



# MACCHIATO

*Assembly Manual*

## MINI DIGITAL SYNTHESIZER



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## INTRODUCTION

The Macchiato Mini-Synth is an 8-bit digital synthesizer you can build yourself from scratch, or order complete and ready-to-play. Fun and easy enough for children; versatile enough for use in performance or in the studio.

## HISTORY

Synthesizers have been around since the 1960's when they started as an experiment in exploring the musicality of electronic circuits. The first of these instruments were all analog synthesizers. While they sound great, synthesizers built with analog components are large, heavy and expensive. In the early days they were only available to the very wealthy or the very nerdy – nerds capable of hacking together their own do-it-yourself electronics.

The late 1970's and early 1980's saw the development of several different digital music technologies. As digital technologies developed they became more affordable with further reaching feature sets. Prices for digital synths have steadily fallen, but analog synthesizers remain bulky, heavy and expensive by comparison.

Today, the Macchiato Mini-Synth combines the best of low-cost microcontroller technology, the Arduino development environment, and the Mozzi Synthesis Library (developed and curated by Tim Barass). The Macchiato emulates many of the best features and sounds of the original beloved analog synths in a tiny, low-cost, lightweight package.

What started out as a bulky and brainy musical experiment in electronics is now available to everyone as a one-evening project with years of musical enjoyment to follow – and you don't even have to be a nerd!

## DESCRIPTION

The Macchiato Mini-Synth is a versatile 8-bit digital synthesizer capable of creating a vast array of unique sounds. The Macchiato is great at creating rich and complex soundscapes, yet it is easy enough to use that kids can start creating music instantly! Capable of 2-note polyphony, the Macchiato is great for textured pads or beautiful flowing dyadic harmonies. It is perfect for bass synth lines, rhythmic and glitchy pulses, or smooth lead synth parts. The Macchiato has a built-in one-octave capacitive touch keyboard (with 4-octave shift), but also has a MIDI IN port for expanded controllability. The 1/8" (3.5mm) line-out jack is suitable for headphones, powered speakers, or recording directly to your computer's line-in jack. There are 9 knobs on top of the instrument which give the user a wide spectrum of control.

The Macchiato Mini-Synth is perfect for:

- electronic musicians and enthusiasts • lo-fi geeks • recording studio producers
- circuit bending fanatics • electronic DIY nerds • music educators • chip music / 8-bit artists
- computer music fans • bass synth lovers • kids...

...Basically anyone wanting to have fun making music! Offered as a DIY kit or fully assembled and ready to play, it's the perfect gift for any music fan!

## HOW IT WORKS

The Macchiato uses “wave table” technology to produce an audio signal. The synth was designed using the Arduino Integrated Development Environment (IDE). Arduino is an open-source platform that uses easy computer software to program a tiny computer chip, or microcontroller. The microcontroller is usually connected to the computer through a USB port. A microcontroller is a tiny computer that can be programmed to do almost anything you can imagine: run the air conditioner, swindle banks, rule the world. The Arduino environment is pretty amazing at simplifying this process. Even a few years ago, only nerdy engineers could do this; now anyone willing to read a few articles and follow a few tutorials can make their own electronic devices!

Although very versatile, microcontrollers are not very good at handling audio. Typically, Arduino is only capable of making simple beeps like you hear from your microwave oven; but recently, Tim Barass, through very clever programming, developed an open-source software add-on he calls “Mozzi” that gives Arduino the ability to create all kinds of unique and interesting sounds. Mozzi is available [here](#) as an Arduino library add-in. You can also download the Macchiato source code [here](#) from Zeppelin Design Labs. Feel free to edit and tweak the code any way you’d like, and then re-program your synth using the ISP header on the main board. The Macchiato is the perfect platform for exploring the sounds that Mozzi offers. You will find detailed instructions for doing this in the Macchiato Mini-Synth Quick Start Guide and Reference Manual.



## WHAT YOU WILL NEED

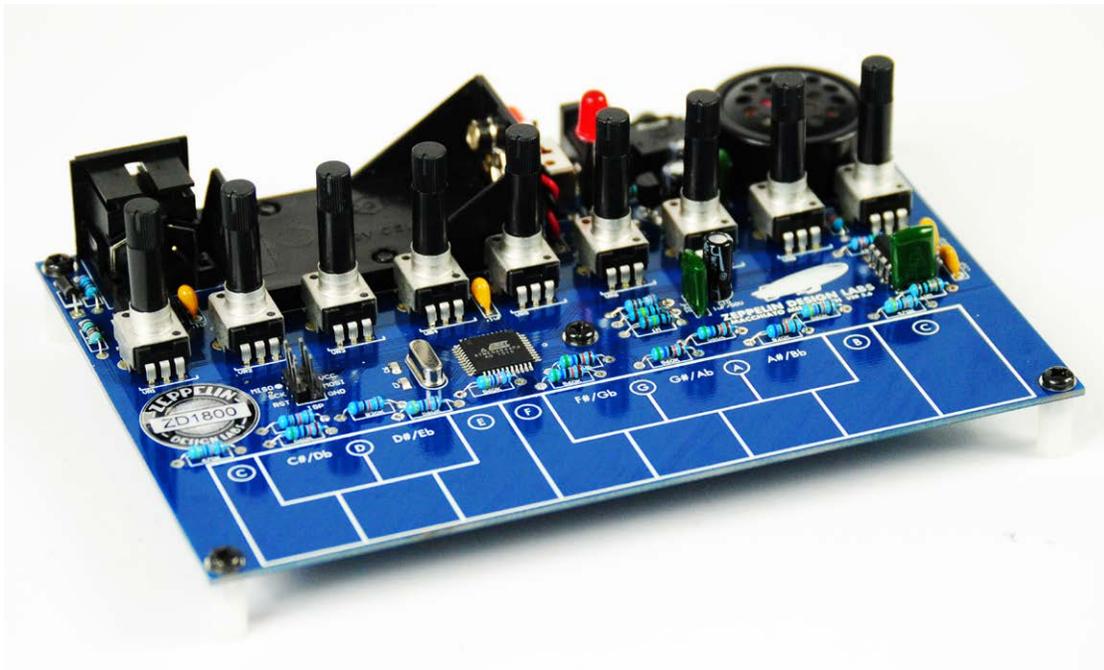
Here's everything you will need to build The Macchiato Mini-Synth kit as shown below. Tools and supplies needed for various cabinet options are discussed in the section "MAKING A CABINET" on page 26.

### TOOLS

1. Digital multimeter
2. #2 Phillips screw driver
3. Soldering iron (not a soldering gun, or a "cold heat" iron), good quality, 15-50 watt, with a good medium or small-sized tip, conical or chisel shape. One with a temperature control and a stand is best.
4. Wet sponge or dry solder-cleaning pad
5. Wire strippers
6. Flush cutters or small diagonal cutters
7. Clamp or vise to hold the printed circuit board while soldering (optional, but handy)
8. Solder sucker or solder braid (optional, but very handy if you have to remove or repair any components!)

### SUPPLIES

1. Solder, 60/40 rosin core, the smaller diameter the better (we prefer .032" diameter). Make sure it's good quality; we prefer Kester brand, but most brands will work fine.



## WHAT'S IN THE BOX

Table 1: The Macchiato Mini-Synth Bill Of Materials (BOM) is a complete parts list of everything that should be present in your kit, followed by photos of each part. Print the BOM and carefully go through the kit, identifying every part. Please read about the proper handling of integrated circuits (ICs) in paragraph 7 on page 18 before removing anything from the silver static-protective bag. Note that some of the components are difficult to tell apart. Compare them carefully with the photos. Besides verifying that nothing is missing, this will acquaint you with the parts and their names. If ANYTHING is missing, first double-check; we double-checked before sealing the box at our lab! If it's still missing, EMAIL US right away at [info@zeppelindesignlabs.com](mailto:info@zeppelindesignlabs.com). If we goofed and shorted your kit, we will get replacement parts in the mail to you as soon as possible. If you lose or damage anything, we will be glad to sell you replacements. The unusual or custom components can be ordered directly from us (contact [info@zeppelindesignlabs.com](mailto:info@zeppelindesignlabs.com)). For more common parts, like resistors, capacitors, or screws, you may prefer to go to a local electronics or hardware store.

**TIP:** Empty the parts of the kit into a bowl, NOT onto the cluttered workbench, or onto the living room carpet! This will protect you from losing tiny parts.

Figure 2: What's In The Box

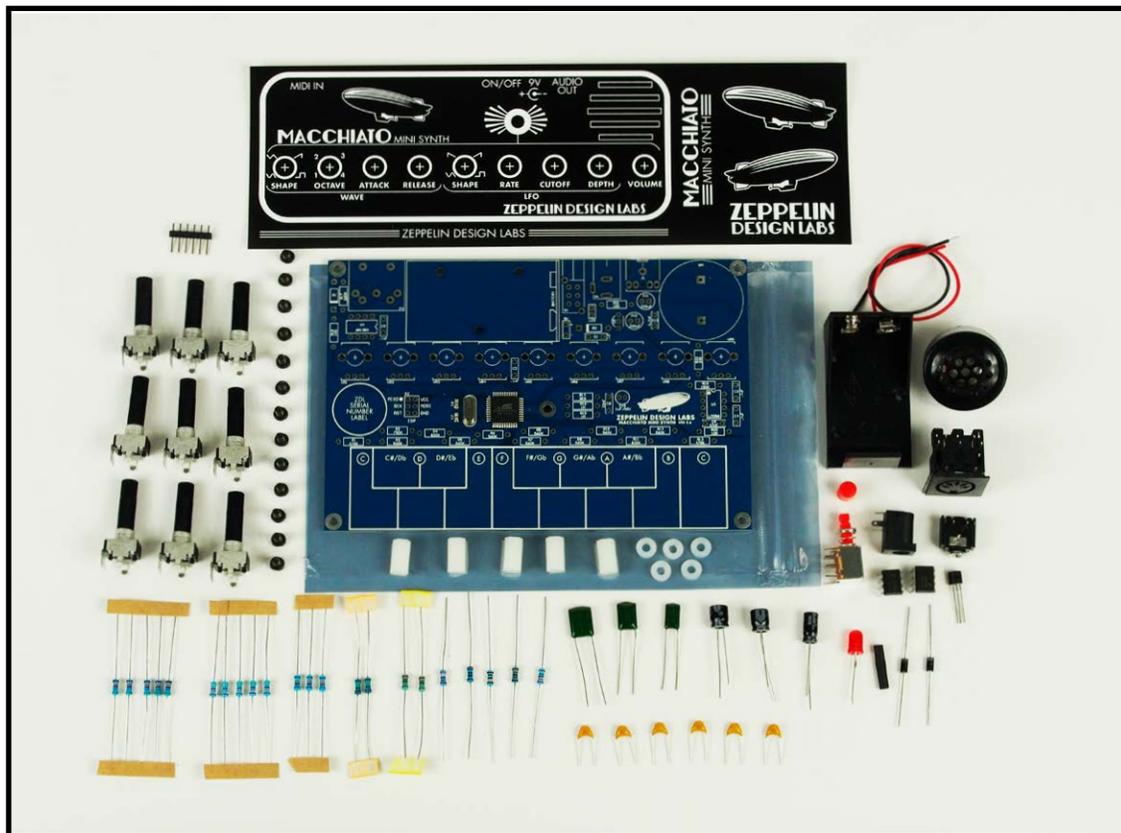
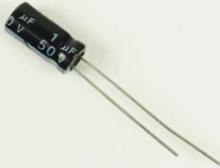
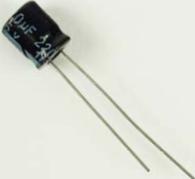
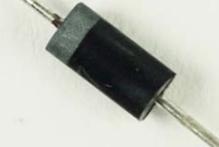
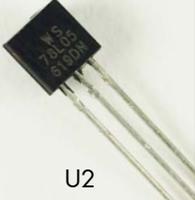
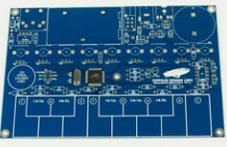


Table 1: The Macchiato Mini-Synth Bill Of Materials

Part #	Description	Notes	Qty
CB-90-11	Heat Shrink Tubing	1/8" x 5/8" (2mm x 15mm)	1
CP-10-03	Capacitor Electrolytic 50V 1uF	C10	1
CP-10-08	Capacitor Electrolytic 16V 220uF	C11, C12	2
CP-20-07	Capacitor Film 100V 22nF	C8	1
CP-20-11	Capacitor Film 100V 4.7nF	C13	1
CP-20-12	Capacitor Film 100V 47nF	C9	1
CP-30-18	Capacitor Ceramic 50V 100nF	C1, C2, C3, C4, C5, C14	6
DI-20-03	Diode General Purpose 1N4007 1000V 1A	D1, D2	2
DI-30-56	LED 5mm Red	LED	1
FA-60-37	Screw Machine Pan Phil M3x6		13
FA-90-25	Washer Flat M3 Nylon		5
HD-05-03	Battery Holder, 9V		1
HD-40-10	DC Power Jack	P1	1
HD-40-40	Headphone Jack 3.5mm Female Stereo	J1	1
HD-40-50	MIDI Jack, Female	P3	1
HE-20-01	Single Row Header. 1x6	P2	1
IC-26-38	Integrated Circuit Amplifier LM386 DIP 8	U3	1
IC-40-13	Optocoupler 6N138 DIP 8	U4	1
IC-80-50	Voltage Regulator 5V 100mA	U2	1
LS-10-10	Loudspeaker 1" 8 Ohm 1 W	SP1	1
PC-70-02	Macchiato PCB		1
PL-10-70	Macchiato Label Sticker		1
PL-10-90	Serial Number Sticker		0
PT-10-10	Potentiometer Linear 100K	VR1 - VR9	9
RS-80-21	Resistor Metal Film 0.25W 1% 10R	R20	1
RS-80-32	Resistor Metal Film 0.25W 1% 220R	R17	1
RS-80-40	Resistor Metal Film 0.25W 1% 1K	R18, R21	2
RS-80-44	Resistor Metal Film 0.25W 1% 3.9K	R14	1
RS-80-53	Resistor Metal Film 0.25W 1% 33K	R22	1
RS-80-62	Resistor Metal Film 0.25W 1% 150K	R19	1
RS-80-64	Resistor Metal Film 0.25W 1% 470K	R1, R13	2
RS-80-65	Resistor Metal Film 0.25W 1% 560K	R3, R5, R6, R7, R8, R9, R10, R12	8
RS-80-67	Resistor Metal Film 0.25W 1% 750K	R2, R4, R11	3
RS-80-71	Resistor Metal Film 0.25W 1% 1M	R15, R16	2
ST-10-23	Standoff Nylon Hex M3 5.6x12		5
SW-50-30	Pushbutton Switch DPDT	S1	1
SW-60-22	Switch Cap Red		1

				
CB-90-11	C10	C11, C12	C8	C13
				
C9	C1 - C5, C14	D1, D2	LED	FA-60-37
				
FA-90-25	HD-05-03	P1	J1	P3
				
P2	U3	U4	U2	SP1
				
PC-70-02	PL-10-70	PL-10-90	VR1 - VR9	R20
				
R17	R18, R21	R14	R22	R19
				
R1, R13	R3, R5 - R10, R12	R2, R4, R11	R15, R16	ST-10-23



## POPULATING THE PRINTED CIRCUIT BOARD

Your work space should be well-lit, well-ventilated, and disposable; that is, don't work on the nice dining room table! Work on a utility surface that you can burn, drill and scratch. A piece of ¼" tempered masonite, or a chunk of MDF, makes an excellent surface if you don't have a utility work bench.

**CAUTION:** Solder fumes are not healthy for you. The fumes consist of vaporized flux, which can irritate your nose, lungs, and even your skin. You **MUST** work in a space where the air drifts away from you as you work, so fumes do not rise straight into your face.

**CAUTION:** Solder residue usually contains lead, which is poisonous if you ingest it. Do not breathe the fumes, do not eat the supplies, wash your hands after you handle solder, and sweep and wipe up your work space after EVERY USE.

Your Macchiato Mini-Synth is built entirely onto one printed circuit board (PCB). The PCB even includes a built-in capacitive touch keyboard! All of the components will be installed on the "component side" of the board, which is the side that has the part labels on it. The other side of the board is called the "solder side," which, as the name implies, is the side on which the legs of the components are soldered. Proper technique for installing and soldering components to a circuit board is demonstrated through several great resources on Instructables and Youtube under the search "PCB soldering tutorial." The general procedure consists of the following:

1. Install the part on the "component side" of the board, by threading the wire leads through the appropriate holes in the board. For your convenience, the board has silk screen outlines indicating where the components should be placed, along with text indicating the part number and the component value.
2. Hold the component in place with your finger and turn the board over.
3. Gently bend the leads out at about 45 degrees to keep the component from falling out of its holes.
4. Install all of one type of component, bending each of the leads as they are installed.
5. Flip the board over solder-side-up, and solder all of the components in one pass.
6. Clip the leads off with small diagonal cutters, right at the solder joint.

You will notice that we have installed a few components on the PCB already. These components are (mostly) surface mounted, which are a little more difficult to solder. The square chip in the middle of the board has been pre-programmed with the software your Macchiato needs to run. If you are interested in changing the way your Macchiato operates then you may want to look into modifying this software and re-programming the chip. Instructions for this process can be found in the Macchiato Reference Manual.

## Let's begin!

1. Standoffs: Use five of the M3 screws (part #FA-60-37) to attach the five standoffs (part #ST-10-23) to the circuit board (1,2). Pass the screws through the component side of the board (the side with the white graphics), and place the standoffs on the solder-side (the blank side) of the board.

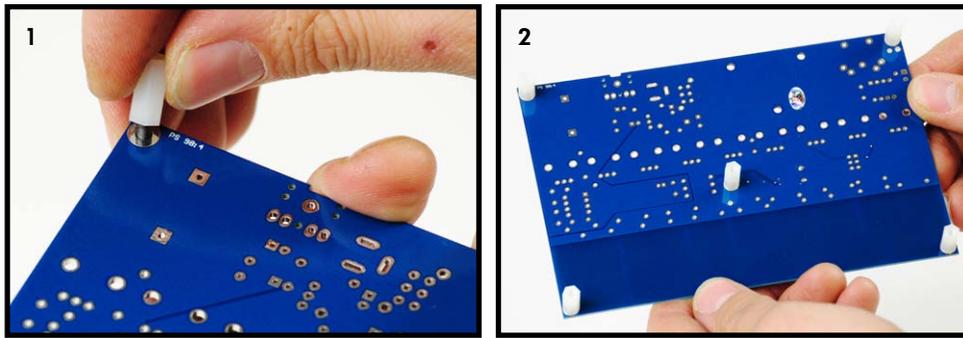
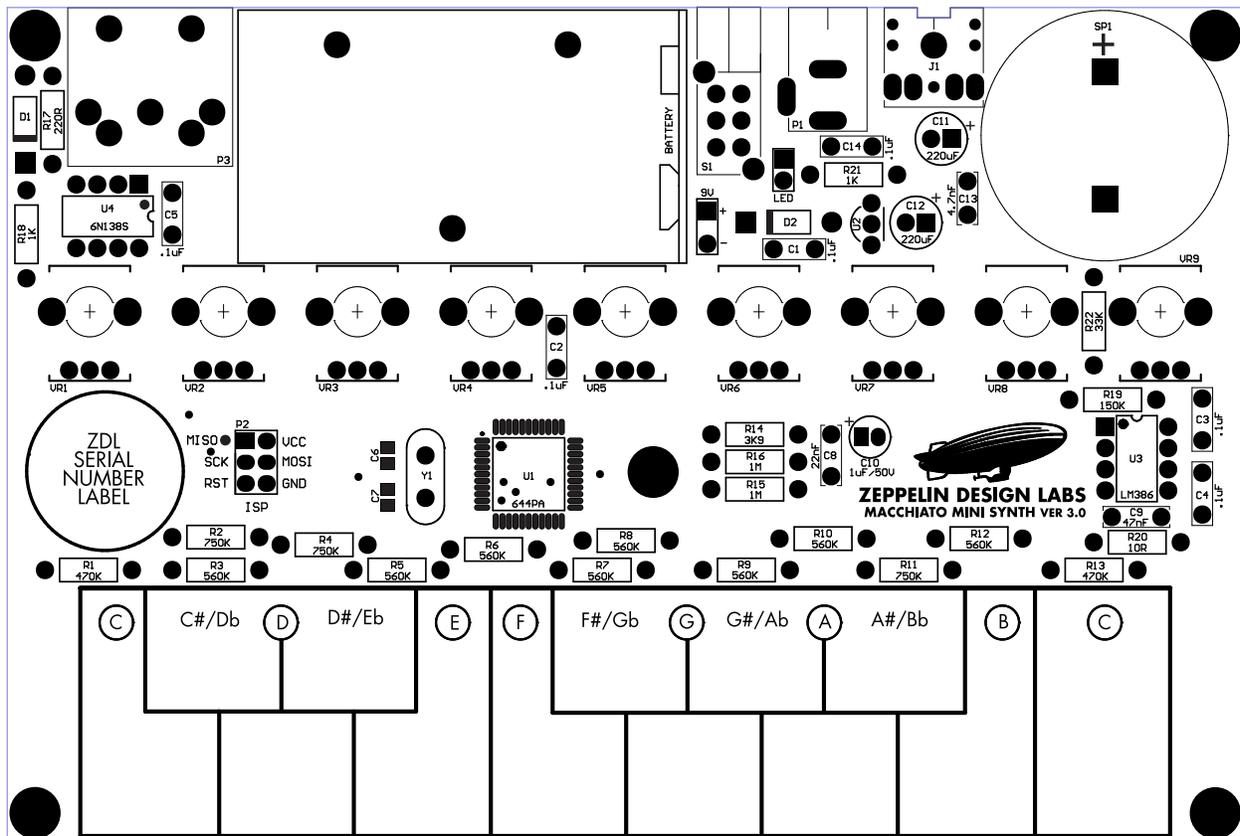


Figure 3: Component Values And Locations



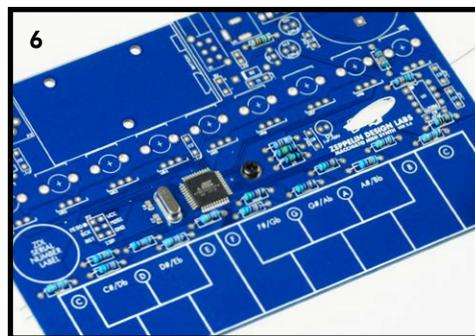
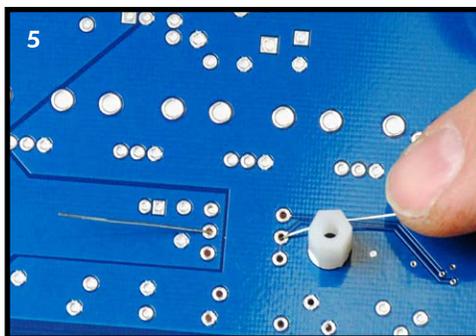
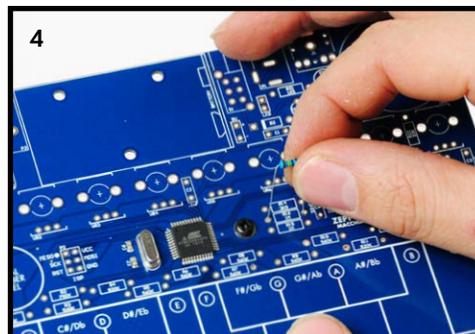
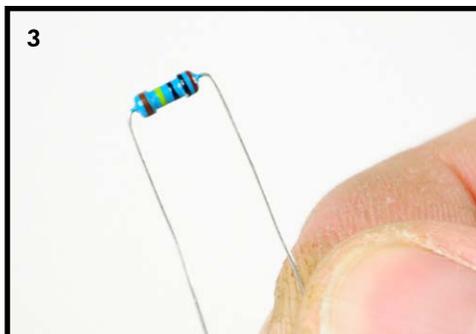
2. Resistors: The values of resistors are given by a series of colored stripes. There are several tutorials online describing how to decode these stripes, but we will identify each resistor for you by simply naming the stripe colors, and giving you the value and the part number. "Figure 3: Component Values And Locations" is a good reference. If you are color blind or can't see the stripes clearly, then you must use your digital multimeter to measure the resistance of each resistor.

The white graphics on the component side of the board give reference to the part number and value. A few revisions were made to the circuit after we had the circuit boards made, so some of the component values printed on the circuit board have changed. Figure 3 does show the correct component values, so please use it to cross check your work.

Resistors are not polarized, meaning they can be installed into their holes in either direction. It doesn't matter which lead goes into which hole.

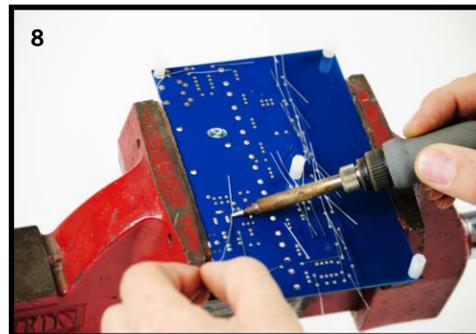
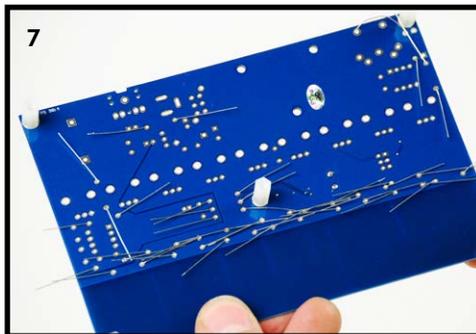
The hole spacing of the resistors on the circuit board allows the leads to be (gently) bent 90 degrees at the body of the resistor (3). This allows the resistors to slip into their holes very easily.

- a. Start with the 1M resistors (R15, R16), labeled BROWN, BLACK, BLACK, YELLOW, BROWN. Compare to its picture in the BOM. Find their locations on the circuit board; install and bend the leads as described above (4,5,6). Don't solder any of them until all 22 resistors are installed; just bend the leads to keep them in place.



- b. Install the 1K resistors (R18,R21). These resistors are labeled BROWN, BLACK, BLACK, BROWN, BROWN. If you have PCB version 2.6 or lower, don't be dismayed that R18 and R21 are not labeled "1K" on the PCB. These values were changed after the PCB's were made. PCB version 3.0 or higher has the correct labeling on the board. Figure 3 has the correct values listed for reference. Bend the leads on the back so they won't fall out.
- c. Install the 220 ohm (220R) resistor (R17), labeled RED, RED, BLACK, BLACK, BROWN. Bend the leads on the back.
- d. Next do the 33K resistor (R22), labeled ORANGE, ORANGE, BLACK, RED, BROWN. Bend the leads on the back.
- e. Install the 150K resistor (R19), labeled BROWN, GREEN, BLACK, ORANGE, BROWN. Bend the leads on the back.
- f. Install the 3.9K ohm (3K9) resistor (R14), labeled ORANGE, WHITE, BLACK, BROWN, BROWN. Bend the leads.
- g. Install the 10 ohm (10R) resistor (R20), labeled BROWN, BLACK, BLACK, GOLD, BROWN. Bend the leads.
- h. Install the 560K resistors (R3,R5,R6,R7,R8,R9,R10,R12), labeled GREEN, BLUE, BLACK, ORANGE, BROWN. Bend the leads on the back.
- i. Install the 470K resistors (R1,R13), labeled YELLOW, PURPLE, BLACK, ORANGE, BROWN. Bend the leads.
- j. Lastly, install the 750K resistors (R2,R4,R11), labeled PURPLE, GREEN, BLACK, ORANGE, BROWN. If you have PCB version 2.6 or lower, don't be dismayed that R4 and R11 are not labeled "750K" on the PCB. These values were changed after the PCB's were made. PCB version 3.0 or higher has the correct labeling on the board. Figure 3 has the correct values listed for reference. Bend the leads.

You should have a whole forest of bent leads coming out the solder side of the board. Now you can turn the board solder-side-up and solder each lead to the board. Use a clamp or vise if you have one; it makes soldering much easier (7, 8).

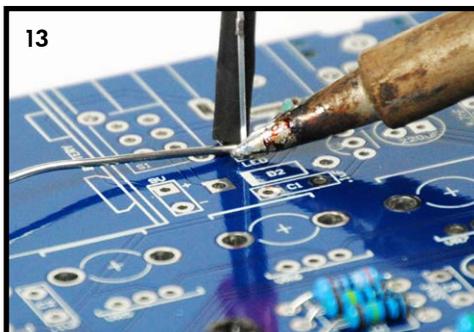
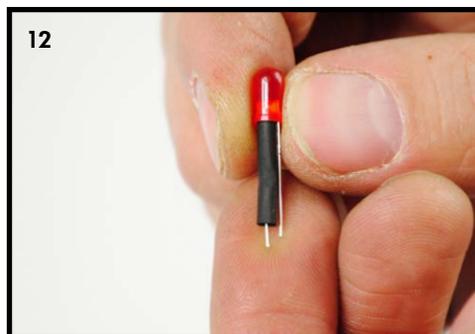


Now clip each lead with your flush cutters at the solder joint (9).

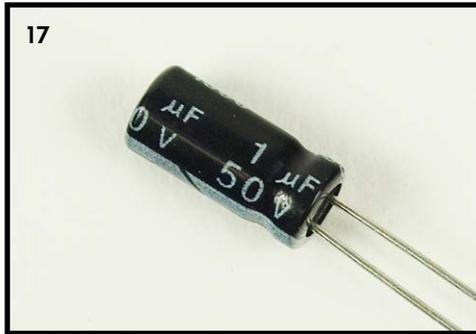
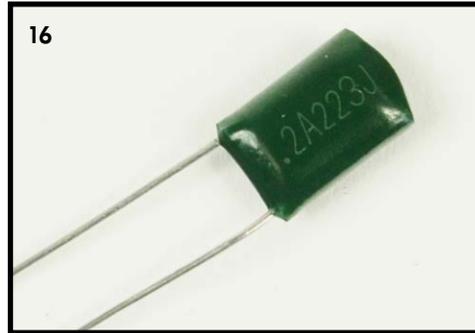


Before installing any more components on the circuit board, double-check the resistance values of each of the installed resistors (10). Set your digital multimeter to the “ohms” or “resistance” setting, and measure across all of the resistors. Compare the measured value to the listed value in Table 1 and in Figure 3. Make sure they are all correct (within 1%) before moving on! Note that the two 1M resistors will measure about 500K because they are in parallel with each other.

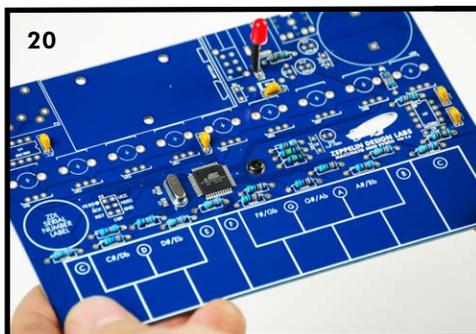
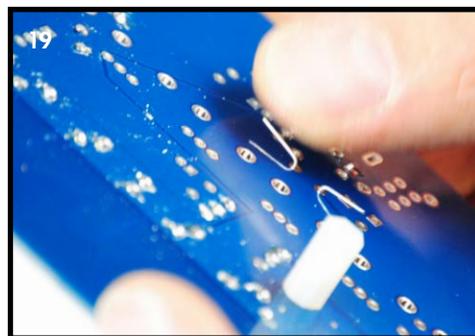
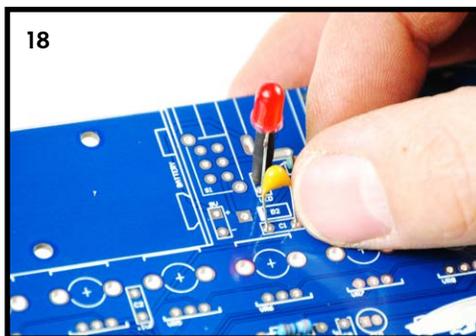
3. Power Light (LED): Make a mark on the shorter LED lead 18mm below the LED (11). Locate the 2mm heat shrink (Part #CB-90-11) and place it over the longer lead of the LED (12); if you wish, you may shrink it with your soldering iron or a heat gun, but it is not necessary. Install the LED on the PCB in the spot marked LED. The long lead with the heat shrink goes into the hole with the square pad. The LED, being a diode, is polarized and must be installed in the correct orientation. If you get it backwards, the light won't work. Make sure it is standing straight up. Insert the LED to the mark you made, so the bottom of the LED is 18mm above the PCB. Solder the short lead from the component side of the board (13). Flip the board over and solder the longer lead (the square pad) (14).



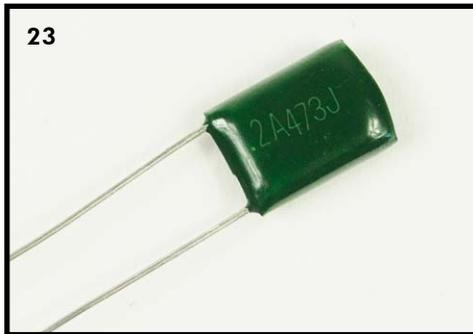
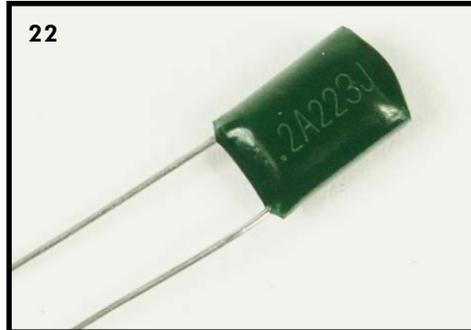
4. Capacitors: There are three different types of capacitors in the kit: ceramic (15), film (16) and electrolytic (17). We will place them in the PCB one type at a time, and then solder them all in at once.



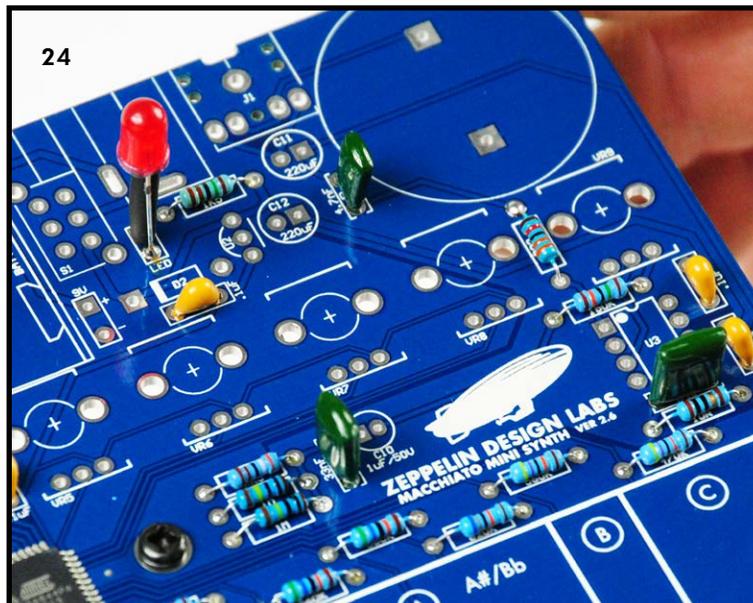
- a. Ceramic Caps: There are six 100nF yellow ceramic caps (C1,C2,C3,C4,C5,C14). If you have PCB version 3.0 or higher (likely), we will install all six capacitors now. Place capacitors C1, C2, C3, C4, C5 and C14 in their respective places on the PCB and bend the leads out on the back so they don't fall out. If you have PCB version 2.6 or lower (not likely), install five caps C1-C5 in their respective locations now. Set cap C14 aside. We will install it later, in Step 10. Like the resistors, these capacitors are not polarized. It doesn't matter which lead goes into which hole.



- b. Film Capacitors: There are 3 green film caps and all of them have different values. The 4.7nF cap (C13) is smaller than the other two and is marked "2A 472 J" (21). The 22nF cap (C8) is marked "2A 223 J" (22). The 47nF cap (C9) is marked "2A 473 J" (23). These caps are not polarized; the leads can go into either hole.



- i. Place the 4.7nF cap (C13) in its place and bend out the leads.
- ii. Place the 47nF cap (C9) in its place and bend out its leads.
- iii. Place the 22nF cap (C8) in its place and bend out its leads. C8 is not labeled "22nF" on the circuit board, but Figure 3 is correct.



- c. Electrolytic Capacitors: There is one 1 $\mu$ F cap (C10) and two 220 $\mu$ F caps (C11,C12). You can read their values on their casings. Electrolytic capacitors ARE POLARIZED: there is a right way and a wrong way to install them. If you get it wrong, your synth will not work and the cap might burst. The white stripe on the case indicates the negative lead of the cap (24).

STRIPE = NEGATIVE = SHORT LEAD = ROUND PAD  
NO STRIPE = POSITIVE = LONG LEAD = SQUARE PAD

Make sure you orient the caps properly! For reference, Figure 3 has little red plus signs (+) on the positive pads.

- i. Install C10 in its place and bend the leads out (24).
- ii. Install C11 & C12 in their places and bend the leads out (25).
- iii. Flip the board over, solder and snip all the leads (26).

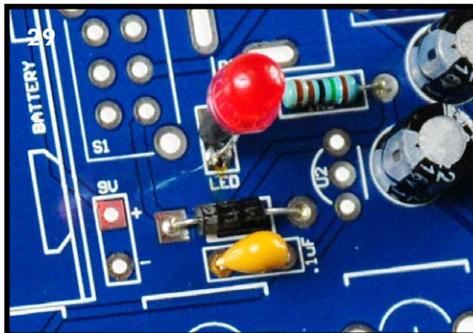
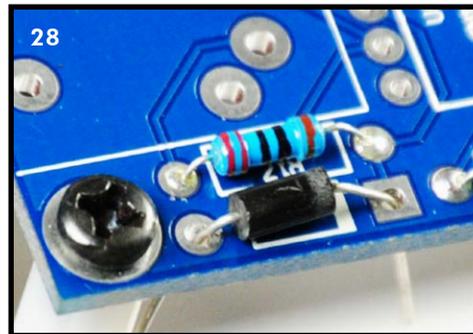
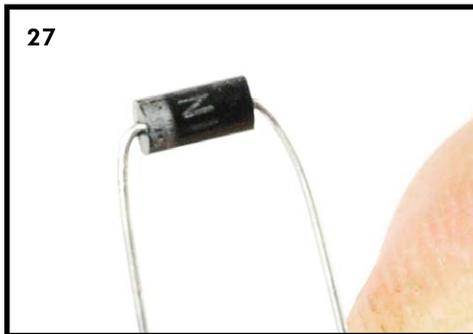


5. Diodes (D1,D2): Diodes are polarized: it matters which lead goes in which hole. You will notice one end of the diode body has a white stripe around it (27). It goes like this:

WHITE STRIPE = SQUARE PAD

NO STRIPE = ROUND PAD

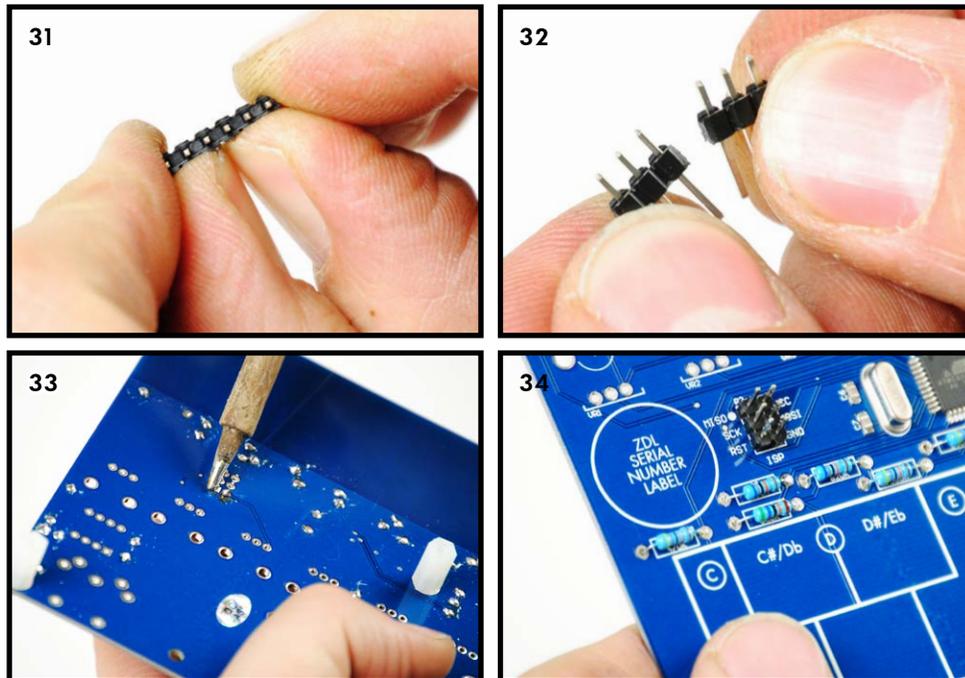
Gently bend the leads like you did for the resistors (27). Place both diodes in their locations on the board (28,29). Make sure they are installed in the correct orientation; otherwise your synth won't work. Bend, solder and clip the leads.



- Header (P2): By installing a 2x3 header array, you create an ISP (in-system programming) port. This is a little socket that enables you to plug a cable into your synthesizer and upload (or “flash”) new software onto the control chip. This is covered in detail in the Macchiato Reference Manual.

Carefully break the header into two pieces with three pins each. You can use your fingers to do this (31,32).

The short pins go through the board; the long pins point up. Make sure the bottom of the headers are flush to the circuit board. Tack one pin down with solder while you hold the header in from the top (33). Once each row has been tacked on, you can solder the other pins in place (34).



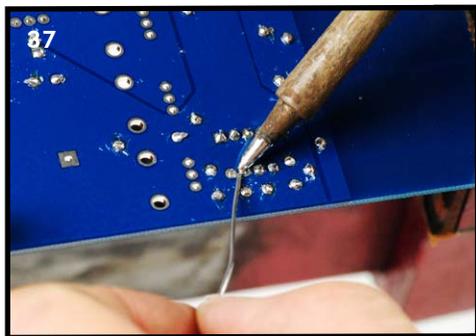
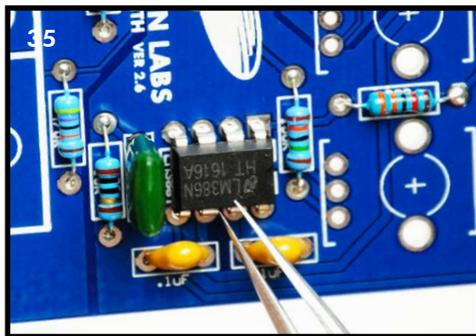
- Integrated Circuits (IC's): This kit contains three integrated circuit components for you to install, plus the microcontroller which comes already installed on the PCB. In general, IC's are quite sensitive to static electricity and could easily be damaged if they are exposed to moderately high voltages. Unfortunately, humans are not sensitive to static electricity at these levels; in fact, most people can't even feel a static discharge less than around 1000 volts! So it is easy to damage these components without even knowing it. The particular IC's in this kit are only moderately sensitive to static discharge but it is still important to be mindful of these principles in handling them. When you do have to handle them, make sure you are grounded, preferably by touching something grounded to the mains like the metal chassis of a plugged-in amplifier, or a refrigerator. At the very least you should touch a large conductive object like a metal desk or a filing cabinet. With this information in mind please proceed carefully.

When soldering IC's, try to keep the IC from getting too hot. Most chips have a temperature threshold that shouldn't be exceeded. As a rule of thumb don't keep your iron on any leg longer than two seconds, and make sure the chip stays cool enough to touch. If you find you have a hard time keeping the IC from getting too hot, just solder one leg at a time and let the chip cool off before proceeding to the next leg.

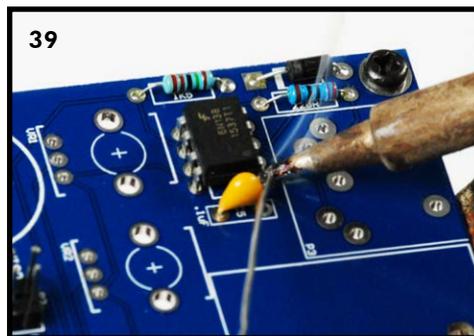
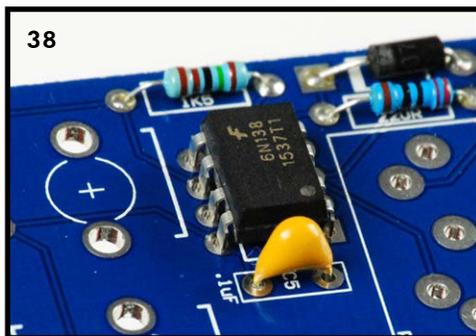
IC's have a specific orientation. If you install them wrong, your synth will not work and you could damage or destroy the IC. Each IC has a dot, divot, or a flat side at one corner or end. These features have a corresponding graphic on Figure 3 to show you how to orient the IC.

- a. LM386 (U3): This chip is the audio amplifier and drives the speaker and line out jack. Install it in the cluster of eight holes at U3. Notice the divot at one end of the chip. There is a matching shape on the PCB graphic. Also, the dot on the IC (near pin 1) should line up with the square pad on the board (35). Press the amp down snugly with your fingertip. Mount the PCB in your clamp and tack one leg down with solder from the component side (36). Now flip the board over and finish soldering the rest of the leads (37).

**TIP:** You can use some painter's tape to hold down the IC to the top of the PCB while you solder it in from the back.



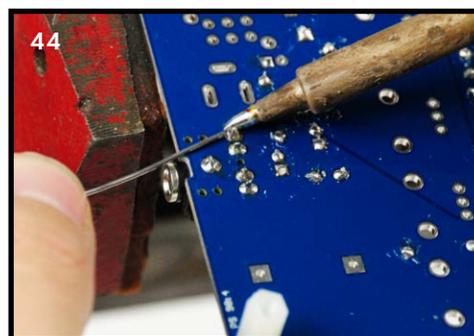
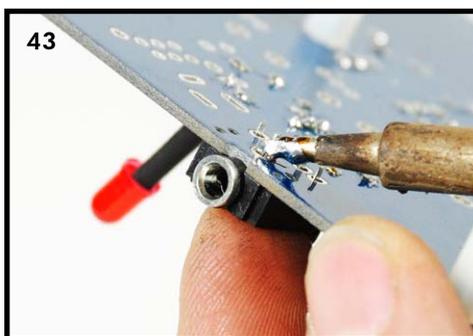
- b. 6N138 Optocoupler (U4): Install the optocoupler at U4. The corner lead marked with a tiny dot goes into the hole with the square pad (38). Solder this chip in the same manner as the last one (39).



- c. Voltage Regulator (U2): This component is shaped like a three-quarter moon. Notice the PCB graphic at U2 has a similar shape to show you the correct orientation. Thread the three leads through the PCB and press this component into place (40). Bend the leads out on the other side of the board. Solder and clip the leads (41,42).



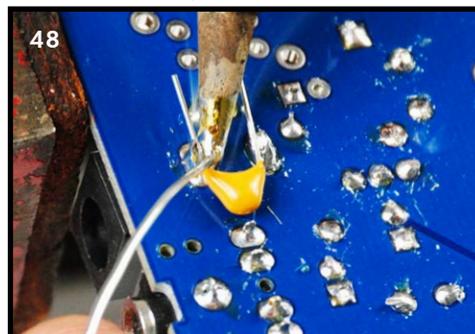
8. Headphone Jack (J1): Install the headphone jack at J1. Press the jack snug to the board with your finger and flip the board over and tack one pin down (43). Once the jack is held in place, finish soldering the rest of the pins. (44).



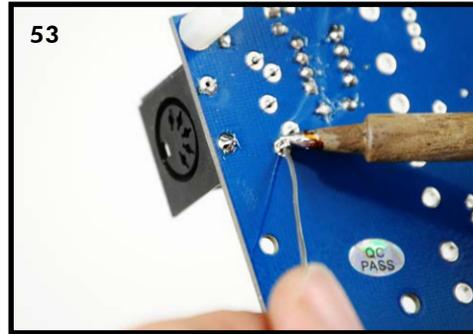
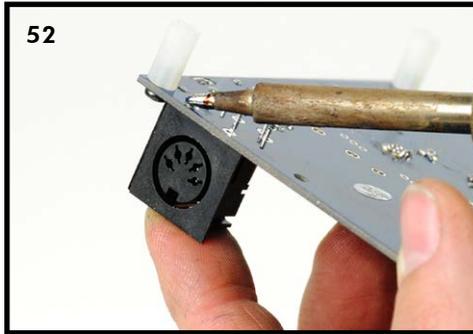
9. DC Power Jack (P1): Press it snug to the board and solder in the pins on the solder side. Double check to make sure it's sitting flush to the board before you solder it (45,46).



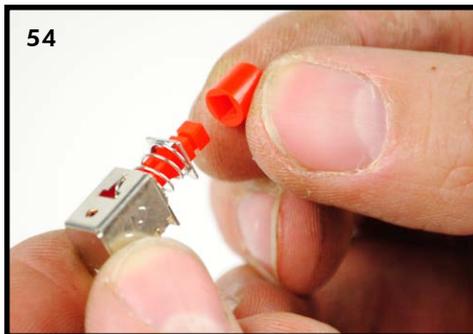
10. Input Filter Capacitor (C14): If you have PCB version 3.0 or higher, skip to the next step. If you have PCB version 2.6 or lower, then we will now install the last 100nF ceramic capacitor. This component will be attached to the solder side of the board, across the DC power jack. Lay the capacitor down flat on the solder side of the PCB; the leads of the cap should be between the facing DC jack pins (47). This cap is not polarized; it doesn't matter which lead is soldered to which pin. Solder one lead of the cap to a pin of the DC jack (47). Solder the other lead to the opposite pin of the DC jack (48,49). Clip the leads off of the cap (50,51).



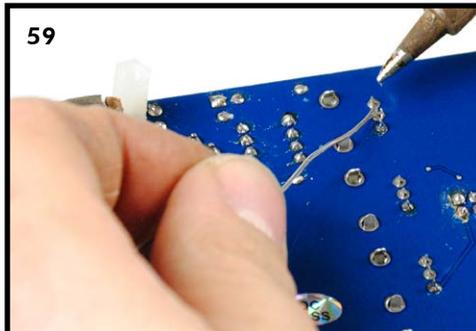
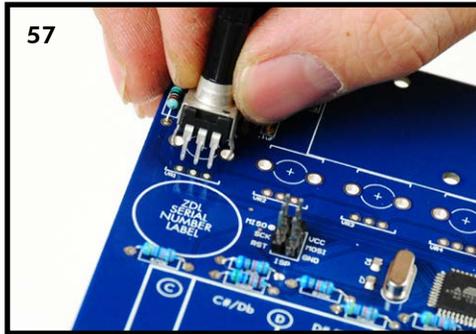
11. MIDI IN Jack (P3): Press it snug to the board. Double check it is flat against the board and then solder it in (52,53).



12. Power Switch (S1): Before you place the power switch on the board, push the little red button onto the switch (54). Press the switch snug to the board and solder the leads (55,56).

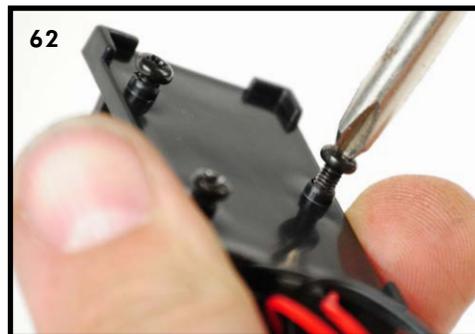


13. Potentiometers (VR1 - VR9): Install the control pots. You will manipulate these components more than any other, so be careful to seat them securely against the PCB (57,58). Solder them carefully and securely (59). Do not use too much heat. If you cannot move quickly with your iron, place all nine pots in the board and solder one pin on each pot sequentially. This will allow each pot to cool before you solder its next leg (60).

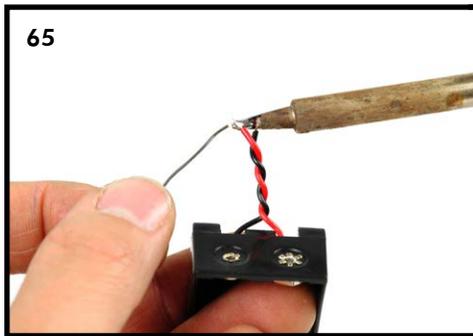
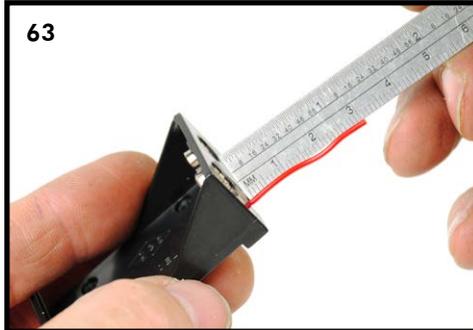


14. Battery Holder (BT1): Before we install the battery holder we need to slightly modify the screw holes to allow them to better accept the screws.

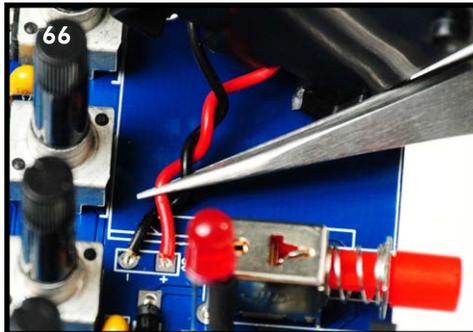
- a. Use the tip of your X-Acto knife to gently flare out the ends of the screw holes just a little bit (before and after photo). To pre-thread the holes, use a #2 Phillips screw driver to drive an M3 screw into each hole. Make sure the screws go in straight. Remove the screws.



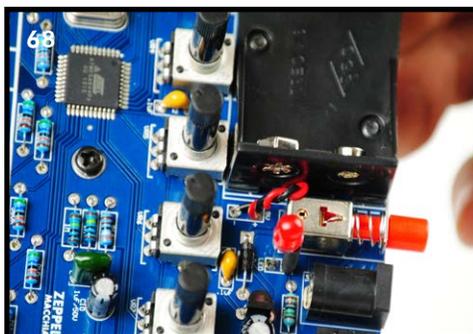
- b. Cut the wire leads to 1-1/4" (30mm) (Fig 63). Strip 1/8" (3mm) insulation off the ends. Gently twist the tiny strands of copper wire together. Now gently twist the red and black wires together (64). Tin the ends of the wires with your soldering iron (65).



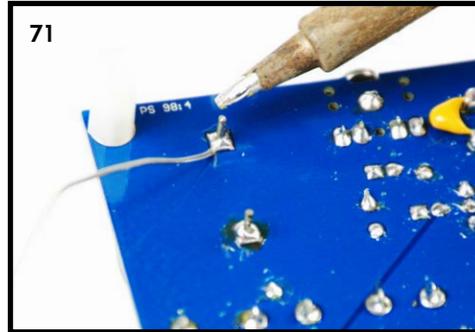
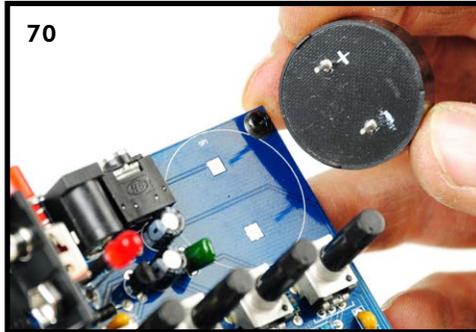
- c. The wires go into the holes marked 9V. Solder the red wire into the hole with the square pad (+). Solder the black wire into the hole with the round pad (-) (Fig 66, 67).



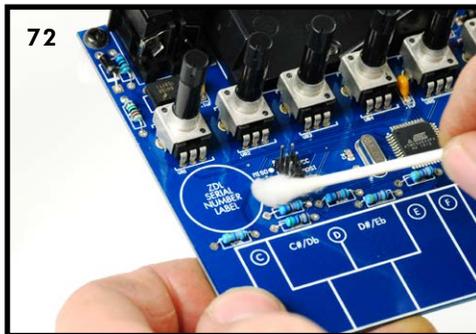
- d. Now swing the battery holder into place (68). Make sure the holder does not rest on top of the wires. Mount the holder to the PCB with three M3 screws. Tighten the battery holder firmly against the PCB (69).



15. Speaker (SP1): Place the speaker into its holes. The pin marked “+” on the bottom of the speaker goes into the hole closest to the corner standoff. This is marked on Figure 3. Solder the leads (70, 71).



16. Serial Number Label (Part #PL-10-90): Clean the PCB with rubbing alcohol to remove fingerprints and solder residue (72). In addition to the sticker site, clean the keyboard area as well. Apply the serial number sticker (73). Rub it down thoroughly. You will need this number if you request assistance or service.



Congratulations! Your Macchiato Mini-Synth is complete, except for the cabinet. I know you are eager to hear cool sounds, so open up the “Macchiato Quick-Start Guide” and make some noise. Keep the label sheet handy so you can keep track of the many knobs. When you are ready to protect your wonderful new synthesizer in its own cabinet, continue on.



## MAKING A CABINET

Your Macchiato wants a cabinet and you have some options: make a cabinet from a cereal box or cardstock from the craft store, or get a plastic cabinet kit from Zeppelin Design Labs. In the future we will publish CAD models that you can download and use to 3D-print your own case. To stay informed, sign up for our newsletter at [www.zeppelindesignlabs.com](http://www.zeppelindesignlabs.com).

### CARDSTOCK CABINET

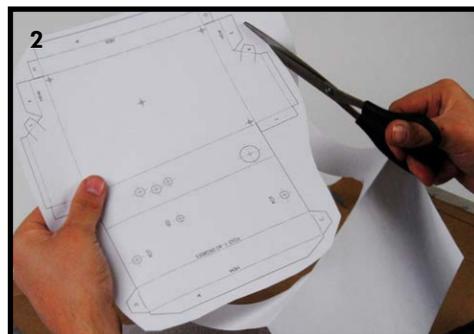
Your synth includes a template for making a nifty cardstock cabinet. If you need an extra copy, you can download it from [www.zeppelindesignlabs.com](http://www.zeppelindesignlabs.com), but you will need to print it on 11x17 (A4) paper. Be sure the template prints to 100% full size! Compare the scale on the template to an actual ruler.

#### WHAT YOU WILL NEED

1. Straightedge
2. X-Acto knife or other sharp hobby knife
3. Sharp scissors
4. Rubber cement
5. Two push pins or thumbtacks
6. Some large paper clips or small binder clips
7. Cereal box or cardstock. If you go to the craft store for cardstock, choose something with these properties:
  - It must be minimum 10" x 10" (25 x 25 cm)
  - It must be at least as stiff as a cereal box, no thinner! Look for 80-100 lb cover stock.
  - The face must be smooth enough to hold the vinyl sticker.
  - The paper must not conduct electricity! Many fancy papers include conductive metallic glitter or mylar film. If unsure, bring your ohm meter in to the craft shop with you and test!

### *Let's Begin!*

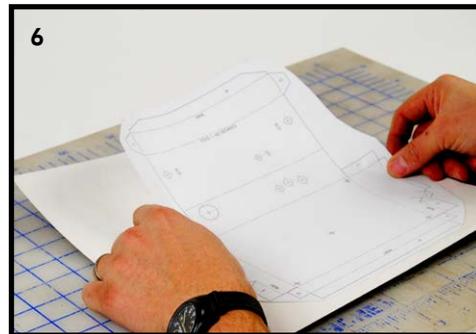
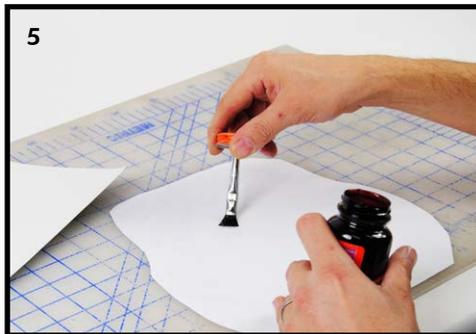
1. Rough-cut the Template, leaving a small margin all around (2).



2. Flatten your cereal box, if that is what you are using. (Use a large box.) Cut the box open along its glued seam (4).

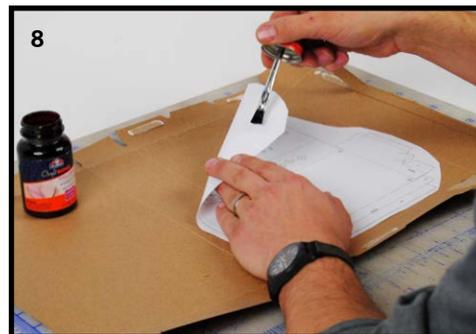
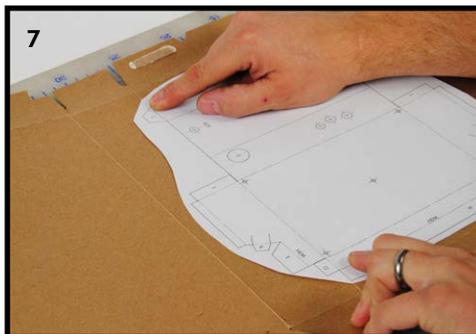


3. Glue the template temporarily to the BACK of your material (the INSIDE of your cabinet.) Use rubber cement (5, 6). You will peel the template off again later.



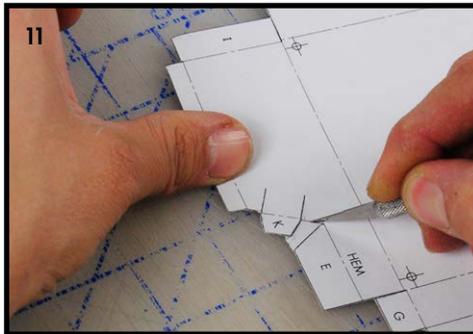
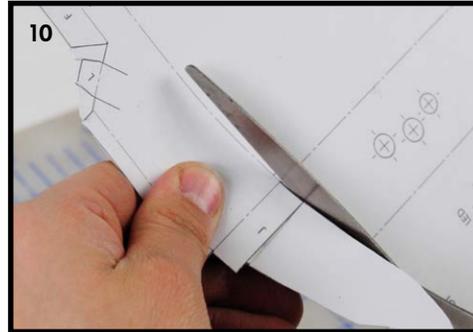
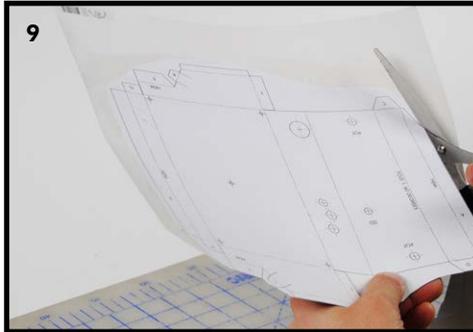
Special Instructions for Cereal Box:

- Align one of the template fold lines with an existing fold in the cereal box (7). Look at the front of the box to get an idea of what graphics will be most prominent on your completed cabinet.
- Glue the template to the box. Double check the alignment of the template fold line with the box fold (8).



4. Cut out the template.

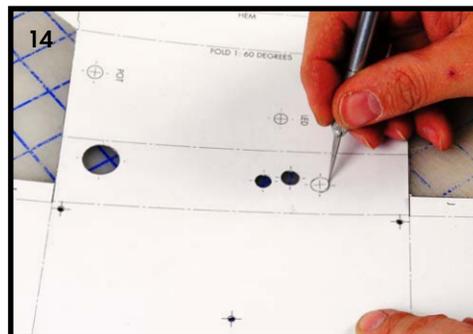
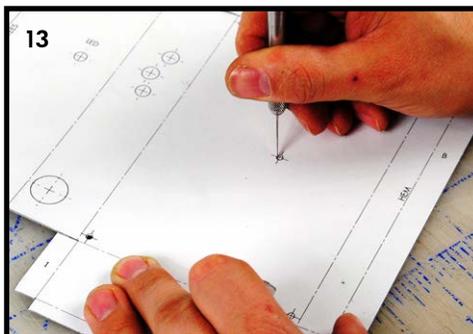
- a. Using sharp scissors, or a metal ruler and an X-Acto knife, carefully cut out the whole perimeter of the template (9,11). Additionally, snip along every solid line near tabs G through L (10).

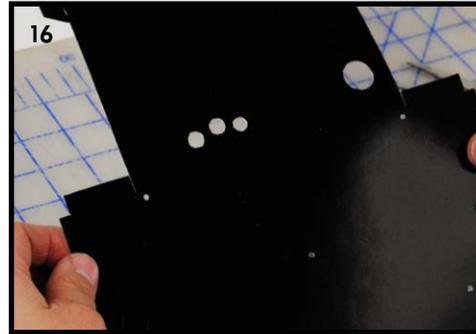
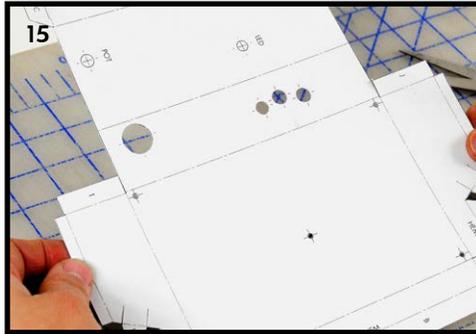


- b. Cut slits in Tabs C & D. Carefully cut along the solid lines with the tip of your blade (12).

5. Cut out some of the holes.

- a. Cut out the five tiny screw holes from the cabinet bottom. It's okay if the holes are a little small, but do not cut them too big (13)!
- b. Cut out the four holes from the cabinet back (14). Cut to the outside of the markings; it is important not to undersize these holes.

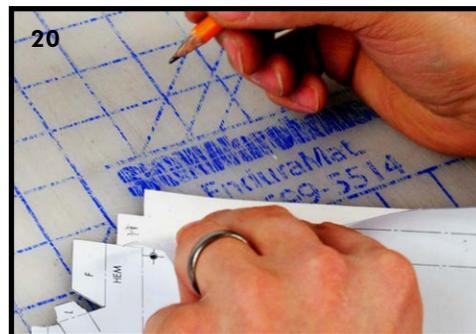
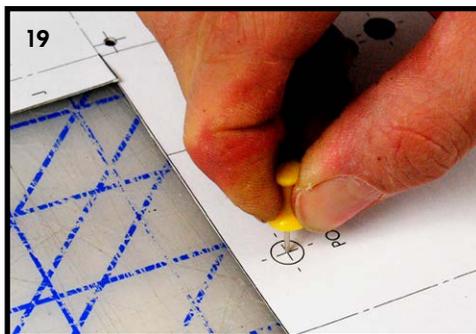




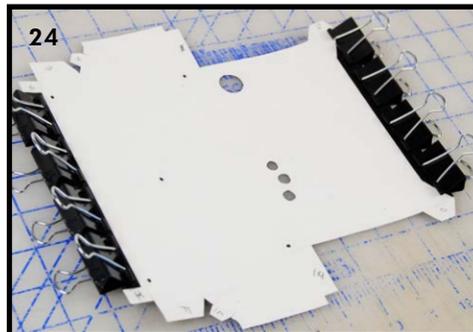
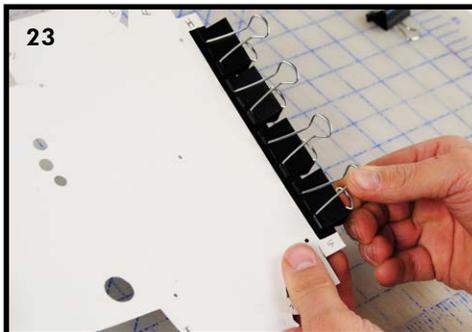
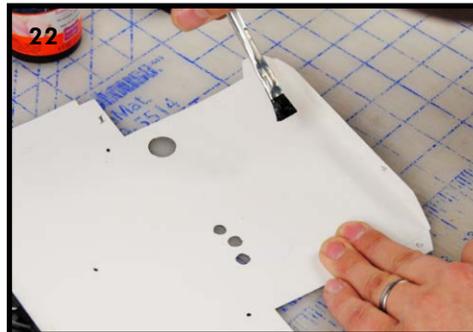
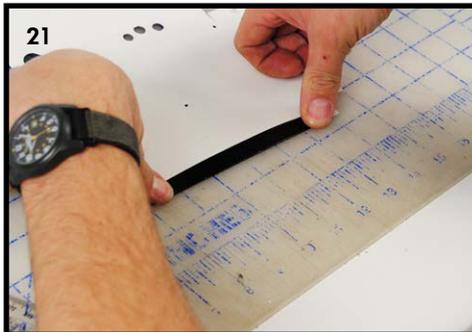
6. Score the fold lines. Use your ruler and the tip of a butter knife to carefully score every dotted fold line (17, 18). Skip Tabs C & D; they will fold neatly without scoring. Be as accurate as you can. Notice the fold lines on Tabs G, H, I & J are offset a little from the adjacent lines. Following these little details will ensure an excellent fit.



7. Use a thumbtack or push pin to poke two pinholes through the cabinet top, at the cross hairs marked "Pots" (19).
8. Now you can peel off the template, but hang on to it for reference; or you may want to write the tab labels onto the cardboard (20).



9. Fold and glue the hems. Tabs A & B are hems, meaning they are to be folded over flat and glued down. Pre-crease them sharply (21). Apply rubber cement, following directions on the jar for the strongest bond (22). Fold the tabs flat and clamp them down with large paper clips or small binder clips (23). Now leave it alone until the glue dries thoroughly. Play with your synth.

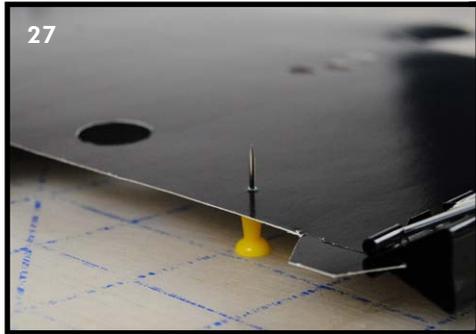


10. Apply the label.

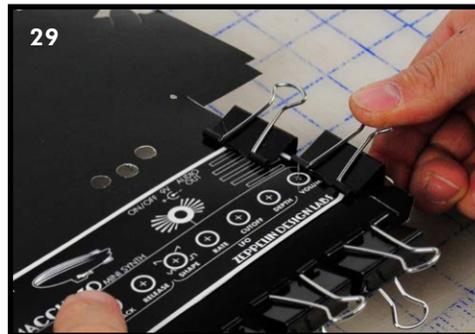
- Clean up any dust or stray paper bits from your workspace.
- Cut out the main control panel label, around the outside of the white border (25).
- Poke pinholes through the label at the crosshairs for the far left and right pots. Be very precise! (26).



- d. Push two pins up through the two pinholes in the cabinet, from the inside to the outside (27)



- e. With the backing still on, fit the label down over the pins in the cabinet (28).
- f. When you have the label neatly settled on the cabinet, hold down one end with binder clips (29). Remove the pins from the cabinet.
- g. Remove the backing from the free end of the label (30). Tear off about half of the backing, and stick that half of the label down (31).



- h. Remove the binder clips; remove the last of the backing (32); stick the label onto the cabinet (33). If your cardstock has a textured surface, you may need to warm the sticker with a hair dryer and burnish it down thoroughly.

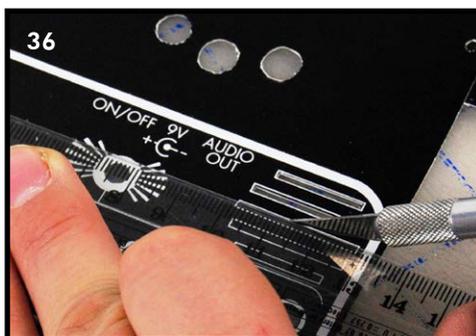


11. Cut out the label holes.

- a. Cutting through the label and down into the cabinet, cut out the nine pot holes and the LED hole. Completely remove the black dots, leaving the white rings (23, 24). Alternatively, you could use a 1/4" round hole punch, but you will have to be very precise since the punched holes will not be much larger than the pot shafts.

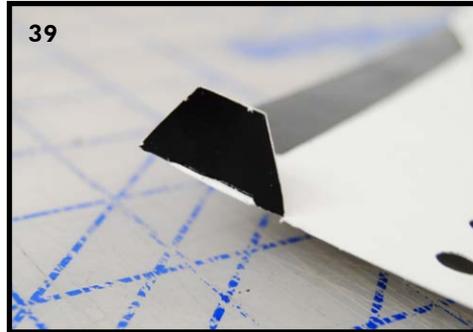
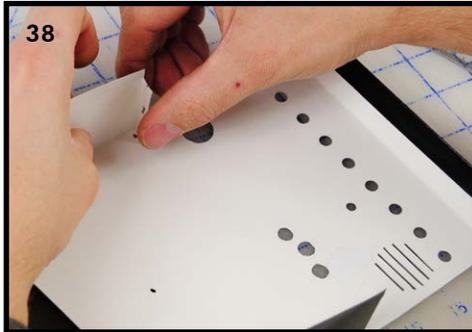


- b. Carefully cut out the five speaker slots, taking care not to cut across the ribs (23). Stay just inside the white lines.



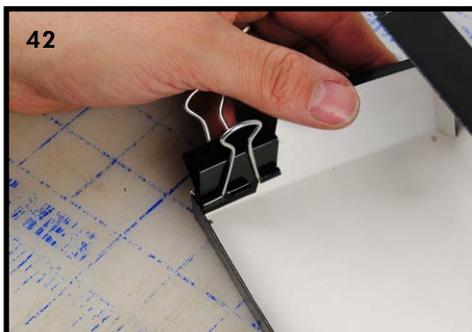
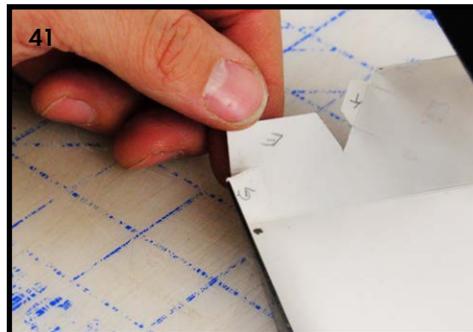
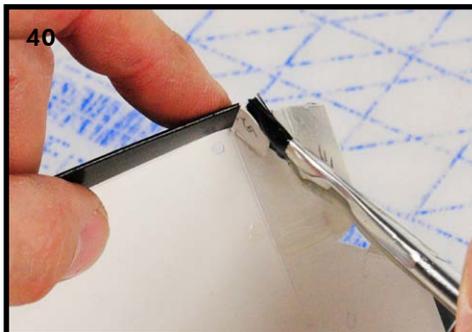
12. Crease the Folds: Crease along each scored fold line, one by one, until each fold more or less stands up at 90 degrees on its own (38), with the following special notes:

- a. Crease Tabs E & F flat as hems.
- b. Very carefully bend Tabs C & D up to 90 degrees. A clear slot should open up where you cut the slits. If necessary, use the tip of your knife to clean out and open up the slots (39).
- c. Crease Fold #1, at the bottom of the label, to stand up at about 60 or 70 degrees (38).



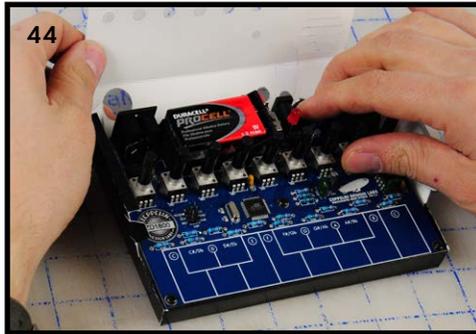
13. Form hems at Tabs E & F. Perform a dry run of this step, before you apply glue, to make sure you are clear on the procedure.

- a. Apply glue to the inside of Tab E, and both sides of G (40).
- b. Fold up the corner as shown (41), folding Tab E down over Tab G.
- c. Clamp Tab E down with a binder clip (42).
- d. Repeat for Tabs F & H (43).



14. Install the Synth.

- a. If desired, pop a 9V DC battery into the battery holder. Now fit the synth into the cabinet, tight to the front (44).
- b. Fold up the back, carefully fitting the red ON/OFF button through its hole (45).



- c. Close the lid over the nine pots. The LED should appear in its hole too. If it does not line up, open the lid again and push the LED around to line it up with its hole. Also check the ON/OFF switch: does it pop in and out as it should? If not, carefully enlarge its hole a little.
- d. Tuck Tabs C & D into the cabinet behind Tabs K & L (46). Direct Tabs K & L into the slots in Tabs C & D (47). They may require some gentle persuasion. Be patient and gentle. If necessary, clear or lengthen the slots in C & D with the tip of your knife. When Tabs K & L slip into place, they will neatly lock the cabinet closed (48). You can open the cabinet up again to change the battery by gently teasing Tabs K & L out with a fingernail. Do this as seldom as possible, or you will wear out the tabs.



- e. Turn the synth over. Slip the nylon washers (Part #FA-90-25) over the last five screws. Use a #2 Phillips screw driver to install them through the cabinet and into the standoffs. Drive them snug but not too tight: you do not want to crush your way right through the cardboard (49).



- f. Add some custom labels, if you wish. The remaining stickers can adorn your Macchiato Mini-Synth in a variety of ways. They look good on the refrigerator, too.



## BUILDING THE PLASTIC CABINET KIT

Zeppelin Design Labs offers a nifty black plastic cabinet kit: rugged, and quick and easy to assemble. Prior to March 15, 2018 this kit contained matte black styrene parts, with spurs and some rough edges to be cleaned up. On March 15, 2018 we began shipping kits containing gloss black acrylic parts, with crisp laser-cut edges with no prep necessary. They are easy to tell apart: the acrylic comes with brown paper on both sides. Assembly is similar. While the following instructions picture the now-discontinued styrene parts, the text will call out the few differences in assembly.

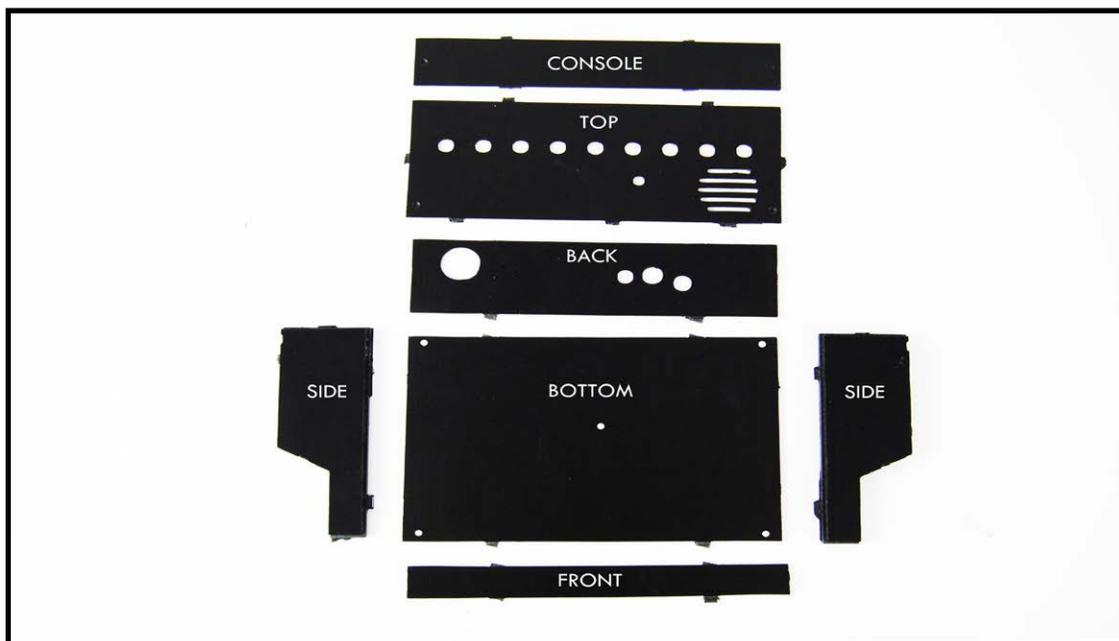
### WHAT YOU WILL NEED

1. X-Acto knife or other sharp hobby knife
2. Some medium and fine sandpapers (180, 240 and 320 grit, more or less; styrene only)
3. Super Glue (cyanoacrylate) for installing magnets. We recommend gel type because it is much thicker and easier to control, i.e. less messy.
4. A few binder clips
5. A toothpick

### *Let's Begin!*

1. Lay out the parts as shown to familiarize yourself with their names and orientation. You are looking at the inside surfaces (1). The styrene parts are shinier on the inside than the outside: lay out all parts shiny-side up. An exception is the Bottom. Be VERY CAREFUL to orient the Bottom correctly! Place your Macchiato over it to verify the center standoff lines up with the center hole. The Bottom may show either the shiny or dull side up.

The acrylic parts, of course, have both sides covered in paper. Note that the Console and Top have two little holes or divots on the inside surface.

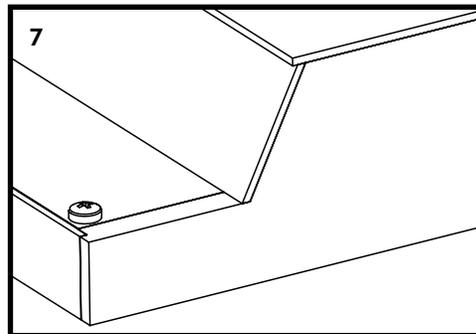
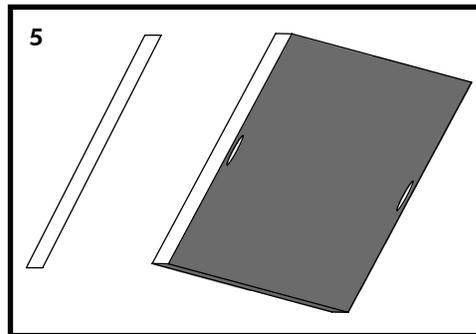


2. Prep the parts.

- a. Acrylic: Remove the paper from the inside faces only. Leave it on the outside faces to protect them from gluey fingerprints. Skip to 3.
- b. Styrene: If any parts in your kit are attached to each other, do not break them apart; slice or chop them with your knife. Shave off and sand down all the tabs, flash and machining ripples from all parts (2, 3).

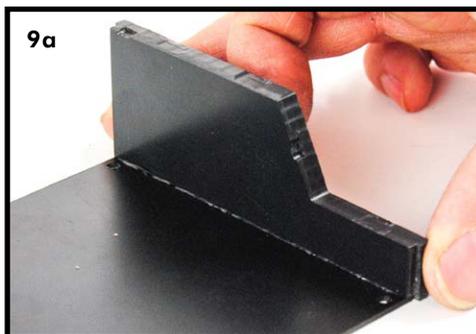
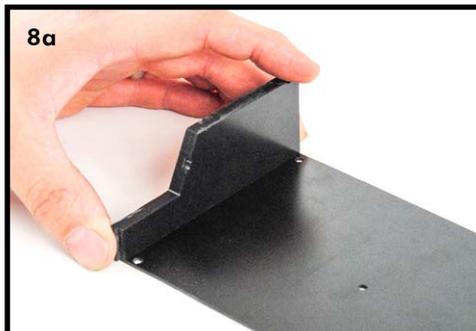


- c. Console: You may want to sand the long edges of the Console as shown to create a 60 degree bevel (4); this may not be necessary depending on how your console piece fits. Be careful to create a parallelogram, not a trapezoid (5). When complete, the console should fit neatly against the sloped faces of the cabinet Sides (6), flush to the top (7).



3. Glue the Sides to the Bottom.

- a. Dry fit the Sides to the Bottom (8a). Note how the Bottom sits flush to the slots in the Side, both toward the front and the rear (9b). Run a very tiny bead of glue inside the slot along the bottom edge of one Side (8b). Start out using a very small amount of glue; you can always add more later if you need it. Remember, it takes way less glue than you might think to put the parts together. Once the glue is applied, press the Side into place. Squeeze it firmly and hold it for about a minute until the glue grabs (9a). Make sure to hold the side perpendicular to the Bottom. Repeat for the other Side, then leave it all alone for a minute or two.



4. Install the Back.

- a. Dry fit the Back into place (10). Be sure to place it flush to the top edge of the Sides. If you are building an acrylic kit, leave the brown paper in place on the outsides of the parts.
- b. Apply glue to the slots in the Sides (11). Be sparing, or you will make a mess.



Press the Back into place and hold for about a minute (12). Add a very small bead of glue to the inside of the joint between Back and Bottom (13).

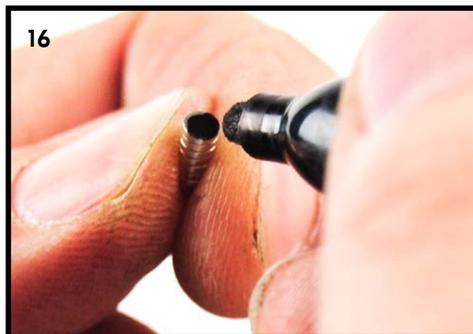


5. Install the Front in exactly the same manner as the Back (14, 15)

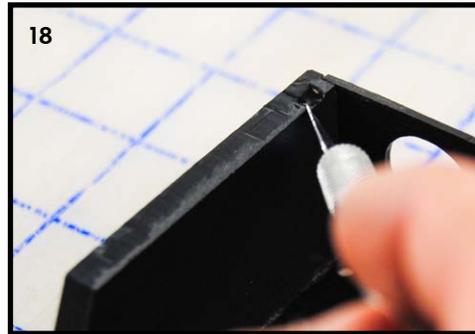
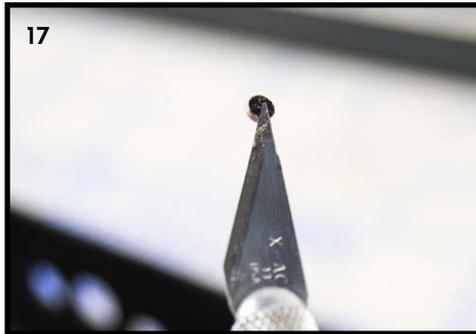


6. Install the Magnets.

- a. Your kit includes 8 tiny, powerful magnets. They are polarized: they like to stick together only when stacked a certain way. You will need to keep track of their polarity, so stack up all the magnets and mark one end with a marker. Set that magnet aside; mark the next magnet and repeat until you have marked one side of every magnet (16).

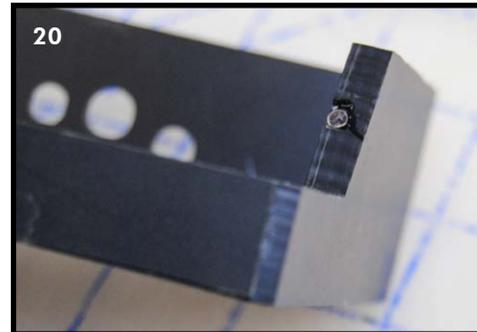
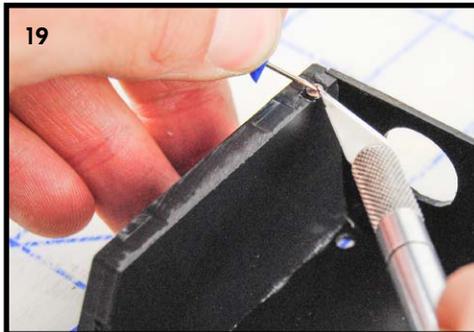


- b. Pick up one magnet on the tip of your hobby knife (17). Dry fit it into each one of the pits on the cabinet Sides. If necessary, clean up the bottom of the pits so that the magnet sits flat at the bottom (styrene only, 18).

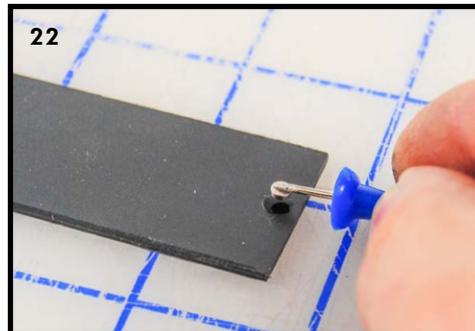
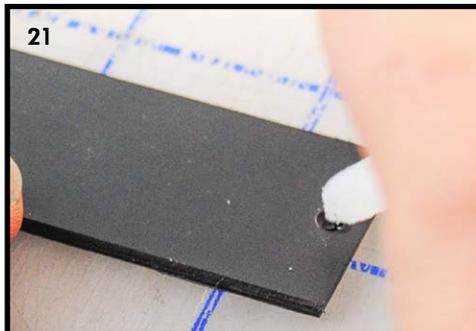


- c. Place a tiny drop of Super Glue in one of the pits. Quickly place a magnet MARKED SIDE UP in the pit and hold it down with a toothpick (19). Don't try to use a push pin as shown, or any other metal object. The magnet will pull itself right out of the plastic. Use a toothpick instead.

Repeat for the other pits in the Sides (20). Place all four magnets with MARKED SIDE UP.

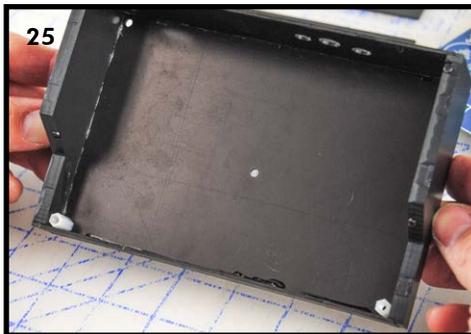
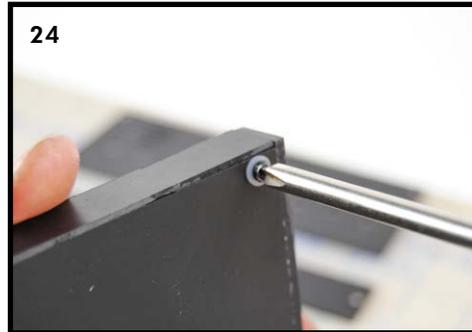
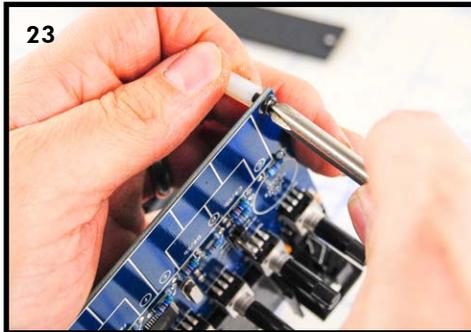


- d. Dry fit the remaining magnets into the little round divots in the Top and Console. They should fit fine, but it is smart to check. In fact, the fit may be tight, which is good. Place a droplet of Super Glue in a divot (21) and place a magnet MARKED SIDE DOWN (22)! If necessary, press the magnet into place with the eraser end of a pencil (not a push pin). Repeat for the last three magnets. Let the Super Glue cure for at least five minutes before continuing, or the magnets will pull each other out of their sockets.



7. Install the synth.

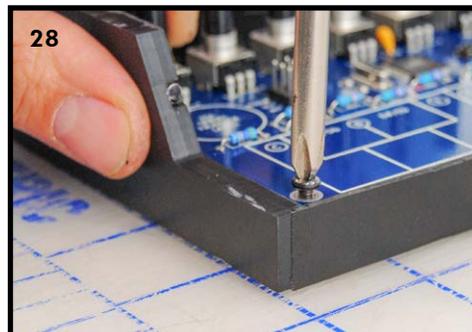
- a. Remove the two front standoffs from your Macchiato PCB (23). Install them in the front two holes in your cabinet, using the tiny plastic washers under the cabinet Bottom (24,25).



- b. Point the ON/OFF switch at its hole in the cabinet Back and slide the synth into place (26). Make sure the ON/OFF switch works easily. If it sticks, or rubs in its hole, remove the synth and enlarge the hole a little with the tip of your knife.



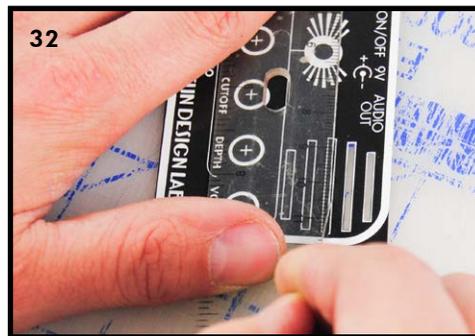
- c. Now run screws with washers up through the cabinet Bottom and into the remaining three standoffs (27). Finally, screw the PCB down to the front two standoffs (28).



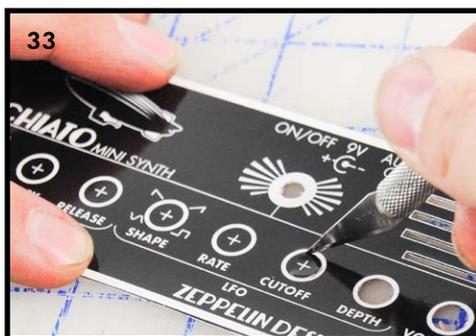


8. Apply the Label.

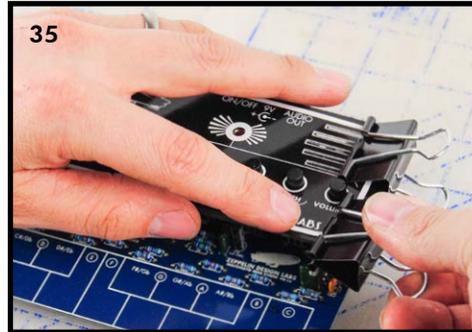
- a. Cut out the label around the outside edge of the white border (31).
- b. Cut out the five speaker slits, staying just inside the white border lines (32).



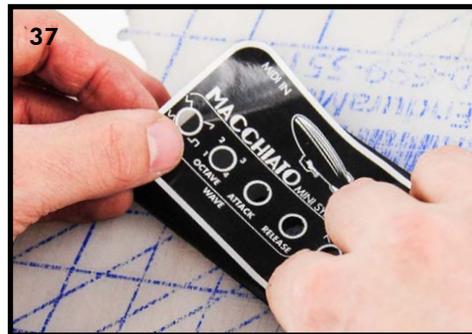
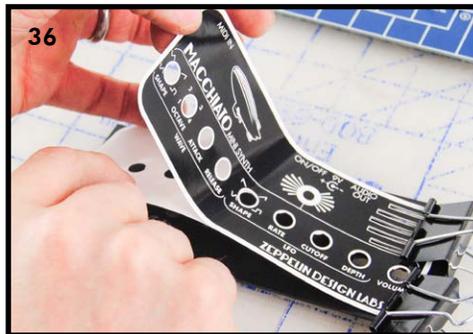
- c. Cut out the nine pot holes and one LED hole. Cut away all of the black dots, staying just inside the white borders.



- d. Place the Top onto the completed PCB so all nine pots and the LED stick through (34). Place the label down over the pots as well. When you like how it lines up, use binder clips or tape to secure one end of the label (35).



- e. Peel and tear off about half of the backing (36). Carefully stick that end of the label down to the Top (37). Smooth out any bubbles or wrinkles.

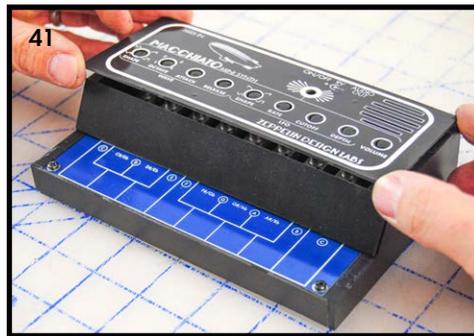


- f. Now remove the binder clips and the last of the backing (38). Smooth down the label (39).



## 9. Assemble the Lid

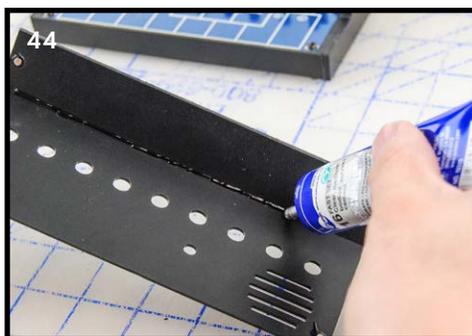
- a. Pop the Console and Top onto the cabinet (40, 41). For acrylic cabinets, the beveled side of the Console piece should be touching the Top, the flat side of the Console should be close to the circuit board. If needed, touch up the Console or the Sides with fine sandpaper to achieve the nicest-looking fit you can (styrene only).



- b. Remove the Top and (acrylic only) peel the mask paper down a little from the top edge. Carefully apply a tiny, very small bead of glue to the top beveled edge of the Console (42). Take particular care not to use too much glue at the ends, near the Sides. If the glue oozes out, it could stick the lid to the Sides. For acrylic cabinets, remove the paper from the front of the Console piece before the glue dries. Replace the Top and press it gently down onto the Console (43). Hold it for at least a minute, then let it set for at least 5 minutes (Super Glue) or 30 minutes (plastic cement).

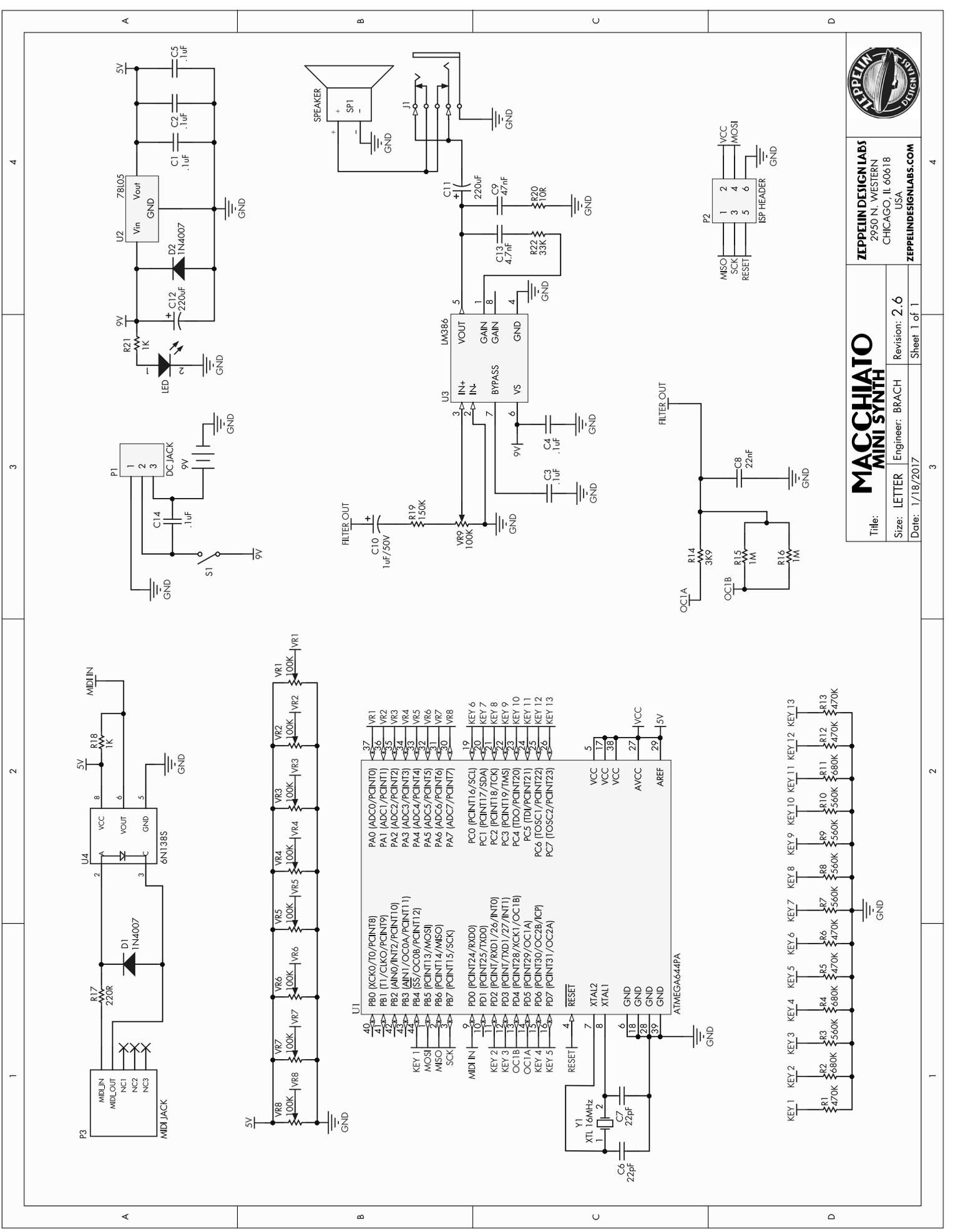


- c. If you feel it is necessary, reinforce the Lid with an additional bead of glue on the inside of the joint (44). Let the lid cure thoroughly before putting it back on the synth (45).



That's it! Apply extra stickers for a custom finish and you are ready for the concert hall. Please see the [Macchiato Quick Start Guide and Reference Manual](#) to get the most out of your new Mini-Synth.





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# MACCHIATO MINI SYNTH

Title: **LETTER** Engineer: BRACH  
 Size: **2.6** Revision: **2.6**  
 Date: 1/18/2017 Sheet 1 of 1

