Figure 1. Physical Photo of ALDD28V15A401

FEATURES

- Digital display for parameter setting and monitoring
- Wide input voltage range: 10V ~ 27V
- Wide output voltage range: $0.1V_{VPS}$ to $0.8V_{VPS}$ (V_{VPS} is input voltage)
- High current capability: 15A
- High efficiency: ≥90%
  (I_{OUT}=15A @ V_{LDA}=20V&V_{VPS}=27V)
- Wide modulation bandwidth: DC ~ 10kHz
- Compact size: 68.5*61.0*16.6 (mm)
- Dual independent current set ports: LISH and LISL
- Direct digital modulation control: PCN
- Three control states: Operation, Standby and Shutdown
- Low output current noise: < $15\mu A_{P-P}$@0.1Hz~10Hz
- High current stability: < ±600μA@15A &−20°C~80°C
- Low output ripple voltage: < $15mV_{P-P}$@500kHz
- Fully shielded
- 100 % Lead (Pb)-free and RoHS compliant

APPLICATIONS

Drive one or multiple laser diodes for DPSSL, EDFA, and fiber lasers with low noise and high efficiency.

DESCRIPTION

This laser driver, ALDD28V15A401, is an electronic module that has all the valuable and important features, but are often difficult to achieve simultaneously such as: wide input and output voltage range, high output current capability, high efficiency, low output noise (but it has an output $6mV_{p-p}$ ripple voltage at 500kHz), wide modulation bandwidth, and small size. The wide output voltage range, $0.1V_{VPS}$ ~ $0.8V_{VPS}$, allows driving one or multiple serial laser diodes at the same time, for up to 15A of well controlled current at high efficiency. The extremely low noise between DC ~ 10kHz and low DC current drift make it ideal for driving diode pumped single mode laser diodes to achieve mode-hop-free and narrow optical wavelength drift, thus, long coherent length.

Because of the high efficiency, the laser driver generates a small amount of heat, thus, no heat sink is necessary for normal operation. The fully shielded case blocks all the incoming and outgoing EMIs (Electro-Magnet Interferences). Therefore, this laser will not interfere other surrounding electronics, nor will other electronics interfere with it. The small package saves valuable PCB space in laser systems. Figure 1 shows the photo of the ALDD28V15A401.

The actual laser current and laser driver temperature are monitored by dedicated ports. In case the laser driver temperature exceeds the limit of 80°C, the laser driver will shut down the output stage by itself and force the laser drive into Standby Mode. There is a loop good indication output to tell if the laser driver is working properly.

The laser driver has three states: Operation, Standby and Shutdown. Under Standby mode, all the laser driver components works except the output stage, see Figure 4. Under Shutdown mode, all the components of the laser driver stops working and the power supply current is reduced to < 3μA.

This laser driver generates a high accuracy high stability low noise, $15mV_{P-P}$, < $2.5mV_{RMS}$, < 8ppm/°C, 4.096V<±2mV, voltage reference output which can be used for setting the output current and also be used as the reference voltage for the ADCs (Analog to Digital Converters)and/or DACs (Digital to Analog Converters).

The ALDD28V15A401 uses a constant frequency high efficiency PWM output stage.

Warning: Both the surface mount and the through hole types of packages can only be soldered manually on the board by a solder iron of < 310°C (590°F), do not use a reflow oven to solder this laser driver.

For noise sensitive applications, please be aware that this laser driver has very low noise between DC to 10kHz, but a little high ripple output voltage, sine-wave, $15mV_{P-P}$, at the switching frequency, 500kHz.

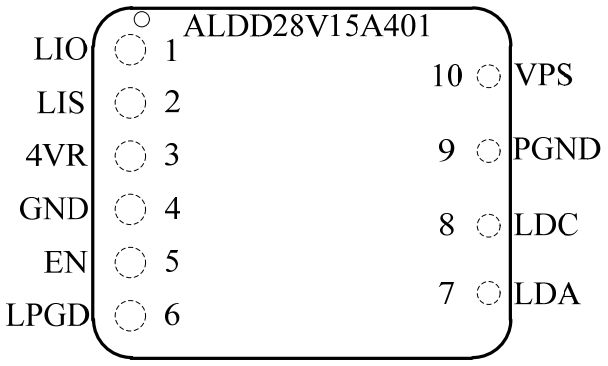


Figure 2. Pin Names and Locations

Figure 2 is the top view of the ALDD28V15A401, which also shows the pin names and locations. Its thickness is 17mm. The pin functions and specifications are described in Table 1 below. Note that the metal case is internally connected to ground.

Table 1.Pin Function Descriptions

Pin #	Name	Type	Description
1	LIO	Analog Output	Laser Current Output indication. 0.1V to 4.096V indicates the laser current being from 0 to 15A linearly.
2	LIS	Analog Input	Laser current low value setting voltage. There is a 10MΩ input resistor tied to GND. Setting it from 0.1V to 4.096V will set the laser lower current from 0 to 15A linearly. The laser driver will output the current set by this pin. The input bias current of this pin is < 0.1μA.
3	4VR	Analog Output	Voltage Reference 4.096V output. It can source and sink up to 10mA output current, with a very low 5μV$_{P-P}$ noise between 0.1 to 10Hz and < 6ppm/°C stability. Under Standby Mode, this pin is still working.
4	GND	Signal Ground	Signal Ground pin. Connect ADC and DAC grounds to here. When using POTs (potentiometer) to set the output currents, connect the ground terminal of the POTs to here.
5	EN	Analog/Digital Input	Standby and Shutdown Control. This pin has three states: between 0V ~ 0.3V, it shuts down the entire laser driver; between 0.5V ~ 1.2V, it sets the laser driver to standby mode; between 1.5V ~ 28V, it sets the laser driver to operation mode. The input current on this pin is < 2μA.
6	LPGD	Digital Output	Loop Good indication. When the laser driver's output current equals the set-point current value, and there is no short nor open circuit at the output, this pin is pulled up high by an internal 3kΩ resistor to an internal 5V power supply as shown in Figure 3; when the output current is not equal to the set-point current, such as there is an open circuit at the output, or the load has too high a resistance that even the output voltage reaches the power supply voltage, the output current is still lower than the set-point value, this pin is pulled low by an open drain MOSFET of which Rdson < 500Ω. When outputting the low value, the sinking capability is < 0.5V at 1mA.
7	LDA	Analog Output	Laser Diode Anode. Connect it to the laser diode anode terminal. The maximum current of this pin can go up to 15A. When doing layout, do not use a thin and long PCB track, otherwise, the inductance might be too high, and oscillation may occur.
8	LDC	Analog Output	Laser Diode Cathode. Connect it to the laser diode cathode terminal. The current on this pin can go up to 15A. Use thick and short PCB track for this pin to minimize the inductance to avoid oscillation or ringing. This pin has a low voltage potential, when the output current is 15A, the potential is 30mV above PGND.
9	PGND	Power Ground	Power ground pin. Connect this pin directly to power supply return path line, 0V. The maximum current on this pin can go up to 15A.
10	VPS	Power Input	Power supply voltage. The driver works from V_{VPS} = 12V ~27V. The maximum current can go up to 15A.

SPECIFICATIONS

Table 3. Characteristics ($T_{AMBIENT}$= 25°C)

Parameter	Value	Unit
Power efficiency I_{OUT} =15A, V_{LDA} =20V & V_{VPS} = 27V.	90	%
Maximum output current	15	A
Low frequency output current noise, peak-to-peak value, 0.1Hz to 10Hz,	<15	μA_{P-P}
Stability @ 15A &–20°C ~80°C	<±0.01	%
	<±650	µA
Laser current control signal at LIS	0.1~4.096	V
LIS control accuracy	±0.1	%
Laser current indication signal at LIO	0.1~4.096	V
LIO indication accuracy	±0.2	%
Reference output voltage	4.096± 0.008	V
Output voltage range at LDA	$0.1V_{VPS}$ to $0.8V_{VPS}$	V
Output voltage at LDC	0	V
Power supply voltage range	10 ~27	V
Maximum power supply voltage	28	V
Start-up time upon releasing the SBDN pin above 2.6V	20	ms
Shutdown time upon pulling the SBDN pin down	20	µs
Standby current	8	mA
Shutdown current	<2	µA
Operating case temperature	–40 ~ 110	°C
Operating ambient temperature	–40 ~ 85	°C

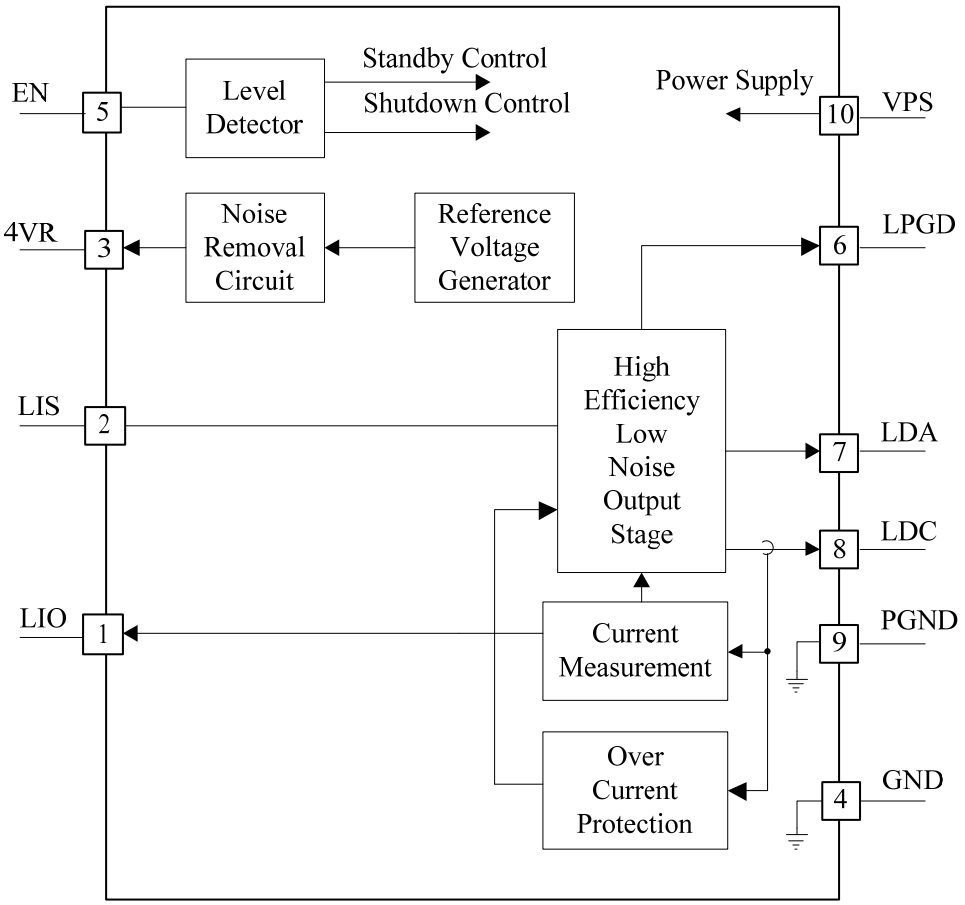


Figure 3. Internal Block Diagram of ALDD28V15A401

OPERATION PRINCIPLE

The block diagram of the driver is shown in Figure 3.The signal from pin 2, EN, is sent to a level detector circuit. As shown in Figure 4, upon detecting signal level between 0V to 0.3V, the shutdown output is activated. It shuts down the whole laser driver and drives the laser driver into shutdown Mode. Upon detecting the level to be between 0.5 and 1.2V, the standby signal is activated, it puts the controller into Standby Mode. When the signal is between 1.5V and above, the controller is driven into Operation Mode.

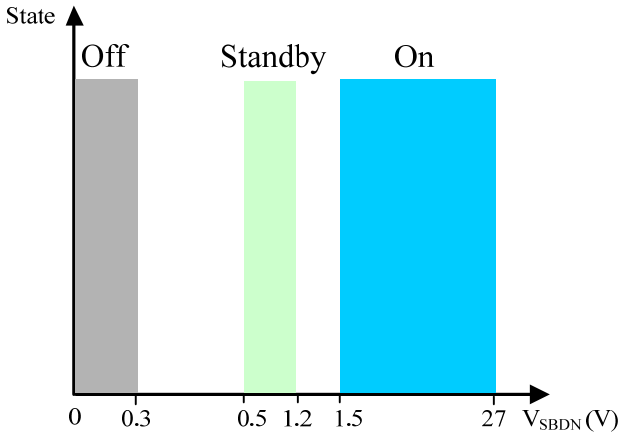


Figure 4. Input Control

There is a temperature protection circuit, upon detecting the temperature to be >80°C, it will force the laser driver into Standby Mode. The laser driver reinitiates the power up sequence when the junction temperature drops below 80°C.

The voltage reference circuit provides internal voltage reference for the driver, its output is taken out after a noise removal circuit

at 4VR port, pin 4.

LIS pin set the output current without any offset voltage. The relationship between the voltage and the output current is:

I_{OUT} (A) = V_{LIS} (V)/4.096 (V)×15 (A);

V_{LIS} (V) = I_{OUT} (A)/15 (A)×4.096 (V),

Where I_{OUT} is the output current of the laser driver, V_{LIS} represents the voltage on the LIS, in volt.

The LIO port, pin 6, outputs an analog voltage that is proportional to the actual output current. When the output current is 0A, the LIO voltage is 0V; when output current is 15A, the LIO voltage is 4.096V. The relationship is:

V_{LIO} (V) = I_{OUT} (A)/15(A)×4.096 (V);

I_{OUT} (A) = V_{LISL} (V) /4.096(V)×15 (A);

V_{LIO} is the voltage on the LIO pin.

The output stage is designed to achieve low noise, high efficiency, and relatively high modulation speed. It has an over current protection circuit. There is a soft start circuit which increases the output current slowly at the start up time and shuts down the current quickly.

The LPGD pin indicates the control loop status. When this pin goes high, >2V, the control loop is working properly, i.e., the output current equals to the desired value, $V_{LIS} = V_{LIO}$; when this pin goes low, <0.3V, the laser driver is not working properly, there might be a short or open circuit at the output, or the laser driver is protected by the over temperature protection circuit.

APPLICATION INFORMATION

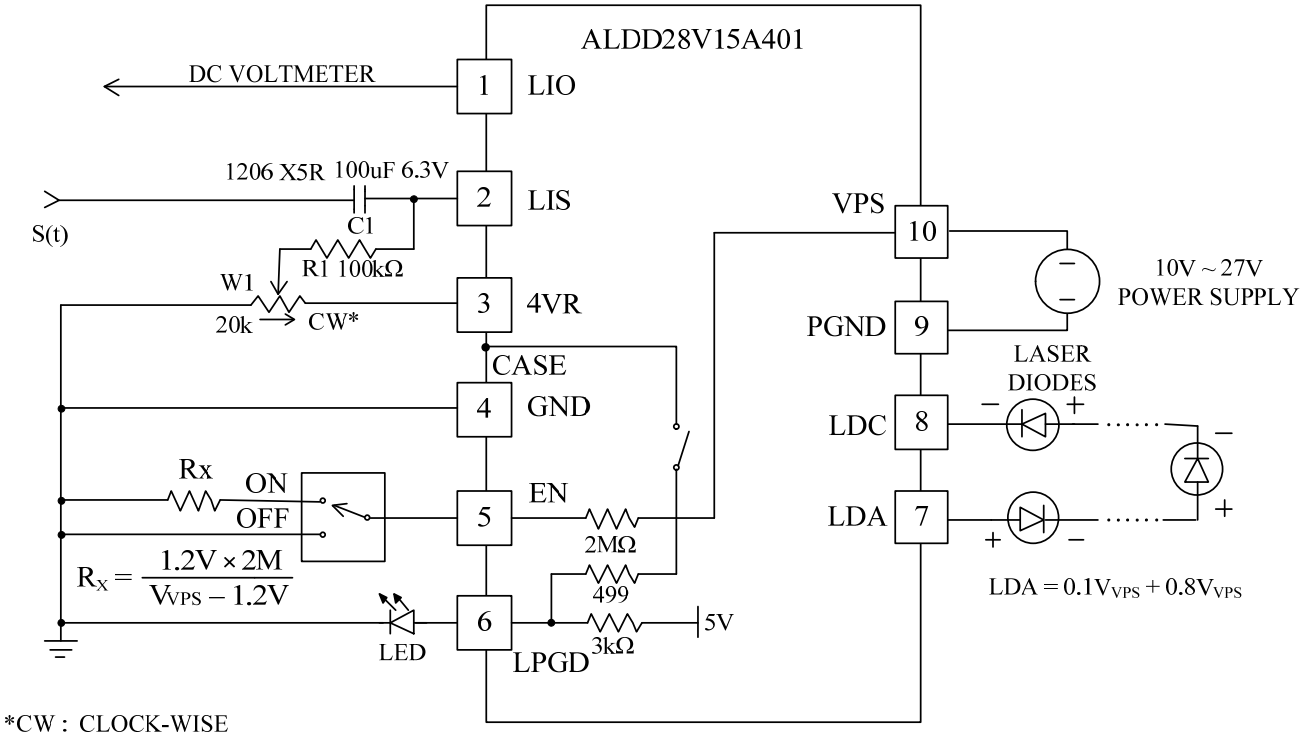


Figure 5. Stand-Alone Application Schematic

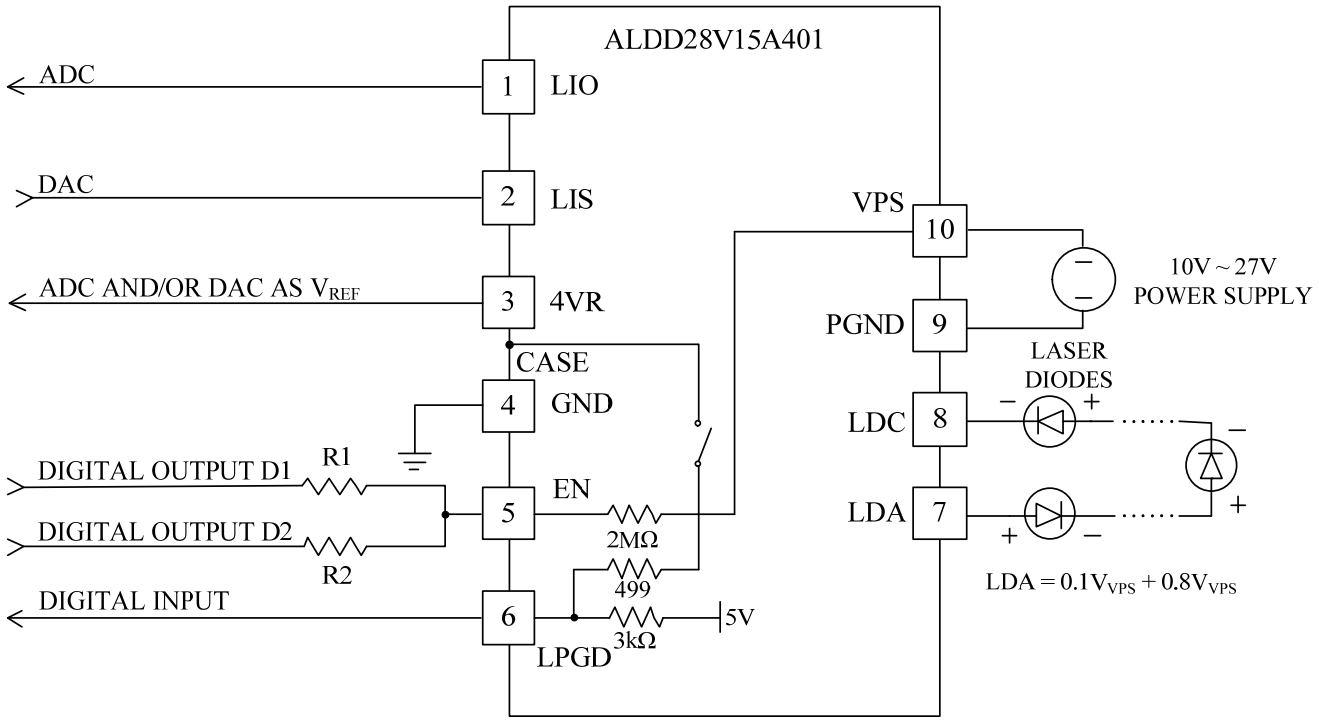


Figure 6. Micro-Controller Based Application Schematic

Figure 6 shows a micro-controller based application schematic.

Table 4 shows the relationship between Digital D1, D2, and laser driver state. Refer to Figure 6.

Table 4.

Digital Output D1	Digital Output D2	Laser Driver State
0	0	Shutdown
0	1	Standby
1	0	Note
1	1	Operation

Note: For the input state D1=1 and D2=0, the controller's state is depending on the output voltage at EN pin:

$$V_{SBND10} = \frac{R2}{R1 + R2} \times V_D$$

$$V_{SBND01} = \frac{R1}{R1 + R2} \times V_D$$

Where, V_D is the logic1 output voltage for D1 & D2 signals.

Digital signal V1 and V2 controls the laser driver into Shutdown, Standby or Operation mode. The starting up time delay is about 20mS and the shut down time is about 20µS.

It is worth mentioning that to achieve high speed and low distortion digital modulation, one can use the LIS pin to set a current that is a little lower than the threshold current of the laser diode to turn off the laser beam, such as half of its value. Use the LIS pin to set the laser current when the laser diode is turned on. In this way, the laser beam is turned on and off, while the driver control loop is always kept on, so that the output stage is always under control, no distortion is caused by turning on/off the output stage.

When LPGD pin is high, > 2V, the laser diode control loop is working properly. When LPGD pin is low, <0.3V, the laser diode control loop is not working properly, there might be a short or open circuit at the laser diode, or the laser driver is put into Standby or Shutdown mode.

The LPGD pin can also be connected to a digital input pin of a micro-driver, when software/firmware is utilized in the system. The equivalent circuit of this pin is a 3kΩ resistor pulling it up to 5V rail and an open drain FET, 500Ω, pulling it down to the ground. The pull-up current can be increased by connecting an external pull-up resistor between LPGD and VPS. Tie this added additional pull up resistor to a 3.3V or 5V power supply if they are available. Make sure that the pull up current is not too high, otherwise, the internal open drain FET cannot pull-down the LPGD pin low enough to turn off the LED.

The laser diodes are connected between LDA and LDC pins. It is worth mentioning that the power supply return terminal should be connected to the pin 9, PGND.

Minimizing the Output Noise

The laser driver has extremely low output noise; care must be taken in using this laser driver to achieve this lower noise performance. One of the noise sources is the beating frequency interference from other power mode electronics, such as another laser driver, TEC (Thermo-Electric Cooler) controller, or power supply. There are 2 ways to avoid the frequency beating: set the switching frequencies of other electronics to be far away from the switching frequency of the laser driver, 500kHz.

The driver can be turned on and off by setting the SBDN 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 SBDN 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 controlled by the SBDN pin: leave it unconnected and turn the driver on and off by the power supply.

Adjusting the Output Current

The output current is set by adjusting W1, which sets input voltages of LISL and LISH, pin 6 and 7. See Figure 6. The output current will be:

I_{OUT} (A) = 3.662×V_{LIS}

LIS can also be set by using a DAC to replace the W1 in Figure 6. Make sure that the DAC has low 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 a micro-driver based system where the ADC is available and monitoring of the current in real time is required. This pin provides a very low noise voltage signal and is proportional to the output current:

I_{OUT} (A) =3.662× V_{LIO} (A).

For example, when the output signal is 4.096V, the output current is 15A.

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

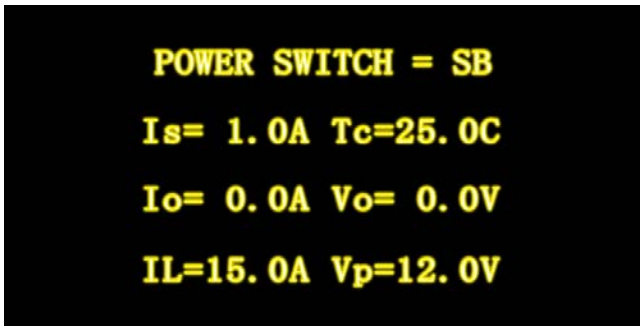
First Time Power Up

Laser diode is a highly valuable asset yet, a delicate 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 18 regular diodes which is > 15A 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 no over-shoot output voltage at the LDA pin. At the same time, it uses an ammeter in series with the dummy laser, to make sure that the output current is correct. After thoroughly checking and making sure the system is free of faults, 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 V_{VPS} (power supply input voltage).

WORKING PRINCIPLE

1. After the controller is powered on, turn the switch on the lower right to “SB”, the display contents are as follows:



2. Press the “Set” button, enter the password, and then enter the setup mode.

Press the “Set” button, the display contents are as follows:

Two digits stand for the password. When the last digit flashes, use “↑” to change the number (0 ~ 9); press the “Set” button to select which digit to be changed. When the first digit flashes, use “↑” to change the number (0 ~ 9). The default password is "99". Once you enter the correct password, you can start setting up the controller.

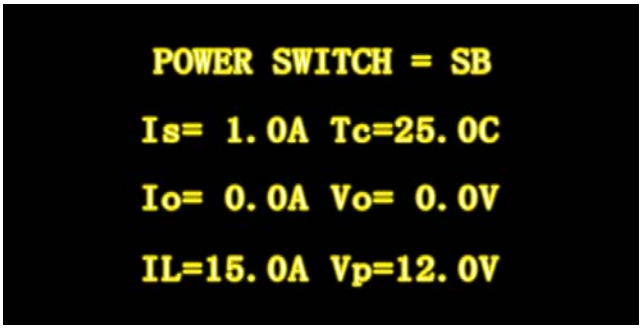
3. After entering the correct password, press and hold the “Set” button to enter the setup mode. The display contents are as follows:

We can select internal control or external control by pressing the “↑” button, then press the “Set” button to lock the selection, or press and hold the “Set” button to enter the internal control or external control current setting.

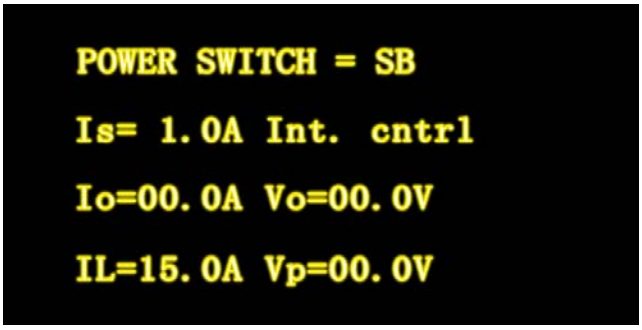
The current can be adjusted by pressing the “Set” button to place the cursor. Use the "↑" button to adjust the current.

Or

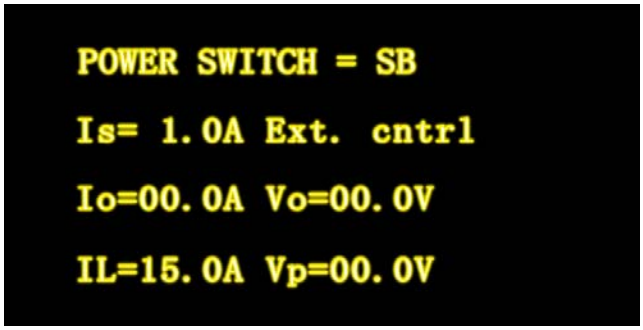
After setting the current, press and hold the “Set” button to save the setting and exit to the initial state.



Press “↑” button to switch between the connection state and temperature state



Or



After the setting is completed, turn the switch to "ON" and the controller starts working.

Press and hold the "Help" button, the display contents are as follows:

OUTLINE DIMENSIONS

Dimensions of the DIP package driver are shown in Figure 7.

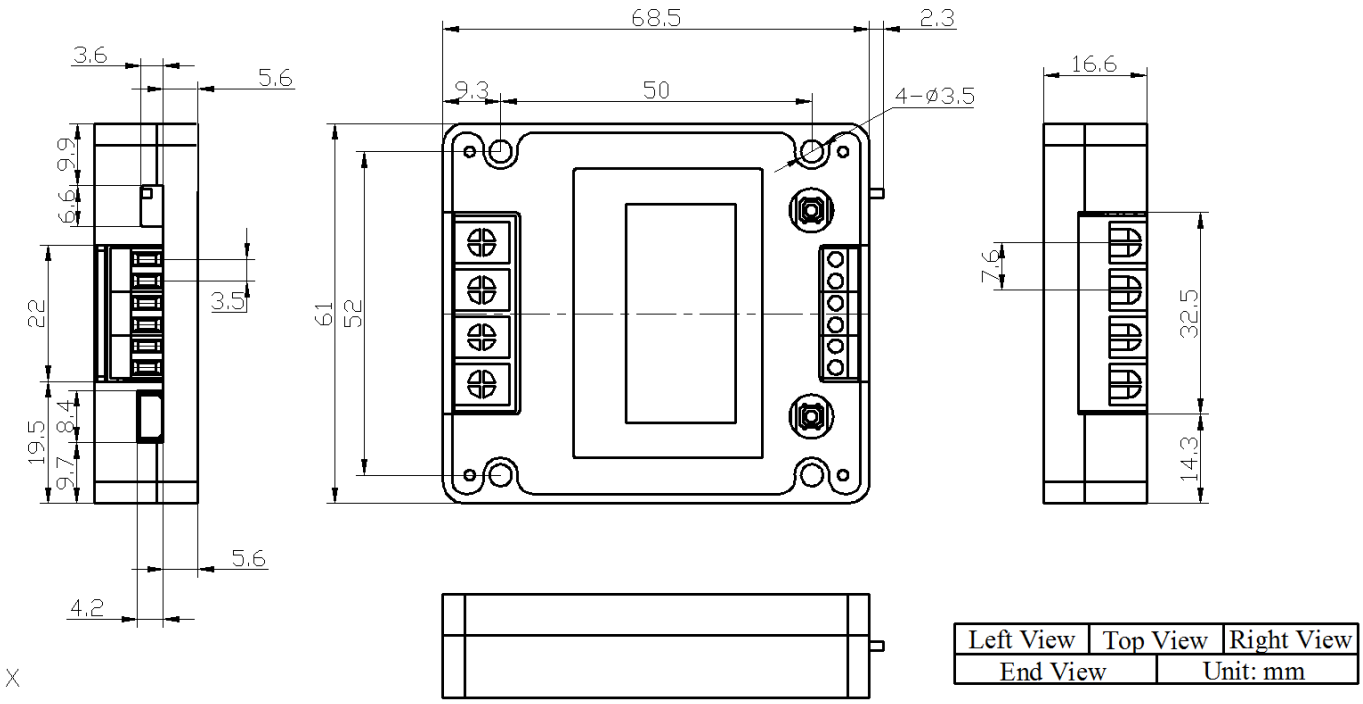


Figure 7. Dimensions of the DIP Package Driver

It is highly recommended to lower the solder iron temperature to 310°C (590°F) 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.

NOTE: The power supplies may have over-shoot voltage spikes when they are not connected well with the load or when they recover from an over current protection state. When that happens, it may exceed the maximum allowed input voltage, 27V, of the controller and damage the controller permanently. To avoid this from happening, do the following:

1. Connect the controller well with the power supply before turning on the power.
2. Make sure that the power supply has sufficient output current. It is suggested that the power supply can supply 1.2 to 1.5 times the maximum current the controller requires.

3. When using a bench top power supply, set the current limit to >1.5 times higher than the maximum current the controller requires.

Warning: Both the surface mount and the through hole types of packages can only be soldered manually on the board by a solder iron of < 310°C (590°F), do not use a reflow oven to solder this laser driver.

ORDERING INFORMATION

Table 5. Part Number

Part Number	Description
ALDD28V15A401D	15A constant current driver

Table 6. Unit Price

Quantity (pcs)	1 – 4	5 – 24	25 – 99	≥100
Unit Price	$588	$567	$546	$524

NOTICE

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