



User Manual
Model 480H
OZONE MONITOR

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

NEVER use any combustible/explosive gas with this product!

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 produit doit être utilisé aux fins décrites et de la manière décrite dans ce manuel. Si vous utilisez cet produit 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 de gaz explosive ou combustible avec cet produit!

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.



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1. INTRODUCTION

Teledyne API's Model 480H Ozone Monitor measures high concentration ozone monitor that measures process ozone concentrations and is specifically optimized for applications in water treatment and in the medical, food, and beverage industries. This microprocessor-controlled instrument provides fast response times with minimal zero drift for accurate and stable readings, and it has built-in tests and diagnostics to allow maximum uptime.

We at Teledyne API will be 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 always available to answer your questions.

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2. SPECIFICATIONS AND AGENCY APPROVALS

2.1. MODEL 480H SPECIFICATIONS

PARAMETER	SPECIFICATION
Measuring Principle	UV absorption (Beer Lambert Law)
Ranges	0-5 WT% to 0-25 WT% 0-100 g/Nm ³ to 0-400 g/Nm ³
Measurement Units	WT%, g/Nm ³
Accuracy	± 1% of Full Scale
Precision/Repeatability	± 0.5% of Full Scale
Display Resolution	0.01 WT%, 0.1 g/Nm ³
Response Time (95%)	<30 seconds to 95%
Compensation	Pressure, Temperature (NTP = 273.15K, 760 mmHg)
Gas Inlet Pressure Range	3.0-30.0 psig
Sample Flow Rate	0.2-2.0 LPM
Humidity Range	10-90% RH, non-condensing
Temperature Range	5-45° C
Dimensions (H x W x D)	NEMA 4X – 17.35" x 15.96" x 6.80" (440.7 mm x 405.4 mm x 172.7 mm)
Weight	NEMA 4X – 17.6 lbs (8 kg)
Power	100-240 V~, 47-63 Hz, 74 W
Environmental	Installation Category II Pollution Degree 2 For Indoor/Outdoor Use Maximum Operating Altitude 2000 meters
Degree of Protection (NEMA enclosure)	IP65 (NEMA 4X)
Analog Output	0 – 5 V or 4-20 mA isolated output
Status Outputs	Sensor OK, Invalid Reading, Check Lamp, Pneumatic Error
High Current Relay Outputs	SPDT (Form C) Dry Contact, 250VAC, 5A (System OK, Global HI alarm, Global HI-HI alarm)
Communication Interface	Ethernet RS-232/RS-485

2.2. APPROVALS

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

2.2.1. SAFETY

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

2.2.2. EMC

IEC/EN 61326-1:2010, Class A Emissions/Industrial Immunity
FCC 47 CFR Part 15B, Class A Emissions

2.2.3. 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 480H Display and Control Panel

3.1. UNPACKING

Upon receiving the 480H 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 should be used to secure the monitor.
- If using bolts, ensure they are stainless steel, 5/16" (8 mm) diameter, capable of supporting 20 lbs each.

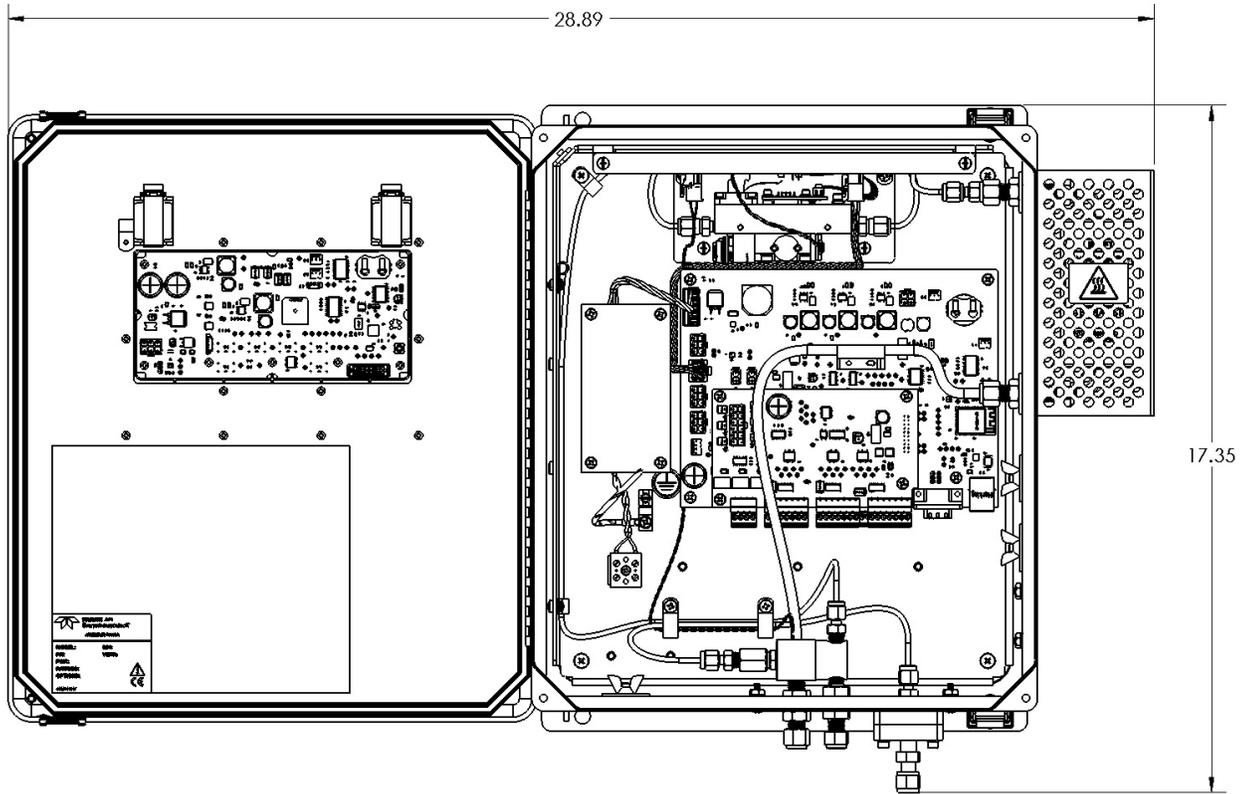


Figure 3-2. 480H Dimensions

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 receptacle labeled “Earth Ground” on the 3-pin AC connector. Failure to do so may result in a shock hazard and malfunction of the monitor.

3.3.1. WIRING REQUIREMENTS

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 (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

1. Install a ½” conduit fitting for routing the electrical wiring into the monitor through the hole provided in the bottom face of the NEMA enclosure; an appropriate sealed conduit connector should be used.
2. Hard-wire the electrical connection to the terminal block and grounding lug on the chassis. AC power connection to the monitor should be made with 12-14 AWG stranded 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.

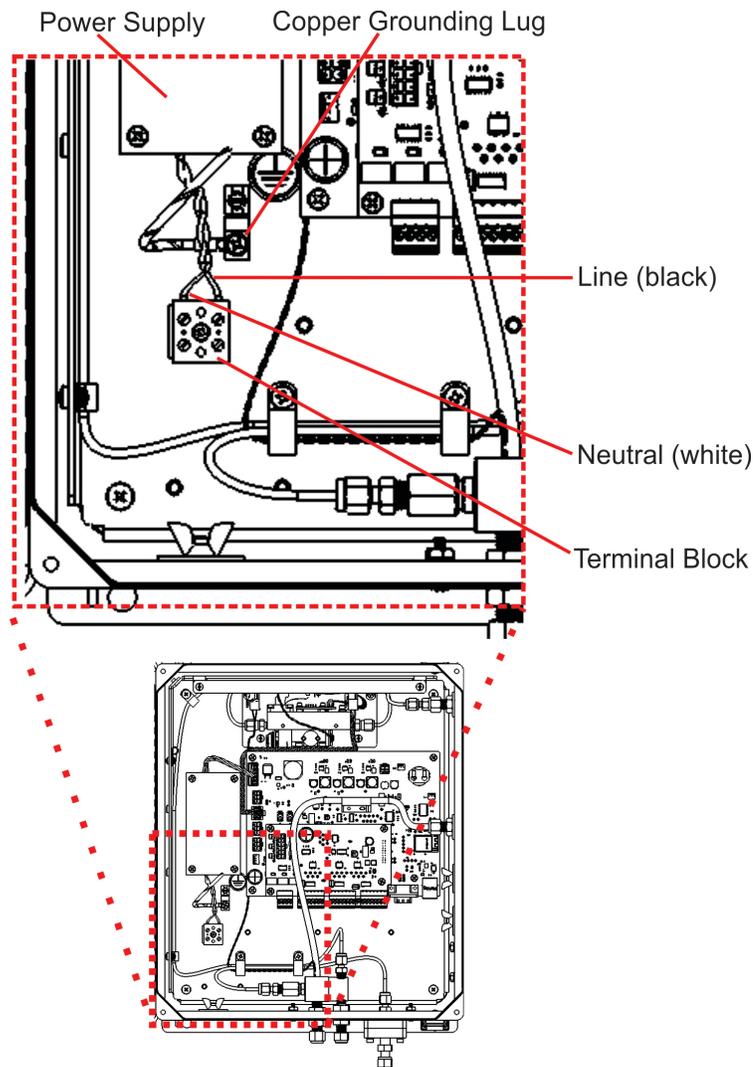


Figure 3-3. AC Power Connection to Monitor

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

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 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.

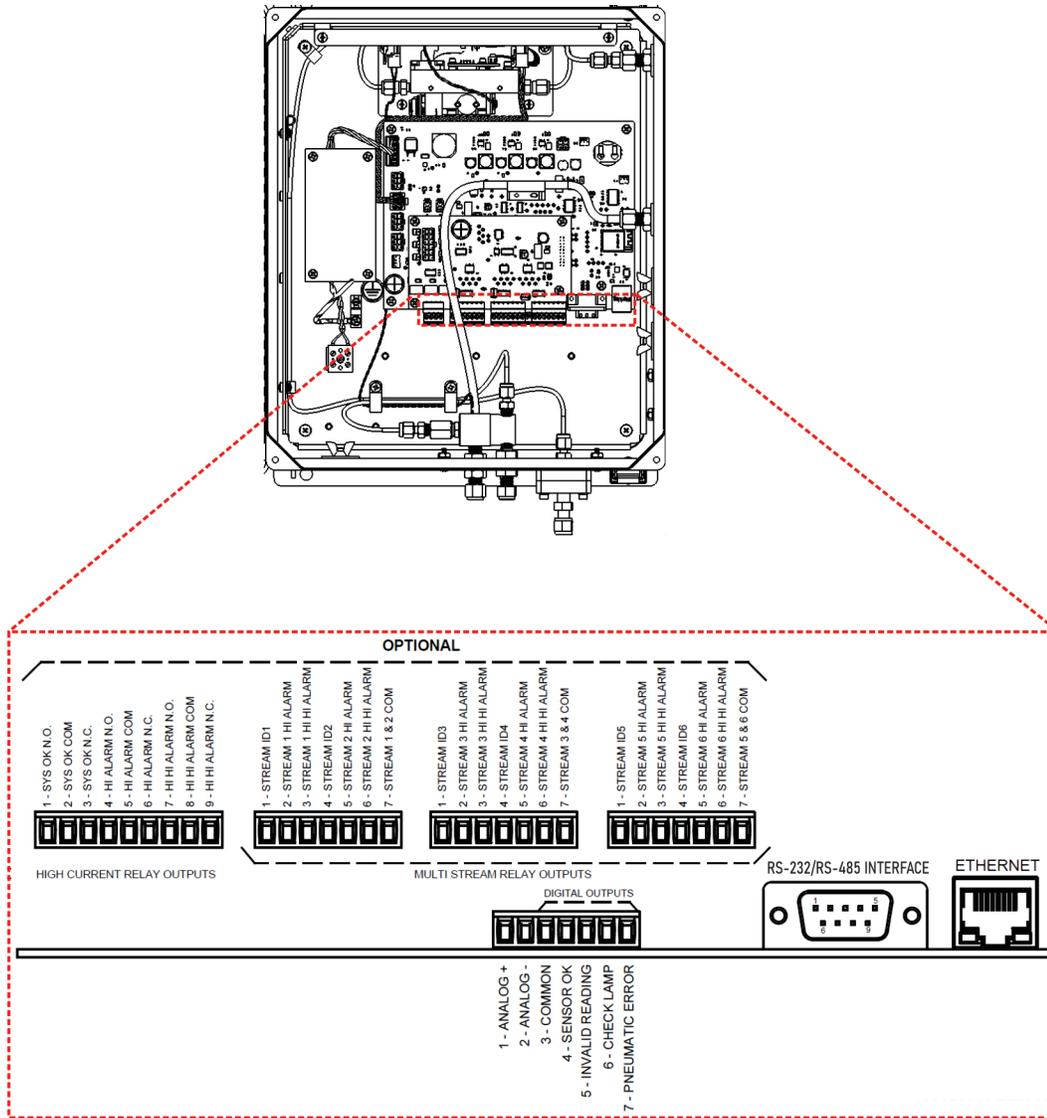


Figure 3-4. Interior Location of I/O Connectors

3.4.1. ANALOG OUTPUT

Refer to Figure 3-4 for the location of the analog output, which can be configured for 0-5V 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 5.2.4.2 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 (NEMA Configuration).
7. Reconnect power to the monitor.

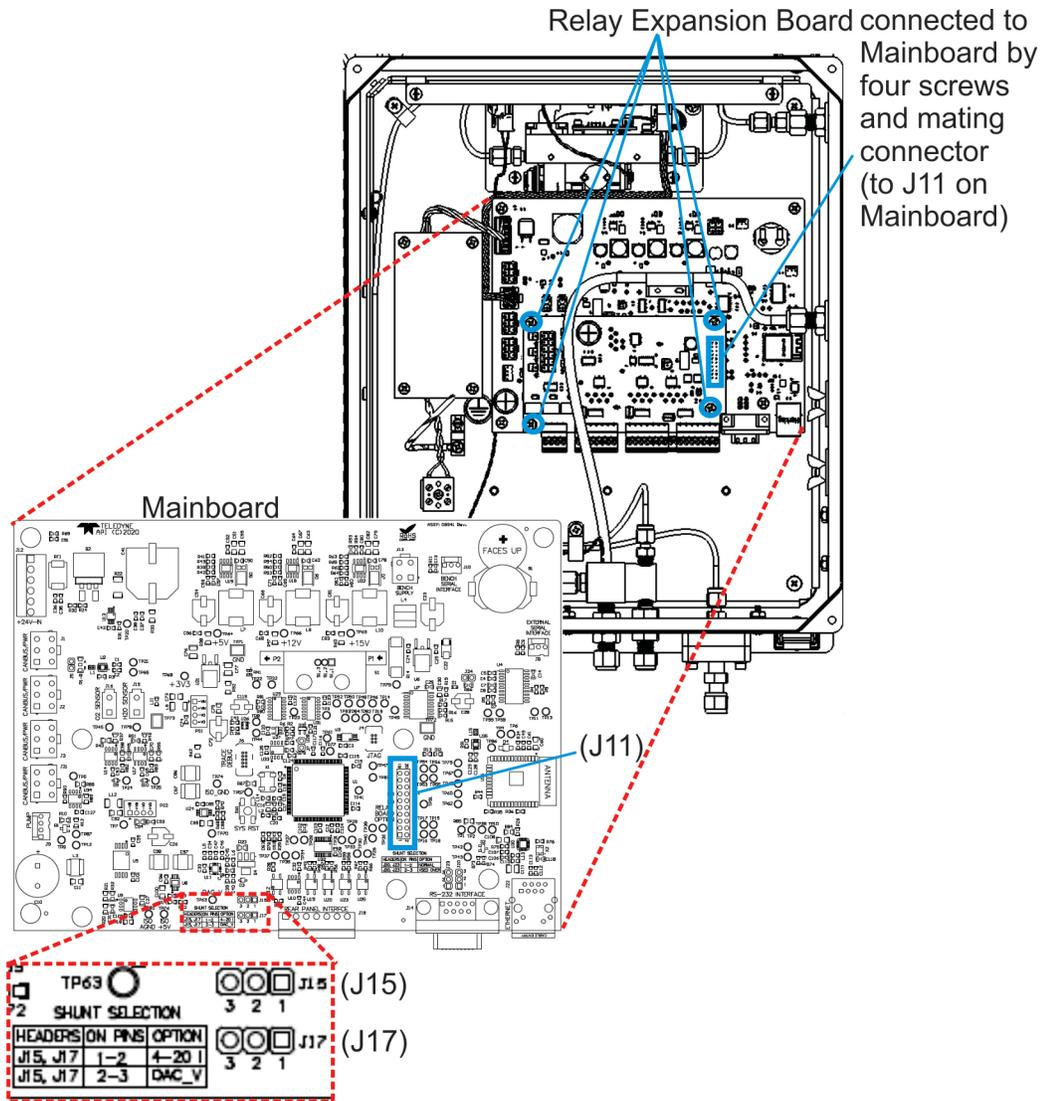


Figure 3-5. Mainboard – Analog Output Configuration

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 the values shown in the status area of the menu structure. They 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 State
Sensor OK	Active – Connected to ground
Invalid Reading	Inactive - Open resistance
Check Lamp	Inactive - Open resistance
Pneumatic Flow	Inactive - Open resistance

3.4.3. HI-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.

Table 3-2. Relay Functions for Single Stream Config

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

3.4.4. FAILSAFE OPERATION SIGNAL AND RELAY OUTPUTS

The digital Status outputs and Alarm relays can be configured using the Failsafe Operation variable (VAR) found in the Display 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.

Additionally, when the Failsafe is ON, the Alarm relays, HI Alarm and HI-HI Alarm behave the same as the System OK relay. In that, the normal operating state, the relay coils are energized and the (NO) contact closes.

Table 3-5. Status Output Definitions - Fail Safe Operation ON, No Error State Detected

Status Output	Failsafe Operating State Transistor Status
Sensor OK *	Active
Invalid Reading	Active
Check Lamp	Active
Pneumatic Error	Active

* Failsafe does not change System OK behavior.

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

Relay #	Function	Fail Safe Operating State
1	System OK *	Energized
2	Hi Alarm	Energized
3	Hi-Hi Alarm	Energized

* Failsafe does not change System OK behavior.

3.4.5. DIGITAL COMMUNICATION INTERFACES

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

3.4.5.1 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).

3.4.5.2 SERIAL: RS-232 OR RS-485

For Serialcommunication, 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

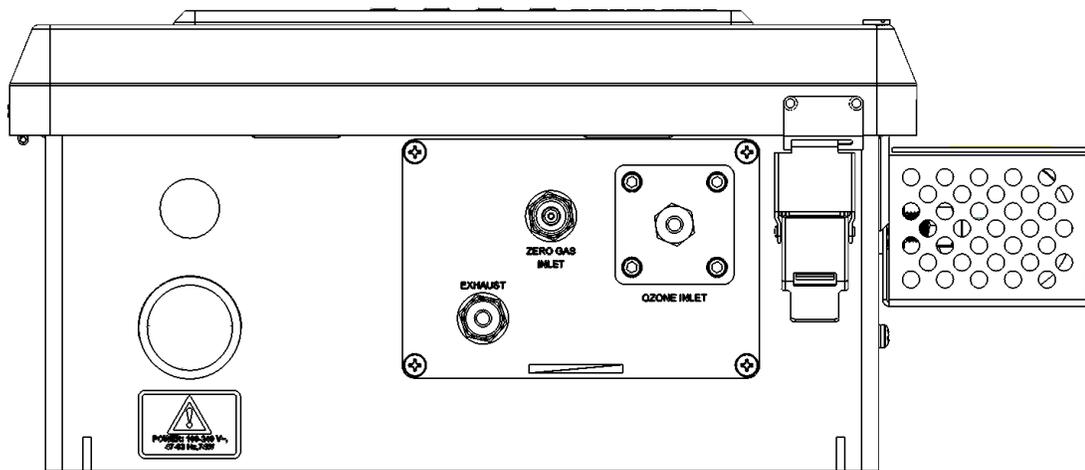


Figure 3-6. Pneumatic Connections

3.5.1. INSTALLING FLOW CONTROL ASSEMBLIES

Two (2) Flow Control assemblies are supplied separately from the monitor, these are used to control the flow into the monitor. These Flow Control Assemblies will supply a fixed flow into the monitor that is dependent on gas supply pressure.

Alternately, customer supplied needle valves can be used in place of these Flow Control Assemblies if an adjustable flow control is desired. Use only needle valves that are constructed of materials compatible with high concentrations of ozone, such as stainless steel and Teflon.

Attach the Flow Control Assemblies by screwing them onto the threaded fittings of the ozone inlet and the zero gas inlet.

- Hand-tighten orifice assemblies until snug.
- With a 9/16" open-end wrench, tighten each orifice assembly 1/8–1/4 turn. Use a 1/2" back-up wrench to anchor the fittings of the zero gas and ozone inlet ports in place.
- Do not over tighten the fittings.

3.5.2. OZONE INLET CONNECTION

Connect the ozone delivery line to the Flow Control Assembly (See Section 3.5.1) on the “Ozone Inlet” on the bottom face of the enclosure (See Figure 3-6). The ozone delivery should be regulated between 5-30 psig.

1/4" O.D. FEP (Teflon™) or Stainless Steel tubing is recommended to connect the sample source to the monitor. Any fittings used in the sample lines should also be constructed of Stainless Steel.

A Flow Control assembly is provided with the monitor, see Section 3.5.1.

3.5.3. ZERO GAS INLET CONNECTION

Connect the oxygen or other dry zero gas sources to the to the Flow Control Assembly (See Section 3.5.1) on the ‘Zero Gas Inlet.’ Zero Gas supply pressure should be regulated between 5 and 30 psig.

3.5.4. EXHAUST CONNECTION



CAUTION – Risk of Personal Injury or Death

DO NOT vent the exhaust gas into any enclosed or occupied area. Exhaust gas from the monitor may contain dangerous levels of ozone!

Connect a ¼” OD vent line to the “Exhaust” fitting on the outside bottom panel. 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 as described above.

3.6. PNEUMATIC FLOW DIAGRAM

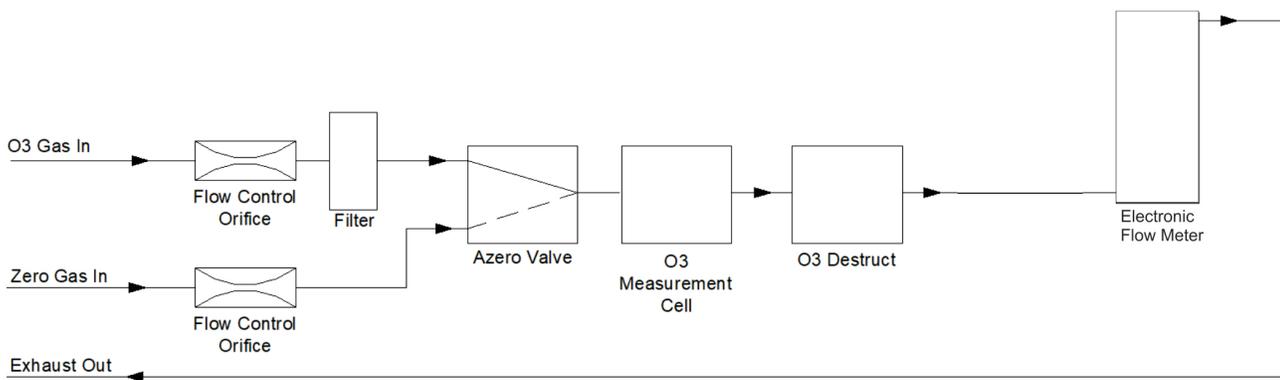


Figure 3-7. Pneumatic Diagram

4. CALIBRATION

Calibrations are an important part of maintaining accuracy.

4.1. FACTORY CALIBRATION

The monitor is calibrated to internal TAPI calibration standards prior to shipment. A calibration certificate for your instrument can be purchased from Teledyne API if required. Teledyne API also recommends that the monitor be re-calibrated once a year. Teledyne API can provide NIST traceable calibration services at our factory or on-site. Please contact Technical Support for details on these services (see Section 8.2.4.2).

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.

5. OPERATION

Connect the power cord to an appropriate power outlet or hardwired connection (see the serial number tag for correct voltage and frequency). The monitor (NEMA configuration) turns on when power is applied. 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.

5.1. FRONT PANEL OVERVIEW

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

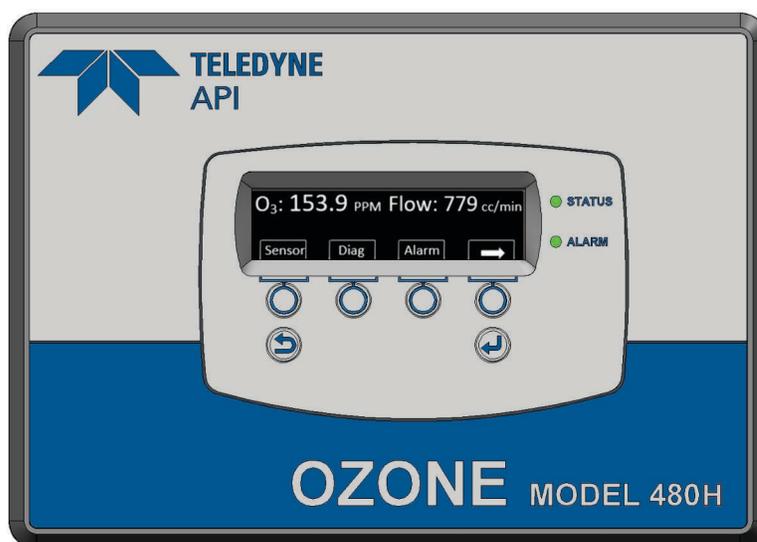


Figure 5-1. Front Panel Display and Controls

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.

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.

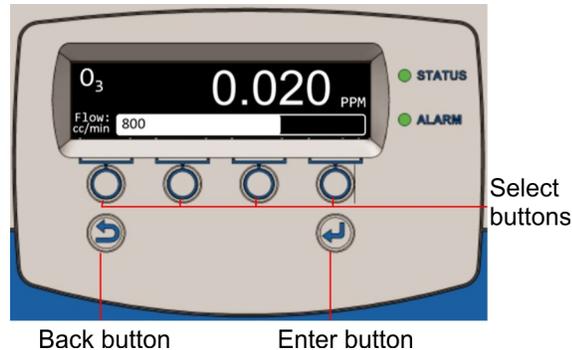


Figure 5-2. Front Panel Selection and Control Buttons

-  **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 Home Screen.

5.1.3. INDICATOR LEDES

 **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 the ALARM LED is off. When lit red, an alarm has been triggered and the display immediately switches to the Alarm screen and a table which shows by a solid filled radio button whether there is a Hi Alarm or a Hi Hi Alarm.

5.2. FRONT PANEL MENUS

The monitor 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 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 O ₃ ; set target (O ₃ 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	Allows user to set up Alarm mode and Alarm configurations Stream duration and Range
Vars	(editable Vars)
Comm	Allows user to set MODBUS ID and View Ethernet Info and IP Mode
Info	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 control key 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 – 3120
REF	UV detector reading, reference cycle	mV	250 – 3120
CELL TEMP	Measurement of cell temperature, depends on ambient conditions	°C	5 - 50
O3 CELL PRESSURE	Sample pressure	psia	9.0 – 18.0
FLOW	Sample Gas Flow Rate	cc/min	340 – 1860

*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 rear panel I/O of the instrument.

5.2.3.1. ANALOG STEP

This menu exercises the analog output of the system through a five-point step test that corresponds to the ozone concentration range. With this function, 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 %, representing the output configuration of either Voltage or Current (see Table 5-3 for values). The operator can manually control the stepping by pressing either one of the **UP** / **DOWN** arrow buttons.

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. CAL/ZERO

This function performs a zero calibration based on gas from the “Zero In” port. If the Auto Zero calibration is enabled, the internal ozone offset factor will automatically be adjusted every 720 minutes. If the zero calibration is disabled, then manual calibration is necessary based on the customer’s applications. For normal applications, the Auto Zero is not necessary. Enabling or disabling the Auto Zero can be accessed in the Setup>Vars menu.

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 zero inlet. Allow the instrument to stabilize on the zero air source before attempting to zero. This normally takes 10-15 minutes.

From the Diag>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 may occur and is normal. This noise is typically $\pm 0.5\%$ of the full scale range in magnitude.

5.2.3.3. CAL/SPAN

The Span Calibration also allows the instrument to calibrate its internal ozone offset factor. This calibration, however, is done with some controlled concentration gas connected to the sample inlet. It is recommended that the span gas is concentrated to around 80% of the operating range. Allow the instrument to stabilize on the span gas source for at least one 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 arrow fields 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. CAL/FLOW

The flow calibration allows the instrument to calibrate its internal flowmeter reading. This should be done with a calibrated flowmeter connected to the sample inlet of the monitor.

In the Diag>Cal>Flow Cal menu, use the buttons under the Up/Down arrow fields 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 the instrument's configuration and allows the user to setup details and change Vars.

5.2.4.1. SETUP VARS MENU

The VARS menu allows viewing and editing of various global setup variables that effect how the 480H operates. These variables are stored in the instrument's non-volatile memory. Table 5-4 lists these variables and their function.

Table 5-4. VARS List

VAR	DESCRIPTION	Default Value	Range
MANUAL MODE T	[Not applicable in this model]		
FLOW SLOPE	Slope value for flow calibration.	(value determined during calibration)	
FLOW SET POINT	Sample flow set point.	800 cc/min	
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
DWELL	[Not applicable in this model]		

VAR	DESCRIPTION	Default Value	Range
REF GAIN	Gain applied for zero calibration.	1	
FAILSAFE OPERATION	Relays and digital outputs operate in fail safe operation. Outputs are energized in normal operation and de-energized in fault	OFF	ON/OFF
AZERO INTERVAL	Interval at which zero calibration is performed. (minutes)	6	3-1440
AZERO ENABLE	Enables/Disengages zero calibration	ON	ON/OFF
ANALOG_RANGE	Full-scale concentration range. Used to scale the analog output.	20	5-50 g/Nm ³ 0.5-25.0 WT%
ANALOG HW CONF	Determines if the analog output uses 4-20mA or 0-5V output	4-20mA	4-20mA, 0-5V
O3 OFFSET	[Not available in this model]		
O3 SLOPE	Calibration slope value	1.0	0.5 - 1.5
USER SLOPE	User-editable calibration slope value	1.0	0.5 – 1.5
USER UNITS	Setting for concentration unit-of-measure.	WT%, g/Nm ³ (user selectable)	
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	

5.2.4.2. SETUP ALARM MENU

The ALARM menu allows the operator to view and edit properties of the concentration alarms. The table below summarizes the alarm configuration settings. The Alarm screen becomes the default screen any time an alarm is triggered.

Table 5-5. Alarm Configuration Settings

Property	Meaning	Default Value	Range
ALARM_MODE	Controls the latching behavior of the concentration alarms. When Latching is enabled, the alarm persists until 'Reset' is pressed to clear the alarm*	ON	ON/OFF
HI ALARM	HI alarm trigger value	1.00 WT% 1.00 g/Nm3	0.02%-25.0WT % 0.02-400 g/Nm3
HIHI ALARM	HI-HI alarm trigger value	1.02 WT%, 1.02 g/Nm3	0.02%-25.0WT% 0.02-400 g/Nm3
ON/OFF HI ALARM	HI alarm enable, enables HI alarm operation	ON	ON/OFF
ON/OFF HI HI ALARM	HI-HI alarm enable, enables HI-HI alarm operation	ON	ON/OFF

*The alarm cannot be reset if the ozone reading for that channel, or all channels for the global alarms, 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

5.2.4.1. 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).

5.2.4.2. 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 0). 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. STATUS SCREEN

Provides the status of Pneumatic, Sensor, Lamp, and Valid Reading functions, and becomes the default screen any time an Error occurs. See Section 8.2 for descriptions.

6. DIGITAL COMMUNICATIONS

The 480H comes equipped with digital communications capability that can be connected to a computer or 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 3.4.5.1), 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 the serial configuration is MODBUS RTU. For details on the MODBUS RTU specification, please see <http://www.modbus.org/>.

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

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

To change or verify the configuration of the serial COM, refer to Figure 6.1 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 3-5).
4. Set the desired COM as shown in 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. Re-secure the front panel.
6. 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, J14, need to be changed to accommodate the serial cable pins. In that case, refer to Figure 6-1 to make the adjustments for 232 XSED OVER by setting the jumper pins 2-3 on both J20 and J23.

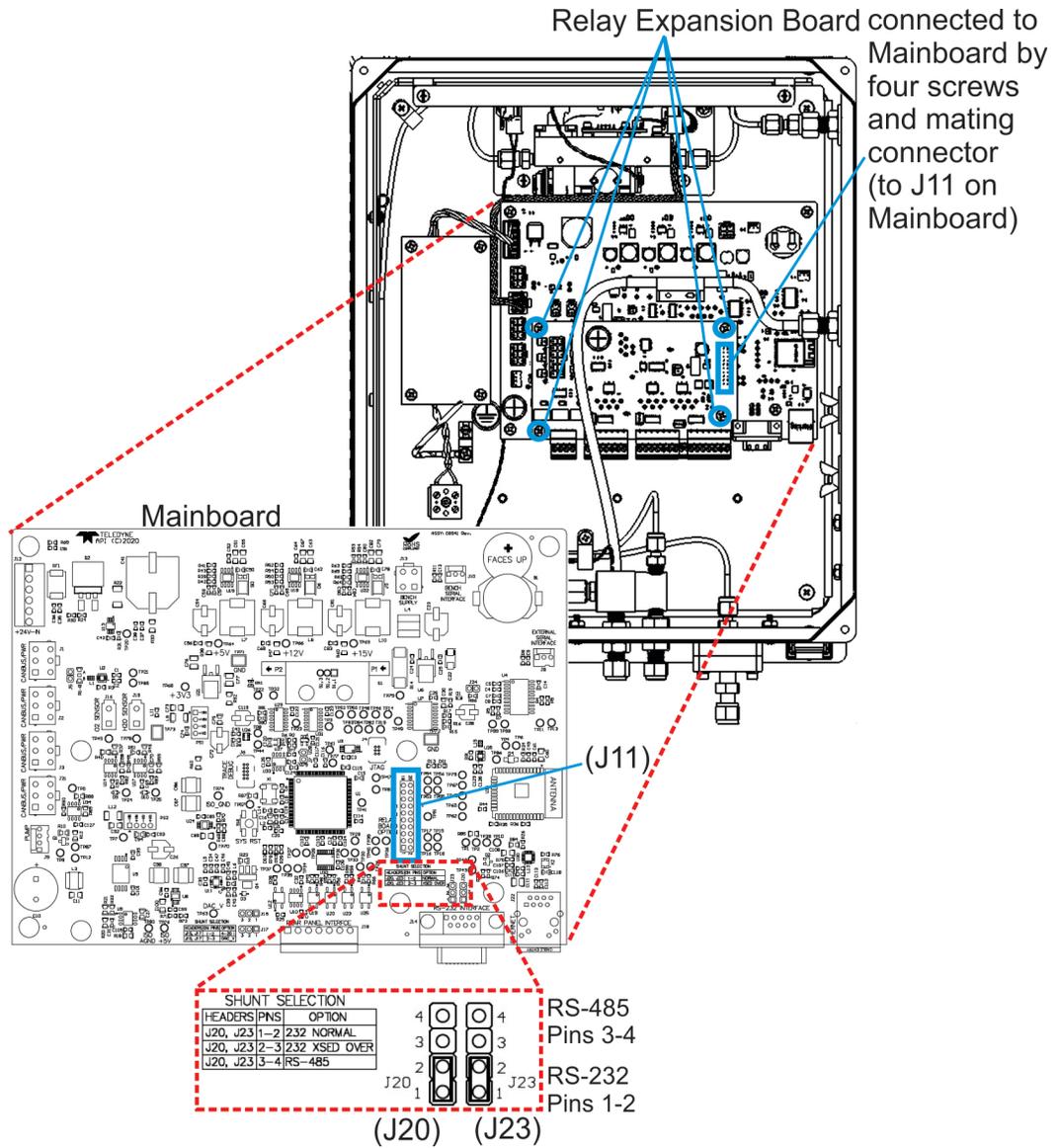


Figure 6-1. RS-232 Signal Configurations

6.3. MODBUS REGISTER MAPS

6.3.1. MODBUS COMMANDS SUPPORTED

Table 6-2 lists the MODBUS commands that are supported by the 480H. 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

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
6	Stream 1 HI-HI Alarm Status, 1= ON	STREAM_1_HI_HI_ALARM	Boolean	1

6.3.4. INSTRUMENT SETUP AND CONFIGURATION REGISTERS (READ / WRITE)

Coil Registers (Read/Write)				
Register Address	Description	Tag Name	Data Type	# Bits
6	Stream 1 HI Alarm Enable, 1=ON	STREAM_1_HI_ALARM_ENABLE	Boolean	1
12	Stream 1 HI-HI Alarm Enable, 1=ON	STREAM_1_HI_HI_ALARM_ENABLE	Boolean	1
18	Alarm Latch Mode, 1= Latching, 0= Non-Latching	ALARM_MODE	Boolean	1

Holding Registers (Read/Write)

Floating Point Holding Registers (32-bit IEEE 754 format; read in highword, low-word order)

Register Address	Description	Tag Name	Data Type	# Bits
12	Stream 1 HI Alarm Limit (PPB)	STREAM_1_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
36	Stream 1 Analog Range (PPB)	STREAM_1_RANG	Inverse Float(Double)	32

7. MAINTENANCE



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 480H 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 particulate filter element	6 months	7.3
Replace UV LED	When UV LED intensity drops to a level that triggers the Check Lamp status, and the Sensor OK status indicates an ERROR.	7.5
Replace Auto-Zero Valve	annually	7.4
Rebuild cells, replace o-rings	3 years	Return to factory
Cleaning	As needed.	7.8

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 480H. These figures will be referenced in the procedures that follow.

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

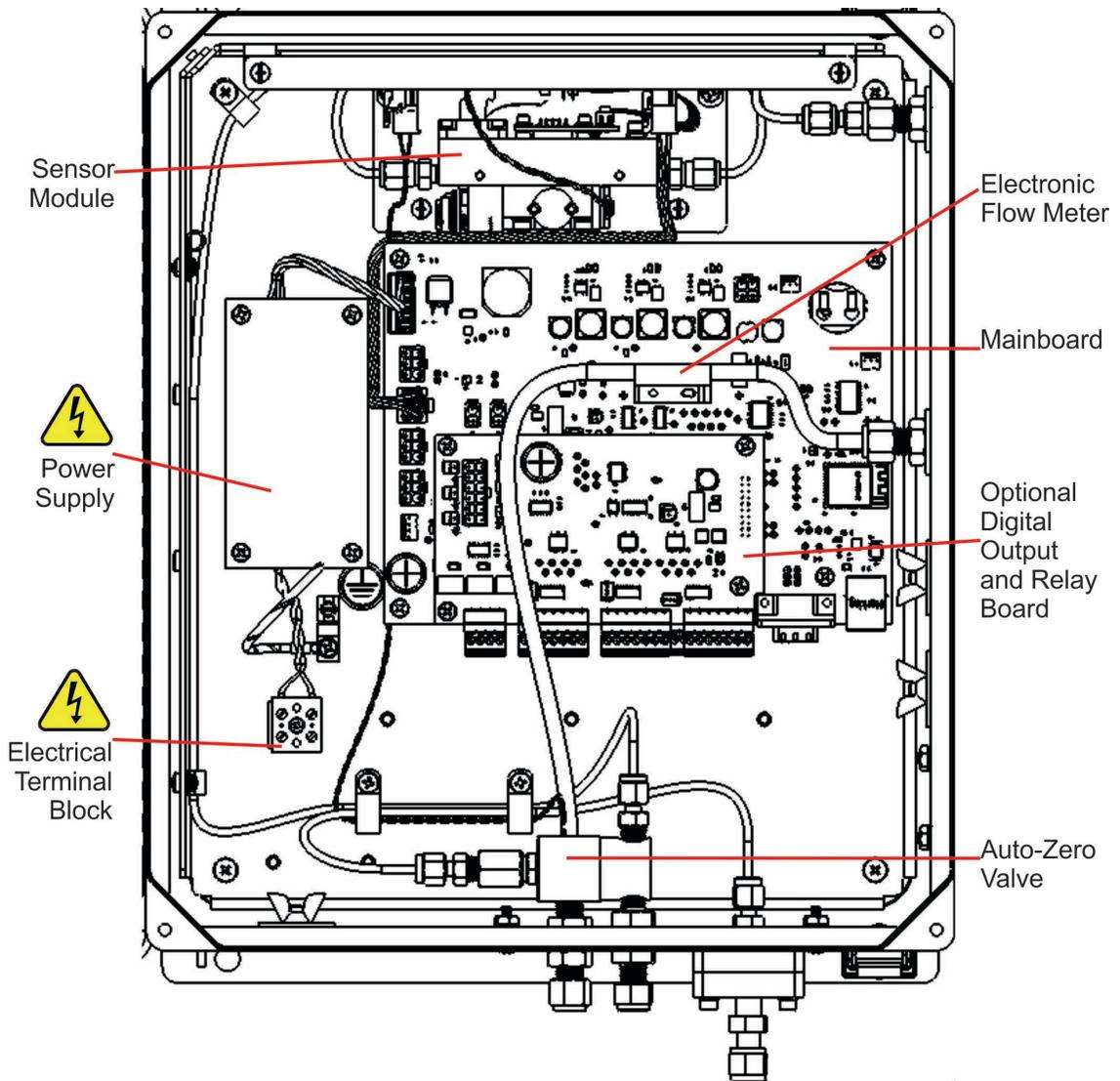


Figure 7-1. Instrument Layout

7.3. PARTICULATE FILTER REPLACEMENT

1. Disconnect power from the monitor.
2. Locate the particulate housing filter on the bottom panel and loosen the four screws on the sample filter body (see Figure 7-2).
3. Remove the four screws, the four washers and the sample filter body from the sample filter base.
4. Remove the o-ring and inspect for any cracks or deformities. If there are cracks or deformities, replace the o-ring with a new one; otherwise, it can be reused.
5. Remove the two sample filter retainers and glass fiber filter element from the sample filter body.
6. Discard the glass fiber filter element.
7. Place a new glass fiber filter element in between the two sample filter retainers and place in the sample filter body.
8. Place the sample filter body on the sample body base and secure with the four screws and four washers.
9. Close the front panel.

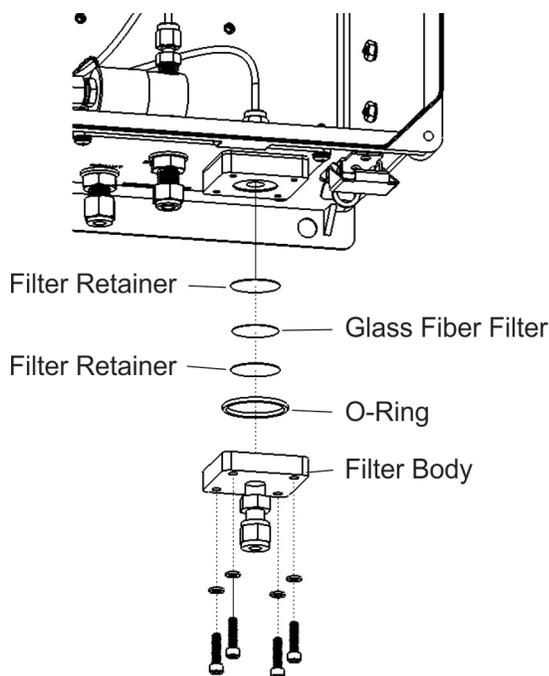


Figure 7-2. Particulate Filter (PN 02832) Replacement

7.4. AUTO-ZERO VALVE REPLACEMENT

1. Disconnect power from the 480H.
2. Open front panel.
3. Locate the auto-zero valve (See Figure 7-1).
4. Unplug the two-pin valve connector from the mainboard PCA.
5. Remove the silver retainer clip from the top of the sensor valve. A pair of pliers may be used to slide off the retainer clip.
6. The valve coil can now be removed by sliding upwards.
7. Remove the two (2) mounting screws using a #2 Phillips screwdriver. Note that there are four screw heads visible on the top of the valve body, only two (2) of these should be removed. Use the new valve as a reference to determine which two screws need to be removed.
8. Note the orientation of the valve body on the manifold so that the new valve can be installed in the same orientation.
9. Remove valve body from sensor manifold.
10. Clean any residue or dirt off the surface of the manifold using a lint-free cloth and distilled or DI water.
11. Install the new valve by reversing steps 1-7.

7.5. UV LED REPLACEMENT

Replace the UV LED by first disconnecting its power at the J12 connector (Figure 7-3) and removing the two larger socket head screws (Figure 7-4) to access the UV 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).

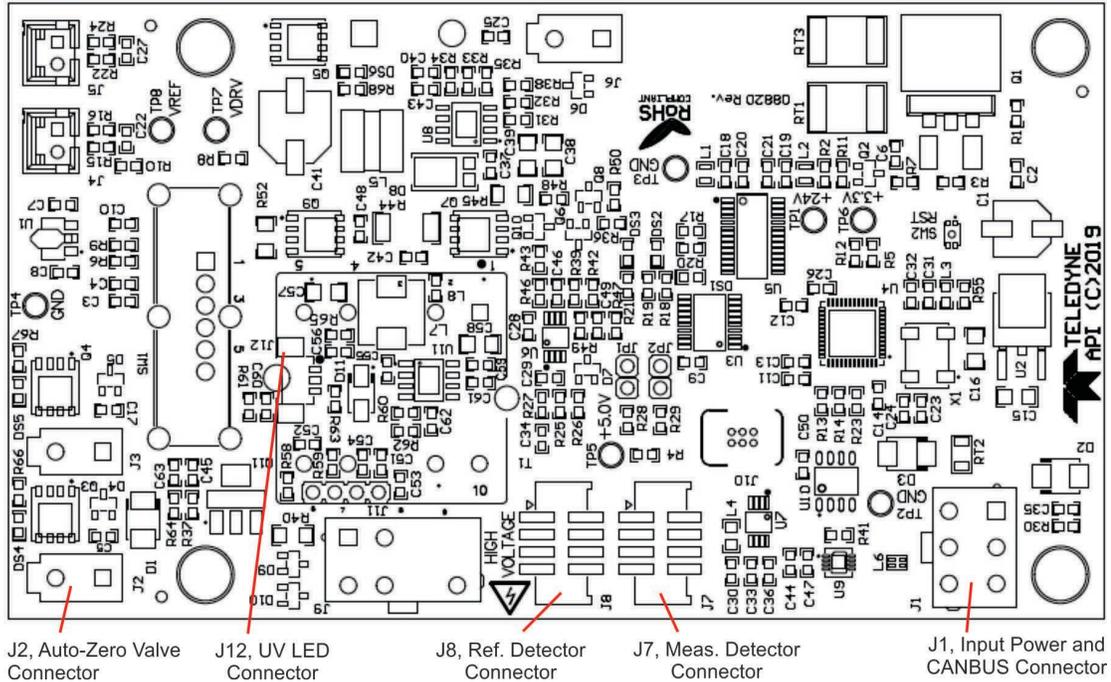


Figure 7-3. O3 Sensor Module Board

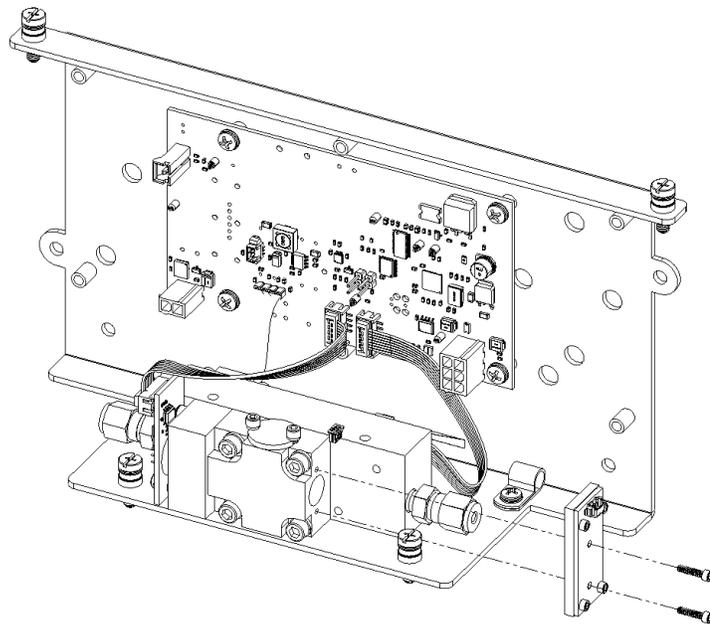


Figure 7-4. UV LED Access

7.6. 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.

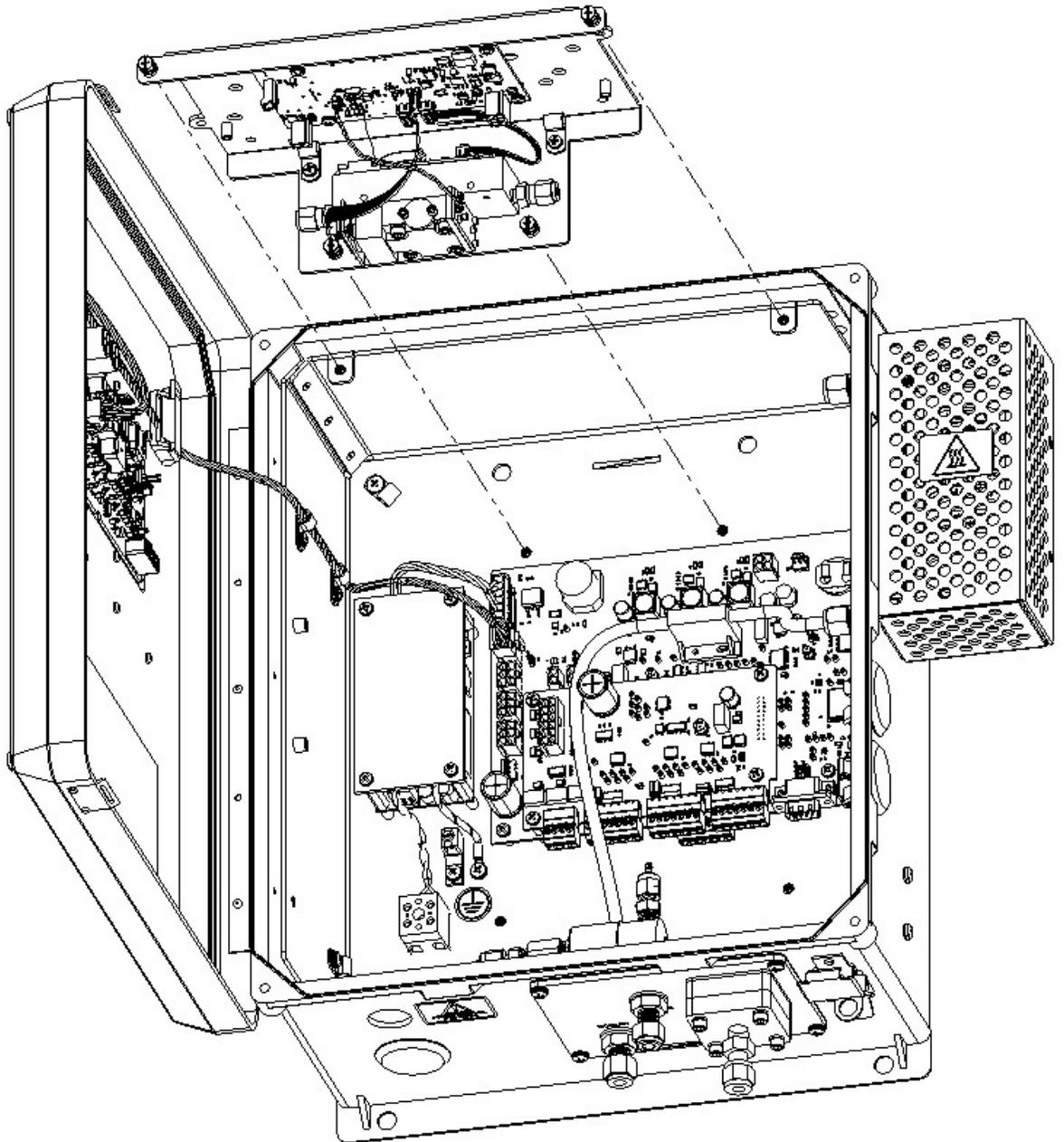


Figure 7-5. Sensor Module Removal

7.7. 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, thereby 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 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.

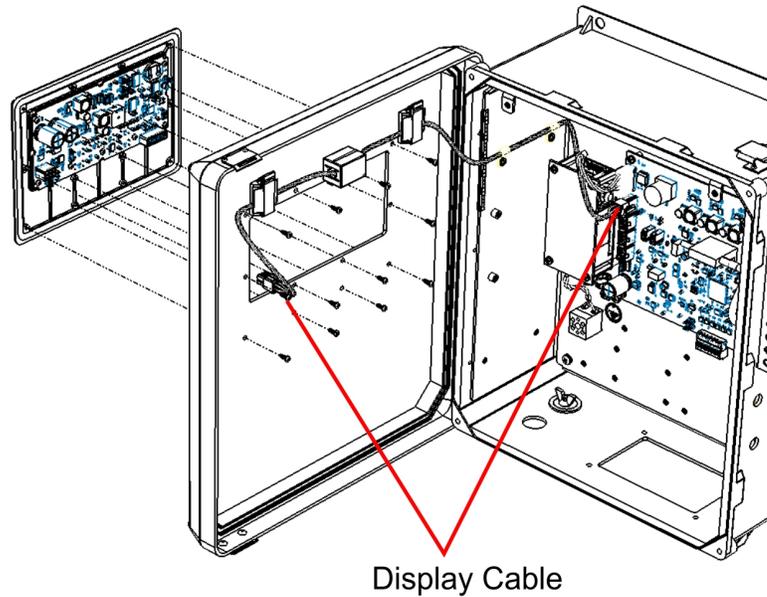


Figure 7-6. Display Assembly Removal

7.8. CLEANING EXTERIOR SURFACES OF THE 480H

If necessary, the front panel mask and keyboard of the 480H 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.

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 USING FRONT PANEL STATUS LED AND STATUS OUTPUTS

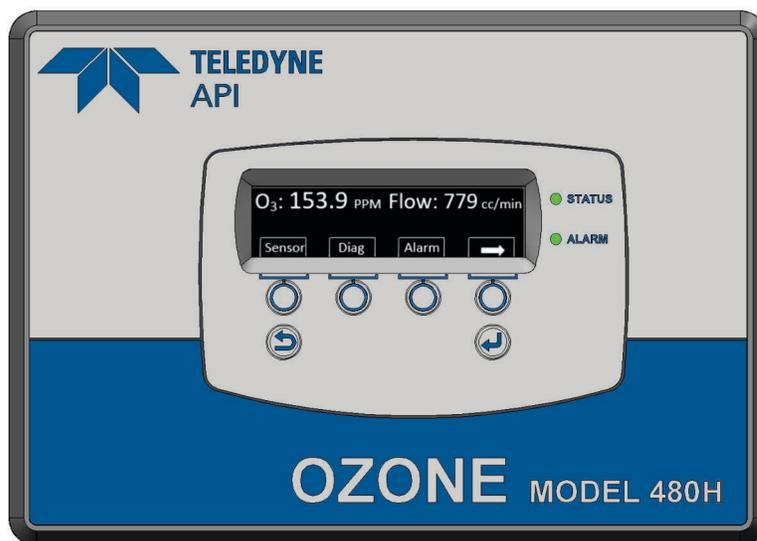


Figure 8-1. Display and Control Panel

The status LED on the front panel reflects the current operating status of the monitor and indicates fault conditions. See Section 3.4.2 for more information on the Status Outputs and Table 8-1 for additional information.

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. This section provides information on the four status outputs.

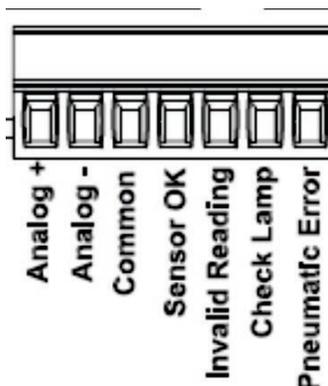


Figure 8-2. Status Outputs

Table 8-1. Status LED/Output Definitions

Status Output #	Status LED Label	Normal Operating State	Triggers	Critical Warning									
1	Sensor OK	On	Reference < 125.0 mV OR Reference > 3120.0 mV Measure > 3120.0 mV	Yes									
2	Invalid Reading	Off	O3 Concentration too low <table border="1" data-bbox="706 1102 1091 1228"> <thead> <tr> <th>Units</th> <th colspan="2">O₃ Concentration</th> </tr> </thead> <tbody> <tr> <td>WT%</td> <td><</td> <td>-0.3</td> </tr> <tr> <td>g/Nm³</td> <td><</td> <td>-3.0</td> </tr> </tbody> </table> O3 Concentration > F.S. Range	Units	O ₃ Concentration		WT%	<	-0.3	g/Nm ³	<	-3.0	No
Units	O ₃ Concentration												
WT%	<	-0.3											
g/Nm ³	<	-3.0											
3	Check Lamp	Off	Reference < 250.0 mV OR Measure > 3120.0	No									
4	Pneumatic Error	Off	Pressure < 9.0 psia Pressure > 18.0 psia Flow < 200 cc/min Flow > 2000 cc/min	No									

8.2.1. SENSOR OK

The Sensor OK LED indicates the status of the O₃ sensor module in the monitor. The normal state of this LED (or Status Output) is On. If this LED remains off after the normal warm-up period, then a failure has occurred and the monitor should be removed from service and repaired.

The most common cause of this warning is a failure of the UV LED. If the UV LED intensity has dropped to a level that cannot meet the specified values, then it should be replaced (See Section 7.5).

8.2.2. INVALID READING

The Invalid Reading LED 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 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 for details on setting the range value.

8.2.3. CHECK LAMP

The Check Lamp status indicates that the UV LED intensity has dropped to a level where the UV LED needs to be replaced (Section 7.5) the Sensor OK LED will also turn off, indicating that the monitor must be immediately serviced or taken off-line.

8.2.4. PNEUMATIC ERROR

The Pneumatic Error LED indicates that one of the pneumatic parameters, flow or pressure, has gone outside of normal ranges. Note that this is a non-critical warning. Unless it is also accompanied by Sensor OK LED turning off, the instrument does not need to be removed from service at this time.

The first step in troubleshooting a Pneumatic Error is determining which parameter has caused the warning. At the monitor front panel, navigate to the VIEW menu (See Section 5.2.2). Examine the Flow and Pressure values and compare them to the limits described in Table 8-1 and take appropriate action as described below.

8.2.4.1. PRESSURE TOO HIGH

- The gas inlet pressure is too high. Verify that the ozone gas and zero gas delivery pressure is regulated to between 9 and 18 psig (high pressure error occurs when pressure exceeds 18 psig).
- Something is restricting the flow in the monitor. Check for restriction in the exhaust gas line. Check for kinked or obstructed tubing inside the monitor.
- The pressure sensor has failed or drifted.

8.2.4.2. PRESSURE TOO LOW

- The exhaust line is connected to a vacuum source. Disconnect exhaust line and see if pressure returns to specified range.
- The pressure sensor has failed or drifted. Contact Teledyne API Technical Support for assistance.

8.2.5. TECHNICAL ASSISTANCE

If this manual does not solve your problems, technical assistance may be obtained from:

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

Toll-free Phone: +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 O₃ molecule. The 480H uses an LED lamp constructed so that a large majority of the light emitted is at the 254nm wavelength. Light from the lamp 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_0 . 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.

$$C_{O_3} = -\frac{10^6}{\alpha \times L} \times \frac{T}{273 \text{ K}} \times \frac{14.695 \text{ psi}}{P} \times \ln \frac{I}{I_0}$$

Where:

I = Intensity of light passed through the sample

I_0 = Intensity of light through sample free of ozone

α = absorption coefficient

L = path length

C_{O_3} = concentration of ozone in parts per million

T = sample temperature in Kelvin

P = pressure in pounds per square inch (absolute)

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 of the gas changes the number of ozone molecules in the absorption cell 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 $308 \text{ cm}^{-1} \text{ atm}^{-1}$ 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 cell.

The intensity of light is converted into a voltage by the detector/preamp module. The voltage is converted into a number by a high resolution A/D (analog-to-digital) converter. The digitized signal, along with the other variables, is used by the CPU to compute the concentration using the above formula.