

Construction of an Experimental Tetrahedral Ambisonic Microphone

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PLEASE READ ALL OF THESE INSTRUCTIONS BEFORE BEGINNING.

Microphone printed circuit board construction:

Parts list (quantities for 4 preamplifiers):

Quantity	Item Description	Nomenclature
12	Capacitor, 22uF 16V electrolytic	C1, C4-C5
24	Capacitor, 0.1uF ceramic	C2, C6-C9, C12
4	Capacitor, 22uF 25V electrolytic, non-polar	C3
8	Capacitor, 10uF 50V electrolytic, non-polar	C10-C11
4	Capacitor, 47pF ceramic	C13
4	Connector, 4 section dual-row male, right angle, 0.1x0.1	J1
4	Connector, 2-pin female	Gain jumper
4	Diode, zener, 5.1V (1N5231B)	D1
8	Diode, zener, 10V (1N5240B)	D2-D3
16	Diode, general purpose (1N4148)	D4-D7
4	Integrated circuit, THAT 1512P	IC1
2	Printed circuit boards, Exp2 v1.32 (2 preamps per board)	PCB
12	Resistor, 10K 1/8W 1% (brown-black-black-red)*	R1-R2,R4
4	Resistor, 4.7K 1/8W 1% (yellow-violet-black-red)*	R3
4	Resistor, 162 ohm 1/4W 1% (brown-blue-red-black)*	R5a
4	Resistor, 523 ohm 1/4W 1% (green-red-orange-black)*	R5b
4	Resistor, 1.87K 1/4W 1% (black-grey-violet-brown)*	R5c
4	Resistor, 10K 1/4W 1% (brown-black-black-orange)*	R5d
8	Resistor, 51 ohm 1/4W 1% (green-brown-black-gold)*	R6, R9
8	Resistors, 20K 1/4W 1% (red-black-black-orange)*	R7, R8

*Tolerance band on a 1% resistor is brown.

(See <http://www.digikey.com/web%20export/mkt/general/mkt/resistor-color-chart.jpg> for a resistor color code chart.)

Tools and materials:

Wire cutters, small flush-cut (see notes)

Needle-nosed pliers

Soldering iron, pencil type, 40-60 watts

Solder

Cleaning materials acceptable for local use (see text)

Process with pictures:

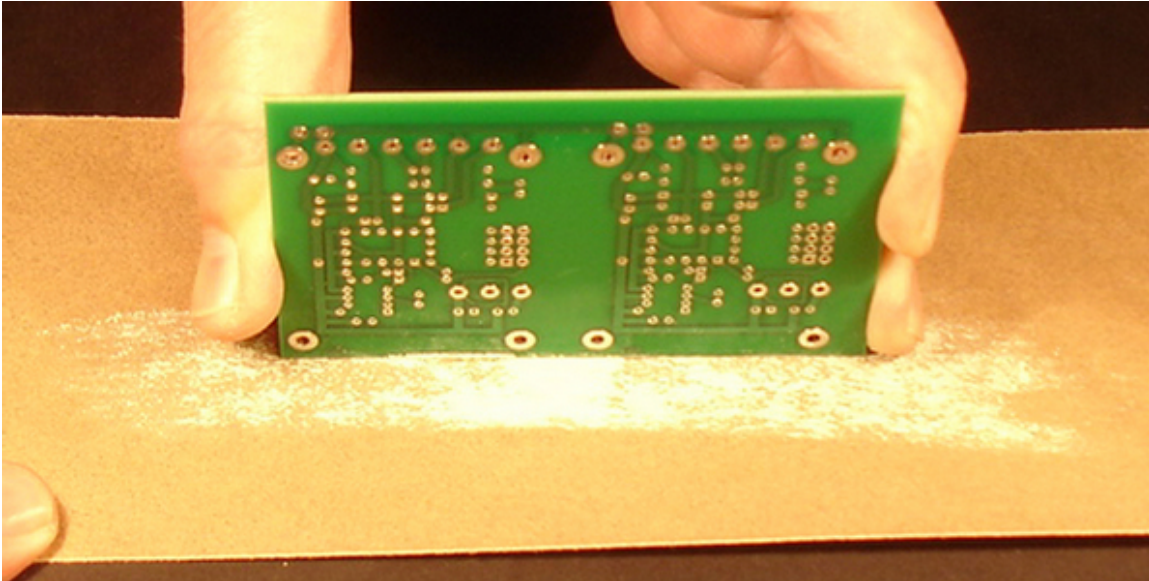
Note: Some things are better described in pictures. I tried to do that as much as possible; at times I used the timer on my camera to show things that required my two hands. There are times that the length of the timer was too short to get things in front of the lens, and I will describe those in text! The numbers of each step match up with the picture numbers. Picture numbers are 2-characters wide since most computer programs, even photo software, look at alpha-numeric increments rather than numeric ones.

CAUTION! Use caution in handling the soldering iron and the components. Do not breathe the smoke from the solder. Use protective glasses, especially when cutting component leads. Be careful where you “aim” the leads when you cut them.

NOTES:

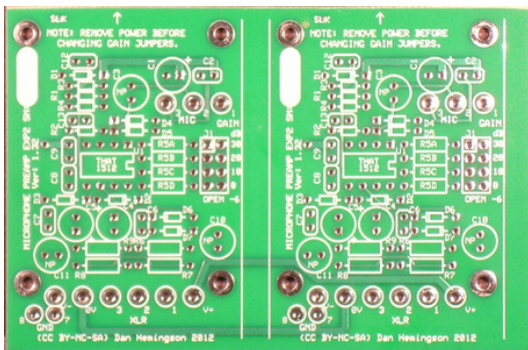
1. The printed circuit board shown in these instructions is version 1.32. It is also the first version with resistors specified at 1% tolerance and, therefore, resistors have 4 bands for value plus one band for tolerance.
2. I assume that you have at least a little experience in soldering. Warm both the component lead and the hole. Solder only from the *bottom* side of the pc board. There is no need to have the holes overflowing with solder, just full. This technique is different from soldering the heavy copper wire on the tetrahedral frame, yet similar in that too much heat for too long can do bad things!
3. The instructions give the order of component placement so the board can be placed on a flat surface component side down to hold the parts in place while soldering. Load the components into both preamps and solder as directed in each step; then go to the next step. I suggest you complete one pc board (both preamps) then repeat the sequence with the second pc board.
4. Do not bend the leads of the resistors or diodes sharply next to the body of the component. They fit into the holes with a small radius.
5. I suggest that you use small wire cutters with one flush or near-flush edge, Erem 777E, Xcelite 54CG, or similar.
6. When cutting the excess wire from the back of the printed circuit board (PCB) be careful not to cut so close to the board that the trace, hole pad, or the solder mask (the coating over the copper traces) is damaged. Avoid cutting the leads with the very tips of the cutters to avoid damage to the cutters, especially when cutting the leads from the jumper connector block.
7. Keep components separated by values, especially the diodes. There are 3 values of diodes that look identical. If they get mixed up, do not install them on the pc boards until you are assured that your visual identification checks of the numbers printed on each device is valid.





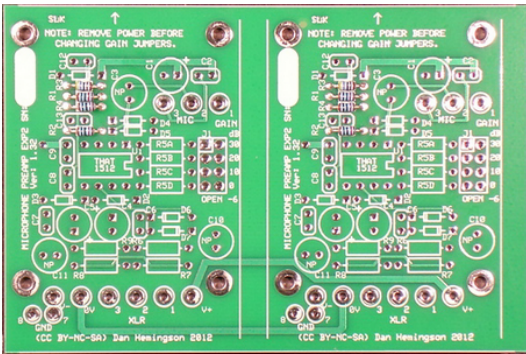
00. Before stuffing the pc boards, be certain that each of the pc boards will slide into the bottom card slot of a clamshell. If not, it is a case of attempting to fit a 2.5-inch object into a 2.5-inch slot! *Sand the edge of the board with the silkscreened arrows.* DO NOT clamp the pc board in a vise. Use a fine grit (150) sand paper (a fine flat file could be used). Do not breathe the dust. Do not sand too much; just a few thousandths of an inch.

Lay the sandpaper on a flat surface with the grit surface up. Grasp the board by the *short edges* and hold it vertically. Keep the card edge vertical while sanding. Sand each board individually with the edge moving against the stationary sandpaper. Stop when the PCB will just slide into the bottom card slot of the clamshell. Tilt the card about 45-degrees each way and “break” the corners of the freshly sanded edge, using only a few sanding strokes on each edge corner. The card should now slide all of the way into the slot. Clean the edge of the card with a damp cloth.

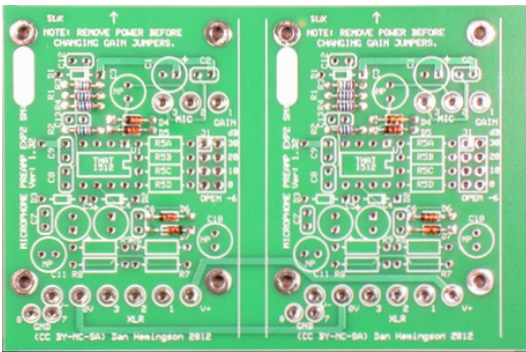


01. Top view of a blank Exp2 v1.32 dual-preamp printed circuit board.

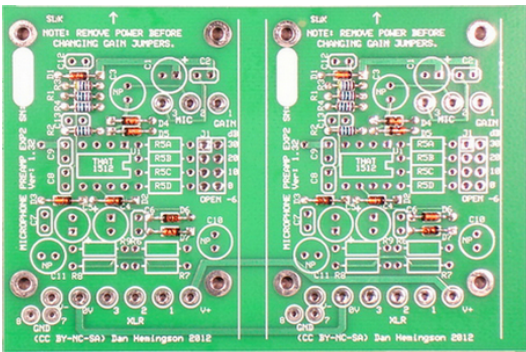
After inserting each group of parts, turn the board over with the bottom side up so the components rest between the pc board and a flat surface. Be sure the pc board is flat with the surface and each part’s leads are vertical as you solder the leads. Trim the excess leads on the back of the board after each step. Protect your eyes from flying leads.



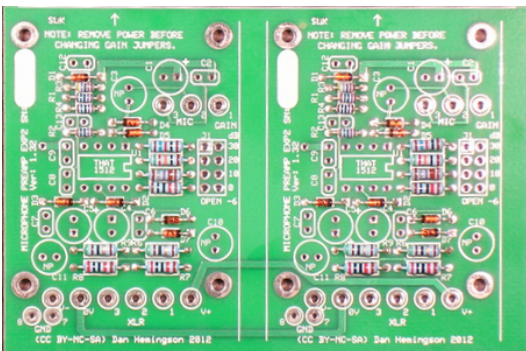
02. Insert and solder resistors R1, R2, and R4, then insert and solder R3. Note that the orientation of all of the resistors is the same in the photo. While it does not matter electronically for resistors, it looks neater and a confirmation of part values is easier if they are oriented in the same direction. Typically resistors are stuffed with the color bands reading left to right.



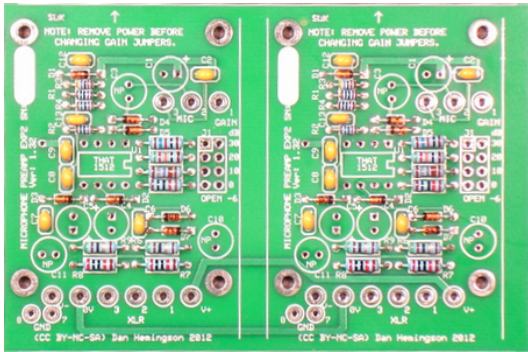
03. Insert and solder diodes D4 through D7. The orientation of a diode *is* important. Notice the black ring around one end of each diode. This will correspond with the extra bar on the diode location on the PCB silkscreen.



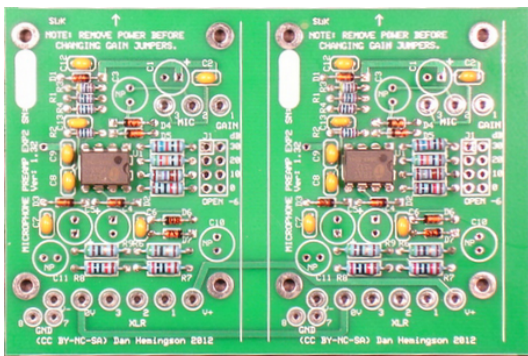
04. Insert and solder D1, then add and solder D2 and D3.



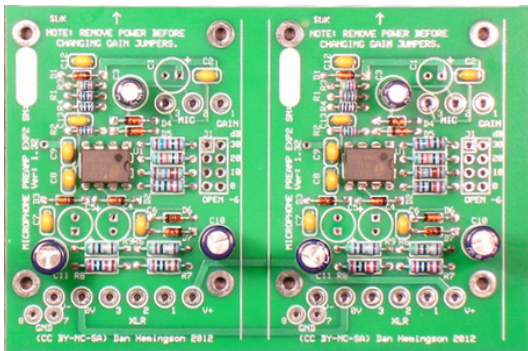
05. Insert and solder resistors R5a thru R5d (check for the proper resistor in the proper holes before soldering) and then add and solder R6 and R9. Now insert and solder resistors R7 and R8.



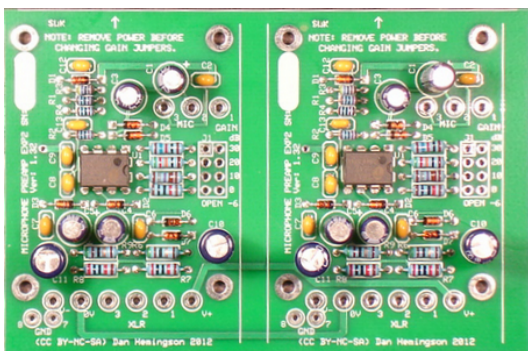
06. Insert all of the bypass capacitors C2, C6 through C9, and C12. The orientation of ceramic capacitors is not important. Place a small piece of heavy paper on top of the board to hold the capacitors in place while you turn it over. As you solder the leads, you want each capacitor to remain perpendicular to the PCB; keep the leads vertical when soldering. Now add C13 (a different value than the bypass capacitors) and solder.



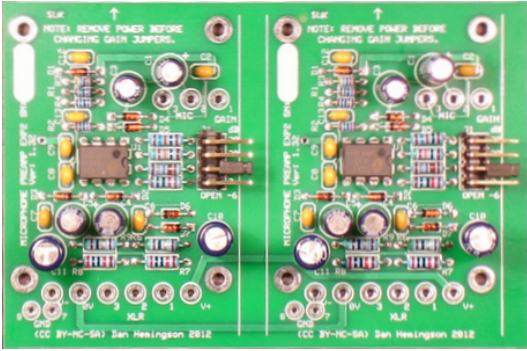
07. Insert the THAT 1512 IC, orienting the dot on top of the IC toward resistors R5A through R5D. Make sure that the IC is flat with the pc board before you solder it in place.



08. C3, C10, and C11 are non-polarized electrolytic capacitors (marked NP or BP for bi-polar). Note that neither pad on the pc board is square as will be the case with polarized capacitors. It doesn't matter which lead goes into either hole on the capacitor locations, but remember C3 is a different value from C10 and C11. Do not press the capacitors hard against the pc board. Insert and solder them.



09. Insert the leads of the polarized electrolytic capacitors C1, C4, and C5 with the longer lead into the square pad. Do not press them hard against the pc board when you solder them.



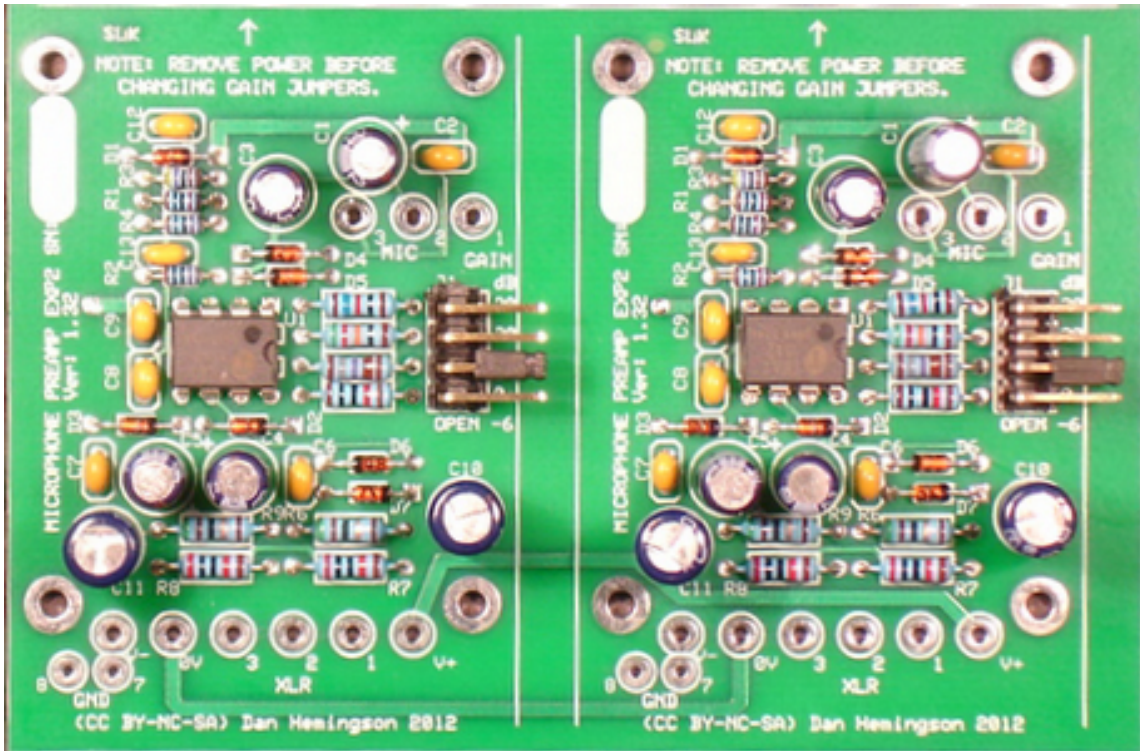
10. Install the gain jumper connector block with the black insulation *flat* against the PCB. Put a 2-pin gain jumper vertically on one pair of the pins as shown in the picture. See “caution” before soldering.

CAUTION!!! These pins get **HOT** and hot pins can melt the black plastic block. Solder only the outside lead whose pin is covered by the jumper *and* is next to the edge of the PCB; this is *not* the inside (top) pin. This is a time when turning the board upside down will not hold parts in place, but you still must turn the board over. Use needle-nosed pliers or a kitchen hot-pad to avoid getting burned. A third hand may (or may not) be helpful. Check that the plastic block is correctly aligned and is flat against the board. If not, heat the solder joint and reset the block.

Solder the lead from the inside pin connected by the jumper. Let it cool. Move the jumper to another set of pins. Solder these 2 pins. Repeat until all of the pins are soldered.

Cutting the jumper block pins on the bottom side of the PCB can easily destroy a fine pair of wire cutters. If some larger cutters are available, use them. Insert the cutting edge as far onto the pin as you can. Cut one pin at a time with the cutting edge of the cutters on the cross section of the pin, not on the square edges.

Put the jumper on the pins marked “10db”.



11. A through-hole is a hole with no component lead; it serves as a connector between the top and bottom layers. There is one near C9. It needs to be filled with solder just like the component holes.

12. If this is the first board you have completed, go back to step 02 and “stuff” the second one, otherwise it is time for the final board cleaning.

There will be resin remaining on the back side of the PCB. I use 91% (or better) rubbing alcohol (isopropyl) on a cotton swab or light brush to remove the resin. Note that alcohol may or may not be environmentally acceptable in your locale. Distilled water is a second choice, but not as effective. Properly dispose of any cleaning materials according to local policy. Avoid soaking the board in cleaning solutions, especially the capacitors.

Good job. The final assembly is the next step.