User's Guide

Precision Current Sources
LDX-3500 Series

ILX Lightwave
Photonic Test & Measurement Instrumentation

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

SAFETY AND WARRANTY INFORMATION

The Safety and Warranty Information section provides details about cautionary symbols used in the manual, safety markings used on the instrument, and information about the Warranty including Customer Service contact information.

Safety Information and the Manual

Throughout this manual, you will see the words *Caution* and *Warning* indicating potentially dangerous or hazardous situations which, if not avoided, could result in death, serious or minor injury, or damage to the product. Specifically:

Caution indicates a potentially hazardous situation which can result in minor or moderate injury or damage to the product or equipment.

Warning indicates a potentially dangerous situation which can result in serious injury or death.

Visible and/or invisible laser radiation. Avoid direct exposure to the beam.

General Safety Considerations

If any of the following conditions exist, or are even suspected, do not use the instrument until safe operation can be verified by trained service personnel:

- Visible damage
- Severe transport stress
- Prolonged storage under adverse conditions
- Failure to perform intended measurements or functions

If necessary, return the instrument to ILX Lightwave, or authorized local ILX Lightwave distributor, for service or repair to ensure that safety features are maintained (see the contact information on page x).

All instruments returned to ILX Lightwave are required to have a Return Authorization Number assigned by an official representative of ILX Lightwave Corporation. See Returning an Instrument on page ix for more information.

SAFETY SYMBOLS

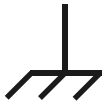
This section describes the safety symbols and classifications.

Technical specifications including electrical ratings and weight are included within the manual. See the Table of Contents to locate the specifications and other product information. The following classifications are standard across all ILX Lightwave products:

- Indoor use only
- Ordinary Protection: This product is NOT protected against the harmful ingress of moisture.
- Class I Equipment (grounded type)
- Mains supply voltage fluctuations are not to exceed ±10% of the nominal supply voltage.
- Pollution Degree II
- Installation (overvoltage) Category II for transient overvoltages
- Maximum Relative Humidity: <80% RH, non-condensing
- Operating temperature range of 0 °C to 40 °C
- Storage and transportation temperature of –40 °C to 70 °C
- Maximum altitude: 3000 m (9843 ft.)
- This equipment is suitable for continuous operation.

Safety Marking Symbols

This section provides a description of the safety marking symbols that appear on the instrument. These symbols provide information about potentially dangerous situations which can result in death, injury, or damage to the instrument and other components.

 Caution, refer to manual	 Earth ground Terminal	 Alternating current	 Visible and/or invisible laser radiation
 Caution, risk of electric shock	 Protective Conductor Terminal	 Caution, hot surface	 Frame or chassis Terminal
 or (I) On: In position of a bistable push control. The slash (I) only denotes that mains are on.		 or (O) Off: Out position of a bistable push control. The circle (O) only denotes that mains are off.	

WARRANTY

ILX LIGHTWAVE CORPORATION warrants this instrument to be free from defects in material and workmanship for a period of one year from date of shipment. During the warranty period, ILX will repair or replace the unit, at our option, without charge.

Limitations

This warranty does not apply to fuses, lamps, defects caused by abuse, modifications, or to use of the product for which it was not intended**.**

This warranty is in lieu of all other warranties, expressed or implied, including any implied warranty of merchantability or fitness for any particular purpose. ILX Lightwave Corporation shall not be liable for any incidental, special, or consequential damages**.**

If a problem occurs, please contact ILX Lightwave Corporation with the instrument's serial number, and thoroughly describe the nature of the problem.

Returning an Instrument

If an instrument is to be shipped to ILX Lightwave for repair or service, be sure to:

1. Obtain a Return Authorization number (RA) from ILX Customer Service.
2. Attach a tag to the instrument identifying the owner and indicating the required service or repair. Include the instrument serial number from the rear panel of the instrument.
3. Attach the anti-static protective caps that were shipped with the instrument and place the instrument in a protective anti-static bag.
4. Place the instrument in the original packing container with at least 3 inches (7.5 cm) of compressible packaging material. **Shipping damage is not covered by this warranty.**
5. Secure the packing box with fiber reinforced strapping tape or metal bands.
6. Send the instrument, transportation pre-paid, to ILX Lightwave. Clearly write the return authorization number on the outside of the box and on the shipping paperwork. ILX Lightwave recommends you insure the shipment.

If the original shipping container is not available, place your instrument in a container with at least 3 inches (7.5 cm) of compressible packaging material on all sides.

Repairs are made and the instrument returned transportation pre-paid. Repairs are warranted for the remainder of the original warranty or for 90 days, whichever is greater.

Claims for Shipping Damage

When you receive the instrument, inspect it immediately for any damage or shortages on the packing list. If the instrument is damaged, file a claim with the carrier. The factory will supply you with a quotation for estimated costs of repair. You must negotiate and settle with the carrier for the amount of damage.

Comments, Suggestions, and Problems

To ensure that you get the most out of your ILX Lightwave product, we ask that you direct any product operation or service related questions or comments to ILX Lightwave Customer Support. You may contact us in whatever way is most convenient:

Phone . . . . . (800) 459-9459 or (406) 586-1244

Fax . . . . . (406) 586-9405

On the web at: . . . . . ilx.custhelp.com

Or mail to:

ILX Lightwave Corporation
P. O. Box 6310
Bozeman, Montana, U.S.A 59771
www.ilxlightwave.com

When you contact us, please have the following information:

Model Number: _____

Serial Number: _____

End-user Name: _____

Company: _____

Phone: _____

Fax: _____

Description of what is connected to the ILX Lightwave instrument: _____

Description of the problem: _____

If ILX Lightwave determines that a return to the factory is necessary, you are issued a Return Authorization (RA) number. Please mark this number on the outside of the shipping box.

You or your shipping service are responsible for any shipping damage when returning the instrument to ILX Lightwave; ILX recommends you insure the shipment. If the original shipping container is not available, place your instrument in a container with at least 3 inches (7.5 cm) of compressible packaging material on all sides.

We look forward to serving you even better in the future!

CHAPTER 1

INTRODUCTION AND SPECIFICATIONS

This manual contains operation and maintenance information for the LDX-3500 Series Precision Current Sources. If you want to get started right away, read Chapter 2, which covers Operation, first.

Product Overview

The LDX-3500 Series Precision Current Sources provide a high stability output with a fully redundant current limit and multiple laser protection features.

Available Options and Accessories

Options and accessories available for the LDX-3500 Series Precision Current Sources include the following:

Description	Model Number
Single rack mount flange kit	134
Dual rack mount flange kit (enables installation into a standard 19 inch wide rack)	135
Temperature Controlled Laser Diode Mount	4407
Temperature Controlled Laser Diode Mount (available with collimating assembly)	4412
High Power Laser Diode Mount	4442
Current Source Interconnect Cable	301

Other Laser Diode Mounts are available. Please contact ILX Lightwave for information on additional options for your applications.

Specifications: LDX-3525

Current Source	200 mA Range	500 mA Range
Set Point Accuracy	±0.2 mA	±0.5 mA
Set Point Resolution	50 μA	125 μA
Compliance Voltage (fixed)	7 V maximum	7 V maximum
Temperature Coefficient	< 50 ppm/°C	< 50 ppm/°C
Stability[1], for 1 hour	< 20 ppm	< 20 ppm
Stability[1], for 24 hours	< 50 ppm	< 50 ppm
Noise and Ripple[2] High Bandwidth Mode CW Mode	 < 1mA < 5 mA	 < 1 mA < 5 mA
Worst Case Transients[3] Operational[4] Power-line induced[5]	 < 1 mA < 5 mA	 < 1 mA < 5 mA

1. Stability specifications are measured at half-scale output, after a one hour warm-up period.
2. Extrapolated from resulting intensity fluctuations of a laser diode, measured optically with a 150 kHz bandwidth photodetector.
3. The instrument contains a circuit which will turn off the output if a transient is detected.
4. Maximum output current transients resulting from normal operational situations (e.g., power on-off) as well as accidental situations (e.g., power line plug removal)
5. Maximum output current transients resulting from a 200 V power-line spike.

Photodiode Feedback	
Range	5 to 5000 μA
Output Stability[6]	±0.02%
Set Point Accuracy	±5 μA
Bias Voltage	0 - 5 V reverse bias (± 10%)
Power Modulation Bandwidth	1 kHz

6. Specified values are a percent of nominal. Constant-power mode stability specification assumes zero drift in detector responsivity.

Display	200 mA Range	500 mA Range
Output Current Range	0.0 to 200.0 mA	0.0 to 500.0 mA
Output Current Resolution	0.1 mA	0.1 mA
Output Current Accuracy at 25 °C	±0.2 mA	±0.5 mA
Photodiode Current Range	0 - 5000 µA	0 - 5000 µA
Photodiode Current Resolution	1 µA	1 µA
Photodiode Current Accuracy	±5 µA	±5 µA
Responsivity Range	0.001 - 1.000 mA/mW	0.001 - 1.000 mA/mW
Responsivity Resolution	0.001 mA/mW	0.001 mA/mW
Optical Power Range	0.000 mW - 500.0 mW	0.000 mW - 500.0 mW
Output Power Resolution	1 µW, 10 µW or 100 µW	1 µW, 10 µW or 100 µW

Current Limit Setting	200 mA Range	500 mA Range
Range	0 - 202 mA	0 - 505 mA
Resolution	1 mA	2 mA
Accuracy	±2 mA	±5 mA

Analog Modulation/Voltage Control		
Input	0 - 10 V, 10 KX	0 - 10 V, 10 KX
Transfer Function	20 mA/V	50 mA/V
Transfer Function Accuracy	±10%	±10%
Bandwidth[7] (3 dB) High Bandwidth Mode CW Mode	 DC to 500 kHz DC to 100 Hz	 DC to 150 kHz DC to 100 Hz

7. Fifty percent modulation at half-scale output.

Analog Output		
Output Voltage	0 - 10 V	0 - 10 V
Transfer Function	20 mA/V	50 mA/V
Transfer Function Accuracy	±5%	±5%

General LDX-3525 Specifications	
Connectors	
Photodiode Monitor and Current Source Connectors	9-pin, D-sub; auxiliary BNC for monitor photodiode output
External Modulation Connector	BNC, instrumentation amplifier input
Analog Output	BNC
General	
Size	3.5” x 7.3” x 12”
Weight	6.0 lbs.
Power Requirements	100, 120, 220-240 VAC (±10%), 50-60 Hz
Temperature	0 to +40 ^{o}C operating; -40 to +70 ^{o}C storage
Humidity	< 85% relative humidity, non-condensing
Laser Safety Feature	Key switch, interlock and output delay (meets CDRH US21 CFR 1040.10)
Display type	4-digit, green LED

Specifications: LDX-3545

Current Source	1000 mA Range	3000 mA Range
Set Point Accuracy	±1 mA	±3 mA
Set Point Resolution	250 µA	750 µA
Compliance Voltage (fixed)	6.5 V maximum	6.5 V maximum
Temperature Coefficient	< 50 ppm/°C	< 50 ppm/°C
Stability[1], for 1 hour	< 20 ppm	< 20 ppm
Stability[1], for 24 hours	< 50 ppm	< 50 ppm
Noise and Ripple[2] High Bandwidth Mode CW Mode	 < 8 µA rms < 8 µA rms	 < 20 µA rms < 15 µA rms
Worst Case Transients[3] Operational[4] Power-line induced[5]	 < 2 mA < 10 mA	 < 5 mA < 10 mA

1. Stability specifications are measured at half-scale output, after a one hour warm-up period.
2. Extrapolated from resulting intensity fluctuations of a laser diode, measured optically with a 150 kHz bandwidth photodetector.
3. The instrument contains a circuit which will turn off the output if a transient is detected.
4. Maximum output current transients resulting from normal operational situations (e.g., power on-off) as well as accidental situations (e.g., power line plug removal)
5. Maximum output current transients resulting from a 200 V power-line spike.

Photodiode Feedback	
Range	5 to 9999 µA
Output Stability[6]	±0.02%
Set Point Accuracy	±10 µA
Bias Voltage	0 - 5 V reverse bias (± 10%); adjustable on back panel
Power Modulation Bandwidth	1 kHz

6. Specified values are a percent of nominal. Constant-power mode stability specification assumes zero drift in detector responsivity.

Display	1000 mA Range	3000 mA Range
Output Current Range	0.0 to 999.9 mA	0.0 to 3000.0 mA
Output Current Resolution	0.1 mA	1 mA
Output Current Accuracy at 25 °C	±1 mA	±3 mA
Photodiode Current Range	0 - 9999 µA	0 - 9999 µA
Photodiode Current Resolution	1 µA	1 µA
Photodiode Current Accuracy	±10 µA	±10 µA
Responsivity Range	0.001 - 1.000 mA/mW	0.001 - 1.000 mA/mW
Responsivity Resolution	0.001 mA/mW	0.001 mA/mW
Optical Power Range	0.000 mW - 3000.0 mW	0.000 mW - 3000.0 mW
Output Power Resolution	1 µW, 10 µW, 100 µW or 1 mW	1 µW, 10 µW, 100 µW or 1 mW

Current Limit Setting	1000 mA Range	3000 mA Range
Range	0 - 1010 mA	0 - 3030 mA
Resolution	4 mA	12 mA
Accuracy	±10 mA	±30 mA

Analog Modulation/Voltage Control		
Input	0 - 10 V, 10 KX	0 - 10 V, 10 KX
Transfer Function	100 mA/V	300 mA/V
Transfer Function Accuracy	±10%	±10%
Bandwidth[7] (3 dB) High Bandwidth Mode CW Mode	 DC to 200 kHz DC to 100 Hz	 DC to 50 kHz DC to 100 Hz

7. Fifty percent modulation at half-scale output.

Analog Output		
Output Voltage	0 - 10 V	0 - 10 V
Transfer Function	100 mA/V	300 mA/V
Transfer Function Accuracy	±5%	±5%

General LDX-3525 Specifications	
Connectors	
Photodiode Monitor and Current Source Connectors	9-pin, D-sub; auxiliary BNC for monitor photodiode output
External Modulation Connector	BNC, instrumentation amplifier input
Analog Output	BNC
General	
Size	3.5” x 7.3” x 12”
Weight	8.0 lbs.
Power Requirements	100, 120, 220-240 VAC (±10%), 50-60 Hz
Temperature	0 to +40 ^{o}C operating; -40 to +70 ^{o}C storage
Humidity	< 85% relative humidity, non-condensing
Laser Safety Feature	Key switch, interlock and output delay (meets CDRH US21 CFR 1040.10)
Display type	4-digit, green LED

Specifications: LDX-3565

Current Source	2000 mA Range	6000 mA Range
Set Point Accuracy	±2 mA	±6 mA
Set Point Resolution	0.5 mA	1.5 mA
Compliance Voltage (fixed)	5 V maximum	5 V maximum
Temperature Coefficient	< 50 ppm/°C	< 100 ppm/°C
Stability[1], for 1 hour	< 20 ppm	< 20 ppm
Stability[1], for 24 hours	< 50 ppm	< 50 ppm
Noise and Ripple[2] High Bandwidth Mode CW Mode	 < 200 µA rms < 50 µA rms	 < 200 µA rms < 50 µA rms
Worst Case Transients[3] Operational[4] Power-line induced[5]	 < 5 mA < 10 mA	 < 15 mA < 40 mA

1. Stability specifications are measured at half-scale output, after a one hour warm-up period.
2. Extrapolated from resulting intensity fluctuations of a laser diode, measured optically with a 150 kHz bandwidth photodetector.
3. The instrument contains a circuit which will turn off the output if a transient is detected.
4. Maximum output current transients resulting from normal operational situations (e.g., power on-off) as well as accidental situations (e.g., power line plug removal)
5. Maximum output current transients resulting from a 200 V power-line spike.

Photodiode Feedback	
Range	0.01 to 25 mA
Output Stability[6]	±0.02%
Set Point Accuracy	±25 µA
Bias Voltage	0 - 5 V reverse bias (± 10%); adjustable on back panel
Power Modulation Bandwidth	1 kHz

6. Specified values are a percent of nominal. Constant-power mode stability specification assumes zero drift in detector responsivity.

Display	2000 mA Range	6000 mA Range
Output Current Range	0.0 to 2000.0 mA	0.0 to 6000.0 mA
Output Current Resolution	1 mA	1 mA
Output Current Accuracy at 25 °C	±2 mA	±6 mA
Photodiode Current Range	0 - 25.00 mA	0 - 25.0 mA
Photodiode Current Resolution	10 µA	10 µA
Photodiode Current Accuracy	±25 µA	±25 µA
Responsivity Range	0.001 - 1.000 mA/mW	0.001 - 1.000 mA/mW
Responsivity Resolution	0.001 mA/mW	0.001 mA/mW
Optical Power Range	0.000 mW - 6000.0 mW	0.000 mW - 6000.0 mW
Output Power Resolution	0.01, 0.1 or 1 mW	0.01, 0.1 or 1 mW

Current Limit Setting	2000 mA Range	6000 mA Range
Range	0 - 2020 mA	0 - 6060 mA
Resolution	8 mA	24 mA
Accuracy	±20 mA	±60 mA

Analog Modulation/Voltage Control		
Input	0 - 10 V, 10 KX	0 - 10 V, 10 KX
Transfer Function	200 mA/V	600 mA/V
Transfer Function Accuracy	±10%	±10%
Bandwidth[7] (3 dB) High Bandwidth Mode CW Mode	 DC to 70 kHz DC to 100 Hz	 DC to 20 kHz DC to 100 Hz

7. Fifty percent modulation at half-scale output.

Analog Output		
Output Voltage	0 - 10 V	0 - 10 V
Transfer Function	200 mA/V	600 mA/V
Transfer Function Accuracy	±5%	±5%

General LDX-3525 Specifications	
Connectors	
Photodiode Monitor and Current Source Connectors	9-pin, D-sub; auxiliary BNC for monitor photodiode output
External Modulation Connector	BNC, instrumentation amplifier input
Analog Output	BNC
General	
Size	3.5” x 7.3” x 12”
Weight	9.5 lbs.
Power Requirements	100, 120, 220-240 VAC (±10%), 50-60 Hz
Minimum Output Load	1 V at 6A max
Temperature	0 to +40 ^{o}C operating; -40 to +70 ^{o}C storage
Humidity	< 85% relative humidity, non-condensing
Laser Safety Feature	Key switch, interlock and output delay (meets CDRH US21 CFR 1040.10)
Display type	4-digit, green LED

Our goal is to make the best laser diode instrumentation available anywhere. To achieve this, we need your ideas and comments on ways we can improve our products. We invite you to contact us at any time with your suggestions.

CHAPTER 2

INSTALLATION AND OPERATION

This chapter describes how to install, adjust, and operate the LDX-3500 Series Precision Current Sources. It is divided into sections covering installation, familiarization and adjustment, and normal operating procedures.

Later in this chapter, there is an overview of the LDX-3500 Series' front panel features, and it presents a guide to quickly familiarize the user with the front panel operations.

Installation

AC Power Considerations

The LDX-3500 Series Controllers can be configured to operate at nominal line voltages 100, 120, 220-240 VAC. Normally, this is done at the factory and need not be changed before operating the instrument. However, check to be sure that the voltage marked on the back panel of the instrument matches the power-line voltage in your area. Refer to Chapter 3 Maintenance if it is necessary to reconfigure the input voltage range.

WARNING

To avoid electrical shock hazard, connect the instrument to properly earth-grounded, 3-prong receptacles only. Failure to observe this precaution can result in severe injury or death.

Rack Mounting

The LDX-3500 Series Precision Current Source may be rack mounted by installing a rack mount flange on either side of the enclosure. All rack mount accessory kits contain detailed mounting instructions. Refer to Section 1.3 for applicable rack mount accessory part numbers.

Power-Up Sequence

With the LDX-3500 Series Precision Current Source connected to an AC power source, pressing the POWER switch will supply power to the instrument and start the power-up sequence.

During the power-up sequence, the following takes place. For about two seconds all indicators light up, and all of the 7-segment displays indicate "8". Then all lamps are turned off for two seconds. After this, the firmware version number is displayed for two seconds. After this, the unit is configured to the state it was in when the power was last shut off.

Introduction to the LDX-3500 Series Front Panel

The LDX-3500 Series Precision Current Source's front panel contains displays and controls for the current source hardware. Each of the labeled areas on the front panel (e.g. DISPLAY, MODE) is described in this chapter.

Refer to Figure 2.1 for the following discussions of the LDX-3500 Series Precision Current Sources front panel sections. The key words are in capital letters for quick identification. Although an LDX-3525 front panel is shown, Figure 2.1 may be used for front panel familiarization with the LDX-3545 and LDX-3565.

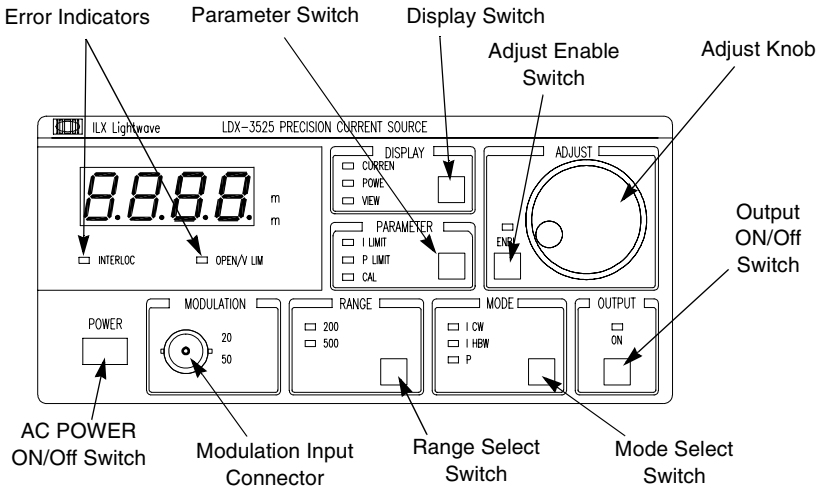


Figure 2.1 LDX-3525 Front Panel

Adjustments

The ADJUST section contains the Adjust knob for entering values, and it contains the ENBL (adjust enable) switch and indicator. In order to make any set point or parameter adjustment, the ENBL indicator must be lit. Pressing the ENBL switch toggles the ENBL indicator on or off.

Display

The display is used to show measurements, output set point, and parameter set points. Whenever a set point is being displayed, the VIEW SET indicator will be lit.

The DISPLAY switch is used to select the measured current, power, or the set point value. The set point type is determined by the MODE selection.

When in I CW or I HBW modes, the set point will be output current and the display switch will toggle between output current measurement, output current set point, and power measurement. When in POWER mode, the set point will be laser

power, and the display switch will toggle between laser power measurement, laser power set point, and output current measurement.

When any control mode measurement is displayed, pressing the display switch once will toggle to the specific control mode set point. If the display switch is not pressed again within three seconds, the display will automatically return to the control mode measurement. Likewise, when the output is off and a measurement is displayed, if the adjust knob is turned the control mode set point will be displayed for three seconds. If the set point is adjusted (by turning the adjust knob) the set point timer will be restarted. Therefore, three seconds after the set point is adjusted the display will return to the last measurement.

Parameters

The 3500 Series Precision Current Source allows adjustment of the following parameters, I LIMIT (output current limit), P LIMIT (laser power limit) and CAL PD (monitor photodiode responsivity).

When the I LIMIT is set, the hardware will limit the output current to the I LIMIT value, regardless of the set point or control mode.

When the P LIMIT is set and the user is in POWER mode, the P LIMIT will NOT limit the output current. If the power limit is reached in power mode, the P LIMIT indicator will blink as a warning.

The CAL PD parameter is used to convert monitor diode (back facet) current measurements to light power. The range of this parameter is 0.001 to 1.000 mA/mW. Setting CAL PD to 1.000 allows the user to measure the monitor diode current directly in mA.

Parameter Setup

The PARAMETER switch is used to view and edit the parameters. Repeatedly pressing the PARAMETER switch will cycle through the parameters.

When a parameter is selected for viewing, its value will remain on the display for three seconds. If an adjustment is made to the parameter (by turning the adjust knob) the three second timer will be restarted. Three seconds after the parameter adjustment is done, the display will revert to the last measurement mode.

Current Output

The OUTPUT section contains the ON switch and indicator. The ON indicator is lit whenever the output is on. Pressing the ON switch will toggle the current output on or off.

Conditions Which Will Automatically Shut Off the OUTPUT

- 1. Interlock/ENABLE Key Lock State open
- 2. Open Circuit (While Output On)
- 3. Switching Ranges or Modes (While Output On)
- 4. Internal Overheating Sense Switch (LDX-3565 only)

Control Mode and Current Range

The MODE switch is used to select the output control mode. Repeatedly pressing the MODE switch cycles through the current (I CW), high bandwidth current (I HBW), and light power (P) control modes. The LED indicators show the selected mode. Changing the control mode forces the output off.

The RANGE switch is used to switch between the high and low laser current output ranges. Switching ranges forces the current output off.

Modulation

The MODULATION connector (BNC) allows a modulation signal to be applied to the output. The bandwidth depends on the selected current range and bandwidth mode (see specifications, Chapter 1). Bandwidth specifications are measured across a 1 Ω load. The modulation port input impedance is 10 kΩ. The transfer function (mA/V) in Figure 2.1 is shown for the LDX-3525. This transfer function varies by model and laser drive current output range, as shown in Table 2.1.

Model	Low Range	High Range
LDX-3525	20 mA/V	50 mA/V
LDX-3545	100 mA/V	300 mA/V
LDX-3565	200 mA/V	600 mA/V

Table 2.1 Modulation Transfer Functions

The error indicators become lit when the corresponding conditions occur. The INTLK/ENBL light comes on whenever the back panel ENABLE switch or the interlock connections (pins 1 and 2 of the 9-pin connector) are open.

The OPEN/V LIM indicator becomes lit whenever an open circuit (or a high impedance condition) occurs on the output when the output is on. When the OPEN/V LIM condition occurs, the output will be shut off and the indicator will remain on until the problem is resolved and the output is turned on again. The OPEN/V LIM indicator blinks at 1 Hz whenever the output voltage is near its

compliance limit. If this occurs, the impedance of the output load is too high and may cause the output to shut off if the output current is increased.

On the LDX-3565, the OPEN/V LIM indicator also becomes lit whenever the internal overheating sense circuit senses an internal overheating condition and shuts the output off.

The I LIMIT indicator will blink at 1 Hz whenever the output current tries to exceed the I LIMIT value. A circuit is used to sense this condition, and the actual output current is limited to the I LIMIT value, regardless of operating mode.

The P LIMIT indicator blinks at 1 Hz whenever the output (laser) power exceeds the P LIMIT value while in the constant P mode. This indicator is just a warning device. There is no actual hardware limiting to a P LIMIT value. Therefore, the user should set I LIMIT appropriately to protect the laser.

Back Panel Controls and Connections

Refer to Figure 2.2 for the following discussions of back panel controls and connectors. There are no user serviceable parts in the instrument,including the external fuses in the AC power entry module.

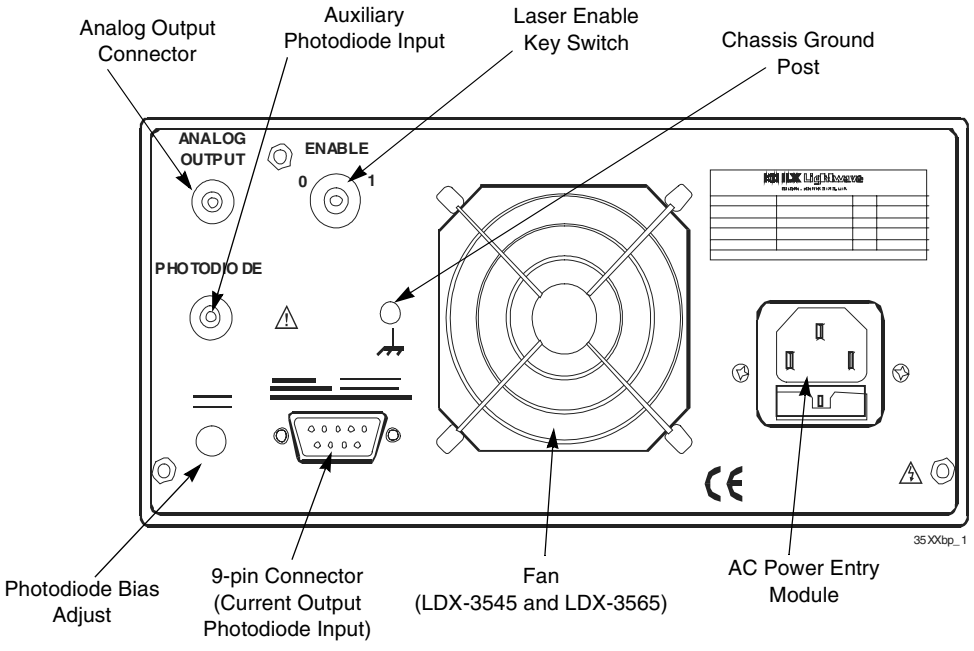


Figure 2.2 LDX-3500 Series Back Panel

The Laser Connectors

At the left of center, when facing the back panel, you will find a 9-pin D-sub connector for the laser diode connections. The pinout diagram for this connector is shown in Figure 2.3.

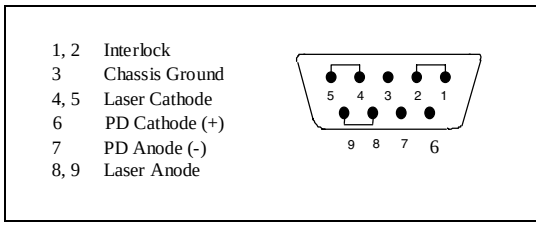


Figure 2.3 Back Panel LD Controller

The Interlock pins must be shorted in order to turn the LDX-3500 Series Precision Current Source output on.

The Photodiode BNC connector may also be used instead of pins 6 and 7 of the D-sub connector. The PD Cathode (+) is on the center connection to the BNC, and the PD Anode (-) is on the outer connection to the BNC.

Analog Output

An analog output signal is available at the ANALOG OUTPUT connector (BNC) on the back panel. This signal is a voltage between 0 - 10 volts which is proportional to the output current. For example, an analog output signal of 5 volts would represent an output current of about 50% of full scale.

Connecting to Your Laser

When connecting laser diodes and other sensitive devices to the LDX-3500 Series Precision Current Source, we recommend that the unit be powered up and the LASER output be off (OUTPUT ON LED unlit). In this condition, a low impedance shunt is active across the output terminals. When disconnecting devices, it is only necessary to turn the LASER Output off.

Key Switch

The back panel ENABLE key switch is used to enable/disable the current output. The key must be turned clockwise for the laser output current to turn on. If this switch is in the off position, the front panel INTLK/ENBL error indicator will be lit.

Laser Diode Connections and Shielding

WARNING

Before connecting the laser diode to the LDX-3500 Series Precision Current Source, be sure that the front panel (OUTPUT) ON switch is in the OFF position (ON LED unlit). Before turning on the LASER output, be sure that the current limit has been correctly set.

The interlock pins (1 and 2) on the LASER connector must be shorted in order to turn on the LASER output current.

Figures 2.4 - 2.7 show the possible configuration of connecting laser diodes and photodiodes with the LDX-3500 Series Precision Current Sources.

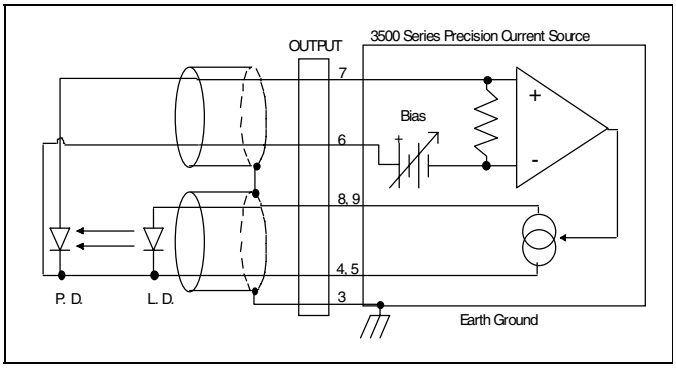


Figure 2.4 Common Laser Cathode - Photodiode Cathode

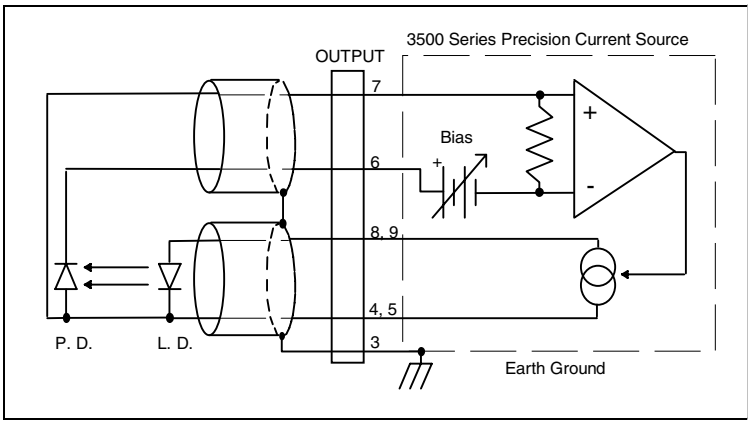


Figure 2.5 Common Laser Cathode - Photodiode Anode

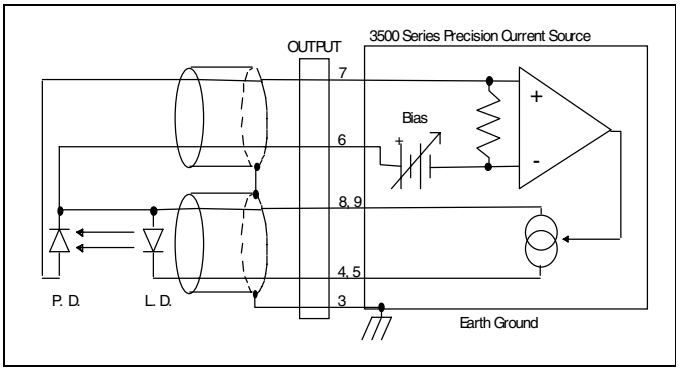


Figure 2.6 Common Laser Anode - Photodiode Cathode

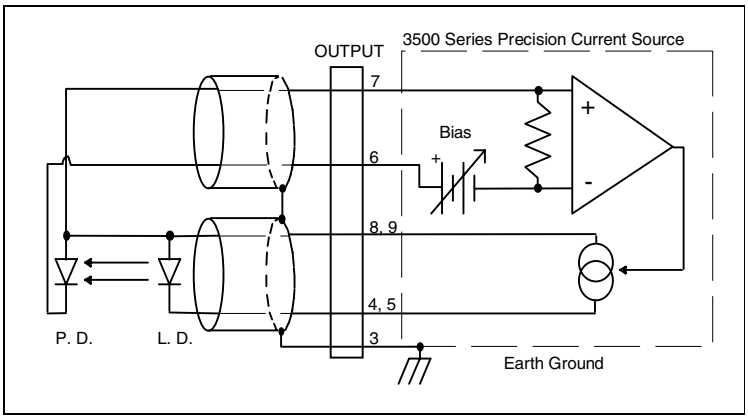


Figure 2.7 Common Laser Anode - Photodiode Anode

WARNING

The cable connections to the laser must be secure enough that they won't open-circuit, should they be jostled or bumped. Should an open circuit occur during laser operation, the LASER output will be turned off (ON LED unlit) automatically.

Experience indicates that should an open circuit occur during laser operation (while the LASER is on, the lasr may be damaged by a momentary circuit break-and-remake before the final circuit break. Therefore, although the LDX-3500 Series Precision Current Source provides a proprietary debounce protection circuit for LASER output, secure cabling is important.

It is recommended that the connections to the LDX-3500 Series Precision Current Source output be made using twisted wire pairs with an earth-grounded shield (see Figures 2.4 - 2.7). The output terminals of the unit are left floating relative to earth ground to suppress AC power-on/power-off transients that may occur

through an earth-ground path. If the output circuit is earth-grounded at some point (such as through the laser package and mount), the user must be careful to avoid multiple earth grounds in the circuit. Multiple earth grounds may provide circuit paths that induce spurious currents in the photodiode feedback circuit and output leads.

Photodiode Feedback Connections

The 9-pin connector on the back panel contains the current supply output. The photodiode signal is input at the connector at pins 6 and 7 (see Figure 2.3). The LDX-3500 Series Precision Current Source provides an adjustable reverse bias of 0 - 5 V for the photodiode. To set the photodiode bias to 5 volts reverse bias, turn the back panel PHOTODIODE BIAS ADJUST fully clockwise. To set the photodiode bias to 0 volts reverse bias, turn the back panel PHOTODIODE BIAS ADJUST fully counter-clockwise.

The photodiode feedback may also be connected via the PHOTODIODE (BNC) connector, located above the main 9-pin D-sub connector.

Many laser diode modules contain an internal photodiode that monitors the back-facet emission of the laser. Usually, this photodiode is internally connected to either the laser anode or cathode. Figures 2.4A - 2.4D show the recommended connections and shielding for the various configurations of laser diode modules and photodiode feedback schemes.

The photodiode and laser inputs of the LDX-3500 Series Precision Current Source are electrically isolated from ground and each other. So, if a 4-pin connection is made (no common connections) no additional jumpers are required. Figures 2.4A - 2.4D show the recommended connections and shielding for 3-pin lasers (where the common connection is internal to the device). A 4-pin laser should be connected with the same shielding as shown in Figure 2.4, but the common connection (between the photodiode and the laser) is optional.

Grounding Considerations

The LASER outputs of the LDX-3500 Series Precision Current Source are isolated from chassis ground allowing either output terminal to be grounded at the user's option. Figure 2.4 shows the proper earth-ground shielding for laser diode/photodiode connections.

General Operating Procedures

The following sections present some guidelines for operation, as well as some common operating procedures.

Warm-Up and Environmental Considerations

Operate the LDX-3500 Series Precision Current Source at an ambient temperature in the range of 0 to +40 °C. Storage temperatures should be in the range of -40 to +70 °C. To achieve rated accuracy, let the LDX-3500 Series Precision Current Source warm up for about 1 hour before use.

Current Mode Operation

You can operate the LASER current source portion of the LDX-3500 Series Precision Current Source in several modes, constant I CW, constant I HBW, or constant POWER. This example is for constant I CW or I HBW mode. Refer later in this chapter for POWER mode operation.

- Plug the LDX-3500 Series Precision Current Source into an AC power source supplying the correct voltage and frequency for your unit (refer to the back panel for the correct ratings).
- Turn on the LDX-3500 Series Precision Current Source. The OUTPUT stage will be off at power-up and the unit will automatically configure its parameters to the state which existed when the power was last shut off.
- Press the ENBL switch in the ADJUST section of the front panel so that the indicator is lit (adjustment enabled). Press the MODE switch until the I CW or I HBW (high bandwidth) mode is selected. Press the RANGE switch until the desired current range is selected.
- Press the PARAMETER switch and check the setting of I LIMIT to insure that it is compatible with the laser you are using. If not, turn the adjust knob until the current limit is correct.
- Press the DISPLAY switch and check the set point (operating) current. If it requires changing, turn the adjust knob until the desired value is displayed.
- Turn the current output on by pressing the ON switch (in the OUTPUT section). The unit will automatically drive the laser to the set point current.

  In I CW or I HBW mode the output may also be modulated via the MODULATION input.

  During operation, the adjust knob may be disabled by pressing the ADJUST ENBL switch. The LED indicator will be unlit when the adjust knob is disabled.
- When the unit is powered off, the state of the unit at power-down is saved in non-volatile memory.

Power Mode Operation

You can operate the LASER current source portion of the LDX-3500 Series Precision Current Source in several modes, constant I CW, constant I HBW, or constant POWER. This example is for constant POWER mode. Refer to Section 2.6.3 for constant I CW or I HBW mode operation.

- Plug the LDX-3500 Series Precision Current Source into a properly grounded, three-terminal AC power source supplying the correct voltage and frequency for your unit (refer to the back panel for the correct ratings).
- Turn on the LDX-3500 Series Precision Current Source. The OUTPUT stage will be off at power-up and the unit will automatically configure its parameters to the state which existed when the power was last shut off.
- Press the ENBL switch in the ADJUST section of the front panel so that the ENBL indicator is lit (adjustment enabled). Press the MODE switch until the POWER mode is selected. Press the RANGE switch until the desired current range is selected.
- Press the PARAMETER switch and check the setting of I LIMIT to insure that it is compatible with the laser you are using. If not, turn the adjust knob until the current limit is correct.

  Press the PARAMETER switch again and check the setting of P LIMIT to ensure that it is as desired. If not, turn the adjust knob until the power limit is correct.

  Press the PARAMETER switch again and check the setting of CAL PD to ensure that it is as desired. If not, turn the adjust knob until the CAL PD value matches the responsivity of your monitor photodiode.
- Press the DISPLAY switch and check the set point (operating) power. If it requires changing, turn the adjust knob until the desired value is displayed.
- Turn the current output on by pressing the ON switch (in the OUTPUT section). The unit will automatically drive the laser to the set point power. If the laser power exceeds the P LIMIT setting, the P LIMIT indicator will blink.

  If necessary, adjust the PHOTODIODE BIAS on the back panel, as needed.

  In POWER mode the output may also be modulated via the MODULATION input. When modulating in POWER mode the user should take special care to set I LIMIT properly. Since the monitor diode current (feedback) controls the drive current in this mode, the modulation bandwidth is limited and the response time of the control feedback (monitor current) greatly affects the drive current operation.

  During operation, the adjust knob may be disabled by pressing the ADJUST ENBL switch. The LED indicator will be unlit when the adjust knob is disabled.
- When the unit is powered off, the state of the unit at power-down is saved in non-volatile memory.

CHAPTER 3

MAINTENANCE

This chapter describes how to maintain the LDX-3500 Series Precision Current Source. Included are sections covering calibration, line voltage selection and disassembly.

WARNING

There are no user serviceable parts including the fuses in the power entry module. Potentially lethal voltages exist within the LDX-3500 Series Precision Current Source. To avoid electric shock, do not perform any of the procedures described in this chapter unless you are qualified to do so.

Qualified service personnel are required to wear protective eyeglasses and anti-static wrist bands while working on the LDX-3500 Series Precision Current Source circuit boards.

CAUTION

High voltages are present on and around the printed circuit boards of the LDT-5525 Temperature Controller.

Calibration Overview

The LDX-3500 Series Precision Current Source should be calibrated every 12 months or whenever performance verification indicates that calibration is necessary.

All calibrations can be done with the case closed. The instrument is calibrated by changing the internally stored digital calibration constants.

Recommended Equipment

Recommended test equipment for calibrating the LDX-3500 Series Precision Current Source is listed in Table 3.1. Equipment other than that sown in the table may be used if the specifications meet or exceed those listed.

Description	Manufacturing/Model	Specification
DMM	HP-3457A	DC Amps (@ 1.0 A): ±0.02 % Resistance (@ 10); ±0.02% 0.1 µA or 0.1 mV resolution
Resistors	High Power	1Ω, 20 W, low TCR, (LDX-3545) 0.5 Ω, 20 W, low TCR (LDX-3565) for current calibration
I_{PD} Calibration		
Resistors	Metal Film High-Power	49 Ω, 100 Ω, 1.0 MΩ, 1%, 1/4 W 10 Ω, 5 W, low TCR (LDX-3525) 5 Ω, 10 W, low TCR (LDX-3545) 5 Ω, 10W, low TCR (LDX-3565)
Optical Isolator		TIL117 or equivalent, 6-pin
Battery		9 V battery
Connector	D-sub	9-pin male

Table 3.1 Recommended Test Equipment

Environmental Conditions

Calibrate this instrument under laboratory conditions. We recommend calibration at 23 °C ± 1.0 °C. When necessary, however, the LDX-3500 Series Precision Current Source may be calibrated at its intended use temperature if this is within the specified operating temperature range of 0 to 40 °C.

Warm-Up

The LDT-5525 should be allowed to warm up for at least 1 hour before calibration.

Calibration Adjustments

There are two calibration adjustments that need to be made for the LDX-3500 Series Precision Current Source. They are calibration of the constant current source for both bandwidths and ranges, and calibration of the constant power (I_{PD}) feedback circuits for both ranges.

The LDX-3500 implements a two-point calibration. Two currents are applied to a load, and the resulting measured currents are fed back (by the user) to the LDX-3500 Precision Current Source. The LDX-3500 calibration program uses the two sets of data to calculate calibration constants that it will thereafter use to set current.

If a problem arises during calibration which prevents its normal completion, the calibration may be aborted with no ill effects by simply turning the power off. Then, at power-up, the old calibration values will be initialized and the user may re-calibrate. This is possible because the calibration values are not saved to non-volatile memory until the last step of calibration.

If an open-circuit condition occurs during calibration, the calibration mode will abort automatically, with no ill effect to the calibration data.

Current Source Calibration

The following procedure is for calibrating the output current measurement and set point. This procedure calibrates the circuits for the constant current modes. When the calibration set point values are reached and are stable, the user enters the actual value of the current, as measured by an external DMM. The LDX-3500 Series Precision Current Source then automatically calibrates the current limit circuits.

- Set the current limit (I LIMIT) to 90% of full scale (e.g., 900 mA for 1000 mA range on the LDX-3545), set the mode to I CW, set the output range as desired, and current set point to 80% of full scale (i. e. 800 mA for 1000 mA range on LDX-3545).

  Disconnect any laser from the output. Connect a calibrated DMM across the LASER output terminals and measure the current directly.

  OR - Connect a 1 Ω, 20 W, (LDX-3525 or LDX-3545) or 5 Ω, 20 W, (LDX-3565) resistor across the LASER output terminals and use a calibrated DMM to measure the voltage across the resistor.

  Calculate the current in the following steps by using Ohm's Law:

  I = E / R

  -where E is the accurately measured voltage across the resistor, and R is the accurately measured load resistance. (A 4-point probe resistance measurement is recommended.)

- Enter calibration mode by pushing the OUTPUT ON and ADJUST ENBL switches at the same time for one second. The display will blank for two seconds and then turn the output on (if it is not already on) and indicate output current in mA.
- Let the current settle for about two minutes until the measurement indicates that it is stable to five digits. Then, press and hold in the ADJUST ENBL switch and turn the ADJUST knob until the display indicates the same current as measured on the DMM or as calculated in Step a (if a voltage measurement is made).
- Release the ADJUST ENBL switch to accept the first calibration point. After the ADJUST ENBL switch is released, the LDX-3500 Series Precision Current Source will apply the second calibration current, approximately one-fourth of the original current. (For example, if the first calibration set point was 800 mA, the second set point will be about 200 mA.)
- If a voltage measurement is used, calculate the second current as in Step a.
- Press and hold in the ADJUST ENBL switch and turn the ADJUST knob until the LASER display indicates the same current as shown on the DMM or calculated in Step e (if a voltage measurement is used).
- Release the ADJUST ENBL switch to accept the second calibration point. After the ADJUST ENBL switch is released, the LDX-3500 Series Precision Current Source will calculate the calibration constants

  Then, the LDX-3500 Series Precision Current Source will automatically perform a current limit calibration, which takes about 10 seconds (for IHBW mode) or 20 seconds (CW mode). During this calibration the output will be driven to about 80% and then 20% of full scale. No user input is required for the limit calibration.

  After the limit is calibrated, the LDX-3500 Series Precision Current Source will store all the calibration constants into non-volatile memory and then return to its former (before calibration) state. The output remains on after calibration.

- Repeat this procedure with the high bandwidth (I HBW), and then repeat it all with other range (four combinations are possible).

Monitor Current (Power Mode) Calibration

The following procedure is for calibrating the I_{PD} measurement and power set point. This procedure calibrates the feedback circuits for constant power mode. When the calibration set point values are reached and are stable, the user enters the actual value of the current, as measured by an external DMM.

- With the LASER output off, connect a calibrated ammeter to the PD Anode output of the LDX-3500 Series Precision Current Source, and connect the circuit of Figure 3.1 to the laser and PD outputs (R3 = 5 Ω, LDX-3565; 5 Ω, LDX-3545; or 10 Ω, LDX-3525).

  If a calibrated ammeter (with 0.1 mA resolution) is not available, use a zero-Ohm jumper in place of the ammeter. Then, place a calibrated DMM (with 0.1 mV resolution) to measure the voltage across the resistor, R1, as shown in Figure 3.1.

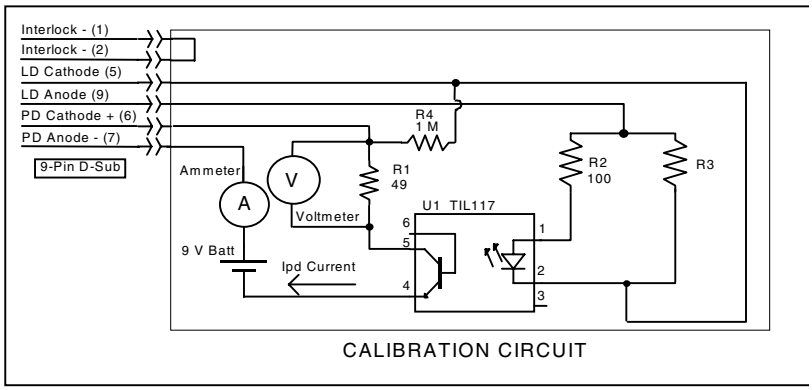


Figure 3.1 IPD Calibration Circuit

Calculate the current in the following steps by using Ohm's Law:

I = E / R

-where E is the accurately measured voltage across the resistor, and R is the accurately measured load resistance. (A 4-point probe resistance measurement is recommended.)

- Set the LDX-3500 Series Laser Diode Current Source's mode to P. Set the current range to the lower output range. Set the current limit (I LIMIT) to 80% of full scale. Set the P LIMIT to 100% of full scale (Power limit may be ignored during calibration). Set the power set point to 4.000 mW (LDX- 3525) or 8.000 mW (LDX-3545) or 40.00 mW (LDX-3565), and set the CAL PD parameter to 1.000 (mA/mW).

  This puts the LDX-3500 Series Precision Current Source into a mode in which the measured monitor current is equivalent to the power.

- Press the ON switch to turn the output on. Verify proper operation, i.e., the power set point should be close, and the unit should not be in current limit.

- Press the OUTPUT ON and ADJUST ENBL switches at the same time (for one second) to place the LDX-3500 Series Precision Current Source in its calibration mode.

  The display will blank for two seconds. Then the output will come on (if it wasn't already) and the display will show the power set point value.

- After the value on the display is stable (has not changed by more than one digit for several seconds) the LDX-3500 Series Precision Current Source is ready for the actual I_{PD} value to be entered.

  Press and hold in the ADJUST ENBL switch and turn the ADJUST knob until the display shows the correct value, as shown on the calibrated ammeter (or the calculated monitor current value from Step a).

- Release the ADJUST ENBL switch to store the first calibration value. The LDX-3500 Series Precision Current Source will then set the second calibration current (power), approximately one-fourth of the original current. (For example, if the first calibration set point was 4.000 mW (mA), the second set point will be about 1.000 mW (mA). Calculate the second calibration current as in Step a.

  After the value on the display is stable (has not changed by more than one digit for several seconds) the LDX-3500 Series Precision Current Source is ready for the second actual I_{PD} value to be entered.

  When it the set point value is stable, press and hold in the ADJUST ENBL switch and turn the ADJUST knob until the display indicates the same current as calculated in Step f.

- Release the ADJUST ENBL switch to accept the second calibration point. After the ADJUST ENBL switch is released, the LDX-3500 Series Precision Current Source will calculate the calibration constants. After this, the LDX-3500 Series Precision Current Source will store all the calibration constants into non-volatile memory and then return to its former (before calibration) state. The output remains on after calibration. Repeat this procedure for the higher output current range.

APPENDIX A

TROUBLESHOOTING

This appendix is a guide to troubleshooting the LDX-3500 Series Precision Current Source. Some of the more common symptoms are listed here, and the appropriate troubleshooting actions are given. We recommend that the user start at the beginning of this guide. Read the symptom descriptions, and follow the steps for the corrective actions which apply. If you encounter problems which are beyond the scope of this guide, contact your ILX Lightwave representative.

SYMPTOM	CORRECTIVE ACTION
LDX-3500 Series unit will not power up	Check AC power line voltage and power cord connection
Power on, but display is frozen, switches don't work	This may occur if the unit loses power (AC line) briefly. Turn the power switch off and on again to restart
Power on, but no current output	Check the Interlock and back panel ENABLE key switch If OPEN CIRCUIT indicator is lit, check the load connections and then try again On the LDX-3565, an OPEN error may be indicated as a result of internal overheating Check the OUTPUT ON switch, the LED should be lit
Unable to adjust output	Check the ADJUST ENBL switch; the indicator must be lit for any adjustments to be made Check the I LIMIT parameter; see that it is set above 0 mA
Output current at limit; cannot be lowered	If POWER mode is used, check the monitor diode (feedback) connections. Try reversing the polarity of the monitor photodiode. Check the photodiode bias adjustment on the back panel If I CW of I HBW mode, check the current set point and I LIMIT setting. Setting the output below the limit may require several turns of the adjust know if the set point is much greater than the desired limit setting.

Output goes off intermittently	Check the interlock circuit; an intermittent interlock will turn the output off Check that the AC power cord connection is secure. Power line drop-outs may reset the unit and when power is restored, the output will be off.
Power Mode operation has high output current, but little or no power is measured	Check back panel PD BIAS; if set too low, may act as an open feedback loop; if in doubt, set the PD BIAS to mid range
Output exceeds power limit	The “power limit” is not a hardware limit; it only serves as a warning that the power measurement has exceeded the limit set point
Power Limit Indicator does not work in CW or IHBW modes	Power limit is not detected in the constant current modes
Open Circuit Error occurs during calibration	Check load connections; check that meter does not auto-range (use non-auto-ranging modes)
Calibration is aborted unintentionally	Calibration modes will be aborted if an open circuit is detected
OPEN/V LIM indicator blinks	This indicates a voltage limit error; check laser connections; a higher impedance may cause this condition

ILX Lightwave
Lighting the Way in Electro-Optic Instrumentation

DECLARATION OF CONFORMITY

Application of Council Directive(s) 89/336/EEC EMC Directive
73/23/EEC Low Voltage Directive

Manufacturer's Name ILX Lightwave Corporation

Manufacturer's Address P.O. Box 6310 31950 E. Frontage Road
Bozeman, Montana 59771

Equipment Type/Environment Power Supply / Class I / Laboratory

Model Name ***LDX-35X5 LD Current Sources including LDX-3525, LDX-3545, LDX-3565***

Beginning Serial No. **35251202 35451061 35651032**

The CE Mark was first applied in 1996.

Conformance to Emissions Standard Cispr 11 (EN55011)

Immunity Standard 50082-1, IEC 801 - 2, 3, 4 (EN55101 - 2, 3, 4)
IEC-950-1,-2:1992, and referencing -3:1995, or EN60950-3:1995
with all amendments through Jan. 1997

I, the undersigned, hereby declare that the equipment specified above conforms to the above Directive(s). The documentation required to demonstrate that this product meets the requirements of the EMC, and Low Voltage Directives is available for inspection to the relevant authorities at the location shown below..

James A. Schreiner

Authority:
James Schreiner
Full Name
LDC Product Line Director
Position
Phone :1-406-586-1244
Fax: 1-406-586-9405

Signature **Date**

Documentation Location
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Tarporley Business Ctr., Tarporley
Cheshire, England CW6 9UY
Phone: 44-1829-733-305

ILX Lightwave
Lighting the Way in Electro-Optic Instrumentation

DECLARATION OF CONFORMITY

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73/23/EEC Low Voltage Directive

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James A. Schreiner

Authority:
James Schreiner
Full Name
LDC Product Line Director
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