Build a 9 volt battery torch

This kit makes good use of the 9 volt batteries normally discarded when you change the batteries in your smoke detectors.

Most 9 volt batteries removed from smoke detectors are only partly discharged—often they have 60% or more capacity still left in them. These batteries are small, and being alkaline or lithium, they are ideal as the basis for a pocket torch or emergency flasher.

The 9 volt battery kit is a very simple kit that consists of two LEDs, a resistor, a trimpot and a 4 position slide switch, all mounted on a 17mm x 27mm PCB, along with two battery terminals. You can use any 3mm or 5mm LEDs you like, and so can build the unit up as a torch with a narrow beam, or a lantern with a wide beam, or even as a flasher with a combination of flashing LED and normal LED. We've even tried it with two flashing LEDs, and they flash at their own rate, not in sync, despite being connected in series—not what you might expect!

The circuit will discharge the battery down to 3 volts or less, depending on the type of LEDs used, before they become too dim to use. This represents a much larger portion of the usable battery capacity than a smoke detector will use.

How it works

The circuit is quite simple. When the switch is turned on to the two LED position ("Both" on the PCB), current flows from the battery through the resistor and through the two LEDs, back to the battery. And that's it! The 150 ohm resistor limits the current through the LEDs to around 20mA, depending on the LEDs used and the state of charge of the battery. If you are using LEDs with a relatively high voltage drop, such as white, blue or green LEDs, then you should use the 150 ohm resistor supplied. If using red or amber LEDs, you should use a higher value, say around 220 ohm, unless you want to run the LEDs at a higher current. In most cases, they should be okay.

When using the torch on a full battery it is recommended that you always use both LEDs until they start to get too dim. Then you can use the torch in single LED mode ("One" on the PCB), which will allow you to discharge the battery almost completely. Running the torch in single LED mode with a full battery will result in a LED current of up to 50mA, which may damage some LEDs and may reduce their lifespan.

The third switch position ("Low") allows the LEDs to run via the 150 ohm resistor plus the 10k trimpot. The trimpot allows you to vary the current down to as little as 1mA or less, giving a moonlight mode. A good quality 9V battery will run the LEDs in this mode for around two weeks, so they are ideal as marker lights in this mode.

Building it

There isn't much to building this kit, just put the components into the board at their appropriate places and solder them in place. **However, you must start with the battery terminals.**

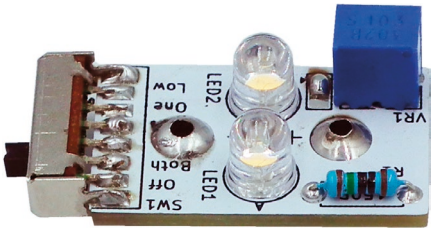
The female terminal (the larger one) goes at the +ve position on the board (closest to the resistor), and the smaller one goes at the –ve position, next to the switch. The terminals mount underneath the board, not on the component side.

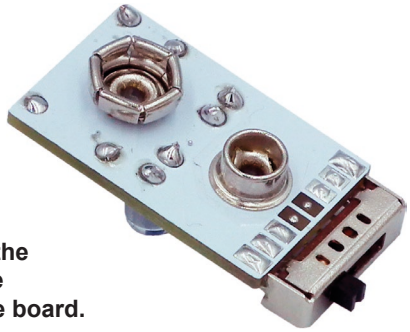
Fitting the terminals is a little tricky, but the female terminal is easiest, so start

with that. Firstly, place one of the rivets through the terminal, from the front (the side that mates to the battery) to the back. Now position the terminal and rivet so that the shaft of the rivet is aligned with the +ve hole in the board, and press it in until it grips the inside of the hole. The rivets are usually a press fit, so you now need to place the board over some form of support—the slightly open jaws of a vice, or a block of wood with a small hole a bit larger than the rivet shaft drilled into it.

Note: the rivet manufacturer has adjusted the size down slightly on the latest batch, from 2.45mm to 2.40mm diameter, and so the rivets may not be a press fit. If you find this is the case, then you need to squeeze the rivet shaft with pliers to make it slightly oval—don't squeeze too hard or you may crush the rivet! This will allow the rivet shaft to grip the inside of the PCB holes without the need for too much force, but still firmly enough such that the rivet holds the terminal firmly in place.

Once the board is supported, press the rivet all the way through the hole until the terminal is seated tightly against the PCB—you should not be able to spin the terminal around—it must be tight to maintain good electrical contact. The ide-





At left you can see the component side of the board with the terminal rivets after they are soldered. At right is the terminal side of the board.

al tool for this task is a #0 or #1 Phillips head screwdriver.

Now you must do the same with the male terminal. However, as the rivets were designed to be used in the opposite direction to what we are using them (ie, inserted through a board, then the terminal, and crimped in place), you need to trim the head of the second rivet so that it will fit inside the male terminal. This will only take a few seconds with a pair of sharp side cutters. The best way is to trim the rivet head to a square shape, cutting most of each side off almost down to the shaft. The rivets are thin brass, so won't damage cutters designed to cut electronic component leads.

Once the rivet head is trimmed, use it to fit the male terminal to the PCB at the –ve position, once again making sure the terminal is tight against the PCB.

Once the terminals are in place, solder them on the component side of the board—this will take a bit of heat, and make sure the solder sticks to the rivet. There should be around 2mm of rivet shaft protruding through the board, which is more than enough to solder to.

The rest of the board is simple. Fit and solder the LEDs (make sure they are around the right way!) and the resistor.

Moonlight mode

At this stage, you have to decide whether you will be running one LED or two in moonlight mode. If you are using rechargeable 9V batteries, which tend to have a stable voltage until almost flat, then you should use both LEDs. This involves bridging the two solder pads next to the trimpot that are closest to the edge of the PCB (see Figure 1). If you are going to use disposable batteries, such as those from your smoke alarms, then you will be better off using a single LED for moonlight mode to make best use of the battery. So simply bridge the centre and innermost solder pads.

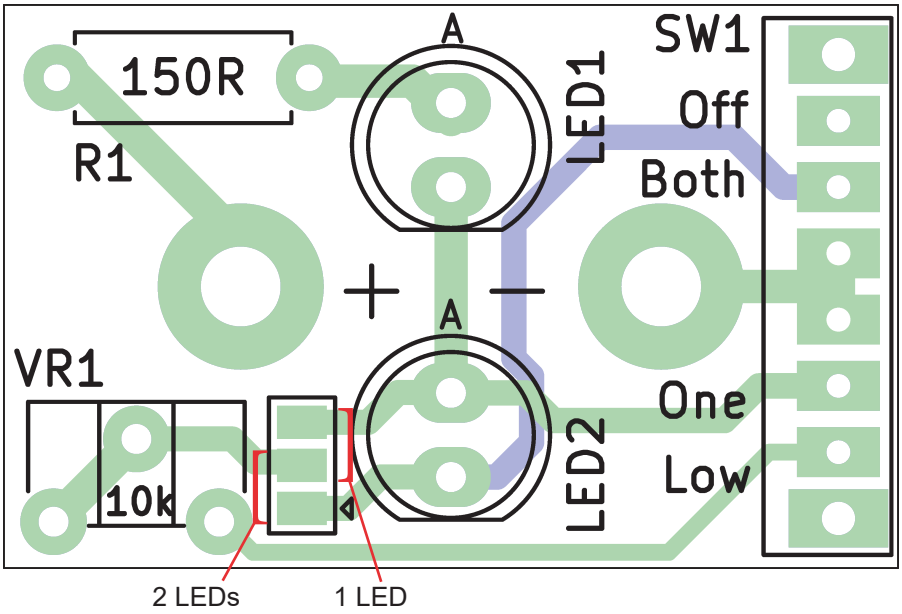


Figure 1. The torch PCB showing the solder pads to bridge for one or two LEDs in moonlight mode. Note that green is the front copper layer while blue is the rear copper layer.

Note that these pads should be bridged before installing the trimpot as they are more difficult to access once the trimpot is in place. Now install the trimpot.

The switch is the last item and the PCB is designed so that the switch is lying on its side. Position the switch on the top side of the board and solder one terminal, then make sure it is aligned and solder the two outer end case terminals—these might need a bit of heat, but make sure the solder flows onto them as they are the mechanical support for the switch. Then solder the rest of the terminals—you can press each pin down a little closer to the PCB pad with a suitable tool like a small screwdriver before soldering if you wish.

Once the torch is assembled, just click it onto a 9V battery and check that the three modes work as expected. Adjust the trimpot to the required LED brightness for moonlight mode (the LEDs get brighter as you rotate the trimpot clockwise) and you are ready to go.