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TITLE
**OPERATING MANUAL, DIODE DRIVER
 MODEL 766**

ANGULAR X = N/A	SCALE N / A	SIZE A	FSCM 61651	SHEET 1 OF 17	DRAWING NUMBER	14-071	REV. A
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1.0 Overview

The 766 laser diode driver is a medium power, short pulse, diode driver. It is designed to be driven by two digital signals. It has a single status output which is compatible with most logic devices.

1.1 Description

The driver has 6 basic subsystems. Refer to [Figure 1](#).

1. The high voltage power supply.
2. The high voltage pulse generator.
3. The pulse shaping circuits.
4. The enabling system.
5. The triggering system.
6. The TEC controller system.

1.1.1 The High Voltage Power Supply

The high voltage power supply is a standard switching topology, adjustable supply. It is adjustable from 50 to 250V. The supply has been developed to have exceptionally low over and undershoot due to step load changes. The supply can provide up to 10W output power. The power supply output is controlled by the enable signal. Its start-up is staggered with the TEC Controller to reduce inrush current during power on. The output current is monitored and should it exceed 33mA, will cause a shut down. The Temperature Fault line will be driven low. This fault is only produced by repetition rate in excess of specification.

1.1.2 The High Voltage Pulse Generator

The high voltage pulse generator consists of two power FETs, a charge storage capacitor, and associated driving circuits. The output is a pulse of 3 to 4ns FWHM and approx. 2/3 the high voltage power supply setting. The circuit discharges the cap and then recharges it once per trigger event. A bleed resistor maintains the charge when the circuit is not being triggered.

1.1.3 Pulse Shaping Circuits

The pulse shaping circuits are a proprietary system of active and passive components designed to handle the following functions:

1. Optimize the source impedance of the driver as seen by the laser diode.
2. Speed up and narrow the pulse from the high voltage pulse generator.
3. Attenuate the ring current to prevent voltage reversal across the intrinsic laser diode. Voltage reversal does occur across the laser diode package parasitics.
4. Prevent the occurrence of a second, third, etc. follow on pulses.

1.1.4 The Enabling System

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

1. Implement the Boolean function: $\text{Enable_out} = \text{Enable_in} \text{ AND NOT}(\text{Temperature Fault})$.
2. Level shift the signals to perform their functions.
3. Reset Temperature Faults caused by excessive repetition rates.

Its output enables/inhibits both the driver and the high voltage power supply.

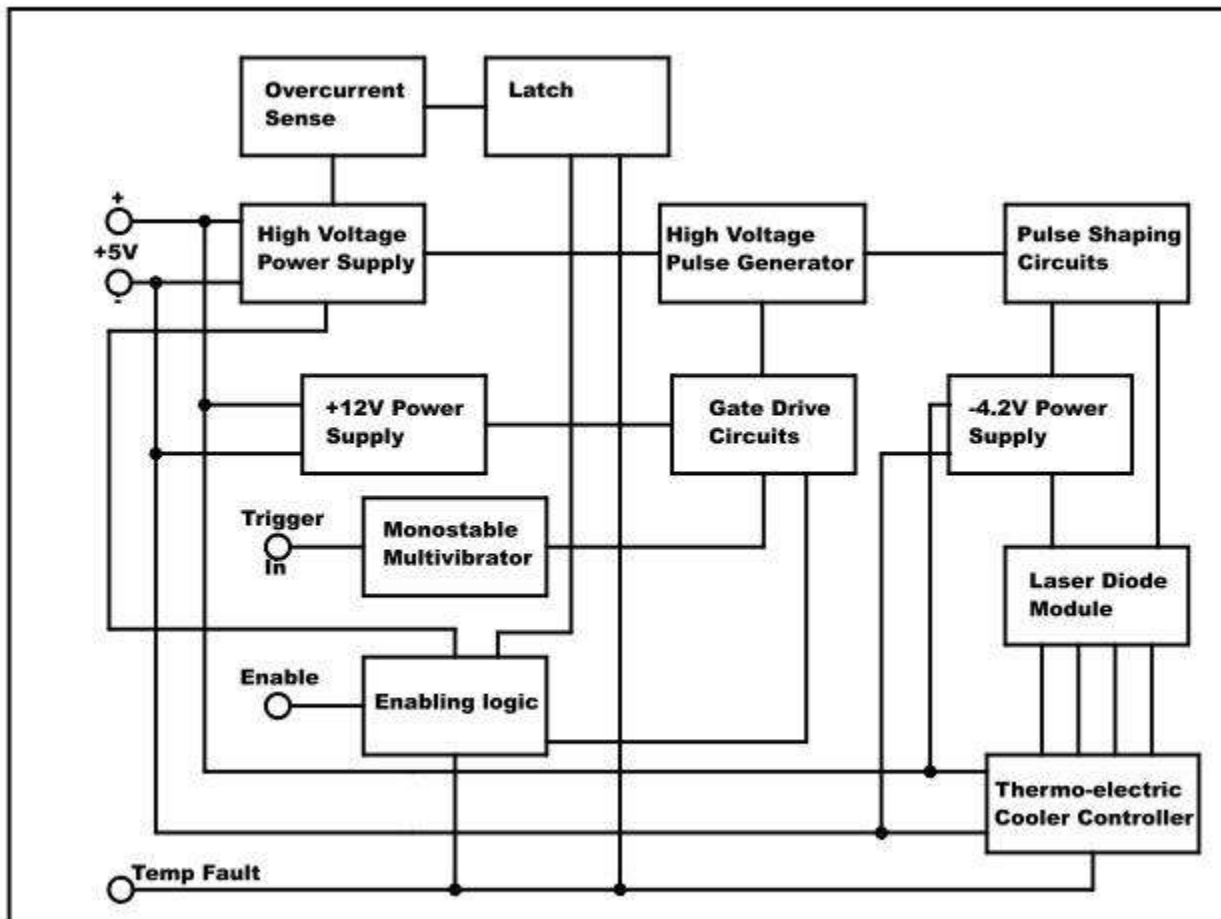
1.1.5 The Triggering System

This subsystem establishes the input impedance and normalizes the trigger pulse. The trigger takes place on the rising edge of the trigger pulse. The monostable produces the correct width of pulse to initiate system functions on both the leading and trailing edges.

1.1.6 The TEC Controller System

The TEC controller is a commercial dual switching regulator type. It is capable of supplying up to 4V and $\pm 3A$ of current. There is an over and under temperature flag with a window of approx. 1°C . This flag is wire OR'ed to the HV power supplies over current signal to produce the temperature fault output. When faulted, the driver will be internally inhibited as will the HV power supply. When the temperature fault is generated by the TEC controller, it will self clear as soon as the laser temperature is within the window

Figure 1: Block Diagram



2.0 Handling

2.1 Storage, Packaging, etc.

2.1.1 General

1. The driver is a static sensitive electronic assembly. All normal anti-static precautions apply.
2. When packaging for shipment, the back side of the PCB may lie in contact with the packaging material.
3. When packaging for shipment, if a laser is attached, the packaging material should be kept away from the laser on both sides of the board. The fiber should be stabilized separately next to the board by taping to a carrier of foam or cardboard, and securing that so that it can't move.

2.2 Safety

2.2.1 Personal Safety

Observe proper laser source safety restrictions. These drivers produce only nanojoules of energy in each pulse. However, the accumulated power of a large number of pulses can produce eye or skin damage especially as we have no control over the wavelength of the laser used, or any light amplifying equipment to which it may be connected.

When working with fibered lasers, make sure to keep any pieces or trimmings of the fiber policed up. Dispose of them safely. These can be very dangerous if they pierce the skin, are inhaled or ingested.

When operating, the driver can have up to 250VDC on some components. . **DO NOT TOUCH THE DRIVER WHILE IT IS OPERATING. DISABLE AND WAIT AT LEAST 2 SECONDS FOR THE HIGH VOLTAGE TO BLEED DOWN BEFORE TOUCHING THE UNIT.**

2.2.2 Driver and Laser Safety

Many components in the driver operate at intermittent voltages near breakdown. **DO NOT PROBE THE DRIVER WITH AN OSCILLOSCOPE OR METER. THE CHANGE IN LOAD CAUSE BY THE CAPACITANCE AND INDUCTANCE OF THE PROBES WILL CAUSE A CHANGE IN OPERATING CHARACTERISTICS AND CAN CAUSE DAMAGE TO THE LASER OR THE DRIVER.**

The exception to this is the temperature set test point which can be probed at any time. The driver and laser diode are static sensitive devices. Observe static precautions at all times.

Avoid applying force to the PCB when mounted with the laser. Board flex in the laser cutout can create sufficient force on the laser package leads to damage the laser or the pads to which it is soldered.

2.3 Mounting the Driver

Note: See Section on laser mounting to determine whether mounting plate should be used. If so, the following section on site selection applies to the host, but the mounting instructions apply to the plate. The plate may be modified as needed for mounting in the host system. It is also effective to substitute longer screws (not supplied) for the PCB mounting screws, and then use nuts and washers on the protruding ends to join the assembly to the host.

2.3.1 Site Selection

If convection cooling is to be used, the most favored position is vertical. The driver should be mounted at least ¼" away from corners to allow free air circulation to the back side of the PCB.

If fan cooling is to be used the air should be ducted or baffled to flow both over the top and behind the PCB or the unit and fan location should be chosen to allow this to occur naturally.

2.3.2 EMI

The generation of picosecond switching times on high voltages inevitably leads to production of EMI. Consideration of this should be given in selecting a mounting position. Mounting near low voltage logic such as a gate array or microprocessor may cause erratic operation. Fast analog circuitry can also be affected. The following items should be considered when the driver is to be used in an OEM capacity:

1. Application of shielding or compartmentalization.
2. Use of grounded cases of other items such as power supplies, to shield the driver from the sensitive circuitry.
3. Mounting the driver so that the back of the PCB faces the sensitive circuitry.
4. Mounting the driver in a shared shielded area with other EMI producing items.

2.3.3 Materials Required

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

1. The Driver
2. 4 #4-40 X .312" machine screws
3. 4 Washers for above
4. 4 #4 X .125" spacers.
5. Thread locking compound Loctite 222 or equivalent.

2.3.4 Procedure

Note: If long screws are being used, it is better to put the Loctite on the screws just below the standoff length.

1. Place a drop of Loctite in each mounting hole.
2. Place the mounting screws with washers into two of the holes at the same end of the board, not diagonal. Slip the standoffs onto the screws. Align with their appropriate mounting holes. Screw in only 2 turns.
3. Insert the other screw/washer assemblies into the remaining mounting holes. Add the standoffs as the screws are being inserted.
4. Tighten all the screws only to the point where the board can be repositioned easily.

2.4 Mounting the Laser

2.4.1 General

In order to maximally reduce the stress on the laser leads, which must be kept short, the laser leads should be soldered after both the laser and the driver are bolted into their final positions.

If the mounting site is satisfactory, but using a separate mounting plate is not desirable, an assembly fixture can be used to preassemble the laser to the board. Such a fixture must not only assure that the mounting holes will be sufficiently well aligned to result in no twisting or stretching of the assembly when mounted in the host, but also that the vertical location of the laser relative to the board will be within .001" (.025mm) of its position when mounted in the host. Otherwise, the assembly will not be reliable in use.

The laser diode case must not be grounded. The capacitance to ground should not exceed 3pf. If these conditions are not met additional ringing and possibly multiple pulses may be generated. A resistor is included in the circuit to damp the package parasitics. AC or DC grounding of the package will bypass the resistor.

2.4.2 Trimming the Leads

Trim all leads to .080" \pm .005" measured from the ceramic plate to which the leads are brazed. Be sure to cut square to lead. Shearing type cutters produce better results than pinch off cutters.

2.4.3 Mounting

The laser diode must be attached to a heatsink for the TEC to maintain the diode operating temperature. The power contributed by the pulse action is negligible, but as the efficiency of thermoelectric cooling decreases rapidly as the hot side temperature is increased, the maximum rise in the heat sink must be limited to 20°C to allow operation at +50°C ambient. The preceding assumes a laser diode operating temperature of +25°C. The figures would need to be adjusted for other operating

temperatures either diode, or ambient. Thermoelectric heating is 100% efficient, so that in situations where the laser would be always heated, no heat sink would be required.

If for any reason the laser diode temperature control is not used, no heat sink will be required.

When heat sinking, a thermal interface material must be used between the laser package and the mounting surface. A relatively thick insulator should be used to limit the capacitance to ground.

2.4.4 Materials Required

1. The laser diode with trimmed leads.
2. Thermal pads should be used.
3. 4ea. #2-56 X .187" machine screws
4. 4ea. washers for above
5. Thread locking compound Loctite 222 or equivalent.

2.4.5 Procedure

1. Apply thermal pad to the mounting surface.
2. Place a drop of thread locking compound in each threaded laser mounting hole.
3. Assemble a washer on one of the screws. Place through a laser diode hole. Insert the laser/screw assembly through the cutout in the driver PCB observing the direction of the fiber cutout. Thread screw into the mounting hole just sufficient to retain laser.
4. Assemble the other three screw/washer pairs. Insert and loosely thread.
5. Tighten all laser diode mounting screws to the specifications of the laser/thermal material manufacturer.
6. Move the driver PCB around to obtain exact alignment between the laser diode leads and the PCB pad pattern.
7. Tighten the board retaining screws to 3 in-oz.
8. Carefully examine the distance between the bottom of the leads and the PCB pads. If greater than .003" (estimate is OK), with a suitable tool, press down on the extreme tip of the lead to reduce the gap. Do not attempt to make the lead lie flat on the pad. A broken laser will result. It is sufficient that the tip of the lead be close to the pad.

2.4.6 Soldering

Solder the pins to the corresponding exposed pads with a solder alloy compliant to the ROHS specification. During soldering DO NOT apply any pressure to the board, or the laser leads. The joints must solidify stress free.

3.0 Electrical Specifications and Requirements

3.1 Interface

3.1.1 Connectors

The power is connected via 1 Molex 3.5mm pitch 2 pin terminal block, see [Figure 1](#) for polarity assignment.

The trigger signal is connected through a single right angle MMCX coaxial socket. A matching cable is supplied with the driver.

The balance of the input and output signals are connected via 1 - 8 pin TE Connectivity MicroMatch Connector 188275-8. A matching cable is supplied with the driver.

3.1.2 Signals on the I/O Connector

Table 3.1: I/O Connector Pin Out

Pin	Signal
1	Enable Input 3.1.5 Enable Input
2	Ground 3.1.7 Ground
3	Temperature Fault 3.1.6 Temperature Fault
4	Ground
5	Reserved - N/C
6	Ground
7	Reserved - N/C
8	Ground

3.1.3 The Trigger Signal

The trigger input impedance is 50 Ohms.

1. The input pulse "Zero" level must be below 1.35V.
2. The input pulse "One" level must be greater than 3.85V.
3. The minimum pulse width for triggering is 10ns.
4. The maximum pulse width is 0.8 times the pulse spacing.
5. The minimum trigger spacing is 1uS.
6. There is no maximum trigger spacing.

Within the listed rules, pulse timing can be totally arbitrary. One output pulse will be produced for each trigger pulse rising edge.

There are no specific requirements for the pulse rise and fall times. The fall time is inconsequential. The optical pulse timing jitter will improve with reducing rise time of the trigger pulse down to approx. 1ns.

From 0 to 100KHz there is little change in optical amplitude and a small change in width. From 100KHz to 1MHz, the pulse width will narrow and the amplitude fall. If you will be operating at high rep rates, it is recommended that you set the high rate and then adjust the pulse to suit.

3.1.4 Input Power

The driver is designed to operate from a DC current source of +5V \pm 0.25V at 2.5A maximum current. It is recommended that the power source ripple be less than 100mV at full current.

The TEC controller and the high voltage power supply both have significant inrush current, the TEC controller at power up and the high voltage supply at the time of enabling. Should the source voltage dip too far, neither circuit will start properly. It is recommended that a wire gauge of #20 as a minimum should be used to connect the power, if the runs are short (<4"). For longer runs, up to #16 gauge may be used limited by the maximum wire size the terminal block will accept.

3.1.5 Enable Input

This is a TTL voltage level compatible active low input. The input will tolerate -0.5V to 5.5V. The input impedance is 4.75K to +5V. The input can also be driven by open or short to ground, 5V CMOS, 3.3V CMOS, open collector or drain transistor. When this signal is HIGH the laser and the high voltage power supply will be disabled. When LOW, the power supply and the driver circuits will be enabled. If this input is left open it will default HIGH (Disabled).

If operating from 3.3V CMOS, a 6.8K resistor should be connected from the input to ground to prevent the high level from exceeding the 3.3V rail.

3.1.6 Temperature Fault

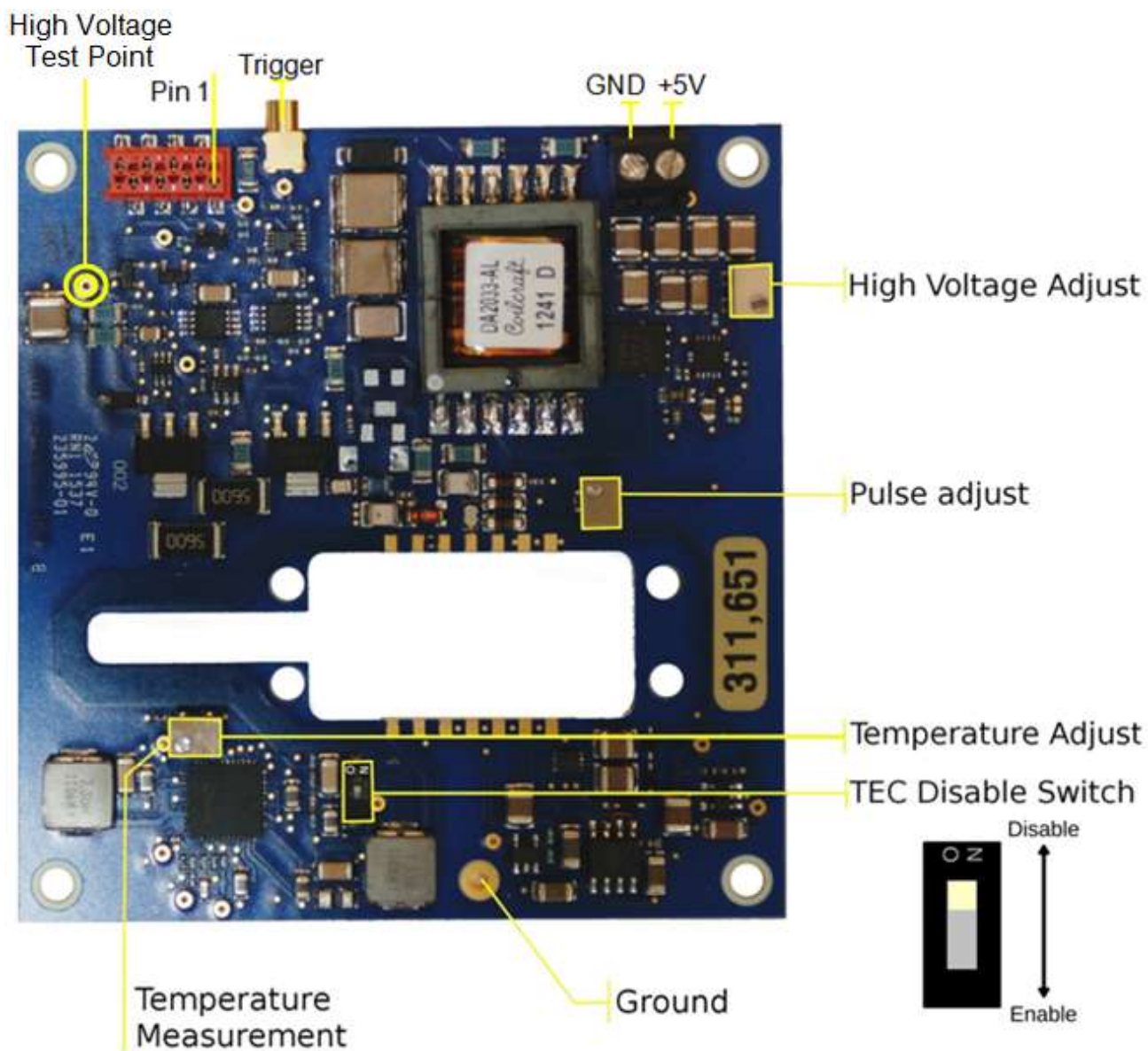
This is an active low, open drain output with 4.75K pull up resistance. The output will be high during normal operation. It will be pulled low if the laser is greater than 1°C high or low of the set point, or if excessive current is being drawn from the HV power supply. When low, the driver will be internally disabled, until the temperature stabilizes in the window.

Use of this signal is discretionary. If set by the HV power supply, it must be reset by cycling the 5V source or the Enable line after correcting the repetition rate. It is capable of driving TTL, 3.3 and 5V CMOS, sensitive relays, transistors, FETs, and LEDs. If the signal is used to drive 3.3V CMOS, a 6.8K resistor to ground should be added to prevent over voltage on the CMOS input. The maximum sink load should be limited to 25mA.

3.1.7 Ground

The grounds in the signal connector should be used to reference all analog signals.

Figure 2: Printed Circuit Board



3.2 Controls

3.2.1 High Voltage Adjustment Pot

The high voltage adjustment pot will be set between 150V and 200V at the factory during test. It is adjustable over a range of about 75 to 230V. In general, lower voltages will result in narrower pulses with lower power. Higher voltages lead to wider pulses and higher power. The voltage can be measured at the high voltage test point. See [Figure 2: Printed Circuit Board](#). Setting the voltage to very low values may not respond as expected. Recommended range is 150V to 200V. The test point scale is 26mV/V.

3.2.2 Pulse Shaping Bias Adjust Pot

This adjustment is set to minimum at the factory. Adjust this pot as desired to set the pulse width.

3.2.3 Laser Temperature Adjustment Pot

The laser temperature pot may be adjusted between -5 and +60°C. See temperature set instructions [4.5 Setting the Laser Diode Temperature](#).

3.2.4 TEC Disable Switch

In some situations, it may be desirable to operate the laser without benefit of temperature stabilization. Additionally, there are some devices which do not have a thermoelectric cooler in the package. In either of these situations the TEC controller must be turned off. There is a small switch on the driver for this purpose. See [Figure 2: Printed Circuit Board](#).

4 Using the Driver

4.1 Power On

As there is only a single supply, there is no power up sequence for this driver. It is recommended that the Enable input be kept open or HIGH and Trigger 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. The high voltage supply is initialized, but disabled at power on.

4.2 Enable

Set the Enable input to LOW state. The driver will require 10ms to become fully operational after the Enable signal falls. During this time the high voltage supply charges the energy storage capacitor for the first time. There are no restrictions on Trigger state. However, if triggered during the high voltage power supply rise time, the pulses generated will have a reduction in amplitude or missing. The driver

can be enabled at any time.

4.3 Disable

Raise or open circuit the Enable input to disable. The driver will require 2 seconds to completely disable. During this time the high voltage is drained from all circuits. There are no restrictions on the Trigger input. The driver can be disabled at any time.

4.4 Pulsed Operation

1. Apply power per specification. See power specifications [3.1.4 Input Power](#).
2. Enable driver. See Enable signal requirements [3.1.5 Enable Input](#).
3. Apply trigger pulses. See trigger pulse requirements [3.1.3 The Trigger Signal](#).
4. Adjust pulse width if desired.

4.4.1 Setting the Pulse Width

1. Set up whatever test equipment will be required to measure the parameter to be optimized by adjusting the pulse width of the optical output.
2. Connect the optical output to the system and test equipment.
3. Power up the driver.
4. Enable the driver.
5. Input trigger pulses at the rep rate to be used after adjustment.

While monitoring the test equipment, adjust the pulse width to the desired value by turning the Pulse Adjust potentiometer. Clockwise increases pulse width and power. See [Figure 2: Printed Circuit Board](#).

Should the adjustment be at the end of the range some additional range can be obtained by adjusting the high voltage.

4.5 Setting the Laser Diode Temperature

The industry standard for the thermistor in the diode package is an NTC thermistor with a value of 10K @+25°C. If your laser has a different value it will not work correctly with this controller set up (Consult Factory for options).

Even though the nominal value of the thermistor is the same, different manufactures have similar, but not identical curves. If you wish to set the temperature to a value different than 25°C, a table of resistance vs. temperature will be required for the laser diode in question.

The temperature can also be set using the output wavelength as a basis.

4.5.1 Factory Setting

The factory setting will produce an operating temperature of $+25^{\circ}\text{C} \pm 1^{\circ}\text{C}$ for any 10K thermistor.

4.5.2 Adjustment Procedure

For setting by temperature:

Note: It is recommended that this procedure be performed with the driver disabled.

1. Look up desired temperature in the resistance/temperature table.
2. Apply the following Equation to obtain a test point voltage value.

$$V_{SET} = \frac{1.5 * R_{th}}{(R_{th} + 10000)}$$

3. Turn on the driver and wait for stabilization.
4. Connect a voltmeter from the Ground test point to the Temperature Measurement point. See [Figure 2: Printed Circuit Board](#).
5. Adjust the Temperature Adjust potentiometer for the desired voltage.

For setting by wavelength:

Note: Since this is an active adjustment the driver must be operating. The operator's attention will be on another instrument. Please heed the following precautions:

- Use a commercial or fabricated plastic bodied adjustment tool. A ceramic or plastic tip is best, but metal can be used. If the bare metal is longer than 1/8", cover the balance with tubing, tape, or other insulating material. If the tool has a metal clip remove it. If the tool is accidentally dropped into the driver or the operator touches a high voltage point with the tip, the probability of damage to the laser, the driver, or the operator is greatly reduced or eliminated completely with a ceramic or plastic tip.
- Keep track of what the free hand is doing to avoid accidental contact with the high voltage while the operator's attention is focused elsewhere.
- Have someone evaluate the safety of the location with the above in mind. In addition examine any additional hazards which the operator must avoid. Rearrange the workstation, if necessary to remove sources of distraction. If any part of the body will (or can) be in contact with ground, insulate the hands and arms with safety gloves. A single point contact with the high voltage is unpleasant. Connecting the operator across the high voltage and ground is damaging.
- Train the operator that if anything unusual happens, such as dropping the adjustment tool, to disable the driver or turn off power and wait 2 seconds before trying to retrieve the tool or correct for the event.

1. Set up whatever test equipment will be required to measure the parameter to be optimized by adjusting the wavelength of the optical output.
2. Connect the optical output to the system and test equipment.
3. Power up the driver.
4. Enable the driver.
5. Input trigger pulses as needed.
6. While monitoring the parameter to be optimized, slowly adjust the Temperature Adjust pot (See: [Figure 2: Printed Circuit Board](#)) to achieve the best response.