LaserHawk 360P
Particulate Matter Monitor
Operations Manual

(This page intentionally left blank.)

SERIAL NUMBER: _____

DOCUMENT NO.: 1810-0055-01 REV B

June 2015

Made in the United States of America

Manufacturing Location:
35 Inverness Drive East
Englewood, Co 80122

TABLE OF CONTENTS

Page

TABLE OF CONTENTS
(Continued)

Page

TABLE OF CONTENTS
(Continued)

Page

(This page intentionally left blank.)

1.0 SYSTEM OVERVIEW

This manual describes the installation, operation, calibration and routine maintenance of the Teledyne Monitor Labs *LaserHawk* 360P Particulate Matter Monitor.

The *LaserHawk* 360P is a laser-based particulate monitor that is designed to continuously monitor the dust loading of combustion exhaust gas streams. The electrical output from the *LaserHawk* 360P is proportional to the light scattered back from particles in the gas stream. The 360P comes with 2 analog outputs, software selectable to output backscatter energy or particulate mass. The signal may also be conditioned by a Teledyne Monitor Labs (TML) Ethernet Module or user supplied device in order to create outputs which are linear with particulate dust loading levels.

1.1 GENERAL SAFETY

This equipment is intended only for the purposes specified in this manual. Safety protections inherent in this equipment may be impaired if the *LaserHawk* 360P is used in a manner different than specified herein.

This optical head is capable of use in indoor applications and outdoor environments appropriate to IP66, with or without a Weather Cover and installed by a qualified electrician employing liquid tight conduit fittings according to applicable electrical codes. See Section 2 of this manual.

The rated pollution degree of this equipment is pollution degree 2 as defined by international safety standards.

1.1.1 Sound Pressure Level

The Protective Purge Air System included with this equipment employs a blower that produces sound pressure levels of approximately 54 dbA at a distance of 1 meter,. It is the only element of this equipment which produces a significant acoustic emission. The sound pressure level produced by this blower does NOT represent a hazard to human hearing and thus hearing protection is NOT required for safe operation of the equipment.

1.1.2 Internationally Recognized Symbols Used on the *LaserHawk*

The following are internationally recognized symbols used on the *LaserHawk* 360P along with specific cautions applicable to the equipment.

Label Standard Number:
ISO 3864 B.3.1

Generic meaning:
CAUTION: RISK OF DANGER. CONSULT MANUFACTURER'S DOCUMENTATION.

Cautions Invoked By This Label for the *LaserHawk* 360P:

1. Optical Head and Junction Box Cover Screws must NOT be tightened beyond finger-tight.
2. Optical Head and Junction Box Covers are to be removed only by trained service personnel.
3. This equipment must be installed by a qualified electrician.

Label Standard Number:
ISO 3864 B.3.6

Meaning:
CAUTION: RISK OF ELECTRIC SHOCK.
Hazardous AC supply inside. Remove power before servicing.

1.1.3 Lifting Instructions

The *LaserHawk* Optical Head and lift-off section of the Weather Cover assemblies individually do not exceed 39.7 pounds (18 Kg) thus they do not require special lifting instructions or equipment. Once installed, in the course of use, repair and maintenance of a fully assembled *LaserHawk* does not normally need to be lifted or moved since its intended use is as permanently installed equipment bolted to a flange.

However, should a need arise to transport the Optical Head and Protective Purge System assemblies as one, or the Protective Purge System individually, such as during transport to and from the monitoring location during initial installation, a dolly rated for a load of at least 200 pounds (90.7 Kg) should be used to move the assemblies.

When mounting the Protective Purge System to the stack flange, the Optical Head assembly must not be attached to the stack flange and the lift-off section of the Weather Cover must be removed to access the flange nuts. Removing the lift-off section of the Weather Cover and the Optical Head assembly will reduce the weight below 39.7 pounds (18 Kg). Thus this aspect of the installation process does not require special lifting equipment if Weather Cover and Optical Head are removed prior to mounting on the stack flange.

1.2 LASER RADIATION SAFETY

DANGER: The *LaserHawk* 360P monitor uses a 35 mW @ 655nm LASER light source that is directed into the stack or duct during normal operation. This laser has the potential to produce biological damage to the eye if the beam, or reflected beam, is viewed directly.

The *LaserHawk* 360P monitor is to be operated only when the unit has been installed on a duct or stack with the beam projected into the interior of that duct or stack, except during the calibration procedures specified in the manual. It is not intended for any other application.

The duct or stack is never to be entered when the *LaserHawk* 360P monitor is powered.

Safety interlocks, warning placards and operational procedures have been developed to prevent accidental exposure.

All persons are WARNED:

- **DO NOT look into or stare at the laser beam or its reflection**
- **Heed all WARNING placards**
- **DO NOT tamper with or disable any safety interlock device**
- **DO NOT perform any service, repair or testing beyond the scope of this manual without appropriate safety training and procedures**
- **DO NOT configure the instrument for test, demonstration, evaluation or operation so that the laser beam might present a hazard to themselves or others**

This instrument is based on the principle of backscatter. A light beam with specific spectral characteristics is projected into the effluent stream of a stack or duct exhausting combustion or process gases. The amount of light reflected back to the instrument from the particulate in the stream is measured. The amount of return signal is an indication of the particulate mass in the effluent. The backscatter energy is usually expressed as a percentage.

The *LaserHawk* 360P System consists of the following standard equipment:

- ❑ Optical Head Assembly
- ❑ Protective Purge Air System
- ❑ Calibration Kit Assembly

As shown on the *LaserHawk* 360P Installation Drawing, the first two are located on the stack. The third item, the Calibration Kit and Filter Case, should be stored indoors in a secure location.

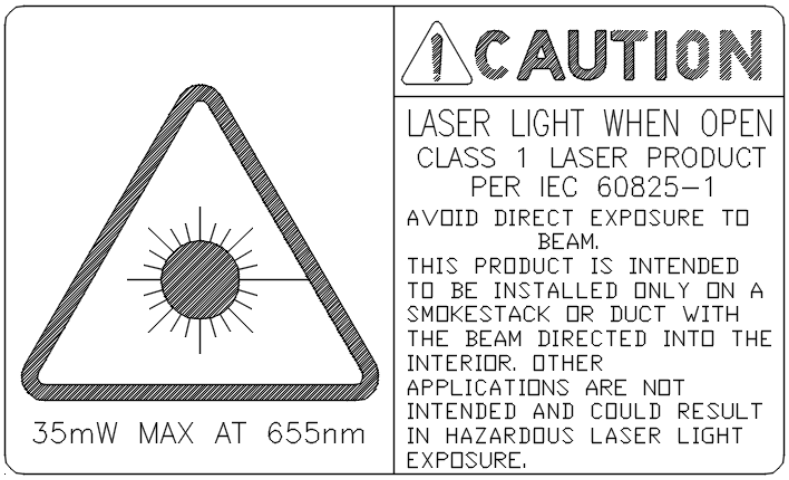
Optional items include:

- ❑ Instrument Air Purge System
- ❑ High Temperature Operation (500° F to 1500° F)
- ❑ Heat Shield
- ❑ Pressure and Temperature Input Interface (Analog Input Module)
- ❑ Light Trap Assembly
- ❑ Ethernet Module (Standalone)
- ❑ Purge Air Heater

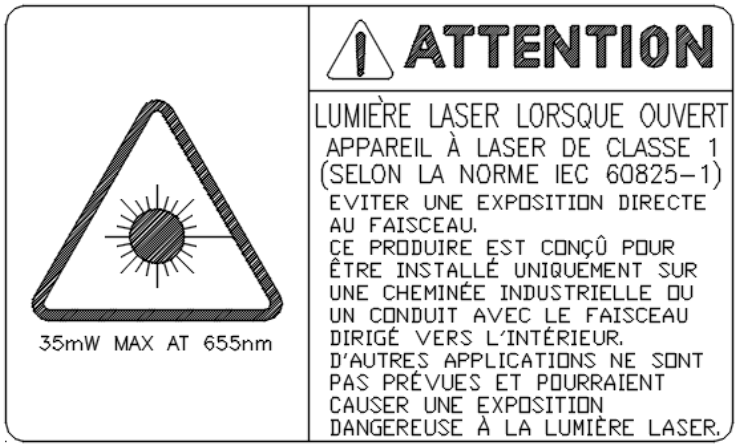
A description of each optional item can be found in Section 2.0. To verify what options this monitor is equipped with see the Site Specification Data Sheets in Appendix A.

1.2.1 Laser Radiation Caution Labels Used Throughout This System

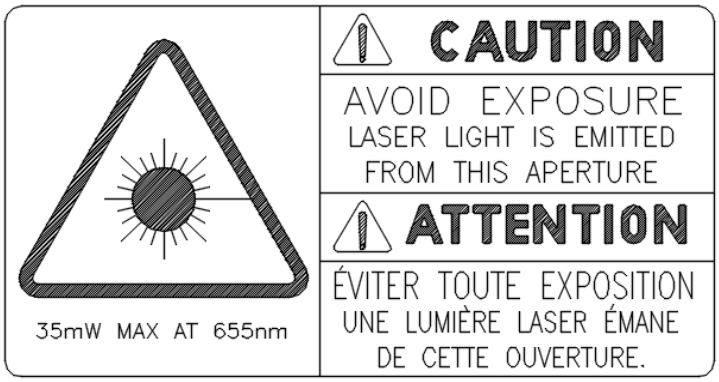
All labels in this section except the last two (CAL KIT COVER LABEL and CAL KIT BODY LABEL) address laser radiation exposure.



OPTICAL HEAD COVER WARNING LABEL (ENGLISH)

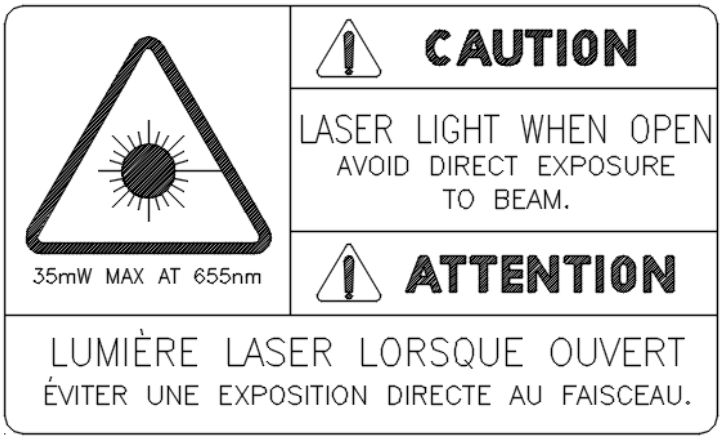


OPTICAL HEAD COVER, SIDE (FRENCH [CANADIAN])

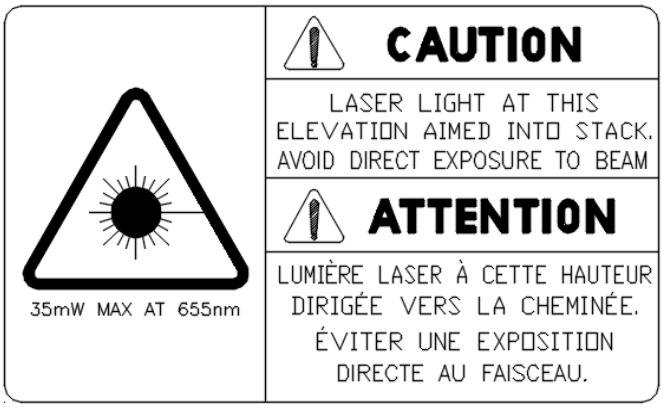


PURGE NOZZLE WARNING LABEL

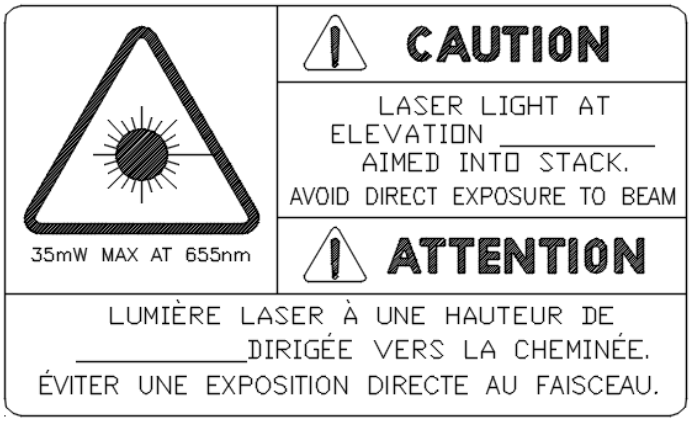
MIDDLE HOUSING WARNING LABEL



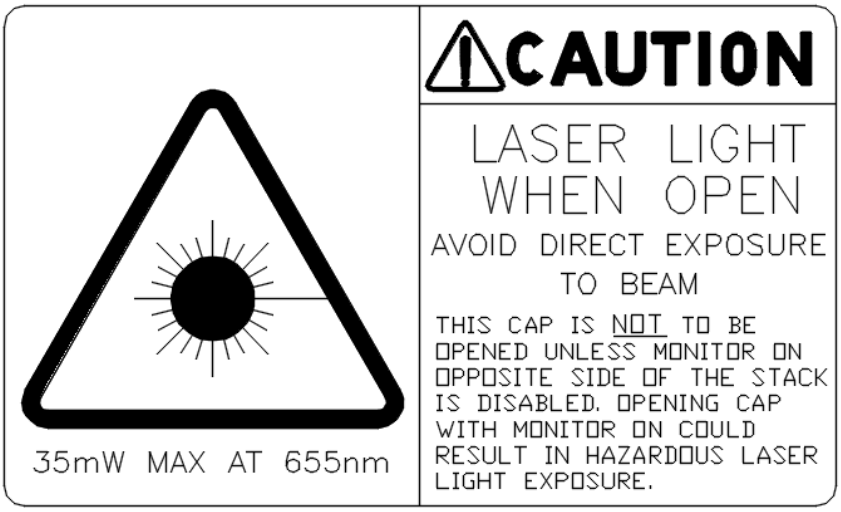
WEATHER COVER WARNING LABEL



INSTRUMENT LEVEL WARNING LABEL

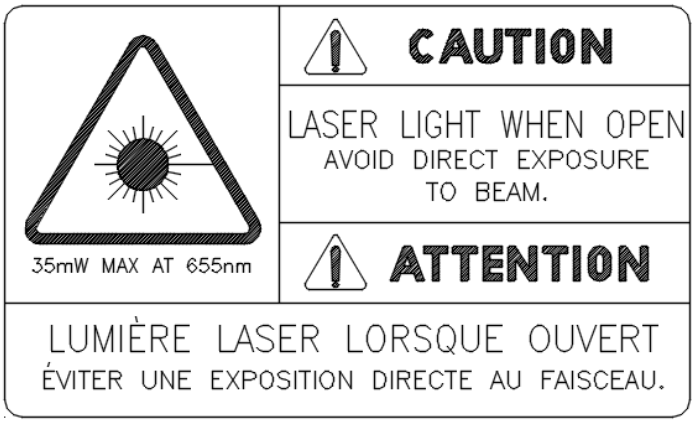


GROUND LEVEL WARNING LABEL

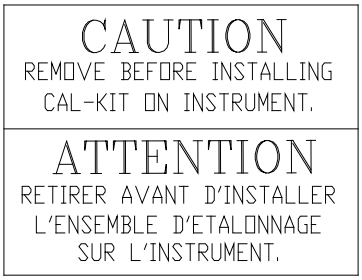


LIGHT TRAP WARNING LABEL (ENGLISH)

LIGHT TRAP WARNING LABEL (FRENCH [CANADIAN])



CAL KIT WARNING LABEL



CAL-KIT COVER LABEL

1.3 SYSTEM DESCRIPTION, STANDARD EQUIPMENT

1.3.1 Optical Head Assembly

The Optical Head Assembly contains all the active electronics necessary to project a modulated red LASER light beam into the stack or duct and receive, detect, and amplify the returned signal. It contains all of the optical components used to direct the laser and focus the received energy onto the photo-detector. These electronic and optical components are protected from the elements by sealed, cast aluminum covers that may be removed to perform maintenance and repair functions. Access to the front exit window is accomplished by opening the stainless steel latch and swinging the unit away from the purge casting. An "O" ring seals the two pieces when closed. An indicating desiccator may be seen just above the exit window and checked with the unit open. The Cal Kit may be affixed for zero and upscale system response verification.

A numeric display and keypad are available for operator interface. Data transfer is accomplished either through the standard analog, relay contact and isolator input interface to the Six Point IO Board over multiple twisted pair wires; or via the optional Standalone Ethernet Module via a commercial network communication protocol.

1.3.1.1 Laser Safety Interlock Switches

A pair of redundant micro-switches is mounted on the Optical Head Assembly at the interface with the purge housing. The switches disable the laser output whenever the housing is opened. This is done to prevent possible eye injury. When the stainless steel latch is released and the assembly starts to rotate away from the purge housing, the pressure on the switch plungers is released and both switches open. These switches are internally wired in series with the power mains to the Optical Head Assembly. Thus when either switch is open, the power mains circuit opens and no laser energy can be generated. See Section 3.0 Optical Head Assembly, Figure 3-2.

If both interlock switches and the interlock circuitry should somehow fail and allow the laser to be powered, then laser energy (35 mW max. at 655 nm) could be emitted through the output window. Care must be taken NOT to look directly into the exit window with the unprotected eye during calibration and maintenance.

Laser energy would be accessible under those failure conditions only if the Optical Head Assembly was rotated away from the purge housing. The presence

of scattered light from the visible beam should provide a clear indication of failure.

The monitor is typically installed in limited-access areas in industrial plants. It is frequently mounted high in the air on a smokestack or duct. Access is generally limited to operator or service personnel.

WARNING: ***If the inside of the stack or duct is to be inspected by personnel during process outages, the power to the LaserHawk 360P must be turned off in order to eliminate any potential eye hazard to the inspection team.***

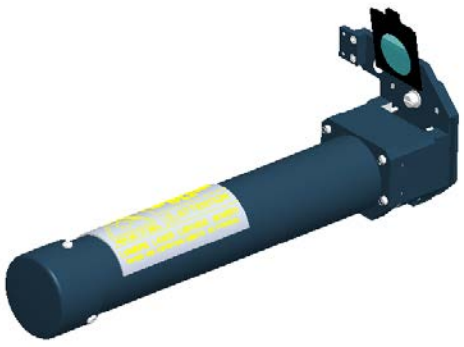
1.3.2 Protective Purge Air System

The Purge Air System provides filtered air to the Optical Head. The Purge Air System consists of the blower motor, hose, air filter, blower mounting plate, and protective cover. The Purge System provides filtered air in a manner that keeps the effluent from contaminating the instrument optical surfaces.

There is a Purge Status Assembly on the Optical Head Assembly. It consists of a pressure switch and determines if the Purge Air System is delivering sufficient airflow to protect the instrument.

1.3.3 Calibration Kit

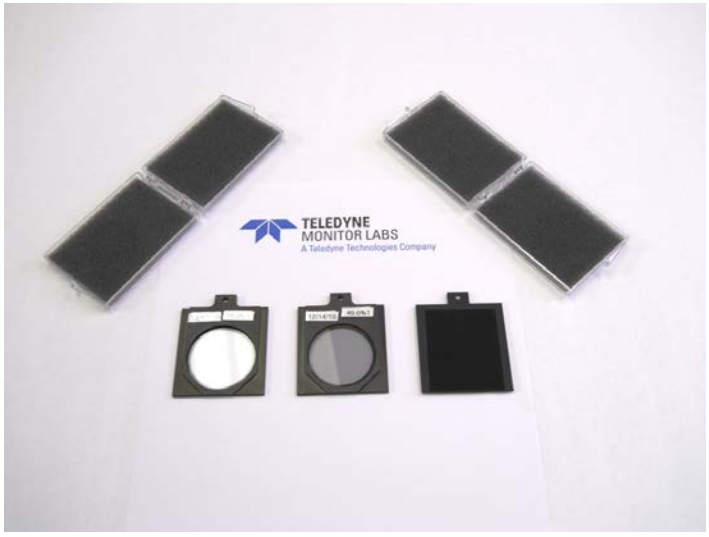
The Calibration Kit is a fixture designed to mount in front of the exit window of the Optical Head when performing maintenance or audits. It is adjusted to simulate a full scale condition. It also holds audit standards used to check intermediate upscale and zero system responses. Each Calibration Kit is unique to the monitor for which it was adjusted. It is labeled with a serial number that matches the monitor for which it was adjusted.



Cal Kit Fixture

1.3.4 Audit Standards

Two audit standards and an opaque blocking plate are provided to insert into the Calibration Kit. Each audit standard gives a different upscale response. The opaque plate is used to simulate a Zero reading. The percent backscatter values of the two audit standards are marked on their edge. The audit standards are stored in a protective container.



Audit Standards

1.4 SPECIFICATIONS (STANDARD SYSTEM)

PHYSICAL DIMENSIONS

Optical Head	*15 3/4”(400mm)(L) X 9”(229mm)(W) X 14”(356mm)(H)*
Purge Blower Assembly	*22-1/4”(565mm)(L) X 20”(508mm)(W) X 33”(838mm)(H)*

PHYSICAL WEIGHTS

Optical Head	*27 lbs. (12.3 kg)*
Purge Blower Assembly	*65 lbs. (29.5 kg)*

OPTICAL CHARACTERISTICS

Optical Measurement Technique	*Optical back-scatter of light from a red laser*
Spectral Response	*655 nanometers(nominal) +/- 20 nanometers*

SYSTEM PERFORMANCE

Resolution	*0.5 mg per actual m3*
Measurement Range	
Minimum	*0 – 20 mg per actual m3*
Maximum	*0 - 10,000 mg per actual m3*

SYSTEM MEASUREMENT CHARACTERISTICS

Response Time (To 95% of change)	*Less than 10 seconds*
Stability Over Operating Temperature Range	*±2.0% of Full Scale Maximum per 40℉ (22.2℃) change in temperature)*
Stability Over Operating Mains Voltage Range	*±1.0% of Full Scale*

POWER REQUIREMENTS

Optical Head	*85-245 VAC, 47-63Hz, Single Phase, 30 VA Maximum* *Fuses* *Power Supply Board: 1.25 Amp Time Delay, 250V, TR5* *Power Input Module: 5 Amp Fast Acting, 250V, 5x20mm*
Purge Blower System**	*115VAC/230VAC, 60/50 Hz, Single Phase, 414 VA Maximum*
Dual Analog Input Module	*85-245 VAC, 47-63Hz, Single Phase, 35 VA Maximum* *Fuses* *Power Supply Board: 1.25 Amp Time Delay, 250V, TR5* *Power Input Module: 2 Amp Fast Acting, 250V, 5x20mm*

AMBIENT OPERATING CONDITIONS

Optical Head	*Temperature Range:-4 to +140℉ (-20 to +60℃)(startup)* *-25 to +140℉ (-32 to +60℃)(operating)* *Relative Humidity Range: 0 to 100% condensing*
Dual Analog Input Module	*Temperature Range:-25 to +140℉ (-32 to +60℃* *Relative Humidity Range: 0 to 100% condensing* *Enclosure Rating: IP66*

MEASUREMENT MEDIUM CONDITIONS

Static Pressure Range**	*Standard Purge Blower:-15.0 to +5.0 inches H2O (-3736 to +1246 Pa) Gauge > +5 inches H2O consult factory.*
Gas Composition	*not critical*
Humidity	*must be non-condensing for valid measurement*
Maximum Temperature**	*+500℉ (260℃) (without High Temperature Option)* *+1500℉ (816℃) (with High Temperature Option)* *Consult factory for higher temperature operation*

OPTICAL HEAD HUMAN/MACHINE INTERFACE (HMI) CHARACTERISTICS

Display Type	*Six 7 Segment LED’s*
Indicating LED’s	*Fault, Set, In Cal, Power*
User Input Controls	*10-key keypad*

SIX POINT I/O BOARD ANALOG OUTPUTS

Number	2
Isolation Type	*Optical & capacitive barriers; channel to channel, channel to circuit common & earth*
Minimum Isolation Voltage	*500Vpeak*, 500VDC**
Output Type	*4-20mA with live 4mA zero, OR 0-20mA w/o live zero*
Maximum Load Resistance	*900 ohms*
Maximum Offset	*±0.05% of full scale*
Total Output Error	*±0.30% of full scale*

SIX POINT I/O BOARD DIGITAL INPUTS (Not Used)

Number	2
Modes	*Isolated and Non-isolated*
Isolated Mode Minimum Isolation Voltage	*500Vrms**
Isolated Mode Minimum Actuation Voltage	*5VDC (user supplied)*
Isolated Mode Maximum Actuation Voltage	*24VDC (user supplied)*
Isolated Mode Maximum Input Current	*50mA @ 24VDC*
Non-Isolated Mode Actuation Condition	*Dry contact closure*
Non-Isolated Mode Internal Operating Voltage	*5VDC*

SIX POINT I/O BOARD RELAY OUTPUTS

Number	2 SPST, N.O. (Single Pole Single Throw, Normally Open or Normally Closed [jumper selectable])
Minimum Isolation	*500Vrms**
Maximum Contact Voltage	*250VAC*
Maximum Contact Current	*1Amp AC, 1Amp DC*

* I/O wires with respect to earth (common mode).
** Does not apply to Instrument Air Purge version. Consult factory.

1.5 MEASUREMENT UNITS

Light from the laser is projected into the stack at a shallow angle with respect to the axis of the viewing optics. The receive optics' field of view is focused onto the signal detector. Dust particles in the stack or duct effluent reflect a portion of the projected laser light back into the instrument optical system where a direct current signal, proportional to the amount of optical backscatter energy, is generated. This signal is related to the dust content of the sample medium. The parameter that is actually measured by the instrument is energy received at the signal detector. The output from the Optical Head Assembly is directly proportional to the light that is backscattered from the particulate matter in the gas stream.

If there is no dust in the stack, the backscatter return signal will be zero. (The projected beam is aimed and the receive optics are focused so that reflections off the far wall of the stack or duct are out of the detector's field of view.) As the dust concentration becomes very high (on the order of 20 grams per actual cubic meter), the backscatter will asymptotically approach some maximum value. The maximum backscatter value is determined by the dust characteristics (size, shape, and reflectivity) at the individual site.

If quantitative particulate mass datum is required, a backscatter particulate matter monitor must be calibrated against site specific isokinetic samples by performing US EPA 40CFR60 Appendix A Methods 5 or 17 (or other test methods approved by the Agency) while simultaneously recording the *LaserHawk* 360P reading.

These sets of simultaneous data may then be used to create a response curve to correlate the dust monitor output to concentrations such as milligrams per cubic meter (mg/M3). A user supplied data acquisition device may be used to record the data to perform this function. The correlation curve parameters can be entered via the Optical Head.

(This page intentionally left blank.)

2.0 OPTIONAL EQUIPMENT

The components listed below are optional on the *LaserHawk* 360P Particulate Matter System. They are not included on a standard system. Please consult the Site Specification Data Sheets in Appendix A for the details of your particular system.

2.1 INSTRUMENT AIR PURGE

When this option is chosen, the customer must supply and install ½ inch pipe to carry the plant supplied Instrument Air. The air must be delivered at a dynamic pressure of 16 PSIG (110 KpaG) minimum at the regulator, at a flow rate of 20 CFM (566 LPM) minimum. Connection to the Optical Head Assembly is 3/8 inch tube.

If a light trap is supplied the customer must supply and install ½ inch pipe to a tee to carry the plant supplied Instrument Air. The air must be delivered at a dynamic pressure of 30 PSIG (207 KpaG) minimum at the regulator, at a flow rate of 35 CFM (991 LPM) minimum. Connection to the Optical Head Assembly & light trap is by 3/8 inch tubes.

2.2 HIGH TEMPERATURE OPERATION

High Temperature Hardware Kit with fiberglass seal and stainless steel nozzle ***MUST*** be supplied for applications where the stack gas temperature exceeds 500°F (260° C).

2.3 HEAT SHIELD

A Heat Shield is available for installations where radiant heat is a problem. This is typically necessary for stack temperatures of 1000° F (538° C) or more but in some instances may not be required when the stack is very well insulated. Consult factory.

2.4 PRESSURE AND TEMPERATURE INPUT INTERFACE

The Dual Analog Input Interface Module is used when the stack temperature and pressure data must be input to the *LaserHawk* 360P to correct Particulate Mass to standard conditions. The user must supply the 4-20 mA or 0-5VDC signals to the module corresponding to the absolute stack pressure and temperature. The pressure and temperature ranges are field adjustable by parameter entry via the Optical Head. However, the user is encouraged to provide range information prior to factory setup, so that ranges can be factory programmed into the system. Temperature is scaled in degrees C, and pressure in K Pascals absolute.

2.4.1 Resistive Temperature Device (RTD)

An optional Resistive Temperature Device (RTD) probe is available from TML for use as an external temperature sensor. The RTD is a simple alternative to a user supplied 4-20 mA signal. The heart of the assembly is a 1000 ohm 2 wire RTD. Consult the system wiring diagram in Appendix D for connection of the RTD Assembly to the Dual Analog Input Interface Module described above.

The optional Dual Analog Input Interface Module is required in order to use the RTD assembly. See Table 2-1 for the applicable Dual Analog Input Interface Module jumper settings for the assembly.

Table 2-1

Dual Analog Input Interface Module Jumpers for External Temperature

DESCRIPTION	JUMPER NUMBER	LABEL	POSITION	WIRING
1000 ohm RTD	JU1	RTD	1-2	J3 Terminals 2 and 3
4-20Ma Temperature Transmitter	JU1	CUR	3-4	J3 Terminals 4(+) and 5(-)
0-5VDC Temperature Transmitter	JU1	VOL	5-6	J3 Terminals 6(+) and 5(-)

2.4.2 Barometric Pressure Sensor Assembly

An optional Barometric Pressure Sensor Assembly is available from Teledyne Monitor Labs for the purpose of correcting Particulate Mass data to standard pressure. The assembly contains an on-board absolute pressure transducer that reads the ambient pressure outside the stack or duct. This approach is recommended only for applications in which the static gage pressure of the process is not likely to undergo dramatic changes. For cases where static pressure varies widely, a pressure transducer measuring the actual process pressure will deliver maximum accuracy.

The Barometric Pressure Sensor Assembly is inserted into a connector on the Dual Analog Input Interface Module.

See Table 2-2 for the Dual Analog Input Interface Module jumper settings for use of the Barometric Pressure Sensor Assembly.

Table 2-2

Dual Analog Input Interface Module Jumpers for Pressure Input

DESCRIPTION	JUMPER NUMBER	LABEL	POSITION	WIRING
Barometric Pressure Assembly	JU2	*Any*	*Any*	None
	JU3	INT	1-2	
4-20mA Pressure Transmitter	JU2	CUR	1-2	J4 Terminals 1(+) and 2(-)
	JU3	EXT	3-4	
0-5VDC Pressure Transmitter	JU2	VOL	3-4	J4 Terminals 3(+) and 2(-)
	JU3	EXT	3-4	

2.5 ETHERNET MODULE (STANDALONE)

The Standalone Ethernet Module is an optional device packaged in its own separate enclosure that can provide instrument data via a 10/100 BaseT Ethernet connection. It is typically installed in a controlled environment in close proximity to an Ethernet network.

The Standalone Ethernet Module connects to the Optical Head over a commercial industrial network using a single twisted shielded pair. External connection of a 10/100 BaseT Ethernet network to the Standalone Ethernet Module is made via a standard RJ45 connector socket.

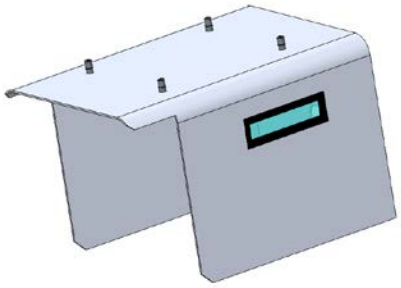
The module will provide web browser-based remote access, configuration and control of the *LaserHawk* 360P. At the same time the Ethernet Module can provide HTML web pages for user interface and fast Modbus TCP access to instrument data and parameters. The details of this powerful optional feature are described in its own instruction manual which is provided with the instrument.

2.6 PURGE AIR HEATER

The *LaserHawk* 360P Purge Air Heater option is offered only to those customers whose measured gas stream contains high moisture content with a dew point below the typical purge air temperature. In some rare cases, the inclusion of the relatively cool purge air may cause the stack water vapor to condense at the interface between the purge air and the stack effluent. Under these conditions the indicated particulate readings would be biased high because of the backscatter signal created by the condensed moisture.

The Purge Air Heater employs a 650 watt, 115VAC heater with over-temperature protection housed in a stainless steel pipe. Teledyne Monitor Labs Technical Support should be consulted prior to the decision to install this option, since there are additional site specific issues that must be considered in order to insure that the option is safe and effective.

2.7 OPTICAL HEAD DUST COVER



Provided in lieu of the Optical Head Weather Cover. This is only recommended for installations where the Optical Head is not subjected to outdoor weather conditions, for instance when the instrument is mounted indoors or in an annular space between the liner and exterior shell of a smokestack.

2.8 LIGHT TRAP ASSEMBLY

This is an optional device. Please consult the Site Specification Data Sheets in Appendix A for the details of your particular system.

The optional Light Trap Assembly is a device that prevents projected laser energy that strikes the stack wall, opposite the Optical Head Assembly, from being reflected back into the viewing optics. The Light Trap Assembly is generally required only when a user's stack diameter is less than 6.5 feet (2 meters, but may be necessary at greater diameters based on mounting tube length, particulate mass range and other factors.) Consult factory.

2.9 ADAPTER PLATES FOR FLANGES OTHER THEN 4"

If ports exist from other equipment, adapter plates can be supplied so the 360 can be mounted to them. Consult the factory for available sizes and price.

3.0 OPTICAL HEAD ASSEMBLY

3.1 OVERVIEW

Section 3.0 describes the Optical Head mechanical, optical, electrical and user interface configurations. It also defines the Optical Head status and mode codes and status LEDs. A numeric display and keypad are mounted directly on the *LaserHawk* 360P Optical Head.

3.2 MECHANICAL DESCRIPTION

The Optical Head Assembly is constructed primarily of cast aluminum, 1966 rated. It is comprised of a Rear Optical Section and an Integral Junction Box. The Rear Optical Section houses the electronic circuit boards and the primary projection and receive optics. The Integral Junction Box acts as a weather tight junction box to permit user power and signal wiring to connect with the instrument.

Access to the Exit Window may be gained by releasing the catches on both sides of the Optical Head Assembly. The Rear Optical Section may be swung to the right to fully access this area.

3.3 OPTICAL DESCRIPTION

Figure 3-1 shows the optical block diagram for the *LaserHawk* 360P Particulate Matter Monitor System.

The visible light laser illuminates the internal Reference Detector providing a signal that is used to maintain constant laser intensity. The projected laser light passes through the exit window entering the stack at a shallow angle. In the process the laser beam crosses the field of view of the viewing optics over an extended path within the stack.

Laser light is reflected by the dust particles in the medium sending optical energy back through the stack, window and receiving lens. Half of this light is reflected by the beam splitter and sent through an aperture stop and a lens to the signal detector.

The remainder of the light that is transmitted through the beam splitter goes to the eyepiece and reticule (cross hair) and through the window. An observer may view the visible light through the window in the cover during alignment.

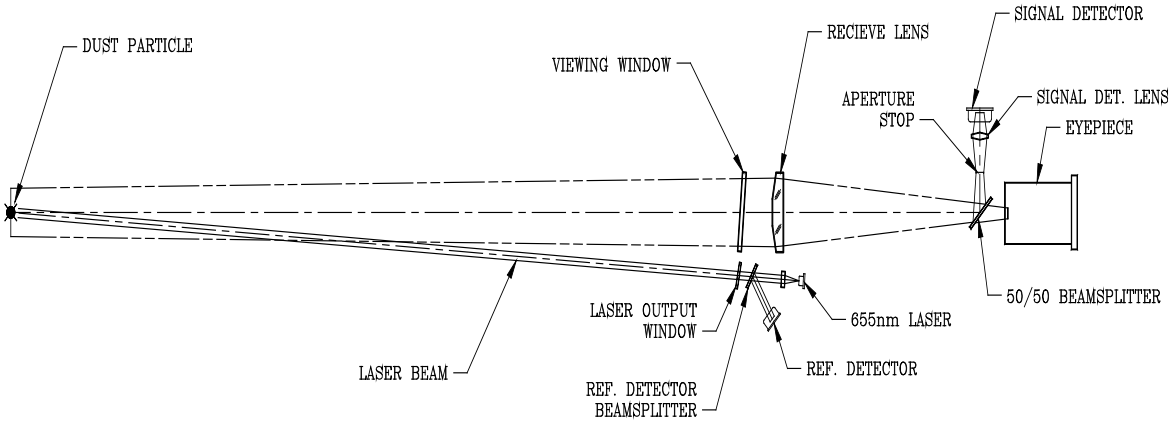

DUST PARTICLE
VIEWING WINDOW
RECIEVE LENS
SIGNAL DETECTOR
APERTURE STOP
SIGNAL DET. LENS
EYEPIECE
50/50 BEAMSPLITTER
655nm LASER
LASER OUTPUT WINDOW
REF. DETECTOR
LASER BEAM
REF. DETECTOR BEAMSPLITTER

Figure 3-1

3.4 ELECTRICAL DESCRIPTION

The electrical configuration of the Optical Head includes connections for AC power wiring from user supplied circuits and internal signal processing electronics.

3.4.1 AC Power Connections

The Optical Head has been designed to operate over a wide range of international power supply ranges and frequencies without the need for modifications or adjustments. *(See Section 1.0 of this manual for input power specifications.)* All AC power connections from user supplied circuits are made to the Integral Junction Box located on the bottom of the Optical Head Assembly. Terminals for the network communication wiring between the Optical Head Assembly and peripheral devices are also located in this Integral Junction Box.

3.4.2 Signal Processing Electronics

A family of small electronic circuit boards is located inside the Rear Optical Section. These boards are responsible for the Laser drive/modulation, signal detection, computer processing, display driver, keypad control and supporting power supply functions. These circuit boards are nested around the optical components and connected to the keypad on the electronics cover by a ribbon cable. *See the block diagram and the jumper tables for the Optical Head circuitry on the following pages. Of particular note is JU-3 on the Optical Amplifier Board, whose positions vary depending on the Common Gain parameter.*

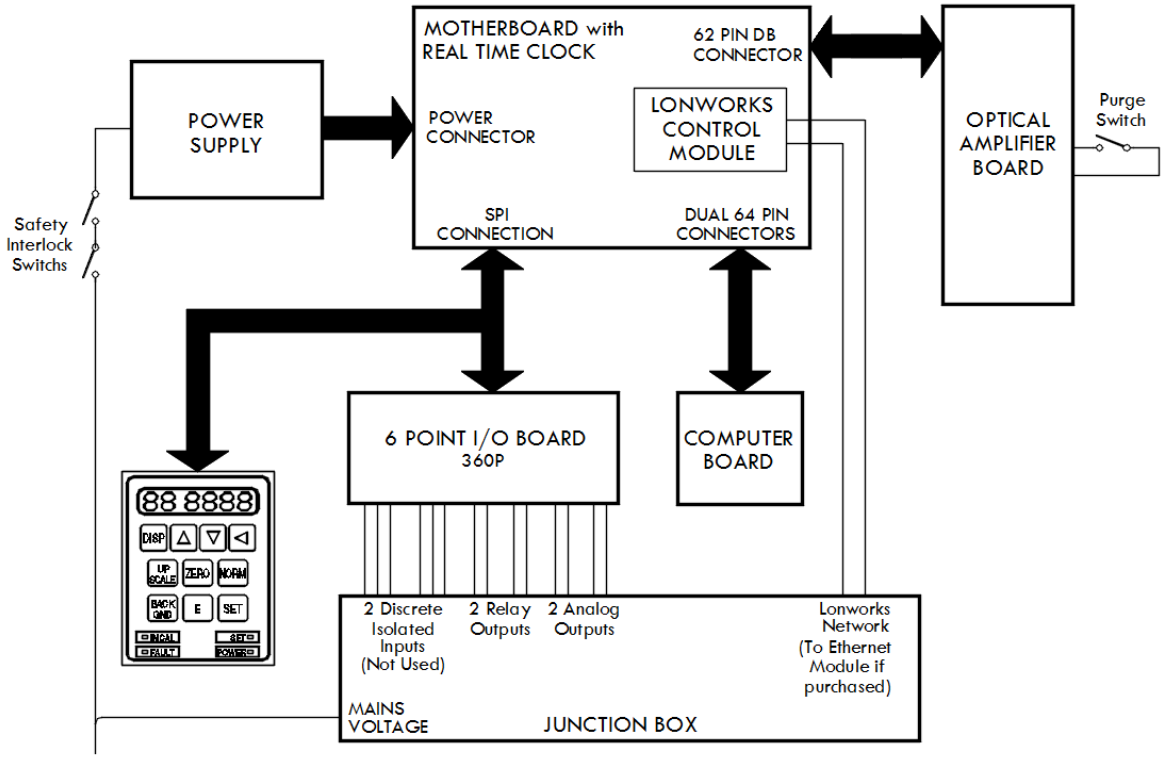

MOTHERBOARD with
REAL TIME CLOCK
62 PIN DB
CONNECTOR
POWER
SUPPLY
POWER
CONNECTOR
LONWORKS
CONTROL
MODULE
OPTICAL
AMPLIFIER
BOARD
Purge
Switch
Safety
Interlock
Switchs
SPI
CONNECTION
DUAL 64 PIN
CONNECTORS
6 POINT I/O BOARD
360P
COMPUTER
BOARD
DISP
UP
SCALE
ZERO
NORM
BACK
GND
E
SET
2 Discrete
Isolated
Inputs
(Not Used)
2 Relay
Outputs
2 Analog
Outputs
Lonworks
Network
(To Ethernet
Module if
purchased)
MAINS
VOLTAGE
JUNCTION BOX

Figure 3-2

OPTICAL AMPLIFIER BOARD (1860-0400) JUMPERS

Jumper	Options (Circle Configuration)	Default	Function
OP	IN **OUT**	OUT	Default mandatory
OP/50	IN **OUT**	OUT	Default mandatory
BS	**IN** OUT	IN	Default mandatory
JU1	**RUN** TEST	RUN	Default mandatory
JU2	**0** 1	0	Default mandatory
JU3	1 - 2, **3 - 4,** 5 - 6	**3 - 4**	Application Dependent (1-3 & 5-6 if Common Gain non-zero)
JU6	**IN** OUT	IN	Default mandatory
JU7	**1 – 2,** 3 – 4, **5 – 6, 7 – 8,** 9 – 10, **11 - 12**	1-2,5-6,7-8,11-12	Default mandatory
JU8	**RUN** TEST	RUN	Default mandatory
JU9	**RUN** TEST	RUN	Default mandatory

SBC332 (A1) JUMPERS

J2A	**1 2** 3	1 2	Configures board for type of memory Default mandatory
J2B	1 **2 3**	2 3	
J2C	1 **2 3**	2 3	
J2D	**1 2** 3	1 2	
J2E	**1 2** 3	1 2	
J2F	1 **2 3**	2 3	
J3	**1 2** 3 OUT	1 2	Enables watchdog timer
J9	**1 2** 3 OUT	1 2	Length of watchdog timer
J7	**IN** OUT	IN	Ram backup Mandatory
J10	1 2 **OUT**	OUT	Default mandatory
J12	1 2 **OUT**	OUT	Default mandatory

MOTHERBOARD (1860-0500) JUMPERS

JU1	IRQ6 **IRQ5** IRQ4 IRQ3 IRQ2 IRQ1	IRQ5	Default mandatory

SIX POINT I/O BOARD (1860-0700) JUMPERS

JU1	**0** 1	0	Hardware range for analog output #1
JU2	0 **1**	1	
JU3	**0** 1	0	Hardware range for analog output #2
JU4	0 **1**	1	
JU5	+5V **DRY**	DRY	Selects input #1 type
JU6	+5V **DRY**	DRY	Selects input #2 type
JU7	A (TOP=Force $_{upscale}$) . B (MID=Not used) . **C** (BOTTOM=Force $_{cal\ cycle}$)	BOTTOM	Selects input #1 function (NA for 360P)
JU8	**A** (TOP=Force $_{Zero}$) . B (MID=not used) . C (BOTTOM=Dump $_{Dirt}$)	TOP	Selects input #2 function (NA for 360P)
JU9	**4** 0	4	Software range. ma outputs
JU10	**OFF** ZERO	OFF	Test Zero
JU11	**OFF** FS	OFF	Test Full Scale
JU12	H **G** F E D C B A	G (Purge fail)	K1 relay closure condition
JU13	H G F E D C **B** A	B (Fault)	K2 relay closure condition
JU14	B **A**	A	K1 Relay operation NC/NO
JU15	B **A**	A	K2 Relay operation NC/NO

3.5 USER INTERFACE DESCRIPTION

The Optical Head Assembly user interface consists of a six character LED display and a keypad for data entry and display control.

3.5.1 Six Character LED Display

The Optical Head Assembly contains a 6 character, 7 segment display and a keypad. The two leftmost characters are GREEN while the 4 remaining characters to the right are RED. The display is organized so that the 2 GREEN characters describe the memory location of data, operational variables, markers or configuration modifiers. The 4 RED characters to the right hold the value of the data, status or marker in that memory location.

The locations are organized into different categories or BANKs of data and parameters. The leftmost GREEN letter character describes the BANK or category of display information, while the second GREEN numeric character identifies the individual memory location within the BANK.

The data BANKs are organized:

"U" - User data

"S" - Service data

"F" - Fundamental parameters

"A" - Auxiliary parameters

“E” – External Parameter

3.5.2 Keypad

The Optical Head Keypad contains 10 individual function keys that act both independently and in conjunction with one another to initiate actions, configure operations and control the six character display. The Keypad also contains 4 LED status lights that provide operational information to the user.

3.5.2.1 Individual Keys

SET: When pressed by itself when a parameter is currently displayed and password has been entered, causes the four seven segment display value to be entered. When pressed by itself when a data field is currently displayed, there is no effect. When pressed and held simultaneously with NORM or BACKGND buttons, a SET function is initiated for each respective mode button.

DISPLAY: No effect when pressed by itself. See "Combinations of Keys" Section 3.5.2.2 for more details.

INCREMENT: Increases the value of the parameter displayed. For example if F3 is 1.32, pressing INCREMENT increases F3 to 1.33. Repeat functions are supported for this button. No effect if data is displayed.

DECREMENT: Decreases the value of the parameter displayed. For example if F3 is 1.32, pressing DECREMENT decreases F3 to 1.31. Repeat functions are supported for this button. No effect if data is displayed.

LEFT: Moves the parameter value column that INCREMENT and DECREMENT affect to the left. Wraps around to the least significant column. Repeat functions are not supported.

UPSCALE: No effect.

ZERO: No effect.

NORMAL: Places instrument in NORMAL mode.

BACKGROUND: No effect when pressed by itself. See "Combinations of Keys" Section 3.5.2.2 for more details.

EXPONENT: Display/Change EXPONENT (See Section 3.5.2.3)

3.5.2.2 Combinations of Keys

SET * BACKGROUND: Initiates a BACKGROUND SET function.

SET * NORMAL: Initiates a NORMAL SET.

SET * UPSCALE: No effect.

UPSCALE * ZERO: No effect.

DISPLAY * LEFT: Toggles the display from User data (U) to Service data (S) and parameter (F, A, E) banks when pressed and held for about a second. Repeat functions are supported for this combination of buttons.

DISPLAY * INC: Increments the variable number displayed, i.e., U0 becomes U1, F0 becomes F1, etc. Repeat functions are supported for this combination of buttons.

DISPLAY * DEC: Decrements the variable number displayed, i.e., U5 becomes U4, F5 becomes F4, etc. Repeat functions are supported for this combination of buttons.

3.5.2.3 E Button Display Mode

Some parameters (A4, A5, A6, E1, E3, E5 and E7) are displayed using scientific notation. For example, if a value is “0.0235”, it will display the mantissa as “2.350”. If the “E” button is pressed, then the display will change to display the exponent, in this case “E-02”.

3.5.3 Status LEDs

The status LEDs in the Optical Head overlay are defined as follows:

IN CAL: Not used.

FAULT: Lights when an instrument malfunction occurs or instrument is put out of service.

SET: Lights when NORMAL or BACKGROUND sets are in progress or when parameter changes have been accepted. Blinks when NORMAL or BACKGROUND sets are about to begin.

POWER: Lights when power is being delivered to the Optical Head.

3.5.4 Data and Parameter Location Definitions

The memory locations are organized into different categories or BANKs of data and parameters. The left most GREEN letter character describes the BANK or category of display information, while the right most GREEN numeric character identifies the individual memory location within the BANK.

The "DISP" and "←" keys on the keypad are used to cycle the display through the different BANKs. Once inside the desired BANK, the "DISP" and "↑" and "↓" keys are used to cycle through the individual locations.

Example:

To display the data in location ***U2***

Press and hold the display ("DISP") key

Then press the "←" key until the left letter character displays the letter "U"

Press and hold the display ("DISP") key

Then press the "↑" key until the second character increments to the number "2"

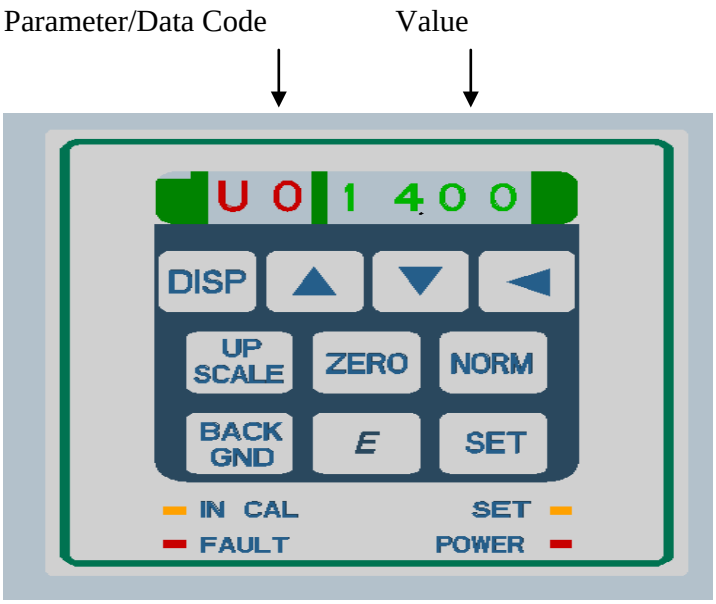
The value of the data in location U2 will be displayed on the RED 4 digit display to the right of the location identifier.

A laminated card describing the memory location definitions and display information is secured at the Optical Head for quick reference.

3.5.4.1 Data Codes

Data are not user configurable. They are primarily measurements that the instrument produces. There are two data banks:

- User Data Bank
- Service Data Bank



3.5.4.1.1 U Bank (User Data Bank)

The U Bank variables are outputs that users need to see regularly. The U Bank is referred to as the User Data Bank.

The following are the definitions of the data contained in the U BANK locations:

U0: Instantaneous Backscatter energy [Particulate Mass]

U1: 1 Minute Average Backscatter energy [Particulate Mass]

U2: Selectable Average Backscatter energy [Particulate Mass]

U3: Primary Status Code

Primary Status Code Definition

The following is the definition of the 4 digit Status Code displayed at location U3.

4 *X X X* = NORMAL SET voltage out of range

2 *X X X* = PRESSURE out of limits

1 *X X X* = TEMPERATURE out of limits

X 4 *X X* = ANY SET in progress

X 2 *X X* = *Not used*

X 1 *X X* = *Not used*

X X 4 *X* = *Not used*

X X 2 *X* = Reference Fault

X X 1 *X* = ADC Fault

X X X 4 = Out of Service

X X X 2 = *Not used*

X X X 1 = Purge Failure Analyzer Side

U4: Extended Status Code

Extended Status Code Definition

The following is the definition of the 4 digit Status Code displayed at location U4.

X X 1 *X = Not used*

X X X 4 = *Not used*

X X X 2 = Not used

X X X 1 = *Not used*

U5: Mode Code

Mode Code Definition

The following is the definition of the 4 digit Mode Code displayed at location U5.

X X X 0 = Unknown Mode

X X X 1 = NORMAL (Stack) Mode

X X X 2 = *Not used*

X X X 3 = *Not used*

6PIO Analog Output Condition

X X 0 *X* = NORMAL Mode

X X 1 *X* = *Not used*

X X 2 *X* = *Not used*

X X 3 *X* = *Not used*

X X 4 *X* = *Not used*

X X 5 *X* = TEST ZERO SCALE Mode

X X 6 *X* = TEST MID SCALE Mode

X X 7 *X* = TEST FULL SCALE Mode

U6: *Not used*

U7: *Not used*

U8: *Not used*

U9: *Not used*

UA: 332 Version --- Software version of 68332 microprocessor code

UB: Neuron Version --- Software version of Neuron microprocessor code

UC: *Not used*

UD: *Not used*

UE: *Not used*

3.5.4.1.2 S Bank (Service Data Bank)

The S Bank data locations contain maintenance-oriented data from the analyzer. The S Bank is referred to as the Service Data Bank.

S0: Signal Voltage

S1: Reference Voltage

S2: Laser Current

S3: Normal SET Voltage

S4: *Not used*

S5: BACKGROUND SET Voltage

S6: Optical Head Temperature, °C

S7: *Not used*

S8: +15V Power Supply Voltage (+/-5%)

S9: -15V Power Supply Voltage (+/-5%)

SA: +5VA (analog) Power Supply Voltage (+/-5%)

SB: -5VA (analog) Power Supply Voltage (+/-5%)

SC: +5VD (digital) Power Supply Voltage (+/-5%)

SD: Stack Temperature, °C

SE: Stack Pressure, kPa

3.5.4.2 Parameter Codes

Parameters are configuration-oriented variables. All are user configurable only after password entry. They are divided into F, A, and E Banks, where F represents Fundamental, A signifies Auxiliary, and E represents External Parameter.

3.5.4.2.1 F Bank (Fundamental Parameter Bank)

Note: Password protected

F0: Measurement Unit (Backscatter = 1, Particulate Mass = 3)

F1: Time of Day, Hours Minutes

F2: Date, Month Day

F3: Year, YYYY

F4: Reserved

F5: Six Point I/O Control (Normal 6PIO AO data = 0, 6PIO AO's to TEST ZERO SCALE = 1, 6PIO AO's to TEST MID SCALE = 2, 6PIO AO's to TEST FULL SCALE = 3)

F6: Service Marker (Normal Data = 0, Out of Service = 1)

F7: Reserved

F8: Signal Gain

F9: Reference Gain

FA: Common Gain

FB: Averaging Interval, minutes

FC: Reference Temperature, °C

FD: Reference Pressure, kPa

FE: Six Point I/O Full Scale (applies to DAC#1 and DAC#2, may be Backscatter Energy or Particulate Mass)

FF: *Not used*

3.5.4.2.2 A Bank (Auxiliary Parameter Bank)

Note: Password protected

A0: Instantaneous Alarm 1 Level

A1: Selectable Average Alarm 1 Level

A2: Password: (Password = 9860, expires after 2 hour boundaries are crossed, cleared at RESET)

A3: Curve Select (0 = Polynomial, 1 = Logarithmic, 2 = 2 Exponential)

A4: Curve Parameter A0 (See Section 3.5.2.3 & 3.5.6.1)

A5: Curve Parameter A1 (See Section 3.5.2.3 & 3.5.6.1)

A6: Curve Parameter A2 (See Section 3.5.2.3 & 3.5.6.1)

A7: *Not used*

A8: Reserved

A9: *Not used*

3.5.4.2.3 E Bank (External Parameter Bank)

Note: Password protected

E0: X1 = A/D Counts for Temperature

E1: Y1 = Temperature in Degrees C (See Section 3.5.2.3 & 3.5.6.1)

E2: X2 = A/D Counts for Temperature

E3: Y2 = Temperature in Degrees C (See Section 3.5.2.3 & 3.5.6.1)

E4: X1 = A/D Counts for Pressure

E5: Y1 = Pressure in kilo-Pascal (See Section 3.5.2.3 & 3.5.6.1)

E6: X2 = A/D Counts for Pressure

E7: Y2 = Pressure in kilo-Pascal (See Section 3.5.2.3 & 3.5.6.1)

E8: Temperature Correction Enable; (0=Disable/1=Enable)

E9: Pressure Correction Enable; (0=Disable/1=Enable)

EA: Low Temperature Set Point

EB: High Temperature Set Point

EC: Low Pressure Set Point

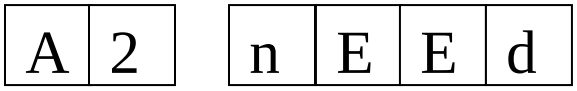
ED: High Pressure Set Point

3.5.5 Entering the Optical Head Password

Before any parameters can be changed via the Optical Head Keypad, a password must be entered.

- While depressing the "DISP" key, increment the "←" key until an "A" appears in the leftmost green display character.

- While depressing the "DISP" key, increment either the "↑" or "↓" key until a "2" appears in the rightmost green display character.



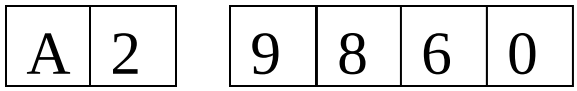
The word "nEEd" will appear in the 4 digit red display, alternating with the word "PASS".

- Depress the "←" key. The 4 digit display will now contain all 0's, with the LSD (Least Significant Digit) blinking.

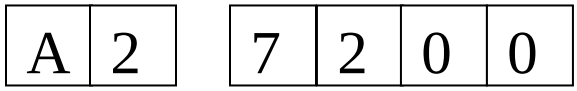
- Depress the "←" key again. The 4 digit display will still contain all 0's, but the 2nd LSD will now be blinking.

- Depress the "↑" key until the 2nd LSD is a 6.

- Repeat selecting and incrementing each character until the password (9860) is displayed.



- Now depress the "SET" key. The 4 digit display will read 7200 and begin counting down. This indicates the number of seconds remaining to make parameter changes until you must enter the password again.



3.5.6 Changing Parameters

After the password has been entered, parameters can be changed. This section applies to all parameters except A4, A5, A6, E1, E3, E5 and E7. See Section 3.5.6.1 for the latter.

- Use the "DISP" and the "←" keys simultaneously to navigate to the desired bank.
- Depress the "DISP" and either the "↑" or "↓" key until the desired parameter is displayed.
- Depress the "←" key. The 4 digit display will now have the LSD (Least Significant Digit) blinking.
- Increment or decrement the LSD using the "↑" or "↓".
- Depress the "←" key again. The 4 digit display will now have the 2nd LSD blinking.
- Increment or decrement the 2nd LSD using the "↑" or "↓".
- Repeat selecting and incrementing each character until the desired value is displayed.
- Now depress the "SET" key to command the parameter change.

3.5.6.1 E Button Change Mode

This section applies only to parameters A4, A5, A6, E1, E3, E5 and E7 with the password entered as in Section 3.5.5.

When the LEFT ARROW (←) is pressed for the first time, the data goes into a display mode where the most significant digit of the green LED bank selection is blanked off and the second digit displays either **"P"** for positive numbers or **"-"** for negative numbers. The four (4) digits of display on the right will display the mantissa.

If the display is showing a positive mantissa, then the 4 digit display will remain the same and the right digit of the green LED bank selection will change to a **"P"** to indicate that the mantissa is "positive" **(X P #. # # #)**. If the display is showing a negative mantissa, then the 4 digit display will shift to the left to show four (4) digits of mantissa and the right digit of the green LED bank selection will change to a **"-"** to indicate that the mantissa is "negative" **(X - #. # # #)**. The **"X"** is used to indicate that the left most LED display is blanked off.

If the LEFT ARROW (←) is pressed a second time, the keypad will enter the data entry mode. This will be true for either the mantissa or the exponent. All changes

made to the mantissa and/or the exponent are temporary until the SET button is pressed. This temporary altered value will be maintained for both mantissa and exponent as the display is switched back and forth between the two parts of the display by using the “E” button. The actual value used by the stack will not be altered unless the SET button is pressed.

The right most digit will blink to indicate which digit is being modified. Use the UP ARROW (↑) and DOWN ARROW (↓) to change the value. Each time the UP ARROW (↑) is pressed a value of (0.001) will be added to the displayed value. Likewise a value of (0.001) will be subtracted from the value each time the DOWN ARROW (↓) is pressed. Note that the value will overflow into the upper digits once the value is incremented past a value of **"9"**. Similarly the value will also underflow when it is decremented past **"0"**.

(This page intentionally left blank.)

4.0 SIX POINT I/O BOARD FOR *LASERHAWK* 360P

4.1 OVERVIEW

This section describes the behavior of the Six Point I/O Board (6PIO) in the *LaserHawk* 360P system. The Six Point I/O Board used in the *LaserHawk* 360P is packaged in the Optical Head. (See board location drawing at end of this section) External connections are made through the External Interface PC Board. (See Wiring Diagram at end of this section)

Many of the configuration details of the 6PIO Board are user selectable. Some parameters are software selectable using the keypad and digital display of the Optical Head Assembly. Other details are configured by placement of small jumpers located on the circuit board.

4.2 ANALOG OUTPUT DESCRIPTION

There are two analog outputs. They are isolated from each other and circuit common.

DAC 1 (Channel 1 or Out 1) is always dedicated to the Instantaneous value.

DAC 2 (Channel 2 or Out 2) is always Selectable Average.

The DAC 1 and 2 output scaling may be based on either Backscatter or Particulate Mass depending on the software selectable Measurement Unit parameter value in Bank F0; whatever the user has selected for the LED display will be assumed to be the desired analog output variable. For example, if Measurement Unit (F0 location) = 1, the LED display and analog outputs will take their inputs from Backscatter Energy, if Measurement Unit = 3, they will use Particulate Mass, etc.

4.2.1 Measurement full scale:

This is software selectable at bank FE on the optical head keypad. Typically if units selected are backscatter full scale is 100%. Particulate Mass full scale units are mg/m^3, full scale number is based on test data collected. Example; If particulate testing shows your average mg/m^3 are 40 you may want your full scale to be 100. (See note)

NOTE: Banks A3-A6 on the optical head keypad can be used to setup a three point Dust Mass curve.

4.2.2 Analog Output Current Range Selection

Two output current options are available from the 6PIO Board (either 4 – 20Ma or 0 – 20Ma). This range will apply to any measurement unit configuration selected above.

- Both analog channels are configured identically and the current range selected by the placement of jumper JU9 on the 6PIO Board. Placing the removable jumper between the two *leftmost* pins of JU9 (or the "4" position) will select the 4 – 20Ma range. Placement of the jumper between the two rightmost pins of JU9 (or the "0" position) will select the 0 – 20Ma range. Only the 4-20mA range possesses live zero capability.

4.2.3 Analog Output Scaling

- If ((Measurement Unit Parameter F0 = 1) ***AND*** (6PIO Jumper JU9 = 4)):
  4mA = 0% Backscatter Energy

  20mA = Six Point I/O Full Scale Backscatter Energy Value

- If ((Measurement Unit Parameter F0 = 1) ***AND*** (6PIO Jumper JU9 = 0)):
  0mA = 0% Backscatter Energy

  20mA = Six Point I/O Full Scale Backscatter Energy Value

- If ((Measurement Unit Parameter F0 = 3) ***AND*** (6PIO Jumper JU9 = 4)):
  4mA = 0 mg/m^3 Particulate Mass

  20mA = Six Point I/O Full Scale mg/m^3 Particulate Mass

- If ((Measurement Unit Parameter F0 = 3) ***AND*** (6PIO Jumper JU9 = 0)):
  0mA = 0 mg/m^3 Particulate Mass

  20mA = Six Point I/O Full Scale mg/m^3 Particulate Mass

4.3 JUMPERS THAT EFFECT ANALOG OUTPUTS

- **TEST ZERO SCALE (JU10):** This jumper is used to set both analog outputs to ZERO SCALE which can be either 0 or 4mA depending on the setting of the JU9 jumper. Potentiometer R11 is used to adjust output #1, and R23 to adjust output #2 for zero scale.

- **TEST FULL SCALE (JU11):** This jumper is used to set both analog outputs to FULL SCALE (20mA). Potentiometer R10 is used to adjust output #1, and R22 to adjust output #2 for full scale.

- **TEST ZERO SCALE AND TEST FULL SCALE:** When both of these jumpers are actuated simultaneously, both the analog outputs go to MID SCALE (12mA if the JU9 jumper is set to 4, 10mA if the JU9 jumper is set to 0).

- **JU1, JU2, JU3, AND JU4:** These jumpers are used to setup internal measurement parameters for the 6PIO. These must remain in the positions detailed below for all 6PIO configurations.

Table 4-1
Output Jumper Configuration

Jumper Position	Function
JU9 "0"	Analog Outputs 0-20 mA
JU9 "4"	Analog Outputs 4-20 mA
JU10 "Z"	Test Zero Scale
JU11 "FS"	Test Full Scale
JU10 "Z" & JU11 "FS"	Test Mid Scale
JU1 = 0 JU2 = 1 JU3 = 0 JU4 = 1	Internal Ranging (Do not move)

4.4 ANALOG OUTPUT ADJUSTMENT

The output current from each channel of the 6PT I/O may be measured at test points located on the board. The 0 – 20 or 4 – 20mA currents may be measured using a digital voltmeter to read the voltage across a 100Ω resistor at test points TP3 and TP4 for analog channel #1 (DAC1). 2.00 VDC between TP3 and TP4 indicates a 20mA output current. 0.40 VDC corresponds to a 4mA output.

To do this, wire jumpers must be installed between pins 6 & 7 (DAC1) and pins 9 & 10 (DAC2) on TB2, located on the external interface PC board which is mounted inside the junction box. JU9 on the 6PT I/O PC Board must be in the "4" position. To adjust the 4mA output current, place jumper JU10 in the "Z" (Zero scale) position. Adjust Potentiometer R11 till .40 VDC is achieved. Put JU10 back in the "OFF" positon and place JU11 in the "FS" (Full Scale) position. Adjust Potentiometer R10 till 2.00 VDC is achieved. Place JU10 back into the "Z" position. You should get a voltage of 1.2 VDC. This is the mid range scale. Return both JU10 & JU11 to there off positions.

The analog channel #2 (DAC2) output is measured between test points TP10 and TP11. Voltage readings on channel #2 are the same as channel #1.

2.00 VDC = 20mA
0.40 VDC = 4mA

Jumpers must be moved per DAC1 instructions. Potentiometer R23 & R22 are used for adjustment.

	TEST POINTS	ZERO ADJUST	FULL SCALE ADJUST
Channel #1 (DAC1)	TP3 – TP4	R11	R10
Channel #2 (DAC2)	TP10 – TP11	R23	R22

Analog Output Channel Adjustment Details

4.5 RELAY OUTPUTS

Two relays are available. Contacts are SPDT Form C. The configuration of the relays is jumper selectable as per the following table.

Table 4-2
Relay Function Configuration Jumpers

K1 JU12	K2 JU13	Function
A	A	Not used
B	B	Instrument Malfunction
C	C	Instantaneous Alarm 1 Actuated
D	D	Selectable Average Alarm 1 Actuated
E	E	Not used
F	F	Not used
G	G	Purge Failure
H	H	Not used

The contacts of each relay are jumper configurable for either N.O. or N.C. operation as per the following table.

Table 4-3
Relay Contact Configuration Jumpers

RELAY	N.O.	N.C.
K1	JU14 A	JU14 B
K2	JU15 A	JU15 B

4.6 DATA CABLES

Two data cables are needed to interconnect the 6PT I/O to external devices. One is a 4 conductor #20 AWG (0.5 mm^2) cable for connecting the contacts from the two relays. The other one Teledyne Monitor Labs recommends is a 6-pair #24 AWG (0.25 mm^2) shielded cable for connection to the two analog outputs. This would leave four pairs as spares for future use. See Wiring Diagram at end of this section for details on external connections to the 6PIO PC Board.

4.7 Six Point I/O Board Specifications

SIX POINT I/O BOARD ANALOG OUTPUTS

Number	*2*
Isolation Type	*Optical & capacitive barriers; channel to channel, channel to circuit common & earth*
Minimum Isolation Voltage	*500Vpeak*, 500VDC**
Output Type	*4-20mA with live 4mA zero, OR 0-20mA w/o live zero*
Maximum Load Resistance	*900 ohms*
Maximum Offset	*±0.05% of full scale*
Total Output Error	*±0.30% of full scale*

SIX POINT I/O BOARD DIGITAL INPUTS (NA for 360P)

Number	*2*
Modes	*Isolated and Non-isolated*
Isolated Mode Minimum Isolation Voltage	*500Vrms**
Isolated Mode Minimum Actuation Voltage	*5VDC (user supplied)*
Isolated Mode Maximum Actuation Voltage	*24VDC (user supplied)*
Isolated Mode Maximum Input Current	*50mA @ 24VDC*
Non-Isolated Mode Actuation Condition	*Dry contact closure*
Non-Isolated Mode Internal Operating Voltage	*5VDC*

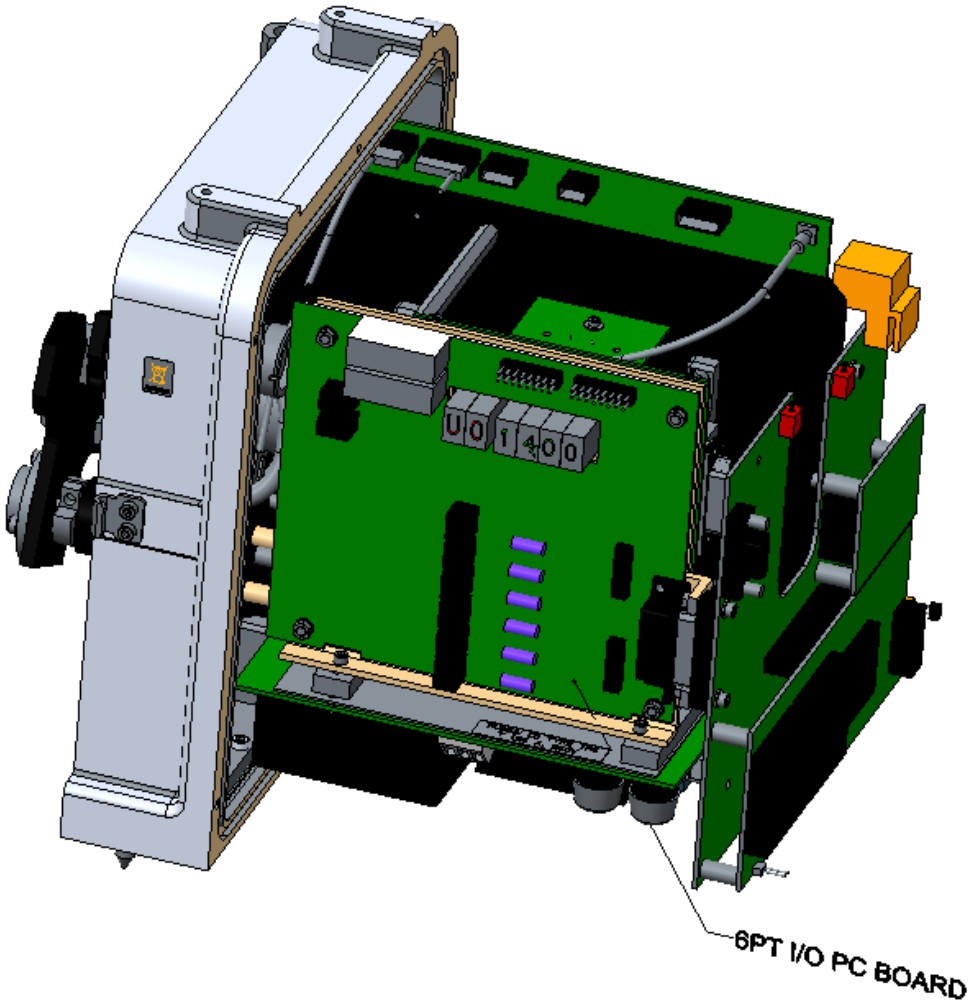
SIX POINT I/O BOARD RELAY OUTPUTS

Number	*2 SPST, N.O. (Single Pole Single Throw, Normally Open or Normally Closed [jumper selectable])*
Minimum Isolation	*500Vrms**
Maximum Contact Voltage	*250VAC*
Maximum Contact Current	*1Amp AC, 1Amp DC*

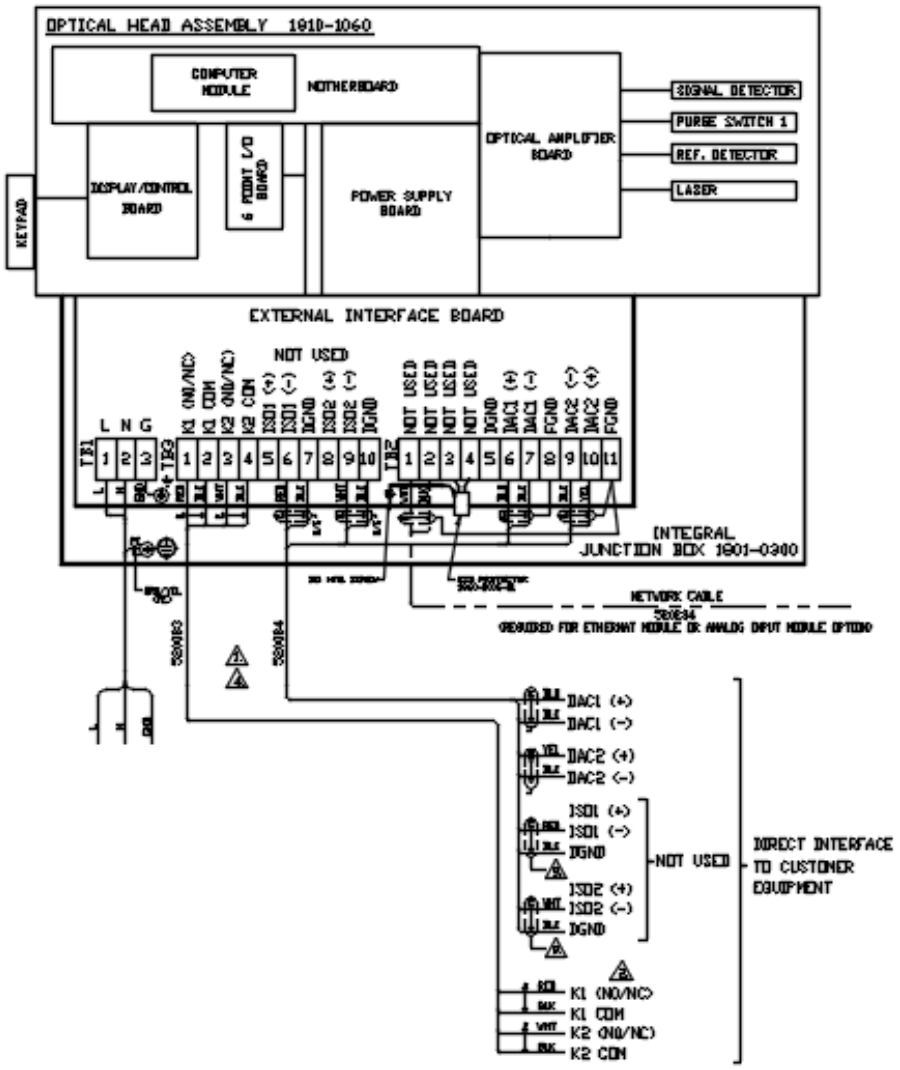
*I/O wires with respect to earth (common mode).

SIX POINT I/O BOARD (1860-0700) DEFAULT JUMPERS

JU1	**0** 1	0	Hardware range for analog output #1
JU2	0 **1**	1	
JU3	**0** 1	0	Hardware range for analog output #2
JU4	0 **1**	1	
JU5	+5V **DRY**	DRY	Selects input #1 type
JU6	+5V **DRY**	DRY	Selects input #2 type
JU7	A (TOP=Force $_{upscale}$) . B (MID=$_{not\ used}$) . **C** (BOTTOM=Force $_{cal\ cycle}$)	BOTTOM	Selects input #1 function **(NA for 360P)**
JU8	**A** (TOP=Force $_{Zero}$) . B (MID=$_{not\ used}$) . C (BOTTOM=Dump $_{Dust}$)	TOP	Selects input #2 function **(NA for 360P)**
JU9	**4** 0	4	Software range. ma outputs
JU10	**OFF** ZERO	OFF	Test Zero
JU11	**OFF** FS	OFF	Test Full Scale
JU12	H **G** F E D C B A	G (Purge Fail)	K1 relay closure condition
JU13	H G F E D C **B** A	B (Instr. Malf.)	K2 relay closure condition
JU14	B **A**	A (NO)	K1 Relay operation NC/NO
JU15	B **A**	A (NO)	K2 Relay operation NC/NO



6PT I/O PC BOARD LOCATION



6PT I/O WIRING DIAGRAM

(This page intentionally left blank.)

5.0 PURGE SYSTEM OVERVIEW

The Protective Purge Air System provides clean air to the Optical Head Assembly. The filtered air is directed in a way that prevents the sample medium from touching the optical surfaces. The purge air is injected into the stack through the purge nozzle of the Optical Head. The Purge System has an air intake filter that prevents ambient dust from contaminating the purge air. Filter replacement is very important to prevent contamination of the optical system. The weather cover protects the filter so that rain does not wash through the filter and allow contaminants to enter the purge blower.

Refer to the Site Specification Data Sheets in Appendix A to determine your particular system configuration.

5.1 MECHANICAL DESCRIPTION

The Purge Air System consists of the following major components.

- Mounting Plate and Weather Cover
- Purge Blower Motor
- Blower Intake Air Filter and Associated Pipes and Hardware

These components are shown on the *LaserHawk* 360P System Installation drawing in Appendix D.

5.2 ELECTRICAL DESCRIPTION

The purge blower motor is connected to user supplied AC voltage source capable of supplying continuous (uninterrupted) power. The input voltage, current and phase will differ for some users. A breaker of sufficient rating to allow for motor start up current must be used.

Please consult the Site Specification Data Sheets in Appendix A for the specific Purge Blower motor supplied with your system.

NOTE: *One of the primary causes of blower motor failure is the location of the inlet to the Purge System. These systems must draw air that is free from corrosive gaseous pollutants so that the lubricant in the bearings of the motors is not contaminated.*

5.3 OPERATION

The air intake filter and Purge System must be maintained in good working condition in order to adequately protect the Optical Head.

NOTE: *Interruption of the Protective Purge Air System requires immediate corrective action by the user. In no case should the Optical Head Assembly be placed in service or mounted on the stack without the Protective Purge Air System in operation.*

5.4 PURGE STATUS

If the purge blower is providing proper airflow, a pressure sensitive switch will be closed in the Optical Head. If the switch senses that the airflow is not sufficient, it will open. Switch status is determined on the Optical Amplifier Board, and triggers a fault when purge air is malfunctioning. The status of the Optical Head purge switch is internal to the Optical Head Assembly.

5.5 INSTRUMENT AIR PURGE OPTION

Please consult the Site Specification Data Sheets in Appendix A for the specific configuration of your system.

This option requires that the customer must supply and install ½ inch pipe to carry the Instrument Air. The air must be delivered at a dynamic pressure of 16 PSIG (110 KpaG) minimum, at a flow rate of 20 CFM (566 LPM) minimum. Connection to the Optical Head Assembly is via 3/8-inch tube. Reference *LaserHawk* 360 w/Inst Air System Installation drawing in Appendix D.

If a light trap is supplied the customer must supply and install ½ inch pipe to a tee to carry the plant supplied Instrument Air. The air must be delivered at a dynamic pressure of 30 PSIG (207 KpaG) minimum at the regulator, at a flow rate of 35 CFM (991 LPM) minimum. Connection to the Optical Head Assembly & light trap are by 3/8 inch tubes. Reference *LaserHawk* 360 Inst Air System w/light trap Installation drawing in Appendix D.

5.6 LIGHT TRAP OPTION

If the Light Trap option is provided a Protective Purge Air System is also provided. The purge air system has all the same specs as the optical head purge system except for a couple of differences.

1. The purge blower and associated plumbing have there on weather cover.

2. There is no purge fail switch to give an indication of a purge air failure.

6.0 CALIBRATION KIT OVERVIEW

The Calibration Kit may be used to optically simulate various levels of backscatter signals. After the *LaserHawk* 360P Optical Head Assembly has been properly calibrated at the user's installation site, the Calibration Kit can be used to document several upscale reference levels. Once documented the Calibration Kit may be used to perform subsequent adjustments and repairs even while the Optical Head Assembly remains on the stack. The Calibration Kit consists of two pieces. A fixture that looks like a black plastic cylinder approximately 2 1/2 inches (5 cm) in diameter, by 18 inches (45 cm) long; and a case. (Reference Cal Kit Assembly Drawing in Appendix D.) The fixture mounts on the Optical Head to simulate a full scale particulate condition and several intermediate upscale backscatter values. The case contains two audit standards and an opaque blocking plate. Each audit standard is calibrated to give a different upscale response. The Cal Kit is also used to set the Laser tilt angle, insuring that the return signal is always originating from the same section of the stack media. The end of the tube has a material of known diffuse reflectance that provides an optical reflection for laser tilt angle inspection and also serves as a reference material on which to base the analyzer calibration.

There are two different cal-kits that may be provided.
360P-Standard cal-kit for ports up to 16" long.
Long port cal-kit for ports 16.1" to 36" long.
(Uses different LASER tilt angle)

6.1 OPERATION

NOTE: *Only the Calibration Kit Fixture that has the same serial number as the Optical head may be used to calibrate an individual monitor.*

CAUTION: ***The Calibration Kit iris can be adjusted during Preliminary Field Scaling as described in Section 7.2. The iris must never be readjusted after Final Field Characterization described in Section 7.3.***

The Calibration Kit without audit standards should be used for all subsequent on stack electronics adjustment of 100 percent backscatter.

Before installing the Calibration Kit, be sure that the Optical Head exit windows are clean and free of lint so that the signal returned from the fixture will not be reduced.

Install the Cal Kit Fixture on the face of the Optical Head Subassembly. Remove the protective cover. There are three small holes approximately one inch apart just above the instrument exit window. The two outermost of these will accept the two ¼ inch diameter locator pins protruding from the rear of the Cal Kit Fixture. The center hole is tapped to receive the thumbscrew that holds the

fixture in place while the kit is in use. It is very important that the Cal Kit Fixture sits flat and flush against the face of the Optical Head Subassembly so that the safety interlock switches are engaged by the two pins in the upper corner of the Cal Kit Fixture. Since the clearances are small on the precision locator pins, it may be necessary to wiggle the test fixture a bit so that the locator pins go into the subassembly face to their full extent before beginning to tighten the thumbscrew by hand. A small common screwdriver may be used to tighten the captive thumbscrew to hold the fixture firmly in place. With the Cal Kit Fixture in place and no audit standards or blocking plate installed, the Cal Kit will generate a signal equivalent to 100% backscatter energy. The opaque blocking disk is used to simulate a 0% backscatter reading when inserted into the fixture. The percent backscatter values of the two audit standards are marked on the edge of their tabs. The audit standards are used to check the linearity and system response to different values of backscatter energy.

6.2 LASER TILT ANGLE

The laser angle can be observed by viewing the Photo-Gray material on the end of the Cal Kit through the eyepiece on the Optical Head. Verify the Laser beam is nominally centered on the Reticule cross hairs.

CAUTION: ***Adjustment of the Laser Tilt Angle can affect the accuracy of the LASERHAWK 360P. This adjustment must only be performed by Factory technicians and a description is beyond the scope of this operator's manual.***

6.3 STORAGE

The Calibration Kit Fixture and audit standards should be stored in the case it was supplied in when not in use. Keep them in a location that is not subject to extremes in temperature.

(This page intentionally left blank.)

7.0 CALIBRATION & CHECKOUT

To have the *LaserHawk* 360P System be capable of producing an output in terms of Particulate Mass, three separate steps must be taken.

- ❑ Factory Setup
- ❑ Preliminary Field Scaling
- ❑ Final Field Characterization

7.1 FACTORY SET-UP

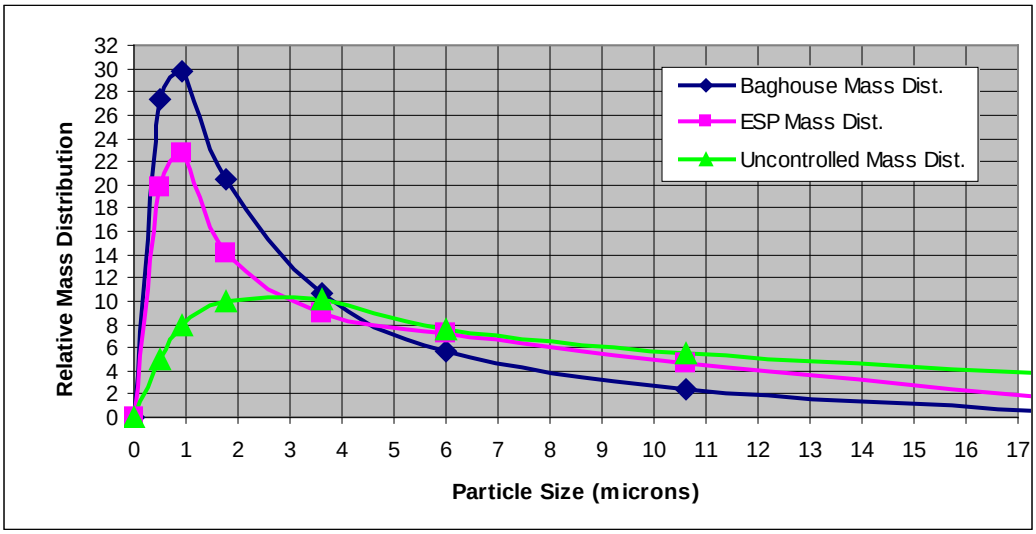
Initial setup of the *LaserHawk* 360P Particulate Matter Monitoring System is performed at the Teledyne Monitor Labs factory by experienced personnel. The optical and electrical system is nominally configured for the requirements of the individual installation location based on information received by Teledyne Monitor Labs from the user. Theoretical calibration of a Backscatter instrument is much less predictable than is possible for an extinction transmissometer. All optical particulate mass measurement devices are inherently imperfect devices because they measure secondary properties, not direct particle mass. However, in many applications they can be a suitable fit provided the variation in the following particle characteristics are given due consideration.

Shape: This is, arguably, probably one of the less significant sources of error. There is some indication from the literature that particulates from coal combustion tend to be spherical, with some agglomerates. Though no existing or emerging optical technology can effectively mitigate the effects of particle shape, this is not thought to be a primary source of error due to the expected sphericity.

Density: Density is thought to be relatively consistent for a given type of fuel. Once again, as is the case with shape, though no existing or emerging optical technology can effectively compensate for particle density changes, for consistent fuel situations this is not considered to be a major source of error.

Size: Particle size is the most significant issue when applying optical technologies, as can be illustrated by examining the figure below. All particulate control devices alter particle size distribution in some manner. Process changes that merely increase the total mass of particulate entering a removal device will probably not appreciably alter the exit size distribution; but changes in the efficiency of the control device with respect to particle size could have a deleterious effect on the accuracy of the correlation, while an increase in total particulate mass (PM) with little change in the particle size ratio implies more PM entering the control device.

Particle Reflectivity: This can be an issue for backscatter monitors in some applications such as multi-fuel boilers or incinerators. However, particle reflectivity is thought to be relatively consistent for given types of fuel.



Typical Size Distributions for Particulate Control Devices

NOTE: *If quantitative Particulate Mass loading data is required, a Backscatter dust detector must always be calibrated against site-specific isokinetic samples by performing US EPA Reference Methods 5, 17 or alternate method approved by the Agency while simultaneously recording the LaserHawk 360P output.*

CAUTION: ***Complete optical alignment is accomplished using factory procedures and special tooling not available to the user. Teledyne Monitor Labs strongly recommends that if optical components have moved or been damaged, the Teledyne Monitor Labs factory should be consulted before the user attempts repairs. Under ordinary conditions, once the user has received the system from the Teledyne Monitor Labs factory there should be no need to perform any internal optical alignment of the Optical Head Assembly such as refocusing of lenses, etc.***

7.1.1 Simulating User Conditions on Test Stand

During factory set-up, Teledyne Monitor Labs mounts the user's Optical Head Assembly on an optical test stand to simulate the user's installation configuration. The test stand allows the assembly to be aligned as it would be on the stack and introduce optical reference materials and audit standards to simulate a nominal backscatter response. Reference materials with documented reflective characteristics are used to set up the instrument response. This is a nominal response and cannot be directly equated with any specific user particulate mass values. The instrument response to the reference material and specific audit

standards is documented in the Site Specification Data Sheets in Appendix A of this manual. This data, used in conjunction with the optional Calibration Kit Assembly, may be used to return the instrument to this nominal factory setting after any repairs.

7.1.2 Calibration Kit Response

Once the *LaserHawk* 360P is nominally adjusted for the application, a Calibration Kit is installed. The adjustable iris is used to produce a 100% reading. Two different audit standards are then inserted in the Cal Kit and the responses recorded. The Calibration Kit then becomes a standard or reference fixture that may be used to verify the *LaserHawk* 360P Particulate Matter Monitor at the stack location while the stack is in operation. The Calibration Kit uses a diffused reflective material to assure a reliable reference for future repairs and calibration. The Calibration Kit also is used to check the optical alignment of the laser.

WARNING: ***Do not insert any highly reflective or mirror like objects into the slot in the Calibration Kit that could reflect the laser energy out. The potential for eye damage exists in these circumstances.***

7.1.2.1 Calibration Kit

The Calibration Kit is factory set to simulate a 100% full scale reading with the Laser aligned to the center of the crosshairs as viewed through the reticule. The Calibration Kit then becomes a reference fixture to be used to audit or completely adjust the Optical Head Assembly electronics at the stack location while the stack is in operation.

Before installing the Calibration Kit, remove its protective cover. Ensure that the audit standards are clean and free of lint so that the signal returned from the fixture will not be reduced. Clean with low pressure air only.

Install the Cal Kit Fixture on the face of the Optical Head Subassembly. There are three small holes approximately one inch apart just above the instrument exit window. The two outermost of these will accept the two ¼ inch diameter locator pins protruding from the rear of the Cal Kit Fixture. The center hole is tapped to receive the #10-32 thumbscrew which holds the fixture in place while the kit is in use. It is very important that the Cal Kit Fixture sits flat and flush against the face of the Optical Head. Since the clearances are small on the precision locator pins, it may be necessary to wiggle the test fixture a bit so that the locator pins go into the subassembly face to their full extent before beginning to tighten the thumbscrew by hand. A small common screwdriver may be used to tighten the captive thumbscrew to hold the fixture firmly in place.

With the Cal Kit Fixture in place and no audit standards installed, the Cal Kit will generate a signal equivalent to the 100% full scale of the monitor being tested. A blocking plate in the shape of an audit standard (hereafter referred to as an opaque

blocking plate) is used to simulate a 0% reading when inserted into the fixture. The percent full scale values of the two audit standards are marked on them as %T. The plates are used to check the linearity and system response to different values of Particulate Mass.

It should be noted that for any specific application, the signal from the stack particulate is unique to the individual stack conditions and cannot be accurately predicted without establishing a correlation to a particulate mass reference method. The Calibration Kit and audit standards are used to verify, prior to shipment, that the monitor is functioning correctly and can be adjusted over a wide range of possible particulate mass levels that may be expected. Final calibration of the monitor must be done on site. To achieve a particulate mass relationship for a specific stack with its own unique dust characteristics, the monitor must be correlated against a reference sampling method.

During scheduled maintenance it may be necessary to make adjustments to compensate for changes in the electronic and optical components. Calibration will also be required to return the analyzer to service after a repair.

7.2 PRELIMINARY FIELD SCALING

After the instrument has been installed at the user site, the nominal factory setup must be evaluated for proper dynamic range. It should be noted that, for any specific application, the signal returned to the Optical Head Assembly is unique to the individual stack conditions and cannot be accurately predicted during the factory setup. Before any site testing is undertaken, the *LaserHawk* 360P response to the user's stack conditions must be scaled to allow meaningful quantitative analysis of future reference method isokinetic sampling.

Due to the unique optical characteristics of any particular user's dust stream, it is possible that the nominal factory setup may produce an output signal that is either extremely low or above full scale. If this is the case, the *LaserHawk* 360P output must be rescaled before further quantitative testing is attempted. Evaluation of the instrument output under the extremes of expected dust load conditions will provide useful information on whether or not the *LaserHawk* 360P factory setup has sufficient dynamic range. To proceed further the source must be operated in its maximum, minimum and typical dust loading conditions while recording the *LaserHawk* 360P output.

7.2.1 Output Too Low

If the *LaserHawk* 360P response to both the maximum and typical particulate mass conditions remains less than 50% of scale, then the backscatter Signal Gain must be increased before further characterization is under taken. The Signal Gain must be increased until the maximum dust load response is in the 60 to 80% of the instrument full scale. **Generally speaking, in typical applications doubling the Signal Gain will double the percent full scale output reading.** To adequately

document this new sensitivity properly, a *LaserHawk* 360P Calibration Kit should be installed after this adjustment has been made and readjusted. **(See Section 7.2.3 Calibration Kit Adjustment.)** This will allow the new setting to be reproduced if any malfunction or miss-adjustment should occur before the characterization process is completed.

7.2.2 Output Too High

If the *LaserHawk* 360P response to both the maximum or typical particulate conditions is greater than full scale, then the backscatter Signal Gain must be decreased before further characterization is under taken. The Signal Gain must be decreased until the maximum dust load response is in the 60 to 80% of the instrument full scale. To adequately document this new sensitivity properly, a *LaserHawk* 360P Calibration Kit should be installed after this adjustment has been made and readjusted. **(See Section 7.2.3 Calibration Kit Adjustment.)** This will allow the new setting to be reproduced if any malfunction or mis-adjustment should occur before the characterization process is completed.

7.2.3 Calibration Kit Adjustment

If the Signal Gain has been adjusted, the Calibration Kit iris must be readjusted for future use. The iris location and adjustment procedure is the same for both the Low and High Range Cal Kit Fixtures.

- After removing its protective cover, install the Calibration Kit and verify that no audit standards or the opaque blocking plate are in place.
- Allow the Signal Voltage (location S0) to stabilize.
- Carefully loosen the iris locking/adjustment lever. Rotate the adjustment lever until the Signal Voltage (S0) = 6 VDC ± 0.5 VDC.

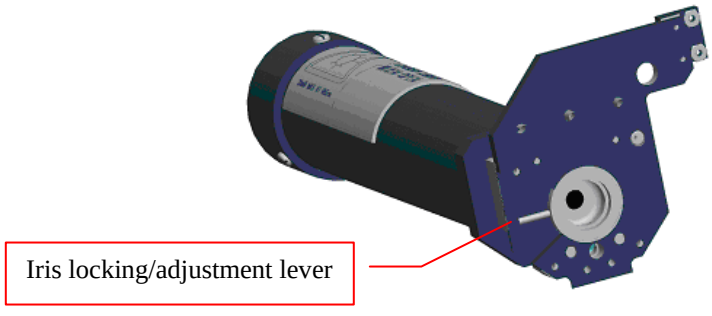


Figure 7-1
Cal Kit Fixture Iris

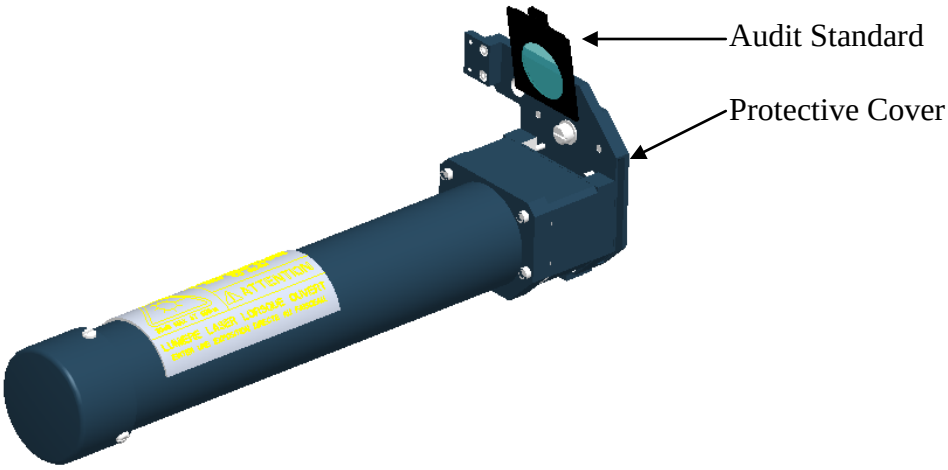


Figure 7-2
Cal Kit Fixture

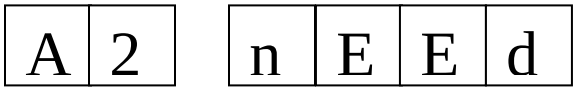
- Carefully tighten the iris locking/adjustment lever and recheck the Signal Voltage to confirm the proper voltage.
- Install the opaque blocking plate into the Cal Kit and allow the Signal Voltage to stabilize.
- Perform a Background Set as described in Section 8.1.1.
- Once the “SET” LED goes out, remove the opaque blocking plate creating 100% backscatter, then allow the Signal Voltage to stabilize.
- Perform a Normal Set as described in Section 8.1.2.
- Once the “SET” LED goes out, the Normal Set is complete.

7.2.3.1 Entering the Optical Head Password

Before any parameters can be changed via the Optical Head keypad, a password must be entered. **NOTE:** ***The password is NOT required to perform SETs or a Calibration Cycle.***

- While depressing the "DISP" key, increment the "←" key until an "A" appears in the left most green display character.

- While depressing the "DISP" key, increment either the "↑" or "↓" key until a "2" appears in the next green display character.



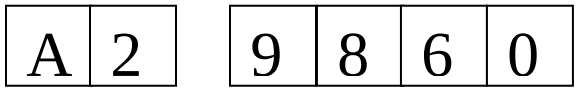
The word "nEEd"will appear in the 4 digit red display, followed by the word "PASS".

- Depress the "←" key. The 4 digit display will now contain all 0's, with the LSD (Least Significant Digit) blinking.

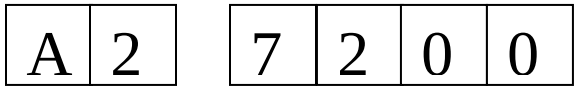
- Depress the "←" key again. The 4 digit display will still contain all 0's, but the 2nd LSD will now be blinking.

- Depress the "↑" key until the 2nd LSD is a 6.

- Repeat selecting and incrementing each character until the password (9860) is displayed.



- Now depress the "SET" key. The 4 digit display will read 7200 and begin counting down. This indicates the number of seconds remaining to make parameter changes until you must enter the password again.



7.3 FINAL FIELD CHARACTERIZATION

NOTE: *If the LaserHawk 360P is being used only for comparative readings to detect process or control upset conditions, final characterization is not necessary.*

Once the *LaserHawk* 360P output range has been scaled for the proper sensitivity, final characterization for quantitative particulate mass may be undertaken if required. This step requires that the analyzer data is being recorded by a computer / PLC data collection device.

- ❑ Check that the instrument response to maximum particulate mass is in the 60 to 80% full scale range as described in Sections 7.2.1 and 7.2.2.

- ❑ Perform source reference method isokinetic sampling (US EPA reference methods 5, 17 or alternate method approved by the Agency) while simultaneously recording the *LaserHawk* 360P percent backscatter output.

- ❑ Perform this testing at diverse particulate loading levels (at least 2 levels, 3 preferred) with a minimum of 3 runs at each level.

- ❑ Use the simultaneous data from all tests to create a polynomial curve fit equation that will modify the *LaserHawk* 360P output to produce quantitative dust loading.

NOTE: *When performing PS-11 correlation testing, it is not necessary to enter the resulting correlation curve into the monitor.*

7.4 RECALIBRATION OR REPAIR/REALIGNMENT OF OPTICAL COMPONENTS

Some analyzer optical components may be replaced or aligned in the field. In these cases, the analyzer may be recalibrated with the Calibration Kit Fixture and restored to service. Examples of these cases are:

Replacement of:

- ❑ Signal Detector Assembly

Optical alignment of:

- ❑ Laser Source Assembly (realignment ***but not focusing***)
  NOTE: *Although laser realignment is possible at a user's site, performance details of this task are beyond the scope of this document. The factory must be consulted for guidance before any attempt is made to realign the laser angle.*

Some analyzer repair situations require special equipment and fixtures available in the factory but not typically present at the end user site. In these cases, the analyzer must be returned to the factory for repair and recalibration. Examples of these cases are:

Replacement of or damage to:

- Laser Source Assembly
- Any Internal Optics
- Calibration Kit Fixture

Optical alignment of:

- Any Internal Optics

7.5 FACTORY SELECTION OF OPTICAL ELEMENTS

Factory calibration of the analyzer involves the selection of optical components that are site specific and should not be attempted by the end user. However, user maintenance personnel in the normal course of maintenance and audit testing may perform the electronic adjustment and set function portions of the calibration procedure.

NOTE: *The user should not attempt the internal alignment of individual optical elements.*

7.6 CLEANING THE OPTICAL SURFACES

Dirt that accumulates on the instrument optical surfaces will attenuate the optical energy and be detected as either increased dirt compensation signal or decreased particulate mass by the instrument. Under normal conditions, only the exit window of the Optical Head Assembly needs to be cleaned.

7.6.1 Cleaning Materials

The external optical windows and surfaces should be cleaned using a soft lint free cloth or cotton swab, and quality commercial glass cleaning solution. An ammonia based window cleaner may be used so long as it does ***not*** contain an anti-fog additive. The anti-fog agents leave a residue on the glass surface that may react with stack gases and produce a perceptible haze on the windows. A second choice would be a mixture of 50% alcohol and 50% distilled water. Care should be taken not to use alcohol containing oily contaminates as this will leave a residue on the optical surfaces. Teledyne Monitor Labs recommends the use of a reagent grade isopropyl alcohol. Many optical surfaces are treated with an anti-

reflective coating. **Strong solvents such as acetone should <u>not</u> be used for cleaning.**

7.6.2 <u>Cleaning Procedure</u>

Two surfaces must be cleaned before calibration. Both of these areas must be cleaned so that the particulate matter monitor may properly display and compensate for any future accumulations of dust on the surfaces.

- ❑ The Optical Head exit windows
  - The large diameter Viewing window
  - The smaller Laser Output window located just below

7.6.2.1 Optical Head Exit Windows

The exit windows are accessible by releasing the latches on both sides of the Optical Head Assembly and opening the hinged section. ***<u>Carefully</u>*** clean the exit windows using a soft lint-free cloth and solution. Cotton cleaning swabs may be employed to clean hard to reach areas.

(This page intentionally left blank.)

8.0 ELECTRONIC ADJUSTMENT

Recalibration of the *LaserHawk* 360P is accomplished by performing a series of procedures called "SETS". These procedures establish reference levels for 0% and 100% backscatter energy. The Optical Head exit windows and Calibration Kit Fixture should be free of dirt and dust before the "SET" functions are performed.

8.1 CALIBRATION SET FUNCTIONS

The "SET" functions consist of two procedures that must be performed in a specific order: "Background Set" then "Normal Set". Both procedures must be performed.

8.1.1 Background Set

1. Install the Calibration Kit Fixture.

2. Install the opaque blocking plate into the Cal Kit and allow the Signal Voltage (S0) to stabilize.

3. Perform a BACKGROUND SET by simultaneously pressing the "BACKGND" and "SET" keys on the keypad. The "SET" and "BACKGND" keys must be pressed continuously for about 10 seconds. The yellow "SET" LED will flash at a two second rate during this acknowledgement period.

NOTE: *The yellow "SET" LED will light continuously during the actual 6 minute BACKGROUND SET process.*

4. Once the "SET" LED goes out, the Background Set is complete.

8.1.2 Normal Set

1. Remove the opaque blocking plate from the Cal Kit to create 100% backscatter energy. Allow the Signal Voltage (S0) to stabilize.

2. Perform a NORMAL SET by simultaneously pressing the "NORM" and "SET" keys on the keypad. The "SET" and "NORM" keys must be pressed continuously for about 10 seconds. The yellow "SET" LED will flash at a two second rate during this acknowledgement period.

NOTE: *The yellow "SET" LED will light continuously during the actual 6 minute NORMAL SET process.*

3. Once the "SET" LED goes out, the Normal Set is complete.

(This page intentionally left blank.)

9.0 INSTALLATION

This section contains information about installing the basic *LaserHawk* 360P System. Information specific to the Optional Equipment may be found in Section 2.0 as well as the drawing appendix. The installation overview of the *LaserHawk* 360P System is shown on the Backscatter System Installation drawing in Appendix D. It is important that the optical center-line of the Optical Head be maintained so that the laser beam is pointed directly into the stack or duct.

9.1 PRE-INSTALLATION PLANNING AND PREPARATION

The engineering that precedes installation of the *LaserHawk* 360P is vital to successful operation of the instrument and must be performed consulting current environmental regulations, site construction, and maintenance personnel. Key factors that must be considered include:

- Location of the Optical Head. Issues such as vibration, ambient temperature range, stream turbulence, distance from bends, installation and maintenance access, and protection from environmental and mechanical hazards must be considered.

- Electrical power source, cable and conduit runs, overload protection, and provisions for safety disconnect.

- Signal cable run (distance, routing, and proximity to other electrical equipment).

- Access to the inside of the stack or duct, such that anyone could look into the laser beam, must be restricted.

- Location of the Warning Labels.

An installation packet containing a number of Teledyne Monitor Labs drawings and a document titled, "*LaserHawk* 360P Installation Checklist", is provided to the user soon after the purchase order for the equipment is received by Teledyne Monitor Labs. The Installation Checklist contains a number of questions that must be answered by the user before assembly and calibration of the system may begin at the Teledyne Monitor Labs factory.

9.2 SITE SELECTION

Without question, the single most important factor affecting overall performance of any continuous monitoring device is that of site selection. If this decision is not made prudently, monitor accuracy and reliability will suffer.

9.2.1 Representative Sampling Location

Guidelines on proper site selection for opacity monitoring are contained in the Code of Federal Regulations, Title 40, Part 60, Appendix B, Performance Specification 1 (PS-1), Section 4. Similar considerations apply to use of a Backscatter monitor in some applications. Title 40, Part 60 Appendix B Performance Specification 11 contains guidelines on installation and certification of particulate matter continuous emissions monitors (PM CEMS) and in some instances may be more appropriate than PS-1 for guidance on installation issues. For users seeking an international standard on the installation and characterization of PM CEMS, ISO10155-1995 may serve as a valuable reference document.

Other factors specific to the user's process must also be considered and weighed before final decisions are made regarding this important matter.

9.2.2 Access to Sampling Location

Ease of access to the stack mounted equipment is a factor that is nearly always underrated when deciding on an installation site. If the monitor location is only accessible via vertical ladders with extensive climbing involved, or in exposed outside areas where maintenance personnel are subject to extremes of wind, precipitation, or temperature, then monitor maintenance will suffer adversely in the long term. Without proper maintenance, reliability decreases and the access problems extend monitor outage during repair.

9.2.3 Environmental Conditions at the Sampling Location

The other important factor involved in site selection is to consider the potential conditions of the area where the stack equipment will be located. Ambient conditions at this location must not exceed the temperature range specified by Teledyne Monitor Labs. This will void the Teledyne Monitor Labs warranty.

The presence of potentially corrosive or toxic gases in the ambient air in the vicinity of the Optical Head and Purge System may deteriorate the condition of electrical connections such as IC sockets, connectors, etc., in the electronic assembly. This may also greatly reduce the expected life of the purge motor by causing early bearing failure. The hazards and limitations placed on servicing personnel would also reduce the basic reliability of the monitoring system.

9.3 FLANGE MOUNTING

The *LaserHawk* 360P mounts on a 4 inch 150 pound flange. Before the flange can be mounted, the stack or duct must be cut so that a clear path into the stack can be seen. This flange must be put up so that the mounting holes fall on vertical and horizontal lines. A distance between the flange and the stack or duct must be provided so that the mounting hardware can be accessed. This dimension must be at least 2 inches (50.8 mm). The flange must be welded to a 4 inch schedule 40

(American Standard) pipe. The pipe in turn must be attached to the stack or duct. THE LASER BEAM **MUST NOT TOUCH THE PIPE** BETWEEN THE OPTICAL HEAD ASSEMBLY AND GAS STREAM.

NOTE: *The distance between the flange and the stack or duct must be kept as short as possible but no less than 2 inches (50.8mm). The LaserHawk 360P has its best sensitivity in the first 3 feet (1-meter) of path length. Use of a long mounting pipe will have the LaserHawk 360P measuring the filtered purge air and not the stack effluent. If the stack is considered high temperature (+500 F) a distance of 6" is recommended so that radiant heat is minimized.*

9.4 POWER REQUIREMENTS

Power requirements for the standard *LaserHawk* 360P System are determined primarily by the Purge System. The system power requirements are listed in the specifications in Section 1.0. Please consult the Site Specification Data Sheets in Appendix A for your system configuration and power mains voltage to install your system.

9.5 PURGE AIR SYSTEM

CAUTION: ***Care must be taken to be certain that the purge air is in operation and connected BEFORE any of the optical components are mounted on the flange. Failure to provide purge air to the system components could result in damage to the system that will not be covered under the Teledyne Monitor Labs warranty.***

Power to the Purge System should be provided via a circuit that is always activated so long as the stack is in operation. This will prevent the inadvertent deactivation of the circuit causing potential damage to the optical components.

9.6 DATA CABLE

Two data cables are needed to interconnect the Six Point I/O Board (6PIO) to external devices. One is a 4 conductor #20 AWG (0.5 mm^2) cable for connecting the contacts from the two relays. The other one Teledyne Monitor Labs recommends is a 6-pair #24 AWG (0.25 mm^2) shielded cable for connection to the two analog outputs and two isolators. This would leave two pairs as spares or for future use. See Wiring Diagram in Appendix D for details on external connections to the 6PIO PC Board via the external interface board of the integral junction box.

NOTE: *If it is desired to use existing shielded cable, the shield MUST be terminated to earth ground using a Teledyne Monitor Labs Shield Termination Kit, Part No. 0650-0400-01, as per LaserHawk 360P System Wiring Diagram, 1810-0012 in Appendix D.*

9.7 MOUNTING THE OPTICAL HEAD ASSEMBLY

As mentioned previously, the purge air must be in operation and connected before mounting of the optical components. The mounting configuration of the Optical Head Assembly is described in the drawings in Appendix D of this manual.

Optical alignment of the system is accomplished as described in Section 7.0 Calibration & Checkout. Evaluation of the monitor output and calibration is covered in Section 8.0 Electronic Adjustment.

9.8 SAFETY WARNING LABELS

Advisory protective warning labels that indicate the relative hazard of laser light contained within the area shall be placed on ground level and instrument level structures.

10.0 TROUBLESHOOTING

The status code together with the System Properties values will define almost any system problem.

If a malfunction is indicated or you suspect a problem, go to the Optical Head LED display and write down the status code in the U3 Bank. Decode the status code according to the laminated card provided at the Optical Head or the definitions in Section 10.1 of this manual. This alone may point to the problem. Compare the values to historical values.

10.1 STATUS CODES (LOCATION U3)

0000 Normal: No errors detected.

XXX**1 Purge Fail Analyzer:** Check the blower operation, blower plumbing and Optical Head pressure switch.

XXX**4 Out of Service:** Place the analyzer back in service by setting the F6 Bank to zero using the Optical Head keypad and LED Display. (See Section 3.5.4.2.1.)

XX**1**X **ADC Fault:** This fault may occur when the particulate concentration is much greater than full scale and the Optical Head Optical Amplifier Board A-to-D converter saturates. There are other conditions beyond the scope of this manual that may also cause this fault. If you have occurrences of this fault and suspect they are not particulate concentration related, contact Teledyne Monitor Labs Technical Support at (800) 846-6062, option 3.

XX**2**X **Reference Fault:** Check the Reference Voltage value in the S1 Bank of the Optical Head LED display. Reference Voltage must be between +5VDC to +8VDC. Contact Teledyne Monitor Labs Technical Support at (800) 846-6062, option 3, if the Reference Voltage falls outside the allowable range.

X**4**XX **ANY SET in Progress:** Normal indication when performing SETs as described in Section 8.0. This status should clear when SETs are complete.

1XXX **Temperature Out of Limits**: Compare the temperature reading in the Sd Bank of the Optical Head LED display with the allowable limits listed in the EA and Eb Banks of the Optical Head LED display. Check the temperature sensor.

2XXX **Pressure Out of Limits:** Compare the pressure reading in the SE Bank of the Optical Head LED display with the allowable limits listed in the EC and Ed Banks of the Optical Head LED display. Check the pressure sensor.

4XXX **NORMAL SET Voltage Out of Range:** Check the Normal Set Voltage value in the S3 Bank of the Optical Head LED display. The Normal Set Voltage must be between +5VDC to +8VDC. Perform SETS as described in Section 8.0.

10.2 ASSISTANCE

If you are unable to determine the problem, call Teledyne Monitor Labs Technical Support at (800) 846-6062, option 3. An experienced factory trained technician will assist you.

11.0 MAINTENANCE

This section contains the information needed to provide proper maintenance. Proper periodic maintenance is discussed in this section as well as troubleshooting procedures. These maintenance and troubleshooting procedures are specific to the *LaserHawk* 360P.

11.1 MAINTENANCE

11.1.1 Maintenance Schedule

It must be noted that the conditions under which the monitoring system operates vary widely from installation to installation. However, Teledyne Monitor Labs has found the following schedule to be more than adequate to provide high monitor availability.

11.1.1.1 After Initial Installation

Teledyne Monitor Labs recommends that the optical surfaces of the Optical Head be inspected approximately 30 days after installation and again at 30 day intervals for the first 3 months of operation. This is a check to see that the purge air being supplied to the nozzle assembly is adequate and to confirm that the normal maintenance schedule routine will be sufficient. During these initial inspections, Teledyne Monitor Labs recommends that the "Maintenance Check Sheets for *LaserHawk* 360P System" be used to record the data collected while performing this maintenance. (See "Maintenance Check Sheets for *LaserHawk* 360P System" in Appendix B.)

11.1.1.2 Normal Maintenance

Under normal circumstances, Teledyne Monitor Labs recommends that the maintenance check be performed quarterly. The exception to this recommended schedule would be if the initial inspections performed after installation revealed that the ambient conditions of the monitor were so adverse that they require the purge air filter to be changed more frequently. Extremely dusty conditions in the area of the purge blower will cause the inlet filter to clog, thus reducing the volume of the protective purge air. Actual site experience must be used in order to develop an adequate replacement schedule for the purge air filter.

11.1.2 General Maintenance Procedures of Optical Head

The Optical Head Assembly is the only opto-electronic stack mounted assembly in the *LaserHawk* 360P system. It contains both the optics and electronics required to perform the backscatter function. This section describes the general maintenance procedures for this assembly.

11.1.2.1 Care of Optics

NOTE: *All internal optical elements have been aligned and set at the factory and should not be adjusted.*

During normal maintenance, only the exit windows of the Optical Head Assembly need to be cleaned. The cleaning solution should be a 50% alcohol and distilled water solution. Care should be taken not to use alcohol containing oily contaminates as this will leave a residue on the optical surfaces. Teledyne Monitor Labs recommends the use of a reagent grade isopropyl alcohol. An ammonia-based window cleaner may be used as a second resort so long as it does ***not*** contain an anti-fog additive. When excessive dirt does build up in the optical section, performance will be affected and these surfaces must then be cleaned.

WARNING: ***Be certain power to the laser drive circuit has been disabled during cleaning of the exit windows. Do not depress plunger on interlock switches during cleaning of the exit windows.***

11.1.2.2 Electronics

The electronics section normally requires little maintenance. Electronic adjustments are generally done as described in Section 8.0 using the Calibration Kit.

11.1.2.3 Purge Blower Air Filter

The Purge System has an air filter that prevents ambient dust from entering the Optical Head Assembly area. This filter must be changed periodically so that the proper amount of purge air is provided to the system. In typical locations, replacing the filter every 2-3 months should be adequate. However, observing this filter is important since the Optical Head Assembly's ability to keep stack effluent from contaminating the optics is dependent upon the proper amount of purge air. It is important that the purge housing cover protect the filter so that rain does not wash through the filter and allow water to enter the purge blower.

NOTE: *One of the primary causes of failure of blower motors is the location of the inlet to the Purge System. This system must draw non-contaminated air so that the lubricant in the bearings of the motor does not get contaminated.*

11.1.2.4 Desiccator

There is one desiccator located in the Optical Head Assembly of the *LaserHawk* 360P System. The Optical Head Assembly desiccator can be observed by swinging the Optical Head Assembly open and looking to the upper right hand corner of the assembly. When the desiccator is not completely spent, it will indicate a blue to blue/white color. When the desiccator indicates a pinkish color, it is completely spent. The desiccator may be reactivated by baking at 150 degrees Fahrenheit.

WARNING: ***Be certain power to the laser drive circuit has been disabled during desiccator removal. Do not depress plunger on interlock switches during desiccator removal.***

11.1.3 Procedure for Maintenance Check Sheet

TOOLS:

- Standard Common Screwdriver
- ¾" Open End Wrench or Adjustable Wrench

TEST EQUIPMENT:

- Instrument Calibration Kit Fixture
- Audit Standards

MISCELLANEOUS:

- 50% solution of distilled water & isopropyl alcohol, Windex or other commercially available glass cleaner --- ***Be certain that none of these contain an anti-fog additive.***
- Lint Free, Untreated Lens Cleaning Cloth
- Maintenance Check Sheets for *LaserHawk* 360P System (Appendix B)

The check sheet begins at the DAS / recording / final output device then moves to the stack mounted equipment. After the stack equipment checks are complete, the checklist moves back to the DAS/recording / final output device. Begin the checklist by filling in the information regarding serial number, location, date, and service person.

11.1.3.1 Reason for Service

Place a check or an "X" in the appropriate circle to indicate the reason maintenance is being performed. Explain any important information on the lines provided.

11.1.3.2. Final Output Device Checks

- Current Readings
    - Record the "As Found" particulate mass readings on the Final Output Device.

- Record the status, ON or OFF, of any available Operational Status Indicators on the Final Output Device: Faults / Alarms.

11.1.3.3 On Stack Checks

- Inspect
  - Purge Filter - Check condition of Purge Air Filter and replace if necessary. Record condition.
  - Flex Hose - Check the condition of the flex hose and replace if necessary. Record results.
  - Mounting Tube - Open the latch on the Optical Head and swing it open. Check the mounting tube for obstructions. Record condition of the mounting tube.
  - Desiccator - To access the Optical Head's desiccator, open the latch and swing the Optical Head Assembly open. Its desiccator is mounted on the top right of the front plate. If the desiccator is still useable, it will indicate a blue to blue/white color. When the desiccator indicates a pink color, it is completely spent. The desiccator may be reactivated by baking at 150 degrees Fahrenheit for several hours. Report condition of desiccator.

- Cleaning
  - Clean both the small laser exit window and the larger viewing window. A 50/50 mix of alcohol and water is recommended. Mark the data sheet to indicate that each optical surface was cleaned.

- Install the Cal Kit Fixture
  - Remove the protective cover from the Cal Kit. Install the Cal Kit Fixture on the face of the Optical Head Subassembly. Mark "OK" when finished.

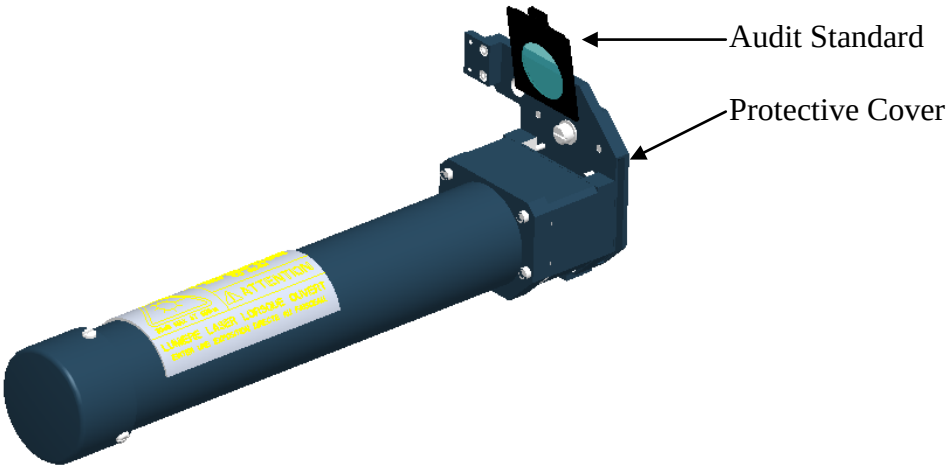
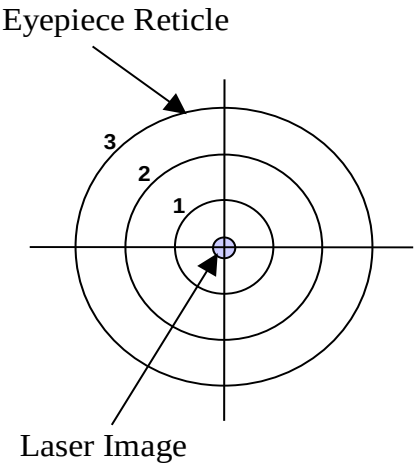


Figure 11-1
Cal Kit Fixture

- Alignment
  Observe the Laser beam image from the alignment eyepiece window at the rear of the Optical Head Assembly. The cross hairs of the reticule should be centered on the beam image and the outside edge of the RED Laser image must be inside of the # 1 ring of the eyepiece. Record the alignment condition on the data sheet. ***Laser alignment adjustment should only be performed by Factory technicians and a description is beyond the scope of this operator's manual.***



NOTE: *Wait for at least 3 minutes after all FAULT codes have been cleared before performing any SET functions. This is particularly important in the case of a Reference FAULT occurring immediately after any power cycle event.*

- ❑ Perform BACKGROUND SET

  - Create a 0.0% backscatter condition by inserting opaque blocking plate into the Cal Kit. Perform a BACKGROUND SET by simultaneously pressing the "BACKGND" and "SET" keys on the keypad. The "SET" and "BACKGND" keys must be pressed continuously for about 10 seconds. The yellow "SET" LED will flash at a two second rate during this acknowledgement period. The "SET" LED will then come on continuously and stay lit for about 6 minutes. Once the "SET" LED goes out, remove the opaque blocking plate. Mark "OK" when finished.

NOTE: *The yellow "SET" LED will light continuously during the actual 6 minute BACKGROUND SET process.*

- ❑ Perform NORMAL SET

  - With no Audit Standard in the Cal Kit, simultaneously press the "NORM" and "SET" keys on the keypad until the "SET" LED quits blinking. The "SET" and "NORM" keys must be pressed continuously for about 10 seconds. The yellow "SET" LED will flash at a two second rate during this acknowledgement period. Once again the "SET" LED will light continuously for about 6 minutes. Leave the unit undisturbed until the set light goes out. During this period, the 100% backscatter reference is established. Mark "OK" when finished.

NOTE: *The yellow "SET" LED will light continuously during the actual 6 minute NORMAL SET process.*

- ❑ Cal Kit Readings, Audit Standard Checks

  - Be certain that the Blocking Disc and all Audit Standards have been removed from the Cal Kit Fixture. Then record the reading from Location U2 in the "100% Backscatter" column in the check sheet. Allow sufficient time for the instrument to stabilize – at least two averaging periods.

  - Install each of the Audit Standards successively and record their responses from location U2 in the "Low" and "Mid" columns of the check sheet. Again, remember to wait at least two averaging periods between the "Low" and "Mid" readings so that the U2 reading has time to stabilize.

- Remove the Audit Standards and insert the Blocking Disc. After at least two averaging periods, record the stabilized location U2 readings in the "Zero Backscatter" column of the check sheet.

These data will be compared to those from the permanent data recorder and Audit Standard values in a later step.

- ❑ Remove the Cal Kit Fixture. Mark "OK" when finished. Close the Optical Head Assembly.

- ❑ Install the weather cover. At this time all stack checks are completed. Return to the Final Output Device location.

11.1.3.4 Data Collection

- ❑ Check Recorder Output

  - Examine the recorder or data collection device for the Audit Standard values that were collected during the Cal Kit checks. Record them under "Output Value" in the table located in Section (3)F. Compare these values with the Audit Standard values for the absolute difference. Enter this difference in the table. It should be ≤ 2% Backscatter.

- ❑ Fill in Section (2)A "AS LEFT"

  - Record the Instantaneous and Average Backscatter values **"AS LEFT"** in Section (2)A**.**

12.0 SAFE USE OF LASERS

12.1 APPLICATION

The objective of this section is to provide reasonable and adequate guidance for the safe use of lasers and laser systems. A practical means for accomplishing this is first to classify lasers and laser systems according to their relative hazards and then to specify appropriate controls for each classification.

The basis of the hazard classification scheme is the ability of the primary laser beam or reflected primary laser beam to cause biological damage to the eye or skin during intended use. The Teledyne Monitor Labs *LaserHawk* 360P Particulate Matter Monitor is classified as a Class 1 laser system; however, during service functions access to the laser beam may be required, exposing an embedded Class 3b laser classification. In the *LaserHawk* 360P, laser power up to 35 mW at 655 nm could be accessible in the interior if the interlocks are defeated. Beam divergence of the laser energy that is emitted from the monitor does not exceed 1.25 milli-radians.

It must be recognized that the classification scheme given in this manual relates specifically to the laser product and its potential hazard, based on operating characteristics. However, the conditions under which the laser is used, the level of safety training of individuals using the laser, and other environmental and personnel factors are important considerations in determining the full extent of safety control measures. Since such situations require informed judgments by responsible persons, major responsibility for such judgments has been assigned to a person with the requisite authority and responsibility, namely the Laser Safety Officer (LSO).

Teledyne Monitor Labs recommends that the users obtain a copy of and follow the requirements in the ANSI Z136.1 “Standard for the Safe Use of Lasers”. That document is available from the Laser Institute of America in Florida at (407) 380-1553.

12.2 LASER SAFETY OFFICER (LSO)

An individual should be designated the Laser Safety Officer (LSO) with the authority and responsibility to monitor and enforce the control of laser hazards, and to effect the knowledgeable evaluation and control of laser hazards.

In some instances, designation of an LSO may not be required. Operations and maintenance of Class 1 lasers and laser systems normally do not require the designation of an LSO. However, the *LaserHawk* 360P has an embedded Class 3b laser classification when service is performed on the laser system. For such instances, the designation of an LSO may be the responsibility of the organization requiring access to the embedded laser or laser system, such as the service company or organization.

12.3 GENERAL OPERATION AND MAINTENANCE

During general operation and maintenance the *LaserHawk* 360P is a Class 1 laser system incapable of producing damaging radiation levels and is therefore exempt from any control levels or other forms of surveillance.

The monitor is only intended to be used in installations with the laser beam directed into a stack or duct that is entered only during service by trained personnel. If entry to the stack or duct is required, power to the laser system should be turned off. The *LaserHawk* 360P is not intended to be used in any applications that could allow access to laser energy during operation. Any attempt to remove the monitor and operate it outside of the installation may result in hazardous laser light exposure.

12.3.1 Stack Controls and Adjustments

Refer to Section 7.0 Calibration & Checkout.

12.4 SERVICE

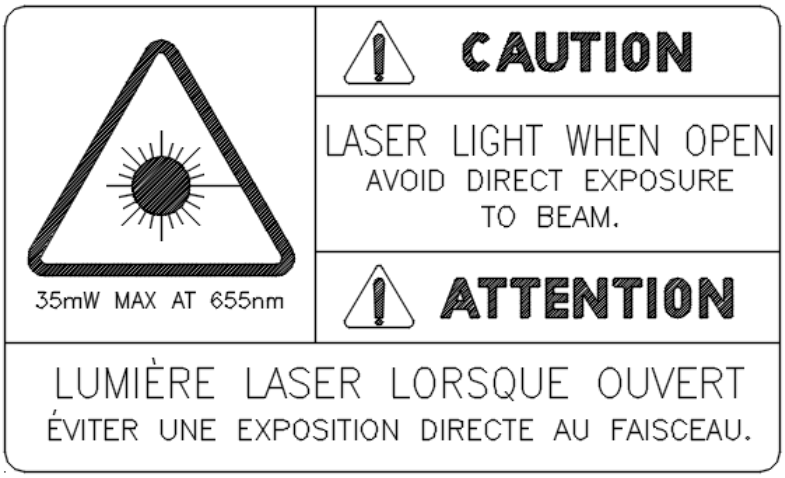
Service functions are usually performed with far less frequency than maintenance functions and usually require access to the laser beam by those performing the service functions. It should be noted that during periods of service, control measures appropriate to the class of the embedded laser shall be implemented when the beam enclosures are removed and beam access is possible. The fact that beam access is possible during service procedures will not alter the classification of the laser system, which is based upon beam access conditions during operation.

12.5 EQUIPMENT LABELS

Advisory protective housing labels that indicate the relative hazard of laser light contained within the housing shall be placed on all removable protective housings, which have no safety interlock and which can be removed or displaced during operation, maintenance, or service, and thereby allow access to laser light in excess of the applicable maximum permissible exposure.

12.5.1 Purge System Cover Warning Label

The Purge System Cover warning label is an advisory label warning personnel of the possible exposure to laser light if opened. The labels are affixed to the Purge System Cover in two places, on opposite sides, during manufacturing at Teledyne Monitor Labs. See Figure 12-1.



PURGE SYSTEM COVER WARNING LABEL

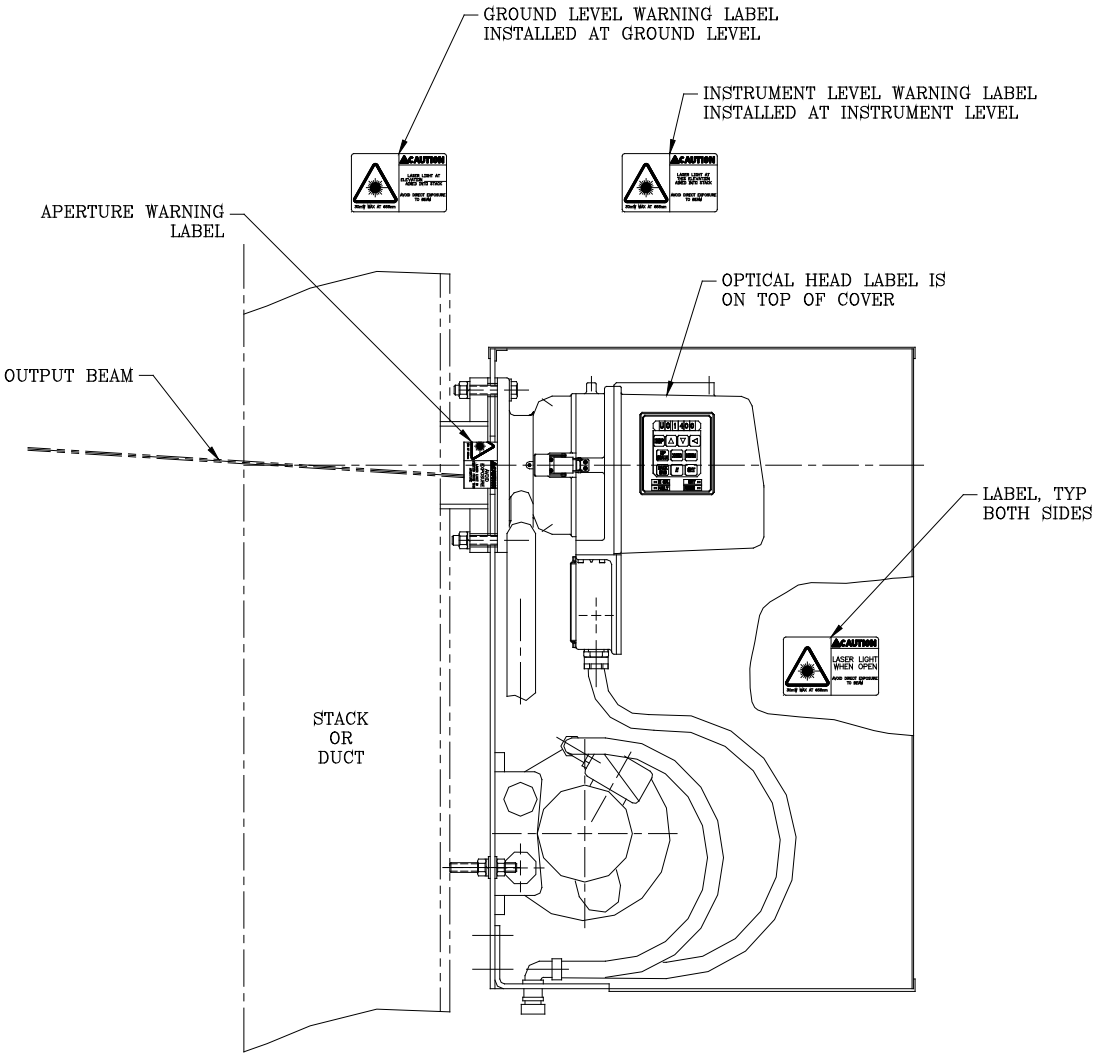
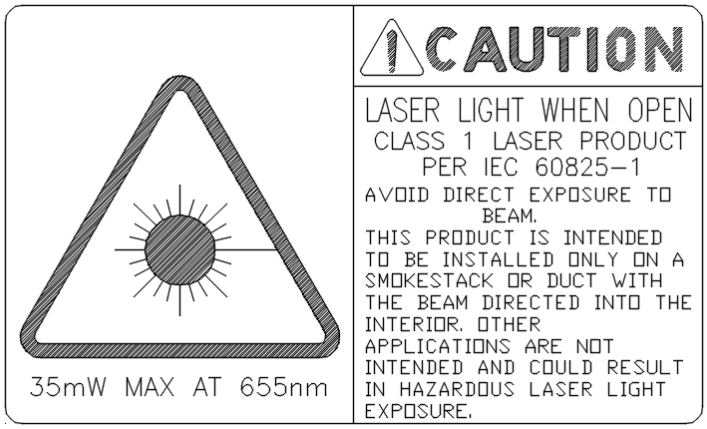


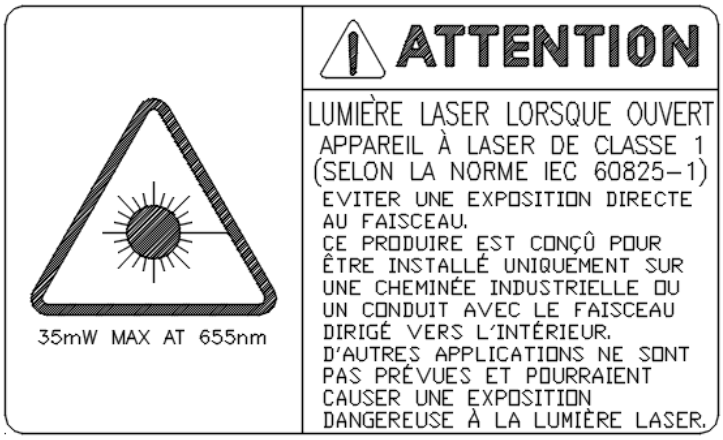
Figure 12-1
***LaserHawk* 360P System Installation**

12.5.2 Optical Head Cover Warning Label

The Optical Head Cover warning label is an advisory label warning personnel of the possible exposure to laser light if removed. The Optical Head Cover is a removable protective housing, enclosing the optics and electronics. The English label is affixed to the top of the Optical Head cover and the French label is affixed to the side of the Optical Head cover during manufacturing at Teledyne Monitor Labs.



OPTICAL HEAD COVER WARNING LABEL, ENGLISH



OPTICAL HEAD COVER WARNING LABEL, FRENCH

12.5.3 Middle Housing Warning Label

The instrument Middle Housing warning label is an advisory label warning personnel of exposure to laser light if the interlock switches are defeated.

The label is affixed to the front of the instrument Middle Housing during manufacturing at Teledyne Monitor Labs. (See Figure 12-2.) The label is only visible when the latch on the Optical Head Assembly is released, and the assembly is rotated on its hinges away from the Purge Housing. (See Figure 12-1.) When the pressure on the interlock switch plunger is released, both switches open and the laser light is turned off.

MIDDLE HOUSING WARNING LABEL

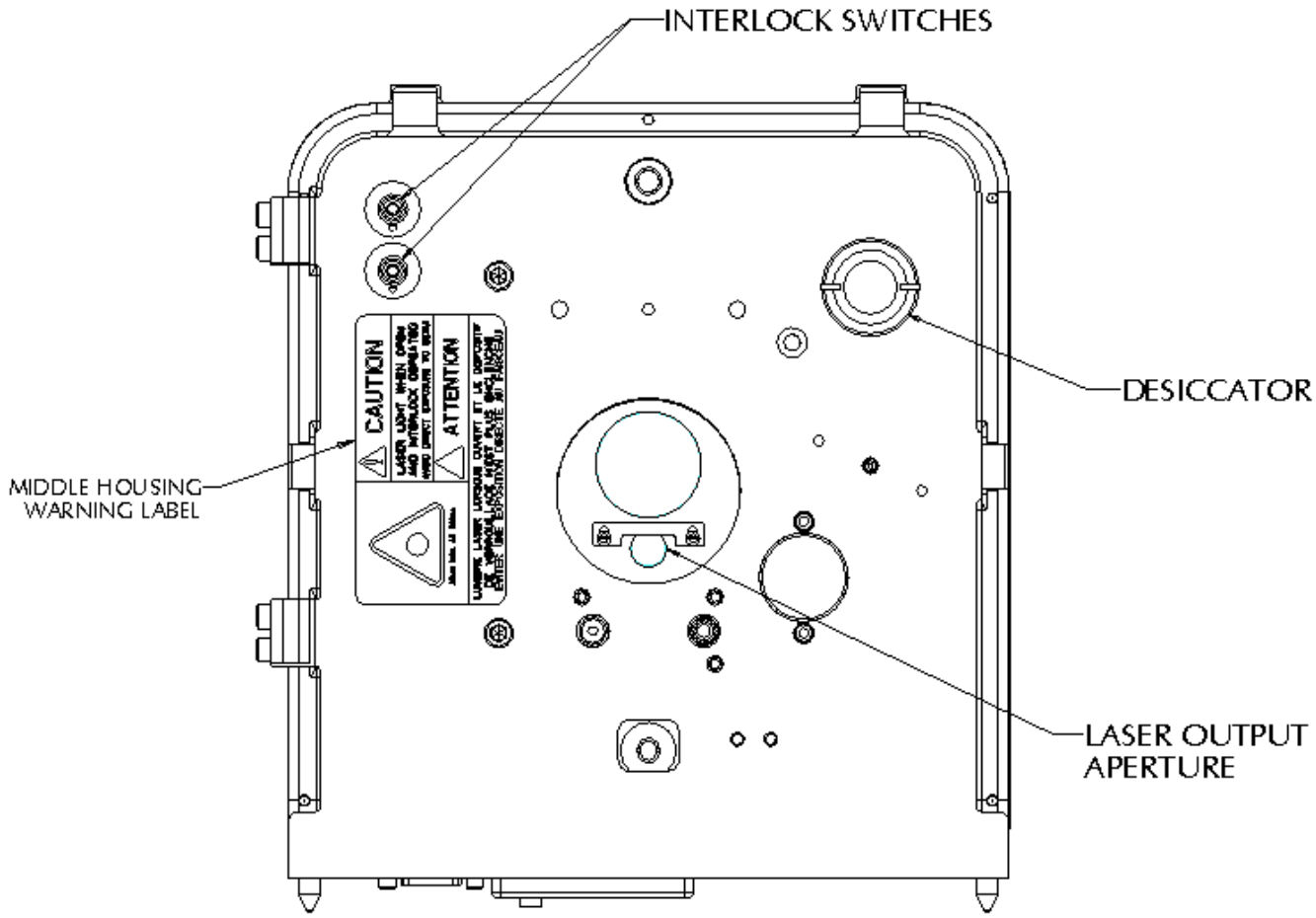
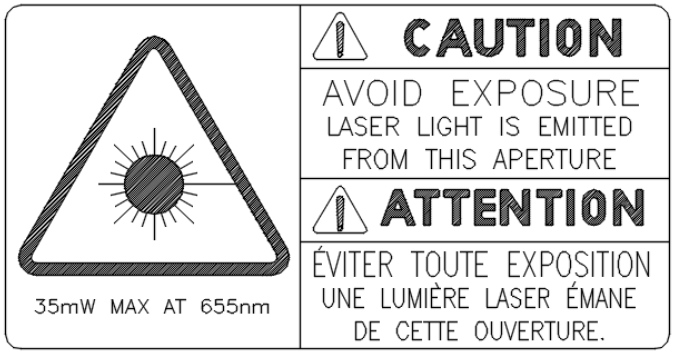


Figure 12-2
Rear Optical Section When Open

12.5.4 Purge Nozzle Warning Label

The Purge Nozzle warning label is an advisory label warning personnel of exposure to laser light being emitted from the nozzle aperture. The label is affixed to the Purge Nozzle during manufacturing at Teledyne Monitor Labs.



PURGE NOZZLE WARNING LABEL

12.5.5 Cal Kit Warning Label

The Cal Kit warning label is an advisory label warning personnel of possible exposure to laser light being emitted from the Cal Kit aperture. This normally could happen if the user inserts a reflective surface into an open section of the Cal Kit or removes the rear cap during calibration and maintenance as described in Section 7.1.2. The label is affixed to the Cal Kit during manufacturing at Teledyne Monitor Labs. The label is placed toward the aperture end of the Cal Kit, keeping it visible to calibration and maintenance personnel. See Figure 12-3. The Cal Kit warning label looks exactly like the Purge System Cover warning label pictured in Section 12.5.1 previously.

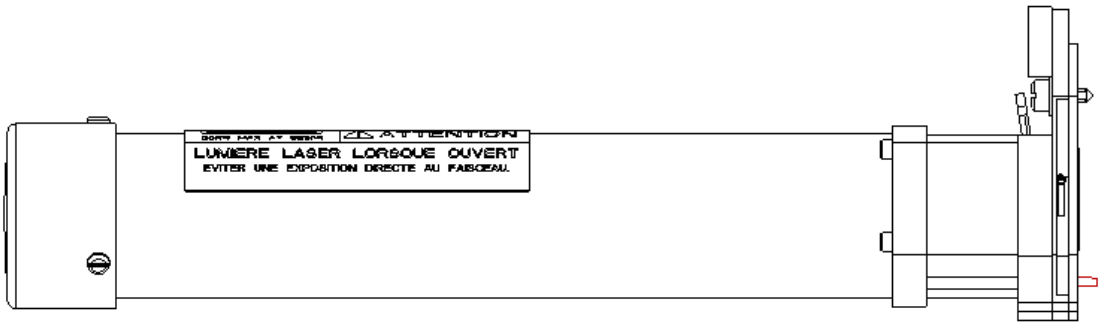
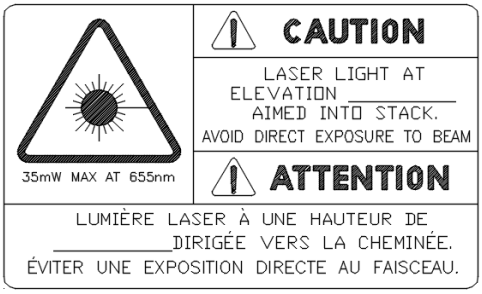


Figure 12-3
Cal Kit Assembly

12.5.6 Ground Level Warning Label

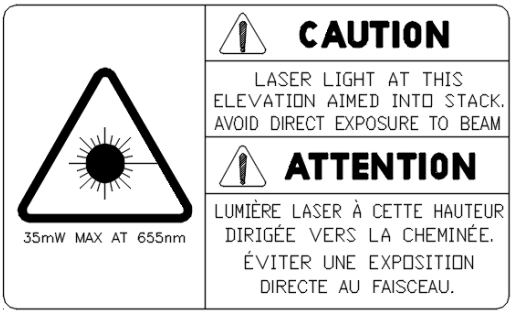
The Ground Level warning label is an advisory label warning personnel that a laser or laser system is installed at a certain elevation noted on the label. The label is installed by authorized plant personnel, such as the Laser Safety Officer, at a suitable location on any means of approach to the monitor and at any means of access into the stack or duct. These include elevators, ladders, access panels, hatches, doors, etc. If an elevator provides access to the installation, a warning label shall be placed inside of the elevator. The plant LSO shall verify the correct elevation is noted on the label. See Figure 12-1.



GROUND LEVEL WARNING LABEL

12.5.7 Instrument Level Warning Label

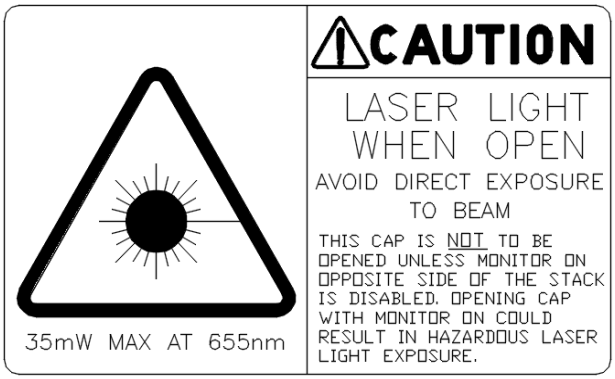
The Instrument Level warning label is an advisory label warning personnel that a laser or laser system is installed at the elevation of this label. The label is installed by authorized plant personnel, such as the LSO, at the elevation of the installed laser or laser system. The label shall be affixed at a suitable location on any means of approach or any means of access, including elevators, ladders, access panels, hatches doors, etc. See Figure 12-1.



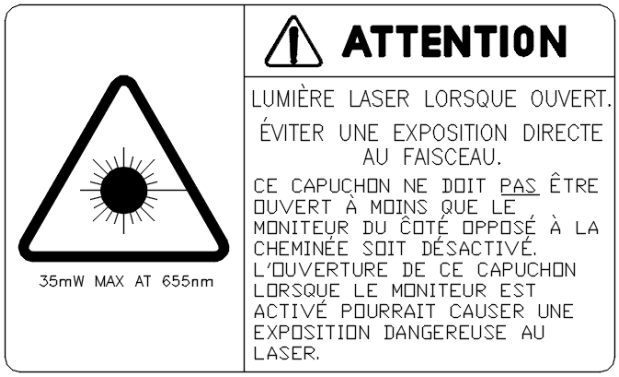
INSTRUMENT LEVEL WARNING LABEL

12.5.8 Light Trap Warning Label

The Light Trap warning label is an advisory label warning personnel of possible exposure to laser light being emitted if the cap is opened for service. The label is affixed to the Light Trap during manufacturing at Teledyne Monitor Labs. The English label is placed on the cap, the French label is placed on the side keeping it visible to calibration and maintenance personnel.



LIGHT TRAP WARNING LABEL, ENGLISH



LIGHT TRAP WARNING LABEL, FRENCH

APPENDIX A

SITE SPECIFICATION DATA SHEETS

(This page intentionally left blank.)

5/7/2015

SITE SPECIFICATION DATA

Teledyne Monitor Labs *LaserHawk* 360P Particulate Matter Monitor

COMPANY:

TML SHOP ORDER NO: CAL DATE:

UNIT SERIAL #: UNIT ID:

CAL. TECHNICIAN:

I. OPTICAL HEAD

Mother Board PN: SN:
Computer Module PN: SN:
Optical Amplifier PN: SN:
Display Board PN: SN:

Laser Field of View feet meters
Mounting Tube Length inches

A. SIX POINT I/O:

YES	
NO	

PN: SN:

OUTPUT UNITS F(0) Backscatter = 1, Part Mass = 3
OUTPUT FULL SCALE F(E)

HARDWARE CURRENT RANGE

OUTPUT #1	*JU1*		0 or 1
	JU2		0 or 1
OUTPUT #2	*JU3*		0 or 1
	JU4		0 or 1

SOFTWARE RANGE FOR CURRENT OUTPUT

JU9		4 or 0	4 = 4-20ma, 0 = 0-20ma

RELAY JUMPERS

K1: JU12		A through H
K1: JU14		NC = Normally Closed or NO = Normally Open
K2: JU13		A through H
K2: JU15		NC = Normally Closed or NO = Normally Open

ISOLATOR INPUT JUMPERS **(Not used)**

ISO1: JU7		A, B or C
ISO1: JU5		DRY or +5V
ISO2: JU8		A, B or C
ISO2: JU6		DRY or +5V

B. POWER SUPPLY

PN: SN:

+15 VDC:		*21 / S(8)*
-15 VDC:		*22 / S(9)*
+5 VDC *analog*:		*23 / S(A)*
-5 VDC *analog*:		*24 / S(B)*
+5 VDC *digital*:		*25 / S(C)*

C. "AS SHIPPED" CONFIG.

SIGNAL VOLTS		*13 / S(0)*	AVG. INTERVAL		*89 / F(B)*
REF. VOLTS		*14 / S(1)*	STACK 332 VERSION:		*94 / U(A)*
LASER CURRENT		*15 / S(2)*	STACK NEURON VER:		*95 / U(B)*
NORMAL SET VOLTS		*16 / S(3)*	SIGNAL GAIN:		*99 / F(8)*
BCK GRD SET VOLTS		*18 / S(5)*	REFERENCE GAIN:		*100 / F(9)*
			COMMON GAIN:		*101 / F(A)*
OPTICAL AMPLIFIER BOARD JU3 JUMPER			TEMP. CORRECTION		*104 / E(8)*
			PRESS. CORRECTION		*105 / E(9)*

II. PURGE SYSTEM

SINGLE BLOWER CFM

Dual BLOWER (Used w/ Light Trap)

INSTRUMENT AIR

SITE SPECIFICATION DATA

Teledyne Monitor Labs *LaserHawk* 360P Particulate Matter Monitor

COMPANY: _____

TML SHOP ORDER NO: _____ CAL DATE: _____

UNIT SERIAL #: _____ UNIT ID: _____

CAL. TECHNICIAN: _____

III. LIGHT TRAP

YES	
NO	

IV. CALIBRATION KIT _____ 1810-0640-01 360P Standard _____ -02 360P Long Ports

A. IRIS OPENING DIAMETER

_____ decimal inches, approximate, enter 0.38" as 0.38

_____ Cap Type

_____ ND Filter (No or type)

B. AUDIT STANDARD VALUES:

BACKSCATTER

1) _____

2) _____

3) _____

V. DUAL ANALOG INPUT MODULE _____

Dual Analog Board PN: _____ SN: _____

BP Sensor PN: _____ SN: _____

Power Supply PN: _____ SN: _____

TEMPERATURE CHANNEL

JU1		RTD or CUR or VOL
JU4		A or B
JU7		A or B

PRESSURE CHANNEL

JU2		CUR or VOL	REF TEMP.	*102 / F(C)*
JU3		INT or EXT	REF PRESS.	*103 / F(D)*

NETWORK TERMINATORS

JU5		IN or OUT
JU6		IN or OUT

VI. ETHERNET MODULE

PN: _____ SN: _____

MAC: _____

Ethernet Neuron Ver: _____ Web Server: _____

Use Static IP: _____

IP Address: _____

Subnet Mask: _____

Default Gateway: _____

Rev. 6/12/15

Teledyne Monitor Labs
MAINTENANCE CHECK SHEETS for *LASERHAWK* 360P SYSTEM

PLANT NAME _____ **LOCATION** _____

SERVICE PERSON _____ **SERIAL #** _____ **DATE** _____

(1) REASON FOR SERVICE

ROUTINE ◯ **EMERGENCY** ◯ **INSTALL** ◯ **OTHER** ◯
EXPLAIN: _____

_____

(2) FINAL OUTPUT DEVICE CHECKS

A. CURRENT BACKSCATTER READINGS

	INST BACKSCATTER	AVG BACKSCATTER
AS FOUND	_____ %	_____ %
AS LEFT	_____ %	_____ %

B. FAULT OR ALARM INDICATORS (if provided)

	Inst. Malf	Purge Fail	Inst. Alm	Avg. Alm
ON	◯	◯	◯	◯
OFF	◯	◯	◯	◯

(3) ON STACK CHECKS

A. INSPECT

	PURGE AIR FILTER	FLEX HOSE	MOUNTING TUBES	DESICCATOR
OK	◯	◯	◯	◯
CLEANED	◯	◯	◯	◯
REPLACED	◯	◯	◯	◯

COMMENTS: _____
_____

B. CLEAN: EXIT WINDOWS ☐ LIGHT TRAP ☐

Rev. 6/12/15

C. ***INSTALL*** CAL KIT FIXTURE **OK** ☐ **OTHER** ☐

	OPTICAL ALIGNMENT LASER
OK	◯
ADJUSTED	◯

D. PERFORM BACKGROUND SET **OK** ☐ **OTHER** ☐

E. PERFORM NORMAL SET **OK** ☐ **OTHER** ☐

F. CAL KIT READINGS

	100% Backscatter	LOW	MID	Zero Backscatter
AUDIT STANDARD VALUE				
LASERHAWK READING				
OUTPUT VALUE (DAS)				
DIFFERENCE (+/- 2.0 %)				

G. ***REMOVE*** CAL KIT FIXTURE **OK** ☐ **OTHER** ☐

(4) **DATA COLLECTION**

A. RECHECK OUTPUT DEVICE VALUES ABOVE **OK** ☐ **OTHER** ☐

B. FILL IN BACKSCATTER READINGS SECTION 2A: **"AS LEFT"** **OK** ☐ **OTHER** ☐

NOTES OR RECOMMENDATIONS :

APPENDIX C

SPARE PARTS

(This page intentionally left blank.)

RECOMMENDED SPARE PARTS

Recommended spare parts for the *LaserHawk* 360P Particulate Matter Monitor are organized into three categories. User can stock the appropriate parts for their level of maintenance. The three lists do not overlap. For the highest level of maintenance all three lists should be stocked. For normal maintenance the Start Up/Operational and Normal Wear and Maintenance lists should be stocked. The three levels are:

- ❑ Start Up/Operational
  - Parts and supplies that may be used during start up and daily operation.
- ❑ Normal Wear and Maintenance
  - Parts that may be required as a result of normal wear over time.
- ❑ Emergency/Quick Response
  - Parts that will facilitate the fastest possible repair time in failure situations such as power surges, lightning strikes, etc.

"Start Up/Operational" Spare Parts

The following table represents a selection of parts and supplies that may be required during start up and normal operation.

This is the least comprehensive list. These parts will support only a minimal maintenance level.

TELEDYNE MONITOR LABS (TML) *LASERHAWK* 360P "START UP/OPERATIONAL" RECOMMENDED SPARE PARTS							
Part Name	**TML Part #**	**System Location**	**Stocking Quantity 1 on Site**	**Stocking Quantity 2 – 5 on Site**	**Stocking Quantity 5 – 10 on Site**	**Monitor Recal Required After Replacement**	**Mean Time Between Replacement**
Fuse (1.25A)	527441	Optical Head Power Supply Board	5	5	5	No	N/A
Fuse (5.0 A)	527418	Optical Head	5	5	5	No	N/A
***** Purge Filters	528873	Purge System	12	24	48	No	N/A
Wipes	550026	General	1 Box	1 Box	2 Boxes	N/A	N/A
Lens Cleaning Fluid	530023	General	1 Bottle	1 Bottle	1 Bottle	N/A	N/A
Desiccator (Head)	997788	Optical Head Assembly	1	2	3	No	N/A

NOTE: ***** Not needed if Instrument Air Purge option is chosen.

"Normal Wear and Maintenance" Spare Parts

These are parts that may be used as a result of normal wear over time.

TELEDYNE MONITOR LABS (TML) *LASERHAWK* 360P "NORMAL WEAR AND MAINTENANCE" RECOMMENDED SPARE PARTS							
Part Name	**TML Part #**	**System Location**	**Stocking Quantity 1 on Site**	**Stocking Quantity 2 - 5 on Site**	**Stocking Quantity 5 - 10 on Site**	**Monitor Recal Required After Replacement**	**Estimated Mean Time Between Failures**
Purge Switch	528312SP	Optical Head	1	2	4	No	3-5 Yrs.
***** Purge Hose 1-1/4" Dia.	980540 980541	Purge System (STD) Hi-Temp	2 Ft.	6 Ft.	10 Ft.	No	2-5 Yrs.
***** Hose Clamp	980537	Purge System	2	4	6	No	N/A
Lithium Battery	550047	Optical Head Motherboard	1	2	3	No	3-5 Yrs

NOTE: ***** Not needed if Instrument Air Purge option is chosen.

"Emergency/Quick Response" Spare Parts

The following is a list of spares that the user may wish to keep on hand in order to minimize system downtime in the event of an unforeseen failure such as power surges, lightning strikes, etc.

TELEDYNE MONITOR LABS (TML) *LASERHAWK* 360P
"EMERGENCY/QUICK RESPONSE" RECOMMENDED SPARE PARTS

Part Name	TML Part #	System Location	Stocking Quantity 1 on Site	Stocking Quantity 2 - 5 on Site	Stocking Quantity 5 - 10 on Site	Monitor Recal Required After Replacement	Estimated Mean Time Between Replacement
Optical Amplifier PCB	1860-0400-03	Optical Head	1	1	1	Yes	N/A
* *LaserHawk* 360P Mother Board PCB	1860-0500-05	Optical Head	1	1	1	Yes	N/A
Display/Control PCB	1860-0600-01	Optical Head	1	1	1	No	N/A
**6 Point I/O PCB	1860-0700-01	Optical Head	1	1	1	No	N/A
** Control Module PCB	515445	Optical Head	1	1	1	No	N/A
Power Supply PCB	1860-1100-02	Optical Head	1	1	1	No	N/A
Keypad	1810-0190-01	Optical Head	1	1	1	No	N/A
Keypad Pnl. Gasket	1860-0193-01	Optical Head	1	1	1	No	N/A
*** Blower Motor	980142	Purge System	1	1	1	No	3-5 Yrs.
Signal Detector Assy.	1810-0230-01	Optical Head	1	2-5	5-10	Yes	N/A

NOTE: * Mother Board (1860-0500-05) includes one Control Module (515445).

** Needed only if Direct Interface option is chosen.

*** Not required if Instrument Air Purge option is chosen.

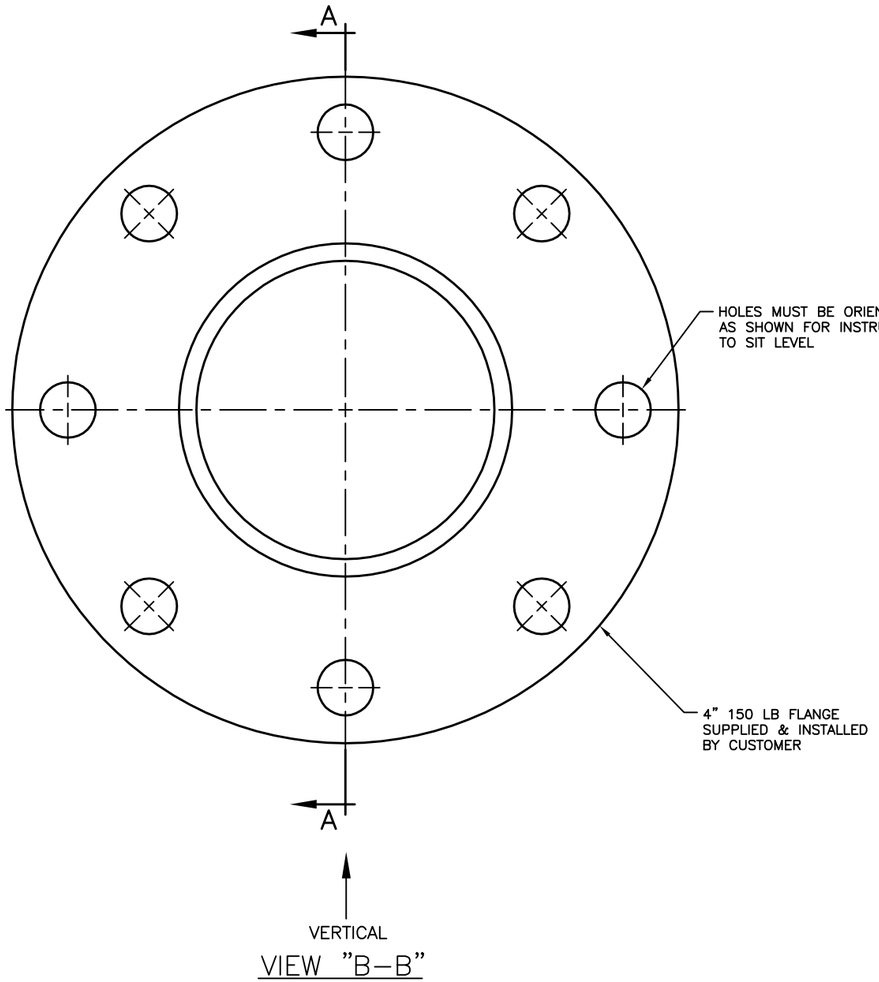
APPENDIX D

DRAWINGS

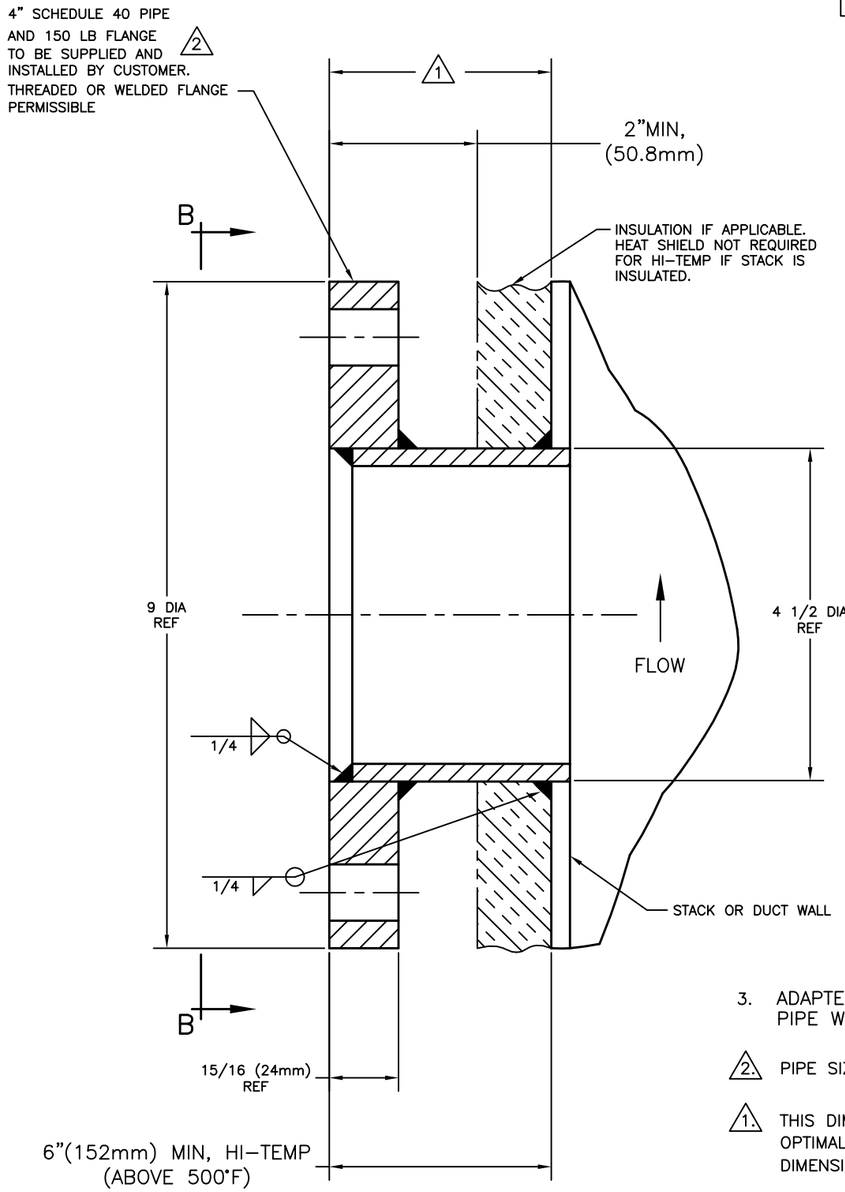
(This page intentionally left blank.)

DWG. NO	SH
1810–0013	1

REVISIONS				
ZONE	SYM.	DESCRIPTION	DATE	APPD.
	A	RELEASE FOR PRODUCTION	12–15–05	ELM



VIEW "B–B"



SECTION "A–A"

3. ADAPTER PLATES ARE AVAILABLE FOR 3",5" & 6" PIPE WITH 150# FLANGES.

2. PIPE SIZES ARE AMERICAN STANDARD.

1. THIS DIMENSION SHOULD BE KEPT TO A MINIMUM FOR OPTIMAL PERFORMANCE. CONTACT THE FACTORY IF THIS DIMENSION EXCEEDS 8".

NOTES:

DIMENSIONAL TOLERANCES
UNLESS OTHERWISE SPECIFIED

FRACTIONS	DECIMALS	ANGLES
0 TO 4 ±1/32	.XX ±.01	±0°30'
4 TO 8 ±1/16	.XXX ±.005	RMS FINISH
8 AND UP ±1/8		√

ALL DIMENSIONS ARE IN INCHES
DO NOT SCALE THIS DRAWING

AUTHORIZATION	BY	DATE
DRAWN	EAS	3–17–05
CHECKED	EAS	Apr–05
DESIGNED	EAS	Mar–05
ENGINEERED	ELM	4–20–05
PRODUCTION	GA	1–4–06
Q.A.	AS	1–4–06

PROJECTION

USED ON	
DASH NO	NEXT ASSEMBLY
–01	

MAT'L.

FINISH

JIG NO.

SCALE 1:1

SHEET 1 OF 1

TELEDYNE MONITOR LABS
A Teledyne Technologies Company

TITLE
360
BACKSCATTER MONITOR
FLANGE MTG. METHODS

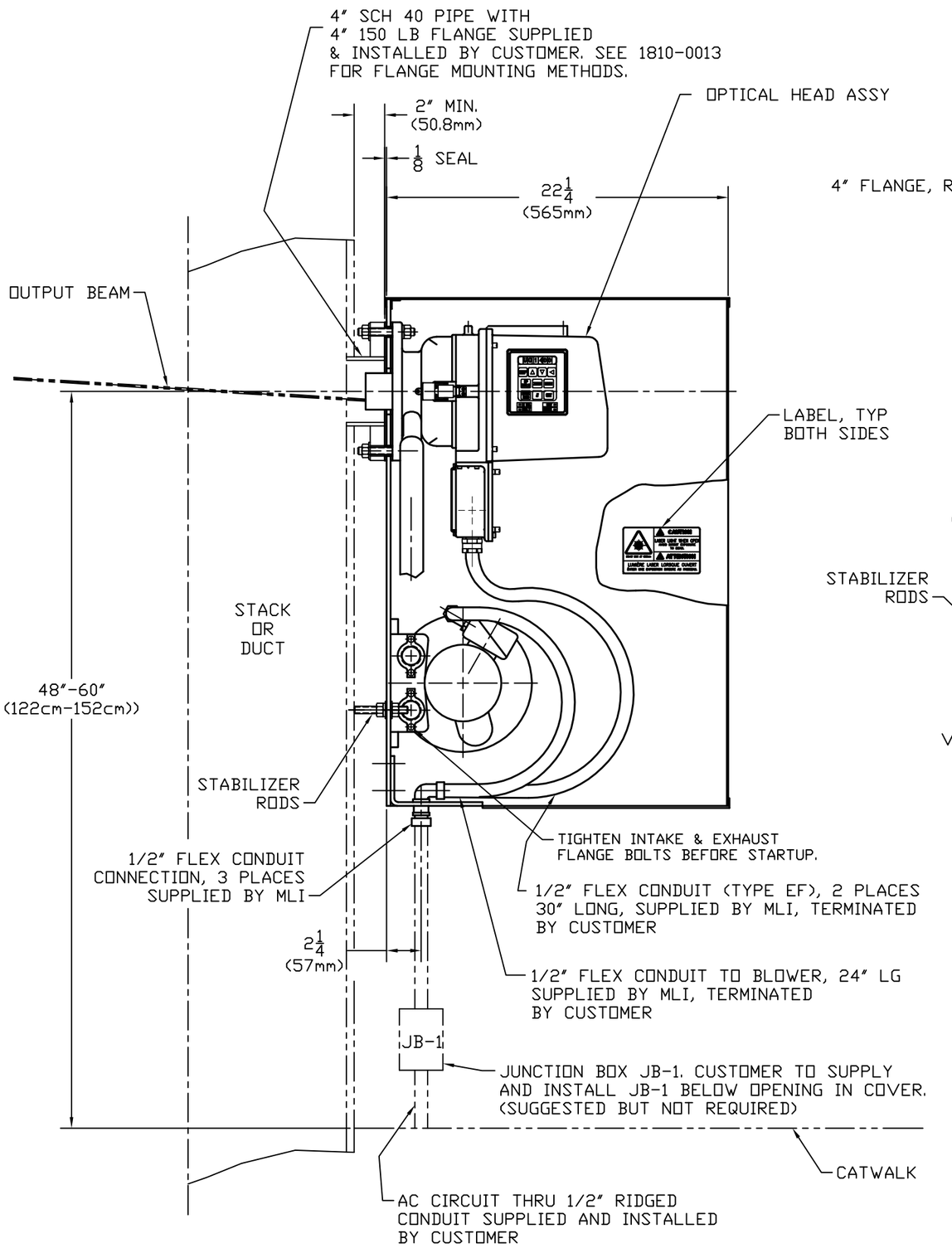
DRAWING NO. D 1810–0013 LATEST REVISION A

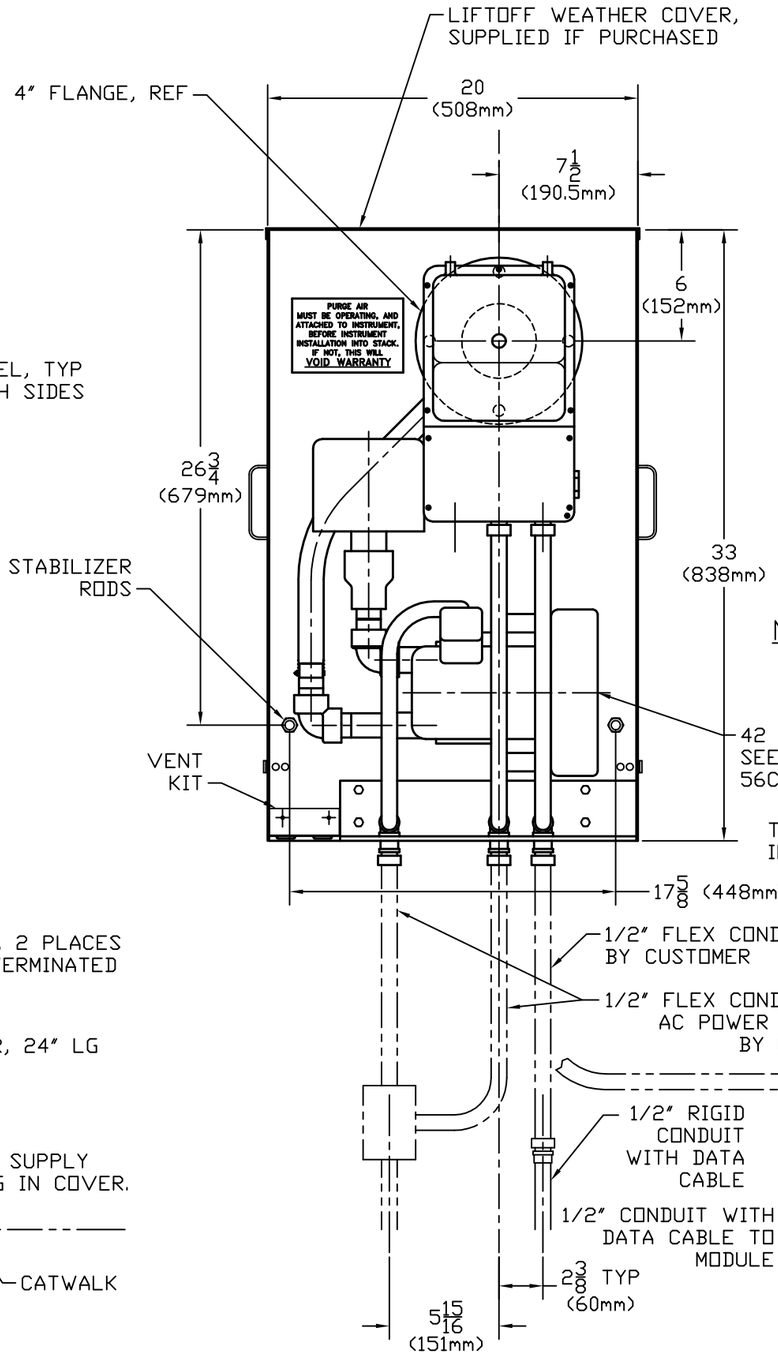
12–15–05

ACAD2004 FILE: 18100013

DVG. NO 1810-0015 SH 1

REVISIONS				
ZONE	SYM.	DESCRIPTION	DATE	APPD.
	A	RELEASE FOR PRODUCTION	12-14-05	ELM
	B	PER DCN 1810-0015B	1-3-08	ELM
	C	NO CHANGE THIS SHEET	3-19-09	ELM
	D	NO CHANGE THIS SHEET	6-16-11	EAS
	E	PER DCN 1810-0015E	6-9-14	JL





SEE SHEET 2 FOR HI-TEMP
SEE SHEET 3 FOR INSTR. AIR
SEE SHEET 4 FOR LIGHT TRAP, SINGLE BLOWER (OBSOLETE)
SEE SHEET 5 FOR LIGHT TRAP, DUAL BLOWERS
SEE SHEET 6 FOR LIGHT TRAP, INSTR. AIR
SEE SHEET 7 56CFM BLOWER OPTION

3 IF STACK DIA IS 6.5FT (2 meters) OR LESS
A LIGHT TRAP MAY BE REQUIRED. CONSULT FACTORY.
SEE SHEET 4 FOR LIGHT TRAP INSTALLATION.

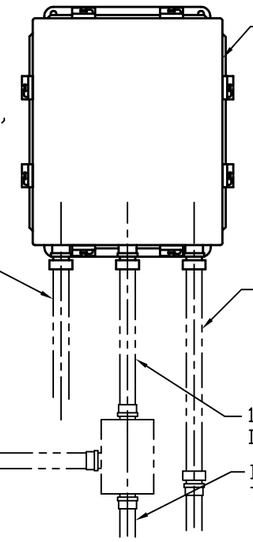
2. AFTER FINAL INSTALLATION AND STARTUP:

a) VERIFY THAT ALL WARNING LABELS ARE AFFIXED AT THE SUITABLE LOCATIONS ON ANY MEANS OF APPROACH TO THE MONITOR AND AT ANY MEANS OF ACCESS INTO THE STACK OR DUCT. THESE INCLUDE ELEVATORS, LADDERS, ACCESS PANELS, HATCHES, DOORS ETC.

b) VERIFY THAT THE WARNING LABEL ON THE REAR COVER WOULD BE VISIBLE IN THE INSTALLED CONFIGURATION PRIOR TO THE REMOVAL OF THE MONITOR, SHOULD THAT BE NEEDED.

1. FOR WIRING DIAGRAM SEE DRAWING 1810-0012

NOTES:



DIMENSIONS IN () ARE METRIC

DIMENSIONAL TOLERANCES
UNLESS OTHERWISE SPECIFIED
FRACTIONS 0 TO 4 ±1/32, 4 TO 8 ±1/16, 8 AND UP ±1/8
DECIMALS XX ±.01, XXX ±.005
ANGLES ±0°30'
RMS FINISH
ALL DIMENSIONS ARE IN INCHES
DO NOT SCALE THIS DRAWING

AUTHORIZATION	BY	DATE
DRAWN	EAS	3-17-05
CHECKED	EAS	Apr-05
DESIGNED	EAS	Mar-05
ENGINEERED	ELM	4-20-05
PRODUCTION	GA	1-4-06
Q.A.	AS	1-4-06

PROJECTION

USED ON

DASH NO	NEXT ASSEMBLY
-01	

TELEDYNE MONITOR LABS
Everywhereyoulook™

TITLE
360 BACKSCATTER
SYSTEM INSTALLATION

MAT'L. FINISH
JIG NO.
SCALE 1/4 SHEET 1 of 7

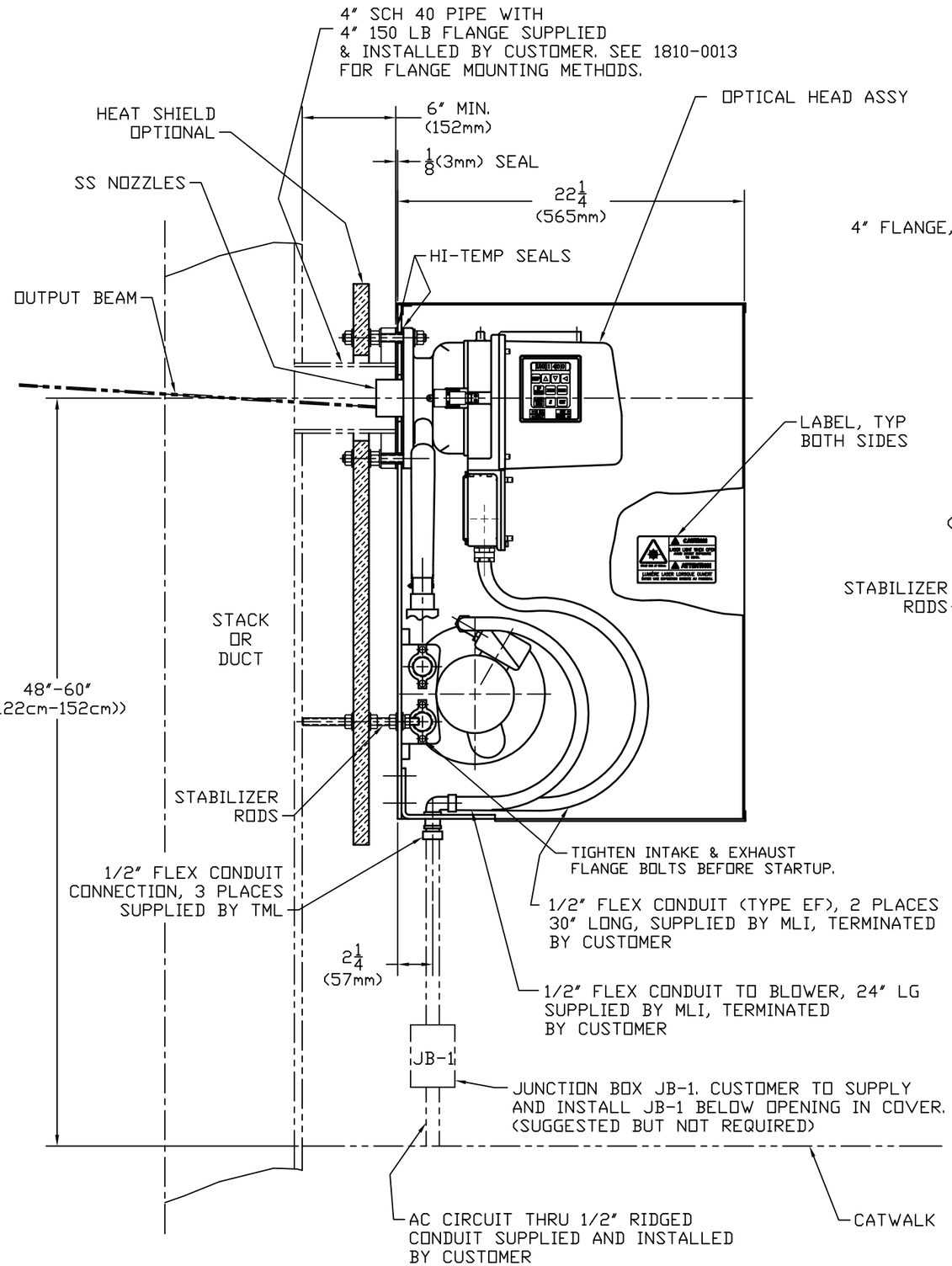
D | DRAWING NO. 1810-0015 | LATEST REVISION E

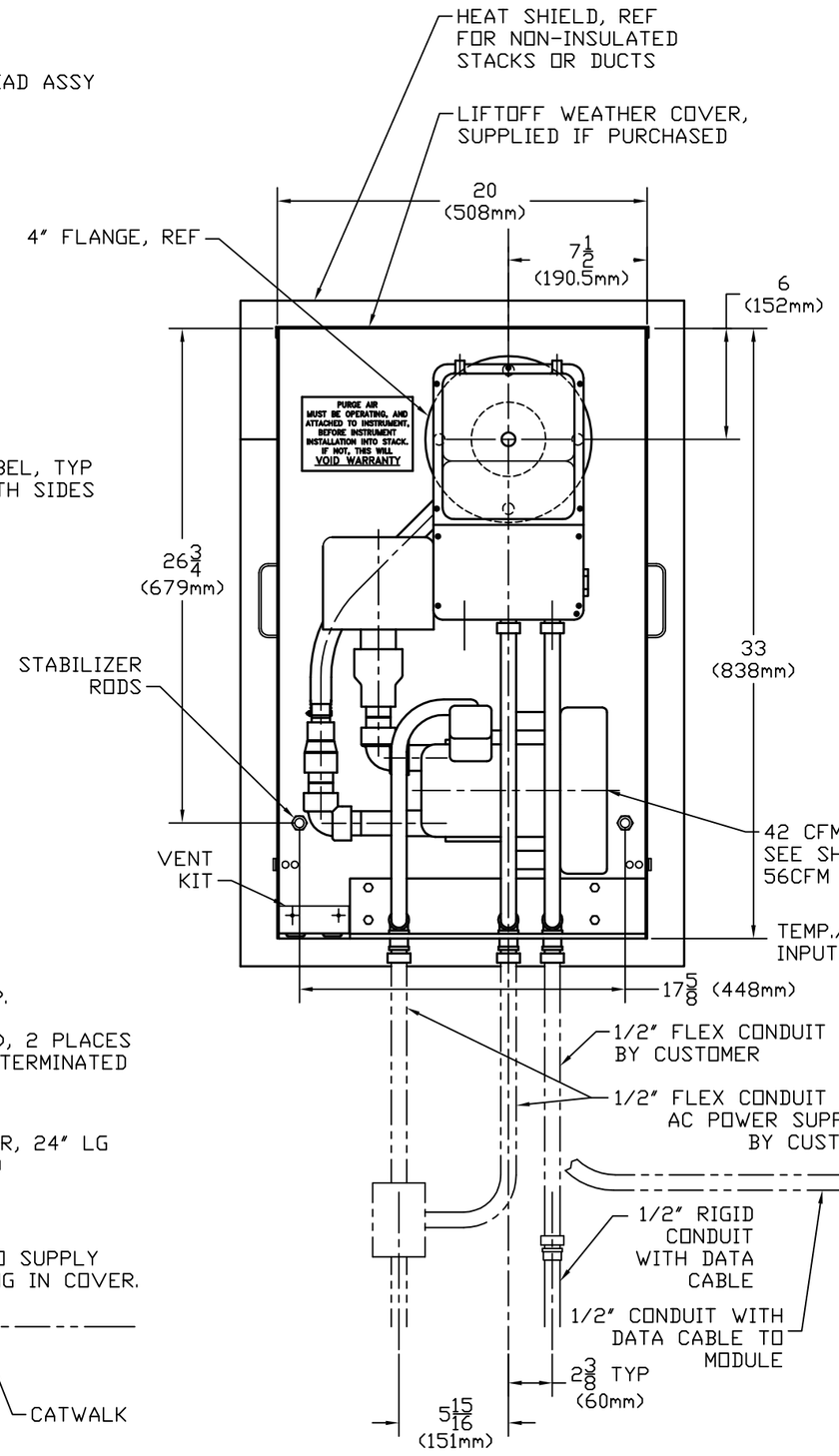
6-9-14

ACAD2007 FILE 18100015

DVG. NO 1810-0015 SH 2

REVISIONS				
ZONE	SYM.	DESCRIPTION	DATE	APPD.
	A	RELEASE FOR PRODUCTION	12-15-05	ELM
	B	PER DCN 1810-0015B	1-3-08	ELM
	C	NO CHANGE THIS SHEET	3-19-09	ELM
	D	NO CHANGE THIS SHEET	6-16-11	EAS
	E	PER DCN 1810-0015E	6-9-14	JL





3 IF STACK DIA IS 6.5FT (2 meters) OR LESS A LIGHT TRAP MAY BE REQUIRED. CONSULT FACTORY. SEE SHEET 4 FOR LIGHT TRAP INSTALLATION.

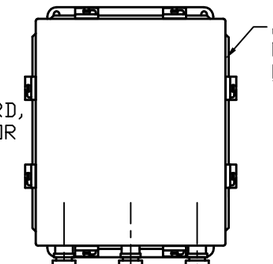
2. AFTER FINAL INSTALLATION AND STARTUP:

a) VERIFY THAT ALL WARNING LABELS ARE AFFIXED AT THE SUITABLE LOCATIONS ON ANY MEANS OF APPROACH TO THE MONITOR AND AT ANY MEANS OF ACCESS INTO THE STACK OR DUCT. THESE INCLUDE ELEVATORS, LADDERS, ACCESS PANELS, HATCHES, DOORS ETC.

b) VERIFY THAT THE WARNING LABEL ON THE REAR COVER WOULD BE VISIBLE IN THE INSTALLED CONFIGURATION PRIOR TO THE REMOVAL OF THE MONITOR, SHOULD THAT BE NEEDED.

1. FOR WIRING DIAGRAM SEE DRAWING 1810-0012

NOTES:



DIMENSIONS IN () ARE METRIC

PROJECTION

DIMENSIONAL TOLERANCES UNLESS OTHERWISE SPECIFIED			
FRACTIONS	DECIMALS	ANGLES	
0 TO 4 ±1/32	XX ±.01	±0°30'	
4 TO 8 ±1/16	XXX ±.005	RMS FINISH	
8 AND UP ±1/8			
ALL DIMENSIONS ARE IN INCHES DO NOT SCALE THIS DRAWING			

AUTHORIZATION	BY	DATE
DRAWN	EAS	3-21-05
CHECKED	EAS	Dec-05
DESIGNED	EAS	Mar-05
ENGINEERED	ELM	1-3-06
PRODUCTION	GA	1-4-06
Q.A.	AS	1-4-06

USED ON	
DASH NO	NEXT ASSEMBLY
-02	

TELEDYNE MONITOR LABS
Everywhereyoulook™

TITLE
360 BACKSCATTER
SYSTEM INSTALLATION

MAT'L. | FINISH

JIG NO.

SCALE	SHEET
1/4	2 OF 7

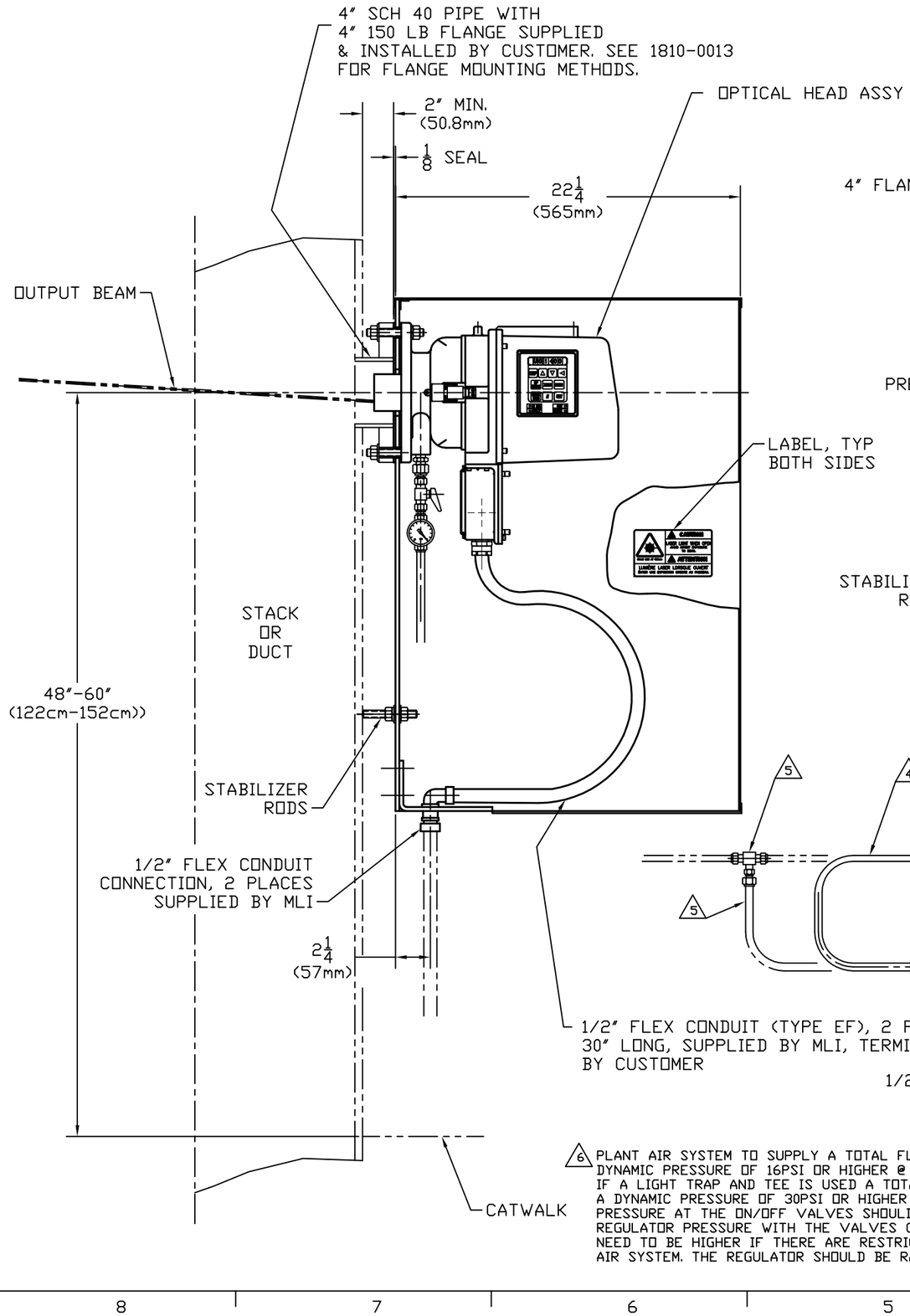
DRAWING NO.	LATEST REVISION
1810-0015	E

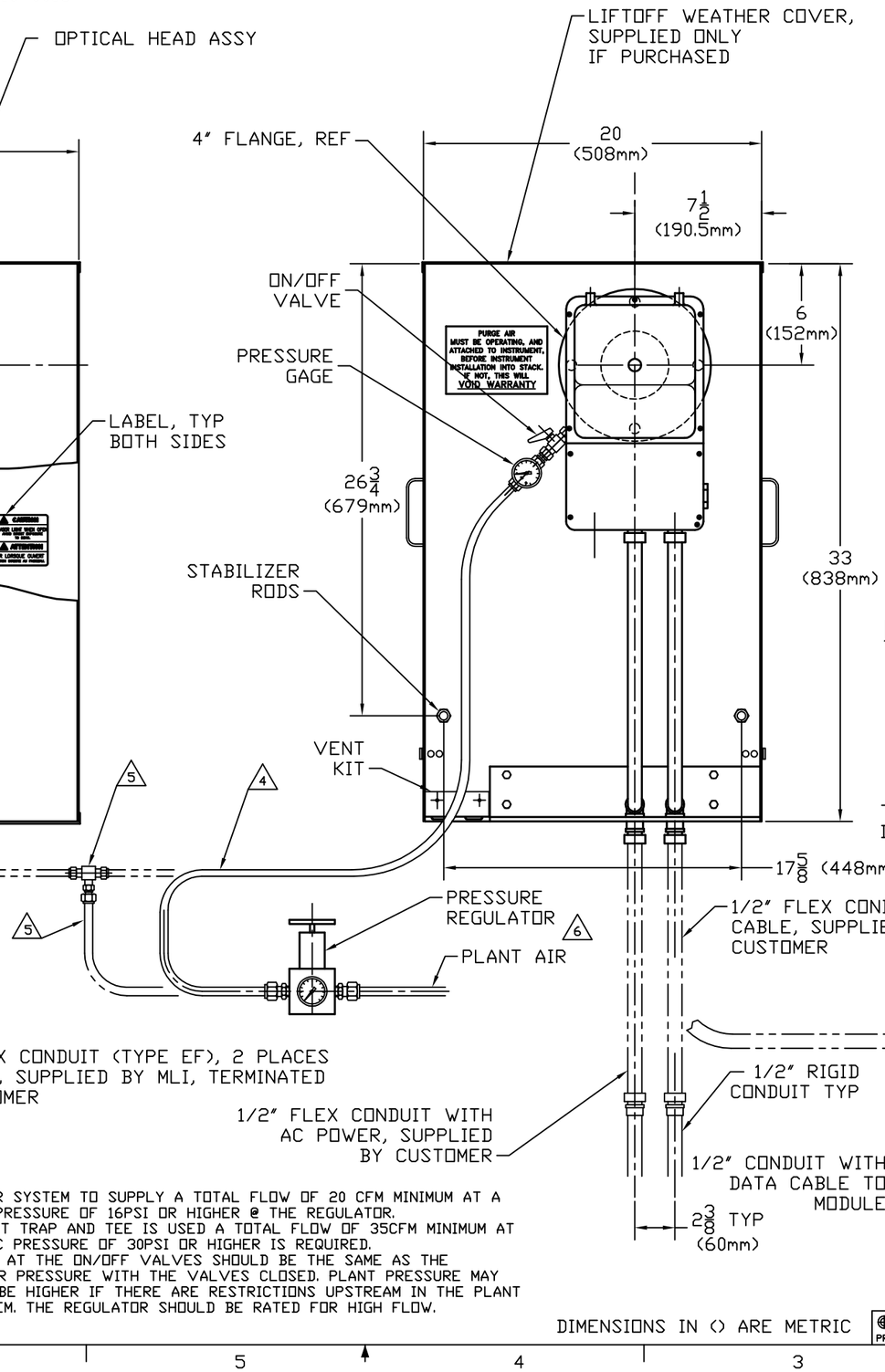
D

6-9-14

ACAD2007 FILE 1810015-S2

REVISIONS				
ZONE	SYM.	DESCRIPTION	DATE	APPD.
	A	RELEASE FOR PRODUCTION	12-15-05	ELM
	B	PER DCN 1810-0015B	1-3-08	ELM
	C	NO CHANGE THIS SHEET	3-19-09	ELM
	D	NO CHANGE THIS SHEET	6-16-11	EAS
	E	NO CHANGE THIS SHEET	6-9-14	JL





SEE SHT-6 FOR INSTR. AIR W/LIGHT TRAP

5 IF LIGHT TRAP IS USED CUSTOMER MUST SUPPLY AND INSTALL 3/8 UNION TEE W/1/2-3/8 REDUCER. LINE RUNNING FROM REGULATOR TO TEE MUST BE 1/2" OD X 3/8 ID.

4 CUSTOMER TO SUPPLY AND INSTALL 3/8 OD x 5/16 ID TUBING TO CARRY INSTR. AIR

3 IF STACK DIA IS 6.5FT (2 meters) OR LESS A LIGHT TRAP MAY BE REQUIRED. CONSULT FACTORY. SEE SHEET 4 FOR LIGHT TRAP INSTALLATION.

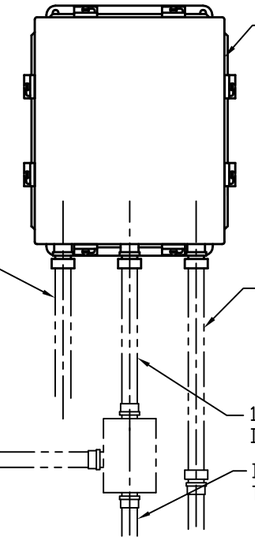
2. AFTER FINAL INSTALLATION AND STARTUP:

a) VERIFY THAT ALL WARNING LABELS ARE AFFIXED AT THE SUITABLE LOCATIONS ON ANY MEANS OF APPROACH TO THE MONITOR AND AT ANY MEANS OF ACCESS INTO THE STACK OR DUCT. THESE INCLUDE ELEVATORS, LADDERS, ACCESS PANELS, HATCHES, DOORS ETC.

b) VERIFY THAT THE WARNING LABEL ON THE REAR COVER WOULD BE VISIBLE IN THE INSTALLED CONFIGURATION PRIOR TO THE REMOVAL OF THE MONITOR, SHOULD THAT BE NEEDED.

1. FOR WIRING DIAGRAM SEE DRAWING 1810-0012

NOTES:



6 PLANT AIR SYSTEM TO SUPPLY A TOTAL FLOW OF 20 CFM MINIMUM AT A DYNAMIC PRESSURE OF 16PSI OR HIGHER @ THE REGULATOR. IF A LIGHT TRAP AND TEE IS USED A TOTAL FLOW OF 35CFM MINIMUM AT A DYNAMIC PRESSURE OF 30PSI OR HIGHER IS REQUIRED. PRESSURE AT THE ON/OFF VALVES SHOULD BE THE SAME AS THE REGULATOR PRESSURE WITH THE VALVES CLOSED. PLANT PRESSURE MAY NEED TO BE HIGHER IF THERE ARE RESTRICTIONS UPSTREAM IN THE PLANT AIR SYSTEM. THE REGULATOR SHOULD BE RATED FOR HIGH FLOW.

DIMENSIONS IN () ARE METRIC

DIMENSIONAL TOLERANCES UNLESS OTHERWISE SPECIFIED
FRACTIONS 0 TO 4 ±1/32, 4 TO 8 ±1/16, 8 AND UP ±1/8
DECIMALS .XX ±.01, .XXX ±.005
ANGLES ±0°30'
RMS FINISH
ALL DIMENSIONS ARE IN INCHES
DO NOT SCALE THIS DRAWING

AUTHORIZATION	BY	DATE
DRAWN	EAS	3-17-05
CHECKED	EAS	Apr-05
DESIGNED	EAS	Mar-05
ENGINEERED	ELM	4-20-05
PRODUCTION	GA	1-4-06
Q.A.	AS	1-4-06

PROJECTION

USED ON

DASH NO	NEXT ASSEMBLY
-03	

TELEDYNE MONITOR LABS
Everywhereyoulook™

TITLE
360 BACKSCATTER
SYSTEM INSTALLATION

MAT'L. FINISH

JIG NO.

SCALE 1/4 SHEET 3 OF 7

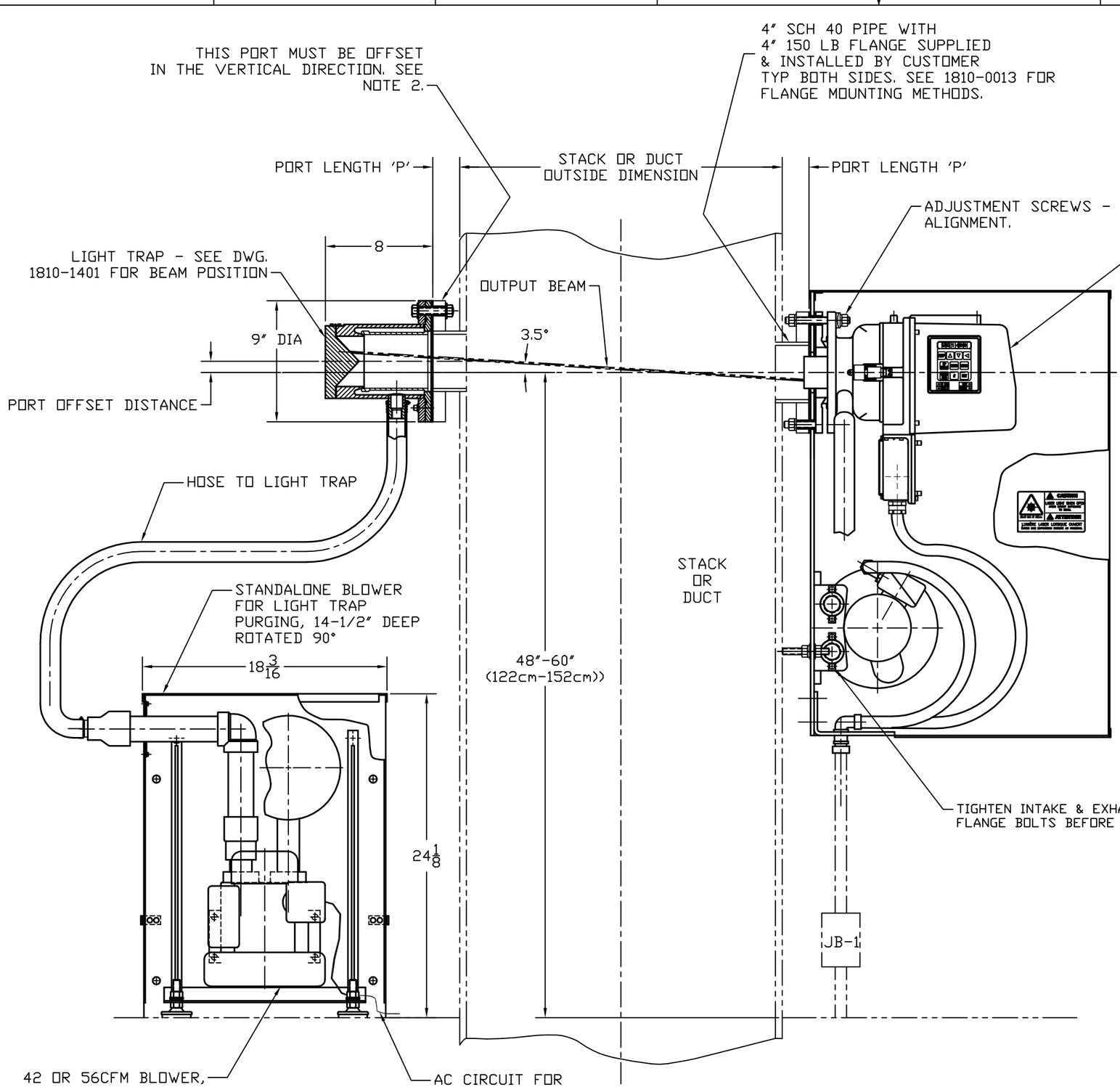
DRAWING NO. 1810-0015

LATEST REVISION E

D

6-9-14

REVISIONS				
ZONE	SYM.	DESCRIPTION	DATE	APPD.
	D	ADDED THIS SHEET PER DCN 1810-0015D	6-16-11	EAS
	E	PER DCN 1810-0015E	6-9-14	JL



2. PORT OFFSET DISTANCE CALCULATION:
   ENGLISH
   (((P X 2)+STACK OD+6.19")XTAN3.5°)-1.25"= OFFSET DISTANCE
   METRIC
   (((P X 2)+STACK OD+157mm)XTAN3.5°)-32MM= OFFSET DISTANCE

1. THIS SHEET IS TO BE USED FOR LIGHT TRAP, DUAL BLOWERS INSTALLATION ONLY. SEE SHEET 1,2 OR 3 FOR ALL OTHER INSTALLATION DETAILS.

NOTES:

WITH LIGHT TRAP, DUAL BLOWERS

DIMENSIONS IN () ARE METRIC

DIMENSIONAL TOLERANCES UNLESS OTHERWISE SPECIFIED
FRACTIONS 0 TO 4 ±1/32; 4 TO 8 ±1/16; 8 AND UP ±1/8
DECIMALS .XX ±.01; .XXX ±.005
ANGLES ±0°30'
RMS FINISH ✓
ALL DIMENSIONS ARE IN INCHES
DO NOT SCALE THIS DRAWING

AUTHORIZATION	BY	DATE
DRAWN	EAS	2-11-11
CHECKED	EAS	7-22-11
DESIGNED	EAS	FEB-11
ENGINEERED	EAS	6-24-11
PRODUCTION	BH	7-22-11
Q.A.	AS	7-22-11

PROJECTION

USED ON	
DASH NO	NEXT ASSEMBLY
-05	

TELEDYNE MONITOR LABS Everywhereyoulook™

TITLE
360 BACKSCATTER
LIGHT TRAP INSTALLATION

MAT'L.
FINISH
JIG NO.
SCALE 1/4
SHEET 5 OF 7

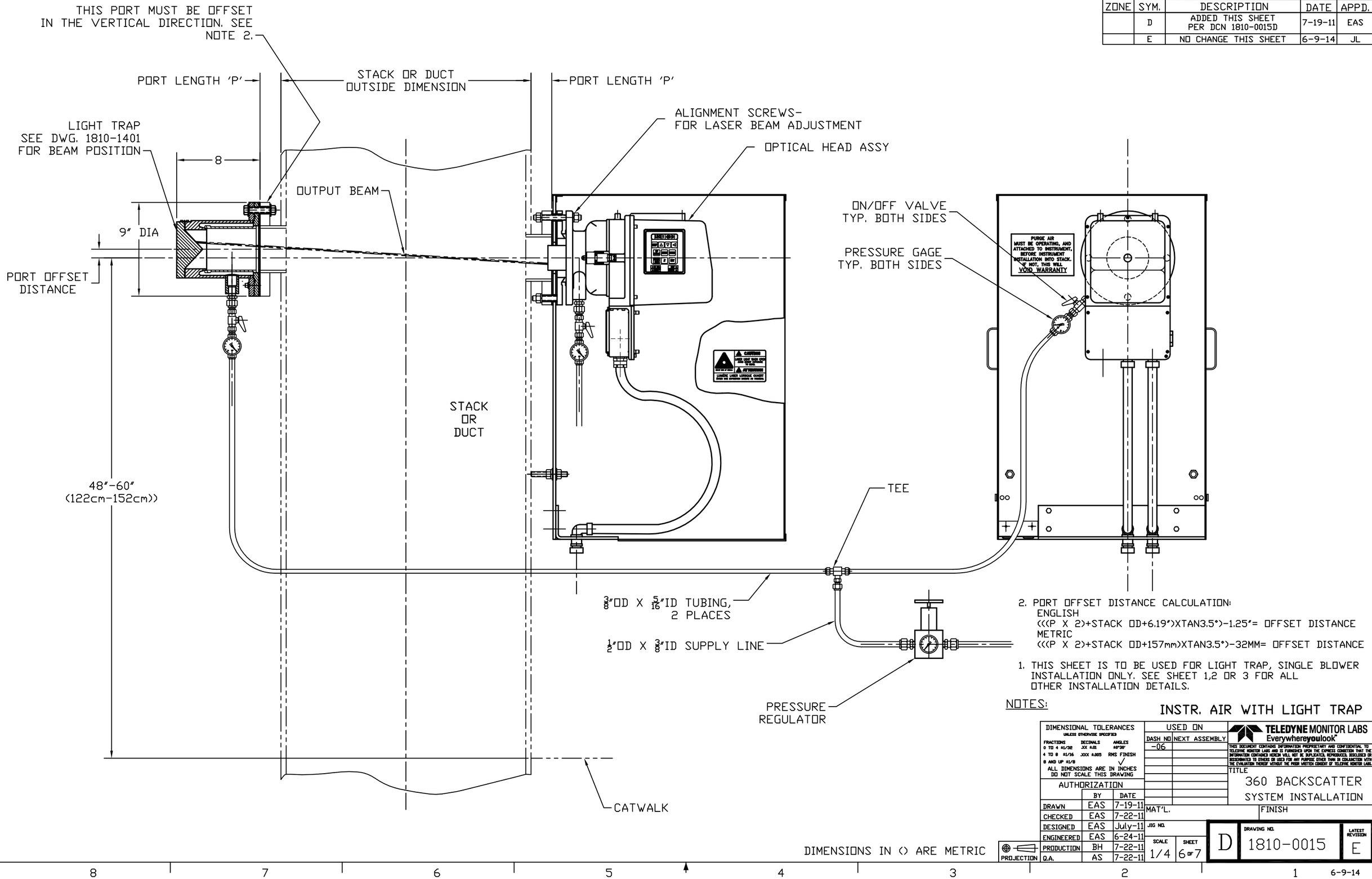
DRAWING NO.	LATEST REVISION
D 1810-0015	E

6-9-14

ACAD FILE 1810015-S5

DWG. NO 1810-0015 SH 6

REVISIONS				
ZONE	SYM.	DESCRIPTION	DATE	APP'D.
	D	ADDED THIS SHEET PER DCN 1810-0015D	7-19-11	EAS
	E	NO CHANGE THIS SHEET	6-9-14	JL



2. PORT OFFSET DISTANCE CALCULATION:
   ENGLISH
   (((P X 2)+STACK OD+6.19")XTAN3.5°)-1.25"= OFFSET DISTANCE
   METRIC
   (((P X 2)+STACK OD+157mm)XTAN3.5°)-32MM= OFFSET DISTANCE

1. THIS SHEET IS TO BE USED FOR LIGHT TRAP, SINGLE BLOWER INSTALLATION ONLY. SEE SHEET 1,2 OR 3 FOR ALL OTHER INSTALLATION DETAILS.

NOTES:

INSTR. AIR WITH LIGHT TRAP

DIMENSIONAL TOLERANCES
UNLESS OTHERWISE SPECIFIED
FRACTIONS 0 TO 4 ±1/32; 4 TO 8 ±1/16; 8 AND UP ±1/8
DECIMALS .XX ±.01; .XXX ±.005
ANGLES ±0°30'
RMS FINISH √
ALL DIMENSIONS ARE IN INCHES
DO NOT SCALE THIS DRAWING

AUTHORIZATION	BY	DATE
DRAWN	EAS	7-19-11
CHECKED	EAS	7-22-11
DESIGNED	EAS	July-11
ENGINEERED	EAS	6-24-11
PRODUCTION	BH	7-22-11
Q.A.	AS	7-22-11

USED ON	
DASH NO	NEXT ASSEMBLY
-06	

TELEDYNE MONITOR LABS
Everywhereyoulook™

TITLE
360 BACKSCATTER SYSTEM INSTALLATION

MAT'L. | FINISH | JIG NO.

SCALE 1/4 | SHEET 6 OF 7

DRAWING NO. 1810-0015 | LATEST REVISION E

PROJECTION

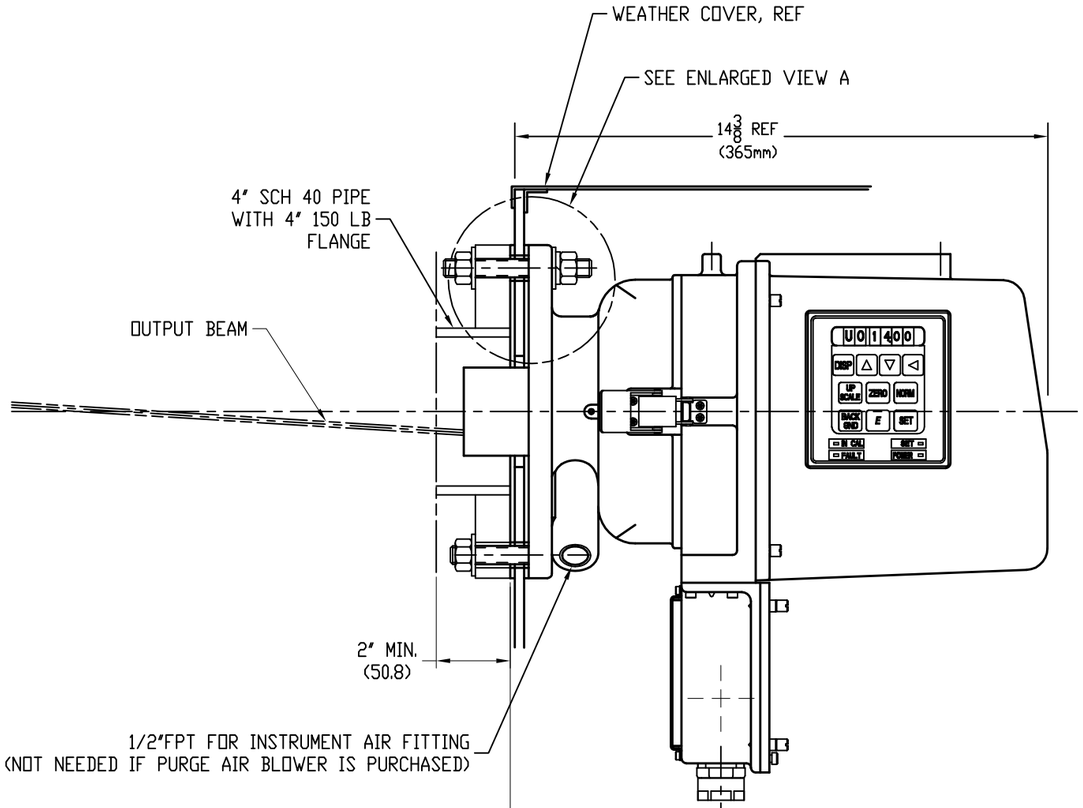
DIMENSIONS IN () ARE METRIC

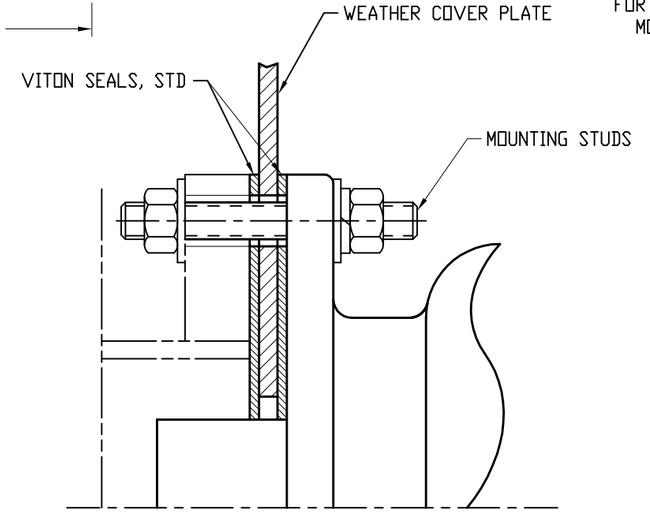
6-9-14

ACAD FILE 1810015-S6

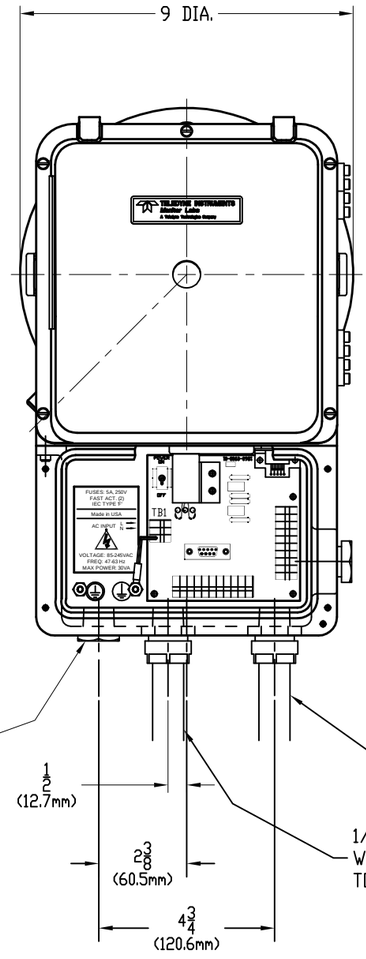
DWG. NO 1810-0014 SH 1

REVISIONS				
ZONE	SYM.	DESCRIPTION	DATE	APPD.
	A	RELEASE FOR PRODUCTION	12-15-05	ELM
	B	PER DCN1810-0014B	7-16-07	ELM





VIEW A
FULL SCALE



SEE SHEET 2 FOR HI-TEMP
SEE SHEET 3 FOR LIGHT TRAP

DIMENSIONAL TOLERANCES
UNLESS OTHERWISE SPECIFIED
FRACTIONS 0 TO 4 ±1/32; 4 TO 8 ±1/16; 8 AND UP ±1/8
DECIMALS .XX ±.01; .XXX ±.005
ANGLES ±0°30'
RMS FINISH √
ALL DIMENSIONS ARE IN INCHES
DO NOT SCALE THIS DRAWING

AUTHORIZATION	BY	DATE
DRAWN	EAS	3-17-05
CHECKED	EAS	Apr-05
DESIGNED	EAS	Mar-05
ENGINEERED	ELM	1-03-06
PRODUCTION	GA	1-4-06
Q.A.	AS	1-4-06

PROJECTION

USED ON

DASH NO	NEXT ASSEMBLY
-01	

TELEDYNE MONITOR LABS
Everywhereyoulook™

TITLE
360 BACKSCATTER
OPTICAL HEAD INSTALL

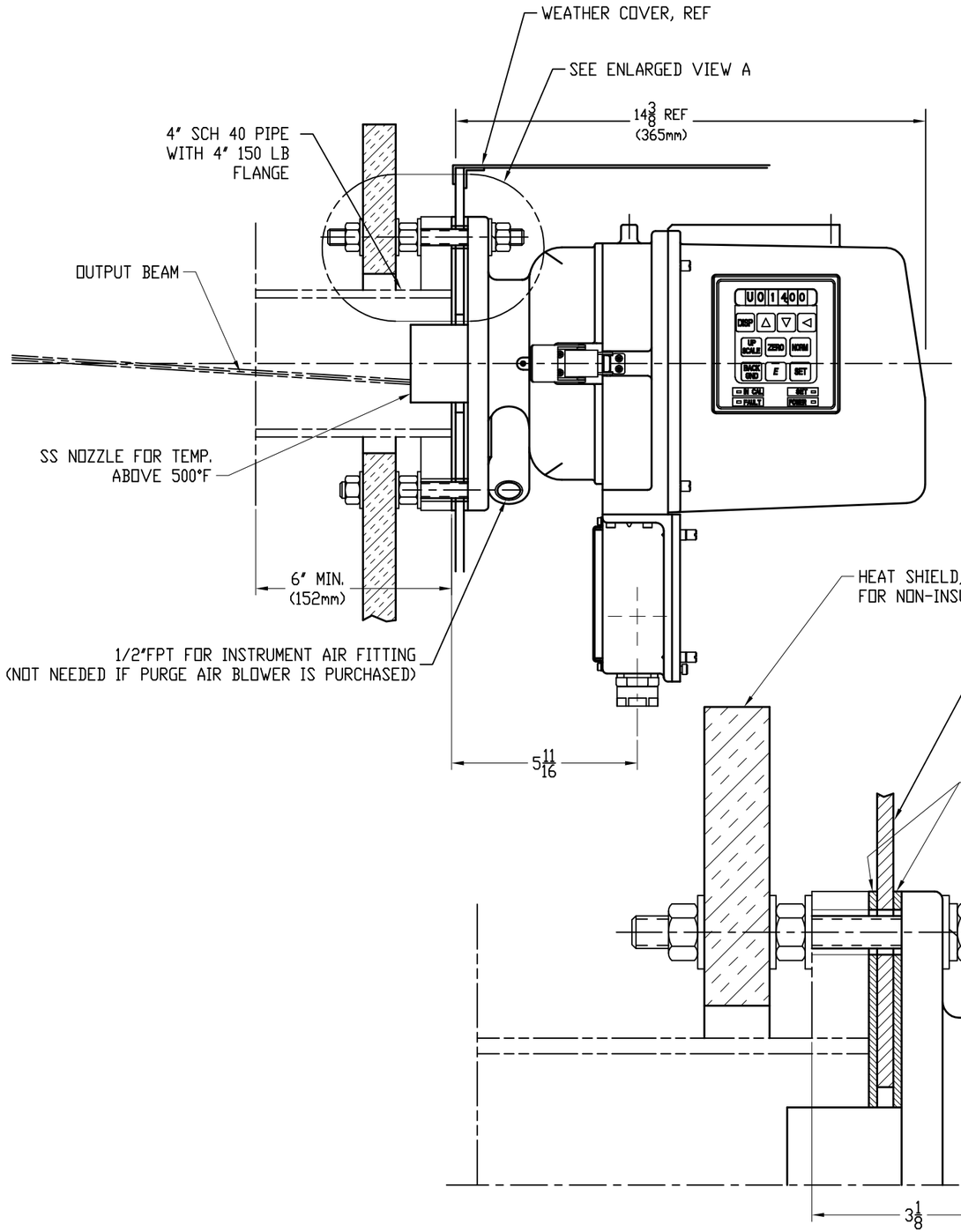
MAT'L.
FINISH
JIG NO.
SCALE 1/2
SHEET 1 OF 3

D | DRAWING NO. 1810-0014 | LATEST REVISION B

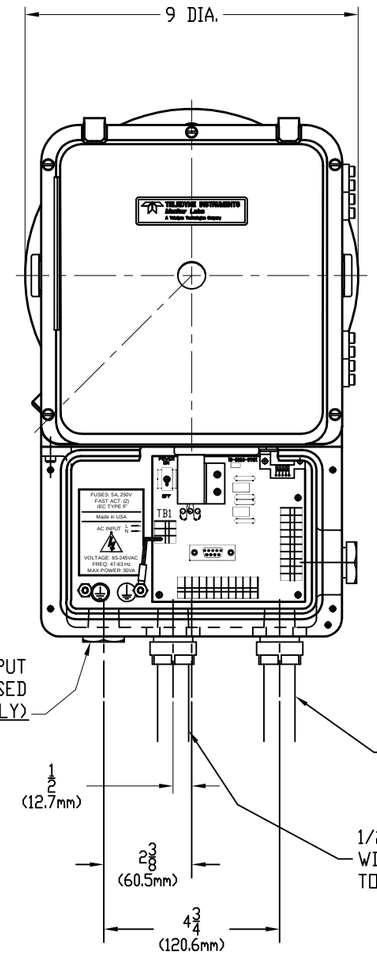
7-16-07

ACAD2004 FILE 18100014

REVISIONS				
ZONE	SYM.	DESCRIPTION	DATE	APPD.
	A	RELEASE FOR PRODUCTION	12-15-05	ELM
	B	PER 1810-0014B	7-16-07	ELM



VIEW A
FULL SCALE



HI-TEMP APPLICATIONS

DIMENSIONAL TOLERANCES UNLESS OTHERWISE SPECIFIED			
FRACTIONS	DECIMALS	ANGLES	
0 TO 4 ±1/32	.XX ±.01	±0°30'	
4 TO 8 ±1/16	.XXX ±.005	RMS FINISH	
8 AND UP ±1/8		✓	
ALL DIMENSIONS ARE IN INCHES DO NOT SCALE THIS DRAWING			

AUTHORIZATION	BY	DATE
DRAWN	EAS	3-21-05
CHECKED	EAS	Dec-05
DESIGNED	EAS	Mar-05
ENGINEERED	ELM	1-03-06
PRODUCTION	GA	1-4-06
Q.A.	AS	1-4-06

USED ON	
DASH NO	NEXT ASSEMBLY
-02	

TELEDYNE MONITOR LABS
Everywhereyoulook™

TITLE
360 BACKSCATTER
OPTICAL HEAD INSTALL

MAT'L.
FINISH
JIG NO.

SCALE	SHEET
1/2	2 OF 3

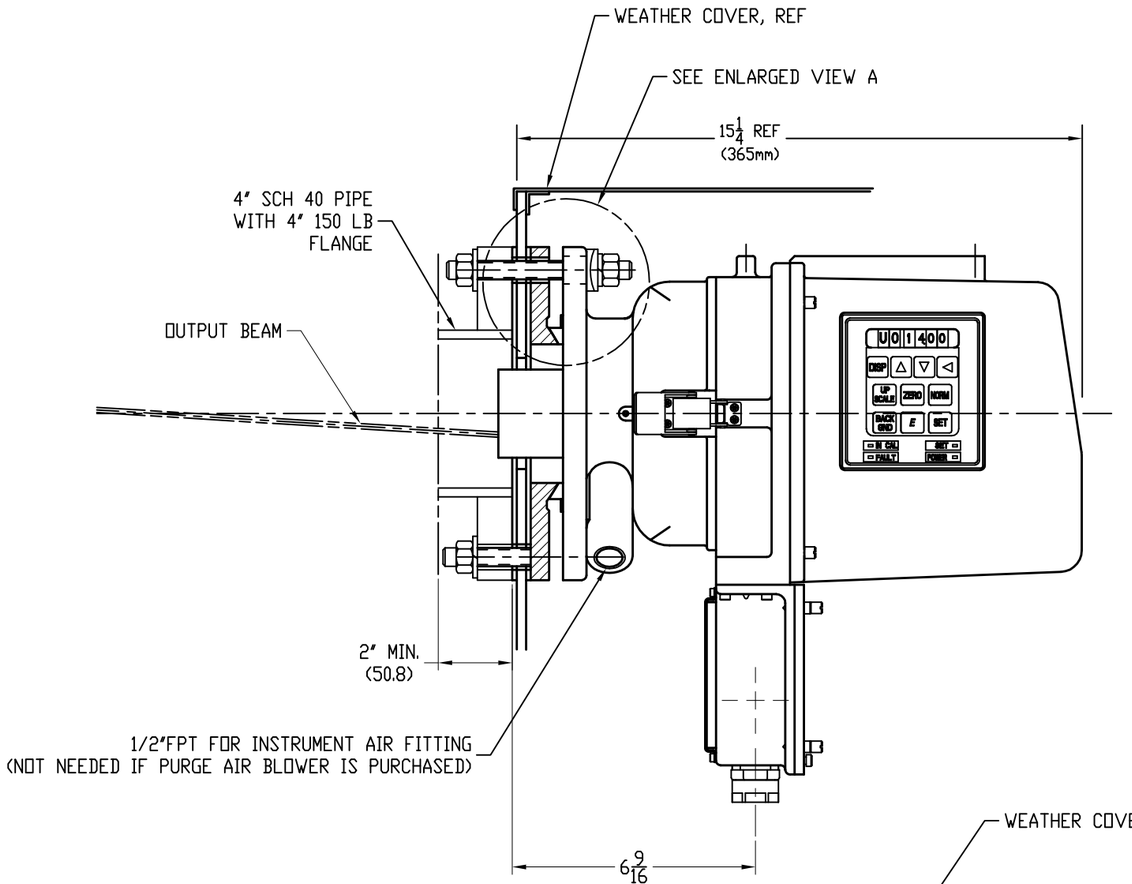
DRAWING NO.	LATEST REVISION
1810-0014	B

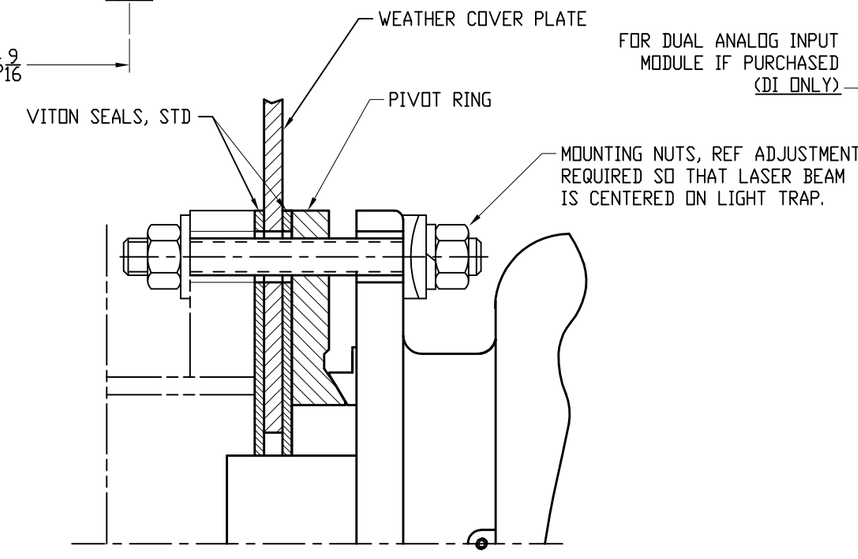
PROJECTION

7-16-07

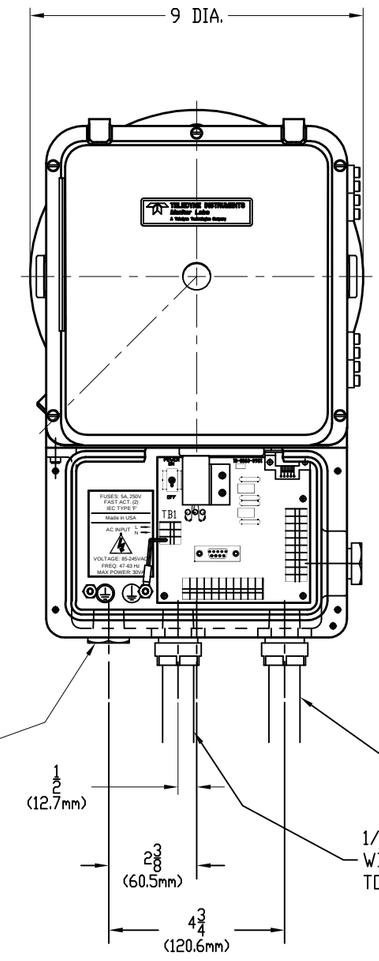
ACAD2007 FILE 18100014-S2

REVISIONS				
ZONE	SYM.	DESCRIPTION	DATE	APPD.
	A	RELEASE FOR PRODUCTION	12-15-05	ELM
	B	PER DCN1810-0014B	7-16-07	ELM





VIEW A
FULL SCALE



FOR LIGHT TRAP INSTALLATION

DIMENSIONAL TOLERANCES
UNLESS OTHERWISE SPECIFIED
FRACTIONS 0 TO 4 ±1/32; 4 TO 8 ±1/16; 8 AND UP ±1/8
DECIMALS .XX ±.01; .XXX ±.005
ANGLES ±0°30'
RMS FINISH √
ALL DIMENSIONS ARE IN INCHES
DO NOT SCALE THIS DRAWING

AUTHORIZATION	BY	DATE
DRAWN	EAS	4-6-05
CHECKED	EAS	Dec-05
DESIGNED	EAS	Apr-05
ENGINEERED	ELM	1-03-06
PRODUCTION	GA	1-4-06
Q.A.	AS	1-4-06

PROJECTION

USED ON

DASH NO	NEXT ASSEMBLY
-03	

TELEDYNE MONITOR LABS
Everywhereyoulook™

TITLE
360 BACKSCATTER
OPTICAL HEAD INSTALL

MAT'L.
FINISH
JIG NO.
SCALE 1/2
SHEET 3 OF 3

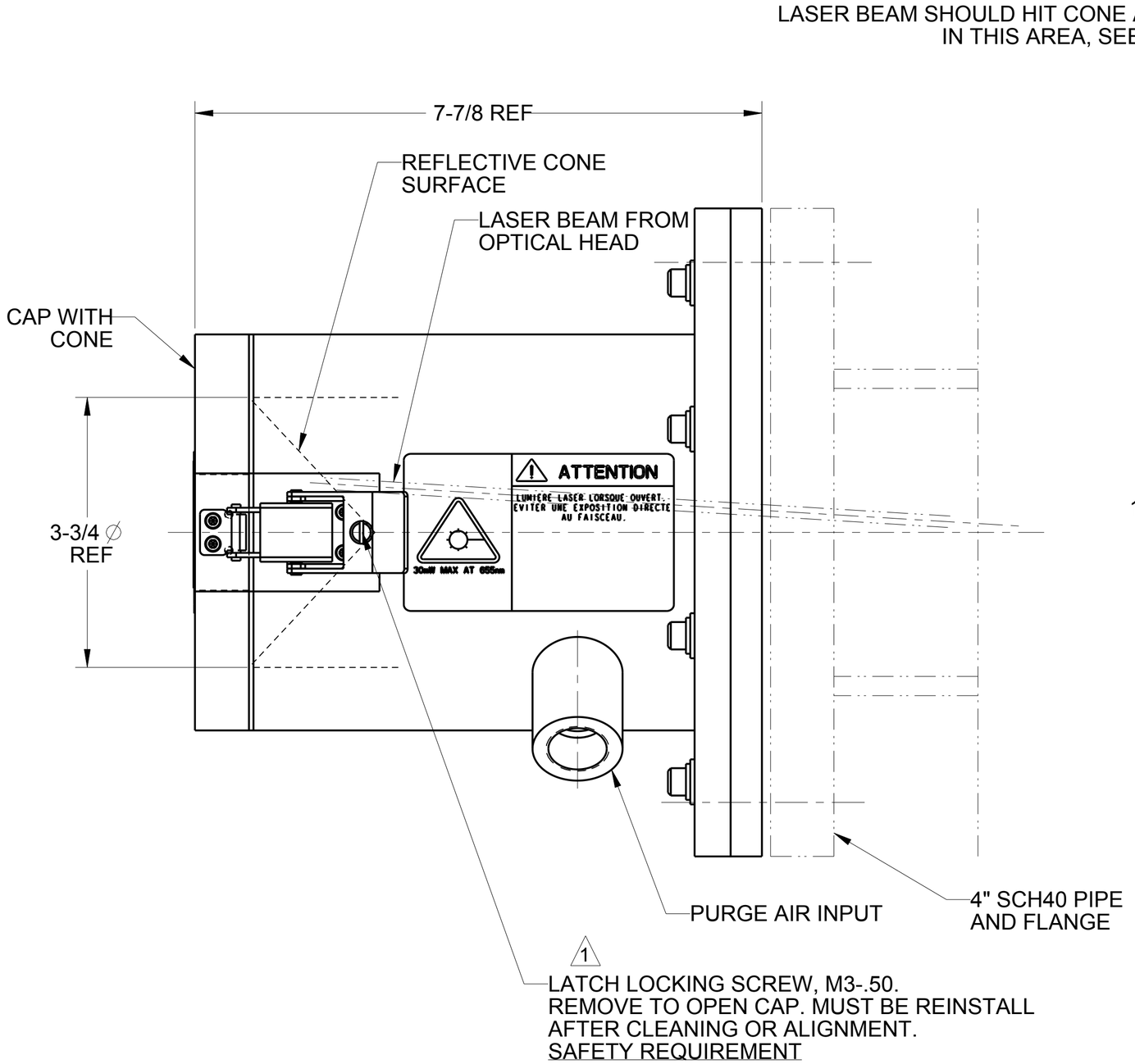
DRAWING NO.	LATEST REVISION
1810-0014	B

D

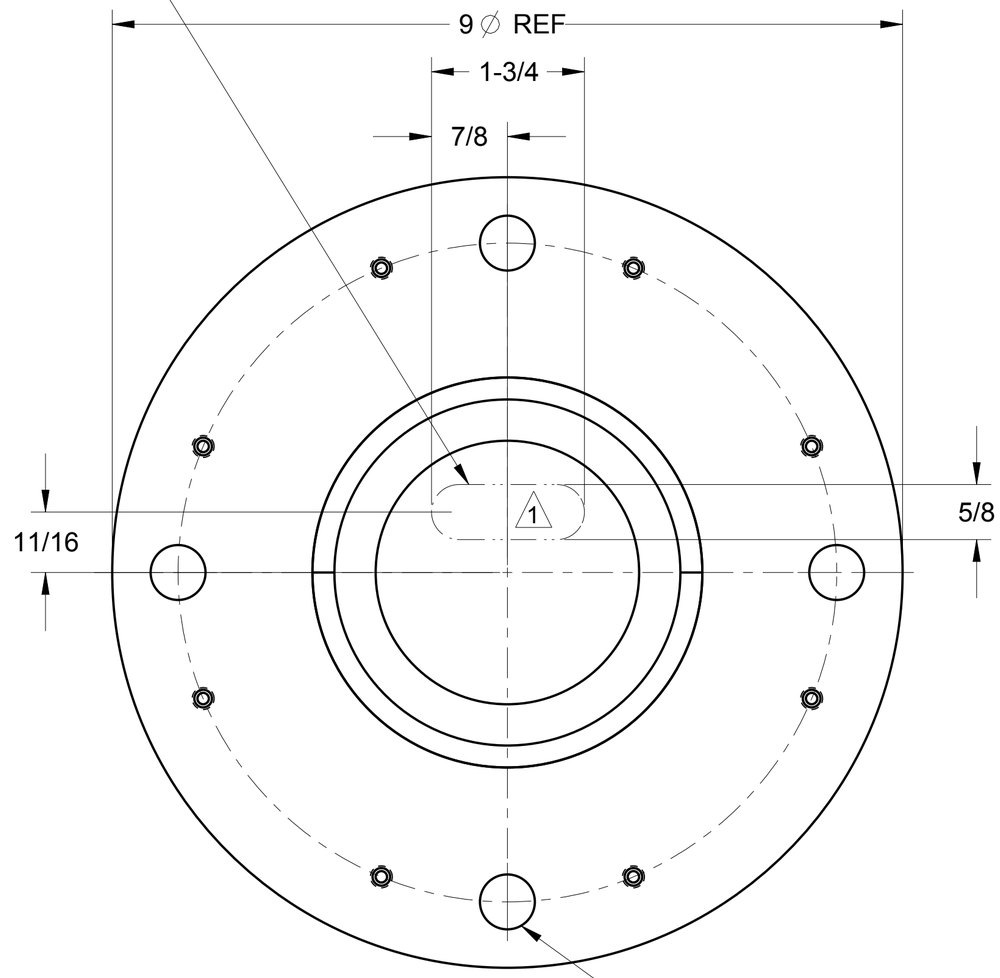
7-16-07

ACAD2007 FILE 18100014-S3

REVISIONS			
SYM.	DESCRIPTION	DATE	APPD.
A	RELEASE TO CUSTOMER	3-23-09	ELM
B	NO CHANGE THIS SHEET	7-31-12	ELM



LASER BEAM SHOULD HIT CONE APPROX. IN THIS AREA, SEE NOTE 1



FRONT VIEW

SEE SHEET 2 FOR LIGHT TRAP WITH ND FILTERS

1. LASER ALIGNMENT:
CAUTION: DONOT LOOK DIRECTLY INTO LASER BEAM DURING ALIGNMENT.
USING A PIECE OF FROSTED MATERIAL (SUCH AS MYLAR) DRAW THE BOUNDRY THAT WILL BE USED FOR ALIGNMENT AS SHOWN IN FRONT VIEW. REMOVE THE LATCH LOCKING SCREW AND OPEN THE CAP. PLACE THE FROSTED MATERIAL OVER THE OPENING, POSITIONING RELATIVE TO THE 3-3/4" HOLE AS SHOWN. TILT THE OPTICAL HEAD TILL THE LASER BEAM FALLS NEAR THE CENTER OF THE DESIRED AREA. REMOVE THE FROSTED MATERIAL AND CLOSE THE CAP. REPLACE THE LOCKING SCREW.

DIMENSIONAL TOLERANCES
UNLESS OTHERWISE SPECIFIED
FRACTIONS DECIMALS ANGLES
0 TO 4 ±1/32 .XX ±.01 ±0° 30'
4 TO 8 ±1/16 .XXX ±.005 RMS FINISH
8 AND UP ±1/8
ALL DIMENSIONS ARE IN INCHES
DO NOT SCALE THIS DRAWING

AUTHORIZATION	BY	DATE
DRAWN	EAS	13-Mar-09
CHECKED	EAS	3-24-09
DESIGNED	EAS	Mar-09
ENGINEERED	ELM	3-24-09
PRODUCTION	GA	3-25-09
Q.A.	AS	3-24-09

PROJECTION

USED ON	
DASH NO	NEXT ASSEMBLY
-01	PM360

TELEDYNE MONITOR LABS
Everywhere **you** look

TITLE
360 LIGHT TRAP ASSY, W/CONE
INSTALLATION DRAWING

MAT'L
FINISH
JIG NO.

SCALE	SHEET
0.750	1 OF 2

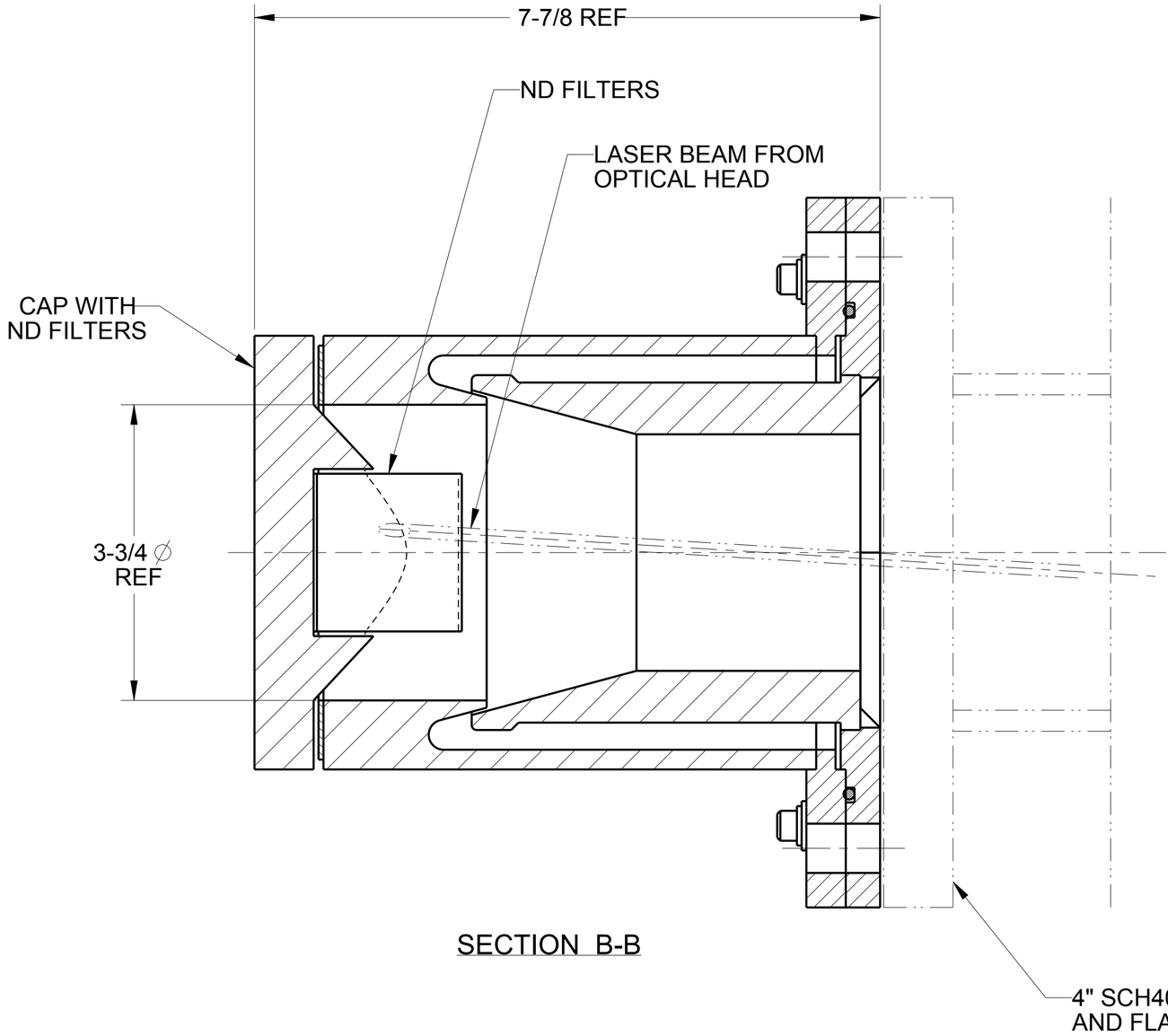
DRAWING NO.	REVISION
C 1810-1401	B

DWG. No. 1810-1401 SH 1

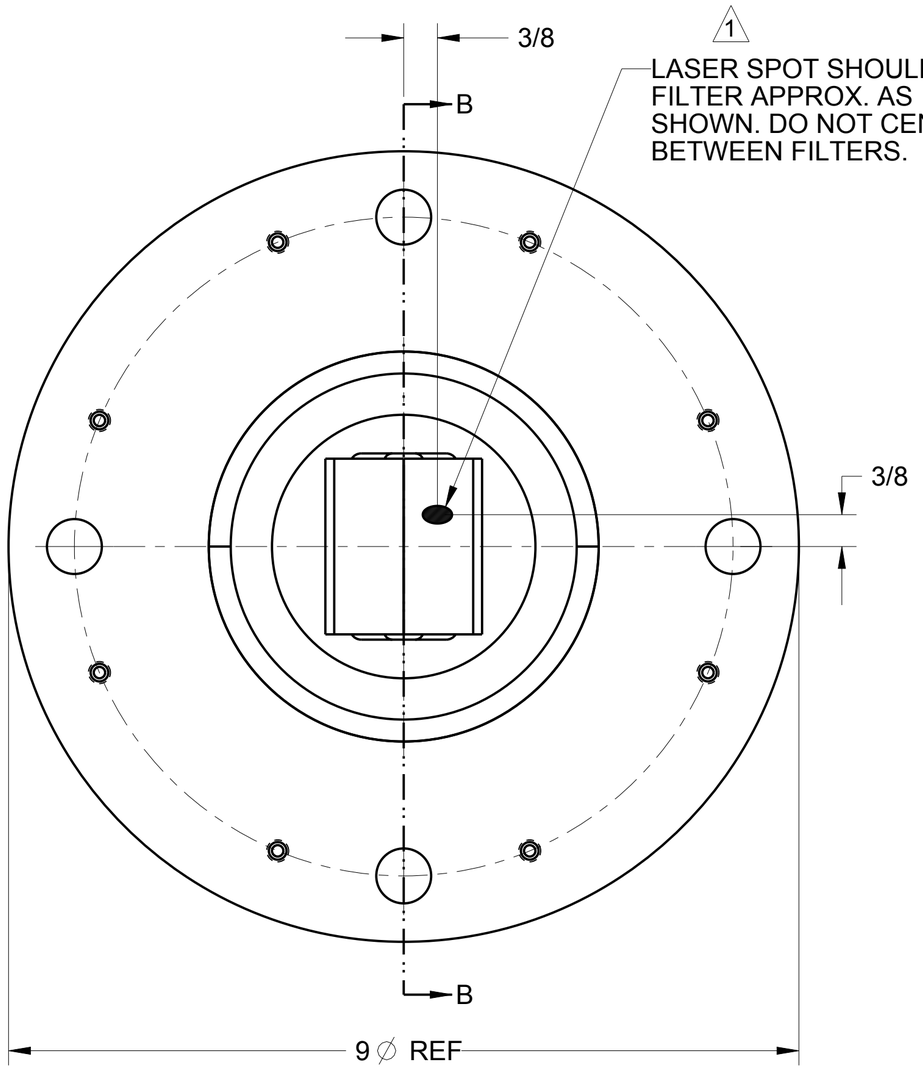
PROE FILE 1810-1401.drw

7-31-12

REVISIONS			
SYM.	DESCRIPTION	DATE	APPD.
B	ADDED THIS SHEET PER DCN 1810-1401B	7-31-12	ELM



SECTION B-B



FRONT VIEW

1. LASER ALIGNMENT:
CAUTION: DONOT LOOK DIRECTLY INTO LASER BEAM DURING ALIGNMENT.
USING A PIECE OF FROSTED MATERIAL (SUCH AS MYLAR) DRAW THE POSITION THAT WILL BE USED FOR ALIGNMENT AS SHOWN IN FRONT VIEW. REMOVE THE LATCH LOCKING SCREW AND OPEN THE CAP. PLACE THE FROSTED MATERIAL OVER THE OPENING, POSITIONING RELATIVE TO THE 3-3/4" HOLE AS SHOWN. TILT THE OPTICAL HEAD TILL THE LASER BEAM FALLS NEAR THE DESIRED POSITION. REMOVE THE FROSTED MATERIAL AND CLOSE THE CAP. REPLACE THE LOCKING SCREW.

LIGHT TRAP WITH ND FILTERS

DIMENSIONAL TOLERANCES
UNLESS OTHERWISE SPECIFIED
FRACTIONS DECIMALS ANGLES
0 TO 4 ±1/32 .XX ±.01 ±0° 30'
4 TO 8 ±1/16 .XXX ±.005 RMS FINISH
8 AND UP ±1/8 ✓
ALL DIMENSIONS ARE IN INCHES
DO NOT SCALE THIS DRAWING

AUTHORIZATION	BY	DATE
DRAWN	EAS	31-Jul-12
CHECKED	EAS	8-1-12
DESIGNED	EAS	July-12
ENGINEERED	ELM	8-1-12
PRODUCTION	GA	8-1-12
Q.A.	AS	8-1-12

USED ON	
DASH NO	NEXT ASSEMBLY
-02	PM360

TELEDYNE MONITOR LABS
Everywhere **you** look

TITLE
LIGHT TRAP ASSY. W/CONE & 4.0 ND
360 BACKSCATTER

MAT'L SEE BOM
FINISH
JIG NO.
SCALE 0.750
SHEET 2 OF 2

DRAWING NO.	REVISION
1810-1401	B

PROJECTION

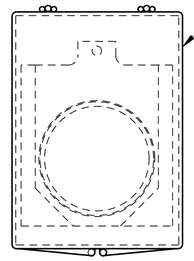
7-31-12

DWG. No. 1810-1401 SH 2

PROE FILE 1810-1401.drw

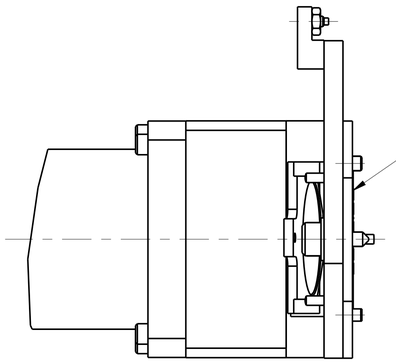
DWG. No. 1810-0647	SH 1

REVISIONS			
SYM.	DESCRIPTION	DATE	APPD.
A	RELEASE FOR PRODUCTION	3-14-11	ELM



2 AUDIT STANDARDS AND
1 BLOCKING PLATE SUPPLIED
IN CAL-KIT CASE

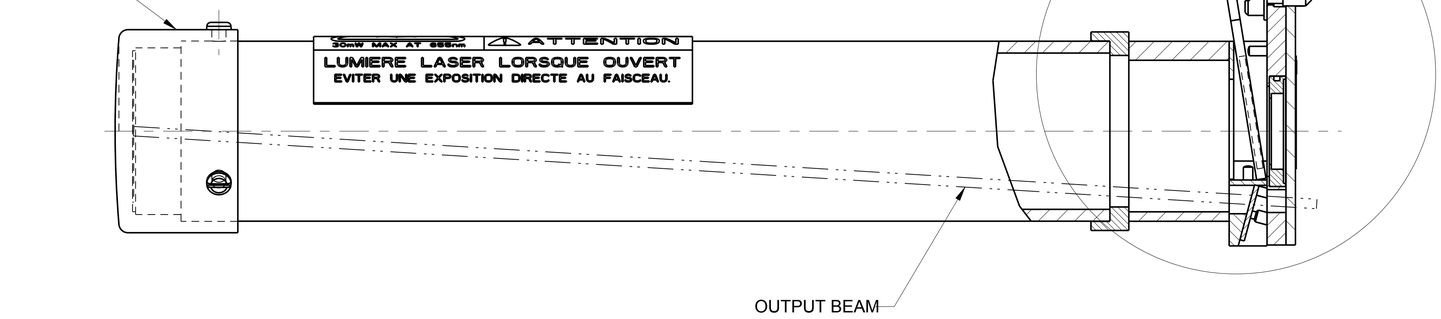
SCALE 1.000

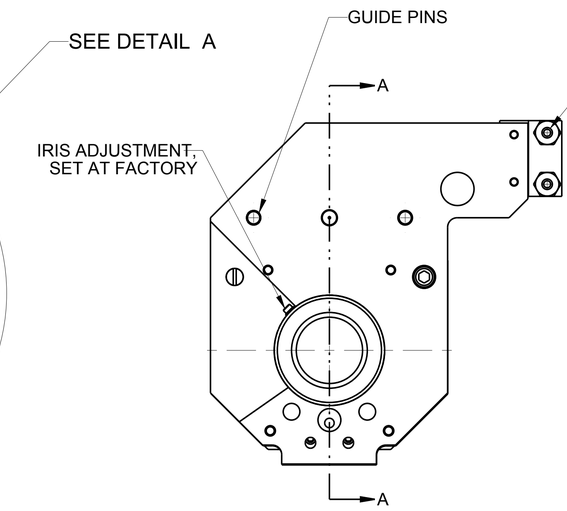


CAL-KIT COVER, REMOVE BEFORE
INSTALLING CAL-KIT ON TO INSTRUMENT

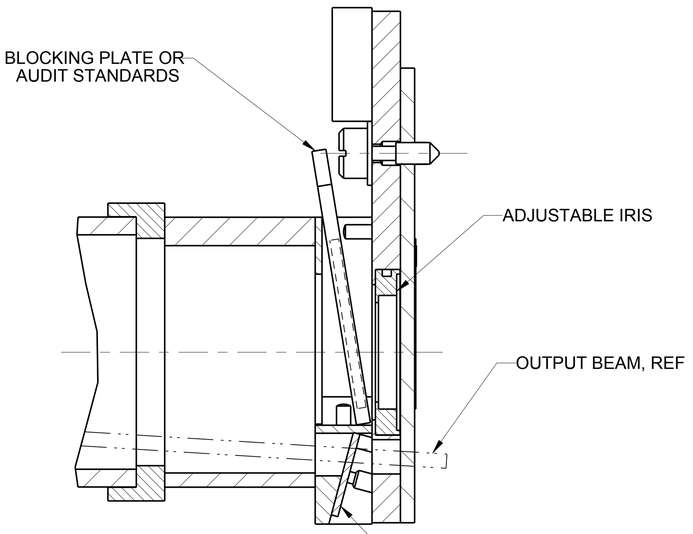
SEE DETAIL A

CAL-KIT MOUNTING SCREW





SECTION A-A



DETAIL A
SCALE 1.500

NOTES:

1. ONE OF THREE DIFFERENT CAPS CAN BE USED ON THE CAL-KIT. THE OTHER 2 ARE STORED IN THE CASE. IF A DIFFERENT CAP IS REQUIRED, CAUTION SHOULD BE TAKEN, NOT TO LOOK INTO THE LASER BEAM, WHEN SWITCHING CAPS.

DIMENSIONAL TOLERANCES		
UNLESS OTHERWISE SPECIFIED		
FRACTIONS	DECIMALS	ANGLES
0 TO 4 ±1/32	XX ±.01	±0° 30'
4 TO 8 ±1/16	XXX ±.005	RMS FINISH
8 AND UP ±1/8		
ALL DIMENSIONS ARE IN INCHES		
DO NOT SCALE THIS DRAWING		

AUTHORIZATION	BY	DATE
DRAWN	EAS	14-Mar-11
CHECKED	EAS	3-15-11
DESIGNED	EAS	Mar-11
ENGINEERED	ELM	3-22-11
PRODUCTION	GA	3-22-11
Q.A.	AS	3-22-11

USED ON	
DASH NO	NEXT ASSEMBLY
-01	PM360P

TELEDYNE MONITOR LABS
A Teledyne technologies Company

TITLE
CAL-KIT OUTLINE
360P BACKSCATTER

MAT'L SEE BOM
FINISH
JIG NO.
SCALE 1.000
SHEET 1 OF 1
DRAWING NO. 1810-0647
REVISION A
SIZE D

PROJECTION

PROE FILE 1810-0647.drw

3-15-11

REVISIONS				
ZONE	SYM.	DESCRIPTION	DATE	APPD.
	A	RELEASE FOR PRODUCTION	12-7-05	ELM
	B	PER DCN 1810-0012B	3-12-07	ELM
	C	PER DCN 1810-0012C	2-24-10	ELM
	D	NO CHANGE THIS SHEET	6-24-11	EAS
	E	PER DCN 1810-0012E	8-9-11	FWD
	F	ECO 1371; PER DCN 1810-0012F	6-9-14	J.L.
	G	ECO 1417; PER DCN 1810-0012G	5-8-15	EAS

OPTIONAL
(WITH LIGHT TRAP)
BLOWER MOTOR

SEE BLOWER MFR. WIRING DETAILS PACKAGED WITH BLOWER

LINE-(L) NEU-(N) GND

1.

F N GND 115V — CIRCUIT BREAKER/FUSED DISC. SW, 1ø, WITH HI INRUSH CURRENT DELAY. (42 CFM BLOWER, 5 AMP) (56 CFM BLOWER, 8 AMP) TO BE SUPPLIED BY CUSTOMER (AT SAME ELEVATION AS TML INSTRUMENT)

F N GND 230V — CIRCUIT BREAKER/FUSED DISC. SW, 1ø, WITH HI INRUSH CURRENT DELAY. (42 CFM BLOWER, 3 AMP) (56 CFM BLOWER, 4 AMP) TO BE SUPPLIED BY CUSTOMER (AT SAME ELEVATION AS TML INSTRUMENT)

5. 10. AC SERVICE ENTRANCE CIRCUIT #3

OPTIONAL

OPTICAL HEAD ASSEMBLY 1810-1060

KEYPAD

COMPUTER MODULE — MOTHERBOARD

DISPLAY/CONTROL BOARD

6 POINT I/O BOARD

POWER SUPPLY BOARD

OPTICAL AMPLIFIER BOARD

SIGNAL DETECTOR
PURGE SWITCH 1
REF. DETECTOR
LASER

EXTERNAL INTERFACE BOARD

3.

TB1: L N G
TB3: 1 K1 (NO/NC) RED; 2 K1 COM BLK; 3 K2 (NO/NC) WHT; 4 K2 COM BLK; 5 ISO1 (+) RED; 6 ISO1 (-) BLK; 7 DGND; 8 ISO2 (+) WHT; 9 ISO2 (-) BLK; 10 DGND
TB2: 1 NOT USED WHT; 2 NOT USED BLK; 3 NOT USED; 4 NOT USED; 5 DGND; 6 DAC1 (+) BLU; 7 DAC1 (-) BLK; 8 FGND; 9 DAC2 (-) BLK; 10 DAC2 (+) YEL; 11 FGND

PE — GRN/YEL (PE)

BD. MTG. SCREW

ESD PROTECTOR 1860-0006-01

INTEGRAL 6. JUNCTION BOX 1801-0300

NETWORK CABLE
520234
(REQUIRED FOR STANDALONE ETHERNET MODULE OR ANALOG INPUT MODULE OPTION)

520083

520084

1. 4.

AC SERVICE ENTRANCE CIRCUIT #1 (TO BE SUPPLIED BY CUSTOMER)
4. 1.
LINE (L) — L
NEU (N) — N
GND — GND
85-245VAC, 47-63Hz, 1ø (14 VA MAX)

1.

L 115VAC-LINE (L)
N 115VAC-NEU (N)
GND GND
CIRCUIT BREAKER/FUSED DISC. SW, 1ø WITH HI INRUSH CURRENT DELAY. (42 CFM BLOWER, 5 AMP) (56 CFM BLOWER, 8 AMP) TO BE SUPPLIED BY CUSTOMER (AT SAME ELEVATION AS TML INSTRUMENT)

(OR)

L 230VAC-LINE (L)
N 230VAC-NEU (N)
GND GND
CIRCUIT BREAKER/FUSED DISC. SW, 1ø WITH HI INRUSH CURRENT DELAY. (42 CFM BLOWER, 3 AMP) (56 CFM BLOWER, 4 AMP) TO BE SUPPLIED BY CUSTOMER (AT SAME ELEVATION AS TML INSTRUMENT)

5. 10. AC SERVICE ENTRANCE CIRCUIT #2

LINE-(L) NEU-(N) GND

SEE BLOWER MFR. WIRING DETAILS PACKAGED WITH BLOWER

BLOWER MOTOR (OPTICAL HEAD SIDE)

1. 4.

BLU DAC1 (+)
BLK DAC1 (-)
YEL DAC2 (+)
BLK DAC2 (-)
RED ISO1 (+)
BLK ISO1 (-)
BLK DGND 9.
WHT ISO2 (+)
BLK ISO2 (-)
BLK DGND 9.

3.

1. 8. DIRECT INTERFACE TO CUSTOMER EQUIPMENT

2.

RED K1 (NO/NC)
BLK K1 COM
WHT K2 (NO/NC)
BLK K2 COM

DUAL ANALOG INPUT MOD. 1810-1500 6. (OPTIONAL)

CUSTOMER USE: -15VDC, +15VDC, AGND — TB2: 7, 8, 9

8.

5. LINE — TB1: 1
7. NEUT — TB1: 2
PE — TB1: 3
GRN/YEL

POWER SUPPLY

DUAL ANALOG INPUT PC BOARD

WHT BLK

P2 J2:
1 1 DATA A
2 2 DATA B
3 3 DATA A
4 4 DATA B

J4 P4: 4-20mA, GND, V IN
J3 P3: REF, RTD INP, 4-20mA, GND, V IN

8.

4-20mA INPUT (OPTIONAL)
4-20mA INPUT (OPTIONAL)
RTD INPUT (OPTIONAL)

OPTIONAL WIRING FOR DUAL ANLG INP BD

10. BLOWER SELECTION GUIDE: 42 CFM RECOMMENDED FOR POSITIVE PRESSURE STACKS UP TO +10" OF WATER. 56 CFM RECOMMENDED FOR STACKS ABOVE +10" WATER.

9. TERMINATE SHIELDS TO FRAME GROUND AT CUSTOMER'S EQUIPMENT END OF CABLE.

8. ALL FIELD WIRING TERMINATING ON STACK MOUNTED EQUIPMENT MUST BE RATED MINIMUM 70 DEGREES C. NO GREEN FIELD WIRES MAY BE TERMINATED ON TML PROVIDED TERMINALS OTHER THAN 'PE' AS SHOWN.

7. POWER REQUIREMENT IS 85-245VAC, 50/60Hz, 1ø (35VA).

6. MAINTENENCE PROCEDURES REQUIRING THE REMOVAL OF THE COVER ARE INTENDED TO BE PERFORMED BY TRAINED PERSONELL ONLY.

5. CUSTOMER TO PROVIDE CIRCUIT BREAKER OR FUSED DISC. SWITCH OF APPROPRIATE RATING AT SAME ELEVATION AS TML EQUIPMENT BEING SUPPLIED. LABEL DISC. DEVICES WITH NAME/TAG NO. OF OF EACH DEVICE BEING SUPPLIED.

4. CABLES SIZED AND CHOSEN TO FIT TOGETHER IN 1/2" CONDUIT WITH 40% MAXIMUM FILL. USING OTHER CABLES MAY REQUIRE LARGER CONDUITS/FITTINGS.

3. NOT USED

2. RELAY CONTACTS ARE JUMPER SELECTABLE ON 6 POINT I/O PC BOARD (N.O. OR N.C.). SEE USER'S MANUAL.

NOTES: 1. TERMINATED AT SITE DURING FINAL INSTALLATION.

DIMENSIONAL TOLERANCES UNLESS OTHERWISE SPECIFIED
FRACTIONS 0 TO 4 ±1/32; 4 TO 8 ±1/16; 8 AND UP ±1/8
DECIMALS .XX ±.01; .XXX ±.005
ANGLES ±0°30'
RMS FINISH
ALL DIMENSIONS ARE IN INCHES DO NOT SCALE THIS DRAWING

AUTHORIZATION	BY	DATE
DRAWN	DCH	3-8-05
CHECKED	ELM	4-20-05
DESIGNED	DCH	3-8-05
ENGINEERED	ELM	4-20-05
PRODUCTION	GA	1-4-06
Q.A.	AS	1-4-06

PROJECTION

USED ON

DASH NO	NEXT ASSEMBLY
	TOP

TELEDYNE MONITOR LABS Everywhereyoulook™

TITLE: WIRING DIAGRAM LASERHAWK PROCESS 360P WITH BLOWER(S)

MAT'L. | FINISH | JIG NO.

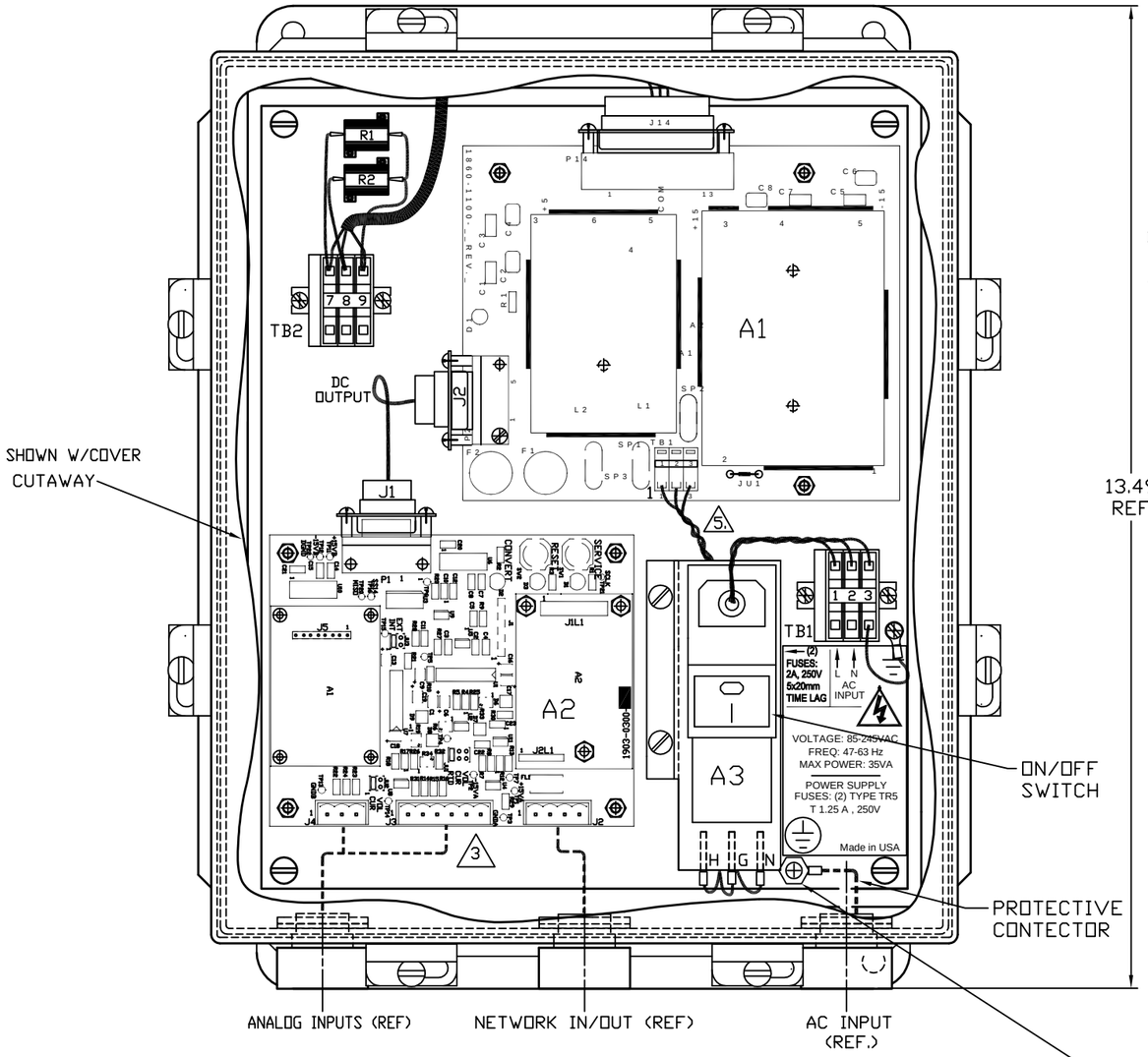
SCALE NTS | SHEET 3 OF 5

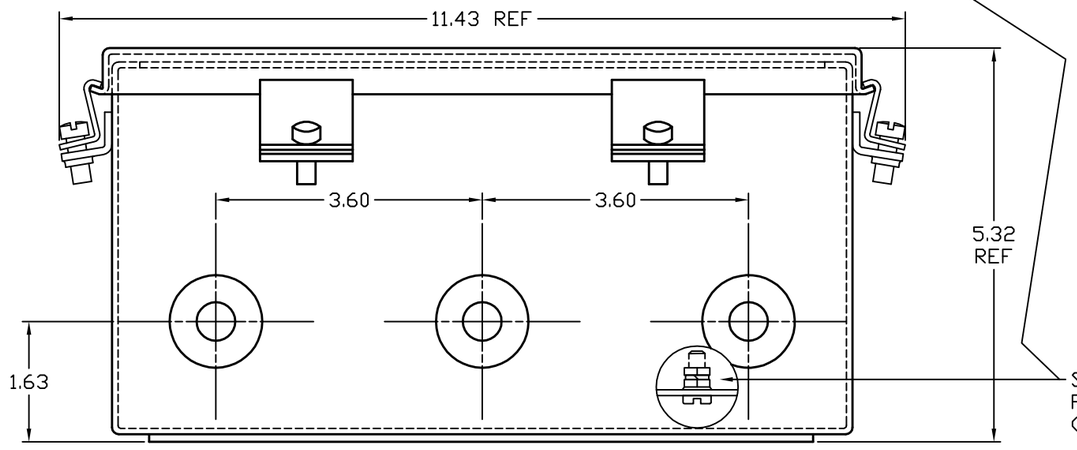
D | DRAWING NO. 1810-0012 | LATEST REVISION G

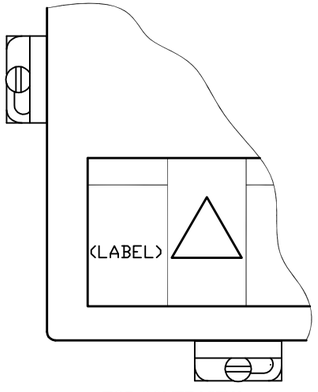
ACAD FILE 18100012-S3

DWG. NO 1810-1505 | SH 1

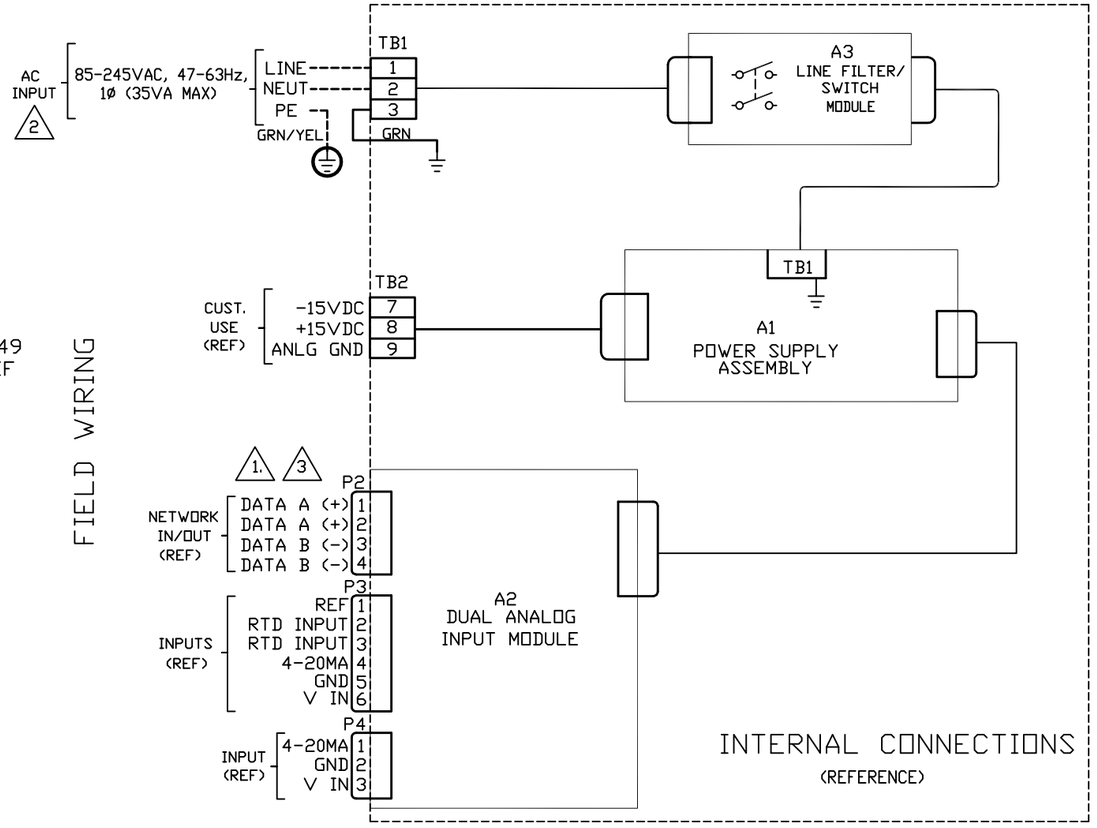
REVISIONS				
ZONE	SYM.	DESCRIPTION	DATE	APPD.
	A	RELEASE FOR PRODUCTION	12-15-05	ELM
	B	PER DCN 1810-1505B	1-17-07	ELM







TOP COVER VIEW (PARTIAL)



4. MAINTENENCE PROCEDURES REQUIRING THE REMOVAL OF THE COVER ARE INTENDED TO BE PERFORMED BY TRAINED PERSONNEL ONLY.

3. FIELD CONNECTORS PROVIDED WITH PC BOARD.

2. CUSTOMER TO PROVIDE FUSED DISC. SWITCH OR CIRCUIT BREAKER OF ADEQUATE RATING (PER SUPPLY VOLTAGE) AT SAME ELEVATION AS EQUIPMENT. DISCONNECT DEVICE TO BE LABELED WITH NAME/TAG NO. OF EQUIPMENT IT SUPPLIES. TERMINATE AC WIRING TO TB1 AS INDICATED ABOVE.

NOTES: 1. ALL WIRING FOR FIELD CONNECTIONS TO BE TEMPERATURE RATED MINIMUM 70 DEGREES CENTIGRADE.

DIMENSIONAL TOLERANCES UNLESS OTHERWISE SPECIFIED
FRACTIONS 0 TO 4 ±1/32; 4 TO 8 ±1/16; 8 AND UP ±1/8
DECIMALS .XX ±.01; .XXX ±.005
ANGLES ±0°30'
RMS FINISH
ALL DIMENSIONS ARE IN INCHES
DO NOT SCALE THIS DRAWING

AUTHORIZATION	BY	DATE
DRAWN	EAS	12-15-05
CHECKED	ELM	1-03-06
DESIGNED	EAS	Dec-05
ENGINEERED	ELM	1-03-06
PRODUCTION	GA	1-4-06
Q.A.	AS	1-4-06

PROJECTION

USED ON

DASH NO	NEXT ASSEMBLY
-01	

TELEDYNE MONITOR LABS Everywhereyoulook™

TITLE LONWORKS NETWORKED DUAL ANALOG INPUT ASSY INSTALLATION DRAWING

MAT'L. | FINISH

JIG NO.

SCALE 1:1 | SHEET 1 OF 1

DRAWING NO. 1810-1505 | LATEST REVISION B | D

1-23-07

ACAD2004 FILE 18101505