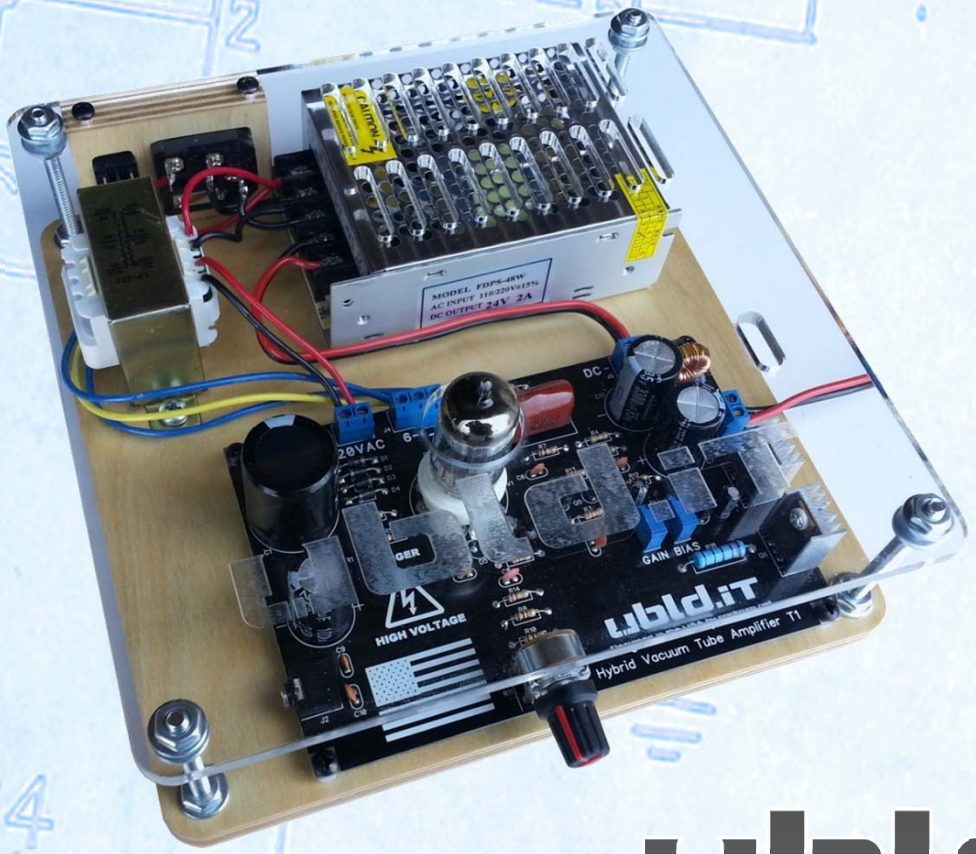
HYBRID VACUUM TUBE AMPLIFIER



Assembly Guide

Mono Tube Amplifier
13 Watts Peak @ 8ohms
6.25 Watts RMS @ 8 Ohms

Warm sounds of a tube pre-amp coupled with the low distortion solid state amplifier.

ubld.it

Support: http://ubld.it/hybrid-vacuum-tube-amplifier

Manual: v1.0

Kit Version: v1.0

Tool Checklist

1. Soldering Iron

We recommend the Hakko FX888 or similar iron with a chisel tip.

2. Wire Cutters

Small cutters for clipping excess wire leads after soldering.

3. Solder

Electronic solder is used for soldering parts to the PCB.

4. Multimeter

Multimeter for verifying component values and adjusting the circuit.

5. Wire Strippers

18 AWG Wire Strippers for removing insulation from wires.

6. Hand Tools

An adjustable wrench, small flat head and Phillips screwdriver are also used.

Tool Checklist

7. Clamp

Used for holding parts in place while pre-drilling.

8. Hot Glue Gun

Small amount is used to keep the inductor from ringing.

9. Drill

A drill is used for pre-drilling screw holes. Pre-Drilling is required.

10. Drill Bit 3/32 “

Used for pre-drilling screw holes. Pre-Drilling is Required.

STEP 1: Check the BOM

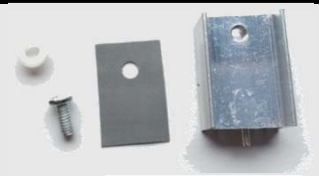
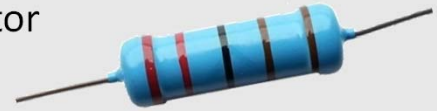
BOM is short for Bill of Materials. Check each line item as you verify the required quantity of components.

☑	Line	Designator	Description		Required	Kit Qty
☐	1	C1	470uF 250V Capacitor		1	1
☐	2	C2	100uF 250V Capacitor		1	1
☐	3	C3,C6,C9,C10,C11,C12	100pF Disk Capacitor		6	6
☐	4	C4, C13, C14	10uF Electrolytic Capacitor		3	3
☐	5	C5	2.2uF 250V Film Capacitor		1	1
☐	6	C7, C15	3300uF 35V Electrolytic Capacitor		2	2

STEP 1: Check the BOM (continued)

✓	Line	Designator	Description		Required	Kit Qty
☐	7	C8, C16, C17	.1uF Disk Capacitor		3	3
☐	8	D1, D2, D3, D4	1N4004 Diode		4	4
☐	9	D5, D6	Blue 5mm LED		2	2
☐	10	J1, J3, J5	2 Pole 5mm Terminal Block		3	3
☐	11	J2	1/8” Audio Jack		1	1
☐	12	J4	3 Pole 5mm Terminal Block		1	1
☐	13	L1	100uH 3A Toroid Inductor		1	1

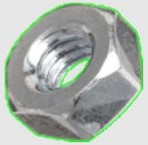
STEP 1: Check the BOM (continued)

✓	Line	Designator	Description		Required	Kit Qty
☐	14	M1,M2	TO-220 Heat Sink Assembly		2	2
☐	15	Q1	2N5401 Transistor		1	1
☐	16	Q2	TIP122 Darlington Transistor		1	1
☐	17	Q3, Q4, Q5	BC546B Transistor		3	3
☐	18	Q6	TIP127 Darlington Transistor		1	1
☐	19	R1, R3, R16	2.2k Ohm ¼ Watt Resistor		3	3
☐	20	R18	2.2k Ohm 2-Watt Resistor		1	1

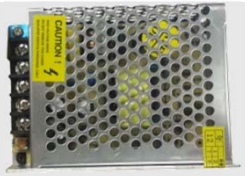
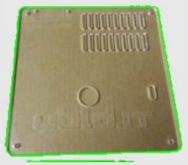
STEP 1: Check the BOM (continued)

☑	Line	Designator	Description		Required	Kit Qty
☐	21	R2, R5, R14	220k Ohm ¼ Watt Resistor		3	3
☐	22	R4, R9	470k Ohm ¼ Watt Resistor		2	2
☐	23	R7, R12, R15	10k Ohm ¼ Watt Resistor		3	3
☐	24	R6, R17	10k Trim Potentiometers		2	2
☐	25	R8, R10	1k Ohm ¼ Watt Resistor		2	2
☐	26	R11	5k Potentiometer		1	1
☐	27	R13	22k Ohm ¼ Watt Resistor		1	1

STEP 1: Check the BOM (continued)

✓	Line	Designator	Description		Required	Kit Qty
☐	28	R19	4.7k Ohm ¼ Watt Resistor		1	1
☐	29	V1	12AU7 Vacuum Tube and Socket		1	1
☐	31	Transformer Screws	#10 x ½ Pan Head Phillips Screw		2	2
☐	32	Feet, Power Supply, IEC Connector Screws	#6 x 3/8 Pan Head Phillips Screw		8	8
☐	33	IEC Mount Screws	#6 x 5/8 Pan Head Phillips Screw		4	4
☐	34	PCB Screws	#6 x ½ Pan Head Phillips Screw		5	5
☐	35	Standoff Nuts	10-24 Nuts		12	12

STEP 1: Check the BOM (continued)

✓	Line	Designator	Description		Required	Kit Qty
☐	36		10-24 Screws 2 ½”		4	4
☐	37		10-24 Washers		16	16
☐	38		24V 2Amp Switching Power Supply		1	1
☐	39	PCB Spacers	3/16 #6 Nylon Spacers		5	5
☐	40		Acrylic Top		1	1
☐	41		Dual Primary /Secondary 120/220v 6/12 Transformer		1	1
☐	42		Fused IEC Connector (Fuse Included)		1	1

STEP 1: Check the BOM (continued)

✓	Line	Designator	Description		Required	Kit Qty
☐	43		Wood Laminate Base		1	1
☐	44		Wood Laminate IEC/Switch Mount		1	1
☐	45		18AWG Red and Black Wire		1ft	1ft
☐	46		On/Off Switch		1	1
☐	47		Rubber Feet		4	4
☐	48		Tube Amp T1 Circuit Board		1	1
☐	49		Knob		1	1

STEP 1: Check the BOM (continued)

☑	Line	Designator	Description	Required	Kit Qty
☐	43		IEC Power Cable	1	1
☐	44		1/8” Audio Cable	1	1

STEP 2: Inserting the first component

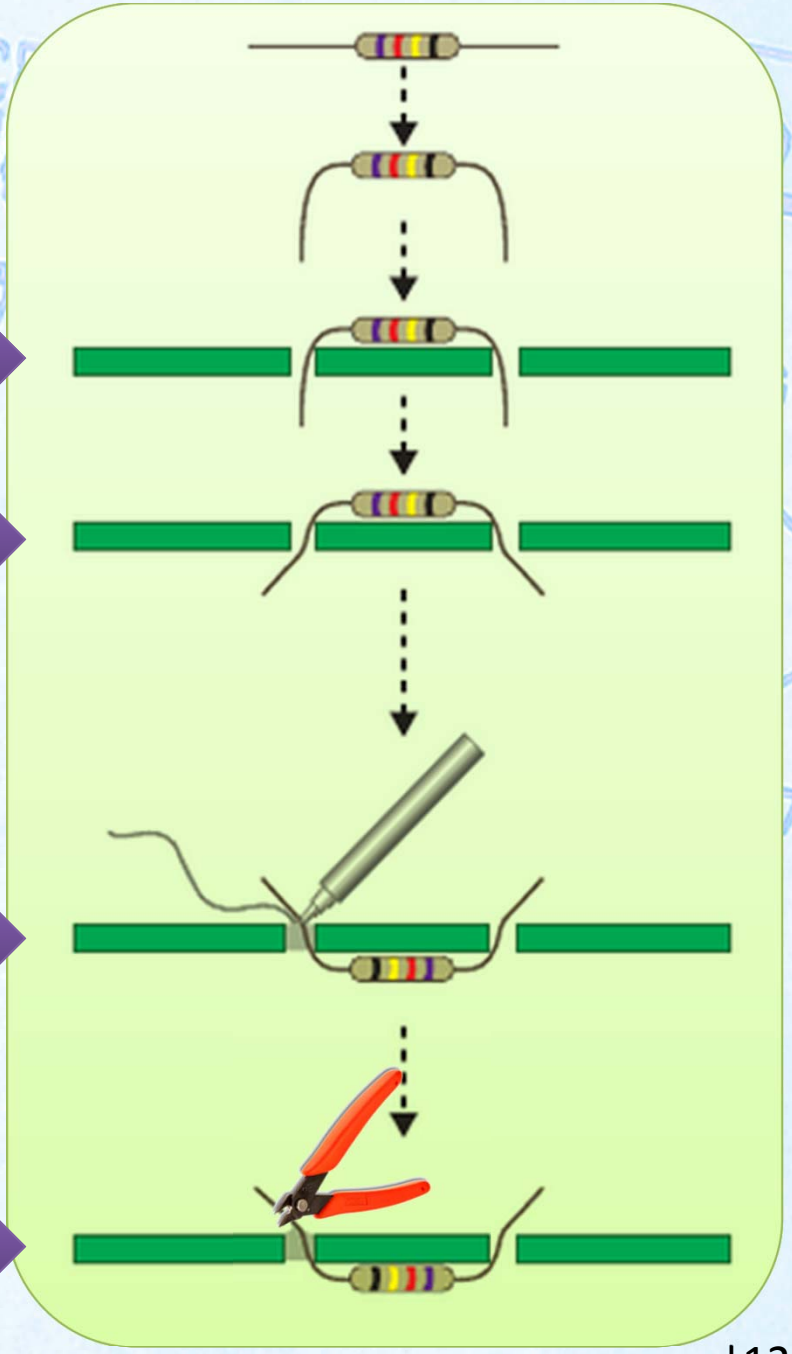
Before we locate the first component let's take a minute to review the proper way to insert and solder the components to your circuit board.

Insert the components into the circuit board.

Bend the component leads to hold the component in place while soldering.

Flip the board and solder the component leads .

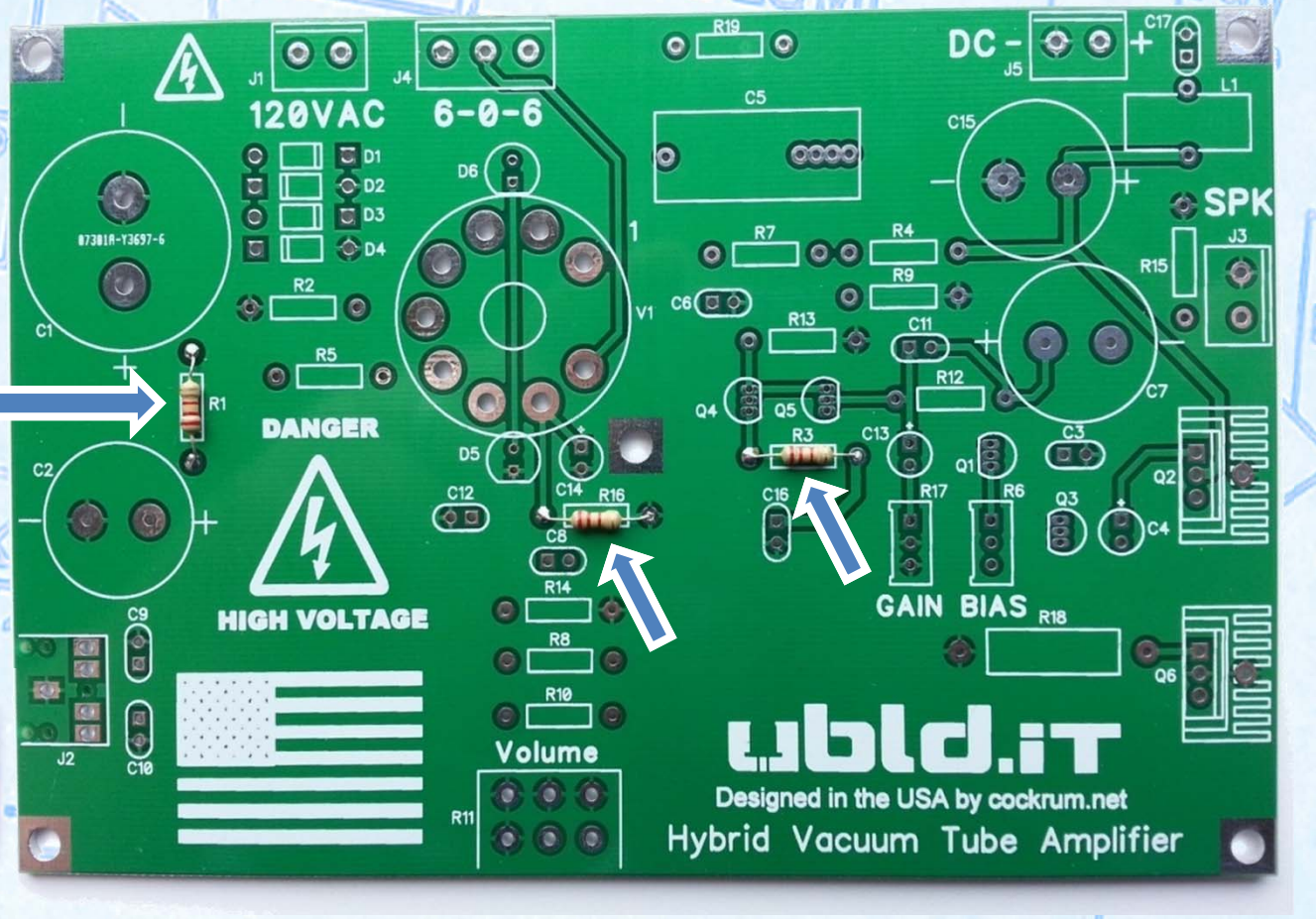
Trim the component leads at the top of the solder joint.



STEP 2b: Inserting the first component

Solder the 2.2kΩ ¼ Watt resistors into R1, R3, and R16.

The first components to locate are three 2.2k ohm resistors (line #19).



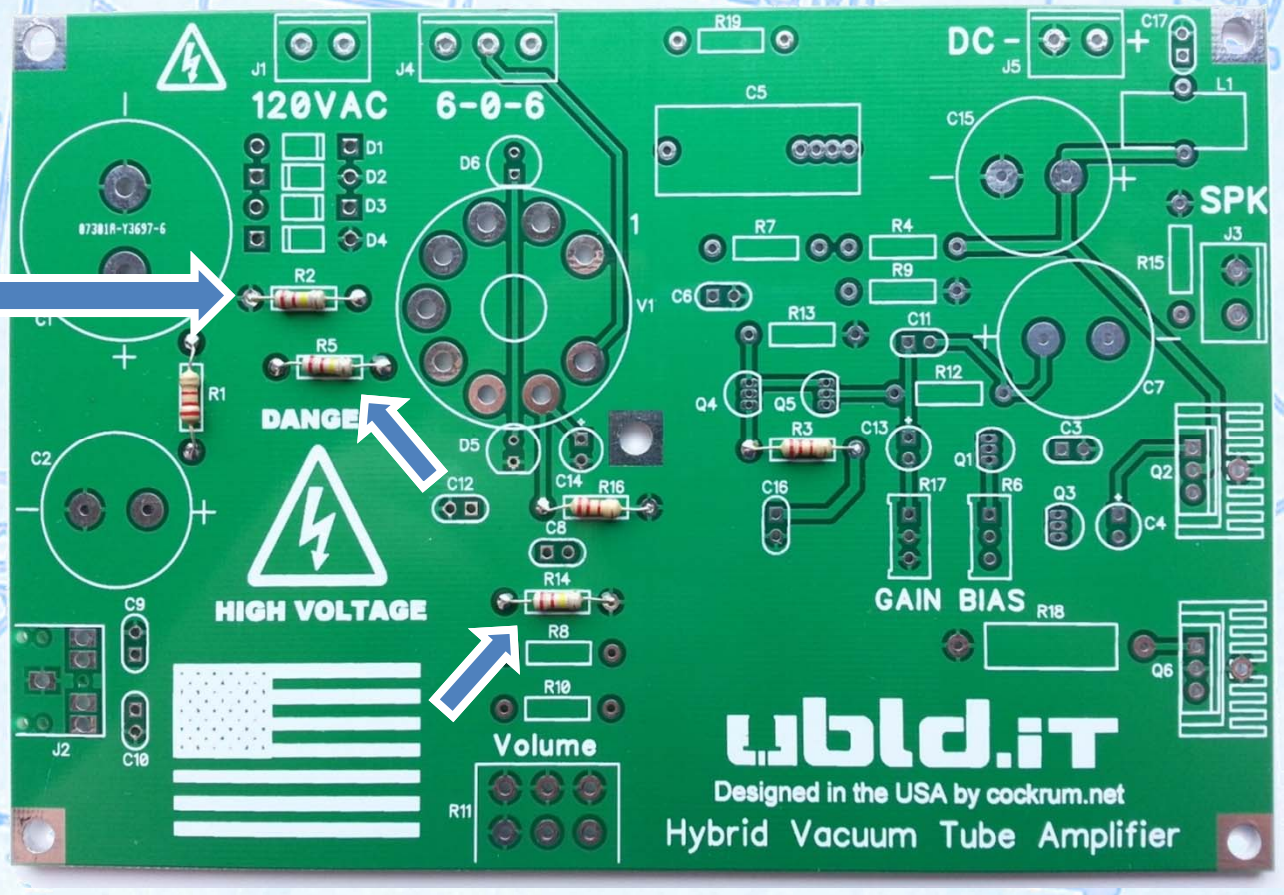
Note: Your board may not look exactly like this.

Axial Lead Resistors such as the ones used in this kit are color coded. Compare the resistor you are installing to the images shown in each step. Also double check the values with a multimeter on the ohm setting.

STEP 3: Insert the 220k Ohm Resistors

Locate three 220k ohm resistors (line #21).

Solder the 220kΩ ¼ Watt resistors into R2, R5, and R14.

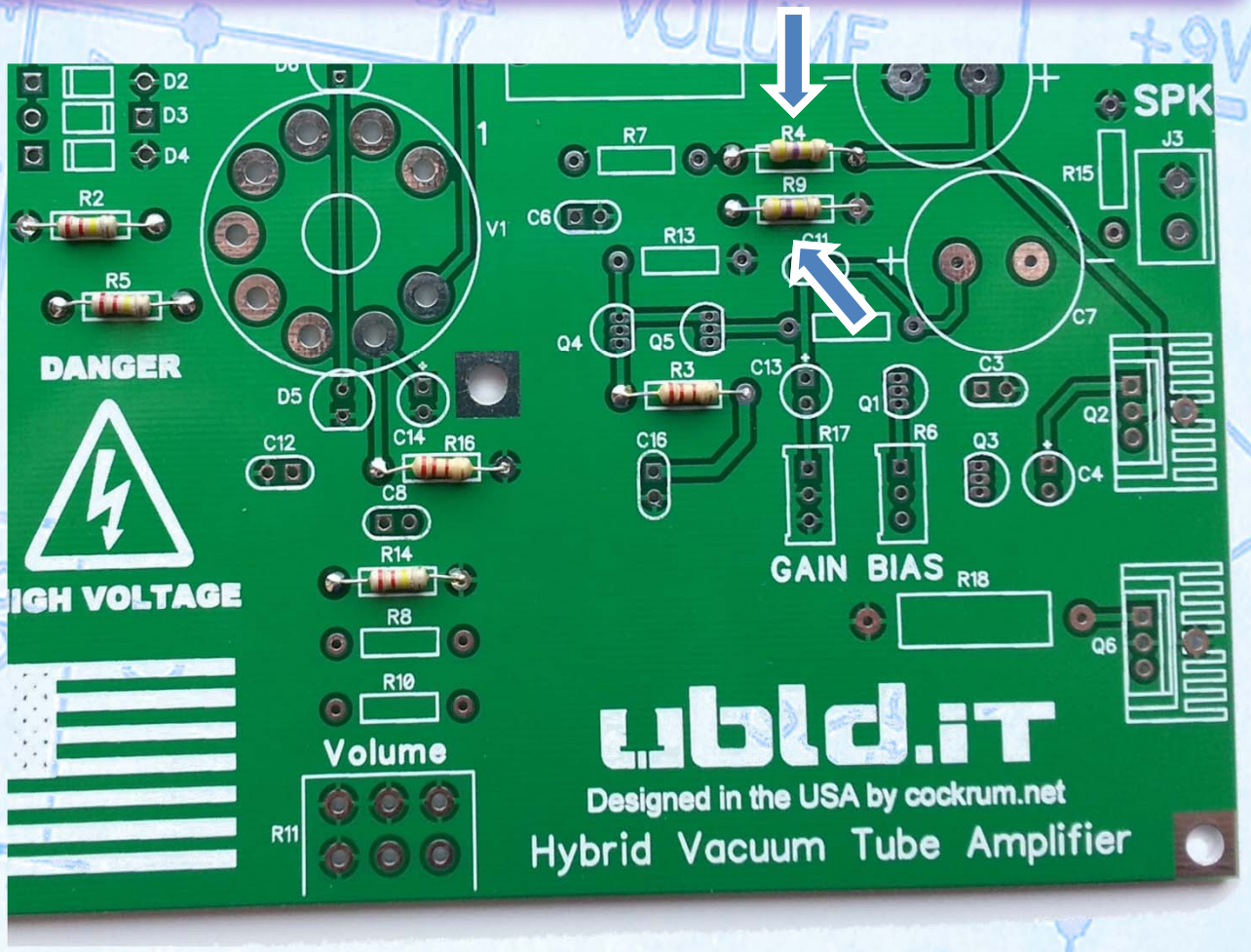


Take pride in your work. This is a show piece so make sure you take your time to bend all the components leads to 90 degree angles using needle nose pliers.

STEP 4: Insert the 470k Ohm Resistors

Locate two 470k ohm resistors (line #22).

Solder the 470kΩ ¼ Watt resistors into R4 and R9.

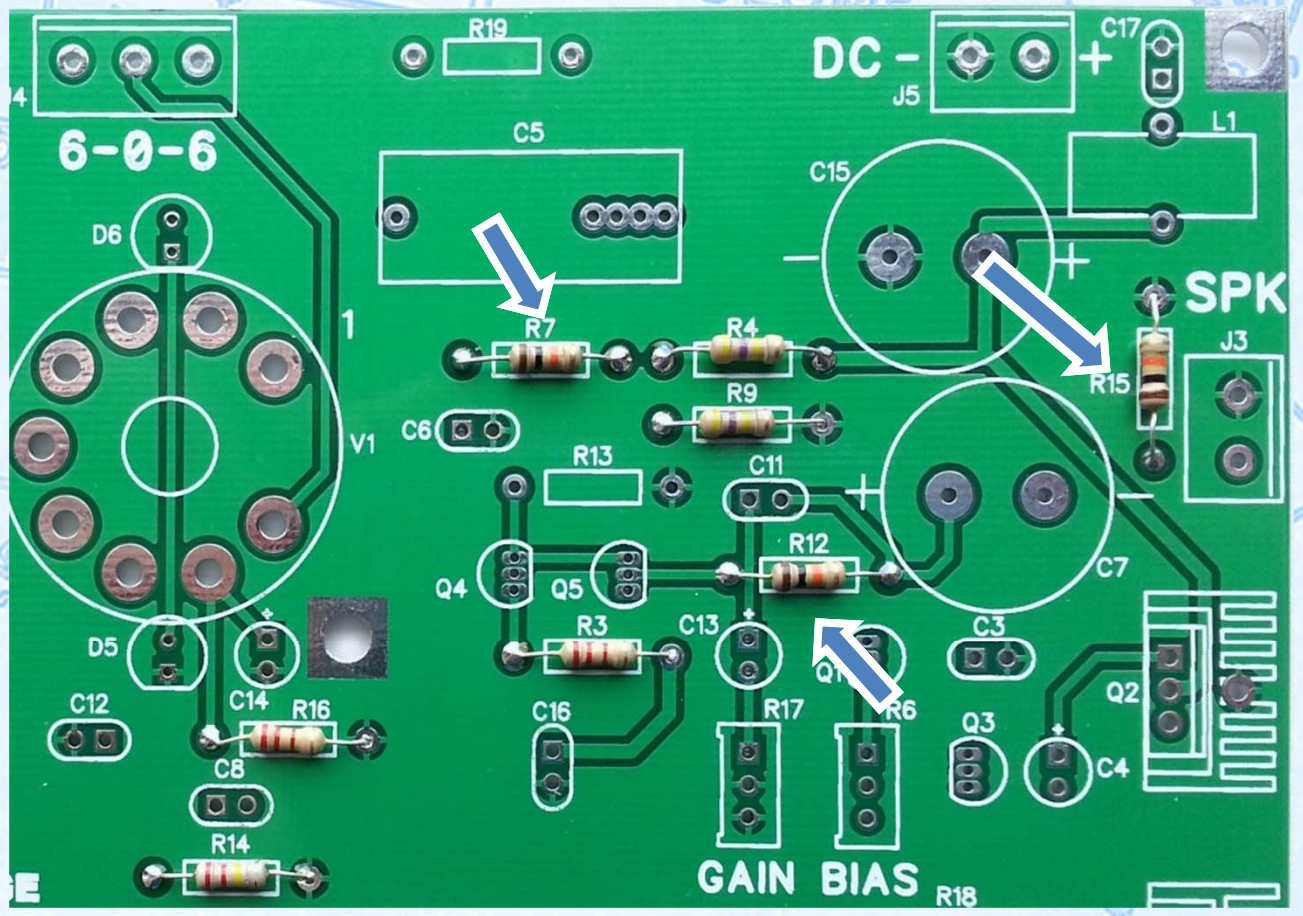


It's not necessary for resistors, but inserting them all in the same direction will make your board look that much better. Use the last band (tolerance band) as a reference for the orientation.

STEP 5: Insert the 10k Ohm Resistors

Locate three 10k ohm resistors (line #23).

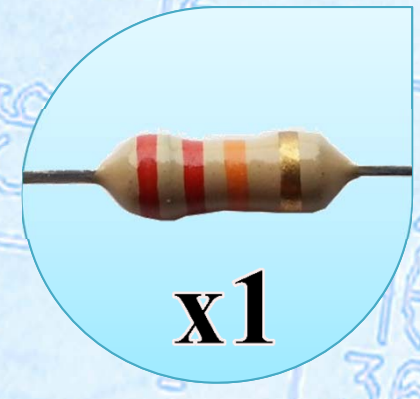
Solder the 10kΩ ¼ Watt resistors into R7, R12 and R15.



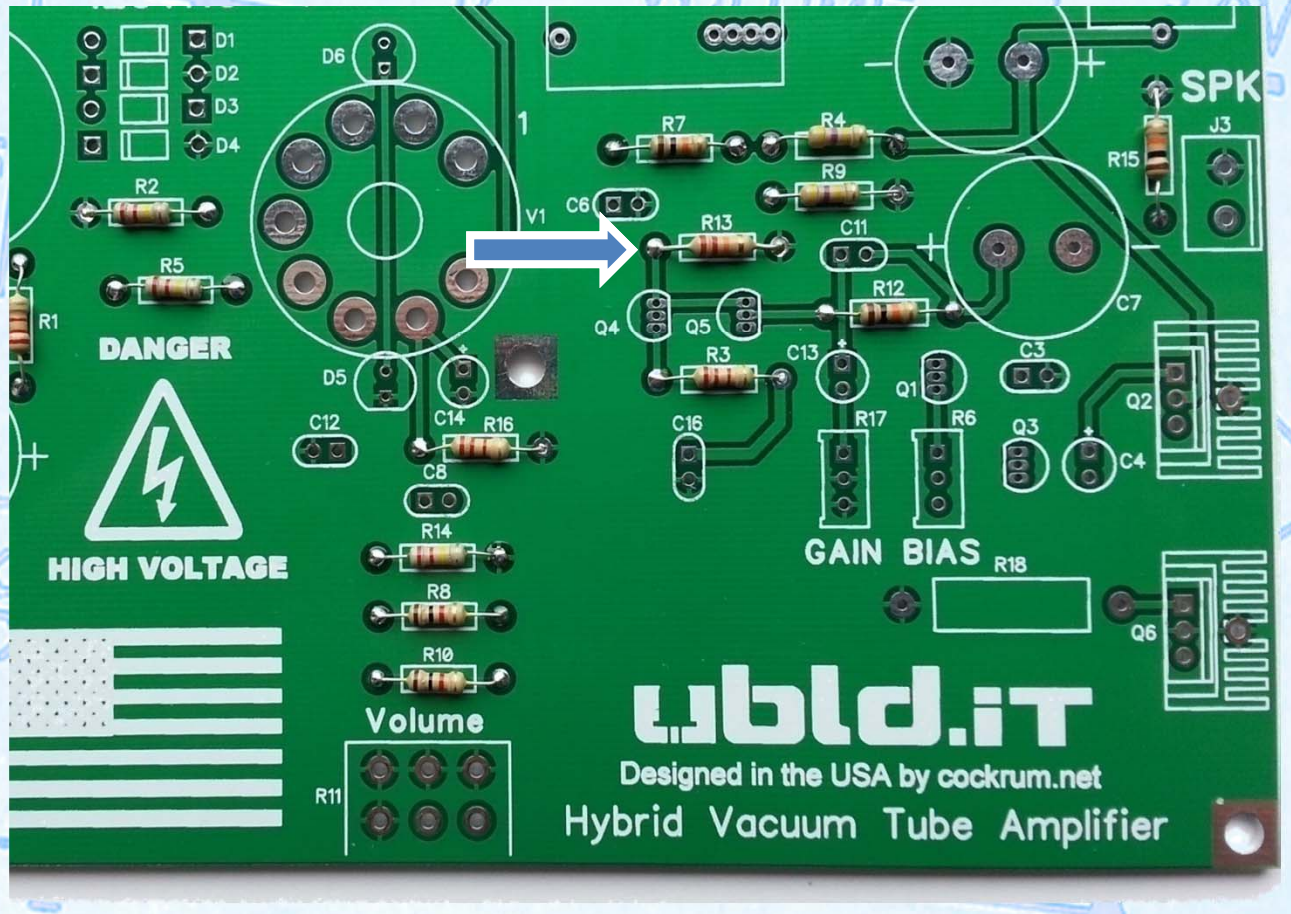
For better looking solder joints use Kester #2331-ZX water soluble flux pen on every pad before applying solder. Flux removes oxidation and allows heat to transfer from your iron to the pad.

STEP 6: Insert the 22k Ohm Resistors

Locate one 22k ohm resistors (line #27).



Solder the 22kΩ ¼ Watt resistor into R13.

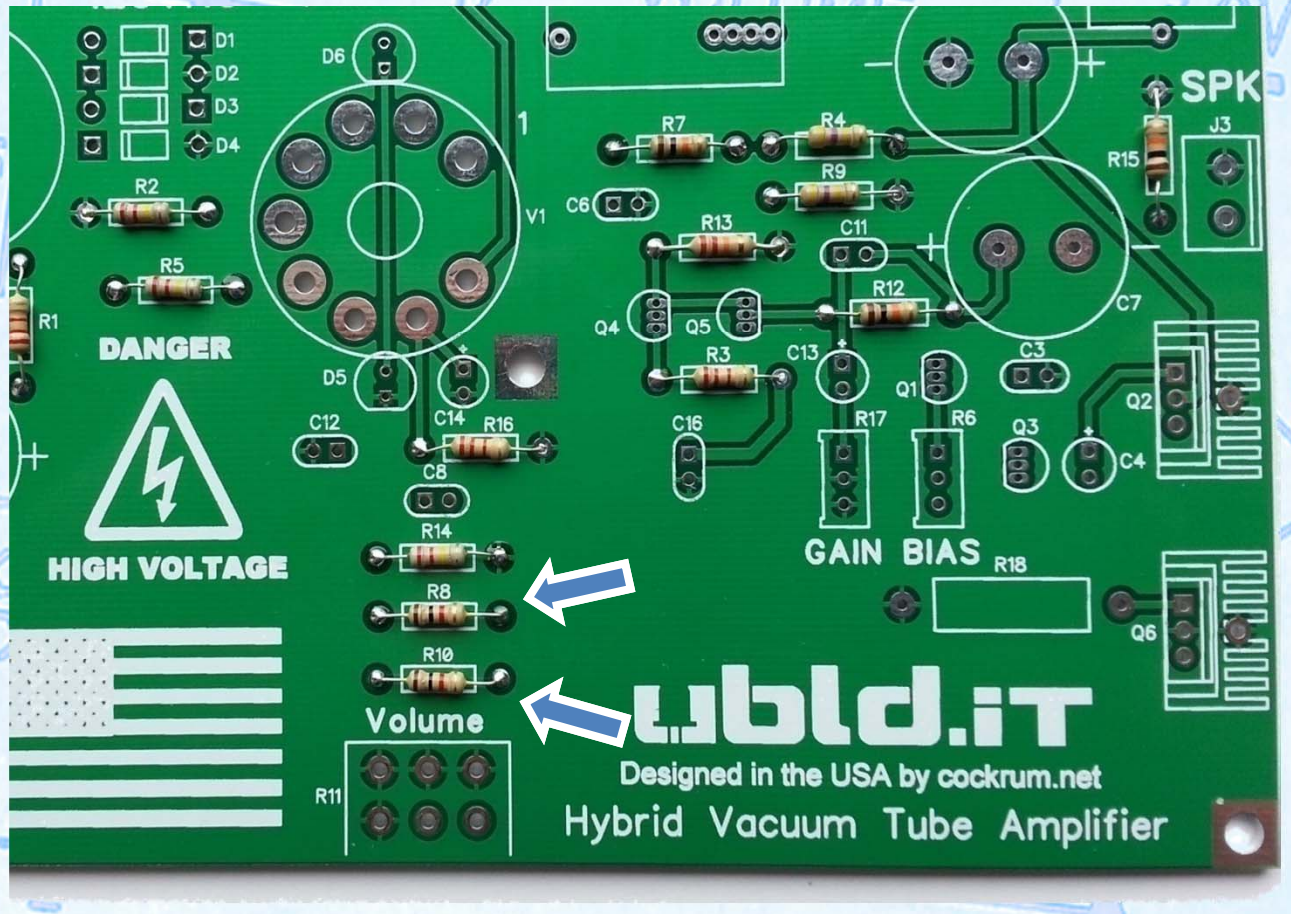


Learning about electronics can seem overwhelming at first. Building kits not only allows you to practice soldering but also provides you with a circuit to learn about. Don't stop at the assembly. Review the schematic too!

STEP 7: Insert the 1k Ohm Resistors

Locate two 1k ohm resistors (line #25).

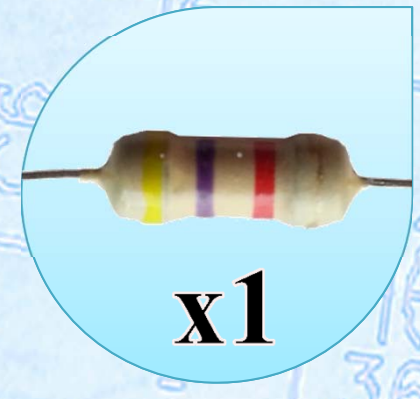
Solder the 1kΩ resistors into R8, and R10.



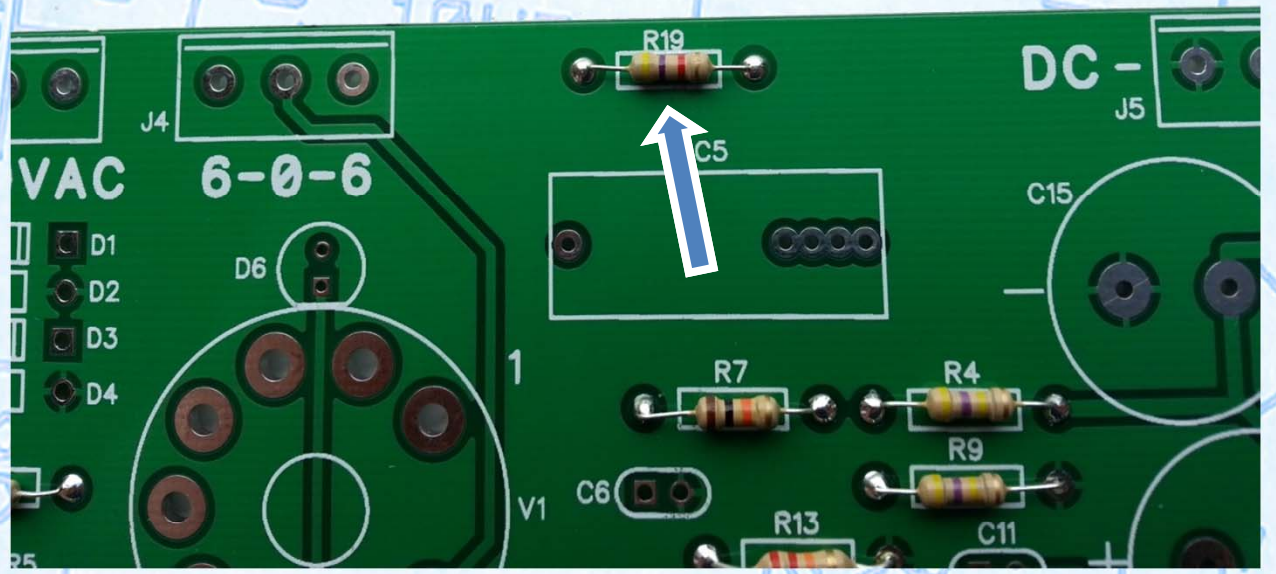
You don't have to be an expert in math to learn electronics but you do need to understand Ohms law and Watts law. ($E = I*R$ and $P = I*E$). Take the time to learn the difference between Voltage, Current, Power, and Resistance.

STEP 8: Insert the 4.7k Ohm Resistors

Locate one 4.7k ohm resistors (line #28).



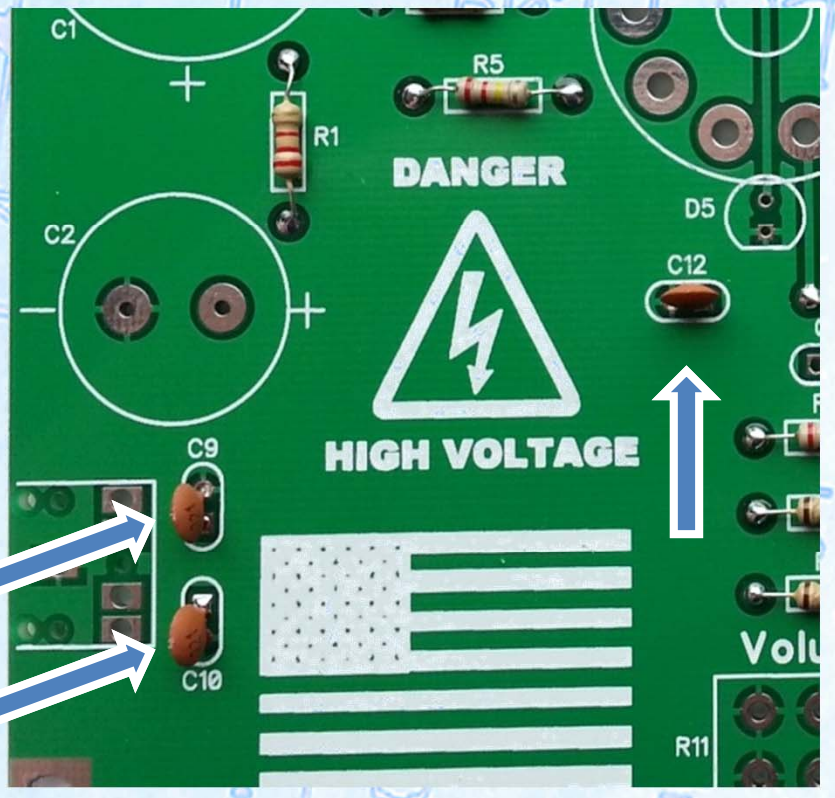
Solder the 4.7kΩ resistors into R19.



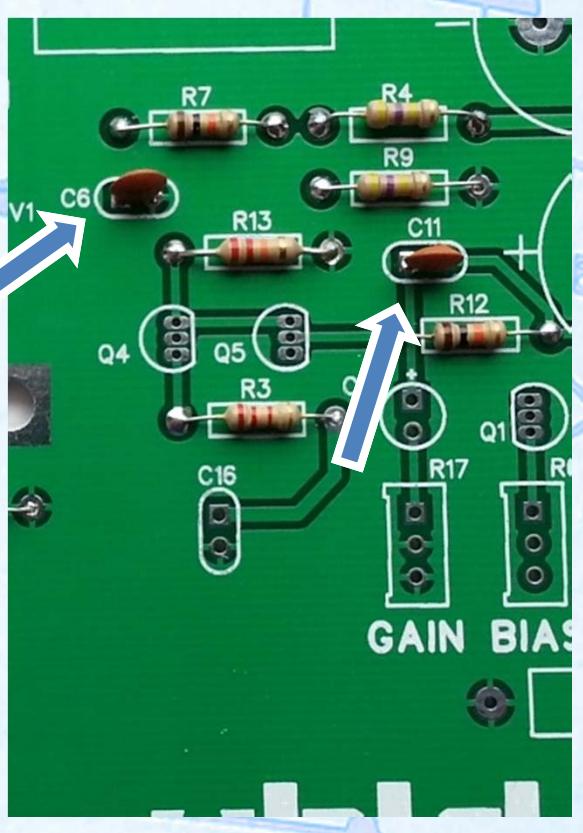
A resistor limits the flow of electrons. The flow of electrons is called the current (Amps). Therefore, a resistor is known as a current limiting device.

STEP 9: Insert the 100pF Capacitors

Solder the 100pF Capacitors into C6, C9, C10, C11, and C12.



Locate five 100pF Capacitors (line #3).

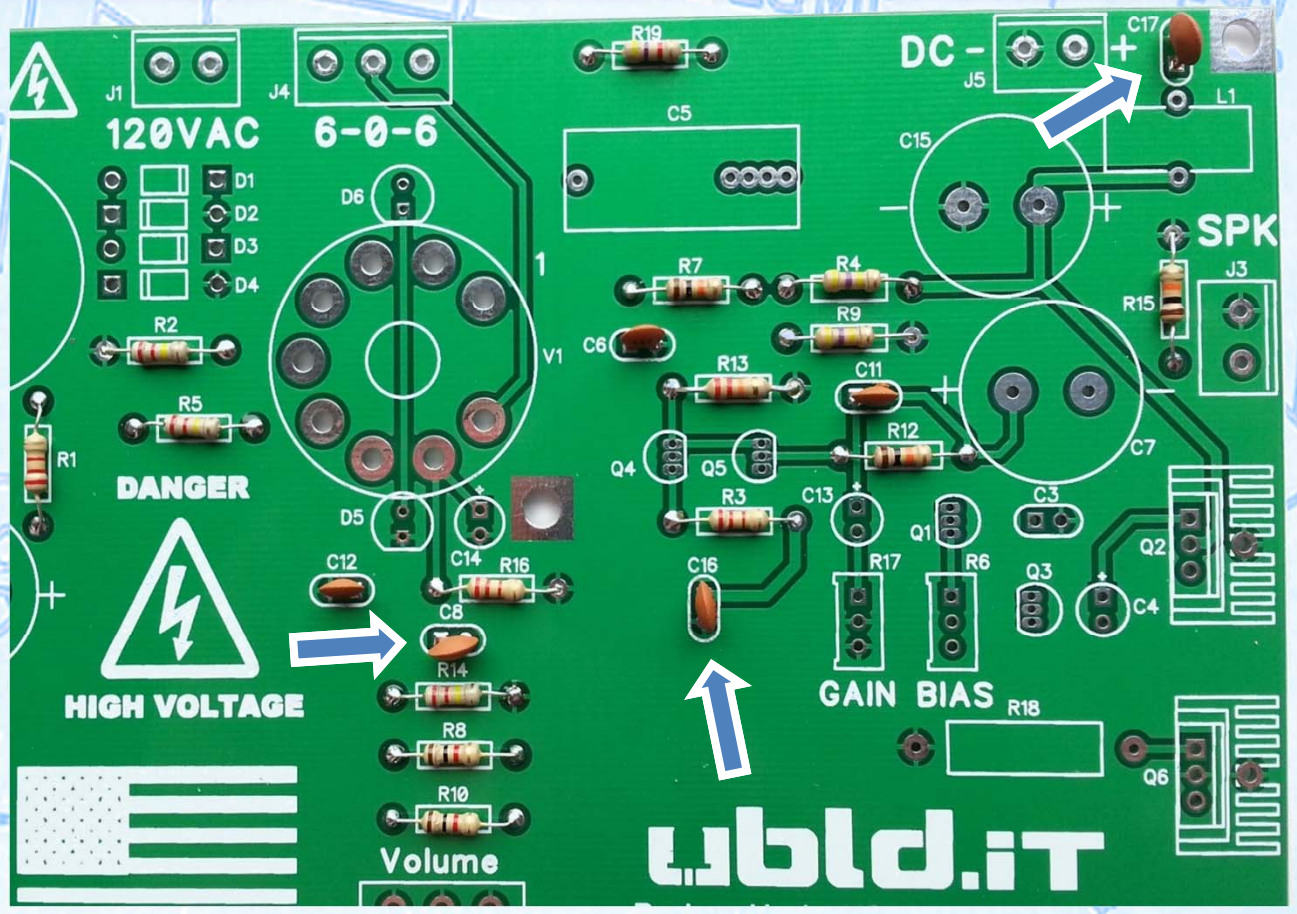


Note: Due to a last minute BOM change C3 which is also a 100pF capacitor is installed in a later step.

STEP 10: Insert the .1uF Capacitors

Locate three .1uF Capacitors (line #7).

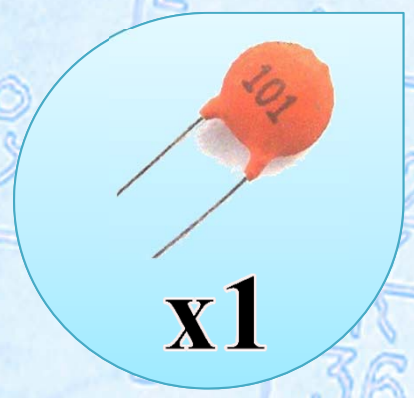
Solder the .1uF Disk Capacitors into C8, C16, and C17.



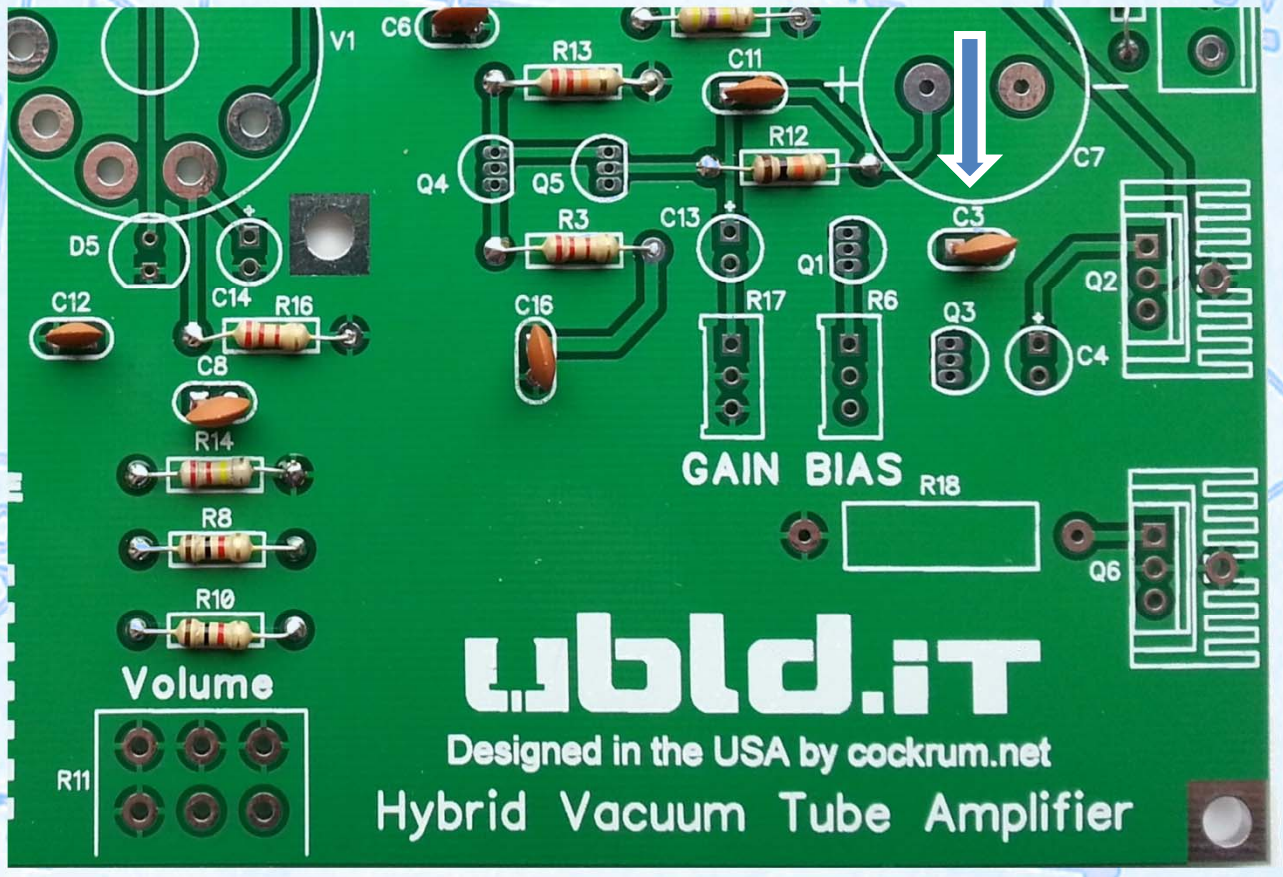
Capacitors store an electrical charge much like your body builds and stores static. It's also good to know that since a capacitor takes time to charge and discharge it's said that it opposes changes in voltage.

STEP 11: Insert the 100pF Capacitors

Locate one 100pF Capacitors (line #3).



Solder the 100pF Capacitor into C3.

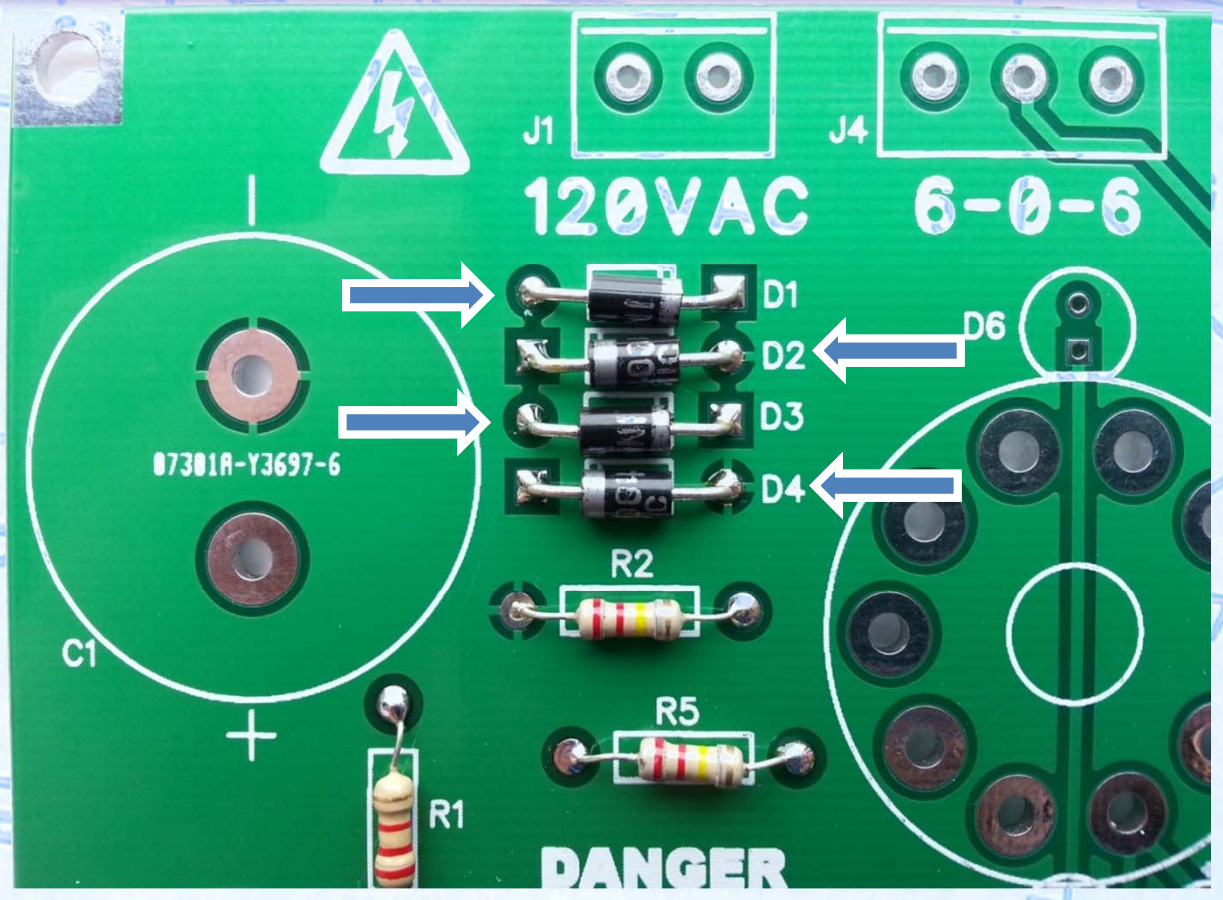


Capacitors look like an open circuit to Direct Current(DC).

STEP 12: Insert the 1n4004 Diodes

Locate four 1N4004 Diodes (line #8).

Solder the 1N4004 Diodes into D1, D2, D3, and D4. Pay attention to the orientation. The line on the diode goes towards the stripe on the silkscreen.

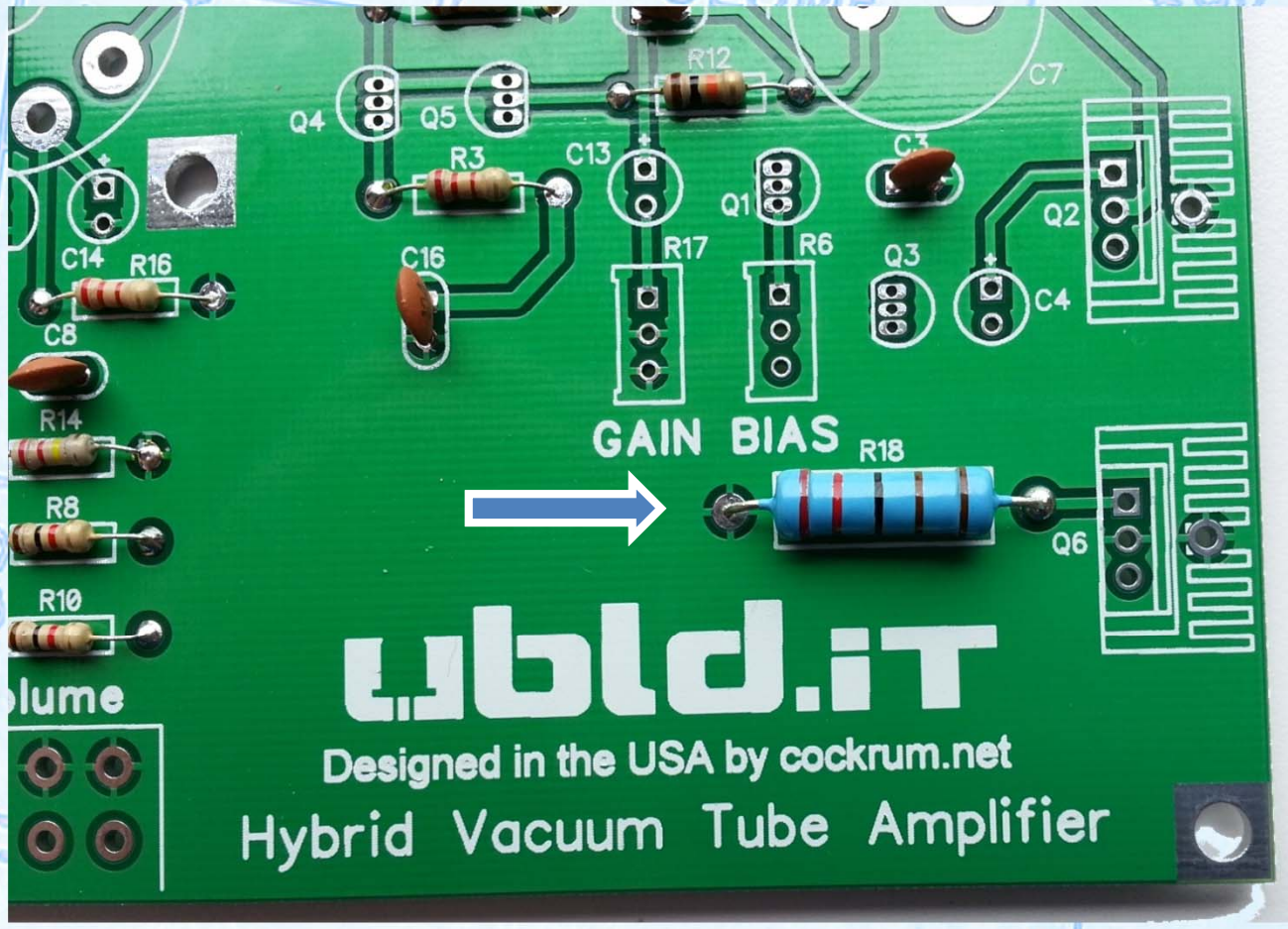


These four diodes form a bridge rectifier. A bridge rectifier converts AC into DC. Capacitors C1, C2 and Resistor R1 are used to smooth out the DC.

STEP 13: Insert the 2.2k Ohm 2 Watt Resistor

Locate one 2.2k Ohm 2 Watt Resistor (line #20).

Solder the 2.2kΩ 2 Watt Resistor into R18.

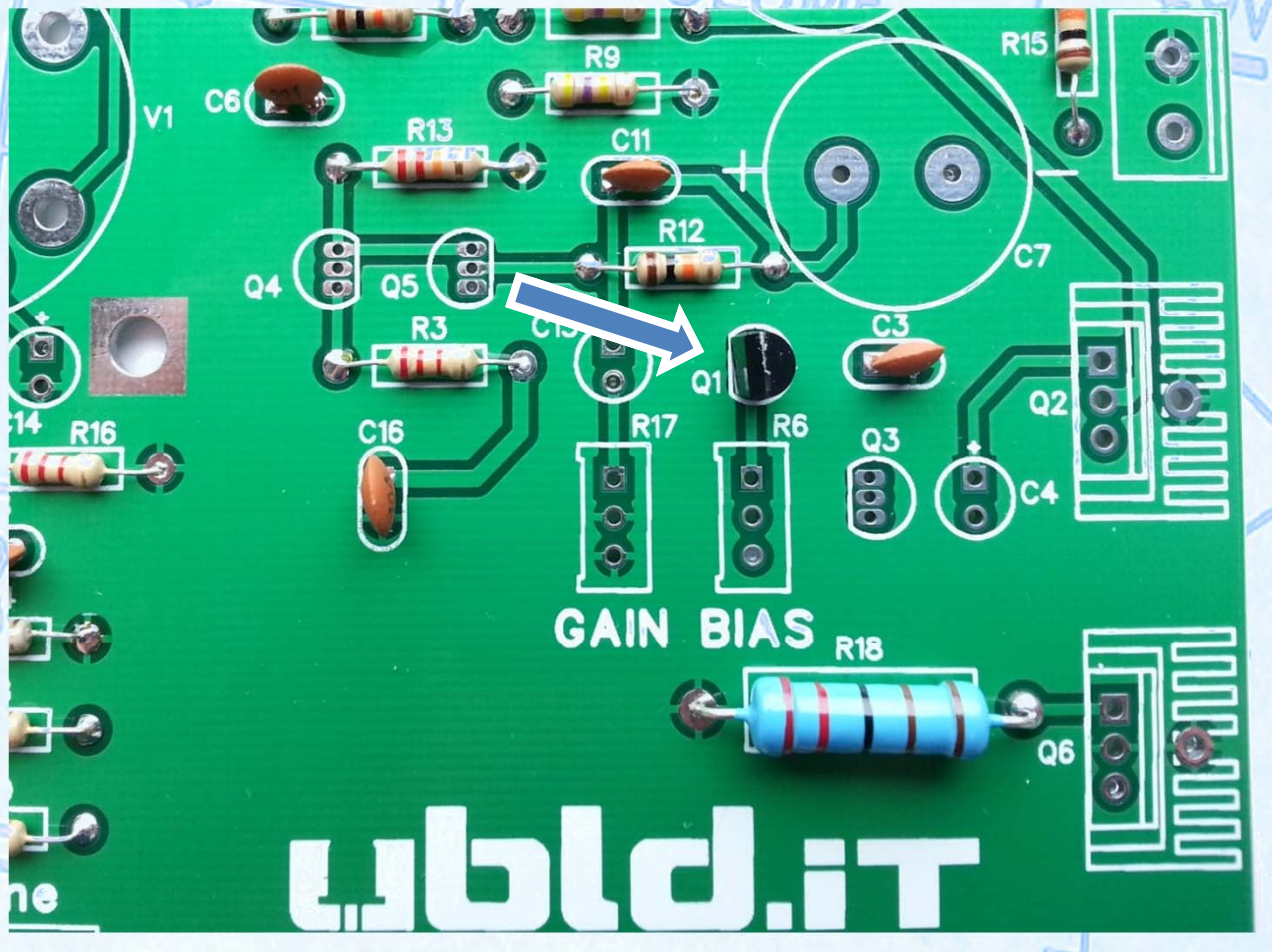


Through hole resistors increase in size as their power rating increases. Hence the reason the 2-Watt resistor is significantly larger than the 1/4 watt resistors.

STEP 14: Insert the 2N5401 Transistor

Locate one 2N5401 Transistor (line #15).

Solder the 2N5401 Transistor into Q1.



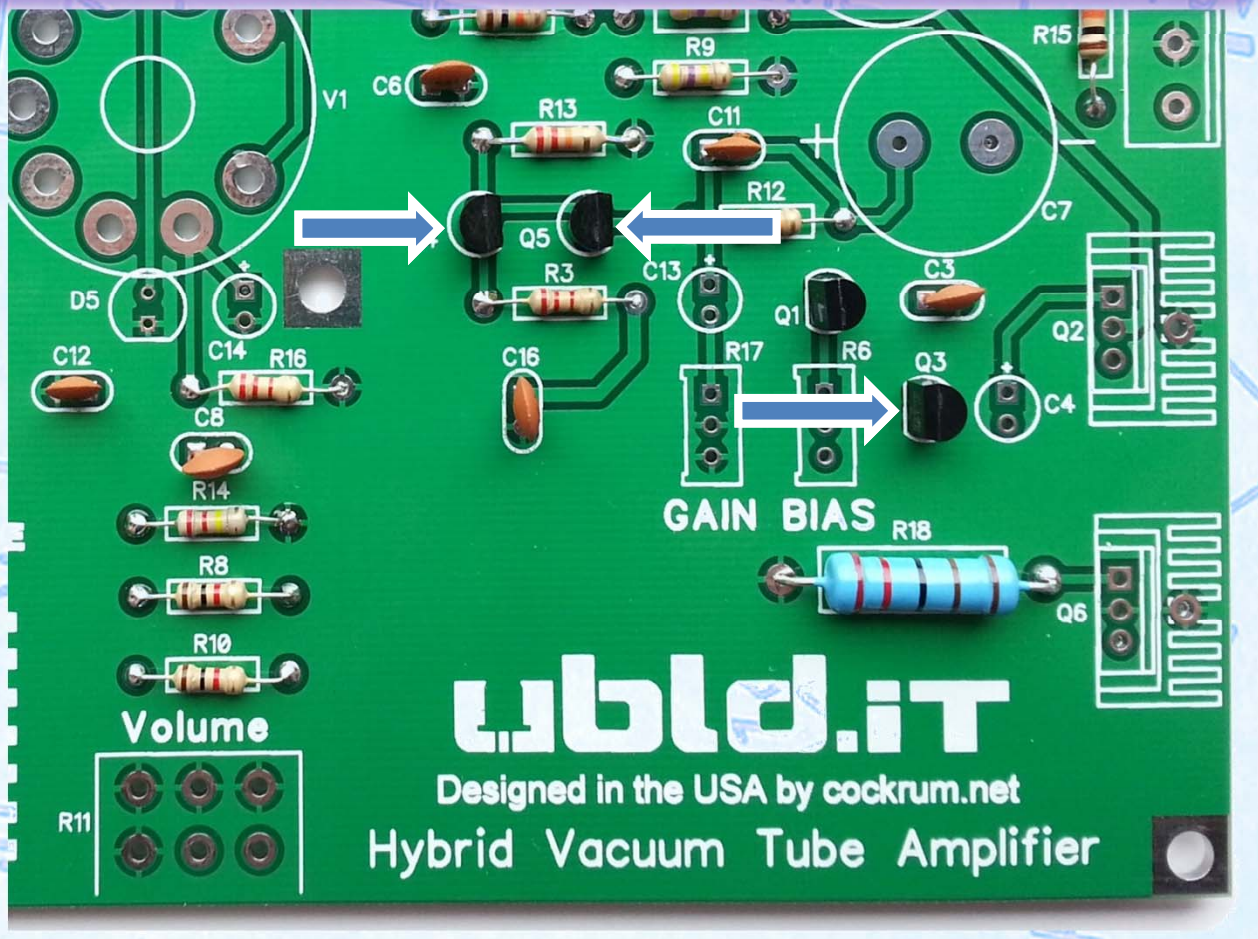
Transistors are used for signal amplification and switching.

STEP 15: Insert the BC546B Transistor

Locate three BC546B Transistor (line #17).

If you manage to bridge the pads use solder wick to remove excess solder.

Solder the BC546B Transistors into Q3, Q4, and Q5. Be extra careful to not bridge the pads together. Using flux here will help.

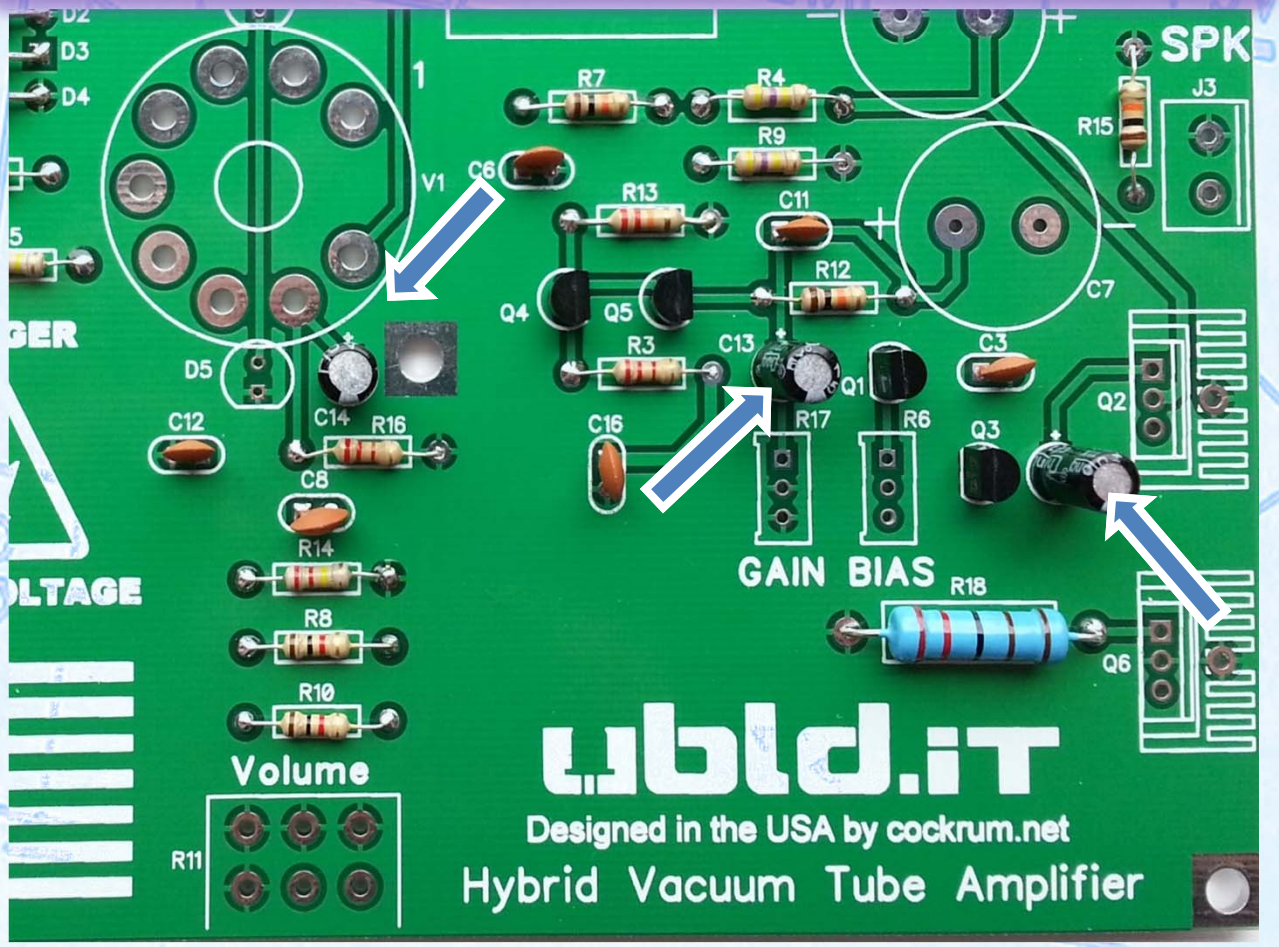


Transistors Q4 and Q5 form a Long Tailed Pair (LTP) configuration. This is a differential amplifier configuration meaning it amplifies the difference between its two inputs. The GAIN potentiometer controls one of the inputs.

STEP 16: Insert the 10uF Capacitors

Locate three 10uF Capacitors (line #4).

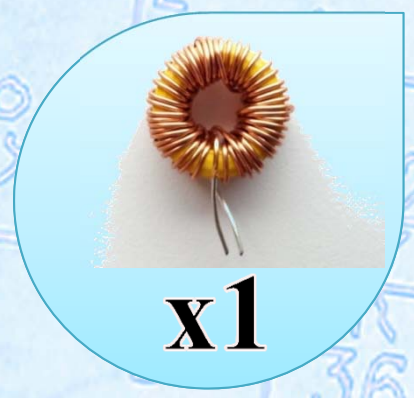
Solder the 10uF Electrolytic Capacitors into C4, C13, and C14. Note that these are polarized so pay attention to orientation.



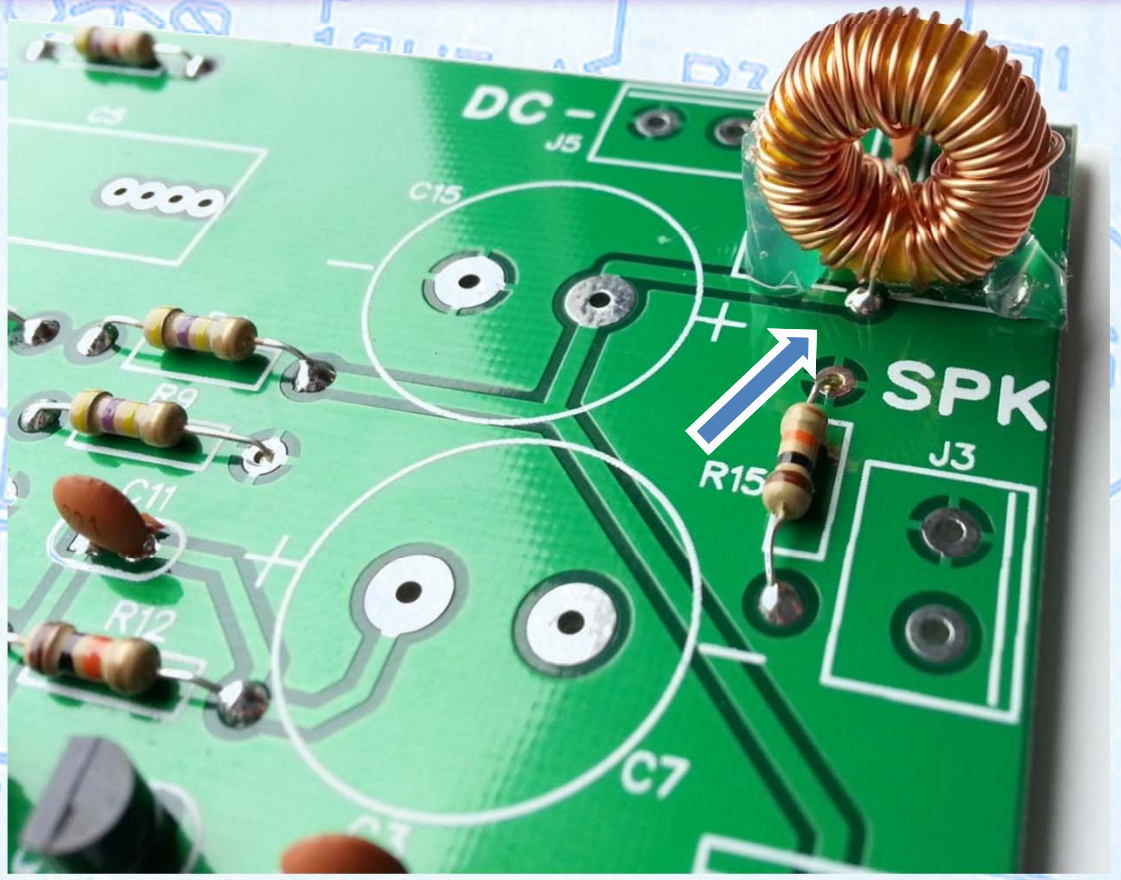
Electrolytic Capacitors have a specific orientation. They are said to be polarized. The stripe indicates the negative side. The + symbol on the silkscreen should be aligned with the positive side of the capacitor.

STEP 17: Insert the 100uH Inductor

Locate one 100uH Inductor (line #13).



Solder the 100uH Inductor into L1. (Optional) Add a small amount of hot glue to the sides to prevent the inductor from making noise.

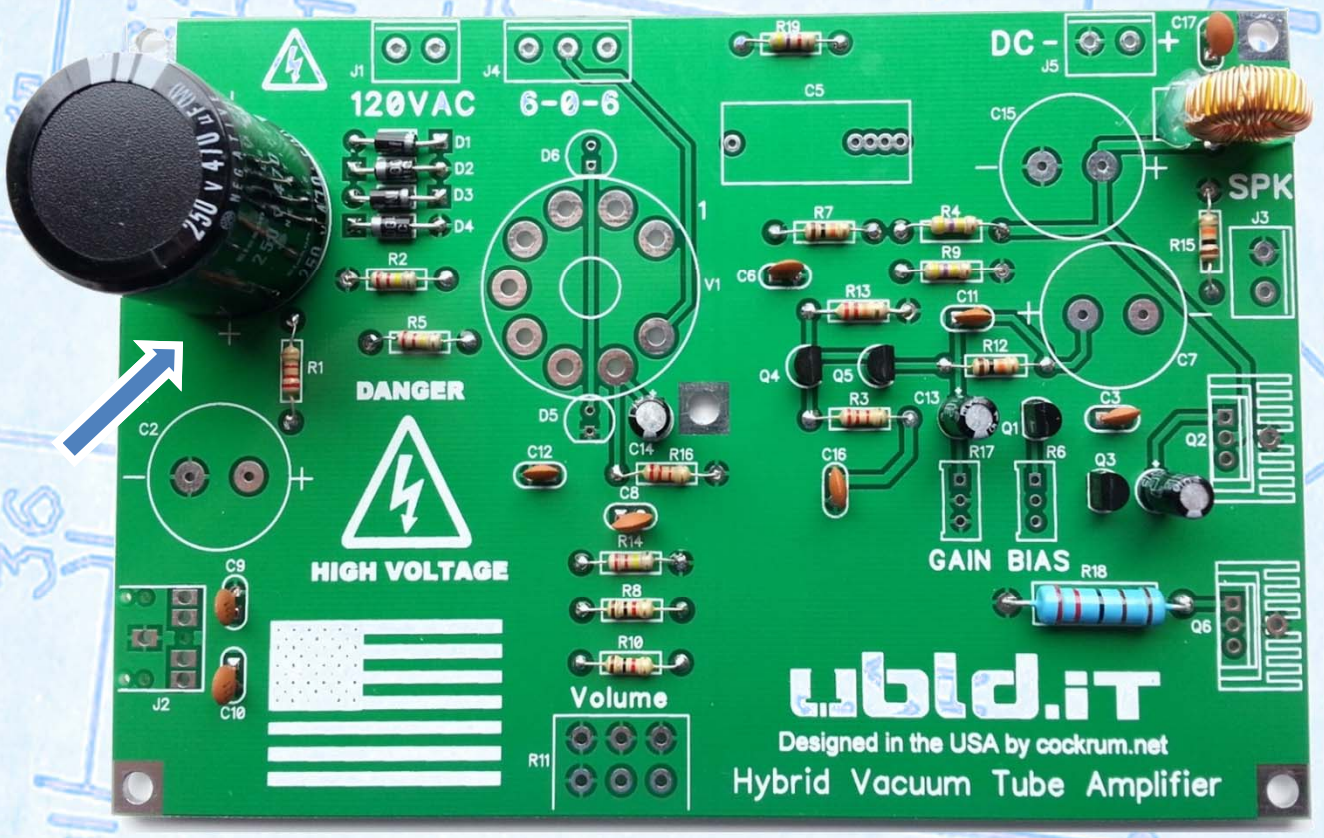


It's common for inductors to make noise. Adding a small amount of hot glue will help absorb any vibrations.

STEP 18: Insert the 470uF 250V Capacitor

Locate one 470uF Capacitors (line #1).

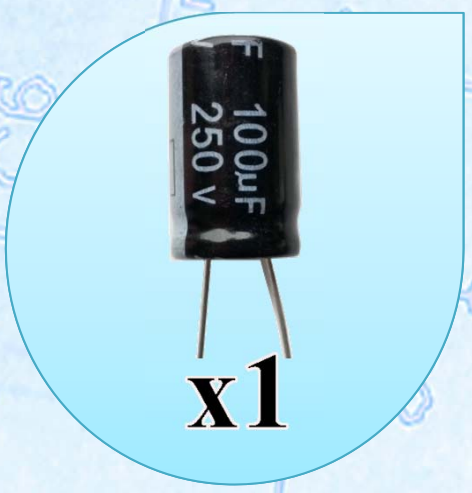
Solder the 470uF Capacitor into C1. **Danger!** This component will explode violently if inserted backwards.



Warning: Inserting any of the polarized capacitors backwards will cause them to explode violently. Double check the polarity for all electrolytic capacitors.

STEP 19: Insert the 100uF 250V Capacitor

Locate one 100uF Capacitors (line #2).

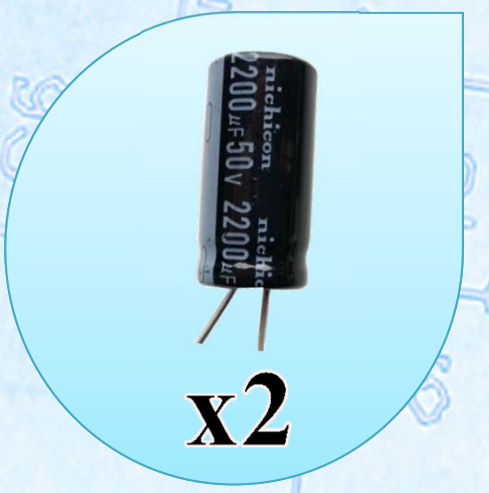


Solder the 100uF Capacitor into C2. **Danger!** This component will explode violently if inserted backwards.

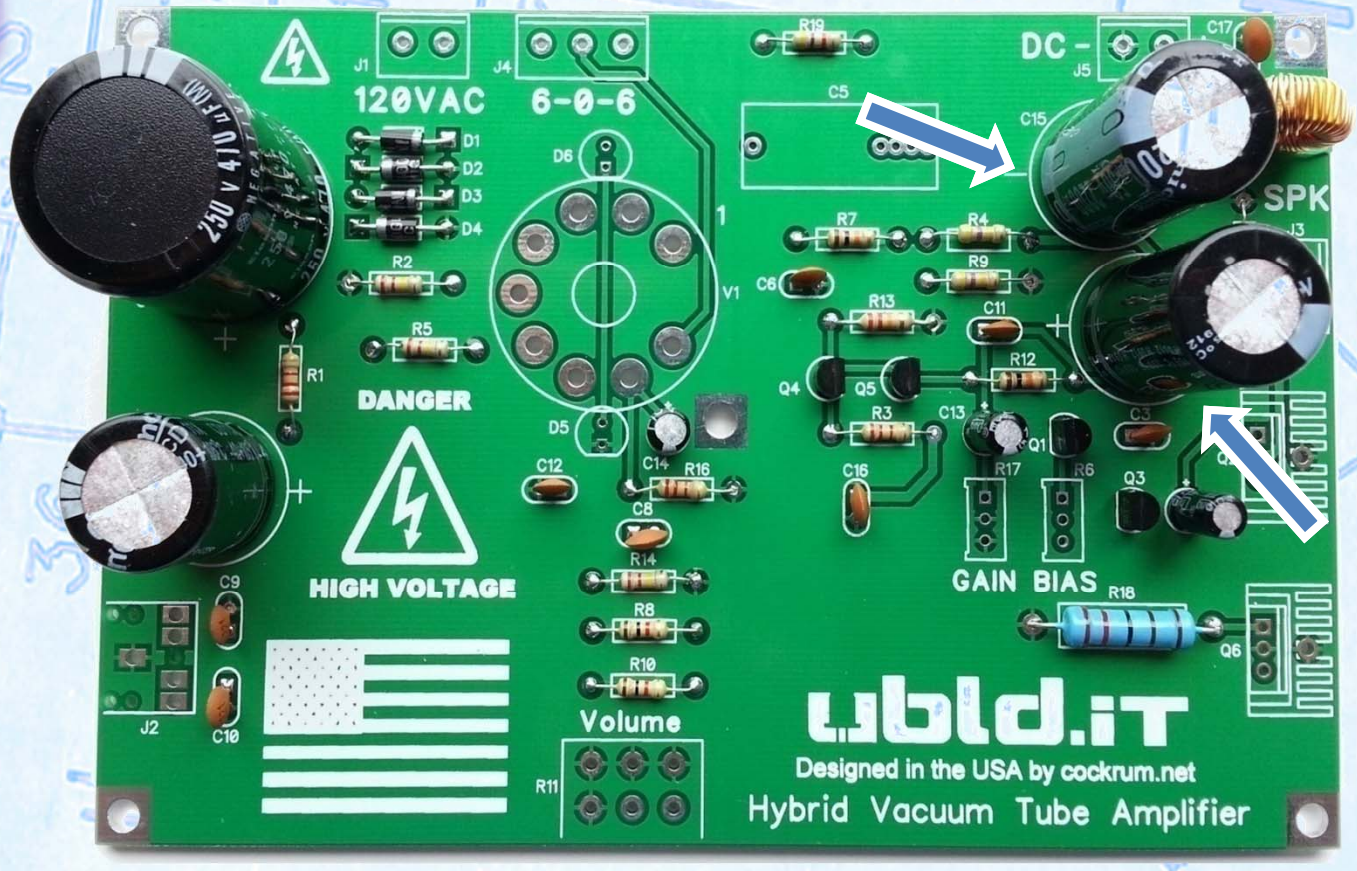
Warning: Inserting any of the polarized capacitors backwards will cause them to explode violently. Double check the polarity for all electrolytic capacitors.

STEP 20: Insert the 3300uF 35V Capacitor

Locate two 3300uF Capacitors (line #6).



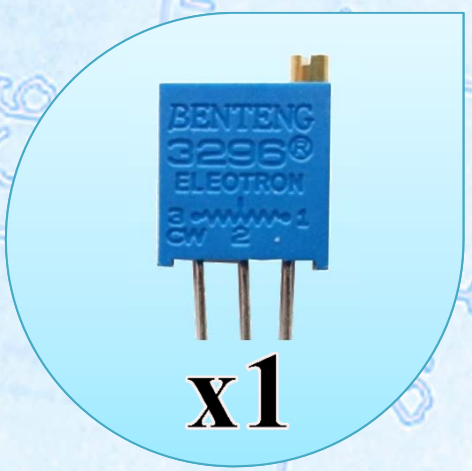
Solder the 3300uF Capacitors into C7 and C15. **Danger!** This component will explode violently if inserted backwards.



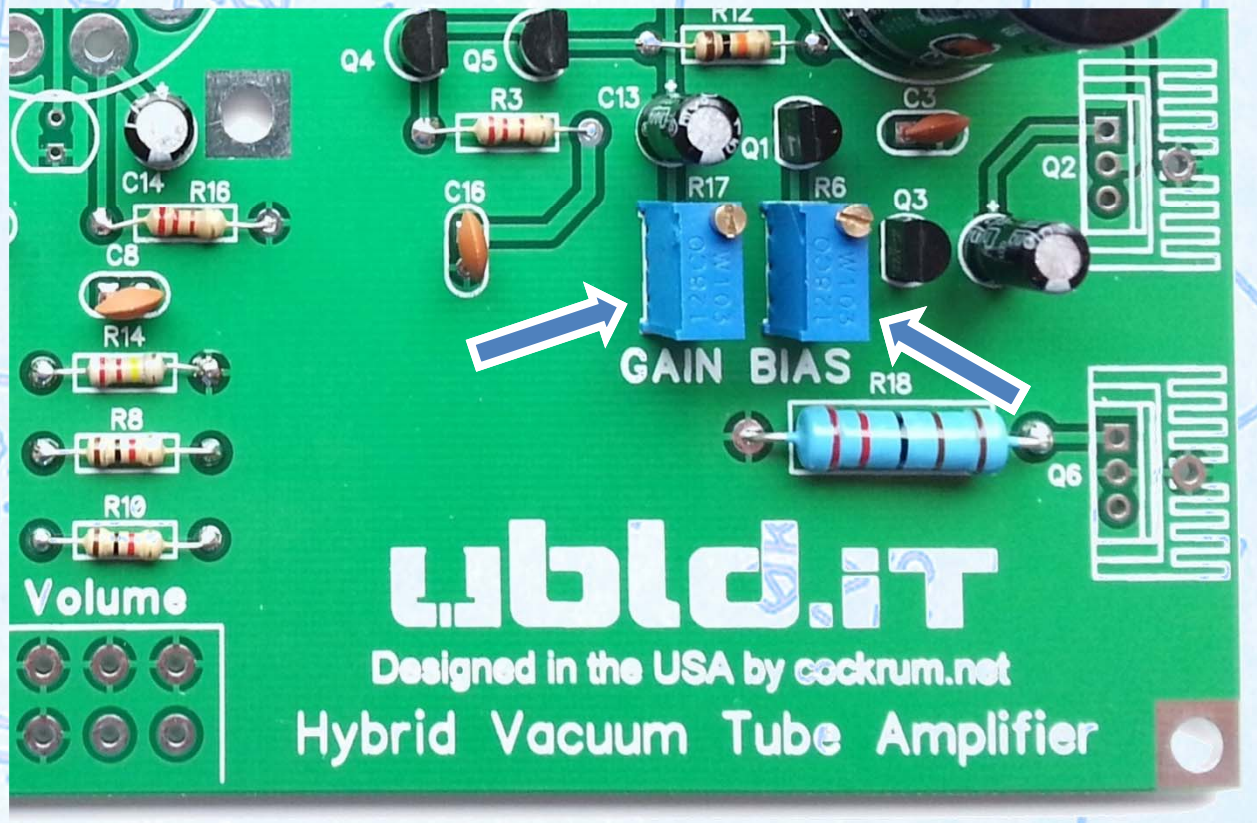
Warning: Inserting any of the polarized capacitors backwards will cause them to explode violently. Double check the polarity for all electrolytic capacitors.

STEP 21: Insert the 10k Ohm Potentiometer

Locate two 10k Potentiometers (line #24).



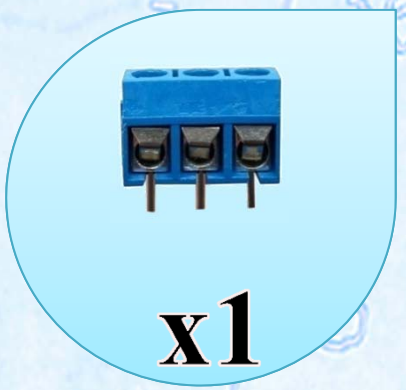
Solder the 10k Ohm Potentiometers into R6 and R17. **Warning!** You will need to adjust the BIAS pot before powering up for the first time.



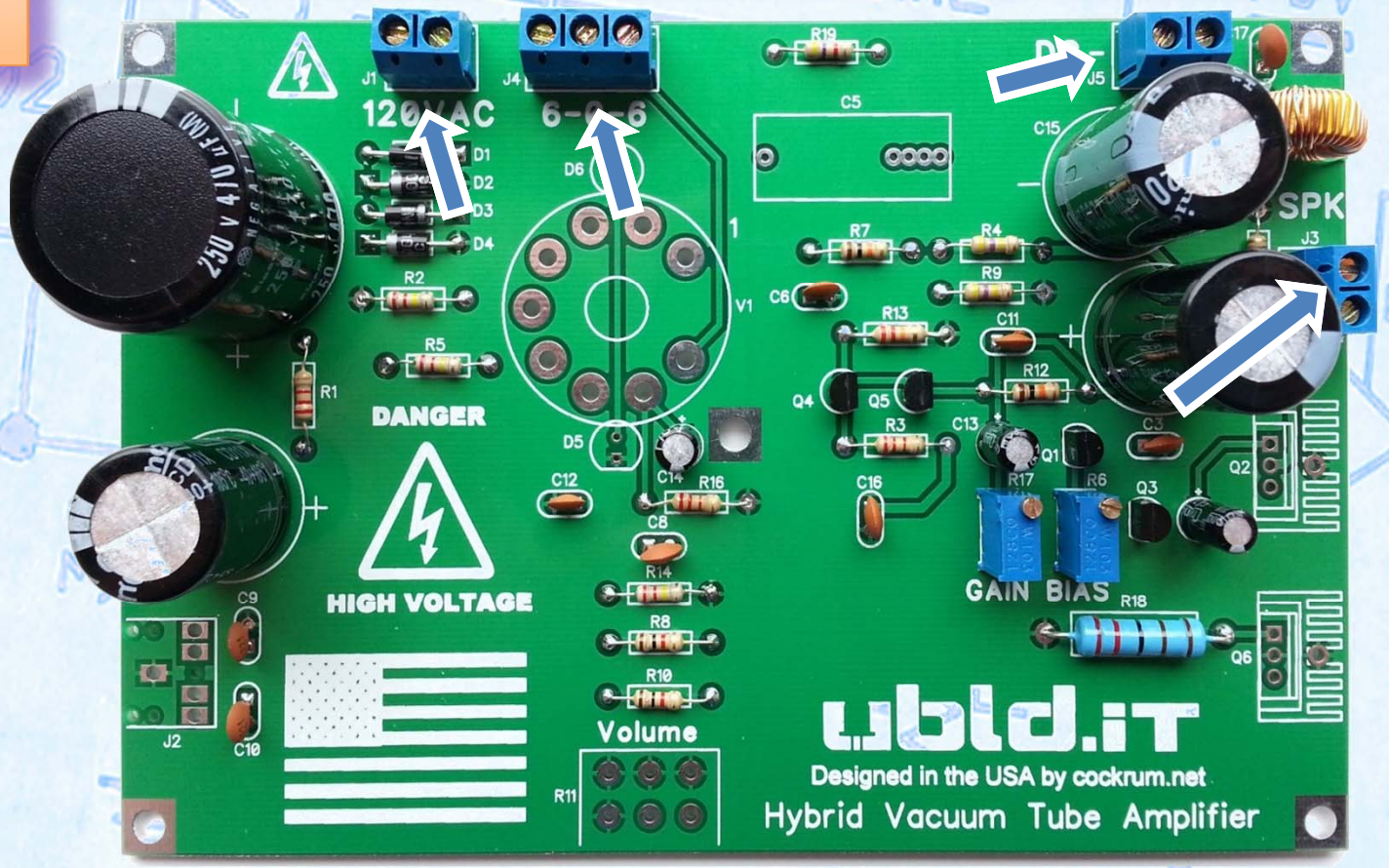
Warning! In a later step you will need to adjust the BIAS before powering the system. Failure to complete that step will result in Q2 and Q6 burning up.

STEP 22: Insert the Terminal Blocks

Locate three 2-Pole terminals (line #10) and one 3-Pole Terminal. (line #12).



Solder the terminals into J1, J3, J4, and J5 with the connectors facing outward..

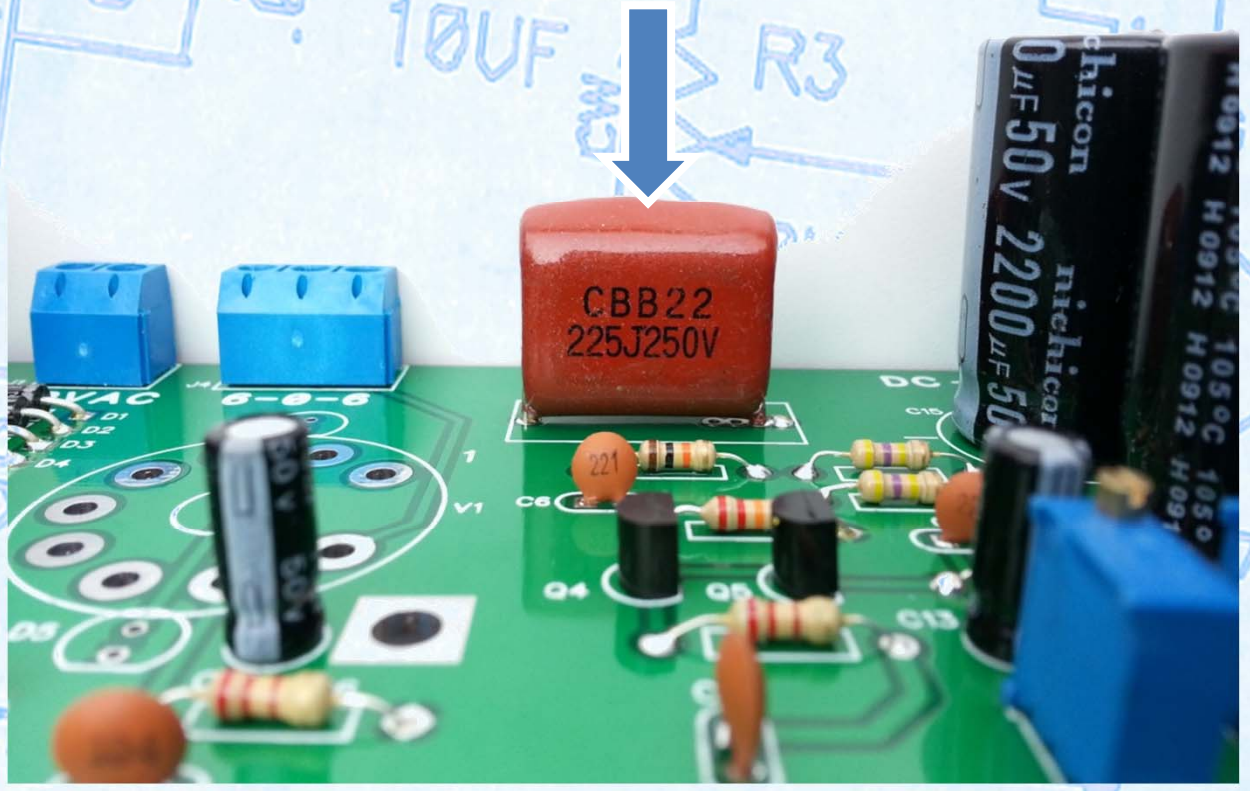


Take the time to align the terminal blocks parallel with the edge of the circuit board. It's possible for them to be aligned a little slanted.

STEP 23: Insert the 2.2uF Capacitor

Locate one 2.2uF Capacitor (line #5).

Solder the 2.2uF Film Capacitor into C5.

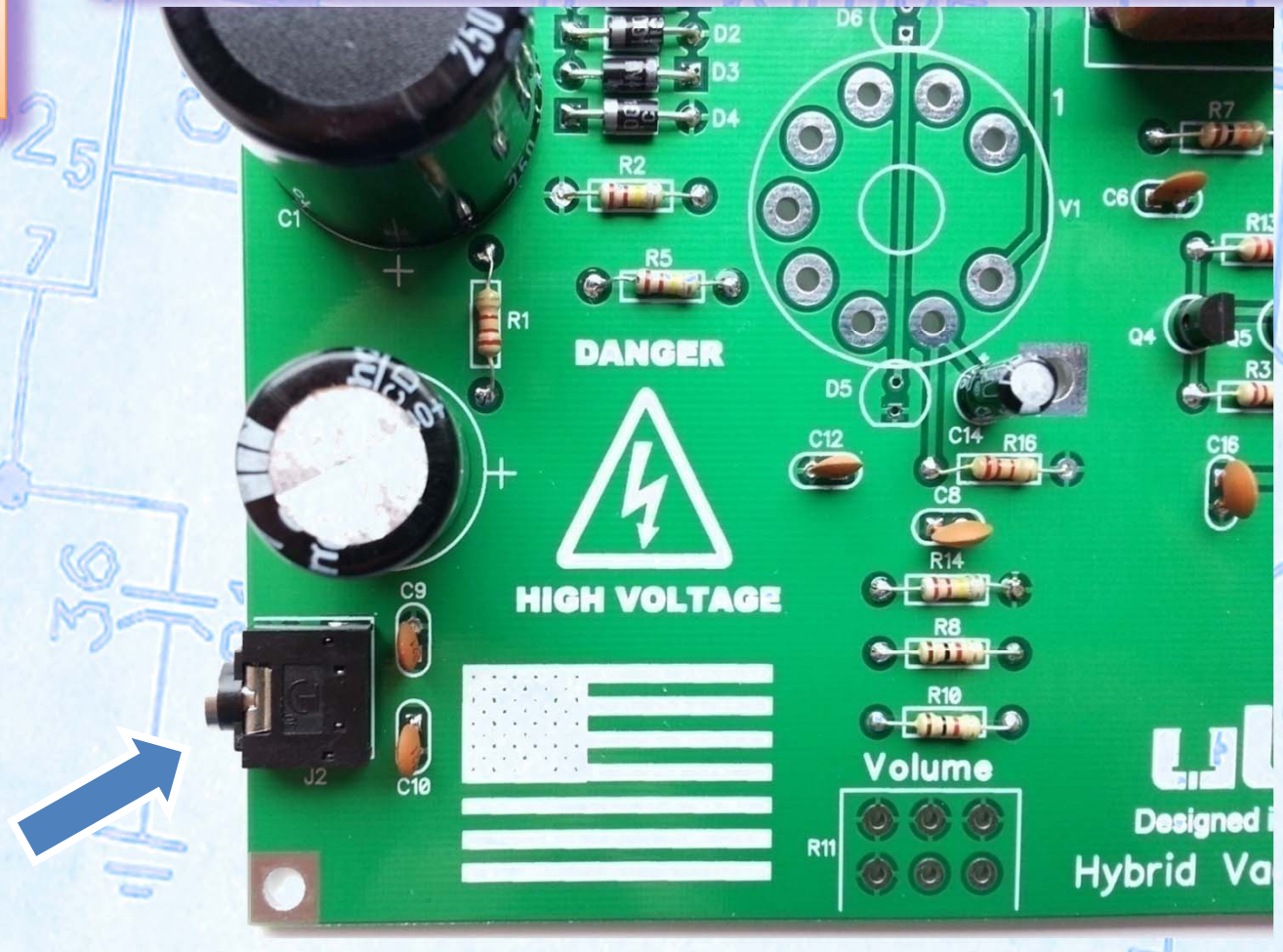


C5 is a Metallized Polypropylene Film Capacitor (MPF).

STEP 24: Insert the 3.5mm Audio Jack

Solder the 3.5mm Audio Jack into J2.

Locate one 1/8” Audio Jack (line #11).

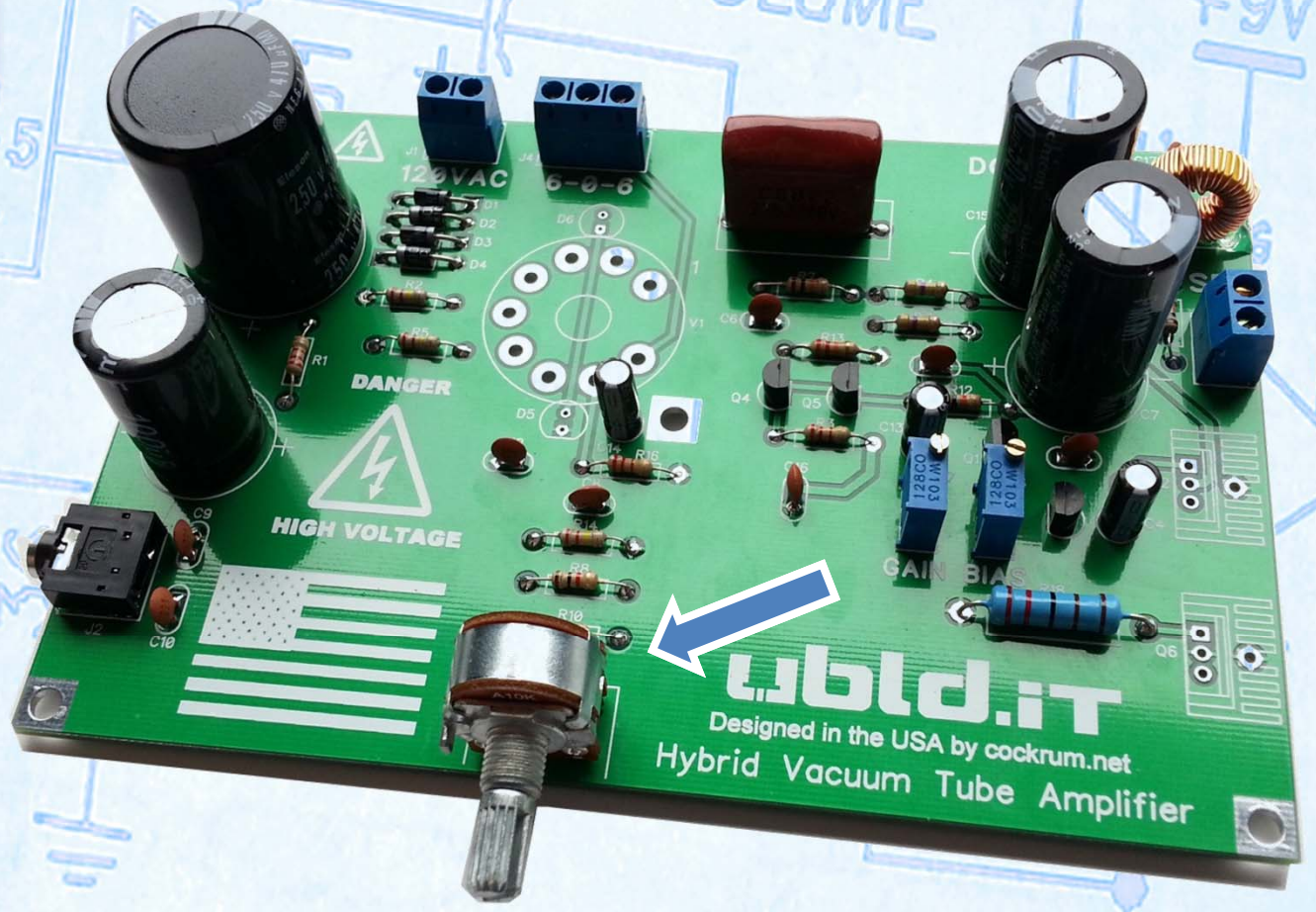


J2 is where you will plug in your audio source such as your cell phone, iPod or MP3 Player.

STEP 25: Insert the 5k Ohm Potentiomter

Locate one 5kΩ Potentiometer (Line 26).

Solder the 5kΩ Potentiometer into R11.

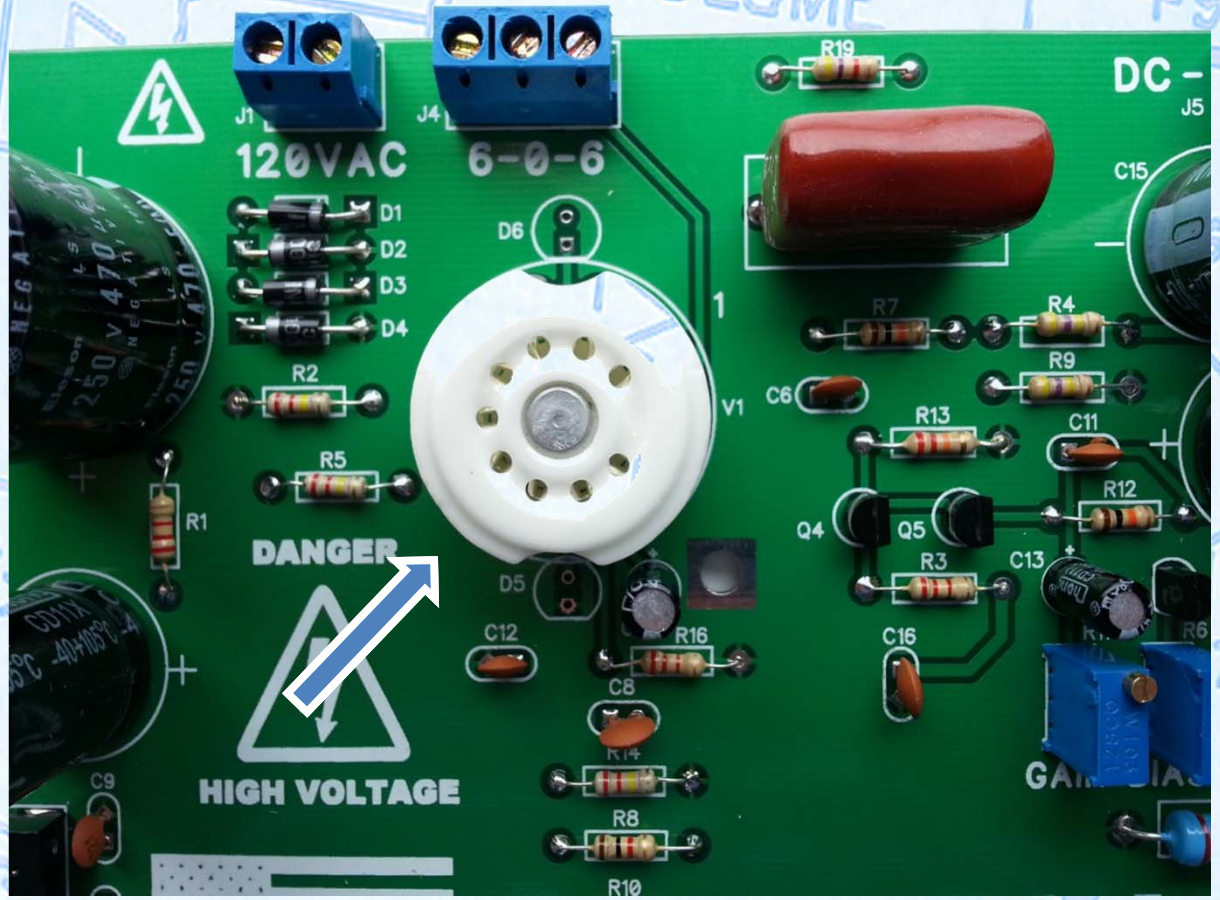


R11 controls the audio volume. It is used as a voltage divider controlling the input signal level to the tube.

STEP 26: Insert Tube Socket

Locate one 12AU7 Tube Socket (line #29).

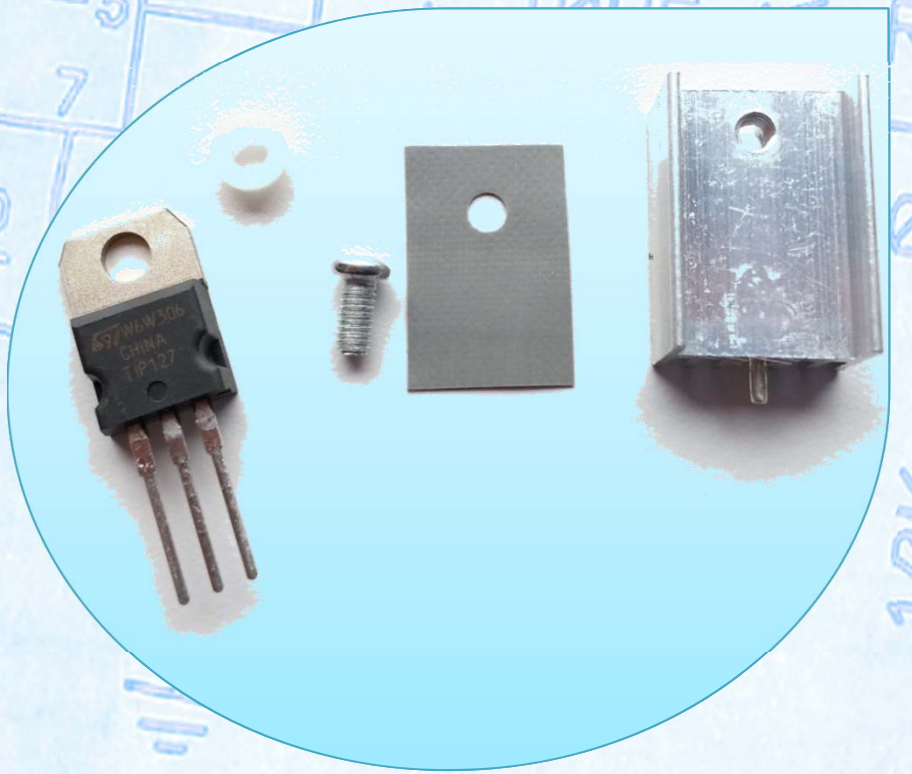
Solder the 12AU7 Tube Socket into V1.



Tubes are voltage amplifiers as opposed to transistors which are current amplification devices. As a consequence, tubes are a more linear amplification technology, requiring less overall negative feedback to make the circuit linear.

STEP 27: Locate the TIP127 Darlington Transistor and Heat Sinks

Locate one TIP127 Darlington Transistor (Line 18), one insulating grommet, one screw, one thermal conductive heat sink pad, and one TO-220 heatsink (Line 14).



The insulating grommet and thermal conductive heat sink pad are considered to be part of the TO-220 heatsink from line 14.

STEP 28: Assemble TIP127 Transistor and Heat Sink

Place the thermal heat sink pad onto the heat sink as shown making sure the holes are aligned.

Thermal heat sink pads are used to ensure full contact between the surface of the transistor and the heat sink.

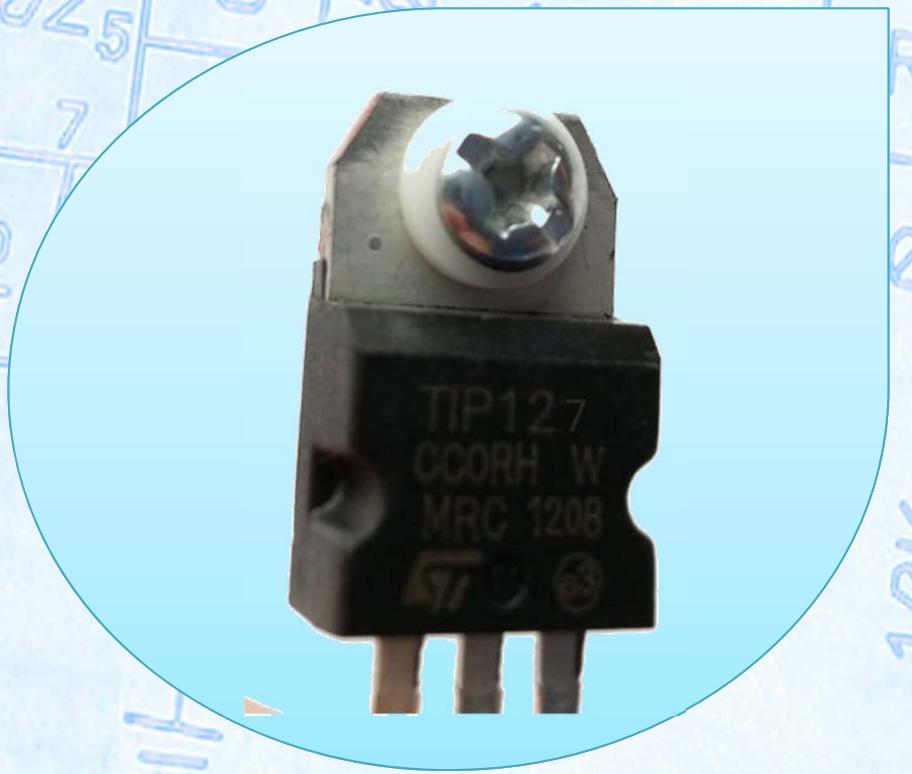
STEP 29: Assemble the Insulating Grommet and Screw

Place the thermal heat sink pad onto the heat sink as shown making sure the holes are aligned.

The insulating grommet prevents electrical contact between the transistor and the heat sink as does the thermal heat sink pad.

STEP 30: Insert the Screw into the TIP127 Transistor

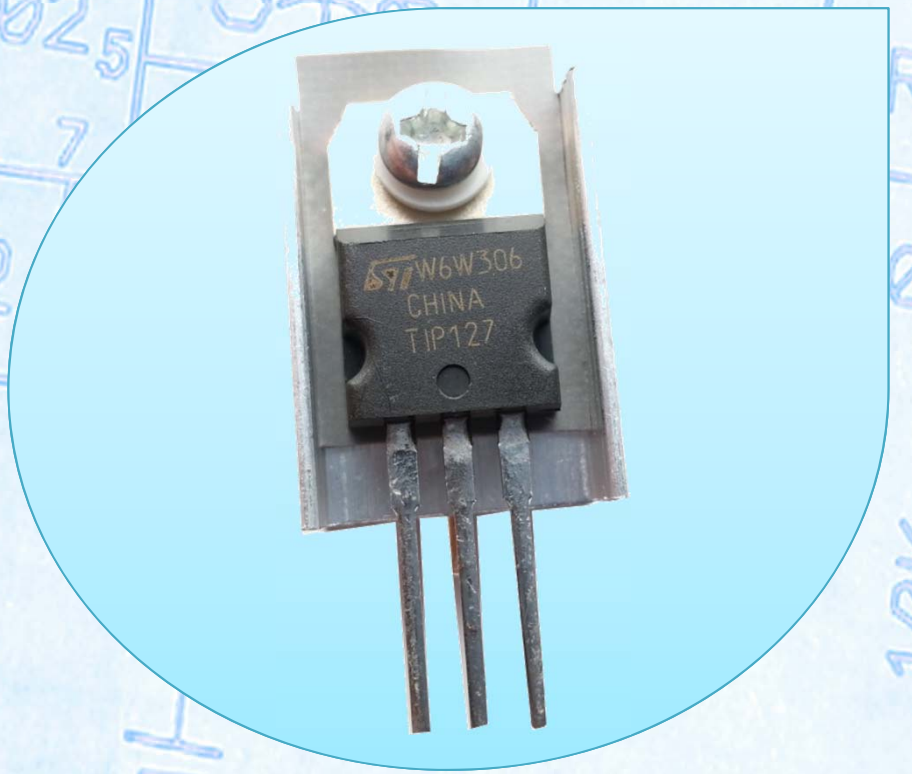
Insert the screw and grommet into the TIP127 Transistor as shown.



TIP127 and TIP122 can burn out if you do not properly set the BIAS potentiometer in a later step.

STEP 31: Screw the Transistor to the Heatsink

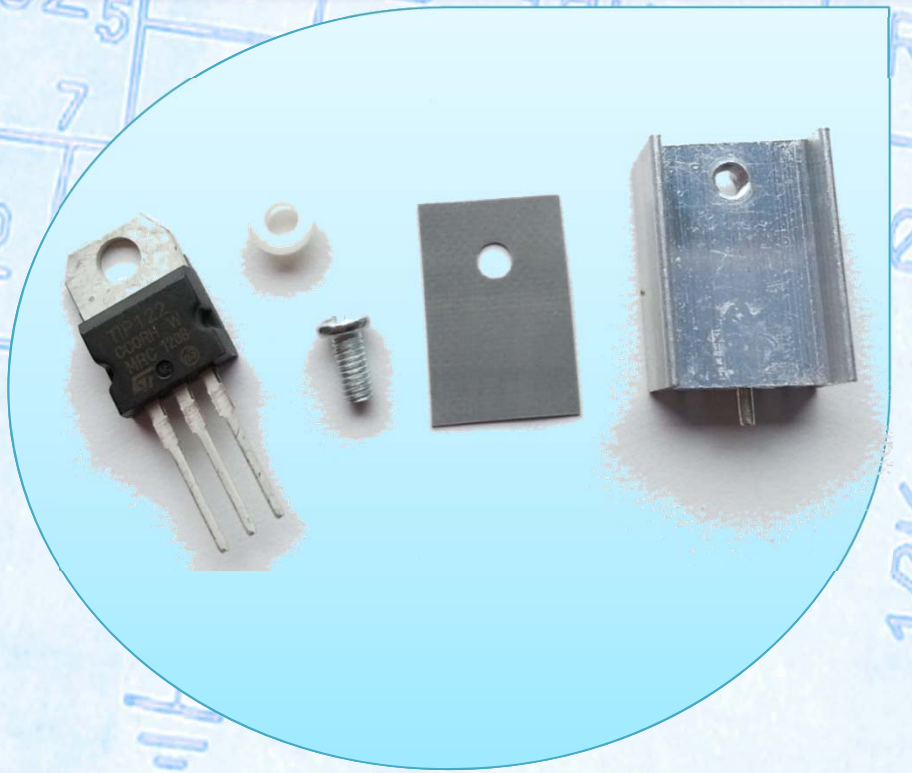
Screw the transistor to the heat sink as shown. Set aside for a later step.



You may want to leave the screw a little lose to make inserting the components into the circuit board a little easier.

STEP 32: Locate the TIP122 Darlington Transistor and Heat Sinks

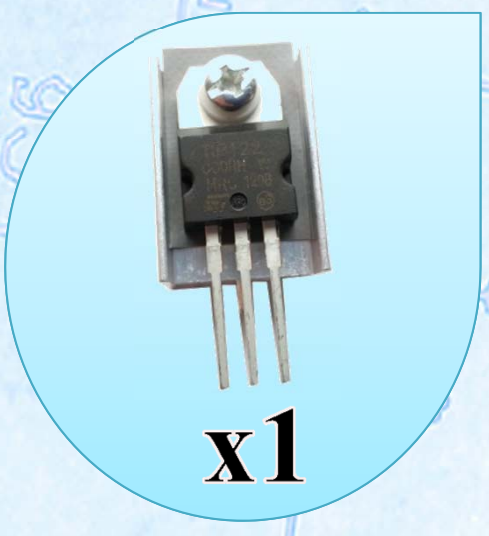
Locate one TIP122 Darlington Transistor (Line 16), one insulating grommet, one screw, one thermal conductive heat sink pad, and one TO-220 heatsink (Line 14). **Then Repeat Steps 28 – 30.**



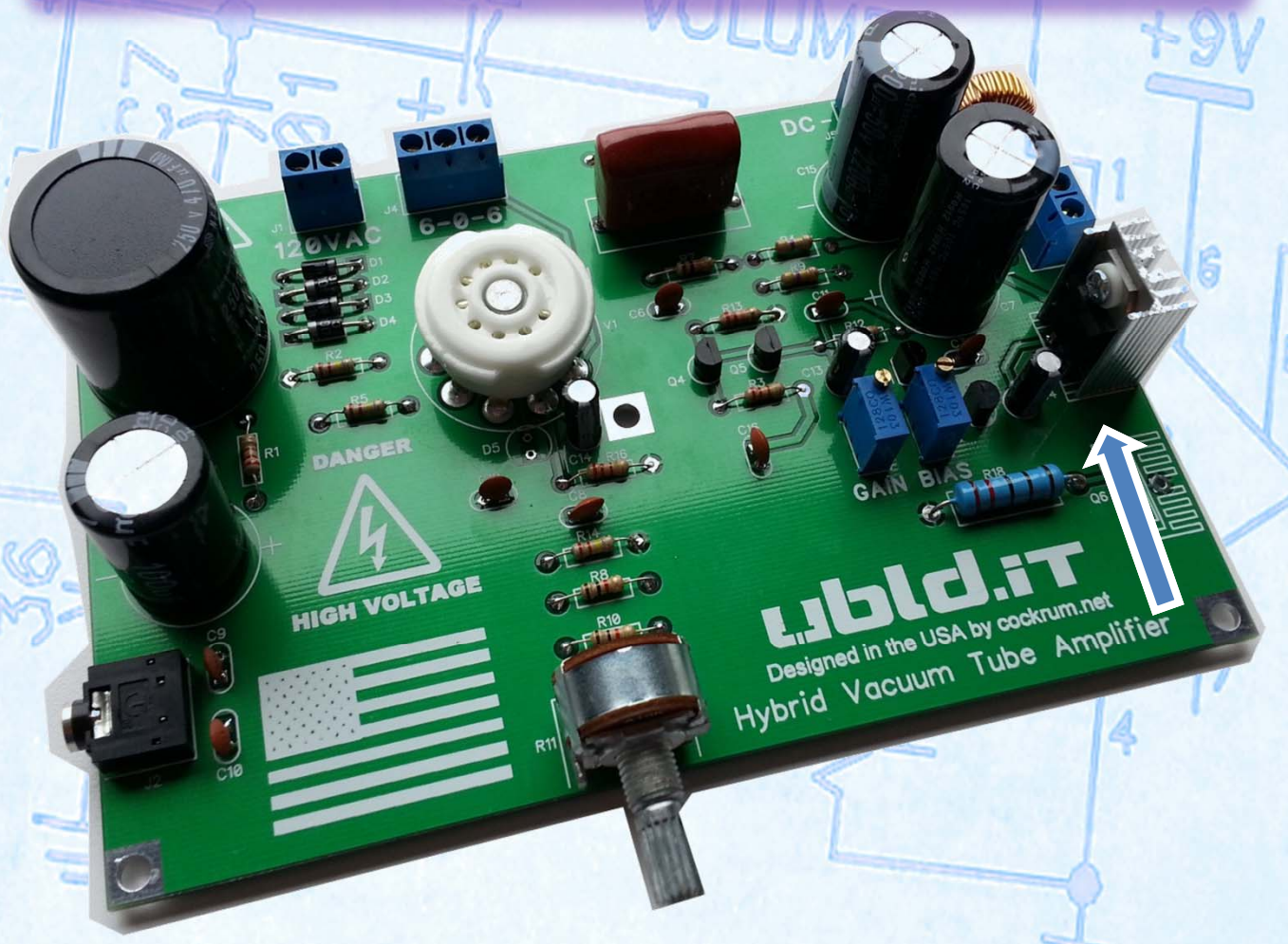
Missing a tool? Don't understand a particular step? It's okay! Contact your local hackerspace / makerspace to ask for help. http://www.hackerspaces.org

STEP 33: Insert the TIP122 Assembly

Locate one TIP122 Assembly [Step #31]



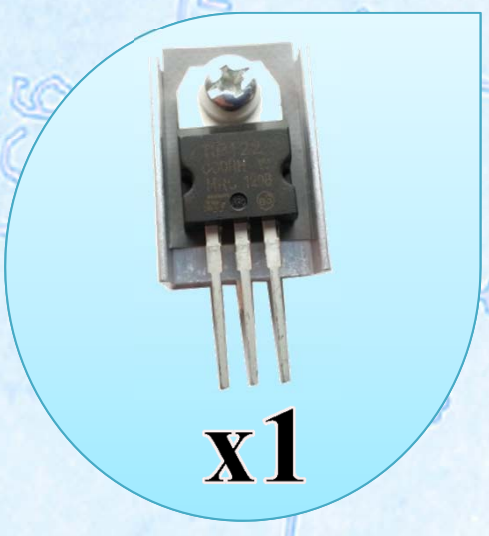
Solder the TIP122 Assembly into Q2.



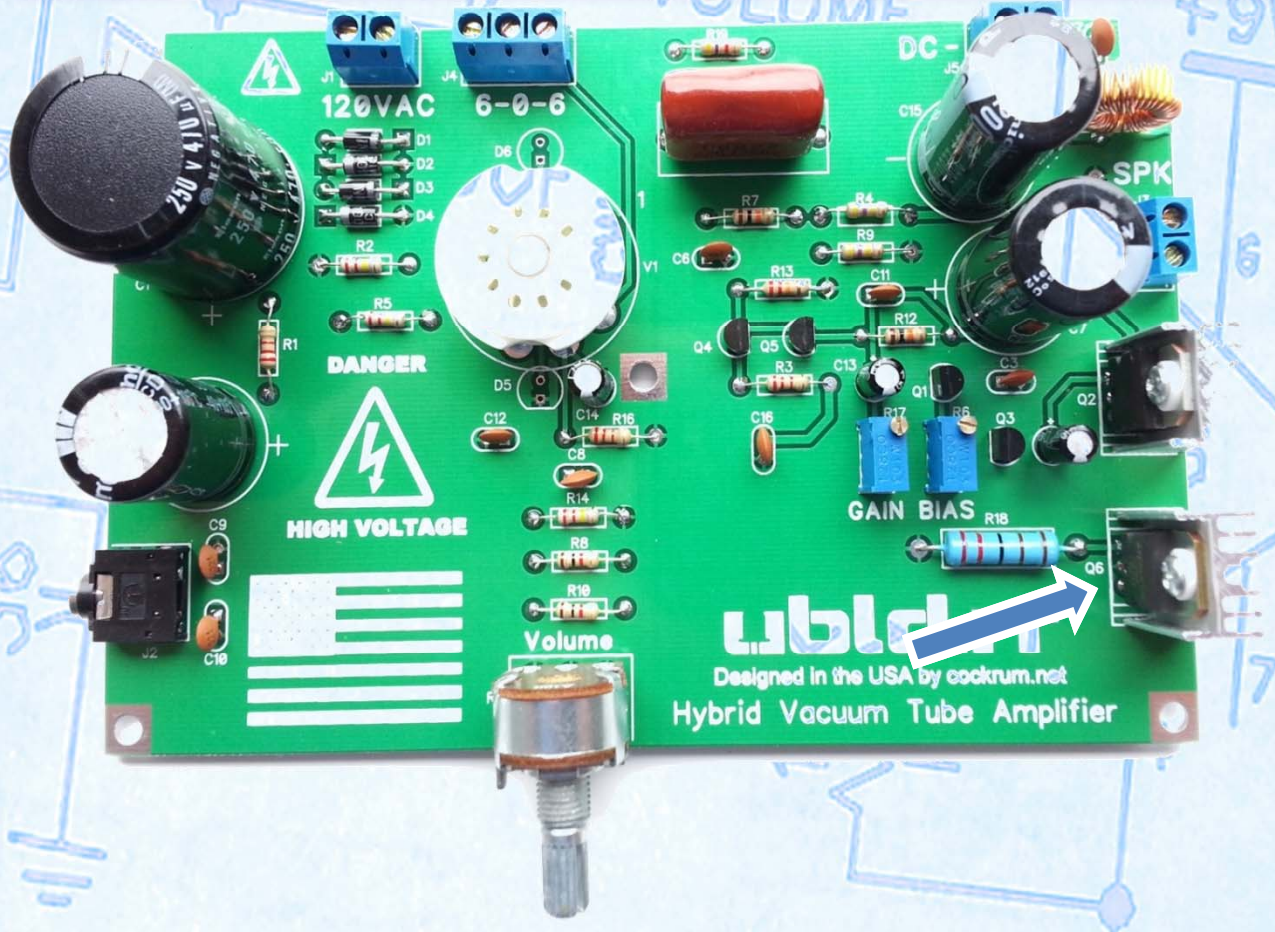
Double check that you are inserting TIP122 into Q2 and not TIP127. Getting these backwards would be really bad.

STEP 34: Insert the TIP127 Assembly

Locate one TIP127 Assembly (Step #30)



Solder the TIP127 Assembly into Q6.



You must properly set the BIAS potentiometer. Not doing so could result in Q6 burning up. This is done is a later step. Do not apply power until it is set.

STEP 35: Insert the Blue LEDs

Locate two Blue LEDs (Line #9)

Solder two Blue LEDs into D5 and D6. Note that the LEDs are not pushed all the way in and are slightly bent. **The Tube is inserted here for demonstration purposes only.**

The blue LEDs are optional. They are for decoration only.

(Optional) Sand and Apply Finish

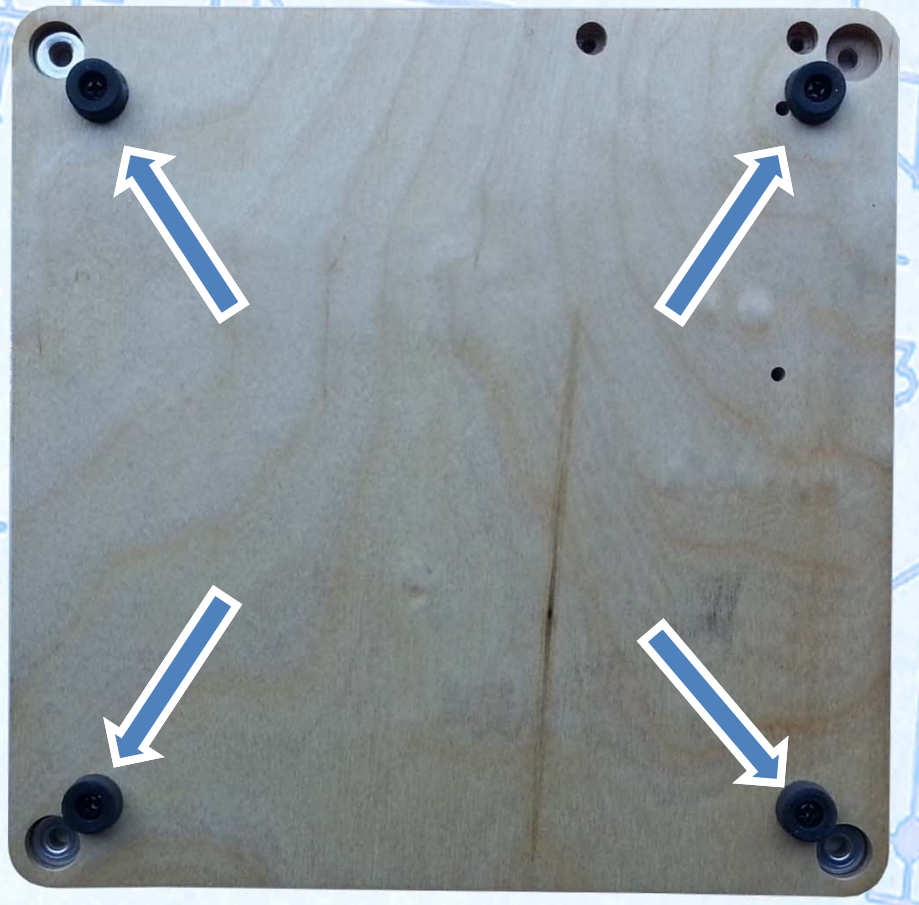
Optional: Sand and finish by paining or staining the wooden parts if you desire.

STEP 36: Screw Rubber Feet into the Wood Base

Insert a screw into each of the rubber feet. Using a Phillips screwdriver fasten the rubber feet to the bottom of the base. Note that the location of the feet is marked with a small indentation.

Locate four Rubber Feet (Line # 47) Locate four screws (Line # 32)

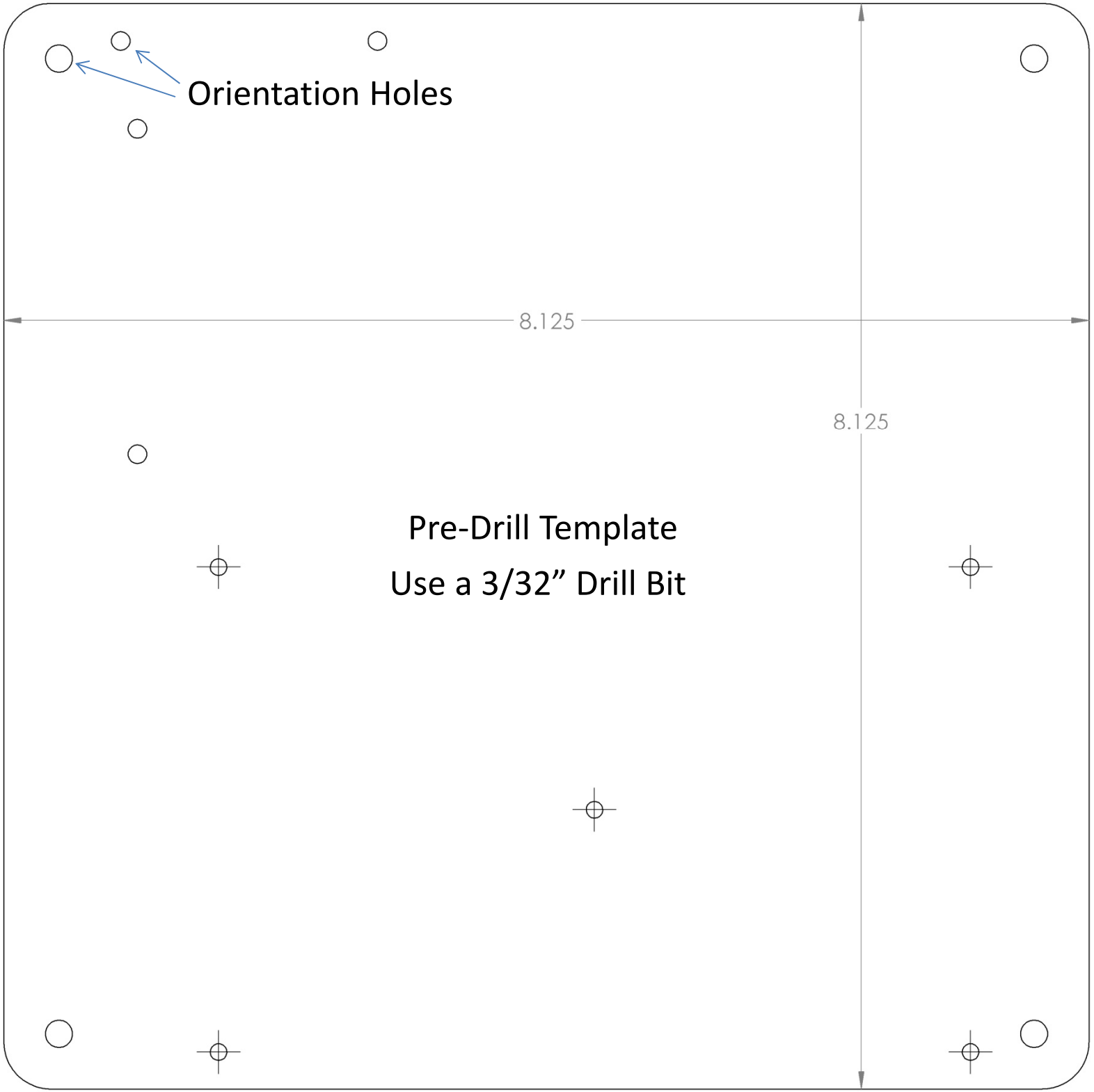
x4



Appling the feet first will help protect the wood from being scratched while handling the unit.

STEP 37: Print the Drill Template

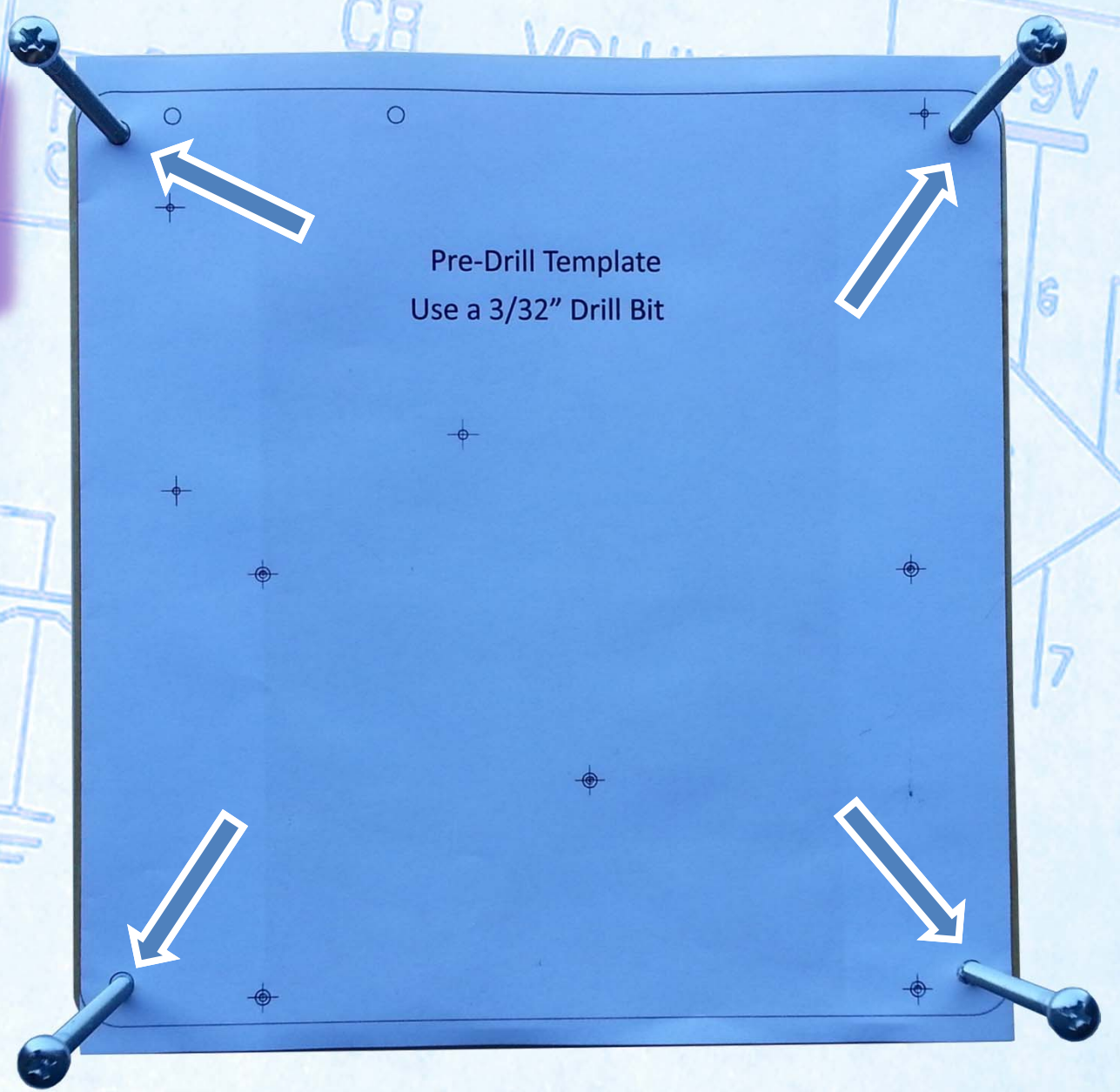
On the next page there is a Drill Template. Print this template. Make sure your printer does not scale the print. It is intended to be printed on 8.5” x 11” paper. You may also download the template as a PDF from the http://ubld.it website.


Orientation Holes
8.125
8.125
Pre-Drill Template
Use a 3/32” Drill Bit

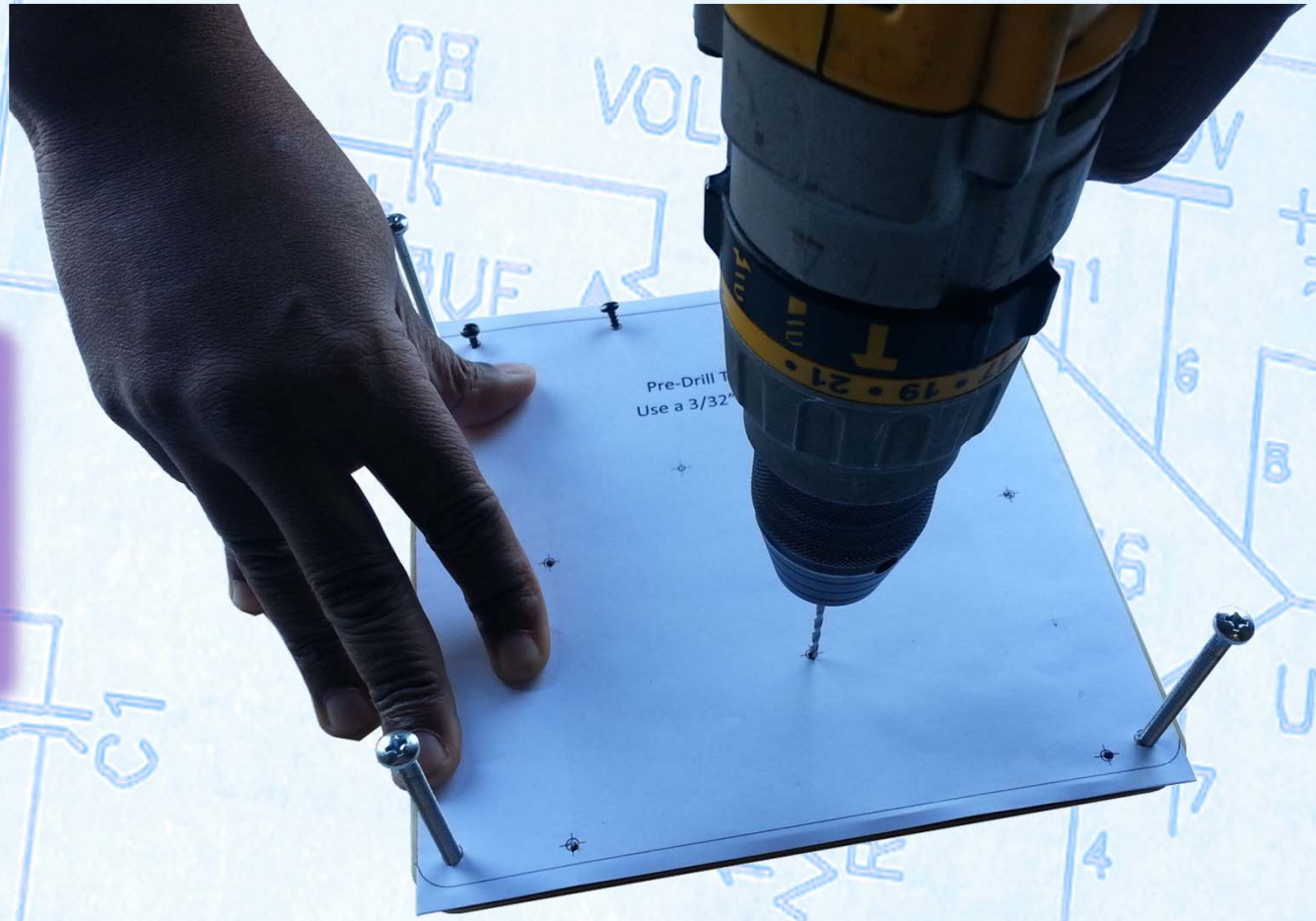
STEP 38: Align Drill Template

Use the existing four corner holes to align the Pre-Drill Template on the **top side** of the wood base.

Use a Phillips screw driver to poke holes into the paper at the four corners. This will allow the long screws to be inserted to hold the paper in place.



STEP 39: Pre-Drill Mounting Holes



Using a 3/32” drill bit drill seven holes at the locations marked with cross hairs.

You only need to drill about half way through the wood base.

Pre-drilling these holes is essential to ensure the wood base does not split while mounting the components.

STEP 40: Remove Pre-Drill Template

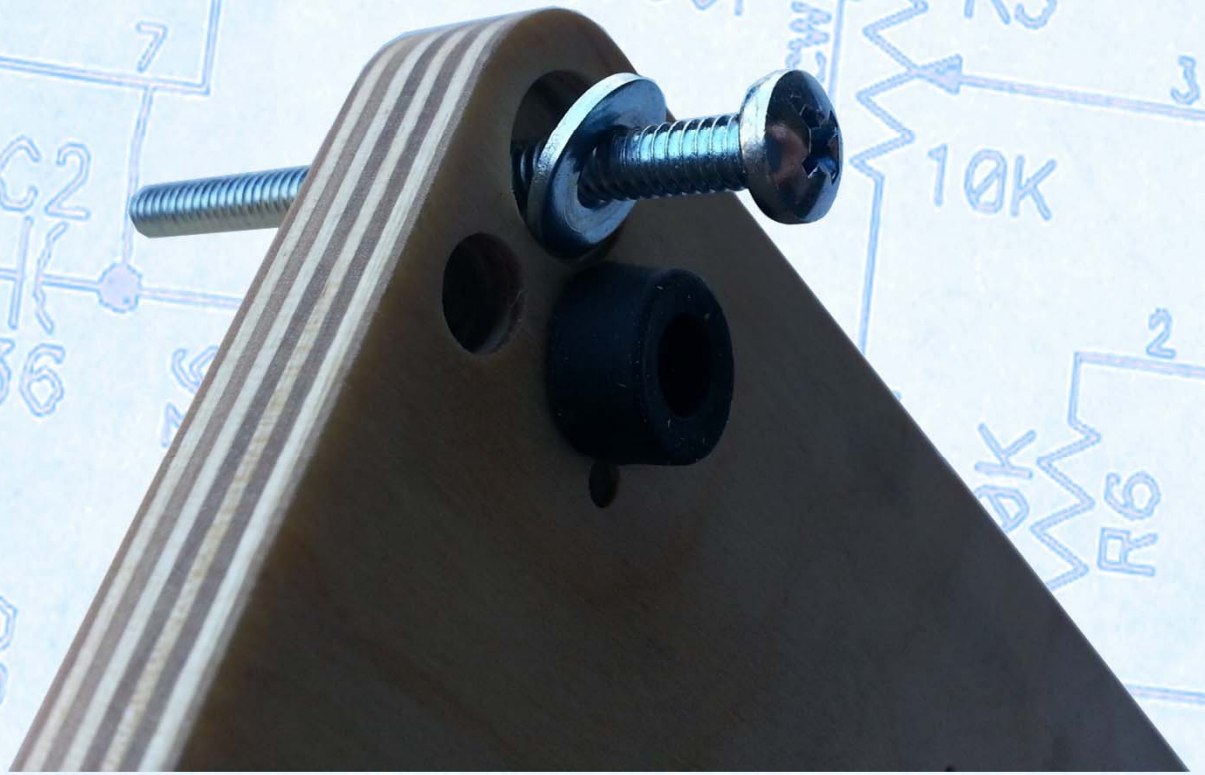
Remove the Pre-Drill Template to reveal the holes you have drilled.

You may want to use a piece of fine grit sand paper to remove any burs from the holes.

You may also want to apply oil or stain to the wood at this stage.

STEP 41: Insert Long Screws

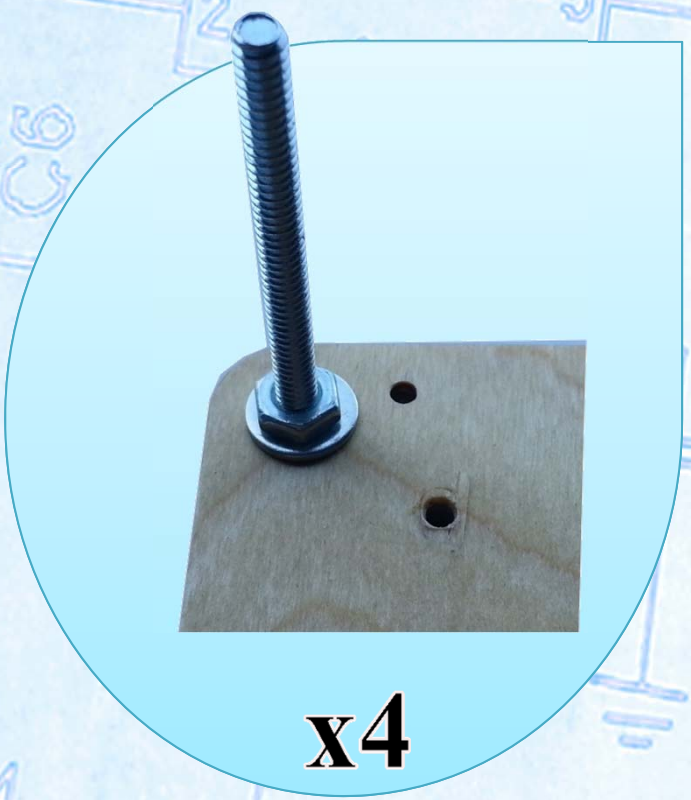
For each corner hole Insert a long screw through a washer and insert it into the wood base from the bottom side.



The four long screws are used as standoffs for the acrylic top.

STEP 42: Fasten Standoffs with Washer and Nut

For each long screw place a washer on the screw and fasten the screw with a nut from the top side of the wood base. Use a Phillips screwdriver and a wrench tighten.

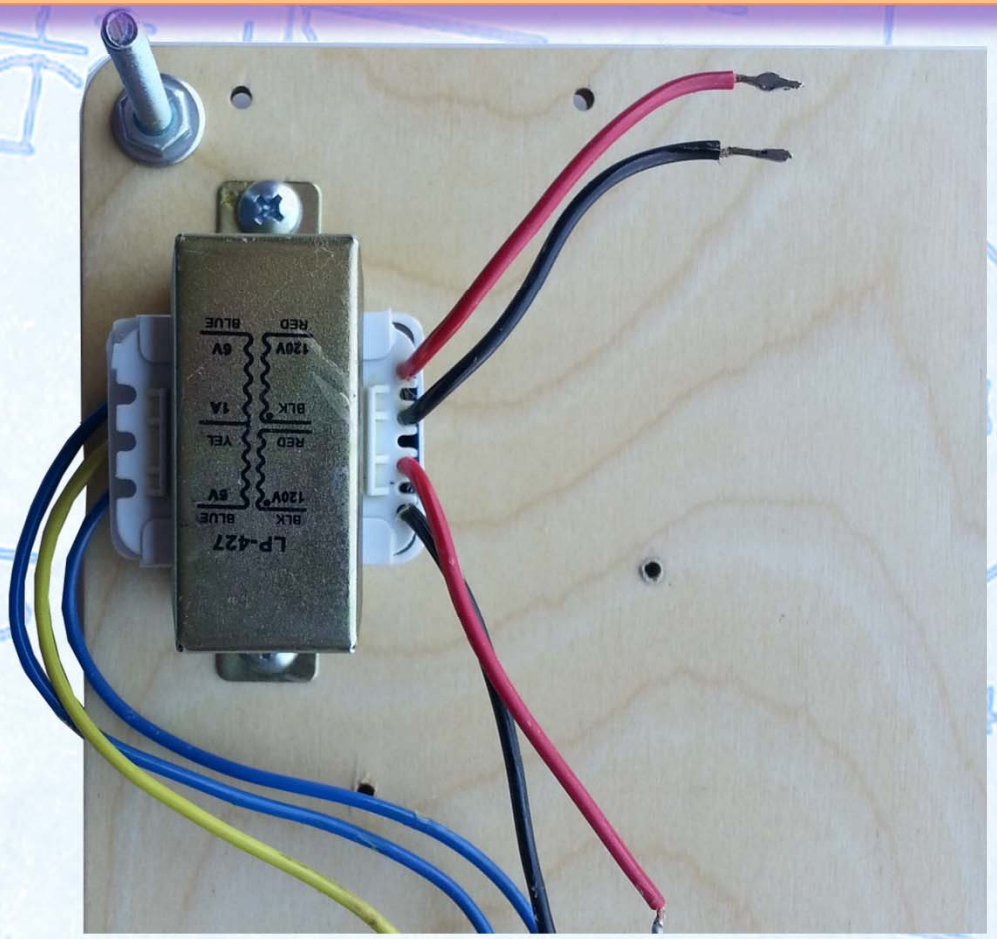


x4

Don't over tighten your hardware. Wood will compress which will unnecessarily cause the hardware to sink into the wood.

STEP 43: Fasten Transformer with Screws

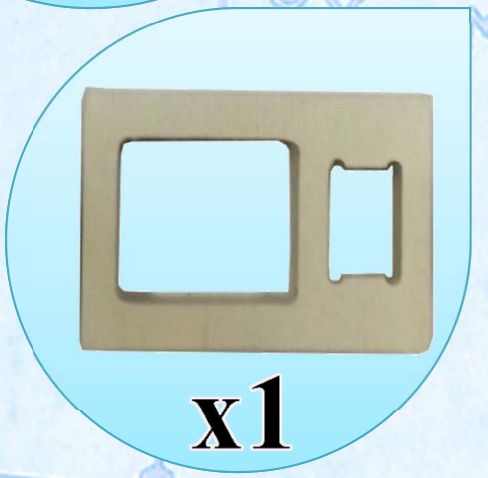
Fasten the transformer in place using two screws (Line #31). The Blue and Yellow wires should face outward while the Red and Black wires face inward.



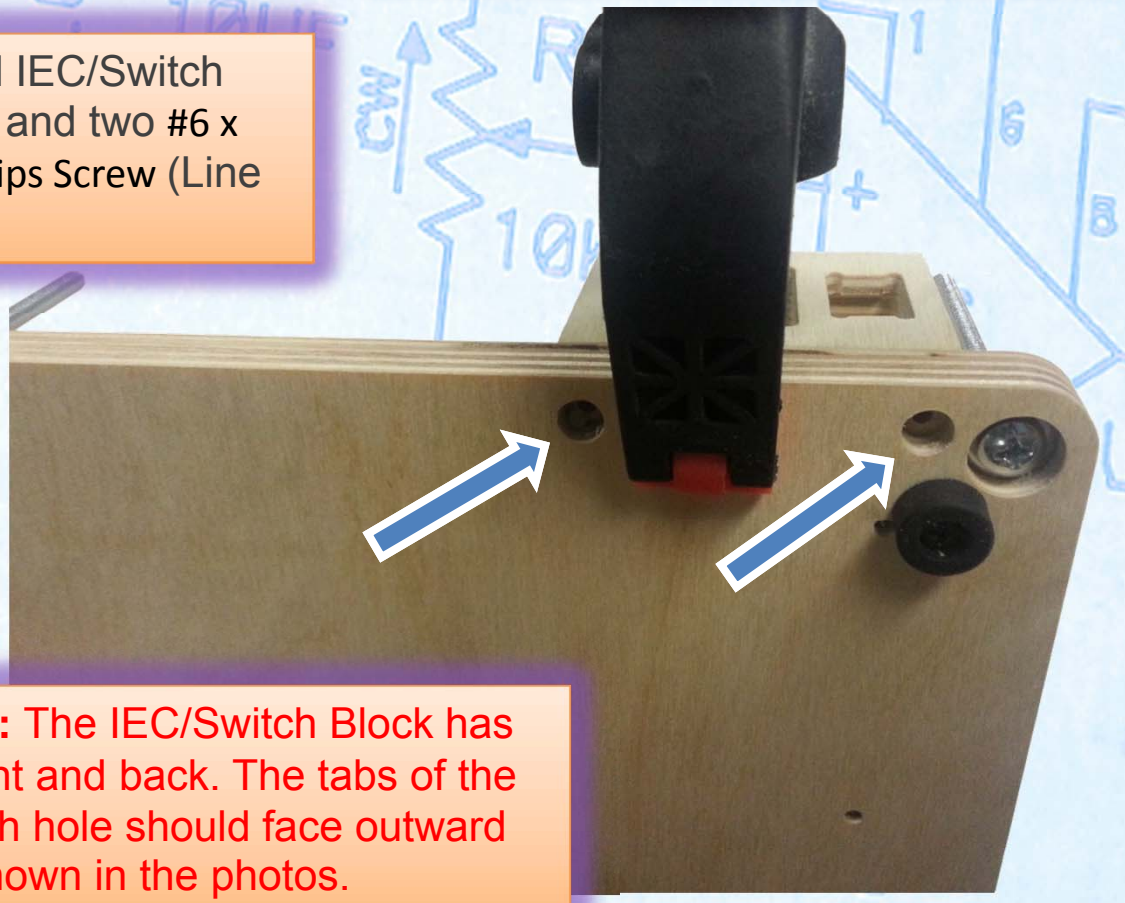
This transformer takes 120v AC in on one pair of the Red and Black wires and reduces it down to the two Blue 6v AC lines to power the tube.

STEP 44: Pre-Drill Bottom of IEC/Switch Block and Fasten

Clamp the IEC/Switch Block to the base aligning it with the edge of the base. The IEC.Switch Block should also rest up against the washer from step 42. Finally, pre-drill one 3/32” hole in the IEC.Switch Block using the existing holes in the base as a guide. Insert one of the provided screws. Then pre-drill the second hole and insert the second screw.



Locate one wood IEC/Switch block (Line # 44) and two #6 x 5/8 Pan Head Phillips Screw (Line # 33)



Note: The IEC/Switch Block has a front and back. The tabs of the switch hole should face outward as shown in the photos.

Pre-drilling is required for this step. Not doing so will almost certainly result in the block being split.

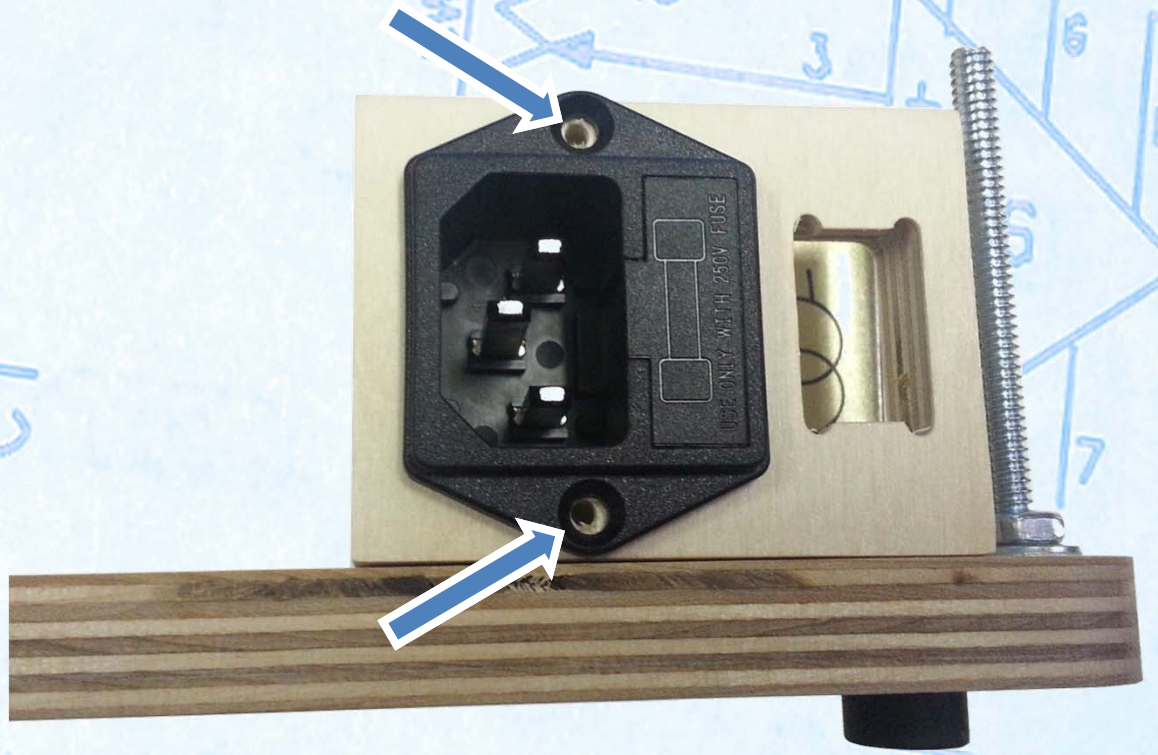
STEP 45: Insert IEC and Pre-Drill Wood IEC/Switch Block

Locate one IEC Connector (Line # 42) and two #6 x 5/8 Pan Head Phillips Screw (Line # 33)

x1

x2

Insert the IEC Connector and pre-drill two holes using a 3/32” Drill Bit. Then fasten the IEC connector using the screws provided.



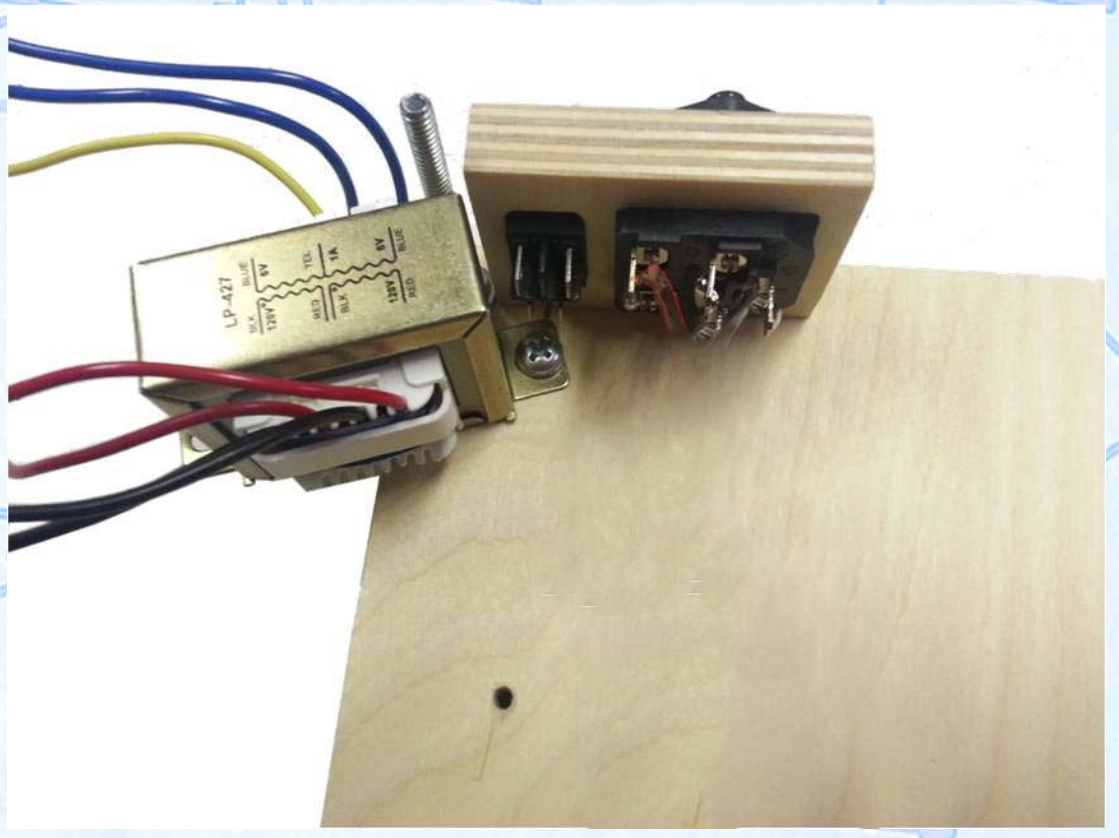
Pre-drilling is required prior to screwing in the IEC Connector. Not doing so will almost certainly result in the block being split.

STEP 46: Insert the Switch and Move the Transformer

Remove one screw from the Transformer and slide it to the side. Insert the switch into the IEC/Switch Block with the 'O' towards the bottom as shown in the photos.

Locate one Switch (Line # 46)

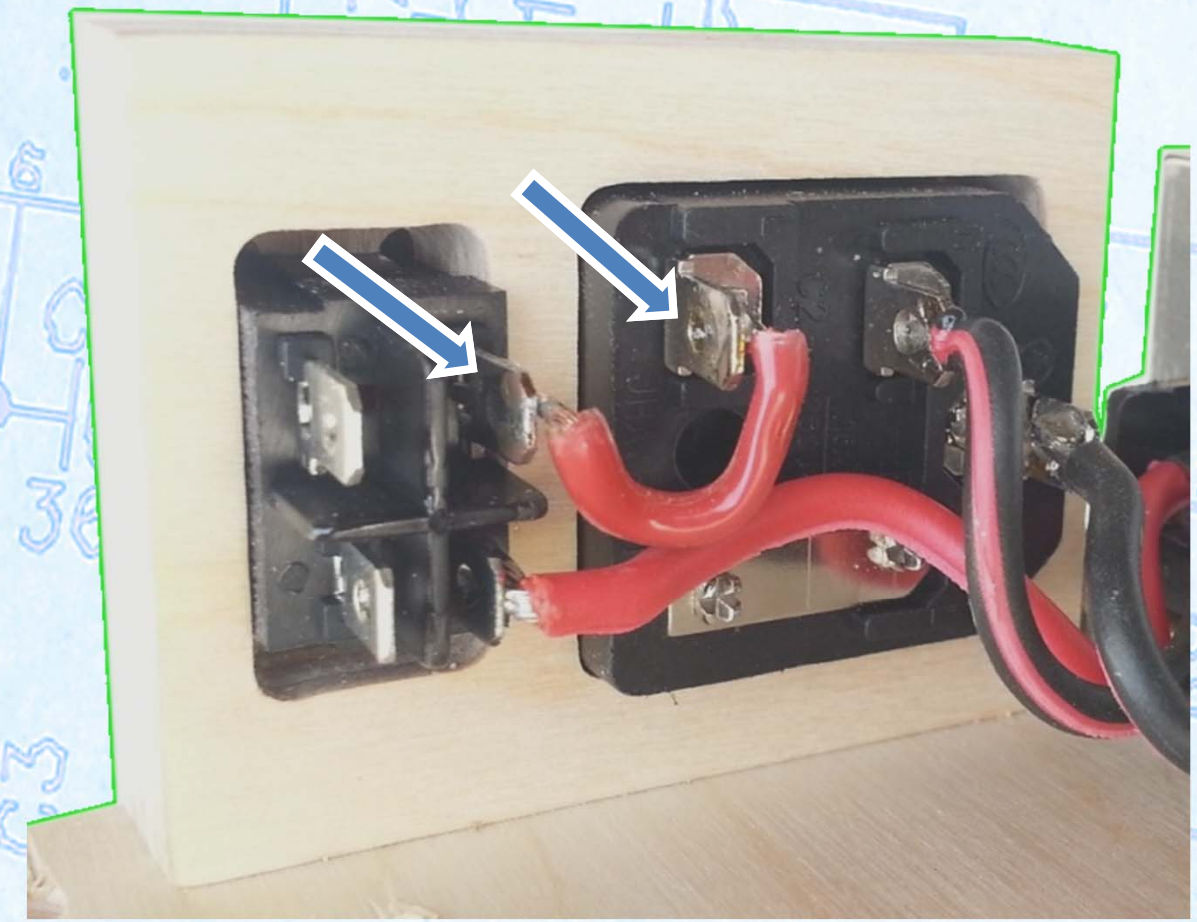
x1



There are red and black wires attached to the IEC connector in the above image. You will be soldering these wires on in the next few steps.

STEP 47: Wire the Switch to the IEC Connector

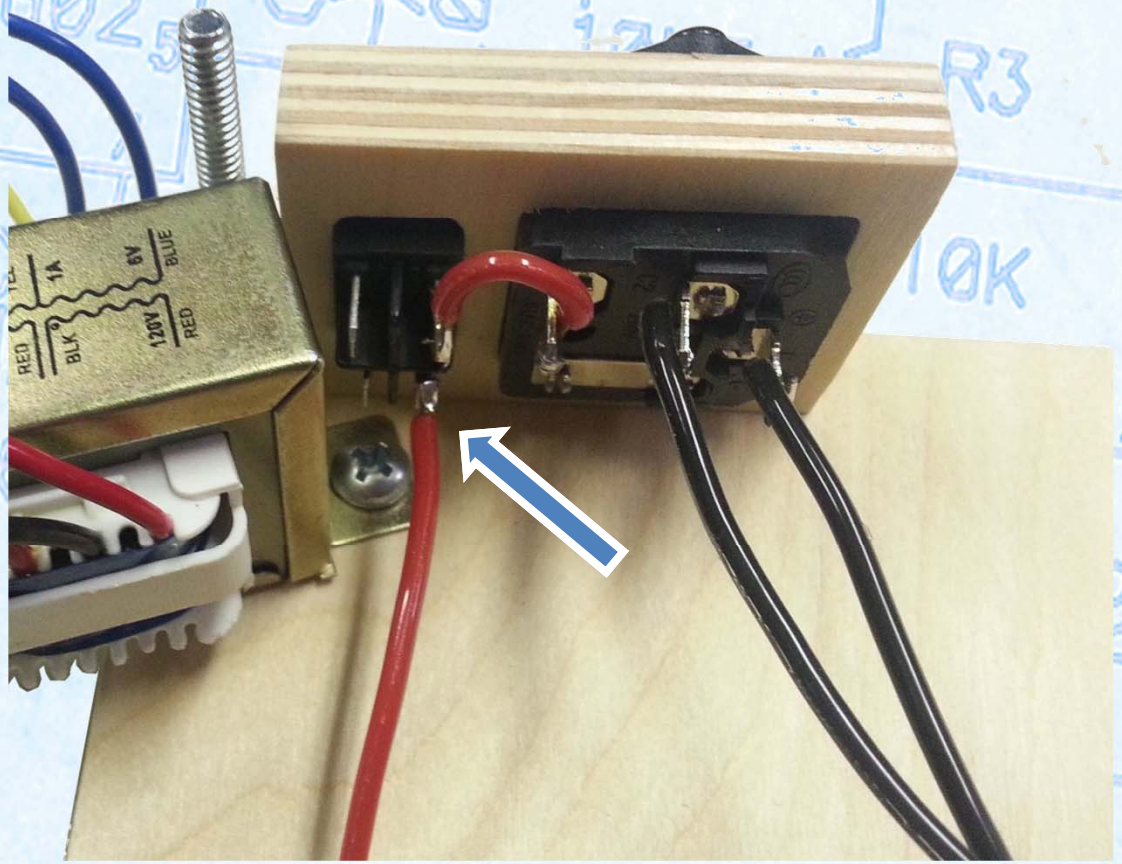
Solder the short red wire (Line # 45) to the switch and IEC Connector as shown. This wire is about 1 inch in length.



Soldering to the inside terminals of the switch will help prevent someone from getting shocked by sticking their fingers into the enclosure.

STEP 48: Solder Wire to Bottom of Switch

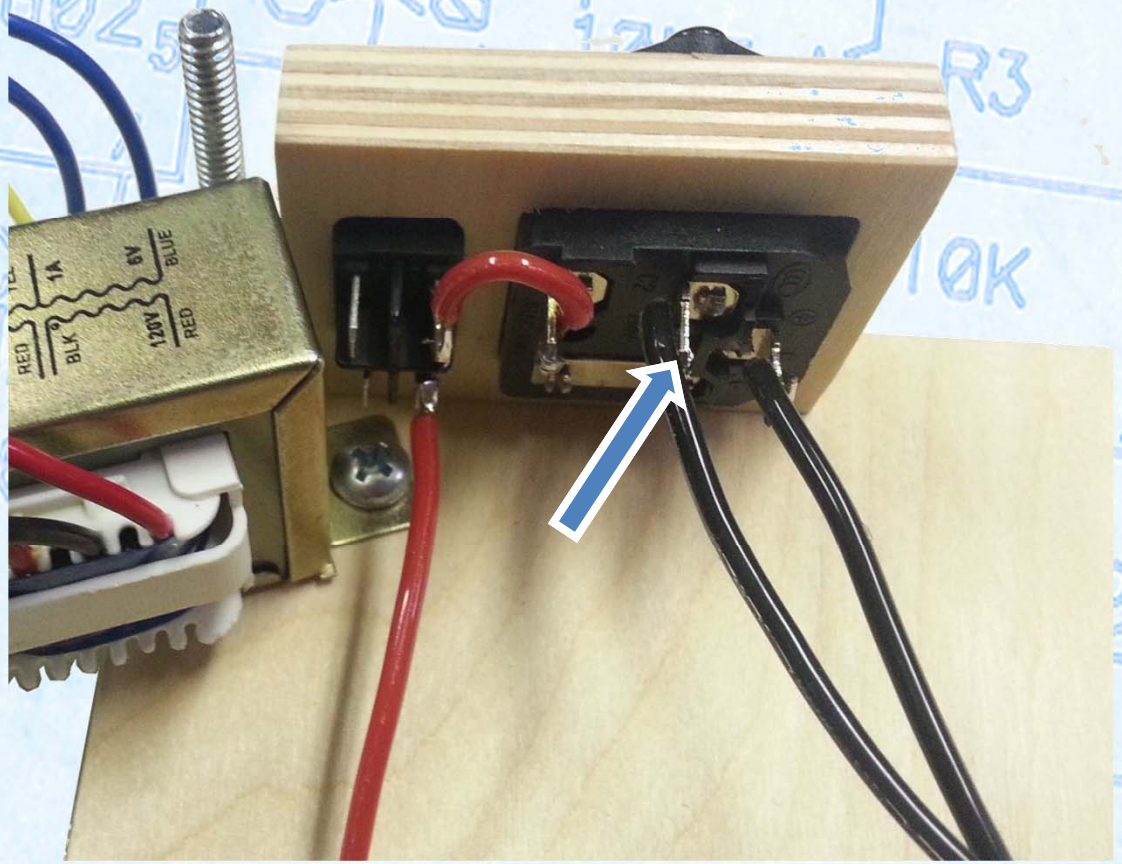
Solder about 4 inches of red wire (Line # 45) to the bottom inside terminal of the switch as shown in the photo.



Soldering to the inside terminals of the switch will help prevent someone from getting shocked by sticking their fingers into the enclosure.

STEP 49: Solder Wire to Bottom of Switch

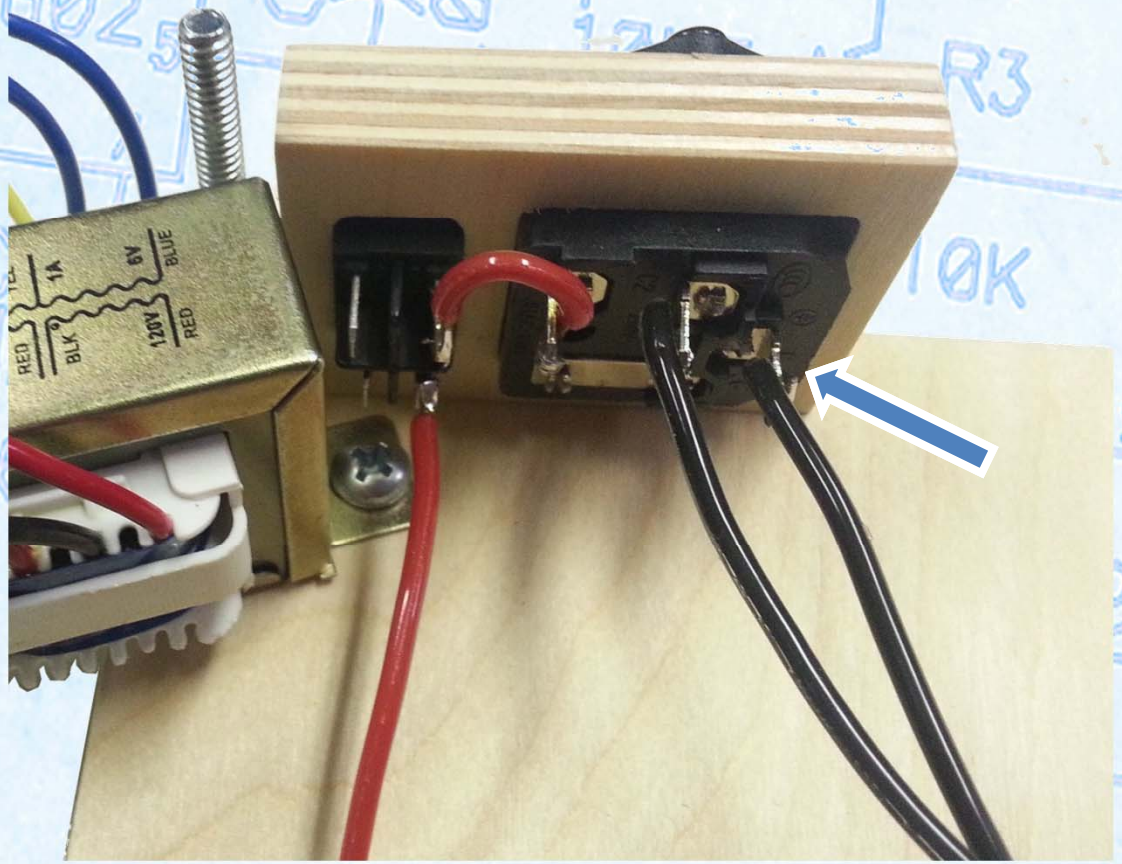
Solder about 4 inches of black wire (Line # 45) to the top middle terminal of the IEC connector as shown in the photo.



Soldering to the inside terminals of the switch will help prevent someone from getting shocked by sticking their fingers into the enclosure.

STEP 50: Solder Wire to Bottom of Switch

Solder about 4 inches of black wire (Line # 45) to the bottom right terminal of the IEC connector as shown in the photo.



Soldering to the inside terminals of the switch will help prevent someone from getting shocked by sticking their fingers into the enclosure.

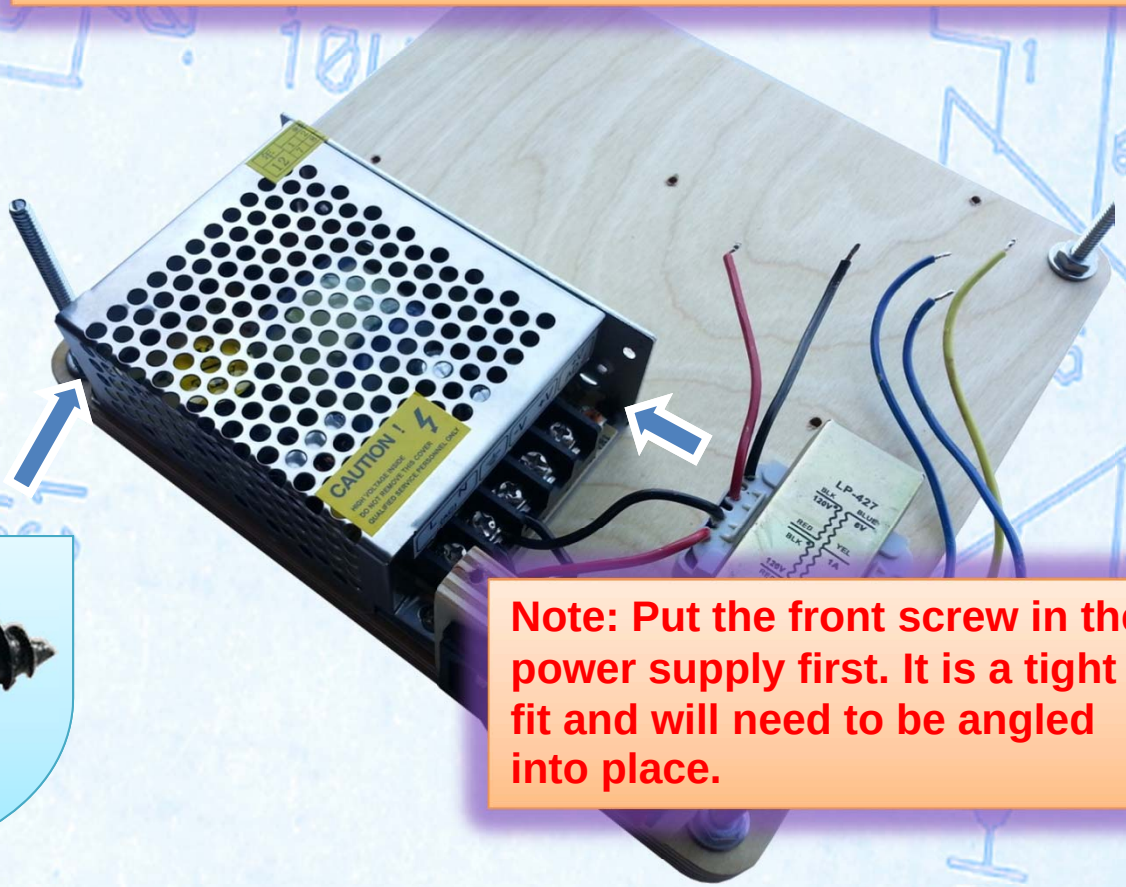
STEP 51: Mount the Power Supply

Locate one Power Supply (Line # 38) and two #6 x 3/8 Pan Head Phillips Screw (Line # 32)

x1

x2

Rest the power supply against the edge of the base and the IEC/Switch Block. Mark the two screw holes and **Pre-Drill the holes**. Use the two screws provided to mount the DC Power Supply.S

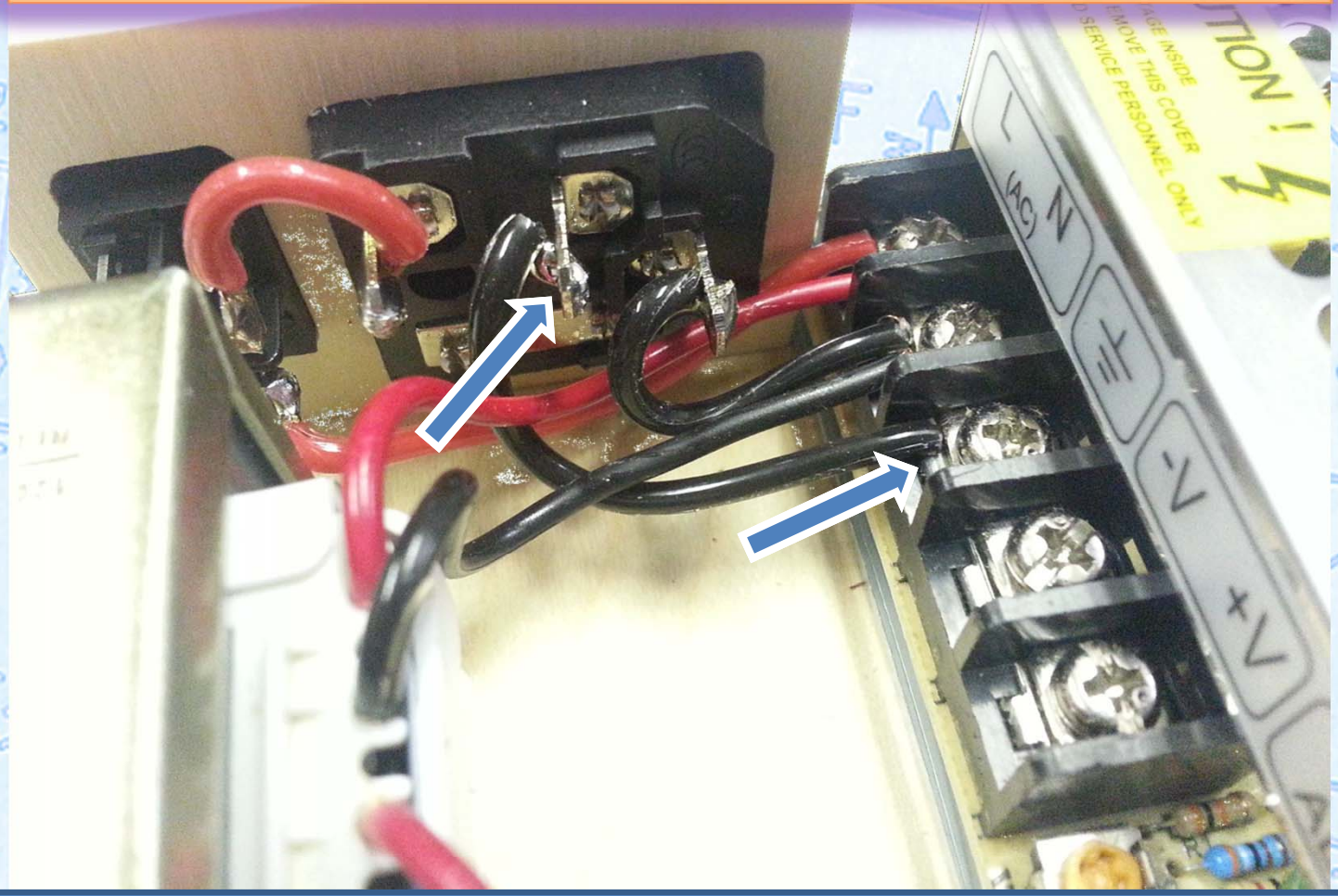


Note: Put the front screw in the power supply first. It is a tight fit and will need to be angled into place.

The DC Power Supply provides 24 DC to the circuit board.

STEP 52: Screw Ground Wire to Power Supply

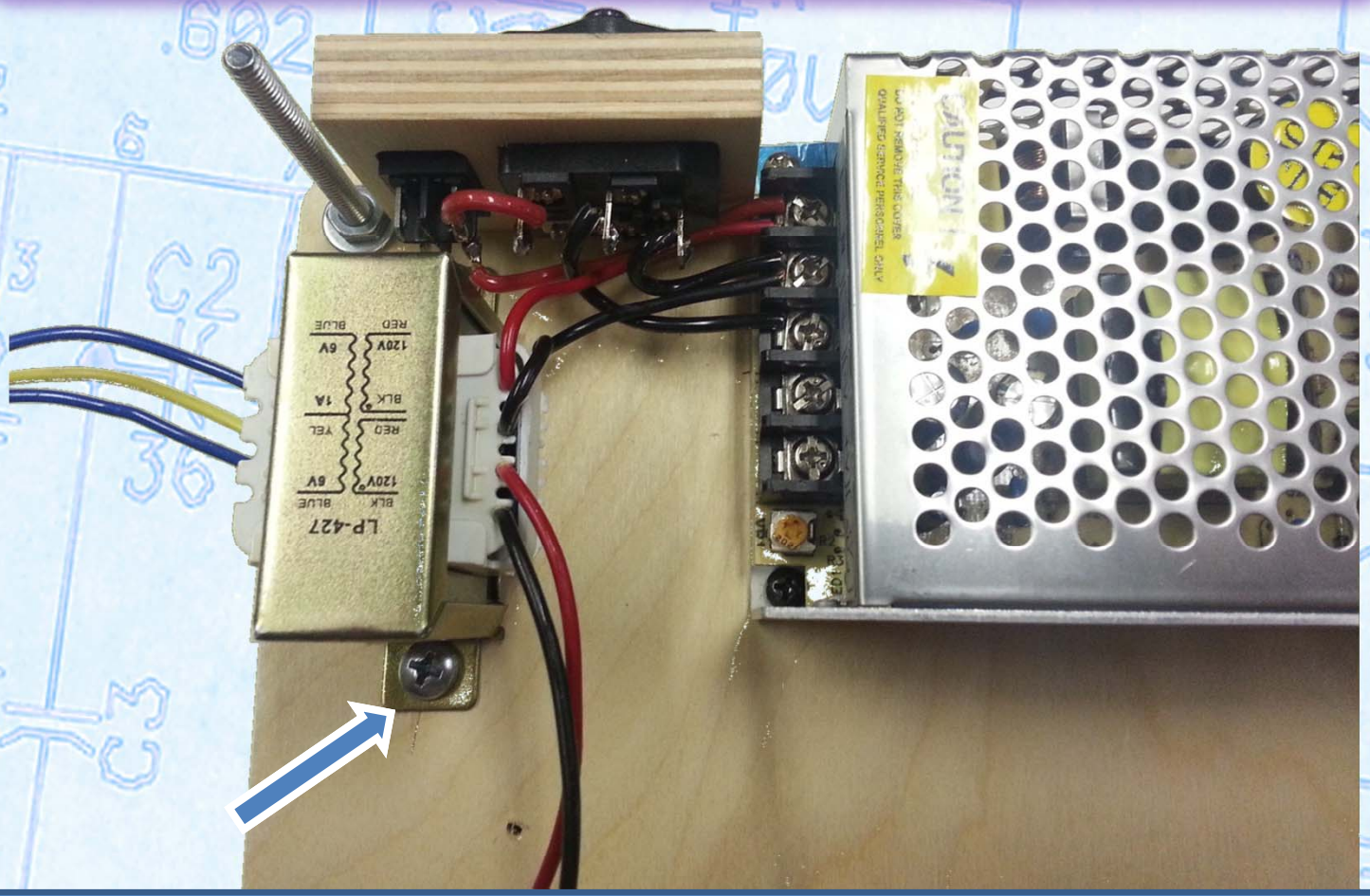
Strip about a ½" of insulation from the black wire which is attached to the middle IEC Connector terminal and it to the ground terminal of the power supply. You can cut this wire to length if you wish.



Soldering to the inside terminals of the switch will help prevent someone from getting shocked by sticking their fingers into the enclosure.

STEP 53: Replace the Transformer Screw

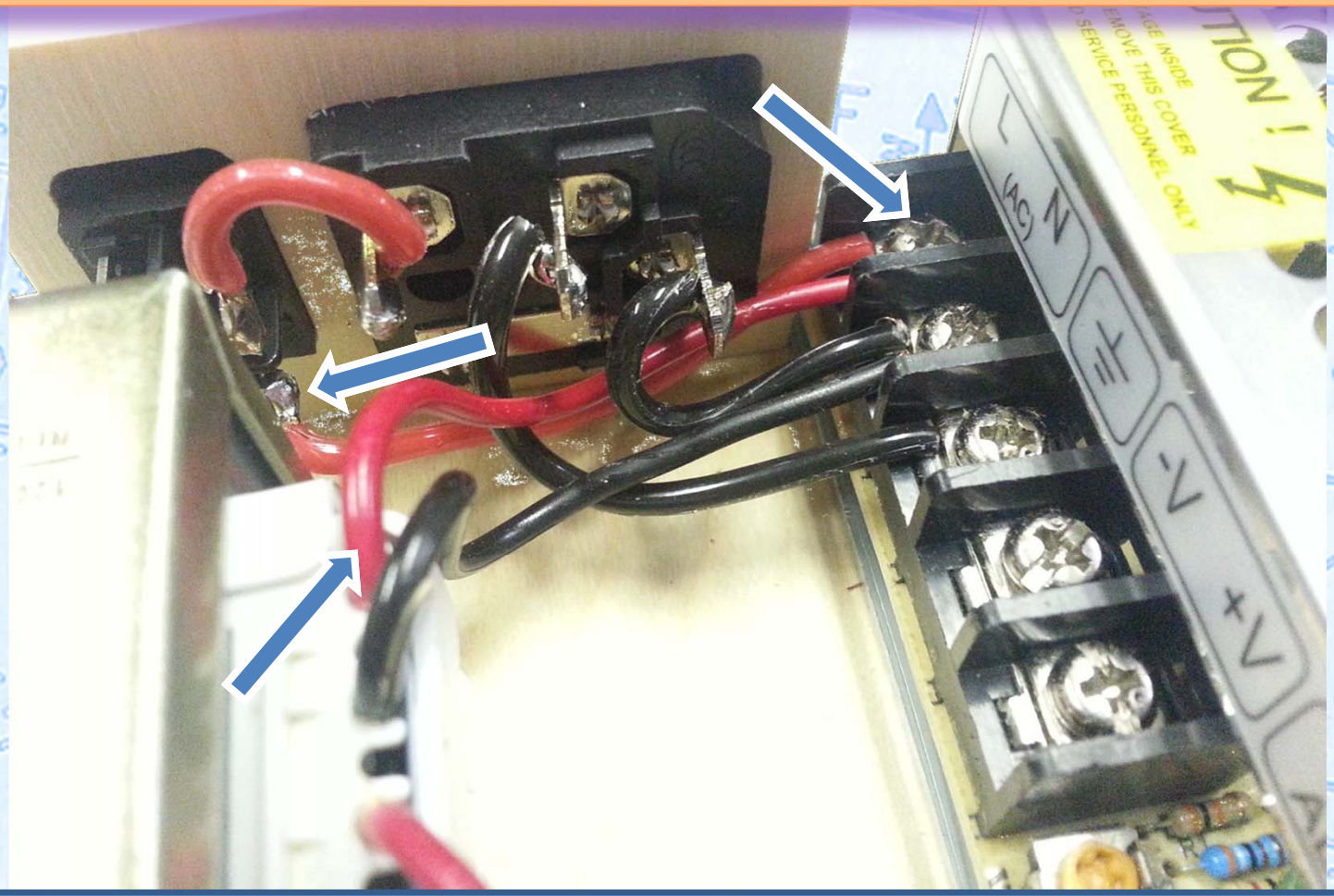
Replace the transformer screw that was removed in step 46 making sure the wires from the switch and IEC connector are routed towards the power supply.



Soldering to the inside terminals of the switch will help prevent someone from getting shocked by sticking their fingers into the enclosure.

STEP 54: Screw Line Wires to Power Supply

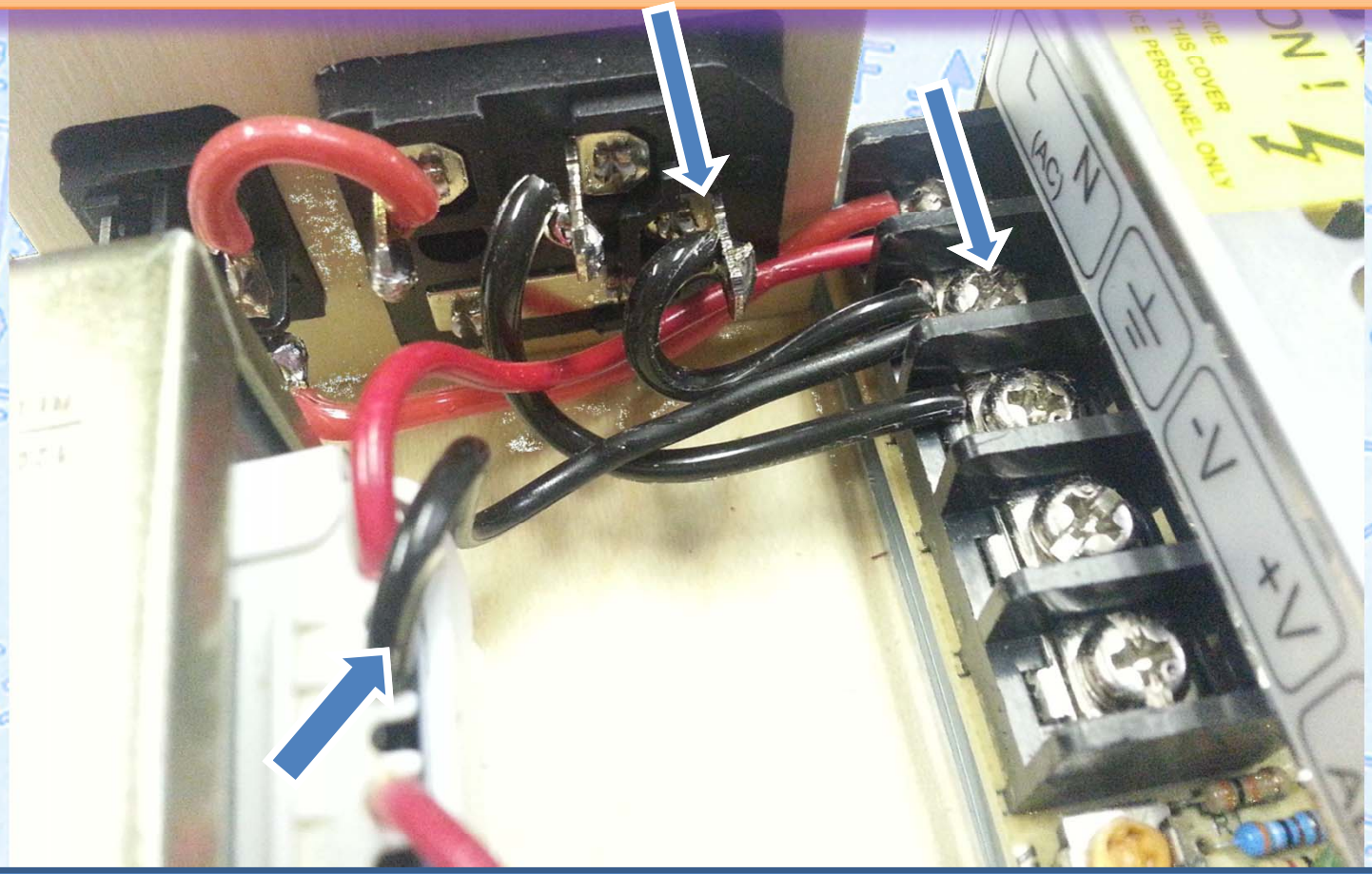
Strip about a ½" of insulation from the red wire which is attached to the bottom switch terminal. Also strip ½" of insulation from the red wire on the transformer closest to the IEC/Switch Block. Screw both of these wires to the 'L' (Line) terminal of the power supply. You may cut these wires to length.



Soldering to the inside terminals of the switch will help prevent someone from getting shocked by sticking their fingers into the enclosure.

STEP 55: Screw Neutral Wires to Power Supply

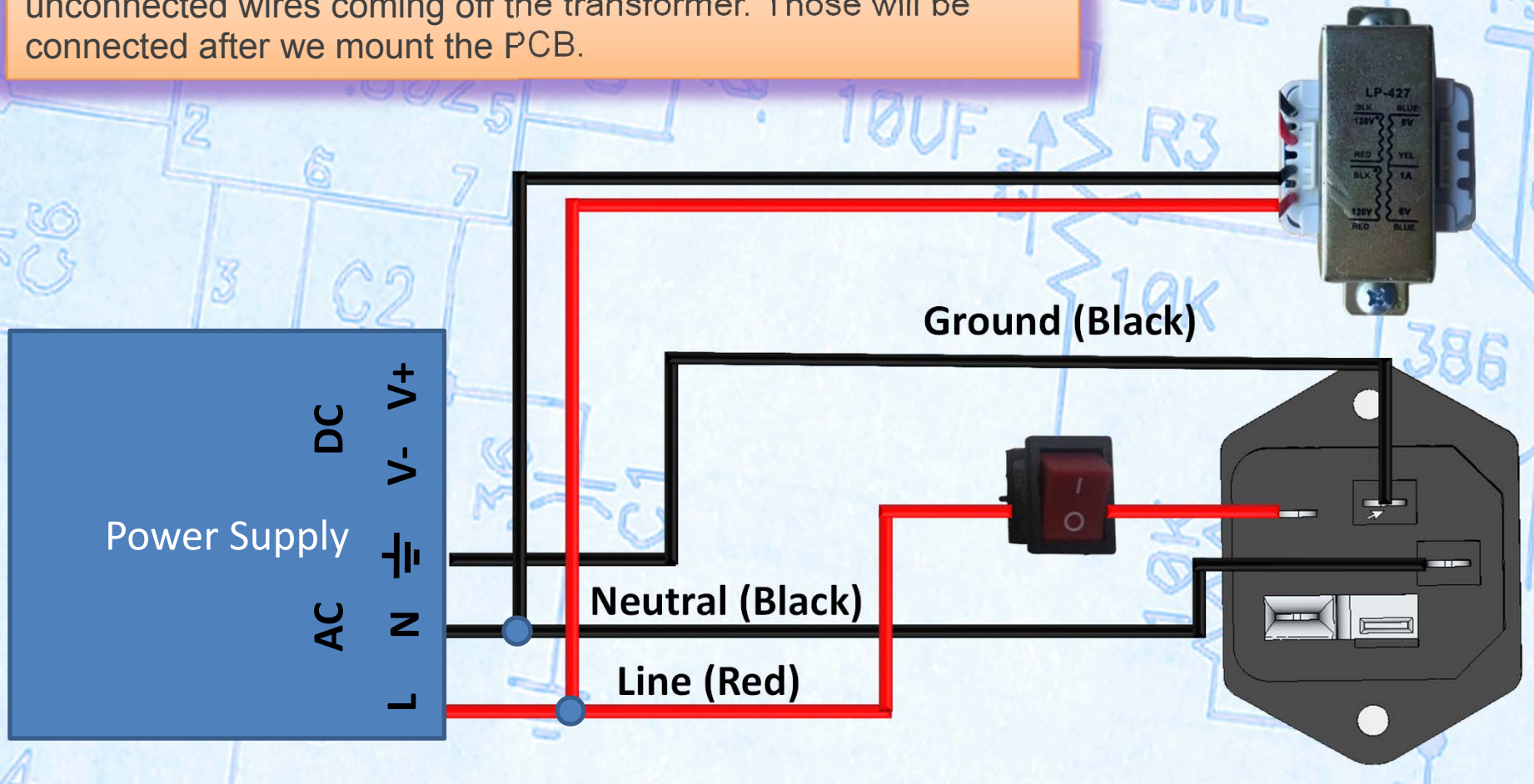
Strip about a ½" of insulation from the black wire which is attached to the bottom right IEC Connector terminal. Also strip ½" of insulation from the black wire on the transformer closest to the IEC/Switch Block. Screw both of these wires to the 'N' (Neutral) terminal of the power supply. You may cut these wires to length.



Soldering to the inside terminals of the switch will help prevent someone from getting shocked by sticking their fingers into the enclosure.

STEP 56: Verify your wiring (Do Not Apply Power)

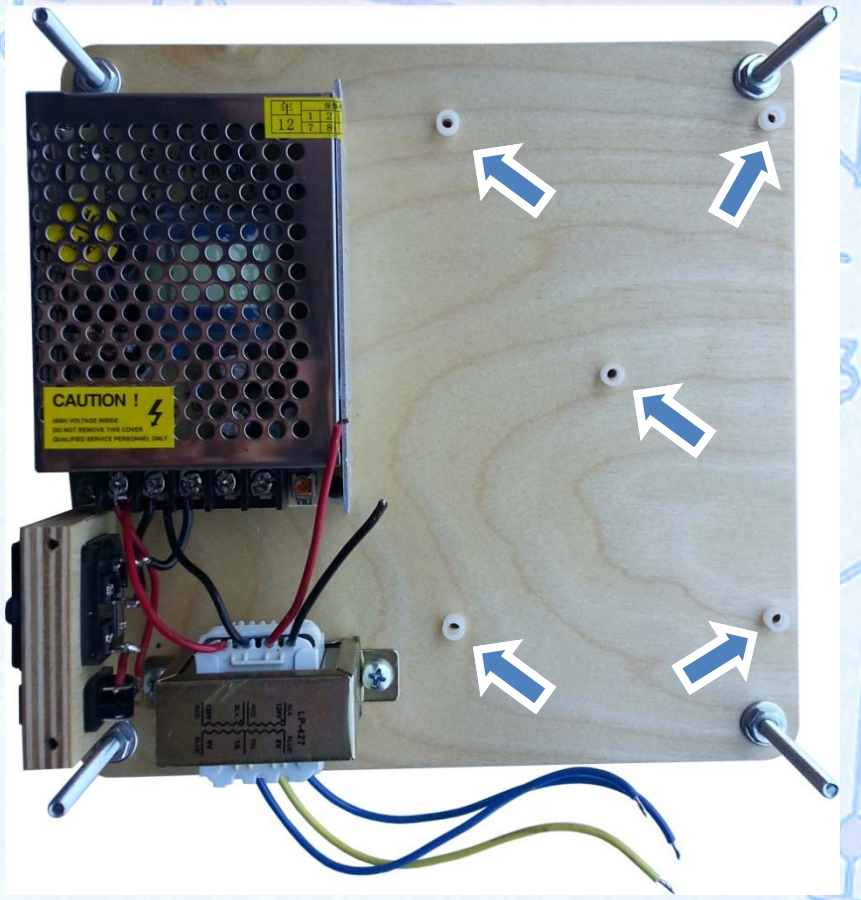
DO NOT APPLY POWER! Take a moment to carefully verify your wiring. Compare it to the diagram below. You should have 5 unconnected wires coming off the transformer. Those will be connected after we mount the PCB.



If for some reason these drawings are not clear enough another drawing of these connection can be seen in Step 59.

STEP 57: Place PCB Standoffs on the Base

Place five PCB Standoffs on the Base.
(Line # 39)

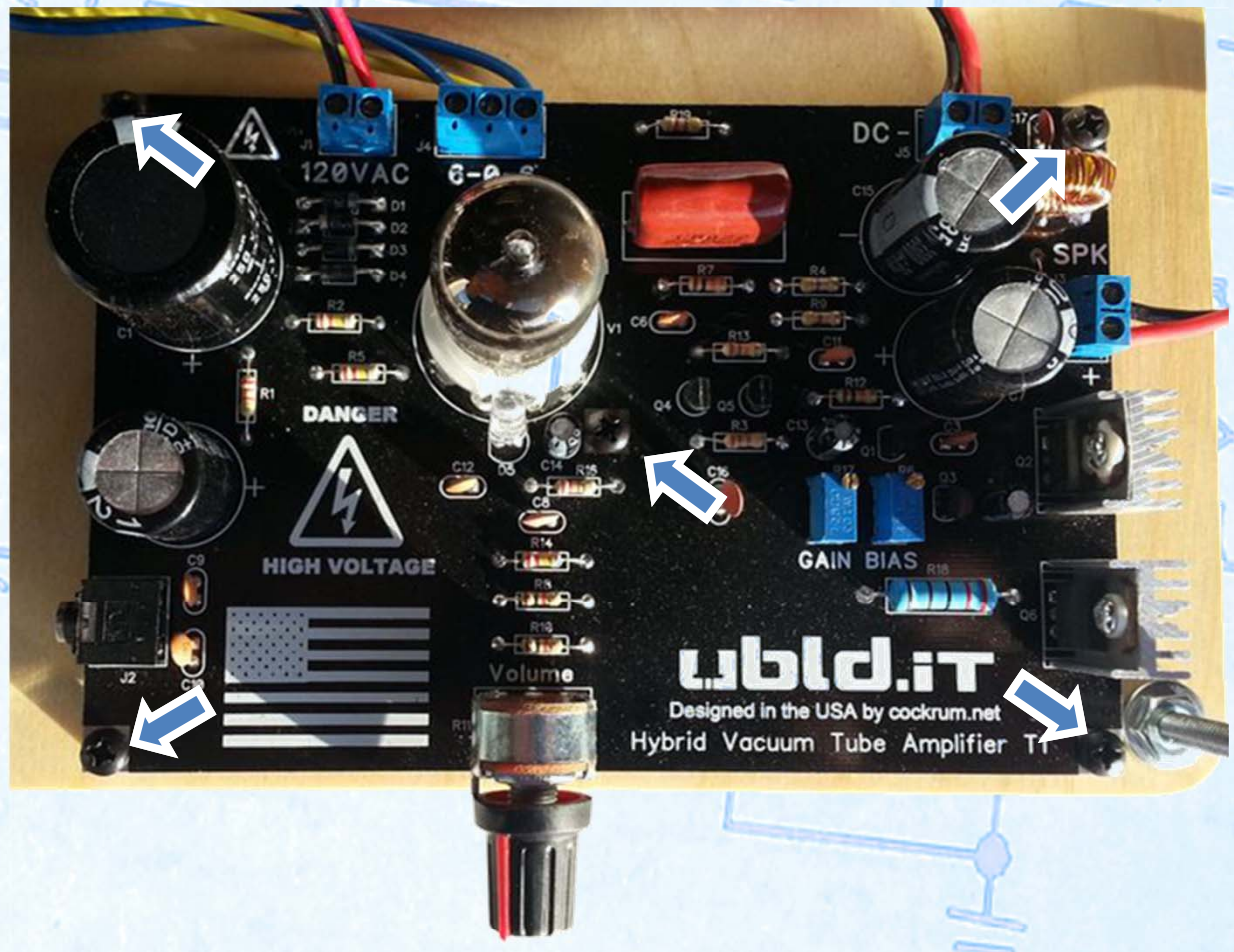


Nylon standoffs are use to provide an even mounting surface since all the solder joint are uneven.

STEP 58: Fasten the PCB to the Wood Base and Insert Tube

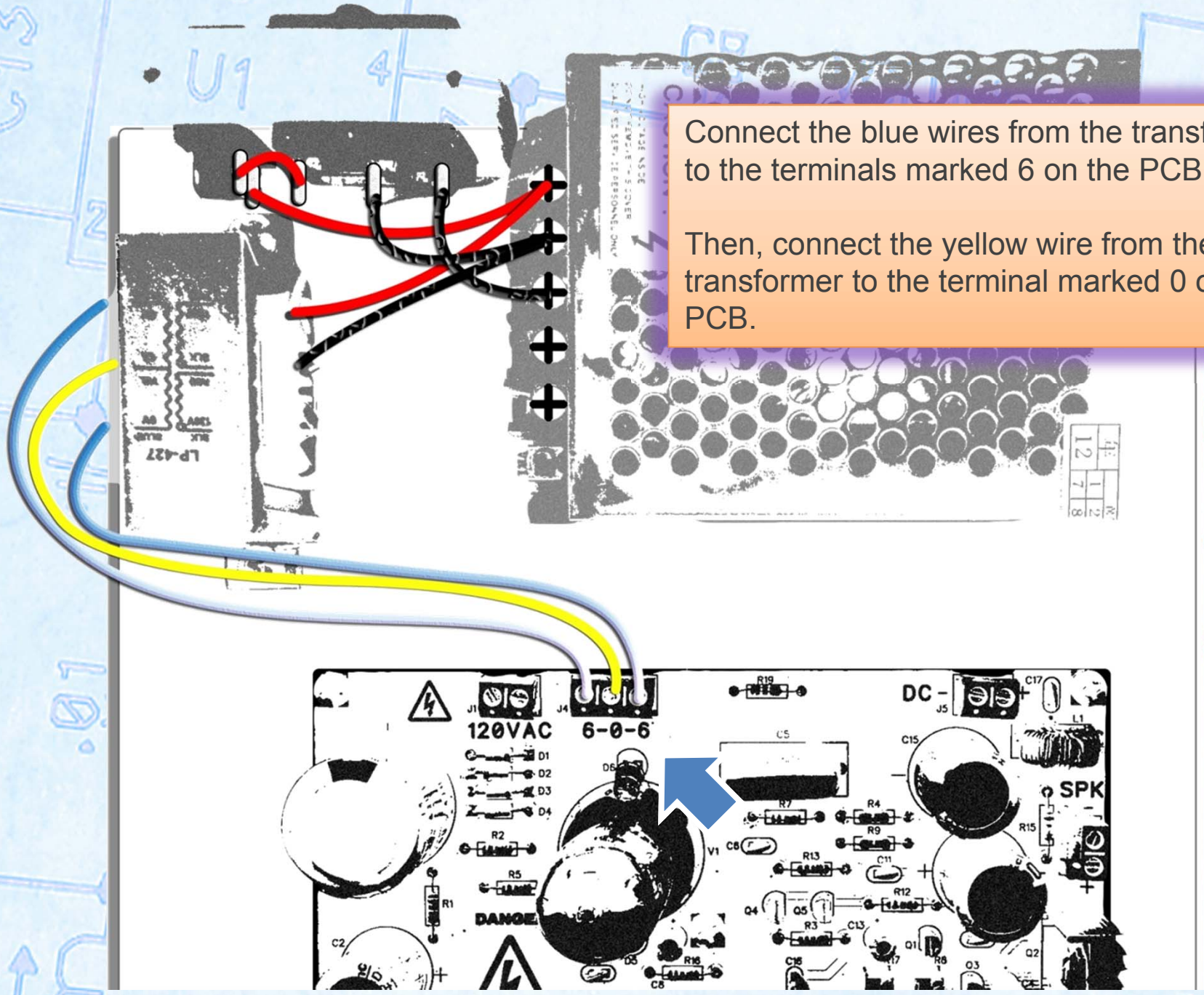
Locate two #6 x ½ Pan Head Phillips Screw (Line # 34)

Insert the screw in the center of the PCB first then insert the remaining four corner screws. Then insert the tube (Line # 29)



Inserting the center screw first will allow you to easily reposition the corner standoffs should they become misaligned.

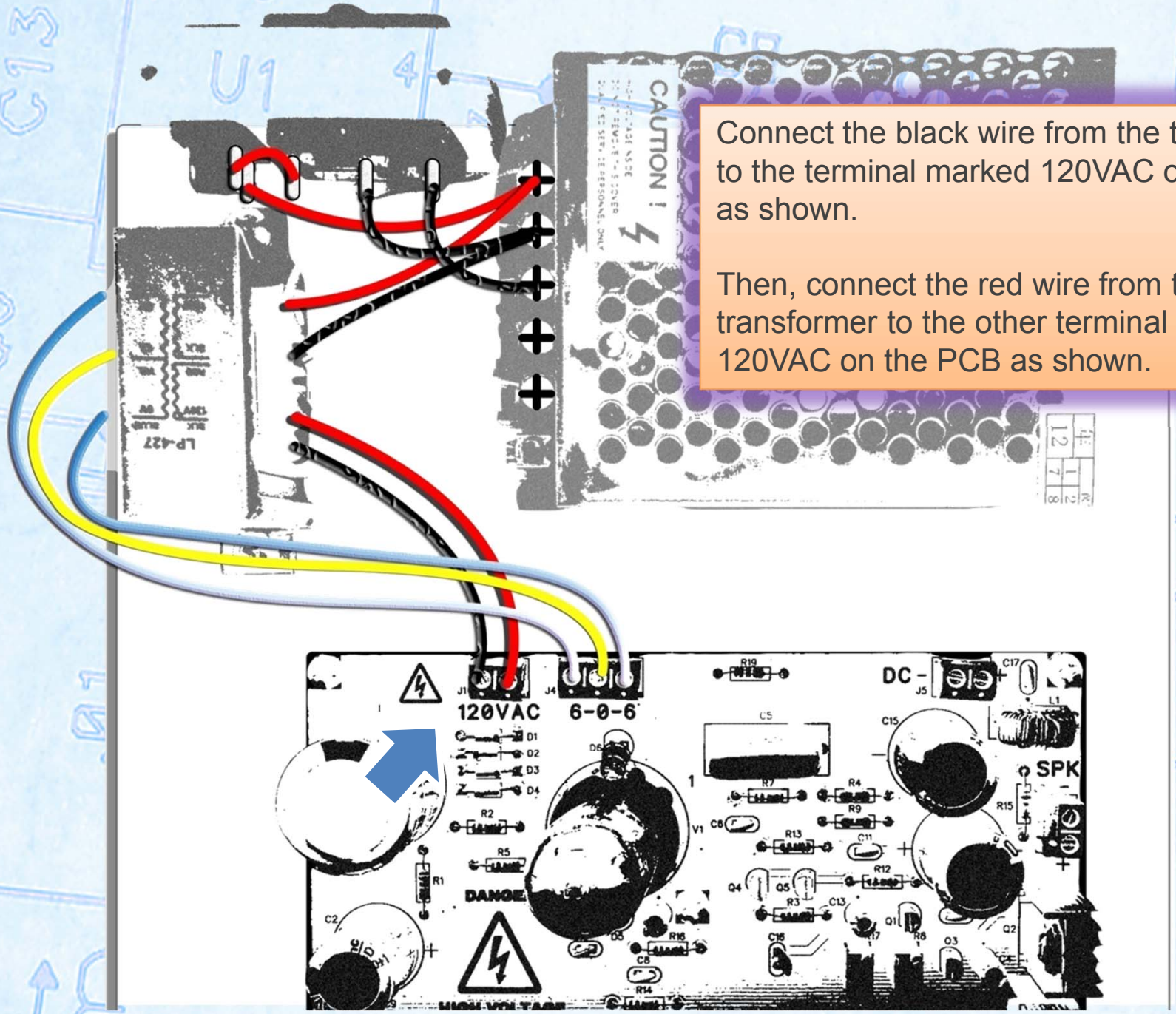
STEP 59: Connect the PCB to the Transformer (6-0-6)



Connect the blue wires from the transformer to the terminals marked 6 on the PCB.

Then, connect the yellow wire from the transformer to the terminal marked 0 on the PCB.

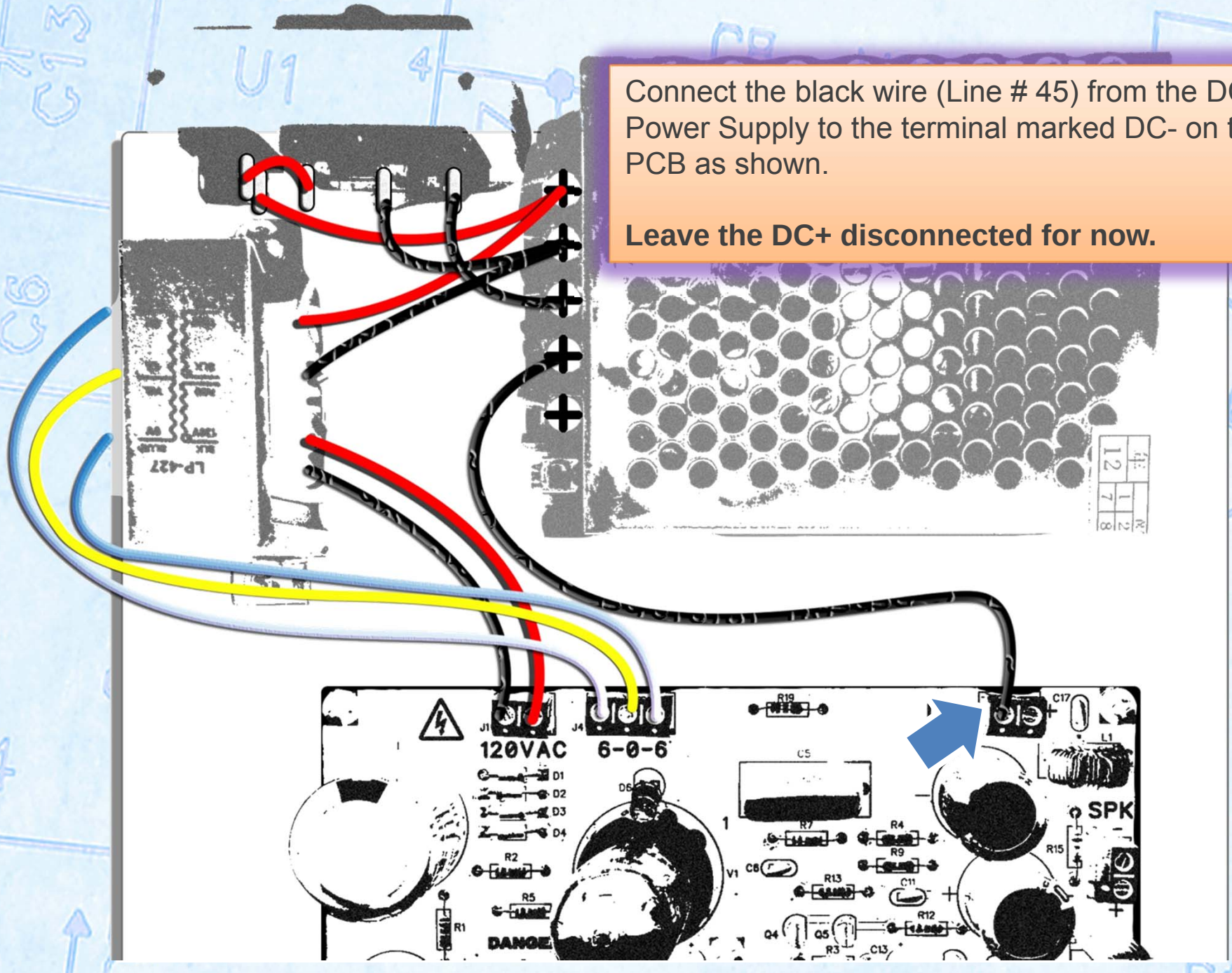
STEP 60: Connect the PCB to the Transformer (120VAC)



Connect the black wire from the transformer to the terminal marked 120VAC on the PCB as shown.

Then, connect the red wire from the transformer to the other terminal marked 120VAC on the PCB as shown.

STEP 61: Connect the PCB to the DC Power Supply (V- to DC-)



Connect the black wire (Line # 45) from the DC Power Supply to the terminal marked DC- on the PCB as shown.

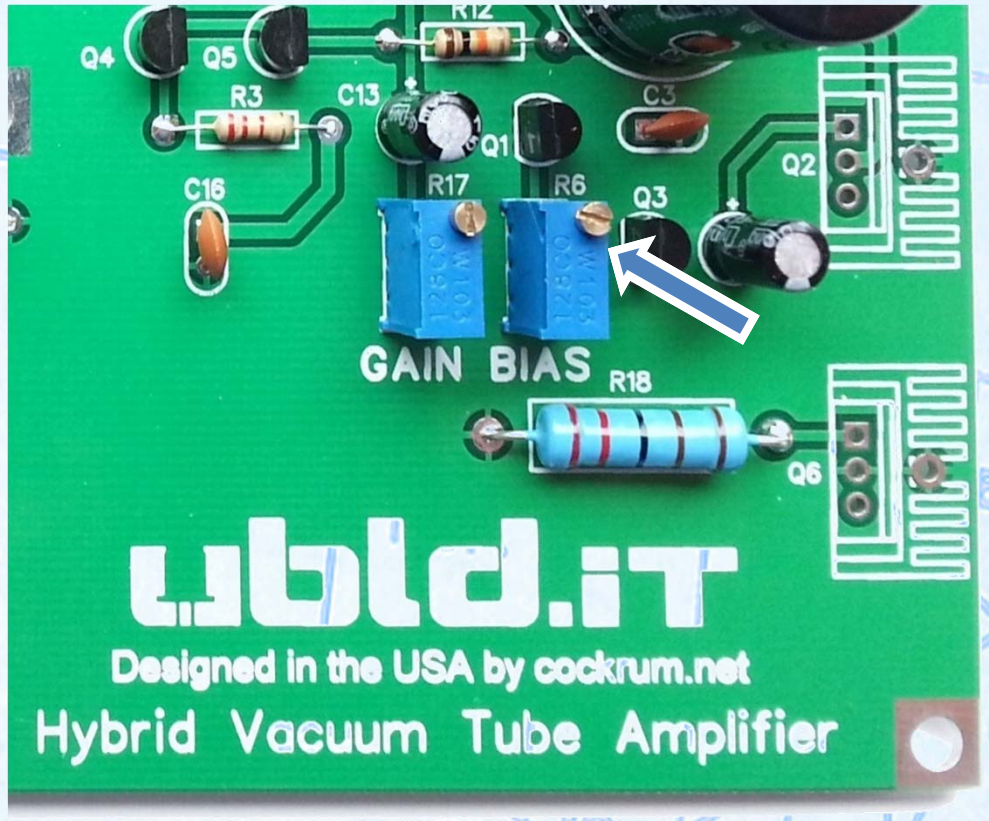
Leave the DC+ disconnected for now.

STEP 62: Before Powering Up

1) Turn the BIAS Potentiomter Counter Clockwise ↶ at least 20 full turns. **Not doing this step will almost certainly result in a fried Q2 or Q6 transistor**

2) Place the power switch in the off position.

3) Plug in the provided IEC Power Cable and turn the switch on **Observe that there is no smoke or fire. Quickly turn the switch off if you sense anything is wrong.**



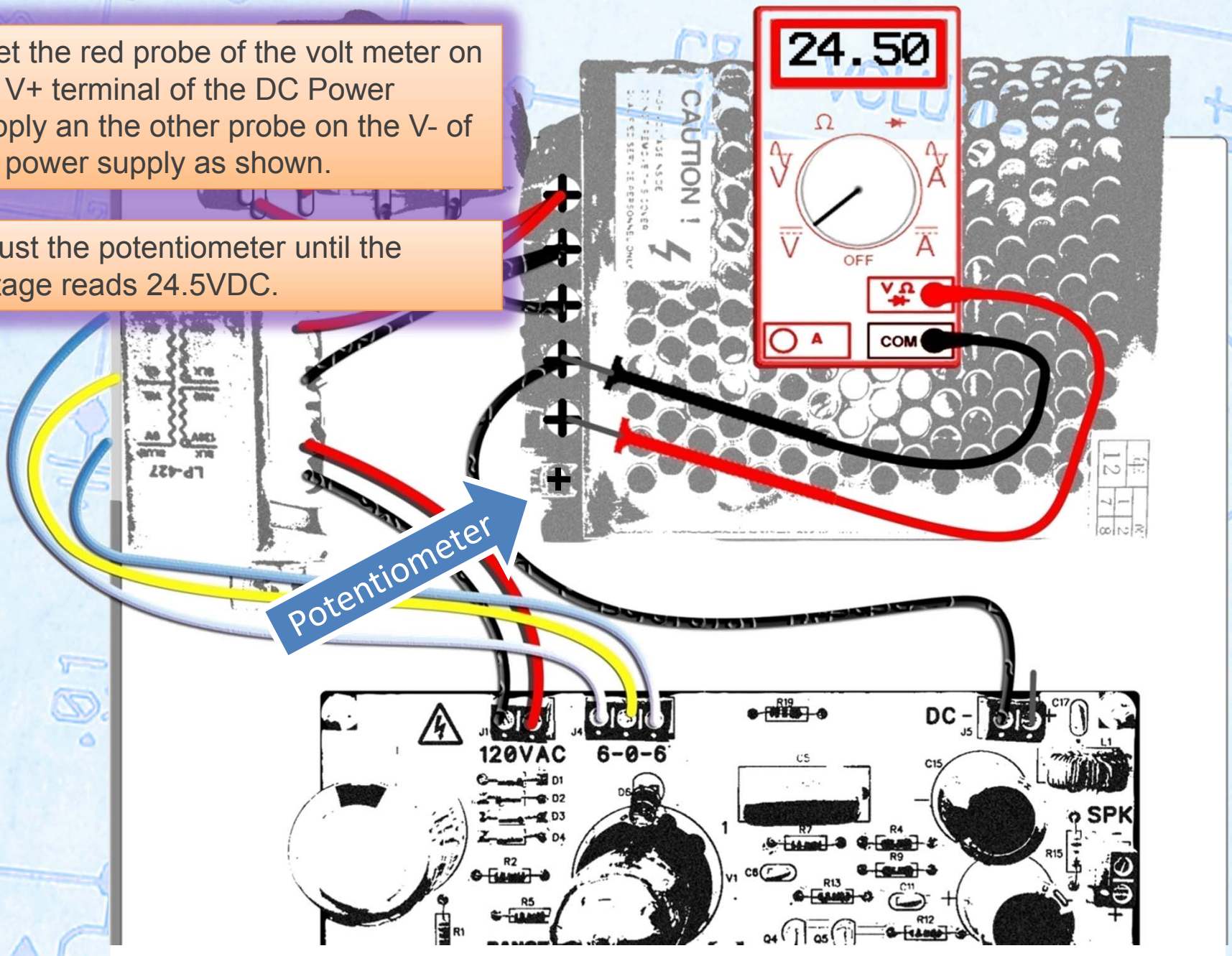
Caution: High Voltage. Probing around is dangerous. Follow directions closely

4) Observe The green LED DC Power Supply light came on.

STEP 63: Adjust DC Power Supply with Volt Meter (V+ and V-)

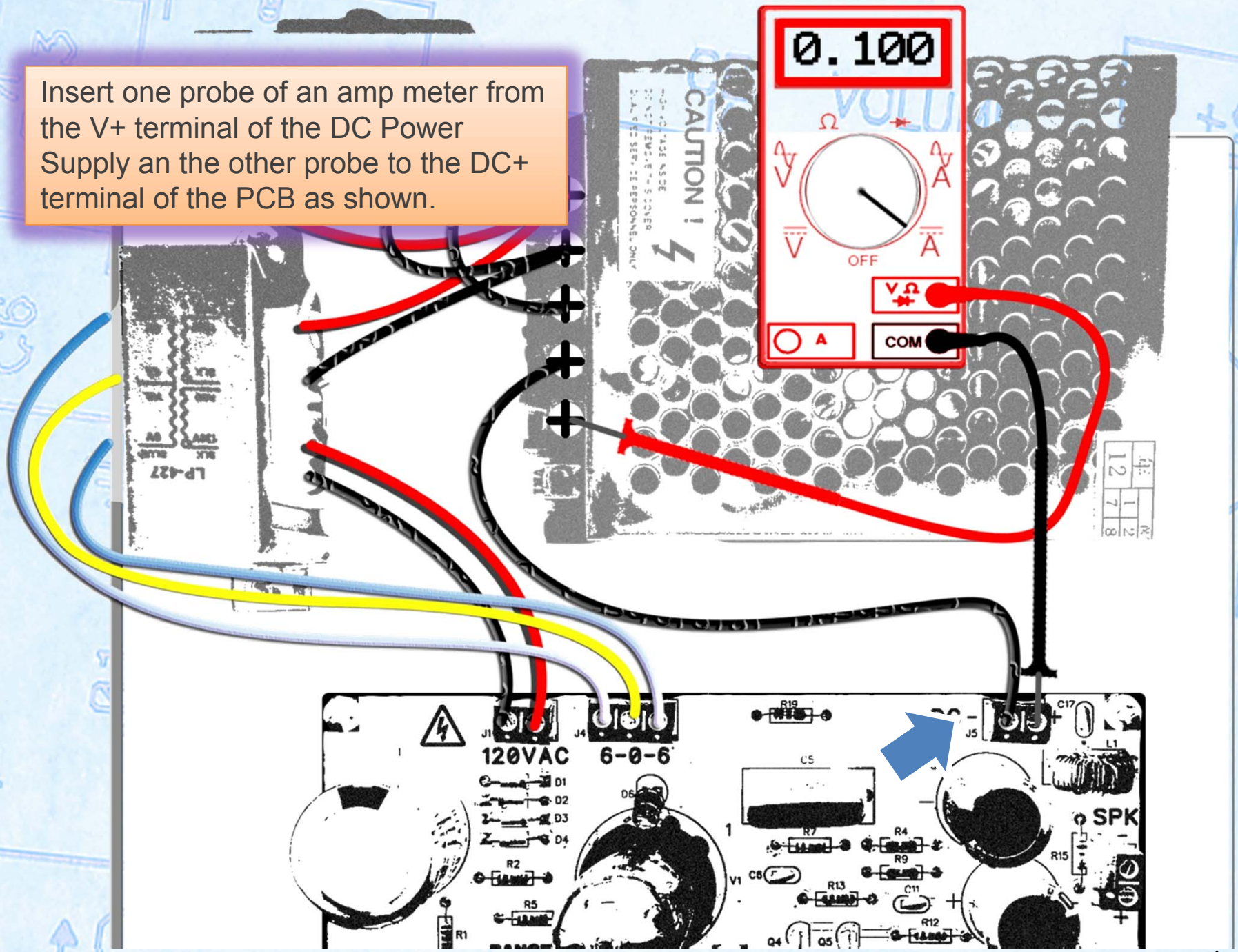
Inset the red probe of the volt meter on the V+ terminal of the DC Power Supply an the other probe on the V- of the power supply as shown.

Adjust the potentiometer until the voltage reads 24.5VDC.



STEP 64: Insert an AMP meter (V+ to DC+)

Insert one probe of an amp meter from the V+ terminal of the DC Power Supply an the other probe to the DC+ terminal of the PCB as shown.

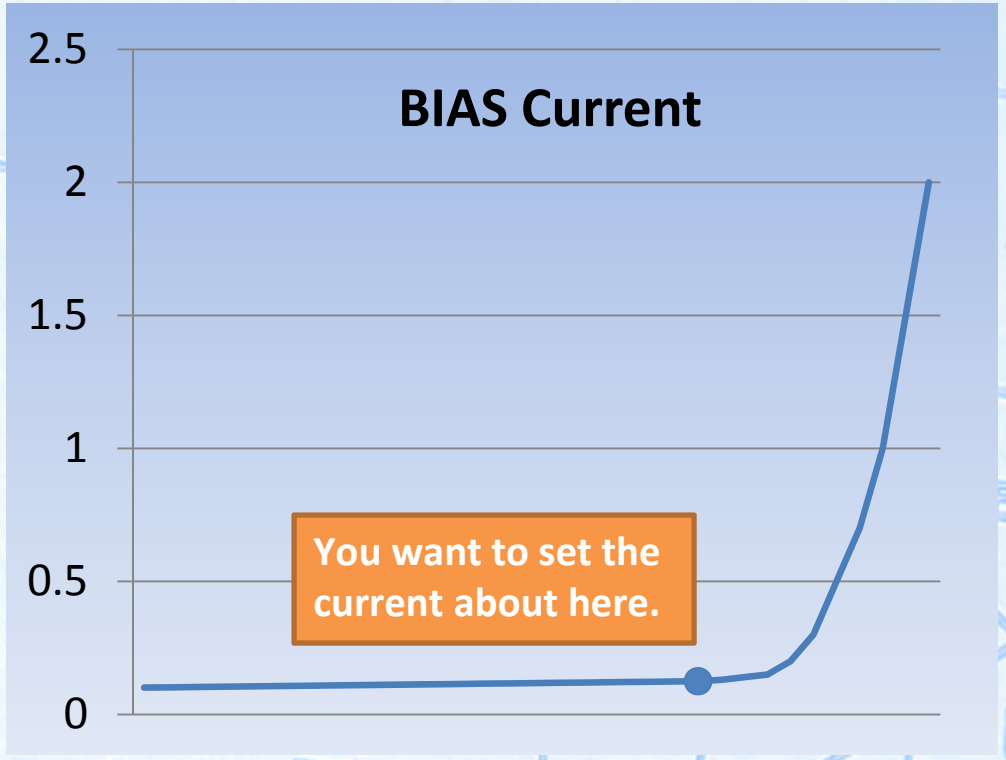


STEP 65: Set the BIAS Potentiometer

1) Place the power switch in the off position.

2) Place meter in current mode and insert it across V+ of the power supply and DC+ of the PCB as shown in step: 65. **Note: Most meters require the probes be place in the 10A position while reading current.**

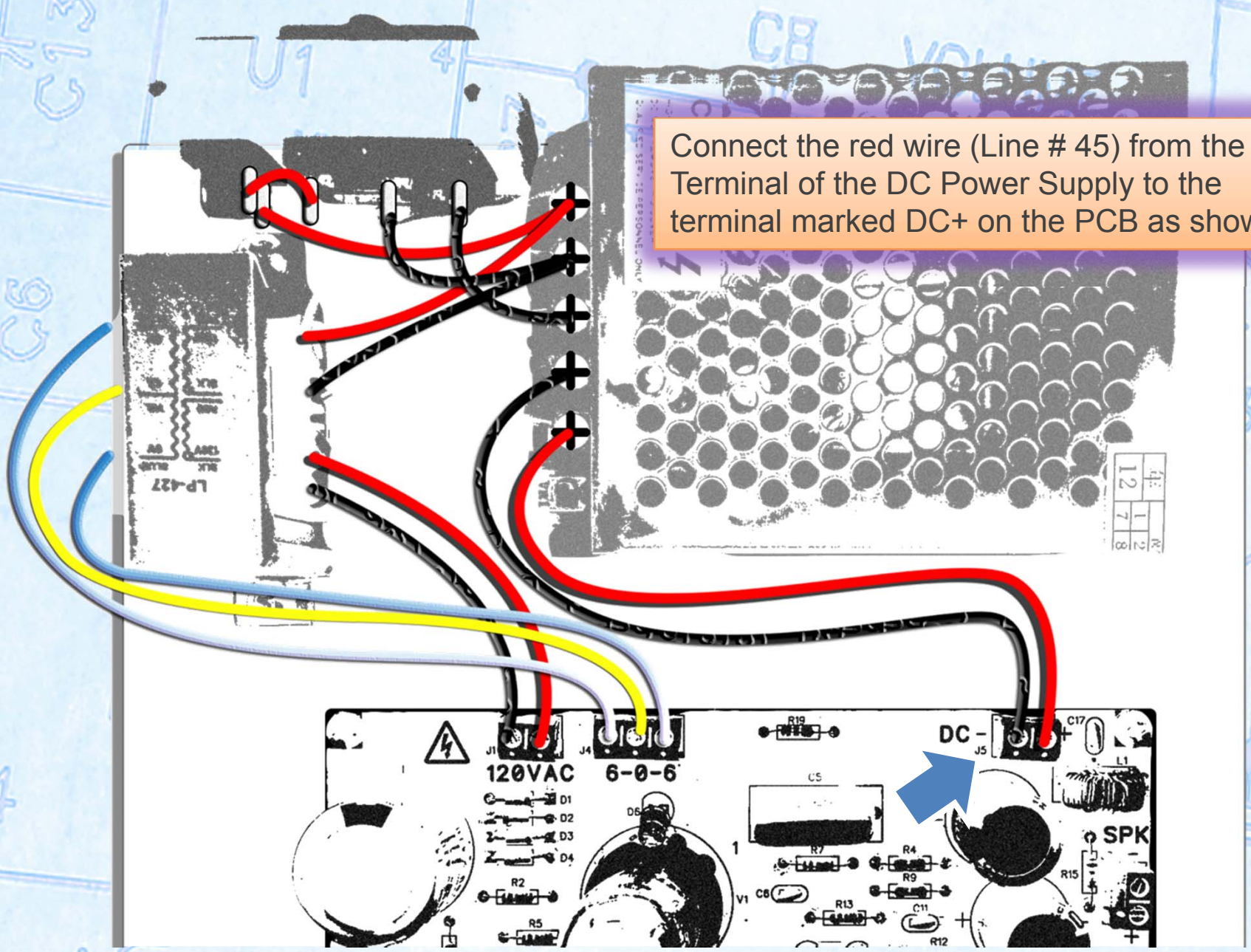
3) Turn the switch on. **Observe that there is no smoke or fire.** Quickly turn the switch off if you sense anything is wrong.



4) Note the current reading when you first powered up. It should be low because in an earlier step you turned the pot 20 time counter clockwise.

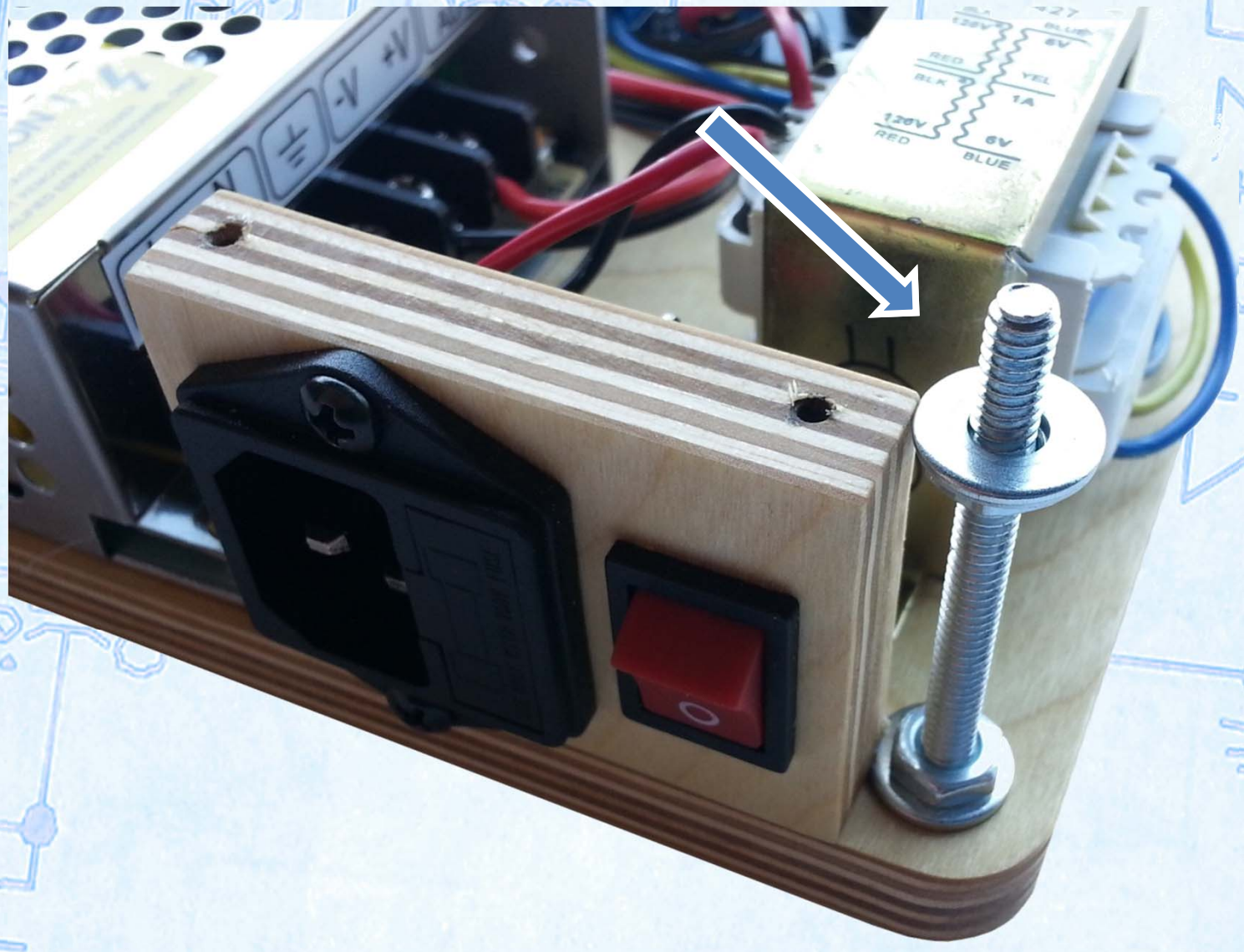
5) Start turning the BIAS pot clockwise slowly about a half turn at a time until you see the current raise rapidly (no more than double the previous turn) and immediately back it off counter clockwise until you return to the value it was at just before it spiked.

STEP 66: Connect the PCB to the DC Power Supply (DC-)



STEP 67: Place Nut and Washer to Corner Post

For all four corner post add a Nut then a Washer. The washer should be level with the top of the IEC/Switch block.



STEP 68: Attach the Acrylic Top

Use the remaining four washers and screws to faster the four corners of the Acrylic lid. Then pre-drill the top of the IEC/Switch wood block and fasten with the remaining two black screws.