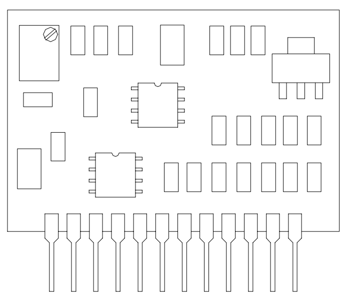
Thorlabs Model LD1100

Constant Power Laser Driver



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⚠ **Important Note: The LD1100 has been designed to provide many hours of trouble-free performance. To ensure proper operation, be sure follow these instructions:**

a. Wrist Strap - a grounded wrist strap should always be worn when handling laser diodes to prevent electrostatic damage to the laser.

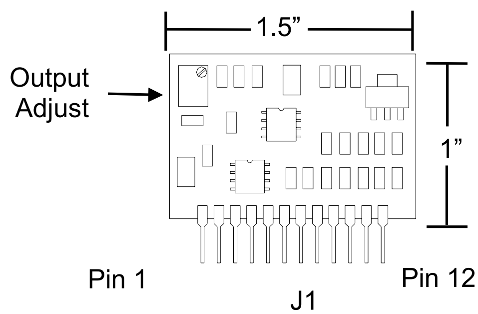
b. Solder Joint Quality - when installing the LD1100, sound, high-quality solder joints must be used. A cold solder joint or blobs of solder may cause intermittent connections or shorts that can damage the laser and the driver.

c. Laser Performance Data - When setting the laser output levels and the gain of the LD1100, be sure to use the actual performance for the diode you have in hand. Many manufacturers data sheets and brochures specify typical and maximum values and are meant to only be used as a guideline.

Where provided, use the actual performance data supplied with the diode. This is usually found on the outside of the diode wrapper or provided on a separate data sheet. If in doubt, please call a Thorlabs engineer and we will be happy to assist you.

Section 1 - Specifications

Operating Mode: Constant-Power (photodiode feedback)
Output Current: 0 to 250mA
Output Control: 12-Turn potentiometer (on-board)
Output Stability: <0.01%
Output Noise: 0.1µA RMS
Feedback Gain: On-board pin-programmable, also externally configurable
Monitor Current Range: 5µA to 5mA
Operating Voltage: +8 to +12VDC
Quiescent Current: 9 mA
Dimensions: 1” x 1.5” 12 Pin SIP Package
ESD Protection: 100 ms Slow Start



Pin	Signal	Description
1	+V	Circuit Power, 8 to 12VDC, 250mA, **NOTE: Internally tied to Laser Diode Anode, the laser anode must be isolated from the power supply COM.**
2	COM	Circuit ground
3	V_{REF}	Internal 2.5V reference
4	PDA	Photodiode Anode
5	LDA	Laser Diode Anode (internally tied to +V (pin 1))
6	LDC	Laser Diode Cathode
7	RA	When tied to common puts a 100KΩ in parallel with 249KΩ internal gain res.
8	RB	When tied to common puts a 33.2KΩ in parallel with 249KΩ internal gain res.
9	RC	When tied to common puts a 10KΩ in parallel with 249KΩ internal gain res.
10	RD	When tied to common puts a 3.32KΩ in parallel with 249KΩ internal gain res.
11	RE	When tied to common puts a 1KΩ in parallel with 249KΩ internal gain res.
12	I_{MON}	Laser Diode Current Monitor (10mV / mA)

Figure 1. LD1100 Pinouts

Section 2 - LD1100 Description

The LD1100 is a constant-power laser driver module. Its features include an on-board 12-turn trim pot for continuous laser output adjustment, pin-programmable feedback gain, ON/OFF control input, and a current monitor output for observing the laser drive current. Measuring only 1” x 1.5”, the LD1100 is a compact module which can be embedded into a custom design. All input and output signals are provided on a 12-pin SIP connector which allows simple integration into a printed circuit design.

The LD1100 can drive lasers up to 250mA in a constant-power mode. It uses the internal monitor photodiode for a feedback signal into a proportional-integral feedback loop to stabilize the output power to within 0.01%. To accommodate a wide range of laser diodes, the feedback gain can be set by jumpering any combination of the 5 gain setting resistor pins to the power supply common. This allows lasers with monitor currents over a range from 5µA to 5mA to be used with a single driver.

The LD1100 supports the following two laser pin configurations:

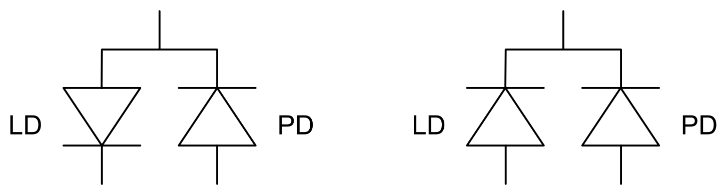


Figure 2. Laser Packages Supported.

Section 3 - Setup

Warning: Laser Diodes are extremely static sensitive and can be easily damaged by mishandling. Always use a grounded wrist strap and work on an anti-static mat when handling lasers.

3.1 Setting the LD1100 Feedback Gain for a given Monitor Photocurrent

The LD1100 has a pin-programmable feedback gain to accommodate a wide range of laser monitor photodiode currents. It is important that this gain be matched to the specific laser so that the LD1100 operates properly. Please refer to Figure 1 for identifying LD1100 features. For a detailed description of the feedback circuit as well as instructions on fully optimizing the gain, refer to Appendix.

3.1.1 Determine the monitor photodiode feedback current for your laser. This is usually given in the laser manufacturer’s data sheet.

3.1.2 Using Table 1. Look up the resistor combination that matches the photodiode current. If an exact match is not found, pick the combination that yields the next highest feedback current.

3.1.3 Read across Table 1 to identify the gain resistors that need to be enabled. The resistors that have an "ON" in their respective column need to be enabled by connecting their pin to the power supply common (J1 pin 2). The resistors that are labeled "OFF" should not be connected to any other pin.

Example: Laser is a CQL806/D (Iop = 70mA, Imon = 400µA). Looking up Table 1, the closest monitor current to that is 770µA which is set by jumpering RD to the power supply common and leaving RA-RC, & RE open.

In this example, the maximum feedback current of 770µA occurs when the output adjust pot is turned up to the full 12 turns. However, this particular laser reaches a maximum output at 400µA which occurs at an output adjust pot setting proportionately lower then 12 turns (400µA / 770µA * 12 turns = 6¼ turns). If you turn the output adjust above this point you will overdrive the laser and cause pre-mature laser failure.

IMPORTANT NOTE: When using the on-board gain settings, it is possible to overdrive the laser if the output adjust pot is turned completely up. This may be avoided by precisely matching the gain to your laser (see Appendix A for more details).

Max Imon (ma)	RA 100kΩ	RB 33 kΩ	RC 10 kΩ	RD 3.3 kΩ	RE 1kΩ
0.010	OFF	OFF	OFF	OFF	OFF
0.035	ON	OFF	OFF	OFF	OFF
0.085	OFF	ON	OFF	OFF	OFF
0.110	ON	ON	OFF	OFF	OFF
0.260	OFF	OFF	ON	OFF	OFF
0.285	ON	OFF	ON	OFF	OFF
0.335	OFF	ON	ON	OFF	OFF
0.360	ON	ON	ON	OFF	OFF
0.767	OFF	OFF	OFF	ON	OFF
0.792	ON	OFF	OFF	ON	OFF
0.843	OFF	ON	OFF	ON	OFF
0.868	ON	ON	OFF	ON	OFF
1.017	OFF	OFF	ON	ON	OFF
1.042	ON	OFF	ON	ON	OFF
1.093	OFF	ON	ON	ON	OFF
1.118	ON	ON	ON	ON	OFF
2.510	OFF	OFF	OFF	OFF	ON
2.535	ON	OFF	OFF	OFF	ON
2.585	OFF	ON	OFF	OFF	ON
2.610	ON	ON	OFF	OFF	ON
2.760	OFF	OFF	ON	OFF	ON
2.785	ON	OFF	ON	OFF	ON
2.835	OFF	ON	ON	OFF	ON
2.860	ON	ON	ON	OFF	ON
3.267	OFF	OFF	OFF	ON	ON
3.292	ON	OFF	OFF	ON	ON
3.343	OFF	ON	OFF	ON	ON
3.368	ON	ON	OFF	ON	ON
3.517	OFF	OFF	ON	ON	ON
3.542	ON	OFF	ON	ON	ON
3.593	OFF	ON	ON	ON	ON
3.62	ON	ON	ON	ON	ON

Table 1. Feedback Gain Resistor Settings

3.2 DC Power Supply Connection

A high-quality DC power supply with good turn-on and turn-off transient suppression will offer the best performance and protection for your laser. Avoid using switching supplies which typically have higher transient noise that can couple into the laser output as well as unregulated DC supplies. The LD1100 can also be operated off a battery. The usable lifetime of the battery will be limited to the laser operating current and the battery capacity.

Connect the '+' terminal of the power supply to J1 pin 1. Connect the power supply common to J1 pin 2.

!

Note: The output compliance voltage is determined by the power supply voltage and the laser operating voltage and current and can be determined as follows:

$$V_{COMPLIANCE} = V_{CC} - (V_F + 10{*}I_{LD} + 0.8V)$$

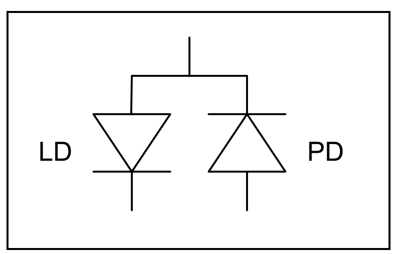
where: V_{CC} power supply voltage, V_F= laser forward voltage, I_{LD}= laser operating current.

3.3 Laser Diode Connection

The LD1100 supports two laser pin configurations (see Figure 2). We recommend using 24AWG wire from the LD1100 output pins to the laser and keeping the overall wire length to a minimum (1m max.). Twist the three leads from the driver to the laser to minimize pick-up. If a socket is to be used for the laser, make sure it is a high-quality socket with high-retention force pin sockets (i.e. Thorlabs P/N S8060 (9mm lasers) or S7060 (5.6mm lasers).

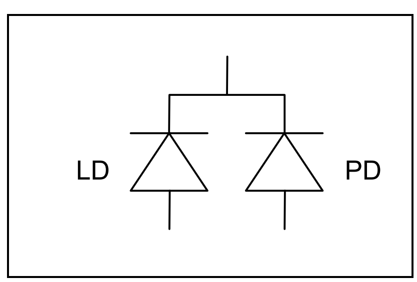
3.3.1 Laser Anode - Photodiode Cathode Common - This configuration is used for most visible laser diodes.

Laser Pin	J1 Pin
PDA	4
LDA / PDC	5
LDC	6



3.3.2 Laser Cathode - Photodiode Cathode Common - This configuration is used for many near-IR laser diodes

Laser Pin	J1 Pin
PDA	4
LDA	5
LDC / PDC	6



3.4 Accessories

Thorlabs offers evaluation boards as well as a pre-assembled kits for the LD1100 to make set up and testing even easier. Please refer to Appendix C for setup and operation of the EB1100 / EK1101/EK1102.

Section 4 - Operation

4.1 Laser Output Adjust -

After following the setup procedure in Section 3, the LD1100 should be ready to start driving your laser. Please read and use the following steps to operate the laser:

a. Before turning the laser on for the first time, turn the output adjustment pot down to the minimum setting by turning the adjustment screw counter-clockwise 12 full turns (this control does not have a mechanical stop but by turning it 12 turns assures the pot is at its minimum value).

b. Turn the DC power supply on, at this point you may see a very slight emission from the laser (particularly for lasers with low monitor currents) but it should be well below the lasing threshold.

c. Slowly turn the output adjustment pot clockwise until the output starts to increase. Use a calibrated power meter to precisely set the optical output power. Once the output adjustment has been set, it should not need any further adjustment unless you wish to change the output power.

4.2 ON / OFF Control

The LD1100 has an external ON / OFF control (J1, pin 3) which allows the laser output to be set to a reduced level. This function is activated by pulling this pin to 0V using either a mechanical switch or a transistor (open-drain FET or open-collector bipolar). This pin is internally pulled up to V_{CC} through a 2K resistor and must be allowed to float when the laser is operating. The normal voltage on this pin with the laser operating is 2.5V.

4.3 Monitoring the Laser Operating Current -

The laser operating current can be monitored by measuring the voltage on J1 pin 12. This pin has an output of 10mV/mA (i.e. J1-12 = 550mV, laser is operating at 55mA). Use only a high input impedance device (greater than 1KΩ) to avoid excessive load of the LD1100 output circuit.

Appendix A - Feedback Circuit Operation

The LD1100 uses a proportional-integral type (PI) feedback circuit to maintain an extremely stable laser output. The laser power is stabilized by varying the laser drive current in response to the monitor photodiode feedback to maintain a constant output power. This compensates for changes in the laser efficiency due to thermal and aging effects.

The feedback circuit converts the monitor photodiode current to a voltage which is compared to an adjustable internal reference to generate the control signal for the laser drive current. A decrease in the photodiode current is sensed as a reduction in the output power and the feedback loop will try to compensate by increasing the drive current to the laser. Likewise, if the photodiode current increases, the feedback loop will reduce the laser drive current to maintain a constant output power.

The LD1100 uses an adjustable 2.5V reference to establish the laser output power. The monitor photodiode current is converted to a voltage through a bank of programmable parallel resistors (see Figure A1) and compared to the internal reference. The programmable resistor bank support a wide range of laser monitor currents. It is important to select the right combination of resistors for proper operation. Ideally, the effective resistance of the parallel combination of resistors should be:

eq 1. $R_{eff} = 2.5V / I_{MON}$

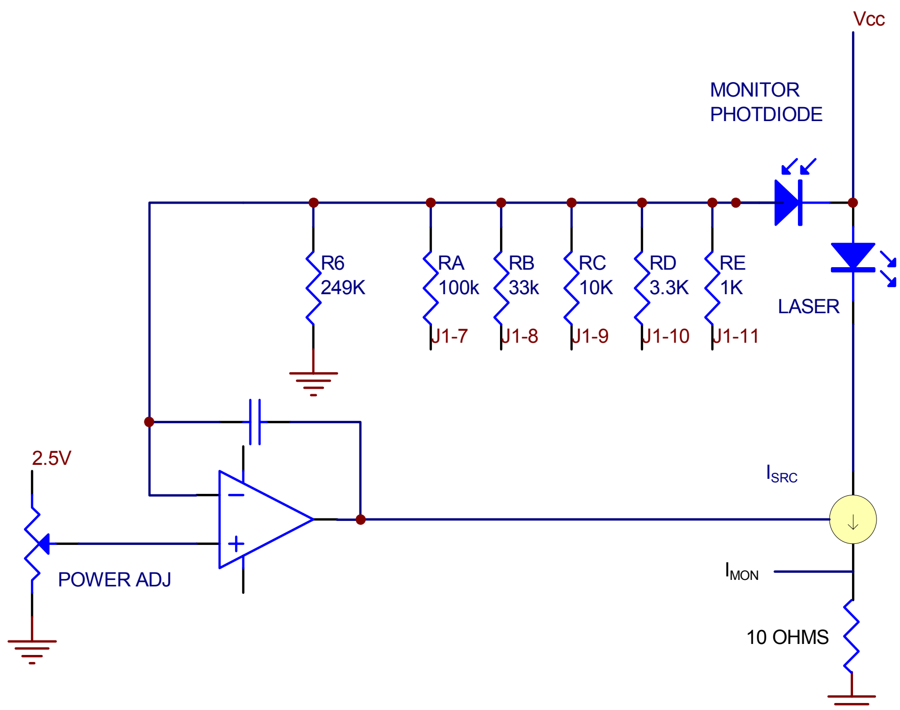


Figure A1 - Feedback Loop Functional Diagram

The effective resistance is easily calculated by:

eq 2. $$R_{eff} = \frac{1}{\left(\frac{1}{249K} + \frac{1}{RA} + \frac{1}{RB} + \frac{1}{RC} + \frac{1}{RD} + \frac{1}{RE}\right)}$$

Use only resistor values that are jumpered to the supply common in equation 2.

Since it is not possible to match every possible monitor current with the 5 available resistors, a compromise must be made. Table 1 in Section 3 provides a convenient list of all 32 possible resistor combinations. Note that with all five resistors open, the LD1100 still has a 249K resistor (R6) in the feedback loop. This was set so that the feedback loop will safely saturate before the laser is overdriven for most lasers (assuming the output control is turned down before powering up).

For critical applications, it is possible to set the feedback gain precisely with an external resistance tied to one of the gain setting pins. For these cases, add the external resistance to the resistance of the pin used.

Appendix B - Troubleshooting

Once it is set up, the LD1100 should be easy to operate and provide many hours of use. In case you experience any problems, we've included a few checks to help in troubleshooting the problem. If you have any questions, please call the factory and a Thorlabs engineer will be happy to assist you.

B1 - Laser Output Too Low

a. Check that the appropriate gain setting is used for your laser (refer to Section 3)
b. Check the output adjust pot. Turning it clockwise should increase the laser output power.
c. Make sure pin J1-3 is floating high and not pulled to ground.
d. Check that DC power supply (should be 8 to 12VDC)
e. Check the laser for possible damage. A typical healthy laser should have a homogeneous elliptical output beam whereas a damaged laser usually has low output power, a diffused output beam, and sometimes dark striations through the main lobe.

B2 - Laser Output Control Too Sensitive

a. Check that the appropriate gain setting is used for your laser (refer to Section 3)

Appendix C - EB1100 Evaluation Board / EK1101 and EK1102 Eval. Kits

Thorlabs offers two options to make setup and operation of the LD1100 Laser Driver easier. The EB1100 is an evaluation printed circuit board that the user can install the LD1100 onto and connect to the laser and power supply using components supplied by the user. The EB1100 requires some assembly and wiring prior to using the LD1100.

The EK1101 and EK1102 are complete evaluation kits which includes the LD1100 Laser Driver, the EB1100 Evaluation Board, a 6-position DIP switch for selecting the photo diode feedback gain, a 9V transistor battery connector for the power source, and miscellaneous components. In addition, the EK1101 and EK1102 come pre-assembled. The EK1101 is configured for the *Laser Anode - Photo Diode Cathode Common* package, where as the EK1102 is configured for the *Laser Cathode - Photo Diode Cathode Common* package.

C.1 Initial Setup

The EK1101 and EK1102 come pre-assembled. There is only one connection that needs to be made to begin operating these units; the DC input power. This will be described in the next sections.

The EB1100 consists of only the evaluation printed circuit board. The LD1100 is purchased separately. Also, the user must provide any needed components and the required assembly of the pcb.

Warning: As with all quality electronic equipment, the LD1100 requires high-quality soldered connections to the printed circuit board and the accompanying wiring harnesses. A poor solder joint on the LD1100 connection to the EB1100 or in any of the wiring harnesses or components can result in an intermittent connection that will lead to permanent damage to the laser. Thorlabs does not warrant against any losses caused by poor soldering practices. Be sure to check the quality of all solder joints before turning on the LD1100 power source.

C.2 DC Power Supply Connections

A high quality DC power supply with good turn-on and turn-off transient suppression will offer the best performance and protection for your laser. Avoid using switching power supplies which typically have higher transient noise as well as unregulated power supplies. The EK1101 and EK1102 can also be operated off a battery. The useable lifetime of the battery will be limited to the laser operating current and the battery capacity.

C.2.1 The EK1101 and EK1102 kits provide a 9V battery connector to supply power to the circuit. Connect the red (+) wire to the pin labeled "+V" and connect the black (-) wire to the pin labeled "COM".

C.2.2 If a DC power supply is preferred, connect the positive lead to the pin labeled "+V" and the negative lead (power supply return) to the pin labeled "COM". Adjust the DC power supply to a voltage between +8 and +12 volts before connecting to the evaluation board to prevent any damage to the circuit.

C.3 Power Switch Connection

The EK1101 and EK1102 each have a slide switch that switches the power to the LD1100. Before turning on the power to the laser, make sure that the feedback gain settings are correct and the adjustment potentiometer on the LD1100 is turned to its lowest setting (12 turns counter clockwise).

EB1100 Users: the ON / OFF position on the EB1100 can be used with a single pole, single throw switch. Power to the LD1100 is provided when pin 1 of this connector is jumpered to pin 2.

C.4   Laser Diode Connections

The EK1101 and EK1102 kits are provided with a laser diode socket assembly to connect the laser diode to the circuit. The wiring diagram for the socket assembly is shown in figure 2. The EK1100 series supports two laser pin configurations.

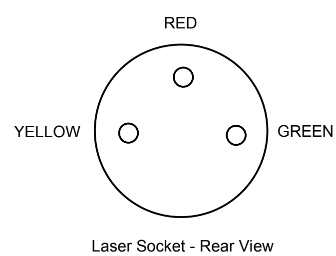
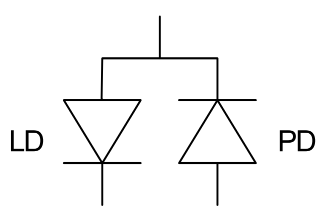


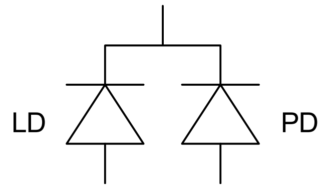
Figure C.1 - Laser Socket Wiring Harness

C.4.1 **EK1101** (Laser Anode - Photodiode Cathode Common) - This configuration is used for most visible laser diodes.

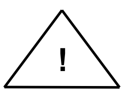


Laser Pin	J2 Pin (on EB1100)	Wire Color
PDA	**PD_A**	**Green**
LDA/PDC	**LD_A**	**Red**
LDC	**LD_C**	**Yellow**

C.4.2 **EK1102** (Laser Cathode - Photodiode Cathode Common) - This configuration is used for many near-IR laser diodes.



Laser Pin	J2 Pin (on EB1100)	Wire Color
PDA	**PD_A**	**Green**
LDA	**LD_A**	**Yellow**
LDC/PDC	**LD_C**	**Red**



Note on isolating the laser mount: The LD1100 places the laser anode and cathode at a voltage above ground. The laser mount should be electrically isolated from the power supply used to operate the EB1100. For best results, use a floating power supply that has outputs isolated from the AC ground to run the EB1100 and connect the laser mount to a suitable earth ground to improve ESD protection

C.5 Setting EK1101 and EK1102 Feedback Gain for a Given Monitor Current

The EK1101 and EK1102 have a dip switch programmable feedback gain to accommodate a wide range of laser monitor photo diode currents. Please refer to Section 3 (setup) to determine the feedback gain. The gain can now be set by turning on the proper dip switches.

For EB1100 users: the gain may be permanently selected by installing a jumper in place of the switch positions that are designated in the ON position in Table 1.

C.6 Customizing the Feedback Gain

For critical applications, it is possible to set the feedback gain precisely by calculating an external resistance (R_{EXT}) and placing it on the evaluation board. Note: R_{EXT} is added to the 1kΩ resistance of RE. The sum of RE and R_{EXT} is in parallel with the internal 249kΩ resistor. Use equation 1 below to calculate the required value of R_{EXT}

To operate in this mode, all of the dip switches should be in the off position.

$$R_{EXT} := \frac{1}{\left(\frac{1}{R_{eff}} - \frac{1}{249K}\right)} - 1K$$

eq 1.

Where:

R_{eff} is the desired feedback gain. R_{eff} can be calculated from the maximum photo diode monitor current for the laser as follows:

Reff = 2.5V / I_{MON}

Important note: When calculating the desired operating points of laser diodes, it is important that you use the actual performance data for the diode you have in hand. Many manufacturers data sheets and brochures specify typical and maximum values and are meant to only be used as a guideline.

Where provided, use the actual performance data supplied with the diode. This is usually found on the outside of the diode wrapper or provided on a separate data sheet. If in doubt, please call a Thorlabs engineer and we will be happy to assist you.

For a detailed description of the feedback circuit refer to the Appendix of the LD1100 Operations Manual.

Caution: Do not change the gain settings while the power is connected to the circuit. This may damage the laser.

C.7 EK1101 and EK1102 Operation

The EK1101 or EK1102 must first be set up properly. Please refer to the preceding sections and follow each step completely before attempting to operate a laser.

a) Attach the laser socket to the laser diode. See the note on isolating the laser mount.
b) Adjust the POWER ADJ trim pot 12 turns counter-clockwise to set the output power to the minimum level.
c) Verify the gain settings are correctly set for your laser.
d) Turn the power switch on. At this point it is normal for some light to emit from the diode but it should be well below the lasing threshold.
e) Using a calibrated power meter to monitor the laser output power, slowly adjust the POWER ADJ trim pot to reach the desired operating power of the laser. We recommend that the power meter surface be tilted slightly (approximately 2 degrees) to avoid reflecting the laser light directly back into the laser which can lead to errors in setting the laser power.

C.8 Monitoring the Laser Operating Current

The laser operating current can be monitored by measuring the voltage on J1 pin 1 (ILD) of the evaluation board. This pin has an output of 10mV/mA.

C.9 Troubleshooting the EK1101 and EK1102

The EK1101 and EK1102 are fairly simple device to set up and operate and should provide many hours of trouble-free operation. Should you encounter any problems with the EK1101 or EK1102 during operation we recommend checking the following:

a) Check that the gain settings match the monitor photo diode current of your laser. Be sure to use the actual performance data for your specific laser.
b) Check that the laser socket pin connections match the pinouts of you laser.
c) Check that all solder joints are clean and of high quality. Cold solder joints or blobs of solder can cause shorts and intermittent connections.
d) Check that the power supply voltage is between 8 and 12volts. If using a battery, replace with a new battery.
e) Check that the power switch is on.

If you still experience problems, please call Thorlabs and an engineer will be happy to assist you.