WIRELESS LEDS - MANUAL

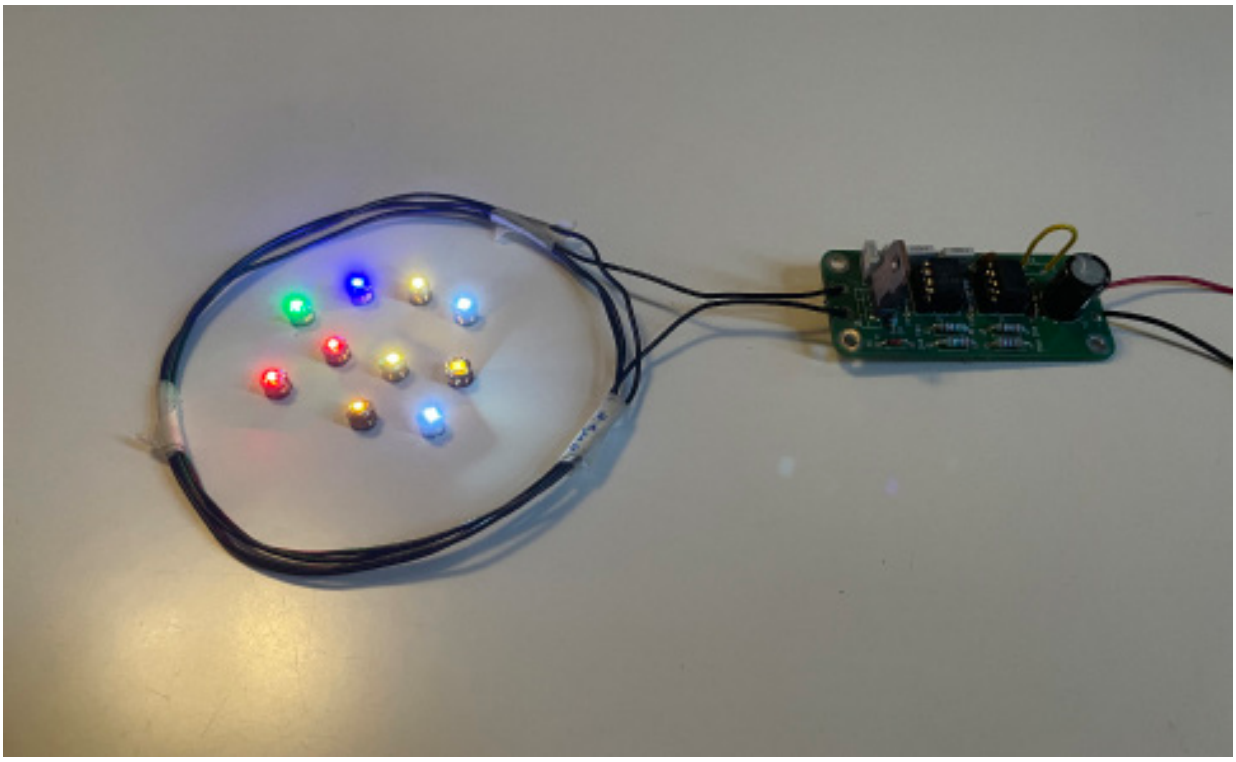
Welcome to this soldering workshop for creating your own wireless LED driver!

In this workshop you will learn the basics of PCB soldering. It's a good basis if you want to start soldering simple things yourself.

A few handy suggestions:

- Always keep your workspace clean. Place unused bits of wire to the side of your bench so that your working area is always clean.
- Always solder underneath the fume hood!
- When cutting excess wire from components, make sure you hold the excess wire with your non-cutting hand to prevent sharp pieces of wire flying through the air.
- Gently clean the tip of your soldering iron in the brass wire cleaner after every step. Just brush the tip through the brass ball twice to clean it.
- Turn off the soldering iron after completing the soldering in each step. This will prevent the soldering iron tip from becoming damaged.

This workshop is the first in a series of 5 workshops. These workshops increase in difficulty. If you want to get really good at soldering, you can follow all 5 of them. They will be taught throughout the year, with a new one every 2 months.

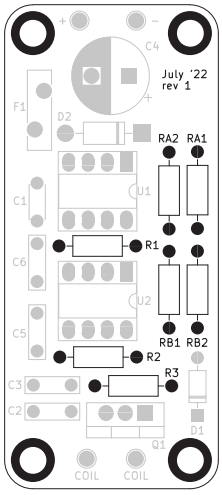


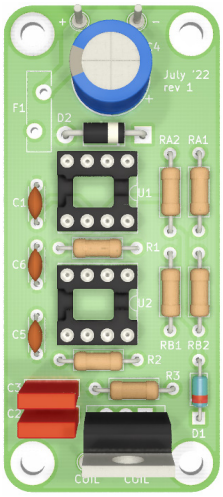
STEP 1: RESISTORS

Tip: Always start with the least tall components first.

Solder the resistors on the highlighted footprints. Insert a resistor, flip over the PCB and bend the wires out a little to prevent the resistor from falling out of its footprint. You can insert all the resistors and then solder all of them at once.

7x resistor



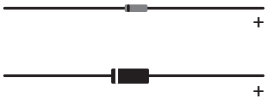


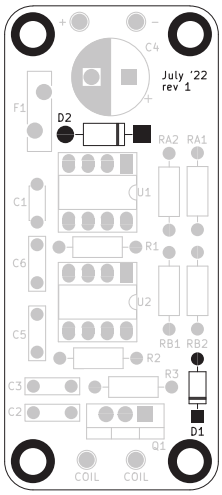
STEP 2: DIODES

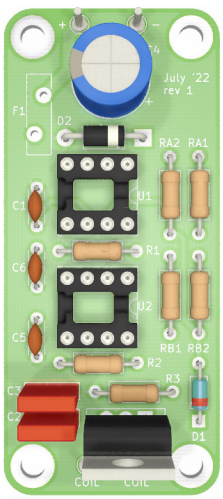
Solder the 2 diodes on the highlighted footprints.

Make sure you align the vertical stripe on the diode with the vertical stripe on the footprint!

2x diode





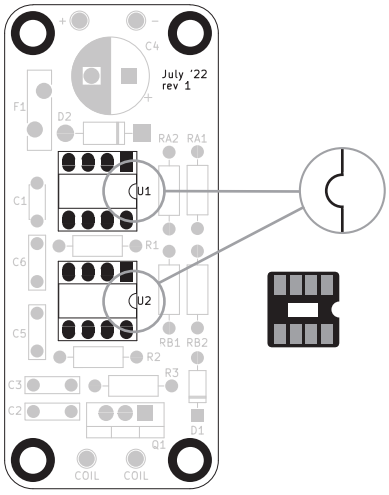


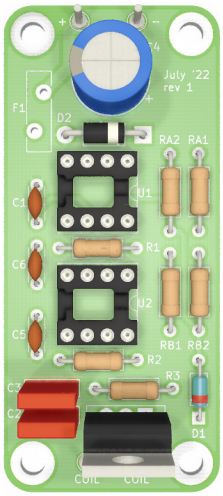
STEP 3: IC SOCKETS

Solder the IC sockets one by one. Make sure you align the circle cutouts with the cutouts on the footprint!

Tip: Solder only 1 pin of the socket and then check if the socket is sitting flat on the PCB. If not, adjust. Then solder the remaining pins. This is always a good idea for components with many pins!

2x IC socket





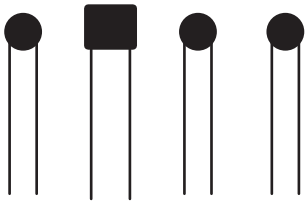
STEP 4: CAPACITORS (UNPOLARISED)

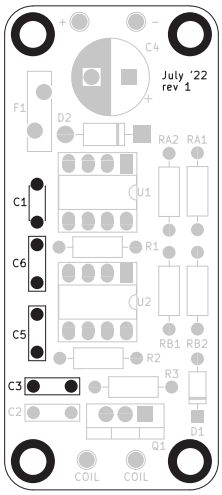
Solder the 4 capacitors on the highlighted footprints.

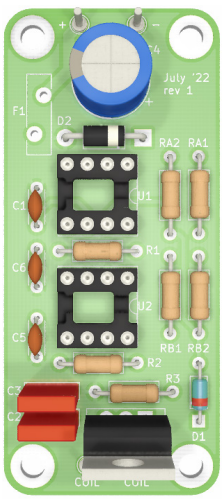
Tip: start with C1, C6, and C5 first as they are smaller than C3.

C2 will remain empty for now.

4x capacitor (unpolarised)



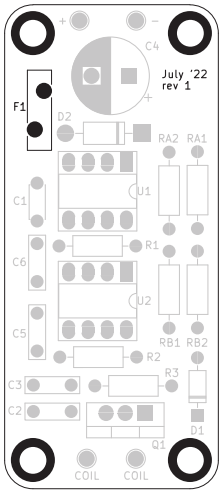


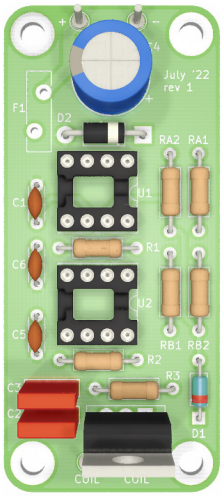


STEP 5: FUSE

Solder the fuse.
It's not polarised (no + or -), so the orientation doesn't matter.

1x fuse

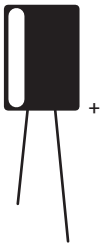


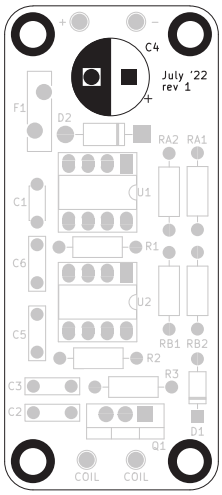


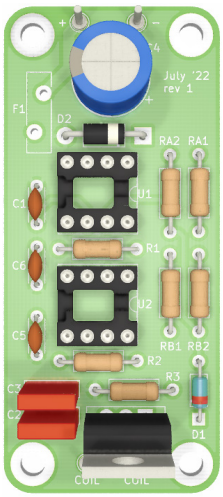
STEP 6: CAPACITOR (POLARISED)

Solder the polarised capacitor. Be very careful to orient it properly! The white (negative) side should point to the left in the diagram below.

1x capacitor (polarised)



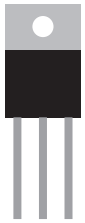


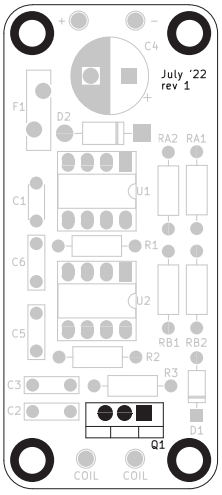


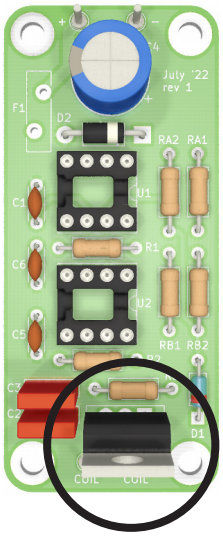
STEP 7: MOSFET

Solder the MOSFET. Take care that you orient it properly.

1x MOSFET



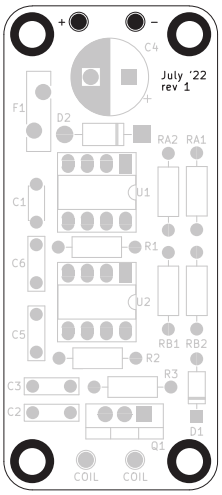


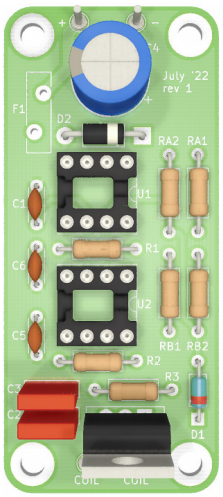


STEP 8: POWER WIRES

Strip the wires on both ends with the stripping tool. Strip away roughly 2-3mm. Solder the power wires. Use black for the negative (-) and red for the positive (+) terminal.

2x 10cm wire

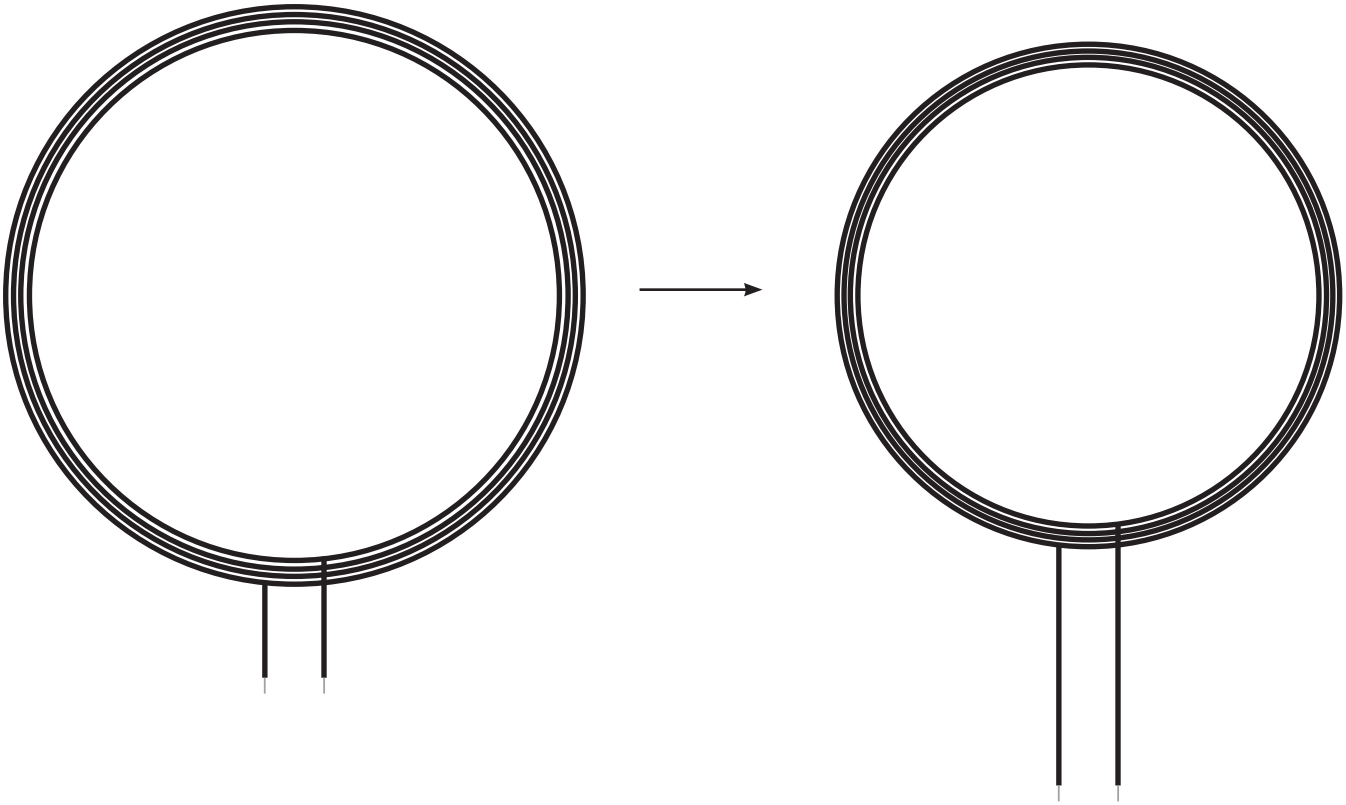




STEP 9: COIL

Wrap the coil. Make it 10cm in diameter. The workshop leaders will provide you with wire and a cylinder for winding. Start out with 4 windings and cut the wire. Strip 3mm off the ends. Use some tape to secure the windings together. Measure the inductance. It should be between 3 and 4µH (microHenry). If the value is a little too high, try to make the coil a little smaller in diameter. You don't have to cut the wires yet. Just try it out with longer leads.

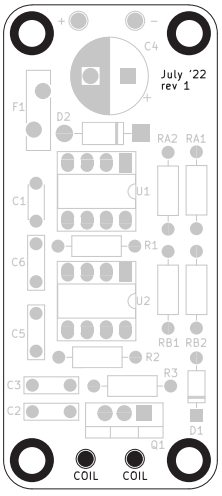
The coil doesn't have to be perfectly circular. You can even experiment with square coils.

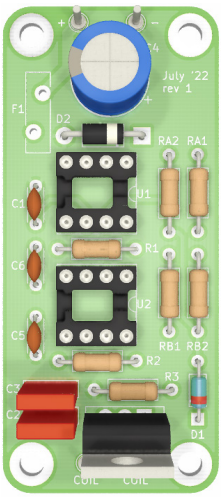


Solder the ends of the coil into the two coil holes highlighted on below. Orientation doesn't matter as there's no polarity.

STEP 10: CHECKING PCB

That's it! Have your PCB checked by the workshop leaders and pick up the two ICs (the brains of the circuit) from them. Once your PCB has been checked, you're ready to test!





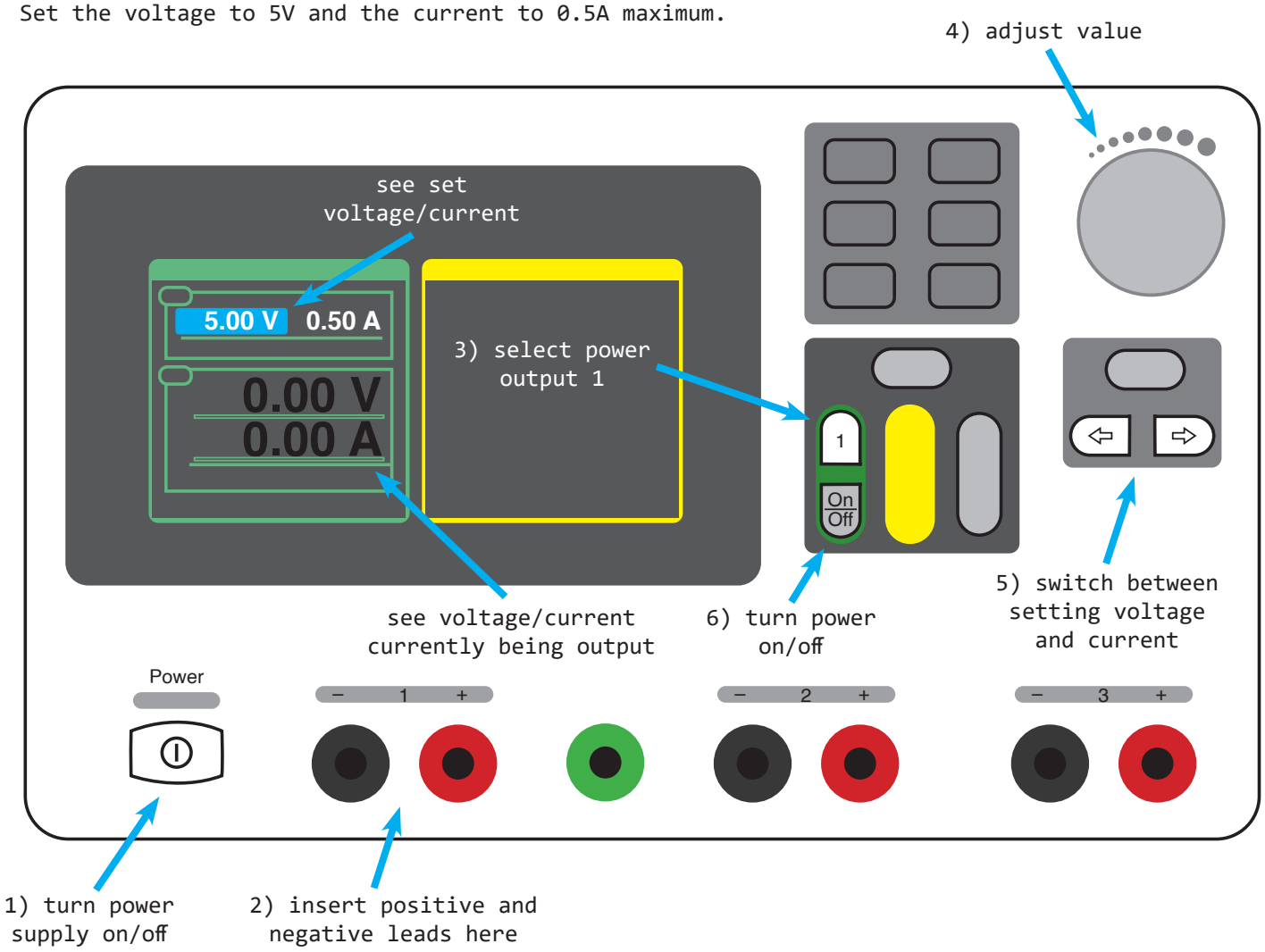
STEP 11: POWER SUPPLY

Connect Power Supply to PCB
Get two leads with banana plugs on both ends. Get two alligator clips and slide them over one red banana plug and one black banana plug. Plug the leads into the power supply (2). Connect the alligator clips (the red and black wires) to the PCB power leads (the red and black wires you soldered). Turn on the power supply (1) but don't turn on the power yet.

Double check that the positive terminal of the power supply is indeed connected to the positive terminal of the PCB and that the negative terminals are also connected. If the terminals are reversed, the big capacitor might blow up!

Set output power on power supply
On the power supply, select power output 1 (3). The green screen indicates the values for output 1. The selected output type (voltage or current) will light up in blue. You can now switch between setting voltage and current with the arrow buttons (5). The values can be adjusted with the knob (4).

Set the voltage to 5V and the current to 0.5A maximum.



Testing
Place your LEDs inside the coil. Now turn on the power (6). Your circuit should draw around 80mA of current (0.08A). You can see this from the larger numbers in the green screen. Values between 60mA (0.06A) and 120mA (0.12A) are also acceptable.

If your circuit draws more than 0.12A, turn off the power and consult a workshop leader to fix the problem.

Once everything is working, you can play around with your LEDs!

STEP 12: OPTIMALISATION (OPTIONAL)

If you like, you can also tweak your PCB by experimenting with some capacitor values on footprint C2. To do this, get some small capacitor values (between 1nF and 47nF) from a workshop leader. Gently push the lowest value into footprint C2 but don't solder it yet! Power the PCB and tilt the capacitor a little, applying pressure, to make sure it's making firm contact with the solder pads. Keep a close eye on the current being drawn and the brightness of the LEDs. Is the current going down but are the LEDs staying equally bright? Then you're improving the resonance of the circuit. Is the current going up (a lot)? Then the resonance is getting worse. Also check if putting the LEDs close to each other inside the coil is causing interference between the LEDs, causing them to burn less brightly.

You can keep going to higher values for C2 until you start noticing that:

- current isn't going down anymore, or is even increasing
- LEDs are growing dimmer
- LED interference is increasing

Solder in the capacitor that gave you the best results in terms of current draw, LED brightness, and LED interference.

Congratulations! You've just successfully calibrated your circuit!

STEP 13: USB CABLE (OPTIONAL)

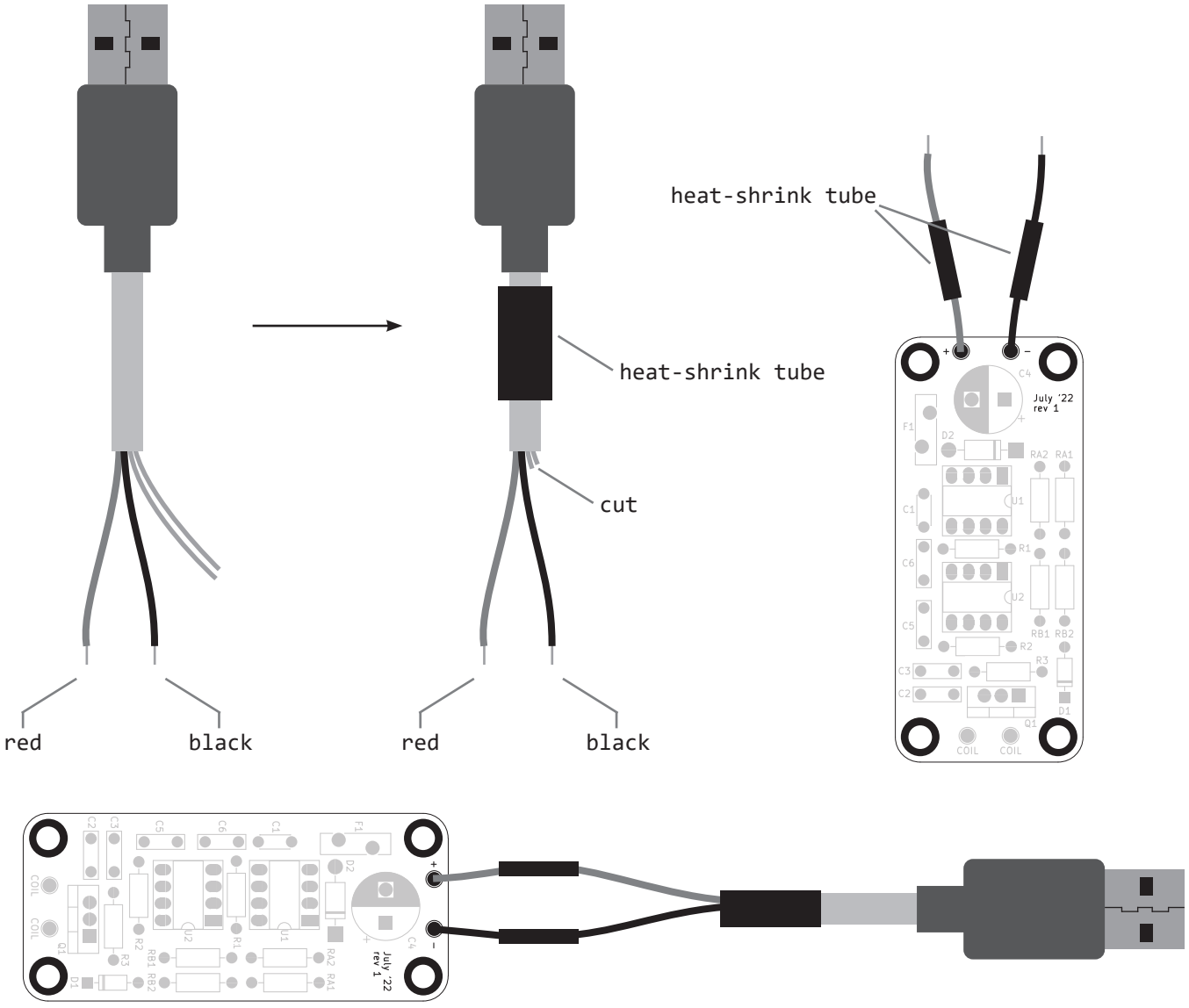
Now that you've got a circuit that works with a power supply, you can also solder on a USB plug so you can use the wireless LEDs with your laptop or a power bank.

Cut the USB cable close to the USB-A plug. Leave around 5cm. Pull/cut the mantle back 1.5cm and you will see 4 wires, of which 1 is red and 1 is black. The red and black wires carry the power, and can be soldered to the red and black wires on your PCB. Cut the other wires close to the mantle.

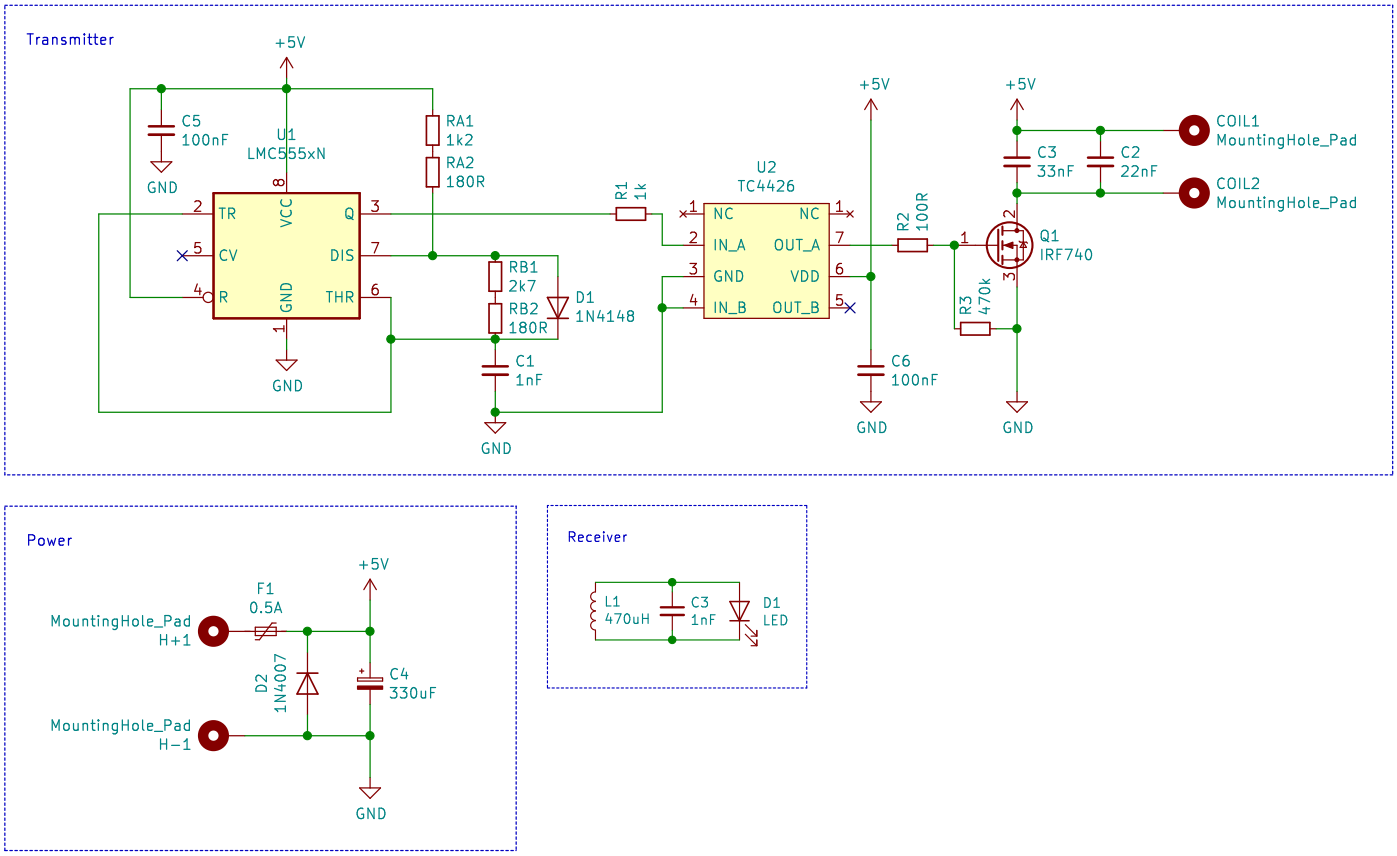
Strip roughly 2-3mm off the ends of red and black wires on the USB cable. Clamp the wires in a helping hand and melt some tin onto the bare wires. Pre-tinning the wires helps you create better solder connections later. Also pre-tin the ends of the red and black power wires on your PCB.

Ask the workshop leaders for some heat-shrink tubing. Slide a small heat-shrink tube over each power wire of the PCB. And slide one bigger heat-shrink tube over the intact USB cable (so not on the part you've trimmed). Now solder the red wires together and the black wires together. Slide the heat-shrink tubes over the soldered areas and heat the tubes with the soldering iron. The tube will shrink, covering the solder joint and protecting the wires from short-circuiting. Now slide the bigger tube over the USB-wires you cut earlier and heat it too.

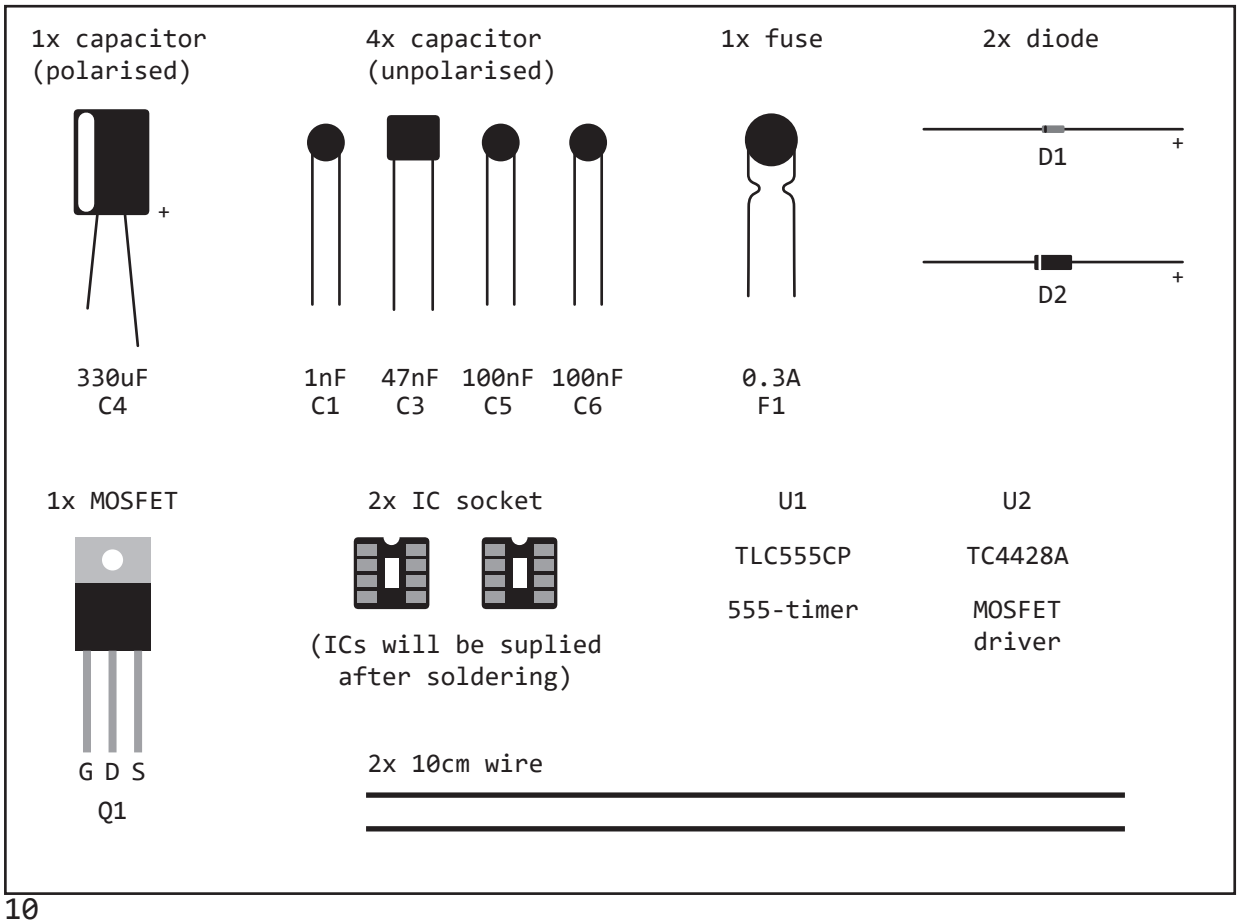
That's it! You're all done!



SCHEMATIC

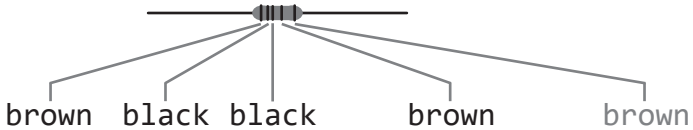


COMPONENTS



COMPONENTS

R1 1k

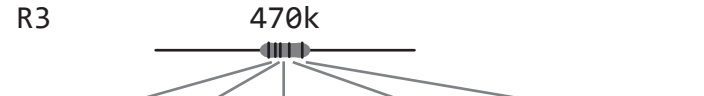


= 1,000 Ohm

R2 100R

= 100 Ohm

R3 470k



= 470,000 Ohm

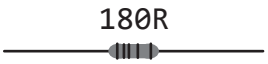
RA1 1k2

= 1,200 Ohm

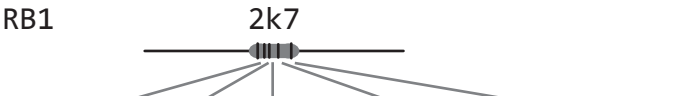
RA2 180R

= 180 Ohm

RB2 180R



RB1 2k7



= 2,700 Ohm