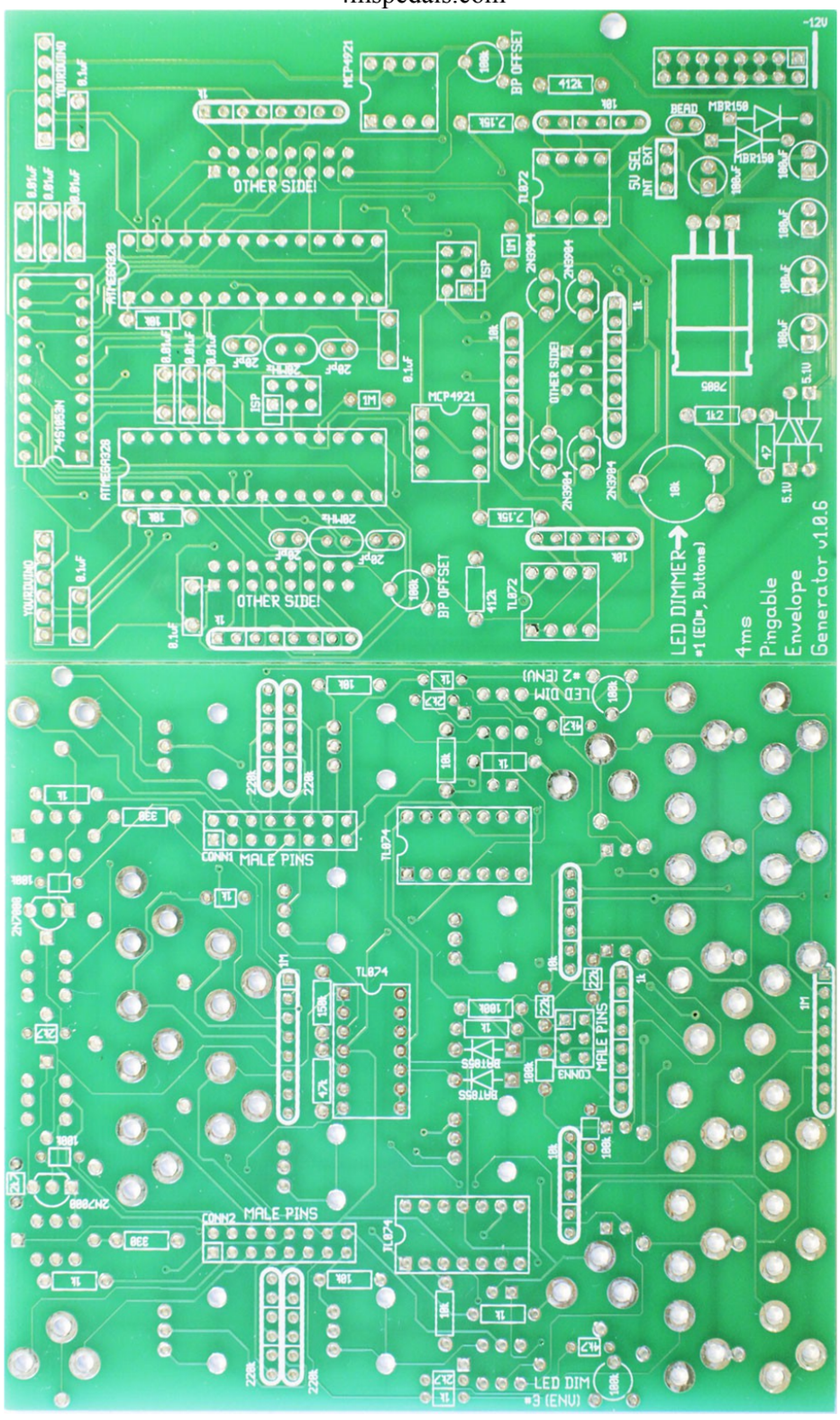
Pingable Envelope Generator

Kit Builder's Guide for PCB v1.0.6

4mspedals.com



PEG

This guide is for building a Pingable Envelope Generator (PEG). It's an intermediate-level kit. You should have basic soldering skills, and a basic familiarity with identifying electronics 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:

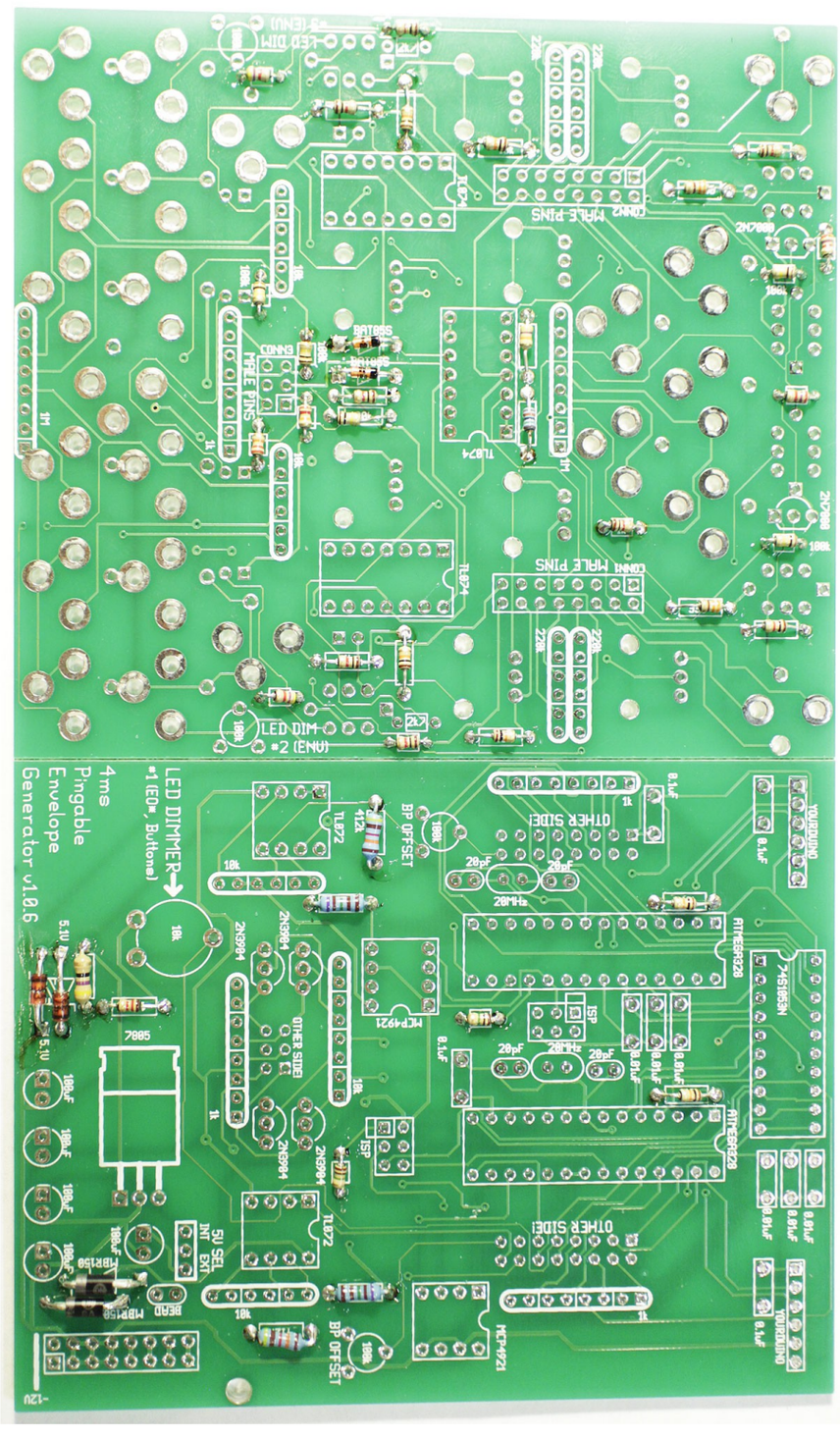
- Soldering iron, solder
- Flush snips
- Needlenose pliers (for removing a component if you make a mistake)
- 5/16" socket driver (optional: pliers will work too if you're careful)
- Multimeter (for reading resistor values if you don't know the resistor color code chart)

Step 1: Resistors

Insert and solder the 34 resistors and 6 diodes. There are thirty 5% resistors (tan body) and four 1% resistors (blue 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). The diodes must go in with the black or grey band facing the tip of the arrow.

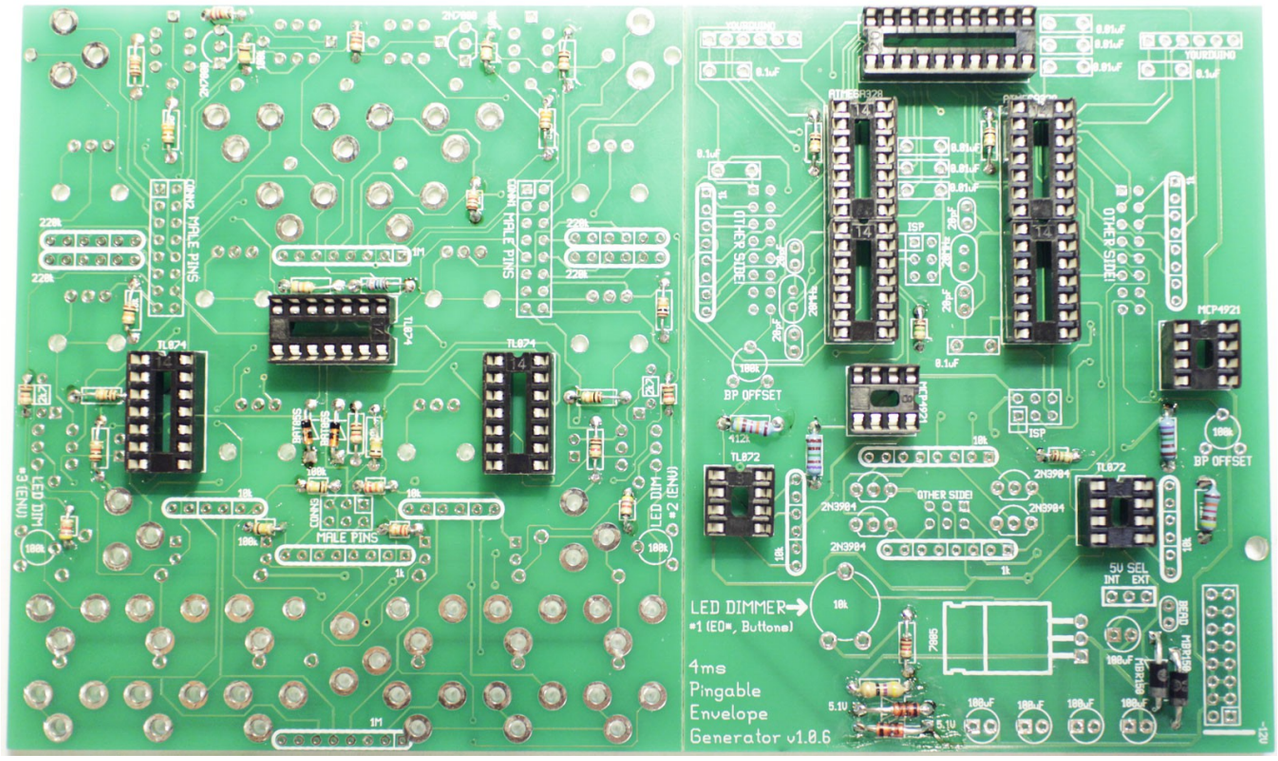
After soldering, snip the leads nearly flush to the PCB (you'll be snipping the leads flush on all the components after soldering).

The 33 tan resistors (5%): • *47 ohm (yellow purple black gold) 1/4W large body* • *330 ohm x 2 (orange orange brown gold)* • *1k x 8 (brown black red gold)* • *1k2 (brown red red gold)* • *2k7 x 4 (red purple red gold)* • *4k7 x 2 (yellow purple red gold)* • *10k x 6 (brown black orange)* • *22k x 2 (red red orange gold)* • *47k x 1 (yellow purple orange gold)* • *100k x 4 (brown black yellow gold)* • *1M x 2 (brown black green gold)*	The 5 blue resistors (1%): • *7.15k x 2 (purple brown green brown red brown)* • *150k x 1 (brown green black orange brown)* • *412k x 2 (yellow brown red orange brown)* ***Value may vary, but will be always start with yellow and end with orange brown (400k-470k)*** The 6 diodes: • *5.1V Zener 1N4733 x 2 (large body glass)* • *BAT85S Schottky x 2 (small body glass)* • *MBR150 x 2 (black body)* ***Note orientation! Band=arrow tip***



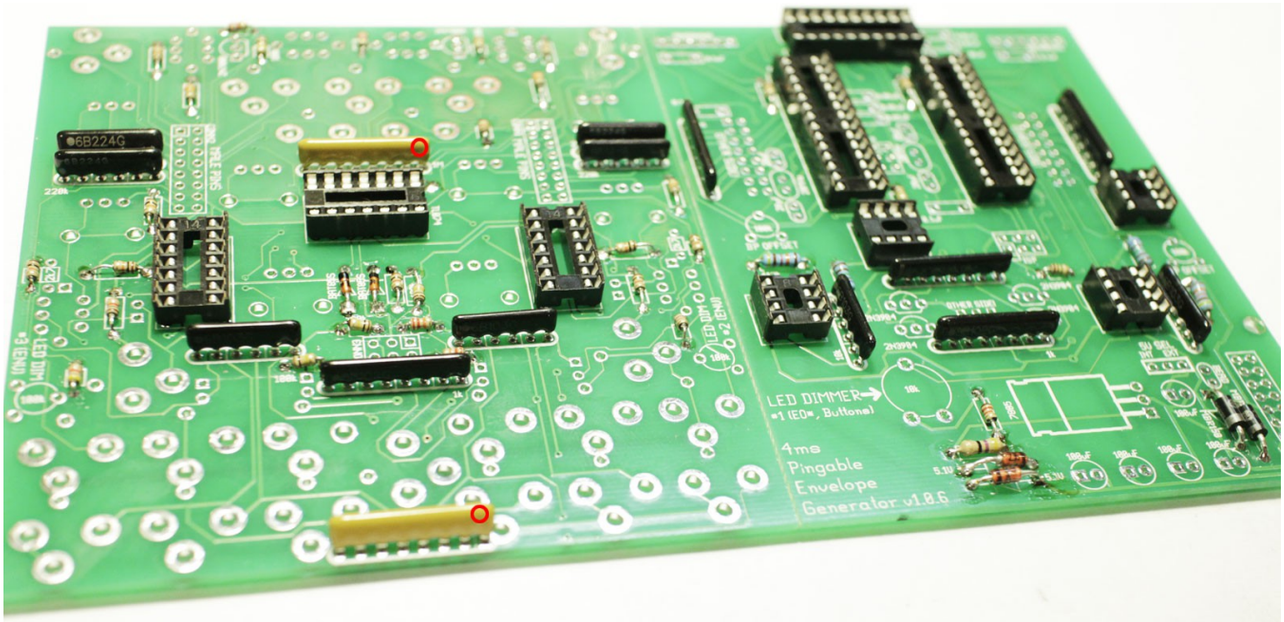
Step 2: Sockets:
Insert and solder the IC sockets. The notch in the sockets should line up with a matching notch drawn on the PCB. Note that the 28-pin sockets are formed by inserting two 14-pin sockets.

- *8 pin socket x 4*
- *14 pin socket x 3*
- *28 pin socket x 2 (each is made with 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” or "L83S102...")*
- *10k isolated 8-pin array x 1 (“8B103G” or "L83S103...")*
- *10k isolated 6-pin array x 4 ("6B103G")*
- *220k isolated 6-pin array x 4 ("6B224G")*
- *1M bussed 8-pin array x 2 (yellow "8X-1-105LF" or black "8A105G")*



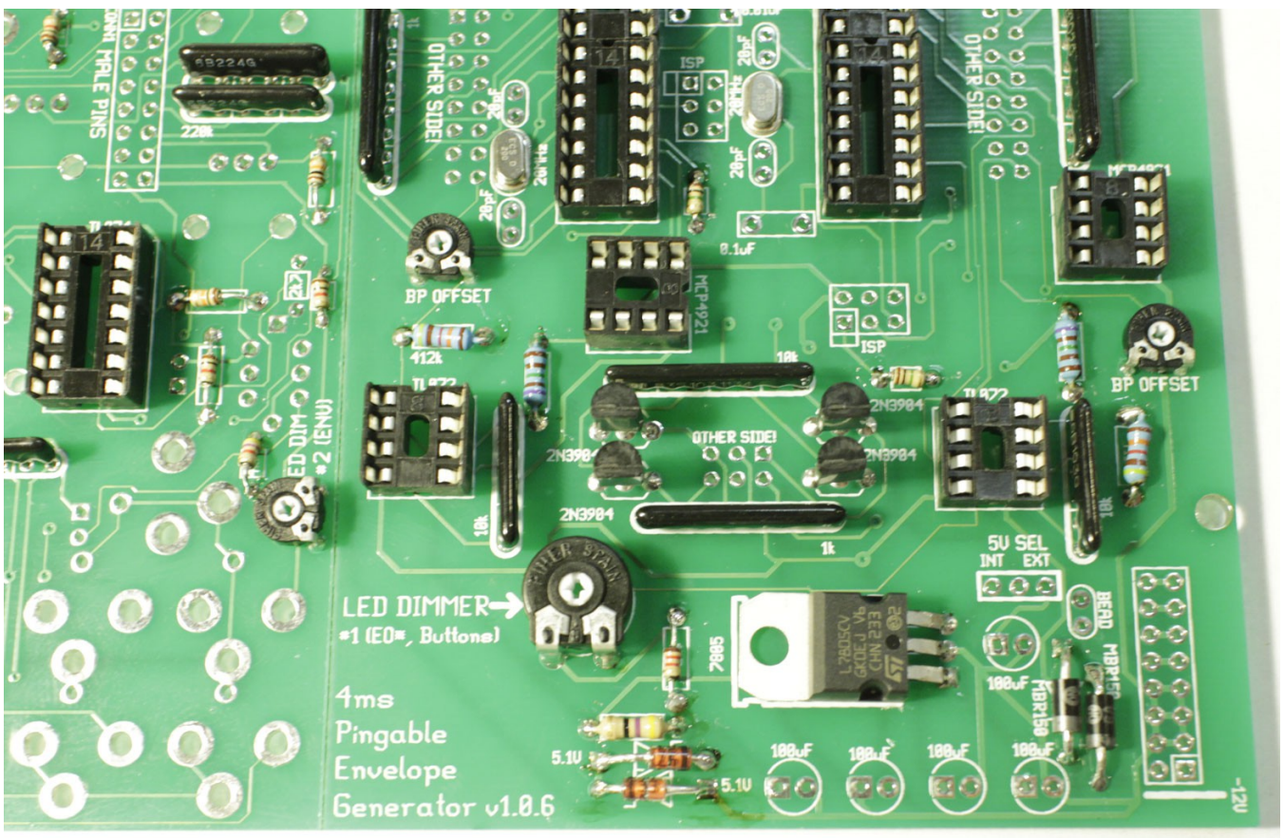
Step 4: Transistors, Voltage Regulator, Resonators, Trimpots:

Insert and solder the transistors. The orientation is crucial: the curved and flat sides of each transistor must match the outline drawn on the PCB. Four transistors have their flat sides facing the bottom (2N3904's) and two are facing to the right (2N7000's)

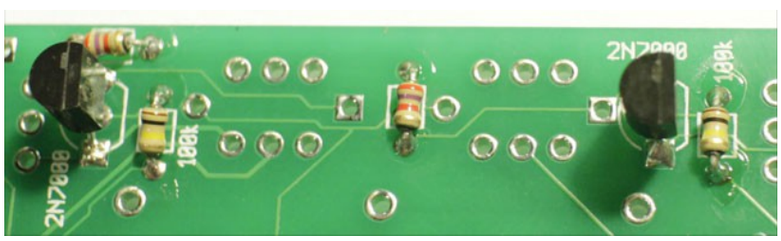
- *2N3904 x 4*
- *2N7000 x 2*

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 small metal crystal resonators (orientation doesn't matter), the four 100k trim pots, and one 10k trim pot.

- *7805 voltage regulator -- Bend down flush to PCB*
- *100k trim pots x 4*
- *10k trim pot x 1*
- *20MHz Crystal Resonators x 2 -- splay the leads after you insert them, so they don't fall out*



Above: 100k trimpot on far left edge



Above: two 2N7000's on the top edge, left side

Step 5: Male Header pins:

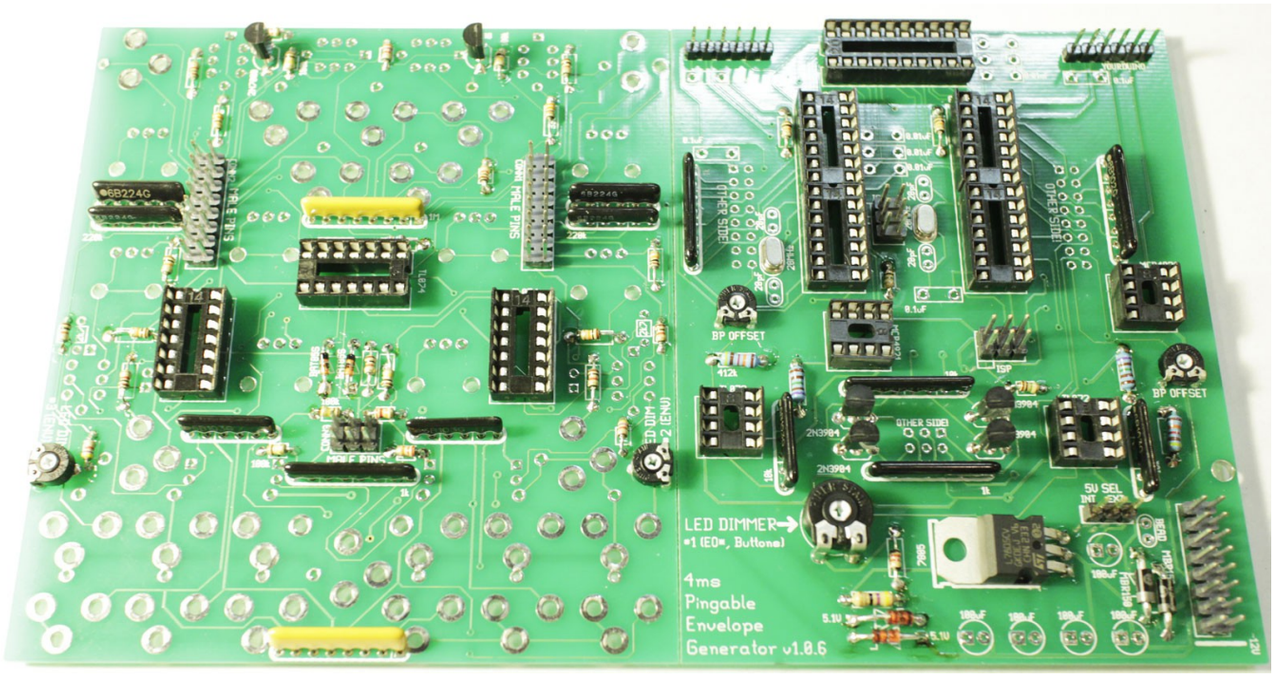
Insert and solder the male header pins. Since the headers fall out easily, it helps to put a piece of cardboard or a book over the PCB, then flip over the book and PCB together before soldering.

Peek ahead to Step 7: Don't accidentally put male headers where females go!

Make sure the header pins are flush and vertical-- your PEG won't fit together if the header pins are not perfectly vertical!

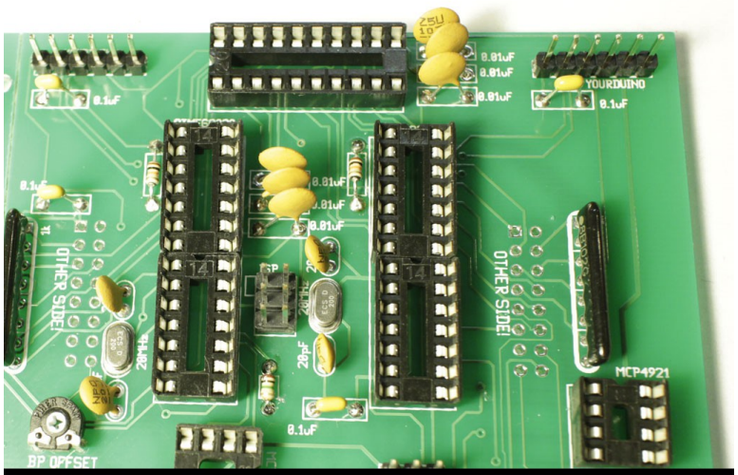
Solder one or two pins per header, then flip the board back over and check to make sure they are lined up, flush to the PCB, and the pins are at a perfect right angle to the PCB. When you verify this, flip the board back over and solder the rest of the pins.

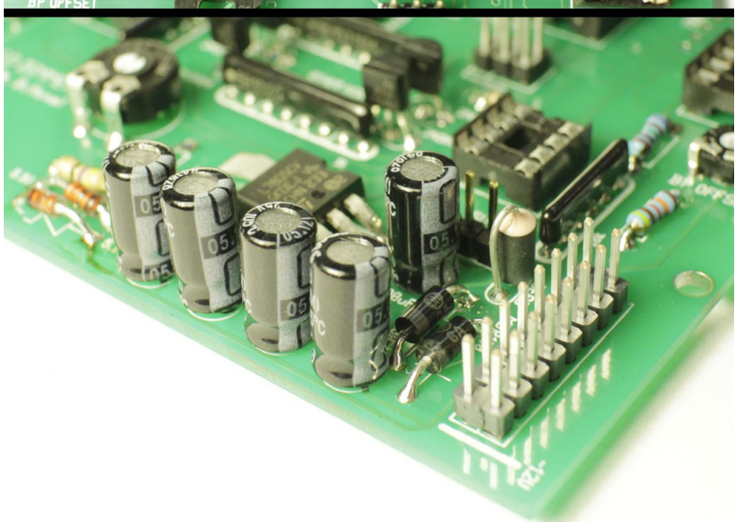
- *2x8 headers x 3*
- *2x3 headers x 3*
- *1x6 headers x 2*
- *1x3 header x 1*



Step 6: Capacitors:

Insert and solder the 19 capacitors and the ferrite bead. The 20pF, 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. The ferrite bead can go in either way, but one lead must be bent 180° so that it stands up.





Top photo:

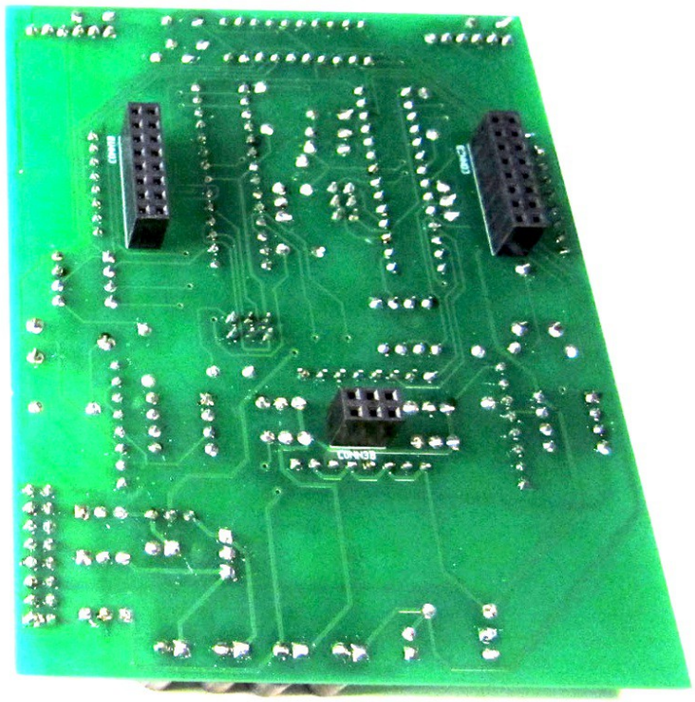
- *20pF x 4*
- *0.1uF (104) x 4*
- *0.01uF (103) x 6*

Bottom photo:

- *100uF x 5*
- *Ferrite bead x 1*

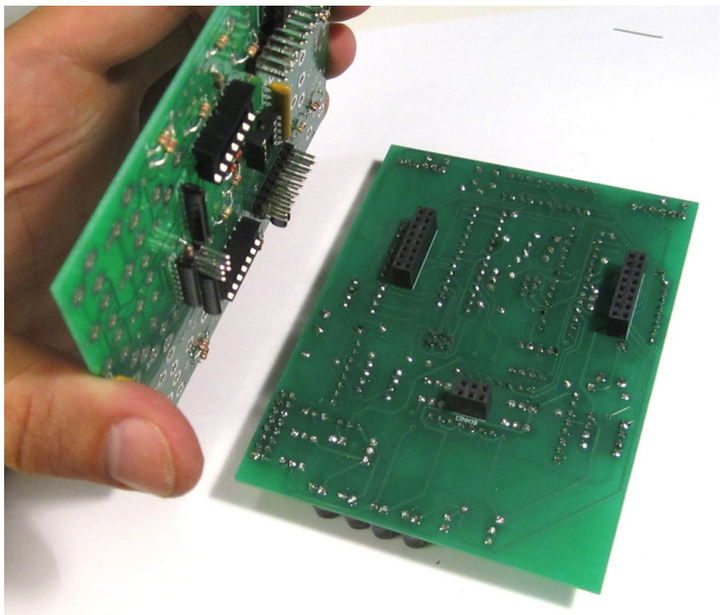
Step 7: Female headers:

A. First, snap you boards apart. They are scored down the length, and you can just snap them apart with your hands.

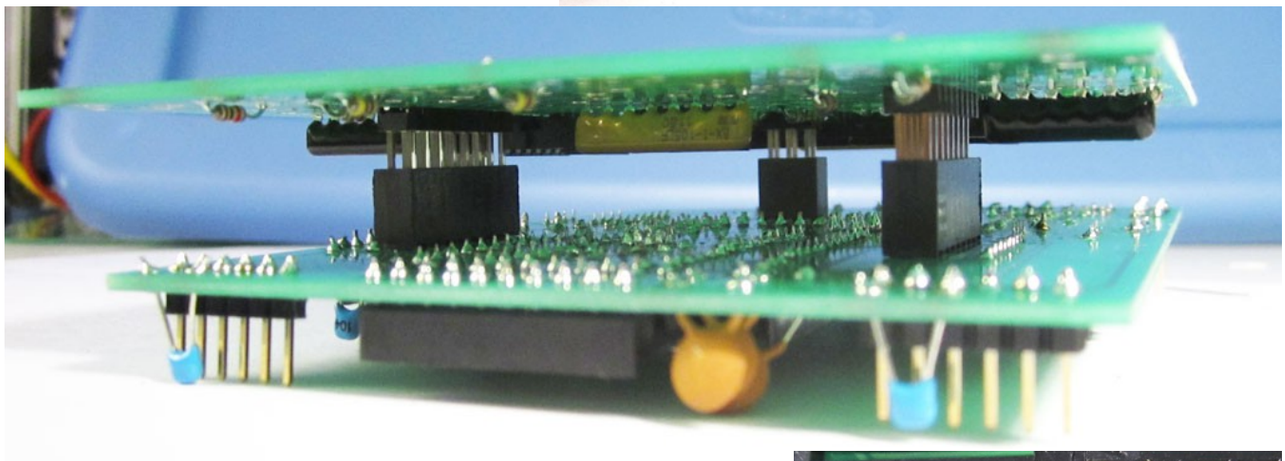


B. Flip the smaller board over so the resistors, sockets, etc are facing down. Insert the 3 female headers as shown. **Do not solder yet!**

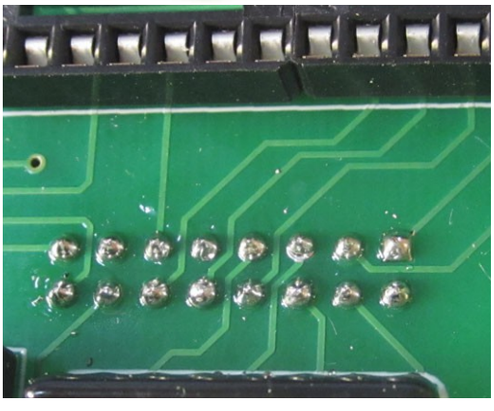
C. Lay the larger board on top of the smaller board so that the 3 header pins line up with the female headers.



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.

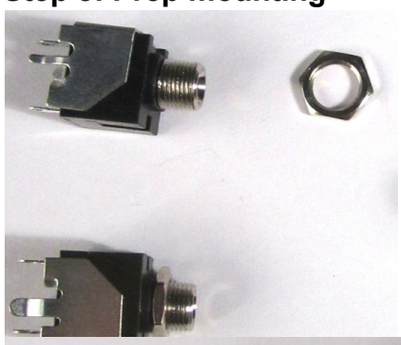


F. Now, squeezing the boards together so the female headers don't fall out, flip the boards over and solder the female headers



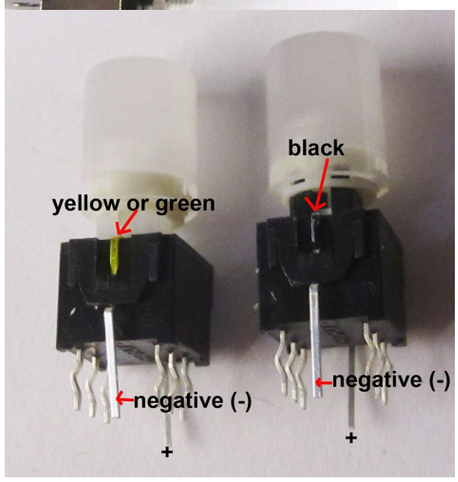
G. Take a minute to carefully inspect the large board. Make sure every component is soldered, and that you didn't miss a joint. It's especially easy to miss a joint in the rows of header pins. **After the next step, locating and fixing a problem will be harder, so take the time now to check everything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

Step 8: Prep mounting



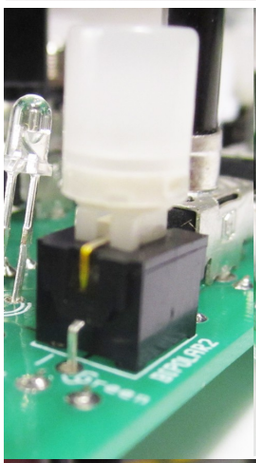
A. Put a hex nut on each of the 22 jacks. Finger tighten the nut (don't use a wrench). Insert the 22 jacks into the PCB. Do not solder yet.

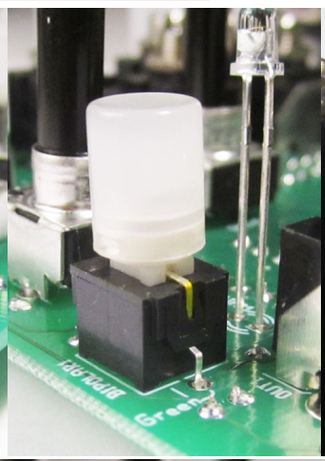
B. Insert the 8 pots into the PCB. You may have to slightly bend the large tabs inwards so the pots will snap in place. Do not solder yet

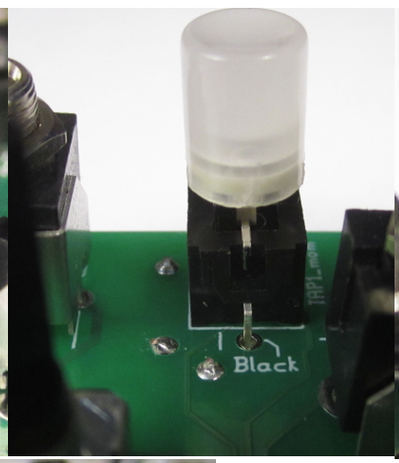


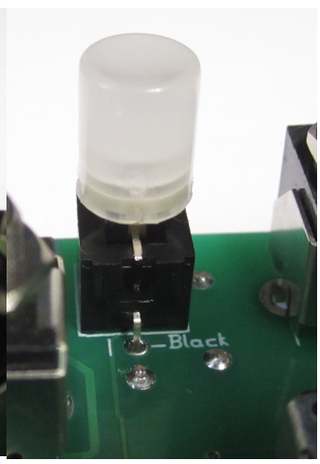
C. Look closely at the six buttons. Four are marked with a yellow mark and two are marked with black See the photo on left. The side with the black or yellow mark is the negative side. On the PCB, this side is marked with a minus sign (-) as well as the name of the color that should go in that hole**.**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

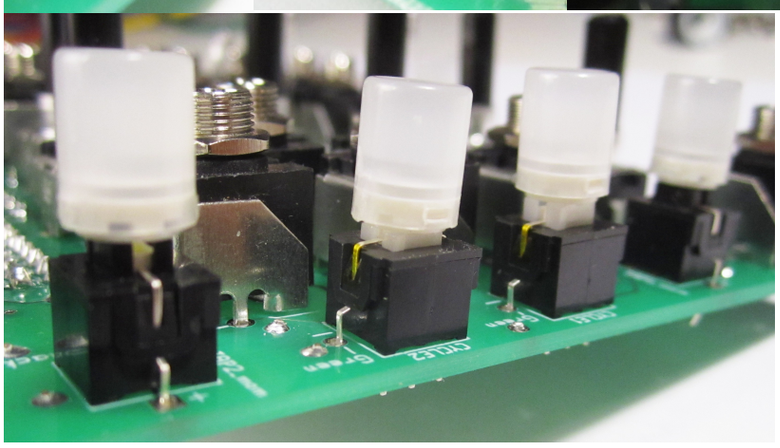
D. Verify your LED buttons are in correctly. It's very difficult to remove a button that's in backwards or is the wrong type. See photos. Check carefully.

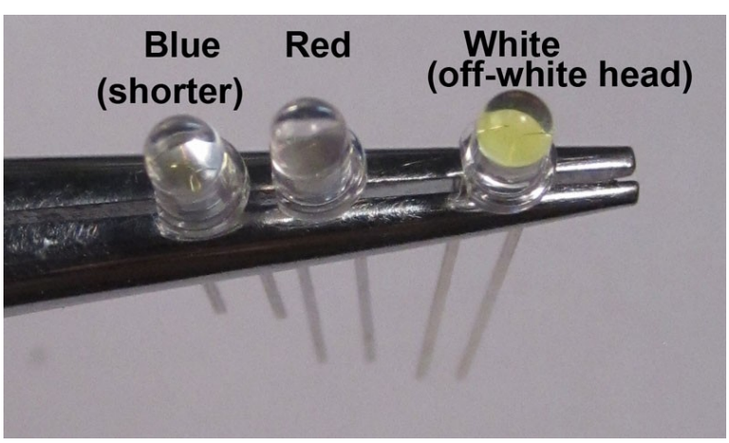






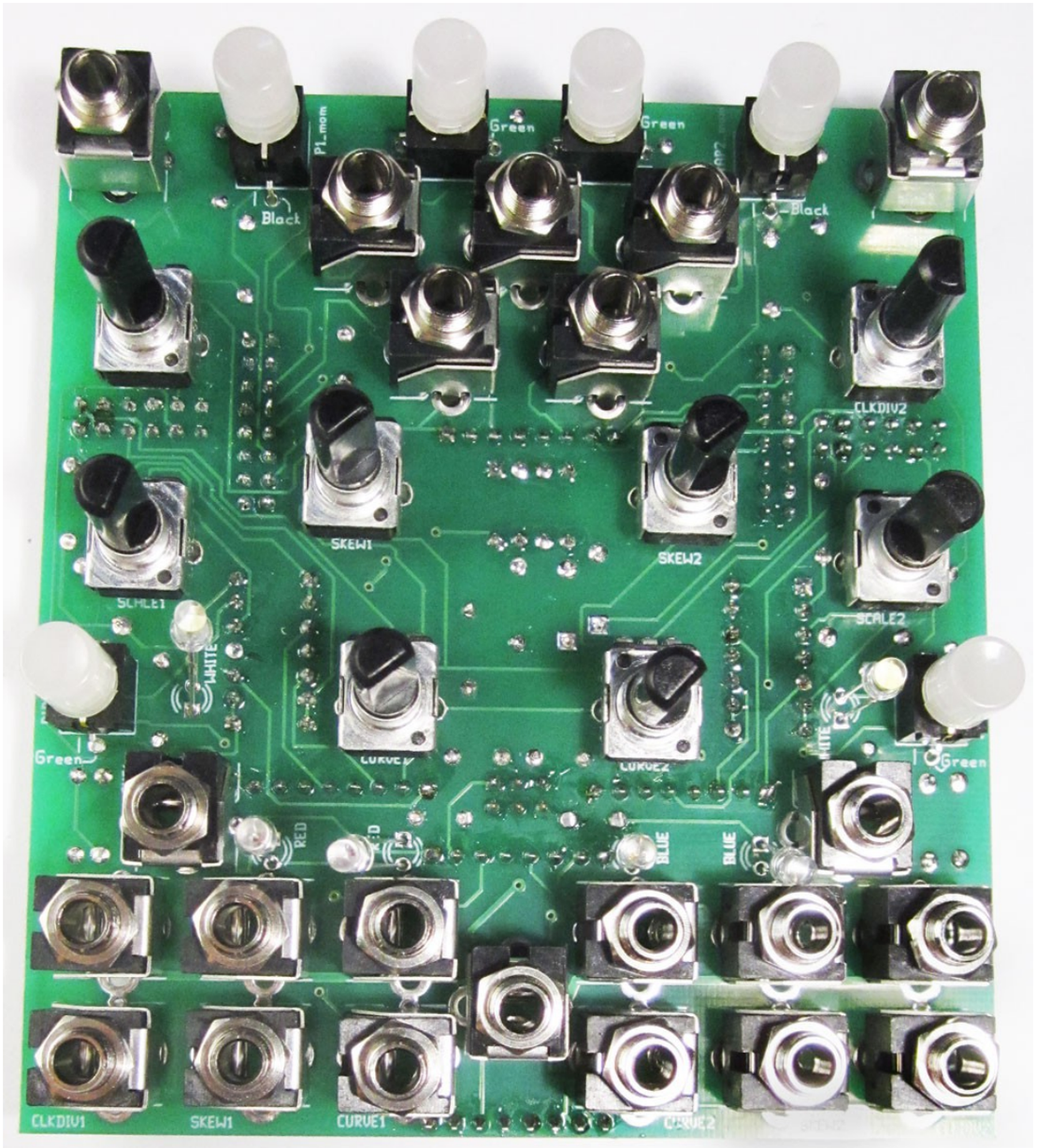




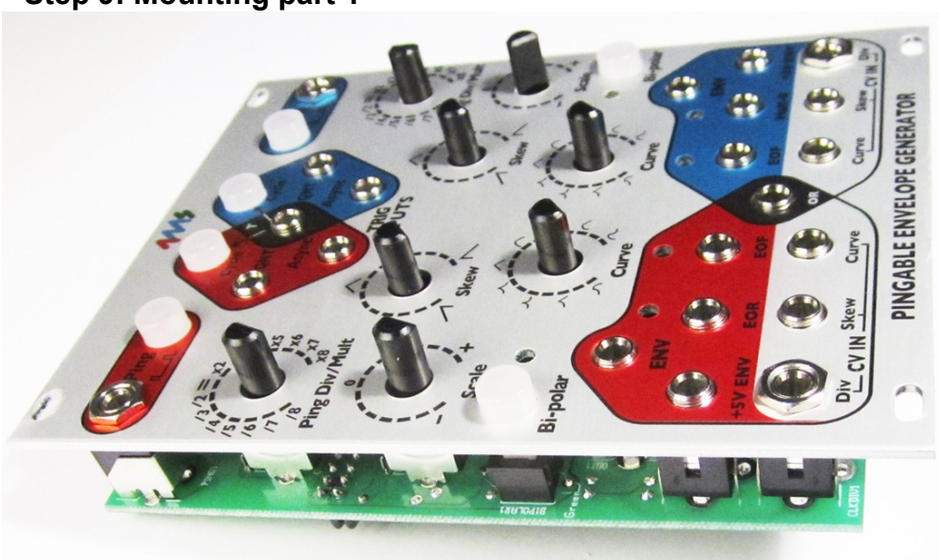


E. Look closely at the 6 LEDs. The ones with short leads are Blue, the ones with milky off-white heads are White, and the clear, long ones are Red. Insert the LEDs into the PCB where marked. The longer lead goes in the square hole.

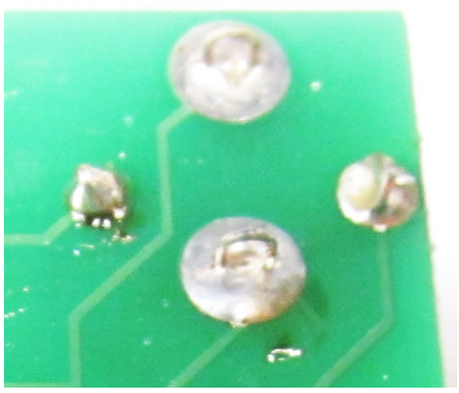
F. After inserting all 6 LEDs, verify the long lead is in the square hole. This is easy to mix up, and hard to fix later.



Step 9: Mounting part 1



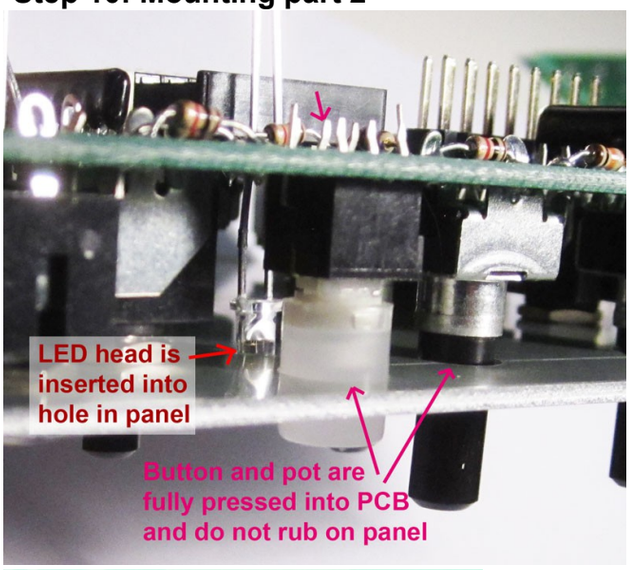
A. Push the LEDs down close to the PCB. Take the panel and gently lower it down on the PCB. Wiggle it slightly so that it fits over the pot shafts, then the buttons, then the jacks.



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 (1/8 turn)** with a 5/16" socket or pliers (be careful not the scratch the panel!).

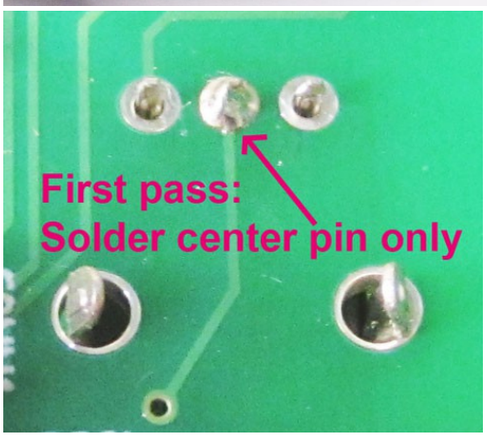
C. Flip it over and solder the 4 corner jacks (see photo)

Step 10: Mounting part 2



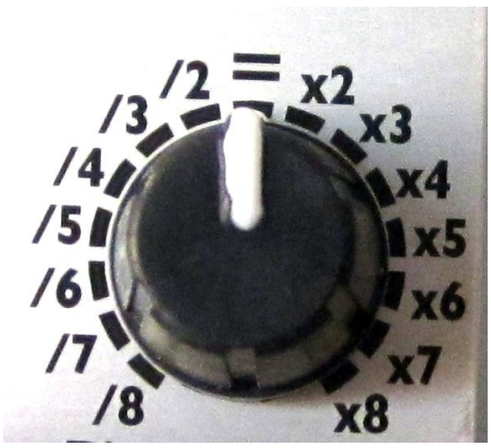
A. Hold the unit so the panel is facing the floor. Gently guide the LEDs by their leads so their heads fit flush into their holes in the panel. You may want to slightly splay their leads out so they stay in place.

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 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!)

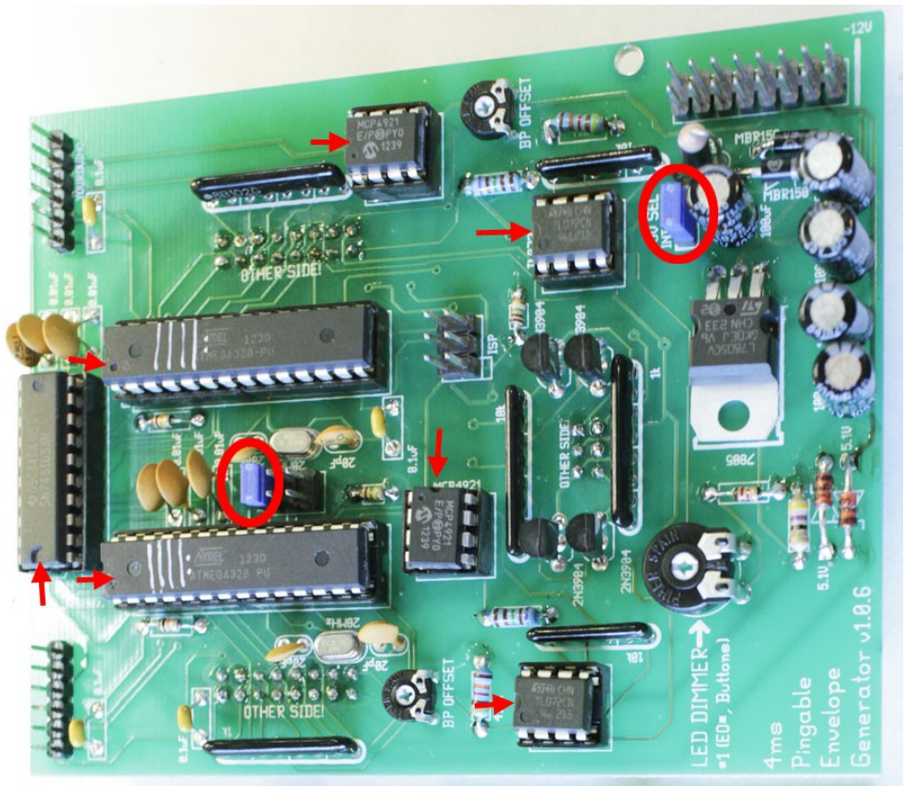
G. Check all the pots, buttons, and LEDs a third and final time, and then flip the unit over and solder the rest of the PCB (all jacks, pots, buttons, and LEDs). Snip the LED leads short.

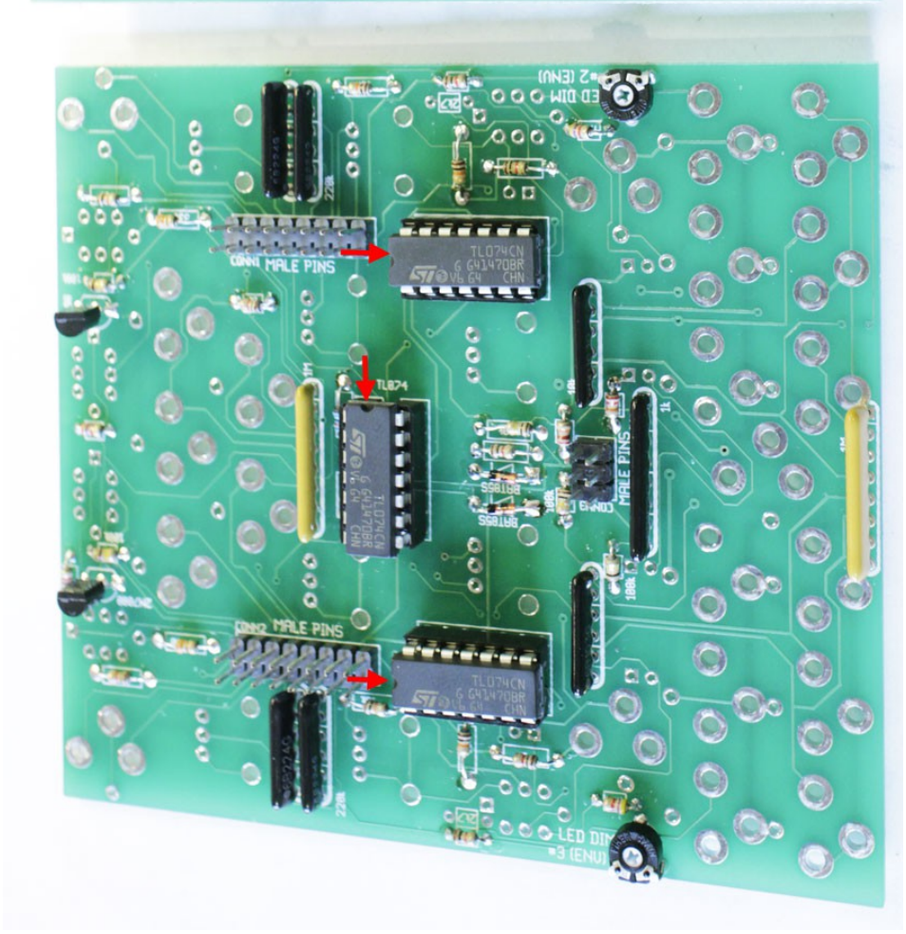
Step 11: Insert ICs and jumpers

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 2: Both on the small board (notch facing up)*
- *TL074 (14-pin) x 3: All on the large board (two with notch facing up, one with notch to the right)*
- *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) x 2: Both on the small board, close to the ATMEGA chips. One notch faces right, one notch faces up*

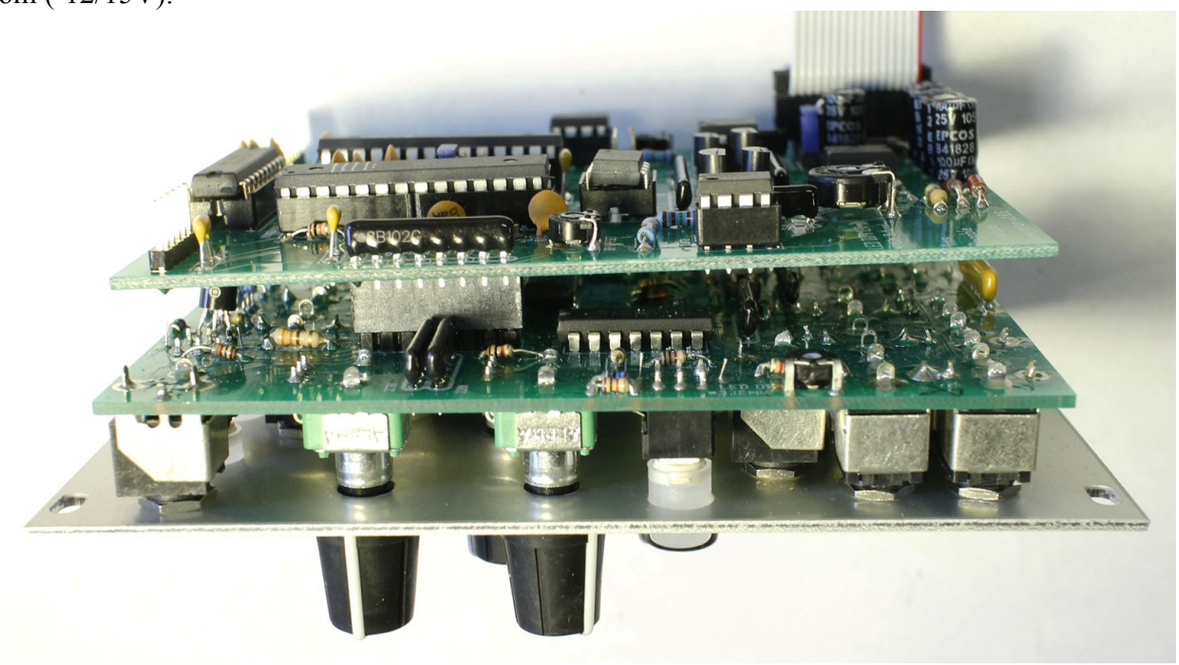
Install one of the blue jumpers on the 3-pin header, on the left side ("INT"). Install the other jumper between the top two pins on the 2x3 ISP header that's between the two ATMEGA chips, as shown by the red circles in photos





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).



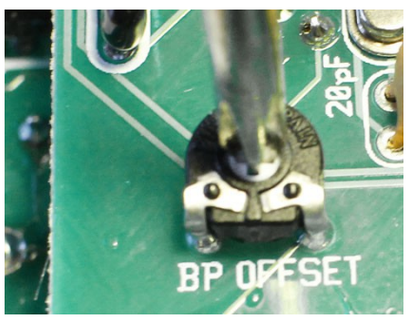
Step 13: Take a break.

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 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 two blue jumpers in the right places.

Step 14: Power up and calibration

Power it up! Some lights should come on. If not, unplug immediately and check around for errors, especially near the power connector (missing a blue jumper on the 1x3 header??). If there's a problem, skip ahead to the Troubleshooting section.



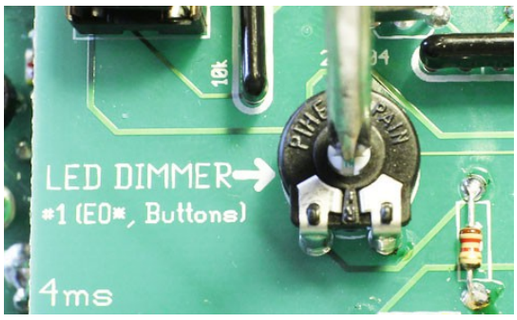
BP Offset trim pots:

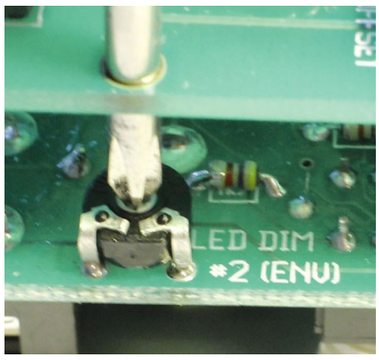
Each channel has a trim pot to adjust the DC offset of the bi-polar output. This can be set to anything you like or find useful/fun: the unit will function 100% perfectly no matter where you set the trim pot. If you want your unit to match the 4ms factory setting, do the following:

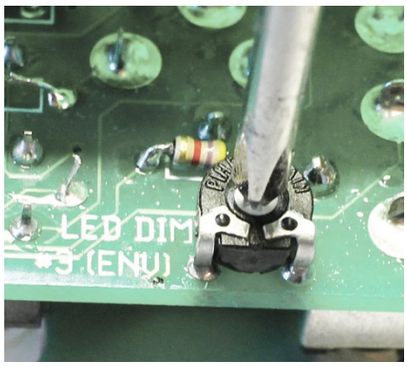
1. Turn all knobs to center up, except turn the Scale knobs to fully Clockwise
2. Press both Bi-polar buttons so they light up.
3. Tap both Ping buttons twice.
4. Press both Cycle buttons so they light up. The six red/blue/white LEDs should be blinking.
5. If you have an oscilloscope, adjust the trimpot 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)
6. 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.

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.

LED DIMMER trim pots:
There are 3 trim pots for adjusting the brightness of all the LEDs and LED buttons. All these can be adjusted to your taste. Default setting is center (50%).







- The main LED DIMMER is the large (10mm) trim pot located on the top of the small board. It controls the brightness of the Cycle, Bi-polar, and Ping buttons (orange and white), and the EOR, EOF, and Half-R LEDs (blue and red).
- LED DIM #2 is the small trim pot on the right edge of the large board. This controls the brightness of the white ENV LED on the red channel. There's a hole in the small board for easier access.
- LED DIM #3 is the small trim pot on the left edge of the large board. This controls the brightness of the white ENV LED on the blue channel.

Troubleshooting
Hopefully you've gotten everything working, but if not here's some things to check:

Problem: Ping and Cycle buttons don't respond. Bi-Polar buttons turn on and off when you press them. Some lights are on, but they don't change.
Diagnosis: The AVR ATMEGA328 chips are not running. This could be because:

- Chips are not getting power (see Power Problems)
- Crystal resonators are not well soldered to the chips or to the 20pF capacitors
- Chips have been "zapped" and need to be re-flashed or replaced (see Chip Problems)

Problem: One channel works, the other doesn't.
Try swapping the AVR chips. If the problem switches sides too, then you know it's a bad chip. If the problem stays the same, then it's a problem with a component or joint on the bad channel.
It's rare to need to replace the metal crystals, and also rare that the chips get zapped in shipping. That said, it has been known to happen.

Power problems:
First, verify the blue jumper is set to INT. Next, use a DC voltmeter to measure the DC voltage at several places. You can use the large tab of the 7805 for ground.

- Measure all three pins of the 7805. They should be 11.7,V, 0V, and 5.0V, respectively from top to bottom
- Measure for 5.0V on both AVR chips: Pin 1, Pin 7, Pin 20, and Pin 21
- Measure for 0V (ground) on both AVR chips: Pin 8 and Pin 22

If the 7805 is not getting 11.7V then for some reason the positive +12V rail is not reaching the circuit. Check the MBR150 diode is in correctly.
If the 7805 is not outputting 5.0V, then you might have a backwards chip or a solder blob shorting out power to ground. This could fry the 7805 if it gets too hot! Try moving the jumper to EXT (which uses the 5V power rail), if that fixes the problem then your 7805 is fried.
If the AVR chips are not getting power or ground, then look for bad solder joints.

Chip problems:
If you've narrowed it down that a chip is bad, you can try re-flashing it. See our blog post for how to do that.

- http://4ms.org/?p=64
- http://4ms.org/?p=160

Or, email us at 4ms at 4mspedals døt com, and we can send you replacement chips.