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ANALOG MODULES, INC.
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UNLESS OTHERWISE SPECIFIED:
ALL DIMENSIONS ARE IN INCHES. ALL CAPACITANCE VALUES ARE IN MICROFARADS. ALL RESISTANCE VALUES ARE IN OHMS.

TOLERANCES

DECIMAL
.XX = N/A
.XXX = N/A

TITLE
OPERATING MANUAL, DIODE DRIVER MODEL 785

ANGULAR
X = N/A

SCALE	SIZE	FSCM	SHEET	DRAWING		REV.
N / A	A	61651	1 OF 21	NUMBER	8958	-

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1 Overview

The 785 laser diode driver is a high power, medium speed, analog current source driver. It is designed to be driven by a group of analog and digital signals. It has status outputs which are also both analog and digital. The ripple and noise are much superior to those of a switching driver.

1.1 Description

The driver has 5 basic subsystems. Refer to Figure 1.

1. The diode driver.

2. The input signal processing system.

3. The protection/fault system.

4. The enabling system.

5. The monitoring system.

1.1.1 Input Processing

This subsystem normalizes the input impedance and performs input scaling. It also contains provisions for activating and deactivating the Drive Control input. When the Pulse Source is high, a scaled version of the Drive Control input is applied to the driver.

1.1.2 The Enabling System

The Enabling system normalizes the Enable input. It provides three principal operating functions:

1. Implement the Boolean function: Enable_out = Enable_in AND NOT(Fault).

2. Generate a reset signal for the fault latch. The latch is reset when the Enable/Disable input goes LOW.

3. Level shifts the signals to perform their function.

Figure 1: Block Diagram
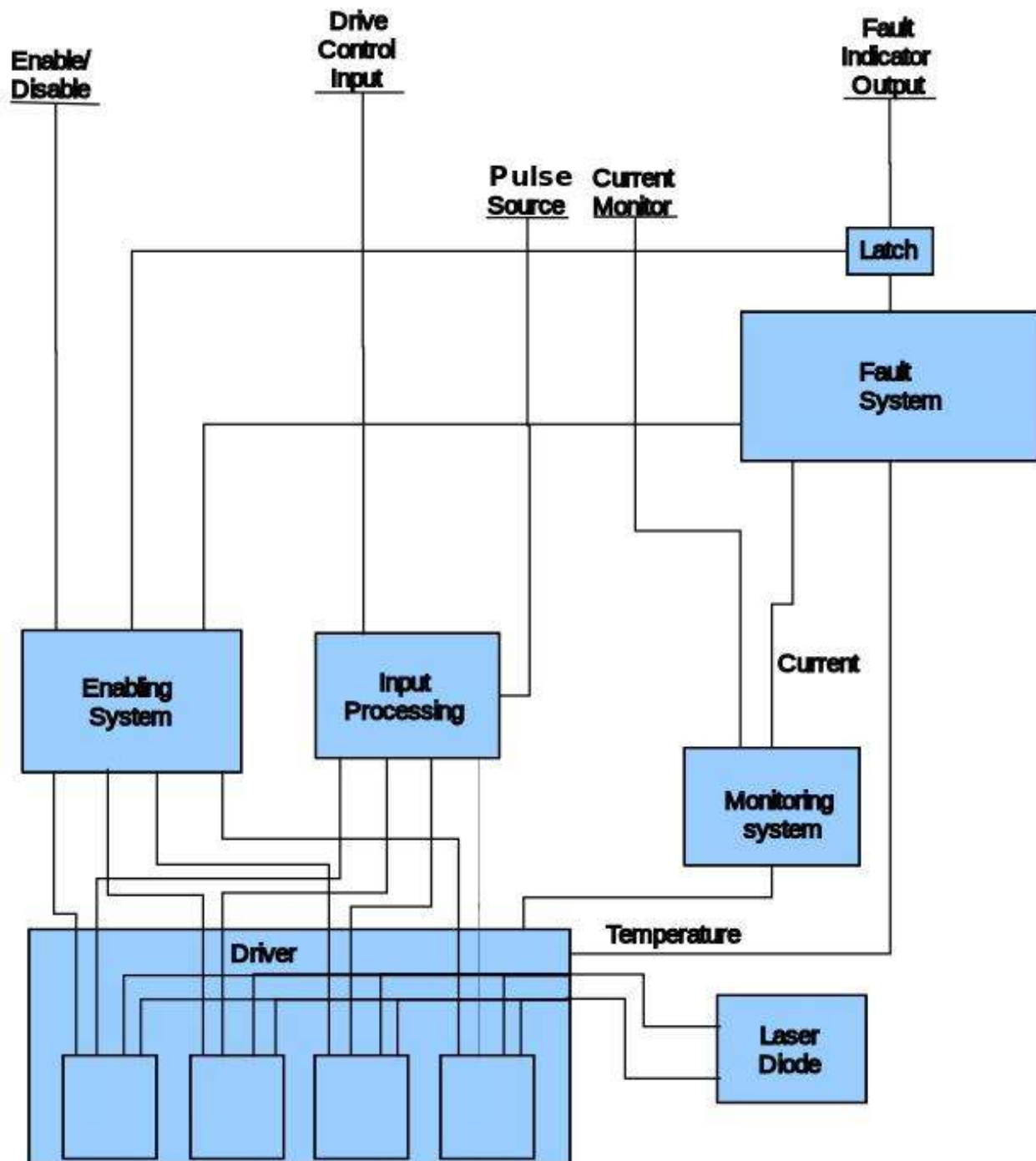
1.1.3 The Driver

The driver consists of four current controlled scaled current sources connected in parallel to increase power handling capability. Each is equipped with both a fast and slow disabling circuit. The fast disabler will react to a fault in about 20ns and will protect the laser from all types of driver failure except for a shorted power FET or a defect in the fault system. If the slow disable is not active, the fast system will cause some parts to overheat in order to save the laser. The slow system will disable the driver in about 1.5µs. The slow disable reduces the power dissipation of the entire driver including the dissipation in the fast disable system. Both systems are activated simultaneously by the enable system in response to either the user changing the state or a driver fault signal.

1.1.4 The Monitor System

The monitor system performs two main functions:

1. Provides a scaled output voltage representing the laser current for use by the Fault system.
2. Generates the Current Monitor output signal.

1.1.5 The Fault System

The fault system processes two kinds of faults:

1. Current fault: Current exceeds adjustable set level.
2. Temperature fault: Power FET case temperature exceeds preset limits.

Both of the faults are created by simple comparators monitoring appropriate signals. They are OR'ed together and latched to provide the fault output. Cycling the Enable/Disable input with the fault condition corrected will reset the latch as will cycling the power.

2 Handling

2.1 Prior to Mounting

The driver assembly will require careful handling after removal from its shipping plate. Leave the driver attached to the shipping plate until ready to transfer to its permanent mounting location.

Each assembly has a two-part heat sink attached. The heat sink is kept assembled by two screws. The heat sinks are held in place relative to the board strictly by the friction, adhesion, and conformation around the parts of the thermal interface material. This material can be damaged by forcing the heat sink out of position. Should this happen, the interface thermal resistance will rise, and the driver reliability will be compromised. Damage of this type can be detected by misalignment of the heat sink mounting holes. Should damage to the interface material occur, the best practice is to return the driver to the factory for replacement of the thermal interface material and realignment of the heat sinks.

The heat sink body parts are made of soft copper. They are plated with nickel to increase scratch resistance. The bottom (mounting) surface of the heat sink is machined very flat and smooth. An impact with a harder object, especially along the bottom edge can deform the soft copper and cause a large increase in the mounted thermal resistance. Should this type of damage occur, the bottom heat sink part will require replacement.

Neither of these damage modes is applicable after the driver is mounted.

2.2 Mounting the Driver

2.2.1 Materials Required

The following materials will be needed to mount the driver assembly:

1. The Driver

2. An air, water, or Thermo-electric cooled mounting surface with 0.06°C/Watt or better for maximum rated power. Heat sink temperature at the mounting point should not exceed 40°C.

3. Thermal mounting pad

4. 8ea. M2.5 X 0.45 X 20mm screws

5. 8ea. Washers for above

6. 8ea. Conical lock washers for above

7. 3ea. M3 X 0.5 X 5mm screws

8. 3ea. Washers for above.

9. 3ea. M3 X 0.5 X 5mm male/female standoff spacers.

10. Thread locking compound Loctite 222 or equivalent.

11. Isopropyl alcohol.

12. Lint Free wipes.

Items 3 through 9 are supplied with the unit.

2.2.2 Inspection and Cleaning

Inspect the mating surfaces of both the driver and the base. Do not continue assembly if they are not completely flat and smooth. Clean the mating surfaces of both parts with alcohol and a clean wipe. Place the mating surfaces in contact. Verify with a strong back light that parts are in intimate contact.

2.2.3 Install Standoffs

Apply a drop of thread lock to the male end of the standoff. Thread into the plate, and tighten.

2.2.4 Applying Thread Lock and Thermal Pad

Place a drop of thread lock in each mounting hole in the plate and in the female ends of the standoffs. Wipe clean any that gets on the mating surface of the plate. Peel the plastic protective sheet from both sides of the thermal pad. Place on the plate aligned with the mounting holes. Insert screws with washers and conical washers (large end of cone on flat washer, small end to screw head) into the four holes farthest apart. These will be used to assist in aligning the driver with the mounting holes.

2.2.5 Attach

Carefully lower the assembly so that the screws enter their appropriate mounting holes. Tighten the two M3 screws at the standoffs. Insert all of the other screw/cone/washer assemblies into the remaining mounting holes. Screw in all of the screws to leave a small gap (<1mm) between the screw head and the washer.

Figure 2: Heat Sink Screw Torque

Torquing Group	Sequence	Torque 1	Final Torque
1	See Figure 4	30cNm	50cNm
2	See Figure 4	----	30cNm

2.2.6 Torque

Referring to Figure 4, tighten the Torque Group 1 screws, in the sequence shown, in two steps to the Final Torque as shown in Figure 2. Do Not Touch the Second and Fifth screws on the heat sink. Torque the same group to the Final Torque again. Torque the Group 2 screws to the table value in the sequence shown.

The resulting interface should have a thermal resistance of <0.1°C/W.

2.2.7 Disassembly

Should it be necessary to remove a mounted driver, remove the torque Group 2 screws sequenced as in assembly, but no torque steps are required. Then the torque Group 1 screws. Remember not to disturb the shipping screws in the heat sinks if the drivers are to be reused. Thoroughly clean all parts that will not be discarded. A new thermal pad will be needed for reassembly.

2.3 Mounting the Laser

2.3.1 Mounting

The laser should be screwed to the base plate using materials and methods prescribed by the laser manufacturer.

2.3.2 Soldering

After screwing down the laser, solder the pins or cable to the cathode and anode pads (See Figure 4).

3 Electrical Specifications and Requirements

3.1 Interface

3.1.1 Connectors

The high current power is connected via 2ea. IHI B12-PCB-S Box Connectors, see Figure 4 for polarity assignment.

The input, output signals and power for the electronics are connected via 1ea. - 14 pin Tyco MicroMatch Connector P/N 8-215460-4. The mate for this connector is Tyco P/N 8-215083-4. See Figure 4 for pin and key location.

3.2 Signals

3.2.1 Input Power

Electronics Power

The driver is designed to operate from a DC voltage source of +10V to 14V at 100mA maximum current. This is delivered to the unit via the 14 pin connector (Figure 3) and processed on the board to operate the drive electronics.

Laser Power

The load is powered through a high current supply. It is recommended that the power source ripple be less than 100mV at full current. The driver inherently produces no ripple of its own. Standard techniques for reducing the ripple applied to the circuit have been applied, but the effectiveness of these techniques will not be just a function of the driver design. It will also be a function of the host system wiring, the wiring inside the laser box, ground loops, distance to the power source and the power source responses to sudden load change. It is recommended that the power wiring be a twisted pair, be kept as short as possible and as far from the analog circuitry as possible inside the package. The board layout keeps the most sensitive areas of the board far from the power input but shielding should be considered to prevent crosstalk between the power wires and the signal cable. The wire used for the power hook up should be at least #14 AWG and up to #10 AWG based on the length of the run.

Figure 3: I/O Connector Pin Out

Pin	Signal
1	Current Monitor Output
2	Ground
3	Pulse Source
4	Ground
5	Drive Control Input
6	Ground
7	N/C
8	Ground
9	Enable/Disable
10	Ground
11	Fault Indicator Output
12	Ground
13	N/C
14	+12V ±2V @ 100mA

3.2.2 Current Monitor Output

The current monitor output is the direct output of a rail to rail operational amplifier. It is scaled to reach 5.0V at 20A. Due to its rail to rail nature, the actual maximum output voltage will be determined by load and 5V on board power supply tolerance but should not be lower than 4.73V with a light load. There is a 50Ω resistor in series to damp the line inductance and isolate the Op Amp output from any capacitance added to the line. This is a common practice when using an A/D converter as the load. Despite the 50Ω source impedance, no more than 10mA should be drawn from this output.

3.2.3 Pulse Source

This is a TTL voltage level compatible input. The input impedance is 1.0kΩ to ground. It will tolerate input voltages from 0V to 5.5V. When the input is LOW, only bias current flows in the laser. When HIGH, the programmed drive control current will flow in the laser. Should this input become open circuited, the input will default to LOW.

3.2.4 Drive Control Input

This input is an analog input with the range of 0.0V to 5.0V. The input impedance is 1.0kΩ. The input will tolerate voltages up 5.5V. The voltage at this input will determine the laser current when the Pulse Source transitions from LOW to HIGH. It is scaled at 4A/V. If this input becomes open circuited, it will default to 0V.

3.2.5 Enable/Disable Input

This is a TTL voltage level compatible input. The input impedance is 900Ω to ground. The input will tolerate 0.0V to 5.0V. When this signal is HIGH the laser will be driven with either the bias current or the bias current plus the programmed drive current. When LOW there will be no laser current regardless of the state of any other input. If this input is left open it will default LOW.

3.2.6 Fault Indicator Output

This TTL level compatible latched output is capable of sourcing or sinking up to 50mA. However, it is recommended for best reliability to limit the source and sink currents to 10mA max. This output is not short circuit safe to either rail. The output will be HIGH if either of the two fault types has gone TRUE since the last reset or power up. The latch can be reset by setting Enable/Disable LOW. Note that if the fault has not gone away (applies mostly to temperature due to its slow response), the output may oscillate while the Enable/Disable is LOW. This response is typical of a set/reset latch when both the set and reset are active simultaneously.

3.2.7 Ground

The grounds in the signal connector should be used to reference all analog signals. Use of the power ground for reference will result in coupling the drops due to current drain to the input of the device. This will at least cause errors in the driver current level. At worst, the driver may self oscillate from the feedback.

3.3 Controls

3.3.1 Current Limit Adjustment Pot

The current limit adjustment pot is used to set the current level at which the driver will shut down and issue a current fault. It has an adjustment range of from near zero to slightly higher than 20A. As received, the pot will be factory set to fault between 20A and 20.4A.

For the location of the pot see Figure 4. For the adjustment procedure see 4.10.

3.3.2 Laser Bias Adjustment Pot

For the best pulse response, the laser needs to be biased with a small current. Each of the four drivers needs to have some current in it. Failure to bias the drivers positive will result in the op amps being saturated negative. The slow recovery from saturation when commanded for current will cause a long delay followed by discrete steps on the rising edge. Consequently, negative or zero bias is only useful for Continuous Wave (CW) applications where the shape of the rising edge is unimportant. The factory setting for the bias is just sufficient to obtain positive current in all four drivers. The current setting for each unit is recorded on the test data sheet.

For the location of the pot see Figure 4.

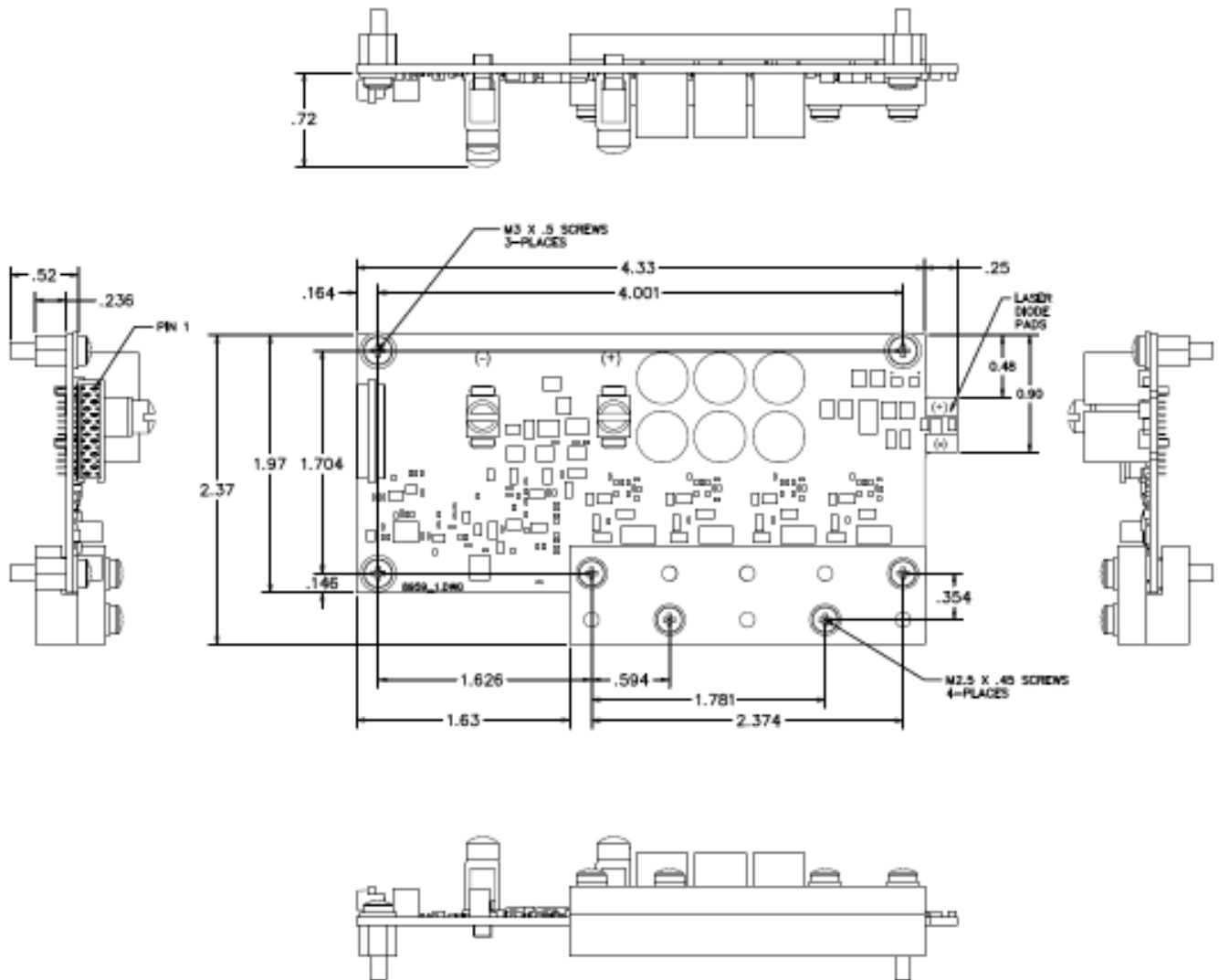Should readjustment of the bias level be required or a different setting is needed, see 4.11

Figure 4: PCB Drawing
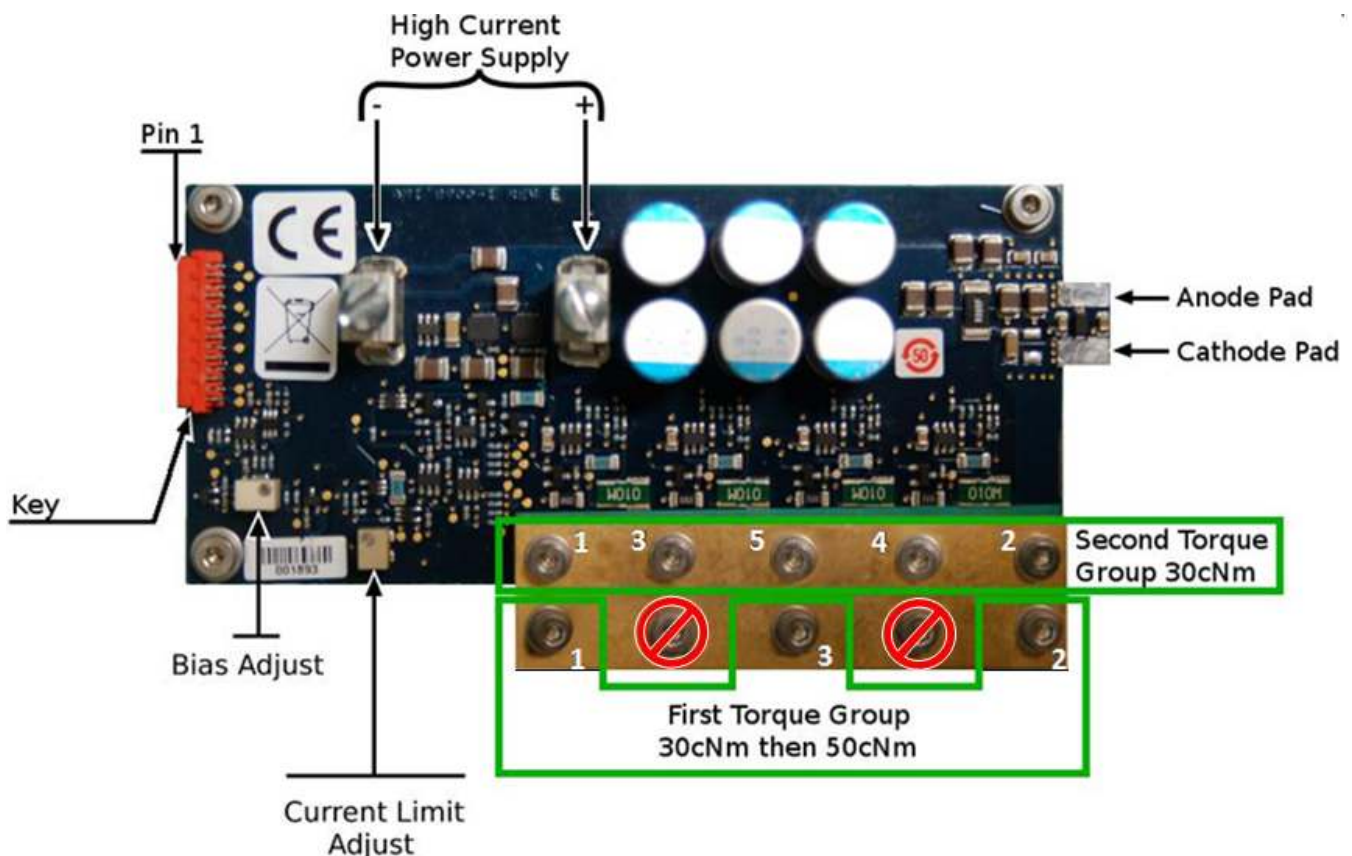
Figure 5: Mechanical Outline Drawing

4 Using the Driver

Warning: The optical output of this laser system is of such a power to represent a significant hazard. It has the potential to produce severe skin and eye damage. DO NOT enable the driver unless the optical output is under control (somewhere where the optical output will not damage personnel or equipment). Make certain all required safety devices are employed and functional. The responsibility for safe operation lies with the user.

4.1 Matching the Driver to the Application

The first item of information needed is the laser voltage drop at the planned maximum current. The laser power supply should be 1-5V above the laser drop.

The low end of the range gives better efficiency in the driver and allows minimizing the power supply requirements. Use this end of the range if rise times >1µs are not a problem.

The high end of the range will give the shortest rise times. How high the voltage needs to be for best performance is a function of the wiring length and any inductance reducing techniques which are used in the laser hook up. Using voltages higher than necessary will waste power.

Determine the maximum current to be applied and the duty cycle for pulsed applications. Arbitrary waveforms should be treated as Quasi-Continuous Wave (QCW) (duty cycle =1). Use the following equation to determine the max power dissipation of the application:

$$P = (dutycycle) \times (LaserSupply - LaserDrop) \times (PeakCurrent)$$

The thermal resistance from the FET junction to the mounting surface is approximately 0.525 deg./Watt, including the thermal pad. Use this figure, the power, and the ambient conditions to determine the required heat sink and cooling method. Use of some safety factor would be wise to cover aging and cooling system efficiency factors (such as clogging of air filter, low water level, etc).

If the power is >125W, the assembly will benefit from preconditioning. Heat the assembly to 70-80°C. Re-torque all of the screws to their final values including the two screws with the ø sign in Figure 4 while the assembly is still hot. Two of the insulators are phase change pads. Performing this preconditioning will melt the pads and allow the screw pressure to force out some of the material and at the same time increase the wetting to the heat sink. The result will be a reduction in the junction temperature of up to 15°C

4.2 Power On

It is best to keep the laser power off until after the driver power has stabilized. Considerable effort has been expended to avoid transient light output at turn on and off under any circumstance where light would not be emitted during steady state operation. It is, however, recommended that the Enable/Disable and Drive Control inputs be kept LOW at turn on. Allow a full second for the on board power supplies to start up and stabilize before commanding action.

4.3 Enable

Raise the Enable/Disable input to the HIGH state. The driver will require 100ns to become fully operational after the Enable/Disable signal rises. There are no restrictions on any other signal states. The driver can be enabled at any time.

4.4 Disable

Lower the Enable/Disable input to the LOW state. The driver will require 170ns to completely disable. There are no restrictions on any other signal states. The driver can be disabled at any time.

4.5 Quasi-Continuous Wave (QCW) Mode

Normally this would be accomplished by setting a small bias current, holding Pulse Input HIGH and setting the desired Continuous Wave (CW) current with the Drive Control.

4.5.1 Drive Control Setting

Set the Drive Control input voltage to the desired current according to the following formula:

$$V = A/4.0$$

Where: V is the Drive Control input voltage and A is the desired current. The laser current will require a maximum of 1µS to respond to a new value.

Note: This current will only flow in the laser when the Pulse Input is HIGH. The laser current will equal the programmed current plus the bias current.

4.6 Pulsed Operation

Pulsed operation can be accomplished in two ways. Both will have similar pulse characteristics.

4.6.1 Modulation with Drive Control

In this mode the Pulse Input is held HIGH. The Drive Control input is pulsed from 0V to ((desired_HIGH_current) - (bias_current))/4V. The rise and fall time will be the slower of 1µs or the rise time of the source.

4.6.2 Modulation with the Pulse Source

In this mode the HIGH current level is set on the Drive Control input ((desired_HIGH_current) - bias_current))/4V and the Pulse Source is switched to form the pulses. In this mode the rise and fall times will be 1µS maximum unaffected by the Pulse Source signal characteristics.

4.7 Arbitrary Waveform Creation

To create and arbitrary waveform, set the bias current to a low level (100mA or so). Set the Pulse Source HIGH. Rapidly set the Drive Control incrementally or use a continuously varying analog signal to control the envelope of the waveform. Note: if using digital control, waveform slopes may display a "stair step" effect if the resolution and or speed are not sufficient. The current will step from point to point in less than 1µS.

4.8 Mixed Modes

The driver places no restrictions on the manipulation of the inputs. Any signal can be changed at any time, and the unit will respond within the speed and amplitude constraints of each signal. Signals containing both amplitude and pulse position, pulse width, frequency or phase modulation can be created.

4.9 Auxiliary Signals

There are two auxiliary outputs on the driver to monitor the status of the device. Use of these signals is discretionary. A description of each follows.

4.9.1 The Current Monitor Output

For electrical specifications for this signal see 3.2.2. This output is a direct representation of the current in the laser. The signal responds to all signals which affect laser current. The delay in response is about 50ns. With this large phase delay it would be difficult to use the signal to produce an analog closed loop current control, so this is not recommended.

4.9.2 The Fault Output

Latching of the fault output can result from two causes. The fault system's primary function is to protect the laser first and then the driver.

A fault generally results from one of the following causes:

1. User error (current set too high, failure to turn on cooling system, incorrect setting of current limit or wiring problem with laser and/or driver signals). This will usually occur during system development or testing.

2. Component failure or drift in settings or values(aging). Generally occurs after long field life.

3. Cooling system failure. Base plate temperature must be held below 40°C.

4. Unit overheats. Should not happen if the unit is properly mounted, the cooling system is properly designed/specified and the driver dissipation is ≤155W. See 2.2

5. Noise. False fault from system (including host) noise. Should be very rare.

Except for item 5 above, a fault means there is something wrong. There is only a single fault output, so it cannot differentiate the source. In general, current faults can be reset immediately. If the current is set to 0 and the fault repeats immediately, then it will usually be a thermal fault. Wait 1 minute and try to reset again. If unit resets, it was thermal and needed to cool down some. If not, it is probably a component failure. If it resets immediately, set the current to a low value (1-2A). If it faults again immediately, it is a defective component. This is the extent of troubleshooting which can be done without test equipment.

Repeated faults over a long period can be the result of component or setting drift, or a marginal cooling situation (blocked air filter, clogged cooling fins, etc.). It is best to find and correct the problem rather than to repeatedly reset.

4.9.3 Resetting a Fault

To reset the fault, set the Enable/Disable input to LOW (Disabled). If the fault condition has cleared, normal operation should resume when the driver is re-enabled.

4.10 Setting the Current Limit Trip Point

4.10.1 Factory Setting

The trip point is set at the factory to between 20A and 20.4A. If this is not satisfactory or has been disturbed, proceed with the process described below.

4.10.2 Adjustment Procedure

1. Set then Current Limit adjustment pot fully counter-clockwise. (See 3.2)

2. Set up the driver for pulsed output (See 4.6) with the HIGH level equal to the desired trip point.

3. Monitor one of these signals with scope or meter: Current Monitor or Fault Output.

4. SLOWLY adjust the pot clockwise. Stop immediately when one of the following happens: Current Monitor output drops, Fault output goes HIGH.

5. Lower the current by 100ma. Tap pot several times to settle the wiper.

6. Reset fault (See 4.9.3)

7. Incrementally increase current. Verify the setting where the driver faults. If current is satisfactory, adjustment is complete. If not, repeat process from step 2.

4.11 Setting the Laser Bias

4.11.1 Factory Setting

The factory setting is listed on the unit test data sheet supplied with the unit.

4.11.2 Duplicating the Factory Setting

If the test data sheet has been lost or separated from the unit, use the procedure below. Otherwise, read the current level from the data sheet and use the procedure from the next subsection.

1. Set the unit up for pulsed operation, with a 100µs pulse width.

2. Rotate the bias pot fully counterclockwise.

3. Observe the driver output on an oscilloscope connected to the current monitor output.

4. The pulse on the scope should have a number of stair steps on the leading edge.

5. Rotate the pot clockwise until all of the stair steps have disappeared.

6. Rotate the pot clockwise an additional 1/8 turn.

7. Tap the pot several time to stress relieve. If none of the steps return the adjustment is finished.

4.11.3 Setting to a Fixed Current

1. Set up unit for Continuous Wave (CW) operation. Enable, but keep the pulse input at the LOW level.

2. Rotate the bias pot fully counterclockwise.

3. Observe the driver output with a DC voltmeter connected to the current monitor output.

4. Read the voltage and be sure to note sign.

5. Calculate the required reading from the following equation:

0.25 x Current in Amps + Voltage from Step 4

6. Adjust the pot clockwise to obtain the calculated value on the meter.

7. Tap the pot several time to stress relieve. If reading on meter is satisfactory the adjustment is finished.

It is not uncommon for a pot to stress relieve after adjustment. This is the reason for the tapping in the above procedure. As the adjustment direction is CW, the stress relief will usually move the wiper CCW or to a lower bias current setting. If this is problematic, pre-adjust the initial current to a slightly higher value. After de-stressing the adjustment will be closer to the desired value.