



**26 Ward Hill Ave., Bradford, MA 01835**  
**Phone: 978-241-8260 Fax: 978-241-8262**

## **USER MANUAL**

### **HPP-750-XX-YY**

**XX= Ioutmax**  
**YY = Maximum Compliance Voltage**



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## 1. Warnings

### **Warning – Output Floating**

**Do not connect the HPP-750 output or laser diode load to any ground, it must remain floating, or serious damage to the power supply and laser diode will occur!**

The output of the HPP-750 is floating and therefore, neither side of the laser diode must be connected to the same ground as signal ground (Program, Monitor).

### **Warning – Output Floating**

**Do not connect an oscilloscope or any instrumentation directly to the laser diode load! Only floating measurements can be used such as a differential voltage probe and Hall Effect current sensors.**

### **Warning – Voltage Compliance Requirement**

Each HPP-750 is custom configured to deliver current pulses into a diode array requiring a predefined compliance voltage. See the Serial Number label of the unit for the compliance voltage rating. The HPP-750 takes DC input voltage and will not operate properly when the input is great than 10V higher than the load compliance voltage and will not start when the input is 20V lower that the rating on the S/N label or lower than 20V. Consult factory for wider operating conditions.

**WARNING:** Only Lumina Power, Inc. qualified service personnel are allowed to remove the covers and service this equipment.

**WARNING:** **NEVER OPERATE THE POWER SUPPLY:**

1. Without providing adequate protection of personnel from high voltage.
2. Without proper ground connections.
3. Without covers and panels properly installed.
4. Without a suitable load for the application and properly rated for the required power dissipation.



**Warning:** This equipment produces voltages that can cause electrical shocks. Only Lumina Power, Inc. qualified service personnel are allowed to service this equipment.



**Chassis Ground:** This symbol where the protective earth ground connection is located.

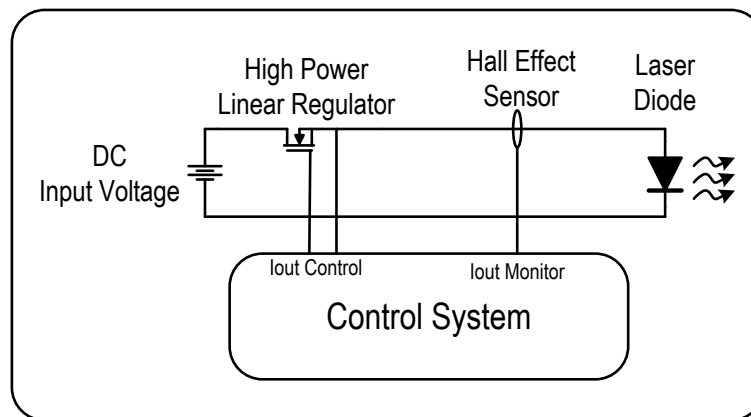
## 2. Description of HPP-750 System

### Warning – Output Floating

**Do not connect the HPP-750 output or laser diode load to any ground, it must remain floating, or serious damage to the power supply and laser diode will occur!**

The output of the HPP-750 is floating and therefore, neither side of the laser diode must be connected to the same ground as signal ground (Program, Monitor).

Lumina Power's HPP-750 power supplies are designed for pulsing diode lasers in Quasi-CW applications. Before operating this unit, it is important to understand the operation. A block diagram of the power supply is shown below.



**Figure 1, HPP-750 Block Diagram**

Referring to Figure 1, the basic elements of the HPP-750 system is a high power linear regulator. The four main components are:

- A **storage capacitor**, which holds the energy for a high power pulse.
- A **high power linear regulator**, which is controlled by an error signal.
- A **high current sensing circuit**.
- The **control system**.

The **DC input voltage** source must be voltage programmable and have current limit but not current fold-back. It must be able to deliver constant current into a big capacitor which is a short at start up and the voltage will be discharged to a low level at the end of every pulse. Set the output voltage at 2 to 5V higher than the load compliance voltage for optimal efficiency.

Even though the HPP-750 output current has better than 15us rise/fall time, the compliance voltage must be set to be only a few volts higher than the load voltage.

The **high power linear** regulator is a bank of high power MOSFETS mounted on an appropriate heat sink with over-temp protection.

The **control system** provides the interface to the supply and provides various protection circuits for the laser diode.

### 3. Pulsing Characteristics

The rise and fall times of the HPP-750 pulses are a compromise between speed and minimization of overshoot. The following figures show typical pulse performance for a HPP-750 with 300 Apeak output. In each of the figures, the oscilloscope traces are

Channel 1: Output Current. 100Amp/V

Channel 2: Pulse Command Signal

Channel 3: Current Monitor

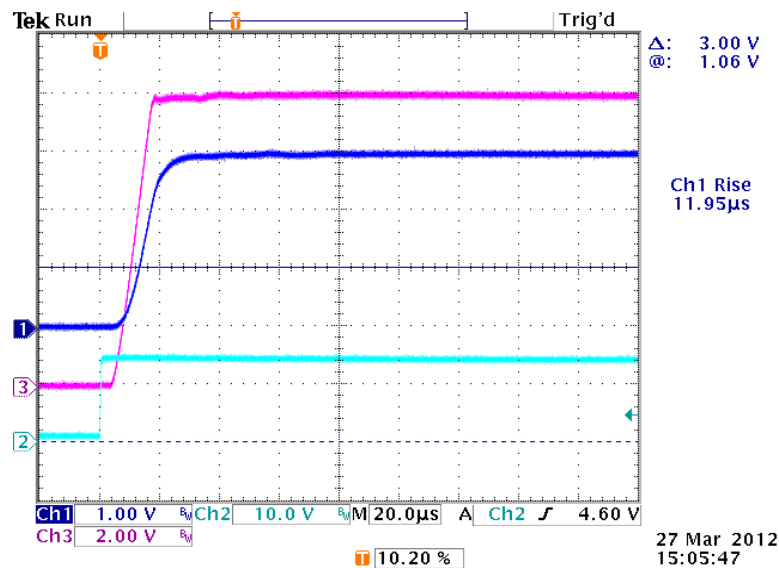


Figure 2, Typical Rise Time

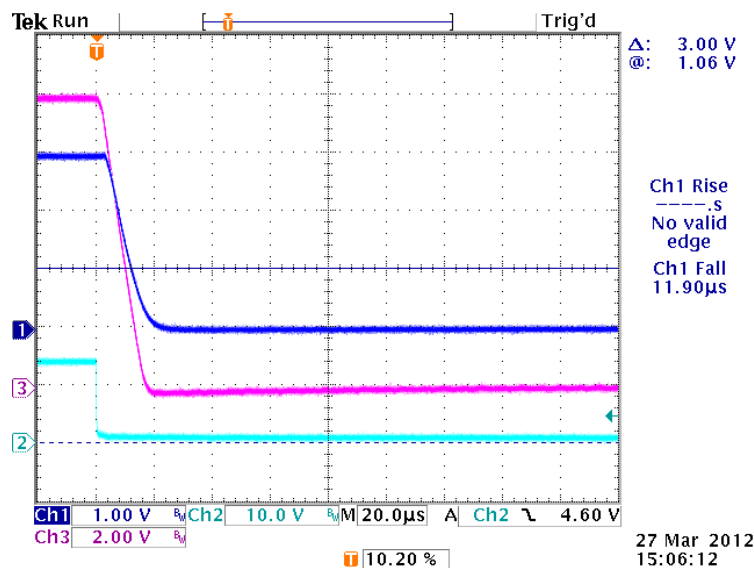


Figure 3, Typical Fall Time

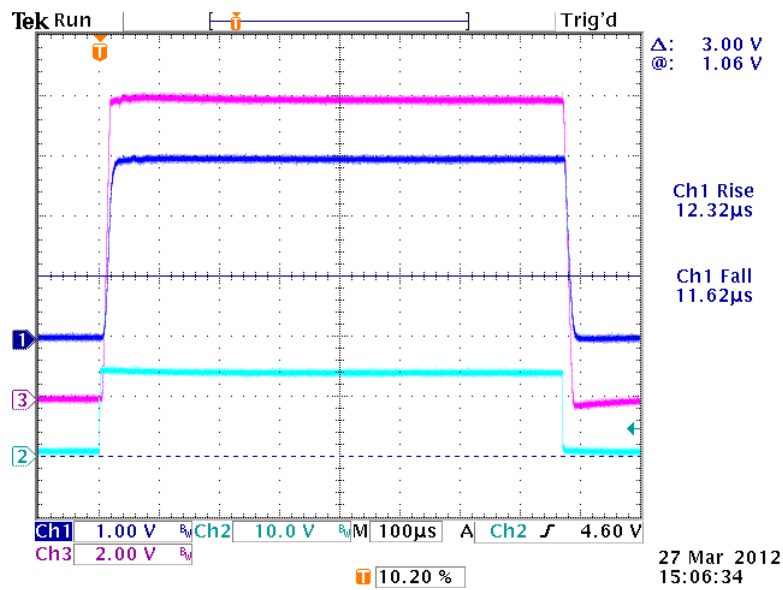


Figure 4, Pulse Output

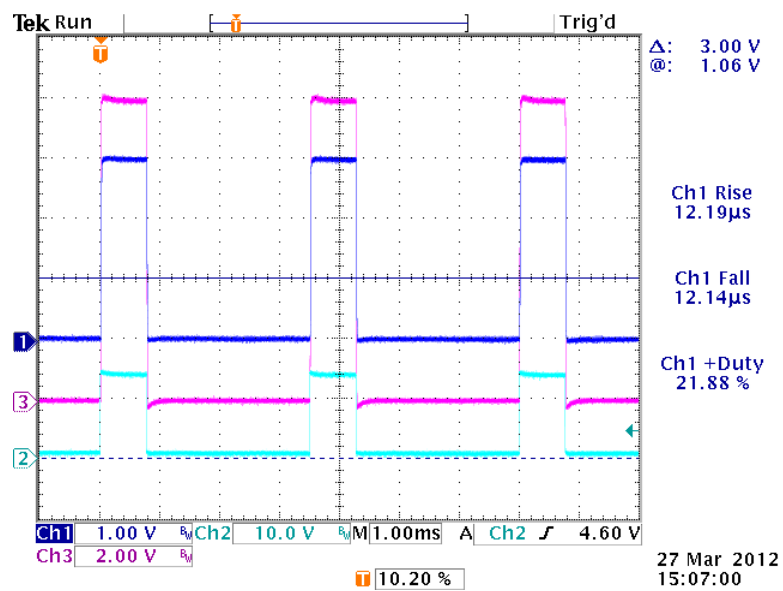


Figure 5, Repetition Rate

## 4. DC power supply for HPP

The HPP-750 can be driven by any DC power source without current fold-back.

When the HPP-750 is ON, it will draw high current from the DC source which should send continuous limited current to the HPP-750 and should not fold back because the HPP-750 needs a certain input voltage to operate.

It is recommended to use a LDN-2000, LDD-3000, or LDD-6000 to drive the HPP-750.

The LDD-3000/6000-xx-yy-HP is configured to run with the HPP. Output voltage can be set to match the laser load and output current can be set to meet the max average load current.

For lower average power, a LDN-2000 series power supply can be used with the VP option. This version has a voltage adjust control input on pin 7 (alternate input is pin 2, please consult factory) of the control interface to allow the user to match the LDN output voltage to the HPP-750 load requirements.



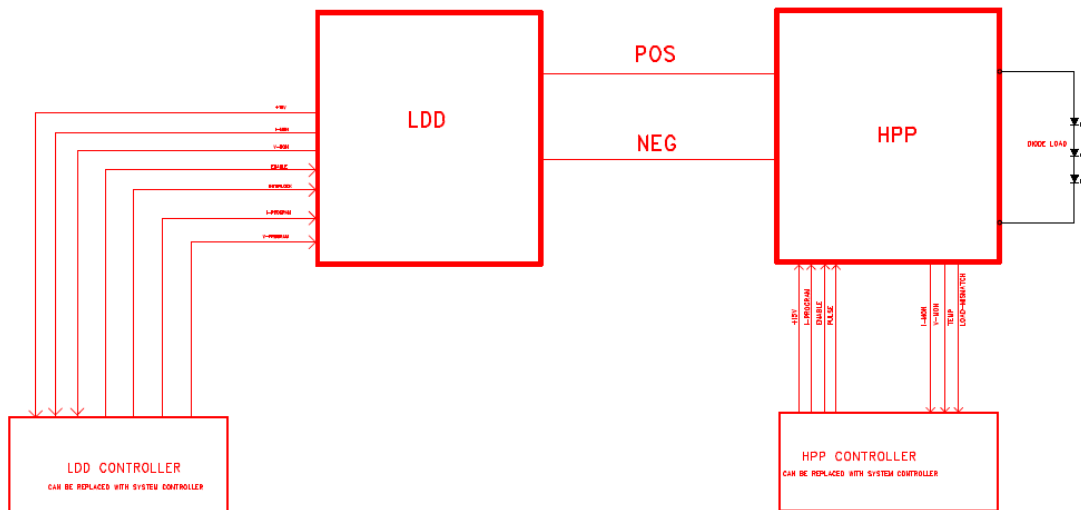
## Warning – Output Floating

**Do not connect the HPP-750 output or laser diode load to any ground, it must remain floating, or serious damage to the power supply and laser diode will occur!**

The output of the HPP-750 is floating and therefore, neither side of the laser diode must be connected to the same ground as signal ground (Program, Monitor).

## 5. Supply Interface Connections

The programming, monitoring, and control functions of the HPP-750 Interface are shown below. Refer to Figure 6 below for a simple laser setup.



**Figure 6, Connection Diagram**

## 6. LDD/HPP-750 integration and theory of operation

The HPP-750 was designed to work with Lumina Power's LDD power supplies with the variable output voltage programmable feature.

### The complete system includes:

- 1 LDD-pp-xx-yy-HP where pp is max power, xx is max current, yy is max output voltage and HP designates output voltage program feature.
- 2 HPP-pp-xx-yy-zz. pp is maximum average power, xx is maximum output current, yy is maximum load voltage, and zz is the maximum pulse width.

### Isolator PCB theory of operation:

The HPP-750 requires 15V to operate and the customer's control system **must supply 15V** to run the HPP-750.

### HPP-750 theory of operation.

The HPP-750 is a High Power Pulser. It is a linear current regulator with fast rise and fall time. The input voltage of the HPP-750 must be higher than its output voltage. The ratio of  $V_{out}/V_{in}$  is roughly its efficiency.

The HPP-750 is the most efficient pulser on the market given the rise time and fall time better than 15 $\mu$ s. The average input voltage for a given load varies due to pulse current and pulse width, and must be set such that at the end of the pulse there will be about 1V across the "linear regulator". The average input voltage is higher than the load voltage because the voltage on the internal capacitors will have some droop during the pulse.

The HPP-750 utilizes a proprietary scheme to have fast rise time even though the input voltage is a few volts higher than the output voltage, this gives the HPP-750 the highest efficiency for a linear regulator, and the inductance of the output cable seems to have disappeared.

The requirement is that the LDD output voltage must be programmed to be higher than the expected load voltage, but not too high that the HPP-750 cannot pull it down to have 1V at the end of the pulse. The HPP-750 has a "load-Match" detector circuit that will turn off the pulse if the difference between  $V_{in}$  and  $V_{out}$  is too high (more than 10V at more than 51% rated output current). To allow the best  $V_{out}$  program, the HPP-750 will defeat this protection feature when the output current is programmed less than 50%.

### See section Operation of the HPP Operation of the HPP for detailed operation setup.

For proper voltage programming, set and record the input voltage as follows: Program the output voltage to about 20% lower than the expected load voltage.

The voltage setting must be done with the Pulse signal set to OFF.

How to set up the system with an oscilloscope:

The oscilloscope must be floating, on the safe side, REMOVE the Ground prong on the scope power cord.

Use a 4-channel scope if available. 2-channel is OK.

Reference all Ground leads to the Negative DC Input of the HPP. It is NOT the same as the Negative output of the power supply due to high current ground loop.

For the following scope trace, the channel descriptions are

Channel 1: Output Current. 1V = 100 Amp.

Channel 2: Pulse signal input, from output of the Isolator.

Channel 3: Negative output terminal of the HPP.

This is the voltage across the linear regulator.

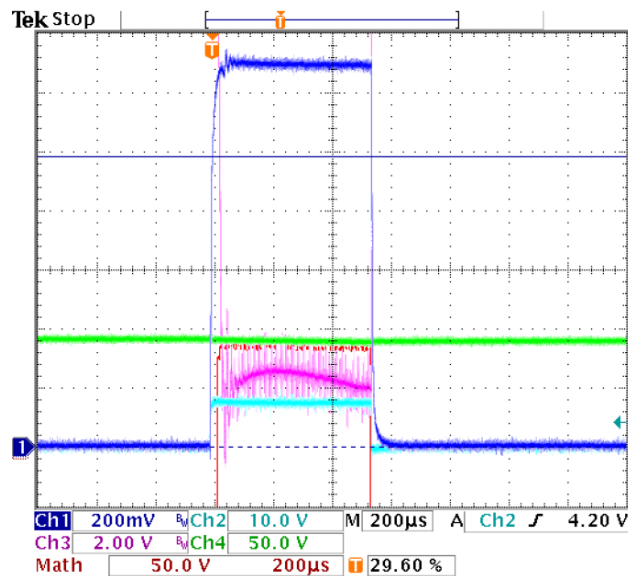
Channel 4: Buss voltage at the Positive input of the HPP.

Math: Load voltage, Channel 4 – Channel 3.

Run pulses with lower than 50% max pulse current. Set the LDD output voltage to 20% less than the diode load voltage. Monitor the output current to make sure the pulse shape is correct. Reduce the input voltage further by reducing the V-program signal on the LDD until the output current fails to regulate at the end of the pulse. This is the minimum input voltage required for this particular load. The output pulse should like Figure 7 below.

If the voltage is so high that the HPP-750 cannot pull it down to have 1 to 2V at the end of the pulse, the system will be inefficient which will result in overheating and shut down. On the oscilloscope, the buss oscillates, resulting in unstable output current.

If the voltage is too high, the HPP-750 will shut off the pulse by the “load-match” detector when the output current is higher than 50%.



**Figure 7, Good setting with 2V across the regulator at the end of the pulse  
Channel 3, at ~130 Amp, 95V.**

**See section** Operation of the HPP Operation of the HPP **for full details of operation setup.**

**CW/Pulse mode selection: (Optional)**

**To be used only to improve efficiency. Recommend NOT to be used in CW mode, as the control is complicated.**

In some applications where the system can switch from pulse to CW, the signal CW/Pulse can be used.

When in Pulse mode, the HPP-750 is working as a linear regulator and puts out the pulsed current requested at the I-program signal. This operation will require some voltage across the linear regulator and that translates into power loss.

When in CW mode, the transistors in the linear regulator are saturated and the only loss will be the Rds-on of the FET bank against the output current. The HPP-750 is now acting as a wire with the impedance of the Rds-on and the current should be controlled by the LDD.

It is advisable that the HPP-750 must be disabled, LDD output voltage should be programed to lower than the load voltage, and current should be programmed to minimum when switching from pulse to CW mode.

**CAUTION: If the output voltage is higher than the load voltage, there will be current spikes to the load that may damage the load.**

## 7. LDD with HP option

In a standard LDD, the output voltage is set to be 105% of, or about 10V above the required load voltage and it is just the compliant voltage, determined by the load.

The LDD-pp-xx-yy-HP is the Laser Diode Drive where -HP option designates the additional feature of programming and regulating the output voltage. The LDD-HP is normally set to be 5V to 10V higher than the load on the companion HPP-750.

When running with the HPP-750, set the LDD output current to about 5% more than the max average HPP-750 current. For example, consider the HPP-750-200-50-500, that is 750Watts, 200 Amp, 50V, 500us max pulse width.

Calculation:

Pulse power:  $200A * 50V = 10,000 \text{ Watts}$ .

Pulse energy:  $500\mu S \text{ of } 10000 \text{ Watts is } 5 \text{ Joules}$ .

Max frequency:  $750 \text{ Watts} / 5 \text{ Joules} = 150 \text{ Hz}$ .

Duty Cycle:  $500\mu s * 150\text{Hz} = 7.5\%$ .

Setting on LDD:  $V_{out} \sim 55V$

$I_{out} = 105\% * P/V_{load} = 1.05 * (750/50) = 16 \text{ Amp}$ .

The LDD interface is listed below for reference.

## LDD-6000-XX-YY -HP

### Connector Type 15 pin D-sub Female

Pin #	Pin Name	Functional Voltage Level	Description
1	<b>Enable</b> (input. 10k impedance)	High = RUN = +5V to +15V Low = OFF = 0V	The Enable function turns the output section of the power supply ON and OFF. Enable signal must be inserted AFTER AC power has been applied as the power supply starts up Disabled disregarding the state of the Enable signal.
2	V-Program	0 – 10V = 0-Full Scale Only when the Pulse signal on the HPP-750 is OFF or twisted pair to HPP-750 disconnected.	Program Output Voltage. Open = Default = Full Scale. <b>Note: Accuracy will be compromised when operating below 30% of the maximum value</b>
3	Interlock	Open = OFF Connect to GND = RUN	The Interlock function can be connected to external interlock switches such as door or over-temp switches.
4	GND		
5	<b>V-Monitor:</b> (Output 100Ω impedance)	0 – 10V = 0 – Full Scale	Monitors output Voltage.
6	<b>I-Mon</b> (Output 100Ω impedance)	0 – 10V = 0 – Full Scale	Monitor Output Current
7	I-Program (Input 200k impedance)	0-10V = 0 – Ioutmax optional. Usually internally set for 105% of HPP-750 max current.	The power supply output current is set by applying a 0-10V analog signal to Iprogram(+). <b>Note: Accuracy will be compromised when operating below 30% of the maximum value</b>
9	GND		
10, 11	<b>5V @0.2A</b> (output)		Auxiliary 5V power supply for user. Up to 0.2A output current available.
12	<b>-15V @0.2A</b> (output)		Auxiliary -15V power supply for user. Up to 0.2A output current available.
13, 14	<b>15V @0.2A</b> (output)		Auxiliary 15V power supply for user. Up to 0.2A output current available.
15	GND		

## 8. LDN with VP option

Another compatible power supply is the LDN series with the VP option. The LDN is only capable of 2000 Watts maximum. Customers can set the V-program on pin 7 (alternate input is pin 2, please consult factory) of the LDN to match the voltage requirements for operating the HPP-750 in the same manner as the LDDs. Please consult the factory for further information.

## 9. HPP-750 Specifications

Model	Average Pout	Output Current	Input Voltage	Size (L x W x H)
HPP-750-XX-YY-ZZ	750 W	Up to 400A Pulse	15 – 200VDC	7.99" x 5.35" x 2.96"
Where XX = $I_{out_{max}}$ YY = $V_{compliance_{max}}$ ZZ = maximum pulse width XX * YY * Duty Cycle cannot exceed 6000W				
<b>Auxiliary Outputs:</b> +15V @0.2A,				

### Input

Voltage 15-200 VDC current source, voltage limited

### Output

Power 750 Watts average

Pulsed Current up to 400 A peak

Continuous Current up to 50 A

Cable 1m (39.4 inch) long, included with unit

### Interface

Connector 15 Pin "D" Sub Female

Pulse Current Program 0-10V for 0-Max Current

Current Monitor 0-10V for 0-Max Current

### Performance

Max Rep Rate: 5 kHz

Rise/Fall Time: ~10  $\mu$ s typical (10% to 90% Full Current)

Current Regulation: 0.5% of maximum output current

Current Ripple: <0.5% of maximum output current

Current Overshoot: <1% of maximum output current

Efficiency: >90% at full load

### Environment

Operating Temp 0 to 40 °C

Storage -20 to 85 °C

Humidity 0 to 90% non-condensing

Cooling Forced air

Altitude and Pressure 2000 meters maximum, 80 to 103 kPa

### Dimensions

Please see Figure 14, HPP-750 Mechanical Outline

Drawing  
Outline 7.99 inch length, 5.35 inch wide, 2.96 inch high  
(does not include mounting flanges or electrical terminals)

## 10. HPP-750 Interface

Connector Type 15 pin D-sub Female

**Table 1, HPP-750 Interface**

Pin #	Pin Name	Functional Level	Description
1	<b>Pulse Input</b> (input, 10k impedance)	High = RUN = +5V to +15V Low = OFF = 0V	The <b>Pulse</b> function turns the pulse current On/OFF at high speed when the power supply is enabled. Current is delivered to load as programmed via <b>Iprogram(+)</b>
2, 3, 8	<b>GND</b>		
4	<b>Temp-Fault</b> (Output, 10k impedance)	15V = Good 0V = Over Temp Fault	Stops power supply when internal heatsink(s) reaches 75 °C
5	<b>Iout Monitor:</b> (output)	0 – 10V = 0 – Full Scale	Monitors output current in real time.
6	<b>Iprogram(+):</b> (input, 20k impedance)	0 – 10V = 0 – Full Scale	The power supply output current is set by applying a 0-10V analog signal to <b>Iprogram(+)</b> . Iprogram must be higher than simmer program on pin 9.
7	<b>Poor Load Match</b> (Output, 10k impedance)	0V=Good. 15V = Fault	Too low load voltage causes excessive voltage across the series regulator. This voltage is measured at the end of each pulse. Toggle Enable signal to clear fault.
9,13,15	<b>No Connection</b>		
10	<b>Vout Monitor:</b> (output)	0 – 10V = 0 – Full Scale	Monitors output voltage in real time.
11, 12	15V @0.4A (input)		+15V power supplied by user for operation of the HPP. Up to 0.4A required for operation.
14	<b>Enable</b>	RUN = +5V to 15V OFF = 0V, default	The Enable function turns the output section of the power supply ON and OFF. When the power supply is enabled, Pin 1 pulse control is operational and current is delivered to the load as programmed via Iprogram(+).



## 11. Operation of the HPP

### Warning – Output Floating

**Do not connect the HPP-750 output or laser diode load to any ground, it must remain floating, or serious damage to the power supply and laser diode will occur!**

The output of the HPP-750 is floating and therefore, neither side of the laser diode must be connected to the same ground as signal ground (Program, Monitor).

### Warning – Output Floating

**Do not connect an oscilloscope or any instrumentation directly to the laser diode load! Only floating measurements can be used such as a differential voltage probe and Hall Effect current sensors.**

### Warning – Voltage Compliance Requirement

Each HPP-750 is custom configured to deliver current pulses into a diode array requiring a predefined compliance voltage.

See the Serial Number label of the unit for the compliance voltage rating. The HPP-750 takes DC input voltage and will not operate properly when the input is great than 10V higher than the load compliance voltage and will not start when the input is 20V lower that the rating on the S/N label or lower than 20V.

Consult factory more wider operating window.

1. Connect the diode laser load to the HPP. A custom twisted cable is supplied to minimize inductance. Please note the cable uses red and black wires, red for the positive connection and black for the negative connection. Do not extend output cable or performance will be compromised.
2. Connect the customer controller to the HPP-750 Interface Connector. Make sure **Iprogram(+)**, pin 6, is set to 0.0V.
3. Connect HPP-750 to the feeding DC power supply, which is OFF.
4. Turn on the +15VDC to pin 11 and 12 to supply power to the HPP-750.
5. Turn ON the feeding DC power supply.
6. Set **Iprogram(+)**, Pin 6 of the interface connector, This signal is the 0-10V program which will program the output current level. Calibration is set so that  $0-10V = 0 - I_{out_{max}}$ .
7. **Enable** the output by applying a TTL level high signal to pin 14 of the interface connector. The **Enable** control checks for faults and prepares the system for pulsing.
8. Pulse the unit via the **Pulsing Input** control, pin 1. Maximum pulse widths should not be greater than specified on the system label. The amplitude of the pulses will be determined via the analog **Iprogram(+)** signal. Maximum average

power delivered to the load should not exceed the rated power capability of the unit.

9. Slowly increase the feeding DC power supply voltage to obtain a good output pulse. See Setting the Voltage Programming below.

### **Measurement during setup with an oscilloscope:**

The oscilloscope must be floating; either REMOVE the ground prong on the scope power cord or use a differential voltage probe.

Use a 4-channel scope if available. 2-channel is OK.

Reference all Ground leads to the Negative DC Input of the HPP-750. It is NOT the same as the Negative output of the HPP-750 pulser!

The following scope traces have the inputs set as follows:

- Channel 1: Output Current. 1V = 100 Amp.
- Channel 2: Pulse signal, from output of the Isolator.
- Channel 3: Negative output terminal of the HPP.  
This is the voltage across the linear regulator.
- Channel 4: Buss voltage at the Positive input of the HPP.
- Math: Load voltage, Channel 4 – Channel 3.

When the HPP-750 and LDD are correctly set up the output pulse should look like Figure 8 below.

### **Setting the Voltage Programming**

At the beginning, ALWAYS set the LDD bus voltage LOWER than the expected load voltage. Monitor HPP-750 output current and slowly increase the LDD output voltage to have a perfect square wave on HPP-750 current.

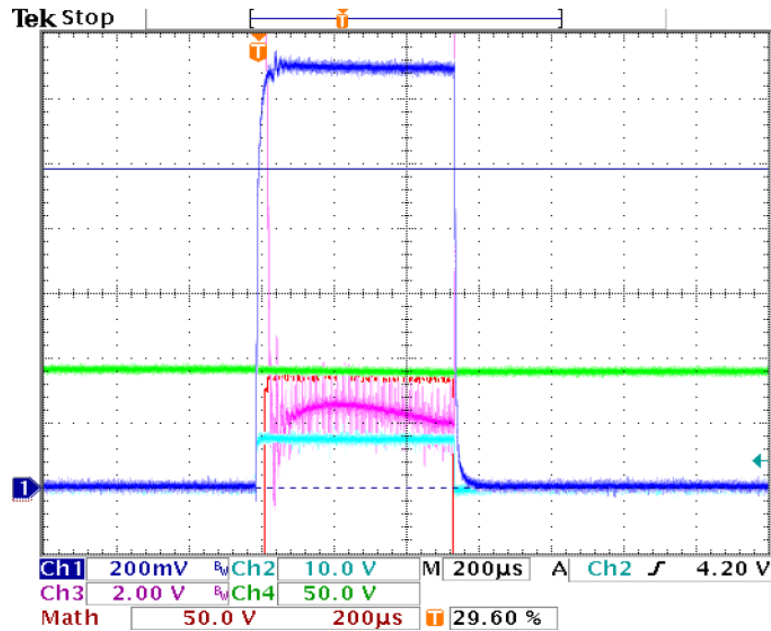
Measure and record LDD output voltage.

During production operation, set the LDD output voltage 7V - 10V higher than the recorded voltage. Set LDD voltage ONLY when the Pulse signal = OFF.

For proper voltage programming, set and record the input voltage as follows:

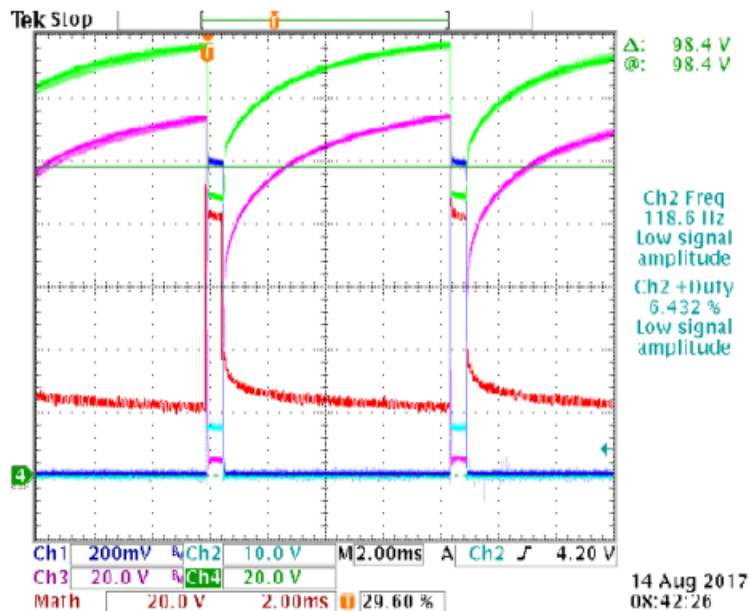
1. Program the output voltage to about 7-10V higher than the expected load voltage. The voltage setting must be done with the Pulse signal = OFF.
2. Run pulses with less than 70% max pulse current. Monitor the output current to make sure the pulse shape is correct.
3. Reduce the input voltage further by reducing the V-program signal on the LDD until the output current fails to regulate at the end of the pulse, see Figure 12 & 13. This is the minimum input voltage required for this particular load and output current.
4. Set the HPP-750 Pulse Input to off and program the LDD output voltage about 7-10V higher than the minimum voltage from step 3. Make sure the Pulse signal is OFF (disabled) at this time.
5. Set the HPP-750 Pulse Input to ON and slowly increase the I-Program input to the desired pulse current output. Verify the output pulse appears like Figure 8 below.

6. If necessary, adjust the DC feed supply voltage so there is between 2 to 3 volts across the regulator at the end of the pulse as shown in Figure 8.



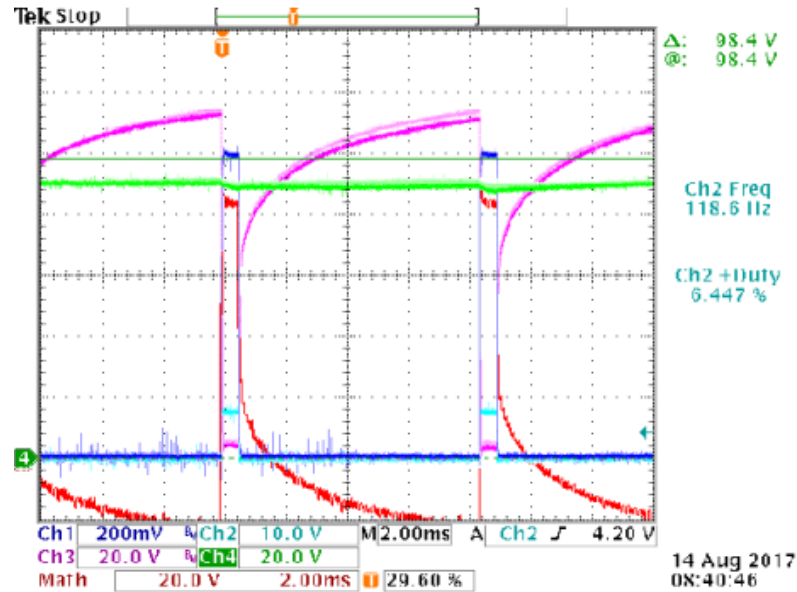
**Figure 8, Good setting with 2V across the regulator at the end of the pulse  
Channel 3, at ~130 Amp, 95V.**

A correct setup pulse train is shown below in Figure 9 for a 100A output pulse and 90V input to the HPP.



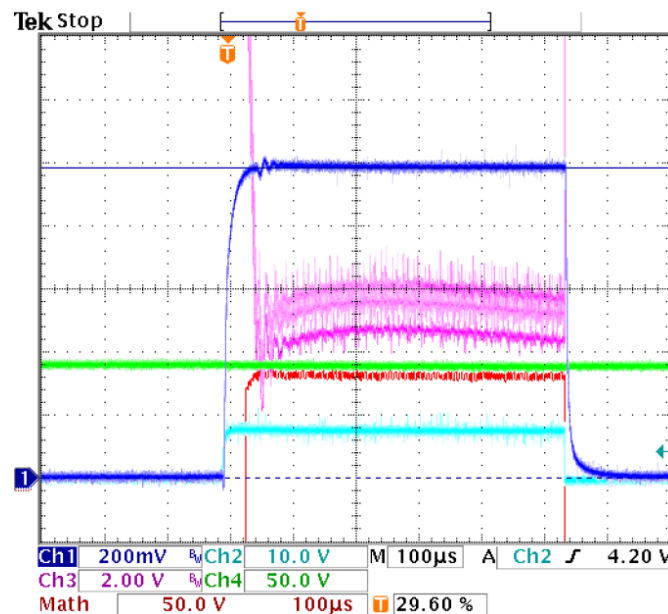
**Figure 9, Good Pulse Train Stable Operation at 100A output, 90V input.**

If the voltage is too high such that the HPP-750 does not have 2V -3V at the end of the pulse, the system will be inefficient which will result in overheating and fail. The buss oscillates, resulting in unstable output current. In Figure 10 & 11 the HPP-750 negative output terminal, channel 3, is oscillating between 4.5 and 6 volts indicating that the input voltage is too high.



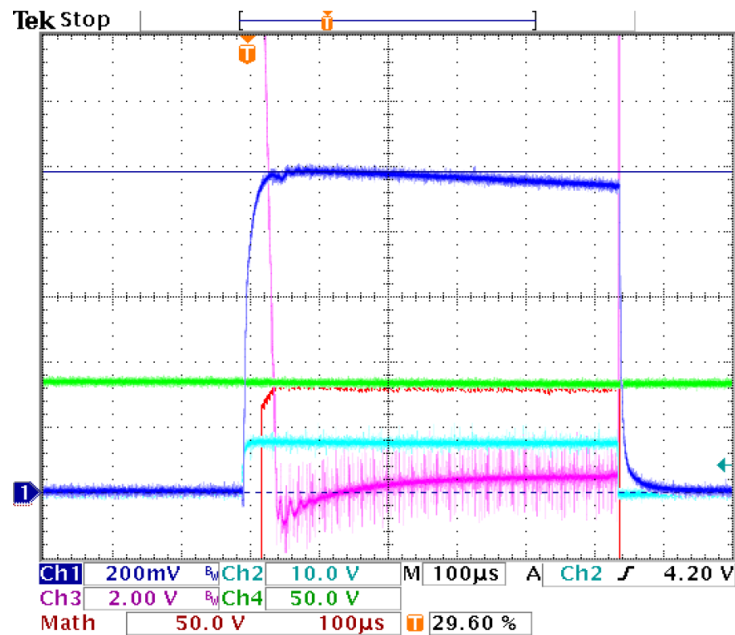
**Figure 10, Buss voltage set too high.**

If the voltage is too high, the HPP-750 may shut off after 3 pulses by the “load-match” detector when the output current is higher than 50%.



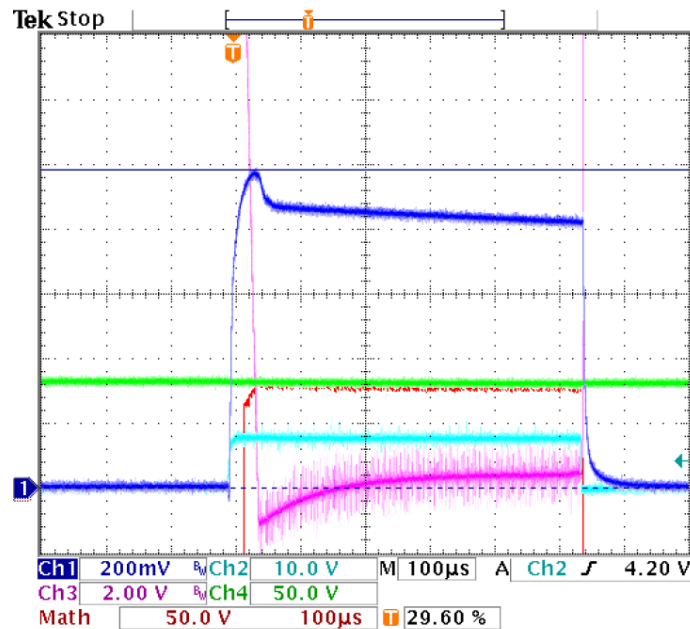
**Figure 11, Buss voltage set too high.**

If the buss voltage is a little too low then the output current starts to droop as shown in Figure 12 below. The HPP-750 negative output on channel 3 indicates less than one volts so the linear regulator cannot regulate the output current.



**Figure 12, Buss voltage set too low, output current starts to droop**

If the buss voltage is very low then the linear regulator cannot regulate at all and the current drops to the I-V curve of the load as shown in Figure 13 below.

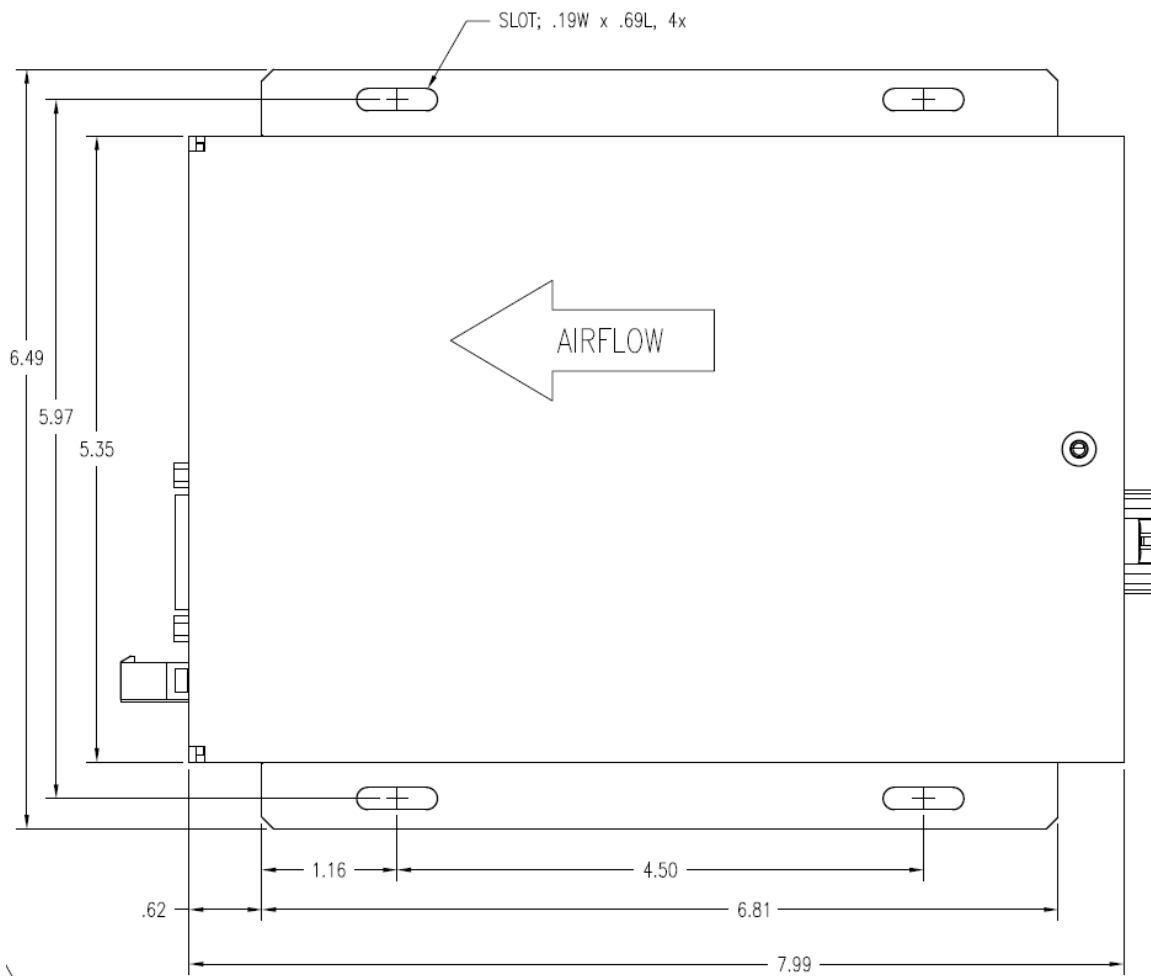


**Figure 13, Buss voltage very low, no pulse regulation**

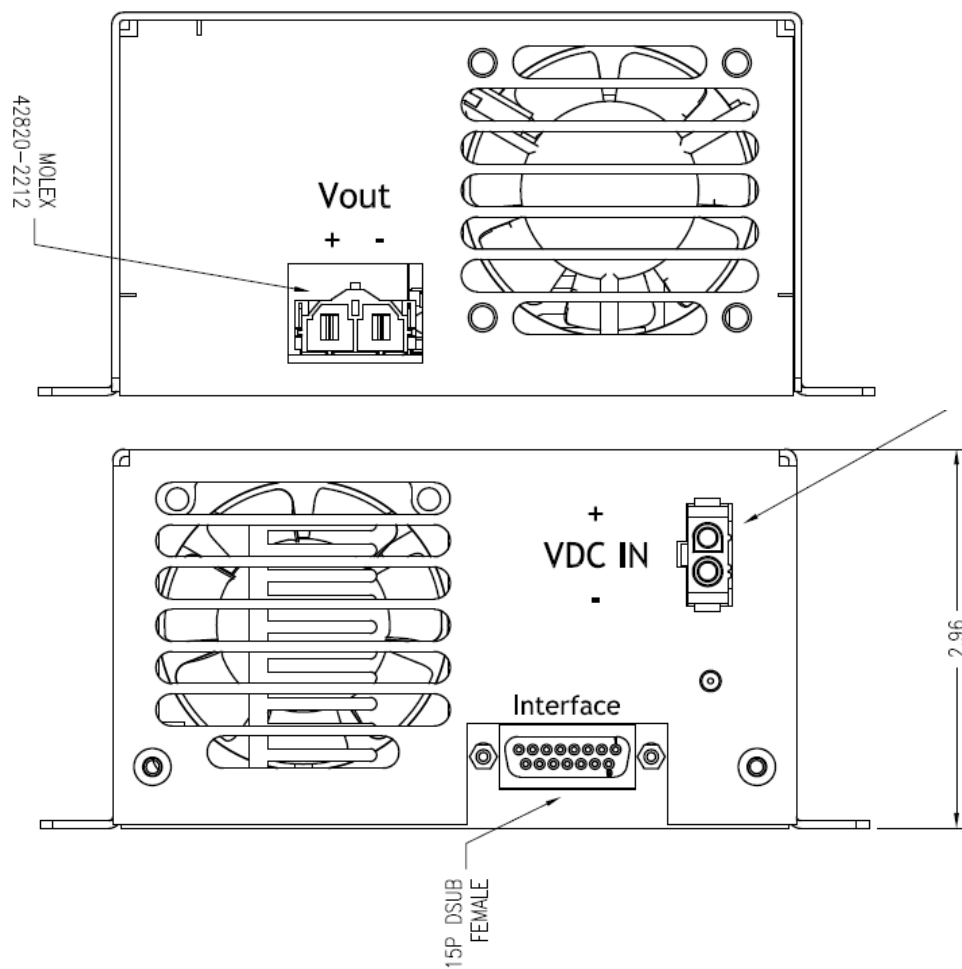
## Unit Faults

The unit is designed to monitor various faults such as:

- **Temp Fault: (Output, TTL, Pin 4)** When the temperature of the internal heat sink has exceeded a safe operating level, the system is shut off and this fault is transmitted. Fault output is TTL high. Fault can be cleared by setting the **Enable**, pin 14, to TTL low and then high.
- **Poor load match: (Output, TTL, Pin 7)** When the voltage compliance of the diode laser load is 8V lower than the DC input voltage. This fault may be cleared via the **Enable** signal.



**Figure 14, HPP-750 Mechanical Outline Drawing, Top View**



**Figure 15, HPP-750 Mechanical Outline and Connections, Front and Back View**



## 12. Product Limited Warranty

Lumina Power, Inc., as Seller, warrants that each Product sold by it is free of defects in materials and workmanship. Duration of warranty is as follows:

- a. All Chassis enclosed products are covered for twenty four (24) months from date of shipment. Products included but are not limited to the following product families: CCPF, CCHP, LDY, LDYHC, LDQCW, XLB (excluding XLB-300), and MLB. Custom fully enclosed products may be covered for the same 24 months. Please consult factory for specific terms.
- b. All Open Frame products are covered for 12 months from date of shipment. Open frame power supplies are defined as any product that is not enclosed in a metal or plastic enclosure. Products included but are not limited to the following product families: LDPC, LDQPC, XLB-300 and any open frame custom products.
- c. All products returned for repair are covered for a period of 6 month or the balance of the original warranty, whichever is longer.

Warranty is not transferable to parties outside of original Buyer's corporate or educational organization. Seller will have sole discretion in making determination of validity of warranty if the Product is transferred to a different user group than the original Buyer.

Normal wear and tear and items expendable in normal use are not covered by this warranty. All warranty repair or replacement of parts shall be limited to Product malfunctions, which, in the sole opinion of Seller, are due or traceable to defects in original materials or workmanship. Such determination will be made when the Product is returned to the Seller's factory, transportation prepaid by the Buyer, within the warranty period.

All obligations under this warranty shall cease immediately in the event of abuse, accident, alteration, misuse, or neglect of the Product. Use and service of the Product in a manner not in accordance with the Owner's Manual (if furnished) will likewise cause all obligations under this warranty to cease. Repaired or replacement parts are warranted only for the remaining unexpired portion of the original warranty period for the Product. After expiration of the applicable warranty period, Buyer shall be charged at the then current prices for parts, labor, and transportation.

Seller has no responsibility under this warranty for the cost of any work (material, labor, and/or other expenses) performed by or incurred by Buyer or any third party for modification or repair of the Product unless specifically authorized in advance in writing by Seller.

Reasonable care must be used to avoid hazards. Seller expressly disclaims responsibility for loss or damage caused by use of its Products other than in accordance with proper operation procedures. Other than those expressly stated herein, there are no other warranties of any kind, expressed or implied, and specifically included but not by way of limitation are the implied warranties of fitness or merchantability for a particular purpose.

It is understood and agreed the seller's liability whether in contract, in tort, under any warranty, in negligence or otherwise shall not exceed the return of the amount of the purchase price paid by the purchaser and under no circumstance shall seller be liable for special, indirect, incidental, or consequential damages. The price stated for the product is a consideration in limiting seller's liability. No action, regardless of form, arising out of the transactions of this agreement may be brought by purchaser more than one year after the cause of action has accrued.

Seller's maximum liability shall not exceed and buyer's remedy is limited to either (i) repair or replacement of the defective part of product, or at seller's option (ii) return of the product and refund of the purchase price, and such remedy shall be the buyer's entire and exclusive remedy.

## 13. Service

**This unit contains no user serviceable parts.** Service and repair should be performed only by qualified personnel from Lumina Power, Inc. For more information contact

**Lumina Power, Inc.**  
**26 Ward Hill Ave.,**  
**Bradford, MA 01835**  
**Ph: 978-241-8260**  
**Fx: 978-241-8262**

**Email:** sales@luminapower.com      **Web site:** www.luminapower.com

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1	7739	Initial Release	MJ	02/26/2018	EK
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