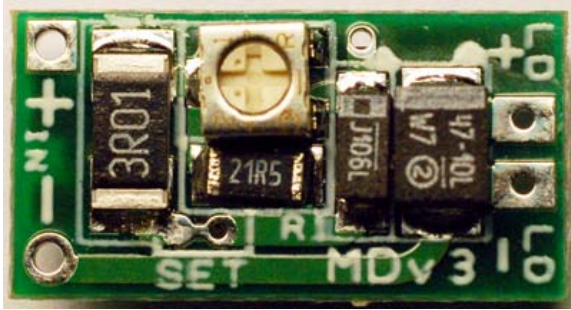


**Micro-Drive adjustable laser diode driver**

This Driver is designed to provide a constant current into any load within its capabilities (about 1.25 to 9V output). It will provide a stable regulation provided you give it the proper overhead voltage to the input (appx. 2.25V over the output voltage). It can be powered by battery or DC power supply and is compact enough to fit almost any application. It is intended for short duration

with the right combination of current and voltage input/output difference, it can run indefinitely and stably.

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## What tools should you have when working with lasers?

1. The most obvious answer is a **soldering iron**. In order to make the connections between the battery, laser diode and the driver, you need a soldering iron and everything else that goes with it. I recommend either a low wattage iron (10-15W) **or** a temperature-controlled iron to prevent overheating joints and damaging components. Another feature you need to have is a grounded tip or ESD-safe iron, which will prevent any voltage build-up on the tip, which can damage sensitive components (like your laser diode!). A temperature regulated iron is not one that you can adjust the wattage, but rather one that you set the temperature on and typically has a base and attached iron with a holder. You can find decent ones from various vendors that are not extremely expensive. An example is the Aoyue 936 or 937+ station.
2. Also, you should have a **thin, rosin-core electronic solder** (ie 0.8mm or 0.032" diameter). I wouldn't suggest the lead-free kinds as they're harder to use, unless you are extremely concerned over toxicity of lead-based (your exposure is minimal, especially if you use gloves).
3. You should also have some form of extra **flux (rosin)**, whether it is a paste, liquid or, my favorite, a flux pen. Flux will help you make quicker, simpler and better solder welds, especially if you are inexperienced with working with small components such as these.
4. A **multimeter**. If you're working with electronics, you should have a multimeter! A decent digital meter should have AT LEAST resistance (0 to Mega-ohms), voltage (DC and AC), current (DC and AC) and a diode or continuity test function. Analog meters are usable, but not quite as useful or simple to use. Some clip-on leads are helpful for using your meter and can be included or purchased separately with some meters.
5. **ESD wrist-strap**, or other anti-static devices. This is important to avoid ESD (electrostatic discharge) while handling laser diodes especially, but other electronics as well.
6. **Other tools**. Things like fine-tipped tweezers, wire cutters (I like micro-flush cutters), wire strippers, a standard or electronic vise, Exacto (hobby) knife and/or pointed metal probe, locking pliers (AKA Vise-grips), diode press tools (small thin-walled metal tube or special-made items), small screwdrivers (like for eyeglasses) and other tools may be useful when working with drivers and laser items in general.

## Handling laser diodes – General Guidelines

Laser diodes are sensitive components. They can be damaged by a variety of methods, whether it is mechanically from extraction from optical drive sleds or pressing into a housing or they can also be damaged by excessive heat, static discharge, reverse voltage polarity/current, high voltage/current, and probably some methods I can't think of right now. So, it goes without saying, they must be handled carefully.

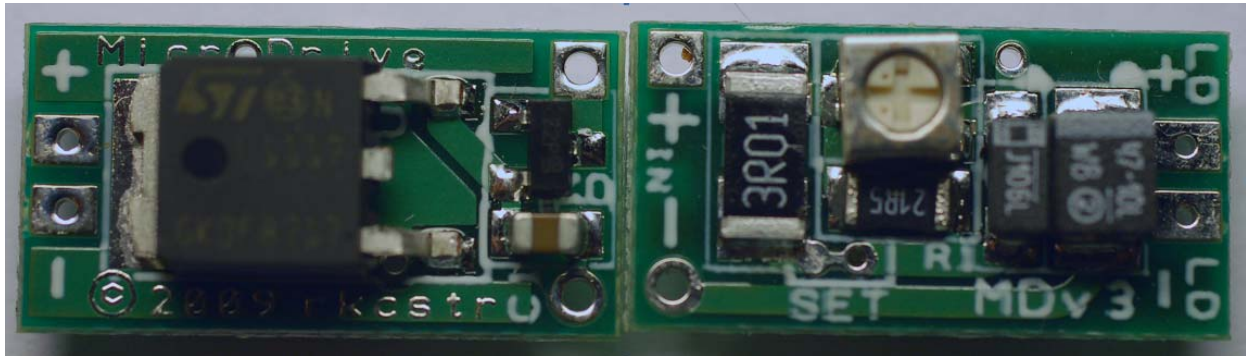
If you have never extracted a laser diode before and you are trying your hand on your first Blu-ray or other laser diode, I would suggest you extract one of the “extra” diodes in the sled (the IR, or the red, in the case of a Blu-ray sled) before you go for the actual diode you're after. Practice removing the small heatsink it is mounted in and getting the ribbon PCB off. You can check out my video on YouTube for removal of the 6x Blu-ray laser diode as an example of some of the techniques (<http://www.youtube.com/watch?v=yJhLa2dpmhw>).

You should always use ESD-safe practices when handling laser diodes. Working on a surface that is not prone to static (like plastic surfaces) and wearing an ESD wrist strap (grounded) are the most important things. Also, when soldering/desoldering connections, you should avoid heating the joint for more than a second or two to prevent heat damage. A temperature-controlled iron will also be helpful in minimizing overheating.

Once you have them extracted, if you are not going to immediately solder it to a driver circuit, you should short the pins or store in an anti-static baggie (shorting the pins is still a good idea). This can be done by simply putting a small solder bridge across all of the pins (see mentioned video above for a demonstration).

Doing the above is a good start to safely handling laser diodes, but are not all inclusive or fool-proof. Always be careful when handling diodes, making sure not to touch the front “window”, or in front of the base in the case of “open can” diodes. Use common sense and think about what you are doing before you do it; blindly following instructions will get you somewhere, but that ‘somewhere’ will probably be ‘lost’.

## The Micro-Drive - Specifications and Considerations



The Micro-Drive is designed to be an inexpensive, reliable and simple-to-use laser diode driver. It provides a constant current to the load connected between the LD+ and LD- pads. The + and – “IN” pads are meant to be connected to the power source, which can be any DC source, whether battery, power supply unit, AC adapter (outputting DC voltage), etc. There are certain specifications and considerations that must be kept aware of in order to safely operate the driver:

- Input voltage must be LESS than 12VDC. This is a limitation of the input voltage polarity protection and can be disabled by removal of one component and shorting two pads to allow for up to 15VDC, or you can use rectifier diodes (ex. 1N4001) to drop input voltage low enough (see page 11 for more information).
- Input voltage must also be MORE than 2.5VDC to properly enable the driver to operate. Also, the input voltage has to be more than 2.25V **over** the voltage of the laser diode (example: a 3V red laser diode would require the driver to have more than 5.25V to the input). Also, if using a battery, voltage drop as it discharges should be considered. If the voltage is less than the necessary 2.25V overhead, the current output of the driver will start to decrease (becomes unregulated), which will be noticed by a decreased output of the laser diode. **THIS WILL NOT HARM THE DRIVER OR DIODE!** It merely tells you that you need to charge your batteries. \*Also, be aware that if you are setting the current on your driver, that you provide adequate voltage for whatever load you have connected to the driver, otherwise you may get a false current reading if the driver does not have enough voltage to regulate the current.
- The temperature of the driver itself can get very high with extended operation, depending on the current setting and/or the input/output voltage difference. Power dissipation (the amount of heat generated) is calculated by  $P_d = (V_{in} - V_{out}) * I_{out}$ . So, you can see that as your input voltage increases for the same output voltage, you generate more heat. This should be a consideration for you when choosing the input

voltage. Temperatures can go over 100C (212F), so be careful when handling an operating or recently operating driver.

Driver Specifications:

- Size: Approximately 9.35mm x 17.85mm +/-0.1mm (0.368" x 0.703", +/-0.004")
- 1117 type regulator IC, low drop-out (LDO) type, in constant-current mode.
- Output current ranges from approximately 55mA to 440mA as set from the factory, or 30 to 57mA if the SET linkage is broken
- Chip maximum current output: 800ma (not supported with this driver)
- No current reverse polarity protection via MOSFET (limited to 12VDC reverse voltage).
- Input voltage: <12V, >2.25V+Diode Forward Voltage (Vf)
- Output voltage: 1.25V to 9.75V

## Setting the current:

There are many ways you can use to set the current on your driver. Here are a few ways I suggest:

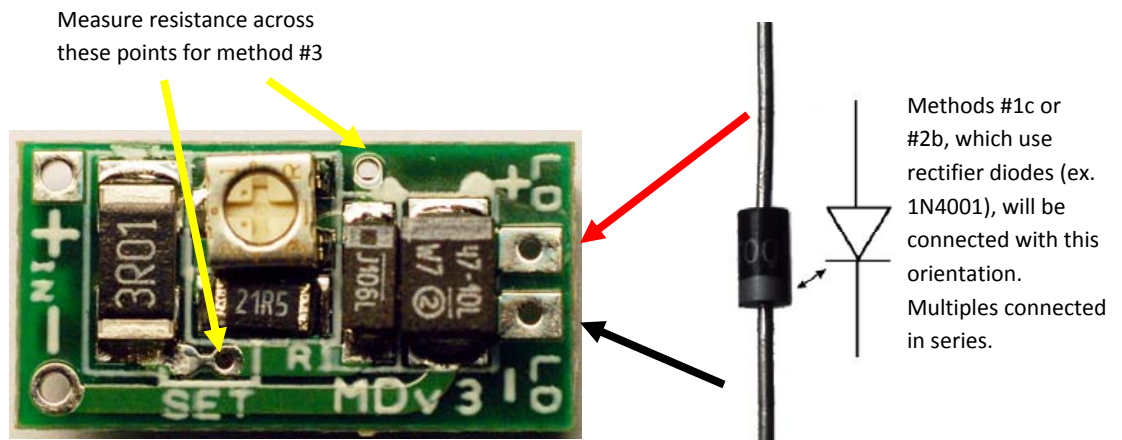


Figure 1. - Current setting method points of interest

1. The most accurate method involves **directly measuring the current** with an ammeter (or multimeter set to measure mA). Make sure your meter is rated to handle at least 500mA and that the measurement range is within your intended setting.
  - a. You can directly attach the multimeter leads to the driver output (red to positive, black to negative) and power up the driver then adjust the pot to set your current while monitoring the meter.
  - b. Another method could be to attach a load (ie rectifier diodes, 1N00x series), if you want to test a specific output voltage, and then connect the multimeter in SERIES with the load (red lead to positive driver output, black to one end of the load, the other end of the load connected to negative driver output).

- c. Lastly, you can measure the current while connected to a diode by connecting the meter in series with the INPUT (red lead to battery positive, black to driver input positive. Or, you can also do series with the negative side). It is slightly less accurate as the driver does consume a few mA, but should be relatively close to actual output.
2. The next accurate method is to measure the **voltage across a load**.
  - a. The most simple way is to use a 1 ohm resistor (for 1 ohm, at least 1/4W rating for up to 500mA, 1W suggested) to make calculations simple, but any resistance is potentially usable, but you should make it under 10 ohms. Connect the resistance to the output (one lead to positive, one to negative, any direction), then power up the driver and measure voltage across the resistor. If you are using 1 ohm, the measured voltage will be equal to the current, so 1mV will be equal to 1 mA ( $1\text{mV} = 0.001\text{V}$ ). If you're using a resistance other than 1 ohm, you can calculate your current with Ohm's Law, by  $I = V / R$ , where I is in Amps ( $1\text{A} = 1000\text{mA}$ ).
  - b. You can also add rectifier diodes in series with the load to simulate a voltage. The 1N00x series typically have a 0.7V drop per diode, so 4 is about equivalent to a red diode and about 6 for a Blu-ray diode (you can measure their voltage drop and add/subtract diodes if you need more/less voltage).
3. The last method is the quickest, but also least accurate and involves **measuring the setting** resistance on the driver. You can estimate the output current by measuring the setting resistance between points 1 and 2 in the above picture, then calculate the output current by the equation:  $I_{\text{out}} = 1.25 / R_{\text{set}}$ .  $I_{\text{out}}$  is in Amps ( $1\text{A} = 1000\text{mA}$ ). You do not need to power up the driver to do this, so it is the simplest method and only requires a multimeter. But, most meters lose accuracy as you approach the lower end of its resistance range, so you may not get an entirely accurate reading which will throw off your calculations. So, do not use this method if you need an accurate reading of current or need an accurate current setting.

## Setting the Low Current Range

These drivers are able to operate at currents down to about 30mA with a minor board modification. There is a small bridge between two solder points on the board, marked by the word "SET" as seen below:

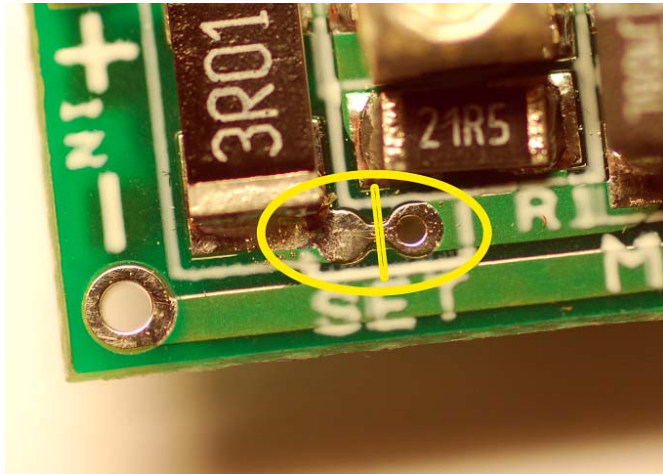
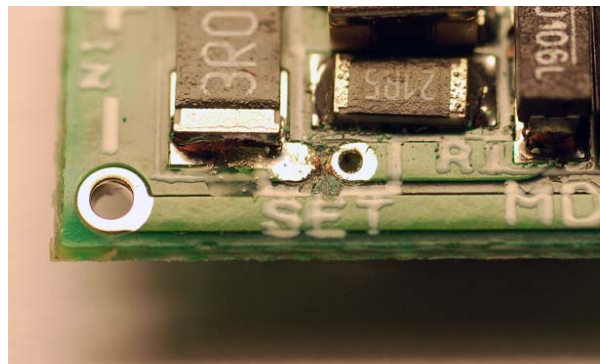


Figure 2. - Diagram of the current range set point. Short trace between two pads must be broken in order to enable the low current range. Solder-bridging the two points will again enable the factory setting.

In order to enable the low current range (~30 to 58mA), the short copper trace between the one solid pad and one thru-hole pad must be broken. In order to do this, you can use something with a point to scrape the trace completely away. I suggest using a sharp (preferably new) Exacto or hobby-knife blade. It does not need to be cut DEEPLY, just enough to completely remove the copper trace, as shown:

Figure 3. - Short trace completely removed between pads to enable low current range.



If you want to again re-enable the default current range, all you have to do is bridge the two pads with solder, like shown:

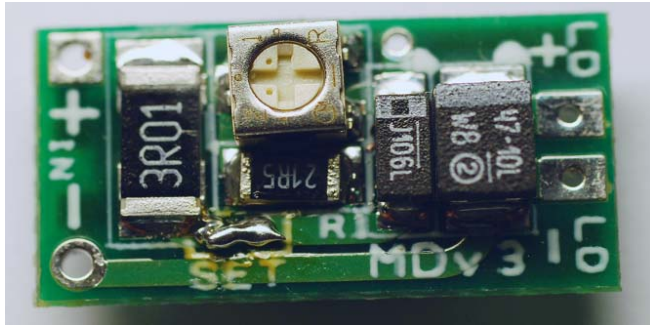


Figure 4. - Current range setting pads bridged to re-enable the factory default range.

### Using Your Driver

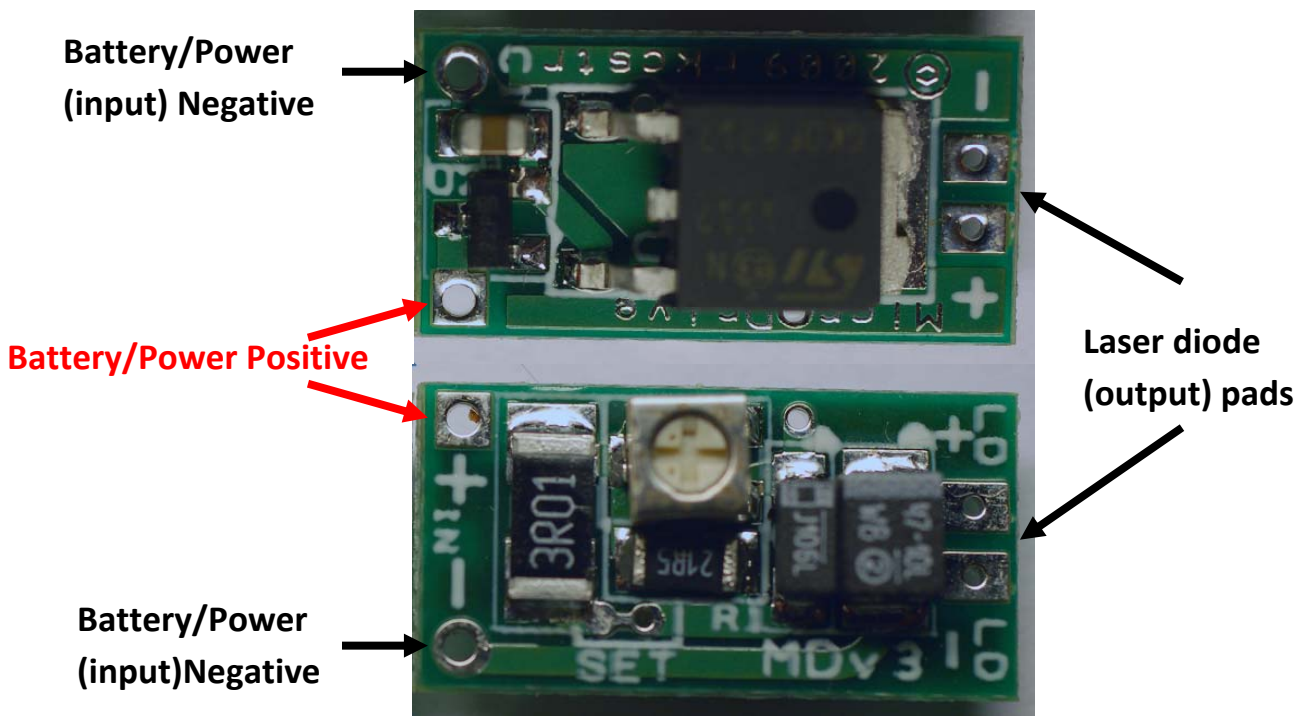


Figure 5. - Micro-Drive Input/Output connections

The first step to using your driver is to set the current, which should already be done a few pages ago. But, setting current prior to attaching the diode is a good safety measure to prevent



accidentally putting too much current through the diode and damaging it. When your driver is ready to go, you can then make the connections between the driver, diode and battery.

**IMPORTANT NOTE: It is a good idea to short the output pads by connecting them together with a piece of wire or with the head of a flat screwdriver, etc. This will discharge any residual charge in the capacitor that could possibly damage your laser diode when you connect it.**

When making connections, if you're soldering wire to the input or output pads, you should make sure the solder flows through the hole so that a good connection is made to both sides of the pad. Making good solder connections is important to prevent them from breaking or producing an intermittent connection.

If you are directly soldering a laser diode to the driver, be sure you are aware that the output pads are connected to BOTH sides and not just one side like previous versions. The polarity of each pad is marked on both sides of the driver, so be sure you do not connect an extra pins to the left over pads unless they have no connection, or are able to be shorted to ground (by connecting to negative pad). **Also, make sure you mount your diode (ex. Press fit into Aixiz module) prior to mounting the driver!**

When all connections are made, make sure you double check that you have no shorts on the board between the laser diode pads, between either input (power) pads and others on the board or, if you modified the range setting, between the range setting pads and nearby pads. You can use a multimeter to check for low resistance between the mentioned pads (none should be lower than 2-3ohms).

Now that it is ready to go, you can power up to test. Testing with a dummy load such as an LED, resistor, diodes, etc is never a bad idea to make sure the driver is functioning properly the first time (especially if you haven't set the current while powered). But, once you have the laser diode running, you should be done.

Some considerations for use:

1. The driver will get hot with use. Sometimes over 100C, which is the boiling point of water and WILL burn you! This is because the excess voltage over the diode (or output) voltage gets converted to heat by the driver. If you want to calculate the power (heat) dissipated, you can use the formula:  $P = (V_{in} - V_{out}) * I_{out}$ 
  - a. Looking at the formula, you can see that as you increase  $V_{out}$ , which is the laser diode's voltage, you will increase the heat dissipation, just the same as if you increase the current. This is why you want to minimize the input voltage to as low as possible or practical. Blu-ray diodes can be OK on up to the 12V limit, but red diodes should be limited to less than 9V and IR diodes to around 7-8V at high currents (ex. >200mA).
2. Only connect **ONE** laser diode at a time to the driver. Connecting more than one laser diode, whether in series or parallel, can cause unequal sharing of current on the diodes and can damage one or the other, or both and the driver if they fail. It is possible to do, but only suggested for those who know what they're doing.
3. If you are connecting a diode directly to the driver, be careful to not twist the board or mounted diode or you can break the pins off or rip off the driver pads!

## Driver modifications

Some things that can be done with the driver are reserved for those who are capable with a soldering iron and are familiar with the working of electronics.

If you want to increase the maximum input voltage to >12V, you can do a simple modification of removing a single component and short two pads, shown in this diagram:

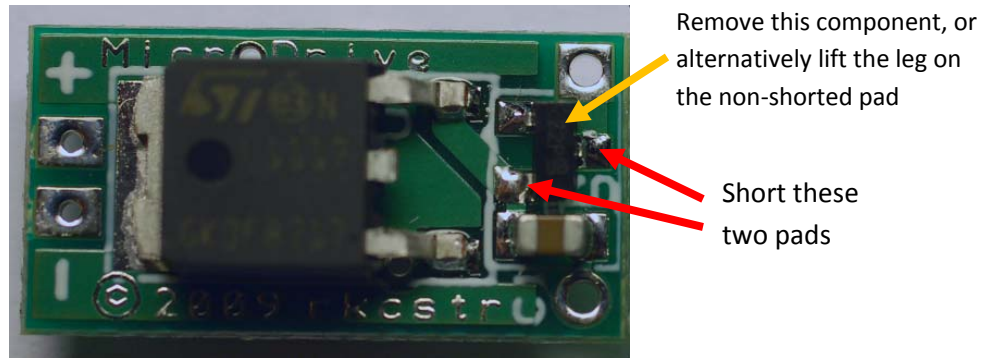


Figure 6. - Higher input voltage modification

If you simply want to use 3 lithium batteries, which can have a maximum voltage of 12.6V, you can simply connect a rectifier diode in series with the input positive to drop ~0.7V, as seen here:

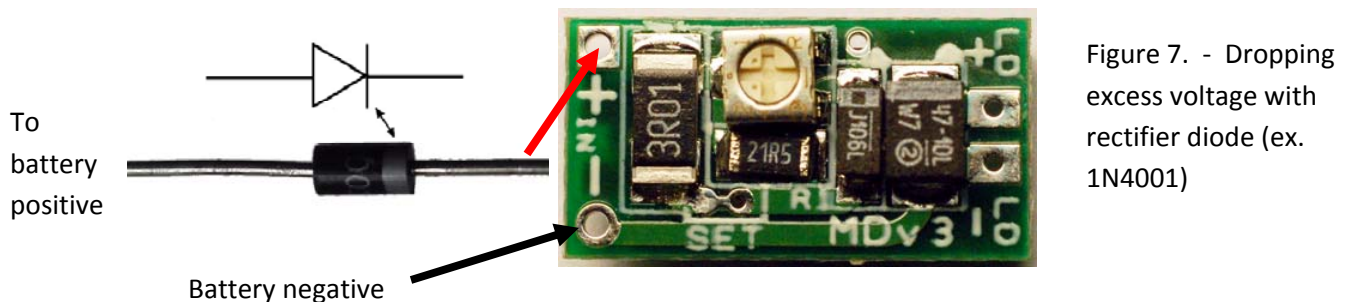


Figure 7. - Dropping excess voltage with a rectifier diode (ex. 1N4001)

If you want to modify the drive to a different range, the following Microsoft Excel spreadsheet can be downloaded to allow you to enter in values to calculate ranges (ignore R1 setting as R1 is in PARALLEL with R2 instead of SERIES in previous versions and calculated in the sheet). Simple enter in your R2 value and leave the pot value the same, which will assume you remove R1 and have the "SET" pads connected and will give you a current range. R2 is the larger component marked "3R01". Component ratings should be taken into consideration when making your selection; power dissipation of each component is automatically calculated in the above sheet as well. You can leave R1 (marked "21R5") in place, you will just have to calculate the parallel equivalent resistance with your chosen R2 value and enter that for R2.

Spreadsheet can be downloaded here: <http://rkcstr.googlepages.com/potoutput.xls>

## Troubleshooting

### **-No light from laser diode when driver is powered:**

1. Check connections to make sure they are properly and appropriately connected (check polarity of battery AND diode connections)
2. Did you set the current high enough? You may be below the minimum operating current of the diode. Check to make sure your current is above the threshold current of your diode.
3. Are you giving the driver enough voltage to drive the diode? The input voltage should be at least 2.25V over the laser diode's (or output) voltage. Also check to make sure your power source is putting out the EXPECTED voltage and not a lower voltage.
4. If no other explanation, your diode may be damaged. Try using a dummy load to check the driver is putting out the correct amount of current.

### **-Diode is emitting a dim light:**

1. Did you set the current high enough? You may be below the minimum operating current of the diode. Check to make sure your current is above the threshold current of your diode.
2. Are you giving the driver enough voltage to drive the diode? The input voltage should be at least 2.25V over the laser diode's (or output) voltage. Also check to make sure your power source is putting out the EXPECTED voltage and not a lower voltage.
3. If no other explanation, your diode may be damaged. Try using a dummy load to check the driver is putting out the correct amount of current.

### **-Driver is not putting out current:**

1. Check to make sure your power source is putting out voltage (batteries not dead, power supply is working).
2. Check for short on the output pads, which would show no current on the load
3. Check connections to make sure they are properly and appropriately connected (check polarity of battery AND diode connections)
4. If no other reason can be found, the driver may be damaged or malfunctioning, contact me at [rkctr@gmail.com](mailto:rkctr@gmail.com) for further assistance in troubleshooting.

### **-Diode gets dim or flashes while operation:**

1. If your diode dims with time as your driver is powered, it is likely the power source (ex. Battery) is dropping too low on voltage to maintain a regulated current. Use a new battery or check your power source for voltage sag.
2. Flashing is likely due to the driver shutting down due to overheating. Try running your driver for shorter amounts of time or reducing the input voltage to reduce heat generation.

Questions? Contact me at [rkctr@gmail.com](mailto:rkctr@gmail.com)!