DDFG

This project, the Double Dual Function Generator, is a Eurorack adaptation of Don Buchla's 200 series 281 Quad Function Generator. It uses mostly modern parts (the FET market is changing quickly these days) that most people should be able to acquire fairly easily from Mouser, Thonk, and the other usual suspects.

Read through the WHOLE document before ordering parts or starting the build.

This is a complex, tightly packed project with a lot of parts that are close friends, but nonetheless don't want to talk to each other. Be very, VERY careful with your soldering to avoid bridges, cold joints, and other assorted nastiness. As an example, there is a via pretty darn close to R155 and D26 on EngB PCB. Also, be careful not to melt any plastic part cases with the soldering iron by mistake.

PARTS

As well as the parts listed in the separate PCB bills of material, there are other parts needed, as well.

Two nylon bolts, or stand-offs, to attach EngA and EngB at the top. (The pin headers do a pretty good job of keeping everything else held together, but there should be mounting holes around the three PCBs if you want to make doubly sure.)

2x8, 2x4, and 1x3 pin headers are used. Three 2x8, three 2x4, and two 1x3 headers, each needing both male and female components. These are bog standard, 2.54mm pitch pin headers.

For the N-Channel JFETs, I tested with J113 and 2N5457, and both of these worked fine. I suspect you can use nearly any N-Channel JFET, but be sure to observe the pinout for a 2N5457 FET.

The calibration trimpots on EngA need to be right angle ones. Bourns RV36 trimpots work well, as do Bourns 3296P trimpots. Be very careful that they are right angle ones, that are not too high! For the calibration trimpots on EngB, you can use pretty much whatever you like.

The voltage regulator is needed to supply part of the circuit with 10V. On EngB, you can use either a TL750M10 in IC8, or a TL750L10 in IC7, but do NOT use both at once! The two component footprints are there in case the builder can only source one type.

The timing capacitors (C2 and C10 on EngA, and C28 and C19 on EngB) have four component holes available in case you feel like trying a posher type of cap. You can fit a 5mm cap, a 7.5mm cap, or a 10mm cap, bearing in mind that any cap used has to be less than 11mm tall.

For the main power filter caps (C1 and C2 on EngB), you can either order low profile caps of less than 10mm height from Mouser, or you can solder them on the opposite side of the board (keeping space around the power header, and making sure that the polarity of the cap is correctly observed.)

For the NPN and PNP transistors, you can probably get away with using nearly anything. Be sure to observe BC54x and BC55x pinout.

PanPCB Bill of Materials

Qty	Value	Device	Parts
10	10kB	9mm PCB mount pot	ATK1, ATK2, ATK3, ATK4, DEC1, DEC2, DEC3, DEC4, PK-B, PK-B1
4	1N4148	Signal Diode	D12, D17, D33, D34
4	3mm Red LED	LED	D8, D16, D25, D32
4	SPDT on-off-on	Toggle Switch	MODE, MODE1, MODE2, MODE3
2	SPDT on-on	Toggle Switch	QUAD, QUAD2
2	1k	¼ watt resistor	R85, R174
12	1k5	¼ watt resistor	R4, R5, R36, R46, R47, R78, R93, R94, R125, R135, R136, R167
2	220k	¼ watt resistor	R87, R176
4	2k2	¼ watt resistor	R86, R89, R175, R178
8	47k	¼ watt resistor	R1, R6, R43, R48, R90, R95, R132, R137
16	49k9	¼ watt resistor	R2, R3, R7, R8, R44, R45, R49, R50, R91, R92, R96, R97, R133, R134, R138, R139
2	56k	¼ watt resistor	R88, R177
4	BC559C	PNP Transistor	Q9, Q10, Q19, Q20
22	Thonkiconn	Thonkiconn	ATKIN1, ATKIN2, ATKIN3, ATKIN4, DECIN1, DECIN2, DECIN3, DECIN4, EOC1, EOC2, EOC3, EOC4, OUT1, OUT2, OUT3, OUT4, PEAKOUT, PEAKOUT1, TRIGGATE1, TRIGGATE2, TRIGGATE3, TRIGGATE4

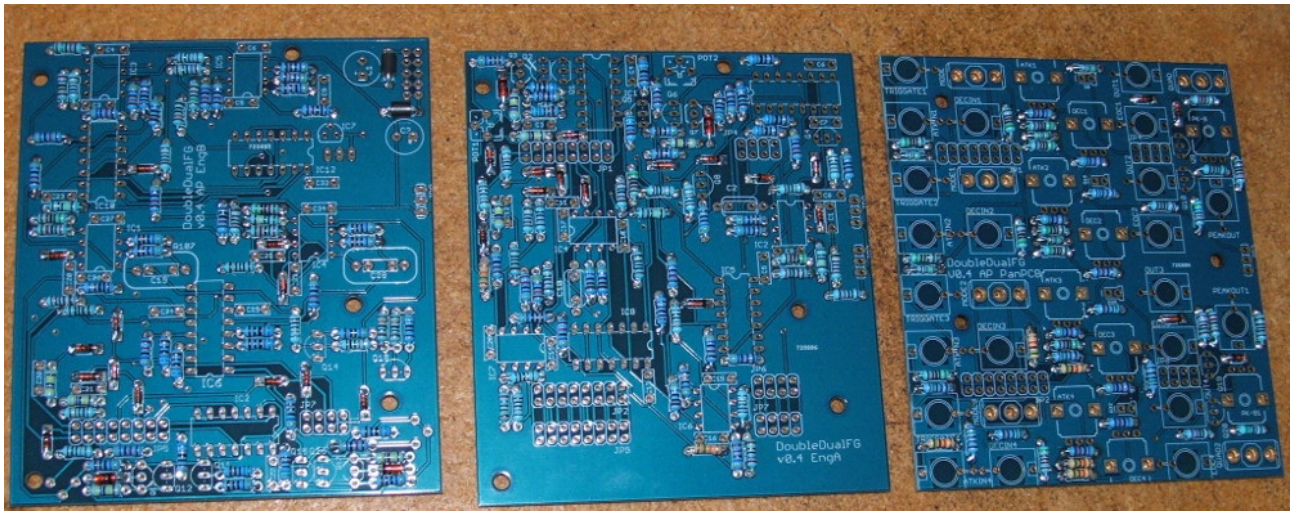
EngA Bill of Materials

Qty	Value	Device	Parts	Description
13	100nF	Box Cap	C4, C5, C6, C7, C8, C9, C13, C15, C16, C17, C18, C19, C20	1000pF - 0.47uF
2	1n8	Box Cap	C3, C12	1000pF - 0.47uF
2	47nF	Box Cap	C1, C11	1000pF - 0.47uF
2	47nF HQ	Timing Cap	C2, C10	0.056 - 0.082uF
2	20k	Trimpot	POT1, POT2	Potentiometers
4	TL072P	Opamp	IC2, IC4, IC6, IC7	OP AMP
2	4001N	NOR	IC5, IC8	Quad 2-input NOR
1	4016N	Switch	IC1	Quad bilateral ANALOG SWITCH
1	LM13700N	Dual OTA	IC3	National Dual OTA with buffers.
13	1N4148	Diode	D1, D2, D3, D4, D5, D6, D7, D9, D10, D11, D13, D14, D15	Fast Switching Diode
2	1n4740 10V	Zener Diode	Z1, Z2	Zener Diode
10	100k	¼ watt resistor	R29, R35, R37, R39, R41, R71, R77, R79, R81, R83	6mm Resistors
4	10k	¼ watt resistor	R20, R27, R62, R69	6mm Resistors
2	12k	¼ watt resistor	R26, R68	6mm Resistors
2	15k	¼ watt resistor	R33, R75	6mm Resistors
2	1k	¼ watt resistor	R1, R2	6mm Resistors
2	1m	¼ watt resistor	R22, R64	6mm Resistors
2	20k1	¼ watt resistor	R24, R66	6mm Resistors
2	2k7	¼ watt resistor	R32, R74	6mm Resistors
2	470k	¼ watt resistor	R21, R63	6mm Resistors
2	470R	¼ watt resistor	R38, R80	6mm Resistors
11	47k	¼ watt resistor	R12, R17, R28, R30, R31, R34, R54, R59, R72, R73, R76	6mm Resistors
2	49k9	¼ watt resistor	R25, R67	6mm Resistors
10	4k7	¼ watt resistor	R11, R16, R18, R19, R23, R53, R58, R60, R61, R65	6mm Resistors
4	4m7	¼ watt resistor	R10, R42, R52, R84	6mm Resistors
2	5k6	¼ watt resistor	R9, R51	6mm Resistors
6	680R	¼ watt resistor	R13, R14, R15, R55, R56, R57	6mm Resistors
2	2N5457	JFET	Q3, Q7	N-CHANNEL JFET
2	BC549C	NPN Trans	Q4, Q8	NPN Transistor
4	BC559C	PNP Trans	Q1, Q2, Q5, Q6	PNP Transistror

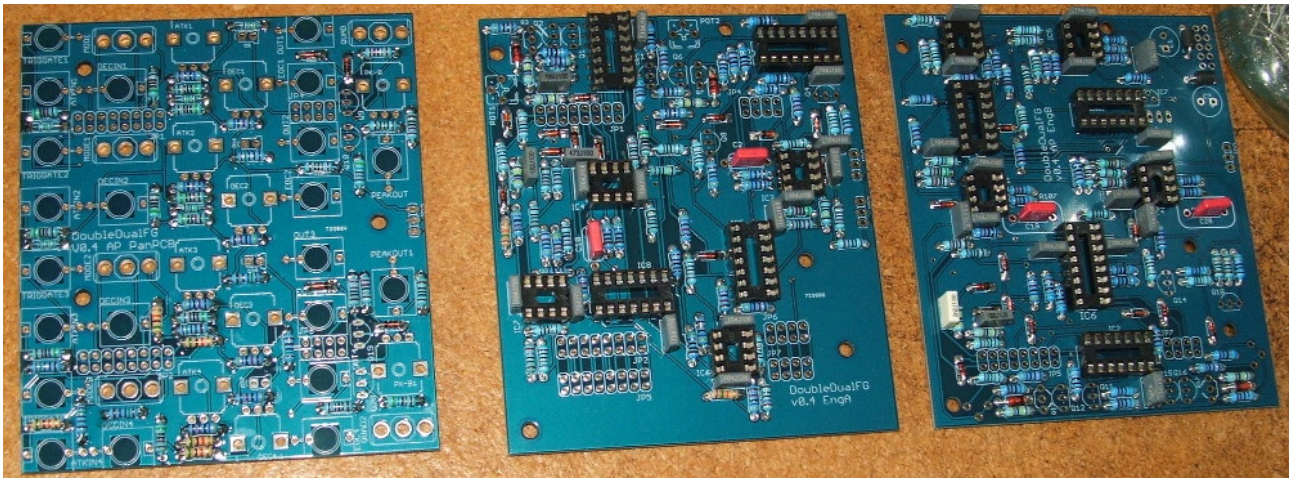
EngB Bill of Material

Qty	Value	Device	Parts
14	100nF	Box Cap	C3, C4, C5, C6, C9, C22, C23, C24, C25, C26, C27, C32, C33, C34
2	1n8	Box Cap	C21, C30
2	47nF	Box Cap	C20, C29
2	47uF	Electrolytic	C1, C2
2	47nF HQ	Timing Cap	C19, C28
1		PINHD-1X3	JP8
1		PINHD-2X4	JP7
1		PINHD-2X8	JP5
1	TL750L10	V-Reg	IC7
1	TL750M10	V-Reg	IC8
2	20k	Trimpot	POT3, POT4
4	TL072P	Opamp	IC1, IC3, IC4, IC5
2	4001N	NOR	IC10, IC12
1	4016N	Switch	IC2
1	LM13700N	Dual OTA	IC6
13	1N4148	Diode	D18, D19, D20, D21, D22, D23, D24, D26, D27, D28, D29, D30, D31
2	1n4740 10V	Zener Diode	Z3, Z4
1	POWER_SIMPLE10	Power header	POWER
10	100k	¼ watt resistor	R118, R124, R126, R128, R130, R160, R166, R168, R170, R172
4	10k	¼ watt resistor	R109, R116, R151, R158
2	12k	¼ watt resistor	R115, R157
2	15k	¼ watt resistor	R122, R164
2	1k	¼ watt resistor	R1, R2
2	1m	¼ watt resistor	R111, R153
2	20k1	¼ watt resistor	R113, R155
2	2k7	¼ watt resistor	R121, R163
2	470k	¼ watt resistor	R110, R152
2	470R	¼ watt resistor	R127, R169
11	47k	¼ watt resistor	R101, R106, R117, R119, R120, R123, R143, R148, R161, R162, R165
2	49k9	¼ watt resistor	R114, R156
10	4k7	¼ watt resistor	R100, R105, R107, R108, R112, R142, R147, R149, R150, R154
4	4m7	¼ watt resistor	R99, R131, R141, R173
2	5k6	¼ watt resistor	R98, R140
6	680R	¼ watt resistor	R102, R103, R104, R144, R145, R146
2	Ferrite Beads	Power filter	IP1, IP2
2	2N5457	JFET	Q13, Q17
2	BC549C	NPN Trans	Q14, Q18
4	BC559C	PNP Trans	Q11, Q12, Q15, Q16

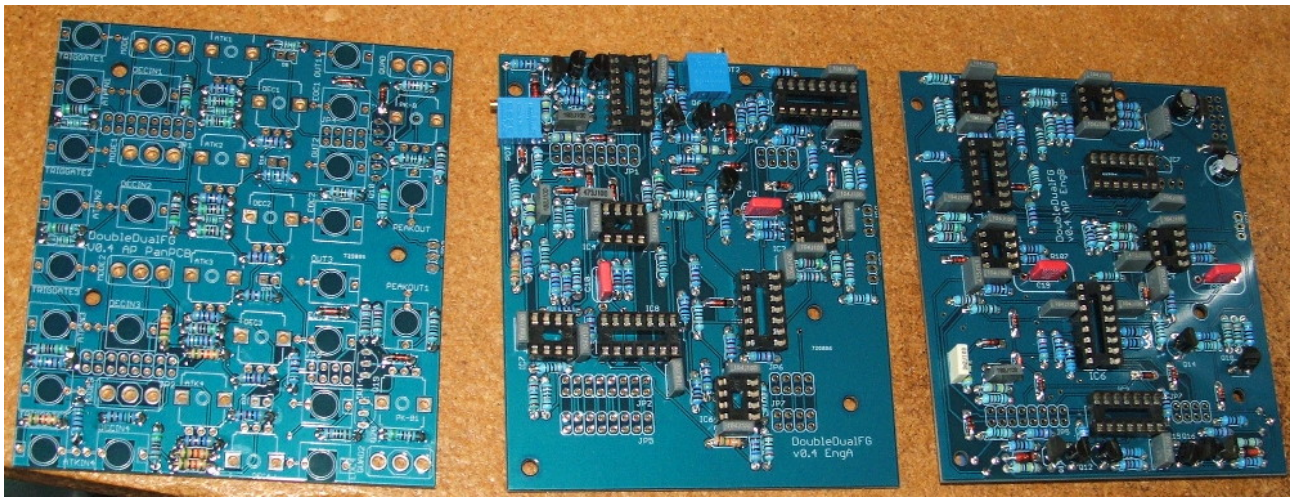
Populate your PCBs with diodes, zener diodes, ferrite beads, and resistors.



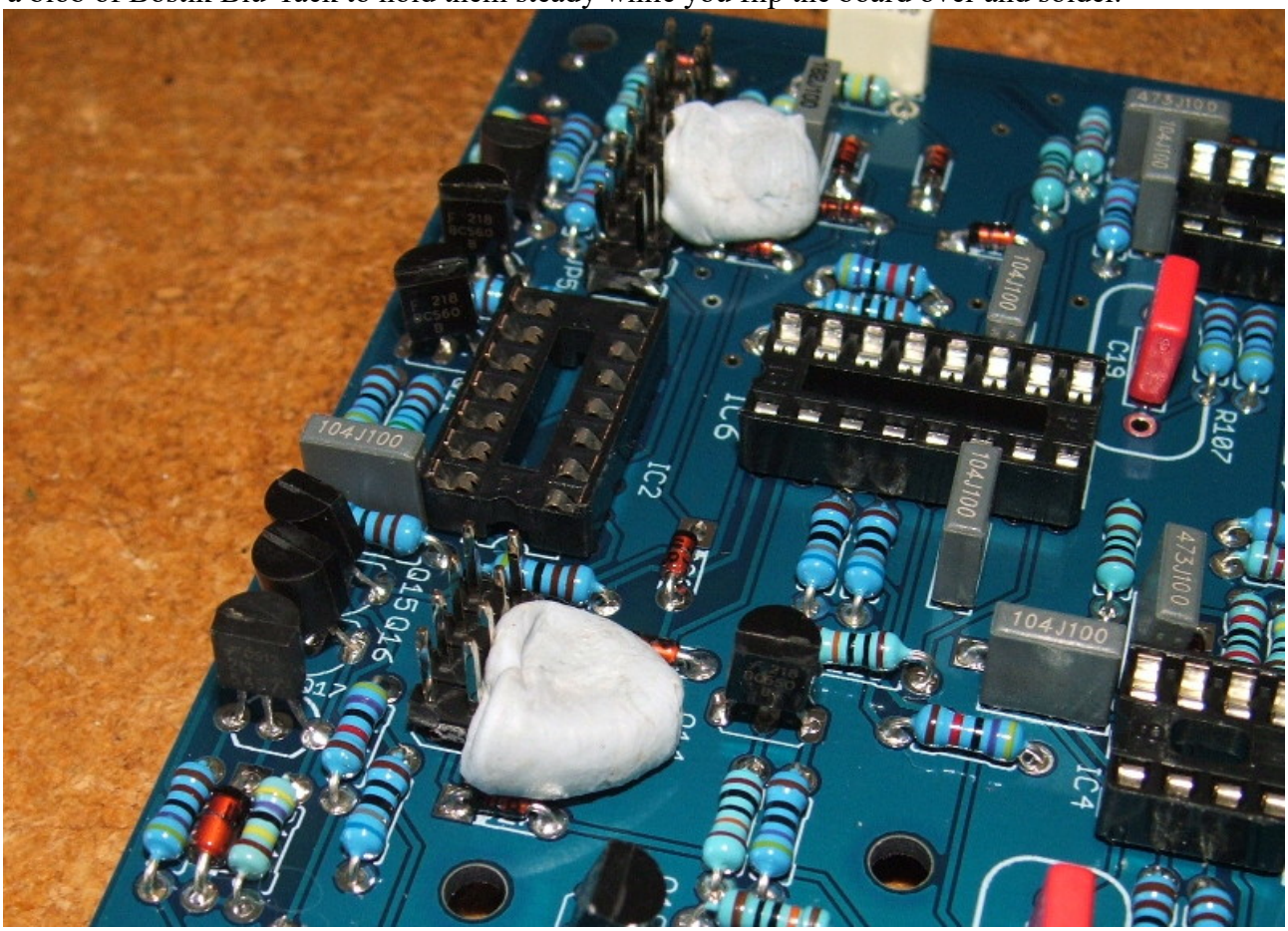
Add IC sockets, and then add the box caps, timing caps, and the electrolytic capacitors.



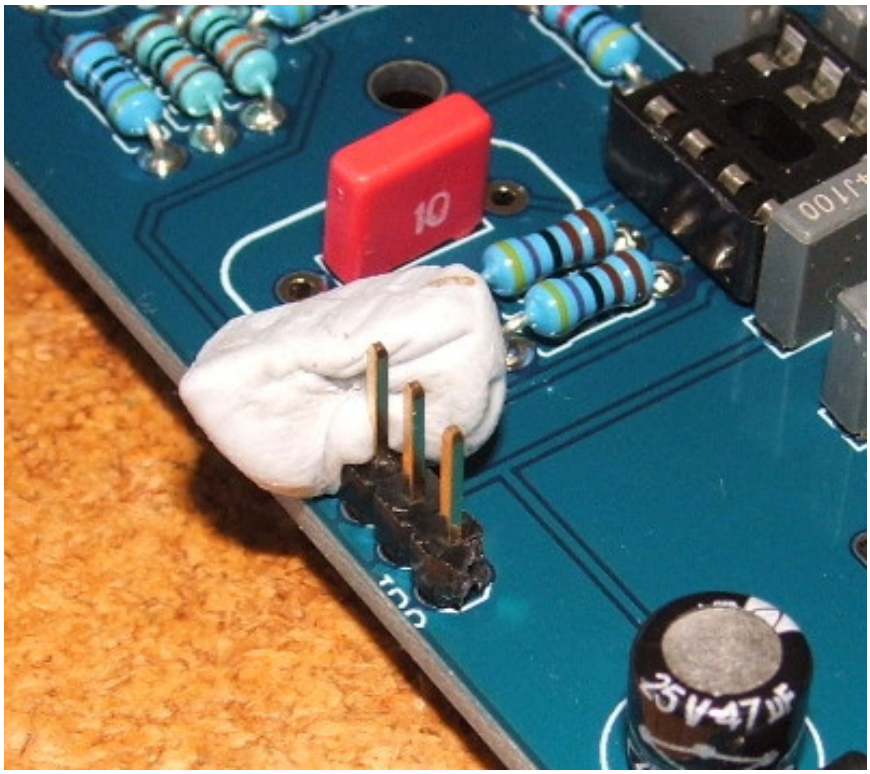
Add the trimpots (the trimpots on EngB will go on the reverse side to components, trimpots on EngA on the component side), the transistors, and the Jfets (keeping them all nice and close to the board, not up in the air, and also being careful not to cook them while soldering.)



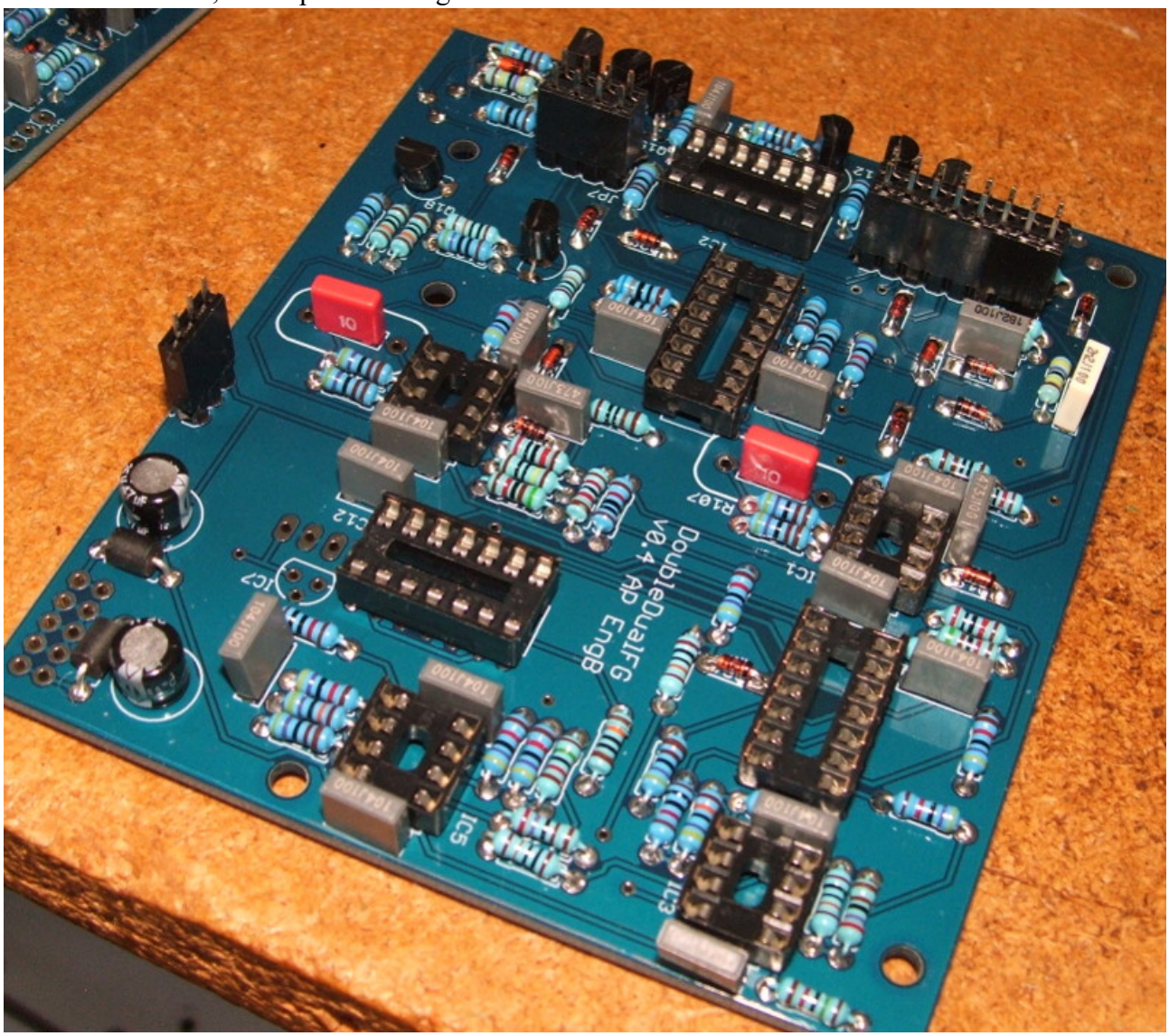
Take a 2x4 and 2x8 section of male pinheader, and place them on the component side of EngB. Use a blob of Bostik Blu-Tack to hold them steady while you flip the board over and solder.



Add a section of 1x3 male pinheader to EngB as well. Be extra careful with these 1x3 sections, that they are at right angles and straight.

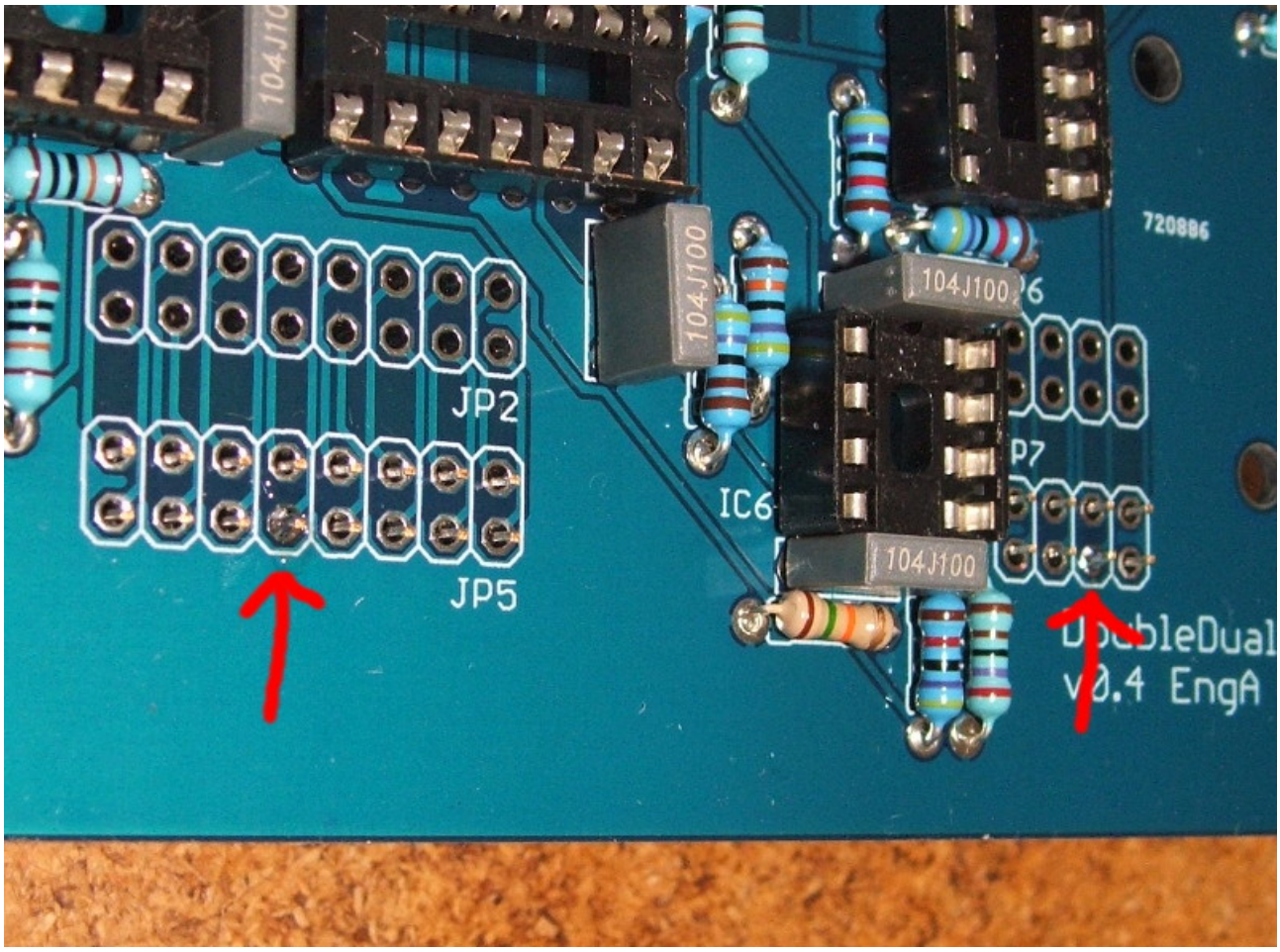


Now that you have soldered these male pinheaders on EngB, place the female pinheaders on top, like so. If one of these pinheaders are not flat to the PCB and at 90 degrees to it, then you are in for a world of trouble, so keep them straight!

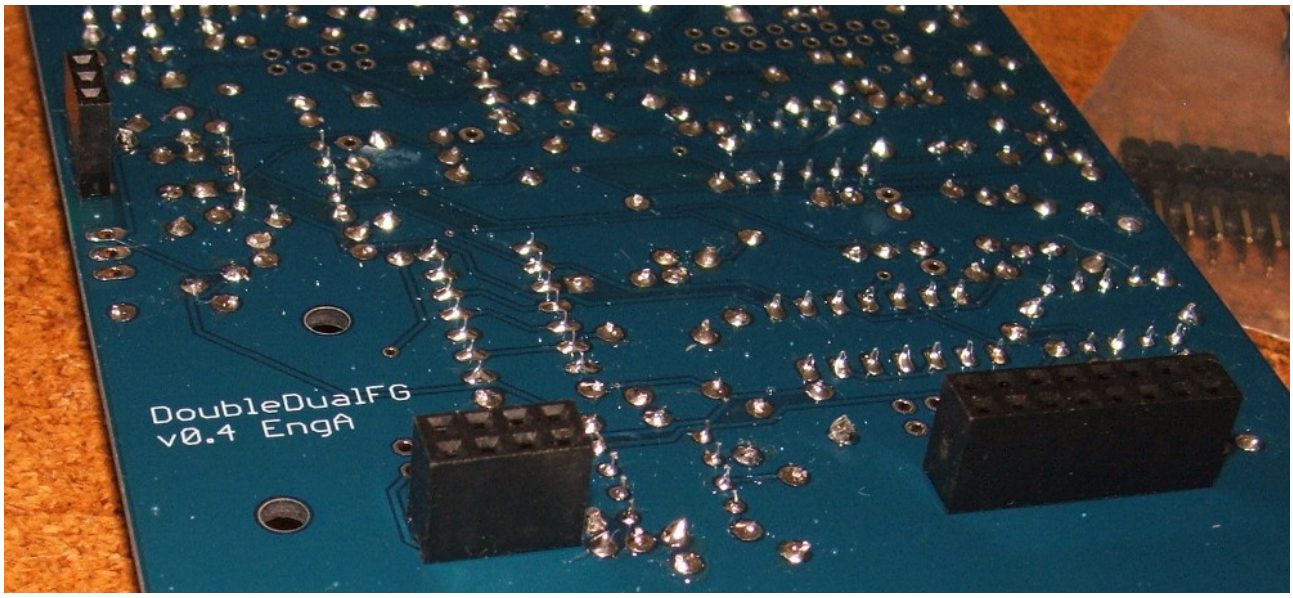


Place EngA on top of the pinheaders, with the edges aligned with EngB's edges. If you've done this correctly, then the female pin header should drop right through the PCB. The 1x3 header may need to be nudged slightly to get it to go into the EngA place for it, however.
While soldering, you may need a weight on the board to keep everything flat, parallel, and close together.

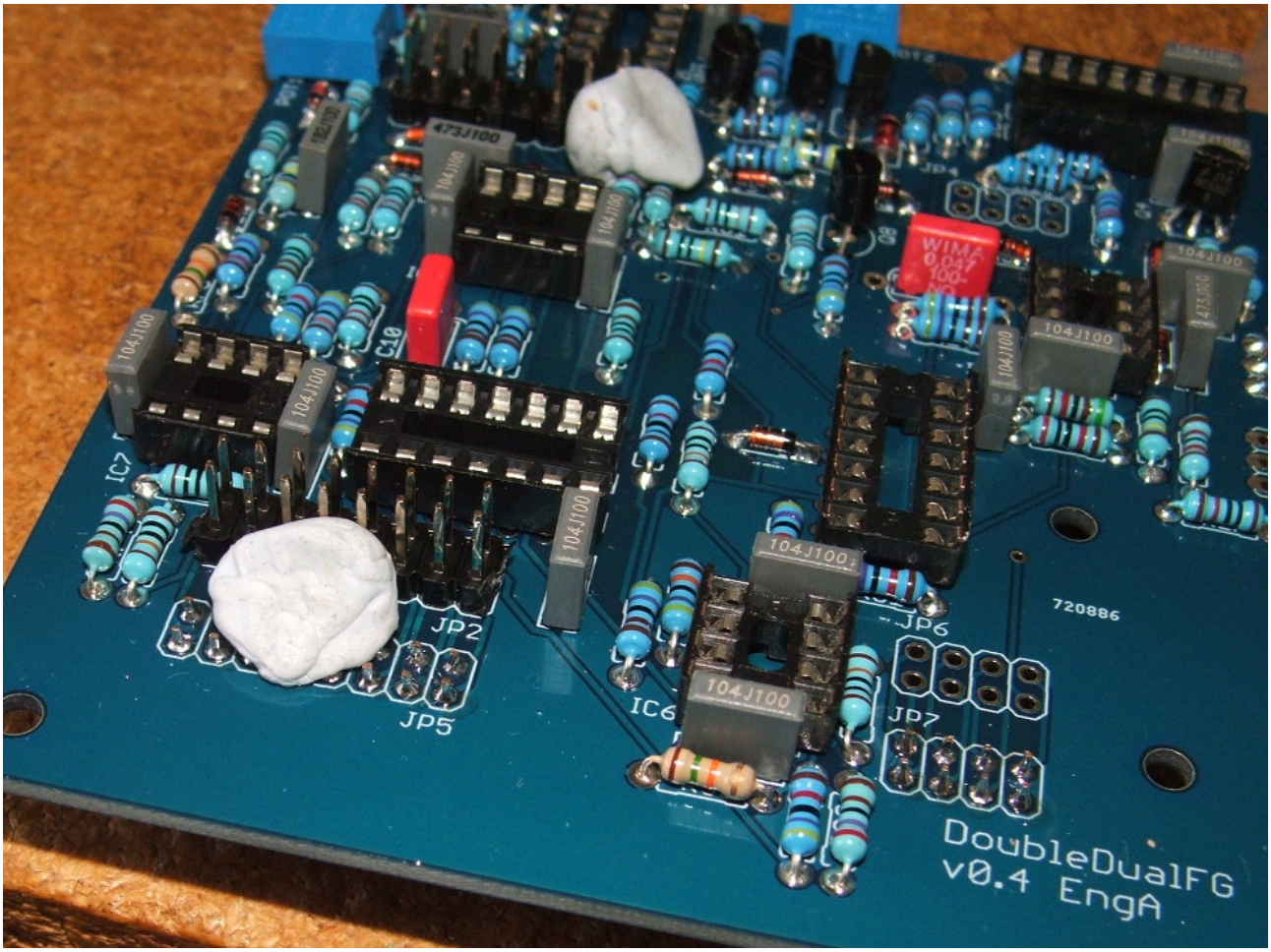
To help with this, solder just one pin, and then check that the pin headers between the PCBs are flat against both PCBs. If they are not, then heat up the single soldered pin and gently push the PCB down.



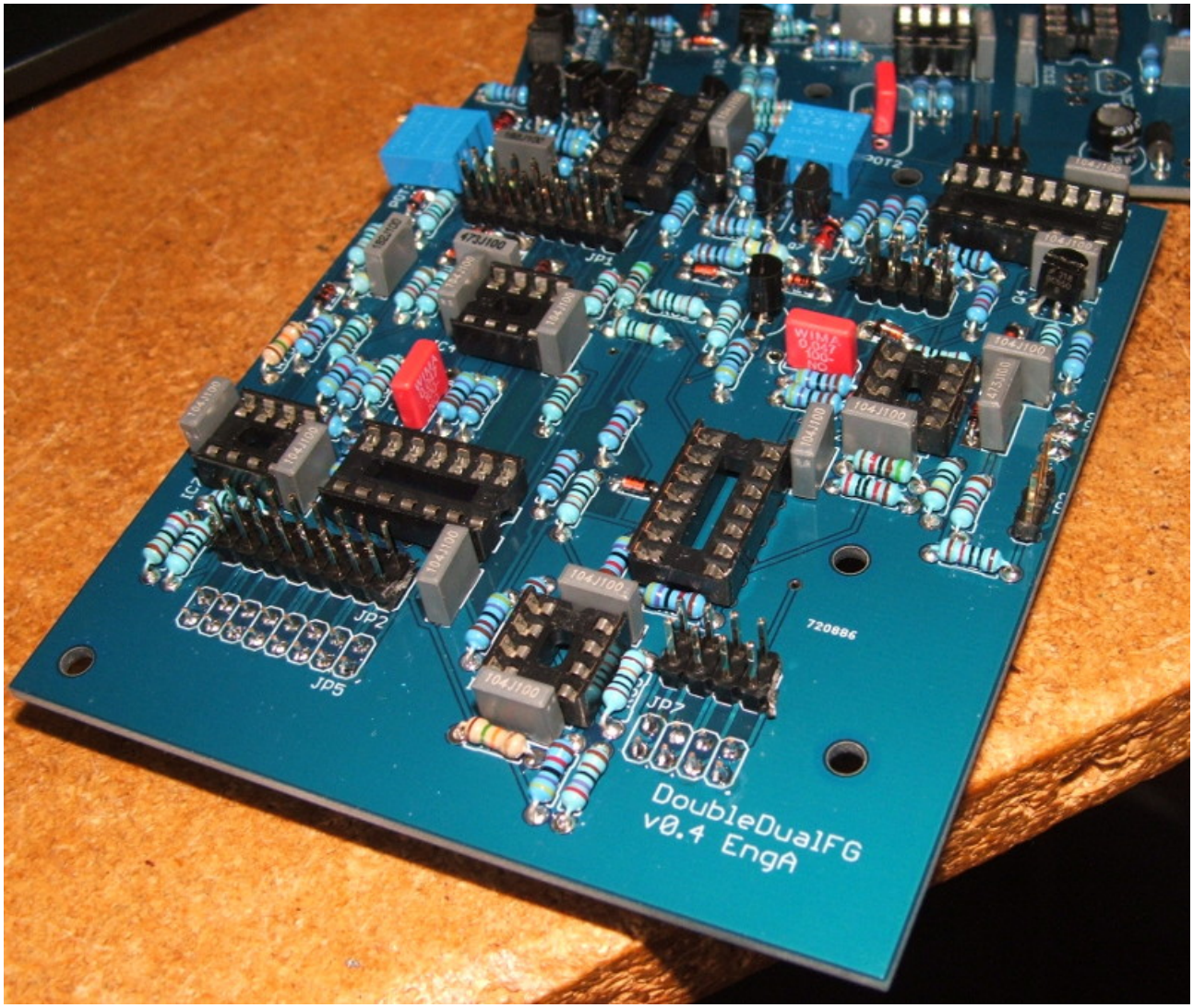
Flip the board over and check that yes, the female pinheaders are flush with the PCB.



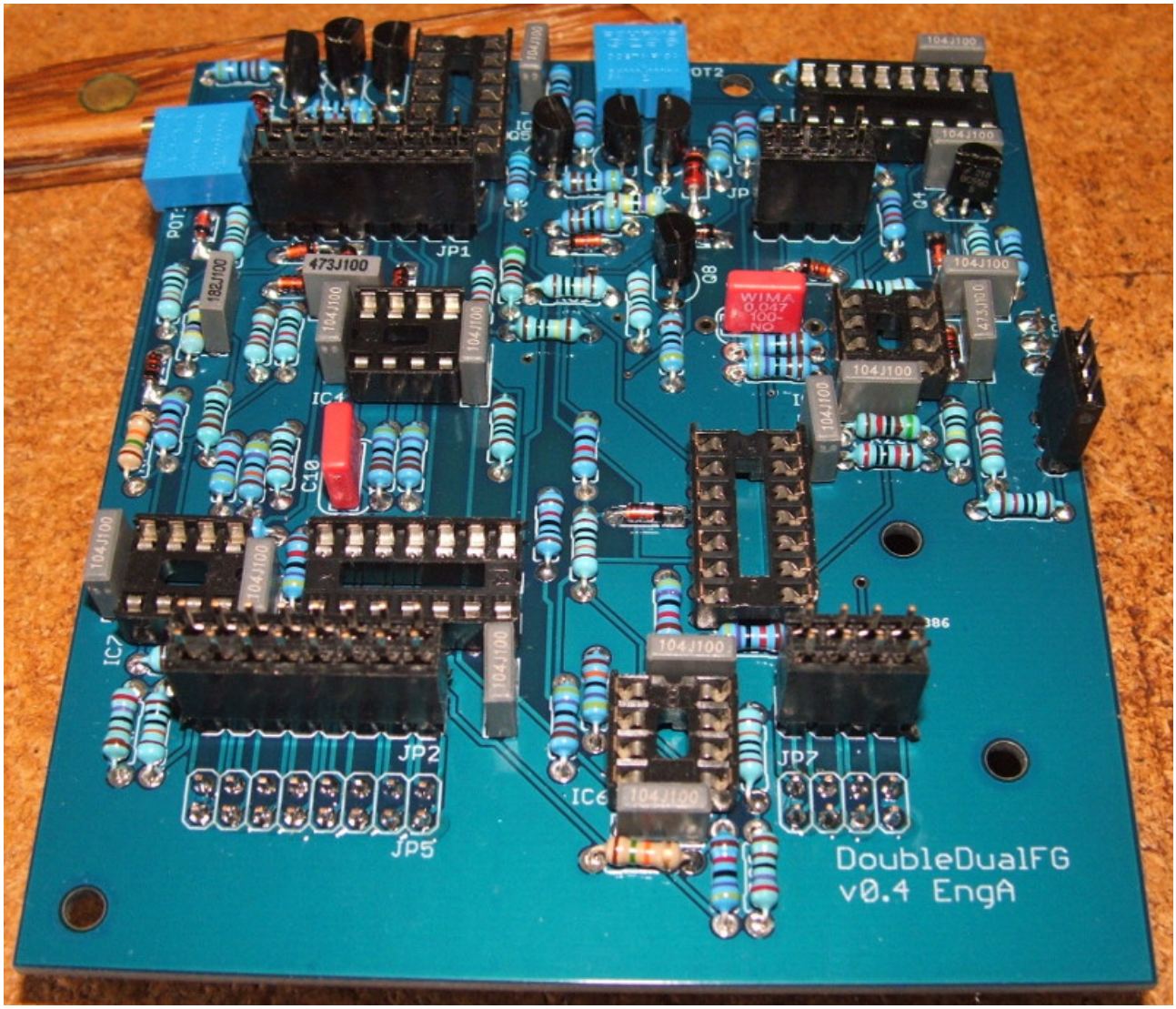
Now flip back to the component side of EngA, and solder in 2 lots of 2x8, two lots of 2x4, and one 1x3 pin header, each in the appropriate place. Use blu-tack to keep everything flat and straight!



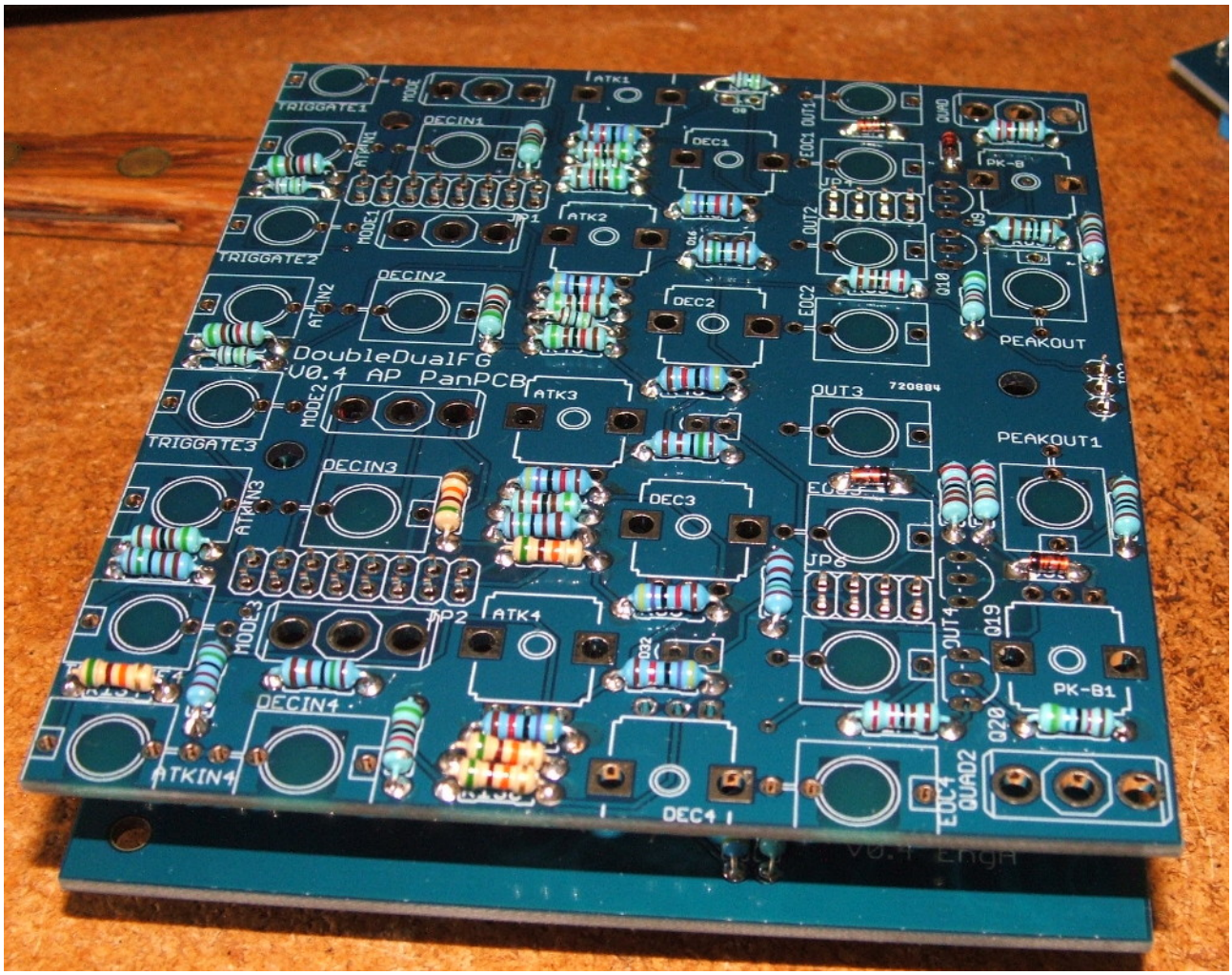
EngA should look something like this.



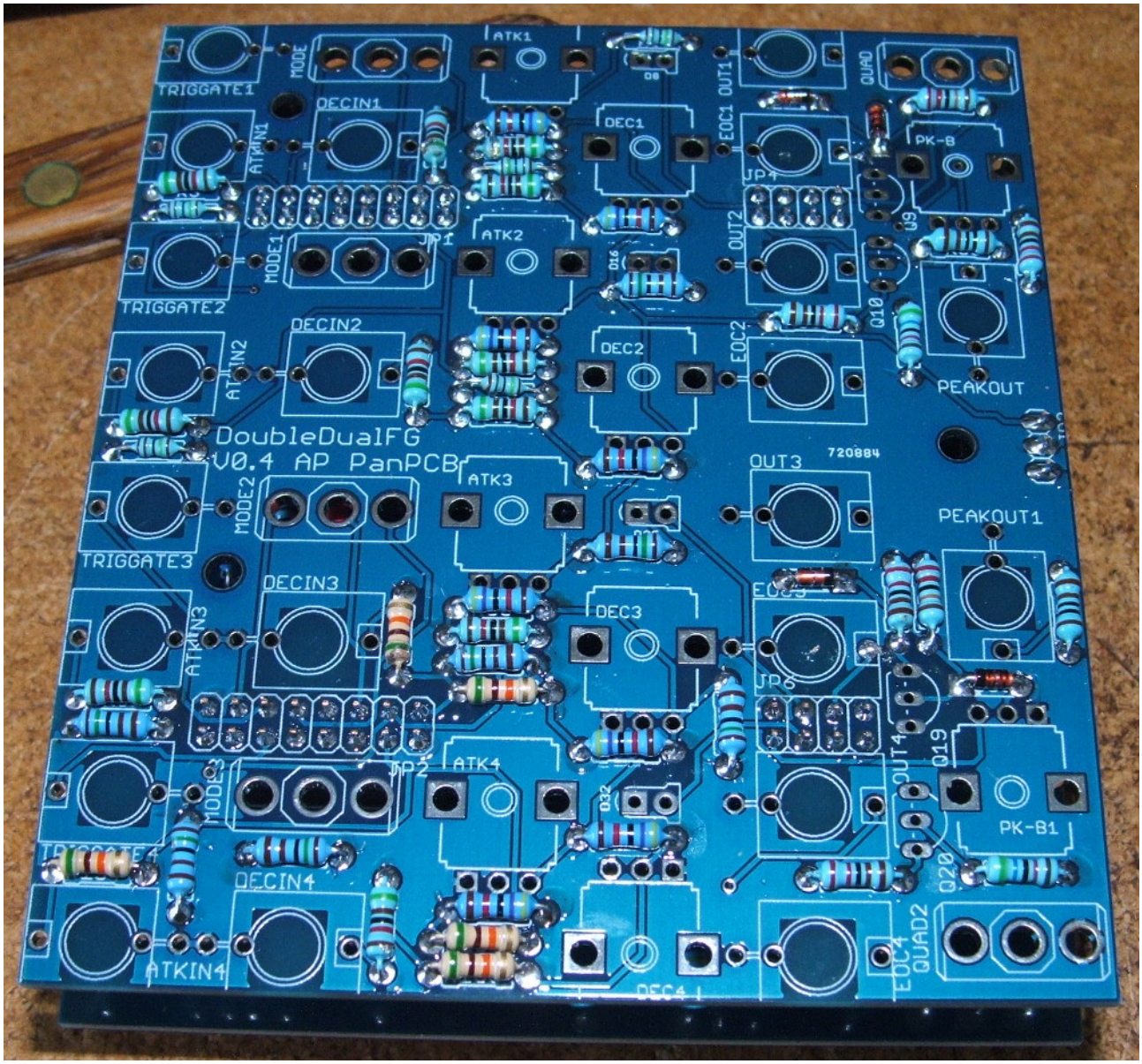
Place the female pin headers on the male ones you just soldered.



Place PanPCB on top of these pin headers – again, if you have everything straight, it should just drop on. The 1x3 header may need nudging.

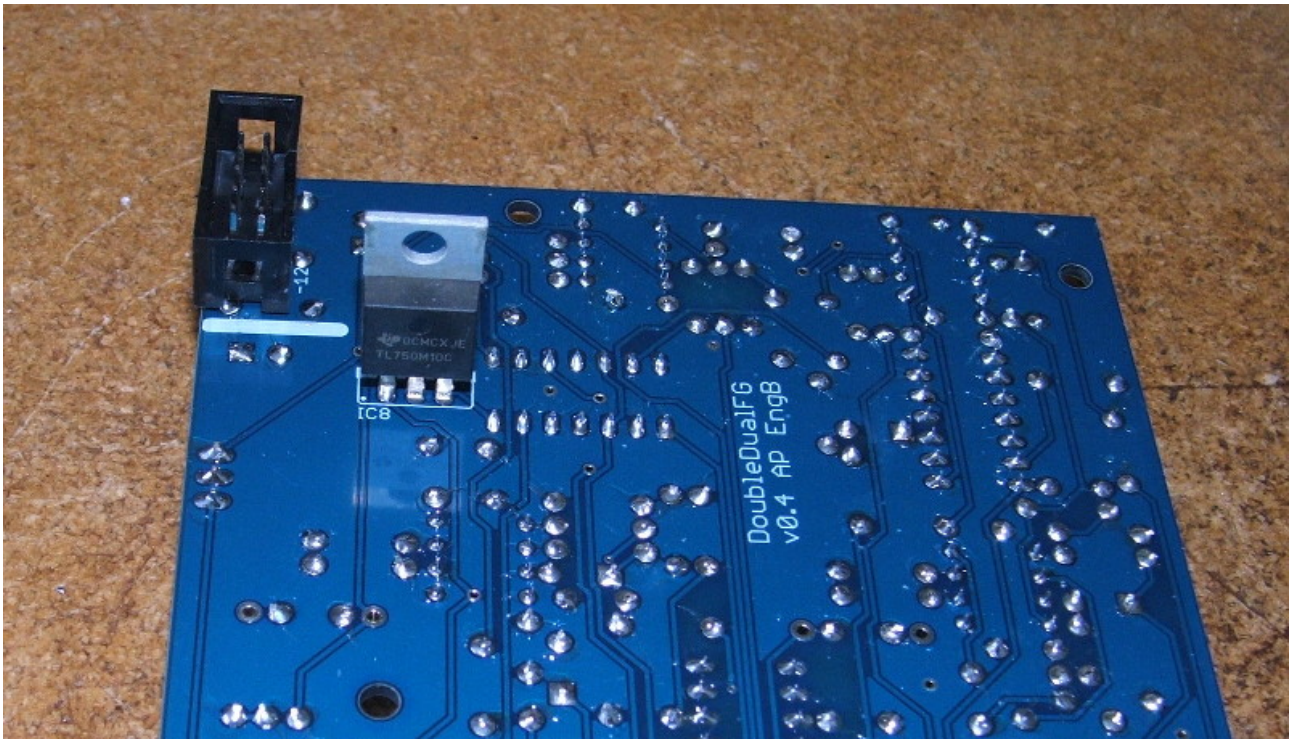


Solder the pinheaders down.

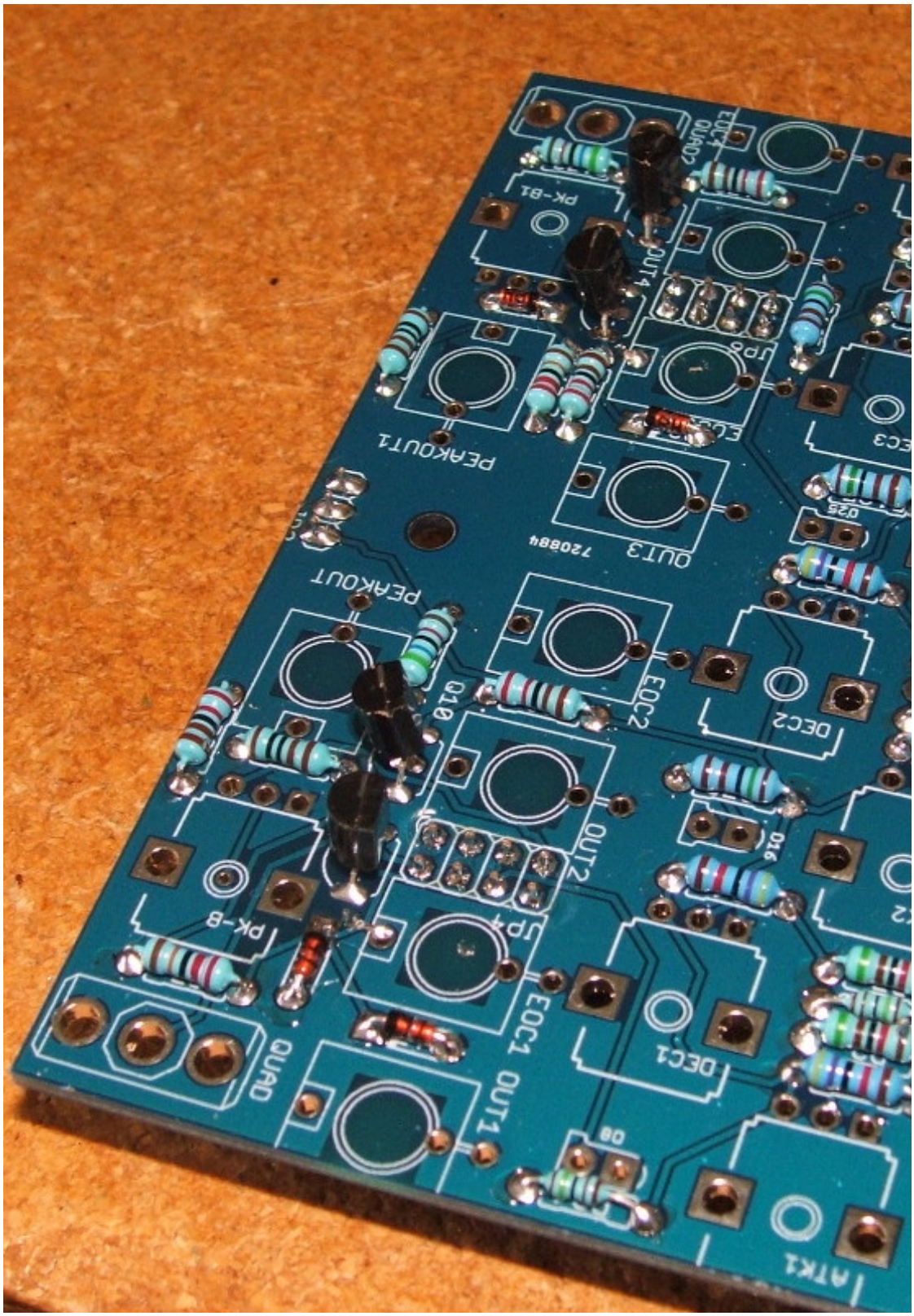


On the back side of EngB, solder the Eurorack power header in (if you use a box header like this, be careful to place Pin 1 at the end with the stripe!

If you have a TL750M10, then solder it in now. If you have the smaller TO-92 package regulator, then solder it on the component side in the appropriate place.



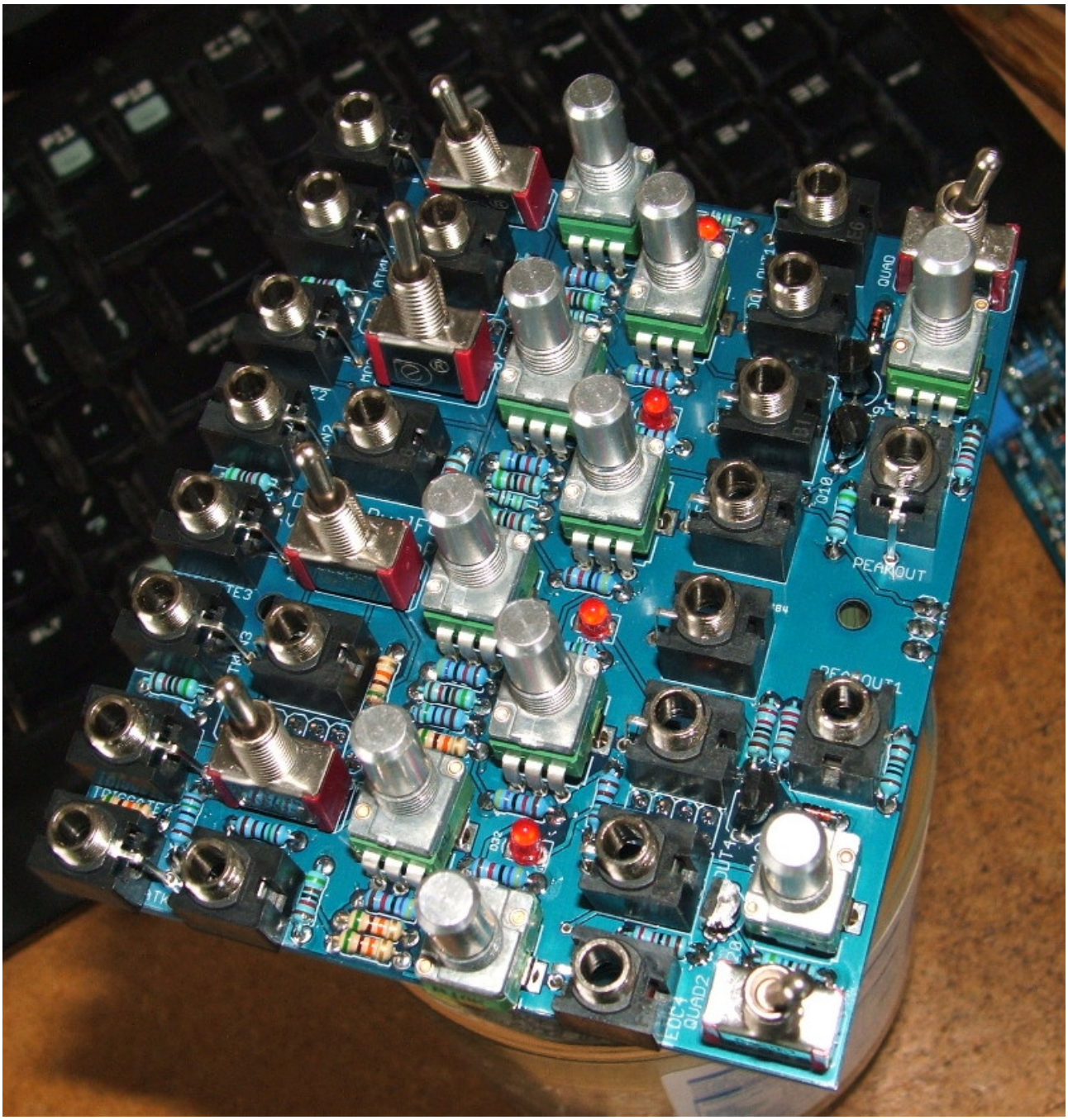
Take your PanPCB, and make sure that the transistors are soldered in.



Solder two Thonkiconn jacks in, on opposing corners of the board. I suggest OUT1, and ATK4. Make sure that they are flush with the board, and do NOT solder ANYTHING else in yet!
Dry fit the rest of the Thonkiconn jacks, and then insert the pots. The ATK and DEC pots are 10kB, and the two Peak Out pots are 100kB. If your pots have a locating lug, cut it off like usual.

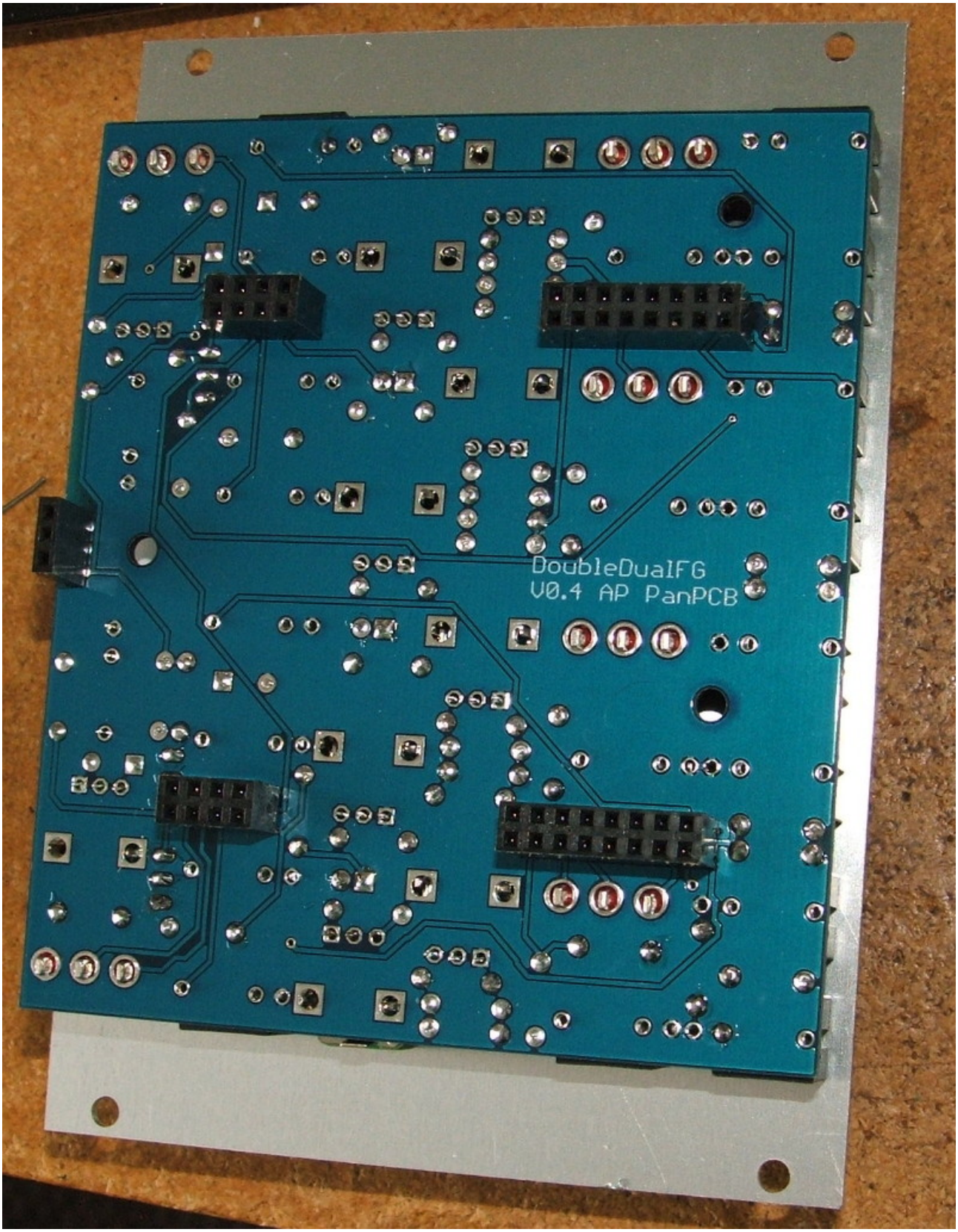
Remove the nuts and washers from the switches, and place them in. The two Quad switches are ON-ON SPDT toggles, and the four Mode switches are ON-OFF-ON SPDT toggles.

Dry fit the LEDs – don't worry if they drop right to the PCB. The ones I used, the long leg went in the square hole. Check for the flat side on your LEDs to make sure of your polarity.

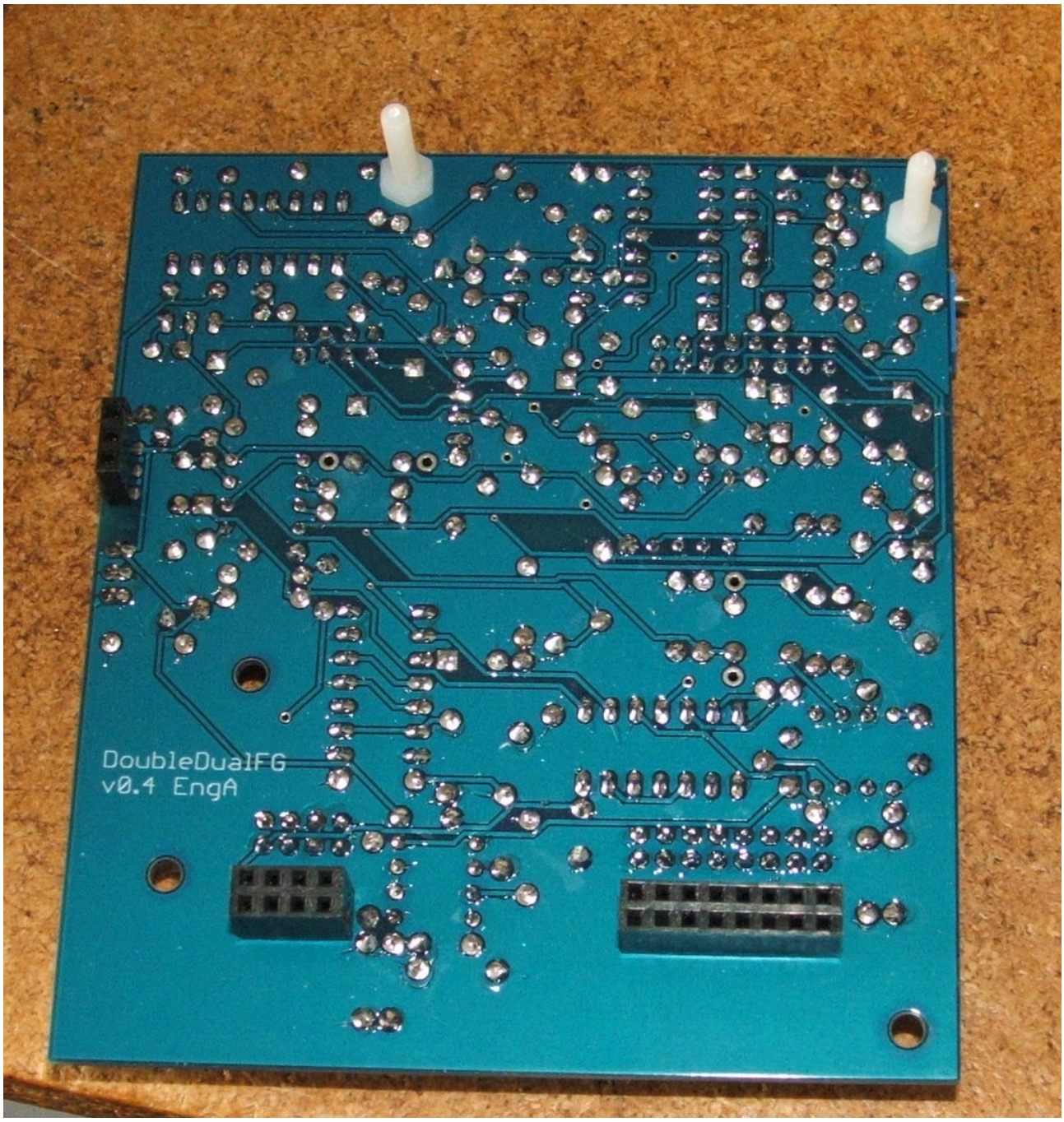


Slowly put the panel on. You will need to move the switches into position, as they will probably have fallen over slightly, and the pots may also need adjustment in position.
Once the panel is completely on, add a washer and nut on the two Thonkiconn jacks you have soldered in, so that everything doesn't fall off and waste all this work.
Solder the LEDs in so that the top of the dome of the LED itself is flush with the front panel. A lot of 3mm LEDs have exposed metal on the flat side of the LED itself, and you do not want this in contact with the panel, hence why you want the top flush with the panel, and not just push the LED through all the way.
Once this is done, add the washers and nuts for the rest of the Thonkiconn jacks, and the potentiometers. The switches can go without.

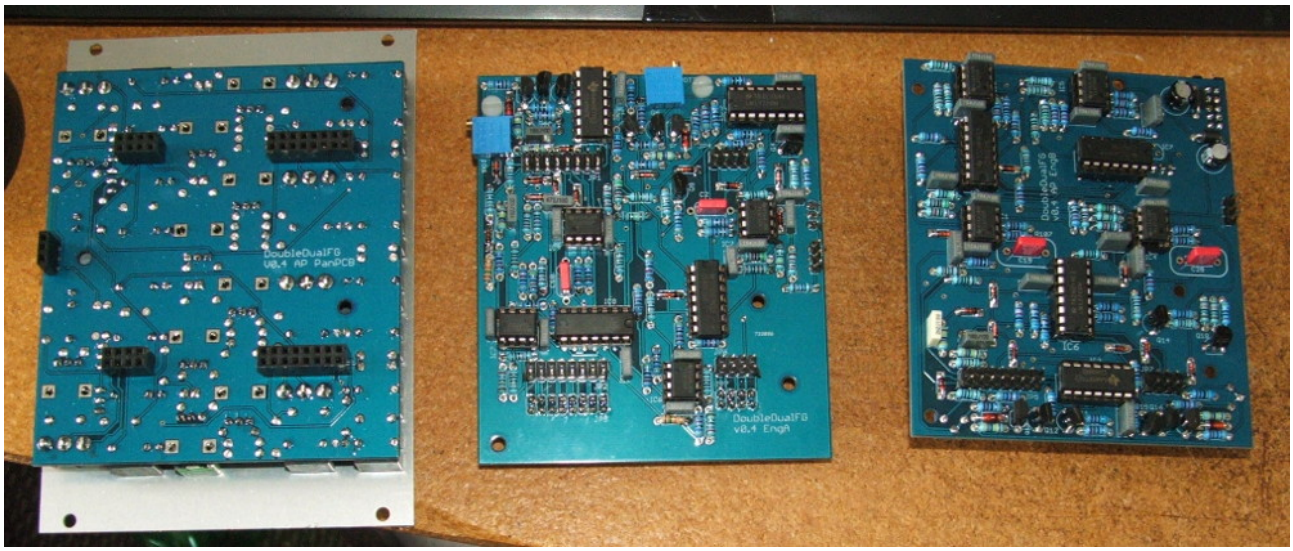
Once your panel-panpcb sandwich looks like the previous page, flip it over and solder everything. Be VERY careful to not melt any of the plastic headers! Turn the PCB around as you work on it to avoid this. We are doing it in this order because soldering the headers in once there is a lot of jacks and pots and switches on the other side is completely unworkable.



Take EngA, and screw in some nylon stand-offs, or some nylon bolts.



Add all the ICs to the two Eng boards. Be careful of the notch in the chips and sockets – there are a lot of them, and they don't always face the same way!



Once you're up to this stage, put the boards together, and add a nut to the nylon bolts/stand-offs.

Check the power header with your multimeter, that +12V, GND, and -12V are not shorted to each other or something.

If you've done everything rightly, then it should now power up, with no magic smoke escaping.

Theoretically, you can now bolt it into your Eurorack case and start having fun! But I strongly recommend calibrating it first.

CALIBRATION

Turn Decay to zero on all four channels.

Turn Attack to maximum.

Put all Mode switches in Cycle.

Put both Quad switches to Off.

Power it up. You may need to send a brief Gate or Trigger into the input for each channel to start them cycling – once they are cycling nicely, you can remove any input patch cables.

Attach an oscilloscope to the Out of channel 1. You should be getting a ramp wave with a period of maybe 10 to 25 seconds. Adjust POT1 on EngA (this is why the right angle trimpots) so that the ramp has a period of 10 seconds (or as close as you can manage.)

Repeat the last step with the other three channels. POT2 for Channel 2, POT3 for Channel 3, and POT4 for Channel 4.