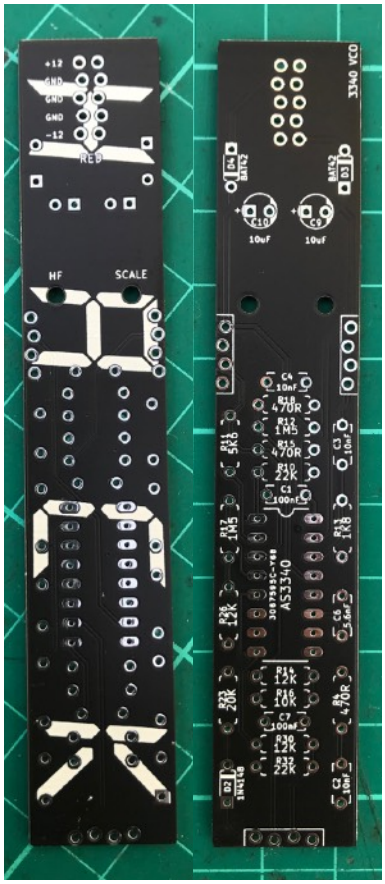
3340 Voltage Controlled Oscillator

Build Document

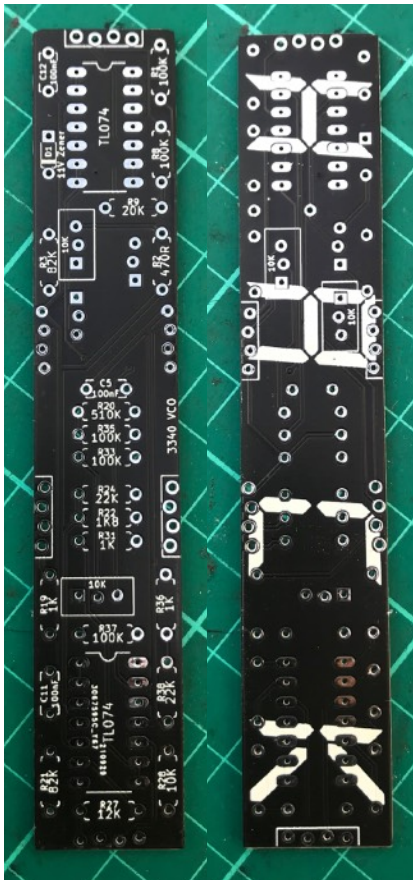
You will find 3340 VCO component, build and calibration videos to help guide you through the steps in this document on the Hack Modular Youtube channel.

The **TOP** sides of each board have the module label along the right edge. **BOTTOM** sides have the big HACK logo. Some components are mounted on the **TOP** side, some on the **BOTTOM**. This is indicated by the silkscreen symbols. The component lies on the side with the silkscreen symbol, the leads poke through pads to the other side where you solder them in place. *As standard, the anode or pin 1 of a component is indicated by a square pad.*

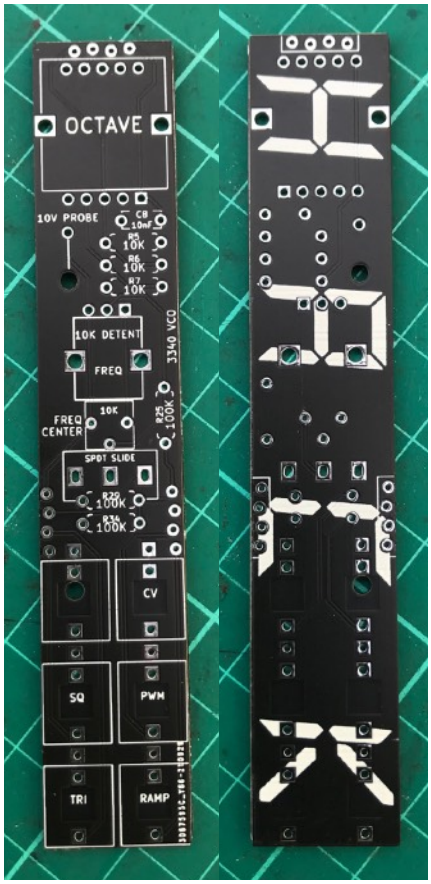
BACK BOARD



MID BOARD

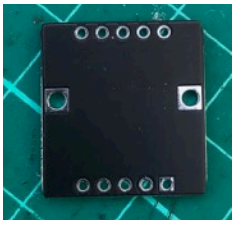


FRONT BOARD



PANEL

SWITCH SHIM



Reference	Package	Value	Quantity
R2,R4,R15,R18	1/4W 1% Metal Film Resistor	470R	4
R19,R31,R36	1/4W 1% Metal Film Resistor	1K	3
R13,R22	1/4W 1% Metal Film Resistor	1K8	2
R11	1/4W 1% Metal Film Resistor	5K6	1
R5,R6,R7,R16,R28	1/4W 1% Metal Film Resistor	10K	5
R14,R26,R27,R30	1/4W 1% Metal Film Resistor	12K	4
R9,R23	1/4W 1% Metal Film Resistor	20K	2
R10,R24,R32,R38	1/4W 1% Metal Film Resistor	22K	4
R3,R21	1/4W 1% Metal Film Resistor	82K	2
R1,R8,R25,R29,R33,R34,R35,R37	1/4W 1% Metal Film Resistor	100K	8
R20	1/4W 1% Metal Film Resistor	510K	1
R12,R17	1/4W 1% Metal Film Resistor	1M5	2
SCALE, HF, 10V, MASTER TUNE	20 Turn Trimmer	10K	4
FREQ CENTER	Small Single Turn Trimmer	10K	1
FREQ	Alpha 9MM Vertical Potentiometer	B10K DETENT	1
D1	Diode	11V Zener	1
D2	Diode	1N4148	1
D3,D4	Diode	BAT42	2
C1,C5,C7,C11,C12	Ceramic Capacitor	100nF (104)	5
C2,C3,C4,C8	Ceramic Capacitor	10nF (103)	4
C6	C0G (NP0) Ceramic Capacitor	5.6nF (562)	1
C9, C10	Electrolytic Capacitor Radial 16V	10uF	2
U1	PDIP IC	AS3340A	1
U2,U3	PDIP IC	TL074	2
U1	IC SOCKET	16 PIN	1
U2,U3	IC SOCKET	14 PIN	2
CV, PWM, SQUARE, TRIANGLE, RAMP	THONKICONN 3.5mm Socket		6
OCTAVE	Rotary Switch	1P4T	1
SPDT SLIDE	C&K SPDT SLIDE SWITCH		1
FEMALE PIN HEADER	1x4 pin	2.54mm pitch	6
MALE PIN HEADER	1x4 pin	2.54mm pitch	6
POWER HEADER	2x5 pin MALE header	2.54mm pitch	1
KNOB			2
STANDOFF	Female to female	11mm	1
SCREW		M2 x 6mm	2
RIBBON CABLE			1

Essential Tools - soldering iron, wire cutters, pliers.

An important note on resistors before we start.

R1, R5, R6, R7, R8 & R9 affect each other and important for tuning. The resistors provided with the full kit have already been matched (and separated into the bag labelled "**MATCHED resistors**") so you do not need to worry about them. If you are sourcing your own resistors you could use ±0.1% tolerance resistors or match cheaper ±1% resistors yourself.

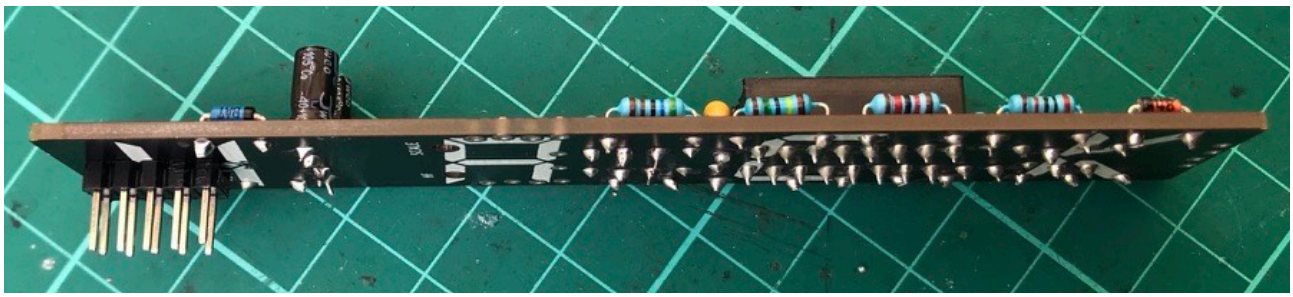
For detailed instructions on how to match resistors see the 3340 VCO Components video on the Hack Modular Youtube channel.

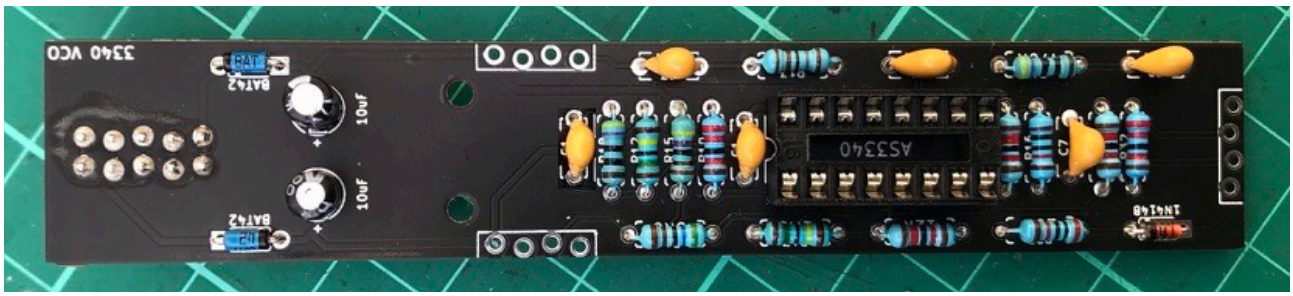
In basic terms, in the real world **resistors cannot be perfectly manufactured** - their true resistance value lies within a tolerance - for example ±1% of the stated value. However by **measuring** and matching individual resistors a more accurate tolerance can be reached. If we are trying to obtain a ±0.1% tolerance between our three 10K resistors (R5, R6, R7), we should find resistors that **only vary by plus or minus 10 ohms**. Within the parameters of a ±0.1% tolerance we would call these resistors "matched". It follows then for our purposes, whatever the average of the **actual real world** matched value of our "10K" resistors is, the measured value of the "20K" resistor (R9) should be double that, and the "100K" resistors (R1, R8) ten times.

Let's begin with the BACK Board

1. We'll start with the smallest components - the **diodes**.
    - D2 is a 1N4148. D3 & D4 are BAT42.
    - **Make sure their orientation is correct**. The line on the diodes aligns with the silkscreen symbol and faces towards the circular pad.
2. **Resistors** next. It doesn't matter which way round these go.
3. Next is the 16 pin **IC socket**. Match the indent at the top with the silkscreen symbol.
4. **Capacitors** next. It's easier to do the ceramic first then electrolytic. *Refer to the table above for ceramic capacitor codes.* Make sure the positive and negative sides of the electrolytic capacitors are in correct orientation - the long leg is positive so align that with the little plus sign on the silkscreen symbol.
5. **Turn the board over** to the **BOTTOM** side, **insert** in the 10 pin **power header** on top of the rectangular silkscreen outline and **solder** it in place.

Put the BACK board aside for the moment. You should have something that looks like this:



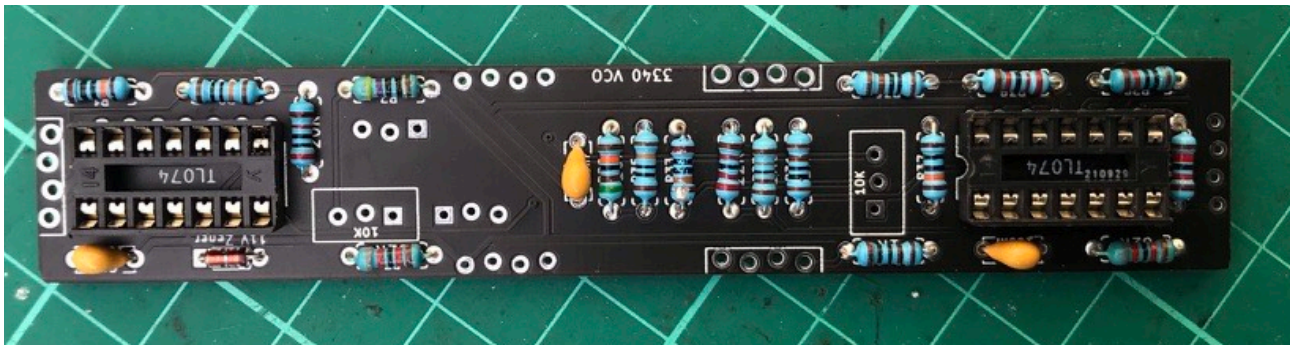


MID Board

1. Again start with the **diode** and check it is oriented correctly. D1 is an **11V Zener**.

2. Then **resistors** (R1, R8 and R9 are part of the matched set), **IC sockets** and **capacitors**.

It should look like this:



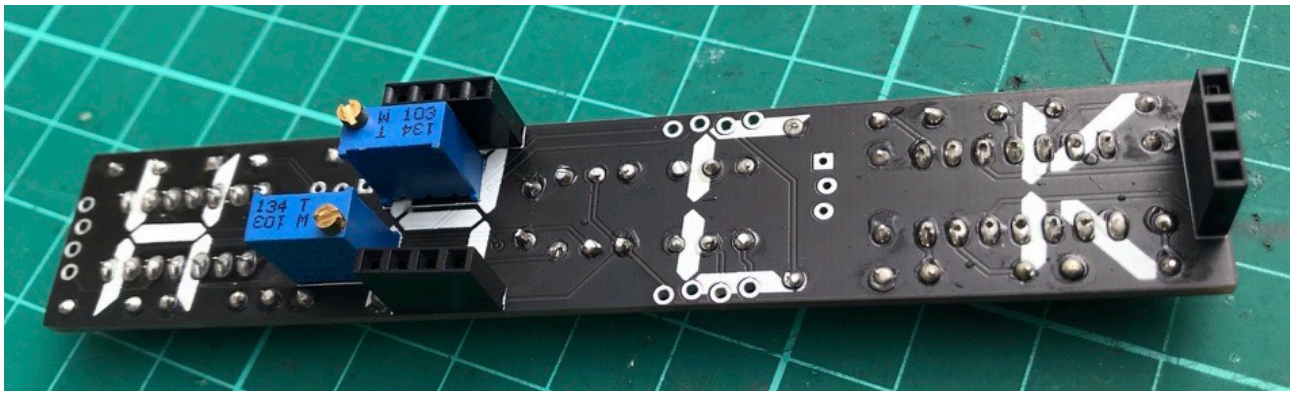
Connecting the BACK and MID boards

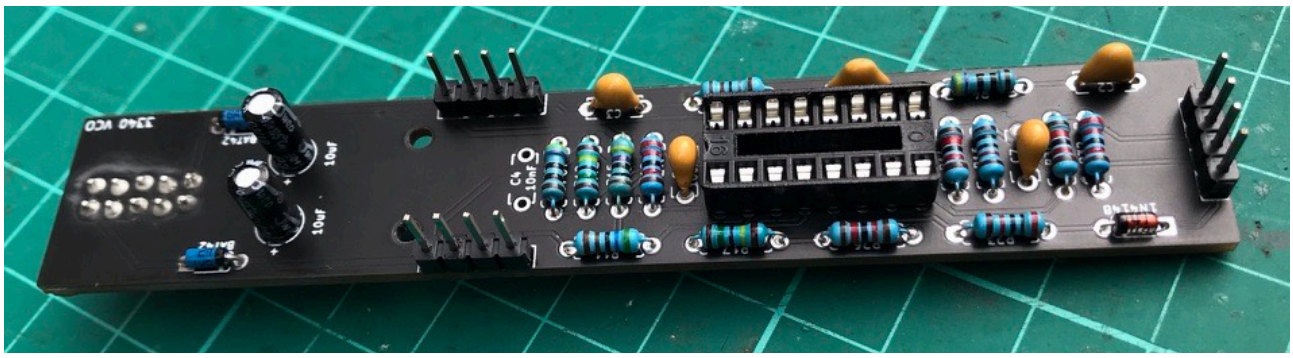
1. Now **insert** the three **FEMALE 4 pin headers** and the two **10K trimmers** on the **BOTTOM** of the **MID** board, but do not solder in yet. The trimmer screws go toward the square pads. All trimmers in the project are 10K.

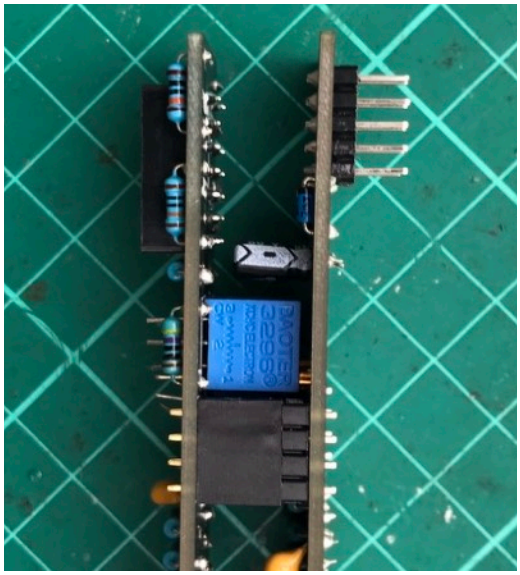
2. On the **BACK** board we put aside earlier insert the **3 MALE headers** on the **TOP** side, but do not solder in yet.

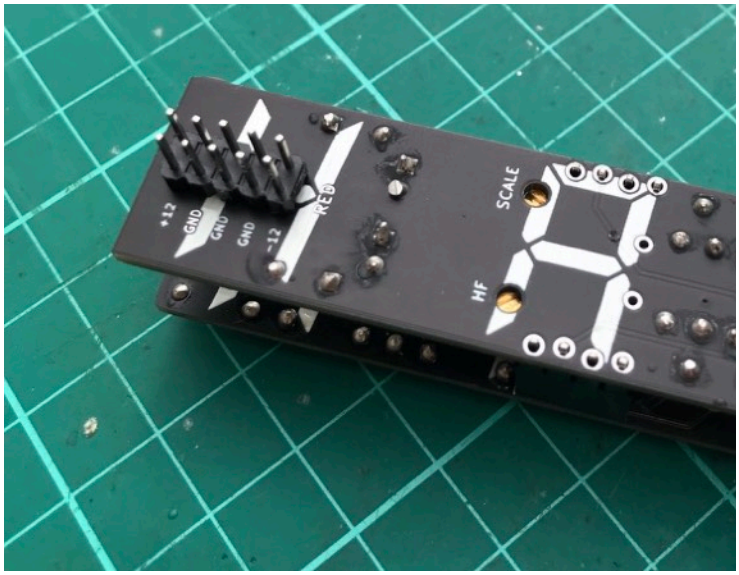
3. **Connect** the two boards together. Check everything is aligned. Use the provided screwdriver to push the trimmers down into the **MID** board so that the screws are lined up while recessed inside their access holes. **Solder** everything in place.

Separate and put both boards to the side.







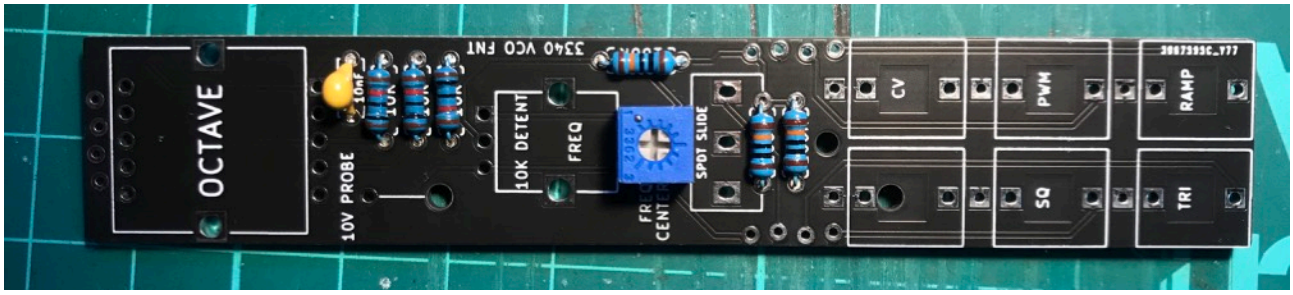


FRONT Board

1. Start by **soldering** in all the **resistors.** R5, R6 and R7 are part of the matched set.

2. **Solder** in the **capacitor C8**.

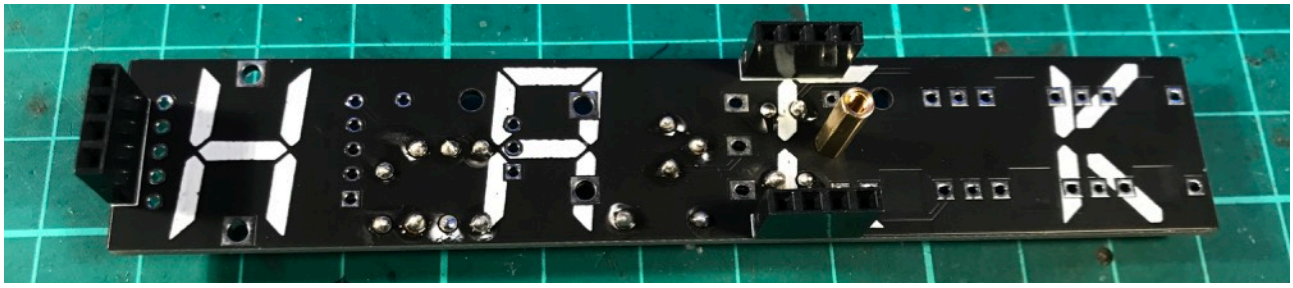
3. **Solder** in the **Freq Center 10K single turn trimmer**.



Connecting the FRONT and MID boards

1. **Insert** an **M2 screw** from the **TOP** of the **FRONT** board through the hole below R34. On the **BOTTOM** of the board thread and tighten the 11mm standoff onto it.

2. **Insert** all three **FEMALE headers** into their slots on the **BOTTOM** of the **FRONT** board, but do not solder in yet.



3. **Insert** the **MALE headers** into place on the **TOP** side of the **MID** board, but do not solder them in yet.

4. Then **insert** the two remaining **20 turn trimmers** onto the **FRONT** of the **MID** board, but do not solder in yet.

5. **Connect** the **FRONT** and **MID** boards together, **thread** the other **screw** into the standoff from the **BOTTOM** of the **MID** board. Check the headers and trimmer screws are aligned. **Solder** in everything in place.

6. **Disconnect** the **MID board** and put it aside.

Mounting the Panel

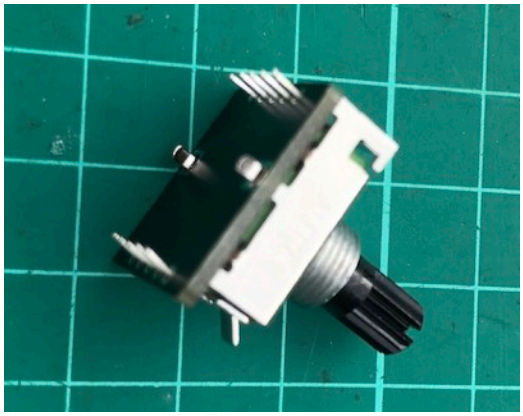
1. Now on the **TOP** side of the **FRONT** board, **insert** the **10K DETENT potentiometer**, but do not solder in yet.

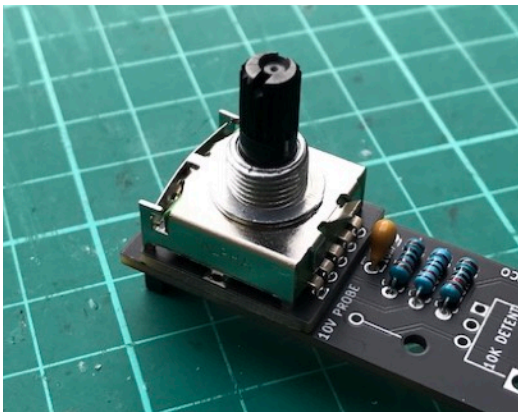
2. **Insert** the **SPDT slide switch**, but do not solder in yet. It can be either way round.

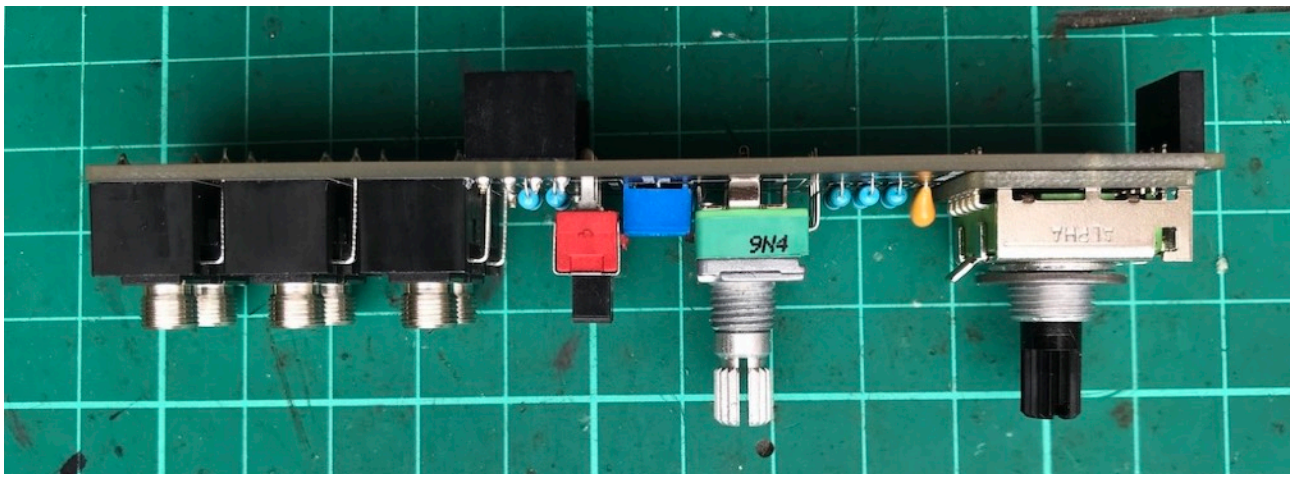
3. Insert all the **jack sockets**, but do not solder in yet. They are turned so that the ground lead is upwards.

4. Insert the legs of the **octave rotary switch** through the **switch shim**, then into it's place on the **FRONT** board, but do not solder in yet.

5. With pliers, **bend** the little metal **tab** on the **rotary switch** downwards so that it will fit under the **PANEL**. Then put the **1mm washer** on the switch shaft.

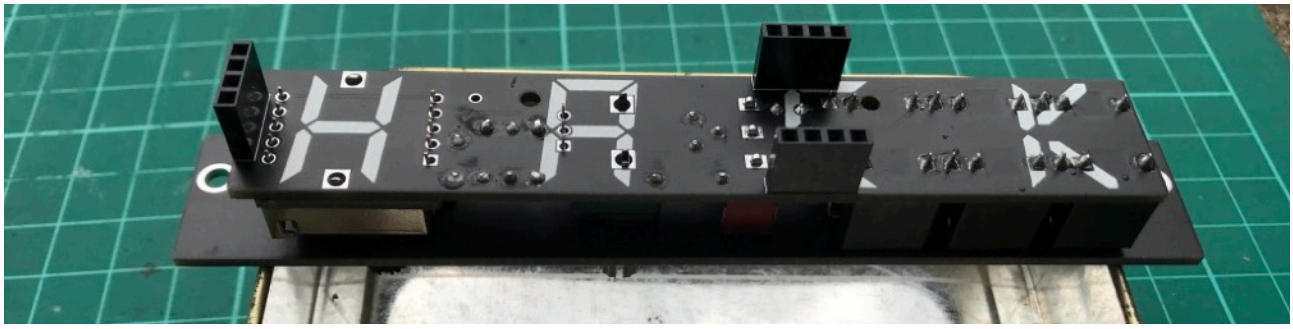






6. Put the **PANEL** on and **screw** the switch, potentiometer and jack **nuts** on, checking all components are well aligned and seated in their holes. The **FREQ** pot also has a washer. *Be careful not to scratch the panel.*

7. Push the **slide switch** so it is flat to the bottom of the panel. **Solder** everything in place. *I use a tin to raise the assembly up while soldering.*



8. **Insert** all of the **ICs** in their sockets, matching the top indent to the socket and silkscreen symbol. *You can see the IC labels on the PCB through the gap in the socket.*

9. Connect the **BACK**, **MID** and **FRONT** boards together. Remember to put the screw back into the standoff from the **MID** board side.

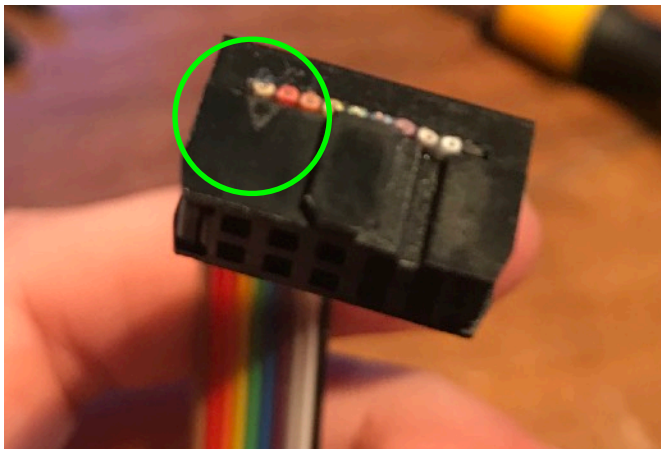
10. **After referring to the Ribbon Cable guide below**, plug in the module and do a basic test of all the functions. Don't worry about exact pitches - that will be set during calibration.

    - Do the SQUARE, TRIANGLE and RAMP outputs make a sound?
    - Does the octave switch change the pitch in the expected direction?
    - Does the FREQ pot change the pitch in the expected direction?
    - Does the LF/AF switch change the pitch?
    - Does the PWM input change the sound of the SQUARE waveform?
    - Can you change the pitch of the waveforms by sending in a control voltage to both of the two CV inputs?

If something is not working, refer to the TROUBLESHOOTING section below.

Ribbon Cable

To avoid damage to modules it is important to connect the power cable correctly. The triangular sign on the black header sockets mark the -12V connection. The RED cable on a standard coloured ribbon cable (and the rainbow cable provided with kits) should be closest to the **RED** silkscreen text on the PCB.



1V/Oct Calibration

For this you need a **voltmeter, 1V/Oct control source** and a **tuner**.

Turn the module on and leave it to warm up for 10 minutes. Make sure the slide switch is in the AF (audio frequency) position. Remove the panel.

Electronic tuners are very precise, so can exaggerate tuning errors. If in doubt, listen to the oscillator and let your musical ear determine if the result you have achieved is acceptable.

1. The first step is a preliminary setting of the **10V Trimmer**. This is found on the **FRONT board** underneath the octave switch.

    - Put the **positive probe** of your voltmeter on the **probe point** above the trimmer screw. Connect the negative probe onto the outside of one of the jacks for a ground reference - this is easier done with an alligator clip.

    - With the provided screwdriver turn the trimmer screw until you read **10 volts.**

2. Now we will adjust the **SCALE** trimmer on the back of the module.

    - **Patch** one of the waveform **outputs** to a **tuner.**

    - You can use the **FREQ** pot or **MASTER TUNE** (found inside the left CV input jack) to set the pitch to an exact interval on your tuner to make the next steps easier.

    - **Plug in** a trusted 1V/Oct output **CV controller** to either input jack. Set the **OCTAVE switch** fully **counter-clockwise**.

    - Switch between **0V** and **1V** (one octave) with your **CV controller**. When the **SCALE** setting is correct the note on your tuner should be the same, just an octave higher. Determine if the interval between the notes is too close together (flat) or too far apart (sharp).

    - Turn the **SCALE** trimmer screw **clockwise to expand the distance** or **anti-clockwise to shrink**. As you adjust the **SCALE** trimmer the overall pitch of the oscillator will also shift. As before, you can adjust it back to a note on your tuner for simplicity. Repeat this process until you hone in on the correct setting.

    - Now switch between **0V** and higher octaves up to **5V**, repeating the process above to fine tune the exact setting.

    - When this is done **unplug** the CV controller.

3. Switch between **octaves** with the **rotary switch**. Finely adjust the **10V Trimmer** until the note you get at each octave matches - similar to how we set the **SCALE** trimmer. *This is averaging out the unique imperfections in our matched resistors.*

4. Now set the **OCTAVE switch fully clockwise** and using the **highest octaves** of your CV controller check if the tuning is still correct. If it is not, use the **HF** (high frequency) trimpot on the back of the module in the same way as we did with the **SCALE** trim to correct the tuning.

    - When this is done **unplug** your CV controller.

5. Turn the **FREQ pot** to the leftmost counter-clockwise position. Set the **octave switch** to the leftmost position. Now we can set the **MASTER TUNE** trimpot - this is found inside the left CV input jack. It sets the lowest note when there is no CV input. I would suggest setting this note to a **C**, or in tune with other oscillator modules in your rack - but there are no hard rules.

6. The full range of the **FREQ pot** should be **TWO** octaves. *In practice this exact range is dependent on the accuracy of our matched resistors and subsequent 10V trim compensation - but it should be very close.*

    - When the pot is in the detented center position (you should feel it lock into place), this should be the middle octave note. To set this center note use the blue **FREQ CENTRE trim pot**.

Reattach the panel (minimalist option on the reversible side), put the knobs on and you're good to go!

To explore the 3340 VCO's features see the USER GUIDE.

Troubleshooting

Firstly, if it's late go to sleep. Normally the problem will be obvious with a clear head.

- Is the ribbon cable connected correctly?
- Are components orientated correctly - diodes, capacitors, ICs?
- Are the legs of the ICs inserted correctly in their sockets?
- Are you expecting to hear a tone but the LF/AF switch is in low frequency mode?

For most problems the likely culprit is a bad solder joint. Reflow any that look suspicious.