

10A High Efficiency Laser Controller ATLD10A5-D Evaluation Board Rev. 1.0

By Gang Liu

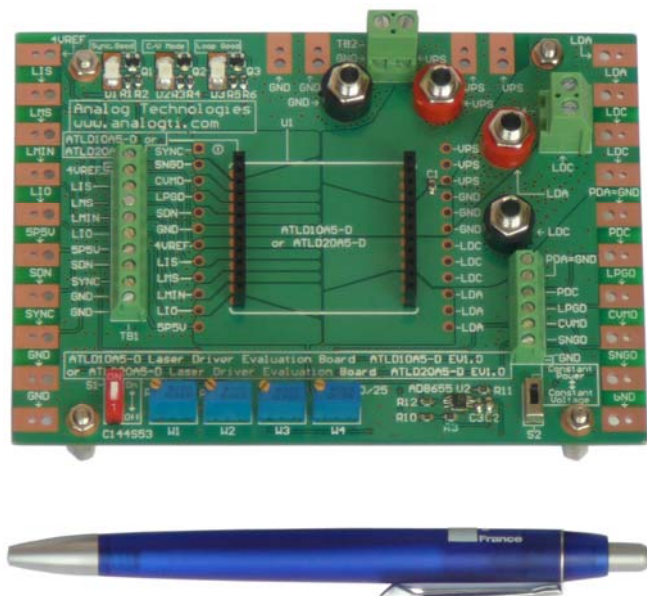


Figure 1 ATLD10A5-D EV1.0 Photo

INTRODUCTION

The ATLD10A5-D is an electronic module designed for driving high current diode lasers with well controlled output current and laser power or voltage. Its efficiency is so high that no heat sink is needed even outputting a 10A current. The output voltage range is from 0V to 14.25V when powered by a 15V power supply. This laser driver module can be evaluated conveniently by using the ATLD10A5-D EV1.0, the evaluation board for ATLD10A5-D Revision 1.0. Figure 1 shows ATLD10A5-D EV1.0 photo. It is recommended to read this application note with the ATLD10A5 datasheet which provides more detail information about the specifications and application guidance for the laser driver module.

The main purpose of using the evaluation board is to let the controller drive an unbreakable power resistors load (It isn't in evaluation board ATLD10A5-D EV1.0, and can be provided additionally. See the load photo in Figure 7) to emulate users' actual expensive laser diode with constant current mode and constant power or constant voltage mode. After making sure the controller works properly and all the features and the set-values meet the requirements of the application. The user will be able to set and monitor the output current, read the controller's temperature, monitor the working status of the controller, etc.

BOARD DESCRIPTION

The ATLD10A5-DEV1.0 Evaluation Board is consisted of a polished application circuit for driving a laser diode. It can set the output current and voltage, the output current and voltage

limit, and has three LEDs for indicating the working status of the controller, has numerous connection pads, terminal connectors and banana sockets for making connections with external components and instruments.

The silkscreen layer of the evaluation board is shown in Figure 2 with other top layers, including top silkscreen, top copper, top solder mask, and multilayer (vias). Figure 3 only shows the image of top silkscreen layer. There is no component in the bottom side of the board, so that there is no bottom silkscreen layer image.

There are solder pads on the left, top and the right edges of the board. These pads can be used for connecting the external instruments or components with and the connections can be made by either soldering wires or clipping by alligator clips.

There are 4 terminal blocks also located on the left, top and the right side of the board, their connectors are for the same nodes of the solder pads. See the silkscreen image in Figure 3.

There are 4 banana sockets located on the top and the right side of the board, their connectors are for the same nodes of the terminal blocks TB2 and TB4. See Figure 2.

On the bottom left location of the board, there is a shut down control switch S1, and on the bottom right location of the board, there is a working mode control switch S2. The 4 potentiometers are located on the right side the switch S1 and on the left the switch S2. See the silkscreen image in Figure 3.

In the four corners of the board, there are 4 copper cylinders for supporting the evaluation board. Please notice that the only copper cylinder in the upper right corner of the board is float, and the others are connected to ground.

When the controller works perfectly, the LEDs on the top left location will be lit up.

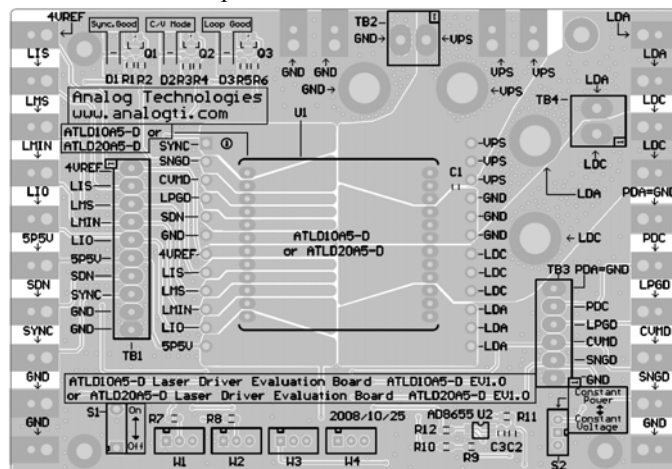


Figure 2 Top Silkscreen Layer with Other Top Layers

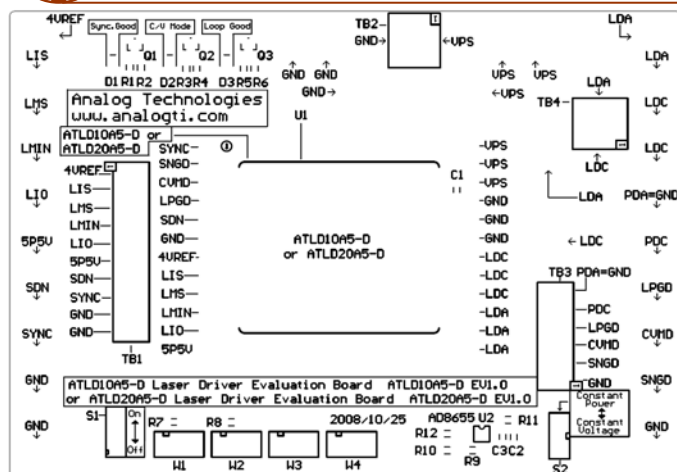


Figure 3 Top Silkscreen

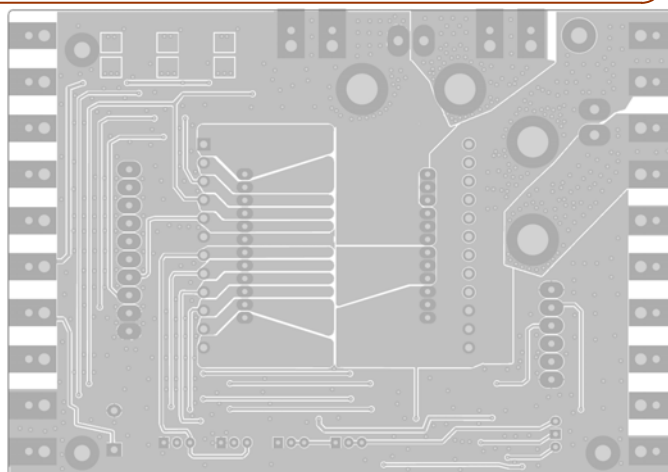


Figure 5 Bottom Layers

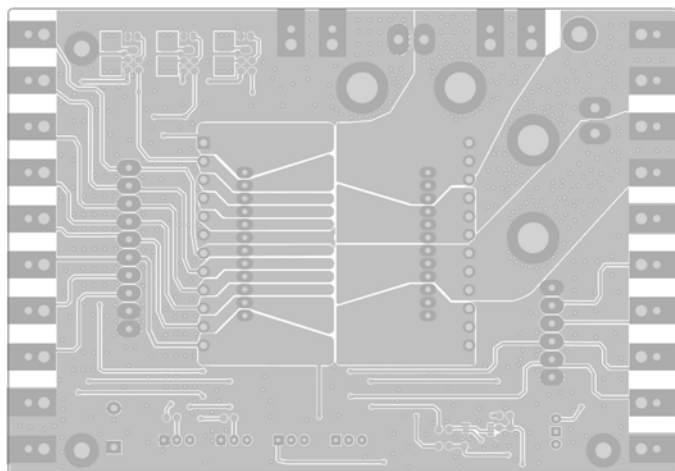


Figure 4 Top Layers without Top Screen Layer

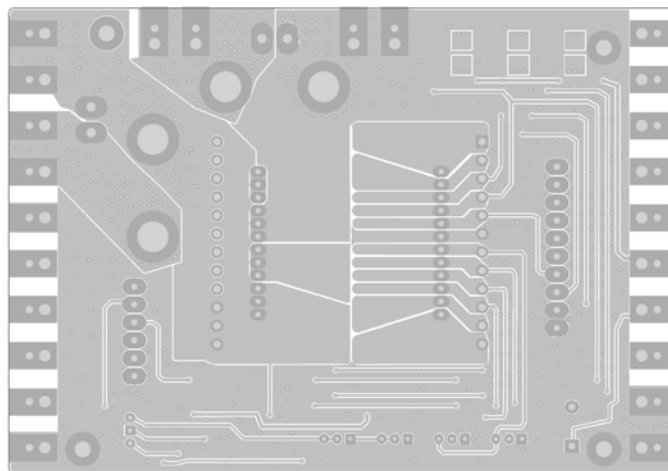


Figure 6 Mirrored Bottom Layers

Figure 4 shows the top layers without the silkscreen layer. Figure 5 below shows the bottom layers, including bottom copper, bottom solder mask, and multilayer (vias). Please notice that this is a “see through” image from the top side.

Figures 3 and 4 can be used as a layout reference for designing a system using the ATLD10A5-D in the system. These are the main points:

1. Connect the power supply return node directly to the power ground pins of the controller before connecting it to any other points. For thermal management purpose, the returned node was not done in this way on the evaluation board.
2. Use as large copper area as possible for the PCB traces of the solder pads of all the pins so that these copper areas become heat-sinks and help dissipating the heat generated by the controller.
3. Use as wide and thick copper area as possible for the PCB traces of power supply nets(VPS, Power ground) and laser diode output nets(LDA, LDC) so that these copper areas become high current wires and help transferring 10A and up current.

Figure 6 shows the mirrored bottom layers which is a directly-seen image from the bottom side.

The ATLD10A5-D laser controller module is located in the center of the ATLD10A5-D EV1.0 Evaluation Board. The voltages of all its pins can be measured directly by probing the vias on the left and right side of the module sockets which are connected directly with pins of the electronic module. Some of the pins are also connected to the connectors of the 4 terminal blocks, the soldering pads, and/or 4 banana sockets on the edges of the board. The names of all these nodes are marked on the board.

The load photo is shown in Figure 7 below. When power supply voltage = 15V and $R_0 = R_1 = 0.7\Omega$, the part number of load is ATL150W0R7V1. When power supply voltage = 5V and $R_0 = R_1 = 0.2\Omega$, the part number of load is ATL50W0R2V1.

The schematic of load is shown in Figure 8 below.

The schematic of ATLD10A5-D EV1.0 is shown in Figure 9 below.

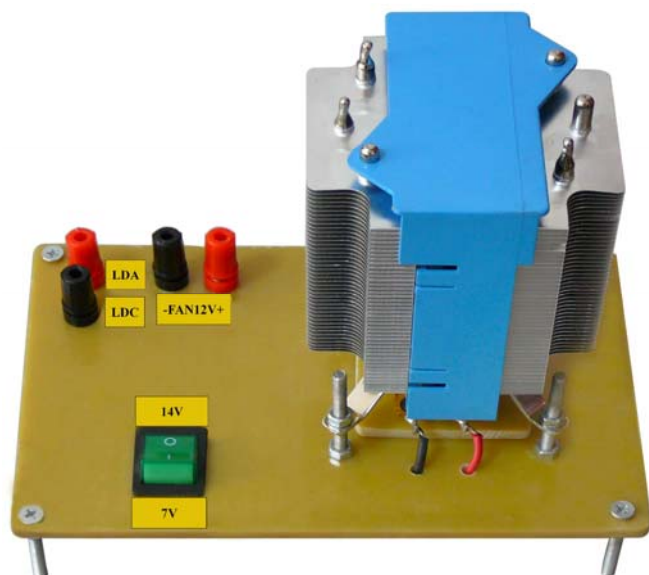


Figure 7 Load Photo

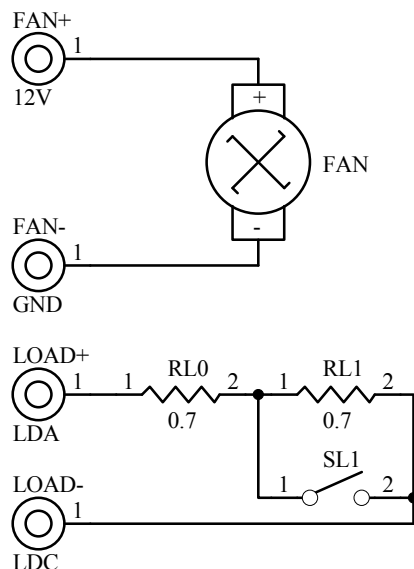


Figure 8 Schematic of Load

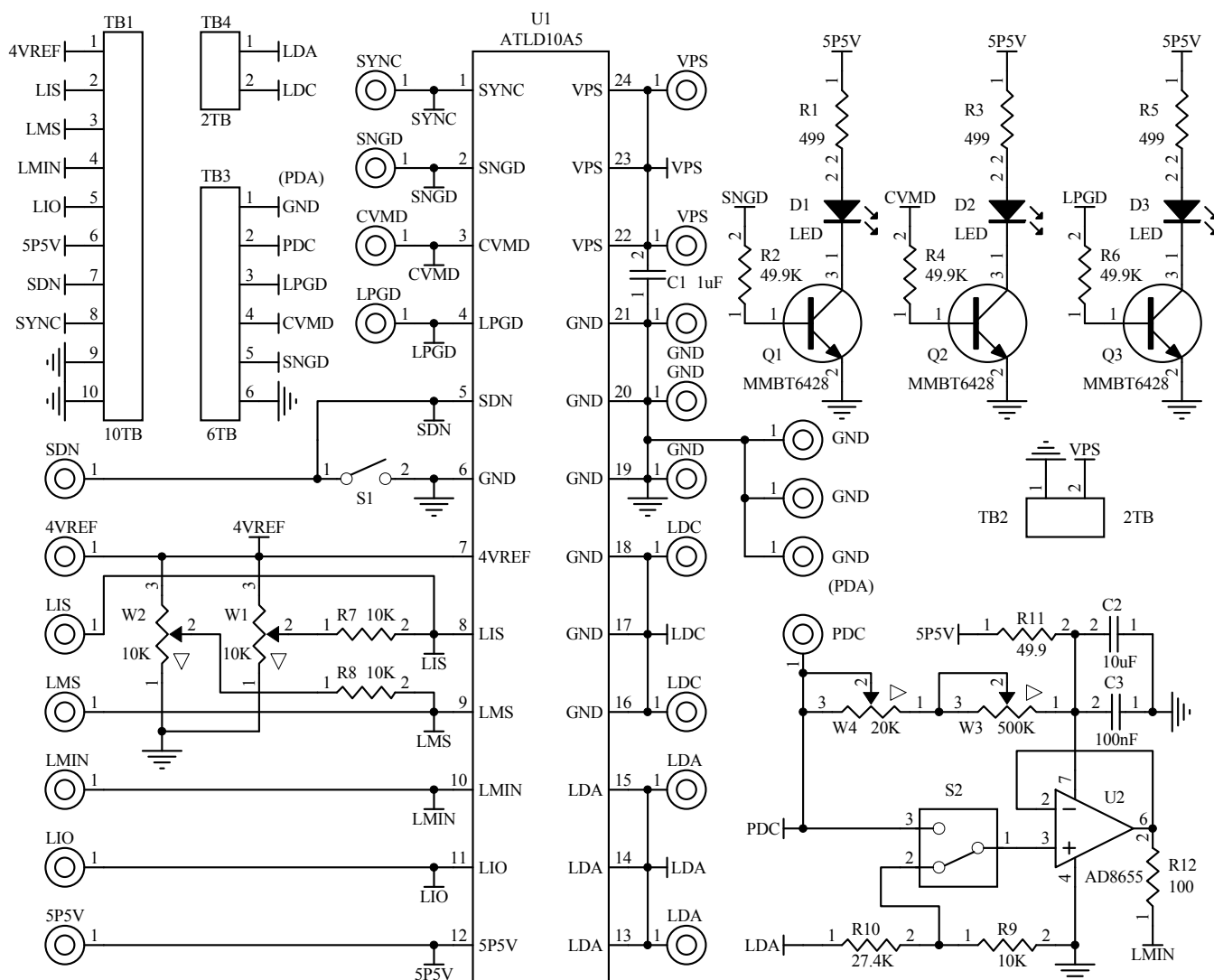


Figure 9 Schematic of Laser Driver ATLD10A5-D Evaluation Board Rev. 1.0



GETTING STARTED

- Hook up the power supply. There are 4 solder pads in the upper right area on the edge for connecting the power supply voltages. The connection can be done by clipping or soldering on the pads, use the bananas to plug banana sockets, or use the screws to lock in 2 wires through the terminal block TB2, see Figure 1.
- Check the voltage reference. Use a voltmeter to check the voltage reference pin 4VREF having an accurate 4.0V.
- Turn on and off the controller. This can be done by either turning off the power supply or turning off the shut-down pin of the controller. To do the latter, turn the switch S1 to its lower position to turn off the controller, which shorts circuit the shutdown pin SDN to the ground, or turn the switch S1 to its upper position to turn on the controller.
- Monitor the output current by using the LIO pin voltage. Measuring the voltage of the LIO pin using a voltmeter (measure between the LIO pin and the ground node) will allow monitoring the output current. The relationship between the LIO voltage and the output current is linear:

$$I_{\text{output}} = 10 \times \text{LIO}/4.0\text{V (A)},$$

where I_{output} is the output current in Ampere,

LIO stands for the voltage at the LIO pin.

- Test the controller with the “dummy laser”. The unbreakable power resistors load, RL0 and RL1, can form a “dummy laser” to act as the laser diode in the place of a real laser so that in case there is a problem in the circuit, the expensive laser would not be damaged, see schematic in Figure 8. Turning switch SL1, off and on will increase (turning off the switch) and decrease (turning on the switch) the forward voltage of the “dummy laser” which can be measured by a volt meter between the LDA and the ground.
Warning: when output 10A current, the load may get very hot, don't put your fingers on them. This is the way to calculate the power consumption of the controller:

$$P_{\text{controller}} = I_{\text{input}} \times V_{\text{PS}} - I_{\text{output}} \times V_{\text{LDA}},$$

where $P_{\text{controller}}$ is the power consumption of the controller,

I_{input} is the power supply input current,

I_{output} is the output current,

V_{PS} is the power supply voltage applied onto the VPS pin of the controller,

V_{LDA} is the voltage across the laser diode,

$$\eta = I_{\text{output}} \times V_{\text{LDA}} / (I_{\text{input}} \times V_{\text{PS}}).$$

- Monitor the output voltage. This can be done by using a volt meter to measure the voltage between LDA and ground. This node is available at the edge pad (upper right corner), the terminal block conductor, the banana socket, and the

controller pin via.

- Setting to constant current mode. When driving a load in current mode, such as a laser diode, configure the controller to work under the current mode, while using the output voltage and the voltage limit setting as protection mechanism. This is the way to do it:
 - Connect LMIN to the LDA pin.
 - Set the LMS pin at the voltage allowed for the laser. For example, if the laser can take at most 4V, set the LMS at 4V.
 - If the maxim output voltage exceeds 15V, use a resistor divider circuit to divide the LDA pin voltage and send the divided signal to the LMIN pin.

The load is now to be driven under constant current mode and the CVMD pin (# 3) will output a voltage of about 5.5V. The output current will be controlled by the current set pin LIS. In case there is one component fails in the controller and the output current exceeds the current limit, the voltage limit control circuit takes over the control the CVMD pin will be pulled low.

The relationship between the input voltage on the LIS pin and the output current is:

$$I_{\text{output}} = 10 * (\text{LIS} - 0.4\text{V}) / 3.696\text{V (A)},$$

I_{output} is the output current and the LIS is the voltage on the LIS pin.

- Setting to constant voltage mode. When driving a voltage load, such as using the controller as a power supply (DC-DC converter), configure the controller to work under the constant voltage mode, while using the current control loop as a protection mechanisms. This is the way:
 - Connect the LMIN pin (#10) to LDA.
 - Set the LMS pin (#9) to the voltage desired.
 - Set the output current limit to about 1.1 times of the maximum output current allowed by setting the LIS pin to a proper voltage.
 - In case the maximum output voltage exceeds 15V, use a resistor divider network to lower the output voltage at the LDA pin.

The load is now being driven under constant voltage mode and the CVMD pin (# 3) will output a voltage of about 0V. The output voltage will now be controlled by voltage set at the LMS pin. In case there is one component fails in the controller and the output voltage exceeds the current limit set by the LIS pin, controller will be working under the current mode and the CVMD pin will be pulled high.

- Setting to constant laser power mode. The ATLD10A5 can be used to control the laser to output a constant laser power by using a photo diode (PD) which detects the laser power. This is the way:



- A. Connect the LMIN pin (#10) to the anode of the PD.
- B. Connect the cathode of the PD to 4VREF pin (# 7).
- C. Connect a resistor between LMIN pin and the ground, GND (# 6).
- D. Set the LMS pin (# 9) to a voltage at which the PD will generate corresponding voltage at the LMIN pin.
- E. Set the LIS pin to a voltage at which the controller will output a current that is maximum for laser. The formula for calculating the voltage needed on the LIS pin is:

$$LIS = I_{\text{output}} * 3.696 / 10 \text{ (V)} + 0.4.$$

For example, a 5W constant laser power is needed, at which, the PD will generate 0.1mA current. The resistor between the LMIN and the ground will need to be:

$$R = 4V / 0.1mA = 40.96K\Omega.$$

Now, when the laser output power changes from 0 to 5W power, the voltage at the LMIN pin will change from 0 to 4V. When needing the output power to be 5W, connect LMS pin to 4VREF; when needing, for example, 2.5W, connect LMS to a 2.048V voltage, which can be obtained by using a resistor divider network to divide the 4VREF voltage by half, or simply using a potentiometer.

10. Loop good indication. When the controller works perfectly, i.e., the output current equals the set-point current set by LIS pin, the LED on the lower right corner of the board will be lit up. Otherwise, it will be dark when the power supply is on and the controller is being shut off (turning the shutdown switch S1H to upper position) or the output voltage is beyond 4V at the current set by the LIS pin.

Monitor the internal temperature of the controller. The controller internal temperature can be monitored by measuring the TMPO pin voltage. The relationship between the LMPO voltage and the temperature is:

$$T = -1525.04 + 10^3 \sqrt{2.4182 + \frac{1.8015 - TMPO}{3.479}} (C) \quad (1)$$

where TMPO is the voltage on the TMPO pin.

This formula can be approximated by a linear equation:

$$T = 192.7 - 90.31 \times TMPO (C) \quad (2)$$

Within the most commonly used temperature range of between 0°C to 100°C, the maximum error occurs at about 1.5V, at which the temperature error between the calculated data by using the formula (1) and the approximated data obtained by using the linear equation (2) is about 0.4°C, with the linear data being a little lower. The curves of the 2

sets of the data are plotted in Figure 8.

Please notice that the TMPO pin has a weak driving capability: the maximum sourcing current is 1μA and the maximum sinking current is 40μA.

The TMPO pin can also be used as an input control pin: when forcing the TMPO voltage to below 0.4V, the laser controller will be shutdown.

11. Connecting external ADCs (Analog to Digital Converters) and DACs (Digital to Analog Converters). The ADCs can be utilized for monitoring the analog voltages on certain pins, such as LIO, TEMPO, LISSET, etc., and the DACs can also be utilized for setting the LIS and/or LISLM pin voltages. The voltage reference from the controller can be used as the voltage reference for the ADCs and DACs.
12. Connecting a real laser diode to the evaluation board. After making sure that the controller works properly by going through the above steps, a real laser diode can be connected to the evaluation board. This is the procedure:
 - A. Set the output current and the current limit to the values desired by driving the dummy laser on the board as described above. The current limit is usually set to the 1.1 times of the output current.
 - B. Solder the laser diode terminal wires to the LDA and LDC solder pads, or use the LDA and LDC conductors on the terminal block TB3 and lock the wires by using the screws. Make sure that the connections are tight and secure, no intermittent disconnection will occur.
 - C. Set the output forward voltage to 1.4V by switching S1A, S1B, S1C and S1D to the upper on position. Turn on the power supply, and see everything works perfectly as described above.
 - D. Turn off the power, turn the switch S1A to the lower off position and turn on the power again. After this moment, be more careful in doing anything on the board, because any mistake in operating the board or causing intermittent disconnections for any connections on the board may result in damaging the laser diode permanently.
 - E. If everything still works fine after step D above, the user can proceed to testing the laser itself. The output current and current limit can be adjusted while the laser is turned on, but make sure that the output current will never exceed the laser's current limit.
 - F. In case there are any suspicious or real problems, disconnect the real laser and use the dummy laser for debugging.

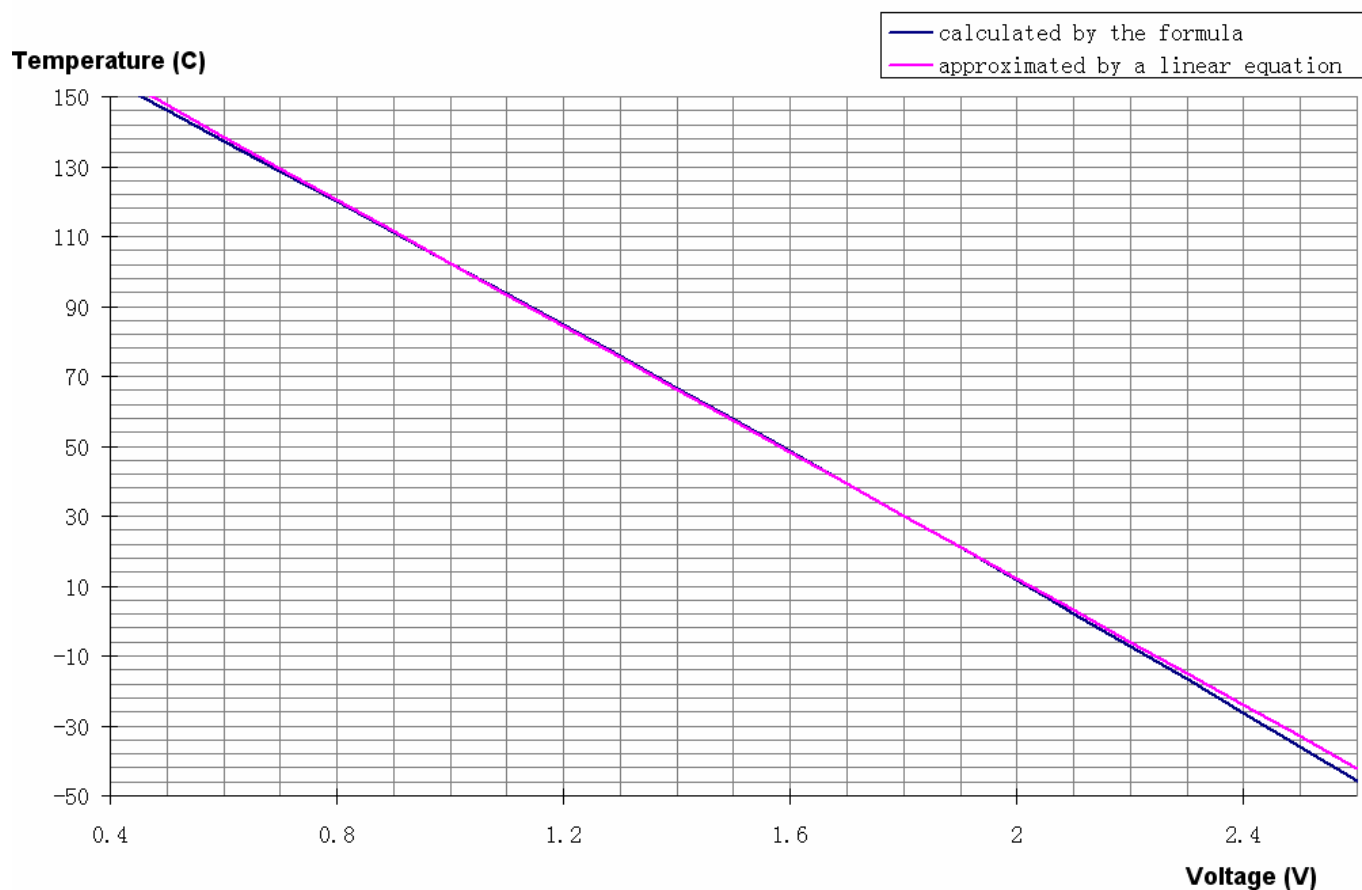


Figure 10 Controller Internal Temperature vs. TMPO Voltage

**ORDERING INFORMATION**

Part Number	Description	1 – 9	10 – 49	50-199	200-499	≥500
ATLD10A5-D EV1.0	Laser controller ATLD10A5-D evaluation board Rev. 1.0	\$90.0	\$85.5	\$81.0	\$76.5	\$72.0

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