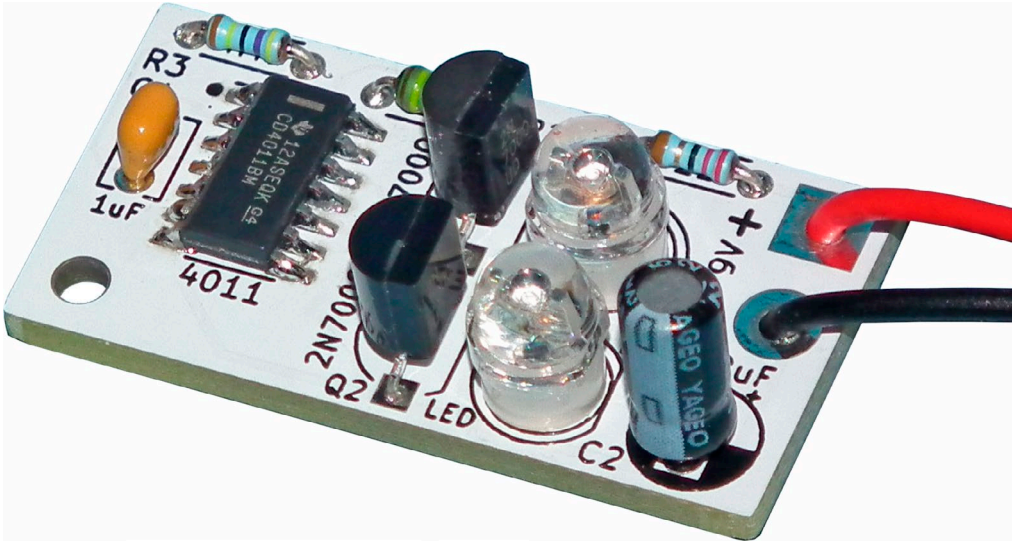
Build a forever LED flasher

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 alternately pulses a pair of superbright LEDs and runs from a 9V to 12V battery. It uses almost no current and will run from a single PP3 9V "transistor radio" battery for years.



How it works

The circuit is based on a surface mount CD4011 quad two-input NAND gate IC (a CD4001 quad NOR gate can also be used). All of the input pairs are tied together, making each gate a simple inverter. The first two inverters are configured to run as a simple astable oscillator, with timing set by a 4.7 megohm resistor (R3) and a 1uF monolithic ceramic capacitor (C1). The output of the oscillator feeds the inputs of the third NAND gate, which acts as a buffer to drive a 2N7000 low power N-channel MOSFET (Q2). The output of that stage also drives the inputs of the fourth NAND gate, which inverts the output and drives another MOSFET, Q1.

The FETs are arranged such that when Q1 is on, current flows through it and one of the LEDs to charge C2, causing the LED to light briefly. When Q1 turns off and Q2 turns on, C2 is discharged via the second LED to ground.

With this arrangement, if both FETs were on at the same time, there would be a short from V+ to ground. However, only one FET is on at a time, and while you might think there is a brief switching transition period when both FETs are on at the same time, causing a short from V+ to ground, in practice this doesn't happen.

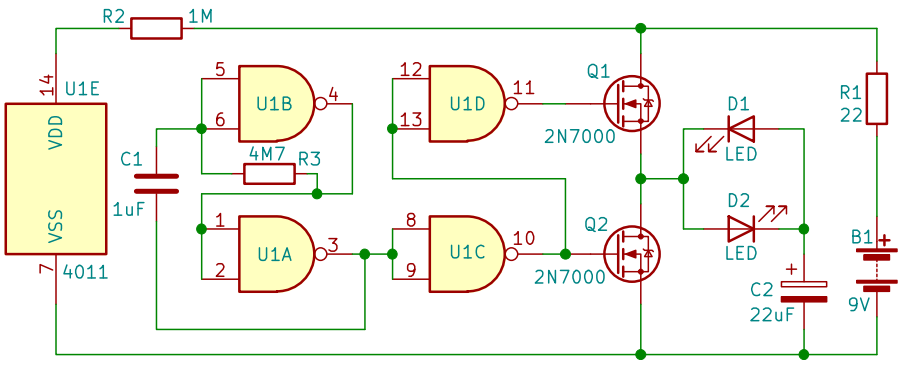
To limit current should a FET fail, and also to limit the maximum current through the LED, the whole circuit is powered via a 22 ohm resistor (R1).

If you have looked at the schematic at right, you will notice that the CD4011 IC seems to be powered via a 1 megohm resistor (R2). While this might seem odd, the IC still operates correctly and the resistor drops the average circuit current to just a few microamps. Given that a good quality PP3 battery can have a 500mAh capacity, you can see how it can run for so long. We tested the prototype to draw 1.5uA continuously, with brief pulses into the low milliamps when the LEDs flash.

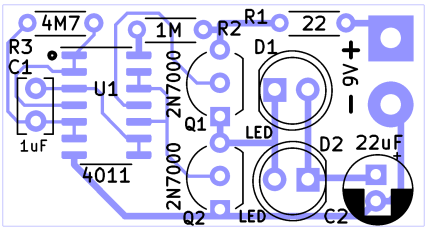
PCB design

The kit is built on a small PCB measuring around 32 x 17mm and is designed around the surface mount version of the IC. The main reason for this is durability—through-hole ICs are often socketed by kit builders, and socketed components can loosen over time with vibration and the like. For maximum reliability, we wanted to ensure the IC would be soldered to the PCB, hence the use of the SMD version. The other reason is size—the SMD version is much smaller than the through-hole version and so the PCB can be much smaller. While we did consider using SMD devices for all the components, there's less advantage to be gained size-wise and so the kit has mostly through-hole components, making it easier for the average hobbyist to assemble—SMD resistors especially are very small and fiddly to work with.

You will need a fine tipped, temperature-controlled soldering iron to assemble this kit, and good eyes, or a decent magnifier, at least for the IC.



The Forever Flasher uses a simple oscillator to pulse two LEDs, while keeping current consumption to extremely low levels.



The PCB is single sided, with all tracks on the front layer. However, the through-hole pads are plated through for robustness.

Parts list

Part	Value	Qty
U1	CD4011 CMOS quad NAND gate (or 4001 quad NOR gate)	1
Q1, Q2	2N7000 N-channel FET	2
R1	22 ohm mini metal film	1
R2	1 megohm mini metal film	1
R3	4.7 megohm mini metal film	1
C1	1uF monolithic ceramic capacitor	1
C2	22uF electrolytic capacitor	1
D1, D2	White superbright LEDs (or whatever LEDs you want to use)	2
PCB	Forever Flasher PCB	1

Building the kit

Speaking of the IC, this is where you start. Align the IC the correct way around, with pin one at the top-left of the PCB (there's a dot on the PCB at pin 1's location), and solder one pin in place. Make sure the IC is aligned on the pads to give you enough soldering room on both rows of pins.

Be careful not to accidentally bridge pins together, but if it happens, check to see if they are pins that are already joined (pin pairs 1 and 2, 5 and 6, 8 and 9, and 12 and 13). If they are, then ignore the issue and move on, but if not, then you will need to break the solder bridge using a solder sucker, desolder braid, or just deft soldering iron skill!

Next install the resistors and capacitors, and lastly the FETs and LEDs, ensuring correct orientation for the FETs, LEDs and C2. Use the supplied LED spacers as they help get the LEDs up above the other components while also giving a small heat buffer—you shouldn't solder too close to the case of the LEDs, so the 3mm spacers provide that bit of protection. Lastly, install the battery clip, if you choose to use it.

Once you have completed assembly, the next step is easy. Apply 9V DC and the LEDs 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 Forever Flasher can be done from any 9-12V DC power source. While a standard PP3 9V battery is probably the easiest solution, other options would include a stack of button cells (say three CR2032 or similar), 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 a switch, the flasher can simply be left running all the time.

Modifications

There are a couple of changes that you can make to the circuit to tailor it to your needs. The first is to adjust the flash rate by changing the timing capacitor, C1. This can be reduced to whatever you wish, but don't go too low or the LED flashes will be too close together. We recommend keeping it to 220nF or above.

Also, the 22uF capacitor C2 can be reduced or increased in value to vary the flash intensity somewhat. Just don't go too large, or the current pulse through the LEDs may reduce their lifespan—a larger value of C2 will also increase average current consumption.

While the kit is supplied with 4.8mm wide angle superbright white LEDs, you can use any small LEDs, even LEDs of different colours, if you so desire.