# LED Torch

## semiconductor white light

Design by B. Kainka

**White light LEDs have been a long time in the making. This design (as part of our Mini Project series) employs a simple circuit to make the best use of the properties of these devices in a neat key-fob torch design.**


White light LEDs are an attractive alternative to the traditional tungsten lamp. They offer far greater reliability and efficiency but also have a much higher forward conduction voltage compared to red or green LEDs. This means that if you want to build a small key-fob sized torch powered by just one battery cell then it will be necessary to resort to a little electronic wizardry to increase the voltage to a level that will cause the LED to conduct.

### Pump up the volume

A voltage converter circuit (**Figure 1**) is all that is needed to drive the LED. You may recognise that it is based on the familiar astable multivibrator configuration. To explain its operation, when S1 is pressed a base current is applied to T1 via resistors R3 and R2 and causes T1 to start conducting. Resistor R2 will ensure that the collector voltage of T1 will be slightly above its base voltage. T2 will therefore also begin conducting and current flows through L1. Electrical noise on the base of T1 will be sufficient to make it start conducting harder, this in turn causes the collector voltage of T1 to fall to ground potential and switch T2 fully off. Current through inductor L1 will be interrupted and the voltage at T2 collector will rise above the supply voltage. LED D1 will now light when this rising voltage exceeds its forward conduction voltage (3.6 V). C1 couples this positive voltage pulse to the base of T1 to reinforce its ON state. The base current charge will now decay until T1 begins to turn off. Its collector voltage rises and with it the base of T2. T2 will now start conducting and current flows through L1 again. The negative-going signal will be coupled to the base of T1 to reinforce its OFF condition. The circuit continues switching alternately between T1 and T2 until power is removed. An important aspect of the design is to ensure that the circuit switches quickly, otherwise the stored energy in L1 will be dissipated by T2 instead of lighting the LED. After all, an LED is a Light Emitting Diode!

### Check it out now

The oscilloscope screenshot in **Figure 2** shows the voltage waveform across the LED (upper trace) and the current through inductor L1 in the lower trace. The horizontal timebase is set to 2 µs and shows that the waveform has a period of approximately 7.7 µs giving an operating frequency of 130 kHz. Conventional voltage multiplier circuits require a diode at the output to rectify the waveform but in this design the diode properties of the LED means that no additional diode is necessary.

The complete circuit draws approximately 20 mA from a 1.5 V battery. This is much less than you would expect from a standard torch

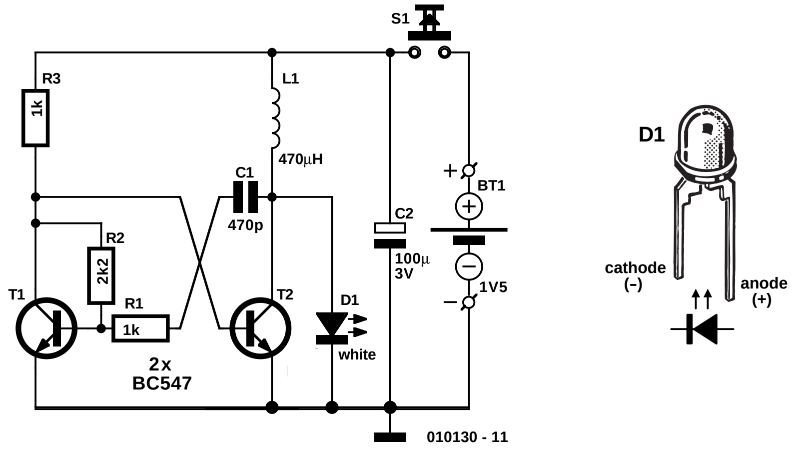


Figure 1. A multivibrator pumps up the voltage across the diode.

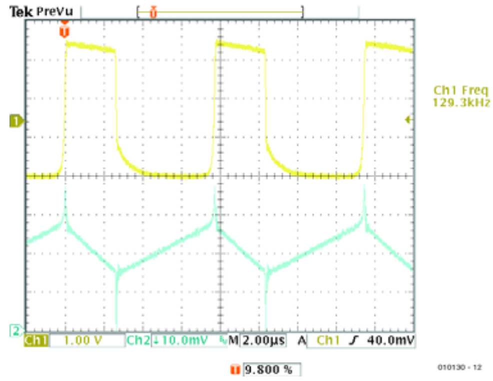


Figure 2. Oscilloscope screenshot of the voltage across the LED. (1 V/DIV).

using an incandescent light bulb. If this circuit were used with a 2,000 mAh alkaline battery it would operate for 100 hrs. The circuit is also tolerant of the falling supply voltage so that a useful output light level can still be achieved even when the battery voltage has dropped below 1 V. This gives you plenty of time to replace the battery and means that you will not find yourself suddenly left in the dark. One environmentally friendly aspect of this design is that it will operate quite happily with old batteries that have too little energy left in them to power a conventional torch. The circuit can also take a rechargeable battery in which case it should draw just 17 mA from a single 1.2 V NiCd cell. The actual value will be dependant to some extent on the quality and tolerances of the components used.

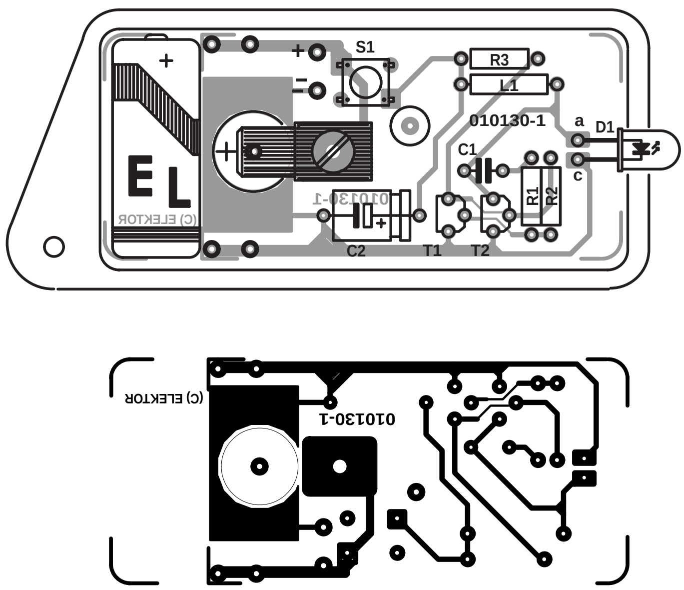


Figure 3. The PCB layout allows fitting of a button cell or LR1 type battery (PCB available ready-made).

## COMPONENTS LIST

**Resistors:**
R1,R3 = 1kΩ
R2 = 2kΩ2

**Capacitors:**
C1 = 470pF
C2 = 100µF 3V

**Semiconductors:**
D1 = LED, white
T1,T2 = BC548C, BC549C or BC550C

**Miscellaneous:**
L1 = 470µH miniature choke
S1 = pushbutton with 1 make contact
Battery (see text)
Enclosure (see text)
Battery mounting materials
PCB, order code **010130-1** (see Readers Services page and website)

PCB layout file available from Free Downloads section at www.elektor-electronics.co.uk

## Little boxes

The layout and construction of the circuit is not critical. A PCB (see **Figure 3**) is available from Elektor Electronics Readers Services. The original PCB was fitted into a UM14 enclosure but if you have difficulty finding this item, Farnell (www.farnell.com) stock suitable alternatives including the similar 1551KBK key-fob enclosure. The PCB provides a fitting for two types of battery, either an LR1 style cell (or any similar cell profile with a diameter less than 12 mm and less than 30 mm long). It may be necessary to modify the housing slightly to accommodate your chosen battery. Be sure that the casing cannot come into contact with any of the PCB tracks, if necessary use insulating material. Alternatively you can use a button cell type 675. This battery is usually fitted to hearing aids and has a useful capacity of 500 mAh at 1.4 V. If you decide to use a button cell it will be necessary to drill a hole through the PCB (see the title photo) for the cell and solder a contact strip to the PCB track-side together with an AMP clip on the component side to ensure a good contact with the battery.

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