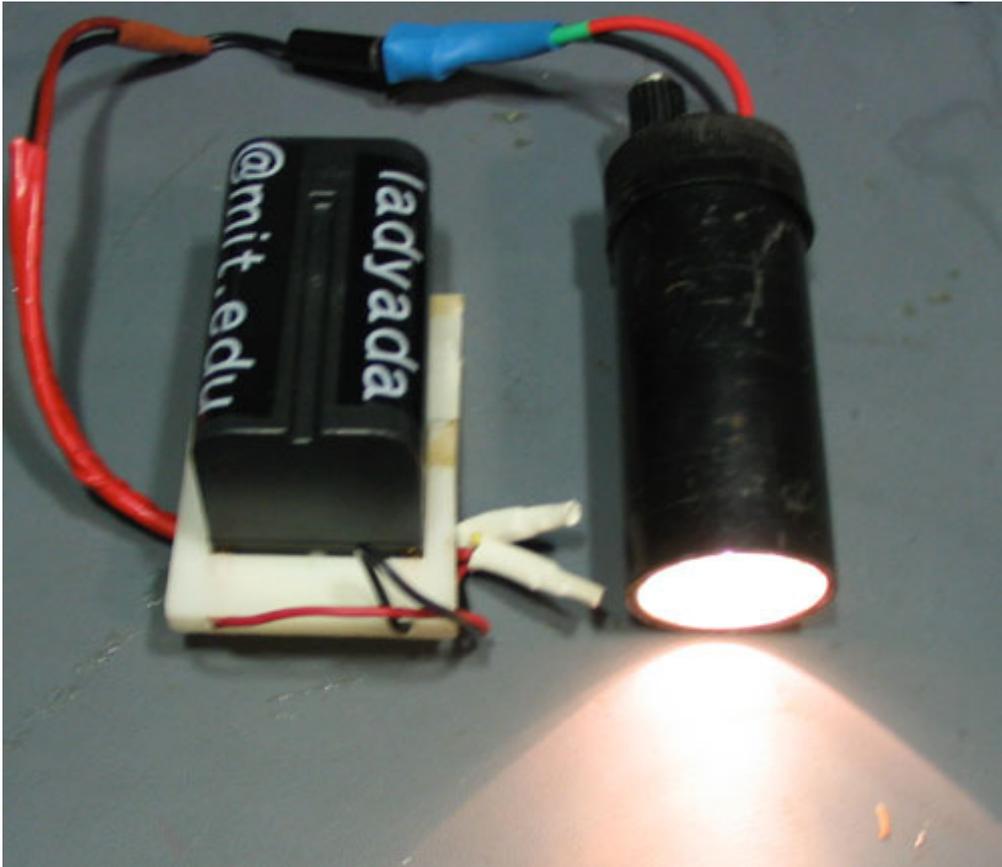




Dimmable Li-Ion Halogen Bike Light

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<https://learn.adafruit.com/dimmable-li-ion-halogen-bike-light>

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Overview

Dimmable Li-Ion Halogen Bike Light

Biking in the winter, or at night, is dangerous without a front light. A good front-light is essential, not only for being seen, but to see the road. LED lamps will not illuminate the road, and they can be too dim for cars to see you (1W or better LEDs are quite nice as headlamps.) I offer here a simple (but high-quality) design to build your own 5 or 10W halogen lamp, which runs off of a rechargeable 7.2V or 7.4V Lithium Ion battery pack.



Assembled light, with 10W halogen, and 3.5Ah 7.2V lithium ion battery pack (the nice battery holder was custom made for another project).

Lilon vs. Other battery types

Lilon are extremely light and small, much lighter/smaller than NiCads, NiMH and for sure Lead Acids. They can handle a couple hundred recharge cycles, are readily available (unlike LiPolymer) and work in cold weather. Another nice thing is their voltage starts at 8V and quickly drops to 7.2V, then stays there for most of the life, before dropping slowly to 6V. This means that overvolting your 6V lamp is really easy.

The bad thing is that you may not notice that the lamp is dimming before it abruptly turns off due to the internal undervoltage fuse.

Li-Ions are a little more delicate than most batteries and must not be over or undervoltaged. I use prepackaged batteries with protection circuitry inside. I would hesitate to use bare-back cells, as fires suck. Regardless, Li-Ions dislike giving burst charges, so you can't just connect your lamp to a battery with a resistor (or potentiometer) in series, as halogens will current-spike (5A? 10A?) if voltage controlled. Therefore you must use a current-control scheme as presented here.

You can buy Sony InfoLithium/Camcorder batteries (such as the NP-F550/F750/F950 formfactor) off of [EBay \(https://adafru.it/c7y\)](https://adafru.it/c7y) for cheap, you can connect to them with mini banana plugs. (Or by soldering directly if you are really really quick and have everything pre-tinned, I don't advocate it unless you're safe!)

Halogens vs. Other lamp types

There isn't really any other reasonably priced options available right now, 5W [luxicons \(https://adafru.it/c7A\)](https://adafru.it/c7A) are \$50 and the white ones don't last more than a couple hundred hours. They are more efficient than the MR-11's I use, but the best is really to go with an MR-16 10W if possible. I had trouble finding a 6V MR-16 bulb, so I stuck with MR-11. Most 'professional' bike systems use MR-11's because they are small and unobtrusive.

Bulb	5W Luxeon	6W MR-11	10W MR-11	10W MR-16	Efficiency (lum/W)	24	13.5	19	40
Output (lumens)	120	80	190	400					

You can overvolt by turning up the pot, for up to 10% overvolting (5% over-current), which will give you 40% more lumens but give you only 1/3 the bulb life. For more information about overvolting see page 8 of the [GE Halogen Guide \(https://adafru.it/Cco\)](https://adafru.it/Cco).

These bulbs are available from [Atlanta Light Bulb \(https://adafru.it/c7E\)](https://adafru.it/c7E) for \$6 each, make sure to get the right voltage, wattage, and with a coverglass.

Parts

There are a few parts necessary, but all of them are pretty easy to get.

Part Name	Use	Cost	Where to Find
Halogen Lamp	light	\$6	Lighting store/Online
MR-11 Socket for lamp		\$6	Lighting store/Online
Halogen Torchiere housing		\$0	In trash
Solid Core/Stranded Wire	Wiring circuitry & Battery	\$0-\$5	Phone wire and thin stereo

hookup is fine Perfboard circuit substrate \$4 RadioShack, etc Lilon Battery power src \$20-\$60 EBay, electronics store

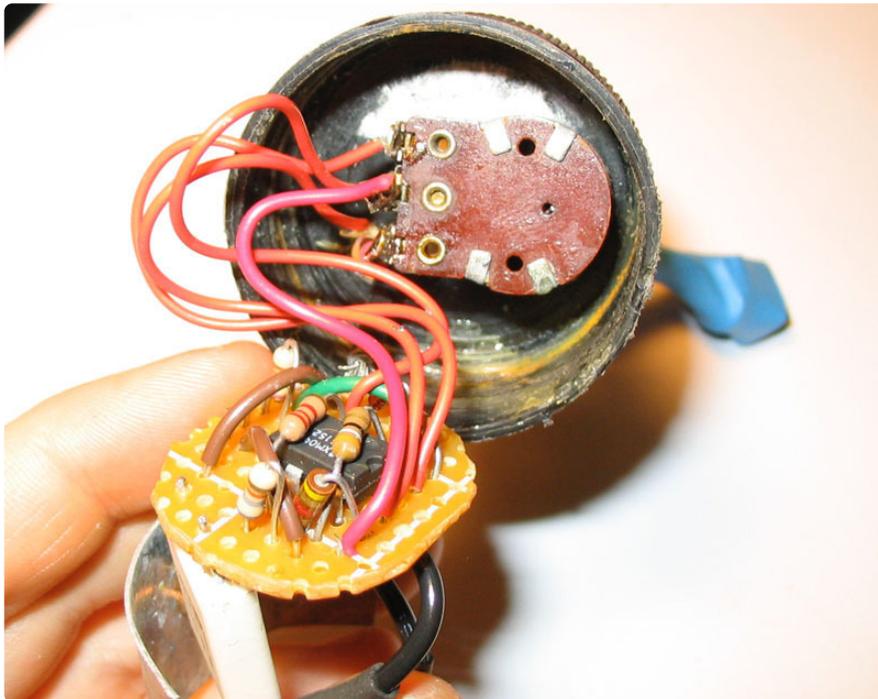
The rest are electronic components, all available from [DigiKey \(https://adafru.it/c8b\)](https://adafru.it/c8b).

Part Name	Part Number	Cost (each)
Rail-to-rail opamp	LMC6482IN-ND	\$2.05
Power P-FET	IRF9Z30-ND	\$1.28
5.1 Zener	1N5231BDICT-ND	\$0.36
10K Pot w/Switch	270X232A103B1B1	\$3.48
0.1ohm 1/2W sense resistor*	605HR100-ND	\$0.42
Mini Banana plugs	J457-ND	\$1.42
DC Jack (for battery connection)	CP-102A-ND	\$0.38
DC Plug (for battery connection)	CP-002A-ND	\$0.38
Various resistors	Search website	\$0.10

* If you're using a 10W or less bulb, 1/2W is ok. Otherwise, 1W is best.

Circuitry

If you plan to build the housing out of halogen lamp tube (35mm I.D.) I would suggest getting a piece of perfboard, perforated prototyping board and cutting it into a circle that will fit inside the tube, then soldering all the parts. This requires a little bit of foresight, and attention as it's hard to remember what pin is what.



The opamp is in the center, with the sense resistor and FET pointing down, the potentiometer has 5 wires because it has a built in switch.

Download the schematic from the download page. Look at it and place all the pieces before soldering anything! Place the 8-DIP opamp first, about center, then place the FET, on the perimeter so that the heat sink will press against the housing, then place

all the resistors. Remember that the 0.1 ohm resistor must be precise in value and 1/2W or 1W (at least) otherwise known as a 'sense resistor.' In the pictures, the white ceramic tablet is the resistor, and the metal sheet is the heatsink for the FET.

Preferably, the potentiometer and on/off switch should be in the same package. Make sure the pot is linear taper, not log/audio taper.

Use solid-core wire when making jumper-wires on the board, and stranded for wires that go to the pot/switch/lamp.



The other side of the circuit board, showing the heat sink, and the large sense resistor. Also, the lamp socket is visible in the top lefthand corner.

To connect to the lamp, you can either (carefully) solder directly, or get a socket. The lamp should last a really really long time (1,000hrs at least) so there's nothing particularly wrong with connecting directly to the lamp. Just make sure you can still assemble it (read the housing assembly instructions since a ring needs to go between the board and lamp).

I didn't include a fuse, but you may want to. (A proper Lilon battery is current limited anyways, which is why the whole system is current-controlled.)

Use heat-shrink liberally when necessary, not electrical tape. Electrical tape doesn't hold as well.

Plug in the lamp and give power to the system, verify that it works, there should be a ~150mV drop across the resistor, and a voltage that is 32 times that on pin 7 of the op amp. There should be 5V at pin 2. Turning the pot should dim/brighten the lamp. (Hopefully)

Housing & Retainer

Find a thrown-out/broken torchiere halogen lamp, the kind that are 7ft tall and break all the time. This should be trivial, as they are cheaper to replace than repair. Check that the I.D is 35mm (1.4"). Cut a piece that is between 3" and 3.5" long that includes a set of threads. Also take one or two of the interconnect threaded pieces.



One end of the housing should have a full set of threads, the two rings are visible in the background.

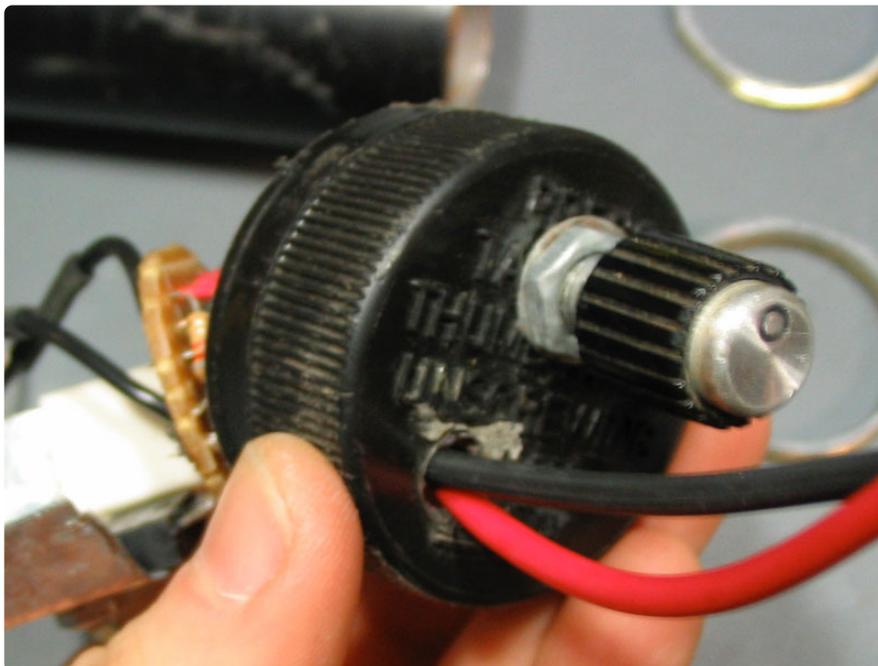
Cut the interconnect so that you have two rings with three threads (or one with four and one with two). Debur/file everything. Thread one of the rings in all the way in, then place the lamp in so that the ring holds it and thread the other piece in, verify that they are the correct size.



One of the filed rings inside the housing.

You can put a gasket in if you'd like, to make it more waterproof.

To cap the other end, find a plastic jug cap that is 1.5" diameter. These are surprisingly common, and I got mine off of a thrown out motor oil container. Cut the threads out with a dremel or knife. Drill a hole and mount the potentiometer. Drill another hole to let the two battery connect wires through.



Final Assembly

To assemble, push the circuit board in, using the heat sink to hold the board in place (the heat sink presses against the sides of the housing).



Push the cap onto the end of the housing.



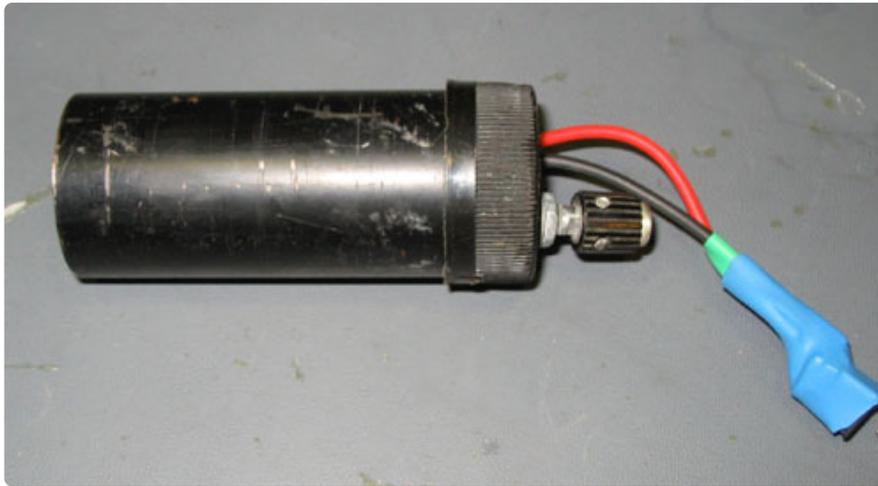
Then thread the inner ring, plug the lamp into the socket (or solder it in).



Then thread on the last ring.



If you don't think you'll open it again, you might want to put a drop of threadlock or superglue, to keep it from unscrewing. Ducttape the cap, and hotglue/epoxy the hole where the battery wires emerge.



I soldered on a DC jack onto the end and shrink wrapped it all.

Schematics

- As an [Eagle](https://adafru.it/c3Y) (<https://adafru.it/c3Y>) [schematic](https://adafru.it/cnq) (<https://adafru.it/cnq>) file

Or just click on the image below to get the embiggened BMP

