Piggyaxe Joule Thief Kit

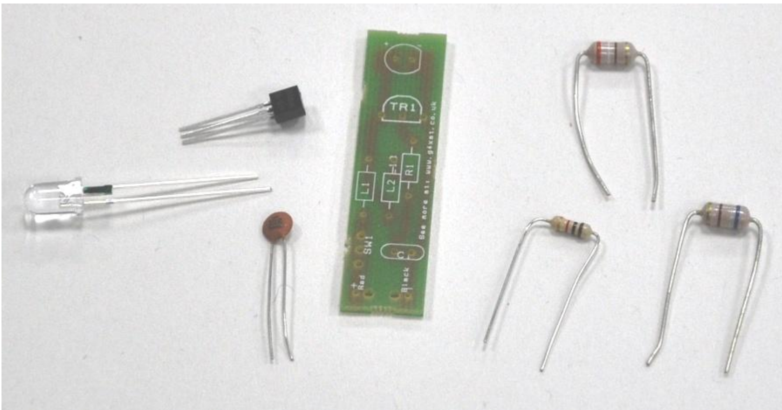
Electronics is FUN – so let's build a Joule Thief and make some light!

Start by collecting the following parts: (Available as a Rapid Electronics kit, order code 70-1059):

Joule Thief PCB, 1x 3mm LED (kit contains white), C1: 1nF ceramic capacitor (brown disc marked 102), R1: 1kΩ resistor (brown-black-red-gold) and two inductors: these look like large resistors and are similarly coded. The ones this circuit uses are 470uH, (yellow-violet-brown-silver). They can be fitted either way around. Finally a transistor: type number BC548 and a 2x AA battery box with switch.

You will also need a soldering iron with a stand and a wet sponge, a PCB holder of some sort, some solder and a pair of side cutters. Remember: soldering irons can burn you. You should always wash your hands after handling solder.

Take great care to fit the components exactly where they are supposed to go, otherwise your circuit may not work as expected. Use the photograph below to help you place the components correctly.



TIP! Bend the resistor and inductor legs as shown will speed up assembly.

The resistor, capacitor and the inductors can be fitted either way around.

The transistor and LED must match the outline.

Put a tick ✓ in each box as you solder in each part or, if you prefer, get someone to check your placement before you solder it. **CHECK TWICE – SOLDER ONCE!**

Resistor R1 ❑ Inductor L1 ❑ Inductor L2 ❑ Capacitor C1 ❑

When fitting the Transistor TR1 make sure that the 'D'-shaped outline matches that shown on the PCB ❑

Next fit the LED making sure that the short lead matches the flat side or '-' sign shown on the PCB. Leave the LED leads at their full length and solder the ends into the PCB ❑

Now carefully check your soldering for errors (missed joints or solder splashes). If it all looks OK, we'll start work on the battery box.

The battery box was designed to house 2 batteries, but we're going to use the space for the second battery to house our circuit board instead. This can be a bit fiddly, but the end product will be worth it.

Here goes:

Find the metal contact that has the red wire attached to it. Pull the metal contact upwards and take it and the red wire completely out of the box. You may need pliers to grip it, or gently lever it upwards with a small slotted head screwdriver. Push the red wire gently back through the hole as you go. Try not to damage it as we'll use it later.

Next remove the double contact from the other end of the box. It just pulls upwards like the other one you just removed. We won't be using this again, so pop it in your odds and ends box.

Now re-fit the contact with the red wire into one side of the space where you removed the double contact from. Fit it in the same side as the remaining spring contact and the switch.

Carefully push and pull the black wire back though the hole.

That's the electrics of the box sorted out, now we need to attack the plastic so that we can get the LED into the hole that the wires used to come out of.

Using a small pair of side cutters, carefully remove the 2 pieces of plastic that formed the slot that originally held the contact with the red wire. Snip it off a bit at a time rather than try to chop it all out in one lump. You're less likely to damage the rest of the box that way. Wear safety glasses or goggles - the bits of plastic tend to ping all over the place so watch out where you're aiming them.

Having removed the slots, we can now remove the round, cylindrical post. You can remove it in a similar fashion to above. Trim it as far down as you can. Alternatively, for a tidier finish, you can try to snap it out in one piece: insert a small slotted screwdriver between the post and the side of the box. Insert it right to the bottom of the box. Move the screwdriver towards the other end of the box, pushing it against the post. The post should snap off neatly at the base. If not, go back to the cutters method.

There, that wasn't so bad was it? This is a good example of how, with a bit of thought, you can adapt an existing item to suit your project and save a lot of effort making a case from scratch.

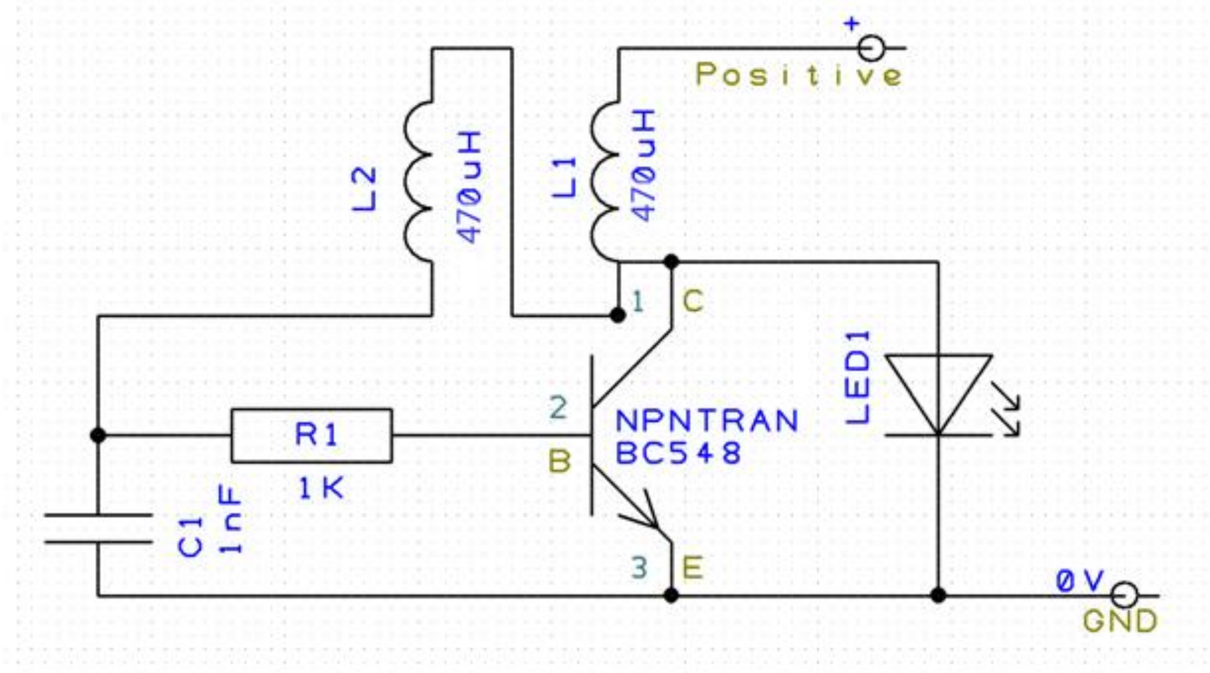
Fit the RED + and BLACK - battery box wires up though the stress relief holes in the PCB then down into the PCB and solder them in.

Fold the extra red and black wire neatly under the PCB. Bend the LED legs carefully so that the LED fits into the hole that the wires used to come out of.

Put a used AA cell in the battery box and switch on – you will be surprised how much energy (as light) can be extracted from a supposedly 'flat' cell.

By re-using a battery that would otherwise have been discarded you are doing your bit for the environment. Remember to re-cycle your cell when it is finally exhausted – it still contains useful chemicals and metals. There are lots of versions of the 'R's that relate to good environmental practise. Think what each one of these means: Reduce, Reuse, Repair, Recycle, Refuse, Re-think. Try to make up a sentence that uses all 6!

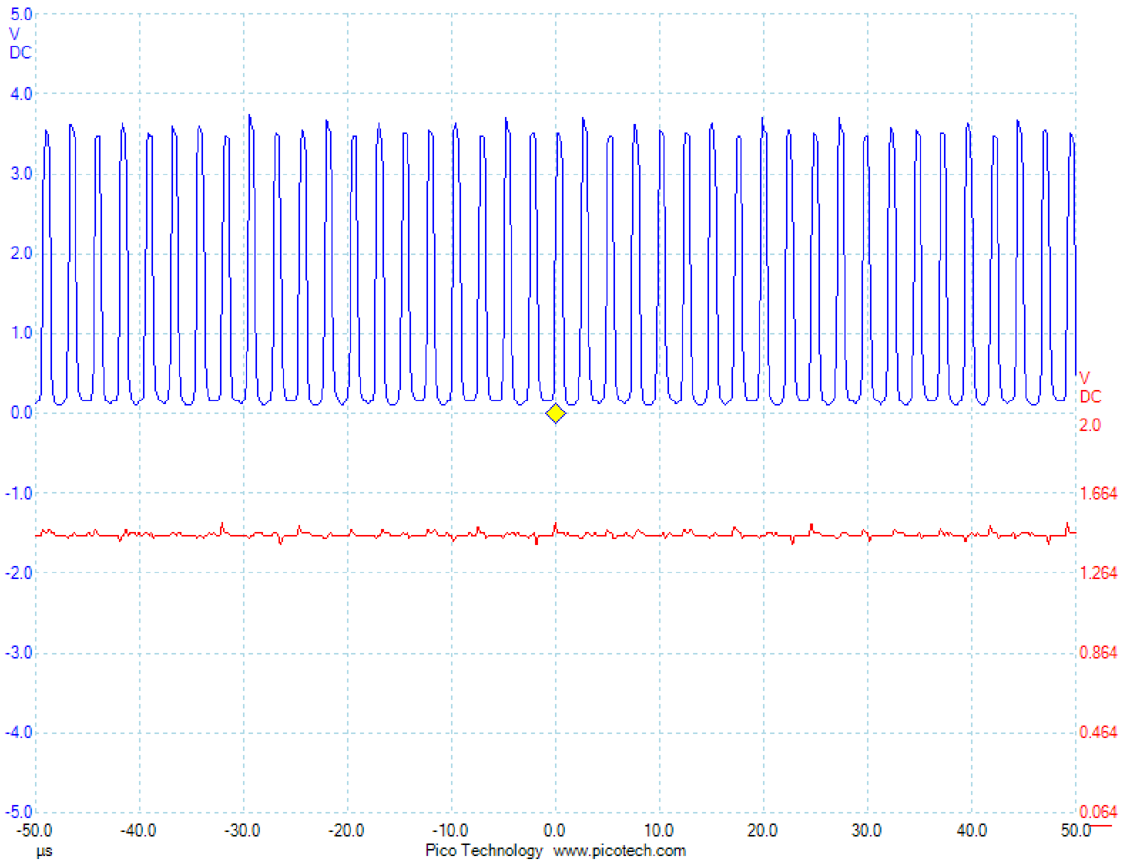
Circuit diagram



The Joule thief is a simple circuit but it delivers great functionality. Its name is derived from the concept that it's stealing energy (Joules) from the cell that powers it. Nothing special there except this circuit will work down to absolute cell exhaustion at around 0.5 volts. Hence the idea that its 'stealing' the last dregs of energy.

If you use a new AA cell the results are even better – you will get well over a week of continuous light! The best thing about using LEDs is that the light will stay the same colour – there will just be less of it as the cell finally runs down.

Almost any NPN transistor can be used – so long as you check the pin connections. The BC548 was chosen as it is very inexpensive. Equally a wide variety of inductors will work for L1 and L2. They don't even need to be the same value, as shown in the circuit diagram above.



The image above is a PICOSCOPE trace - the modern PC-based version of an Oscilloscope (or CRO) which you may have used in Physics. It shows is the input voltage to a Joule thief (RHS column, about 1.3 volts) against the Voltage across the LED, in this case about 3.5 volts. Notice that the LED waveform is also switching off and on. It is this principle that allows it to increase the voltage, similar to how the ignition system works in a petrol-engine car. The difference is that this is switching on and off at about half a million times a second. Your eye cannot react that quickly, so you see the LED as on all the time.

Most modern power supplies (phone chargers, PC and laptop power supplies) work in a similar way. They are more efficient than older linear power supplies, using less electricity in standby mode and less material in their manufacture. Their only failing is that cheap units can produce radio frequency interference. Good design can and should prevent that.