Lumina Power, INC.

USER MANUAL

LDD-3000 CW Laser Diode Driver

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Product Overview

The LDD-3000 laser diode driver is intended for OEM laser applications using high power diode lasers. It has been designed to be integrated into systems for maximum performance at a cost far below traditional laboratory and scientific laser diode drivers.

The LDD-3000 utilizes a proprietary low loss, high frequency power factor correction circuit which keeps power factor above 0.98. Power factor corrected powers supplies use up to 30% less input current and meet stringent IEC harmonic requirements. The output inverter is state-of-the-art zero voltage switching (ZVS) inverter which permits very high frequency conversion with minimum losses.

As a laser diode driver, the LDD-3000 power supply acts as a current source and delivers constant current based on the input program signal, Iprogram(+), which is normally 0-10V. An optional RS-232 interface is available. All units are configured with a maximum current and maximum voltage capability, depending on the user's requirements. The LDD-3000 will deliver current, as programmed, into any load, providing the voltage requirements of that load do not exceed the maximum rated output voltage of the unit. When the required compliance voltage is greater than the maximum rated output voltage of the unit, the unit will limit output current.

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.

LDD-3000 Diode Driver Theory of Operation

(Refer to Figure 1)

The LDD-3000 laser diode driver was 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
- Compact size
- Power factor correction to conform with CE requirements
- Low conducted electromagnetic emissions
- Low leakage for medical applications

Referring to the Figure 1, "LDD-3000 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-3000 line filter has minimum capacitance to ground to minimize leakage currents.

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 circuit 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. For lower power units, such as the LDD-3000-250, a single stage filter is used.

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.

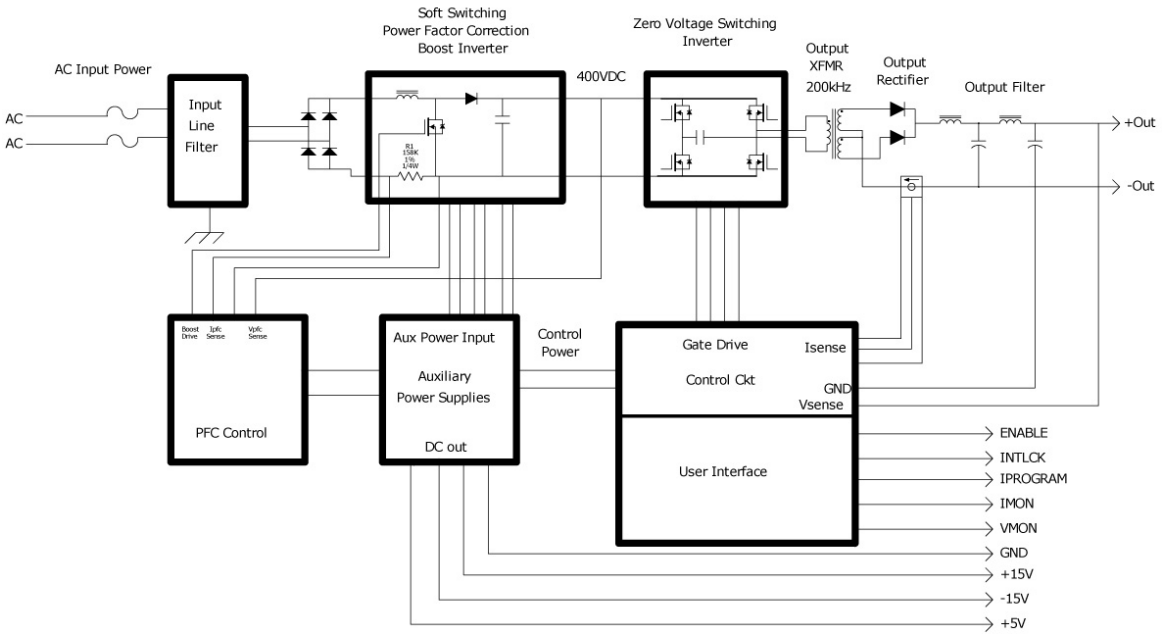


Figure 1
LDD-3000 Block Diagram

LDD-3000-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-3000-XX-YY	3000W	Can be configured from 50A to 200A	**200-240VAC**	17" x 16.5" x 3.5" 43.2cm x 42cm x 8.9cm
Auxiliary Outputs: +5V @0.25A +15V @0.25A -15V @0.25A				
XX= Maximum rated output current YY=Maximum compliance voltage				
RS-232 Option available **Other outputs available upon request**				

Input

Voltage:	200-240VAC, 50/60 Hz, 22A@208VAC
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

Pulse Width Range:	5msec to CW
Rise/Fall Time:	~1msec (10% to 90% Full Current) 600usec available upon request
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:

Industrial Safety:	IEC60950-1:2001 (1st Edition), EN 60950-1,2001, UL60950-1, CSA22.2 No. 60950-03
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

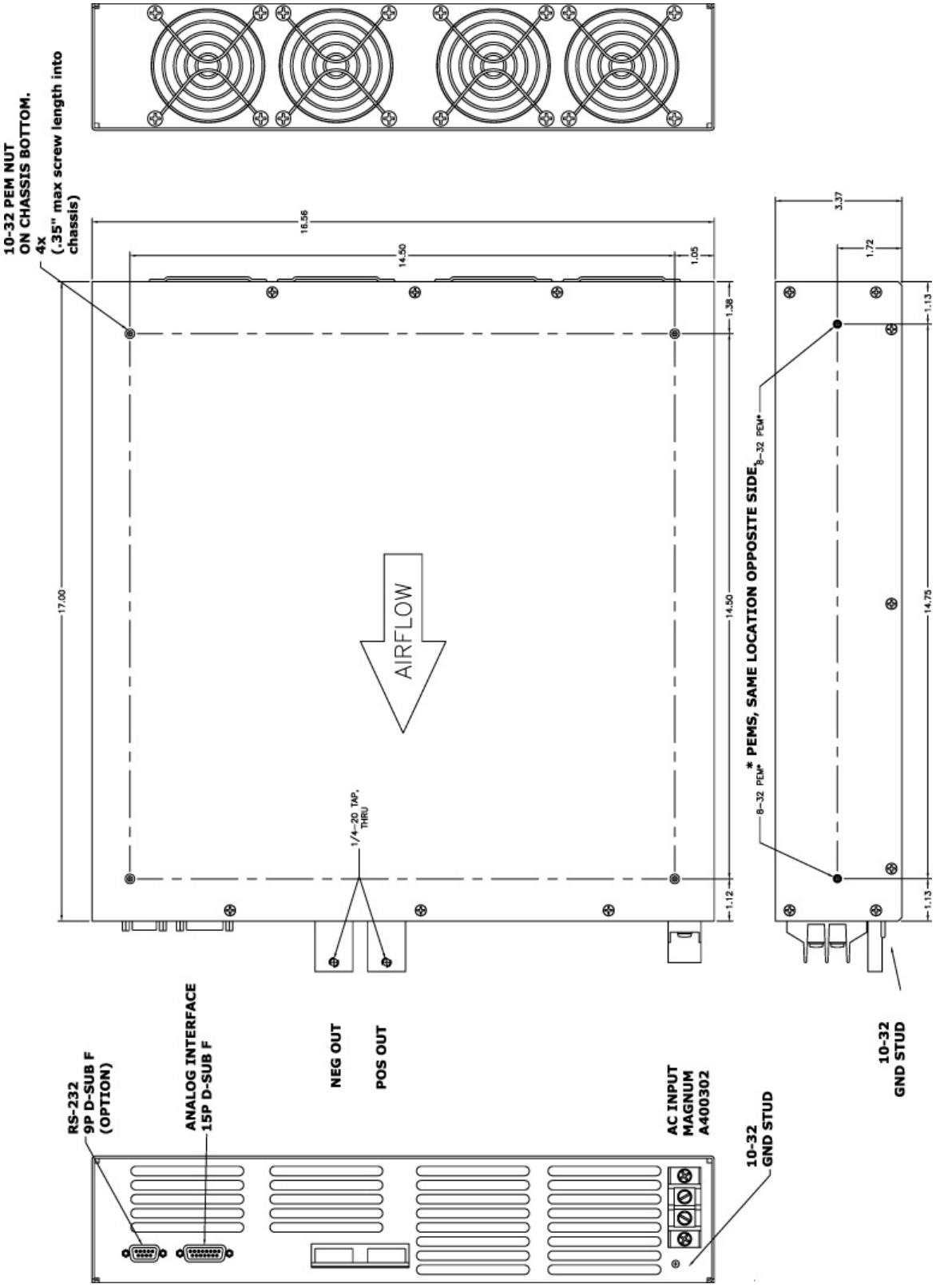


Figure 2
LDD-3000 Outline Drawing

LDD-3000-XX-YY Interface

Connector Type: 15 pin D-sub Female

(Refer to Figure 3. LDD-3000 Interface Schematic)

Pin #	LDD-3000 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, if the **Pulse Control**, Pin 8, is High and the **Interlock,** pin 3 is connected to interface **GND**. Rise times resulting from **Enable** are approximately 25msec. For pulsing, the **Enable** function should be set to ON, and the **Pulsing Control**, Pin 8, should be used.
2	Current Limit	0-10V = 1- 100% Output Current	This is secondary protection. Output current will be limited by this signal. Leaving it open defaults at 105% current.
3	**Interlock** (input)	Open = OFF Connect to GND = RUN	The **Interlock** function must be connected to **GND** in order for output current to be delivered. It can be used for external interlock functions such as door or overtemp switches.
4	**GND**		
5	**Vout Monitor**: (output)	0 – 10V = 0 – $Vout_{max}$	The output voltage of the supply can be monitored by **Vout Monitor**. For LDD-3000's with a maximum **rated** output voltage less than 10V, **Vout Monitor** = Vout. For output voltages greater than or equal to 10V, 0-10V = 0 - $Vout_{max}$.
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	**Pulse Control** (input)	TTL High = On TTL Low = OFF **Default = On**	The output may be pulsed by applying a TTL signal to **Pulse Control**, pin 8. The amplitude of the output current pulse is determined by the voltage programmed via Pin 7, **Iprogram(+)**. Rise/fall times of <1msec are typical. Rise fall times of 500usec can be achieved with special order.
9	**GND**		
10,11	**+5V @ 0.25A** (output)		Auxiliary +5V power supply for user. Up to 0.25A output current capability.
12	**-15V @0.25A** (output)		Auxiliary -15V power supply for user. Up to –0.25A output current available.
13,14	**+15V @0.25A** (output)		Auxiliary +15V power supply for user. Up to 0.25A output current available.
15	**GND**		Interface return

Table 1: LDD-3000 Interface

1. Pin 5: 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-Voutmax. Applying a program voltage greater than 10.5 volts will latch power supply. Output current will not exceed 105% of rating.

Optional RS-232 Protocol
LDD-3000-XX-YY-RS

Refer to Figure 4, LDD-3000 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.

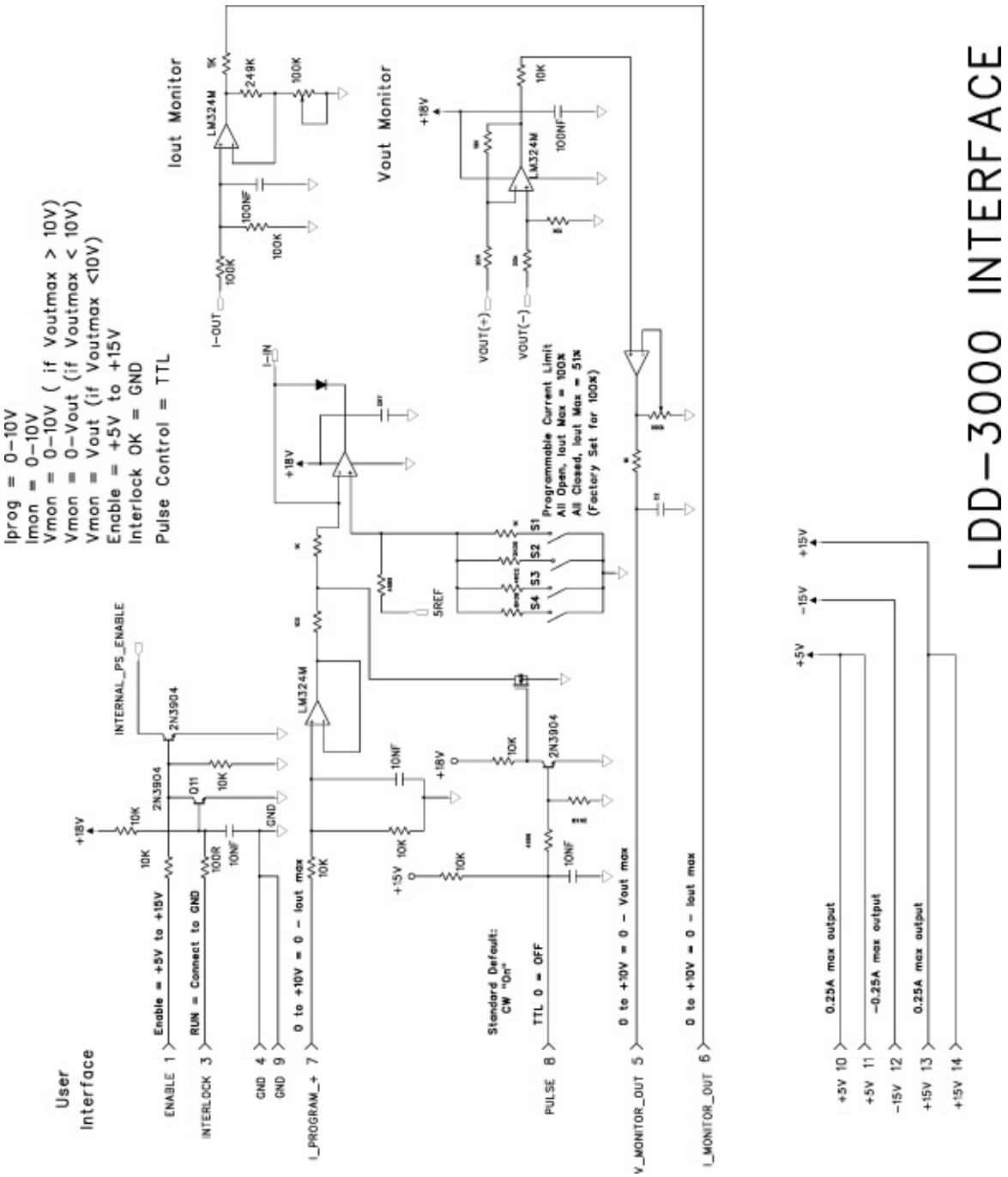


Figure 3
LDD-3000-XX-YY Interface Schematic

Installation and Operation of LDD-3000 Diode Drivers

There are two 8-32 PEM nuts on each side of the LDD-3000 for mounting the unit in a system. Refer to Figure 2, the LDD-3000 Outline Drawing, for the location of these PEM nuts Also, there are four 10-32 PEM nuts on the bottom of the chassis for mounting purposes. If used, mounting screws should not penetrate more than 3/8" into the chassis.

IMPORTANT INSTALLATION NOTE

- LDD-3000 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.

SAFETY WARNING

Because LDD-3000 units are designed for OEM applications, the user must connect AC input power to the power supply chassis. Any input AC voltage must be considered extremely dangerous, and as such, care must be taken to connect AC input power to the unit.

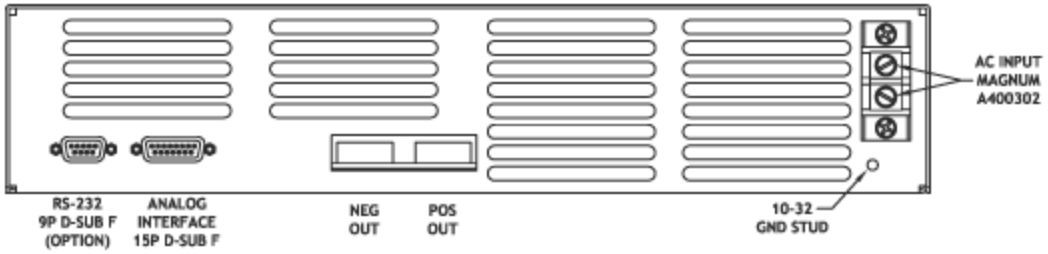


Figure 4
LDD-3000 Input/Output Connections

1. **Connecting to Laser Diode:** Figure 4 shows the location of the LDD-3000 output terminals. Connect diode laser load to the output terminals. 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-3000 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. **PULSE CONTROL**: Pin 8, the **PULSE CONTROL** pin, must be a TTL HIGH in order for the output to deliver current. The **PULSE CONTROL** function is used when the user wants to pulse the output. Because the default for **PULSE CONTROL** is TTL HIGH + ON, for CW operation, the **PULSE CONTROL** pin may be left open. Refer to Section 7 for more information on pulsing.
   c. **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.

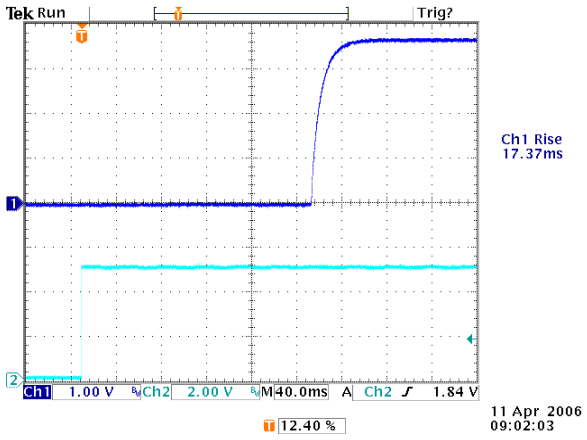
CH 1

Iout

20A/div

CH 2

ENABLE



Typical Response of Iout to ENABLE signal

   d. **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:** Input power is shown in Table 2. Connect AC power and Earth Ground connections to power supply input power terminals. Refer to Figure 4 for location of AC Input.

MODEL	INPUT POWER
LDD-3000-XX-YY	200-240 VAC, 50/60 Hz, 21A @200VAC

Table 2: LDD-3000 AC Input Power Requirements

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 105DegC.

IMPORTANT SYSTEM NOTE ON AC INPUT POWER

LDD-3000 units are fused on both input lines. It does not matter which of the two AC inputs are designated Line or Neutral.

    b. **INTERFACE SETTINGS**: Make sure **Interlock**, Pin 3, is connected to GND and **Pulse Control**, Pin 8, is set to TTL HIGH.
    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 LDD-3000 power supply for desired output current. A 0-10V signal applied to **Iprogram**, Pin 7, will program the LDD-3000 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 output as a result of programming via the **Iprogram**(+) signal is approximately 600usec.

    e. **ENABLE OUTPUT** Apply +5V to +15V to **Enable**, Pin 1. The LDD-3000 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.

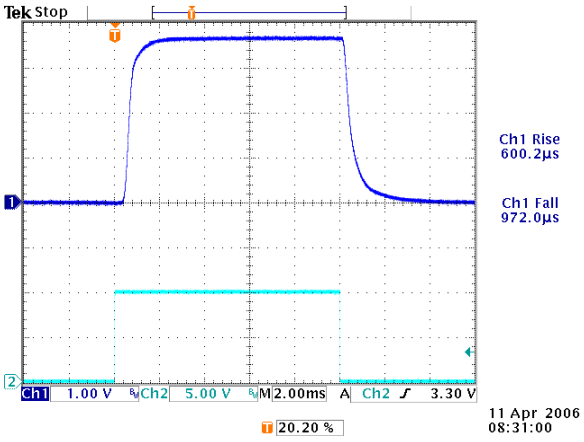
b. **Voltage Monitor** Power supply output voltage can be monitored via pin 5, **Vout Monitor**. A 0-10V signal will represent the output voltage from 0-maximum rated output voltage.

6. **Pulsed Operation:**
The LDD-3000 is intended for CW applications. However due the fast response achievable with very high frequency switchmode power supplies, it is possible to pulse diode lasers at sub QCW speeds. The typical rise and fall times of the LDD-3000 units are approximately 600 usec. Therefore a rep rate of 200Hz to 400Hz is possible. Pulsing can be accomplished via the PULSE CONTROL function on Pin 8. A TTL HIGH must be applied to pulse the output on. The user may configure the pulse train as desired. Typical performance is shown below.

Typical LDD-3000 Rise Fall Time

CH 1
Iout
20A/div

CH 2
ENABLE



Consult the factory for faster rise/fall times.

NOTE: It is not possible to use **Enable**, Pin 1, for pulsing since the ENABLE circuit includes a "soft start" is intended for turning on the power supply output slowly. The **Enable** function controls several soft-start features which do not permit pulsing.

NOTE: For faster pulsing, refer to the data sheet for Lumina Power's LDQCW power supplies. These units have rise/fall times of less than 25usec and can achieve output currents up to 200A. These units can pulse at frequencies up to 5khz, depending on the average power required.

7. **Servicing the LDD-3000:**
LDD-3000 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.

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1	7062	Release	3/9/12	MJ

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