Analog Technologies

Constant Current Laser Driver

ATLS6A201D

Warning: This module can only be soldered manually on the board by a solder iron at < 310℃ (590℉), it cannot go through a reflow oven process.

FEATURES

High Efficiency: ≥85%

Maximum Output Current: 6A

Current Output Noise: 0.05%

High Stability: ± 12mA@6A (0.2%) for entire temp. range

Fully shielded

Compact Size

100 % lead (Pb)-free and RoHS compliant

APPLICATIONS

Driving laser diodes, DPSSL, EDFA, fiber laser, direct diode laser, etc., with low noise and high efficiency.

DESCRIPTION

This laser driver, ATLS6A201D, is an electronic module designed for driving diode lasers by up to 6A constant current with high efficiency, low noise, high reliability, zero EMI, and small package. Figure 1 shows physical photo of the ATLS6A201D.

It provides these functions: laser current control, laser current monitoring, over temperature protection, loop good indication, laser diode status indication, soft start, and shut down.

It comes with a high stability low noise 2.5V voltage reference output which can be used for setting the output current and, at the same time, for the ADCs (Analog to Digital Converters) and/or DACs (Digital to Analog Converters) as the reference voltage.

Figure 1. Physical Photo

The ATLS6A201D is packaged in a 6 sided metal enclosure, which blocks EMIs (Electro-Magnetic Interferences) to prevent the driver and other electronics from interfering 1each other.

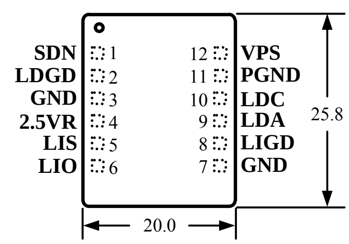

Figure 2. Pin Names and Locations

Figure 2 is the actual sized top view of the ATLS6A201D, which also shows the pin names and locations. Its thickness is 5mm. The pin functions are described in Table 1 below.

Table 1. Pin Function Descriptions

Pin #	Name	Type	Description
1	SDN	Digital Input	Shut down control. Negative logic, >1.4V = enable, <0.95V = shut down, normal threshold voltage = 1.2V.
2	LDGD	Digital Output	Laser diode good indication. When this pin is high, >2V, the control loop is working properly. When this pin is low, <0.3V, the laser diode is bad, or there is a short or open circuit at the laser diode.
3, 7	GND	Signal Ground	Signal ground pin. Connect ADC and DAC grounds to here. When using a POT (potentiometer) to set the output current, connect the ground terminal of the POT to here.
4	2.5VR	Analog Output	Reference voltage. It can source 3mA max, with 5µVp-p noise between 0.1 to 10 Hz and 25ppm/°C stability max.
5	LIS	Analog Input	Laser current setting voltage. There is an input resistor of 10M tied to GND. Setting it from 0V to 2.5V will set the laser current from 0A to 6A linearly.
6	LIO	Analog Output	Laser current output indication. 0V to 2.5V indicates the laser current being from 0A to 6A linearly.
8	LIGD	Analog Output	Laser current good indication. When this pin is stabilized and the value is between 0.2V and 1.8V, the output voltage to the laser at pin 9, LDA, will be 4.8V to 0V linearly, the laser current is stabilized, and the control loop is stable.
9	LDA	Analog Output	Laser diode anode. Connect it to the anode of the laser diode.
10	LDC	Analog Output	Laser diode anode. Connect it to the cathode of the laser diode.

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11	PGND	Power Ground	Power ground pin. Connect this pin directly to power supply return path line.
12	VPS	Power Input	Power supply voltage. The driver works from VPS = 3.0V to 5.5V.

SPECIFICATIONS

Table 2. Characteristics ($T_{ambient}$ = 25°C)

Parameter	Value	Unit
Laser driver efficiency when Iout = 6A, Vout = 2.5V, & VPS = 5V.	≥85	%
Maximum output current	6	A
Low frequency, 0 to 10Hz, output current noise	20	μA
Stability @ 6A	±0.2	%
PWM Frequency	500	KHz
Laser current control signal at LIS	0 ~ 2.5	V
LIS control accuracy	±0.2	%
Laser current indication signal at LIO	0 ~ 2.5	V
LIO indication accuracy	±0.2	%
Reference output voltage	2.5	V
Output voltage range at LDA	0 ~ 0.85×V_{PS}	V
Power supply voltage range	3.0 ~ 5.5	V
Maximum power supply voltage	6	V
Start-up time	4	ms
Typical pull-down current at LDGD	6	mA
Operating case temperature	–40 ~ 85	°C

OPERATION PRINCIPLE

The block diagram of the driver is shown in Figure 3. The shut down control circuit accepts signals from 3 sources: external shut down, over current and over temperature signals. When any of these signals is activated, the driver is shut down. Only when none all these 3 signals is activated, a soft start circuit starts enabling the driver stage.

The soft start circuit increases the output current slowly at the start up time and shuts down the current quickly. Thermal shutdown circuit turns the driver off if the junction temperature exceeds 150°C. The driver is released from shutdown automatically when the junction temperature decreases to 10°C below the thermal shutdown trip point, and starts up under control of the soft start circuit. The over current protection circuit turns the driver off if the output current exceeds 10A @ VPS=3V or 12A @ VPS=6V.

The high stability low noise 2.5V voltage reference is provided for setting the output current by setting the LIS' voltage, and can also be used for the ADCs and/or DACs.

The laser diode status indication circuit monitors laser diode status. When LDGD pin is high, >2V, the control loop is working properly; when this pin goes low, <0.3V, the laser diode is bad, or there is a short or open circuit at the laser diode.

The laser current control indication circuit shows the driving status for the output current. When this voltage is between 0.2V to 1.8V, the output voltage on the laser diode is between 4.8V to 0V.

The current measurement circuit monitors the output current and shuts down the driver upon detecting the output current exceeds the pre-set value. It also provides a signal, LIO, indicating the actual laser diode current. The relationship is:

Laser current = 2.4 × LIO voltage (A).

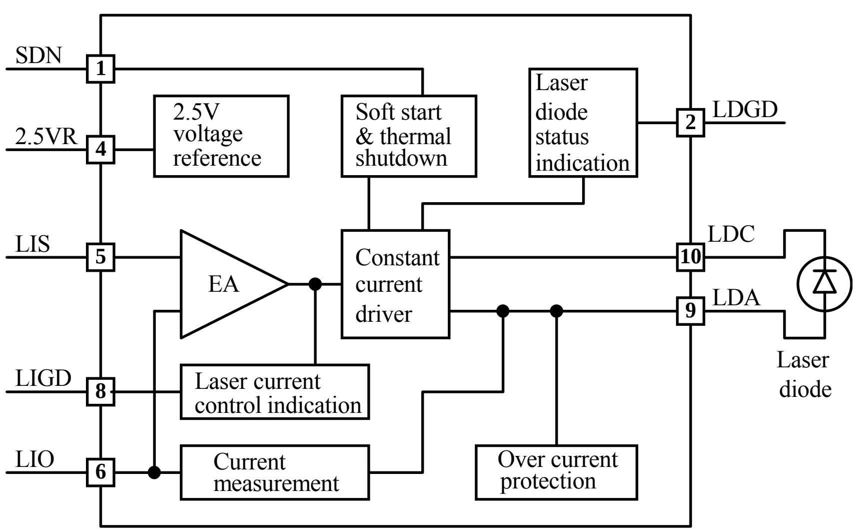

Figure 3. Block Diagram

APPLICATION INFORMATION

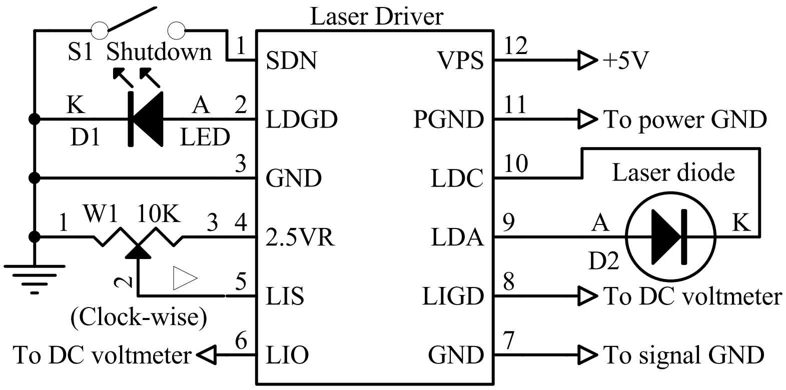

Figure 4. A Typical Stand-alone Application Schematic

Figure 4 shows a typical stand-alone application circuit.

In Figure 4, the switch S1 is an external shut down switch, it turns the driver off and on by tiding SDN pin to the ground or releasing it respectively. The starting up time delay is about 4mS and the shut down time is about 20µS.

The switch S1 can also be an electronic switch, such as an I/O pin of a micro-driver, with an either open drain or push/pull output. See Figure 5. The internal equivalent circuit is a resistor of 100K pulling up this pin to VPS rail. When this pin voltage is >1.4V, the driver is enabled; <0.95V, the driver is shut down. Normal threshold voltage = 1.2V.

If not using a switch (S1) to control the laser, leave the SDN pin unconnected.

In Figure 4, the LED D1 is used to indicate laser diode status. When LDGD pin is high, >2V, the laser diode control loop is working properly. When LDGD pin is low, <0.3V, the laser diode is bad, or there is a short or open circuit at the laser diode. The LDGD pin can also be connected to a digital input pin of a micro-driver, when software/firmware is utilized in the system. See Figure 5. The equivalent circuit of this pin is a 5K resistor pulling up it to the VPS rail and an open drain FET pulling it down to the ground. The pull-up current can be increased by connecting an external pull-up resistor between VPS and LDGD pins, that is equivalent to paralleling the external resistor with the internal 5K pull-up resistor. However, the total pull-up resistor should be ≥1.5K @ VPS=5V or ≥1K @ VPS=3.3V, otherwise, the internal open drain FET cannot provide the resistors with enough pull-down current to achieve a low enough potential level for a logic low indication. To calculate the total pull-up resistor, use the equation below:

$$R\_total = (R\_internal \times R\_external)/(R\_internal + R\_external)$$

where:

R_total is the total pull-up resistor,

R_internal is the internal pull-up resistor,

R_external is the external pull-up resistor.

The laser diode D2 is connected between LDA and LDC. It is worth mentioning that the power supply return terminal should be connected to the pin 11 PGND and the cathode of the laser diode should be connected to the pin 10 LDC. These 2 pins, 10 and 11, should not be connected together externally and they are connected together internally already by the driver.

Figure 5 shows a typical micro-processor-based application circuit.

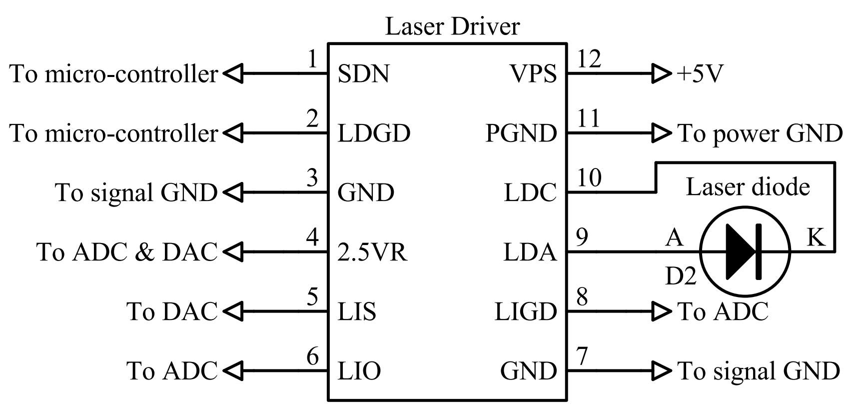

Figure 5. A Typical Micro-processor-based Application Schematic

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Turning the Driver On and Off

The driver can be turned on and off by setting the SDN pin high and low respectively. It is recommended to turn the driver on by this sequence:

To turn on: turn on the power by providing the power supply voltage to the driver on VPS pin, turn on the driver by releasing the SDN pin.

To turn off: turn off the driver by lowering the voltage of SDN pin, turn off the power by stopping the voltage supply on the VPS pin.

When not controlling by the SDN pin: leave it unconnected and turn on and off the driver by the power supply.

Adjusting the Output Current

The output current is set by adjusting W1, which sets input voltages of LIS, pin 5. See Figure 4. The output current will be:

$I\_output = 2.4 \times V_{LIS}$ (A).

LIS can also be set by using a DAC to replace the W1 in Figure 4. Make sure that the DAC has low output noise.

A RC low pass filtered can be inserted between the W1 output or the DAC output and the LIS pin, for lowering the output noise.

Monitoring the Output Current

The output current of the driver can be monitored by measuring the voltage on the LIO pin. This feature is very useful for micro-driver based system where the ADC is available and monitoring the current in real time is required. This pin provides a very low noise voltage signal and is proportional to the output current:

$I\_output = 2.4 \times V_{LIO}$ (A).

For example, when the output signal is 2.5V, the output current is 6A.

LIO can be used to drive an ADC directly, and also be measured by a multi-meter.

Driver Power Consumption

The power consumption of the driver can be calculated by:

$P\_driver = I\_input \times V_{PS} – I\_output \times V_{LDA}$,

where P_driver is the power consumed by the driver itself; I_output is the output current;

I_input is the power supply's input current;

V_{PS} is the power supply voltage;

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

$\eta = (I\_output \times V_{LDA}) / (I\_input \times V_{PS})$.

When P_driver of ATLS6A201D exceeds 2.5W, a heat sink is needed to keep the driver's temperature below certain level, preferably below 85°C. For most applications, the power consumption exceeds 2.5W when the driving is outputting 6A, thus, heat sinking mechanism is needed. The best way for arranging the heat sinking for the driver is as follows: transferring the heat by sandwiching a piece of gap filler material between the top metal surface of ATLS6A201D and the internal metal surface of the final product's case as shown in Figure 6 below.

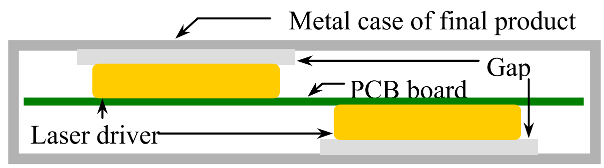

Figure 6. Transferring heat by the gap filler

The gap filler material needs to be mechanically elastic and thermally conductive. One of such products is the T-flex 200 filler sheet made by Lairdtech, the available thickness is between 1mm to 4mm. More detail technical data about this material can be found here: www.lairdtech.com.

To reduce the power consumed by the driver, we recommend using a power supply with its voltage barely higher than

$1.2 \times V\_laser\_diode\_max$.

where V_laser_diode_max is the maximum possible laser diode voltage.

For example, for most diode lasers at 6A, the maximum forward voltage across the laser is about 2.7V, thus, use a 3.3V power supply is enough. Using a 3.3V power supply results in a much lower power consumption by the driver than using a 5V power supply.

First Time Power Up

Laser diode is a high value and vulnerable device. Faults in connections and damages done to the driver during soldering process may damage the laser diode permanently.

To protect the laser diode, it is highly recommend to use 3 to 4 regular diodes of >6A to form a "dummy laser" and insert it in the place of the real laser diode, when powering up the driver for the first time. Use an oscilloscope to monitor the LDA voltage at times of powering up and enabling the shutdown pin, and powering down the laser driver and turning off the shutdown pin, and make sure that there is not over-shoot in output voltage at the LDA pin. At the same time, use an ammeter in serious with the dummy laser, to make sure that the output current is correct.

After thorough checking and making sure free of faults in the system, disconnect the dummy laser diode and connect the real laser diode in place.

The driver output voltage range for the laser is between 0 to $0.85 \times VPS$.

The rise and fall time of this driver is about 15uS.

OUTLINE DIMENSIONS

The driver comes in only one package: through hole mount. It is often called DIP (Dual Inline Package) or D (short for DIP) package. And the part number is: ATLS6A201D. Dimensions of the DIP package driver are shown in Figure 7.

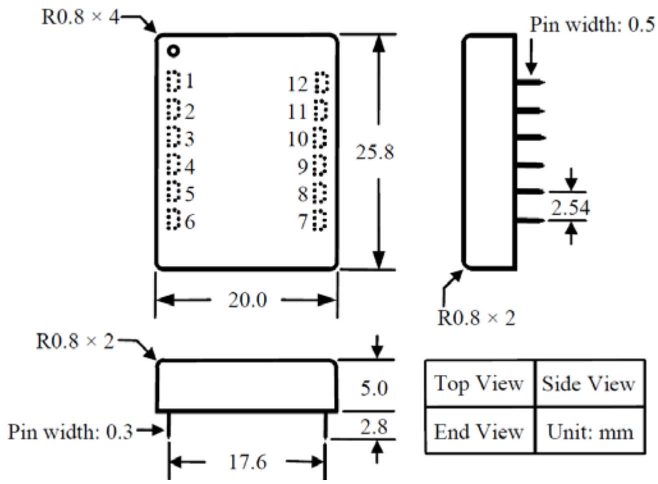

Figure 7. Dimensions of the DIP Package Driver

Figure 8 shows the foot-print which is seen from the end side of the PCB.

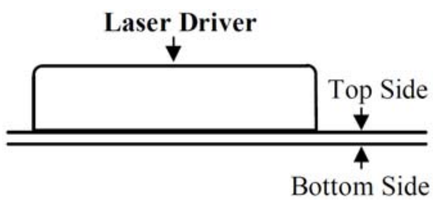

Figure 8. End View of the PCB Foot-print

Figure 9 shows the foot-print which is seen from the top side of the PCB, therefore, it is a "see through" view.

"Tent" (i.e. cover the entire via by the solder mask layer) all the vias under the driver, otherwise, the vias can be shorted by the bottom plate of the driver which is internally connected the ground.

See Figure 9 and 10, it is recommended to use large copper fills for VPS, LDC, and the LDA pins, and other pins if possible, to decrease the thermal resistance between the module and the supporting PCB, to lower the module temperature.

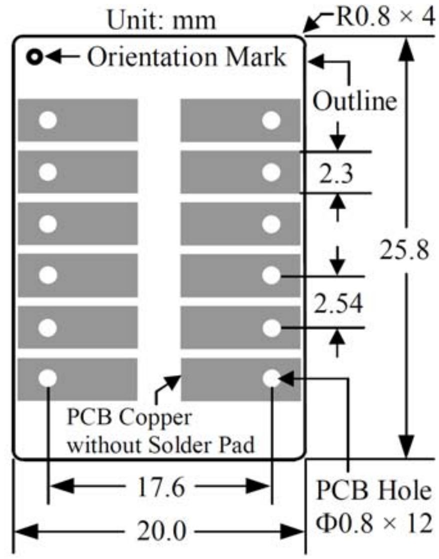

Figure 9. Top View of the Top Side PCB Foot-print

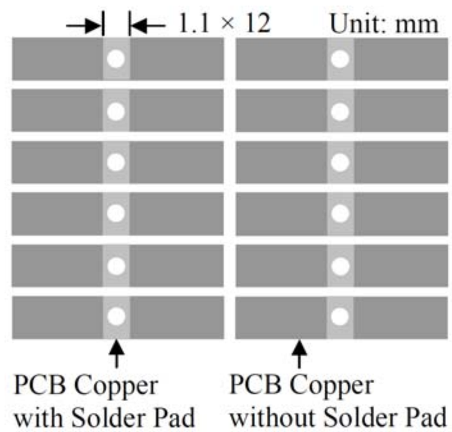

Figure 10. Top View of the Bottom Side PCB Foot-print

Figure 10 shows the foot-print which is seen from the bottom side of the PCB.

MOUNTING

It is highly recommended **to lower solder iron temperature to 310°C and solder the driver manually**, so that the internal contents of the driver would not be affected.

After the soldering, it is also safe to check the laser driver's functionality by using the "dummy laser" before connecting a real laser diode as mentioned previously on page 4.

WARNING: This module can only be soldered manually on the board by a solder iron at < 310℃ (590℉), it cannot go through a reflow oven process.

ORDERING INFORMATION

Table 3. Part Number

Part Number	Description
ATLS6A201D	6A constant current driver in DIP package

Table 4. Unit Price

Quantity (pcs)	1 – 9	10 – 49	50 – 199	200 – 499	≥500
Unit Price	$95.0	$90.3	$85.5	$80.8	$76.0

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