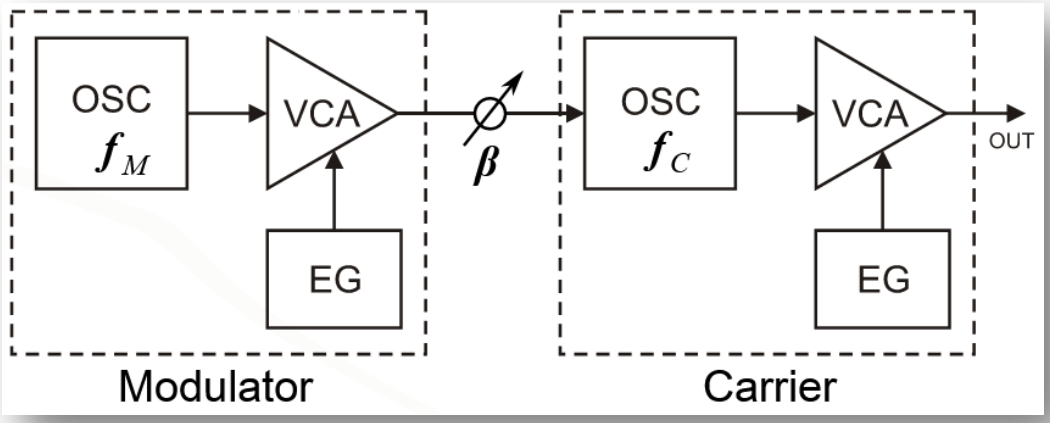
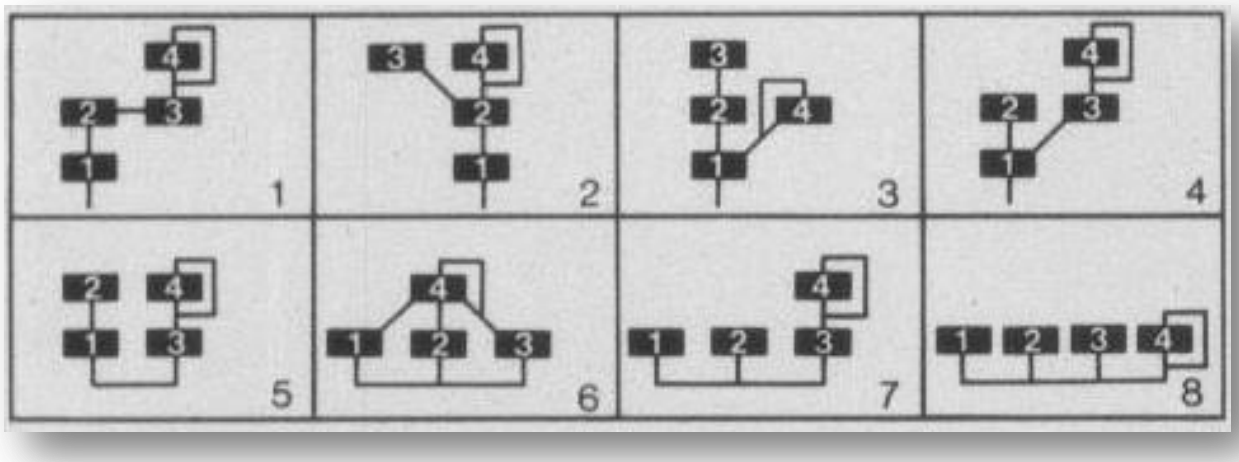
nonlinearcircuits

FM OP build & BOM

This 4HP module is a thru 0 VCO using the SSI2130 chip. It is designed as an FM operator as per the concepts delivered by John Chowning, so for best results 2 or more are needed (get 6!), along with suitable EGs and mixers. The NLC Valmorification (VC EG) and 4HP Mix are intended as support modules to develop an all analogue FM system.



This module contains the oscillator and VCA, the EG must be patched in. The thru-0 oscillator has a good variety of controls – control voltage, frequency modulation, phase modulation and hard sync. There are 100s of ways to patch the modules together, search **FM algorithms** for examples such as this:



The module only has a sine output as per a standard FM operator, although it generally spits out some very complex waveforms. I rarely do any further processing to the signal, such as VCFs or wave folding, there is enough going on.

Before going too far, please check the size and datasheet of the SSI2130 at https://www.soundsemiconductor.com/ . **It is tiny** and will be extremely difficult to solder by hand, much better to use solder paste and a hot air gun or a reflow oven. Also the circuit requires quite a few unusual resistor sizes that need to be obtained from Mouser or similar. This is not a regular NLC design, where all the resistors are just 1k, 10k and 100k. There are a few other components that have never been used on NLC modules before as well, nothing particularly rare or expensive, just probably not in your stash.

A few comments on the design:

Firstly thanks to *Neil Johnson of Sound Semiconductor Inc.* for his support and advice in developing this module. This design has taken me nearly 2 years to get to this point and Neil has been wonderfully helpful and patient with answering my questions.

Yes, I know a dual VCO in 8HP would make more sense and maybe it will happen one day, but it won't be 2022. I'm leaning heavily towards 4HP single function modules these days, back to basics kinda thing.

Most of the design is straight from the SSI2130 datasheet, so have a good read of that to understand what is going on.

There are a couple of quirks with the IC that meant some extra work is needed. The SSI2130 needs a good & clean 5V and 2.5V supply to work well, this also means some of the inputs need protection against voltages going above 5V. This has all been done on the PCB, I have tried hard to damage things by patching in +12V and -12V to various inputs but so far all has been robust.

The chip has been found to lock up at power on for some users. Some people never had a problem. I had it happen with both switching and linear supplies, sometimes it happened every time and then it would be fine for a few sessions.

The solution to get it oscillating is a pulse on the hard sync input. Rather than expecting people to have to patch a signal into sync to get it working, I added a 7555 one shot circuit, which spits out a single pulse approx. 0.5 seconds after start up. So far this has been totally reliable for me.

In the datasheet, the FM input is held at a 2.5V offset which keeps the VCO in a good operating range. The problem here is to get the thru 0 function, the incoming signal needs an extra -2.5V to compensate for this, otherwise the thru 0 action does not happen when the incoming signal crosses zero. My solution is to route the 2.5V offset voltage via the switching pin of the FM input. This way it is disconnected when a signal is patched in.

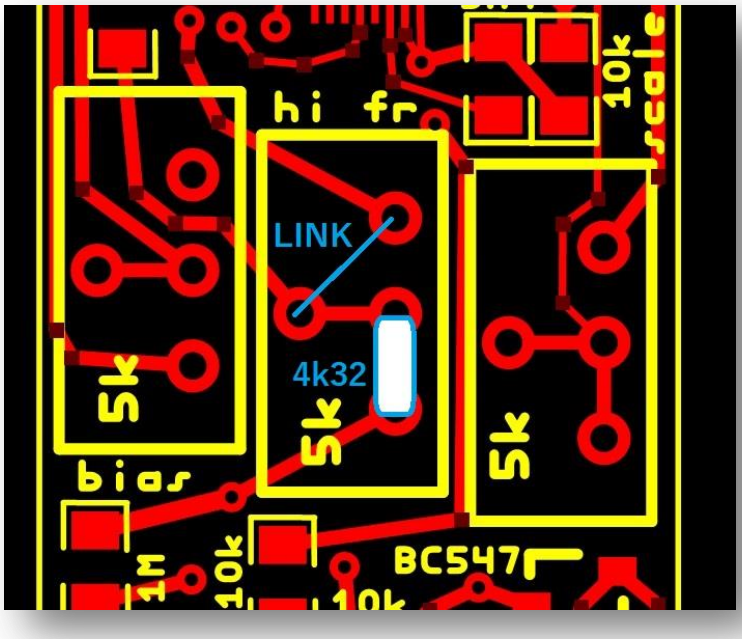
One important point is that the FM pot should be kept at maximum when not using the FM input (offset on the panel). This is not critical and is really just for 'normal' behaviour, nothing bad happens if you don't do it. You may want to turn down this offset voltage when using the Phase modulation input anyway.

The on-board mixer is used as a VCA; by default it is ‘on’ if nothing is patched into the VCA input. It expects a 0-5V signal to work normally and the input is protected to ignore signals outside of this range.

The thru 0 switching circuit is slightly different from the datasheet. I did not use a LM311 comparator IC, rather a spare section of a TL072, a resistor for hysteresis and a BC847 transistor. This is simply to save space on the PCB; there was not enough room for another IC.

For tuning, there is a very good guide in the SSI2130 datasheet. Otherwise use your normal methods for tuning a VCO. I set the Bias trimpot to 27.5Hz; from there you should get tracking over 10 octaves.

Use the scale trim to get the 1V/oct happening, then patch in 8-9V and use the Hi-freq trimpot to get it right up there. You can replace the Hi-freq trimpot with a link and a 4k32 resistor, according to the datasheet, this will suffice (yes, of course you have a 4k32 lying around). See pic:



BOM – The Tayda & Mouser part numbers are given as examples

VALUE	QUANTITY	DETAILS
100pF	1	0805 Tayda: A-3503
3.9nF (3n9)	1	0805 timing cap, see notes #5
10nF	2	0805
100nF	8	0805
10uF	4	0805 25V or higher voltage rating Mouser:963-TMK212BBJ106MG-T or similar
270Ω (270R)	1	0805
1k	7	0805
3.3k (3k3)	1	0805
4.02k (4k02)	1	0805
4.32k (4k32)	1	0805 optional - if replacing Hi Freq trimpot
4.75k (4k75)	2	0805
10k	12	0805
12.7k (12k7)	1	0805
20k	6	0805
22k	1	0805
30k	1	0805
49.9k (49k9)	1	0805
62k	1	0805
100k	4	0805
267k	1	0805
470k	1	0805
510k	1	0805
1M	2	0805
4.7M (4M7)	1	0805
TL072 or TL082	3	Soic Tayda: A-1139
LM78L05	1	Soic Tayda: A-629
7555 or NE555D	1	Soic Tayda: A-074
SSI2130	1	QFN32
BC847	1	SOT23-3 Tayda: A-1339 **printed on PCB as BC547**
2N7002	1	SOT23-3 Tayda: A-1433
BAT54S	2	SOT23-3 Mouser: 755-BAT54SHMFHT116 or similar
TL431	2	SOT23-3 Tayda: A-4323
5k 3296W trimpot	3	Tayda: A-597 but get Bournes or similar from Mouser
Eurorack 10 pin power connector	1	Tayda: A-198 cut to size
S1JL, Schottky, power rectifier or 10R	2	SMD SEE NOTES #1. **dot on PCB indicates CATHODE (stripe on component).**
1N400x power rectifier or similar	1	SOD123 place on bottom side of top PCB – protection for regulator Mouser: 511-STTH1R02ZFY or 863-NRVBS310FA or similar
3.5MM SOCKET Kobiconn style	6	Tayda: A-865 or Thonkiconn Jacks (PJ301M-12) from Thonk, Synthcube or Modular Addict
100k pot	4	Linear Taper Potentiometer Spline Shaft PCB Mount 9mm Tayda: A-4729
3 pin header	2	get a 40 pin strip and cut off as needed Tayda: A-197
4 pin header	2	as above
3 Pin 2.54mm Single Row Female Pin Header	2	Tayda: A-1069 **optional** – you can just solder the upper PCB directly to the header pins.
4 Pin 2.54mm Single Row Female Pin Header	2	Tayda: A-1301 **optional** – you can just solder the upper PCB directly to the header pins.

Additional notes:

1. , Schottky (best option) **or** standard power rectifier diode 50-600V 1A or more, **or** use a resettable fuse **or** just a 10R. Examples: BAT54GWX, PMEG2005EGWX, AEC-Q101, 20V, SOD-123, PMEG2005EH DIODE, SCHOTTKY, 0.5A, 20V, 1N400x or S1JL or similar.

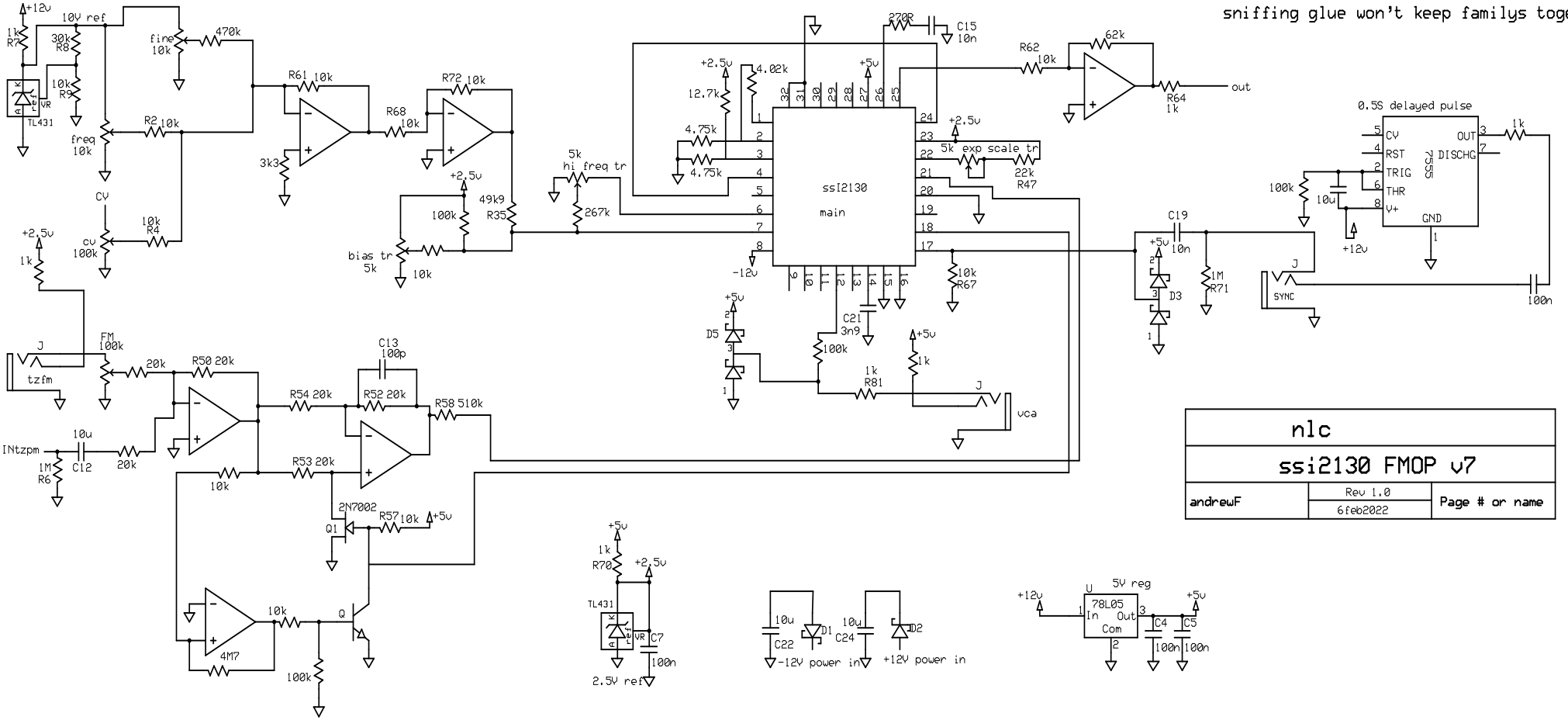
2. The chips, resistors, caps are cheapest from Tayda. Schottky diodes, CMOS & 1uF, 10uF 25V 0805 caps from Mouser/E14/Farnell/etc.

3. Join the Nonlinearcircuits Builders Guild on FB: https://www.facebook.com/groups/174583056349286/ and ask questions there if you have any. If you prefer not to FB then email is fine.

4. The SSI2130 is available from a number of synth and music orientated retailers, rather than Mouser. Start at Synthcube.

5. Get C0G/NP0 3.9nF cap, from Mouser something like 581-08055A392FAT2A or 77-VJ0805A392FXATBC

sniffing glue won't keep familys together



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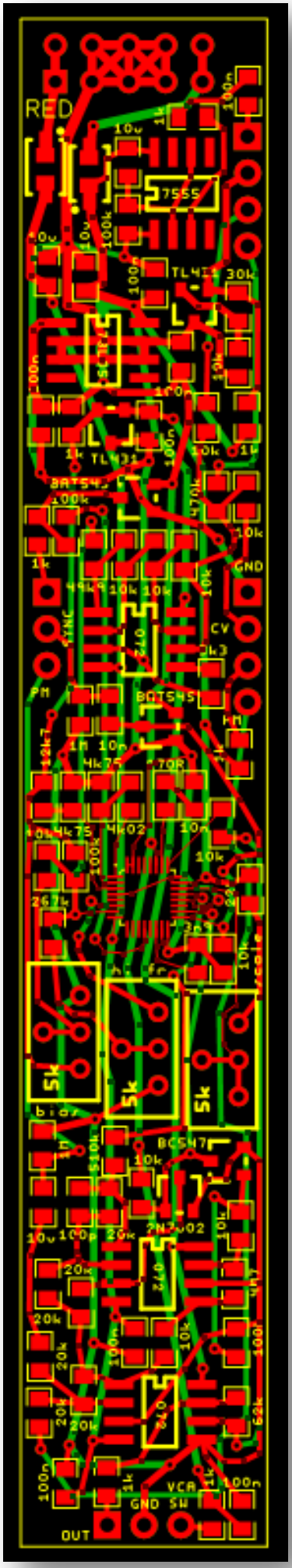
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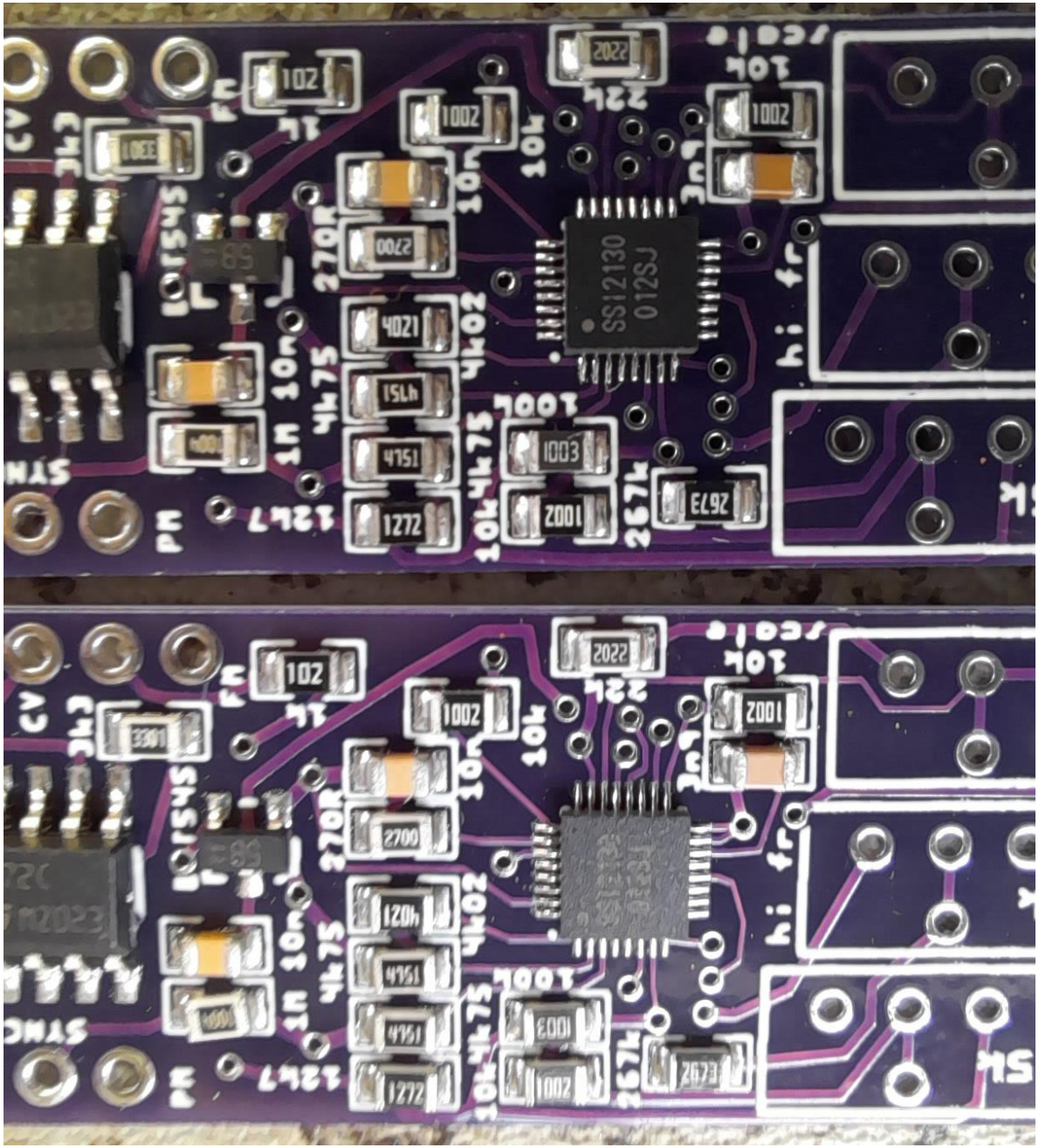
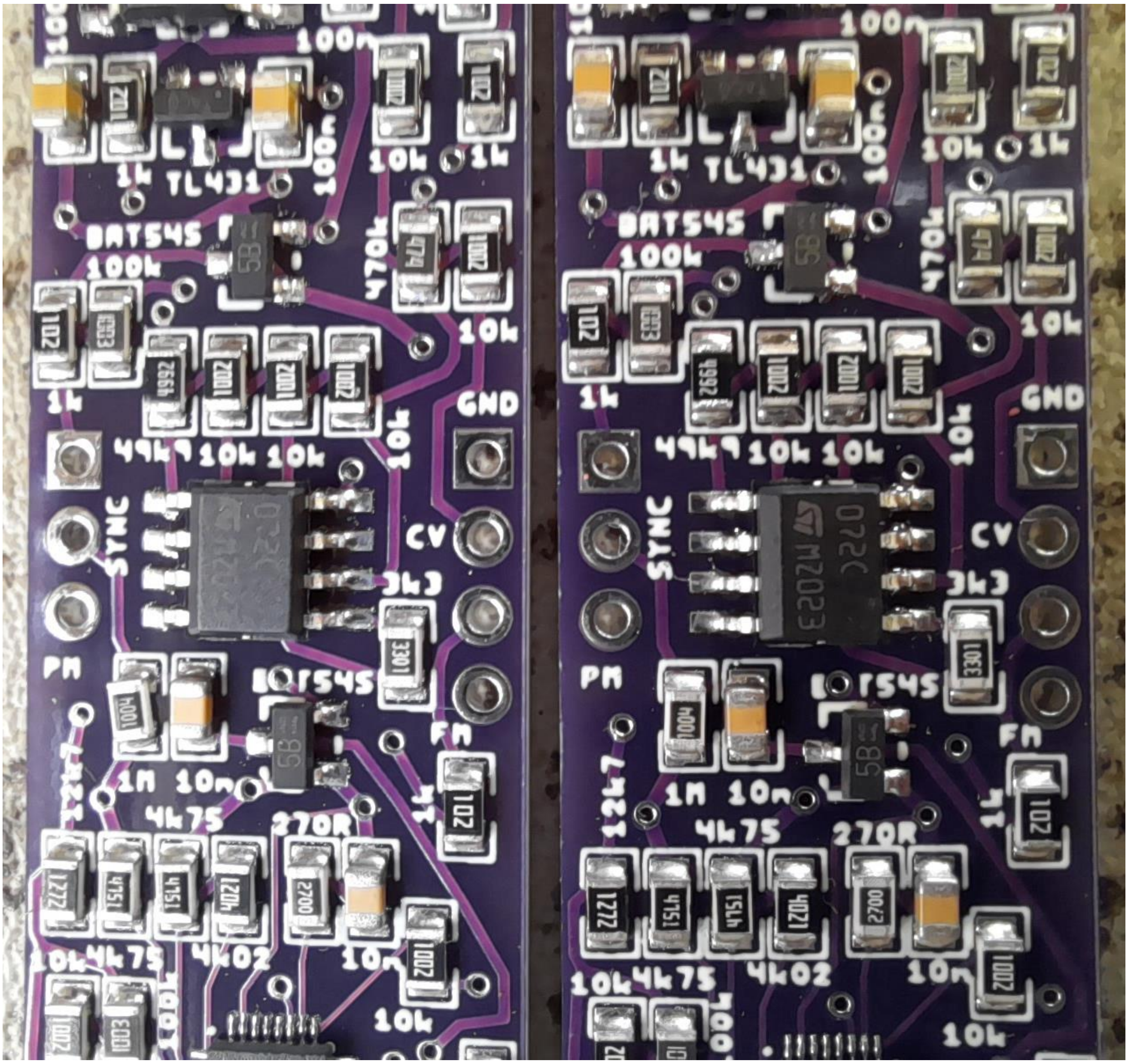
7555
TL431
30k
BAT54J
100k
470k
10k
GND
SYNC
240
CV
2k3
PM
BAT54S
FM
4k75
470R
4k02
267k
5k
5k
5k
BC547
2N7002
20k
62k
VCA
GND SW
OUT


SS12130
012SJ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10k
BAT54S
100k
470k
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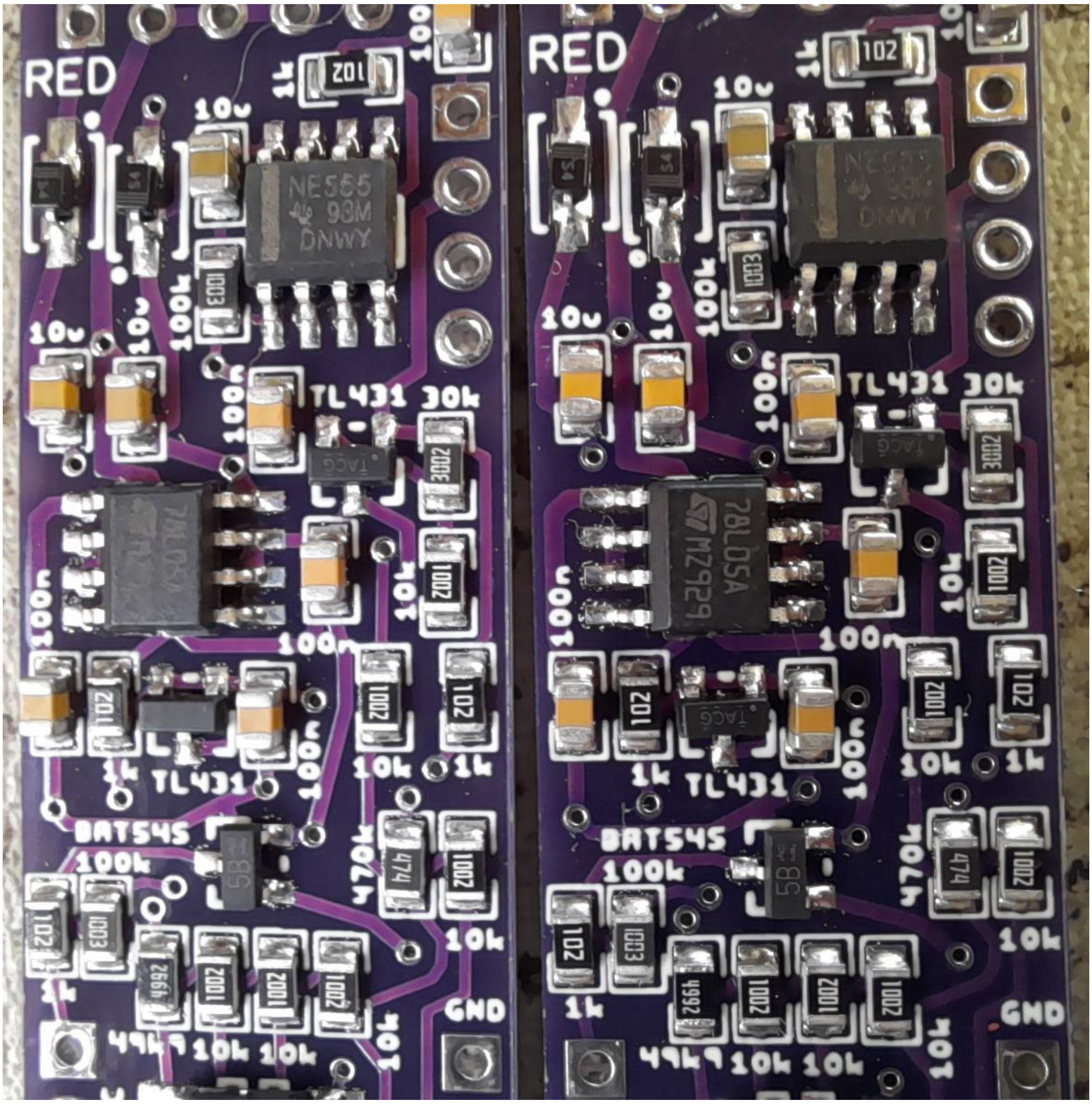
GND
SYNC
CV
3k3
PM
FM
1M
10n
12k7
4k75
270R
4k02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10u
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100n
TL431
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10k
1k
BAT54S
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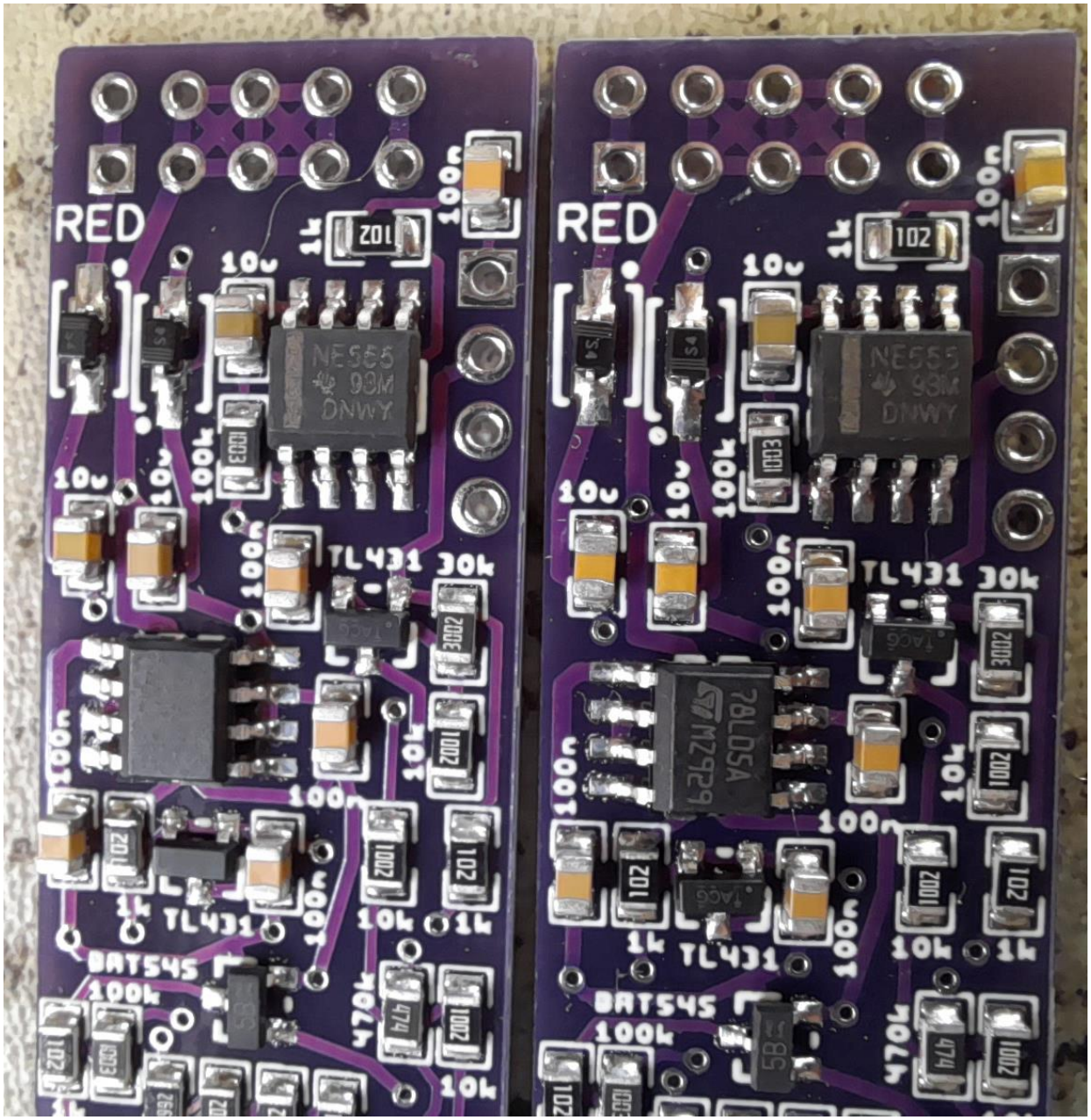
49k9
GND
NE555
78L05A


RED
NE555
98M
DNWY
TL431
BAT54S
78L05A
MZ29
RED
NE555
98M
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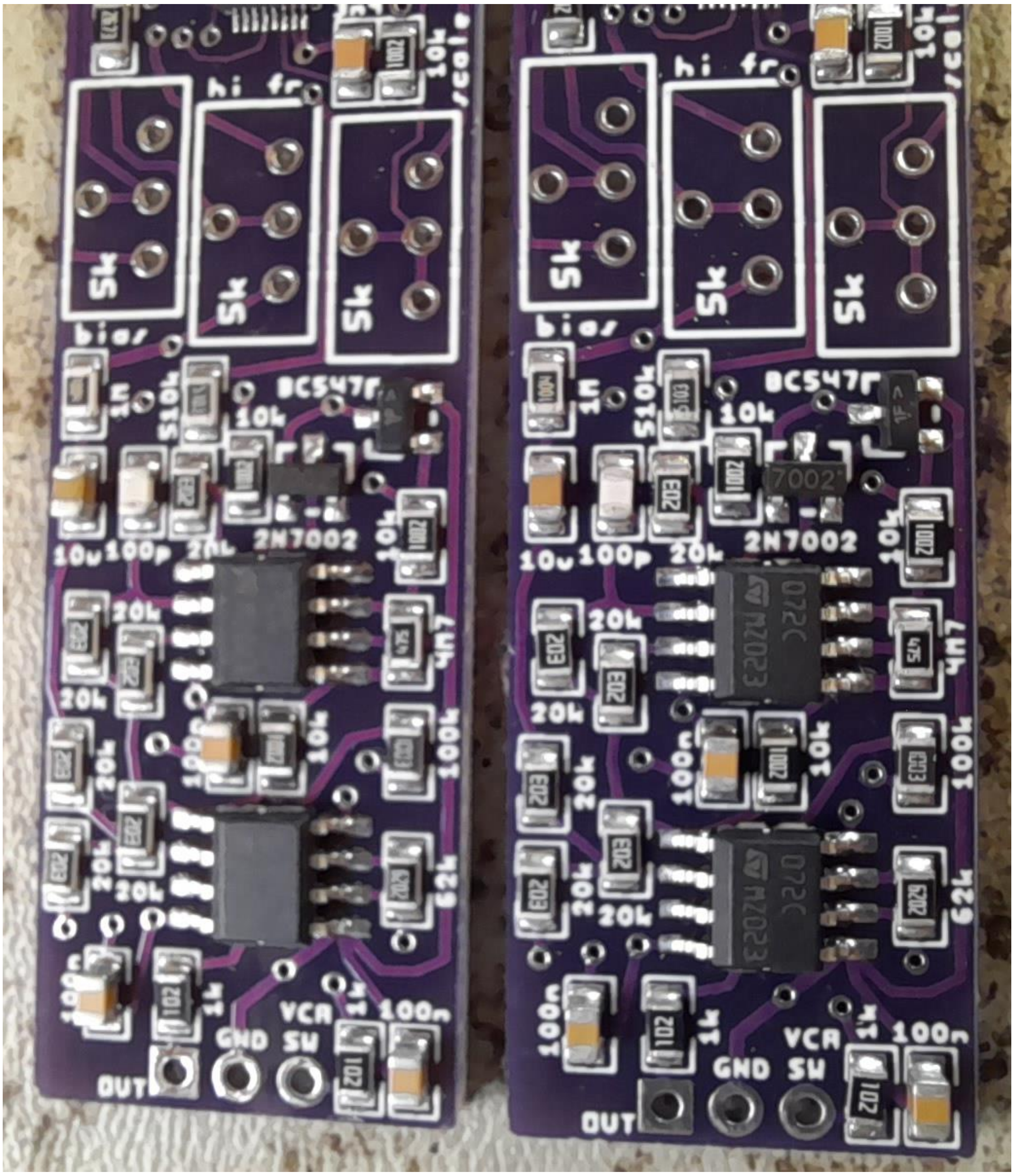
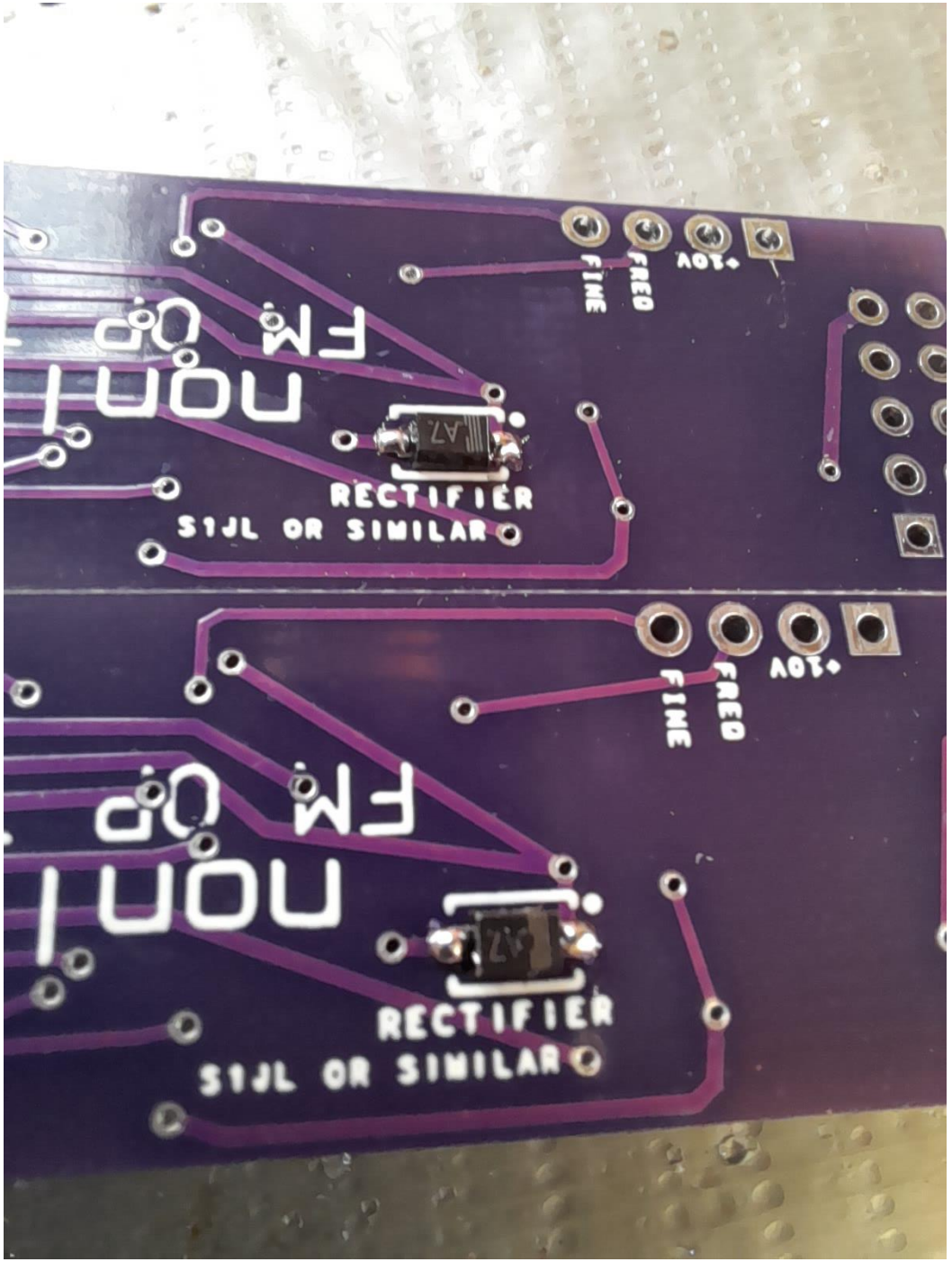
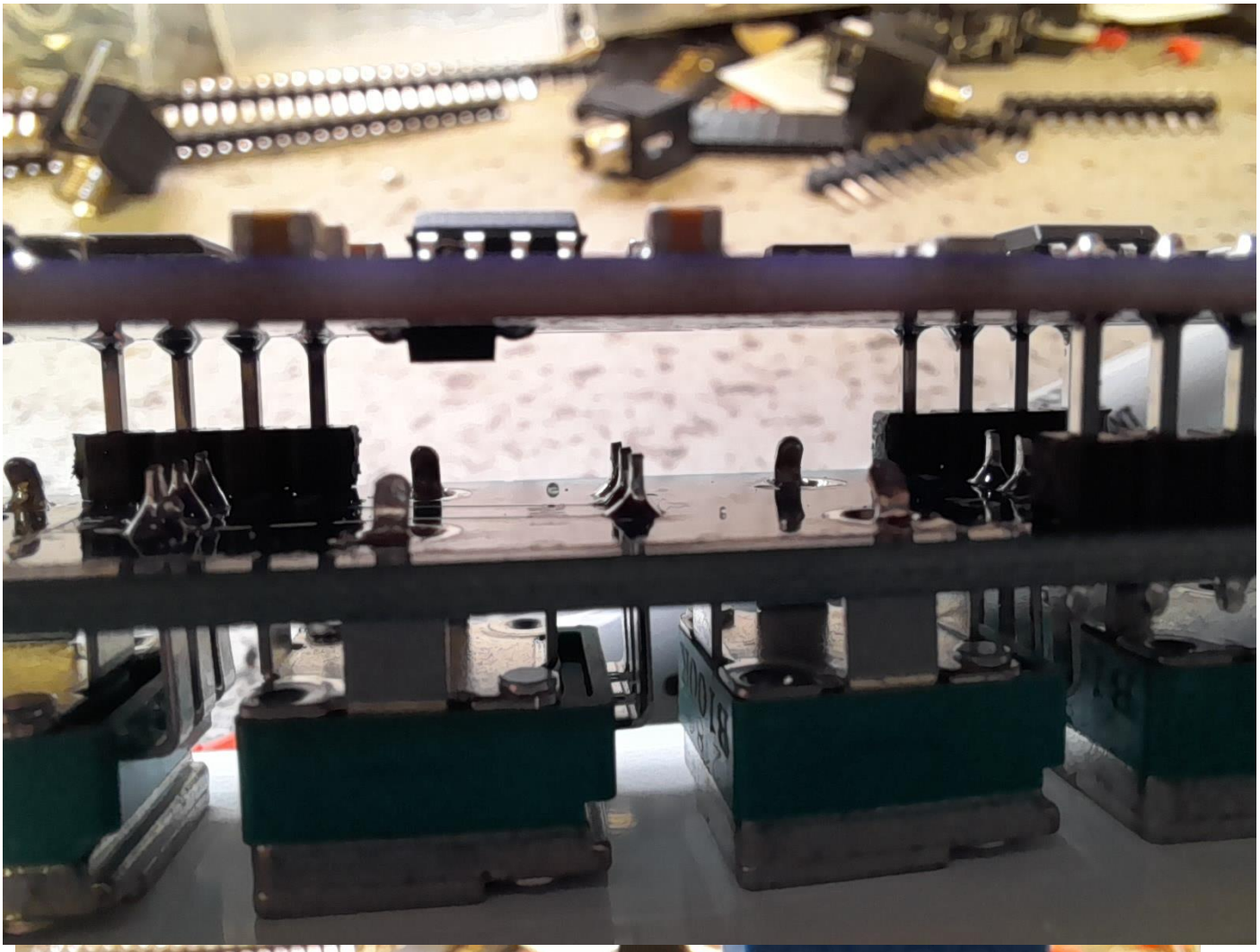
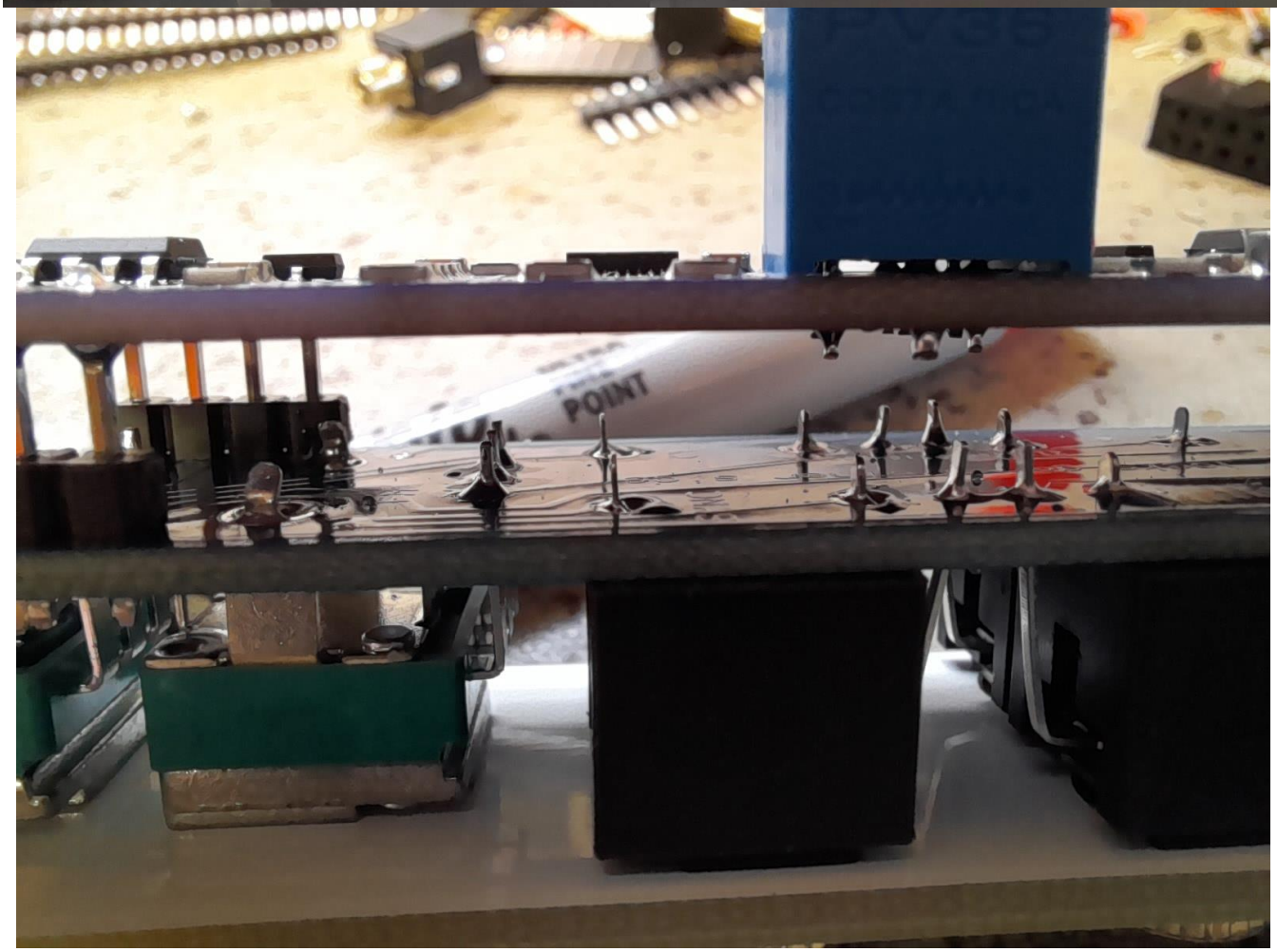
TL431
BAT54S
78L05A
MZ29


hi fr
10k
scale
5k
5k
5k
bias
1n
S10k
10k
BC547
10u
100p
20k
2N7002
10k
20k
4n7
20k
100n
10k
100k
20k
20k
20k
62k
100n
1k
VCA
1k
100n
GND
SW
OUT


FINE
FREQ
+10V
FM Op
non
RECTIFIER
S1JL OR SIMILAR
FINE
FREQ
+10V
FM Op
non
RECTIFIER
S1JL OR SIMILAR

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