



LASER diode driver

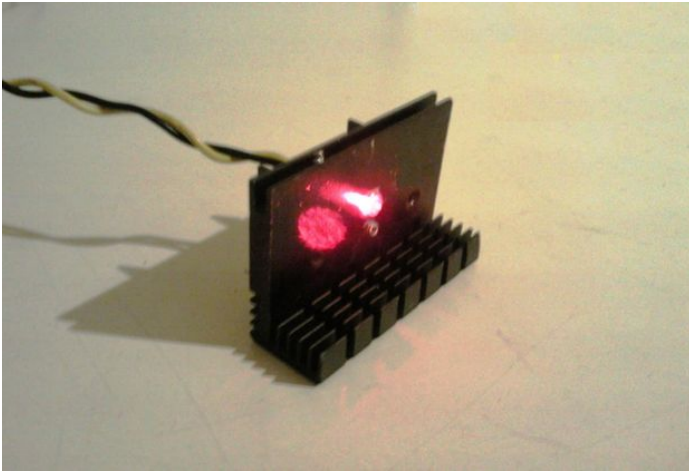
by **Milen** on August 15, 2013

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Intro: LASER diode driver

For the driving of the LASER diodes (LD) special drivers circuits are used. They can work in two ways : 1) produce constant regulated voltage; 2) produce constant current driven through the LD load. The second type is more easy to design and use and different circuits for their implementation exist. The majority of the DIY circuits are based on the LM317 chip. I decided to create a different type simple constant current driver, which can be easy to design, to regulate and able to deliver a big range of driving currents. The proposed schematic is able to sink constant currents from 0 mA up to 0.5 A. If higher currents are desired, small schematics changes are required (mainly: change the value of one resistor). The main active part of the circuit is a single supply dual operational amplifier (Opamp). One of the integrated opamps is used as buffer, the second one in voltage to current converter configuration. The schematics of the driver is presented on the picture.



Step 1: The principle of work of the LD driver

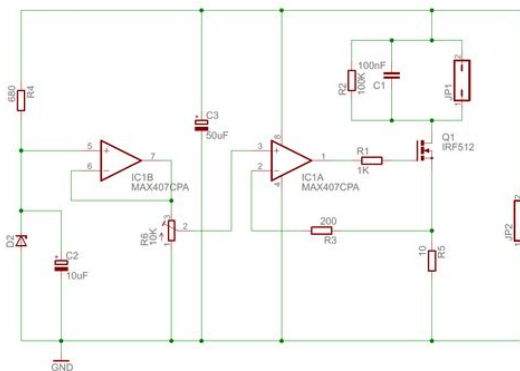
A 5 V reference voltage is created by the Zener diode D2 and the resistor R4. This voltage is filtered by the use of the capacitor C2 and applied to the input of the opamp connected as buffer. The buffer is loaded with trimmer potentiometer connected to ground. In this way on its middle terminal the voltage can vary between 0 and the reference voltage. The second opamp together with the power NMOS transistor work as voltage to current converter - the source voltage of the transistor is identical to the input voltage of the second opamp. This voltage appears at the current defining resistor R5. The generated current is $I_{gen} = V_{in} / R5$, where V_{in} is the voltage drop over R5 and also the input voltage of the second opamp. I have used 5V Zener diode and 10 Ohm R5 resistor - the maximum possible generated current is 500 mA. If higher current is needed, either the reference voltage should be increased, either the value of R5 shall be reduced. Because high current can flow through the NMOS transistor, it must be enough strong to sustain it.

The power generated by the R5 must be also properly dissipated. In my case the maximum power generated by R5 is 2.5W - $5V \cdot 0.5A$. I have used 10W resistor. The resistor R3 is optional. In some cases R1 also. R2 and C1 are used to protect the laser diode from some voltage spikes.

Some words about the used opamp and NMOS transistor:

The power NMOS transistor normally has a big working area, what in most of the cases presumes big input capacitance. For some devices it can reach some dozens of nanofarads. This capacitance appears as capacitive load for the opamp. The opamp must be able to drive such kind of big capacitive load, without losing its stability. Some opamps are compensated for similar loads, but a plenty of standard opamps will oscillate. You have carefully to check in both datasheets (of the opamp and the NMOS), what is the gate capacitance of the power NMOS transistor, and is the opamp stable with this load. In some cases, even the opamp is not stable with the specific NMOS transistor as load, the stability can be drastically improved by the "isolating" the load from the opamp output by the use of simple resistor. This in the schematics is the function of R1. If you have stability problems, you can play with the value of R1 and to try to reach back the stable operation.

The LD is connected at JP1, the pwr supply at JP2.

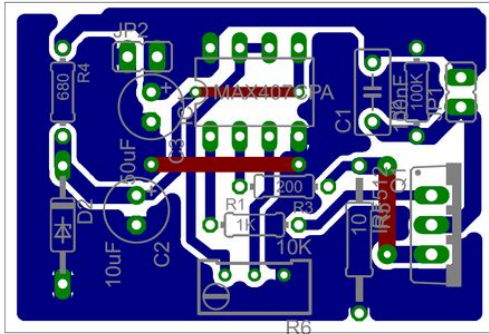


Step 2: Parts list

1 x MAX407 (dual single supply CMOS low offset opamp) - can be used different, having in mind mentioned before (the PCB is designed for DIP package)
1 x SSS7N60B (Fairchild 600V 7A DMOS NMOS transistor) - I have used this, because I had this one available, it can be used another power NMOS transistor like IFR120...and others
1 x 5V Zener diode (can be used other than 5V - the reference voltage divided over R5 value gives the maximum value of the generated current - this voltage can not be higher than the maximum supply voltage of the opamp + (1~2)V)
1 x 680 Ohm resistor
1 x 200 Ohm resistor (can be omitted)
1 x 100 KOhm resistor (can be 10 KOhm - 200KOhm)
1 x 1 Kohm resistor
1 x 10 Ohm 2.5W resistor (can be different, the power dissipation should be recalculated)
1 x 10 KOhm trimmer potentiometer (can be 5KOhm ~ 100KOhm)
1 x 10 uF capacitor
1 x 50 uF capacitor
1 x 100nF (can be 1uF) capacitor

Additional parts:

I have used 3 different types of coolers (radiators) - one to cool the NMOS transistor, the other to make the housing of the LD



Step 3: PCB design

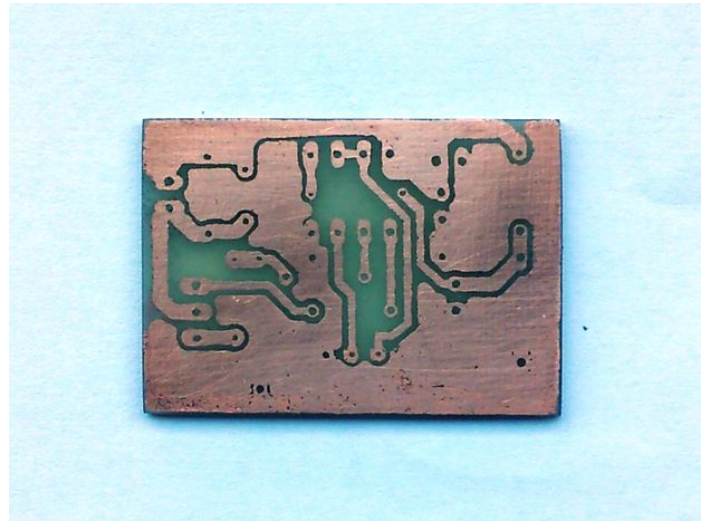
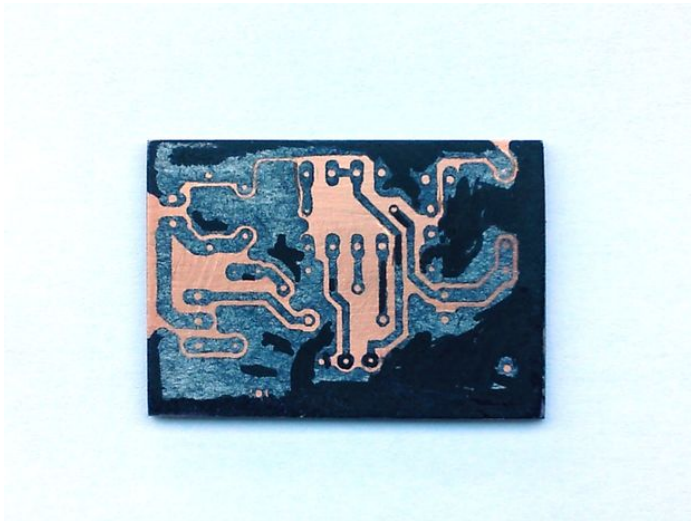
I have designed the PCB in "Eagle". The design files can be downloaded.

I have used the following approach:

The PCB is designed by the use of two conducting layers : bottom and top. If you want to order the PCB in the fab, you can use dual metal technology. I have used the toner transfer DIY method and my PCB is with single metal (only the bottom metal layer). The top metal layer connections are replaced by trivial wire bridges. A PDF file prepared for the toner transfer "lithography" is available also for download.

A picture of the PCB with the transferred toner and retouched with resistant DVD marker is shown on the picture.

The same PCB after etching can be seen also.



File Downloads



V2C.zip (76 KB)

[NOTE: When saving, if you see .tmp as the file ext, rename it to 'V2C.zip']

<http://www.instructables.com/id/LASER-diode-driver/>

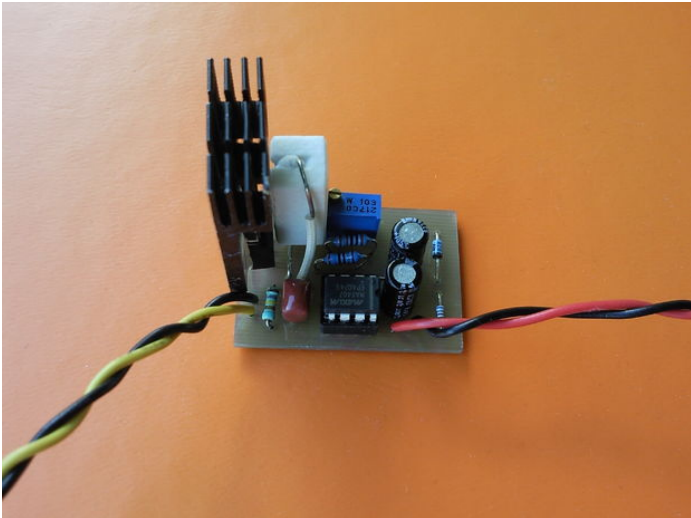
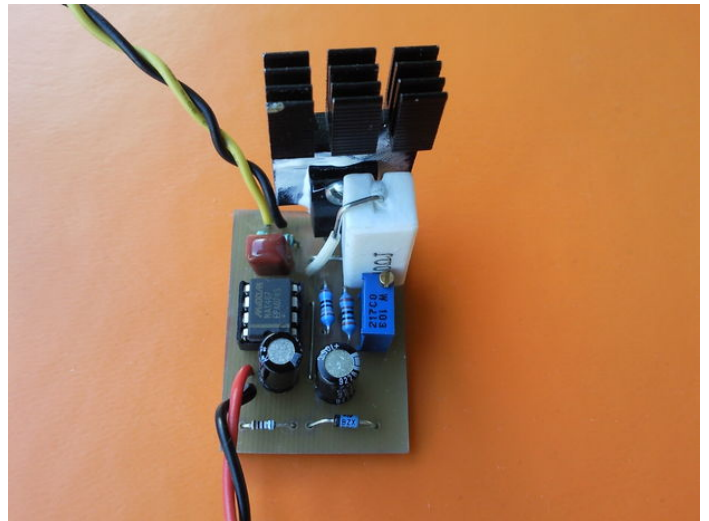
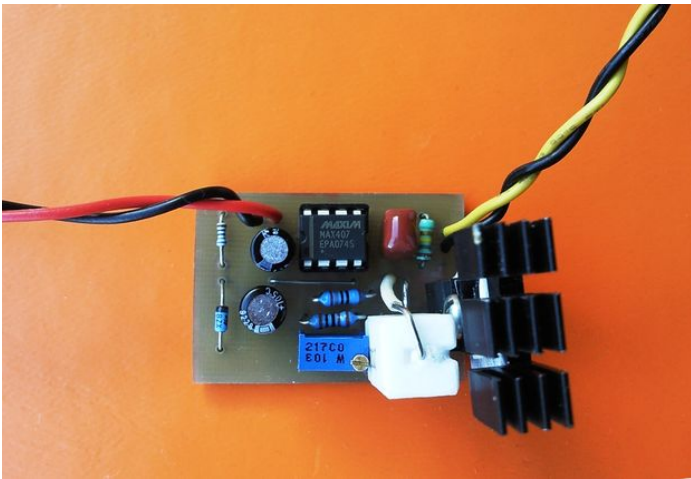
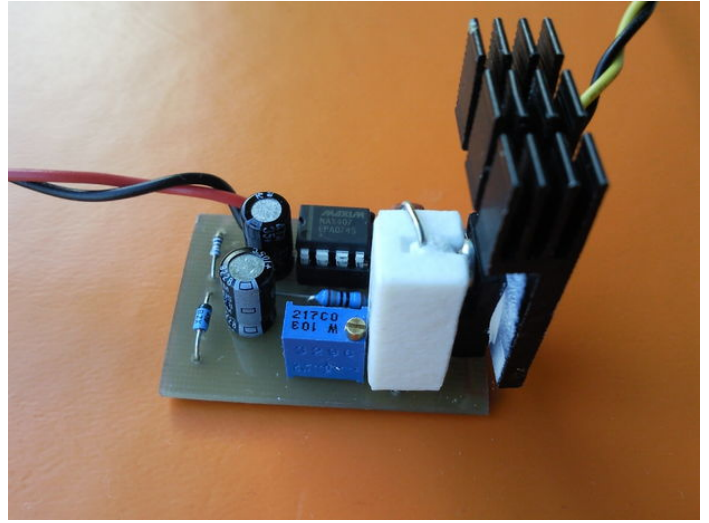
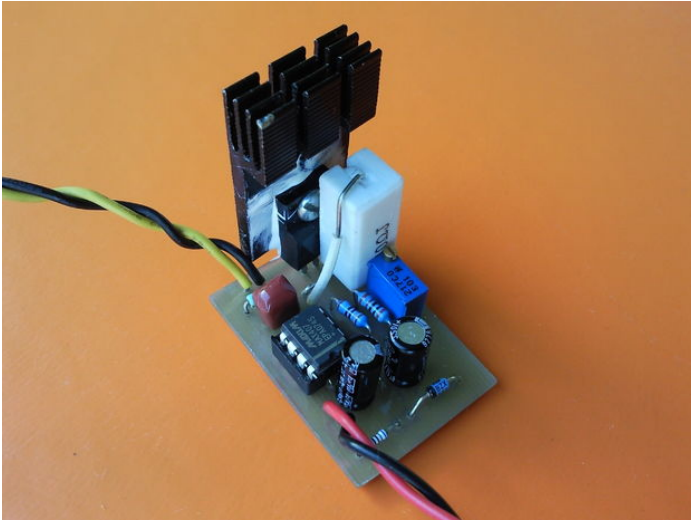


V2C_toner_transfer.pdf (8 KB)

[NOTE: When saving, if you see .tmp as the file ext, rename it to 'V2C_toner_transfer.pdf']

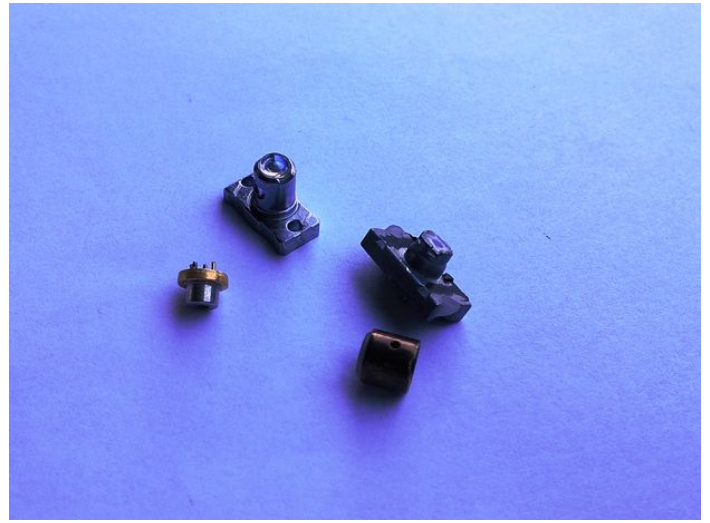
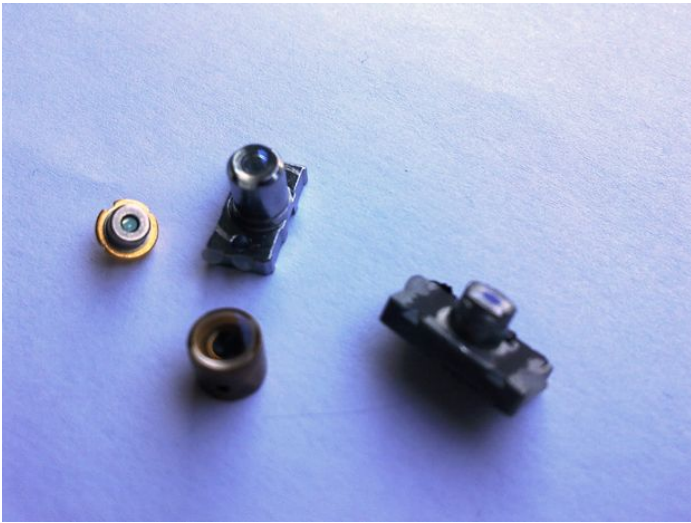
Step 4: The soldered LD driver PCB

Here I show some pictures of the soldered PCB. The opamp is placed in IC socket. The power NMOS has its cooler mounted. Instead the jumpers (as in the schematic), I soldered directly wires.



Step 5: Making the housing of the LD

For this experiment I have used LD extracted from DVD burner. It has its own small housing with lenses, but for high power it needs additional cooling.



Step 6: The LD cooler

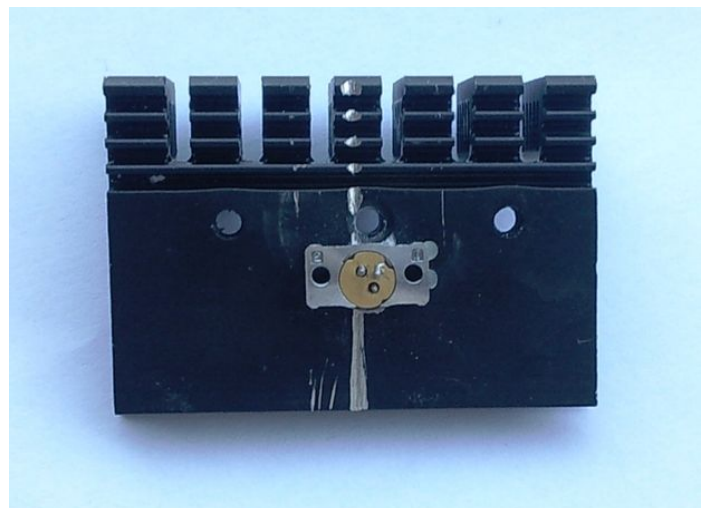
Because big current flows through the LASER diode, it must be cooled. Special cooling housings are available on the market (for example Ebay), but I have decided to make it by myself. For that purpose I have used some available materials: two aluminium coolers, a nut and bolt.

At first I made a hole in the middle of the bigger cooler. After that I have shaped it by the use of round file to pass exactly to the LD placed in its original housing.



Image Notes

1. it has own carving



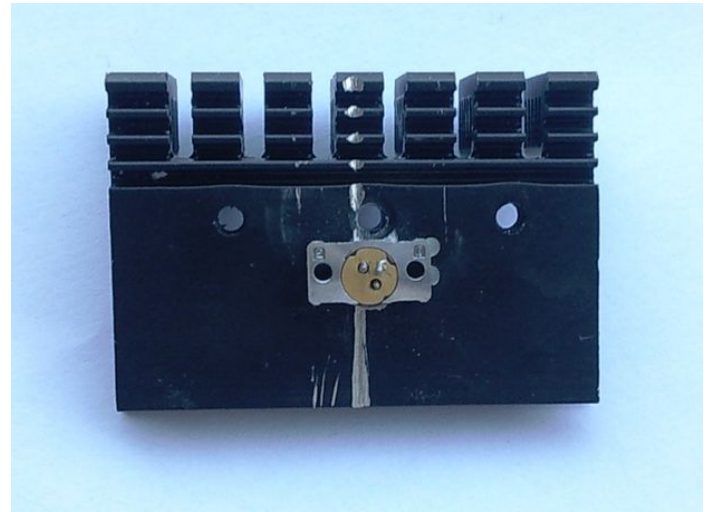
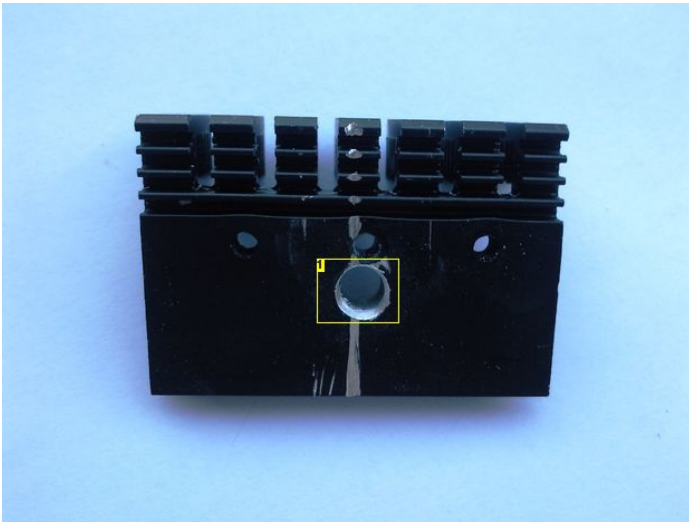
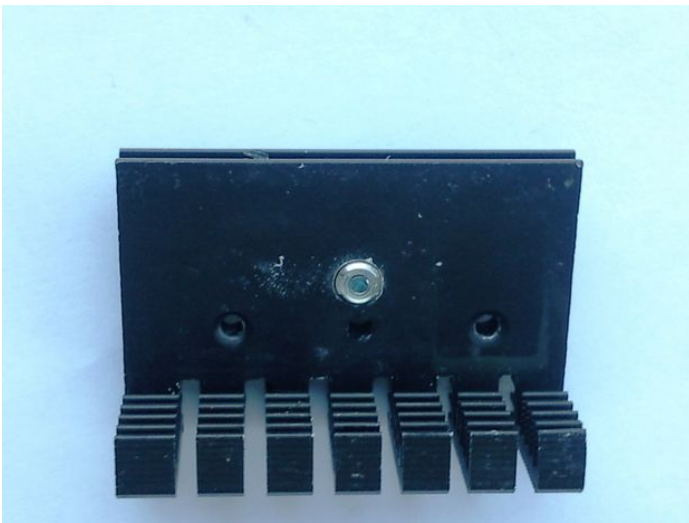


Image Notes

1. hole for the LD housing



Step 7:

I have found a nut, which was quite thick as the LD original housing bottom wall. I filed it to have the same thickness. I have to made thinner also one of the side walls of the nut. The pictures show how it looks like after the filing and where it stays in the cooler.

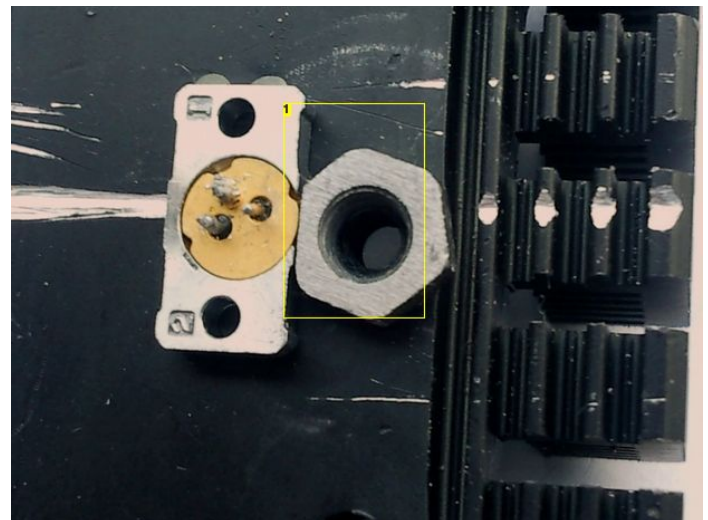
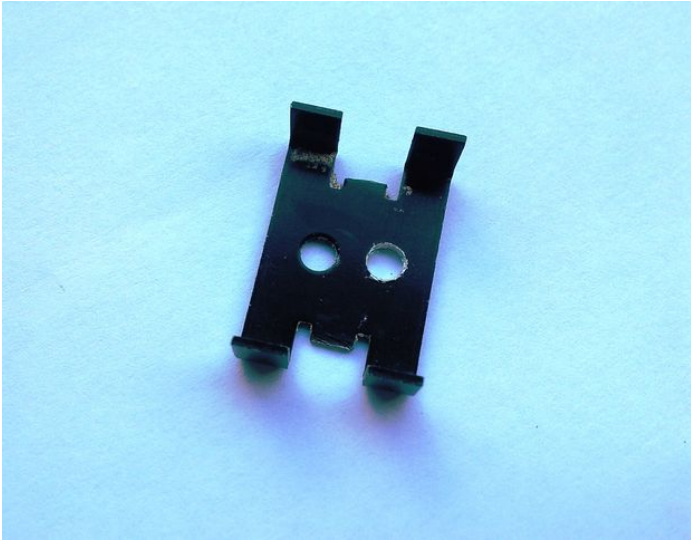


Image Notes

1. the original LD housing and filed nut have the same height

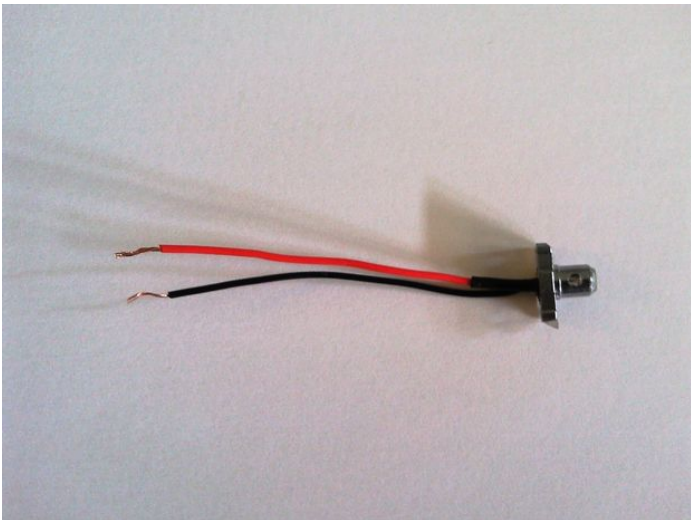
Step 8:

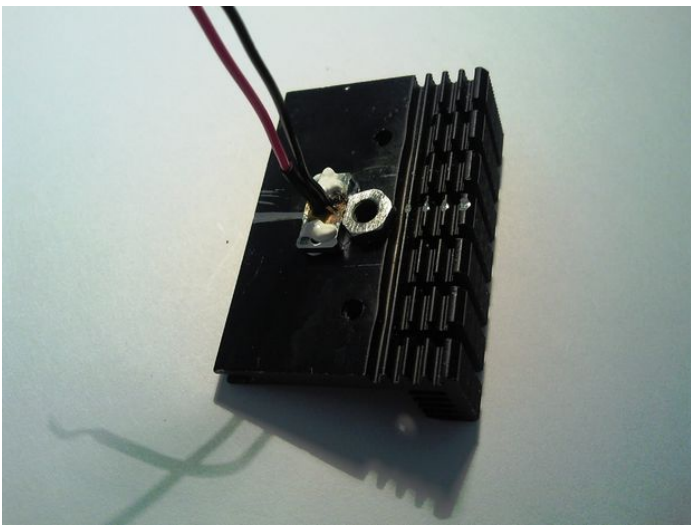
I took a small plate used as cooler, drilled additional hole for the LD terminal connection wires.



Step 9:

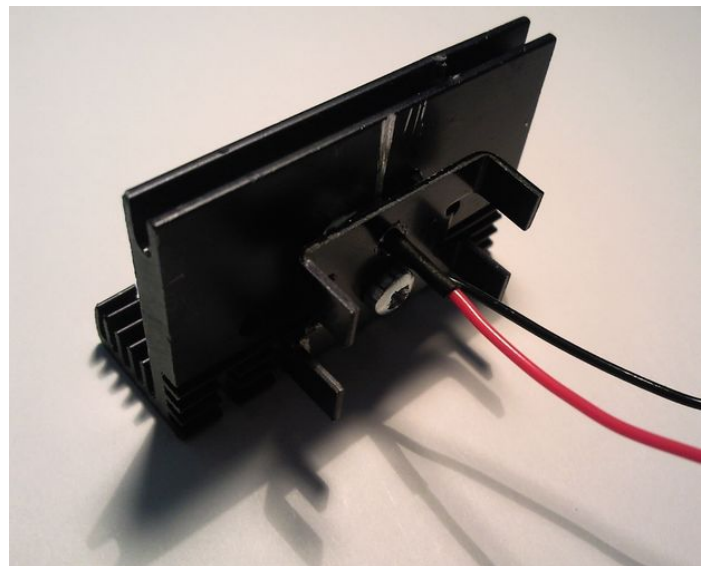
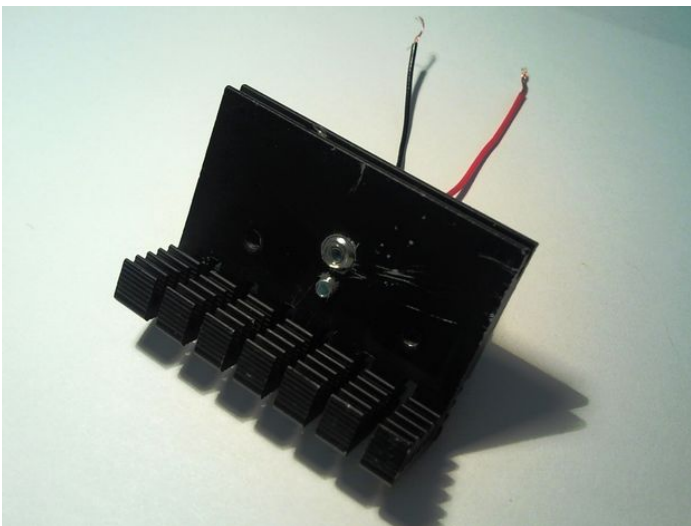
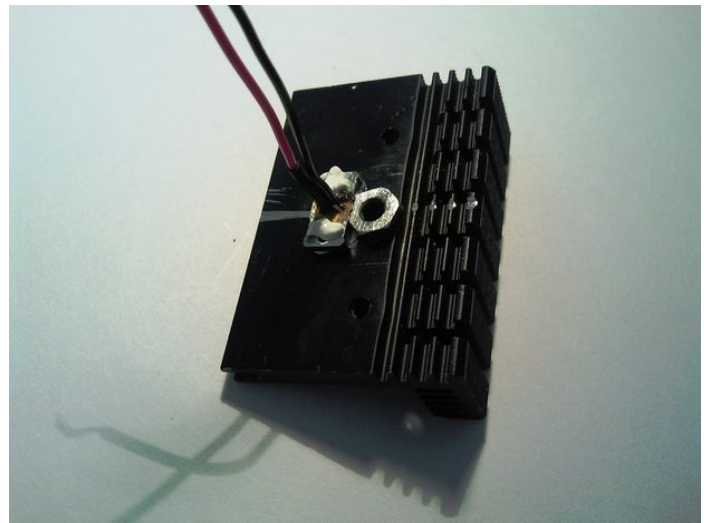
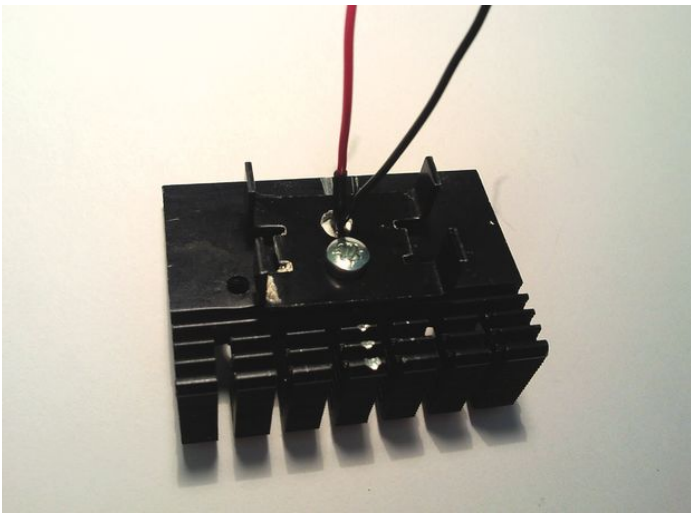
The next step was to solder wires to the LD terminals. You have to check what is what of the terminals in the LD datasheet (they can be as on the picture, but they can be also arranged in different way) . I put a heat shrink cable sleeve on the positive wire to prevent accidental short circuit with negative one.





Step 10:

Finally I have assembled the whole housing - the small plate was fixed with bolt, in this way pressing and holding the LD original housing. I have put some silicone thermal paste to improve the cooling.



Step 11:

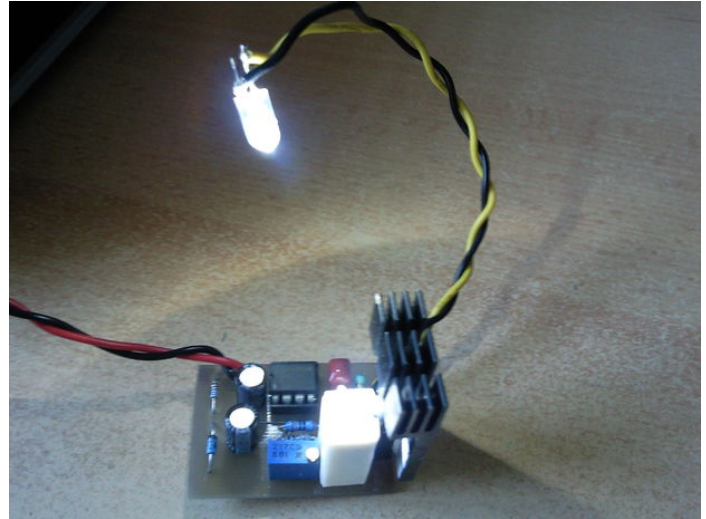
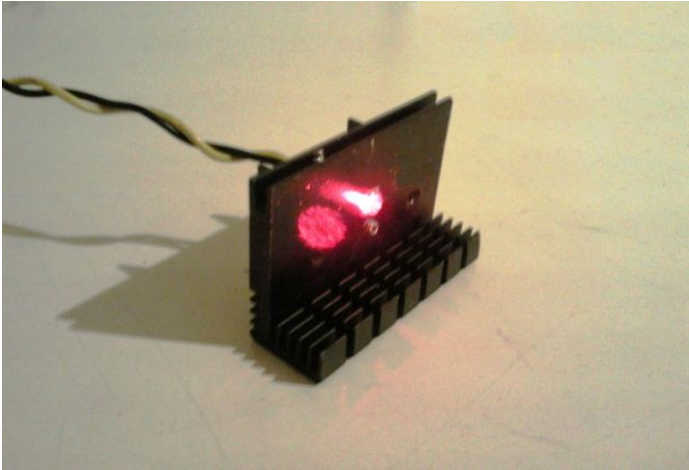
After finishing of the LD housing, before testing, I have turned the trimmer in the position of minimum current driving. I have connected the LD module to the driver, and connected the same to the power supply source set at 6-7V.

I have measured the all special potentials (the reference voltage, the voltage at the input of the second opamp, the voltage at the source of the NMOS transistor - the same as the top terminal of R5, the voltage drop over the LD). I adjusted the supply voltage to be 10V. **Remark** . Be carefull what is the maximum supply voltage of the opamp!After that I started slowly to turn the potentiometer, increasing the voltage over R5, and increasing the current through the LD. When the trigger current of the LD is reached, it starts to light. You can easy astimate the flowing current through the LD measuring the potential at the top terminal of R5 and dividing it on R5.

The maximum allowed current through the LD must not be exceeded, because your LASER diode can be destroyed.

Instead for driving LASER diodes, the presented driver can be used also for driving of LEDs. The second picture shows the driver loaded with bright white LED, and sinking around 10 mA driving current.

Except driving of LDs , LEDs the driver device can be used also for generating a stable with the temperature and supply and constant in the time currents for different sensors, current reference circuits and other electrical and physical experiments. Important for this purpose is to have Zener diode with stable over the temperature voltage. The chosen opamp have very small offset and parameters temperature drift. R5 must be chosen with small TCR.



Related Instructables



Types of Diodes
(Photos) by
dhruvil_patel



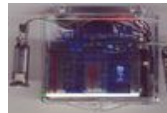
How to build a laser (general guide) by 3zuli



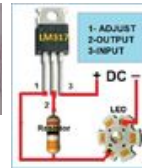
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