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OPERATING MANUAL,
MODEL 767

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1 Overview

The 767 laser diode driver is a medium power, short pulse, diode driver. It is designed to be driven by two digital signals.

1.1 Description

The driver has 5 basic subsystems. Refer to figure 1.1.

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.

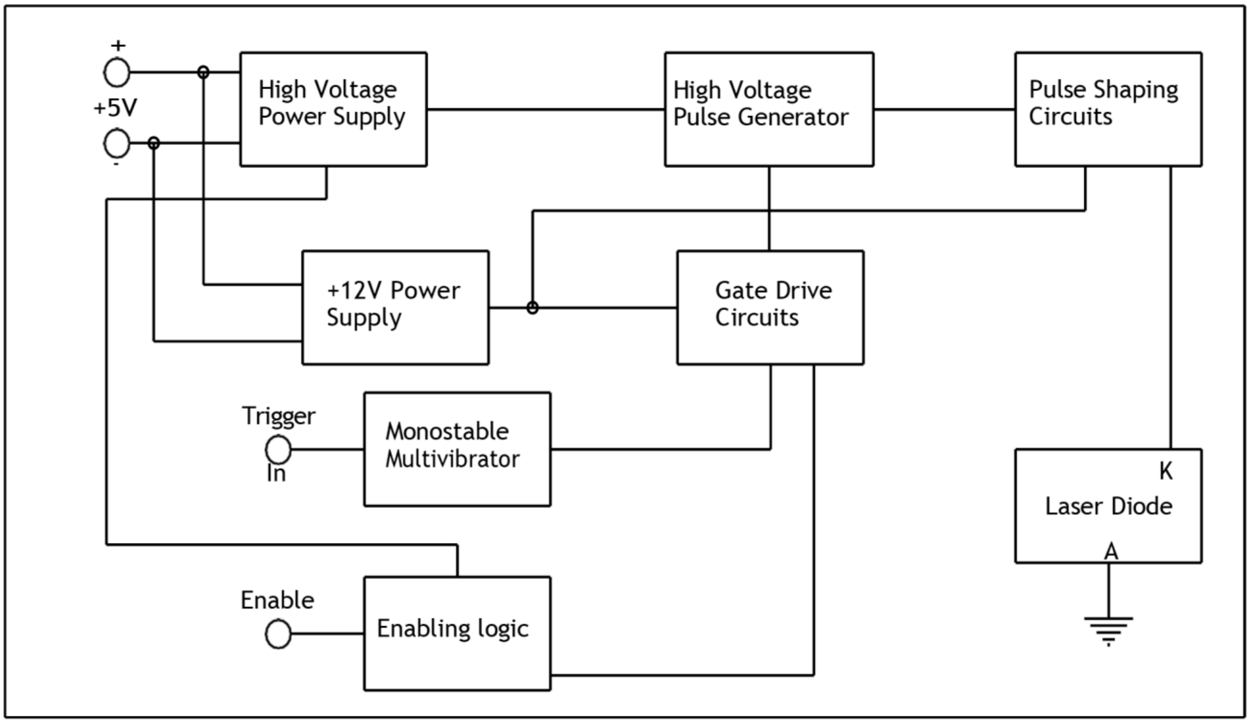

Figure 1.1 Block Diagram

1.1.1 The High Voltage Power Supply.

The high voltage power supply is a fixed 150V to 160V power supply with standard switching topology. 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.

1.1.2 The High Voltage Pulse Generator

The high voltage pulse generator consists of a p-channel MOSFET, used to charge a storage cap, a GaNFET for discharging the cap and associated driving circuits. The output is a pulse of 1.5 to 2ns FWHM, 800ps rise time and approximately 160V peak. The circuit discharges the cap and then recharges it once per trigger event. A bleed resistor maintains the state of charge when the circuit is being triggered at a low rate.

1.1.3 Pulse Shaping Circuits

The pulse shaping circuits are a proprietary system of active and passive components. The second stage performs the following functions:

1. Optimize the source impedance of the driver as seen by the laser diode.

2. Form a controlled current pulse of 5 to 10A with widths as narrow as 100ps from the stage 1 pulse. Much of the energy in this pulse is absorbed by the PCB and laser package parasitics.

3. Establish a control voltage (not current) reversal occurs across the laser diode. This gives a reduced fall time by rapidly discharging the laser 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. Level shifts the signals to perform their functions.

2. Shut down the high voltage power supply.

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. The trailing edge initiates storage cap charging.

2 Handling

2.1 During 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 fibered laser is installed, the fiber should be stabilized separately next to the board by taping to a carrier of foam or cardboard and securing so that it cannot move.

2.2 Safety

2.2.1 Personal Safety

Observe proper laser source safety restrictions. We are not responsible for any failure of the customer to observe safety precautions. 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 160VDC on some components. **DO NOT TOUCH THE DRIVER WHILE IT IS OPERATING. DISABLE AND WAIT AT LEAST 10 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 CAUSED 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 driver and laser diode are static sensitive devices. Always observe static precautions.

2.3 Mounting the Laser

2.3.1 General

The driver is designed to accept most TO type packaged lasers either mounted perpendicular to the board or end launched. There is no standard commercial pin out for these packages. They usually have either two or three pins. There are two sets of 4-hole patterns on the driver. See Fig. 2.3.2. One is for 5.6mm, TO-18 and similar packages. The other is for 9mm and similar packages.

Two pin packages are usually mounted to use a diagonal pair of holes with the diode rotated to put the diode cathode on the cathode pads. If the cathode is common with the case reduced (lower current, wider pulse) performance may be expected. When end launched, the cathode is always on top, but the anode should be connected on the reverse side of the board for improved mounting stability. Pin forming may be required.

Three pin packages have more variety in pin out. Again, if the cathode and case are common, there will be some loss of performance. It is possible to have a pin out that forces both the cathode and a case ground onto the cathode pad. This, of course, will hurt performance. It is possible to install these from the back of the board to alleviate the problem if that is acceptable. These parts can also be end launched without connecting the case to the cathode.

All lasers which are mounted perpendicular to the board should space the laser .01 to .03" above the board surface. Packages with the cathode connected to the case should be mounted up to .06" above the board to reduce cathode to anode capacitance. If vibration or shock is an issue, the laser package can be bonded to the board after mounting. Do not fill in the space around the pins, use package edges only. Do not use an RTV silicone which emits acetic acid during cure.

If end launching, case body should contact the end of the board. Additional reinforcement can be added, if required, as above.

Package	Pin Circle	Mounting Choices
3.8mm	1.5mm	Edge Launch Only
5.6mm	2.0mm	Front, Back, and Edge
9mm	2.5mm	Back and Edge
9.5mm	2.0mm	Back and Edge
TO-18	0.1in	Front, Back, and Edge
TO-5	0.2in	Back and Edge

Table 2.1: Package Options

Some surface mounted VCSEL packages may also be mounted. An exhaustive search and listing of types are beyond the scope of this document.

2.3.2 Materials and tools required.

1. The laser diode.
2. ROHS or non-ROHS solder with flux.
3. Soldering iron
4. Anti-static workstation
5. Flush cut pliers (Non- flush cut pliers will send a shock wave up the pin which may damage the hermetic seal.)
6. Finger cots

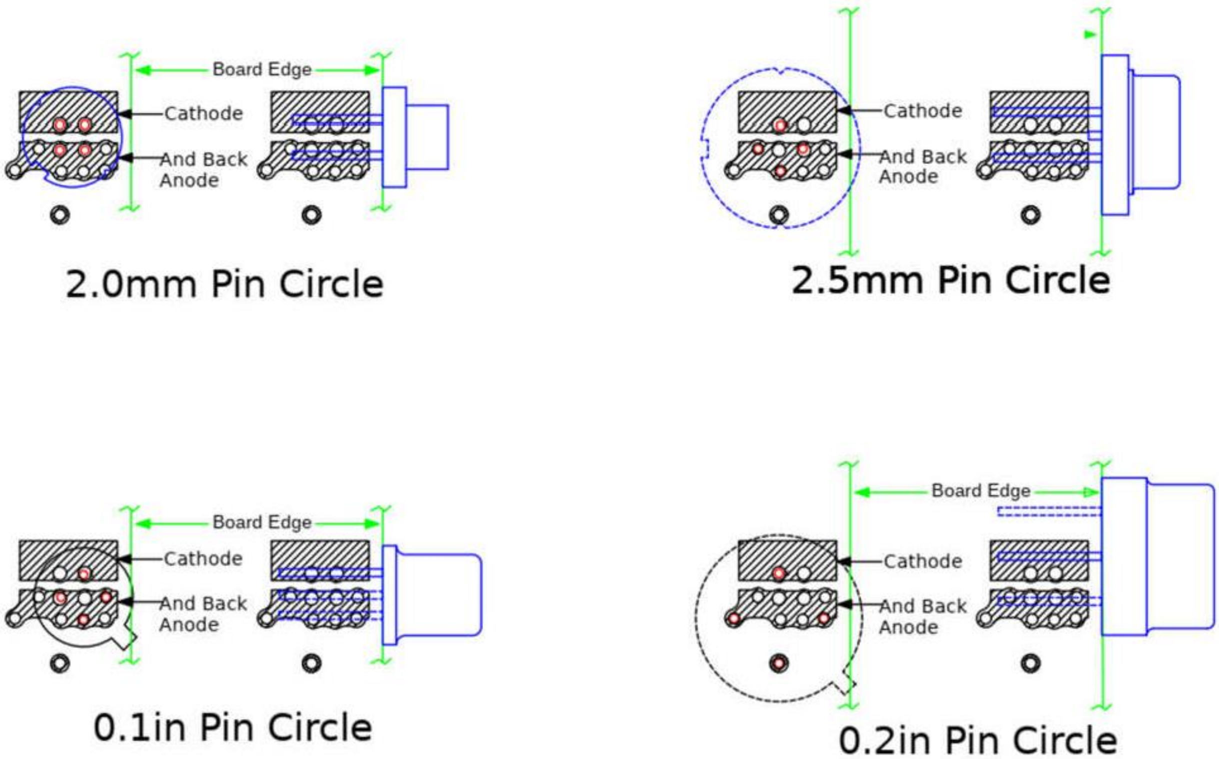

Figure 2.1: Hole Patterns and Connections

2.3.3 Procedure for perpendicular mounting

1. Determine from laser documentation, Table 2.1, and Package mounting figures above:

a) Which four-hole pattern should be used

b) What orientation is needed to accommodate the laser pin out.

2. Connect to Anti-Static Workstation. Apply finger cots to prevent fingerprints on laser window.

3. Slip laser leads through proper holes in the PCB based on the pin out.

4. Insert a spacing tool under the laser.

5. Hold laser snug against the tool. Cut leads approximately 1/32 from opposite side of board with flush cut towards the board.

6. Solder leads with glass seals.

7. Let go of laser. Solder case connected lead, if any.

8. Clean with appropriate cleaning procedure for type of flux used.

9. Make certain that the board and all components are completely dry before applying power.

2.3.4 Procedure for installing edge launch

1. Determine from laser documentation:

a) Which lead is the cathode. This lead must be on top. For two pin lasers, the second pin should be on the bottom of the board.

b) What orientation is needed to accommodate the laser pin out.

2. Connect to Anti-Static workstation. Apply finger cots to prevent fingerprints on laser window.

3. Trim and or form leads in accordance with para. 2.3.5

4. Slide laser into position on board. An assembly fixture may be needed if the position of the optical output is critical.

5. With laser snug against the end of the board, solder all leads. Solder the leads to as close to the package as practical. This will reduce the mounted inductance to a minimum, and thus give the best performance.

6. Clean with appropriate cleaning procedure for type of flux used.

7. Make certain that the board and all components are completely dry before applying power.

2.3.5 Trimming and/or forming the Leads

Trim all leads to .20 to .23" for edge launching. Shearing type cutters produce better results than pinch off cutters. Pinch off types send a shock up the lead which can damage the package seal. Flush cutting pliers with well mated edges will work if the flush cut side is toward the package. In this case all the shock is transferred to the cut off piece. Keep the cathode lead straight and form any backside leads. Do not form within 2 lead diameters of the glass meniscus.

When mounting perpendicular to the board, lead forming is not required.

2.3.6 Special considerations

Shock and vibration

If there is a significant shock or vibration specification on the host device, the laser should be staked to the board. This is especially true of two pin parts. Without staking a heavy environment will either pull the leads from the solder, or from the glass.

Fibered laser

If the laser has been fibered, irrespective of the vibration or shock, the fiber launching structure needs to be supported by a rigid bracket. The bob weight of the fibering structure is much too high for support by the soldered pins even in modest environments.

2.4 Mounting the Driver

2.4.1 Site Selection

The unit temperature will rise by 75°C when operating at 1MHz rep rate in relatively still air. This rise is a linear function of rep rate. There is little rise when unit is not being triggered.

The following instructions apply to obtain the best reliability when operating a maximum rep rate (1MHz).

In relatively still air, the host package should be ventilated sufficient to keep the internal air volume at or below 50°C.

If convection cooling is to be used, the most favored mounting position is vertical. Assuming the air flow is laminar around the driver, Air temperatures as high as 60°C can be tolerated. The driver should be mounted at least 0.25” away from corners to allow free air circulation to the back side of the PCB. The holes admitting the convection air should be located directly below the unit.

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. In these situations, the air flow is sufficiently high that the air temperature can be up to 75°C and still adequately cool the driver.

These recommendations apply to the driver itself; many lasers have reduced temperature specifications that will dominate the ambient temperature and cooling requirements.

2.4.2 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.

2.4.3 Materials Required

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

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

NOTE: M2.5 hardware may be substituted if metric hardware is desired.

2.4.4 Procedure

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.

3 Electrical Specifications and Requirements

3.1 Interface

3.1.1 Connectors

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

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

Pin	Signal
1	Enable Input 3.1.5
2	Ground 3.1.6
3	Ground 3.1.6
4	+5V Power 3.1.4
5	+5V Power 3.1.4
6	Ground 3.1.6
7	Spare
8	+5V Power 3.1.4

Table 3.1: I/O Connector Pin Out

3.1.2 The I/O Connector

3.1.3 The Trigger Signal

The trigger input impedance is AC above 3Mhz 50 Ohms, DC 2K.

1. The input pulse Zero level must be below 1.35V.
2. The input pulse One level must be greater than 3.7V.
3. The minimum pulse width for triggering is 10ns.
4. The maximum pulse width is 0.8 times the trigger spacing.
5. The minimum trigger spacing is 1µS.
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 approximately 1ns.

3.1.4 Input Power

The driver is designed to operate from a DC current source of +5V ±0.25V at 1A maximum current. It is recommended that the power source ripple be less than 100mV at full current.

The high voltage power supply has significant inrush current. The input capacitors charge at power up, but the high voltage supply startup surge is at time of enabling. Should the source voltage dip too far the high voltage supply will not start properly. All three +5V wires in the cable must be used. Similarly, all three ground leads must be used. It is recommended that the cable be limited to 18” or less. When setting up an OEM design be sure to consider power supply droop with 1A load.

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 C-MOS, 3.3V C-MOS, 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 C-MOS, 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 Ground

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

3.2 Controls

3.2.1 HV Pulse Rise Time Control Potentiometer

The potentiometer will affect both rise time and peak current of the output. For shortest output pulses, set to minimum.

3.2.2 Gate Length Adjustment Potentiometer (Main Pulse Width Adjustment)

This adjustment is used to establish the pulse energy. While the action of the circuit on the current pulse is simple and predicable, the effect on the optical pulse is more complex. The current pulse is sawtooth shaped, with the rise time and peak current established by the HV pulse shape. The position of the trailing edge in what would otherwise be a symmetrical shape is controlled by the gate. As the trailing edge slides past the peak current, the current peak is defined by the point of the sawtooth. At some point the laser bandwidth or the measurement system bandwidth will dominate the optical pulse, and the output amplitude will decrease with no change in width.

3.2.3 Differentiation Control Capacitor

The pulse driving the laser is differentiated to produce a large negative voltage swing. This negative voltage rapidly discharges the laser parasitics. The capacitor controls the time constant. It should be long for long pulses. For shorter pulses it should be adjusted for the best compromise of amplitude and fall time. Avoid using a screwdriver for adjustment as the metal shaft will cause significant power to be radiated away causing the adjustment to appear to shift after the tool is removed. For the easiest adjustment make an adjustment tool as follows:

1. Find a straight 26 to 30-gauge stainless steel tubular application needle.

2. Squeeze the tip flat with pliers.

3. Check width and thickness of flattened tip. Must be less than .015” thick, and less than .06” wide. If not, try a different gauge needle.

4. Once good tip is found, cut off needle to 1/8 and prepare as above. File or stone off burrs and square end.

5. Fit to a small dowel, a pencil, a syringe body, or other round handle and use to tune the capacitor.

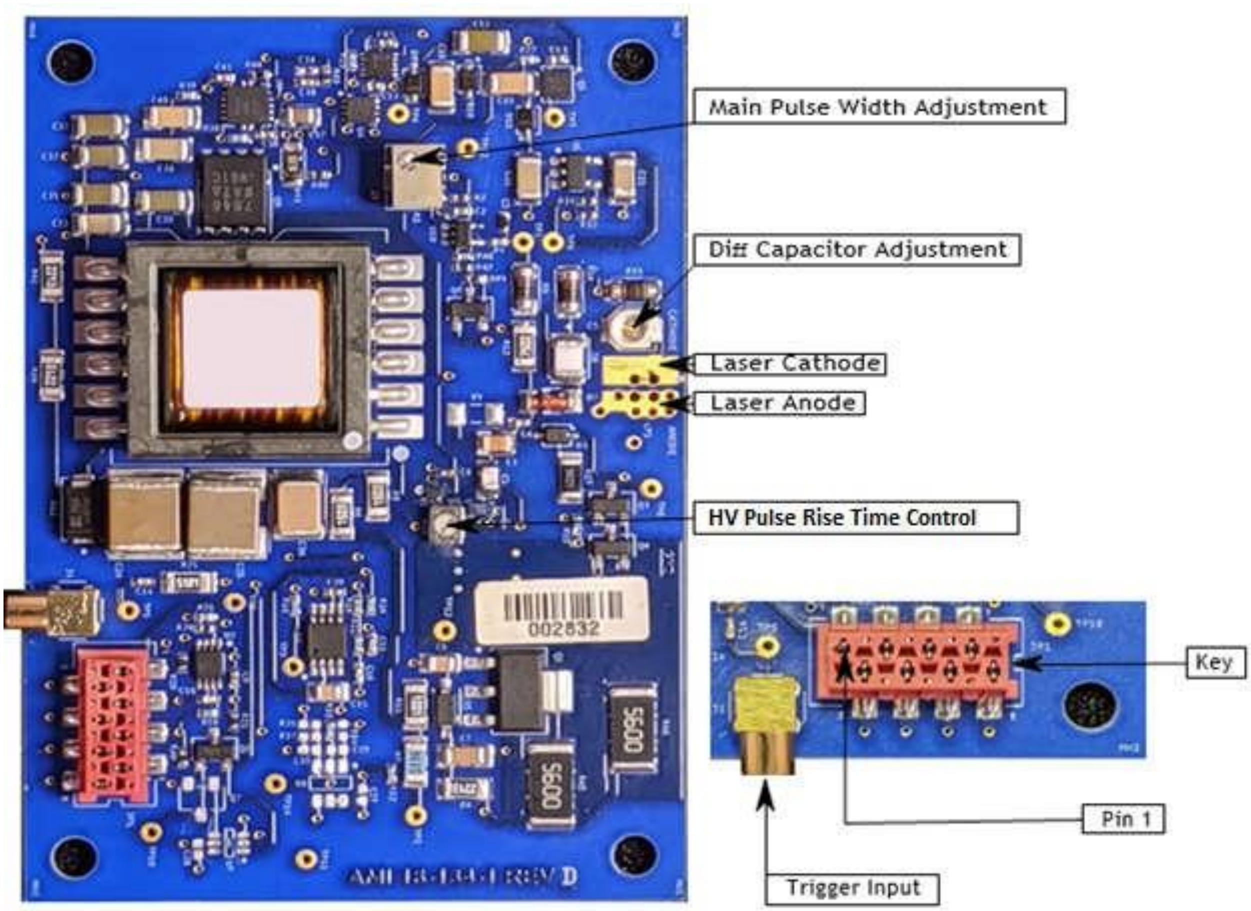

Figure 3.1: Printed Circuit Board

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 50ms to become fully operational after the Enable signal falls. during this time, the high voltage supply starts and 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 be runt 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
2. Enable driver. See Enable signal requirements 3.1.5
3. Apply trigger pulses. See trigger pulse requirements3.1.3
4. Adjust pulse width properties, if desired.

4.4.1 Setting the Parameters

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 repetition rate to be used after adjustment.

6. While monitoring the test equipment, adjust the pulse controls to obtain desired width and shape. See Fig 3.1

4.4.2 Caveats

The 767 is compatible with many different lasers and laser packages. Due to variations in the mounted laser inductance and capacitance, variations will occur in pulse shape width and amplitude. Below is a list of expected difficulties with hopefully useful ways of dealing with them:

1. Low measurement system bandwidth. Our measurement system uses a 6GHz. oscilloscope and a 60ps rise time detector. Combined rise time is 83ps. We have run into system bandwidth limits on both rise time and pulse width. The measured width was 100ps. Optical coupling to the detector must be focused down to the diameter of the detector active area or smaller. Alternatively, the laser output can be fiber coupled with a single mode fiber. Alignment to the active area is critical. Any optical power which strikes the detector outside the active area will reduce the apparent bandwidth. This is caused by the carriers generated having to drift into the active area for collection. This is a slow process. Detector output should be limited to a few tenths of a volt with optical attenuators.

2. Multiple pulses. At some adjustment settings a small trailing pulse may be generated. This is highly laser specific. For all pulses which are not the absolute minimum width or absolute maximum width there are multiple ways to obtain a given pulse width. Usually, a small adjustment of the differentiation control capacitor will remove the second pulse. Similarly, adjustment of the HV pulse rise time control can sometimes remove the extra pulse. The desired PW can then be achieved by adjusting the gate length potentiometer. There is no set procedure for making these adjustments, except that the gate should be adjusted last. This is a stored energy phenomenon, so keeping the laser leads as short as possible will sometimes prevent the problem.

3. Too much optical power. If needed, the power can be reduced, within limits, with the HV pulse rise time control. This is most affective on short pulses.

4. Stacked laser diodes in TO packages. We have not done this, but it is reasonable to expect that the electronics can handle resistive diode drops up to 6V. The laser capacitance will drop by the series combination. The inductance will increase. It may be possible to handle up to 12V if the inductance is exceptionally low. It will, however, be increasingly difficult to concentrate all the optical energy on a detector active area for measurement.

5. Series combination of separately packaged laser diodes. We would expect the inductance to be too high to give useful performance.

6. Modulation. Amplitude modulation would require an external modulator. Any pulse position scheme will work if the minimum spacing is 1us.

7. Pulse width modulation over a limited range can be achieved by removing the adjustment potentiometer and applying an electrical signal. Consult with Factory. The principal limitation on the range is the appearance of trailing pulses, which cannot be adjusted away electrically. This characteristic is highly laser specific, so no general range assumptions.