Low Noise Constant Current Laser Driver

ATLS1A101

Analog Technologies

FEATURES

Ultra Low Noise: <6μA*

High Output Current: 1A

High Absolute Accuracy: <0.1%

High Stability: 100ppm/°C

Dual Modulation Ports: High/Low Speed

Complete Shielding

Compact Size

SMT Package Available

*Total RMS between 0.1Hz to 2MHz.

APPLICATIONS

Drive laser diodes with low noise, including DPSSL, EDFA, fiber laser, direct diode lasers, etc.

DESCRIPTION

The ATLS1A101 is an electronic module designed for driving diode lasers with low noise current of up to 1A.

The ATLS1A101 can be modulated by an external signal. There are two modulation ports for the input signal, one for high speed modulation and the other for low speed.

The controller can drive a 1A laser diode of 2V to 3V without using a heat sink. When driving a 1A laser diode of <2V, additional heat sinking is needed.

The output current can be set linearly by an input voltage and monitored linearly by an output voltage at the same time.

A high stability low noise 2.5V reference voltage is provided internally for setting the output current. This reference can also be as the voltage reference for external ADCs (Analog to Digital Converters) and DACs (Digital to Analog Converters).

The ATLS1A101 is packaged in a 6 sided metal enclosure, which blocks EMIs (Electro-Magnetic Interferences) to prevent the controller and other electronics from interfering each other.

The controller has 2 types of packages: through hole mount and surface mount. The latter saves PCB space the controller takes.
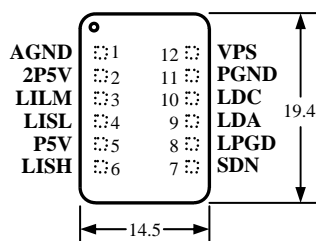

Figure 1 Pin Names and Locations

Figure 1 is the actual size top view of the ATLS1A101, which shows the pin names and locations.

APPLICATIONS

Figure 2 shows a stand-alone application circuit, where W1 sets the current limit and the output current at the same time. It is recommended that the current limit is set to 1.1 times of the output current. S1 is the shut down switch. The internal equivalent input circuit of SDN pin is a pull-up resistor of 100K being connected to VPS. If choose not to use a switch (S1) to control the laser, leave the SDN pin unconnected. D1 is the laser diode, which is float from the ground and the VPS, with its anode connected to the LDA, pin 9, and cathode connected to the LDC, pin 10. D2 is an LED, indicating when the control loop works properly, that is: the output current equals to the input set value. If choose not to use an LED for indicating the working status, leave the LPGD pin unconnected. Adjusting W1, set input voltages of LILM, pin 3, and LISL, pin 4, and the current limit and the output current will respectively be:

$I\_limit = 1.1*LILM(V)/2.5V \ (A)$,

$I\_output = LISL(V)/2.5V \ (A)$.

LILM and LISL should never be left float. Otherwise, the output current will go too high a value and the laser might be damaged.

In addition to using the LPGD pin for monitoring the working status of the controller, the output current can be monitored directly by measuring the voltage of LDC pin. The equation is:

$I\_out = LDC(V)/0.5V \ (A)$.

For example, when seeing LDC = 0.25V, the output current is 0.25V/0.5V = 0.5A.

Figure 3 shows an application where ATLS1A101 is interfaced with a micro-controller. In this circuit, the input current can be set by a DAC (Digital to Analog Converter), the current limit can either be set by a POT (Potentiometer), a pair of resistors, or the same DAC. The output current can now be monitored by an ADC (Analog to Digital Converter). By sensing the logic level of LPGD, pin 8, the working status of the controller can be monitored by a micro-controller (MC), when it is 1, the loop is good; 0, the loop is at fault, which includes open circuit at the laser diode connections, or short circuit at the LDC pin to ground. Shut down pin can also be controlled by the micro-controller, setting it to 1 turns on the controller, 0 off. Please notice that this pin comes with an internal pull up resistor of 100K, it can be ORed by multiple digital ports of several micro-controllers, with each of the port having an open-drain output. The internal voltage reference output, 2P5V, pin 2, can be used as the reference voltage for the ADCs and the DACs.

Figure 4 shows the equivalent input circuits of different pins.

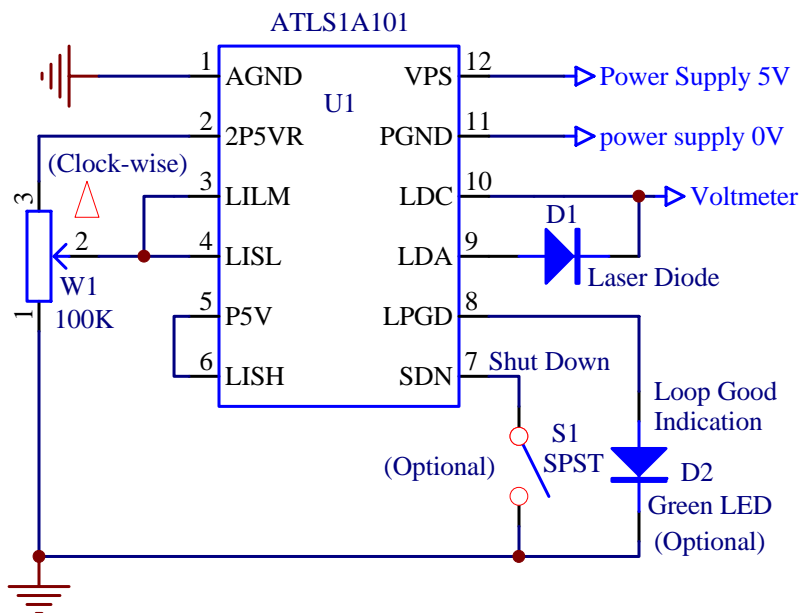Understanding the internal equivalent circuits well helps designing external circuitries.

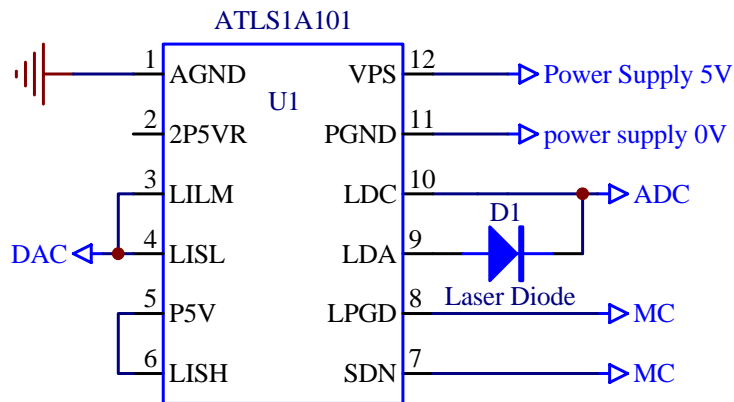ATLS1A101

Figure 2 A Typical Stand-alone Application Schematic

ATLS1A101

Figure 3 A Typical Micro-processor-based Application Schematic

ATLS1A101

Figure 4 Equivalent Internal Circuits

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ATLS1A101

Figure 5 Low Noise Digital Modulation Circuit

SPECIFICATIONS

Maximum output current: 1A

Output current noise: <6μA
(0.1Hz to 2MHz RMS)

Low speed current set voltage: 0 to 2.5V

High speed current set voltage: 0 to 0.5V

Low speed modulation frequency: 0.1Hz

High speed modulation frequency: 300KHz

Power supply voltage range: 4.8V to 5.5V

Power supply input current: output current + 10mA

Operating temperature: −25°C to 85°C

CURRENT LIMIT FUNCTION

This is how the current limit pin works: there is an internal current sense circuit. Its output is sent to compare with the current limit set-point voltage. Upon detecting the output current being higher than the set limit, the controller turns off the output, wait for a few 10's of mS, and turns the controller back on. Therefore, the current limit function can only be used for protection purpose, not for regulating the output current.

MODULATING OUTPUT CURRENT

When low speed current modulation is needed, connect LISL pin to the modulation signal. As LISL changes from 0 to 2.5V, the output current changes from 0 to 1A linearly. The rise and fall time achieved by modulating LISL is about 4 seconds and the equivalent bandwidth is about 0.1Hz. The advantage of using LISL as the modulation signal input port is that the output current noise will not increase. The disadvantage is that the speed is not high.

The LISL pin can be set by a POT, DAC, or a PWM signal

directly from a micro-controller. Please notice that when using a PWM signal for setting the current limit voltage LILM, a low pass filter, an RC network, will be needed; for the LISL pin, this filter is not needed, since there is an internal low pass filter.

It is recommended not to set the LISL pin to 0V, but keep it >0.05V at all the time. The reason is that the laser diode usually has a junction voltage of 2.5V, when setting the LISL pin voltage to 0V, the output voltage will warble between 0V and 2.5V, cause some oscillation slightly.

When high speed current modulation is needed, feed the modulation signal to LISH (no need to connect LISH to P5V pin). As LISH change from 0 to 0.5V, the output current changes from 0 to 1A linearly. The fall and rise time is about 1μS, and the full power bandwidth is about 300KHz. Using LISH pin as the modulation signal input port results in high speed modulation, however, the noise from the modulation signal source will be converted into output current noise.

Figure 5 shows a low noise digital modulation circuit. The switch can be any analog switch, but having low leakage current. W1 sets the output current limit and the peak value of the modulated output current. Make sure that the current limit is set to approximately 1.1 times the peak value of the modulated output current.

MONITORING THE OUTPUT CURRENT

The output current can be monitored in real time by measuring the voltage on the LDC pin. The formula is:

I_output = LDC(V)/0.5V (A).

For example, when seeing the LDC pin has a voltage of 0.5V, the output current = 0.5V/0.5V = 1A.
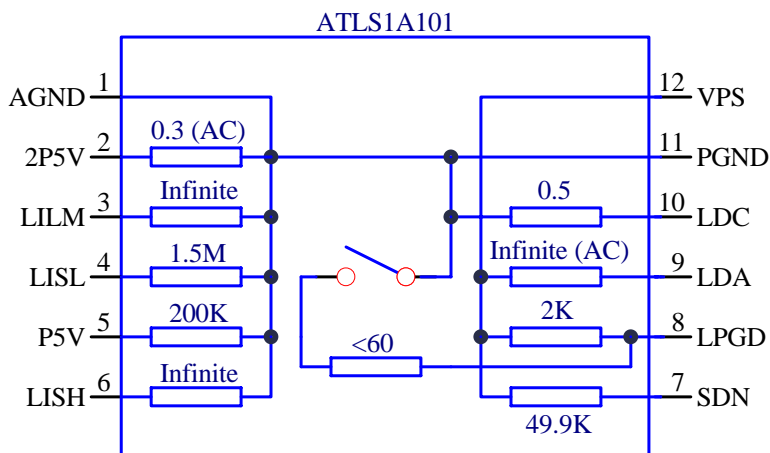
Use a high input impedance voltage meter or DAC to

monitor the output current, such as >5K. Otherwise, some error will be introduced at the output current. When the impedance is 5K, the current error caused at the output is about 0.01%.

Please be aware that adding capacitor on this pin will increase the high frequency noise current. Therefore, when monitoring the output current on this pin continuously, insert a resistor of about >5K in series with the voltage meter or ADC. In this way, there is no big capacitance added on the LDC pin.

Under no-fault operation conditions, the output voltage of LDC is always the same as that of LISH.

POWER UP PROCEDURE

Laser diode is a vulnerable device. Special cautions must be taken for turning on the controller. These are the recommendations:

1. Hold the SDN pin to ground by a mechanical switch or an electronic logic device when turning on the power on the VPS pin and release the SDN pin to logic high after the VPS voltage is stabilized to turn on the laser.

2. If choose not to control the SDN pin for turning on the laser, leave the SDN pin unconnected. There is an internal capacitor holding SDN pin to logic low. Now, the laser can be turned on and off by using the VPS pin.

FIRST TIME POWER UP

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

To protect the laser, it is highly recommend to use 3 regular diodes of >1A to form a "dummy laser" and insert it in the place of the real laser diode, when powering up the controller for the first time. Use an oscilloscope to monitor the LDA voltage at times of power-up and power-down, make sure that there is not over-shoot in voltage. 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 free of faults, disconnect the dummy laser and connect the real laser in place.

The controller output voltage range for the laser is between 0.5 to 3V.

PIN DESCRIPTIONS

Pin #	Pin Name	Pin Type	Function	Note
1	AGND	Ground	Analog signal ground. Connect the grounds of the potentiometer W1, ADCs and/or DACs.	Do not connect the power supply ground to here.
2	2P5V	Analog output	Reference voltage of 2.5V. It can source or sink 3mA current.	
3	LILM	Analog input	This pin sets the output current limit. This pin is used for setting the maximum laser current limit and protecting the laser, but not for regulating the output current. When connecting this pin to the 2P5V, the current limit is set to 1.1A.	
4	LISL	Analog input	This pin set the output current linearly by an analog input voltage at low speed. When setting this pin to 2.5V, the output current is 1A. Keep this voltage >0.05V if possible. It is recommended not to set this pin's voltage to 0V because the output voltage may oscillate due to the junction voltage of the laser diode.	Never leave this pin unconnected.
5	P5VL	Analog output	This pin is a filtered and divided (by 5) output voltage of LISL. When LISL has a voltage of 2.5V, the P5VL voltage is 2.5V/5 = 0.5V. The output impedance of this pin is about 200K.	
6	LISH	Analog input	This pin sets the output current directly. When its voltage is 0.5V, the output current is 1A.	Never leave this pin unconnected.
7	SDN	Digital input	Shut down control, negative logic, 0 = shut down; 1 = turn on. SND >1.4V = enable, <0.95V = shut down, nominal threshold voltage = 1.2V. The input current is between 3μA and 8μA.	It is highly recommended to use this pin for turning on the laser after the power supply is up and turning off the laser before the power supply is shut down.
8	LPGD	Digital	Control loop good indication. When this pin is high, >2V, the	This pin can be used to drive

		output	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 connection.	an LED directly, without using any additional components.
9	LDA	Power output	This pin drives the anode of the laser diode.	
10	LDC	Analog output	This pin drives the cathode of the laser diode. It has the same voltage potential as the LISH pin.	Never short this pin to any other pins, otherwise, the laser may be damaged.
11	PGND	Power ground	Connect this pin directly to power supply return node (0V).	
12	VPS	Power input	Power supply input. The driver works under VPS = 4.8V to 5.5V.	

MECHANICAL DIMENSIONS AND MOUNTING

The ATLS1A101 comes in 2 packages: through hole mount and surface mount. The former is often called DIP (Dual Inline package) or D (short for DIP) package and has a part number: ATLS1A101−D, and the latter is often called SMT (Surface Mount Technology) or SMD (Surface Mount Device) package and has a part number: ATLS1A101−S.
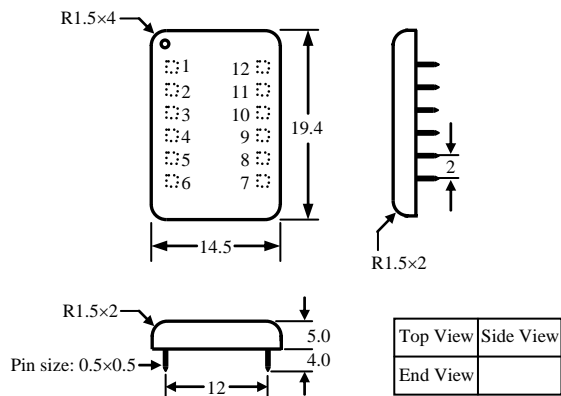
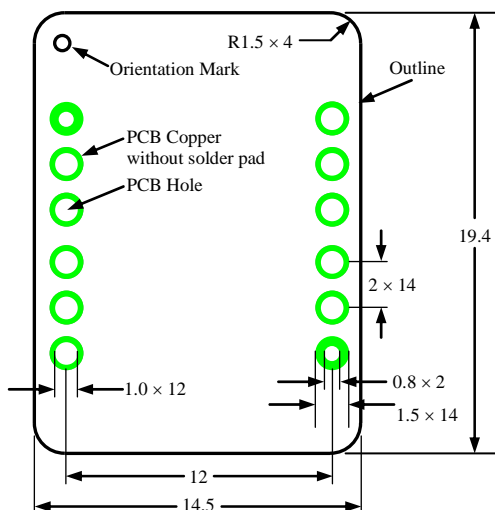Figure 6 Dimensions of the DIP Package Controller

Figure 7 Top Side PCB Foot-print for the DIP Package
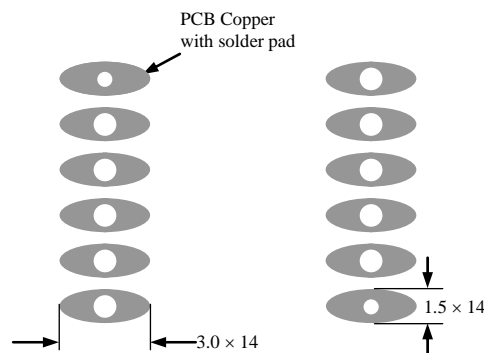

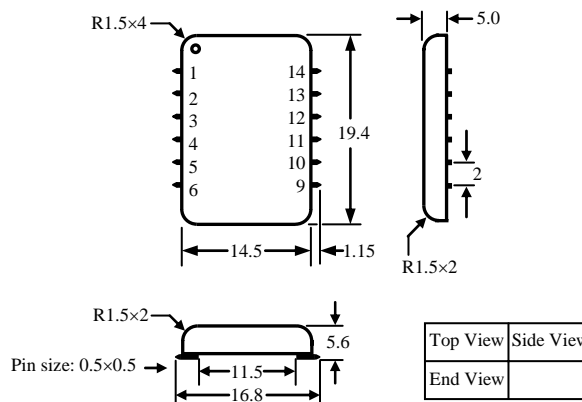Figure 7 Top View of the Bottom Side PCB Foot-print

Figure 8 Dimensions of the SMT Package Controller

Figure 7 shows the foot print which is seen from the top side of the PCB, therefore, it is a "see through" view.

Please notice that, in the recommended foot print for the DIP package, the holes for pin 2 to 6, and 8 to 12 have larger holes than needed for the pins. This arrangement will make it easier for removing the controller from the PCB, in case there is a rework needed. The two smaller holes, for pin 1 and 7, will hold the controller in the right position.

ORDERING INFORMATION

Part #	Description
ATLS1A101−D	Controller in DIP package
ATLS1A101−S*	Controller in SMT package*

* This surface mount package cannot be soldered by reflow oven. It must be soldered manually with the iron temperature < 610°F (≈321°C).

PRICES

Quantity	1 – 9	10 – 49	50 – 199	200 – 999	≥1000
ATLS1A101−D	$95	$85	$75	$65	$55
ATLS1A101−S	$95	$85	$75	$65	$55

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