User Manual

Model N802
Paramagnetic Oxygen 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:

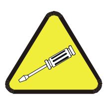
WARNING: Electrical Shock Hazard

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 :

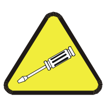
AVERTISSEMENT : Risque de choc électrique

DANGER : Oxydant puissant

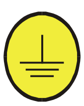
AVERTISSEMENT GÉNÉRAL / MISE EN GARDE : Lire la consigne complémentaire pour des renseignements spécifiques

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 at our website.

CAUTION – Avoid Warranty Invalidation

Failure to comply with proper 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

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. The NumaView™ Software Addendum to T-Series Analyzer Manuals also may be helpful.

Note	**We recommend that all users read this manual in its entirety before operating the instrument.**

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, APPROVALS, & COMPLIANCE

The Teledyne API Model N802 (also referred to as N802) Paramagnetic Oxygen Analyzer is a microprocessor-controlled analyzer that determines the concentration of molecular oxygen (O_2) in a sample gas drawn through the instrument. It uses a paramagnetic sensor that relies on the relatively high reactivity of O_2 molecules to magnetic fields to generate a current that is proportional to the amount of O_2 present in the sensor chamber.

The N802 analyzer's multi-tasking software gives the ability to track and report a large number of operational parameters in real time. These readings are compared to diagnostic limits kept in the analyzer's memory where, should any fall outside of those limits, the analyzer issues automatic warnings.

NumaView™ 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. Specifications

Parameter	Description	
	O_2 Sensor	Optional CO_2 Sensor
Ranges	Min: 0-1% full scale Max: 0-100% full scale (selectable)	Min: 0-1% full scale Max: 0-20% full scale
Zero Noise	< 0.02% (RMS)	< 0.02% (RMS)
Span Noise	< 0.05% of reading (RMS)	< 0.1% of reading (RMS)
Zero Drift	< ±0.02% /24 hrs; < ±0.05% /7 days	< ±0.02%/24 hrs; < ±0.05%/7 days
Span Drift	< ±0.1% /7 days	< ±0.1%/7 days
Lower Detectable Limit	< 0.04%	< 0.04%
Accuracy	< ±0.1%	< ±(1.5% of range +2% of reading)
Temperature Coefficient	< ±0.1% per degree C	< ±0.01%/degree C
Linearity	< ±0.1%	
Response Time	< 60 seconds to 95%	
Sample Flow Rate	120 ml ± 20ml/min	
Recorder Offset	± 10%	
AC Power	100-240V~, 50/60 Hz, 3.0 A	Typical Power Consumption - without pump option: 35 W - with pump option: 40 W

Parameter	Description
Communications	
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 x isolated voltage outputs (5 V, 10 V) 3 x individually isolated current outputs (4-20 mA) 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)
Operating Temperature	5-40 ºC
Humidity Range	0-95% RH, Non-Condensing
Pressure Range	25 - 31 in Hg
Dimensions HxWxD	7” x 17” x 24.3” (178 x 432 x 617 mm)
Weight	Standard, no options: 23.5 lbs (10.7 kg) Standard with pump option: 26 lbs (11.8 kg)
Environmental Conditions	• Installation Category (Over Voltage Category) II Pollution Degree 2 • Intended for Indoor Use Only at Altitudes ≤ 2000m
Note: 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 the analyzer.

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.

WARNING – ELECTRICAL SHOCK HAZARD

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

With no power to the unit, carefully remove the top cover of the 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 of the optional hardware ordered with the unit has been installed. These are listed on the paperwork accompanying the instrument.

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 the instrument	10 cm / 4 in
Sides of the instrument	2.5 cm / 1 in
Above and below the instrument	2.5 cm / 1 in

2.2. INSTRUMENT LAYOUT

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

2.2.1. FRONT PANEL

The 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).

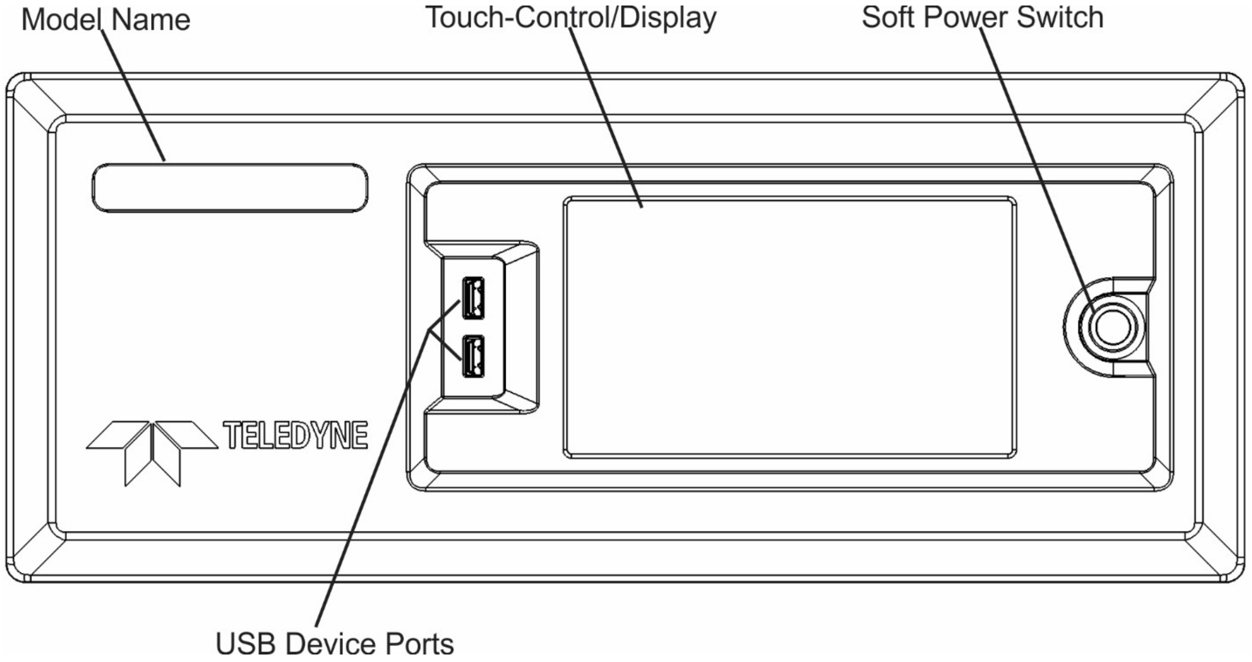


Figure 2-1. Front Panel Layout

2.2.2. REAR PANEL

Figure 2-2 shows the layout of the rear panel.

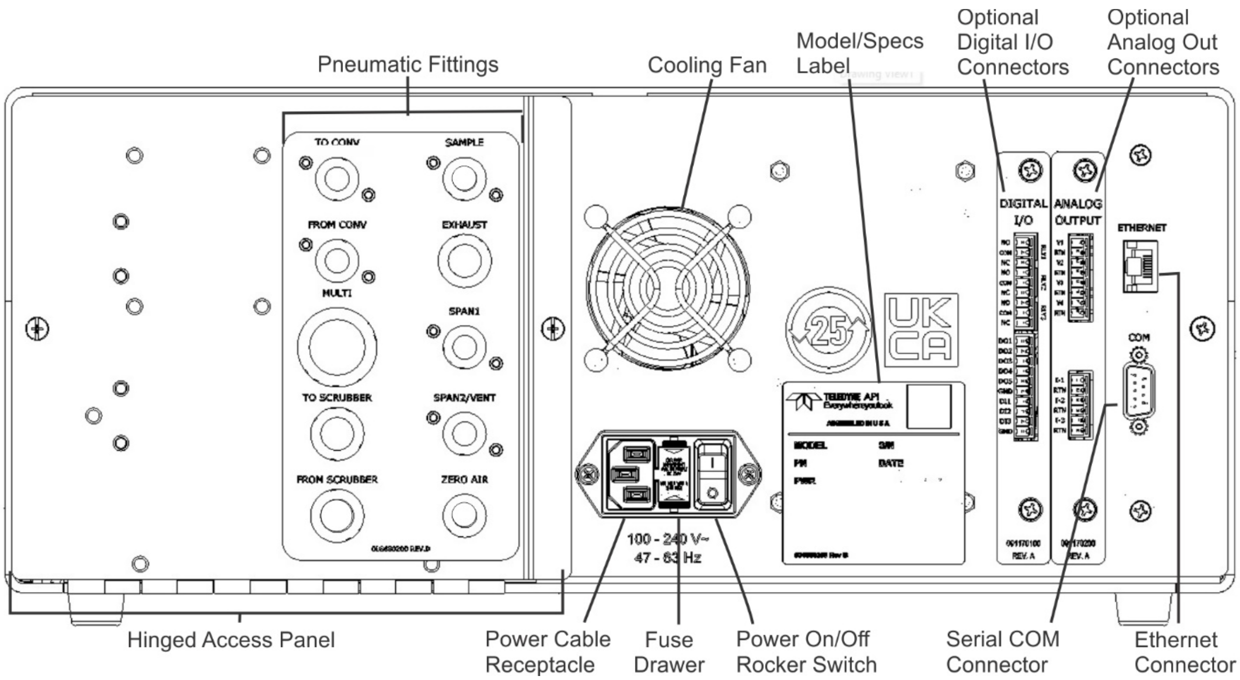


Figure 2-2. Rear Panel Layout, Base Unit (options include additional pneumatic ports)

Table 2-2. Rear Panel Description

COMPONENT	FUNCTION
SAMPLE	Inlet connection to be used for any one of the following: • Sample gas • Span gas • Calibration gas • Zero air
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.
SPAN 1	Not used.
SPAN2/VENT	Not used.
ZERO AIR	Not used.
Cooling Fan	Pulls ambient air into chassis through side vents and exhausts through rear. (software-controlled to Box Temp setpoint).
Model/specs label	Identifies the analyzer model number and provides power specs
AC Power Cable 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 Model number label**
Power On/Off Switch	Rocker switch to power unit on or off. **CAUTION! Prior to powering OFF, use front panel button for preliminary internal "soft" power-down to protect against data loss.**
Fuse drawer	For circuit protection
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.
COM	Serial communications port

2.2.3. INTERNAL CHASSIS

Figure 2-3 shows the internal chassis configuration including the CO_2 sensor option.

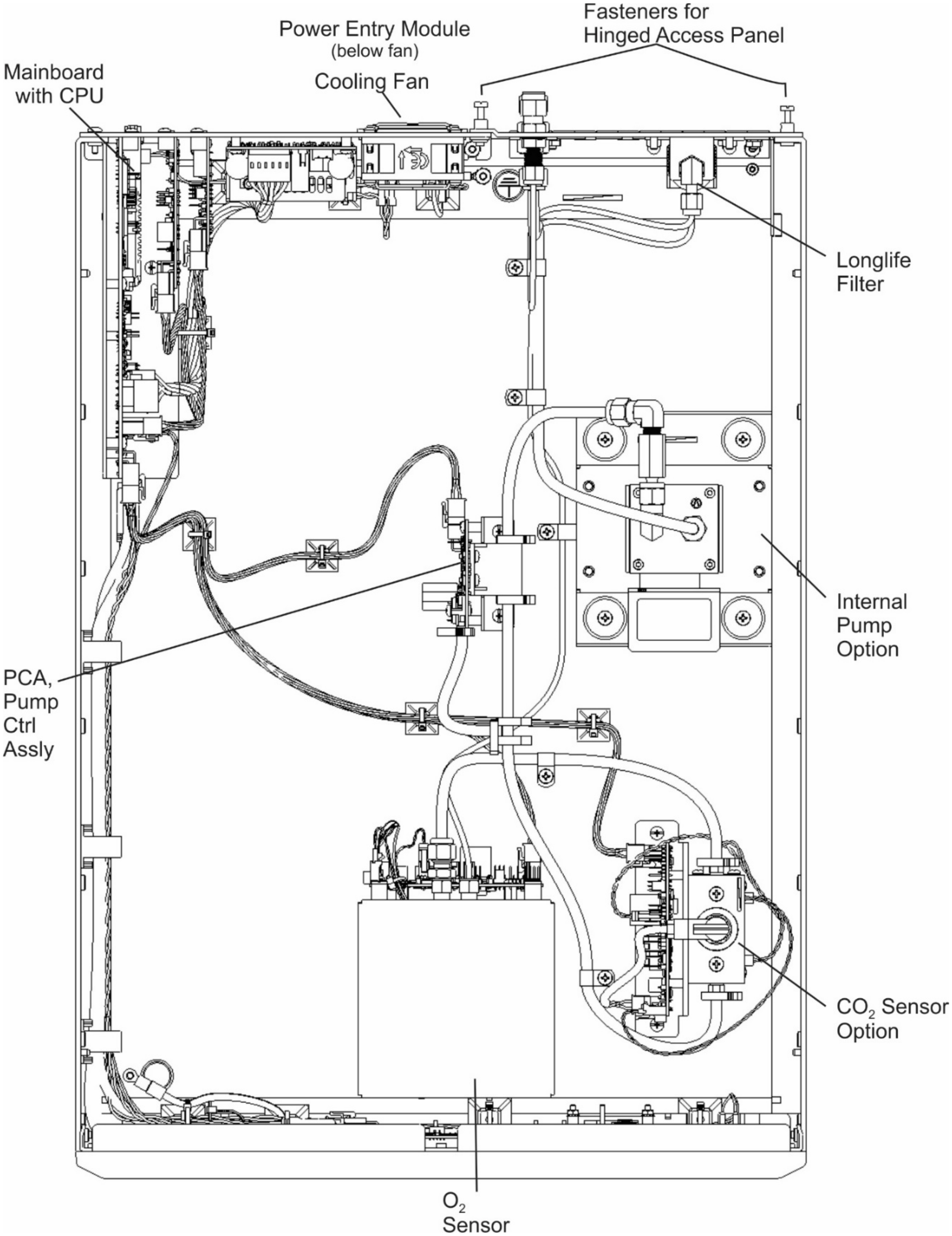


Figure 2-3. Internal Chassis Layout

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).

2.3.1. Electrical Connections

Note **To maintain compliance with EMC standards, cables must be no longer than 3 meters for all I/O connections.**

WARNING – ELECTRICAL SHOCK HAZARD

- High Voltages are present inside the instrument's case.
- Power connection must have functioning ground connection.
- Do not defeat the ground wire on power plug.
- Before disconnecting or connecting electrical subassemblies, follow the Disconnection procedure provided in Section 2.3.1.1.
- Do not operate with cover off.
- Ensure that installation provides access to disconnect power from the instrument

CAUTION – AVOID DAMAGE TO THE INSTRUMENT

Ensure that the AC power voltage matches the voltage indicated on the instrument's rear panel before plugging it into line power.

2.3.1.1 CONNECTING AND DISCONNECTING POWER

Important

COULD CAUSE LOSS OR CORRUPTION OF DATA

Never power off the instrument from the rear panel Hard Power switch before first 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.

To Connect Power:

1. Ensure the rear panel power switch is in the Off position.
2. Attach the power cord to the instrument's AC power connector.
3. Plug the other end into a grounded power outlet rated for the instrument's voltage.
4. Turn rear panel power switch ONl.

To Disconnect Power without losing or corrupting data:

1. Press and hold the front panel power button until its LED is in blinking state.
2. Change the rear panel power switch to Off position.
3. Additionally, if accessing the instrument interior, disconnect the AC power cable.

2.3.1.2 CONNECTING ANALOG OUTPUTS (OPTION)

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.

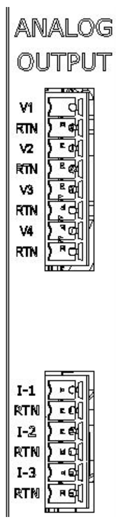


Figure 2-4. Analog Outputs Connectors Panel Option

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 and five digital outputs. The three isolated digital input controls, DI1, DI2, and DI3, are not used in the N802 due to no Z/S span valve option. 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. The Outputs can also be used to interface with devices that accept logic-level digital inputs, such as Programmable Logic Controllers (PLCs).

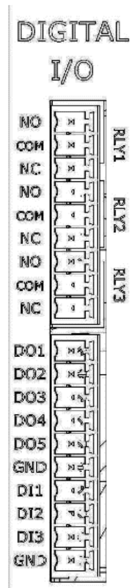


Figure 2-5. Digital I/O Connector Panel Option

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	Not Used	
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.

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 2-11).

WARNING – ELECTRICAL SHOCK HAZARD

Follow the Disconnection procedure provided in Section 2.3.1.1 before performing any operation that requires entry into the interior of the analyzer.

Contact Technical Support (Section 5.8) before reconfiguring the internal serial connector.

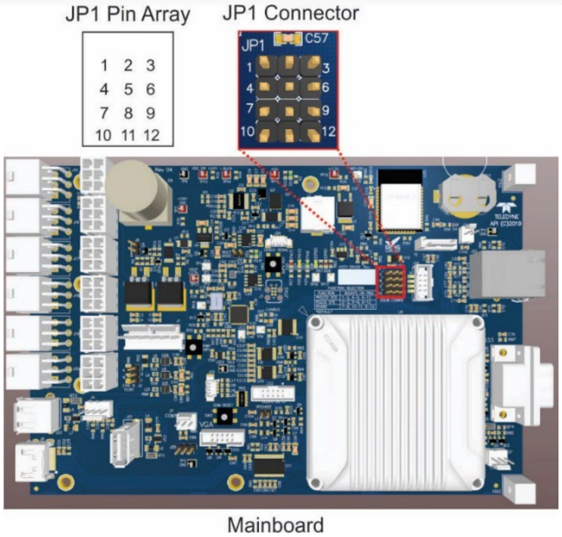


Figure 2-6. Mainboard JP1 Location and Pin Arrangements

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>COM2 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

While O_2 is itself not toxic, the sample gas and in some cases the calibration gases used with the N802 can contain other components that are hazardous (e.g. NO, NO_2, SO_2, CO, etc).

Obtain a Safety Data Sheet (SDS) for each such gas. Read and rigorously follow the safety guidelines described there.

Do not vent sample gases containing hazardous components into enclosed areas.

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.

Tubing:

PTFE material

Outer diameter (OD) minimum ¼" .

Min/max length 2 meters to 10 meters.

Pressure:

Maximum pressure of any gas at the SAMPLE inlet should not exceed 1.5 in-Hg above ambient pressure and ideally should equal ambient atmospheric pressure.

Venting (to prevent back diffusion and pressure effects):

The span gas, zero air supply and sample gas line MUST be vented (Figure 2-7)

In applications where the sample gas is received from a pressurized manifold, a vent must be placed on the sample gas before it enters the analyzer (Figure 2-7).

Run tubing outside the shelter or immediate area surrounding the instrument.

Exhaust Outlet:

Run tubing outside the enclosure or at least into a well-ventilated area.

2.3.2.2. BASIC PNEUMATIC CONNECTIONS

Figure 2-7 shows the basic configuration for pneumatic connections using bottled span gas.

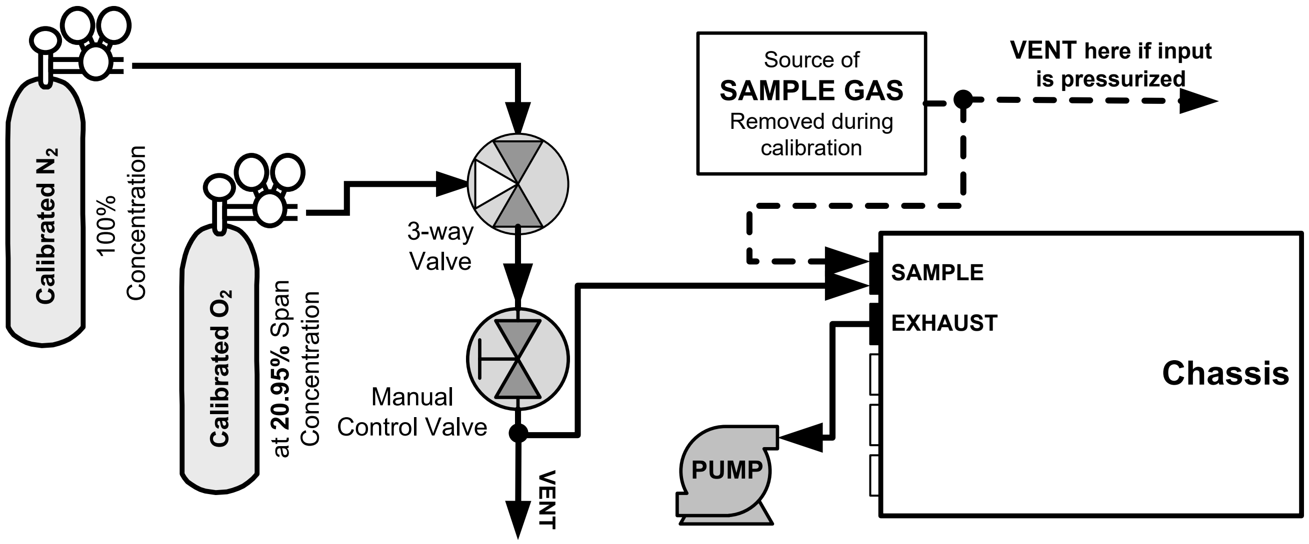


Figure 2-7. Basic Configuration, Using Bottled Span Gas

For the analyzer's basic configuration, in addition to tubing, pressure, venting, and exhaust requirements set out in Section 2.3.2.1, make the following pneumatic connections, noting the difference in exhaust connections for basic vs internal pump option:

SAMPLE INLET

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

Maximum pressure of any gas at the SAMPLE inlet should not exceed 1.5 in-Hg above ambient pressure and ideally should equal ambient atmospheric pressure.

In applications where the sample gas is received from a pressurized manifold, a vent must be placed on the sample gas before it enters the analyzer(Figure 2-7).

EXHAUST OUTLET

Connect an exhaust line to the external pump (for internal pump option, connect the exhaust line the the analyzer's EXHAUST outlet fitting), ensuring that it is vented outside the N802 analyzer's enclosure, preferably outside the shelter or at least into a well-ventilated area.

CALIBRATOR GAS SOURCES AND VENTING

The source of calibration gas is also attached to the **SAMPLE** inlet, but only when a calibration operation is actually being performed.

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

Note	**Zero air and span gas flows should be supplied in excess of the 120 cm^3/min demand of the analyzer.**

Important	**IMPACT ON READINGS OR DATA** **Run a leak check once the appropriate pneumatic connections have been made; check all pneumatic fittings for leaks using the procedures defined in Section 5.6.2.**

2.3.3. Pneumatic Flow Diagrams

This section shows the flow diagrams for basic and CO_2 option configurations.

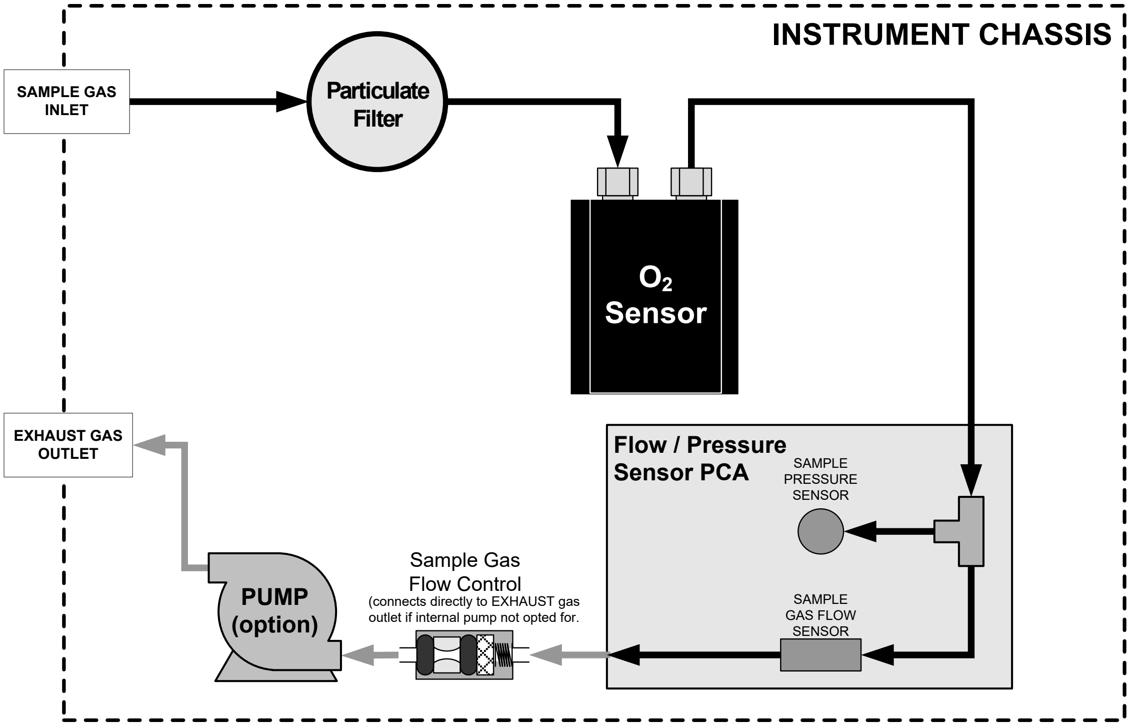


Figure 2-8. Internal Gas Flow, Basic Configuration

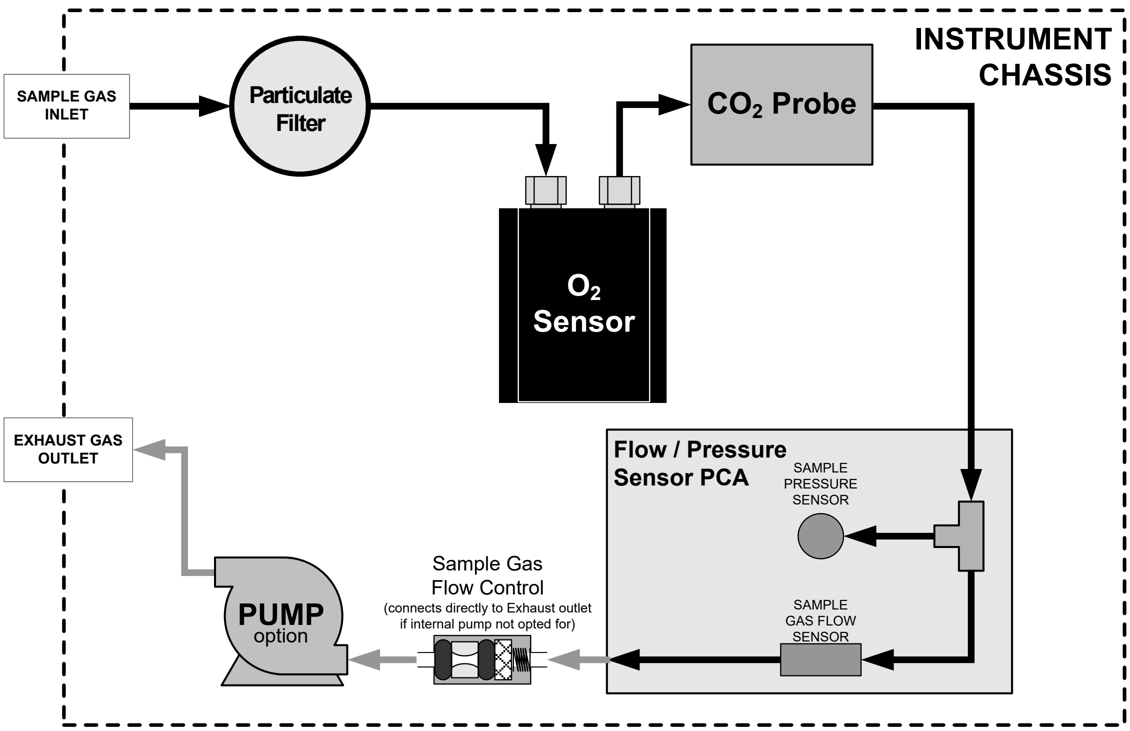


Figure 2-9. Internal Gas Flow with CO_2 Sensor Option

2.3.4. STARTUP, FUNCTIONAL CHECKS AND CALIBRATION

Important

IMPACT ON READINGS OR DATA
The analyzer's cover must be installed to ensure that the temperatures of the internal components are properly controlled.

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, a sequence of status screens (Figure 2-10) appear prior to the Home page (Figure 2-11).

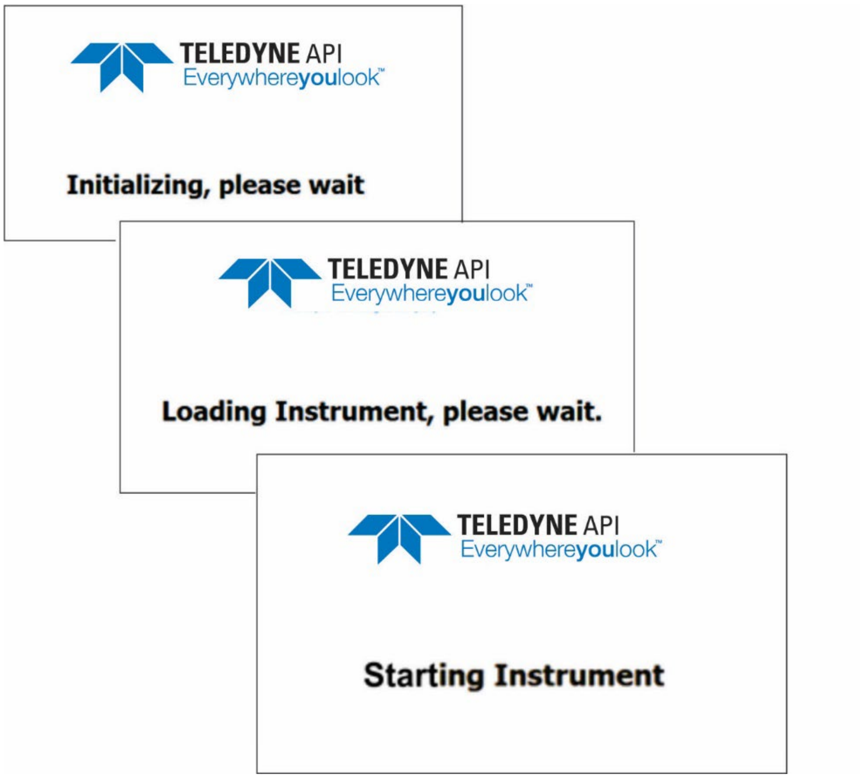


Figure 2-10. Status Screens at Startup

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

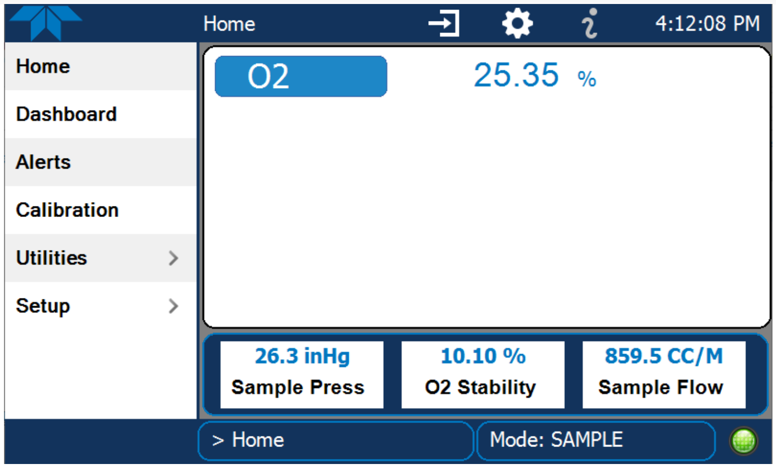


Figure 2-11. Home Page Example (when installed, CO_2 option conc displays below O_2 conc)

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 2-12) 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.

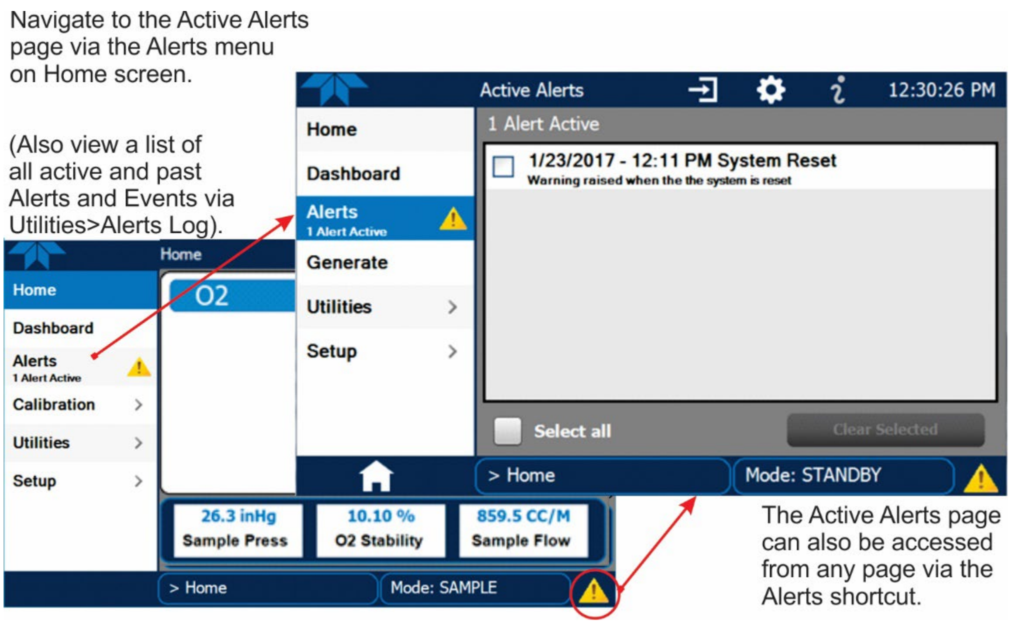


Figure 2-12. Viewing Active Alerts Page

If alerts of warning conditions persist after the warm-up period or after being cleared, investigate their cause using the troubleshooting guidelines in Section 5.6.6.

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 5.6.7).

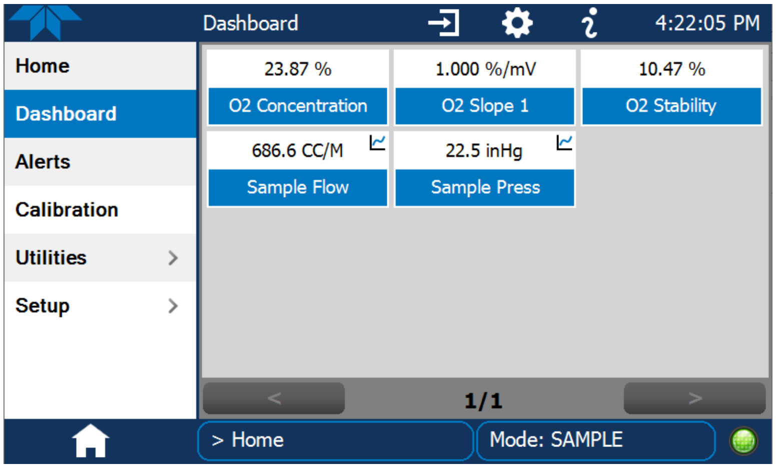


Figure 2-13. Sample Dashboard Page

2.3.4.4 CALIBRATION

Before operation begins, the analyzer requires zero and span calibrations. Also, any time an analyzer is moved or its configuration changed, it must be calibrated. Follow the appropriate calibration instructions presented in Section 4.

2.4 MENU OVERVIEW

Table 2-6 describes the main menus and provides cross-references to the respective sections with configuration details.

Table 2-6. Menu Overview

MENU		DESCRIPTION	LOCATION
Home		View and plot concentration readings and other selectable parameter values (Figure 2-15).	Section 2.4.1
Dashboard		View user-selected parameters and their values, some of which can be displayed in a live-plot graph (Figure 2-16).	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 2-13) via selectable parameters.	Section 2.5.3
	Vars	Manually adjust several software variables that define specific operational parameters.	Section 2.5.4
	Homescreen	Select up to three parameters to be displayed in the meters (Figure 2-14).	Section 2.5.5
	Digital Outputs	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 2.5.6
	Analog Outputs	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 2.5.7
	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 2.5.8
	Comm	View and configure network and serial communications.	Section 2.5.9

2.4.1 HOME PAGE

Figure 2-14 presents an orientation to the main display screen; Figure 2-15 shows that pressing the gas name or its concentration value or a meter below displays a live plot of their respective readings. Section 2.5.5 provides configuration instructions.

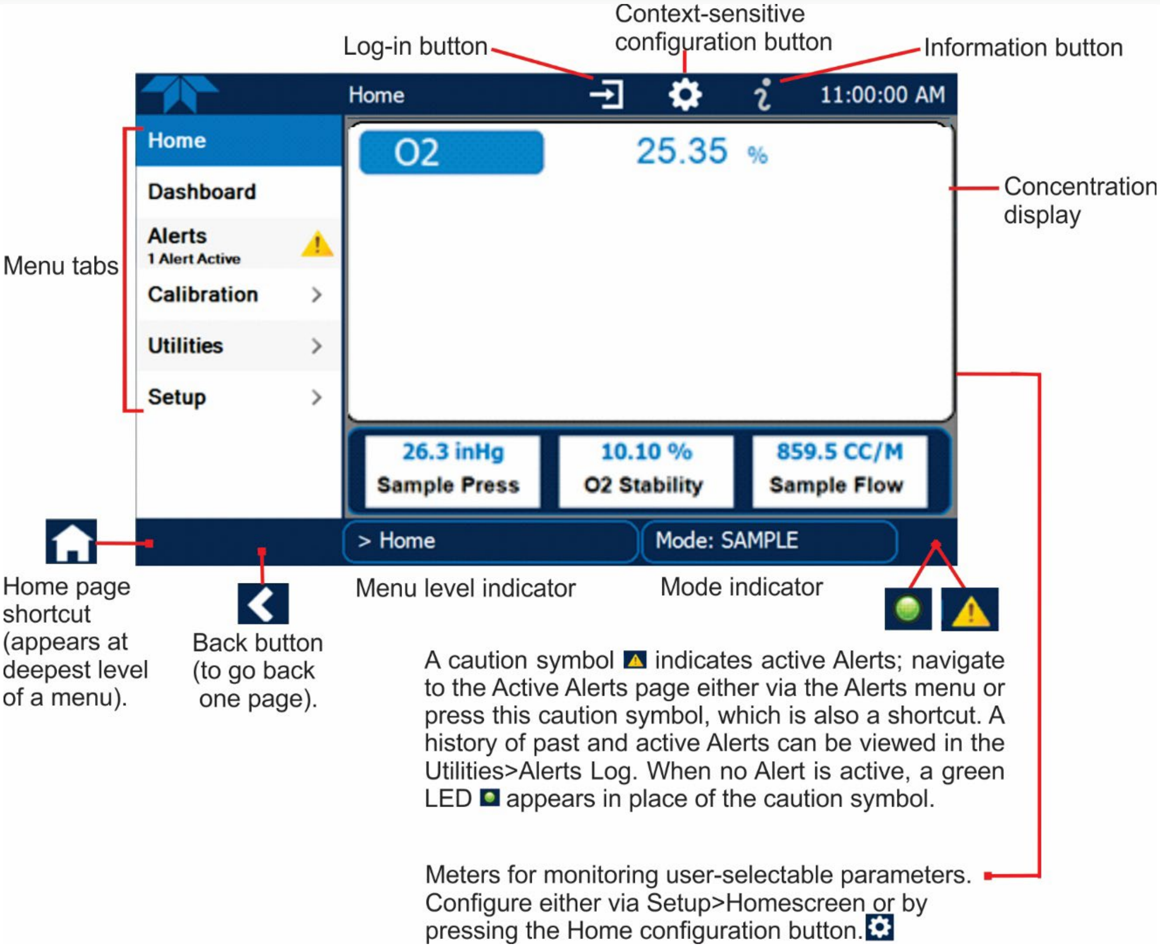


Figure 2-14. User Interface Orientation

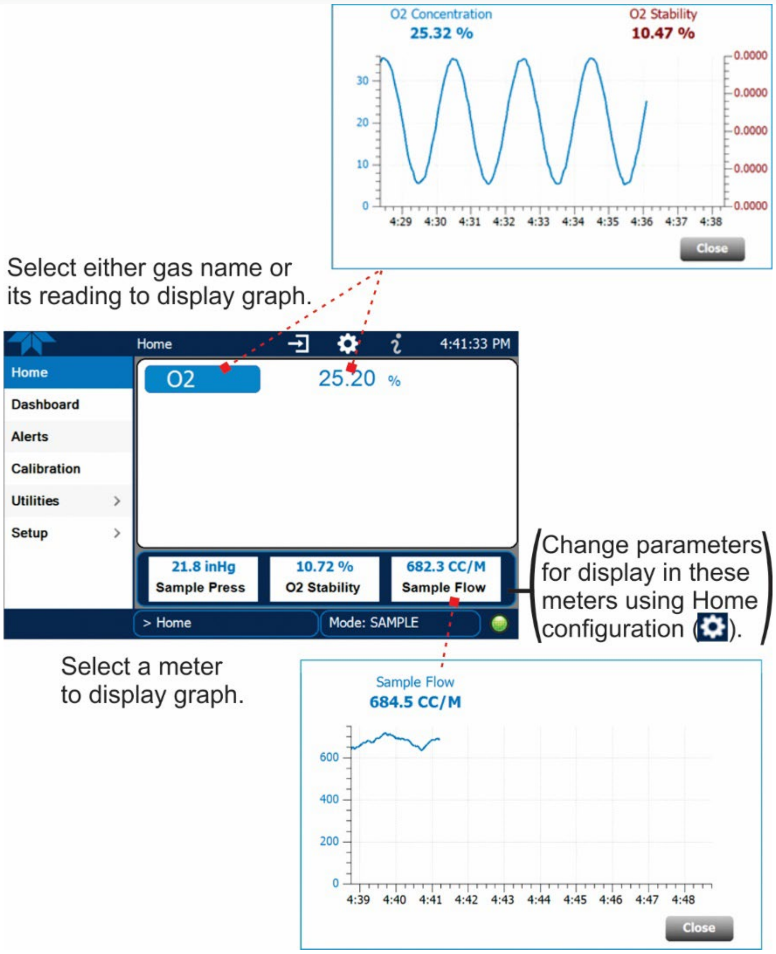


Figure 2-15. Concentration and Stability Graph (top) and Sample Flow Graph (bottom)

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 2-16.

Figure 2-16. 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 2-17).

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

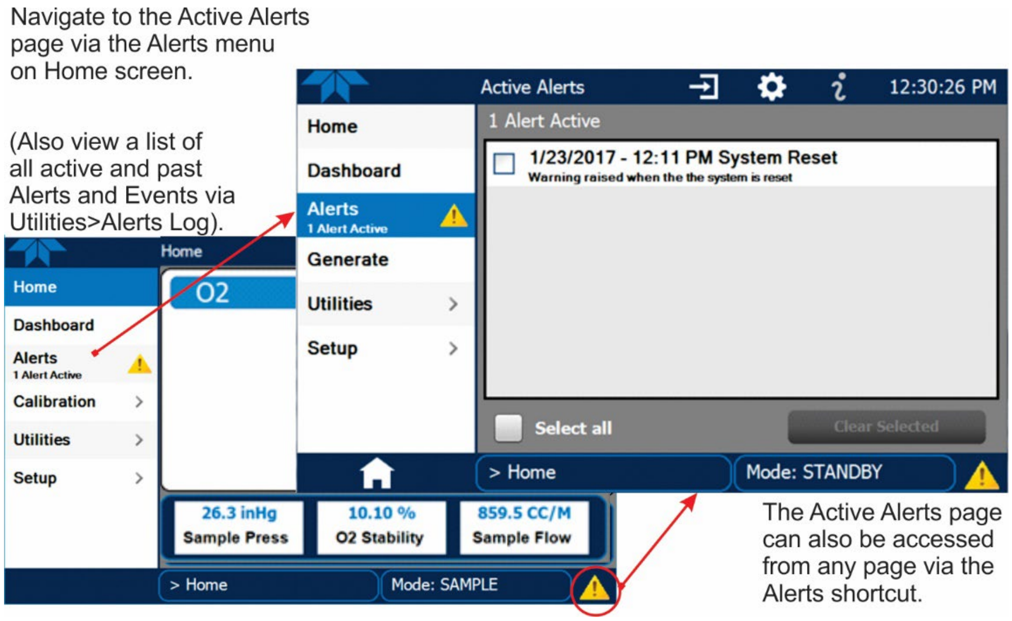


Figure 2-17. Navigating to the Active Alerts Page

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 2-18). However, Alerts can reappear if the conditions causing them are not resolved.

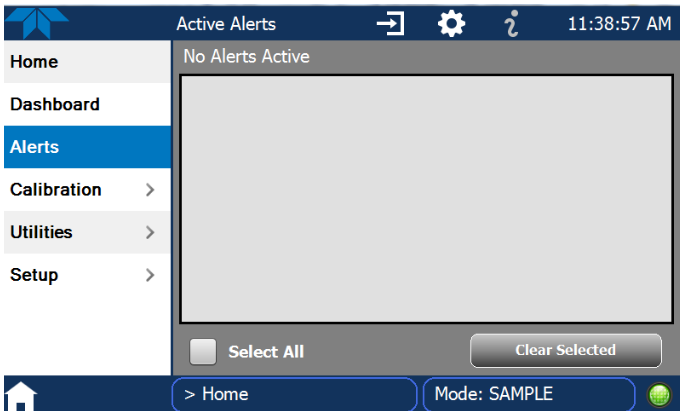


Figure 2-18. Active Alerts Cleared

Alerts and Events remain recorded in the Utilities>Alerts Log (Figure 2-19).

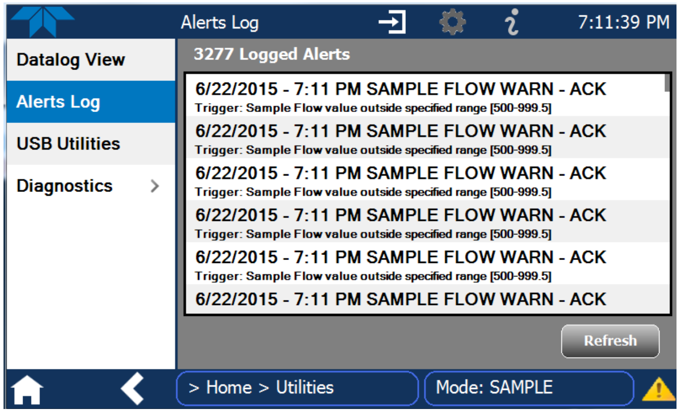


Figure 2-19. Utilities>Alerts Log of Active and Past Alerts and Events

2.4.4 Calibration

The Calibration menu is used for zero and span calibrations, the procedures for which are presented in Section 4.

2.4.5 UTILITIES

The Utilities menu has a variety of functions as described next in Table 2-7.

Table 2-7. 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	Show raw 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 (option)	Show the Voltage or Current signals for the functions selected and configured in the Setup>Analog Outputs menu (Section 2.5.7).
	Digital Inputs (option)	Turn ON or OFF digital inputs for specific available features.
	Digital Outputs (option)	Show the function of user-specified parameters configured in the Setup>Digital Outputs menu (Section 2.5.6).
	Flow Cal	Used to calibrate the sample gas flow reading with actual flow measured by an external device. (See Section 5.6.4).

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 2-20 shows a new log; Figure 2-21 shows a sample existing log, which can be edited or deleted, and Figure 2-22 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.

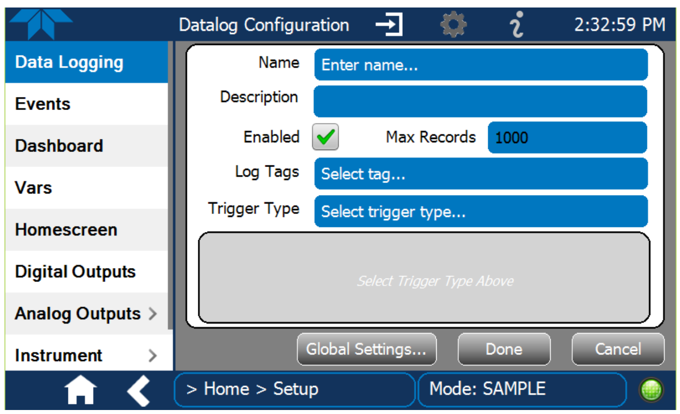


Figure 2-20. Datalog Configuration, New Log Page

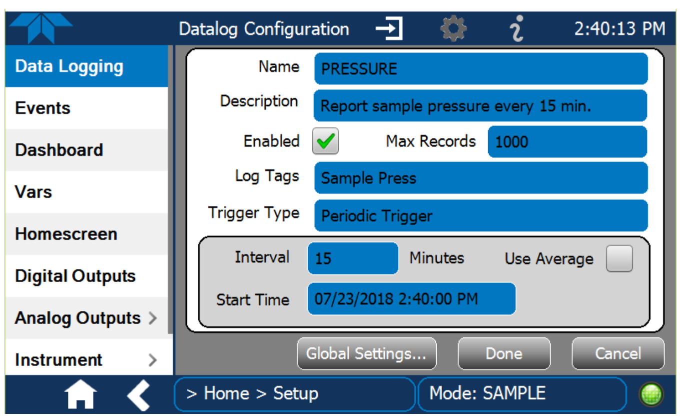


Figure 2-21. Datalog Configuration, Existing Log

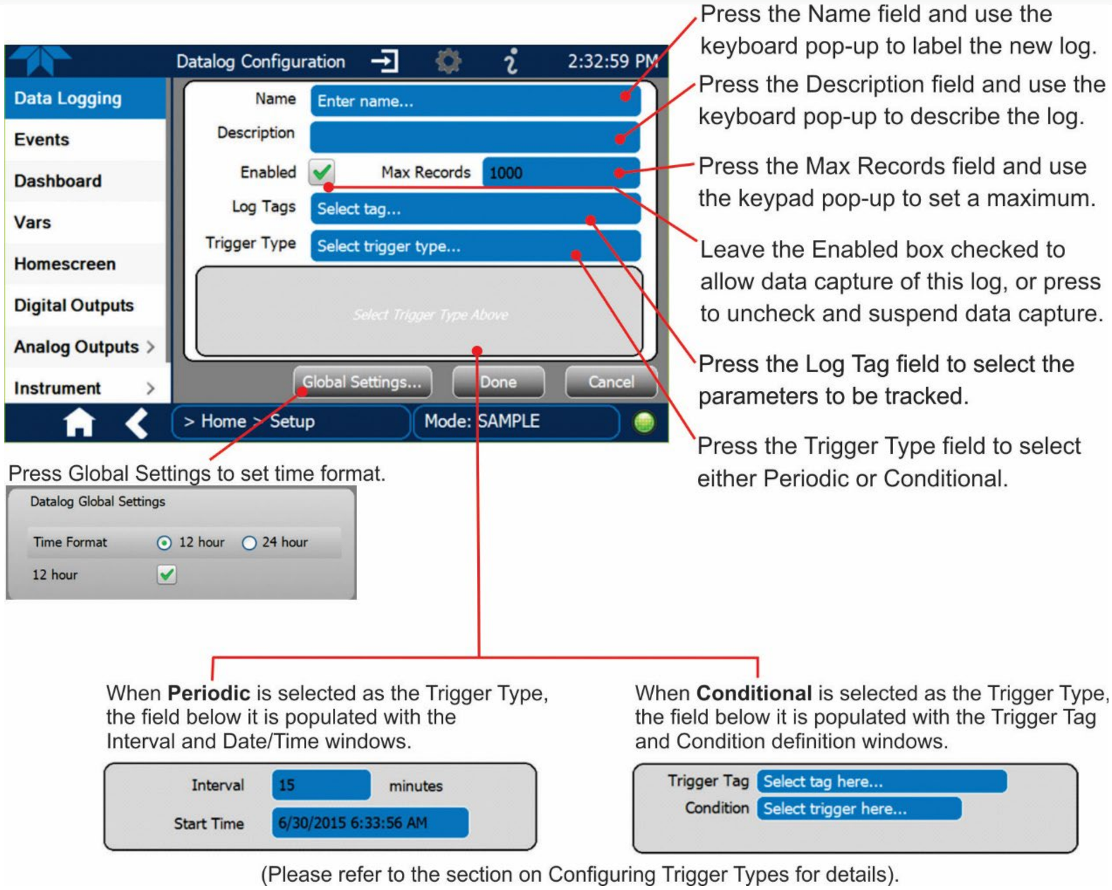


Figure 2-22. Creating a New Data Log

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.

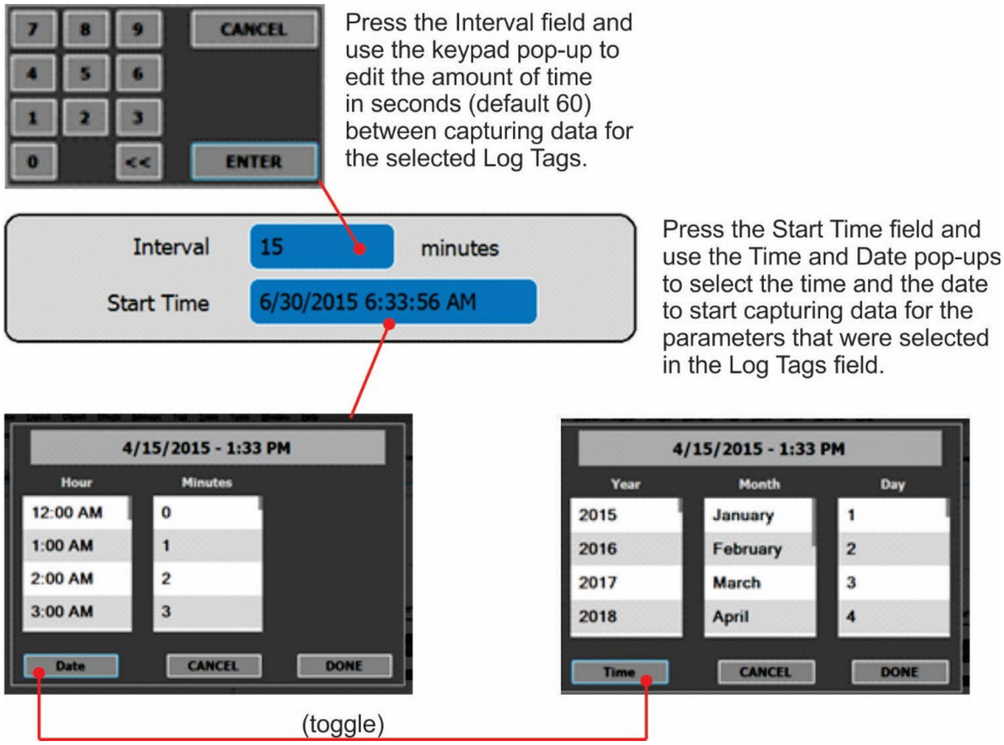


Figure 2-23. Datalog Periodic Trigger Configuration

2.5.1.2 CONFIGURING TRIGGER TYPES: CONDITIONAL

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

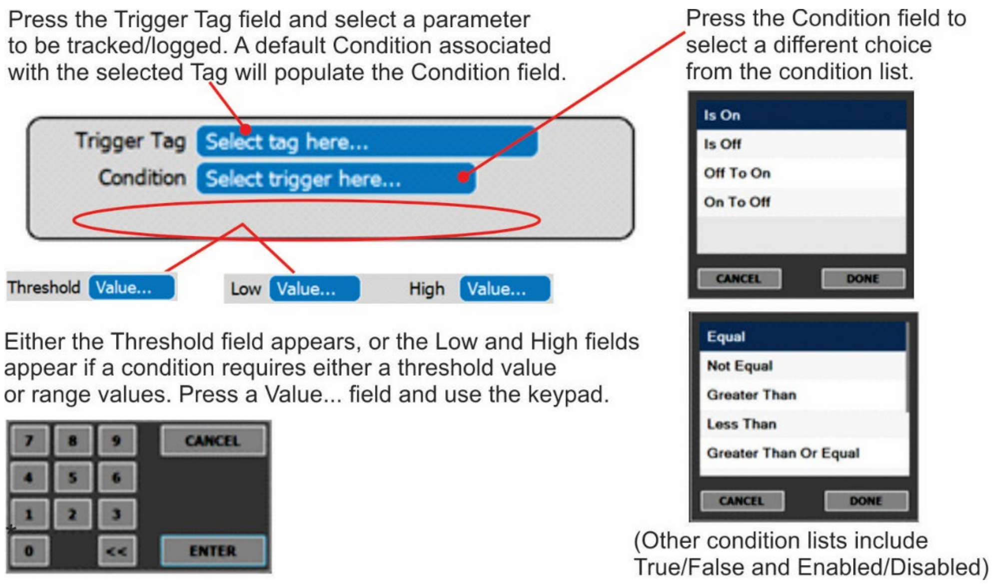


Figure 2-24. Datalog - Conditional Trigger Configuration

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.

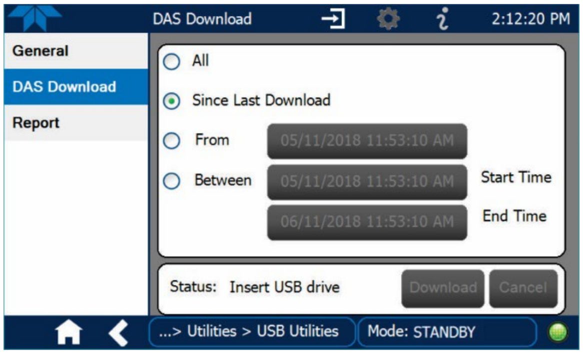


Figure 2-25. DAS Download Page

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 2-26) under the Setup menu.

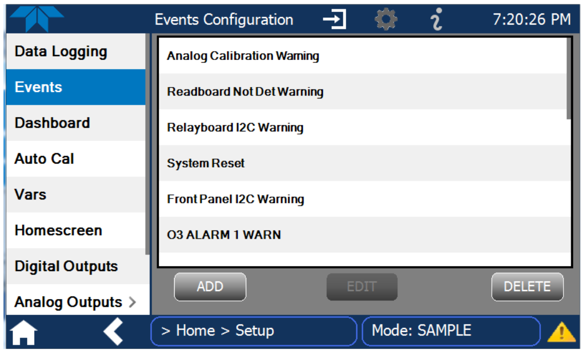


Figure 2-26. Events List

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 2-26). Press ADD to create a new Event (refer to Figure 2-27 for details), or select an existing Event to either Edit or Delete it (Figure 2-29).

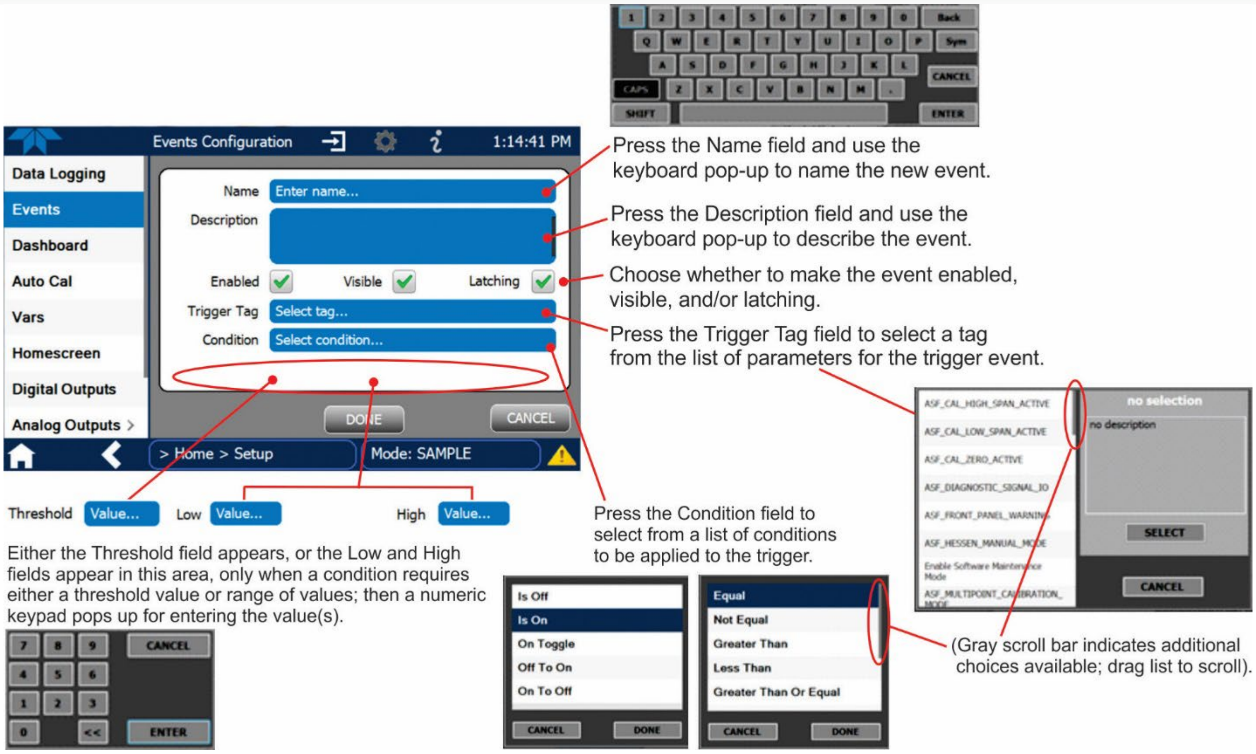


Figure 2-27. Event Configuration

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).

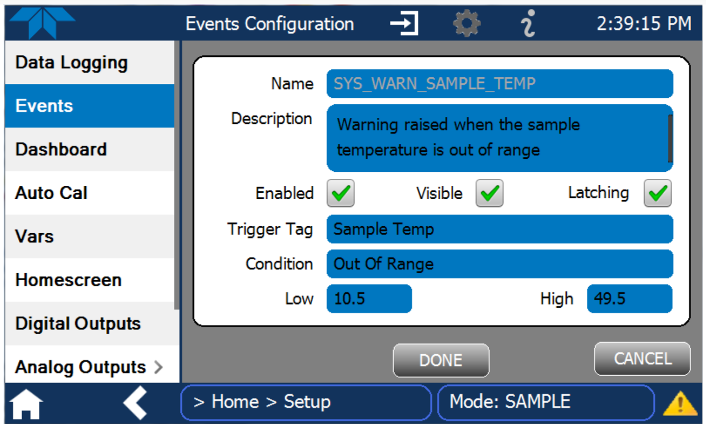


Figure 2-28. Configured Event Sample

2.5.2.1 EDITING OR DELETING EVENTS

Select an Event from the list (Figure 2-26) and press the Edit button to view or edit the details (Figure 2-28), or press the Delete button to delete the Event.

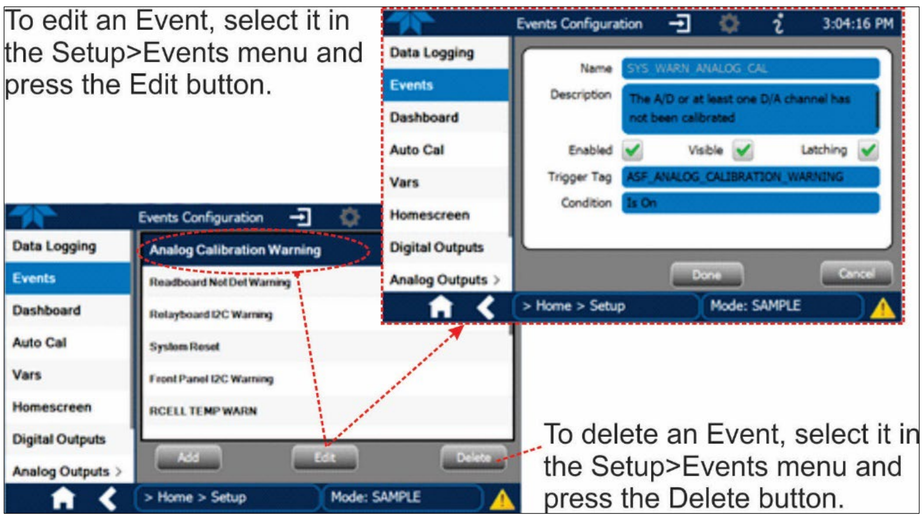


Figure 2-29. Edit or Delete an Event

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

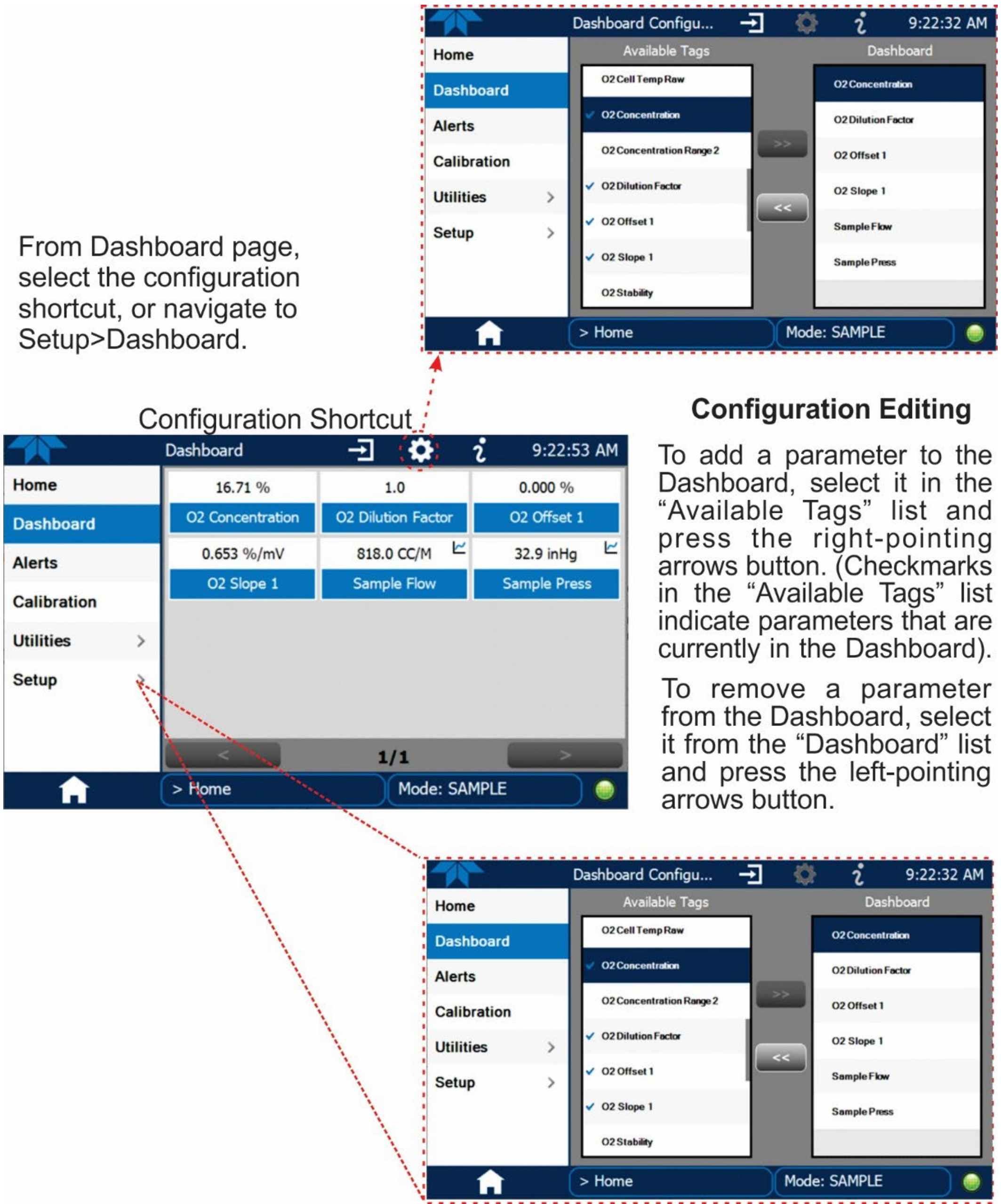


Figure 2-30. Dashboard Display and Configuration

2.5.4 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 2-8 describes some of the Vars.

Table 2-8. 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 Enable	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 gas concentration calculations so that the true (undiluted) concentration values are shown on the instrument's front panel display and reported via the instrument's various outputs. To add the appropriate scaling factor: 1. First, check that the analyzer's measurement units are the same as those used for determining the amount of dilution. (The analyzer's measurement units can be changed in the Setup>Vars>User Units menu). 2. Then, set the Dilution Factor Var as a gain to reflect the dilution ratio that was determined. For example, if the amount of dilution is found to be 20 parts diluent to 1 part sample gas (a dilution ratio of 20:1), the gain to be input into the Setup Vars Dilution Factor should be 20 (most common dilution ratio is 100:1). 3. 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 (a concentration that matches the diluted gas concentration prior to having input the Dilution Factor).
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).
Maint 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.
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).
Service Period Clear	Used to restart timer to track duration from when instrument is serviced until next service.
System Hours	Total system runtime hours.
Upload Report to Cloud	Allows (True) or denies (False) instrument to upload report to cloud service.

2.5.5 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 2-31).

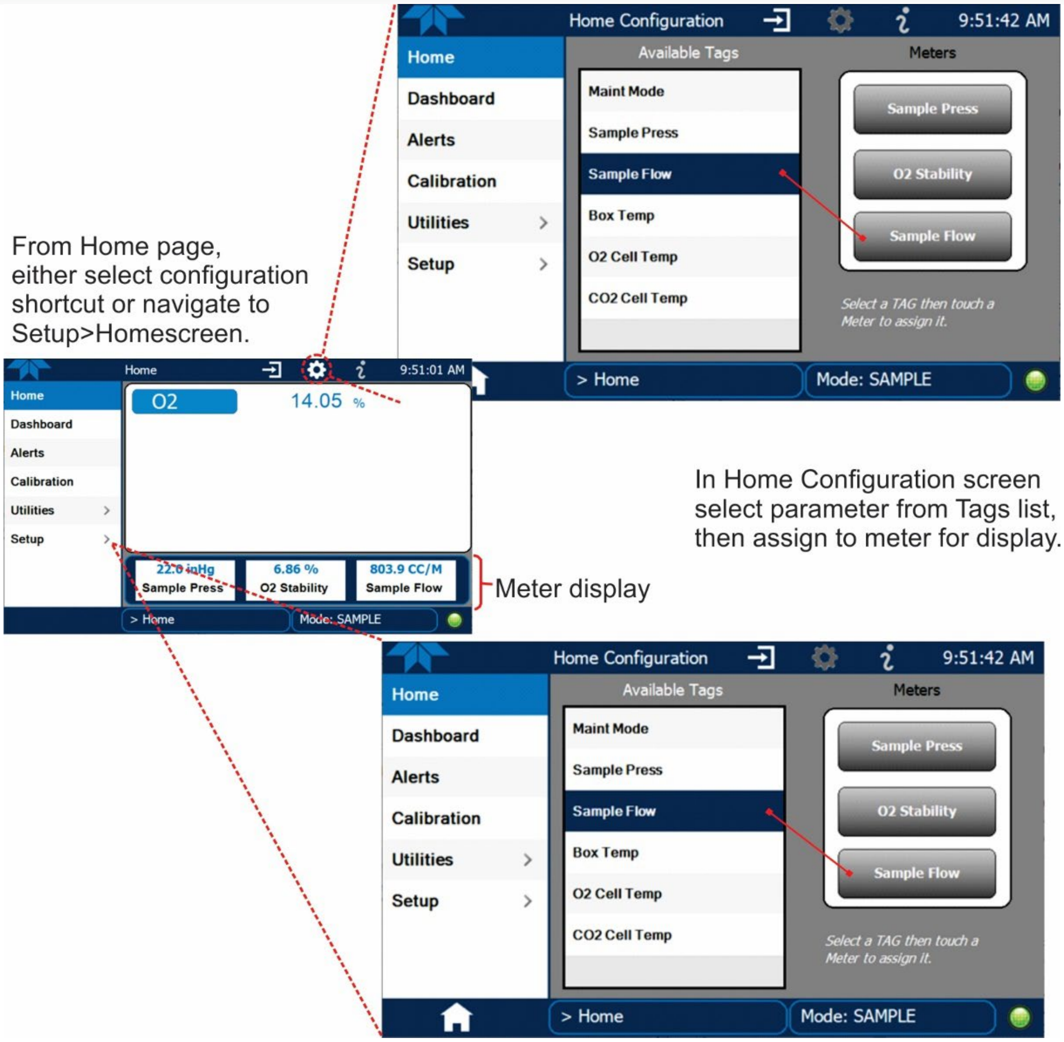


Figure 2-31. Homescreen Configuration

An orientation to the Homescreen was presented in Section 2.4.1, including Figure 2-14 and Figure 2-15.

2.5.6 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.

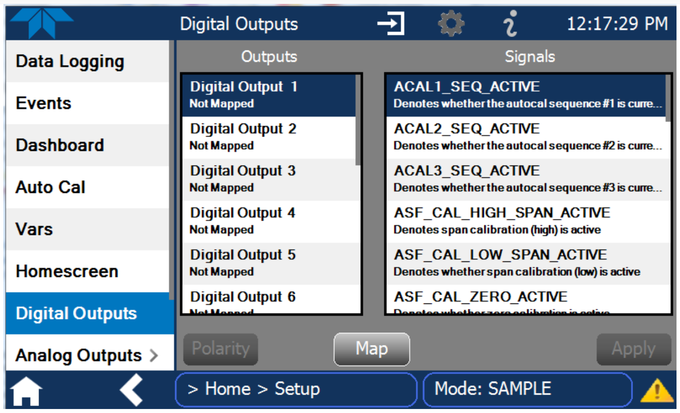


Figure 2-32. Digital Outputs Setup

2.5.7 SETUP>ANALOG OUTPUTS

Map the four 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.

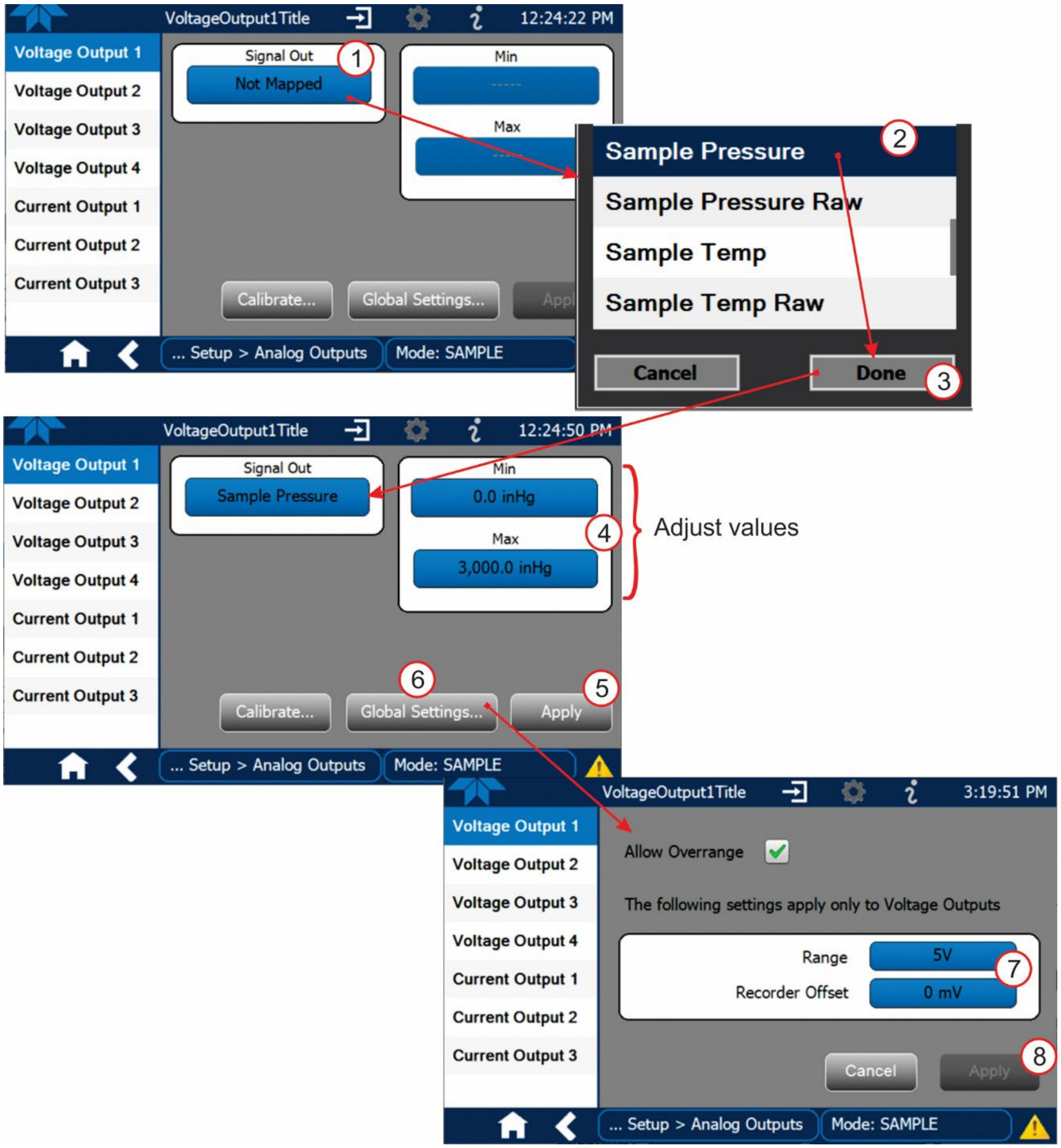


Figure 2-33. Analog Output Configuration for Voltage Output, Example

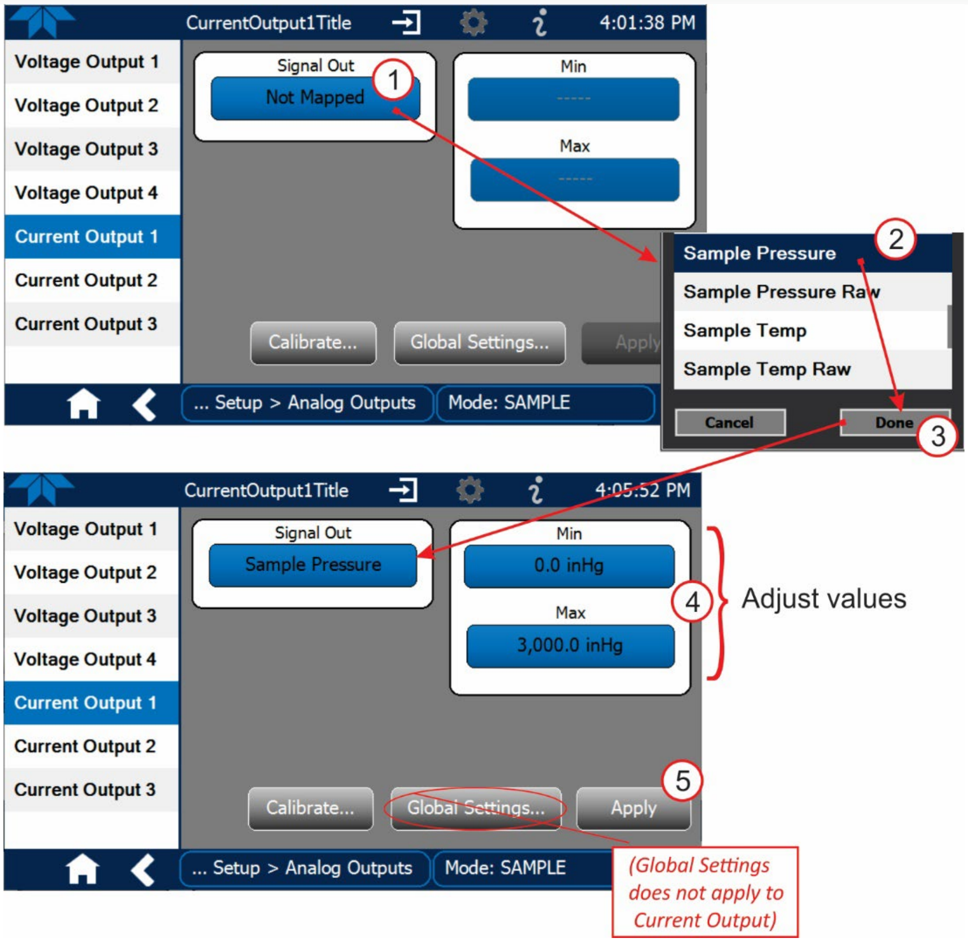


Figure 2-34. Analog Output Configuration for Current Output, Example

Refer to Figure 2-33 Voltage output) or to Figure 2-34 (Current Output) for the following:

1. Signal Out: select a Signal for the output and press Done.
2. Min/Max: edit minimum and maximum values associated with 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: assign a maximum voltage
   - For Current output, Global Settings does not apply. Skip to Step 5.

4. After completing the configurations, press the (Apply or Accept) button.
5. To calibrate, press the Calibrate button, then press the Start button to view the reading, and use the buttons in the Manual Adjust field to make incremental adjustments as needed (for Current output, press the +100 button several times to get the setting close to 4mA), noting the range and the minimum/maximum outputs shown in (Table 2-9.
6. Press the Accept button when adjustment complete.

Table 2-9. Analog Output Voltage/Current Range

RANGE[1]	RANGE SPAN	MINIMUM OUTPUT	MAXIMUM OUTPUT
5V	0-5 VDC	-1VDC	6 VDC
10V	0-10 VDC	-2 VDC	12 VDC
Current[2]	4-20 mA	3 mA	21 mA

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

Figure 2-35. Analog Output Calibration, Voltage or Current

For manual calibration adjustments, see Section 2.5.7.1 for voltage and Section 2.5.7.2 for current.

2.5.7.1 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 2-36) and changing the output signal level in the Manual Adjust field of the Analog Outputs Calibration screen Figure 2-35).

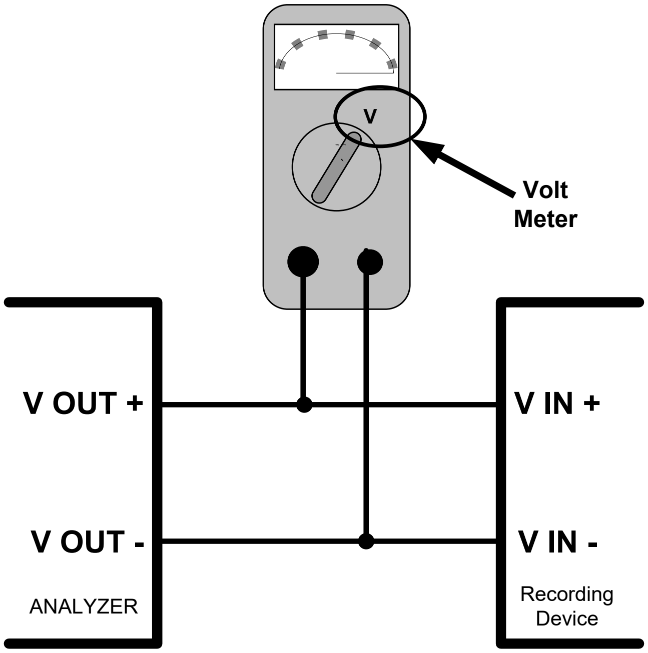


Figure 2-36. Setup for Checking / Calibrating DCV Analog Output Signal Levels

2.5.7.2 MANUAL ADJUSTMENT OF CURRENT RANGE ANALOG OUTPUTS

To manually calibrate the current signals, use an ampmeter (Figure 2-37) 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.

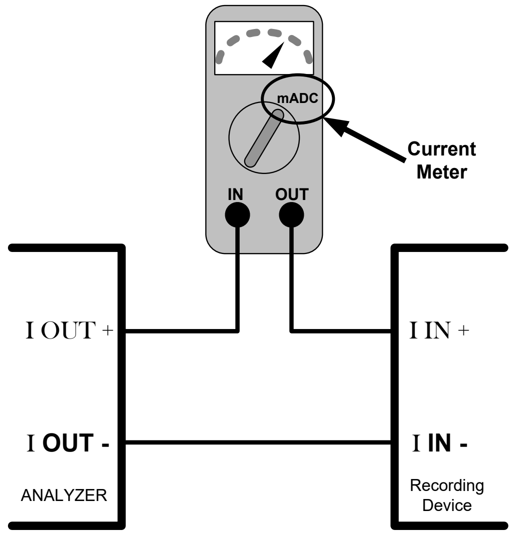


Figure 2-37. Setup for Checking / Calibration Current Output Signal Levels

2.5.8 SETUP>INSTRUMENT

As presented in Table 2-10, view product and system information and network settings, edit network settings, and perform certain maintenance tasks.

Table 2-10. 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).
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).

2.5.9 SETUP>COMM (COMMUNICATIONS)

This menu is for specifying the various communications configurations.

2.5.9.1 COM2

Configure the instrument's rear panel COM port to operate in modes listed in Table 2-11.

Table 2-11. COM Port Configuration

MODE	DESCRIPTION
Baud Rate	Set the baud rate for the COM port.
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: Hessen, MODBUS RTU, or MODBUS ASCII (Section 3.1.1); Hessen: Section 3.1.2), or 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).

2.5.9.2 TCP PORT2

TCP Port2 is configured with the port number for MODBUS.

2.5.9.3 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 2-12 for information).

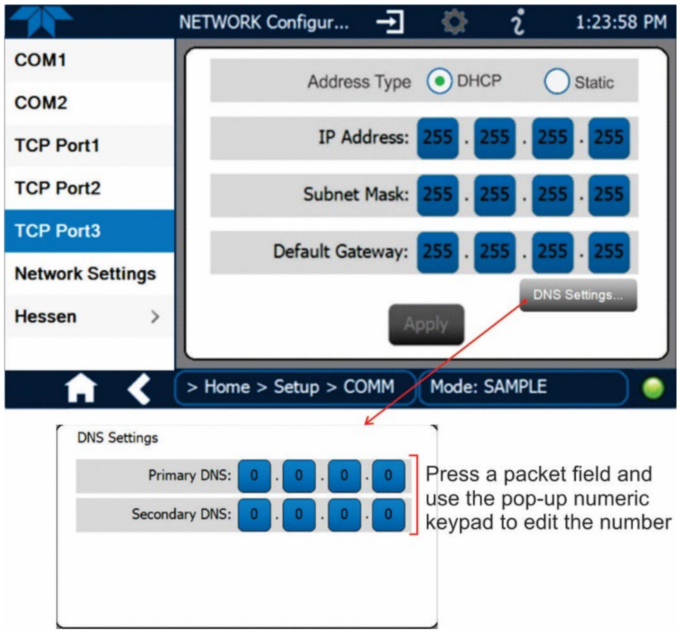


Figure 2-38. Communications Configuration, Network Settings

Table 2-12. 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.

2.5.9.4 HESSEN

Configure Hessen Settings and Gas List (see Section 3.1.2).

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.

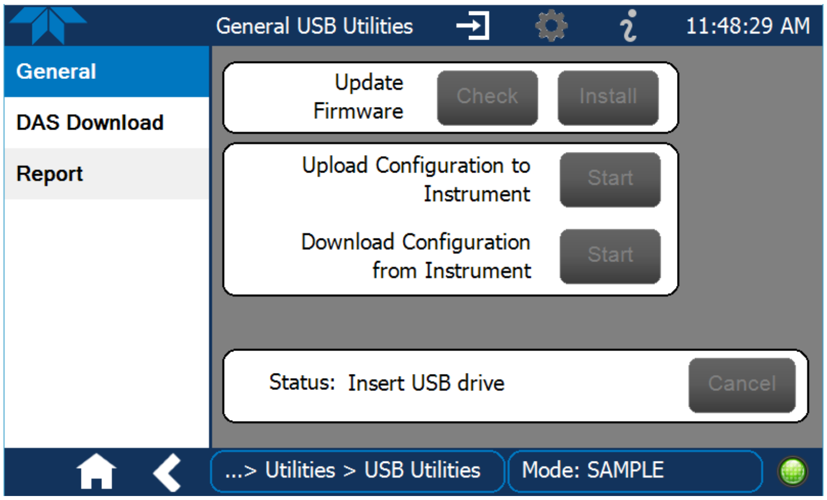


Figure 2-39. Configuration Transfer

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 rear panel connections include an Ethernet port and a serial communications port. Connection instructions were provided in Section 2.3.1.4. Configuration information was provided in Section 2.5.9.

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 operation (more common for PLCs) (Section 2.3.1.4).

Referring to Table 2-11, 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 3.1.1) 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 2-11).
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 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 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)**
Id	**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 product manuals, REST API Tutorial for NumaView™ Instruments.

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 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
green (link)	On when connection to the LAN is valid.
amber (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 2.5.9.3 for configuration details.

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 as well as 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.

Traceability Standards

Optional equipment: See section 4.1.6 for data recording devices.

Note	Zero air and span gases must be supplied at 1.5 to 2 times the instrument's specified gas flow rate.

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. Teledyne API recommends using pure N_2 when calibrating the zero point of your O_2 or optional CO_2 sensor option.

4.1.3 CALIBRATION (SPAN) GAS

Span gas is a gas specifically mixed to match the chemical composition of the type of gas being measured at near full scale of the desired measurement range. In this case, O_2 measurements made with the N802 analyzer, Teledyne API recommends using 21% O_2 in N_2 when calibrating the span point of the O_2 sensor option.

Cylinders of calibrated O_2 gas traceable to NIST-Standard Reference Material specifications (also referred to as SRMs or EPA protocol calibration gases) are commercially available.

4.1.4 Physical Range Measurements

Functionally, the N802 analyzers have one hardware PHYSICAL RANGE that is capable of determining O_2 concentrations from 0.00 % to 100.00 %.

This architecture improves reliability and accuracy by avoiding the need for extra, switchable, gain-amplification circuitry. Once properly calibrated, the analyzer's front panel will accurately report concentrations along the entire span of its physical range.

Because many applications use only a small part of the analyzer's full physical range, data resolution problems can occur for most analog recording devices. For example, in a typical application where a N802 is being used to measure atmospheric O_2 concentration, the full scale of expected values is only 21% of the instrument's full measurement range. Unmodified, the corresponding output signal would also be recorded across only 21% of the range of the recording device.

The N802 analyzers solve this problem by allowing the user to select a scaled reporting range for the analog outputs that only includes that portion of the physical range relevant to the specific application.

Only this REPORTING RANGE of the analog outputs is scaled, the physical range of the analyzer and the readings displayed on the front panel remain unaltered.

4.1.5 Interferents

It should be noted that other gases also react to magnetic influences and will be detected by the N802's paramagnetic sensor. Usually, this influence is extremely minor and can be disregarded; however, several gases, such as Nitrogen Dioxide (NO2) and Nitric Oxide (NO), have strong enough paramagnetic properties to be of concern.

If the Sample Gas to be measured contains high levels of these gases, the gases used for both the zero point calibration and the span calibration should contain the same components in the same proportion in order to cancel any interference effects. Performing calibrations with O2 mixed in N2 in such applications, could induce significant errors into the O2 measurements.

4.1.6 Data Recording Devices

A strip chart recorder, data acquisition system or digital data acquisition system can 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 a 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 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

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 and 4.2.2. after connecting the sources of zero air and span gas in either of the following two ways:

4.2.1 ZERO CALIBRATION CHECK AND ACTUAL CALIBRATION

1. Set up connections per Section 2.3.2.2.
2. Input Zero air through the Sample port and navigate to the Calibration menu. (If the CO_2 sensor option is installed, both O_2 and CO_2 appear).
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.

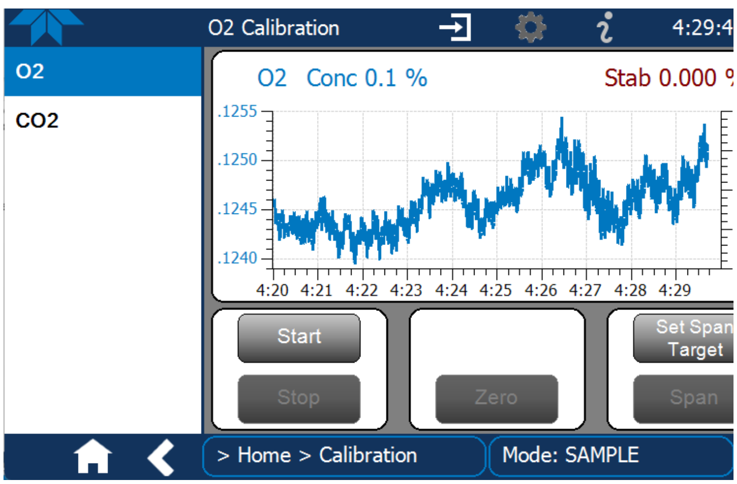


Figure 4-1. Calibration Menu for O_2 Sensor

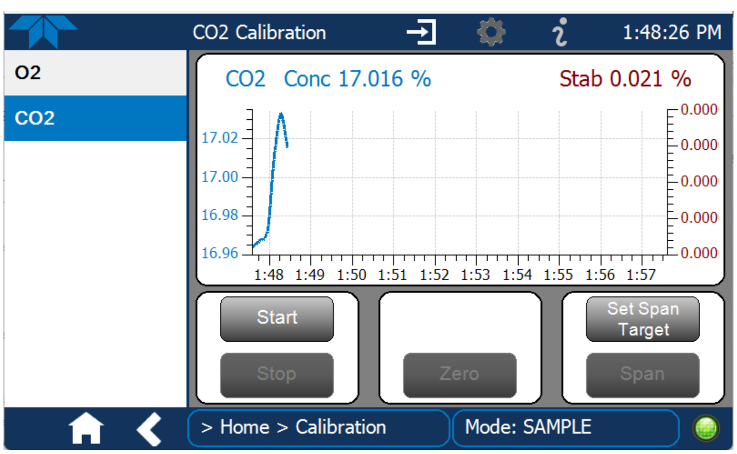


Figure 4-2. Sample Calibration Page for CO_2 Sensor

4.2.2 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 (either the % of O_2 in N_2 or % of CO_2 in N_2., depending on sensor being cal'd).
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 4-1 in Section 4.3 for expected/acceptable values).

4.3 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 Slope and Offset parameters.

Ensure that these parameters are within the limits listed in Table 4-1. If significantly different, refer to the troubleshooting Section 5.6.11.

Table 4-1. Calibration Data Quality Evaluation

FUNCTION	MINIMUM VALUE	OPTIMUM VALUE	MAXIMUM VALUE
SLOPE	0.700	1.000	1.300
Offset	-0.500	0.000	0.500

5 MAINTENANCE AND SERVICE

The N802 Paramagnetic Oxygen Analyzer utilizes a technology that is non-depleting and requires very little maintenance. However, there are a minimal number of simple procedures that when performed regularly will ensure that the analyzer continues to operate accurately and reliably over its lifetime. 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.

ATTENTION

COULD DAMAGE INSTRUMENT AND VOID WARRANTY

Failure to power down the instrument before disconnecting or reconnecting internal electrical assemblies can cause damage to the instrument. Always follow the Power Disconnection procedure provided in Section 2.3.1.1 before accessing the interior of the 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. The actual frequency of performing these procedures can vary depending on the operating environment. Additionally, in some cases, there are local regulations or standards that also need to be considered.

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

WARNING – ELECTRICAL SHOCK HAZARD

Disconnect power (using the Disconnection procedure provided in Section 2.3.1.1) before performing any of the following operations that require entry into the interior of the analyzer.

WARNING – STRONG OXIDIZER

Oxygen is a strong oxidizer. Before working with the casing open, be sure to follow the Disconnection procedure provided in Section 2.3.1.1 to turn off power supply, and perform air or N2 gas purging of not only the analyzer inside, but also the sample gas line.

In addition, carefully prevent oil and grease from adhering to any piping. Otherwise, poisoning, fire or explosion may be caused due to gas leakage, etc..

CAUTION – QUALIFIED PERSONNEL

These maintenance procedures must be performed by qualified technicians only.

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 and 4.2.2, respectively.

Table 5-1. Maintenance Schedule

ITEM	ACTION	FREQ	CAL CHECK REQ'D	DATE PERFORMED									
Dashboard functions	Review and evaluate (Section 2.3.4.3)	Weekly	No										
[1] Particulate (long-life) filter	Change (Section 5.6.1)	Annually or as needed	No										
Zero/span check	Evaluate offset and slope (Section 4.2)	Weekly	No										
[1] Zero/span calibration	Calibrate Zero and span (Section 4.2)	As required per zero/ span check or onsite SOPs	Yes										
[1] Flow	Check Flow (Section 5.6.4.1)	Every 6 months	No										
Software/ Firmware	Check for updates (Section 5.4)	Every 6 months or as set in Vars (also see Section 5.4)	Yes										
Pneumatic sub-system	Check for leaks in gas flow paths and examine lines and clean lines as needed (Section 5.6.3)	Annually or after repairs involving pneumatics	Yes if a leak is repaired or if lines cleaned										
[1] Pump Diaphragm	Replace (Section 5.6.2)	Annually or as needed	Yes										

[1] These Items are required to maintain full warranty; all other items are strongly recommended.

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 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

FUNCTION	CONDITION	BEHAVIOR	INTERPRETATION
Stability	O2 Zero Cal	Increasing	• Pneumatic leaks – instrument and sample system
Pressure	Sample	Increasing > 1"	• Pressurizing the sample pressure through the Sample port
		Decreasing > 1"	• Dirty particulate filter • Pneumatic obstruction between sample inlet and sensor • Obstruction in sampling manifold
Offset	Zero Cal	Increasing	• Pneumatic Leaks • Contaminated zero gas
		Decreasing	• Contaminated zero gas
Slope	Span Cal	Increasing	• Pneumatic Leaks – instrument & sample system • Calibration system deteriorating
		Decreasing	• Calibration system deteriorating

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.

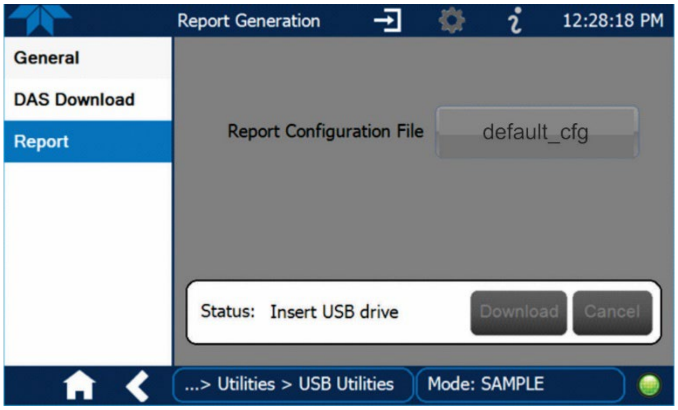


Figure 5-1. Report Generation Page

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.

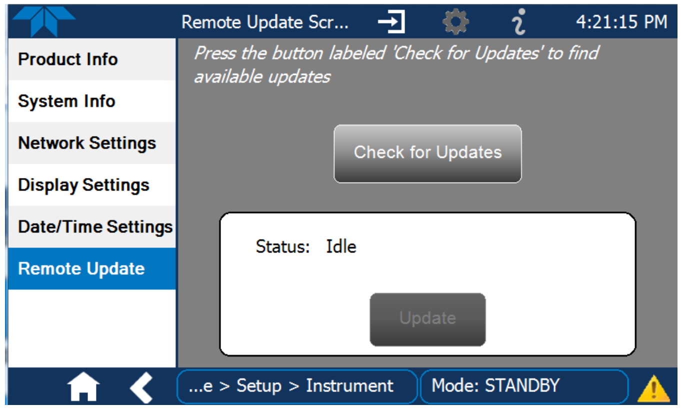


Figure 5-2. Remote Update Page

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.

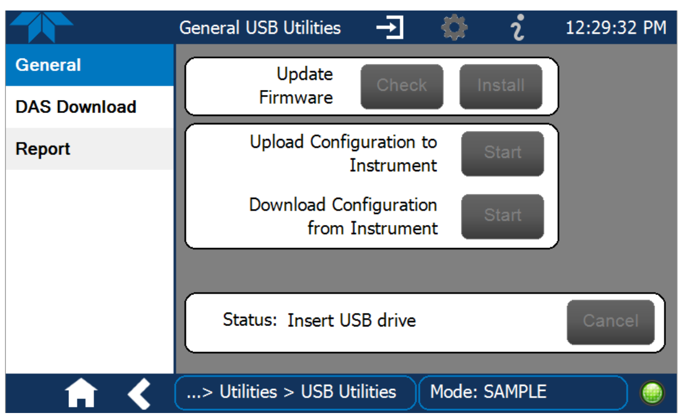


Figure 5-3. Manual Update Page (and other utilities)

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. Follow the Disconnection procedure provided in Section 2.3.1.1 to power off the instrument, then restart 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, follow the Disconnection procedure provided in Section 2.3.1.1 to power off the instrument; then 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.

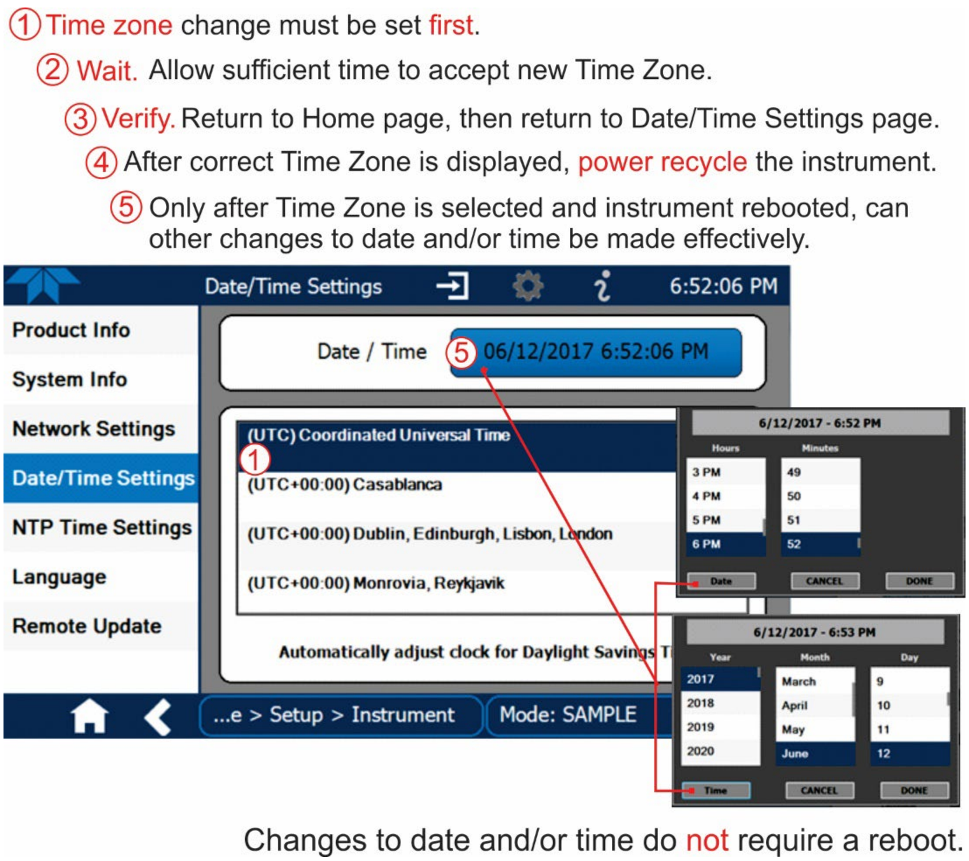


Figure 5-4. Time Zone Change Requirements

5.6 MAINTENANCE AND SERVICE

This section presents maintenance and service procedures as well as troubleshooting guidance.

5.6.1 Replacing the Long-Life Filter

If and when the long-life DFU filter needs to be replaced, the DFU is easily accessible for removal and replacement.

To replace:

1. Follow the Disconnection procedure provided in Section 2.3.1.1 **to p**ower OFF the analyzer. (This is to avoid data loss/corruption ad to prevent drawing debris into the instrument).
2. Access the old filter by lowering the hinged portion of the rear panel.
3. Noting the orientation of the filter, remove filter's tie-down and disconnect its fittings. Dispose of according to code.
4. Install the replacement filter in the same orientation.
5. Secure with tie-down.
6. Close and secure hinged rear panel, power up instrument, and allow time for conditioning.
7. Conduct zero and span calibrations and allow time to stabilize.

5.6.2 Replacing the Sample Pump Option Diaphragm

The diaphragm in the sample pump option periodically wears out (typically indicated by inconsistent flow and/or pressure readings) and must be replaced. A sample rebuild kit is available – see pump for the PN of the pump rebuild kit. Instructions and diagrams are included with the kit.

Always perform a Flow and Leak Check after rebuilding the Sample Pump.

5.6.3 Checking for Pneumatic Leaks

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

ATTENTION

COULD DAMAGE INSTRUMENT AND VOID WARRANTY

Avoid damaging the flow sensor or gas sensors: Do NOT abruptly increase or decrease pressure - maintain a gradual, controlled rate.

CAUTION - TECHNICAL INFORMATION

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

5.6.3.1 VACUUM LEAK CHECK AND PUMP CHECK

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

1. Turn the analyzer ON and allow enough time for flows to stabilize.
2. Cap the SAMPLE inlet port.
3. After several minutes, when the pressures have stabilized, note the Sample Press reading.
   - If the reading is < 10 in-Hg, the pump is in good condition and there are no large leaks.
4. Check the Sample Flow reading. If the flow is <10 cm3/min and stable, there are no large leaks in the instrument's pneumatics.

5.6.3.2 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.

5.6.3.3 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. Follow the Disconnection procedure provided in Section 2.3.1.1 to 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. 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.
6. Clean surfaces from soap solution, reconnect the sample and pump lines and replace the instrument cover.
7. Restart the analyzer.

5.6.4 Performing Flow Checks/Calibrations

Important

IMPACT ON READINGS OR DATA

For accurate measurement checks use a separate, calibrated, volumetric flow meter capable of measuring the instrument's flow specifications..

Because the sample gas flow rate through the analyzer is a key part of the gas concentration reading, 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, calibrated 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.

5.6.4.1 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 calibrated 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).

5.6.4.2 FLOW CALIBRATION

To calibrate the Sample flow (Flow Cal):

1. In the Utilities>Diagnostics>Flow Cal menu (Figure 5-5), 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.

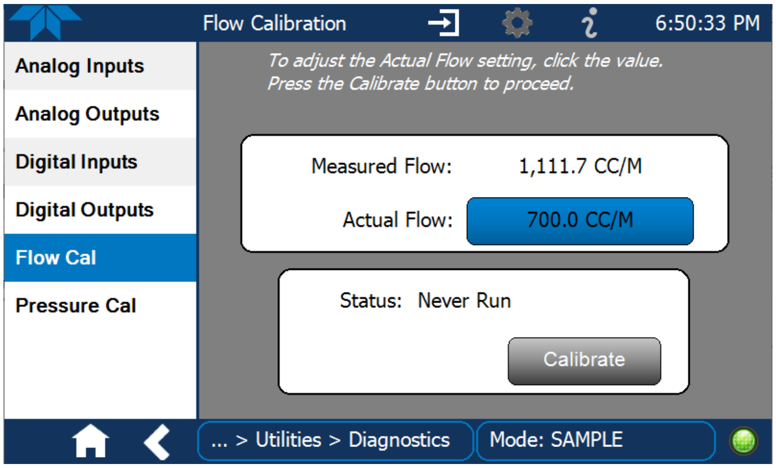
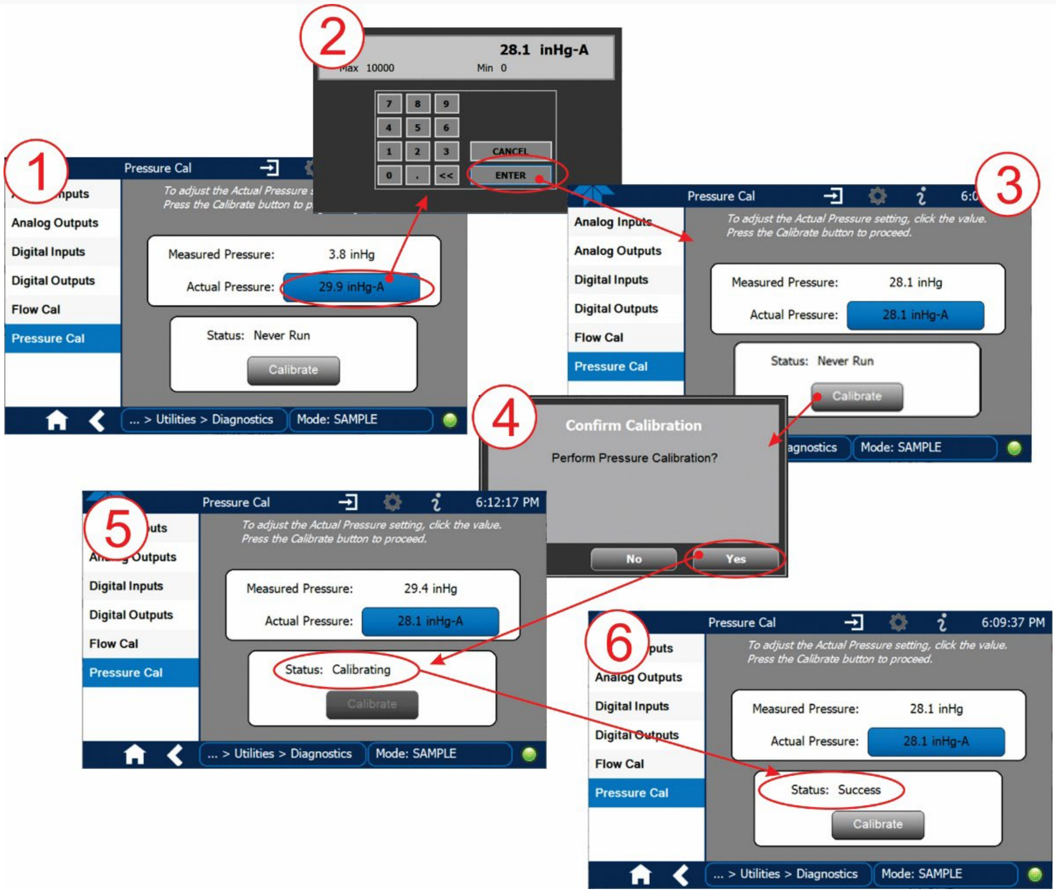


Figure 5-5. Flow Calibration Menu

5.6.5 PERFORMING PRESSURE CALIBRATION

A sensor at the exit of the sample chamber continuously measures the pressure of the sample gas. These data are used to compensate the final O_2 concentration calculation for changes in atmospheric pressure and are stored in the CPU's memory and displayed in the Dashboard as Sample Press (display configurable through Setup>Dashboard menu).

To adjust for the atmospheric pressure changes, power off the sample gas pumpfirst.



1. Navigate to the Utilities>Diagnostics>Pressure Cal menu and press the blue button in the Actual Pressure field.
2. Input the inches of mercury reading from an external barometer and press ENTER
3. Press the Calibrate button.
4. Press the Yes button to start performing calibration.

5.6.6 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
O2 CELL TEMP WARN	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 • Other electronic failure
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 limits
CONFIG INITIALIZED	Configuration and Calibration data reset to original Factory state or erased.	• User erased data
DATA INITIALIZED	Data Storage in DAS was erased before the last power up occurred.	• User cleared data.
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

5.6.7 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	INDICATED FAILURE(S)
Stability	High stability values indicate noise level of instrument or concentration of sample gas, which can be caused by pneumatic leak; defective preamp board; aging detectors.
Sample Flow	Gas flow problems can be caused by clogged critical flow orifice; pneumatic leak; faulty flow sensor; sample line flow restriction.
Box Temp	Out-of-range temperature reading could be caused by environment out of temperature operating range, stopped fan, or inadequate clearance for ventilation.
O2 Cell Temp	Incorrect temperature reading could be caused by high chassis temperature
Pressure	Incorrect sample gas pressure could be due to pneumatic leak; blocked particulate filter, sample inlet or vent line; clogged flow orifices; sample inlet overpressure; faulty pressure sensor
O2 Slope	Slope out of range could be due to: poor calibration quality; contaminated zero air or span gas supply, blocked flow, incorrect span gas concentration input.
O2 Offset	High offset could be due to: incorrect span gas concentration/contaminated zero air/leak.

5.6.8 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.

5.6.9 Fault Diagnosis with LEDs

The following illustrations show connectors and LEDs that can indicate where issues may lie. Figure 5-6 shows the layout for the mainboard, and Figure 5-7 shows the layout for the gas sensor board(s).

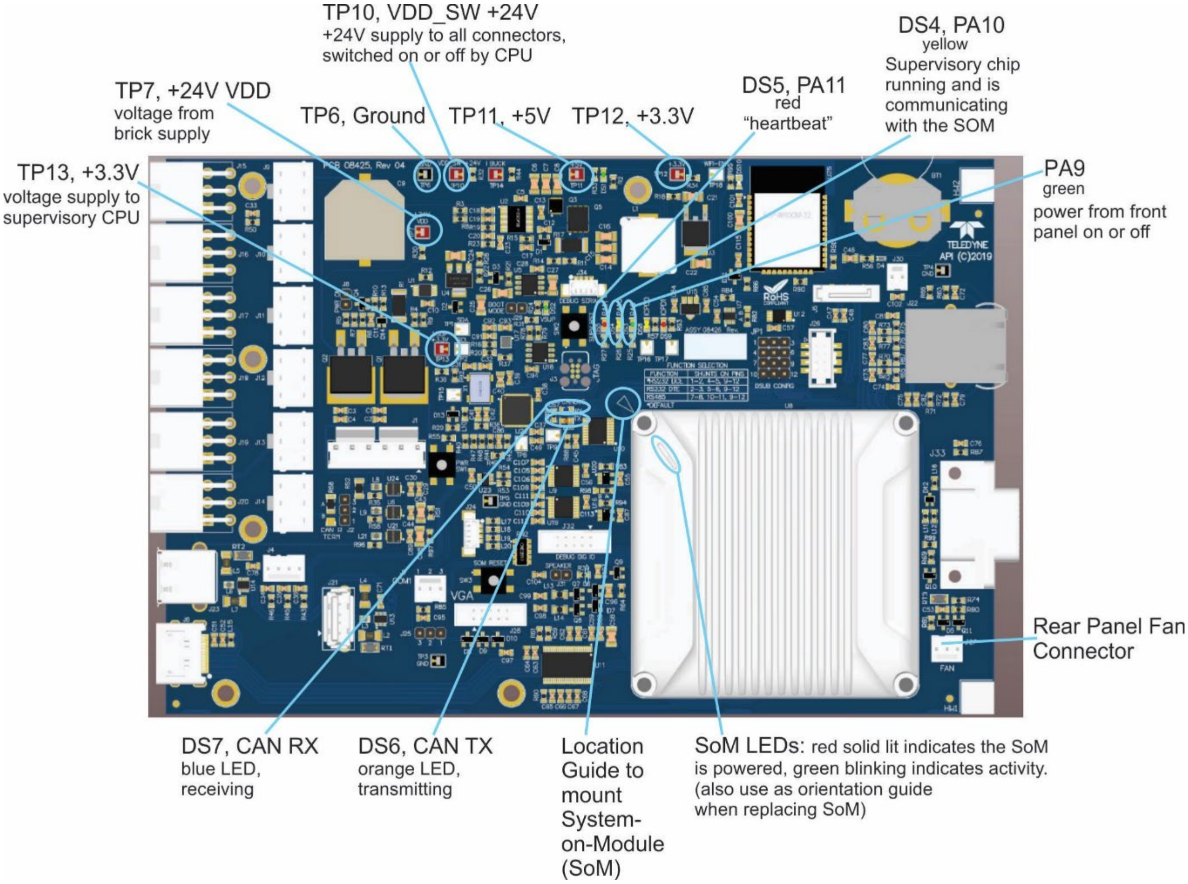


Figure 5-6. Mainboard

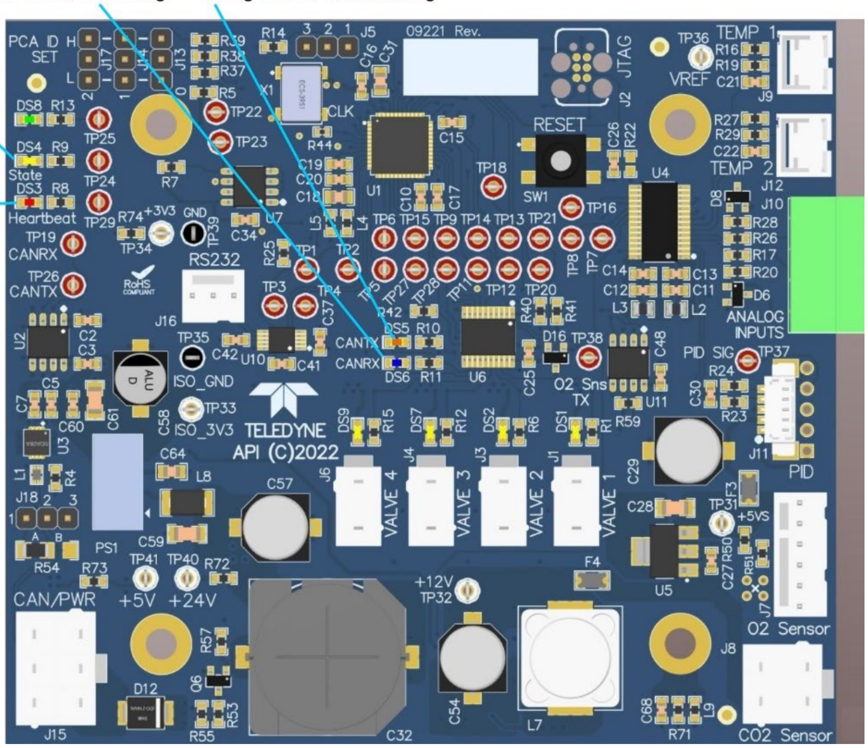


Figure 5-7. Sensor Board (for both the O2 and the CO2 option boards)

5.6.10 FLOW PROBLEMS

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, volumetric flow meter to perform a flow check as described in Section 5.6.4 is essential. Refer to the pneumatic flow diagrams as needed for reference.

Typically, flow problems are when flow is zero or low, or too high, or zero or low but analyzer reports correct readings, each of which is presented next.

5.6.10.1 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) shows nothing instead of a numerical value.

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 voltmeter to ensure that the pump is supplied with the proper power. 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 the 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 5.6.2.

    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.

3. If none of these suggestions help, carry out a detailed leak check of the analyzer as described in Section 5.6.3.3.

5.6.10.2 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 5.6.4), 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.

5.6.10.3 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.

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.

If the actual flow measured does not match the displayed flow, but is within the limits of 100-140 cm3/min, adjust the calibration of the flow measurement (Section 5.6.4.2).

5.6.11 CALIBRATION PROBLEMS

This section describes possible causes of calibration problems.

5.6.11.1 MISCALIBRATED

There are several symptoms that can be caused by the analyzer being miscalibrated. Miscalibration is indicated by out-of-range Slopes and Offsets as displayed through the test functions and is frequently caused by the following:

Bad span gas: This can cause a large error in the slope and a small error in the offset. Delivered from the factory, the N802's slope is within ±15% of nominal. Bad span gas will cause the analyzer to be calibrated to the wrong value. If in doubt have the span gas checked by and independent lab.

Contaminated zero gas: Excess H2O can cause a positive or negative offset and will indirectly affect the slope.

Dilution calibrator not set up correctly or is malfunctioning: This will also cause the slope, but not the zero, to be incorrect. Again the analyzer is being calibrated to the wrong value.

Too many analyzers on the manifold: This can cause either a slope or offset error because ambient gas with its pollutants will dilute the zero or span gas.

5.6.11.2 NON-REPEATABLE ZERO AND SPAN

As stated earlier, leaks both in the N802 and in the external system are a common source of unstable and non-repeatable readings.

1. Check for leaks in the pneumatic systems as described in Section 5.6.3. Don't forget to consider pneumatic components in the gas delivery system outside the N802, such as:

   A change in zero air source such as ambient air leaking into zero air line, or;

   A change in the span gas concentration due to zero air or ambient air leaking into the span gas line.

2. Once the instrument passes a leak check, do a flow check (See Section 10.3.4) to make sure adequate sample is being delivered to the sensor assembly.
3. Confirm the sample pressure, wheel temperature, bench temperature, and sample flow readings are correct and have steady readings.
4. Disconnect the exhaust line from the optical bench near the rear of the instrument and plug this line into the SAMPLE inlet creating a pneumatic loop. The concentration (either zero or span) now must be constant. If readings become quiet, the problem is in the external pneumatics supplies for sample gas, span gas or zero air.

5.6.11.3 INABILITY TO SPAN – NO SPAN BUTTON

1. Confirm that the oxygen span gas source is accurate; this can be done by opening the analyzer's SAMPLE inlet to ambient air. If the concentration is not displayed as ~20.9%, there is a problem with the span gas.
2. Check for leaks in the pneumatic systems as described in Section 10.3.3.
3. Make sure that the expected span gas concentration entered into the instrument during calibration, is the correct span gas concentration and not too different from expected span value. This can be viewed via the CONC submenu of the Sample displays.
4. Check to make sure that there is no ambient air or zero air leaking into span gas line.

5.6.11.4 INABILITY TO ZERO – NO ZERO BUTTON

1. Confirm that there is a good source of zero air. Dilute a tank of span gas with the same amount of zero air from two different sources. If the O2 Concentration of the two measurements is different, there is a problem with one of the sources of zero air.
2. Check for leaks in the pneumatic systems as described in Section 5.6.3.
3. Check to make sure that there is no ambient air leaking into zero air line.

5.6.12 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.

5.6.12.1 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 5.6.3.

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.

5.6.12.2 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 and pressures.

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 calibration gas source to become stable. Wait until stability is low.

5.6.13 SUBSYSTEM CHECK FOR TROUBLESHOOTING

The preceding sections of this manual discussed a variety of methods for identifying possible sources of failures or performance problems within the analyzer. In most cases this included a list of possible causes and, in some cases, quick solutions or at least a pointer to the appropriate sections describing them. This section describes how to determine if a certain component or subsystem is actually the cause of the problem being investigated.

5.6.13.1 AC MAIN POWER DISRUPTION

WARNING – ELECTRICAL SHOCK HAZARD

Should the instrument power off unexpectedly, investigate and correct the condition causing this situation before turning the analyzer back on.

The instrument operates with any of the specified power within the 100 VAC to 240 VAC, at 47 Hz to 63 Hz. Using the properly rated power cord, it will power on when the rear panel Hard Power switch is placed in the ON position. (If the power source is disrupted, the instrument will turn on once the power is restored). If the instrument doesn't start, check 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 5.6.14.2 to remove the fuse for testing.

If the fuse is blown, replace it with a fuse of the correct specifications as instructed in Section 5.6.14.2.

If the fuse is not blown, or if the replacement fuse blows, then call Technical Support (Section 5.8).

5.6.13.2 LCD/DISPLAY MODULE

Assuming that there are no wiring problems and that the DC power supply is operating properly, the display screen should light and show the splash screen and other indications of its state as the CPU goes through its initialization process. Once initialized, test the touch-screen by selecting a menu; if it doesn't respond, verify the screen's functionality by logging on to the instrument remotely with Teledyne API's NumaView™ Remote software. If the analyzer responds to remote commands and the display changes accordingly, then the touch-screen interface may be faulty. In that case, call Technical Support (Section 5.8).

5.6.14 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.

5.6.14.1 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 adhere to Disconnection procedure provided in Section 2.3.1.1 to power off the instrument before disconnecting or reconnecting any wiring when uninstalling/installing modules. Failure to do so will damage certain PCAs.

1. Follow the Disconnection procedure provided in Section 2.3.1.1 to 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 any tubing connected to the module.

4. Unplug electrical connection(s) to the module (see Figure 5-8 for O2 sensor board, Figure 5-9 for CO2 sensor option board, and Figure 5-10 for pump controller connections).

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.

Note **Ensure to carry out a leak check (Section 5.6.2) and a recalibration after the analyzer has warmed up for about 60 minutes.**

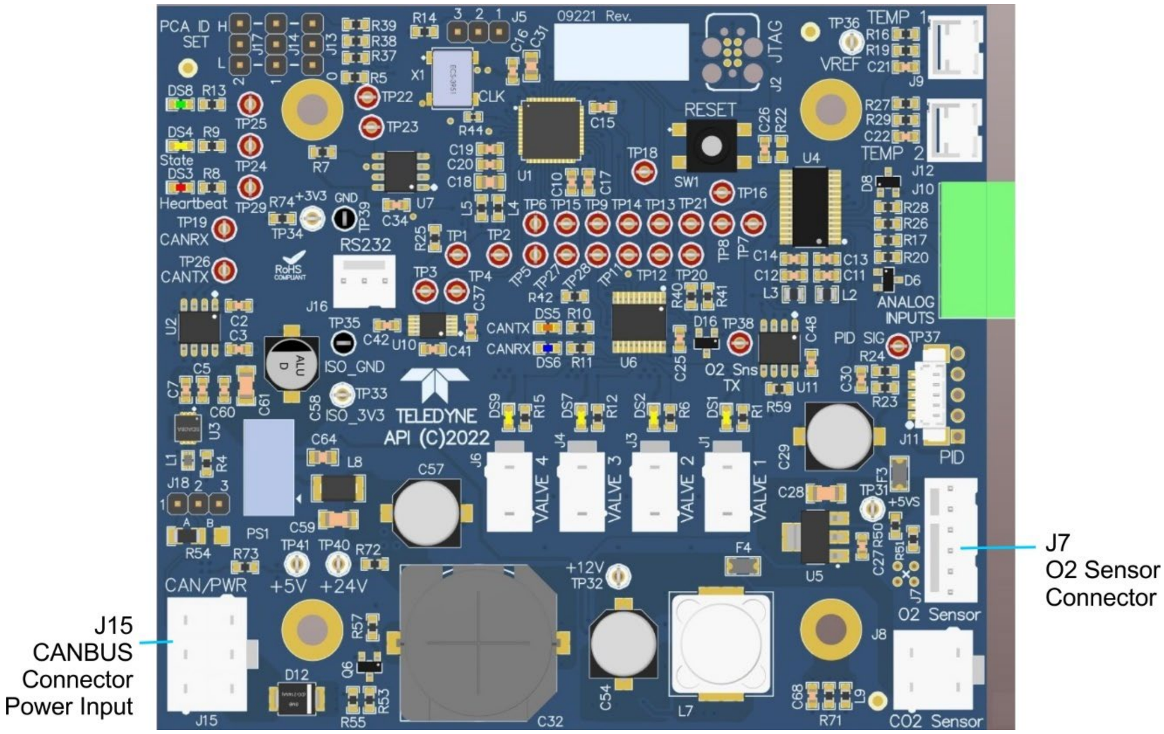


Figure 5-8. O_2 Sensor Connectors

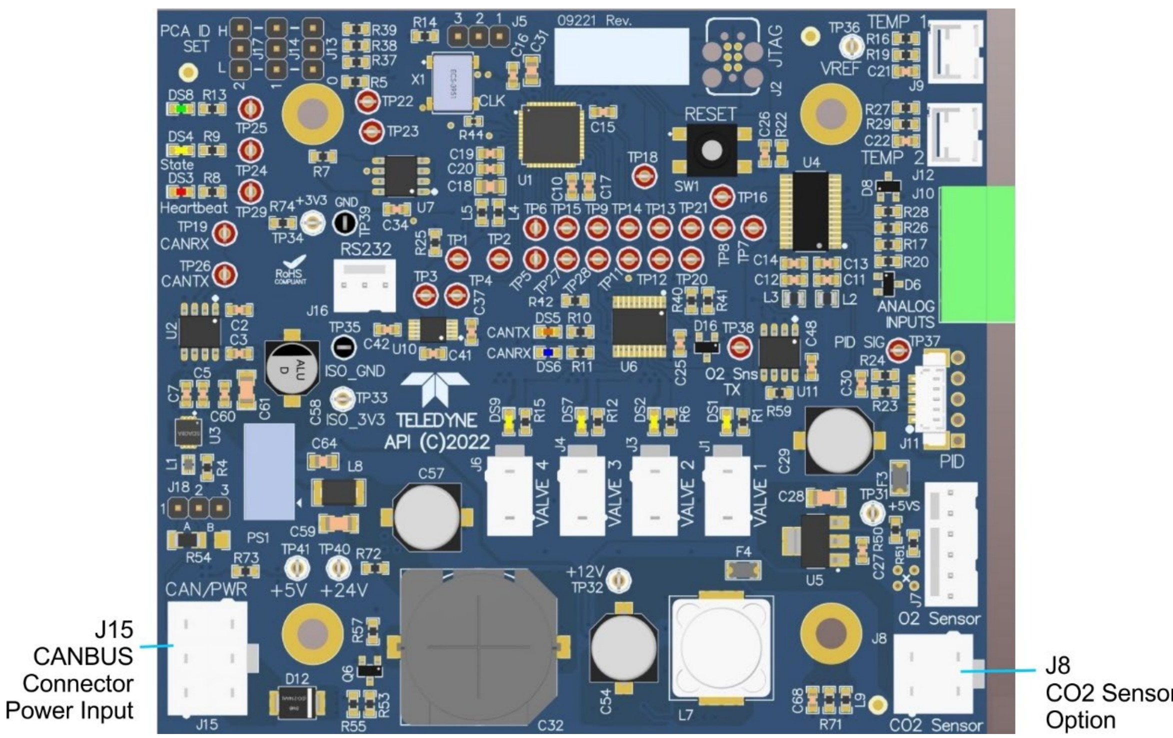


Figure 5-9. CO_2 Sensor Option Connectors

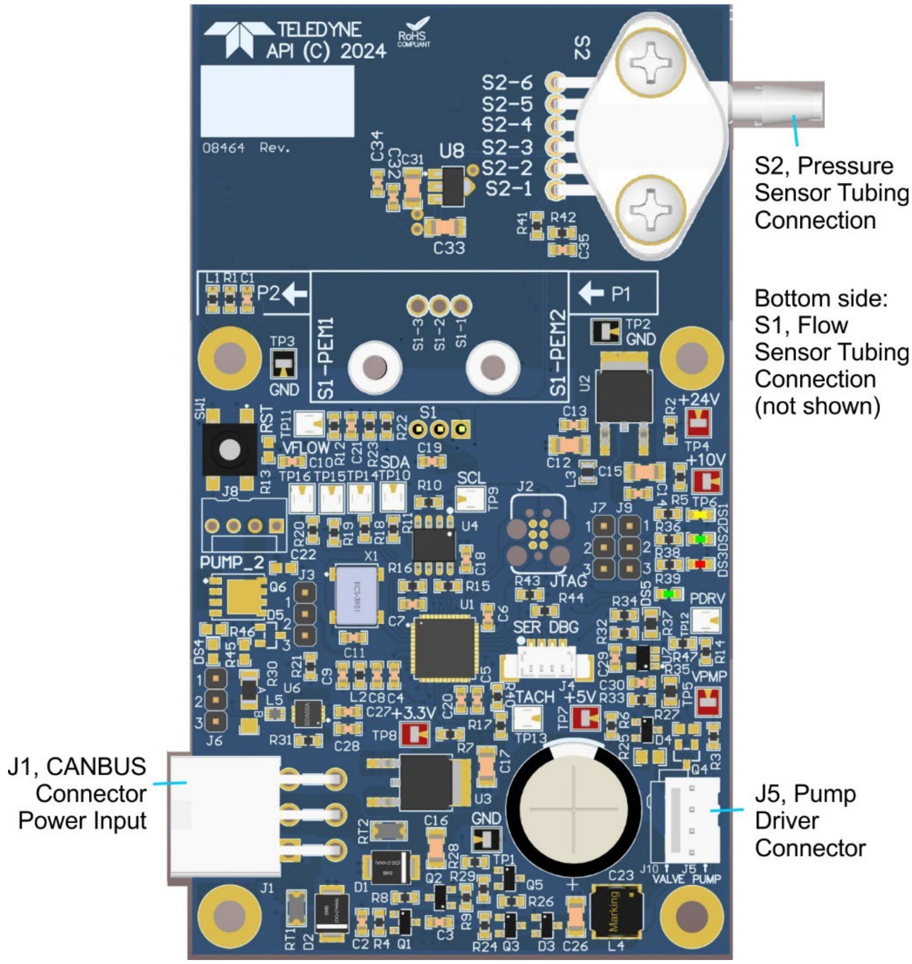


Figure 5-10. Pump Control Board Connections

5.6.14.2 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 5.6.13.1, 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 5.8).

WARNING – ELECTRICAL SHOCK HAZARD

Never pull out fuse drawer without following the Disconnection procedure provided in Section 2.3.1.1 and disconnecting the power cord to ensure there is no power to the instrument before checking/changing fuse.

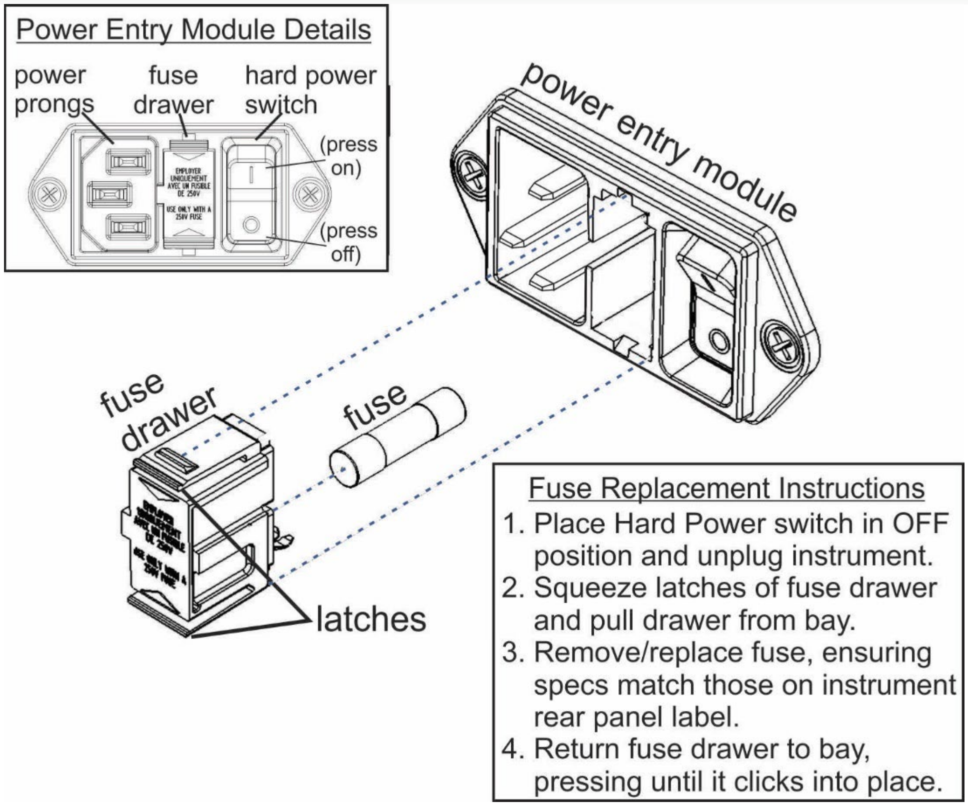


Figure 5-11. Fuse Access

5.7 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. After 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 4.2.2.
How do I measure the sample flow?	For accurate measurement, attach a calibrated, volumetric 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 5.6.4).

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 often does optional internal sample pump need to be rebuilt?	While the pump is designed to last many years, the diaphragm may need to be replaced every couple of years.. 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) and ensure the pin assignments are correct (Section 2.3.1.4 under Serial Connection. • The baud rate of the analyzer’s COM port does not match that of the serial port of your computer/data logger (Table 2-11).
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.
How do I set up and use the contact closures (Control Inputs) on the rear panel of the analyzer?	See Section 2.3.1.3.

5.8 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

This section describes the principles of operation for the O_2 analyzer and its optional CO_2 sensor, as well as and its electronic and software operation.

6.1 OXYGEN (O_2) SENSOR

The O_2 sensor applies paramagnetics to determine the concentration of oxygen in a sample gas drawn through the instrument.

6.1.1 PRINCIPLE OF O_2 MEASUREMENT

Molecular oxygen, O_2, displays a particularly strong susceptibility to the effect of magnetic fields, due to the behavior of the electrons of the two oxygen atoms that make up the O_2 molecule. When the electrons in an orbital are paired, they spin in opposite directions from each other thereby canceling any magnetic field effects. On the other hand, unpaired electrons, such as those of an O_2 molecule, spin in the same direction as each other, increasing the aggregate magnetic field.

The type of paramagnetic sensor used in the N802 analyzer is called a magneto-mechanical sensor, which consists of a small dumbbell-shaped body (a sphere on either end) made of glass and filled with a gas of negative paramagnetic characteristic (in this case, N_2). The dumbbell body is suspended on a platinum fiber within the magnetic field of a permanent magnet in such a way that it is free to rotate. Because the N_2 inside the spheres has a small opposite magnetic charge from the field of the permanent magnet, the dumbbell's resting (neutral) position is slightly deflected away from the strong point of the field.

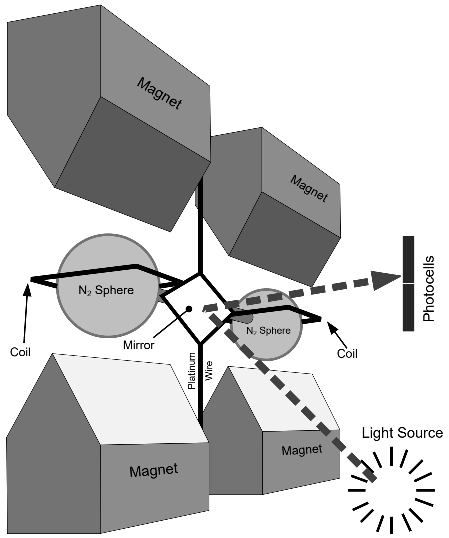


Figure 12 1. Paramagnetic O_2 Sensor Design

When sample gas containing oxygen flows into the magneto-mechanical sensor, the O_2 molecules are drawn toward the strong point of the magnetic field. This causes the N_2 filled spheres to deflect even more so that the suspended dumbbell body pivots on the platinum wire. The more O_2 present the further the dumbbell body is deflected from its neutral position.

The position of the dumbbell is detected by a pair of photocells that receive a light beam reflected from a mirror attached to the center of the dumbbell body. As the dumbbell body pivots, the angle of the reflected light beam on the photocells changes. The resulting potential difference creates a current.

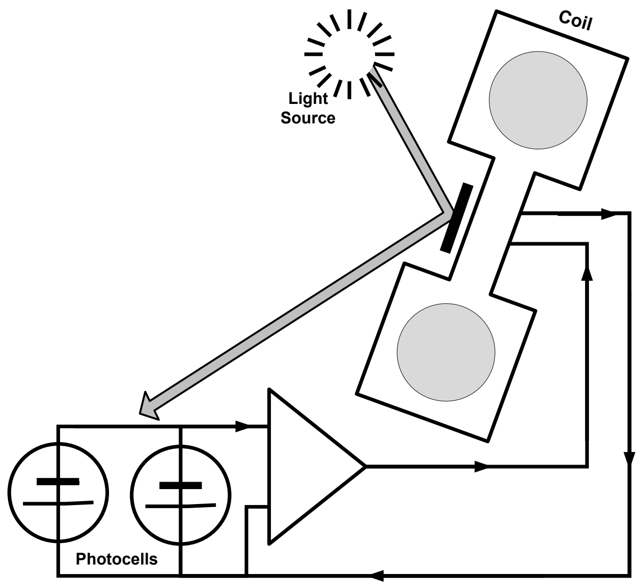


Figure 12 2. Paramagnetic O_2 Sensor Block Diagram

This current is passed to a feedback loop, which generates a second current to a wire winding (in effect, a small DC electric motor) mounted on the suspended mirror. The more O_2 present, the more the dumbbell and its attached mirror moves and the more current is needed to move the dumbbell back to its zero position. The sensor measures the amount of current generated by the feedback control loop which is directly proportional to the concentration of oxygen within the sample gas mixture.

6.2 CARBON DIOXIDE (CO2) SENSOR (OPTION)

The CO_2 sensor option is a silicon based Non-Dispersive Infrared (NDIR) sensor. It uses a single-beam, dual wavelength measurement method. Operationally, the CO_2 sensor is transparently integrated into the core analyzer operation. All functions can be viewed or accessed through the front panel, just like the functions for O_2. The CO_2 concentration range is 0-20%. See Section 9.5.1 for information on calibrating the CO_2.

6.2.1 PRINCIPLE OF CO_2 MEASUREMENT

An infrared source at one end of the measurement chamber emits IR radiation into the sensor's measurement chamber where light at the 4.3 µm wavelength is partially absorbed by any CO_2 present. A special light filter called a Fabry-Perot Interferometer (FPI) is electronically tuned so that only light at the absorption wavelength of CO_2 is allowed to pass and be detected by the sensor's IR detector.

A reference measurement is made by electronically shifting the filter band pass wavelength so that no IR at the CO_2 absorption wavelength is let through.

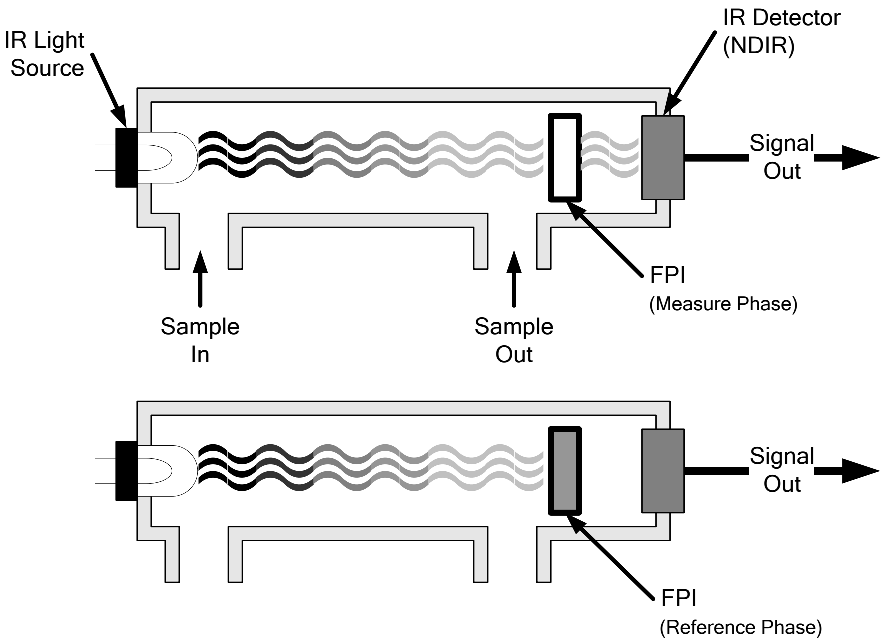


Figure 12 3. CO_2 Sensor Block Diagram

The sensor computes the ratio between the reference signal and the measurement signal to determine the degree of light absorbed by CO_2 present in the sensor chamber. This dual wavelength method of measuring CO2 allows the instrument to compensate for ancillary effects like sensor aging and contamination.

6.3 PNEUMATIC OPERATION

In pneumatic operation a pump evacuates the sample chamber creating a small vacuum that draws sample gas into the analyzer at near ambient pressure. When the CO_2 sensor option is installed, it is placed in line with the O_2 sensor and does not alter the gas flow rate of the sample through the analyzer

6.3.1 Flow Rate Control

To maintain a constant flow rate of the sample gas through the instrument, the N802 uses a special flow control assembly located in the exhaust gas line just before the optional internal pump or connected to the rear panel if using an external pump. The most important component of this flow control assembly is the critical flow orifice, which operates without moving parts by taking advantage of the laws of fluid dynamics. It restricts the flow of gas, which 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.

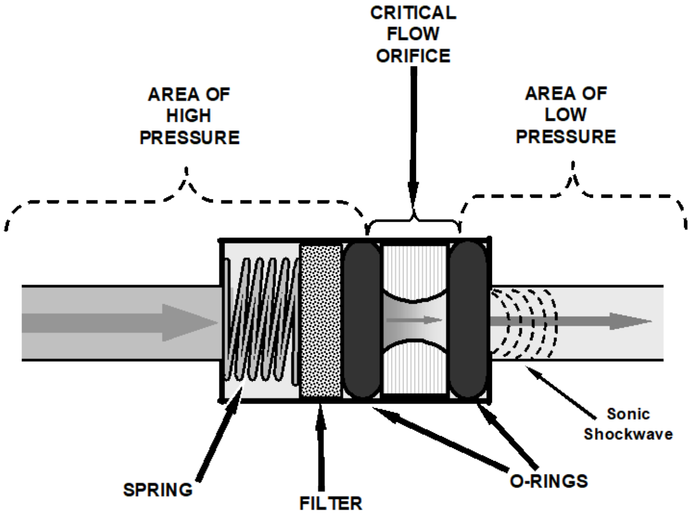


Figure 12 6. Flow Control Assembly & Critical Flow Orifice

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 N802 is designed to provide a flow rate of 120 cm3/min.

6.3.2 Sample Pressure Sensor

An absolute value pressure transducer on the Pump Controller PCA is used to measure sample pressure. The output of the sensor is used to compensate the concentration measurement for changes in ambient air pressure. This sensor is mounted to a printed circuit board along with the sample flow sensor on the sample chamber.

6.3.3 Sample Flow Sensor

A thermal-mass flow sensor is also located on the Pump Controller PCA and is used to measure the sample flow through the analyzer.

6.4 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 6.4.2), the Supervisory Chip directs the soft power-down of the internal components, to safely shut down processes and close connections to prevent data corruption.

6.4.1 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.

6.4.2 POWER SWITCHES

The front panel Soft Power switch is used to prevent data loss. When the instrument is initially powered on, the Supervisory Chip, located on the mainboard, manages the power up of the internal computer components and places them in operational mode (indicated by LED’s solid-lit state). When pressed and held until blinking, the Soft Power switch tells the Supervisory Chip to put the internal computer components through a soft-shutdown process.

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.

6.5 SOFTWARE OPERATION

The instrument’s software developed by Teledyne API interprets user commands via the various interfaces, performs procedures and tasks, stores data in the CPU’s various memory devices and calculates the concentration of the sample gas.

6.5.1 Adaptive Filter

The N802 software processes sample gas measurement and reference data through an adaptive filter built into the software. Unlike other analyzers that average the output signal over a fixed time period, the N802 averages over a set number of samples, where each sample is 1 second. This is technique is known as boxcar averaging. During operation, the software automatically switches between two different length filters based on the conditions at hand.

During conditions of constant or nearly constant concentration the software, by default, computes an average of the last 60 samples or 1 minute. This provides the calculation portion of the software with smooth stable readings. If a rapid change in concentration is detected the filter switches to 10 samples or 10 seconds measurement moving average to allow the analyzer to respond more quickly.

Two conditions must be simultaneously met to switch to the short filter. First, the instantaneous concentration must exceed the average in the long filter by a fixed amount (default setting is <2%). Second, the instantaneous concentration must exceed the average in the long filter by a portion, or percentage, of the average in the long filter (also <2% by default).

6.5.2 Calibration – Slope and Offset

Calibration of the analyzer is performed exclusively in software.

During instrument calibration the user enters expected values for zero and span 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 O_2 concentration of the sample gas.

The instrument slope and offset values recorded during the last calibration are viewable in the Dashboard (Setup>Dashboard to configure).

6.5.3 Temperature and Pressure Compensation

Changes in ambient pressure can have a noticeable effect on the O_2 and optional CO_2 concentration calculations. To account for this, the N802 software includes a feature that allows the instrument to compensate both the O_2 and optional CO_2 calculations based on changes in ambient pressure. Both sensors are housed inside temperature-controlled manifolds. This minimizes temperature effects on the measured concentrations.

6.5.4 Internal Data Acquisition System (DAS)

The DAS, configurable through the Setup>Data Logging menu, is designed to implement predictive diagnostics that store large amounts of trending data that can be retrieved for analysis.

APPENDIX A – MODBUS REGISTERS

ADDR	NAME	DESCRIPTION
Input Registers		
0	O2_SLOPE1	O2 Slope
4	O2_OFFSET1	O2 Offset
8	O2_PRE_CAL_CONC_1	Concentration just prior to last zero/span calibration of range #1
12	O2_CONC	O2 Concentration
16	AI_O2_HEATER_TEMP	O2 Heater Temp
18	AI_O2_HEATER_DUTY_CYCLE	O2 Heater Duty Cycle
20	O2_STABILITY	O2 Stability
22	AI_PUMP_FLOW	Pump Flow
24	AI_PUMP_PRESSURE_UNITS	Pump Sample Pressure
26	AI_BOX_TEMP	Box Temperature
100	CO2_SLOPE1	CO2 Slope
104	CO2_OFFSET1	CO2 Offset
108	CO2_PRE_CAL_CONC_1	Concentration just prior to last zero/span calibration of range #1
112	CO2_CONC	CO2 Concentration
Coils		
0	MODBUS_USE_USER_UNITS	Restart Required. LEGACY for modbus registers to be in PPB, DYNAMIC for modbus registers to be user selected.
4	ASF_MAINTENANCE_MODE_SOFTWARE	Set to trigger software maintenance mode. after the set time out it will expire automatically
20	MB_O2_CAL_RANGE1	set the instrument into calibration mode via modbus *NO TAG*
24	MB_CO2_CAL_RANGE1	set the instrument into CO2 calibration mode via modbus *NO TAG*
Holding Registers		
0	O2_TARGET_SPAN_CONC_1	O2_TARGET_SPAN_CONC_1
100	CO2_TARGET_SPAN_CONC_1	CO2_TARGET_SPAN_CONC_1
Discrete Inputs		
0	BOX_TEMP_WARN	Box Temperature Warning
1	O2_HEATER_TEMP_WARN	O2 Heater Temp Out of Limits
2	SYS_WARN_SAMPLE_FLOW	Warning raised when the flow is out of range
3	SYS_WARN_SAMPLE_PRESSURE	Warning raised when the sample pressure is out of range
4	SYS_WARN_RESET	Warning raised when the system is reset
5	SYS_WARN_SUPERVISOR_COM_WARNING	Warning raised when a module watchdog timer expires
6	SYS_WARN_PUMP_CONTROL_COM_WARNING	Warning raised when the pump watchdog timer expires
7	SYS_WARN_O2_SENSOR_COM_WARNING	Warning raised when the O2 sensor watchdog timer expires
8	AO_OUTPUT1_CAL_WARN_STATE	Denotes whether voltage output #1 requires calibration
9	SYS_WARN_CO2_SENSOR_COM_WARNING	Warning raised when the CO2 sensor watchdog timer expires
12	SF_O2_SENSOR_WARN_CALIBRATION_MODE	Denotes that the O2 sensor is in calibration mode
15	SYS_OK_WARN	System OK Status
19	ACAL1_CALIBRATE_ERROR	Not Used
20	ACAL2_CALIBRATE_ERROR	Not Used
21	ACAL3_CALIBRATE_ERROR	Not Used
101	SF_CO2_SENSOR_WARN_CALIBRATION_MODE	Denotes that the CO2 sensor is in calibration mode
103	SF_CO2_MULTIPOINT_CALIBRATION_MODE	Denotes that the application is in CO2 multi point calibration mode
14	SF_O2_MULTIPOINT_CALIBRATION_MODE	Denotes that the application is in O2 multi point calibration mode

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

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UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ARE:
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DO NOT SCALE DRAWING

TREATMENT
FINISH
SIMILAR TO | ACT WT | CALC WT

CONTRACT

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

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TITLE
DIAGRAM, INTERCONNECT, N802

SIZE	CAGE CODE	DWG NO	REV
D	1JZF4	093590820	01
SCALE 1:1	FORM ENF0029 RevE	SHEET 1 OF 1	