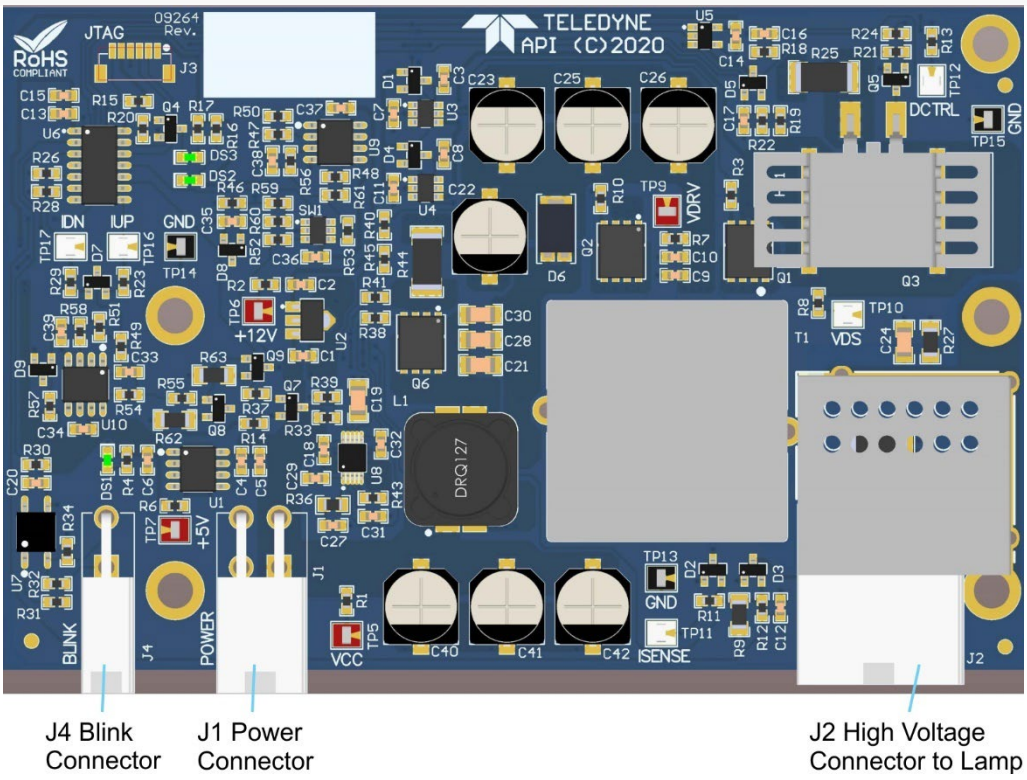


Figure 5-21. Lamp Driver Board Connectors

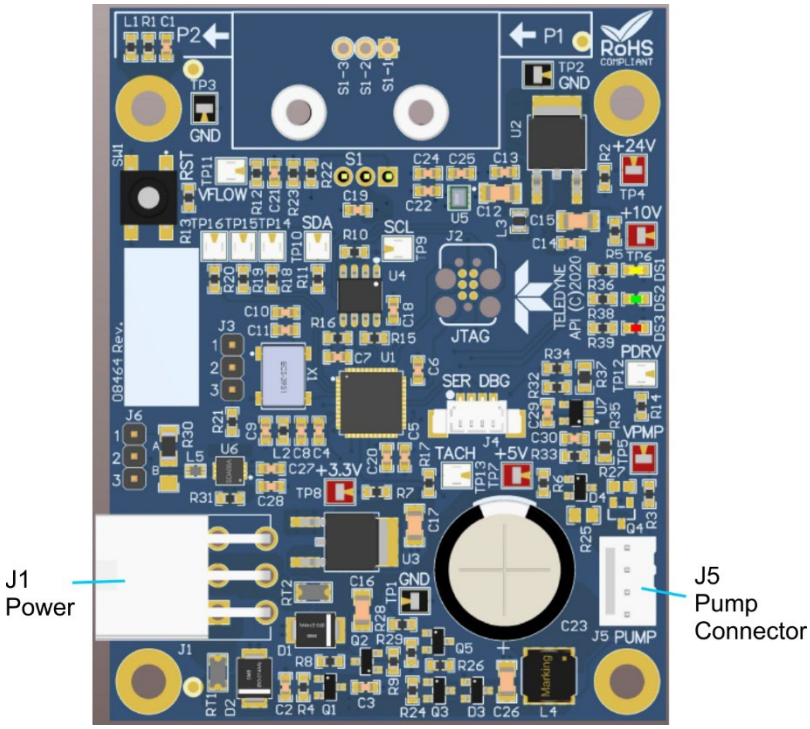


Figure 5-22. DC Pump Control Board Connectors

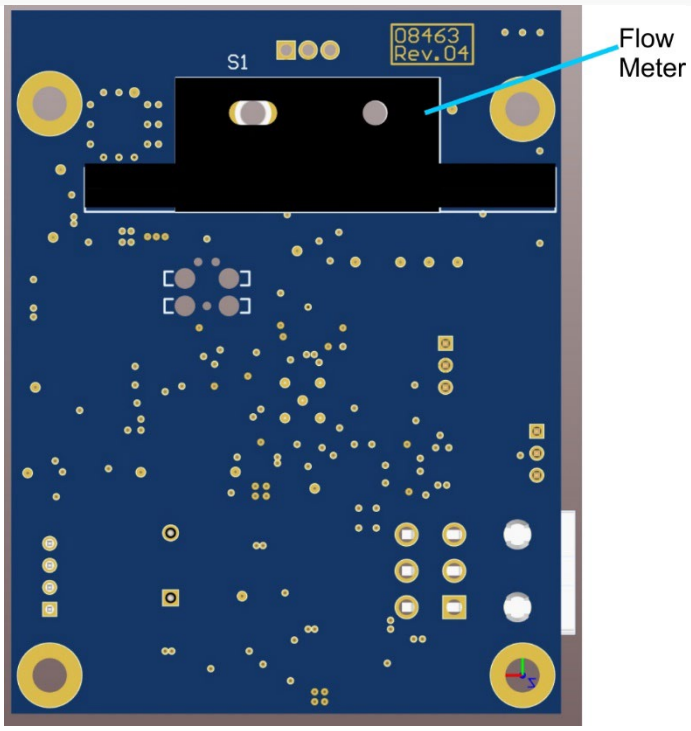


Figure 5-23. DC Pump Flow Meter (DC Pump Control Board Bottom)

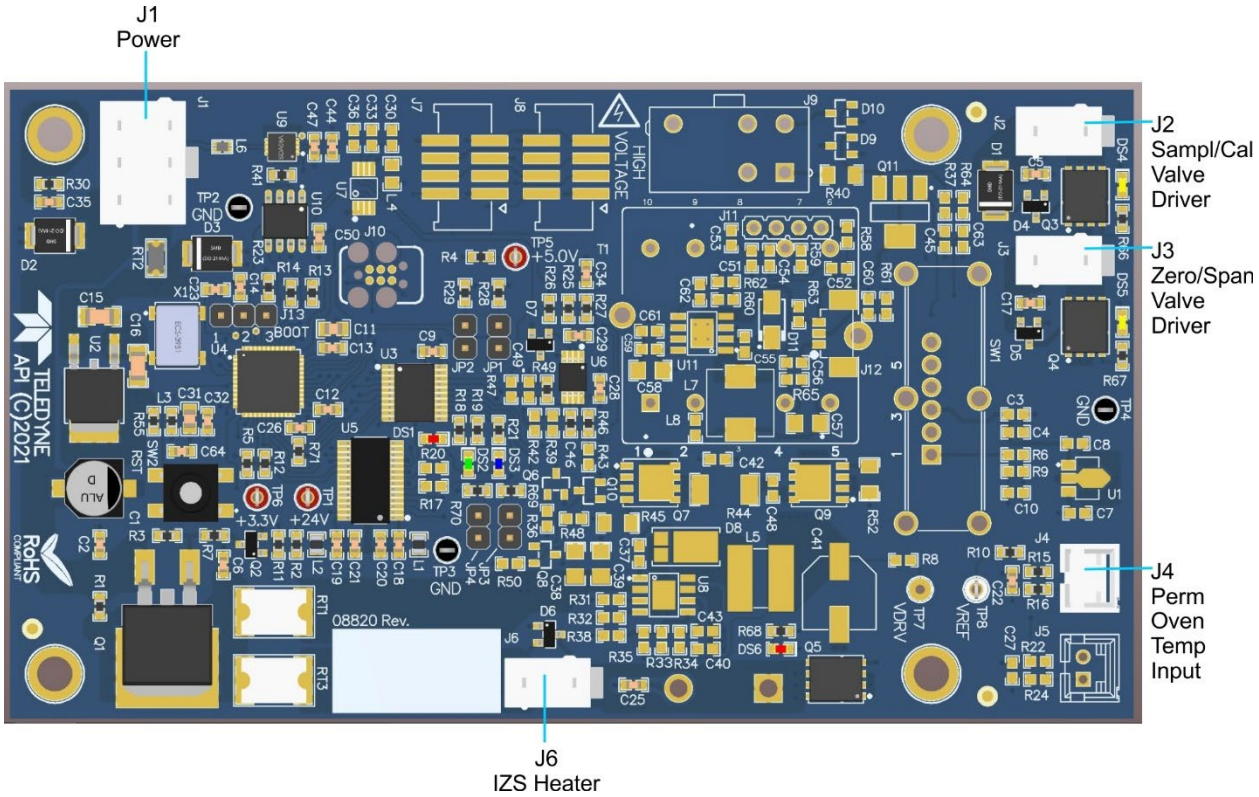


Figure 5-24. IZS Option Board Connectors

Other connectors on the Mainboard are shown next in Figure 5-25.

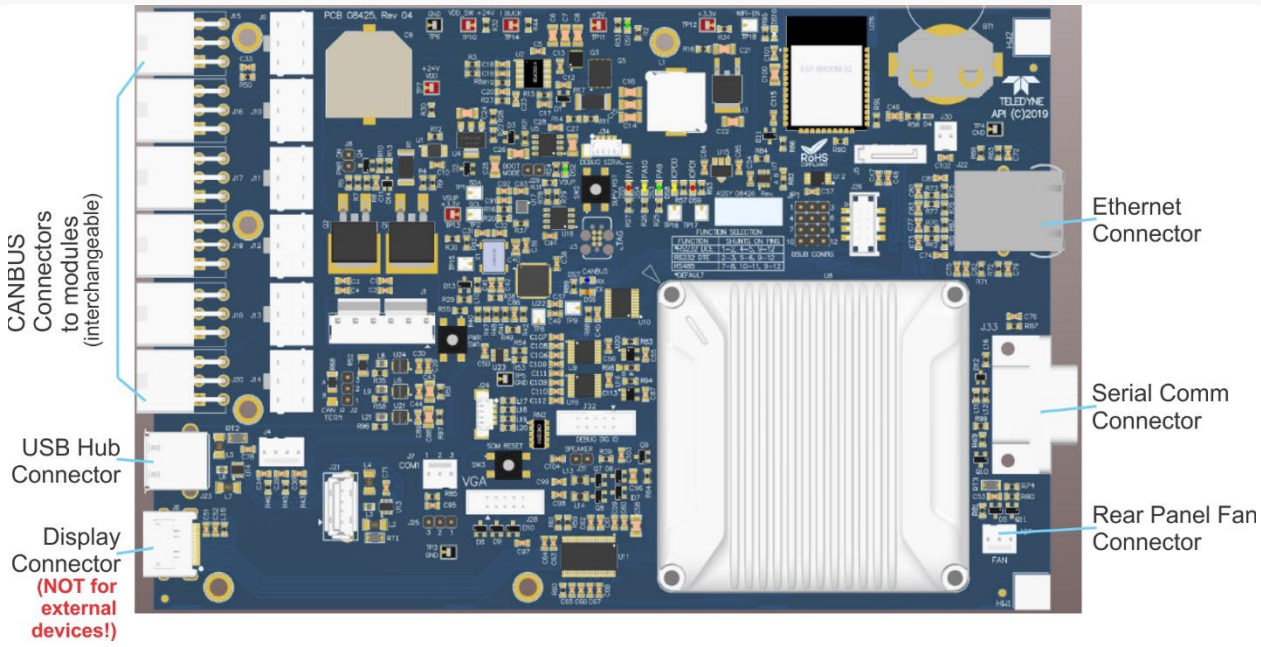


Figure 5-25. Mainboard Connectors

5.7.9.3. SENSOR MODULE REPAIR AND CLEANING

This section presents steps for properly removing and reinstalling the sensor module prior to performing cleaning and repair procedures.

CAUTION – QUALIFIED PERSONNEL

To replace either the PMT or HVPS, power off the analyzer, open its top cover to remove the entire assembly and carry out the procedures at an anti-ESD workstation.

Follow the guidelines for preventing electrostatic damage to electronic components, defined in the manual, Fundamentals of ESD, PN 04786, which can be downloaded from our website at http://www.teledyne-api.com under Help Center > Product Manuals in the Special Manuals section..

CAUTION – GENERAL SAFETY HAZARD

Do not look at the UV lamp while the unit is operating. UV light can cause eye damage. Always use safety glasses made from UV blocking material when working with the UV Lamp Assembly. (Generic plastic glasses are not adequate).

Important

IMPACT ON READINGS OR DATA

- **The sample chamber should only be opened or cleaned on instructions from the Teledyne API Technical Support Department.**
- **Use lint-free gloves to avoid leaving fingerprints 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.**
- **After any repair or service has been performed on the sensor module, the analyzer should be allowed to warm up for 60 minutes.**
- **Always perform a leak check and calibrate the analyzer before placing it back into service.**

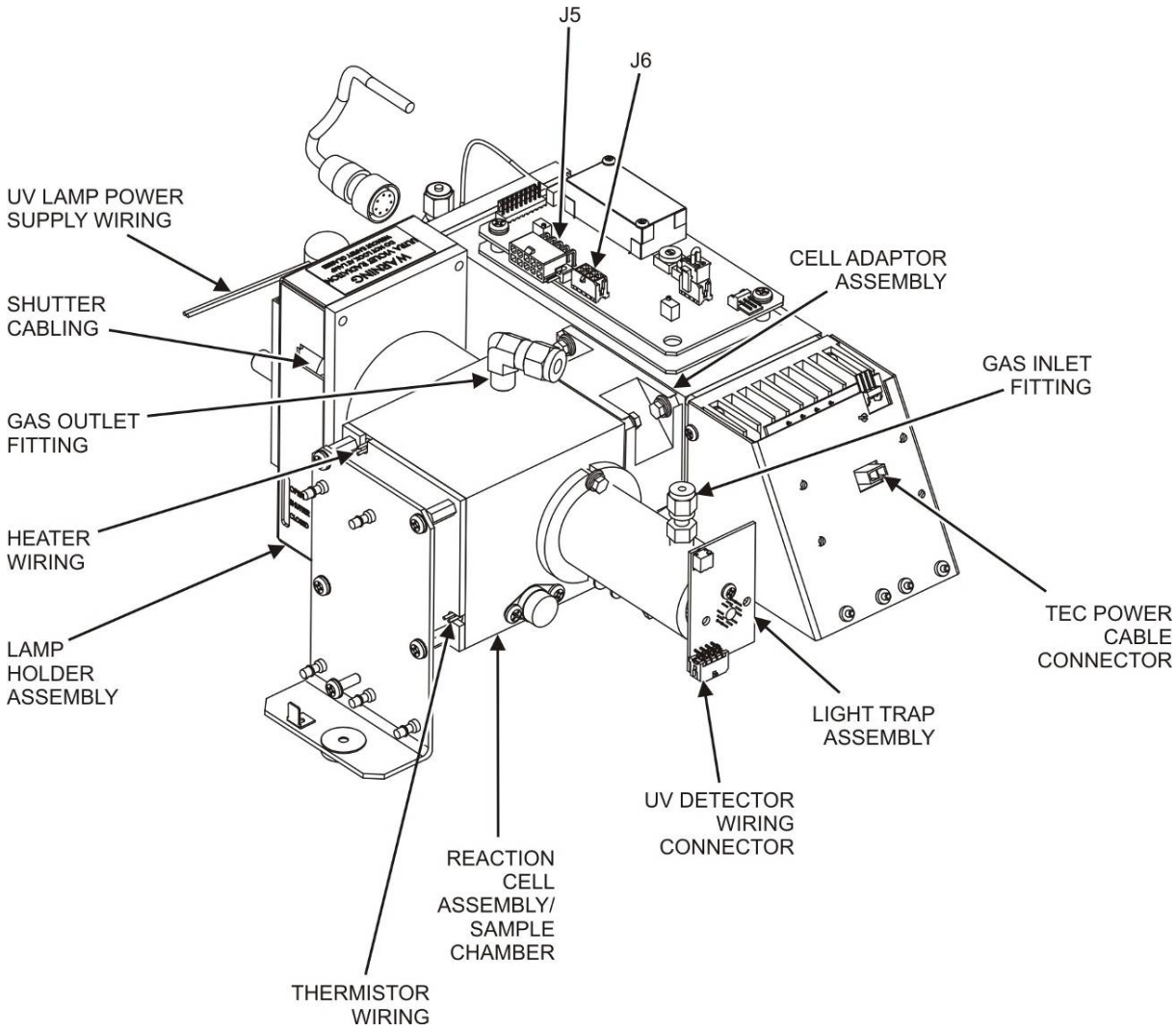


Figure 5-26. Sensor Module Wiring and Pneumatic Fittings

Note **These procedures assume the use of lint-free gloves as cautioned earlier.**

To remove the Sensor Module:

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 (refer to Figure 5-26
   - 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
   - Reaction cell thermistor wiring (yellow)
   - Reaction cell heater wiring (red)
   - UV detector wiring
   - PMT wiring
5. Remove the three sensor module mounting screws to lift the module straight up.

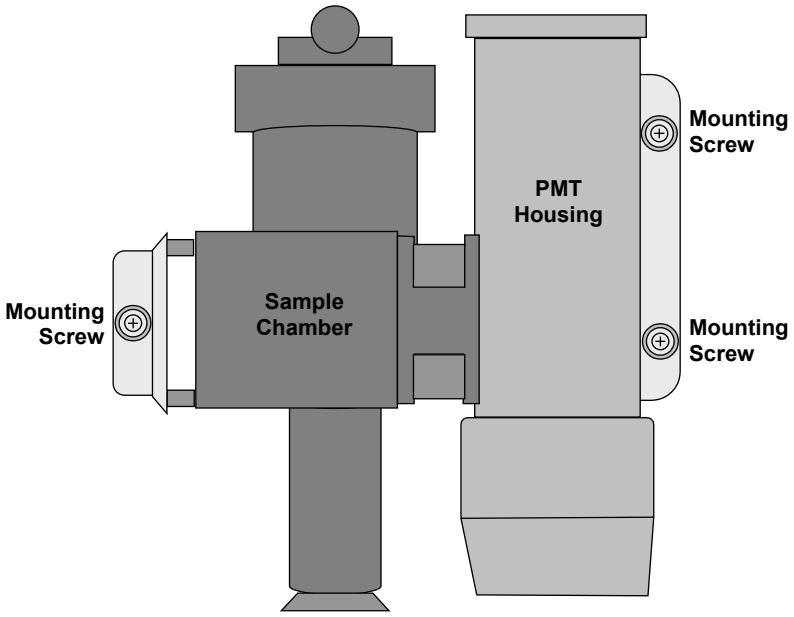


Figure 5-27. Sensor Module Mounting Screws

Follow the above steps in reverse order to reinstall the sensor module.

CLEANING THE PMT LENS AND PMT FILTER

Note **These procedures assume the use of lint-free gloves as cautioned earlier.**

To clean the PMT Lens and filter:

1. Remove the sensor module as described above.

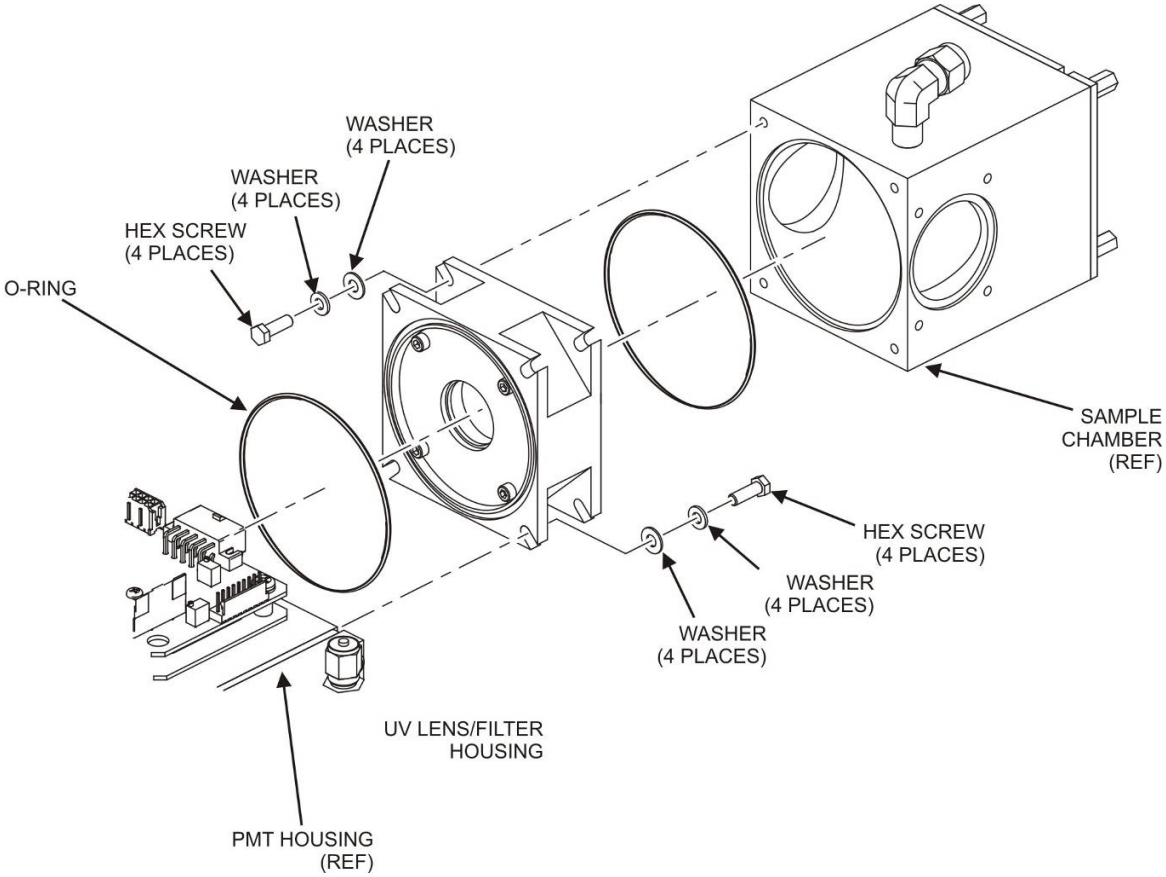


Figure 5-28. Hex Screw Between Lens Housing and Sample Chamber

2. Remove the sample chamber from the PMT lens and filter housing by unscrewing the 4 hex screws that fasten the chamber to the housing.
3. Remove the four lens cover screws.

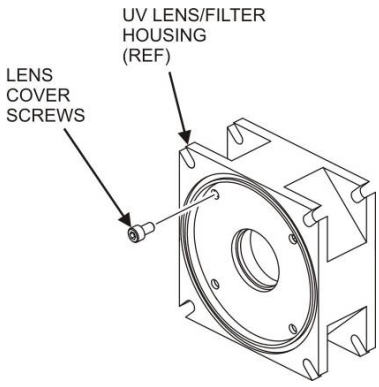


Figure 5-29. UV Lens Housing / Filter Housing

4. Remove the lens/filter cover.
5. Carefully remove the PMT lens and set it aside on soft, lint-free cloth.
6. Remove the 3-piece, lens/filter spacer.
7. Carefully remove the PMT filter and set it aside on soft, lint-free cloth.

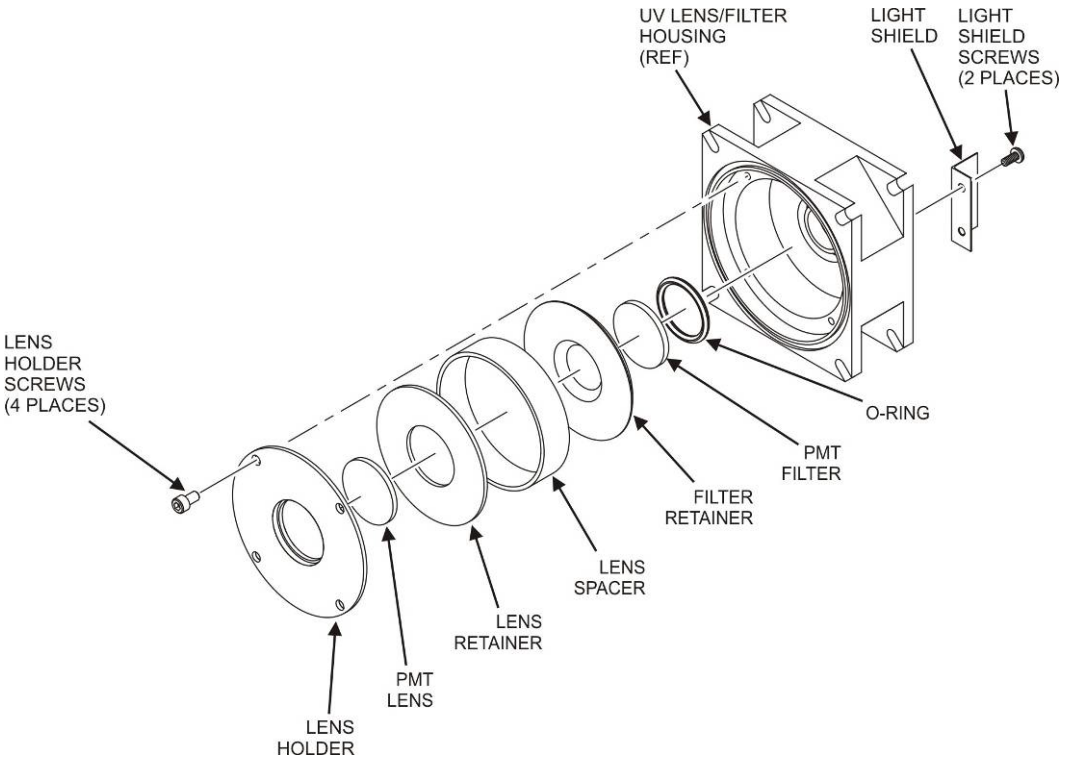


Figure 5-30. PMT UV Filter Housing Disassembled

8. Using a lint-free cloth dampened with distilled water, clean the lens, the filter and all of the housing assembly mechanical parts.
9. Dry everything with a 2nd lint-free cloth.
10. Referring to the illustrations presented, reassemble the lens/filter housing, ensuring to apply Loctite to the four lens holder screws and the two light shield screws.

Important

IMPACT ON READINGS OR DATA

Use gloves and a clean plastic covered surface during assembly. Cleanliness of the inside of the light shield, the UV lens filter housing and the PMT lens is especially important.

REPLACING THE UV FILTER/LENS

Note **These procedures assume the use of lint-free gloves as cautioned earlier.**

To replace the UV filter lens:

1. Turn off the instrument's power and remove the power cord from the instrument.
2. Remove 4 screws from the lamp holder cover (refer to the preceding figures that apply) and remove the cover.
3. Remove 4 screws from the UV filter retainer.

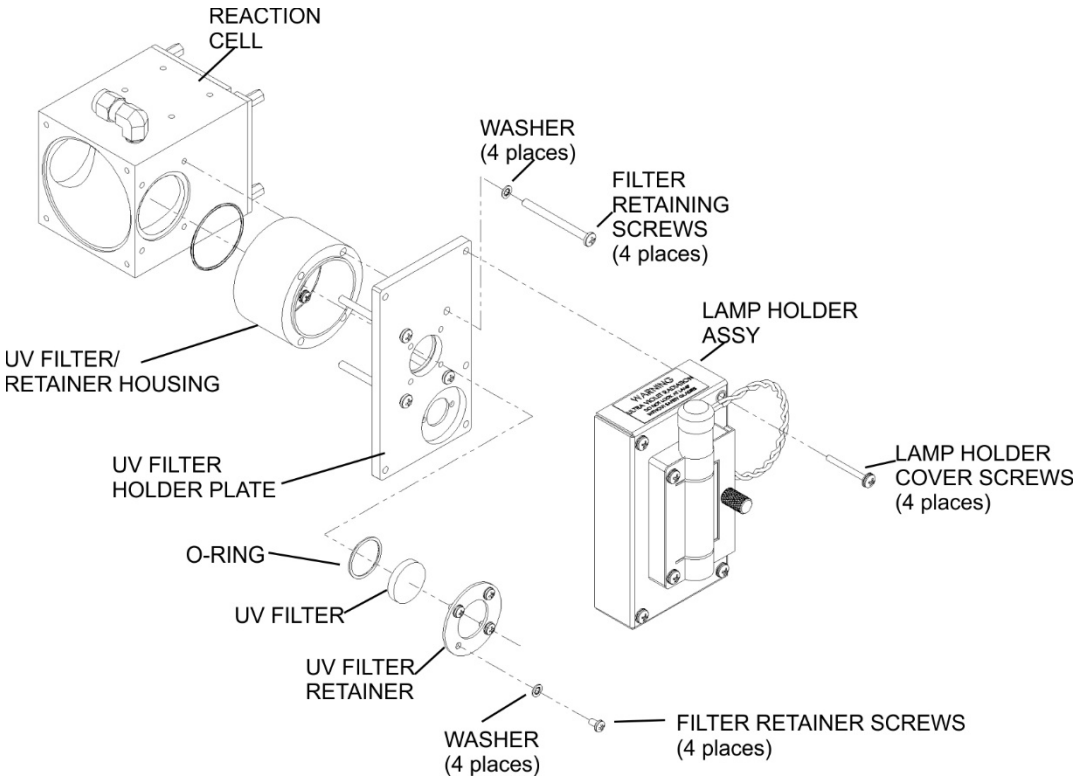


Figure 5-31. Disassembling the UV Filter Assembly

4. Carefully remove the UV filter.
5. Ensuring to never touch its surface, install the new UV filter.
6. UV filter's wider ring side should be facing out.
7. Install UV filter retainer and tighten screws.
8. Install the lamp holder assembly and mini-fit connector, and tighten the 4 screws.
9. Reinstall the sensor module.

ADJUSTING THE UV LAMP (*PEAKING THE LAMP*)

Lamp aging and lamp positioning can affect the UV Lamp output and therefore the accuracy of the SO_2 concentration measurement, described as follows:

- **Lamp Aging**: Over a period of months, the UV energy will show a downward trend and can be up to 50% in the first 90 days, and then a slower rate, until the end of useful life of the lamp. Periodically running the UV lamp calibration routine (Utilities>Diagnostics menu) will compensate for this until the lamp output becomes too low to function at all.

  Note that as the lamp degrades over time, the software for the CPU compensates for the loss of UV output.

- **Lamp Positioning**: The UV output level of the lamp is not even across the entire length of the lamp. Some portions of the lamp shine slightly more brightly than others. At the factory the position of the UV lamp is adjusted to optimize the amount of UV light shining through the UV filter/lens and into the reaction cell. Changes to the physical alignment of the lamp can affect the analyzers ability to accurately measure SO_2.

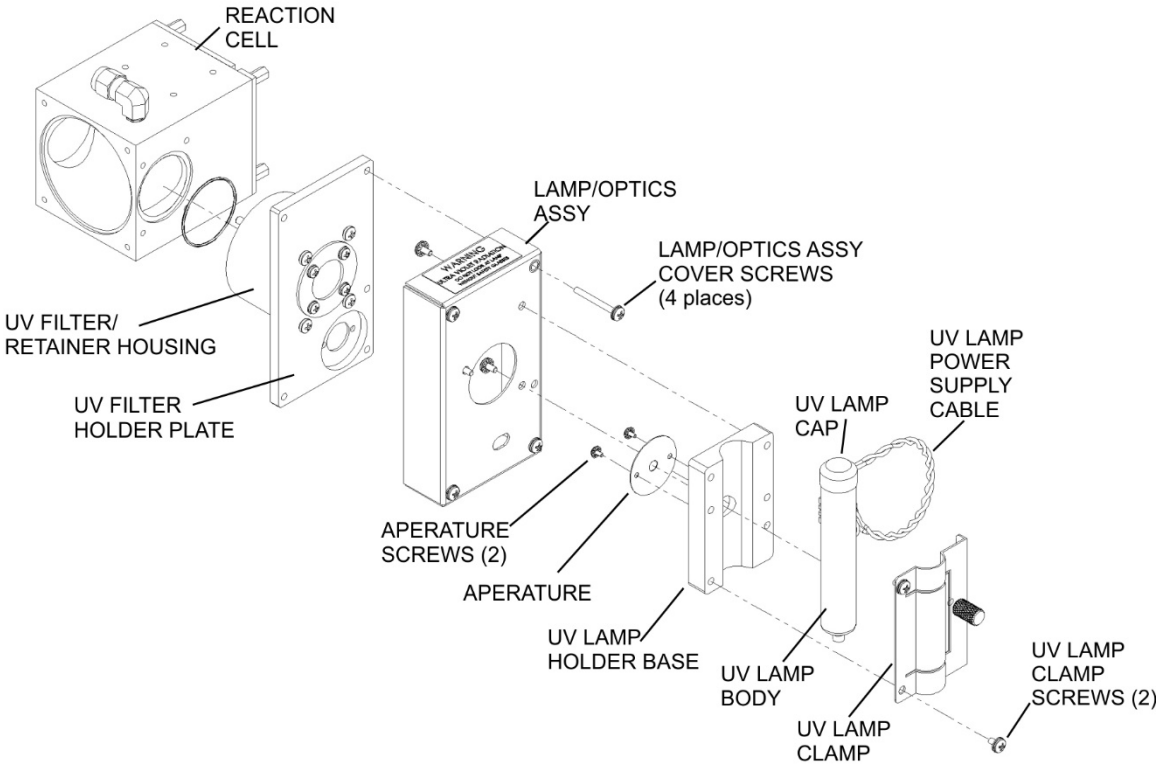


Figure 5-32. Lamp/Optics Assembly

CAUTION – GENERAL SAFETY HAZARD

Do not look at the UV lamp while the unit is operating. UV light can cause eye damage. Always use safety glasses made from UV blocking material when working with the UV Lamp Assembly. (Generic plastic glasses are not adequate).

1. Navigate to the Utilities>Diagnostics>Lamp Cal menu to observe the Lamp Cal Value.
2. Slightly loosen the large brass thumbscrew located on the lamp/optics housing (refer to Figure 5-33) so that the lamp can be moved.

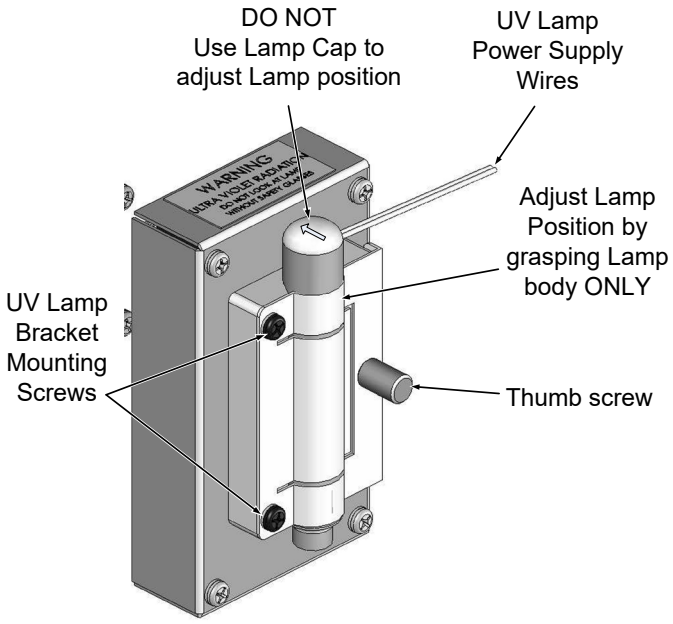


Figure 5-33. UV Lamp Adjustment

ATTENTION

COULD DAMAGE INSTRUMENT AND VOID WARRANTY

DO NOT grasp the UV lamp by its cap when changing its position - always grasp the main body of the lamp (refer to Figure 5-32). Inattention to this detail could twist and potentially disconnect the lamp's power supply wires.

1. While watching the Lamp Cal Value reading, slowly rotate the lamp or move it back and forth vertically until the reading is at its maximum, which can be as high as 1000+ mV and should not fall lower than 200 mV (replace lamp if highest possible reading falls below 200 mV).
2. Finger-tighten the thumbscrew.
3. In the Utilities>Diagnostics>Lamp Cal menu press the Calibrate button to set this new value as the benchmark for use in calculating the concentration.

CAUTION – GENERAL SAFETY HAZARD

DO NOT over tighten the thumbscrew, as over-tightening can cause breakage to the lamp and consequently release mercury into the area.

REPLACING THE UV LAMP

To replace the UV Lamp:

1. Turn off the analyzer.
2. Disconnect the UV lamp from its power supply.
3. You can find the power supply connector by following the two, white UV Lamp power supply wires from the lamp to the power supply.
4. Loosen, but do not remove the two UV lamp bracket screws and the large brass thumbscrew located (refer to Figure 5-32 and Figure 5-33) on the lamp/optics housing so that the lamp can be moved.

ATTENTION

COULD DAMAGE INSTRUMENT AND VOID WARRANTY

DO NOT grasp the UV lamp by its cap when changing its position - always grasp the main body of the lamp (refer to Figure 5-32) Inattention to this detail could twist and potentially disconnect the lamp's power supply wires.

5. Remove the UV Lamp by pulling it straight up.
6. Insert the new UV lamp into the bracket.
7. Tighten the two UV lamp bracket screws, but leave the brass thumb screw un-tightened.
8. Connect the new UV lamp to the power supply.
9. Turn the instrument on and perform the UV adjustment procedure as defined in the preceding section.
10. Finger tighten the thumbscrew.

CAUTION – GENERAL SAFETY HAZARD

DO NOT over tighten the thumbscrew, as over-tightening can cause breakage to the lamp and consequently release mercury into the area.

11. Calibrate the lamp (Utilities>Diagnostics menu).

REPLACING THE PMT, HVPS OR TEC

The photo multiplier tube (PMT) should last for the lifetime of the analyzer, however, the high voltage power supply (HVPS) or the thermo-electric cooler (TEC) components may fail. Replacing any of these components requires opening the sensor module. This is a delicate assembly and it is recommend that you ensure the PMT, HVPS or TEC modules are, indeed, faulty before unnecessarily opening of the module.

1. Turn OFF the analyzer and disconnect the power cord.
2. Remove the cover.
3. Disconnect all pneumatic and electrical connections from the sensor assembly.
4. Remove the sensor assembly.
5. If the TEC is to be replaced, remove the reaction cell assembly at this point by unscrewing two holding screws.
   - This is necessary only if the repair being performed involves removing the PMT cold block.

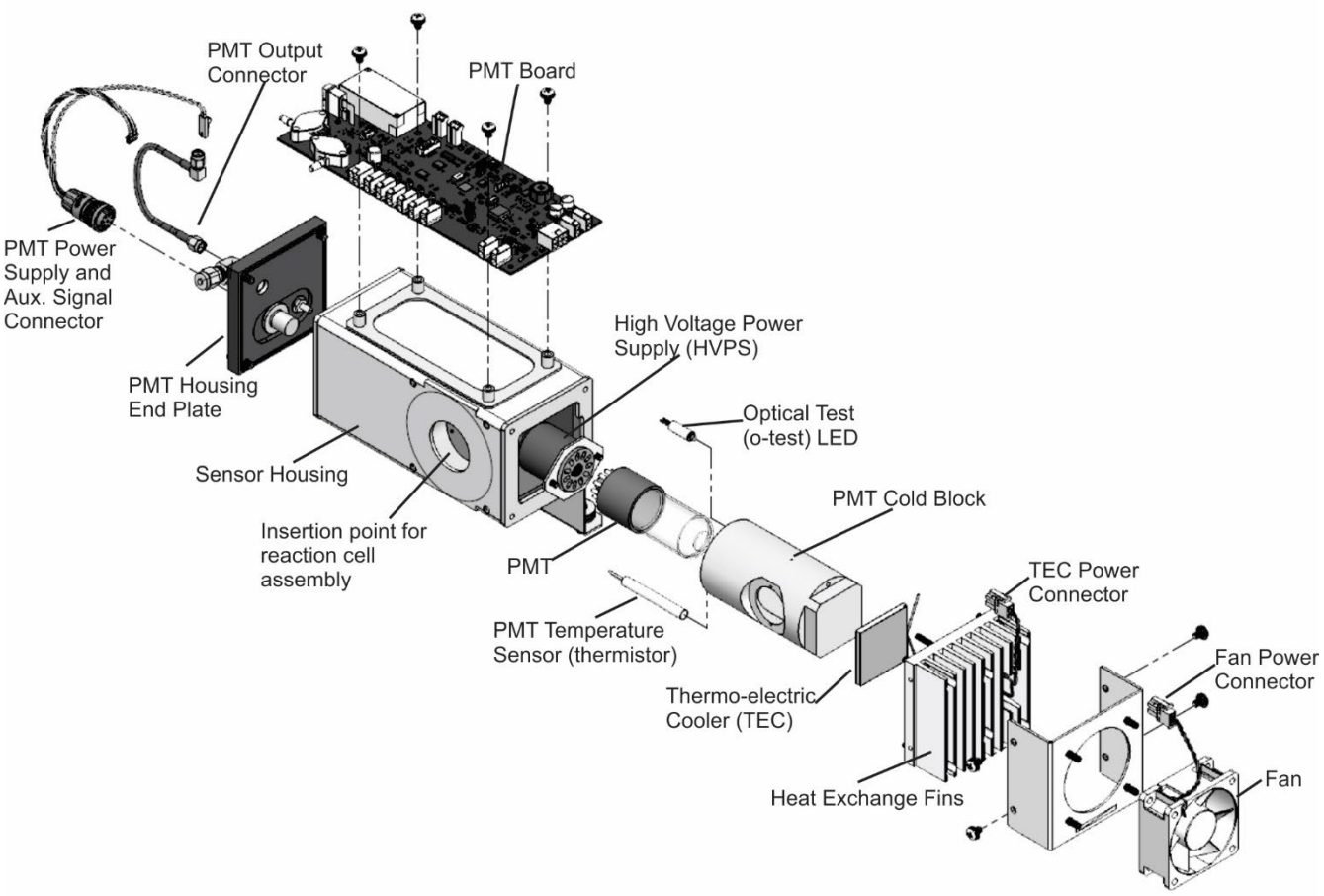


Figure 5-34. PMT Assembly

6. Remove the two connectors on the PMT housing end plate facing towards the front panel.
7. Remove the end plate itself (4 screws with plastic washers).

Note **Any time the black PMT housing end plate for the Sensor Assembly is removed, replace the five desiccant bags inside the housing.**

8. Remove the desiccant bags from the PMT housing.
9. Unscrew the PMT assembly, which is held to the cold block by two plastic screws.
10. Discard the plastic screws and replace with new screws at the end of this procedure (the threads get stripped easily and it is recommended to use new screws).
11. Along with the plate, slide out the optic test (O-Test) LED and the thermistor that measures the PMT temperature.
    - Thermistor will be coated with a white, thermal conducting paste.
    - Do not contaminate the inside of the housing with this grease, as it may contaminate the PMT glass tube on re-assembly.
12. Carefully take out the assembly consisting of the HVPS, the insulation gasket and the PMT.
13. Change the PMT or the HVPS or both, clean the PMT glass tube with a clean, anti-static wipe and do not touch it after cleaning.
14. If the cold block or TEC is to be changed:
    - Disconnect the driver board from the TEC and set the sub-assembly aside.
15. Remove cooling fan.
16. Remove end plate with the cooling fins (4 screws) and slide out the PMT cold block assembly, which contains the TEC.
17. Unscrew the TEC from the cooling fins and the cold block and replace it with a new unit.
18. Reassemble this TEC subassembly in reverse order.
    - Ensure to use thermal grease between TEC and cooling fins as well as between TEC and cold block and that the side opening in the cold block will face the reaction cell when assembled.
    - Evenly tighten the long mounting screws for good thermal conductivity.

CAUTION – QUALIFIED PERSONNEL

The thermo-electric cooler needs to be mounted flat to the heat sink.

If there is any significant gap, the TEC might burn out. Ensure to apply heat sink paste before mounting it and tighten the screws evenly and cross-wise.

19. Reinsert the TEC subassembly in reverse order.
    - Ensure that the O-ring is seated properly and the assembly is tightened evenly.

20. Insert the O-Test LED and thermistor into the cold block, insert new desiccant bags and carefully replace the end plate by making sure that the O-ring is properly in place.
    - Improperly placed O-rings will cause leaks, which – in turn – cause moisture to condense on the inside of the cooler and likely cause a short in the HVPS.
21. Reinsert the PMT/HVPS subassembly in reverse order.
    - Don't forget the insulation gasket between HVPS and PMT.
    - Use new plastic screws to mount the PMT assembly on the PMT cold block.
22. Install new silica gel packets (desiccant bags).
23. Reconnect the cables and the reaction cell (evenly tighten these screws).
24. Replace the sensor assembly into the chassis and fasten with four screws and washers.
25. Reconnect all electrical and pneumatic connections.
26. Leak check the system (see Section 5.6.8).
27. Turn ON the analyzer.
28. Verify the basic operation of the analyzer using the OTEST feature (Section 5.7.8.2) or zero and span gases, then carry out a hardware calibration of the analyzer followed by a zero/span point calibration Section 4.2.1).

5.7.9.4. PMT Sensor Hardware Calibration ("Factory Cal")

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

To calibrate the PMT PCA:

1. Deliver a known concentration of Span Gas, preferably at 90% of the desired range (e.g., 450 ppb in a 500 ppb range.
2. Also in the Setup>Vars menu, if needed, use the HVPS SetPoint Var to edit the setpoint value if grossly out of range.
3. Return to Homescreen and navigate to Utilities>Diagnostics>HVPS Adjust (Figure 5-35).
4. In the lower left field of the HVPS screen click the slider button to change Maintenance Mode to ON. (The Up and Down adjustment buttons become active and an Alert indicates that the instrument is in this mode).
5. Use the Up/Down buttons to make adjustments, allowing time for values to respond and for the concentration to stabilize. (Typically, the value for the PMT Reading in the N100 model should be about the same as the target concentration; for example, 100 ppb sampled gas should give 100 mV PMT response).
6. Before exiting, click the slider button to turn OFF Maintenance Mode.
7. Allow time to stabilize.
8. Perform a calibration if necessary.

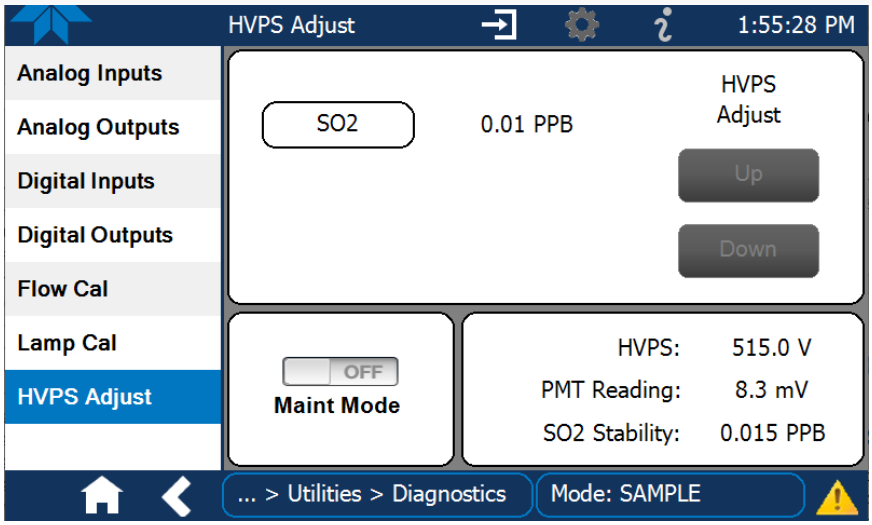


Figure 5-35. HVPS Adjust Menu

5.8. FREQUENTLY ASKED QUESTIONS

The following list was compiled from the Teledyne API's Technical Support Department's ten most commonly asked questions relating to the analyzer.

QUESTION	ANSWER
Why does the ENTR button sometimes disappear on the front panel display?	Sometimes the ENTR button will disappear if you select a setting that is invalid or out of the allowable range for that parameter, such as trying to set the 24-hour clock to 25:00:00 or a range to less than 1 or more than 20000 ppb. Once you adjust the setting to an allowable value, the ENTR button will re-appear.
Why is the ZERO or SPAN button deactivated during calibration?	This happens when the measured gas concentration differs significantly from the span or zero gas concentration value entered by the user. This prevents accidental recalibration of the analyzer to an out-of-range response curve. EXAMPLE: The span set point is 400 ppb but gas concentration being measured is only 50 ppb.
How do I enter or change the value of my Span Gas?	See Section 4.2.1.2.
Can I automate calibration checks of my analyzer?	Any analyzer with zero/span valve or IZS option can be set up to run automatic calibration checks using the instrument's AutoCal feature (Section 4.3).
Can I use the IZS option to calibrate the analyzer?	Yes. However, the accuracy of the IZS option's permeation tube is only ±5%. To achieve highest accuracy, it is recommended to use cylinders of calibrated span gases in combination with a zero air source.
How do I measure the sample flow?	For accurate measurement, attach a calibrated flow meter to the sample inlet port, and get a reading while the instrument is operating. The sample flow should be as specified in Table 1-1. (To calibrate, use the Utilities>Diagnostics menu; refer to Section 5.6.8.3).

QUESTION	ANSWER
How often do I need to change the particulate filter?	Refer to the Maintenance Schedule in Table 5-1. Keep in mind that highly polluted sample air may require more frequent changes.
How long does the sample pump last?	The sample pump should last one to two years and the pump head should be replaced when necessary. If the reaction cell pressure value goes above 10 in-Hg-A, on average, the pump head needs to be rebuilt.
Why does my RS-232 serial connection not work?	There are several possible reasons: • The wrong cable: please use the provided or a generic “straight-through” cable (do not use a “null-modem” type cable). • The baud rate of the analyzer’s COM port does not match that of the serial port of your computer/data logger (Table 2-14).
How do I make the instrument’s display and my data logger agree?	This most commonly occurs when an independent metering device is used besides the data logger/recorder to determine gas concentration levels while calibrating the analyzer. These disagreements result from the analyzer, the metering device and the data logger having slightly different ground levels. Use the data logger itself as the metering device during calibration procedures.
Do the critical flow orifices of my analyzer require regular replacement?	No. The o-rings and the sintered filter associated with them require replacement once a year, but the critical flow orifices do not. See Section 5.6.6 for instructions.
How do I set up and use the Digital Inputs) on the rear panel?	See Section 2.3.1.3.

5.9. TECHNICAL ASSISTANCE

If this manual and its troubleshooting & service section do not solve your problems, technical assistance may be obtained from:

Teledyne API Technical Support
9970 Carroll Canyon Road
San Diego, California 92131-1106 USA

Toll-free Phone: 800-324-5190
Phone: +1 858-657-9800
Fax: +1 858-657-9816
Email: api-techsupport@teledyne.com
Website: http://www.teledyne-api.com/

6. PRINCIPLES OF OPERATION

The N101 UV Fluorescence H_2S Analyzer is a microprocessor controlled analyzer that determines the concentration of hydrogen sulfide (H_2S), in a sample gas drawn through the instrument. It requires that sample and calibration gases be supplied at ambient atmospheric pressure in order to establish a constant gas flow through the sample chamber where the H_2S in the sample gas is converted into SO_2 which is then exposed to ultraviolet light causing the SO_2 molecules to change to an excited state (SO_2*). As these SO_2* molecules decay back into SO_2, they fluoresce. The instrument measures the amount of fluorescence to determine the amount of SO_2 is present in the sample chamber and by inference therefore the amount of H_2S present in the sample gas.

Calibration is performed in the software and usually does not require physical adjustments to the instrument. During calibration, the microprocessor measures the sensor output signal when gases with known amounts of H_2S at various concentrations are supplied and stores these measurements in memory. The microprocessor uses these calibration values along with other performance parameters such as the PMT dark offset, UV lamp ratio and the amount of stray light present and measurements of the temperature and pressure of the sample gas to compute the final H_2S concentration.

6.1. SULFUR DIOXIDE (SO_2) SENSOR

The N101 H_2S analyzer is basically an SO_2 analyzer with an H_2S → SO_2 conversion stage inserted into the gas stream before the sample gas enters the sample chamber.

The H_2S to SO_2 converter receives sample gas from which the SO_2 has been removed by a scrubber. Once the naturally occurring SO_2 is removed from the sample gas, the special converter changes the H_2S in the sample stream to SO_2 using a high-temperature catalytic oxidation.

The chemical process is:

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

Equation 6-1

The converter is a heated stainless steel core containing a catalyst across which the sample gas passes just before induction into the reaction cell. The temperature of the converter is maintained by a software-controlled heater. The converter is enclosed in high-temperature insulation and encased in a stainless steel housing, and is most efficient when it operates at 315°C, converting 95% of the H_2S into SO_2.

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

6.1.1. SO_2 ULTRAVIOLET FLUORESCENCE MEASUREMENT PRINCIPLE

The physical principle upon which the measurement method is based is the fluorescence that occurs when sulfur dioxide (SO_2) is changed to an excited state (SO_2*) by ultraviolet light with wavelengths in the range of 190 nm-230 nm. This reaction is a two-step process.

The first stage (Equation 6-2) occurs when SO_2 molecules are struck by photons (hv) of the appropriate ultraviolet wavelength. In the case of the N101, a band pass filter between the source of the UV light and the affected gas limits the wavelength of the light to approximately 214 nm. The SO_2 absorbs some of energy from the UV light, causing one of the electrons of the SO_2 molecule to move to a higher energy orbital state (SO_2*).

$$SO_2 + hv_{214nm} \xrightarrow{Ia} SO_2 *$$

(Equation 6-2)

The amount of SO_2 converted to SO_2* in the sample chamber is dependent on the average intensity of the UV light (***Ia***) and not its peak intensity because the intensity of UV light is not constant in every part of the sample chamber. Some of the photons are absorbed by the SO_2 as the light travels through the sample gas.

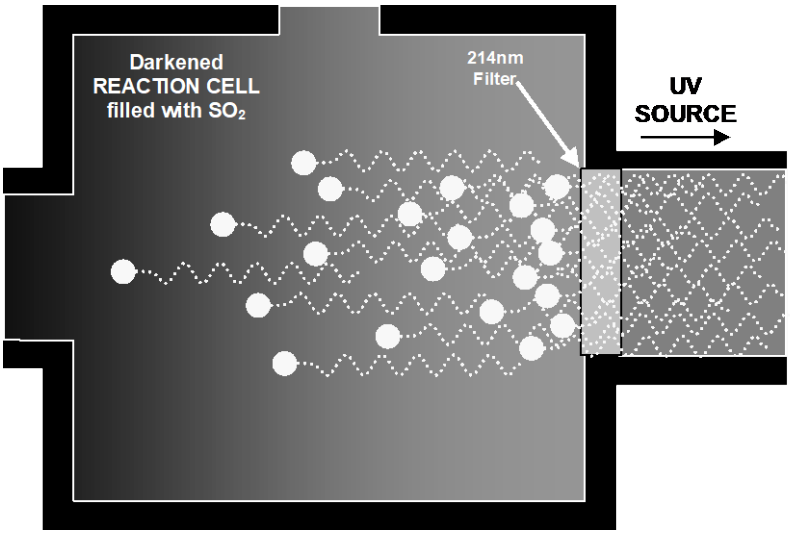


Figure 6-1. UV Absorption

The equation for defining the average intensity of the UV light (***Ia***) is:

$$Ia = I_0\left[1 - exp\left(-ax\left(SO_2\right)\right)\right]$$

(Equation 6-3)

Where:

I_0 = Intensity of the excitation UV light

a = The absorption coefficient of SO_2 (a constant)

SO_2 = Concentration of SO_2 in the sample chamber

x = The distance between the UV source and the SO_2 molecule(s) being affected (path length)

The second stage of this reaction occurs after the SO_2 reaches its excited state (SO_2*). Because the system will seek the lowest available stable energy state, the SO_2* molecule quickly returns to its ground state (Equation 6-4) by giving off the excess energy in the form of a photon ($h\nu$). The wavelength of this fluoresced light is also in the ultraviolet band but at a longer (lower energy) wavelength centered at 330nm.

$$SO_2 * \longrightarrow SO_2 + h\nu_{330nm}$$

(Equation 6-4)

The amount of detectable UV given off by the decay of the SO_2* is affected by the rate at which this reaction occurs (k).

$$F = k(SO_2 *)$$

(Equation 6-5)

Where:

F = the amount of fluorescent light given off.

k = the rate at which the SO_2* (excited state) decays into SO_2.

SO_2* = Amount of excited-state SO_2 in the sample chamber.

Therefore:

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

(Equation 6-6)

Finally, the function (***k***) is affected by the temperature of the gas. The warmer the gas, the faster the individual molecules decay back into their ground state and the more photons of UV light are given off per unit of time.

Given that the absorption rate (***a***) of SO_2 is constant, the amount of fluorescence (***F***) is a result of:

- The amount of SO_2* created which is affected by the variable factors from (Equation 6-3) above: concentration of SO_2; intensity of UV light (I_0); path length of the UV light(***x***) and;
- The amount of fluorescent light created which is affected by the variable factors from (Equation 6-6): the amount of SO_2* present and the rate of decay (***k***) which changes based on the temperature of the gas.

The amount of fluorescent light emitted (***F***) is directly related to the concentration of the SO_2 in the Sample Chamber when:

- the intensity of the light (I_0) is known
- the path length of excited light is short (***x***)
- the temperature of the gas is known and compensated for so that the rate of SO_2*decay is constant (***k***)
- no interfering conditions are present (such as interfering gases or stray light);

The analyzer is specifically designed to create these circumstances:

- The light path is very short (***x***).
- A reference detector measures the intensity of the available excitation UV light and is used to remove effects of lamp drift (I_0).
- The temperature of the sample gas is measured and controlled via heaters attached to the sample chamber so that the rate of decay (***k***) is constant.
- A special hydrocarbon scrubber removes the most common interfering gases from the sample gas.
- And finally, the design of the sample chamber reduces the effects of stray light via its optical geometry and spectral filtering.

The net result is that any variation in UV fluorescence can be directly attributed to changes in the concentration of SO_2 in the sample gas.

6.1.2. UV LIGHT PATH

The optical design of the sample chamber optimizes the fluorescent reaction between SO_2 and UV Light (refer to Figure 6-2) and assure that only UV light resulting from the decay of SO_2* into SO_2 is sensed by the instruments fluorescence detector.

UV radiation is generated by a lamp specifically designed to produce a maximum amount of light of the wavelength needed to excite SO_2 into SO_2* (330 nm) and a special reference detector circuit constantly measures lamp intensity (refer to (Equation 6-3). A Photo Multiplier Tube (PMT) detects the UV given off by the SO_2* decay (214 nm) and outputs an analog signal. Several focusing lenses and optical filters ensure that both detectors are exposed to an optimum amount of only the right wavelengths of UV. To further assure that the PMT only detects light given off by decaying SO_2* the pathway of the excitation UV and field of view of the PMT are perpendicular to each other and the inside surfaces of the sample chamber are coated with a layer of black Teflon® that absorbs stray light.

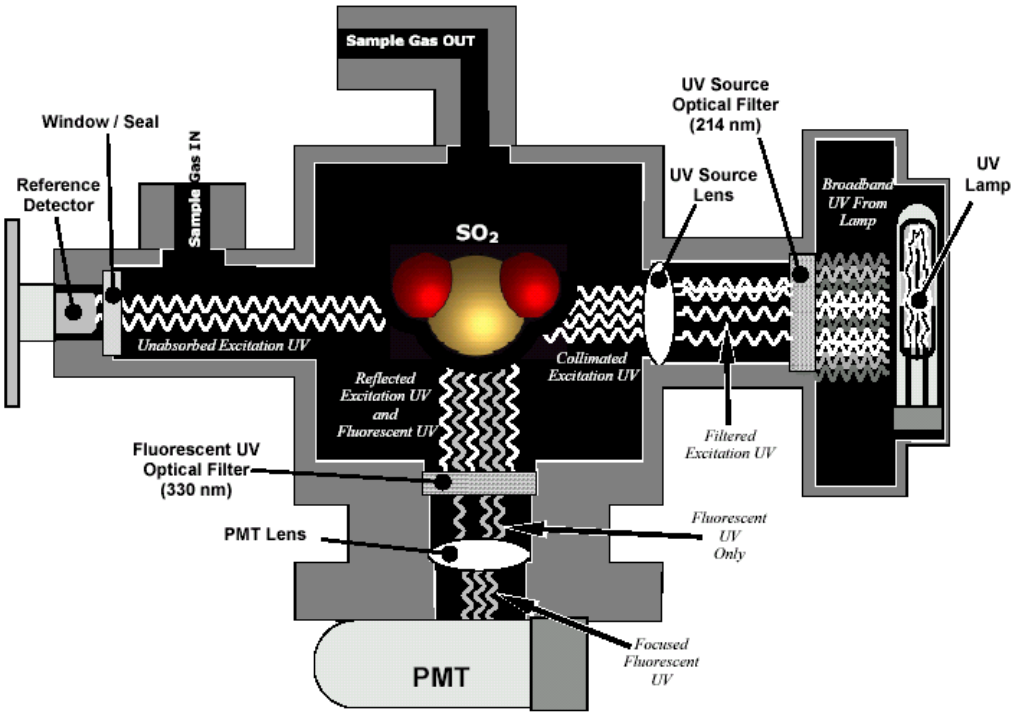


Figure 6-2. UV Light Path

6.1.3. UV SOURCE LAMP

The source of excitation UV light is a low pressure zinc-vapor lamp. An AC voltage heats up and vaporizes zinc contained in the lamp element creating a light-producing plasma arc. Zinc-vapor lamps are preferred over the more common mercury-vapor lamps for this application because they produce very strong emission levels at the wavelength required to convert SO_2 to SO_2*, 214.3 nm (refer to Figure 6-4).

The lamp is constructed with a vacuum jacket surrounding a double-bore lamp element (refer to Figure 6-3). The vacuum jacket isolates the plasma arc from most external temperature fluctuations. The jacket also contains thermal energy created by the lamp's operation therefore helping the lamp to heat up and maintain proper vaporization temperature. Light is emitted through a 20 mm x 5 mm portal.

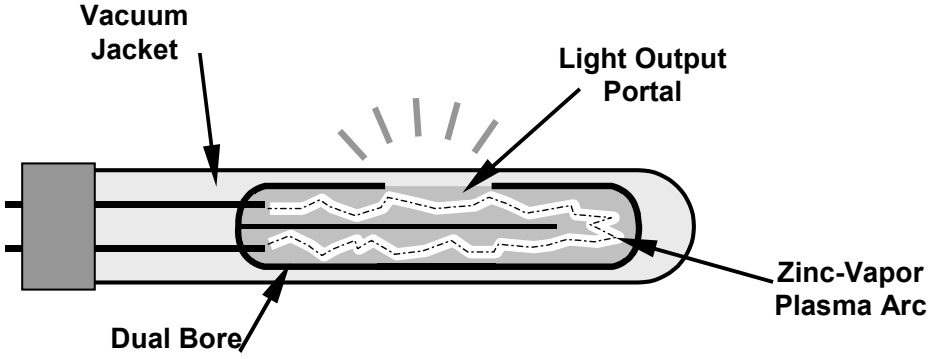


Figure 6-3. Source UV Lamp Construction

6.1.4. REFERENCE DETECTOR

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

6.1.5. PHOTO-MULTIPLIER TUBE (PMT)

The amount of fluoresced UV produced in the sample chamber is much less than the intensity of excitation UV source lamp (refer to Figure 6-4). Therefore, a much more sensitive device is needed to detect this light with enough resolution to be meaningful. The analyzer uses a Photo Multiplier Tube or PMT for this purpose.

A PMT is typically a vacuum tube containing a variety of specially designed electrodes. Photons enter the PMT and strike a negatively charged photo cathode causing it to emit electrons. These electrons are accelerated by a high voltage applied across a series of special electrodes called dynodes that multiply the amount of electrons until a useable current signal is generated. This current increases or decreases with the amount of detected light.

6.1.6. UV LAMP & PMT OFFSET

Inherent in the operation of the PMT are minor electronic offsets, the degree of which can differ among PMTs, and with age. To account for these offsets the UV lamp shuts off, causing a brief dark period in the sample chamber during which the analyzer records the PMT output and factors them into the SO_2 concentration calculation. The PMT offset is stored as **Dark PMT** and can be viewed in the Dashboard**.**

6.1.7. OPTICAL FILTERS

The analyzer uses two stages of optical filters to enhance performance. The first stage conditions the UV light used to excite the SO_2 by removing frequencies of light that are not needed to produce SO_2*. The second stage protects the PMT detector from reacting to light not produced by the SO_2* returning to its ground state.

6.1.7.1. UV SOURCE OPTICAL FILTER

Zinc-vapor lamps output light at other wavelengths beside the 214nm required for the SO_2 → SO_2* transformation including a relatively bright light of the same wavelength at which SO_2* fluoresces as it returns to its SO_2 ground state (330 nm). In fact, the intensity of light emitted by the UV lamp at 330nm is so bright, nearly five orders of magnitude brighter than that resulting from the SO_2* decay, it would drown out the SO_2* fluorescence.

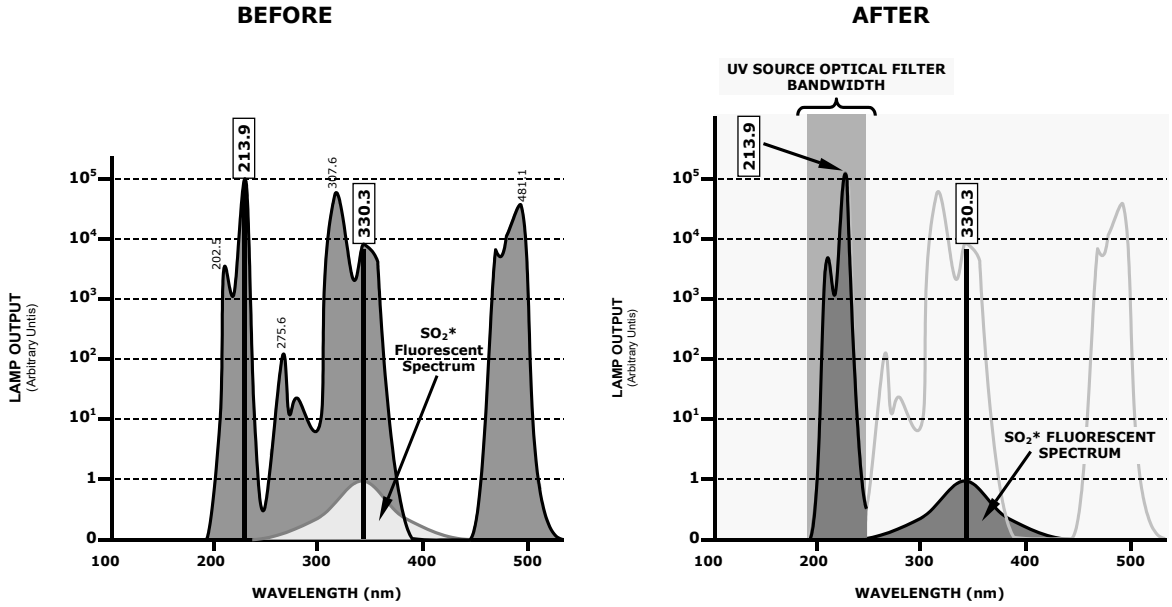


Figure 6-4. Excitation Lamp UV Spectrum Before/After Filtration

To solve this problem, the light emitted by the excitation UV lamp passes through a band pass filter that screens out photons with wavelengths outside the spectrum required to excite SO_2 into SO_2* (refer to Figure 6-4).

6.1.7.2. PMT Optical Filter

The PMT used in the analyzer reacts to a wide spectrum of light which includes much of the visible spectrum and most of the UV spectrum. Even though the 214 nm light used to excite the SO_2 is focused away from the PMT, some of it scatters in the direction of the PMT as it interacts with the sample gas. A second optical band pass filter placed between the sample chamber (refer to Figure 6-2) and the PMT strips away light outside of the fluorescence spectrum of decaying SO_2* (refer to Figure 6-5) including reflected UV form the source lamp and other stray light.

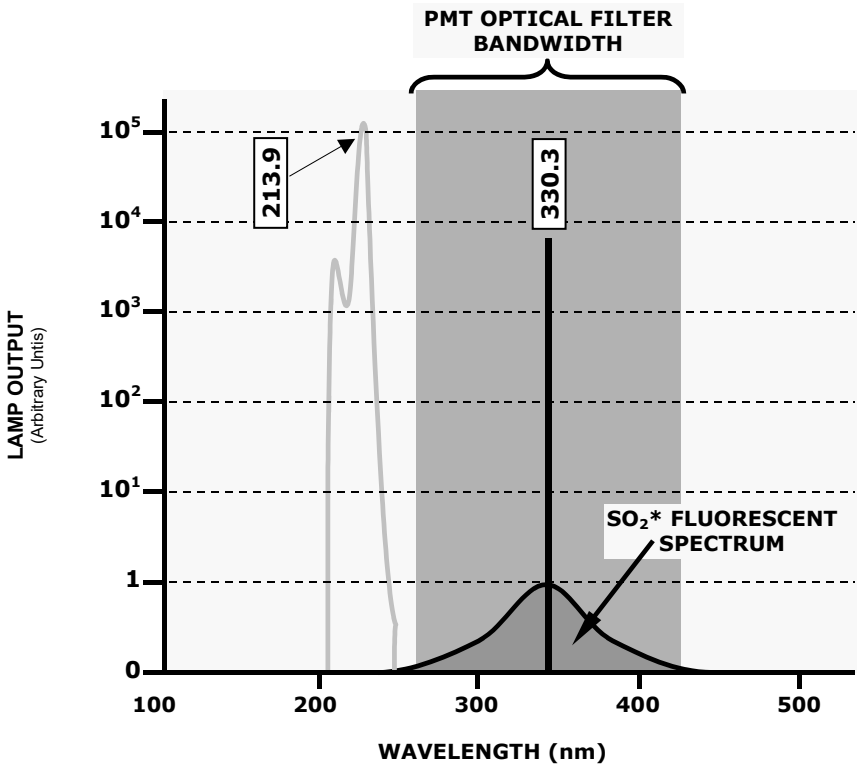


Figure 6-5. PMT Optical Filter Bandwidth

6.1.8. OPTICAL LENSES

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

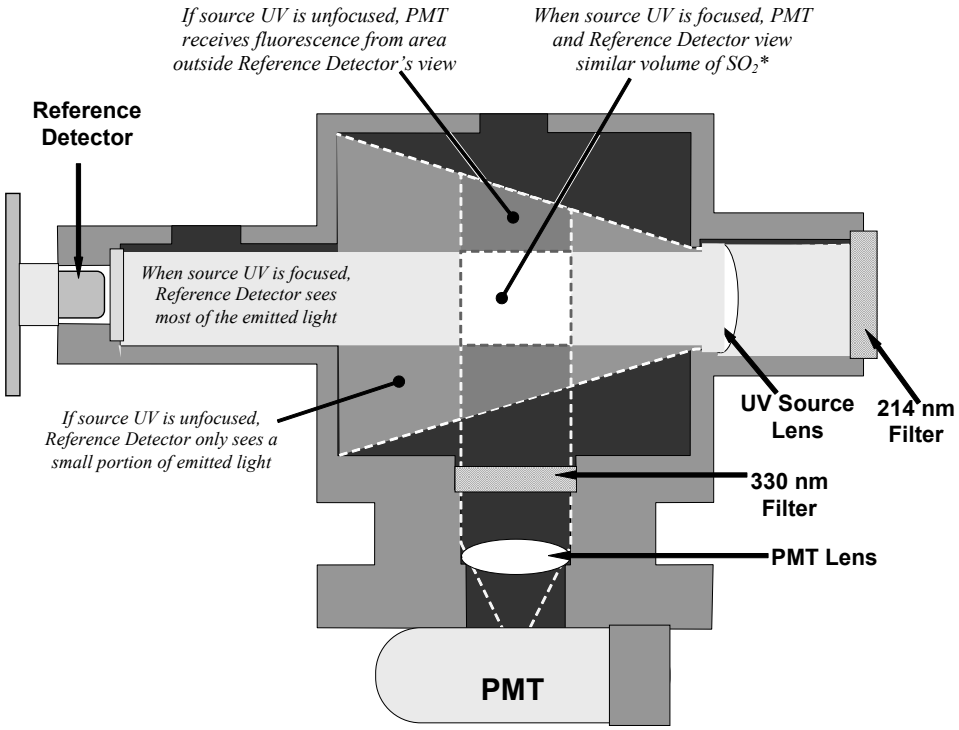


Figure 6-6. Effects of Focusing Source UV in Sample Chamber

A lens located between PMT and the sample chamber collects as much of the fluoresced UV created there as possible and focuses it on the most sensitive part of the PMT's photo cathode.

Another lens located between the excitation UV source lamp and the sample chamber collimates the light emitted by the lamp into a steady, circular beam and focuses that beam directly onto the reference detector. This allows the reference detector to accurately measure the effective intensity of the excitation UV by eliminating the effect of reflected light from the UV lamp reaching the PMT, and by ensuring that all of the light emitted by the source lamp, passes though the 214 nm filter and not absorbed by the SO_2 reaches the reference detector. Conversely, this also makes sure that the volume of sample gas affected by the excitation beam is similar to the volume of fluorescing SO_2* being measured by the PMT, eliminating a possible source of measurement offset.

6.1.9. MEASUREMENT INTERFERENCES

It should be noted that the fluorescence method for detecting H_2S is subject to interference from a number of sources. The N101 has been successfully tested for its ability to reject interference from most of these sources.

6.1.9.1. DIRECT INTERFERENCE

Since the N101 measures H_2S by converting it to SO_2, the most significant interfering gas for this measurement would be ambient SO_2 that is present in the sample gas. The N101 circumvents this by passing the sample gas through a chemical scrubber that removes all SO_2 from the sample gas before the $H_2S \rightarrow SO_2$ conversion takes place. This ensures that the only SO_2 present in the sample chamber is the result of the $H_2S \rightarrow SO_2$ conversion. Obviously to make sure that the analyzer operates correctly it is important to make sure that this scrubber is functioning properly.

The second most common source of interference is from other gases that fluoresce in a similar fashion to SO_2 when exposed to UV Light. The most significant of these is a class of hydrocarbons called poly-nuclear aromatics (PNA) of which xylene and naphthalene are two prominent examples. Nitrogen oxide fluoresces in a spectral range near to SO_2. For critical applications where high levels of NO are expected an optional optical filter is available that improves the rejection of NO (contact Technical Support for more information).

- The analyzer has several methods for rejecting interference from these gases:
- A special scrubber (kicker) mechanism removes any PNA chemicals present in the sample gas before it the reach the sample chamber.
- The exact wavelength of light needed to excite a specific non-SO_2 fluorescing gas is removed by the source UV optical filter.
- The light given off by Nitrogen Oxide and many of the other fluorescing gases is outside of the bandwidth passed by the PMT optical filter.

6.1.9.2. UV ABSORPTION BY OZONE

Because ozone absorbs UV Light over a relatively broad spectrum it could cause a measurement offset by absorbing some of the UV given off by the decaying SO_2* in the sample chamber. The analyzer prevents this from occurring by having a very short light path between the area where the SO_2* fluorescence occurs and the PMT detector. Because the light path is so short, the amount of O_3 needed to cause a noticeable effect would be much higher than could be reasonably expected in any application for which this instrument is intended.

6.1.9.3. DILUTION

Certain gases with higher viscosities can lower the flow rate though the critical flow orifice that controls the movement of sample gas though the analyzer reducing the amount of sample gas in the sample chamber and thus the amount of SO_2 available to react with the UV light. While this can be a significant problem for some analyzers, the design of this analyzer is very tolerant of variations in sample gas flow rate and therefore does not suffer from this type of interference.

6.1.9.4. THIRD BODY QUENCHING

While the decay of SO_2* to SO_2 happens quickly, it is not instantaneous. Because it is not instantaneous it is possible for the extra energy possessed by the excited electron of the SO_2* molecule to be given off as kinetic energy during a collision with another molecule. This in effect heats the other molecule slightly and allows the excited electron to move into a lower energy orbit without emitting a photon.

The most significant interferents in this regard are nitrogen oxide (NO), carbon dioxide (CO_2), water vapor (H_2O) and molecular oxygen (O_2). In ambient applications the quenching effect of these gases is negligible. For stack applications where the concentrations of some or all of these may be very high, specific steps MUST be taken to remove them from the sample gas before it enters the analyzer.

6.1.9.5. LIGHT POLLUTION

Because the analyzer measures light as a means of calculating the amount of SO_2 present, obviously stray light can be a significant interfering factor. It removes this interference source in several ways.

- The sample chamber is designed to be completely light tight to light from sources other than the excitation UV source lamp.
- All pneumatic tubing leading into the sample chamber is completely opaque in order to prevent light from being piped into the chamber by the tubing walls.
- The optical filters discussed in Section 6.1.7; remove UV with wavelengths extraneous to the excitation and decay of SO_2/SO_2*.
- Most importantly, during instrument calibration the difference between the value of the most recently recorded PMT offset and the PMT output while measuring zero gas (calibration gas devoid of H_2S) is recorded as the test function **OFFSET**. This **OFFSET** value is used during the calculation of the H_2S concentration.

6.2. PNEUMATIC OPERATION

Important

IMPACT ON READINGS OR DATA

It is important that the sample airflow system is leak-tight and not pressurized over ambient pressure. Regular leak checks should be performed on the analyzer as stated in the Maintenance Schedule.

Note

Relative Pressure vs Absolute Pressure: In this manual vacuum readings are given in inches of mercury absolute pressure (in-Hg-A), i.e. indicate an absolute pressure referenced against zero (a perfect vacuum).

6.2.1. SAMPLE GAS FLOW

The flow of gas through the Analyzer is created by a small internal pump that pulls air though the instrument.

6.2.2. FLOW RATE CONTROL

A special flow control assembly located in the exhaust vacuum manifold (refer to pneumatic flow diagrams in Section 2.3.3) is used to maintain a constant flow rate of the sample gas through the instrument. This assembly (refer to Figure 6-7) consists of:

- A critical flow orifice
- Two o-rings, located just before and after the critical flow orifice, to seal the gap between the walls of assembly housing and the critical flow orifice
- A sintered filter
- A spring for mechanical force to maintain the seal between the filter, the o-rings, and the critical flow orifice within the assembly housing.

6.2.2.1. CRITICAL FLOW ORIFICE

The most important component of this flow control assembly (Figure 6-7) is the critical flow orifice.

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

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

variations only travel at the speed of sound themselves and are therefore cancelled out by the sonic shockwave at the downstream exit of the critical flow orifice.

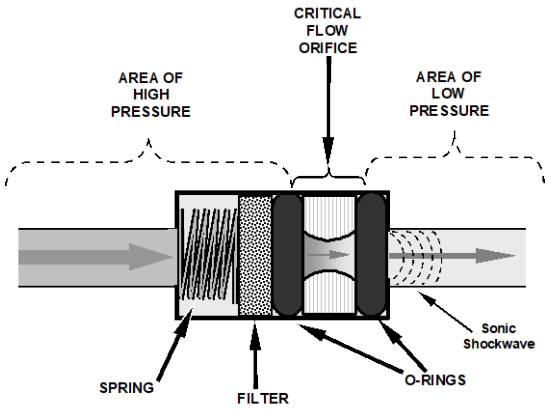


Figure 6-7. Flow Control Assembly & Critical Flow Orifice

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

The critical flow orifice used in the N101 is designed to provide a flow rate of 600 cm^3/min.

6.2.2.2. Sample Particulate Filter

To remove particles in the sample gas, the analyzer is equipped with a Teflon membrane filter of 47 mm diameter (also referred to as the sample filter) with a 1 µm or 5 µm pore size. The filter is accessible through the front panel, which folds down, and should be changed according to the Maintenance Schedule.

6.2.3. HYDROCARBON SCRUBBER (KICKER)

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

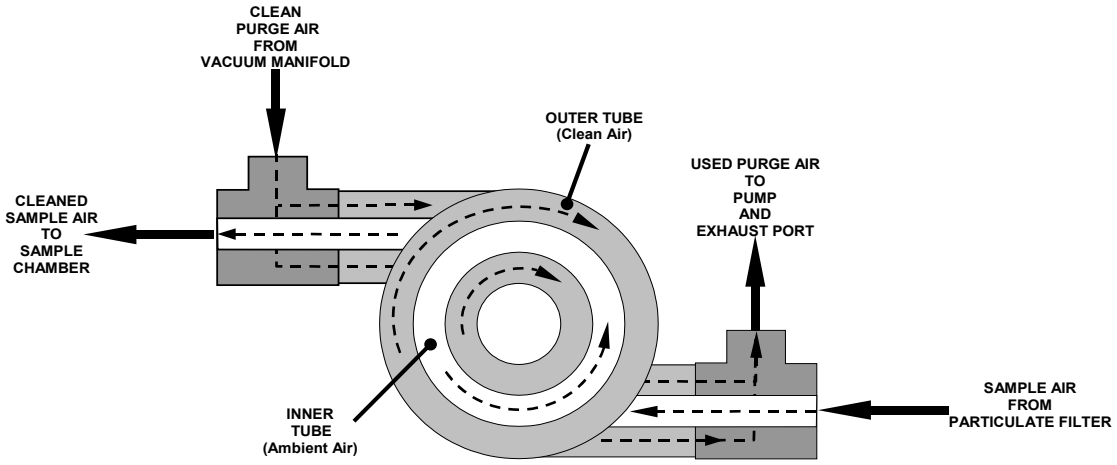


Figure 6-8. Hydrocarbon Scrubber (Kicker)

In this analyzer some of the cleaned air from the inner tube is returned to be used as the purge gas in the outer tube (refer to Figure 6-8). This means that when the analyzer is first started, the concentration gradient between the inner and outer tubes is not very large and the scrubber's efficiency is relatively low. When the instrument is turned on after having been off for more than 30 minutes, it takes a certain amount of time for the gradient to become large enough for the scrubber to adequately remove hydrocarbons from the sample air.

6.2.4. SO_2 SCRUBBER

In order to ensure that no ambient SO_2 interferes with the N101's H_2S measurements, the sample gas is passed through a chemical scrubber that removes SO_2 from the sample stream before it is passed though the respective converter. The scrubber is a Teflon encased, stand-alone unit located inside the N101 chassis, and contains a room-temperature tube with scrubber material that is expended as it removes SO_2. The frequency of replacing the scrubber's material depends on the levels of SO_2 in the sample gas.

6.2.5. PNEUMATIC SENSORS

The analyzer uses two pneumatic sensors to verify gas streams. These sensors are located on a printed circuit assembly: pneumatic pressure sensor is on the PMT Bench Module board, and the flow sensor is on the pump control board. The flow simultaneously enters the sample pressure sensor and the flow sensor from the outlet of the reaction cell.

6.2.5.1. SAMPLE PRESSURE SENSOR

An absolute pressure transducer plumbed to the input of the analyzer's sample chamber is used to measure the pressure of the sample gas before it enters the chamber. This upstream measurement is used to validate the critical flow condition (2:1 pressure ratio) through the instrument's critical flow orifice (refer to Section 6.2.2). Also, if the Temperature/Pressure Compensation (TPC) feature is turned on, the output of this sensor is also used to supply pressure data for that calculation.

The actual pressure measurement is viewable in the Dashboard as Pressure.

6.2.5.2. SAMPLE FLOW SENSOR

A thermal-mass flow sensor is used to measure the sample flow through the analyzer. This sensor is also mounted on the pneumatic pressure/flow sensor board upstream of the sample chamber. The flow rate is monitored so that an Alert is issued if the flow rate is too low or too high

The flow rate of the sample gas is viewable in the Dashboard as Sample Flow.

6.2.6. MULTIGAS MEASUREMENT AND SWITCHING VALVE

When activated for operation the multigas measurement mode allows the instrument to measure either or both gases via a Teflon® switching valve. This software-controlled valve directs the sample gas stream either through the SO_2 scrubber and H_2S → SO_2 converter (H_2S measurement mode) or directly to the sample chamber bypassing the converter, allowing the analyzer to measure only SO_2. The cycle for this operation is presented in Table 6-1.

Table 6-1. Multigas Valve Cycle-Phases

GAS MODE	SWITCHING VALVE STATUS	DEFAULT TIMES	ACTIVITY
H_2S	Gas stream directed through scrubber and converter	0 – 3 minutes	Wait period. Ensures sample chamber has been flushed of previous gas.
		3 – 10 m	Analyzer measures florescence in sample chamber
SO_2	Gas stream bypasses through scrubber and converter	0 – 3 minutes	Wait period (dwell time). Ensures sample chamber has been flushed of previous gas.
		3 – 10 m	Analyzer measures florescence in sample chamber
Cycle repeats every ~20 minutes			

6.3. ELECTRONIC OPERATION

The electronic platform is based on a Controller Area Network (CAN) bus modular system. CAN is the central networking system that enables communication among all the parts and facilitates centralized diagnoses of errors, as well as configuration of all the parts. CAN bus technology allows for a uniform cable architecture with interchangeable 6-pin connectors configured for power (5 V and 24 V) and communications (CAN high and CAN low serial lines).

The Mainboard is the main hub, which not only contains the Central Processing Unit (CPU) that communicates with other modules, but also directs power and communication distribution. The Mainboard includes an altitude sensor, a temperature sensor, and the Supervisory Chip.

The Supervisory Chip monitors power and the sensors, and when the front panel Soft Power switch is pressed (see Power Switches, Section 6.3.2), the Supervisory Chip directs the soft power down of the internal components.

6.3.1. MODULES

Each module consists of its own board controlled by a microprocessor that receives messages from and sends information to the Mainboard on the CAN network. Depending on the signal line, CAN Low or CAN High, the modules can determine whether a message is intended for them and what the priority is, and then act on the applicable messages. These are called “Smart Modules,” which conduct local operations, such as activating valves or controlling manifold temperature. There is also the Sensor Module, which is comprised of the gas sensor and its operational components, as well as the data acquisition (DAQ) board with logic device, microcontroller and LED driver mounted on it. The Sensor Module calculates gas concentrations and may command the Smart Modules.

6.3.2. POWER SWITCHES

The front panel Soft Power switch is used to protect against data loss. When the instrument is initially powered on, the Supervisory Chip spins up the internal computer components and places them in operational mode (indicated by LED’s solid-lit state). However, before powering off the instrument, pressing and momentarily holding the solid-lit Soft Power switch tells the Supervisory Chip to put the internal computer components through a soft-shutdown process and into deep sleep mode (indicated by LED’s blinking state).

The rear panel Hard Power switch is used to turn on or off the instrument; however, before turning off the instrument, the Soft Power switch must be used first as described above. If there is an unexpected loss of source power while the instrument is running, it will power up in the ON state when source power is restored.

6.4. SOFTWARE OPERATION

6.4.1. ADAPTIVE FILTER

The analyzer software processes sample gas measurement and reference data through a built-in adaptive filter. Unlike other analyzers that average the output signal over a fixed time period, these analyzers average over a defined number of samples. This technique is known as boxcar filtering. During operation, the software may automatically switch between two different filter lengths based on the conditions at hand.

During constant or nearly constant concentrations, the software, by default, computes an average sample value using the long filter. This provides smooth and stable readings and averages out a considerable amount of random noise for an overall less noisy concentration reading.

If the filter detects rapid changes in concentration, the filter reduces its size, which allows the analyzer to respond more quickly. Two conditions must be simultaneously met to switch to the short filter. First, the instantaneous concentration must differ from the average in the long filter by an absolute amount. Second, the instantaneous concentration must differ from the average in the long filter by at least a set percentage of the average in the long filter.

6.4.2. CALIBRATION - SLOPE AND OFFSET

Calibration of the analyzer is performed exclusively in the software. During instrument calibration, (see Section 4) the user enters expected values for zero and span via the front panel touchscreen control and commands the instrument to make readings of calibrated sample gases for both levels.

- The readings taken are adjusted, linearized and compared to the expected values.
- With this information, the software computes values for instrument slope and offset and stores these values in memory for use in calculating the concentration of the sample gas.

The instrument slope and offset values recorded during the last calibration can be viewed in the Dashboard.

6.4.3. TEMPERATURE/PRESSURE COMPENSATION (TPC)

As explained in the principles of operation, changes in temperature can significantly affect the amount of fluoresced UV light generated in the instrument's sample chamber. To negate this effect the analyzer maintains the sample gas at a stable, raised temperature.

Pressure changes can also have a noticeable, if more subtle, effect on the SO_2 concentration calculation. To account for this, the analyzer software includes a feature that allows the instrument to compensate changes in ambient pressure during the SO_2 calculations.

When the TPC feature is enabled, the analyzer's SO_2 concentration is divided by a factor called PRESSCO, which is based on the difference between the ambient pressure of the sample gas normalized to standard atmospheric pressure (Equation 6-7). As ambient pressure increases, the compensated SO_2 concentration is decreased.

$$PRESSCO = \frac{SAMPLE\_PRESSURE\ (" HG - A) \times SAMP\_PRESS\_SLOPE}{29.92\ (" HG - A)}$$

(Equation 6-7)

SAMPLE_PRESSURE: The ambient pressure of the sample gas as measured by the instrument's sample pressure sensor in "Hg-A.

SAMP_PRESS_SLOPE: Sample pressure slope correction factor.

The SETUP>VARS menu enables/disables the TPC feature.

6.4.4. INTERNAL DATA ACQUISITION SYSTEM (DAS)

The DAS is designed to implement predictive diagnostics that store trending data for users to anticipate when an instrument will require service. Large amounts of data can be stored and retrieved for analysis. The DAS is configured and managed through the Data Logging menu (Section 2.5.1).

GLOSSARY

Term	Description/Definition
10BaseT	an Ethernet standard that uses twisted ("T") pairs of copper wires to transmit at 10 megabits per second (Mbps)
100BaseT	same as 10BaseT except ten times faster (100 Mbps)
ASSY	*Assembly*
CAS	*Code-Activated Switch*
CD	*Corona Discharge*, a frequently luminous discharge, at the surface of a conductor or between two conductors of the same transmission line, accompanied by ionization of the surrounding atmosphere and often by a power loss
CE	*Converter Efficiency*, the percentage of the total amount that is actually converted (e.g., light energy into electricity; NO_2 into NO, etc.)
CEM	*Continuous Emission Monitoring*
Chemical elements that may be included in this document:	
CO_2	carbon dioxide
C_3H_8	propane
CH_4	methane
H_2O	water vapor
HC	general abbreviation for hydrocarbon
HNO_3	nitric acid
H_2S	hydrogen sulfide
NO	nitric oxide
NO_2	nitrogen dioxide
NO_X	nitrogen oxides, here defined as the sum of NO and NO_2
NO_y	nitrogen oxides, often called odd nitrogen: the sum of NO_X plus other compounds such as HNO_3 (definitions vary widely and may include nitrate (NO_3), PAN, N_2O and other compounds as well)
NH_3	ammonia
O_2	molecular oxygen
O_3	ozone
SO_2	sulfur dioxide
CPU	*Central Processing Unit*
DAC	*Digital-to-Analog Converter*
DAS	*Data Acquisition System*
DCE	*Data Communication Equipment*
DFU	*Disposable Filter Unit*
DHCP	*Dynamic Host Configuration Protocol.* A protocol used by LAN or Internet servers to automatically set up the interface protocols between themselves and any other addressable device connected to the network
DTE	*Data Terminal Equipment*
ESD	*Electro-Static Discharge*
ETEST	*Electrical Test*
Ethernet	a standardized (IEEE 802.3) computer networking technology for local area networks (LANs), facilitating communication and sharing resources

Term	Description/Definition
FEP	*Fluorinated Ethylene Propylene* polymer, one of the polymers that Du Pont markets as *Teflon®*
Flash	non-volatile, solid-state memory
FPI	*Fabry-Perot Interface*: a special light filter typically made of a transparent plate with two reflecting surfaces or two parallel, highly reflective mirrors
GFC	*Gas Filter Correlation*
IC	*Integrated Circuit*, a modern, semi-conductor circuit that can contain many basic components such as resistors, transistors, capacitors, etc., in a miniaturized package used in electronic assemblies
IP	*Internet Protocol*
IZS	*Internal Zero Span*
LAN	*Local Area Network*
LCD	*Liquid Crystal Display*
LED	*Light Emitting Diode*
LPM	*Liters Per Minute*
MFC	*Mass Flow Controller*
M/R	*Measure/Reference*
NDIR	*Non-Dispersive Infrared*
MOLAR MASS	the mass, expressed in grams, of 1 mole of a specific substance. Conversely, one mole is the amount of the substance needed for the molar mass to be the same number in grams as the atomic mass of that substance. EXAMPLE: The atomic weight of Carbon is 12 therefore the molar mass of Carbon is 12 grams. Conversely, one mole of carbon equals the amount of carbon atoms that weighs 12 grams. Atomic weights can be found on any Periodic Table of Elements.
NDIR	*Non-Dispersive Infrared*
NIST-SRM	*National Institute of Standards and Technology - Standard Reference Material*
PC	*Personal Computer*
PCA	P*rinted Circuit Assembly*, the PCB with electronic components, ready to use
PC/AT	*Personal Computer / Advanced Technology*
PCB	*Printed Circuit Board*, the bare board without electronic component
PFA	*Per-Fluoro-Alkoxy*, an inert polymer; one of the polymers that *Du Pont* markets as *Teflon®*
PLC	*Programmable Logic Controller*, a device that is used to control instruments based on a logic level signal coming from the analyzer
PLD	*Programmable Logic Device*
PLL	*Phase Lock Loop*
PMT	*Photo Multiplier Tube*, a vacuum tube of electrodes that multiply electrons collected and charged to create a detectable current signal
P/N (or PN)	*Part Number*
PSD	*Prevention of Significant Deterioration*
PTFE	*Poly-Tetra-Fluoro-Ethylene*, a very inert polymer material used to handle gases that may react on other surfaces; one of the polymers that *Du Pont* markets as *Teflon®*
PVC	*Poly Vinyl Chloride*, a polymer used for downstream tubing
Rdg	Reading

Term	Description/Definition
RS-232	specification and standard describing a serial communication method between DTE (Data Terminal Equipment) and DCE (Data Circuit-terminating Equipment) devices, using a maximum cable-length of 50 feet
RS-485	specification and standard describing a binary serial communication method among multiple devices at a data rate faster than RS-232 with a much longer distance between the host and the furthest device
SAROAD	*Storage and Retrieval of Aerometric Data*
SLAMS	*State and Local Air Monitoring Network Plan*
SLPM	*Standard Liters Per Minute* of a gas at standard temperature and pressure
STP	*Standard Temperature and Pressure*
TCP/IP	*Transfer Control Protocol / Internet Protocol*, the standard communications protocol for Ethernet devices
TEC	*Thermal Electric Cooler*
TPC	*Temperature/Pressure Compensation*
USB	*Universal Serial Bus*: a standard connection method to establish communication between peripheral devices and a host controller, such as a mouse and/or keyboard and a personal computer or laptop
VARS	*Variables*, the variable settings of the instrument
V-F	*Voltage-to-Frequency*
Z/S	*Zero / Span*

APPENDIX A – MODBUS REGISTERS

ADDR	NAME	DESCRIPTION
Discrete Inputs		
0	PMT_DET_WARN	PMT detector output outside operational limits
1	UV_DET_WARN	UV intensity outside set limits
3	BOX_TEMP_WARN	Chassis temperature outside specified limits
4	PMT_TEMP_WARN	PMT temperature outside set limits
5	RCELL_TEMP_WARN	Sample chamber temperature out of range
8	SYS_WARN_RESET	CPU has rebooted
9	SYS_WARN_SUPERVISOR_COM_WARNING	Supervisor communication warning when module watchdog timer has expired
16	SF_ZERO_CALIBRATION_MODE	In zero calibration mode
17	SF_SPAN_CALIBRATION_MODE	In span calibration mode
18	SF_MULTIPOINT_CALIBRATION_MODE	In multi-point calibration mode
19	SYS_OK_WARN	Denotes whether fault is present in system
20	FLOW_WARN	Sample flow outside of operating limits
21	IZS_BLOCK_TEMP_WARN	IZS temperature outside of operating limits
22	CONVERTER_TEMP_WARN	Converter temperature outside of operating limits
Coils		
0	DO_RELAY1	Control relay 36
1	DO_RELAY2	Control relay 37
2	DO_RELAY3	Control relay 38
4	ASF_MAINTENANCE_MODE_SOFTWARE	Control Maintenance mode
20	MB_ZERO_CAL_RANGE1	Enable/disable external zero cal
21	MB_SPAN_CAL_RANGE1	Enable/disable external low span cal
22	MB_ZERO_CAL_RANGE2	Enable/disable external zero cal (range 2)
23	MB_SPAN_CAL_RANGE2	Enable/disable external low span cal (range 2)
Input Registers		
0	AI_PMT	PMT Detector Reading in mV
2	AI_UVLAMP_RAW	UV Lamp Intensity Reading in mV
4	AI_UVLAMP	UV Lamp ratio of Calibrated Intensity in %
6	AI_PMT_DARK	PMT electrical offset in mV
10	SO2_SLOPE1	SO2 Slope for range 1
12	SO2_SLOPE2	SO2 Slope for range 2
14	H2S_SLOPE1	H2S Slope for range 1
16	H2S_SLOPE2	H2S Slope for range 2
18	SO2_OFFSET1	SO2 Offset for range 1
20	SO2_OFFSET2	SO2 Offset for range 2
22	H2S_OFFSET1	H2S Offset for range 1
24	H2S_OFFSET2	H2S Offset for range 2
26	SO2_PRE_CAL_CONC_1	SO2 concentration for range 1 during zero/span calibration
28	SO2_PRE_CAL_CONC_2	SO2 concentration for range 2 during zero/span calibration
30	H2S_PRE_CAL_CONC_1	H2S concentration for range 1 during zero/span calibration
32	H2S_PRE_CAL_CONC_2	H2S concentration for range 2 during zero/span calibration
34	SO2_CONC	SO2 concentration for range 1
36	SO2_CONC_2	SO2 concentration for range 2
38	H2S_CONC	SO2 concentration for range 1
40	H2S_CONC_2	SO2 concentration for range 2
42	SO2_STABILITY	SO2 Stability
46	AI_RCELL_TEMP	Reaction cell temperature in degrees C
48	AI_IZS_BLOCK_TEMP	IZS temperature in degrees C
50	AI_PMT_TEMP	PMT temperature in degrees C
56	AI_PUMP_FLOW	Pump flow in CCM
58	AI_SAMPLE_PRESSURE	Sample pressure in In.Hg-A

ADDR	NAME	DESCRIPTION
60	AI_BOX_TEMP	Internal box temperature in degrees C
62	AO_HVPS_SETPOINT	High voltage power supply output in Volts
80	AI_CONVERTER_TEMP	Converter Temp in degree C
84	H2S_STABILITY	H2S Stability
Holding Registers		
0	SO2_TARGET_SPAN_CONC_1	SO2 Target Span range 1
2	SO2_TARGET_SPAN_CONC_2	SO2 Target span range 2
4	H2S_TARGET_SPAN_CONC_1	H2S Target Span range 1
6	H2S_TARGET_SPAN_CONC_2	H2S Target Span range 2

REVISION HISTORY					
ZONE	DCN	REV	DESCRIPTION	DATE	APPROVED
		01	INITIAL RELEASE, PROTOTYPE	8/9/2019	PVU

FRONT PANEL

CHASSIS GROUND

019320100, CBL, GRND STRAP

093640000. CBL, PREAMP TO HVPS

093630000. CBL, SMA PLUG

092070000 PCA, SENSOR, SOX & NOX, N-SERIES

J11 J14 J7 TEC POWER J16 TEC FAN J20 J12 J15 J13 J1 J8 J2 J3 J21 J22 J23 J6 J4 J5

093200000 ASSY, PMT, SOX

093260000 ASSY, SO2 SENSOR, AMB,

093690000, ASSY, THERMISTOR, RXCELL

093210000, ASSY, RXCELL HEATER/SWITCH

MOLY CONVERTER, BNAD HEATER

MOLY CONVERTER, THERMOCOUPLE

072120000 ASSY, UV LAMP, 10K

093920200, ASSY, MOLY-CON

SAMPLE IN

HOT

094320000, CBL ASSY, UV CONTROL PCA, N-SERIES

089490000 PCA, UV DET, W/OP20,

WR0000281, CBL, RIBBON, 12"

087960100, CBL, 24" CANBUS

087960200, CBL, 12" CANBUS

084260000 PCA, MAINBOARD, FOR SOM304

J15 J9 J16 J10 J17 J11 J18 J12 J19 J13 J20 J14 J23 J4 J6 J1 PULSE J27 FAN

089090000 ASSY, FAN, 24VDC

088830000, CBL ASSY

WR0000277, CABLE

07842000, CABLE, HDMI

087960200, CBL, 12" CANBUS

088840000, CBL ASSY

OPTION

PS0000049AC-DC, 180W SWITCHING, 24V(PA)

088820000, CBL ASSY

J9 J15 J4 J1

066970000 PCA, INTRF. LCD TOUCH SCRN, F/P

008960000, PCA, PCA, DIGITAL IO

OPTION

088960000,PCA, ANALOG OUTPUT

BLACK WHITE

CN0000831 CONN, PWR ENTRY MODULE, SW, FUSE, 10A(230-0035-01, FUSE, 5A, 250V 5X20MM, SLO-BLO)

093080000 SWITCH, PUSHBUTTON

CHASSIS GROUND

089270000 CBL ASSY

J1

084640100 PCA, DC PUMP CONTROLLER, ANALOG

PUMP J5

J2

092640000 PCA, LAMP DRIVER

J1 J4

OPTION

J6 HEATER

J4 TEMP.

SPAN/CAL ZERO/SPAN

088200100 PCA, IZS MODULE

J3 J2 J1

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THIRD ANGLE PROJECTION

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TOLERANCES ARE:
FRACTIONS ±1/16 DECIMALS .XX = ±.03 .XXX = ±.010 ANGLES ±0°30'

DO NOT SCALE DRAWING

TREATMENT

FINISH

SIMILAR TO | ACT WT | CALC WT

CONTRACT

APPROVALS	DATE
DRAWN -	-
CHECKED -	-
CCB -	-
ISSUED -	-

TELEDYNE ADVANCED POLLUTION INSTRUMENTATION
Everywhereyoulook™

TITLE

DIAGRAM, INTERCONNECT, N101

SIZE	CAGE CODE	DWG NO	REV
D	1JZF4	093590130	01

SCALE 1:1 FORM ENF0029 RevE SHEET 1 OF 1