IN USA™

H1 Series
OZONE ANALYZERS
Installation and Use Manual

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GENERAL NOTES

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- This product should only be used as specified by this manual. Any use other than as specified may impair the safety features of the system. This product is not intended or recommended by IN USA™ for use in (a) medical therapy or physical therapy of any kind whether as a direct or adjunct part of such therapy, including, without limitation, life support (i.e., critical medical) applications or (b) any nuclear facility applications. IN USA™ will not knowingly sell this product for use in such applications. Use of the IN USA™ product in connection with medical or like treatment cannot be reasonably expected to produce accurate monitorings of therapy or treatment and may cause failure of the life support device or significantly affect its safety or effectiveness. Use by any direct purchaser or after-market purchaser in such applications whether or not known to IN USA™ shall absolve IN USA™ of any responsibility or liability to such purchaser (s) or to any person (s) subjected to or affected by such use knowingly or unknowingly.

CONFIGURATION

MODEL	
SERIAL NUMBER	
CPU REV	
HVPS REV	
PRE-AMP REV	
KEYBOARD REV	
SOFTWARE VERSION	
CELL CONSTANT	
CALIBRATION DATE/INITIALS	
CELL VALUE AND DATE	

INSTALLED/SUPPLIED OPTIONS		PRESSURE AND TEMPERATURE
		AUTOZERO
		OTHER:
ENCLOSURE		NEMA 4X / IP65
		BENCHTOP
		19” RACK
		OTHER:
AC VOLTAGE SERVICE		115 VAC
		220 VAC
		UNIVERSAL (100-240 VAC)
		SPECIFIED VOLTAGE ONLY:
INLET/OUTLET FITTINGS		1/8" COMPRESSION
		1/4” COMPRESSION
		1/4" MALE VCR® COMPATIBLE
		OTHER:
INTERNAL TUBING TYPE		TEFLON®
		STAINLESS STEEL
FLOWMETER TYPE		PG SERIES
		FM SERIES
		VALVED
ACCESSORIES		INLET PARTICLE FILTER
Modifications/Notes		

Contents

1 Introduction/Safety

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1.1 General safety guidelines

⚠ WARNING

Use this product ONLY as detailed in this manual.
This product is not intended or recommended by IN USA for use in (a) medical therapy or physical therapy of any kind whether as a direct or adjunct part of such therapy, including, without limitation, life support (i.e., critical medical) applications or (b) any nuclear facility applications. IN USA will not knowingly sell this product for use in such applications. Use of the IN USA product in connection with medical or like treatment cannot be reasonably expected to produce accurate monitorings of therapy or treatment and may cause failure of the life support device or significantly affect its safety or effectiveness. Use by any direct purchaser or after-market purchaser in such applications whether or not known to IN USA shall absolve IN USA of any responsibility or liability to such purchaser (s) or to any person (s) subjected to or affected by such use knowingly or unknowingly.

⚠ WARNING

Ozone (O_3) is a toxic gas. High concentrations of ozone are dangerous and harmful to humans. Take reasonable steps to avoid exposure. The current maximum 8-hour exposure limit for ozone is 0.1 ppm (according to U.S. OSHA).

- Install appropriate safety monitoring equipment wherever high concentrations of ozone are used. *IN USA, INC*. manufactures several ozone monitors for workplace safety applications.
- Materials in contact with high concentrations of ozone should be suitable for such use. 316L Stainless, Teflon®, Chemraz® and Kynar® are recommended.
- Use only stainless steel gaskets for VCR® gas connections
- Ozone must be destroyed before it can be released to exhaust. IN USA, Inc. manufactures a complete line of ozone destruction equipment. Please consult with us for your ozone destruction requirements.
- Never attempt to open ozone catalyst canisters (if supplied). The content of the canisters can be hazardous if not handled properly.

Use only *IN USA, INC*. recommended spare parts. Substitution parts could result in damage to the equipment and may create hazardous conditions and will void the warranty.

⚠ WARNING

Leak Hazard!

USE ONLY MATERIALS WHICH ARE RESISTANT TO HIGH OZONE CONCENTRATIONS SUCH AS TEFLON® and 316L Stainless Steel.
Materials in contact with ozone should be suitable for such use. 316L Stainless, Teflon®, Chemraz® and Kynar® are recommended.

EXPOSURE TO OZONE IS HAZARDOUS. ENSURE THAT ALL GAS CONNECTIONS ARE TIGHT AND THAT NO LEAKS EXIST. THE EXHAUST STREAM WILL TYPICALLY CONTAIN LARGE AMOUNTS OF OZONE. ENSURE PROPER MEANS OF SAFELY DISPOSING OF THE OZONE CONTENT OF THE EXHAUST STREAM. PLEASE CONTACT ***IN USA, INC.*** FOR TECHNICAL ADVICE OR TO ASK ABOUT AVAILABLE OZONE DESTRUCTION UNITS.

⚠ WARNING

UV RADIATION HAZARD

Remove all power from the system before servicing the UV lamp.

NEVER PULL THE LAMP OUT ENTIRELY OF ITS HOUSING WHEN POWER IS ON. DO NOT LOOK AT THE LIGHTED PART OF THE LAMP WITHOUT PROPER EYE PROTECTION.

DO NOT look directly at a UV lamp as irreversible, disabling eye damage can occur. Always wear proper eye protection equipment to prevent accidental exposure.

⚠ WARNING

Electrical Shock Hazard!

DO NOT OPEN COVERS to the ozone analyzer or any panel to access electrical equipment with the power on, unless you are certified to perform specific troubleshooting/repair tasks.

When performing any maintenance to the unit, make sure all AC power is disconnected from the unit.

⚠ WARNING

Burn Hazard!

Certain components may be hot to the touch. Please allow proper cooling time before working with these components.

⚠ CAUTION

Read the operating manual before operating the unit.

Do not subject the unit to extreme physical or thermal shock.

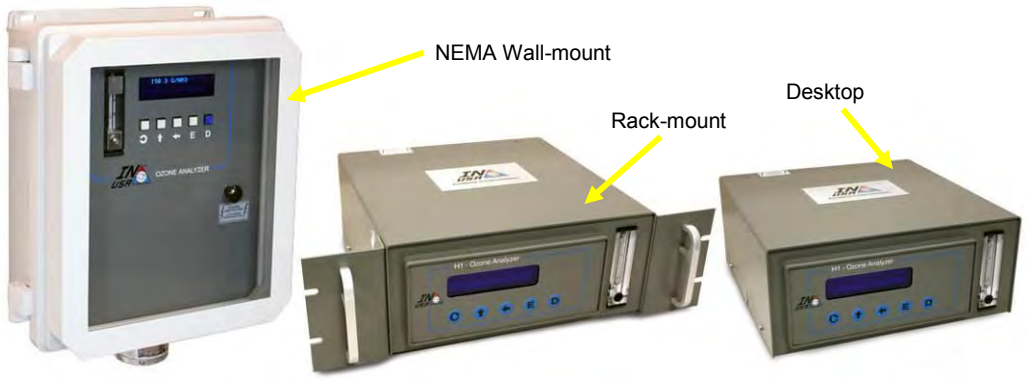
Use care in handling the unit and any of its components.

DO NOT use this equipment in any manner not specified by the manufacturer. If the equipment is used in a manner other than as specified in this document, the safety protections may be impaired.

2 System Overview

2.1 System Overview

The H1 series Ozone Analyzers are ultraviolet (UV) absorption analyzers designed for the monitoring of high concentrations of ozone in the gaseous phase. The system is available for use as NEMA wall-mount unit, rack-mount, or desktop configuration.



Applications include:

- Ozone generator output monitoring
- Ultrapure water systems
- Pharmaceutical industry
- Water treatment applications
- Other industrial processes

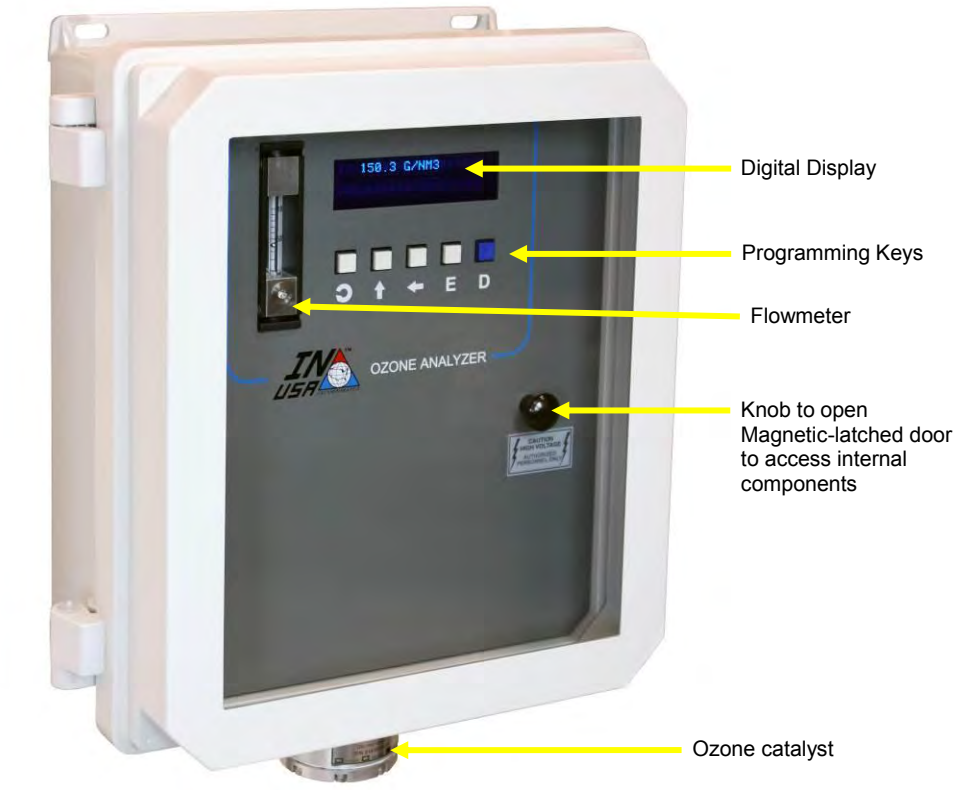
Features include:

- High accuracy UV absorption method
- Ranges up to 400 g/m^3
- Automatic, continuous sample flow
- Microprocessor-controlled
- Analog and Digital I/O built-in
- User programmable alarm relays
- Continuous internal diagnostics
- No solenoid valves, no external reference
- Molecular weight compensation
- Automatic sample pressure and temperature compensation option
- Automatic auto-zero

Models:

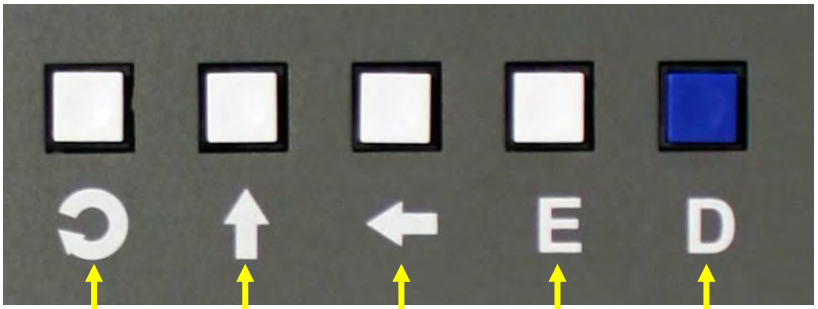
- H1- LR: 0 - 50 g/m^3 (4 %wt)
- H1- S: 0 - 125 g/m^3 (10 %wt)
- H1- X: 0 - 200 g/m^3 (16 %wt)
- H1- UH: 0 - 400 g/m^3 (28 %wt)

Major External Components:



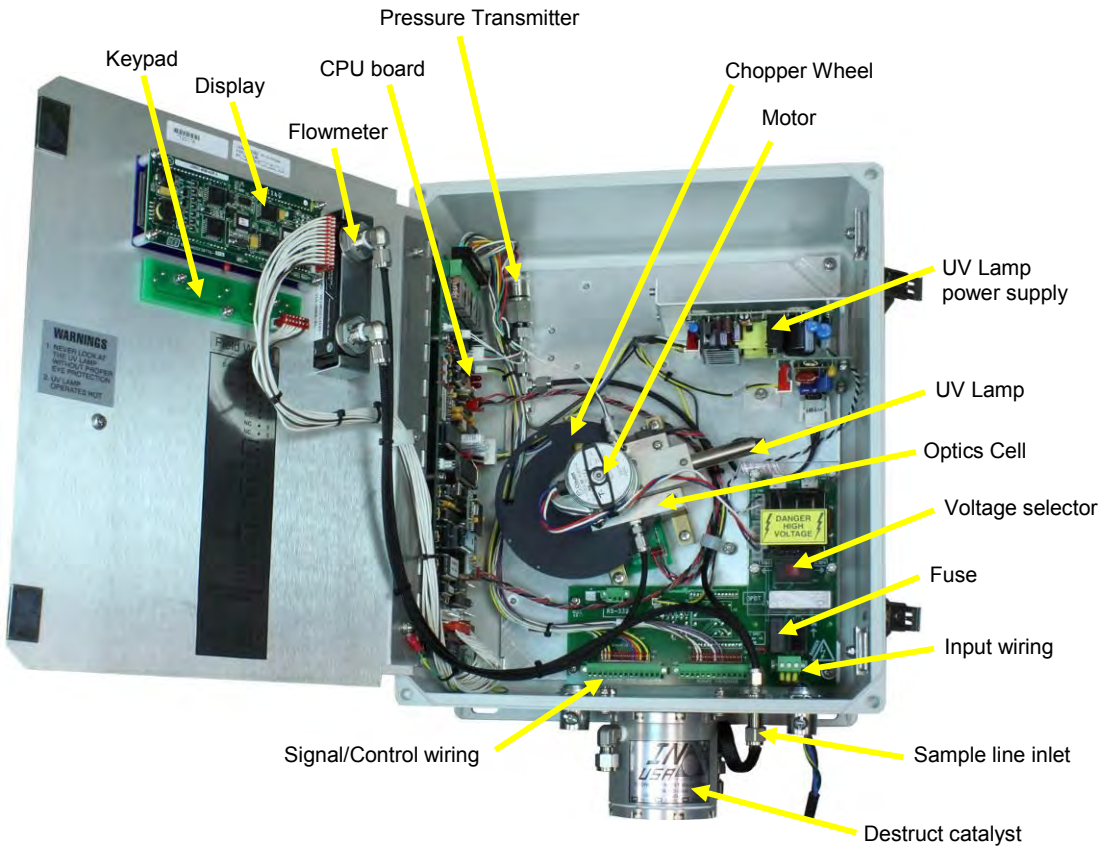
Major Components – Wall-Mount Unit

Programming Keys:



Major Internal Components:

Major internal components are highlighted below for the wall-mount unit. Identical components are installed in the desktop and rack-mount unit (location of components and layout varies, optional equipment locations are noted).



Major Internal Components (Wall mount unit)

Pressure and Temperature Compensation:

The Pressure and Temperature (P&T) consists of a Stainless Steel chamber fitted with an absolute pressure transducer and with a temperature sensor. The P&T feature is designed to accurately measure the pressure and temperature of the ozonated gas mixture whose ozone concentration is determined in the absorption cell. The Model H1 also allows the user to select or enter the molecular weight of the carrier gas used. The three parameters of pressure, temperature, and molecular weight are used to convert ozone concentration from g/m^3 into g/Nm^3, %weight, or %volume.

All UV absorption photometers invariably measure ozone concentration as mass of ozone per unit volume of the mixture. The volume of the mixture varies with pressure and temperature according to the Universal Law of Gases.

IMPORTANT: In order to fully describe the ozone contents of a gaseous mixture in terms of mass of ozone per unit volume gas, the temperature and the pressure of the measured gas sample must be considered, as well as the molecular weight of the carrier gas.

The Model H1 maximum operating pressure is 30 PSIA. If a higher operating pressure is required, please consult with the Factory.

The pressure is displayed in the readout in any one of the following units (field selectable through the Front Panel):

- mm of Mercury, (Torr)
- Pounds per square inch absolute, (PSIA)
- millibars, (mB)

The temperature of the gas is displayed in any one of the following units (field selectable through the Front Panel):

- Degrees Centigrade (°C)
- Degrees Fahrenheit (°F)
- Degrees Kelvin (°K)

Options:

The Model H1 may include several options and accessories designed to expand its capabilities, detailed below:

AutoZero Option:

The AutoZero Function is an option offered for H1 High Concentration Ozone Analyzers which allows for the automatic zeroing of the UV analyzer with ozone-free gas flowing through the absorption cell.

The AutoZero option interfaces with an internal 3-way solenoid which at user defined intervals will allow ozone free gas to purge the measuring chamber of the analyzer and zero the instrument. The source of ozone free gas can be bottled provided by the user (e.g. oxygen or dry air lines), or it can be pumped through the analyzer by means of an on-board pump which is controlled by the AutoZero PC board.

Thermostatically Controlled Heating

Under certain environmental operating conditions, a Model H1 housed in a NEMA enclosure may be equipped with an internal thermostatically controlled heater.

NOTE: This option is factory Installed

2.2 Principle of Operation

The Model H1 UV Analyzer consists of a non-dispersive Ultra-Violet photometer capable of numerical calculations, digital data processing, digital and analog data transmission, self-diagnostics, auto-zeroing, and every other amenity that a microprocessor based electronic instrument can provide.

The analyzer operates according to the principle of absorption of electromagnetic radiation. Ozone exhibits a peak of absorption at the wave length of 253.7 nm, in the ultraviolet range of the spectrum. The sensing system of the Model H1 consists of one UV source (the UV Lamp) and a single photo-detector. The ozonated gas flows through the absorption cuvette (chamber), the Pressure and Temperature Housing (if the P&T Option is installed) and the flowmeter.

The photo-detector alternatively receives light from:

(a) the UV beam through the cuvette (Attenuated according to the amount of ozone present in the ozonated gas), and

(b) the UV beam without attenuation.

The relationship between the measured light intensities is used to calculate the ozone concentration as expressed by the Beer-Lambert equation:

$$I_s = I_r * e^{-XLC}$$

where:

I_s is the intensity of light from the sample
I_r is the intensity of light from the reference
X is the ozone absorption coefficient constant at 253.7 nm wave length
L is the length of the absorption chamber
C is the concentration of ozone in weight/volume

Since L and X are fixed quantities, by measuring the intensities I_S and I_r of UV light one can solve for the ozone concentration. The Beer-Lambert equation provides an absolute determination of ozone concentration.

The U.V. source used is a low pressure mercury lamp, and most of the radiant energy it emits is concentrated at a wavelength of 253.7 nm. The analyzer utilizes an interference optical narrow band-pass filter to ensure monochromatic operation at 253.7 nm (better than 99.5%).

The Model H1 continuously measures the intensity of the light and reports it to the electronics. The unit also checks for this intensity to be within a specified range, to allow for the diagnostics of a weak or non-performing UV Source.

The Model H1 utilizes the Beer-Lambert law to precisely calculate ozone levels. Since the Beer Lambert law relates ozone concentration to the RATIOS of the intensity of UV light not exposed to ozone to that of UV light exposed to ozone, any natural aging of the UV lamp is compensated for automatically.

In addition to ozone, the Model H1 (fitted with the T&P Option) continuously measures temperature and pressure. The temperature and pressure information, together with the molecular weight information programmed by the user, are utilized to calculate the ozone concentration in units other than g/m^3; i.e.: grams of ozone per NORMALIZED cubic meter of gas, percent by weight, and percent by volume.

Temperature and pressure can also be displayed in the alphanumeric readout.

In addition to the alpha numeric display, the ozone concentration is available as an analog current signal and as an analog voltage signal and as a digitally transmitted signal, through the RS-232 Port. Refer to Tables 1 and 2 for the pin-out of the Field Wiring Terminal Block and the RS-232 Compatible digital Serial Interface, and to Figure 4 for its location.

ACCURACY AND CALIBRATION

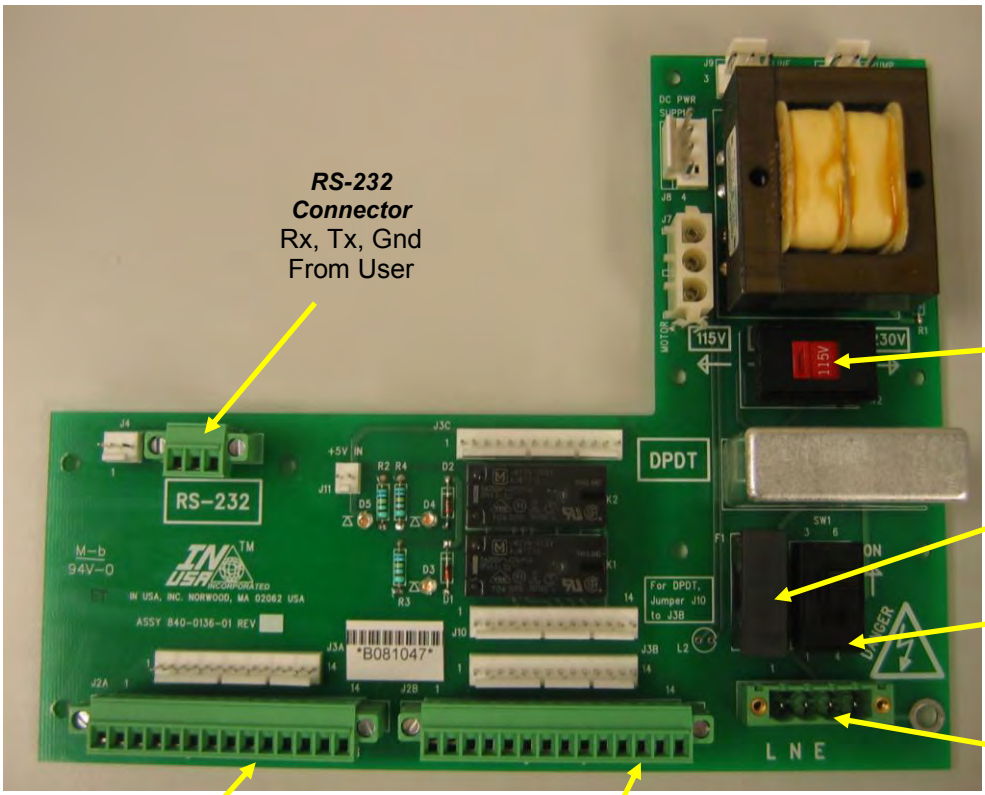
The Model H1 Analyzer has been carefully calibrated against a Factory Standard Unit. This Factory Standard Unit was calibrated by an independent analytical chemistry laboratory using the Standard KI Titration Method. A certificate of calibration and details of this procedure are available from IN USA.

The Model H1 Ozone Analyzer does not require any "span" or "gain" adjustments. The unit will always measure linearly throughout its measuring range, and the zero offset will always be zero after the zero calibration procedure.

2.3 System Internal Field Wiring Board

A field wiring board is provided in the system to provide power and control wiring connections. External connectors are provided at the rear of the rack-mount units. Direct wiring to the Field Wiring board is required in the wall-mount unit.

The system is factory set and tested at either 115 VAC or 230 VAC.

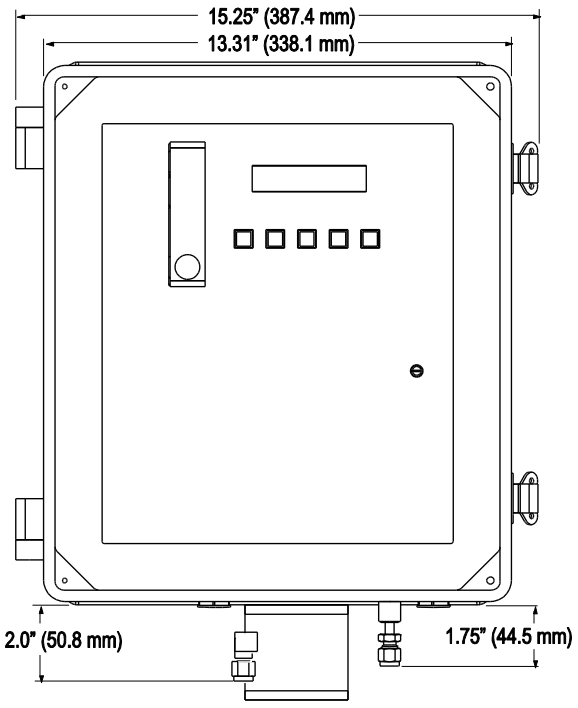


2.4 System Dimensions

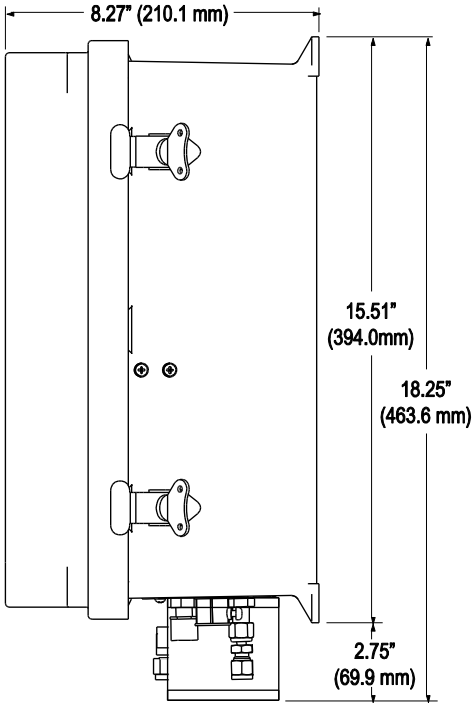
The H1 is available in multiple configurations to match end-user usage needs: bench-top, 19" rack installation, or wall mounting. The instrument should be used in areas where the operating conditions are within the envelope defined under General Specifications, and where free air circulation is provided for convection cooling. Never install outdoors without proper protection from sun and severe weather conditions.

***Note**: If the analyzer is rack mounted, it should either have side rails or be supported in the back to reduce stress on the front panel. The front panel mounting "ears" are not robust enough to support the weight of the unit.*

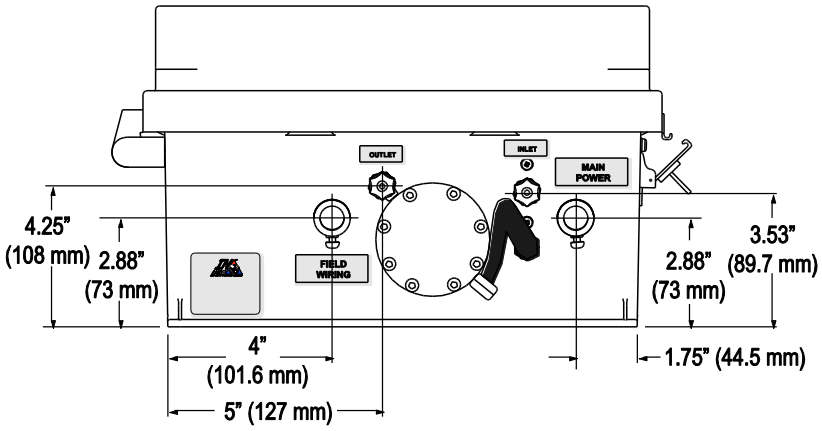
2.4.1 Dimensions: Wall-Mounted Analyzer



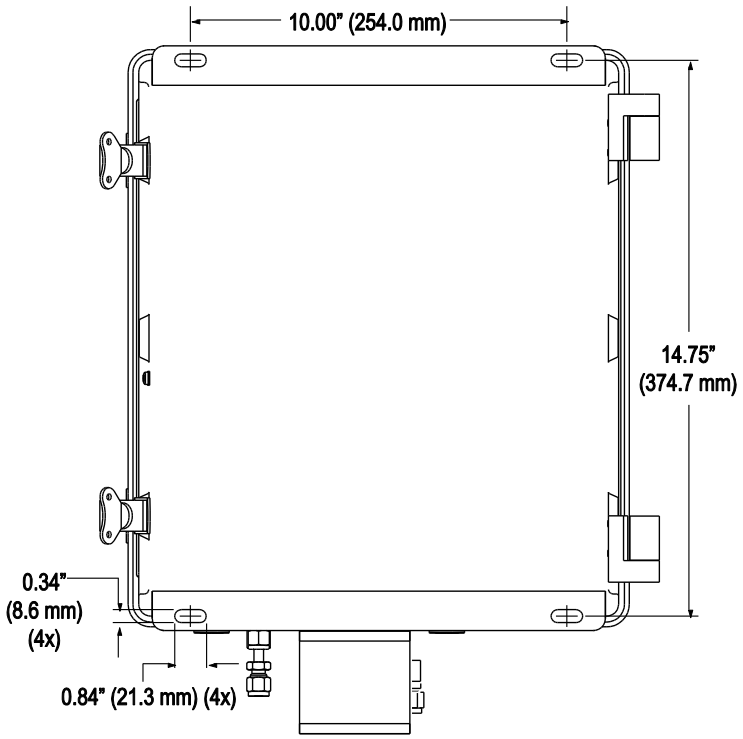
Front View



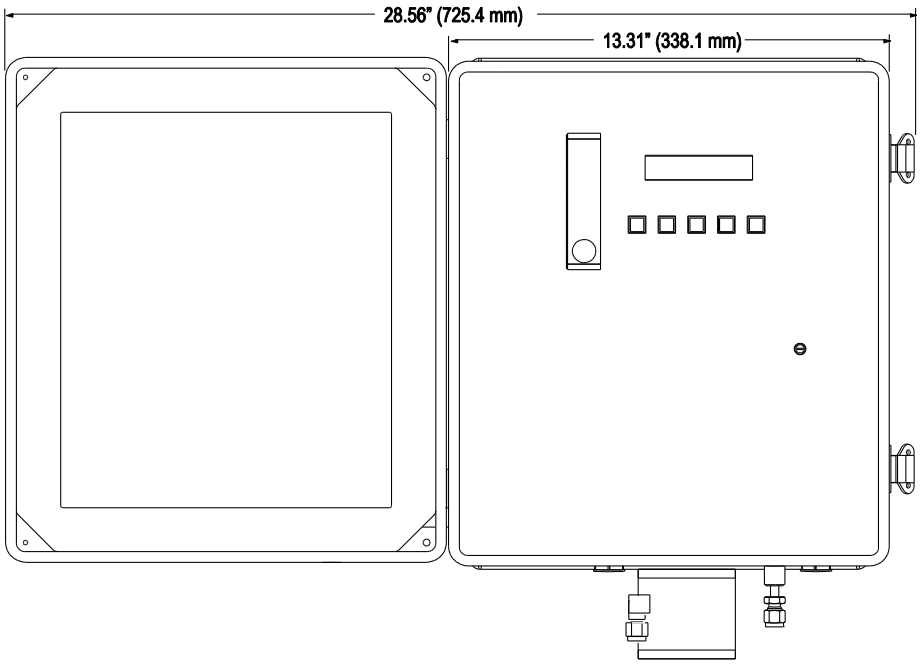
Right Side View



Bottom View

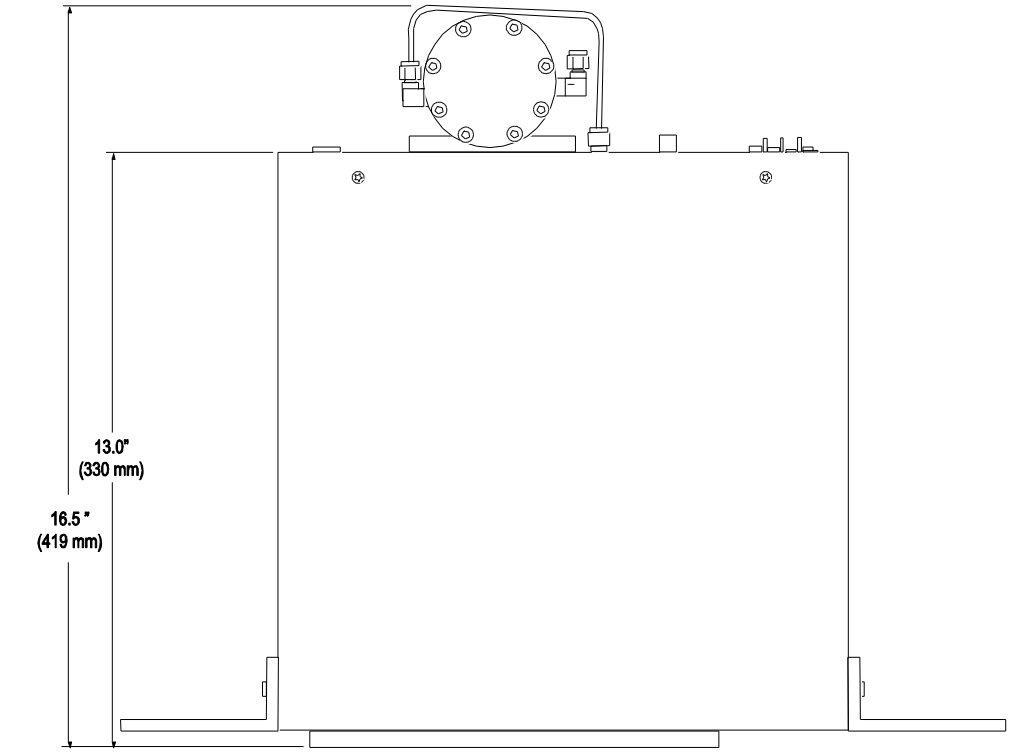


Rear View

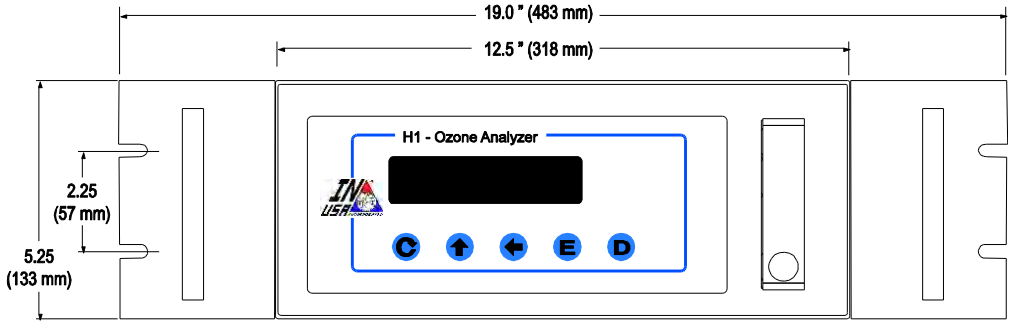


View with Door Open (Maximum)

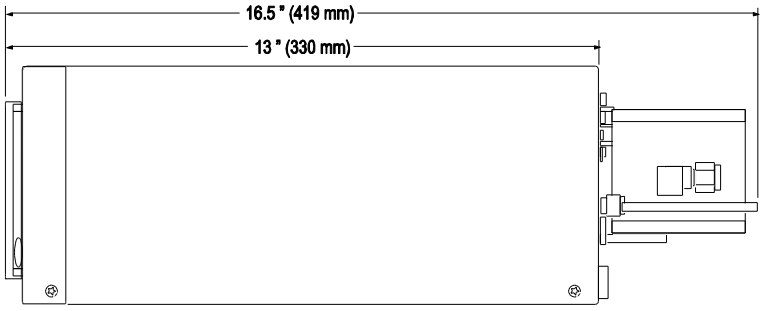
2.4.2 Dimensions: 19” Rack-mount Unit



Rack-Mount: Top View

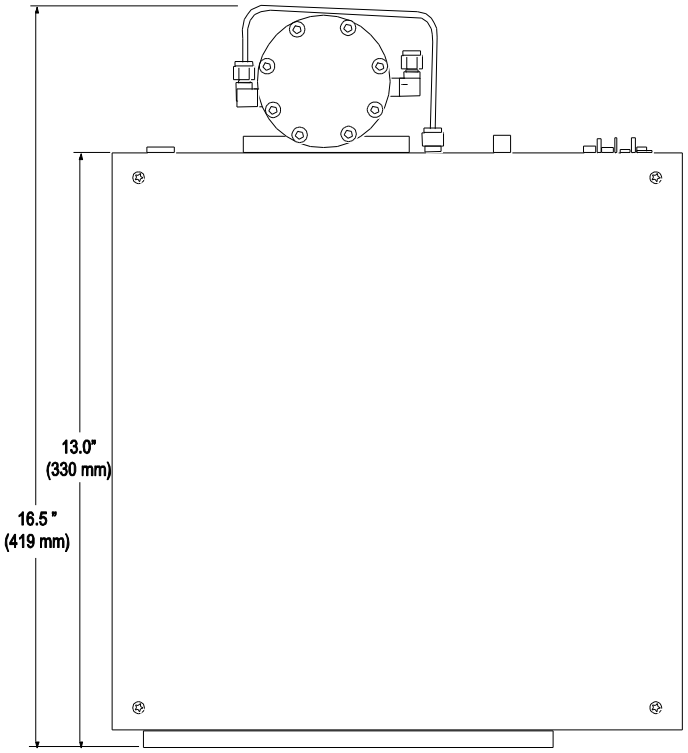


Rack-Mount: Front View

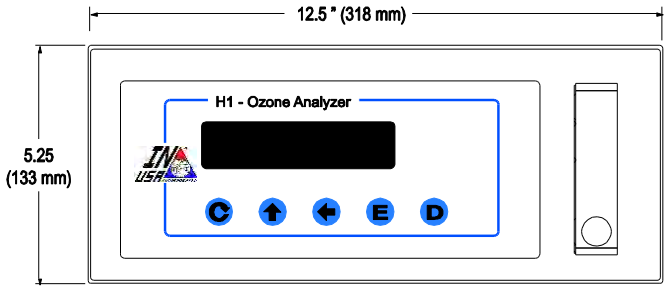


Rack-Mount: Side View

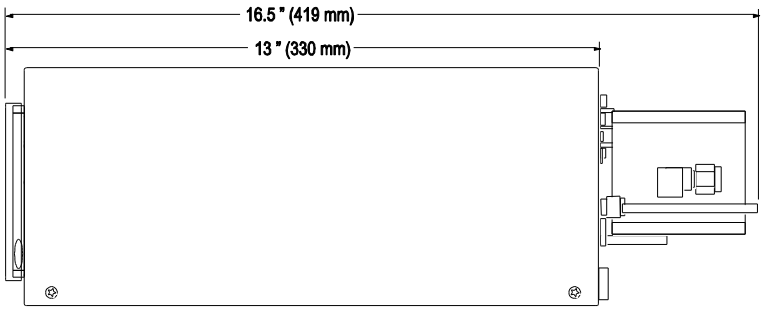
2.4.3 Dimensions: Desktop Unit



Desktop: Top View



Desktop: Front View



Desktop: Side View

2.5 H1 Specifications

<table>
<tr><th colspan="2">Item</th><th>Specification</th></tr>
<tr><td rowspan="13">Performance/ Range</td><td>Measuring Principle</td><td>Absolute determination by UV absorption. Automatic compensation for sample pressure, temperature, and molecular weight</td></tr>
<tr><td>Cycle Time</td><td>Continuous measurement, uninterrupted flow, no solenoid valves</td></tr>
<tr><td>Measuring Range (Factory Set)</td><td>H1- LR: 0 - 50 g/m^3 (4%wt)
H1- S: 0 - 125 g/m^3 (10%wt)
H1- X: 0 - 200 g/m^3 (16%wt)
H1- UH: 0 - 400 g/m^3 (28%wt)</td></tr>
<tr><td>Sensitivity/Resolution</td><td>0.1 g/m^3 up to 125 g/m^3 ; 1 g/m^3 above 125 g/m^3</td></tr>
<tr><td>Zero Drift</td><td>None, digitally autozeroed. Optional programmable auto zero.</td></tr>
<tr><td>Precision/Repeatability</td><td>0.1 g/m^3 or 1% of reading (whichever is greater)</td></tr>
<tr><td>Linearity</td><td>Better than 99% throughout range</td></tr>
<tr><td>Calibration Standard</td><td>Per the International Ozone Association KI method to 1% repeatability</td></tr>
<tr><td>Ozone Concentration Units</td><td>g/m^3, g/Nm^3, %weight, % volume (selectable)</td></tr>
<tr><td>Measured Temperature*</td><td>0 to 70 °C (32 °F to 158 °F)</td></tr>
<tr><td>Measured Pressure*</td><td>600 to 2025 mB (standard)</td></tr>
<tr><td>Readout</td><td>2x20 character, alpha-numeric, Vacuum Fluorescent</td></tr>
<tr><td>Gas Sample Flow Rate</td><td>0.5 L/min. nominal</td></tr>
<tr><td>Diagnostic Features</td><td>Continuous internal diagnostics with error messaging and instrument error relay</td></tr>
<tr><td rowspan="4">Connections</td><td>Analog Outputs</td><td>4-20 mA and 0-10 V DC standard. 0 to 20 mA and 0-1 VDC optional</td></tr>
<tr><td>Digital Output</td><td>RS-232 compatible interface, bi-directional</td></tr>
<tr><td>Relay Contacts</td><td>3 Form C (Single Pole - Double Throw, make before break) rated at 5 AMP resistive load at 250</td></tr>
<tr><td>Supply Voltage</td><td>100-240 VAC, 50/60 Hz</td></tr>
<tr><td></td><td>Sample Ports</td><td>1/8" or 1/4" Swagelok standard. Metric and VCR® optional</td></tr>
<tr><td rowspan="4">Configuration and Environment</td><td>Configurations</td><td>Wall-mount NEMA 4x / IP65 enclosure, 19" rack 3U height, or desktop unit</td></tr>
<tr><td>Dimensions</td><td>
<table>
<tr><th></th><th>Wall-Mount</th><th>Rack-Mount</th><th>Desktop</th></tr>
<tr><td>Width</td><td>14.1” (358 mm)</td><td>19” (483 mm)</td><td>12.5” (318 mm)</td></tr>
<tr><td>Height</td><td>15.51” (394 mm)</td><td>5.25” (133 mm, 3U)</td><td>5.25” (133 mm)</td></tr>
<tr><td>Depth</td><td>8.27” (210 mm)</td><td>16.5” (419 mm)</td><td>16.5” (419 mm)</td></tr>
</table>
</td></tr>
<tr><td>Weight, Approx.</td><td>Wall-mount: 25 lbs (11 kg)
Rack-mount & Desktop Units: 32 lbs (14.5 kg)</td></tr>
<tr><td>Environmental Operating Conditions</td><td>Indoor Use Only
Temperature 5-40°C
Altitude 2000 m
Humidity 80 % for temperatures up to 31°C decreasing linearly to 50 % relative humidity at 40°C
Mains Supply Tolerance ±10%
Overvoltage Category II
Pollution Degree 2</td></tr>
<tr><td>Compliance</td><td colspan="2">CE</td></tr>
</table>

Specifications subject to change without notice

3 Installation

3.1 Site Preparation

3.1.1 Pre-Installation Checklist

If possible, locate the Model H1 Ozone Analyzer in a clean area where free convection of air is possible. Make any connections to external recording or monitoring equipment as necessary at the Field Wiring Terminal Block or at the RS-232 Output Connector (through the conduit fitting for NEMA 4x / IP65 units). Connect the sources of ozonated gas to the INLET gas port using clean stainless steel or Teflon tubing, keeping the sample lines as short as possible. If necessary use appropriate Teflon element filters to remove particulate matter from the gas sample. Refer to the following instructions for details.

Item	Details	Verified
Unit installation space and clearance requirements	Use the dimensional drawings as a reference for dimensions, locations and clearance space (Section 2.4: Dimensions) The system should be located as close as possible to the ozonated source. Minimize tubing lengths. Leave appropriate clearance space around the unit to perform any connections, maintenance or troubleshooting activities. The wall-mounted NEMA unit typically requires an off-wall clearance of 36” for access to the inside of the unit. **CAUTION**: Do not install the equipment near high-heat generating equipment such as power supplies, transformers, blowers, heat ducts, exhaust ducts and other similar equipment.	
Ozone analyzer wiring	AC wiring for unit – see specifications section Analog output wiring Relay contacts wiring	

3.1.2 Required Equipment and Supplies

Installation requires the use of standard fitting equipment and techniques to make leak-tight gas fittings.

Customer-Supplied Equipment:

- Mounting bolts for wall-mount units

Required Tools:

- Level
- Tubing cutter
- Standard electrical toolkits
- Standard mechanical tool kits including open-end wrenches

3.2 Installation Procedure

Step 1: Mount the Analyzer

1. Plan sufficient clearance space around the system:
   Installation size requirements are detailed in the "System Dimensions" section of this manual. Refer to the diagrams to plan sufficient clearance space around the units as noted below.

Type	Required Clearance Space
Wall-mount	Leave a minimum of 36 inches in front of the system to allow opening of the unit door and service access
Rack-mount	Leave sufficient space in front of and behind the rack to allow connections to the rear of the unit, and the ability to slide the unit out of the rack to remove the top cover, as necessary for servicing.
Desk-top	Leave a minimum of 8 inches at the rear of the unit to allow wiring and plumbing connections. Leave room above the unit to remove the cover as necessary for servicing.

Special Clearance Space Notes:
Typically all units should be installed with free convection of air to allow cooling. Never block any vents. Never locate the equipment next to high heat generating equipment. Never install outdoors without proper protection from sun and severe weather conditions.

2. For wall-mount analyzers, mount the display of the analyzer at eye level.

   Mounting notes:

Type	Mounting Notes
Wall-mount Ozone	Refer to the system drawings for mounting hole locations on the top and bottom of the unit.
Rack-mount units	Rack-mount units must be supported on side rails in the rack or be supported in the back to reduce stress on the front panel. The front panel mounting "ears" are for securing the unit in place, only. **DO NOT** 'hang' the unit by the front panel or damage to the unit will occur.
Desktop usage	Support the base of the unit fully on a level secure desktop or sturdy shelf.

Step 2: Connect Gas Lines

1. Make the following connections:

⚠ WARNING

Leak Hazard!

USE ONLY MATERIALS WHICH ARE RESISTANT TO HIGH CONCENTRATION OZONE SERVICE SUCH AS TEFLON® OR STAINLESS STEEL.

EXPOSURE TO OZONE IS HAZARDOUS. ENSURE THAT ALL GAS CONNECTIONS ARE TIGHT AND THAT NO LEAKS EXIST. THE EXHAUST STREAM WILL TYPICALLY CONTAIN LARGE AMOUNTS OF OZONE. ENSURE PROPER MEANS OF SAFELY DISPOSING OF THE OZONE CONTENT OF THE EXHAUST STREAM. PLEASE CONTACT ***IN USA, INC.*** FOR TECHNICAL ADVICE OR TO ASK ABOUT AVAILABLE OZONE DESTRUCTION UNITS.

Type	Connection	Fitting
INLET	Use clean Teflon tubing. Keep the sample line as short as possible. An IN USA inline element filter and housing must be installed to remove particulate matter from the gas sample. See installation instructions on the follow pages.	1/4" compression
OUTLET	Connect the ozone analyzer's exhaust to an ozone compatible exhaust system.	1/4" compression, typical

The standard version of the H1 is not equipped with a pump. For that reason gas flow through the unit should be supplied by external means, for example by sampling from a source which is at positive pressure.

The recommended gas flow rate is 30 liters/hour (0.5 liters/min). Operation under lower or higher flow rates is possible. Please consult IN USA for technical assistance.

The maximum operating pressure is 30 PSIA. If the operating pressure is above 30 PSIA, please consult with *IN USA, INC*.

Step 3: Electrical Installation

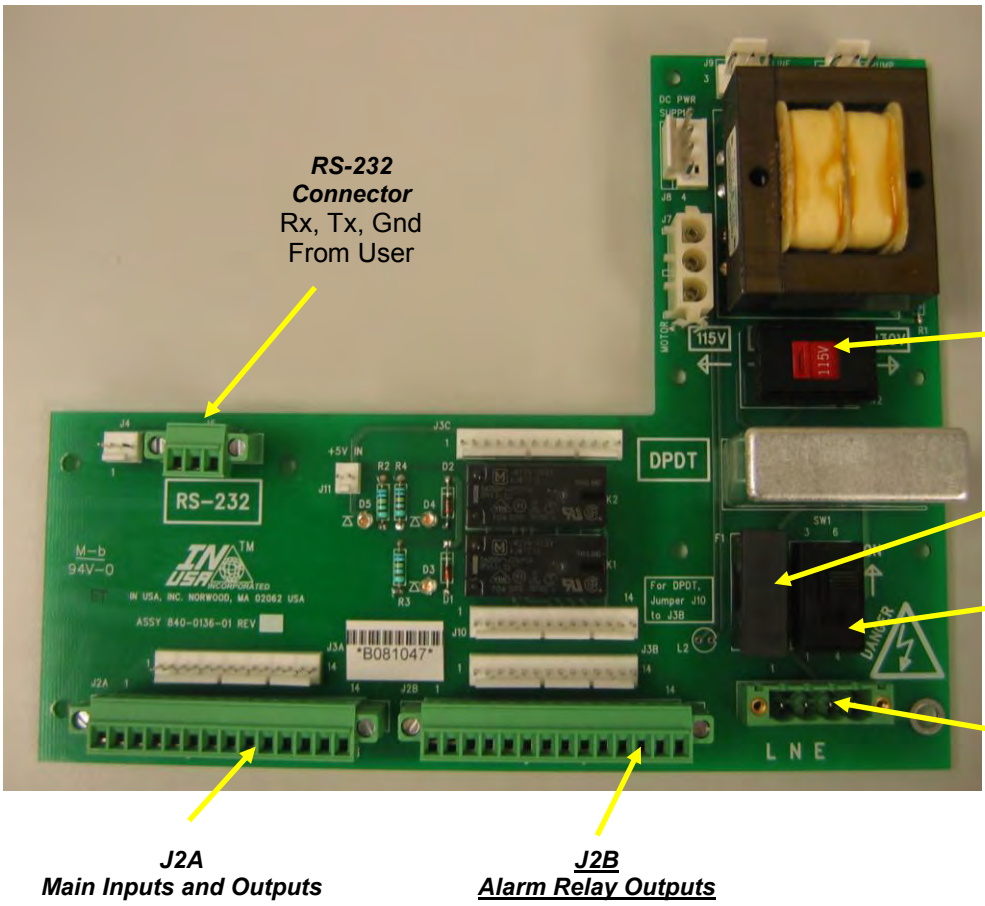
1. Verify the power setting on the equipment.

   IMPORTANT: The instrument is also designed to operate on 220/240 VAC ±10%, 50/60 Hz. When operation at this voltage is required, the removable fuse block in the power receptacle must be turned around so that the “220VAC” lettering is right side up.

Unit Type	
Wall-mount ozone analyzer	Open the front door and control panel and verify power switch location for the input power requirements 
Rack-mount units, Desktop units	Verify power setting at the rear of unit for the input power requirements

2. Make control and signal wiring connections, as desired for each unit. Each connector is detailed below and on the following pages:

A field wiring board is provided in the system to provide power and control wiring connections. External connectors are provided at the rear of the rack-mount units. Direct wiring to the Field Wiring board is required in the wall-mount unit.



Wall-Mount Unit

J2A Main Inputs and Outputs

Pos	Function	Operation	
1	Analog Voltage Output	+	0 to 10 volts Out (can be set to 0 – 1V)
2		-	Analog Ground
3	Analog Current Output	+	4 to 20 mA (can be set to 0 to 20mA)
4		-	
5-9	Not used		
10	K1 Normally Open (De-energized Open)	Instrument Error – error when de-energized (Fail Safe)	
11	K1 Common		
12	K1 Normally Closed (De-energized Closed)		
13	Zero	Close these contacts to perform a zero operation	
14			

J2B Relay K1 and K2 Outputs (SPDT)

Pos	Function	Operation
15	K3 De-energized Open	Alarm 1 – alarm when de-energized (Fail Safe)
16	K3 Common	
17	K3 De-energized Closed	
18-20	Not Used	
21	K2 De-energized Open	Alarm 2 – alarm when de-energized (Fail Safe)
22	K2 Common	
23	K2 De-energized Closed	
24-28	Not Used	

J5 RS-232 Connector Pin-out

Pin #	Description
1	Transmitted Data (TXD)
2	Received Data (RXD)
3	Signal Ground (GND)

When configured at the factory, Alarm 1 and Alarm 2 appear at J2B as DPDT relays:

J2B Relay K1 and K2 Outputs (DPDT)

Pos	Function	Operation
15	K3A De-energized Open	Alarm 1 – alarm when de-energized (Fail Safe)
16	K3A Common	
17	K3A De-energized Closed	
18	K3B De-energized Open	
19	K3B Common	
20	K3B De-energized Closed	
21	K2A De-energized Open	Alarm 2 – alarm when de-energized (Fail Safe)
22	K2A Common	
23	K2A De-energized Closed	
24	K2B De-energized Open	
25	K2B Common	
26	K2B De-energized Closed	
27-28	Not Used	

Rack-Mount/Desktop Unit

RS-232 Connector

Pos	Function
2	Transmitted Data (TXD)
3	Received Data (RXD)
7	Signal Ground (GND)

AUX Connector

The auxiliary Connector is used for isolated outputs.

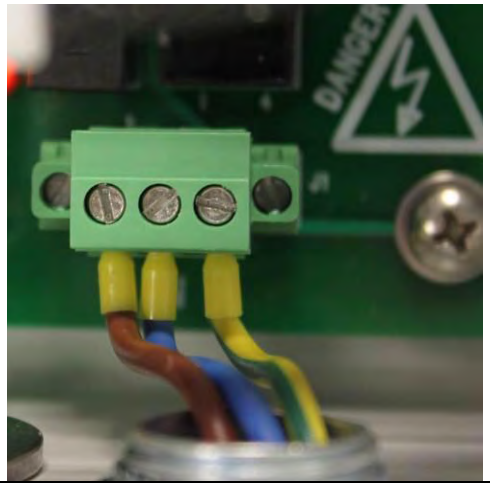
Pos	Function
1	+ 0-10V (or 0-1 V)
2	- 0-10V (or 0-1 V)
3	+ 4-20 mA (or 0-20 mA)
4	- 4-20 mA (or 0-20 mA)

Field Wiring Connector

Pos	Function	Operation	
1	Analog Voltage Output	+	0 to 10 volts Out (can be set to 0 – 1V)
2		-	
3	Analog Current Output	+	4 to 20 mA (can be setto 0-20 mA)
4		-	
5	K1 De-energized Open	Instrument Error – error when de-energized	
6	K1 Common		
7	K1 De-energized Closed		
8	K2 De-energized Open	Alarm 2 – alarm when de-energized (Fail Safe)	
9	K2 Common		
10	K2 De-energized Closed		
11	K3 De-energized Open	Alarm 1 – alarm when de-energized (Fail Safe)	

3. Connect system input power:

   Fuse Information:
   The instrument requires up to a maximum of 70 Watts and is fused with a 1.0 amp, Slo-Blo fuse found in the Power receptacle located on the board

Unit	Input Power Location/Notes	Fuse Information
NEMA 4X/IP65 Systems	Input power is provided via hard-wiring to the power terminal on the Field Wiring board. Open the system cover and provide wiring through the conduit hole at the base of the system. 	The unit requires a maximum of 70 Watts and is protected via a 1A 5x20 mm med blow fuse. Refer to Maintenance section for replacement fuse part number.
Bench Top or 19" Rack Systems	Input power is supplied via a standard AC power receptacle and a 3-wire power line cord for use with a grounded power outlet.	Refer to the power connector for fuse type and size. Fuses are found in the power receptacle located in the rear panel. Refer to Maintenance section for replacement fuse part number.

Step 3: Connect sample tubing

1. Connect sample gas tubing (inlet and outlet) to the device. The system uses ¼" compression fittings. Connections to the rack-mount units are located at the rear of the unit. Connections to the wall-mount units are located at the bottom of the housing.

   An inline filter must be installed on the inlet line to protect the system from contamination.

4 Operation

4.1 System Operation

STEP 1: Verify initial setup

1. Verify that the input voltage selected is set for your installation power:
   100/115 VAC or 208/220/240 VAC

   Note: The system is configured and tested at the factory for either 100/115 VAC operation or, if requested, 220/240 VAC. Always verify that the power switch is properly set and has not been inadvertently changed.
2. Make any connections to external recording or monitoring equipment as necessary at the field wiring terminal block or at the RS-232 output connector. See the Installation section of this manual.
3. Connect the desired sample point to the INLET gas port. Use clean Teflon tubing. Keep the sample line as short as possible. It is highly recommended to use the Teflon element filter (supplied by IN USA) to remove particulate matter from the gas sample. Verify that the inlet gas can flow rate can be regulated for a sample flow rate of 0.5 L/min.

STEP 2: Turn on the unit and allow it to warm up

1. Turn on system power. (Turn the instrument on by the Power switch located on the rear panel or on the Field Wiring Board for the NEMA enclosures.)
2. After a few seconds, the readout will display "Warming Up."
3. Set the sample flow rate to 0.5 L/min. Flow rate adjustments must be made external to the H1 unit unless the analyzer is equipped with a throttling flow meter.
4. Press the D key; the ozone concentration value is then displayed.

   The warm-up period is necessary to allow the UV lamp to reach stable temperature and brightness. Once the UV lamp has reached stability, the "Warming Up" message is extinguished. Allow a minimum of 3 hours for the monitor to warm up.

   The unit contains a very sensitive photometer. It should be warmed up a minimum of 3 hours from a cold start. For first time startup, an overnight warm-up period is recommended to allow complete purging of the system and associated tubing.

   While the "Warming Up" message is on, the relays associated with programmable alarms and the instrument error are de-activated (to prevent misinterpretation by any peripherals connected to the relay contacts). In addition, the front panel display and analog output will be read 0.00 PPM during the warm up period. The system should be operational and displaying correct ozone readings after the warm up period.
   Note: For maximum performance, it is recommended that the H1 remains ON at all times.

STEP 3: Perform a ZERO CALIBRATION

The Zero Calibration is a procedure to establish (or verify) the analyzer's 'zero'. It is normal for the instrument to require a zero calibration after being turned on and having warmed up.

A zero calibration would be required if the instrument does not read "zero" when analyzing an ozone-free gas sample. In this case the instrument's display will indicate either a small positive number, or it could display the message "Negative Result". This value is an offset value. Regardless of what the zero offset is, the instrument will measure accurately if a zero calibration is performed. The zero calibration brings the offset value back to absolute zero.

Please consult with IN USA, INC. if you have any questions regarding the instrument zero.

The Model H1 provides two zero calibration methods: Manual and Programmed or Automatic (if the Auto-Zero option is installed).

Recommended Zero-Calibration Frequency:
The Model H1 analyzer has minimal zero drift. A "zero calibration" should be performed at least once per quarter. A zero-calibration should also be performed whenever the unit warms up from a "cold" start, or after it has been moved or shipped.

Note: Should the unit's zero continuously drift upward, this is probably an indication of contamination of the optical components caused by impurities in the sample gas. The root source of the contamination should be remedied, and the optical components of the analyzer may need to be eventually cleaned. However, given the nature of the measurement and the optical design of the instrument, you can continue using the instrument to make reliable measurements of ozone provided you zero it first. As a rule of thumb, if there is a good zero, the readings will be reliable. If you have any questions, please ask for technical assistance from *IN USA*.

Note that the instrument will display "Gain Ratio Error" if over time it detects drift caused by dirtying of the optical components. Refer to the Troubleshooting section of this manual for details.

The Zero Calibration procedure requires the flow of Ozone free gas through the unit.

Manual Zero Calibration

CAUTION: Before attempting a Zero Calibration, make sure that:

- The unit has warmed up completely
- Ozone-free gas is flowing through the analyzer. For the purpose of zeroing the Model H1, the following Ozone free gases are recommended: Oxygen, dry air, or Nitrogen. The Ozone free gas should flow at 0.5 L/min or higher for at least 3 minutes.

1. ***Press and hold the "D" key*** (the readout will display "Review System Parameters") and while holding the D key down ***press the Scroll key three (3) times.***

   The display will now read “UNITS”, and the instrument is now in “programming mode”.

   You can now release the "D" key.

2. Once in program mode, use the Scroll key until the digital displays reads "Zero Calibration".
3. Press the "E" (Enter) key three (3) times. Then follow the instructions on the display.

   On instruments equipped with the Auto-Zero option, the procedure takes about 3 minutes because the instrument allows for a 3 minute purge time. If the Auto-Zero option is not installed, the zero calibration procedure will prompt the user to "TURN OFF OZONE AND PRESS ENTER", and it assumes that the user will allow the proper purging time. Once the user presses "E" (Enter), the unit will complete its zero calibration within 12 seconds.

   Pressing the "D" (Display) key will abort the manual ZERO CALIBRATION.
4. When the manual zero calibration is completed, the user is prompted by the message "ZEROING COMPLETE, PRESS ANY KEY". Upon this key press, the instrument will continue in Programming Mode and "Units" will be displayed. Press “D” to bring the analyzer out of Programming Mode and back to measuring mode.

Programmed (Automatic) Zero Calibration

This function is only available if the AutoZero option is installed.

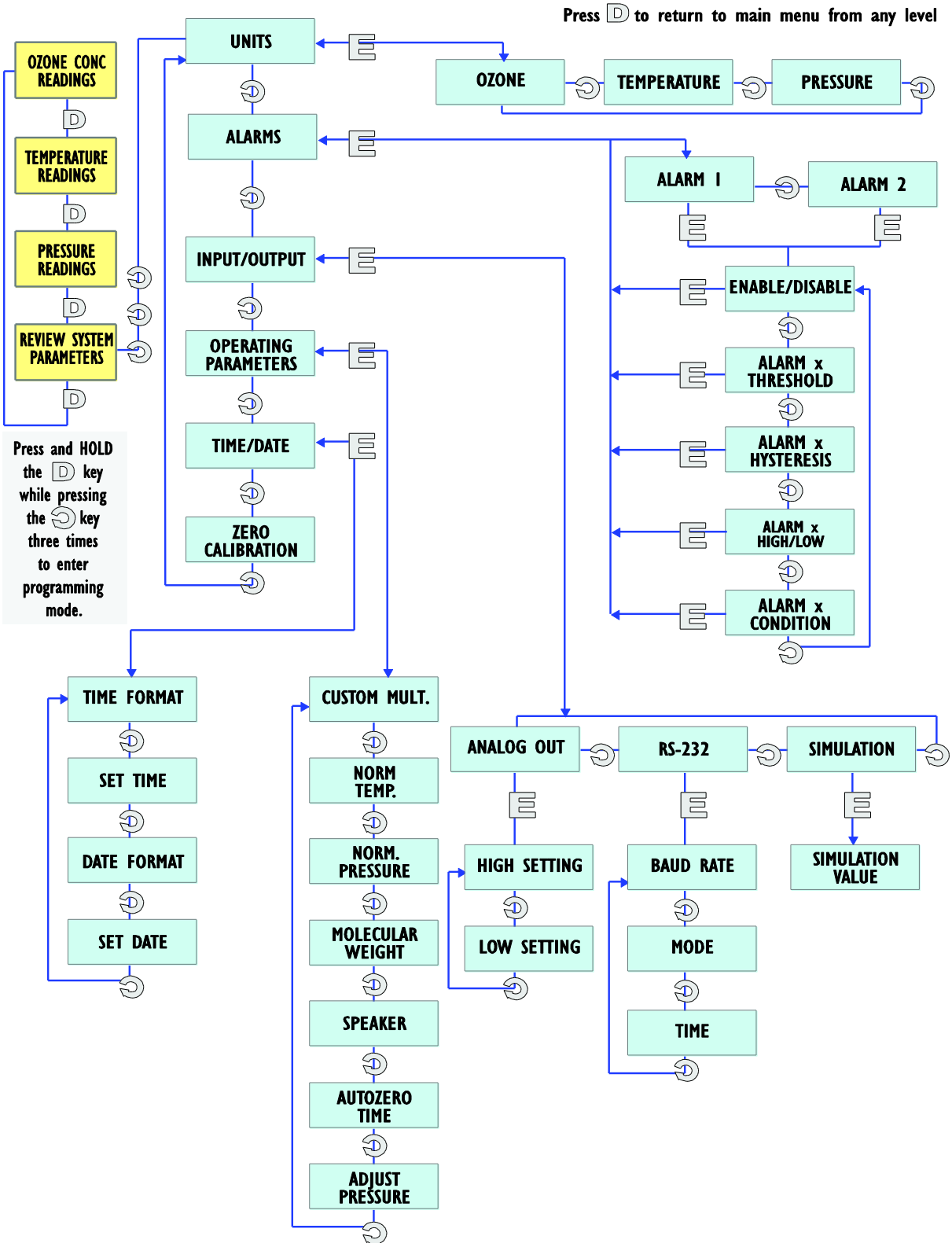
Access to the Autozero Time function is through the “Operating Parameters” menu item as described before. The Model H1 accepts as time intervals between auto zeros a 2 (two) digit number, from "01" to "99" hours. A numerical entry of "00" results in no timed autozero. The autozero interval is measured from the end of the last Autozero until the beginning of the new one.

Once the Internal Timer commands the unit to perform an Autozero, the following sequence takes place:

a) The Alarms are disabled
b) The internal pump is powered on (if installed)
c) The internal solenoid valve is energized (if installed)
d) There is a wait period of 3 minutes, to let the pneumatic components flush with the ozone free gas
e) The actual Autozero mathematical routines are executed.
f) The analyzer resumes normal measuring mode.

4.2 Programming Menu

Press keys, as noted, to navigate from item to item.



4.3 Programmable Parameters

The H1 allows the operator to review (browse without altering) several parameters.

Refer to the following Menu Chart for a layout of programmable parameters.

Numerous operating parameters can be accessed and modified by the operator, detailed in the following table.

Note: Not all parameters are available on all system configurations.

Note: All programmable parameters are stored in nonvolatile memory. Powering the unit off or removing power from the unit will not affect these parameters.

Units

Item	Details/Options	Notes
OZONE CONCENTRATION	g/m^3: Grams of Ozone per cubic meter of Gas (Default for standard Model)	(1) Normalizing Temperature and Pressure are defined by user. The default values are: 0 °C (273 °K) and 1013.25 mB (1 atmosphere). (2) Molecular Weight of Carrier Gas is defined by user. The default value is 32 gr/Mol, corresponding to Oxygen.
	g/Nm^3: Grams of Ozone per Normalized cubic meter of Gas (1)	
	% Weight: Percent by weight (1) (2)	
	% Volume: Percent by volume (1) (2)	
TEMPERATURE	° C: Degrees Centigrade (Default)	
	° F: Degrees Fahrenheit	
	° K: Degrees Kelvin	
PRESSURE	mB: Millibars (Default)	1 atm = 1013.2 mB = 14.696 psi = 760 Torr
	PSIA: Pounds per Square Inch Absolute	
	Torr: Torricceli (mm Hg)	

Alarm 1 and Alarm 2 Parameters

Item	Details/Options	Notes
STATUS	The Alarm Status condition defines the alarms as either enabled or disabled.	The default status is disabled.
THRESHOLD	The Alarm Threshold value at which the given alarm will be triggered. The threshold is expressed in the currently active Units of Measurement of Ozone Concentration. The default values are 0.	**Note**: The threshold values "follow" the Units of Measurement of Ozone Concentration. When the user changes the units of measurement, the alarm thresholds automatically adjust to the new units. The conversion is linear and expressed by the following relationships: 0-50 g/m3 = 0-4 % Weight 0-125 g/m3 = 0-10 % Weight 0-200 g/m3 = 0-16 % Weight 0-400 g/m3 = 0-28 % Weight

HYSTERESIS	This parameter is only relevant for alarms that are unlatched. After a HIGH alarm is triggered, the ozone concentration level must drop below the threshold value less the hysteresis value before the alarm is cleared. After a LOW alarm is triggered, the ozone concentration level must climb above the threshold value plus the alarm hysteresis value before the alarm is cleared. The default values are 0.	
NATURE	This parameter defines the threshold as either HIGH or LOW. The default values are Low. A high alarm is one in which an alarm condition is triggered when the ozone concentration rises above the alarm threshold. A low alarm is one in which an alarm condition is triggered when the ozone concentration falls below the alarm threshold.	
TYPE	Defines whether an alarm that is triggered should be LATCHED or UNLATCHED. The default is Latched. An unlatched alarm will only remain active while the given alarm condition that triggered it is present. A latched alarm will remain active until it is reset. Resetting a Latched alarm is accomplished by actuating the "E" key, located on the Front Panel. Of course, pressing the "E" Key will only clear a latched alarm if the original alarm condition is no longer present.	

Input/Output

The Model H1 features 2 (two) Analog Output Signals that correspond to ozone concentration:

- 4 to 20 mADC (std.) or 0 to 20 mADC Current Loop, Non-isolated
- 0 to 10 VDC (std.) or 0 to 1 VDC

It also features a Digital Serial Communications Interface that is RS-232 Compatible.

SIMULATION OF THE ANALOG OUTPUTS

The analog outputs can be tested by means of the "Simulation". In simulation mode, the analyzer simulates ozone concentrations in % of Full Range. The analog outputs are enabled and should provide the corresponding voltage or current outputs.

Simulation mode is only available when the unit is in programming mode. Simulation is part of the "Input/Output" menu. Simulation values are "toggled" using either the "Up Arrow" key or the "Left Arrow" key. With each press of either key, the simulation value cycles through the available parameters. Whichever value is currently displayed is the value being simulated. Simulation ends automatically when the programming mode is exited or when another menu item is selected.

Analog Output Signals

For each of the Analog Output Signals, the following parameters may be set:

Item	Details/Options	Notes
ANALOG OUTPUT HIGH SETTING	This is a number, expressed as a percent of Full Scale that corresponds to the upper end of the analog outputs; i.e., to the 20 mADC or to the 1.0/10.0 VDC.	The default is 100%.
ANALOG OUTPUT LOW SETTING	This is a number, expressed as a percentage of Full Scale that corresponds to the lower end of the analog outputs; i.e., to the 4 mADC or to the 0.0 VDC.	The default is 0%.
RS 232	RS-232 Baud Rate	The baud rate can selected to any one of the following values: 300 600 1200 2400 4800 9600 (Default) 19200 38400
	RS-232 MODE	The parameter can be set to either Timed or to Polled. By default, the Model H1 RS-232 channel will operate in Timed Mode. If timed mode is selected, then the time between messages is input. The Time Between Messages, is expressed in seconds and can take values from 00 to 59 seconds. The default value is once every 10 seconds. Regardless of the Time Setting, a dump to the RS-232 channel will also be triggered at the start of any alarm condition.

		If polled mode is selected, Model H1 RS-2332 Port will remain marking waiting to receive the ASCII character "?" or "!" to commence transmission.
Simulation	In simulation mode, the analyzer simulates ozone concentrations in % of Full Range. The analog outputs are enabled and should provide the corresponding voltage or current outputs.	Simulation mode is only available when the unit is in programming mode. Simulation values are "toggled" using either the "Up Arrow" key or the "Left Arrow" key. With each press of either key, the simulation value cycles through the available parameters

Operating Parameters

Item	Details/Options	Notes
CUSTOMER SCALING MULTIPLIER	The customer multiplier is a scaling factor (numerical gain). It can take values from 0.01 to 9.99 times the measured ozone concentration. The default value is 1.00. The Customer Multiplier affects both the display and the Analog Outputs.	**CAUTION**: When the Customer Scaling Multiplier is set to a value other than the default value of 1.00, the displayed ozone concentration will no longer match the factory calibration. IN USA, INC. assumes no responsibility for errors or damages caused by such readings.
NORMALIZING TEMPERATURE	The normalizing temperature, referred to as T2, is the temperature used during the numerical calculations of Ozone Concentration in g/Nm^3. The Normalizing Temperature default value is 273.3 °Kelvin, (0 °C).	Available only in units with the P&T Option
NORMALIZING PRESSURE	The normalizing pressure, referred to as P2 is the pressure used during the numerical calculations of Ozone Concentration in g/nm3. The Normalizing Pressure default value is 1013.25 mB, (14.70 PSIA).	Available only in units with the P&T Option
MOLECULAR WEIGHT OF CARRIER GAS	The Model H1 accepts three molecular weight options as follows: ● Air: 29.0 gr/Mol (Default) ● Oxygen: 32.0 gr/Mol ● Other: User is prompted for numerical entry	Available only in units with the P&T Option
SPEAKER OUTPUT	Enabled or Disabled	The default is Enabled
AUTOZERO INTERVAL	The Model H1 accepts as time intervals between auto-zeros a 2 (two) digit number, from "01" to "99" hours. A numerical entry of "00" results in no timed autozero. The autozero interval is measured from the end of the last Autozero until the beginning of the new one.	Only available in units with the AutoZero Option Once the Internal Timer commands the unit to perform an Autozero, the following sequence takes place: 1. The Alarms are disabled 2. The internal pump is powered on (if installed) 3. The internal solenoid valve is energized (if installed)

		4. There is a wait period of 3.0 minutes, to let the pneumatic components flush with the ozone free gas 5. The actual Autozero mathematical routines are executed. 6. The analyzer resumes normal measuring mode.
ADJUST PRESSURE	This parameter is used to compensate for a zero offset of the pressure sensor. If the unit is pressurized to a known pressure, this pressure can be entered as the "Adjust Pressure" parameter. The instrument then uses this entered value to calculate the pressure offset. For example, if the instrument's pressure sensor indicates a pressure of 1020 mB when the actual pressure is 1025 mB, the value 1025 would be entered as the "Adjust Pressure" parameter. The instrument would then correct any pressure reading by +5 mB.	The "Adjust Pressure" parameter is factory set based on our in-house standard calibrated barometer. The pressure must be entered in millibars (mB). (1013.2 mB = 14.696 psi = 760 Torr).

Time and Date

Item	Details/Options	Notes
Time Format	Time can be displayed in either 24 hour format or 12 hour format	
Time	Time can be set by keying in hour, minute and second	
Date Format	Date can be displayed either as month/day/year (MM/DD/YY) or day/month/year (DD/MM/YY)	
Date	Date information can be set by keying in day, month and year information.	

4.4 Programming Programmable Parameters

To prevent accidental modification of the programmable parameters, a special key-press sequence must be followed to enter into "programming" mode.

1. Press the "D" (DISPLAY) key.
1. In units **with** the P&T option, press "D" until the display shows the pressure reading. In units **without** the P&T option, press "D" until the display shows the ozone concentration reading.

   Next, ***press and hold the "D" key*** (the readout will display "Review System Parameters"), and ***simultaneously press the Scroll key three (3) times.***

   The display will now read “UNITS”, and the instrument is now in “programming mode”.

   You can now release the "D" key.

2. Refer to the menu tree which illustrates how you can move within the available parameter items. The Scroll key allows you to move horizontally along menu items and the Enter key moves you vertically within a menu item.
   - To change the values of a Toggle parameter, use either the Digit Shift Key (left arrow " < ") or the Digit Increment key (up arrow " ^ "). With each press of the key, the preprogrammed values are scrolled on the screen. When the value you want is displayed, press the "E" to accept the value and remain in programming mode, or press the "D" key to accept the value and leave the programming mode.

   - To change the value of a Numerical parameter use the Digit Shift key (left arrow " < ") to position the cursor (flashing square) over the digit to be changed, then use the Digit Increment (up arrow " ^ ") to change the value of the digit between 0 and 9.

5 Troubleshooting

5.1 WARNING/ERROR MESSAGES

The Model H1 continuously goes through sophisticated self-diagnostic routines which are designed to detect malfunctions or abnormal situations that can lead to potential problems. The instrument informs the user of these conditions by displaying a message on the front panel, by transmitting this message via the RS232 interface, and, in some cases, by triggering the Instrument Error relay. Some warnings/alarm conditions can be cleared by pressing the "E" key. Others are considered "fatal errors" and will remain latched which means that the instrument error relay will remain energized until the condition is fixed and the "E" key is pressed. When such error conditions exist, the instrument generally cannot be used for accurate ozone measurement.

Warning/Error conditions, their causes, and the recommended course of action are outlined below

Condition	Type
Non Fatal Conditions	…do not trigger the Instrument Error Relay and automatically reset when the events that cause them are no longer present
Warning Conditions	…trigger the Instrument Error Relay. Recovery is automatic.
Fatal Conditions (latching)	…trigger the Instrument Error Relay. Once the causing event is no longer present, this condition requires user intervention to extinguish (Via a front panel keyboard "E" Key).

Diagnostics Conditions

Message	Type	Possible Cause	Corrective Action
WARMING UP	WARNING	Instrument has been turned on recently, warm up period has not been completed.	Wait for system to warm up
WHEEL MOTOR BROKEN	FATAL	Chopper wheel is not rotating most likely due to motor/gear assembly failure, or power is selected to 220 VAC and 115 VAC is actually in use	Inspect or replace motor/gear assembly, or match supply voltage with power receptacle setting
UV LIGHT ERROR	FATAL	UV light is too weak or not lit. BASEREF values bellow 1100	Make sure UV lamp is connected to UV lamp driver board. Check the "A/D Raw Data" (see above) and replace lamp if needed
GAIN RATIO ERROR	WARNING	Dirty optical components. As the optical components get dirty, the instrument's zero may drift upwards. When a zero calibration is performed, a new zero will be established and the instrument will electronically compensate for the contamination. However, if the soiling of the optics exceed the dynamic range of the electronic compensation, then the "Gain Ratio Error" message will appear.	Press the "E" key to clear the message. If the zero continues to drift, you will need to clean the optical components. Please refer to the chapter on Maintenance. Take steps to ensure that the sample gas is clean to avoid further soiling.
EXCESS UV LIGHT	FATAL	UV light too bright	Loosen the set screw which secures the UV lamp and rotate the lamp 90 degrees or until the error can be cleared. **NOTE:** this error is a latching error, which means that it can only be cleared if the "E" key is pressed *AND* the condition no longer exists. When this error occurs, the CELL values of the A/D raw data dump (see previous section) will show a values of -32577. **CAUTION: DO NOT SLIDE THE LAMP OUT OF ITS HOUSING WHILE IT IS ON. UV RADIATION WILL CAUSE DAMAGE TO UNPROTECTED EYES.** **CAUTION: THE LAMP STEM MAY BE HOT.**
LOW CELL VALUE	FATAL	UV lamp too weak or optical components are too dirty. CELL values are below 50.	Replace UV lamp or clean the optical components
INVALID DATA	FATAL	UV lamp too weak or external light effects too high	Replace UV lamp, replace covers and close doors of unit.
UNSTABLE UV LAMP	FATAL	UV lamp has gone into so-called "snaking" or "swirling" mode, analogous to a fluorescent tube flickering. A low pressure mercury vapor lamp may begin flickering this way when there are impurities in the mercury plasma.	Turn power off for 5 seconds and power back on. If the problem resurfaces after a short period of time, replace the UV lamp

6 MAINTENANCE

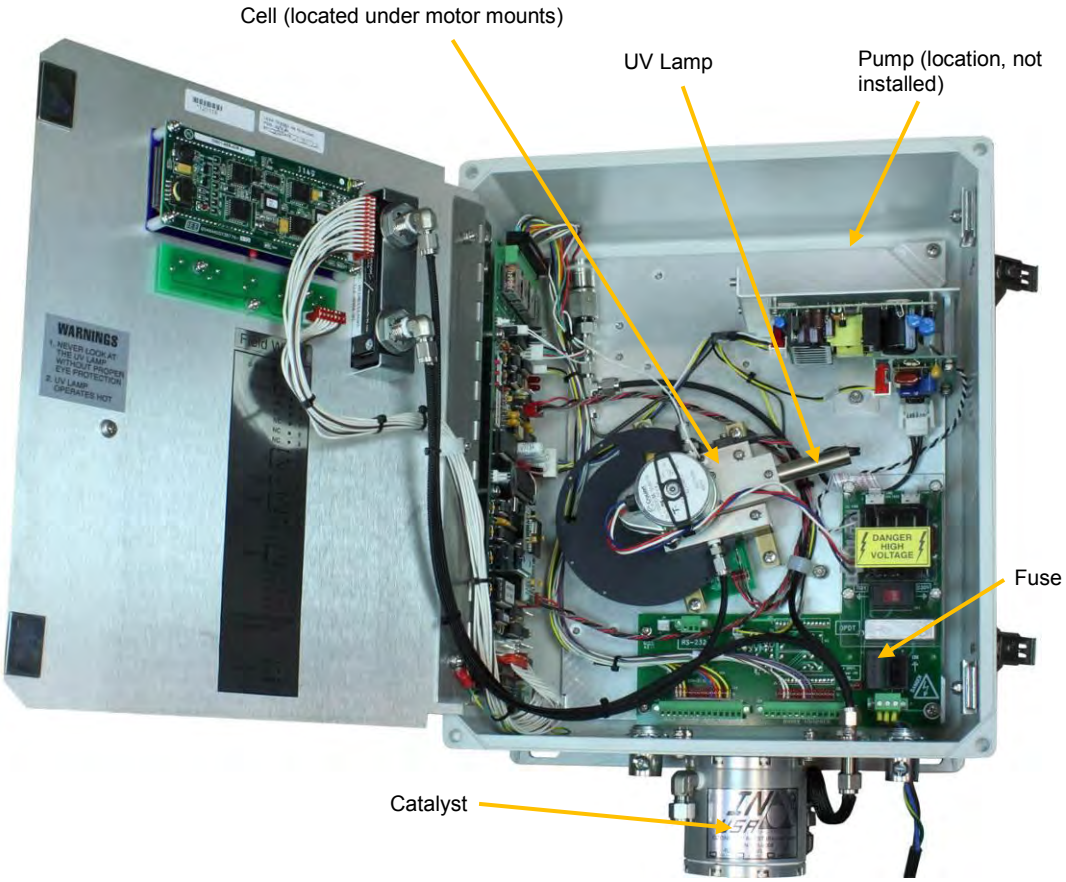
Performance of periodic maintenance requires advanced knowledge, understanding, and training with the Ozone Analyzer System. NEVER perform a maintenance task unless you are trained and certified to perform the task safely. All seals, connections, and fittings must be leak-tight. Refer to procedures for details and warnings.

6.1 Preventative Maintenance Schedule

Item		Interval				
	As Needed	Monthly	6 Months	1 Year	2 Years	5 Years
Replace Inlet Sample Filter Element	YES	-	-	YES	YES	YES
Replace the UV Lamp	YES	-	-	YES	YES	YES
Inspect Optics Cell	-	-	-	YES	YES	YES
Replace Optics Cell Components	-	-	-	-	YES	YES
Replace Motor/Gear Assembly	-	-	-	-	YES	YES
Replace Catalyst	YES	-	-	-	YES	YES
Replace Pump	-	-	-	-	YES	YES
Zero Calibration	YES	YES	YES	YES	YES	YES
Replace Chopper Wheel	-	-	-	-	-	YES

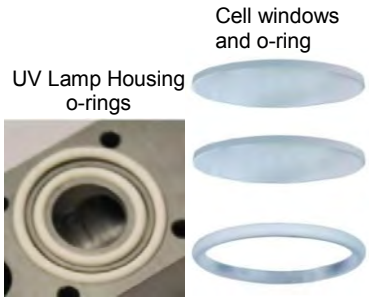
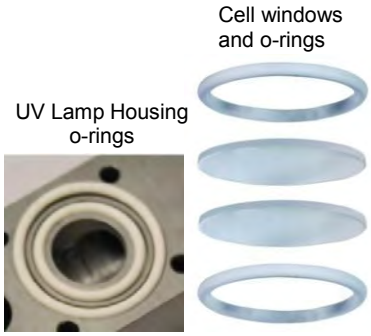
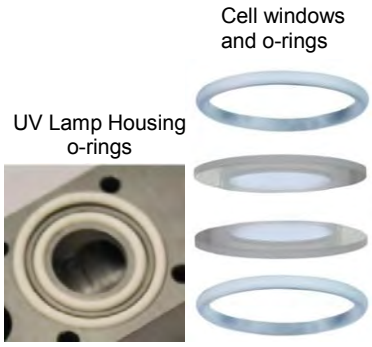
6.2 Consumable Parts – Locations

Components are shown in the wall-mount unit for reference:



Wall-Mount Unit, Major Components

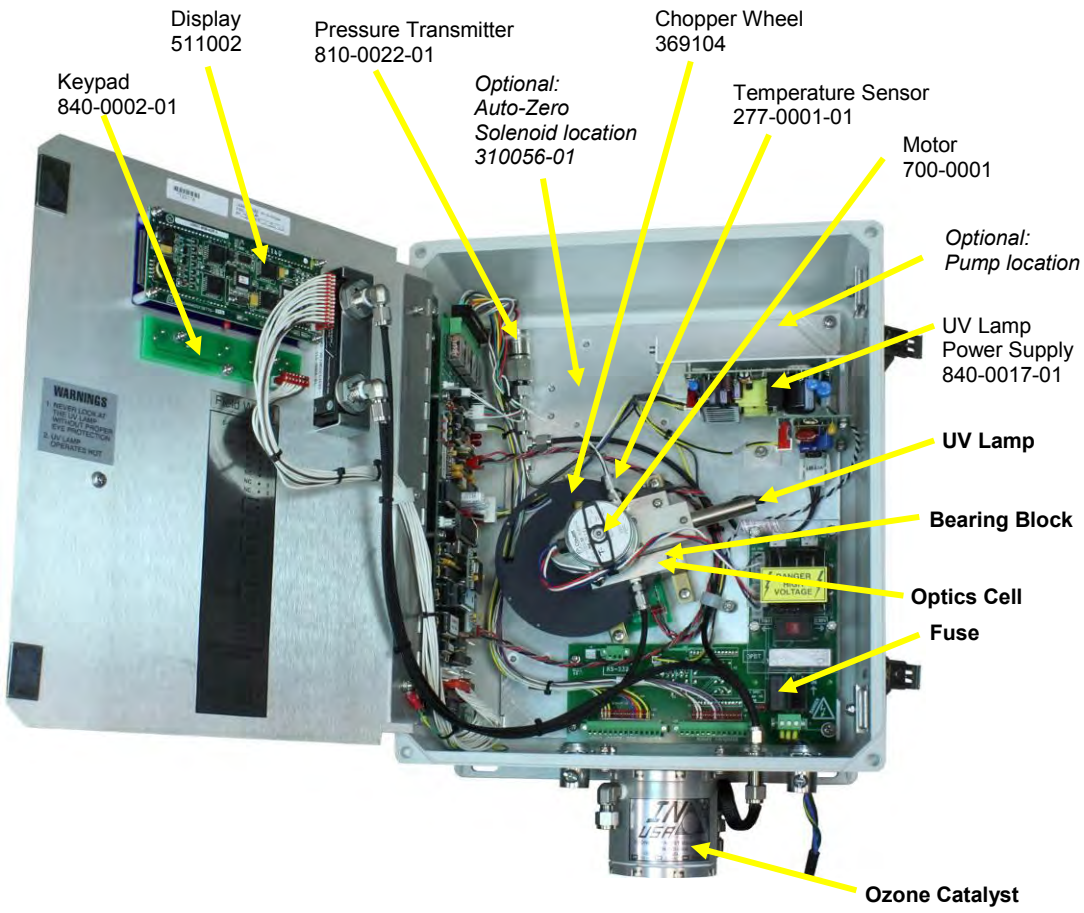
6.3 Consumable Parts Ordering Information

Item	Description	Part Number	Qty
	External Filter Element and O-ring Kit	390-0049-01	1
	Cell Kit H1-LR	870-0013-01	1
	Cell Kit H1-S/X	870-0011-01	
	Cell Kit H1-UH	870-0012-01	

	UV Lamp	110003	1
	Ozone Catalyst (Note: Fittings orientation may vary from that shown)	810-0008-01	1
	Motor	700-0001	1
	Chopper Wheel	369104	1

6.4 Replacement Parts Ordering Information

The following parts illustration is provided for reference, should repair become necessary. Contact IN USA with any questions.

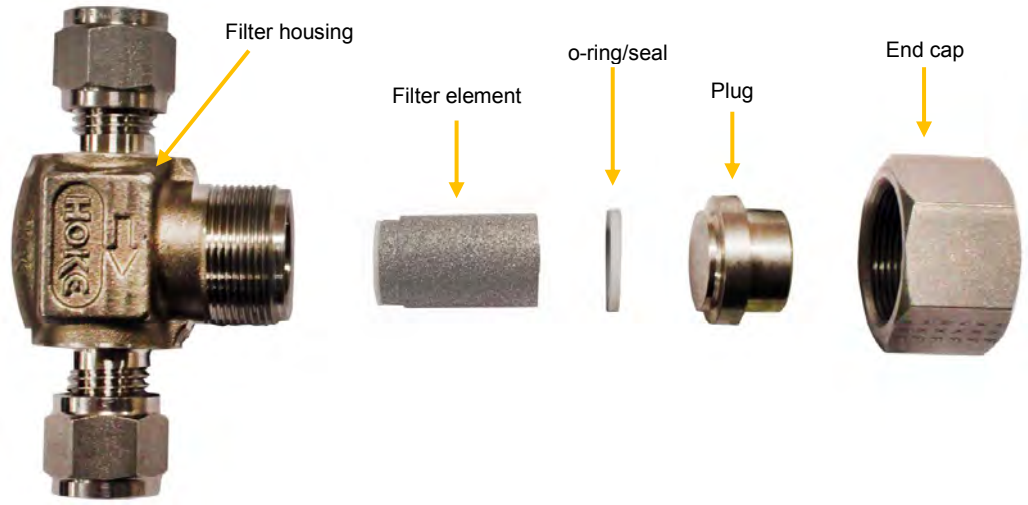


Item	Part Number	Qty
Fuse – Wall-Mount Unit	110014	1
Fuse – Bench Unit	230-0046-01	2
¼" Ferrule	311-0002-01	
¼" Nut	311-0019-01	
½ Amp Fuse (220 VAC)	230-0013-01	
1 Amp Fuse (115 VAC)	230-0014-01	
1/8 Ferrule	310004-1	
1/8" Nut	310050	
1/8" Teflon Tubing (Price Per Ft.)	720016	
AC Input Cable	369317	
Assy. 1.5mm Gas Chamber (H1S/X)	A369402-2	

Autozero Board	A369019	
Autozero Pump, 115 VAC	314026-1	
Autozero Pump, 220 VAC	314026-2	
Autozero Solenoid	310056-2	
Clock Chip	112013	
DC Power Supply	221-0028-01	
Display	511002	
Filter Holder	390-0048-01	
Flow Restrictor	310130-1	
Gain Attenuator	250-0005-01	
H1-LR Cell Assembly (Calibrated)	820-1022-01	
H1-S / LR CPU	A369315	
H1-S Cell Assembly (Calibrated)	820-1014-02	
H1-UH Cell Assembly (Calibrated)	820-1010-02	
H1-UH CPU	A369315-2	
H1-X Cell Assembly (Calibrated)	820-1014-01	
H1-X CPU	840-0001-01	
Hoya Filter	369110	
Keyboard	A369313	
LC Flowmeter	316-0008-01	
Non-Valved Flowmeter Ozone	316-0004-02	
OCA Filter	420-0003-01	
Power Receptacle & Switch	311005	
Power Supply Cable	A369316	
Preamp Board	A369303	
Pressure & Temperature Sensor	A369201	
Serial Port Cable	A369323	
Tach Assembly	A369319	
Temperature Sensor	277-0001-01	
UV Lamp Power Supply	**840-0017-01	
Valved Flowmeter Ozone	316-0004-01	

6.5 PM: Replace Inlet Sample Gas Filter Element

1. Stop the flow of gas to the H1 unit
2. Use two wrenches: one to hold the filter housing firmly in place, and one to remove the end cap.
3. Remove and replace the filter element and o-ring/seal, then re-install the plug, and cap, as shown below:



6.6 PM: Replace the UV Lamp

The UV lamp will degrade (output) over time, and may discolor (as shown below).

Required Equipment:

- Power-free latex gloves to handle the lamp
- UV protective eyeglasses
- Phillips screwdriver

CAUTIONS:

⚠ WARNING

UV RADIATION HAZARD

Remove all power from the system before servicing the UV lamp.

NEVER PULL THE LAMP OUT ENTIRELY OF ITS HOUSING WHEN POWER IS ON. DO NOT LOOK AT THE LIGHTED PART OF THE LAMP WITHOUT PROPER EYE PROTECTION.

DO NOT look directly at a UV lamp as irreversible, disabling eye damage can occur. Always wear proper eye protection equipment when calibrating UV lamps to prevent accidental exposure.

⚠ CAUTION

MERCURY CONTENT!

The UV lamp contains Mercury (Hg). Dispose of according to Local, State, and Federal Laws! If you have any questions, return the UV lamp to IN USA, Inc. for proper disposal.

⚠ IMPORTANT

USE ONLY IN USA LAMPS

Use ONLY UV Lamps purchased from or approved by IN USA. The H1 Analyzer will not operate properly and could be severely damaged if an improper lamp is used. In this case, any warranty, expressed or implied will become null and void.

Procedure:

1. Stop the flow of any gas to the H1 unit.
2. Disconnect power to the H1 unit.

⚠ WARNING

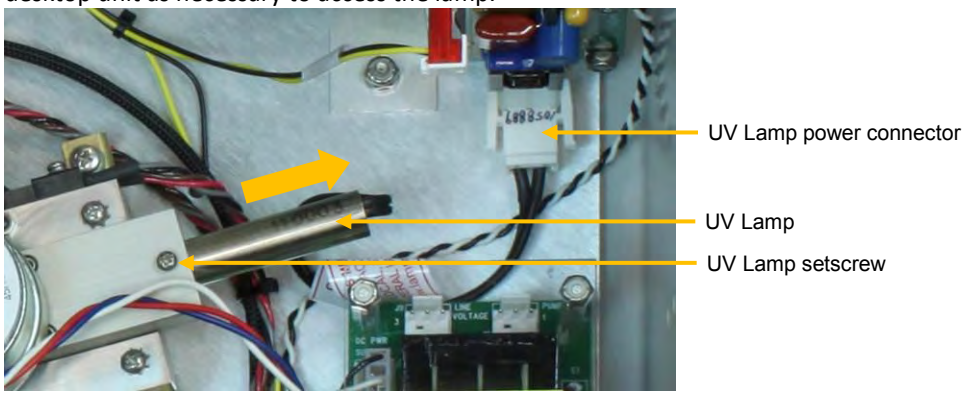
UV RADIATION HAZARD

Remove all power from the system before servicing the UV lamp.

NEVER PULL THE LAMP OUT ENTIRELY OF ITS HOUSING WHEN

	POWER IS ON. DO NOT LOOK AT THE LIGHTED PART OF THE LAMP WITHOUT PROPER EYE PROTECTION. DO NOT look directly at a UV lamp as irreversible, disabling eye damage can occur. Always wear proper eye protection equipment when calibrating UV lamps to prevent accidental exposure.

3. Open the front door of the wall-mount unit or remove the top panel of the rack-mount or desktop unit as necessary to access the lamp.



4. Disconnect the UV Lamp's power connector.
5. Loosen the UV lamp setscrew and carefully pull the lamp out of its housing.
6. Install the replacement lamp and tighten the setscrew
7. Close all panels as appropriate and Restore power to the H1 unit.

Step 2: Perform a Zero Calibration

1. Refer to the Operation section of this manual to perform a zero-calibration of the UV lamp.

6.7 PM: Replace Optics Cell Windows and O-ring

Replacement of the optics cell is an advanced procedure and should only be completed by qualified technicians. This procedure is typically performed at IN USA as part of a yearly PM, cleaning, and recertification of the H1 Analyzer. Consult with IN USA with any questions.

⚠ WARNING

Leak Hazard!

This procedure violates the leak tightness of the instrument.

Careless reassembly of the Optical Chamber could result in leaks of the gas sample. These leaks can cause damage to components inside the analyzer, pose a health hazard, and cause erroneous ozone measurements. You should leak-test the analyzer prior to resuming its normal use. IN USA, INC. assumes no responsibility and shall be held harmless for problems caused as a result of improper handling of the optical components. The optical chamber and all other gas-tight components of the Model H1 analyzer have been leak tested at the factory to 10^{-5} cc/sec using Helium.

EXPOSURE TO OZONE IS HAZARDOUS. ENSURE THAT ALL GAS CONNECTIONS ARE TIGHT AND THAT NO LEAKS EXIST. THE EXHAUST STREAM WILL TYPICALLY CONTAIN LARGE AMOUNTS OF OZONE. ENSURE PROPER MEANS OF SAFELY DISPOSING OF THE OZONE CONTENT OF THE EXHAUST STREAM. PLEASE CONTACT ***IN USA, INC.*** FOR TECHNICAL ADVICE OR TO ASK ABOUT AVAILABLE OZONE DESTRUCTION UNITS.

Required Equipment:

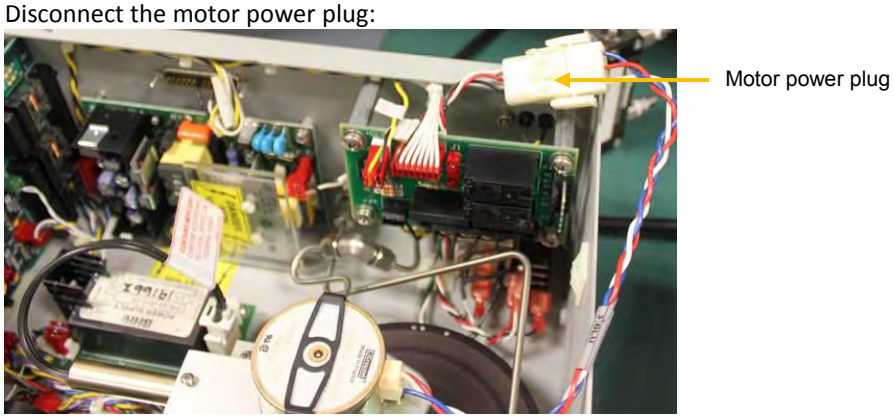
- Powder-free latex gloves to handle the optics elements
- Cleanroom wipes
- Isopropyl alcohol (for wipe-cleaning of metal components)
- Large, medium, and small Phillips screwdriver
- L-shaped Phillips screwdriver
- O-ring extractor (optional)
- Pointed razor blade (Exactor blade or equivalent)
- Two (2) 7/16” open end wrenches
- Allen wrench sets, English and Metric

Procedure:

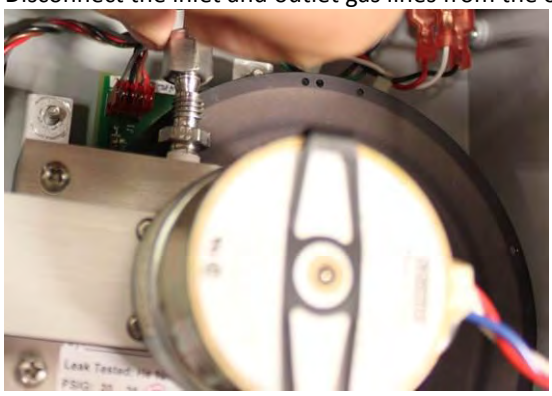
Step 1: Remove the Motor/Wheel/Optics Assembly from the Unit

1. Stop the flow of any gas to the H1 unit.
2. Disconnect power to the H1 unit.
3. Remove covers or open the doors as necessary to access the interior.

4. Disconnect the motor power plug:

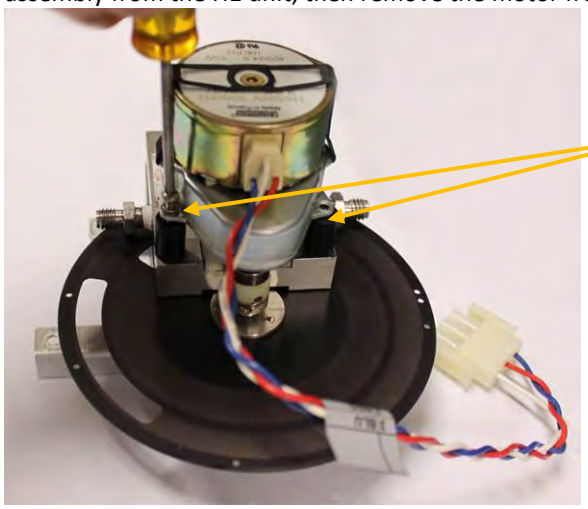


5. Disconnect the UV Lamp's power connector, loosen the UV lamp setscrew and carefully pull the lamp out of its housing.
6. Disconnect the inlet and outlet gas lines from the optics assembly.



7. Remove the position sensor from the optics cell.

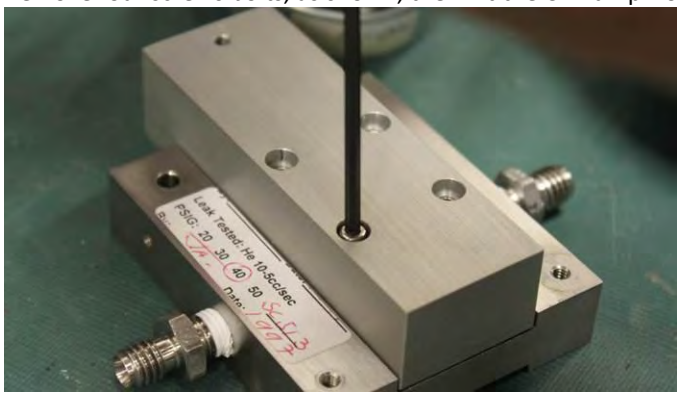
8. Use a socket wrench to remove bolts as necessary to remove the motor, wheel, and optics assembly from the H1 unit, then remove the motor from the assembly.



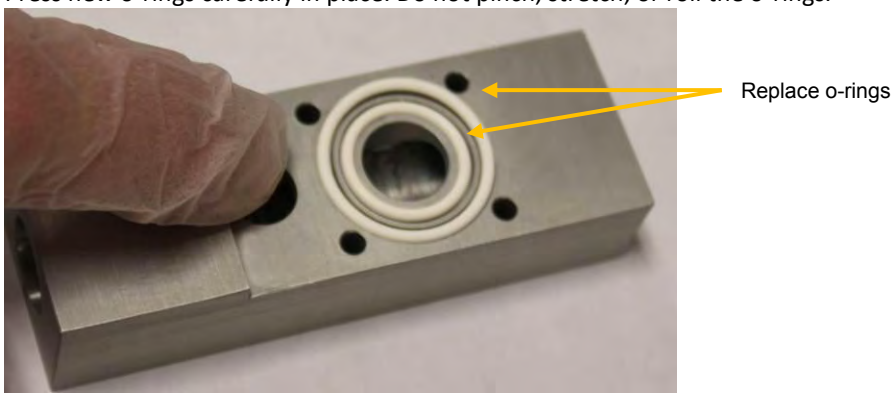
9. Remove optics cell (bearing block) from the wheel assembly.

Step 2: Disassemble Optics Cell

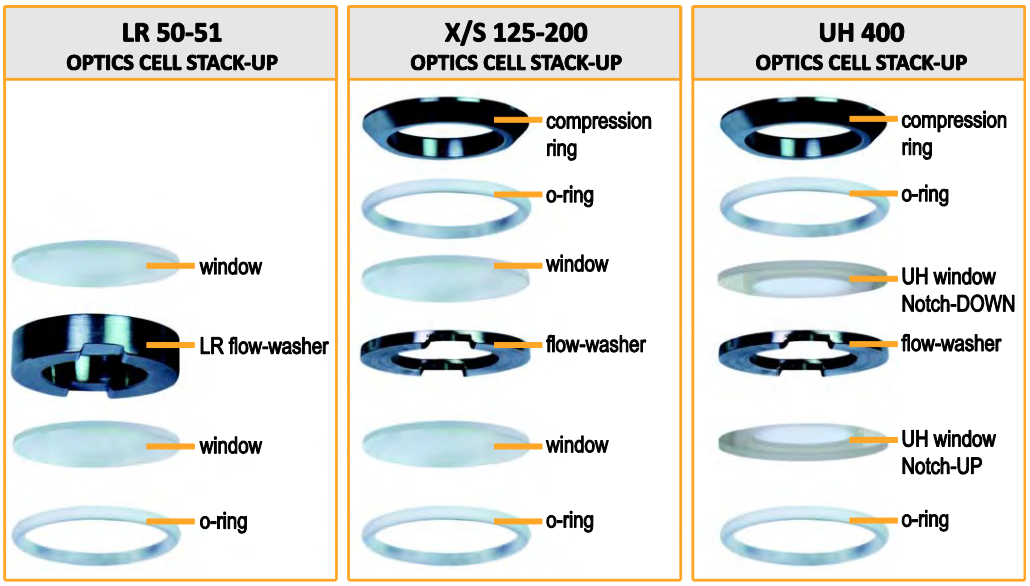
1. Remove four screws bolts, as shown, then lift the UV Lamp Housing from the optics cell block.



2. Replace both o-rings on the UV lamp housing. Be careful not to damage sealing surfaces. Press new o-rings carefully in place. Do not pinch, stretch, or roll the o-rings.



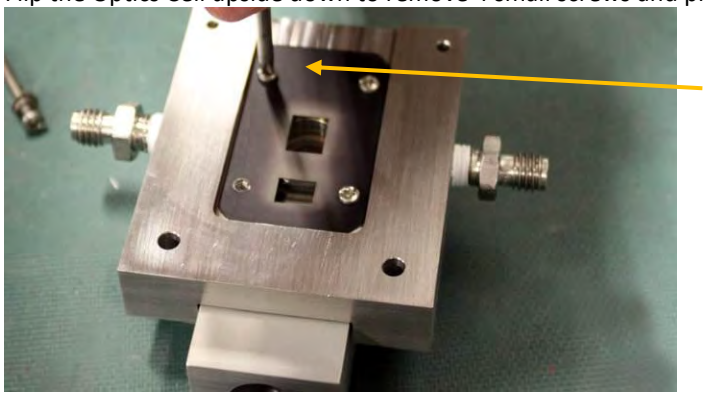
3. Refer to the Optics Cell chart below for your system for reference as parts vary per system flow range:



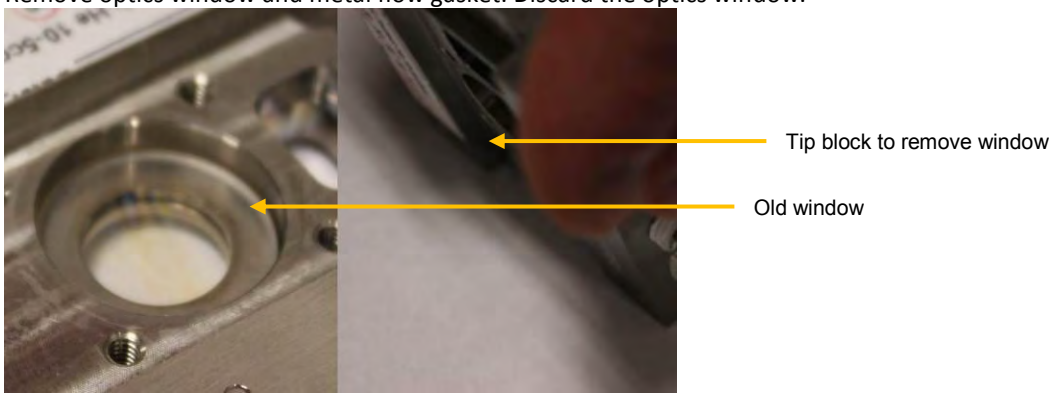
4. If present, lift the top compression ring (angular) out of the optics cell.
Use an o-ring extractor or Exacto blade if necessary, as shown, but be careful not to scratch the ring. Retain the ring for re-assembly.

5. If present, remove the top o-ring and discard.
   Note: Do not re-use o-rings or the cell will leak.

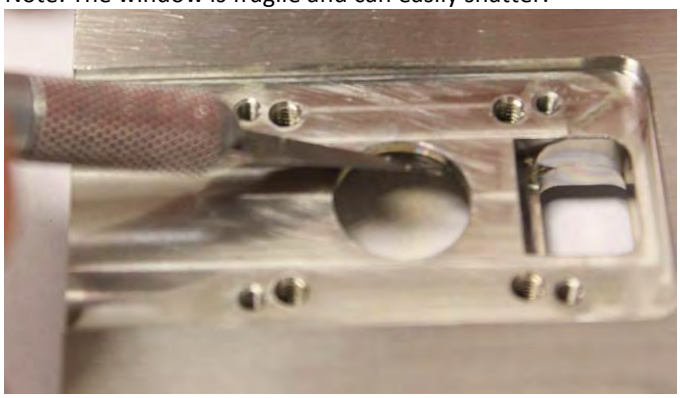
6. Flip the Optics Cell upside down to remove 4 small screws and plate, as shown:



7. Remove optics window and metal flow gasket. Discard the optics window.



8. Carefully remove the lower window and discard. If it is press-sealed, use blade to very gently free the window from the Optics block
   Note: The window is fragile and can easily shatter.

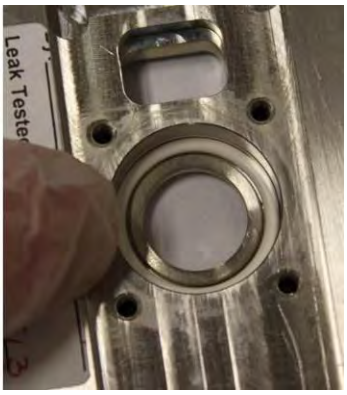


9. Flip the block back over and remove the lower o-ring and discard.

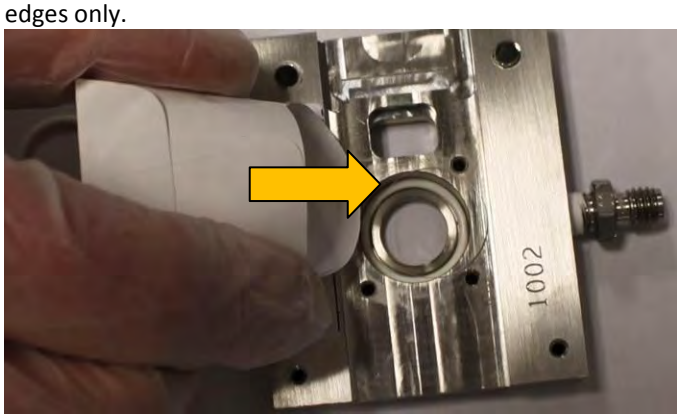
10. Wipe clean the assembly and metal rings/washers with cleanroom wipes and 100% IPA.
    DO NOT use DI water or any water-based cleaner.

Step 3: Re-assemble the Optics Cell with New Windows and Seals

1. Install a new o-ring in the base of the optics block. Use extreme care to prevent damage to the o-ring. DO NOT use any sharp tools. Press lightly into the o-ring groove. Do not twist or roll the o-ring.

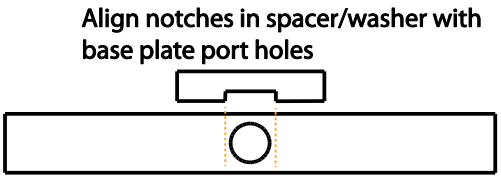


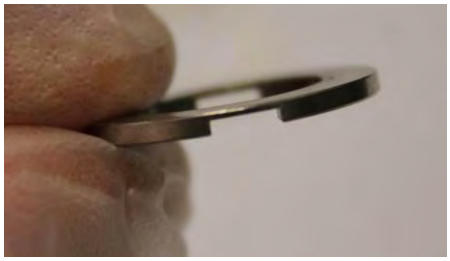
2. Completely remove any tape from the new window's paper shipping envelope, then carefully slide a new optics window into the cell. Use the envelope to push the window into the cell without touching the top or bottom surfaces. If necessary, you can hold the window by the edges only.



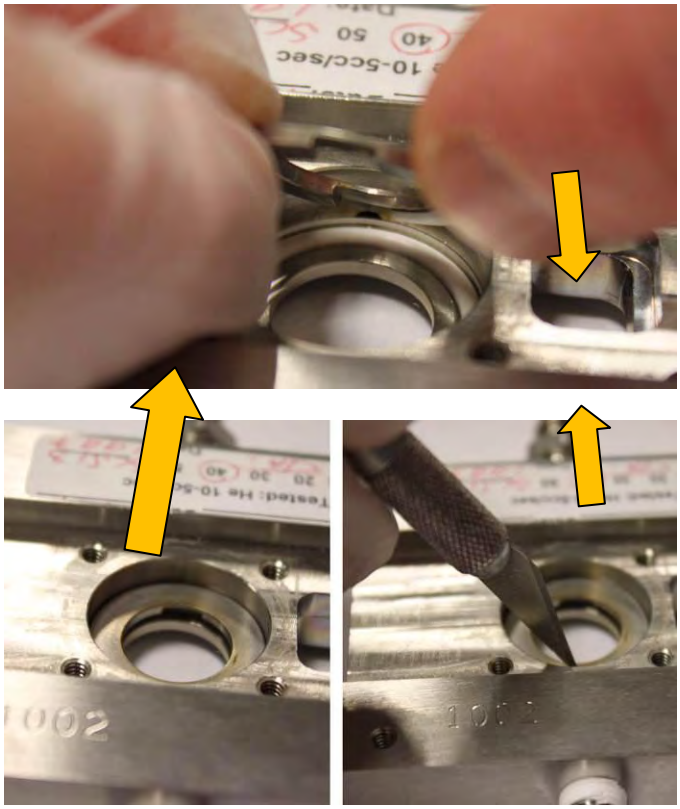
The windows are very easily scratched and/or the edges can very easily chipped, resulting in leaks. Use extreme care.

3. Insert the flow spacer into the cell. Be sure to note the flow orientation of the flow-washer. Align the openings to match exactly with the flow holes in the optics cell block. Press in place.

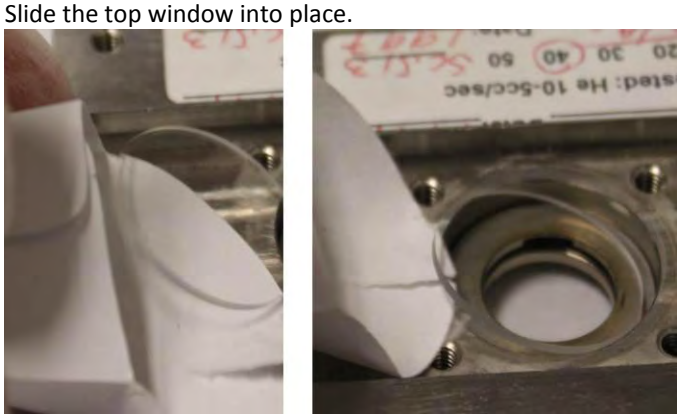




UH and X/S washer shown Use LR washer for LR series.

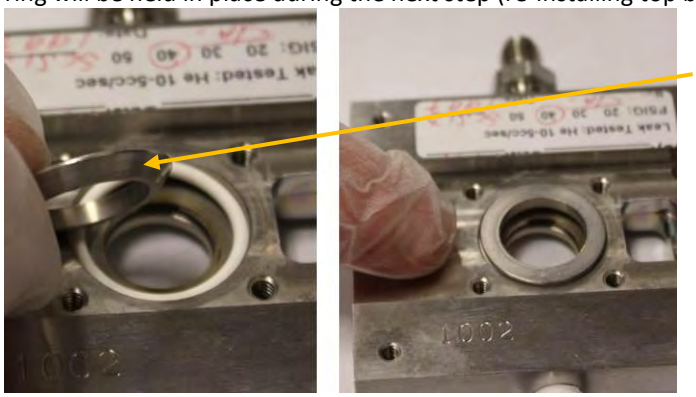


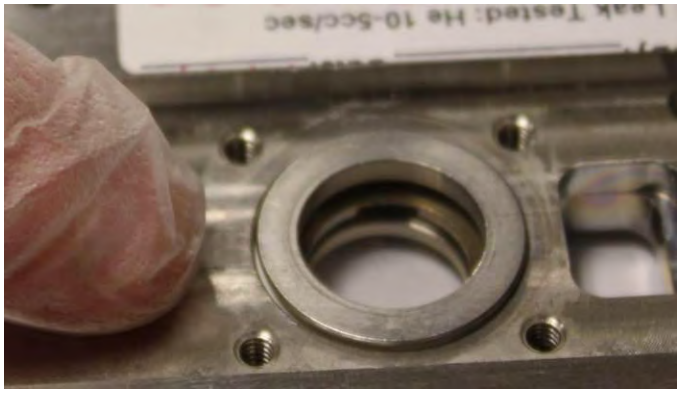
4. Slide the top window into place.



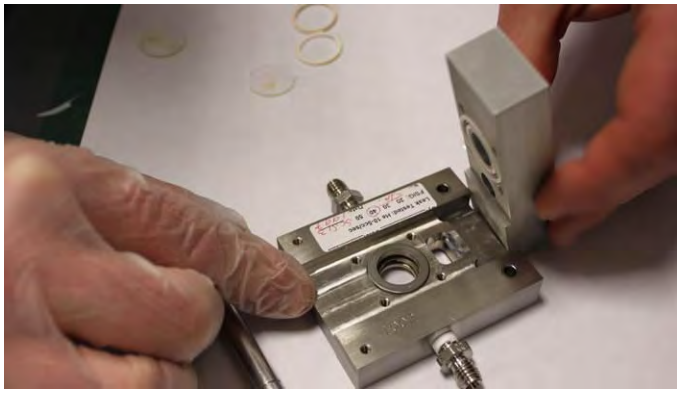
5. On UH and X/S series cells, insert a new o-ring on top of the window:

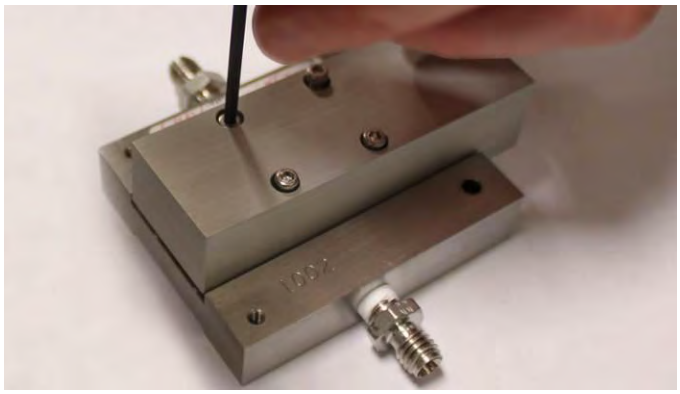
6. On UH and X/S series cells, place the top compression ring on the o-ring, lightly as shown. The ring will be held in place during the next step (re-installing top block).



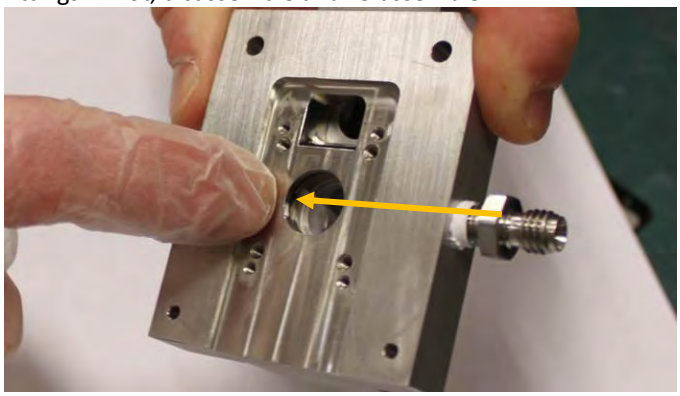


7. Re-install the UV lamp housing, as shown, which will hold the cell optics and spacers in place. Tighten each screw evenly by alternating in a star-pattern across each of the four screws until each screw is secure.

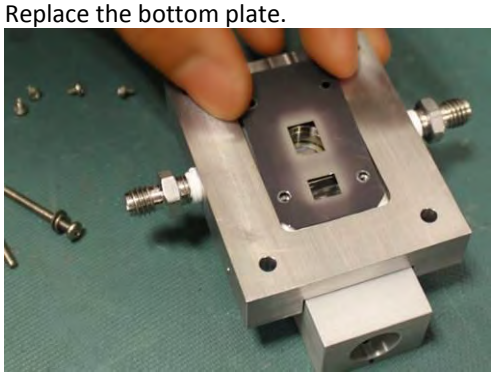




8. Flip the optics cell over and verify that the flow-washer in in-line with the inlet and outlet fittings. If not, disassemble and re-assemble.



9. Replace the bottom plate.



Step 4: Leak test the assembly

1. Leak test the optics assembly using standard helium-leak checking procedures. Consult IN USA with any questions. The unit should be leak-tested to 10^{-5} cc/sec.

⚠ WARNING

Leak Hazard!

This procedure violates the leak tightness of the instrument.

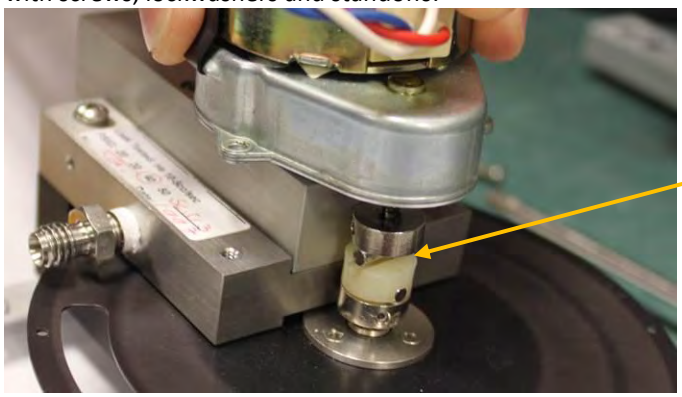
Careless reassembly of the Optical Chamber could result in leaks of the gas sample. These leaks can cause damage to components inside the analyzer, pose a health hazard, and cause erroneous ozone measurements. You should leak-test the analyzer prior to resuming its normal use. IN USA, INC. assumes no responsibility and shall be held harmless for problems caused as a result of improper handling of the optical components. The optical chamber and all other gas-tight components of the Model H1 analyzer have been leak tested at the factory to 10^{-5} cc/sec using Helium.

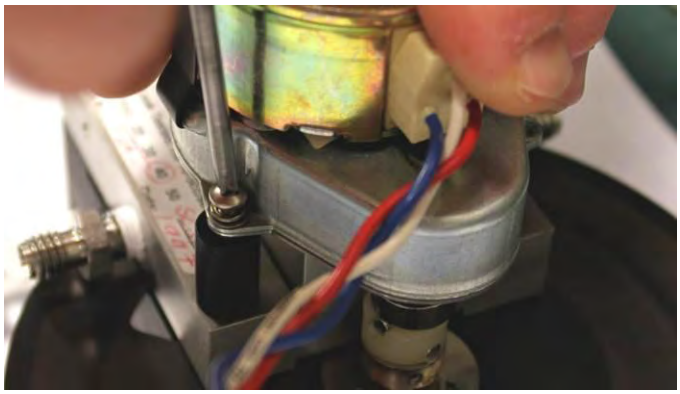
EXPOSURE TO OZONE IS HAZARDOUS. ENSURE THAT ALL GAS CONNECTIONS ARE TIGHT AND THAT NO LEAKS EXIST. THE EXHAUST STREAM WILL TYPICALLY CONTAIN LARGE AMOUNTS OF OZONE. ENSURE PROPER MEANS OF SAFELY DISPOSING OF THE OZONE CONTENT OF THE EXHAUST STREAM. PLEASE CONTACT ***IN USA, INC.*** FOR TECHNICAL ADVICE OR TO ASK ABOUT AVAILABLE OZONE DESTRUCTION UNITS.

Step 5: Re-assembly the Optics Wheel

1. Re-connect the optics cell on the wheel assembly as shown using two long screws. Tighten screws and carefully check that the wheel freely turns beneath the optics block.

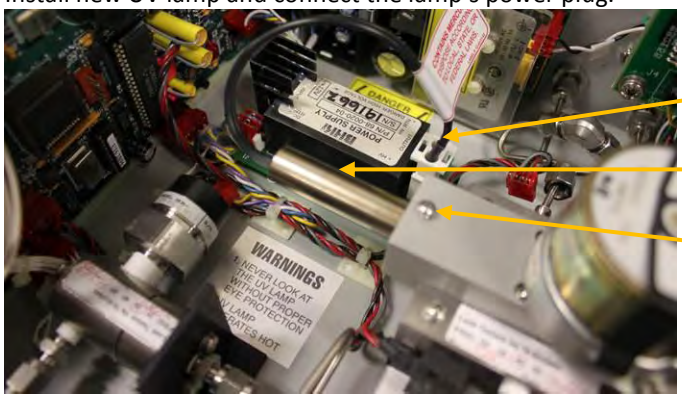
2. Align the wheel and the motor connection then lower the motor onto the optics cell. Re-attach with screws, lockwashers and standoffs:



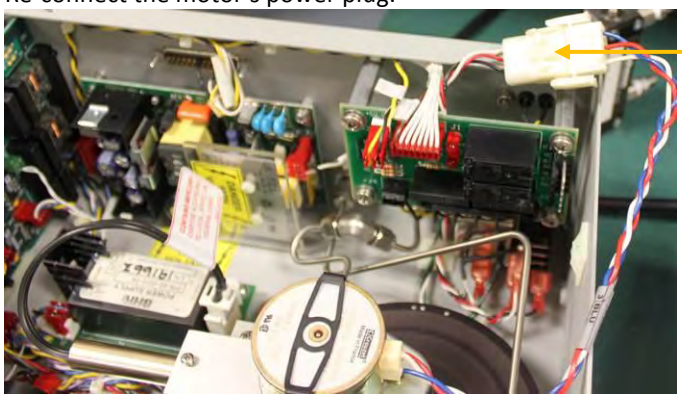


3. Re-install the wheel assembly into the H1 unit with star-lockwashers and nuts (4 places)

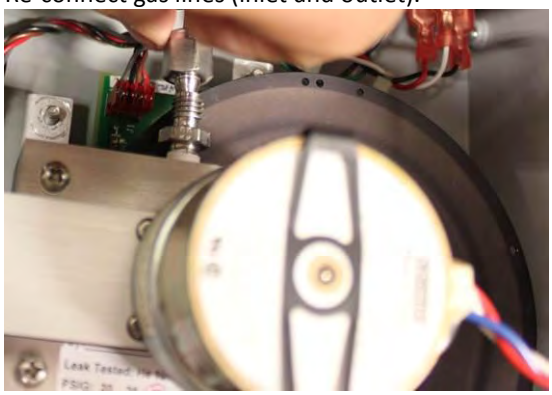
4. Install new UV lamp and connect the lamp's power plug.



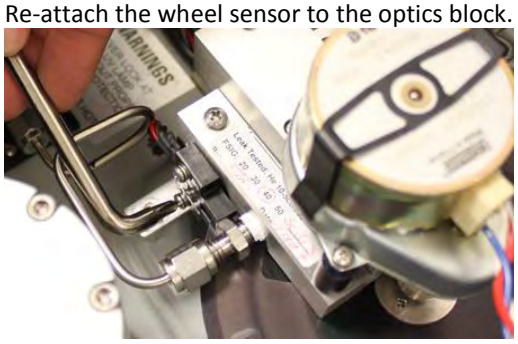
5. Re-connect the motor's power plug:



6. Re-connect gas lines (inlet and outlet).



7. Re-attach the wheel sensor to the optics block.



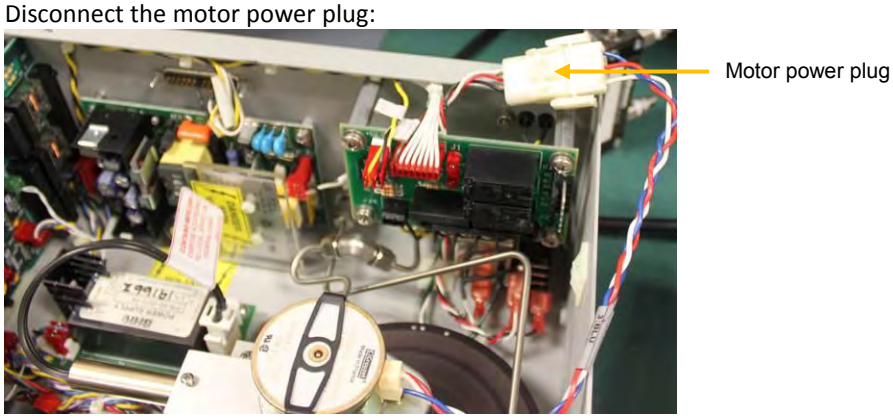
6.8 PM: Replace Motor/Gear Assembly

Required Equipment:

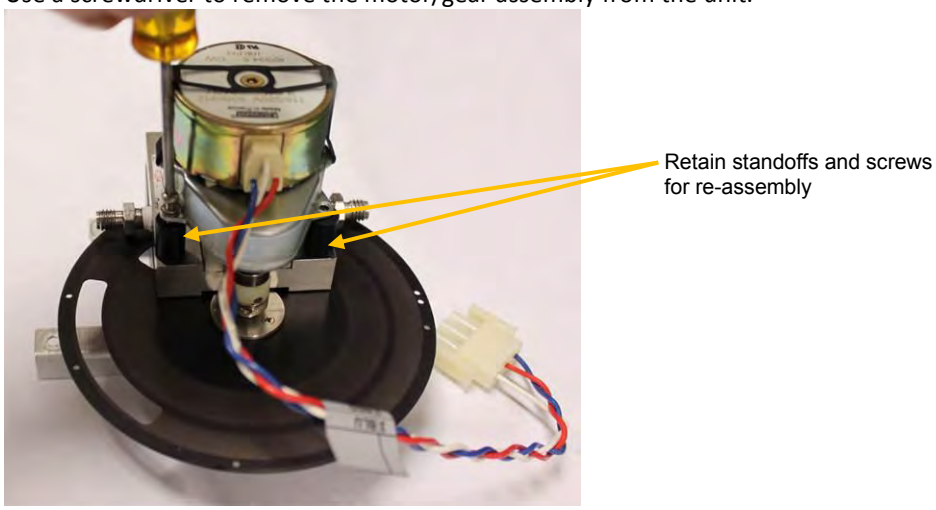
- Phillips screwdriver

Procedure:

1. Stop the flow of any gas to the H1 unit.
2. Disconnect power to the H1 unit.
3. Remove covers or open the doors as necessary to access the interior.
4. Disconnect the motor power plug:



5. Use a screwdriver to remove the motor/gear assembly from the unit.

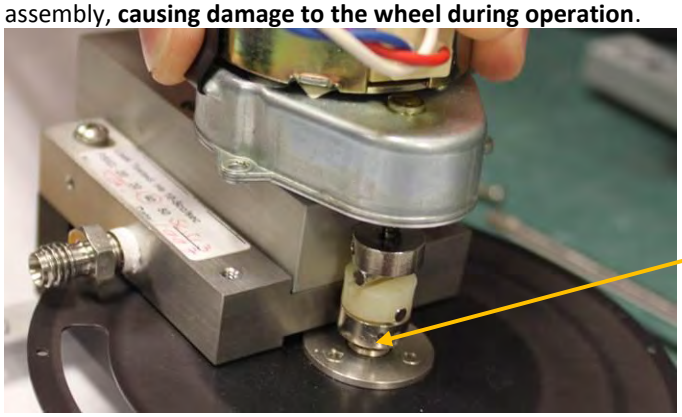


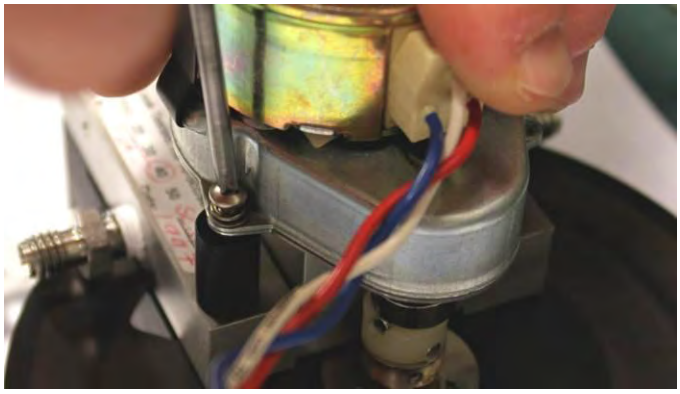
(shown external to the system for clarity – remove two screws, only!)

6. Install the replacement motor/gear assembly: Align the wheel and the motor connection then lower the motor onto the optics cell. Re-attach with screws, lockwashers and standoffs.

   DO NOT OVER-TIGHTEN!
   Carefully check that the optics wheel rotates freely without scraping.

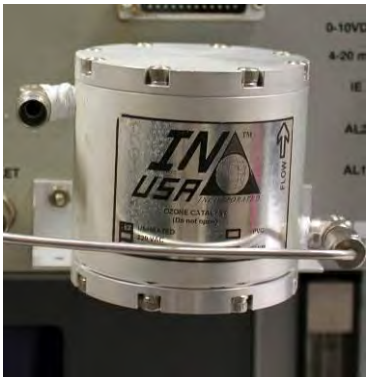
   The screws should be tight to hold the motor/gear assembly in place, regardless of any vibration. However**, if the screws are too tight, the standoffs can get compressed** and tilt the assembly, **causing damage to the wheel during operation**.





7. Connect the motor power plug to the power supply.
8. Restore the system to operation.

6.9 PM: Replace Reference Catalyst



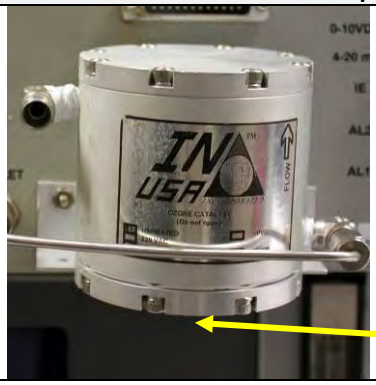
1. Turn off all gas supplies to the H1 system.
2. Remove all power from the system.
3. Disconnect all inlet and outlet tubes from the reference catalyst cell.

⚠ WARNING

Hazardous Chemicals!

DO NOT open the catalyst unit. PLEASE CONTACT ***IN USA, INC.*** with any questions for proper disposal in accordance with all Local, State, and National laws.

4. Remove the catalyst unit from the system and return to IN USA for proper disposal, or consult IN USA Technical Support for proper disposal in accordance with all local and national codes.

Wall-Mount Unit	Rack-Mount or Desktop Unit
 Remove screws 4 places	 Remove screws attaching Catalyst to mounting plate

5. Install a replacement catalyst unit and reconnect all tubing.

6.10 PM: Replace Chopper Wheel

Refer to the “Replace Optics Cells Components” procedure for details.

6.11 PM Service, Accuracy, and Calibration by IN USA

Calibration Standard

The H1 system has been carefully calibrated against a factory standard unit. This factory standard unit was calibrated by NIST and, consequently, the units themselves are NIST traceable. A certificate of calibration is issued with each unit. Further details on this procedure are available from IN USA, Inc.

PM Service and Recertification by IN USA

Many end users send their instruments to our facility on a yearly scheduled basis for optics cell component replacement, PM service or quotation/evaluation, and leak integrity testing and system calibration recertification. Please consult with IN USA, Inc. to determine the most appropriate calibration schedule for your application.

7 SERIAL DIGITAL PORT

The Model H-1 features an RS-232 Compatible Digital Serial Interface. This interface is required to calibrate the system.

The analyzer can be connected to a terminal or to a PC in terminal emulation mode (i.e. VT102, VT52) by using a standard RS232 cable. When using a PC, software such as Procom Plus™ or Windows™ Terminal can be used for terminal emulation.

7.1 Data Format

The Data Format is as follows:

1 Start Bit, 8 Data Bits, No Parity, 1 Stop Bit

7.2 Baud Rate

The Baud Rate is programmable to any one of the following values:

300
600
1200
2,400
4,800
9,600 (default)
19,200
38,400

The Baud Rate set in the analyzer must match the Baud Rate selected in the 'terminal'.

7.3 MENU OF COMMANDS

To display the Monitor Menu on a terminal, type "H" (upper case important) followed by carriage return. The following menu will be displayed:

---------- IN USA MONITOR COMMANDS ----------

A.....Dump raw A/D ozone readings
H.....To display this HELP screen
P.....Set Polled Mode
Tn..... Set Timed Mode - Output once every n seconds
!.....Transmit Polled Mode Data
?.....Dump all machine variables (Polled Mode)

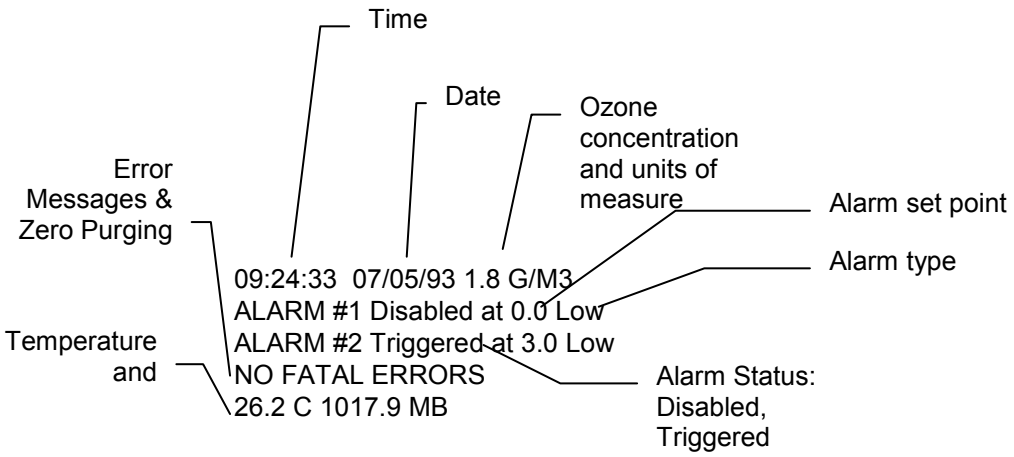
7.4 Data Output Stream

Data can be output from the Model H1 under either a TIMED or POLLED Mode, as determined by the user. If the operation is Timed Mode, the time between messages is programmed by the user for between 1 and 59 seconds.

Data output can be stopped from the terminal by pressing "Ctl + C". The "Esc" key will not have any effect.

When in the Polled Mode, the Model H1 is marking, waiting for a "?" or "!" character (ASCII) to trigger the transmission of a message.

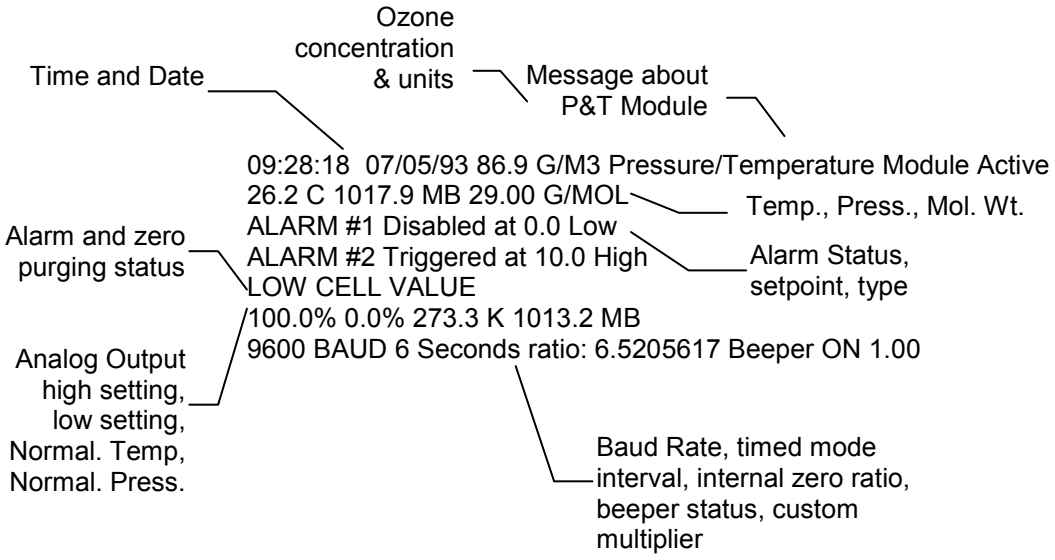
When in TIMED MODE, the RS-232 output is formatted as in the following example:



When in POLLED MODE, the Model H1 will not transmit any data until one of two polling commands is received:

" ! ": The unit transmits the same message format as in TIMED MODE,

" ? ": The unit transmits all the parameters and variables in the machine as in the following example:



7.5 Raw A/D Dump

The "Dump raw A/D ozone readings" command displays the light sensor information for the UV lamp, as described below:

1. Type "H" then press the Return key on the computer keyboard ("H" must be in upper case). The RS232 Menu will display:

---------- IN USA MONITOR COMMANDS ----------

A.....Dump raw A/D ozone readings
H.....To display this HELP screen
P.....Set Polled Mode
Tn..... Set Timed Mode - Output once every n seconds
!.....Transmit Polled Mode Data
?.....Dump all machine variables (Polled Mode)

2. Type "A" then press the Return key to display the instrument transmits data as shown in the example below:

RBLACK = 1 1 1 1 1 1 1 1

BASE REF= 4290 4290 4290 4290 4290 4290 4290 4291

CELL = 26816 26826 26826 26825 26826 26825 26826 26825

Averages of each of these three sets of values are used by the analyzer to determine ozone concentration.

Item	Meaning	Acceptable Values	Details
RBLACK	"dark current" measurement (sensor exposed to no UV light)	<20	In general, the absolute value of RBLACK should be a small number (typically less than 20). The values within a set of readings should be very stable.
BASE REF	reference light (no ozone)	1500 to 5000	The value of BASE REF will decrease as the lamp ages and will generally be between 1500 and 5000. BASE REF values should be very stable over short periods of time, provided the instrument is fully warmed up.
CELL	light through the measuring cell (optics cell)	3000 to 30000 with no ozone flow	The value of CELL will decrease as the concentration of ozone increases. The value of CELL ***when there is no ozone in the measuring chamber*** will generally be between 3000 and 30000. When ***no ozone is present***, the CELL values should be very stable over short periods of time, provided the instrument is fully warmed up.

8 Working Equations And Unit Conversions

8.1 Beer-Lambert Law

The Beer-Lambert Law of Absorption, in combination with the IOA (International Ozone Association) Standard 002/87 are used in calculating the ozone concentration as follows:

$$I_s = I_r * e^{-XLC}$$

where:

I_s is the intensity of light from the sample
I_r is the intensity of light from the reference
X is the ozone absorption coefficient constant at 253.7 nm wave length
L is the length of the absorption chamber
C is the concentration of ozone in weight/volume

The analyzer solves this equation for "C" in g/m^3

8.2 Conversion of g/m3 to % by Weight

The numerical computations used to calculate the Percent by weight can be approximated by the following equation:

$$G = C1 * (T1/P1) * (R/Mc) * 10^{-4}$$

Where:

G = The desired % result by weight
C1 = Ozone concentration in g/m^3
T1 = The temperature at which the measurement took place (°K)
P1 = The pressure at which the measurement took place (mB)
R = the Universal Gas Constant 83,143.3
Mc = The molecular weight of the carrier Gas in g/Mol

NOTE: the Model H1 solves a more accurate (and more complicated) equation to produce the numerical value of G

8.3 Normalization Conversion

To convert a concentration "c1" measured at Temperature "T1" and pressure "P1" to a concentration at different temperature and pressure (T2, P2), "c2", the following equation is used

$$c2 = c1 * (T1/T2) * (P2/P1)$$

Where:

c2 = the normalized result in g/m^3
c1 = ozone concentration in g/m^3
T1 = The temperature at which the measurement took place (°K)
P1 = The pressure at which the measurement took place (mB)
T2 = The temperature to which "c2" is normalized (referred), in °K
P2 = The pressure to which "c2" is normalized (referred), in mB.

9 AUTOZERO OPTION OPERATION

9.1 Electrical Installation

The AutoZero PCB assembly interconnects with the analyzer's main CPU and power supply, and with field equipment. The Auto Zero PCB also provides dry contacts for remote initiation and for interfacing to other control devices. Please refer to **Error! Reference source not found.** below for a description of the typical Auto Zero PCB interfaces.

9.2 AutoZero Principle of Operation

The AutoZero Function allows for the automatic zeroing of the UV analyzer with ozone-free gas flowing through the absorption cell.

The Function consists of:

1. Switching a 3-way Solenoid Valve (through a relay) to stop the flow of ozonated gas through the measuring cuvette and to allow for the flow of Zero Gas (Ozone-free gas).

2. Energizing a pump through a relay, to force the flow of Zero Gas.

3. Performing the mathematical zeroing

9.3 Initiation of the AutoZero Sequence

The AutoZero Sequence can be initiated through:

1. an external piece of equipment, interconnected to the AutoZero PCB through J4. This sequence is referred to as Hardware Initiated.

2. a timer internal to the analyzer as set by the operator through programming of the auto zero parameters. This sequence is referred to as Timer Initiated. (See "

Programmed (Automatic) Zero Calibration", page 33.)

3. the keyboard located in the front panel of the Analyzer (see "Manual Zero Calibration" on page 32.) This sequence is referred to as Keyboard Initiated

NOTE: Hardware Initiated and Timer Initiated autozeros require that the AutoZero PCB be installed.

9.4 Autozero Option, Messages

The Model H1 provides the user with status information during the AutoZero sequences. This information is available at the alpha numeric readout as well as at the Digital Serial RS-232 Compatible Interface.

Also available for the purpose of signaling to and communicating with other pieces of equipment to other are the second set of contact associated with the two relays K1 and K2 used to command the Pump and Solenoid Valve. These contacts remain energized during the whole sequence. (Actually, the Pump relay energizes 1 second ahead and de-energized 1 second later than the Solenoid relay).

The following Tables illustrates the messages and their relationship to the steps in the sequence.

Table 1: Messages for Hardware Initiated Auto Zero

STEP(S)	**MESSAGE**
1 thru 5	"PURGING 1"
6	"ZEROING 1"
Wait Loop	"ZEROING 1" (*)
End of Wait Loop	"ZEROING 1" (*)
Repeat 6	"ZEROING 2" (*)
7 thru 11	"PURGING 2"

(*) Will take place only if the Hardware autozero request does not return to normal during the Purging 1 period.

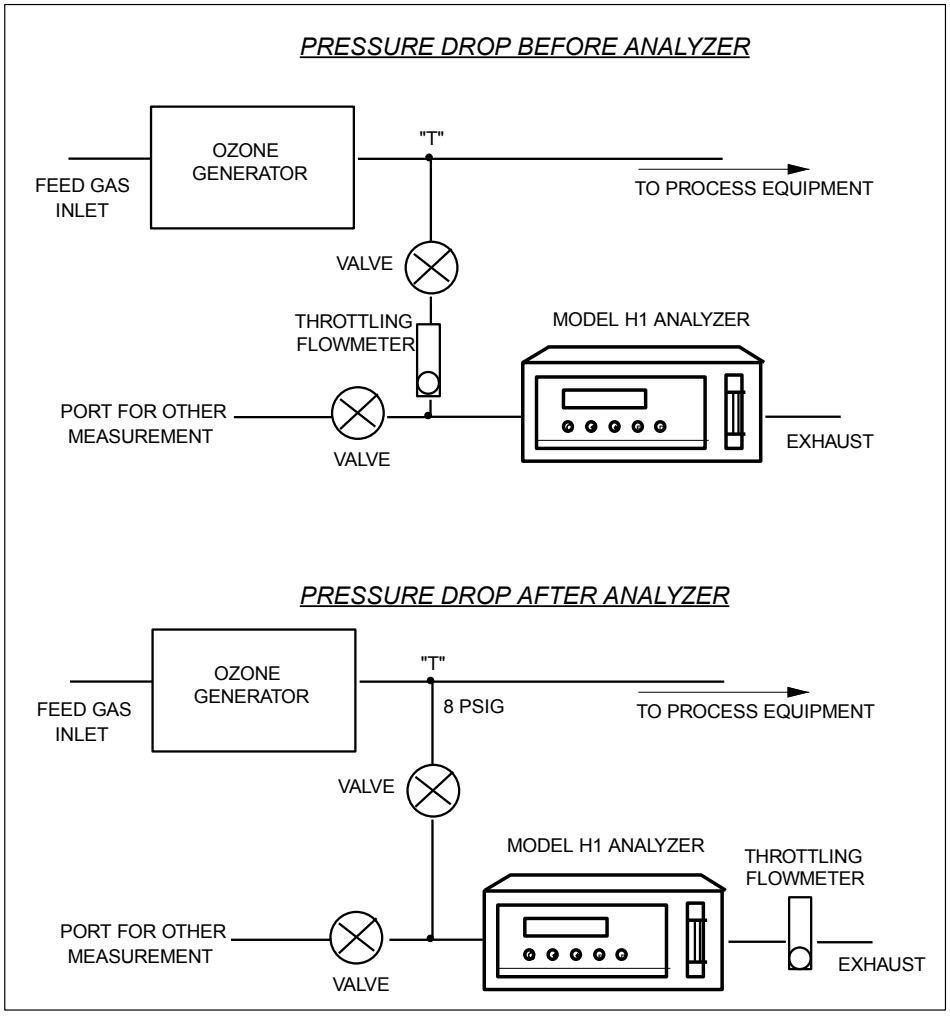
Table 2: Timer and Keyboard Initiated Auto Zero Messages

STEP(S)	**MESSAGE**
1 thru 5	"PURGING 1"
6	"ZEROING 1"
7 thru 11	"PURGING 2"

10 GENERATOR OUTPUT MONITORING

When the Model H1 ozone analyzer is used for monitoring the output from a generator, pneumatic (sample) connections can be configured so that the sample pressure drops before it is fed to the analyzer or after. The second option is only possible if the sample pressure is below the maximum operating pressure of the unit (typically 30 psia).

Configurations for Ozone Generator Monitoring



About IN USA

IN USA, INC. manufactures instrumentation and control systems. The company is the world's leading manufacturer of Ozone monitoring equipment. *IN USA, INC*. provides customized, optical-based monitoring systems which include sophisticated process control hardware and software.

Air-Cooled
Ozone Generator
AC Series

Ambient/Safety
Monitor
IN2000 L2-LC

Dissolved Ozone
Analyzer
W1

High
Concentration
Calibration
Checker
Mini HiCon

Handheld Ozone
Monitor
AET-55

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