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USER MANUAL
LDD-600/1000/1500-XX-YY
CW Diode Driver Power Supplies

The LDD-600/1000/1500 family of high power CW diode laser can be configured for output currents from as low as 10A to output current up to 100A at maximum power levels from 600W to 1500W.

As a laser diode driver, the LDD diode driver acts as a programmable current source and delivers constant current based on the input program signal, Iprogram(+), which is normally 0-10V. All units are configured with a maximum current and maximum voltage capability, depending on the user's requirements. LDD power supplies will deliver current, as programmed, into any load, providing the voltage requirements of that load do not exceed the maximum rated voltage of the unit. When the required compliance voltage is higher then the maximum rated output voltage of the unit, the unit will limit output current.

LDD diode drivers utilize a proprietary low loss, high frequency power factor correction circuit which keeps 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.

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Tables and Figures

LDD Diode Drivers - Theory of Operation

(Refer to Figure 1)

LDD laser diode drivers were designed specifically for the OEM high power CW laser diode systems. OEM power supplies for the laser diode industry have the following requirements:

- Safe laser diode operation
- Broad range of control of output current
- Safe rise/fall times
- Small size
- Power factor correction to conform with CE requirements
- Low conducted electromagnetic emissions
- Low leakage for medical applications

Referring to the "LDD Laser Diode Power Supply" 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 LDD-600/1000/1500 line filter has minimum capacitance to ground to minimize leakage currents. Earth Ground stud is provided near the AC input terminals and should be connected to the system ground.

Power Factor Correction Boost Inverter

The rectified input power is next applied to power factor boost inverter. This inverter boosts the input voltage to 400VDC. In the process of boosting the input AC 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.

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 input capacitor filter. This results in substantial switching noise conducted to the line. 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.

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 the appropriate 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 I^2R 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 heatsink requirements.

Output Circuit

The output filter is a two stage RC filter designed to keep ripple and output noise very low.

Control Circuit

The control circuit handles all the responsibilities associated with safe operation of the laser diode. Controlled rise and fall times, 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 and +5V power supplies are derived from the power factor control boost inductor. All auxiliary power supplies are regulated by standard linear regulators.

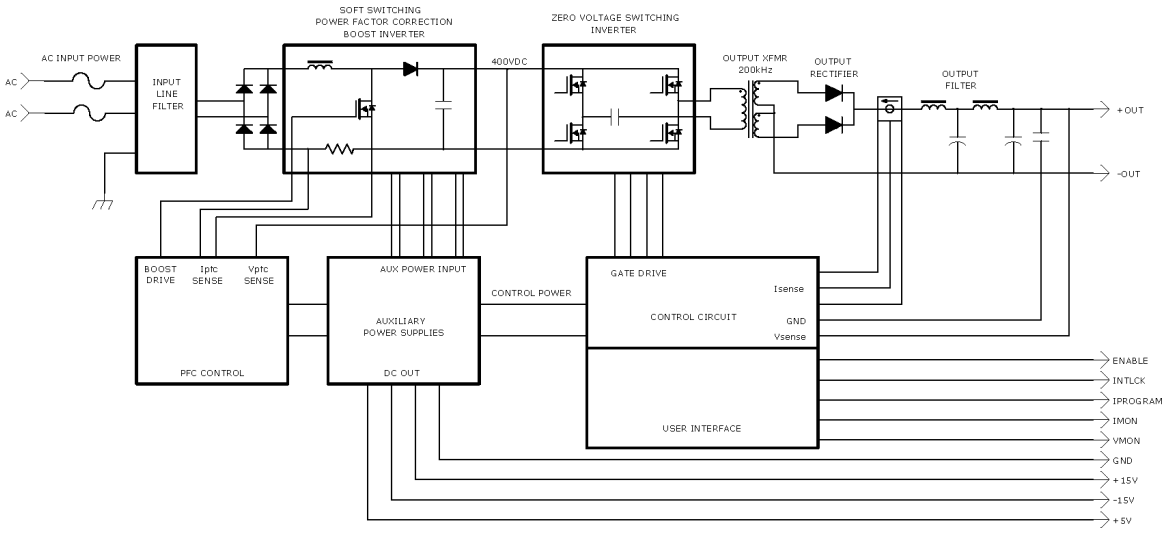


Figure 1
LDD-600/1000/1500 Block Diagram

LDD-600/1000/1500-XX-YY SPECIFICATIONS

XX = $Iout_{max}$ YY = $Vout_{max}$ XX * YY cannot exceed $Pout_{max}$

Model	$Pout_{max}$	$Iout_{max}$	Input Voltage	Size (L x W x H)
LDD-600-XX-YY	600W	Can be configured from 10A to 100A	100-240VAC	9.9" x 7.2" x 2.5" 25.1 x 18.3 x 6.35 cm
LDD-1000-XX-YY	1000W		100-240VAC	
LDD-1500-XX-YY*	1500W		200-240VAC	
Auxiliary Outputs: +5V @0.25A +15V @0.25A -15V @0.25A				
* LDD-1500 input voltage: 200-240VAC Maximum compliance voltage determined by maximum rated power				
RS-232 Option available **Other outputs available upon request**				

Input

Voltage: See table above
Power Factor: >.98

Interface

Connector: 15 Pin "D" Sub Female
Current Program: 0-10V for 0-Max Current
Current Monitor: 0-10V for 0-Max Current
Voltage Monitor: 0-10V for 0-Max Voltage

Performance

Rise/Fall Time: ~600usec (10% to 90% Full Current)
Current Regulation: 0.5% of Maximum output current
Temperature Drift: 0.5% over temperature range after 30 minute warmup (<0.5% in first 30 minutes)
Current Ripple: <0.5% of maximum output current
Current Overshoot: <1% of maximum output current
Power Limit: Limited to maximum power with power fold-back circuit

Environment

Operating Temp: 0 to 40 ^{o}C
Storage: -20 to 85 ^{o}C
Humidity: 0 to 90% non-condensing
Cooling: Forced air

Regulatory

Leakage Current: <350uA

Approvals:

Medical Safety: UL60601-1, IEC 60601-1, EN 60601-1, CAN/CSA C22.2 No. 601.1-M90
Industrial Safety UL60950
Emissions/Immunity: FCC 47 CFR Class A Emissions, EN55011:1998 Group 1 Class A Emissions, EN61000-3-2 Limits for harmonic current emissions, EN 610000303 Flicker, EN60601-1-2:2001 Electromagnetic emissions and immunity for medical equipment

Dimensions:

See Figure 2, LDD-600/1000/1500 Outline Drawing

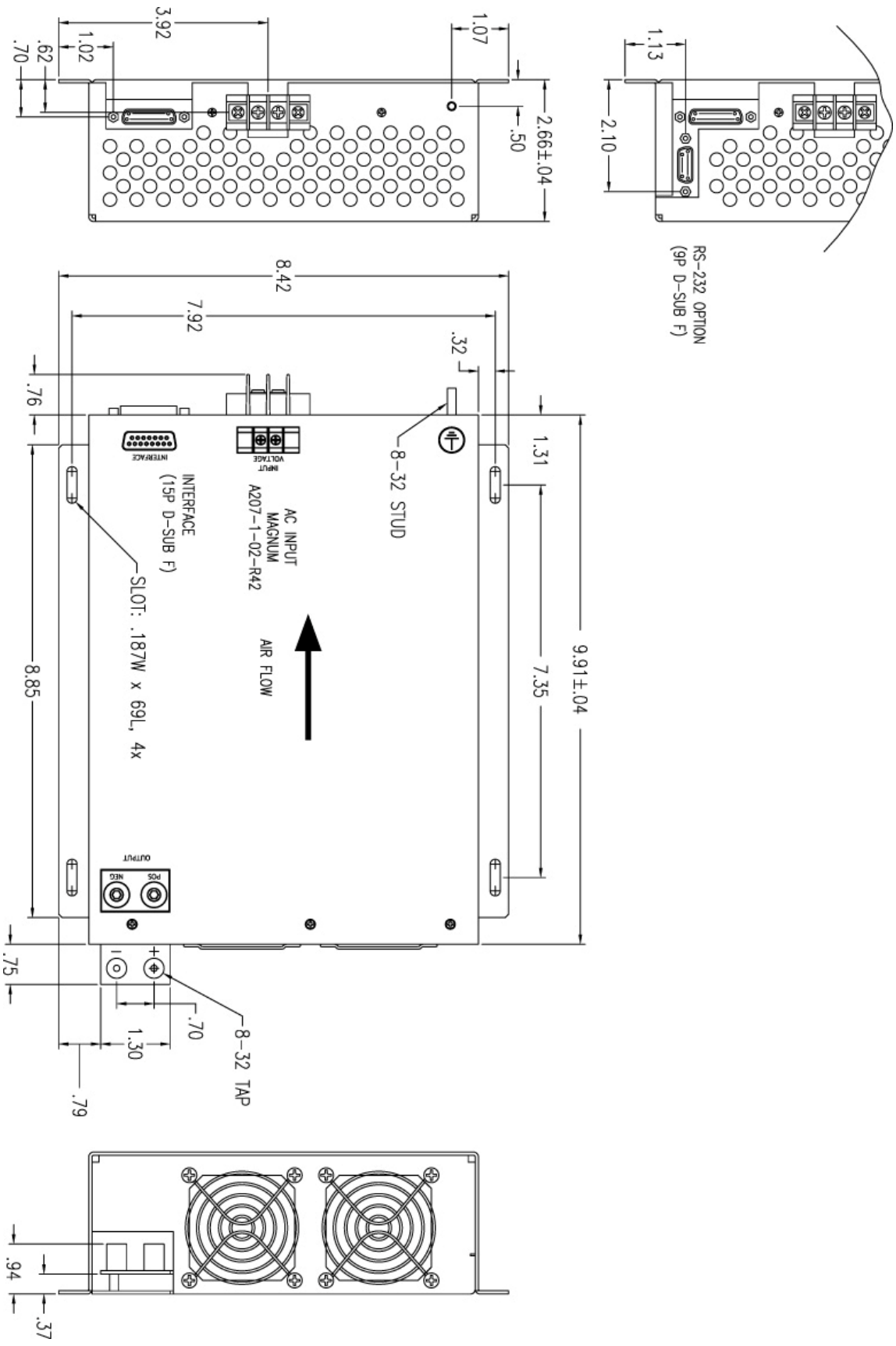


Figure 2
LDD-600/1000/1500 Outline Drawing

LDD-600/1000/1500-XX-YY Interface

(Where XX = $Iout_{max}$, and YY = $Vout_{max}$)

Connector Type: 15 pin D-sub Female

(Refer to Figure 3, LDD Interface Schematic)

Pin #	Pin Name	Functional Voltage Level	Description
1	**Enable** (input)	High = RUN = +5V to +15V Low = OFF = 0V	The **Enable** function turns the output section of the power supply ON and OFF. When the power supply is enabled, current is delivered to load as programmed via **Iprogram(+)**, Pin 7. Rise times resulting from **Enable** are approximately 25msec.
2	N/C		
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	GND		Referred to (-) output of power supply.
5	**Vout Monitor**: (output)	0 – 10V = 0 – $Vout_{max}$*	The output voltage of the supply can be monitored by **Vout Monitor**.
6	**Iout Monitor** (output)	0 – 10V = 0 – $Iout_{max}$	The output current of the supply can be monitored by **Iout Monitor**.
7	**Iprogram(+)**: (input)	0 – 10V = 0 – $Iout_{max}$	The power supply output current is set by applying a 0-10V analog signal to **Iprogram(+)**.
8	N/C		
9	GND		Referred to (-) output of the power supply.
10,11	**+5V @ 0.5A** (output)		Auxiliary +5V power supply for user. Up to 0.5A output current capability.
12	**-15V @0.5A** (output)		Auxiliary -15V power supply for user. Up to 0.5A output current available.
13,14	**+15V @0.5A** (output)		Auxiliary +15V power supply for user. Up to 0.5A output current available.
15	Gnd		Referred to (-) output of the power supply.

TABLE 1: LDD-600/1000/1500 Interface

* If maximum compliance voltage is less than 10V, **Vout Monitor** will read output voltage directly. If maximum compliance voltage is greater than 10V, then **Vout Monitor** will be scaled such that 0-10V = 0-$Vout_{max}$.

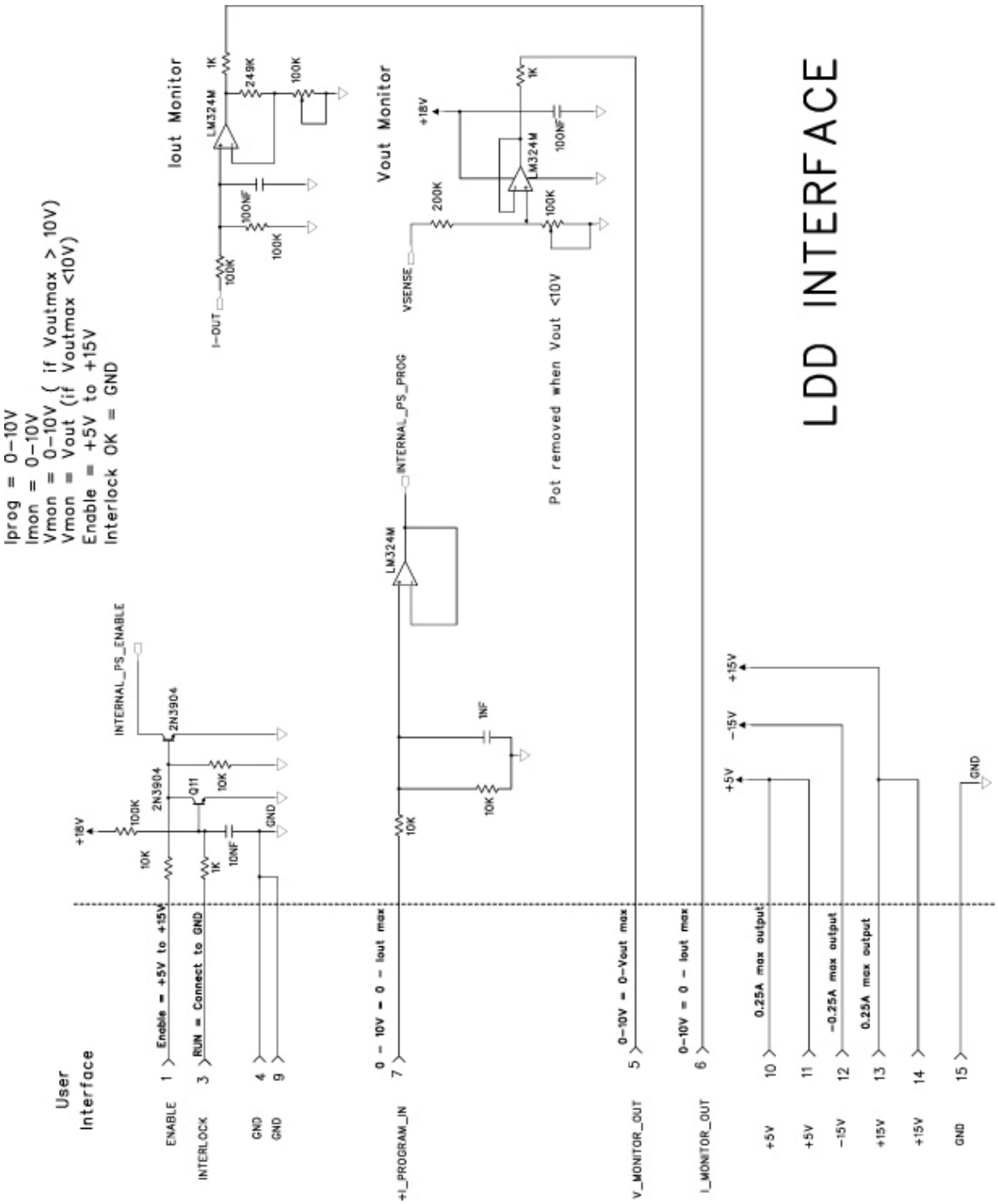


Figure 3
LDD-600/1000/1500 Interface

INSTALLATION AND OPERATION OF
LDD-600/1000/1500 Diode Drivers

IMPORTANT INSTALLATION NOTES

- LDD-600/1000/1500 diode drivers are air cooled by internal fans. Do not restrict air flow near the input or output air vents of the power supply. If the unit overheats due to restricted air flow, it will shut down and remain off until the unit has cooled to a safe operating temperature.
- LDD-600/1000/1500 units should be mounted in systems using 8-32 (or M4) bolts to secure the mounting flanges to mounting plate.

SAFETY WARNING

Because LDD-600/1000/1500 units are designed for OEM applications, the user must connect AC input power to the power supply. Any input AC voltage must be considered extremely dangerous and extreme care must be taken to connect AC input power to the unit.

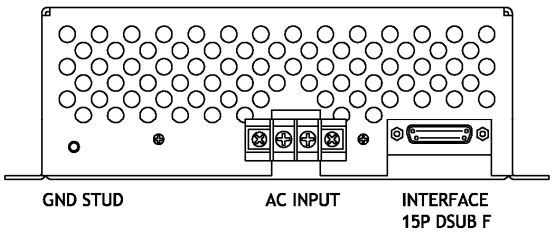


Figure 4
Input Connections

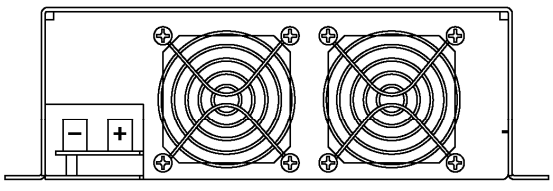


Figure 5
Output Connections

1. **CONNECTING TO DIODE LASER** Figure 5 shows the location of the LDD-600/1000/1500 output terminals. Connect diode laser load to the output terminals. **Consult standard wire gauge tables to ensure proper gauge wire with respect to maximum output current.** Although CW diode laser applications are generally free of voltage spikes associated with high speed Quasi-CW applications, it is still good practice to keep connections between the diode laser and power supply as short as possible to avoid I^2R losses in the wire.

2. **INTERFACE CONNECTION** Connect user system to 15 pin D-sub connector shown in Figure 4. (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 3 for description of LDD-600/1000/1500 Interface and the associated simplified interface schematic.

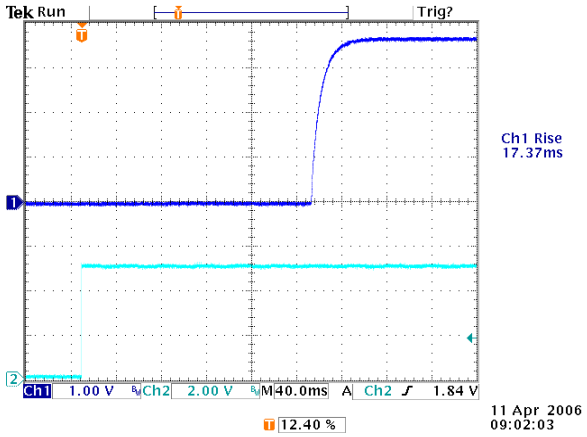
IMPORTANT NOTE

Make sure when connecting interface that the current program setting, **Iprogram(+)**, is set no higher then the value required for operation. When AC power is applied and system is **Enabled**, output current will rise to this program value

3. **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.
   b. **ENABLE**: Pin 1, the **ENABLE** signal is a 5V to 24V signal used to turn the output section on. The **ENABLE** circuitry incorporates a soft start function which ensures rise times of approximately 15 to 20msec.

CH 1
Iout
20A/div

CH 2
ENABLE



Response of Iout to ENABLE signal

   c. **Iprogram:** Pin 7. A 0-10V signal results in 0 to $Iout_{max}$, as long as the rated compliance voltage of the driver is not exceeded.

4. **Operating the LDD**
   a. **AC INPUT POWER CONNECTION** Connect AC power connections to power supply input power terminals as follows (refer to Figure 3.):.
      - Neutral wire (16AWG) connected to the right contact of the AC input terminal (labeled N).
      - Line wire (16AWG) connected to the left contact of the AC terminal block.
      - Ground wire shall be crimped to a # 8 ring-lug and connected to the ground stud.

IMPORTANT APPLICATON NOTE REGARING AC INPUT POWER

AC Input wires should be at least #16 AWG, rated for at least 300V and 105DegC.

IMPORTANT SYSTEM NOTE ON AC INPUT POWER

LDD-600/1000/1500 units are fused on both input lines. It does not matter which of the two AC inputs are designated Line or Neutral.

AC input power requirements for LDD-600/1000/1500 models are as follows:

Table 2
LDD-600/1000/1500 AC Input Power Requirements

MODEL	INPUT POWER
LDD-600-XX-YY	100-240 VAC, 50/60 Hz, 7A @115VAC
LDD-1000-XX-YY	100-240 VAC, 50/60 Hz, 12A @115VAC
LDD-1500-XX-YY	200-240 VAC, 50/60 Hz, 9A @220VAC

b. **INTERFACE SETTINGS**: Make sure **INTERLOCK**, Pin 3, is connected to GND.
c. **APPLY INPUT AC POWER** Turn ON AC power. After a few seconds the power supply fans should begin to run.
d. **PROGRAMMING OUTPUT CURRENT** Program LDD-600/1000/1500 power supply for desired output current. Once the unit has been **ENABLED** via Pin 1, a 0-10V signal applied to **Iprogram**, Pin 7, will program the LDD-600/1000/1500 diode driver for 0 to maximum rated output current.

IMPORTANT APPLICATION NOTE
When the power supply is enabled using the ENABLE signal, internal soft start functions limit the rise time of the output current to approximately 20msec. Once the power supply is enabled, the rise/fall time of the Iprogram(+) signal is approximately 600usec.

e. **ENABLE OUTPUT** Apply +5V to +15V to **ENABLE**, Pin 1. The LDD-600/1000/1500 will deliver output current as programmed.

5. **Monitoring LDD 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. If maximum compliance voltage is less than 10V, **Vout Monitor** will read output voltage directly. If maximum compliance voltage is greater than 10V, then **Vout Monitor** will be scaled such that 0-10V = 0-$Vout_{max}$.

Optional RS-232 Protocol
LDD-600/1000/1500-XX-YY-RS

Refer to Figure 2, LDD-600/1000/1500 Outline Drawing for location of RS-232 Connector

The RS232 interface for Lumina supplies has the following characteristics:

Baud rate: 9600
Command format: ASCII characters terminated by carriage return
Reply formats: ASCII characters terminated by carriage return
Connection: 9 Pin "D" Female (**Tx**: Pin 2, **Rx:** Pin 3, **GND**: Pin 5)

The interface supports programming the output current and power limit of the supply and reading back the output current and voltage. The output can be turned on and off with a command as well.

Command	**Reply**	**Function**
P***xx.xx@xx.xx***<cr>	<cr>	Program output current to max rated output current ***xx.xx*** between 0 and 10.00 = 0 – $Iout_{max}$ (Note: P***xx.xx***<cr> will also work)
I<cr>	***xx.xx***<cr>	Read output current ***xx.xx*** between 0 and 10.00 = 0 $Iout_{max}$
V<cr>	***xx.xx***<cr>	Read output voltage ***xx***. ***xx*** between 0 and 10.00 = 0 to $Vout_{max}$
ON<cr>	<cr>	Enable supply output
OFF<cr>	<cr>	Disable supply output
Jhkhkh<cr>	?<cr>	Response to unrecognized command

Numbers sent to the supply should be in fixed point decimal format. The numbers sent back will have four digits and a decimal point, but the resolution is limited to 12 bits and the accuracy is limited by the specifications of the supply.

Connections to Analog Interface when using RS-232

Interlock function, **Pin 3**, must be employed whether using LDD analog interface or RS-232. None of the other controls in the Analog interface need be utilized when using the RS-232 optional interface.

Analog Connector Type: 15 pin D-sub Female

(Refer to Figure 2, LDD Interface Schematic)

Pin #	Pin Name	Functional Voltage Level	Description
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. **Must be used with RS Interface**

Servicing LDD-600/1000/1500 Diode Drivers

LDD-600/1000/1500 units have no serviceable parts. Do not attempt to repair or service this unit in the field. For further information, contact Lumina Power at 978-241-8260.

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