Build a micropower LED flasher

There are many LED flasher circuits, but most will only run from a battery for a few days at most. This flasher will run for years!

Sometimes, you just need a simple marker flasher to let you locate an item in the dark. Or maybe you need to mark a path or trail, without the worry that the flasher battery will go flat at the worst possible time.

This flasher pulses a superbright LED and runs from a 3V to 12V battery. It uses almost no current and will run from a single PP3 9V "transistor radio" battery for years.

How it works

This LED flasher has an average current of less than one microamp and flashes the LED roughly once every two seconds. The low current means it can be used as an ultra-low-power indicator in places where an indicator is not normally possible, such as a power-on indicator in devices powered by lithium button batteries. A CR1620 cell has a usable capacity of about 70mAh, which will power this flasher for eight years.

The circuit is basically a relaxation oscillator. It charges a capacitor, then discharges the capacitor through the LED. There are three main sections in the circuit:

- A trigger circuit, which detects when the capacitor reaches full charge.
- A monostable, which generates a fixed-length pulse.
- A power stage to drive the LED.

The trigger circuit starts the monostable and the monostable's output drives the power stage.

The 1µF capacitor is charged over time, then powers the LED for each flash. It is charged mostly through 2.2MΩ resistor R1 and partially through Q2's emitter and base resistors (and its emitter-base junction).

PNP transistors Q1 and Q2, and the resistors around them, are the trigger circuit, which monitors the voltage across R1. As the 1µF capacitor charges, the voltage across R1 drops.

When it's below approximately 0.6V, the two transistors act as a Schmitt trigger, turning the gradually changing voltage across R1 into an abrupt signal at the collector of Q1 to start the monostable.

NPN transistor Q4 and PNP transistor Q5, along with the resistors around them and the 100nF capacitor, form the monostable circuit. The 100nF capacitor charges through R6 at the same time as the other capacitor. Q4 and Q5 are wired as a discrete thyristor (SCR); once it gets the trigger signal, Q4 starts to switch on, which makes Q5 start to switch on, and they hold each other on.

The monostable is powered by the 100nF capacitor, so while it is on, this capacitor discharges, ultimately dropping to a voltage too low to keep the transistors on, at which time the monostable turns off.

NPN transistor Q3 is the power stage. While the monostable is on, the voltage across Q4's emitter resistor is high enough to drive hundreds of microamps into the base of Q3, which goes into saturation and permits current to flow through the LED. The current through the LED discharges the 1µF capacitor, creating a flash that lasts a fraction of a millisecond.

The LED choice is critical in this circuit. As the amount of power available to drive the LED is tiny, an ordinary standard brightness LED will produce a barely-visible flash. You need a wide-angle super bright LED; if the angle is too narrow, the flash won't be visible when your eye is not on-axis with the LED.

PCB design

The kit is built on a small PCB measuring around 33 x 18.5mm and is designed around discrete transistors, so it is rugged and simple. Mini resistors are used throughout to reduce the PCB size while still being easy to handle and solder compared to surface mount components.

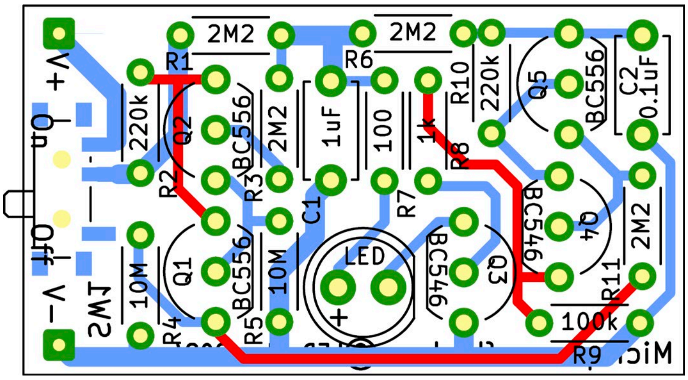
You will need a fine tipped, temperature-controlled soldering iron to assemble this kit, and good eyes, or a decent magnifier, as some of the pads are quite small and the surface mount switch is rather tiny.

Building the kit

Start by installing surface mount switch on the rear of the PCB. It has two pins that locate into two holes in the PCB and so is easy to align. Make sure the pins are properly soldered, including the case tabs, as these provide strength.

Next comes the resistors and capacitors. You might want to check the values of the resistors with a multimeter as the colour bands on these tiny resistors can be difficult to read and are sometimes barely visible – if in doubt, meter it!

Then install the transistors and LED, ensuring correct location



The PCB is double sided (top layer shown in red, bottom layer in blue), with the through-hole pads plated through for robustness.

Parts list

Part	Value	Qty
PCB		1
Q1, Q2, Q5	BC556	3
Q3, Q4	BC546	2
C1	1uF	1
C2	0.1uF	1
R1, R3, R6, R11	2M2	4
R2, R10	220k	2
R4, R5	10M	2
R7	100 ohm	1
R8	1k	1
R9	100k	1
LED1	5mm superbright LED (narrow and wide)	2
LED spacer	LED spacer	1
SW1	SPST Switch	1
BH1	Battery snap	1

and orientation for the transistors and correct polarity for the LED. Use the supplied LED spacer as it helps get the LED up above the other components while also giving a small heat buffer – you shouldn't solder too close to the case of the LED, so the 3mm spacer provides that bit of protection. Lastly, install the battery clip, if you choose to use it.

After building this circuit, clean off all solder flux residue, as flux can absorb moisture from the air and become conductive. Even a fraction of a microamp leaking through flux can prevent the circuit from working!

Once you have completed assembly, the next step is easy. Apply power and the LED should start flashing once every few seconds. If so, you are done, if not, check your work, looking for dry solder joints or accidental solder bridges.

Powering the Micropower Flasher can be done from any DC power source up to 12V. The component values in the circuit are for use with a 3V or 3.3V supply. Higher supply voltages can be used, but the average current will increase, and the flash rate will also increase.

The higher the supply voltage, the brighter the flash and the greater the current consumption, but even at 12V, the circuit will still only draw current in the low microamps range. A 9V battery gives a good compromise between brightness and energy consumption and will run for years powering this circuit.

To use a higher supply voltage while keeping the supply current low, increase the value of all four 2.2MΩ resistors; for example, 3.9MΩ will work well for a 4.5V supply.

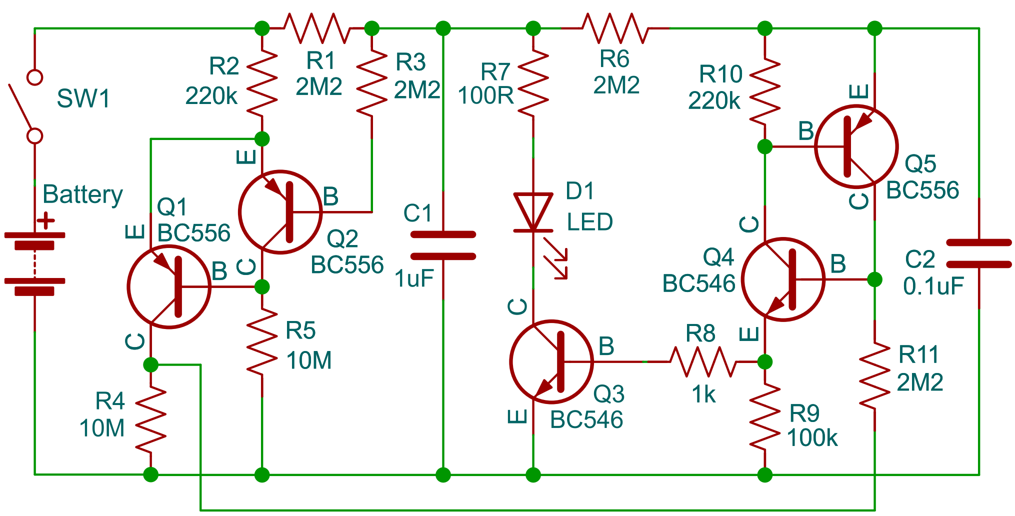
While a standard PP3 9V battery is probably the easiest solution to power the circuit, other options would include one or more button cells, some AA or AAA batteries, or any other suitable DC source.

If you need a waterproof flasher, you can pot or dip the entire PCB in clear potting resin, or fit it inside a waterproof enclosure. Because it uses so little power, you really don't need the switch, the flasher can simply be left running all the time.

Modifications

While the kit is supplied with a 5mm narrow angle and a 4.8mm wide angle superbright white LED (use the one that suits your needs), you can use any small LEDs. Superbright red or amber LEDs, having a lower forward voltage drop, can make better use of low supply voltages and can operate on a single lithium button cell.

The Micropower Flasher was designed by Russell Gurrin and first appeared in the November 2023 issue of Silicon Chip magazine. Published with permission of Silicon Chip.



The schematic for the Micropower Flasher. No ICs here, just discrete components.