THE CORTADO MKII

Assembly Instructions

BALANCED PIEZO CONTACT MIC

ZEPPELIN DESIGN LABS

ZEPPELINDESIGNLABS.COM • 2950 N. WESTERN, CHICAGO, IL 60618

THE CORTADO MKII

Balanced Piezo Contact Microphone

INTRODUCTION

Piezo sensors are quite incredible little things. They can be used to detect the slightest variation in pressure, force, or strain and convert that energy into a voltage. Over the past several decades they've been used in numerous applications in several fields including the audio industry. Unfortunately, they've developed a bad reputation for sounding "harsh" and "brittle" when used as contact microphones in acoustic instruments. This is due to improper impedance matching and the inadequate driving circuits that are usually used with these sensors in audio applications. Piezo sensors in themselves are capable of a very wide bandwidth, and when used properly, can achieve excellent results. So with the intention of getting the most out of a piezo sensor, we here at Zeppelin Design Labs have developed The Cortado – a balanced piezo contact microphone. This mic contains a phantom powered circuit that properly matches the piezo sensor input impedance and drives the signal via a balanced output, which allows for wide bandwidth (~20Hz-20kHz), low signal losses, and high signal to noise ratio. The Cortado's circuit was originally designed by Alex Rice (http://www.zachpoff.com/diy-resources/alex-rice-piezo-preamplifier/) for use in his contact mic hydrophone, but it can be used in countless other applications with excellent results. In the recording studio or on stage the Cortado can be used on pianos, percussion, guitars or other stringed instruments. It can be used for a variety of mic and sensor applications such as a plate reverb pickup or wooden stomp box mic. We even created a tin can vocal microphone out of stuff we found in the trash (as pictured on this manual's cover). This is the perfect accessory for a lofi geek or a field recording enthusiast. Let your imagination run wild... discover what the pipes in your apartment building sound like, what bridge suspension cables sound like, even what melting ice sounds like. Anything that vibrates or resonates with an audible frequency can be captured by The Cortado contact mic. Several field recording enthusiasts around the web use this circuit (or something similar) to record some pretty cool stuff. Just do a Google or Youtube search for "contact mic field recording."

The assembled Cortado kit can take several forms, suitable for many different applications.

- Standard Contact Mic. The circuit board is shielded in a metal box and the piezo disc and cable are also shielded.
- Tin Can Mic. Use this configuration whenever the entire Cortado will be installed inside a shielding container, such as a tin can, garbage pail, grounded metal sculpture, etc. The piezo is attached with a fine wire; the piezo and circuit board remain unshielded.
- Instrument Pickup. Similar to the Standard Contact Mic, but the circuit is shielded not with a metal box but with copper tape, to reduce size.

STANDARD CONTACT MIC

TIN CAN MIC

INSTRUMENT PICKUP

WHAT YOU WILL NEED

Here's everything you will need to build The Cortado DIY kit as shown (Figure 2 on page 4).

TOOLS

1. Digital Multimeter, able to measure Resistance
2. #2 Phillips Screw Driver
3. Small flathead screwdriver
4. Ruler
5. Small awl, or metal poking probe
6. 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 "screwdriver" shape. One with a temperature control and a stand is best.
7. Wet sponge or dry solder-cleaning pad
8. Wire strippers
9. Flush cutters or small diagonal cutters
10. Needle-nose pliers
11. Clamp or vise to hold the printed circuit board while soldering (optional, but handy).
12. Solder sucker or solder braid – optional, but very handy if you have to remove / repair any components!
13. Scissors
14. Drill and bits: 9/64" (3.5mm) and 3/8" (10mm), plus several in between, or stepper bit

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. Isopropyl alcohol, denatured alcohol, or rubbing alcohol
3. Rough grit sandpaper
4. Electrical tape

Figure 1: What's In The Box

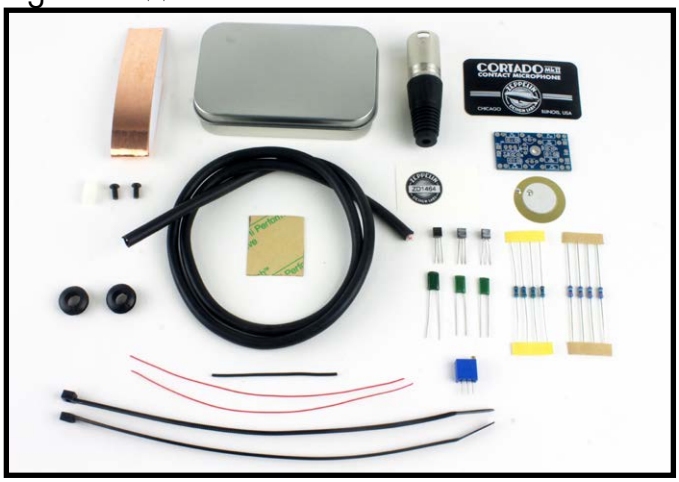


Figure 2: The Finished Kit

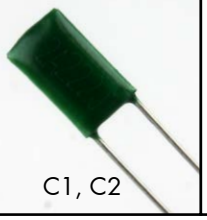
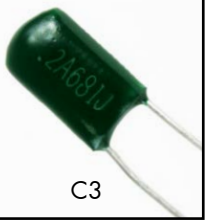
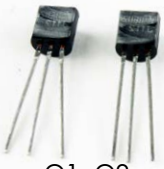
WHAT'S IN THE BOX

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.

Table 1: The Cortado Balanced Piezo Contact Mic 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 FETs (Q1,Q2,Q3) on page 12 before removing them from the 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 support@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 support@zeppelindesignlabs.com). For more common parts, like resistors, caps, or screws, you may just want to go to a local electronics or hardware store.

Table 1: The Cortado Balanced Piezo Contact Mic Bill Of Materials

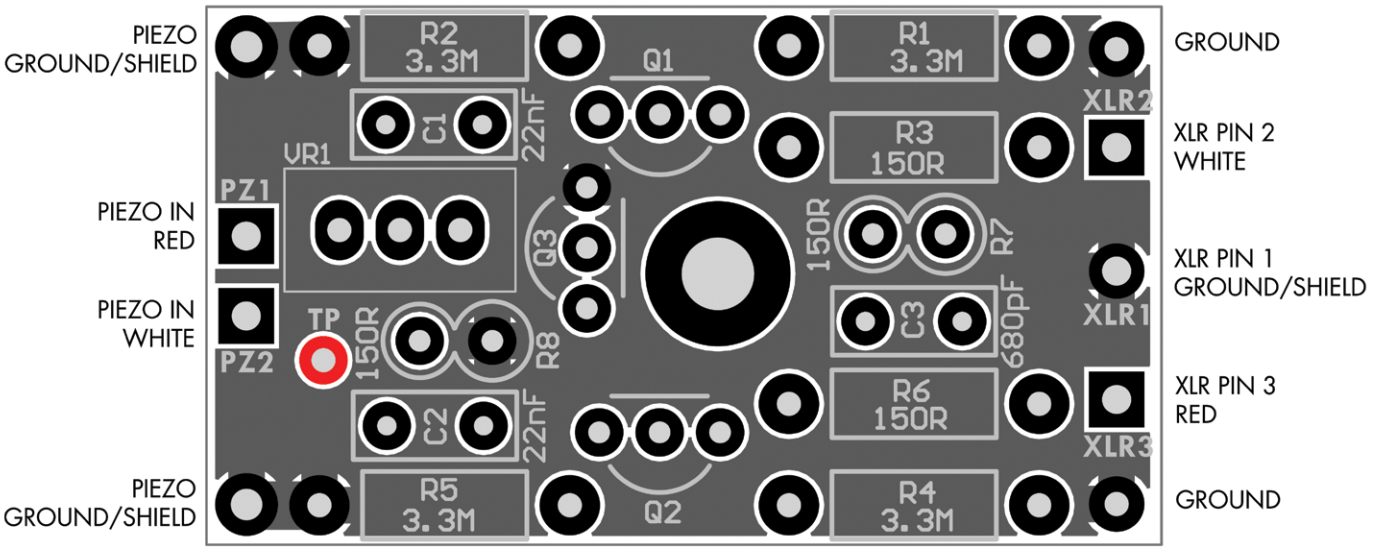
Part #	Description	Notes	Qty
HD-40-30	Male XLR Jack		1
TD-10-22	Piezo disc		1
CB-20-30	Microphone cable	30" (76cm)	1
CB-01-30	Hookup Wire 24/1	2-3/8" (7cm)	1
CB-01-69	Wire-wrap Wire 30/1	12" (30cm) total, for piezo disc	1
TP-30-11	Double-Sided Tape	~1" (2.5cm) sq.	1
TP-20-14	Copper tape	11.5" (29cm) total	1
HD-08-01	Zip Tie		2
ST-10-23	Nylon Hex Standoff M3x12		1
FA-60-37	Phillips Machine Screw – Pan head M3x6		2
EN-30-01	Tin Box		1
PL-10-42	Cortado MKII Label Sticker		1
PL10-90	Serial Number Sticker		1
HD-20-02	Rubber Grommet		2
PC-41-01	PCB	Printed Circuit Board	1
VR1	Potentiometer Trimmer 5K		1
R3, R6, R7, R8	Resistor 150R		4
R1, R2, R4, R5	Resistor 3.3M (or 3M3)		4
C1, C2	Film Capacitor 2.2nF/100V		2
C3	Film Capacitor 680pF/100V		1
Q1, Q2	Matched Pair FETs	J112 - Painted Silver	2
Q3	Unmatched single FET	J112	1

 HD-40-30	 TD-10-22	 CB-20-18	CB-01-30	 CB-01-69
 TP-30-11	 TP-20-14	HD-08-01	ST-10-23	 FA-60-37
 EN-30-01	 PL-10-42	 PL-10-90	 HD-20-02	 PC-41-01
 VR1	 R3, R6, R7, R8	 R1, R2, R4, R5	 C1, C2	 C3
 Q1, Q2	 Q3			

SENSOR UPGRADE

If you purchased the optional sensor upgrade, the package will contain one sensor assembly with a 72" cable lead, and one 1/4" rubber grommet.

Figure 3: Component Values and Locations



THE PRINTED CIRCUIT BOARD

Whatever configuration you are building, all Cortados start with a 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 cover 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 onto 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.

The printed circuit board (PCB) holds the components in this circuit. All of the components will be installed on the "component side" of the board, which is the side that has the part numbers 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 to the board. 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:

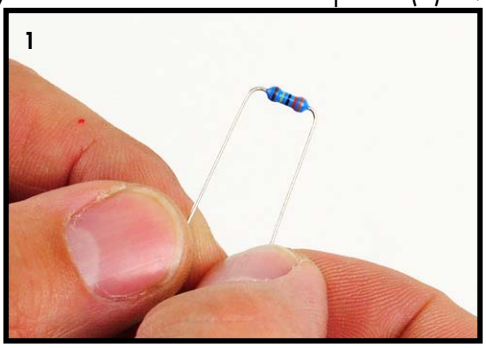
1. Install the part on the "component side" of the board, by threading the wire leads through the appropriate holes in the board. For your convenience, the board has silk screen outlines indicating where the components should be placed, along with text indicating the part number and the component value.
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.

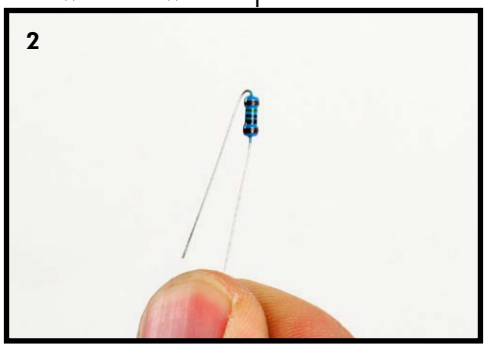
Let's begin!

1. Resistors: The values of resistors are given by a series of colored stripes on their body. There are several tutorials on-line 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.

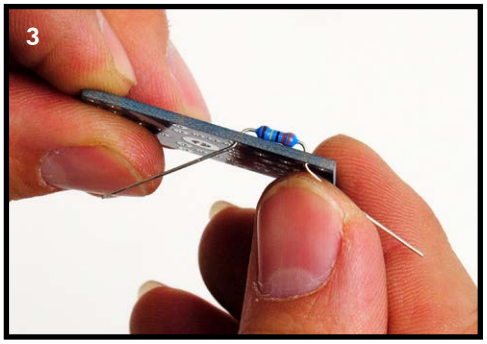
   Resistors are not polarized, meaning they can be installed in their holes in either direction. It doesn't matter which lead goes in what hole.

   The hole spacing of most of the resistors on the circuit board allows the leads to be (gently) bent 90 degrees at the body of the resistor (1). This allows most resistors to slip into their holes very easily. Resistors R7 & R8 are exceptions (2). Note how those two components are bent.



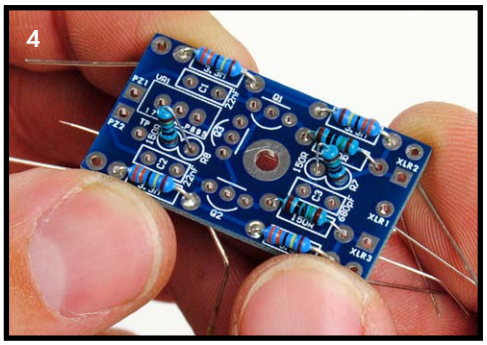


   a. Start with the 3.3M resistors (R1, R2, R4, R5), labeled ORANGE, ORANGE, BLACK YELLOW, BROWN. Compare to its picture in the BOM. Find their locations on the circuit board; install and bend the leads as described above (3). Don't solder any of them until all 8 resistors are installed; just bend the leads to keep them in their place.

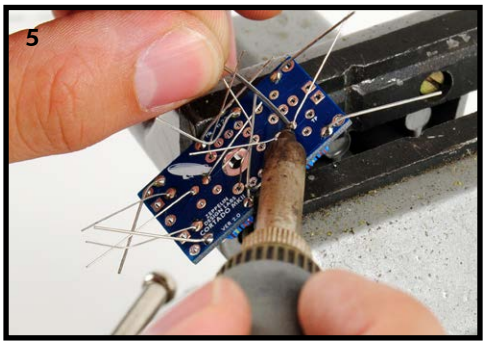


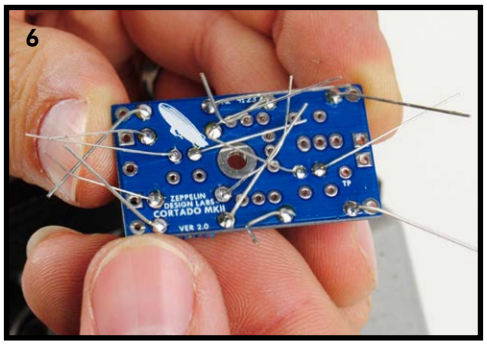
   b. Continue with the 150 ohm (150R) resistors (R3, R6, R7, R8). The body of these resistors are blue and are labeled BROWN, GREEN, BLACK, BLACK, BROWN. R7 and R8 stand upright

on the PCB so bend one lead nearly parallel with their bodies and install them standing up (4). Bend the leads on the back so they won't fall out.

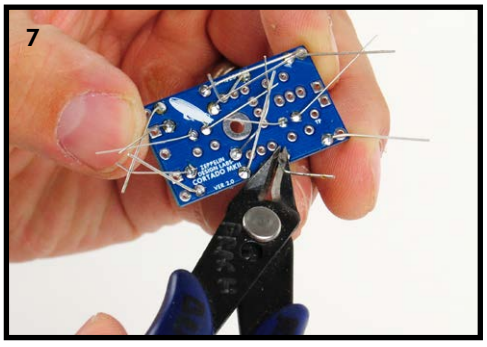


c. You should have a whole forest of bent leads coming out the solder side of the board. Now you can turn the board solder-side-up and solder each one to the board. Use a clamp or vise if you have one; it makes soldering much easier (5,6).





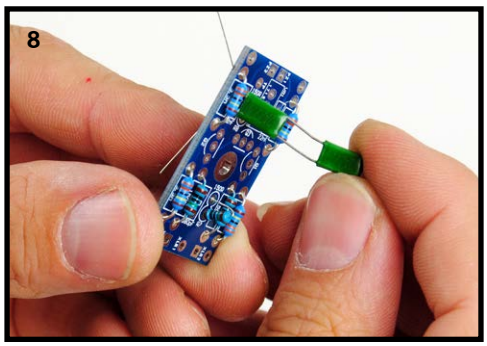
d. Now clip each lead with your flush cutters at the solder joint (7).



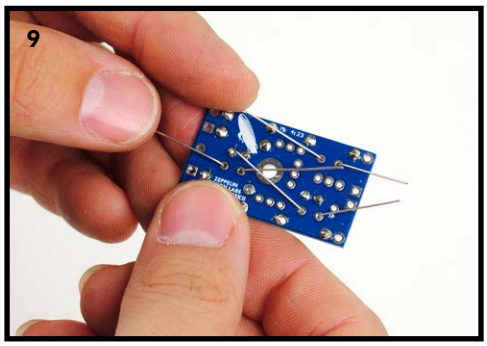
e. Before installing any more components on the circuit board, double check the resistance values of each of the installed resistors. Set your digital multimeter to the "ohms" or "resistance" setting, and measure across all of the resistors. Compare the measured value to the listed value in Table 1 and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

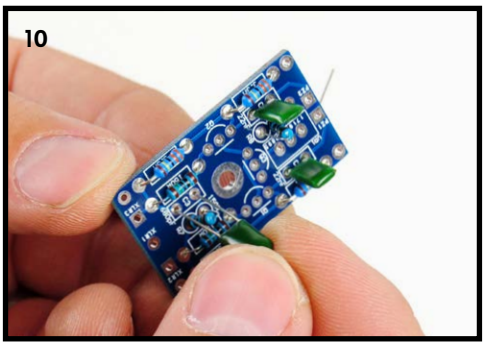
2. Capacitors: There are three film capacitors of two different values in this circuit. Both values of capacitors look very similar so please make sure you look closely at their markings and compare them to the photos in the BOM. Like the resistors, these capacitors are not polarized. They can be installed either direction; it doesn't matter which lead goes in which hole.

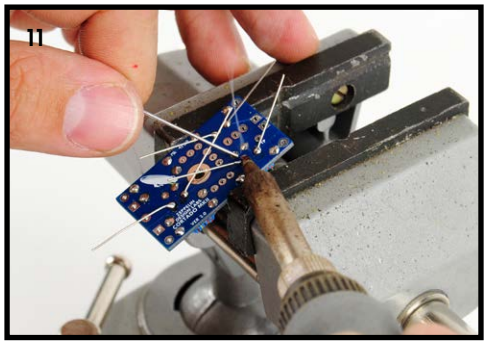
   a. The 2.2nF capacitors (C1,C2) are labeled "2A222J." Place both C1and C2 in their holes and bend the leads on the back (8).

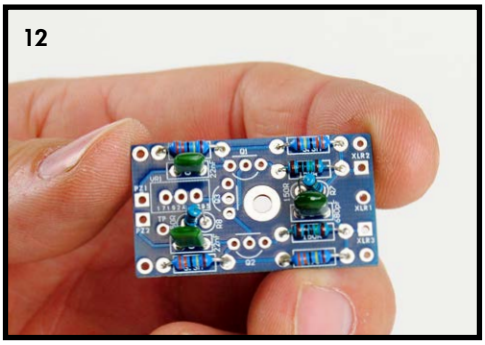


   b. The 680pF capacitor (C3) is labeled ".2A681J." Place the C3 in its holes and bend the leads out. When you have all three caps placed, turn the board over, solder and then clip the leads (9,10,11,12).

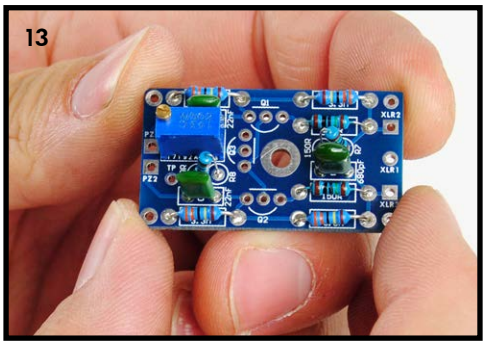








3. Trimmer Potentiometer: Place VR1 in it's location with the adjustment screw located toward the PZ holes. Solder and clip the leads (13).



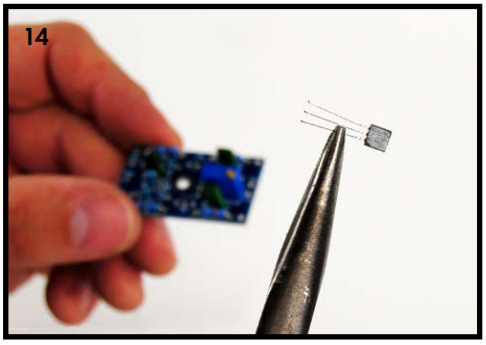
4. Transistors: This circuit contains three field effect transistors (FETs). FETs are quite sensitive to static electricity and could easily be damaged if they are exposed to moderately high voltages. The voltage rating of these FETs is only 35V, meaning that if over 35 volts is applied across two leads on one of these components it will most likely be damaged to the point of not being usable. Unfortunately, humans are not sensitive to static electricity at such low levels; in fact, most people can't even feel a static discharge less than 1000 volts! So it is very easy to damage these components without even knowing it. Consequently, it is important to handle these components as little as possible. 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.

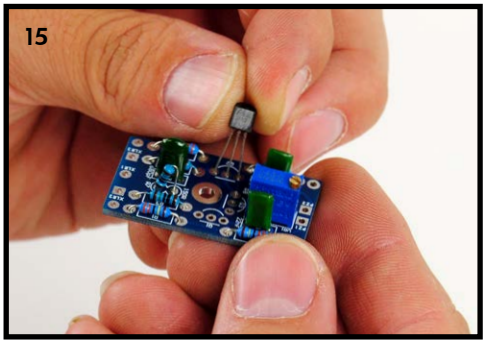
   Two of the three FETs have silver paint on their face. We painted them to indicate that these two FETs have been "matched" to each other. This means that the gate-source turn-off voltage of these transistors were measured to be within about 100th of a volt of each other. This allows both sides of the circuit to be balanced very closely, achieving very high common mode rejection, which results in a very quiet microphone.

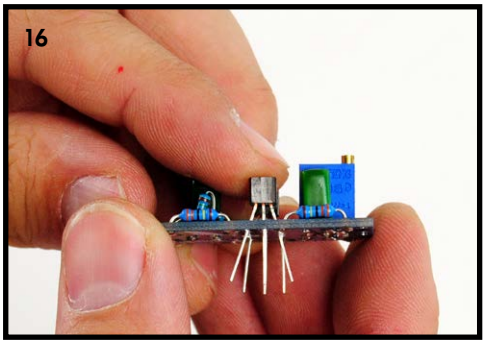
   Transistors are polarized, meaning it is important which way they fit into the holes. The component side of the circuit board shows an outline of the transistor body in the correct orientation.

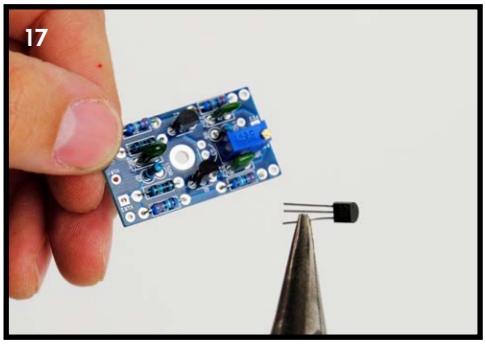
a. Place the silver-painted FETs in the locations of Q1 and Q2. Either silver FET can be Q1 or Q2; it doesn't matter which one goes in those locations as long as they are both silver (14,15). On the bottom of the board bend the leads a bit so they won't fall out of their holes.

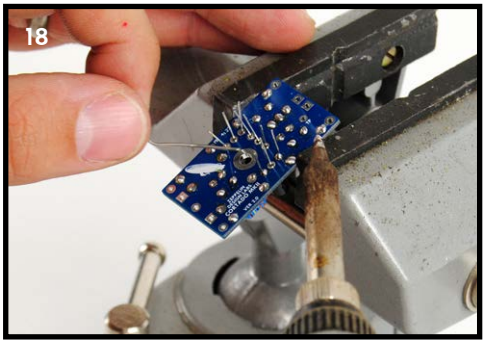
b. Place the other FET in the Q3 location (16). Please be mindful of the correct orientation. Bend the leads of Q3. Turn the board over, solder and clip all the transistor leads (17,18,19).

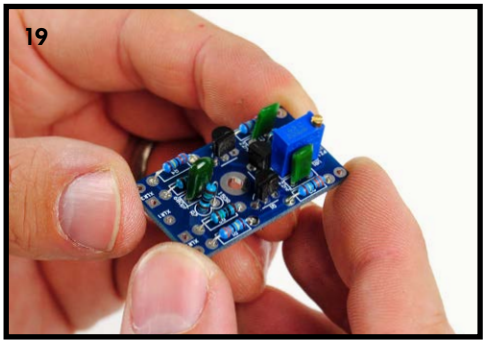




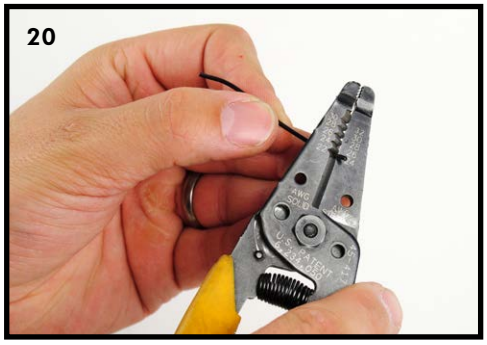


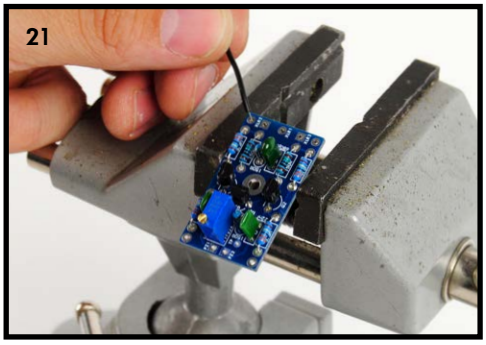


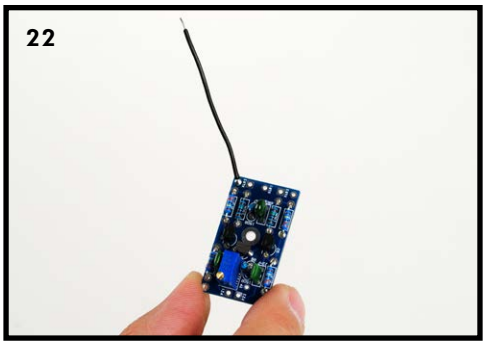




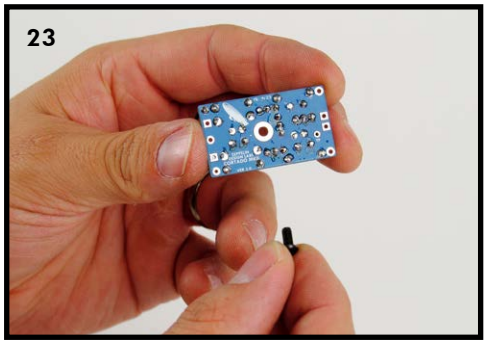
5. Grounding wire (Part #CB-01-30): Strip about ¼" off of both ends of the black grounding wire (20). Place one of the ends of the wire in one of the holes in the corner of the board (note the picture) (21,22). Solder the wire in place.

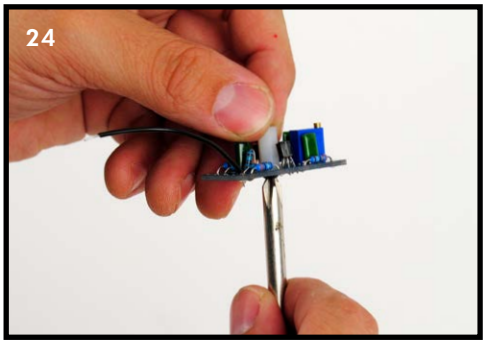


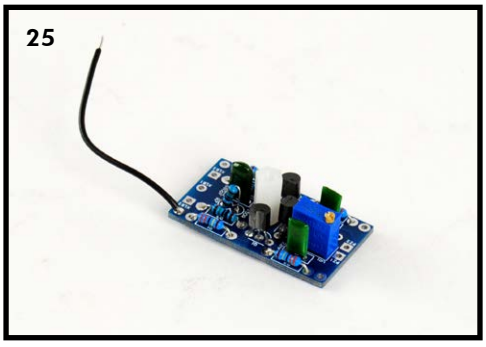




6. Use one of the black M3 screws to screw the standoff to the board. The standoff should be on the component-side of the board (23,24,25).







XLR JACK

All Cortado configurations use the same XLR cable.

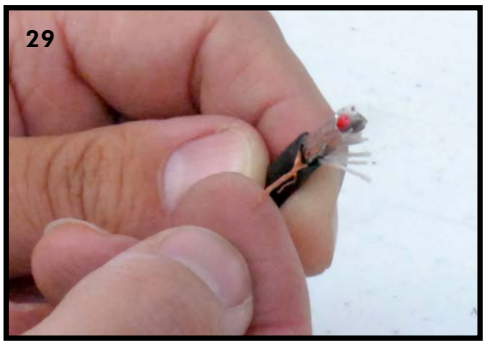
1. Prep the Mic Cable, part CB-20-30:

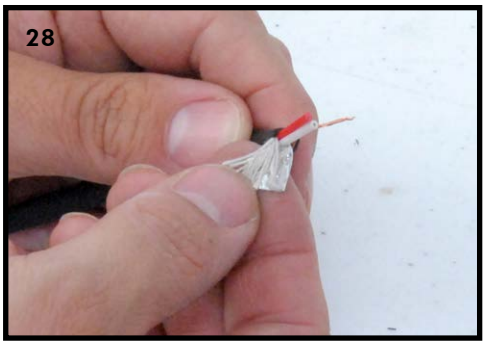
   a. Cut the mic cable into two pieces, about 18" (45cm) and 12" (30cm) long, or to suit your application (26). Note that if you are going to install the entire Cortado inside a shielding container, like a Tin Can Mic, you will only need one piece of mic cable.

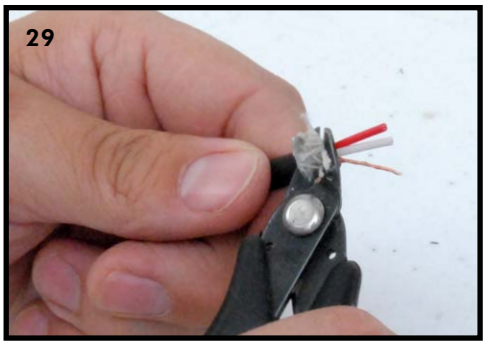
   b. Strip off about ½" (13 mm) of outer insulation from one cable-end. When stripping the outer insulation be careful not to cut too deep, or you will cut through the thin copper wires acting as the cable shield.

   c. Pull all of these copper shield wires to one side of the cable and twist them together (27).

   d. Pull the layer of foil and the cotton strings to the other side of the cable and cut all of them off with your snips (28, 29).



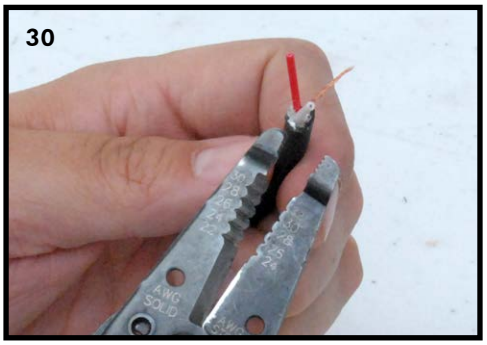


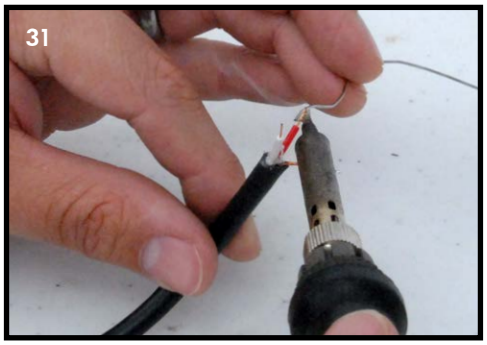


   e. Strip off about ⅛" (3 mm) from the white and red wires (30).

   f. Tin the twisted copper shield wire, the red wire, and the white wire (31).

g. Repeat Step 1a - 1f for the other three cable ends.

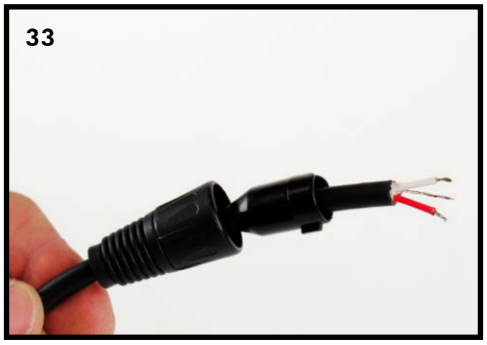




2. Disassemble the XLR jack (HD-40-30):

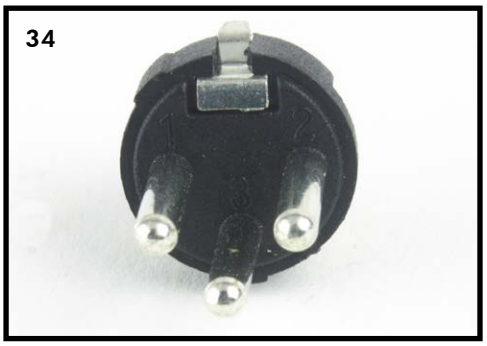
   a. Unscrew the tailpiece, remove the strain relief, and push the pins out of the housing (32).

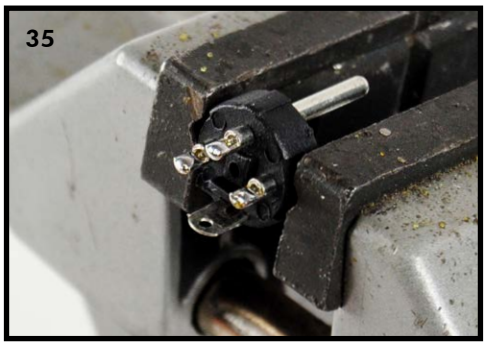
   b. Place the tailpiece and the strain relief onto the 12" (30cm) cable (33).



3. Solder the wires to the pin insert:

   a. Take a close look at the pin insert. Note how the pins are numbered (34). Mount the pin insert in a clamp if you have one, with the pins oriented so they appear as three troughs (35). Make sure to tin each pin on the XLR jack. If the trough seems hard to fill with solder, just find a single place on each pin that solder adheres to. It may help to use flux or a degreaser to clean the pin first.

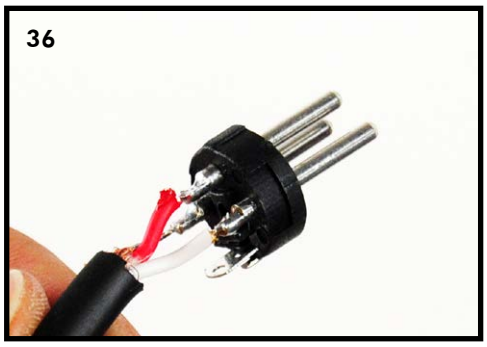


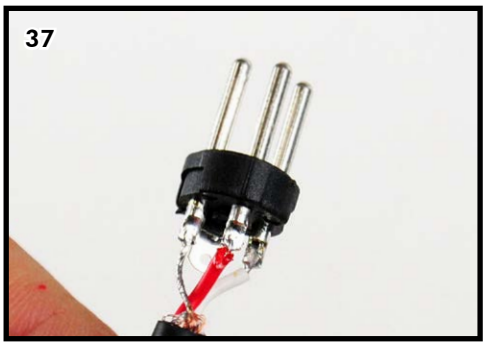


b. Solder the white wire to Pin 2 (36).

c. Solder the red wire to Pin 3 (36).

d. Solder the ground wire to Pin 1 (37).





4. Reassemble the Jack:

   a. Slide the strain relief up to the pin insert. Make sure the key on the insert is aligned with the key on the strain relief.

   b. Carefully line up the keys on the insert and relief with the slot in the housing–it is opposite the rectangular hole. Gently press the pin insert and strain relief into the housing (38). Be very careful not to disturb your nice new solder connections.

   c. Screw on the tailpiece (39).

You have completed all the steps that are common to all Cortado configurations. As you continue, look for the sections particular to your project: Standard contact Mic, Tin Can Mic, Instrument Pickup.

PIEZO DISC

From this point onward, sections of the manual are specific to your application.

If you are using the pre-assembled sensor upgrade you can skip this section. Continue with the FINAL ASSEMBLY on page 23.

The piezo disc and its connection to the circuit must be carefully shielded. The procedure is the same for the Standard Contact Mic and the Instrument Pickup: you attach the piezo to the remaining piece of mic cable, then wrap the piezo in electrical tape, and then copper tape.

You can also provide shielding by installing the whole Cortado into a grounded, conductive enclosure, as with the Tin Can Mic. In this case you attach the piezo to a fine wire, with no further shielding.

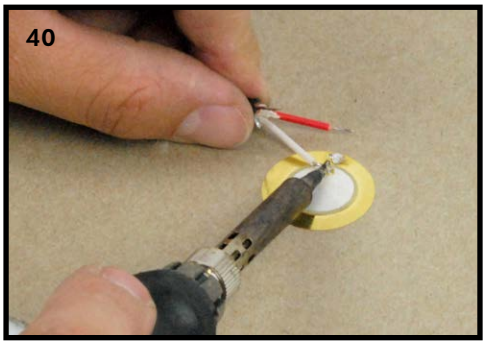
Now drop down to the section appropriate to your project.

STANDARD CONTACT MIC & INSTRUMENT PICKUP

Follow this section to prepare the piezo for use with either the Standard Contact Mic or Instrument Pickup.

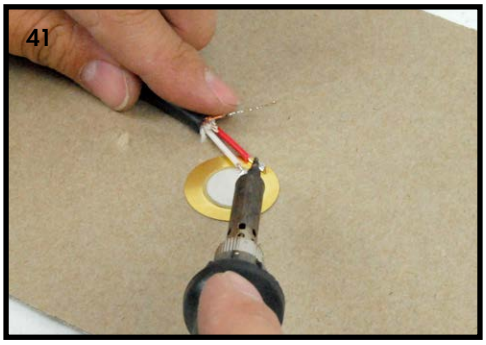
1. Solder the 18" (45cm) microphone cable to the Piezo disc (Part #TD-10-22): For your convenience, we have tinned the disc to make soldering easier.

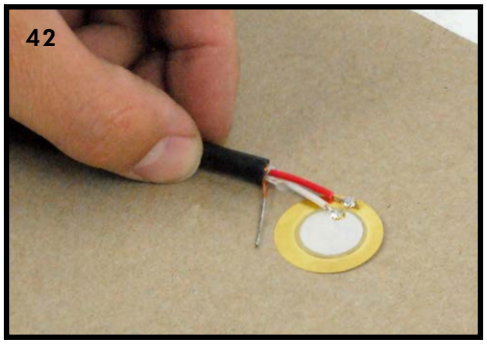
   a. Solder the white wire to the ceramic part of the piezo disc (40).



TIP: The best way to successfully solder wires to the disc is to lay the tinned wire on top of the tinned part of the disc and very quickly touch them together with the soldering iron.

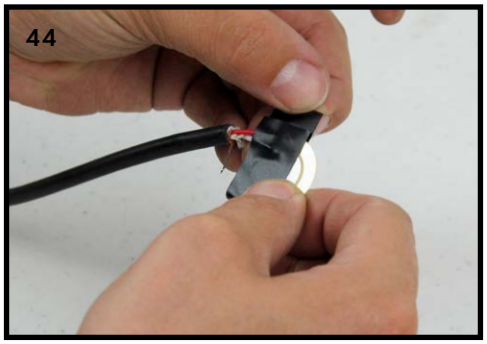
b. Solder the red wire to the brass part of the disc (41,42).

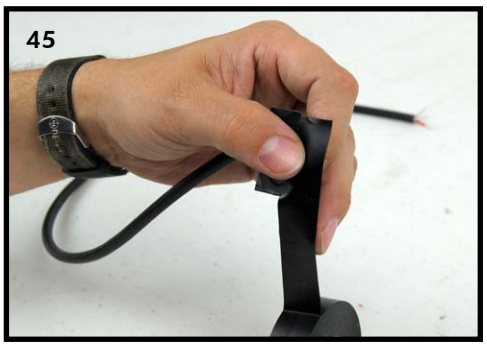




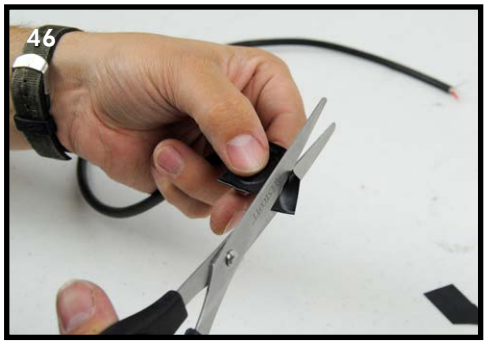
2. Now you need to electrically insulate the piezo disc. When we make Cortados in the lab, we use Plasti-Dip tool handle coating, but you can use electrical tape.

   a. Wrap the piezo disc in electrical tape (43,44). Keep the tape only one layer thick, especially on the back (the flat side) of the disc. Use two pieces of electrical tape butted side-by-side to wrap the disc (45).





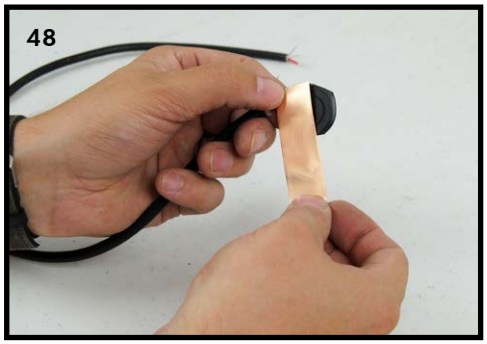
b. Use your scissors to trim off the excess tape to within about a millimeter around the edge of the disc (46,47).

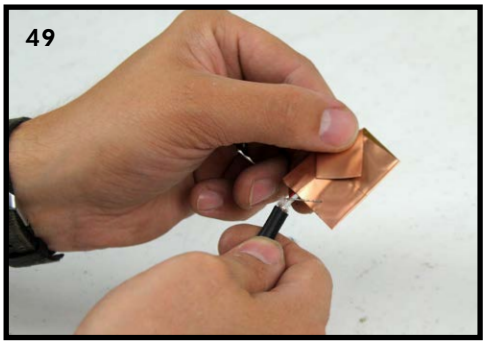


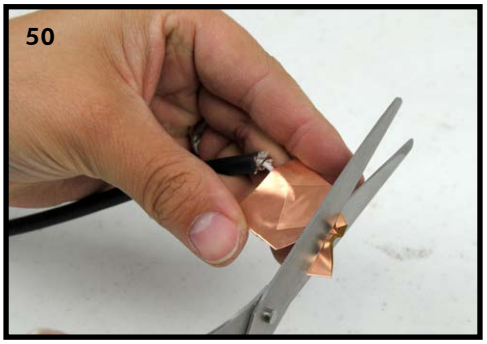
3. Shield with copper tape:

a. Cut two pieces of copper tape about 2-¼" long. Use one piece of copper tape to wrap the disc in a similar way as with the electrical tape (48,49). Once again, keep the tape only one layer thick on the back of the disc.

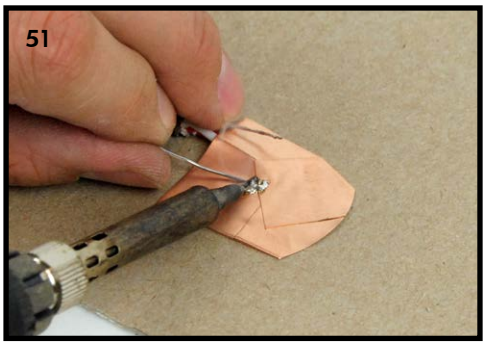
b. Trim off some of the excess copper tape around the disc (50), but make sure to keep a fold somewhere, to maintain a conductivity path all the way around the disc: the copper tape on the front of the disc must be electrically connected to the copper tape on the back side of the disc.

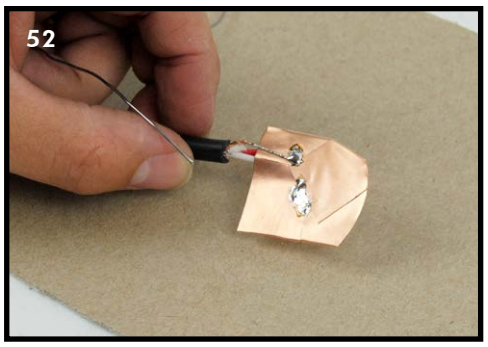


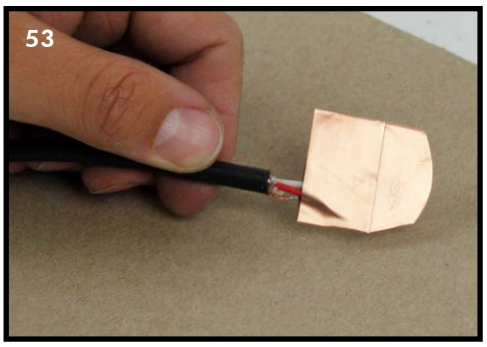




c. With as little heat as possible, solder the two pieces of copper tape together on the top of the disc (51). Also solder the shield of the microphone cable to the copper tape. Make sure the back of the disc remains flat so it can be mounted on a flat surface (52,53).





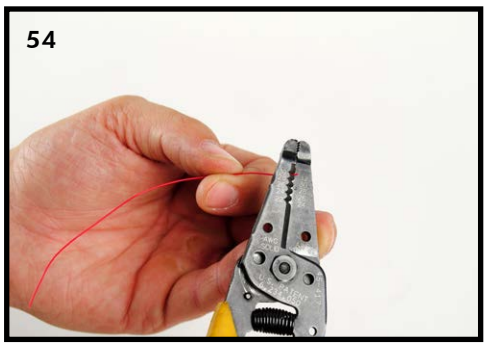


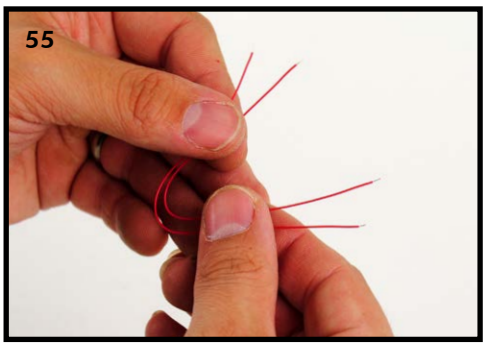
That's it! Move on to the FINAL ASSEMBLY chapter, and find the section specific to your project..

TIN CAN MIC, OR OTHER SHIELDING CONTAINER

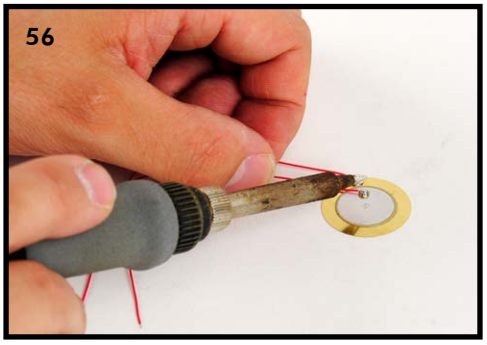
If you are building a ZDL Tin Can Mic, you should follow our Instructable from here on out. Follow this section if you have your own Tin Can Mic design in mind, or if you are going to incorporate the Cortado into some other conductive shielding container. In this situation, since the cable between the piezo and PCB does not need its own shielding, we use a very lightweight wire. This may improve response, and also makes it easier to install.

1. Cut the red wrap wire (CB-01-69) into two 6" pieces (if it's not already that length). Strip about ⅛" (3mm) off of each end of each wire (54, 55).





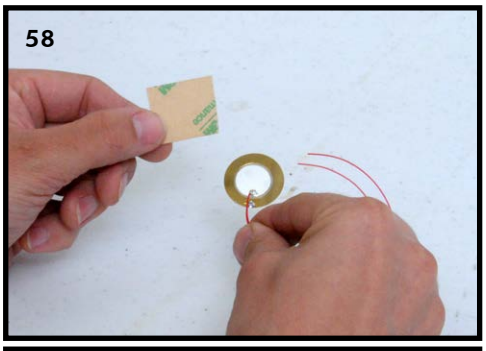
2. Solder the wires to the piezo disc (56). The ceramic part of the disc is very sensitive to heat and can be tricky to solder to. For your convenience, we have tinned the disc to make soldering easier.

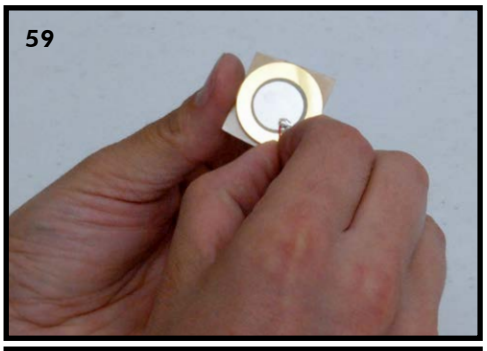


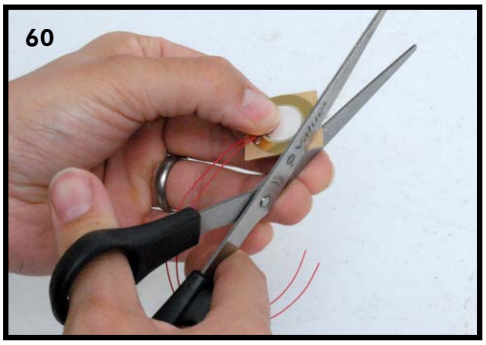
TIP: The best way to successfully solder wires to the disc is to lay the tinned wire on top of the tinned part of the disc and very quickly touch them together with the soldering iron.

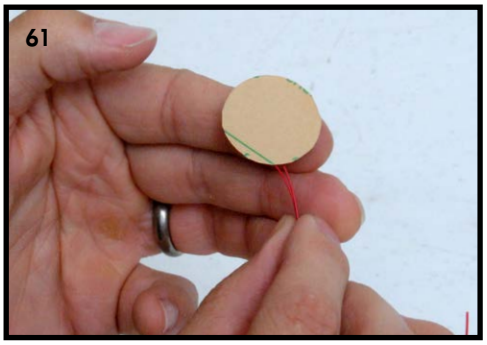
3. Clean all the finger oil and other contaminants from the bottom of the disc with rubbing alcohol and a rag or paper towel (57). Make sure you don't touch the surface you just cleaned!

4. Place the double sided tape on the bottom of the piezo disc (58,59). Make sure it covers the entire bottom surface. Trim off the overhanging excess with scissors (60,61).









5. Gently Twist the wires of the disc together.

FINAL ASSEMBLY

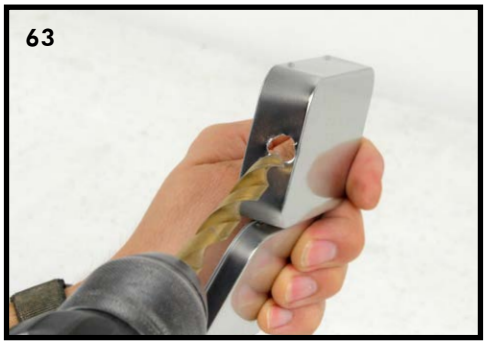
Jump to the section appropriate to your project.

STANDARD CONTACT MIC

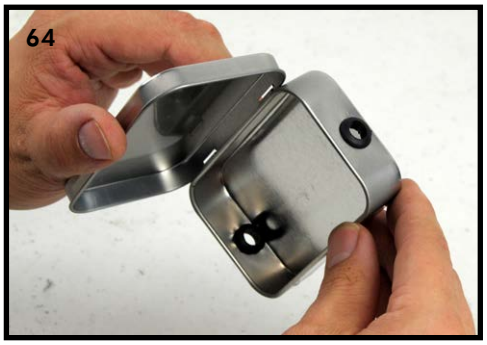
1. Prep the container:

   If you are using the standard, stock piezo sensor drill a 3/8" (10mm) hole on both ends of the metal tin, 17/64" (7mm) up from the bottom. (62,63) This is more likely to be successful if you start with a smaller bit and re-drill a few times with progressively larger bits.
   If you are using the pre-assembled sensor upgrade drill one 3/8" (10mm) hole on one end of the can (for the XLR cable) and one 1/4" hole on the other end of the can (for the sensor cable). Drill both holes 17/64" (7mm) up from the bottom edge.


62


63

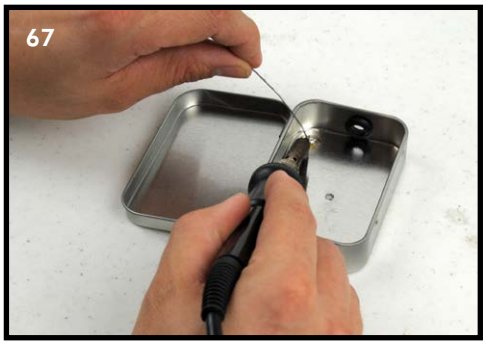
a. Place the grommets in each hole (64). If you are using the sensor upgrade, obviously place the correctly sized grommet in each hole.


64

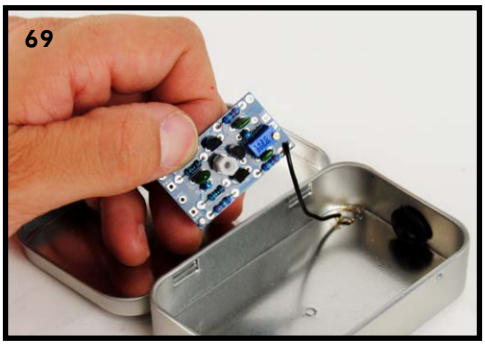
b. Drill a 9/64" (3.5mm) hole in the bottom of the tin, roughly in the middle (65,66).

2. Attach the grounding wire:

a. Use a bit of sandpaper or your flat head screwdriver to scratch up a tiny patch in the corner of the can. With your soldering iron, tin this area (67).

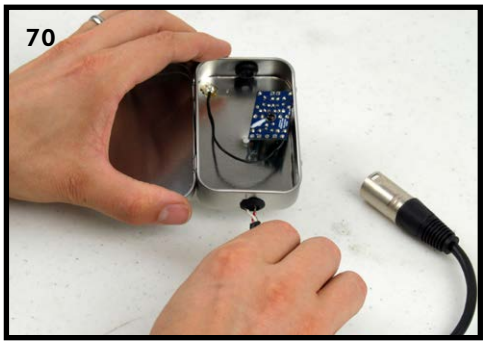


b. Solder the ground wire to the tinned area (68,69).

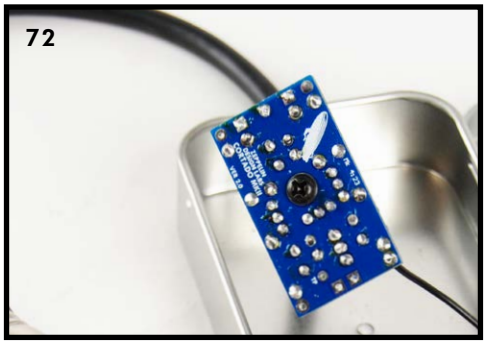


3. Attach the cables to the PCB:

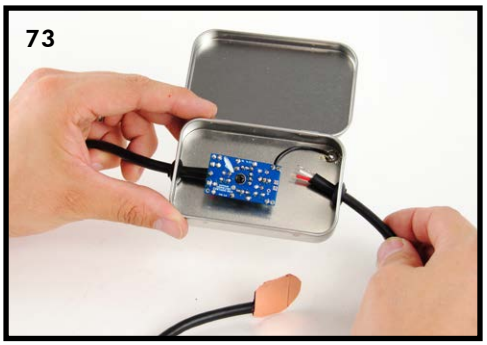
   a. Pinch together all three wires at the end of the XLR cable, and slide the cable through the grommet from the outside of the tin (70).

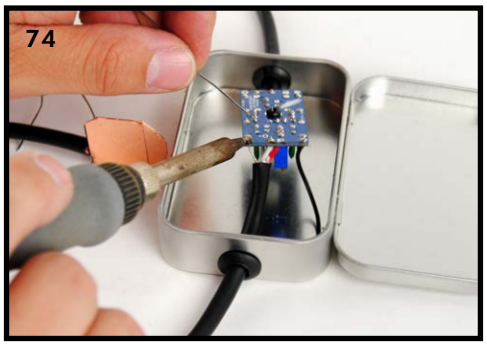


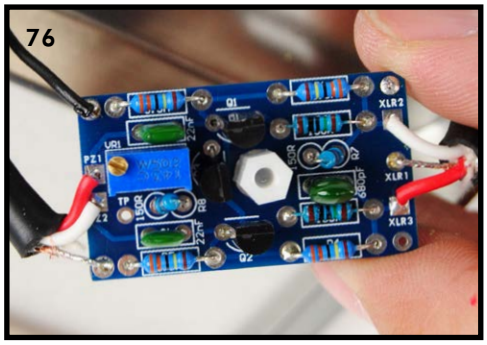
   b. Solder the XLR cable to the PCB (71,72,76). The red goes to the hole labeled XLR3 and the white wire goes to the hole labeled XLR2 The copper shield wire goes in the round hole labeled XLR1.



   c. Slide the piezo disc cable (or sensor upgrade cable) through the other grommet (73). Solder the red wire to the hole labeled PZ1. Solder the white wire to PZ2. Solder the shield of the cable to ground: use one of the holes in the corder of the circuit board closest to either R2 or R7. Use whichever hole doesn't have the ground wire installed in it (76).



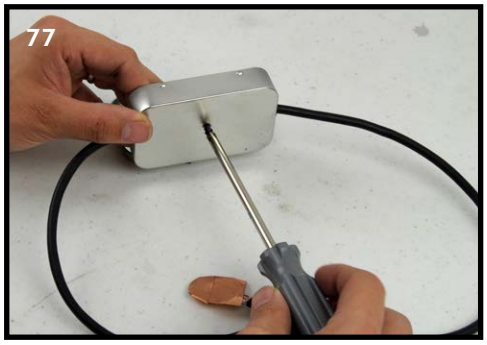




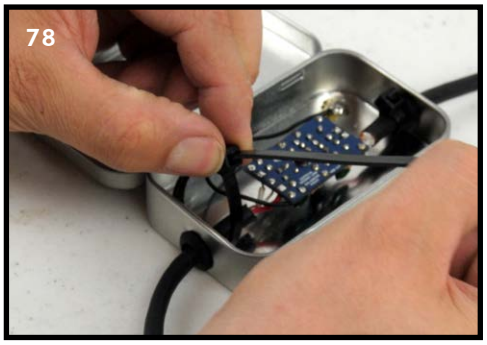
4. At this point take a break from assembly, and set the bias by following the steps in the section "SETTING THE BIAS" on page 32. After the bias is set, continue on from here to the end of the section.

5. Install the PCB into the metal can:

   a. Screw the PCB stand-off to the metal can via the hole in the bottom of the can (77).



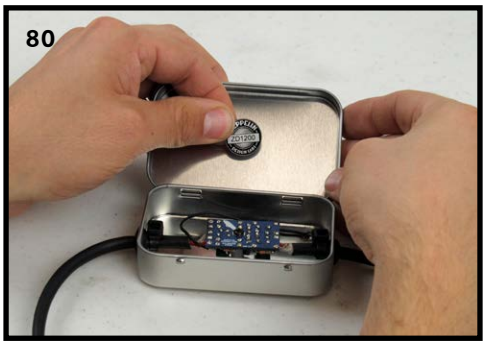
   b. Fasten the zip ties around each of the cables on the inside of the tin (78). This acts as a strain relief and protects the solder connections. Press the tie snug against the can interior, and pull the tail as tight as it will go (78). Trim off the tail with your snips (79).



6. Add stickers:

   a. Clean the lid of the can, inside and out, with alcohol.

   b. Place the serial number sticker on the inside of the lid (80,81).



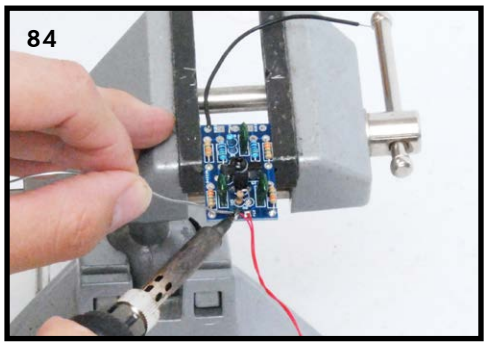
   c. Place the Cortado Label sticker on the top of the box (82,83). Your Cortado Standard Contact Mic is done!

TIN CAN MIC, OR OTHER SHIELDING CONTAINER

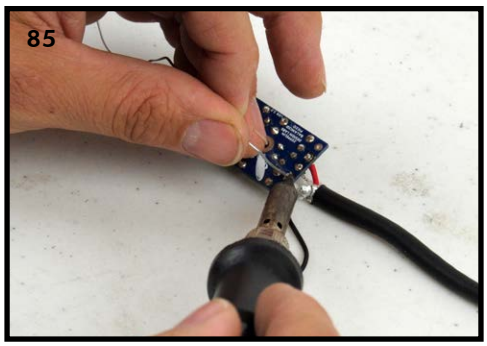
If you are making the ZDL Tin Can Mic, you should be reading our Instructable from this point on.

When the entire Cortado is installed inside a grounded shielding container, like a tin can or garbage pail or steel sculpture, it does not require additional shielding.

1. Solder the piezo disc wires to the PCB. Use a multimeter/continuity tester to identify the wire attached to the brass part of the disc, and solder this to the hole labeled PZ1 on the PCB (84). Solder the wire attached to the white ceramic part of the disc to PZ2.



2. Solder the XLR cable to the PCB (85). The red goes to XLR3. The white wire goes to XLR2. The copper shield wire goes to XLR1.

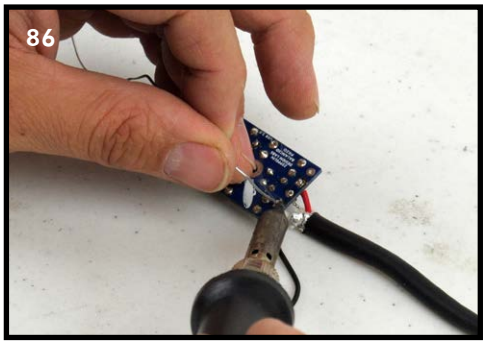


It's time to set the bias, so please turn to "SETTING THE BIAS" on page 32. Once the bias is set, your Cortado is complete, and ready to install inside your shielding container. This can be made of anything that conducts electricity. You must connect the grounding wire to the container itself; the PCB must NOT touch the container. If necessary, insulate it with electrical tape, or mount it with the standoff provided.

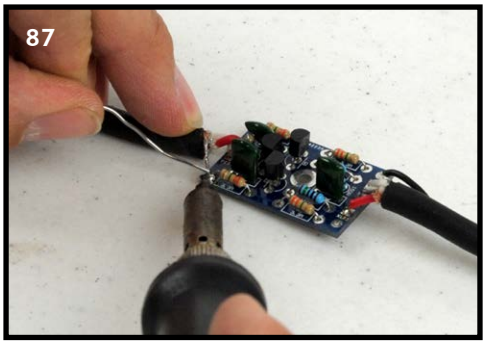
INSTRUMENT PICKUP

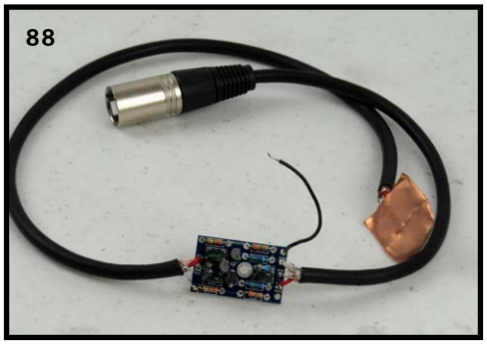
To permanently install your Cortado inside a musical instrument, or a non-metallic sculpture or art installation, you may use the copper tape instead of the metal can to shield the PCB. This will keep the over-all size of the Cortado small and easy to tuck inside a sound hole or instrument body. Unscrew the standoff from the PCB.

1. Solder the XLR cable to the PCB (86). The red wire goes to the hole labeled XLR3. The white wire goes to XLR2. The copper shield wire goes to XLR1 (88).



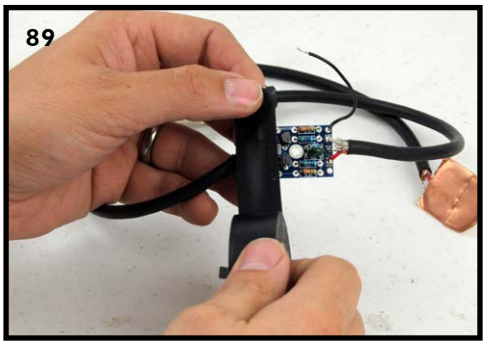
2. Solder the piezo disc cable to the PCB. The red wire goes PZ1. The white wire goes to PZ2. Solder the shield of the cable to ground: use a pad in one of the corners of the PCB. Use whichever is closest (87,88).

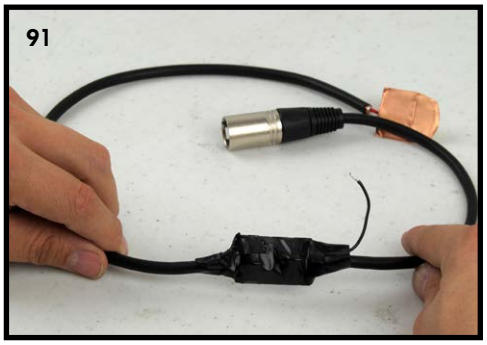




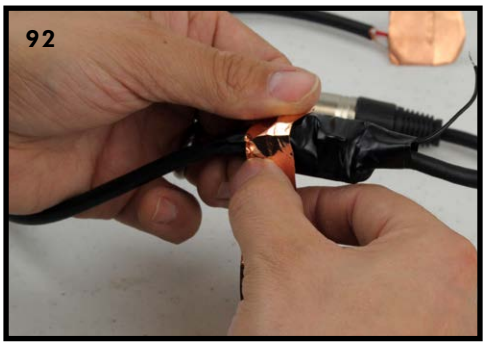
3. At this point take a break from assembly, and set the bias by following the steps in the section "SETTING THE BIAS" on page 32. After the bias is set, continue on from here to the end of the section.

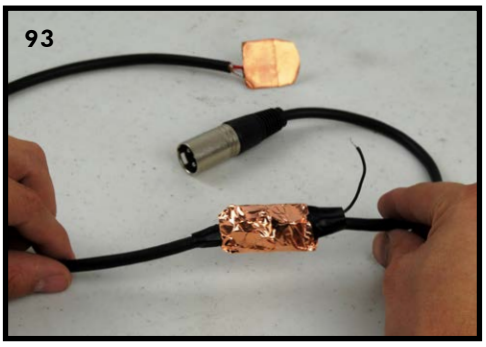
4. Wrap the entire PCB and exposed cable wires in electrical tape (89,90,91).





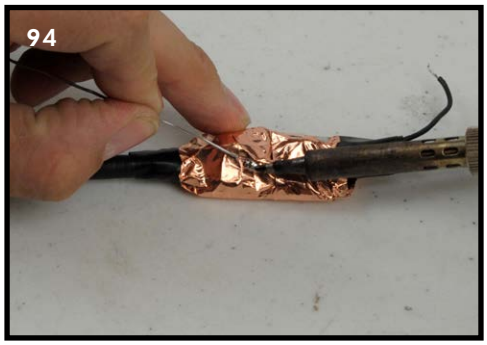
5. Very carefully remove the backing from the remaining piece of copper tape. Very carefully wrap the copper tape around the circuit board. The goal is to encase as much of the circuit board as possible. It may be easier to handle the tape if you cut it into two equal lengths (92,93).

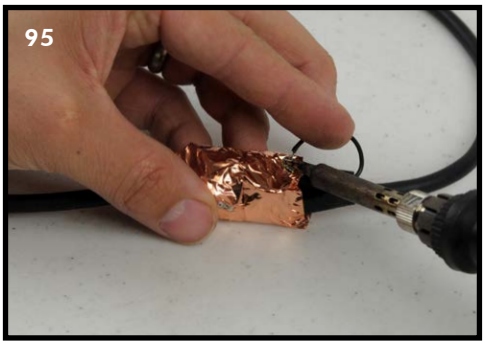




6. If you cut the copper tape into two pieces, put a solder joint spanning the edge of the two pieces so they will be electrically connected (94).

7. Solder the ground wire anywhere on the copper tape (95). When soldering the copper tape make sure you don't use too much heat which could melt the electrical tape under the copper.





The copper shielded electronics of the Cortado can be anchored to the inside of the instrument with Velcro®. The disc should be mounted to a flat, resonating surface inside the instrument, such as the sound board of an acoustic guitar. Experiment with placement by using a temporary adhesive such as sticky-tack, or poster putty. When you find the sweet spot, permanently attach the piezo with epoxy.

An alternate way to permanently wire the output of the Cortado is to replace the XLR jack with a balanced female end-pin jack installed through the body of the instrument. You can plug the instrument into a sound system using a ¼" TRS male to XLR male cable, in order to supply phantom power to the circuit.

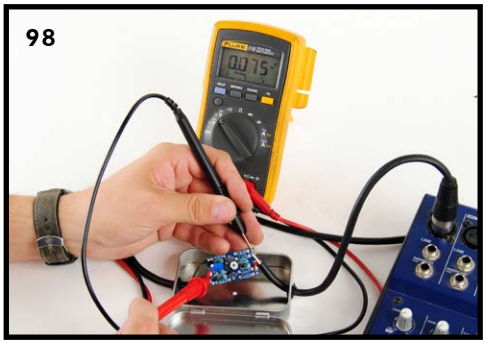
SETTING THE BIAS

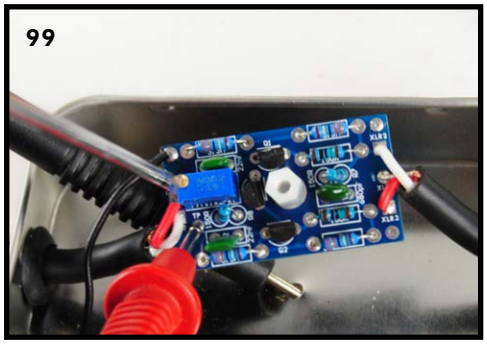
In setting the bias of your Cortado MKII, you are simply adjusting the amount of nominal current that is passing through the FETs, Q1 and Q2. The more current that passes through the FETs, the more gain the circuitry will have on the signal from the piezo disc. But on the other hand, the more gain the circuit has, the more the small differences in the matched FETs will be magnified. The result is less common-mode rejection and thus a slightly higher noise floor. So we are seeking a balance between output volume and noise rejection. We found these FETs can work well with a wide range of bias voltages between .2mA and 1mA.

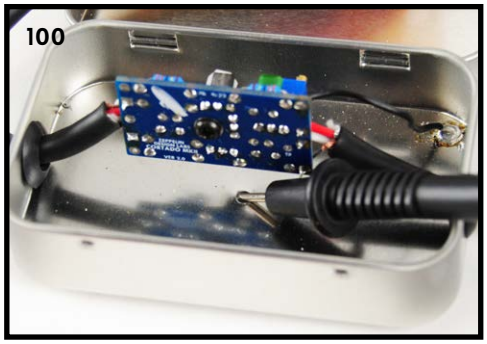
Follow these steps to set the bias on your Cortado MKII:

1. First, you need to supply power to the Cortado by plugging the XLR jack into a mixing console or other phantom power source (such as the Espresso, by Zeppelin Design Labs).

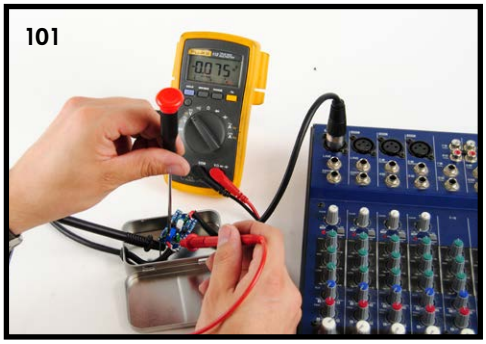
2. With phantom power applied to the circuit, use your multimeter to measure the DC voltage across TP (test point, marked red on Figure 3) and ground (98.99). Make sure that the solder joints on the PCB don't short against the tin container. A convenient ground point to put your meter probe is through the hole in the bottom of the container (100).







3. If you are using the standard, stock piezo sensor, turn the trim pot (VR1) until the voltage on TP is .075V (101). This will set the bias current to .25mA per FET. If you are using the pre-assembled sensor upgrade, set the voltage on TP to .2V, which corresponds to .67mA per FET.



4. Now you just need to listen to how it sounds. Stick the piezo to something and listen. If you'd like more gain turn VR1 (clockwise), so that the voltage on TP is slightly higher. Do not set TP higher than 0.3V, which corresponds to 1mA going through each FET.

USING YOUR CONTACT MICROPHONE

There are about as many applications for the Cortado as there are sound sources in the world. Please read this section carefully to learn how to get the most from your contact mic and how to use it properly. With some basic supplies and a little creativity your Cortado contact mic should give you years of great service.

MOUNTING

One of the most important things to know when using piezoelectric devices is how to mount them to obtain the best pickup. If your piezo disc is mounted incorrectly most likely it will have a very narrow bandwidth (meaning it won't pick up a wide range of frequencies), have a low signal to noise ratio, and in a worst-case scenario, get damaged. Piezo electric devices pick up the best when they are very tightly coupled to a vibrating surface. The more securely mounted they are, the better. The best place to mount the piezo disc is on a smooth, flat surface, where the surface area of the disc can make the most contact with the vibrating material. The double-sided tape provided with your kit is excellent for permanently installing the disc on a flat sound source. If non-permanent installation is required, then just taping the piezo disc to a sound source with painter's tape also works sufficiently; just make sure it can't rattle or vibrate against the surface and it is held securely. Sticky-tack (the stuff used to hold posters on the wall) also works well for non-permanent installations. If you need to mount it on a round or uneven object a plastic clamp works well, but do not allow the piezo disc to bend at all; this will damage the disc. The disc is rather fragile and the ceramic element can crack if it is not handled carefully.

The circuit board is intended to be mounted inside a shielded enclosure, such as the tin can furnished with the kit. However, any conductive container to which you can attach the ground wire will work, such as a tuna can or soup can. A die-cast aluminum box (like the Hammond 1590 series) would also work well as long as you can figure out a way to attach the ground wire (such as a solder lug attached via a nut and bolt). The PCB is easy to mount with the stand-off and the two screws it comes with, but it's not necessary to use them. If the container you use is too small to mount the board via the standoff, it is possible to just wrap the board in electrical tape and leave it floating (not anchored to anything). In the container you use, you must drill two ⅜" holes for the XLR cable and piezo disc cable. Two rubber grommets are provided in the kit for mounting in the holes around the cables. Two zip ties are also provided in the kit to tie around the cables on the inside of the container to provide strain relief.

USING MULTIPLE MICS AT ONCE

Some applications may require more than one contact mic being used on the same source. This works very well for many musical instruments particularly stringed instruments and pianos. The main thing to be mindful of in these situations is the phase of each microphone. In most situations the relative phase of all mics should be the same. This means that a positive impulse from the sound source will be picked up as a positive (not negative) signal from all the microphones. If you followed these assembly instructions properly, then any Cortado you build should be in the same relative phase.

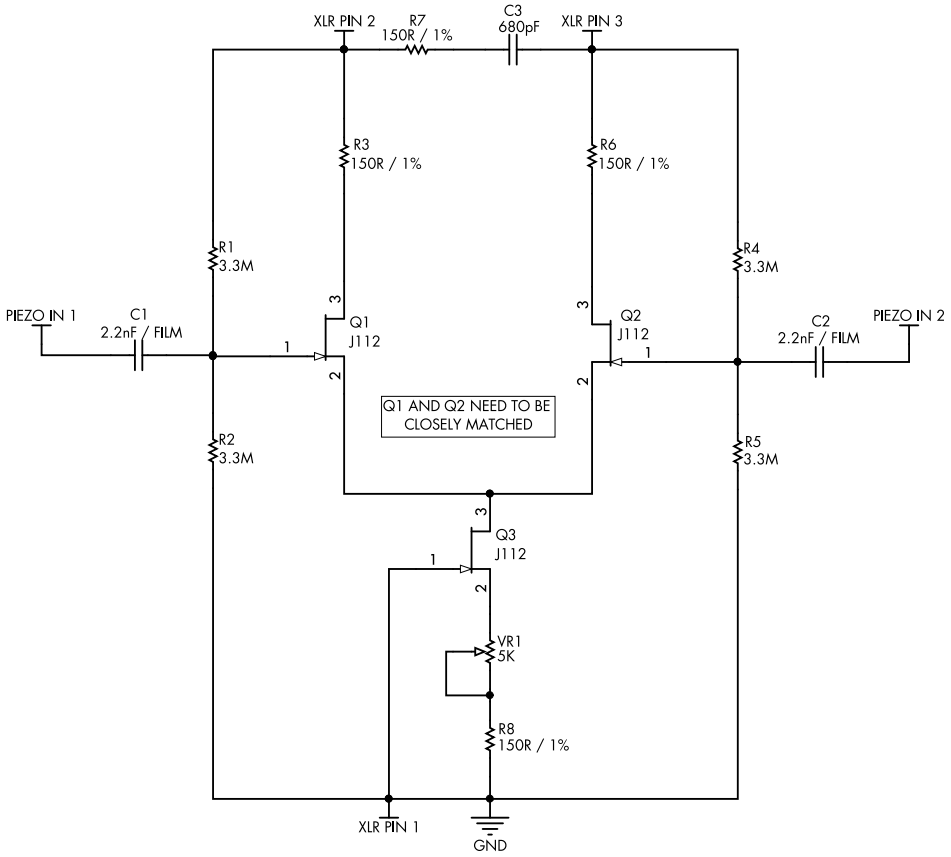
In some cases you may want to invert the phase of one of the microphones. One example of when you might want to do this would be when you use two mics on opposite sides of a vibrating plane, such as an acoustic guitar soundboard. With one mic on the bottom (inside the body) of a guitar soundboard, and another mic on the top (outside the body) of the soundboard, these mics should be out of phase with each other. This can be accomplished by reversing the two piezo disc conductors (the red and white wires in PZ1 and PZ2) on only one of the mics. But manually reversing these wires may not be necessary if the equipment you are using has a phase switch.

A WORD ABOUT CABLES

In some cases you may find it useful to extend the distance between the piezo pickup and the circuit board. This is possible by replacing the 18" cable with a shielded balanced cable of your desired length. The maximum cable length that you can use without experiencing signal degradation will depend on the quality of cable used, but in most cases it should easily be over 100 feet. The length of the XLR cable could also be extended, theoretically even further than the piezo cable (assuming it is connected to a good quality receiving circuit). One of the main things to keep in mind when using long balanced cable lengths is the quality of the shielding. Only use cable that has a tight shield. The more area the shield covers around the internal wires, the better.

PHANTOM POWER

The Cortado microphone circuitry does need power to operate. This is provided through phantom power via pins 2 and 3 of the XLR jack. The circuit works best at 48Vdc phantom power, but can function with much less voltage. It is not recommended to use less than 18Vdc or the mics headroom will be too low for most applications. If the device you are plugging the microphone into doesn't provide phantom power then you need to use an external phantom power supply (available at most pro-audio stores). Zeppelin Design Labs is currently developing an external phantom supply DIY kit which should be available soon.



Title:	**CORTADO MKII** BALANCED PIEZO CONTACT MIC		
Size: A	Engineer: Brach	Revision: 1.0	
Date: 8/23/2016		Sheet 1 of 1	

ZEPPELIN DESIGN LABS
2950 N. WESTERN
CHICAGO, IL 60618
USA
ZEPPELINDESIGNLABS.COM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