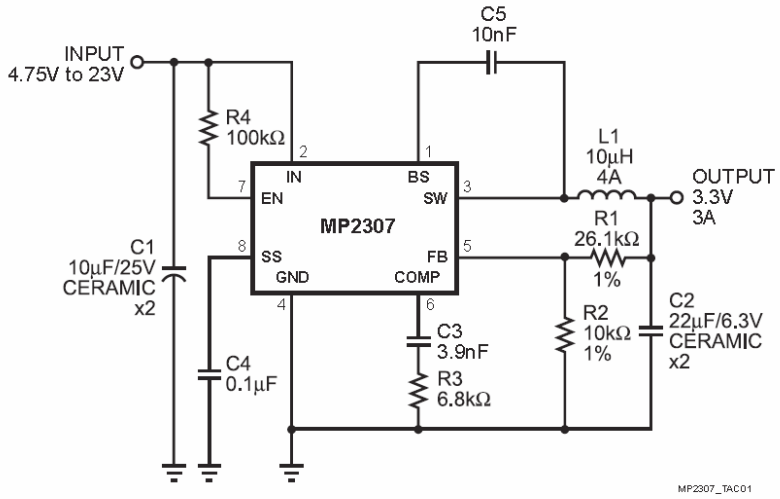
A simple, low cost, conversion of incandescent-lamp illuminator to a power LED

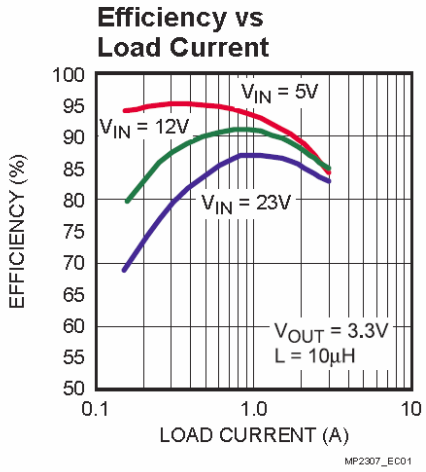
By Dushan Grujich, on October 15th. 2012

My LOMO microscope, Biolam 70, has come with the OI-32 illuminator, using a 220 VAC 15W incandescent-lamp, which, when used for longer period gets very hot to the touch and it also heats up the scope frame as well as the object. This situation had me thinking of replacing incandescent-lamp with a power LED. I experimented with the use of power LEDs, as a conclusion I have made a simple carrier for the LED that mounts inside the body of the OI-32 (no modifications to the OI-32 housing were needed).

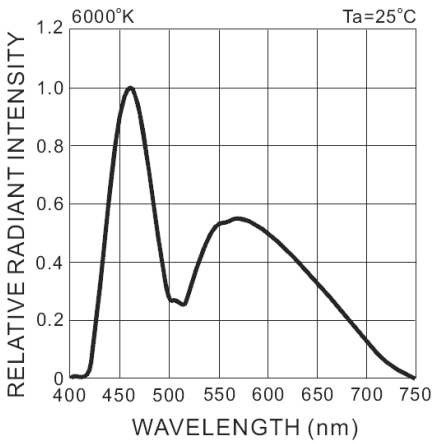
To drive power LED I have used a low cost 10 W DC-DC Step Down Converter KIS-3R33S module, capable of delivering up to 3A continuously. Module comes with output voltage preset to 3.3V, however it is easy to readjust and have output set at any voltage from 1.21 V – 10.43 V and if modified then up to 20V.

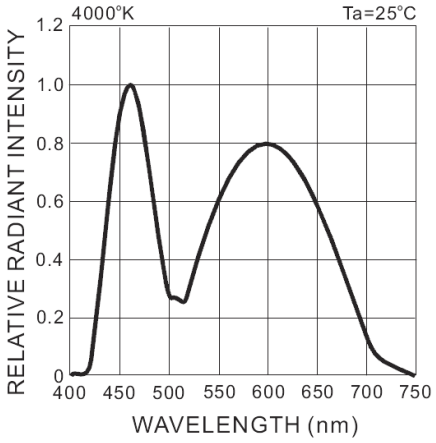
TYPICAL APPLICATION





TYPICAL ELECTRICAL OPTICAL CHARACTERISTICS CURVES





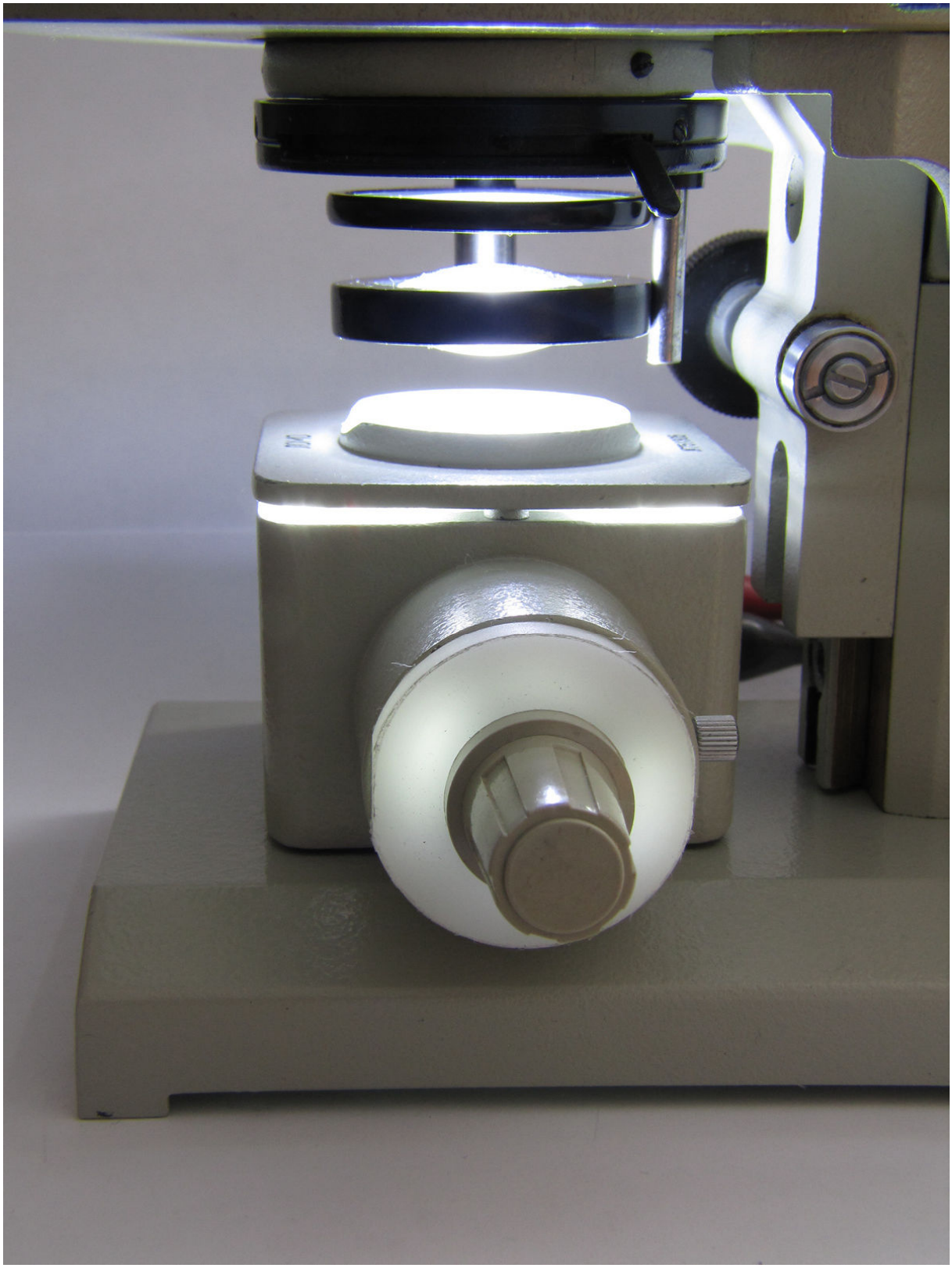


Fig. 1 - Completed conversion with illuminator in use

The final choice of LED was 1W “Pure White”, 150 lm with colour temperature of 6000º K., to avoid using blue filter and because 15 W lamp, as used originally, is rated 90 lm at 230 VAC.

For power LEDs, the one-watt HPB8-49KWHB rated 150 lm and three-watt HPB8b-49K3WHB rated 235 lm, the electrical characteristics specify maximum continuos forward voltage at 3.6 and 3.7 V for one-watt and-three watt LEDs respectively. Accordingly, I have chosen to limit the maximum output voltage of the module to 3.6V and 3.7V so that it will suit both power LEDs and the only change is the resistance of the potentiometer, 220kOhm for one-watt and 470 kOhm for three-watt.

Because module comes preset at 3.3V output, there is need to modify it in order to achieve the rated LED output power. I also wanted to have the means of LED brightness adjustment. Necessary modification consists in the removal and replacement of three SMD resistors and it was done as follows.

Resistors R3, R4 (both marked 513 i.e. 51 kOhm) and R6 (marked 332 i.e. 3.3 kOhm) should be removed, and replaced. R3 and R4 with 39 kOhm and 180 kOhm (order of placement is unimportant as they are connected in parallel). Resistor R6 should be replaced with one of the 51 kOhm resistors removed from R3 or R4 positions.

The only additional components are the logarithmic tracking potentiometer VR1 220 kOhm (470 kOhm if 3W LED is used to bring up output voltage to 3.7 V), connected externally, and optionally a switch can be connected from ground GND (marked on circuit diagram and component layout) to terminal EN which when switch is engaged turns off the DC-DC converter. In addition, two ceramic capacitors 10uF /25V should be connected across VIN and GND and across VOUT and GND.

The value of the resistor R6, chosen to prevent voltage output falling below 2.70 Volts as below that value LED will cut off. Combination of resistors R3, R4, R5, R6 and VR1 determines the output voltage according to the following formula:

Vout = (((R3||R4||(R6+VR1))+R5)/R5)*0.925

Resistors R3, R4, R6+VR1 (R6 is connected in serries with VR1) are connected in parallel and are actually acting as one resistor. To calculate value of two or more resistors in parallel:

Rx=1/(1/R1+1/R2+1/Rn)

in our case Rx=1/(1/R3+1/R4+1/(R6+VR1))) so Vout becomes:

Vout = (Rx+R5)/R5)*0.925 (where R5 stays unchanged, as is, 10 kOhm)

Different LEDs from different manufacturers operate at different maximum continuous voltage, which in turn determines the maximum current flowing through the LED, so we need to limit the voltage output from the KIS-3R33S module, to protect LED, to provide stable light characteristics.

LED is positioned, inside the housing, at the exact place where the incandescent lamp filament was. To improve overall performance of the illuminator and to achieve even more flat and uniform illumination, it was suggested to place a ground glass filter just above the LED.

I have machined a “plug”, out of Delrin, to mount the potentiometer at and to close the opening where the incandescent lamp was originally located.

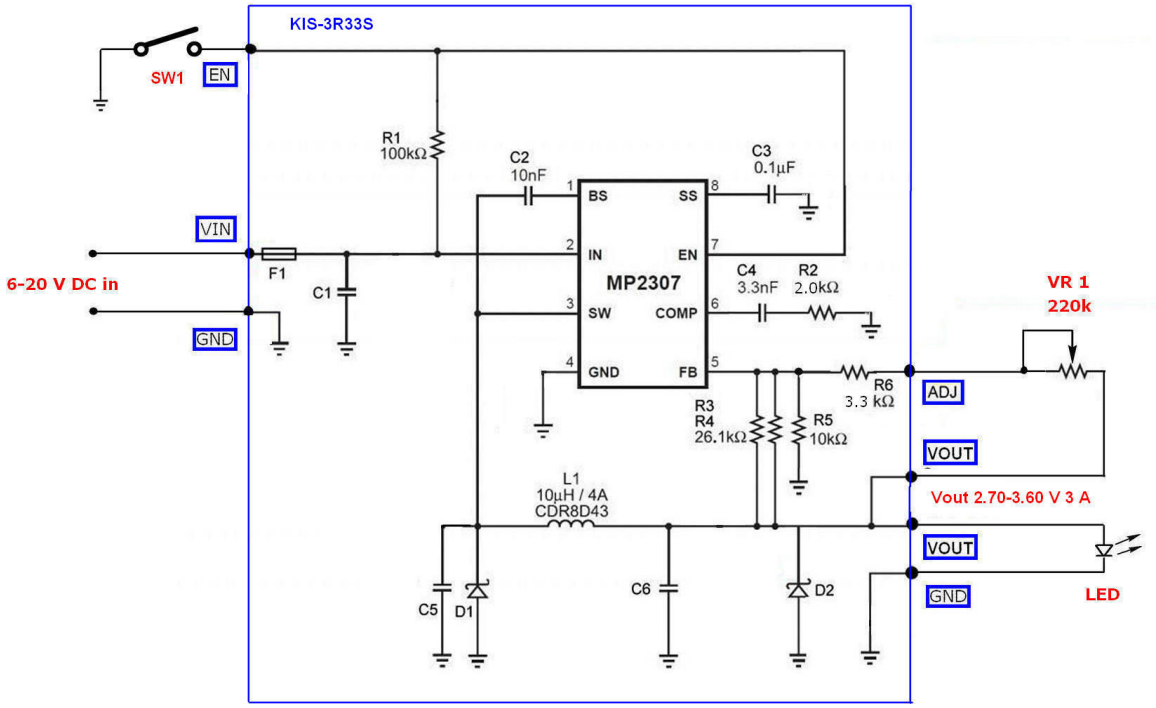
The module is very small, measuring 21x22x10 mm total. To assemble the unit and to enable mounting it in a box together with a switch and potentiometer one can use a small piece of proto board. Centre distance between soldering pads is 0.1" (2.54 mm) and terminals of the module correspond to the grid and are easy to solder to the pads. Connections between pads are made by jumper wire, as needed.

Parts required:

KIS-3R33S module		1 pc.	
Power LED	1W or 3W	1 pc.	
Resistor SMD 603	39k	1 pc.	
Resistor SMD 603	180k	1 pc.	
Potentiometer	220k log	1 pc.	– use with one-watt LED
or	470k log	1 pc.	– use with three-watt LED
Capacitor X5R SMD 1206	10 uF/25V	2 pcs.	
Switch SPST		1 pc.	– optional
Proto board	size depends on the box used		

References:

1. HPB8-49KxWHBx data sheet - HUEY JANN ELECTRONICS INDUSTRY CO., LTD.
2. HPB8b-49K3xWHBx data sheet - HUEY JANN ELECTRONICS INDUSTRY CO., LTD.
3. MP2307_r1.9 data sheet - Monolithic Power Systems, Inc.



Vout=(((R3||R4||(R6+VR1))+R5)/R5)*0.925

KIS-3R33S - 3A DC-DC Step Down Coverter

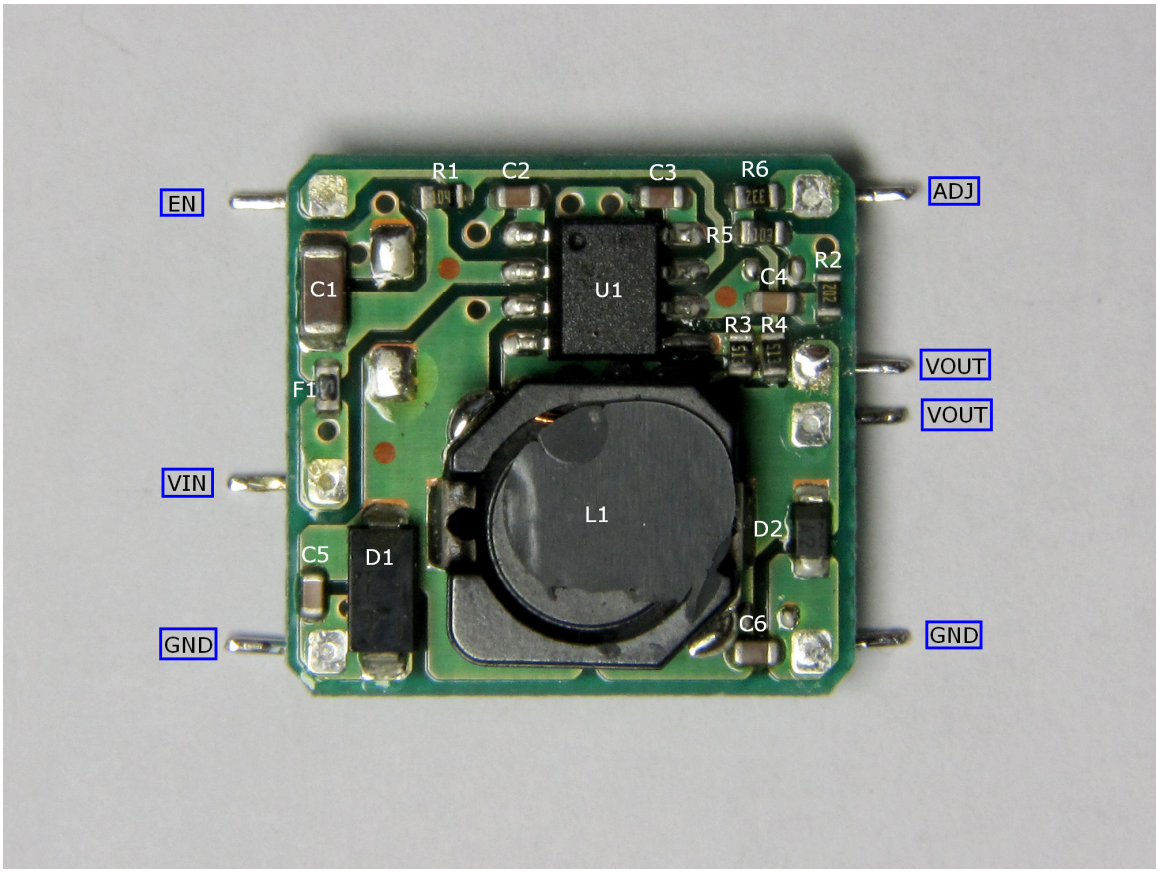


Fig. 2 The component layout

Fig. 3 OI-32 Illuminator

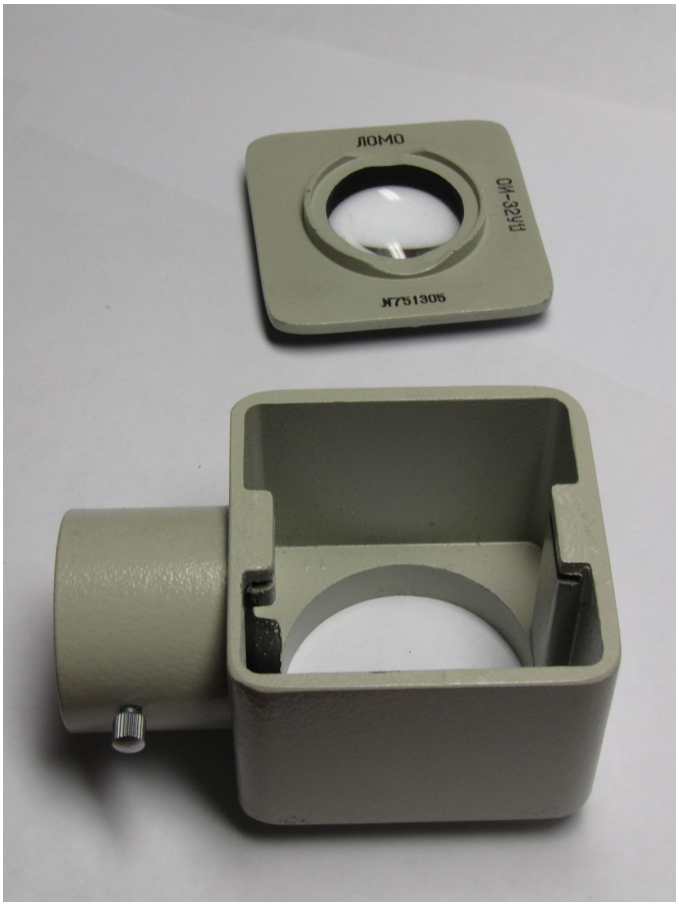


Fig. 4 Condenser plate removed

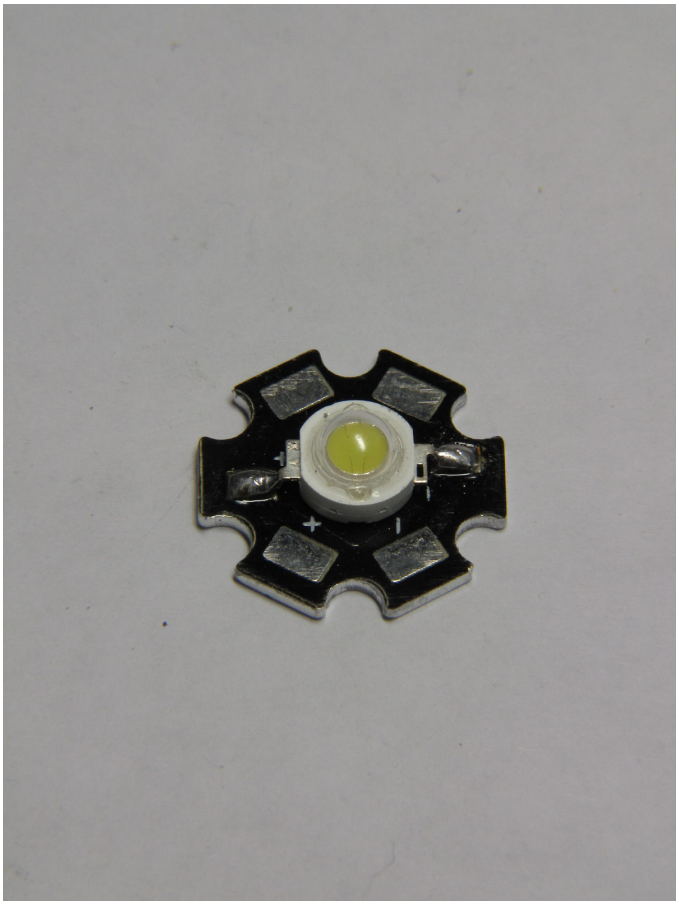


Fig. 5 1W LED

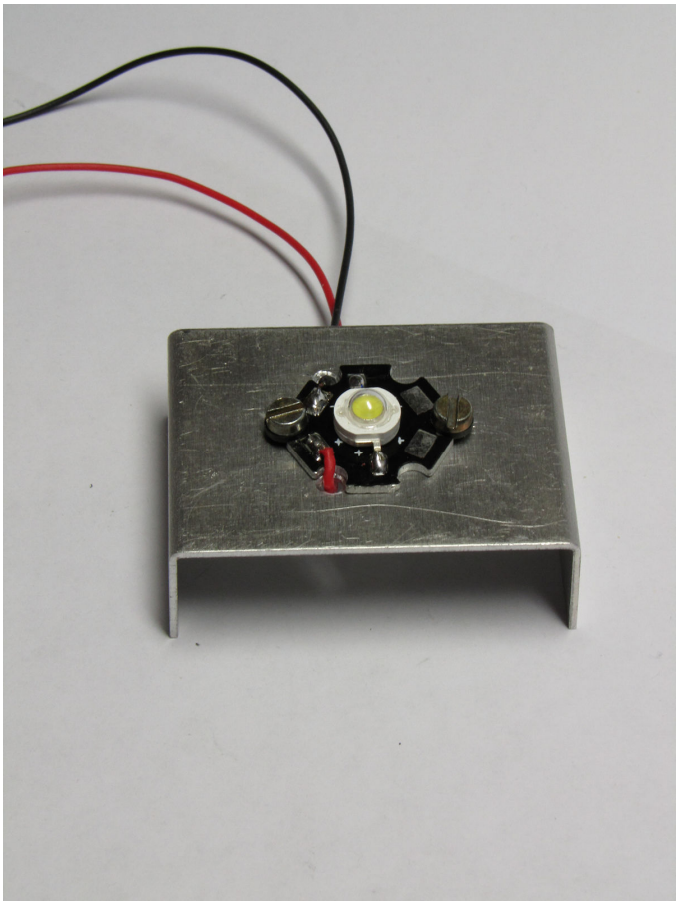


Fig. 6 the 1W LED mounted

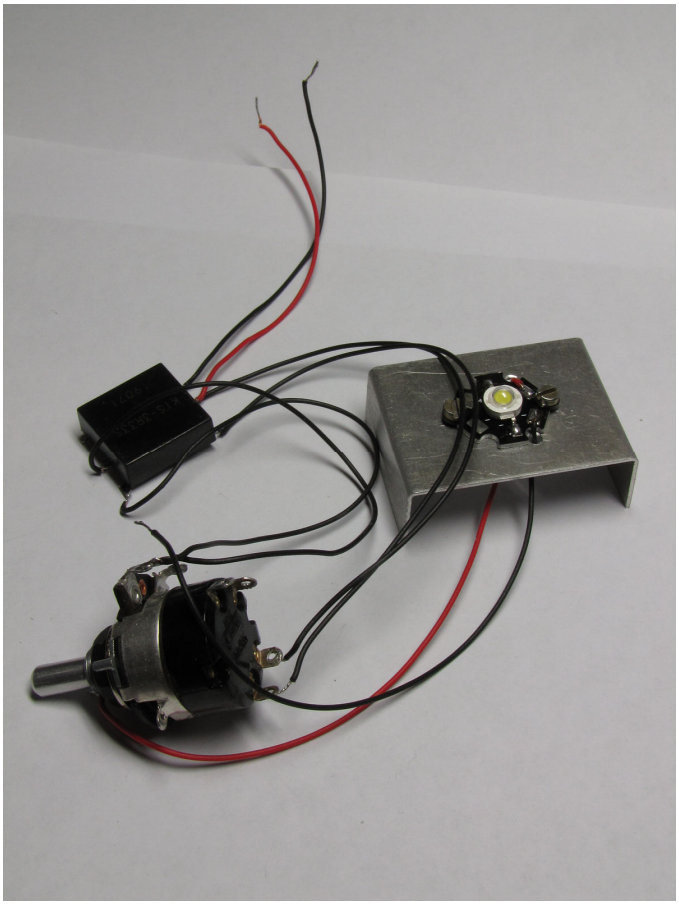


Fig. 7 driver module and LED wired for testing

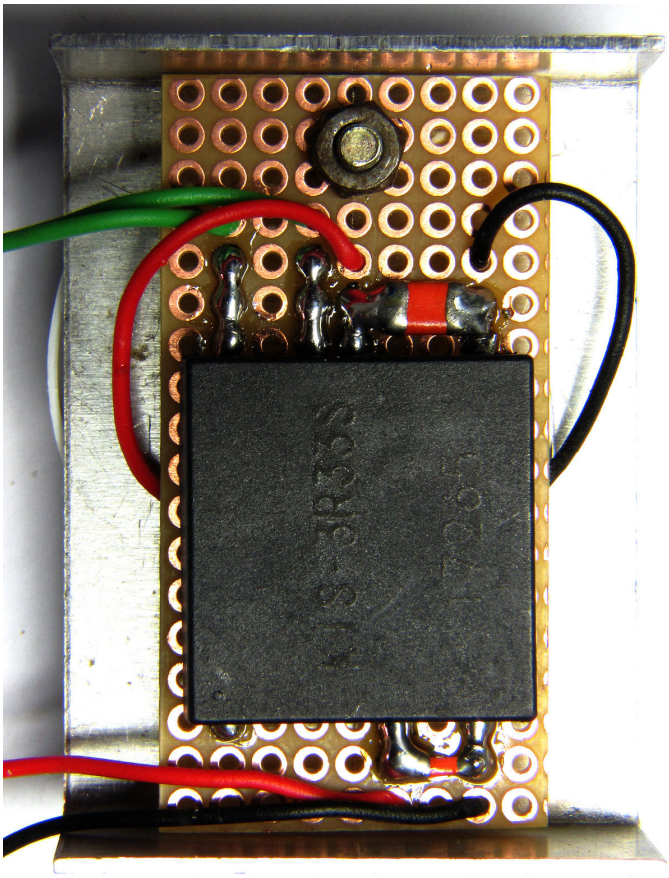


Fig. 8 Driver module mounted on the back of the carrier/heat sink

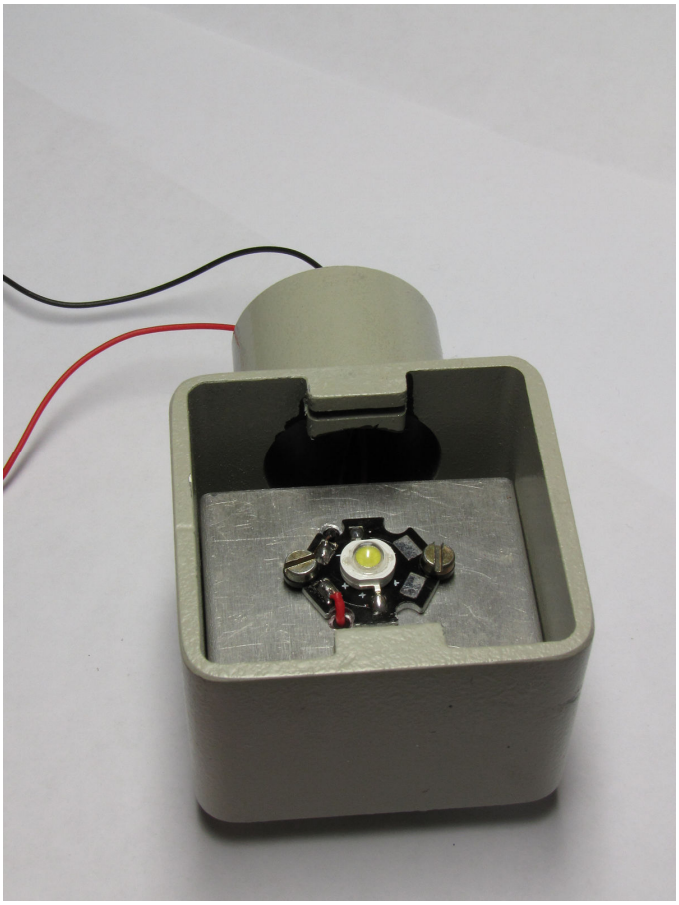


Fig. 9 LED assembly mounted and centred inside the illuminator housing

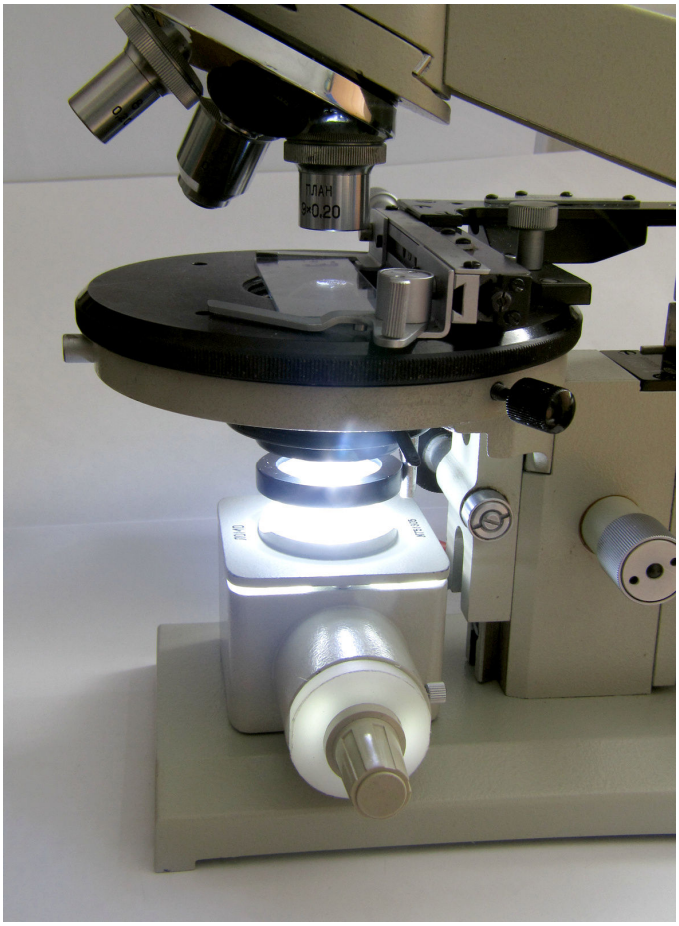


Fig. 10 Illuminator finished and placed in its cradle with a pot mounted in a Delrin plug ready for use