

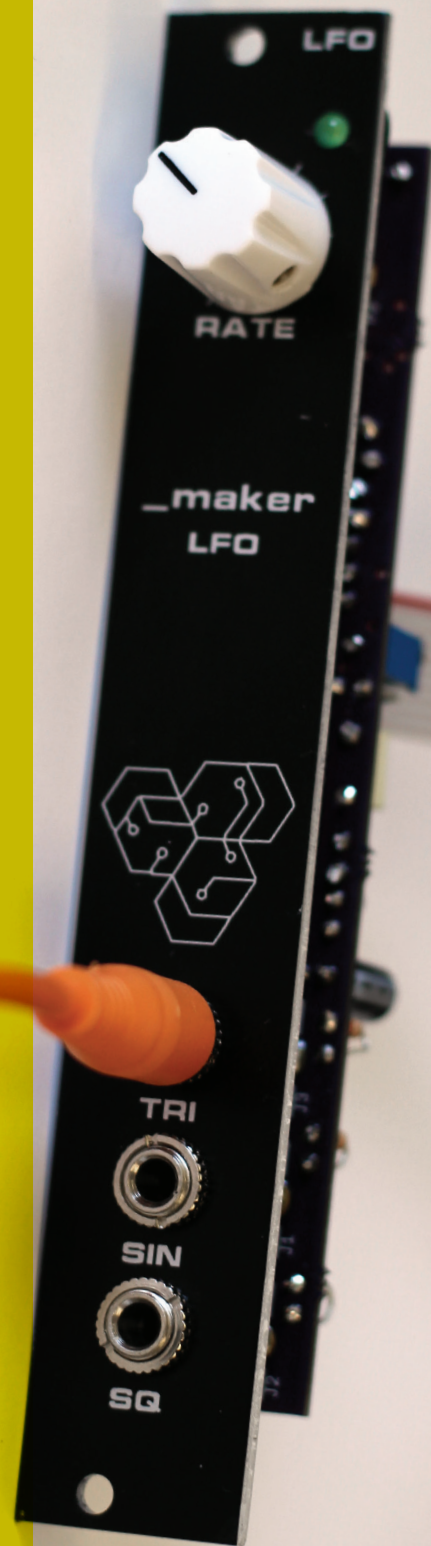
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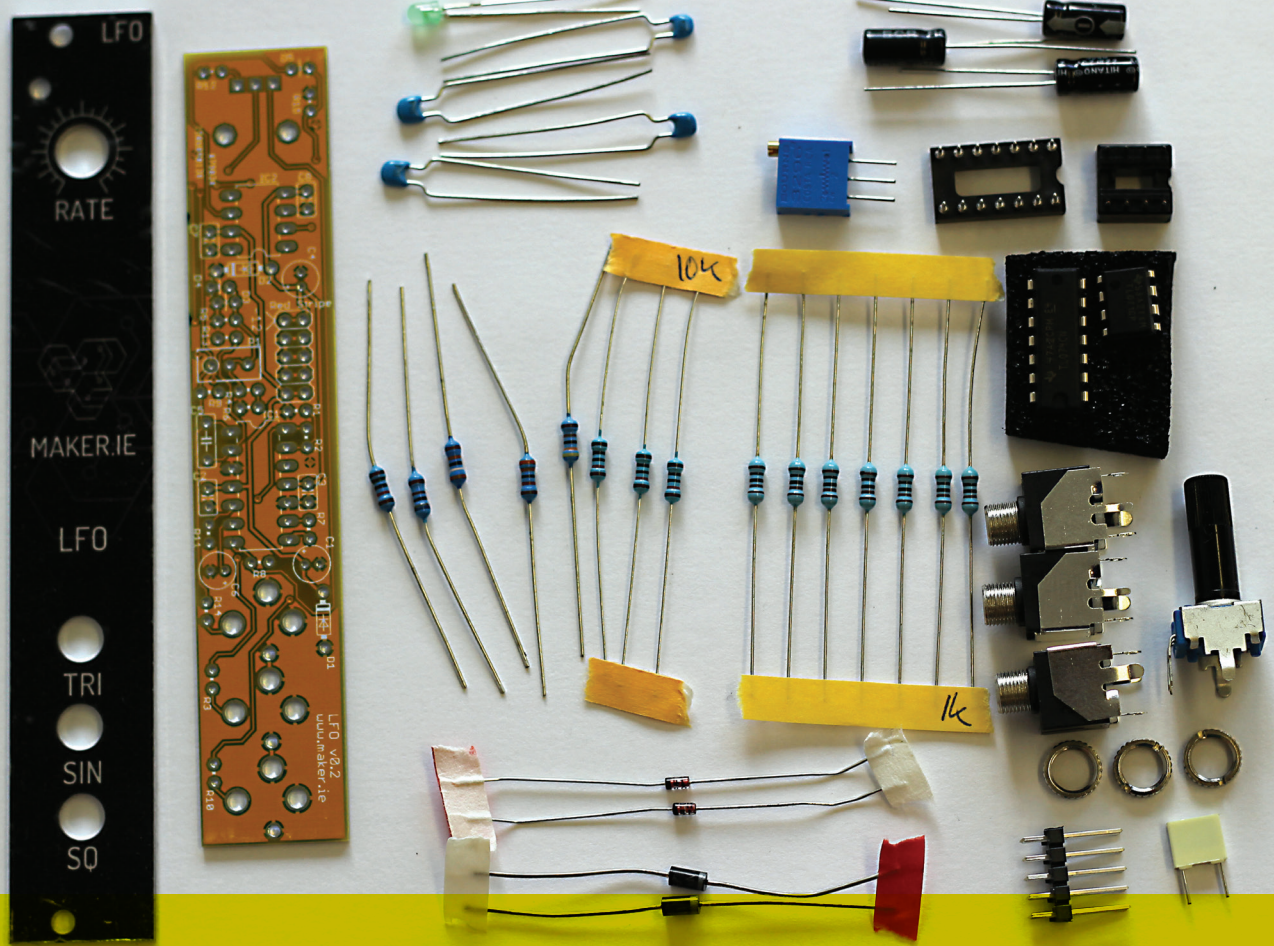
MAKER LFO

Assembly Guide



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Technical Specifications

- Low Frequency Oscillator in a compact 4HP, skiff friendly 30 mm depth size
- Square, Triangle and approximated Sine Wave outputs (5V Peak to Peak)
- Rate/ Frequency range - 0.01Hz to 40Hz
- LED indicator for Rate
- Current Consumption +12v 20mA, -12v 20mA

Tools

Below is a brief overview of the tools we will need:

- Soldering iron (15 w will do fine, any hotter may start to burn the PCB)
- Solder
- Wire cutters
- Multi-meter
- De-soldering pump
- Helping hands/ soldering stand
- 3/4";1" clamps x2

Components

Here is a brief overview of the components we'll be using:

- Printed Circuit Board-Mechanically supports and electrically connects the components in the circuit
- TL074-Quad Operational Amplifier- the heart of the circuit, helps create the different wave forms
- TL071-Single Operational Amplifier- this is used to power the LED rate indicator
- Resistors- resist the flow of current
- Ceramic capacitors - power supply bypass capacitors
- Polyester capacitor - helps set the oscillator frequency
- Electrolytic capacitors- used for power supply bypassing and also to help set the frequency of the oscillator
- Diodes- these are used for reverse power supply protection

and other functions in the circuit

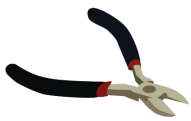
- Pin header - This connects the power from the Eurorack system power bus to the module
- Aluminium panel- Mounts to the circuit board after the components are on, so the module will fit in a rack unit
- Jack sockets - for plugging cables in and out of the modules

This is a beginner level kit. Some previous experience of completing electronic kit is recommended but not essential. This is the assembly guide for PCB version 0.2.

Okay let's begin...

Soldering is easy, here's how to do it

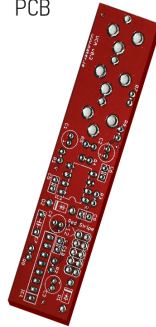
Wire cutter



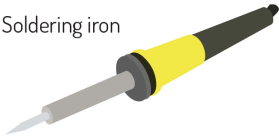
Solder



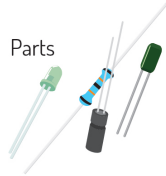
PCB



Soldering iron



Parts

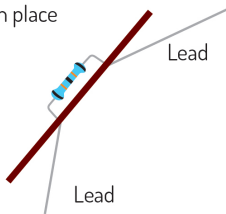


The iron is hot, be careful !

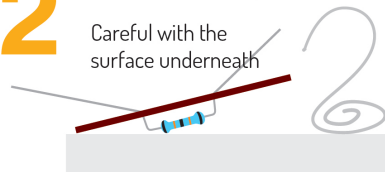
Your kit should come with instructions for what parts go where and what way !

Clean the tip of your iron before each solder connection !

1 Put your part in place. Bend out the leads so it stays in place



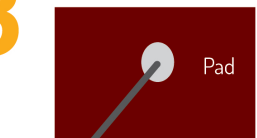
2 Put the PCB down so you can solder. Careful with the surface underneath



Find some good way to keep it steady

If you need a third hand, you can make a standing coil of the solder instead of holding it in your hands

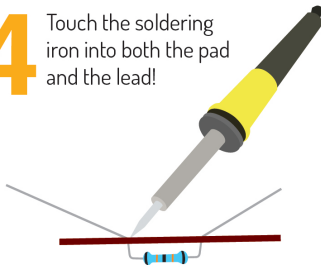
3 O.K, Lets solder!



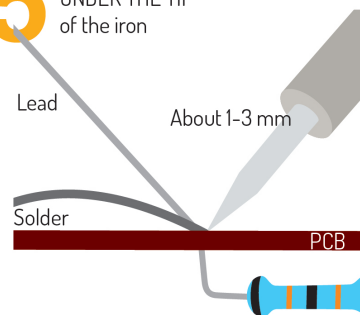
Psst! Clean the tip first!

First, you want to heat both the pad and the lead for about 1 second

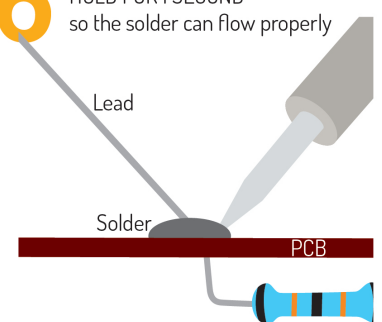
4 Touch the soldering iron into both the pad and the lead!



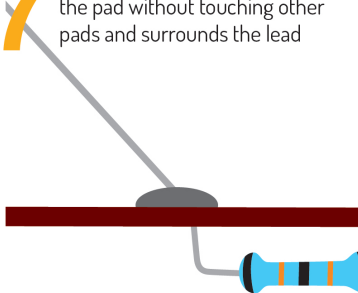
5 Now feed the solder UNDER THE TIP of the iron



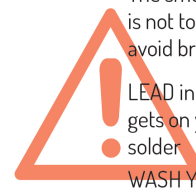
6 Stop feeding the solder then HOLD FOR 1 SECOND so the solder can flow properly



7 A good connection covers the pad without touching other pads and surrounds the lead



8 Cut the leads off with the wire cutter



The smoke from the melting solder is not toxic, but blow gently on it to avoid breathing it.

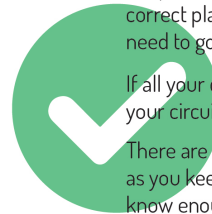
LEAD in the other hand is TOXIC, and gets on your skin when holding the solder

WASH YOUR HANDS WHEN YOU'RE DONE

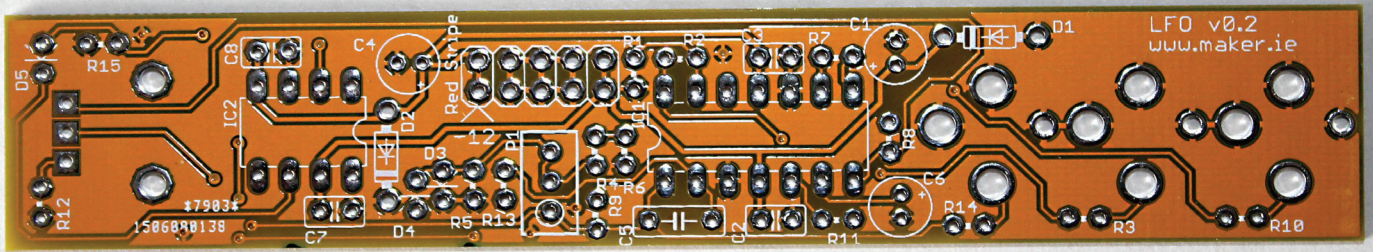
Keep soldering each part in its correct place. Remember some parts need to go in a certain way!

If all your connections are good, your circuit will just work!

There are more tricks you will learn as you keep soldering, but now you know enough to make many cool things.



Soldering



We are now going to begin soldering the circuit board. You will notice that the circuit board has numbers (R5, C11, etc.) beside the component outlines (known as the silkscreen layer of the board). The outlines and the components numbers help us to identify which components to solder where on the PCB.

The circuit board is double sided. We will be soldering some components on the top side of the board, and some on the bottom side. We will go through the com-

ponents step by step. The most important things to keep in mind are:

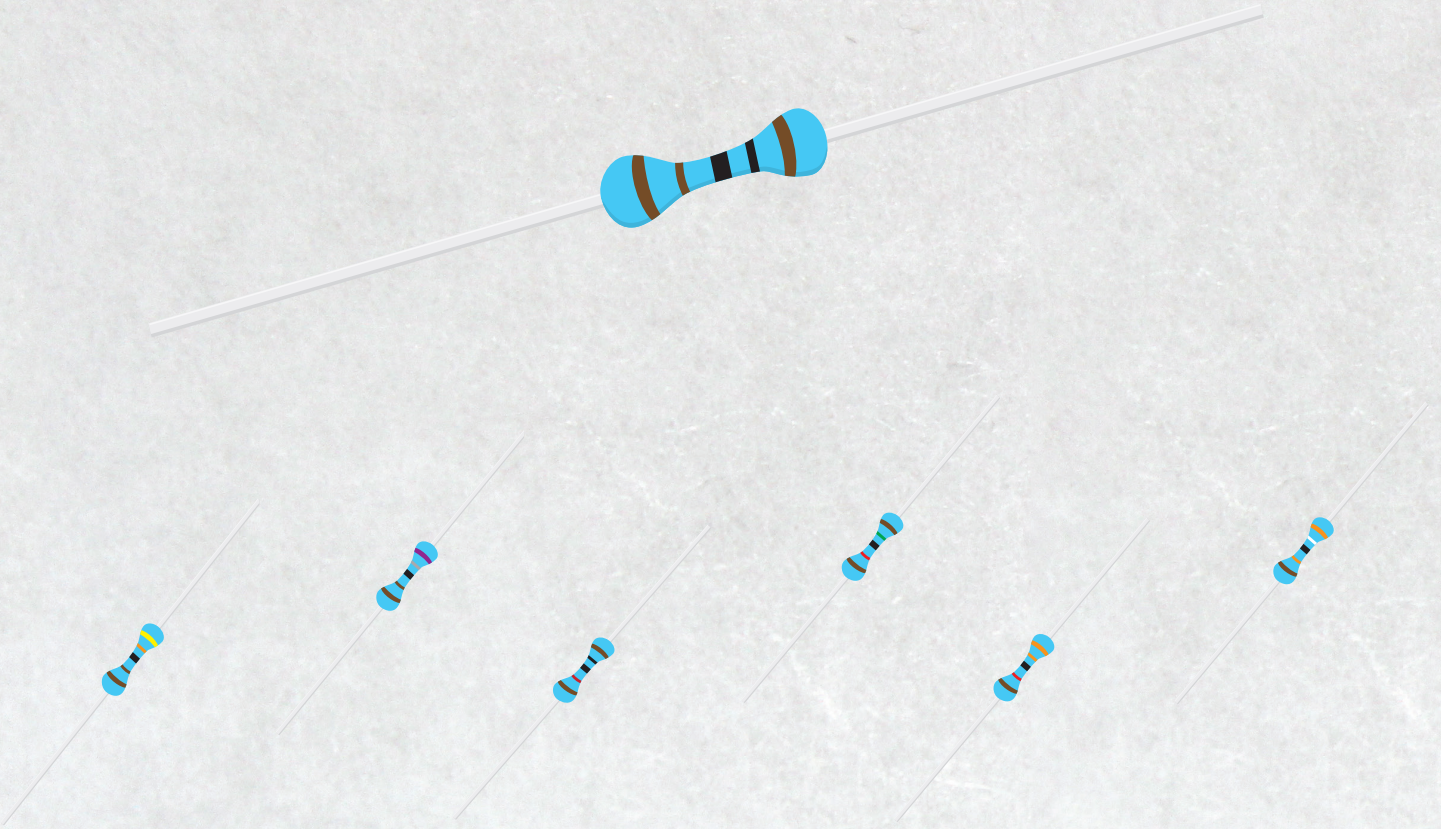
- Take your time and check the silkscreen and the orientation of the components; some components are polarized or must be orientated in certain direction.
- You want to make sure the solder joints are good and solid and they should fill in the pad on the board that the component leg is coming through.

- Do not let solder cross between the solder pads on the board. This will cause a short circuit and mean your circuit will not work. A de-solder pump can easily fix this problem.

- Components which must be orientated correctly include the diodes, electrolytic capacitors, IC sockets and ICs, mono jacks and the variable potentiometer.

- Before soldering any component, empty all them into a small bowl or plate.

Step 1 – Resistors



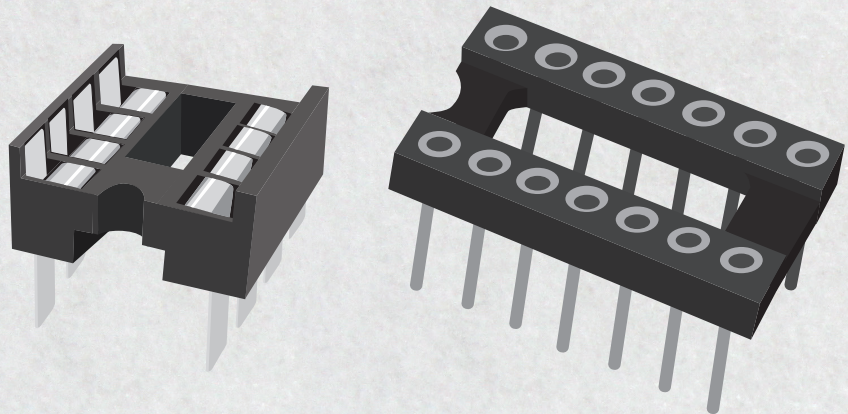
Solder the resistors following the numbers on the PCB and the guide below. Check the resistor colour codes and measure the values first with a multi-meter before soldering in place. All resistors in the kit are 1% tolerance. Insert the resistors vertically through the bottom side of the board where the numbers are marked, on the silkscreen, and the solder to the pads on the top side. Clip the lead off each resistor with the wire cutter after soldering each joint. Cut the leads above the solder joint, also be careful not to cut the joint as this can break the solder joint.

From the top left corner of the board (top side) and moving clockwise:

1k - (Brown, Black, Black, Brown, Brown) – R15, R1, R10, R3, R14, R4, R12
10k - (Brown, Black, Black, Red, Brown) – R6, R9, R5
6.8k (Purple, Grey, Black, Brown, Brown) – R2
4.3k (Yellow, Orange, Black, Brown, Brown) – R7
15k (Brown, Green, Black, Red, Brown) – R8
33k (Orange, Orange, Black, Red, Brown) – R11
390k (Orange, White, Black, Orange, Brown) – R13

Step 2 – IC Sockets

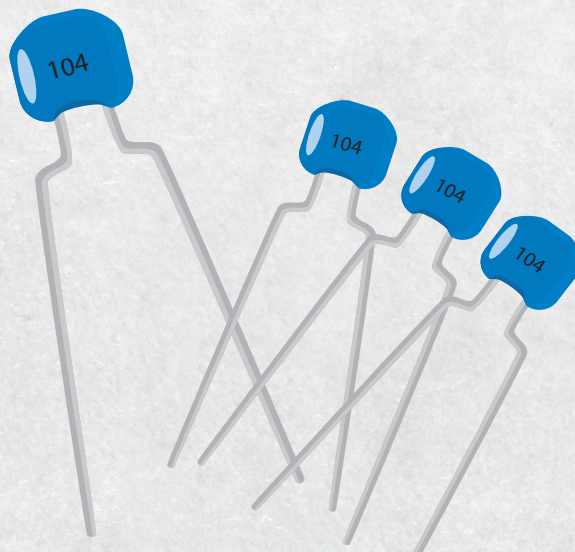
Solder the IC sockets in the IC positions on the top side of the PCB. Check the orientation, the little notch on the socket should match up with the notch on the PCB. Solder the tails on the sockets to the solder pads on the bottom side of the board. Use a small piece of cello tape to hold the socket in place while soldering.



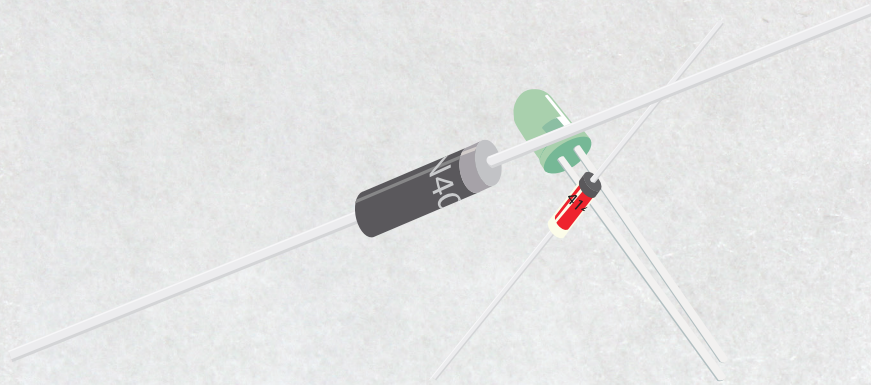
.....Step 3 – Ceramic Capacitors

Insert the ceramic capacitors through the top side of the board and solder to the pads on the bottom side of the board. These capacitors are not polarised. Follow the below guide (from the top left of the board and moving clockwise):

C8, C3, C2, and C7 - These are all 100n value and they are marked 104 on the capacitor.



Step 4 – Diodes



Next, we will solder the diodes. Diodes are polarised, meaning there is a positive and a negative pin, and must be soldered in the correct orientation for the circuit to work. Insert the diodes through the top side of the board and solder to the pads on the bottom side of the board. Again moving clockwise from the top left of the board:

D5 – LED – we will skip this for the minute because we want to add this at the end (after the panel is mounted) to make sure it fits snugly through the panel.

D1 – IN4001 – inserted horizontally, match the marking on the diode with the marking on the circuit board

D3 – IN4148 – this is inserted vertically on the board, match the

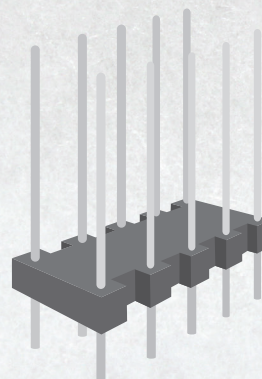
marking on the diode with the arrow on the silkscreen

D4 – IN4148 - this is inserted vertically on the board, match the marking on the diode with the arrow on the silkscreen, which is opposite to the orientation of D3

D2 – IN4001 – inserted horizontally, match the marking on the diode with the marking on the circuit board

.....Step 5 – Power Pin Header

Insert the power pin header through the top side of the board and solder the tails on the header to the solder pads on the bottom side of the board. The header is not polarised. Use a small piece of cello tape to hold the header in place before soldering.



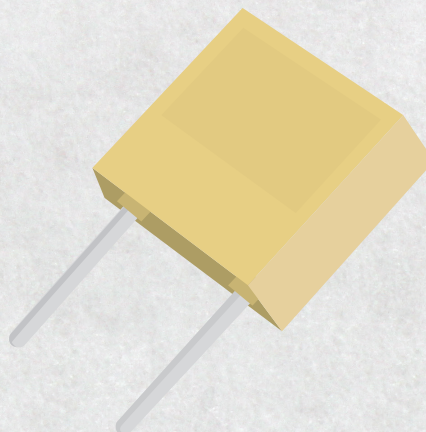
Step 6 – Trimmer Resistor

Insert the trimmer resistor, P1, through the top side of the board and solder to the pads on the bottom side of the board. The trimmer on top of the package should match the the circle on the PCB silkscreen.



.....Step 7 – Polyester Capacitor

Insert the polyester film box capacitor, C5, value 100n, through the top side of the board and solder to the bottom side of the board. This capacitor is not polarised.

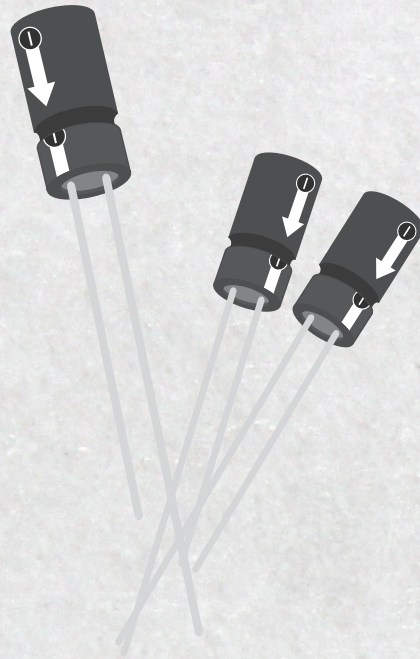


Step 8 – Electrolytic Capacitors

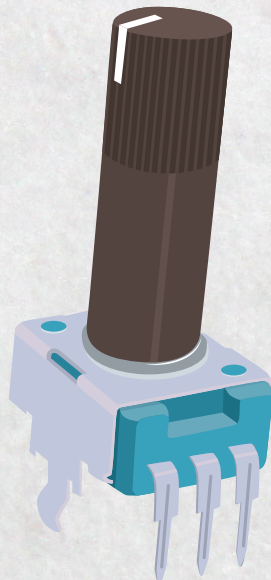
Insert the Electrolytic Capacitors through the top side of the board and solder to the pads on the bottom side of the board. These capacitors are polarised; the positive (+) pin must go through the pad marked (+) on the PCB. Clock wise from the top left of the board the values are:

- C4 22uF
- C1 22uF
- C6 4.7uF

Now we are finished soldering the bottom side of the board. The rest of the components are placed on the top side of the board.

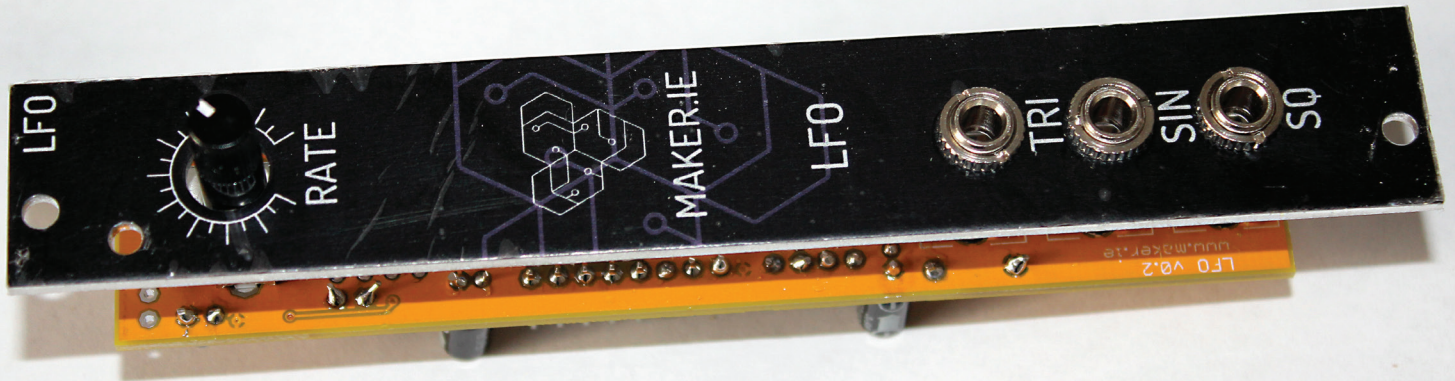


..... Step 9 – 9mm Potentiometer



Turn the board over and insert the 9mm potentiometer through the bottom side of the board, and solder to the pads on the top side of the board. The potentiometer should snap to the board fairly tightly so should stay in place fine for soldering. The pot value is 100k and it is marked B104.

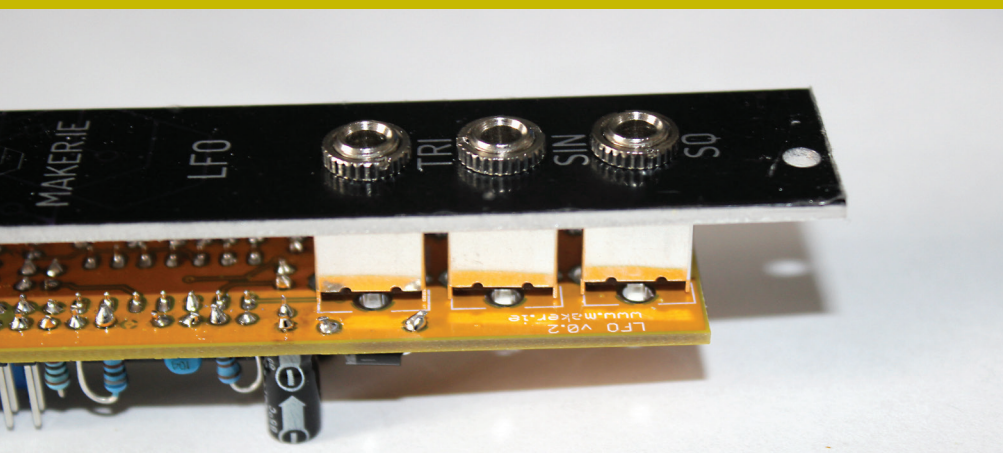
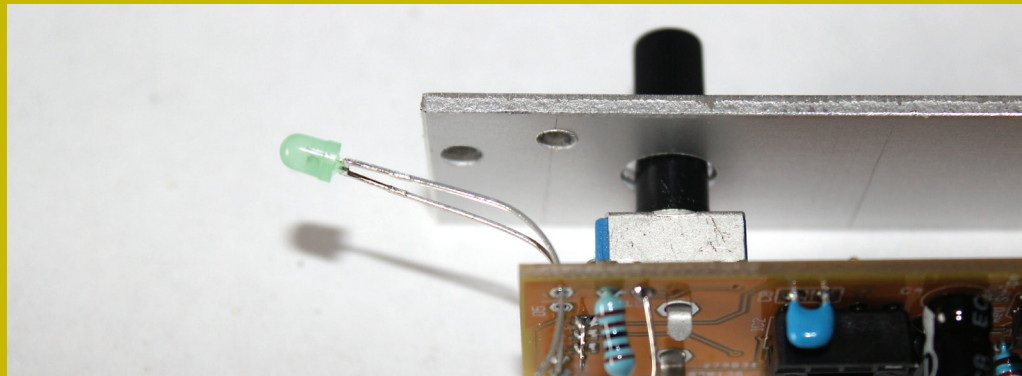
Step 10 - Jacks, LED, and Panel



Now, insert the 3 jacks through the bottom side of the board. There is only one orientation that will fit.

DON'T SOLDER THESE YET.

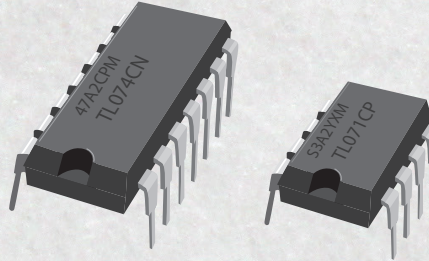
Next, place the LED through the top side of the board (following the markings on the board, the anode (+pin) is at the top right corner of the board), but don't solder it yet, adjust the LED so that the top fits snugly through the panel cut-out. Bend the leads a little at the bottom.



Next, place the panel over the bottom of the board with the jack and pot shafts matching the panel cut-outs. Screw the knurled nuts over the jack shafts, taking care just to use your fingers and not to scrape the panel. Screw these tight by hand, and the panel should be held firmly in place. Remove the protective covering from the panel then solder the LED and the jacks to the solder pads on the top side of the board

Step 11 – Insert the ICs

Carefully insert the TL074 and TL071 into the IC sockets. Two things to watch out for here. The IC pins can be quite fragile and easily broken. Usually the pins will require some gentle bending to fit them into the socket. Some people use an IC insertion tool for this job. If you're taking an IC



out of the socket, you could use a small flat headed screwdriver or tweezer blade and slide it under the IC, which works as good as an insertion tool. Also make sure to check the orientation of the IC, the little notch on the IC should match up with the notch on the IC socket.

Step 12 – Testing and troubleshooting

Before you power on the circuit, double check your soldering work and check for any bad/cold solder joints or any points where there may be bridging (where two pads close together are connected by small pieces of solder). You can use a multi-meter on continuity range to check if any two pads or points you're not sure about are connected or not. De-fluxing is recommended also. Be thorough, even a very tiny piece of solder is enough to create a short in the circuit.

Connecting the power pin header – (important!) match the red stripe on the power cable with the red stripe / -12V marking on the PCB. This is assuming your eurorack power bus is following the convention that Red Stripe is equal to -12V! The circuit has reverse polarity protection included, so in the case that you do plug your power cable in the wrong way, plug it out quickly and insert

it the correct way round.

On power up the LED rate indicator should blink and change as the potentiometer is adjusted. Plug in an audio cable and test the audio outputs.

If the circuit is not working, the most likely causes are:

- **IC CHIP MIS-SOCKETED**
Check the orientation of the the chips. The notches on the chips should match up with the notches on the PCB. If your socket has been soldered in with the wrong orientation, it won't matter as long as the IC is the right way round.
- **EXPOSED METAL CAUSING A SHORT CIRCUIT**
Are solder lugs or bits of wire from one component touching another? This may be causing a short circuit. Adjust the component's position or de-solder / re-solder

the component to the pad.

• COMPONENTS INSERTED IN WRONG ORIENTATION

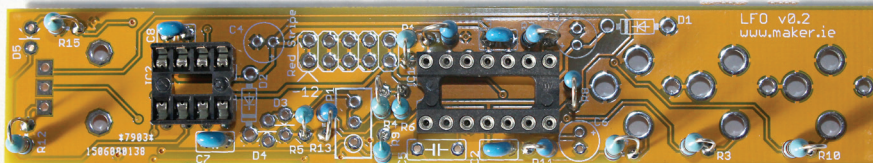
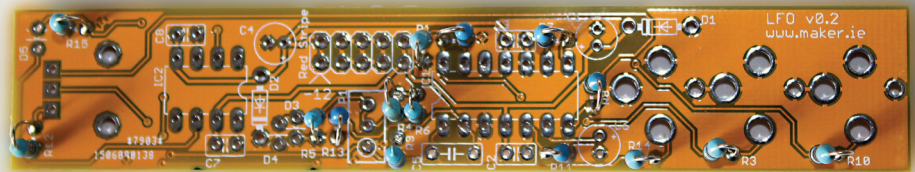
Double check the orientation of all the polarised components (diodes, capacitors, ICs) with the markings on the PCB and the circuit schematic.

• BAD SOLDER JOINT

A bad solder joint can be caused by a number of reasons. Often dirt can get in and create a weak bond between the solder pad and the component. Re-heating the joint or applying a small piece of extra solder can help in these situations. Be careful re-soldering on certain components as extended periods of heat can damage them. If you think the component may be damaged by excess heat, it might be best to replace the component

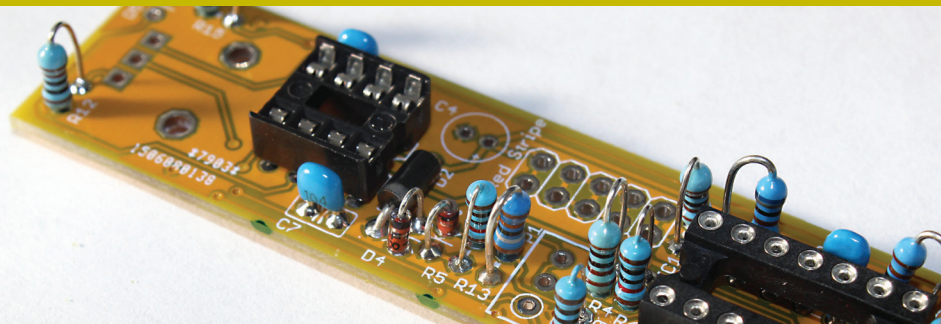
Maker LFO- Step by Step

Resistors

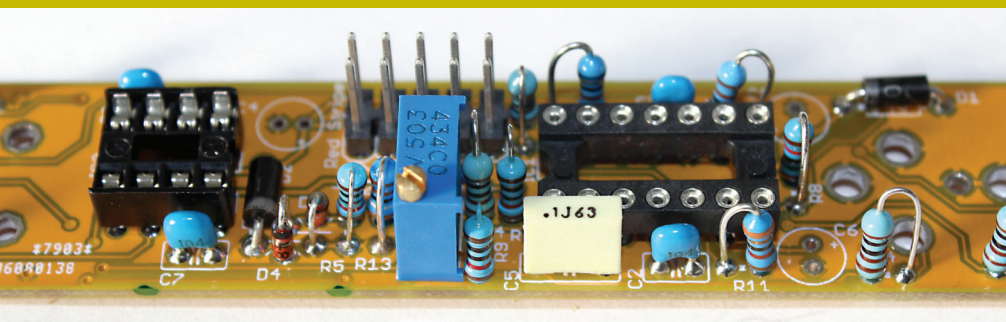


IC Sockets
Ceramic Capacitors

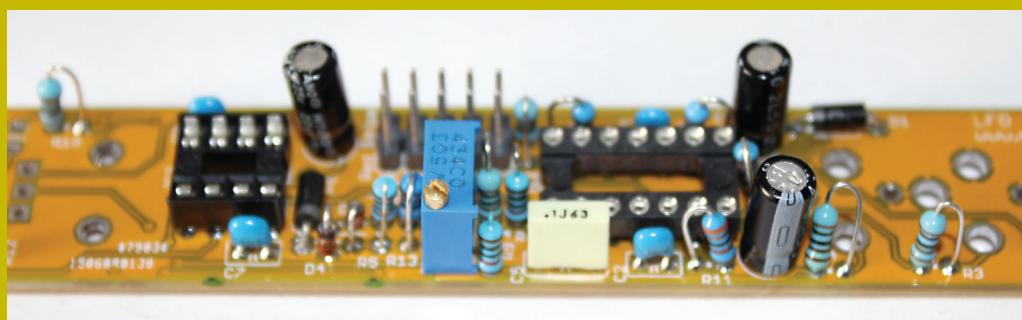
Diodes



Power Pin header
Trimmer resistor
Polyester capacitor



Electrolytic capacitors



Circuit Description.....

What's is happening in the circuit?

Power is provided to the circuit using the Eurorack power bus, which supplies +12v, -12v and Ground (0v). Diodes D1 and D2 provide reverse polarity protection; in the event that the input power polarity is reversed, the current travels through the diodes (path of least resistance) to Ground. Capacitors C1 and C4 smooth out ripples in the power supply voltages. The op-amps IC1 and IC2 are powered by the +12v and -12v voltages.

IC1A and IC1B are the main oscillator section of the circuit, generating triangle and square wave outputs. This oscillator configuration is known as a relaxation oscillator. The frequency of the oscillator is determined by the values of C6 (timing capacitor) and R13 plus P2. The timing capacitor charges towards V+, at a time determined by the RC time constant of C6 and R13+P2, creating a ramp output at pin 1 of IC1A, and a negative ramp as the capacitor discharges towards V-. A triangle wave output is then generated at pin 1 of IC1A, and a saturated square wave output at pin 7 of IC1B.

IC1C takes the output square wave at pin 7 of IC1B, which is approximately 15v, and attenuates this by

approximately $\frac{2}{3}$ ($AV = -R7/R8$), to give a square wave output at pin 8 of IC1C of approximately 5v.

The sine wave output is an approximated sine wave generated by using the non-linear transfer function of diodes D3 and D4. P1 adjusts the voltage across the diodes D1 and D2, bringing them into conduction. D1 shapes the top part of the triangle wave in the +ve cycle, D2 shapes the bottom part of the triangle wave in the -ve cycle. Adjust the value of the trimmer potentiometer P1 to see how the triangle wave "bends" to form a sine wave type shape. The sine wave output across R4 is amplified by IC1D by approximately 6 times, to give a sine wave output of approximately 5v at pin 14.

IC2 takes the triangle wave output as input to the non-inverting input of the op-amp, and includes an LED in the feedback loop of the op-amp. The current across the LED is determined by the rate of the input frequency.

Capacitors C2, C3, C7 and C8 are bypass capacitors, which are located close to the IC pins to provide a local reservoir of power and provide a low impedance path to ground for power supply current returns.



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