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***LaserHawk* 360/360DI/360ES**

Particulate Matter Monitor

Operations Manual



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SERIAL NUMBER: _____

DOCUMENT NO.: 1810-0050-01 REV G

JANUARY 2015

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1810-0012	1 of 5	G	Wiring Diagram, Model 360/360ES (120 / 230 VAC)
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1810-0014	1 of 3	B	Installation Distances, Optical Head Assembly
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1810-0014	3 of 3	B	Installation Distances, Optical Head Assembly w/Light Trap
1810-0657	1 of 1	B	Cal Kit, 360, Customer Outline
1803-2003	2 of 2	H	ERP Assembly, Customer Outline
1810-1401	1 of 2	B	Light trap Assembly w/Cone Installation
1810-1401	2 of 2	B	Light trap Assembly w/ND filters Installation (360ES)
1810-1505	1 of 1	B	Installation Distances, Dual Analog Input Assembly

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1.0 SYSTEM OVERVIEW

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

The *LaserHawk* 360 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* 360 is proportional to the light scattered back from particles in the gas stream. This signal may be conditioned by a Teledyne Monitor Labs (TML) Enhanced Remote Panel (ERP) or user supplied device in order to create outputs which are linear with particulate dust loading levels.

There are three different models that can be purchased.

LaserHawk 360: Standard unit with ERP, minimum particulate level 20mg/M³

LaserHawk 360DI: Direct Interface version having a 6PT I/O PC Board in the optical head, minimum particulate level 20mg/M³

Laser Hawk 360ES: Extra sensitivity unit with ERP, minimum particulate level 5mg/M³

1.1 ELECTRICAL 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* 360 is used in a manner different than specified herein.

The following are internationally recognized symbols used on the *LaserHawk* 360 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* 360:

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.

1.2 LASER RADIATION SAFETY

DANGER: The *LaserHawk 360* 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 360* 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 360* 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 360* is designed to meet or exceed all requirements of the US-EPA Performance Specification 11 – Specifications and Test Procedures for Particulate Matter Continuous Emission Monitoring Systems at Stationary Sources (PS-11) – that apply to in-situ light scatter instruments.

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

- Optical Head Assembly
- Protective Purge Air System
- Enhanced Remote Panel (Not supplied with 360DI)
- Calibration Kit Assembly

As shown on the *LaserHawk 360* Installation Drawing, the first two are located on the stack. The Enhanced Remote Panel Assembly is located in the Control Room. A Calibration Kit and Filter Case are also provided.

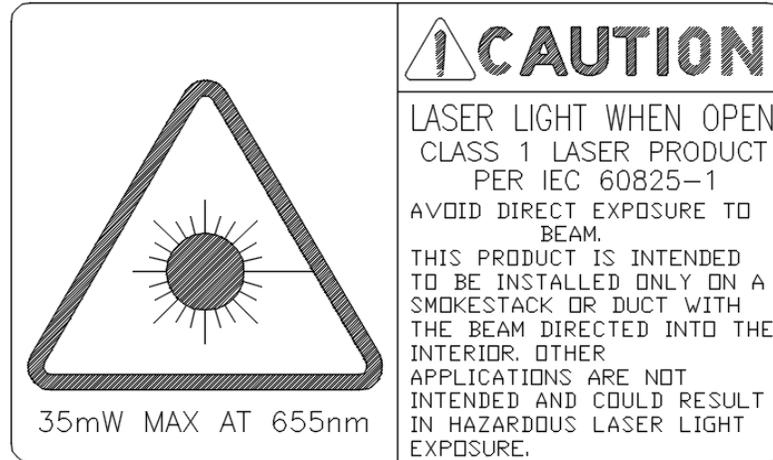
Optional items include:

- Instrument Air Purge System
- High Temperature Operation (500° F to 1500° F)
- Heat Shield
- Pressure and Temperature Input Interface (Analog Input Module)
- 6PT I/O PC Board (360DI Only)
- Light Trap Assembly

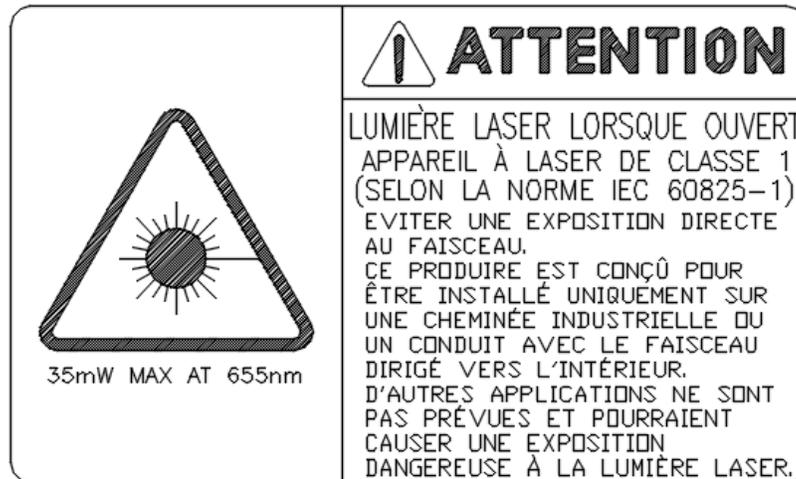
A description of each optional item can be found in Section 2.0. To verify what options this monitor is equipped with see the Site Specification Data Sheets in Appendix A.

1.2.1 Laser Radiation Caution Labels Used Throughout This System

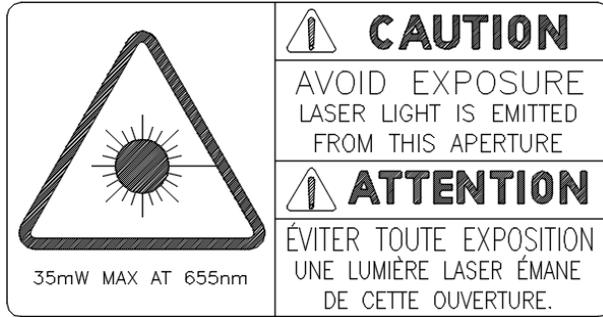
All labels in this section except the last two (CAL KIT COVER LABEL and CAL KIT BODY LABEL) address laser radiation exposure.



OPTICAL HEAD COVER WARNING LABEL (ENGLISH)



OPTICAL HEAD COVER, SIDE (FRENCH [CANADIAN])



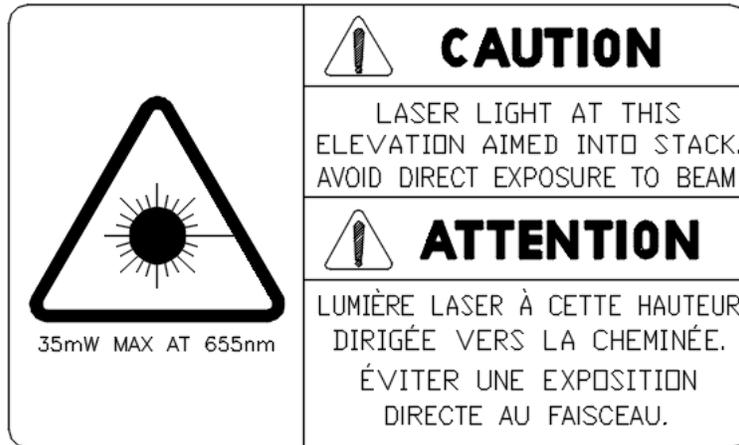
PURGE NOZZLE WARNING LABEL



MIDDLE HOUSING WARNING LABEL



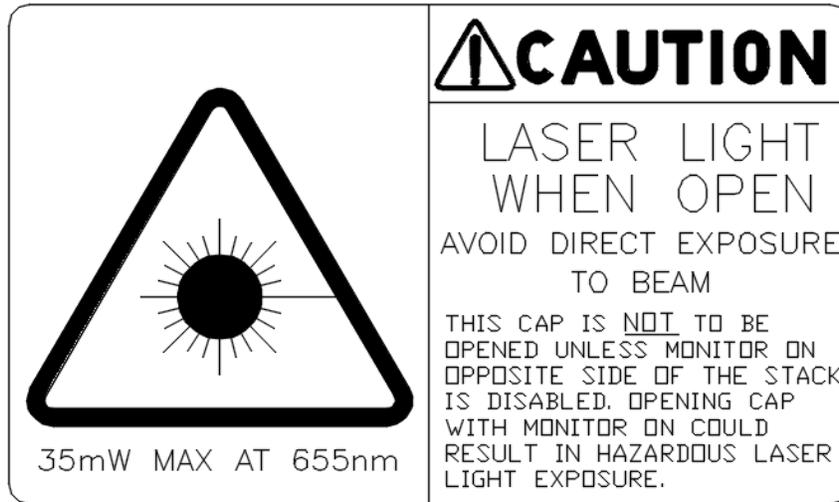
WEATHER COVER WARNING LABEL



INSTRUMENT LEVEL WARNING LABEL



GROUND LEVEL WARNING LABEL



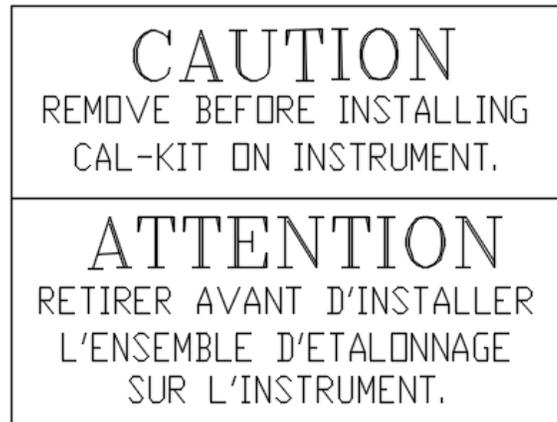
LIGHT TRAP WARNING LABEL (ENGLISH)



LIGHT TRAP WARNING LABEL (FRENCH [CANADIAN])



CAL KIT WARNING LABEL



CAL-KIT COVER LABEL



CAL-KIT BODY 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 with the Enhanced Remote Panel, or other optional components, is via a commercial network communication protocol. Automated simulated zero and upscale calibration devices are incorporated into the Optical Head Assembly.

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 (30 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 360 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 **Enhanced Remote Panel with Multi I/O Board (Not supplied with 360DI)**

The Enhanced Remote Panel is built with a modular design. It is rack mountable. The software is menu driven and uses a commercial network communications platform. It uses a membrane switch keypad, a 4 ½” LCD display with graphics capability and a key lockout for critical functions. The Multi I/O Board has eight relay outputs, eight digital inputs, and four individually isolated analog outputs.



1.3.3.1 **Ethernet Module**

The Ethernet Module is a single printed circuit board located inside of the ERP chassis. External connection to the Ethernet Module is made via a standard RJ45 connector socket in the rear panel of the ERP. The module will provide web browser-based remote access, configuration and control of the *LaserHawk 360*. 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 ERP feature are described in its own instruction manual which is provided with the instrument. The customer supplied network cable may be installed into the socket marked “Ethernet” at the right hand side of the ERP rear panel.

NOTE: Standalone version available for use with the 360DI.

1.3.4 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.



1.3.5 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.



1.4 SPECIFICATIONS

PHYSICAL DIMENSIONS

Optical Head (with cal mechanism)	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)
Enhanced Remote Panel	3U 19" (483mm) Rack Mount 5-1/4" (133mm) (H) X 9" (229mm) Depth

PHYSICAL WEIGHTS

Optical Head (with cal mechanism)	28 lbs. (12.7 kg)
Purge Blower Assembly	65 lbs. (29.5 kg)
Enhanced Remote Panel	10 lbs. (4.5 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	0 - 5 mg per actual M3, 360ES
Minimum	0 - 20 mg per actual M3, 360/360DI
Maximum	0- 1000 mg per actual M3

SYSTEM MEASUREMENT CHARACTERISTICS

Response Time (To 95% of change)	Less than 10 seconds
Calibration Zero Operation	On command
Upscale Calibration Operation	On command
Stability Over Operating Temperature Range	±2.0% of Full Scale Maximum per 40°F (22.2°C) 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 <u>Fuses</u> 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
Enhanced Remote Panel	85-245 VAC, 47-63Hz, Single Phase, 30 VA Maximum <u>Fuses</u> 2 Amp Time Delay, 250V, 5x20mm
Dual Analog Input Module	85-245 VAC, 47-63Hz, Single Phase, 35 VA Maximum <u>Fuses</u> 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°F (-20 to +60°C) (startup) -25 to +140°F (-32 to +60°C) (operating) Relative Humidity Range: 0 to 100% condensing Optical head rating: IP66
Enhanced Remote Panel	Temperature Range: +32 to +104°F (0 to +40°C) Relative Humidity Range: 0-95% noncondensing
Dual Analog Input Module	Temperature Range: -4 to +140°F (-20 to +60°C) (startup) -25 to +140°F (-32 to +60°C) (operating) Relative Humidity Range: 0 to 100% condensing Enclosure Rating: IP66

*** 2 circuits if light trap is supplied

MEASUREMENT MEDIUM CONDITIONS

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

OPTICAL HEAD HUMAN/MACHINE INTERFACE (HMI) CHARACTERISTICS

Display Type	<i>Six 7 Segment LED's</i>
Indicating LED's	<i>Fault, Set, In Cal, Power</i>
User Input Controls	<i>10-key keypad</i>

WIRING REQUIREMENTS, OPTICAL HEAD TO ENHANCED REMOTE PANEL

Network Transceiver Type	<i>Free Topology Transceiver (FTT10A)</i>
Cable Type	<i>2 conductor shielded twisted pair, 16 AWG (Alpha 5610B1601 or equivalent)</i>
Termination Style	<i>Jumper Selectable Double Termination (Internal)</i>
Maximum Distance Between Optical Head & Enhanced Remote Panel	<i>3281 feet (1000 meters) [must be Double Terminated]</i>
Maximum Total Network Length	<i>3281 feet (1000 meters) [must be Double Terminated]</i>

ENHANCED REMOTE PANEL HUMAN/MACHINE INTERFACE (HMI) CHARACTERISTICS

Display Type	<i>Graphics mode liquid crystal with LED backlight</i>
Display Resolution	<i>240 X 128</i>
Indicating LED's	<i>Fault, Alarm, Power</i>
User Input Controls	<i>20-key keypad, security keyswitch</i>

ENHANCED REMOTE PANEL SERIAL PORT CHARACTERISTICS

Number	<i>2 (one RS232C, one RS422 or RS485 [jumper selectable])</i>
RS232C Port Configuration	
BAUD Rate	<i>9600</i>
Data Bits	<i>8</i>
Stop Bits	<i>2</i>
Parity Type	<i>No Parity</i>
Connector Designation & Type	<i>J16, DB9</i>
RS422/RS485 Port Configuration	
BAUD Rate	<i>9600</i>
Data Bits	<i>8</i>
Stop Bits	<i>2</i>
Parity Type	<i>No Parity</i>
Connector Designation & Type	<i>J17, DB15</i>

MULTI I/O BOARD ANALOG OUTPUTS

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

MULTI I/O BOARD DIGITAL INPUTS

Number	<i>8</i>
Modes	<i>Isolated and Non-isolated</i>
Isolated Mode Minimum Isolation Voltage	<i>500Vrms*</i>
Isolated Mode Minimum Actuation Voltage	<i>5VDC (user supplied)</i>
Isolated Mode Maximum Actuation Voltage	<i>24VDC (user supplied)</i>
Isolated Mode Maximum Input Current	<i>50mA @ 24VDC</i>
Non-Isolated Mode Actuation Condition	<i>Dry contact closure</i>
Non-Isolated Mode Internal Operating Voltage	<i>5VDC</i>

MULTI I/O BOARD RELAY OUTPUTS

Number	8 SPST, N.O. (Single Pole Single Throw, Normally Open)
Minimum Isolation	500Vrms*
Maximum Contact Voltage	250VAC
Maximum Contact Current	3Amps AC, 3Amps 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* 360 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). The Enhanced Remote Display or user supplied data acquisition device may be used to record the data to perform this function. The correlation curve parameters can be entered either via the Enhanced Remote Display or the Optical Head.

2.0 OPTIONAL EQUIPMENT

The components listed below are optional on the *LaserHawk 360* 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 by a 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 Hi-Temp seals 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 360* 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 Enhanced Remote Display or 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	<i>Any</i>	<i>Any</i>	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	

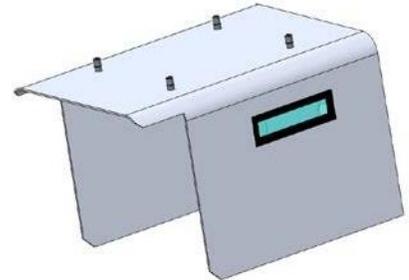
2.5 PURGE AIR HEATER

The *LaserHawk* 360 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.

2.6 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.



2.7 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.



2.8 6PT I/O PC BOARD OPTION FOR 360DI

The Six Point I/O Board is an optional device intended to provide a low cost Direct Interface feature to the *LaserHawk* 360DI where analog output and control signals are supplied directly from the Optical Head Assembly. The PC Board has 2 analog outputs, 2 digital inputs and 2 relay outputs. The configuration of the 6PIO Board is software selectable using the keypad on the outside of the optical head. Below are the specifications. More details on this option are described in its own instruction manual.

360 DI Six Point I/O Board Specifications

SIX POINT I/O BOARD ANALOG OUTPUTS

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

SIX POINT I/O BOARD DIGITAL INPUTS

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

SIX POINT I/O BOARD RELAY OUTPUTS

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

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

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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* 360 Optical Head.

3.2 MECHANICAL DESCRIPTION

The Optical Head Assembly is constructed primarily of cast aluminum, IP66 rating. It is comprised of a Rear Optical Section, an Integral Junction Box and the automated Calibration Mechanism. 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. The Calibration Mechanism acts as an automated simulated zero/upscale device. It receives its drive and control from a motor inside the Rear Optical Section. The optical portion of the Calibration Mechanism is housed in a plenum area that is protected by the Purge Air System. This mechanism is located outside of the Rear Optical Section and may be manually or automatically commanded to rotate two separate devices into the optical field of view.

Access to the Calibration Mechanism and 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* 360 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 a field 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. The reticule is used for LASER alignment purposes. For LASER alignment the calibration kit must be installed.

The Calibration Mechanism intercepts the projected light from the Laser when the mechanism is activated. Two separate optical references simulate both zero and upscale signals returned to the detection system.

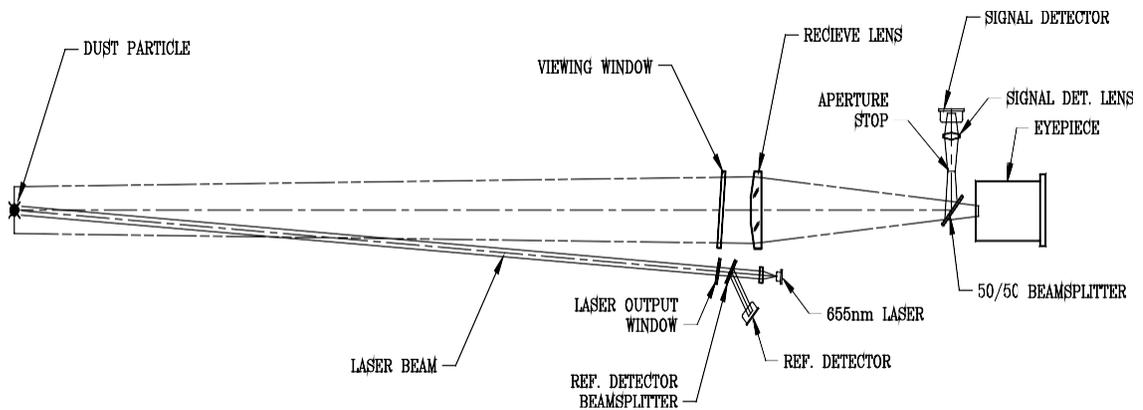


Figure 3-1

3.4 ELECTRICAL DESCRIPTION

The electrical configuration of the Optical Head includes connections for AC power wiring from user supplied circuits, internal signal processing electronics and Calibration Mechanism drive and position decode circuitry.

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. See Section 4.4.7.5 Change Optics Properties.*

3.4.3 Simulated Zero/Upscale Device Drive Components

A DC motor and associated position encoder is also located inside the Rear Optical Section cover. They drive and control the simulated zero/upscale device position. The position signals are transmitted through the Optical Amplifier Board and allow the signal processing electronics to determine whether the detector signals are being generated from the backscatter energy or the zero/upscale device.

LASERHAWK 360 PARTICULATE MATTER MONITOR

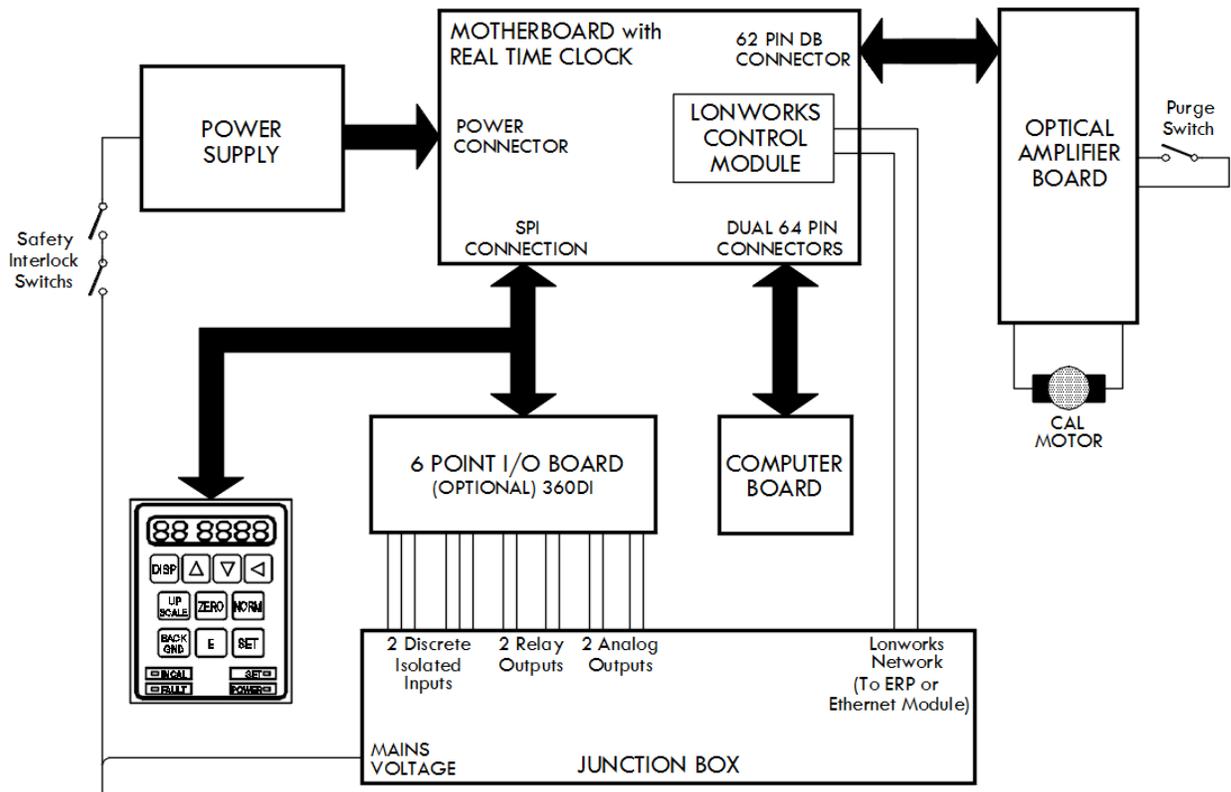


Figure 3-2

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

VESTA 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
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SIX POINT I/O BOARD (1860-0700) JUMPERS (360DI only)

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 _{calcycle})	BOTTOM	Selects input #1 function
JU8	A (TOP=Force _{Zero}) . B (MID=Not Used) . C (BOTTOM=Dump _{Dust})	TOP	Selects input #2 function
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	A (Cal)	K1 relay closure condition
JU13	H G F E D C B A	B (Fault)	K2 relay closure condition
JU14	B A	A (NO)	K1 Relay operation NC/NO
JU15	B A	A (NO)	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

"C" - Calibration 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, UPSCALE 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: Initiates an UPSCALE calibration.



ZERO: Initiates a ZERO calibration.



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: Initiates an UPSCALE SET function.

UPSCALE * ZERO: Initiates a Calibration Cycle.

DISPLAY * LEFT: Toggles the display from User data (U) to Service data (S) and parameter (F, C, 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: Lights when the Calibration Mechanism is in UPSCALE or ZERO position. Blinks when the Calibration Mechanism is in NORMAL position but the analog outputs contain DUST COMP information.

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

SET: Lights when UPSCALE, NORMAL, or BACKGROUND sets are in progress or when parameter changes have been accepted. Blinks when UPSCALE, 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"

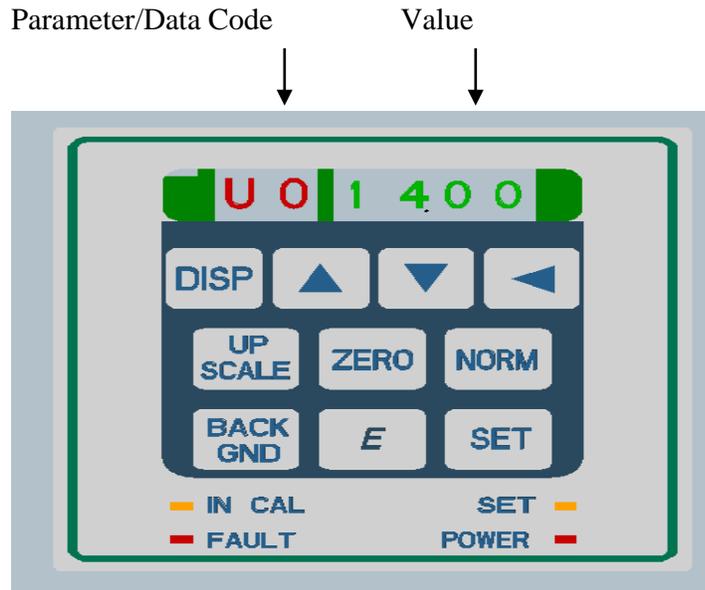
The value of the data in location U2 will be displayed on the RED 4 digit display to the right of the location identifier.

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:

1. User Data Bank
2. 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 = UPSCALE position not achieved
- X 1 X X = ZERO position not achieved
- X X 4 X = NORMAL position not achieved
- 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 = Excessive DUST Compensation
- X X X 4 = UPSCALE Calibration bad
- X X X 2 = ZERO Calibration bad
- X X X 1 = UPSCALE SET voltage out of range

U5: Mode Code

Mode Code Definition

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

- Calibration Mechanism Condition
- X X X 0 = Unknown Mode
- X X X 1 = NORMAL (Stack) Mode

X X X 2 = ZERO Calibration Mode

X X X 3 = UPSCALE Calibration Mode

6PIO Analog Output Condition

X X 0 X = NORMAL Mode

X X 1 X = ZERO Mode

X X 2 X = UPSCALE Mode

X X 3 X = not used

X X 4 X = DUST COMP Mode

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: Last ZERO Calibration {ZERO Backscatter}[ZERO Particulate Mass]
- U7: Last UPSCALE Calibration {UPSCALE Backscatter}[UPSCALE Particulate Mass]
- U8: Dust Compensation {Dust Comp. Backscatter}[Dust Comp. Particulate Mass]
- U9: ML Correction Factor {Particulate Mass Load Correction Factor}
[multiplicative correction of Particulate Mass data to standard temperature and pressure conditions]
- UA: 332 Version --- Software version of 68332 microprocessor code
- UB: Neuron Version --- Software version of Neuron microprocessor code
- UC: Zero Drift Value
- UD: Upscale Drift Value
- UE: Set Upscale Value

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:	Calibration UPSCALE SET Voltage
S5:	BACKGROUND SET Voltage
S6:	Optical Head Temperature, °C
S7:	Calibration Mechanism Position
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, C, A, and E Banks, where F represents Fundamental, C represents Calibration, 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: Six Point I/O Zero/Dust Comp Scaling Flag (0 = NORMAL mode scaling; 1= EXPANDED scaling)

3.5.4.2.2 C Bank (Calibration Parameter Bank)

Note: Password protected

- C0: Calibration ZERO Set Point, Backscatter Energy, Particulate Mass
- C1: Calibration UPSCALE Set Point, Backscatter Energy, Particulate Mass

- C2: Dust Compensation Tolerance, Backscatter Energy, Particulate Mass
- C3: Calibration Tolerance (Delta), Backscatter Energy, Particulate Mass
- C4: Hour of Calibration
- C5: Minute of Calibration
- C6: Interval Between Calibration, Hours
- C7: Seconds of ZERO (In Calibration Automatic Daily Cycle)
- C8: Seconds of UPSCALE (In Calibration Automatic Daily Cycle)
- C9: Reserved
- CA: Seconds of DUST COMP (In Calibration Automatic Daily Cycle)

3.5.4.2.3 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: Auto Adjust Limit
- A8: Reserved
- A9: Upscale Position Encoder Count command (used for testing only)

3.5.4.2.4 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.

A	2	n	E	E	d
---	---	---	---	---	---

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.

A	2	9	8	6	0
---	---	---	---	---	---

- 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.

A	2	7	2	0	0
---	---	---	---	---	---

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".

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4.0 ENHANCED REMOTE PANEL WITH MULTI I/O MODULE & ETHERNET

4.1 OVERVIEW

The Enhanced Remote Panel is menu driven. It features a touch sensitive keypad, a 4 ½" (11.4 cm) LCD display, key lockout, RS-232 and RS-422/485 serial communication capability, and a commercial network communication node. The Multi I/O Board has eight relay outputs, eight digital inputs, and four individually isolated analog outputs.

4.2 MECHANICAL DESCRIPTION

The Enhanced Remote Panel uses a modular design. The components of the display are mounted in a 19" rack mountable enclosure. The enclosure is 5" (13 cm) high, x 9" (22 cm) deep, x 16 ½" (41 cm) wide.

All external connections are made from the back panel with pluggable connectors. Access to the inside of the unit is through the top panel. The top panel is removed by taking out four screws. Once this is done, slide out the top panel for access.

Inside the enclosure there are eight circuit boards, a power entry module, several interconnect cables, and the LCD display. The LCD Driver Board is integral to the display and the keypad is built into the front panel. The Terminal Block PC Board mounts to the back panel. The Ethernet module mounts on standoffs on a side panel. The other five boards mount off of the bottom panel in a stacked arrangement. The Mother Board, I/O Board, and Power Supply Board mount on standoffs and are connected by ribbon cables. The SBC332 Processor Board and the LonWorks® Board mount directly into sockets on the Mother Board.

Modules of the Enhanced Remote Panel

- Mother Board
- SBC332 Processor Board
- LonWorks® LTM-10A Board
- Terminal Block PC Board
- Power Supply Board
- Multi I/O Board
- LCD w / Driver Board
- Power Entry Module

- ❑ Ethernet Module
- ❑ Keypad / Front Panel Assembly

4.3 ELECTRICAL DESCRIPTION

4.3.1 Input Power Requirement

The Enhanced Remote Panel 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.*) The internal DC supply is auto-ranging and automatically adjusts for the power mains voltage.

4.3.2 Circuit Description (Overview)

The Enhanced Remote Panel with Multi I/O Board and Ethernet Module has three separate networked devices mounted in a single package: the Enhanced Remote Panel Mother Board node (hereafter referred to as the Enhanced Remote Display) and Multi I/O Board node (hereafter referred to as the Multi I/O Board) and the Ethernet Module (hereafter referred to as the Ethernet Module). Each has independent software and a unique network address. They share a common power supply and chassis. The Enhanced Remote Display acts as the operator interface. The Multi I/O Board is the peripheral hardware interface. The Ethernet Module allows access to the ERP from a web browser.

4.3.2.1 Liquid Crystal Display

The display is a graphics capable, 240x128 pixel, backlit LCD. The Display Driver Board is integral with the LCD and communicates to the Mother Board via ribbon cable. The contrast and backlight brightness are adjustable from the keypad.

4.3.2.2 Keypad

The Keypad is a light touch, membrane switch array. It is built into the front panel assembly and connects directly to the Mother Board via a ribbon cable.

4.3.2.3 Front Panel LEDs

The Power, Fault, and Alarm LEDs are also integral to the front panel assembly. They are connected to and driven by the Mother Board via a six-pin ribbon cable (J3).

4.3.2.4 Security Key Switch

The Security Key Switch is functionally in parallel with the administrator password. Protected variables can be unlocked with the administrator password or Key Switch.

4.3.2.5 Power Supply Board

The Power Supply Board produces the +5 VDC logic power for the Enhanced Remote. It has two connectors -- one for input and one for output. The input wires come from the input power module that contains the line cord connector power switch, and initial filtering. Surge protection and fusing are located on the board.

4.3.2.6 Terminal Block PC Board

The Terminal Block PC Board mounts to the rear panel and handles all I/O connections. It has ten connector plugs mounted on the outside that extend through the metal panel. Incoming wires terminate in the female half of the connector with the push of a screwdriver. This type of connector allows the wires to be removed one wire at a time or by connector group.

4.3.2.7 Enhanced Remote Panel Mother Board

The Enhanced Remote Panel Mother Board has two microprocessors, a 68332, and an LTM-10A. Each is laid out on a separate Daughter Board that plugs horizontally into the Mother Board. The Mother Board has circuits to perform the following:

- Interface the two processors
- Buffer the data buss
- Adjust contrast and brightness outputs to the display
- Drive and Buffer the keypad
- Drive the FTT10 A network communication port
- ESD protection for all I/Os
- Drive the front panel LEDs for Fault and Alarm
- Communicate with the display
- Provide -20 VDC and -24 VDC for the LCD

NOTE: See jumper and test point tables along with schematic drawing for complete detail.

4.3.2.8 RS-232 and RS-422/485

A serial communication interface for monitoring of network variables is provided. The user can use a standard terminal emulator program on a PC to communicate with the panel. Communication is provided on both the RS-232 and RS-422

ports. The RS-422 port can be converted to a RS-485 port with an internal jumper located on the Mother Board.

The communication parameters of both ports are fixed. They are listed in Table 4-1.

Table 4-1

Baud Rate	Data Bits	Stop Bits	Parity
9600	8	2	N

Two communication protocols are provided, Simple and Matched Pair. Neither protocol allows modification of variable values.

4.3.2.8.1 Simple Protocol

The protocol is strictly a polled mode. The user sends a command in ASCII characters in the format ‘nnn?<CR>’, where nnn is a number from 1 to 125 from a list of available variables provided to the user, and <CR> is the carriage return character. All other characters are ignored. A time delay of more than 10 seconds between characters will cause the previously sent characters to be discarded. The panel responds to the request with the following output: text identifying the variable and the current value of the variable, terminated with <CR>, or ‘UNRECOGNIZED **COMMAND**’ for input not in the above format, OR ‘**INVALID VARIABLE NUMBER**’ for an input number that is not on the list of available variables, terminated with <CR>. The output appears on the port where the command is received. An example command and subsequent transmission is shown below.

User sends: 1?<CR>

Enhanced Remote Display responds with: 1 Head Status : 0<CR>

Transmission of the characters **255?<CR>** will cause all available variables to be sent sequentially, i.e., starting with variable 1, followed by 2, etc., until the last variable is reached.

The Status Code History can be output through the serial port by the following command line: **991?<CR>**

The Alarm History can be output through the serial port by the following command line: **993?<CR>**

4.3.2.8.2 Matched Pair Protocol

One of the drawbacks of the previously mentioned protocol is that there is no sum-check or other methods to verify that the data is valid. This represents a problem in that if a character is lost in the transmission, then the data represents an error that is not detected. The Matched Pair protocol overcomes this problem by using four (4) values separated by commas and ending in a “carriage-return” and “line-feed”. The first and third values must be exactly the same, and the second and fourth values must be exactly the same. If EITHER of these two conditions is not met, then the ENHANCED REMOTE PANEL will ignore the data stream if it receives it as an input. In a similar manner the DAS should ignore data it receives from the ENHANCED REMOTE PANEL if both of the data pairs do not match.

A typical command or data line will look like the following:
“first-value” , “second-value” , “third-value” , “fourth-value” <CR><LF>

There are two types of functions that may be performed using the matched pair protocol. First, the calibration may be initiated and controlled, and second, variables may be requested for output. No variables may be modified from the serial ports.

4.3.2.8.2.1 Initiation and Control of Calibration for Matched Pair Protocol

If the following command line is given to the ENHANCED REMOTE PANEL, it will list the commands available for the calibration input command line.

```

997 ?<CR><LF>
OutPut Cal Enum Help
0 = Mode Unknown
1 = Normal Mode
2 = Zero Mode
3 = Upscale Mode
4 = RESERVED
5 = Dust Comp Mode
6 = Force Cal Cycle
7 = Test Zero Scale
8 = Test Mid Scale
9 = Test Full Scale
10 = Put In Service
11 = Out of Service
12 = Reset OPT Head

```

The system calibration may be initiated and controlled from the serial port. The following command string may be used.

The command string for Calibration Control is as follows:

998,“command”, 998 ,“command”<CR><LF>

The value for “**command**” is chosen from the above list of commands.

For example, to request the *LaserHawk 360* to go into the **Upscale Mode**, the following command line would be used.

998, 3, 998, 3 <CR><LF>

The serial port will respond with: **OutPut Cal = UpScale Mode**

4.3.2.8.2.2 Data Request for the Matched Pair Protocol

To request data values in the matched pair format use the following command line.

990, “variable-number”, 990, “variable-number” <CR><LF>

The “**variable-number**” is the same as the variable numbers used in the Simple Protocol.

For example, the average Backscatter Energy is contained in variable #72 and could be read in the Simple Protocol by the following command line.

72 ?<CR><LF>

The ENHANCED REMOTE PANEL will reply:

72 AveBackScatterEnergy: 23.56

To request this variable in the Matched Pair Protocol, use the following command line.

990, 72, 990, 72<CR><LF>

The ENHANCED REMOTE PANEL will reply:

72, 23.56, 72, 23.56<CR><LF>

The DAS receiving this input should verify that both pairs match before accepting the data as valid.

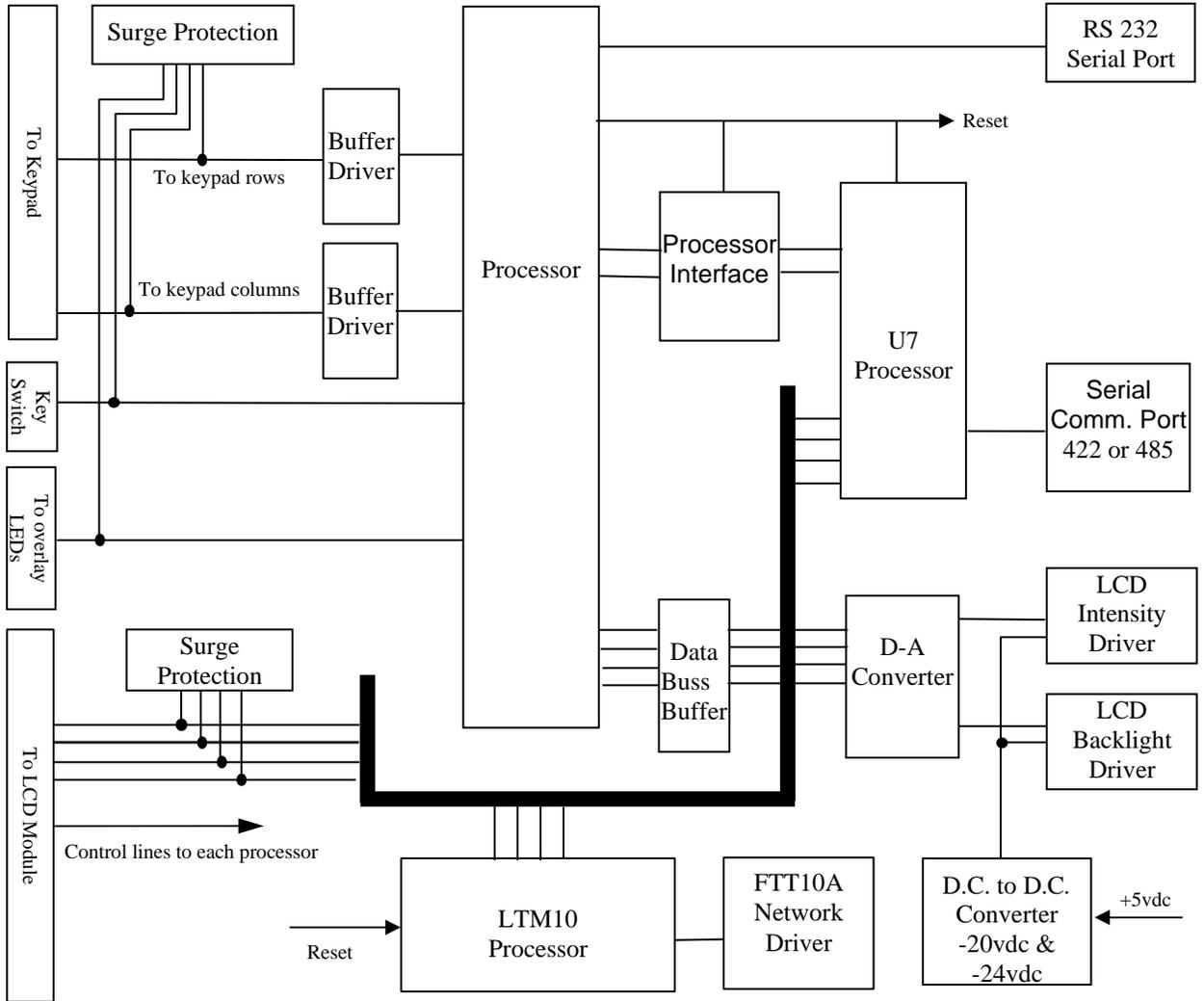


Figure 4.1
Block Diagram, Mother Board, 1803-0200

Enhanced Remote Display Mother Board Jumper Definitions

Jumper #	Selections							Functional Description
JU1	IRQ1	IRQ2	IRQ3	IRQ4	IRQ5	IRQ6	Out	Selects IRQ for reset signal
JU2	IRQ1	IRQ2	IRQ3	IRQ4	IRQ5	IRQ6	Out	RS422/485 Receive IRQ
JU3	UART			TPU				Selects where to send received data
JU4	UART			TPU				Selects UART or TPU data for transmit to J6
JU5	UART		TPU		422			Selects handshake signal or full time on
JU6	A – B = single			B – C = double				Selects single or double termination of network
JU7	A – B = terminated			B – C = not terminated				Selects if network is terminated at remote or not
JU8	-20V			-24V				Selects drive voltage for LCD contrast adjustment

68332 Processor, SBC332 Board, Jumper Definitions

Jumper #	Selections		Functional Description	
J2A	1 -- 2	2 -- 3	J2A, through J2F configure the SBC 332 board for the type of memory used. Standard settings are highlighted.	
J2B	1 – 2	2 -- 3		
J2C	1 -- 2	2 -- 3		
J2D	1 -- 2	2 -- 3		
J2E	1 -- 2	2 -- 3		
J2F	1 -- 2	2 -- 3		
J3	1 – 2 = Enabled	2 – 3 = Disabled	J3 enables or disables the 68332's watchdog timer	
J9	1 -- 2	2 -- 3	1-2 = 1200ms timeout	J9 selects the length of time the watchdog timer waits
J7	IN	Out		J7 puts in or takes out the RAM supercap for backup
J10	IN		Out	Selects the serial port outputs of the 68332
J12	IN		Out	Selects the serial port outputs of the 68332

NOTE: 1. J1, J4, J5A, J5B, J6, and J11 on the SBC332 board are actually connectors.

NEVER jumper together any of the pins on these headers.

2. Bold print or shading indicates the standard selection.

4.3.2.9 Multi I/O Board (Hardware)

The Multi I/O Board is a peripheral hardware interface. It communicates with the other devices in the system via a network interface. It gathers information from the Optical Head and Enhanced Remote Display via the network. It processes this information together with its digital inputs and site specific configuration to control its outputs.

The Multi I/O is capable of driving eight digital outputs (dry relay contacts) and four analog outputs. It can read up to eight digital inputs. The digital inputs are jumper configurable to be either dry contacts or 0 – 5 VDC signals. Dry contacts are standard. The analog outputs are jumper configurable to be 0 – 20 mA, 4 – 20 mA, or 0 – 24 mA current loop signals. (0 – 20 mA) is standard. Test points are provided for measuring output current. See Jumper and Test Point tables below.

Multi I/O Jumper Definitions

Jumper #	Selections			Functional Description					
	4--20ma	0--20ma	0—24ma						
JU1	1	0	1	Jumpers JU1 & JU2 configure the range of the analog outputs for channel #1.					
JU2	0	1	1						
JU3	1	0	1	Configures the range of analog output #2					
JU4	0	1	1						
JU5	1	0	1	Configures the range of analog output #3					
JU6	0	1	1						
JU7	1	0	1	Configures the range of analog output #4					
JU8	0	1	1						
	Dry Contact		5vdc Digital						
JU9	1—2—3		1—2—3	Configures digital input #1 hardware to work with dry contact or 5vdc logic signals					
JU10	1—2—3		1—2—3	Configures digital input #2 hardware.					
JU11	1—2—3		1—2—3	Configures digital input #3 hardware.					
JU12	1—2—3		1—2—3	Configures digital input #4 hardware.					
JU13	1—2—3		1—2—3	Configures digital input #5 hardware.					
JU14	1—2—3		1—2—3	Configures digital input #6 hardware.					
JU15	1—2—3		1—2—3	Configures digital input #7 hardware.					
JU16	1—2—3		1—2—3	Configures digital input #8 hardware.					
	Ram 128 K	Ram 32K	RO M 128K	ROM 64K	RO M 32K	Flash 128K	Flash 64K	Flash 32K	
JU17	A	A	B	B	B	B	B	B	Jumpers JU17 & JU18 together, select the type of memory chips to be used.
JU18	D	D	C	C	B	C	C	A	
JU19	IN----OUT Double terminated			IN----OUT Single terminated					Selects whether the network termination will be single or double termination. This is usually done elsewhere.
JU20	IN----OUT Out = unterminated			IN----OUT IN = terminated					Terminates the network if necessary. This is usually done elsewhere.

NOTE: 1. For exact jumper positions as shipped see “Site Specification Data Sheets” in Appendix A.
2. Bold print indicates the standard selection.

Multi I/O Test Point Descriptions

Test Point #	Functional Description	Output
TP1	24vdc isolated drive voltage for analog output #1. Referenced to TP2	Output #1
TP2	GND reference for TP1 and all points within #1 output circuit	
TP3	TP3 & TP4 are on opposite sides of a 100Ω resistor that is in series with the output #1 current loop. Measure the DC voltage across these test points and divide by 100 to calculate the actual output current of channel #1.	
TP4		
TP5	24vdc isolated drive voltage for analog output #2. Referenced to TP6	Output #2
TP6	GND reference for TP5 and all points within #2 output circuit	
TP7	TP7 & TP8 are on opposite sides of a 100Ω resistor that is in series with the output #2 current loop. Measure the DC voltage across these test points and divide by 100 to calculate the actual output current of channel #2.	
TP8		
TP9	24vdc isolated drive voltage for analog output #3. Referenced to TP10	Output #3
TP10	GND reference for TP9 and all points within #3 output circuit	
TP11	TP11 & TP12 are on opposite sides of a 100Ω resistor that is in series with the output #3 current loop. Measure the DC voltage across these test points and divide by 100 to calculate the actual output current of channel #3.	
TP12		
TP13	24vdc isolated drive voltage for analog output #4. Referenced to TP14	Output #4
TP14	GND reference for TP13 and all points within #4 output circuit	
TP15	TP15 & TP16 are on opposite sides of a 100Ω resistor that is in series with the output #4 current loop. Measure the DC voltage across these test points and divide by 100 to calculate the actual output current of channel #4.	
TP16		

4.3.2.10 Multi I/O Software

The four analog outputs of the Multi I/O Board can be configured to carry any one of 26 parameters. See “Parameters for Analog Output” table. Scaling for each of these four outputs is configurable and completely independent of the parameter selected. Both zero and full scale may be chosen for each output. Also each output may be configured to allow calibration cycles to appear on it regardless of the parameter selected with the exception of full-time Upscale, Zero, Dust Compensation, and Service Data selections. See “Multi I/O Output Modes” table for calibration mode scaling.

The Multi I/O can issue mode change commands to the Optical Head Assembly. These commands typically control the state of the Calibration Mechanism. They are issued under user command only via the Isolator Inputs #1, #2, #4, and #5. These Inputs are referred to as the Optical Head Mode Change Isolators and their operation is described in the "Optical Head Mode Change Isolators" table.

Isolators #3 and #6 are not used.

The Multi I/O analog outputs can be forced to diagnostic states (TEST FULL SCALE, TEST ZERO SCALE, etc.) from two sources: the Enhanced Remote Display keypad and its own Isolator Inputs (Inputs #7 and #8). These Isolator Inputs are referred to as the Analog Output Isolators and their operation is described in the "Analog Output Isolators" table. If the Multi I/O receives conflicting or overlapping requests for output, its priority handler will assign requests from the Isolator Inputs top priority and the keypad requests from the Enhanced Remote Display second priority.

The Optical Head Mode Change and Analog Output Isolators operate independently. If an Optical Head Mode Change Isolator is actuated simultaneously with an Analog Output Isolator, both commands will be issued without interference with the other. For interpretation of simultaneous actuation of Isolator Inputs of the same type, consult both isolator tables.

The Multi I/O Board's eight digital outputs (relays) can be configured to activate on any one of 23 parameters. These are listed in the "Parameters for Relay Assignment" table. They fall into three categories: alarm indicators, malfunction indicators, and output mode indicators. Standard practice is to assign a relay to each of the three cal modes. These signals will then indicate when and what data is present on the analog outputs for data logging purposes. A functional description of the thirteen output modes including analog output and relay timing is contained in the "Multi I/O Output Modes" table. For more information on software function see Section 4.4 Operational Description.

The malfunction indicator selections are listed in the System Trouble column of the "Parameters for Relay Assignment" table. All are self-explanatory but the Data Valid and Fault selections.

A Data Valid condition implies that the backscatter monitor data is valid. A Fault condition arises when *any* abnormal situation exists regardless of data validity. Practically speaking, a Fault will exist when the Multi I/O detects *any* non-zero Optical Head status code regardless of analog output mode. The Data Valid condition will be FALSE when the Multi I/O detects *any* non-zero Optical Head status code or when the analog outputs are in TEST FULL SCALE, TEST MID SCALE or TEST ZERO SCALE modes.

Data Valid and Fault are fail-safe in nature: they are energized during normal operation and de-energized during instrument failure conditions.

Optical Head Mode Change Isolators Table

Input #1	Input #2	Input #4	Input #5	Command
0	0	0	0	No action results. No command request recognized.
1	0	0	0	FORCE UPSCALE
0	1	0	0	FORCE ZERO
1	1	0	0	DUMP DUST COMPENSATION
0	0	1	0	DUMP DUST COMPENSATION
0	0	0	1	FORCE CAL CYCLE
All other combinations of Inputs #1 through #5.				No action results. These are considered invalid command requests.

NOTE: In the above table, a “1” designates actuation of an Isolator Input and “0” designates de-actuation. Isolator #3 and #6 are not used.

Analog Output Isolators Table

Input #7	Input #8	Command
0	0	No action results. No command request recognized.
1	0	TEST ZERO SCALE
0	1	TEST FULL SCALE
1	1	TEST MID SCALE

NOTE: In the above table, a “1” designates actuation of an Isolator Input and “0” designates de-actuation. Isolator #3 and #6 are not used.

**Parameters for Relay Assignment
(Digital Output Closure Conditions)**

Backscatter Exceedence	Particulate Mass Exceedence	System Trouble	Calibration Control
Inst. Backscatter Level #1	Inst. Particulate Mass Level #1	Cal Failure	Normal
Inst Backscatter Level #2	Inst. Particulate Mass Level #2	Excess Dirt Compensation	Cal on A.O.
Min. Backscatter Level #1	Min. Particulate Mass Level #1	Instrument Malfunction	Dust Compensation on A.O.
Min. Backscatter Level #2	Min. Particulate Mass Level #2	Instrument Alert	Zero on A.O
Avg. Backscatter Level #1	Avg. Particulate Mass Level #1	Purge Failure	Upscale on A.O.
Avg. Backscatter Level #2	Avg. Particulate Mass Level #2	No Selection	-----

Parameters for Analog Output

Parameter Name	Functional Description
Instant Backscatter	Instantaneous Backscatter. Update time is 6-8 seconds.
Minute Avg Backscatter	A one minute average of the instantaneous Backscatter reading. The period is minute to minute according to the real time clock in the Optical Head.
Selectable Avg Backscatter	An average Backscatter reading whose time period is selectable in one-minute increments. The time selected should divide evenly into 60 minutes. 1,2,4,6,10,12,15,30 and 60-minute averages are possible.
Zero Drift Backscatter	$\text{Zero Drift} = \frac{ \text{ZCEM} - \text{RL} }{\text{RU}} * 100$ <p>where ZCEM is the zero response of the analyzer in terms of particulate mass (actual, not standard, conditions), RL is the zero set point in terms of particulate mass (actual, not standard, conditions) and RU is the upscale set point in terms of particulate mass (actual, not standard, conditions).</p>
Upscale Drift Backscatter	$\text{Upscale Drift} = \frac{ \text{RCEM} - \text{RU} }{\text{RU}} * 100$ <p>where RCEM is the upscale response of the analyzer in terms of particulate mass (actual, not standard, conditions) and RU is the same as above.</p>
Upscale Set Value	Updated after Upscale Set function completes to the recommended Upscale Set Point in % Backscatter.
Instant Particulate Mass	Instantaneous Particulate Mass loading in mg/m ³ . Update time is 6-8 seconds. This is a mathematical correlation from the Backscatter reading by a curve that is developed through extractive testing. This is not available for output until the correlation testing is done and the results entered into the <i>LaserHawk 360</i> software.
Minute Avg Particulate Mass	A one minute average of the instantaneous Particulate Mass reading. The period is minute to minute according to the real time clock in the Optical Head. Not available for output until testing results are entered.
Select Avg Particulate Mass	An average Particulate Mass reading whose time period is selectable in one-minute increments. The time selected should divide evenly into 60 minutes. 1, 2, 4, 6, 10, 12, 15, 30, and 60-minute averages are possible. Not available for output until testing results are entered.
Dust Compensation Output	The amount of Dust Compensation build up. The Dust Compensation factor applied to the NORMAL and UPSCALE mode readings is limited to the Auto Adjust Limit in % Backscatter. However, the Dust Compensation reading is unbounded.
Zero Backscatter	The calibration Zero value.
Upscale Backscatter	The calibration Upscale value.
Signal Voltage	Signal Voltage from the Optical Head in VDC. (Service Data selection)
Reference Voltage	Reference Voltage from the Optical Head in VDC. (Service Data selection)
Laser Current ma.	Laser Current reading in mA. (Service Data selection)
Normal Set Voltage	Cal Kit 100% Backscatter Set Voltage in VDC. (Service Data selection)
Upscale Set Voltage	Upscale Set Voltage in VDC. (Service Data selection)
Background Set Voltage	Background Set Voltage in VDC. (Service Data selection)
Optical Head Temperature	Optical Head Temperature in degrees Centigrade. (Service Data selection)
Calibration Mechanism Position	Calibration Mechanism Position. Dimensionless integer units equal to the Calibration Mechanism quadrature encoder value. (Service Data selection)
+15V Power Supply	Optical Head +15V Power Supply in VDC. (Service Data selection) (+/-5%)
-15V Power Supply	Optical Head -15V Power Supply in VDC. (Service Data selection) (+/-5%)
+5V Analog Power Supply	Optical Head +5V Analog Power Supply in VDC (Service Data selection) (+/-5%)
-5V Analog Power Supply	Optical Head -5V Analog Power Supply in VDC. (Service Data selection) (+/-5%)
+5V Digital Power Supply	Optical Head +5V Digital Power Supply in VDC. (Service Data selection) (+/-5%)
No Selection	Deactivates output.

Multi I/O Output Modes

Mode	Analog Output Function	Digital Output Function
NORMAL MODE <i>Initiated by: Enhanced Remote Display & Optical Head Keypads or System Clock</i>	Causes the analog outputs to display the data that they are configured for under normal operation.	Any relay configured for one of the calibration modes will drop out if already actuated.
ZERO <i>Initiated by: Input #2 or Enhanced Remote Display & Optical Head Keypads or System Clock</i>	Forced ZERO output. This will cause any or all of the four analog outputs to indicate the current zero value if they are configured to allow calibrations on them. For the scaling of the ZERO cal output see the “Zero and Dust Compensation Calibration Scaling Table”.	If a relay is configured as “ZERO ON AO” or “CAL ON AO” it will actuate when the calibration mechanism is in the ZERO position.
UPSCALE <i>Initiated by: Input #1, Enhanced Remote Display & Optical Head Keypads or System Clock</i>	Forced UPSCALE output. This will cause the Optical Head Calibration Mechanism to go to the UPSCALE position. If the Optical Head accepts the command, any or all of the four analog outputs will indicate the current instantaneous Upscale value if they are configured to allow calibrations on them. The scaling of this Cal UPSCALE value equals the NORMAL mode scaling.	If a relay is configured as “UPSCALE ON AO” or “CAL ON AO” it will actuate when the calibration mechanism is in the UPSCALE position.
RESERVED	N/A	N/A
DUST COMPENSATION <i>Initiated by: Input #4, #1 & #2 together or Enhanced Remote Display & Optical Head Keypads or System Clock</i>	Forced DUST COMPENSATION output. This will cause any or all of the four analog outputs to indicate the current DUST COMPENSATION value if they are configured to allow calibrations on them. For the scaling of the DUST COMPENSATION cal output see the “Zero and Dust Compensation Calibration Scaling Table”. Note: The Calibration Mechanism must be in NORMAL position for this command to be accepted.	If a relay is configured as “DUST COMPENSATION ON AO” or “CAL ON AO” it will actuate when the command is sent.
FORCE CAL CYCLE <i>Initiated by: Input #5 or Enhanced Remote Display & Optical Head Keypads or System Clock</i>	This test initiates an internally controlled cal sequence. This sequence is fixed in software. It consists of three parameters each posted to the outputs for 0-720 sec. (user selectable). The sequence of the parameters is: 1st ZERO: See “Zero & Dust....Scaling Table”. 2nd UPSCALE: NORMAL mode scaling (0-100% typ.) 3rd DUST COMP.: See “Zero & Dust....Scaling Table”.	If a relay is configured as “CAL ON AO”, during a cal cycle it will actuate when the calibration mechanism is in UPSCALE or ZERO positions or the Optical Head is in DUST COMP mode. It will drop out when the cal mechanism is between positions during a cal cycle.
TEST ZERO SCALE <i>Initiated by: Input #7 or Enhanced Remote Display & Optical Head Keypads or System Clock</i>	This test will drive all analog outputs regardless of configuration to their zero scale (4mA).	Any mode relays already actuated will drop out.
TEST MID SCALE <i>Initiated by: Inputs #7 & #8 together or Enhanced Remote Display & Optical Head Keypads or System Clock</i>	This test will drive all analog outputs regardless of configuration to their mid scale value (12mA).	Any mode relays already actuated will drop out
TEST FULL SCALE <i>Initiated by: Input #8 Enhanced Remote Display & Optical Head Keypads or System Clock</i>	This test will drive all analog outputs regardless of configuration to their full scale (20mA).	Any mode relays already actuated will drop out

NOTE: Digital inputs #3 and #6 are not used. Digital inputs 1, 2, 4, 5, 7, and 8 require actuation for 5 seconds before the software will recognize the input as a valid request. This is intended to prevent mode changes due to external transients.

Zero and Dust Compensation Calibration Scaling Table

“WITH” Field in Output Module Configuration	Value at ZERO SCALE (4mA) During Zero and Dust Compensation Modes		Value at FULL SCALE (20mA) During Zero and Dust Compensation Modes	
YES	Equal to NORMAL mode ZERO SCALE (typically 0% Backscatter)		Equal to NORMAL mode FULL SCALE (typically 100% Backscatter)	
EXP	-5% Backscatter	+5% Backscatter	+25 mg/m ³	+25 mg/m ³

NOTE: This table does not apply to full-time Zero and Dust Compensation outputs, in which case scaling is to the ZERO and FULL SCALE values and is independent of mode. This table applies only to outputs configured for backscatter and particulate mass that are selected to contain time-multiplexed calibration data.

4.3.2.11 ETHERNET MODULE

The need for simplified web browser-based remote access, configuration and control of intelligent embedded microprocessor-based devices has led Teledyne Monitor Labs (TML) to include the Ethernet Module in the ERP. The Ethernet module provides HTML web pages for user interface and fast Modbus TCP access to instrument data and parameters. The browser based mode of operation is accessible to users via commercial readily available PC programs and is consequently much simpler than Modbus TCP communication. The latter requires development of a driver program at the PC end, hence dealing with this mode of communication presume the reader has a background in software development and some familiarity with the instrument. See the separate manual on the Ethernet module.

NOTE: Can also be supplied in a standalone version for the 360DI.

4.4 OPERATIONAL DESCRIPTION

The Enhanced Remote Panel is menu driven. Operational and configuration parameters are viewed and changed through the display menu screens. The system configuration parameters are password protected. They can be accessed with the supervisor password or the security key switch. Operational and test parameters may be viewed and/or changed by scrolling through the menus using the “↑”, “↓”, “Page Up”, “Page Down”, “ESC”, and “↵” keys. The functions of these keys are described on each menu screen. The ESC key will return you to the previous menu. Password protected screens will prompt for the password before displaying the screen. To use the SECURITY key switch it must be in the ON position when that screen is selected.

4.4.1 Main Display Screen

This is the screen that is typically displayed during normal operation. The screen has four pages accessed by the Page Up and Page Down keys. No parameters displayed can be changed from this screen. Page #1 is the display screen default on power up and reset. It is at the top of the menu structure. All other screens can be accessed through these pages by moving down through the menu choices.

This information is updated continuously. The backscatter and particulate mass readings update at the instantaneous sample rate of about 2 seconds. The Upscale

and Zero readings update with average values at the conclusion of Upscale and Zero modes.

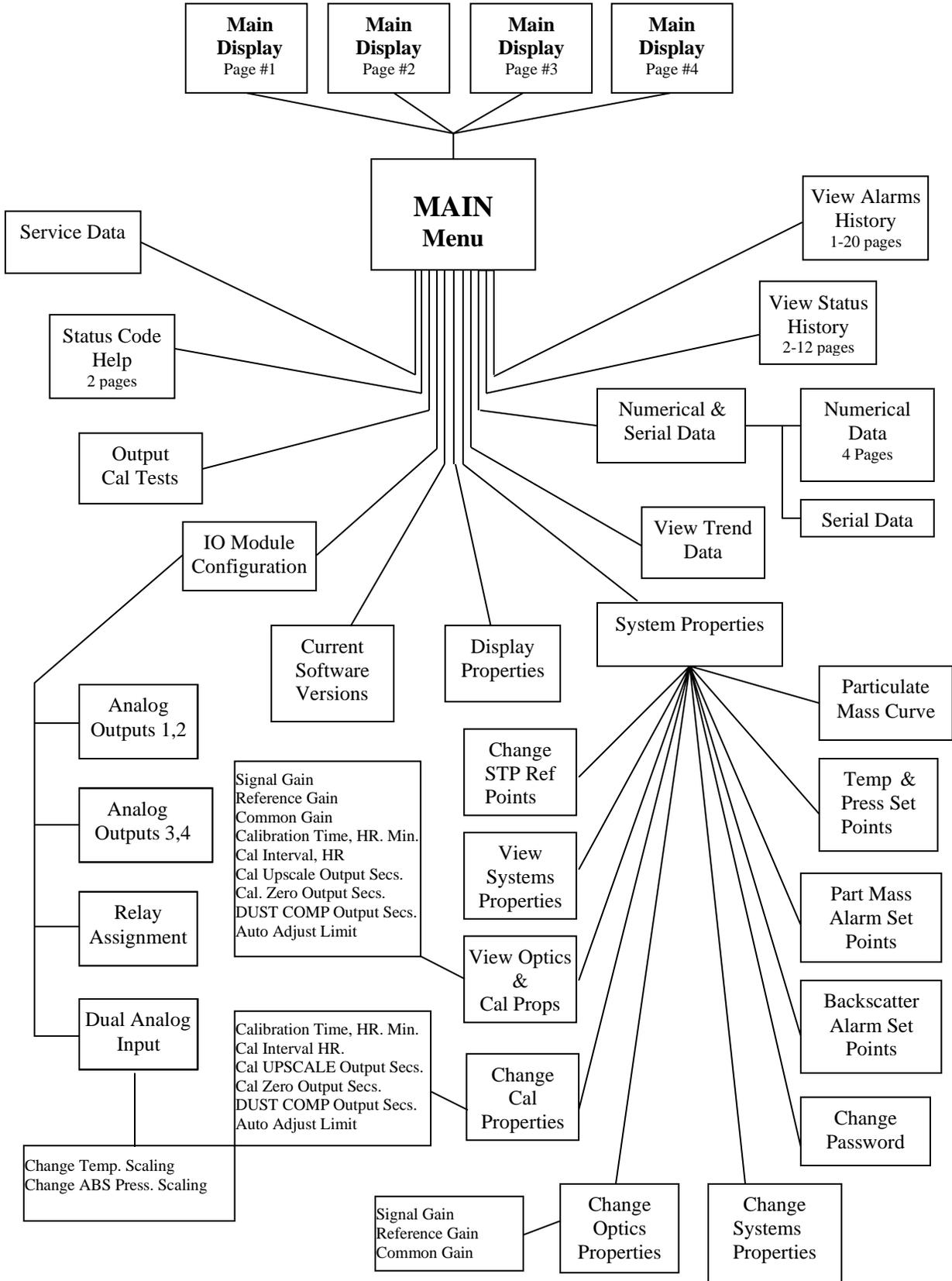
The status text and code fields are updated immediately on any change in the monitor status. If multiple malfunctions are indicated, the status text field can be made to scroll through the list of errors by pressing either arrow button (↓ or ↑) once. After scrolling is completed the status text field will stop and continuously display the most significant error. The Net Status field will display the status of network communication between the Optical Head and the display node. The Head Mode field will display the operational mode of the Optical Head.

From any one of the four pages of this display press the “↵” key to view the first level “Main” menu. The “ESC” key will bring you back up to this screen.

4.4.1.1 Memory Test

The memory test runs at power up before the logo screen is displayed. It tests all the used areas of the RAM ICs. If they pass, a message is briefly displayed on the screen before the logo. If either one fails, a message indicating which chip failed remains on the screen and the CPU halts.

LaserHawk 360 Menu Tree



4.4.2 Main Menu Screen

This is the first level of the menu structure. From this screen you can choose one of the submenus that lead to the information of interest. For a detailed description of the information available under a particular sub menu refer to the section about that submenu. To choose a submenu press the arrow buttons (↓ or ↑) until your selection is highlighted, then press the “↵” key to select. The “ESC” key will take you back to the previous screen.

4.4.3 Service Data Menu

This screen is view only. The information displayed is useful in determining the status of the Optical Head Assembly. Use the “ESC” or “↵” key to exit the screen when you are done. (*Consult the LaserHawk 360 Menu Tree diagram of Section 4.0 to find the menu/submenu location of individual screens.*)

NOTE: *This screen corresponds to parts of the Service Data Bank of the Optical Head.*

4.4.4 Status Codes Help

This screen has two pages. Both are view only. The information on both pages is reference only with the exception of CURRENT STATUS word that updates continuously. The CURRENT STATUS word will be equal to the sum of the active codes on both pages. For example a “7” in any status word digit would mean that three errors were present: the 1, 2, and 4 errors of that digit. Use the “Page-Up” or “Page-Down” key to move between pages. Press the “↵” to return to the exit screen when you are done. (*Consult the LaserHawk 360 Menu Tree diagram of Section 4.0 to find the menu/submenu location of individual screens.*)

NOTE: *The Enhanced Remote Display CURRENT STATUS word on this screen is the combination of the Primary Status and Extended Status words on the Optical Head Assembly (U3 and U4, respectively, of the User Bank). The 4 least significant digits of the status word on this screen map to the Primary Status word. The most significant digit of the status word on this screen maps to the least and only significant digit of the Extended Status word.*

4.4.5 Output & Cal Tests

This screen allows the user to send commands to the Optical Head and the Multi I/O Board analog outputs. The current OPTICAL HEAD MODE and Multi I/O Board mode (displayed as “OUTPUT MODULE MODE”) are displayed in the top half of the screen. User interface is via the highlighted command line displayed under the COMMAND MODE: heading.

While the mode line is highlighted press the Page-Up or Page-Down key to choose the command you want, then press ↵. The highlight bar will then move

down to the SEND THIS COMMAND line for confirmation. Press ↵ and the command will be sent to the Optical Head and Multi I/O Board. The highlight bar will move back to the mode line so you may enter another test.

Commands that invoke calibration modes (ZERO MODE, FORCE CAL CYCLE, etc.) will initiate calibrations on the Optical Head. In these cases, only Multi I/O Board analog outputs that have been configured “WITH CAL.” will respond. TEST ZERO SCALE, TEST MID SCALE and TEST FULL SCALE affect all four analog outputs. See “Multi I/O Output Modes” table in Section 4.0 for detail on how each mode works.

NOTE: *When this screen is exited, the Enhanced Remote Display will automatically send a “Normal” mode command to the Optical Head and Multi I/O Board.*

4.4.6 IO Module Configuration Menu

This screen is password protected. To get to this screen you must have the security key or supervisor password. If using the key it must be turned before selecting the IO MODULE CONFIG menu or you will be prompted for the password. Enter the password on the keypad and press ↵.

This menu allows you to choose between the four configuration menus of the Multi I/O and Dual Analog Input Boards. The menus titled ANALOG OUTPUTS 1,2 and ANALOG OUTPUTS 3,4 configure their respective analog output parameter mapping and scaling. The Relay Assignment menu configures the conditions for closure of the eight output relays. The Dual Analog Input menu lets you change calibration values for the external temperature and pressure sensors. Use the arrow keys to select the menu you want, then press ↵. (***Consult the LaserHawk 360 Menu Tree diagram of Section 4.0 to find the menu/submenu location of individual screens.***)

4.4.6.1 Analog Outputs 1,2

This screen is password protected. This screen configures the Multi I/O Board’s #1 and #2 analog outputs. It chooses the parameter for display, whether or not cal values will be time multiplexed on the output, the numerical value at zero scale, and the numerical value at full scale. As described in previous sections, the physical properties of the outputs are configured with hardware jumpers on the Multi I/O Board. For a list of possible output parameters refer to the parameter selection table.

When this screen comes up, the parameter for display on output #1 will be highlighted. Use the Page Up and Page Down keys to find the parameter you want. Press “↵” to choose and move to the next property.

The field labeled VALUE AT ZERO SCALE is the numerical value that will correspond to 4mA output. VALUE AT FULL SCALE is the numerical value at full scale (20mA) output. These values are what you would change to rescale the output if needed. Enter the numbers desired through the keypad. Press “↵” to move to the next field.

The WITH CAL. field can be "YES", "NO" or "EXP". If "YES", calibration cycle data will be sent to that output. Calibration data scaling for Upscale, Zero and Dust Compensation will be the same as the Normal mode scaling entered in VALUE AT ZERO SCALE and VALUE AT FULL SCALE. If "NO", the output will not have calibration values on it. If "EXP" (EXPANDED SCALING) is selected, calibration data will be present on the analog output, but Zero and Dust Compensation scaling will be expanded for better resolution. Consult the “Zero and Dust Compensation Calibration Scaling Table” for further details. Make your selection and press “↵”. (*Consult the LaserHawk 360 Menu Tree diagram of Section 4.0 to find the menu/submenu location of individual screens.*)

NOTE: *No changes are accepted by the Multi I/O configuration until the last field, SAVE THIS CONFIG. is entered. This field confirms that you want to implement the changes entered. If one of the fields is not correct, use the ↑ or ↓ key to scroll to it. Once corrected move to “SAVE THIS CONFIG. and press the enter “↵” key.*

4.4.6.2 Analog Outputs 3,4

This screen is password protected. The ANALOG OUTPUTS 3,4 menu screen functions exactly the same as the ANALOG OUTPUTS 1,2 menu screen. Only the output # references have changed. Refer to the Analog Outputs 1,2 section for a functional description. (*Consult the LaserHawk 360 Menu Tree diagram of Section 4.0 to find the menu/submenu location of individual screens.*)

4.4.6.3 Relay Assignments

This screen is password protected. This menu screen sets the condition for closure for each of the eight output relays on the Multi I/O Board. While the assignment for a particular relay is highlighted, scroll to the desired condition using the Page Up, and Page Down keys. Press “↵” to select. The ESC key will take you back to the I/O configuration menu.

NOTE: *No changes are accepted in the Multi I/O configuration until the last field, SAVE THIS CONFIG. is entered. This field confirms that you want to implement the changes entered. If one of the fields is not correct, use the ↑ or ↓ key to scroll to it. Once corrected move to SAVE THIS CONFIG. and press the “↵” key. (Consult the LaserHawk 360 Menu Tree diagram of Section 4.0 to find the menu/submenu location of individual screens.)*

4.4.6.4 Dual Analog Input

This screen is password protected. This menu lets you change the current calibration settings for the external temperature and pressure scaling.

4.4.6.4.1 Change Temperature Scaling

This screen allows you to alter the two point calibration curve for the external medium temperature transducer. The counts parameters are analog to digital converter values that correspond to the temperatures at the two points. The last two lines display the present A-to-D counts and the present calculated temperature.

4.4.6.4.2 Change ABS Pressure Scaling

This screen allows you to alter the two point calibration curve for the external medium pressure transducer. The counts parameters are analog to digital converter values that correspond to the pressures at the two points. The last two lines display the present A-to-D counts and the present calculated pressure.

4.4.7 System Properties Menu

This menu allows you to choose a group of system level properties to view or alter. The screens labeled “VIEW” are not password protected. Screens labeled “CHANGE” require either the security key or supervisor password to access. Use the “↑” & “↓” keys to select the screen and “↵” to enter. (*Consult the LaserHawk 360 Menu Tree diagram of Section 4.0 to find the menu/submenu location of individual screens.*)

4.4.7.1 Change STP Ref Points

This screen is password protected. (Consult the LaserHawk 360 Menu Tree diagram of Section 4.0 to find the menu/submenu location of individual screens.)

This screen is for entering the temperature and pressure reference points used by the Optical Head in the conversion of Particulate Mass data to standard temperature and pressure (STP) conditions.

Pressure units are in KiloPascals absolute. One atmosphere (101.3 KPascals) is the typical reference pressure value. The temperature unit is degrees Celsius. Twenty degrees Celsius is the typical value.

To keep the existing value, press “↵” or ESC back to the previous menu. To make a change, type in the new value, press ↵, then move to “SAVE THIS CONFIG.” with the “↑” “↓” keys and press ↵. Press ESC to leave this screen when you are done.

4.4.7.2 View System Properties

This screen is provided to view the Backscatter System Set Points. It is view only. No Set Point changes are permitted from this screen. The ESC key will take you back to the SYSTEM PROPERTIES menu. (*Consult the LaserHawk 360 Menu Tree diagram of Section 4.0 to find the menu/submenu location of individual screens.*)

4.4.7.3 View Optics & Cal Properties

This screen displays current Optical Amplifier board gains (Signal, Reference and Common) and the calibration cycle parameters (Calibration Time, Cal Interval, Cal Upscale, Zero, Dust Comp Output Seconds, and Auto Adjust Limit). It is view only. No changes can be made. (*Consult the LaserHawk 360 Menu Tree diagram of Section 4.0 to find the menu/submenu location of individual screens.*)

4.4.7.4 Change Cal Properties

This screen is password protected. The menu sets the start time for the internally controlled calibration output cycle and the interval, in hours, between successive cycles. This allows from 0 to 24 calibration cycles per day.

NOTE: *Calibration data will appear only on analog output channels selected WITH CAL on the analog output configuration menu. The internal sequence, (Zero, Upscale, and Dust Compensation from first to last), is fixed in firmware. It is made up of three selectable duration Calibration Cycle modes.*

To disable the internal sequence, set the hour value of the CALIBRATION TIME field to 24 or larger. Since such hour values are invalid, the cycle will never start.

To enable the internal sequence, set the hour value of the CALIBRATION TIME field to 0-23 and the minute value to 0 to 59. If the CAL INTERVAL value is set to 0, the internal sequence will occur once a day. CAL INTERVAL value of 1 will cause the internal sequence to occur once an hour starting from the CALIBRATION TIME value until the CALIBRATION TIME hour and minute values occur again; a value of 2 will initiate an internal sequence every 2 hours from the CALIBRATION TIME value; etc.

Calibration cycle mode durations (CAL. XX OUTPUT SECS.) can be set from 0 – 720 seconds. Entering a zero will disable that calibration mode. If all mode durations are set to zero, all cycle mode durations will default to 90 seconds.

The AUTO ADJUST LIMIT can also be set in this screen. The value is in percent of reading and sets a limit on the amount of correction applied to the data as a result of the upscale calibration part of the cal cycle.

NOTE: *No changes are made to the configuration until the last field, SAVE THIS CONFIG., is entered. (Consult the LaserHawk 360 Menu Tree diagram of Section 4.0 to find the menu/submenu location of individual screens.)*

4.4.7.5 Change Optics Properties

This screen is password protected. (Consult the LaserHawk 360 Menu Tree diagram of Section 4.0 to find the menu/submenu location of individual screens.)

There are three parameters available on the screen: SIGNAL GAIN, REFERENCE GAIN and COMMON GAIN. These parameters set amplifier gains on the Optical Amplifier Board on the Optical Head Assembly. COMMON GAIN applies to both the Reference and Signal channels. It is typically equal to zero. For non-zero COMMON GAIN values, the JU3 jumper on the Optical Amplifier Board must be in a non-default position. See the jumper tables and the Signal Processing Description in Section 3.0 Optical Head Assembly.

NOTE: *Adjustment of these values is NOT required during NORMAL operation. Enhanced Remote access to these parameters would only be required during a complete off-stack calibration. For additional information, consult Section 3.0 Optical Head Assembly.*

To keep the existing value, press ESC back to the previous menu. To make a change, type in the new value, press “↵”, then move to SAVE THIS CONFIG. with the “↑” or “↓” keys and press “↵”. Press ESC to leave this screen when you are done.

4.4.7.6 Change System Properties

This screen is password protected. You must have the security key or supervisor password to gain access. This screen can be used to change the following parameters:

1. DATE/TIME
2. PART MASS UNITS
3. AVERAGING INTERVAL, MIN
4. CAL ZERO SET POINT %BS
5. CAL UPSCALE SET POINT %BS
6. CAL FAIL LEVEL (tolerable error for Zero and Upscale)

All parameter data is in numerical format with the exception of the month field of the date, and the PART MASS UNITS. The month is displayed using the first three letters of the English spelling of the month. The date is displayed in the European style: day, month and year respectively. Year is displayed as a two-digit field but four digit entry, i.e., 2000, 2001, etc. is supported and encouraged.

Use the "↑" "↓" keys to select a field and the numerical keys to enter the values for all data fields except month and PART MASS UNITS which are changed by the "Page Up" and "Page Down" keys. It is not necessary to use leading zeroes for single digits. The "←" key can be used to correct mistakes within a field. Hit the "↵" key to register a value on the screen.

To save a DATE/TIME change, use the "↑" or "↓" key to highlight SAVE DATE/TIME and press "↵". To save the other parameters in this screen, use the "↑", "↓" keys to highlight the SAVE THIS CONFIG. and then press "↵". Press ESC to leave this screen when finished. Any changes will be applied after leaving the screen. (*Consult the LaserHawk 360 Menu Tree diagram of Section 4.0 to find the menu/submenu location of individual screens.*)

4.4.7.7 Change Password

This screen is password protected. This screen permits the supervisor password to be changed. In order to access this screen you must have the security key or the current supervisor password.

Once you have gained access the CHANGE PASSWORD screen will appear. It prompts you to enter a new password of at least four digits but not more than six digits. Enter by pressing the "↵" key. You must then confirm your selection by typing the new password again in the CONFIRM PASSWORD field. Enter by pressing the "↵" key. Exit out of this screen by pressing the ESC key.

4.4.7.8 Backscatter Alarm Set Points

This screen is password protected. The backscatter alarm levels are changed using this screen. These are maximum allowed settings. A backscatter reading higher than these levels will trigger an alarm. To keep the existing value, press "↵" or ESC back to the previous menu. To make a change type in the new value, press "↵", then move to SAVE THIS CONFIG. with the "↑" or "↓" keys and press "↵". Press ESC to exit this screen. (*Consult the LaserHawk 360 Menu Tree diagram of Section 4.0 to find the menu/submenu location of individual screens.*)

4.4.7.9 Part Mass Alarm Set Points

This screen is password protected. The Particulate Mass alarm levels are changed using this screen. These are maximum allowed settings. A higher value will trigger an alarm. To keep the existing value, press "↵" or ESC back to the

previous menu. To make a change, type in the new value, enter, move to SAVE THIS CONFIG. with the “↑” “↓” keys and enter. Press ESC to exit this screen. *(Consult the LaserHawk 360 Menu Tree diagram of Section 4.0 to find the menu/submenu location of individual screens.)*

4.4.7.10 Temp and Press Set Points

4.4.7.10.1 View Temp & Press Set Points

This screen is to view whether Temperature and Pressure corrections are enabled, and min/max alarm set points. It is not password protected.

4.4.7.10.2 Change Temp & Press Set Points

This screen is password protected. This screen is used to enable/disable Temperature and Pressure corrections, and set the min/max Temp and Press faults, which are used as a data integrity plausibility test for the stack temperature and pressure measurement hardware. Use the “↑” “↓” keys to select a field and the numerical keys to enter the values for all data fields except Temp and Press enable/disable which are changed by the “Page Up” and “Page Down” keys. It is not necessary to use leading zeroes for single digits. The “←” key can be used to correct mistakes within a field. Hit the “↵” key to register a value on the screen. *(Consult the LaserHawk 360 Menu Tree diagram of Section 4.0 to find the menu/submenu location of individual screens.)*

4.4.7.11 Particulate Mass Curve

This screen is password protected. A correlation curve that converts Backscatter into Particulate Mass loading is entered via this screen. The correlation curve must be derived by monitoring the instrument’s backscatter output while simultaneously performing extractive testing to determine the user’s source particulate mass. Any one of three types of curves can be used: Polynomial, Logarithmic or Exponential. Each of the curves provides three coefficients: a0, a1 and a2. The equation for each functional form is given below.

Equations:

Polynomial: $Y = a_0 + a_1 * X + a_2 * X * X$

Logarithmic: $Y = a_0 * (\ln(a_1 * X + a_2))$

Exponential: $Y = a_0 * \exp(a_1 * X) + a_2$

Where: Y = Particulate Mass output
 X = Percent Backscatter Energy
 ln = natural logarithm
 exp = e raised to the power

To save the parameters in this screen, use the "↑", "↓" keys to highlight the SAVE THIS CONFIG. field and then press "↵". Press ESC to exit this screen. Any changes will be applied after leaving the screen. (*Consult the LaserHawk 360 Menu Tree diagram of Section 4.0 to find the menu/submenu location of individual screens.*)

4.4.8 Display Properties Menu

This screen permits adjustment of the Brightness and Contrast of the Display. Use the "↑" "↓" keys to select the parameter you want to adjust. Then use the Page-up and Page-Down keys to increase or decrease. The screen should visually change while pressing these keys. When the screen looks the way you want it, return to the main screen by pressing ESC.

An alternate method can be used to adjust the LCD display Contrast and backlight Brightness:

- ❑ To increase display Contrast, press "Page Up" and hold the "↑" key.
- ❑ To decrease display Contrast, press "Page Up" and hold the "↓" key.
- ❑ To increase display backlight Brightness, press "Page Down" and hold the "↑" key.
- ❑ To decrease display backlight Brightness, press "Page Down" and hold the "↓" key. (*Consult the LaserHawk 360 Menu Tree diagram of Section 4.0 to find the menu/submenu location of individual screens.*)

4.4.9 View Alarm Set Points

The current alarm set points may be viewed from this screen. These are maximum acceptable settings. A higher value will trigger an alarm. No changes can be made from here. Press ESC or "↵" to return to the previous screen.

(*Consult the LaserHawk 360 Menu Tree diagram of Section 4.0 to find the menu/submenu location of individual screens.*)

4.4.10 View Trending Data

This menu screen selects the parameter trend to be displayed. Use the "↑" & "↓" keys to select the parameter you want to display, then press "↵" to view that trend screen. ESC will take you back to the main menu. (*Consult the LaserHawk 360 Menu Tree diagram of Section 4.0 to find the menu/submenu location of individual screens.*)

4.4.10.1 Trend Screen, Instantaneous Backscatter

The trend screen displays the previous one hundred values of the parameter selected in the preceding menu. The units of the trend x-axis will always be number of values no matter if the parameter selected is instantaneous or six minute average. This screen actively updates as new values are received. This makes viewing process changes easier. The trend screen is capable of bar graphs only. (*Consult the LaserHawk 360 Menu Tree diagram of Section 4.0 to find the menu/submenu location of individual screens.*)

4.4.11 Numerical Data & Serial Data Menu

This menu allows you to choose between viewing Numerical Data and setting up automatic Serial outputs.

4.4.11.1 Numerical Data

There are four pages to the Numerical Data screen: Temperature/Pressure data, Backscatter Energy data, Particulate Mass data and Network Status data. It is designed to be a place to simultaneously view all of the parameters for a given type of measurement, i.e., backscatter energy or particulate mass. This is a good place to do a daily check of the monitor since all values are updated concurrently. If readings are taken from multiple screens, some differences in the readings may occur due to updates occurring while you are switching screens.

The NETWORK STATUS screen contains event counters that keep a tally of the number of times each of the eight possible network errors occurs. These are specific errors defined by the network protocol. Each time one of the errors occurs at the Enhanced Remote Display node, an error message is issued and the network status log value for that error is incremented by one. These errors do not necessarily require corrective action but happen due to network contention issues that are a normal consequence of the network topology. A full description of these errors is beyond the scope of this manual. If necessary, please consult Teledyne Monitor Labs technical support for more information. This information will always be current. (*Consult the LaserHawk 360 Menu Tree diagram of Section 4.0 to find the menu/submenu location of individual screens.*)

4.4.11.2 Serial Data

This screen is used to program the Enhanced Remote Panel to automatically broadcast up to 16 network variables serially. The screen consists of two lists: Fast Access and Slow Access, and two time intervals: Time Secs and Time Min. Eight network variables can be broadcast serially every 1 to 59 seconds using the Fast Access list and Time Secs. Using the Slow Access list and Time Min, eight more network variables can be broadcast serially every 1 to 59 minutes. To disable any individual variable output simply set its' value to 0. To disable an entire list, set its time interval to 0. The serial output format is "VARIABLE#", "VALUE", "VARIABLE#", "VALUE"<CR><CF>. Automatic serial data is

ONLY available from the RS-232 port. See Section 4.3.2.8.1 Simple Protocol, for more details.

4.4.12 View Status History

This Screen has up to twelve pages depending on the number of system status changes that have taken place. It stores the previous 100 non-zero status word changes. Consecutive, identical non-zero status words cause only one entry. After one hundred entries the log is first in, first out. The most recent entries are at the top of the list on page one. Each entry consists of a code, the date, and time it occurred. Status words can be decoded as per the STATUS CODE HELP screen. *(Consult the LaserHawk 360 Menu Tree diagram of Section 4.0 to find the menu/submenu location of individual screens.)*

4.4.13 View Alarms History

The View Alarms History screen can have as many as twenty pages. The "Page-Up" & "Page Down" keys move you to the next or previous page. This screen stores the previous 100 alarm events. An alarm event consists of setting or clearing any of the alarms that are defined in the SYSTEM PROPERTIES menu. Each entry stores the parameter in alarm, type of alarm, date, time, and whether the event set or cleared the alarm. If an alarm event happens while viewing the screen, the information will scroll down and the new event will be posted at the top of page #1. After one hundred entries are recorded, the oldest one gets dropped from the log. *(Consult the LaserHawk 360 Menu Tree diagram of Section 4.0 to find the menu/submenu location of individual screens.)*

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 360 Blower System Installation* drawing provided.

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* 360 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.) The fixture mounts on the Optical Head to simulate a full scale particulate condition and several intermediate upscale backscatter values. The clear plastic case in the case assembly 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 from the same section of the stack media. The end of the tube has an 18% photographic Photo-Gray material to provide an optical reflection for laser tilt angle inspection.

There are three different cal-kits that may be provided.
 360/360DI-Standard cal-kit for ports up to 16" long.
 360/360DI-Long port cal-kit for ports 16.1" to 36" long.
 (Different LASER tilt angle used)
 360ES- Standard 360ES cal-kit. (Special dark material used)

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 window is 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 1/4 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

A small black slide is located on the left hand side (looking from the cap end) of the Cal Kit Fixture for inspection of the laser tilt angle. With the Cal Kit installed, pull the black slide approximately ½ inch from the Cal Kit body. 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 360. This adjustment must only be preformed by Factory technicians and a description is beyond the scope of this operator's manual.

Fully insert the black slide into the Cal Kit Fixture after observation of tilt angle is complete. Audit standards will not read correctly if left open.

6.3 STORAGE

The Calibration Kit Fixture and audit standards should be stored in the case provided when not in use. This will prevent dirt contamination of the optical surfaces. Keep the case in a location that is not subject to extremes in temperature.

7.0 CALIBRATION & CHECKOUT

To have the *LaserHawk* 360 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

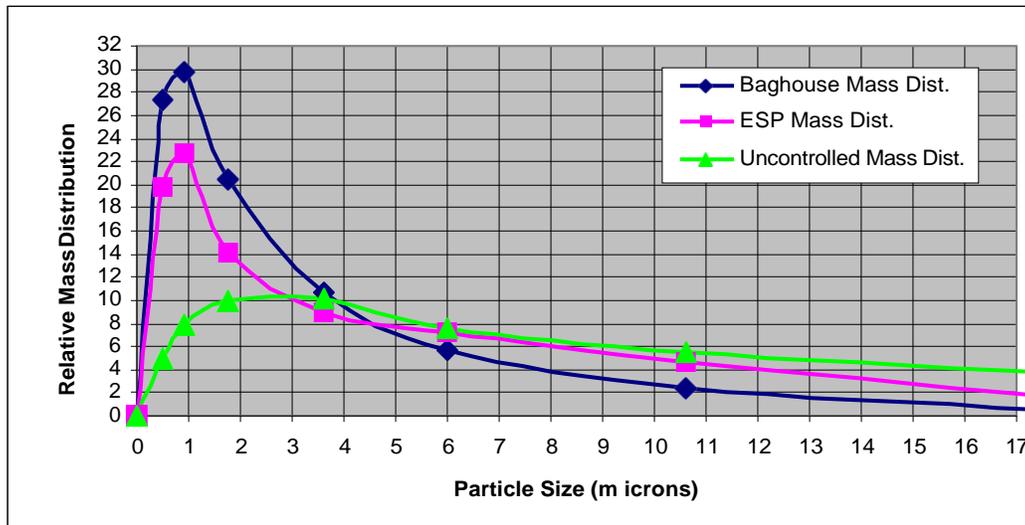
Initial setup of the *LaserHawk* 360 Particulate Matter Monitoring System is performed at the Teledyne Monitor Labs factory by experienced personnel. The optical and electrical system is nominally configured for the requirements of the individual installation location based on information received by 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 360 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 Check Arm

During this factory set-up the simulated zero and upscale Calibration Arm is set up to have a nominal zero reading of < 20%, and upscale reading of between 50-90%. The instrument response to the zero and upscale Calibration Check is documented in the Site Specification Data Sheets in Appendix A of this manual.

7.1.3 Calibration Kit Response

Once the *LaserHawk* 360 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* 360 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 optically align 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.*

7.1.3.1 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 360* 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 360* 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 360* 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 360* output.

7.2.1 Output Too Low

If the *LaserHawk* 360 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 characterizations 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* 360 Calibration Kit should be installed after this adjustment has been made and readjusted. (See Section 7.2.3 Calibration Kit Adjustment.) This will allow new setting to be reproduced if any malfunction or miss-adjustment should occur before the characterization process is completed. The instrument response to the simulated zero and upscale Calibration Arm should be checked and adjusted if needed. Calibration zero should be <20%. Calibration upscale should be 50-90%. (See Section 7.2.4 Zero and Upscale Calibration Arm Adjustment, if needed.)

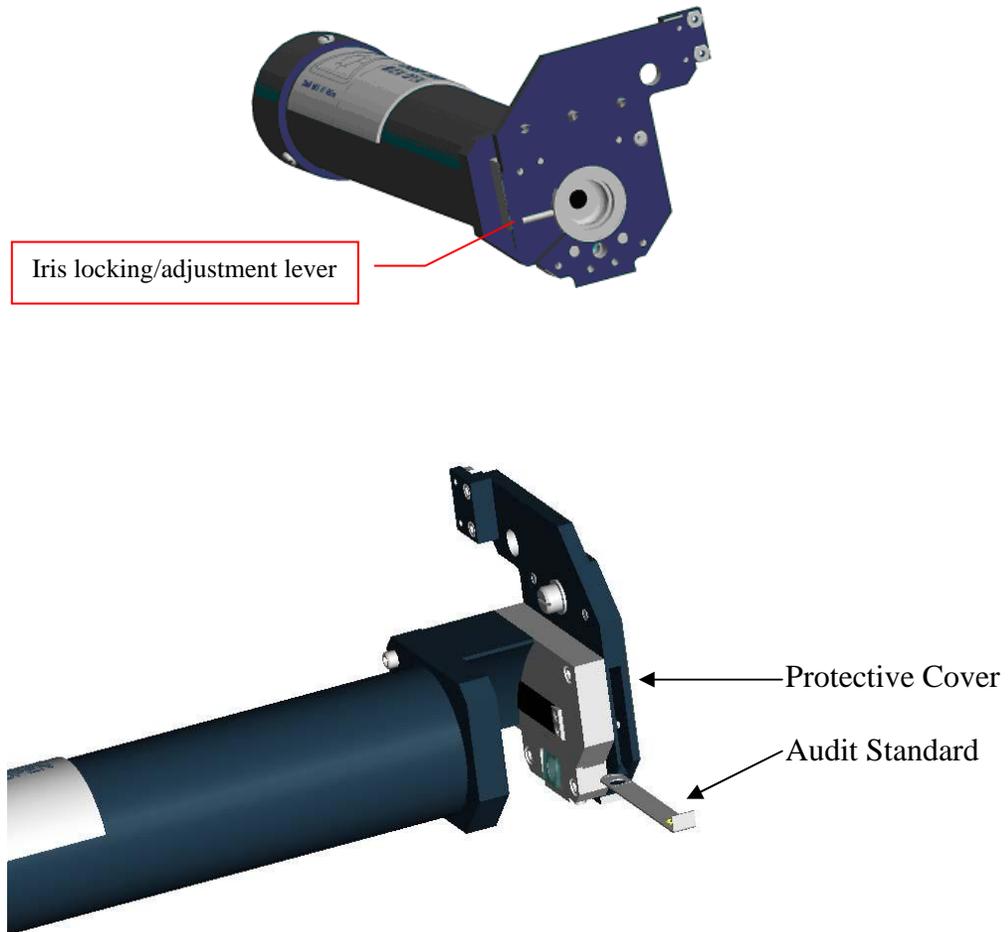
7.2.2 Output Too High

If the *LaserHawk* 360 response to both the maximum or typical particulate conditions is greater than full scale, then the backscatter Signal Gain must be decreased before further characterizations 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* 360 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. The instrument response to the simulated zero and upscale Calibration Arm should be checked and adjusted if needed. Calibration zero should be <20%. calibration upscale should be 50-90%. (See Section 7.2.4 Zero and Upscale Calibration Arm Adjustment if needed.)

7.2.3 Calibration Kit Adjustment

If the Signal Gain has been adjusted, the Calibration Kit iris must be readjusted for future use.

- 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 \pm 0.5 VDC.

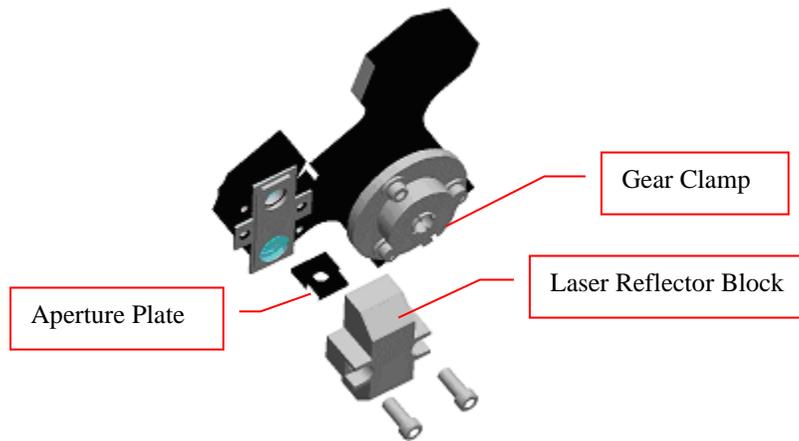


- Carefully tighten the iris locking/adjustment lever and recheck the Signal Voltage to confirm the proper voltage.
- Install the opaque blocking plate into the Cal Kit and allow the Signal Voltage to stabilize.
- Perform a Background Set as described in Section 8.1.1.
- Once the “SET” LED goes out,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

7.2.4 Zero and Upscale Calibration Arm Adjustment

If the Signal Gain has been adjusted and the simulated upscale response is not within 50-90% backscatter energy, the Calibration Arm must be adjusted.

- Remove the Calibration Kit from the Optical Head.
- Loosen the gear clamp and slide the Calibration Arm off of the Drive Motor Shaft.
- Remove the two shoulder screws attaching the Laser Reflector Block to the Calibration Arm.



- Remove the Aperture Plate from the Laser Reflector Block.
- If the upscale response was below 50% backscatter, a larger Aperture Plate must be installed. When the response is greater than 90% backscatter, a smaller Aperture Plate should be used.
- After the proper Aperture Plate is installed, carefully re-attach the Laser Reflector Block to the Calibration Arm using the Shoulder Screws.
- Return the Cal Mechanism Arm to the shaft making sure that the guide pin slides into the slot on the arm. Put the gear clamp back on and tighten.

7.2.5 Adjustment of the Calibration Set Points

If either the Signal Gain and or the Aperture Plate has been changed, it is necessary to verify and possibly change the Calibration Set Points of the *LaserHawk 360*.

7.2.5.1 Entering the Optical Head Password

Before any parameters can be change 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.

A	2	n	E	E	d
---	---	---	---	---	---

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.

A	2	9	8	6	0
---	---	---	---	---	---

- 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.

A	2	7	2	0	0
---	---	---	---	---	---

7.2.5.2 Upscale Set Point

The *LaserHawk 360* will calculate the proper Upscale Calibration Set Point but it is necessary to manually enter this value if needed.

- Close and latch the Optical Head.
- Perform an Upscale Set as described in Section 8.1.3.
- Once the “SET” LED goes out, read and document the value of the Upscale Set Value (location UE).
- Go to location C1 (Upscale Set Point) and enter the value recorded from location UE (Upscale Set Value). (The password must have been entered as described in Section 7.2.5.1.)

7.2.5.3 Zero Set Point

After completing the UPSCALE SET, perform a calibration cycle and change the Calibration Zero Set Point if needed.

- Command a Calibration Cycle as described in Section 8.2.
- After the Cal Cycle completes, read and document the value of the Last Zero Calibration (location U6).
- Go to location C0 (Calibration Zero Set Point) and enter the value recorded from location U6. (The password must have been entered as described in Section 7.2.5.1.)

7.3 FINAL FIELD CHARACTERIZATION

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

Once the *LaserHawk 360* output range has been scaled for the proper sensitivity, final characterization for quantitative dust loading may be under taken if required. This step requires that the system be using the *LaserHawk 360* Enhanced Remote Panel, or a computer / PLC data collection device capable of generating a nonlinear correlation equation.

- Check that the instrument response to maximum dust loading is in the 60 to 80% full scale range as described in 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 360* 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* 360 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 and the simulated zero/upscale mechanism windows need 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 contaminants 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 not be used for cleaning.**

7.6.2 Cleaning Procedure

Several 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 consisting of;
 - ❑ The large diameter Viewing window, top
 - ❑ The smaller Laser Output window located just below.
- ❑ The Cal Mechanism windows.

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. ***Carefully*** clean the exit windows using a soft lint-free cloth and solution. Cotton cleaning swabs may be employed to clean hard to reach areas.

7.6.2.2 Cal Mechanism Sections

While the Optical Head hinged section is open, the simulated zero and upscale windows of the calibration assembly may be cleaned. If at all possible, the Cal Mechanism Arm Assembly should be cleaned in place and should not be removed from the shaft. Doing so may slightly alter the Upscale Set Point. **Care should be taken not to damage guide pin if the Cal Mechanism Arm is removed.** Using the standard cloth and solution clean both windows. Cotton cleaning swabs may be employed to clean hard to reach areas. If arm is removed an upscale set should be performed.(See section 8.1.3)

8.0 ELECTRONIC ADJUSTMENT

Recalibration of the *LaserHawk 360* is accomplished by performing a series of procedures called “SETS”. These procedures establish reference levels for 0% and 100% backscatter energy. A reference is also created for the upscale calibration value for future automatic Dust Compensation. The Optical Head exit window, Calibration Arm 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 three procedures that must be performed in a specific order: “Background Set”, “Normal Set” and “Upscale Set”. All three 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 “NORMAL” 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.

8.1.3 Upscale Set

1. Remove the Cal Kit, close and latch the Optical Head.
2. Perform an Upscale Set by simultaneously pressing the “UPSCALE” and “SET” keys on the keypad. The “SET” and “UPSCALE” keys must be pressed continuously for about 10 seconds. The YELLOW “SET” LED will flash at a two seconds rate during this acknowledgement period.

NOTE: *The YELLOW “SET” LED will light continuously during the actual 6 minute UPSCALE SET process.*

3. Once the “SET” LED goes out, the Upscale Set is complete.

8.1.4 Upscale Set Point Input

Once the upscale set is complete, read the upscale set value in Bank UE of the LUI. Enter that value into Bank C1. You will need to input password 9860 into the Bank A3 so you can enter the value into the Bank C1.

8.2 CALIBRATION CYCLE

After all three sets are complete, perform a Calibration Cycle by simultaneously pressing the “ZERO” and UPSCALE” keys.

A Calibration Cycle will command the *LaserHawk 360* to check its simulated ZERO and UPSCALE values by activating the Calibration Arm drive motor. The cycle consists of three phases: ZERO, UPSCALE and DUST COMPENSATION.

During the ZERO phase the calibration drive motor will position the ZERO section of the Calibration Arm in front of the exit window. The “IN CAL” LED on the Optical Head keypad will light continuously during this phase. The duration of the ZERO phase is programmed in location C7.

In the UPSCALE phase, the UPSCALE section of the Calibration Arm is moved in front of the exit window. The “IN CAL” LED on the Optical Head keypad will light continuously. The duration of the UPSCALE phase is programmed in location C8. At the completion of this phase, the *LaserHawk 360* will calculate the Dust Compensation value.

The final phase DUST COMPENSATION, is simply a data output of the dust compensation that will be applied to all subsequent measurements. At this time the Calibration Arm is in the normal position. The “IN CAL” LED on the Optical Head keypad is blinking. The duration of the DUST COMPENSATION phase is programmed in location CA.

9.0 INSTALLATION

This section contains information about installing the basic *LaserHawk 360* 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 360* System is shown on the Backscatter Monitor Installation drawing. 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 360* 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 360* 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* 360 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 360 has its best sensitivity in the first 3 feet (1-meter) of path length. Use of a long mounting pipe will have the LaserHawk 360 measuring the filtered purge air and not the stack effluent.*

9.4 POWER REQUIREMENTS

Power requirements for the standard *LaserHawk 360* 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 and 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

360/360ES: The data cable between the Integral Junction Box and the Enhanced Remote Display should consist of a shielded twisted pair composed of 16 AWG (1.0mm²) wires and suitable jacket material. See the Wiring Diagram-*LaserHawk 360* drawing and the *LaserHawk 360* specifications in Section 1.0 for details about maximum cable length and appropriate cable.

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 360* System Wiring Diagram, 1810-0012.*

360DI: The data cables between the Integral Junction Box and the recording device consists of one 4 conductor, 20GA cable and one, 6 pair shielded 24GA cable. Two pairs in the 6 pair cable are spares. See 6PT I/O manual for further details

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 Teledyne Monitor Labs drawings at the end of the 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 ENHANCED REMOTE PANEL ASSEMBLY

The Enhanced Remote Panel Assembly may be 19" (483mm) rack mounted, panel mounted, or located inside an enclosure. See the specifications in Section 1.0 for ambient temperature conditions of the *LaserHawk* 360.

9.9 MOUNTING THE LIGHT TRAP ASSEMBLY

The *LIGHT TRAP* 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 3 inches (76.2 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 **offset** as shown on drawing 1810-0015 SHT-7. **THE LASER BEAM MUST NOT TOUCH THE PIPE WHEN ENTERING THE LIGHT TRAP.**

The purge air must be in operation and connected before mounting of the light trap. The mounting configuration of the Light Trap Assembly is described in the Teledyne Monitor Labs drawings at the end of the manual.

Optical alignment of the optical head to the light trap is accomplished by adjusting the mounting nuts, which in turn pivot the optical head, shown on drawing 1810-0015 SHT-7. The alignment of the LASER beam when it enters the light trap is per drawing 1810-1401 SHT-1 for the cone light trap (360) or 1810-1401 SHT-2 for the ND filter light trap (360ES).

9.10 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.

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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 Enhanced Remote Display and write down the status code and values of the parameters in the System Properties screens. Decode the status code according to the help screen or definitions in Section 10.1. This alone may point to the problem. Compare the System Properties parameter values to historical values.

10.1 STATUS CODES

0 Normal: No errors detected.

XXXXX1 Purge Fail Analyzer: Check the blower operation, blower plumbing and Optical Head pressure switch.

XXXXX2 No Stack Communication: Check data cable from stack to the Enhanced Remote Panel. Verify the Calibration Arm on the Optical Head is operating correctly.

XXXXX4 Out of Service: Use the “Output Cal Test” screen on the Enhanced Remote Panel and place the analyzer in service. (See Section 4.4.5.)

XXXX1X 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 .

XXXX2X Reference Fault: Check the Reference Voltage value on the “Service Data” screen. Reference 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.

XXXX4X NORMAL Position Not Achieved: Verify the operation of the Calibration Arm on the Optical Head.

XXX1XX ZERO Position Not Achieved: Verify the operation of the Calibration Arm on the Optical Head.

XXX2XX UPSCALE Position Not Achieved: Verify the operation of the Calibration Arm on the Optical Head.

XXX4XX ANY SET in Progress: Normal indication when performing SETs as described in Section 8.0. This status should clear when SETs are complete.

XX1XXX Temperature Out of Limits: Compare the temperature reading on the “Numerical Data” screen with the allowable limits listed on the “Temp and Press Set Points” screen in the System Properties Menu. Check the temperature sensor.

XX2XXX Pressure Out of Limits: Compare the pressure reading on the “Numerical Data” screen with the allowable limits listed on the “Temp and Press Set Points” screen in the System Properties Menu. Check the pressure sensor.

XX4XXX NORMAL SET Voltage Out of Range: Check the Normal Set Voltage value on the “Service Data” screen. The Normal Set Voltage must be between +5VDC to +8VDC. Perform SETS as described in Section 8.0.

X1XXXX UPSCALE SET Voltage Out of Range: Perform SETS as described in Section 8.0. If error continues after SETS are complete, the upscale section of the Calibration Arm may need adjusted. Contact Teledyne Monitor Labs Technical Support at (800) 846-6062, option 3.

X2XXXX ZERO Calibration Bad: Clean exit window and Calibration Arm, perform SETS as described in Section 8.0.

X4XXXX UPSCALE Calibration Bad: Clean exit window and Calibration Arm. Perform SETS as described in Section 8.0

1XXXXX Excessive Dust Compensation: Clean exit windows and Calibration Arm windows. 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 handle your call.

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 360*. For Quality Assurance criteria and procedures applicable to Particulate Matter Continuous Emissions Monitor Systems (PM CEMS) in Performance Specification 11 (PS-11) applications, consult Title 40 CFR60 Appendix F, Procedure 2.

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 & reflective surface of the light trap (If supplied) 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 360* System" be used to record the data collected while performing this maintenance. (See "Maintenance Check Sheets for *LaserHawk 360* 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* Monitor 360 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 contaminants 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 window. **Do not** depress plunger on interlock switches during cleaning of the exit window.*

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 360* System. The Optical Head Assembly desiccator can be observed by swinging the Optical Head Assembly open and looking to the upper left 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* 360 System (Appendix B)

The check sheet begins at the Enhanced Remote Panel, moves to the DAS/recording device for a few readings before going to the stack mounted equipment. After the stack equipment checks are complete, the checklist moves back to the Enhanced Remote Panel, then finishes at the DAS/recorder. 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. Enhanced Remote Display Checks

- Current Readings
 - Record the “As Found” particulate mass readings. Obtain these values from Page 2 of the MAIN DISPLAY Screen.
 - Record the status, ON or OFF, of the 2 Operational Status Indicator LEDs: Faults / Alarms.

- Status Word
 - Record the five digit Status Code from the MAIN DISPLAY screen. If this is anything other than “0”, increment the screen to the STATUS HELP screen and explain the status code in the space provided.

- Current Calibration Values
 - Record the current calibration values in the BEFORE column of the data sheet. Obtain these values from Page 2 of the MAIN DISPLAY Screen.

- Calibration Set Points
 - Increment the display to the VIEW SYSTEM PROPERTIES screen. Record the calibration set points, and CAL FAIL LEVEL in the BEFORE column.

NOTE: *To get to VIEW SYSTEM PROPERTIES from the MAIN DISPLAY, first press the enter key (↵) to go to the SYSTEM PROPERTIES, then use the down arrow (↓) to select VIEW SYSTEM PROPERTIES and press enter (↵) to select. When finished, press ESC to return to the main display screen.*

- Check the Permanent Data Record for the Results of the Last Cal.
 - Review the strip chart recorder, DAS or data collection device, for the last calibration values received from Enhanced Remote Display. Record these values.

- Check Analog Outputs
 - Increment the display to the OUTPUT MODULE CONFIG screen for CH.1,2 then 3,4. This will require either the security key or the supervisor password. Record the parameter that each channel is configured to carry and if it is configured to display the calibration output.
 - Return to the MAIN MENU and select the SYSTEM PROPERTIES, VIEW SYSTEM PROPERTIES screen. Record the AVERAGE INTERVAL MIN. This is the sampling period for the selectable average parameters. Increment to the OUTPUT & CAL TEST screen. Select TEST ZERO SCALE. Then select SEND THIS COMMAND and enter (↵). This will drive all four outputs to Zero scale. Check the outputs for accuracy. Send the outputs a TEST FULL SCALE command and then a TEST MID SCALE command. Check for accuracy of each output at each point. Record how the outputs were checked and if adjustments were made.

NOTE: *There are two ways to verify the outputs' calibration. One is by placing a current meter in series with the output. The other is to evaluate the reading of the output device. Usually, checking them against the output device sets them up for best accuracy on that device. If a problem is suspected, use a multimeter.*

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 tubes.
 - 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.
 - Light Trap (If supplied) - Open the latch on the Light Trap cap and swing it open. Check the mounting tube for obstructions. Record condition of the mounting tubes.

□ Cleaning

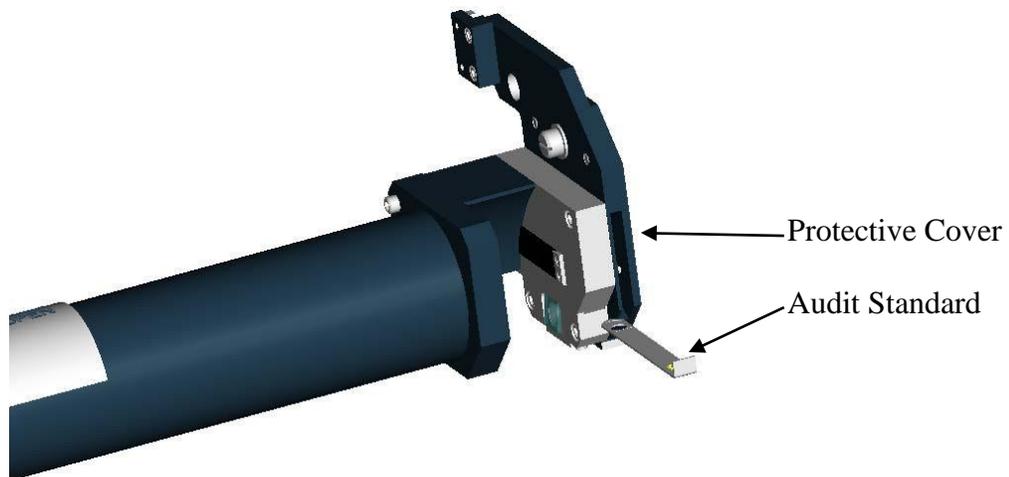
- Optical Head: Clean [the small laser](#) exit window, [larger viewing window](#) and Cal Mechanism windows. A 50/50 mix of alcohol and water is recommended. Mark the data sheet to indicate that each optical surface was cleaned.

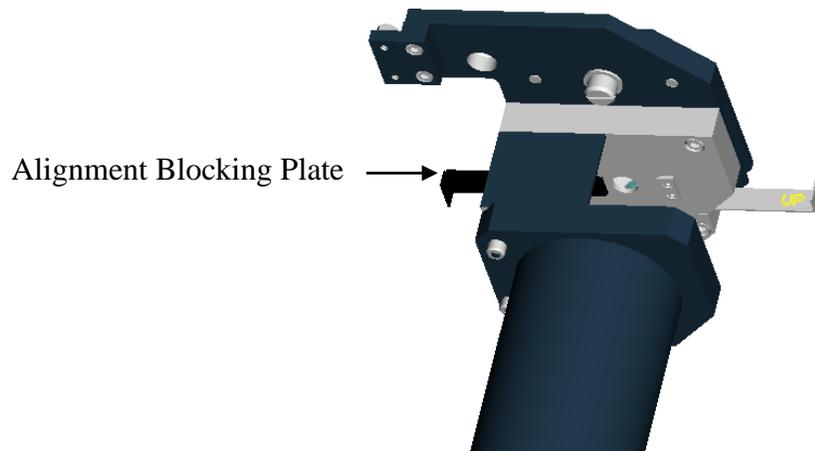
CAUTION: *Do not remove the arm when cleaning the Cal Mechanism Window unless absolutely necessary. Removing the arm may alter the Upscale Set Point. If the arm is removed, care should be taken not to bend the guide pin when removing and reinstalling arm. The pin should always be fully engaged in the cal arm slot.*

- Light Trap (If supplied): If the cone light trap is supplied clean the shiny surface of the cone with lens cleaner containing 10% alcohol. This is a painted surface so any kind of solvent will remove the paint. If the ND filter light trap is supplied, clean the outside faces of the ND filter glass with a 50/50 mix of alcohol and water.

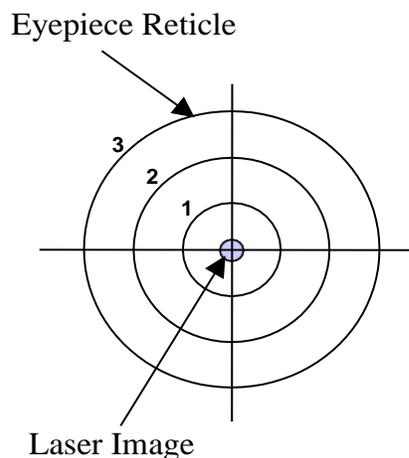
□ Install the Cal Kit Fixture

- 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.





- Alignment – Slide back the alignment blocking plate until the hole is exposed. 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 trained technicians and a description is beyond the scope of this operator's manual.*** Slide blocking plate back into its fully closed position. If not closed, the normal set will not be valid.



□ 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.*

□ Remove the Cal Kit Fixture

- Be certain that the Cal Mechanism is in the NORMAL mode/position. Remove the Cal Kit fixture from the Rear Optical section of the Optical Head. Mark “OK” when finished.

□ Perform UPSCALE SET

- Confirm that the unit is in the NORMAL mode/position. Simultaneously press the UPSCALE and SET keys on the keypad until the SET LED quits blinking. The “SET” and “UPSCALE” 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 UPSCALE calibration value and DUST reference is established. Mark "OK" when finished.

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

- ❑ Once the upscale set is complete, read the upscale set value in Bank UE of the LUI. Enter that value into Bank C1. You will need to input password 9860 into Bank A2 so you can enter the value into the Bank C1.

- ❑ Check the Cal ZERO value
 - Depress and release the "ZERO" key. The unit will go into the CAL ZERO mode. Check that the CAL ZERO value is <20.0%, and within $\pm 2.00\%$ of the CAL ZERO SET value in Bank C0. Put instrument back in normal mode. If not within $\pm 2.00\%$ of the CAL ZERO SET value, read the value in Bank U6. Enter that value into bank C0. NOTE: The value in U6 should be the value observed when in ZERO CAL. If not recheck after a Cal Cycle and enter that value.

- ❑ Cal Cycle Check
 - Run through a complete Cal Cycle by simultaneously depressing the ZERO and UPSCALE keys on the keypad. When the Cal Cycle is complete, check that the last Upscale Calibration (location U7) is within $\pm 1\%$ of the target value (location C1). Mark "OK" when finished.

- ❑ Cal Kit Readings, Audit Standard Checks
 - Record the value of each of the three Audit Standards. Place the Audit Standards in the Cal Kit one at a time. Allow sufficient time for your systems average backscatter reading to reach the Audit Standard's value (at least two averaging periods) before removing it. Record the reading from location U2 (Selectable Average Backscatter). The recorder readings will be compared with the Audit Standard in a later step.
 - Remove the Cal Kit Fixture. Close the Optical Head Assembly.
 - Install the weather cover. At this time all stack checks are completed. Return to the Enhanced Remote Display.

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 of Section 3. Compare these values with the Audit Standard values for the absolute difference. Enter this difference in the table. It should be $\leq 2\%$ Backscatter.

- Fill in Section 2 "AS LEFT"
 - Record the instantaneous and average Backscatter values “**AS LEFT**” in Section 2.

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* 360 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* 360, laser power up to 30 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* 360 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* 360 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* 360 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 and Checkout.

12.4 SERVICE

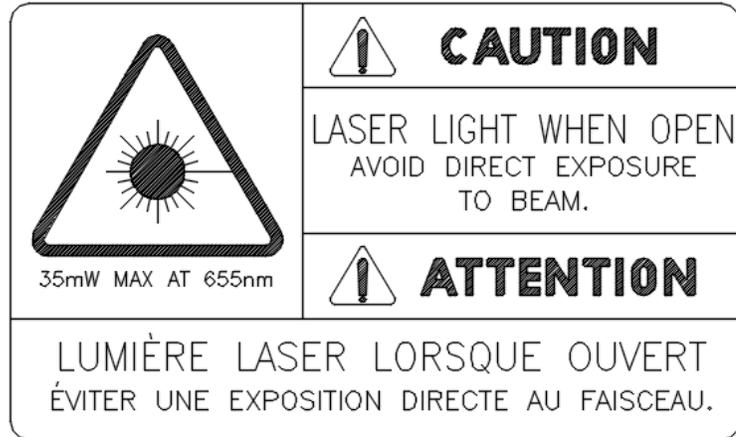
Service functions are usually performed with far less frequency than maintenance functions and usually require access to the laser beam by those performing the service functions. It should be noted that during periods of service, control measures appropriate to the class of the embedded laser shall be 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

LASERHAWK 360 PARTICULATE MATTER MONITOR

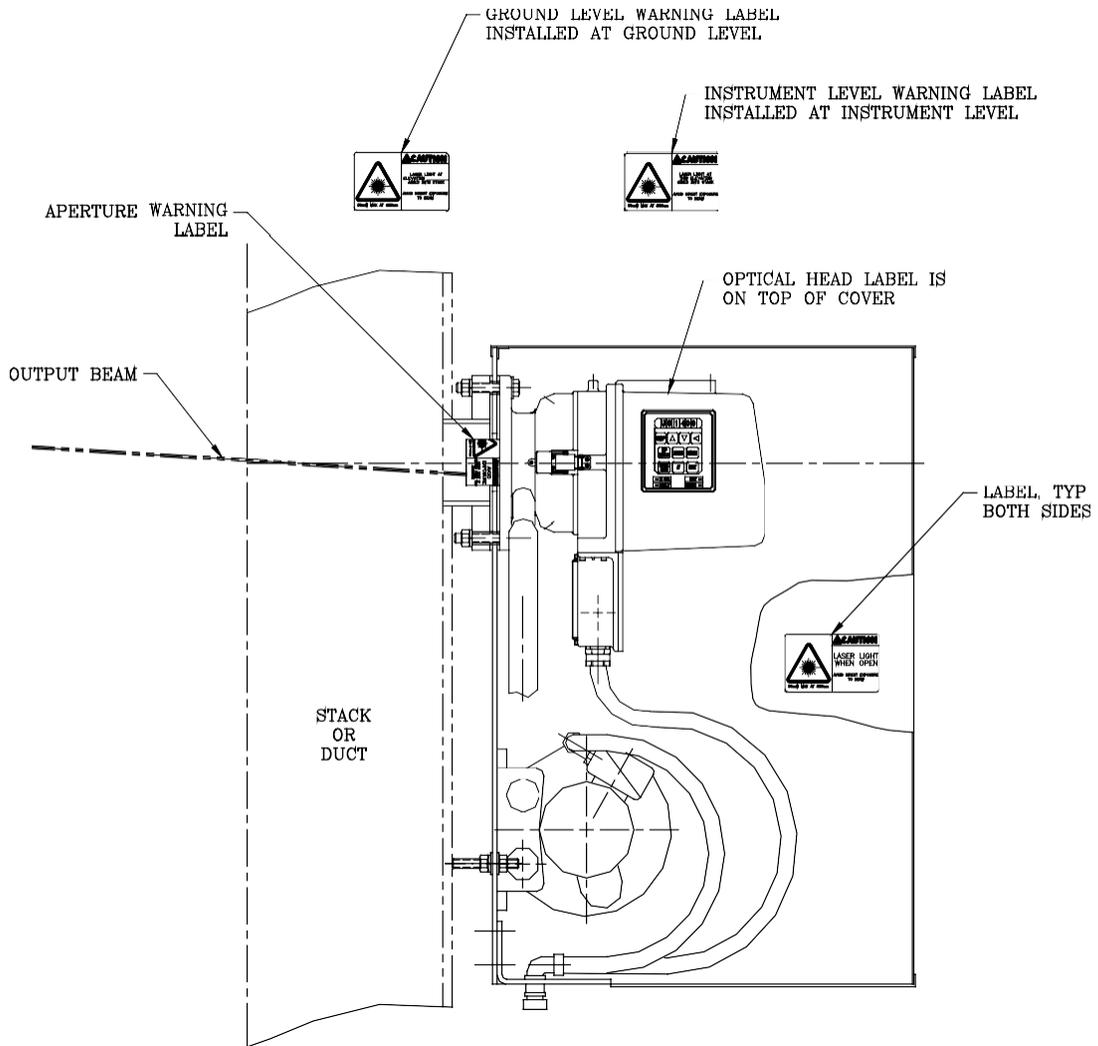
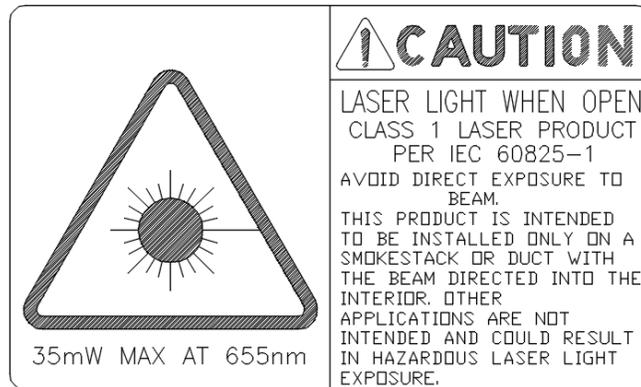


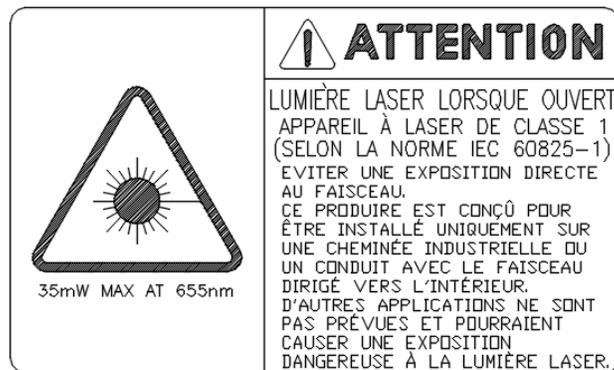
FIGURE 12-1
LASERHAWK 360 SYSTEM INSTALLATION

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 label is affixed to the top of the Optical Head Cover during manufacturing at Teledyne Monitor Labs. See Figure 12-1.



OPTICAL HEAD COVER WARNING LABEL, ENGLISH



OPTICAL HEAD COVER WARNING LABEL, FRENCH CANADIAN

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

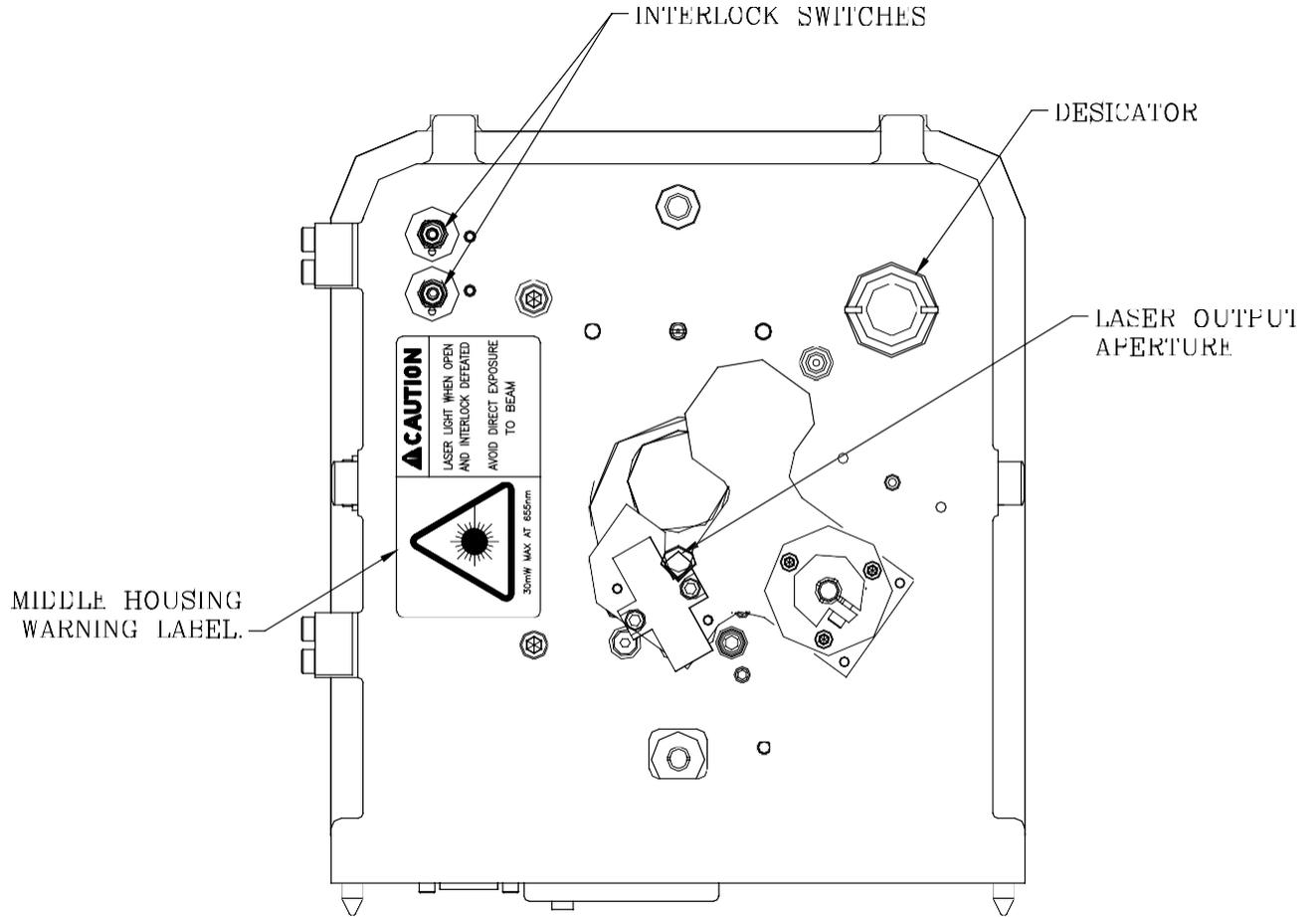
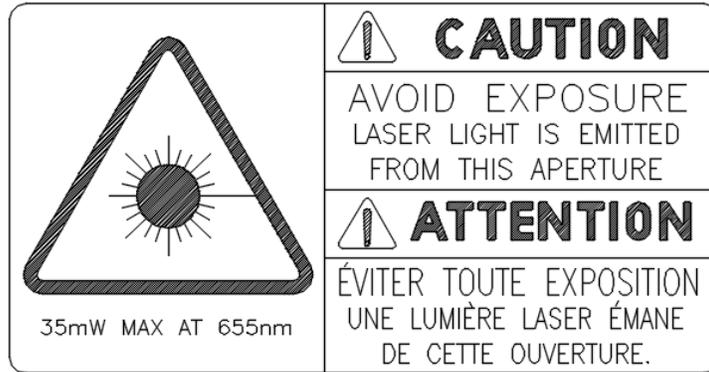


FIGURE 12-2
REAR OPTICAL SECTION WHEN OPEN

12.5.4 Purge Nozzle Warning Label

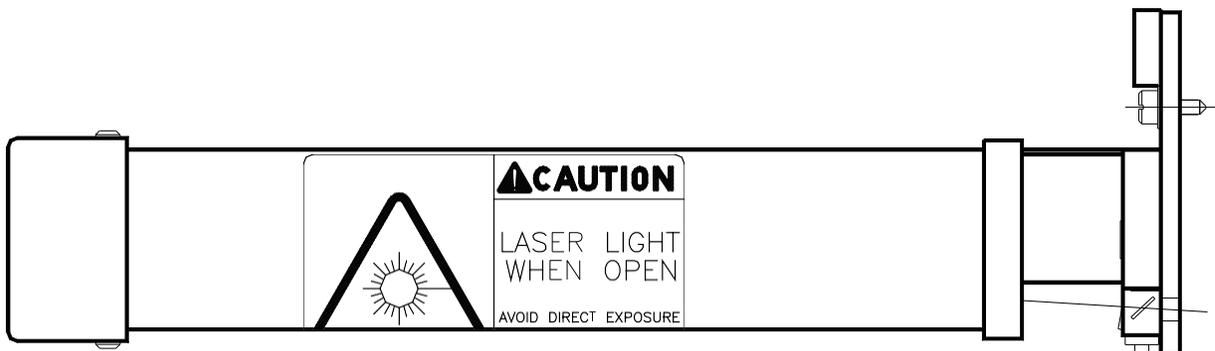
The Purge Nozzle warning label is an advisory label warning personnel of exposure to laser light being emitted from the nozzle aperture. The label is affixed to the Purge Nozzle during manufacturing at Teledyne Monitor Labs.



PURGE NOZZLE WARNING LABEL

12.5.5 Cal Kit Warning Label

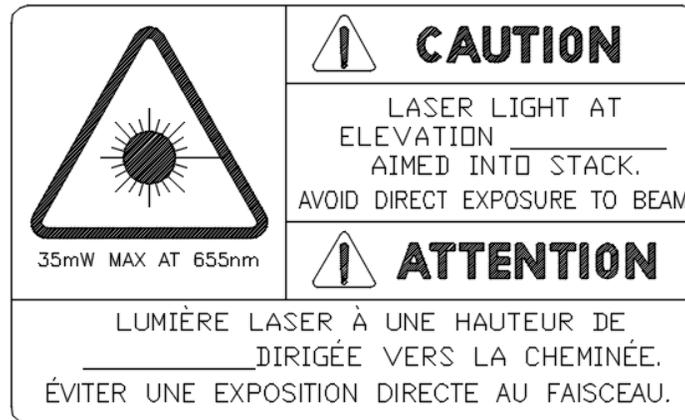
The Cal Kit warning label is an advisory label warning personnel of possible exposure to laser light being emitted from the Cal Kit aperture. This normally could happen if the user inserts a reflective surface into an open section of the Cal Kit or removes the rear cap during calibration and maintenance as described in Section 7.1.3. 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 12.5.1 previously.



**FIGURE 12-3
CAL KIT ASSEMBLY**

12.5.6 Ground Level Warning Label

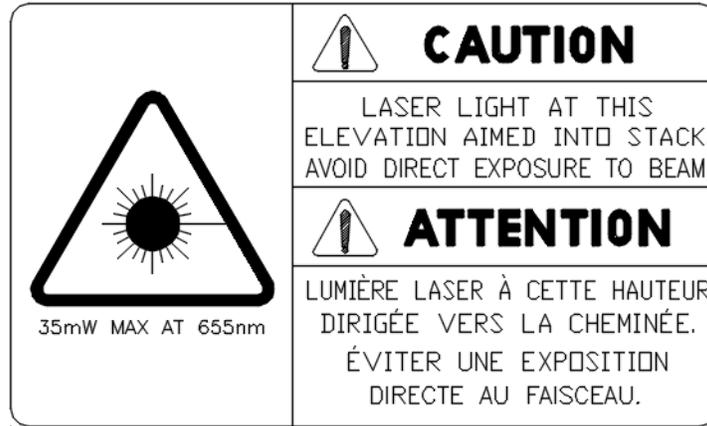
The Ground Level warning label is an advisory label warning personnel that a laser or laser system is installed at a certain elevation noted on the label. The label is installed by authorized plant personnel, such as the Laser Safety Officer, at a suitable location on any means of approach to the monitor 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

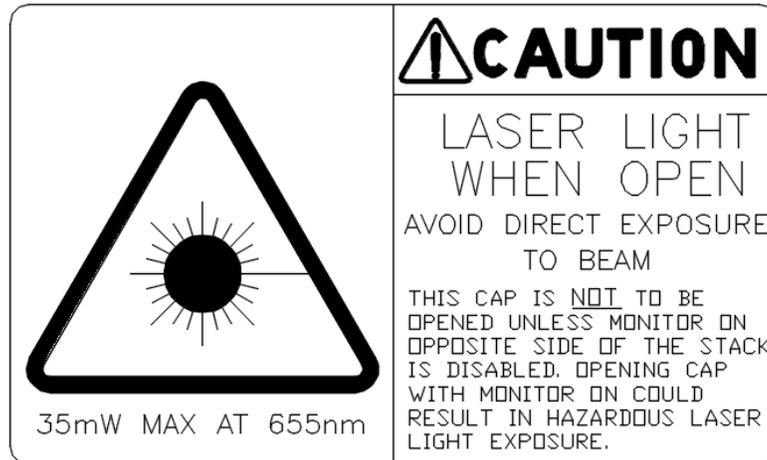
The Instrument Level warning label is an advisory label warning personnel that a laser or laser system is installed at the elevation of this label. The label is installed by authorized plant personnel, such as the LSO, at the elevation of the installed laser or laser system. The label shall be affixed 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 label is placed on the cap, keeping it visible to calibration and maintenance personnel.



LIGHT TRAP WARNING LABEL, ENGLISH



LIGHT TRAP WARNING LABEL, FRENCH CANADIAN

APPENDIX A
SITE SPECIFICATION DATA SHEETS

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11/10/2014

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SITE SPECIFICATION DATA
Teledyne Monitor Labs LaserHawk 360 Particulate Matter Monitor

COMPANY: _____

TML SHOP ORDER NO: _____

CAL DATE: _____

UNIT SERIAL #: _____

CAL. TECHNICIAN: _____

I. OPTICAL HEAD

Mother Board PN: _____ SN: _____

SB332 PN: _____ SN: _____

Optical Amplifier PN: _____ SN: _____

Display Board PN: _____ SN: _____

Laser Field of View _____ feet _____ meters

A. SIX POINT I/O:
(360DI ONLY)

YES	_____
NO	_____

PN: _____

SN: _____

OUTPUT UNITS _____ F(0) Backscatter = 1, Part Mass = 3
 OUTPUT FULL SCALE _____ F(E)
 CAL ZERO/DUST COMP SCALING _____ F(F) 0 = NORMAL mode scaling; 1= EXPANDED scaling

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

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

B. CAL MECHANISM

Cal Drive Assembly SN: _____

ZERO CAL VALUE _____ % Backscatter 90 / C(0)

UPSCALE CAL VALUE _____ % Backscatter 91 / C(1)

UPSCALE APERTURE PLATE _____ decimal inches, (enter 0.25" as 0.25) or NA for none

CAL ARM POLARIZER (YES/NO) _____

CAL ARM EXIT GLASS (OPAL/CLEAR) _____

SITE SPECIFICATION DATA

Teledyne Monitor Labs LaserHawk 360 Particulate Matter Monitor

COMPANY: _____

TML SHOP ORDER NO: _____

CAL DATE: _____

UNIT SERIAL #: _____

CAL. TECHNICIAN: _____

C. AUTO CAL CYCLE

CYCLE FREQUENCY		
CAL TIME HOUR	_____ HR	63 / C(4)
CAL TIME MIN.	_____ MIN.	64 / C(5)
CAL INTERVAL HOUR	_____ HR	65 / C(6)
CYCLE DURATIONS		
UPSCALE	_____ SEC	66 / C(8)
ZERO	_____ SEC	67 / C(7)
DUST COMP.	_____ SEC	68 / C(A)

D. 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)

E. "AS SHIPPED" CONFIG.

ZERO CAL BACKSCATTER	_____	73 / U(6)	DUST COMP ALARM	_____	32 / C(2)
UPSCALE CAL BACKSCATTER	_____	74 / U(7)	CAL DELTA	_____	92 / C(3)
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)
UPSCALE SET VOLTS	_____	17 / S(4)	REFERENCE GAIN:	_____	100 / F(9)
BCK GRD SET VOLTS	_____	18 / S(5)	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

INSTRUMENT AIR _____

III. LIGHT TRAP

YES	_____
NO	_____

SITE SPECIFICATION DATA
Teledyne Monitor Labs LaserHawk 360 Particulate Matter Monitor

COMPANY: _____

TML SHOP ORDER NO: _____ CAL DATE: _____

UNIT SERIAL #: _____

CAL. TECHNICIAN: _____

IV. CALIBRATION KIT 1810-0675-01 360 Standard, -02 360 Long Ports
 1810-0675-03 360ES Only

A. IRIS OPENING DIAMETER
 _____ decimal inches, approximate, enter 0.38" as 0.38
 _____ OPAL GLASS (YES/NO)

B. AUDIT STANDARD VALUES:
 BACKSCATTER

- 1) _____
- 2) _____
- 3) _____

V. ENHANCED REMOTE PANEL _____
 (360/360ES ONLY)

Mother Board PN: _____	SN: _____
SB332 PN: _____	SN: _____
Power Supply PN: _____	SN: _____
MIO PN: _____	SN: _____

A. ANALOG OUTPUT CHANNEL SELECTIONS

CHANNEL 1	DEFINITION _____	39
	WITH / W.O. CAL _____	40
	ZERO VALUE _____	41
	FULL SCALE _____	42
CHANNEL 2	DEFINITION _____	43
	WITH / W.O. CAL _____	44
	ZERO VALUE _____	45
	FULL SCALE _____	46
CHANNEL 3	DEFINITION _____	47
	WITH / W.O. CAL _____	48
	ZERO VALUE _____	49
	FULL SCALE _____	50
CHANNEL 4	DEFINITION _____	51
	WITH / W.O. CAL _____	51
	ZERO VALUE _____	53
	FULL SCALE _____	54

B. DIGITAL OUTPUT (Relay) SELECTIONS

DIGITAL OUTPUT 1 _____	55
DIGITAL OUTPUT 2 _____	56
DIGITAL OUTPUT 3 _____	57
DIGITAL OUTPUT 4 _____	58
DIGITAL OUTPUT 5 _____	59
DIGITAL OUTPUT 6 _____	60
DIGITAL OUTPUT 7 _____	61
DIGITAL OUTPUT 8 _____	62

SITE SPECIFICATION DATA

Teledyne Monitor Labs LaserHawk 360 Particulate Matter Monitor

COMPANY: _____

TML SHOP ORDER NO: _____ CAL DATE: _____

UNIT SERIAL #: _____

CAL. TECHNICIAN: _____

C. "AS SHIPPED" CONFIG.

FIBRELINK	_____	
MIO VERSION	_____	96
PANEL332 VERSION	_____	97
PANEL NEURON VERSION	_____	98
REF. TEMP	_____	102
REF. PRESSURE	_____	103

D. MULTI I/O JUMPERS

	HARDWARE CURRENT RANGE		ISOLATOR INPUT JUMPERS
Output #1	JU1	_____	ISO1 JU9
	JU2	_____	ISO1 JU10
Output #2	JU3	_____	ISO1 JU11
	JU4	_____	ISO1 JU12
Output #3	JU5	_____	ISO1 JU13
	JU6	_____	ISO1 JU14
Output #4	JU7	_____	ISO1 JU15
	JU8	_____	ISO1 JU16

RELAY MODE	
K1 JU21	_____
K2 JU22	_____
K3 JU23	_____
K4 JU24	_____
K5 JU25	_____
K6 JU26	_____
K7 JU27	_____
K8 JU28	_____

MEMORY SELECT	NETWORK TERMINATORS
JU17	JU19
JU18	JU20

VI. DUAL ANALOG INPUT

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
JU3	_____	INT or EXT

NETWORK TERMINATORS

JU5	_____	IN or OUT
JU6	_____	IN or OUT

APPENDIX B
MAINTENANCE CHECK SHEETS

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11/11/2014

PAGE 1 OF 3

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

PLANT NAME _____ LOCATION _____

SERVICE PERSON _____ SERIAL # _____ DATE _____

(1)

A. REASON FOR SERVICE			
ROUTINE	<input type="radio"/>	EMERGENCY	<input type="radio"/>
INSTALL	<input type="radio"/>	OTHER	<input type="radio"/>
EXPLAIN: _____			

(2) **Enhanced Remote Display Checks (360/360ES)**

A. Current Part. Mass Readings (MAIN DISPLAY)

	INST PART. MASS	AVG PART. MASS
AS FOUND	_____ %	_____ %
AS LEFT	_____ %	_____ %

B. FAULT INDICATOR'S (LED's)

	FAULTS	ALARM
ON	<input type="radio"/>	<input type="radio"/>
OFF	<input type="radio"/>	<input type="radio"/>

C. STATUS WORD (MAIN DISPLAY SCREEN)

EXPLAIN _____

D. CURRENT CALIBRATION VALUES (From MAIN DISPLAY page 2)

	BEFORE	AFTER
1. CURRENT CAL ZERO	_____	_____ %T
2. UPSCALE CAL	_____	_____ %T
3. DUST COMP	_____	_____ %T

E. CALIBRATION SET POINTS (from the VIEW SYSTEM PROPERTIES screen)

	BEFORE	AFTER
1. CAL ZERO SET POINT	_____	_____ %T
2. UPSCALE SET POINT	_____	_____ %T
3. CAL FAIL LEVEL	_____	_____ %T

LASERHAWK 360 PARTICULATE MATTER MONITOR

DATE 1/0/1900 _____

SERIAL# 0

PAGE 2 OF 3

F. CHECK THE PERMANENT DATA RECORD FOR THE LAST CAL RESULTS

ZERO CAL = _____ %T

DUST COMP= _____ %T

UPSCALE CAL = _____ %T

G. ANALOG OUTPUTS ENHANCED REMOTE DISPLAY

CHECKED WITH

MULTIMETER	<input type="checkbox"/>	OUTPUT DEVICE (DAS)	<input type="checkbox"/>
------------	--------------------------	---------------------	--------------------------

AVERAGING INTERVAL MIN _____ MIN ("VIEW SYSTEM PROPERTIES" screen)

	*SELECTION	*WITH CAL? ADJUSTED? (Y/N/EXP)	(Y/N)
CHANNEL 1			
CHANNEL 2			
CHANNEL 3			
CHANNEL 4			

* View ed on "ANALOG OUTPUT 1,2" and "ANALOG OUTPUT 3,4" screens

(3) On-Stack Checks

A. INSPECT

	PURGE AIR FILTER	FLEX HOSE	MOUNTING TUBE	DESIC-CATOR
OK	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
CLEANED	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
REPLACED	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>

	OPTICAL ALIGN- MENT <u>LASER</u>	OPTICAL ALIGN- MENT <u>LIGHT TRAP</u>	(IF SUPPLIED)
OK	<input checked="" type="checkbox"/>	<input type="checkbox"/>	
ADJUSTED	<input checked="" type="checkbox"/>	<input type="checkbox"/>	

B. COMMENTS:

DATE 1/01/1900

SERIAL # 0

PAGE 3 OF 3

C. CLEAN: CAL KIT EXIT WINDOW CAL MECH LIGHT TRAP

D. **INSTALL** CAL KIT FIXTURE OK OTHER

E. PERFORM BACKGROUND SE OK OTHER

F. PERFORM NORMAL SET OK OTHER

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

H. PERFORM UPSCALE SET OK OTHER

REPEATED

OK OTHER

INPUT NEW UPSCALE SET VALUE OK OTHER
(READ BANK SF) (INPUT INTO BANK C1)

J. COMMAND CAL CYCLE OK OTHER

K. CAL CYCLE RESULTS ZERO _____ UPSCALE _____ DUST COMP _____

OK OTHER

CAL KIT READINGS

	ZERO	MID	HIGH	FS
APERTURE VALUE				
LASERHAWK READING				
OUTPUT VALUE (DAS)				
DIFFERENCE (+/- 2.0 %)				

(4) DATA COLLECTION

A. RECHECK OUTPUT DEVICE OK OTHER
VALUES ABOVE

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

NOTES OR RECOMMENDATIONS :

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APPENDIX C
SPARE PARTS

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RECOMMENDED SPARE PARTS

Recommended spare parts for the *LaserHawk* 360 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) <i>LASERHAWK 360</i> “START UP/OPERATIONAL” RECOMMENDED SPARE PARTS							
<u>Part Name</u>	<u>TML Part #</u>	<u>System Location</u>	<u>Stocking</u> <u>Quantity</u>	<u>Stocking</u> <u>Quantity</u>	<u>Stocking</u> <u>Quantity</u>	<u>Monitor</u> <u>Recal</u> <u>Required</u> <u>After</u> <u>Replacement</u>	<u>Mean Time</u> <u>Between</u> <u>Replacement</u>
			1 on Site	2 – 5 on Site	5 – 10 on Site		
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
*** Fuse, 2 amp	527438	Enhanced Remote and Multi I/O	6	6	12	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
***Multi I/O Connector Kit	1803-0006-01	Enhanced Remote Panel	1	1	1	No	N/A

NOTE: *** Not needed if Direct Interface option (360DI) is chosen.

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) <i>LASERHAWK 360</i> "NORMAL WEAR AND MAINTENANCE" RECOMMENDED SPARE PARTS							
<u>Part Name</u>	<u>TML Part #</u>	<u>System Location</u>	<u>Stocking Quantity</u> <u>1 on Site</u>	<u>Stocking Quantity</u> <u>2 - 5 on Site</u>	<u>Stocking Quantity</u> <u>5 - 10 on Site</u>	<u>Monitor Recal Required After Replacement</u>	<u>Estimated Mean Time Between Failures</u>
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
*** Key Switch	525414	Remote display w/multi I/O	1	1	2	No	N/A

NOTE: *** Not needed if Direct Interface option (360DI) is chosen.

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) <i>LASERHAWK 360</i> "EMERGENCY/QUICK RESPONSE" RECOMMENDED SPARE PARTS							
<u>Part Name</u>	<u>TML Part #</u>	<u>System Location</u>	<u>Stocking</u>	<u>Stocking</u>	<u>Stocking</u>	<u>Monitor</u> <u>Recal</u> <u>Required</u> <u>After</u> <u>Replacement</u>	<u>Estimated</u> <u>Mean Time</u> <u>Between</u> <u>Replacement</u>
			<u>Quantity</u> <u>1 on Site</u>	<u>Quantity</u> <u>2 - 5 on</u> <u>Site</u>	<u>Quantity</u> <u>5 - 10 on</u> <u>Site</u>		
Optical Amplifier PCB	1860-0400-03 1860-0400-04	Optical Head, 360 Optical Head, 360ES	1	1	1	Yes	N/A
## <i>LaserHawk</i> 360 Mother Board PCB	1860-0500-04 1860-0500-06	Optical Head, 360 Optical Head, 360ES	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
Calibration Drive Assy.	1860-0125-03	Optical Head	1	1	1	Yes	4-6 Yrs.
# Blower Motor	980142	Purge System, 42CFM	1	1	1	No	3-5 Yrs.
Signal Detector Assy.	1810-0230-01	Optical Head	1	2-5	5-10	Yes	N/A
*** Enhanced Remote Mother Board PCB	1803-2200-04	Enhanced Remote Panel	1	1	2	No	N/A
*** Multi I/O PCB	1803-2500-06	Enhanced Remote Panel	1	1	2	No	N/A
*** Enhanced Remote LCD Display	1803-1400-02	Enhanced Remote Panel	1	1	2	No	N/A
*** Power Supply PCB	1803-0300-02	Enhanced Remote Panel	1	1	2	No	N/A

NOTE: ** Only needed when Direct Interface option (360DI) is chosen.

*** Not required if Direct Interface option (360DI) is chosen.

Not required if Instrument Air Purge option is chosen.

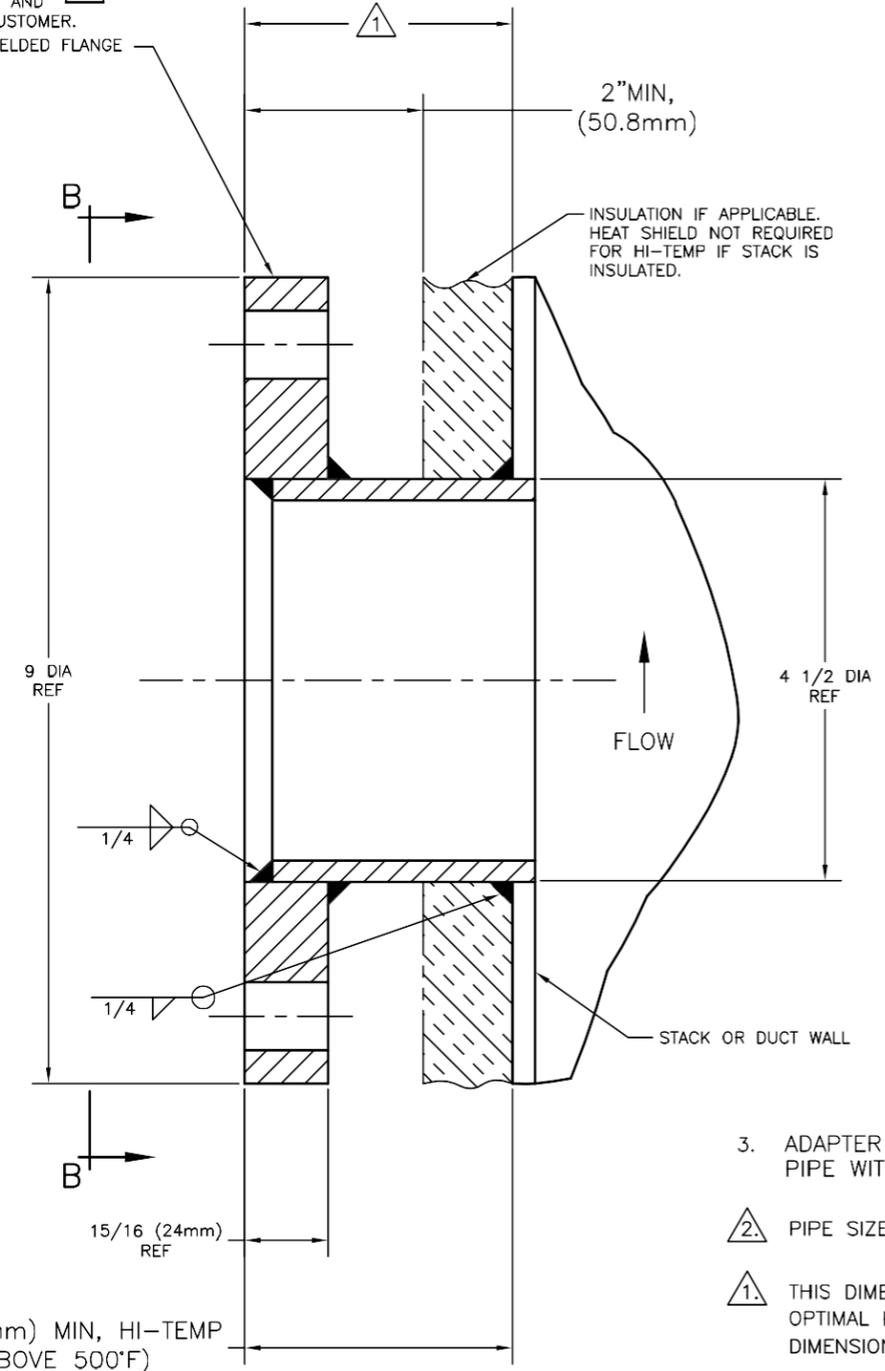
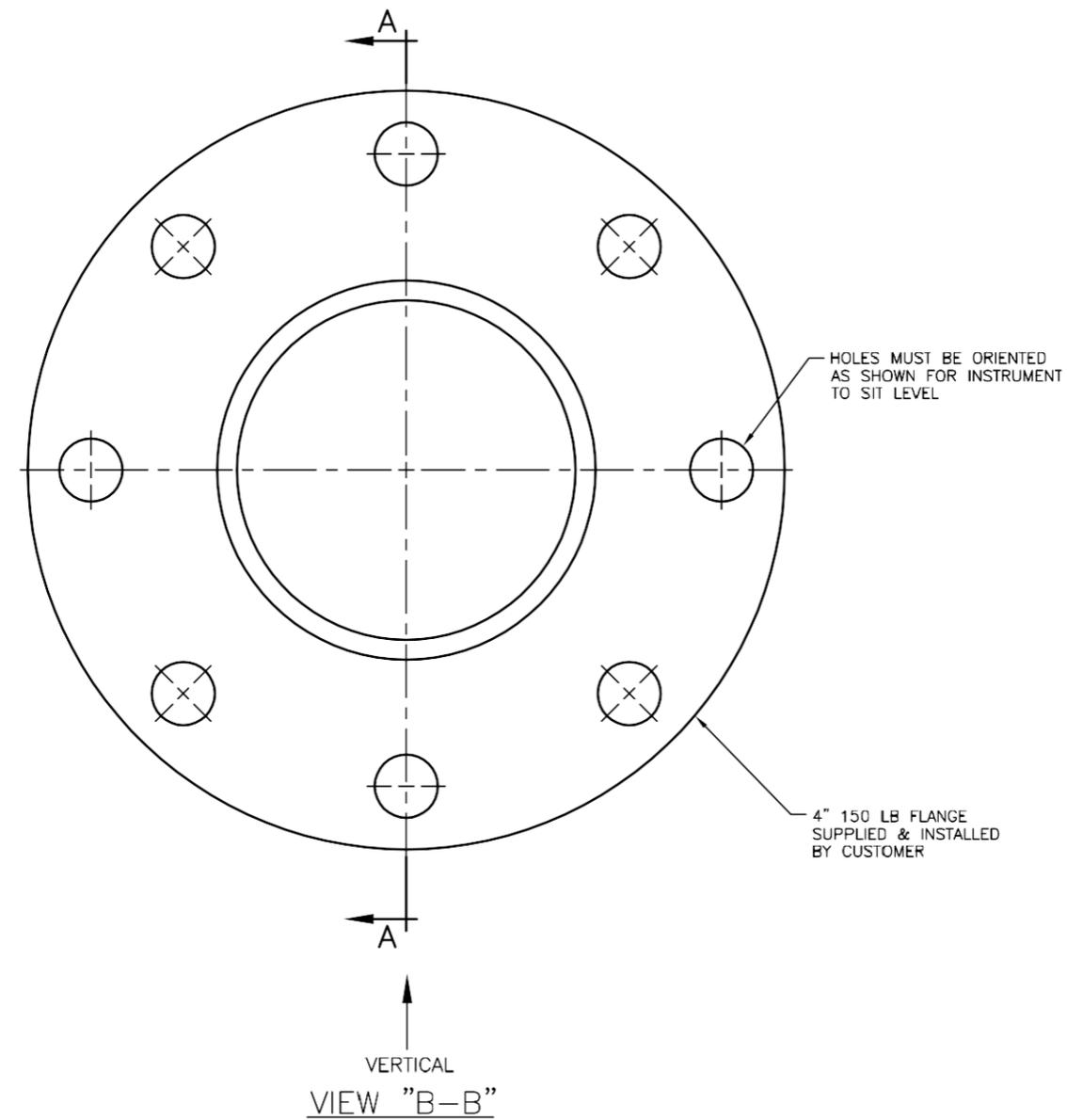
Mother Board (1860-0500) includes one Control Module (515445).

APPENDIX D
DRAWINGS

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

4" SCHEDULE 40 PIPE AND 150 LB FLANGE TO BE SUPPLIED AND INSTALLED BY CUSTOMER. THREADED OR WELDED FLANGE PERMISSIBLE



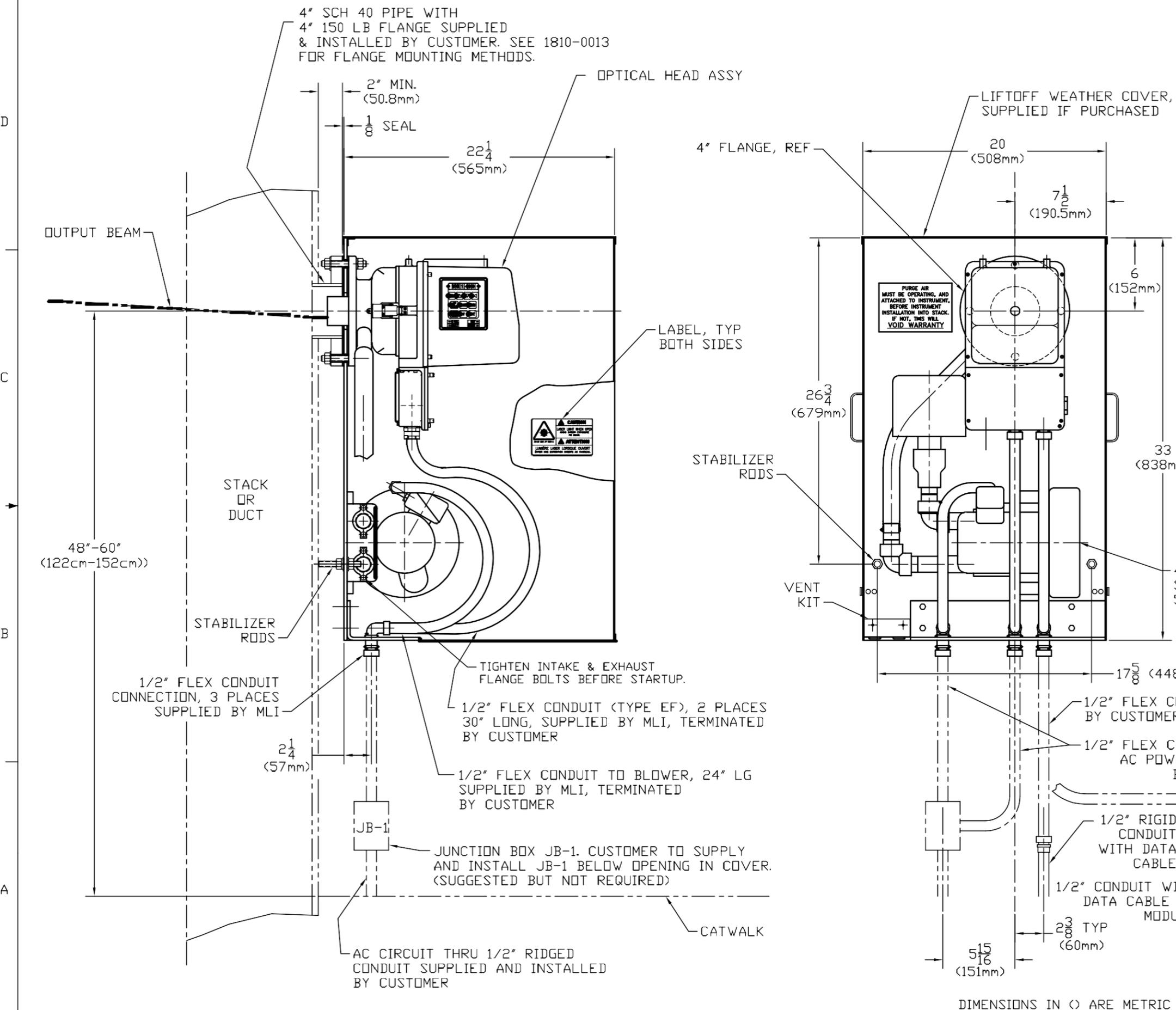
- 3. ADAPTER PLATES ARE AVAILABLE FOR 3", 5" & 6" PIPE WITH 150# FLANGES.
- 2. PIPE SIZES ARE AMERICAN STANDARD.
- 1. THIS DIMENSION SHOULD BE KEPT TO A MINIMUM FOR OPTIMAL PERFORMANCE. CONTACT THE FACTORY IF THIS DIMENSION EXCEEDS 8".

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		USED ON DASH NO NEXT ASSEMBLY -01		<p>TELEDYNE MONITOR LABS A Teledyne Technologies Company</p> <p>THIS DOCUMENT CONTAINS INFORMATION PROPRIETARY AND CONFIDENTIAL TO TELEDYNE MONITOR LABS AND IS FURNISHED UNDER THE EXPRESS CONDITION THAT THE INFORMATION CONTAINED HEREIN WILL NOT BE DUPLICATED, REPRODUCED, DISCLOSED OR DISSEMINATED TO OTHERS OR USED FOR ANY PURPOSE OTHER THAN IN CONNECTION WITH THE EVALUATION THEREOF WITHOUT THE PRIOR WRITTEN CONSENT OF TELEDYNE MONITOR LABS.</p>
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		MAT'L. FINISH JIG NO. SCALE SHEET 1:1 1 of 1		
TITLE 360 BACKSCATTER MONITOR FLANGE MTG. METHODS			DRAWING NO. 1810-0013 LATEST REVISION A	



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



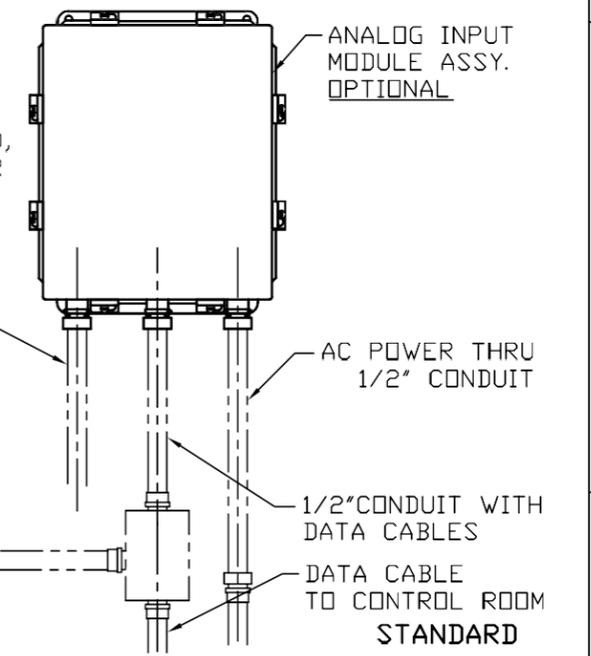
SEE SHEET 2 FOR HI-TEMP
 SEE SHEET 3 FOR INSTR. AIR
 SEE SHEET 4 FOR LIGHT TRAP, SINGLE BLOWER (OBSOLETE)
 SEE SHEET 5 FOR LIGHT TRAP, DUAL BLOWERS
 SEE SHEET 6 FOR LIGHT TRAP, INSTR. AIR
 SEE SHEET 7 56CFM BLOWER OPTION

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:



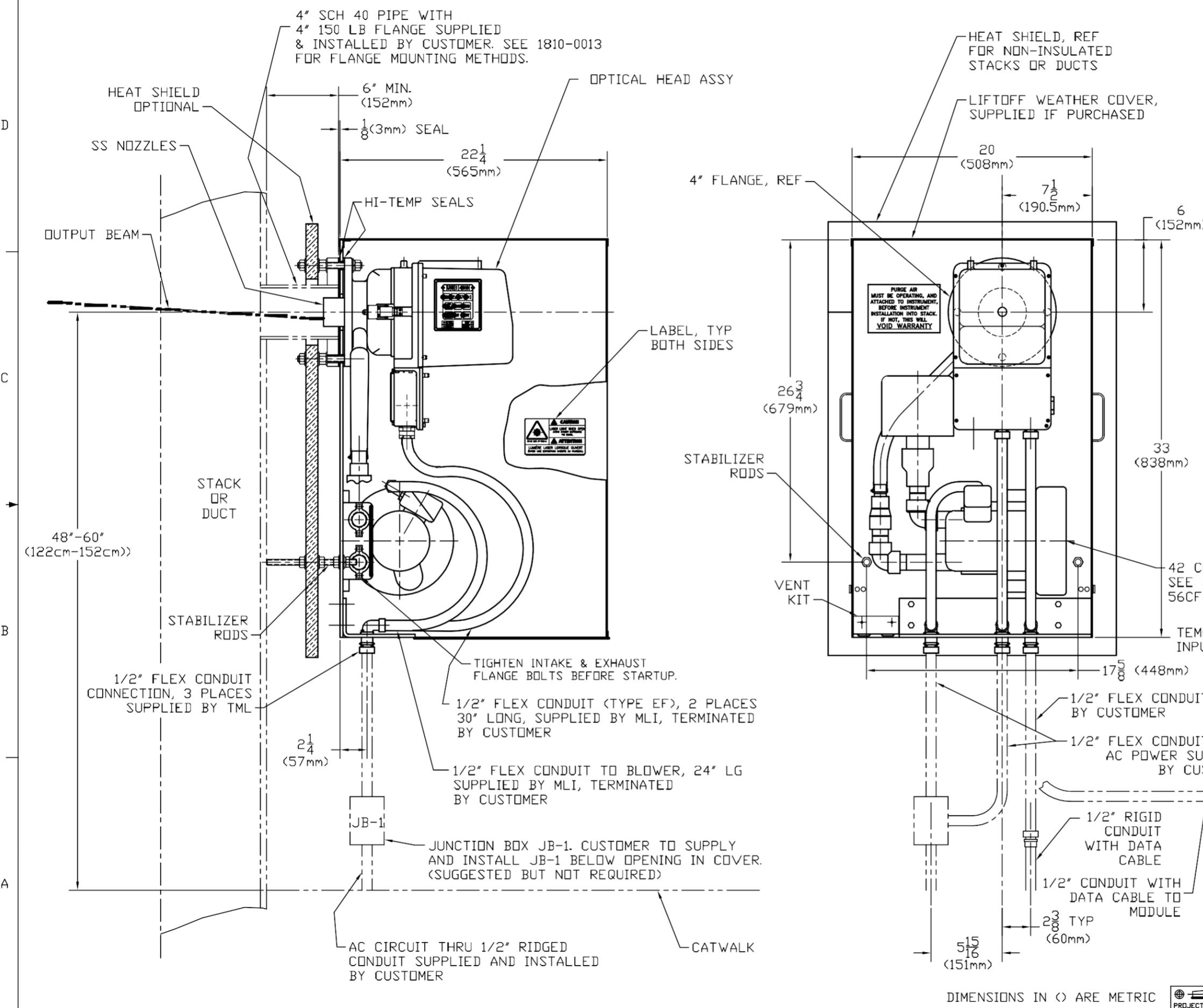
DIMENSIONAL TOLERANCES UNLESS OTHERWISE SPECIFIED		USED ON		 Everywheretheylook
FRACTIONS	DECIMALS	DASH NO	NEXT ASSEMBLY	
0 TO 4 11/32	.XX 1/16	-01		
4 TO 8 1/16	.XX 1/32			
8 AND UP 1/8	.XX 1/64			
ALL DIMENSIONS ARE IN INCHES DO NOT SCALE THIS DRAWING				TITLE
AUTHORIZATION				360 BACKSCATTER SYSTEM INSTALLATION
DRAWN	EAS	DATE	3-17-05	MAT'L
CHECKED	EAS	DATE	Apr-05	FINISH
DESIGNED	EAS	DATE	Mar-05	
ENGINEERED	ELM	DATE	4-20-05	
PRODUCTION	GA	DATE	1-4-06	
Q.A.	AS	DATE	1-4-06	



DIMENSIONS IN () ARE METRIC

D	DRAWING NO.	1810-0015	LATEST REVISION	E
	SCALE	1/4		

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

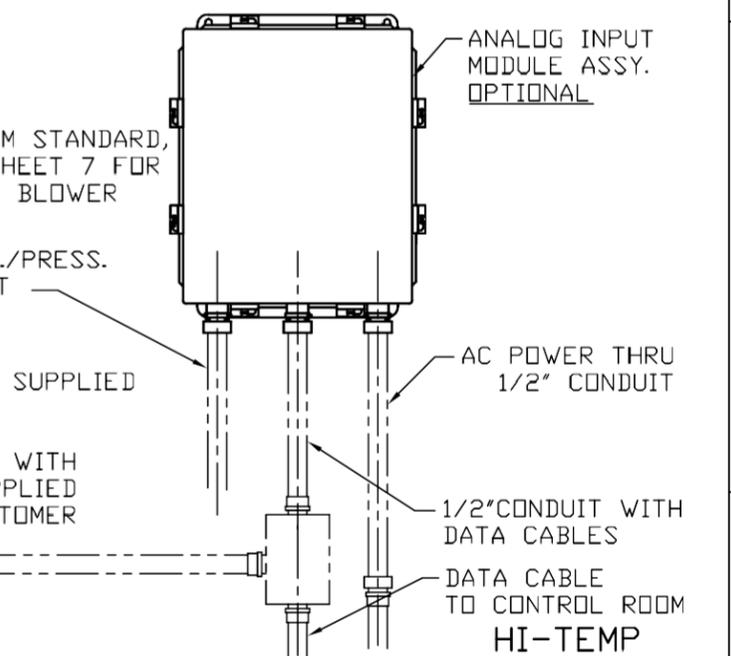


3 IF STACK DIA IS 6.5FT (2 meters) OR LESS A LIGHT TRAP MAY BE REQUIRED. CONSULT FACTORY. SEE SHEET 4 FOR LIGHT TRAP INSTALLATION.

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:



DIMENSIONAL TOLERANCES UNLESS OTHERWISE SPECIFIED		USED ON		TELEDYNE MONITOR LABS Everywhere you look	
FRACTIONS	DECIMALS	DASH NO	NEXT ASSEMBLY	THIS DOCUMENT CONTAINS INFORMATION PROPRIETARY AND CONFIDENTIAL TO TELEDYNE MONITOR LABS AND IS FURNISHED WITH THE EXPRESS CONDITION THAT THE INFORMATION CONTAINED HEREIN WILL NOT BE REPRODUCED, REPRODUCED, DISCLOSED OR DISSEMINATED TO OTHERS OR USED FOR ANY PURPOSE OTHER THAN BY COLLECTOR WITH THE EVALUATION THEREOF WITHOUT THE PRIOR WRITTEN CONSENT OF TELEDYNE MONITOR LABS.	
0 TO 4 11/32	.XX 1/16	-02		TITLE	
4 TO 8 11/32	.XX 1/16			360 BACKSCATTER SYSTEM INSTALLATION	
8 AND UP 11/8	.XX 1/16			FINISH	
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				
SCALE		SHEET		DRAWING NO.	
1/4		2 OF 7		D 1810-0015	
				LATEST REVISION	
				E	

DIMENSIONS IN () ARE METRIC

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.

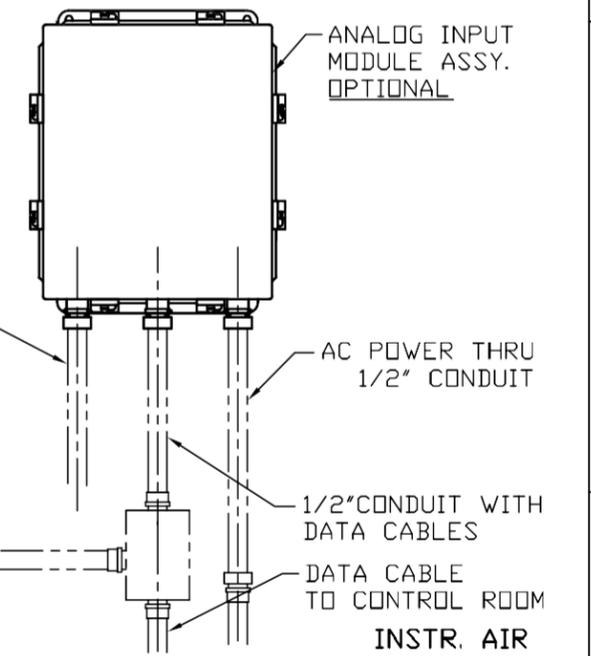
2. AFTER FINAL INSTALLATION AND STARTUP:

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

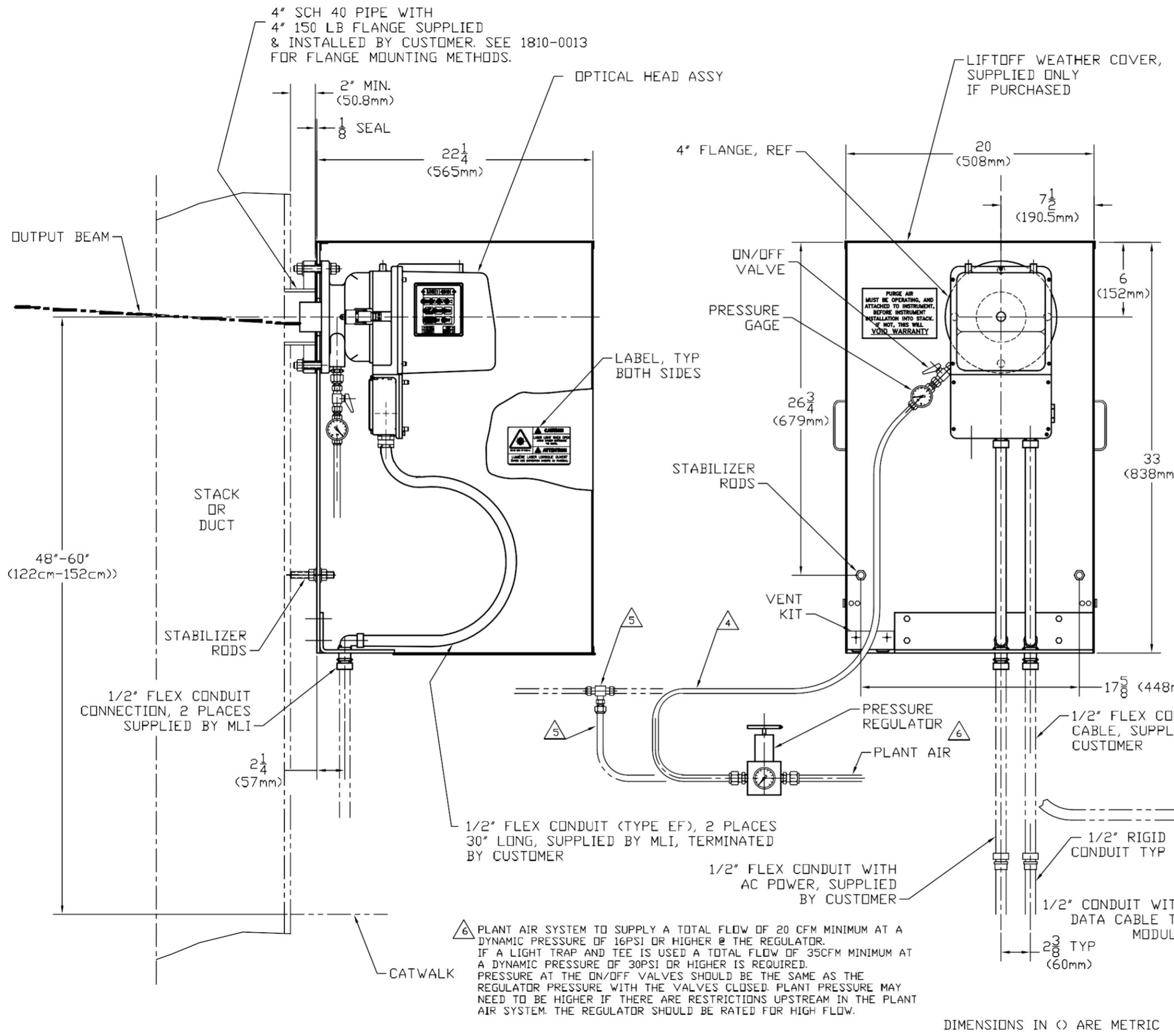
NOTES:



TEMP./PRESS. INPUT

ANALOG INPUT MODULE ASSY. OPTIONAL
 AC POWER THRU 1/2" CONDUIT
 1/2" CONDUIT WITH DATA CABLES
 DATA CABLE TO CONTROL ROOM
 INSTR. AIR

DIMENSIONAL TOLERANCES UNLESS OTHERWISE SPECIFIED		USED ON		TELEDYNE MONITOR LABS Everywhere you look	
FRACTIONS	DECIMALS	DASH NO	NEXT ASSEMBLY	THIS DOCUMENT CONTAINS PROPRIETARY AND CONFIDENTIAL INFORMATION. IT IS FURNISHED WITH THE EXPRESS UNDERSTANDING THAT THE INFORMATION CONTAINED HEREIN WILL NOT BE REPRODUCED, COPIED, DISCLOSED OR DISSEMINATED TO OTHERS OR USED FOR ANY PURPOSE OTHER THAN THAT AUTHORIZED BY THE EVALUATION THEREOF WITHOUT THE WRITTEN CONSENT OF TELEDYNE MONITOR LABS.	
0 TO 4 11/32	.XX X.XX	-03		TITLE	
4 TO 8 11/32	.XX X.XX			360 BACKSCATTER SYSTEM INSTALLATION	
8 AND UP 11/32	.XX X.XX			AUTHORIZATION	
ALL DIMENSIONS ARE IN INCHES DO NOT SCALE THIS DRAWING				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	
				MATERIAL FINISH	
				DRAWING NO. 1810-0015	
				LATEST REVISION E	

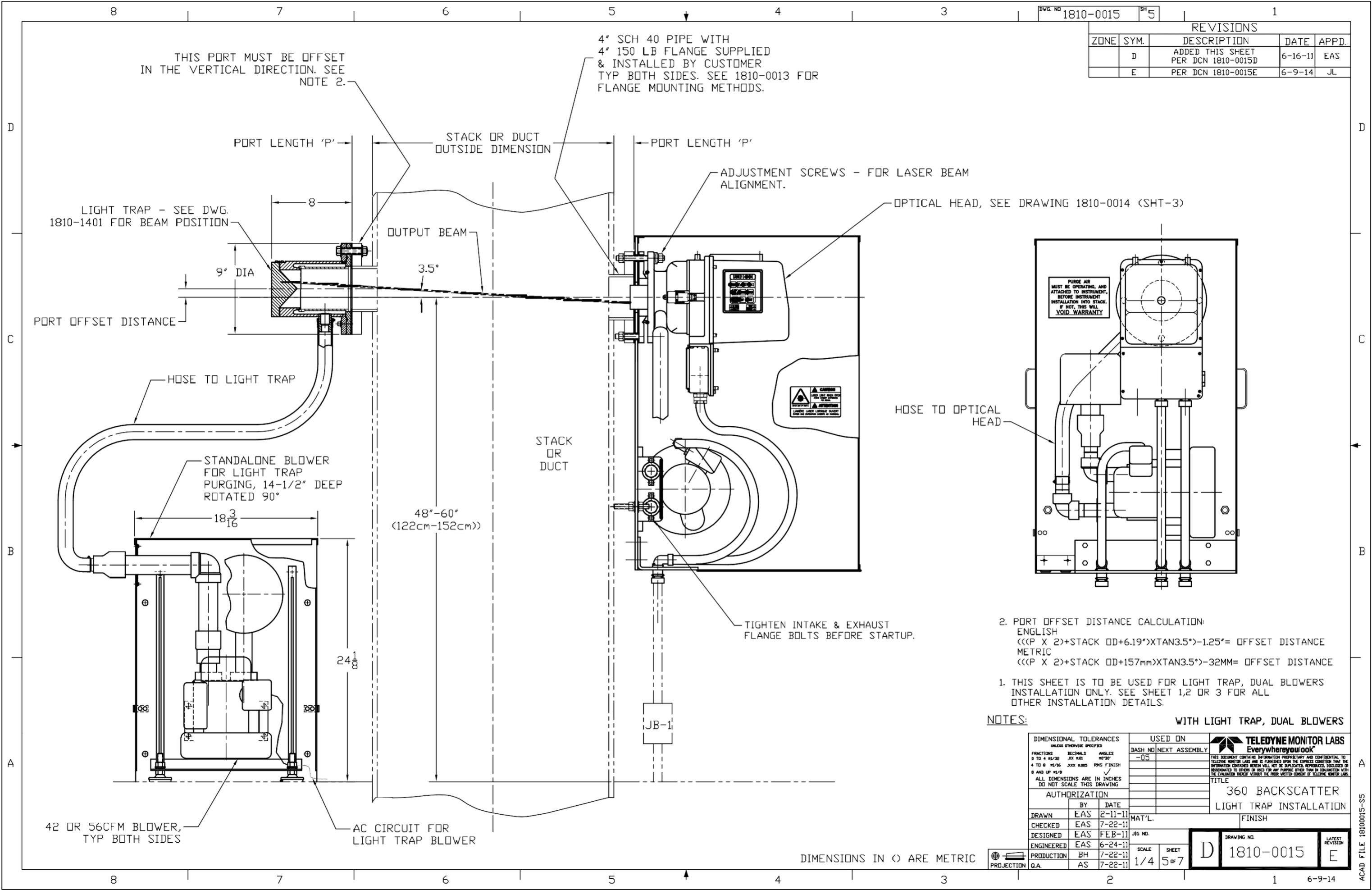


6 PLANT AIR SYSTEM TO SUPPLY A TOTAL FLOW OF 20 CFM MINIMUM AT A DYNAMIC PRESSURE OF 16PSI OR HIGHER @ THE REGULATOR. IF A LIGHT TRAP AND TEE IS USED A TOTAL FLOW OF 35CFM MINIMUM AT A DYNAMIC PRESSURE OF 30PSI OR HIGHER IS REQUIRED. PRESSURE AT THE ON/OFF VALVES SHOULD BE THE SAME AS THE REGULATOR PRESSURE 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



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



4" SCH 40 PIPE WITH 4" 150 LB FLANGE SUPPLIED & INSTALLED BY CUSTOMER TYP BOTH SIDES. SEE 1810-0013 FOR FLANGE MOUNTING METHODS.

THIS PORT MUST BE OFFSET IN THE VERTICAL DIRECTION. SEE NOTE 2.

2. PORT OFFSET DISTANCE CALCULATION:
 ENGLISH
 $\ll(P \times 2) + \text{STACK OD} + 6.19'' \times \text{TAN} 3.5'' - 1.25'' = \text{OFFSET DISTANCE}$
 METRIC
 $\ll(P \times 2) + \text{STACK OD} + 157\text{mm} \times \text{TAN} 3.5'' - 32\text{MM} = \text{OFFSET DISTANCE}$

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

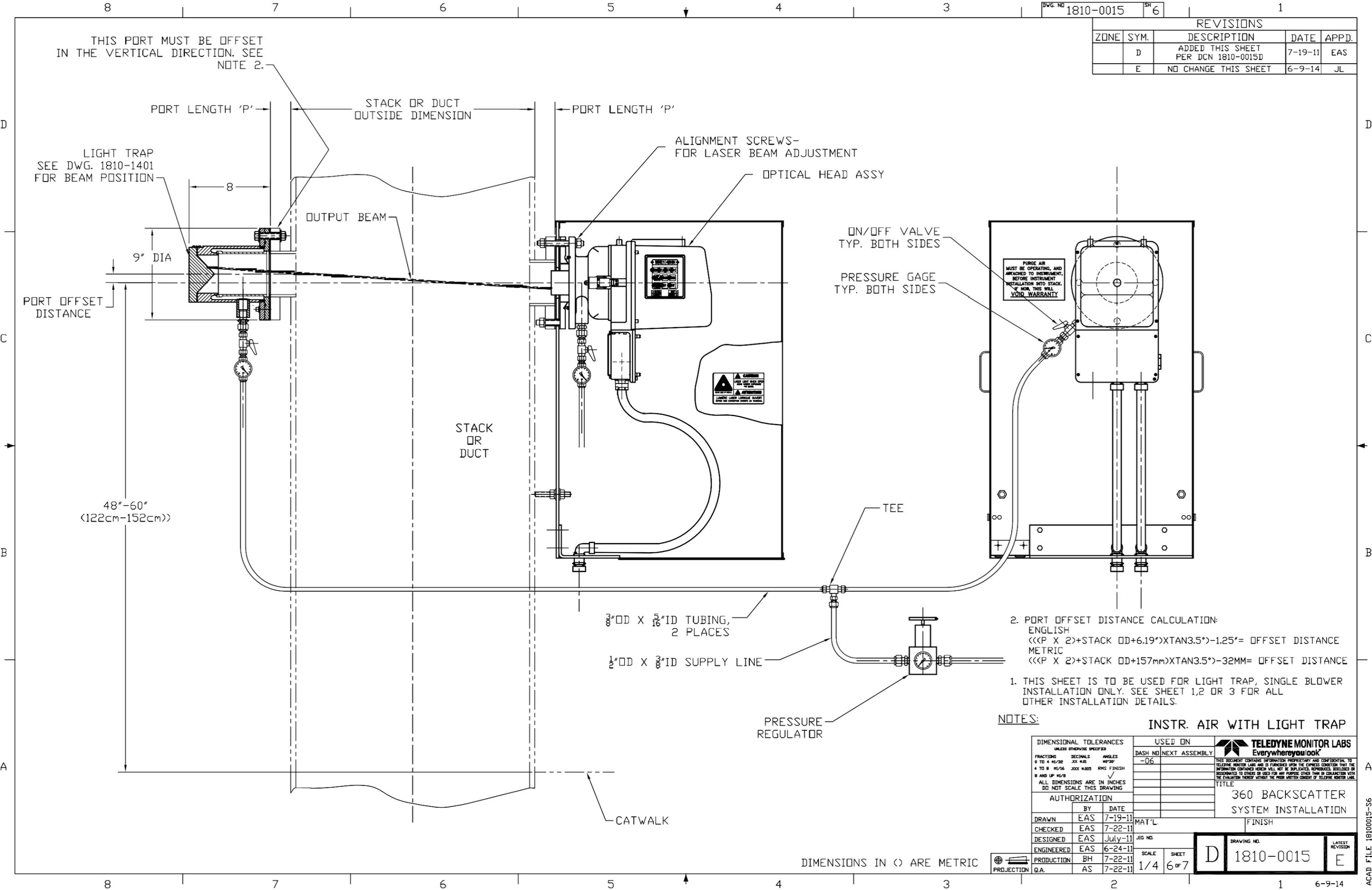
DIMENSIONAL TOLERANCES UNLESS OTHERWISE SPECIFIED		USED ON		
FRACTIONS	DECIMALS	DASH NO	NEXT ASSEMBLY	
0 TO 4 16/32	.XX XLS	-05		THIS DOCUMENT CONTAINS INFORMATION PROPRIETARY AND CONFIDENTIAL TO TELEDYNE MONITOR LABS AND IS FURNISHED UNDER THE EXPRESS CONDITION THAT THE INFORMATION CONTAINED HEREIN WILL NOT BE REPRODUCED, REPRODUCED, DISCLOSED OR DISSEMINATED TO OTHERS OR USED FOR ANY PURPOSE OTHER THAN BY COLLECTOR WITH THE EVALUATION THEREOF WITHOUT THE PRIOR WRITTEN CONSENT OF TELEDYNE MONITOR LABS.
4 TO 8 16/32	.XXX XLS			
8 AND UP 16/8				TITLE
ALL DIMENSIONS ARE IN INCHES DO NOT SCALE THIS DRAWING				360 BACKSCATTER
AUTHORIZATION				LIGHT TRAP INSTALLATION
BY	DATE			FINISH
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

DIMENSIONS IN () ARE METRIC

D	DRAWING NO.	LATEST REVISION
	1810-0015	E

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



THIS PORT MUST BE OFFSET IN THE VERTICAL DIRECTION. SEE NOTE 2.

PORT LENGTH 'P'

STACK OR DUCT OUTSIDE DIMENSION

PORT LENGTH 'P'

LIGHT TRAP SEE DWG. 1810-1401 FOR BEAM POSITION

ALIGNMENT SCREWS- FOR LASER BEAM ADJUSTMENT

OPTICAL HEAD ASSY

OUTPUT BEAM

9" DIA

ON/OFF VALVE TYP. BOTH SIDES

PRESSURE GAGE TYP. BOTH SIDES

PURGE AIR MUST BE OPERATING, AND ATTACHED TO INSTRUMENT, BEFORE INSTRUMENT INSTALLATION INTO STACK. IF NOT, THIS WILL VOID WARRANTY.

PORT OFFSET DISTANCE

STACK OR DUCT

48"-60" (122cm-152cm)

3/8"OD X 5/16"ID TUBING, 2 PLACES

1/2"OD X 3/8"ID SUPPLY LINE

PRESSURE REGULATOR

2. PORT OFFSET DISTANCE CALCULATION:
 ENGLISH
 $((P \times 2) + \text{STACK OD} + 6.19') \times \text{TAN} 3.5^\circ - 1.25' = \text{OFFSET DISTANCE}$
 METRIC
 $((P \times 2) + \text{STACK OD} + 157\text{mm}) \times \text{TAN} 3.5^\circ - 32\text{MM} = \text{OFFSET DISTANCE}$

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:

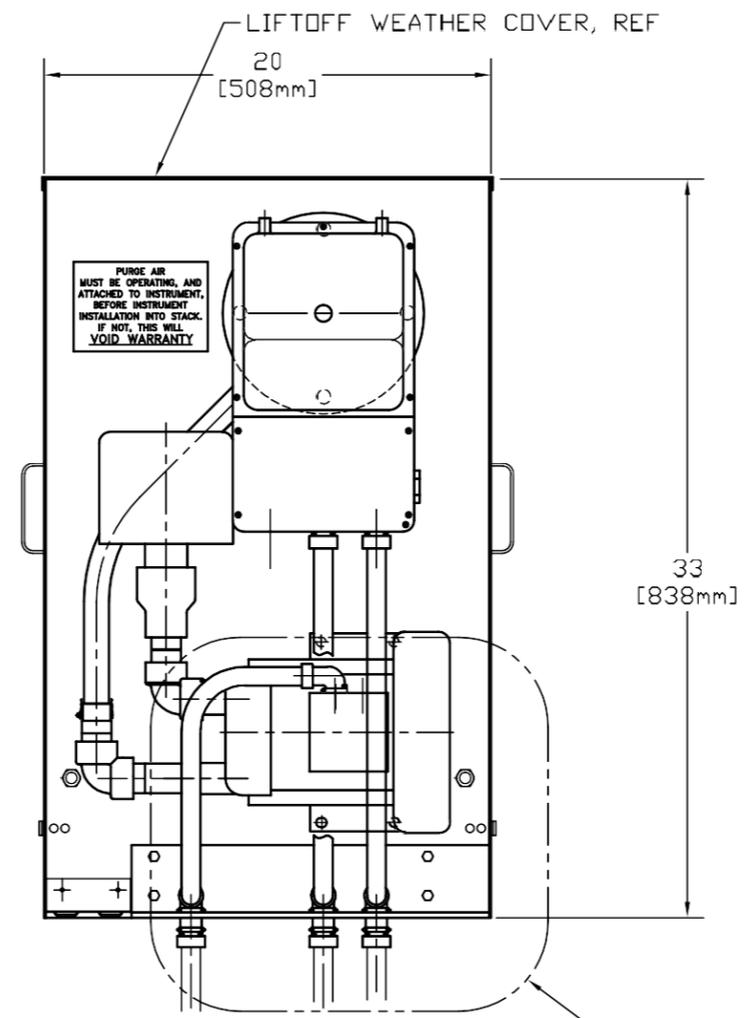
INSTR. AIR WITH LIGHT TRAP

DIMENSIONAL TOLERANCES UNLESS OTHERWISE SPECIFIED		USED ON		TELEDYNE MONITOR LABS Everywhere you look	
FRACTIONS	DECIMALS	DASH NO	NEXT ASSEMBLY	THIS DOCUMENT CONTAINS INFORMATION PROPRIETARY AND CONFIDENTIAL TO TELEDYNE MONITOR LABS AND IS FURNISHED WITH THE EXPRESS CONDITION THAT THE INFORMATION CONTAINED HEREIN WILL NOT BE REPRODUCED, REPAIRED, RECLOSED OR DISSEMINATED TO OTHERS OR USED FOR ANY PURPOSE OTHER THAN IN CONNECTION WITH THE EVALUATION THEREOF WITHOUT THE PRIOR WRITTEN CONSENT OF TELEDYNE MONITOR LABS.	
0 TO 4 #1/32	.005	-06		TITLE	
4 TO 8 #1/16	.010			360 BACKSCATTER SYSTEM INSTALLATION	
8 AND UP #1/8	.015			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				
SCALE		SHEET		DRAWING NO.	
1/4		6 OF 7		D 1810-0015	
				LATEST REVISION	
				E	

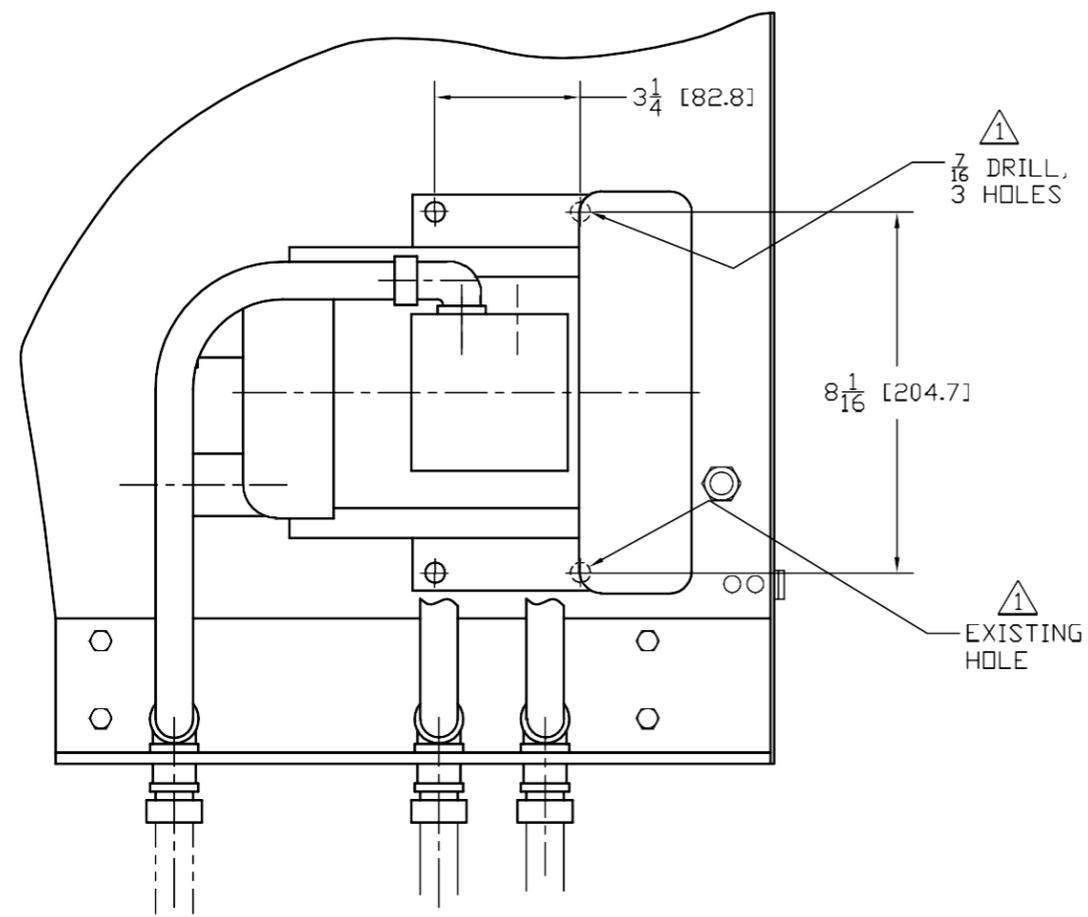
DIMENSIONS IN () ARE METRIC



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



SEE ENLARGED VIEW A



ENLARGED VIEW A
SCALE 1/2

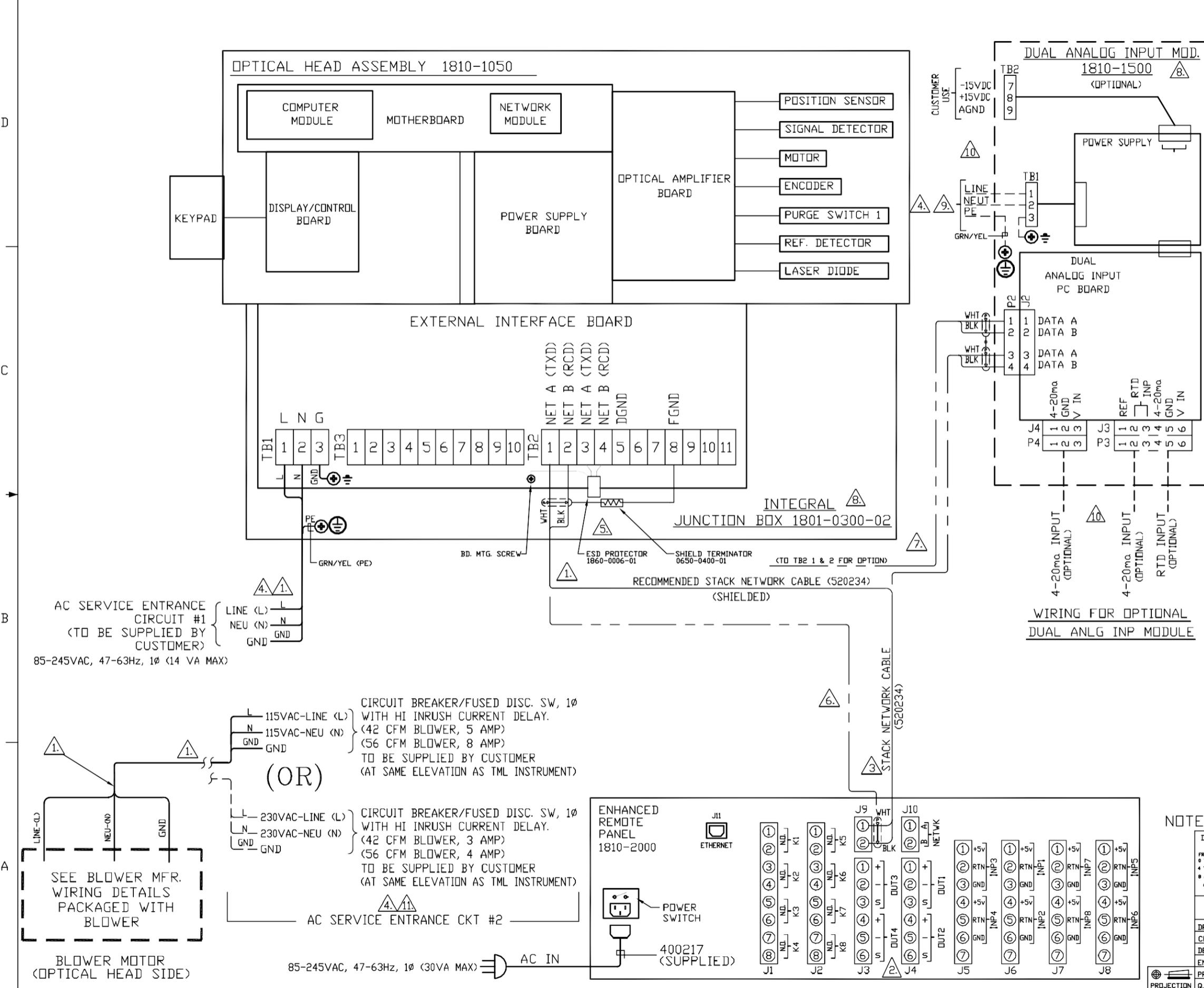
⚠ IF HOLES DO NOT EXIST YOU WILL NEED TO DRILL (3) 7/16 HOLES FOR MOUNTING THE 56CFM BLOWER. USE THE EXISTING LOWER RIGHT HAND CORNER HOLE FOR THE 4th

56CFM BLOWER OPTION

DIMENSIONAL TOLERANCES UNLESS OTHERWISE SPECIFIED FRACTIONS DECIMALS ANGLES 0 TO 4 ±1/32 .004 ±.01 90°/30° 4 TO 8 ±1/16 .005 ±.015 RMS FINISH 8 AND UP ±1/8 ALL DIMENSIONS ARE IN INCHES DO NOT SCALE THIS DRAWING		USED ON DASH NO NEXT ASSEMBLY -01	<p>TELEDYNE MONITOR LABS Everywhere you look</p> <p>THIS DOCUMENT CONTAINS INFORMATION PROPRIETARY AND CONFIDENTIAL TO TELEDYNE MONITOR LABS AND IS FURNISHED UNDER THE EXPRESS CONDITION THAT THE INFORMATION CONTAINED HEREIN WILL NOT BE REPRODUCED, REPRODUCED, REPRODUCED OR DISSEMINATED TO OTHERS OR USED FOR ANY PURPOSE OTHER THAN BY CONTRACTOR WITH THE EVALUATION THEREOF WITHOUT THE PRIOR WRITTEN CONSENT OF TELEDYNE MONITOR LABS.</p>
AUTHORIZATION BY DATE DRAWN EAS 6-9-14 CHECKED EAS 6-9-14 DESIGNED EAS Jun-14 ENGINEERED JL 6-11-14 PRODUCTION GA 6-11-14 Q.A. AS 6-11-14		MAT'L. JIG NO. SCALE SHEET 1/4 7 OF 7	TITLE 360 BACKSCATTER SYSTEM INSTALLATION FINISH
DIMENSIONS IN [] ARE METRIC		DRAWING NO. 1810-0015	LATEST REVISION E

REVISIONS				
ZONE	SYM.	DESCRIPTION	DATE	APPD.
	C	NO CHANGE THIS SHEET	2-24-10	ELM
	D	NO CHANGE THIS SHEET	6-24-11	EAS
	E	NO CHANGE THIS SHEET	8-9-11	FWD
	F	ECD 1371; PER DCN1810-0012F	6-9-14	JL
	G	ECD 1417; PER DCN1810-0012G	5-8-15	EAS

ERP REAR PANEL I/O TERMINATIONS			
ISOLATED INPUTS			
INPUT	DRY	+5VDC	
RELAYS			
K1-J1 (1&2)	INP #1 FORCE UPSCALE	J6-(2&3)	(1&2)
K2-J1 (3&4)	INP #2 FORCE ZERO	J6-(5&6)	(4&5)
K3-J1 (5&6)	INP #3	J5-(2&3)	(1&2)
K4-J1 (7&8)	INP #4 DUMP DUST COMP	J5-(5&6)	(4&5)
K5-J2 (1&2)	INP #5 FORCE CAL CYCLE	J8-(2&3)	(1&2)
K6-J2 (3&4)	INP #6		NOT USED
K7-J2 (5&6)	INP #7 TEST ZERO SCALE	J7-(2&3)	(1&2)
K8-J2 (7&8)	INP #8 TEST FULL SCALE	J7-(5&6)	(4&5)
ANLG OUTPUTS			
	#1 J4 1(+)	2(-)	3(SH)
	#2 J4 4(+)	5(-)	6(SH)
	#3 J3 1(+)	2(-)	3(SH)
	#4 J3 4(+)	5(-)	6(SH)



- 1. BLOWER SELECTION GUIDE: 42 CFM RECOMMENDED FOR POSITIVE PRESSURE STACKS UP TO +10' OF WATER. 56 CFM RECOMMENDED FOR STACKS ABOVE +10' WATER.
- 2. 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.
- 3. POWER REQUIREMENT IS 85-245VAC, 50/60Hz, 1Ø (35VA).
- 4. MAINTENANCE PROCEDURES REQUIRING THE REMOVAL OF THE COVER ARE INTENDED TO BE PERFORMED BY TRAINED PERSONNEL ONLY. CONSULT MANUAL.
- 5. IF OPTIONAL DUAL ANALOG INPUT MODULE IS PURCHASED, TERMINATE WIRES AS SHOWN, CONNECT BLACK AND WHITE WIRES TO TERMINALS AS SHOWN.
- 6. IF FIBRELINK III OPTION IS PROVIDED, CONNECT STACK/CONTROL RM. UNITS AND DATA CABLES PER TML SUPPLEMENTAL WIRING DIAGRAM 1810-0016.
- 7. RECOMMENDED STACK NETWORK CABLE IS '16 GA SHIELDED'. SHIELD MUST BE TERMINATED WITH 0650-0400-01 NETWORK AS SHOWN AT THE OPTICAL HEAD. IN NO INSTALLATION SHALL DATA CABLE BE RUN IN TRAYS OR CONDUIT WITH OTHER CABLES EXCEEDING 230 VAC. IF NOT ALREADY INSTALLED, AN 1860-0006-01 ESD PROTECTOR MAY BE ADDED FOR ADDITIONAL ESD PROTECTION. AS SHOWN ON SPARE NETWORK TERMINALS.
- 8. 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 EACH DEVICE BEING SUPPLIED.
- 9. TERMINATE WIRES TO REAR PANEL USING CAGE CLAMP STYLE CONNECTORS FROM KIT PROVIDED.
- 10. ALL CUSTOMER CONNECTIONS TO ANALOG OUTPUTS MUST BE THRU TWISTED PAIR SHIELDED CABLES. ALL SUCH SHIELDS SHALL TERMINATE AT P4-3; P4-6; P3-3; P3-6 FOR OUTPUTS 1 THRU 4 RESPECTIVELY.

NOTES:

1. TERMINATED AT SITE DURING FINAL INSTALLATION.

DIMENSIONAL TOLERANCES UNLESS OTHERWISE SPECIFIED		USED ON	
FRACTIONS	DECIMALS	DASH NO	NEXT ASSEMBLY
0 TO 4 1/32	.005		TOP
4 TO 8 1/16	.010		
8 AND UP 1/8	.015		

TELEDYNE MONITOR LABS
Everywhere you look

THIS DOCUMENT CONTAINS INFORMATION PROPRIETARY AND CONFIDENTIAL TO TELEDYNE MONITOR LABS AND IS FURNISHED UNDER THE EXPRESS CONDITION THAT THE INFORMATION CONTAINED HEREIN WILL NOT BE REPRODUCED, COPIED, DISCLOSED OR TRANSMITTED TO OTHERS OR USED FOR ANY PURPOSE OTHER THAN BY COLLECTOR WITH THE EVALUATION THEREOF WITHOUT THE PRIOR WRITTEN CONSENT OF TELEDYNE MONITOR LABS.

AUTHORIZATION

BY	DATE	MAT'L.	FINISH
DCH	3-8-05		
E.L.M.	4-20-05		
DCH	3-8-05		
E.L.M.	4-20-05		
GA	1-4-06		
AS	1-4-06		

TITLE
LASERHAWK MODEL 360/360ES SYSTEM WIRING DIAGRAM

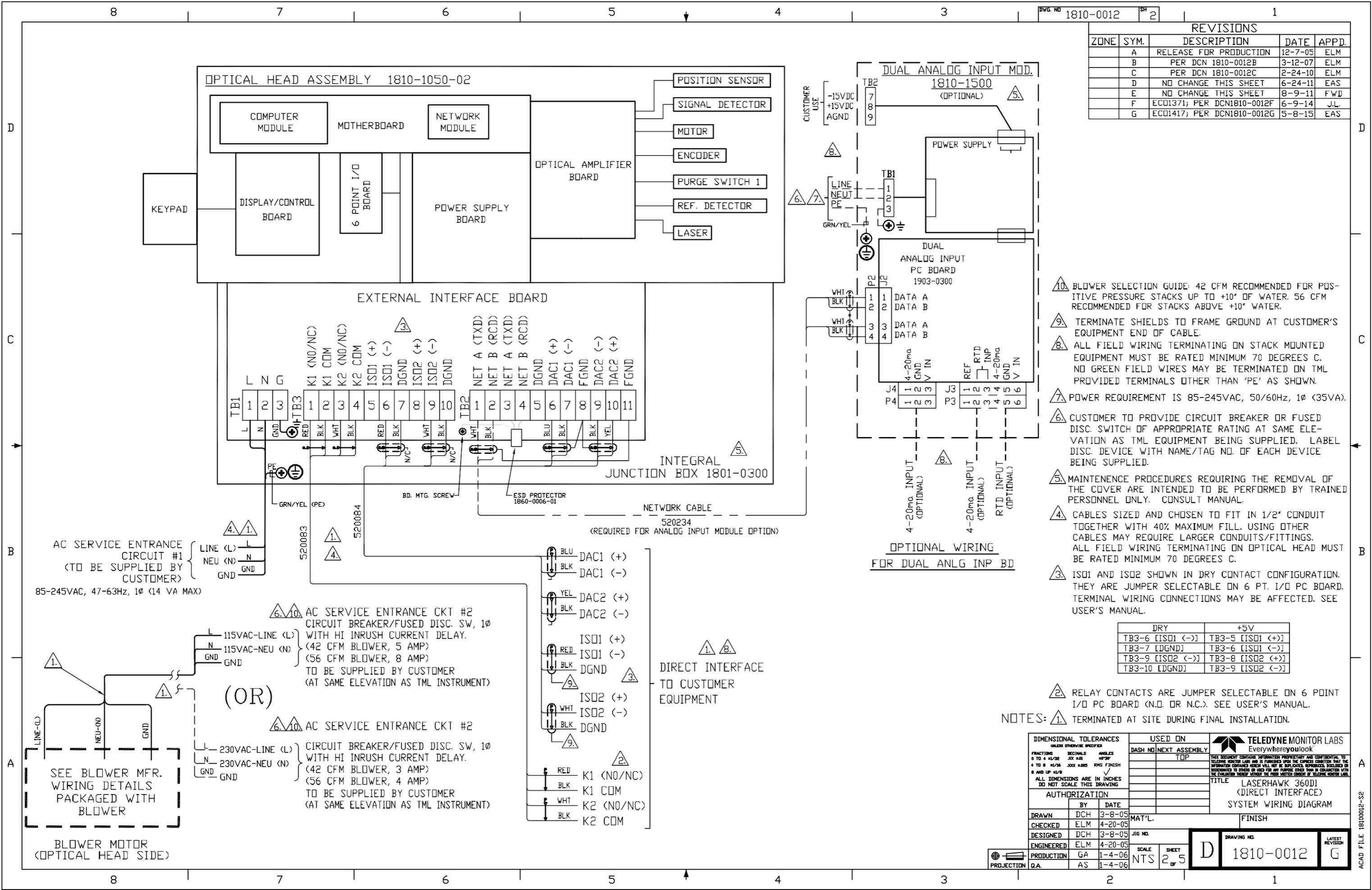
DRAWING NO. 1810-0012

LATEST REVISION G

SCALE NTS

SHEET 1 OF 5

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	NO CHANGE THIS SHEET	8-9-11	FWD
	F	ECD1371; PER DCN1810-0012F	6-9-14	J.L.
	G	ECD1417; PER DCN1810-0012G	5-8-15	EAS



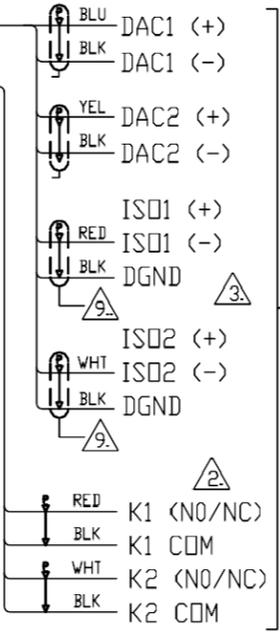
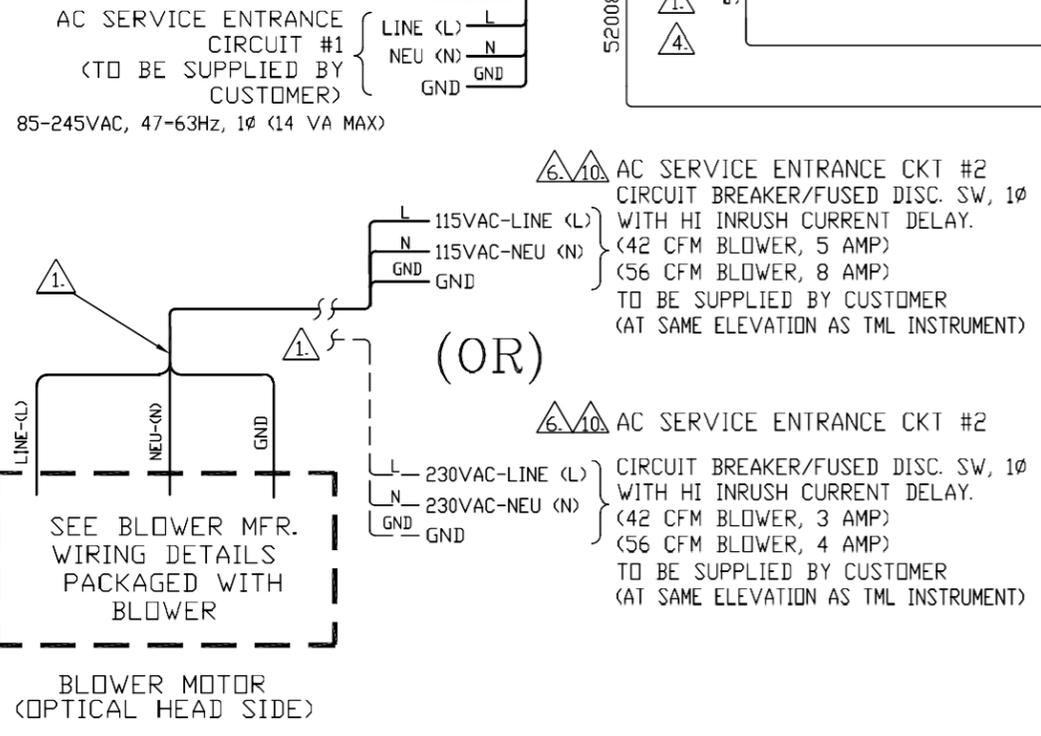
- 10 BLOWER SELECTION GUIDE: 42 CFM RECOMMENDED FOR POSITIVE PRESSURE STACKS UP TO +10" OF WATER. 56 CFM RECOMMENDED FOR STACKS ABOVE +10" WATER.
- 9 TERMINATE SHIELDS TO FRAME GROUND AT CUSTOMER'S EQUIPMENT END OF CABLE.
- 8 ALL FIELD WIRING TERMINATING ON STACK MOUNTED EQUIPMENT MUST BE RATED MINIMUM 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 CUSTOMER TO PROVIDE CIRCUIT BREAKER OR FUSED DISC SWITCH OF APPROPRIATE RATING AT SAME ELEVATION AS TML EQUIPMENT BEING SUPPLIED. LABEL DISC. DEVICE WITH NAME/TAG NO. OF EACH DEVICE BEING SUPPLIED.
- 5 MAINTENANCE PROCEDURES REQUIRING THE REMOVAL OF THE COVER ARE INTENDED TO BE PERFORMED BY TRAINED PERSONNEL ONLY. CONSULT MANUAL.
- 4 CABLES SIZED AND CHOSEN TO FIT IN 1/2" CONDUIT TOGETHER WITH 40% MAXIMUM FILL. USING OTHER CABLES MAY REQUIRE LARGER CONDUITS/FITTINGS. ALL FIELD WIRING TERMINATING ON OPTICAL HEAD MUST BE RATED MINIMUM 70 DEGREES C.
- 3 ISD1 AND ISD2 SHOWN IN DRY CONTACT CONFIGURATION. THEY ARE JUMPER SELECTABLE ON 6 PT. I/O PC BOARD. TERMINAL WIRING CONNECTIONS MAY BE AFFECTED. SEE USER'S MANUAL.

DRY		+5V	
TB3-6 [ISD1 (-)]	TB3-5 [ISD1 (+)]		
TB3-7 [DGND]	TB3-6 [ISD1 (-)]		
TB3-9 [ISD2 (-)]	TB3-8 [ISD2 (+)]		
TB3-10 [DGND]	TB3-9 [ISD2 (-)]		

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		USED ON		 Everywhere you look
FRACTIONS	DECIMALS	DASH NO	NEXT ASSEMBLY	
0 TO 4 1/32	.001		TOP	THIS DOCUMENT CONTAINS INFORMATION PROPRIETARY AND CONFIDENTIAL TO TELEDYNE MONITOR LABS AND IS FURNISHED WITH THE EXPRESS CONDITION THAT THE INFORMATION CONTAINED HEREIN WILL NOT BE REPRODUCED, REPLICATED, OR DISSEMINATED TO OTHERS OR USED FOR ANY PURPOSE OTHER THAN BY CONTRACTOR WITH THE EVALUATION HEREOF WITHOUT THE WRITTEN CONSENT OF TELEDYNE MONITOR LABS.
4 TO 8 1/16	.002			
8 AND UP 1/8	.005			TITLE
ALL DIMENSIONS ARE IN INCHES DO NOT SCALE THIS DRAWING				LASERHAWK 360DI
AUTHORIZATION				<DIRECT INTERFACE>
				SYSTEM WIRING DIAGRAM
DRAWN	DCH	3-8-05	MAT'L.	FINISH
CHECKED	ELM	4-20-05		
DESIGNED	DCH	3-8-05	JIG NO.	
ENGINEERED	ELM	4-20-05		
PRODUCTION	GA	1-4-06	SCALE	SHEET
G.A.	AS	1-4-06	NTS	2 OF 5

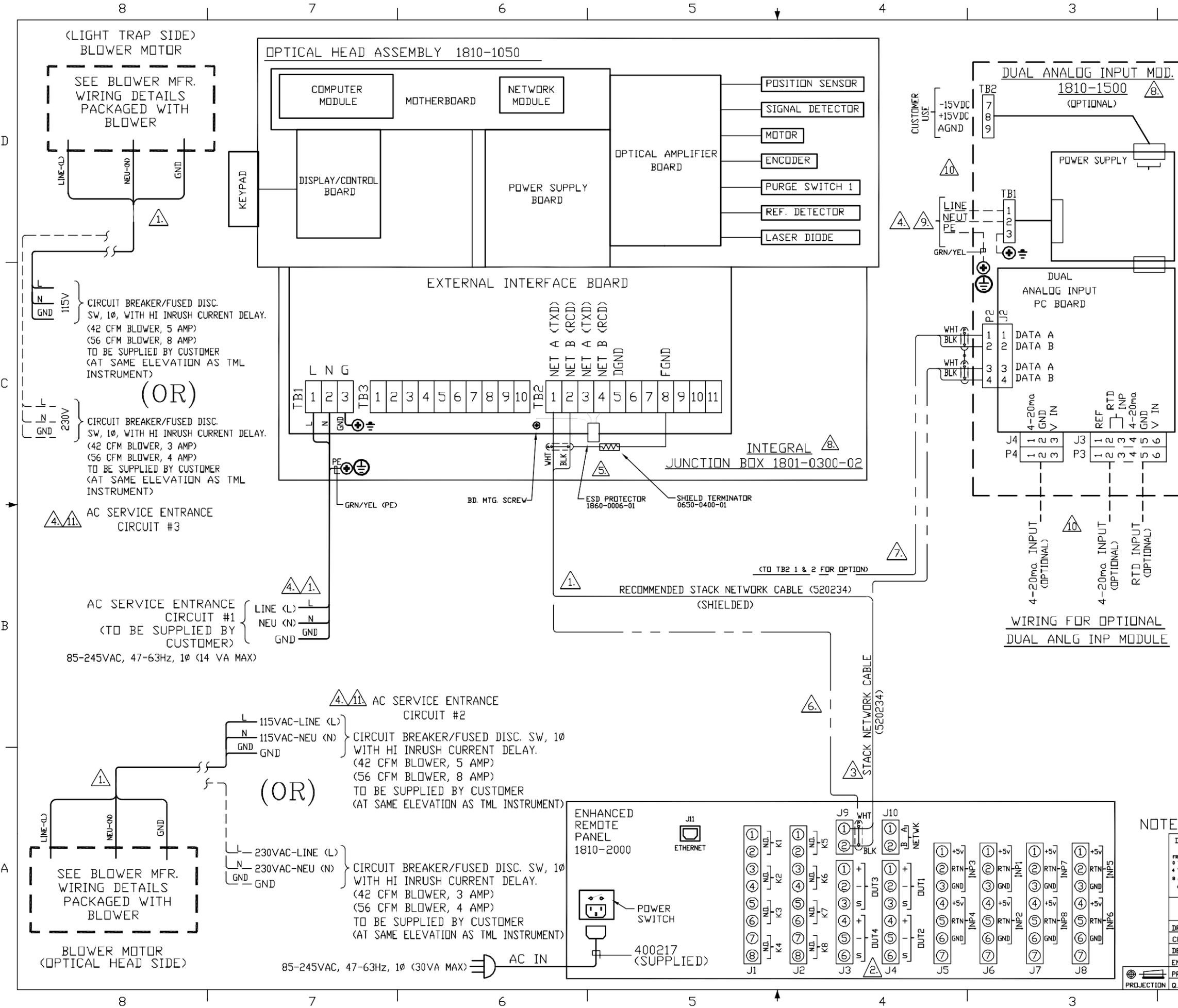


ZONE	SYM.	DESCRIPTION	DATE	APPD.
E		NO CHANGE THIS SHEET	8-9-11	FWD
F		ECD1371; PER DCN 1810-0012F	6-9-14	JL.
G		ECD1417; PER DCN 1810-0012G	5-8-15	EAS

ERP REAR PANEL I/O TERMINATIONS

ISOLATED INPUTS			
INPUT	DRY	+5VDC	
INP #1 FORCE UPSCALE	J6-(2&3)	(1&2)	
INP #2 FORCE ZERO	J6-(5&6)	(4&5)	
INP #3	J5-(2&3)	(1&2)	
INP #4 DUMP DUST COMP	J5-(5&6)	(4&5)	
INP #5 FORCE CAL CYCLE	J8-(2&3)	(1&2)	
INP #6		NOT USED	
INP #7 TEST ZERO SCALE	J7-(2&3)	(1&2)	
INP #8 TEST FULL SCALE	J7-(5&6)	(4&5)	

ANLG OUTPUTS			
#1	J4 1(+)	2(-)	3(SH)
#2	J4 4(+)	5(-)	6(SH)
#3	J3 1(+)	2(-)	3(SH)
#4	J3 4(+)	5(-)	6(SH)



- 11 BLOWER SELECTION GUIDE: 42 CFM RECOMMENDED FOR POSITIVE PRESSURE STACKS UP TO +10' OF WATER. 56 CFM RECOMMENDED FOR STACKS ABOVE +10' WATER.
- 10 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.
- 9 POWER REQUIREMENT IS 85-245VAC, 50/60Hz, 1Ø (35VA).
- 8 MAINTENANCE PROCEDURES REQUIRING THE REMOVAL OF THE COVER ARE INTENDED TO BE PERFORMED BY TRAINED PERSONNEL ONLY. CONSULT MANUAL.
- 7 IF OPTIONAL DUAL ANALOG INPUT MODULE IS PURCHASED, TERMINATE WIRES AS SHOWN, CONNECT WIRES FROM ERP TO D.A.I. MODULE AND FROM D.A.I. MODULE TO THE OPTICAL HEAD, CONNECT BLACK AND WHITE WIRES TO TERMINALS AS SHOWN.
- 6 IF FIBRELINK III OPTION IS PROVIDED, CONNECT STACK/CONTROL RM. UNITS AND DATA CABLES PER TML SUPPLEMENTAL WIRING DIAGRAM 1810-0016.
- 5 RECOMMENDED STACK NETWORK CABLE IS '16 GA. SHIELDED'. SHIELD MUST BE TERMINATED WITH 0650-0400-01 NETWORK AS SHOWN AT THE OPTICAL HEAD. IN NO INSTALLATION SHALL DATA CABLE BE RUN IN TRAYS OR CONDUIT WITH OTHER CABLES EXCEEDING 230 VAC. IF NOT ALREADY INSTALLED, AN 1860-0006-01 ESD PROTECTOR MAY BE ADDED FOR ADDITIONAL ESD PROTECTION. AS SHOWN ON SPARE NETWORK TERMINALS.
- 4 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 EACH DEVICE BEING SUPPLIED.
- 3 TERMINATE WIRES TO REAR PANEL USING CAGE CLAMP STYLE CONNECTORS FROM KIT PROVIDED.
- 2 ALL CUSTOMER CONNECTIONS TO ANALOG OUTPUTS MUST BE THRU TWISTED PAIR SHIELDED CABLES. ALL SUCH SHIELDS SHALL TERMINATE AT P4-3; P4-6; P3-3; P3-6 FOR OUTPUTS 1 THRU 4 RESPECTIVELY.

NOTES: 1 TERMINATED AT SITE DURING FINAL INSTALLATION.

DIMENSIONAL TOLERANCES UNLESS OTHERWISE SPECIFIED		USED ON	
FRACTIONS	DECIMALS	DASH NO	NEXT ASSEMBLY
0 TO 4 1/32	.001		TOP
4 TO 8 1/16	.002		
8 AND UP 1/8	.005		

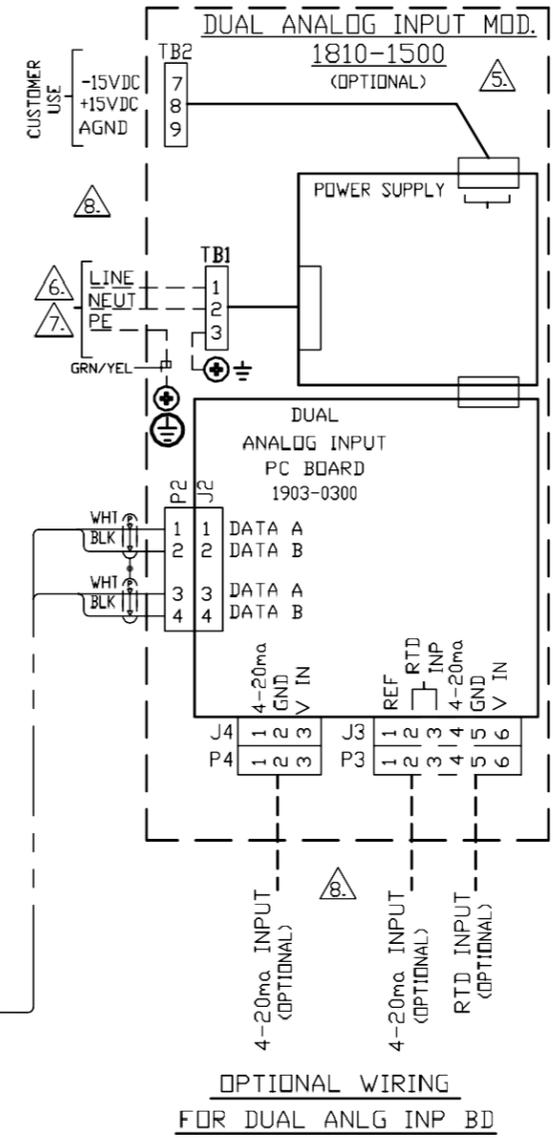
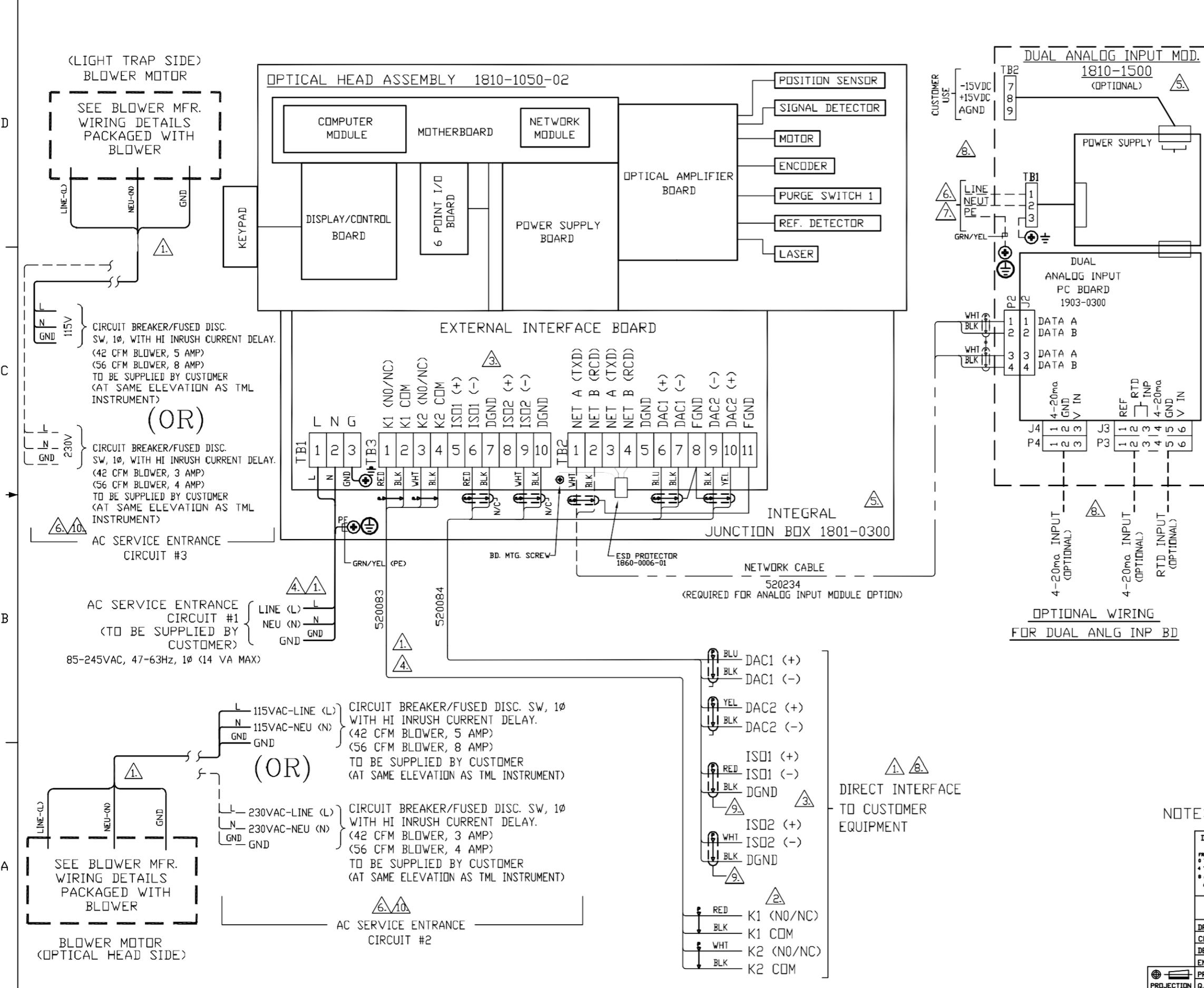
ALL DIMENSIONS ARE IN INCHES UNLESS OTHERWISE SPECIFIED. DO NOT SCALE THIS DRAWING.

AUTHORIZATION		TELEDYNE MONITOR LABS	
BY	DATE	Everywhere you look	
DCH	6-24-11	THIS DOCUMENT CONTAINS INFORMATION PROPRIETARY AND CONFIDENTIAL TO TELEDYNE MONITOR LABS AND IS FURNISHED UNDER THE EXPRESS CONDITION THAT THE INFORMATION CONTAINED HEREIN WILL NOT BE REPRODUCED, COPIED, DISCLOSED OR TRANSMITTED TO OTHERS OR USED FOR ANY PURPOSE OTHER THAN THAT AUTHORIZED BY THE EVALUATION THEREOF WITHOUT THE WRITTEN CONSENT OF TELEDYNE MONITOR LABS.	
EAS	7-22-11	TITLE	
DCH	6-24-11	LASERHAWK MODEL 360360ES	
EAS	6-24-11	WITH LIGHT TRAP/DISPLAY PNL	
BH	7-22-11	SYSTEM WIRING DIAGRAM	
AS	7-22-11		

DRAWN	DCH	6-24-11	MAT'L.	FINISH
CHECKED	EAS	7-22-11		
DESIGNED	DCH	6-24-11	JIG NO.	
ENGINEERED	EAS	6-24-11		
PRODUCTION	BH	7-22-11	SCALE	SHEET
Q.A.	AS	7-22-11	NTS	4 OF 5

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

REVISIONS				
ZONE	SYM.	DESCRIPTION	DATE	APPD.
	D	ADDED THIS SHEET	6-24-11	EAS
	E	NO CHANGE THIS SHEET	8-9-11	FWD
	F	ECD 1371; PER DCN1810-0012F	6-9-14	J.L.
	G	ECD 1417; PER DCN1810-0012G	5-8-15	EAS



- 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 CUSTOMER TO PROVIDE CIRCUIT BREAKER OR FUSED DISC SWITCH OF APPROPRIATE RATING AT SAME ELEVATION AS TML EQUIPMENT BEING SUPPLIED. LABEL DISC. DEVICE WITH NAME/TAG NO. OF EACH DEVICE BEING SUPPLIED.
- 5 MAINTENANCE PROCEDURES REQUIRING THE REMOVAL OF THE COVER ARE INTENDED TO BE PERFORMED BY TRAINED PERSONNEL ONLY. CONSULT MANUAL.
- 4 CABLES SIZED AND CHOSEN TO FIT IN 1/2" CONDUIT TOGETHER WITH 40% MAXIMUM FILL. USING OTHER CABLES MAY REQUIRE LARGER CONDUITS/FITTINGS. ALL FIELD WIRING TERMINATING ON OPTICAL HEAD MUST BE RATED MINIMUM 70 DEGREES C.
- 3 ISO1 AND ISO2 SHOWN IN DRY CONTACT CONFIGURATION. THEY ARE JUMPER SELECTABLE ON 6 PT. I/O PC BOARD. TERMINAL WIRING CONNECTIONS MAY BE AFFECTED. SEE USER'S MANUAL.

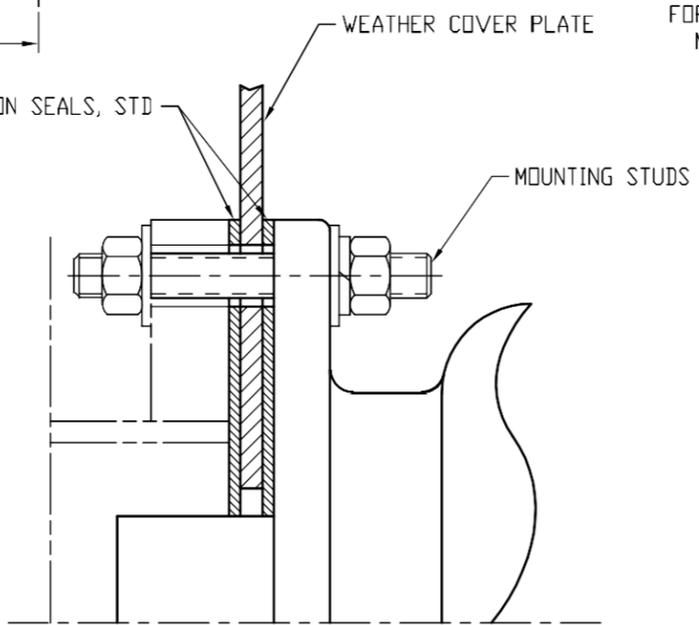
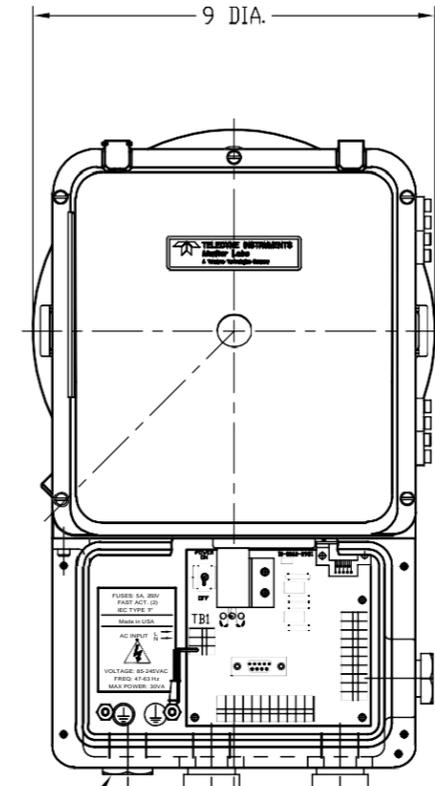
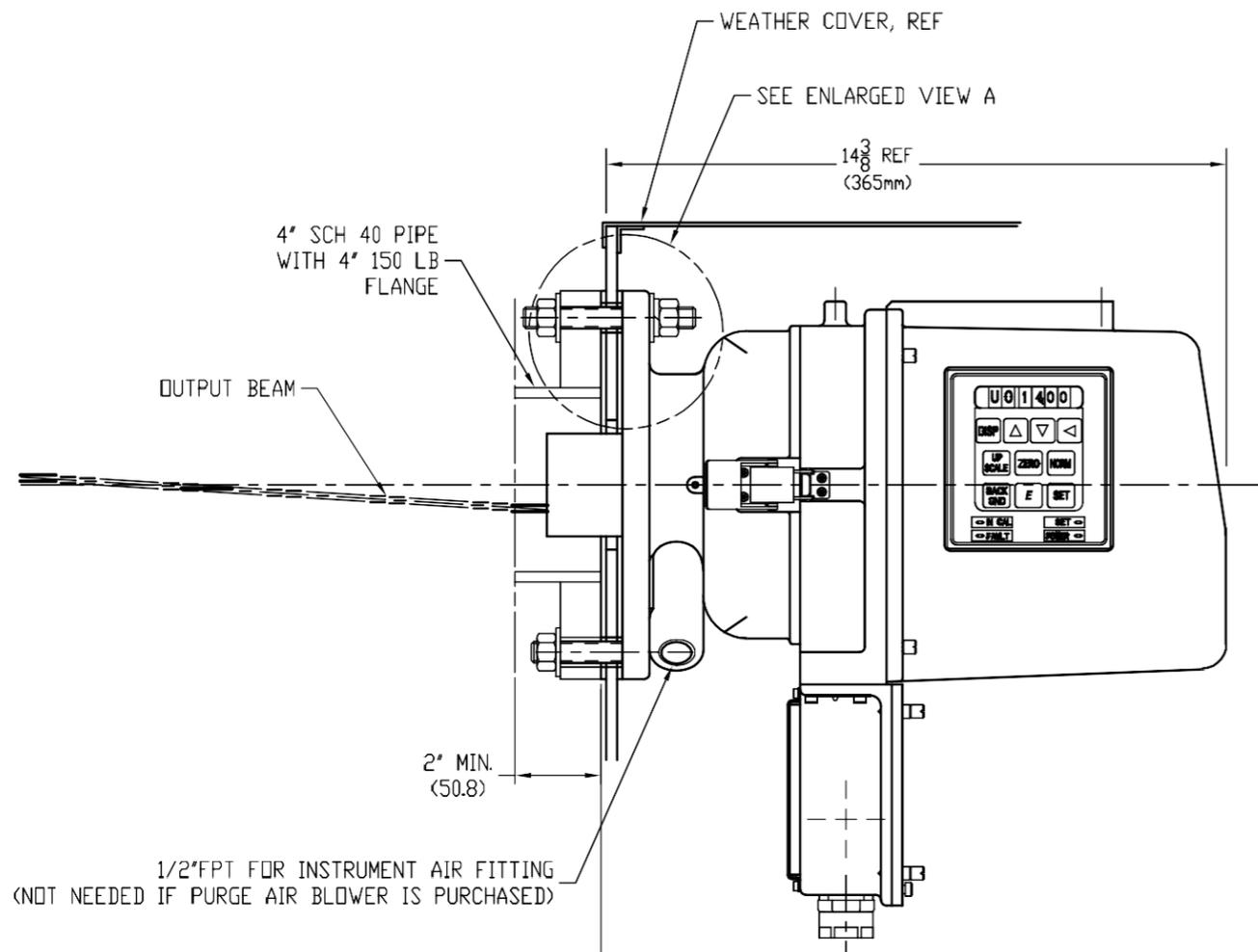
DRY		+5V	
TB3-6 [ISO1 (-)]	TB3-5 [ISO1 (+)]		
TB3-7 [DGND]	TB3-6 [ISO1 (-)]		
TB3-9 [ISO2 (-)]	TB3-8 [ISO2 (+)]		
TB3-10 [DGND]	TB3-9 [ISO2 (-)]		

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 DECIMALS ANGLES 0 TO 4 1/32 .001 30° 30' 4 TO 8 1/16 .002 30° 30' 8 AND UP 1/8 .005 RNS FINISH		USED ON DASH NO NEXT ASSEMBLY TOP		 Everywhere you look	
ALL DIMENSIONS ARE IN INCHES DO NOT SCALE THIS DRAWING					
AUTHORIZATION DRAWN BY DATE DCH 6-24-11					
CHECKED BY DATE EAS 7-22-11					
DESIGNED BY DATE DCH 6-24-11					
ENGINEERED BY DATE EAS 6-24-11					
PRODUCTION BY DATE BH 7-22-11					
Q.A. BY DATE AS 7-22-11					
TITLE LASERHAWK 360DI (DIRECT INTERFACE) W/LIGHT TRAP SYSTEM WIRING DIAGRAM		MAT'L. FINISH		JIG NO.	
SCALE NTS		SHEET 5 OF 5		DRAWING NO. 1810-0012	
LATEST REVISION G					

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	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

USED ON	
DASH NO	NEXT ASSEMBLY
-01	

TELEDYNE MONITOR LABS
Everywhere you look

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TITLE
360 BACKSCATTER OPTICAL HEAD INSTALL

FINISH

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

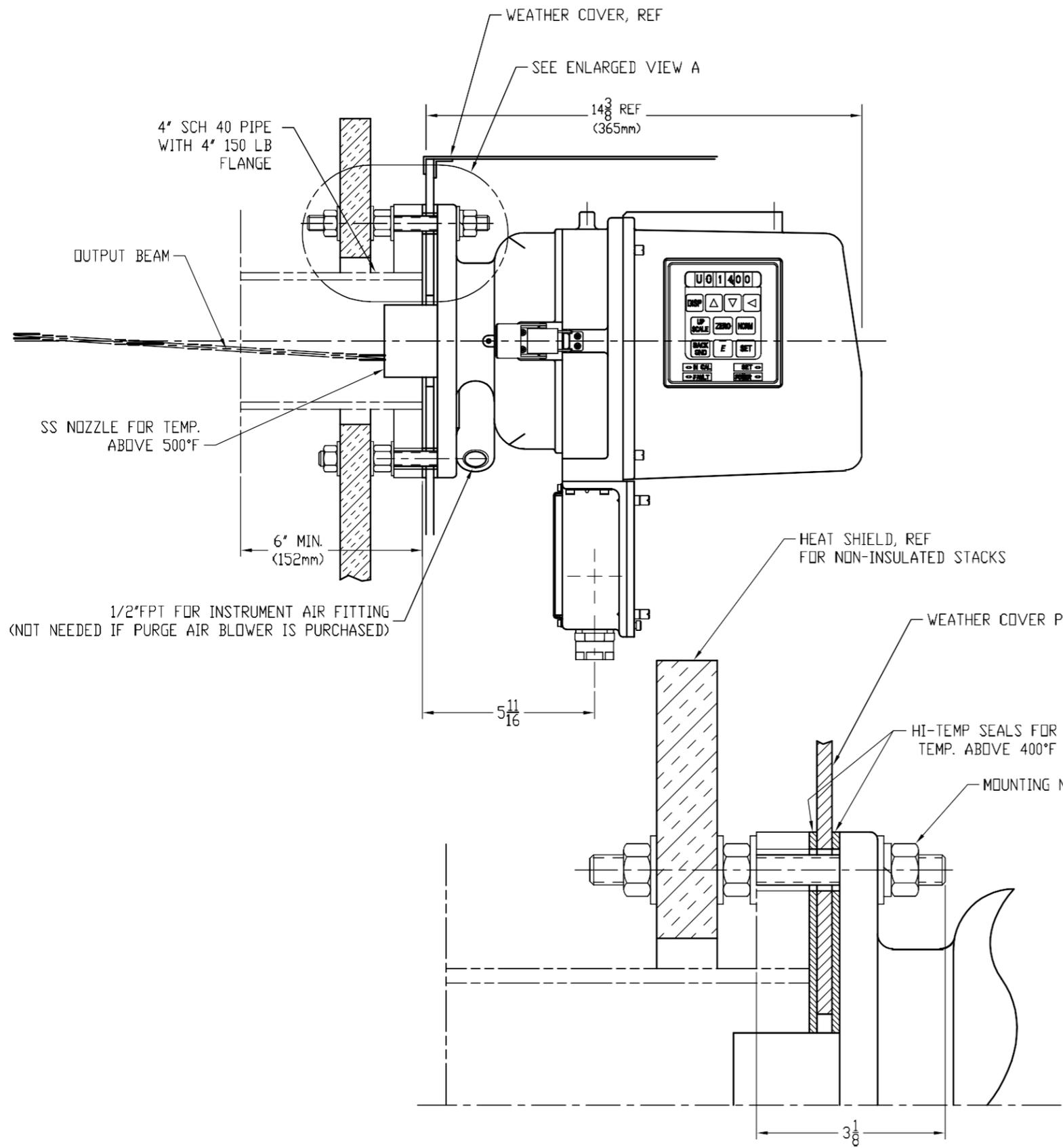
DRAWING NO.	LATEST REVISION
D 1810-0014	B



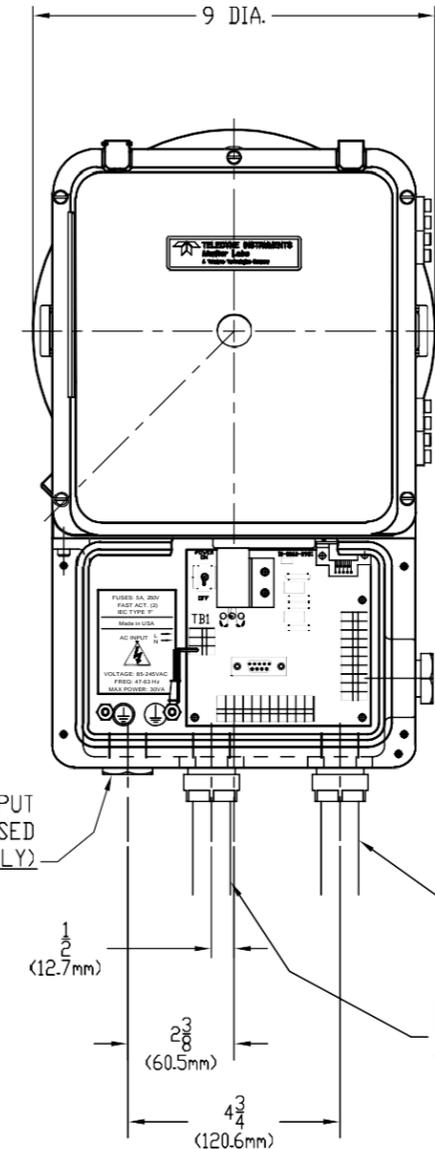
PROJECTION

SCALE	SHEET
1/2	1 OF 3

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



FOR DUAL ANALOG INPUT
MODULE IF PURCHASED
(DI ONLY)

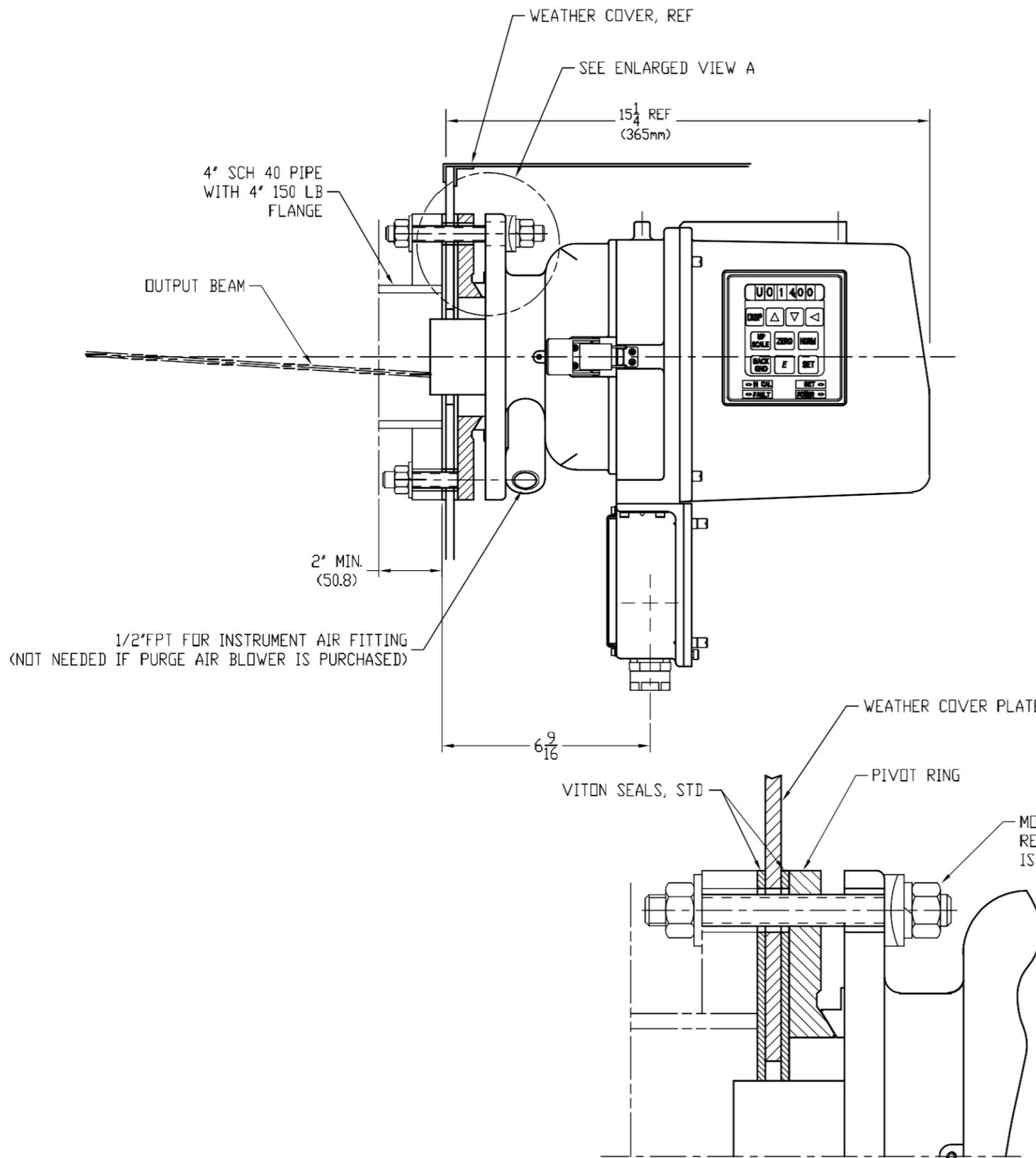
1/2" FLEX CONDUIT WITH DATA CABLE,
TO CONTROL ROOM OR DUAL ANALOG
INPUT MODULE IF PURCHASED.

1/2" FLEX CONDUIT
WITH AC POWER
TO TB1

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		USED ON DASH NO NEXT ASSEMBLY -02	<p>TELEDYNE MONITOR LABS Everywhere you look</p> <p>THIS DOCUMENT CONTAINS INFORMATION PROPRIETARY AND CONFIDENTIAL TO TELEDYNE MONITOR LABS AND IS FURNISHED UNDER THE EXPRESS CONDITION THAT THE INFORMATION CONTAINED HEREIN WILL NOT BE REPRODUCED, DISCLOSED OR TRANSMITTED TO OTHERS OR USED FOR ANY PURPOSE OTHER THAN IN CONNECTION WITH THE EVALUATION THEREOF WITHOUT THE PRIOR WRITTEN CONSENT OF TELEDYNE MONITOR LABS.</p>
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		MAT'L FINISH	
PROJECTION 		SCALE SHEET 1/2 2 OF 3	DRAWING NO. 1810-0014 LATEST REVISION B

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



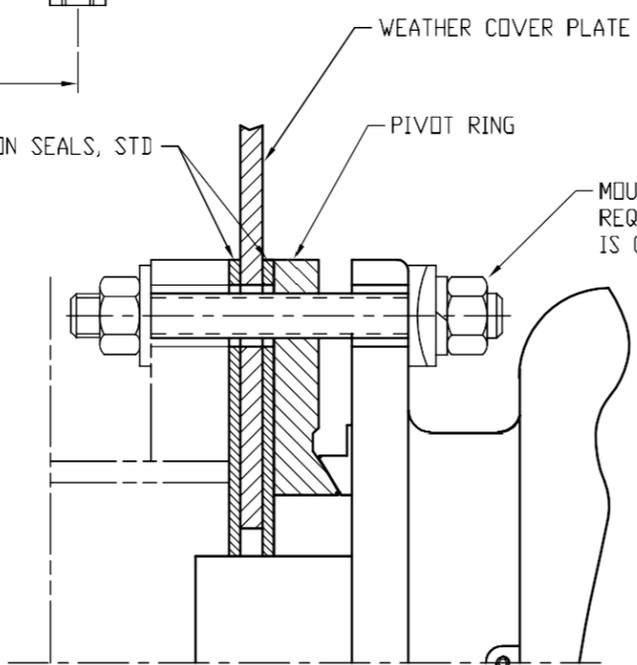
1/2" FPT FOR INSTRUMENT AIR FITTING
(NOT NEEDED IF PURGE AIR BLOWER IS PURCHASED)

FOR DUAL ANALOG INPUT
MODULE IF PURCHASED
(DI ONLY)

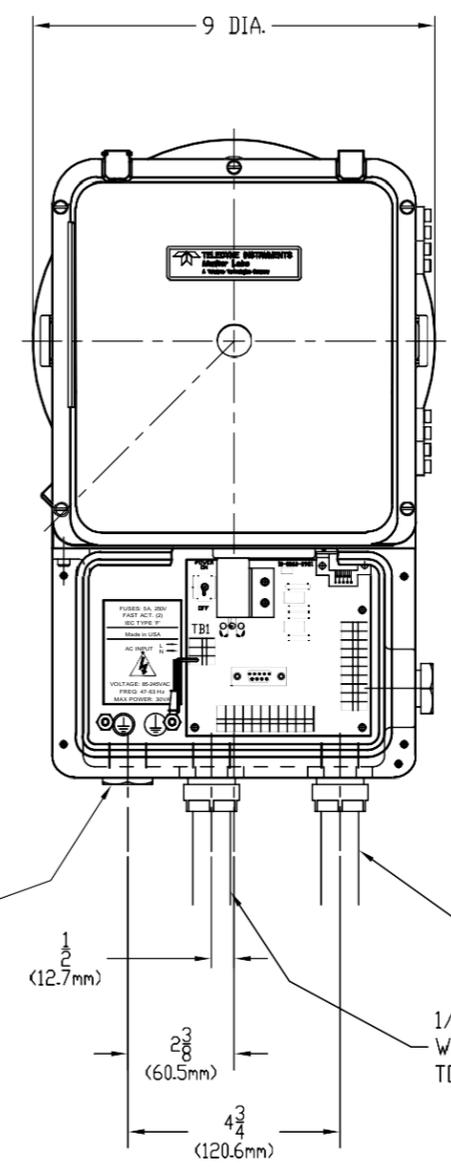
1/2" FLEX CONDUIT WITH DATA CABLE,
TO CONTROL ROOM OR DUAL ANALOG
INPUT MODULE IF PURCHASED.

1/2" FLEX CONDUIT
WITH AC POWER
TO TB1

MOUNTING NUTS, REF ADJUSTMENT
REQUIRED SO THAT LASER BEAM
IS CENTERED ON LIGHT TRAP.

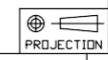


VIEW A
FULL SCALE

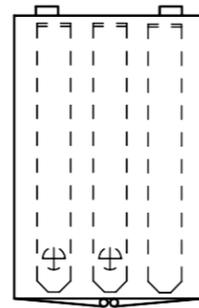


FOR LIGHT TRAP INSTALLATION

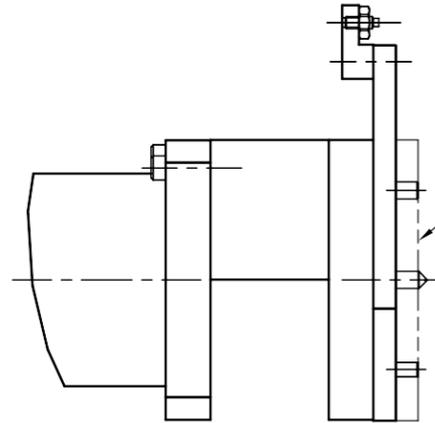
DIMENSIONAL TOLERANCES UNLESS OTHERWISE SPECIFIED FRACTIONS DECIMALS ANGLES 0 TO 4 ±1/32 .XX ±.01 ±0°30' 4 TO 8 ±1/16 .XXX ±.005 RMS FINISH 8 AND UP ±1/8 ✓ ALL DIMENSIONS ARE IN INCHES DO NOT SCALE THIS DRAWING		USED ON DASH NO NEXT ASSEMBLY -03	<p>TELEDYNE MONITOR LABS Everywhere you look</p> <p>THIS DOCUMENT CONTAINS INFORMATION PROPRIETARY AND CONFIDENTIAL TO TELEDYNE MONITOR LABS AND IS FURNISHED WITH THE EXPRESS CONDITION THAT THE INFORMATION CONTAINED HEREIN WILL NOT BE REPRODUCED, DISCLOSED OR TRANSMITTED TO OTHERS OR USED FOR ANY PURPOSE OTHER THAN IN CONNECTION WITH THE EVALUATION THEREOF WITHOUT THE PRIOR WRITTEN CONSENT OF TELEDYNE MONITOR LABS.</p>
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		MAT'L FINISH	
DRAWING NO. 1810-0014		SCALE SHEET 1/2 3 OF 3	LATEST REVISION B



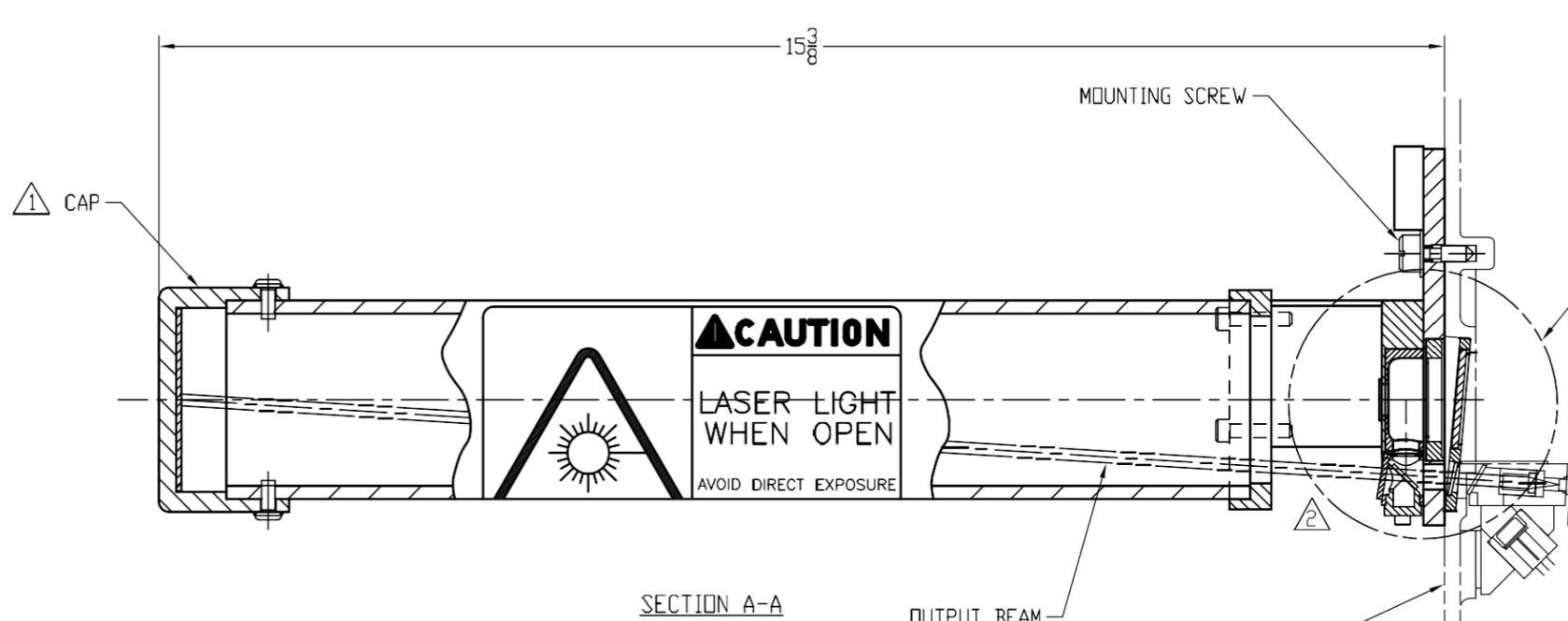
REVISIONS				
ZONE	SYM.	DESCRIPTION	DATE	APPD.
	A	RELEASE FOR PROD.	12-15-05	ELM
	B	PER DCN #1810-0657B	9-8-06	ELM



CALIBRATION PLATES IN STORAGE CASE



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

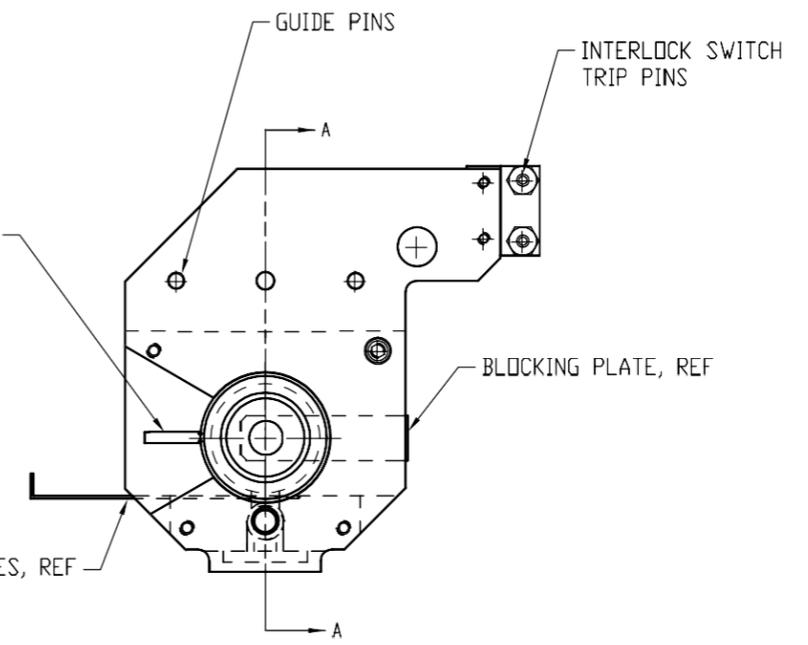


SECTION A-A

OUTPUT BEAM

IRIS ADJUSTMENT, SET AT FACTORY

SEE VIEW B-B



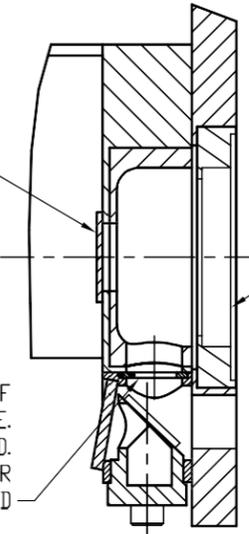
GUIDE PINS

INTERLOCK SWITCH TRIP PINS

BLOCKING PLATE, REF

CALIBRATION PLATES, REF

BLOCKING PLATE, REF REMOVE FOR ALIGNMENT CHECK ONLY. MUST BE INSTALLED WHEN DOING CALIBRATION CHECKS.



IRIS, REF

CALIBRATION PLATES, REF SLIDE IN AND OUT FROM THE SIDE. DIFFERENT SIZES SUPPLIED. ONE FOR 0% & OTHERS FOR HIGHER LEVELS AS REQUIRED

VIEW B-B SCALE 2X

⚠️ BE CERTAIN NOT TO INSERT ANY HIGHLY REFLECTIVE OR MIRROR-LIKE OBJECTS INTO THE SLOT THAT COULD REFLECT LASER ENERGY OUT.

⚠️ NEVER REMOVE CAP UNLESS UNIT IS OFF. CAP SHOULD BE REMOVED BY SKILLED TECHNICIAN ONLY.

NOTES:

DIMENSIONAL TOLERANCES UNLESS OTHERWISE SPECIFIED		
FRACTIONS	DECIMALS	ANGLES
0 TO 4 ±1/32	.XX ±.01	40°-90°
4 TO 8 ±1/16	.XXX ±.005	RMS FINISH
8 AND UP ±1/8		
ALL DIMENSIONS ARE IN INCHES DO NOT SCALE THIS DRAWING		

USED ON	
DASH NO	NEXT ASSEMBLY
-01	

TELEDYNE MONITOR LABS
Everywhere you look

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TITLE
360 BACKSCATTER, CAL KIT OUTLINE

DRAWN	EAS	3-22-05
CHECKED	EAS	Jan-06
DESIGNED	EAS	Mar-05
ENGINEERED	ELM	1-03-06
PRODUCTION	GA	1-4-06
Q.A.	AS	1-4-06

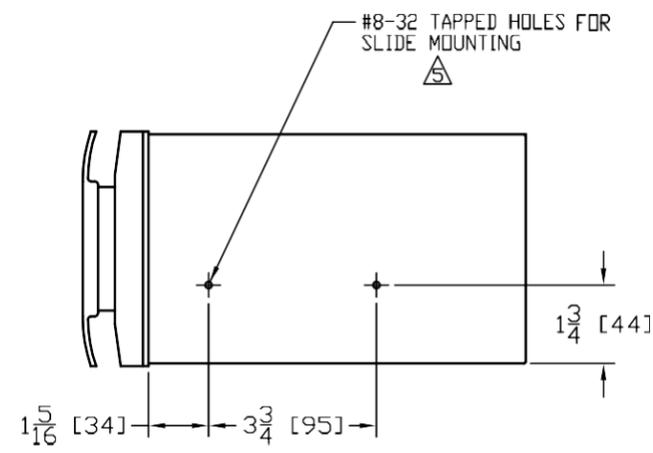
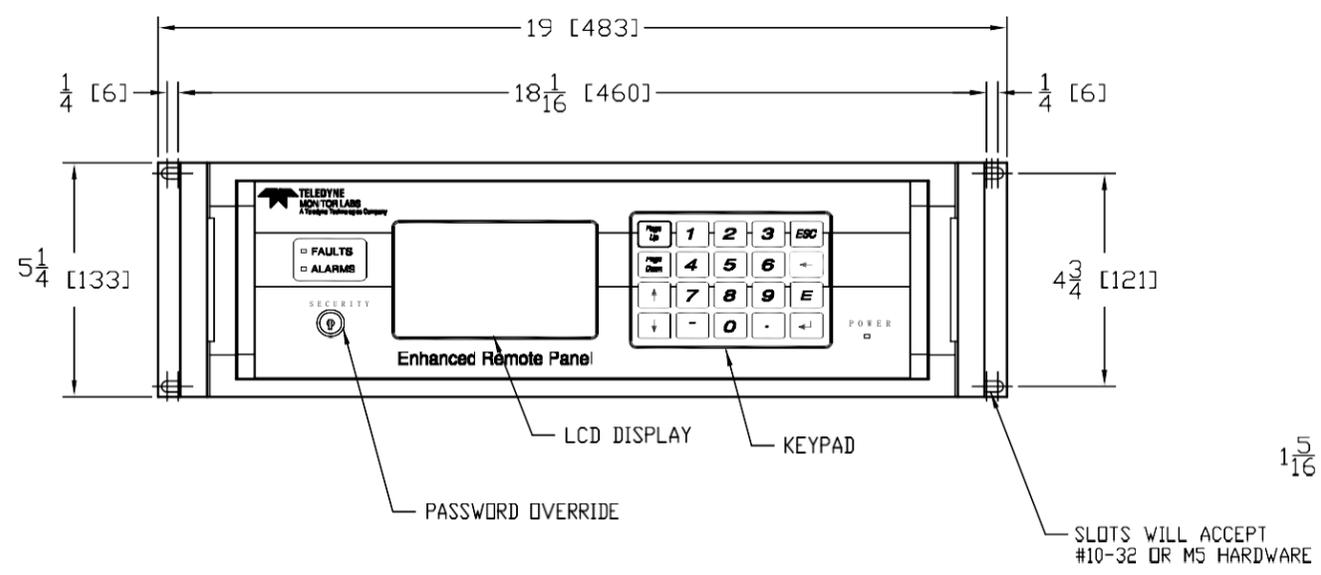
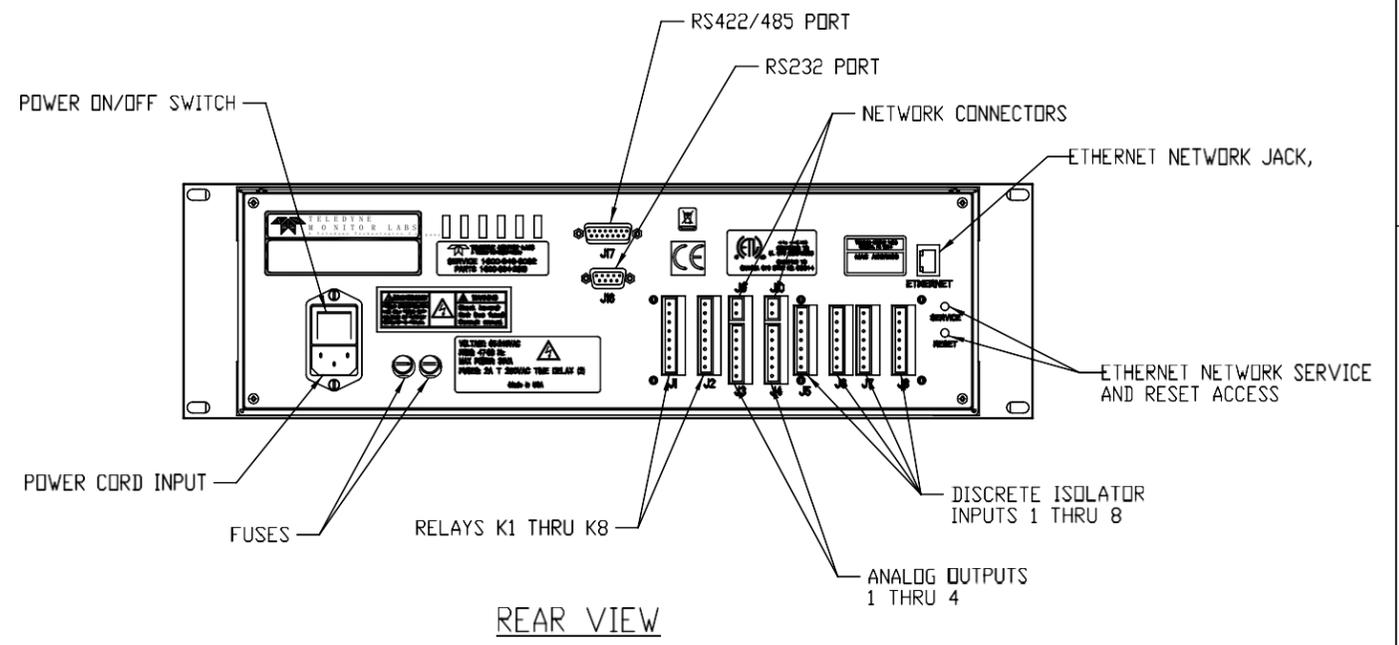
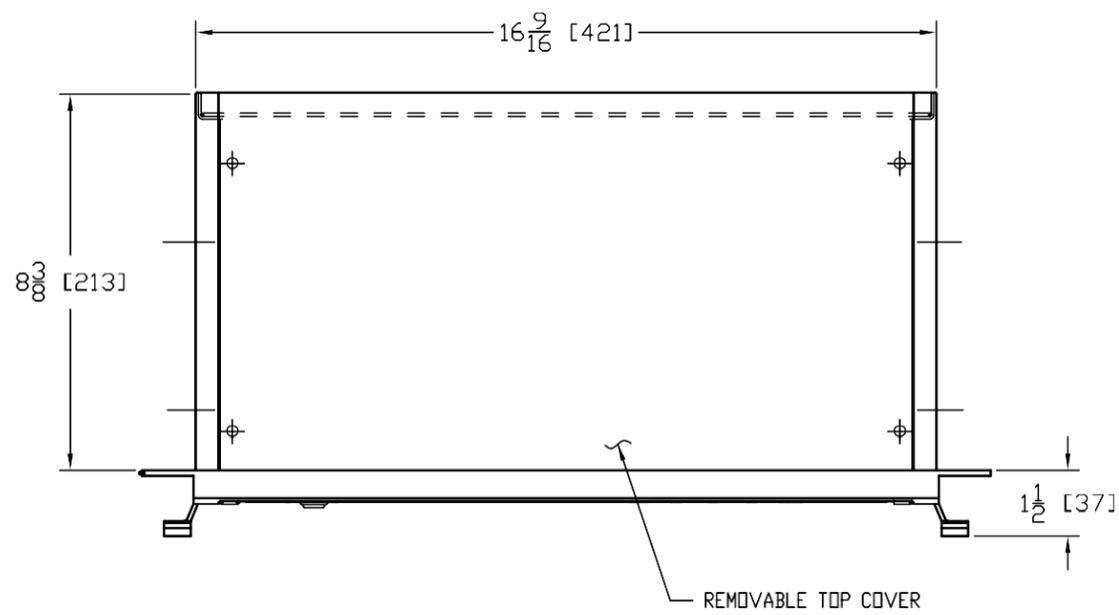
SCALE 1:1 SHEET 1 OF 1

DRAWING NO. 1810-0657 LATEST REVISION B



PROJECTION

REVISIONS			
ZONE SYM.	DESCRIPTION	DATE	APPD.
G	PER DCN 1803-2003G	9-6-11	ELM
H	PER DCN 1803-2003H	4-25-12	FWD



△ SLIDES ARE AVAILABLE AS AN OPTION. CONSULT FACTORY

4

3 MINIMUM REAR CLEARANCE 5"(127mm)

2 DIMENSIONS IN () ARE METRIC

1 DISPLAY FITS IN STANDARD 19"(482.6mm) RACK MOUNT, 5-1/4" (3U) HIGH CHASSIS

NOTE:

CUSTOMER OUTLINE DRAWING

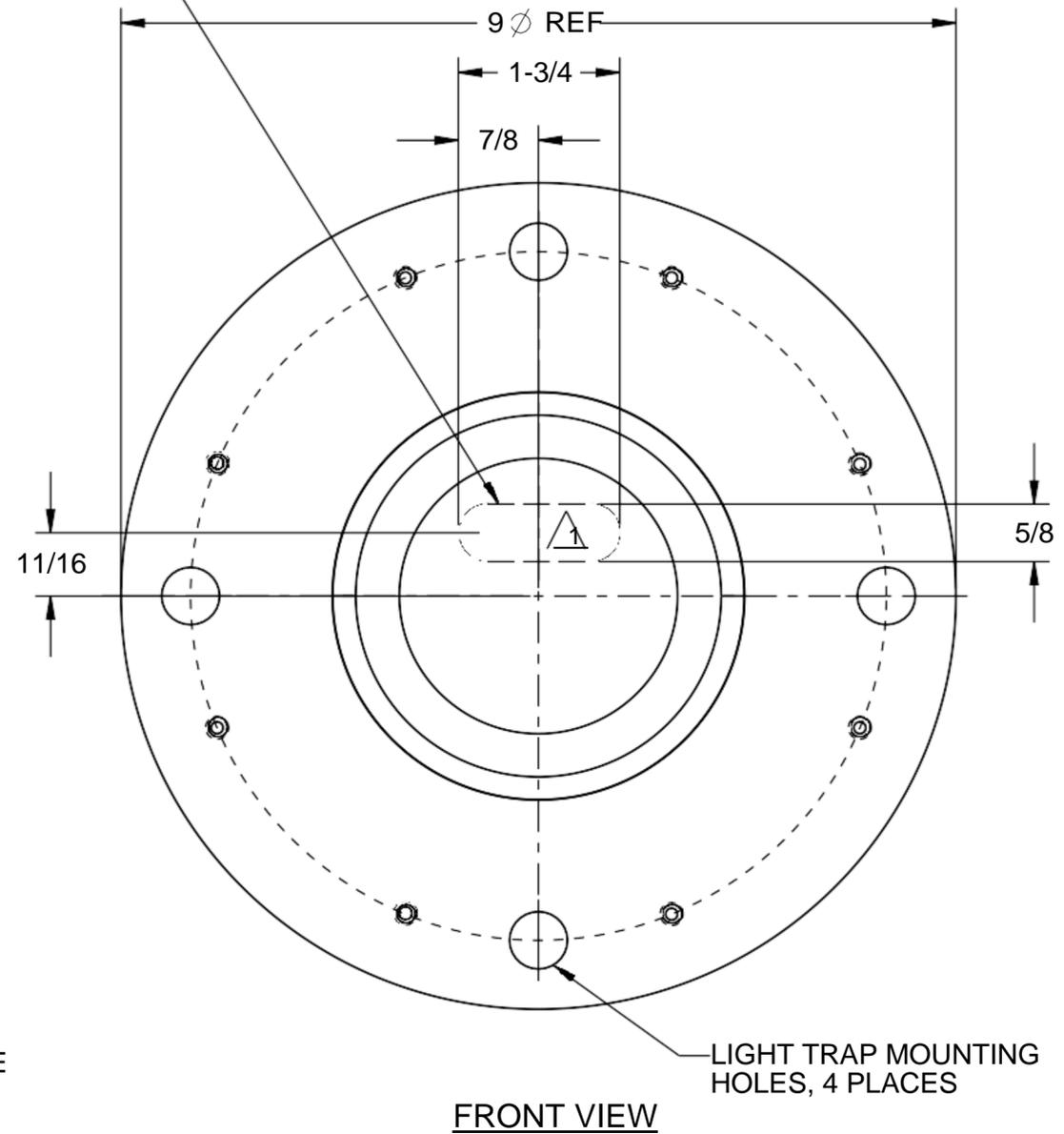
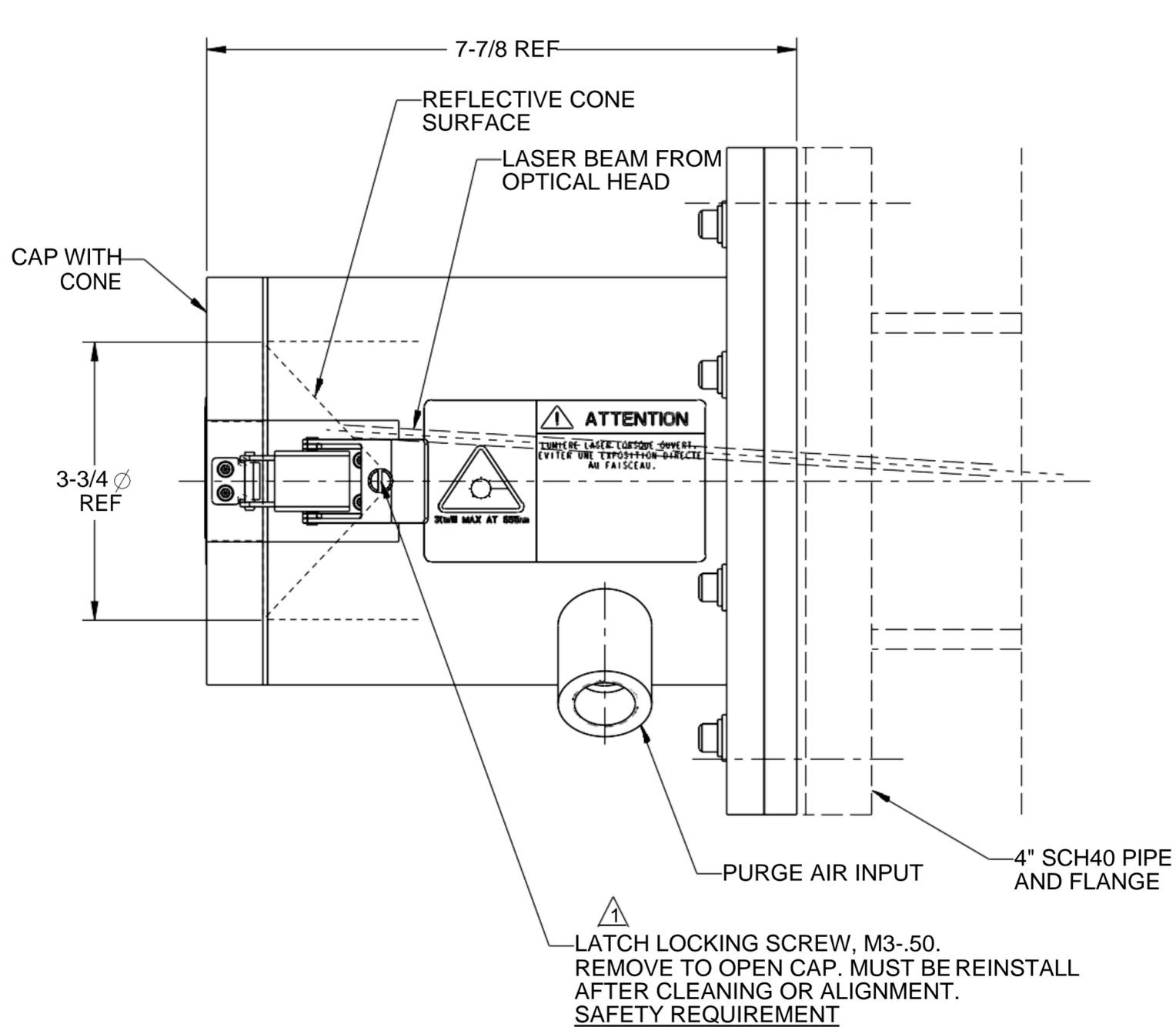
DIMENSIONAL TOLERANCES UNLESS OTHERWISE SPECIFIED		USED ON		<p>TELEDYNE MONITOR LABS Everywhere you look</p>
FRACTIONS	DECIMALS	DASH NO	NEXT ASSEMBLY	
0 TO 4 #1/32	.0015	-02		<small>THIS DOCUMENT CONTAINS INFORMATION PROPRIETARY AND CONFIDENTIAL TO TELEDYNE MONITOR LABS AND IS FURNISHED UNDER THE EXPRESS CONDITION THAT THE INFORMATION CONTAINED HEREIN WILL NOT BE REPRODUCED, REPRINTERED, DISCLOSED OR DISSEMINATED TO OTHERS OR USED FOR ANY PURPOSE OTHER THAN BY COLLECTOR WITH THE EVALUATION HEREOF WITHOUT THE PRIOR WRITTEN CONSENT OF TELEDYNE MONITOR LABS.</small>
4 TO 8 #1/16	.0025			
8 AND UP #1/8	.005			TITLE
ALL DIMENSIONS ARE IN INCHES DO NOT SCALE THIS DRAWING				TML ENHANCED REMOTE PANEL ASSEMBLY, W/NEW CASE
AUTHORIZATION				FINISH
BY	DATE			
DRAWN	EAS 16-Jul-02	MAT'L		
CHECKED	EAS 7-18-02			
DESIGNED	EAS Jul-02	JIG NO.		
ENGINEERED	ELM 7-24-02			
PRODUCTION	PD 7-24-02	SCALE	SHEET	
Q.A.	AS 7-24-02	1/2	2 of 2	

DRAWING NO. 1803-2003 H LATEST REVISION



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



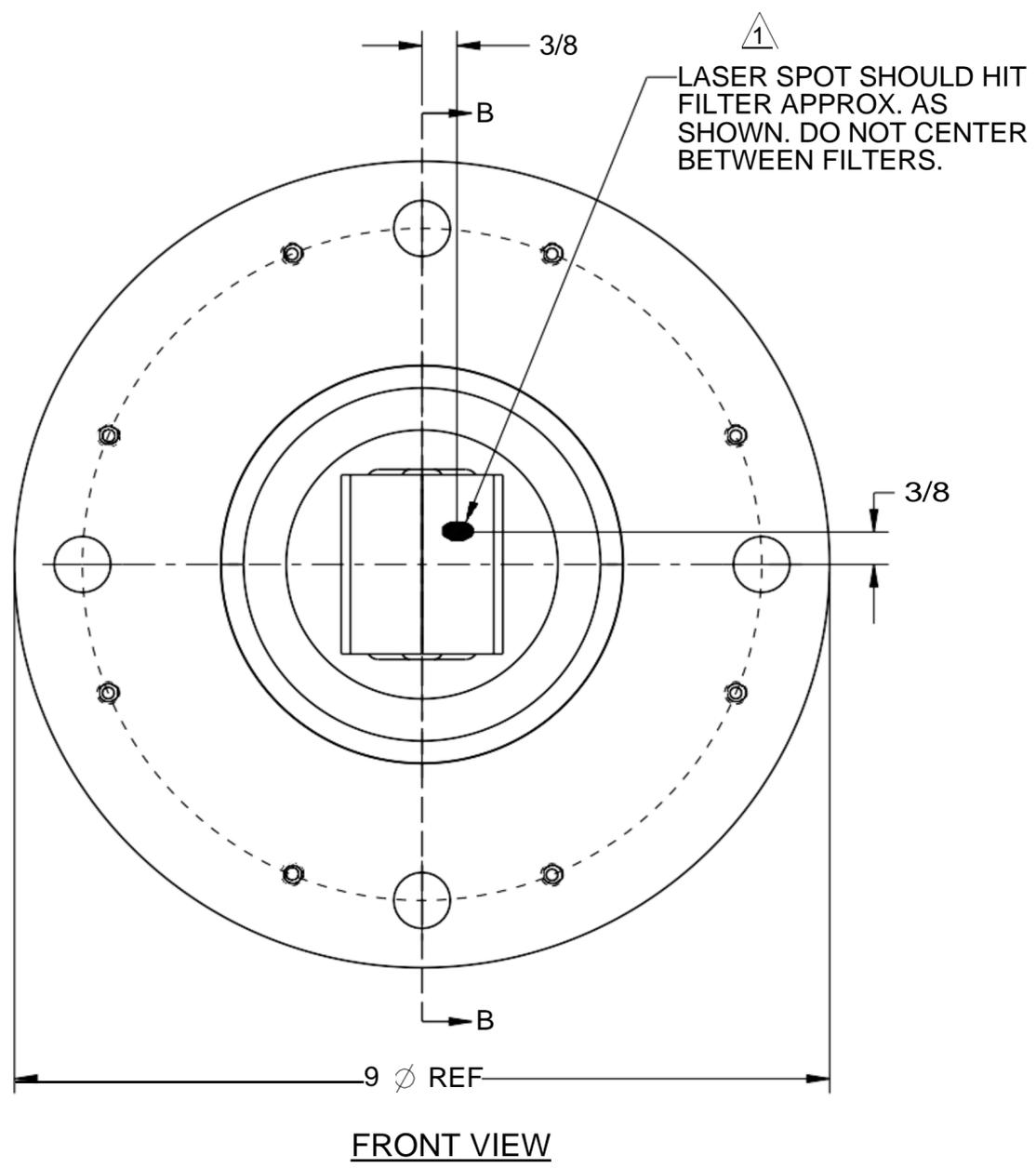
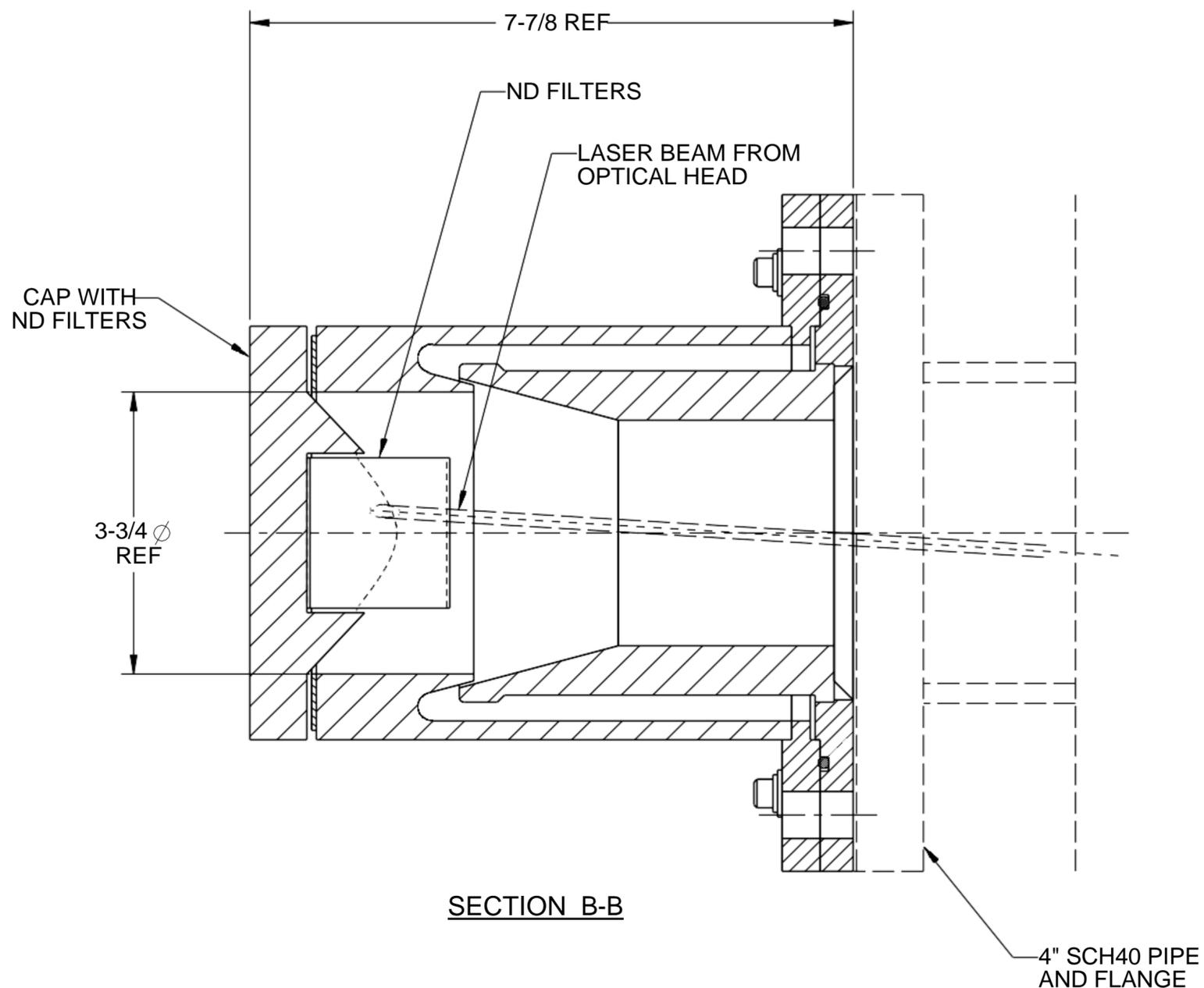
SEE SHEET 2 FOR LIGHT TRAP WITH ND FILTERS

⚠ 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 <small>UNLESS OTHERWISE SPECIFIED</small> FRACTIONS DECIMALS ANGLES 0 TO 4 \pm 1/32 .XX \pm .01 \pm 0°30' 4 TO 8 \pm 1/16 .XXX .00 \pm RMS FINISH 8 AND UP \pm 1/8 ALL DIMENSIONS ARE IN INCHES DO NOT SCALE THIS DRAWING		USED ON DASH NO NEXT ASSEMBLY -01 PM360	TELEDYNE MONITOR LABS Everywhere you look <small>THIS DOCUMENT CONTAINS INFORMATION PROPRIETARY AND CONFIDENTIAL TO TELEDYNE MONITOR LABS AND IS FURNISHED UPON THE EXPRESS CONDITION THAT THE INFORMATION CONTAINED HEREIN WILL NOT BE DUPLICATED, REPRODUCED, DISCLOSED OR DISSEMINATED TO OTHERS OR USED FOR ANY PURPOSE OTHER THAN IN CONNECTION WITH THE EVALUATION THEREOF WITHOUT THE PRIOR WRITTEN CONSENT OF TELEDYNE MONITOR LABS</small>																											
AUTHORIZATION <table border="1"> <thead> <tr> <th></th> <th>BY</th> <th>DATE</th> </tr> </thead> <tbody> <tr> <td>DRAWN</td> <td>EAS</td> <td>13-Mar-09</td> </tr> <tr> <td>CHECKED</td> <td>EAS</td> <td>3-24-09</td> </tr> <tr> <td>DESIGNED</td> <td>EAS</td> <td>Mar-09</td> </tr> <tr> <td>ENGINEERED</td> <td>ELM</td> <td>3-24-09</td> </tr> <tr> <td>PRODUCTION</td> <td>GA</td> <td>3-25-09</td> </tr> <tr> <td>Q.A.</td> <td>AS</td> <td>3-24-09</td> </tr> </tbody> </table>			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	TITLE 360 LIGHT TRAP ASSY, W/CONE INSTALLATION DRAWING	<table border="1"> <thead> <tr> <th colspan="2">FINISH</th> </tr> <tr> <th>DRAWING NO.</th> <th>REVISION</th> </tr> </thead> <tbody> <tr> <td>1810-1401</td> <td>B</td> </tr> </tbody> </table>	FINISH		DRAWING NO.	REVISION	1810-1401	B
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PROJECTION 		MAT'L JIG NO. SCALE SHEET 0.750 1 OF 2	<table border="1"> <tr> <td rowspan="2" style="font-size: 2em; font-weight: bold;">C</td> <td>1810-1401</td> <td>B</td> </tr> <tr> <td>7-31-12</td> <td></td> </tr> </table>	C	1810-1401	B	7-31-12																							
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	7-31-12																													

DWG. No. 1810-1401 SH 1
 PROE FILE 1810-1401.dwg

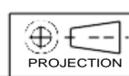
REVISIONS			
SYM.	DESCRIPTION	DATE	APPD.
B	ADDED THIS SHEET PER DCN 1810-1401B	7-31-12	ELM



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.

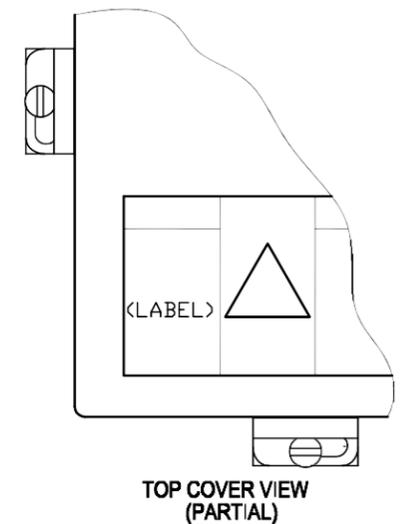
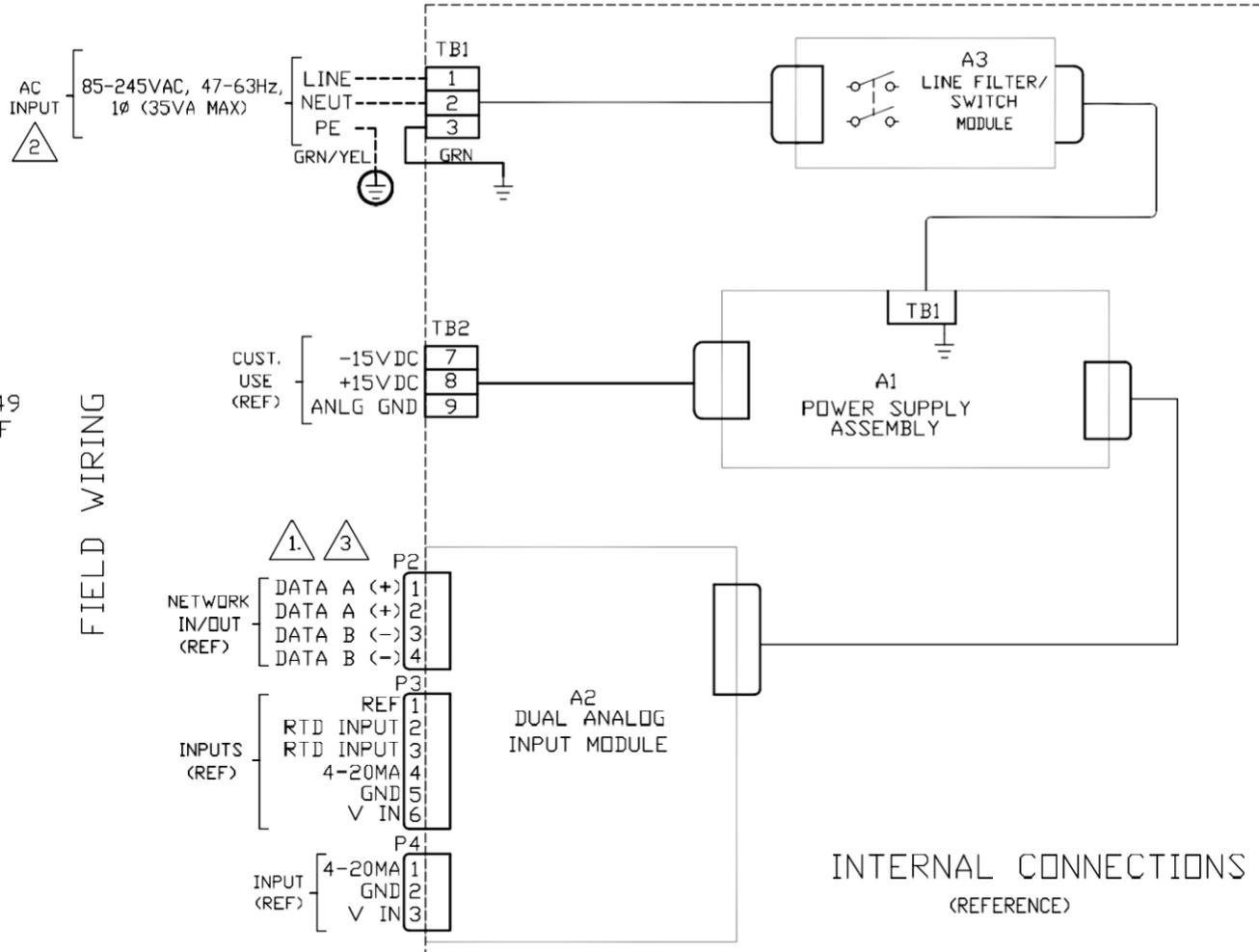
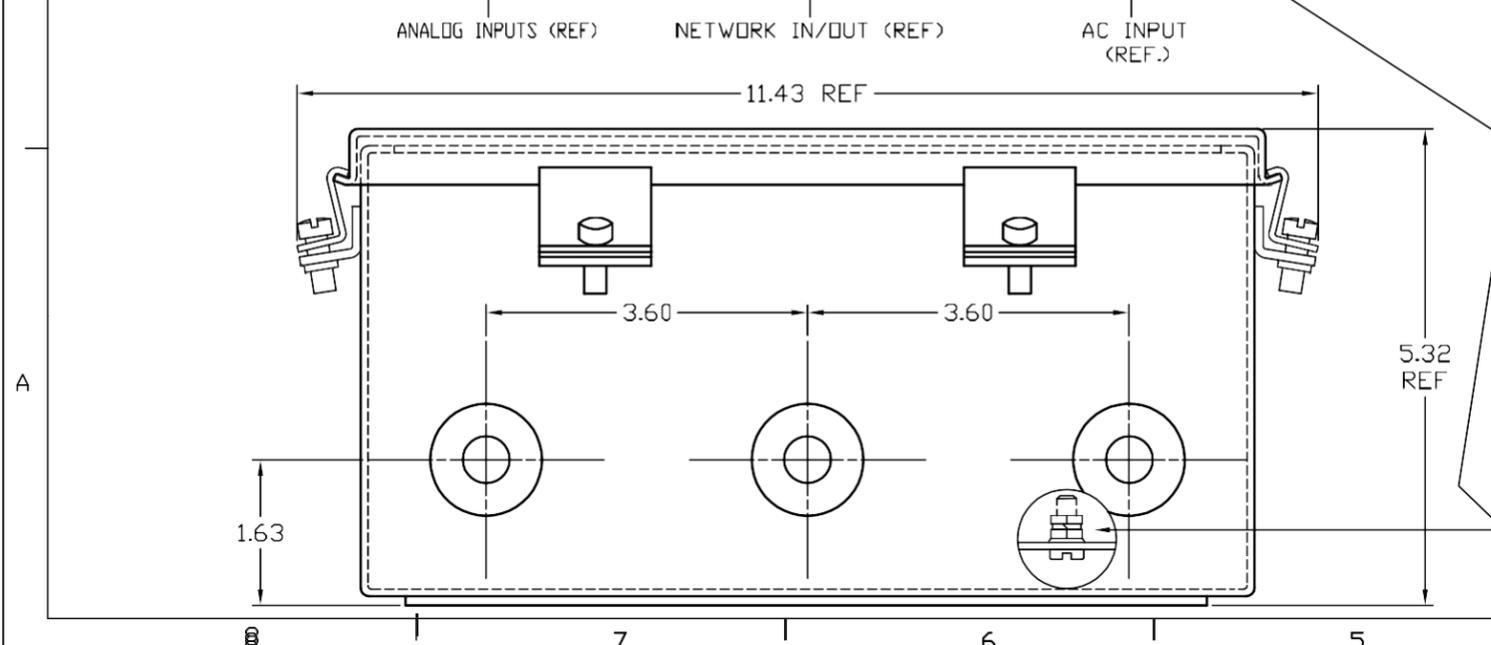
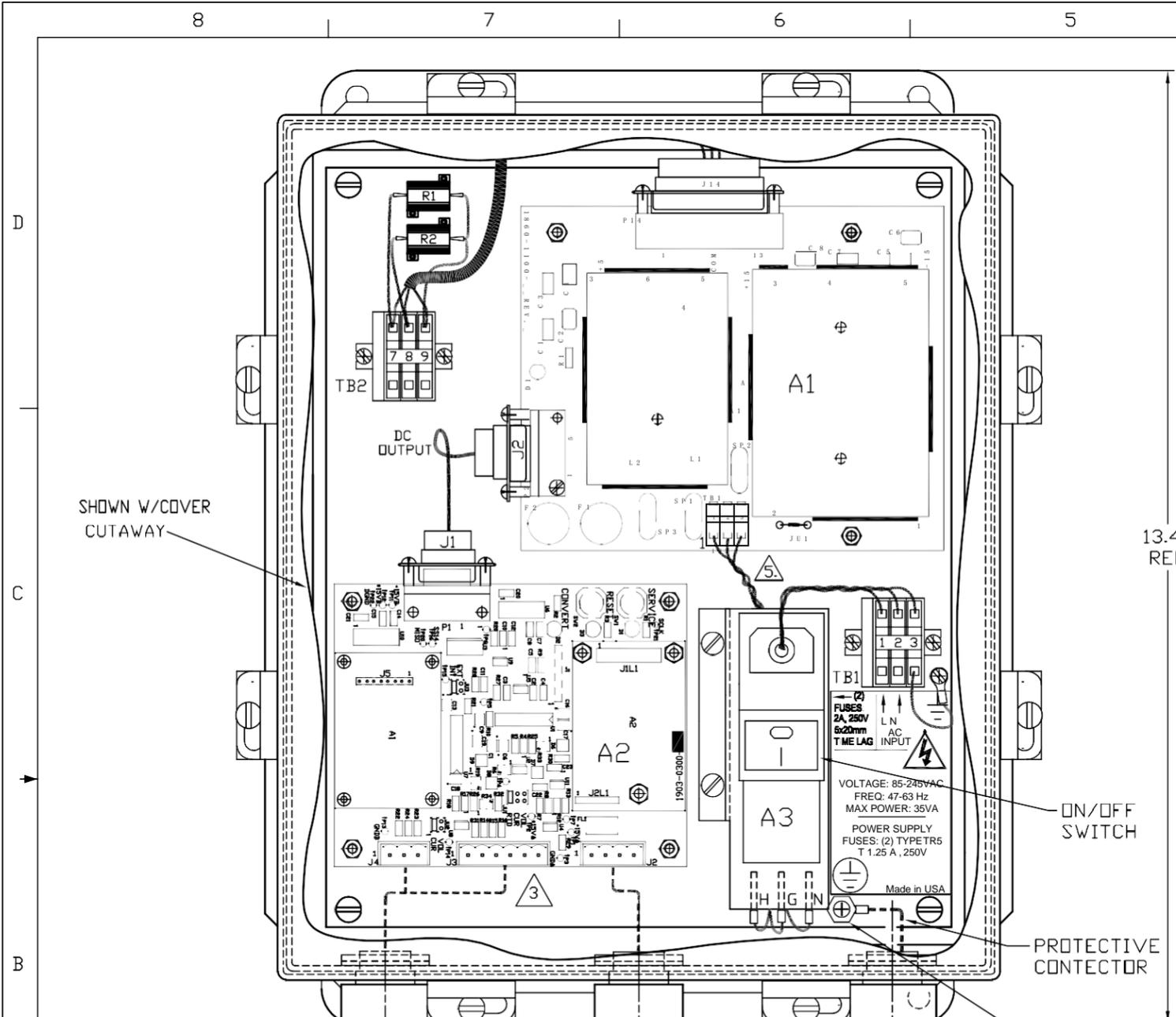
LIGHT TRAP WITH ND FILTERS

DIMENSIONAL TOLERANCES <small>UNLESS OTHERWISE SPECIFIED</small> FRACTIONS DECIMALS ANGLES 0 TO 4 ± 1/32 .XX ± 0.1 ± 0°30' 4 TO 8 ± 1/16 .XXX .00± RMS FINISH 8 AND UP ± 1/8 ALL DIMENSIONS ARE IN INCHES DO NOT SCALE THIS DRAWING		USED ON DASH NO NEXT ASSEMBLY -02 PM360	TELEDYNE MONITOR LABS Everywhere you look <small>THIS DOCUMENT CONTAINS INFORMATION PROPRIETARY AND CONFIDENTIAL TO TELEDYNE MONITOR LABS AND IS FURNISHED UPON THE EXPRESS CONDITION THAT THE INFORMATION CONTAINED HEREIN WILL NOT BE DUPLICATED, REPRODUCED, DISCLOSED OR DISSEMINATED TO OTHERS OR USED FOR ANY PURPOSE OTHER THAN IN CONJUNCTION WITH THE EVALUATION THEREOF WITHOUT THE PRIOR WRITTEN CONSENT OF TELEDYNE MONITOR LABS.</small>
AUTHORIZATION DRAWN BY EAS DATE 31-JUL-12 CHECKED EAS DATE 8-1-12 DESIGNED EAS DATE July-12 ENGINEERED ELM DATE 8-1-12 PRODUCTION GA DATE 8-1-12 Q.A. AS DATE 8-1-12		MAT'L SEE BOM JIG NO. SCALE 0.750 SHEET 2 OF 2	TITLE LIGHT TRAP ASSY. W/CONE & 4.0 ND 360 BACKSCATTER DRAWING NO. 1810-1401 REVISION B



DWG. No. 1810-1401 SH 2
 PROJ FILE 1810-1401.dwg
 7-31-12

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



SAFETY EARTH GROUND FOR PROTECTIVE CONDUCTOR (PE). (USE RING TERMINAL).

- NOTES:
- ALL WIRING FOR FIELD CONNECTIONS TO BE TEMPERATURE RATED MINIMUM 70 DEGREES CENTIGRADE.
 - 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.
 - FIELD CONNECTORS PROVIDED WITH PC BOARD.
 - MAINTENANCE PROCEDURES REQUIRING THE REMOVAL OF THE COVER ARE INTENDED TO BE PERFORMED BY TRAINED PERSONNEL ONLY.

DIMENSIONAL TOLERANCES UNLESS OTHERWISE SPECIFIED		USED ON		TELEDYNE MONITOR LABS Everywhere you look
FRACTIONS	DECIMALS	DASH NO	NEXT ASSEMBLY	
0 TO 4 11/32	.001	-01		THIS DOCUMENT CONTAINS INFORMATION PROPRIETARY AND CONFIDENTIAL TO TELEDYNE MONITOR LABS AND IS FURNISHED UNDER THE EXPRESS CONDITION THAT THE INFORMATION CONTAINED HEREIN WILL NOT BE DUPLICATED, REPRODUCED, DISCLOSED OR DISSEMINATED TO OTHERS OR USED FOR ANY PURPOSE OTHER THAN IN CONNECTION WITH THE EVALUATION HEREOF WITHOUT THE PRIOR WRITTEN CONSENT OF TELEDYNE MONITOR LABS.
4 TO 8 11/32	.002			
8 AND UP 11/8	.005			TITLE LONWORKS NETWORKED DUAL ANALOG INPUT ASSY INSTALLATION DRAWING
AUTHORIZATION				
DRAWN		BY	DATE	MATERIAL FINISH
CHECKED		EAS	12-15-05	
DESIGNED		ELM	1-03-06	
ENGINEERED		EAS	Dec-05	
PRODUCTION		GA	1-4-06	
Q.A.		AS	1-4-06	JIG NO.
PROJECTION		SCALE	SHEET	DRAWING NO.
		1:1	1 OF 1	1810-1505
				LATEST REVISION
				B

APPENDIX E

ENHANCED SERIAL PORT COMMUNICATION PROTOCOL

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ENHANCED SERIAL PORT COMMUNICATION PROTOCOL

A short description of the original communication is described in the Enhanced Remote Display section of the manual. It explains how to use the simple commands that utilize the question mark symbol (?) to request information from the RS232 or RS422/485 ports of the Enhanced Remote Panel. This is still a valid form of communication with either of these ports.

The configuration of the serial ports are still fixed at:

9600, 8 data bits, no parity, one stop bit*.

NOTE: *The RS232 will also work with two stop bits.

Although the original communication is very simple, it has some drawbacks. One of these is the fact that there is no data validation within the structure of the protocol and as a result, characters could be lost or corrupted from time to time.

In order to add flexibility for users that need the ability to acquire data serially from our instruments for their Data Acquisition and Handling Systems, we have included an optional serial communication format used on some of our legacy equipment.

It consists of four values separated by commas ending in a 'Carriage-Return' and 'Line-Feed'. The first and third values must match exactly. The second and fourth values must also match exactly. If **either** of these two conditions is not met, then the Enhanced Remote Panel will ignore the data stream as an input. In a similar manner, a DAS should ignore any data streams that do not have matching pairs.

A typical command or data stream would look like the following:

“first value”, “second value”, “first value repeated”, “second value repeated”<CR><LF>

There are two types of functions that can be sent to the Enhanced Remote Panel using this format. One function is a more robust and error free way in which to request data. The other function has the ability to command and control calibrations and initiate other modes of operation. It is important to note that program parameters **CANNOT** be modified from the serial ports.

MATCHED PAIR DATA REQUEST PROTOCOL FOR A DAS

To request data in the matched pair format, use the following command line:

990 “variable number”, 990, “variable number”<CR><LF>

The “variable number” is the same number designation used to number the variables in the original protocol. A list of the variable numbers can be obtained from the Enhanced Remote Panel by using the original 255? command. An example is included later in this appendix.

INITIATION AND CONTROL OF CALIBRATIONS AND MODES OF OPERATION

The system calibration may be initiated and controlled from the serial port.

The command string is as follows: 998, "command", 998, "command" <CR><LF>

The value for "command" is chosen from the following list of commands.

Command Number	Action resulting from specified Command Number
1	NORMAL
2	ZERO
3	UPSCALE
4	RESERVED
5	DUST COMP
6	FORCE_CAL_CYCLE (the Optical Head will complete a full calibration cycle typically consisting of <u>at least</u> both Zero and Span High modes and then returning to Normal operation.
7	TEST_ZERO_SCALE (for MIO 4 to 20 mA outputs)
8	TEST_MID_SCALE (for MIO 4 to 20 mA outputs)
9	TEST_FULL_SCALE (for MIO 4 to 20 mA outputs)
10	PUT_IN_SERVICE (may be used to indicate when the monitor is finished having maintenance done on it)
11	PUT_OUT_OF_SERVICE (may be used to indicate when maintenance is done on the monitor)
12	RESET (sends a command to reset the Optical Head)
13	Not Used

- MIO stands for the printed circuit board (Multi Input Output) commonly used to interface with computers via isolator inputs, relay outputs and analog outputs)

For example to request the OPTICAL HEAD to go into the UPSCALE mode the following command line would be used.

998, 2, 998, 2 <CR><LF>

If the following command line is given to the ENHANCED REMOTE PANEL, it will list the commands available for the calibration input command line such as shown in the above table.

997 ? <CR><LF>

A SUMMARY OF THE ENHANCED COMMANDS AVAILABLE

The program variables are listed later in this appendix. The 990 and 998 commands described below are used with the matched-pair format.

990 This variable is used to request variables in the matched-pair format.

The following is the proper way to use this variable:

990, "VAR#",990,"VAR#" <cr> where "VAR#" is the variable number desired.

After receiving this input the ERP will respond with the following output:

"VAR#","VALUE of VAR#","VAR#","VALUE of VAR#" <cr>

991 This variable is used to request the STATUS HISTORY

Proper usage is: 991?<cr>

The ERP will respond by printing the STATUS HISTORY in a similar format as on the ERP screen display.

992 This variable is not used

993 This variable is used to request the ALARM HISTORY

Proper usage is: 993?<cr>

The ERP will respond by printing the ALARM HISTORY in a similar format as on the ERP screen display.

994 This variable is not used

995 This variable is not used

996 This variable is not used

997 This variable may be used to request a printout of the enumerations used for calibration.

Proper usage is: 997?<cr>

998 This variable is used to request a calibration mode for the Optical Head from the serial port.

Proper usage is as follows: 998,"DESIRED MODE",998,"DESIRED MODE"<cr>

999 This variable is not used

BROADCAST MODE

A screen on the Enhanced Remote Panel can be used to output data on a periodic basis. This allows a technician to log data without the need to request each data point independently. This serial transmission is only available on the RS-232 port and will only be in the matched-pair protocol.

There are two groups of data variables. They are called the FAST Access group and the SLOW Access group. Each group may contain 0 to 8 variables for output as entered on the Enhanced Remote Panel screen. A common time base may be entered on the screen to control the serial output rate for each group. The time base for the FAST group is in multiples of seconds and the time base for the SLOW group is in multiples of minutes. This means that if the value of 10 is entered for the FAST group rate, then ALL of the variables in the FAST list will be transmitted every 10 seconds. If a value of 6 is entered for the SLOW group rate then ALL of the variables in the SLOW list will be transmitted every 6 minutes. Each group rate may be independently entered by the technician.

The technician may enter the desired variable numbers into either list using the keyboard of the Enhanced Remote Panel. The variable numbers are listed later in this appendix. A value of 0, (zero) would indicate that no-selection is made.

A common ENABLE / DISABLE is provided to turn the group serial transmission on or off.

The screen is located under VIEW NUMERICAL DATA\ SERIAL DATA from the Main Menu. The screen looks something like the following picture:

SERIAL DATA	
FAST ACCESS	SLOW ACCESS
VAR 1: 0	VAR 1: 0
VAR 2: 0	VAR 2: 0
VAR 3: 0	VAR 3: 0
VAR 4: 0	VAR 4: 0
VAR 5: 0	VAR 5: 0
VAR 6: 0	VAR 6: 0
VAR 7: 0	VAR 7: 0
VAR 8: 0	VAR 8: 0
TIME SEC: 0	TIME MIN: 0
VAR = 0 NO SELECTION	
TIME = 0 NO BROADCAST	
← TO ENTER, ESC TO CANCEL	

MECHANICAL CONNECTIONS

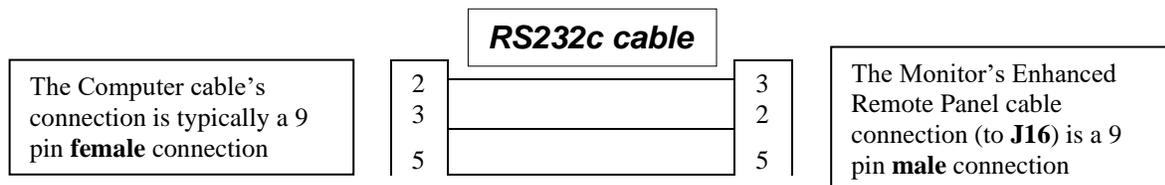
To fasten a laptop or other computer running a standard serial program to the serial port of the ENHANCED REMOTE PANEL you must use following hardware connections.

RS-232 MECHANICAL CONNECTIONS

The connections to the ENHANCED REMOTE PANEL are at the rear of the unit on a standard 9-pin "D" connector labeled J16. Only a 3-wire protocol is supported. It uses 9600 baud, 8 data bits, no parity, and one stop bit.

- J16 - pin - 3 = Transmit
- J16 - pin - 2 = Receive
- J16 - pin - 5 = Ground

A null modem cable is required to connect between the Computer's RS232 serial port and the Monitor's Enhanced Remote Panel. The following diagram shows how to construct the RS232 cable used to connect with the Enhanced Remote Panel's J16. J16 is a DB9 female connection on the back of the Enhanced Remote Panel.



RS-422 MECHANICAL CONNECTIONS

The connections to the ENHANCED REMOTE PANEL are at the rear of the unit on a standard 15-pin "D" connector labeled J17. Only a 4-wire protocol is supported. It uses 9600 baud, 8 data bits, no parity, and can use two stop bits.

- J17 - pin - 3 = Receive-A
- J17 - pin - 15 = Receive-B
- J17 - pin - 2 = Transmit-A
- J17 - pin - 14 = Transmit-B
- J17 - pin - 1 = Shield Ground

Note that RS-422 communication is also at 9600 baud and it requires using 2 stop bits.

ENHANCED REMOTE MOTHERBOARD JUMPERS for Serial Communication

Jumper	Options	RS-232	RS-422	RS-485
JU3	UART TPU	UART	UART	UART
JU4	UART TPU	UART	UART	UART
JU5	UART TPU 422	UART	422	UART

VARIABLE LIST

The following is a list of variables available from the Enhanced Remote Panel RS232 serial port. TML reserves the right to modify this list at any time. It is best to request a list from the Enhanced Remote Panel with 255? command.

Status and time:

1 Head Status:1
2 System Date: 1-Jan-2015
3 System Time:13:58:56

LonWorks® Network data:

4 MIO Status: 1
5 Net Xmit Errors: 0
6 Net Trans Timeouts: 15
7 Net Rcv Trans Full: 0
8 Net Lost Msgs: 0
9 Net Missed Msgs: 0
10 Net Reset Cause: 1
11 Net Node State: 4
12 Net Error Log: 1

Service data:

13 Signal Voltage: 5.25
14 Reference Voltage: 6.87
15 Laser Current mA: 30
16 Normal Set volts: 6.02
17 Up Scale Set Voltage: 4.51
18 Background Set Volts: 0.01
19 Optical Head Temp: 26
20 Calib Mech Posit: 168
21 +15V Supply Voltage: 14.93
22 -15V Supply Voltage: -14.86
23 +5V Analog Supply: 5.01
24 -5V Analog Supply: -4.98
25 +5V Digital Supply: 5.02

Alarm Configuration data: Backscatter

26 Inst BackScat Level1: 50
27 1Min BackScat Level1: 50
28 Avg BackScat Level1: 50
29 Inst BackScat Level2: 70
30 1Min BackScat Level2: 70
31 Avg BackScat Level2: 70
32 Dirt Compensation: 4

Alarm Configuration data: Particulate Mass

33 Inst PartMass Level1: 50
34 1Min PartMass Level1: 50
35 Avg PartMass Level1: 50
36 Inst PartMass Level2: 70
37 1Min PartMass Level2: 70
38 Avg PartMass Level1: 70

MIO Configuration data:

39 MIO Ch 1: INSTANT BACKSCATTER
40 MIO Ch 1 With Calib: YES
41 MIO Ch 1 Zero Scale: 0.000
42 MIO Ch 1 Full Scale: 150.000
43 MIO Ch 2: LASER CURRENT mA
44 MIO Ch 2 With Calib: NO
45 MIO Ch 2 Zero Scale: 0
46 MIO Ch 2 Full Scale: 60.000
47 MIO Ch 3: OPTICAL HEAD TEMP C
48 MIO Ch 3 With Calib: NO
49 MIO Ch 3 Zero Scale: 20.000
50 MIO Ch 3 Full Scale: 80.000
51 MIO Ch 4: SIGNAL VOLTAGE
52 MIO Ch 4 With Calib: NO
53 MIO Ch 4 Zero Scale: 0
54 MIO Ch 4 Full Scale: 15.000
55 Dig Out 1: DATA VALID
56 Dig Out 2: FAULT
57 Dig Out 3: PURGE FAILURE
58 Dig Out 4: EXCESS DUST COMP
59 Dig Out 5: CAL FAILURE
60 Dig Out 6: NORMAL ON AO
61 Dig Out 7: ZERO ON AO
62 Dig Out 8: UPSCALE ON AO

Calibration Configuration data:

63 Cal Time Hour: 25
64 Cal Time Min: 0
65 Cal Interval Hour: 0
66 Upscale Secs: 120
67 Zero Secs: 120
68 Dust Secs: 15
69 AutoAdjustLimit: 6

Backscatter data:

70 InstBackScaterEnergy: 50
71 1MinBackScaterEnergy: 50.2
72 AveBackScatterEnergy: 50.1
73 ZeroCalBackScatter: 1.2
74 UpScaleBackScatter: 71.70
75 DirtCompBackScatter: .31
76 Zero Drift Part Mass: 1.245
77 UpScaleDriftPartMass: 4.123
78 UpScaleSetValue %BS: 71.23

Particulate Mass data:

79 InstParticulateMass: 30 mg/M3
80 1MinParticulateMass: 30.1 mg/M3
81 AveParticulateMass: 30.2 mg/M3
82 ZeroCalPartMass: 2 mg/M3
83 UpScalePartMass: 70 mg/M3
84 DirtCompPartMass: 4 mg/M3
85 ZeroPartMassSetPoint: 2
86 SpanPartMassSetPoint: 70
87 Correct Factor: 0
88 Part Mass Units: mg/M3

Other data:

89 Averaging Interval: 6
90 Zero Cal Setpoint: 1.2
91 Upscale Cal Setpoint: 71.23
92 Cal Delta: 4
93 Six PIO Mode: NORMAL MODE

Firmware versions:

94 Stack332 Version: 3.01
95 StackNeuron Version: 1.65
96 MIO Version: 1.62
97 Panel332 Version: 1.15
98 PanelNeuron Version: 1.63

Gains and References:

99 Signal Gain: 65
100 Ref Gain: 50
101 Common Gain: 0
102 Ref Temp: 20
103 Ref Pressure: 101.3

Temperature & Pressure Correction data:

104 Temp Correction: DISABLE
105 Pressure Correction: DISABLE
106 Low Temperature: 0
107 High Temperature: 0
108 Low Pressure: 0
109 High Pressure: 0

Particulate Mass correlation curve data:

110 Curve Type: POLYNOMIAL
111 Variable_a0: 0
112 Variable_a1: 1
113 Variable_a2: 0

Temperature & Pressure scaling data:

114 Temp A/D Counts X1: 0
115 Temperature DegC Y1: 0
116 Temp A/D Counts X2: 0
117 Temperature DegC Y2: 0
118 Press A/D Counts X1: 0
119 Pressure Kil Pas Y1: 0
120 Press A/D Counts X2: 0
121 Pressure Kil Pas Y2: 0
122 Temp_A/D_Counts: 0
123 CalculatedTemp: 0
124 Press_A/D_Counts: 0
125 CalculatedPress: 0

Latest Alarm data:

126 Alarm: MIN PART MASS: HI LEV 2 CLEAR