USER MANUAL

XLB-1000/1500 Short Arc Xenon Lamp Ballast

Note: Also see XLB Application Notes:
http://luminapower.com/pdf/xlb_app_notes.pdf

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Tables and Figures

Product Overview

The XLB-1000/1500 Xenon lamp ballast is a very compact power supply designed for OEM applications. When configured as an XLB-1000, the maximum output power is 1000W and the unit can be driven off line voltages between 100VAC to 240VAC. When configured as an XLB-1500, the maximum output power is 1500W and the unit can be driven off line voltages between 200VAC and 240VAC. The XLB-1000/1500 is ideal for high power applications where economy is important and performance cannot be compromised.

Compact size is possible due to a low-loss Zero Voltage Switching inverter and incorporation of planar magnetics. Power factor is greater than 0.98 and conducted emissions meet stringent European regulations. No additional line filter is required to meet EN 55011 emission requirements. Lumina Power's XLB series sets the standard for reliable lamp ignition and long term high power operation in a low cost, compact package. The XLB-1000/1500 is ideal for medical, projection and industrial applications where a stable light source is essential.

As a Xenon lamp ballast, the XLB-1000/1500 power supply first ignites the lamp with a high voltage pulse and, once the lamp is ignited, acts as a programmable current source delivering constant current based on the input program signal, Iprogram(+), which is normally 0-10V. The XLB-1000/1500 can be configured for output current up to 75A. Typical lamp voltages are between 15 and 45V.

The XLB-1000/1500 utilizes a proprietary low loss, high frequency power factor correction circuit which maintains a power factor above 0.98. Power factor corrected power supplies use up to 30% less input current and meet stringent IEC harmonic requirements. The output inverter is a state-of-the-art zero voltage switching (ZVS) inverter which permits very high frequency power conversion with minimum losses and electromagnetic noise.

Explanation of Symbols

Hazard: This equipment produces high voltages which can be fatal. Only service personnel of Lumina Power, Inc. are qualified to service this equipment.

High Voltage Present: This power supply produces lethal high voltages. Only service personnel of Lumina Power, Inc. are qualified to service this equipment. Only qualified service personnel are permitted to install this power supply.

XLB-1000/1500 Theory of Operation

(Refer to Figure 1)

The XLB-1000/1500 Xenon lamp ballast has been designed to drive high power Xenon lamps. OEM power supplies for Xenon lamps have the following requirements:

- Safe lamp operation
- Reliable short pulse lamp ignition
- Compact size
- Power factor correction to conform with CE requirements
- Low conducted electromagnetic emissions
- Low leakage for medical applications

Referring to the Figure 1, "XLB-1000/1500 BLOCK DIAGRAM", the following is a brief description of operation.

AC Input Power Circuitry

AC input power is processed through a line filter to reduce the conducted EMI to an acceptable level. The XLB-1000/1500 line filter has minimum capacitance to ground to minimize leakage currents.

Power Factor Correction Boost Inverter

The rectified input power is next applied to a power factor boost inverter. This inverter boosts the input voltage to 400VDC. In the process of boosting the rectified input voltage, the input AC current is adjusted so that is always in phase with the input AC voltage. Without this power factor correction circuit, the AC input current would be delivered to the power supply in high amplitude, narrow spikes, having a high harmonic content. With power factor correction, the non-50/60 Hz harmonics are reduced to near zero. Since only the fundamental frequency is now used to deliver power, the efficiency of the power supply is improved considerably.

Lumina Power employs a proprietary soft-switching boost inverter which produces minimum switching noise, reduces switching losses, and results in a smaller heat sink associated with the power factor circuit. One problem with standard input power factor correction circuits is that a high frequency switching circuit is placed across the line in the input side of the traditional capacitor filter capacitor. This circuit results in substantial switching noise conducted to the line.

Zero Voltage Switching (ZVS) Inverter

The ZVS inverter and the output transformer are used to step the 400VDC bus down to the appropriate output value. The ZVS inverter is the most modern high frequency/low loss/low noise topology utilized in power electronics today. Instead of running the inverter in a traditional PWM mode, the inverter is run in a phase shift mode. With the appropriate output inductor and capacitance across

each switching device - in this case MOSFETS - there are virtually no switching losses in the inverter. The only losses in the devices are IR^2 losses associated with the Drain/Source resistance of the MOSFETS. Therefore, the ZVS inverter also contributes to reduced losses, reduce EMI noise and a reduction in overall system heat sink requirements.

Output Circuit
The output filter is a single stage RC filter designed to minimize output ripple and noise.

Control Circuit
The control circuit handles all the responsibilities associated with safe operation of the Xenon lamp. Reliable lamp ignition as well as tight current regulation, overvoltage and over power protection are controlled and monitored in the control circuit.

Auxiliary Power
All internal power supply requirements as well as the external +15V power supply and are derived from the power factor control boost inductor. All auxiliary power supplies are regulated by standard linear regulators.

Lamp Igniter Module
The igniter module provides the 40kV pulse required to break down the Xenon gas and facilitate ignition. In standard configurations, the pulse is applied through the positive output to the lamp anode. Power to the module is provided by the main power supply chassis. Internal circuitry in the igniter module senses the presence of the high voltage arc and briefly disables operation in the main power supply chassis in order to minimize damage from high voltage noise.

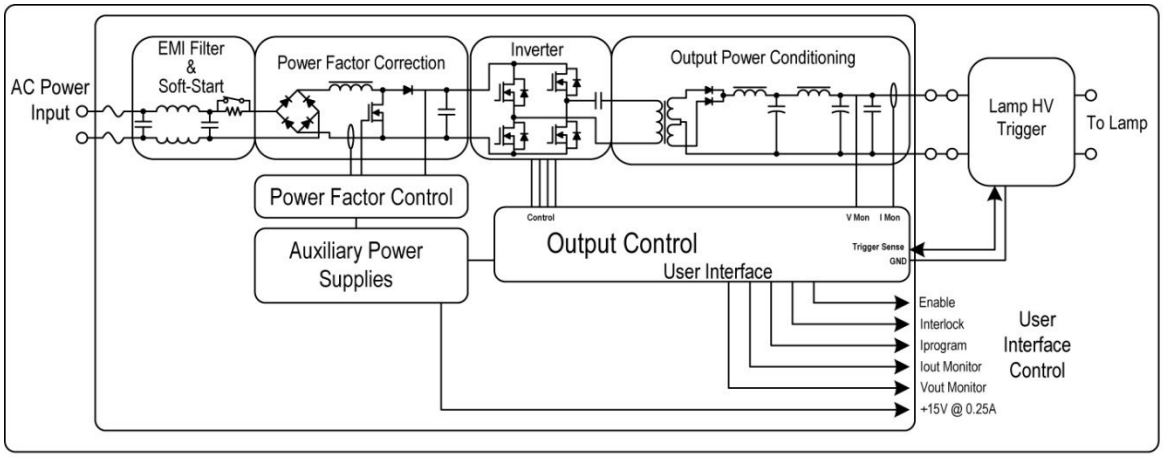


Figure 1
XLB-1000/1500 BLOCK DIAGRAM

XLB-1000/1500-XX-YY Specifications

XX = $Iout_{max}$ YY= $Vout_{max}$

Model	$Pout_{max}$	$Iout_{max}$	Input Voltage	Size (L x W x H)
XLB-1000-XX-YY	1000W	50A	100-240VAC	10.6" x 8.2" x 3" 269 x 208 x 76mm
XLB-1500-XX-YY	1500W	75A	200-240VAC	
Maximum output voltage: 35V		**Auxiliary Outputs**: +15V @0.20A		

Input

Voltage: See table above
Current: XLB-1000: 50/60 Hz, 6A @220VAC
XLB-1500: 50/60 Hz, 8A @220VAC
Power Factor: >.98

Interface

(See interface description page 3)
Connector: 15 Pin "D" Sub Female

Ignition/Boost

Boost Voltage: 250V
Boost Energy: 500 mJ
Ignition Voltage: Up to 45kV (~1uSec rise time)
Igniter Polarity: Positive or Negative (Factory Set per customer request)
Ignition Energy: 65mj.
Igniter Dimensions: 5.5" x 3.6" x 2.6"
140 x 92 x 66mm

Performance

Line Regulation: <0.2% of maximum output current
Current Regulation: <0.5% of Maximum output current
Current Ripple: <0.5% of maximum output current
Power Limit: Limited to 105% of maximum power with power fold-back circuit

Environment

Operating Temp: 0 to 40 ^{o}C
Storage: -20 to 85 ^{o}C
Humidity: 0 to 95% non-condensing
Cooling: Forced air
Altitude: Range: 101 kPa to 81 kPa (sea level to 2000m)

Regulatory

Leakage Current: <350uA

Approvals:

Medical Safety: EN 60601-1:1990 including A1:1993, A2:1995, A13:1996
IEC 60601-1:1988 (2nd Edition) + A1:1991 + A2:1995
UL 60601-1 (1st Edition, 2003 & CSA C22.2 601.1-M90, B90) CB/CCA scheme
Emissions/Immunity: EN 60601-1-2:2007
IEC 60601-1-2:207

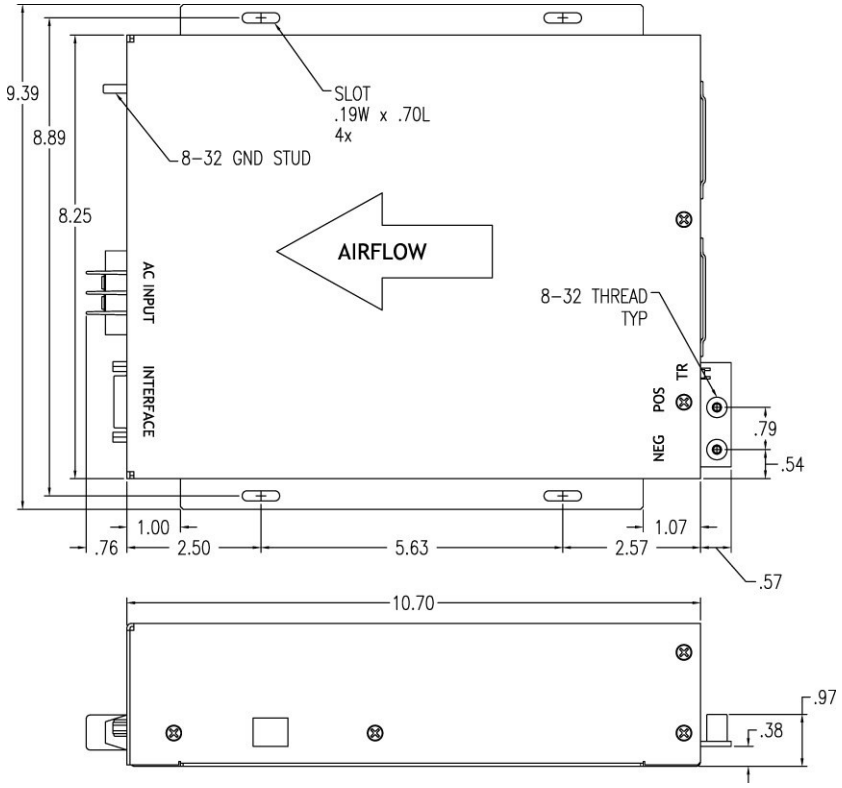
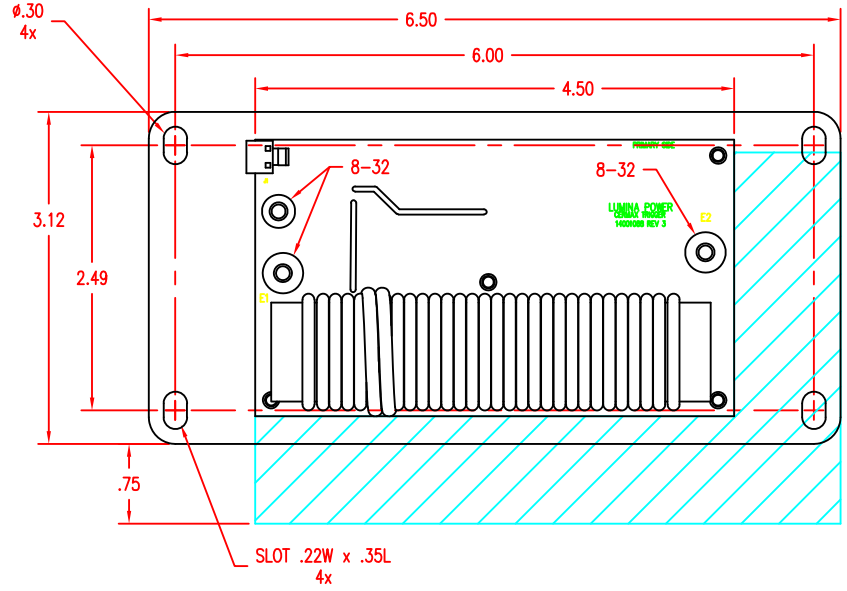
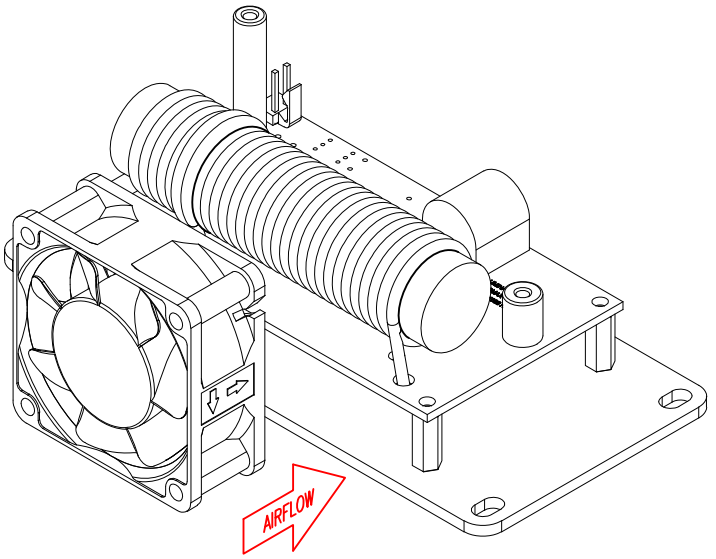


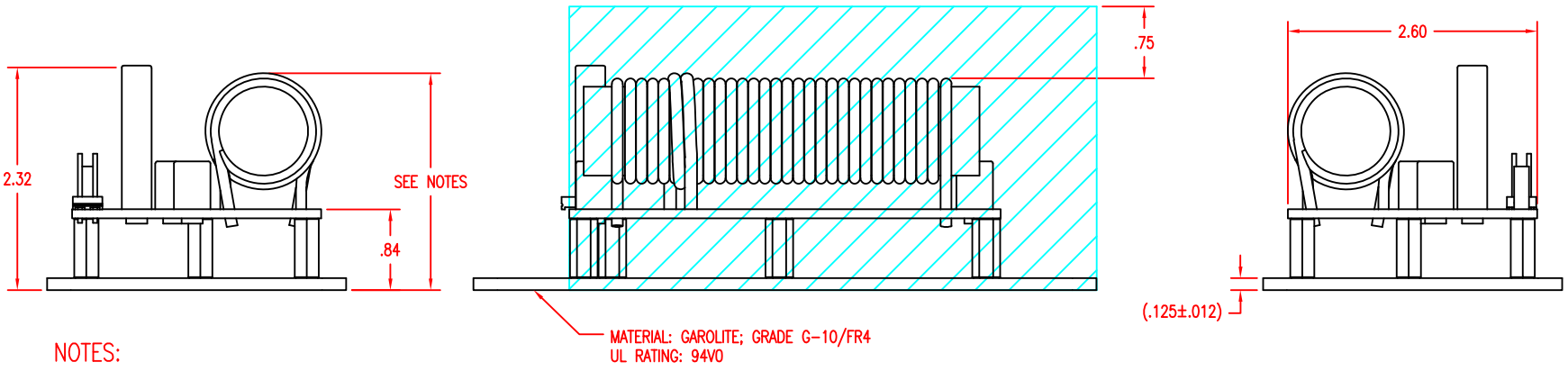
Figure 2
XLB-1000/1500 Chassis Outline Drawing





IGNITOR ASSEMBLY WITH
RECOMMENDED FAN POSITION
(KEEP FAN A MINIMUM OF ¾" FROM IGNITOR COIL)

MAINTAIN DISTANCE FROM CONDUCTIVE OBJECTS.



NOTES:

1. RANGES FROM 2.25" TO 2.60" DEPENDING ON CURRENT RATING OF TRIGGER TRANSFORMER.

XLB-1000/1500-XX-YY Interface

Connector Type: 15 pin D-sub Female

(Refer to Figure 4 XLB-1000/1500 Interface Schematic)

Pin #	XLB-1000/1500 Pin Name	Functional Voltage Level	Description
1	**Lamp On/Off** (input) (Note: 1)	High=RUN=+5V to +15V Low = OFF = 0V	The **Lamp On/Off** function is the control function which turns the lamp on and off. When the lamp is turned on, a trigger and boost sequence will ignite the lamp and deliver current as programmed via Iprogram, Pin 7.
2	No connection Do not connect		
3	**Interlock** (input)	Open = OFF Connect to GND = RUN	The **Interlock** function can be connected to external interlock switches such as door or overtemp switches.
4, 9, 15	**GND**		
5	**Vout Monitor**: (output)	0 – 10V = 0 – $V_{out_{max}}$	The output voltage of the supply can be monitored by **Vout Monitor**.
6	**Iout Monitor** (output)	0 – 10V = 0 – $I_{out_{max}}$	The output current of the supply can be monitored by **Iout Monitor**.
7	**Iprogram(+)**: (input)	0-10V = 0- $I_{out_{max}}$	The power supply output current is set by applying a 0-10V analog signal to **Iprogram(+)**. Note that even with **Iprogram(+)** set between 0V and 2V,when the lamp is turned on via **Lamp On/Off**, the XLB-1000/1500 will deliver 20% of the maximum current rating of the unit.This is the minimum current required to keep the lamp on. To deliver more than 20% of the maximum rated current,Iprogram(+) must be set higher than 2V. **Note: Accuracy will be compromised when operating below 30% of the maximum value**
8	**Lamp On/Off Status** (output)	High = Lamp Off = 15V Low = Lamp On = 0V	The lamp status is monitored and if at least 20% of the rated current of the power supply is flowing through the lamp, the **Lamp On/Off Status** signal will be pulled low. When the lamp is off, this pin is pulled high to 15V through a 10K resistor.
10,11, 12	No connection Do not connect		
13,14	**+15V** (output)		Auxiliary +15V power supply for user. Up to 0.2A output current available.

Table 1: XLB-1000/1500 Interface

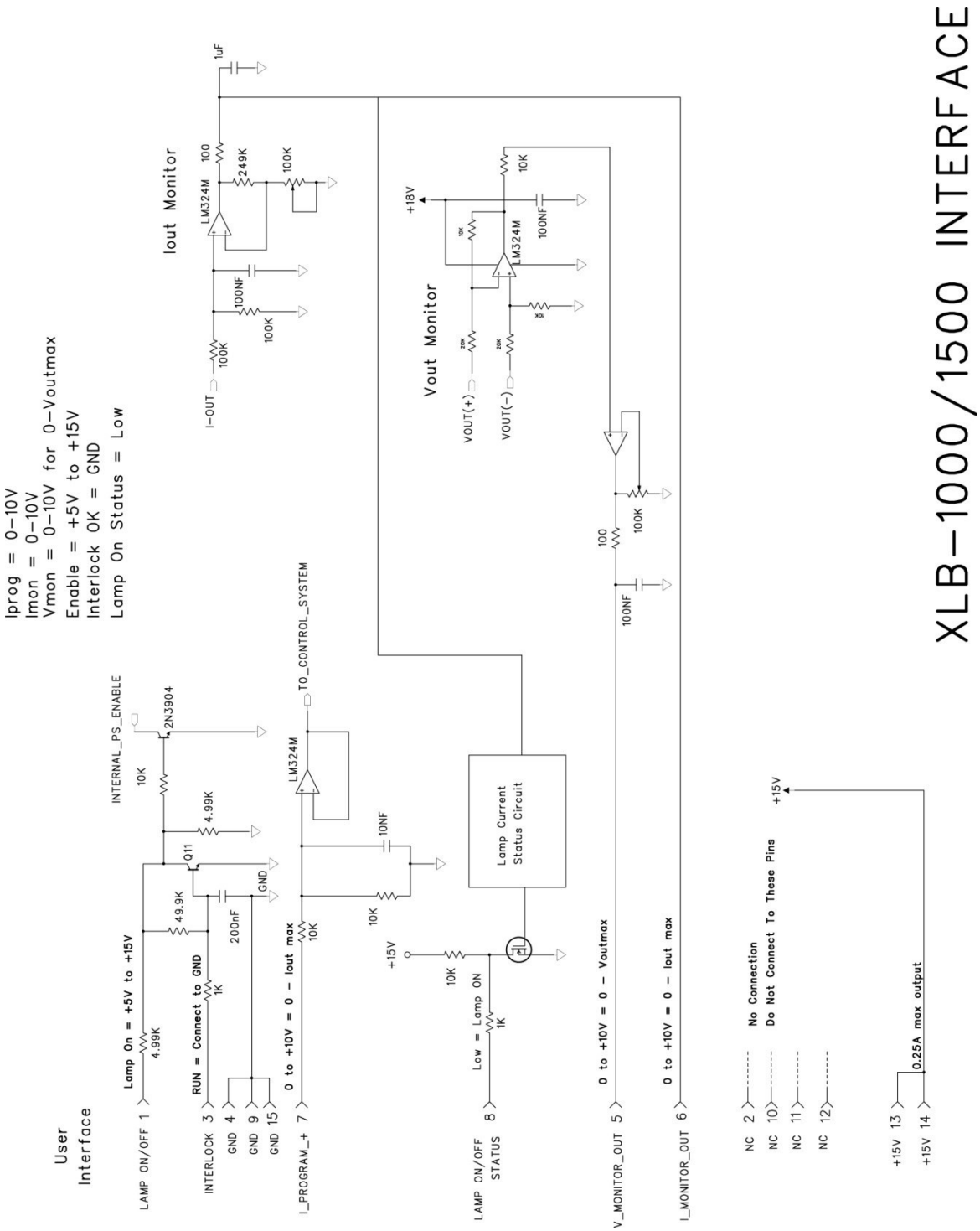


Figure 4
XLB-1000/1500-XX-YY Interface Schematic

The XLB-1000/1500 chassis is mounted using the mounting brackets as shown in Figure 2, the XLB-1000/1500 Outline Drawing. The XLB-1000/1500 Igniter module has a mounting plate shown in Figure 3.

IMPORTANT HIGH VOLTAGE INSTALLATION NOTE

- The XLB-1000/1500 system trigger module produces a 45kV pulse during lamp ignition. The igniter module should be placed as close as possible to the Xenon lamp in order to keep the leads between the igniter and the Xenon lamp as short as possible. No other wires should be in the vicinity of the igniter output wires connecting to the Xenon lamp. The HV pulse produces transients that can be destructive to low signal electronics.
- Please refer to Figure 3, XLB-1000/1500 Igniter Outline Drawing, for information regarding required clearances around the high voltage igniter coil.

SAFETY WARNING

Because XLB-1000/1500 units are designed for OEM applications, the user must connect AC input power to the power supply terminal block. Any input AC voltage must be considered extremely dangerous, and as such, care must be taken to connect AC input power to the unit.

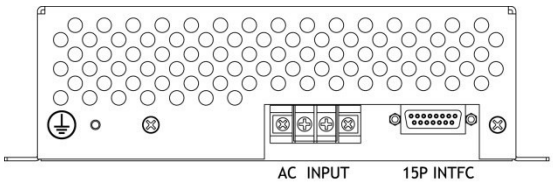


Figure 5
XLB-1000/1500 Input Connections

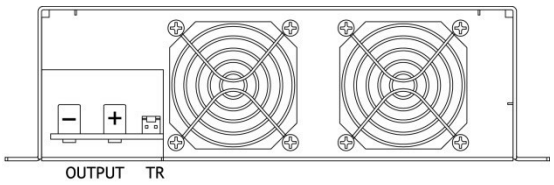
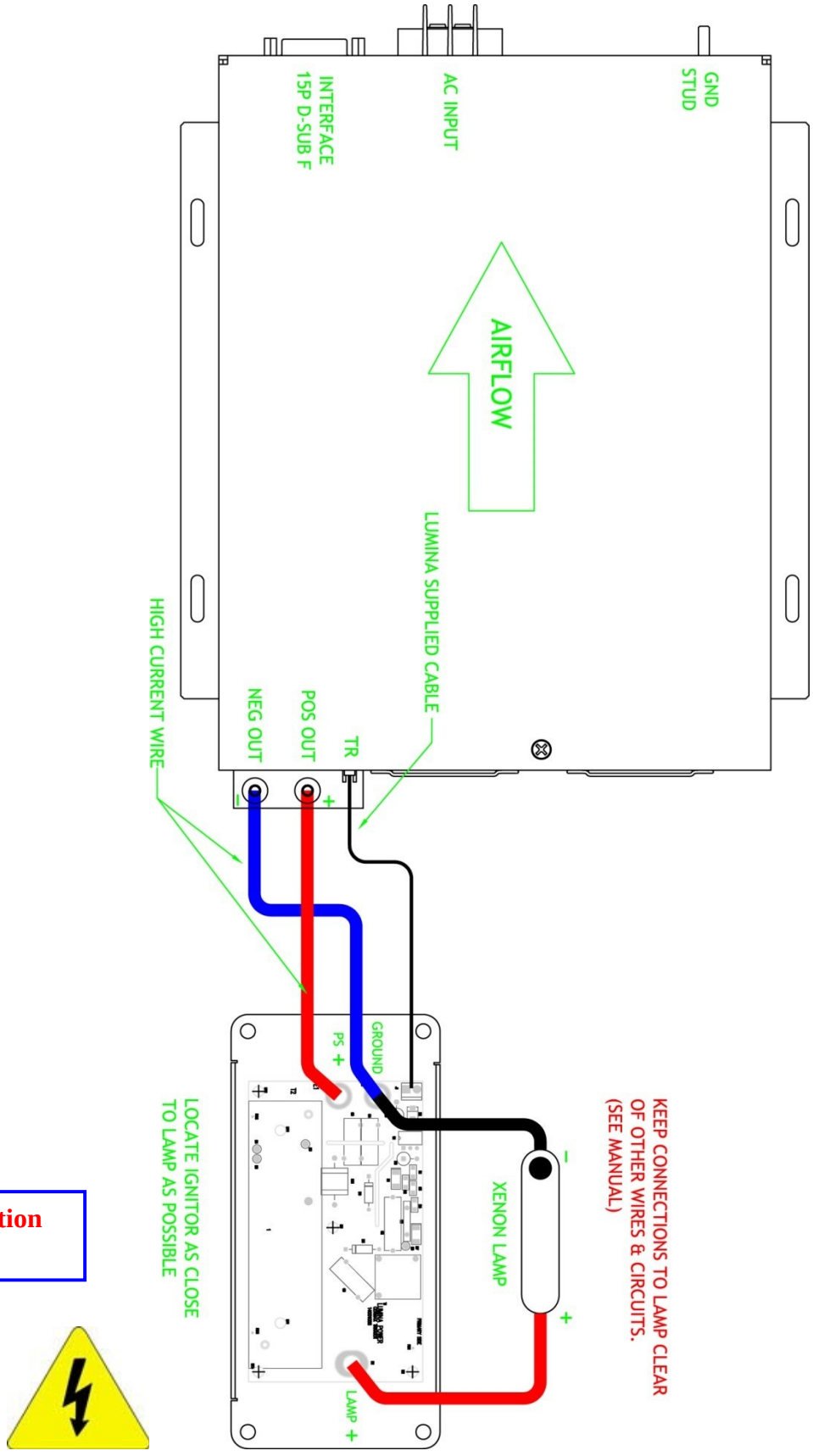


Figure 6
XLB-1000/1500 Output Connections



Note: Negative ignition is available

Figure 7
XLB-1000/1500 Lamp Connections

1. **Connecting to Xenon Lamp:** Figure 7 shows the interconnections between the XLB-1000/1500, the Igniter module and the Xenon lamp. Because the Igniter module produces a high speed 45kV pulse when igniting the Xenon lamp, it is important to keep connections between the igniter module and the lamp as short as possible to avoid I^2R losses in the wire. Wire length of 30 cm or less is recommended for reliable ignition!

2. **TR Trigger Sense Connection:** Connect the TR trigger sense connection wire to the trigger module and the XLB-1000/1500 main power supply chassis. The cable for this connection has been provided. The location of the connections is shown in Figure 7. Note: unit will not operate if not connected.

> **IMPORTANT NOTE**
> Make sure when connecting interface that the current program setting, **Iprogram(+)**, is set no higher then the value required for Xenon lamp operation. When AC power is applied and system is enabled via **Lamp On/Off**, output current will rise to this program value

3. **Interface Connection:** Connect user system to Interface 15 pin D-sub connector shown in Figure 5. (Although the user interface is typically designed by the user, Lumina Power can provide any assistance necessary to modify interface program and monitor levels) See Table 1 and Figure 4 for description of XLB-1000/1500 Interface and the associated simplified interface schematic.

4. **Interface Information before applying AC Power:** The unit may be programmed for output current via Pin 7, the **Iprogram** function. But there are three interface control signals which must be properly set before the output will deliver current as programmed by Iprogram.
   a. **Interlock:** Pin 3, the **Interlock,** must be grounded via Pins 4, 9 or 15 in order for the output to deliver current. Users typically wire system interlock switches in series with this interlock connection.
   b. **Lamp On/Off**: Pin 1, the **Lamp On/Off** signal is a 5V to 15V signal used to turn the output section on.
   c. **Iprogram:** Pin 7. A 0-10V signal results in output current as shown in the table below. Note that even with **Iprogram(+)** set between 0V and 2V, when the lamp is turned on via **Lamp On/Off** the XLB-1000/1500 will deliver 20% of the maximum current rating of the unit. This is the minimum current required to keep the lamp on. To deliver more than 20% of the maximum rated current, Iprogram(+) must be set higher than 2V.

Iprogram(+)	Iout
0V	20% $Iout_{max}$
2V	20% $Iout_{max}$
4V	40% $Iout_{max}$
6V	60% $Iout_{max}$
8V	80% $Iout_{max}$
10V	100% $Iout_{max}$

5. **Operating the XLB:**
    a. **AC Input Power Connection:** Input power is as shown below in Table 2. Connect AC power connections to power supply input power terminals. Refer to Figure 5 for location of AC Input.

MODEL	INPUT POWER
XLB-1000-XX-YY	100-240VAC, 50/60 Hz, 6A @220VAC
XLB-1500-XX-YY	200-240VAC, 50/60 Hz, 8A @220VAC

Table 2: XLB-1000/1500 AC Input Power Requirements

IMPORTANT SYSTEM NOTE ON AC INPUT POWER

XLB-1000/1500 units are fused on both input lines. It does not matter which of the two AC inputs are designated Line or Neutral.

IMPORTANT APPLICATON NOTE REGARDING AC INPUT POWER

AC Input wires and Earth Ground wire should be at least #12 AWG; rated for at least 300V and 105 ^{O}C.

    b. **Interface Settings**: Make sure **Interlock**, Pin 3, is connected to Interface GND via Interface pins 4, 9 or 15
    c. **Apply Input AC Power:** Turn ON AC power. After a few seconds the power supply fans will begin to run.
    d. **Programming Output Current:** Program XLB-1000/1500 power supply for desired output current. A 0-10V signal applied to **Iprogram**, Pin 7, will program the XLB-1000/1500 for 0 to maximum rated output current.
    e. **Lamp On/Off:** Apply +5V to +15V to **Lamp On/Off**, Pin 1. The lamp will ignite. After ignition, XLB-1000/1500 will deliver output current as programmed.

6. **Monitoring XLB output and performance:**
    a. **Current Monitor** Power supply output current can be monitored via pin 6, **Iout Monitor**. A 0-10V signal will represent the output current from 0 to maximum rated output current.
    b. **Voltage Monitor** Power supply output voltage can be monitored via pin 5, **Vout Monitor**. A 0-10V signal will represent the output voltage from 0-maximum rated output voltage.
    c. **Lamp On/Off Status:** Once the lamp has successfully ignited and at least 20% of the maximum rated current of the power supply is being delivered to the lamp, the LAMP ON/OFF Status signal will go low.

7. **DC output connections:**

IMPORTANT APPLICATON NOTE REGARDING DC OUTPUT CONNECTIONS

DC Output can be as high as 75 amps! We recommend the user refer to the NEC for wire gauge guide lines for steady state and peak current condition operation. Wire terminations should be sized accordingly and crimped & soldered. Increased resistance due to poor connections will cause voltage drops and I^2R heating which could be dangerous or damaging to improperly sized wires, wire insulation and terminations.

8. **Servicing the XLB-1000/1500:**
XLB-1000/1500 units have no serviceable parts. Do not attempt to repair or service this unit in the field. Removing tamper seals from chassis will void warranty. For further information, contact Lumina Power at 978-241-8260.

Rev	ECO	Description	Date	Doc Control
1	7062	Release	9/20/11	MJ
2	7474	Update	11/18/14	MJ

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Note: Also see XLB Application Notes:
http://luminapower.com/pdf/xlb_app_notes.pdf