INSTRUMENTATION

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SERIES IN-2000 SINGLE AND MULTI-CHANNEL GASEOUS OZONE ANALYZERS

OPERATING MANUAL

VERSION 3.0
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SPECIFICATIONS FOR THIS ANALYZER

MODEL	
SERIAL NUMBER	
CELL LENGTH	
CPU REV	
HVPS REV	
SOFTWARE VERSION	
SPAN NUMBER	
ZERO OFFSET NUMBER	
CALIBRATION DATE/INITIALS	
SF/CF VALUES AND DATE	

	CHAN 1	CHAN 2	CHAN 3	CHAN 4	CHAN 5
MEASURING RANGE					
SENSITIVITY					
REPEATABILITY					
ANALOG OUTPUT SCALING					

INSTALLED/SUPPLIED OPTIONS:
- MULTI-CHANNEL CONTROL SYSTEM MODEL RB-5L (SEPARATE UNIT)
- 4-20 mA *ISOLATED* OUTPUT
- RS-232 INTERFACE
- OTHER:_____
  _____

ENCLOSURE:
- BENCH TOP / 19" RACK
- NEMA 4X / IP65
- HEATED
- OTHER: _____
  _____

AC VOLTAGE SERVICE:
- UNIVERSAL (100-240 VAC)
- 115 VAC
- 220 VAC

INLET/OUTLET FITTINGS:
- 1/4" POLYPROPYLENE
- 1/4" STAINLESS STEEL
- OTHER: _____

ACCESSORIES:
- EXTERNAL DUST FILTER (QTY _____)
- OTHER: _____

MODIFICATIONS: _____
_____
_____

GENERAL SPECIFICATIONS FOR THE "IN-2000" OZONE ANALYZERS

Measuring Principle	Absolute determination by UV absorption
Number of Sample Points	1, 3 or 5. Multi channel units have a built-in manifold and programmable sequencer
Measuring Ranges	0-1.000 ppmv, 0-10.00 ppmv, 0-100.0 ppmv, 0-1000 ppmv. Other ranges on request. Multi-ranges units available on multi-channel instruments only
Display Resolution	0.001 ppmv (range 0-1.000 ppmv)
Zero Drift	Better than 0.005 ppmv per month, non-cumulative..
Precision/Repeatability	0.005 ppmv (range 0-1.000 ppmv)
Linearity	Better than 99% throughout range
Calibration Standard	Traceable to the U.S. NIST, +/- 1%
Ozone Concentration Units	ppmv. Others on request
Readout	1 line x 20 character, alpha-numeric, Vacuum Fluorescent
Gas Sample Flow Rate	1-2 l/min nominal
Analog Outputs	0-1 VDC and 4-20 mA (optional isolated)
Digital Output	Optional RS-232 compatible interface
Alarms	2 programmable alarms per channel . 2 form C relay contacts (SPDT) rated at 5 AMP resistive load at 250
Additional Interfaces	Optional Multi-Channel Control System (Model RB-5L) provides 2 form C relay contacts per channel for multi-channel units, and provides channel ID signal.
Diagnostic Features	Continuous internal diagnostics with error messaging and instrument error relay
Configurations	Wall mountable NEMA 4x / IP65 enclosure, or 19" rack 3U height. Heated enclosures optional.
Sample ports	1/4" or 6 mm compression fittings.
Supply voltage	120 or 240 VAC, 50/60 Hz
Environmental Operating Conditions	5-45°C; 0-95% RH non condensing

Specifications subject to change without notice.

CAUTIONS AND GENERAL NOTES

CAUTION: OZONE MAY BE DANGEROUS AND HARMFUL TO HUMANS. TAKE REASONABLE STEPS TO AVOID EXPOSURE. THE CURRENT GUIDELINE FOR MAXIMUM 8-HOUR EXPOSURE LIMIT TO OZONE IS 0.1 PPMV.

CAUTION: NEVER LOOK DIRECTLY AT THE UV LAMP WHICH IS INSIDE THIS ANALYZER WITHOUT PROPER EYE PROTECTION. UV RADIATION CAN CAUSE PERMANENT EYE DAMAGE.

CAUTION: COMPONENTS WITHIN THIS ANALYZER ARE POWERED BY AC VOLTAGE. TAKE ALL NECESSARY PRECAUTIONS TO ELIMINATE THE RISK OF ELECTRICAL SHOCKS.

CAUTION: CERTAIN COMPONENTS MAY BE HOT TO THE TOUCH. PLEASE ALLOW PROPER COOLING TIME BEFORE WORKING WITH THESE COMPONENTS.

IN USA, INC. reserves the right to make changes to the product covered in this manual to improve performance, reliability or manufacturability. Make sure that this Manual is used with the original product it was shipped with.

Although every effort has been made to ensure accuracy of the information contained in this manual, IN USA™ assumes no responsibility for inadvertent errors.

IN USA™ assumes no responsibility for the use of any measuring schemes described herein.

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.

INTRODUCTION

The AFX® IN-2000 single and multi-channel UV absorption ozone analyzers are designed to measure ozone in the gaseous phase. The IN-2000 is supplied in a variety of configurations based on measuring range, number of channels, and type of enclosure.

The most common measuring range is 0.00-10.00 ppmv, the range of interest in worker safety (industrial hygiene) applications. Multi-channel versions of the IN-2000 can also be supplied as dual-range units, where each channel can be set to measure at one of two measuring ranges. In addition, special version of the IN-2000 are supplied as part of the AFX® System W Dissolved Ozone in Water analyzer.

One key difference between these various analyzers is the length of the absorption cell in the optical assembly, which varies from 1 cm (for higher ozone concentrations) to 28 cm (for lower ozone concentrations). The length of the cell is a key factor in determining the range and sensitivity of the analyzer, as explained later on in the section on principle of measurement.

Typical models in the IN-2000 family include the following:

MODEL	***BRIEF DESCRIPTION***
AFX® IN-2000	Low ppmv range, basic unit
AFX® IN-2000-X	Medium ppmv range
AFX® IN-2000-3 or -5	3-channel or 5-channel
AFX® IN-2000-3M or -5M	3-channel or 5-channel with dual range
AFX® IN-2000-W1	Part of the AFX® System W dissolved ozone analyzer

Please refer to the specifications at the beginning of this manual for the exact specifications of your analyzer.

CAUTION: Do not use the analyzer to measure ozone concentrations above its designed measuring range, as this may damage the instrument. Please contact IN USA for technical support if you find that your analyzer's measuring range is not appropriate for your current application. IN USA's AFX® line of ozone analyzers includes models for measuring every level of ozone, including ozone generator output.

The IN-2000 is housed in either a standard 19" rack (3U height) configuration (which is also used as the bench-top configuration), or in a water and dust tight NEMA 4x (IP65) wall mountable enclosure (see Figure 1 and Figure 2).

The IN-2000 series ozone analyzers include single and multi-channel versions. The single channel version has a single sample inlet port. The multi-channel analyzers have multiple sample inlets

(typically three or five), and a built in programmable manifold/sequencer which allows automatic or manual sequencing through the sampling points. The various models in the series IN-2000 include:

- Model IN-2000: Single Channel (one sample input)
- Model IN-2000-3: Three Channel (three sample inputs)
- Model IN-2000-5: Five Channels (five sample inputs)

Multi-channel instruments can be interfaced with *IN USA, INC.*'s Model RB-5L Multi-Channel Control System. The RB-5L provides two SPDT alarm relay contacts for each of the channels, plus channel ID dry contact information to facilitate complete alarm and control functionality. A separate manual is supplied for the RB-5L when it is part of the IN-2000 system.

IN-2000 analyzers are designed for continuous, uninterrupted operation and require minimal maintenance. The instruments feature internal diagnostic routines which continuously check key instrument parameters to ensure fail safe operation. Upon instrument failure or power interruption, an "instrument error" message will be displayed and a corresponding instrument error relay will be de-energized.

A NOTE ABOUT OZONE

Long term exposure to ozone may be harmful to humans. The generally accepted 8 hour ozone exposure limit is 0.10 ppmv. Short term exposure limits are generally set at 0.30 ppmv. At certain concentrations, ozone may cause irreversible health problems and even death. Thus, one of the most popular uses for the IN-2000 analyzer is worker safety.

OPTIONS AND ACCESSORIES

The AFX® Model IN-2000 may include several options and accessories designed to expand its capabilities.

4-20 mA and 0-1 VDC Analog Outputs

Both 0-1 VDC and 4-20 mA DC analog outputs are standard with the IN-2000.

The IN-2000 optionally provides an isolated 4-20 mA analog output. Please refer to the specifications for your particular analyzer (refer to the first pages of this manual) to determine the type of analog outputs installed in your analyzer.

The non-isolated 4 - 20 mA DC output compliance is 750 Ohm and the loop is open-circuit protected.

The range of the analog outputs typically corresponds to the measuring range of the instrument or of a particular channel for multi-range units. Refer to the instrument's specifications to determine the analog output scale.

The analog output signal is linear to the displayed ozone concentration. If the measured ozone level is above the full scale range of the instrument, the analog output will be at full scale.

On multi-channel instruments, the display and the analog outputs are reset to zero whenever the channel is changed.

NOTE: The analog outputs are factory installed

RS-232 Output Interface

The IN-2000 optionally provides an RS-232 output interface for sending information in RS232 format. The data from the RS-232 interface can be captured using a VT terminal, or using a PC emulating such a terminal. With a PC, a communications program such as Procom™ or Windows™ Terminal must be used. The communications protocol is as follows:

- 1200 baud
- No Parity
- 8 Data Bits
- 1 Stop Bit

The table below illustrates the format of the information transmitted via the RS-232 port under different conditions. Note that each line of information is followed by a carriage return / line feed.

NOTE: The RS-232 signal carries NO information about the status of the ozone alarms.

OPERATION	***SINGLE CHANNEL***	***MULTI CHANNEL***	***FREQUENCY***
Measuring mode	XXXX	Cn [space] XXXX	every 12 or 24 seconds
Over-range	+OVER	Cn [space] +OVER	every 12 or 24 seconds
Instrument error	0.000	Cn [space] 0.000	every 12 or 24 seconds
SF/CF button pressed	&YYYYY@ZZZZZ	&YYYYY@ZZZZZ	every second
Span/Zero button pressed	$DDDaFF	$DDDaFF	every second
Alarm buttons pressed	no transmission	no transmission	no transmission
Interval button pressed	no transmission	no transmission	no transmission

NOTES:

- "XXXX" represents ozone concentration - the position of the decimal point and the number of decimal places will vary depending on the range of the instrument or of the particular channel.
- "YYYYY" is the "SF" value, preceded by the ASCII character "&". "ZZZZZ" is the "CF" value, preceded by the ASCII character "@". (Refer to INTERNAL DIAGNOSTICS - SF/CF VALUES, page 31)
- "DDD" is the Span value, preceded by the ASCII character "$". "FF" is the Zero offset value, preceded by the ASCII character "a". (Refer to SPAN AND ZERO OFFSET on page 33)

NOTE: The RS-232 option is factory installed

Thermostatically Controlled Internal Heater

If the IN-2000 is to be used in environments where the temperature may fall below 0°C, or where there is a risk of water condensation build-up inside the unit, and optional thermostatically controlled heater may be factory installed. An addendum to the manual is included whenever a heater is installed.

NOTE: This option is factory installed

Wall Mounting, NEMA 12 - 4- 4X (IP65) Enclosure

The AFX® Series IN-2000 analyzers can be housed in a non-metallic NEMA 4/4X (IP65) enclosure which is designed to be wall mounted. The standard enclosure is made of fiber-glass reinforced plastic. The NEMA 4x / IP65 rating means that the enclosure provides a certain level of protection from water and dust ingress.

NOTE: This option is factory installed.

External Multi-Channel Control System (AFX® RB5L or RB3L), Multi-Channel Units Only

The multi-channel versions of the AFX® Series IN-2000 analyzers can be interfaced with an AFX® external multi-channel control system (relay box) which provides 2 independent alarm relay contacts for each channel plus channel ID signals. The relay box is a separate device, EXTERNAL to the analyzer. Please refer to the manual included with the relay box for complete operating and installation instructions.

NOTE: Depending on configurations, special cable assemblies for interfacing with the relay box are supplied by the factory, or the wiring can be done in the field via special terminal blocks in the IN-2000 and the RB-5L.

Modified Measuring Ranges or Units of Measure

The AFX® Series IN-2000 analyzers are factory configured to measure a variety of ozone concentration levels depending on user preference and instrument optical bench. Please refer to SPECIFICATIONS FOR THIS ANALYZER on page 4 to determine your instrument's measuring range, precision, and units of measure. The standard unit of measure on all IN-2000 analyzers is ppmv (parts per million by volume).

NOTE: Measuring range and units of measure can only be changed by installing new software in the analyzer. Consult with the factory if you need to configure your instrument differently.

Multiple Ranges

Multi-channel versions (only) of the IN-2000 can be factory configured such that different channels operate at different measuring ranges (multi-range).

IMPORTANT: The analog output range of a multi channel instrument will automatically change depending on the range of the particular channel being measured. For example, if the range of channel 1 is 0-1 ppmv, then 4-20 mA correspond to 0-1 ppmv. If the range for channel 2 is 0-100 ppmv, then 4-20 mA will correspond to 0-100 ppmv when that channel is enabled.

NOTE: Different measuring ranges will have different display resolutions. The instrument automatically adjusts for these conditions.

NOTE: Measuring range and units of measure can only be changed by installing new software in the analyzer. Consult with the factory if you need to configure your instrument differently.

External Dust Filters

In certain environments it is advisable to use a dust filter on the inlet(s) of the instrument in order to minimize the ingress of dust into the unit. Typically a 1 micron filter element is used. Filters are either of the “aerosol” type, which mount at the inlet of a sampling tube, or of the “in-line” type, which are installed at a junction in the sample tube.

IMPORTANT: For ambient ozone measurement applications, use only Teflon or Glass filtration media, with NO BINDERS. Use of any other materials, or use of filters which contain binders, may consume ozone and affect the measurement. Recommended material for filter holders is Teflon.

Other Options/Customizations

Please refer to the SPECIFICATIONS FOR THIS ANALYZER for additional information about special options or customizations.

MECHANICAL INSTALLATION

The AFX® Series IN-2000 analyzer's mechanical dimensions for the bench-top / 19" rack enclosure and for the NEMA 4x / IP65 enclosure are shown in Figure 1 and Figure 2. The instrument should be operated in areas where the environmental conditions are within the envelope defined under GENERAL SPECIFICATIONS FOR THE "IN-2000" OZONE ANALYZERS, and where free air circulation is provided for convection cooling.

CAUTION: **Take necessary steps to ensure that WATER CONDENSATION WILL NOT FORM in the interior of the analyzer during storage or during operation. Serious damage to the instrument may result with water condensation.**

PNEUMATIC INSTALLATION

The IN-2000 accepts either a single sample inlet (for single channel units) or up to 5 sample inlets (for multi-channel units). Sample inlets are via bulkhead compression fittings which accept 1/4" (or 6 mm) OD tubing. The sample gas is exhausted through a single bullhead fitting accepting 1/4" (or 6 mm) OD tubing. THE BEST **TUBING MATERIAL IS FLOUROCARBON PLASTIC (PFA, TFE). STAINLESS STEEL TUBING CAN BE USED IF IT IS CLEAN FOR OXYGEN SERVICE.**

IMPORTANT: If the ozone level being measured is above the safe threshold guidelines published by regulatory agencies, take all necessary precautions to properly and safely vent the exhaust. Though most IN-2000 instruments include an exhaust ozone catalyst, in certain cases the exhaust may still contain significant traces of ozone.

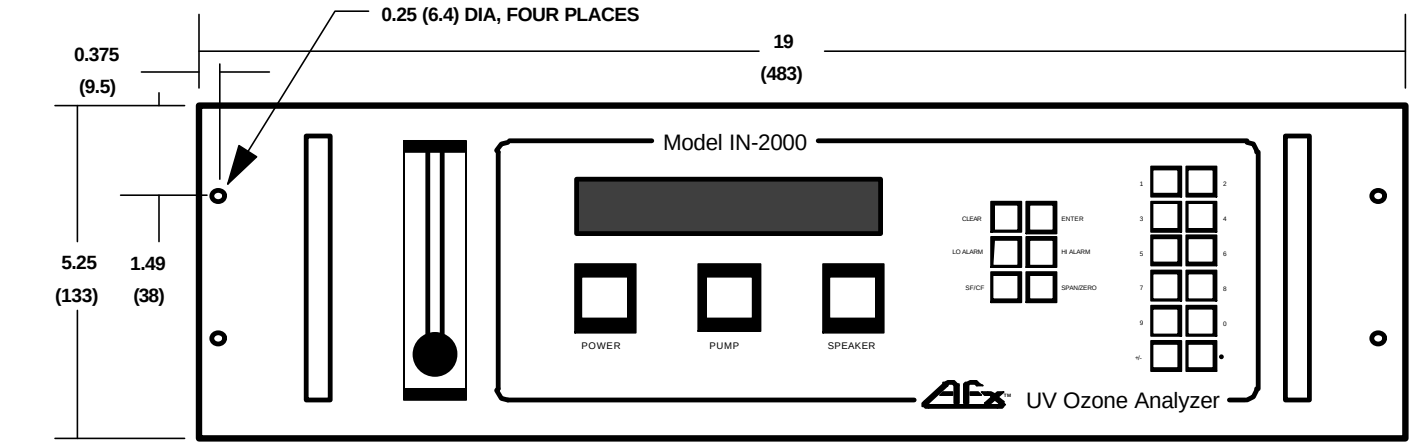
Sample tubing length should be kept as short as possible. The maximum recommended tubing run is 80 feet (~25 meters).

External dust filters (if supplied) should be installed on the end of the sampling tube farthest away from the analyzer. Refer to External Dust Filters, on page 12.

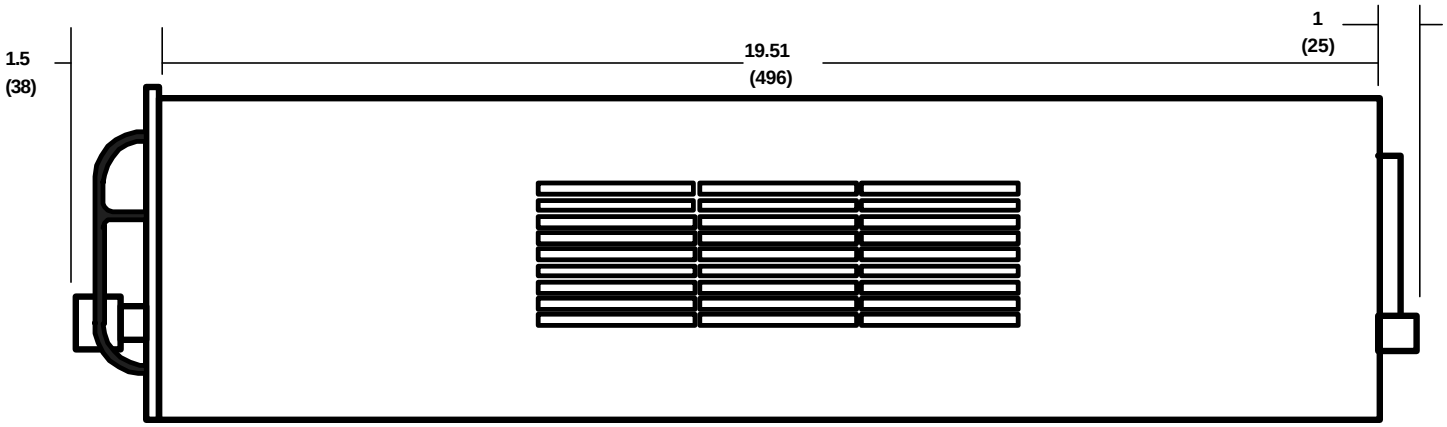
On some IN-2000 models, particularly those configured to measure higher levels of ozone, a "Reference Gas" inlet port may be supplied. Connect a source of ozone-free, dry air to this port using the appropriate size tubing (usually 1/4" OD).

Figure 1: Dimensions of the 19" Rack and Bench Top Units in Inches (mm)

(NOTE: BENCH TOP UNIT RUBBER FEET ADD APPROXIMATELY 1/4” (6MM) TO OVERALL HEIGHT)

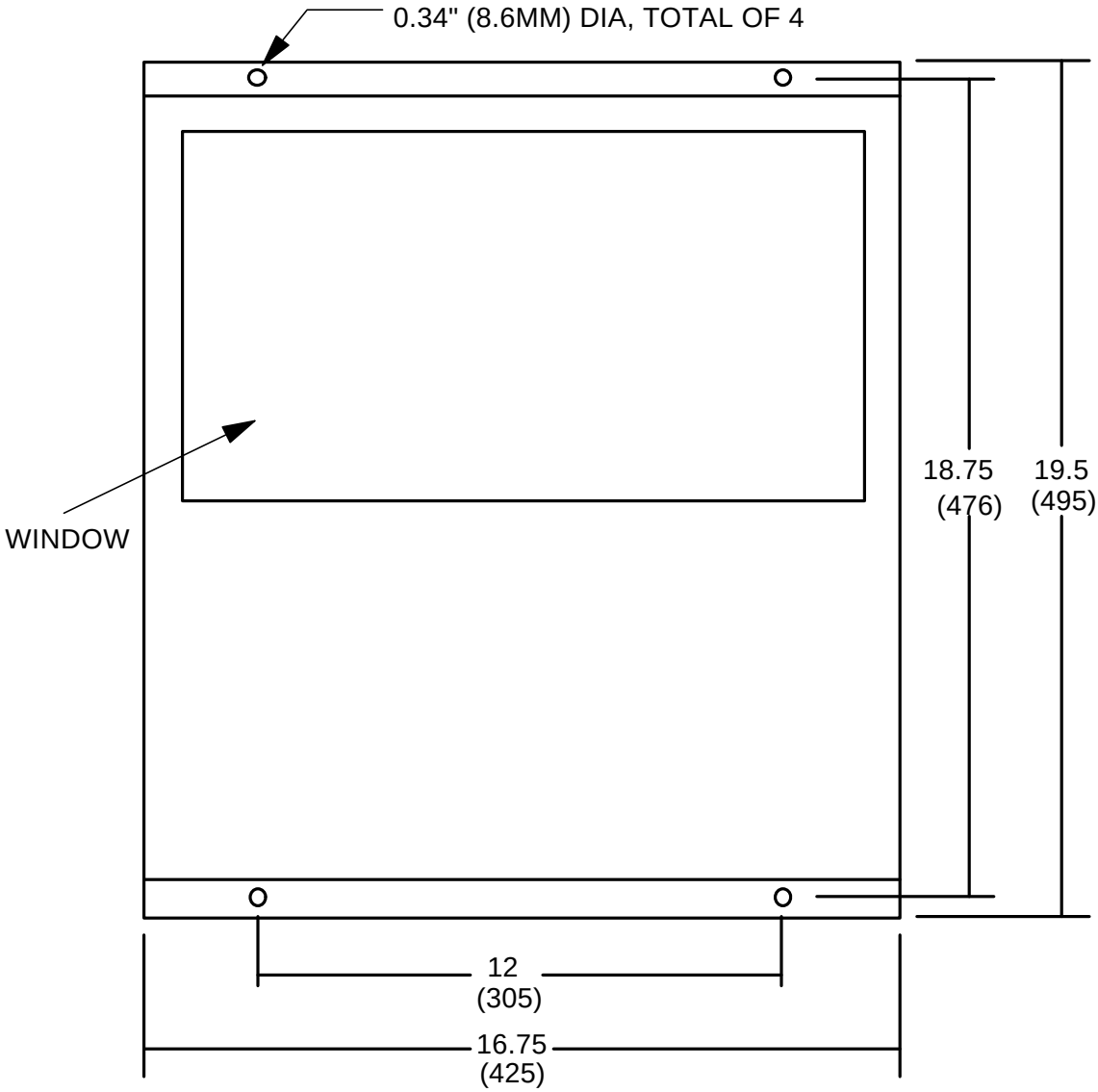


FRONT VIEW



SIDE VIEW

Figure 2: NEMA 4X / IP65 Enclosure Dimensions



ALL DIMENSIONS NOMINAL IN INCHES

NOTE: THIS ENCLOSURE IS 9.625" (244 MM) DEEP. ALLOW ADDIT'L
20" (508 MM) DEPTH CLEARANCE FOR OPENING OF DOOR

ELECTRICAL INSTALLATION

Please familiarize yourself with the electrical and field wiring connections available in the instrument. The NEMA 4x / IP65 configuration features barrier strip type terminal blocks inside the instrument as shown in Figure 6 on page 23. The rear panel of the IN-2000 19" rack is shown in Figure 7 on page 26.

Power Connections

The IN-2000 operates on 100, 120 or 240 VAC power.

IMPORTANT: PLEASE CHECK THE VOLTAGE FOR WHICH YOUR UNIT HAS BEEN CONFIGURED AND OPERATE IT ONLY AT THIS VOLTAGE.

When housed in the bench top or 19" rack configurations, the rear panel of the AFX® Model IN-2000 includes a standard AC power receptacle which will accept a standard 3-wire power line cord for use with a grounded 120 or 240 VAC, 50/60 Hz power outlet. When housed in a NEMA 4x / IP65 enclosure, an AC power terminal block is provided. Mains electrical wiring should be brought into the enclosure via the conduit fittings on the bottom wall of the NEMA 4x enclosure. Power connections should be made through the conduit fitting to the terminal block located on the mounting plate inside the enclosure, labeled "HOT", "NEUTRAL" and "GND" . The instrument requires up to a maximum of 70 Watts and is fused with a 1.0 to 1.5 A, Slo-Blo fuse (0.5 - 0.75 A for 240 VAC units).

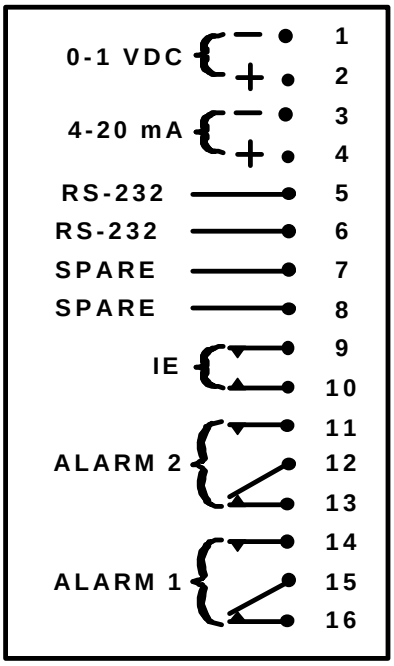
NOTE: If additional conduit fittings need to be installed in a NEMA 4x / IP65 enclosure, they should be installed on the bottom wall of the enclosure only. When drilling through the enclosure, care should be taken to avoid damaging any components. DO NOT RUN ANY HIGH VOLTAGE LINES INSIDE THE INSTRUMENT (E.G. FROM TOP TO BOTTOM ALONG THE SIDES) SINCE THESE LINES COULD CAUSE ELECTRICAL NOISE INSIDE THE UNIT.

Signal Connections - Field Wiring

The AFX® Model IN-2000 provides analog and digital serial data outputs. It also provides contacts for field wiring of alarms relays and an "IE" or instrument error relay. A polarized "plug-in" type terminal block is provided on all IN-2000 instruments for field wiring. Each position on the terminal block is labeled, and the standard pin-out is shown in Figure 3 below.

The optional RS-232 interface is available via the standard "D" size male 25 pin connector on the back of the 19" rack units, or on the field wiring terminal block in NEMA 4x / IP65 units. A label on the instrument identifies the RS-232 connections.

Figure 3: Standard Field Wiring Pin-Out



NOTE: In NEMA 4x/IP65 enclosures, the label identifying the pins of the terminal blocks is located on the bottom inside wall of the enclosure.

IMPORTANT: NOTE THAT THE <u>ALARM RELAY</u> CONTACTS ON THE LABEL ABOVE AND ON THE LABELING IN THE INSTRUMENT ARE SHOWN IN THE <u>ENERGIZED</u> OR ALARM CONDITION.

THE <u>INSTRUMENT ERROR RELAY</u> CONTACT IS SHOWN IN THE <u>NORMAL</u> (NON-ERROR) CONDITION.

Both alarms are “high” alarms in that their relays become energized when the ozone concentration goes above the programmed alarm threshold. However, Alarm 1 is referred to as “Low Alarm” in the instrument’s display, and Alarm 2 as “High Alarm”. In reality, Alarm 1 works as a “high” alarm, and Alarm 2 as a “high-high” alarm.

Wiring to the Multi-Channel Control System (Model RB-5L)

Multi-channel versions of the AFX® Model IN-2000 can be interfaced with the Model RB-5L control system. On 19" rack instruments, a cable assembly is provided with connectors on each end which plug into special mating receptacles in the rear panels of the IN-2000 and RB-5L. When the instruments are configured in a NEMA 4X / IP65 enclosure, the user must provide the wiring between the IN-2000 and the RB-5L. Special terminal blocks for this purpose are available inside each unit.

FUNDAMENTAL PRINCIPLE OF MEASUREMENT

Ozone exhibits a narrow and pronounced peak of absorption in the UV spectrum at a wavelength of 253.7 nm. The concentration of ozone can therefore be directly calculated by measuring the amount of UV light absorbed at that wavelength. Few other gases exhibit significant absorption at 253.7 nm. Therefore, measurements of ozone using UV absorption at that wavelength are very selective to ozone and subject to few, albeit quantifiable, interferences. Please contact *IN USA, INC.* if you have questions regarding interferences.

The IN-2000 measures the intensity of light at 253.7 nm generated by the internal UV lamp after the light passes through an absorption cell containing the gas sample. The absorption cell consists of a leak tight chamber closed at both ends by quartz windows. A gas sample is introduced through a fitting at one end of the cell and exits at the other end. The absorption cell is alternately filled with the sample gas and with an ozone-free (reference) gas. This reference gas is typically generated by flowing the sample through an ozone destruction unit. In each case, the intensity of light is recorded by the analyzer's microprocessor.

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

$$\mathbf{C} = \frac{\mathrm{Ln}\frac{I_r}{I_s}}{\mathrm{E} \times \mathrm{L}}$$

where:

I_r is the intensity of light when the absorption cell is filled with the reference gas
I_S is the intensity of light when the absorption cell is filled with the sample gas
E is the ozone absorption coefficient constant
L is the length of the absorption cell
C is the concentration of ozone

The values of L and E are not variable in time for a given instrument. The values I_r and I_s are measured through the same optical bench using the same optical components. Variations of the optical components over time are common to both measurements and thus have no influence on the measurement. The IN-2000's self-diagnostic functions enable it to check variables which could affect the measurement of I_s and I_r Note that because L is fixed for a given instrument, there is a limit to

what a particular instrument's upper and lower detection limits are. There is always an optimal range of ozone concentrations at which error is minimized and sensitivity maximized, within the limitations of the electronics.

The Beer-Lambert equation provides an absolute determination of ozone concentration.

A simplified schematic of the main components of the IN-2000 is shown in Figure 6. The "sample" measurement is made by directing the sample into the absorption cell. After 6 seconds (12 seconds on some units), the 3-way solenoid valve then diverts the gas sample through the reference catalyst which destroys the ozone and generates the ozone free "reference".

Note: Certain analyzers may be provided without a reference catalyst. Instead, a fitting is provided for an external "zero gas" inlet.

As the "reference" and "sample" gas pass through the optical chamber, the amount of UV light is measured by the sample photosensor opposite the UV lamp.

To enhance stability, the UV lamp is housed in a thermostatically controlled aluminum block. To further improve stability, the IN-2000 features a control photosensor which is located near the UV lamp. This sensor monitors the performance of the UV lamp during measurement, compensating for any variations in lamp intensity and alerting to any error conditions associated with the lamp.

The recommended sample flow rate for the 28 cm instruments is 2.5 liters/min. For units with a 1 cm cell, the flow rate should be 1 liter/min. (All IN-2000 units used in the Model W1 dissolved ozone measurement systems should have a sample flow rate of 1 l/min). The recommended flow rates allow for an appropriate number of volume changes to take place inside the optical chambers.

A simplified schematic of the IN-2000 is shown in Figure 5.

Ozone Destruct Catalytic Modules

The IN-2000 typically includes two canisters containing a catalytic material which destroys ozone by converting it into oxygen. The catalytic material consists mainly of MnO2 in pellet form.

The canisters contain screens and filters designed to trap any dust from the catalyst pellets. The "reference" catalyst is used during measurement to generate the ozone free reference gas as explained earlier. The "exhaust" catalyst is used to substantially eliminate ozone in the exhausted gas stream.

CAUTION: DO NOT ATTEMPT TO OPEN THE CANISTERS. DO NOT REPLACE THE CATALYTIC MATERIAL.

CPU

The IN-2000 main CPU board is accessed by removing the bottom cover in 19" rack units. In units housed in NEMA 4x / IP65 enclosures, the CPU board is mounted to the back of the front panel. Components on the CPU require no field adjustments, so access to the board should not be necessary. Failure of CPU components is extremely rare.

A simplified schematic of the CPU interconnections is shown in Figure 4.

Figure 4: CPU Interconnections

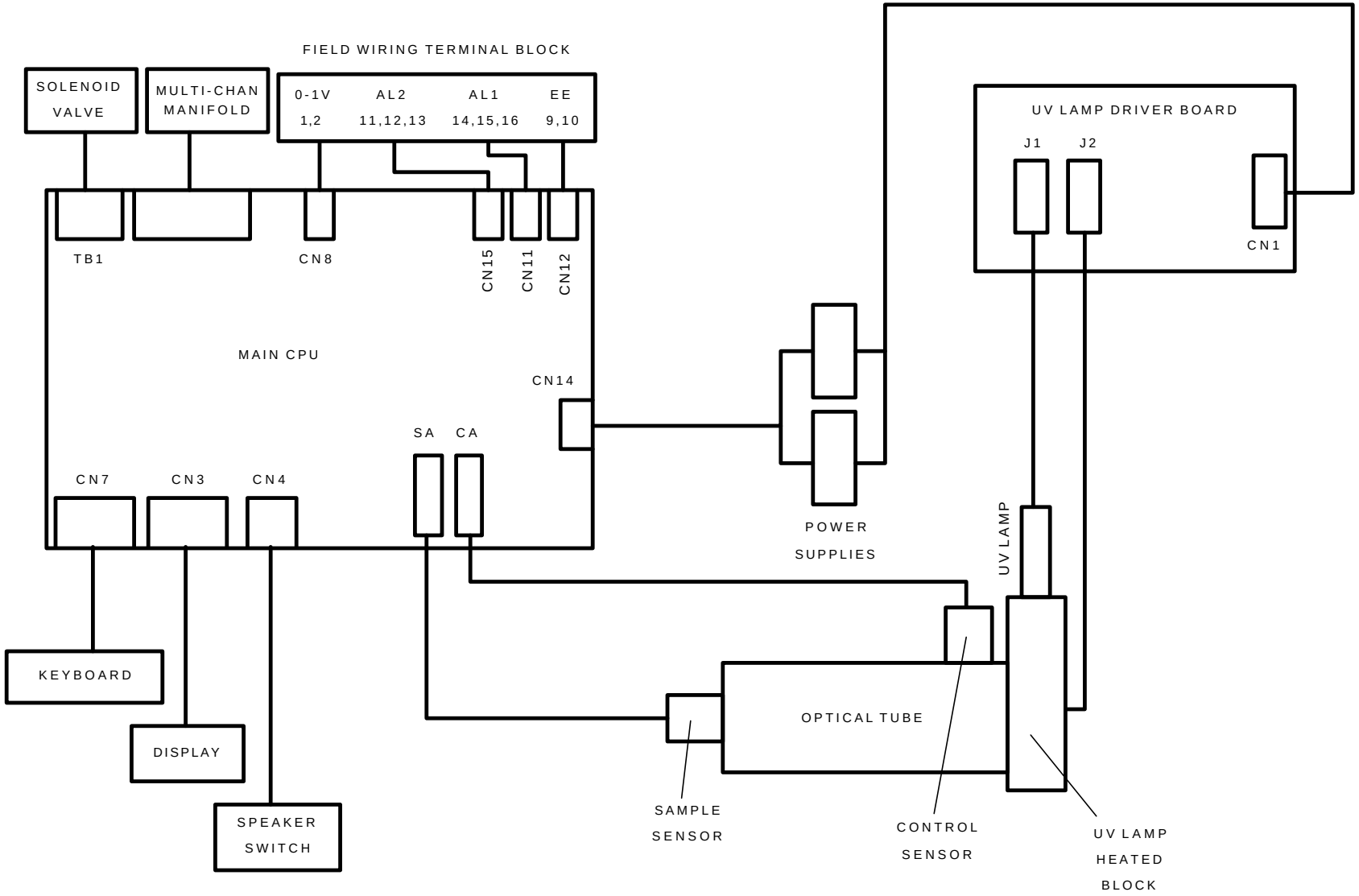


Figure 5: Simplified Schematic of the IN-2000

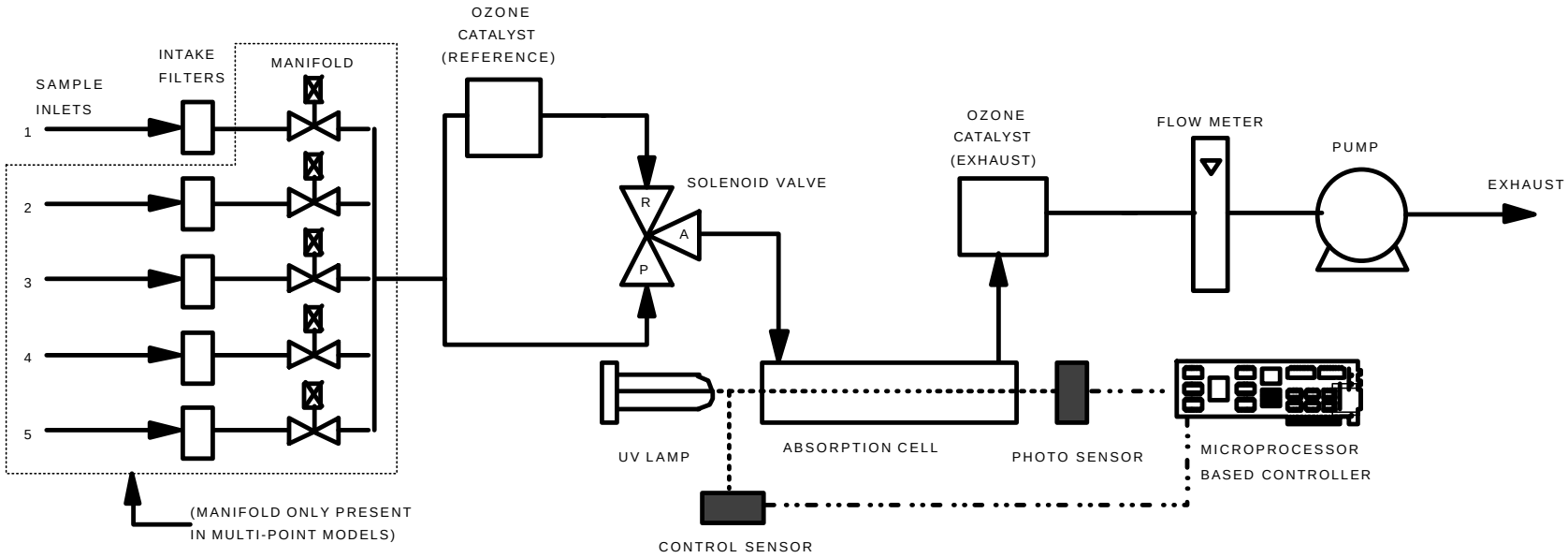
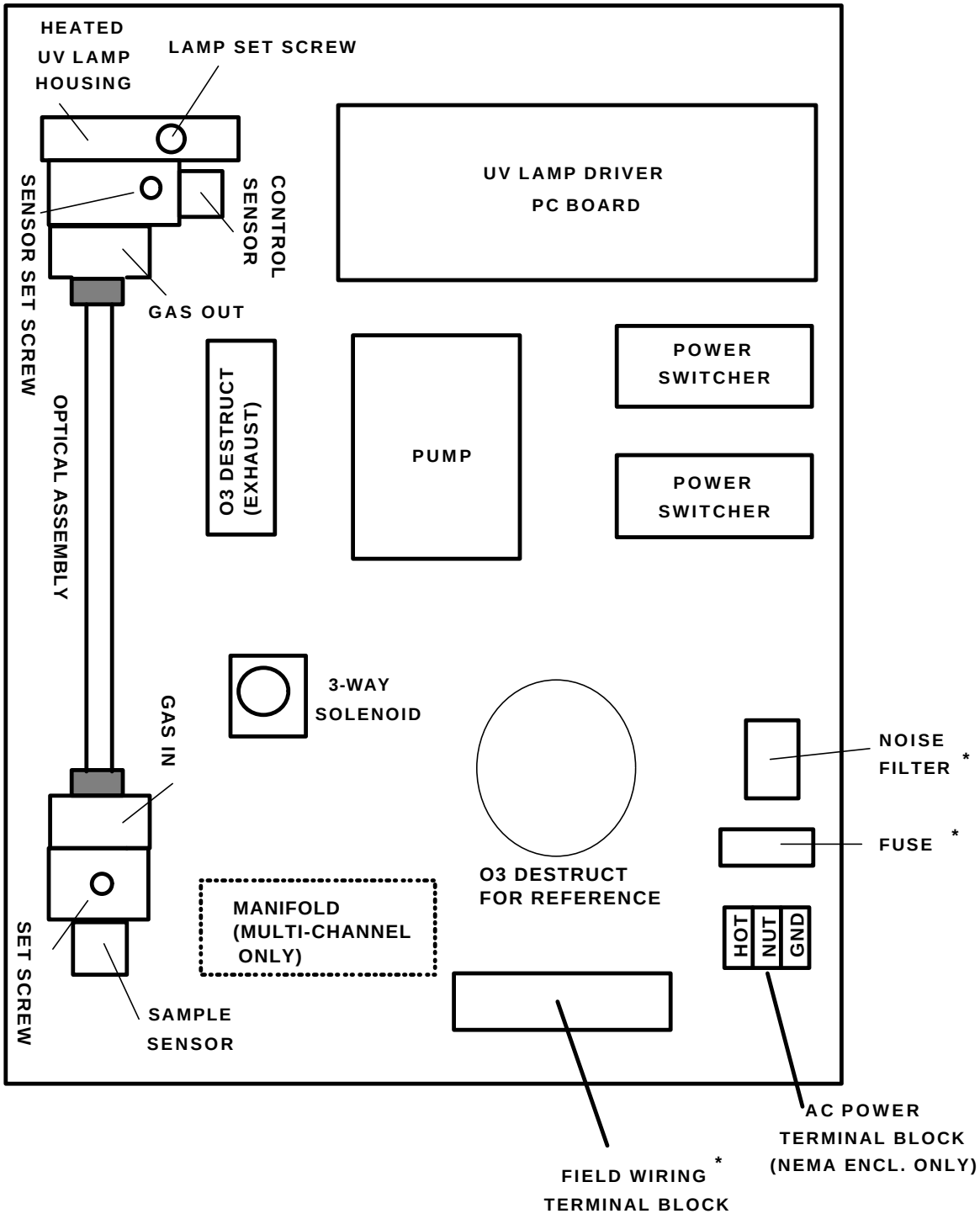


Figure 6: Main Components of the IN-2000



* THESE ITEMS ARE LOCATED ON THE BACK PANEL IN THE BENCH-TOP AND 19" RACK CONFIGURATIONS

OPERATION OF THE INSTRUMENT

Preparation for Operation

Familiarize yourself with the front panel controls of the instrument as shown in Figure 8 on page 27.

Please follow these steps before turning the instrument on:

- Make sure the power switch is off
- **CHECK WHETHER THE ANALYZER REQUIRES 120 VAC 50/60 Hz OR 220 VAC 50/60 Hz.** Power consumption is approximately 70 VA. Connect the main AC power cord to the rear panel . For equipment in NEMA 4/IP 65 enclosures, provide AC power via the AC Power barrier strip terminal block.
- If supplied, connect the particulate dust filter(s) to the sample inlet(s)
- Connect the sample tubing to the sample inlet bulkhead fittings and tighten. Use either 1/4" OD or 6 mm OD tubing.

IMPORTANT: Use tubing in the "Teflon" family (PTFE, PFA, etc.) or Stainless Steel clean for Oxygen Service. Do not use any other tubing materials. Use of other tubing materials will affect accuracy. Other materials may not be compatible with ozone.

Turning the Instrument On

- Turn the main power switch to "on".
- Turn the pump switch to "on".
- Turn the speaker switch "off"
- Adjust flow meter valve so that the flow is set within recommended limits.

There will be two sounds: 1) The pump (a constant purr), and 2) the switching valve (a soft click every 6 (or 12) seconds followed by a louder click after 6 (or 12) seconds). If there is a loud high-pitch alarm, this is probably because the speaker on/off switch is "on". Turn this switch off. If the high pitched alarm continues, check the front panel display for any error messages and refer to the section on Error Messages for instructions.

Warm-Up Time

UV lamps require a warm up time in order to achieve stability. A 30-45 minute warm up is recommended for the IN-2000. The UV lamp of the IN-2000 is in a thermostatically heated housing which reduces the warm up time and helps maintain lamp stability.

During warm-up time, the display may flash several diagnostic or error messages. These are described later in this manual. It is normal for the displayed ozone concentration numbers during warm-up to be unstable and even erratic.

IMPORTANT: Do not use the analyzer until it has completely warmed up.

After warming up, the unit will accurately measure the ozone concentration. It is not uncommon for the analyzer to report ozone levels above 0 (e.g., 0.03 ppmv) in enclosed or outdoors environments. Ambient background ozone levels can range from 0.00 to 0.08 ppmv.

NOTE: During warm-up it is normal for the instrument to display negative numbers. If negative values persist after warm up time, the most probable cause is a poisoned reference catalyst. Please call *IN USA, INC*. for advice. Refer to Negative Ozone Concentration Values on page 40.

The IN-2000 is designed for continuous operation. The UV lamp should provide 18-24 months of useful continuous life.

NOTE: It is normal for the readings of the analyzer to change momentarily when the unit's position is changed, when the covers are removed, or when the enclosure doors are opened. These actions may cause changes in the UV lamp plasma which can cause momentary instabilities. Stable readings will resume after a few seconds.

Figure 7: Rear Panel, 19" Rack Unit

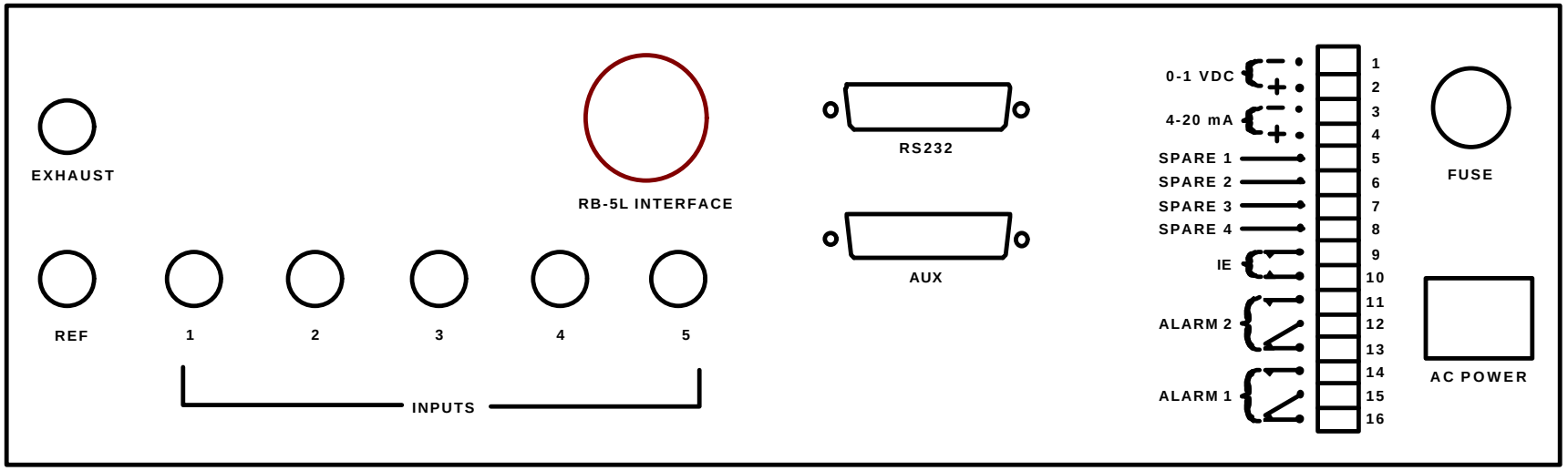
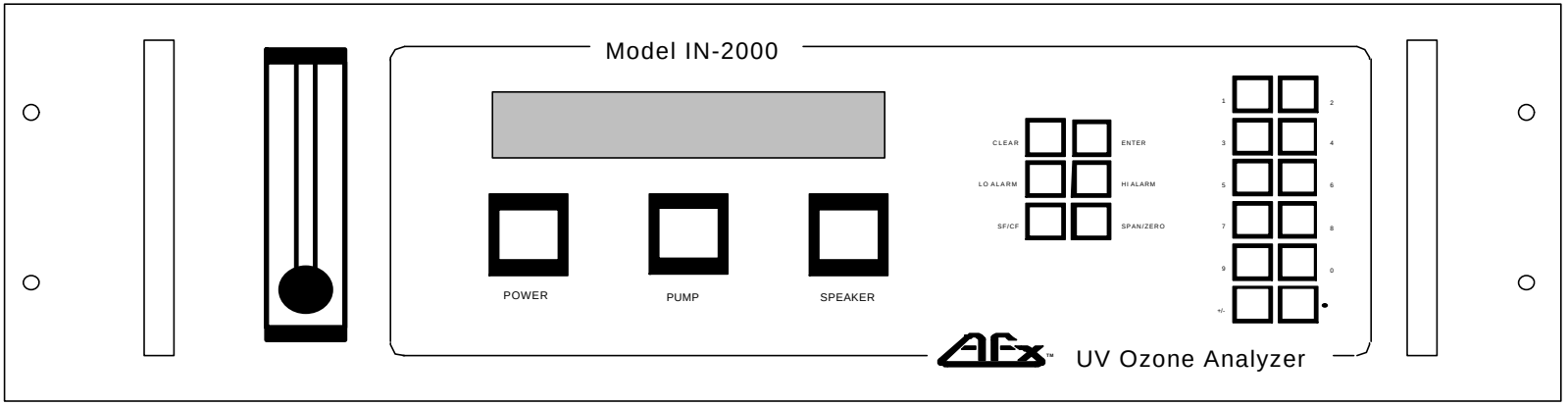
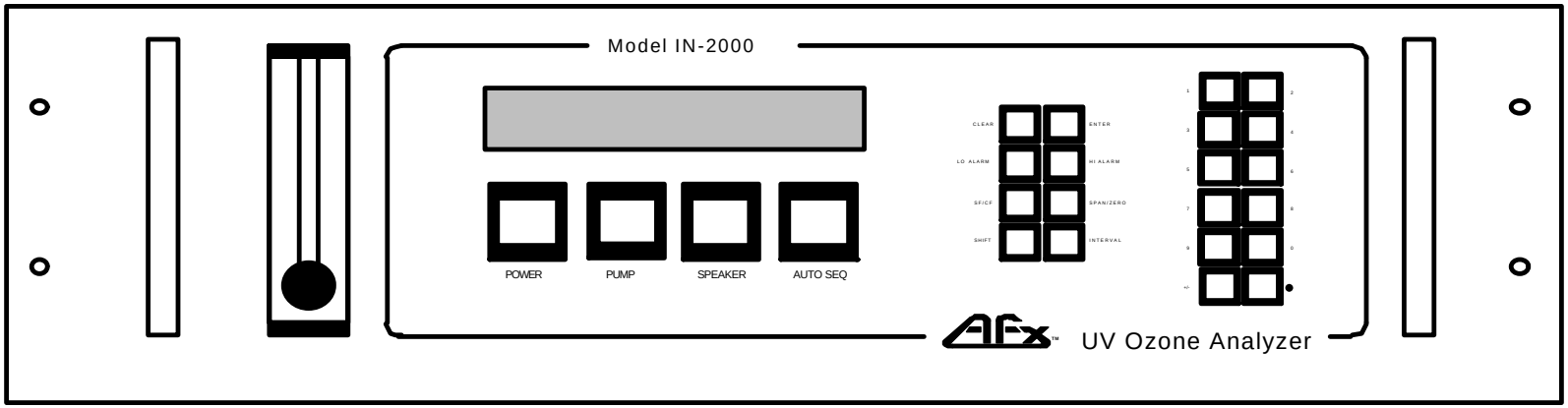


Figure 8: Front Panel Layout and Controls

SINGLE CHANNEL



MULTI CHANNEL



Front Panel Operation

The following controls are located on the front panel (see Figure 8)

Flow meter valve:	Used to regulate sample flow rate
Main power switch:	Turns instrument on/off (turns off pump, too)
Pump power switch:	Turns pump power on/off (Main power switch must be on for pump to activate)
Speaker switch:	Turns audible alarm on/off. Does not affect relay outputs or other alarm features.
Auto Seq. switch:	(Multi-channel units only) Turns the automatic sequencer on/off

Keypad (18 keys on single channel units, 20 keys on multi-channel units)

Clear	Used to clear user-programmed entries such as alarm thresholds
Enter	Used to confirm a numeric entry when setting programmable parameters.
Hi Alarm	Allows access for setting the threshold of alarm 2 (“high-high” alarm)
Lo Alarm	Allows access for setting the low alarm the threshold of alarm 1 (“high” alarm)
SF/CF	Used to display the sample and control (reference) frequencies
Span/Zero	Used to display or change span value and zero offset value
Shift	(multi-channel only) Used to shift to the next channel if the Auto Seq. switch is set to off (manual switching mode)
Interval	(multi-channel only) Used to program the time interval of the sequencer.
0 - 9 keys	Numeric keypad for entering values
.	Decimal point

+/- Used for changing the sign on the zero offset

ALARM OPERATION

The IN-2000 provides two alarms related to ozone concentration and one alarm related to instrument error conditions (IE alarm).

The IN-2000 has two independently programmable ozone alarm threshold settings per channel. The alarms are labeled "Low" and "High", or “1” and “2”.

NOTE: Both alarms are “high” alarms in that their relays become energized when the ozone concentration exceeds the programmed alarm threshold. However, Alarm 1 is referred to as “Low Alarm” in the instrument’s display, and Alarm 2 as “High Alarm”. Alarm 1 works as a “high” alarm, and Alarm 2 as a “high-high” alarm. For both ozone alarms, an alarm condition will exist (and alarm relays will energize) when the measured ozone concentration value exceeds the set threshold. See Signal Connections - Field Wiring, page 16, for alarm relay field wiring instructions. If the instrument interfaces with an external RB-5L multi-channel control system, refer to that system’s manual for a description of the alarm options.

IMPORTANT: AN OZONE ALARM CONDITION IS RECOGNIZED ONLY AFTER 3 CONSECUTIVE OZONE CONCENTRATION READINGS IN EXCESS OF THE PRESET ALARM THRESHOLD ARE REPORTED.

Note that the “high-high” alarm threshold should always be greater than the “high” alarm value. The analyzer will reject high-high threshold values which are lower than the high threshold values.

Alarm values can be only set within the measuring range of the instrument. When setting alarm thresholds on multi-range instruments, the unit automatically requires the appropriate range depending on which channel’s alarms are being set.

Setting the Ozone Alarm Thresholds

1. Enter the alarm programming mode by pressing either the *Hi Alarm* or the *Lo Alarm* key. The display will read:

   HI [or LO] ALARM x.xx PPM (single channel units), or
   HI [or LO] ALARM n x.xx PPM (multi-channel units, where n = channel ID)

   where “x.xx” is the current alarm threshold value.

   The number of decimal places displayed in the alarm threshold values will be either 0, 1, or 2 depending on the display resolution of the particular channel.

2. The leftmost digit will be flashing. Proceed as follows:

a) Press the *Clear* key. This will erase the current alarm threshold value.

b) Enter the new alarm value using the numerical keypad. For example, to enter 0.30 ppm, press the following: "0", then ".", then "3", then "0". Depending on the measuring range of the instrument or of the particular channel, the decimal point key may be inactive.

c) Press the *Enter* key to accept the alarm value.

NOTE: the "high" alarm value must be larger than the "low" alarm value for any given channel.

d) (Multi-channel units only) Press *Shift* to set the alarm for the next channel and repeat steps a), b) and c).

e) Press the *Hi Alarm* or the *Lo Alarm* key to exit the alarm program mode and return to measuring mode.

To check an alarm's current threshold, press the *Hi Alarm* or *Lo Alarm* key to view the display, and then press the key again to return to measuring mode.

Ozone Alarm Relay Energizing

The alarm relays are energized only after 3 consecutive ozone measurements exceed the set alarm thresholds. Both alarms are non-latching. The relays associated with these alarms will de-energize once the zero level has dropped below the set thresholds.

Ozone Alarm Relay Connections

Please refer to the section on Signal Connections - Field Wiring for details on alarm relay connections. The table below shows the status of the alarm relays under different operating conditions.

Relays are form "C", with normally open, normally closed, and common pins.

IMPORTANT: NOTE THAT ON SOME MODEL IN-2000 ANALYZERS, THE LABEL ON THE FIELD WIRING CONNECTOR ON THE INSTRUMENT ITSELF SHOWS THE ALARM 1 AND ALARM 2 RELAYS IN THE <u>ENERGIZED OR ALARM</u> CONDITION

Instrument Error (IE) Alarm

The standard configuration for the IE relay is normal open. The relay is energized under certain instrument error conditions, such as power failure and UV lamp errors. The relay can also be factory configured to be normally closed such that the relay will open (de-energize) under error conditions.

Status of the Alarm Relays

There are 3 possible alarm conditions:

1) Ozone concentration is above the preset high level
2) Ozone concentration is above the preset low level
3) Instrument malfunction or power off

The table below shows the status of the relays under various operating conditions:

RELAY	*PINS (Figure 3, page 17)*	*OZONE LEVEL BELOW ALARM THRESHOLD*	*OZONE LEVEL ABOVE ALARM THRESHOLD*	*INSTRUMENT ERROR CONDITION*	*POWER OFF*
Alarm 1	15-16	Open	Closed	see note below	Open
Alarm 1	14-15	Closed	Open	see note below	Closed
Alarm 2	12-13	Open	Closed	see note below	Open
Alarm 2	11-12	Closed	Open	see note below	Closed
IE, n.o.	9-10	Open	Open	Closed	Closed
IE, n.c	9-10	Closed	Closed	Open	Open

NOTE: The IE relay is normally shipped in the n.o. (normal open) configuration.

NOTE: If the ozone concentration level is above the full scale range of the instrument or of the particular channel being measured, the relays of both alarms 1 and 2 will energize

NOTE: AN "IE" (INSTRUMENT ERROR) ALARM CONDITION SHOULD SUPERSEDE ANY OTHER ALARM CONDITIONS. IN OTHER WORDS, IF AN "IE" ALARM IS ACTIVE ANY READINGS BY THE INSTRUMENT OR ANY "HI" OR "LO" ALARM CONDITIONS COULD BE UNRELIABLE. CHECK THE INSTRUMENT IMMEDIATELY TO DETERMINE THE CAUSE OF THE "IE" CONDITION.

MAJOR CAUSES OF "INSTRUMENT ERROR" INCLUDE:

- **POWER FAILURE**
- **UV LIGHT RELATED ERRORS (TOO LITTLE OR TOO MUCH LIGHT)**
- **SOFTWARE/MEMORY PROBLEMS**

INTERNAL DIAGNOSTICS - SF/CF VALUES

The IN-2000's microprocessor continuously checks various instrument parameters which are critical to the correct performance of the instrument. Should a problem be detected (Instrument Error), a message will be displayed on the readout and appropriate corrective action should be taken. Error messages and corrective actions are explained later.

One of the key parameters checked by the analyzer's microprocessor is the intensity and stability of the UV light and photo-sensors. The intensity of the UV light is detected by 2 sensors:

- The “Sample Sensor” which makes the ozone measurements. The light which this sensor sees is translated by the instrument’s microprocessor into a “Sample Frequency”, or SF.

- The “Control Sensor” which monitors directly the UV light. This sensor is used to detect and compensate for any small variations in UV light output occurring during the measurement cycle. The light which this sensor sees is translates by the instrument’s microprocessor into a “Control Frequency”, or CF.

Please refer to Figure 6 on page 23 for the location of these sensors within the instrument.

The IN-2000 continuously checks the CF and SF values:

1. The CF and SF values each must be between 25000 and 55000 when no ozone Is present. If the sensors detect less light (values under 25000) or more light (values above 55000), instrument error conditions will occur, and a message will be displayed as follows:

    - “LO FREQ” (low frequency) - value below 25000
    - “HI FREQ” (high frequency) - value above 55000

2. The CF value must be relatively stable. If the value changes by more than 15 points per second, an instrument error condition will occur and a message will be displayed as follows:

    - “UN FREQ” (unstable frequency)

Adjustments to the SF/CF values are explained later.

The SF and CF values reflect the combined effect of the following factors:

- Cleanliness of the absorption cell and quartz windows.
- Intensity of the UV lamp
- Stability of the UV lamp
- Cleanliness and performance of the photo-sensors
- Alignment of cell optical components
- Warm-up condition

Dirty optical components, a weak or unstable lamp, a malfunctioning sensor, or a "cold" instrument could each cause the CF and/or SF values to be unstable or out of range, therefore triggering an SF/CF related Instrument Error.

The SF and CF values can be viewed by pressing the *SF/CF* key. The display will then read:

SF XXXXX CF XXXXX

where XXXXX is typically a 5-digit number (or the word "OVER if the value is much higher than 55000). To return to normal measuring mode, press the SF/CF key again.

The CF/SF values cannot be changed via the front panel keypad. However, they can be adjusted by re-positioning the lamp or the appropriate sensor as explained later.

The values are updated every second. Under normal operating conditions, and with no ozone running through, the values should not change by more than 2 counts per second. However, it is normal for the values to change over long periods of time, when the instrument is moved, or when it is powered on again.

SPAN AND ZERO OFFSET

Span

The "Span Number" is an instrument gain. It is set at the factory during calibration of the instrument, and it is recommended that the value **NOT** be changed by the user. (The procedure for changing the value is described later). The Span value should only be changed to adjust the calibration of the analyzer. The Span value is typically between 480 and 520.

The effect of the span number is best explained by example: if the span number is changed to 90% of its original value (for example, from 500 to 450), then the ozone concentration reported by the analyzer will always be 90% of what it would have been with the original span value.

IMPORTANT: The span value is unique to the optical bench of an instrument. When the instrument is calibrated, the span number is recorded in the operating manual. Keep a record of this value in case it needs to be re-entered at a future date. *THE SPAN VALUE IS OBTAINED AT THE FACTORY DURING CALIBRATION AGAINST AN NIST TRACEABLE MACHINE. THE SPAN VALUE SHOULD NOT BE CHANGED BY UNAUTHORIZED PERSONNEL.*

Zero

The "Zero Offset" number will be added to the measured ozone concentration, and the result reported by the analyzer. For example, if the measured value of the ozone concentration is 0.03 ppmv and the zero offset value is +07 (positive 07), the reported concentration will be 0.10 ppmv. The zero offset value is typically zero.

Note that the "zero offset" number is a 2-digit number. The analyzer will divide this number by either 1, 10, 100 or 1000 (depending on the range of the analyzer) and add the result to the measured concentration. For example, if the measuring range is 0-1.000 ppmv, then the zero offset value is typically divided by 1000 so that a value of 13 translates to an offset of 0.013 ppmv. If the measuring range is 0-100 ppmv, then the value is typically divided by 10 so that 13 translates to an offset of 1.3 ppmv.

The zero offset value is typically 0. Any value other than zero is typically used to compensate for an offset caused by background interferences.

IMPORTANT: ON MULTI-RANGE INSTRUMENTS, THE INTERNALLY CALCULATED ZERO OFFSET VALUE WILL CHANGE BASED ON THE RANGE OF THE CHANNEL BEING MEASURED.

Viewing the Current Span And Zero Offset Values

To view the current Span and Zero Offset values, press the “Span/Zero” key. Press the key again to return to measuring mode.

Span Value and Zero Value Adjustments

The "span" number is integral to determining ozone concentrations and is usually a number around 500. The exact number varies for each analyzer and is factory set during final calibration and testing against in-house standards. Typically the *IN USA* in-house standard is traceable to NIST (National Institute of Standards and Technology), previously known as NBS (National Bureau of Standards).

If the unit is to be calibrated against a different standard by the end user, the "span" value may require adjustment.

The zero offset value is typically zero. If it is desirable to "offset" the instrument reading by a fixed amount (for example, to offset any background interferences), the zero offset value may require adjustment.

IMPORTANT: The span and zero offset values directly affect the reported ozone concentration. Therefore, adjustments should only be made by authorized persons. *IN USA, INC*. assumes no liability for errors incurred if the values are changed from those set at the factory on shipment. Any values of span and zero offset which are different from those originally set at the factory will void the calibration of the unit and its traceability to NIST.

IMPORTANT: IF NEW VALUES ARE ENTERED, MAKE A NOTE OF THEM WHERE THEY CAN ALWAYS BE REFERENCED. ALWAYS KEEP A RECORD OF THE ORIGINAL, FACTORY SET SPAN NUMBER. CHANGING THE SPAN AND ZERO NUMBERS SHOULD ONLY BE PERFORMED BY QUALIFIED PERSONNEL. *IN USA, INC.* DOES NOT RECOMMEND ADJUSTMENTS IN EITHER NUMBER WITHOUT PRIOR CONSULTATION. *IN USA* CANNOT BE RESPONSIBLE FOR ERRORS IN OZONE MEASUREMENTS CAUSED BY IMPROPER SETTINGS OF THE SPAN/ZERO NUMBERS.

New "span" and "zero offset" numbers can be entered as follows:

1) Press the *Span/Zero* key. The display will show:

   SPAN XXX ZERO +/-XX

   The leftmost digit of the "span" number will be flashing.

   a) If you want to change the "span" number, proceed with step number (2)

   b) If you do NOT wish to make any changes, simply press the *Span/Zero* key again to return to normal operating mode.

c) If you wish to change ONLY the "zero" offset, press *Enter*. The leftmost digit of the "zero" number will now flash. Proceed with step (4) below.

2) Enter the new "span" number by using the numerical keypad. Or you may also first clear the current "span" number by pressing *Clear*. Then enter the new "span" number by using the numerical keypad.

3) Press the *Enter* key when you are done entering the "span" number. You will now be able to change the "zero" offset number, or return to normal operating mode by pressing the *Span/Zero* key and skip the rest of the steps below.

4) The left-most digit of the “zero” offset number will be flashing. Enter the new offset value by using the numerical keypad, or press the *Clear* key to clear the current value before entering a new one. Change the sign of the number by pressing the +/- key first.

5) Press the *Enter* key to accept the new "zero offset" number. The display will show:

6) Press the *Span/Zero* key to return to normal measuring mode.

To verify the new values, press the *Span/Zero* key, read the values, and then press the key again to return to measuring mode.

SAMPLING MULTIPLE POINTS (MULTI-CHANNEL UNITS ONLY)

A Multi-Channel Model IN-2000 can measure ozone levels from up to 5 different points (channels). The channels can be selected manually (using the *Shift* key) or the instrument can sequence through the channels automatically. The analyzer is this “automatic” mode when the *Auto Seq.* switch is ON. In this mode, the analyzer will automatically sequence through the sample inlet ports and sample from a particular channel for the amount of minutes programmed for that channel (the "interval"). Programming of the interval is explained below.

The manual mode is entered when the *Auto Seq.* switch is OFF. In this mode, the desired channel is selected by pressing the *Shift* key. The unit will continue to draw a sample from the selected channel until the *Shift* key is pressed again, or until the unit is put in automatic mode.

Programming the Interval

When a multi-channel instrument is in automatic sequence mode, the cycling time (in minutes) for each channel is programmed as an “interval”. For each channel, the duty cycle can be programmed in increments of 1 minute, between 0 and 99 minutes.

NOTE: A time of zero (00) minutes will cause the instrument to skip that particular channel. However, the instrument will not accept a zero entry for all channels

Use the following procedure to program the sampling time on each sample point:

1) Press the *Interval* key. Display will read:

   SAMPLE TIME n XX MIN

   where n is the channel number and XX is the current value for the number of minutes.

2) Use the numeric keypad to enter the required time, or press the *Clear* key first to clear the entry before entering a new one. For example, to enter 3 minutes press the following keys: "0" "3".

3) Press the *Enter* key to accept the entry.

4) Press the *Shift* key to set the time for the next channel, and follow steps (2) and (3) above.

5) Repeat until the time interval for each channels is set. Press the *Interval* key to return to operating mode.

DESCRIPTION OF THE DISPLAY MESSAGES

The IN-2000 is equipped with a 20 character, vacuum fluorescent alphanumeric display. In addition to ozone concentration, the display can announce alarm and error conditions as described below. Error conditions are explained in more detail later.

DISPLAY SINGLE CHANNEL UNITS	DISPLAY MULTI CHANNEL UNITS	EXPLANATION
OZ X.XX PPM	Cn X.XX PPM	Measuring mode, current ozone concentration [of channel n]
OZ X.XX PPM HI ALM	Cn X.XX PPM Cm HI ALM	Current concentration [of channel n]; ozone level has exceeded the alarm 2 threshold [in channel m]
OZ X.XX PPM LO ALM	Cn X.XX PPM Cm LO ALM	Current concentration [of channel n]; ozone level has exceeded the alarm 1 threshold [in channel m]
OZ + OVER	Cn + OVER	Ozone level is above the full scale range [for channel n]
OZ X.XX LO FREQ	Cn X.XX LO FREQ	**Error!** CF value below 25000
OZ X.XX HI FREQ	Cn X.XX HI FREQ	**Error!** CF or SF values (or both) above 55000
OZ X.XX UN FREQ	Cn X.XX UN FREQ	**Error!** CF values are unstable
ILLEGAL DATA	ILLEGAL DATA	**Error!** Measured data is outside the boundaries of the machine

RUN TIME ERROR	RUN TIME ERROR	**Error!** Software/Hardware failure
CHECK MEMORY DATA	CHECK MEMORY DATA	**Error!** Memory of the programmed parameters (Span/Zero, Alarms, Interval) has been lost and must be re-entered.

ERROR MESSAGES AND TROUBLE-SHOOTING

Low Frequency / High Frequency

These errors are reported when there is either insufficient light (low frequency) or too much light (high frequency) reaching the sample and/or control sensor. Please refer to INTERNAL DIAGNOSTICS - SF/CF VALUES on page 31 for a through description.

In order of probability/priority, the possible causes of these errors and their remedies are listed below:

CAUSE (in order of likelihood)	***TYPICAL REMEDY***
Not enough warm-up time	Allow instrument to warm up (minimum 20 minutes)
UV lamp not positioned properly	Re-position UV lamp (see below)
Sample or Control Sensor not positioned properly	Re-position sensor(s) (see below
Dirty optical components	Clean optical components (explained later)
UV lamp is too weak	Replace lamp

If the unit has warmed up and an SF/CF related error still occurs, the SF and CF values can usually be adjusted so that they are between 25000 and 55000. Follow the steps below:

IMPORTANT: ADJUSTMENTS TO THE LAMP OR SENSORS SHOULD ONLY BE PERFORMED WHILE OZONE-FREE GAS IS FLOWING THROUGH.

1. Press the CF/SF button **THREE CONSECUTIVE TIMES** (this further ensures that ozone free gas will be flowing through the analyzer by putting the solenoid valve into its de-energized position).
2. Gain access to the optical bench of the instrument by removing the top cover (19" rack units) or by opening the front panel door (NEMA 4x / IP65 units)
3. Loosen the set screw holding the UV lamp in place.
4. Hold the UV lamp stem. It may be warm to the touch.

5. Slowly slide the lamp in or out of its housing while watching the SF value. Pushing the lamp in will increase the SF value.

CAUTION: DO NOT PULL THE LAMP OUT ENTIRELY. DO NOT LOOK AT THE LIGHTED PART OF THE LAMP WITHOUT PROPER EYE PROTECTION.

6. Try to get the SF value to around 40000, though any value between 25000 and 55000 is acceptable.
7. Tighten the lamp set screw after setting the SF value.
8. To adjust the CF value, loosen the set screw for the control sensor.
9. Hold the end of the sensor (where the sensor's wires are). There is no danger of electrical shock from these wires. Slowly slide the control sensor in or out or its housing. Sliding the sensor our will decrease the CF value.
10. Try to get the CF value to be around 40000, though any value between 25000 and 55000 is acceptable.
11. Tighten the sensor set screw after setting the SF value

The Sample Sensor can also be re-positioned, though it seldom requires it.

Unstable Frequency

These errors are reported when the light is unstable. Please refer to INTERNAL DIAGNOSTICS - SF/CF VALUES on page 31 for a through description.

In order of probability/priority, the possible causes and remedies of this error are listed below:

CAUSE (in order of likelihood)	***TYPICAL REMEDY***
Not enough warm-up time	Allow instrument to warm up (minimum 20 minutes)
UV lamp loose	Tighten UV lamp set screw
Sample or Control Sensor loose	Tighten sensor set screws
Optical bench chamber tube loose	Tighten loose chamber tube
Instrument is subject to vibration or other motion	Make sure instrument is isolated from vibration
UV lamp failure	Replace lamp

Run Time Error

This error is rare, and typically is cleared by switching main power to the analyzer off and back on. If the error persists, a corruption of the software has probably occurred. Please call *IN USA* for service.

Memory Data Errors

This error is typically caused by a loss of the field-programmable parameters such as alarm thresholds, sequence intervals, and span/zero. If the data is missing, enter it again. Please note that the low alarm values for a given sample point must always be lower than the high alarm values for that point.

Sample Flow Effects

The sample flow rate should be adjusted to 2 liters/minute nominal using the valve on the front panel flow meter. (For units used as part of the System W dissolved ozone in water analyzer, the flow should be set to 1 l/min). The flow rate is important in order to ensure rapid air changes of the wetted components. If the flow drops, please check the following:

- Is the pump power switch on?
- Are all tubing connections tight?
- Are there restrictions in any of the tubes?
- Are there leaks in any tubes?
- Is the flow meter clogged?
- Is the pump not working?
- Is the solenoid valve operating properly?
- Is there a leak through the quartz windows in the optical assembly?

Negative Ozone Concentration Values

Typical reasons and remedies for negative results are shown below:

POSSIBLE CAUSE	***REMEDIES***
Insufficient warm-up time	Allow at least 20 minutes of warm-up
Reference catalyst contamination caused by: • high moisture content • other gases (CLO2, NOx)	Replace the reference catalyst
Inappropriate materials for tubing, filters	Use only materials compatible with ozone. Do NOT use Tygon or other plasticized materials.

OPTICAL ASSEMBLY - CLEANING AND ASSEMBLY

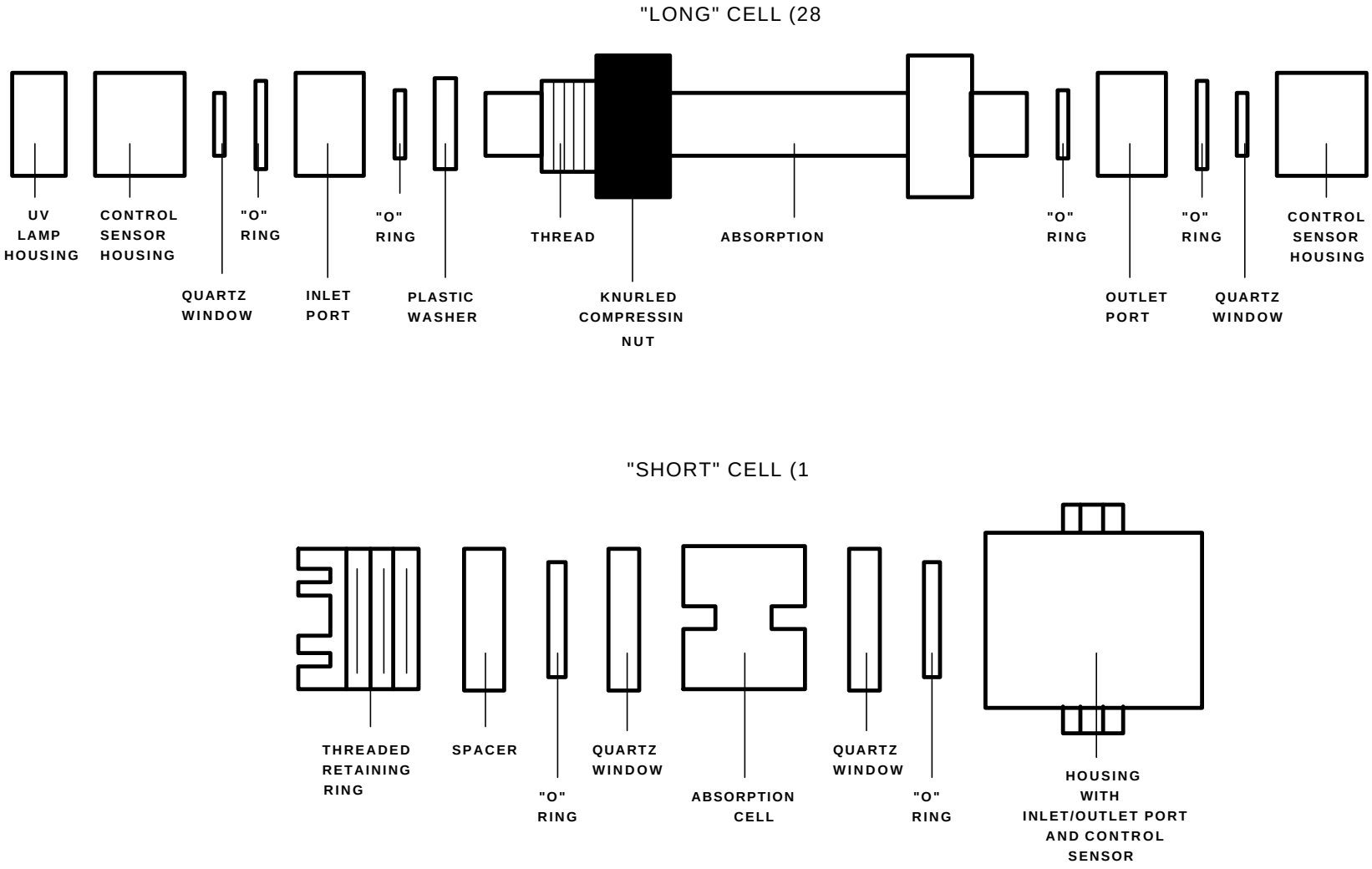
IMPORTANT: Work on the optical assembly should only be performed by skilled personnel. Care should be taken to avoid breakage of components, particularly the quartz windows.

The IN-2000 ozone analyzers are typically built with one of two optical benches, depending on how the instrument is to be used:

- 28 cm cell
- 1 cm cell

The key difference between the two benches is the length of the optical path, which is roughly defined as the distance between the two quartz windows bounding the gas chamber through which the sample flows. An exploded view of the two benches is shown in Figure 9.

Figure 9: IN-2000 Optical Benches



The optical bench may need to be removed in order to clean it, to replace a damaged quartz window, or to replace a seal.

In the 28 cm optical bench assembly, the long tube between the inlet and outlet port blocks is compressed between the blocks by tightening the knurled compression nut. Sealing is accomplished by "O" rings on either end of the absorption cell. To remove the tube, loosen the knurled nut and push the tube into the block located closest to the nut. The remove the other end of the tube from its block. To install, reverse this procedure.

When cleaning or replacing the quartz windows, take extra care not to touch the surfaces with your fingers, and use only clean, lint-free cloths to avoid scratches. Alcohol or ammonia based cleaners can be used.

After the optical components are reassembled, adjustments to the position of the sensors and/or UV lamp may be needed to bring the SF/CF values within range as explained under Low Frequency / High Frequency on page 38.

PERIODIC MAINTENANCE

The IN-2000 is designed to provide continuous operation. Periodic maintenance of the following items will help ensure trouble free operation:

Inlet particulate filter

If present, the filter element of the external dust filters should be replaced as needed when it becomes soiled. Replace with the same type of filter element.

SF/CF Value Adjustments

Check these values periodically and adjust as explained before

UV lamp

It is recommended that a spare UV lamp always be kept on hand. UV lamps typically provide 12-18 months of continuous service life. Replace the lamp when the SF/CF numbers fall below 25000 (with clean optical components) and the adjustments described in Low Frequency / High Frequency on page 38 cannot bring the values up.

CAUTION: NEVER REMOVE THE UV LAMP WHILE THE UNIT IS POWERED ON. NEVER LOOK AT THE UV LAMP WITHOUT PROPER EYE PROTECTION.

Pump

The pump diaphragm may need replacement after 24 months, or the entire pump can be replaced. It is recommended that a spare pump be on hand at all times.

CALIBRATION AND ACCURACY

IN USA offers calibration services, and calibrates all units against in-house standards. For analyzers with range 0-10 ppmv, the calibration is traceable to NIST. A certificate of calibration is issued for every unit. Many end users opt to send instruments to our facility on a yearly schedule for re-certification. Please consult with *IN USA, INC*. to determine the most appropriate calibration schedule for your application.

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Model IN-2000 Analyzer

SINGLE and MULTI-POINT AMBIENT OZONE ANALYZER

IN USA's model IN-2000 measures ambient ozone levels to monitor ozone leaks in the workplace environment. Above certain concentration levels, ozone is a toxic and corrosive gas. Therefore, the need to monitor worker exposure to ozone to meet OSHA Requirements (see attached table). The model IN-2000 is typically used in areas around ozone generators, gas chambers, gas delivery systems, and semiconductor tools. In addition, it is also used to monitor ozone levels in vent gas, post-destruct or pre-destruct units with a sample conditioning system.

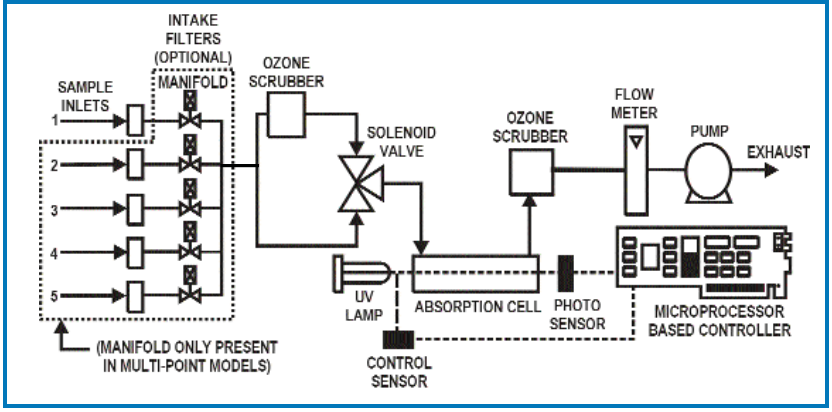
- Microprocessor controlled
- UV absorption technique
- Measures up to 5 sample points
- Built-in field programmable sequencer
- Dedicated 4-20 mA output per channel
- Isolated Analog Outputs
- Dual alarms per channel
- Highly stable Optical System

Specifications

IN-2000 Analyzer

Specifications subject to change without notice

Principle of Operation



Measuring Principle:	Absolute determination using UV absorption
Number of Sample Points:	1, 3 or 5. Multichannel units have a built-in manifold and programmable sequencer
Measuring Ranges:	0-1 ppm, 0-10 ppm,1-100 ppm and, 0-1000 ppm
Display Units:	ppm standard
Precision:	0.005 ppm (range 0.001-1.000) 0.01 ppm (range 0.01-10.00) 0.1 ppm (range 0.1-100.0) 1 ppm (range 0-1000)
Linearity:	Better than 99% throughout range
Resolution:	0.001 ppm (range 0-1 ppm) 0.01 ppm (range 0-10 ppm)
Zero Drift:	Less than 0.005 ppm per month
Calibration:	Against UV photometer traceable to the U.S. NIST
Compliance:	CE

Diagnostic Features:	Continuous internal diagnostics with error messages & instrument error relay
Readout:	1 line by 20 character alphanumeric vacuum fluorescent display
Analog Outputs:	Isolated 4-20 mA per channel - Optional
Digital Outputs:	RS-232 interface - Optional RS-422 interface - Optional
Standard Alarms:	Two field programmable alarms with form C relay contacts (5A 250 VAC resistive) per channel - Optional
Supply Voltage:	100-240 VAC 50/60 Hz
Sample Flow Rate:	1.0 to 2.0 l/min nominal. Built-in sampling pump and throttling valve
Connections:	1/4" compression fittings
Configurations:	NEMA 4X / IP65 Wall Mount, 19" Rack or Bench Mount

U.S. OSHA Requirements		
TLV-TWA Threshold Limit Value-Time Weighted Average	0.1 ppm_V	The maximum continuous ozone concentration to which an individual can be exposed during a normal 8 hour day / 40 hour work week without adverse effects.
TLV-STEL Threshold Limit Value-Short-Term Exposure Limit	0.3 ppm_V	The maximum intermittent ozone concentration to which an individual can be exposed (provided that TLV-TWA is not exceeded) for no longer than 15 minutes and no more than 4 times per day (with at least 1 hour between exposures.)

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INSTRUMENTATION

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MODELS H1, H1-X AND H1-UH HIGH CONCENTRATION PROCESS OZONE ANALYZERS

OPERATING MANUAL

VERSION 5.2
RELEASE B
APRIL 1995

TABLE OF CONTENTS

LIST OF FIGURES:

SPECIFICATIONS FOR THIS ANALYZER

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

INSTALLED OPTIONS:
- PRESSURE AND TEMPERATURE
- AUTO ZERO
- OTHER: _____
  _____

ENCLOSURE:
- BENCH TOP
- 19" RACK
- NEMA 4X / IP65
- OTHER: _____
  _____

TUBING TYPE:
- TEFLON
- STAINLESS STEEL

FLOW METER TYPE:
- PG SERIES
- FM SERIES
- VALVED

AC VOLTAGE SERVICE:
- UNIVERSAL (100-240 VAC)
- SPECIFIED VOLTAGE ONLY: _____

INLET/OUTLET FITTINGS:
- 1/8" SWAGELOK™
- 1/4" SWAGELOK™
- 1/4" MALE VCR™
- OTHER: _____

ADDITIONAL NOTES:
_____
_____
_____
_____
_____

GENERAL SPECIFICATIONS FOR THE "H" SERIES OZONE ANALYZERS

Measuring Principle	Absolute determination by UV absorption. Automatic compensation for sample pressure, temperature, and molecular weight
Cycle Time	Continuous measurement, uninterrupted flow, no solenoid valves
Measuring Range	0-125 g/m^3 (standard); 0-200 g/m^3 (extended); 0-400 g/m^3 (ultra high)
Sensitivity/Resolution	0.1 g/m^3 up to 125 g/m^3 ;1 g/m^3 above 125 g/m^3
Zero Drift	None, digitally autozeroed. Optional programmable auto zero.
Precision/Repeatability	0.1 g/m^3 or 1% of reading (whichever is greater)
Linearity	Better than 99% throughout range
Calibration Standard	Against the International Ozone Association KI method to 1% repeatability
Ozone Concentration Units	g/m^3 (g/Nm^3 , %w/w, %v/v are field selectable when the P&T module is installed)
Measured Temperature*	0 to 70 °C (32 °F to 158 °F)
Measured Pressure*	600 to 2025 mB (standard)
Readout	2x20 character, alpha-numeric, Vacuum Fluorescent
Gas Sample Flow Rate	0.5 l/min nominal
Analog Outputs	4-20 mA and 0-10 V DC standard. 0 to 20 mA and 0-1 VDC optional
Digital Output	RS-232 compatible interface, bi-directional
Relay Contacts	3 Form C (Single Pole - Double Throw, make before break) rated at 5 AMP resistive load at 250
Diagnostic Features	Continuous internal diagnostics with error messaging and instrument error relay
Configurations	Bench top, wall mountable NEMA 4x / IP65 enclosure, or 19" rack 3U height
Sample ports	1/8" or 1/4" Swagelok standard. Metric and VCR optional
Supply voltage	100-240 VAC, 50/60 Hz
Environmental Operating Conditions	5-45°C; 0-95% RH non condensing

*Only available when the optional P&T module is installed
Specifications subject to change without notice.

CAUTIONS AND GENERAL NOTES

CAUTION: 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.

NEVER LOOK DIRECTLY AT THE UV LAMP WHICH IS INSIDE THIS ANALYZER WITHOUT PROPER EYE PROTECTION. UV RADIATION CAN CAUSE PERMANENT EYE DAMAGE.

COMPONENTS WITHIN THIS ANALYZER ARE POWERED BY AC. TAKE ALL NECESSARY PRECAUTIONS TO ELIMINATE THE RISK OF ELECTRICAL SHOCKS.

CERTAIN COMPONENTS MAY BE HOT TO THE TOUCH. PLEASE ALLOW PROPER COOLING TIME BEFORE WORKING WITH THESE COMPONENTS.

IN USA, INC. reserves the right to make changes to the product covered in this manual to improve performance, reliability or manufacturability. Make sure that this Manual is used with the original Product it was shipped with.

Although every effort has been made to ensure accuracy of the information contained in this manual, IN USA™ assumes no responsibility for inadvertent errors.

IN USA™ assumes no responsibility for the use of any measuring schemes describes herein.

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.

GENERAL DESCRIPTION

Overview

The AFX® Series "H" Process Ozone Analyzers are Ultra-Violet (UV) Absorption Analyzers designed for the continuous measurement of high concentrations of ozone in the gaseous phase. The analyzers operate from a mains supply of 100/115/220/240 VAC, 50/60Hz.

This manual covers three models offered within the AFX® Series "H" analyzers. The principal difference between the three models is their ozone measuring range as described below:

- Model H1, range 0-125 g/m^3
- Model H1-X, range 0-200 g/m^3
- Model H1-UH, range 0-400 g/m^3

Features and operation of the units is virtually identical. With exception of the measuring range, all references to the "Model H1" apply to all three models.

OPTIONS AND ACCESSORIES

The AFX® Model H1 may include several options and accessories designed to expand its capabilities.

Pressure and Temperature Compensation

The Pressure and Temperature Option (P&T option) consists of a Stainless Steel chamber fitted with and absolute pressure transducer and with a temperature sensor. The P&T option is designed to accurately measure the pressure and temperature of the ozonated gas mixture whose ozone concentration is determined in the absorption cell. When the option is installed, the AFX® 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 AFX® 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)

NOTE: The P&T option must be factory installed

Extended Concentration Range

The standard Ozone concentration range of the AFX® Model H1 UV Analyzer is 0 to 125 g O_3 per m^3 of carrier gas (g/m^3), equivalent to 10% by weight in air at 0 °C and 1 atmosphere. The Extended Concentration Range (ECR) Option (Model H1-X) expands the standard Ozone concentration range to 0 to 200 g/m^3 equivalent to 16% by weight in air at 0 °C, 1 atmosphere. The Ultra High Range unit (Model H1-UH) measures in the range of 0-400 g/m^3.

NOTE: The extended range options must be factory installed.

Wall Mounting, NEMA 12 - 4- 4X (IP65) Enclosure

The AFX® Model H1 can be housed in a non-metallic NEMA 4/4X enclosure which is designed to be wall mounted.

NOTE: This option is factory installed.

19" Rack Mounting

The standard bench-top Model H1 can be modified to be mounted in a standard 19" rack. The unit height is 3U (5.25" or 133 mm)

NOTE: This option is factory installed

AutoZero Option

The AutoZero Function is an Option offered for the Series AFX® Model H1 High Concentration Ozone Analyzer which allows for the automatic zeroing of the UV analyzer with ozone-free gas flowing through the absorption cell.

In the Model H1, 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. Please refer to APPENDIX 2: AUTOZERO OPTION OPERATION, page 45.

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

MECHANICAL INSTALLATION

The AFX® Model H1 analyzer's mechanical dimensions for the bench top, 19" rack, and NEMA enclosure are shown in Figure 1, page 13, Figure 2, page 14, and Figure 3, page 15, respectively. 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.

ELECTRICAL INSTALLATION

Power Connections

When housed in the bench top or 19" rack configurations, the AFX® Model H1 is provided with a standard AC power receptacle and with a standard 3-wire power line cord for use with a grounded 120 VAC, 50/60 Hz power outlet. When housed in a NEMA 4x / IP65 enclosure, an AC power terminal block is provided and a conduit fitting on the bottom wall of the NEMA 4x enclosure. Power connections should be made through the conduit fitting to the terminal block located on the mounting plate inside the enclosure, labeled “HOT”, “NUT” and “GND” . 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 in the rear panel. 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.

CAUTION: Before power is applied to the unit, make sure that the voltage selector switch setting matches the mains power available at the outlet. The voltage selector switch is located in the power receptacle.

Do not attempt to change the voltage selector switch without first making sure that the power cord is disconnected from the source of AC power. The proper fuses for operation in either range are included in the power receptacle assembly.

Figure 1: Bench Top Dimensions

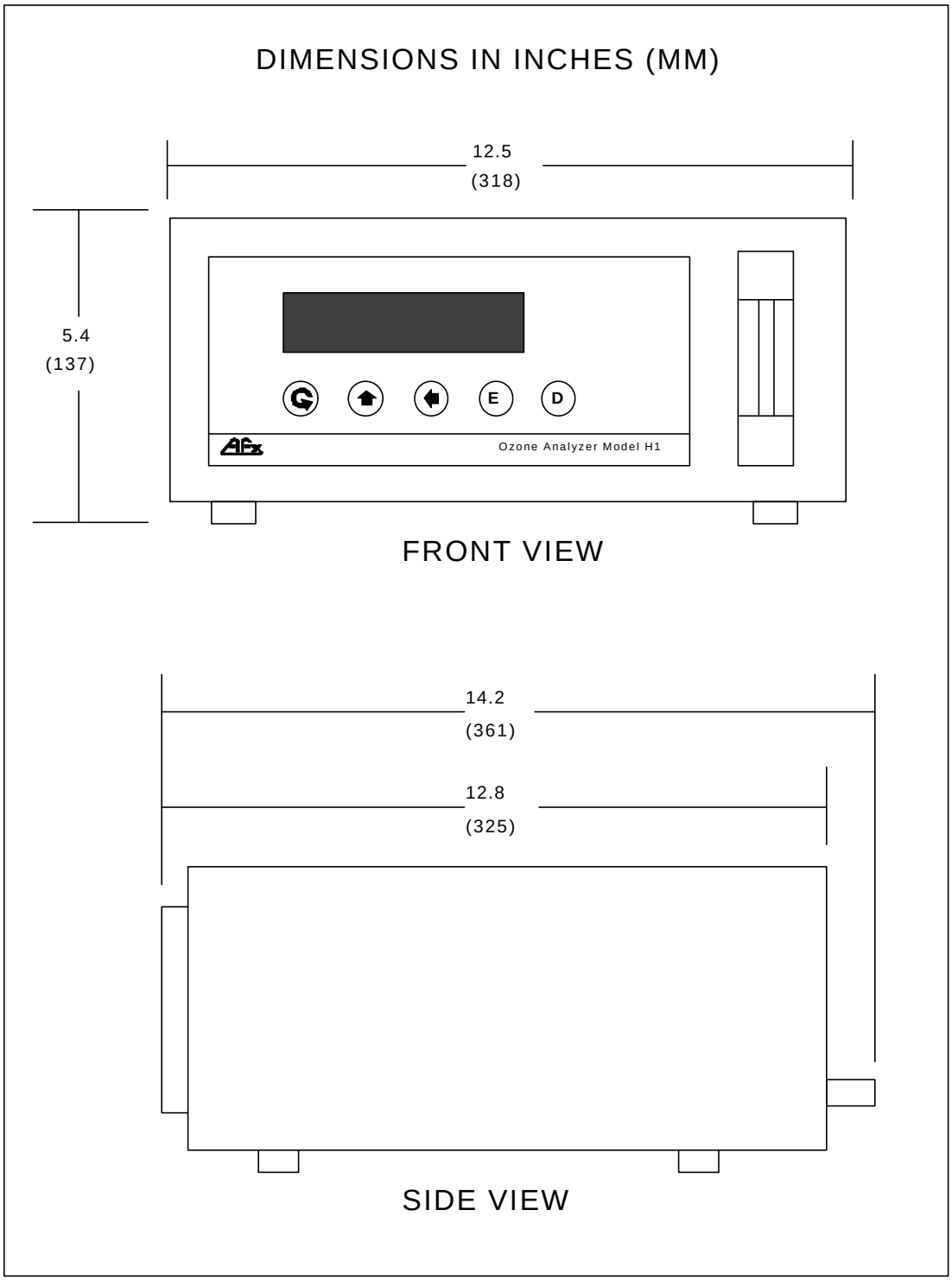


Figure 2: 19" Rack Dimensions

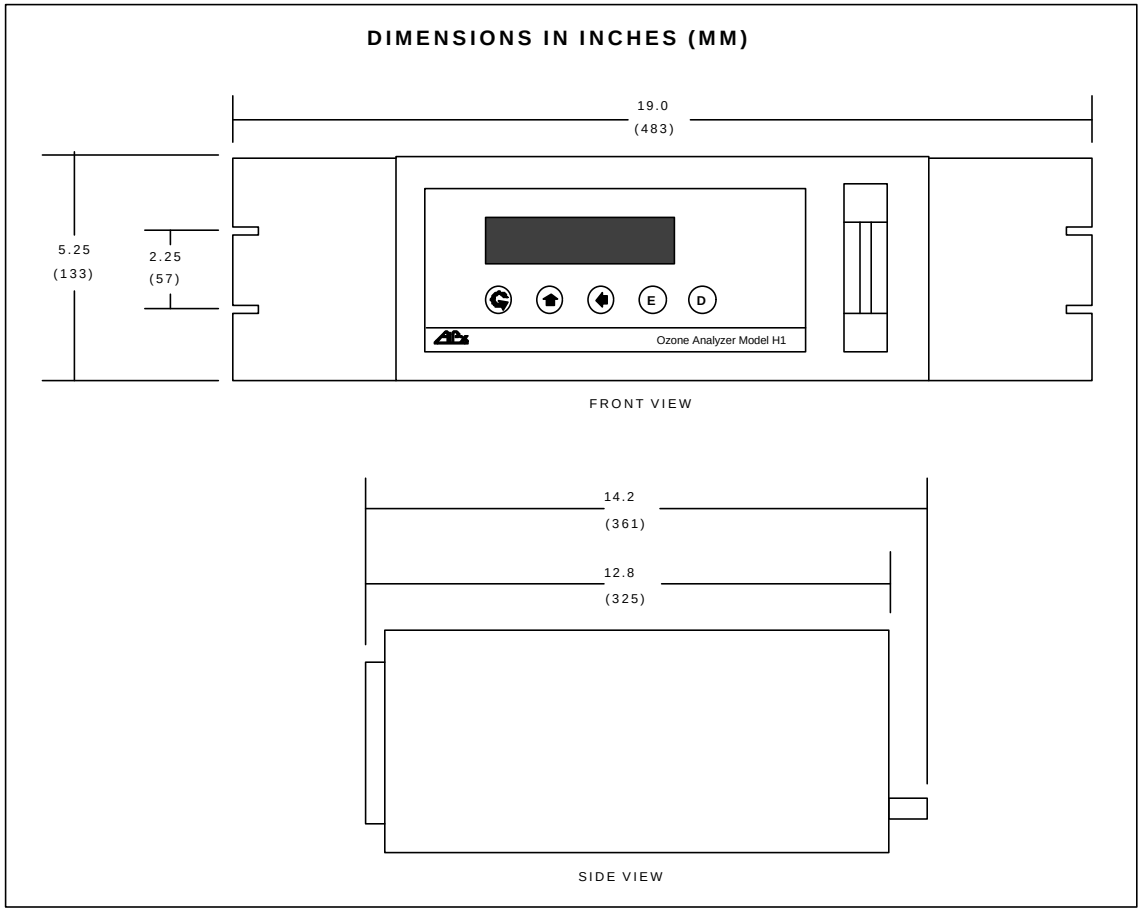
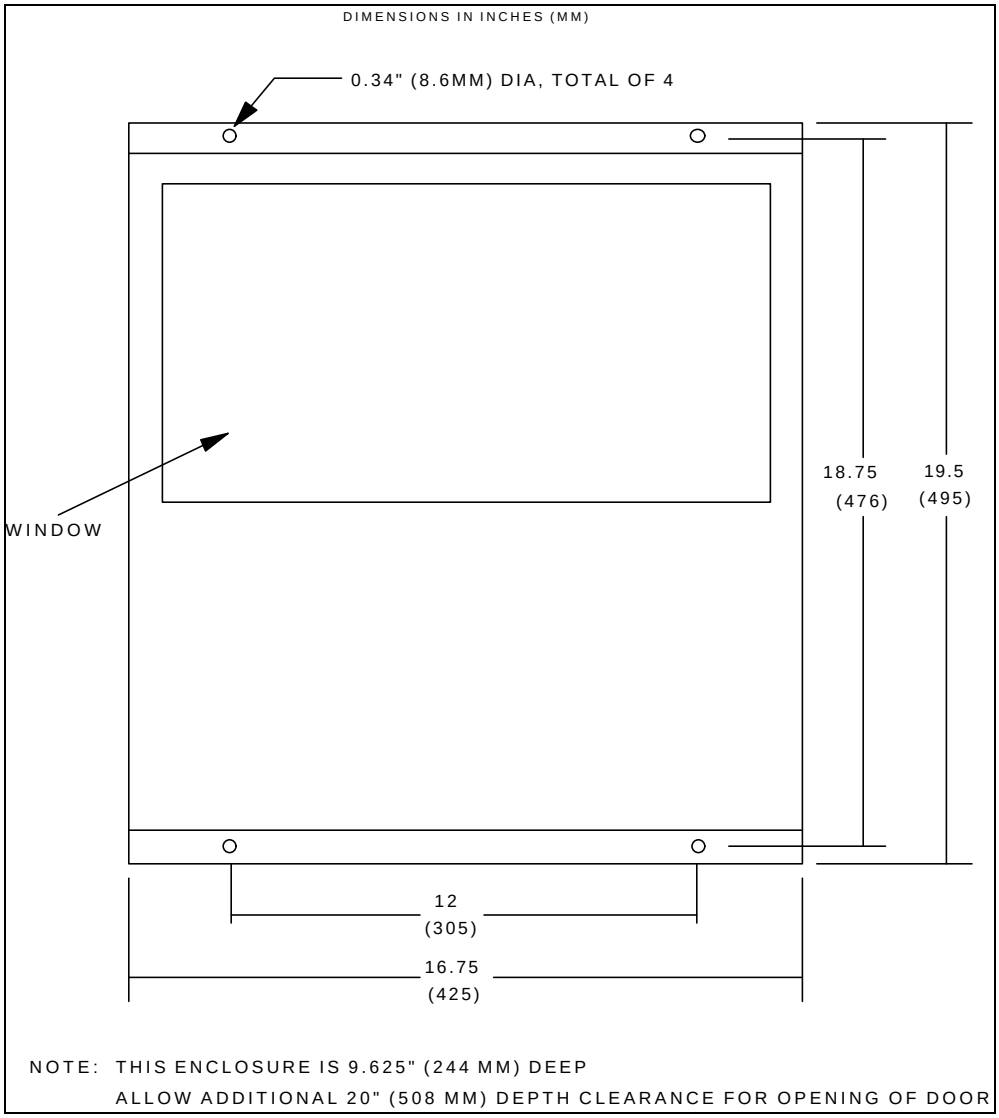


Figure 3: Wall Mount NEMA 4x / IP65 Enclosure Dimensions



Signal Connections - Field Wiring

The AFX® Model H1 produces analog and digital serial data outputs. It also provides contacts for field wiring of alarms and instrument relays.

Refer to Figure 4: Rear Panel, page 16 for location and identification of connectors. There is a 13 position Terminal Block (TB) and a "D" size male connector, labeled RS-232.

Figure 4: Rear Panel

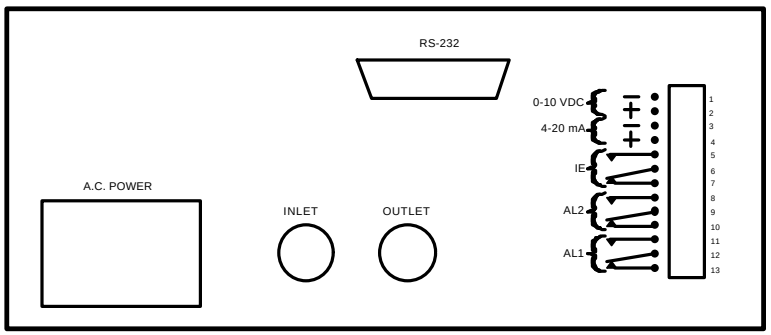


Table 1 below provides the pin-out of the 13 position Terminal Block.
Table 2 below provides the pin-out of the RS-232 Digital Serial Communications Port.

When housed in a NEMA 4x / IP65 enclosure, a conduit fitting is supplied on the bottom wall enclosure for field wiring.

Table 1: 13-Position Terminal Block Pin-out

PIN #	DESCRIPTION OF OUTPUT	NOTES
1	Common Ground, Analog Output, 0 to +1 VDC or +10 VDC	1
2	0 to +1 VDC or +10 VDC, Analog Output voltage, O_3 Concentration	1
3	4 to 20 mADC Return, Ozone Concentration	2
4	4 to 20 mADC, Ozone Concentration	2
5	Instrument Error Relay Contact, Open on Alarm condition	3
6	Instrument Error Relay Contact, COMMON	3
7	Instrument Error Relay Contact, Closed on Alarm condition	3
8	Alarm #2 Relay Contact, Open on Alarm condition	4
9	Alarm #2 Relay Contact, COMMON	4
10	Alarm #2 Relay Contact, Closed on Alarm condition	4
11	Alarm #1 Relay Contact, Open on Alarm condition	4
12	Alarm #1 Relay Contact, COMMON	4
13	Alarm #1 Relay Contact, Closed on Alarm condition	4

Notes:

1. 0-1 VDC or 0-10 VDC factory selected. This is a Low impedance, short-circuit protected analog output, intended primarily for data acquisition (recording) and monitoring.

2. 4 - 20 mADC, is a non-isolated current loop. Compliance is 750 Ohm an the loop is open-circuit protected.

3. Instrument Error (IE) relay is normally energized. If there is a "malfunction" of the power supply, the motor or any key component in the optical sensing scheme, the relay will de-energize and become active. It is a Form-C, single Pole, Double Throw (SPDT), Break before Make relay, with contact ratings of 5 Amp at 250 VAC, resistive load. Please refer to WARNING/ERROR MESSAGES on page 36 for a description of errors which trigger this relay.

4. The Alarm Relays are Form-C, single Pole, Double Throw (SPDT), Break before Make relay, with contact ratings of 5 Amp at 250 VAC, resistive load. They are normally de-energized, that is, only under alarm conditions will they energize.

Table 2: RS-232 Connector Pin-out

PIN #	DESCRIPTION
2	Transmitted Data (TXD)
3	Received Data (RXD)
7	Signal Ground (GND)

SAMPLE GAS CONNECTIONS

There are two (2) pneumatic ports located on the rear panel of the Model H1 (see figure 4) labeled INLET and OUTLET. The ozone sample line should be connected to the port labeled INLET. The gas sample flows from the INLET to the measuring chamber, the P&T option (if installed) and the flow meter, and will exit through the OUTLET port.

Given the ozone concentration in the gas mixture, only Stainless Steel tubing or Teflon tubing and connectors are recommended for interconnecting the analyzer to the ozone source.

CAUTION: USE ONLY MATERIALS SUITABLE FOR HIGH CONCENTRATION OZONE SERVICE. CONSULT WITH *IN USA, INC.* FOR ADVICE ON MATERIALS.

CAUTION: 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.

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.* Please refer to APPENDIX 3: GENERATOR OUTPUT MONITORING, page 50 for a discussion on pneumatic configurations for ozone generator output monitoring.

SETTING THE SAMPLE FLOW RATE

The sample flow rate should be set to 0.5 l/min (see previous section). Flow rate adjustments must be made external to the Model H1 unless the analyzer is equipped with a throttling flow meter (the standard flow meter does not include a valve).

INSTALLATION OF OPTIONS AND ACCESSORIES

Almost all of the options and accessories of the AFX® Model H1 UV Analyzer are factory installed. Make sure that the Options required and that accessories specified are installed. Please refer to the table of contents and index in this manual to find complete descriptions of installation procedures and operation of the options

PRINCIPLE OF OPERATION

The AFX® 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 AFX® 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 flow-meter.

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.

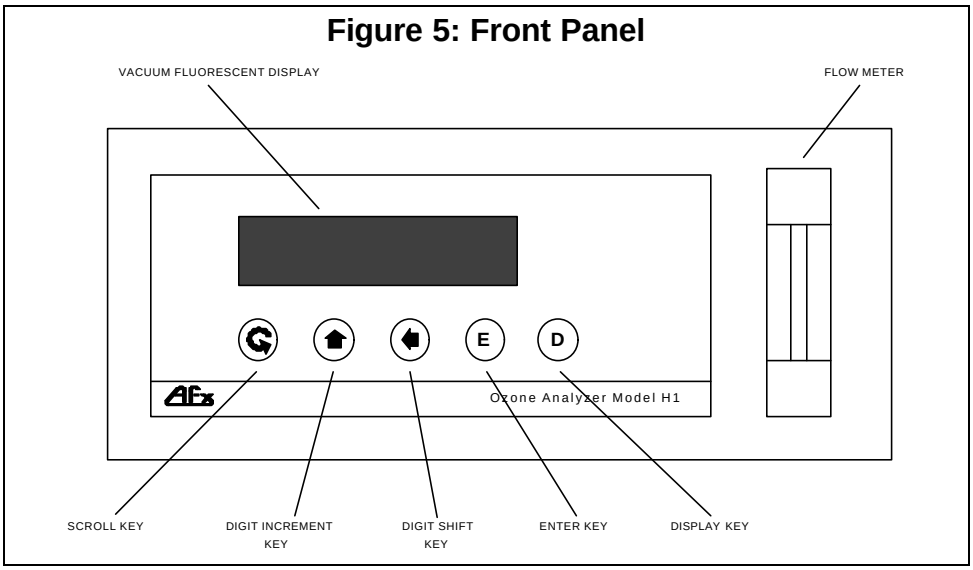
ACCURACY AND CALIBRATION

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.

FRONT PANEL DESCRIPTION

Refer to Figure 5. The Front Panel contains the Digital Readout, Keyboard and flow meter.

Figure 5: Front Panel



Digital Readout Description

The Digital Readout consists of 2 rows of 20 alpha-numeric characters each. The display is vacuum fluorescent. A blue color filter is used to enhance contrast and legibility. Under normal operation the displayed information is updated every 6 seconds.

Keyboard Description

There are 5 (five) active keys, located in the front panel of the H1 analyzer:

1. SCROLL, identified as a circular arrow
2. DIGIT INCREMENT, identified as an up arrow
3. DIGIT SHIFT, identified as left arrow
4. ENTER, identified as E
5. DISPLAY, identified as D

Flow meter

As described before (see Setting the sample flow rate, page 18), there is a valveless flow meter located on the front panel of the H1 analyzer. (NOTE: on some Model H1 units, a flow meter with built-in valve is supplied and can be used to regulate the sample flow rate). This flow meter indicates the volumetric flow of gas through the analyzer. The scale on the tube is 0 to 1 liter/minute. The sample gas flow rate should be 0.5 l/min.

Wetted parts of this flow meter have been selected to be compatible with high levels of Ozone.

REAR PANEL DESCRIPTION

Refer to Figure 4: Rear Panel, page 16. The Rear Panel of the H1 analyzer contains the Pneumatic Ports, the Digital Serial Port, the Field Wiring Port, Mains Power receptacle and Power Switch.

PREPARATION FOR OPERATION

The AFX® Model H1 Ozone Analyzer, as shipped, is configured for 100/115 VAC operation, and has been tested as such. However, before using the equipment, certain precautionary checks should be made to ensure that the instrument is set up properly for the particular application in question.

AC Input Voltage Selection

Select the input voltage planned for your installation, either 100/115 VAC or 220/240 VAC. The voltage selector is located in the power receptacle in the rear panel. See Power Connections, page 12.

Initial Set Up

If possible, locate the AFX® 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.

OPERATING PROCEDURES

Below is a description of key operating procedures.

Warm Up

Turn the instrument on by actuating the POWER Switch located in the rear panel. After a few seconds, the readout will display "Warming Up". Press the " D " switch in the keyboard, and the ozone concentration value will be displayed. The warm-up period is necessary to allow the UV lamp to reach equilibrium temperature and brightness. Once the UV lamp has reached stability, the "Warming Up" message will extinguish and the readout stabilizes.

The AFX® Model H1 unit has the intelligence to time the warm up period according to when the Analyzer was last turned off. Warm-up times will be longer from a cold starts.

It is recommended that you allow for the "Warming Up" message to extinguish before using the unit. It is perfectly normal for this to be almost 60 minutes.

While the "Warming Up" message is on, the three (3) relays associated to the two programmable alarms and to the Instrument Error Alarm are disabled (to prevent miss-interpretation by any peripherals connects to the relay contacts).

After the "Warming Up" message has extinguished, perform a Zero Operation as detailed in the next section (ZEROING THE ANALYZER, page 31).

Programmable Parameters

The AFX® Model H1 allows the operator to ***review*** (browse without altering) and ***program*** (change) several parameters.

NOTE: All programmable parameters are stored in non-volatile memory. Powering the unit off or removing power from the unit will not affect these parameters

Please refer to Figure 6: Menu Structure on page 29 for a "layout" of all programmable parameters.

Numerous operating parameters can be accessed and modified by the operator. These parameters are:

Units

NOTE: Available only in units with the P&T Option.

The units of measurement for ozone concentration, pressure and temperature can be selected as follows:

1. OZONE CONCENTRATION

   The AFX® Model H1 can display Ozone Concentration in the following units of measurement.

   I. g/m^3: Grams of Ozone per cubic meter of Gas (Default for standard Model)

II. g/Nm^3: Grams of Ozone per Normalized cubic meter of Gas (1).

III. % Weight: Percent by weight (1) (2)

IV. % Volume: Percent by volume (1) (2)

NOTES:
(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 29 gr/Mol, corresponding to air.

2. TEMPERATURE

The AFX® Model H1 can display Temperature in the following units of measurement.

I. ° C: Degrees Centigrade (Default)

II. ° F: Degrees Fahrenheit

III. ° K: Degrees Kelvin

3. PRESSURE

The AFX® Model H1 can display Pressure in the following units of measurement.

I. mB: Millibars (Default)

II. PSIA: Pounds per Square Inch Absolute

III. Torr: Torricceli (mm Hg)

(NOTE: 1 atm = 1013.2 mB = 14.696 psi = 760 Torr)

Alarm 1 and Alarm 2 Parameters

For each of the Alarms 1 and 2, the following parameters may be set:

1. STATUS:

The Alarm Status condition defines the alarms as either enabled or disabled. The default status is disabled.

2. 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:

0-125 g/m3 = 0-10 % Weight = 0-6 % Volume
0-200 g/m3 = 0-16 % Weight = 0-10 % Volume

3. 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.

4. 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.

5. 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 AFX® Model H1 features 2 (two) Analog Output Signals, that correspond to the ozone concentration:

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

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

The analog outputs can be tested by means of the "Simulation" described below.

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

1. 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%.

2. 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%.

AFX® series H analyzers with version 5.2 or later software feature a "Simulation" mode which allows for testing of the analog outputs. The simulation mode can only be accessed in "program mode" (see Programming Programmable Parameters on page 30). The simulation procedure is described in section titled SIMULATION OF THE ANALOG OUTPUTS on page 33.

For the RS-232 the following parameters may be set.

1. 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

2. RS-232 MODE

   The parameter can be set to either Timed or to Polled. By default, the AFX® 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, AFX® Model H1 RS-2332 Port will remain marking waiting to receive the ASCII character "?" or "!" to commence transmission.

Operating Parameters

Following are the Operating Parameters that may be set by the user:

1. Customer Multiplier
2. Normalizing Temperature (only if P&T option is installed)
3. Normalizing Pressure (only if P&T option is installed)
4. Gas Molecular Weight (only if P&T option is installed)
5. Speaker Output
6. Autozero Interval (only if autozero option is installed)
7. Adjust Pressure (only if P&T option is installed)

1. 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.

2. NORMALIZING TEMPERATURE:

NOTE: Available only in units with the P&T Option.

The normalizing temperature, referred to as T_2 (See Appendix 1: Working Equations And Unit Conversions, page 43), 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).

3. NORMALIZING PRESSURE:

NOTE: Available only in units with the P&T Option.

The normalizing pressure, referred to as P_2 (See APPENDIX 1: WORKING EQUATIONS AND UNIT CONVERSIONS, page 43), is the pressure used during the numerical calculations of Ozone Concentration in g/nm^3. The Normalizing Pressure default value is 1013.25 mB, (14.70 PSIA).

4. MOLECULAR WEIGHT OF CARRIER GAS:

NOTE: Available only in units with the P&T Option.

The AFX® Model H1 accepts three molecular weight options as follows:

a) Air: 29.0 gr/Mol (Default)
b) Oxygen: 32.0 gr/Mol

c) Other: User is prompted for numerical entry

5. SPEAKER OUTPUT:

The speaker output can be either Enabled or Disabled. The default is Enabled.

6 AUTOZERO INTERVAL:

NOTE: only available in units with the AutoZero Option.

The AFX® 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 3.0 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.

7. ADJUST PRESSURE

NOTE: Available only in units with the P&T Option.

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.

NOTES:
- 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

The AFX® Model H1 provides Time and Date keeping. Time and Date provide two different displaying formats and can be set as follows:

1. TIME FORMAT:

Time can be displayed in either 24 hour format or 12 hour format

2. TIME:

   Time can be set by keying in hour, minute and second

3. DATE FORMAT:

   Date can be displayed either as month/day/year (MM/DD/YY) or day/month/year (DD/MM/YY)

4 DATE:

   Date information can be set by keying in day, month and year information.

Reviewing Programmable Parameters

To review parameters, the sequence below should be followed:

1. Press the "D" (DISPLAY) key. The top line of the readout should scroll as follows:

Table 3: Display Scrolling

UNITS WITH P&T OPTION	UNITS WITHOUT P&T OPTION
a) Ozone Concentration	a) Ozone Concentration
b) Gas Pressure	b) Message: "Review Operating Parameters" (repeat)
c) Gas Temperature	
d) Message: "Review Operating Parameters" (repeat)	

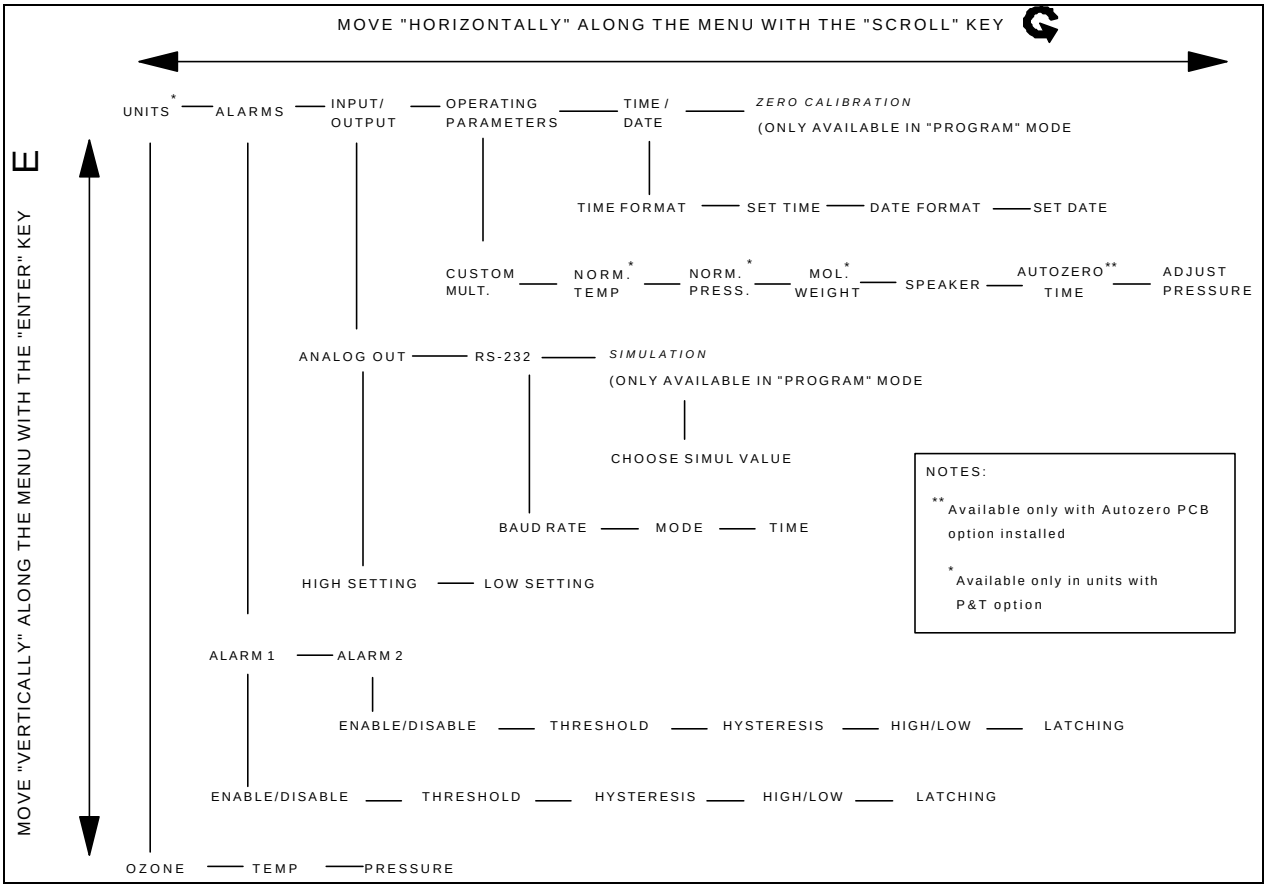
2. While the readout is displaying "Review System Parameters", press the Scroll (circular arrow) key. The readout should scroll as follows, (refer to figure F:)

Table 4 : Reviewing System Parameters

UNITS WITH P&T OPTION	UNITS WITHOUT P&T OPTION
a) Units	a) Alarms
b) Alarms	b) Input/Output
c) Input/Output	c) Operating Parameters
d) Time and Date	d) Time and Date
e) Operating Parameters (repeat)	(repeat)

Please refer to Figure 6: Menu Structure on page 29 which illustrates how to move within the available parameter items. The Scroll key allows movement horizontally along menu items and the Enter key allows movement vertically within a menu item.

Figure 6: Menu Structure



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. The top line of the readout should scroll as shown in Table 3: Display Scrolling on page 28.

2. 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.

Please refer to Figure 6: Menu Structure, page 29, 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.

The programmable parameters have been described in a previous section, Programmable Parameters, beginning on page 22.

In the “programming mode”, the following parameters are displayed with each press of the scroll key. The parameters are identical to those visible in “review mode" (see Table 4 : Reviewing System Parameters, page 29) with the addition of the parameter "Zero Calibration".

Table 5: Programmable System Parameters

UNITS WITH P&T OPTION	UNITS WITHOUT P&T OPTION
a) Units	a) Alarms
b) Alarms	b) Input/Output
c) Input/Output	c) Operating Parameters
d) Time and Date	d) Time and Date
e) Operating Parameters	e) Zero Calibration
f) Zero Calibration	(repeat)
(repeat)	

Parameters that can be changed fall into two categories:

1. Toggle parameters

Toggle parameters can only take preprogrammed values. For instance:

Alarm Nature (High/Low),
Speaker (Enabled/Disabled)

2. Numerical parameters

The value of each digit in a numerical parameters can be changed. For instance:

Alarm 1 Threshold (xxx.x digits)
Time (xx:xx:xx)

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.

ZEROING THE ANALYZER

The Zero Calibration is a procedure intended to establish (or verify) the analyzer's zero.

The Model H1 provides two zero calibration facilities: Manual and Programmed or Automatic. The latter is only available if the Auto-Zero option is installed.

Please refer to APPENDIX 2: AUTOZERO OPTION OPERATION on page 45 for a complete discussion of the AutoZero option.

The Model H1 analyzer has minimal zero drift, and if it is used continuously (i.e., power is never interrupted), a "zero calibration" will seldom be required. However, it is recommended that the unit be zeroed after it warms up from a "cold" start, or after it has been moved or shipped.

Should the unit's zero continuously drift upward, this is probably an indication of dirtying 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. See the section on WARNING/ERROR MESSAGES beginning on page 36 for a detailed description of this message.

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:

a. The unit has warmed up completely
b. 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 and Nitrogen. The Ozone free gas should flow at 0.5 l/min or higher for at least 3 minutes.

The Manual Zero Calibration is accessed as the last level in the programming mode, (see Figure 6: Menu Structure, page 29, and Table 5: Programmable System Parameters, page 30). The procedure for entering into the programming mode was explained before in the section on Programming Programmable Parameters beginning on page 30.

Once in program mode, use the Scroll key until the digital readout displays the message "Zero Calibration". To initiate the analyzer's Zero Calibration routine, press the " E " (Enter) key three (3) times. Then follow the instructions on the readout. 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.

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. Pressing “D” will 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 AFX® 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 a 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 3.0 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.

When to Perform a Zero Calibration

As explained before, 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.

SIMULATION OF THE ANALOG OUTPUTS

Units with software version 5.2 (or later) provide simulation facilities to test the analog outputs. In simulation mode, the analyzer simulates ozone concentrations of 50, 100, 150 or 200 g/m^3 and the analog outputs are enabled and should provide the corresponding votage or current outputs.

Simulation mode is only available when the unit is in programming mode. Simulation is part of the "Input/Output" menu as shown in Figure 6: Menu Structure, page 29. Simlation values are "toggled" using either the "Up Arrow" key or the "Left Arrow" key as described in Programming Programmable Parameters (page 30). With each press of either key, the simulation value changes from 50 to 100 to 150 to 200 and back to 50. 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.

INSTRUMENT "SPAN"

The AFX® 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.

Please refer to the section on Operating Parameters on page 26 for a description of the "Customer Multiplier", which can be used to change the gain of the instrument. However, please bear in mind the warnings given in the caution statement.

SERIAL DIGITAL PORT

The AFX® Model H-1 features an RS-232 Compatible Digital Serial Interface. 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.

1. DATA FORMAT

The Data Format is as follows:

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

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.

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)

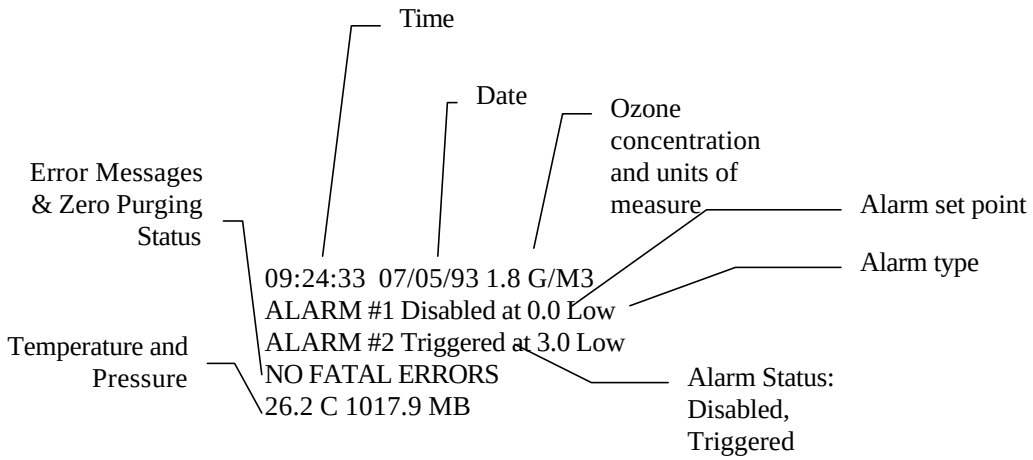
3. DATA OUTPUT STREAM

Data can be output from the AFX® 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 AFX® Model H1 is marking, waiting for a "?" or "!" character (ASCII) to trigger the transmission of a message.

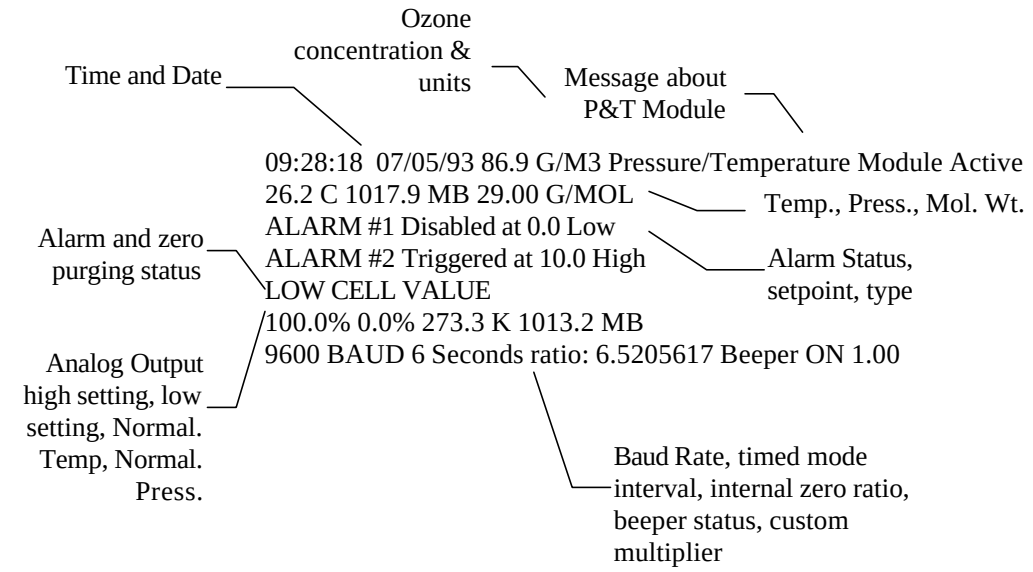
When in TIMED MODE, the RS-232 output is formatted as in the following example:



When in POLLED MODE, the AFX® Model H1 will not transmit any data unit 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:



A/D Raw Data Dump

When the unit receives an "A" command (see Menu of Commands above), the instrument transmits data as shown in the example below:

This information may be used for troubleshooting as explained later.

```
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
```

RBLACK corresponds to the “dark current” measurement (sensor exposed to no UV light).

BASE REF corresponds to the reference light (no ozone)

CELL corresponds to the light through the measuring cell.

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

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.

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.

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.

WARNING/ERROR MESSAGES

The AFX® 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:

WARMING UP:

Warning condition. This message will stay on for a variable period of time (see the section "Warm Up" on page 22) This message is NOT a fatal error: it does not trigger the instrument error relay.

Cause: instrument has been turned on recently, warm up period has not been completed.

Course of Action: allow instrument to warm up.

WHEEL MOTOR BROKEN:

Fatal error.

Cause: 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.

Course of Action: inspect or replace motor/gear assembly, or match supply voltage with power receptacle setting.

UV LIGHT ERROR

Fatal error.

Cause: UV light is too weak or not lit. BASEREF values bellow 1100.

Course of Action: 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 condition.

Cause: dirtying of the 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. See page 31, "ZEROING THE ANALYZER", for a complete discussion about zero calibration.

Course of Action: 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 error.

Cause: UV light too bright.

Course of Action: 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 error.

Cause: UV lamp too weak or optical components are too dirty. CELL values are below 50.

Course of action: Replace UV lamp or clean the optical components.

INVALID DATA

Fatal error.

Cause: UV lamp too weak or external light effects too high

Course of action: Replace UV lamp, replace covers and close doors of unit.

UNSTABLE UV LAMP

Fatal error.

Cause: 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.

Course of action: Turn power off for 5 seconds and power back on. If the problem resurfaces after a short period of time, replace the UV lamp.

TROUBLESHOOTING

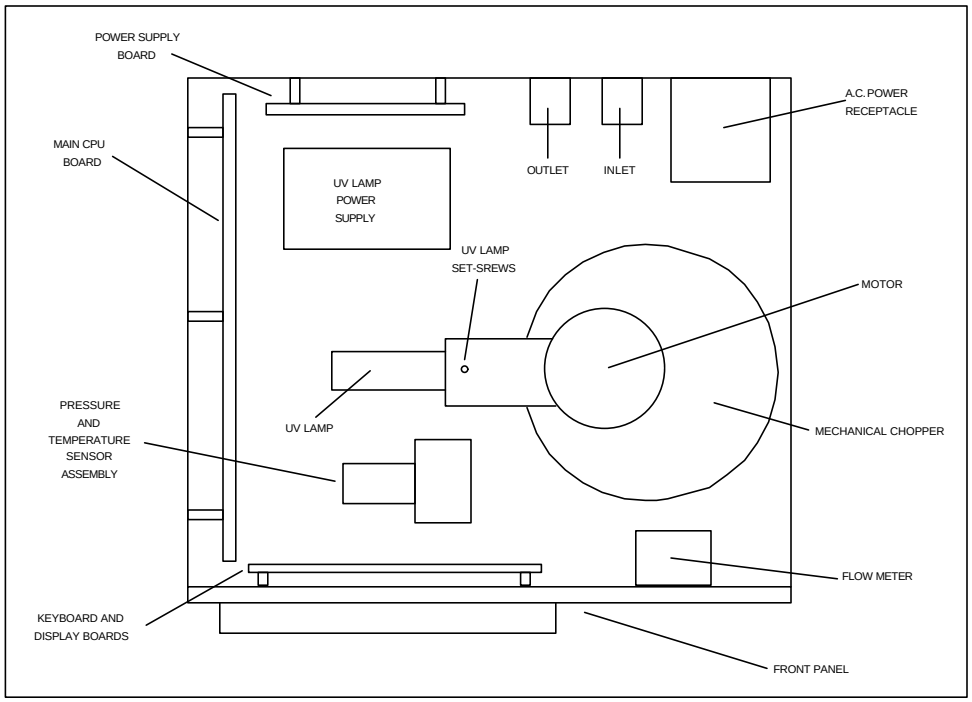
The previous section described the most likely corrective actions for several fault conditions. The raw A/D converter data output (via the RS232 communications interface) is available for further troubleshooting when errors are related to the optical components (UV light, absorption cell), or when the instrument drifts or becomes unstable. Please refer to "SERIAL DIGITAL PORT" on page 33 for details on how to access and interpreted this data.

MAINTENANCE

The AFX® Model H1 UV Ozone Analyzer requires little maintenance due to its solid state design. The main components which may require periodic maintenance and or replacement are the UV Lamp and the Motor/Gear Assembly.

Please refer to Figure 7 on page 39 for identification of major components of the analyzer. (NOTE: front panel shown for reference only. In NEMA 4x units, the location of the front panel is different)

Figure 7: Main Internal Components



Periodic Maintenance

It is recommended that the UV Lamp be changed under the following conditions:

- After 12 month of continuous operation
- If after the warm-up period following a ZERO CALIBRATION the Analyzer displays the message: “Negative result".
- If the analyzer displays the message: “UV Lamp Error"

It is recommended that the Motor/Gear Assembly should be changed under the following conditions:

- After 12 months of continuous operation.
- If the analyzer displays the message: “Motor Wheel Broken"

Replacing the UV Lamp

CAUTION: ALWAYS DISCONNECT POWER TO THE ANALYZER BEFORE WORKING ON THE UV LAMP.

UV LIGHT IS DAMAGING TO THE EYES. NEVER LOOK AT A POWERED UV LAMP DIRECTLY WITHOUT APPROPRIATE EYE PROTECTION.

WHILE WORKING WITH THE SENSOR ASSEMBLY TAKE EXTRA CARE IN NOT WARPING OR BENDING THE APERTURE DISK.

USE POWDER FREE LATEX GLOVES TO HANDLE THE UV LAMP.

(Please refer to Figure 7 on page 39)

1. Remove the cover from the unit.
2. Disconnect the UV Lamp from its Power Supply Printed Circuit Board.
3. Loosen the set screw that holds the lamp in its holder.
4. Gently pull the lamp out off its holder.
5. Insert the new lamp in the holder. The lamp holder has a built-in step. Make sure that the base of the lamp sits against that stEP.
6. Tighten the set screw to secure the lamp in the holder.
7. Connect the lamp to the Power Supply Printed Circuit Board. Note that the connectors are polarized and there is only one way to interconnect the two pieces.
8. Install the cover
9. Apply power and allow the unit to warm up. NOTE: a new UV lamp may require a longer warm up period before stabilizing.
10. Perform a ZERO CALIBRATION Procedure after warm up (see ZEROING THE ANALYZER on page 31.)

Use only UV Lamps purchased from or approved by IN USA. The AFX® Model H1 Analyzer will not operate properly and could be severely damaged if the improper lamp is used.

Replacing the Motor/Gear Assembly

CAUTION: ALWAYS DISCONNECT POWER TO THE ANALYZER BEFORE WORKING ON THE MOTOR/GEAR ASSEMBLY

WHILE WORKING WITH THE ASSEMBLY TAKE EXTRA CARE IN NOT WARPING OR BENDING THE APERTURE DISK.

(Refer to Figure 7 on page 39.)

1. Remove the cover from the unit.
2. Disconnect the in-line connector that powers the motor.
3. Remove the 2 (two) screws that secure the Motor/Gear Box Assembly to UV-optical assembly.
4. Remove the Motor/Gear assembly. Note that the shaft coupling is part of the motor shaft.
5. Place the new Motor/Gear Assembly in place. Make sure that the shaft coupling guide lines up and fits into the coupling slot.
6. Insert the 2 screws that secure the assembly.
7. Connect the in-line connector that powers the motor.
8. Install the cover

Use only parts purchased from or approved by IN USA. The AFX® Model H1 Analyzer performance could be severely damaged if the improper parts are used.

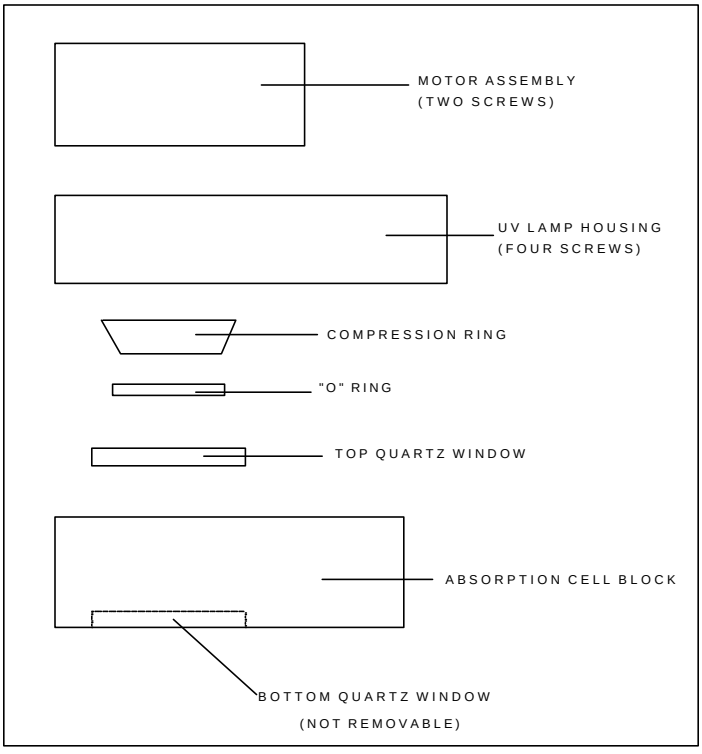
Cleaning the Cell Optics

CAUTION: Handle optical components with care. Use powder less latex gloves and clean only with lint-free materials.

WARNING: 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.

The inside of the Optical Chamber can be cleaned by following the procedure below. Refer to Figure 8: Optical Chamber Assembly below for a description of the components.

Figure 8: Optical Chamber Assembly



1. Loosen the two screws holding the chopper motor assembly and remove the assembly. Make sure not to lose the spacers. Be careful not to loose any of the couplings on the motor's shaft.
2. Unplug the UV lamp from the UV lamp power supply board.
3. Loosen the four screws holding the UV lamp housing and remove the housing.
4. Remove the "O" ring, compression ring and top quartz window. Be careful not to chip or scratch the quartz. Clean this quartz window, using Isopropyl alcohol, and dry it using lint-free, clean soft cloth.
5. Clean the bottom quartz window the same way. Note that this window is not removable.
6. Assemble in the reverse order. It is recommended that the “O” ring be replaced with a new one purchased from *IN USA, INC.* TIGHTEN THE LAMP HOUSING SCREWS EVENLY. DO NOT OVER TIGHTEN THE LAMP HOUSING SCREWS OR YOU RISK DAMAGING THE QUARTZ WINDOW.
7. Leak test.
8. Re-calibrate

APPENDIX 1: WORKING EQUATIONS AND UNIT CONVERSIONS

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

Conversion of g/m^3 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

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.

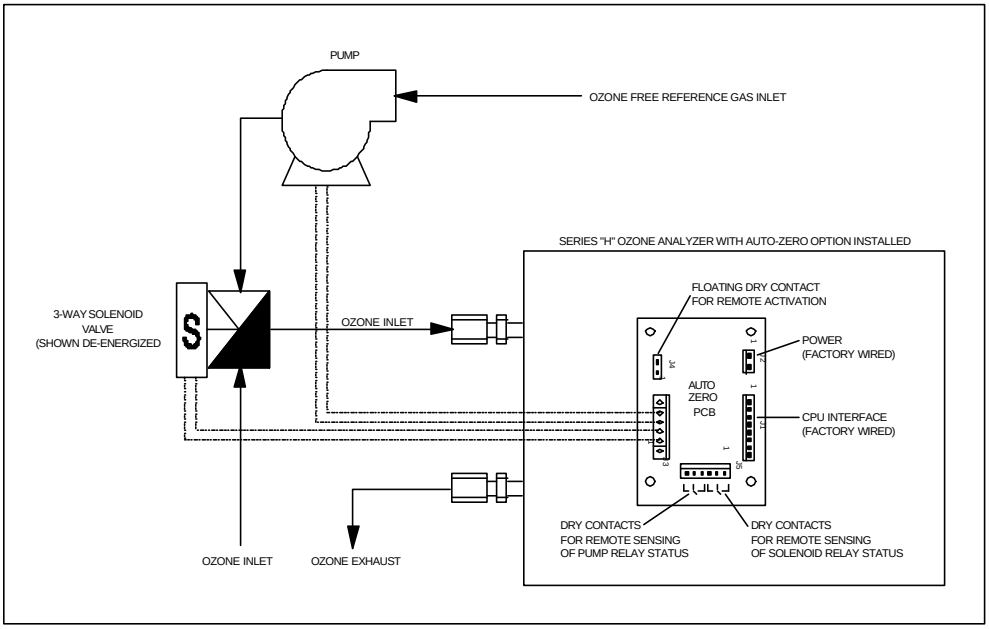
APPENDIX 2: AUTOZERO OPTION OPERATION

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 Figure 9 below for a description of the typical Auto Zero PCB interfaces.

To provide for convenient field wiring, a 16 position terminal block is typically provided for the Auto Zero PCB interconnections. See Figure 10 on page 46 for a schematic showing the pin-out of this terminal block. If the terminal block is not available, field wiring should be made directly to the Auto Zero PCB.

Figure 9: Typical Auto Zero Board Interfaces



The Auto Zero PCB interfaces with:

- The Central Processing Unit (CPU) PCB, through an 8 (eight) position single-in-line, 0.100" centers connector, identified as J1. A jumper cable connects J1 at the AutoZero Board to J8 at the CPU Board. Both connectors are polarized and feature locking ramp mechanisms.

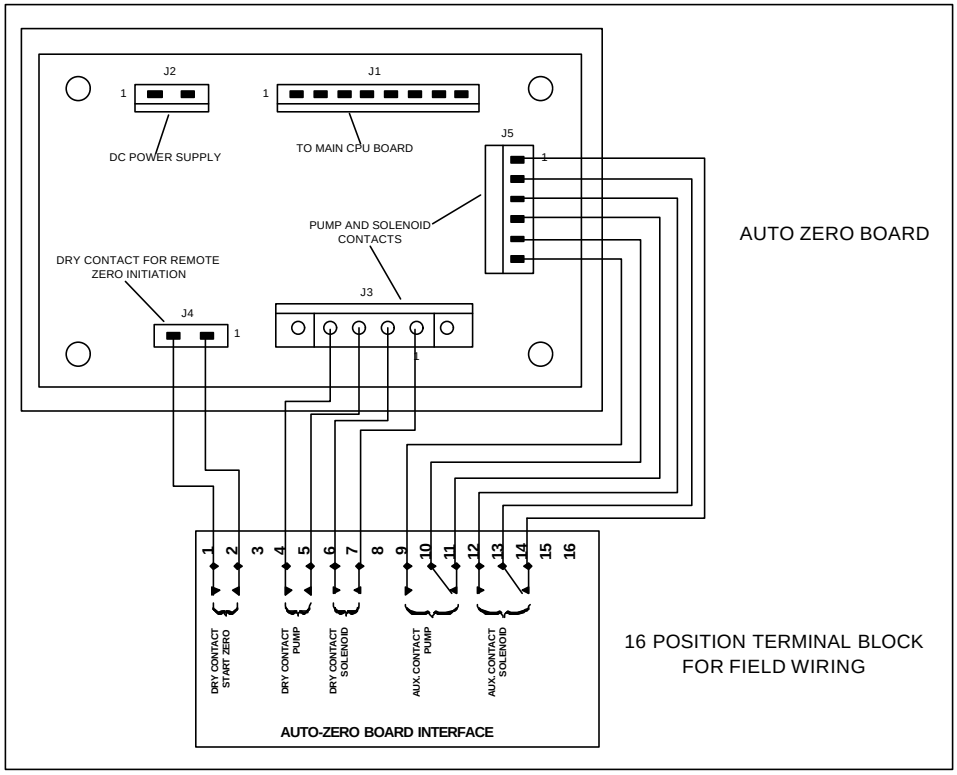
- The Power Supply through a 2 (two) position, single-in-line, 0.156" centers connector, labeled J2. J2 is a polarized connector, featuring a locking ramp mechanism.

  ⇒ J2-1, (J2 position 1), is connected to +5.0 VDC;
  ⇒ J2-2 is connected to ground (GND).

The Open Frame Universal Switcher mounted on the Models' H1 chassis has the ability to power the AutoZero PCB.

- Field Equipment through a 2 Position Terminal Block, labeled J4. J4 provides for a floating dry contact to start the AutoZero sequence from an external source. J4 is a polarized connector, featuring locking ramp mechanism.

Figure 10: Auto Zero PCB



- Pump and Solenoid Valve, through a 4 (four) position Barrier Strip Connector, labeled J3.

  ⇒ J3-1 and J3-2 are used to command the Solenoid Valve. J3-1 and J3-2 are Normal Open (NO). They close for the purpose of energizing the valve. (refer to Section 3.2 for detailed explanation of operation). These contacts are rated for 2 AMPS at 240 VAC.

  ⇒ J3-3 and J3-4 are used to command the Pump. J3-3 and J3-4 are Normal Open (NO). They close for the purpose of energizing the pump. (refer to Section 3.2 for detailed explanation of operation).These contacts are rated for 2 AMPS at 240 VAC.

- Auxiliary Field Apparatus through a 6 (six) position, single-in-line, 0.100" centers connector, labeled J5. J5 is a polarized connector, featuring locking ramp mechanism.

  ⇒ J5 provides 2 (two) sets of single inverters, associated with the Pump and Solenoid Valve relays. These contacts are rated for 2 AMPS at 240 VAC.

⇒ J5-1 is the Normal Close (NC) pole of the switch associated with K1, the Solenoid Relay.

⇒ J5-2 is the Common Pole of the switch associated with K1, the Solenoid Relay.

⇒ J5-3 is the Normal Open (NO) pole of the switch associated with K1, the Solenoid Relay.

⇒ J5-4 is the Normal Close (NC) pole of the switch associated with K2, the Pump Relay.

⇒ J5-5 is the Common pole of the switch associated with K2, the Pump Relay.

⇒ J5-6 is the Normal Open (NO) pole of the switch associated with K2, the Pump Relay.

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

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 as explained in the section on Operating Parameters on page 26. This sequence is referred to as Timer Initiated. (See "Programmed (Automatic) Zero Calibration", page 32.)

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.

Hardware Initiated AutoZero Sequence

This sequence, intended for interfacing the Model H1 UV Analyzer with external equipment, is started upon detection of a contact closure across J4. The Model H1 continuously monitors J4,

"looking" for a contact closure, called "hardware autozero request". Upon detection of this event, (there is a debouncing period of a few seconds), the following sequence takes place:

1. The Alarms are disabled
2. The Relay associated with the pump is energized, activating the pump to force the flow of Zero Gas.
3. A delay of 1.0 Sec
4. The Relay associated with the 3-Way Solenoid Valve is energized, to stop the flow of ozonated gas and to allow the flow of Zero Gas through the measuring cuvette.
5. There is a wait period of 3.0 minutes, to let the pneumatic components flush.
6. The Autozero mathematical routines are executed.
7. The relay associated with the 3-Way Solenoid Valve is de-energized, to allow for the flow of ozonated gas.
8. A delay of 1.0 Sec
9. The relay associated with the pump is de-energized, shutting the pump off.
10. There is a delay of 6 seconds
11. The alarms are enabled.

If the hardware autozero request remains active (contact is closed) at the end of step 6, the Model H1 will enter and remain in a Wait Loop until such time as the hardware autozero request returns to its normal value. When the hardware autozero request returns to normal, a second autozero mathematical routine is executed before proceeding to step 7.

Keyboard and Timer Initiated Autozeros

Keyboard and Timer initiated Autozeros involve entering the program mode of the analyzer. Refer to "Programming Programmable Parameters" on page 30 and "ZEROING THE ANALYZER" on page 31.

Autozero Option, Messages

The AFX® 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 6: 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 7: Timer and Keyboard Initiated Auto Zero Messages

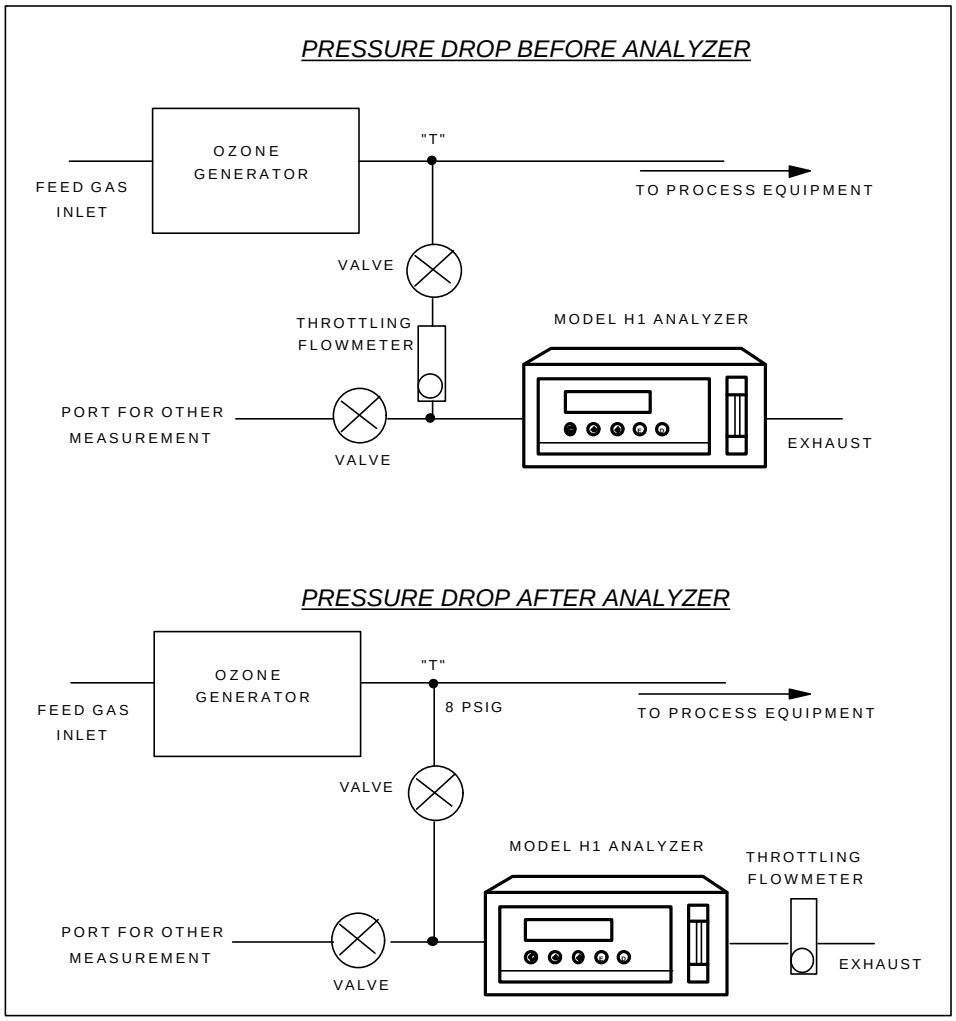
STEP(S)	**MESSAGE**
1 thru 5	"PURGING 1"
6	"ZEROING 1"
7 thru 11	"PURGING 2"

APPENDIX 3: GENERATOR OUTPUT MONITORING

When the AFX® 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).

Please refer to Figure 11 below for a description of the options.

Figure 11: Configurations for Ozone Generator Monitoring



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www.inusacorp.com

H1 Series

High Concentration Process Ozone Analyzers

Ideal for Measuring Ozone Generator Output

Applications:

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

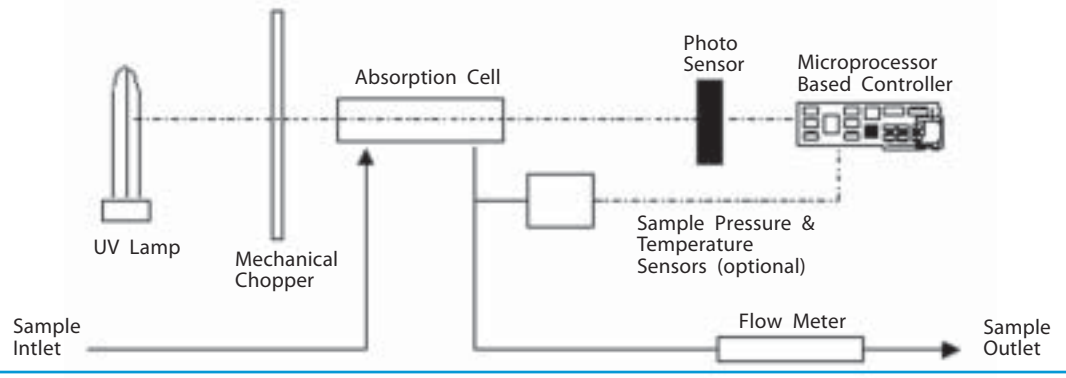
Features:

- Microprocessor controlled
- High accuracy UV Absorption method
- Ranges up to 400 g/m3
- Automatic sample pressure and sample temperature compensation
- Molecular weight compensation
- Continuous sample flow
- No solenoid valves, no external reference
- Analog and Digital I/O built-in
- User programmable alarm relays
- AutoZero built-in
- Continuous internal diagnostics
- No regular maintenance required

Specifications

H1 Series

Principle of Operation



Specifications

Measuring Principle	Absolute determination by UV absorption through innovative optical system
Cycle Time	Continuous measurement, uninterrupted sample flow - no solenoid valves
Upper Measurement Ranges	H1-LR: 50 G/M^3 (4%) - H1-S: 125 G/M^3 (10%) - H1-X: 200 G/M^3 (15%) - H1-UH: 400 G/M^3 (28%)
Precision/Repeatability	0.1 G/M^3 or 1% of reading (whichever is greater)
Resolution	0.1 G/M^3 (0.01% W/W) in the range from 0.1-125 G/M^3
Linearity	Better than 99% throughout range
Zero Drift	Less than 0.1 G/M^3 per month, non cumulative
Calibrated Standard	Per the International Ozone Association (IOA) K1 method to 1% repeatability
Ozone Concentration Units	G/M^3, G/NM^3, % weight, % volume (field selectable)
Sample Pressure and Temperature Sensors	Optional, automatic compensation for sample pressure, temperature and molecular weight. Normalizing parameters are field selectable
Standard Alarms	2 field programmable alarms with form C relay contacts (5 A 250 VAC res.)
Diagnostic Features	Continuous internal diagnostics with error messaging & instrument error relay
Sample Flow Rate	0.5 l/min. (built-in flow meter) at 30 PSIG max. Higher pressures on request
Readout	2 line by 20 character alphanumeric vacuum fluorescent display
Analog Outputs	Scalable 4-20 mA and 0-10 VDC standard. Others available on request
Digital Outputs	RS232 bi-directional interface standard
Available Configurations	NEMA 4x/IP65 non-metallic enclosure (wall mount); 19" rack; bench-top
Sample Inlet/Outlet Ports	1/8" or 1/4" compression fittings. Metric, VCR or other fittings on request
Supply Voltage	100-240 VAC 50/60 Hz
Dimensions (W x H x D)	Bench:12.5" x 5.4" x 14.2" (318 x 137 x 361 mm) Rack : 19"x 5.3" x 14.2" (483 x 133 x 361 mm) Wall mount: 16.8"x 19.5"x 9.6" (425 x 495 x 244 mm)
Compliance	CE

Specifications subject to change without notice

Ozone instrumentation for every application						
	Generator Output	Safety/Leak Detection	Tool Leak Detection	Stack & Environment	Dissolved Ozone	Spot Checking
Model dFFOZ-TR					●	
Model dFFOZ					●	
Model W1 Series					●	
Model gFFOZ	●					
Model Mini-HiCon	●					
Model H1 Series	●					
Model L2RM			●			
Model IN-2000		●	●	●		
Model AET-030						●

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Rev. 1561-P

DESCRIPTION:	ADDENDUM #:	PAGE: OF:
Model H1 MODIFICATION. Unit is housed in a NEMA 4X Enclosure of different mechanical dimensions than those covered in the Product Manual	1046	1 8

Model H1 covered under this addendum S/N_____

The Model H1 covered in this addendum has been modified:

- The unit is housed in a NEMA 4X Type enclosure.
- The mechanical dimensions of the enclosure are illustrated in Figure 1.
- Figure 2 illustrates the Front Panel, including the location of the 5-key keyboard and the flow-meter
- Figure 3 illustrates the location of some of the key components and subassemblies of the Model H1 panel.
- The Field Wiring Connector and the Main Power connector have been combined into a single PCB, as illustrated in Figure 3
- Table 1 identifies the Field Wiring Connector. Note that only a single contact pair (as opposed to a Single Pole Single Through, Form C) switch is available from the Instrument Error Relay.
- The Fuse is rated to 0.75 A, Slo-Blo, 3AG.

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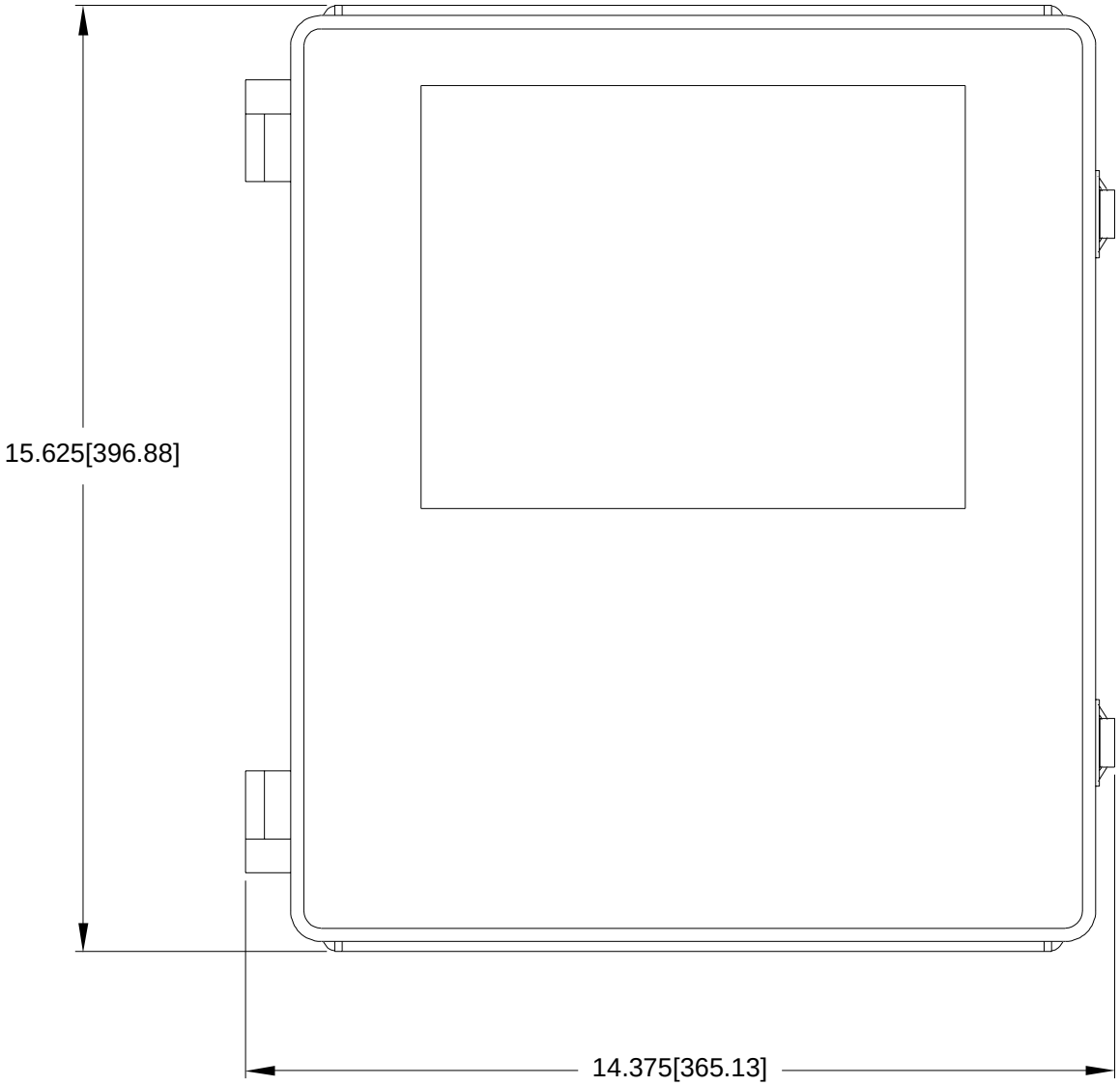
Model H1 MODIFICATION. Unit is housed in a NEMA 4X Enclosure of different mechanical dimensions than those covered in the Product Manual	1046	2 8

Figure 1 Wall Mounted, NEMA 4X, Mechanical Dimensions
Front View



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Model H1 MODIFICATION. Unit is housed in a NEMA 4X Enclosure of different mechanical dimensions than those covered in the Product Manual	1046	3 8

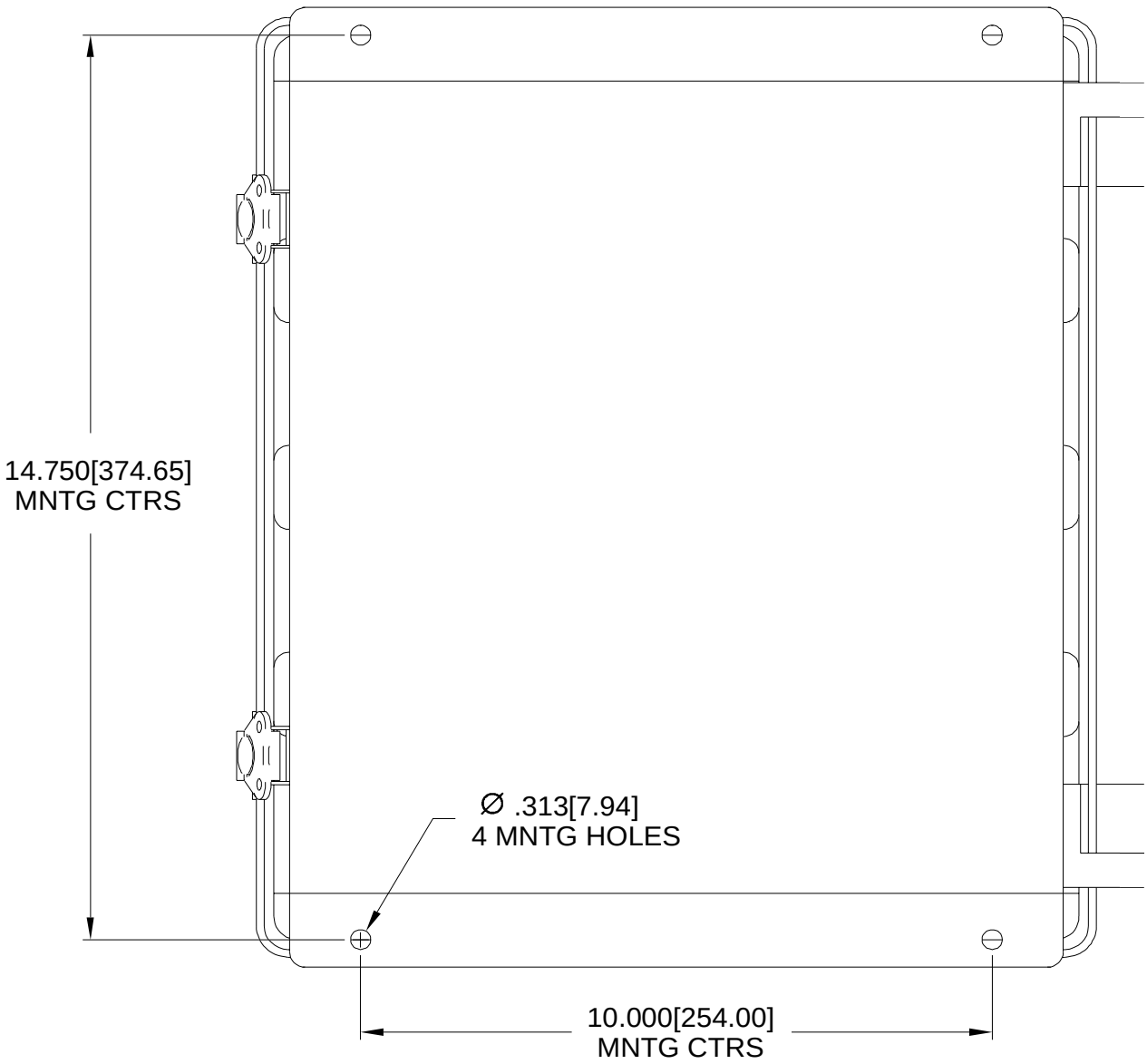

Figure 1 Wall Mounted, NEMA 4X, Mechanical Dimensions (Continued) Rear View

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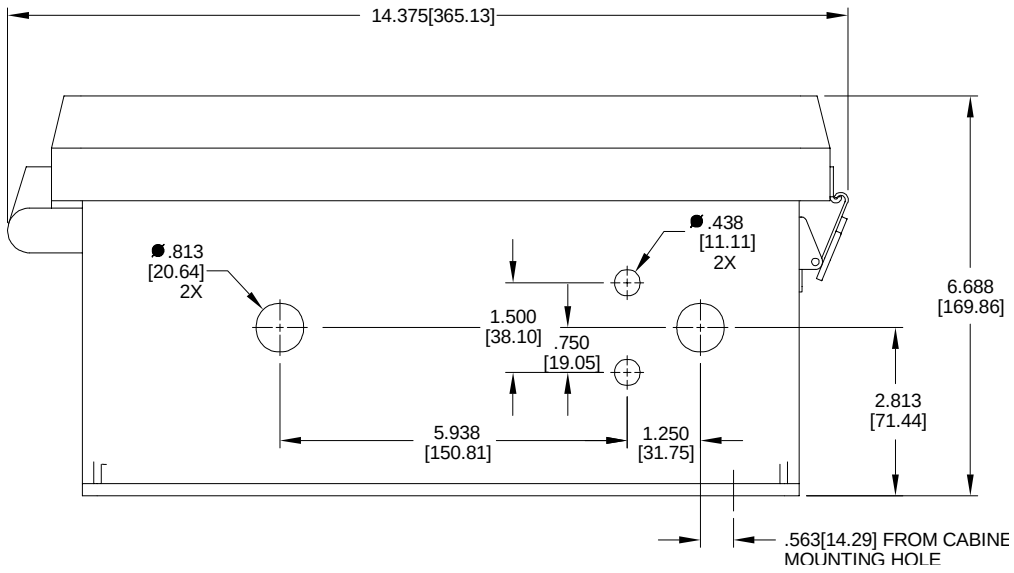
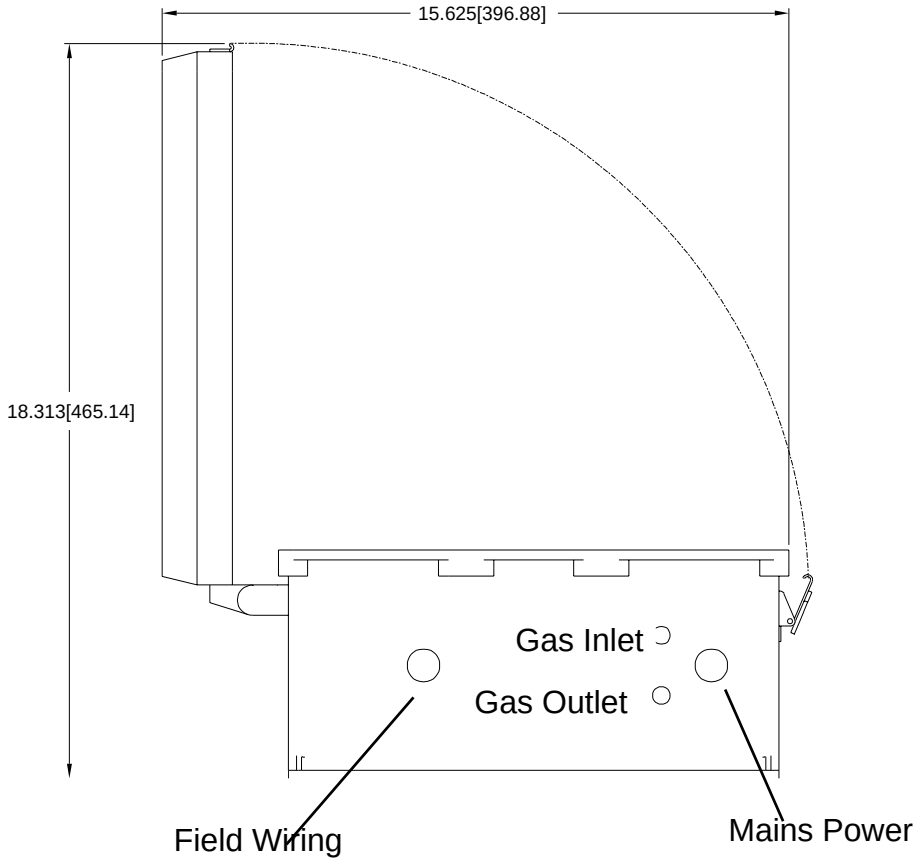
Model H1 MODIFICATION. Unit is housed in a NEMA 4X Enclosure of different mechanical dimensions than those covered in the Product Manual	1046	4 8

Figure 1 Wall Mounted, NEMA 4X, Mechanical Dimensions (Continued) Side Views



DESCRIPTION:	ADDENDUM #:	PAGE: OF:
Model H1 MODIFICATION. Unit is housed in a NEMA 4X Enclosure of different mechanical dimensions than those covered in the Product Manual	1046	5 8

Figure 1 Wall Mounted, NEMA 4X, Mechanical Dimensions (Continued) Side Views



DESCRIPTION:	ADDENDUM #:	PAGE: OF:
Model H1 MODIFICATION. Unit is housed in a NEMA 4X Enclosure of different mechanical dimensions than those covered in the Product Manual	1046	6 8

Figure 2 Wall Mounted, NEMA 4X,
Front Panel, Keyboard And Flow Meter Location

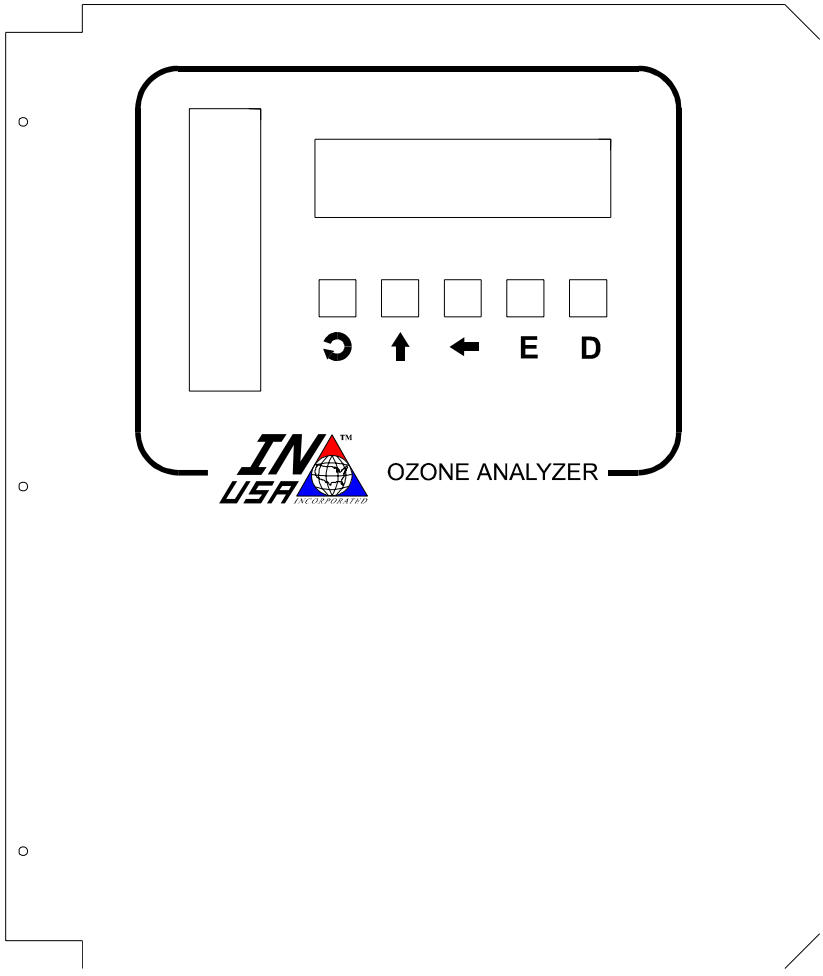


Table 1.b: 19-Position Terminal Block Pin-out

NEMA 4, Wall Mounted Units

PIN #	DESCRIPTION OF OUTPUT	NOTES
1	Common Ground, Analog Output, 0-+1 VDC or +10 VDC	1
2	0-+1 VDC or +10 VDC, Analog Output Voltage,Concentration	1
3	4-20 mADC Return, Ozone Concentration	2
4	4-20 mADC, Ozone Concentration	2
5	Instrument Error Relay Contact ,Close on Error Condition	3
6	Instrument Error Relay Contact, Close on Error Condition	3
7	Alarm #2 Relay Contact, Open on Alarm Condition	4
8	Alarm #2 Relay Contact, COMMON	4
9	Alarm #2 Relay Contact, Closed on Alarm Condition	4
10	Alarm #1 Relay Contact, Open on Alarm Condition	4
11	Alarm #1 Relay Contact, COMMON	4
12	Alarm #1 Relay Contact, Closed on Alarm Condition	4
13-19	No Connection	5

Notes:

1. 0-1 VDC or 0-10 VDC factory selected. This is a Low impedance, short-circuit protected analog output, intended primarily for data acquisition (recording) and monitoring.

2. 4-20 mADC is a non-isolated current loop. Compliance is 750 Ohm, and the loop is open-circuit protected.

3. Instrument Error (IE) relay is normally energized. If there is a "malfunction" of the power supply, or any key component in the optical sensing scheme, the relay will de-energize and become active. It is a Form-C, Single Pole, Double Throw (SPDT), Break before Make relay, with contact ratings of 5 Amp at 250 VAC, resistive load.. In the NEMA version of the unit, two contacts of the relay are available to the user. There is an open circuit between pin #5 and #6 only if there is power applied to the unit, and no problems are detected by the embedded diagnostic software.

4. The alarm relays are Form-C, Single Pole, Double Throw (SPDT), Break before Make relay, with contact ratings of 5 Amp at 250 VAC, resistive load. They are normally de-energized; that is, only under alarm conditions will they energize.

5. Positions 13 through 19 are not used in the Model L2-LC

DESCRIPTION:	ADDENDUM #:	PAGE: OF:
Model H1 MODIFICATION. Unit is housed in a NEMA 4X Enclosure of different mechanical dimensions than those covered in the Product Manual	1046	8 8

Figure 3 Wall Mounted, NEMA 4X,
Location of Main Components and Sub-assemblies