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 diode laser 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 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 with permits very high frequency power conversion with minimum losses.

As a diode laser 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. LDD-3000 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.

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 has been 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
- Auxiliary power supplies to simplify overall laser system design
- Power factor correction to conform with CE requirements
- Low conducted electromagnetic emissions

Referring to Figure 1, the "LDD-3000 Laser Diode Driver 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. 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 boost inverter boosts the input power to 400VDC. In the process of boosting the input AC voltage, the input AC current is adjusted so that is 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, which have 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 on 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 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, reduced 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.

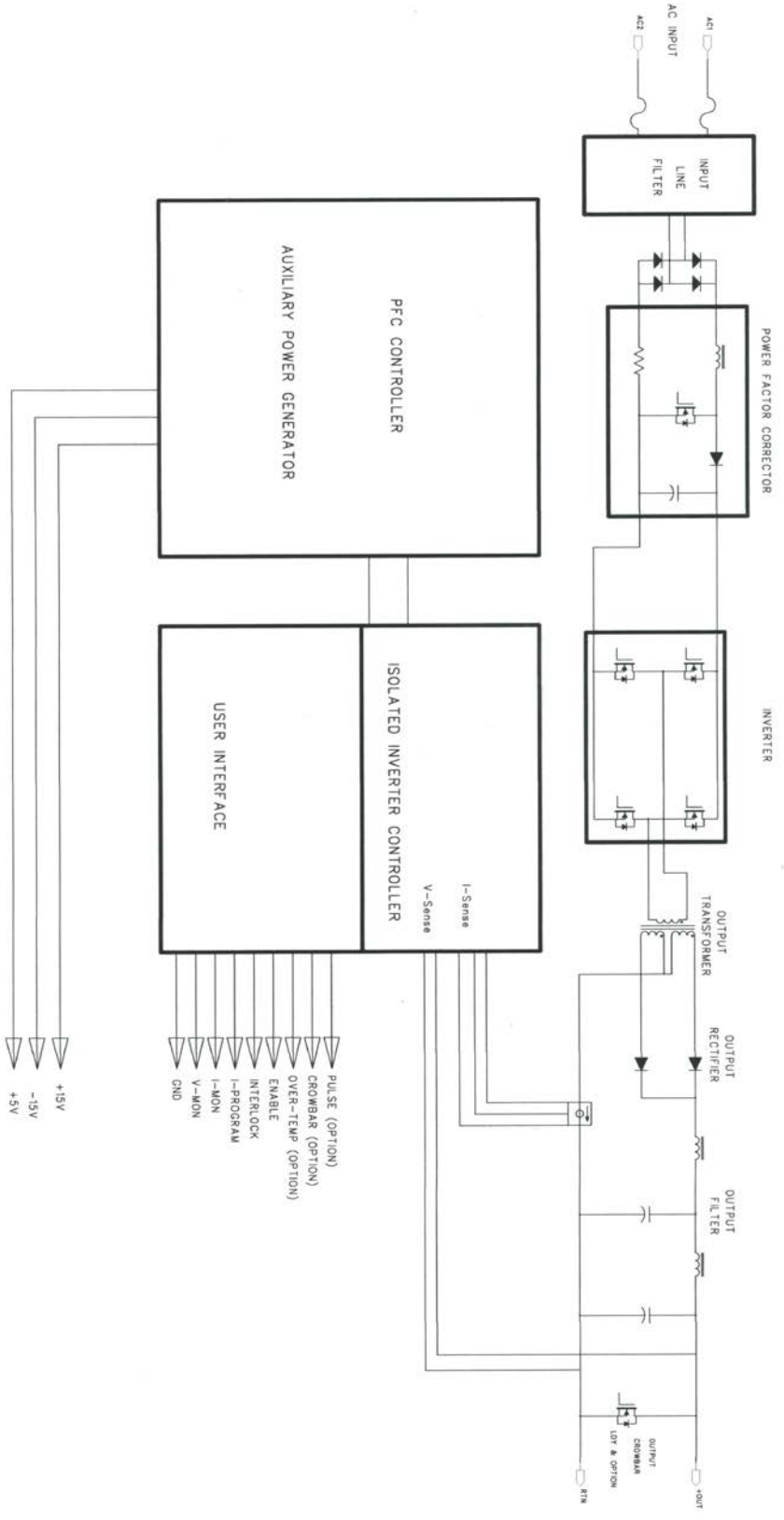


Figure 1
LDD-3000 Block Diagram

LDD-3000 Specifications

Model	$Pout_{max}$	Output Current	Input Voltage	Size (L x W x H)
LDD-3000-XX-YY	3000W	Up to 200A	200-240VAC	17” x 16.6” x 3.4” 43.2cm x 42.2cm x 8.6cm
Where XX = $Iout_{max}$ YY = $Vcompliance_{max}$ XX * YY cannot exceed 3000W				
Auxiliary Outputs: +5V @0.2A, +15V @0.2A, -15V @0.2A				

Table 1: Specification Overview

Input

Voltage: 200-240VAC, 21.5A-17.8A, 50-60Hz
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

RS-232 Interface available per special request.

Performance

Max Rep Rate: 500Hz
Rise/Fall Time: ~1msec standard, 600usec – upon request (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
Power Limit: Limited to maximum power with power fold-back circuit

Environment

Operating Temp: 0 to 40 ºC
Storage: -20 to 85 ºC
Humidity: 0 to 90% non-condensing
Cooling: Forced air

Regulatory:

Industrial Safety: IEC60950-1:2001 (1st Ed.), EN60950-1:2001, UL60950-1, CSA 22.2 No. 60950-03

EMC Emissions: EN55022:1998 /A1:2000/A2:2003 Class A ITE emissions requirements (EU, AS/NZS)
ICES-003 Issue 4 Class A Digital Apparatus emission requirements (Canada)
VCCI Class A ITE emission requirements (Japan)
FCC 47 CFR Part 15 Class A emission requirements (USA)

EMC Immunity: EN 61000-6-2:2005 Immunity for heavy industrial environment-Generic.
RoHS compliant.

Leakage Current: <1800uA

LDD-3000-XX-YY Interface

(Where XX = Iout max, and YY = Voutmax)

Connector Type: 15 pin D-sub Female

(Refer to Figure 2, LDD-3000 Interface Schematic)

RS-232 Interface available upon request.

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	Current Limit (Input) (OPTIONAL)	0-10V = 1-100% output Current Default = 105%.	This is the 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 can be connected to external interlock switches such as door or overtemp switches.
4, 9, 15	GND		
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(+)**. **Note: Accuracy will be compromised when operating below 30% of the maximum value**
8	**Pulse Control** (input)	TTL High = On TTL Low = OFF **Default = On**	The output may be pulsed OFF by applying a TTL 0 to **Pulse Control**, pin 8. When a TTL 1 is applied to pin 8, the amplitude of the output current pulse is determined by the current level programmed via Pin 7, **Iprogram(+)**. Rise fall times of 1msec are typical. **The default condition is ON, which permits CW operation with no connection to Pin 8.**
10,11	**+5V @ 0.2A** (output)		Auxiliary +5V power supply for user. Up to 0.2A output current capability.
12	**-15V @0.2A** (output)		Auxiliary -15V power supply for user. Up to –0.2A output current available.
13,14	**+15V @0.2A** (output)		Auxiliary +15V power supply for user. Up to 0.2A output current available.

Table 2: LDD-3000 Interface Pinout

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.

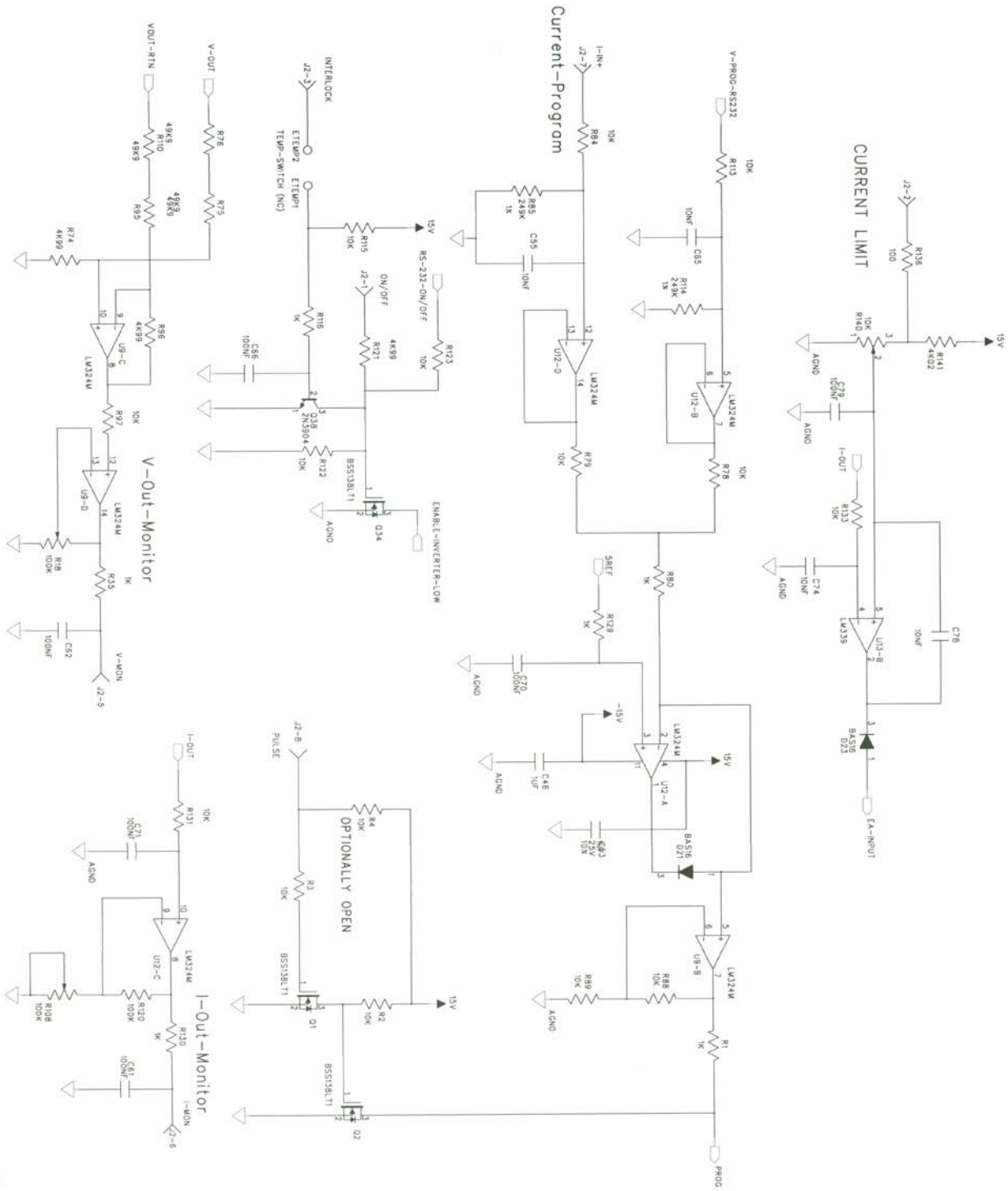


Figure 2
LDD-3000-XX-YY Interface Schematic

Installation and Operation of LDD-3000 Diode Drivers

IMPORTANT INSTALLATION NOTES

- The LDD-3000 diode driver is 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 is designed for OEM applications, the user must connect AC input power to the power supply AC Input terminal strip. Any input AC voltage must be considered extremely dangerous, and as such, care must be taken to connect AC input power to the unit.

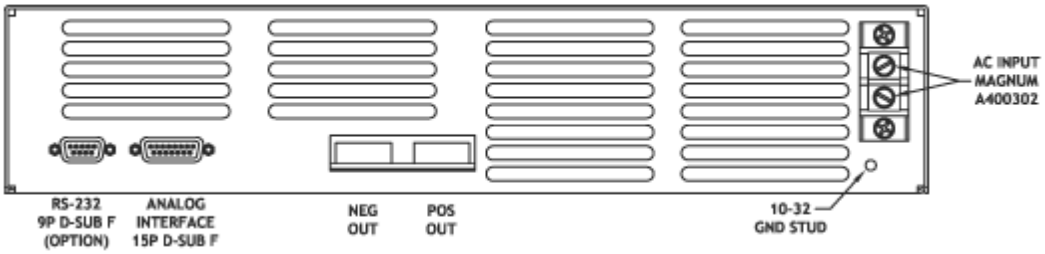


Figure 3
LDD-3000 Input/Output Connections

1. **Installing the power supply:** Refer to Figure 4, the LDD-3000 Outline Drawing. There are two 8-32 threaded PEM holes on both sides of the power supply which can be used to mount rack slides. Also, there are four 10-32 threaded PEM holes on the bottom of the supply for mounting purposes. The mounting screws should not penetrate the power supply more than 3/8”

2. **Connecting to Diode Laser:** Figure 3 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 minimize inductance and avoid I^2R losses in the wire.

3. **Interface Connection:** Connect user interface to Analog Interface 15 pin D-sub connector shown in Figure 3. (Although this interface is typically designed by the user, Lumina Power can provide any assistance necessary to modify interface program and monitor levels) See Table 2 and related schematic for a description of the LDD-3000 Interface Pinout.

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 **ENABLE** is applied, output current will rise to this program value

4. **AC Input Power Connection:** Connect AC power connections to power supply input power terminals as follows (refer to Table 3 and Figure 3.):

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

Table 3: LDD-3000 Input Power

- AC Connections (#12AWG) are connected to the terminal strip connections shown in Figure 3.
- Ground wire (#12AWG) is connected to the ground stud shown in Figure 3.

IMPORTANT APPLICATON NOTE REGARDING AC INPUT POWER

AC Input wires 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 lines.

5. **Apply AC Input Power:** Turn ON AC power. After a few seconds the power supply fans should begin to run.

6. **Programming Output Current:** Program LDD-3000 power supply for desired output current. A 0-10V signal applied to interface pin 7 (see Table 2) 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 25msec. Once the power supply is enabled, the rise/fall time of the Iprogram(+) signal is approximately 2msec. Slower rise/fall times are available upon request. A rise/fall time of 2msec does not typically result in dangerous voltage spikes on the diode laser.

7. **Enable Output:** Enable LDD-3000 power supply by applying +15V to Enable Pin 1 (see Table 2). Current will now be delivered to laser diode as programmed.

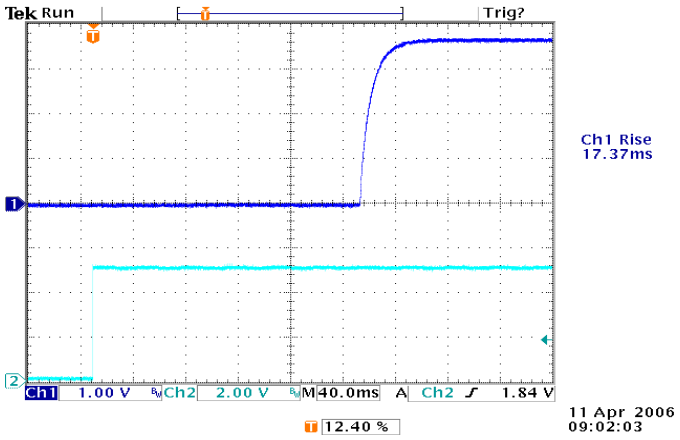
8. **Current Monitor:** Power supply output current can be monitored via pin 6 (see Table 2). A 0-10V signal will represent the output current from 0 to maximum rated output current.

9. **Voltage Monitor:** Power supply output voltage can be monitored via pin 5 (See Table 2). A 0-10V signal will represent the output voltage from 0-maximum rated output voltage.

10. **Pulsing:** The LDD-3000 laser diode driver is designed for CW applications. However due the fast response achievable with very high frequency switchmode power supplies, it is possible to pulse this unit at sub-Quasi-CW speeds. The typical rise and fall times of the LDD-3000 is ~ 1msec, but can be configured for rise times as fast as 0.6msec. Therefore, pulsing at frequencies up to 500Hz is possible. Pulsing can be accomplished with the **Pulse Control** function, Pin 8 (see Table 2). When Pin 8 is grounded, an internal circuit defeats the **Iprogram** signal. When Pin 8 is High, **Iprogram** is delivered to the control system as programmed. When no connection is made to Pin 8, the **Pulse Control** function is internally set HIGH, permitting CW operation. The **Pulse Control** function is much faster than the **ENABLE** function, which has a soft-start function.

CH 1
Iout
20A/div

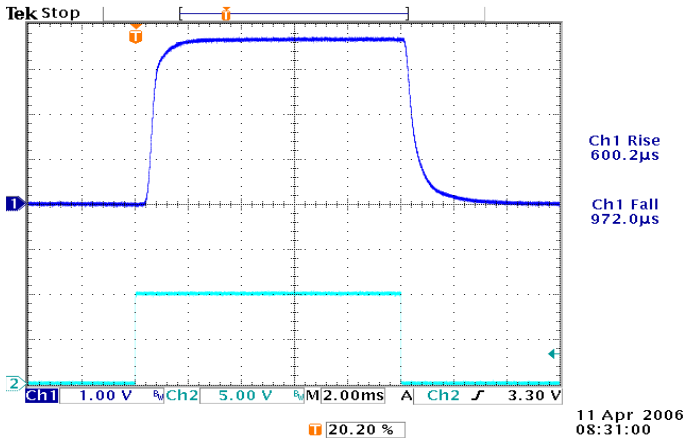
CH 2
ENABLE



Typical Response of Iout to ENABLE signal

CH 1
Iout
20A/div

CH 2
Pulse Signal



Typical LDD-3000 Rise Fall Time using Pulse Function
Consult the factory for faster rise/fall times.

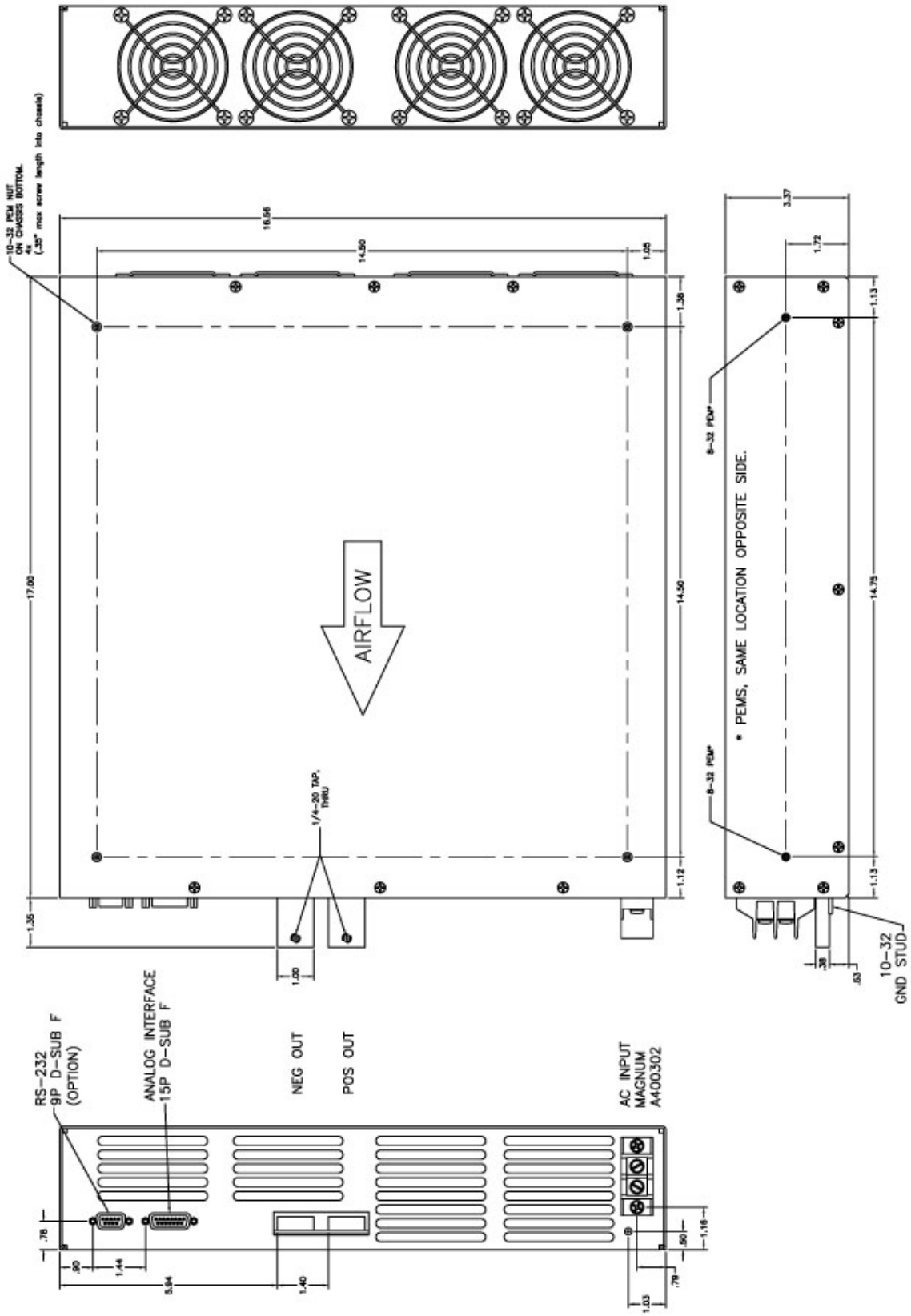


Figure 4
LDD-3000 Outline Drawing

Servicing LDD-3000 Diode Drivers

LDD-3000 units has 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.

Rev	ECO	Description	Date	Doc Control
1	7062	Release	3/13/12	MJ

26 Ward Hill Avenue, Bradford, MA 01835
Ph: 978-241-8260 Fx: 978-241-8262
www.luminapower.com
sales@luminapower.com