# Low Noise Laser Driver ATLS100MA116D Evaluation Board Rev. 1.0

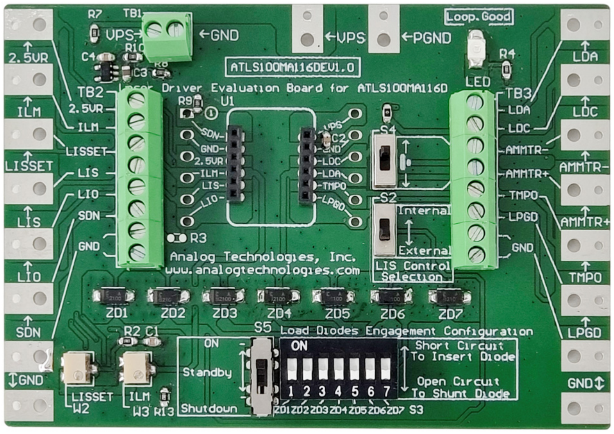


Figure 1. Physical Photo of ATLS100MA116DEV1.0

## FEATURES

- Come with a dummy laser on the board.
- Use the dummy laser to emulate expensive real laser first.
- Allow setting the output current conveniently.
- Evaluate the laser controllers (listed below) conveniently.

## APPLICATIONS

Evaluate the laser driver ATLS100MA116D.

## INTRODUCTION

The ATLS100MA116D is an electronic module designed for driving diode lasers with ultra low noise current and DIP package. The output voltage range is from 5V to 14V when powered by a 16V power supply.

This evaluation board, ATLS100MA116DEV1.0, is designed for evaluating ATLS100MA116D laser driver module conveniently. It is recommended to read this application note with the driver 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 a voltage configurable unbreakable dummy laser diode on the board to emulate users' actual expensive laser diode with a programmable current. After making sure the controller works properly and all the features and the set-values meet the requirements of the application, the users can disconnect the dummy laser from the controller by turning a switch and connect a real diode laser onto proper connections of the board. 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 ATLS100MA116DEV1.0 Evaluation Board is consisted of a complete application circuit for driving a laser diode. It can set the output current, the output current limit, has an LED for indicating the working status of the controller, has numerous connection pads and terminal connectors for making connections with external components and instruments. Its physical photo of ATLS100MA116DEV1.0 is shown in Figure 1.

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.

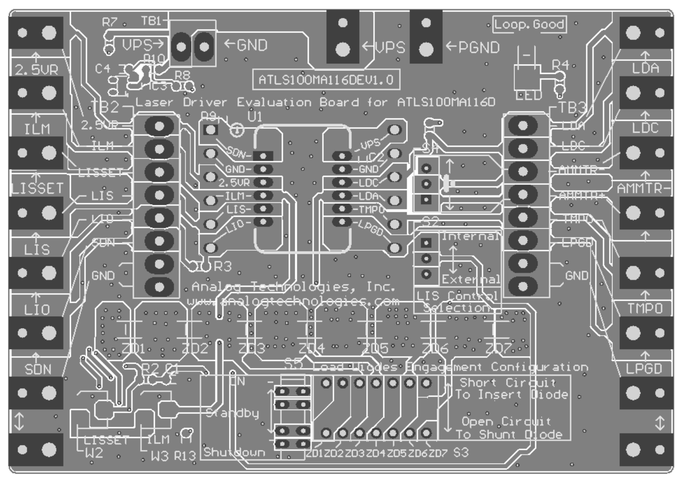


Figure 2. Top Silkscreen Layer with Other Top Layers

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 3 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.

On the bottom center of the board, there is a switch bank. The 2 potentiometers are located on the left side the switch bank.

When the controller works perfectly, the LED on the upper right location will be lit up.

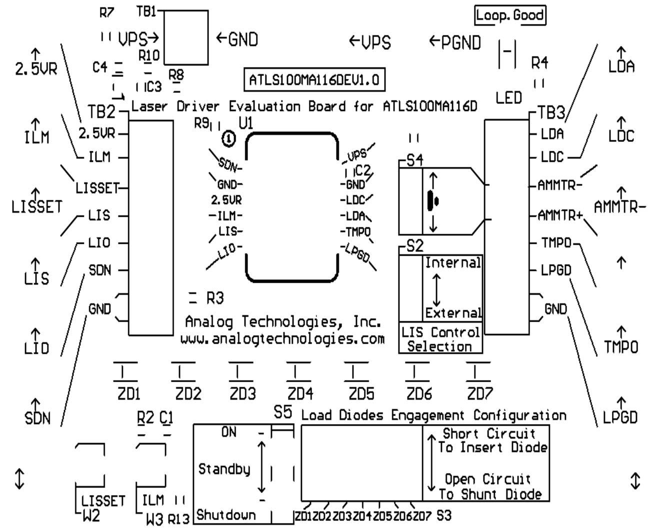


Figure 3. Top Silkscreen

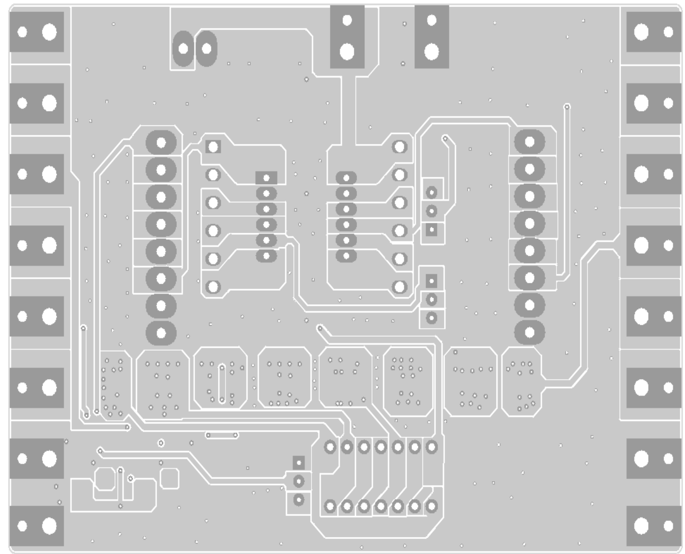

Figure 5. Bottom Layers

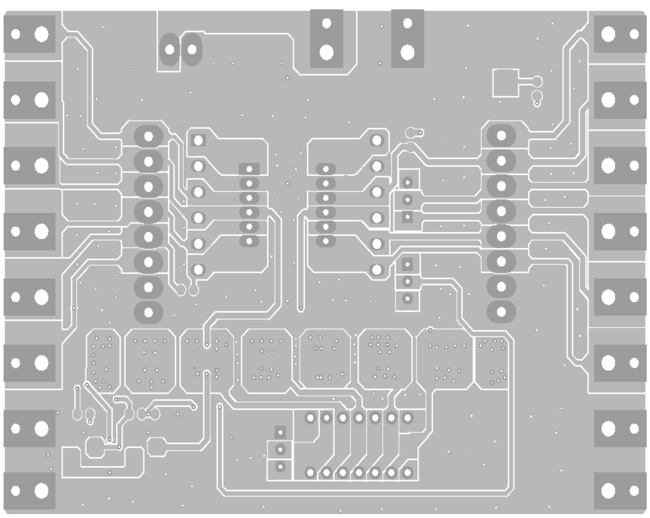

Figure 4. Top Layers without Top Screen Layer

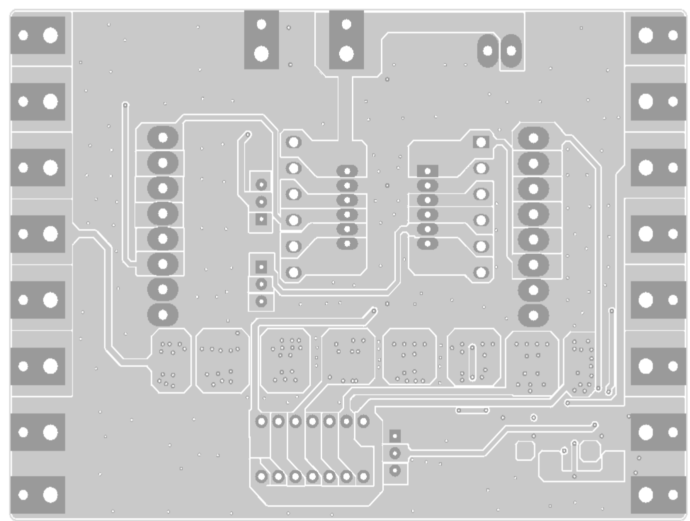

Figure 6. Mirrored Bottom Layers

Figure 4 shows the top layers without the silkscreen layer. Figure 5 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 4 and 5 can be used as a layout reference for designing a system using the ATLS100MA116D in the system. These are the main points:

1. Connect the power supply return node directly to the PGND pin 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.

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

The ATLS100MA116D laser controller module is located in the center of the ATLS100MA116DEV1.0 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 3 terminal blocks, and/or the soldering pads on the edges of the board. The names of all these nodes are marked on the board.

Please notice that when the board is working, the 7 diodes on the bottom center may get hot, therefore, avoid touching them with your fingers.

The schematic is shown in Figure 7 below.

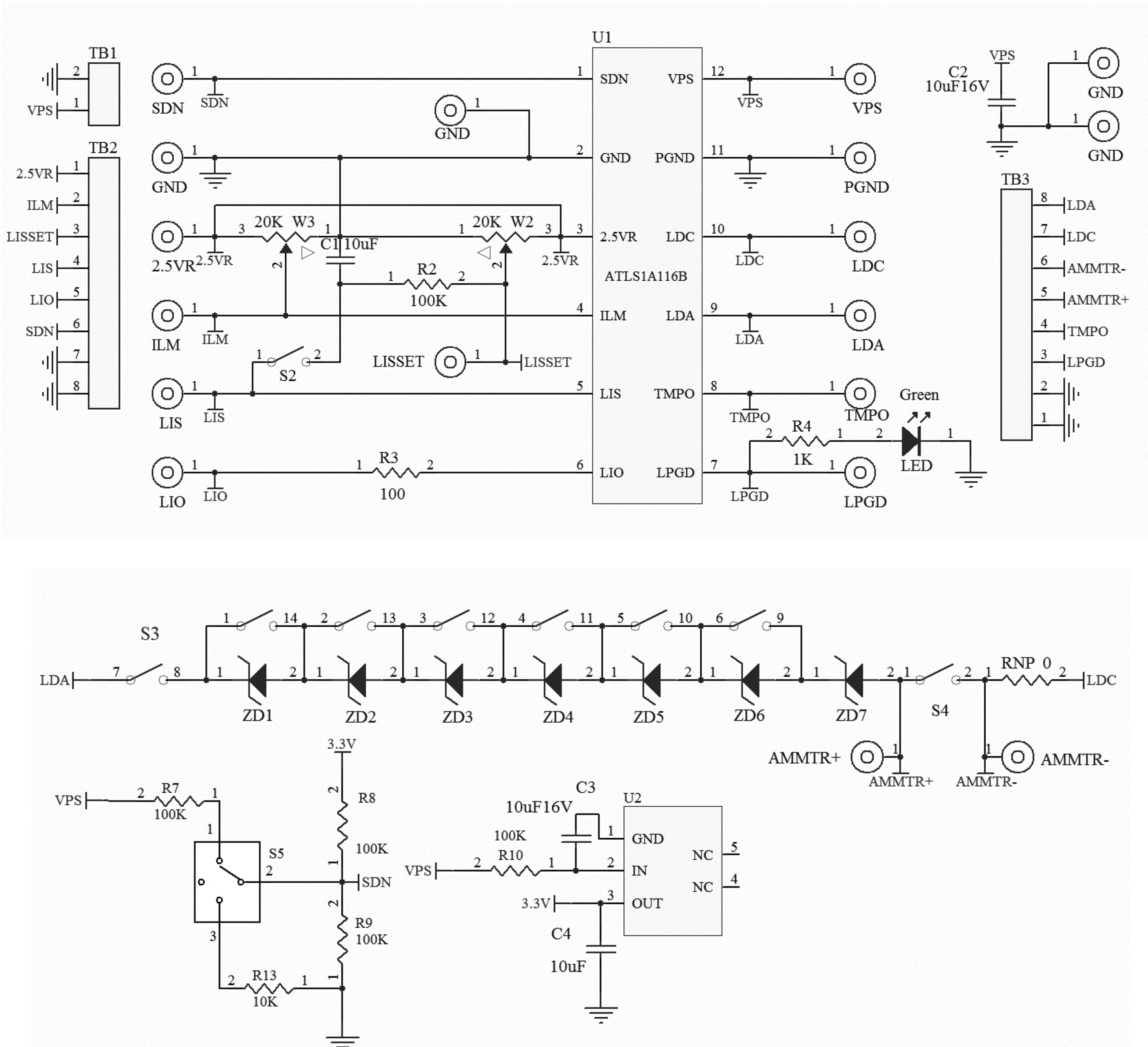


Figure 7. Schematic of ATLS100MA116DEV1.0

## GETTING STARTED

1. Hook up the power supply. There are 2 solder pads in the upper center area on the edge for connecting the power supply voltages. The connection can be done by clipping or soldering on the pads, or use the screws to lock in 2 wires through the terminal block TB1, see Figure 1. Usually the power supply is set to 12V.
2. Check the voltage reference. Use a voltmeter to check the voltage reference pin 2.5VR having an accurate 2.5V.
3. 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 S5 to its lower position to turn off the controller, or turn the switch S5 to its upper position to turn on the controller, at this time, this pin is pulled high.
4. 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:

$I_{OUT} = I_{MAX} \times LIO/2.5V$ (A)

where $I_{OUT}$ is the output current in ampere, $I_{LDMAX}$ is the maximum current of the laser driver in the evaluation board, LIO stands for the voltage at the LIO pin.

5. Monitoring the output current directly by using an Ammeter. Comparing with the approach to measure current by measuring the voltage of LIO pin as described above, Measuring the output current directly by using an Ammeter is not recommended when a real laser is connected, because these potential problems:

   A. The Ammeter brings in EMI (Electro-Magnetic Interference) noise.

   B. The Ammeter has voltage drop, which decreases the maximum output voltage.

   C. **If the Ammeter is not connected well or there is an intermittent disconnection at any portion of the circuit, the real laser may be damaged permanently.**

   If the user really needs to do it in this way, this is the procedure to do so:

   A. Use the terminal block on the right side, the 3rd and the 4th conductors, insert the Ammeter between AMMTR+ pin and AMMTR− pin.

   B. Turn the switch S4 to its upper on position, thus the output current goes through the ammeter and can be measured by reading Ammeter's value.; when the switch S4 is placed in the lower off position, the ampere meter is shorted, thus, it does not measure the output current, see the schematic shown in Figure 7.

   C. Set the Ammeter to a fixed gain or the high value setting, such as 10A. Otherwise, the automatic ranging setting circuit of the Ammeter may cause some noise to the laser when the current range setting is switched inside the Ammeter.

6. Test the controller with the "dummy laser". The 5 diodes on the board, D1 to D7, 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 7. Turn the switch S3 to the on position (upper), to connect the "dummy laser" to the controller. Turning switches ZD1, ZD2, ZD3, ZD4, ZD5, and ZD6, up and down will increase (turning down the switches) and decrease (turning up the switches) the forward voltage of the "dummy laser" which can be measured by a volt meter between the LDA and the ground. Each diode can increase or decrease the output forward voltage by about 0.7V when the output current is 100mA. The switch bank and their corresponding diodes are shown in the table 2 below. The diode ZD7 is always activated so that the total forward voltage range is from 0.7V to 0.7V + 0.7×6 = 4.9V. Please be aware of this fact: when the output voltage is low by shorting circuit all the diodes, the controller will need to consume a lot of power and may get too hot that the internal temperature protection circuit shut off the controller automatically. When this happens, wait for a few seconds, let the controller cool down, the controller will restart by itself again after the temperature is lowered to certain level. This is the way to calculate the power consumption of the controller:

   $P_{DRIVER} = I_{OUT} \times (V_{VPS} - V_{OUT})$ (W),

   where $P_{DRIVER}$ is the power consumption of the controller, $I_{OUT}$ is the output current, $V_{PS}$ is the power supply voltage applied onto the VPS pin of the controller, $V_{OUT}$ is the output voltage which is also the voltage on the LDA pin. The unit is power. When the controller is placed in a free air, the thermal resistance is about 60°C/W.

   Table 2. The switch controls corresponding diode

   | Switch Name | Corresponding Diode |
   |---|---|
   | ZD1 | ZD1 |
   | ZD2 | ZD2 |
   | ZD3 | ZD3 |
   | ZD4 | ZD4 |
   | ZD5 | ZD5 |
   | ZD6 | ZD6 |

7. Disconnect the dummy laser from the controller. This can be simply done by turning switch S3 to its lower off position.

8. 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, and the controller pin via. **If the controller works well, the output current should remain the same as the output voltage changes.**

9. Set the output current. Adjusting the potentiometer W2 will set the output current from 0 to 100mA by changing the voltage on the LIS pin. Due to the low noise nature of the controller, the actual controllable minimum current is about 10nA, the lowest one available on the market to our knowledge. The relationship between the LIS voltage and the output current is:

   $I_{OUT} = I_{MAX} \times V_{LIS}/2.5V$ (A)

   where $I_{OUT}$ is the output current, $I_{LDMAX}$ is the maximum current of the laser driver in the evaluation board, and $V_{LIS}$ stands for the voltage at the LIS pin.

10. Set the output current limit. Adjusting the potentiometer W3 will set the output current limit from 0 to 100mA by setting the voltage on the LILM pin. The relationship between the LILM voltage and the output current is:

   $I_{OUTLIM} = I_{MAX} \times V_{LILM}/2.5V$ (A),

   where $I_{OUTLIM}$ is the output current limit, $I_{MAX}$ is the maximum current of the laser driver in the evaluation board, and $V_{LILM}$ stands for the voltage at the LILM pin.

   When the output current set by the LIS pin goes higher than the current limit set by the LILM pin, the output current will become the value set by the latter. The laser is thus protected from being damaged by over current.

11. Modulate the output current by an external signal source. This can be done by connecting the external signal source to the LIS node, which is accessible by the LIS solder pad or the LIS conductor on the terminal block TB2, both on the left side of the board. Make sure:

A.The peak of the signal will not set the output current to too high a value that may damage the laser diode, if a real laser is connected to the output.

B. The switch S2 is turned to the lower off position, thus, the LIS pin will solely controlled by the external source signal, not by the LIS1 node.

C. The control bandwidth of the LIS pin is around 2MHz, that is: when inputting a pure square wave signal to the LIS pin, the rise and fall time of the output current will be about 0.35/2MHz = 175nS (nano-second). Please be aware of this: the output current should be seen on an oscilloscope by probing the LIO pin. Probing LDA pin will see a distorted version of the output current because the dummy load or a real laser diode is a non-linear device and also has capacitance between the 2 terminals, thus the voltage waveform is not always proportional to the current waveform.

12. 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.

13. Monitor the internal temperature of the controller. The controller internal temperature can be monitored by measuring the TMPO pin voltage. The relationship between the TMPO 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.

14. 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.

15. 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 same as 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 4.9V by switching ZD1 to ZD6 to the lower off position. Turn on the power supply, and see everything works perfectly as described above.

D. If everything still works fine after step C 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.

E. In case there are any suspicious or real problems, disconnect the real laser and use the dummy laser for debugging.

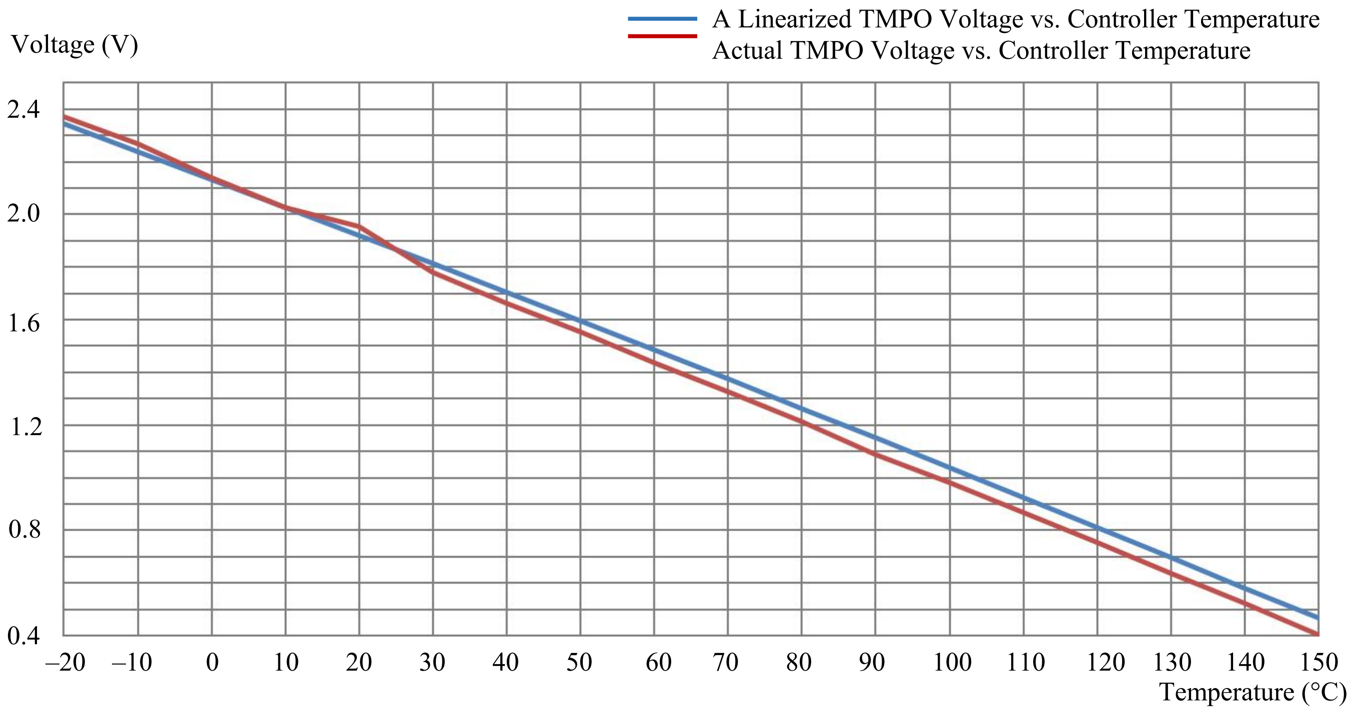


Figure 8. Controller Internal Temperature vs. TMPO Voltage

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