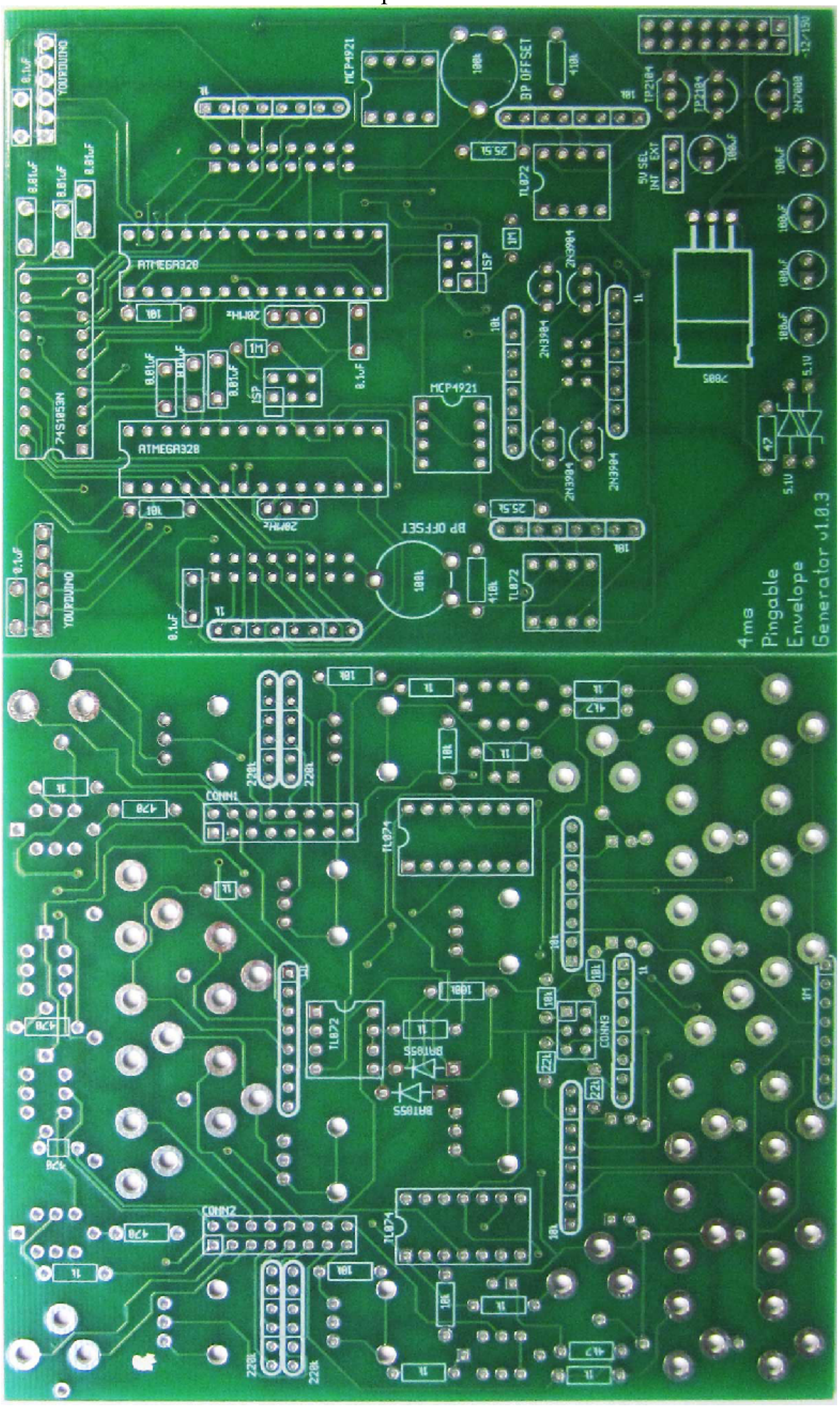
Pingable Envelope Generator

Kit Builder's Guide for PCB v1.0.3

4mspedals.com



PEG

This guide is for building a Pingable Envelope Generator (PEG), which is an intermediate-level kit. You should be confident in your soldering skills, and have a basic familiarity with electronic components. *Note:* The PEG PCB is actually two PCBs that are V-scored so they can be snapped apart. It's easiest to assemble the board in one piece, and then snap the boards apart afterwards.

Tools Needed:

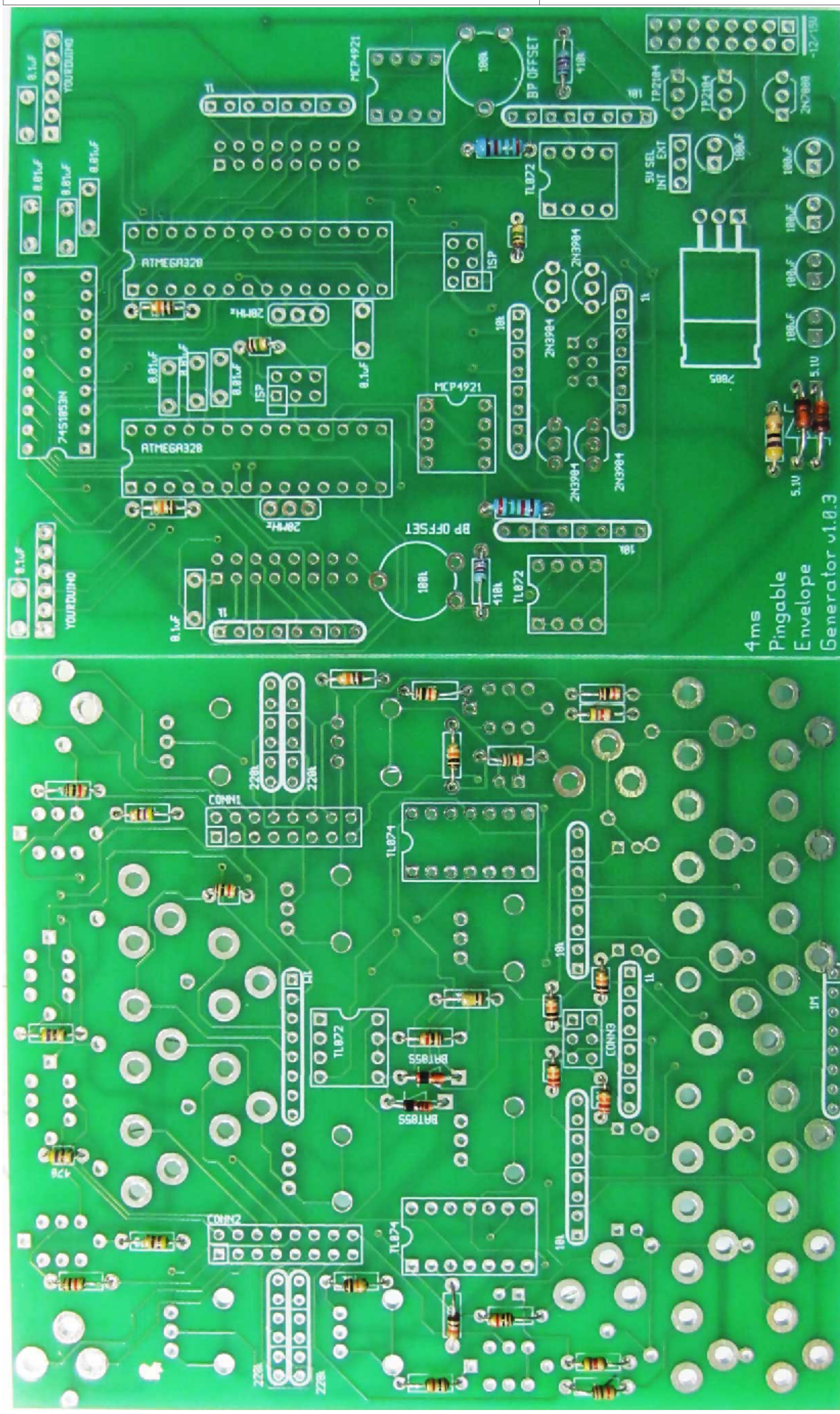
- Soldering iron, solder, tip cleaner/sponge
- Flush snips
- Needlenose pliers (for removing a component if you make a mistake)
- 5/16" socket driver (optional: pliers will work too if you're careful)
- Multimeter (optional: for reading resistor values if you don't know the resistor color code chart, and also useful for troubleshooting)

Step 1: Resistors

Insert and solder the 34 resistors and 4 diodes. There are thirty carbon resistors (tan body), four 1% resistors (blue body), two Zener diodes (large glass body), and two Schottky diodes (small glass body). Due to variations in components, you may find that some resistors are larger than others in your kit. The size is irrelevant, only the color bands matter. The exception is the 47 ohm resistor, which must be the large size (1/4W). After soldering, snip the leads nearly flush to the PCB.

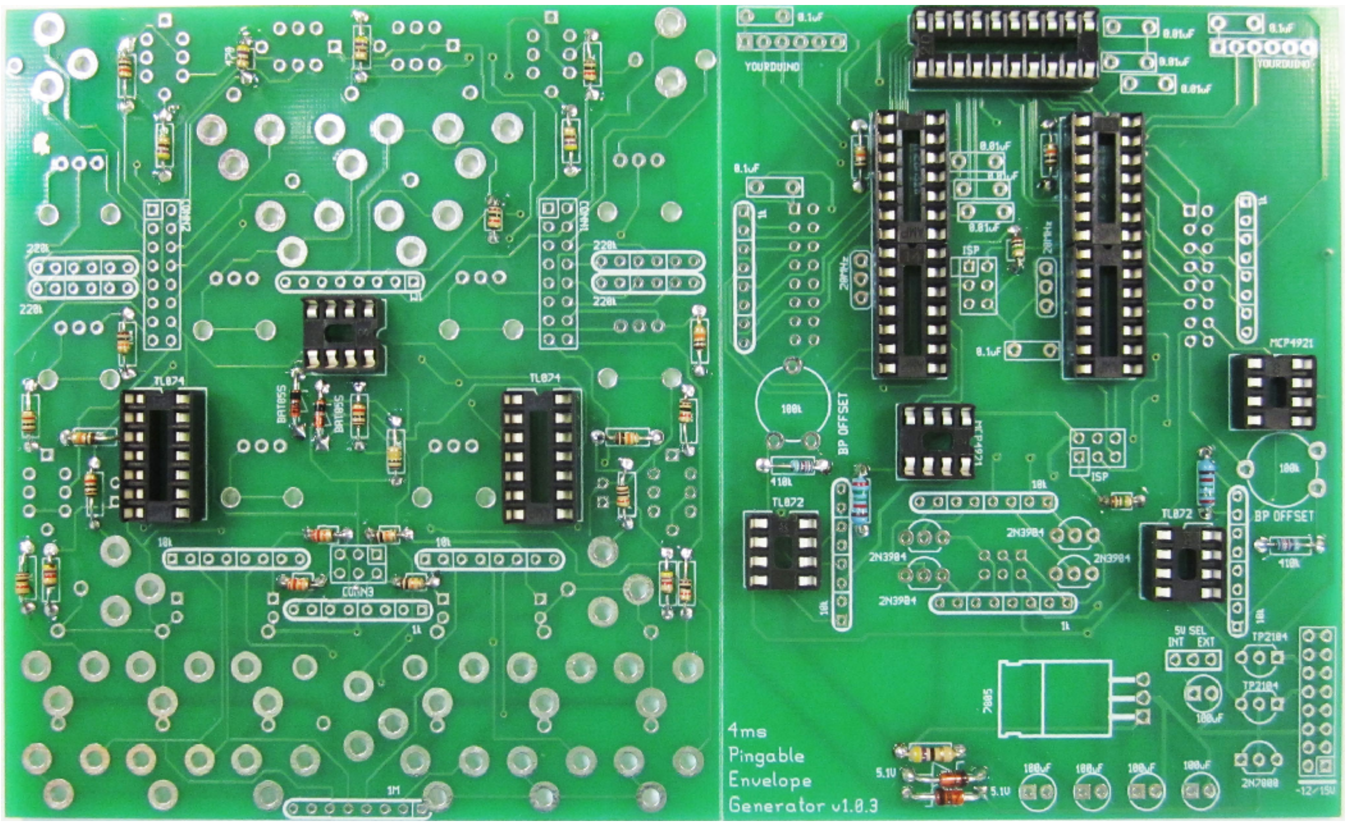
For the diodes, the black band on the diode must go towards the tip of the arrow on the PCB

The 30 tan carbon resistors: • *47ohm x 1 (yellow purple black gold) 1/4W large body* • *470ohm x 4 (yellow purple brown gold)* • *1k x 10 (brown black red gold)* • *4k7 x 2 (yellow purple red gold)* • *10k x 8 (brown black orange gold)* • *22k x 2 (red red orange gold)* • *100k x 1 (brown black yellow gold)* • *1M x 2 (brown black green gold)*	The 4 blue 1% resistors: • *25.5k x 2 (red green green red brown)* • *412k x 2 (yellow brown red orange brown)* ******Value may vary, but will always be yellow [something] [something] orange brown (400k-499k)****** The 4 diodes (red glass): • *5.1V Zener 1N4733 x 2 (large body)* • *BAT85S Schottky x 2 (small body)* **Note orientation! Black band=arrow tip**



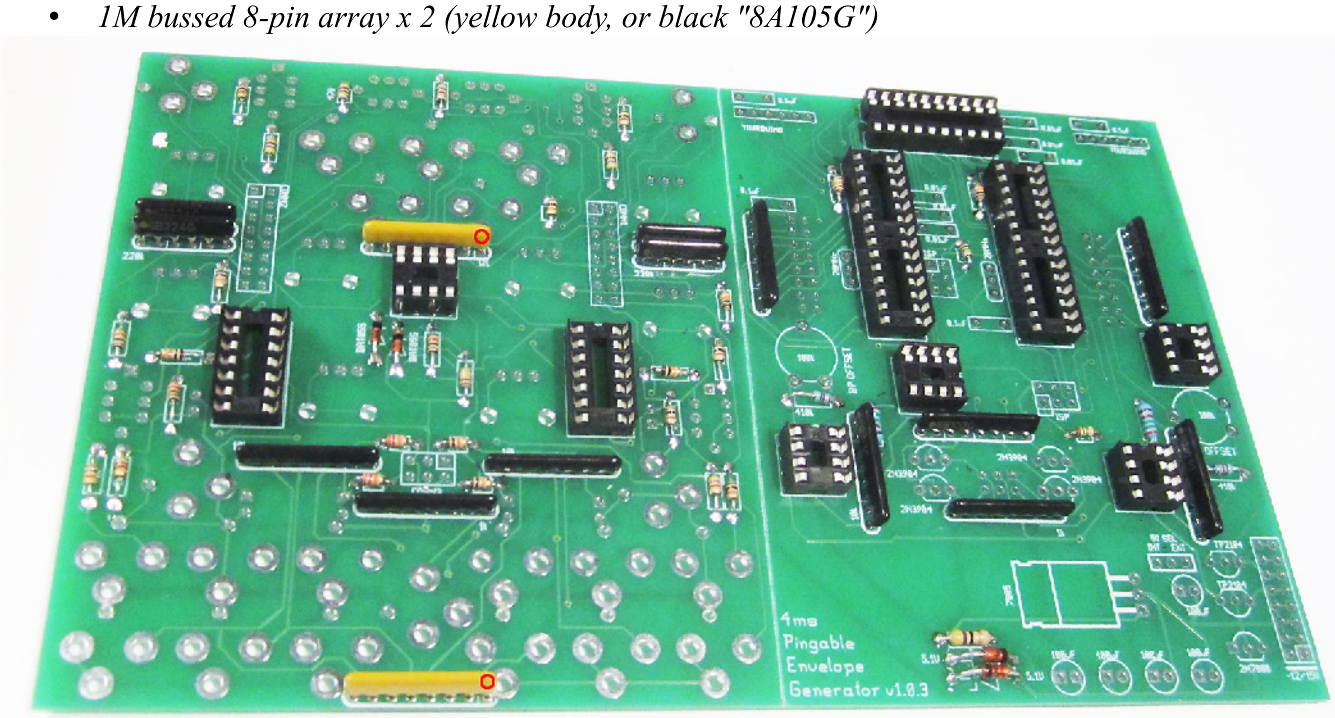
Step 2: Sockets:
Insert and solder the IC sockets. The notch in each socket should match the notch drawn on the PCB. Note that the 28-pin sockets are formed with two 14-pin sockets (these are for the ATMEGA328 chips).

- *8-pin socket x 5*
- *14-pin socket x 2*
- *28-pin socket x 2 (each 28-pin socket is really two 14-pin sockets)*
- *20-pin socket x 1*



Step 3: Resistor Arrays:
Insert and solder the 15 resistor arrays. The 1k's, 10k's and 220k's can go in either way, but the two 1M arrays must go in with the dotted pin in the square hole. The dot can be seen over the leftmost pin if you hold the array so that you can read the writing. In the photo below, the writing on the yellow arrays is facing away from the camera.

- *1k isolated 8-pin array x 4 ("8B102G")*
- *10k isolated 8-pin array x 5 ("8B103G")*
- *220k isolated 6-pin array x 4 ("6B224G")*
- *1M bussed 8-pin array x 2 (yellow body, or black "8A105G")*

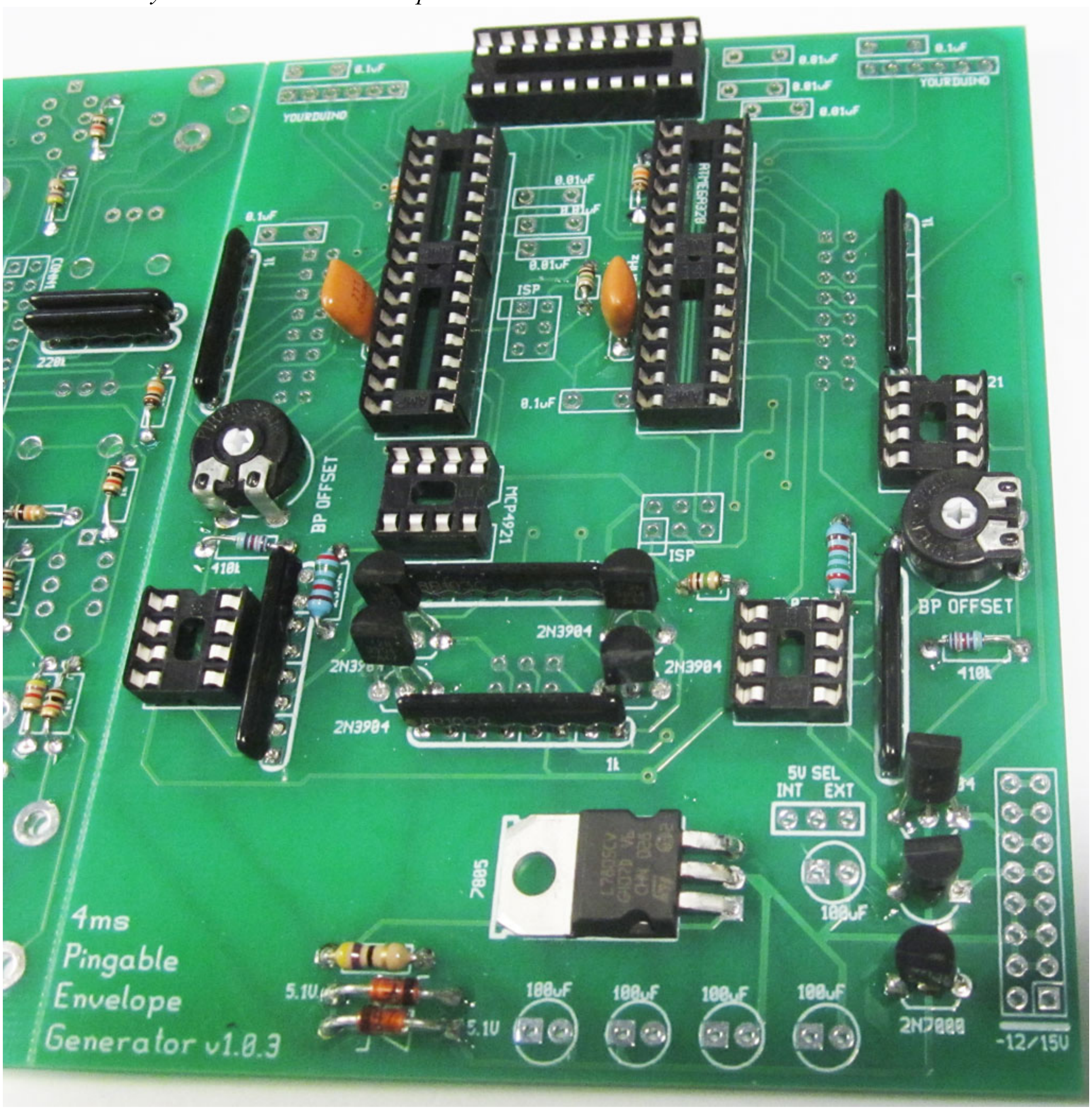


Step 4: Transistors, Voltage Regulator, Resonators, Trimpots:
Insert and solder the transistors. The orientation is crucial: the curved and flat sides of each transistor must match the curved outline drawn on the PCB. Five transistors have their flat sides facing the bottom (2N3904's and 2N7000), and two face the top (TP2104's).

- *2N3904 x 4*
- *TP2104 x 2*
- *2N7000 x 1*

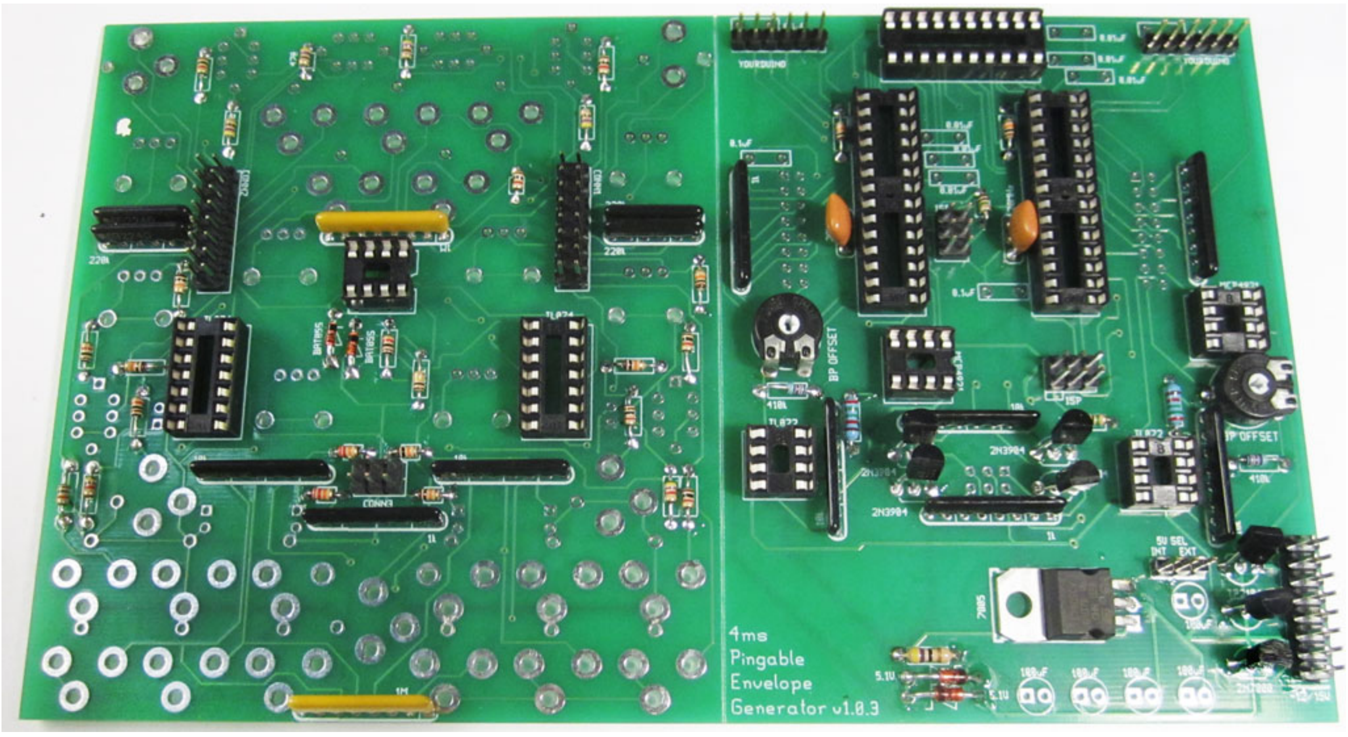
Next, insert and solder the voltage regulator (7805). Bend it down flush to the PCB as shown in the photo. The words must be facing upwards. Also insert and solder the two orange crystal resonators (orientation doesn't matter), and the two 100k trim pots

- *7805 voltage regulator -- Bend down flush to PCB*
- *100k trim pots x 2*
- *16MHz Crystal Resonator -- can be placed either direction*

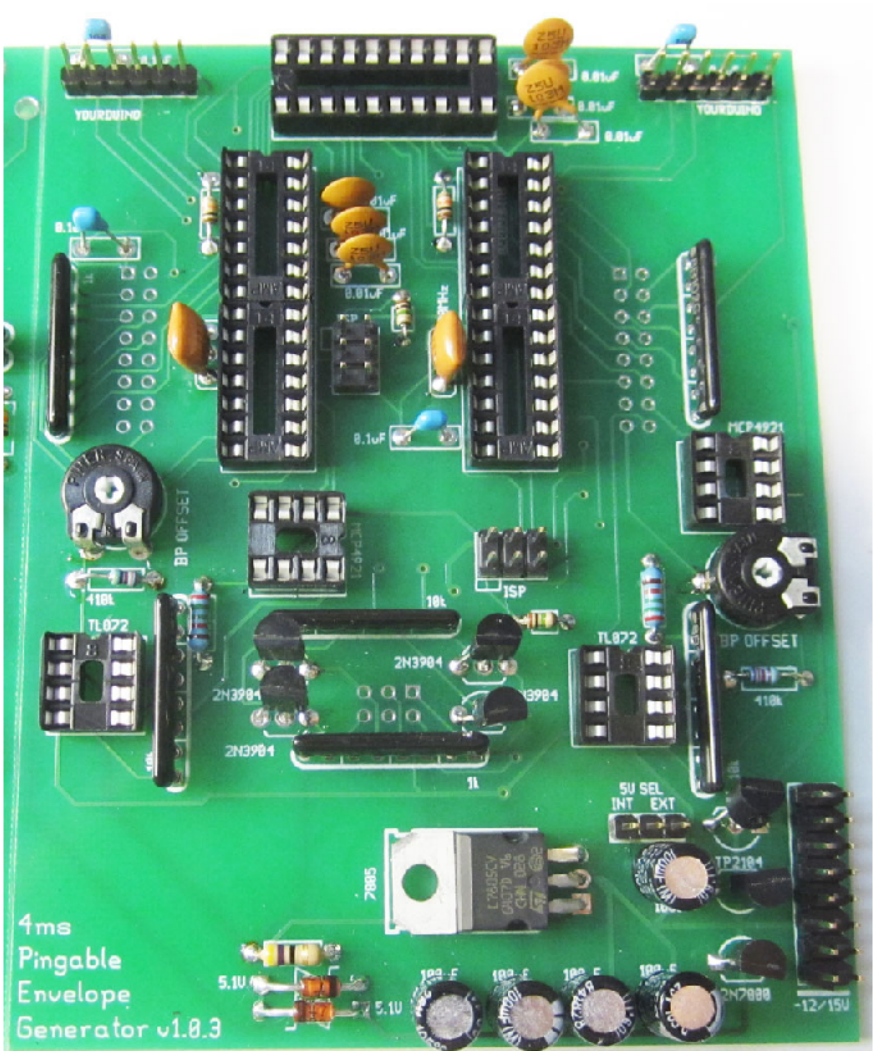


Step 5: Header pins:
Insert and solder the header pins. Since they fall out easily, it helps to put a piece of stiff cardboard or something over the PCB, then flip it over to solder.
Make sure the header pins are flush and vertical-- your PEG won't fit together if the header pins are not vertical! Solder one or two pins per header, then flip the board back over and check to make sure they are lined up, flush to the PCB, and the pins are at a perfect right angle to the PCB. When you verify this, flip the board back over and solder the rest of the pins.

- *2x8 headers x 3*
- *2x3 headers x 3*
- *1x6 headers x 2*
- *1x3 header x 1*



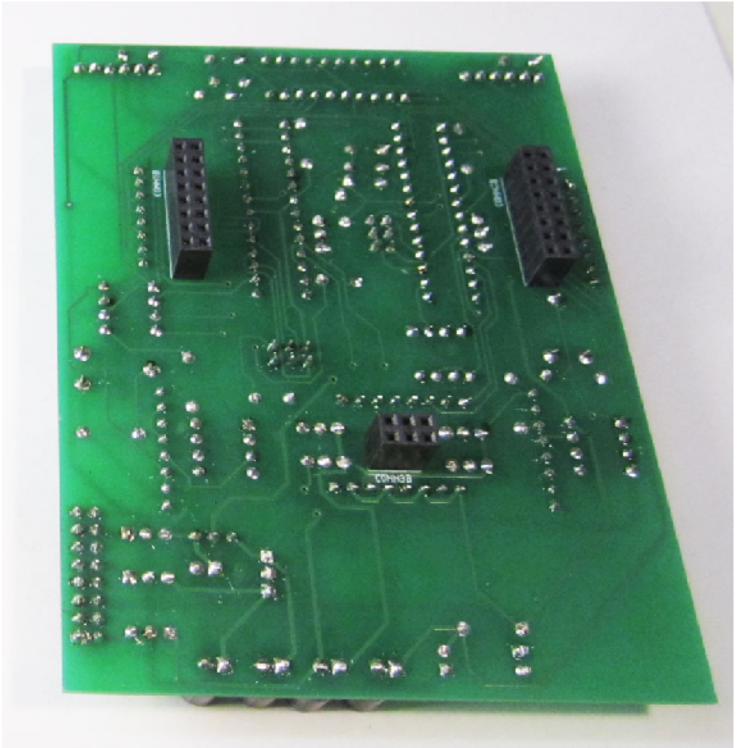
Step 6: Capacitors:
Insert and solder the 15 capacitors. The 0.1uF and 0.01uF caps can go in either way, but the 100uF cylinder caps must go in with the long lead in the square hole. All five 100uF caps are orientated the same way, with the striped side to the right.



- *0.1uF (104) x 4*
- *0.01uF (103) x 6*
- *100uF x 5*

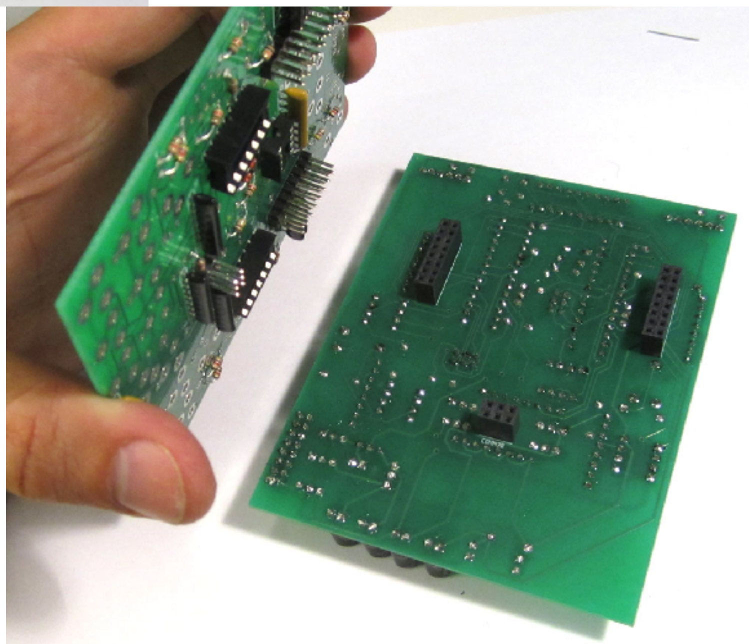
Step 7: Female headers:

A. First, snap you boards apart. There is a score down the board, and you can just snap them apart with your hands.

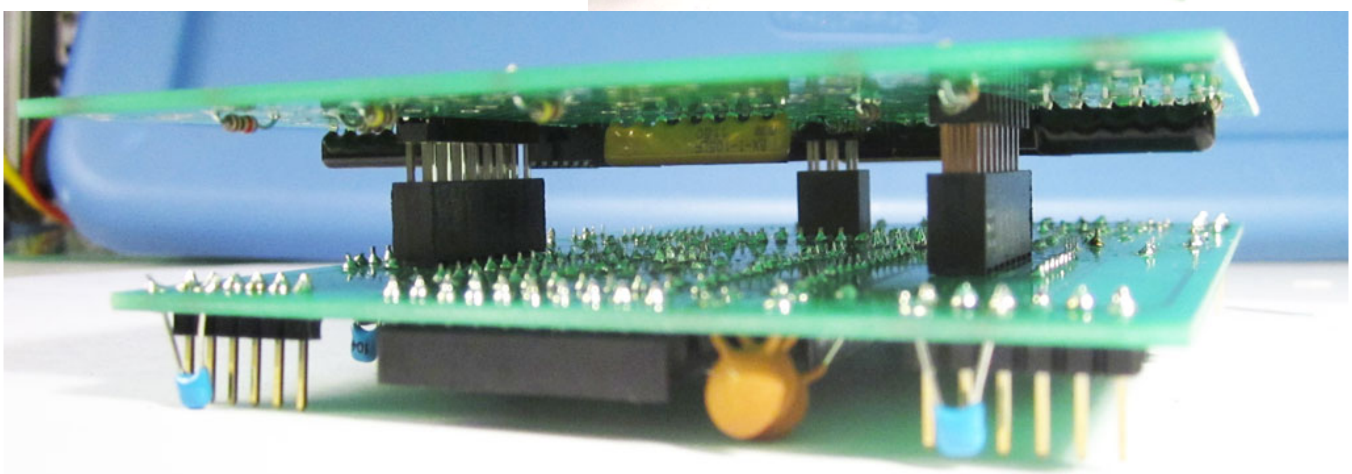


B. Flip the smaller board over so the resistors, sockets, etc are facing down. Insert the 3 female headers as shown. **Do not solder yet!**

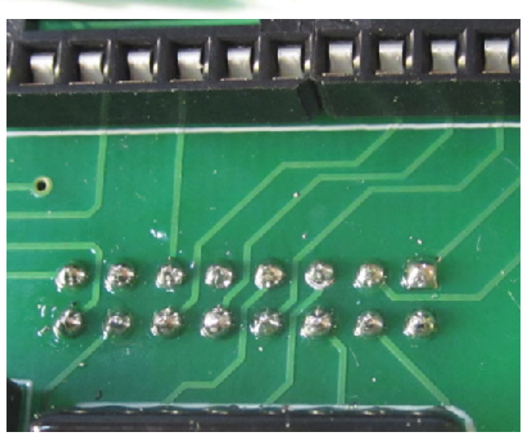
C. Lay the larger board on top of the smaller board so that the three headers line up with the female headers.



D. Gently press the boards together. Verify that everything is straight and none of the headers are at an angle, and no pins are sticking out.

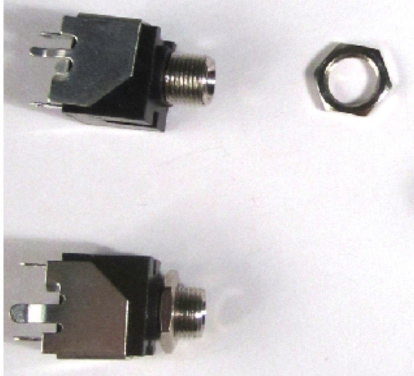


F. Now, squeezing the boards together so the female headers don't fall out, flip the boards over and solder the female headers



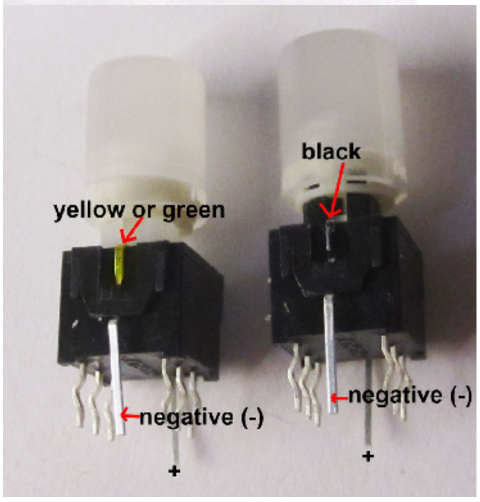
G. Take a minute to carefully inspect the large board. Make sure every component is soldered, and that you didn't miss a joint. It's especially easy to miss a joint in the rows of header pins. **After the next step it will be hard to locate and fix a problem, so take the time now to check everything over.**

Step 8: Prep mounting



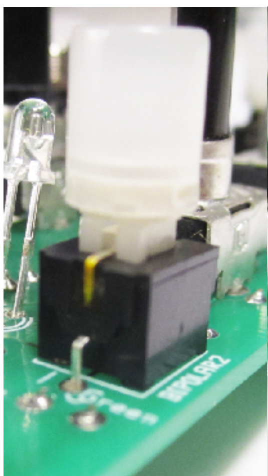
A. Put a hex nut on each of the 22 jacks. Finger tighten the nut (don't use a wrench). Insert the 22 jacks into the PCB. Do not solder yet.

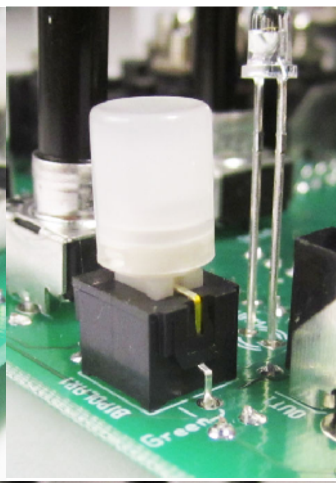
B. Insert the 8 pots into the PCB. You may have to slightly bend the large tabs inwards so the pots will snap in place. Do not solder yet.

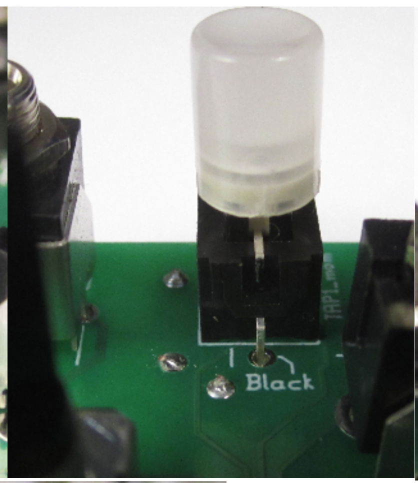


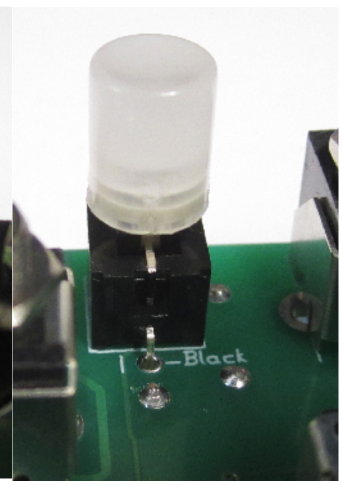
C. Look closely at the six buttons. Four are marked with a yellow mark and two are marked with black. See the photo on left. The side with the black or yellow mark is the negative side. On the PCB, this side is marked with a minus sign (-) as well as the name of the color that should go in that hole. *Note: Green and Yellow are considered the same color.* Insert the buttons into the PCB, being careful that they go in the right way and that no pins are bent.

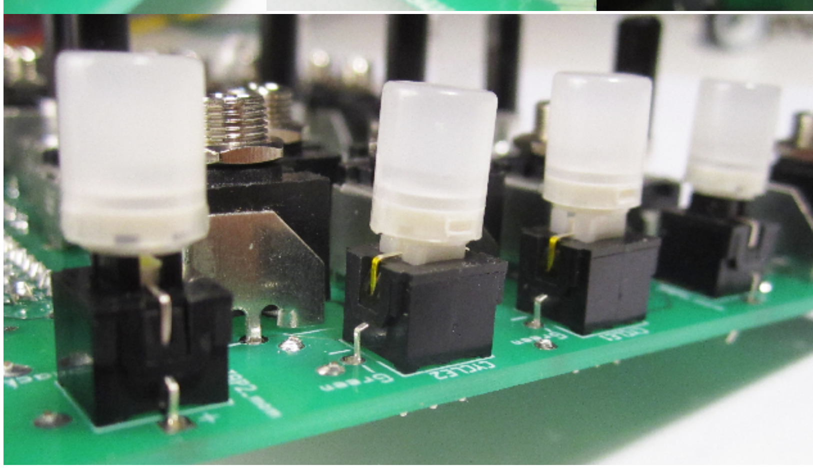
D. Verify your LED buttons are in correctly. It's very difficult to remove a button that's in backwards or is the wrong type. See photos. Check carefully.

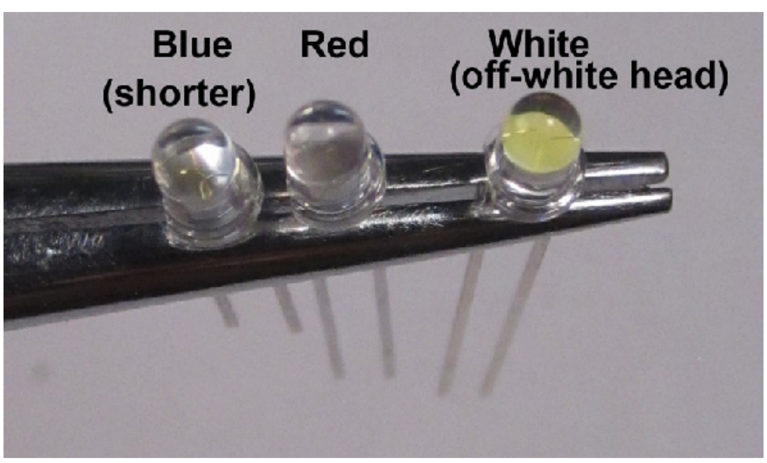






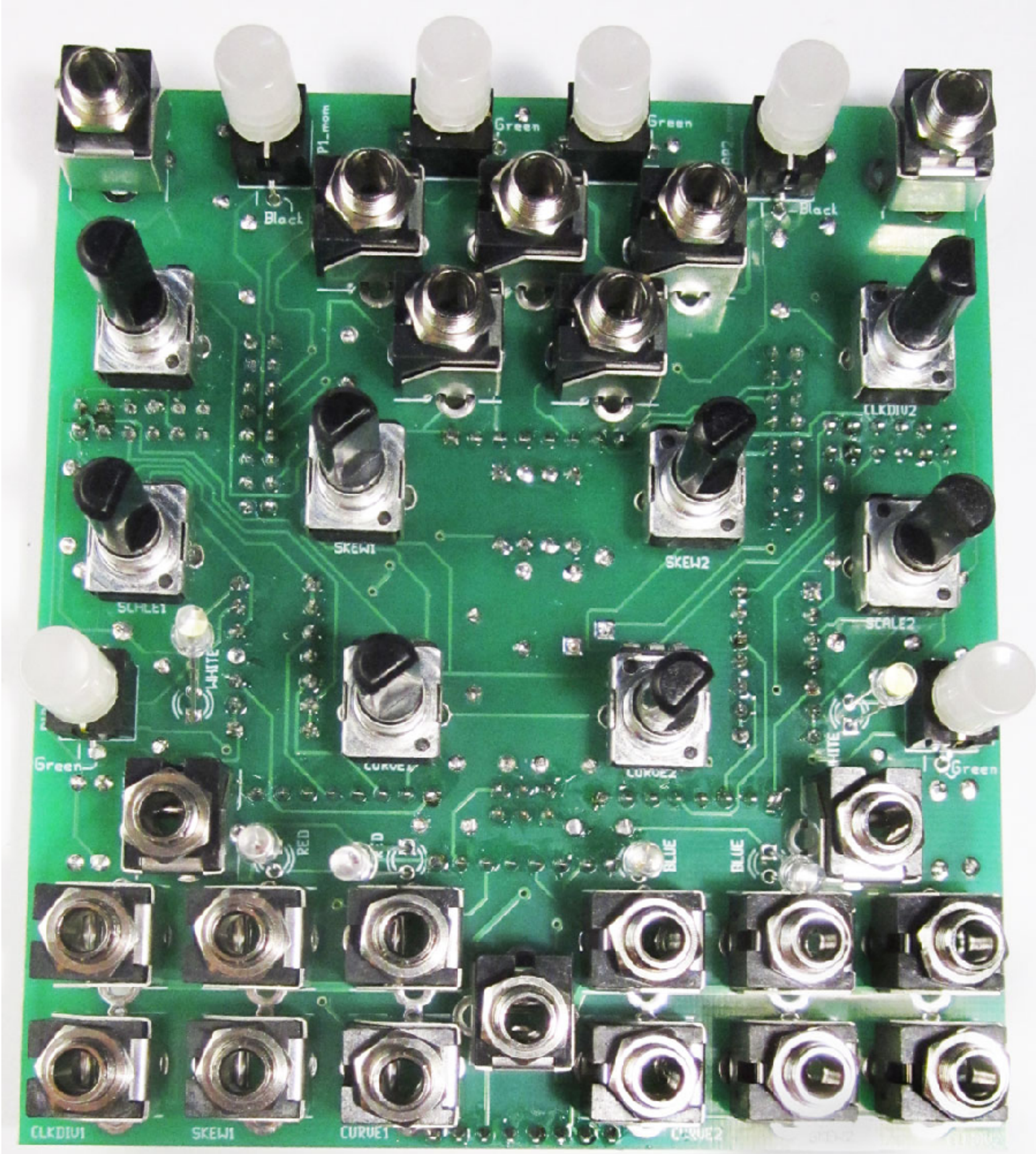




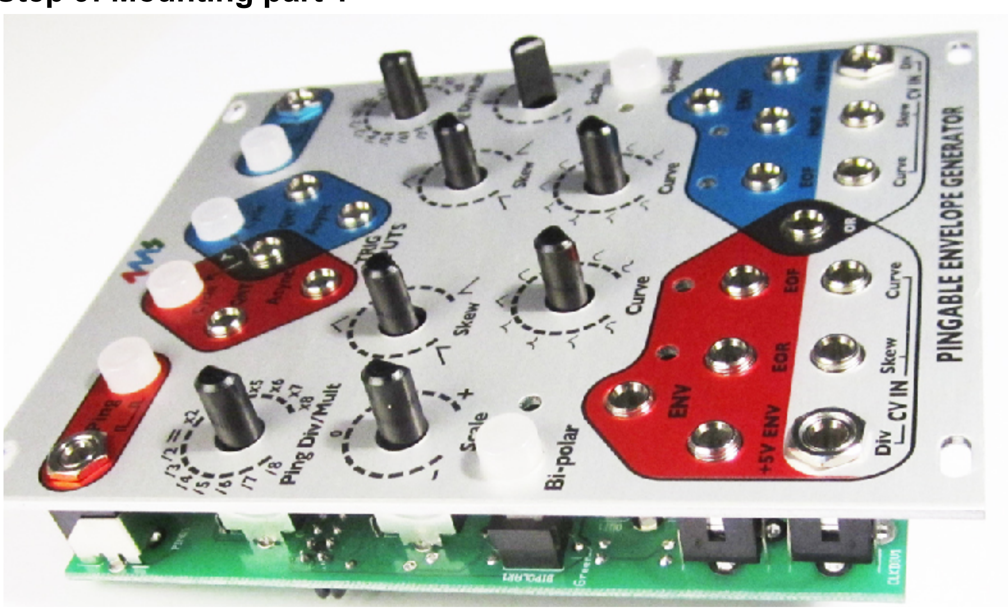


E. Look closely at the 6 LEDs. The ones with short leads are Blue, the ones with milky off-white heads are White, and the clear, long ones are Red. Insert the LEDs into the PCB where marked. The longer lead goes in the square hole.

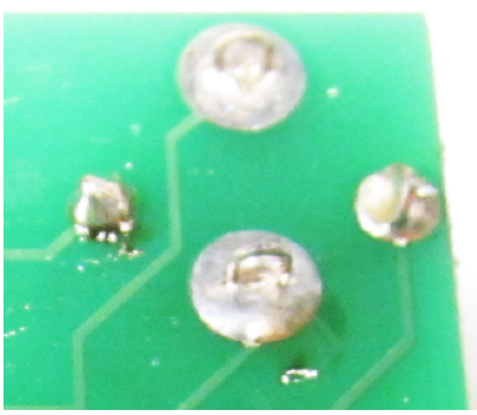
F. After inserting all 6 LEDs, verify the long lead is in the square hole. This is easy to mix up, and hard to fix later.



Step 9: Mounting part 1



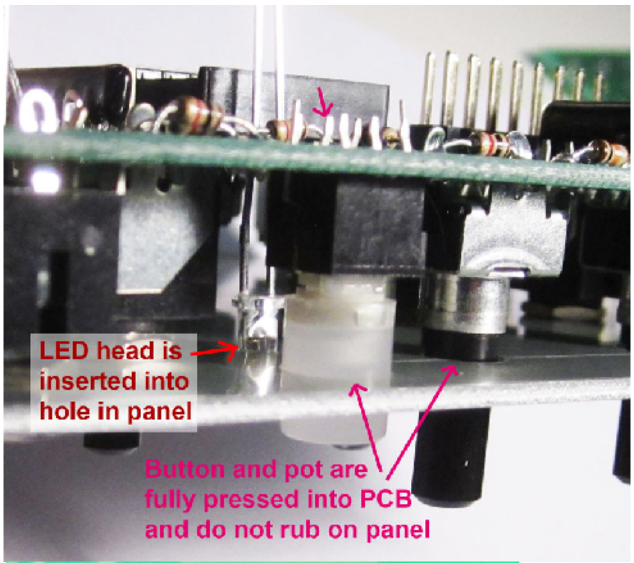
A. Push the LEDs down close to the PCB. Take the panel and gently lower it down on the PCB. Wiggle it slightly so that it fits over the pot shafts, then the buttons, then the jacks.



B. Once the panel is on, hold everything together with one hand while putting a nut on the four corner jacks with the other hand. This is tricky and you may drop the nut a few times: don't worry, this is the hardest part. Tighten the nuts down **slightly (1/16 turn)** with a 5/16" socket or pliers (be careful not the scratch the panel!).

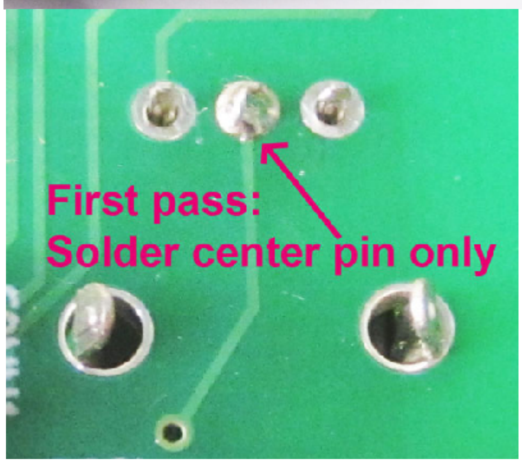
C. Flip it over and solder the 4 corner jacks (see photo)

Step 10: Mounting part 2



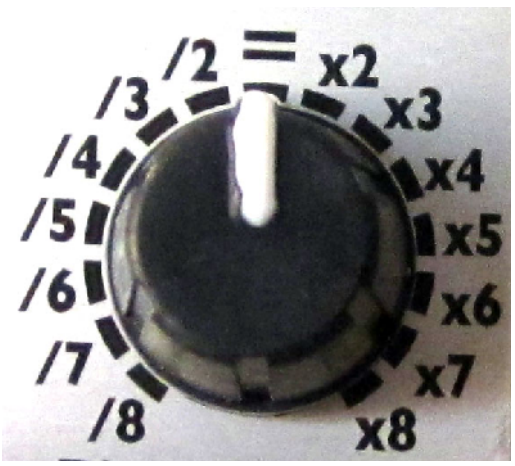
A. Hold the unit so the panel is facing the floor. Gently guide the LEDs by their leads so their heads fit flush into their holes in the panel. You may want to slightly splay their leads out so they stay in place.

Push up on the heads of the 6 buttons to verify they are firmly pressed to the PCB. Do the same for each of the 8 pots.(See photo at left)



B. Now solder one joint on each component:

- One lead of each LED (either one)
- The center pin of each pot (see photo)
- One of the middle-ish pins of each button



C. Flip the unit over and install the 8 knobs on the pots. Notice how the pot shafts have a D shape, as well as the inside of the knob. Place a spacer under the knob, perhaps a toothpick or a piece of cardboard, so as you push the knob firmly down the shaft, it won't go all the way to the panel and rub when you turn the knob.**The knobs are very difficult to remove, so go slow and be careful.**

D. Move each knob so that it's centered within the panel artwork.

E. Verify that each button can be pressed without rubbing on the panel, that each LED is visible through it's hole in the panel. If necessary, re-position a control by heating up the one pin you soldered in step 10B.

F. When you're sure all the pots, jacks, buttons and LEDs are all placed perfectly, install the rest of the jack nuts, and go around and tighten all the nuts with a 5/16" socket or pliers (careful not to scratch the panel!)

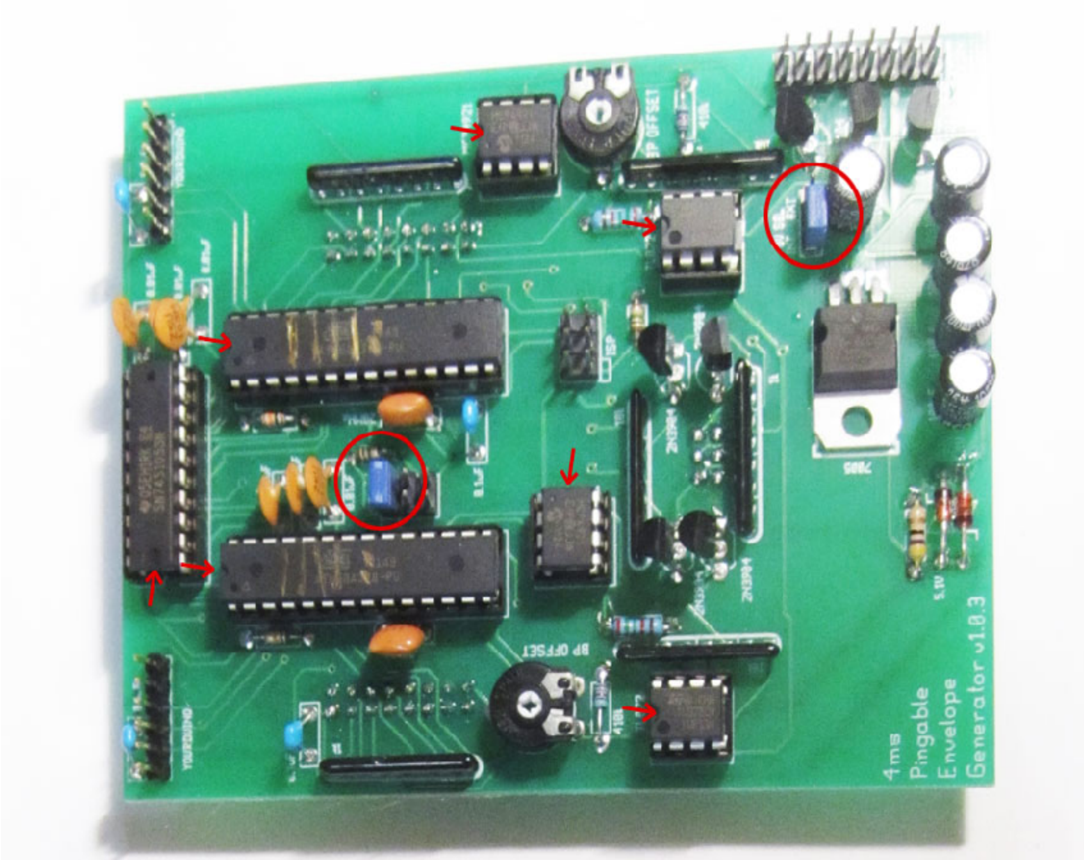
G. Check all the pots, buttons, and LEDs a third and final time, and then flip the unit over and solder the rest of the PCB (all jacks, pots, buttons, and LEDs). Snip the LED leads short.

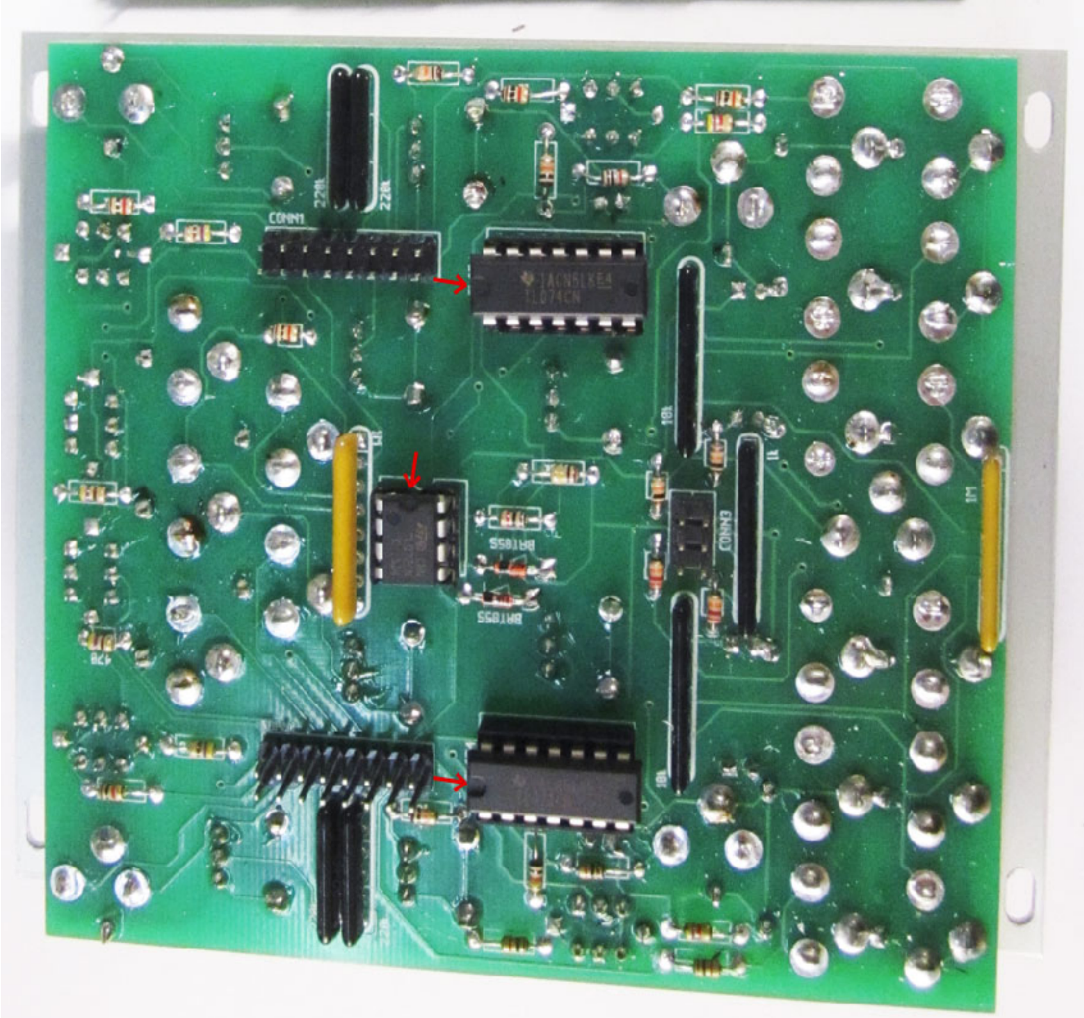
Step 11: Insert ICs and jumpers

Each IC has an orientation, the dot or notch should be pointed towards the notch in the IC socket. Verify you didn't put the IC socket in backwards by checking that the IC notch/dot lines up with the notch drawn in white on the PCB. See photo (the red arrows indicate the notch/dot).

- *TL072 (8-pin) x 3: One on the large board (notch facing right), two on the small board (notch facing up)*
- *TL074 (14-pin) x 2: Both on the large board (notch facing up)*
- *ATMEGA328 (28-pin) x 2: Both on the small board (notch facing up)*
- *74S1053 (20-pin) x 1: On the small board (notch facing left)*
- *MCP4921 (8-pin): Two on the large board, close to the ATMEGA chips. One notch faces right, one notch faces up*

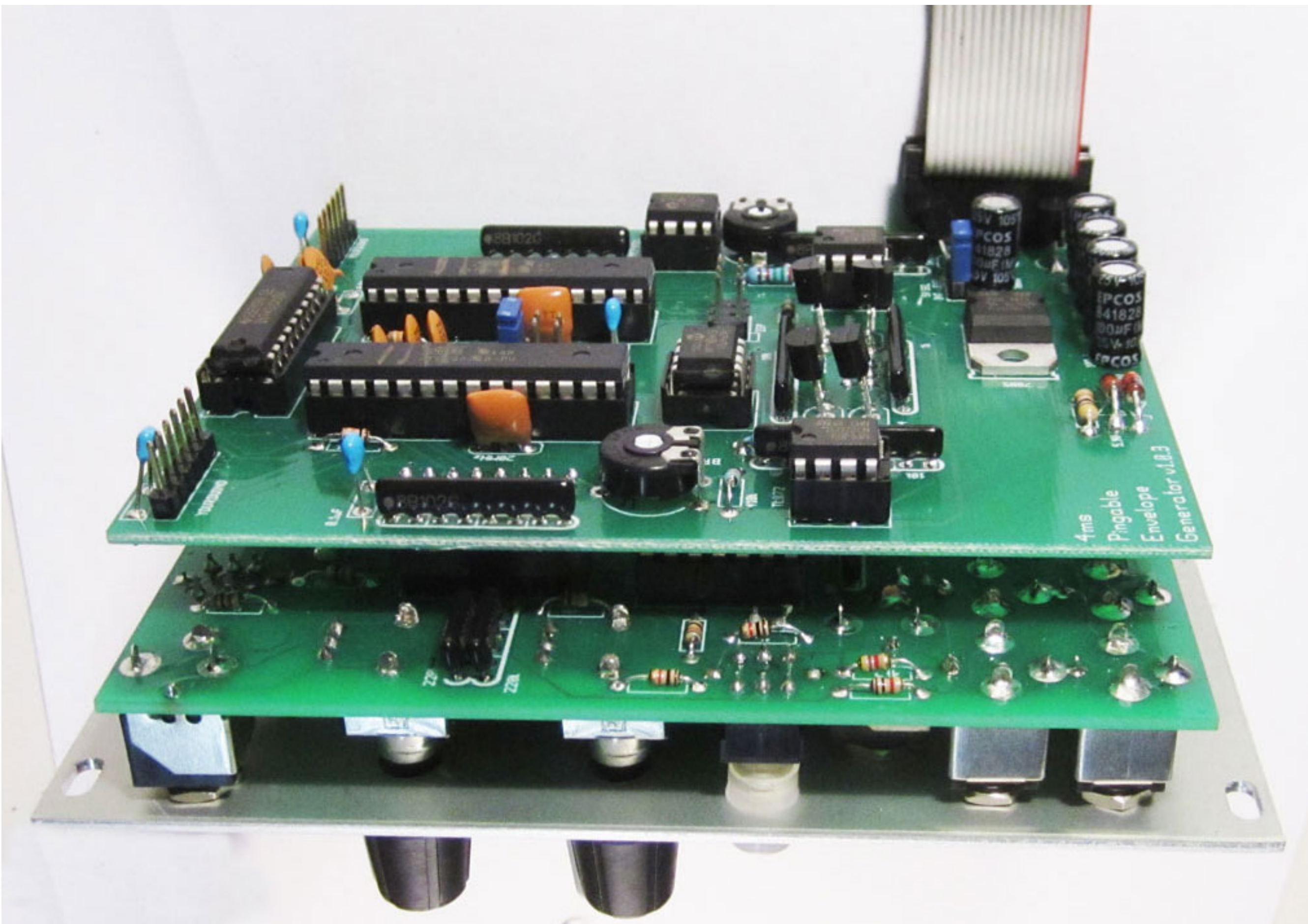
Install one of the blue jumpers on the 3-pin header, on the left side ("INT"). Install the other jumper between the top two pins on the 2x3 ISP header that's between the two ATMEGA chips, as shown by the red circles in photos





Step 12: Finishing touches

Put the two PCBs together: just like you did before in step 7. Push firmly so the pins go all way into the headers and no metal is exposed on the pin.
Install the 16-pin ribbon cable with the red stripe at the bottom (-12/15V).



Step 13: Take a break.

That's right, walk away and do something else.
This is a critical step **especially if you are an advanced kit builder or electronics person** (beginners tend to check their work with more skepticism!). There are many things you can do wrong in building a PEG that causes it to smoke and destroy components. So don't rush, have a clear head, and check your work.
Come back refreshed. Look over everything:

- Check all the solder joints, it's easy to miss one.
- Verify the ICs and IC sockets are not in backwards.
- Verify the transistors and especially the FETs are not in backwards: flat face should face the bottom of the board, except the TP2104's should face the top. **A backwards FET will smoke and pop instantly destroy itself.**
- Verify the diodes have the band pointing to the line on the PCB
- Verify the 100uF caps are not in backwards (stripe to the right).
- Verify the 1M Resistor Arrays have the dot pointing to the right.
- Verify the header pins are not bent.
- Verify no components are sticking up and potentially able to short out to something.
- Verify you installed the blue jumpers in the right places.

Step 14: Power up and calibrate

Power it up! Lights should come on immediately. If not, unplug immediately and check around for errors, especially near the power connector (missing a blue jumper on the 1x3 header??). If it lights up, make sure the buttons respond. If they don't, then the ATMEGA chips may have a problem.
If it's all good so far, you can calibrate the trim pots as follows:

1. Turn all knobs to center up, except turn the Scale knobs to fully Clockwise
2. Press both Bi-polar buttons so they light up.
3. Tap both Ping buttons twice.
4. Press both Cycle buttons so they light up. The six red/blue/white LEDs should be blinking
5. Trim pots: each channel has a trim pot to adjust the DC offset of the bi-polar output. This can be set to anything you like or find useful/fun: the unit will function 100% perfectly no matter where you set the trim pot. If you want your unit to match the 4ms factory setting, do the following:
    1. If you have an oscilloscope, adjust the trimpot on each channel so the waveform on the ENV jack is centered around 0V (should be about +5.0V top peak to -5.0V bottom peak)
    2. If you don't have an oscilloscope, plug the ENV output of one channel into the 1V/oct or pitch control of a VCO. Listen to the VCO's highest pitch. Now turn the Scale knob all the way CCW and listen to the VCO's highest pitch. If the first pitch is higher, nudge the trimpot down a tiny bit; otherwise nudge it up a tiny bit.
    3. This only a starting point. You might find it cool or useful to set the trimpot otherwise. Note that the trimpot has no effect if the Bi-polar button is off. See the PEG manual for an example of setting the trimpot differently to create quadrature output from the PEG.