ALTURA

Assembly Instructions

THEREMIN MIDI CONTROLLER

ZEPPELIN DESIGN LABS

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THEREMIN MIDI CONTROLLER

Assembly Manual

INTRODUCTION

The Altura Theremin MIDI Controller by Zeppelin Design Labs was inspired by the early electronic instrument invented by Russian physicist Léon Theremin. Léon's device features a pair of antennae that can sense the capacitance of a person's hands. The right antenna affects a voltage controlled oscillator (VCO) circuit. As the player moves his hand closer to this antenna, the device emits a sine wave tone that rises in pitch. The left antenna affects a voltage controlled amplifier (VCA) circuit. As the player moves his left hand farther away from this antenna, the tone becomes louder. The device is very sensitive and can make wonderful, spooky music – but it is very tricky to play. The performer has to play by ear: there are no frets in mid-air!

Alexandra Stepanoff playing the theremin on NBC Radio, 1930

The Altura Theremin MIDI Controller makes many improvements on the original device. First, the Altura does not itself make sound; instead, it simply controls synthesizers and computer programs that employ the MIDI protocol (Musical Instrument Digital Interface). Thus any sound that your synthesizer can make the Altura can control. Further, you can determine the key and mode (scale) in which to play.

HISTORY

In 1920, as Léon Theremin (1896 - 1993) was developing radio equipment for the Soviet government, he heard strange sounds coming from some of his circuitry. He noticed that the frequency (or pitch) of this sound changed with how close his hand was to the circuit. He developed this device into a musical instrument which he initially called the Thereminvox. In 1927 he left the USSR to tour Europe in promotion of his invention, performing to large audiences and receiving mixed reactions. His tour took him to New York where he stayed for the next 10 years; in which time he opened a laboratory and studio, patented the Theremin, licensed its manufacture to RCA, performed with a theremin ensemble at Carnegie Hall, and invented an electronic cello. In 1930 he conducted the first-ever concert of an electronic orchestra. In 1938 Léon Theremin suddenly disappeared – it was said that he had been kidnapped by Soviet agents; and later he was presumed dead.

Through the late 30's, Theremin's protégé Clara Rockmore rose to prominence as the world's pre-eminent thereminist. She preformed with world-class orchestras in large concert halls. These performances established the theremin as a legitimate performance instrument and started to open the public consciousness to electronic instruments and electronic music in general.

In the late 50's, Rockmore visited Moscow and by chance made contact with her old friend Léon Theremin. After 20 years of mysterious silence, she received word to meet Léon on a subway platform, where they spoke for a few minutes.

It seems Theremin's disappearance may have had more to do with the IRS than the KGB. What is certain is that upon Theremin's return to Russia, he was arrested and sent to the labor camps. He landed in a secret Soviet laboratory where he developed spy gear for the KGB. He was released in 1947 but "volunteered" to continue with the KGB until 1966.

In 1991 Léon, now 95 years old, returned to New York where he gave concerts, received awards, and was reunited with Clara Rockmore. It is not clear that he remembered her. He died in Moscow in 1993, aged 97.

As for his namesake invention, the theremin was just too difficult to play to ever achieve wide-spread popularity. The performer needed to have a very good sense of relative pitch, if not perfect pitch. Also, the instrument takes a lot of skill to play in a controlled manner. So besides Rockmore, there haven't been many other popular thereminists. But the theremin has never completely gone away. In fact, it has consistently been at the center of a sub-culture passionate about electronic instruments and music, where people are not afraid to blur the line between technology and art. One of our personal heroes, Bob Moog, got his start back in the 1960's designing and selling theremin kits, before he revolutionized popular and electronic music with his modular synthesizers. At Zeppelin Design Labs, with our love of electronic instruments and DIY kits, we hope the Altura will continue Léon Theremin's legacy of inspiring both artists and electronics nerds.

HOW IT WORKS

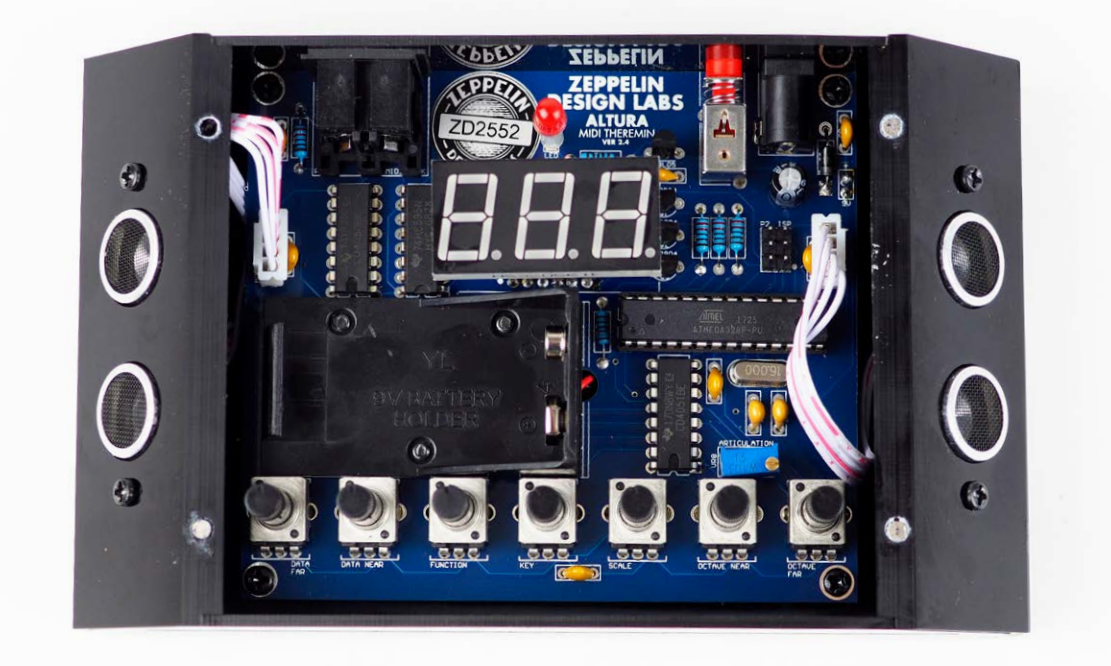
Our MIDI version of Léon's device uses sonar range finders in place of antennae, and rather than producing sound directly, the Altura emits discreet packets of digital data that are interpreted by a separate synthesizer or other sound-making device. The Altura's right-hand sensor transmits Note-On messages to play specific notes, thus controlling pitch. The left sensor transmits Channel Volume data, thus controlling volume. But this is just the start! The left sensor can be set to transmit many MIDI functions, like pitch bend, modulation, note velocity, and portamento time. The Portamento function causes one note to glide smoothly to the next, emulating that spooky Theremin sound; but the device is

always gliding to a specific note within a key and scale you designate. As a result, the Altura always plays in tune!

The Altura was designed as a companion to the Macchiato Mini Synth by Zeppelin Design Labs. There are a few special features that will only work well when paired with the Macchiato. Otherwise, the Altura conforms with General MIDI specifications and should easily control any device bearing this mark. Many MIDI devices do not conform to the General MIDI specification. These devices will not necessarily respond to the Altura as described herein. In these cases, you may need to fiddle a bit with your synthesizer to get it to behave. Alternatively, you can route your Altura controller through a software application that will enable you to redirect its data as needed.

The Altura comes as an easy do-it-yourself kit, or assembled and ready-to-use. You can make your own case from card stock or from a cereal box using the provided template, or you can get a shiny black acrylic case. The acrylic case also comes as a super-easy kit or assembled and ready-to-use.

Connect with your music like never before: build your own gear!



WHAT'S IN THE BOX

Table 1: The Altura Theremin MIDI Controller 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.Before removing anything from the silver static-protective bag, please read about the proper handling of IC's in the paragraph "Integrated Circuits (IC's):" on page 19. 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. 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). 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

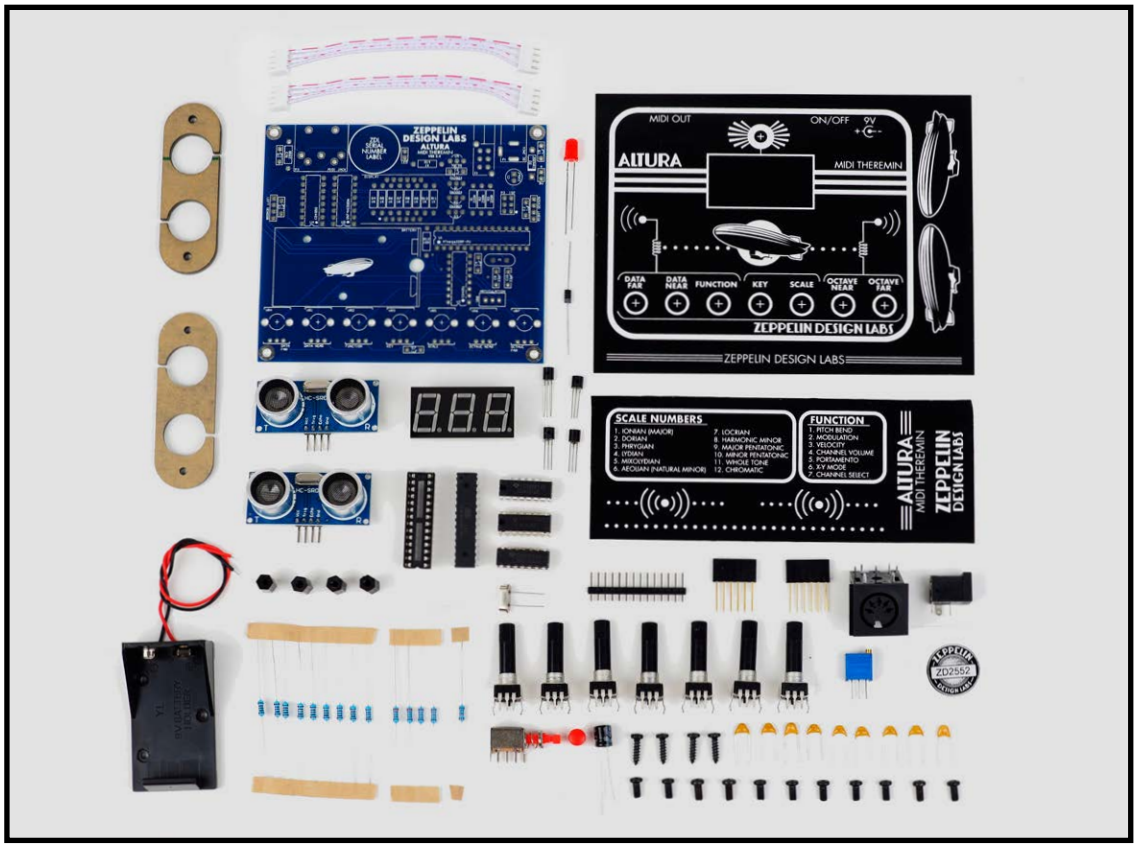
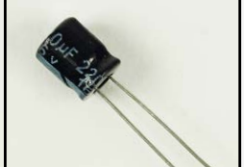
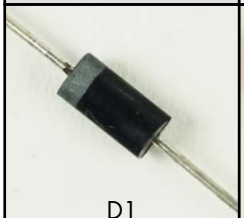
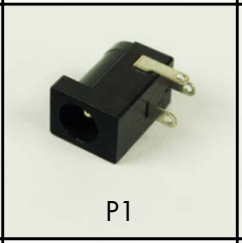
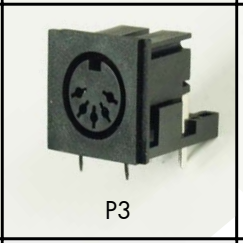
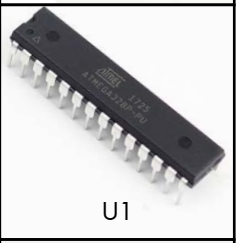
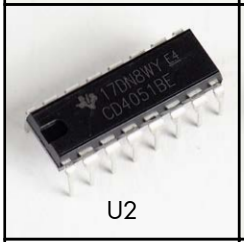
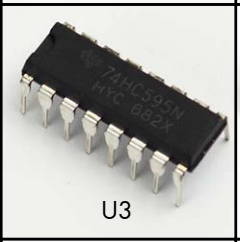
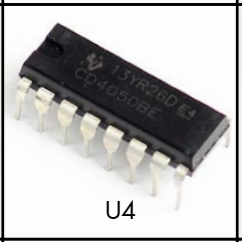
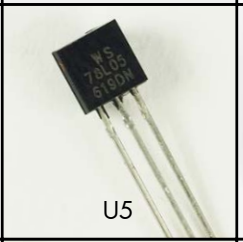
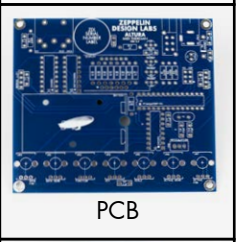
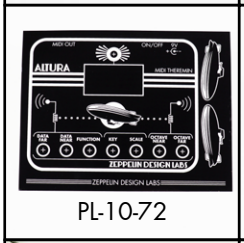
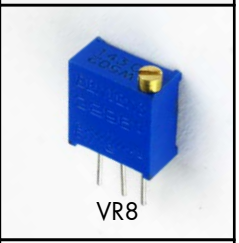
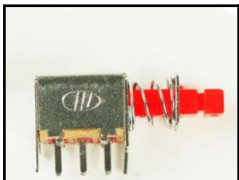


Table 1: The Altura Theremin MIDI Controller Bill Of Materials

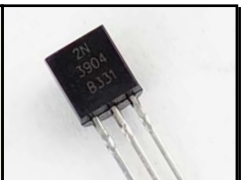
Part #	Description	Notes	Qty
CB-06-10	4 Pin Header Cable	From PCB to distance sensors	2
CP-30-19	Ceramic Capacitor 50V 22pF	C9, C10	2
CP-30-18	Ceramic Capacitor 50V 100nF	C2, C3, C4, C5, C6, C7, C8	7
CP-10-08	Electrolytic Capacitor 16V 220uF	C1	1
CR-10-10	16MHz Crystal Osillator	Y1	1
DI-20-03	Diode General Purpose 1N4007 1000V 1A	D1	1
DI-30-56	LED 5mm Red	LED	1
DS-30-37	3 Digit 7-Segment Display	Display	1
FA-60-37	Machine Screw M3x6		13
FA-90-25	Washer Flat M3 Nylon		8
FA-64-30	Coarse Thread Screw M3x10	For Distance Sensor Holders	4
HD-05-03	Battery Holder, 9V		1
HD-40-10	DC Power Jack	P1	1
HD-40-50	MIDI Jack, Female	P3	1
HD-60-10	Sensor Bracket		2
TD-20-01	Ultrasonic Distance Sensor		2
HE-20-01	Single Row Header. 14 pins	In one or more pieces	1
HE-25-28	28 pin IC Socket	For U1	1
HE-30-01	6 pin Tall Stackable Header	For Display	2
IC-30-60	AtMega328P-PU Microcontroller	U1	1
IC-36-10	IC Multiplexer CD4051BCN	U2	1
IC-90-10	IC Shift Register SN74HC595N	U3	1
IC-50-10	IC Hex Buffer NonINverting CD4050	U4	1
IC-80-50	Voltage Regulator 5V 100mA	U5	1
PC-72-01	Altura PCB		1
PL-10-72	Altura Label Sticker		1
PL-10-73	Extra Altura Label Sticker		1
PL-10-90	Serial Number Sticker		1
PT-10-10	Potentiometer Linear 100K	VR1 - VR7	7
PT-30-10	Trimmer Potentiometer	VR8	1
RS-80-32	Resistor Metal Film 0.25W 1% 220R	R1,R2,R3,R13	4
RS-80-40	Resistor Metal Film 0.25W 1% 1K	R4,R5,R6,R7,R8,R9,R10,R11,R14	9
RS-80-51	Resistor Metal Film 0.25W 1% 10K	R12	1
ST-10-23	Standoff Nylon Hex M3 5.6x12		4
ST-60-10	LED Standoff		1
SW-50-30	Pushbutton Switch DPDT	S1	1
SW-60-22	Switch Cap Red		1
TA-15-20	Trasnsistor NPN 2N3904	Q1,Q2,Q3	3

 CB-06-10	 C9,C10	 C2- C8	 C1	 Y1
 D1	 LED	 DISPLAY	 FA-60-37	 FA-90-25
 FA-64-30	 HD-05-03	 P1	 P3	 HD-60-10
 TD-20-01	 HE-20-01	 HE-25-28	 HE-30-01	 U1
 U2	 U3	 U4	 U5	 PCB
 PL-10-72	 PL-10-73	 PL-10-90	 VR1-VR7	 VR8
 R1,R2,R3,R13	 R4 - R11,R14	 R12	 ST-10-23	 ST-60-01



S1

SW-60-22



Q1,Q2,Q3

WHAT YOU WILL NEED

Here's everything you will need to build The Altura Theremin MIDI Controller kit as shown below. Tools and supplies needed for various cabinet options are discussed in the section "MAKING A CABINET" on page 33.

TOOLS

1. Digital multimeter
2. #2 Phillips screw driver
3. Tiny straight screw driver
4. 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.
5. Wet sponge or dry solder-cleaning pad
6. Wire strippers
7. Flush cutters or small diagonal cutters
8. Clamp or vise to hold the printed circuit board while soldering (optional, but handy)
9. Solder sucker or solder braid (optional, but very handy if you have to remove or repair any components!)
10. Ruler

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.
2. Superglue

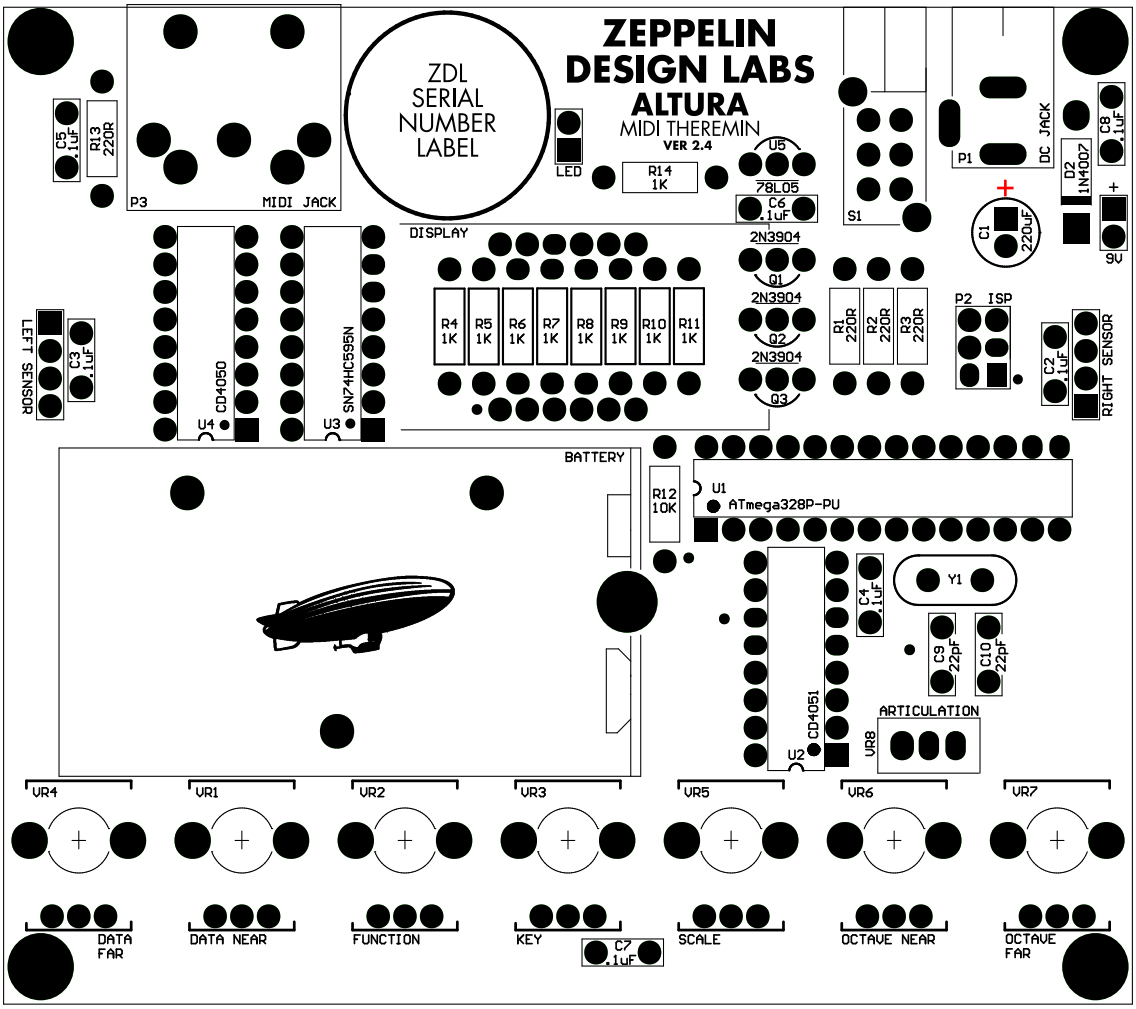
POPULATING THE PRINTED CIRCUIT BOARD

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.

Figure 3: Component Values And Locations



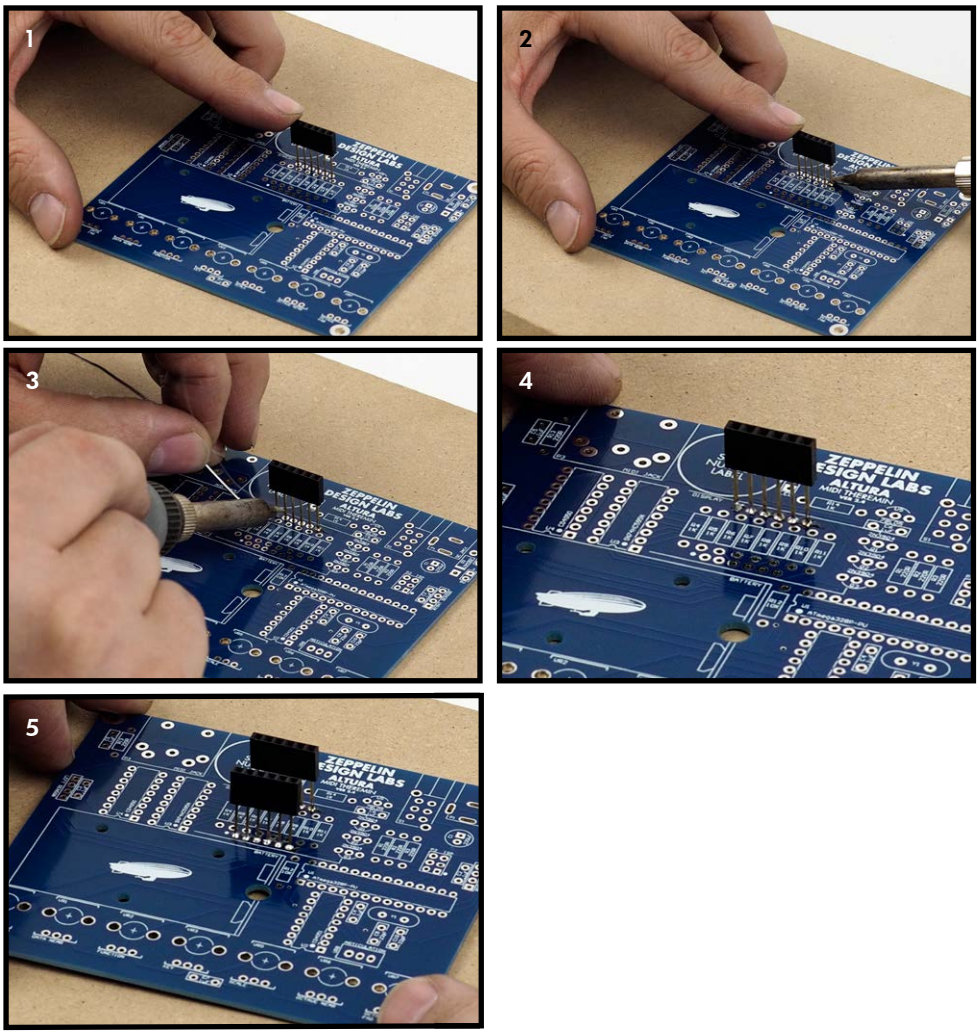
Most of the components in your Altura are soldered to the printed circuit board (PCB); just the distance sensors and the 3-digit display are attached to the board via headers. All of the components to be soldered will be installed from the "component side" of the board (except the battery holder wires), which is the side that has the part labels printed 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.

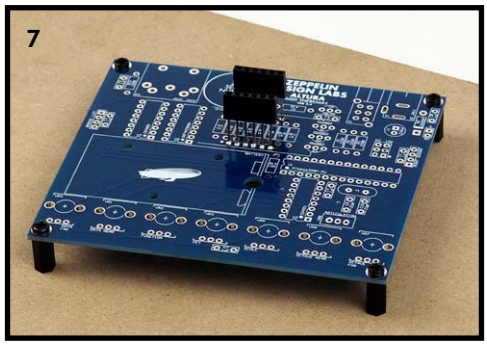
You will notice that we have installed a few components on the PCB already. These components are (mostly) surface mounted, which are a little more difficult to solder. The square chip in the middle of the board has been pre-programed with the software your Altura needs to run. If you are interested in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

Let's begin!

1. Female headers: Lay the PCB on a smooth, flat surface with the component side up. Insert one of the female headers (part #HE-30-01) in its place (1). Make sure the ends of the header's legs are flush with the solder side, underneath the board. Hold the header straight up at 90 degrees and solder one of the legs on the component side (2). Once the header is tacked down by one leg, finish soldering the rest of the legs on the same side of the board (3, 4). Do the same thing with the other female header in its location (5). Be sure it is soldered in at 90 degrees to the PCB. As you continue building the rest of the PCB try not to bump or bend these headers; how well your Altura PCB fits into its case depends on the straightness of these headers.



2. Standoffs: Attach the 4 standoffs (#ST-10-23) to the PCB with 4 M3x6 screws (part #FA-60-37).

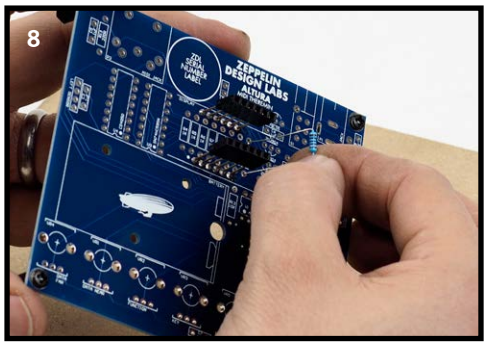


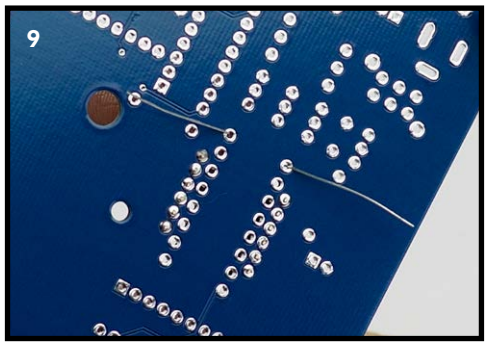
3. Resistors: The values of resistors are given by a series of colored stripes. There are several tutorials online describing how to decode these stripes, but we will simply tell you the values, part numbers and stripe colors. “Figure 3: Component Values And Locations” is a good reference. The white graphics on the component side of the board also give reference to the part number and value. 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.

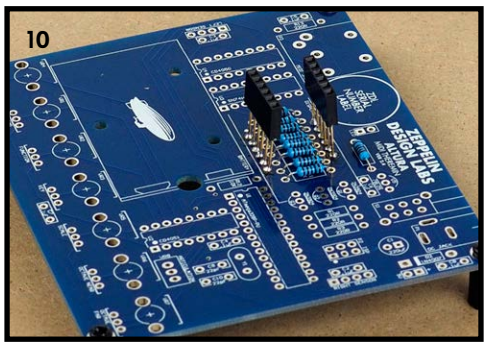
   Resistors are not polarized, meaning they can be installed into their holes in either direction. It doesn’t matter which lead goes into which hole.

   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 (8). This allows the resistors to slip into their holes very easily.

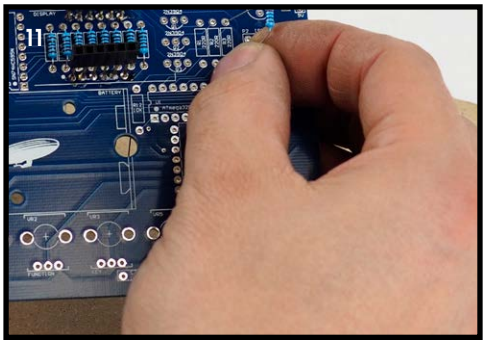
   a. Start with the 1K resistors (R4 - 11, R14), labeled BROWN, BLACK, BLACK, BROWN, BROWN. Compare to its picture in the BOM. Find their locations on the circuit board; install and bend the leads as described above (8,9,10). Don’t solder any of them until all 14 resistors are installed; just bend the leads to keep them in place.

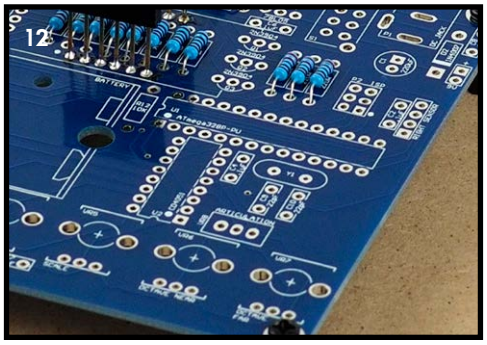




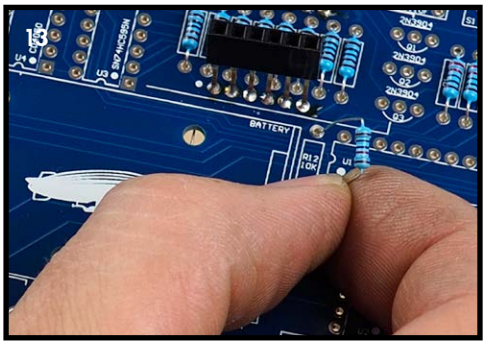


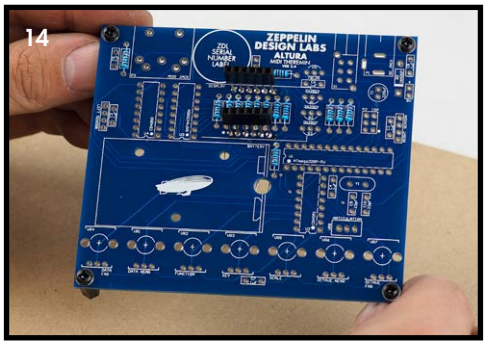
b. Next do the 220 ohm resistors (R1,R2,R3,R13). These resistors are labeled RED, RED, BLACK, BLACK, BROWN. Bend the leads on the back so they won't fall out.



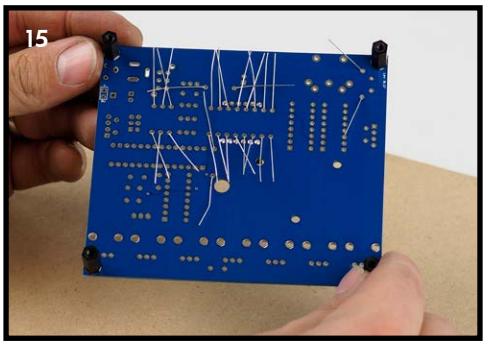


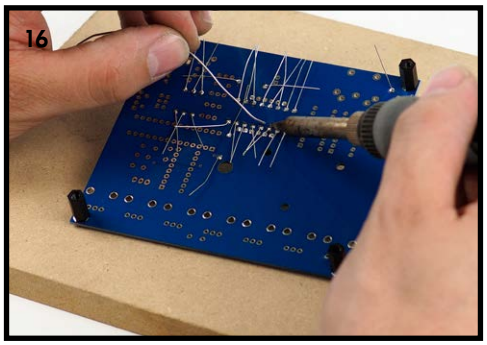
c. Lastly, install the 10K resistor (R12), labeled BROWN, BLACK, BLACK, RED, BROWN. Bend the leads.

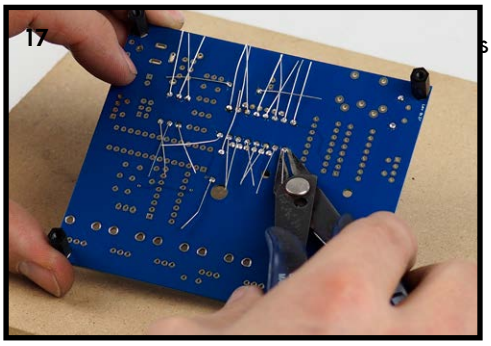


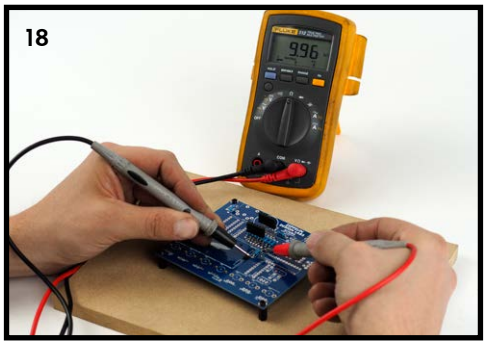


d. You should have a whole forest of bent leads coming out the solder side of the board (15). Now you can turn the board solder-side-up and solder each lead to the board. Use a clamp or vise if you have one; it makes soldering much easier (16). Clip off the leads (17).







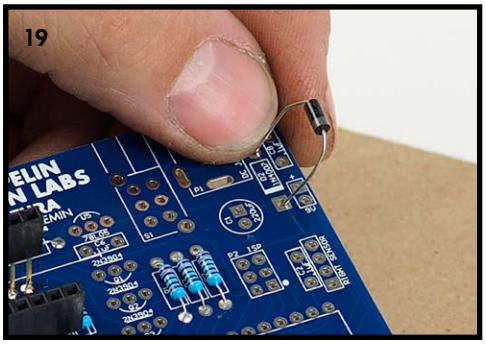


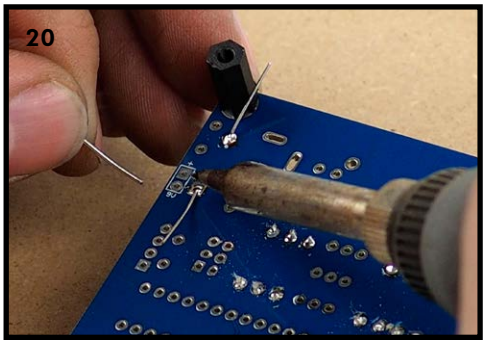
e. Double-check the resistance values of each of the installed resistors (18). Set your digital multimeter to the "ohms" or "resistance" setting, and measure across all of the resistors. Compare the measured value to the listed value in Table 1 and in Figure 3. Make sure they are all correct (within 1%) before moving on!

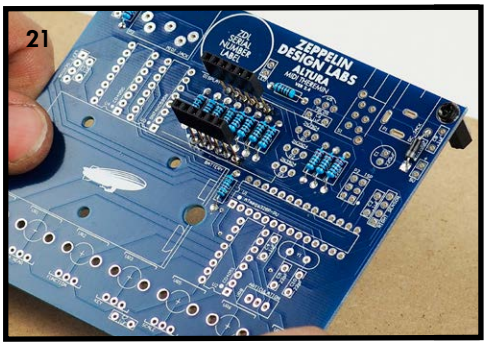
4. Diode (D1): Diodes are polarized; it matters which lead goes in which hole. You will notice one end of the diode body has a white stripe around it (19). Our rule for installing diodes goes like this:

   WHITE STRIPE = SQUARE PAD
   NO STRIPE = ROUND PAD

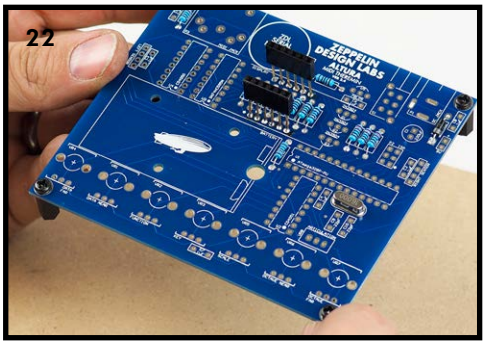
   Gently bend the leads like you did for the resistors (19). Place the diode in its designated location on the board (21). Make sure it is installed in the correct orientation; otherwise your Altura won't work. Bend, solder and clip the leads (20).

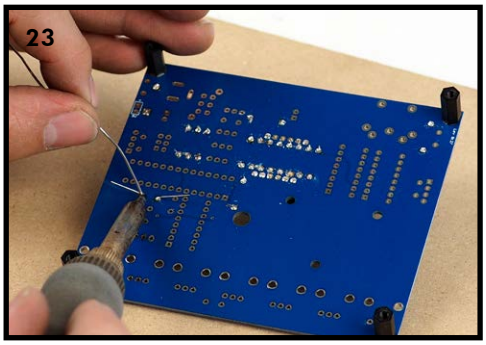






5. Crystal Oscillator (Y1): Place the crystal in the Y1 position on the PCB. Bend the leads out on the bottom; solder and clip the leads.

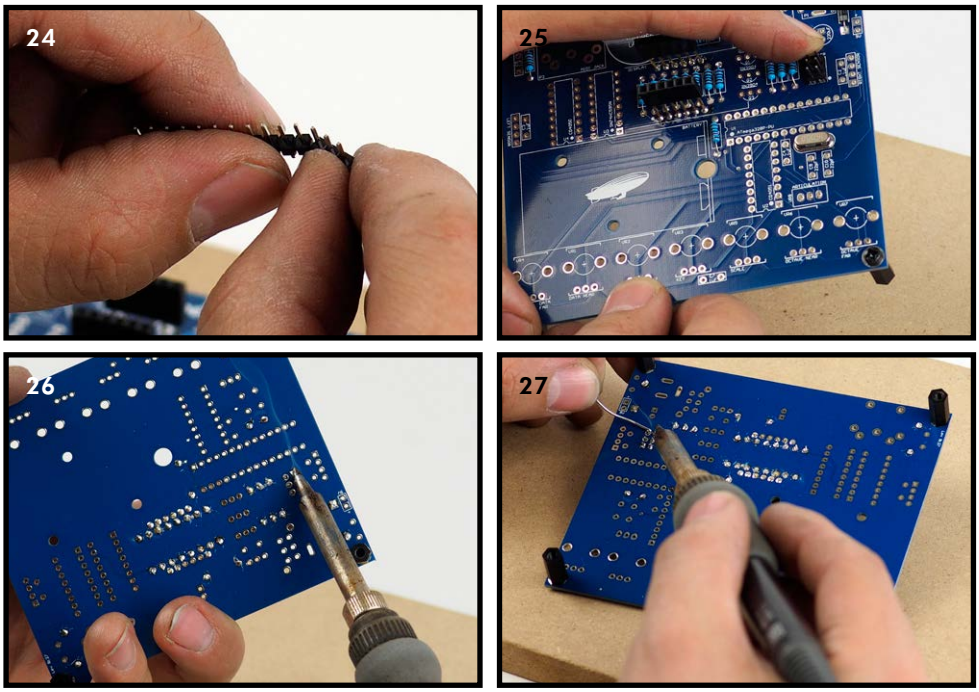




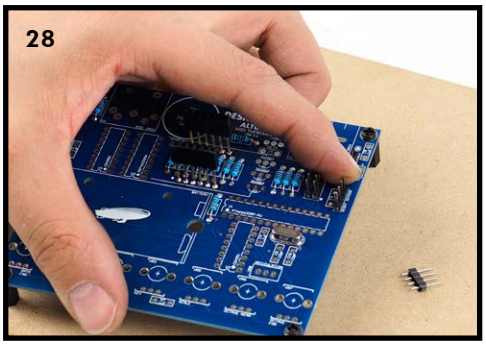
6. Headers (P2): Your kit includes a single row of 14 male headers. These will be installed across three different locations on the PCB.

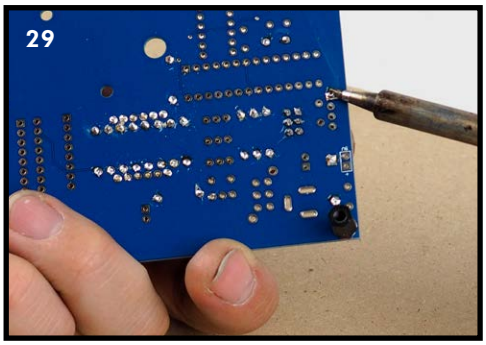
   First, we'll install the In-System Programmer (ISP) headers. This is a 2x3 header array that enables you to plug a cable into your Altura and upload (or "flash") new software onto the microcontroller. This is covered in detail in the Altura Reference Manual.

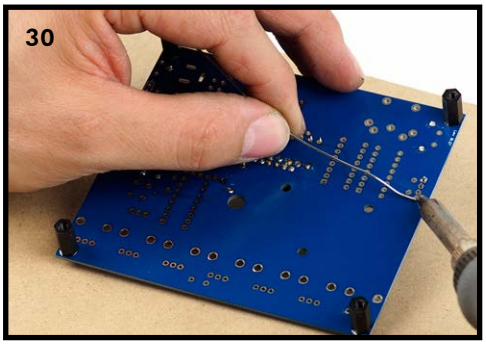
   a. Carefully break two pieces of three pins each from the row of headers (24). Place each of them in the P2 position on the PCB. The short pins go through the board; the long pins point up. Make sure the bottom of the headers are flush to the circuit board (25). Tack one pin on each row down with solder while you hold the header in from the top (26). Once each row has been tacked on, you can solder the other pins in place (27). Remember to properly re-solder the "tacked on" pins.

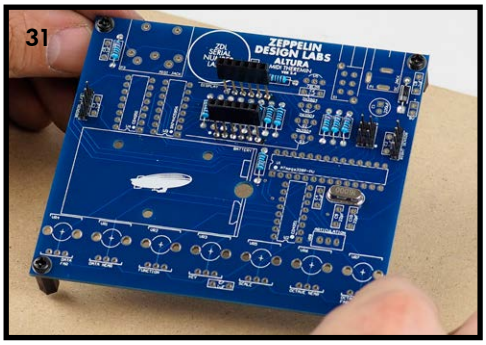


b. Break the remaining 8 pin header in two (4 header pins each). One of the 4-pin pieces goes in the "Right Sensor" position on the PCB (28). Be sure it's flush to the top of the PCB and solder it the same way as the ISP header: tack a pin down and then solder the rest of the pins (29,30). The other 4-pin piece goes into the "Left Sensor" position. Don't worry about clipping the pins; they are too short.

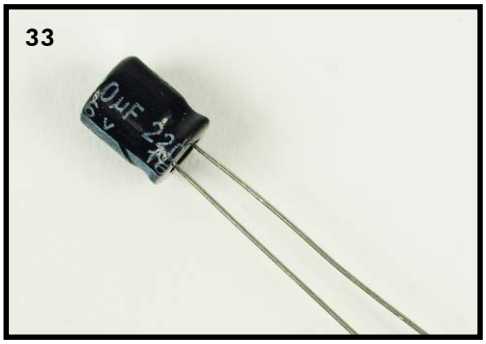






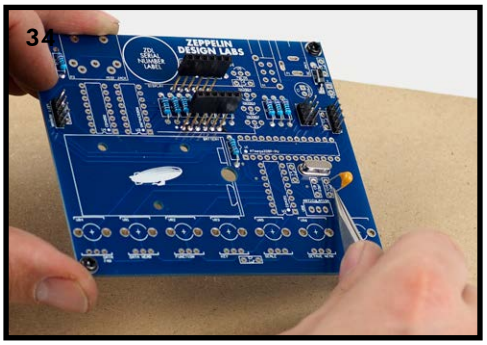


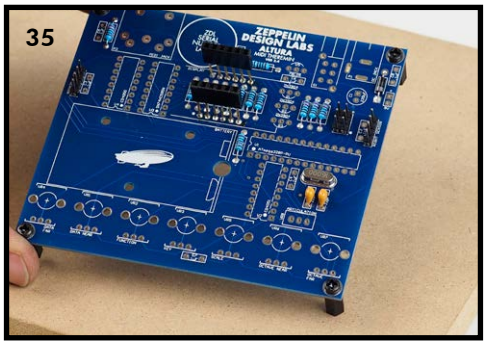
7. Capacitors: There are two different types of capacitors in this kit: ceramic (32) and electrolytic (33). We will place them in the PCB one type at a time, and then solder them all in at once.



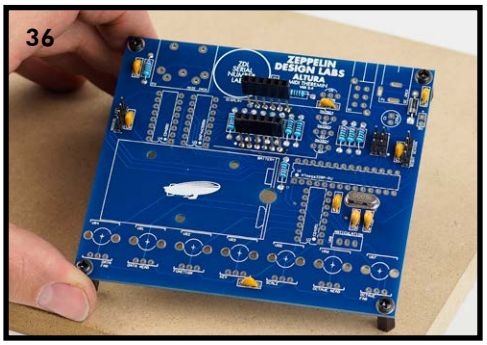
a. Ceramic Caps: These caps look like little yellow blobs with two protruding leads. The Altura uses two values of ceramic caps: 100nF and 22pF. The only noticeable difference between these two capacitor values is the tiny labeling printed on their yellow bodies. The 100nF caps are labeled "104" and 22pF caps are labeled "22". Please make sure that you use the correct value in the correct location.

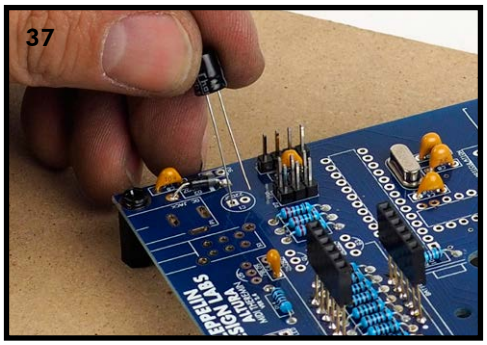
i. There are two 22pF ceramic capacitors (C9,C10). Place the 22pF capacitors in their respective places on the PCB and bend the leads out on the back so they don't fall out (34,35). Once again, please make sure you install the 22pF caps in their correct locations - don't mix them up with the 100nF variety.





ii. There are seven 100nF ceramic capacitors (C2-C8). Like the resistors, these capacitors are not polarized. It doesn't matter which lead goes into which hole. Place all the 100nF capacitors in their respective places on the PCB and bend the leads out on the back.

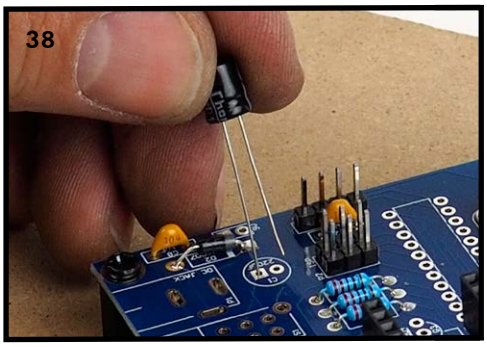




Electrolytic Capacitors: There is one 220uF cap (C1). Electrolytic capacitors ARE POLARIZED: there is a right way and a wrong way to install them. If you get it wrong the cap might burst. The white stripe on the case indicates the negative lead of the cap (38).

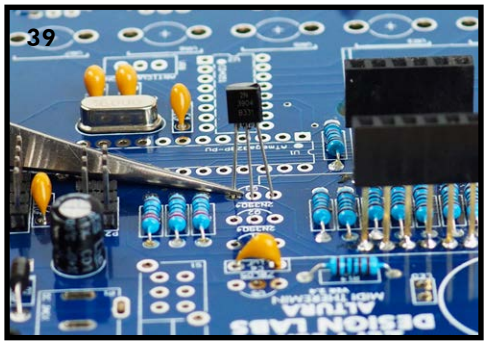
STRIPE = NEGATIVE = SHORT LEAD = ROUND PAD
NO STRIPE = POSITIVE = LONG LEAD = SQUARE PAD

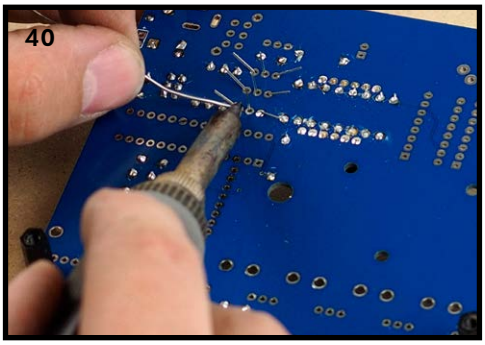
Make sure you orient this cap properly! Notice how the long lead is directed into the square pad (38). For reference, Figure 3 has a little red plus sign(+) on the positive pad. Bend out the leads, flip the board over, solder and snip all the leads.

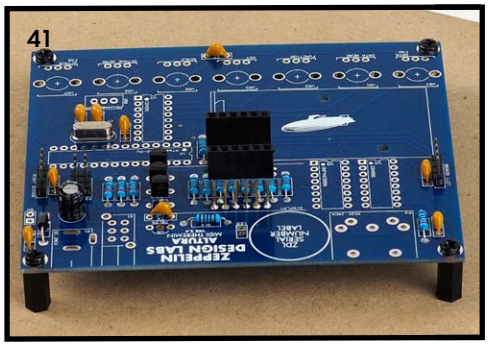


8. Transistors: There are three transistors in the Altura (Q1,Q2,Q3). These transistors are labeled 2N3904 (and possibly a few extra numbers or letters at the end). They look identical to the voltage regulator (labeled L78L05), so please don't get them mixed up – otherwise your Altura won't work!

   These transistors are shaped like a three-quarter moon. Notice the PCB graphics around the holes have a similar shape to show you the correct orientation. Bend the leads out a little bit so that they will fit in their holes and install the transistors in the board (39). Bend the leads out on the other side of the board, solder and clip the leads (40,41).







INTEGRATED CIRCUITS (IC'S)

This kit contains four integrated circuit components. 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 the following principles when handling 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. Next best would be a plumbing fixture. At the very least you should touch a large conductive object like a metal desk or a filing cabinet.
- When soldering IC's, do not let the IC get 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 keep the chip cool enough to touch. If necessary, just solder one leg at 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 Altura will not work and you could damage or destroy the IC. Each IC has a dot or divot at one end. These features have a corresponding graphic on the PCB and in Figure 3 to show you how to orient the IC.

9. Install the IC's and IC Socket

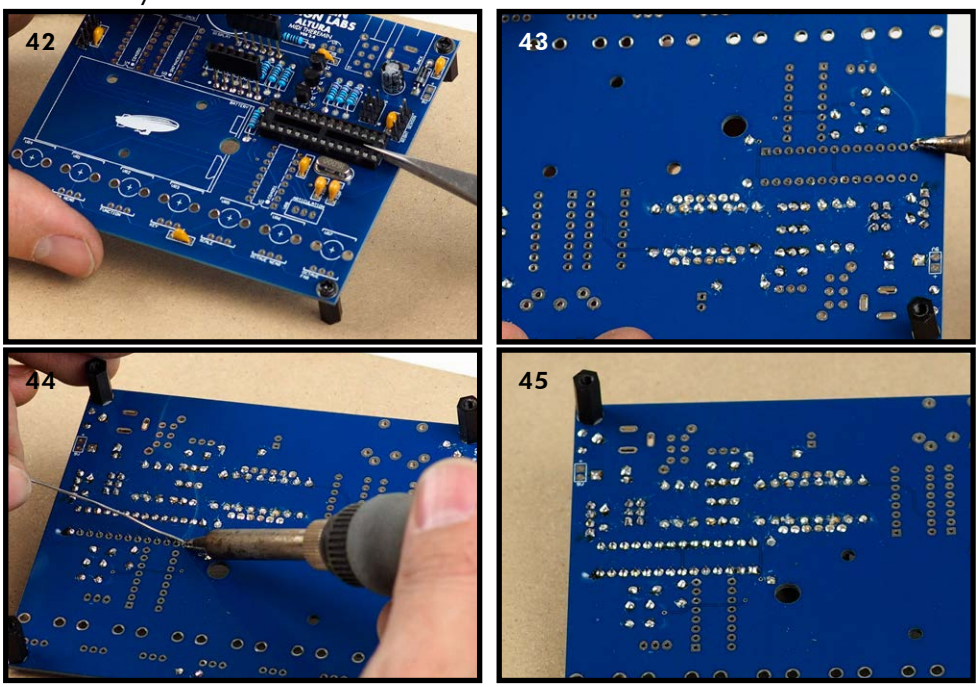
   a. ATMEGA328P (U1): This IC is called a "microcontroller." This is the "brain" of the Altura. We pre-programmed this chip with some software which tells the Altura how to operate. This software is open-source and published under the creative commons license. If you would like to learn more about your Altura or even modify the software to behave differently, please visit our Github page. You can use the popular development environment Arduino to edit and modify the code.

      Since we want to keep this microcontroller accessible for re-programming, we will not actually be soldering it to the PCB itself. Instead we will solder an IC socket to the board and install the microcontroller into the socket.

      i. Install the 28-pin socket (part #HE-25-28) in the U1 location (42). Please note the divot at one end of the socket. This end should align with the dot on the PCB graphic.

      ii. Hold down the socket with one finger while you flip the board over. Tack down one pin with a tiny bit of solder (43).

      iii. Now solder the rest of the pins (44). Don't forget to go back to the original "tacked down" pin to finish soldering that correctly (45). Don't bother clipping the leads on the IC's – they are too short.

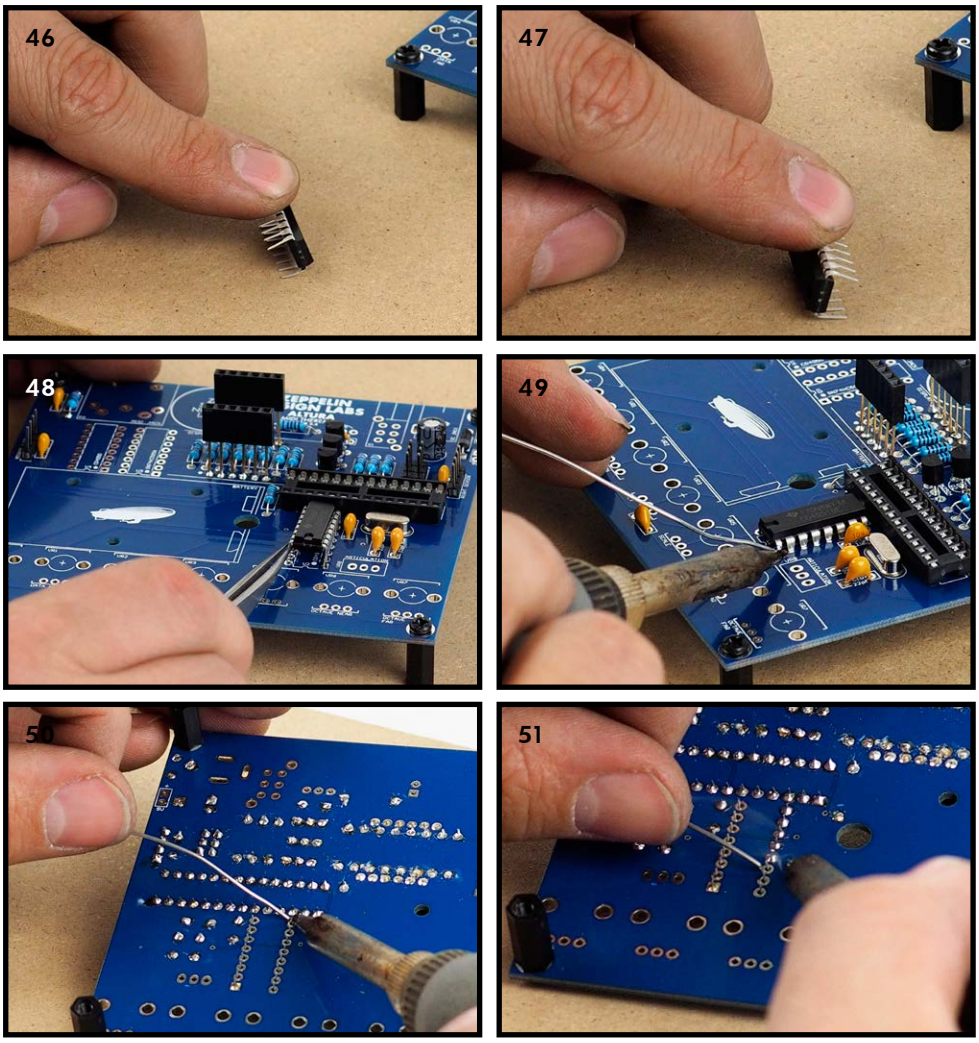


b. CD4051 (U2): This chip is called a "multiplexer." This multiplexer allows the microcontroller to continuously sample the value of each potentiometer, one at a time.

   i. Install the multiplexer in location U2. For it to fit easily into the holes, you may have to gently bend the leads closer together, pushing each side of the chip down on a flat surface (46,47). Notice the divot at one end of the chip. There is a matching shape on the PCB graphic. Press the IC down snugly with your fingertip (48).

   ii. Tack one leg down with solder on the component side (49).

   iii. Now flip the board over and finish soldering the rest of the leads (50,51).

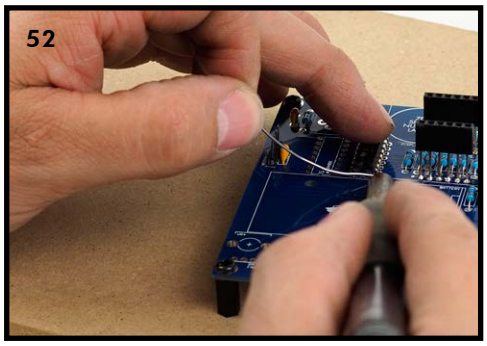


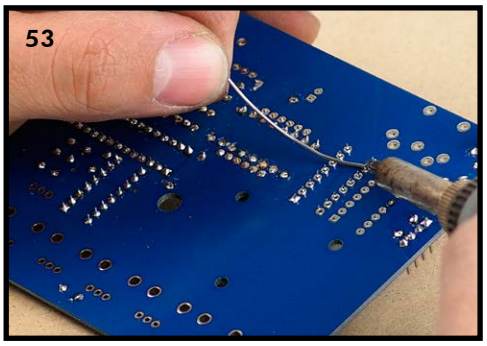
c. SN74HC595 Shift Register (U3): The shift register decodes information received from the microcontroller to operate the 3-digit display. This IC should be installed in the same way as the previous chip.

   i. Mind the divot on one end of the IC and align it with the PCB graphic at U3.

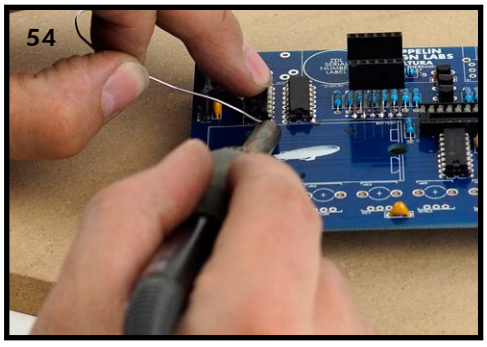
   ii. Tack one pin in from the top (52), then...

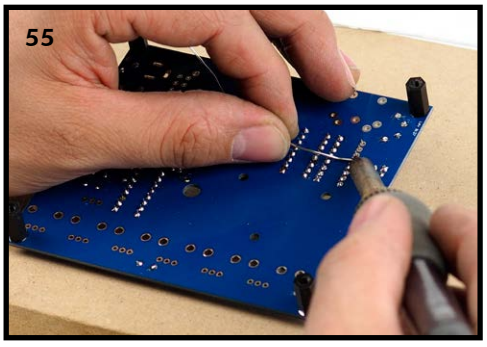
   iii. ...flip the board over and solder the pins on the solder side (53).



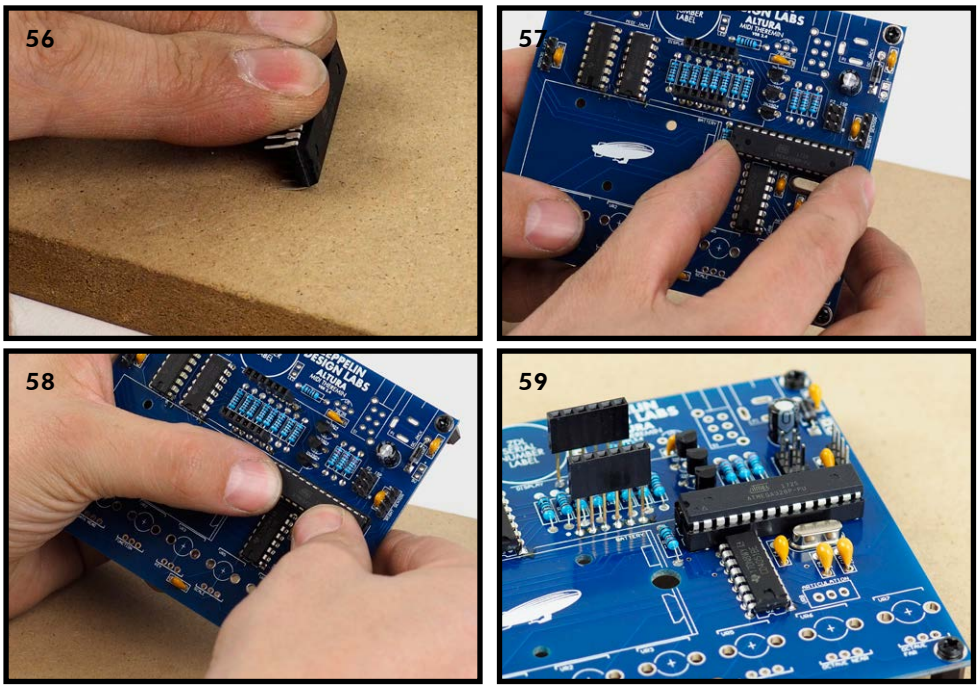


d. CD4050 Hex Driver (U4): This hex driver takes the MIDI data generated by the microcontroller and sends it out the MIDI port with enough current to drive long cable lengths. Once again, install this IC in the same manner as the previous chip. Remember to align the divot on the IC with the PCB graphic on U4. Tack one pin in from the top (54), then flip the board over and solder the pins on the solder side (55).

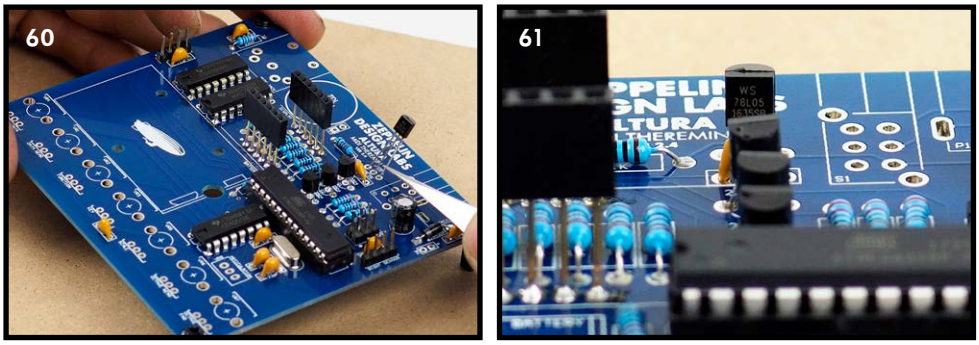




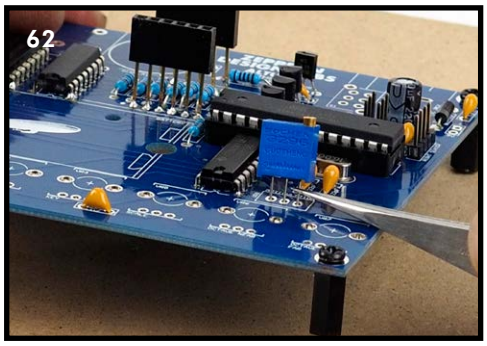
e. Install the AtMega328p microcontroller in its socket. If the pins don't line up too well to the socket, you may have to gently bend the leads a little closer together by pushing each side of the chip down on a flat surface (56). Once the pins line up to the socket holes, push the IC snugly into place (58,59).

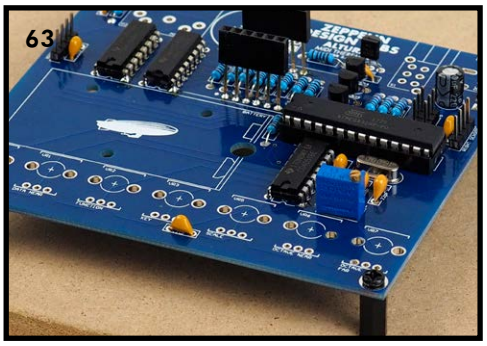


10. Voltage Regulator (U5): This component is shaped like a three-quarter moon and looks very similar to the transistors you installed earlier. Thread the three leads through the PCB and press this component into place (60). Bend the leads out on the other side of the board. Solder and clip the leads.



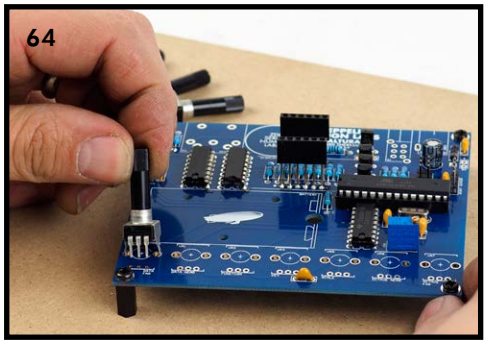
11. Trimmer Potentiometer (VR8): The trim pot will be used to set the "articulation" of the right hand sensor (see the Reference Manual for details). Place the blue trim pot in its place on the board as in the picture. Bend the leads on the back and solder them in place. Clip the leads.

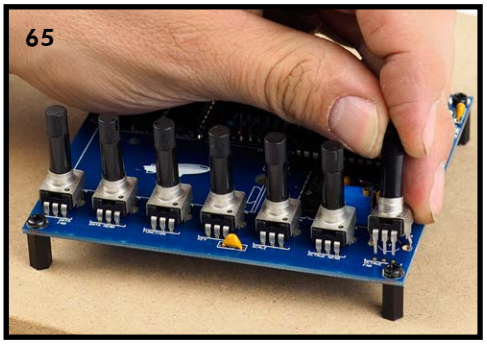


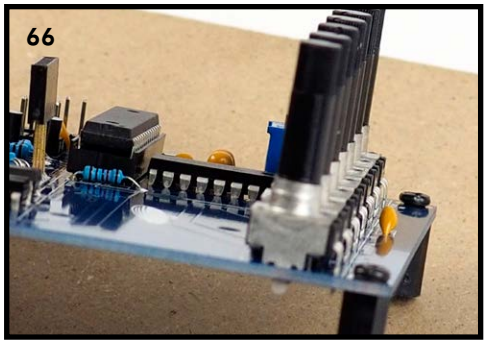


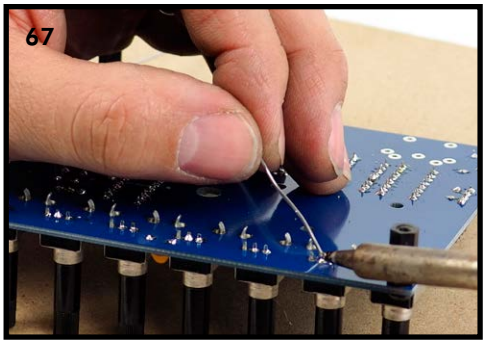
12. Potentiometers (VR1 - VR7):

    a. Install the pots. Make sure they are all seated securely and flush against the PCB; otherwise the completed board won't fit properly into your Altura's case (64,65). Double check that the shafts of the pots are all standing at 90 degrees to the board (66).

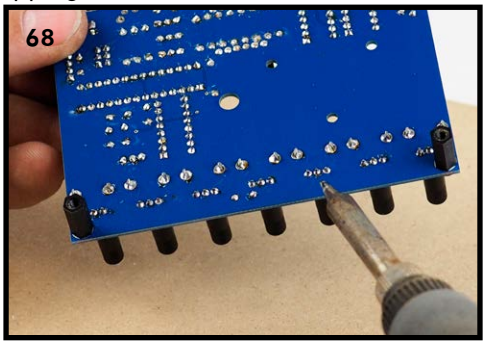


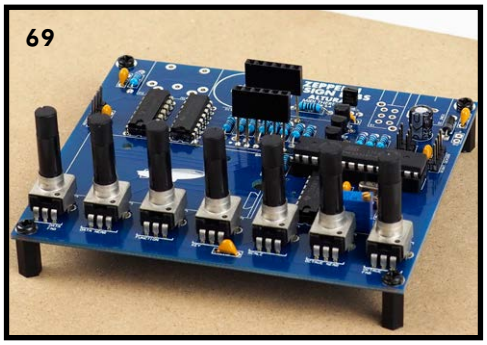




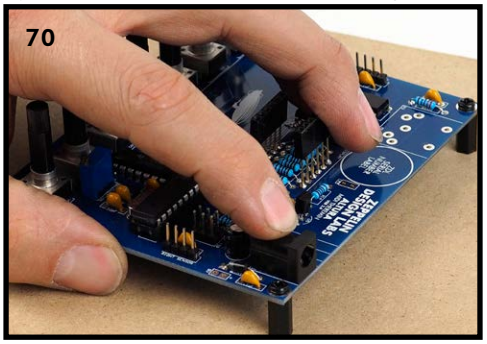


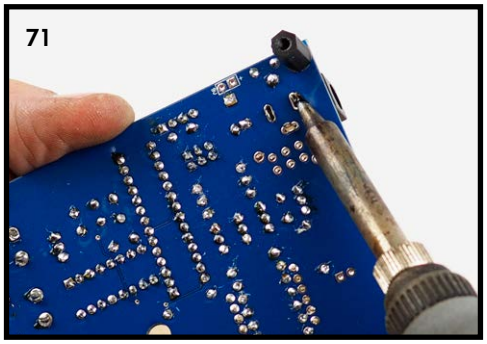
b. Solder the pots. When soldering do not use too much heat. If you cannot move quickly with your iron, solder one pin on each pot sequentially. This will allow each pot to cool before you solder its next leg (67). Make sure all 5 pins of each pot are soldered. Don't bother clipping the short leads.



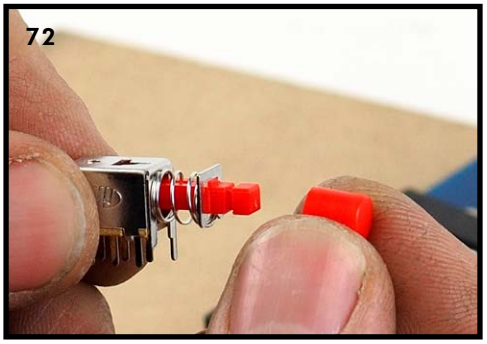


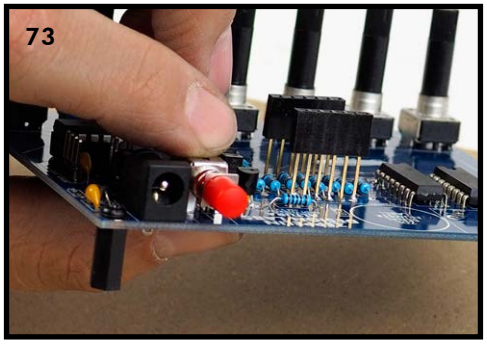
13. DC Power Jack (P1): Press it snug to the board. Double check that it is sitting flush and square to the edge of the board (70). Solder the pins on the solder side. (71).

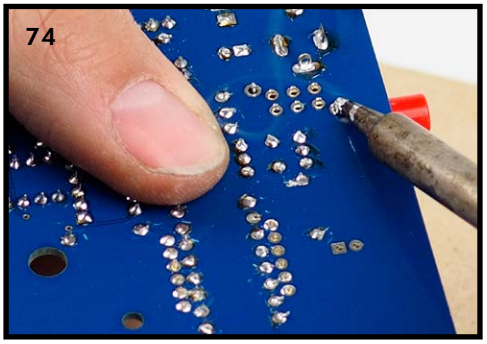


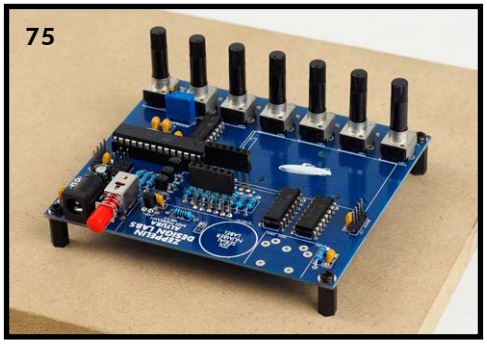


14. Power Switch (S1): Push the little red button (part #SW-60-22) onto the switch (72). If the button seems a little loose, add a tiny drop of super glue to the switch shaft before installing the button. Press the switch snug to the board (73) and solder the leads (74-75).

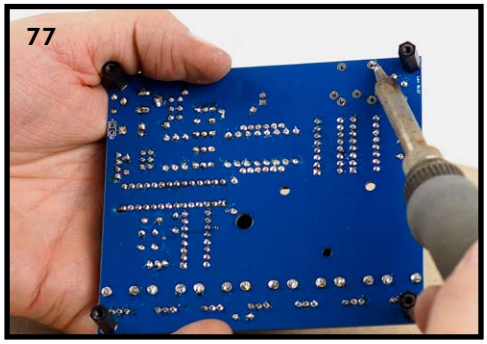


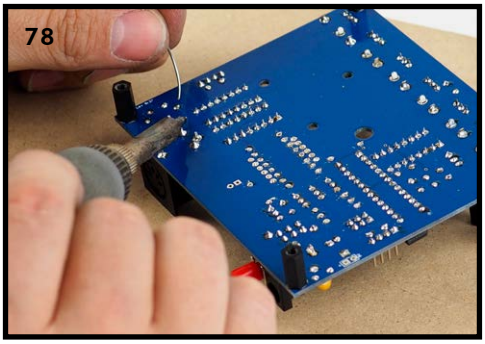


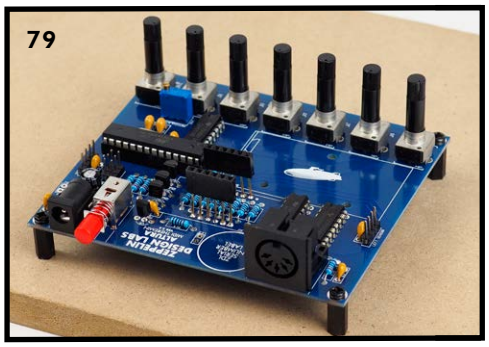




15. MIDI IN Jack (P3): Press it snug to the board. Double check it is flat against the board and then solder it in (77-79).

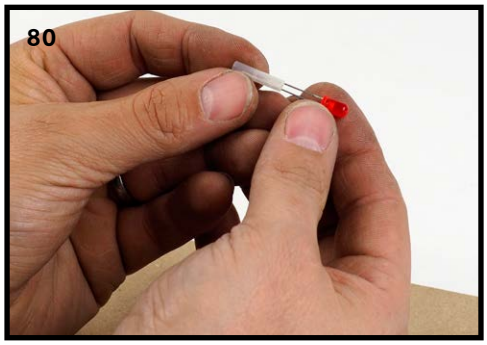




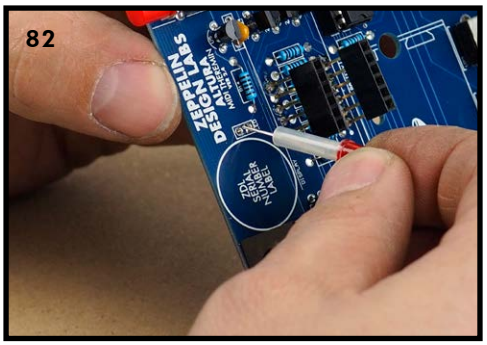


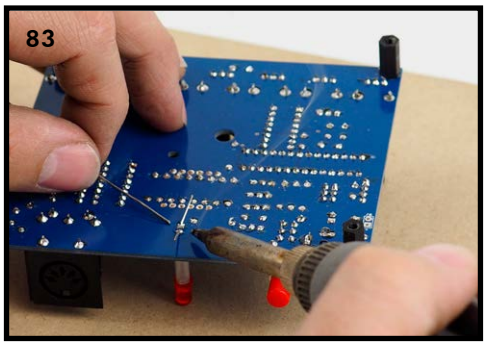
16. Power Light (LED):

a. Place the LED in the LED standoff (part#ST-60-10). Pass the leads in through the two small holes in the capped end of the standoff, and out the open end (80,81).

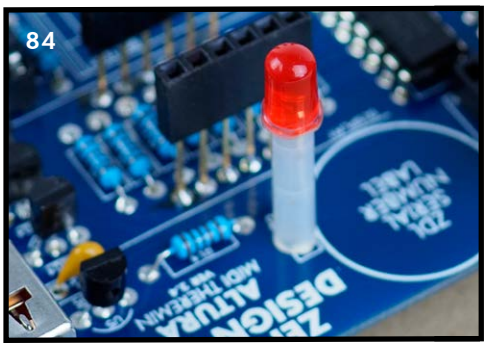


b. The LED is installed on the PCB in the spot marked LED. The LED, being a diode, is polarized and must be installed in the correct orientation. If you get it backwards, the light won't work. The long lead goes into the hole with the square pad. Make sure the standoff is standing straight up. Bend the leads out on the bottom; flip the board over and solder and clip the leads (83).



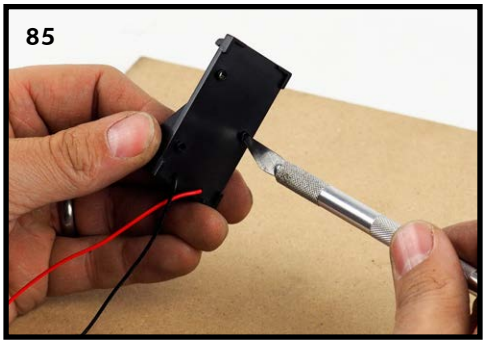


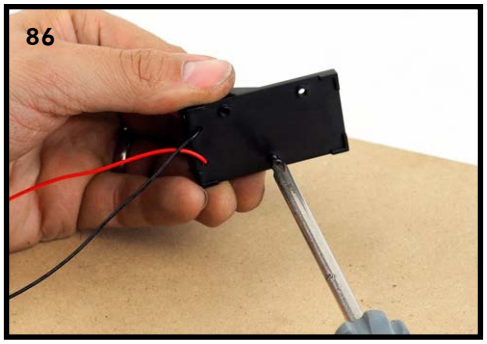
c. If you look closely at the body of the LED, you will notice that there is a flat edge on the side closest to the back edge of the PCB. Make sure the LED's flat side is parallel with the back edge of the PCB. Twist the LED, if necessary, to align these edges. This prevents the leads twisting inside the standoff and possibly shorting out to one another.



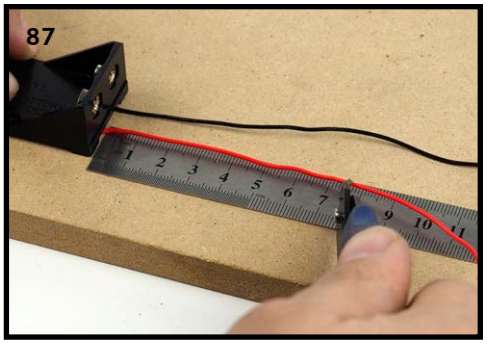
17. Battery Holder (BT1): Before we install the battery holder we need to slightly modify the screw holes to allow them to better accept the screws.

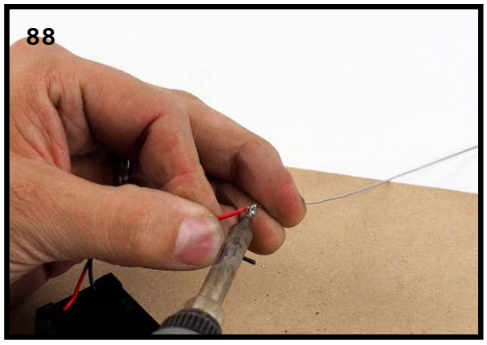
a. Use the tip of your X-Acto knife to gently flare out the ends of the screw holes just a little bit (85). To pre-thread the holes, use a #2 Phillips screw driver to drive an M3x6 machine screw (part #FA-60-37) into each hole. Make sure the screws go in straight (86). Remove the screws.





b. Cut the wire leads to 3-3/16" (80mm) (87). Strip 1/8" (3mm) insulation off the ends. Gently twist the tiny strands of copper wire together. Tin the ends of the wires with your soldering iron (88).

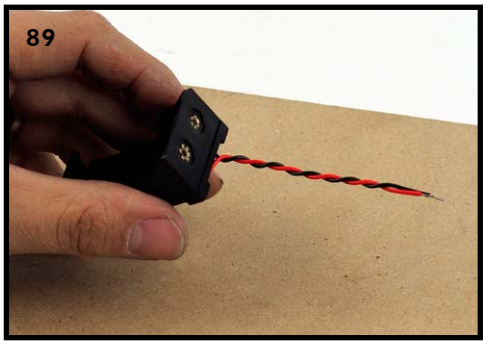


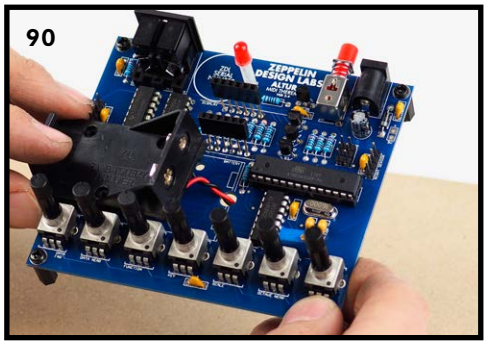


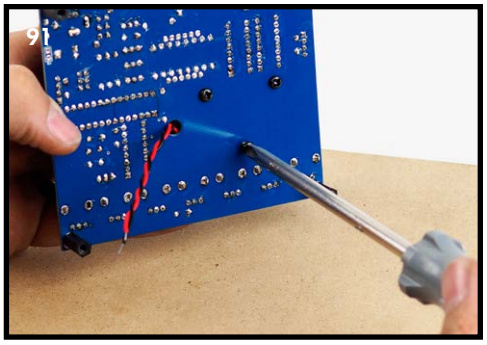
c. Gently twist the red and black wires together (89) Thread the twisted pair of wires through the hole in the PCB. Make sure the holder is not resting on top of the wires (90).

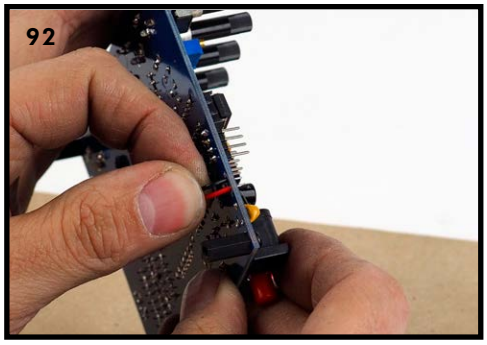
d. Mount the holder to the PCB with three M3 screws (91). Drive the screws tight-but-not-too-tight (91).

e. On the solder side, the wires go into the holes marked 9V. The red wire goes into the hole with the square pad (+); the black wire into the hole with the round pad (92).

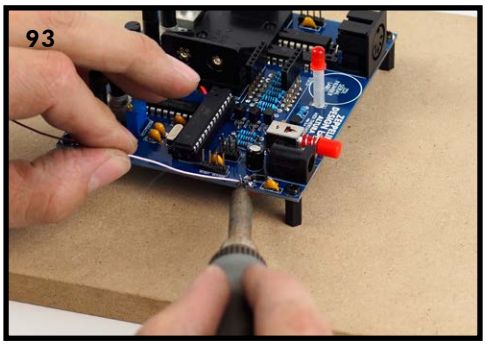


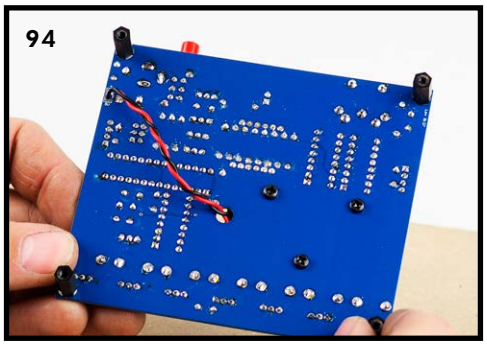




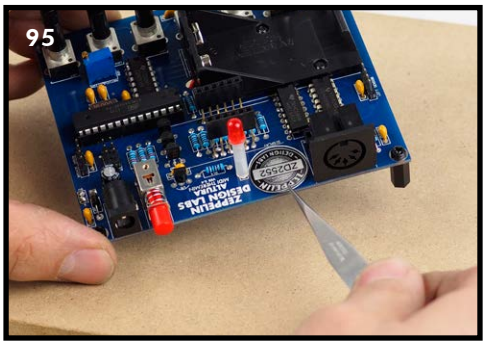


f. Solder these wires on the component side (93).



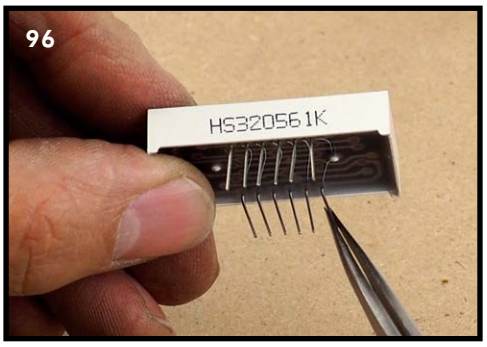


18. Serial Number Label (Part #PL-10-90): Clean the PCB with rubbing alcohol to remove fingerprints and solder residue. Apply the serial number sticker (95). Rub it down thoroughly. You will need this number if you request assistance or service.

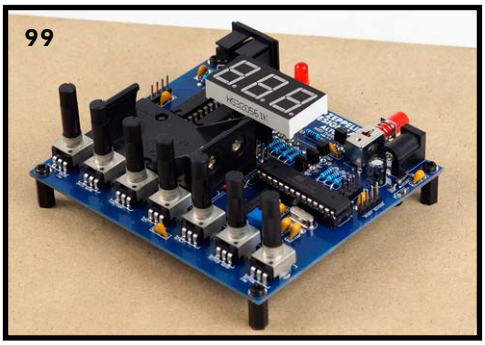


19. 3-Digit Display: The 7-segment, 3 digit display is installed into the female headers that we installed first onto the board.

a. The conductive pins in these headers sometimes don't grip the display pins tight enough, so it's helpful to slightly bend the display pins in alternating directions which helps them make contact with the headers (96,97).

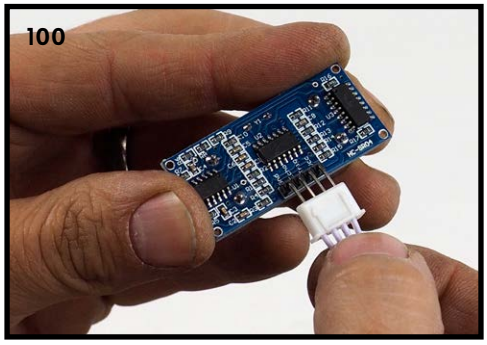


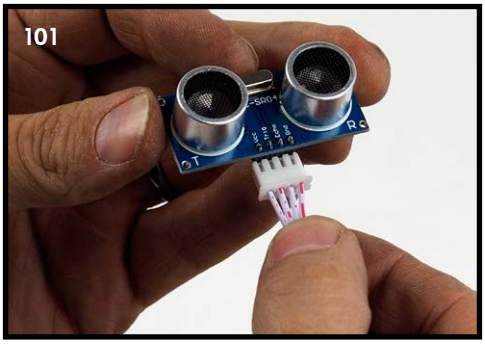
b. Place the display in the headers (98,99). When you turn your Altura on, if some of the segments don't light up on your display it probably means some of the pins should be bent a bit more.



20. Distance Sensing Modules: The distance sensors are connected to the PCB via the 4-wire ribbon cables (Part#CB-06-10). You will need to build a case for your Altura before you can permanently install the distance sensors, but we can temporarily hook them up now for testing.

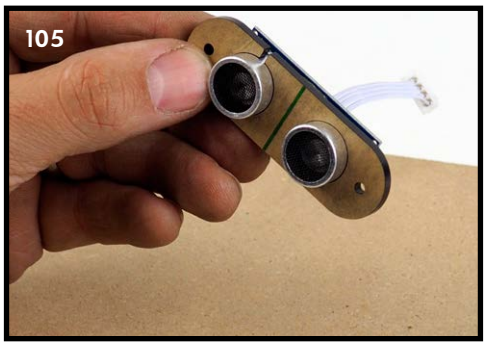
a. Slide the 4 pin female header (on the ribbon cable) onto the male header (on the distance sensor). The two ridges on the female header should be facing away from the metal cylinders on the other side of the module (100,101).



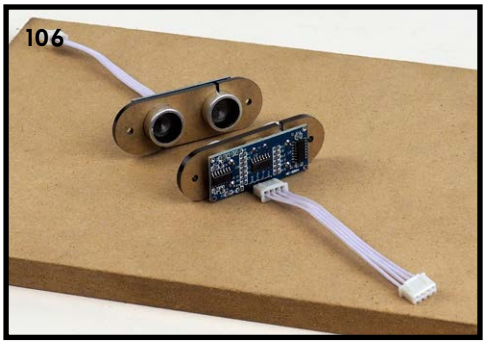


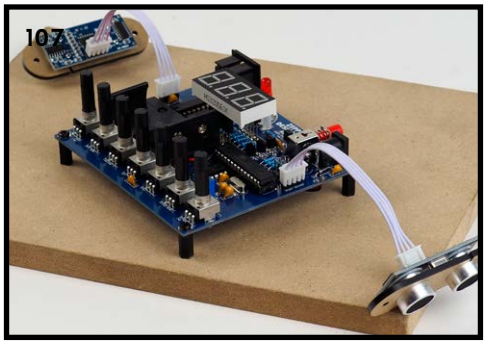
b. Very gently bend the male header's leads a little over 90 degrees, so it ends up looking like the picture (102-104). Do the same thing to the other distance sensor.

c. Place the sensor bracket (part #HD-60-10) over the twin metal cylinders. Slide it down snug as far as it will go. Repeat for the other sensor. (105)



d. Now plug in the other end of each ribbon cable to the "Left Sensor" and "Right Sensor" headers on the PCB. Make sure that the ribbon cable is not twisted and is installed just like in the picture (107). The two ridges on the female header should be facing toward the interior of the board.





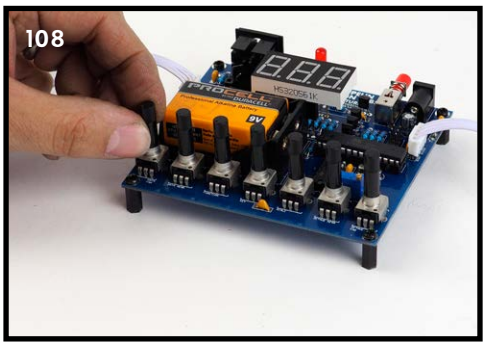
21. Setting the Articulation: Besides calibrating the right-hand sensor, this step will serve to test your assembly job. If you put all the components in their correct place and soldered everything correctly it should work!

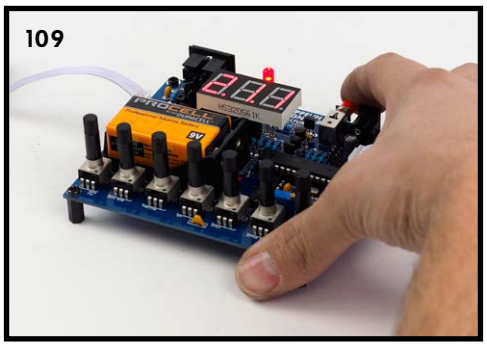
a. Clear off a large space on your bench. Make sure the distance sensors are plugged into the PCB but not touching the board. Plug in a fresh battery or proper power supply. Turn all the knobs to fully counter-clockwise to put your Altura in "Articulation Set Mode" (108).

b. Press the red power button. The LED should light and the display should show the following:

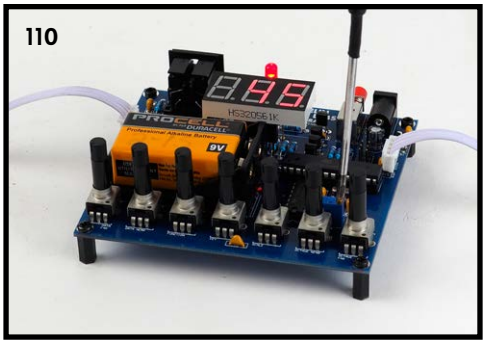
- The software version number
- A number that is a multiple of 15
- The characters "[I"
- If you move your hand near the left sensor, you should see a spinny-thing.
- The right sensor generally does not cause anything to appear on the display. Don't worry.

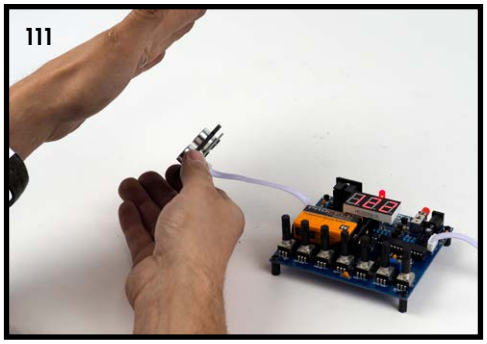
It works!!





c. With a tiny flat head screwdriver turn the little blue articulation trim pot until the display reads "45" (110). This number represents a delay between right-hand distance reads: higher numbers mean a longer pause (less articulate but more stable); lower numbers mean a shorter pause (more articulte but less stable). Start out with the articulation set at "45" and go up or down from there if your playing style calls for adjustment. More information about the articulation can be found in the Altura Reference Manual.





Congratulations!

Your Altura Theremin MIDI Controller is complete, except for the cabinet. I know you are probably eager to control your Macchiato Mini-Synth or other MIDI devices, so open up the "Altura Quick-Start Guide" and give it a whirl. Keep the label sheet handy so you can keep track of the many knobs. When you are ready to give the distance sensors a stable home and protect your wonderful new MIDI controller in its own cabinet, continue on.

MAKING A CABINET

Your Altura wants a cabinet and you have some options: make a cabinet from cardstock or a cereal box, or get an acrylic 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.

CARDSTOCK CABINET

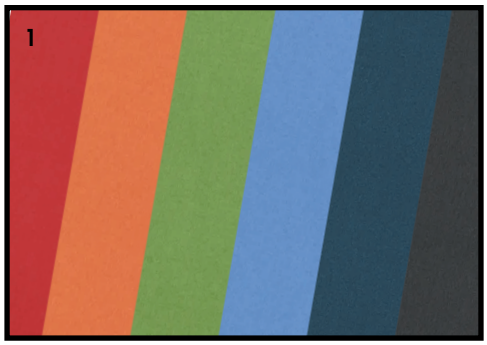
Your synth includes a template for making a nifty cardstock cabinet. If you need an extra copy, you can download it from www.zeppelindesignlabs.com, but you will need to print it on 11x17 (A4) paper. Be sure the template prints to 100% full size! Compare the scale on the template to an actual ruler.

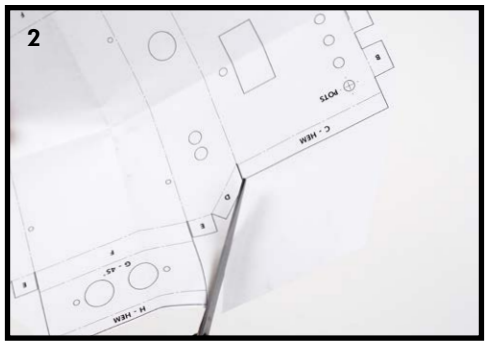
WHAT YOU WILL NEED

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 small binder clips
7. Cereal box or cardstock. Zeppelin Design Labs offers some mice iridescent card stock as an accessory (1), or you can look for your own at a craft supply store. If you get your own cardstock, choose something with these properties:
   - It must be minimum 11" x 11" (28 x 28 cm)
   - It must be at least as stiff as a cereal box, no thinner! Look for 80-105 lb cover stock.
   - The face must be smooth enough to hold the vinyl sticker.

Let's Begin!

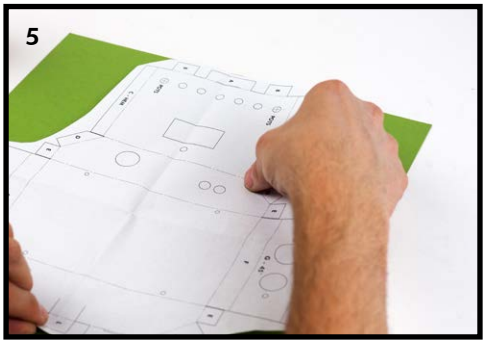
1. Rough-cut the Template, leaving a small margin all around (2).

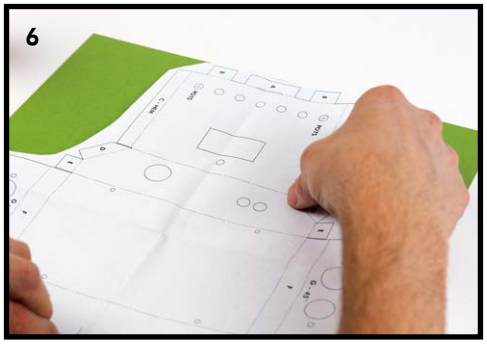




2. Flatten your cereal box, if that is what you are using. (Use a large box.) Cut the box open along its glued seam (4).

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.

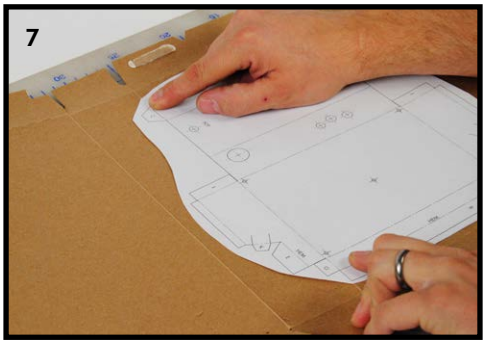


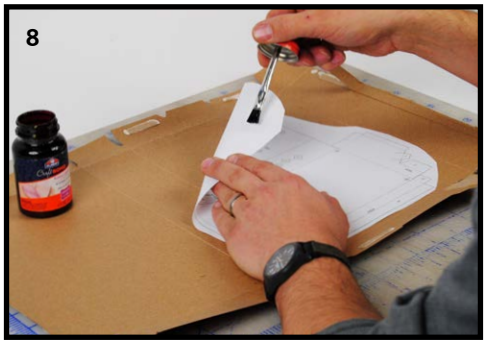


Special Instructions for Cereal Box:

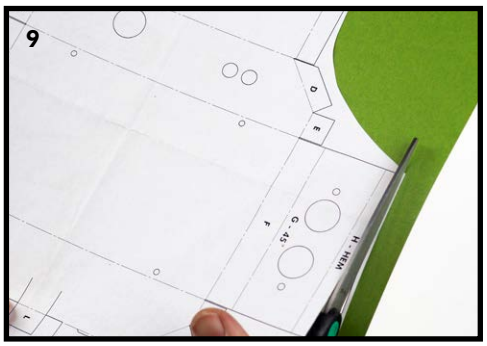
a. Align one of the template fold lines with an existing fold in the cereal box (7). Look at the front of the box to get an idea of what graphics will be most prominent on your completed cabinet.

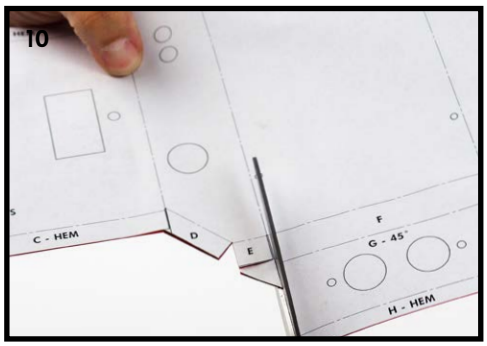
b. Glue the template to the box. Double check the alignment of the template fold line with the box fold (8).



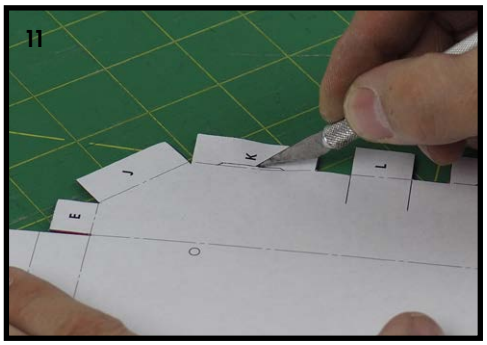


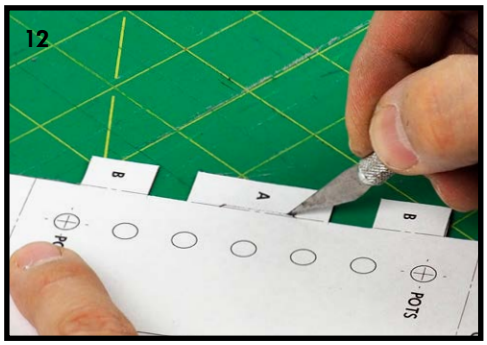
4. Cut out the template. Using sharp scissors, or a metal ruler and an X-Acto knife, carefully cut out the perimeter of the template (9). Additionally, snip along every solid line near tabs D, E, & L (10).





5. Cut slits in Tabs A & K. Carefully cut along the solid lines with the tip of your blade (12).

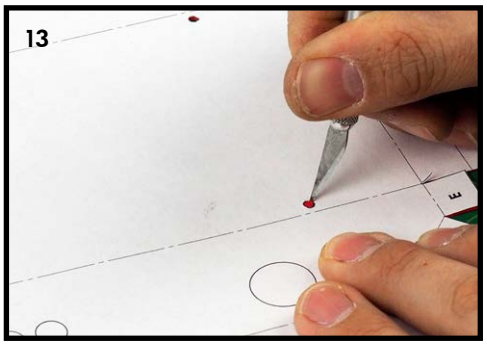


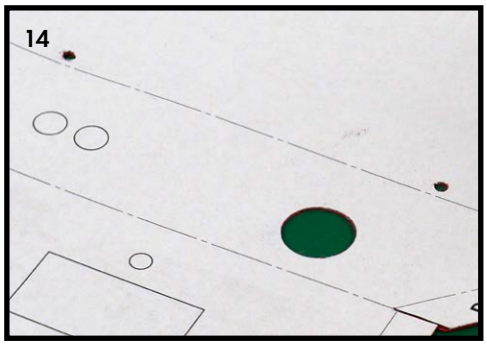


6. Cut out some of the holes.

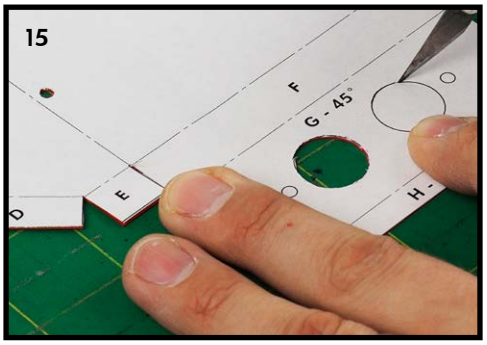
   a. Cut out the four tiny screw holes from the cabinet bottom. It's okay if the holes are a little small, but do not cut them too big (13)!

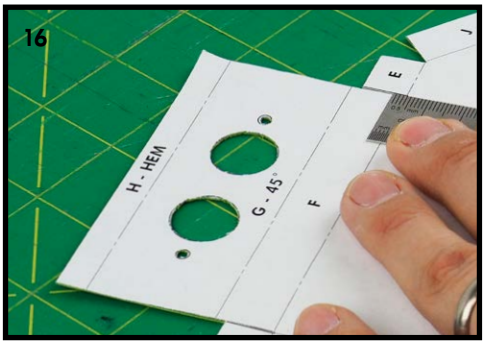
   b. Cut out the three holes from the cabinet back (14). Cut to the outside of the markings; it is important not to undersize these holes.



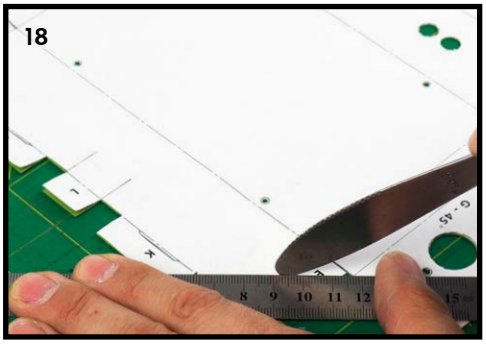


c. Cut out a total of eight holes, four big and four small, from two tabs G. Cut the big holes to the outside of the mark; cut the little holes to the inside (15,16).



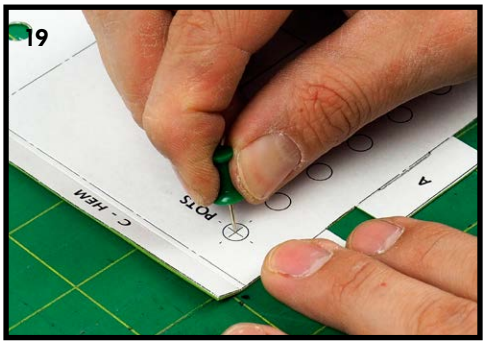


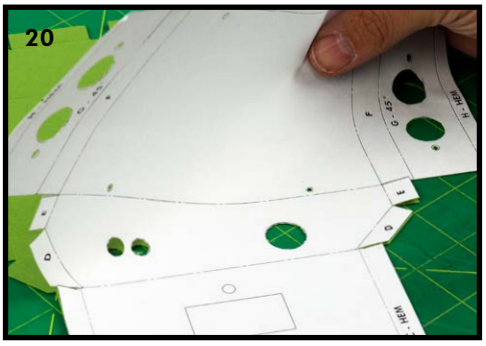
7. Score the fold lines. Use your ruler and the tip of a butter knife to carefully score every dotted fold line (17, 18). Be gentle with Tabs A & K. Be as accurate as you can. The quality of the finished product depends heavily on this step.



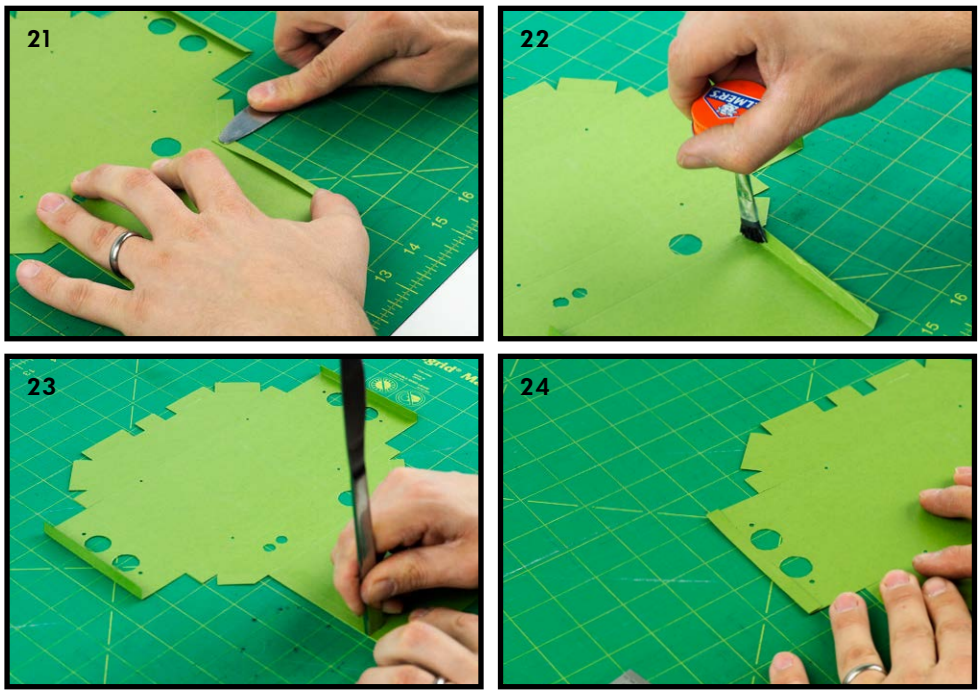
8. Use a thumbtack or push pin to poke two pinholes through the cabinet top, at the cross hairs marked "Pots" (19).

9. 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).





10. Fold and glue the hems. The four tabs C & H are hems, meaning they are to be folded over flat and glued down. Pre-crease them sharply (21), burnishing the fold with your butter knife. Apply rubber cement, following directions on the jar for the strongest bond (22). Fold the tabs flat and burnish again (23). If you have any trouble keeping these hems glued down tight, clamp them with binder clips. Now leave it alone until the glue dries thoroughly.

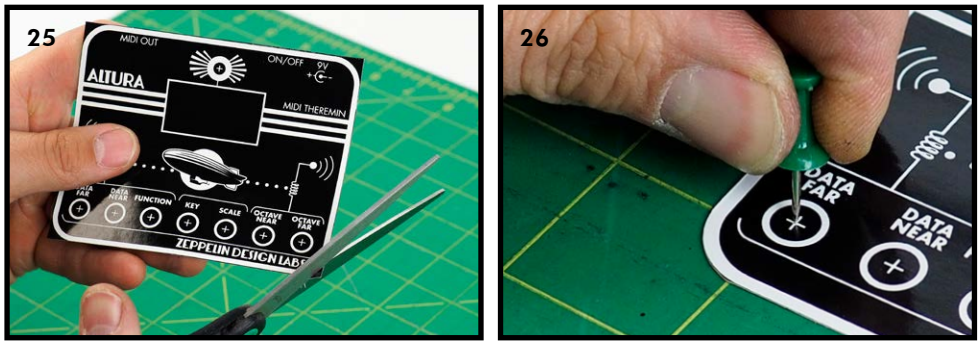


11. Apply the labels.

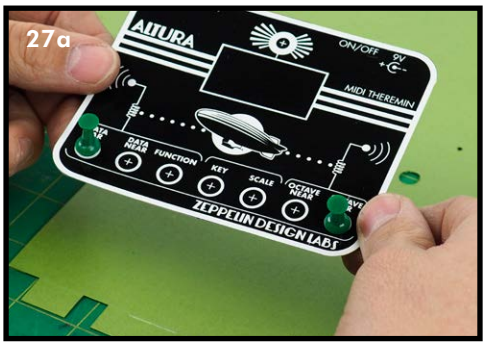
    a. Clean up any dust or stray paper bits from your workspace.

    b. Cut out the main control panel label, around the outside of the white borders (25).

    c. Poke pinholes through the label at the crosshairs for the far left and right pots. Be very precise! (26).

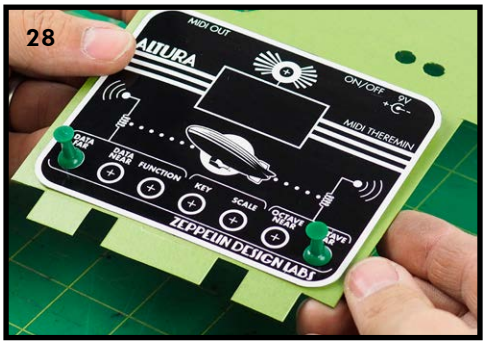


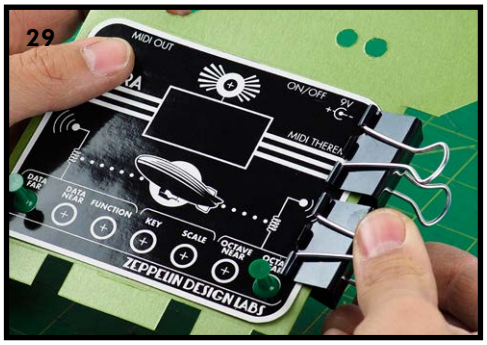
d. Push two pins down through the two pinholes in the label, and pass them through the corresponding holes in the card stock (27a,27b).

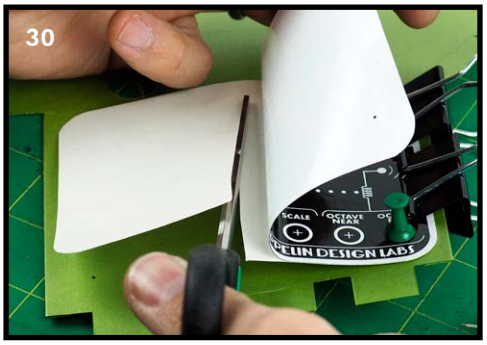


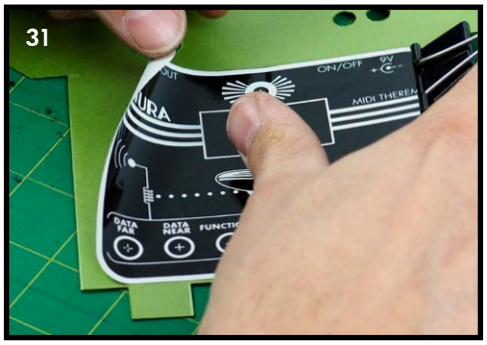
e. With the label backing still in place, neatly settle the label onto the card stock. Securely hold down one end of the label with binder clips (29). Remove the pins.

f. Remove the backing from the free end of the label (30). Cut off about half of the backing, and stick that half of the label down (31). Work from the center towards the end, carefully smoothing the label to avoid air bubbles.

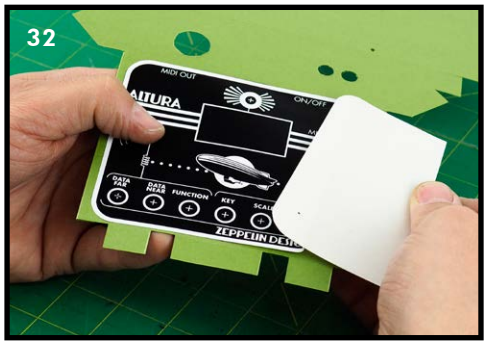








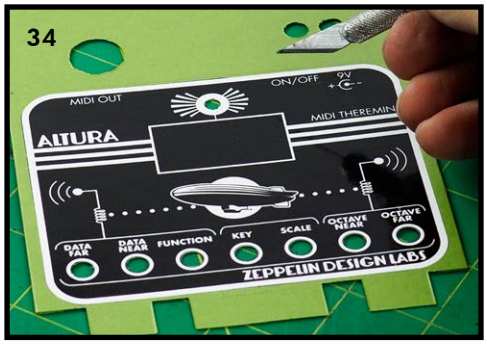
g. Remove the binder clips; remove the last of the backing (32); stick the label onto the cabinet (33). If your card stock has a textured surface, you may need to warm the sticker with a hair dryer and burnish it down thoroughly.



12. Cut out the label holes.

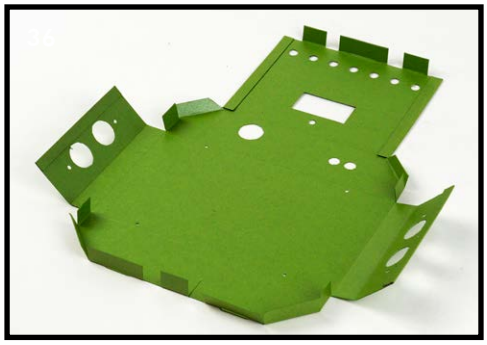
a. Cutting through the label and down into the cabinet, cut out the seven pot holes and the LED hole. Completely remove the black dots, leaving the white rings (34). Alternatively, you could use a 1/4" round hole punch, but you will have to be very precise since the punched holes will not be much larger than the pot shafts.

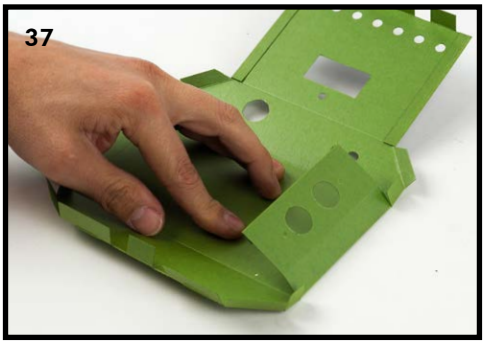
b. Cut out the window for the LED display (35), cutting along the inner edge of the white line.



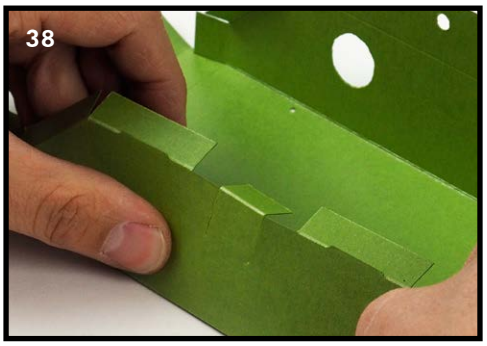
13. Crease the Folds:

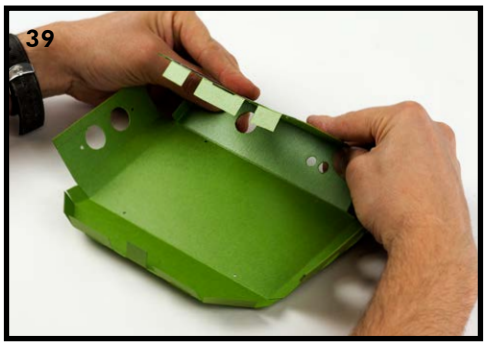
a. Crease along each scored fold line, one by one, until each fold more or less stands up at 90 degrees on its own (39), except Tabs G; these bend up 45 degrees only (36,37).





b. Very carefully bend Tabs A & K 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 (38,39).



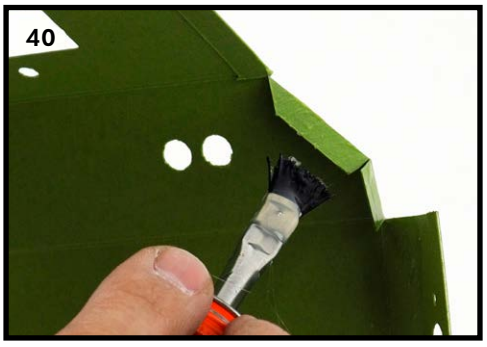


14. Form up the the rear of the box:

a. Apply glue to the mating faces of tabs D, E, F & G, at the back corners of the box (40).

b. Form the back-left corner. Burnish the connection thoroughly with your fingers or the butter knife. If necessary, hold the corner together with a binder clip while the glue sets (41, 42).

c. Repeat for the back-right corner (43).

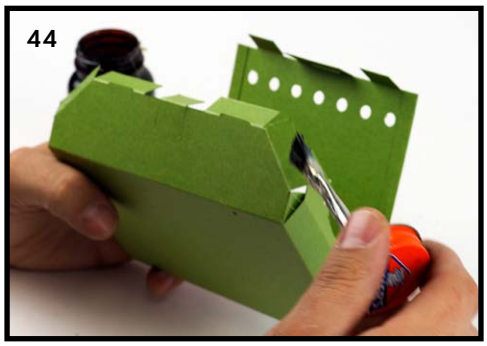


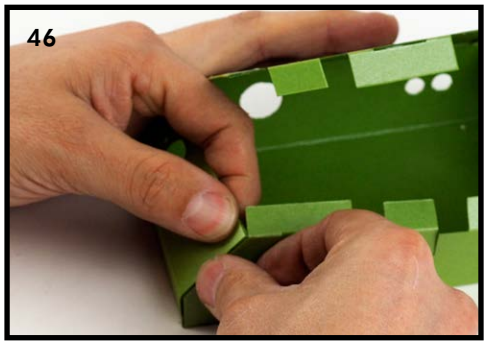
15. Form up the front of the box:

a. Apply glue to the mating faces of Tabs E, F, G & J at the front corners of the box (44).

b. Form the front-left corner. Burnish the connection thoroughly with your fingers or the butter knife. If necessary, hold the corner together with a binder clip while the glue sets (45, 46).

c. Repeat for the front-right corner (47).

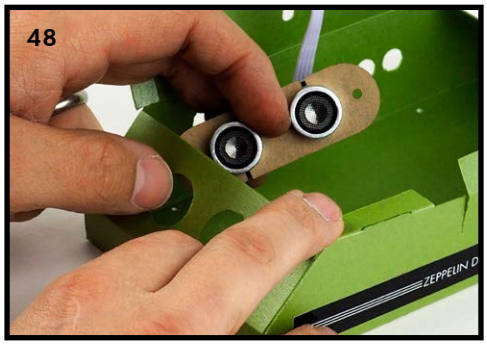


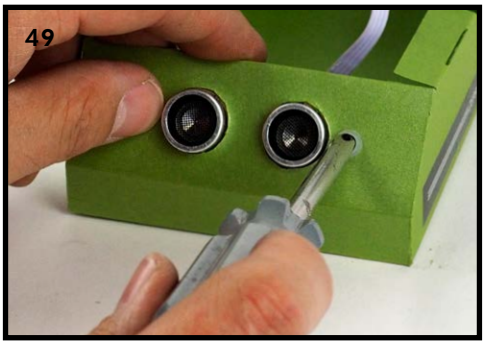


16. Install the Sensors.

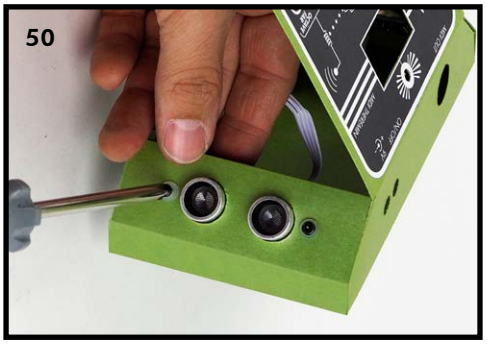
a. Slip nylon washers over two coarse-thread M3x10 screws.

b. Unplug the range sensors from the PCB. Fit one of the range sensor assemblies into one end of the case, with the ribbon cable heading down (48). Use the screws to carefully mount the sonar to the box (49).





c. Repeat for the other sonar assembly (50, 51).

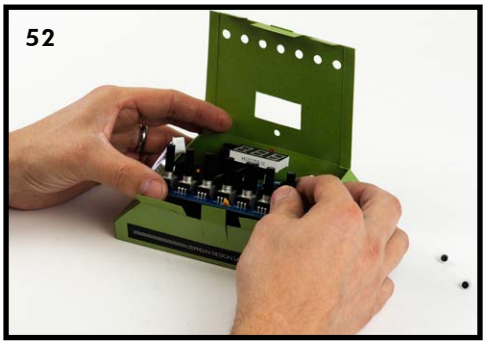


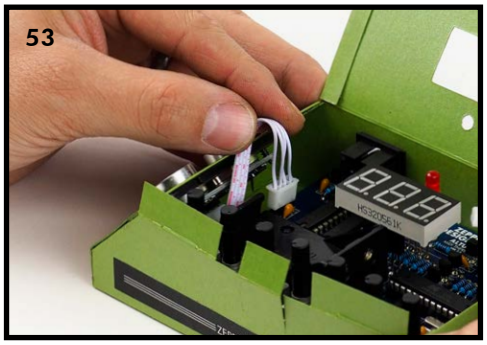
17. Install the PCB:

a. Fish the ribbon cables out of the cabinet and drape them over the sides.

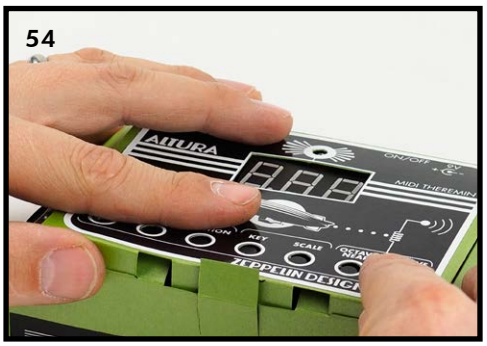
b. If desired, pop in a 9V battery. Gently fit the PCB into the cabinet (52).

c. Plug the two ribbobn cables onto the headers (53). Remember the ribbed side of the ribbon-cable socket faces toward the interior of the PCB. NOTE: DO NOT TWIST THE CABLE! If you install a cable backwards, it won't hurt anything except that the sensor won't work.

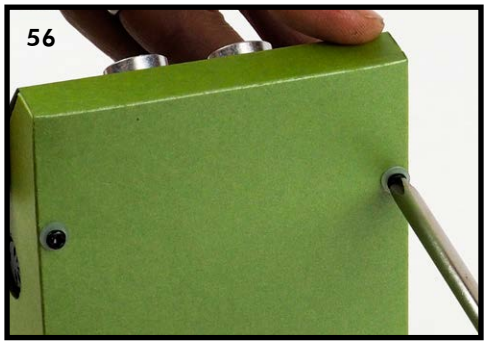




d. Close the lid over the LED, the 3-digit display, and the seven pots (54). You may need to push the LED and 3-digit display around a little to get the lid to fit.Tuck Tabs C into the slits in Tabs K, while also tucking Tab A behind Tab L. (54). Pull Tab L gently away from the cabinet and tuck it into the slit in Tab A (55). This will neatly lock the cabinet closed. You can open the cabinet up again to change the battery by gently teasing Tab L out with a fingernail. Do this as seldom as possible, or you will wear out the tabs.



e. Turn the theremin over. Slip the nylon washers (Part #FA-90-25) over the last four M3x6 machine screws. Use a #2 Phillips screw driver to install them through the cabinet and into the standoffs (56). Drive them snug but not too tight: you do not want to crush your way right through the cardboard.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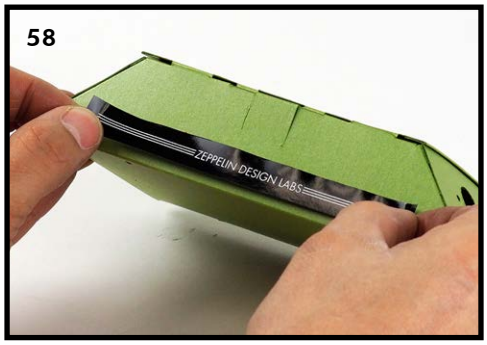
18. Add some custom labels, if you wish. Add the information labels to the front or bottom of the cabinet. The remaining stickers can adorn your Altura Theremin in a variety of ways. They look good on a road case, too.



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That's It!!

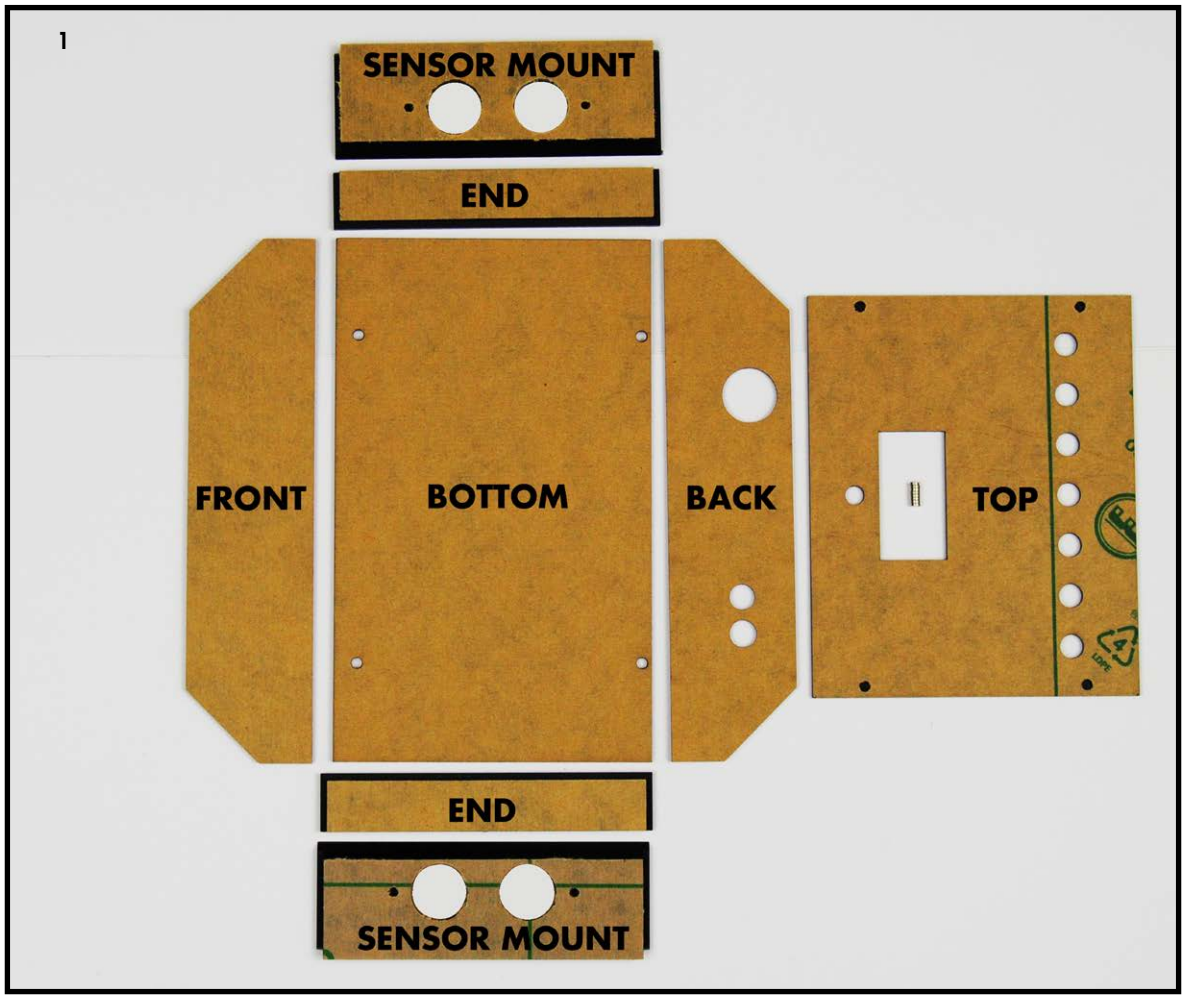
Your Altura Theremin MIDI Controller is all done. Check out the Quick Start Guide to get playing fast. When you are ready to go deeper and become an expert thereminist, continue on to the Reference Manual.

ACRYLIC CABINET KIT

Zeppelin Design Labs offers a nifty black acrylic cabinet kit. It is sleek, rugged, and quick and easy to assemble.

WHAT YOU WILL NEED

1. A scrap of plywood or particle board for a work surface
1. X-Acto knife or other sharp hobby knife
2. Super Glue (cyanoacrylate). Use the gooey kind, NOT the runny liquid kind!
3. Plastic cement for acrylic, liquid in a jar or gooey in a tube. This is OPTIONAL. You can also assemble the cabinet with SuperGlue
4. A few binder clips
5. Permanent marker
6. Tweezers
7. Toothpick



Let's Begin!

1. Your kit parts come with a paper film on both sides. Lay out the parts as shown (1) to familiarize yourself with their names and orientation. You are looking at the inside surfaces, as if we unfolded a completed cabinet.
   - Be careful to orient the BOTTOM correctly! Notice two holes are farther from the edge than the other two. This edge goes towards the FRONT of the cabinet.
   - Some parts have grooves along the edges. These grooves are on the inside surfaces.
   - The LID has four little blind holes on one side to hold magnets. This is the inside surface, so they face up.

   Once you've got it figured out, peel the paper off just the inside surfaces. Leave it on the outside surfaces as long as you conveniently can. This will protect the finish from glue marks. (We removed the paper from both sides for this photo shoot, and regretted it.)

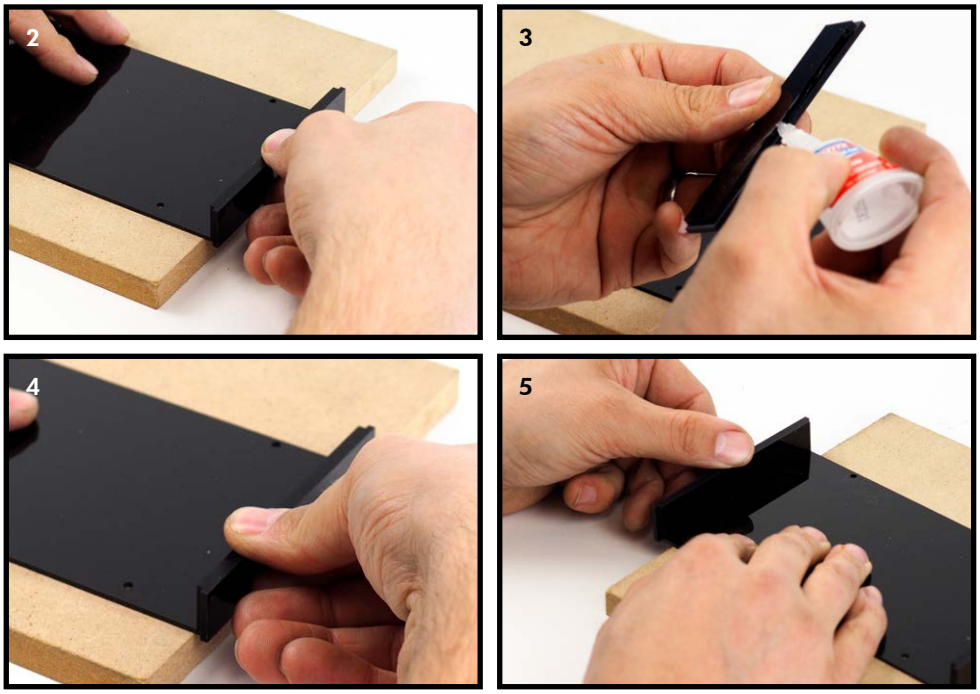
2. Glue the ENDs to the BOTTOM.

   a. Dry-fit the ENDs to the BOTTOM (2). To get a tight fit, you may need to hang the END over the edge of your work surface.

   b. Apply a thin bead of SuperGlue or acrylic cement to the inside of the groove (3).

   c. Attach the two parts and hold them tightly together (4). SuperGlue needs only a few seconds to set. Acrylic cement needs a full minute or two.

   d. Repeat for the other END (5).



3. Dry fit the rest of the cabinet. Place the FRONT, BACK and two SENSOR MOUNTS in place. Notice the SENSOR MOUNTs have two little divots in one face for holding magnets. This faces up. Concentrate on achieving a nice tight joint where the parts all come together. Do not worry about how well the top surfaces align; they will be completely hidden by the LID (7). You may get a better-looking joint when you install the front while it rests against the plywood work surface, or it might look better when it hangs over the edge.

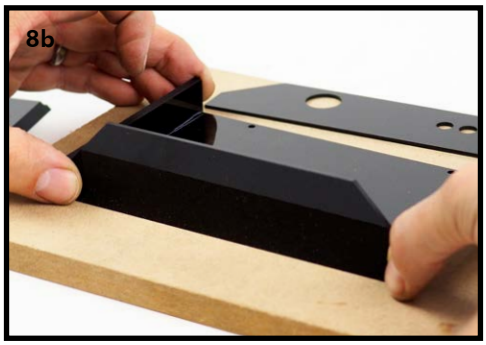
4. Attach the FRONT and BACK:

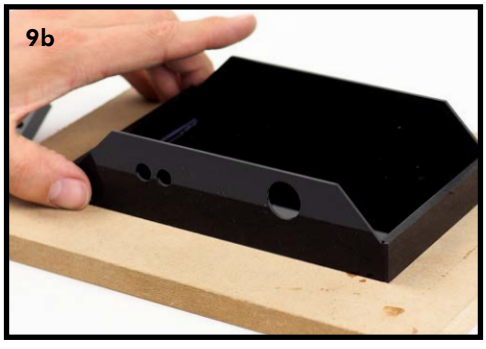
   a. When you have decided on the best way to attach the FRONT, apply glue to the insides of the notches on the ENDs as shown (8a). Remember the front side of the BOTTOM is the edge with the holes farther in.

   b. Peel back some of the paper from the edges of the FRONT and attach it to your cabinet. Hold until the glue sets (8b).

   c. Run a tiny bead of glue along the cabinet interior where the FRONT meets the BOTTOM. Gently press the parts together until the glue sets.

   d. Repeat for the BACK (9a,9b). Let the cabinet sit for a good while until the glue is cured.





5. Install the SENSOR MOUNTS:

    a. Dry fit the SENSOR MOUNTs again. Make sure their magnet-divots are facing up. Practice making the best joint possible between the MOUNT and the SIDE (10). Peel back any paper from along the edges.

    b. Apply glue to the insides of the grooves on the MOUNT, and on the top surface of the SIDE. Hold in place until set.

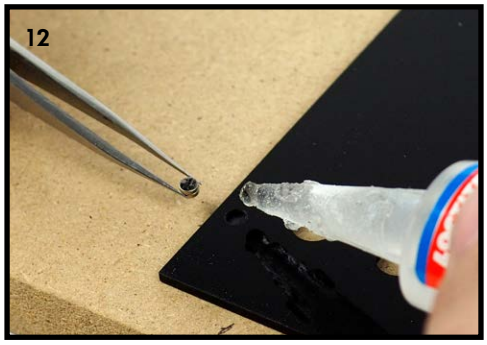
    c. Repeat for the other MOUNT (11)

6. Magnets: Your kit comes with eight tiny rare-earth magnets. They are stuck together in a little slug. Magnets, of course, are polarized. It will be VITAL later on to keep track of the magnet's polarity!

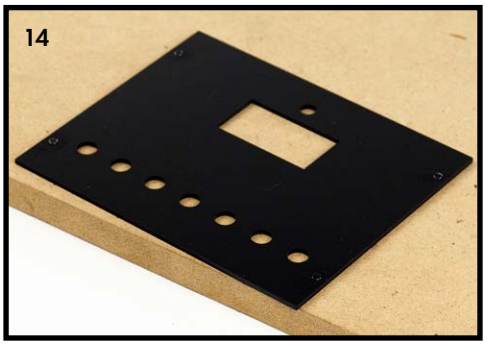
    a. Mark the top magnet on one side with a permanent marker; pick it off the stack and mark the next until all magnets are marked on the same one side. Don't let them re-assemble for a while, until the marker dries!

    b. Place a droplet of SuperGlue into a divot in the LID (12).

    c. Maneuver a magnet into the divot with tweezers. Place it with the MARKED SIDE UP!! (12) Hold the magnet down with a toothpick (not a knife blade!) so you can get the tweezers away (13). Breathing on the SuperGlue can help it cure faster.



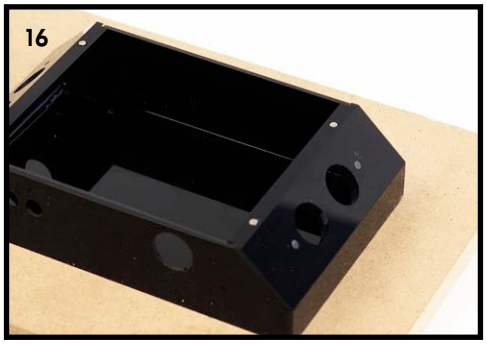
d. Repeat for the other three divots (14). PLACE ALL FOUR MAGNETS MARKED-SIDE-UP!! Set the LID aside, far from the other magnets, until the glue cures THOROUGHLY, an hour for SuperGlue and two or three for acrylic cement. If the LID magnets attach themselves to anything too soon, they will probably pull themselves out of the glue bed!



e. SENSOR MOUNT magnets: As with the LID, place a droplet of SuperGlue into one of the divots on top of the SENSOR MOUNTs.

f. Maneuver a magnet into the divot MARKED-SIDE-DOWN!! **CAUTION:** If you mess up this step, the LID will NOT seat onto the cabinet!! (15). Again, use a toothpick, not a knife blade, to seat the magnet into the divot.

g. Repeat for the last three magnets. PLACE ALL FOUR MAGNETS MARKED-SIDE-DOWN!! (16) This assures that you maintain proper polarity between the magnet pairs. You can color in the magnets later when the glue is cured, if you wish. Keep the cabinet away from the LID until the glue is cured!

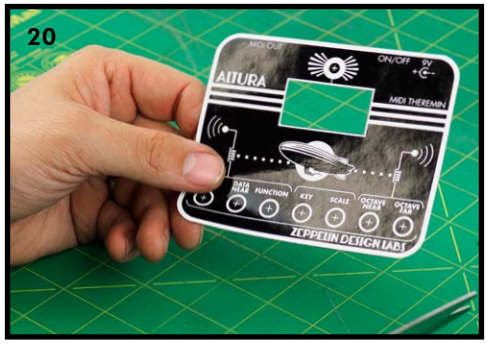


7. Cut out the Labels

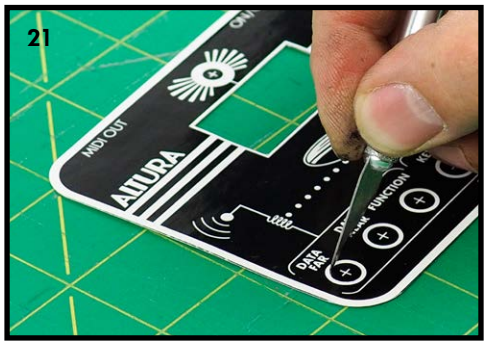
   a. Use a knife and straight edge to cut out the main control panel label. Cut around the outside of the white line (17)

   b. Cut out the rectangle for the 3-digit display. Cut to the inside of the white line (18).

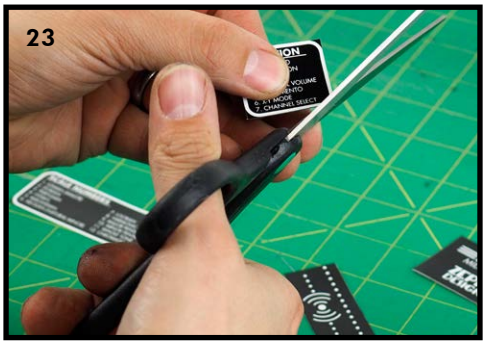
   c. Trim the corners (19, 20)

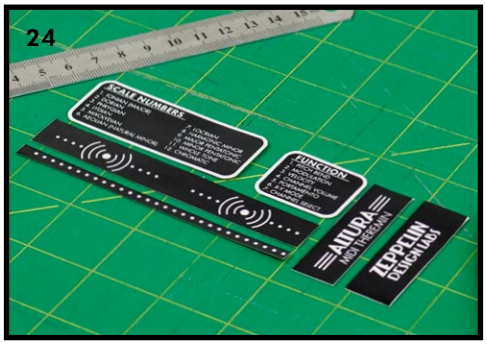


   d. Cut out the seven pot holes and the LED hole (21,22). Cut away all of the black dots. You could use a 1/4" hole punch for the pot holes, but you will have to be very precise.



e. Cut out the rest of the stickers.

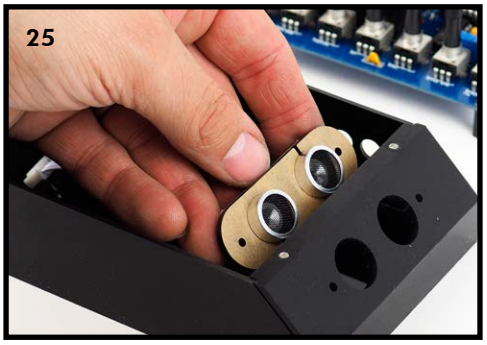


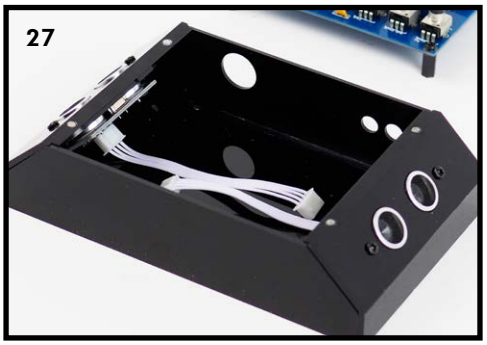


8. Install the Sensors.

a. Unplug the ribbon cables from the PCB. Install a sensor into the cabinet, with the ribbon cable directed downward (25).

b. Use a #2 Philips screw driver and two coarse-thread M3x10 screws (part #FA-64-30) to install the sensor into the cabinet (26). Repeat for the other sensor (27)





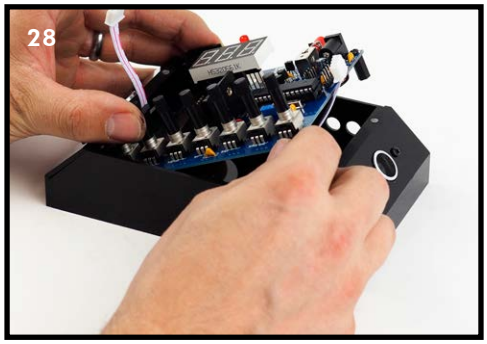
9. Install the PCB.

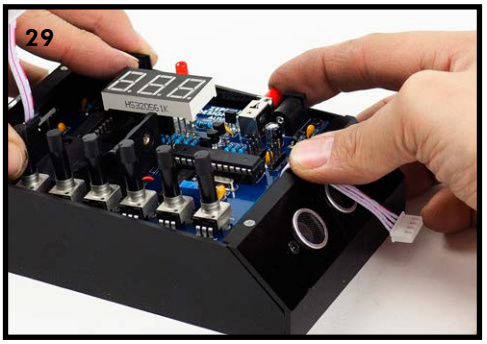
   a. Pull the two ribbon cables up and out of the cabinet. Stick the left end of the PCB down into the cabinet under the ribbon cable (28).

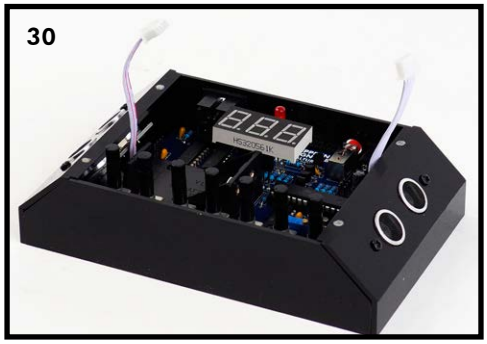
   b. Depress the ON/OFF switch and pop the right end of the PCB down into the cabinet, underneath the ribbon.The PCB should pop into place when the ON/OFF switch finds its hole (29).

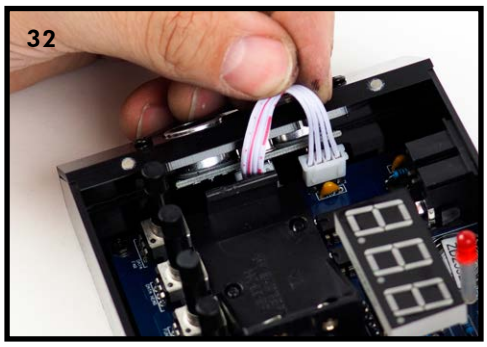
   c. Flip the cabinet over and use four M3x6 screws (part #FA-60-37) to secure the PCB (31).

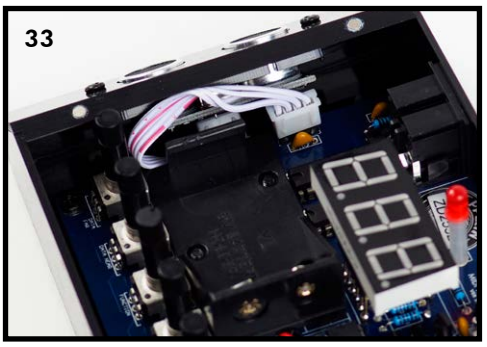
   d. Plug the ribbon cables back into the headers on the PCB. Be careful not to twist the cable! Remember the ribbed side of the cable header faces toward the PCB interior (32). Tuck the ribbons down behind the sensors (33).









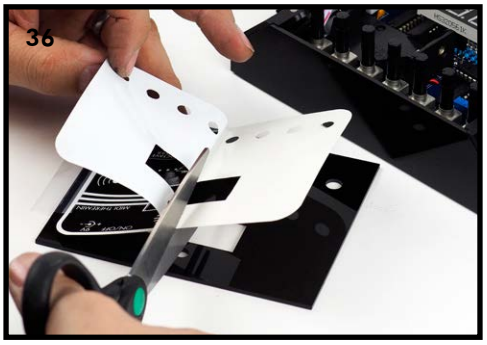


10. Apply the Labels.

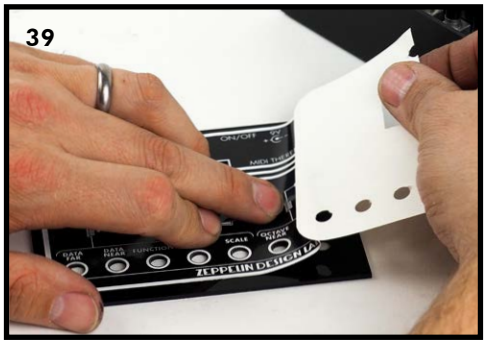
a. If all the magnet glue is thoroughly cured, place the LID on top of the cabinet. (34).

b. Place the label onto the lid. Settle it over the LED, the 3-digit display, and the seven pots (35) and tape it to the lid along one side.

c. Remove the lid from the cabinet. Peel away and cut off about half of the backing (36). Carefully smooth down the label. Watch out for air bubbles! Rub it down thoroughly (37).



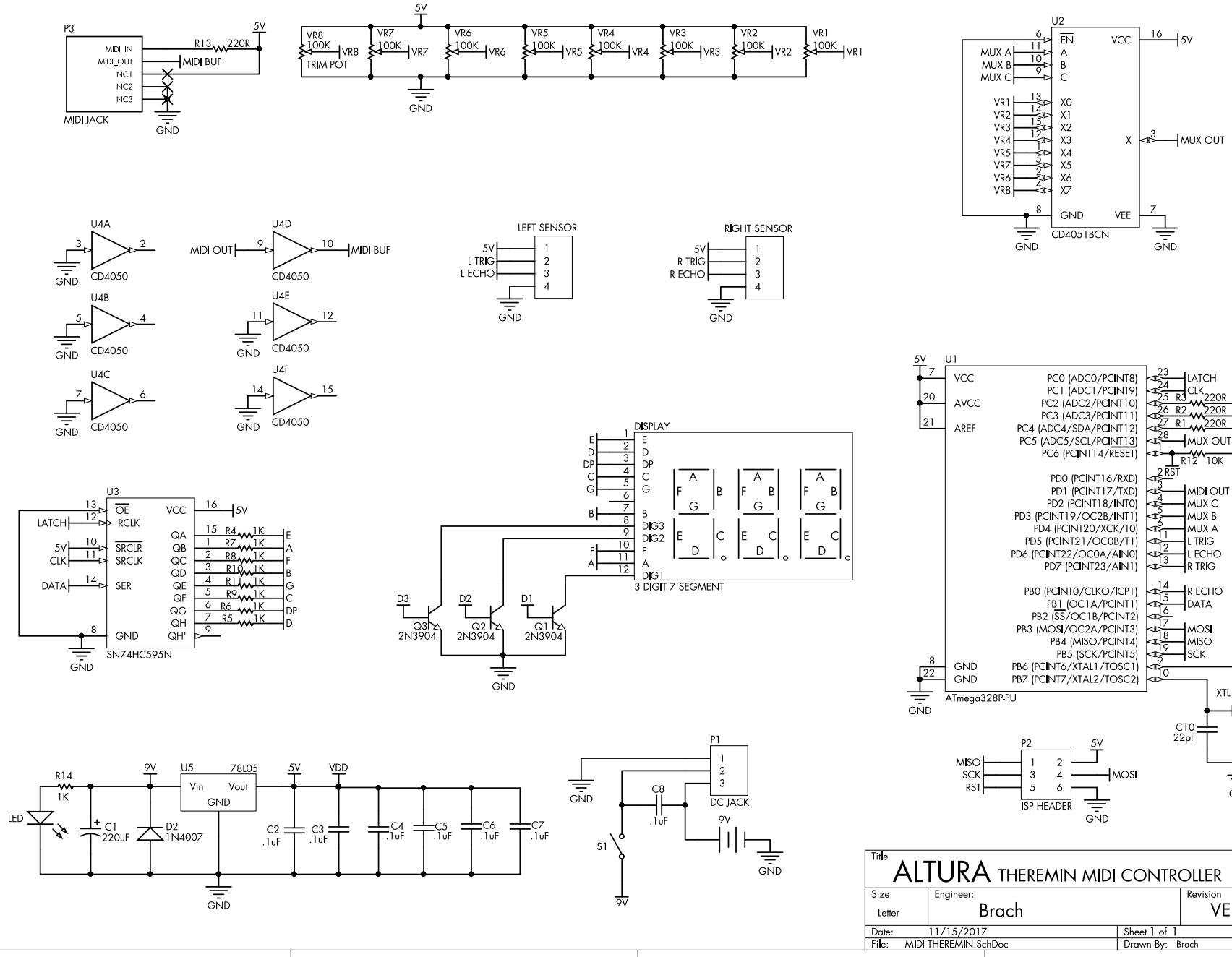
d. Remove the tape (38). Rezmove the remaining backing (39).



e. Smooth down the label (40). Apply the information labels to the bottom of the Altura, or to the front if you prefer, for ready reference (41).

f. Add the "ping" stickers to the ends of the cabinets. Add a pinstripr or two to taste, and your Altura is done!! (43).

That's it! You're ready to wave. Please see the Altura Quick Start Guide and Reference Manual to get the most out of your new Theremin MIDI Controller.


P3
MIDI_IN
MIDI_OUT
NC1
NC2
NC3
R13 220R
5V
MIDI BUF
MIDI JACK
GND
VR8 100K VR8
TRIM POT
VR7 100K VR7
VR6 100K VR6
VR5 100K VR5
VR4 100K VR4
VR3 100K VR3
VR2 100K VR2
VR1 100K VR1
U2
MUX A
MUX B
MUX C
VR1
VR2
VR3
VR4
VR5
VR7
VR6
VR8
EN
VCC
A
B
C
X0
X1
X2
X3
X4
X5
X6
X7
X
VEE
MUX OUT
CD4051BCN
U4A
U4B
U4C
U4D
U4E
U4F
CD4050
MIDI OUT
MIDI BUF
LEFT SENSOR
5V
L TRIG
L ECHO
RIGHT SENSOR
R TRIG
R ECHO
U3
OE
RCLK
SRCLR
SRCLK
SER
QA
QB
QC
QD
QE
QF
QG
QH
QH'
LATCH
CLK
DATA
R4 1K
R7 1K
R8 1K
R10 1K
R11 1K
R9 1K
R6 1K
R5 1K
SN74HC595N
DISPLAY
3 DIGIT 7 SEGMENT
DIG3
DIG2
DIG1
D3
D2
D1
Q3 2N3904
Q2 2N3904
Q1 2N3904
U1
ATmega328P-PU
PC0 (ADC0/PCINT8)
PC1 (ADC1/PCINT9)
PC2 (ADC2/PCINT10)
PC3 (ADC3/PCINT11)
PC4 (ADC4/SDA/PCINT12)
PC5 (ADC5/SCL/PCINT13)
PC6 (PCINT14/RESET)
PD0 (PCINT16/RXD)
PD1 (PCINT17/TXD)
PD2 (PCINT18/INT0)
PD3 (PCINT19/OC2B/INT1)
PD4 (PCINT20/XCK/T0)
PD5 (PCINT21/OC0B/T1)
PD6 (PCINT22/OC0A/AIN0)
PD7 (PCINT23/AIN1)
PB0 (PCINT0/CLKO/ICP1)
PB1 (OC1A/PCINT1)
PB2 (SS/OC1B/PCINT2)
PB3 (MOSI/OC2A/PCINT3)
PB4 (MISO/PCINT4)
PB5 (SCK/PCINT5)
PB6 (PCINT6/XTAL1/TOSC1)
PB7 (PCINT7/XTAL2/TOSC2)
LATCH
CLK
MUX OUT
MUX C
MUX B
MUX A
L TRIG
L ECHO
R TRIG
R ECHO
DATA
MOSI
MISO
SCK
R RST 10K
R3 220R
R2 220R
R1 220R
D3
D2
D1
Y1 XTL 16MHz
C10 22pF
C9 22pF
P2
ISP HEADER
MISO
SCK
RST
MOSI
R14 1K
LED
9V
U5 78L05
Vin
Vout
C1 220uF
D2 1N4007
C2 .1uF
C3 .1uF
C4 .1uF
C5 .1uF
C6 .1uF
C7 .1uF
VDD
P1
DC JACK
C8 .1uF
S1
Title
ALTURA THEREMIN MIDI CONTROLLER
Size
Letter
Engineer:
Brach
Revision
VER 2.4
Date:
11/15/2017
Sheet 1 of 1
File:
MIDI THEREMIN.SchDoc
Drawn By:
Brach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