How to Choose a Laser Driver

When designing a laser system, the first thing needed is to make decision: design a laser driver or use an off-the-shelf laser driver. Which way is better?

Design a Laser Driver vs. Using an Off-the-shelf Laser Driver

It is apparent that designing a laser driver will save money in the long run for high volume production laser systems. But the cost for this route is not low: high design cost, long design time, high risk to fail or result in sacrificed performance because designing a good laser driver requires years' experience and many times failure, high initial cost for production set up and quality control, low reliability because it takes a lot of effort in production for high quality manufacturing, testing and burning-in. On the other hand, laser systems usually do not have high volume need before they are replaced by newer technologies or become obsolete because new optical systems have new sets of features and requirements. Therefore, for most applications, using off-the-shelf laser drivers might be the best way to go: it saves time and money, minimizes the risk and results in good performance.

How to Design a Laser Driver

Inside a laser driver, there are many electronic circuitries as shown in Figure 1. The first part of the circuit is always power supply protection. This circuit keeps the whole laser driver off when the power supply does not have enough voltage. It energizes the whole circuit when the input voltage exceeds a preset threshold value. This circuit also keeps the laser driver off when the input voltage is not stabilized. The last function is to filter out any noise the power supply voltage may have.

The next circuit below on the lower left corner is the signal processing and noise suppression. From the names it can tell that this circuit processes the input control signals to become a less noisy and gained up signals and sends them to the control circuit above. At the same time, the laser status signals, such as laser actual power, laser actual current, laser actual voltage, etc., are used to compare with the input parameter setting signals, such as laser set-point current, laser circuit limit, laser set-point power, etc., and the final differences are sent to the control circuit.

The control circuit receives the signals from the Signal Processing & Noise Suppression circuit, process them, and send them to the Output Stage. This circuit also receives signals from the Shutdown pin and the Stand-by signals.

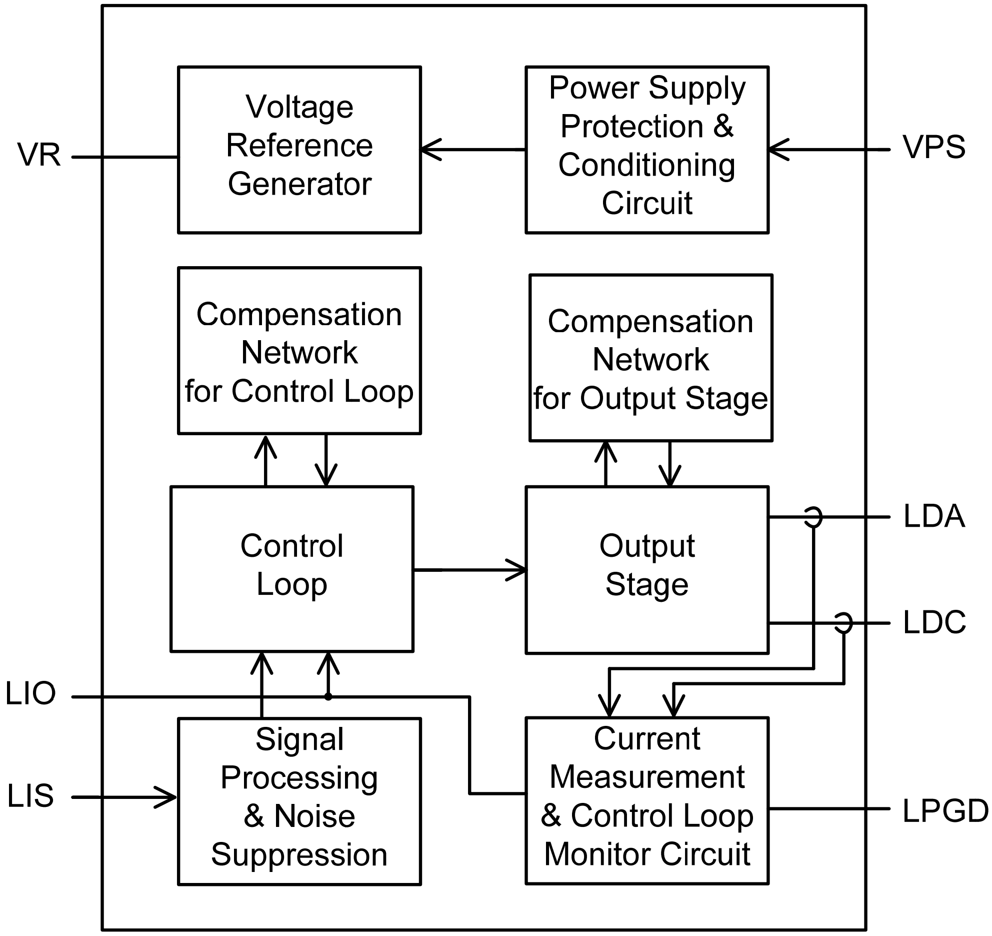


Figure 1. Block Diagram

How to Choose an Off-the-shelf Laser Driver

In order to choose a proper laser driver, we need to consider the following aspects:

1. Current, Voltage & Power

Before choosing an off-the-shelf laser driver, we need to ask some important questions, like what maximum current does the application require? What the maximum voltage does the power supply provide? What efficiency does the application need? These parameters are the basics for selecting a proper laser driver. It's easy to know the maximum current and input voltage that the application requires. About the power consumption, please refer to the following.

When the maximum power consumed by a linear controller is maintained to <1W, it does not require a heat sink to operate. The power dissipated by the laser driver can be calculated by this formula:

$I_{VPS} = I_Q + I_{OUT}$

$P_{IN} = V_{PS} \times I_{VPS}$

$P_{OUT} = V_{OUT} \times I_{OUT}$

$P_{DR} = P_{IN} - P_{OUT}$

$= V_{PS} \times I_Q + (V_{PS} - V_{OUT}) \times I_{OUT}$

where, I_{VPS} is the input current at the V_{PS} node, V_{PS} is the power supply voltage, I_{GND} is the ground pin current, V_{OUT} is the output voltage at the load, I_{OUT} is the output current going through the load.

For switch mode laser driver, the power consumption cost by the laser driver is:

$P_{IN} = P_{DR} + P_{OUT}$

$P_{OUT} = \eta \times P_{IN} \approx 0.9P_{IN}$

$P_{DR} = 0.1P_{IN}$

η is various with working conditions, therefore, you would need to read datasheets for specific different η values on the different working conditions.

2. Linear Mode or Switch Mode

There are linear mode laser driver and switch mode laser driver. For linear type laser driver, it features low noise and high modulation speed, but it generates more heat because of its efficiency. There is an approach to reduce the heat dissipation: make the difference of V_{OUT} and V_{IN} as small as possible, which helps decrease the power loss.

Analog Technologies, Inc. (ATI) makes a wide variety of laser drivers, see the laser driver selection guide below:

Part Number	Output Stage Type	Control Mode	Input Type	V_{IN} Range	Max. I_{OUT}	V_{OUT} Range	Noise @0.1~10Hz	Size (mm)
ATLS500MA212D	Switch mode	Constant current	DC	4.5V to 15V	0.5A	0V to 0.9×VPS	10μA	25.4×20×5
ATLS1A212D	Switch mode	Constant current	DC	4.5V to 15V	1A	0V to 0.9×VPS	12μA	25.4×20×5
ATLS2A212D	Switch mode	Constant current	DC	4.5V to 15V	2A	0V to 0.9×VPS	12μA	25.4×20×5
ATLS3A212D	Switch mode	Constant current	DC	4.5V to 15V	3A	0V to 0.9×VPS	10μA	25.4×20×5
ATLS4A214D	Switch mode	Constant current	DC	5V to 14V	4A	0V to 0.75×VPS	12μA	27.4×21×5.7
ATLS6A214D	Switch mode	Constant current	DC	5V to 14V	6A	0V to 0.75×VPS	12μA	27.4×21×5.7
ATLS8A216D	Linear mode	Constant current	DC	5.5V to 15V	8A	0.8V to 0.8VPS	12μA	27.4×21×5.7
ATLS10A216D	Linear mode	Constant current	DC	5.5V to 15V	10A	0.8V to 0.8VPS	12μA	27.4×21×5.7
ATLS250MA106	Linear mode	Constant current	DC	3V to 5.5V	0.25A	1.5V to 4V	4.5μAP-P	20.14×14.6×5
ATLS500MA106	Linear mode	Constant current	DC	3V to 5.5V	0.5A	1.5V to 4V	4.5μAP-P	20.14×14.6×5
CWD-01-V2-D	Switch mode	Constant current	DC	3.0V to 5.5V	2A	0V to 0.9×VPS	25μAP-P	25.8×20×5
ATLS500MA201D	Switch mode	Constant current	DC	3.0V to 5.5V	0.5A	0V to 0.9×VPS	25μAP-P	25.8×20×5.0
ATLS1A201D	Switch mode	Constant current	DC	3.0V to 5.5V	1A	0V to 0.9×VPS	25μAP-P	25.8×20×5.0
ATLS2A201D	Switch mode	Constant current	DC	3.0V to 5.5V	2A	0V to 0.9×VPS	25μAP-P	25.8×20×5.0
ATLS3A201D	Switch mode	Constant current	DC	3.0V to 5.5V	3A	0V to 0.9×VPS	25μAP-P	25.8×20×5
ATLS4A201D	Switch mode	Constant current	DC	3.0V to 5.5V	4A	0V to 0.9×VPS	25μAP-P	25.8×20×5
ATLS6A201D	Switch mode	Constant current	DC	3.0V to 5.5V	6A	0V to 0.90×VPS	25μAP-P	25.8×20×5
ATLS500MA104	Linear mode	Constant current	DC	4.75V~5.75V	0.5A	3.1V~5.5V	3.96μAP-P	20.14×16.8×5
AAS12A12V	Switch mode	Constant current	AC	100VAC to 240VAC	12A	0V to 12V	354μAP-P	199×99×50
AAS16A9.5V2	Switch mode	Constant current	AC	100VAC to 240VAC	16A	0V to 9.5V	354μAP-P	199×99×50
AAS25A6V	Switch mode	Constant current	AC	100VAC to 240VAC	25A	0V to 6V	354μAP-P	199×99×50

Part Number	Output Stage Type	Control Mode	Input Type	V_{IN} Range	Max. I_{OUT}	V_{OUT} Range	Noise @0.1~10Hz	Size (mm)
AAS40A4V2	Switch mode	Constant current	AC	100VAC to 240VAC	40A	0V to 4V	354µAP-P	199×99×50
ATLS500mA202D	Switch mode	Constant current	DC	3.0V to 5.5V	0.5A	0V to 0.90×VPS	25µAP-P	25.8×20×5
ATLS1A202D	Switch mode	Constant current	DC	3.0V to 5.5V	1A	0V to 0.90×VPS	25µAP-P	25.8×20×5
ATLS2A202D	Switch mode	Constant current	DC	3.1V to 6.0V	2A	0V to 0.90×VPS	25µAP-P	25.8×20×5
ATLS3A202D	Switch mode	Constant current	DC	3.0V to 5.5V	3A	0V to 0.90×VPS	25µAP-P	25.8×20×5
ATLS4A202D	Switch mode	Constant current	DC	3.0V to 5.5V	4A	0V to 0.90×VPS	25µAP-P	25.8×20×5
ATLS6A202D	Switch mode	Constant current	DC	3.0V to 5.5V	6A	0V to 0.90×VPS	25µAP-P	25.8×20×5
LDA1-CP1	Switch mode	Constant current Constant power	DC	3.0V to 5.5V	2A	0V to 0.9×VPS	25µAP-P	25.4×20×4.6
LDA1-CP2	Switch mode	Constant current Constant power	DC	3.0V to 5.5V	2A	0V to 0.9×VPS	25µAP-P	25.4×20×4.6
ATLS1A102	Linear mode	Constant current LDC = 0.5V	DC	3.0V to 5.5V	1A	0V to VPS-1V	10µAP-P	19.4×14.5×5
ATLS500MA104	Linear mode	Constant current	DC	4.75V~5.75V	0.5A	3.1V~5.5V	3.96µAP-P	20.14×16.8×5
AAS12A12V	Switch mode	Constant current	AC	100VAC to 240VAC	12A	0V to 12V	354µAP-P	199×99×50
AAS16A9.5V2	Switch mode	Constant current	AC	100VAC to 240VAC	16A	0V to 9.5V	354µAP-P	199×99×50
AAS25A6V	Switch mode	Constant current	AC	100VAC to 240VAC	25A	0V to 6V	354µAP-P	199×99×50
AAS40A4V2	Switch mode	Constant current	AC	100VAC to 240VAC	40A	0V to 4V	354µAP-P	199×99×50
ATLS100MA103	Linear mode	Constant current Rise time: 300ns LDC = 0V	DC	3.0V to 5.5V	0.1A	0V to VPS-1V	1.5µAP-P	20×14.5×5
ATLS200MA103	Linear mode	Constant current Rise time: 300ns	DC	3.0V to 5.5V	0.2A	0V to VPS-1V	2.5µAP-P	20×14.5×5

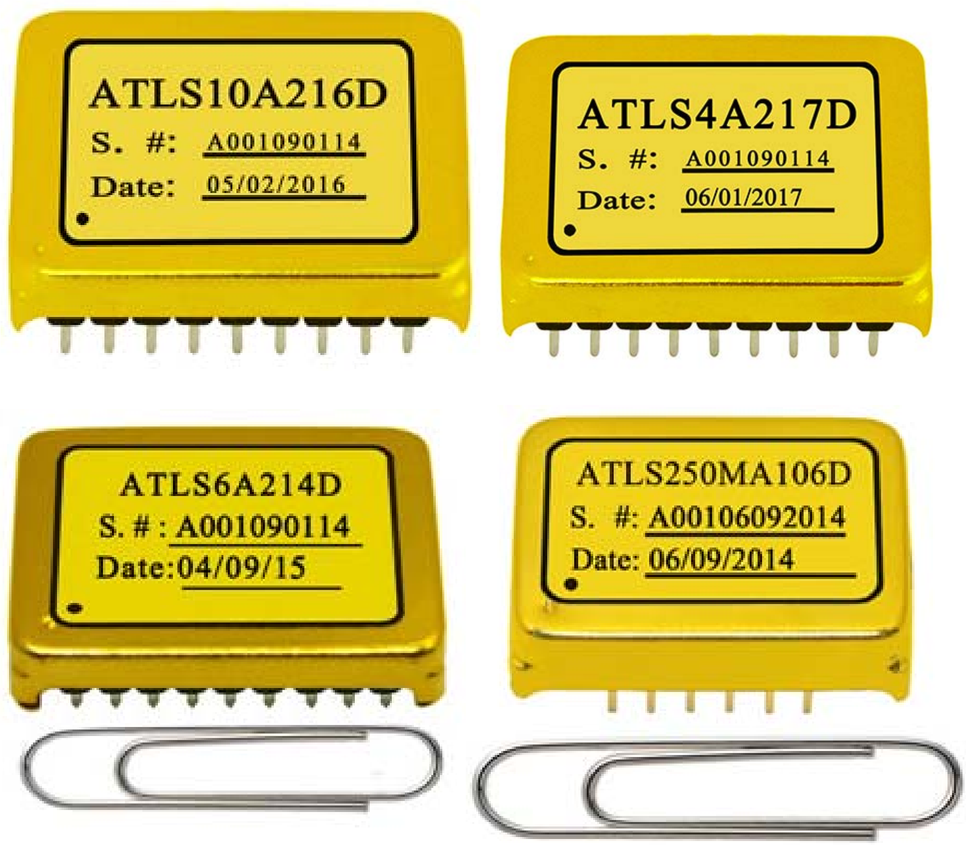
		LDC = 0V						
Part Number	**Output Stage Type**	**Control Mode**	**Input Type**	**V_{IN} Range**	**Max. I_{OUT}**	**V_{OUT} Range**	**Noise @0.1~10Hz**	**Size (mm)**
ATLS250MA103	Linear mode	Constant current Rise time: 300ns LDC = 0V	DC	3.0V to 5.5V	0.25A	0V to VPS-1V	2.5µV_{P-P}	20×14.5×5
ATLS500MA103	Linear mode	Constant current Rise time: 300ns LDC = 0V	DC	3.0V to 5.5V	0.5A	0V to VPS-1V	5µAP-P	20×14.5×5
ATLS1A103	Linear mode	Constant current Rise time: 300ns LDC = 0V	DC	3.0V to 5.5V	1A	0V to VPS-1V	6µAP-P	20×14.5×5
ATLS500MA104	Linear mode	Constant current	DC	4.75V~5.75V	0.5A	3.1V~5.5V	3.96µAP-P	20.14×16.8×5
AAS12A12V	Switch mode	Constant current	AC	100VAC to 240VAC	12A	0V to 12V	354µAP-P	199×99×50
AAS16A9.5V2	Switch mode	Constant current	AC	100VAC to 240VAC	16A	0V to 9.5V	354µAP-P	199×99×50
AAS25A6V	Switch mode	Constant current	AC	100VAC to 240VAC	25A	0V to 6V	354µAP-P	199×99×50
AAS40A4V2	Switch mode	Constant current	AC	100VAC to 240VAC	40A	0V to 4V	354µAP-P	199×99×50

3. Styles

Laser driver can be an instrument or a module. The former generally comes with a front panel with buttons or knobs for users to adjust. Powered by AC power supply, these bench-top laser drivers usually come with a relatively large size. The latter is an electronic module, which can be mounted to a printed circuit board (PCB). Without any moving parts, these laser drivers come with a compact size and powered by DC power supply. The laser driver modules have two packaging types, DIP (Dual Inline Package) and SMT (Surface Mount). These modules save space and can be used in applications with limited space.

ATI makes different styles of laser drivers, see below:

DIP

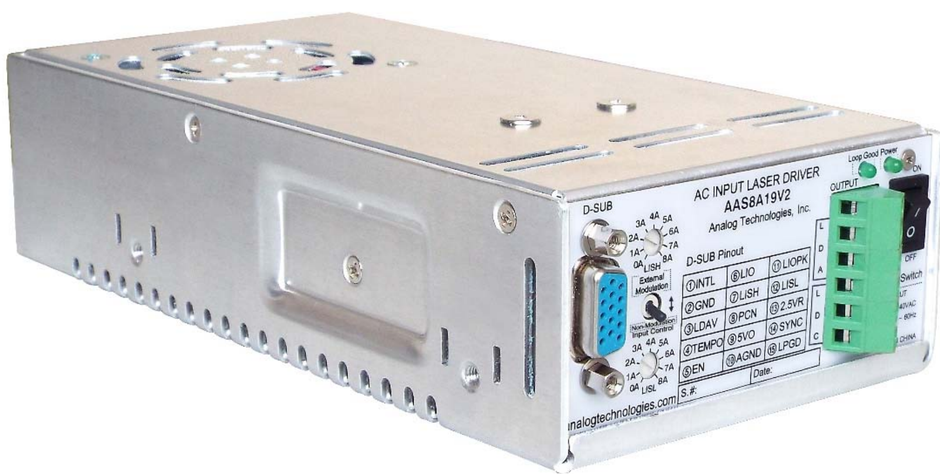


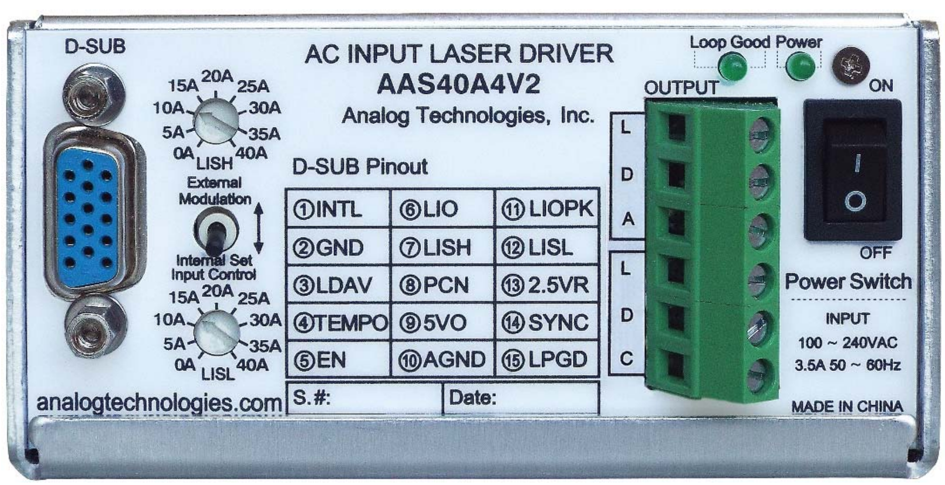
SMT


ATLS100MA103-S
S. #: A001090114
Date: 09/01/14


ATLS500MA103-S
Serial #: A1088
Date: 05/08/09

Brick


AC INPUT LASER DRIVER
AAS8A19V2
Analog Technologies, Inc.
D-SUB
D-SUB Pinout
analogtechnologies.com


D-SUB
AC INPUT LASER DRIVER
AAS40A4V2
Analog Technologies, Inc.
Loop Good Power
OUTPUT
ON
15A 20A 25A
10A 30A
5A 35A
0A LISH 40A
External Modulation
Internal Set Input Control
15A 20A 25A
10A 30A
5A 35A
0A LISL 40A
D-SUB Pinout
①INTL ⑥LIO ⑪LIOPK
②GND ⑦LISH ⑫LISL
③LDAV ⑧PCN ⑬2.5VR
④TEMPO ⑨5VO ⑭SYNC
⑤EN ⑩AGND ⑮LPGD
S.#: Date:
L D A
L D C
OFF
Power Switch
INPUT
100 ~ 240VAC
3.5A 50 ~ 60Hz
MADE IN CHINA
analogtechnologies.com

4. Service Life

Laser drivers are designed for driving diode lasers. Diode lasers are widely used in different applications, such as optical communication, optical storage, laser printing, and lidar, etc. It requires diode lasers to run stably for a long period of time, so that laser drivers should have a long service life too. Overcurrent or overvoltage may damage laser drivers internally, thus protection circuits are needed inside the laser driver to extend their service lives.

From the above introduction, you may be clearer about how to choose an off-the-shelf laser driver or design one by yourself.