

LVR2 Kit Instructions Revised 6/28/98

Start by soldering the 2 SMD's (surface mount devices) U1 & U2 to the PCB. See LVR2 Parts Placement sheet for position and orientation information. Next, insert the bottom row of diodes and resistors by alternating the bodies of each part either to the top or bottom of the PCB, and note that some diodes will have anode down and some up. Proceed by soldering that row, and trim the leads. Next, insert, solder and trim the middle row of resistors the same way. After this the rest of the components can be place and soldered. R10 will select your bulb voltage and can be remotely switched to different resistors if desired. See chart on LVR2 Parts Placement sheet for values. Install the power FET with leads bent down, label facing up, and its body totally hanging over the top edge of the PCB. Finally, install the 1000 uF (or larger cap for higher power applications) either below the PCB, above the PCB, or hanging above the power FET.

NOTES:

- The 2 SMD's labeling must be right side up, with the PCB power FET up.
- LM385Z labeling must face the inside of the PCB.
- C1 positive (stripe) must point down the PCB.
- D2 cathode (stripe) must point to the left.
- D1, D4, & D5 cathodes (stripe) must point up.
- D7 cathode (stripe) must point down.
- C2 negative (stripe) must be in the CAP- or BATTERY- hole for proper polarity.

Once the unit is fully assembled, hook the unit up to a power supply or battery pack which is greater than the your selected bulb voltage to BATTERY + and -. NOTE: all measurements referenced to node BATTERY- (schematic GND). Check that node +C is 0 volts. Next connect a load light bulb or resistor (can be as much as 10K) between BULB + and -. NOTE: that BULB+ is the same as BATTERY+, so the bulb is NOT ground referenced. Now check that node +C is the same DC voltage as the power supply voltage. Next, check that node VREF is one half of your bulb voltage. Next, check that node OSC is approximately a 250 Hz triangular wave on an oscilloscope (or check that PIN 8 U2 measures less but around 1/2 of +C on a DVM on AC scale). Next check node DRIVE for a PWM signal, by varying the power supply up and down (or see below with a DVM). The PWM should reach 100% high at the bulb voltage. The PWM should be 25% at twice the bulb voltage. Set the power supply to near the selected bulb voltage and hook up a light bulb. Turning the supply up should not change the bulb brightness. When the supply is turned down to the bulb voltage the bulb should start flashing about once per second. Now, the unit is ready to use.

If you want to measure the output voltage with DVM you will either need a DC coupled true RMS volt meter (most true RMS DVM's are NOT DC coupled!), or you can make 2 measurements with a inexpensive DVM, and determine the output voltage. Start by connecting at least a 10K load or light bulb to the unit. Measure on a DC scale the average DC voltage of the battery (BAT), then measure the average DC voltage of the bulb output (OUT). Use these formula:

$$\text{Duty Cycle} = \frac{\text{OUT}}{\text{BAT}} \quad \text{RMS Output Voltage} = \frac{\text{---}}{\text{V}} \text{ BAT} * \text{OUT}$$

Quan	Ref	Part Number	Value	Notes
1	U2	LMC6464	Quad Op Amp	Low Voltage Option (3 V min input) Standard Voltage (5 V min input)
1	U2	LM324	Quad Op Amp	
1	U1	74C14 or 40106	Hex Schmitt Trigger	
1	Q1	IRL3803 or Si9426DY	Power FET	
1	U3	LM385Z	Adj. Voltage Reference	
4	D1 D4 D5 D7	SD101	Schottky diode	Low Voltage Option (3 V min input) Standard Voltage (5 V min input)
4	D1 D4 D5 D7	1N914 or 1N4148	Signal diode	
1	D2	1N4744	1W 15V Zener	
1	C2	Electrolytic Cap	1000 uF 16V	
1	C1	Tantalum Cap	2.2 uF 25V	
3	C3 C4 C6	Monolithic Cap	0.1 uF	
1	C5	Monolithic Cap	4.7 nF	
1	R5	1/8W 5% resistor	100ohm	
1	R15		4.7K	
3	R8 R16 R21		100K	
5	R1-4 R13		510K	
1	R18		10M	
3	R11 R12 R14		1/8W 1% resistor	
1	R6	133K		
2	R7 R9	200K		
1	R17	332K		
1	R17	340K		
1	R10	BULBR		

LVR2 Installation Notes Revised 6/28/98

If you have purchase an assembled and tested (A&T) LVR2 and specified your bulb voltage, then the unit was shipped with the bulb voltage preset to your needs. If not, you will need to set the bulb voltage by installing an appropriate value for R10 which can be calculated as follows (or look on Part Placement Sheet table):

$$R10 = 160Kohm * ((Bulb-Voltage / 2) - 1.25)$$

If you have purchase an assembled and tested LVR2 you will notice that the unit has four wires (2 red, yellow, and black) soldered onto the PCB. These wires connect up as follows:

One RED wire	connect to battery positive	node BATTERY+
BLACK wire	connect to battery negative	node BATTERY-
Other RED wire	connect to one side of bulb	node BULB+
YELLOW wire	connect to other side of bulb	node BULB-

Note that since the BULB+ is the same connection as BATTERY+ you must be careful not to have the BULB- shorted to the BATTERY- through common metal frame connection, which can happen with some lighting systems. In other words the LVR2 has a positive common, NOT negative.

The LVR2 must have the battery connected in the proper polarity. If it is connected backwards it will almost certainly damage the unit, and likely the wiring too. If you use polarized plugs on your battery this should not be a problem. If not, you should consider installing a fuse between the LVR2 and the battery, and also install a large amperage diode for reverse polarity protection. The maximum input voltage is 15 volts. Exceeding this will damage the unit.

The LVR2 is designed to dim up the bulb when it is connected to the unit via some switch already installed in the headlamp. If you are using more than one bulb on a single LVR2, then only the first bulb turned on will be dimmed up. The LVR2 automatically senses if the bulb is connected and turns itself on or off. It takes about one second for the unit to turn itself off after the bulb is disconnected. If your headlamp does not have a power switch then either put in between the bulb and the LVR2 or use the LVR2's FET to switch the bulb power. To do this, disconnect the BULB- side of R21 and connect it through a low current switch to the BULB- node. Then you do not need the power switch between the bulb and the LVR2. This has the advantage that power is not wasted in the power switch.

I do not recommend using a power switch between the LVR2 and the battery, because sudden increases in input voltage while the unit is powering a light bulb, can result in burning out the light bulb when a high voltage battery is use on a low voltage bulb. This can happen because of the regulator response time is slower than the rapid increase in input voltage.

C2 is shown to be a 1000 uF capacitor in the schematic. Depending on your battery type (Alkaline, SLA, NiCad), battery voltage, bulb voltage, and bulb current, this capacitor may need to be larger. If you specified your setup when purchased, then the unit was shipped with an appropriate capacitor. For some low power applications it can be much smaller as well. For a 15 watt, 6 volt bulb running on a 12 volt SLA, I recommend about 3300 uF. This capacitor value isn't critical, but if it is too small it will slightly affect the LVR2's regulation. The capacitor virtually can not be made to large.

If you are using the LVR2 with loads above 7 amps total, I recommend a small TO-220 heatsink for the power FET (Q1). If your loads are above 10 amps, then a heatsink is needed. If you specified this when ordering a A&T unit, then the power FET will come with an appropriate heat sink.

If you want to measure the output voltage you must have a 10K load or less resistance (IE light bulb) connected and you will need to use the procedure on the LVR2 Kit Instruction's page. If your unit has the 12V SLA cutoff then the load must be below 100 ohms.

If you want to disable the low battery flashing function change R21 to a 1K. If you want to increase the flashing depth, increase R21 to 200K or 510K.

If you have any problems, questions, comments, please feel free to contact me at:

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READ THIS!

IF YOU THINK YOUR UNIT MIGHT GET WET, PROTECT IT!

The LVR2 must be protected from water. It can be put in a box (battery case) or potted. If it is potted, use a material designed for electrical potting or a material that you know has been tested. Standard silicone rubber will corrode the unit. However, Plasti-Dip tool handle coating material works well for this purpose and is available at most hardware stores. This is what I use to coat LVR2 if purchased it with the optional water resistant coating.

If you chose not to coat or pot your unit you should put it into some sort of enclosure. Headlamps like a Petzl provide a nice enclosure which will keep direct water off of the unit. The box you chose need not be water tight if you know you can keep water from getting directly on the printed circuit board. One problem with a "water tight" box is that if it is not completely water tight, water will tend to build up in it, where as a non sealed box it will evaporate and dry out. Condensation in a non sealed box can potentially be a problem, but distilled water has very high resistivity and as such I haven't noticed this to be a problem. For water immersion use like caving, potting or a sealed box is needed. For diving, a pressure vessel must be used.

RELIABILITY

I have been selling these units for 5 years now and the only failures that I know of have been either broken wires or water damage, except for one bad IC. The electronics are very reliable, much more so than most of the rest of the lighting system.

USE A GOOD QUALITY BATTERY HOLDER

If you are using an after market battery holder, you will be much happier down the road if you use a good quality holder. The cheap plastic holders that are sold at Radio Shack will not last long before the plastic case splits out. Also, these holders can not handle much current before the wiring gets hot and melts into the plastic. Mouser Electronics and Digikey both sell metal battery holders made by Keystone Electronics. These are the best holders I know of, and are still reasonably priced. For caving applications, I recommend soldering to the batteries. I have found it to be the only reliable battery connection.

CAUTIONS ABOUT USE

If the power is connected backwards to the LVR2's 15 volt zener diode will short quickly. This 10 cent part will save the rest of the unit from damage, but you will need a soldering iron and a replacement to fix the unit. So if you have battery connectors that can be plugged in backwards, be careful or replace them with polarized plugs.

If you are using lead acids or NiCad's you may want a fuse in series with the battery located near the battery. These batteries can deliver high enough current to melt your wiring if shorted. If the battery pack is under clothing, this could prove painful if the wire melted into your skin. On the other hand, careful wiring should prevent any short circuits and also fuses do have resistance and some power is lost in the fuse. I personally do not use fuses, but I mention this for people unaware of the possible hazard.

Although the warning flashing will tell you when you are at the end of the battery life, some battery and bulb combination may go out very fast once the battery has been depleted. I have noticed that with a single 9 volt alkaline and a 0.8 watt bulb that after more than 3 hours of constant brightness light, the bulb goes completely out in less than 5 seconds. This can be a bit disturbing, however if the light is switch off for a few seconds then a few seconds more light can be gotten from the depleted battery. I have found that NiCads and lead acids cause the bulb to switch from being bright to being dim but will not go completely out for quite a while. If you need to know how much battery life you have left, I suggest measuring your batteries with a volt meter. If your application is critical, a small analog meter movement can be connected to the switched regulator power and provide a continuous display of the battery condition.

Since the LVR2 is a switching regulator some radio frequency noise is generated. Although the emissions are well within FCC guidelines, there is still a possibility of interference with AM, FM, or two-way radios. If interference is suspected, try turning off your headlamp. Interference from the regulator would be noticed as a 250 Hz whine.

WARRANTY

I can not and do not make any warranty claims whatsoever. You must assume any risk should the LVR2 fail during use. You must assume any risk of injury or death cause by the failure of the LVR2 during activities such as but not limited to caving, cycling, climbing, diving, or mountaineering. If you use this unit in activities where lighting is life critical, you should have completely independent backup lights available. If you are not willing to accept this risk please send the unit back and I will refund your money.

However, I will repair a broken unit, normally for free, depending on what happened to it.