560 6Pt I/O PC Board Option
OPERATIONS MANUAL

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TABLE OF CONTENTS

Page

TABLES 7 Figures

APPENDIX A, Specifications

APPENDIX B, DRAWINGS

SIX POINT I/O BOARD FOR 560 SYSTEM

1.0 OVERVIEW

This manual describes the Six Point I/O Board (6PIO) in the *LightHawk*® 560 system. The Six Point I/O Board option (P/N 1860-3520-01) is used as a Direct Interface feature in the *LightHawk*® 560 where analog output and control signals are required directly from the Optical Head Assembly. The 6PIO is packaged under the Optical Head rear cover and is mounted vertically on the left side. External connections are in the Integral Junction Box. See Appendix B for Wiring Diagram connections and board location.

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

2.0 ANALOG OUTPUT DESCRIPTION

There are two independently isolated analog outputs.

DAC 1 (Channel 1 or Out 1) During the NORMAL mode, the analog output will track Instantaneous values displayed in bank U0. During any CALIBRATION mode, the analog output will hold the last NORMAL mode value. (If CB=0)

DAC 2 (Channel 2 or Out 2) During the NORMAL mode, the analog output will track Selectable Average values displayed in bank U2. During any CALIBRATION mode, the analog output will hold the last Selectable average mode value. (If CB=0)

You can add CALIBRATION mode values to the normal DAC1or selectable average DAC2 channels. This is software selectable in the CB screen of the optical head keypad. 0=None, or no calibration values will be tracked. 1=DAC1 will collect calibration values. 2=DAC2 will collect calibration values. 3=DAC1 & DAC2 will collect calibration values. Calibration data scaling for Upscale, Zero and Dust Compensation will be the same as the Normal mode scaling.

EXPANDED SCALING for Zero/Dust: Normal scaling calibration data will be present on the analog output but Zero and Dust Compensation scaling will be expanded for better resolution. This can be changed in the FF bank at the optical head keypad. 0=NORMAL, 1=EXPANDED scaling. Consult the “Zero and Dust Compensation Calibration Scaling Table” for further details.

Zero and Dust Compensation Calibration Scaling Table

Optical Head FF value	Value at ZERO SCALE (4mA) During Zero and Dust Compensation Modes			Value at FULL SCALE (20mA) During Zero and Dust Comp. Modes		
0=Normal Mode Scaling	Equal to NORMAL mode ZERO SCALE (typically 0% opacity)			Equal to NORMAL mode FULL SCALE (typically 100% opacity)		
1=Expanded mode scaling	-5% Opacity Outputs	-0.025 Optical Density Outputs	-25mg/m^3 Particulate Mass Outputs	+5% Opacity Outputs	+0.025 Optical Density Outputs	+25mg/m^3 Particulate Mass Outputs

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 opacity, optical density and particulate mass that are selected to contain time-multiplexed calibration data.

2.1 Analog Output Measurement Units Selection

The DAC 1 and 2 output units may be Opacity, Optical Density or Dust Mass depending on user selection. The output units are software selectable using the keypad and digital display. The Measurement Unit parameter value will dictate both the LED display and the analog output units. For example, if Measurement Unit (F0 location) = 1, the LED display and analog outputs will be in terms of Opacity. If the Measurement Unit = 2, both will display in units of Optical Density. If the Measurement Unit = 3, both will display in units of Particulate Mass.

Measurement full scale: This is software selectable at bank FE on the optical head keypad. Typically if units selected are opacity full scale is 100%, Optical density full scale is 2. Particulate Mass full scale units are mg/m^3, full scale number is based on test data collected. Example; If particulate testing shows your average mg/m^3 are 40 you may want your full scale to be 100. (See note)

NOTE: Banks A3-A8 on the optical head keypad can be used to setup a three point Optical Density to Dust Mass curve.

2.2 Analog Output Current Range Selection

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

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

2.3 Automatic Calibration Analog Output Sequence

The order of the Automatic Calibration Analog Output Sequence is shown below. The duration of each is programmable in seconds.

Order	Description	Duration/ Parameter #	Opacity Scaling	O.D. Scaling	Dust Scaling
1st	ZERO Calibration	Selectable/ C7	0-100	0-2	0-9999
2nd	UPSCALE Calibration	Selectable/ C8	0-100	0-2	0-9999
3rd	PLCF	Selectable/ C9	0-5	0-5	0-5
4th	DUST Compensation	Selectable/ CA	-5 to +5	-0.022 to +0.022	

Table 2-3-1
Automatic Calibration Sequence

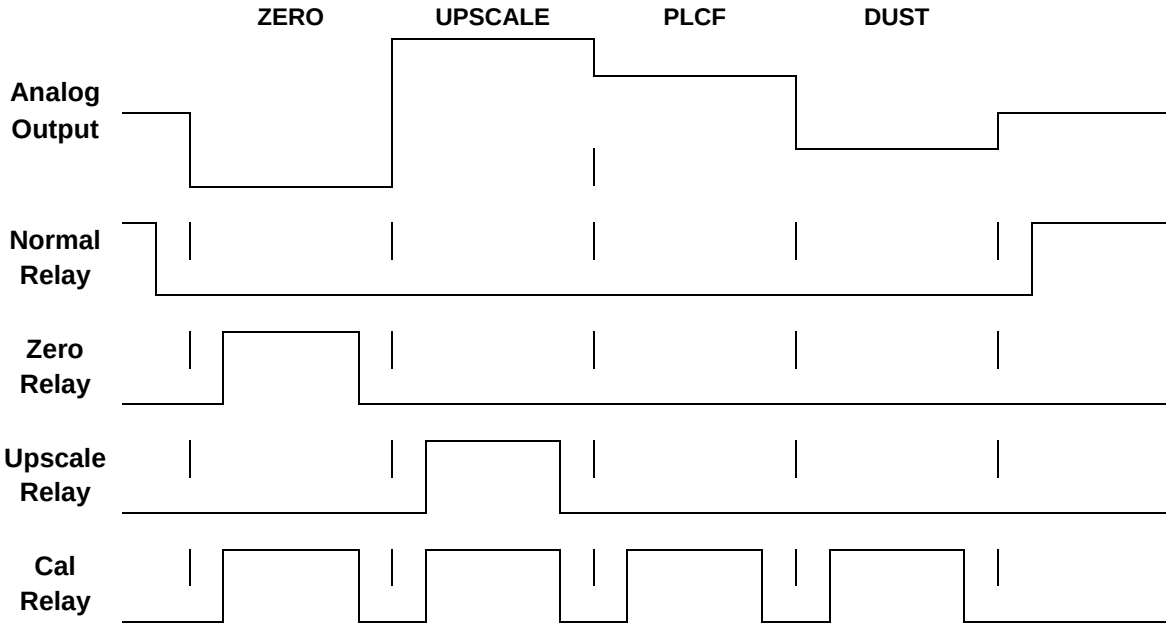

Figure 2-3-2
560 Analog Output Cal Cycle Sequence

PLCF scaling for the Analog Output Cal Cycle (AOCC) is fixed and not user adjustable due to security considerations. The scaling for PLCF is always 0 – 5.

3.0 DISCRETE ISOLATOR INPUTS AND JUMPER SETTINGS EFFECT ON ANALOG OUTPUTS

There are two discrete isolator inputs on the 6PIO Board. Both can be independently configured for operation from +5Vdc or Dry contacts: Jumper JU5 for isolator #1 and JU6 for isolator #2. They are also jumper configurable to perform the following functions:

- **FORCE UPSCALE:** (JU7 in position "A" and Isolator 1 engaged): The instrument goes into calibration UPSCALE mode. The calibration mechanism moves to the UPSCALE position. Normal sampling of stack data ceases. Analog output #2 follows the UPSCALE value. Analog output #1 holds the last stack value.

- **FORCE ZERO:** (JU8 in position "A" and Isolator 2 engaged): The instrument goes into calibration ZERO mode. The calibration mechanism moves to the ZERO position. Normal sampling of stack data ceases. Analog output #2 follows the ZERO value. Analog output #1 holds the last stack value read.

- **FORCE UPSCALE and FORCE ZERO:** (JU7 in position "A", JU8 in position "A", Isolators 1 and 2 engaged): The calibration mechanism moves to NORMAL position. Real time stack data appears on the LED readout and on analog output #1. Analog output #2 follows the DUST COMPENSATION value.

- **DUMP PLCF**: (JU7 in position "B" and Isolator 1 engaged or JU8 in position "B" and Isolator 2 engaged): The calibration mechanism moves to NORMAL position. Real time stack data appears on the LED readout and on analog output #1. Analog output #2 follows the PLCF value with a dedicated scaling: ZERO SCALE = 0 PLCF; FULL SCALE = 5 PLCF.

- **DUMP DUST:** (JU8 in position "C" and Isolator 2 engaged): The calibration mechanism moves to NORMAL position. Real time stack data appears on the LED readout and on analog output #1. Analog output #2 follows the DUST COMPENSATION value.

- **FORCE CALIBRATION:** (JU7 in position "C" and Isolator 1 engaged):

    1. The instrument first goes into calibration ZERO mode. The calibration mechanism moves to ZERO position. Analog output #1 holds the last stack value read. Analog output #2 follows the ZERO value.

    2. After a configurable amount of time, the instrument goes into UPSCALE mode. The calibration mechanism moves to UPSCALE position. Analog output #1 holds the last stack value read. Analog output #2 follows the UPSCALE value.

    3. After a configurable amount of time, the instrument goes into PLCF mode. The calibration mechanism moves to NORMAL position. Real time stack data appears on the LED readout and on analog output #1. Analog output #2 follows the PLCF value with a dedicated scaling: ZERO SCALE = 0 PLCF; FULL SCALE = 5 PLCF.

    4. After a configurable amount of time, the instrument goes into DUST COMPENSATION mode. The calibration mechanism remains in NORMAL position. Real time stack data appears on the LED readout and on analog output #1. Analog output #2 follows the DUST COMPENSATION value.

    5. After a configurable amount of time, the instrument goes into NORMAL mode. Real time stack data appears on the LED readout and on analog output #1. Analog output #2 follows the selectable average stack value.

Jumper Position	Function	Available Isolator
JU7 "A"	FORCE UPSCALE	ISO1
JU8 "A"	FORCE ZERO	ISO2
JU7 "B" or JU8 "B"	DUMP PLCF	ISO1 or ISO2
JU8 "C"	DUMP DUST	ISO2
JU7 "C"	FORCE CALIBRATION CYCLE	ISO1

Table 3-0-1
Isolator Configuration Jumpers

3.1 Other Jumpers That Effect Analog Outputs

- **TEST ZERO SCALE (JU10):** This jumper is used to set both analog outputs to ZERO SCALE when placed in position "Z" (rightmost).

- **TEST FULL SCALE (JU11):** This jumper is used to set both analog outputs to FULL SCALE (20mA) when placed in the "FS" position (rightmost).

- **TEST ZERO SCALE AND TEST FULL SCALE:** When both of these jumpers (JU10 and JU11) are actuated simultaneously, both the analog outputs go to MID SCALE (12mA if the JU9 jumper is set to position "4", 10mA if the JU9 jumper is set to position "0").

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

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

Table 3-1-1
Output Jumper Configuration

4.0 RELAY OUTPUTS

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

K1 (JU12 position)	**K2** (JU13 position)	**Function**
A	A	Calibration Data on Analog Outputs
B	B	Instrument Malfunction (**Not Fail-safe**)
C	C	Instantaneous Alarm 1 Actuated
D	D	Selectable Average Alarm 1 Actuated
E	E	UPSCALE Data on Analog Outputs
F	F	ZERO Data on Analog Outputs
G	G	Purge Failure
H	H	Excessive Dust Compensation

Table 4-0-1
Relay Function Configuration Jumpers

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

RELAY	**N.O.**	**N.C.**
K1	JU14 “A”	JU14 “B”
K2	JU15 “A”	JU15 “B”

Table 4-0-2
Relay Contact Configuration Jumpers

5.0 ANALOG OUTPUT ADJUSTMENT

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

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

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

2.00 VDC = 20mA

0.40 VDC = 4mA

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

Examples 1 and 2 below indicate how the Measurement Unit parameter, 6PIO Full Scale parameter and 6PIO jumper interactivity dictate the analog output response to the instrument measurement levels.

EXAMPLE 1:

If (Measurement Unit = 1) ***AND*** (6PIO Full Scale = 100) ***AND*** (0/4 6PIO Jumper = 4)):

4mA = 0% Opacity

20mA = 100% Opacity

EXAMPLE 2:

If (Measurement Unit = 2) ***AND*** (6PIO Full Scale = 2) ***AND*** (0/4 6PIO Jumper = 0):

0mA = Optical Density of 0

20mA = Optical Density of 2

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

Table 5-0-1
Analog Output Channel Adjustment Details

6.0 DATA CABLES

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

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Appendix A
Six Point I/O Board Specifications

SIX POINT I/O BOARD ANALOG OUTPUTS

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

SIX POINT I/O BOARD DIGITAL INPUTS

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

SIX POINT I/O BOARD RELAY OUTPUTS

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

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

SIX POINT I/O BOARD (1860-0700) DEFAULT JUMPERS (560DI 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=Dump $_{PLCF}$) . **C** (BOTTOM=Force $_{cal\ cycle}$)	BOTTOM	Selects input #1 function
JU8	**A** (TOP=Force $_{Zero}$) . B (MID=Dump $_{PLCF}$) . 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

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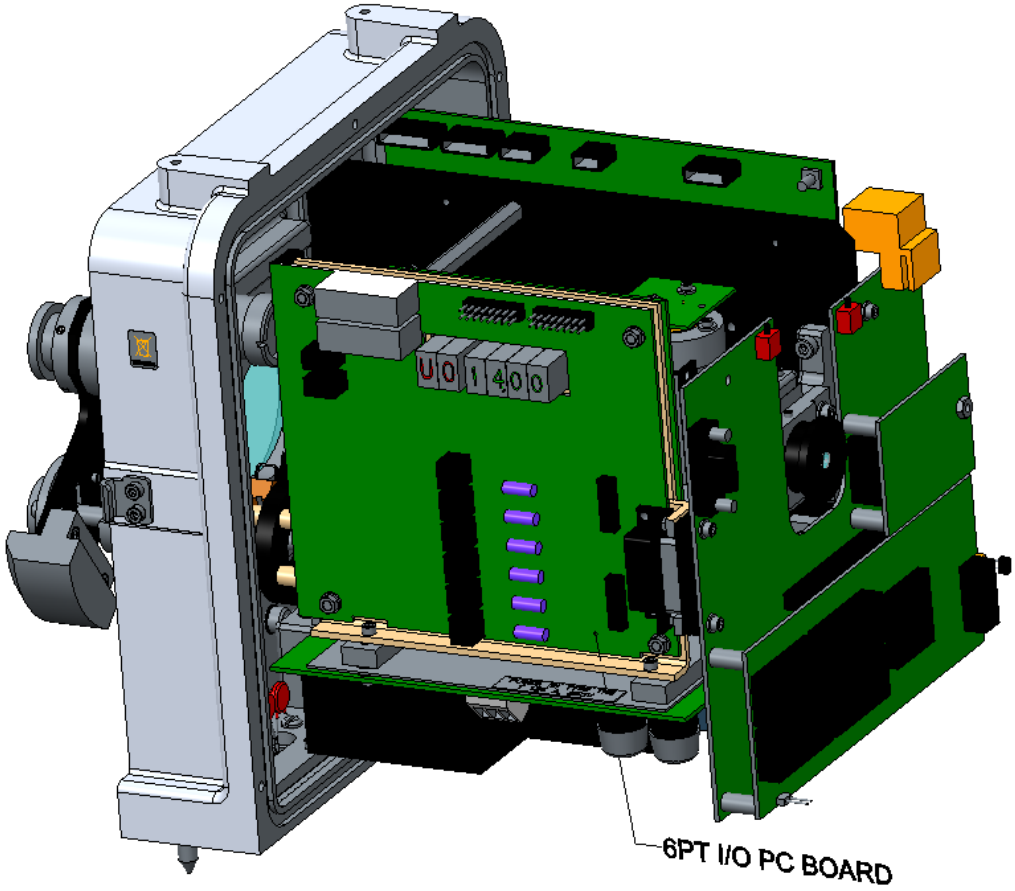
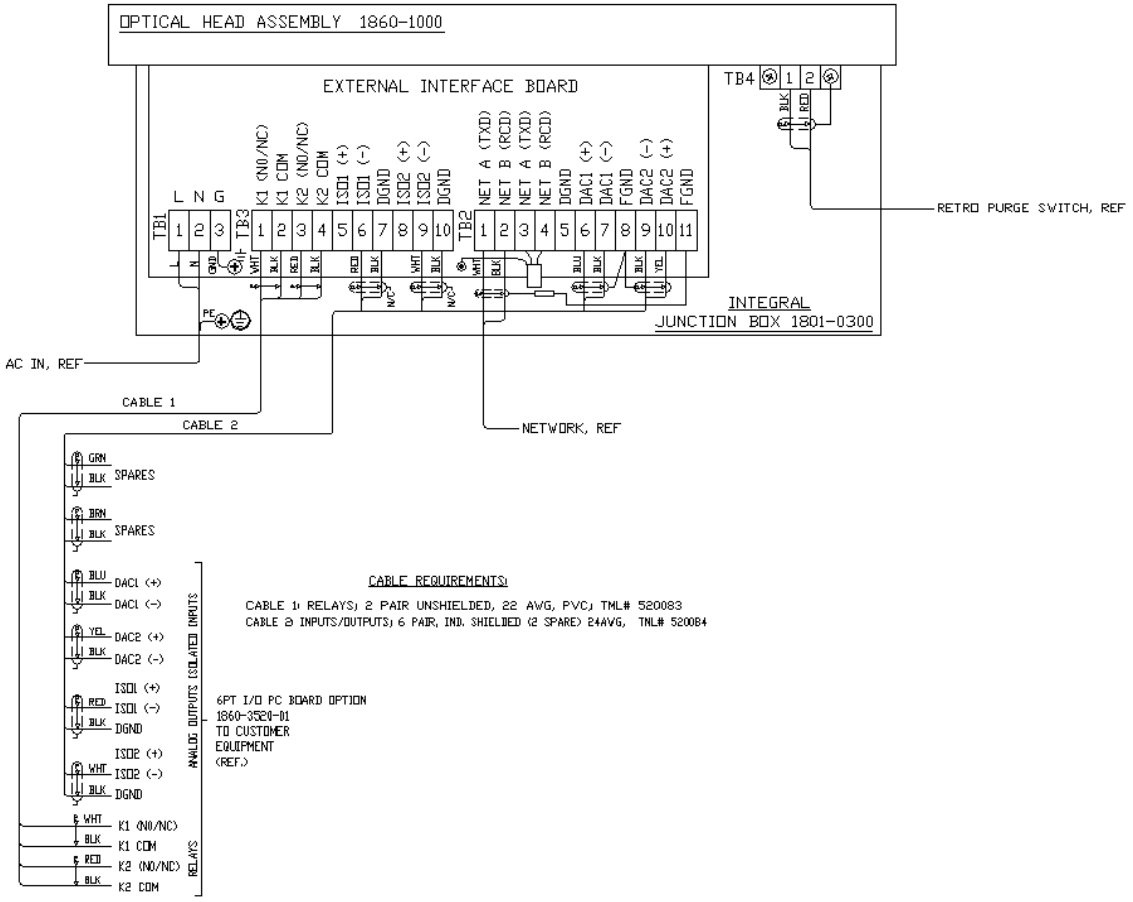
APPENDIX B

DRAWINGS



6PT I/O PC BOARD LOCATION



6PT I/O WIRING DIAGRAM