User Manual

Model 480L
OZONE MONITOR

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NOTICE OF COPYRIGHT

TRADEMARKS

SAFETY MESSAGES

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

WARNING. Electrical Shock Hazard

HAZARD. Strong oxidizer

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

CAUTION. Hot Surface Warning

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

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

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

CAUTION

This instrument should only be used for the purpose and in the manner described in this manual. If you use this instrument in a manner other than that for which it was intended, unpredictable behavior could ensue with possible hazardous consequences.

NEVER use this monitor to sample combustible gas(es)!

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

Telephone. +1 800-324-5190
Email. api-techsupport@teledyne.com

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

CONSIGNES DE SÉCURITÉ

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

AVERTISSEMENT . Risque de choc électrique

DANGER . Oxydant puissant

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

MISE EN GARDE . Surface chaude

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

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

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

MISE EN GARDE

Cet instrument doit être utilisé aux fins décrites et de la manière décrite dans ce manuel. Si vous utilisez cet instrument d'une autre manière que celle pour laquelle il a été prévu, l'instrument pourrait se comporter de façon imprévisible et entraîner des conséquences dangereuses.

NE JAMAIS utiliser cet instrument pour échantillonner des gaz combustibles!

WARRANTY

WARRANTY POLICY (02024J)

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

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

COVERAGE

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

NON-TAPI MANUFACTURED EQUIPMENT

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

Product Return

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

The complete Terms and Conditions of Sale can be reviewed at http://www.teledyne-api.com/terms_and_conditions.asp

CAUTION – Avoid Warranty Invalidation

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

ABOUT THIS MANUAL

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

CONVENTIONS USED

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

ATTENTION	**COULD DAMAGE INSTRUMENT AND VOID WARRANTY** **This special notice provides information to avoid damage to your instrument and possibly invalidate the warranty.**
Important	**IMPACT ON READINGS OR DATA** **Provides information about that which could either affect accuracy of instrument readings or cause loss of data.**
Note	**Provides information pertinent to the proper care, operation or maintenance of the instrument or its parts.**

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1. INTRODUCTION

Teledyne API's Model 480L is a UV photometric ozone monitor designed and manufactured for single/multi-channel industrial hygiene ozone analysis. It is a very stable analyzer, ideal for critical low-level PPM safety and process applications. The 480L is designed to be highly reliable and simple to operate with easy setup and user-friendly menu-driven software that can also be set and monitored remotely.

As the 480L was designed for stability, reliability, and simplicity, it includes built-in tests and diagnostics to facilitate maximum uptime. Teledyne API is pleased to provide you with any support required so that you may utilize our equipment to the fullest extent. Our full time Technical Support department is available to answer your questions.

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9970 Carroll Canyon Road
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2. SPECIFICATIONS AND AGENCY APPROVALS

2.1 SPECIFICATIONS

PARAMETER	SPECIFICATION
Ranges	User selectable to any full scale range from: 1 PPM to 500 PPM Low conc scrubber configuration, 0 to 20 PPM High conc scrubber configuration, >20 PPM
Measurement Units	PPM, PPB, PPHM , µg/m^3
Zero Noise	< .0015 PPM (rms)
Span Noise	< .5% of reading (rms) (above 0.1 PPM)
Lower Detectable Limit	< .003 PPM (rms)
Accuracy	+/- 1% of full scale
Response Time (95%)	<30 sec (<60 sec with the Sample Conditioner option)
Sample Flow Rate	0.8 L/min
Temperature Range	5-45^{o} C
Humidity Range	10-90% RH, Non-Condensing
Power	100-240 V~, 47-63 Hz, 74 W
Environmental Conditions	Installation Category (Overvoltage Category) II Pollution Degree 2 Indoor/Outdoor Use Maximum Operating Altitude 2000 meters
Degree of Protection (NEMA enclosure)	IP65 (NEMA 4X)
Analog Output	0 - 5V, 4-20mA, user selectable
Isolated Digital Status Outputs	Sensor OK, Invalid Reading, Check Lamp, Pneumatic Error 24 VDC, 30 mA per Output Max
High Current Relay Outputs (single-channel only)	SPDT (Form C) Dry Contact, 250 VAC, 5 A (System OK, Global HI alarm, Global HI-HI alarm)
Multi-stream signal outputs (3 or 6 channel, 3 per per channel)	SPST Dry Contact, 50 VDC, 250mA per output (Stream ID, HI Alarm, HI-HI Alarm)
Communications	Ethernet RS-232 / RS-485
Dimensions (H x W x D)	NEMA 4X – 16.17" x 15.96" x 6.8" (410.6mm x 405.4mm x 172.7mm
Weight	NEMA 4X – 17.6 lb. (8 kg)

2.2 MULTI-STREAM SPECIFICATIONS

PARAMETER	SPECIFICATION
Minimum Stream Duration (Cycle Time)	1.0 min
Stream Alarm Status Outputs	Isolated digital output controls (2 per stream) Mechanical Relays; 50 VDC, 250 mA per output
Stream ID Outputs	Isolated digital output controls (1 per stream) Mechanical Relays; 50 VDC, 250 mA per output

2.3 APPROVALS

This section presents Safety and Electromagnetic Compatibility (EMC) compliance approvals for the Model 480L monitor.

2.3.1 SAFETY

IEC/EN 61010-1:2010 (3^{rd} Edition), Safety requirements for electrical equipment for measurement, control, and laboratory use.

2.3.2 EMC

IEC/EN 61326-1:2010, Class A Emissions/Industrial Immunity

FCC 47 CFR Part 15B, Class A Emissions

2.3.3 OTHER TYPE CERTIFICATIONS

For additional certifications, please contact Technical Support:

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

3. GETTING STARTED

WARNING – RISK OF DEATH OR SERIOUS INJURY!

To reduce the risk of death or serious injury from a chemical/combustion explosion hazard due to flammable gases/vapors/liquids, never allow contaminants to enter monitor during installation or use. The combination of ozone and the catalytic ozone destruct media in the monitor can produce strong oxidation reactions. Never allow organic contaminants, including but not limited to peroxides and chlorates, into monitor.

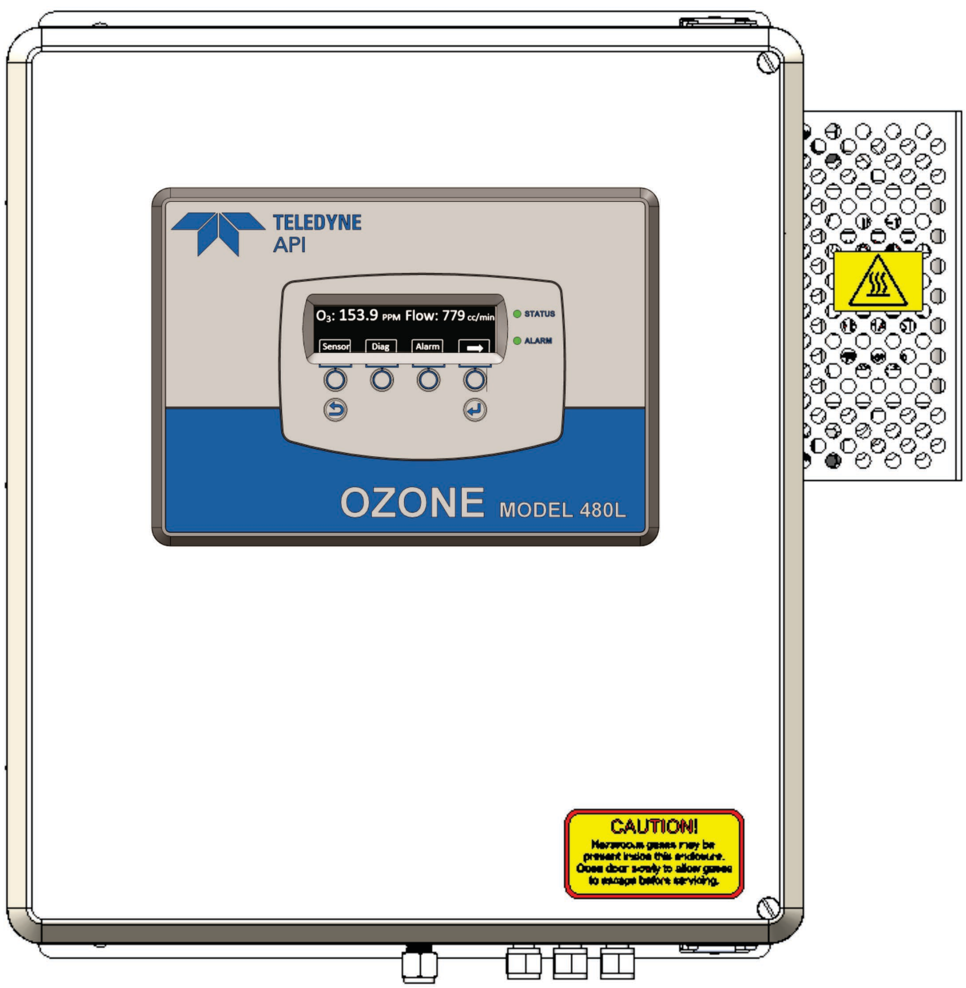


Figure 3-1. Model 480L Display and Control Panel

The monitor is shipped with this user manual and for rack mount version, a power cord.

3.1 UNPACKING

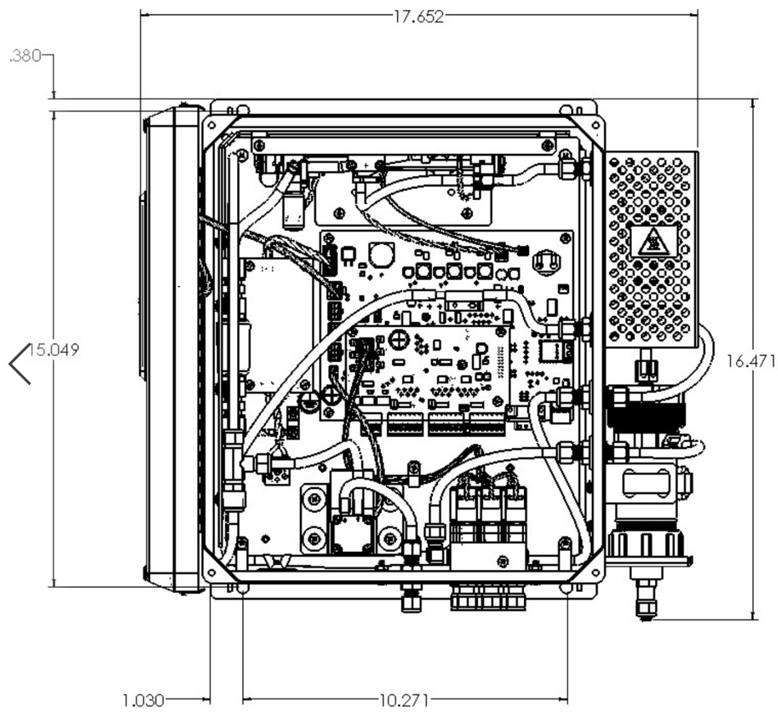
Upon receiving the monitor please verify that there is no apparent shipping damage. (If damage has occurred, please advise shipper first, then Teledyne API).

Check your packing slip for options that may be included, depending on your order, e.g., disposable sample inlet filters.

3.2 MECHANICAL INSTALLATION

When installing the monitor, be sure to leave sufficient clearance on sides, top, and bottom for adequate ventilation and for access to make/adjust all connections. The monitor must be mounted securely with four (4) bolts or anchors to a vertical structure or wall capable of supporting 80 lbs. The mounting bolts or anchors must be capable of supporting 20 lbs each. If using wall anchors, they must be suitable for the type of wall construction and installed per the manufacturer's specifications.

- The illustrations in Figure 3-2 show the mounting dimensions and the locations of the four mounting holes, which are 0.32" (8.128 mm) diameter.
- All four mounting holes must be used to secure the monitor.
- If using bolts, ensure they are stainless steel, 5/16" (8 mm), capable of supporting 20 lbs each.



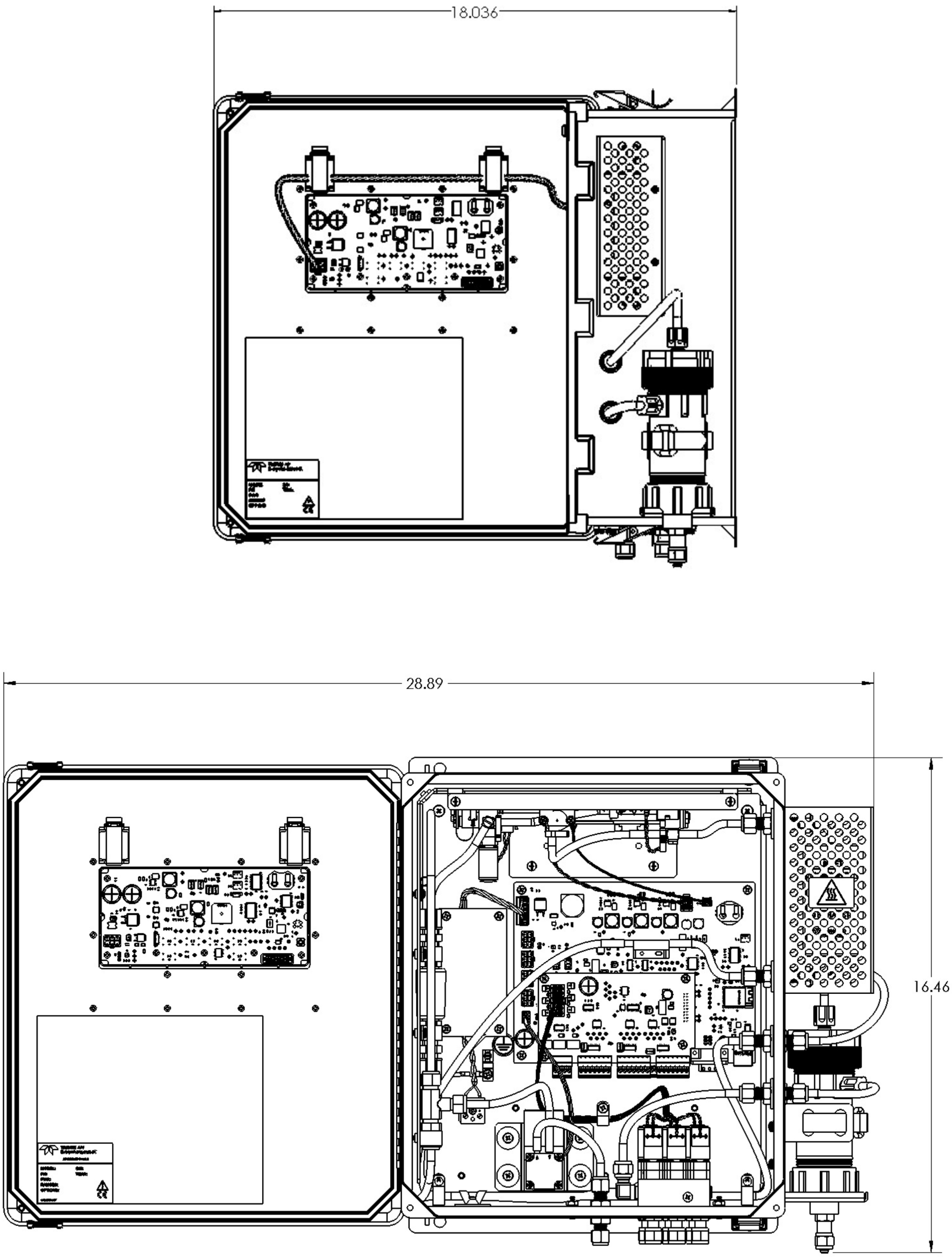


Figure 3-2. Mounting Hole Locations and Dimensions

3.3 AC POWER CONNECTION

WARNING – Electrical Shock Hazard

Disconnect power to the AC mains before making or removing any electrical connections to the monitor.

A proper earth ground connection must be made to the copper lug with the ground symbol on the chassis. Failure to do so may result in a shock hazard and malfunction of the monitor.

3.3.1 WIRING REQUIREMENTS FOR NEMA ENCLOSURES

Use appropriate wiring rated for this type of equipment, ensuring that it meets local and national safety and building requirements.

Ensure that overcurrent protection is used on AC mains connections (a 5 A circuit breaker is recommended), and that it fulfills the following requirements:

- be located as near to the instrument as possible
- quickly and easily accessible
- clearly labeled as the disconnecting device for this instrument

3.3.2 WIRING INSTRUCTIONS

For the NEMA configuration, the electrical connection must be hard-wired to the terminal block and grounding lug on the chassis. AC power connection to the monitor should be made with 12-14 AWG copper wire, connected to the monitor as follows:

- **Earth Ground (green):** Connect the earth ground wire to the copper grounding lug
- **Line (Black):** Connect the Line wire to the terminal block directly across from the black wire that leads to the power supply
- **Neutral (White):** Connect the Neutral wire to the terminal block directly across from the white wire that leads to the power supply.

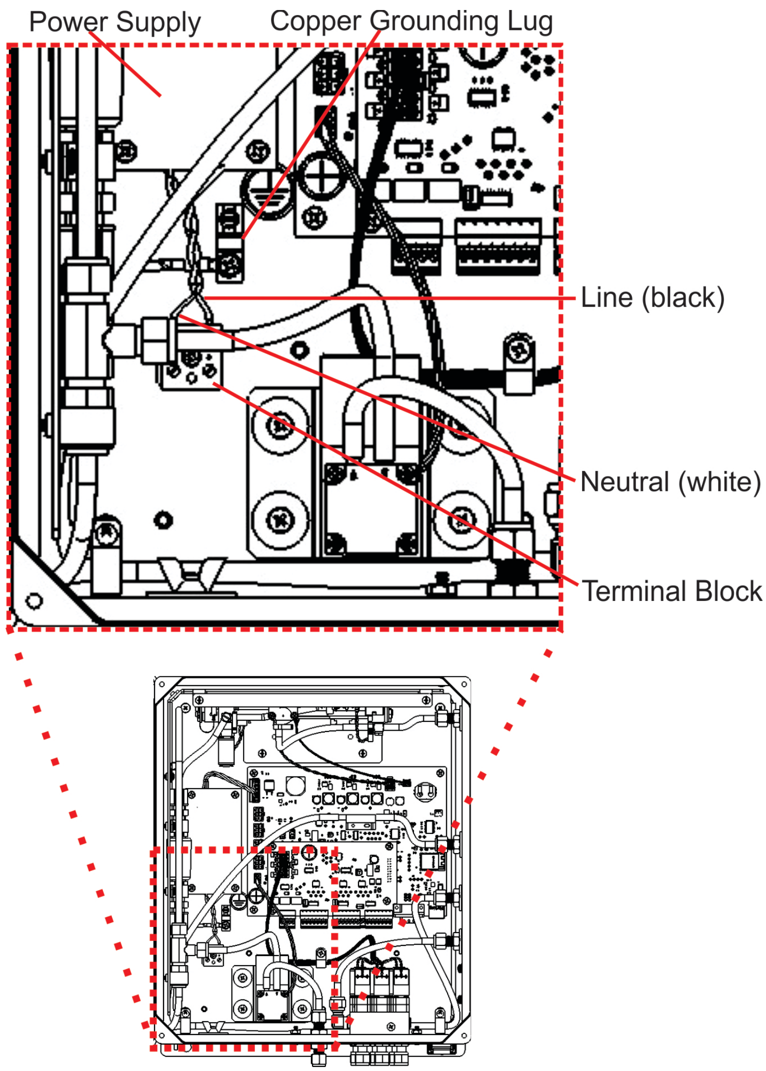


Figure 3-3. NEMA AC Power Connection to Monitor

1. Connect the power cord to an appropriate power outlet or hardwired connection (see the serial number tag for correct voltage and frequency).

> **WARNING**
>
> **Verify that the instrument specification for proper line voltage and frequency is followed. Observe local electrical codes when connecting power to the monitor.**

2. Turn on the 480L by applying power to the monitor. The front panel display will light and display a Teledyne splash screen. The home screen will display the ozone concentration and flow after the monitor begins taking stable readings.

3.4 ELECTRICAL I/O CONNECTIONS

In the NEMA configuration, the I/O connectors are located internally in the instrument. See Figure 3-4 for their locations. Connection to these terminals is usually made via a conduit connection to the NEMA enclosure. There are two conduit penetrations on the enclosure, and an additional penetration can be added to one of the walls of the enclosure if needed.

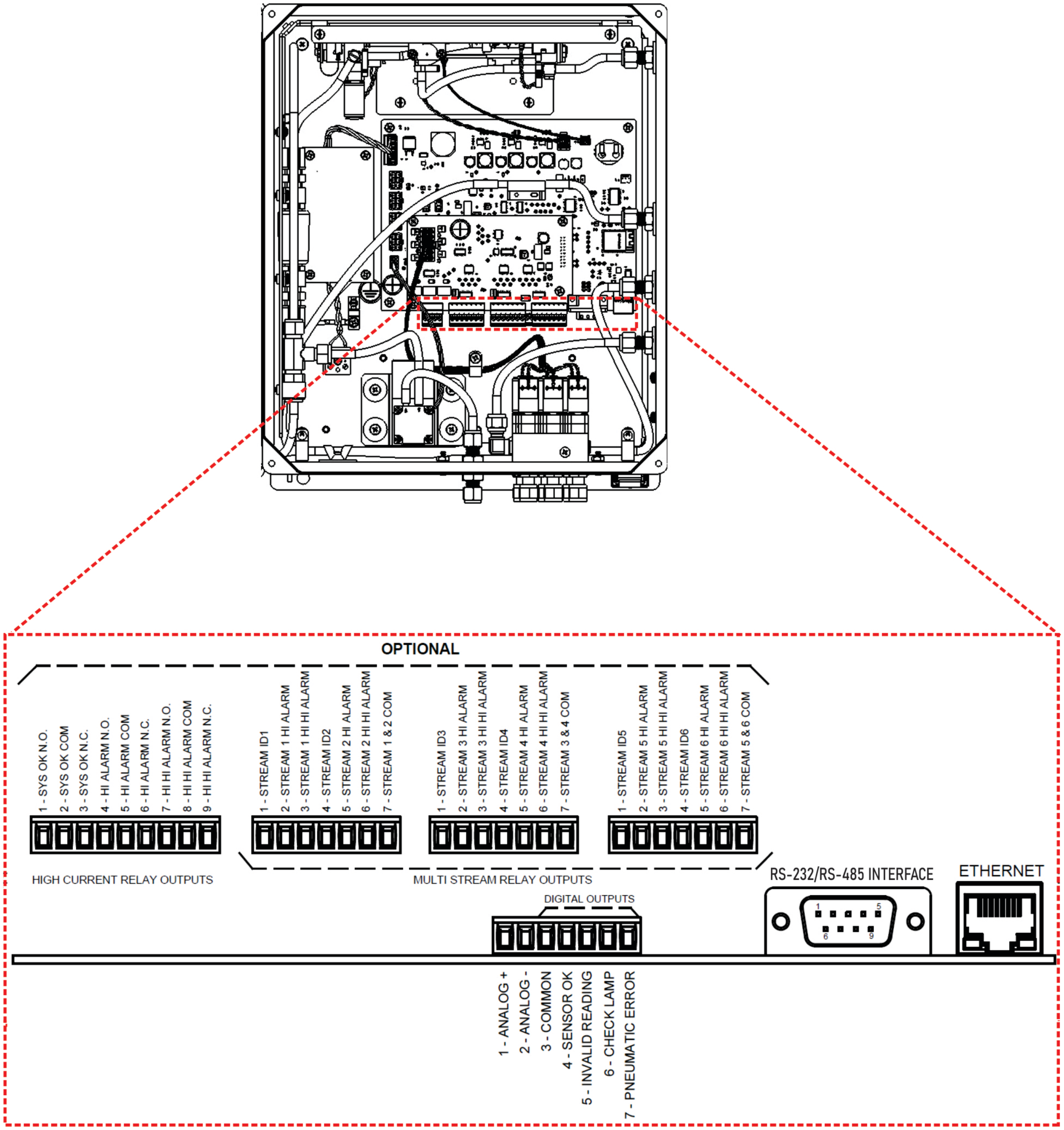


Figure 3-4. Interior Location of I/O Connectors

3.4.1 ANALOG OUTPUT

Refer to Figure 3-4 for the location of the analog output, which can be configured for 0-5 V voltage or 4-20 mA current output. See Section 3.4.1.1 for details on verifying or changing the analog output hardware configuration.

The analog output is automatically scaled to the range of the instrument. See Section 5.2.4.1 for information on changing the range of the monitor.

The monitor has an analog output step-test mode that can be used for verifying the operation of the analog output and calibration of external measurement equipment. This mode is described in Section 5.2.3.1.

3.4.1.1 Analog Output Hardware Verification or Conversion

To change or verify the configuration of the analog output, refer to Figure 3-5 while performing the following instructions:

1. Disconnect power from the monitor.
2. Open front panel.
3. Locate J15 and J17 connectors on the Mainboard PCA (remove Relay Expansion board if installed as indicated in Figure 3-5).
4. Set the desired output as shown in Figure 3-5 where:
   - for Current output (4-20 mA), jumper Pins 1-2 on both J15 and J17, or
   - for Voltage output (0-5 VDC), jumper Pins 2-3 on both J15 and J17.
5. If applicable, reinstall/connect Relay Expansion board.
6. Re-secure the front panel.
7. Reconnect power to the monitor.

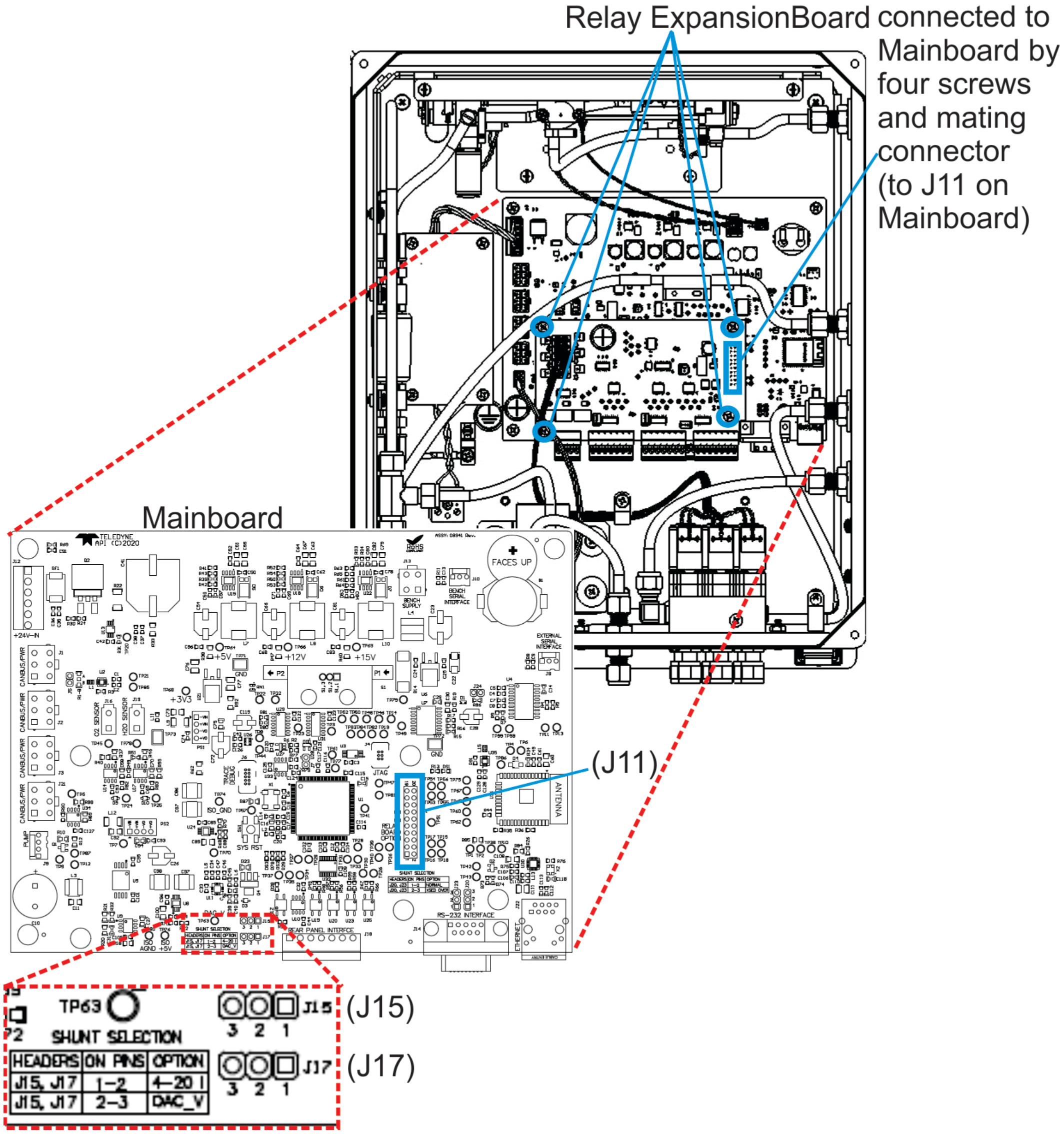


Figure 3-5. Mainboard – Analog Output Configuration

3.4.2 STATUS OUTPUTS

Refer to Figure 3-4 for the location of the status outputs, which are on the same connector as the Analog output and which mirror the state of the values shown in the Status area of the menu structure. The status outputs are defined in Table 3-1.

Electrically these outputs are optically isolated digital outputs that consist of open collector transistors with a common ground. They can be used to interface with devices that accept logic-level digital inputs, such as Programmable Logic Controllers (PLCs).

Table 3-1. Status Output Definitions

Status Output	Normal Operating – Transistor State
Sensor OK	Active – Connected to ground
Invalid Reading	Inactive - Open resistance
Check Lamp	Inactive - Open resistance
Pneumatic Error	Inactive - Open resistance

3.4.3 HIGH-CURRENT RELAY OUTPUTS

Three form C relay outputs are provided on the interior I/O connectors (Figure 3-4). The relays are labeled "Sys OK", "Hi Alarm", and "Hi-Hi Alarm"

The relays are dry contact type form C (SPDT) relays with Normally Open (NO), Normally Closed (NC), and Common (COM) contacts. The relays are capable of switching up to 250 VAC, 5 A each. For maximum contact life, the relays should only be used to drive resistive loads.

Important

IMPACT ON READINGS OR DATA

Contact life may be dramatically shortened if inductive loads are driven without any provision for minimizing high voltage "inductive kick" that can occur.

These relays have slightly different functions depending on whether the monitor is a single stream (Table 3-2) or multi-stream configuration (Table 3-3).

Table 3-2. Relay Functions for Single Stream Configuration

Relay #	Function	Normal Operating State	Relay Coils
1	System OK	Closed	Energized
2	Hi Alarm	Open	De-energized
3	Hi-Hi Alarm	Open	De-energized

Table 3-3. Relay Functions for Multi-Stream Configuration

Relay #	Function	Normal Operating State
1	System OK Diagnostic	Active
2	Global Hi Alarm*	Inactive
3	Global Hi-Hi Alarm*	Inactive

* The state of the global alarm represents all the Hi or Hi-Hi alarm states OR'd together, i.e., if the Hi alarm for one or more of the sample streams is activated, then the Global Hi alarm will be activated.

3.4.4 MULTI-STREAM SIGNAL OUTPUTS

For instruments configured with the optional stream-selector, additional output signals are available (see Figure 3-4).

Electrically these outputs are SPST dry contact relay closures with a common contact. They are capable of switching up to 50 VDC, 250mA maximum current. When relays are activated, they switch on or off any load connected to them. There are no polarity requirements.

Table 3-4. Multi-Stream Outputs

Signal #	Function	If signal is closed
1	Stream ID	Stream X is actively being measured
2	Hi Alarm	Stream X Hi Alarm is triggered
3	Hi-Hi Alarm	Stream X Hi-Hi Alarm is triggered

3.4.5 FAILSAFE OPERATION SIGNAL AND RELAY OUTPUTS

The digital Status outputs and Alarm relays can be configured using the Failsafe Operation variable found in the Setup>Vars menu. When the Failsafe operation has been set to ON, the open collector transistors for the Status Outputs (Invalid Reading, Check lamp and Pneumatic Flow) will switch to ground and become active (Table 3-5).

Additionally, when the Failsafe Var is set to ON, the Alarm relays, HI Alarm and HI-HI Alarm, behave the same as the System OK relay, where, in normal operating state, the relay coils are energized and the Normally Open contact closes (Table 3-6).

For units with multi streams enabled, the Failsafe set to ON behaves much like the high current relays. In normal operating state without the presence of an alarm, the coils are energized and the Normally Open contact becomes Normally Closed (Table 3-7)

Table 3-5. Status Output States - Failsafe Operation ON, No Error State Detected

Status Output	Function
Sensor OK *	Active
Invalid Reading	Active
Check Lam	Active
Pneumatic Error	Active
* Failsafe setting does not change System OK behavior.	

Table 3-6. Relay Functions - Failsafe Operation ON, No Alarms Triggered

Relay #	Function	Failsafe Operating State
1	System OK *	Energized
2	Hi Alarm	Energized
3	Hi-Hi Alarm	Energized
* Failsafe setting does not change System OK behavior.		

Table 3-7. Multi-Stream Outputs - Failsafe Operation ON

Function	Normal Operation- No Alarm Present	Failsafe Operating State
Hi Alarm	Stream X Hi Alarm Off	Energized
Hi-Hi Alarm	Stream X Hi-Hi Alarm Off	Energized
Hi Alarm	Stream X Hi Alarm is triggered	De-energized
Hi-Hi Alarm	Stream X Hi-Hi Alarm is triggered	De-energized

3.4.6 DIGITAL COMMUNICATION INTERFACES

Note **Ensure that there are no communication devices connected until after start-up is complete.**

3.4.6.1 ETHERNET

For network or Internet communication with the monitor, connect an Ethernet cable from the Ethernet interface connector (see Figure 3-4) to an Ethernet port that is connected to a LAN. Although the default setting is DHCP-enabled, it should be manually configured with a Static IP address (Section 6.1).

3.4.6.2 SERIAL: RS-232 OR RS-485

For Serial communication, connect a 9-pin serial cable from the serial connector J14 (see Figure 3-4) to a personal computer serial port. If communication cannot be established, it's possible that the cable is pinned differently, and the signal pinout for the connector can be swapped. See Section 6.2 for additional details.

3.5 PNEUMATIC CONNECTIONS

Note **Sample tubing made from an inert material such as Teflon should be used to minimize sample degradation.**

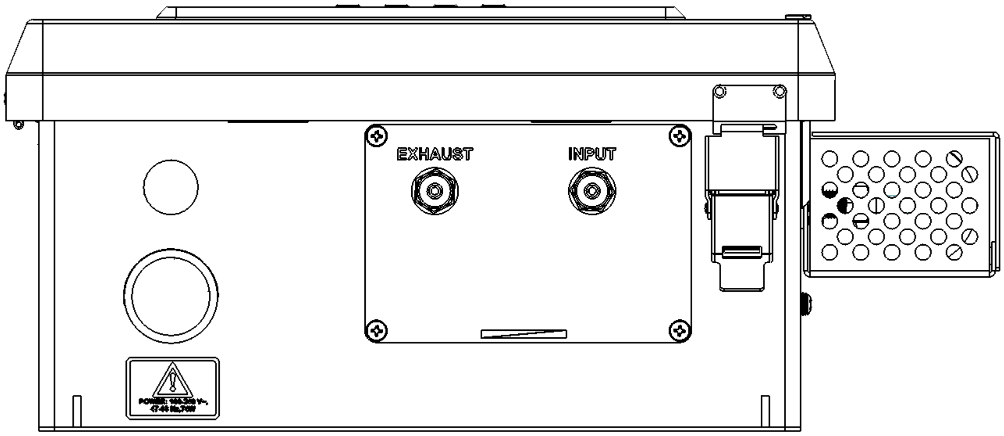


Figure 3-6. Pneumatic Connections, Single Stream

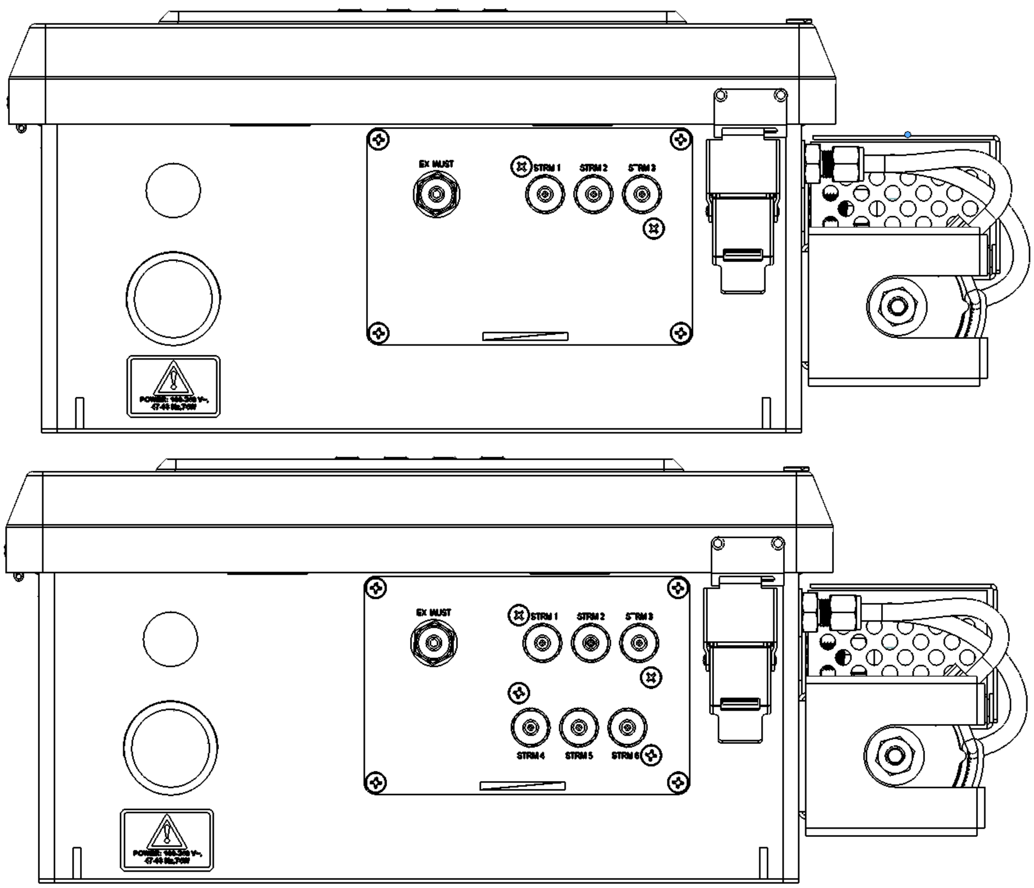


Figure 3-7. Pneumatic Connections, Multi-Stream Option Configurations

3.5.1 SAMPLE GAS CONNECTION

Sample gas connections are made to the ¼" tube fittings on the outside bottom panel. For single stream monitors, use the fitting labeled INPUT (Figure 3-6). For multi-stream monitors, the sample tubing is connected to the fittings labeled STRM 1, STRM 2, etc. (Figure 3-7).

1/4" O.D. FEP (Teflon™) tubing is recommended to connect the sample source to the monitor (recommended length ≤ 50 feet). Any fittings used in the sample lines should be constructed of stainless steel or Teflon™.

Note	**For best analytical performance, the tubing should be pre-conditioned to ozone prior to installation to minimize ozone loss in the sampling lines.**

3.5.1.1 Sample Filtration

The most important factor in maintaining an accurate and stable monitoring system for ozone is the cleanliness of entire pneumatic system leading up to (and including) the sensor assembly inside the instrument. Provision must be made for keeping dust and other particulate matter out of the monitor and upstream sample delivery tubing. The monitor is equipped with an internal particulate filter down-stream of the selector manifold.

In addition, it is recommended that inlet filters be installed at the inlet of each sample line. These filters should be constructed of PTFE or other inert material to avoid degradation of the ozone concentration. Appropriate disposable inlet filters can be purchased from TAPI Sales.

3.5.1.2 Sample System Design in Humid Environments

Care must be taken in the design of the sampling system to ensure that water vapor does not condense in the sampling lines or in the instrument itself. The sample lines should be routed to avoid large temperature gradients along the lines. If sample is brought from a hot, humid area into a much cooler area, then low power heating tape should be wrapped around the lines to keep the temperature of the sample lines up and avoid condensation. The lines should also not have loops or low points where water could collect.

For applications that require sampling of very humid gas, a Sample Conditioner and/or a Permeation Gas Dryer may be required to lower sample gas humidity. A pneumatic block diagram with the locations of these 480L options is shown in Figure 3-8, followed by a description of each. Please contact the Teledyne API Sales Department for additional information.

3.5.2 EXHAUST CONNECTION

CAUTION

Connect the exhaust fitting to a suitable vent outside the monitor area.

Connect a ¼" OD vent line to the EXHAUST fitting on the monitor. This line must be vented outdoors or to an appropriate discharge system capable of handling ozone. Local regulations regarding the discharge of ozone to the atmosphere must be observed. Note that the monitor may be equipped with an internal ozone scrubber for removal of ozone from the exhaust stream. For safety reasons, the exhaust port must still be vented appropriately.

3.5.3 SAMPLE CONDITIONER OPTION

The Sample Conditioner option is a coalescing filter and a permeation gas dryer, designed for high-humidity environments where the sampling gas has been saturated with water vapor and may contain small amounts of condensed water. This coalescing filter removes not only liquid, but also particulates with a Teflon™ filter element.

Due to the additional volume added by the coalescing filter, there is an exception to the Response Time specification for the 480L: when equipped with the Sample Conditioner option, a 480L instrument's Response Time is <60 seconds to 95%.

CAUTION

The Sample Conditioner will NOT protect the unit from damage by large amounts of liquid, such as that ingested through immersion of the sample line.

Furthermore, it is important to closely track the amount of water accumulating in the Coalescing Filter after the monitor has been installed and running. If excessive condensation is occurring in the sample lines leading to the monitor, then heat-traced lines should also be used to minimize condensation.

The Sample Conditioner option includes a Permeation Gas Dryer, which is available as an alternate option (described next) if humidity is the only concern and there is no risk of condensation.

3.5.4 PERMEATION GAS DRYER OPTION

The Permeation Gas Dryer serves to remove water vapor from sampling gas in a humid environment. It is an alternative option when there is no risk of condensation. The permeation material is a Teflon™-type compound and has only a minimal effect on the ozone concentration in the sample stream. When the 480L is equipped with this option, the unit has been calibrated at the factory to compensate for any ozone loss in the permeation dryer.

3.6 PNEUMATIC FLOW DIAGRAM

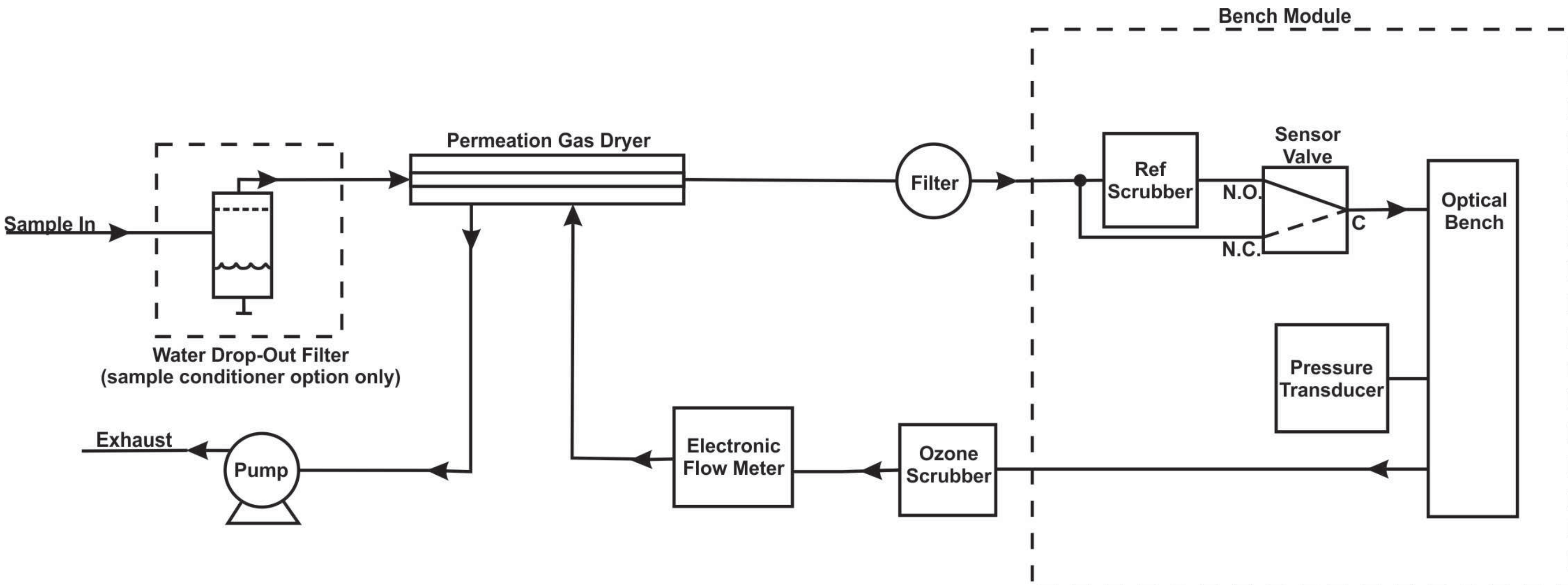


Figure 3-8. 480L Pneumatic Diagram w/Sample Conditioner and Permeation Gas Dryer Options (single-stream configuration shown).

4. CALIBRATION

Calibrations are an important part of maintaining accuracy.

4.1 FACTORY CALIBRATION

The Model 480L is calibrated to NIST traceable standards on the 0-1 ppm range prior to shipment. A calibration certificate for your instrument can be purchased from Teledyne API if required. Teledyne API also recommends that the Model 480L be re-calibrated once a year. Teledyne API can provide NIST traceable calibration services at our factory or on-site. Please contact our Technical Support department for details on these services.

4.2 ZERO, SPAN, AND FLOW CALIBRATIONS

A zero calibration can be easily performed in the field, and Teledyne API recommends that this be done at least annually. See Section 5.2.3.2 for details on performing a zero calibration, Section 5.2.3.3 for span calibration, and Section 5.2.3.4 for flow calibration.

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5. OPERATION

This section presents information for use of the front panel controls, the display, the LEDs, and the menus to operate the monitor.

5.1 FRONT PANEL OVERVIEW

The front panel provides a display screen, status LEDs and menu navigation and selection buttons, Figure 5-1.

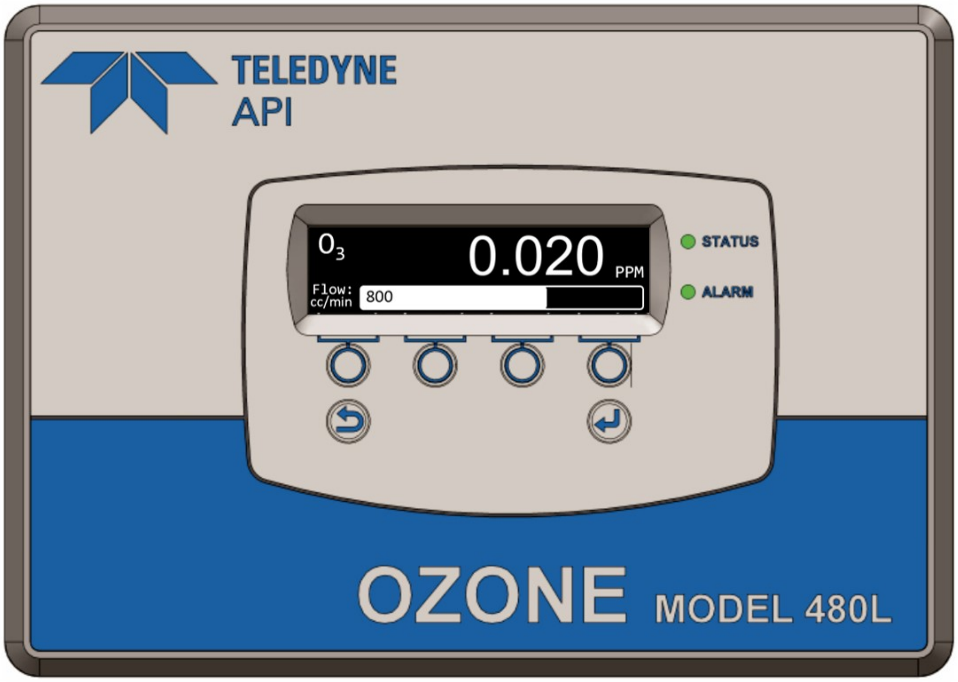

Figure 5-1. Front Panel Display and Controls

5.1.1 DISPLAY

In the Default Screen, the display shows the current ozone concentration measurement and flow rate. Briefly pressing any button causes the Home Screen to appear with ozone concentration, flow rate and menu selections. In multi-stream monitors, the default screen also shows a table listing the streams, indicating which stream is being measured (one at a time), and automatically scrolls to each stream at a rate set in the Setup>Streams>Duration menu. On a multi-stream monitor, Manual Mode can be entered from the Home Screen so that the stream selections can be scrolled manually by pressing the control button below the table of streams. The monitor returns to Auto Mode when the user exits the Manual Mode screen or when a timeout has been exceeded (configurable in Setup>Vars).

5.1.2 CONTROL KEYS

The control keys are used to view operational parameters and to view and modify configurations of the instrument. See Section 5.2 for more detailed information.

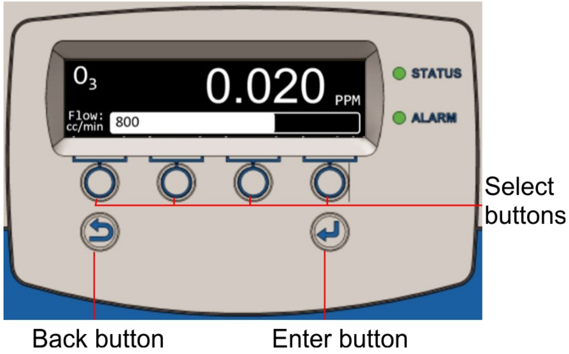

Figure 5-2. Front Panel Selection and Control Buttons

Select: The four unmarked buttons operate the corresponding field directly above them in the bottom of the display screen. The fields show selectable parameters and operations for the current menu, including left, right, up, down arrows to scroll available settings.

Back: Returns to the previous screen up, and when pressed prior to pressing the Enter button, exits the screen without accepting selected input.

Enter: Accepts the selected input.

Pressing and holding any button for at least two seconds or pressing no buttons for at least 30 seconds returns the display directly to the Default Screen.

5.1.3 INDICATOR LEDS

STATUS The default state of the the STATUS LED is solid lit green. When lit red or yellow, it indicates there is an error with any one or more of four parameters: Sensor OK (red), Invalid Reading (yellow), Check Lamp (yellow), or Pneumatic Error (yellow). Details of the error type will be shown as the Default Screen if an error is present or the user can view the state of these parameters in the Status Menu.

ALARM The default state of the ALARM LED is off. When lit red, an alarm has been triggered and the display immediately switches to the Alarm screen; a table indicates by a solid filled radio button whether there is a Hi Alarm or a Hi Hi Alarm (and in the case of a multi-stream monitor, it also shows which stream(s) is(are) affected).

5.2 FRONT PANEL MENUS

The 480L has an interactive menu structure that can be operated from the front panel. From within this menu structure, the operator can view real-time parameters such as temperature and pressure, view configuration information, and edit setup parameters such as alarm limits. Section 5.1.2 describes the control keys and navigation through the menu system. Table 5-1 below shows the menu structure.

Table 5-1. Menu Structure

Sensor	(scroll display to view detector measure values (mV), detector reference values (mV), cell temperature and cell pressure readings)	
Diag		
	Analog Step	As a way to test connected equipment, this mode allows the user to step through five analog output V or I values that represent the ozone concentration range (Section 5.2.3.1).
	Cal	
		Zero Cal (run zero air 10 min. until stable)
		Span Cal (use known conc of O3; set target (O3 units set in Vars); allow span gas to enter for 1 hour prior to execute)
		Flow Cal (set flow target based on external flow meter; execute)
Alarm	(screen becomes Default Screen when alarm is triggered; solid-fill indicates which alarm(s) triggered. Reset allows user to clear an alarm if the ALARM MODE setting is set to LATCHING ON.	
Setup		
	Streams	
		(editable attributes per stream)
	Vars	
		(editable Vars)
	Comm	
		Allows user to set MODBUS ID and View Ethernet Info and IP Mode.
	Info	Shows version information of hardware and firmware.
	Factory Default*	Restores the unit to the factory calibration settings and erases any previously input user settings. *Do not use this menu without explicit direction by Technical Support.

5.2.1 EDITING SETTINGS

Refer to Section 5.1.2 for button descriptions. After navigating to and selecting a menu item, edit the settings by using the up arrow or down arrow. Either accept the new setting by pressing the Enter button, or exit without changing the setting by pressing the Back button.

Note that limit checking is enforced while editing values and changes that would result in invalid values are ignored.

5.2.2 SENSOR MENU

The Sensor menu allows the operator to view various measurement parameters in real-time. This can be useful for diagnosing various instrument or system problems.

Note that these values are updated in real-time as they are repeatedly scrolled on the display.

Table 5-2. Sensor Menu Parameters

Parameter	Description	Units	Normal Range*
MEAS	UV detector reading, measure cycle	mV	250 – 1230
REF	UV detector reading, reference cycle	mV	250 – 1230
CELL TEMP	Measurement of cell temperature, depends on ambient conditions	°C	5 - 50
O3 CELL PRESSURE	Sample pressure	psia	9.0 – 14.9
FLOW	Sample Gas Flow Rate	cc/min	640 – 960

*After initial 5 minute warm-up period.

5.2.3 DIAG MENU

The DIAG menu contains functions that are useful for testing and configuring external equipment that may be connected to the I/O panel of the instrument.

5.2.3.1 ANALOG STEP

When placed in this mode, the instrument will automatically step the analog output (see Section 3.4.1 for details on the analog output connection) through 5 points from 0 to 100 % (see Table 5-3 for values) and display the current value on the front panel. The operator can manually control the stepping by pressing the Select button beneath either one of the Up/Down arrows. The 5 points will correspond to the following analog output values depending on whether the output is configured for 0-5V or 4-20mA:

Table 5-3. Analog Step Test Values

Point	0-5V Output	4-20 mA Output
0%	0.00 V	4 mA
25%	1.25 V	8 mA
50%	2.50 V	12 mA
75%	3.75 V	16 mA
100%	5.00 V	20 mA

Press the Back button to exit from the Analog Step test function.

5.2.3.2 Zero Calibration

The zero calibration allows the instrument to calibrate its internal ozone offset factor. This should only be done with a source of zero air free of ozone, connected to the "Sample In" port of the monitor. Allow the instrument to stabilize on the zero air source before attempting to zero. This normally takes 10-15 minutes.

From the Cal menu, press the control button under the "Zero Cal" field to enter the Zero Calibration menu. Follow the prompts on the screen, and when ready to start the calibration, press the button under Execute Cal. To abort the calibration, press the Back button, which returns the display to the previous menu level. Once calibration begins, the instrument will complete the calibration and adjust the appropriate Vars.

Returning to the default screen should show the concentration display at zero. Please note that while measuring zero air, a certain amount of noise or "dithering" of the concentration about the zero point will occur and is normal. This noise is typically ±0.5% of full scale range in magnitude.

5.2.3.3 Span Calibration

The span calibration allows the instrument to calibrate its internal slope factor based on the source of ozone with a known ozone concentration. Connect the source to the SAMPLE IN port of the monitor. Allow the instrument to stabilize on the span gas source for a minimum of 1 hour before performing the span calibration.

Note

A Span Calibration should only be performed with a precision source of ozone calibration gas. Simple ozone generators without a measurement feedback system should never be used for performing span calibrations.

If you are unsure regarding the suitability of a particular source of calibration gas, contact Technical Support at Teledyne API for assistance.

In the Diag>Cal>Span Cal menu, use the buttons under the Up/Down arrows to set the Span Target concentration (the actual concentration of ozone being supplied to the monitor) and press the Enter button, then press the button under the Execute Cal field to perform the span calibration or press the Back button to abort the cal process

If the calibration is successful, the display will return to the concentration menu and the monitor reading should change adjust to read very close to the target value. If the calibration cannot be performed, a Cal Status Failed message will be displayed and you will need to return to the start of the Span Cal menu.

If the Cal Status Failed message occurs, it means the Span Cal cannot be performed because it would result in an out of range slope value for the monitor. This means that either the sensor in the monitor is malfunctioning, causing improper readings, or the actual ozone concentration being supplied to the monitor is different than the target value being entered.

5.2.3.4 Flow Calibration

The flow calibration allows the instrument to calibrate its internal flowmeter reading. This should be done with a calibrated flowmeter connected to the "Sample In" port of the monitor.

In the Diag>Cal>Flow Cal menu, use the buttons under the Up/Down arrows to set the Flow Cal target (the actual flow as measured at the sample inlet) and press the Enter button; then press the button under the Execute Cal field to perform the flow calibration or press the Back button to abort back to the start.

If the calibration is successful, the flow display on the Default Screen should match the Flow Cal target. If the calibration cannot be performed, a Cal Status Failed message will be displayed, and you will need to return to the start of the Flow Cal menu.

If the Cal Status Failed message occurs, it means the Flow Cal cannot be performed because it would result in an out of range flow slope value for the monitor. This means that either the flow sensor in the monitor is malfunctioning, causing improper readings, or the actual flow is different than the target value being entered.

5.2.4 SETUP MENU

The Setup menu displays specific information related to instrument configuration and allows the user to set up stream details and to change variables (VARS).

5.2.4.1 SETUP-STREAMS Menu

The Streams menu allows the operator to view and edit properties of each measurement stream available. For each stream the following properties are available:

Table 5-4. STREAM Properties

Property		Meaning	Default Value	Range
DELAY		Set number of readings above alarm limit required to trigger alarms.	5	1-10
STREAM		Select configure the details for each stream.		
	HI ALARM	Enable/disable HI alarm operation and set trigger value.	ON	ON/OFF
	HI HI ALARM	Enable/disable HI-HI alarm operation and set trigger value.	ON	ON/OFF
	RANGE	Concentration range for specified stream. Used to scale the analog output.	1.0 PPM	1.0 – 500.0 PPM

Property		Meaning	Default Value	Range
	DURATION	Set stream measurement duration for AUTO stream-selector operation. See Section 5.2.4.3 for additional details.	60.0 Seconds	60.0 – 360.0 Seconds
	ENABLE	Enable or disable each stream for concentration display.	ON	ON-OFF
ALARM MODE		Controls the latching behavior of the concentration alarms. When Latching is set to ON, the alarm persists until 'Reset' is pressed to clear the alarm.**	ON	ON/OFF

** The alarm cannot be reset if the ozone reading has not come down below the alarm set point.
Non-latching alarms will automatically reset when the alarm condition is removed.
The Reset button has no effect when configured for alarms set to LATCHING OFF.

5.2.4.2 SETUP-VARS Menu

The VARS menu allows viewing and editing of various global setup variables (stored in the instrument's non-volatile memory) that affect how the 480L operates. Table 5-5 lists and describes these variables.

Table 5-5. VARS List and Descriptions

VAR	Description	Default Value	Range
MANUAL MODE T	Enables/disables the Manual mode timeout feature. See Section 5.2.4.3 for more detail.	ON	ON, OFF
FLOW SLOPE	Slope value for flow calibration.	(changes with each calibration)	
FLOW SET POINT	Sample flow set point	800 cc/min	700-900cc/min
PRESSURE SLOPE	Slope value for pressure	1.0	
PRESSURE OFFSET	Offset value for pressure, internally calculated value determined during calibration.		
BC FILTER SIZE*	Boxcar filter length for concentration filter. Increasing the size of the filter will smooth out the concentration readings but will also increase the response time.	10	1-30
FAILSAFE OPERATION	Relays and digital outputs operate in fail safe operation. Outputs are energized in normal operation and de-energized during fault status	OFF	ON, OFF
STREAM COUNT*	Specifies the number of streams available in the instrument. Note that the hardware in the instrument must be also configured to support the number of streams specified.	1	1,3,6
DWELL	Amount of time before measurements resume when switching streams so that remnant gas can be cleared from the line of the new stream. (Section 5.2.5.1 also describes this function). Multi-stream units with the Sample Conditioner option (Section 3.5.1.2), require additional dwell time to purge the filter between stream measurements.	30.0 Seconds 45.0 Seconds	0.0 – 30.0 Seconds 0.0 – 45.0 Seconds
ANALOG RANGE	Full-scale concentration range, used to scale the analog output.	1.0 PPM	1.0 – 500 PPM
ANALOG HW CONFIG	Determines if the analog output uses 4-20mA or 0-5V output	4-20mA	4-20mA or 0-5V
O3 OFFSET	Internally calculated value.	N/A	N/A
O3 SLOPE	Calibration slope value	1.000	0.8 – 1.0
USER SLOPE	User-editable calibration slope value	1.0	0.5-1.5
USER UNITS	Setting for concentration unit-of-measure	PPM	PPM, PPB, UGM
CARRIER GAS WEIGHT	Molecular weight of carrier gas (i.e., feed gas for ozone generator). This value is only used for the calculation of wt% concentration units.	32 g/mol	

5.2.4.3 SETUP>COMM MENU

The Setup>Comm menu includes two submenus: Comm Addr and Ethernet.

Select Comm Addr to set the MODBUS address; the Register Maps are presented in Section 6.3.

Select Ethernet to view Info or to set the IP Mode to Static or DHCP (Section 6.1).

5.2.4.4 SETUP>FACTORY DEFAULT MENU

The Factory Default menu restores the factory calibration settings, thereby erasing user-customized settings; therefore, it is strongly recommended that Factory Default be used only when explicitly directed by Technical Support (api-techsupport@teledyne.com) who will then need to provide a software application to reload the factory settings.

To proceed with the Setup>Factory Default menu, select Restore which will trigger a confirmation screen to either continue by pressing the Enter control key or abort by pressing the Back control key (Section 5.1.2). Once you start the Factory Default Restore procedure, follow the instructions displayed, and do not unplug the instrument until instructed to on the display. When the procedure is complete, and the factory settings are loaded, a zero calibration is required after rebooting the instrument.

5.2.5 MULTI-STREAM OPERATION (STREAM SELECTOR OPTION)

The stream selector operates in two modes, Auto (default) and Manual. The display shows the current mode and a table of the streams, highlighting the one whose concentration and flow readings are currently being measured.

In Auto Mode the duration of each measurement before moving to the next stream is governed by the STREAM DURATION setting in the Setup>Streams menu. To switch to Manual Mode, select the button on the Home Screen for manual mode and then arrows will be presented to manually switch streams.

5.2.5.1 MULTI-STREAM AUTO MODE

In Auto mode the monitor is designed to continuously cycle through the enabled sampling streams (stream ENABLE set to ON), and skipping past the streams that are not enabled (stream ENABLE set to OFF). (The ENABLE parameter is accessed through the Setup>Streams>Stream[*n*] menu). The stream cycling is accomplished by activating valves on the stream selector manifold to admit sample gas for a particular stream.

When the 480L first switches to a new sample stream, the instrument goes through a 30-second dwell phase where sample gas is pulled from the new sample stream, but no readings are taken. The purpose of this dwell phase is to purge out any "old" sample gas that has been sitting in the sample line while that stream was inactive. During the dwell phase concentration value will remain a fixed value of the last concentration reported for that stream. After the 30 seconds has elapsed, the current concentration will be displayed. The current stream will now be monitored for the rest of the measurement Duration that has been set for that stream (see Section

5.2.4.1 for details on configuring the individual streams). The actual time period that the stream is measured is the measurement Duration minus the 30 second dwell. So, a 1-minute measurement Duration consists of 30 seconds of dwell followed by 30 seconds of measurement.

For systems that do not require a 30 second dwell between streams, this value can be changed using the DWELL Var (Table 5-5).

5.2.5.2 MULTI-STREAM MANUAL MODE

When in Manual mode, pressing the button below the Up or Down arrows will switch to the next stream. To return to Auto mode, either allow the instrument to switch after a 10 minute time-out (can be set on or off in the Setup>Vars menu), or exit this manual mode screen using the back button. The default state for the Manual mode timeout is ON, which is the recommended setting for instruments used for critical safety applications. This feature prevents the instrument from being inadvertently left in Manual mode, and subsequent loss of monitoring data from the other, unmeasured channels. For applications where Manual mode is the preferred mode of operation, this timeout feature can be turned off. See Section 5.2.4.2 for details on changing this setting.

6. DIGITAL COMMUNICATIONS

The 480L comes equipped with digital communications capability that can be connected to computer or a digital data acquisition system (DAS). See Section for configuration information. There is a serial communications connector that can be configured for RS-232 or RS-485 and an Ethernet connector that uses Ethernet 10 Mbit standard. All three use the standardized MODBUS protocol (see Section 6.3 for register maps).

The connectors can be used for data acquisition, alarm triggering, and instrument configuration. All the functions that are available at the front panel of the instrument can also be performed over the digital communications standards.

6.1 ETHERNET CONFIGURATION

Once an Ethernet cable is connected (Section 3.4.6.1), the instrument should be functioning with a dynamic IP address by default. To configure with a static connection, use the front panel control keys (Section 5.1.2) to navigate to the Setup>Comm>Ethernet>IP mode menu. If you don't know what the IP Address, Mask, or Gateway values should be, consult with your IT Administrator first.

1. Press the Enter button to display the menu.
2. Press the applicable Select button to navigate to the next menu page.
3. Press the Select button under Setup.
4. Press the Select button under Comm.
5. Press Select button under IP mode.
6. Press the Select button to highlight "Static" and press Enter to accept.
7. Press the Back button to move to the previous level.
8. Press the Select button under IP Addr.
9. Press the Select buttons under the right/left arrows as needed to highlight the first place of the IP address string.
10. Press the Select buttons under the up/down (increment/decrement) arrows as needed to change the value in the highlighted place of the IP address string.
11. Repeat the navigation and selection steps until the address is complete.
12. Press the Enter button to accept and the Back button to move to the previous level.
13. Repeat the process for Mask and Gateway if/as directed by IT Admin.

6.2 SERIAL CONFIGURATION - RS-232 AND RS- 485

The RS-232 or RS-485 configuration is usually used when making a one-to-one connection between the instrument and a single computer or PLC. The communications protocol used for serial configuration is MODBUS RTU. For details on the MODBUS RTU specification, please see http://www.modbus.org/.

To change or verify the configuration of the serial COM, refer to Figure 3-5 while performing the following instructions:

1. Disconnect power from the monitor.
2. Open front panel.
3. Locate J20 and J23 connectors on the Mainboard PCA (remove Relay Expansion board if installed as indicated in Figure 6-1).
4. Set the desired COM as shown in Figure 6-1 where:
   - for RS-232 Normal, jumper Pins 1-2 on both J20 and J23, or
   - for RS-485, jumper Pins 3-4 on both J20 and J23.
5. If applicable, reinstall/connect Relay Expansion board.
6. Re-secure the front panel.
7. Reconnect power to the monitor.

If there is a problem with the connection, it's possible that the pinout signals on the RS-232 connector need to be changed to accommodate the serial cable pins. In that case, refer to Section 6.2 to make the adjustments for 232 XSED OVER by setting the jumper pins 2-3 on both J20 and J23.

The serial port setup for RS-232/RS-485 configuration is shown in Table 6-1.

Table 6-1. RS-232/RS-485 Port Setup

Property	Value
Baud Rate	57600
Data Bits	8
Parity	None
Stop Bits	1
Flow Control	None

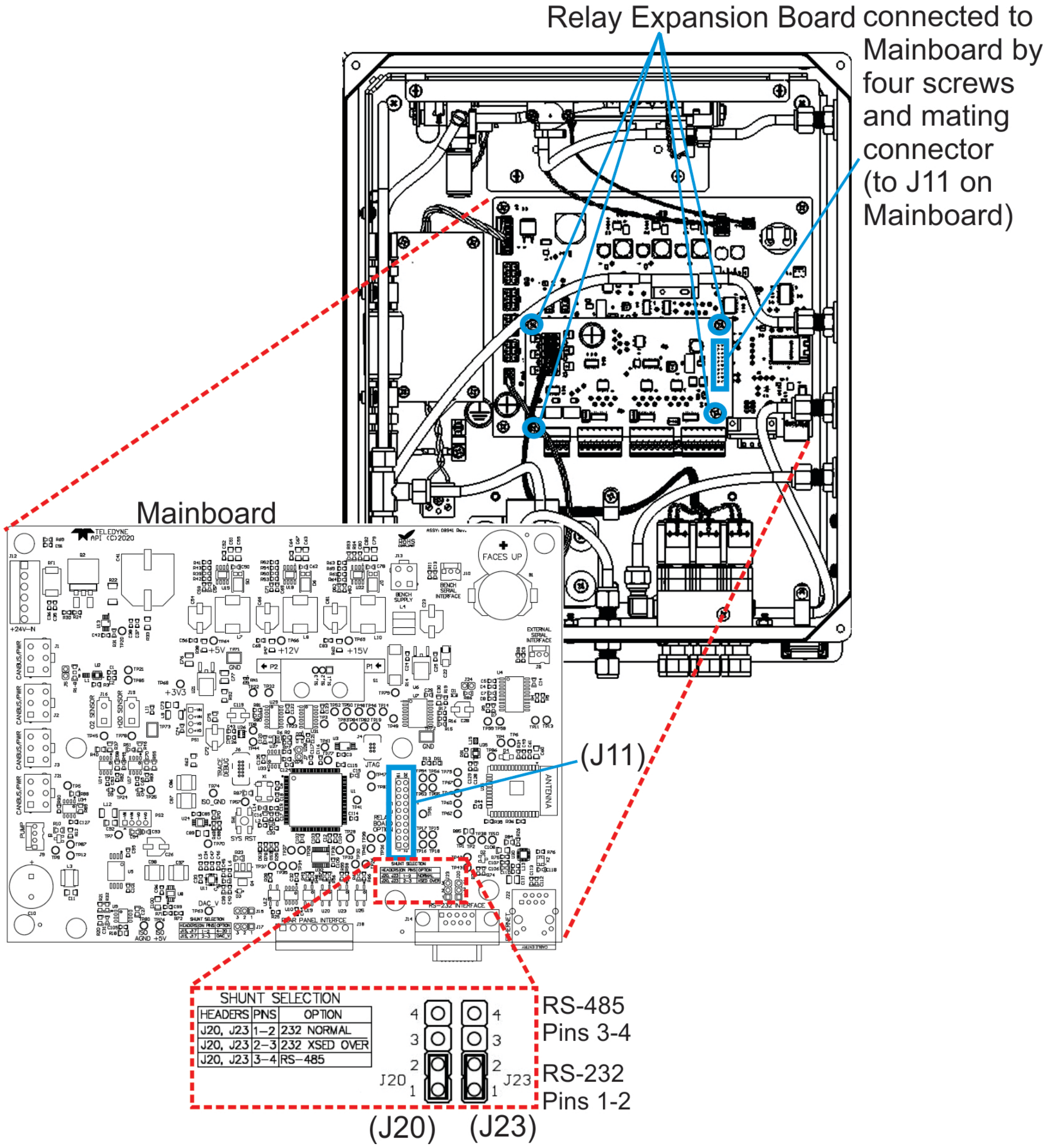

Figure 6-1. RS-232/RS-485 Signal Configurations

6.3 MODBUS REGISTER MAPS

6.3.1 MODBUS COMMANDS SUPPORTED

Table 6-2 lists the MODBUS commands that are supported by the 480L. Note that the "Write" commands will only work with registers that are configured as Read/Write, see Section 6.3.4. The "Read" commands can be used with any register.

Table 6-2. Supported MODBUS Commands

MODBUS Function Code	Description
01	Read Coils
02	Read Discrete Inputs
03	Read Holding Registers
04	Read Input Registers
05	Write Single Coil
06	Write Single Register
15	Write Multiple Coils
16	Write Multiple Registers

Float Inverse data format:

IEEE-754 encoded 32 bit floating point values stored in 2 sequential registers as shown below:

Value Stored in Memory	Register 1	Register 2
0x12345678	0x5678	0x1234

6.3.2 NOTES ON MODBUS REGISTERS

Concentration values in the MODBUS registers are always expressed in units of PPB (parts-per-billion,) regardless of the concentration units setting of the monitor.

6.3.3 REAL-TIME CONCENTRATION AND STATUS REGISTERS (READ ONLY)

Input Registers (Read Only) Floating Point Input Registers (32-bit IEEE 754 format; read in highword, low-word order)				
Register Address	**Description**	**Tag Name**	**Data Type**	**# Bits**
0	Gas Flow (cc/min)	AI_SAMPLE_FLOW	Inverse Float(Double)	32
2	Sensor Reference Value (mV)	AI_REF_MV	Inverse Float(Double)	32
4	Sensor Measure Value (mV)	AI_MEAS_MV	Inverse Float(Double)	32
6	Sensor Pressure Value (psia)	AI_O3_CELL_PRESSURE	Inverse Float(Double)	32
8	Sensor Gas Temperature (K)	AI_CELL_TEMP	Inverse Float(Double)	32
10	Stream 1 Concentration (PPB)	STREAM_1_O3_CONC	Inverse Float(Double)	32
12	Stream 2 Concentration (PPB)	STREAM_2_O3_CONC	Inverse Float(Double)	32
14	Stream 3 Concentration (PPB)	STREAM_3_O3_CONC	Inverse Float(Double)	32
16	Stream 4 Concentration (PPB)	STREAM_4_O3_CONC	Inverse Float(Double)	32
18	Stream 5 Concentration (PPB)	STREAM_5_O3_CONC	Inverse Float(Double)	32
20	Stream 6 Concentration (PPB)	STREAM_6_O3_CONC	Inverse Float(Double)	32

Discrete Input Registers (Read Only)				
Register Address	**Description**	**Tag Name**	**Data Type**	**# Bits**
0	Stream 1 HI Alarm Status, 1= ON	STREAM_1_HI_ALARM	Boolean	1
1	Stream 2 HI Alarm Status, 1= ON	STREAM_2_HI_ALARM	Boolean	1
2	4 Stream 3 HI Alarm Status, 1= ON	STREAM_3_HI_ALARM	Boolean	1
3	Stream 4 HI Alarm Status, 1= ON	STREAM_4_HI_ALARM	Boolean	1
4	Stream 5 HI Alarm Status, 1= ON	STREAM_5_HI_ALARM	Boolean	1
5	Stream 6 HI Alarm Status, 1= ON	STREAM_6_HI_ALARM	Boolean	1

Discrete Input Registers (Read Only)				
Register Address	Description	Tag Name	Data Type	# Bits
6	Stream 1 HI-HI Alarm Status, 1= ON	STREAM_1_HI_HI_ALARM	Boolean	1
7	Stream 2 HI-HI Alarm Status, 1= ON	STREAM_2_HI_HI_ALARM	Boolean	1
8	Stream 3 HI-HI Alarm Status, 1= ON	STREAM_3_HI_HI_ALARM	Boolean	1
9	Stream 4 HI-HI Alarm Status, 1= ON	STREAM_4_HI_HI_ALARM	Boolean	1
10	Stream 5 HI-HI Alarm Status, 1= ON	STREAM_5_HI_HI_ALARM	Boolean	1
11	Stream 6 HI-HI Alarm Status, 1= ON	STREAM_6_HI_HI_ALARM	Boolean	1
12	Stream 1 Active Status, 1= Sampling	STREAM_1_ACTIVE	Boolean	1
13	Stream 2 Active Status, 1= Sampling	STREAM_2_ACTIVE	Boolean	1
14	Stream 3 Active Status, 1= Sampling	STREAM_3_ACTIVE	Boolean	1
15	Stream 4 Active Status, 1= Sampling	STREAM_4_ACTIVE	Boolean	1
16	Stream 5 Active Status, 1= Sampling	STREAM_5_ACTIVE	Boolean	1
17	Stream 6 Active Status, 1= Sampling	STREAM_6_ACTIVE	Boolean	1

6.3.4 INSTRUMENT SETUP AND CONFIGURATION REGISTERS (READ / WRITE)

Coil Registers (Read/Write)				
Register Address	Description	Tag Name	Data Type	# Bits
0	Stream 1 Enable, 1=ON	STREAM_1_ENABLE	Boolean	1
1	Stream 2 Enable, 1=ON	STREAM_2_ENABLE	Boolean	1
2	Stream 3 Enable, 1=ON	STREAM_3_ENABLE	Boolean	1
3	Stream 4 Enable, 1=ON	STREAM_4_ENABLE	Boolean	1
4	Stream 5 Enable, 1=ON	STREAM_5_ENABLE	Boolean	1
5	Stream 6 Enable,	STREAM_6_ENABLE	Boolean	1

Coil Registers (Read/Write)				
Register Address	Description	Tag Name	Data Type	# Bits
	1=ON			
6	Stream 1 HI Alarm Enable, 1=ON	STREAM_1_HI_ALARM_ENABLE	Boolean	1
7	Stream 2 HI Alarm Enable, 1=ON	STREAM_2_HI_ALARM_ENABLE	Boolean	1
8	Stream 3 HI Alarm Enable, 1=ON	STREAM_3_HI_ALARM_ENABLE	Boolean	1
9	Stream 4 HI Alarm Enable, 1=ON	STREAM_4_HI_ALARM_ENABLE	Boolean	1
10	Stream 5 HI Alarm Enable, 1=ON	STREAM_5_HI_ALARM_ENABLE	Boolean	1
11	Stream 6 HI Alarm Enable, 1=ON	STREAM_6_HI_ALARM_ENABLE	Boolean	1
12	Stream 1 HI-HI Alarm Enable, 1=ON	STREAM_1_HI_HI_ALARM_ENABLE	Boolean	1
13	Stream 2 HI-HI Alarm Enable, 1=ON	STREAM_2_HI_HI_ALARM_ENABLE	Boolean	1
14	Stream 3 HI-HI Alarm Enable, 1=ON	STREAM_3_HI_HI_ALARM_ENABLE	Boolean	1
15	Stream 4 HI-HI Alarm Enable, 1=ON	STREAM_4_HI_HI_ALARM_ENABLE	Boolean	1
16	Stream 5 HI-HI Alarm Enable, 1=ON	STREAM_5_HI_HI_ALARM_ENABLE	Boolean	1
17	Stream 6 HI-HI Alarm Enable, 1=ON	STREAM_6_HI_HI_ALARM_ENABLE	Boolean	1
18	Alarm Latch Mode, 1= Latching, 0= Non-Latching	ALARM_MODE	Boolean	1

Holding Registers (Read/Write)				
Register Address	Description	Tag Name	Data Type	# Bits
0	Stream 1 Monitoring Duration	STREAM_1_DURATION	Integer	32
2	Stream 2 Monitoring Duration	STREAM_2_DURATION	Integer	32
4	Stream 3 Monitoring Duration	STREAM_3_DURATION	Integer	32

Holding Registers (Read/Write)				
Register Address	**Description**	**Tag Name**	**Data Type**	**# Bits**
6	Stream 4 Monitoring Duration	STREAM_4_DURATION	Integer	32
8	Stream 5 Monitoring Duration	STREAM_5_DURATION	Integer	32
10	Stream 6 Monitoring Duration	STREAM_6_DURATION	Integer	32
12	Stream 1 HI Alarm Limit (PPB)	STREAM_1_HI_ALARM_SETPOINT	Inverse Float(Double)	32
14	Stream 2 HI Alarm Limit (PPB)	STREAM_2_HI_ALARM_SETPOINT	Inverse Float(Double)	32
16	Stream 3 HI Alarm Limit (PPB)	STREAM_3_HI_ALARM_SETPOINT	Inverse Float(Double)	32
18	Stream 4 HI Alarm Limit (PPB)	STREAM_4_HI_ALARM_SETPOINT	Inverse Float(Double)	32
20	Stream 5 HI Alarm Limit (PPB)	STREAM_5_HI_ALARM_SETPOINT	Inverse Float(Double)	32
22	Stream 6 HI Alarm Limit (PPB)	STREAM_6_HI_ALARM_SETPOINT	Inverse Float(Double)	32
24	Stream 1 HI-HI Alarm Limit (PPB)	STREAM_1_HI_HI_ALARM_SETPOINT	Inverse Float(Double)	32
26	Stream 2 HI-HI Alarm Limit (PPB)	STREAM_2_HI_HI_ALARM_SETPOINT	Inverse Float(Double)	32
28	Stream 3 HI-HI Alarm Limit (PPB)	STREAM_3_HI_HI_ALARM_SETPOINT	Inverse Float(Double)	32
30	Stream 4 HI-HI Alarm Limit (PPB)	STREAM_4_HI_HI_ALARM_SETPOINT	Inverse Float(Double)	32
32	Stream 5 HI-HI Alarm Limit (PPB)	STREAM_5_HI_HI_ALARM_SETPOINT	Inverse Float(Double)	32
34	Stream 6 HI-HI Alarm Limit (PPB)	STREAM_6_HI_HI_ALARM_SETPOINT	Inverse Float(Double)	32
36	Stream 1 Analog Range (PPB)	STREAM_1_RANG	Inverse Float(Double)	32
38	Stream 2 Analog Range (PPB)	STREAM_2_RANG	Inverse Float(Double)	32
40	Stream 3 Analog Range (PPB)	STREAM_3_RANG	Inverse Float(Double)	32
42	Stream 4 Analog Range (PPB)	STREAM_4_RANG	Inverse Float(Double)	32
44	Stream 5 Analog Range (PPB)	STREAM_5_RANG	Inverse Float(Double)	32
46	Stream 6 Analog Range (PPB)	STREAM_6_RANG	Inverse Float(Double)	32

7. MAINTENANCE AND ADJUSTMENTS

WARNING – ELECTRICAL SHOCK HAZARD

The operations outlined in this section are to be performed by qualified maintenance personnel only!

CAUTION – RISK OF PERSONAL INJURY: HAZARDOUS GAS

Prior to opening the front panel for service of any kind, ensure first that the area is well-ventilated before slowly opening the panel and allowing gradual dissipation of any HAZARDOUS GAS that may have accumulated within the enclosure.

CAUTION – RISK OF PERSONAL INJURY: UV RADIATION

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

7.1 MAINTENANCE SCHEDULE

Table 7-1 below outlines the suggested maintenance procedures and intervals for ensuring the 480L continues to operate accurately and reliably. These intervals are based on continuous (24 hours a day – 7 days a week) operation. These intervals may be lengthened for intermittent operation.

Table 7-1. Maintenance Schedule

Maintenance Item	Recommended Interval	Section
Replace internal particulate filter	6 months[1]	7.3
Adjust UV LED	As Indicated by UV Lamp Status or Sensor Error messages	7.6
Replace UV LED	When adjustment can no longer be effective.	7.7
Replace sample pump	If either the flow setpoint can't be met or the pump stops working.	7.4
Replace Sensor Module Valve	2 years	7.5

[1] When external sample line pre-filters are used. If pre-filters are not used, internal sample filter should be replaced every month.

7.2 INSTRUMENT LAYOUT

WARNING – ELECTRICAL SHOCK HAZARD

High voltage may be present when power is connected to the instrument.

Figure 7-1 shows the internal layout of the 480L as reference in the procedures that follow.

Note the locations of the Power Supply and the Electrical Terminal Block where high voltage (line voltage) may be present when power is connected to the instrument.

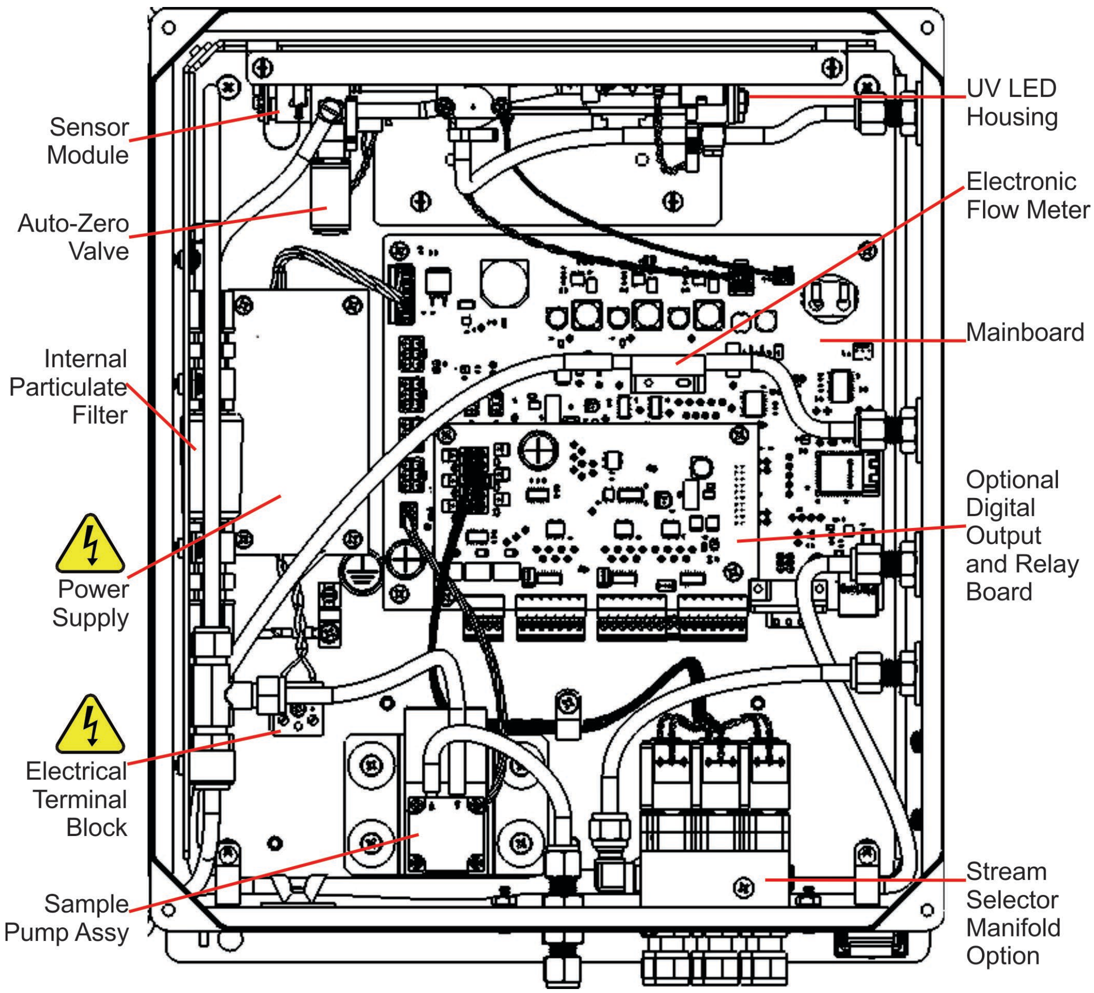

Figure 7-1. Internal Layout, NEMA Configuration

7.3 INTERNAL PARTICULATE FILTER REPLACEMENT

1. Disconnect power from the monitor.
2. Open front panel.
3. Locate the internal particulate filter (see Figure 7-1 above). Un-strap the filter from the two plastic hold-down clamps. Note the arrow on the filter showing flow direction.
4. Loosen the two nuts holding the filter into the two union fittings.
5. Install the nuts on the new filter. *Hand-tighten until snug; do not use tools*.
6. Re-strap the filter in place with the flow-direction arrow oriented as found in Step 3.
7. Reconnect power.

7.4 SAMPLE PUMP REPLACEMENT

1. Disconnect power from the monitor.
2. Open front panel and locate sample pump assembly (See Figure 7-1).
3. Unplug the pump power connector from the mainboard PCA at connector J9 (Figure 7-2).
4. Keeping track of which tubing is connected to inlet and outlet, remove clamps (or ties) that hold tubing to pump nipples, and remove tubing.
5. Remove the four screws attaching the sample pump assembly to the chassis.
6. Turn over pump assembly and remove the two screws holding the sheet-metal base to the pump.
7. Install the base on the new pump.
8. Install new pump assembly back into chassis.
9. Reconnect tubing; note that outlet fitting of pump should be connected to tubing routed to the EXHAUST fitting.
10. Re-install new tubing clamps or cable-ties to secure tubing connections.

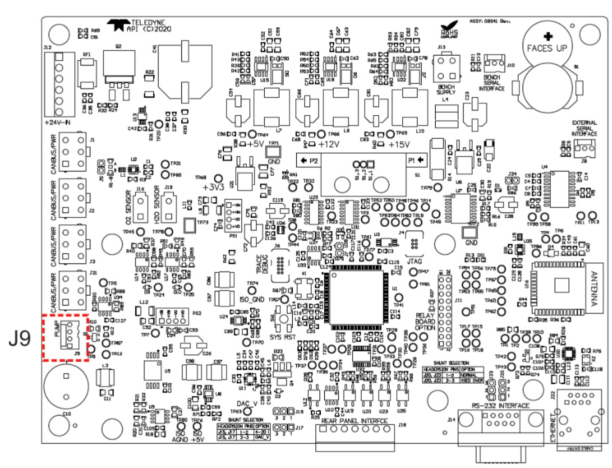

Figure 7-2. J9 Pump Connector on Mainboard

7.5 SENSOR VALVE REPLACEMENT

1. Disconnect power from the 480L.
2. Open front panel and locate sensor module assembly (Figure 7-1).
3. Noting the orientation of the valve, unplug the two-pin valve connector from the sensor PCA.
4. Remove the silver retainer clip from the top of the valve. A pair of pliers may be used to slide off the retainer clip.
5. The valve coil can now be removed by sliding upwards.
6. Remove the two (2) mounting screws using a #2 Phillips screwdriver. See Figure 7-3. Note that there are four screw heads visible on the top of the valve body, only two (2) of these should be removed.
7. Remove valve body from sensor manifold.
8. Clean any residue or dirt off the surface of the manifold using a lint-free cloth and distilled or DI water.
9. Install the new valve by reversing steps 1-7. Note the proper orientation of the new valve as noted in Step 3 above.

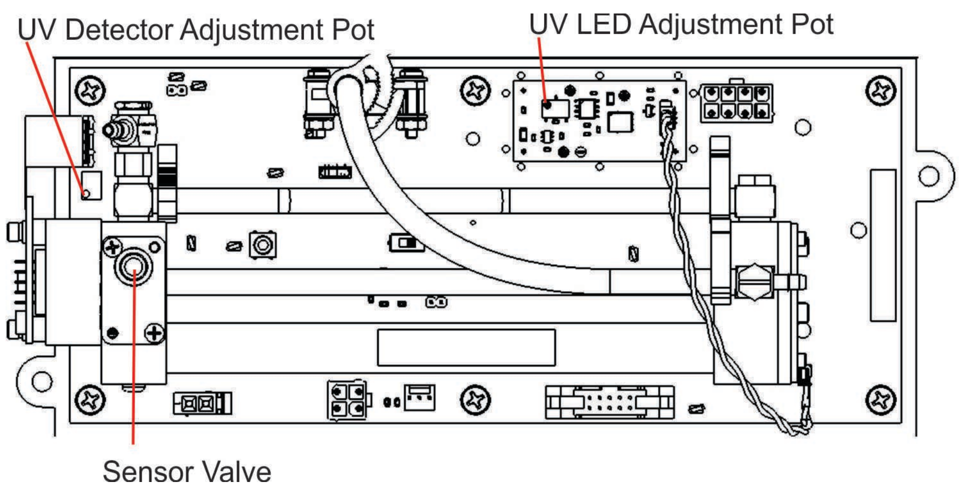

Figure 7-3. Sensor Valve Location

7.6 UV LED ADJUSTMENT

1. Instrument should be running and warmed up for at least 20 minutes.
2. With instrument running, open the front panel
3. Navigate to the front panel menu SENSOR menu and scroll to REF display You should see “REF = XXXX MV.”
4. Locate the UV Detector adjustment pot on the forward end of the sensor module (see Figure 7-3). While observing the REF value on the display, slowly turn the pot to adjust the value. The target adjustment range is as high as possible within the range of 800 – 1150 mV.
5. If the required REF value cannot be achieved by adjusting the UV Detector pot alone, the UV LED intensity can be adjusted using the UV LED adjustment pot

(Figure 7-3). Slowly turn the pot and observe the REF value on the display. The target adjustment range is as high as possible within the range of 800-1150 mV.

6. Close front panel and observe REF value on display for a couple minutes to verify that it does not drift out of the adjustment range.

7.7 UV LED REPLACEMENT

The UV LED can be replaced by disconnecting the power cable from the sensor module's LED housing and removing the two larger socket head screws (Figure 7-4) to remove/replace the LED. After installing and securing the replacement UV LED PCA assembly, it is recommended to perform a Zero Cal (see section 5.2.3.2).

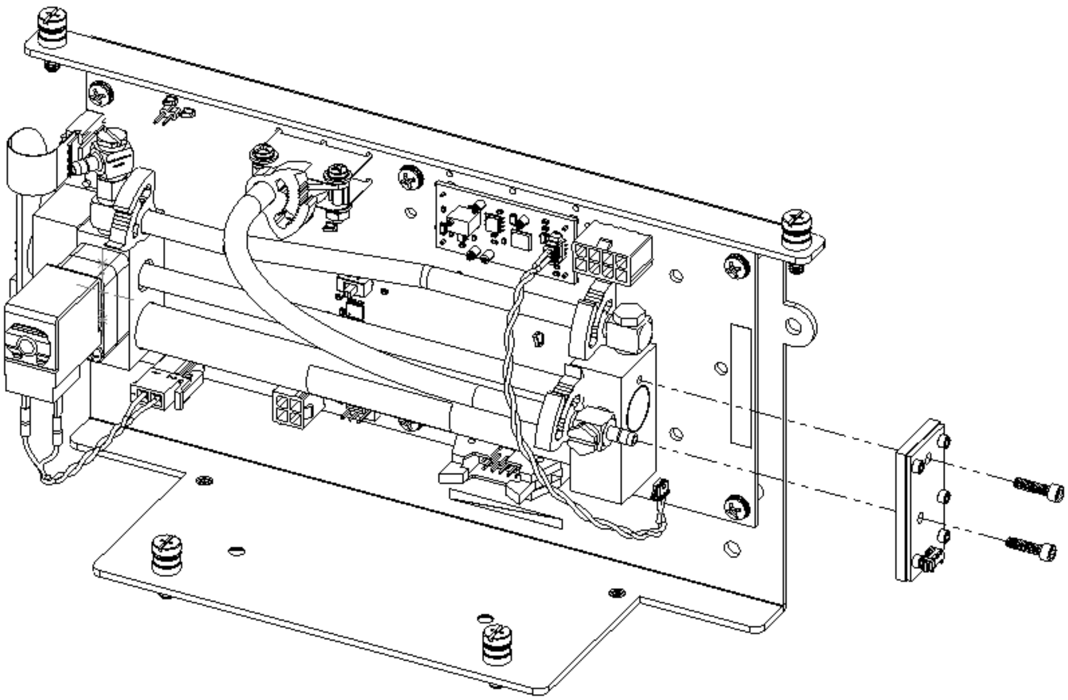

Figure 7-4. UV LED Access

7.8 SENSOR MODULE REPLACEMENT

The module can be replaced by first disconnecting the electronic connectors from the sensor PCA that run to J13 (Bench Supply) and J10 (Bench Serial Interface) on the Mainboard, and by disconnecting the pneumatic tubing at the sample filter and at the input to the scrubber. Then remove the four large socket head screws (Figure 7-5) that hold the mounting bracket in place. Do the reverse to install the replacement module.

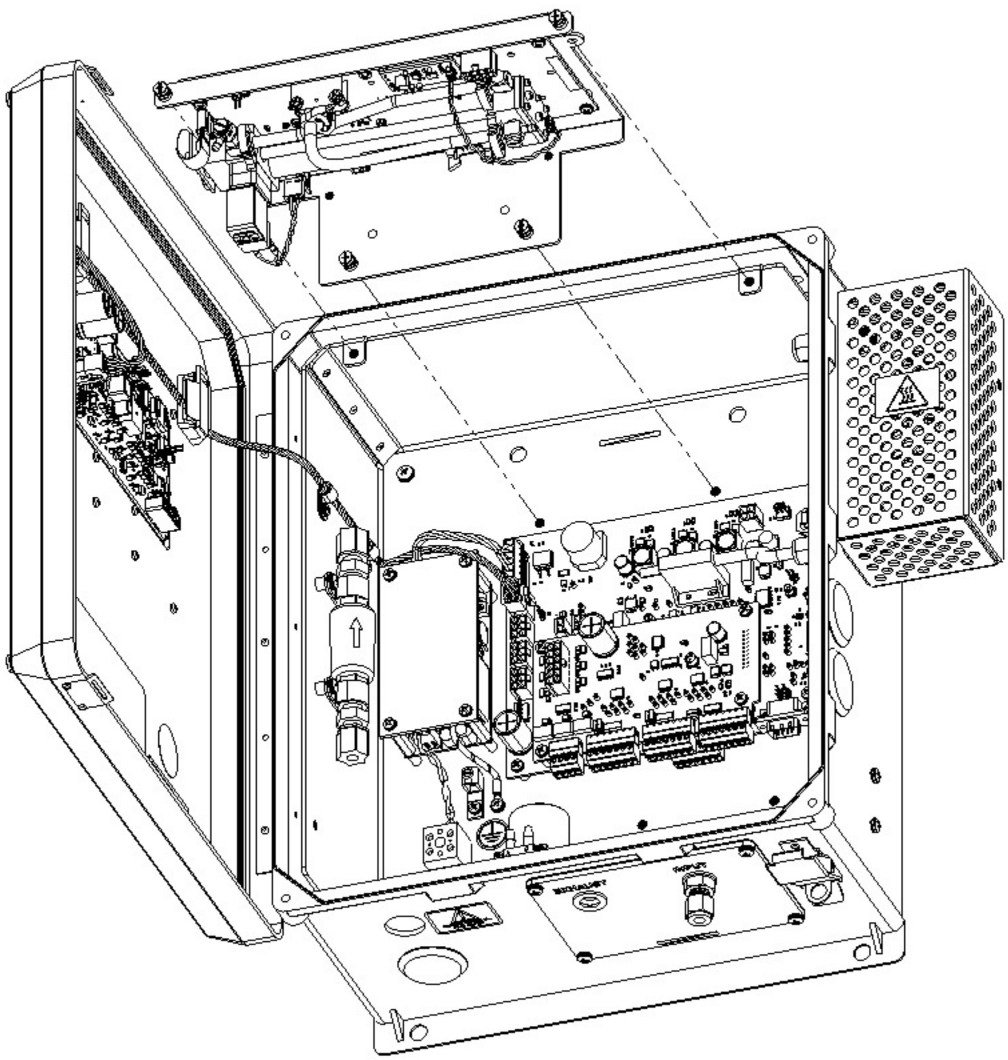

Figure 7-5. Sensor Module Removal

7.9 DISPLAY ASSEMBLY REPLACEMENT

In the event that the front panel display assembly requires replacement due to damage caused by wear and tear or aging, these procedures provide instructions for its careful removal and replacement. This is especially important if there is any damage to the mask, compromising the seal and allowing moisture or other matter to infiltrate the enclosure.

Refer to Figure 7-6 for for the following procedures:

1. Disconnect power from the instrument using proper lockout/tagout procedures per site requirements, and carefully open enclosure panel per cautionary message at start of this Maintenance and Adjustments section.
2. Detach the display cable from the mainboard (pinouts for all four connectors are the same, so placement doesn't matter).
3. Free the display cable from the securing clips.
4. Carefully remove the EMI core from the enclosure and remove any remaining adhesive from the door.
5. Using a Star T10 screwdriver, remove the screws securing the display bezel to the door.
6. Discard the old display bezel with cable per local regulations for electronic waste.
7. Ensure gasket is located in the outer groove of the replacement bezel.
8. String the replacement bezel's display cable through the open window while aligning the bezel with the screw holes on the enclosure door, and start each screw by a few turns.
9. Once all the screws are started, apply a sequence-based tightening pattern to ensure even preload distribution so that the gasket gets equal compression on all sides, until the bezel is completely flush to the door.
10. Route the display cable through the plastic retainers, locating the ferrite core in the center of the display.
11. Remove the tape backing from the ferrite core and press the ferrite core onto the door until well bonded.
12. Plug the display cable into the mainboard.

13. Power up the instrument and confirm that the display and control keys are functioning properly.

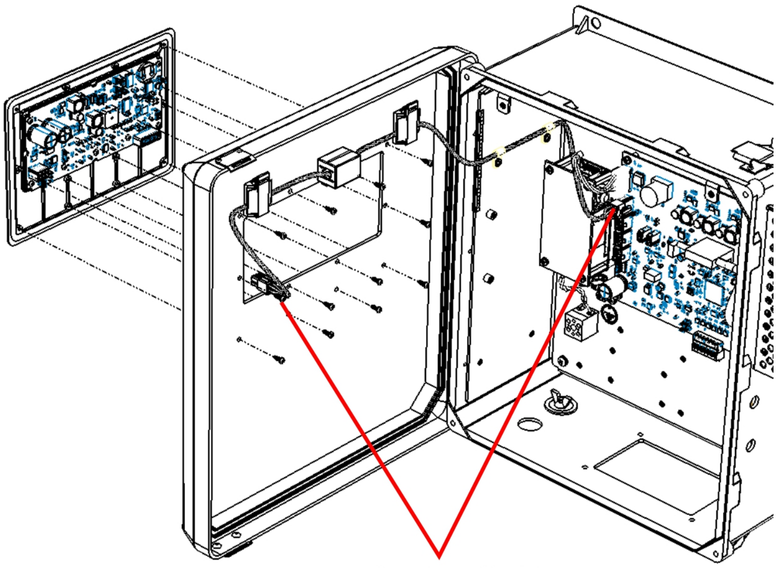

Figure 7-6. Display Assembly Removal

7.10 CLEANING EXTERIOR SURFACES

If necessary, the front panel mask and keyboard can be cleaned with a damp cloth. Do not attempt to clean any of the other surfaces of the instrument. Do not submerge any part of the instrument in water or cleaning solution.

7.11 REMOVING/INSTALLING RELAY EXPANSION BOARD

If the Relay Expansion Board option is installed, it must be removed in order to access the configuration pins for configuring either Analog output (Figure 3-5) or Serial communications (Figure 6-1).

1. Power off the instrument.
2. Locate the relay expansion board (Figure 3-5 or Figure 6-1), and remove the four screws.
3. Disconnect the relay expansion board pins from the Mainboard J11 connector (keyed for correct board alignment).
4. Lift the relay expansion board from the expansion posts to make adequate room to access the shunt selection for both the Analog (J15-J17) and the Serial Communication (J20, J23) jumper pins.
5. Replace the expansion board by aligning the pins to the J11 connector. The connector is keyed to help with correctly lining up the pins, carefully engage the pins and press down the relay board.
6. Secure the board in place by re-installing the same four (#6-32x3/8”) screws into the expansion posts.

8. TROUBLESHOOTING

WARNING – ELECTRICAL SHOCK HAZARD

The operations outlined in this section are to be performed by qualified maintenance personnel only!

8.1 REFERENCE DRAWINGS

There are several illustrations throughout this manual that can be used for reference when performing some of the troubleshooting activities. The flow diagram is located in Section 3.6 for additional reference if needed.

8.2 TROUBLESHOOTING WITH FRONT PANEL STATUS LED AND DETAILS OR STATUS OUTPUTS

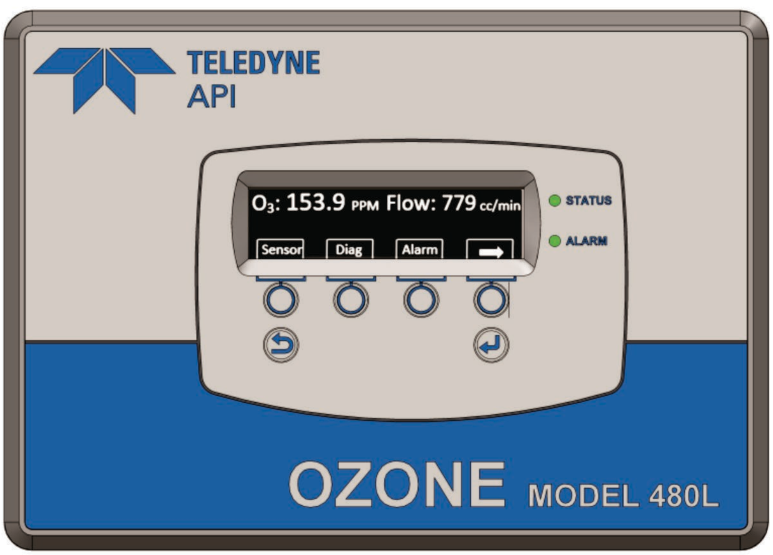

Figure 8-1. Display and Control Panel

The status LED on the front panel reflects the current operating status of the monitor and indicates fault conditionsSee Section 3.4.1.1 for more information on the Status Outputs.

The status details and outputs are categorized into Critical and Non-Critical warnings. Critical warnings are those that would normally require immediately removing the monitor from service and repairing it. Non-critical warnings are those that indicate some maintenance would be useful, but not immediately required. If the front panel LED indicates a status issue, details can be viewed in the STATUS menu from the Home Screen.

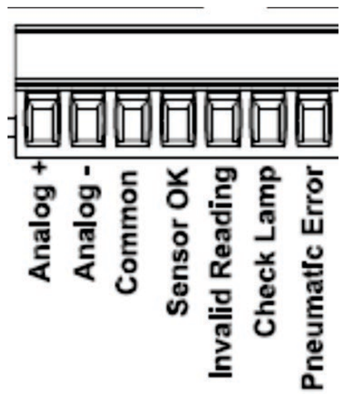

Figure 8-2. Status Outputs

Table 8-1. Status LED/Output Definitions

<table>
<tr><th>Status Output #</th><th>Status output name</th><th>Front Panel LED state</th><th>Status output state</th><th>Triggers</th><th>Critical Warning?</th></tr>
<tr><td>1</td><td>Sensor OK</td><td>Red</td><td>Open</td><td>No bench communications
Reference < 125.0 mV
Measure > 1230.0 mV</td><td>Yes</td></tr>
<tr><td>2</td><td>Invalid Reading</td><td>Yellow</td><td>Closed</td><td>O_3 Concentration is too low
<table><tr><td>Units</td><td colspan="2">O_3 Concentration</td></tr><tr><td>PPB</td><td><</td><td>-30</td></tr><tr><td>PPM</td><td><</td><td>-5</td></tr><tr><td>PPHM</td><td><</td><td>-15</td></tr><tr><td>µg/m³</td><td><</td><td>0.25</td></tr></table>O_3 Concentration > Stream Range, dependent on active Stream</td><td>No</td></tr>
<tr><td>3</td><td>Check Lamp</td><td>Yellow</td><td>Closed</td><td>Reference < 250.0 mV OR
Reference < 125.0 mV OR
Measure >1230.0 mV</td><td>No</td></tr>
<tr><td>4</td><td>Pneumatic Error</td><td>Yellow</td><td>Closed</td><td>Pressure < 9.0 psia
Pressure > 14.9 psia
Flow <500cc/min
Flow > 1100 cc/min</td><td>No</td></tr>
</table>

8.2.1 SENSOR OK

The Sensor OK status indicates the status of the O_3 sensor module in the monitor. The normal state of this report in the status area of the display is OK and the output signal will be open. If this error is triggered, the signal is opened, and the status area will read ERROR.

The most common cause of this warning is a failure of the UV LED A UV LED adjustment (Section 7.6) should be attempted. If the UV LED cannot be adjusted to meet the specified values, then a UV LED replacement should be performed (Section 7.7).

This warning can also be caused by a communications error with the sensor module. Inspect the two cables between the Mainboard PCA and Sensor Module for loose or intermittent connections (See Figure 7-1 for monitor layout). If no cable problem can be found, then the Sensor Module should be replaced.

8.2.2 INVALID READING

The Invalid Reading status area indicates that the instrument is reading a value that cannot be represented properly on the analog output. Since the analog output is limited to 0-5V (or 4-20mA), it cannot properly represent negative values, or values in excess of the full-scale range. If this error is triggered, the signal is closed, and the status area will read ERROR.

If the monitor is consistently reading negative values, then a zero calibration should be performed, see Section 5.2.3.2.

If the monitor is consistently reading values in excess of the full-scale range, then the range value should be adjusted higher. See Section 5.2.4.1 for details on setting the range value.

8.2.3 CHECK LAMP

The Check Lamp status indicates that the UV LED intensity has dropped below 250mV, a level where UV LED adjustment (Section 7.6) should be made at the next convenient opportunity. Note that this is a non-critical warning and immediate service is not required. However, if the UV LED intensity drops below 125mV, then the Sensor OK status will show an ERROR and the monitor must be immediately serviced (Section 7.7) or taken off-line.

8.2.4 PNEUMATIC ERROR

The Pneumatic Error status indicates that one of the pneumatic parameters, flow or pressure, has gone outside of normal ranges. Note that this is a non-critical warning and immediate service is not required. If this error is triggered, the signal is closed, and the status area will read ERROR. However, if the Sensor OK state changes to ERROR then the monitor must be immediately serviced or taken offline.

The first step in troubleshooting a Pneumatic Error is determining which parameter has caused the warning. From the Sensor menu area, view the Flow and Pressure value, compare them to the allowable limits described in Table 8-1 and take appropriate action as described below.

8.2.4.1 PRESSURE TOO HIGH

The monitor inlet is being pressurized. The monitor inlet should be allowed to sample gas at ambient pressure. Disconnect all sample lines from the monitor and read the pressure again. If the value then drops to within the acceptable range, then one of the sample lines is at elevated pressure.

If the inlet is being pressurized, then the design of the sample system should be reviewed and corrected. Contact Teledyne API Technical Support for assistance.

8.2.4.2 PRESSURE TOO LOW

Something may be restricting the flow through the monitor, causing the sample pump to pull a vacuum on the sensor module.

First, unplug the sample pump power plug, J9 on the Mainboard PCA (refer to Figure 7-1 for pump location and Figure 7-2 for connector location) and observe the pressure reading. If the pressure reading is still too low, then likely there is a problem with the pressure sensor on the Sensor Module and the Sensor Module should be replaced.

Next reconnect the pump and disconnect all sample lines from the monitor and see if the pressure increases to normal levels.

- If it does, then the problem is somewhere in the sampling system external to the monitor.
- If the pressure is still below the limit with the sample lines removed, then there is a restriction in the pneumatics of the monitor upstream of the sensor assembly. The most likely cause is a plugged particulate filter.
  - Disconnect the outlet fitting on the sample filter and observe the pressure. If it returns to normal levels, then the restriction is in the particulate filter or inlet manifold assembly (multi-stream configurations only). Replace particulate filter per Section 7.3.

8.3 TECHNICAL ASSISTANCE

If an issue persists, please call our Technical Support Department:

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

Phone (toll free): +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/

9. PRINCIPLES OF OPERATION

The detection of ozone molecules is based on absorption of 254 nm UV light due to an internal electronic resonance of the O_3 molecule. The monitor uses a UV LED constructed so that a large majority of the light emitted is at the 254nm wavelength. Light from the LED shines down a hollow quartz tube that is alternately filled with sample gas, then filled with gas scrubbed to remove ozone. The ratio of the intensity of light passing through the scrubbed gas to that of the sample forms a ratio I/I_O. This ratio forms the basis for the calculation of the ozone concentration.

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

$$C_{O_3} = -\frac{10^9}{\alpha \times \ell} \times \frac{T}{273K} \times \frac{29.92inHg}{P} \times ln\frac{I}{I_o}$$

Where:

I = Intensity of light passed through the sample

I_o = Intensity of light through sample free of ozone

α = absorption coefficient

ℓ = path length

C_{O_3} = concentration of ozone in ppb

T = sample temperature in Kelvin

P = pressure in inches of mercury

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

The intensity of light is converted into a voltage by a high resolution A/D (analog-to-digital) converter. The digitized signal and other variables are used by the CPU to compute the concentration using the above formula.

About every 2.5 seconds the monitor completes a measurement cycle consisting of a 1 second wait period for the sample tube to flush, followed by a 150 ms measurement of the UV light intensity to obtain I. The sample valve is switched to admit scrubbed sample gas for 1 second, followed by a 150 ms measurement of the UV light intensity to obtain I_O. Measurement of the I_O every 2.5 seconds eliminates instrument drift due to changing intensity of the LED caused by aging and dirt.

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

The Mainboard is the main hub, which not only contains the Central Processing Unit (CPU) that communicates with other modules, but also directs power and communication distribution.

The ozone sensor module consists of its own board controlled by a microprocessor that receives messages from and sends information to the Mainboard on the CAN network. It acts on the messages from the Mainboard, and it conducts local operations, such as activating valves or controlling manifold temperature.