November 2015

WAVELENGTH
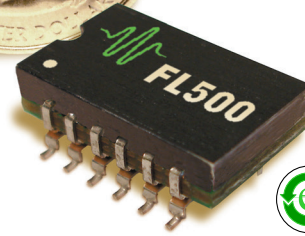## E L E C T R O N I C S

FL500

500 mA laser diode driver or two 250 mA drivers in a small SMT package that is reflow process compatible

RoHS Compliant

GENERAL DESCRIPTION:

The FL500 is ideal for driving low power laser diodes. It operates from 3 to 12 V, so is compatible with Li+ battery operation. It can be configured as two totally independent 250 mA drivers or a single 500 mA driver. Compatible with Type A or B laser diodes.

The FL500 allows for quick and easy operation in Constant Current (CC) mode. For simple CC mode operation the only components that are required are a power supply, an analog control voltage, your laser and optional filtering circuitry.

For additional features, including current limit and photodiode feedback for Constant Power operation, the FL500 can be used with the FL591 evaluation board.

FEATURES:

- Small Package (0.75" x 0.45" x 0.255")
- Low Cost
- Brownout Protection
- 12-pin, SMT package, Reflow Compatible
- Slow Start Laser Diode Protection
- Drive Up to 500 mA Output Current
- Can be configured as two 250 mA drivers
- Voltage Controlled Setpoint
- TTL Compatible Shutdown Pin
- Adjustable Current Limit on Eval boards
- Adjustable Current Range Output
- 500 kHz sinewave Constant Current Bandwidth (100 kHz square wave)
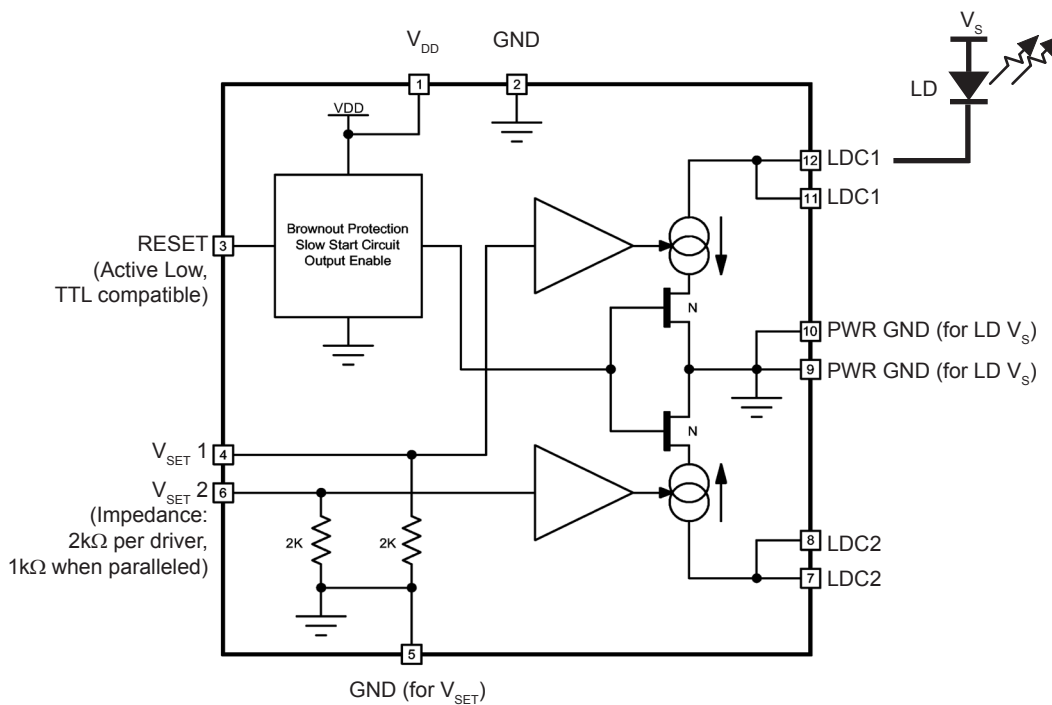
Figure 1
Top View Pin Layout

TOP VIEW *
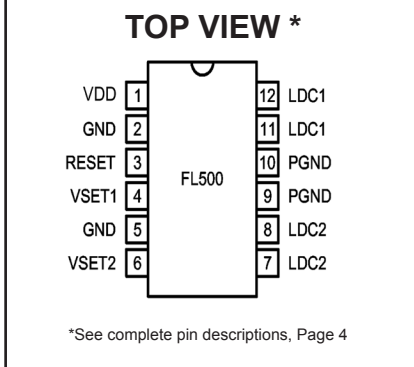
*See complete pin descriptions, Page 4

Figure 2
Connection Diagrams for FL500: Top - Dual Configuration, Bottom - Single Operation
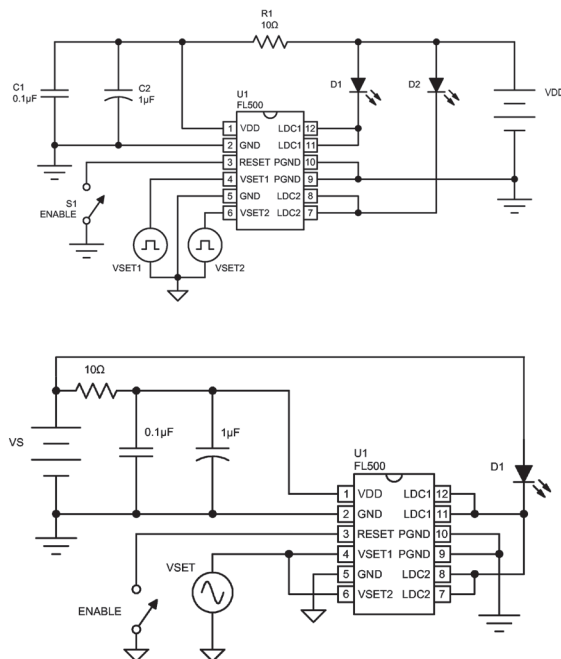
* For Details See Page 6

BLOCK DIAGRAM

SUPPORTS A & B LASER DIODE PACKAGE STYLES

Type A Laser Diode

Laser Diode Anode &
Photodiode Cathode Common

Common
Cathode

Type B Laser Diode

Short
Laser Diode Anode
to Photodiode Cathode

Isolated Photodiode
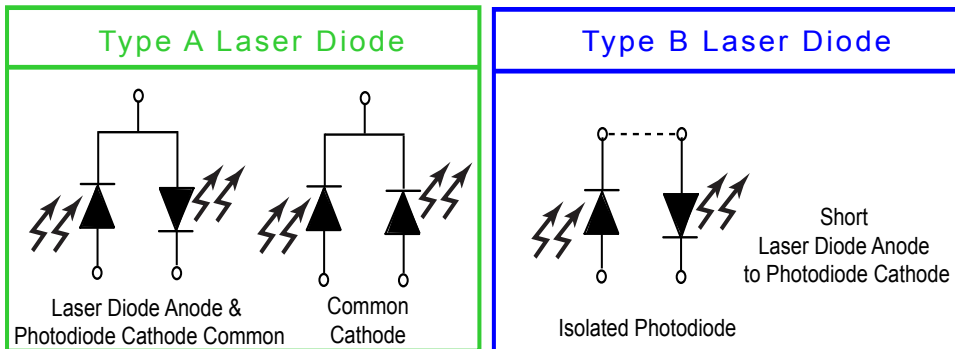
* Contact factory for common cathode configuration

ELECTRICAL AND OPERATING SPECIFICATIONS

ABSOLUTE MAXIMUM RATINGS RATING	SYMBOL	VALUE	UNIT
Supply Voltage (Voltage on Pin 1)	V_{DD}	+3 to +12 **	Volts DC
Output Current (See SOA Chart)	I_{OUT}	500	mA
Power Dissipation, $T_{AMBIENT}$ = +25˚C [1]	P_{MAX}	2	Watts
Operating Temperature, case	T_{OPR}	- 40 to + 85	˚C
Storage Temperature	T_{STG}	- 55 to +125	˚C
Weight	FL500	0.08	oz

PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNITS
CONSTANT CURRENT CONTROL					
Short Term Stability, 1 hour	$T_{AMBIENT}$ = 25˚C		35	40	ppm
Long Term Stability, 24 hours	$T_{AMBIENT}$ = 25˚C	50		75	ppm
CONSTANT POWER CONTROL					
Short Term Stability, 1 hour [3]			0.019		%
Long Term Stability, 24 hours [3]			0.011		%
OUTPUT [2]					
Current, peak, see SOA chart	Per channel	245	250	252	mA
Current, peak, see SOA chart	Two channels operated in parallel	495	500	505	mA
Compliance Voltage, Laser Diode Load	Full Temp. Range, I_{OUT} = 500 mA	V_{DD}- (0.5 x Vset)			Volts
Rise Time	I_{OUT}= 500 mA		300		nsec
Fall Time	I_{OUT}= 500 mA		300		nsec
Bandwidth	Constant Current, Sine Wave		500		kHz
Bandwidth	Constant Current, Square Wave		100		kHz
Delayed start		100			msec
Slow Start ramp rate			15		mA / msec
Depth of Modulation	100 kHz sine wave		99		%
Transfer Function - V_{SET} to I_{OUT}	Configured as two 250 mA drivers		0.125		A / V
Transfer Function - V_{SET} to I_{OUT}	Configured as one 500 mA driver		0.25		A / V
POWER SUPPLY					
Voltage, V_{DD}		3		12**	Volts
Current, V_{DD} supply, quiescent		2.2	2.7	4.6	mA
V_S, Maximum to LD Anode				20**	Volts
INPUT					
Offset Voltage, initial, Imon	Pin 2, $T_{AMBIENT}$ = 25˚C, V_{CM} = 0 V		2		mV
Bias Current (based on input Res of op amp)	Pin 2, $T_{AMBIENT}$ = 25˚C, V_{CM} = 0 V		10	15	nA
Common Mode Range	Pin 2, Full Temp. Range	0		V_{DD}	V
Common Mode Rejection, Set point	Full Temperature Range	-16	64		dB
Power Supply Rejection	Full Temperature Range	60			dB
THERMAL					
Heatspreader Temperature Rise	$T_{AMBIENT}$ = 25˚C		43		˚C / W
Pin Solderability	Solder temp @260˚C		10		Sec
NOISE					
Noise & Ripple (Rms)	I_{OUT} = 100 mA, 100 kHz bandwidth		3		µA
Leakage Current	V_{SET} = 0 V		50		µA
(when using the FL591 circuitry)	V_{SET} = 1 V		100		µA
	V_{SET} = 2 V		150		µA

**The FL591 Evaluation Board revision A or B limits the input voltage to 9 V.

Revision C allows full range operation from +3 V to +12 V.

PIN DESCRIPTIONS

Pin	Pin #	Name	Function
VDD	1	Control Electronics Power	Power supply input for the FL500's internal control electronics. Supply range input for this pin is +3 to +12 Volts DC. It is compatible with Li+ batteries.
GND	2	Control Electronics Ground	Return path for control electronics. Connect ground for V_{DD} power supply here. Do not use for high current ground return.
RESET	3	Enable / RESET Control	TTL compatible. LO = laser diode current on FLOAT or HI = laser diode current attenuated to ~10 µA (~20 µA if drivers are paralleled to produce 500 mA)
VSET1	4	Setpoint for LDC1 control	2 kΩ input impedance. 0 to 2 V range. There is no internal clamping, so higher voltage here will produce more current through the laser diode. **Not recommended above 2 V.**
GND	5	Ground for setpoint inputs	Low Current, Low Noise ground for use with VSET1 & VSET2.
VSET2	6	Setpoint for LDC2 control	2 kΩ input impedance. 0 to 2 V range. There is no internal clamping, so higher voltage here will produce more current through the laser diode. **Not recommended above 2 V.**
LDC2 LDC2	7 8	Laser Diode Cathode, Driver 2	Tie to laser diode cathode for individual drive operation (250 mA max). Tie to LDC1 for parallel operation up to 500 mA. Tie to pin 8 (also LDC2) if laser diode current exceeds 125 mA. Actual pin capacity is greater, but higher current produces offsets and higher noise.
PGND PGND	9 10	Power Ground for VS connection	Use for ground connection of VS power supply. Tie to pin 10 (also PGND) if laser diode current exceeds 125 mA.
LDC1 LDC1	11 12	Laser Diode Cathode, Driver 1	Tie to laser diode cathode for individual drive operation (250 mA max). Tie to LDC2 for parallel operation up to 500 mA. Tie to pin 12 (also LDC1) if laser diode current exceeds 125 mA. Actual pin capacity is greater, but higher current produces offsets and higher noise.

Note [1]. Maximum Power Dissipation is 1 Watt per channel. When configured as one driver, maximum power dissipation is 2 W.

Note [2]. Limit is fixed at 500 mA (250 mA per channel). The Evaluation Board circuitry adds a variable limit circuit.

Note [3]. Constant Power Control is available when the FL500 is used with FL591 and FL593 as well as the LDTC0520/1020 combination boards.

OPERATION

1. RESET / ENABLE FUNCTION
This control pin is common to both sources. When active, this pin attenuates the output current amplitude to near zero (~10 μA when configured for 250 mA max.) Current still flows through the laser diode. The pin is active LO.
LO = LD current flowing to setpoint.
FLOAT or HI = LD current attenuated.
The input is TTL compatible.

2. DELAYED / SLOW START
Once power is applied, current at the attenuated level will flow (~10 μA when configured for 250 mA max). After 100 msec, current will rise to the level dictated by the setpoint voltage at the rate of about 15 mA / msec. This delay ensures that all control electronics are functioning before significant current flows to the laser diode. The delay time is set with internal components. [It can be increased - please request a custom modification through Sales.] Refer to Figure 3 for a typical sequence.

3. BROWN OUT PROTECTION
If V_{DD} drops below 2.7 V, the RESET circuit is triggered immediately (on the order of 100 μsec), reducing current through the laser diode to attenuated levels (~10 μA).

4. V_S & V_{DD}
V_{DD} powers the control electronics. V_S powers the laser diode current source.
a. To power the laser diode from V_{DD}, connect V_{DD} where V_S is shown. For lower noise operation, separate V_{DD} from V_S.
b. V_S can be up to 20 V. At this level, however, too much power can be dissipated in the FL500 causing permanent damage. Calculate the power dissipated in the FL500 using the Safe Operating Area (SOA) Calculator online prior to using a V_S more than 2 V greater than the voltage dropped over the laser diode.
   A maximum power dissipation of 1 W per source (2 W for paralleled operation) must not be exceeded.
c. The minimum V_S is determined by the voltage drop across the laser diode and half the setpoint voltage. $V_{SMIN} = V_{LD} + V_{SET}/2 + 25$ mV (across FET). Ground this power supply at pins 9 and 10 (PGND). **Using pin 2 could damage the FL500.**

Figure 3
Typical Delayed / Slow Start
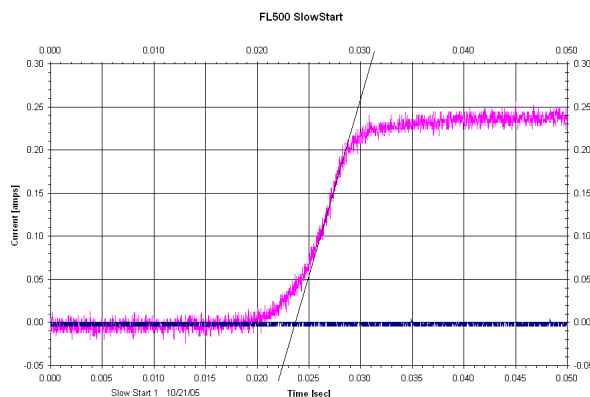
Example V_{SMIN}:
V_{LD} = 1.2 V
V_{SET} = 1.5 V
V_{SMIN} = 1.2V + (1.5 /2) + 0.025 = 1.975 V

OPERATION

5. OPERATION AS TWO INDEPENDENT DRIVERS

The FL500 contains circuitry for two 250 mA drivers. VS1 does not need to be tied to VS2. The transfer function for VSET is 0.125 A / V, the RESET minimum current is 10 μA, and leakage current is less than 1 mA. The FL500 has a known leakage current when disabled equal to the following magnitude:

$$I_{OUT(LEAK)} = \frac{V_{IN}}{20\ k\Omega}$$

This is well below 1 mA, and usual leakage expected is 100 μA.

See Figure 4 for typical operating schematic.

6. OPERATION IN PARALLEL AS ONE DRIVER.

The FL500 contains circuitry for two 250 mA drivers. They can be run in parallel to deliver 500 mA to one laser diode. Tie LDC1 & LDC2 together. VSET1 and VSET2 can be tied together or one can be used to set a DC bias while the other is used for an additive modulation signal. Only one VS can be used. The transfer function for tied VSETs is 0.25 A / V.

The transfer function for independent VSETs is 0.125 A / V. The RESET minimum current is 20 μA, and leakage current is 2 mA. Note that if VSETs are tied together, input impedance becomes two 2 kΩ in parallel or 1 kΩ. The FL500 has a known leakage current when disabled equal to the following magnitude:

$$I_{OUT(LEAK)} = \frac{V_{IN}}{20\ k\Omega}$$

This is well below 1 mA, and usual leakage expected is 100 μA.

See Figure 5 for typical operating schematic.

Figure 4
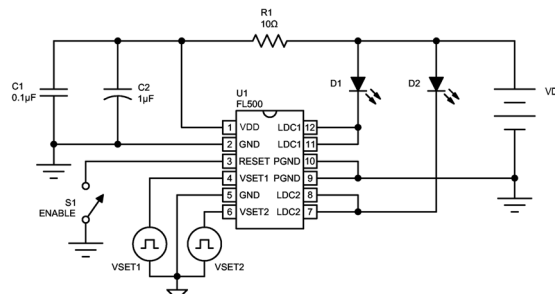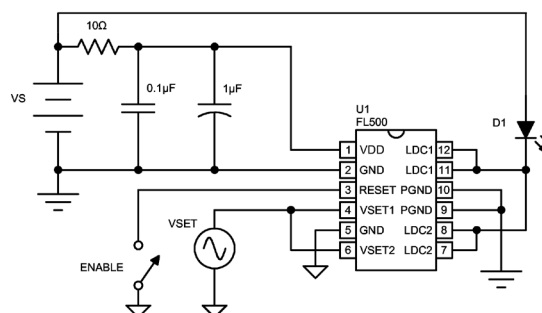Operation as two independent drivers using single supply voltage ($V_S = V_{DD}$).

Figure 5
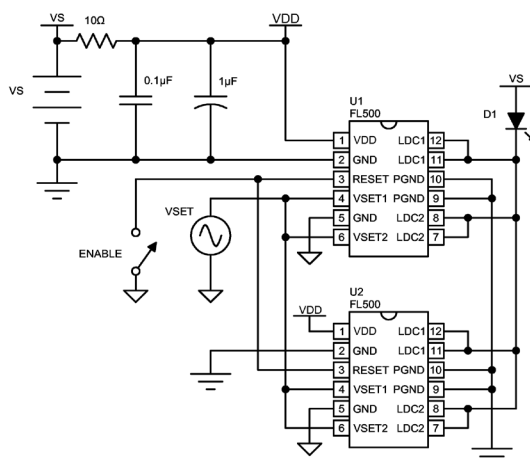Operation in parallel as one driver.

OPERATION

7. MULTIPLE FL500s IN PARALLEL

Multiple FL500s can be used in parallel for 1 A, 1.5 A, etc. operation: Note input impedance on VSET drops. For two FL500s configured for 500 mA each and used in parallel, the input impedance drops to 500 Ω. See Figure 6 for typical operating schematic.

Figure 6
Multiple units in parallel

Caution:

Do not exceed the Safe Operating Area (SOA). Exceeding the SOA voids the warranty.

To determine if the operating parameters fall within the SOA of the device, the maximum voltage drop across the driver and the maximum current must be plotted on the SOA curves.

These values are used for the example SOA determination:

V_S = 5 volts

V_{Load} = 2.5 volts

I_{Load} = 100 mA   } These values are determined from the specifications of the laser diode.
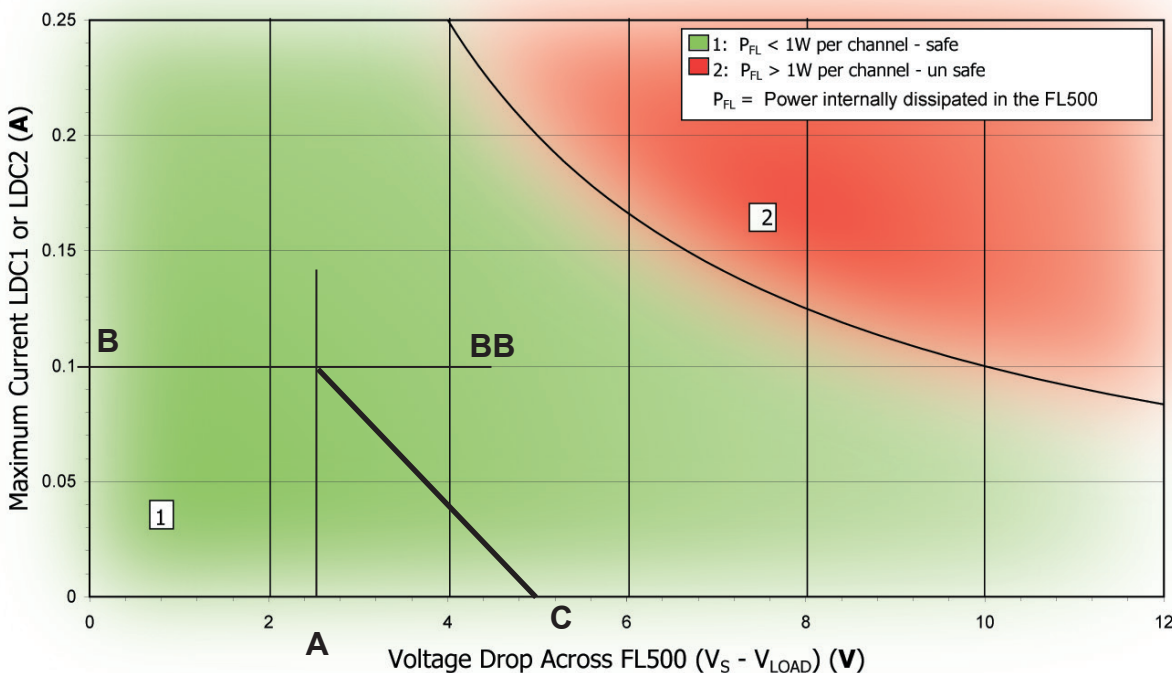
Follow these steps:

1. Determine the maximum voltage drop across the driver, V_S-V_{Load}, and mark on the X axis.
   Example: 5 volts - 2.5 volts = 2.5 volts, Point A)

2. Determine the maximum current, I_{Load}, through the driver and mark on the Y axis:
   (100 mA, Point B)

3. Draw a horizontal line through Point B across the chart. (Line BB)

4. Draw a vertical line from Point A to the maximum current line indicated by Line BB.

5. Mark V_S on the X axis. (Point C)

6. Draw the Load Line from where the vertical line from point A intersects Line BB down to Point C.

Refer to the chart shown below and note that the Load Line is in the Safe Operating Area. Note the first chart is for the independent channels. The second, on the following page, is for dual channels configured as a single 500 mA driver.

An online tool for calculating your load line is at http://www.teamwavelength.com/support/calculator/soa/soald.php.

FL500 Safe Operating Area
Independent Channels 1 W, 250 mA max

Graphs assume:
25°C Ambient
35°C Case

1: P_{FL} < 1W per channel - safe
2: P_{FL} > 1W per channel - un safe
P_{FL} = Power internally dissipated in the FL500

X axis: Voltage Drop Across FL500 (V_S - V_{LOAD}) (**V**)
Y axis: Maximum Current LDC1 or LDC2 (**A**)

Caution:

Do not exceed the Safe Operating Area (SOA). Exceeding the SOA voids the warranty.

To determine if the operating parameters fall within the SOA of the device, the maximum voltage drop across the driver and the maximum current must be plotted on the SOA curves.

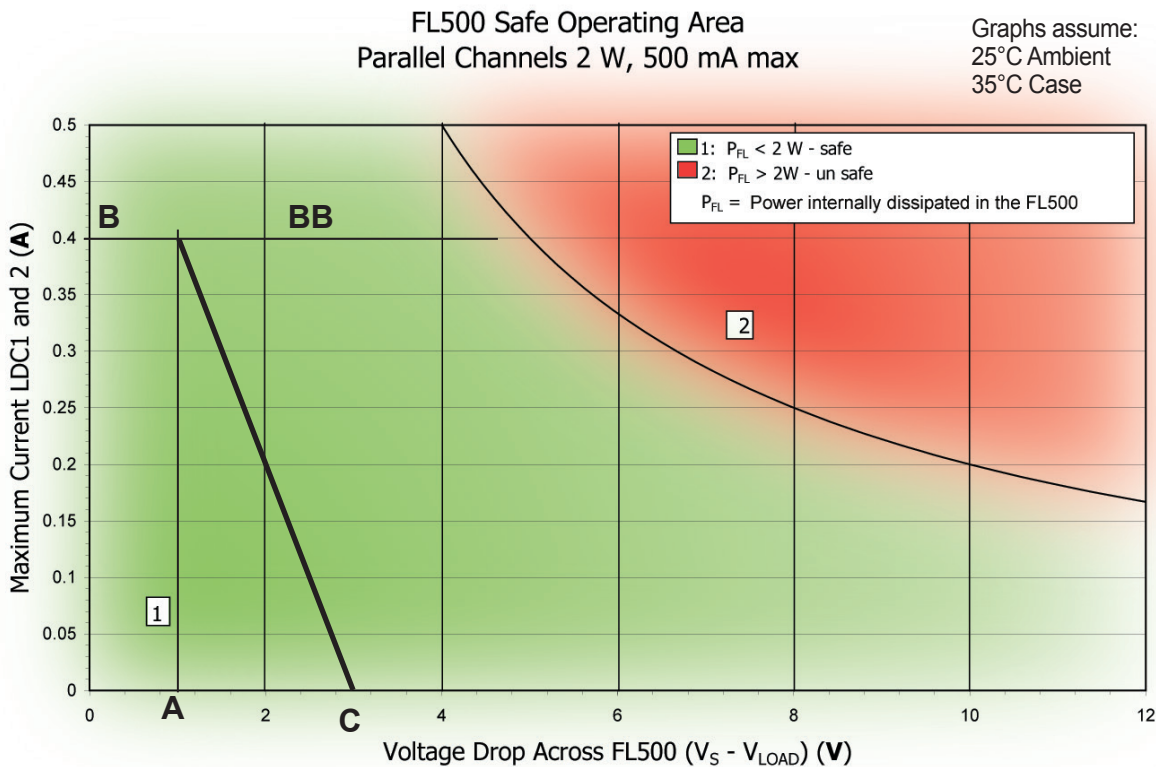These values are used for the example SOA determination:

V_S = 3 volts
V_{Load} = 2 volts
I_{Load} = 400 mA } These values are determined from the specifications of the laser diode.

Follow these steps:

1. Determine the maximum voltage drop across the driver, V_S-V_{Load}, and mark on the X axis.
   Example: 3 volts - 2 volts = 1 volts, Point A)

2. Determine the maximum current, I_{Load}, through the driver and mark on the Y axis:
   (400 mA, Point B)

3. Draw a horizontal line through Point B across the chart. (Line BB)

4. Draw a vertical line from Point A to the maximum current line indicated by Line BB.

5. Mark V_S on the X axis. (Point C)

6. Draw the Load Line from where the vertical line from point A intersects Line BB down to Point C.
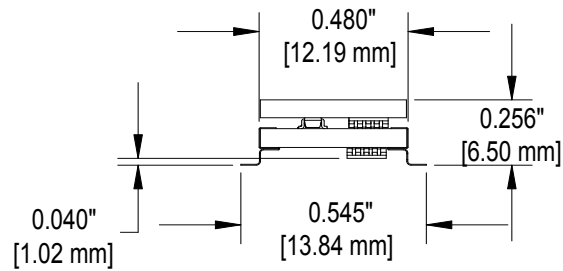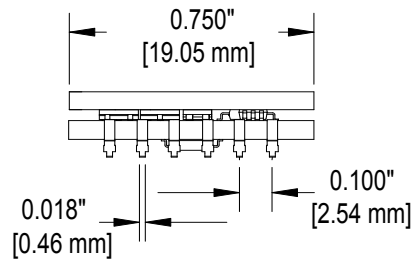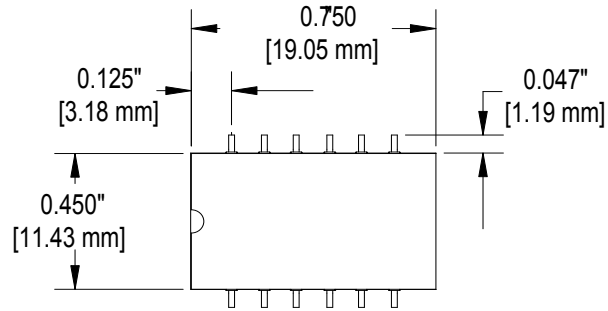
Refer to the chart shown below and note that the Load Line is in the Safe Operating Area. Note this chart is for dual channels configured as a single 500 mA driver. The first, on the previous page, is for independent channels configured for 250 mA max.

An online tool for calculating your load line is at http://www.teamwavelength.com/support/calculator/soa/soald.php.

FL500 Safe Operating Area
Parallel Channels 2 W, 500 mA max

Graphs assume:
25°C Ambient
35°C Case

1: P_{FL} < 2 W - safe
2: P_{FL} > 2W - un safe
P_{FL} = Power internally dissipated in the FL500

Maximum Current LDC1 and 2 (A)

Voltage Drop Across FL500 (V_S - V_{LOAD}) (V)

MECHANICAL SPECIFICATIONS
FL500 is reflow process compatible.

0.750"
[19.05 mm]

0.125"
[3.18 mm]

0.047"
[1.19 mm]

0.450"
[11.43 mm]

0.750"
[19.05 mm]

0.018"
[0.46 mm]

0.100"
[2.54 mm]

0.480"
[12.19 mm]

0.256"
[6.50 mm]

0.040"
[1.02 mm]

0.545"
[13.84 mm]

PCB FOOTPRINT

0.085"
[2.16 mm]

0.100"
[2.54 mm]

0.035"
[0.889 mm]

0.449"
[11.40 mm]
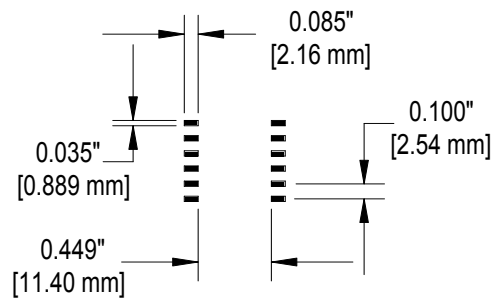
All dimension tolerances are ±5%.

CERTIFICATION AND WARRANTY

CERTIFICATION:
Wavelength Electronics (Wavelength) certifies that this product met it's published specifications at the time of shipment. Wavelength further certifies that its calibration measurements are traceable to the United States National Institute of Standards and Technology, to the extent allowed by that organization's calibration facilities, and to the calibration facilities of other International Standards Organization members.

WARRANTY:
This Wavelength product is warranted against defects in materials and workmanship for a period of one (1) year from date of shipment. During the warranty period, Wavelength will, at its option, either repair or replace products which prove to be defective.

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REVISION HISTORY		
REVISION	**DATE**	**NOTES**
REV. F	24-Feb-09	Updated to include FL500 Reflow Oven compatibility
REV. G	25-Sep-09	Updated to reflect RoHS Status
REV. H	6-June-13	Updated Noise & Ripple specification
REV. I	26-Mar-14	Clarified reflow compatibility
REV. J	15-Dec-14	Updated to fully reflow compatible
REV. K	Nov. 2015	Updated leakage current spec