

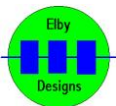


ES20 1973 VCO

Construction Guide

Revision 1.0

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Construction of the ES20 requires the assembly of 3 boards:-

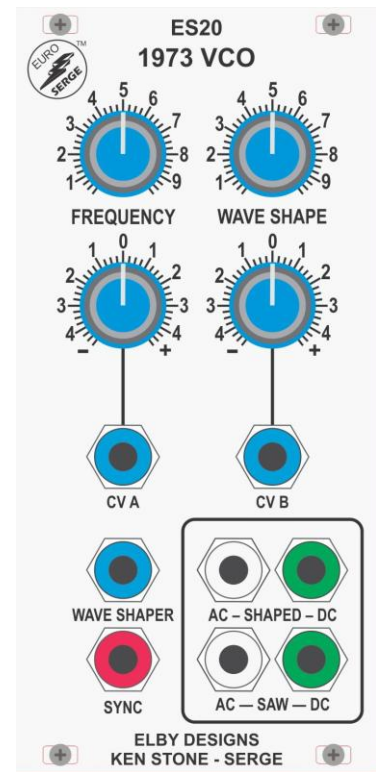
Column 1 - Panther Support 5 PCB ([3D Model](#))

Column 2 - Panther Support 5 PCB ([3D Model](#))

Main B - ES20 PCB ([3D Model](#))

Constructors should refer to the printed Component Overlay for any specific comments regarding the board assemblies, the Bill of Materials for the current value of all components and [General Construction Notes](#) for general pcb assembly guidelines. You are advised to check all of these documents on our website to ensure you have the latest copy.

1. Assemble all 6 Carrier Board assemblies ([3D Model](#))
2. Fit all components to the boards following normal assembly guidelines except for all the jack sub-assemblies
3. Mount the 3x jack sub-assemblies to the Column 1 board and then offer the assembly up to the front panel and secure the using the supplied nuts and washers
4. Solder the jack sub-assemblies in to place
5. Mount the 3x jack sub-assemblies to the Column 2 board and then offer the assembly up to the front panel and secure using the supplied nuts and washers
6. Solder the jack-sub-assemblies in to place
7. Install the Main Board ensuring the correct alignment of the IDC connectors



Calibration

Equipment requirement:

- 0.0V and 2.0V voltage sources (preferably switchable)
- 5K Lin potentiometer (wire in series with Reference output as per *Figure A*)

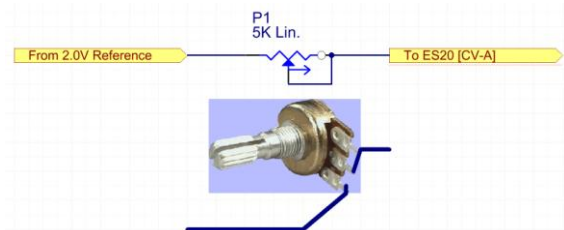
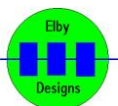


Figure A

Either:-

- Method 1 - a high-accuracy frequency meter, or
- Method 2 - an accurate audible tone generator¹ and a small mono amplifier with a 2-input mixer



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Calibration Procedure using Method 1

Step 1 - LO-End :-

1. Set the '5K Lin' pot fully anti-clockwise
2. Set [FREQUENCY], [WAVE SHAPE] and [CV A] to their minimum (CCW) position
3. Set [CV B] to '0'
4. Monitor [SAW-DC]
5. Adjust P101 for an output of 16Hz

Step 2 - Wave Shaper :-

1. Set P201 to its mid-position
2. Monitor [SHAPED DC]
3. Adjust P201 for best sine shape which should be similar to that in *Figure B*. Note that the wave shaping circuitry can take a couple of seconds to stabilise so make small adjustments and wait for the waveform to stabilise
4. Turn [WAVE SHAPE] to maximum and check that the waveform is similar to that in *Figure C*
5. Repeat steps (3) and (4) until both ends of [WAVE SHAPE] match those in *Figures B & C*

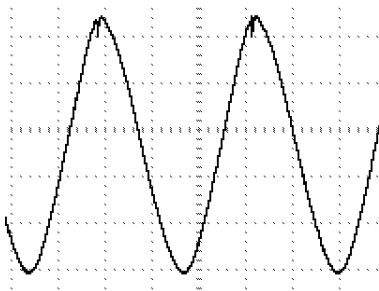


Figure B

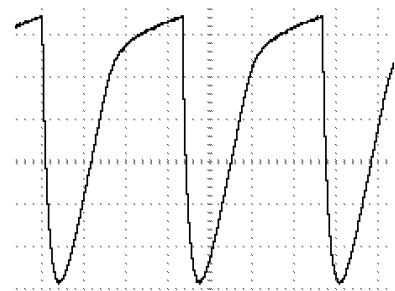


Figure C

Step 3 - HF Trim:-

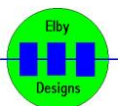
Stage 1:

1. Monitor [SAW DC]
2. Set [CV-B] pot to '0'
3. Apply 0.0V to [CV A]
4. Adjust [FREQUENCY] for 300Hz using [CV-B] pot for fine tuning
5. Apply 2.0V to [CV A]
6. Adjust '5K Lin' pot for 75Hz
7. Repeat steps (3) to (5) for best accuracy

Stage 2:

8. Set [CV-B] pot to '0'
9. Adjust [FREQUENCY] for 300Hz using [CV-B] pot for fine tuning
10. Apply 0.0V to [CV A]
11. Adjust P102 for 1200Hz
12. Repeat steps (9) to (11) for best accuracy

Calibration of the HF Trim is a series of successive approximations so stages 1 and 2 should be repeated several times for optimum accuracy.



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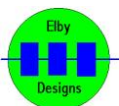
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Step 4 - Tracking Range:-

Check the tracking range by setting to various multiples of frequencies and applying the 2.0V reference as per the table below:-

	Apply 0.0V to [CV-A]. Set [FREQUENCY] to	Apply 2.0V to [CV-A]. Monitor [SAW-DC] for
1	600Hz	150Hz
2	1200Hz	300Hz
3	2400Hz	600Hz
4	4800Hz	1200Hz
5	9600Hz	2400Hz
6	19,200Hz	4800Hz



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Calibration Procedure using Method 2

Step 1 - LO-End :-

1. Set all controls their minimum (CCW) position
2. Set FSG to 16Hz (fast clicking sound)
3. Adjust P101 for an output of 16Hz. The clicks will seem to wander spatially when the FSG and VCO are in sync

Step 2 - Wave Shaper :-

1. Set P201 to its mid-position
2. Set the VCO to about 300Hz
3. Monitor the [SHAPED AC] output
4. Adjust P201 for best sine wave sound possible
5. Turn [WAVE SHAPE] to maximum and check that the waveform becomes rich in harmonics

Step 3 - HF Trim:-

Stage 1:

1. Monitor the [SAW AC] output
2. Set [CV-B] pot to '0'
3. Apply 0.0V to [CV A]
4. Set the FSG to 300Hz
5. Adjust [FREQUENCY] and use [CV-B] pot for minimal beating
6. Apply 2.0V to [CV A]
7. Adjust 5K Lin pot for precisely 75Hz
8. Repeat steps (3) to (7) for best accuracy

Stage 2:

9. Apply 2.0V to [CV A]
10. Set [CV-B] pot to '0'
11. Adjust [FREQUENCY] for 300Hz using [CV B] pot for fine tuning
12. Apply 0.0V to [CV A]
13. Set FSG to 1200Hz
14. Adjust P102 for minimal beating
15. Repeat steps (7) to (11) for best accuracy

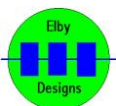
Calibration of the HF Trim is a series of successive approximations so stages 1 and 2 should be repeated several times for optimum accuracy.

Step 4 - Tracking Range:-

Check the tracking range by setting the FSG and VCO to various multiples of frequencies and then applying the 2.0V reference and checking for minimal beating as per the table below:-

	Set FSG to	Apply 0.0V to [CV-A]. Adjust [FREQUENCY] to	Apply 2.0V to [CV-A]. Monitor [SAW-AC] for
1	600Hz	600Hz	150Hz
2	1200Hz	1200Hz	300Hz
3	2400Hz	2400Hz	600Hz
4	4800Hz	4800Hz	1200Hz
5	9600Hz	9600Hz	2400Hz
6	19,200Hz	19,200Hz	4800Hz

NB: In analogue electronics, perfection is necessarily a beat away - but kept as small as humanly possible.



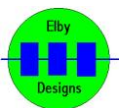
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¹ An app such as Frequency Sound Generator by Aleksandar Mlazev can be run on an Android or Apple phone or tablet. When using such an application you must select a sawtooth output as the tests above rely on even harmonics being present.



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