USER MANUAL

MODEL 465H
OZONE MONITOR

Teledyne API (TAPI)
9970 Carroll Canyon Road
San Diego, CA 92131-1106

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

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 **GENERAL SAFETY HAZARD**
	This instrument should only be used for the purpose and in the manner described in this manual. If you use it in a manner other than that for which it was intended, unpredictable behavior could ensue with possible hazardous consequences. **NEVER use any gas analyzer to sample combustible gas(es).**

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 un analyseur de gaz 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

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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 465H (465H) Ozone Monitor measures high concentration ozone; this microprocessor-controlled instrument provides fast response times with minimal zero drift, and 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.

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

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

2. SPECIFICATIONS AND AGENCY APPROVALS

2.1. Specifications

PARAMETER	DESCRIPTION
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%)	< 5 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	5-45º C
Dimensions (H x W x D)	5.22" x 19.0" x 15.3" (3U RETMA Panel) (133 mm x 483 mm x 388 mm) In NEMA 4X enclosure, typical product envelope: 16.85" x 15.60 (±0.25)" x 6.65" (428mm x 396 (±6)mm x 169mm)
Weight	Rack Mount – 13.6 lbs (6.17 kg) in NEMA 4X enclosure – 15.3 lbs (6.94 kg)
Power	100-240 V~, 47-63 Hz, 74 W
Environmental	Installation Category II Pollution Degree 2 For Indoor Use Only Maximum Operating Altitude 2000 meters
Analog Output (Bi-polar)	0-5V, 4-20 mA isolated output
Status Outputs	System OK, Invalid Reading, Check Lamp, Pneumatic Error
RS-232 (optional RS-485)	57.6 Kbaud, DB-9 connector

2.2. Approvals

This section presents Safety and Electromagnetic Compatibility (EMC) compliance approvals for the Model 465H monitor.

2.2.1. Safety

IEC 61010-1:2001 (3rd Edition), Safety requirements for electrical equipment for measurement, control, and laboratory use.

CE: 2006/95/EC, Low-Voltage Directive

2.2.2. EMC

EN 61326-1 (IEC 61326-1), Class A Emissions/Industrial Immunity

EN 55011 (CISPR 11), Group 1, Class A Emissions

FCC 47 CFR Part 15B, Class A Emissions

CE: 2004/108/EC, Electromagnetic Compatibility Directive

2.2.3. Other Type Certifications

For additional certifications, please contact Technical Support:

Toll-free: 800-324-5190

Phone: +1 858-657-9800

Fax: +1 858-657-9816

Email: api-techsupport@teledyne.com

3. PRINCIPLE 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 465H uses a mercury 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_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.

$$C_{O_3} = -\frac{10^6}{\alpha \times L} \times \frac{T}{273 \text{ K}} \times \frac{14.695 \, psi}{P} \times \ell n \frac{I}{I_o}$$

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 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 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 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.

4. 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.**

The 465H is shipped with the following standard equipment:

- Power cord (Rack mount version only)

- Instruction manual

- Flow Control Assemblies (2X)

Upon receiving the 465H, verify that there is no apparent shipping damage. (If damage has occurred please advise shipper first, then Teledyne API.)

	CAUTION
⚠️	**Connect the exhaust fitting on the rear panel to a suitable vent outside the monitor area.**

4.1. Mechanical Installation (for Monitors in NEMA 4X Enclosures)

Mount the enclosure securely to a vertical surface.
- Figure 4-1 shows 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.

- Use stainless steel, 5/16" (8 mm) diameter bolts.

4.1.1. Ventilation Clearance

When installing the 465H be sure to leave sufficient ventilation clearance.

Table 4-1: 465H Ventilation Clearances, NEMA Version

Area	Minimum required clearance
Back of the monitor	None
Sides of the monitor	1 inch
Above and below the monitor	1 inch

FLANGE DIMENSIONS AND
MOUNTING HOLE LOCATIONS
(NOT TO SCALE)

4X R0.16 ±0.03 THRU
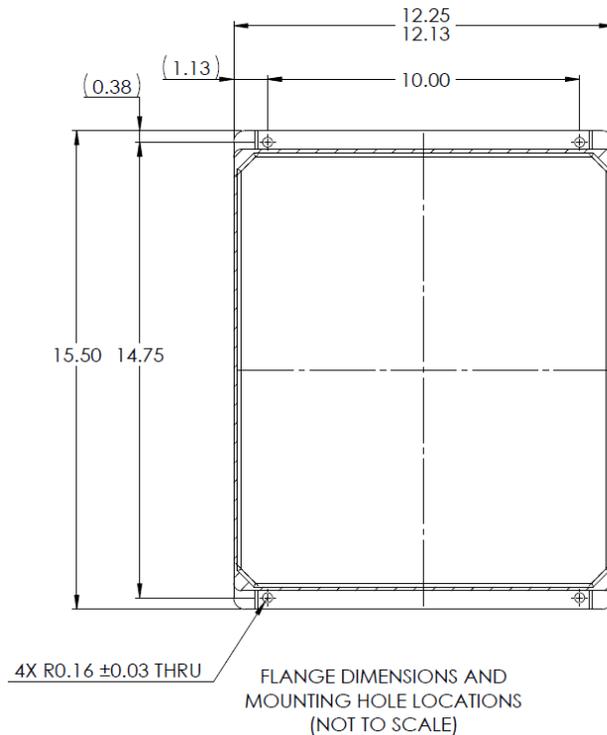
ALL TOLERANCES ±0.05 UNLESS OTHERWISE STATED

Figure 4-1: 465H Mounting Hole Locations and Dimensions

4.2. Mechanical Installation (19" Rack Version)

The Rack Mount version of the 465H was designed to be operated as a bench-top monitor or to be mounted in a standard 19" RETMA instrumentation rack. For rack installations, the four mounting feet should be removed from the bottom of the monitor.

4.2.1. Ventilation Clearance

When installing the 465H be sure to leave sufficient ventilation clearance.

Table 4-2: 465H Ventilation Clearances, Rack Mount Version

Area	Minimum required clearance
Back of the monitor	3 inches
Sides of the monitor	1 inch
Above and below the monitor	1/2 inch

4.3. AC Power Connection (for Monitors in NEMA 4X Enclosure)

	WARNING: Electrical Shock Hazard **Disconnect power to the AC mains before making or removing any electrical connections to the 465H.**

	WARNING: Electrical Shock Hazard **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**

4.3.1. 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 (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

4.3.2. 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. Attach the leads of the power line to the AC power connector (see Figure 4-6).

3. For the **NEMA configuration**, the electrical connection must be hard-wired to the 3-pin connector on the mainboard labeled J23. AC power connection to the monitor should be made with 12-14 AWG stranded copper wire, connected to the monitor as follows:

a. **Earth Ground (green):** Connect the earth ground wire to the screw terminal lug on the chassis as shown in the Figure below. **Do not** connect the earth ground wire directly to the PCB connector on the mainboard PCB.

b. **Line (Black):** Connect the Line wire to the connector on the mainboard PCB labeled "Line".

c. **Neutral (White):** Connect the Neutral wire to the connector on the mainboard PCB labeled "Neutral".
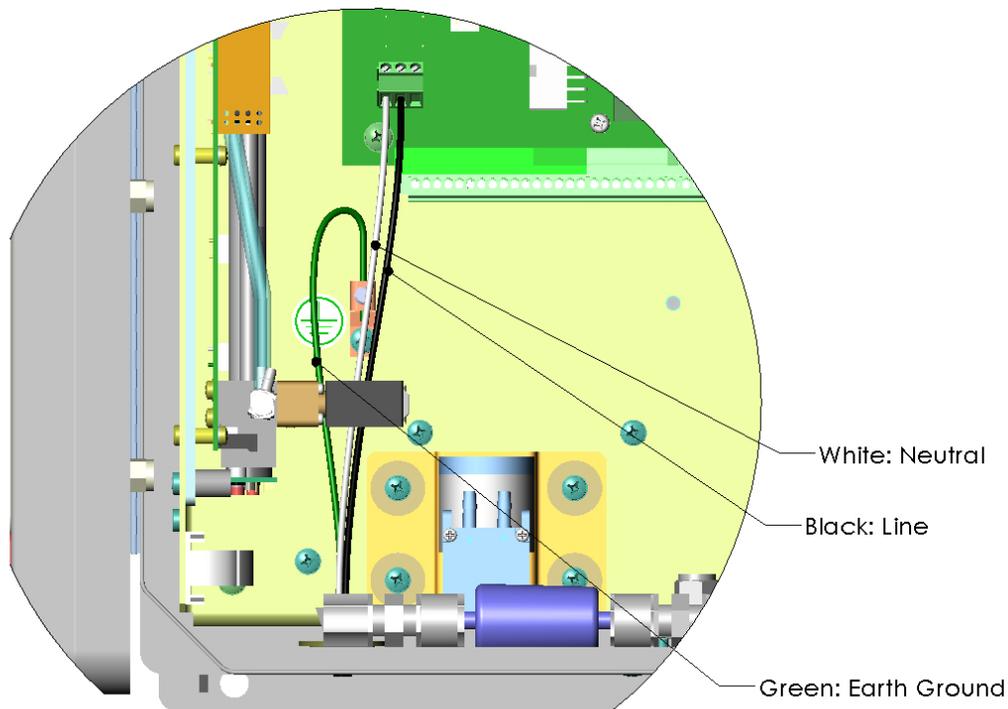
Figure 4-2. NEMA AC Power Connection to Monitor

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

	WARNING
⚠	**Verify that the instrument is set up for proper line voltage and frequency. Observe local electrical codes when connecting power to the monitor.**

5. Turn on the 465H by switching the switch on the left side of the rear panel, or applying power to the monitor (NEMA configuration.) The front panel display should light with a sequence of messages, including the instrument serial number and software revision. (When the instrument first powers up, the display will show 'xxxx', indicating that the instrument is in start-up mode, waiting for the UV detector readings to stabilize).

After the start-up period, the instrument will begin displaying the ozone concentration and the optional stream selector will begin operating, if installed.

4.4. Pneumatic Connections
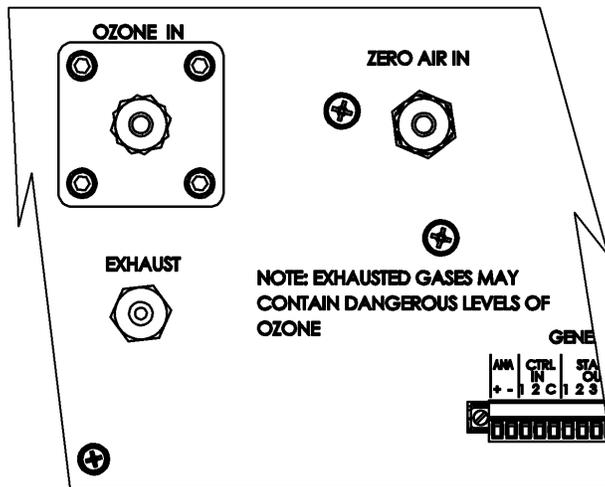
Figure 4-3: Pneumatic Connections, Rack Mount Configuration
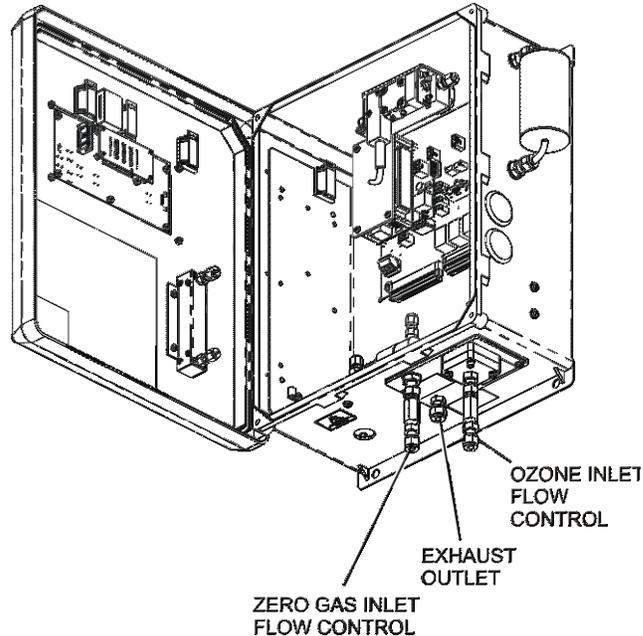
Figure 4-4: Pneumatic Connections, NEMA Configuration

4.4.1. 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 (see Figure 9-1 and Figure 9-2).

- 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.

NOTE
Both flow control assemblies are identical and interchangeable.

4.4.2. Ozone Inlet Connection

Connect the ozone delivery line to the Flow Control Assembly (See Section 4.4.1) on the "Ozone Inlet" on the bottom face of the enclosure (See Figure 4-3 and Figure 4-4.) The ozone delivery should be regulated between 5-30psig.

NOTE
Customers who wish to attach their own flow control devices (e.g. needle valves) should attach their hardware directly to the ¼" fitting (Swagelok compatible) of the ozone inlet and the zero gas inlet.

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 4.4.1.

4.4.3. Zero Gas Connection

Connect the oxygen or other dry zero gas sources to the to the Flow Control Assembly (See Section 4.4.1) on the 'Zero Gas Inlet.' Zero Gas supply pressure should be regulated between 5 and 30 psig.

4.4.4. Exhaust Connection

Connect a ¼" OD vent line to the "Exhaust" fitting on the rear 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
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.

	CAUTION
⚠	**Exhaust gas from the 465H may contain dangerous levels of ozone! Do not vent this gas into enclosed or occupied areas.**
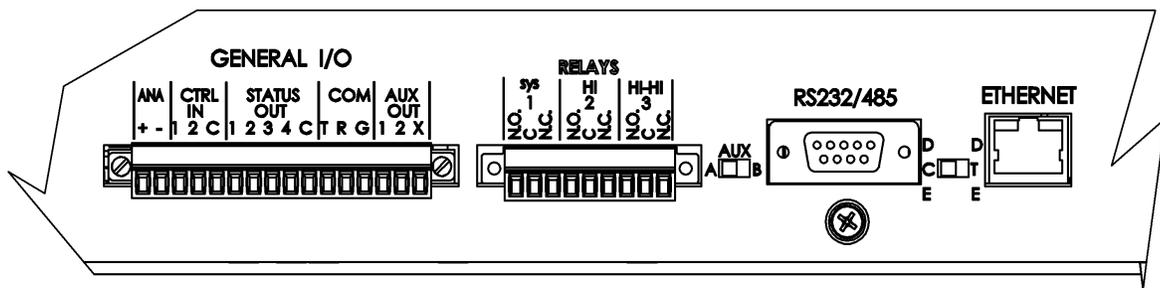
Figure 4-5: Rear Panel Electrical I/O Connections
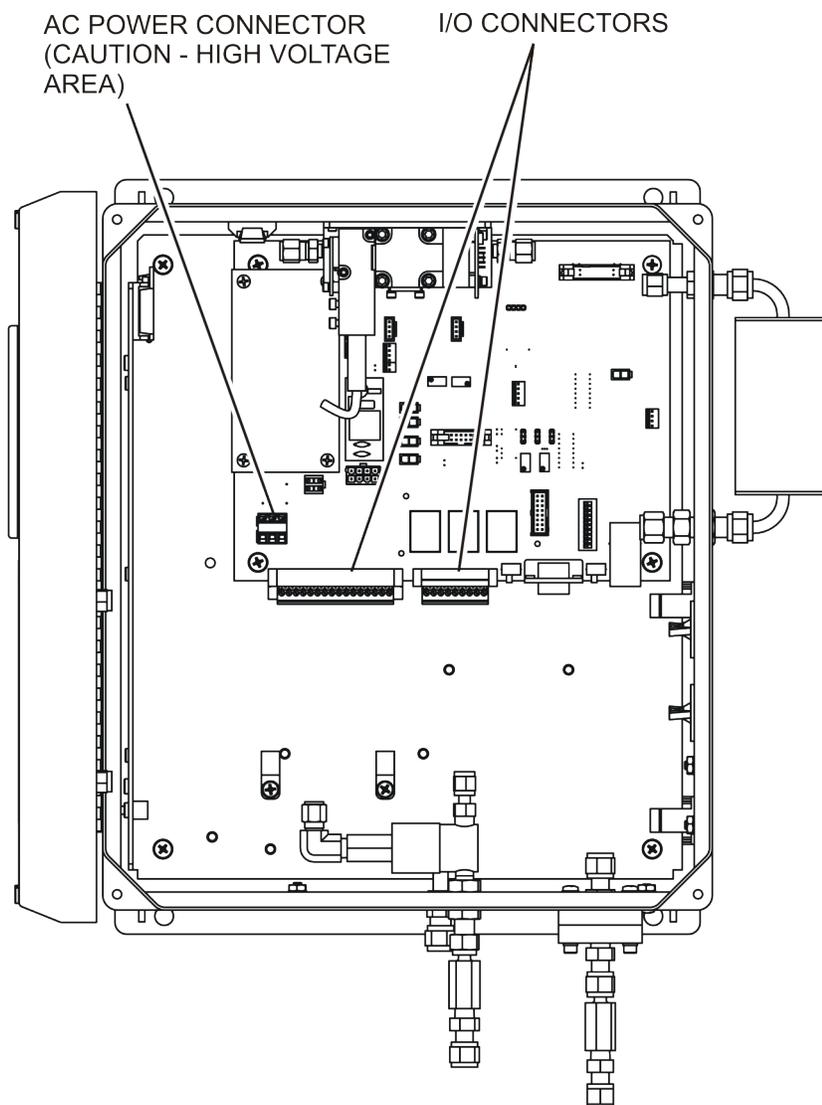
Figure 4-6: NEMA Electrical I/O Connections

4.5. Electrical I/O Connections

4.5.1. Location of I/O Connectors in the NEMA Configuration

In the NEMA configuration of the 465H, the I/O connectors are located internally in the instrument. See Figure 4-6 for their location. Connection to these terminals is usually made via a conduit connection to the NEMA enclosure. A standard conduit penetration may be added to one of the walls of the enclosure for this purpose, or the existing penetration may be used.

The I/O label inside the NEMA cover provides information on the functions of the connectors. See Figure 4-7 below for the location of the I/O Label.
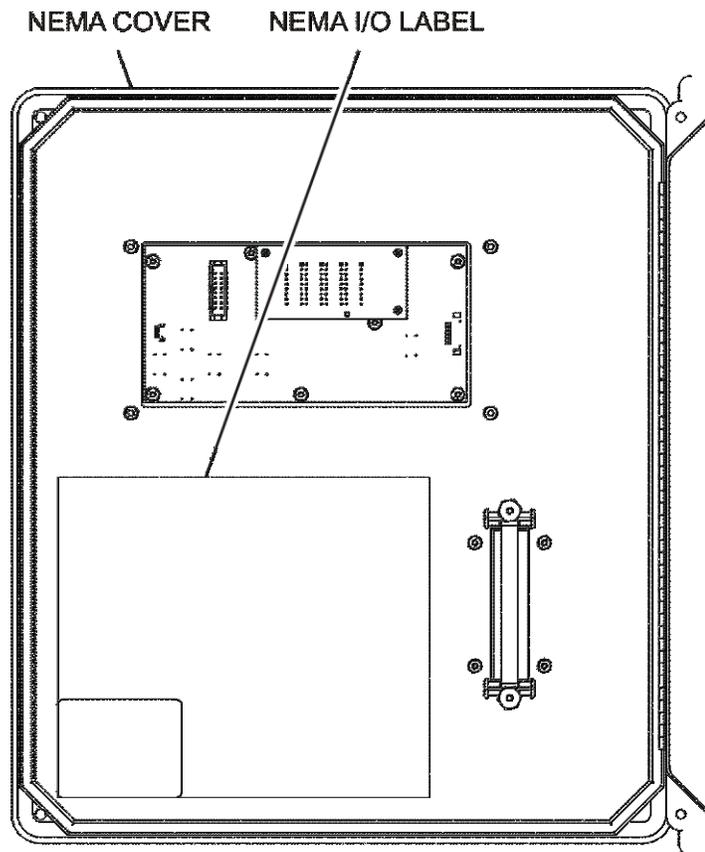
Figure 4-7: NEMA I/O Label

4.5.2. Analog Output

The analog output is located at the "General I/O" connector (See Figure 4-3.) and is labeled "ANA." The analog output can be configured for 0-5V voltage or 4-20 mA current output. See Section 7.2.5.1 to automatically step-test the analog output.

The analog output is automatically scaled to the range of the instrument, i.e. if the monitor range is 100 g/Nm^3, then 5V would correspond to 100 g/Nm^3 and 0V would correspond to 0 g/Nm^3. See Section 7.2.4 for information on changing the range of the monitor.

4.5.3. Status Outputs

There are four instrument status outputs located at the "General I/O" connector. These status outputs mirror the state of the four diagnostic LED's on the front panel. If any of these status outputs are in a different state than shown in Table 4-3 then some adjustment or troubleshooting should be performed. See Section 10.2 for more detailed information.

Electrically these outputs are SPST dry contact relay closures with a common contact, labeled 'C' on the rear panel. They are capable of switching up to 50 VDC, 250mA maximum current. There are no polarity requirements, so the outputs can be used to sink or source current from the 'C' pin, within the maximum voltage and current specified. Schematically, the outputs look as shown in Figure 4-8 below:
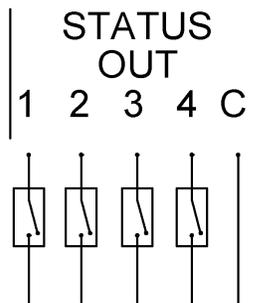
Figure 4-8: Status Output Schematic

The outputs are defined as follows:

Table 4-3: Status Output Definitions

Status Output #	Name	Normal Operating State
1	Sensor OK	On
2	Invalid Reading	Off
3	Check Lamp	Off
4	Pneumatic Error	Off

4.5.4. Hi-Current Relay Outputs

Three form C relay outputs are provided on the rear panel on the nine pin connector (see Figure 4-5). The relays are labeled "Relay 1," "Relay 2," and "Relay 3."

The relays are dry contact type form C (SPDT) relays with Normally Open (N.O.), Normally Closed (N.C.) and Common (COM) contacts. The relays are capable of driving loads of up to 250VAC, 5A. For maximum contact life, the relays should only be used to drive resistive loads. Contact life may be dramatically shortened if inductive loads are driven without any provision for minimizing a high voltage "inductive kick" that can occur. See Section 7.2.3 to configure the alarms.

Table 4-4: Relay Functions

Relay #	Function	Normal Operating State
1	System OK Diagnostic (Identical to Sensor OK status output as described in Table 4-3)	On
2	Hi Alarm	Off
3	Hi-Hi Alarm	Off

4.5.5. Digital Serial Interfaces

There is one external communications port that can be configured for either the RS232, RS485 (Half Duplex,) or Ethernet (10Mbit.) This section provides only a brief overview of the digital serial connections. For more detailed information on configuring and using the digital serial interfaces, see Section 8.

4.5.5.1. RS232 Connection

With the instrument configured for RS232, connection can be made to the DB-9 connector, labeled "RS232/485", or to the three "COM" pins on the "General I/O" connector. See Section 8.2 for additional details.

When using RS232, a 9-pin serial cable (TAPI P/N WR77) can be used to connect the instrument to a standard PC (personal computer) serial port.

4.5.5.2. RS485 Connection

 With the instrument configured for RS485, connection can be made to the DB-9 connector, labeled "RS232/485", or to the three "COM" pins on the "General I/O" connector. See Section 8.2 for additional details.

4.5.5.3. Ethernet Connection

With the instrument configured for Ethernet, connection should be made to the RJ-45 port labeled "Ethernet." Connection can be made using a standard Category 5 or better network patch cable. See Section 8.2 for additional details. TAPI can provide an appropriate cable.

5. FREQUENTLY ASKED QUESTIONS

6. Q: How long does the UV Lamp last?

   A: The typical lifetime is about 2-3 years.
      The lamp output will steadily decrease until lamp adjustment can no longer be performed. The "Check Lamp" warning LED will tell the operator when this adjustment should be attempted. When this adjustment can no longer be performed, the lamp should be replaced. See Chapter 1 for more information.

6. HARDWARE AND SOFTWARE OPTIONS

6.1. Rack Mount Slides

Rack mount slides can be attached to the sides of the instrument, allowing it to slide completely out of a RETMA rack, facilitating maintenance activities.

6.2. Ethernet (MODBUS® TCP/IP)

The Ethernet option consists of a converter that provides a MODBUS® TCP/IP interface to the monitor.

7. OPERATION

7.1. Front Panel Overview

The 465H front panel provides a number of functions in addition to displaying the current ozone concentration being measured. Figure 7-1 below shows the display and keypad portion of the front panel.
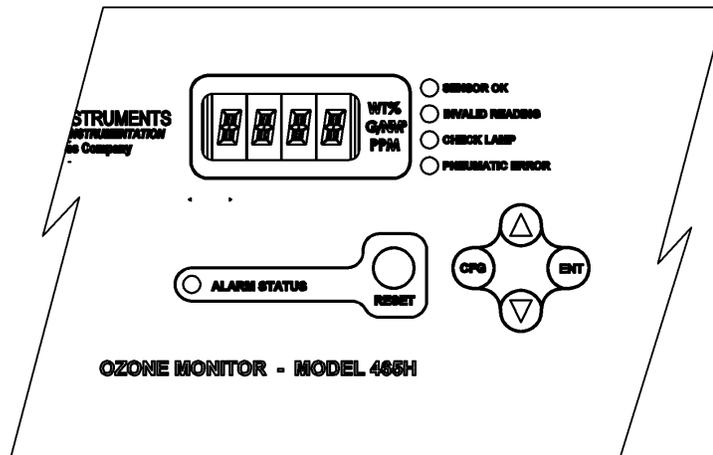
Figure 7-1: Front Panel Display

7.1.1. Ozone Concentration Display

The 4-character LED display in the center of the front panel normally shows the current ozone concentration being measured by the 465H. While displaying concentration, one of the unit-of-measure indicators (i.e. WT%, or g/Nm^3) should be backlit, indicating the current measurement units. If none of these indicators are backlit, then the display is in Menu mode or Startup mode and is not displaying the concentration. If the display is in Menu mode, the display can be returned to Concentration mode by repeatedly pressing the CFG button until one of the unit-of-measure indicators is lit.

> **NOTE**
>
> Even when the display is in Menu mode, normal measurement
> and stream selector operation will continue in the background.

7.1.2. Menu Navigation Keypad

The menu navigation keypad (**CFG**, **ENT** and **UP/DOWN** buttons) is used to navigate the various menu items available on the 465H. The menus allow the operator to view operational parameters of the instrument as well as view and modify the configuration of the instrument. See Section 7.2 for more detailed information.

7.1.3. Concentration Alarm Status/Reset

The 465H front panel displays the concentration alarm status of the sample gas. The LED labeled 'ALARM STATUS' shows the alarm status as follows:

Table 7-1: Alarm LED's

Alarm Status LED Color	Alarm State
Green	No alarm active
Amber	'HI' alarm active
Red	'HI-HI' alarm active

If the alarms are configured for latching operation, then the **RESET** button can be used to attempt to reset all alarms.

NOTE
Alarms can only be reset if the concentration measured has subsequently dropped below the alarm limit.

If the alarms are configured for non-latching operation, they will be automatically cleared when the concentration falls below the alarm threshold. The **RESET** button has no effect when the alarms are configured for non-latching operation.

See Sections 7.2.3 and 4.5.4 for additional details on concentration alarms.

7.1.4. Status LED's

There are four Status LED's on the front panel to the right of the concentration display. These LED's provide a quick view of the instrument's Status and provide indication of any problems that may exist. The normal state for these LED's after the initial warm-up period is as follows:

Table 7-2: Status LED's

Status LED	Normal State
Sensor OK	ON
Invalid Reading	OFF
Check Lamp	OFF
Pneumatic Error	OFF

If any of these LED's are in a different state than shown above, then some adjustment or troubleshooting should be performed. See Section 10.2 for more detailed information.

7.2. Front Panel Menus

The 465H 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.

Figure 7-2 and Figure 7-3 below show the menu structure as well as the buttons that are used to navigate it.

Starting with the display in Concentration mode, press **CFG** to enter Menu mode. At this point the unit-of-measure LED should turn off and the first level of the Menu tree will be active. Pressing the **UP/DOWN** arrows will now select from the items available at this menu level. Press **ENT** to enter one of these sub-menus or press **CFG** to back out of this menu level back to Concentration mode.

7.2.1. Menu Navigation Basics

1. Press **CFG** from Concentration mode to enter Menu mode.

2. Once in Menu mode, **CFG** will move backwards one level in the menu structure and **ENT** will move forward.

3. Each menu level contains an EXIT selection. Selecting EXIT and pressing **ENT** will exit the Menu mode and return the display to Concentration mode.

7.2.2. Editing Numeric Values

At certain places in the menu structure the operator can edit numeric values. The menu buttons behave somewhat different when in this mode.

Press **CFG** to select a digit to edit. The selected digit will blink. Next press the **UP/DOWN** arrows to increment/decrement the selected digit. Press **CFG** again to select another digit. Pressing **CFG** at the last digit will wrap back to the first digit.

Once all the digits have been edited, press **ENT** to accept the new value.

To abort the editing process without changing the original value, press and hold the **CFG** button until the display returns to the previous menu level.

NOTE
Limit checking is enforced, while editing values and changes that would result in invalid values are ignored.
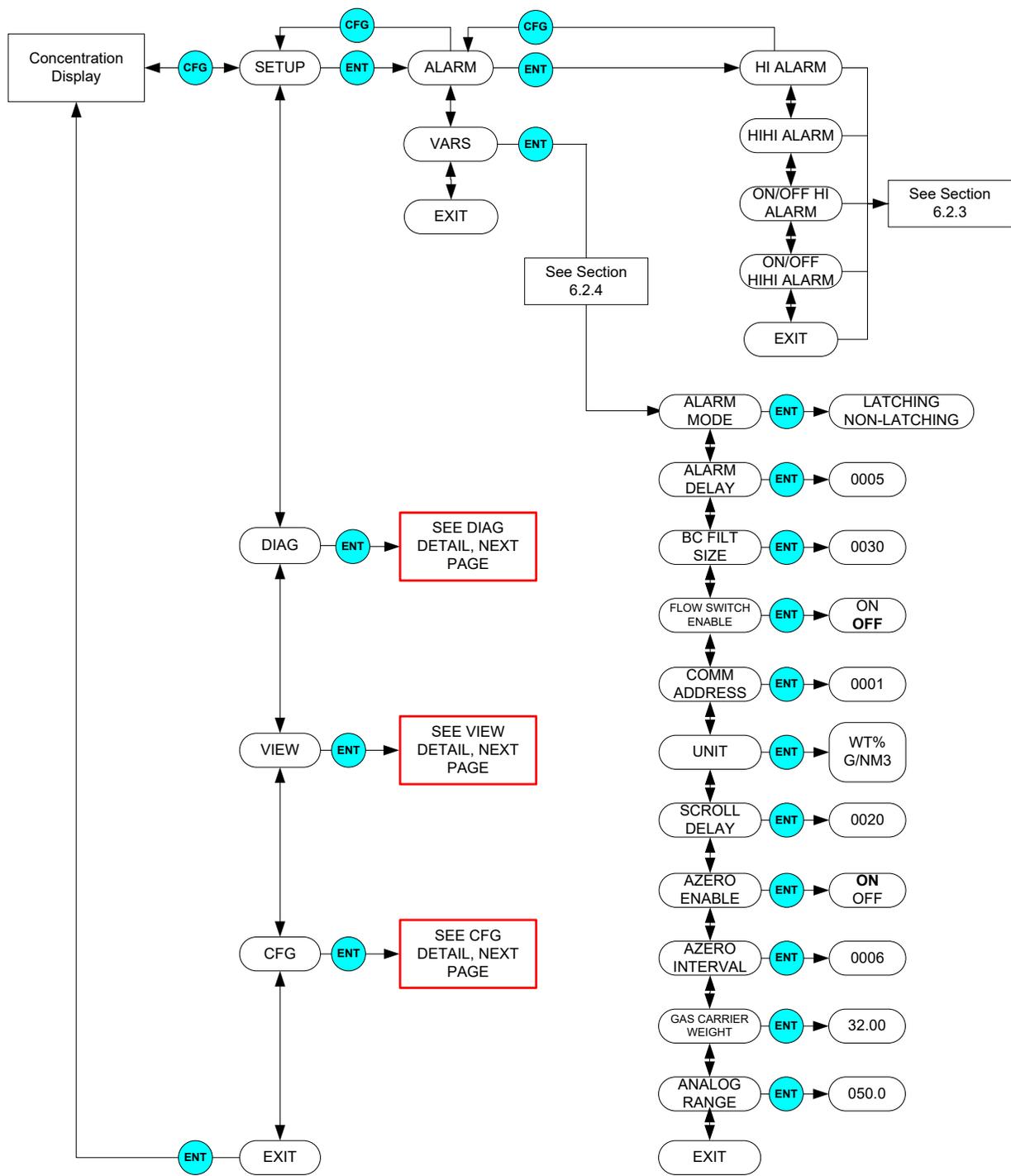
M465H-Front Panel Menu Diagram, Rack Mount

Figure 7-2: Front Panel Menu Diagram
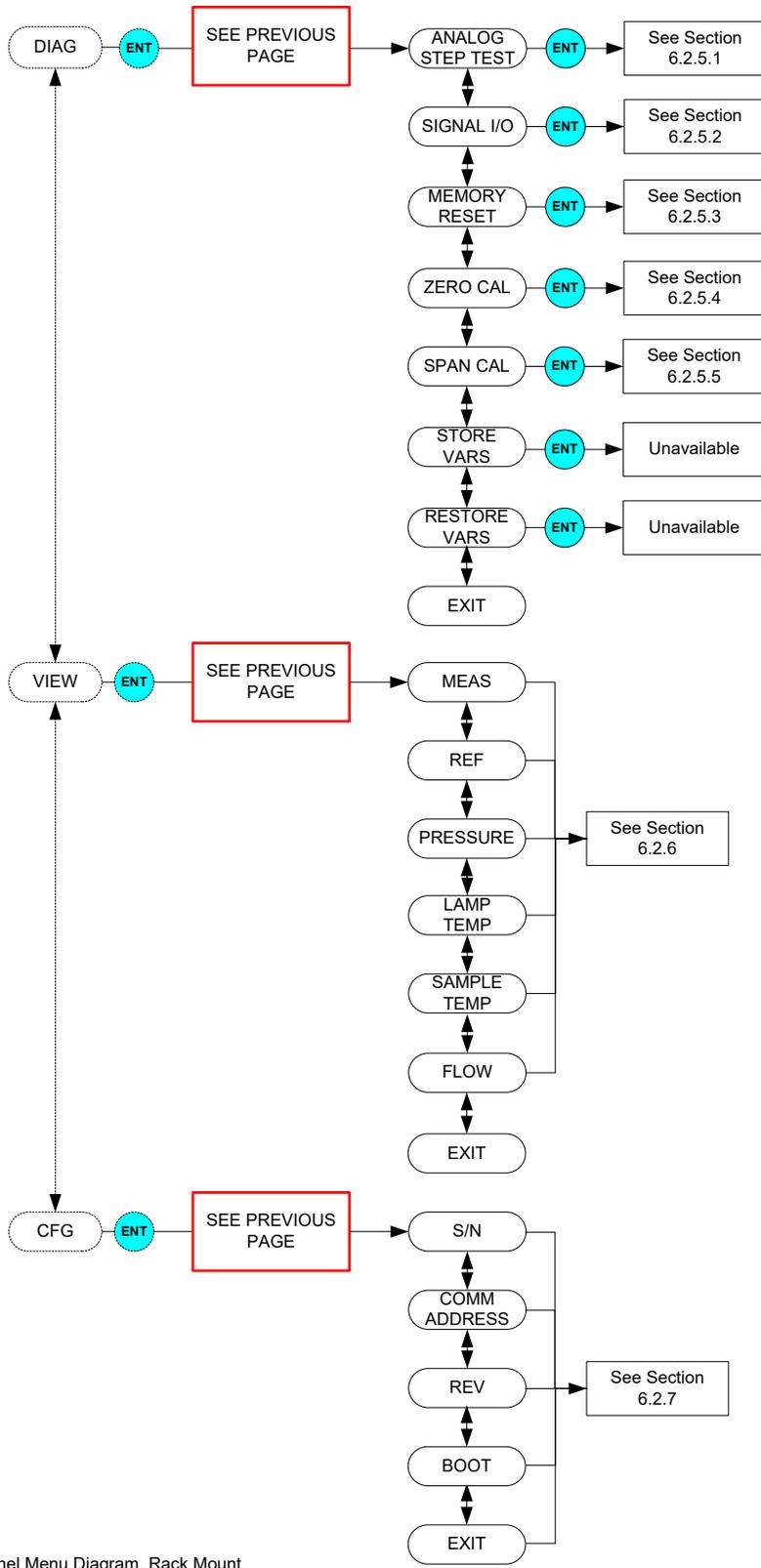
M465H-Front Panel Menu Diagram, Rack Mount

Figure 7-3: Front Panel Menu Diagram

7.2.3. SETUP-ALARM Menu

The ALARM menu gives the option of enabling/disabling the HI, and HI-HI alarms, as well as setting the concentrations at which they are triggered. The options available:

Table 7-3: Alarm Configuration Properties

Property	Meaning	Default Value	Range
HI ALARM	HI alarm trigger value	1.00 WT%, 1.00 g/Nm^3	0.02%-25.0% 0.02-400 g/Nm^3
HIHI ALARM	HI-HI alarm trigger value	1.02 WT%, 1.02 g/Nm^3	0.02%-25.0% 0.02-400 g/Nm^3
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

7.2.4. SETUP-VARS Menu

The VARS menu allows viewing and editing of various global setup variables that effect how the 465H operates. These variables are stored in the instrument's non-volatile memory. Table 7-4 lists these variables and their function.

Table 7-4: VARS List

VAR	Meaning	Default Value	Range
ALARM MODE	Controls the latching behavior of the concentration alarms. See Section 7.1.3 for additional details.	LATCHING	LATCHING, NON-LATCHING
ALARM DELAY	Number of readings above alarm limit required to trigger alarms	5	1 - 20
BC FILT SIZE	Boxcar filter's length for concentration filter. Higher values will smooth out the concentration readings but will also increase the response time.	30	1-30
FLOW SWITCH ENABLE	Enables/disables operation of optional flow switch	OFF	ON, OFF
COMM ADDRESS	MODBUS® address for COM ports.	1	1 - 247
UNIT	Concentration unit-of-measure setting.	g/Nm^3	WT%, g/Nm^3
SCROLL DELAY	Character delay for the front panel display.	20	6-100
AZERO ENABLE	Enables/Disengages zero calibration	ON	ON/OFF
AZERO INTERVAL	Interval at which zero calibration is performed. (minutes)	720	3-1440
GAS CARRIER WEIGHT	Weight of gas without ozone, used in %Weight measurement	32.00	20.0-40.0
ANALOG RANGE	Voltage range corresponding to ozone concentration.	20	5 – 50 g/Nm3 0.5 – 25.0 wt%

7.2.5. DIAG Menu

The DIAG menu (See Figure 7-2 and Figure 7-3) contains functions that are useful for calibration and I/O testing.

7.2.5.1. Analog Step-Test

When placed in this mode, the instrument will automatically step the analog output through 5 points from 0 to 100 % and display the current value on the front panel. The operator can suspend the automatic cycling and manually control the stepping by pressing either one of the **UP** / **DOWN** arrow buttons. To resume automatic cycling, exit the function by pressing **CFG** and re-enter by pressing **ENT**.

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 7-5: Analog Step Test Values

Point	0-5V Output	4-20 mA Output
0%	0.00 V ± 0.02	4 mA ± 0.02
25%	1.25 V ± 0.02	8 mA ± 0.02
50%	2.50 V ± 0.02	12 mA ± 0.02
75%	3.75 V ± 0.02	16 mA ± 0.02
100%	5.00 V ± 0.02	20 mA ± 0.02

Press **CFG** to exit from the Analog Step-Test function.

7.2.5.2. Signal I/O

The Signal I/O menu allows the operator to manually control the various relay outputs and control inputs available on the rear panel of the 465H. This function is useful for testing or debugging external control systems (i.e. data-loggers or PLC's) to which the instrument may be connected.

See Section 4.5 for additional details on making connections to these I/O signals on the rear panel.

See Figure 7-2 and Figure 7-3 for additional details on entering the Signal I/O menu.

Table 7-6: Signal I/O List

Signal Name	Rear Panel Label	Function
AUX 1 IN	CTRL IN - 1	UNDEFINED
AUX 2 IN	CTRL IN - 2	UNDEFINED
RELAY 1	RELAY 1	SENSOR OK
RELAY 2	RELAY 2	HI ALARM
RELAY 3	RELAY 3	HI-HI ALARM
STAT OUT 1	STATUS OUT – 1	SENSOR OK
STAT OUT 2	STATUS OUT – 2	INVALID READING
STAT OUT 3	STATUS OUT – 3	CHECK LAMP
STAT OUT 4	STATUS OUT – 4	PNEUMATIC ERROR
STAT AUX 1	AUX OUT – 1	UNDEFINED
STAT AUX 2	AUX OUT – 2	UNDEFINED

7.2.5.3. Memory Reset

This function is currently disabled.

7.2.5.4. Zero Calibration

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.

The zero calibration allows the instrument to calibrate its internal ozone offset factor. This should only be done with a source of zero air connected to the "Zero In" port of the 465H. Allow the instrument to stabilize on the zero air source before attempting to zero the instrument. This normally takes 10-15 minutes.

When entering the Zero Calibration menu, the prompt "ENT TO CAL" appears on the display. Simply confirm the calibration by pressing the **ENT** button to perform the calibration (to abort the calibration, press and hold the **CFG** button to return to the previous menu level.) After pressing **ENT**, the instrument will automatically exit the menu mode and return to Concentration mode. The concentration reading should quickly go to zero.

> **NOTE**
>
> 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 0.01-0.02 Wt% in magnitude.

7.2.5.5. Span Calibration

The Span Calibration also allows the instrument to calibrate its internal ozone offset factor. The Span Calibration however, is done with some controlled concentration gas connected to the "Sample In" port of the 465H. It is recommended that a span gas is concentrated to around 80% of the operating range. Set the SPAN VALUE to the measured concentration of your calibration gas. This normally takes 10-15 minutes.

> **NOTE**
>
> A Span Calibration should only be performed with a stable source of Ozone and a reference monitor measuring the same gas supply.
>
> If you are unsure regarding the suitability of a particular source of calibration gas, contact Technical Support at Teledyne API for assistance (see Section 0.)

See Figure 7-4 shows the Span Cal menu. After the instrument has stabilized on the source of span gas, navigate to the Span Cal menu (See Figure 7-2 and Figure 7-3) and Press **ENT**. Next enter the Span Target concentration (the actual concentration of ozone being supplied to the monitor) and press **ENT**. The display will next show a confirmation menu, **ENT TO SPAN**. Press **ENT** to perform the Span Calibration, or **CFG** to abort back to the start. 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, an **OUT OF RANGE** error will be displayed. Press **ENT** to confirm and the display will return to the start of the Span Cal menu.

If the **OUT OF RANGE** error 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.
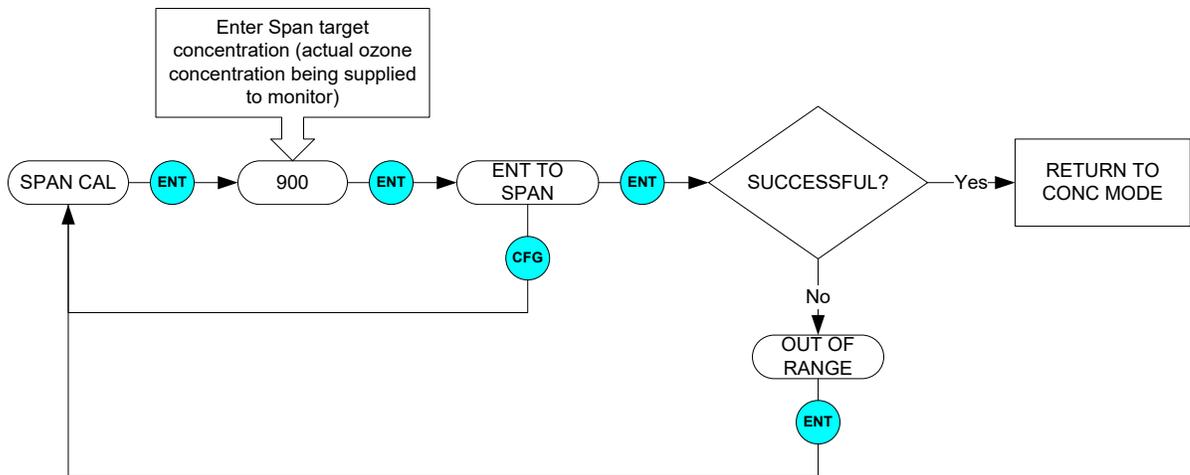
Figure 7-4: Span Cal Menu

7.2.6. VIEW Menu

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

NOTE
These values are updated in real-time as they are repeatedly scrolled on the display.

Table 7-7: VIEW Menu Parameters

Parameter	Meaning	Units	Normal Range*
MEAS	UV detector reading, measure cycle	mV	250 – 1230
REF	UV detector reading, reference cycle	mV	250 – 1230
PRESSURE	Sample pressure	psia	9.0 – 18.0
LAMP TEMP	UV lamp temperature	ºC	50.0 – 52.0
SAMPLE TEMP	Sample temperature	ºC	5.0 –50.0
FLOW	Flow Switch State **	ON/OFF	ON
*After initial 20 minute warm-up period.			
** Only available if Flow Switch Option is installed.			

7.2.7. CONFIG Menu

The CONFIG menu displays important information about the instrument. The Serial Number, COMM address settings, and the latest revision of software installed are information available in the CONFIG menu. Settings can be changed under other menus (see sections 7.2.3, 7.2.4, and 7.2.5); however the CONFIG menu just contains instrument-specific information.

7.3. Analog Output

The 465H provides an analog output of the current O_3 reading on the rear panel (see Section 4.5.2). The output can be configured for 0-5V or 4-20mA isolated current output. The analog output provides a scaled, real-time output of the current ozone concentration being measured by the instrument. See Section 7.2.4 for details on changing the analog output range. See Section 9.6 for details on configuring the output for 0-5 V or 4-20 mA.

8. DIGITAL COMMUNICATIONS

8.1. Digital Communications Overview

The 465H comes equipped with a digital communications (COM) port that can be connected to a computer or digital data acquisition system. This COM port uses the standardized MODBUS® protocol and can be configured for RS232, RS485, or Ethernet (10 Mbit,) allowing for connections to a wide variety of devices and networks. See Section 8.2 for more information on configuring the COM port.

The COM port 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 COM port.

NOTE
The APICOM software provided by Teledyne API does not currently support communications with the 465H. Contact TAPI for more information on compatible MODBUS® software that can be used with the 465H.

8.2. Changing COM Port Hardware Configuration
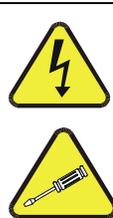
WARNING: Electrical Shock Hazard

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

The COM port can be configured for RS232, RS485, or Ethernet. To change the COM port hardware configuration, perform the following steps:

1. Disconnect power from the 465H.

2. Remove the six screws and the top cover.

3. Locate the DIP switches labeled SW3 on the rear portion of the mainboard.

4. Turn ON the switches specified for the desired COM configuration (See Figure 8-1.) All other switches on SW3 should be OFF.

5. Locate SW2 (DTE-DCE switch) on mainboard.

6. For RS-232 operation, set SW2 to either DTE or DCE (See Section 8.3.) For RS-485 operation, set SW2 to DCE.

7. Re-install the instrument cover.

8. Re-connect power to the instrument.

9. The software portion of the COM port configuration will now automatically be completed after the next instrument boot-up.

RS232 Configuration

RS485 Configuration

Ethernet Configuration
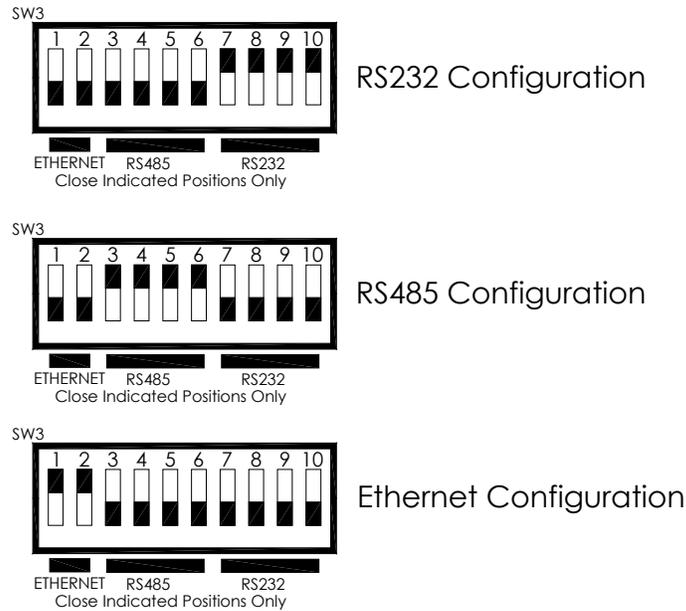
Figure 8-1: COM Configuration Jumper Settings (SW3)

8.3. RS-232 Configuration

The RS-232 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 RS-232 configuration is MODBUS® RTU. For details on the MODBUS® RTU specification, please see http://www.modbus.org/.

With the instrument configured for RS-232, connection can be made to the DB-9 connector, labeled "RS232/485", or to the three "COM" pins on the "General I/O" connector. Only one of these connections should be used, the other must be left unconnected. Table 8-1 below details the pinouts of these two connectors:

Table 8-1: RS-232 Connector Details

Function	DB-9 Connector Pin (SW2 – DTE)	DB-9 Connector Pin (SW2 – DCE)	General I/O Connector
Transmit (Tx)	3	2	'T'
Receive (Rx)	2	3	'R'
Ground	5	5	'G'

NOTE

A DTE-DCE switch is provided so that the instrument can be connected to another device using either a straight-through or crossover (Null-Modem) cable. See Section 8.2 for details on changing this configuration.

The serial port setup for RS-232 configuration is shown in Table 8-2 below:

Table 8-2: RS-232 Port Setup

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

8.4. RS-485 Configuration

RS-485 is commonly used for factory automation busses with a computer or PLC acting as a master. The communications protocol used for the RS-485 configuration is MODBUS® RTU. For details on the MODBUS® RTU specification, please see http://www.modbus.org/.

With the instrument configured for RS-485, connection can be made to the DB-9 connector, labeled "RS232/485", or to the three "COM" pins on the "General I/O" connector. Table 8-3 below details the pinouts of these two connectors:

Table 8-3: RS-485 Connector Details

Function	DB-9 Connector Pin (SW2 – DCE)	General I/O Connector
RS485 - A	2	'T'
RS485 - B	3	'R'
Ground	5	'G'

NOTE

For RS-485 configuration, the DTE-DCE switch should always be set to DCE. See Section 8.2 for details on changing this configuration.

The serial port setup for RS-485 configuration is shown in Table 8-4 below:

Table 8-4: RS-485 Port Setup

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

8.5. Ethernet Configuration

Ethernet is commonly used for factory automation busses with a computer or PLC acting as a master. The communications protocol used for the Ethernet configuration is MODBUS® TCP/IP. For details on the MODBUS® TCP/IP specification, please see http://www.modbus.org/.

A Windows software application, *DeviceInstaller*, is available for configuring the Ethernet module used in the 465H. This application is available for download here:

http://www.lantronix.com/device-networking/utilities-tools/device-installer.html

8.5.1. Hardware Setup for Configuring the Ethernet Module

To make the first-time configuration of the Ethernet module as easy as possible, the module comes from the factory with DHCP enabled. The 465H can simply be plugged into a network with a DHCP server and an IP Address should be automatically assigned to, and stored in, the device.

A simple network can easily be constructed for this purpose by using a small broadband router commonly used for home networks. The 465H and a PC can then be connected to the router and the router's DHCP server will assign IP Addresses to both the PC and the 465H, enabling them to communicate.

8.5.2. Verifying Network Hardware Connection

With the 465H connected to a network and powered up, check the status of the two LED's on the Ethernet connector on the rear panel. The left-hand LED should be lit; either amber or green indicating link status and the right-hand led should blink periodically, indicating activity on the network. See Table 8-5 below for more details on the status LED's.

If neither of the LED's are lit, then the Ethernet module may not be powered up or the instrument may not be connected to a valid network. Check the COM port configuration per Section 8.2 and make sure that it is set to "Ethernet."

Table 8-5: Ethernet LED Definitions

Link LED (Left Side)		Activity LED (Right Side)	
Color	Meaning	Color	Meaning
Off	No Link	Off	No Activity
Amber	10 Mbps Connection	Amber	Half-Duplex
Green	100 Mbps Connection	Green	Full-Duplex

8.5.3. Determining a Dynamically Assigned IP Address (DHCP Mode)

The *DeviceInstaller* software application (See Section 8.5) can be used to search a network for instruments and determine the IP Address assigned by a DHCP server.

1. Click **Start->Programs->Lantronix DeviceInstaller->DeviceInstaller.** If your PC has more than one network adapter, a message displays. Select an adapter and click **OK**.

2. Click on the **Search** icon. After a moment a list of instruments on the network will be displayed. The 465H should be listed as an **XPORT-IAP** type device.

3. Double-click on the device in the right-hand section of the *DeviceInstaller* window; a list of configuration parameters will be shown, including the IP Address. If multiple devices are shown, the correct one can be determined by matching the Hardware Address shown with the address printed on the label of the Ethernet module in the 465H.

NOTE
The instrument cover must be removed to inspect this address in the instrument.

8.5.4. Manually Assigning a Static IP Address

For applications where the IP Address must remain constant, a static IP Address can be manually assigned to the instrument and the DHCP function must be disabled.

1. Click **Start->Programs->Lantronix DeviceInstaller->DeviceInstaller.** If your PC has more than one network adapter, a message displays. Select an adapter and click **OK**.

NOTE
If the unit already has an IP address (e.g., DHCP has assigned an IP address), click the Search icon and select the unit from the list of Lantronix device servers on the local network.

2. Click the **Assign IP** icon.

3. If prompted, enter the hardware address (on the product label) and click **Next**.

4. Select **Assign a specific IP address** and click **Next**.

5. Enter the **IP address**. The **Subnet mask** displays automatically based on the IP address; if desired, you may change it. On a local network, you can leave the **Default gateway** blank (all zeros). Click **Next**.

6. Click the **Assign** button and wait several seconds until a confirmation message displays. Click **Finish**.

7. Select the device from the main window list and select **Ping** from the **Tools** menu. The Ping Device dialog box shows the IP address of the selected unit.

8. From the **Tools** menu, click the **Ping** button. The results display in the Status window. Click the **Clear Status** button to clear the window so you can ping the device again.

> **NOTE**
>
> If you do not receive "Reply" messages, make sure the unit is properly attached to the network and that the IP address assigned is valid for the particular network segment you are working with. If you are not sure, check with your systems administrator.

9. Click the **Close** button to close the dialog box and return to the main window.

8.6. MODBUS® Register Maps

8.6.1. Notes on MODBUS® registers

Concentration values in the MODBUS® registers are always expressed in terms of the desired 465H settings, whether in %WT or g/Nm^3.

8.6.2. Real-Time Concentration and Status Registers (Read Only)

Decimal Address	Description	Register Type	Start Bit	# Bits
1	Stream Concentration	Float Inverse	0	32
3	Hi Alarm Status	Byte	0	8
3	Hi Hi Alarm Status	Byte	8	8
4	Gas Flow (cc/min)	Float Inverse	0	32
19	Sensor Reference Value	Float Inverse	0	32
21	Sensor Measure Value (mV)	Float Inverse	0	32
23	Sensor Pressure Value (mV)	Float Inverse	0	32
25	Sensor Gas Temperature (K)	Float Inverse	0	32
27	Sensor UV Lamp Temperature (ºC)	Float Inverse	0	32

8.6.3. Instrument Setup and Configuration Registers (Read / Write)

Decimal Address	Description	Register Type	Start Bit	# Bits
1030	Hi Alarm Value (WT%)	Float Inverse	0	32
1032	Hi Hi Alarm Value (WT%)	Float Inverse	0	32
1034	Hi Alarm Enable (WT%)	Byte	0	8
1034	Hi Hi Alarm Enable (WT%)	Byte	8	8
1035	Alarm Latch Mode	Byte	0	8
1038	Analog Range (WT%)	Float Inverse	0	32

9. MAINTENANCE

⚠⚡ ⚠🔧	**WARNING: Electrical Shock Hazard** **The operations outlined in this section are to be performed by qualified maintenance personnel only!**

9.1. Maintenance Schedule

Table 9-1 outlines the suggested maintenance procedures and intervals for ensuring the 465H continues to operate accurately and reliably.

Table 9-1: Maintenance Schedule

Maintenance Item	Recommended Interval	Section
Replace particulate filter	6 months	9.3
Adjust UV lamp	As Indicated by 'Check Lamp' LED or status output	9.4
Replace lamp	As required; when adjustment can no longer be performed.	9.5
Replace Auto Zero Valve	Annually	9.6
Rebuild cell, replace o-rings	3 Years	Return to Factory

9.2. Instrument Layout

Figure 9-2 show the instrument layout of the 465H. These figures will be referenced in the procedures that follow.

UV DETECTOR ADJUSTMENT POT, PR3

UV DETECTOR ADJUSTMENT POT, PR4

AUTO-ZERO VALVE

OZONE INLET FLOW CONTROL

ZERO GAS INLET FLOW CONTROL

MAINBOARD PCA

PARTICULATE FILTER HOUSING

UV LAMP

SENSOR ASSEMBLY

OZONE DESTRUCT
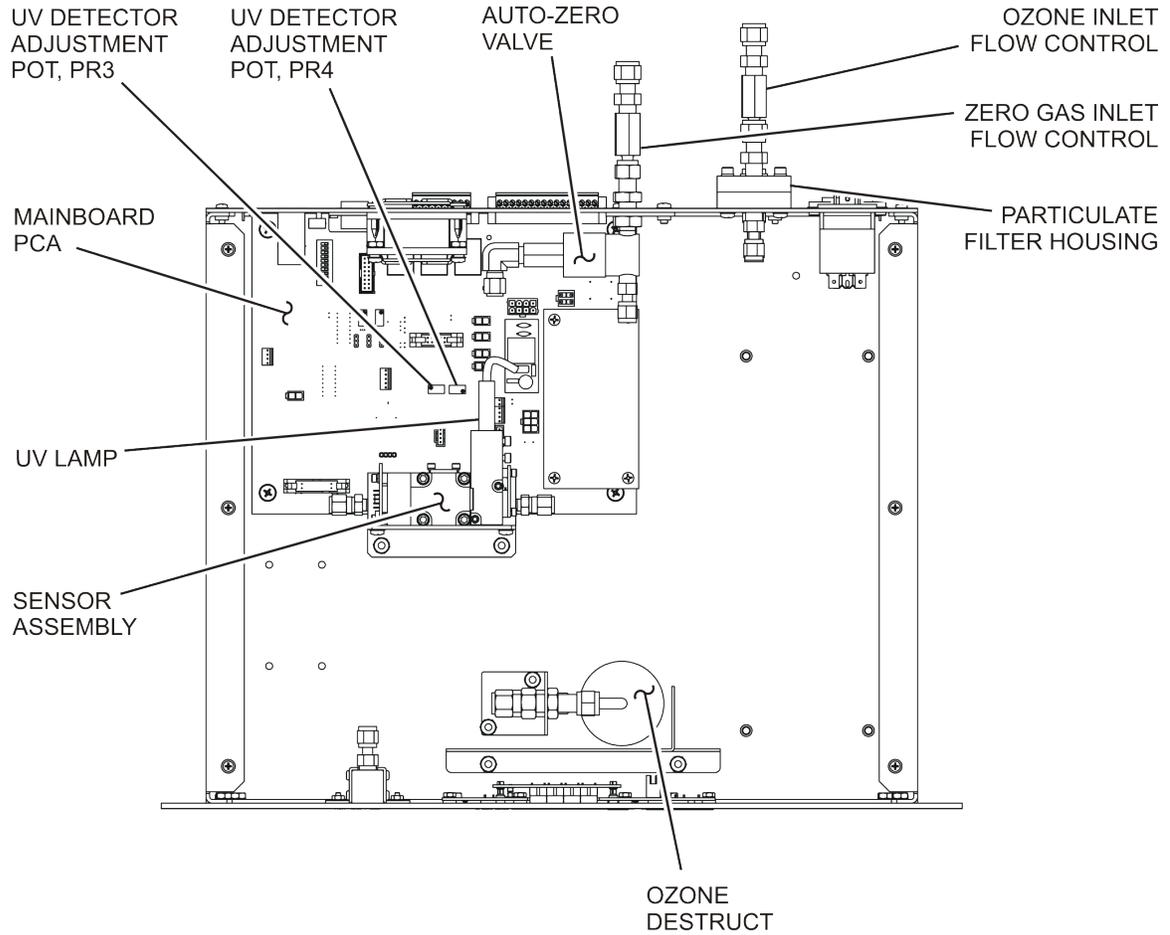
Figure 9-1: Instrument Layout, Rack Mount Configuration

SENSOR
MODULE

UV DETECTOR
ADJUSTMENT
POT, PR4

UV DETECTOR
ADJUSTMENT
POT, PR3

UV LAMP

AC/DC
POWER
SUPPLY

MAINBOARD
PCA

OZONE
DESTRUCT

AC POWER
CONNECTOR
(CAUTION - HIGH
VOLTAGE AREA)

AUTO-ZERO
VALVE

PARTICULATE
FILTER HOUSING

ZERO GAS INLET
FLOW CONTROL

OZONE INLET FLOW
CONTROL
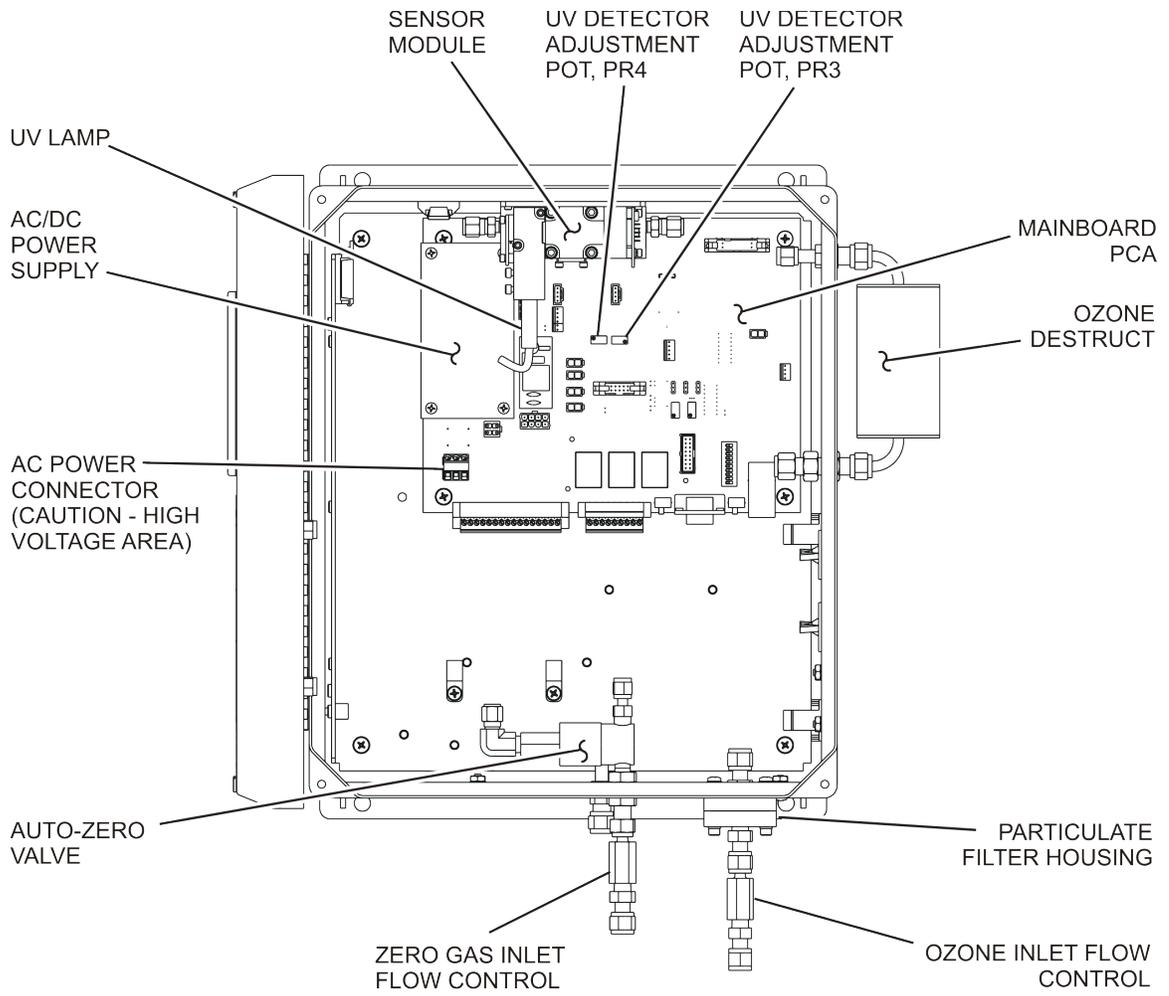
Figure 9-2: Instrument Layout, NEMA Configuration

9.3. Replacing Internal Particulate Filter

1. Disconnect power from the 465H.

2. Loosen the six screws from the top cover (Rack Mount Configuration, see Figure 9-1) or open front panel (NEMA Configuration, see Figure 9-2.)

3. Remove the six screws and top cover from the instrument.

4. Locate the particulate housing filter on the rear panel (Rack Mount Configuration, see Figure 9-1) or the bottom panel (NEMA Configuration, see Figure 9-2.)

5. Loosen the four screws on the sample filter body (see Figure 9-3.)

6. Remove the fours screws, the four washers and the sample filter body from the sample filter base.

7. Remove the o-ring and inspect for any cracks or deformities. If there are no cracks or deformities, place the o-ring back in the sample filter body.

NOTE
If the o-ring is cracked or deformed, discard the o-ring and replace with a new one.

8. Remove the two sample filter retainers and glass fiber filter element from the sample filter body.

9. Discard the glass fiber filter element.

10. Place a new glass fiber filter element in between the two sample filter retainers and place in the sample filter body.

11. Place the sample filter body on the sample body base and secure with the four screws and fours washers.

12. Reinstall the top cover on the instrument and secure with the six screws or close the front panel.

RACK MOUNT CONFIGURATION SHOWN
NEMA CONFIGURATION SIMILAR

GLASS FIBER SAMPLE FILTER
ASSEMBLY, P/N 03462
(USED ON BOTH CONFIGURATIONS)

CONNECTOR-M,
P/N FT0000008

WASHER,
P/N Sn0000183
(4 PLACES)

SAMPLE FILTER,
BASE, P/N 02690

CONNECTOR-M,
P/N FT0000012

GLASS FIBER
FILTER ELEMENT,
P/N EL0000017

SCREW,
P/N Sn0000210
(4 PLACES)

SAMPLE FILTER,
BODY, P/N 02689

O-RING,
PN OR0000082

SAMPLE
FILTER
RETAINER,
P/N 02814
(2 PLACES)

SCREWS
(6 PLACES, THROUGH TOP COVER)

Figure 9-3: Internal Particulate Filter Replacement

9.4. UV Lamp Adjustment

1. Instrument should be running and warmed up for at least 20 minutes.
2. With instrument running, remove the six screws and the top cover (Rack Mount Configuration) or open front panel (NEMA Configuration.)
3. Locate the Reference UV Detector adjustment pot, PR3, on the Mainboard PCA (see Figure 9-1 or Figure 9-2.)
4. Navigate the front panel menu to VIEW menu and scroll to REF display and press **ENT**. At this point there should be a scrolling display similar to "REF = XXXX MV." See Section 7.2 for details on menu navigation.
5. 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.**
6. Locate the Measure UV Detector adjustment pot, PR4, on the mainboard PCA (see Figure 9-1 or Figure 9-2.)
7. Navigate the front panel menu to VIEW menu and scroll to MEAS display and press **ENT**. At this point there should be a scrolling display similar to "MEAS = XXXX MV." See Section 7.2 for details on menu navigation.
8. While observing the MEAS 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.**

9. If the required adjustment cannot be achieved by adjusting the UV Detector pot alone, then additional adjustment can be made by loosening the two UV lamp setscrews on the UV lamp housing (see Figure 9-1 or Figure 9-2) and rotating the lamp. Rotate the lamp very slowly while observing the REF or MEAS value on the display. Make sure the lamp does not pull out and remains seated in the housing while it is being rotated. Re-tighten the two setscrews when a desired point has been reached.

10. If necessary, additional "fine tuning" can now be done with the UV Detector adjustment pots per steps 4-8.

11. Re-Install instrument cover and observe REF and MEAS values on display for a couple minutes to verify it does not drift out of the adjustment range.

9.5. UV Lamp Replacement

1. Disconnect power from the 465H.
2. Remove the six screws and the top cover (Rack Mount Configuration) or open front panel (NEMA Configuration.)
3. Loosen the two UV lamp setscrews on the UV lamp housing (see Figure 9-1 or Figure 9-2.)
4. Unplug the lamp power cord from the connector labeled J18 on the mainboard PCA.
5. Carefully slide the lamp out of housing.
6. Install the new lamp, seating it in the lamp housing until it stops.
7. Re-tighten the two UV lamp setscrews.
8. Plug the lamp power cord into J18 on the mainboard PCA.
9. Reconnect power to the instrument and turn on power switch. Let instrument warm up for at least 20 minutes.
10. Perform UV lamp adjustment procedure per Section 9.4.

9.6. Replacing the Auto-Zero Valve

1. Disconnect power from the 465H.

2. Remove the six screws and the top cover (Rack Mount Configuration) or open front panel (NEMA Configuration.)

3. Locate the auto-zero valve (See Figure 9-1 or Figure 9-2.)

4. Unplug the two-pin valve connector from the mainboard PCA.

5. Remove the 1/8" fittings from the valve.

6. Remove the bulkhead nut (from outside the panel: bottom in NEMA, rear in Rack Mount). Note the orientation of the valve body so that the new valve can be installed in the same orientation.

7. Remove valve body from the bulkhead.

8. Clean any residue or dirt off the surface of the bulkhead using a lint-free cloth and distilled or DI water.

9. Install the new valve by reversing steps 1-7.

9.7. Configuring the Analog Output

The analog output can be configured for either 0-5V DC or 4-20mA operation. To change or verify the configuration of the analog output:

1. Disconnect power from the 465H.

2. Remove the six screws and the top cover (Rack Mount Configuration) or open front panel (NEMA Configuration.)

3. Locate the Mainboard PCA (see Figure 9-1 or Figure 9-2).

4. Set the desired operation as shown in Figure 9-4.

5. Re-Install the top cover or re-secure the front panel (NEMA Configuration.)

Figure 9-4: Mainboard – Analog Output Configuration
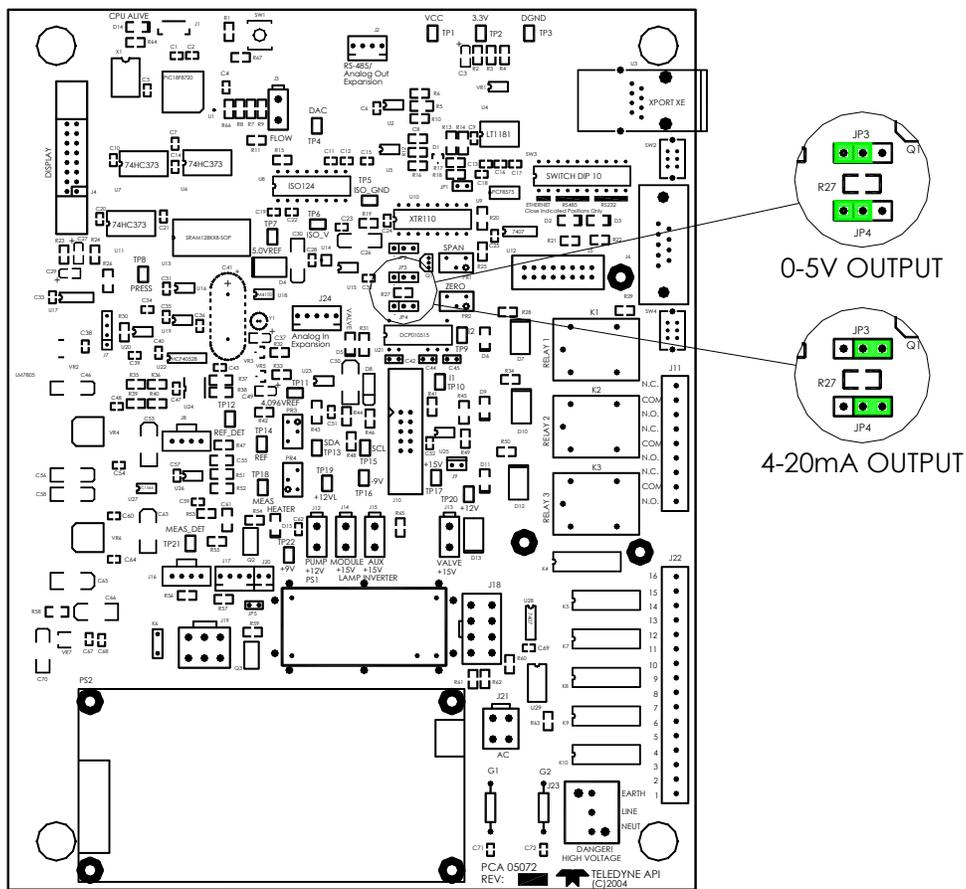
9.8. Cleaning Exterior Surfaces of the 465H

If necessary, the front panel mask and keyboard of the 465H 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.

9.9. Boot Loader Operation

The main function of a boot loader is to load or update the firmware to the microcontroller on the Printed Circuit Board (PCB) of an instrument. There are two types of boot loader setup: hardware and software, described in the following sections.

NOTE
When an external MODBUS host device is attempting to communicate with the instrument over the serial or Ethernet port while the instrument is starting up, the instrument may halt. In order to prevent the problem from occurring, ensure that there are no devices attempting communication with the instrument during start-up. Once the sign-on message is displayed on the front panel, it is safe to begin communications.

9.9.1. Boot Loader – Hardware Setup

Verify that the instrument is configured for an RS-232 connection. See Section 8.2 for details on changing the COM port configuration. The instrument can be connected to the PC COM port using a 9-pin serial cable (TAPI P/N WR77).

9.9.2. Boot Loader – Software Setup

Table 9-2 lists the required firmware loader software and firmware options.

Table 9-2: Required Software

SOFTWARE TYPE	FILE TYPE/VERSION
PC Software	FirmwareLoader.EXE
Instrument Firmware	05498-00_XX.HEX (for ppb, ppm, ugm)
	05498-01_XX.HEX (for ppb, ppm, pphm)

The firmware loader is available on Teledyne API's website at http://www.teledyne-api.com/software/.

1. Install the firmware loader software onto a PC.

2. Verify the cable connections. Do not power up the instrument.

3. Run the firmware loader application on the PC.

4. Select the COM port that the instrument is connected to.

5. Select the HEX file for the appropriate firmware.

6. Refer to Section 9.9.2.1 to upload the firmware or to Section 9.9.2.2 to verify the firmware.

9.9.2.1. Upload Firmware

1. Press "Write". The screen will display, "Wait for boot loader".

2. When the screen displays, "Power cycle instrument now", power up the instrument.

NOTE
Search for boot loader will time out in 20 seconds. If the instrument is not powered up in 20 seconds, the screen will display, "No boot loader detected." Go back to step 1 to rewrite the firmware.

   The firmware loader software should display a message "Boot loader found, uploading…". If this message is not displayed, power down the instrument and receck the COM port configuration and cable (see Section 9.9.1) and retry.

3. When the upload is complete, a message, "Write-flash completed successfully" should be displayed. If it is an unsuccessful upload, a message, "Write-flash error" is displayed. If a Write-flash error occurs, ensure that the correct PC COM port is selected for the instrument (see Section 9.9.2, step 4).

NOTE
It is not recommended to stop the writing process half way through. This will cause the firmware to not be fully uploaded.

9.9.2.2. Verify Firmware

The verify function compares the instrument's current firmware to the selected HEX file (see Section 9.9.2, step 5) and confirms whether or not the files are a match.

1. Press "Verify". The screen will display, "Wait for boot loader".

2. When the screen displays, "Power cycle instrument now", power up the instrument.

NOTE
Search for boot loader will time out in 20 seconds. If the instrument is not powered up in 20 seconds, the screen will display, "No boot loader detected." Go back to step 1 to verify the firmware.

   The firmware loader software should display a message "Boot loader found, verifying…". If this message is not displayed, power down the instrument and receck the COM port configuration and cable (see Section 9.9.1) and retry.

3. When the upload is complete, a message, "Verify-flash completed successfully" should be displayed. If it is an unsuccessful upload, a message "Verify-flash error" is displayed. If a Verify-flash error occurs, ensure that the correct PC COM port is selected for the instrument (see Section 9.9.2, step 4).

NOTE
A verification process can be stopped at any point in time. This will not affect the firmware that is already uploaded on the instrument. The instrument will automatically go to the firmware in 10 seconds.

10. TROUBLESHOOTING

	WARNING: Electrical Shock Hazard
	The operations outlined in this section are to be performed by qualified maintenance personnel only!

10.1. Reference Drawings

The drawings contained in this section are for general reference and may be useful when performing certain troubleshooting activities.

10.1.1. Pneumatic Diagram

Figure 10-1 is a pneumatic diagram that can be referenced when performing troubleshooting on the monitor.
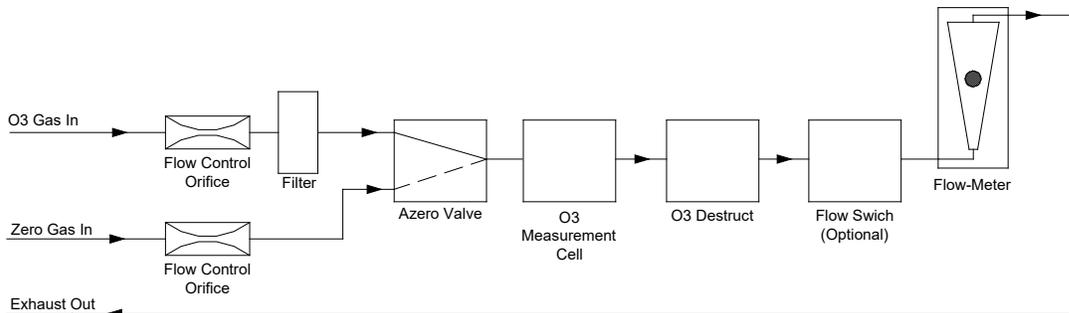
Figure 10-1: Pneumatic Diagram

10.1.2. Interconnect Diagram

Figure 10-2 provide details on the electrical connections between the various electronic modules in the 465H.
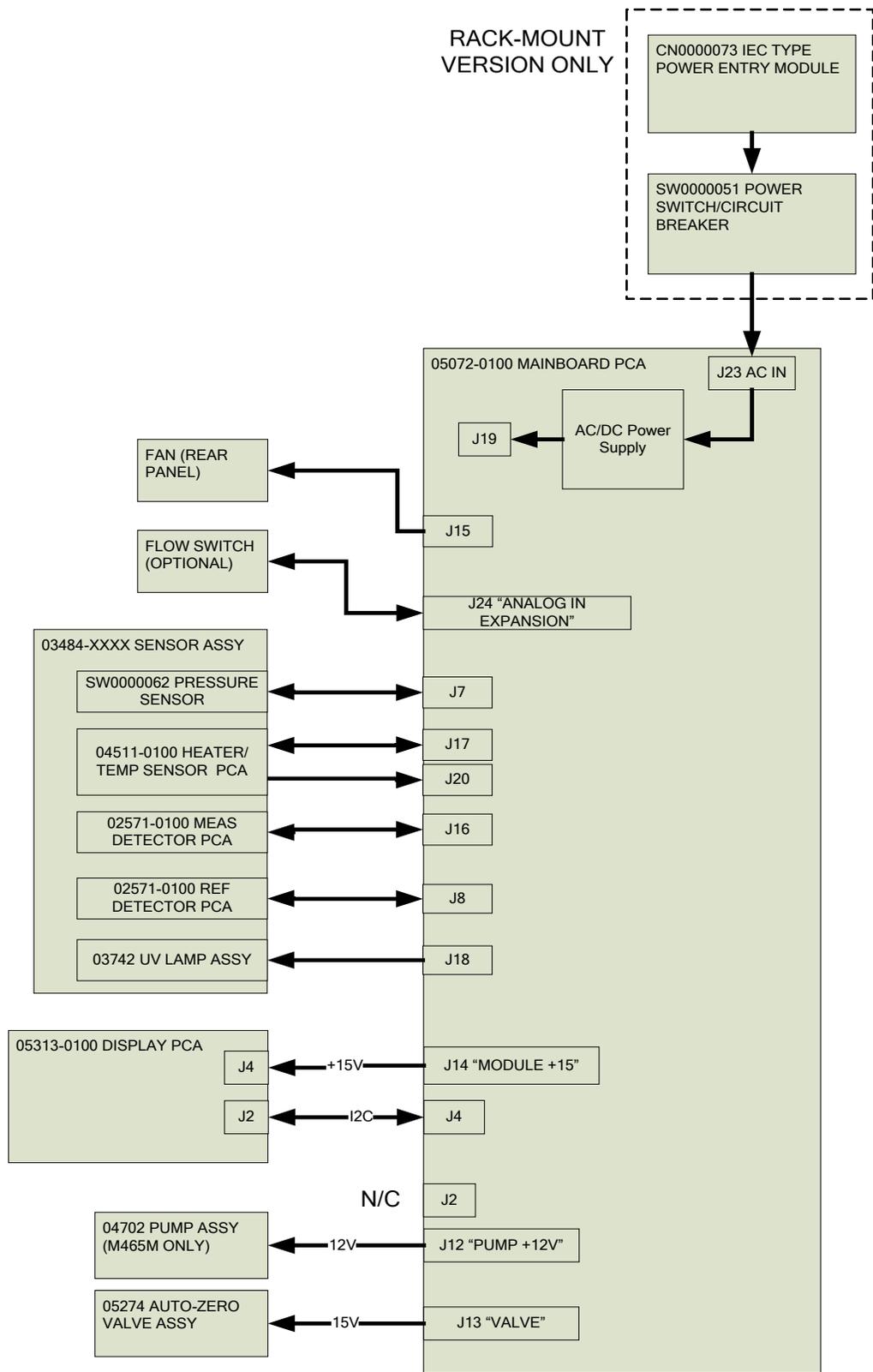
Figure 10-2: Interconnect Diagram

10.2. Troubleshooting Using Front Panel Status LED's or Status Outputs

The 465H has 4 front-panel status LED's that reflect the current operating status of the monitor, and indicate fault conditions. There are also four relay Status Outputs on the rear panel (or internally in the NEMA configuration) that also reflect the state of these status LED's. See Section 4.5.3 for more information on the Status Outputs.

The Status LED's 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.

Table 10-1: Status LED/Output Definitions

Status Output #	Status LED Label	Normal Operating State	Triggers	Critical Warning?
1	Sensor OK	On	• Reference < 125.0 mV • Measure > 1230.0 mV	Yes
2	Invalid Reading	Off	• O3 Concentration < -0.5 WT% • O3 Concentration > Analog Range	No
3	Check Lamp	Off	• Reference < 250.0 mV	No
4	Pneumatic Error	Off	• Pressure < 9.0 psia • Pressure > 18.0 psia • Flow < 500 cc/min	No
*If Flow Switch Option installed				

10.2.1. Sensor OK

The Sensor OK LED indicates the status of the O_3 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 Lamp. A UV Lamp Adjustment (See Section 9.4) should be attempted. If the UV Lamp cannot be adjusted to meet the specified values, then a UV Lamp Replacement should be performed (See Section 9.5.)

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 Section 9.2 for monitor layout.) If no cable problem can be found, then the Sensor Module should be replaced.

10.2.2. 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 7.2.5.4.

If the monitor is consistently reading values in excess of the full-scale range, then the range value should be adjusted higher. See Section 7.2.4 for details on setting the range value.

10.2.3. Check Lamp

The Check Lamp LED indicates that the UV Lamp intensity has dropped below 250mV, a level where UV Lamp Adjustment (See Section 9.4) 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 Lamp intensity drops below 125mV, then the Sensor OK LED will also turn off, indicating that the monitor must be immediately serviced or taken off-line.

10.2.4. 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 7.2.6.) Examine the Flow and Pressure values and compare them to the limits described in Table 10-1 and take appropriate action as described below.

10.2.4.1. Pressure Too High

a. 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).

b. 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.

c. The pressure sensor has failed or drifted. To check the pressure sensor, disconnect the input gas and allow the monitor pressure to read ambient pressure. On the mainboard PCA measure the voltage between Ground (TP3) and the pressure signal (TP8.) This voltage should read between 1.15 – 1.34 V when measuring ambient (atmospheric) pressure. If the voltage is outside this range, then the pressure sensor should be replaced.

10.2.4.2. Pressure Too Low

a. The exhaust line is connected to a vacuum source. Disconnect exhaust line and see if pressure returns to specified range.

b. The pressure sensor has failed or drifted. To check the pressure sensor, disconnect the input gas and allow the monitor pressure to read ambient pressure. On the mainboard PCA measure the voltage between Ground (TP3) and the pressure signal (TP8.) This voltage should read between 1.15 – 1.34 V when measuring ambient (atmospheric) pressure. If the voltage is outside this range, then the pressure sensor should be replaced. Contact Teledyne API Technical Spport for assistance.

11. CALIBRATION

⚠️⚠️	**WARNING: Electrical Shock Hazard** **The operations outlined in this section are to be performed by qualified maintenance personnel only!**

11.1. Factory Calibration

The 465H is calibrated to internal Teledyne API (TAPI) calibration standards to shipment. A calibration certificate for your instrument can be purchased from TAPI if required. TAPI also recommends that the 465H be re-calibrated once a year. TAPI can provide NIST traceable calibration services at our factory or on-site. Please contact our Technical Support department for details on these services (see Section 12).

12. 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:	800-324-5190
Phone:	+1 858-657-9800
Fax:	+1 858-657-9816
Email:	api-techsupport@teledyne.com
Website:	http://www.Teledyne-API.com