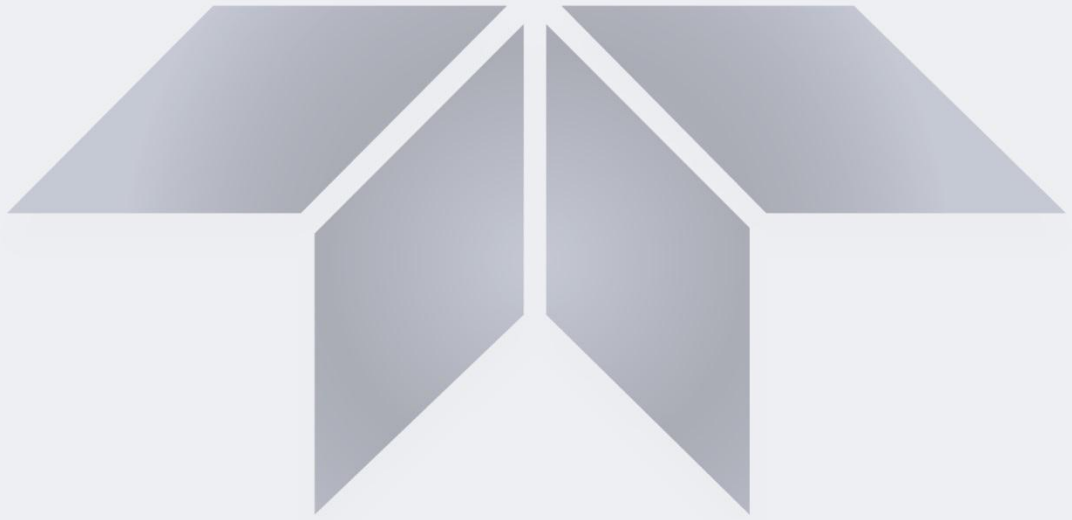
TELEDYNE API
Everywhereyoulook™



User Manual

Model N703U
Photometric O_3 Calibrators

with NumaView™ Software

© TELEDYNE API (TAPI)
9970 CARROLL CANYON ROAD
SAN DIEGO, CALIFORNIA 92131-1106
USA

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

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TRADEMARKS

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IMPORTANT SAFETY INFORMATION

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 are placed throughout this manual and inside the instrument. The symbols with messages are defined 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.

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 STATEMENT

WARRANTY POLICY (02024J)

Teledyne Advanced Pollution Instrumentation (Teledyne API), a business unit of Teledyne Instruments, Inc., provides that:

Prior to shipment, Teledyne API equipment is thoroughly inspected and tested. Should equipment failure occur, Teledyne API 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, Teledyne API 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-TELEDYNE API MANUFACTURED EQUIPMENT

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

PRODUCT RETURN

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

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

CAUTION – AVOID WARRANTY INVALIDATION



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

CONVENTIONS USED IN THIS MANUAL

In addition to the safety symbols as presented in the *Important Safety Information* page, this manual provides *special notices* related to the safety and effective use of the analyzer and other pertinent information.

Special Notices appear as follows:

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 AND APPROVALS

This manual provides information and operation instructions for the Model N703U calibrator.

1.1 CALIBRATOR OVERVIEW

The Model N703U is a microprocessor-controlled ozone calibrator for calibration of precision ambient ozone instruments, such as the TAPI N400. It features an internal ozone photometer that provides very accurate closed loop feedback control of the ozone concentration. N703U is also capable of generating ozone in a low range (fractional mode), for ultra-low ozone production.

An almost unlimited number of independent calibration sequences may be programmed into the N703U, covering time periods of up to one year. The setup of sequences is simple and intuitive and may be actuated manually, automatically, or by a remote signal. The sequences may be uploaded remotely, including remote editing. All programs are maintained in non-volatile memory.

The N703U design emphasizes fast response, repeatability, overall accuracy and ease of operation. It may be combined with the Model 701 Zero Air Generator to provide the ultimate in easy to use, precise calibration for your ozone instrument's features.

Some of the exceptional features of your N703U Photometric O_3 Calibrator are:

- N-Series modular electronics
- LCD Graphical User Interface with capacitive touch screen
- Bi directional RS-232 and 10/100Base-T Ethernet, optional USB and RS-485, ports for remote operation
- Front panel USB ports for peripheral devices
- 12 independent timers for sequences
- Nested sequences (up to 5 levels)
- Internal ozone generator and photometer allows use as primary or transfer standard
- UV Lamp Feedback modes: current control; photometer control
- Lightweight for transportability
- Ultra-low ozone production down to 2ppb

1.2 SPECIFICATIONS

All specifications are based on constant conditions.

Table 1-1. N703U System Specifications

PARAMETER	SPECIFICATION	
System	Linearity	+/- 1% of Full scale
	Precision	1.0 ppb
	Response Time	< 240 seconds to 95%
	Stability (7 days)	<1% with photometer feedback
		<3% without photometer feedback (CNST)
Ozone Generator Module	Flow Rate (with internal zero air source)	1 to 5 LPM adjustable
	Flow rate (with external zero air source)	1-15 LPM adjustable
	Maximum Concentration	5ppm at 1 LPM
	Minimum Concentration	2ppb at 5 LPM
	Response Time	<240 seconds to 98%
UV Photometer	Range	0-100 ppb to 0-10 ppm (selectable)
	Precision	1.0 ppb
	Linearity	+/-1% of full scale
	Rise/Fall Time	20 seconds to 95% (photometer response)
	Response Time	<180 seconds to 95% (system response)
	Zero Drift	<1.0ppb/7 days
	Span Drift	<1%/24 hours
	Lag Time	<10 seconds
	Flow Rate	800 cc/min +/-10%
Electrical Specifications	Power Requirements	10V-240V, 50/60 Hz, typical consumption 85W
Communication Specifications	Included I/O	1 x Ethernet (TCP/IP)
		1 x RS232
		2 x front panel USB device ports
	Optional IO	Digital I/O Expansion Option:
		10 Control Inputs (user definable)
		8 Digital status outputs (user definable)
		Valve Driver Expansion Option:
		12 Control outputs capable of driving up to 8 x 8-watt valves (user definable)
		1 Analog channel (10V or 5 VV ranges, user finable)
Physical Specifications:	Operating Temperature Range:	5 to 40C (41 to 104F)
	Dimensions:	7"H x 17"W x 24"D (17.8 x 43.2 x 60.9 cm)
	Weight:	31.25 lbs (14.18 kg)
Environmental Specifications:		Installation Category (Over Voltage Category) II Pollution Degree 2 Intended for Indoor Use Only at Altitudes ≤ 2000m

Table 1-2. N703U Specifications for Ozone Generator

	N703U
Flow Rate	w/internal zero air source: 1 to 5 LPM adjustable w/external zero air source: 1 to 15 LPM adjustable
Concentration	Min: 2ppb at 5 LPM Max: 5 ppm at 1 LPM
Output	Min: 15 ppb LPM Max: 5 ppm LPM
Response Time:	<240 sec. to 98%
Optical Feedback	

Table 1-3. N703U Specifications for O3 Photometer

PARAMETER	SPECIFICATION
Ranges	0-100 ppb to 0-10 ppm, user selectable
Zero Noise	0.3ppb (RMS)
Span Noise	<0.5%
Lower Detectable Limits	0.6 ppb (RMS)
Precision	1.0 ppb
Linearity	1.0% of Full Scale
Lag Time	<10 seconds
Rise/Fall Time	<20 sec (photometer response)
Zero Drift	<1.0 ppb / 7 days
Span Drift	<1% / 24 hours; <2% / 7 days
Flow Rate	800 cc/min +/- 10%

1.3 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 the procedures for unpacking the instrument and inspecting for damage, presents clearance specifications for proper ventilation, introduces the instrument layout, then presents the procedures for getting started: making electrical and pneumatic connections, and conducting an initial calibration check.

2.1 UNPACKING



CAUTION – RISK OF PERSONAL INJURY

The calibrator weighs about 18 kg (40 pounds) without options installed. To avoid personal injury, always use two persons and proper lift and carry techniques to move/relocate the calibrator.

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 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.



CAUTION – AVOID DAMAGE TO THE INSTRUMENT

BEFORE operating instrument, remove dust plugs from pneumatic ports.



WARNING!

Never disconnect or reconnect electronic circuit boards, wiring harnesses or electronic subassemblies while the unit is under power.

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.

1. Inspect the received packages for external shipping damage. If damaged, please advise the shipper first, then Teledyne API.
2. Included with your calibrator 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.
3. Carefully remove the top cover of the calibrator and check for internal shipping damage.
    a. Inspect the interior of the instrument to ensure all circuit boards and other components are intact and securely seated.
    b. Check the connectors of the various internal wiring harnesses and pneumatic hoses to ensure they are firmly and securely seated.
    c. Verify that all of the optional hardware ordered with the unit has been installed. (These are checked on the paperwork accompanying the instrument).

2.1.1 VENTILATION CLEARANCE

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

Table 2-1. Instrument Ventilation Clearance Requirements

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

Various rack mount kits are available for this instrument. Call Sales for more information.

Note **The disconnect switch is located at the rear of the calibrator. Keep a minimum of 4 inches per the required space above for access to this switch**

2.2 INSTRUMENT LAYOUT

The front panel (Figure 2-1) has two USB ports for peripheral device connections: mouse and keyboard as alternatives to the touchscreen interface, or flash drive for uploads/downloads (devices not included).

2.2.1 FRONT PANEL

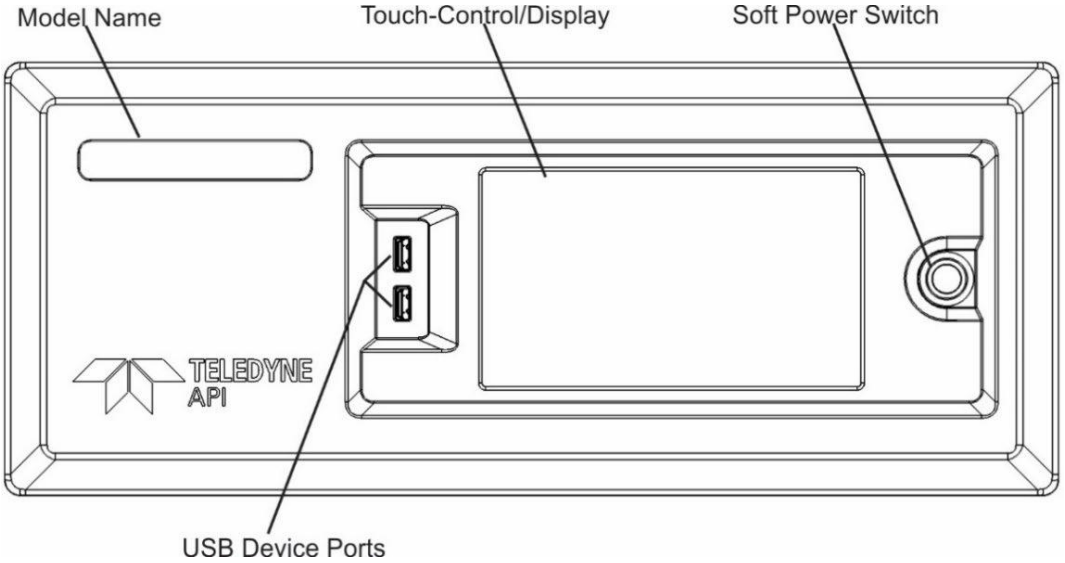


Figure 2-1. Calibrator Front Panel Layout

CAUTION – AVOID DAMAGING TOUCHSCREEN

Do not use hard-surfaced instruments such as pens to operate the touch screen buttons.

2.2.2 REAR PANEL

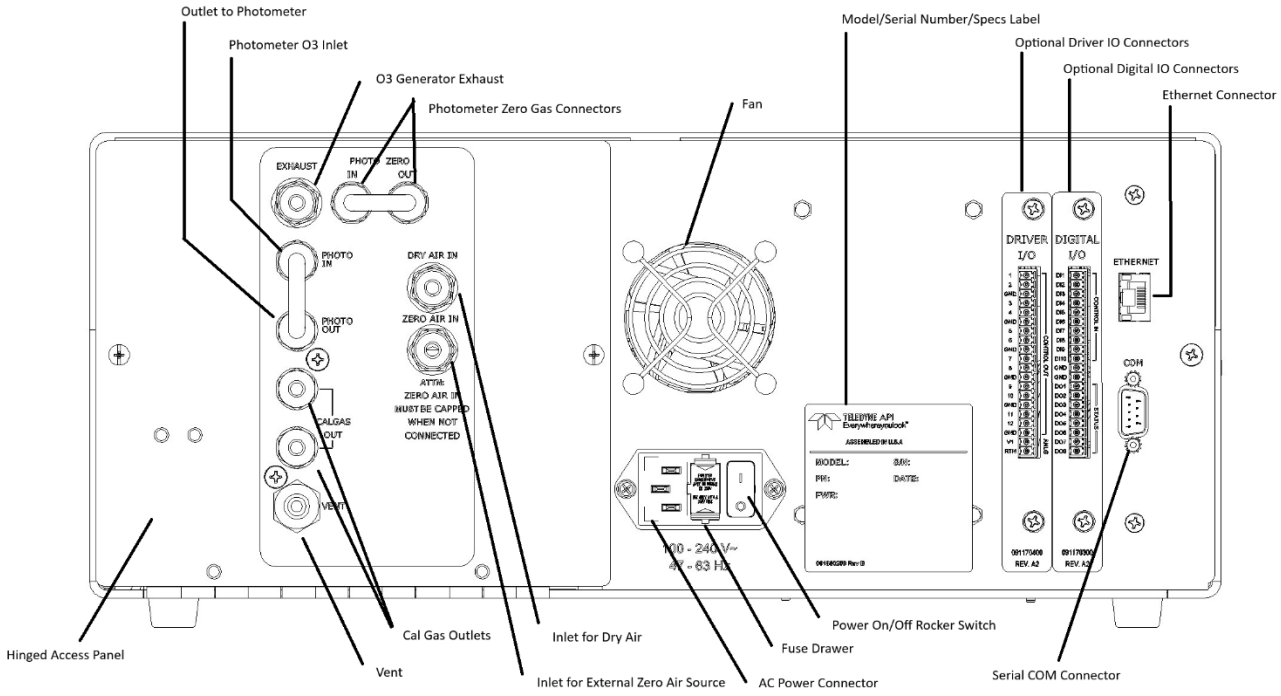


Figure 2-2. Calibrator Rear Panel Layout

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

Table 2-2. Rear Panel Description

COMPONENT	FUNCTION
Fan	For cooling: pulls ambient air through chassis from side vents; exhausts through rear.
 **AC Power Connector**	Connector for three-prong cord to apply AC power to the instrument **CAUTION! The cord's power specifications (specs) MUST comply with the power specs on the calibrator's rear panel Model number label.**
 **EXHAUST**	Exhaust gas from ozone generator and photometer **CAUTION! Exhaust gas must be vented outside.**
PHOTO ZERO IN	Inlet for photometer Zero Gas
PHOTO ZERO OUT	Outlet for photometer Zero Gas
PHOTO IN	Measurement gas input for O_3 photometer
PHOTO OUT	Calibration gas outlet to O_3 photometer
CAL GAS OUT	Two outlets for calibration gas.
VENT	Vent port for output manifold
DRY AIR IN	Inlet for dry air.
ZERO AIR IN	Inlet for external zero air source – MUST BE CAPPED WHEN NOT CONNECTED.
COM	Serial communications port for RS-232 only.
OPTIONAL CONTROL OUT	For outputs to devices such as Programmable Logic Controllers (PLCs).
OPTIONAL STATUS	For outputs to devices such as Programmable Logic Controllers (PLCs).
OPTIONAL ANALOG OUT	For voltage or current loop outputs to a strip chart recorder and/or a data logger.
OPTIONAL CONTROL IN	For remotely activating the zero and span calibration modes.
ETHERNET	Connector for network or Internet remote communication, using Ethernet cable.
Label w/power specs	Identifies the instrument model number and lists voltage and frequency specifications

2.2.3 INTERNAL LAYOUT

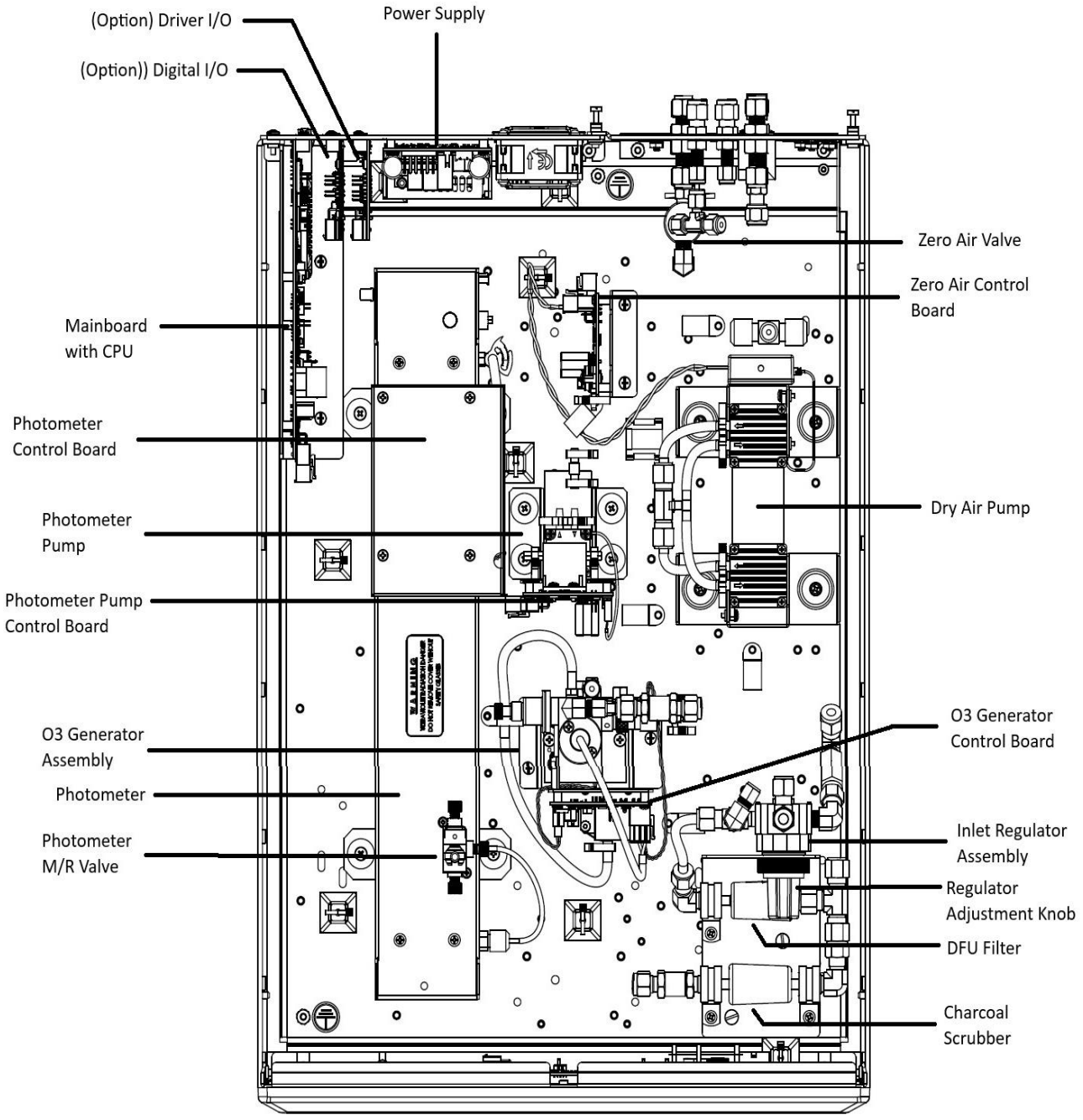


Figure 2-3. N703U Internal Layout

2.3 CONNECTIONS

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.

2.3.1 ELECTRICAL CONNECTIONS

Note **To maintain compliance with EMC standards, it is required that the cable length be no greater 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.**
- **Turn off instrument power before disconnecting or connecting electrical subassemblies.**
- **Do not operate with cover off.**



CAUTION – AVOID DAMAGE TO THE INSTRUMENT

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

2.3.1.1 CONNECTING POWER

Attach the power cord between the instrument's AC power connector and a power outlet capable of carrying (at a minimum) the rated current at your AC voltage range.

Important **Adhere to all safety and cautionary messages and ensure that the outlet is equipped with a functioning earth ground.**



CAUTION! – AVOID PERSONAL INJURY

UV light can cause severe eye damage. DO NOT look at the photometer UV lamp without glasses made from Safety UV filtering glass (plastic glasses are inadequate).

2.3.1.2 CONNECTING TO THE OPTIONAL DRIVER I/O CARD

The driver I/O option provides control outputs and voltage analog outputs. Control outputs are triggered from sequences and can trigger valves, PLCs or data loggers. Analog output may be connected to a strip chart or data logger and is configurable on the setup page. For

more information, please see Configuration information presented in the Setup Section (**Setup** > **Analog Outputs** > **Section 2.6.8**).

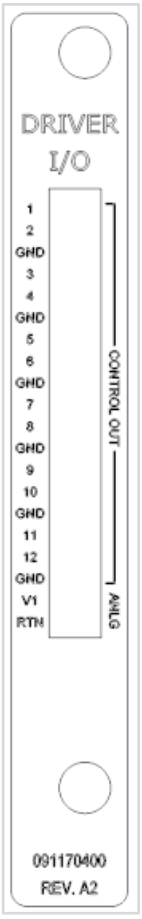


Figure 2-4. Driver Card

2.3.1.3 CONNECTING THE DIGITAL CONTROL OUTPUTS

The calibrator is equipped with 12 digital control outputs on a 20-pin connector (Figure 2-7); see Figure 2-2. Calibrator Rear Panel Layout Figure 2-2 for rear panel location. Each output pair has an isolated ground that should be connected. These outputs may be used to interface with devices that accept logic-level digital inputs, such as Programmable Logic Controllers (PLCs), data loggers, or digital relays/valve drivers, and are activated by the calibrator's user-programmable calibration sequences. Create the sequences in Setup>Sequences menu; then map the digital control outputs to the sequences through the **Setup** > **Sequences** menu (see Section 2.6.7 for instructions on assigning the control outputs to specific calibration sequences).

2.3.1.4 CONNECTING EXTERNAL VALVES TO THE OPTIONAL DRIVER BOARD CONTROL OUTPUTS

The optional driver I/O board can drive up to eight 8-watt valves using customer supplied 12VDC or 24VDC power. The valves can be driven by the same CC outputs as the control outputs. When valves are connected to the Control Outputs, for every pair of valves connected, one iso ground should be connected. The control output board has overcurrent

protection. All outputs are connected to the same overcurrent protector and will all be disabled if an overcurrent is detected.

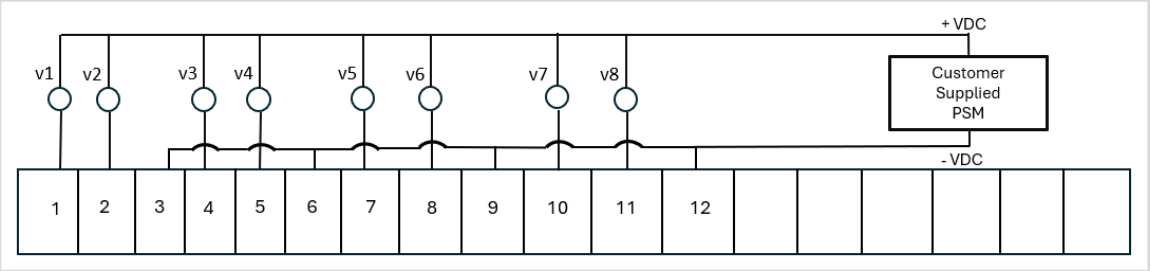


Figure 2-5. Valve Connections Using CC Outputs Using the Driver Card

2.3.1.5 CONNECTING ANALOG OUTPUTS

The calibrator is equipped with an analog output channel for one of several diagnostic functions and is accessible through the ANALOG OUT connector (Figure 2-4) on the rear panel. Its standard available output is 0-5 VDC. Attach a strip chart recorder or data-logger to the analog output connector. Configuration information is presented in the Setup Section (Setup>Analog Outputs>, Section 2.6.8).

Table 2-3. Control Outputs Pin Assignments and Functions Check

CONNECTOR PIN	CORRESPONDING OUTPUTS
1	Control Output 01
2	Control Output 02
3	Isolated Ground (GND)
4	Control Output 03
5	Control Output 04
6	Isolated Ground (GND)
7	Control Output 05
8	Control Output 06
9	Isolated Ground (GND)
10	Control Output 07
11	Control Output 08
12	Isolated Ground (GND)
13	Control Output 09
14	Control Output 10
15	Isolated Ground (GND)
16	Control Output 11
17	Control Output 12
18	Isolated Ground (GND)

Table 2-4. Analog Output Connector

CONNECTOR PIN	CORRESPONDING OUTPUTS
19	Analog Voltage Out (+)
20	Analog Voltage Return (-)

2.3.1.6 CONNECTING THE OPTIONAL DIGITAL I/O CARD

The optional digital I/O provides 10 control inputs and 8 status outputs. Control inputs can be used by a PLC or data logger to trigger sequences (configured though Setup>Sequences). Status outputs can be configured to report the status of eight configurable calibrator conditions (configured though **Setup** > **Digital Outputs**).

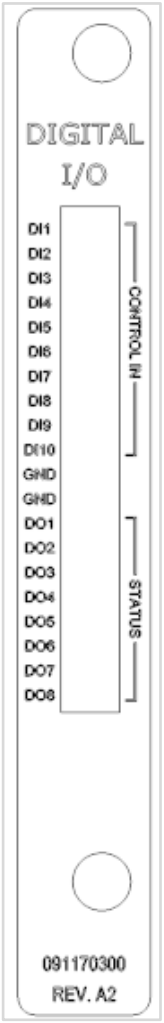


Figure 2-6. Digital I/O Card

2.3.1.7 CONNECTING THE CONTROL INPUTS (DIGITAL INPUTS)

The calibrator is equipped with 10 digital control inputs, which can be used to initiate various user-programmable calibration sequences (see Section 2.6.7.1 for instructions on assigning the control inputs to specific calibration sequences).

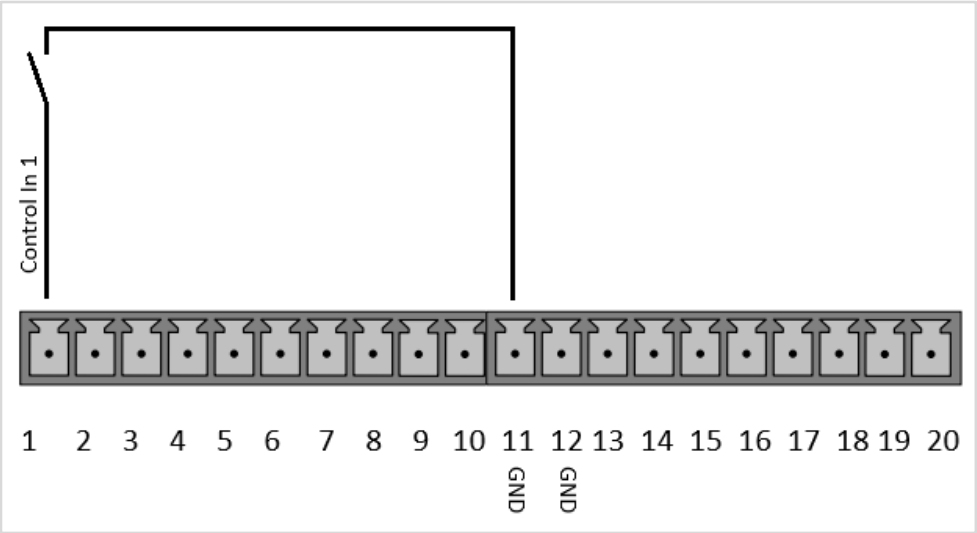


Figure 2-7. Connection to Digital Inputs on the Digital I/O Card

Attention

ATTENTION: COULD DAMAGE INSTRUMENT AND VOID WARRANTY

Most PLC's have internal provisions for limiting the current that the input will draw from an external device. When connecting to a unit that does not have this feature, an external dropping resistor must be used to limit the current through the transistor output to less than 50 mA. At 50 mA, the transistor will drop approximately 1.2V from its collector to emitter.

2.3.1.8 CONNECTING THE STATUS OUTPUTS (DIGITAL OUTPUTS)

The eight STATUS connectors allow the digital status outputs to report up to eight user-selected calibrator conditions (configured through the Setup>Digital Outputs menu, Section 2.6.6) via mosfets, which sink up to 1A of DC current. These outputs can be used to interface with devices that accept logic-level digital inputs, such as Programmable Logic Controllers (PLCs). Each Status bit is an open collector output that can withstand up to 24 VDC. All outputs are overcurrent protected. Overcurrent protection is connected to all digital outputs where an over current on one output will disable all digital outputs.

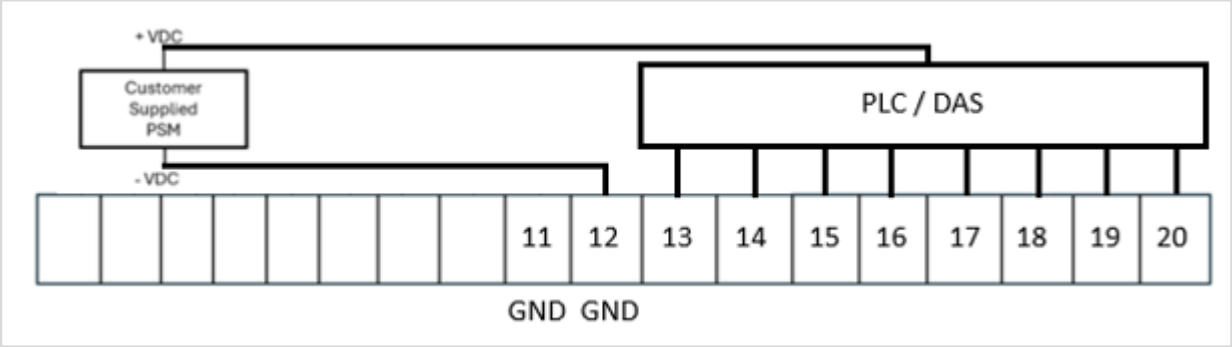


Figure 2-8. Digital Outputs (Status Out) on the Digital I/O Card

Table 2-5. Calibrator Control Input Pin Assignments and Digital Inputs

CONNECTOR PIN	CORRESPONDING OUTPUTS
1	Control Input 01
2	Control Input 02
3	Control Input 03
4	Control Input 04
5	Control Input 05
6	Control Input 06
7	Control Input 07
8	Control Input 08
9	Control Input 09
10	Control Input 10
11	Ground (GND)
12	Ground (GND)
13	Status Output 01
14	Status Output 02
15	Status Output 03
16	Status Output 04
17	Status Output 05
18	Status Output 06
19	Status Output 07
20	Status Output 08

2.3.1.9 CONNECTING COMMUNICATIONS INTERFACES

The N-Series analyzers are equipped with connectors for remote communications interfaces: Ethernet and RS-232 with DCE (default) or DTE (configurable, shown in this section) signals. Configuration details for Setup>Comm are presented in Section 2.6.10.

ETHERNET CONNECTION

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

SERIAL CONNECTION

Received from the factory, the analyzer COM port is set up for RS-232 communications with data communication equipment (DCE). This port can be reconfigured for RS-232 communications with data terminal equipment (DTE) by jumpering the pins on JP1 as indicated in Table 2-6 (view/edit software settings Table 2-11).

WARNING! – ELECTRICAL SHOCK HAZARD

Disconnect power before performing any operation that requires entry into the interior of the analyzer. Contact Teledyne API Technical Support before reconfiguring the internal serial communications connector.

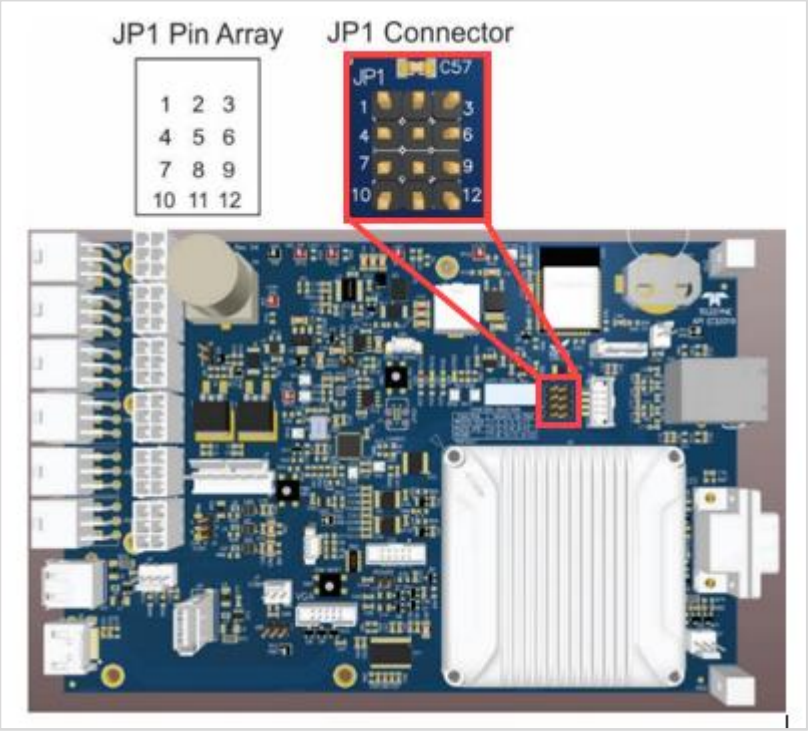


Figure 2-9. Mainboard JP1 Location and Pin Arrangements

Table 2-6. JP1 Configurations for Serial Communication

FUNCTION	JUMPERS	DSUB PINS	
DCE RS232 (default)	1-2, 4-5, 9-12	2	3
DTE RS232	2-3, 5-6, 9-12	232Tx	232Rx

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

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 shows the connections for basic pneumatic setup and for use as an ozone photometer, and provides guidance for pneumatic port configurations.

Important

IMPACT ON READINGS OR DATA

Each time the pneumatic configuration is changed for any purpose, a back pressure compensation calibration must be performed (Section 5.1).

2.3.2.1 CONNECTIONS FOR BASIC OPERATION

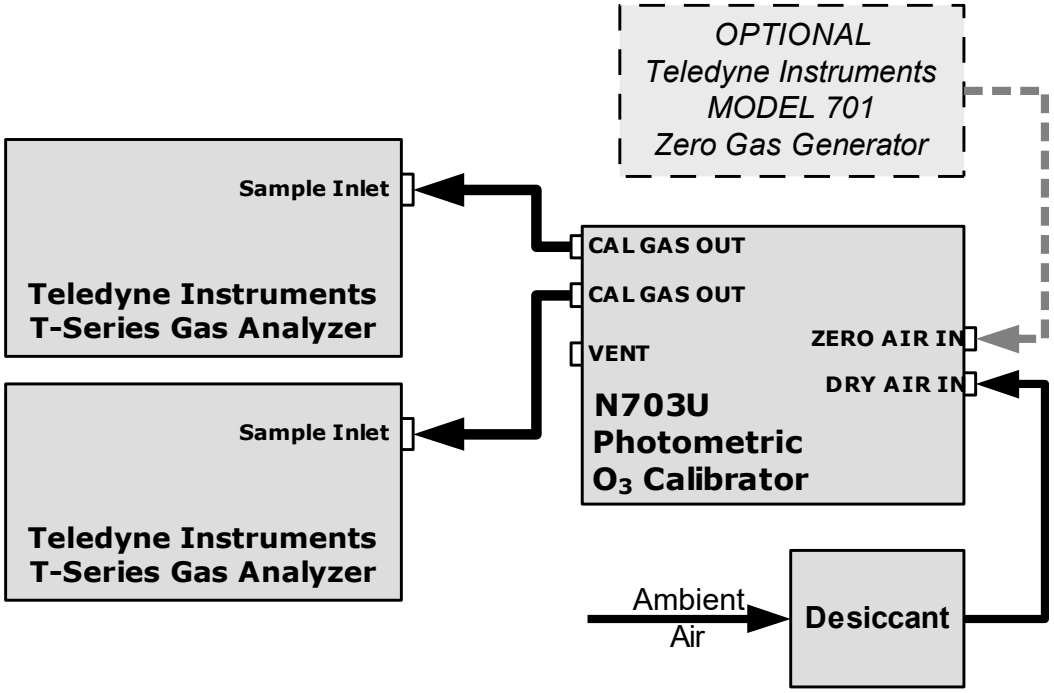


Figure 2-10. Basic Pneumatic Setup

2.3.2.2 DRY AIR IN

When using the internal zero air pump, a source of dry air should be connected to the port labeled 'Dry Air In' on the rear panel. This air should be supplied at atmospheric pressure. The supplied air should have a dew point of –20 °C or less.

Teledyne API can supply an optional desiccant cartridge that can be used to supply dry air to the N703U.

2.3.2.3 ZERO AIR IN

An external pressurized source of zero air can be supplied at the 'Zero Air" port on the rear panel. This is the standard configuration when the zero air pump is not installed. This zero air should be scrubbed of ozone and have a dew point of -20 °C or less. The pressure of the zero air should be regulated to 20-35 psig.

Note **When connecting an external source of zero air to a N703U with an internal zero air pump installed, the zero air pump should be disabled (Setup>Vars>ZA Pump Enable, Edit and set to OFF).**

2.3.2.4 OUTPUT MANIFOLD

A three-port output manifold is supplied on the rear panel of the N703U enabling simultaneous testing of up to two external instruments. Sample lines for ozone instruments to be calibrated can be connected directly to this manifold.

To prevent ozone exposure, the bottom port of this manifold is used as a vent and should be connected to a proper unpressurized vent manifold. It is important that the backpressure at this vent fitting be kept to a minimum. If a vent line longer than 2 meters (~6 feet) is required, then 3/8" OD tubing should be used.

Any unused ports on this manifold must be capped.

2.3.2.5 EXHAUST

The port labeled 'EXHAUST' contains the exhaust gas from the internal photometer and may contain ozone. This port should be connected to a proper unpressurized vent manifold to prevent ozone exposure.

2.3.2.6 SETUP FOR OPERATION AS AN O_3 PHOTOMETER

The N703U can be converted from an O_3 calibrator to an O_3 photometer to measure an external source of ozone.

Note **Gas from any external source must be supplied at atmospheric pressure.**

Refer to Figure 2-11 to set up the N703U as follows:

1. Remove the two loop-back tubing assemblies on the rear panel connected to the 'PHOTO IN' and 'PHOTO ZERO IN' fittings.
2. Connect the ozone source to be measured to the 'PHOTO IN' fitting.
   - This gas must be supplied at atmospheric pressure.
3. Connect a reference gas (Zero Air) for the photometer to the 'PHOTO ZERO IN.'
   - This gas must be supplied at atmospheric pressure. To avoid interference effects, the reference gas should be from the same source that is being used to feed the ozone generator that is being tested.

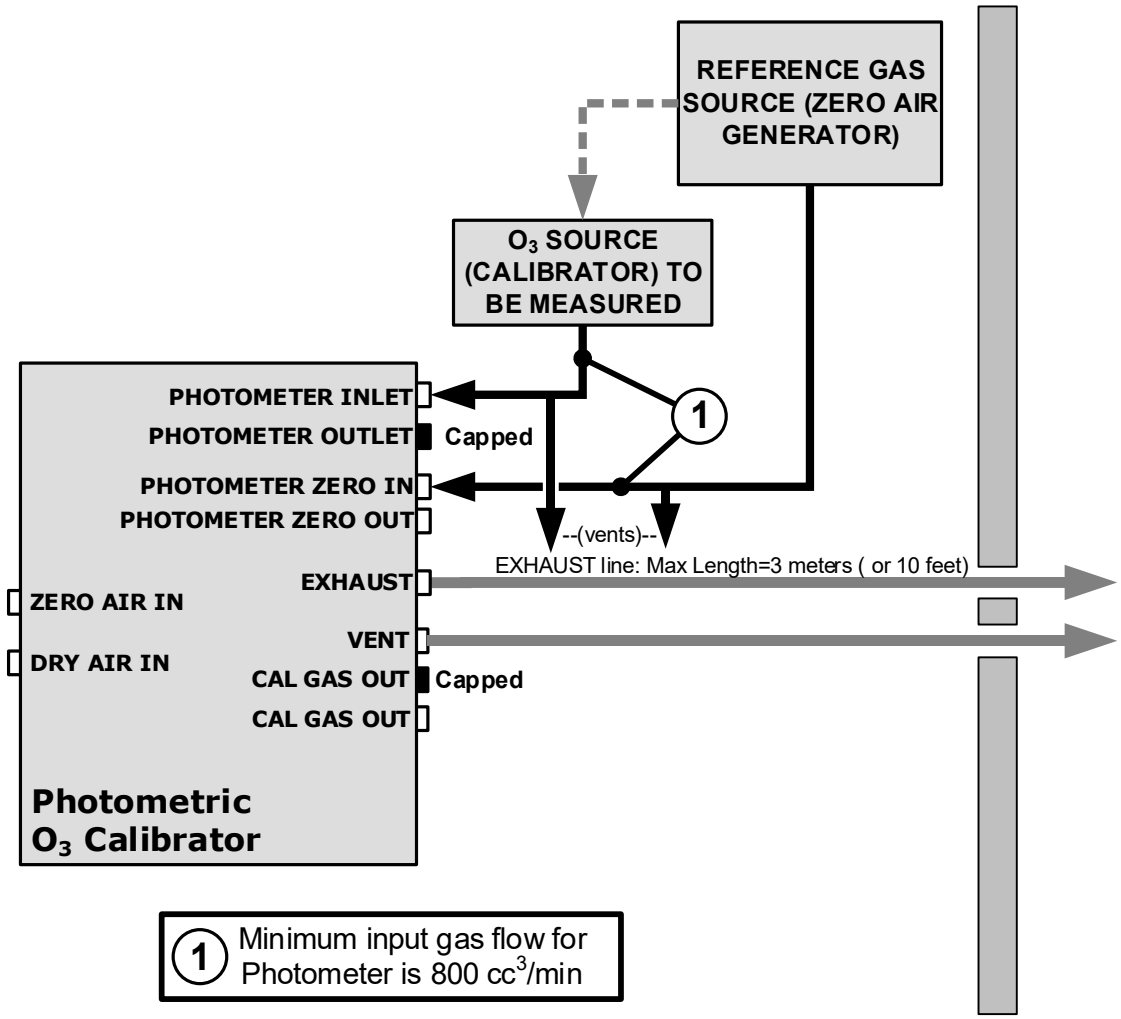


Figure 2-11. Set up to Measure an External O_3 Source

The N703U is now set up to operate as an O3 photometer. Operation instructions are provided in Section 3.3.

2.3.3 PNEUMATIC FLOW DIAGRAMS

This section shows pneumatic flow for the N703U.

2.3.3.1 N703U PNEUMATIC FLOW

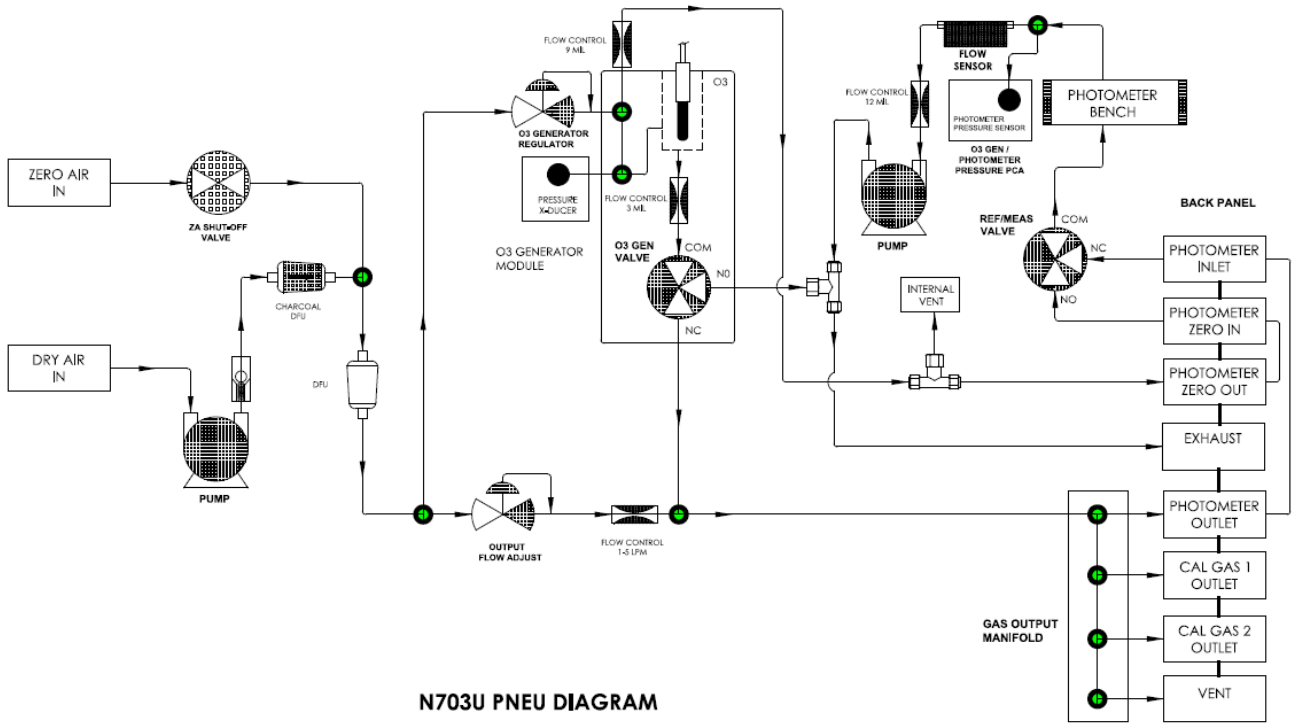


Figure 2-12. N703U Pneumatic Flow Diagram

2.4 STARTUP AND FUNCTIONAL CHECKS

If you are unfamiliar with the calibrator principles of operation, we recommend that you read Section 8.

2.4.1 INITIAL STARTUP

1 After making the electrical and pneumatic connections, turn on the instrument. The exhaust fan (and pump if photometer option installed) should start immediately. A sequence of status screens (Figure 2-13) appear prior to the Home page. The calibrator will be in STANDBY mode and requires a minimum of 30 minutes for all of its internal components to reach a stable operating temperature.

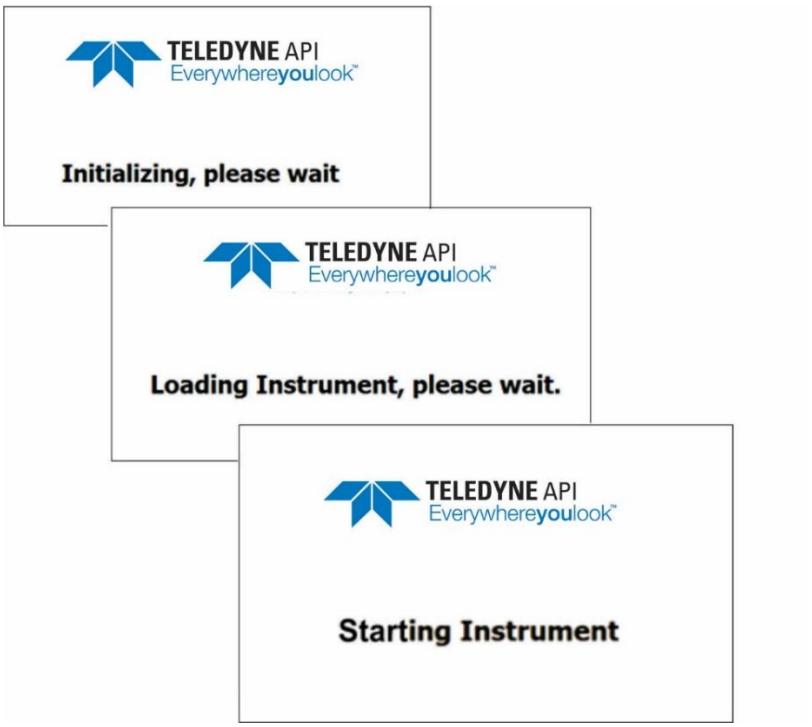


Figure 2-13. Status Screens at Startup

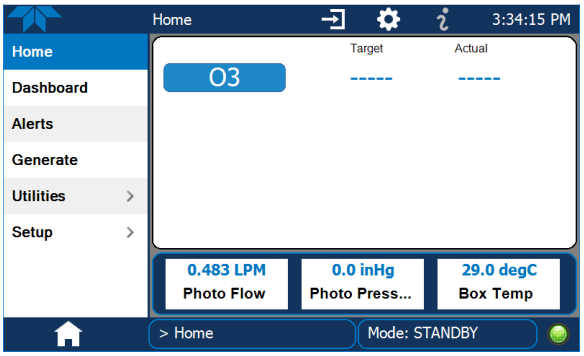


Figure 2-14. Typical Home Page Prior to Configuration

2.4.2 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 2-15) shows the status of any active warning conditions or user-configured Events. (For more detailed information about Alerts, see Section 2.5.3 provides, and for Events, see Section 2.6.2).

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.

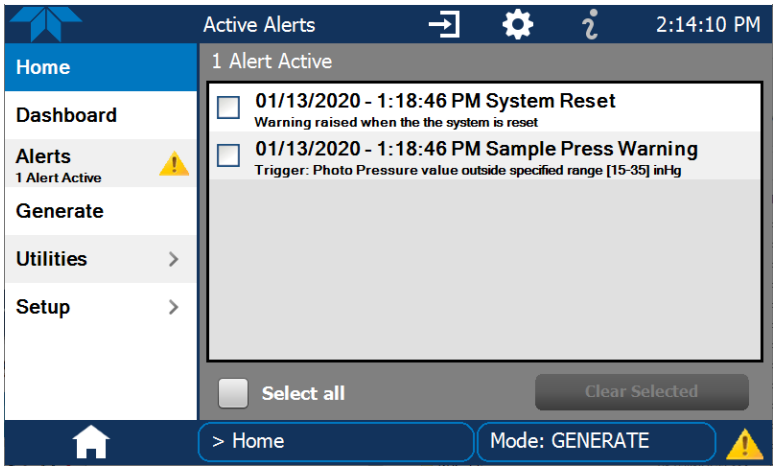


Figure 2-15. Viewing Active Alerts Page

2.4.3 FUNCTIONAL CHECKS AND VERIFICATION

During warm-up, verify that the software properly supports any hardware options that are installed by navigating to the Setup>Instrument>Product Info page.

After warm-up, verify that the instrument is functioning within allowable operating parameters by checking their values in the Dashboard:

- Check values for the operating parameters in 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, Section 2.6.3).
- Generate ozone by using the Generate>Auto menu (Section) and verify its value in the Dashboard. (Place in Standby mode after verifying and whenever ozone generation is not needed).

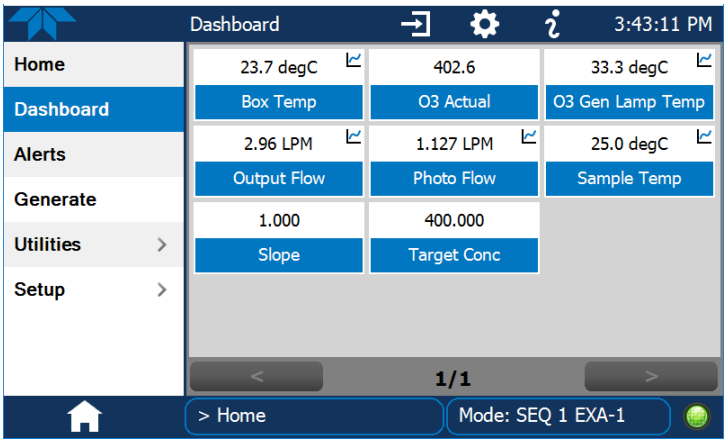


Figure 2-16. Sample Dashboard Page

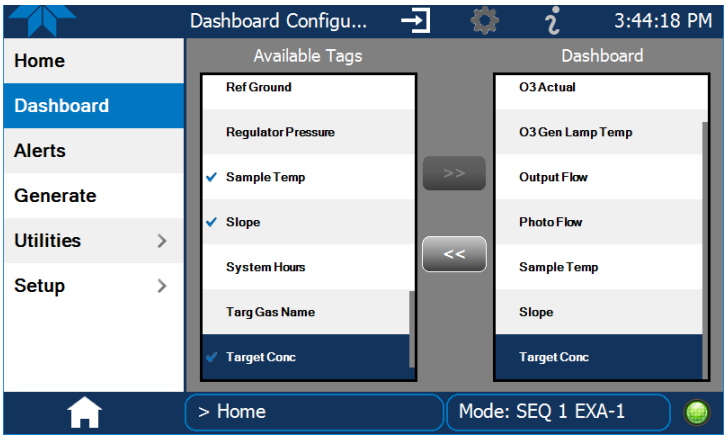


Figure 2-17. Dashboard Configurator

2.4.4 SELECTING A MODE FOR THE O_3 GENERATOR

The calibrator can generate O3 in either of two different modes: Constant or Bench, which can be set after first ensuring that the calibrator is in Standby Mode (set via the Home page Generate menu); then in the Setup>Vars menu edit O3 Bench Only. The default for this value is "True," which will use BNCH mode.

Note **The N703U calibrator should always be placed in Standby mode when not needed to produce ozone (Home>Generate>Standby).**

2.4.4.1 CNST (CONSTANT) MODE

In this mode, the O_3 output of the generator is based on a single, constant, drive voltage, and there is no Feedback loop control by the calibrator's CPU.

2.4.4.2 BNCH (BENCH) MODE

The O_3 concentration control loop will use the photometer's O_3 measurement as input. This is the default mode and is used whenever the calibrator is using the Generate>Auto menu or the Generate command in a Sequence step.

2.4.5 SETTING THE CALIBRATOR'S OUTPUT FLOW RATE

The output flow rate must consider both the total gas flow requirements of all analyzers connected to the output manifold and the minimum output flow of the O_3 generator. Figure 2-18 shows a close-up of the regulator assembly.

2.4.5.1 CALCULATING OUTPUT FLOW RATE

First, add the sum of the flow requirements of all of the instruments to which the N703U will be supplying calibration gas plus 1 LPM excess flow. For example, if the N703U is expected to supply calibration gas mixtures simultaneously to two analyzers, each requiring 0.8 LPM , the minimum Total Flow output would be:

$$(0.8 + 0.8) + 1.0 = 2.6 \text{ LPM}$$

Second, calculate the flow rate requirements of the O_3 generator output, which must remain above the minimum specification of 20 PPB*LPM. Use the following equation to determine the minimum flow rate (FT) for the O_3 generator output:

$$F_T \geq \frac{20 ppb \bullet LPM}{O_3 Conc}$$

Compare the values calculated from the of the above formulae; the greater of the two is the minimum Total Flow that must be set.

2.4.5.2 OUTPUT FLOW RATE SETUP

To set the output flow:

1. Go to Generate>Auto and set the gas to zero. Press Generate.
2. Open the top panel of the calibrator by removing the security screws on the sides and sliding the cover backwards and then lifting the front.
3. Pull out the regulator knob and adjust the regulator until the desired flow is achieved.

   The front panel of the calibrator displays the approximate output flow based on the measured regulator pressure, but this flow should be verified with an independent calibrated flow meter attached to one of the CAL GAS outlets on the back of the instrument.

4. Push the pressure regulator knob (Figure 2-27) back in to lock.
5. Close the top panel.

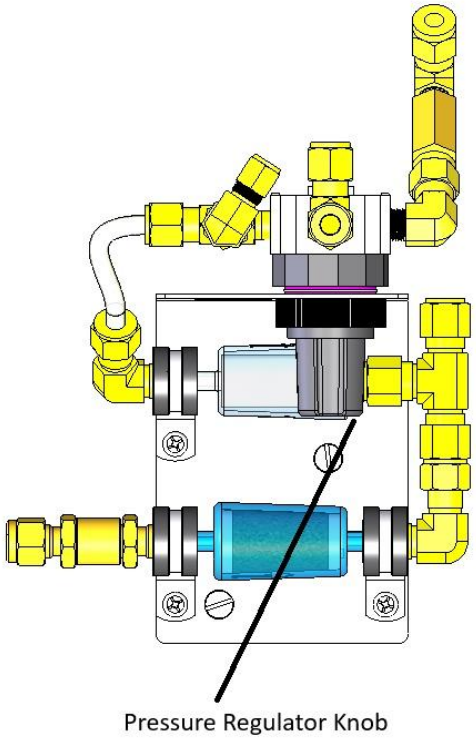


Figure 2-18. Output Pressure Regulator Assembly

2.5 MENU OVERVIEW

Table 2-7 describes the main menus and provides cross-references to the respective sections with configuration details.

Table 2-7. Menu Overview

MENU	DESCRIPTION		REFERENCE
Home	View and plot concentration readings and other user-selected parameters set up through the configuration shortcut or the Setup>Homescreen menu.		Sections 2.5.1 and 2.6.5
Dashboard	View user-selected parameters (Setup>Dashboard) and their values, some of which can be displayed in a live-plot graph (Figure 2-19).		Sections 2.5.2 and 2.6.3
Alerts	View and clear active Alerts that were triggered by either factory-defined or user-configured Events (see Setup>Events). Active and past Alerts are recorded in the Utilities>Alerts Log).		Section 2.5.3
Generate	Generate ozone. Execute sequences configured in the Setup>Sequences menu. Place the calibrator in Standby mode.		Section 2.5.4
Utilities	View logs, download data and firmware updates, copy configurations between instruments, and run diagnostics.		Section 2.5.5
	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, which is downloadable through the Utilities>USB Utilities page.	Section 2.5.5.1
	Alerts Log	Displays a history of Alert messages triggered by factory-defined and user-defined Events, such as warnings and alarms (See Section 2.6.2 for Events configuration).	Section 2.5.5.2
	USB Utilities	Serves multiple purposes using a flash drive connected to the instrument's front panel USB port: • download data from instrument's Data Acquisition System (DAS), the Data Logger, to a flash drive (Section 2.5.5.3) • update firmware (Section 6.3) • transfer instrument configuration from/to other instruments of the same model (Section 2.5.5.3) • download a basic operation functionality report (Section 6.2)	Section 2.5.5.3

MENU	DESCRIPTION		REFERENCE
	Diagnostics	Provides access to various pages that facilitate troubleshooting.	(various)
		Analog Inputs — This page shows voltage signals of several analog input parameters, including those from other instrumentation when the External Analog Inputs Option is installed.	Section 7.1.3
		Analog Outputs — Shows voltage signals for one parameter (configured through Setup>Analog Outputs, Section 2.6.8).	Section 7.1.3
		Digital Inputs — Shows whether specific available Signal In features are active (ON) or inactive (OFF).	Section 7.1.3
		Digital Outputs — Activate (ON)/deactivate (OFF) user-specified Signal Out features (configured in the Setup>Digital Outputs menu, Section 2.6.6.	Section 7.1.3
		Flow Cal — Calibrate the photometer flow.	Section 5.3.1
		Regulator Flow Cal — Calibrate output flow, slope, offset, and sensor offset.	Section 5.3.2
		O3 Gen Cal — Calibrates the Ozone Generator using a table of drive voltages for initial settings.	Section 5.5
		Back Pressure Compensation — Required any time there is a change made in the pneumatic configuration or after a gas pressure calibration.	Section 5.1
		Bench Cal — Calibrate the ozone photometer (bench)	Section 5.4.3
		Pressure Cal — Calibrate pressure sensors.	Section 5.1
Setup	Configure a variety of features and functions for customized operation.		Section 2.6
	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 and downloaded to a flash drive via the Utilities>USB Utilities menu (Section 2.6.1.3).	Section 2.6
	Events	Select parameters and define the conditions by which they are to be flagged and recorded in the Alerts log (Utilities>Alerts Log) when they are triggered.	Section 2.6.2
	Dashboard	Select parameters monitoring instrument functionality (Figure 2-16, Figure 2-17).	Section 2.6.3
	Vars	Manually adjust several software variables that define specific operational parameters.	Section 2.6.4
	Homescreen	Configure the three meters located along the bottom of the display to show desired functions (Figure 2-38, Figure 2-19).	Section 2.6.5
	Digital Outputs	Map the rear-panel digital status outputs to a variety of signals present in the instrument to monitor operating conditions or custom Events (Setup>Events).	Section 2.6.6
	Sequences	Create automated sequential calibration steps.	Section 2.6.7
	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 2.6.8
	Instrument	View product and system information, including list of options, if any; view network settings; view/adjust Date and Time settings; and check for firmware updates when connected to a network that is connected to the Internet.	Section 2.6.9
	COMM	View and configure network and serial communications.	Section 2.6.10

2.5.1 HOME

Figure 2-19 shows the features of the main interface from the Home page. The meters at the bottom of the display are user-selectable (see Section 2.6.5).

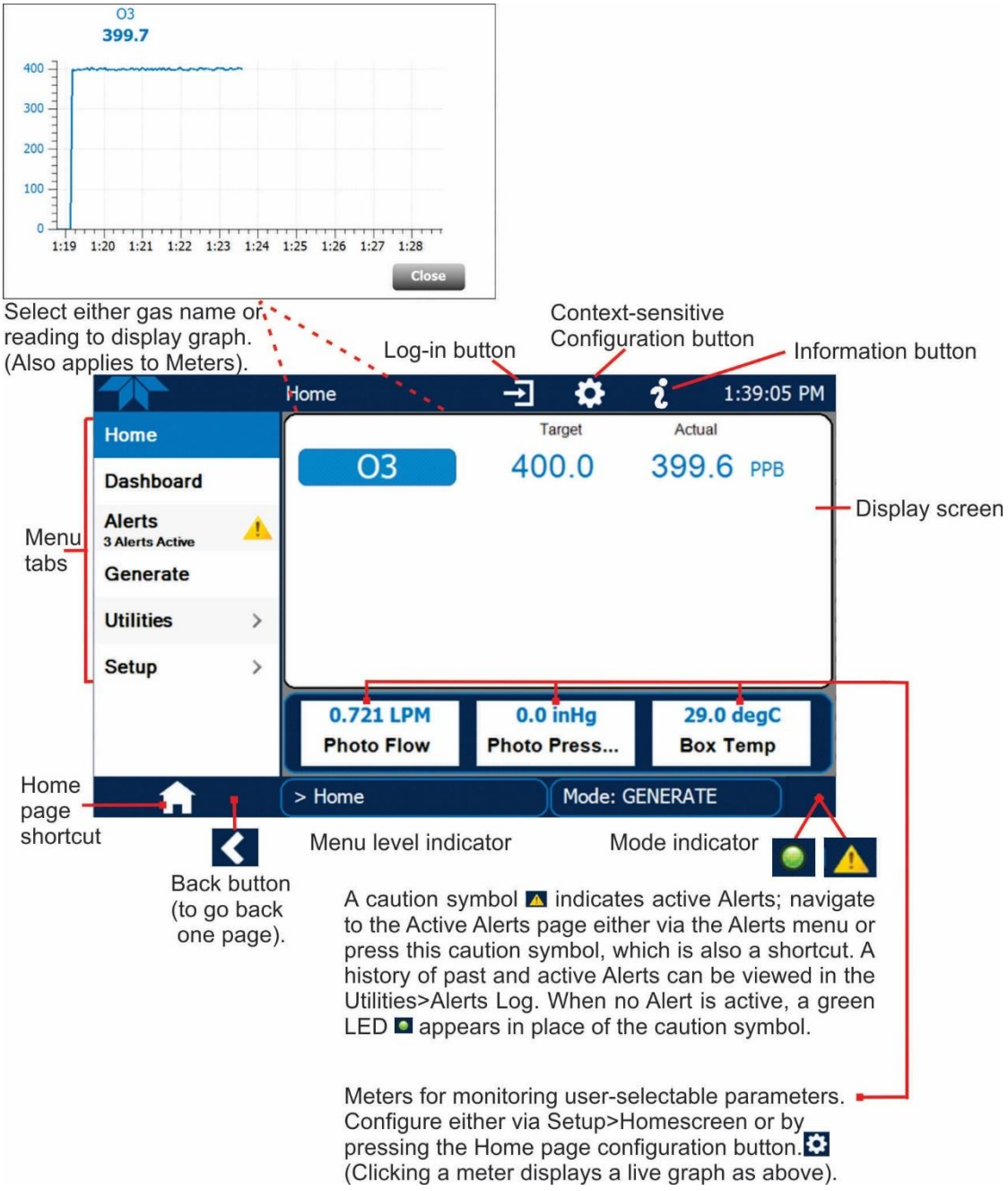


Figure 2-19. User Interface Orientation

Note **The last page on display prior to drilling into a menu remains on display until a choice in the menu is selected.**

2.5.2 DASHBOARD

The dashboard displays an array of user-selected parameters and their values (Figure 2-20). 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 2-21. Depending on the number of available parameters selected, the Dashboard can have more than one page. See Section 2.6.3 for configuration details.

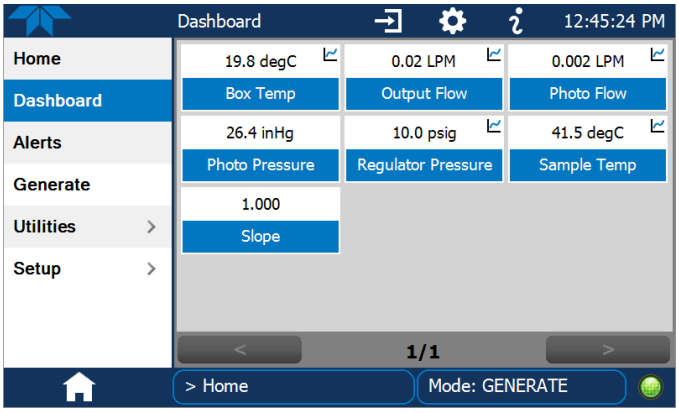


Figure 2-20. Dashboard Page

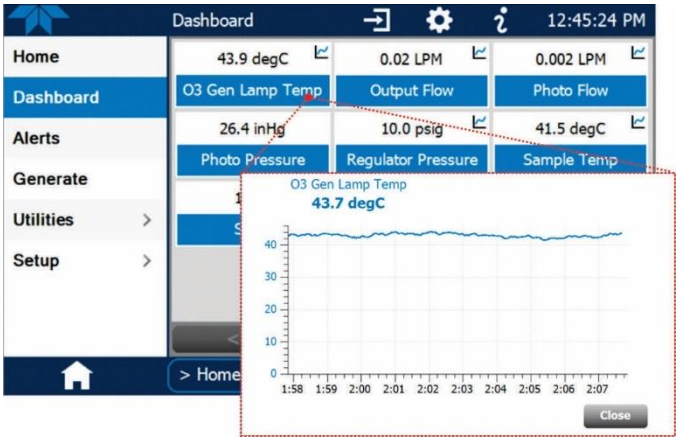


Figure 2-21. Viewing a Live Plot from Dashboard Page

Three of the dashboard parameters can be set up for continuous display as meters located below the concentration display of the Home page through the Setup>Homescreen menu (Section 2.6.5).

2.5.3 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 2.6.2). 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 2-22).

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

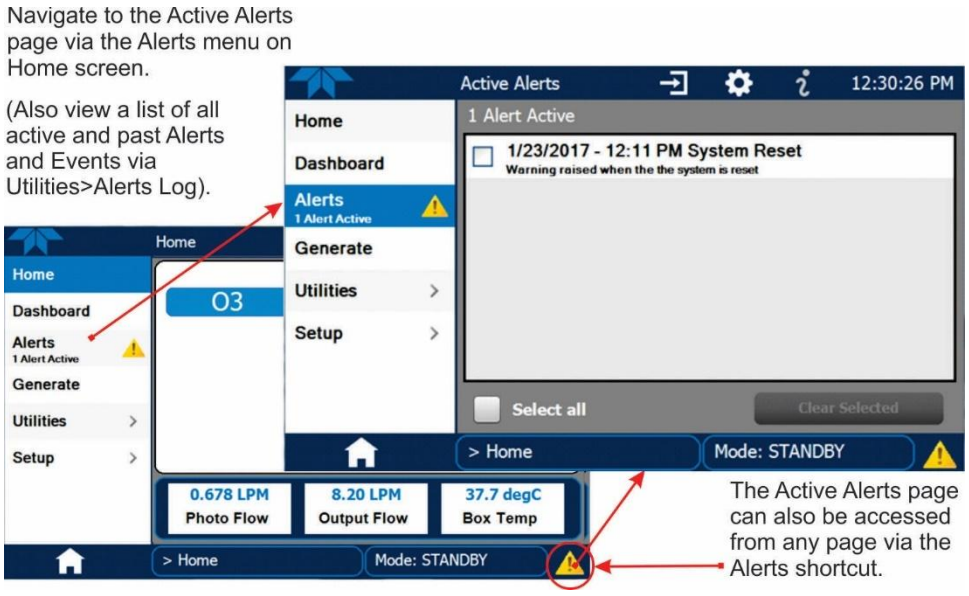


Figure 2-22. Navigating to the Active Alerts Page

Alerts appear as either latching or non-latching:

- Latching. displayed in Active Alerts screen when an Event is triggered and must be cleared by the user.
- Non-latching: Active Alerts screen continuously updates based on the Event criteria, clearing on its own.

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 2-23). However, Alerts can reappear if the conditions causing them are not resolved. For troubleshooting guidance, refer to the instrument's user manual.

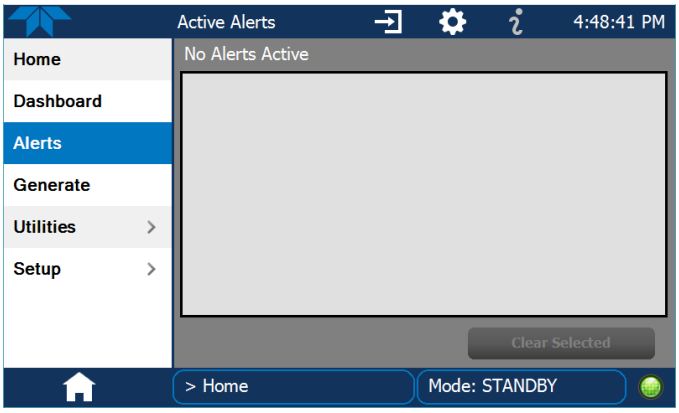


Figure 2-23. Active Alerts Cleared

2.5.4 GENERATE

The Generate menu provides the ability to:

- Generate either ozone or zero air
- Execute a Sequence (configured in the Setup menu)
- Place the instrument into Standby mode (suspend generating gas)

The Generate menu is presented in Section 3.1. To configure Sequences, see Section 2.6.7.

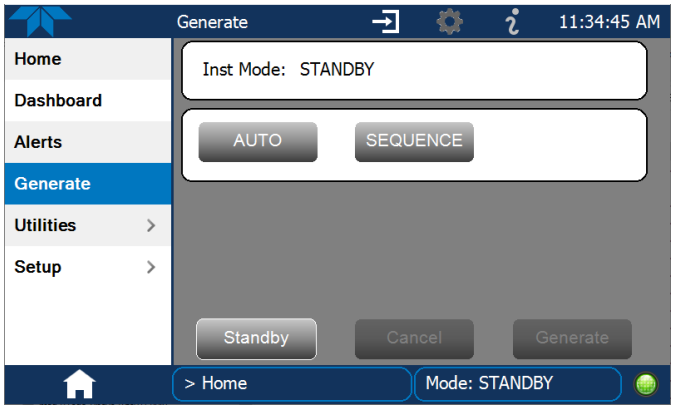


Figure 2-24. Generate Page

2.5.5 UTILITIES

The Utilities menu opens to the Datalog View, the Alerts Log, the USB Utilities, and the Diagnostics submenus.

2.5.5.1 DATALOG VIEW

The Datalog View tab displays a list of data logs that were configured in the Setup>Data Logging menu (Section 2.6.1). From this list a log can be selected and filters applied to view the desired data.

2.5.5.2 ALERTS LOG

The Alerts Log holds a history of alerts that were triggered by factory-defined and user-defined Events, such as warnings and alarms.

2.5.5.3 USB UTILITIES (DOWNLOADS AND UPDATES)

The USB Utility page serves multiple purposes using a flash drive connected to the instrument's front panel USB port:

- downloading Data Acquisition System (DAS) data from the instrument to a flash drive (presented below).
- updating firmware (presented below and in Section 6.3).
- copying a configuration from one instrument to other same-model instruments (presented below).
- downloading a basic operation functionality report (presented below and in Section 6.2)

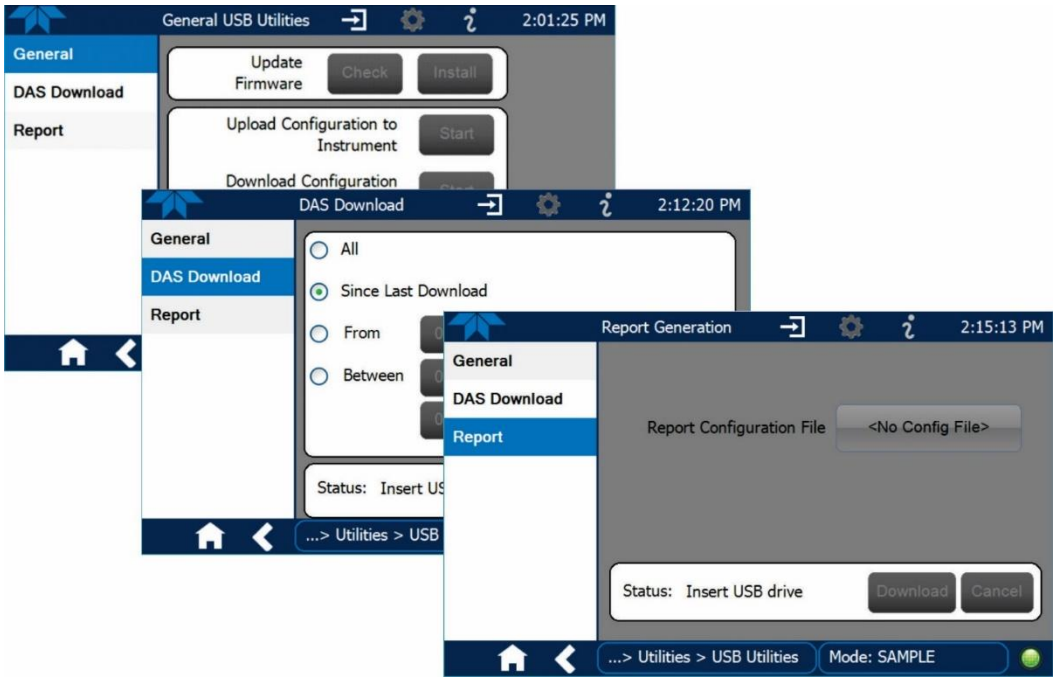


Figure 2-25. USB Utilities Pages

The Status field shows when an inserted flash drive has been detected, at which time firmware updates, configuration copying and DAS downloading can be carried out.

DOWNLOADING DAS (DATA ACQUISITION SYSTEM) DATA

DAS data (collected by the Datalogger, Section 2.6.1) can be downloaded from the instrument to a flash drive through the Utilities>USB Utilities>DAS Download menu, as follows:

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.

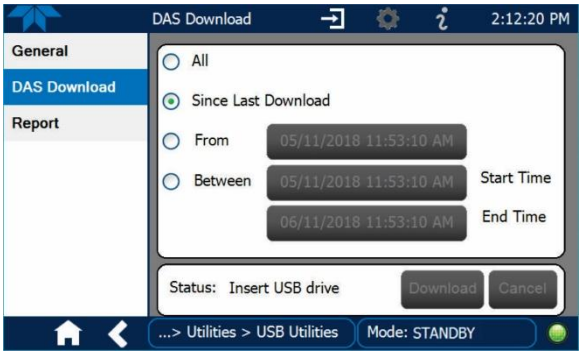


Figure 2-26. DAS Download Page

2. To copy the data to the flash drive, press the Start button next to “Download DAS Data from Instrument.” (The Cancel button will be enabled).
3. When complete, as indicated in the Status field, the Cancel button becomes the Done button: press Done and then remove the flash drive.

UPDATING FIRMWARE

It is possible to check for firmware updates, reload current firmware, and to update firmware remotely. Because this is a maintenance item and there is more than one way to implement an update, instructions are provided in Section 6.3.

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.

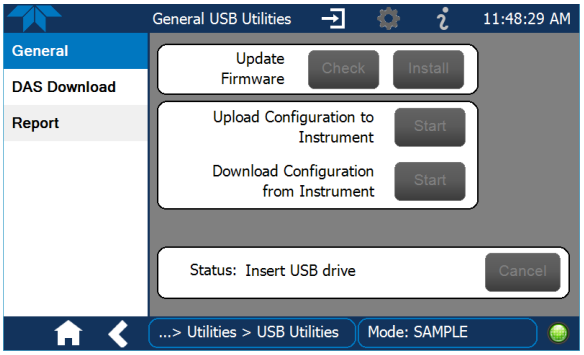


Figure 2-27. Configuration Transfer

1. In the source instrument, navigate 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, navigate 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.

When the Status field indicates that the upload is complete, remove the flash drive.

GENERATING A REPORT

The Report page is used typically for monitoring the functionality of the instrument. A new report is generated every 24 hours and can be downloaded, and it can be uploaded to a Cloud service for TAPI Technical Support. Because it is used in maintenance and troubleshooting, the Report feature is presented in Section 6.2.

2.5.5.4 DIAGNOSTICS

The Diagnostics menu provides access to several features, such as signals for inputs and outputs which can be helpful in troubleshooting (Section 7). The outputs are configurable through the Setup menu, and also some important calibration functions are located here. When an item in the menu is selected, the display shows its description. Table 2-7 on page 45 also provides descriptions.

Note **Some Diagnostics items do not appear in the menu until the instrument is placed in Standby mode (Home>Generate menu).**

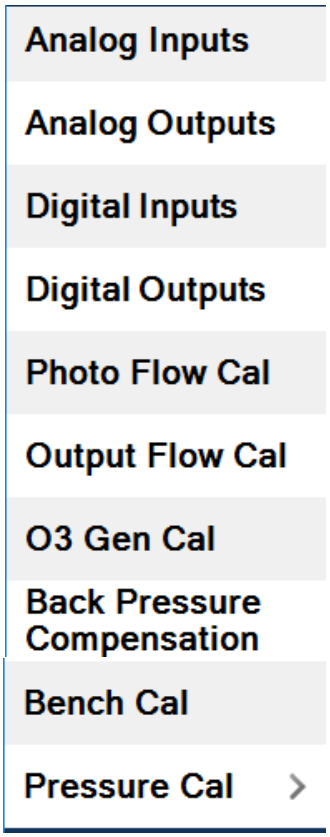


Figure 2-28. Sample Diagnostics Menu (may differ by calibrator configuration)

2.5.6 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 2.6 provides details for the menus under Setup.

2.6 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 2.7).

2.6.1 SETUP>DATA LOGGING (DATA ACQUISITION SYSTEM, DAS)

The Data Logger captures and stores user-defined data. In the Setup>Data Logging menu press the ADD button to create a new log, or select an existing log from the Data Logging list and press the EDIT or DELETE button to make the desired changes. Follow instruction shown in Figure 2-29.

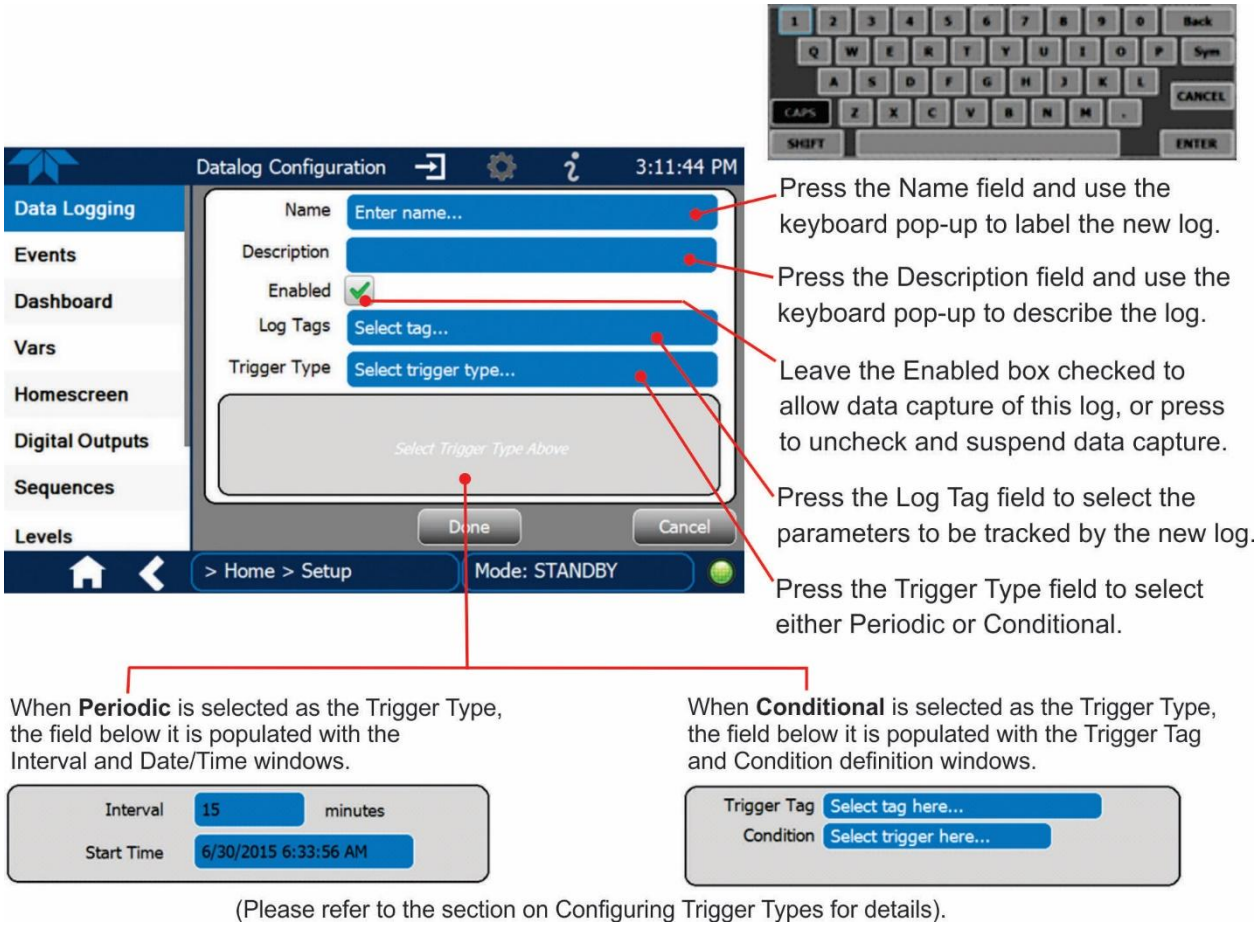


Figure 2-29. Data Log Configuration

2.6.1.1 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.

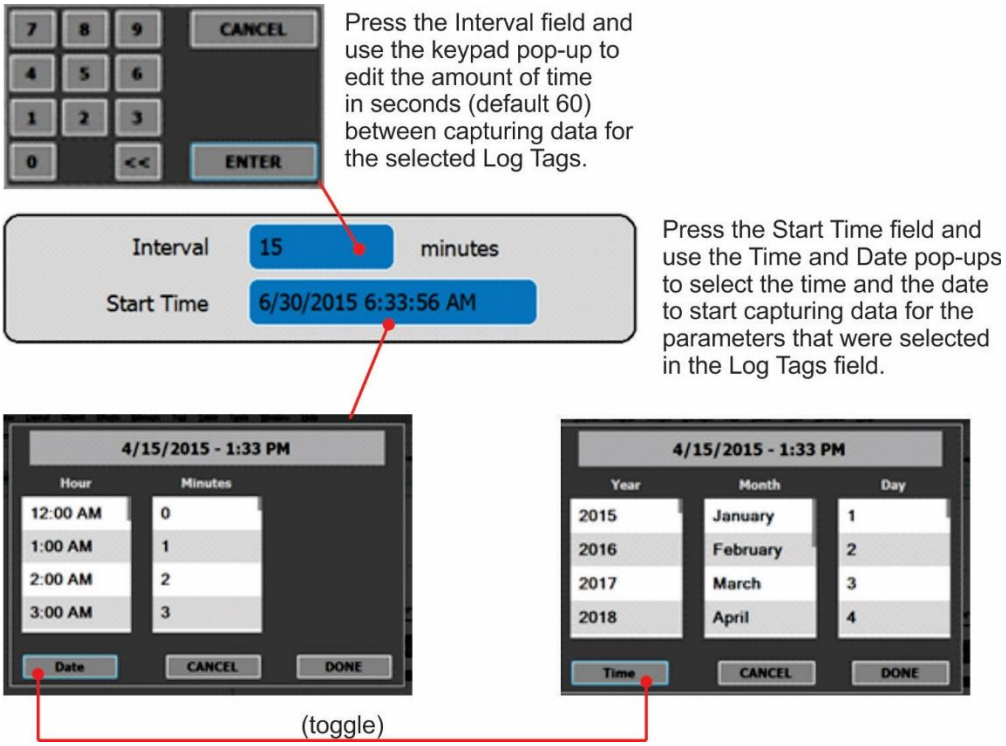


Figure 2-30. Datalog Periodic Trigger Configuration

2.6.1.2 CONFIGURING TRIGGER TYPES: CONDITIONAL

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

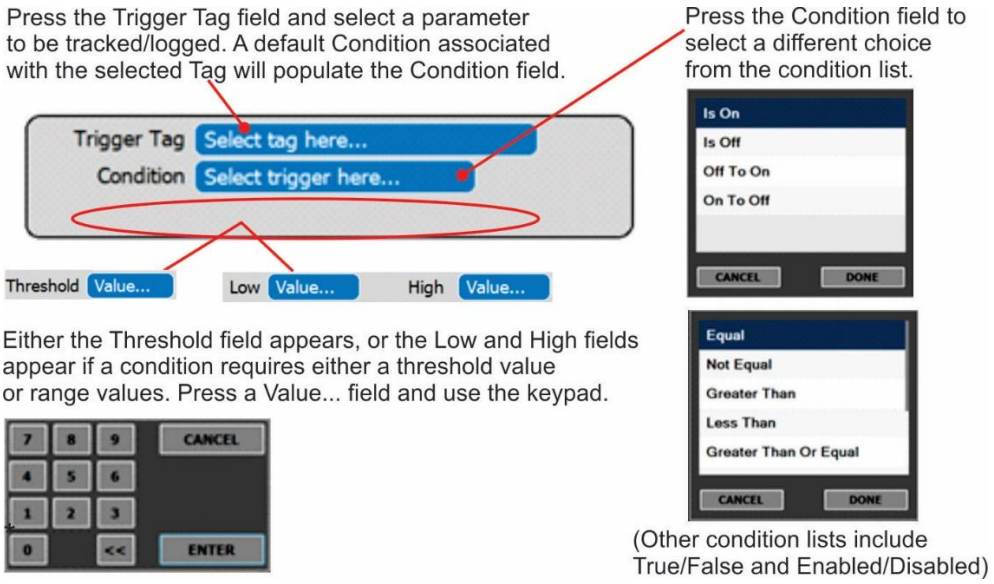


Figure 2-31. Datalog - Conditional Trigger Configuration

2.6.1.3 DOWNLOADING DAS (DATA ACQUISITION SYSTEM) DATA

In the Utilities>USB Utilities menu, instrument data can be downloaded to a flash drive, as presented here.

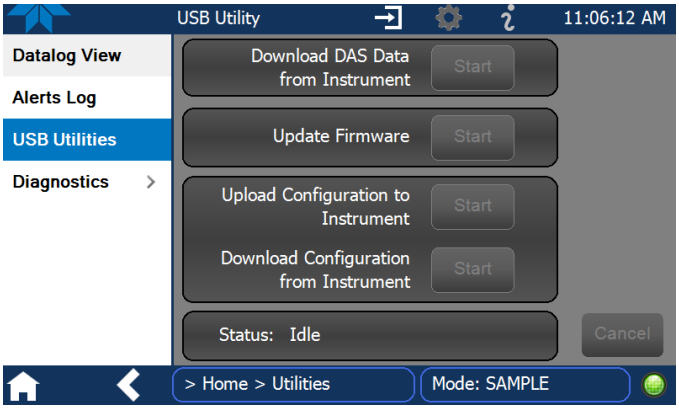


Figure 2-32. USB Utility Page

8. Press USB Utilities menu to open the utility page (Figure 2-32).
9. Insert a flash drive into a front panel USB port and wait for the Status field to indicate that the drive has been detected and available buttons are enabled (Figure 2-33).

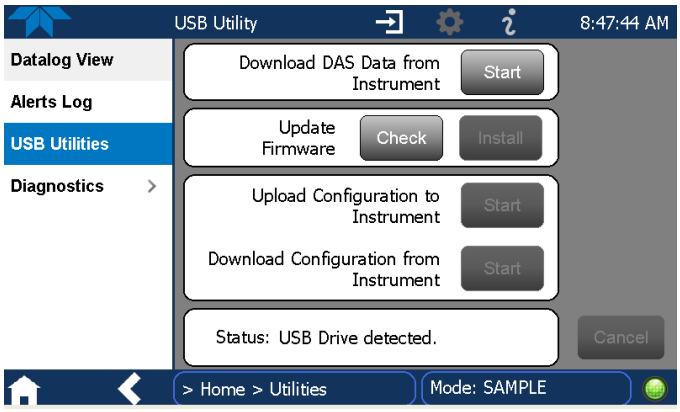


Figure 2-33. DAS Data Download

10. To copy the data to the flash drive, press the Start button next to "Download DAS Data from Instrument." (The Cancel button will be enabled).
11. Wait for the Status field to indicate that the transfer is complete and that the Cancel button becomes the Done button.
12. Press the Done button; then remove the flash drive.

(The Update Firmware field is for checking for and installing firmware updates when the instrument is connected to the Internet and is presented in Section 6.2. The Upload/Download Configuration field is for transferring instrument configuration from/to other instruments and is presented in Section 2.7).

2.6.2 SETUP>EVENTS

Events are occurrences that relate to any operating function and will trigger Alerts (Section 2.5.3). Events can provide diagnostic information about the instrument, typically referred to as "Warnings", or they can provide additional instrument functionality, such as concentration alarms. The instrument comes from the factory with a number of pre-defined warning Events, while the Setup>Events Configuration page provides the capability to create additional, user-defined Events. Events are listed in the Events page (Figure 2-34) under the Setup menu.

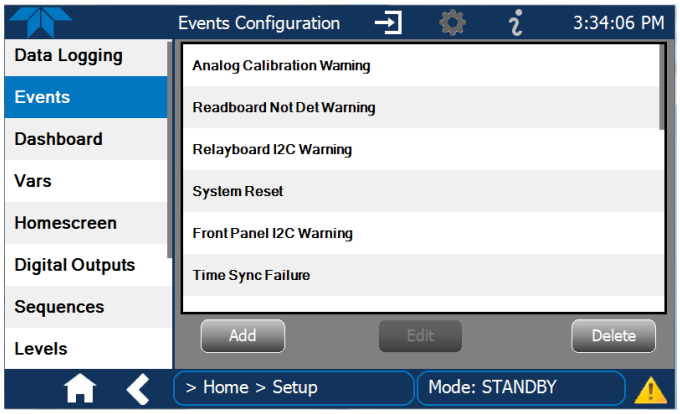


Figure 2-34. Events List

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 2-34). Press ADD to create a new Event (refer to Figure 2-35 for details), or select an existing Event to either Edit or Delete it.

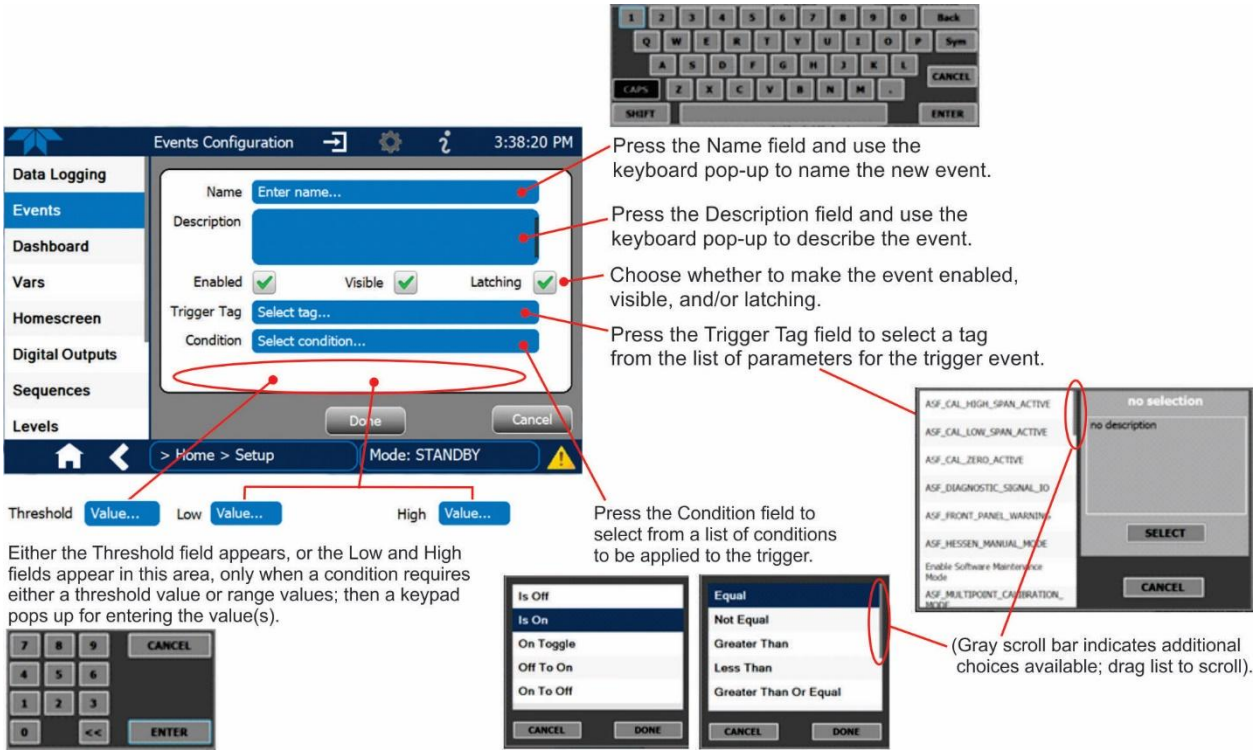


Figure 2-35. Event Configuration

- 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).

2.6.3 SETUP>DASHBOARD

Configure the Dashboard to show the functions and conditions desired for viewing. Select an available tag in the left column and press the right arrow to populate the Dashboard.



Figure 2-36. Dashboard Configuration

2.6.4 SETUP>VARS: INTERNAL VARIABLES

The calibrator has several user-adjustable software variables, which define certain operational parameters. Usually, these variables are automatically set by the instrument's firmware, but can be manually redefined using the Setup>Vars menu. Select a Var to see its description to the right in the VARS Configurator. Press the Edit button to change the attributes of the selected Var.

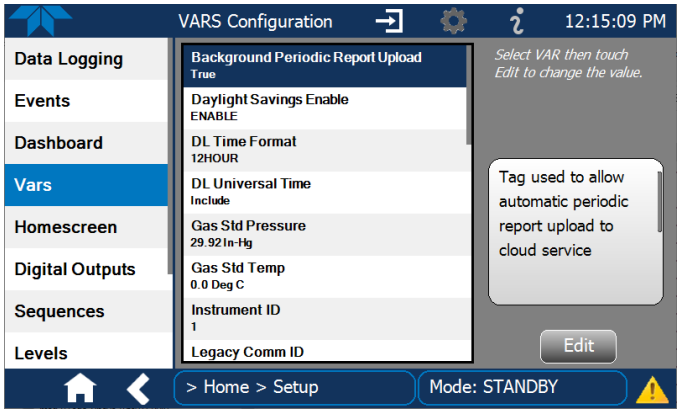


Figure 2-37. Vars Configuration

2.6.5 SETUP>HOMESCREEN

Configure the Homescreen to display three of the available tags and their values in the meters located along the bottom of Home page. Refer to Figure 2-19 for an orientation to Home page and Figure 2-38 for Homescreen configuration page.



Figure 2-38. Homescreen Configuration

2.6.6 SETUP>DIGITAL (STATUS) 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 2.6.2). (If the Motherboard Relay Option was installed, the four additional relays can also be mapped).

To map Digital Outputs to Signals:

1. In the Outputs list select a pin to be configured.
2. In the Signals list select a parameter to assign to the selected pin.
3. Press the Map button.
4. If/as needed, toggle the polarity by pressing the Polarity button.
5. To save, press the Apply button, or to discard, press the Home or the back icon (a pop-up provides a warning that the changes will be lost, and will prompt for confirmation to apply changes or not). Another option is to reassign the pin to the "Not Mapped" parameter.

These status outputs are visible in the Utilities>Diagnostics>Digital Outputs menu, and are labeled "Digital Output [#]" followed by the signal name. They can be selected and their state changed between ON and OFF. (Note that the Digital Outputs list in the Utilities>Diagnostics menu also includes the Control Outputs and other functions).



Figure 2-39. Digital Outputs Setup

2.6.7 SETUP>SEQUENCES: AUTOMATIC CALIBRATION OPERATIONS

This menu appears only when the Mode is set to STANDBY (from the Generate menu)). The calibrator can be set up to perform automatic calibration sequences of multiple steps. These sequences can perform all of the calibration mixture operations available for manual operation and can be initiated by one of the following methods:

- front panel touch screen buttons
- internal timer
- external digital control inputs
- RS-232 interface
- Ethernet interface
- sub-processes in another sequence

Multiple sequences can be programmed and enabled or disabled. Configurable sequence attributes are listed and described in Table 2-8. Figure 2-40 illustrates sequence setup.

Note

Last in = first out: the last step input into the program during configuration under "Edit Steps" is the first step executed, which means that multiple steps must be input in their reverse order; advanced planning is recommended.

Table 2-8. Calibration Sequences Configuration Attributes

ATTRIBUTE NAME	DESCRIPTION
Name	Allows the user to input a unique label identifying the sequence.
Timer	Controls the date and time to start the sequence (Timer Start) and the amount of time to wait before repeating the sequence (Timer Delta) if the Repeat Count attribute is set.
Repeat Count	Number of times to execute the same sequence.
Input CC	Specifies which of the calibrator's Digital Control Inputs will initiate the sequence.
Output CC	Specifies which of the calibrator's Digital Control Outputs will be set when the sequence is active.
☑ Enable	Checked Enable box enables the attribute to initiate the sequence as configured. Unchecked Enable box disables the attribute's initiation of the sequence.

ATTRIBUTE NAME	DESCRIPTION	
Step Types	Selections for programming the activities and instructions that make up the calibration sequence.	
	GENERATE	Puts the instrument into GENERATE mode. Similar in operation and effect to the Generate>Generate>AUTO function used at the front panel.
	STANDBY	Puts the calibrator in Standby mode for the duration
	EXECSEQ	Calls another sequence to be executed at this time. The calling sequence will resume running when the called sequence is completed. Up to 5 levels of nested sequences can be programmed.
	SET CC OUTPUT	Causes the sequence to activate the calibrator's digital control outputs. Similar to the CC OUTPUT attribute, but can be set and reset by individual steps. It is very useful in situations where the control outputs are being used to trigger other devices that need to be turned off and on in sync with the operation of the calibrator as it progresses through the sequence.
	SET STATUS BLOCK	Allows activation of Status Block 1 for rear panel physical Control Outputs and/or Status Block 2 for communicating status.

Note **The last instruction in a sequence should always be to place the calibrator in STANDBY mode.**

Figure 2-40 shows the main screens in Sequence configuration.

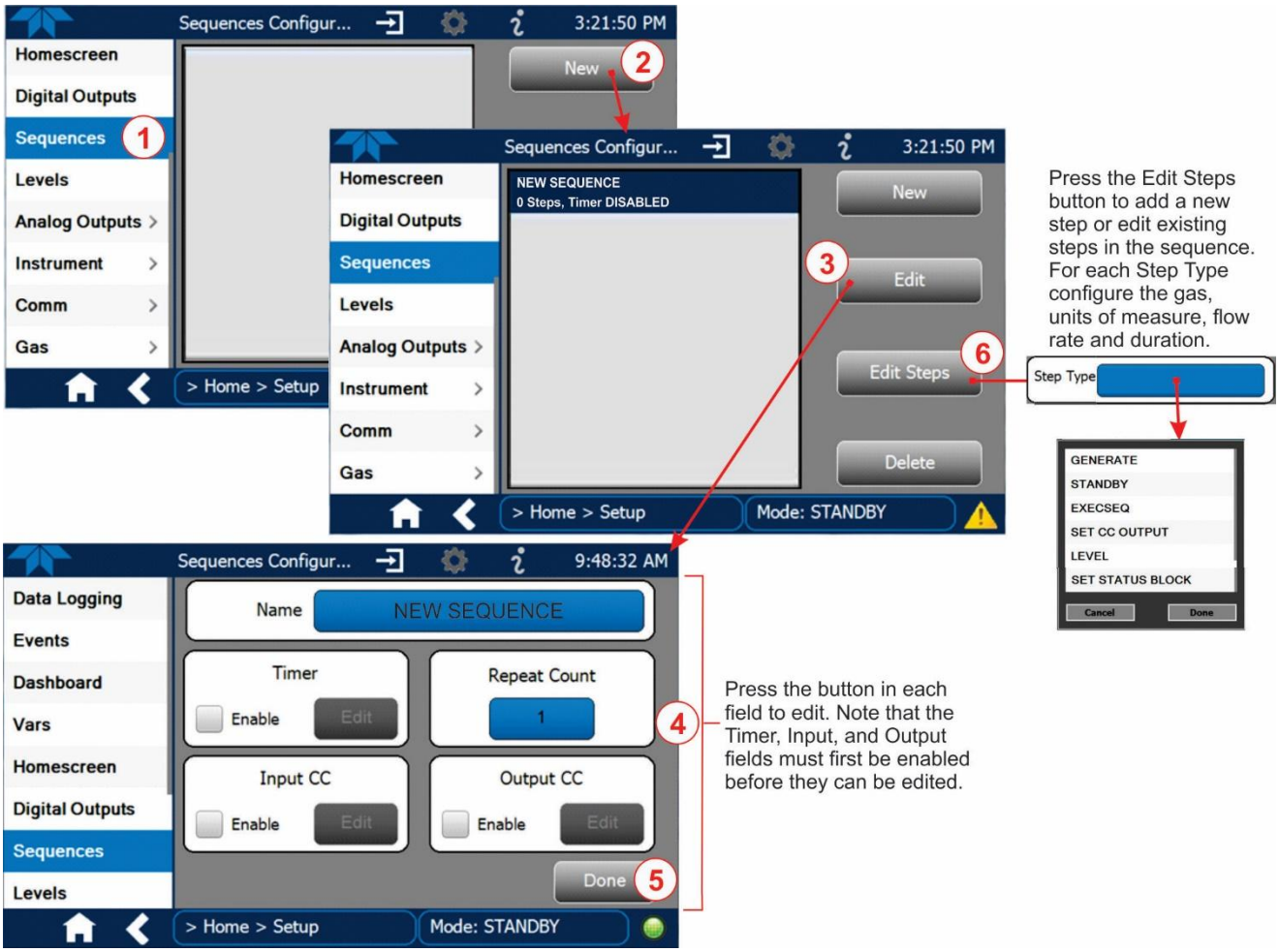


Figure 2-40. Sequence Configuration

Note **When the start time is set for a date/time that has passed, the sequence will properly calculate the next run time based on that past date/time.**

2.6.7.1 SETTING UP CONTROL INPUTS FOR A SEQUENCE

The calibrator's control inputs allow the entire sequence to be triggered from an external source. This feature allows the calibrator to operate in a slave mode so that external control sources, such as a data logger can initiate the calibration sequences.

The calibrator's control inputs connector is located on the rear panel (Figure 2-2).

- 12 separate ON/OFF switches assigned to separate calibration sequences or;
- A 12-bit wide bus allowing the user to define activation codes for up to 4095 separate calibration sequences.

To assign a **CC INPUT** pattern/code to a particular sequence in the Setup>Sequences menu:

1. Select the desired Sequence (or create a new Sequence).
2. In the Input CC field check the Enable box.
3. Press the Edit button.
4. Check the desired control input pin(s).
5. Press Done.

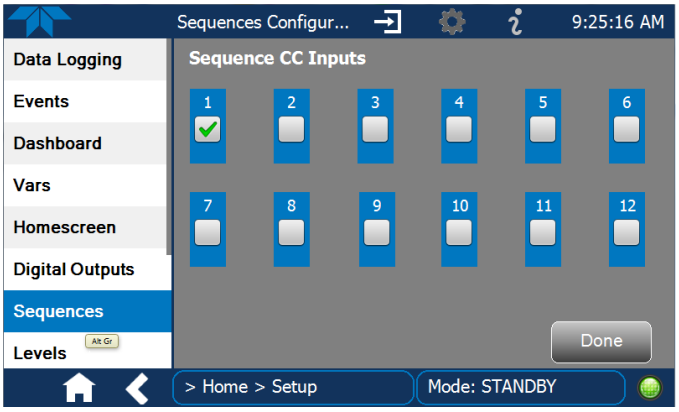


Figure 2-41. Sequence CC Inputs Setup Page

2.6.7.2 SETTING UP CONTROL OUTPUTS FOR A SEQUENCE

The calibrator's control outputs allow the calibrator to control devices that accept logic-level digital inputs, such as programmable logic controllers (PLCs), data loggers, or digital relays/valve drivers.

They can be used as:

- 12 separate ON/OFF switches assigned to separate calibration sequences, or
- a 12-bit wide bus allowing the user to define activation codes for up to 4095 separate calibration sequences.

They can be set so that they are:

- active whenever a particular calibration sequence is operating, or
- activated or deactivated as individual steps within a calibration sequence (see Section 2.6.7.4).

To assign a **CC OUTPUT** pattern/code to a particular sequence in the Setup>Sequences menu:

1. Select the desired Sequence (or create a new Sequence).
2. In the Output CC field check the Enable box.
3. Press the Edit button to open the Sequence CC Outputs page.
4. Check the desired control output pin(s).
5. Press Done.

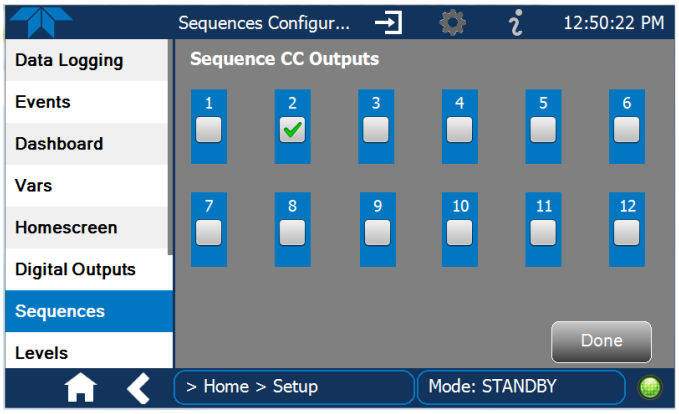


Figure 2-42. Sequence CC Outputs Setup Page

2.6.7.3 PARAMETERS FOR THE STEP TYPES

Several parameters are configurable within a Step Type (Table 2-8 contains step type descriptions), such as gas, concentration, units of measure, and/or flow. Each Step Type has its own parameters, and all allow setting a Duration in minutes, except EXECSEQ, which is for nesting previously configured sequences. Duration causes the calibrator to continue performing the Step Type for the number of minutes input.

2.6.7.4 DELETING OR EDITING SEQUENCES OR INDIVIDUAL STEPS IN A SEQUENCE

In the Setup>Sequences menu, select the Sequence to be changed, and press the button for the intended action:

Edit. Edit the Sequence name, timer, repeat count, input and output CCs.

Edit Steps. Add a new step within the sequence (New).

Select a specific step within the sequence to change (Edit or Delete).

Delete. Delete the entire sequence with all of its steps.

2.6.8 SETUP > ANALOG OUTPUT

2 The calibrator comes equipped with one configurable analog output. It can be set by the user to carry the current signal level of any one of several functions in the calibrator. The Analog Out connector will output an analog VDC signal that rises and falls in relationship with the value of the selected function.

1. In the Setup>Analog Outputs>Analog Output Cfg menu press the button in the Signal Out field and select a function for output from the pop-up list. (Selecting “Not Mapped” disables all other fields in the Analog Output Configurator).

2. In the Min Max fields input the minimum and maximum values for the selected function's range.
3. In the Calibration Type field, select either AUTO or MANUAL.
   - AUTO sets the software to automatically calibrate the user-selected Signal Out function.
   - MANUAL allows fine and coarse adjustments when calibrating the user-selected Signal Out function.
4. In the Range field* select either voltage or current loop and the desired full-scale value of the signal output (see Section 2.6.8.1).
5. In the Recorder Offset field* input a bipolar voltage offset if needed to compensate for noise (see Section 2.6.8.2). This field is not available when Range is set to Current loop.
6. For the Allow Overrange box, either check to allow ± 5% over range, or leave blank if your recording device is sensitive to excess voltage or current.
7. Press the Apply button.
8. Go to the Analog Output Cal menu to calibrate the new settings (see Section 2.6.8.3).

* Changes to Range or Recorder Offset require that this output be recalibrated.



Figure 2-43. Analog Output Configuration

2.6.8.1 ANALOG OUTPUT VOLTAGE RANGE CONFIGURATION

In its standard configuration, the analog outputs is set to output a 0 – 5 VDC signals. Several other output ranges are available (see Table 2-9). Each range is usable from -5% to + 5% of the rated span.

Table 2-9. Analog Output Voltage Range Min/Max

RANGE SPAN	MINIMUM OUTPUT	MAXIMUM OUTPUT
0-5 VDC	-0.25 VDC	5.25 VDC
0-10 VDC	-0.5 VDC	10.5 VDC
The default offset for all ranges is 0 VDC.		

2.6.8.2 ADDING A RECORDER OFFSET

Some analog signal recorders require that the zero signal be significantly different from the baseline of the recorder in order to record slightly negative readings from noise around the zero point. This can be achieved in the calibrator by defining a zero offset, a small voltage (e.g., 10% of span).

2.6.8.3 ANALOG OUTPUT CHANNEL CALIBRATION

Analog Output calibration needs to be carried out on first startup of the calibrator (performed in the factory as part of the configuration process) or whenever recalibration is required. The analog outputs can be calibrated automatically or adjusted manually.

In its default mode, the instrument is configured for automatic calibration of all channels, which is useful for clearing any analog calibration warnings associated with channels that will not be used or connected to any input or recording device, e.g., data logger.

Note **Manual calibration should be used for the 0.1V range or in cases where the outputs must be closely matched to the characteristics of the recording device.**

MANUAL CALIBRATION OF THE ANALOG OUTPUTS CONFIGURED FOR VOLTAGE RANGES

For highest accuracy, the voltages of the analog outputs can be calibrated manually.

Calibration is performed with a voltmeter connected across the output terminals and by changing the actual output signal level in 100, 10 or 1-count increments in the Analog Output Cal page with the Calibration Type set to Manual.

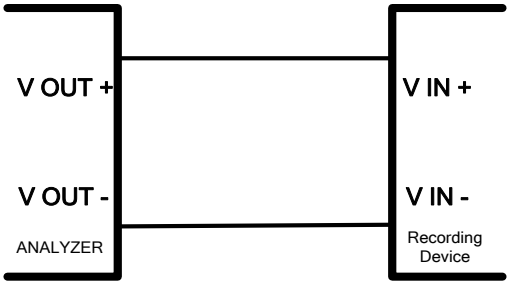


Figure 2-44. Setup for Calibrating the Analog Output Signals

Table 2-10. Voltage Tolerances for the Analog Output Calibration

FULL SCALE	ZERO TOLERANCE	SPAN VOLTAGE	SPAN TOLERANCE	MINIMUM ADJUSTMENT (1 COUNT)
5 VDC	±0.002V	4500 mV	±0.003V	1.22 mV
10 VDC	±0.004V	4500 mV	±0.006V	2.44 mV

Adjust the signal levels of the analog output in the Setup>Analog Outputs>Analog Output Cal menu.

2.6.9 SETUP > INSTRUMENT

This submenu displays product, system, and software information for the instrument (useful for identifying the software and hardware when contacting Technical Support), and allows time zone and language selection. It is also an alternate place to check for and install software updates.

Special instrument or software features or installed options may also be listed here.

2.6.10 SETUP > COMM: COMMUNICATIONS PORTS

This menu is for specifying the various communications configurations.

2.6.10.1 COM2

Configure the instrument's COM2 port to operate in modes listed in Table 2-11.

Table 2-11. COM2 Configuration

MODE	DESCRIPTION
Baud Rate	Set the baud rate for the COM2 port being configured.
Command Prompt Display	Enable/disable a command prompt to be displayed when in terminal mode.
Data Bits	Set the data bits to 7 or 8 (typically set in conjunction with Parity and Stop bits).
Echo and Line Editing	Enable/disable character echoing and line editing.
Handshaking Mode	Choose SOFTWARE handshaking for data flow control (do NOT use SOFTWARE handshaking mode when using MODBUS RTU for Protocol mode; select only HARDWARE or OFF for MODBUS RTU), or HARDWARE for CTS/RTS style hardwired transmission handshaking. (This style of data transmission handshaking is commonly used with modems or terminal emulation protocols). Or choose to turn OFF handshaking.
Hardware Error Checking	Enable/disable hardware error checking.
Hardware FIFO	Enable/disable the hardware First In – First Out (FIFO) for improving data transfer rate for that COM port.
Modem Connection	Select either a modem connection or a direct cable connection.
Modem Init String	Input an initialization string to enable the modem to communicate.
Multidrop	Enable/disable multidrop mode for multi-instrument configuration on a single communications channel. Multidrop requires a unique ID for each instrument in the chain (Setup>Vars>Instrument ID).
Parity	Select odd, or even, or no parity (typically set in conjunction with Data Bits and Stop Bits).
Protocol	Select among the communications protocols.
Quiet Mode	Enable/disable Quiet mode, which suppresses any feedback from the analyzer (such as warning messages) 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.
RS-485	Enable/disable the rear panel **COM2** Port for RS-485 communication. RS-485 mode has precedence over Multidrop mode if both are enabled. Also, RS-485 configuration disables the rear panel USB port.
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).

2.6.10.2 TCP PORT2

TCP Port2 is configured with the port number for MODBUS.

2.6.10.3 NETWORK SETTINGS

The Setup>Comm>Network Settings menu is for Ethernet configuration. The address settings default to automatic configuration by Dynamic Host Configuration Protocol (DHCP). Most users will want to configure the instrument with a static IP address: click the Static radio button to manually assign a static IP address (consult your network administrator, and see Table 2-12 for information).

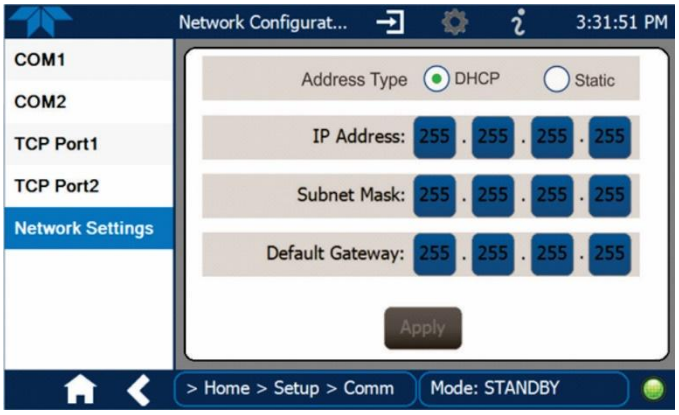


Figure 2-45. Communications Configuration, Network Settings

Table 2-12. LAN/Ethernet Configuration Properties

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.

2.7 TRANSFERRING CONFIGURATION TO OTHER INSTRUMENTS

Once an instrument is configured, the same configuration can be copied to other instruments of the same Model.

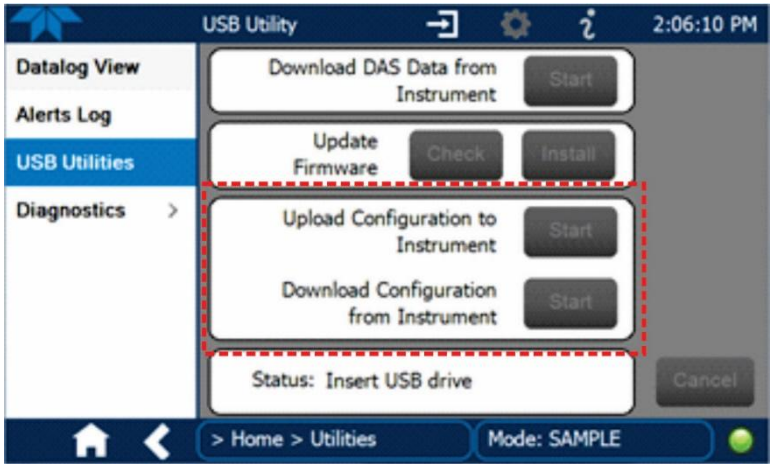


Figure 2-46. Configuration Transfer

1. In the source instrument, go to the Home>Utilities>USB Utilities 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 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.

2.8 TRANSFERRING CONFIGURATION TO OTHER INSTRUMENTS

2.8.1 UPLOAD/DOWNLOAD SEQUENCES

Sequences made on one N703U can be easily downloaded and uploaded to another N703U. This feature allows multiple N703Us to have the same sequence on them without having to create them locally on each machine.

Note **Sequences made on an N703U can be copied ONLY to another N703U (earlier models are not supported).**

Important **The file generated from the download sequence function should not be modified. If changes are needed to the sequences, they should be made on the N703U and a new sequence file downloaded. Uploading a sequence file to a**

calibrator deletes all sequences currently on the calibrator and replace them with the ones uploaded to it.

Restart the instrument. The new sequences from the upload appear in the calibrator as designed.

2.8.2 DOWNLOADING A SEQUENCE FILE

1. Open the NumaView Remote software Version 1.3.12 or later.
2. Connect to an instance of an N703U instrument (if not already connected).
3. Right-click the name of the instrument and select **Download Sequence**.

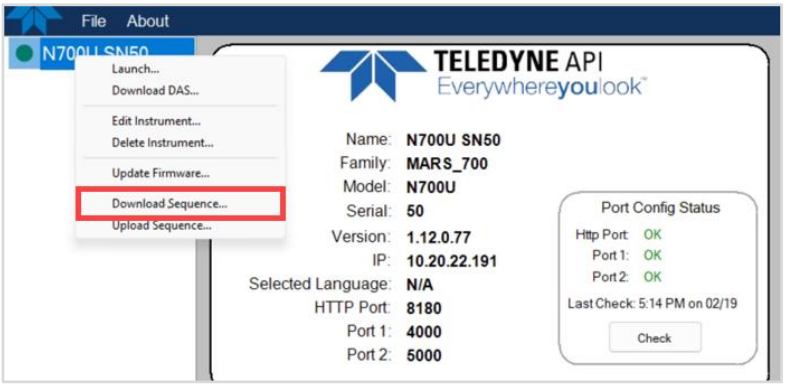


Figure 2-47. Download Sequence

4. Select **Browse** and then select a location for the download.
5. Edit the file name (if needed).

Note **Sequences made on an N703U can be copied ONLY to another N703U (earlier models are not supported).**

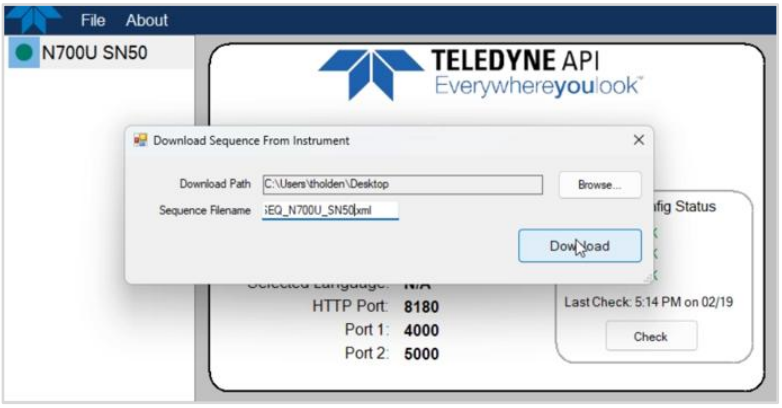


Figure 2-48. Download Sequence from Instrument

6. Select **Download**.
7. NumaView Remote displays a notification when the sequence file has been successfully written.

2.8.3 Uploading a Sequence File

1. Open the NumaView Remote software Version 1.3.12 or later.
2. Connect to an instance of an N703U instrument (if not already connected).
3. Right-click the name of the instrument and select Download Sequence.

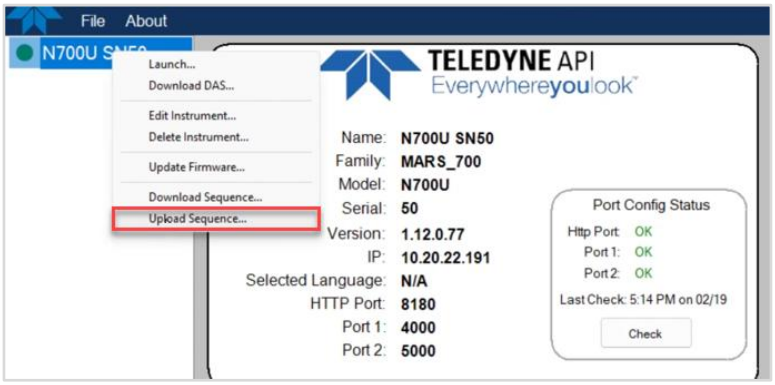


Figure 2-49. Download Sequence from Instrument

4. Select **Browse** and then navigate to the sequence file to be uploaded.

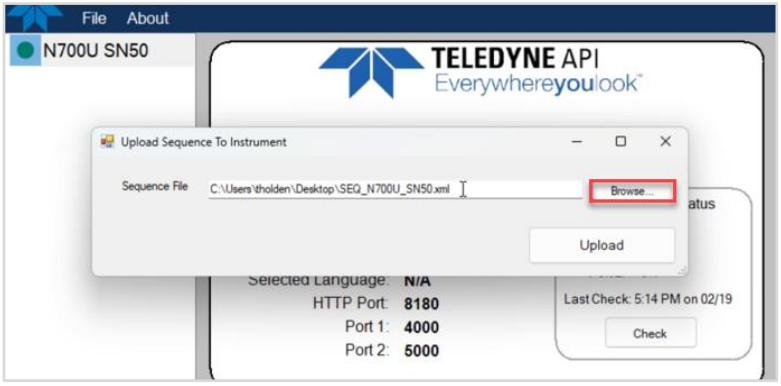


Figure 2-50. Download Sequence from Instrument

5. Select **Upload.**

NumaView Remote reports Success when the upload succeeds.

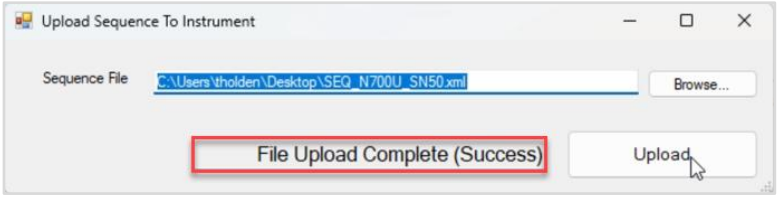


Figure 2-51. Sequence Filename

New sequences overwrite the existing sequences on the next calibrator startup.

3 OPERATING MODES, BASIC OPERATION, AND CONFIGURATIONS

This Section starts with a description of the basic modes of operation in order to begin operation right away, and then provides configuration instructions for other functions.

Standby is the most common of the calibrator's software operating modes; place the calibrator in Standby while configuring the calibrator and performing other procedures. Generate is another common mode; use this mode to generate ozone or zero air, or to execute sequences that were configured under the Setup menu.

Note that the ozone generator in the N703U can operate in a high range or a low range. High range allows for full flow through the O_3 generator and higher concentrations. Low range is more like a fractional mode in that it is used for producing ultra-low levels of ozone (viewable in the Dashboard with the O3GenFraction tag). The N703U low range operation is automatically invoked based on the O_3 concentration and the value of the Low Range Threshold Variable.

Table 3-1 presents descriptions of the modes. Sections 3.1 and 3.2 provide details.

Table 3-1. Calibrator Operating Modes

MODE	DESCRIPTION	
STANDBY	The calibrator and all of its subsystems are inactive. Always ensure that the calibrator is in this mode when performing configurations (Section). The Standby button is in the Generate page.	
GENERATE	In this mode, the instrument is engaged in producing ozone or zero air.	
	AUTO	The calibrator generates ozone or zero air as selected (Section 3.2.1).
	SEQUENCE	The calibrator executes Sequences (Section 3.2.2) that were configured in the Setup>Sequences menu (Section 2.6.7).

3.1 STANDBY MODE

When the calibrator is in Standby mode (Generate>Standby), it is inactive, although Dashboard functions and Alerts continuously update as displayed in the front panel. Airflow is maintained during Standby mode so that the generator can continue to operate at its most efficient temperature.

3.2 GENERATE MODE

In Generate Mode the calibrator generates either zero air or the O_3 concentration set by the user in the Auto function or in the selected Sequence preprogrammed by the user.

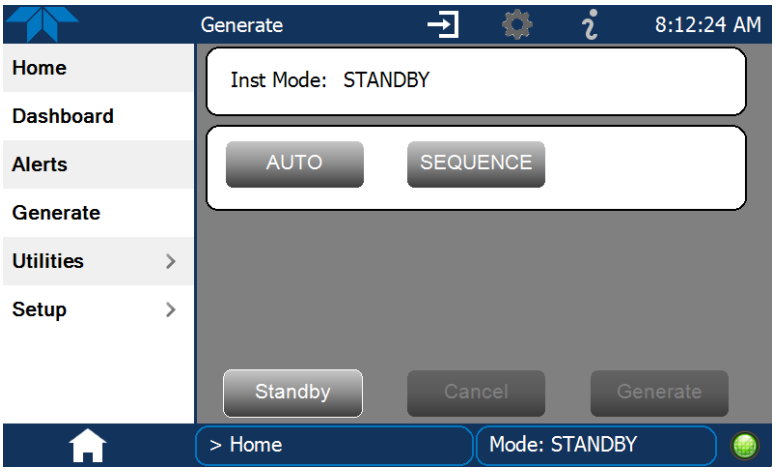


Figure 3-1. Generate Menu

3.2.1 GENERATE>AUTO

3 Pressing the AUTO button brings up the Gas field to select either ozone and the desired concentration and units, or to select ZERO. After making the selection(s), press the Generate button.

To stop generating either ozone or zero air, press the Standby button.

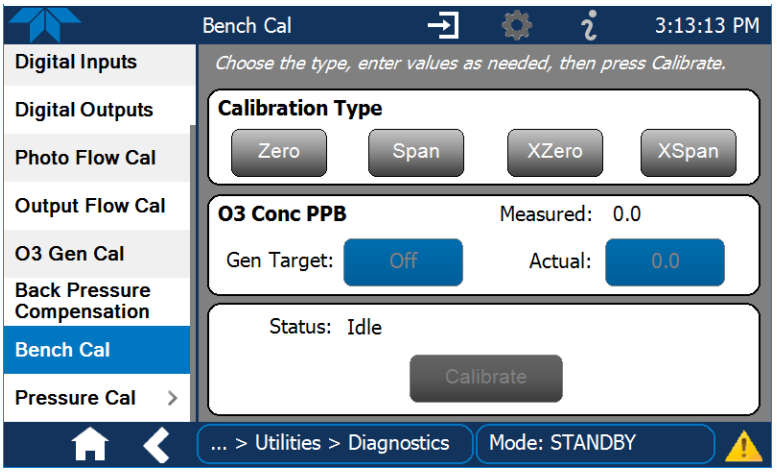
3.2.2 GENERATE > SEQUENCE

Sequences, a set of calibration steps for serial execution, are configured in the Setup>Sequences menu (Section 2.6.7). To execute a Sequence, navigate to the Generate menu (Figure 3-1), press the SEQUENCE button, and select the desired Sequence, then press the Generate button.

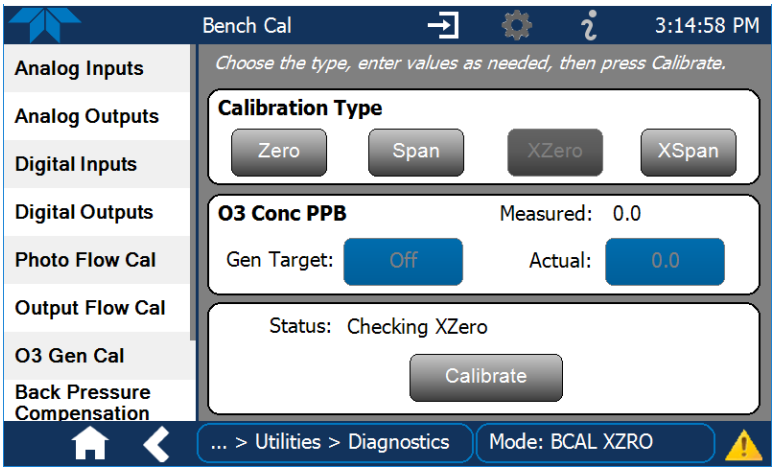
3.3 OPERATION AS AN O_3 PHOTOMETER

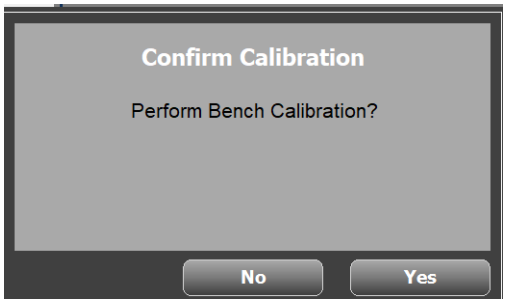
To operate the N703U as a photometer for measuring an external source of ozone:

8. Make the pneumatic connections for this function as presented in Section 2.3.2.6, ensuring that the external gas sources are supplied at atmospheric pressure.
9. Navigate to the Setup>Vars> menu and set the “ZA Pump Enable” Var to OFF (this turns off the internal zero air pump while the external zero air source is in use for this particular application).
10. Navigate to the Utilities>Diagnostics>Bench Cal menu.



11. Press the XZero button, wait 30 minutes to allow for stability, then press the Calibrate button and confirm calibration request by pressing the Yes button; wait for the Status field to display “Success.”





12. Press the XSpan button, wait 30 minutes to allow for stability, then press the Calibrate button and confirm calibration request by pressing the Yes button; wait for the Status field to display “Success.”

The Measured reading will appear in the field above the Status field.

4 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 2.3.1.9. Configuration information was provided in Section 2.6.10.

Data acquisition is set up through the Datalogger (Section 2.6.1).

4.1 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 2.3.1.9).

Referring to Table 2-16, use the SETUP>COMM menu to view/edit the communications settings for the COM port.

4.1.1 MODBUS

MODBUS communications can be configured through the Setup>Comm>COM2 menu for transmission over Ethernet (Section 4.2) 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.

4.2 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 3-3. 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 2.6.10.3 for configuration details.

For MODBUS communications configuration, see Section 4.1.1.

4.3 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.

5 CALIBRATION AND VERIFICATION

Basic electronic calibration of the instrument is performed at the factory. Normally there is no need to perform this factory calibration in the field; however, the performance of the instrument's two key subsystems should be verified periodically and adjusted if necessary:

- O_3 Photometer: performance should be periodically verified against an external transfer standard.
- O_3 Generator: should be periodically calibrated.

Note **Calibration of subsystems will be rendered inaccurate if there are issues with pressure or flow. Follow the order of procedures as recommended herein.**

Prior to verifying and calibrating these subsystems, it is important to verify and calibrate the gas pressure sensors first, then run a back pressure compensation, followed by gas flow calibration, and finally a leak check, all in that order. These procedures will help to eliminate any issues that would interfere with accurate verification and calibration of the bench and should be performed in the order presented in the next several subsections.

5.1 VERIFYING AND CALIBRATING THE GAS PRESSURE SENSORS

Note **The procedures described in this Section require a separate pressure meter/monitor.**

The N703U Calibrator has two sensors that monitor the pressure of the gases flowing through the instrument: a Regulator pressure sensor and a Photometer Sample Gas pressure sensor. The N703U also has those two sensors plus one more: an O_3 Generator Regulator pressure sensor. The data collected by these sensors are used to compensate the final concentration calculations for changes in atmospheric pressure and are stored in the CPU's memory as test functions:

Table 5-1. N703U Pressure Sensors

SENSOR	ASSOCIATED TEST FUNCTION	UNITS	PRESSURE MONITOR MEASUREMENT POINT
Regulator Pressure Sensor	**REGULATOR PRESURE**	**PSIG**	Capped fitting on backside of regulator assembly. See Figure 5-2.
Photometer Sample Gas Pressure Sensor	**SAMPLE PRESSURE**	**IN-HG-A**	Use monitor to measure ambient atmospheric pressure at the calibrator's location.
O_3 Generator Regulator Pressure Sensor	**O3 PRES**	**PSIG**	Capped fitting on O_3 Generator Regulator assembly. See Figure 5-3.

5.1.1 PRESSURE SENSOR CALIBRATION SET UP

Attach the independent, calibrated pressure meter/monitor at the location shown in Figure 5-1.

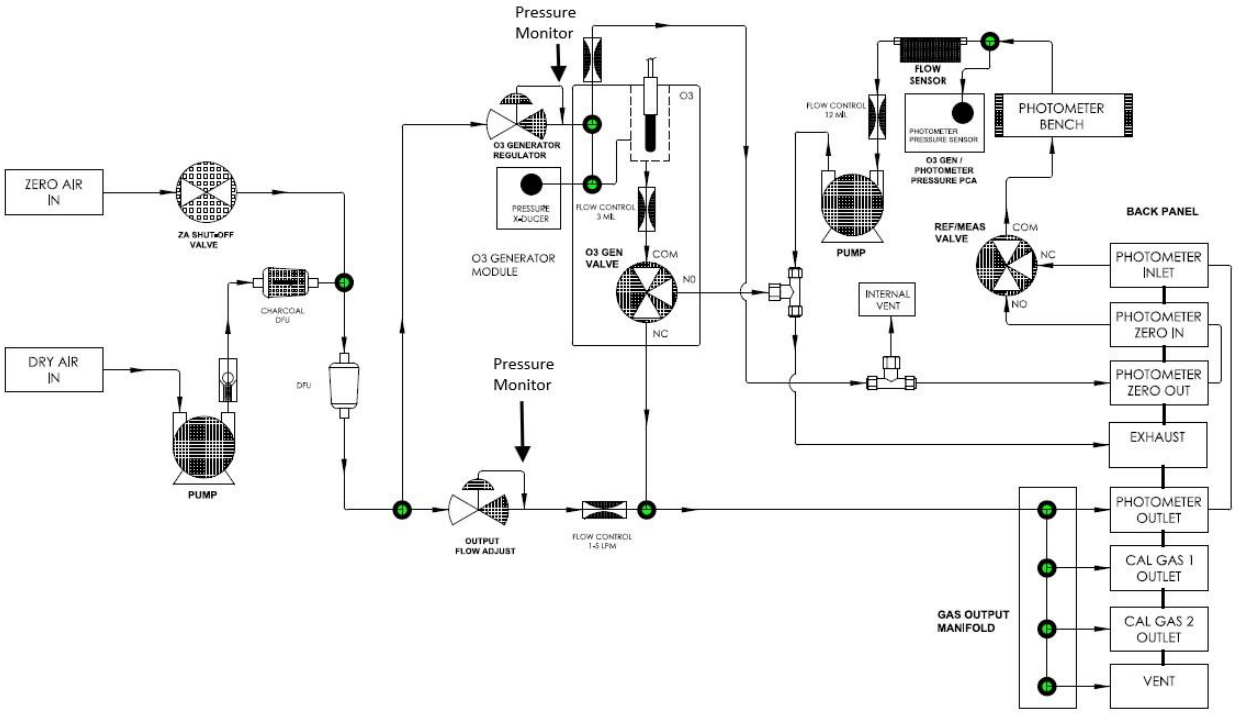


Figure 5-1. N703U Pressure Monitor Points

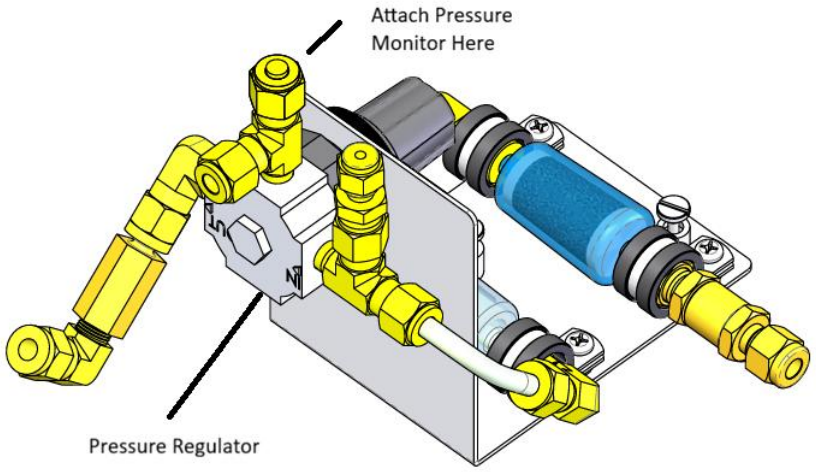


Figure 5-2. Pressure Regulator Monitor Connection

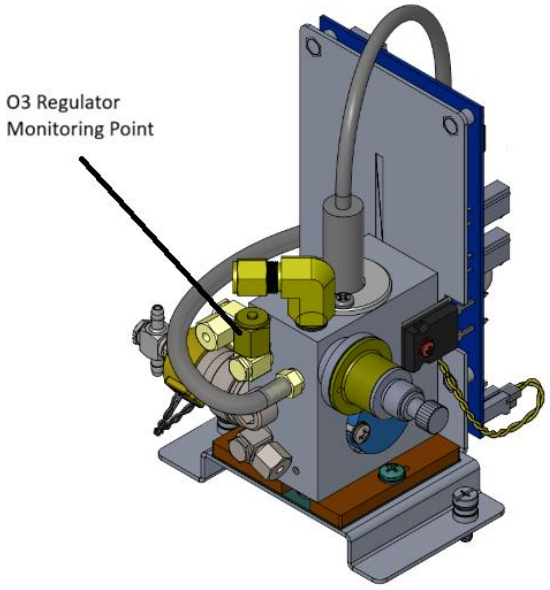


Figure 5-3. O3 Regulator Pressure Monitor Point

5.1.2 PRESSURE SENSOR CALIBRATION

The following procedure requires a pump. There is an internal pump in the N703U.

1. Turn off the calibrator and open the top cover.
2. Connect a pressure meter to the Regulator Pressure measurement fitting (see Figure 5-2). This fitting is located on the backside of the regulator assembly.
3. Connect a pressure meter to the O_3 Regulator (Figure 5-3)
4. Turn on the calibrator and navigate to the Utilities>Diagnostics>Pressure Cal menu.
5. Select the pressure sensor to be calibrated, and in the “Actual Pressure” field (press button to bring up keypad) input value obtained from pressure meter and press Enter. (Enable the valve if interface shows an Enable button).
6. Press the Calibrate button, and then confirm that the calibration is to be carried out.
7. Follow with a Back Pressure Compensation, described next.

The Status field should read “Success” when complete.

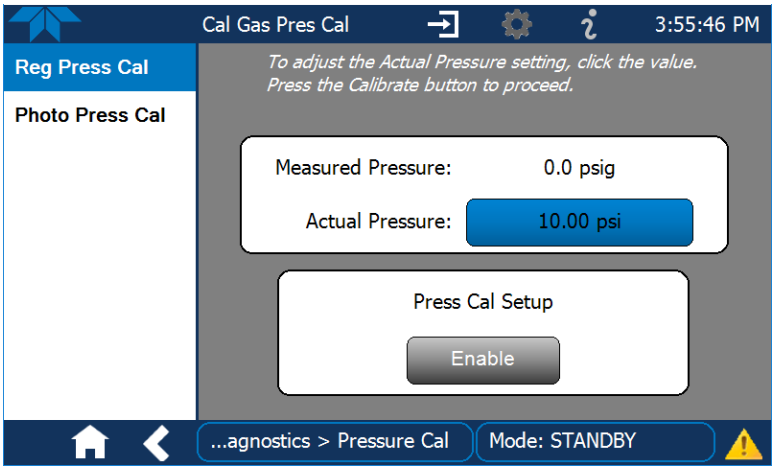


Figure 5-4. T703 Pressure Calibration Menu

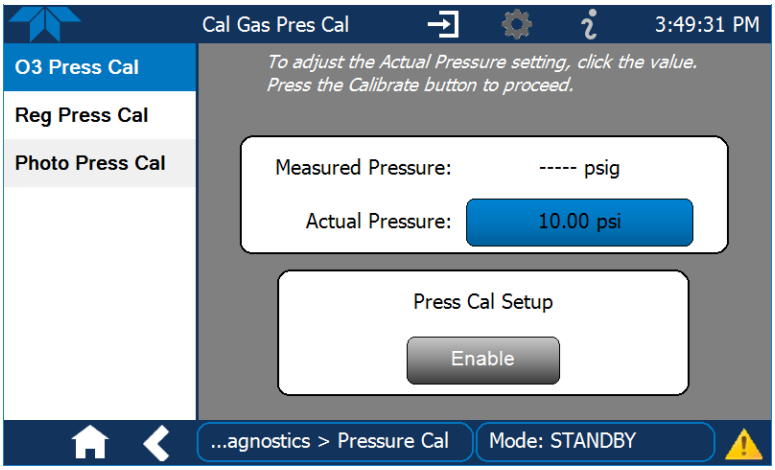


Figure 5-5. T703U Pressure Calibration Menu

5.2 BACK PRESSURE COMPENSATION

Any time there is a pneumatic configuration change (whether locally to the instrument or to the sampling system) or a gas pressure calibration, there is risk of impacting the internal measure/reference pressure. To compensate for this, a back pressure compensation calibration should be performed.

1. Place the calibrator in Standby mode.
    a. Select **Generate**.
    b. Select **Standby**.
2. Select **Utilities**.
3. Select **Diagnostics**.
4. Select **Back Pressure Compensation**.
5. Select **Calibrate**.

The operation will take a few minutes.

Another occasion to run a Back Pressure Compensation is if there is a fluctuating difference of more than .2 in Hg in the Photo Pressure parameter while ozone is being generated. This

would be where the Meas/Ref valve is cycling (about six seconds per full cycle), and the Photo Pressure reading changes by more than .2 as the valve switches approximately every three seconds.

This change in pressure can be seen in the Pressure Delta dashboard (shown below) and DAS item.

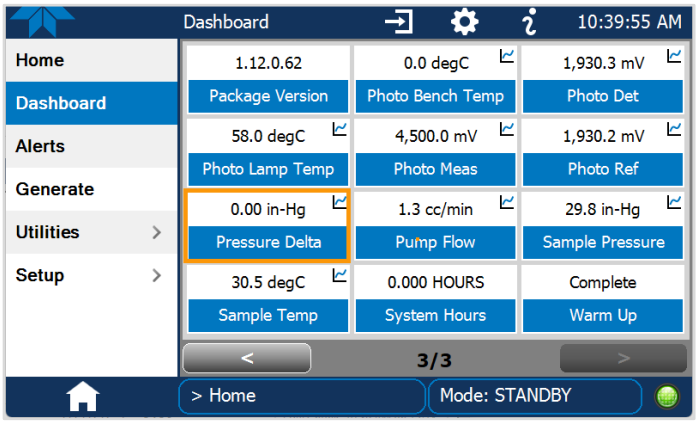


Figure 5-6. Pressure Delta Dashboard

5.3 GAS FLOW CALIBRATION

The N703U has two gas flow characteristics that affect its performance: the flow of gas through the sample chamber of the instrument's photometer (Photo Flow) and the total gas flow being output (Output Flow). While both are stored in the calibrator's memory and used to compensate the final concentration calculations for changes in atmospheric pressure, they are calculated quite differently: the Photo Flow rate is calculated by applying the slope factor from the previous Photo Flow calibration to the reading measured by a flow sensor located on the pressure/flow sensor PCA, whereas the Output Flow rate is calculated by applying a separate slope factor to an interpolated value.

Both can be viewed in the Dashboard (if not shown, use the Setup>Dashboard menu).

Run the Photo Flow Cal (Section 5.3.1) and then the Output Flow Cal (Section 5.3.2).

5.3.1 CALIBRATING THE PHOTOMETER'S SAMPLE GAS FLOW (PHOTO FLOW CAL)

Note **The procedures described in this section requires that an independent, calibrated gas flow meter/monitor be connected to the PTFE inlet fitting on the photometer of the N703U.**

1. Connect an independent, calibrated external flow meter/monitor per the preceding Note.
2. Navigate to the Utilities>Diagnostics>Photo Flow Cal menu (Figure 5-8).
3. Press the Enable button to start the flow.
4. Adjust the Actual Flow as measured by the external flow meter and press the ENTER button.
5. Press the Calibrate button.
6. A confirmation window will pop up: pressing the No button aborts the calibration, or pressing the Yes button starts the calibration.
7. The Status field will display "Success" when complete.

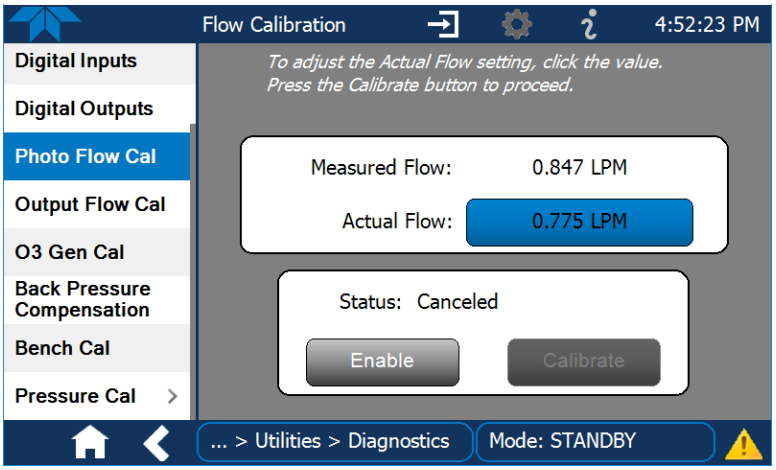


Figure 5-7. Photo Flow Calibration Menu

5.3.2 CALIBRATING THE OUTPUT GAS FLOW (OUTPUT FLOW CAL)

Note

The procedures described in this Section requires that an independent, calibrated external gas flow meter/monitor be connected to one CAL GAS OUT port, with the other CAL GAS OUT PORT and the VENT port capped.

1. Connect an independent, calibrated external flow meter/monitor per the preceding Note.
2. Navigate to the Utilities>Diagnostics>Output Flow Cal menu (Figure 5-8).

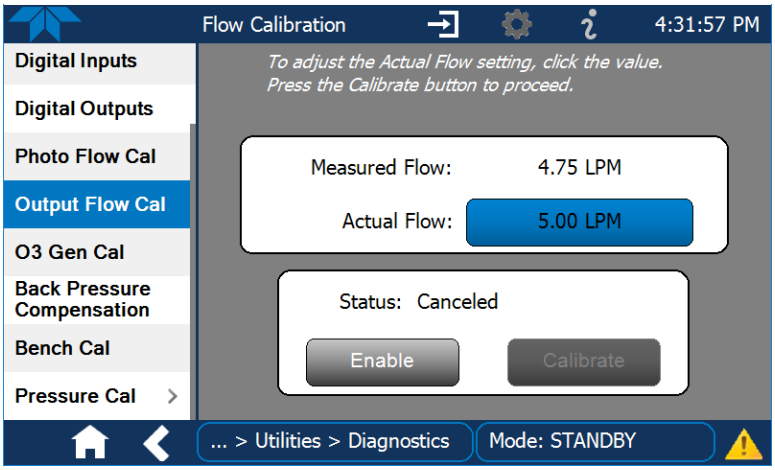


Figure 5-8. Output Flow Calibration Menu

3. Press the Enable button to start the flow.
4. Adjust the Actual Flow as measured by the external flow meter and press the ENTER button.
5. Press the Calibrate button.
6. A confirmation window will pop up: pressing the No button aborts the calibration; pressing the Yes button starts the calibration.
7. The Status field will display “Success” when complete.
8. Now run a leak check Run a leak check (Section 6.5.1) prior to moving on to verifying and calibrating the bench.

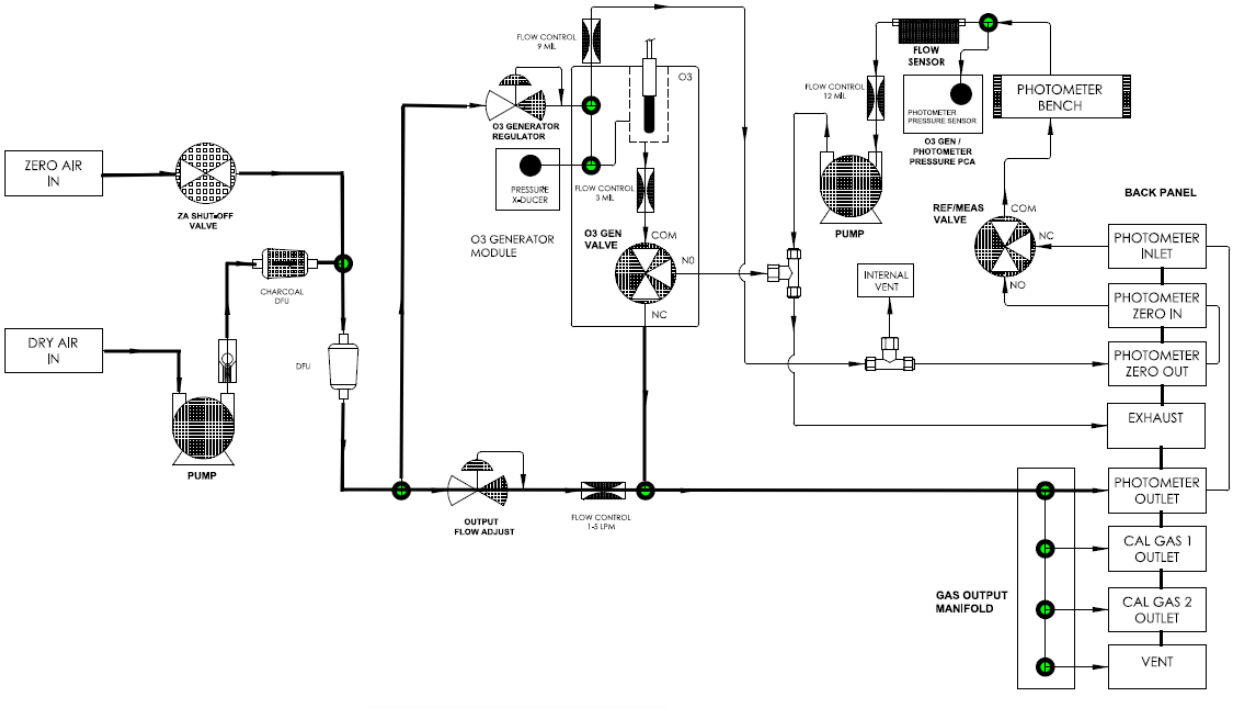


Figure 5-9. N703U Output Flow Calibration Flow

5.4 VERIFYING AND CALIBRATING THE O_3 PHOTOMETER (BENCH)

The accuracy of O_3 produced by the calibrator depends entirely on the accuracy of the photometer; therefore, it is very important to verify its accuracy and calibrate if necessary. The verification procedure can be performed by using either the instrument's internal O_3 generator or an external source of O_3. For zero air, either the internal ZA pump can be used or an external source, such as a Teledyne API's Model 701 Zero Air Generator can be used.

- Setup illustrations: Section 5.4.1
- Performance verification instructions: Section 5.4.2
- Calibration instructions (if required): Section 5.4.3

5.4.1 SETUP FOR VERIFYING AND CALIBRATING THE O_3 PHOTOMETER

Note **This operation requires an external reference photometer.**

Place the calibrator in Standby mode (from the Generate menu), and set up the calibrator and reference photometer as illustrated in either Figure 5-10 (when using the internal ozone generator) or Figure 5-11 (when using an external ozone source). When using the internal ozone generator, the zero air can be configured in either of two ways:

- External Zero Air: cap the DRY AIR IN port, and disable the internal zero air pump via the Setup>Vars>ZA Pump Enable menu (press the Edit button to change to OFF).

or

- Internal Zero Air: connect a dry air desiccant cannister to the DRY AIR IN port, cap the ZERO AIR IN port, and enable the zero air pump via the Setup>Vars>ZA Pump Enable menu (press the Edit button to change to ON).

The manifold's excess gas should be vented to a suitable vent outside of the room. This vent should be of large enough internal diameter to avoid any appreciable pressure drop, and it must be located sufficiently downstream of the output ports to assure that no ambient air enters the manifold due to eddy currents or back diffusion.

Note **It is recommended that the calibration manifold's exhaust vent have a minimum internal diameter of 3/8 inch and a maximum length of 3 meters (or 10 feet).**

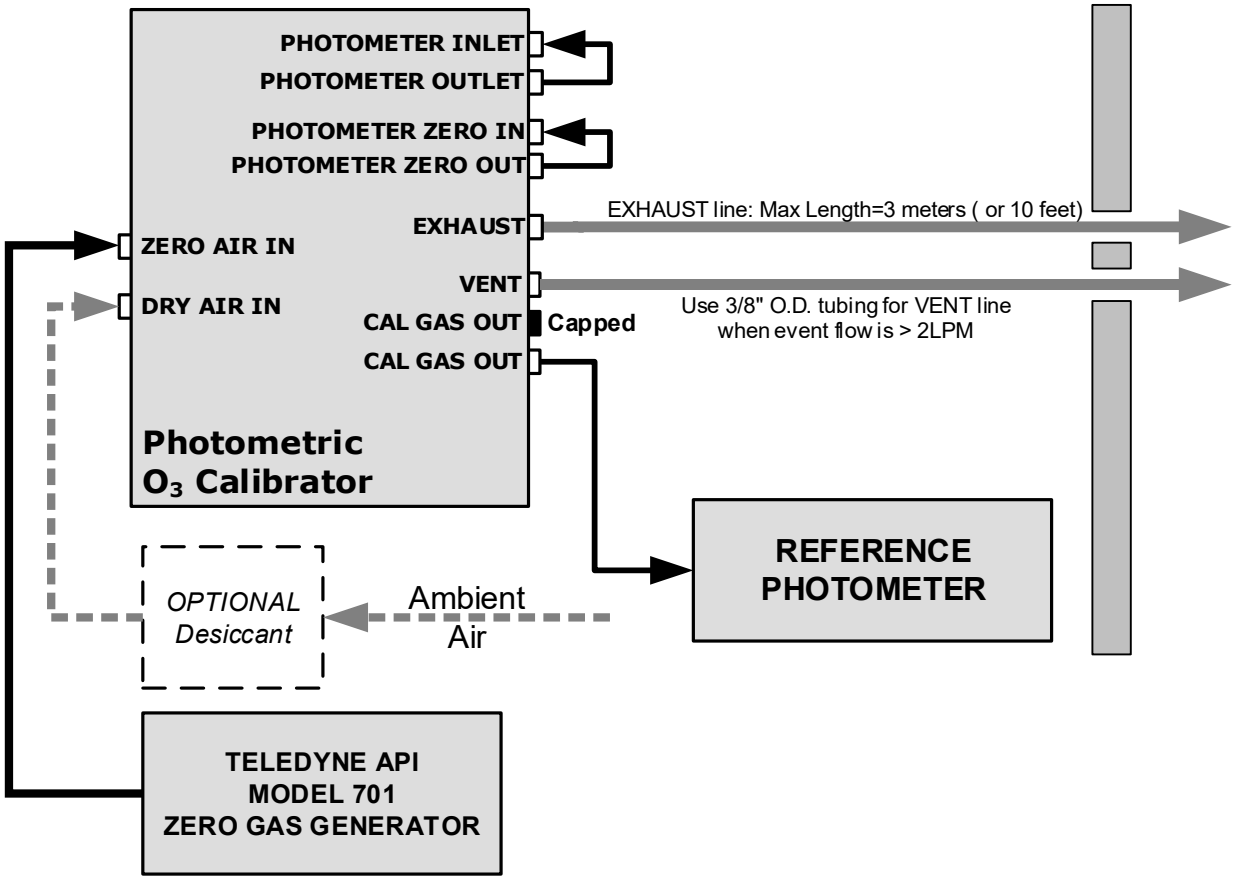


Figure 5-10. Set up for Verifying O_3 Photometer Using Internal O_3 Generator

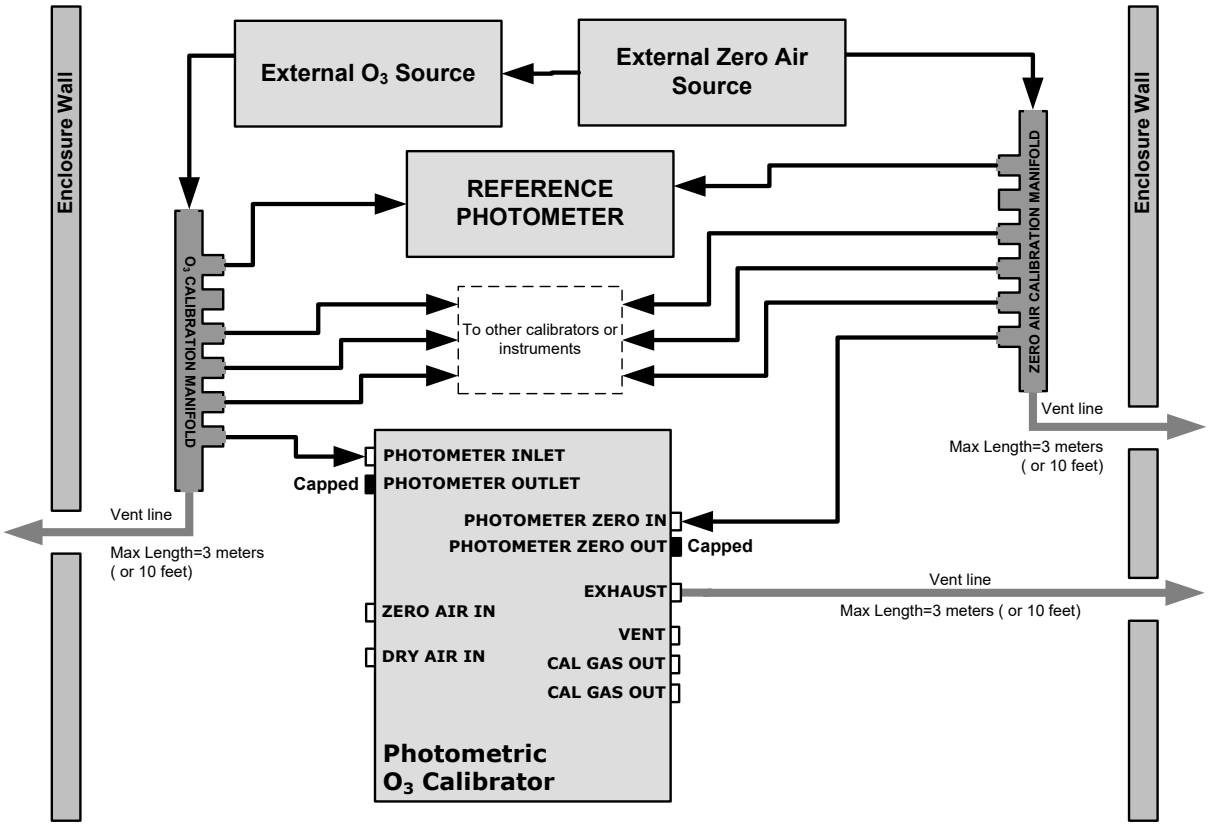


Figure 5-11. Set up for Verifying O_3 Photometer Using an External O_3 Generator

5.4.2 VERIFYING O_3 PHOTOMETER PERFORMANCE

To verify the performance of photometer after setting up the connections (Section 5.4.1), place the calibrator in Standby mode (in Generate menu), and perform the following steps:

1. In the Generate menu press the AUTO button.
2. Ensure the Gas is set to O3, and set the target concentration and units of measure, as desired.
3. Press the Generate button and see the settings in the upper portion of the display.
4. Go to Home page and wait about 10 minutes or more until the reading under “Actual” stabilizes before comparing that value to the reading of the reference photometer to ensure they are within 1% of each other (If not, calibrate per Section 5.4.3).
5. If the performance check is acceptable, go on with operations. If the check results are not acceptable, then move on to Calibrating the O3 Photometer.

5.4.3 CALIBRATING THE O_3 PHOTOMETER (BENCH)

First zero the photometer (Section 5.4.3.1), then span the photometer (Section 5.4.3.2)

5.4.3.1 PHOTOMETER ZERO CALIBRATION

This procedure sets the values held in the calibrator's memory for zero point Offset and Slope.

1. Ensure the calibrator is in Standby mode and navigate to the Utilities>Diagnostics>Bench Cal menu.
2. Select the Calibration Type: The Zero button is for internal zero calibration, and the XZero button is for external zero calibration.
3. Allow Zero air to enter the PHOTO ZERO IN port of the calibrator's rear panel.
4. Press the Calibrate button. (Pressing "Yes" in the Confirm Calibration window changes the Offset and Flow values for the O_3 measurement, where "No" aborts the calibration).

5.4.3.2 PHOTOMETER SPAN CALIBRATION

This procedure sets the response Slope for the photometer.

1. Ensure the calibrator is in Standby mode and navigate to the Utilities>Diagnostics>Bench Cal menu.
2. Select the Calibration Type: The Span button is for internal span calibration, and the XSpan button is for external span calibration.
3. For an internal span, set the Gen Target value and the Actual value, then press the Calibrate button, or for an external span, set the Actual value, then press the Calibrate button.

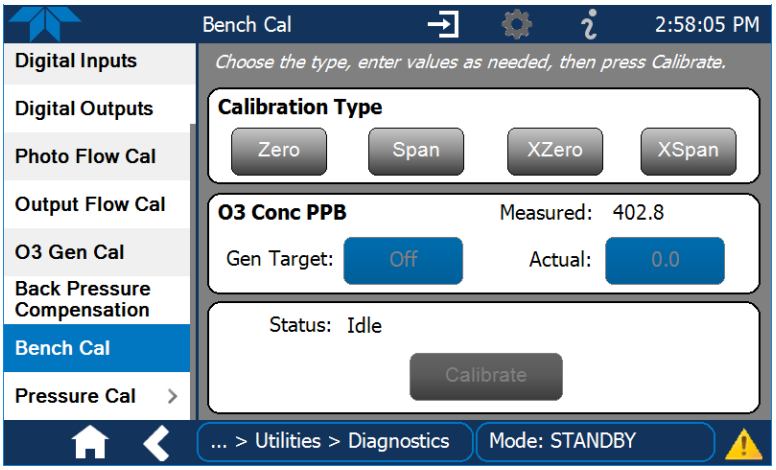


Figure 5-12. Bench Calibration Screen

5.5 CALIBRATING THE O_3 GENERATOR

The N703U calibrator's software includes a routine for automatically calibrating the O_3 generator. A calibration table of drive voltages stored in the calibrator's memory is the basis for this calibration. This table is used by the N703U to set initial O_3 generator drive settings.

The calibrator's software includes a routine for automatically calibrating the O_3 generator. It should be used only under the following circumstances:

- When your facility's Standard Operating Procedure (SOP) requires it, or
- When there has been a change to a component of the ozone generator tower, or
- If the total flow has been changed significantly (greater than 1 lpm change)

And only after first:

- Performing a pressure leak check (Section 6.5.1), followed by
- Running a Back Pressure Compensation (Section 5.1)

To run the automatic O_3 generator calibration program:

1. Set up the vent either by using the vent on the manifold and capping the calibrator's rear Vent port, or vent the calibrator's rear Vent port with at least a 10-inch tube.
2. Navigate to Utilities>Diagnostics and press O3 Gen Cal.
3. You can independently calibrate the full flow or fractional flow table for the O3 generator, but it is recommended to calibrate both of them at the same time

6 MAINTENANCE

Predictive diagnostic functions including failure warnings and alarms built into the calibrator's firmware allow the user to determine when repairs are necessary without performing painstaking preventative maintenance procedures.

Follow the maintenance schedule provided in this section.

ATTENTION **COULD DAMAGE INSTRUMENT AND VOID WARRANTY**

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

Also, when cleaning (or any time), avoid spraying or dripping anything directly onto any part of the ozone generator, photometer or any PCA.

6.1 MAINTENANCE SCHEDULE

Table 6-1 shows a typical maintenance schedule for the calibrator. 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. Please note that in certain environments (i.e. dusty, very high ambient pollutant levels) some maintenance procedures may need to be performed more often than shown.

Note **If the instrument has the optional O_3 photometer installed, a Span and Zero Calibration Check must be performed on the photometer following some of the maintenance procedure listed below. See Section 5.1 for instructions on performing checks.**



WARNING – RISK OF ELECTRICAL SHOCK

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



CAUTION

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

Table 6-1. Maintenance Schedule

ITEM	ACTION	FREQ	CAL CHECK REQ'D.[1]	DATE PERFORMED									
Verify Basic Functions	Record and analyze (Dashboard)	Weekly or after any Maintenance or Repair	No										
Photometer Pump Diaphragm	**No Replacement Required. Under Normal Circumstances the Pumps Will Last the Lifetime of the Instrument.**												
Dry Air Pump	Replace (Section 6.5.3	Annually or as needed (per frequency/length of use)	Yes										
Absorption Tube	Inspect - - - Clean or Replace (Section 6.5.2)	As Needed	Yes after cleaning	Cleaning of the Photometer Absorption Tube should not be required as long as ONLY CLEAN, DRY, PARTICULATE FREE Zero Air (Diluent Gas) is used with the calibrator									
Perform Leak Check	Verify Leak Tight (Section 6.5.1)	Annually or after any Maintenance or Repair	Yes										
Pneumatic lines	Examine and clean	As needed	Yes if cleaned										
DFU Filter	Inspect Replace if Needed	Annually or as needed (per frequency/length of use)	No										
Carbon Filter	Inspect Replace if Needed	Annually or as needed (only used when dry air pump is used)	No										

6.2 OPERATIONAL HEALTH CHECKS

Navigate to the Utilities>USB Utilities>Report menu (Figure 6-1) to download a report on the basic operations of the instrument. 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.

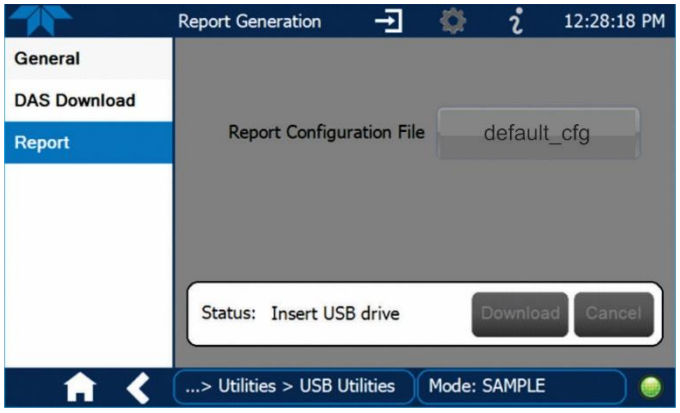


Figure 6-1. Report Generation Page

The report can also be set to generate periodically and sent to a Web services "cloud" where it is available for viewing by Teledyne API technical support personnel. Set this function with two Vars:

Setup>Vars>Upload Report to Cloud: set to True.

Setup>Vars>Report Upload>Interval: edit the number of hours between report uploads.

6.3 SOFTWARE/FIRMWARE UPDATES

There are two ways to check for and acquire updates: either remotely or manually.

6.3.1 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 the Check for Updates button. If an update is available, it can be downloaded through this page.

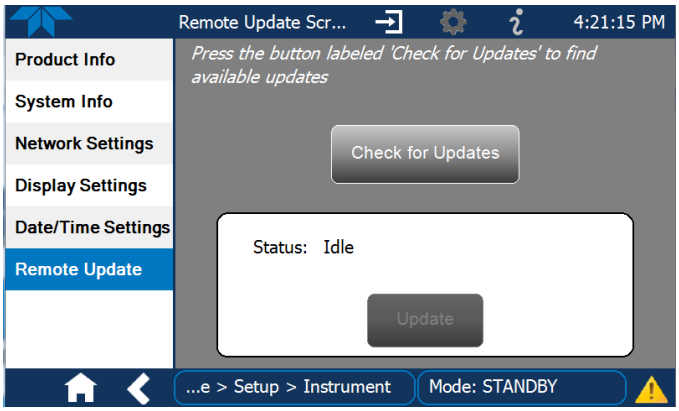


Figure 6-2. Remote Update Page

6.3.2 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.

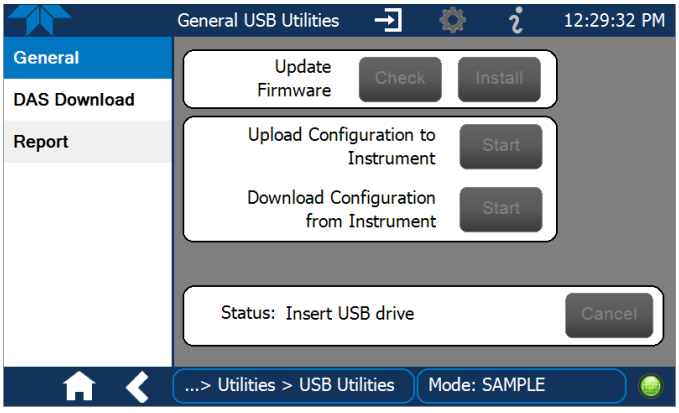


Figure 6-3. General Utilities Page

3. Insert a flash drive into a front panel USB port and wait for the Status field to indicate that the drive has been detected.
4. In the Update Firmware field, press the Check button for the instrument to determine whether the firmware on the flash drive is more recent than what is

currently installed. Once it's been determined that the firmware is new, the Install button will be enabled; if the firmware version on the flash drive is the same as or older than the current firmware of the instrument, the Install button will not be enabled.

5. Press the Install button and note the messages in the Status field at the bottom of the page. Use the Cancel button if necessary.
6. When complete, as indicated in the Status field, press the Done button, which replaces the Cancel button, and remove the flash drive.
7. Power off and restart the instrument to complete the new firmware installation.

6.4 TIME ZONE CHANGES

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

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

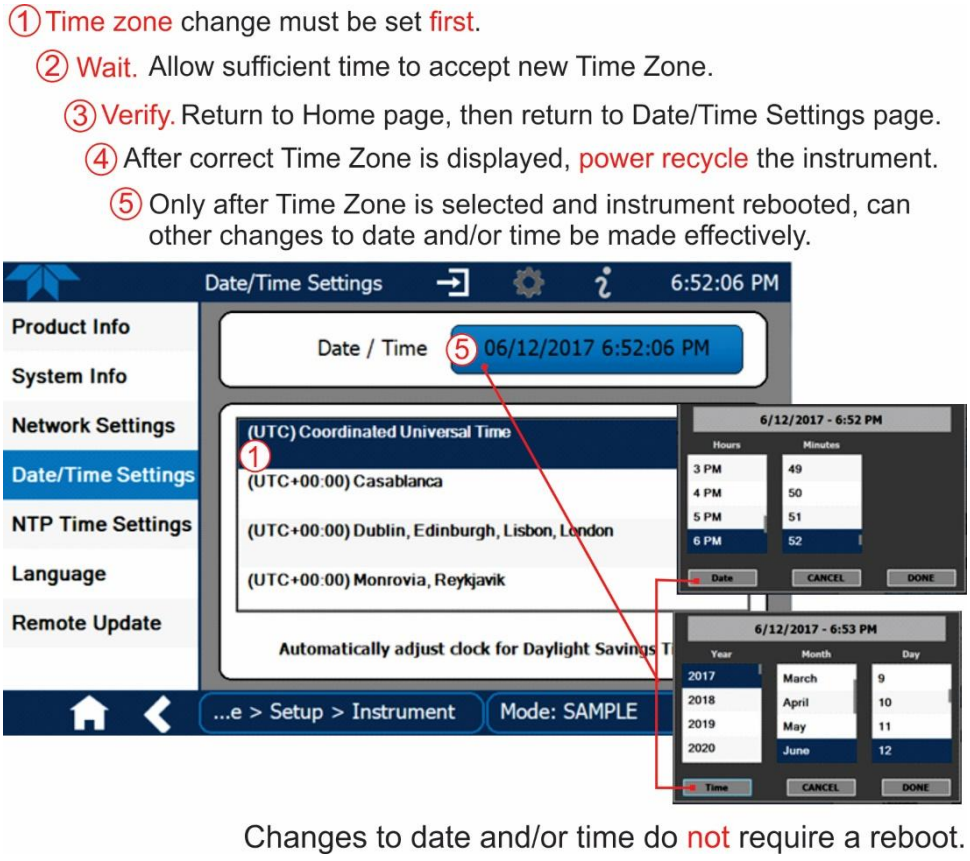


Figure 6-4. Time Zone Change Requirements

6.5 MAINTENANCE PROCEDURES

The following procedures are to be performed periodically as part of the standard maintenance of the calibrator.

6.5.1 PRESSURE LEAK CHECK

The following pressure leak check instructions can be used with either a leak checker or a tank of pressurized gas, with the two-stage regulator adjusted to ≤ 15 psi, a shutoff valve and pressure gauge may be used.



CAUTION

Once the fittings have been wetted with soap solution, do not apply a vacuum as this will cause soap solution to be drawn into the instrument, contaminating it.

DO NOT EXCEED 15 PSI PRESSURE.

1. Turn OFF power to the calibrator.
2. Remove the instrument cover
3. Install a leak checker or tank of gas as described above on the “DRY AIR IN” port at the rear panel.
4. Install caps on the Internal Vent and on the following rear panel fittings:
   - Exhaust
   - Vent
   - Zero Air In
   - Both CALGAS OUT fittings

Due to normal internal leakage that occurs with pumps, they will need to be bypassed for the leak check:

5. Locate the dry air pump.
6. Disconnect the two fittings on the dry air pump and install a union fitting in place of the pump.
7. Locate the photometer pump.
8. Disconnect the line between the pump and the check valve. install cap at check valve.
9. Pressurize the calibrator with the leak checker or with the tank – without exceeding 15 psi pressure, allowing enough time to pressurize the instrument fully.
10. Check each fitting with soap bubble solution and look for bubbles (do not reapply vacuum as doing so will draw soap solution into the instrument and contaminate it).
11. Once the leak has been located and repaired, remove any residual soap solution from the instrument interior with a clean, absorbent cloth.

The leak-down rate should be < 1 in-Hg (0.4 psi) in 5 minutes after the pressure is shut off.

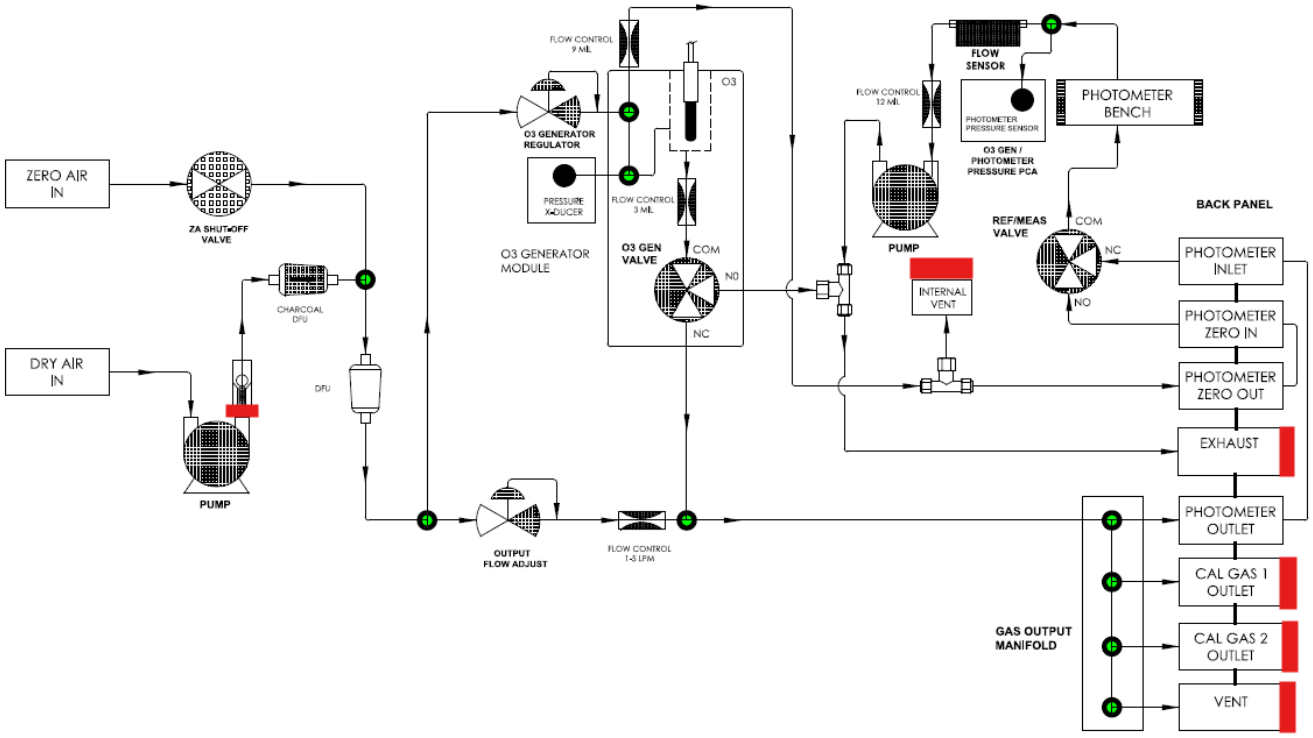


Figure 6-5. N703U Pneumatic Setup for Performing Pressure Leak Checks

6.5.2 Absorption Tube Cleaning or Replacement

Note

Although this procedure should never be needed as long as the user is careful to supply the photometer with clean, dry and particulate free zero air only, it is included here for those rare occasions when cleaning or replacing the absorption tube may be required.

1. Remove the center cover from the optical bench.
2. Unclip the sample thermistor from the tube.
3. Loosen the two screws on the round tube retainers at either end of the tube.
4. Using both hands, carefully rotate the tube to free it.
5. Slide the tube towards the lamp housing.
   - The front of the tube can now be slid past the detector block and out of the instrument.

CAUTION

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

6. Clean the tube by rinsing with de-ionized water.

7. Air dry the tube.
8. Check the cleaning job by looking down the bore of the tube.
   - It should be free from dirt and lint.
9. Inspect the o-rings that seal the ends of the optical tube (these o-rings may stay seated in the manifolds when the tube is removed).
10. If there is any noticeable damage to these o-rings, they should be replaced.
11. Re-assemble the tube into the lamp housing and perform an Auto Leak Check on the instrument.

Note

It is important for proper optical alignment that the tube be pushed all the way towards the front of the optical bench when it is reassembled prior to gently retightening the tube retainer screws. This will ensure that the tube is assembled with the forward end against the stop inside the detector manifold.

6.5.3 Dry Air Pump Replacement



CAUTION! – HOT SURFACE WARNING

The dry air pump heads can reach up to 90°C during operation. Do not handle the assembly until it is at room temperature.

The internal dry air pump will periodically wear out and require replacement, the frequency dependent on usage. Contact Technical Support for the replacement kit. Instructions are included with the kit.

Always perform a Flow and Leak Check after replacing the pump.

6.5.4 Photometer UV Source Lamp Adjustment



CAUTION! – GENERAL SAFETY HAZARD

The UV lamp contains mercury (Hg), which is hazardous waste. Dispose of the used lamp in accordance with local regulations regarding waste containing mercury.

This procedure provides in detail the steps for adjusting the UV source lamp in the optical bench assembly. Adjustment should be done whenever the Photo Reference function (in the Vars menu) value drops below 1000 mV. If necessary, refer to Section 6.5.5 for replacement instructions.

1. Ensure that the calibrator is warmed up and running for at least 30 minutes before proceeding.
2. Remove the cover from the calibrator.
3. Slightly loosen the UV lamp setscrew.
4. Next, slowly rotate the lamp up to ¼ turn in either direction while watching the Photo Detector signal until the maximum detector signal value is found.
5. When maximum value is found, tighten set screw.
6. Replace cover on calibrator.

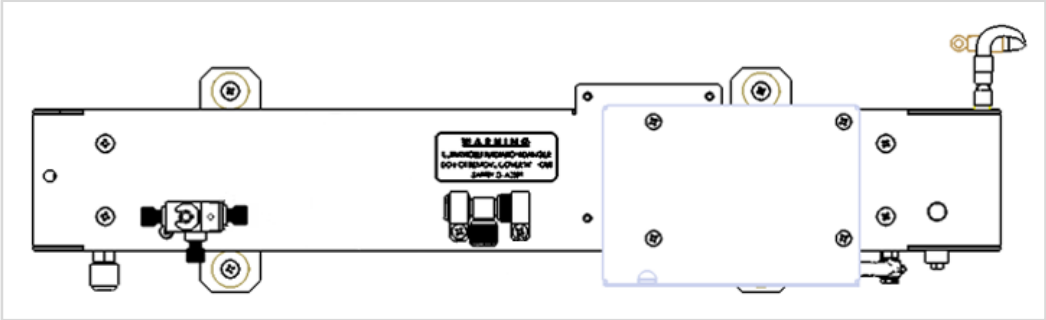


Figure 6-6. Photometer Assembly – Lamp Adjustment/Installation

6.5.5 PHOTOMETER UV SOURCE LAMP REPLACEMENT

GENERAL WARNING/CAUTION! – READ THE ACCOMPANYING MESSAGE FOR SPECIFIC INFORMATION.

The UV lamp contains mercury (Hg), which is hazardous waste. Dispose of the used lamp in accordance with local regulations regarding waste containing mercury.

GENERAL WARNING/CAUTION! – READ THE ACCOMPANYING MESSAGE FOR SPECIFIC INFORMATION.

Power off the instrument before proceeding with lamp replacement. When the instrument is powered back on during this procedure, do not look directly at the light of the UV lamp. Use safety glasses rated for UV protection while performing the adjustments.

This procedure details the steps for replacement of the UV source lamp in the optical bench assembly. This procedure should be done whenever the lamp can no longer be adjusted as described in Section 6.5.4.

1. Power off the analyzer.
2. Remove the cover from the analyzer.
3. Locate the Optical Bench Assembly
4. Locate the UV lamp at the front of the optical bench assembly (see Figure 6-6. Photometer Assembly – Lamp Adjustment/Installation).
5. Unplug the lamp cable from the power supply connector on the side of the optical bench.
6. Slightly loosen (do not remove) the UV lamp setscrew and pull the lamp from its housing.
7. Install a new lamp in the housing, pushing it all the way in.
8. Leave the UV lamp setscrew loose for now.
9. Turn the analyzer back on and allow it to warm up for at least 15 minutes.
10. Navigate to **Utilities** > **Diagnostics** > **Analog Inputs** > **Photo Detector**.
11. While ensuring that the new lamp is pushed all the way into the housing, slightly rotate the lamp up to ¼ turn in either direction until the maximum Photo Detector signal value is observed.

12. At the point where the Photo Detector signal reaches maximum observed value, tighten the lamp setscrew at that position.
13. Replace the cover on the analyzer.

6.5.6 OZONE GENERATOR UV LAMP ADJUSTMENT AND REPLACEMENT

GENERAL WARNING/CAUTION! - READ THE ACCOMPANYING MESSAGE FOR SPECIFIC INFORMATION.

The UV lamp contains mercury (Hg), which is hazardous waste. Dispose of the used lamp in accordance with local regulations regarding waste containing mercury.

GENERAL WARNING/CAUTION! - READ THE ACCOMPANYING MESSAGE FOR SPECIFIC INFORMATION.

Power off the instrument before proceeding with lamp replacement. When the instrument is powered back on during this procedure, do not look directly at the light of the UV lamp. Use safety glasses rated for UV protection while performing the adjustments.

This procedure details the steps for replacement and initial adjustment of the ozone generator lamp. If adjusting an existing lamp, skip to Step 8 (units equipped with a reference sensor only).

1. Turn off the calibrator.
2. Remove the cover from the calibrator.
3. Locate the O3 generator (see Figure 6-7).

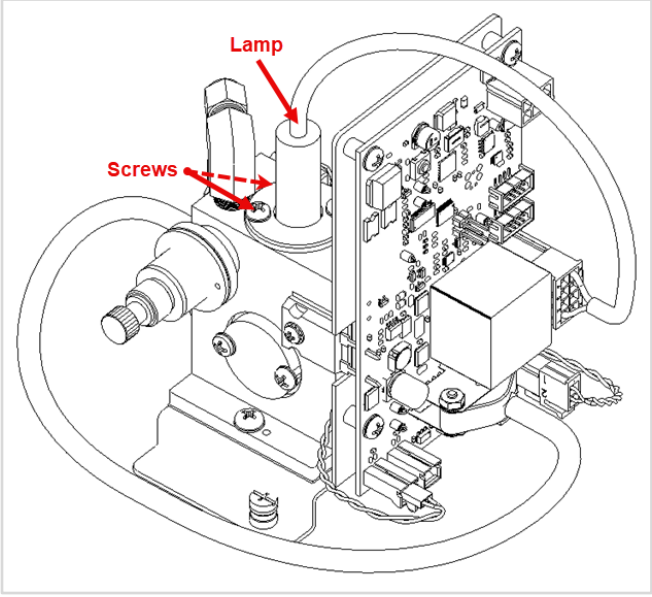


Figure 6-7. O_3 Generator UV Lamp Location

4. Unscrew the UV lamp holder and gently pull out the old lamp.

5. Inspect the O-ring beneath the lamp holder and replace if damaged.
6. Install the new lamp in O_3 generator housing and partially tighten the UV lamp holder.
7. The lamp should be free enough to be rotated in the assembly by grasping the lamp cable.
8. Finish screwing in the UV lamp holder so that it is snug but not excessively tight.
9. Replace the calibrator's cover.
10. Perform a pressure leak check (See Section 6.5.1).
11. Perform an Ozone Generator calibration (see Section 5.4).

7 TROUBLESHOOTING AND SERVICE

This Section contains a variety of methods for identifying and solving performance problems with the calibrator.



ATTENTION

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



WARNING

- Risk of electrical shock. Some operations need to be carried out with the instrument open and running.
- Exercise caution to avoid electrical shocks and electrostatic or mechanical damage to the calibrator.
- Do not drop tools into the calibrator or leave those after your procedures.
- Do not shorten or touch electric connections with metallic tools while operating inside the calibrator.
- Use common sense when operating inside a running calibrator.

7.1 GENERAL TROUBLESHOOTING

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

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

1. Note any warning messages and take corrective action as necessary.
2. View and compare Dashboard functions' values to factory values. Note any major deviations from the factory values and take corrective action.
3. Use the internal electronic status LEDs to determine whether the electronic communication channels are operating properly.
   - Follow the procedures defined in Section 2.4.2 to confirm that the calibrator's vital functions are working (power supplies, CPU, relay PCA, etc.).

7.1.1 FAULT DIAGNOSIS WITH ALERTS

The most common and/or serious instrument failures will result in a warning message being displayed as an Alert Table 7-1 lists warning messages, along with their meaning and recommended corrective action.

Table 7-1. Warning Messages in Alerts Page

ALERT	FAULT CONDITION	POSSIBLE CAUSES
CONFIG INITIALIZED	Configuration and Calibration data reset to original Factory state.	User has erased configuration data.
DATA INITIALIZED	Data Storage in DAS was erased.	User cleared data.
O3 GEN LAMP TEMP WARNING[1]	Ozone Generator Temp is outside of control range of 48° C ±3° C.	-O3 generator heater.
		-O3 generator temperature sensor.
PHOTO LAMP TEMP WARNING[2]	The photometer lamp temp is < 55 C or >61 C.	Possible failure of:
		-Bench lamp heater
		-Bench lamp temperature sensor
		-Hot Lamp
PHOTO LAMP STABILITY WARNING	Value output during the Photometer's reference cycle changes from measurements to measurement more than 25% of the time.	-Faulty UV source lamp
PHOTO REF WARNING[1]	Occurs when Ref is <700 mVDC or >2900 mVDC.	-UV Lamp
		-UV Photo-Detector Preamp
O3 Gen Pressure Warning[1]	O3 Gen regulator pressure is < 5 PSIG or > 11 PSIG.	-Zero or source air supply is incorrectly set up or improperly vented.
		-Incorrectly adjusted O3 zero air pressure regulator
		-Leak or blockage exists in the calibrator's internal pneumatics
		-Failed O3 Generator Input pressure sensor
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
IO Board Overcurrent Warning[1]	Current draw on IO board outputs exceeds 5.3A total	-Check connections at IO board
		-Check which digital outputs are on
		-Check current draw of connected valves on IO board
Driver Board Overcurrent Warning[1]	Current draw on Driver board outputs exceeds 5.3A total	-Check connections at IO board
		-Check which digital outputs are on
		-Check current draw of connected valves on IO board
Module Communication Warning	Module is not communicating with system	-Check 6-pin cable connection
		-Check correct LED lights are on

[1] Optional module.

7.1.2 FAULT DIAGNOSIS WITH DASHBOARD FUNCTIONS

Besides being useful as predictive diagnostic tools, the Dashboard functions can be used to isolate and identify many operational problems when combined with a thorough understanding of the calibrator's Theory of Operation (see Section 8).

The acceptable ranges for these functions are listed in the "Nominal Range" column of the calibrator Final Test and Validation Data Sheet shipped with the instrument. Values outside these acceptable ranges indicate a failure of one or more of the calibrator'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.

Table 7-2 contains some of the more common causes for these values to be out of range.

Table 7-2. Functions – Indicated Failures

TERM	DESCRIPTION/DEFINITION
O3 Gen Flow	This reports the current flow of the O generator. It can indicate if the calibrator is in fractional mode
O3 Gen Lamp Drive	This is the current lamp drive in a percentage This can be used to diagnose a bad O3 Gen Lamp (drive values unusually high or large fluctuations)
O3 Gen Lamp Temp	Incorrect Lamp temperature can affect the efficiency and durability of the O_3 generators UV lamp. Possible causes of faults are the same as O3 GEN LAMP TEMP WARNING from Table 7-1.
O3 Press	O3 Gen Pressure. Value should be 8 PSIG. If value is out of range when diluent air is supplied, adjust regulator, check tube/fittings for leaks, calibrate sensor or replace control board.
O3 Gen Stabilized	This indicates the O3 Gen Lamp drive has stabilized enough that the current concentration and lamp drive have been memorized
Box Temp	Box Temperature typically runs ~7°C warmer than ambient temperature. If the Box Temperature is out of range, ensure that: • The exhaust fan is running. • There is sufficient space on the exterior sides and rear of the instrument to allow adequate ventilation.
Photo Meas & Photo Ref	If the value displayed is too high (the full-scale range of the detector is up to 2990mV), the UV Source has become brighter. If the Measure or Reference values are at 2990mV: If the value displayed is too low: • < 100mV – Bad UV lamp or UV lamp power supply. • < 700mV – Lamp output has dropped; adjust or replace lamp. If the value displayed is constantly changing: • Bad UV lamp. • Defective UV lamp power supply. If the Photo Ref value changes by more than 10mV between zero and span gas: Defective/leaking switching valve.
Pump Flow	Gas flow problems directly affect the accuracy of the photometer measurements and therefore the concentration accuracy of cal gas mixtures involving O3 and GPT mixtures. Check for Gas Flow problems.
Photo Lamp Temp	Poor photometer temp control can cause instrument noise, stability and drift. Temperatures outside of the specified range or oscillating temperatures are cause for concern. Possible causes of faults are the same as PHOTO LAMP TEMP WARNING from Table 7-1.
Sample Pressure	The pressure of the gas in the photometer's sample chamber calculates the concentration of O3 in the gas stream. Incorrect sample pressure can cause inaccurate readings. Check for Gas Flow problems. See Section Table 7-1.

Sample Temp	The temperature of the gas in the photometer's sample chamber is used to calculate the concentration of O3 in the gas stream. Incorrect sample temperature can cause inaccurate readings. Possible causes of faults are: • Bad bench lamp heater • Failed sample temperature sensor • Hot lamp
Photo Slope	Values outside range indicate: • Contamination of the Zero Air or Span Gas supply. • Instrument is miscalibrated. • Blocked Gas Flow. • Faulty Sample Pressure Sensor or circuitry • Bad/incorrect Span Gas concentration
Photo Offset	Values outside range indicate contamination of the Zero Air supply.
Pressure Delta	This indicates the back pressure on the system when the photometer is running. The smaller the value, the less back pressure on the system. A large value may indicate • Long runs of hose on output or vent • Small diameter hose on the output or vent • Higher output flow than system requirement
Pump Run Time Hours	This indicates the number of hours the photometer pump has been running since the last reset. This value can be reset in Setup>Vars
ZA Pump Run Time Hours	This indicates the number of hours the zero air pump has been running since the last reset. This value can be reset in Setup>Vars

7.1.3 USING THE DIAGNOSTIC SIGNAL I/O FUNCTIONS

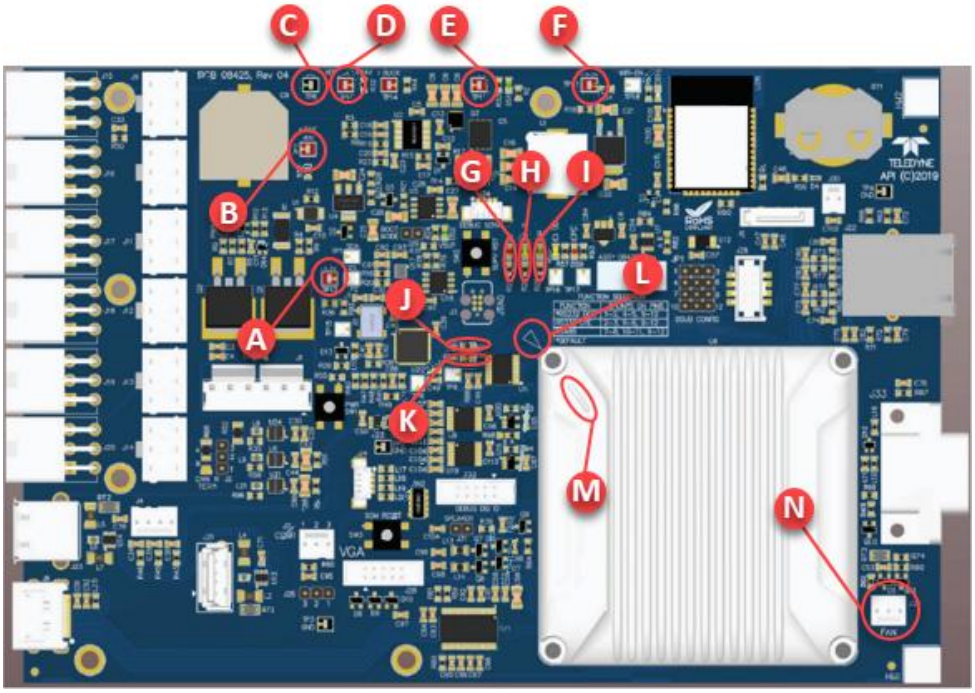
The signals found in the Dashboard and in the Utilities>Diagnostics submenus, combined with a thorough understanding of the instrument's Principles of Operation (Section 8), are useful for troubleshooting in three ways:

- The technician can view the raw, unprocessed signal level of the calibrator'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 calibrator.

7.2 FAULT DIAGNOSIS WITH BOARD LEDS

The following illustrations show connectors and LEDs that can indicate where issues may lie. Figure 7-1 shows the layout for the mainboard.



A	TP13, +3.3V Voltage supply to supervisory CPU	H	DS4, PA10 Yellow LED Supervisory chip is running and is communicating with SOM
B	TP7, +24V VDD Voltage from brick supply	I	PA9 Green LED Power from front panel on or off
C	TP6, Ground	J	DS7, CAN RX Blue LED Receiving
D	TP10, VDD_SW +24V +24V supply to all connectors, Switched on or off by CPU	K	DS6, CAN TX Orange LED Transmitting
E	TP11, +5V	L	Location Guide to mount System-on-Module (SoM)
F	TP12, +3.3V	M	SoM LEDs: Red solid indicates the SoM is powered, green blinking indicates activity (also use as orientation guide when replacing SoM).
G	DS5, P11 Red “heartbeat”	N	Rear Panel Fan Connector

Figure 7-1. Mainboard

7.3 SUBSYSTEM CHECKOUT

The preceding sections of this manual discussed a variety of methods for identifying possible sources of failures or performance problems within the calibrator. In most cases, this included a list of possible components or subsystems that might be the source of the problem. This section describes the steps to check individual components or subsystems to determine the cause of the problem being investigated.

7.3.1 VERIFY SUBSYSTEM CALIBRATION

A good first step when troubleshooting the operation of the calibrator is to verify that its major subsystems are properly calibrated. These are:

Gas pressure calibration (see Section 5.1).

Gas Flow Calibration (see Section 5.3).

Photometer Calibration: (see Section 5.4).

O3 Generator Calibration: (see Section 5.5).

7.3.2 AC MAIN POWER



WARNING! – ELECTRICAL SHOCK HAZARD

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

The instrument's electronic systems will operate with any of the power specifications listed in Section 1.2 and will power on when the Hard Power switch (rear panel) 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.

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 that no tools were left inside.

If the preceding checks reveal no cause, then check the fuse with an ohmmeter to determine its viability: carefully follow the instructions in Section 7.6.3 to remove the fuse for testing.

If the fuse is blown, replace it with a fuse of the correct specifications (see Section 7.6.3).

If the fuse is not blown, or if the replacement fuse blows, then call Technical Support (Section 7.7).

Last, check that the cable running from the power supply is properly seated in its connector at J1 on the Mainboard, and use a voltmeter to check TP7 on the Mainboard (Figure 7-1).

7.3.3 LCD DISPLAY MODULE

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

7.3.4 PHOTOMETER CONTROLLER PCA

This assembly is installed on top of the photometer cover. This PCA has the following diagnostic LEDs.

Table 7-3. Photometer Controlled PCA LED Descriptions

LED COLOR	DESCRIPTION/DEFINITION
Blue communication LED	Solid blue when communicating
Red status LED	Flashes red in 1 second intervals if the firmware on the board is running
Yellow digital output LED	Next to the valve connector and turns on when the output is on

7.3.5 O_3 GENERATOR CONTROLLED PCA

This assembly is installed on O_3 Generators. It is installed on the front of the O3 Generator. This PCA has the following diagnostic LEDs.

Table 7-4. O_3 Generator Controlled PCA LED Descriptions

LED COLOR	DESCRIPTION/DEFINITION
Blue communication LED	Solid blue when communicating
Red status LED	Flashes red in 1 second intervals if the firmware on the board is running
Yellow digital output LED	Next to the valve connector and turns on when the output is on

7.3.6 PUMP CONTROLLER PCA

This assembly is only present in calibrators with photometers. This PCA is installed on the pump assembly. This PCA has the following status LEDs:

Table 7-5. O_3 Generator Controlled PCA LED Descriptions

LED COLOR	DESCRIPTION/DEFINITION
Red status LED	Flashes in 1 second intervals if the module firmware is running
Green output LED	Turns on when the pump is running

7.3.7 ZERO AIR PCA

This assembly is only present in calibrators with photometers. This PCA is installed on the pump assembly. This PCA has the following status LEDs:

Table 7-6. O_3 Generator Controlled PCA LED Descriptions

LED COLOR	DESCRIPTION/DEFINITION
Red status LED	Flashes in 1 second intervals if the module firmware is running
Green output LED 1 next to pump connector	Turns on when the zero air pump is running
Green output LED 2 above valve connector	Turns on when zero air valve is on

7.3.8 ANALOG OUTPUTS VOLTAGE TEST

To verify that Analog Output 4, if configured, is working properly, connect a voltmeter to the rear panel ANALOG OUT connector and perform an output step test as follows:

1. Navigate to the Utilities > Diagnostics > Analog Outputs page.

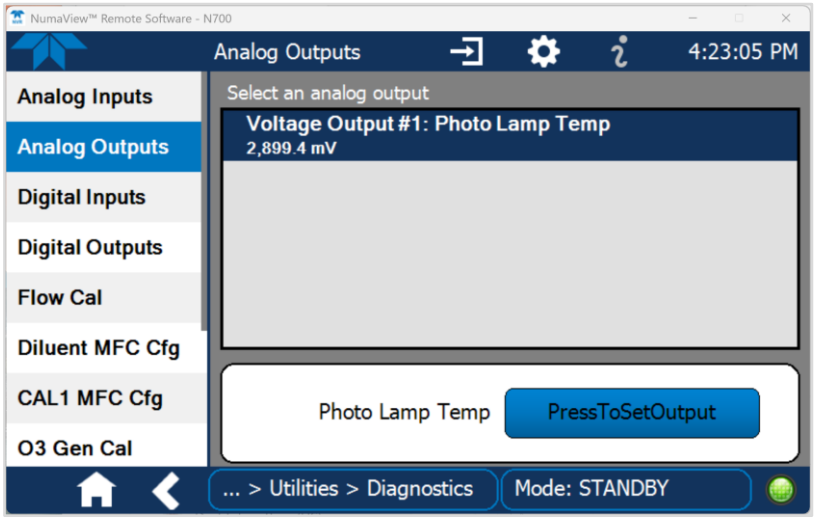


Figure 7-2. Analog Outputs Voltage Test

2. Select PresstoSetOutput.
3. Set the desired percent of the signal output in the numeric keypad that pops up, and select Enter.
4. Compare the value displayed in the Analog Output field to the voltmeter.

For each percentage set, the output should be within 1% of the nominal value. Use the table below as an example. Be sure to consider any offset that may have been programmed into the analog output channel.

Table 7-7. Analog Output Test Function - Nominal Values Voltage Outputs

FULL SCALE OUTPUT OF VOLTAGE RANGE		
	5V	10V
	NOMINAL OUTPUT VOLTAGE	
0	0	0
20	1	2
40	2	4
60	3	6
80	4	8

7.3.9 CALIBRATOR DOES NOT APPEAR ON LAN OR INTERNET

Most problems related to Internet communications via the Ethernet card will be due to problems external to the calibrator (e.g. bad network wiring or connections, failed routers, malfunctioning servers, etc.) However, there are several symptoms that indicate the problem may be with the Ethernet card itself.

If neither of the Ethernet cable's two status LED's (located on the back of the cable connector) is lit while the instrument is connected to a network:

Verify that the instrument is being connected to an active network jack.

Check the internal cable connection between the Ethernet card and the CPU board.

7.3.10 RS-232 COMMUNICATIONS

7.3.10.1 GENERAL RS-232 TROUBLESHOOTING

Teledyne API calibrators use the RS-232 communications protocol to allow the instrument to be connected to a variety of computer-based equipment. RS-232 has been used for many years and as equipment has become more advanced, connections between various types of hardware have become increasingly difficult. Generally, every manufacturer observes the signal and timing requirements of the protocol very carefully.

Problems with RS-232 connections usually center around 4 general areas:

- Incorrect cabling and connectors. See Section 2.3.1.9 for connector and pin-out information.
- The baud rate and protocol are incorrectly configured. See Section 2.6.10.1.
- If a modem is being used, additional configuration and wiring rules must be observed. See Section 2.6.10.1.
- Incorrect setting of the DTE-DCE Switch is set correctly.
- Verify that the cable (P/N 03596) that connects the serial COMM ports of the CPU to J12 of the motherboard is properly seated.

7.3.11 TEMPERATURE PROBLEMS

Individual control loops are used to maintain the set point of the Photometer UV Lamp (optional), and the Ozone Generator Lamp (optional). If any of these temperatures are out of range or are poorly controlled, the calibrator will perform poorly.

7.3.11.1 BOX / CHASSIS TEMPERATURE

The box temperature sensor can't be directly accessed with a voltmeter to check its resistance. Instead, the **Box Temp** voltage signal must be configured in the Setup>Analog Outputs>Analog Output Cfg menu first: Map the Signal Out field to Box Temp and scale it 0.0 degC (Min) to 100.0 degC (Max); set the Calibration type to AUTO. Start calibration in the Analog Output Cal menu. Compare the Home > Dashboard > Box Temp value to the Utilities > Diagnostics > Analog Outputs > Analog Output 4: Box Temp voltage. That voltage signal on a scale of 0 to 5,000 mV should be relative to the scaled temperature value. For example, at ~30ºC (6-7° above room temperature) the signal should be ~1450 mV.

7.3.11.2 PHOTOMETER OPTION SAMPLE CHAMBER TEMPERATURE

In the Dashboard, the temperature of the gas in the photometer sample chamber (Photo Samp Temp) should read approximately 5.0°C higher than the Box Temp reading.

7.3.11.3 UV LAMP TEMPERATURE

A possible cause for UV Lamp temperature failure could be that the lamp heater has failed.

7.4 TROUBLESHOOTING THE O_3 PHOTOMETER

Issues with the O3 photometer could be related to either dynamic functions or to Measure/Reference valve functions.

7.4.1 DYNAMIC PROBLEMS WITH THE O_3 PHOTOMETER

Dynamic problems are problems that only manifest themselves when the photometer is measuring O_3 concentration gas mixtures. These can be the most difficult and time consuming to isolate and resolve.

Since many photometer behaviors that appear to be a dynamic in nature are often a symptom of a seemingly unrelated static problems, it is recommended that dynamic problems not be addressed until all static problems, warning conditions and subsystems have been checked and any problems found are resolved.

Once this has been accomplished, the following most common dynamic problems should be checked.

7.4.1.1 NOISY OR UNSTABLE O_3 READINGS AT ZERO

- Check for leaks in the pneumatic system as described in Section 6.5.1.
- Confirm that the Zero gas is free of Ozone.
- Confirm that the Source Lamp is fully inserted and that the lamp hold-down thumb-screw is tight.
- Check for a dirty Absorption Cell and/or pneumatic lines. Clean as necessary as described in Section 6.5.2.
- Disconnect the exhaust line from the optical bench (the pneumatic line at the lamp end of the bench) and plug the port in the bench. If readings remain noisy,

the problem is in one of the electronic sections of the instrument. If readings become quiet, the problem is in the instrument's pneumatics.

7.4.1.2 NOISY, UNSTABLE, OR NON-LINEAR SPAN O_3 READINGS

- Check for leaks in the pneumatic systems as described in Section 6.5.1.
- Check for proper operation of the meas/ref switching valve as described in Section 7.4.2.
- Check for dirty absorption cell and clean or replace as necessary as described in Section 6.5.2.
- Confirm the Sample Temperature, Sample Pressure and Sample Flow readings are correct. Check and adjust as required.

7.4.1.3 SLOW RESPONSE TO CHANGES IN CONCENTRATION

- Check for dirty absorption cell and clean or replace as necessary as described in Section 6.5.2.
- Check for pneumatic leaks as described in Section 6.5.1.
- The photometer needs 800 cm3/min of gas flow. Ensure that this is accounted for when calculating total required output flow for the calibrator (see Section 2.4.5).

7.4.1.4 THE ANALOG OUTPUT SIGNAL LEVEL DOES NOT AGREE WITH FRONT PANEL READINGS

- Confirm that the recorder offset (see Section 2.6.8.2) is set to zero.
- Perform an Analog Output calibration (see Section 2.6.8.3).

7.4.1.5 CANNOT ZERO

- Check for leaks in the pneumatic system as described in Section 6.5.1.
- Confirm that the Zero gas is free of Ozone.
- The photometer needs 800 cm^3/min of gas flow. Ensure that this is accounted for when calculating total required output flow for the calibrator (see Section 2.4.5).

7.4.1.6 CANNOT SPAN

- Check for leaks in the pneumatic systems as described in Section 6.5.1.
- Check for dirty absorption cell and clean or replace as necessary as described in Section 6.5.2.
- Confirm the Sample Temperature, Sample Pressure and Sample Flow readings are correct. Check and adjust as required.
- The photometer needs 800 cm3/min of gas flow. Ensure that this is accounted for when calculating total required output flow for the calibrator (see Section 2.4.5).

7.4.2 CHECKING THE MEASURE / REFERENCE VALVE

To check the function of the photometer's measure / reference valve:

1. View the Dashboard parameter, O3 Ref (configure via Setup>Dashboard if needed).

2. Feed zero gas and wait for stability.
3. Note the O3 Ref value.
4. Feed span gas and wait for stability.
5. Note the O3 Ref value.
6. If there is a difference between the two values of more than 1 mV, then call Technical Support to replace the valve.

7.5 TROUBLESHOOTING THE OPTIONAL O_3 GENERATOR

The only significant components of the O_3 generator that might reasonable malfunction is the power supply assembly for the UV source lamp and the lamp itself.

7.6 SERVICE PROCEDURES

7.6.1 SERVICING THE SAMPLE FLOW CONTROL ASSEMBLY

The critical flow orifice is housed in the flow control assembly located on the top of the optical bench. A sintered filter protects the jewel orifice, so it is unusual for the orifice to need replacing, but if it does, or the filter needs replacement please use the following procedure (contact Technical Support for parts and kits):

1. Turn off power to the calibrator.
2. Locate the assembly to be repaired.
3. Disconnect the pneumatic connection from the flow assembly.
4. Remove the fitting and the components as shown in the exploded view in Figure 7-4.
5. Replace the O-rings (p/n OR000001) and the sintered filter (p/n FL000001).
6. If replacing the critical flow orifice itself (P/N FM0000026), make sure that the side with the colored window (usually red) is facing downstream to the gas flow.
7. Apply new Teflon® or PTFE tape to the male connector threads.
8. Reassemble in reverse order.

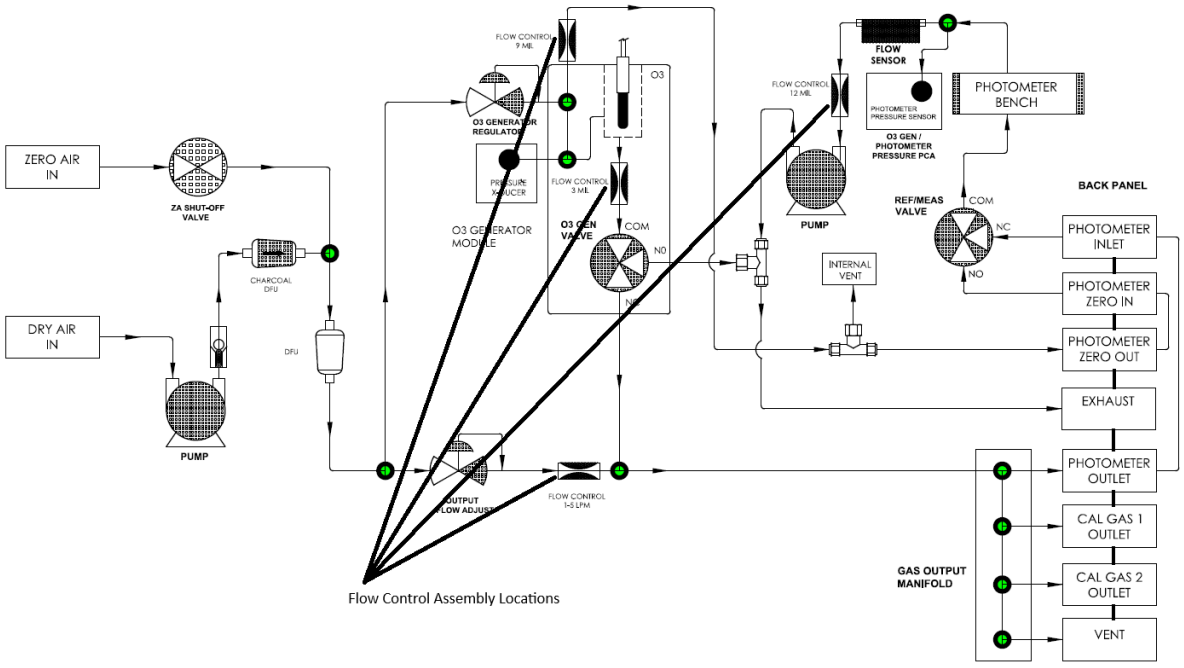


Figure 7-3. Location of Gas Flow Control Assemblies - N703U

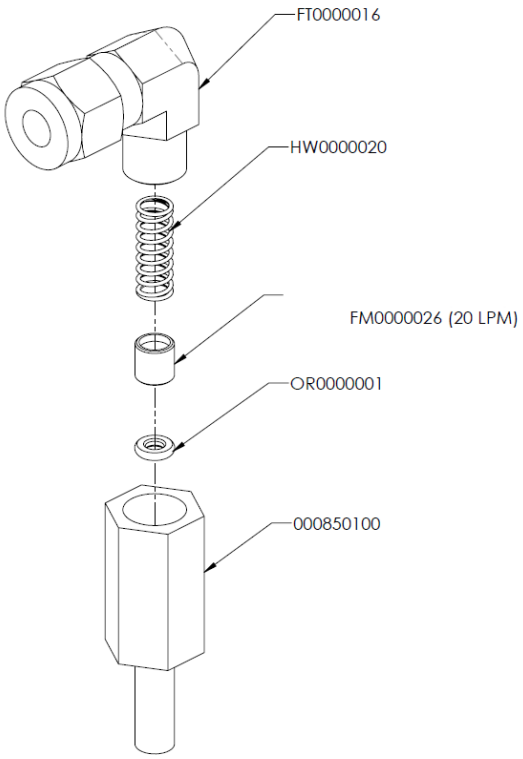


Figure 7-4. Critical Flow Restrictor Assembly Disassembly

7.6.2 REPLACING A MODULE

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

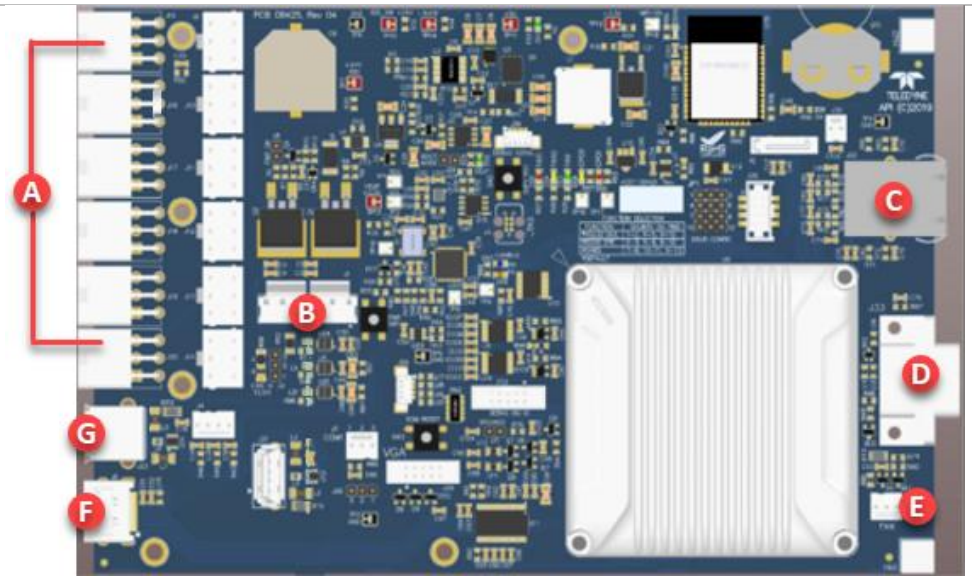
1. Turn off the analyzer power (noting that the front panel switch LED should either be blinking or solid off before powering down via the rear panel switch).
2. Remove the power cord and the analyzer cover.
3. Disconnect the tubing attached to the module.
4. Unplug the electrical connection to the module.
5. Unscrew the mounting screws that attach the module to the chassis and lift out the entire assembly.

If you received a complete replacement module with circuit board and mounting bracket attached, simply reverse the above steps to install.

Note **Be sure to carry out a leak check (Section 5.6.3) and a recalibration after the analyzer has warmed up for about 60 minutes.**

7.6.2.1 CONNECTORS ON MAINBOARD

Modules can be connected to any of the Mainboard's six CANBUS connectors.



A	CAN bus Connectors to modules (interchangeable)	E	Rear Panel Fan Connector
B	Power Supply Connector	F	Display Connector (NOT for external devices)
C	Ethernet Connector	G	USB Hub Connector
D	Serial Comm Connector		

Figure 7-5. Mainboard Connectors

7.6.3 REPLACING THE FUSE

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, 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 7.7).

WARNING! – ELECTRICAL SHOCK HAZARD

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

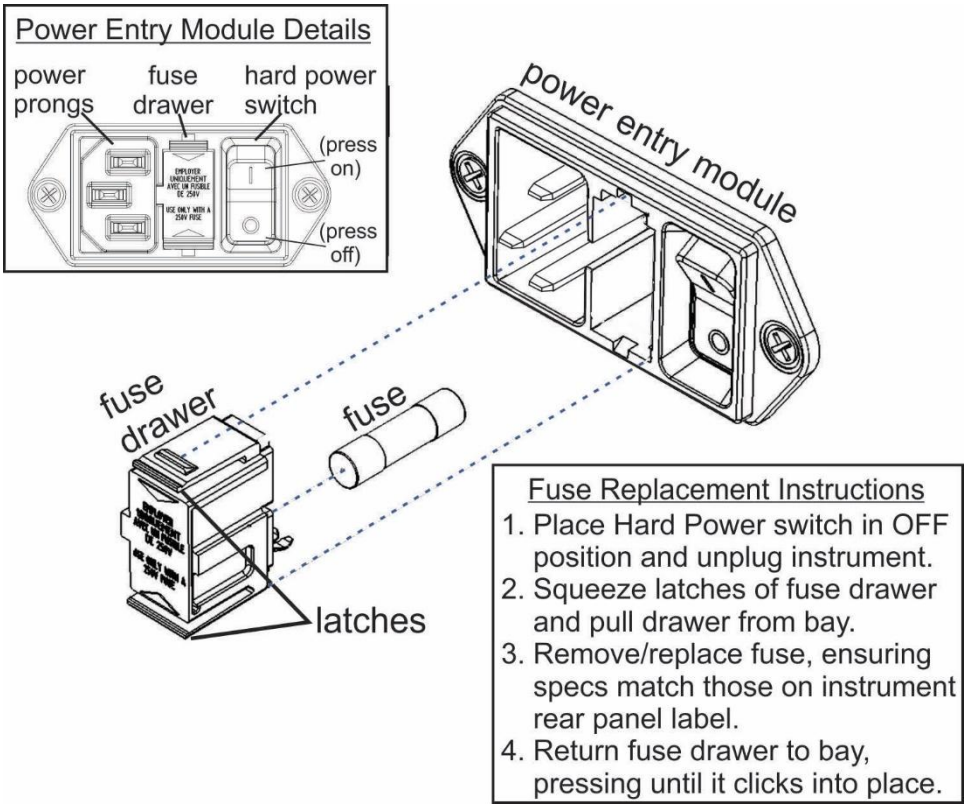


Figure 7-6. Fuse Access

7.7 TECHNICAL ASSISTANCE

If this manual and its Service Section do not solve your problems, technical assistance may be obtained from Teledyne API, Technical Support:

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

7.8 FREQUENTLY ASKED QUESTIONS (FAQS)

The following list of FAQs is from the Teledyne API's Technical Support Department's most commonly asked questions relating to the Dynamic Dilution Calibrator.

QUESTION	ANSWER
My ozone reading is not what I should expect - why?	Look at the Photo Ref/Meas. These are most likely too low and need to be adjusted up to 1000mV. Another possible cause would be no gas flow to the photometer causing the O_3 reading to be out of range – low. Check back pressure on the photometer. Check pressure delta on the dashboard. This should be as low as possible. If it is above 0.20, perform back pressure compensation calibration.
When I generate ozone, it takes a long time to settle out, or it fluctuates around the value until finally stabilizing.	Perform an O_3 Gen Calibration (Section 5.5). Re-run points.
Why do some buttons appear grayed out or disappear?	They are deactivated until applicable.
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 The DCE/DTE switch on the back of the analyzer is not set properly; ensure that both green and red lights are on (Section 2.3.1.9). The baud rate of the analyzer's COM port does not match that of the serial port of your computer/data logger.
When should I change the sintered filter(s) in the calibrator's critical flow orifice(s) and how do I change them?	The sintered filters do not require regular replacement. Should one require replacement as part of a troubleshooting or repair exercise, contact Technical Support.

How often should I rebuild the photometer pump on my calibrator?	It does not require rebuilding; the entire pump should be replaced every two years.
How long do the UV lamps of the optional O_3 generator and photometer last?	The typical lifetime is about 2-3 years.

8 PRINCIPLES OF OPERATION

This section describes the instrument's pneumatic operation (Section 8.1) and then principles behind the O_3 generator operation (Section 8.2) and the Photometer operation (Section 8.3).

8.1 PNEUMATIC OPERATION

8.1.1 GAS FLOW

Gas flow rates are set by various flow control assemblies in the gas stream(s); each of the assemblies includes a critical flow orifice to regulate the flow.

8.1.2 PHOTOMETER CRITICAL FLOW ORIFICE

Critical flow orifices operate without moving parts by taking advantage of the laws of fluid dynamics. By restricting the flow of gas though the orifice, a pressure differential is created. This pressure differential combined with the action of the calibrator's pump draws the gas through the orifice.

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

The 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.

8.1.3 INTERNAL GAS PRESSURE SENSORS

There are two pressure sensors in the N703U: one for the regulator and one for the photometer. A 100 psig pressure sensor monitors the downstream regulator pressure, and a 0-15 psia (absolute pressure) range sensor measures the pressure of gas in the photometer's absorption tube. The data are used by the CPU when calculating the O_3 concentration inside the absorption tube.

8.2 O_3 GENERATOR OPERATION

8.2.1 PRINCIPLE OF PHOTOLYTIC O_3 GENERATION

The two main principles of ozone generation are UV-light and corona discharge. The N703U calibrator employs the UV-light method to produce low, accurate concentrations of the desired ozone. An ultra-violet lamp inside the generator emits a precise wavelength of UV Light (185 nm). Ambient air is passed over the lamp, splitting some of the air's molecular oxygen (O_2) into individual oxygen atoms (O) that attach to other remaining oxygen molecules (O_2), forming ozone (O_3).

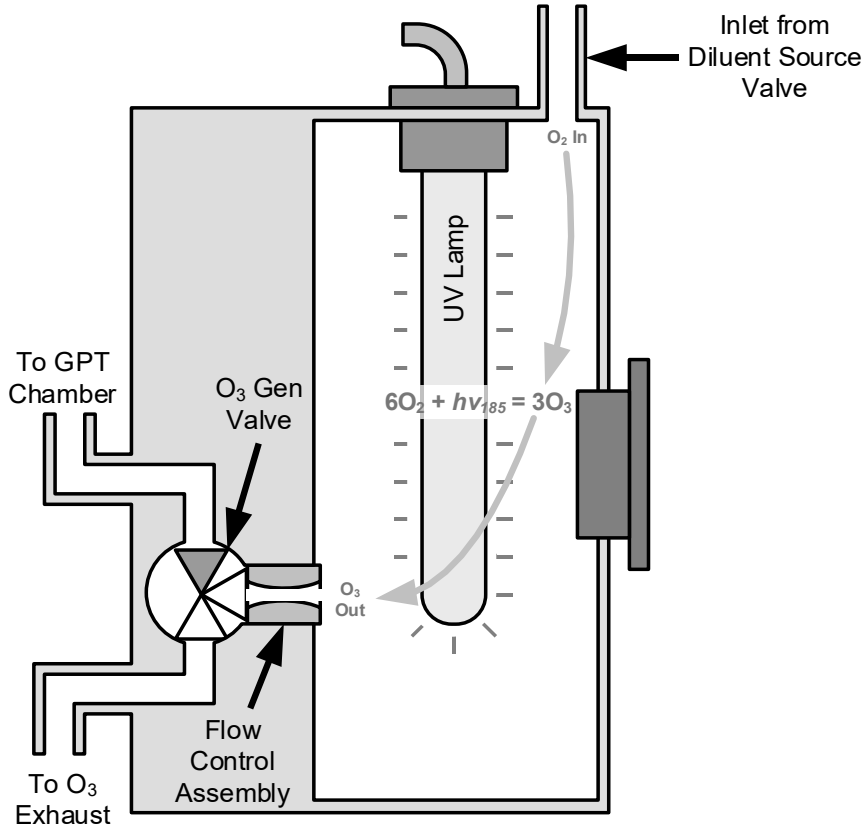


Figure 8-1. O_3 Generator Internal Pneumatics

8.2.2 O_3 GENERATOR – PNEUMATIC OPERATION

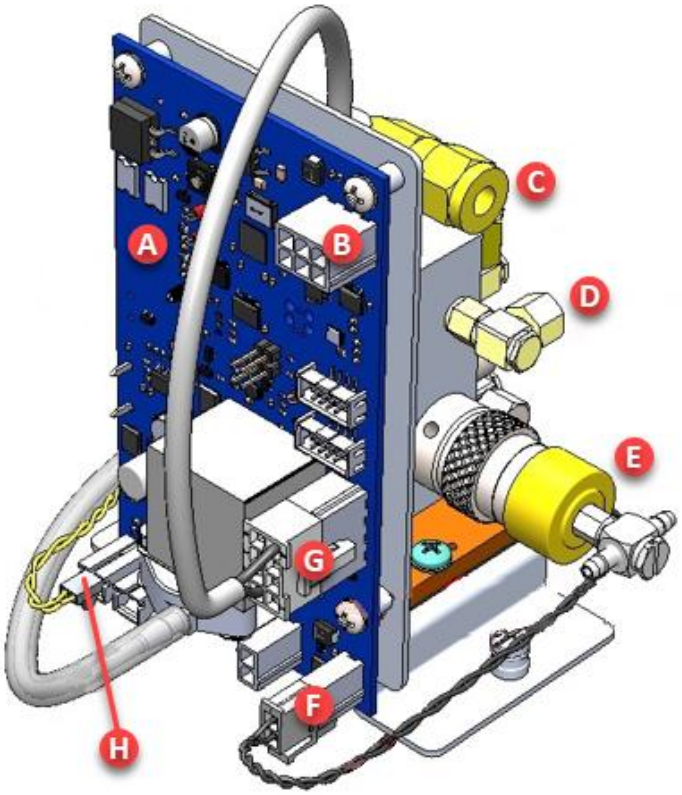
Pneumatic flow through the O_3 generator is created by supplying zero air (diluent) to it under pressure. The zero air source must be capable of maintaining a continuous flow rate of at least 60 ccm^3/min unless the optional photometer is also installed, in which case the minimum continuous flow rate must be at least 1.1 LPM.

Input and output gas flow is directed by two valves, both of which must be open:

- The diluent inlet valve: This valve (located on back panel) allows diluent / zero air into the calibrator.
- The O_3 generation valve. This valve is located on the body of the O_3 generator is downstream from the generator chamber itself and directs the output of the

generator to either the GPT mixing chamber or the exhaust vent at the back of the calibrator.

The rate of flow through the O_3 generator is controlled by a 60 ccm^3/min flow control assembly positioned between the O_3 generation chamber and the O_3 generation valve. A self-adjusting pressure regulator on the zero air (diluent) supply gas line maintains the pressure across the critical flow orifice of the flow control assembly (see Section 8.1.2).

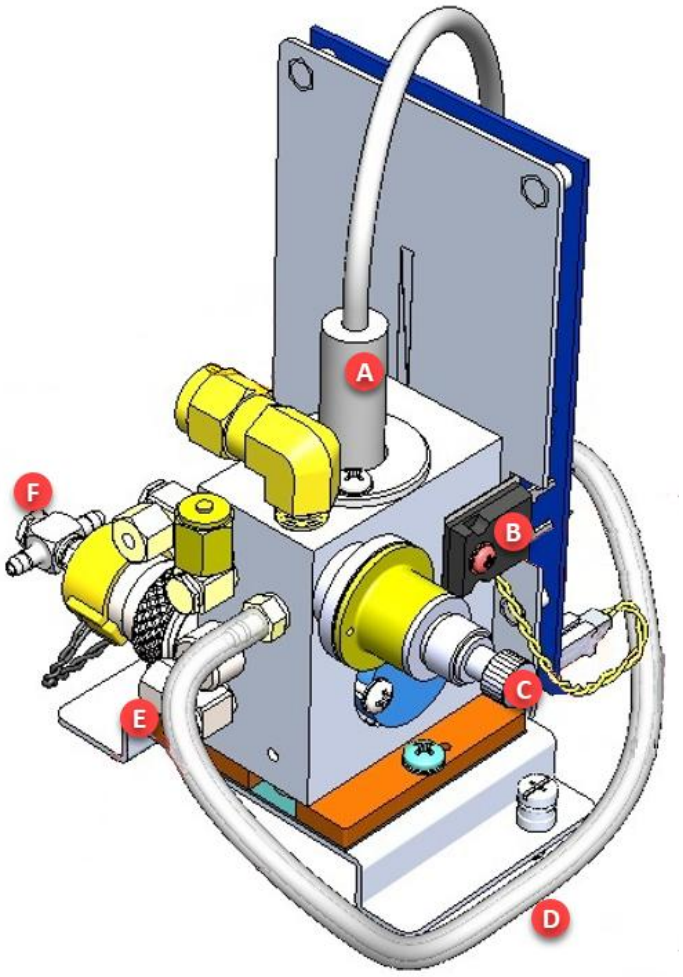


A	O_3 Gen PCA
B	CAN bus Connector
C	O_3 Gas Generator Inlet
D	Outlet to Photo Zero Out
E	O_3 Gen Valve
F	Ozone Valve Connector
G	Lamp Connector
H	UV Lamp Thermistor Connector

Figure 8-2. O_3 Generator Valve and Gas Fixture Locations

8.2.3 O_3 GENERATOR – ELECTRONIC OPERATION

Electronically, the O_3 generator and its subcomponents act as a module and communicate with the main bard via CANBUS using the 6 pin CANBUS connector.



A	UV Lamp
B	Heater
C	Regulator
D	To Pressure Sensor
E	To GPT Chamber
F	From Pump to Exhaust

Figure 8-3. O_3 Generator Electronic Components Location

8.2.3.1 O_3 GENERATOR TEMPERATURE CONTROL

To operate at peak efficiency, the UV lamp of the calibrator's O_3 generator is maintained at a constant 48ºC. A warning is issued if the lamp temperature falls below 45ºC or rises above 51ºC.

8.2.3.2 PNEUMATIC SENSOR FOR THE O_3 GENERATOR

A pressure sensor, located on the O_3 generator PCA, monitors the output gas pressure of the regulator on the O_3 generator's zero air supply. The regulator is adjusted at the factory to maintain a pressure of 8 PSIG on this line. If the pressure drops below 5 PSIG or rises above 11 PSIG a warning is issued.

8.3 PHOTOMETER OPERATION

The calibrator's photometer determines the concentration of Ozone (O_3) in a sample gas drawn through it. Sample and calibration gasses must be supplied at ambient atmospheric pressure in order to establish a stable gas flow through the absorption tube where the gas' ability to absorb ultraviolet (UV) radiation of a certain wavelength (in this case 254 nm) is measured.

Gas bearing O_3 and zero air are alternately routed through the photometer's absorption tube. Measurements of the UV light passing through the sample gas with and without O_3 present are made and recorded.

Calibration of the photometer is performed in software and does not require physical adjustments. Two internal variables, a slope and offset are used to adjust the calibration of the photometer.

The CPU uses these calibration values, the UV absorption measurements made on the sample gas in the absorption tube along with data regarding the current temperature and pressure of the gas to calculate a final O_3 concentration.

8.3.1 MEASUREMENT METHOD

8.3.1.1 CALCULATING O_3 CONCENTRATION

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

Equation 9-5

$$I = I_o e^{-\alpha LC} \quad at\ STP$$

Where:

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

I is the intensity with absorption.

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

C is the concentration of the absorbing gas. In the case of the Model N703, Ozone (O_3).

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

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

Equation 9-6

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

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

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

Equation 9-7

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

Where:

T = sample ambient temperature in degrees Kelvin

P = ambient pressure in inches of mercury

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

Equation 9-8

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

In a nutshell the photometer:

- Measures each of the above variables: ambient temperature; ambient gas pressure; the intensity of the UV light beam with and without O_3 present;
- Inserts know values for the length of the absorption path and the absorption coefficient, and:
- Calculates the concentration of O_3 present in the sample gas.

8.3.1.2 THE MEASUREMENT / REFERENCE CYCLE

In order to solve the Beer-Lambert equation it is necessary to know the intensity of the light passing through the absorption path both when O_3 is present and when it is not. A valve called the measure/reference (M/R) valve, physically located on front-left corner of the O_3 generator assembly (see Figures 3-4 and 9-14) alternates the gas stream flowing to the photometer between zero air (diluent gas) and the O_3 output from the O_3 generator. This cycle takes about 6 seconds.

Table 8-1. Photometer Measurement / Reference Cycle

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

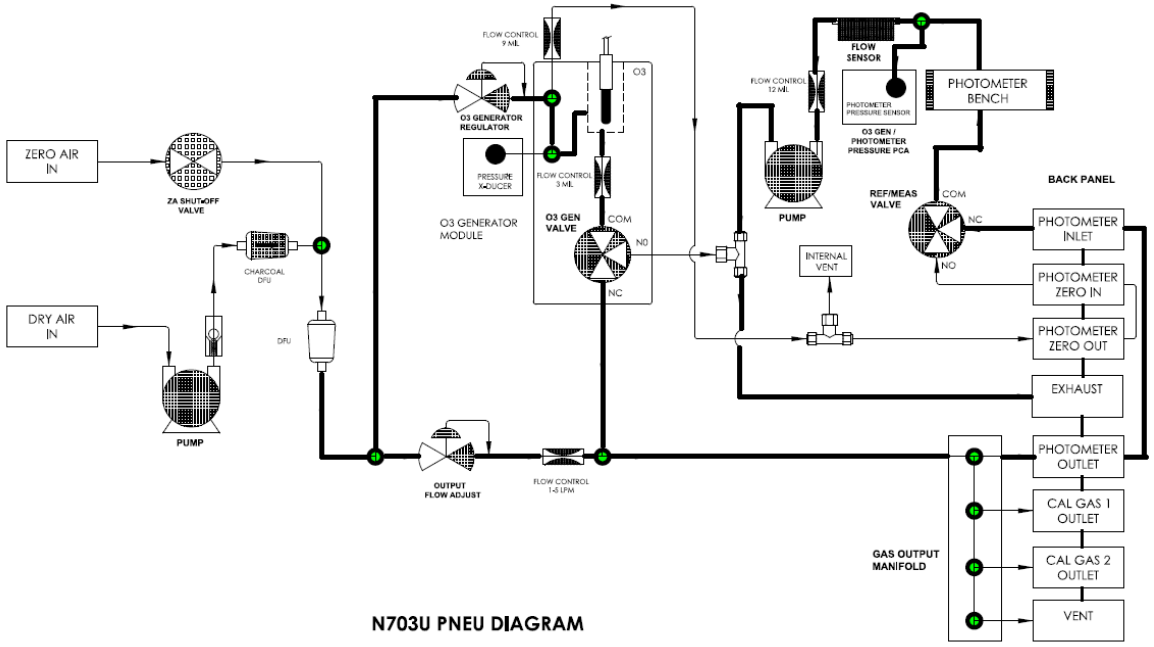


Figure 8-4. N703U O_3 Photometer Gas Flow – Measure Cycle

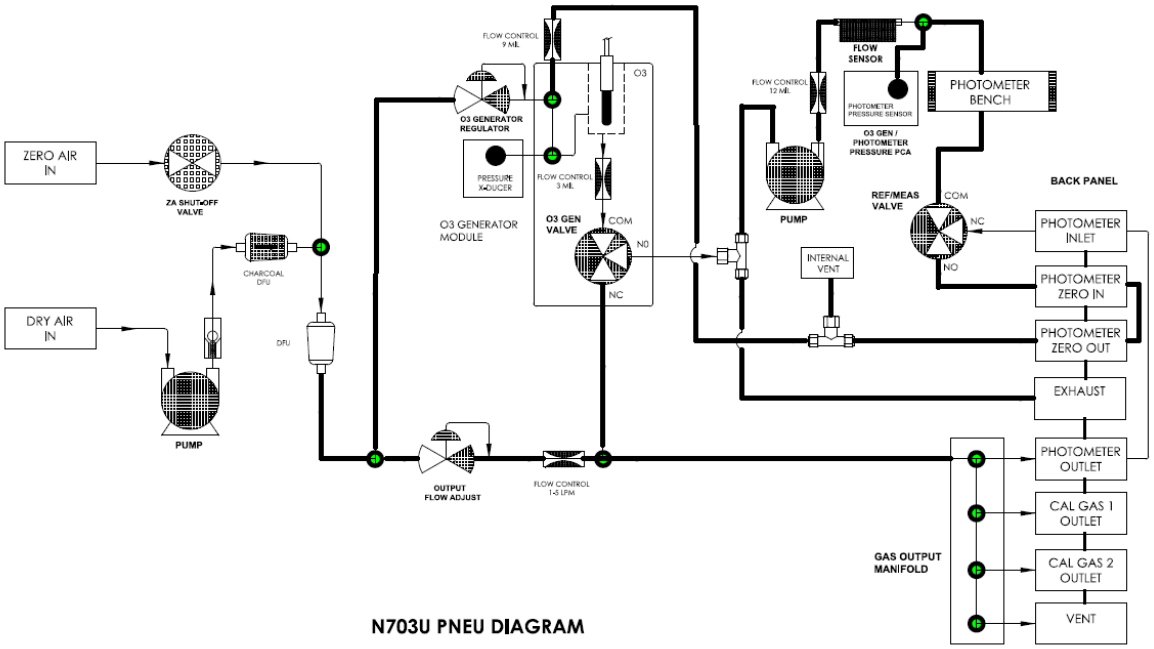


Figure 8-5. N703U O_3 Photometer Gas Flow – Reference Cycle

8.3.1.3 THE ABSORPTION PATH

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

Because ozone is a very efficient absorber of UV radiation, the absorption path length required to create a measurable decrease in UV intensity is short enough (approximately 35.6 cm) that the light beam is only required to make one pass through the Absorption Tube. Therefore, no complex mirror system is needed to lengthen the effective path by bouncing the beam back and forth.

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

The detector assembly reacts to the UV light and outputs a voltage that varies in direct relationship with the light's intensity. This voltage is digitized and sent to the instrument's CPU to be used in computing the concentration of O3 in the absorption tube.

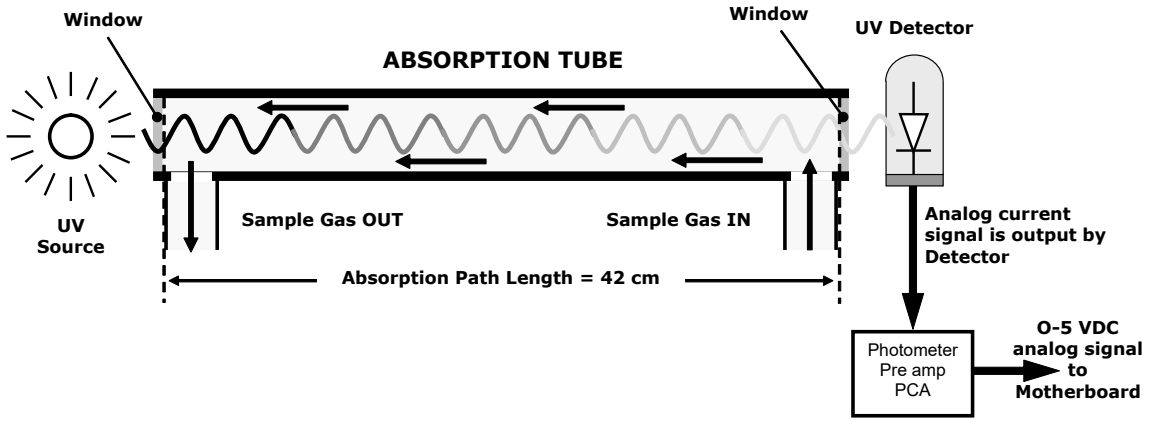


Figure 8-6. O_3 Photometer Absorption Path

8.3.1.4 INTERFERENT REJECTION

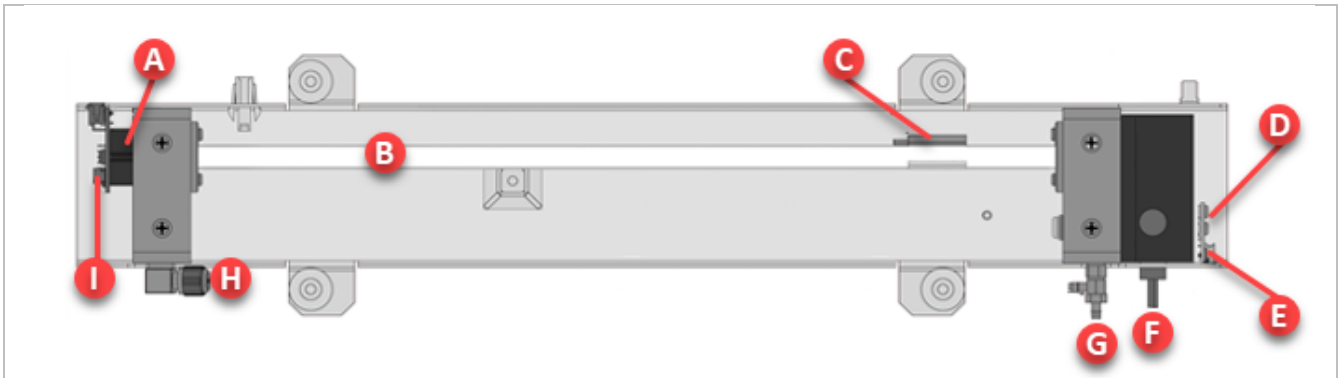
It should be noted that the UV absorption method for detecting ozone is subject to interference from a number of sources. The photometer has been successfully tested for its ability to reject interference from sulfur dioxide, nitrogen dioxide, nitric oxide, water, and meta-xylene.

While the photometer rejects interference from the aromatic hydrocarbon meta-xylene, it should be noted that there are a very large number of other volatile aromatic hydrocarbons that could potentially interfere with ozone detection. If the calibrator is installed in an environment where high aromatic hydrocarbon concentrations are suspected, specific tests should be conducted to reveal the amount of interference these compounds may be causing.

8.3.2 PHOTOMETER LAYOUT

The photometer is where the absorption of UV light by ozone is measured and converted into a voltage. It consists of several sub-assemblies:

1. A mercury-vapor UV lamp. This lamp is coated in a material that optically screens the UV radiation output to remove the O_3 producing 185nm radiation. Only light at 254nm is emitted.
2. An AC power supply to supply the current for starting and maintaining the plasma arc of the mercury vapor lamp.
3. A thermistor and DC heater attached to the UV Lamp to maintain the Lamp at an optimum operating temperature.
4. 35.6 cm long quartz absorption tube.
5. A thermistor attached to the quartz tube for measuring sample gas temperature.
6. Gas inlet and outlet mounting blocks that route sample gas into and out of the photometer.
7. The vacuum diode, UV detector that converts UV light to a DC current.



A	UV Detector	F	UV Lamp
B	Absorption Tube	G	Sample Gas Outlet
C	Sample Gas Thermistor	H	Sample Gas Inlet
D	UV Lamp Thermistor (UV Lamp Heater Behind Thermistor)	I	UV Detector Preamp PCA
E	UV Lamp Heater Control PCA		

Figure 8-7. O3 Photometer Layout – Top Cover Removed

The critical flow orifice installed in the pump supply line is tuned to create a flow of 800 cc/min. A pressure sensor and a flow sensor, located on the O_3 generator/photometer pressure flow sensor PCA, monitor the pressure and flow rate of the gas passing through the photometers absorption tube.

See Figure 8-4 and Figure 8-5 for depictions of the airflow related to the photometer.

8.3.3 Photometer Pneumatic Operation

The flow of gas through the photometer is created by a small internal pump that pulls air though the instrument. There are several advantages to this "pull through" configuration. Placing the pump downstream of the absorption tube avoids problems caused by the pumping process heating and compressing the sample.

In order to measure accurately the presences of low concentrations of O_3 in the sample air it is necessary to establish and maintain a relatively constant and stable volumetric flow of sample gas through the photometer. The simplest way to accomplish this is by placing a flow control assembly containing a critical flow orifice directly upstream of the pump but downstream of the absorption tube.

The critical flow orifice installed in the pump supply line is tuned to create a gas flow of 800 cm^3/min. A pressure sensor and a flow sensor, located on the O_3 generator / photometer pressure flow sensor PCA, monitor the pressure and flow rate of the gas passing through the photometers absorption tube.

8.3.4 PHOTOMETER ELECTRONIC OPERATION

Like the O_3 generator, the O_3 photometer and its subcomponents act independent modules that communicate back to the mainboard via CANBUS. Sensor inputs and device management is handled locally with commands and data sent between the mainboard and Photometer.

8.3.5 O_3 PHOTOMETER TEMPERATURE CONTROL

To operate at peak efficiency, the UV lamp of the calibrator's O_3 photometer is maintained at a constant 58º C. This is intentionally set at a temperature higher than the ambient temperature of the calibrator's operating environment to ensure that local changes in temperature do not affect the UV Lamp. If the lamp temperature falls below 56 ºC or rises above 61 ºC a warning is issued by the calibrator's CPU.

This temperature is controlled by an internal control circuit on the PCA.

The following functions report these temperatures and are viewable in the instrument's Dashboard, or at bottom of Home screen if so configured:

Photo Lamp Temp - The temperature of the UV Lamp reported in ºC.

Photo Samp Temp - The temperature of the Sample gas in the absorption tube reported in ºC.

8.3.6 PNEUMATIC SENSORS FOR THE O3 PHOTOMETER

There is a pressure sensor and a flow sensor, described as follows:

The pressure sensor located on the Photometer PCA measures the absolute pressure of gas inside the photometer's absorption tube.

The flow sensor mounted to the pump PCA measures the flow rate of gas in the photometer's absorption tube. This information is used by the Photometer PCA to calculate the concentration of O_3 (See Section 8.3.1.1). Both of these measurements are made downstream from the absorption tube but upstream of the pump. A critical flow orifice located between the flow sensor and the pump maintains the gas flow through the photometer at rate stated in Specifications (Section 1.2).

The following functions are viewable in the instrument's Dashboard menu, or at bottom of Home screen if so configured:

PUMP FLOW - flow rate of gas through the photometer measured in LPM.

SAMPLE PRESSURE – pressure of **THE** gas inside the absorption tube. This pressure is reported in inches of mercury-absolute (**in-Hg-A**), i.e. referenced to a vacuum (zero absolute pressure). This is not the same as **PSIG.**

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GLOSSARY

Note: Some terms in this glossary may not occur elsewhere in this manual.

TERM	DESCRIPTION/DEFINITION
10BaseT	an Ethernet standard that uses twisted ("T") pairs of copper wires to transmit at 10 megabits per second (Mbps)
100BaseT	same as 10BaseT except ten times faster (100 Mbps)
APICOM	name of a remote control program offered by Teledyne-API to its customers
ASSY	Assembly
CAS	*Code-Activated Switch*
CD	*Corona Discharge*, a frequently luminous discharge, at the surface of a conductor or between two conductors of the same transmission line, accompanied by ionization of the surrounding atmosphere and often by a power loss
CE	*Converter Efficiency*, the percentage of light energy that is actually converted into electricity
CEM	*Continuous Emission Monitoring*
Chemical formulas that may be included in this document:	
C_{O2}	carbon dioxide
C_3H_8	propane
CH_4	methane
H_2O	water vapor
HC	general abbreviation for hydrocarbon
HNO_3	nitric acid
H_2S	hydrogen sulfide
NO	nitric oxide
NO_2	nitrogen dioxide
NOx	nitrogen oxides, here defined as the sum of NO and NO_2
NOy	nitrogen oxides, often called odd nitrogen: the sum of NOx plus other compounds such as HNO_3 (definitions vary widely and may include nitrate (NO_3), PAN, N_2O and other compounds as well)
NH_3	ammonia
O_2	molecular oxygen
O_3	ozone
SO_2	sulfur dioxide
cm^3	metric abbreviation for *cubic centimeter* (replaces the obsolete abbreviation "cc")
CPU	*Central Processing Unit*
DAC	*Digital-to-Analog Converter*
DAS	Data Acquisition System
DCE	*Data Communication Equipment*
DFU	*Dry Filter Unit*

TERM	DESCRIPTION/DEFINITION
DHCP	*Dynamic Host Configuration Protocol.* A protocol used by LAN or Internet servers to automatically set up the interface protocols between themselves and any other addressable device connected to the network
DIAG	*Diagnostics*, the diagnostic settings of the analyzer.
DOM	*Disk On Module,* a 44-pin IDE flash drive with up to 256MB storage capacity for instrument's firmware, configuration settings and data
DOS	*Disk Operating System*
DRAM	*Dynamic Random Access Memory*
DR-DOS	*Digital Research DOS*
DTE	*Data Terminal Equipment*
EEPROM	Electrically Erasable Programmable Read-Only Memory also referred to as a FLASH chip or drive
ESD	Electro-Static Discharge
ETEST	Electrical Test
Ethernet	a standardized (IEEE 802.3) computer networking technology for local area networks (LANs), facilitating communication and sharing resources
FEP	*Fluorinated Ethylene Propylene* polymer, one of the polymers that Du Pont markets as *Teflon*®
Flash	non-volatile, solid-state memory
FPI	*Fabry-Perot Interface*: a special light filter typically made of a transparent plate with two reflecting surfaces or two parallel, highly reflective mirrors
GFC	Gas Filter Correlation
I^2C bus	a clocked, bi-directional, serial bus for communication between individual analyzer components
IC	*Integrated Circuit*, a modern, semi-conductor circuit that can contain many basic components such as resistors, transistors, capacitors etc in a miniaturized package used in electronic assemblies
IP	*Internet Protocol*
IZS	*Internal Zero Span*
LAN	*Local Area Network*
LCD	Liquid Crystal Display
LED	*Light Emitting Diode*
LPM	Liters Per Minute
MFC	*Mass Flow Controller*
M/R	Measure/Reference

TERM	DESCRIPTION/DEFINITION
MOLAR MASS	the mass, expressed in grams, of 1 mole of a specific substance. Conversely, one mole is the amount of the substance needed for the molar mass to be the same number in grams as the atomic mass of that substance. EXAMPLE. The atomic weight of Carbon is 12 therefore the molar mass of Carbon is 12 grams. Conversely, one mole of carbon equals the amount of carbon atoms that weighs 12 grams. Atomic weights can be found on any Periodic Table of Elements.
NDIR	*Non-Dispersive Infrared*
NIST-SRM	*National Institute of Standards and Technology - Standard Reference Material*
PC	*Personal Computer*
PCA	P*rinted Circuit Assembly*, the PCB with electronic components, ready to use
PC/AT	Personal Computer / Advanced Technology
PCB	*Printed Circuit Board*, the bare board without electronic component
PFA	*Per-Fluoro-Alkoxy*, an inert polymer; one of the polymers that *Du Pont* markets as *Teflon®*
PLC	*Programmable Logic Controller*, a device that is used to control instruments based on a logic level signal coming from the analyzer
PLD	*Programmable Logic Device*
PLL	*Phase Lock Loop*
PMT	*Photo Multiplier Tube*, a vacuum tube of electrodes that multiply electrons collected and charged to create a detectable current signal
P/N (or PN)	*Part Number*
PSD	*Prevention of Significant Deterioration*
PTFE	*Poly-Tetra-Fluoro-Ethylene*, a very inert polymer material used to handle gases that may react on other surfaces; one of the polymers that *Du Pont* markets as *Teflon®*
PVC	*Poly Vinyl Chloride*, a polymer used for downstream tubing
Rdg	Reading
RS-232	specification and standard describing a serial communication method between DTE (Data Terminal Equipment) and DCE (Data Circuit-terminating Equipment) devices, using a maximum cable-length of 50 feet
RS-485	specification and standard describing a binary serial communication method among multiple devices at a data rate faster than RS-232 with a much longer distance between the host and the furthest device
SAROAD	*Storage and Retrieval of Aerometric Data*
SLAMS	*State and Local Air Monitoring Network Plan*
SLPM	*Standard Liters Per Minute* of a gas at standard temperature and pressure
STP	*Standard Temperature and Pressure*
TCP/IP	*Transfer Control Protocol / Internet Protocol*, the standard communications protocol for Ethernet devices

TERM	DESCRIPTION/DEFINITION
TEC	*Thermal Electric Cooler*
TPC	*Temperature/Pressure Compensation*
USB	*Universal Serial Bus*: a standard connection method to establish communication between peripheral devices and a host controller, such as a mouse and/or keyboard and a personal computer or laptop
VARS	*Variables*, the variable settings of the instrument
V-F	*Voltage-to-Frequency*
Z/S	*Zero / Span*

APPENDIX A – MODBUS REGISTERS

MODBUS REGISTER ADDRESS (DEC., 0-BASED)	DESCRIPTION	UNITS
MODBUS FLOATING POINT INPUT REGISTERS (32-BIT IEEE 754 FORMAT; READ IN HIGH-WORD, LOW-WORD ORDER; READ-ONLY)		
0	Output Flow Rate	LPM
2	Photometer Measured Ozone Concentration	PPB
6	Ozone Generator Lamp Drive	Percent
8	Ozone Generator Lamp Temperature	C
10	Regulator Pressure	PSIG
12	Internal Box Temperature	C
14	Photometer Detector Measure Reading	mV
16	Photometer Detector Reference Reading	mV
18	Photometer Sample Flow Rate	LPM
20	Photometer Lamp Temperature	C
22	Photometer Sample pressure	In-Hg
24	Photometer Sample Temperature	C
26	Photometer Slope	-
28	Photometer Offset	PPB
34	O3 Generator Pressure	PSIG
208	Instrument Serial Number	-

MODBUS DISCRETE INPUT REGISTERS (SINGLE-BIT; READ-ONLY)		
0	System Reset Warning	
1	Box Temperature Warning	
2	Photometer Lamp Temperature Warning	
3	O3 Generator Lamp Temperature Warning	
4	Photometer Reference Warning	
5	Photometer Lamp Stability Warning	
11	Analog Calibration Warning	
12	System is OK	
13	O3 Generator Stabilized	
16	O3 Generator Pressure Warning	
17	IO Board Overcurrent Warning	
18	Driver Board Overcurrent Warning	
19	Supervisor Communication Warning	
20	Ozone Generator Communication Warning	
21	Photometer Communication Warning	
22	Photometer Pump Communication Warning	
23	Zero Air Control Communication Warning	
24	IO Board Communication Warning	
25	Driver Board Communication Warning	

MODBUS REGISTER ADDRESS (DEC., 0-BASED)	DESCRIPTION	
	MODBUS COIL REGISTERS (SINGLE-BIT; READ/WRITE)	
00-99	Trigger execution of sequence whose name begins with “00” - “99”. Turning a coil on executes a sequence. Turning a coil off does nothing. When reading coils, the value indicates which sequence is executing. If a coil is on, the sequence is executing; if off the sequence is not executing. Supports nested sequences, so multiple sequence coils may be on simultaneously.	
100	Turning coil on turns on purge. Turning coil off does nothing. When reading coil, the value indicates whether purge is active. If on, purge is active; if off, purge is not active. Purge may be invoked within a sequence, so purge coil may be on at the same time as a sequence coil.	
101	Turning coil on puts instrument in standby. Turning coil off does nothing. When reading coil, the value indicates whether instrument is in standby mode. If on, instrument is in standby; if off, instrument is not in standby.	
200-211	Connected to the control outputs (CONTROL_OUT_1–CONTROL_OUT_12). These coils may be turned both on and off. Reading the coils indicates the current state.	

APPENDIX B – INTERCONNECT DIAGRAM

REVISION HISTORY					
ZONE	DCN	REV	DESCRIPTION	DATE	APPROVED
		01	INITIAL RELEASE, PROTOTYPE	8/9/2019	PVU
		02	PU127 WAS PU124, PU117 WAS PU117	7/28/2026	TN

FRONT PANEL
CHASSIS GROUND
019320100, CBL, GRND STRAP
087960100, CBL, 24" CANBUS
047760000, ASSY, UV LAMP, BENCH
WR0000282,CABLE, RIBBON
088590000, ASSY, VALVE, 3-WAY, 24VDC
041440000, PCA, DC HTR/TEMP, BENCH
088200400, PCA, OZONE SENSOR, LOW CONC, HG LAMP
078640000, ASSY, BENCH THERMISTOR
089490000, PCA UV DET, W/OP20
095250000, CABLE, LAMP HTR/THERM
093110300, ASSY, BENCH O3 SHORT, LAMP
084260000 PCA, MAINBOARD, FOR SOM304
089090000 ASSY, FAN, 24VDC
088830000, CBL ASSY
WR0000277, CABLE
07842000, CABLE, HDMI
087960200, CBL, 12" CANBUS
088840000, CBL ASSY
PS0000049AC-DC, 180W SWITCHING, 24V(PA)
OPTION
084640300 PCA, PUMP CONTROLLER, N-SERIES, W/HIGH CUR DRIVE
066970000 PCA, INTRF. LCD TOUCH SCRN, F/P
095970000 PCA DIGITAL I/O
088820000, CBL ASSY
BLACK
WHITE
CN0000831 CONN, PWR ENTRY MODULE, SW, FUSE, 10A(230-0035-01, FUSE, 5A, 250V 5X20MM, SLO-BLO)
CHASSIS GROUND
089270000 CBL ASSY
09498, ASSY, O3 GEN, OPTION
080990000 ASSY, O3 GEN LAMP (OP48)
PU127
VA87
088200000 PCA, O3 GEN, HG LAMP
078640000, ASSY, BENCH THERMISTOR
PU117
084640100 PCA, DC PUMP CONTROLLER, ANALOG
093080000 SWITCH, PUSHBUTTON
095940000,PCA, ANALOG OUTPUT

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UNLESS OTHERWISE SPECIFIED
ALL DIMENSIONS ARE IN INCHES
TOLERANCES: FRACTIONS ±1/16, DECIMALS .XX ± .03 .XXX ± .010, ANGLES ±0°30'
SURFACE ROUGHNESS 125
DO NOT SCALE DRAWING
THIRD ANGLE PROJECTION
APPROVALS | DATE
DRAWN -

TELEDYNE API Everywhereyoulook™

TITLE: DIAGRAM, INTERCONNECT, N703U
SIZE D | CAGE CODE 3DCY1 | DWG NO 093590730 | REV 02
SCALE 1:1 | FORM ENF0029 Rev G | SHEET 1 OF 2