ALLSCILLATOR

DIY BUILD DOCUMENT V1.1

APOLLO VIEW

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SPECIAL THANKS

Thomaas Banks	Thomaas Banks
Ben Wilson	DivKid
Alex Zaslavsky	Alfa Rpar

INTRODUCTION

ORIGIN

The Curtis Electromusic Specialties CEM3340 is a classic integrated circuit VCO – “oscillator on a chip” designed by Doug Curtis and released in 1980. The CEM3340 is found in many of the famous synths of the analogue era; the Sequential Prophet-10, Prophet 600, Pro-One, Prophet 5 and T8, the Oberheim OB-Xa, OB-Sx and OB-8, the Roland SH-101, MC-20, Jupiter 6 and early model MKS-80, the Voyetra 8, even the MemoryMoog and more. Instruments with CEM ICs are said to have that Curtis sound, described as "fantastically saturated, brash and powerful"[1]. Many believe this chip to be the greatest sounding analogue oscillator of all time.

If you are curious, Tom Wiltshire (Electric Druid) has an excellent article on [CEM3340 VCO designs] where he explores the implementation of this chip in the Roland MKS-80, Roland SH-101, Sequential Prophet 5 Rev.3 and the MemoryMoog.

We wish to pay our respects to Doug Curtis for all of his achievements and technical contributions to music. Without his contributions to integrated circuit design, many of the famous synths we know and love might have sounded different.

The original CEM3340 went out of production decades ago and in more recent years, it was cloned and updated by Alfa Rpar and Cool Audio separately. CEM themselves reissued the CEM3340 rev G in 2016. We had wished to use the CEM3340 rev G for Allscillator. Unfortunately, it is only available in a PDIP-16 (300mil) package. To meet our design constraints of keeping Allscillator to 10HP, we chose to use the AS3340 from Alfa Rpar which is available in a smaller SOIC-16 (150 mil) package. We wish to highlight the technical support from Alfa Rpar has been excellent throughout our development process.

3340 VCOs are precision voltage controlled oscillators, featuring both exponential and linear control scales and four buffered output waveforms: triangle, sawtooth, square, and pulse with voltage controllable pulse width. Through waveshaping, we have expanded these basic waveshapes to include additional output waveforms of square-sine, Sharktooth, pulse-width modulation saw, and sub-octave output that can be switched between -1 octave, -2 octave and -2* octave (-2* is achieved by summing waveshaped -1 and -2 octave signals). Unusually, also included on the 3340 is a provision for hard and soft synchronisation of the frequency. Many classic synthesisers' designs overlooked this feature and opted to include alternative circuits to implement a classic synth effect. We have stuck to the original CEM3340 datasheets concept for the frequency sync inputs as, according to the datasheet, this method will ‘provide a wider variety of synchronised sounds than available through conventionally synchronised oscillators”[2].

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[1] Description of Sequential Circuits Prophet-600 sounds

[2] CEM3340 datasheet

TOOLS

ESSENTIAL

- Soldering Iron - a solder station with temperature control is best. Some components on this build are connected to the ground plane and require a large amount of heat. A low Wattage soldering iron that plugs directly into the power supply will not be good enough to achieve an effective solder joint. When soldering pots and jacks, 370ºC is best; for everything else, 340ºC (this is dependent on the solder you use, so check out your solder's data sheet).

- Solder - We find thin is best, around 0.6mm. We use a lead-free rosin core solder.
- 7mm & 10mm Nut drivers
- Bananut driver
- Side Cutters
- Pliers
- Solder Sucker
- Watchmaker screwdrivers, Phillips ≅2.3mm and flathead ≅2.3mm

CALIBRATION

- Millivoltmeter (multimeter) with crocodile clips
- Male to female Jumper wire like this is perfect
- Voltage source 1V-5V, a 1V/Oct keyboard or a sequencer will do just fine
- A tuner
- Oscilloscope and spectrum analyser for calibrating the Sine Output. If these are not available, you can use your ears

OPTIONAL

- Flux Pen
- Cleaning Brush (an old toothbrush will do)
- Masking Tape (It can help hold components in place when flipping the board over to solder)

Construction Guide

There are already excellent soldering guides in existence, so we will refrain from reinventing the wheel here.

If you need some guidance, please check out the Moritz Klein x Erica Synth Build Documents. The soldering appendix is an excellent resource.

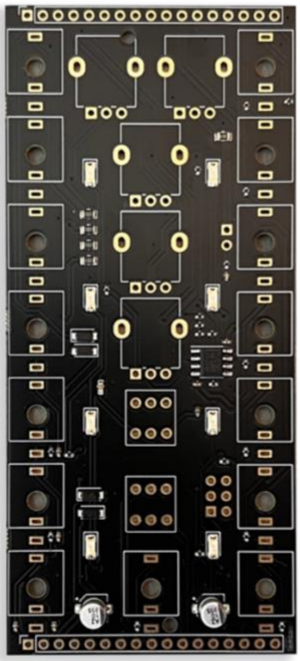
Or, if you prefer videos, this is a pretty good guide.
In most cases, components can be placed onto the PCBs, and then the board can be flipped upside down and laid face down on the soldering mat to solder the legs to the back of the PCB.

PARTS LIST

Allscillator Component per module	Qty
Faceplate Allscillator	1
Faceplate Screws	4
Front PCB Allscillator	1
Back PCB Allscillator	1
AS3340 VCO Chip - Presoldered to Back PCB	1
Right Angle 2 x 3 pin header	1
Ring Angle 2 x 1 pin header	3
Trimmer Bourns 3296X-1-103 10k Side Slot Adjustment	3
Trimmer Bourns 3296X-1-503 50k Side Slot Adjustment	2
Trimmer Bourns 3296X-1-203 20k Side Slot Adjustment	1
Trimmer Bourns 3296X-1-502 5k Side Slot Adjustment	1
Trimmer Bourns 3296X-1-501 500R Side Slot Adjustment	1
Trimmer Bourns 3296X-1-104 100k Side Slot Adjustment	1
2 Pin Jumper	2
Standoff	2
Standoff Screws Front (countersunk)	2
Standoff Screws back (Round head)	2
01 x 17 Pin Header	2
01 x 17 Pin Socket	2
Right Angle Shrouded Power Header	1
Knobs	5
DPDT Switch On-On-On	2
B100k Alpha D Shaft	5
Thonkiconn Jack	15
Bananuts	15
Black Hex Nut	5
Power Cable	1

ASSEMBLY STEPS

Note: when instructed to solder things in place, it is also implied to cut the legs off the components with legs once soldering is complete. In this build, the trimmers are the only components which need their legs cut. Once the legs are cut, you can apply heat again (and solder if required) from the soldering iron to make an aesthetically pleasing solder joint.



Front PCB Face

Front PCB Rear

Back PCB Face

Back PCB Rear

1. Find the 1x2 pin headers. Put two of these to the side for step 4. Locate the 2x3 header.

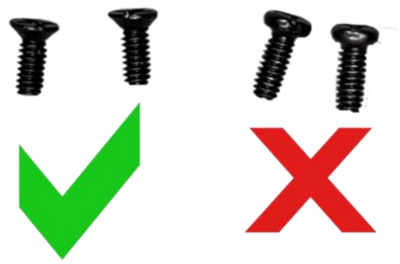
2. Place one 1x2 pin header and the 2x3 pin header in the footprints on the rear of the Front PCB.

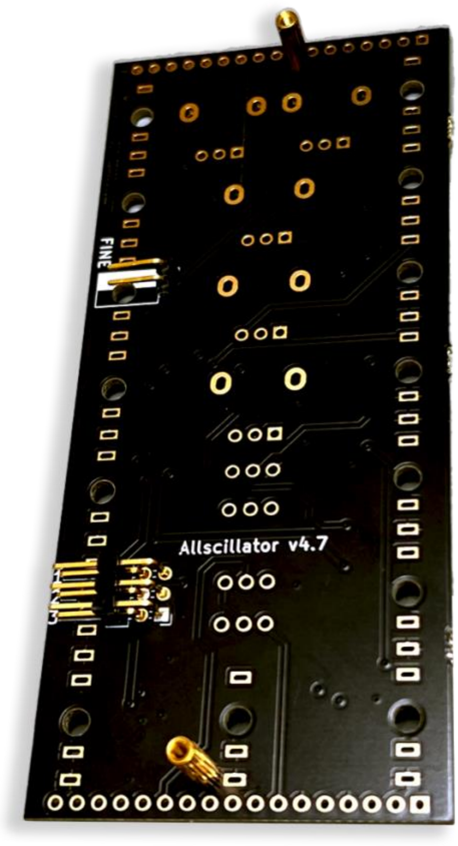
   Take care to ensure the pins are horizontal to the PCBs.

   Note: Positioning is easier by soldering one pin first, checking alignment, and making any corrections before soldering the remaining pins.

   Solder in place.

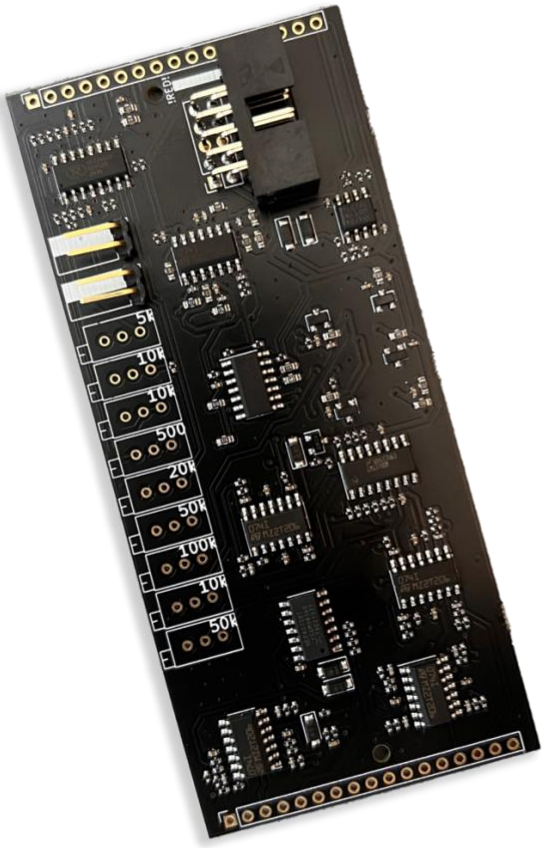
3. Attach the standoffs to the rear of the Front PCB with two Countersunk M2 screws. Put the other Roundhead M2 screws to the side for now.





4. Place the two remaining 1x2 pin headers in the footprints on the front of the Back PCB. Flip the board holding them in and solder them in place. A flux pen can help get a good solder joint here; a light wipe over the pads is all that's required.

5. Place the 2x5 pin right angle shrouded power header onto the face of the Back PCB. Flip the board over, and ensure good alignment against the PCB and solder.



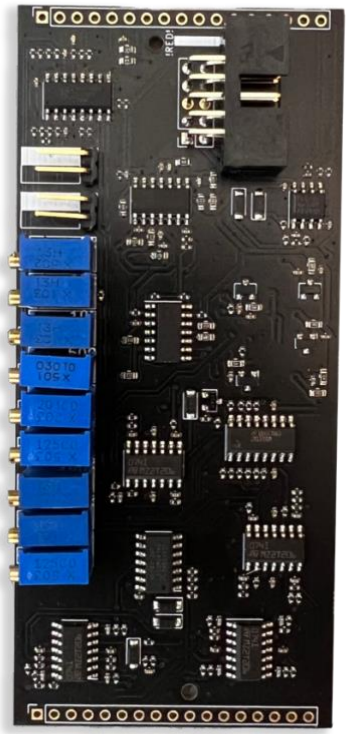
6. Identify the trimmers.

Resistance	500 ohm	5k	10k	20k	50k	100k
Code	501	502	103	203	503	104

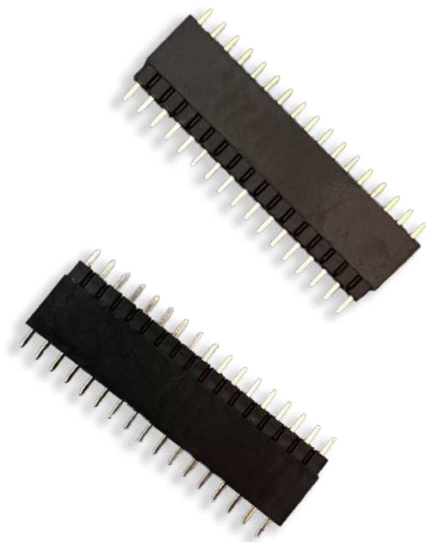
Below are pictured 50K and 5K Trimmers.

7. The footprints on the Back PCB have been labelled with the resistance values. Place the trimmers in place. **Note:** it might be easier to do 4 or 5 at a time. Solder the middle leg in place, check the trimmer is flush against the PCB board soldering the remaining pins.

8. Solder in place all trimmers



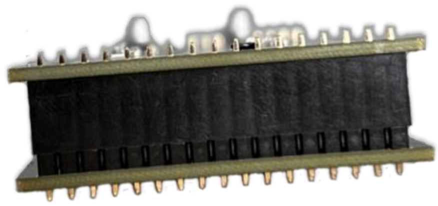
9. Locate the pin headers.



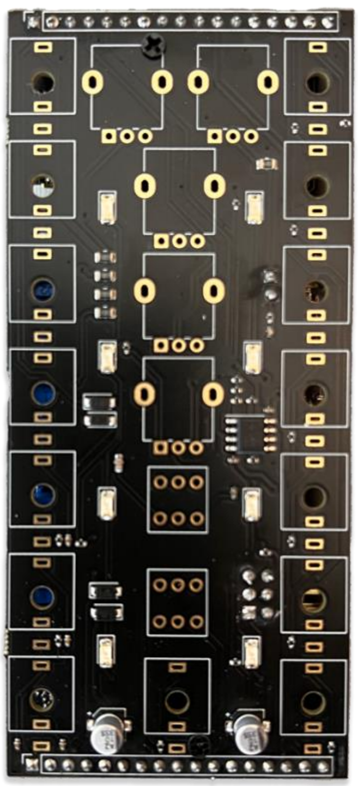
10. Lay the Front PCB face down and lay the pin headers and pin sockets onto the rear of the PCB. Don’t solder yet.

    Note: we kindly put the pins into the sockets already. We have a convention to place the sockets against the rear of the Front PCB; this will help compatibility if there are any future issues swapping any broken PCB parts around.

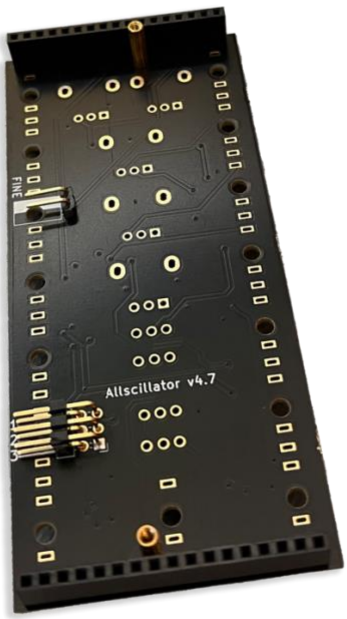
11. Lay the Back PCB face down on the pin headers. Attach the Back PCB to the standoffs with the remaining two Roundhead M2 screws.



12. Solder the pin headers and pin sockets in place.

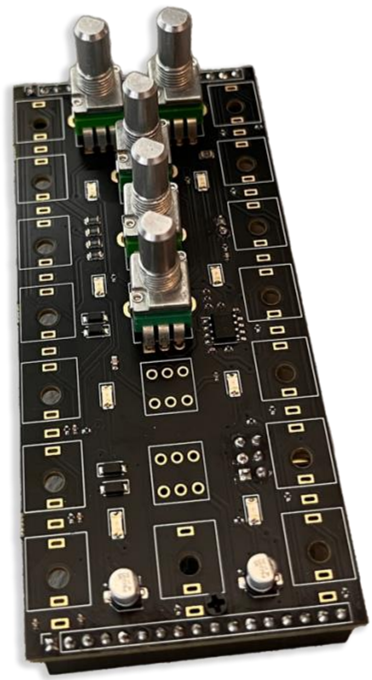


13. Unscrew the Back PCB separate the boards, and set the two M2 screws to one side.

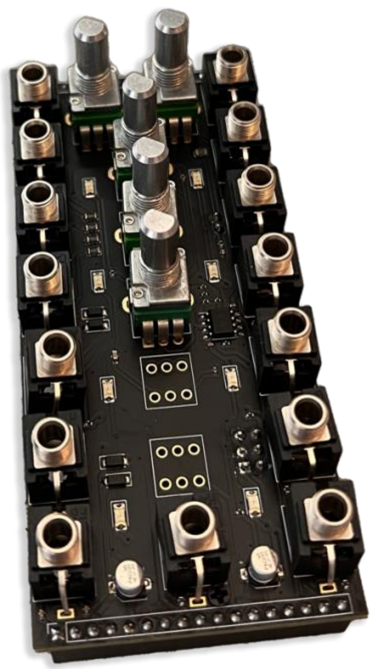


14. We will now populate the face side of the Front PCB, starting with the potentiometers, which are all B100k (the potentiometers are clearly labelled with their value). Using pliers to straighten the kinked legs can help with positioning the potentiometers.

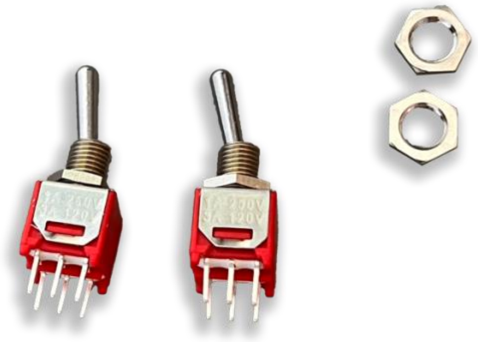
    Note: Don't solder anything until the Faceplate is on.



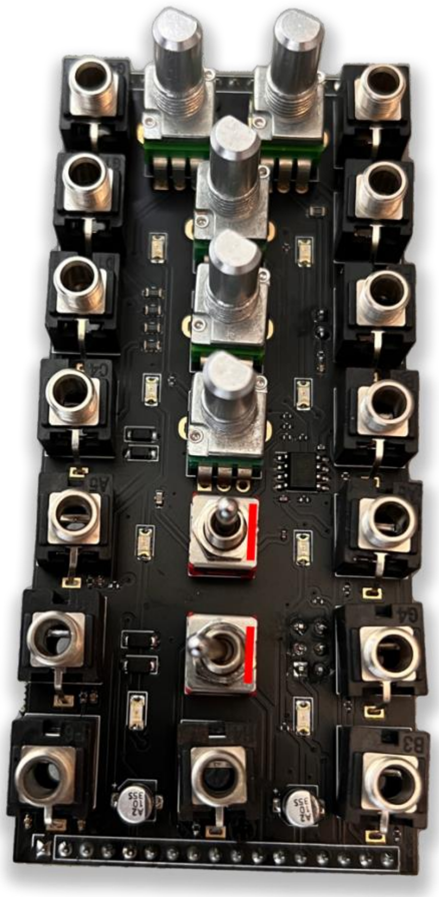
15. Next, populate with the 15 Thonkiconn 3.5mm jack sockets.



16. Screw a nut onto each of the two DPDT switches.



17. Place switches with the flat key (on the thread/barrel of the switch) facing the right of the PCB. When this step is done, the Front PCB should look as follows (the red line indicates the flat thread/barrel of the switch).



18. Place on the Faceplate. Take care not to dislodge any components. The switches should both be in the **Middle** position.

19. Holding the faceplate on firmly, check the rear of the Front PCB and ensure that all the legs are through the holes. Take care that **all** of the jacks' ground pins are through, as these springy little legs are susceptible to popping out. If any components need realigning and the legs placed through holes, do this before moving on to the next step.
20. Put black hex nuts on first. Place them with the smooth/rounded side down. If you position them with the flatter side down, they scratch the Faceplate while tightening.

    Note: The washers aren't strictly necessary but can be used if desired. We chose to leave them off as we found it more aesthetically pleasing.

21. Finger Tighten the black hex nuts first before tightening with 10mm hex driver.
22. Then position and finger tighten the Bananuts onto the jacks. Do the final tightening with the Bananut driver.
23. Then position and finger tighten the switch nuts. Do the final tightening with the 7mm hex driver.

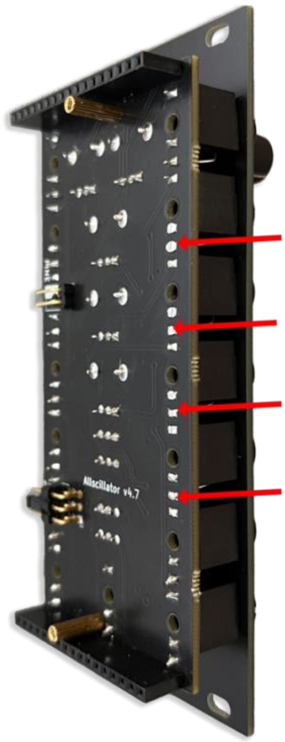
24. Boom! You are ready to solder everything in place.

25. Give all solder joints a quick scrub with a cleaning brush to remove flux.
26. Put the jumper on the 2x3 pin header. Position 2 Is the default Flashing mode.

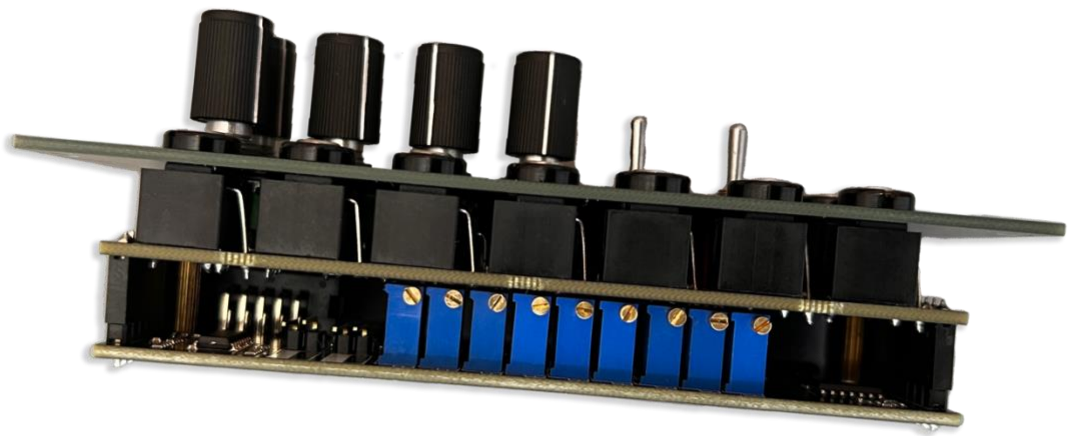
    Position 1. LEDs constantly OFF
    Position 2. LEDs flash with the -2 octave of the frequency of Allscillator
    Position 3. LEDs constantly ON

27. Push the Knobs onto the pots; this requires a fair amount of force.

28. Using side cutters, cut the solder joints on the right of the PCB so they are flush with the board. This step is necessary to make space for the trimmers to sit nicely when we bring the Front and Back PCBs together.



29. Screw the Back PCB onto the standoffs with the Roundhead M2 screws you put to the side earlier.

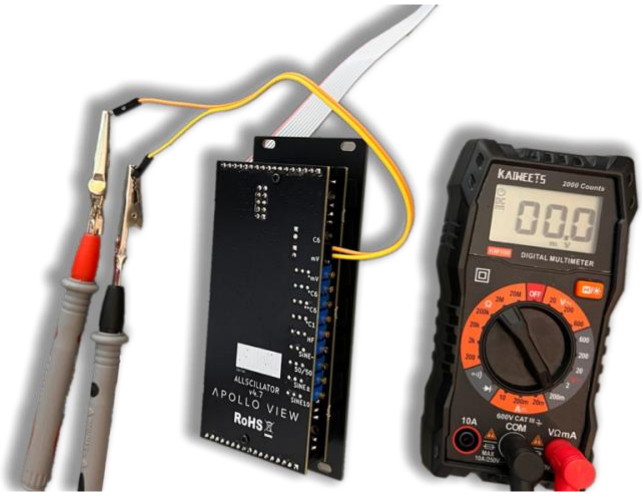


30. Place the power cable into the shrouded header, and we are ready to calibrate.

CALIBRATION

1V/Oct TUNING

This process requires a millivoltmeter (multimeter) with crocodile clips and some jumper wire, as shown below, a voltage source and a tuner. The voltage source should be capable of accurately supplying 0V, 1V, 2V, 3V, 4V, 5V, (6V and 7V for High Frequency tuning). A typical keyboard with 1V/Oct CV output is fine, or any sequencer where you can accurately be aware of the output voltage.



1. Leave Allscillator switched on in your case, for half an hour before attempting the rest of the tuning steps so Allscillator reaches normal working temperature
2. Attach the voltmeter setup to the mV pins
3. Adjust the mV trimmer to read 0.0mV on the voltmeter
4. Set the Coarse knob fully counterclockwise, making sure it doesn't get knocked when completing the following steps
5. Connect the tuner to the Sine output
6. Place the Jumper on the C6 pins
7. Adjust *C6 trimmer until you read C6 on the tuner.
8. Remove the Jumper and place it to the side. It needs to be placed on the Fine pins later when calibration is complete
9. Plug your voltage source into 1V/Oct and supply 5V
10. Check the reading on the tuner
11. Adjust the **C6 trimmer until the tuner reads C6 (due to component tolerances, some modules will require tweaking of *C6 trimmer to bring the frequency down to hit C6, this does not affect tracking performance)
12. Supply 0V to the 1V/Oct
13. Check the reading on the tuner
14. Adjust *C1 until the tuner reads C1
15. Supply 7V to 1V/Oct
16. Adjust HF trimmer until tuner reads C8
17. Supply 4V to the 1V/Oct
18. Check the tuner
19. Adjust **C6 until the tuner reads C5

20. Supply 1V to the 1V/Oct
21. Check the tuner
22. Adjust C1 until the tuner reads C2
23. This should complete the calibration steps
24. Play a sequence into the 1V/Oct to check the tracking
25. Repeat the above steps if necessary
26. Place the Jumper on the Fine pins

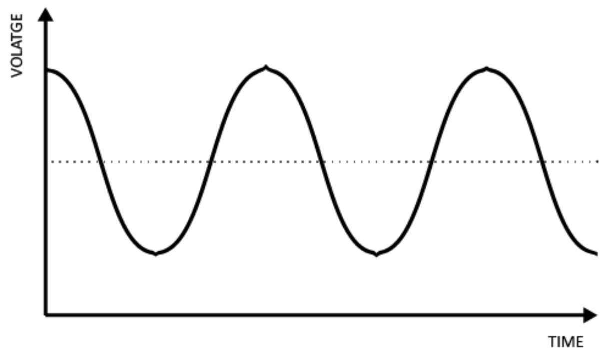
SINE OUTPUT CALIBRATION

This is best achieved by using a measurement oscilloscope and a spectrum analyser. The objective is to reduce the harmonics caused by any deviations from a mathematically pure sine wave until we have just the fundamental frequency. Therefore, it is possible to achieve this by ear, but the oscilloscope and spectrum analyser simplify and speed up the process.

In practice getting a pure sine from analogue circuitry is challenging and can require a high component count. We have struck a good balance with Allscillator's Sine Output; we get very close to pure sine with a manageable component count. Therefore, don't expect to remove **all** traces of the harmonics when calibrating. But **do** expect a much better result than many other analogue VCO sine outputs.

The Sine is derived from the Triangle Output. There are a few processes to waveshape the triangle into sine.

Many other VCOs saturate the Triangle to flatten it into a Sine through saturation. However, this process fails to remove the peaks from the Triangle wave, so they are still apparent in the Sine Output, which adds third harmonics.



Typical Analogue VCO Sine

The trick we have employed in achieving a purer Sine is to mix an inverted copy of the Triangle into the Sine to remove these little peaks. Thereby decreasing the unwanted third harmonics.

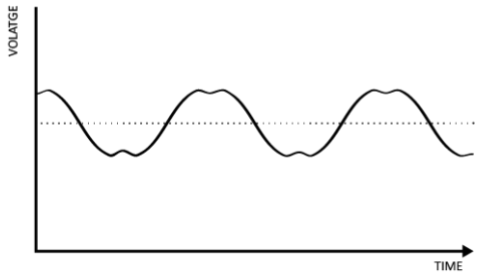
There are 4 trimmers we will adjust in this calibration process.

SINE ~	Mix amount of inverted Triangle wave
50 / 50	Duty cycle of the Sine (side effect – affects the sine offset)
SINE ±	Offset of the Sine
SINE10	The amplitude of the Sine

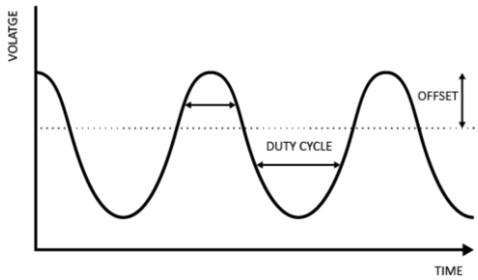
1. Make the following adjustments while observing both the oscilloscope and the spectrum analyser

2. Set the frequency to 100Hz

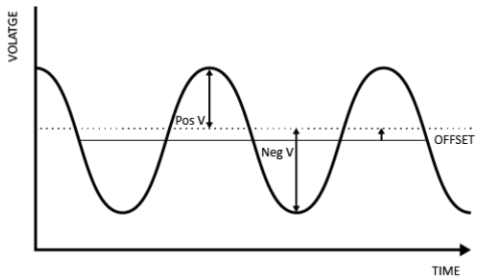
3. Adjust SINE ~ If your waveform is similar to the image in the figure, you need to turn the trimmer anticlockwise. On the oscilloscope, you are aiming to visualise the most natural Sine. This should be verified with the spectrum analyser that you have a result with a minimum odd harmonic series, 300Hz, 500Hz, 700Hz etc.



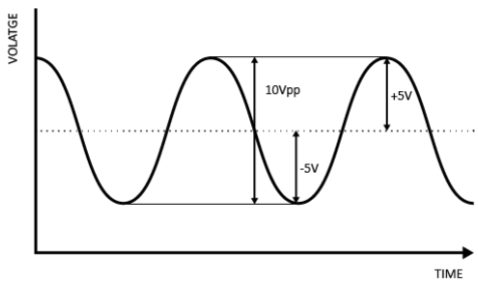
4. Adjust 50/50 you need to read 50% and 50% for the +Duty and -Duty cycle.
   On the oscilloscope, you are aiming to visualise the most natural Sine. This should be verified with the spectrum analyser that you have a result with a minimum even harmonic series, 200Hz, 400Hz, 600Hz etc.



5. Adjust SINE ± to read equal magnitude voltages for the positive and negative portions of the waveform. For example, Top +4.26V and Base -4.26V



6. Adjust SINE10 to read an amplitude of 10Vpp, or +5.00V Top and -5.00V Base



Calibration is now complete!

If you have issues with the calibration (or anything else), don't hesitate to get in touch with info@apolloviewmodular.com for support.

SERIAL NUMBER

Now you have completed your build, contact us at info@apolloviewmodular.com and we will issue your special DIY serial number. This can be written in indelible ink on the back PCB and the details of the registration card can be updated.

THAT´S IT; YOU´RE GOOD TO GO!

PLEASE READ THE MANUAL FOR MORE OPERATIONAL INFO

GO MAKE SOME FILTHY SOUNDS.

ALLSCILLATOR
DIY BUILD DOCUMENT V1.1

APOLLO VIEW

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