How To Build A Fuzz E-One

By Steve Daniels, President, Small Bear Electronics LLC

What Is The Fuzz E-One?

The Fuzz E-One is a clone of the famous Gibson/Maestro FZ-1A, the “Satisfaction” fuzz. It uses old-stock, matched germanium transistors to nail that raspy, 60s-70s tone, but has the features that let it play gracefully on a modern pedalboard: negative-ground power, a DC power jack, true-bypass switching and an in-use LED.

This manual contains complete instructions for building the pedal, and it is written to guide people who have never built a pedal before. (Experienced hobbyists note: You can skip sections as you need to.) I don't presume that you know any electronics, but you do need some skill with hand tools and I don't cover in here how to solder; more about these issues in the next section. That said, much of the information and many of the techniques shown here are applicable to building *lots* of other pedals, and even other electronic devices.

I know that you'll enjoy building--and playing through!--the Fuzz E-One. While I've done my best to make these instructions complete, I'm available by E-mail if you have questions, problems or suggestions.

Yours In Good Music,

Small Bear Electronics LLC
123 Seventh Avenue # 156
Brooklyn, NY 11215
Http://www.smallbearelec.com
Smallbearelec@ix.netcom.com

Can I Really Build It Myself?

Yes, IF:

- You can follow directions.
- You are comfortable with using basic hand tools.
- You can solder well.

The kit includes a precision-drilled enclosure that eliminates most tooling. I will show you in this manual, step-by-step, the assembly, painting and decal-application procedures that I used. If you have never soldered before, you may need to check out some how-to information on-line about that, and maybe practice a little before tackling this kit. Which brings me to:

What Tools And Materials Will I Need?

You don't need a drill. However, installing the board in the enclosure is easier if you have a Dremel, or similar, rotary tool, or have access to one that you can borrow. You will also need:

A 25- to 35-watt soldering iron, rosin-core solder, cleaning sponge and de-soldering braid.

NB: Yes, a Radio Shack iron will do, if the tip is relatively new and well-tinned. The big problem with very inexpensive irons is that the tips aren't properly clad and so corrode quickly.

Small screwdriver
Small chain-nose plier and side-cutter
Small locking-grip ("Vise-grip") plier
X-acto or similar knife
Self-locking tweezers or other "third hand"
A small round file and small flat file
A pointed steel "pick" or scratch awl
A Sharpie Marker

The case is drilled, but not painted, so you will need materials for finishing—carborundum paper, spray primer, spray enamel and Acetone. Sealing the decal (included in the kit) requires a clear, spray lacquer like Krylon. You will also need a little epoxy cement for securing the battery snap to the enclosure.

- **Identify The Components**

5% Tolerance Carbon Film Resistors

The values are in Ohms. The first two colored bands define the base number. The third band is the number of zeroes to add, and the gold fourth band indicates 5% tolerance.

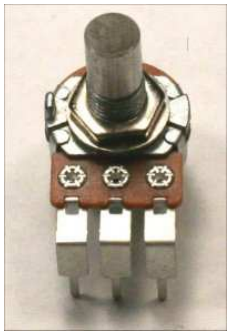
Value		How Many?
1,000,000 ohm or 1 Megohm (Brown, Black, Green, Gold) 1 0 + 5 zeros		1
10,000 ohm (or 10 K ohm) (Brown, Orange, Black, Gold)		**1**
100,000 (or 100 K ohm) (Brown, Black, Yellow, Gold)		**1**
470,000 (or 470 K ohm) (Yellow, Violet, Yellow, Gold)		1
2,200 ohm (or 2.2 K ohm) (Red, Red, Red, Gold)		1
22,000 ohm (or 22 K ohm) (Red, Red, Orange, Gold)		1
4,700 ohm (or 4.7 K ohm) (Yellow, Violet, Red, Gold)		**1**
100,000,000 or 100 Megohm (Brown, Black, Violet, Gold)		1

The above resistors are required for all builds. If you bought the kit, four additional resistors will come with the set of matched transistors. If you are using your own transistors, you will have to determine the correct values for those resistors. There is information on how to do this in the build-it article for the perfboard version of the pedal.

http://www.smallbearelec.com/Projects/FuzzE-One/FuzzE-One.htm

Potentiometers

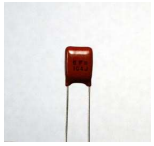
This style has pins that solder directly to the PC board.



	Quantity	Marked
50K Audio	1	A50K
50K Linear	1	B50K

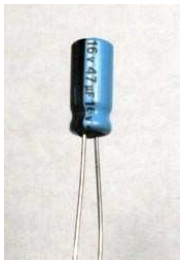
Capacitors

Metallized Polyester Film (Have no polarity)



	Quantity	Marked
.01 mf. (microfarad or µf.)	1	103
.0033 mf.	1	332

Radial Electrolytic (These are polarized; the black band marks the negative side.)

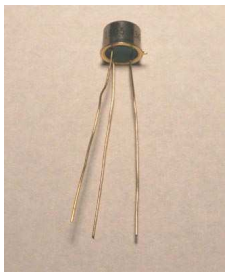


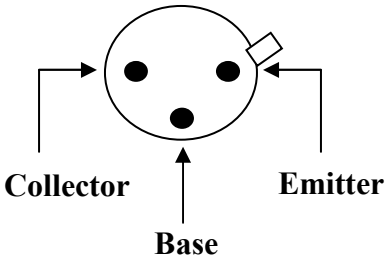
	Quantity
1 mf.	2
100 mf.	1

Transistors

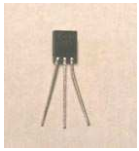
The matched germanium transistors supplied with the kit may be in metal or glass cases, and may be any of several styles. The most common is the TO-5, and the legend on the PC board indicates where the metal tab on the case must be positioned.

Many European types have the three leads side-by-side, and a red dot on the case indicates the Collector. The Base is then in the middle, and the Emitter on the left.





The MPSA14driver transistor for the in-use LED comes in a plastic case called TO-92 style. The flat side of the case will be oriented according to the silkscreened legend on the PC board. Left to right, the leads are Emitter, Base, Collector



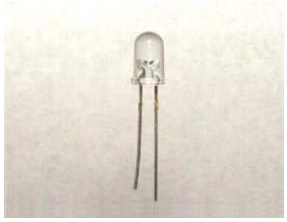
Diodes

The band on the case indicates how they should be oriented on the PC board.

	Quantity
1N5818	1
4.7 Volt Zener	1
1N914	**3**

LED

Note that one lead is longer than the other. That marks the positive side.



Jacks

This build uses board-mounted, ¼" diameter jacks, stereo for the input and mono for the output. The DC power jack is also board-mounted.

Stomp Switch

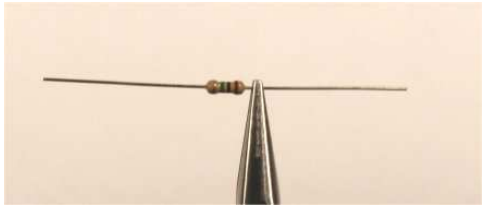
Battery Snap

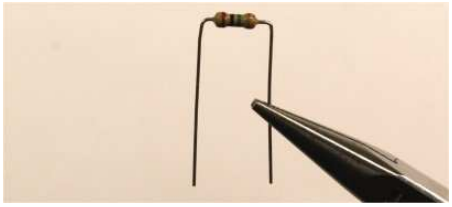
You should also have: Rubber feet, knobs, the PC board, the enclosure and a decal. If you have all the parts and materials, the next step is assembling the PC Board.

Stuffing The Board

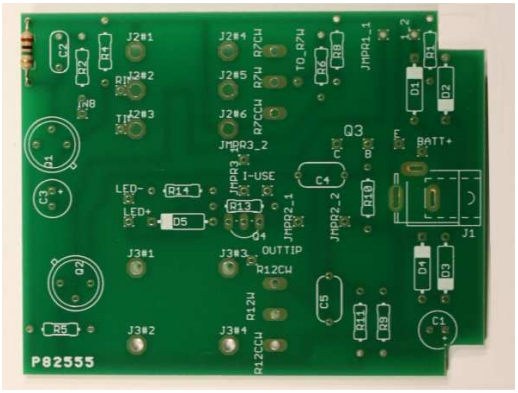
That's what we call the process of mounting components on the printed circuit board (PC board) and soldering them in place. While the order in which the parts are mounted won't affect the audible result, it's convenient to mount small parts first, and finish with the pots and jacks. Heat up and tin your soldering iron, wet your cleaning sponge and let's begin, starting with the resistors. Find resistor **R3 (1 Meg = Brown, Black, Green, Gold.)**

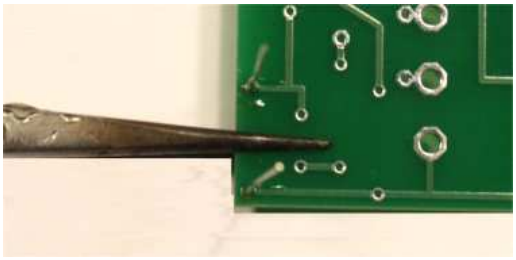
Using a chain-nose plier, grab one lead of the resistor about 1/16" from the body. Bend the resistor lead sharply downward at right angles to the body of the component. Then do the same with the other lead:



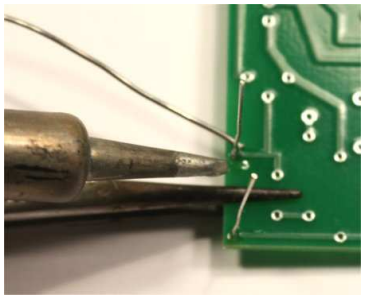


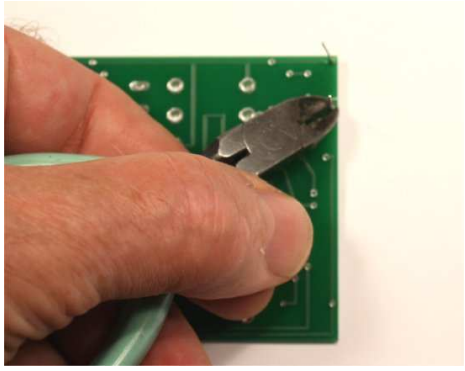
Look for the silkscreened legend "R3" on the PC Board, and insert the resistor into the appropriate holes. (Resistors have no polarity and can go in either way.) Hold it in place temporarily with self-locking tweezers.





Solder in place on the bottom of the board and trim the leads closely with side-cutters:

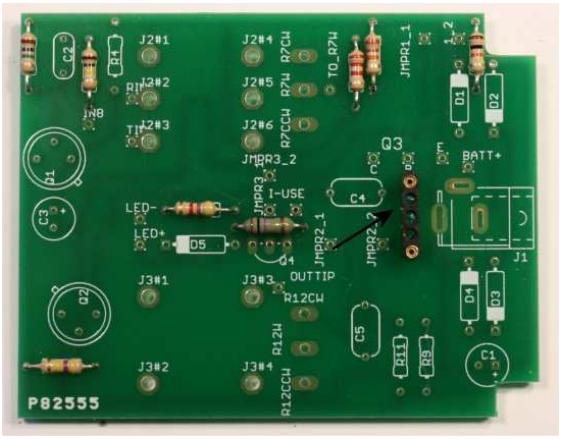


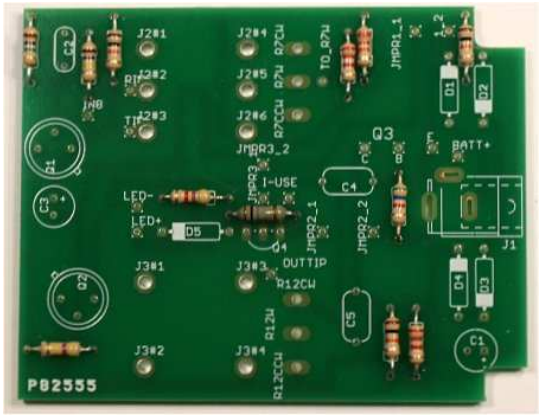


In similar fashion, form the leads for these resistors and solder them in place:

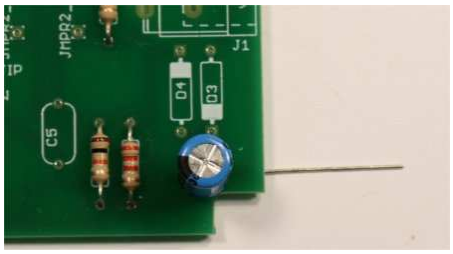
R2 (100K = Brown, Black, Yellow, Gold)
R5 (470K = Yellow, Violet, Yellow, Gold)
R6 (2.2K = Red, Red, Red, Gold)
R8 (22K = Red, Red, Orange, Gold)
R13 (100 Meg = Brown, Black, Violet, Gold)
R14 (4.7K = Yellow, Violet, Red, Gold)
R1 (10K = Brown, Black, Orange, Gold)

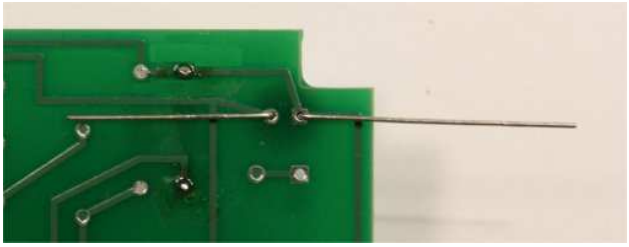
Now install the four resistors that are specific to the transistors you are using. In the schematic, these are R4, R9, R10 and R11. If you bought the PC board only, you may want to install single-in-line socket material in these locations as shown in the left-hand pic. The correct resistor values can then be determined later during setup. The right-hand pic shows the board with all resistors installed.





Capacitors come next. Start with C1, which is a **100 mf. electrolytic**. The side with the black band goes to the left. To hold it in place for soldering, it is OK to press the body close to the board on top and bend the leads flush to the board on bottom:

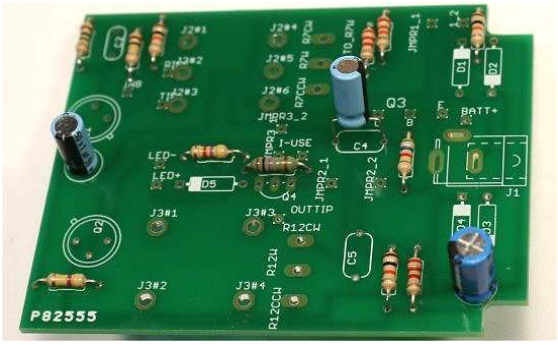


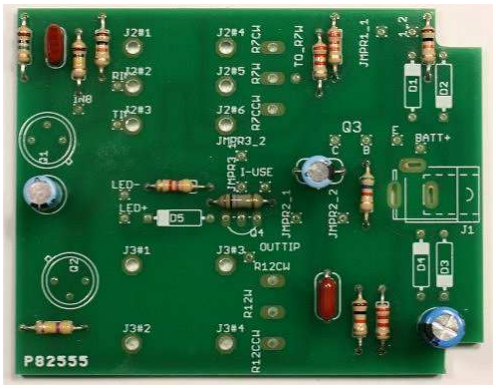


Trim the excess lead length when you are done soldering.

Follow with C3 and C4, the 1 mf. electrolytics. Again, observe the polarity markings; the negative side of C3 (black band) faces Q2. The leads for capacitor C4 must be formed to span its outline, and the side with the black band is close to the Base (B) of transistor Q3.

Finish the capacitors by adding the poly films. C2 is .01 mf. (marked 103) and C5 is .0033 mf. (marked 332). These are not polarized and so can go in either way.

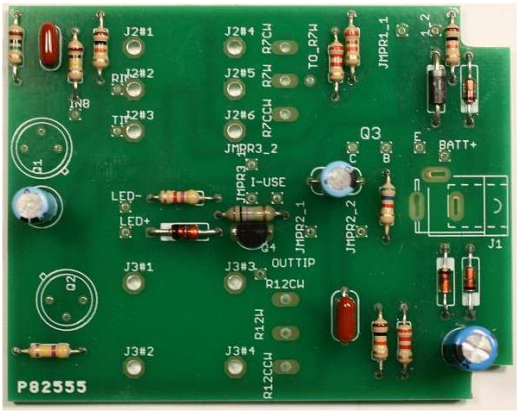


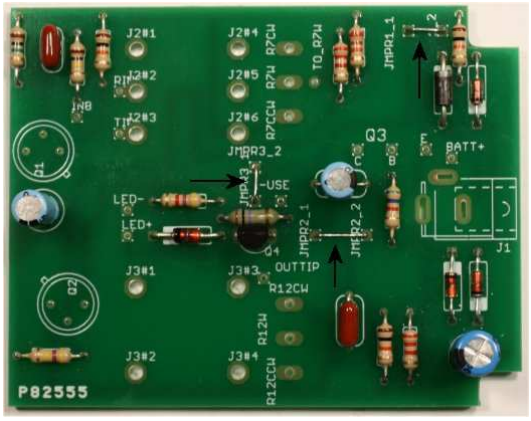


Diodes come next. There are three 1N914s (small glass body) and one 1N5818 (black or blue body) in the voltage regulator, and a 4.7 volt zener (glass body) in the LED circuit. Form leads and solder all in place, making sure that the bar on the body of each diode is aligned with the bar in the corresponding outline.

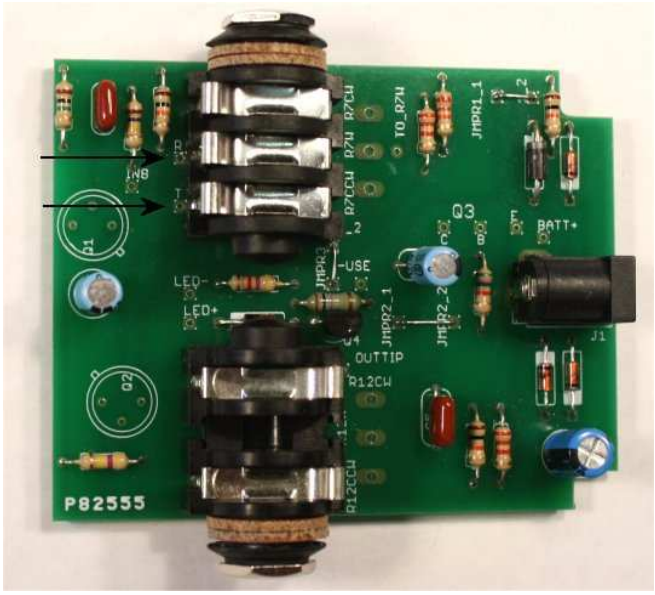
Add the driver transistor for the LED, aligning the flat side of its package with the outline. This one is silicon, and it will tolerate normal soldering heat without special precautions. The left-hand pic shows where we are.

This layout requires three bare-wire jumpers. Make these from the wire scraps left from when you trimmed the resistors and solder at the points shown in the right-hand pic.

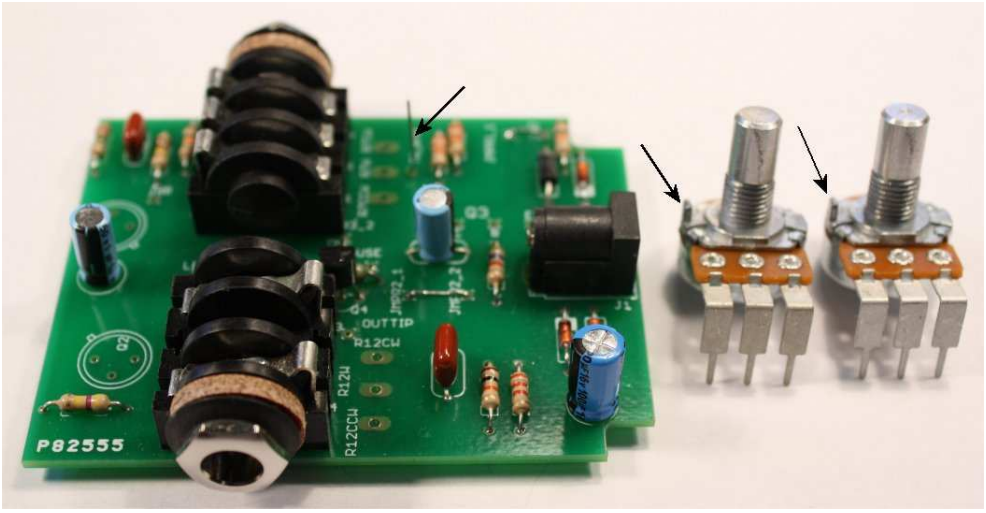




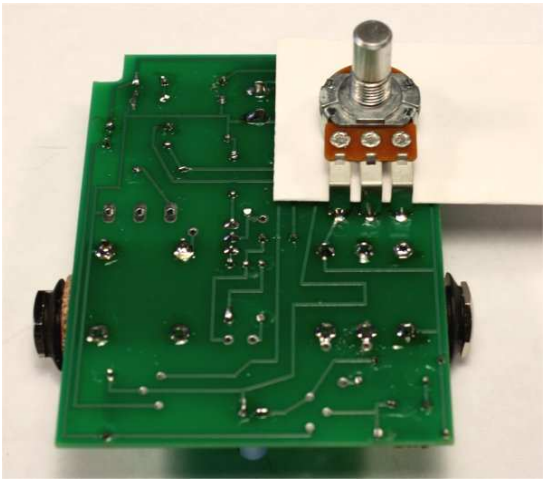
Install the input and output jacks and then the DC power jack. Use solder sparingly on the contacts where off-board connections will be made later so to avoid filling up the smaller pads (arrows) before you are ready. When soldering the power jack, hold it in place with a pair of locking tweezers. Its front edge should be parallel with the front edge of the board.

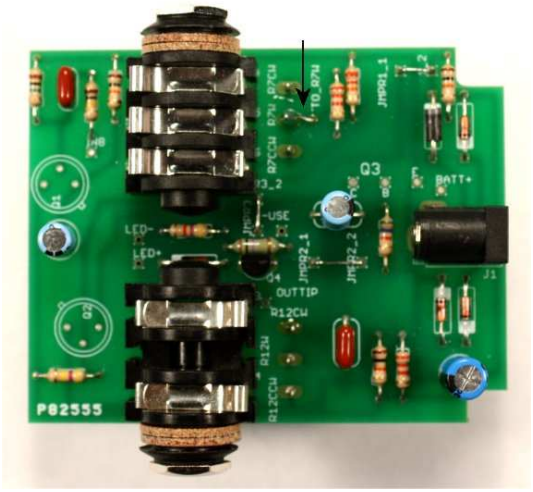


Solder a very short bare-wire jumper at the point shown. The silkscreen legend designates it as “To R7_W.” Remove nuts and washers from the pots, and then use a chain-nose plier to break off the anti-rotation tabs, as this build does not use them.



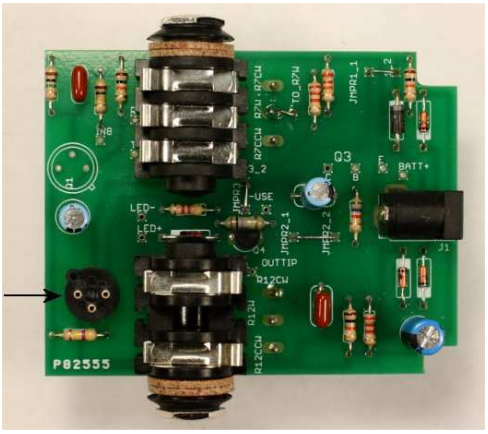
Solder the pots in place, remembering that R7 is linear taper (B50K) and R12 is audio (A50K). Slip a small piece of paper under the can of each pot before soldering so that the can is parallel to the surface of the board. Make sure that you apply enough solder and enough heat so that the whole surface of each pad is covered. The jumper that you installed earlier for R7 is wrapped around the center terminal and soldered there.

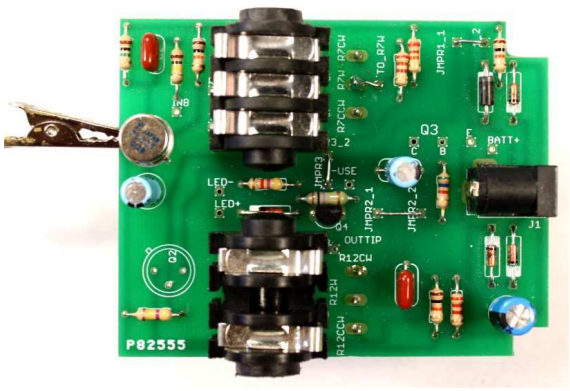




The last step before off-board wiring is installing the transistors. If you bought the PC board only and are using your own devices, you should install transistor sockets now, unless you have already done the lining up on breadboard. If you are using one of my matched sets, sockets are not required unless you think you might want to experiment.

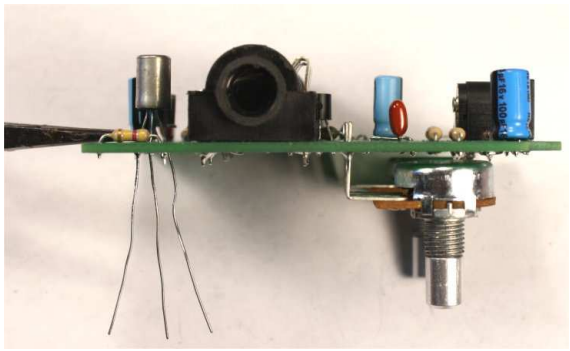
Germanium devices are extremely heat-sensitive. When soldering a lead in place, some form of heat sink on the lead is a must. An alligator clip or soldering tweezers will do. Starting with Q1, clamp the tool on the lead near the body and then solder. Repeat for each lead.

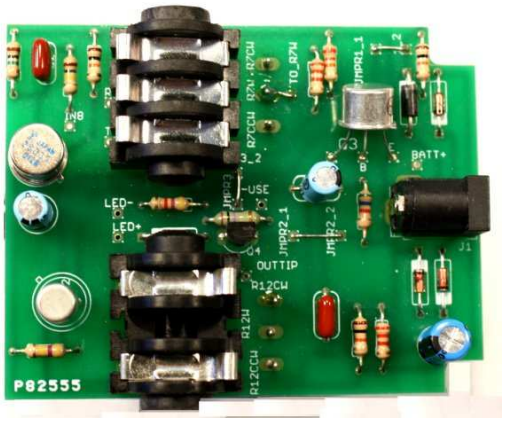




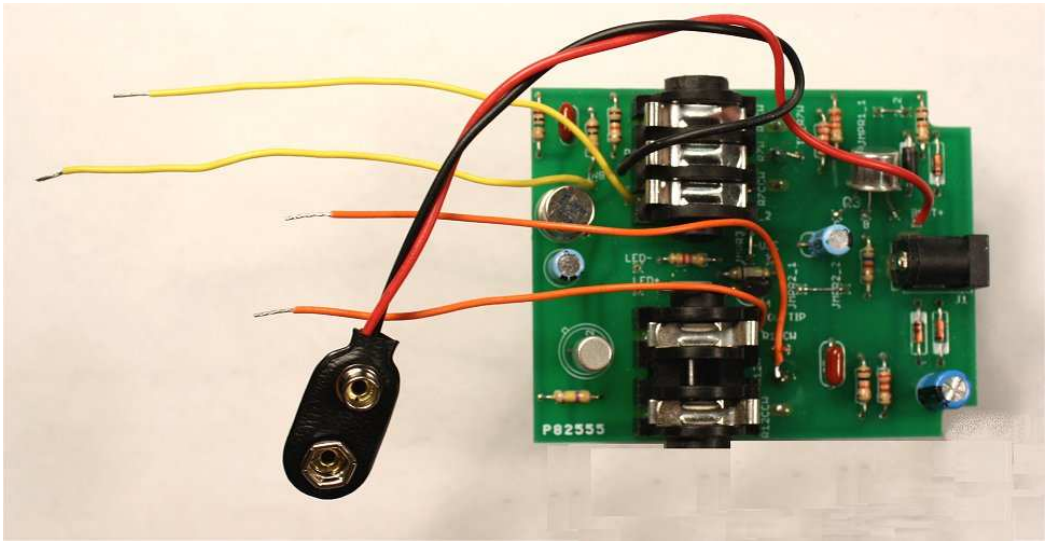
The hole patterns on this board presume that Q1 and Q2 will be TO-5 cases and Q3 will be installed with its pins in-line. However, the board leaves room for any common type to fit in any location if the leads are trimmed to suit. Q2 in the set I used for this build is a TO-44 case. The pic on the left shows it in the process of being installed.

Q3 in this set turned out to be a TO-5, and the right-hand pic shows how I mounted it. After I tested the board, I secured the case with a small bead of silicone rubber underneath to eliminate any chance that the case would short to the nearby resistor lead.

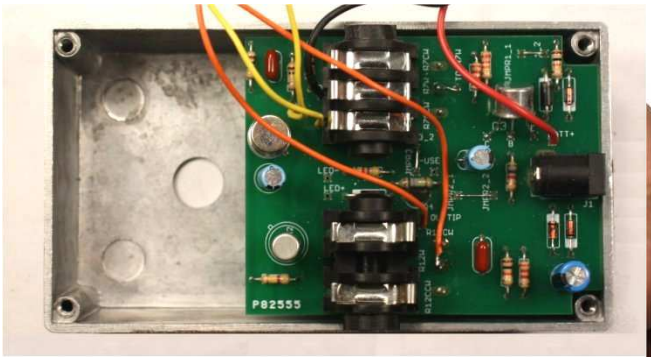


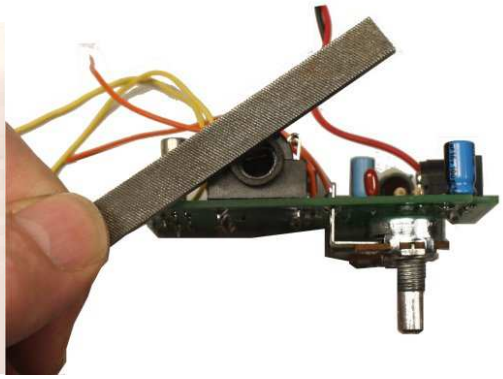


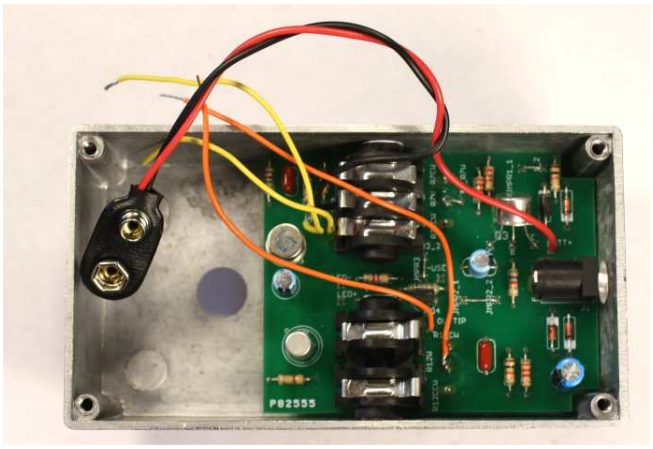
Before testing the board, do the off-board wiring as shown below. The two yellow leads are for the input jack and input to the circuit, and the orange leads are from the output jack and the level pot. One orange lead is soldered directly to the middle contact of the level pot.



Now it’s time to fit the board to the enclosure. Set the shafts of the pots into their appropriate holes, and you will see that the front flanges of the jacks are slightly too long to permit lowering the board into place. Using a small flat file (or a grinding stone on your Dremel tool), remove a little bit of material at a time from each jack until the board drops down and sits at its proper level. The potentiometers need to be flush to the floor and the jacks lined up with their openings. Be patient with this operation, and don’t try to force the board in.

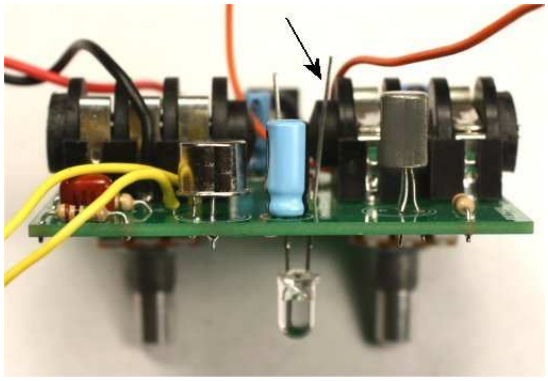


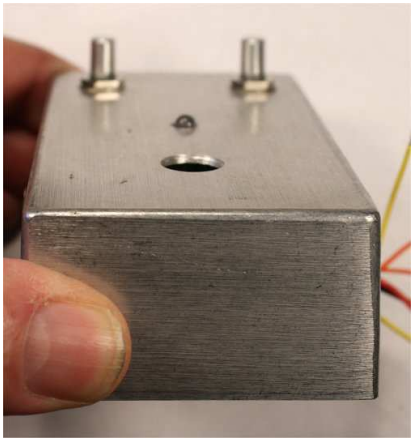




The last step before testing is to install the in-use LED. Remember: The positive side is the longer lead, and this must go into the hole that is marked **LED +** on the board. Insert the LED as shown in the left-hand pic, but don't solder yet.

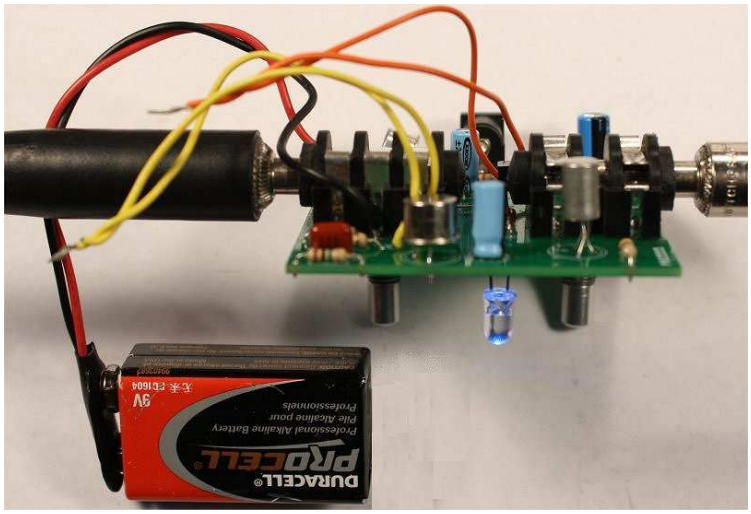
Slip the board into the enclosure and gently press it into place. Install the hardware for the pots and jacks, but finger-tight only. Fit the LED into its hole on the front panel; you may have to wiggle it a bit to get it in there. Now adjust its height off the panel.





Bend the leads of the LED as shown in the left-hand pic to fix its height. Remove the hardware, remove the board, solder the LED in place and trim the remaining leads on top of the board.

The board is ready to test. Temporarily twist together the input leads and the output leads and set both pots about half-way up. Connect your guitar and an amplifier and a battery. The in-use LED should light immediately; if it does not, immediately disconnect power and see the troubleshooting notes below.



Got raspy fuzz?

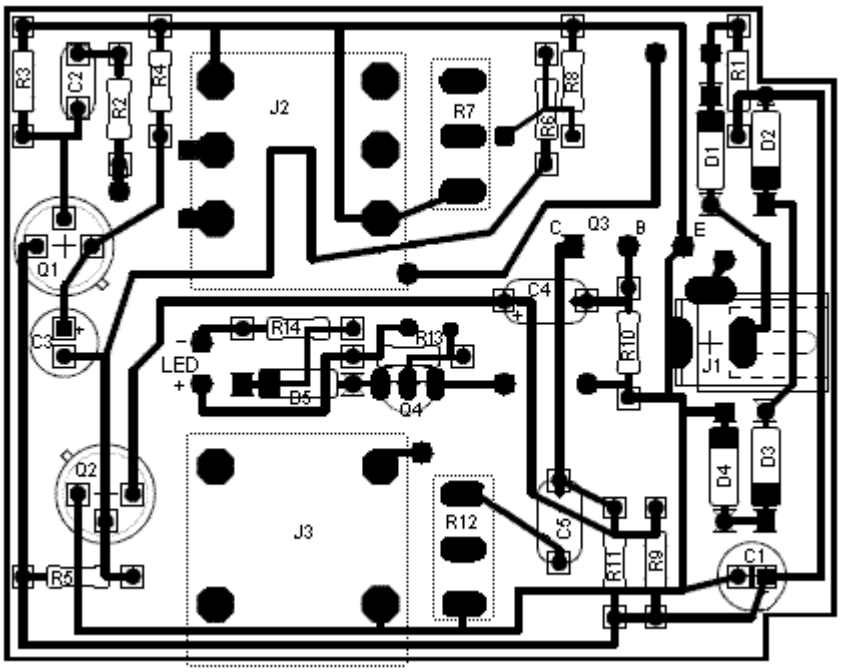
CONGRATULATIONS! Make sure that both controls work correctly. Before you continue, connect a power supply and make sure that everything still works with/without a battery.

When It Doesn't Work

Time to break out the multimeter and figure out where the problems are. Here are the measured transistor voltages in the build you see here:

	Collector	Base	Emitter
Q1	1.68	.824	.78
Q2	.53	.07	0
Q3	1.1	.02	0

YMMV depending on transistor gains, leakages and ambient temp, but any serious differences are a sure indication that something is not right. Here is an "X-Ray" view of the board:



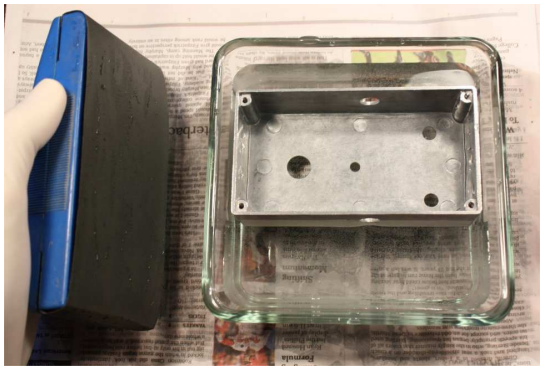
Check *everything* against this layout and the pics. Use the continuity scale of your meter to make sure that everything that should be connected really is. Since this is a factory-made board, the most likely problems are poor soldering and/or a component that is mis-placed or wrongly oriented. This being essentially an FZ-1A, there are many out there who have built similar circuits and can help you debug a build. The Forum at diystompboxes.com is an amazing resource for this. If you bought the full kit, I will help you debug by e-mail. Write to: smallbearelec@ix.netcom.com

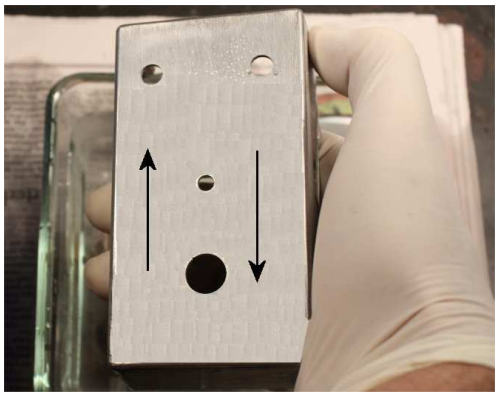
Finishing The Enclosure

I have described this process in other articles, but I will repeat it here on the assumption that some readers may never have worked with paint and decals.

Your first job is to smooth and polish the rough surface of the enclosure by wet-sanding with progressively finer grits of Carborundum paper like 3M Wet-Or-Dry. Grits up to 600 are available in most any hardware store or from my Stock List. You can make a sanding block by stapling material to a small block of soft wood, or get a commercial block like the one shown in these pics. It accepts a standard-size piece of abrasive paper, fits an average hand easily and doesn't need staples to grip the material.

Set yourself up as shown with a small tray of water and 220 grit paper in the block. This process is hell on hands, so I keep a box of disposable rubber surgical gloves in the Cave. Wet both the paper and the surface of the enclosure. Sand each surface of the enclosure, working back-and-forth, in the long direction—Don't scour. Dunk the enclosure every so often to keep it wet.





As the abrasive begins to really smooth the surface, it will start to feel a little slippery. Periodically, give the enclosure a thorough washing and dry it to check your progress. There will still be fine scratches at 220 grit; you want to get All the larger scratches out and have an even finish all over. At some point, take a small piece of the 220 grit paper in your hands and go over the whole surface evenly, but pay special attention to the rounded edges and corners. Sand the lid in the same way.

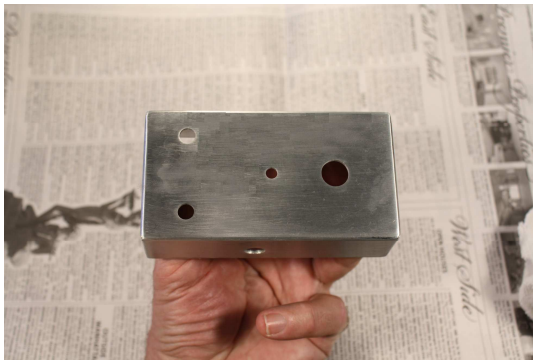
When you are satisfied with the finish at 220 grit, refill your tray with clean water, charge your block with 400 grit material, and repeat the whole, miserable process. Do the same with 600 grit. In my experience, a 600 grit finish will do nicely for putting down a sandable primer and then a coat of automotive touch-up paint.

A suggestion: There is nothing worse than having to sand out a ding, especially after you have put several hours into creating a nice finish. Whenever you are moving around the shop with your piece, do so **slowly**, and **be aware of where you are going**.

My "Recipe" For Painting

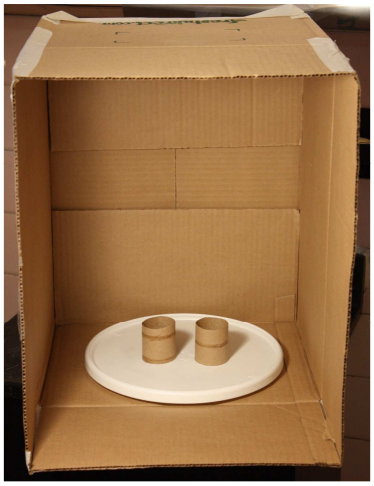
Getting paint to adhere to metal is difficult, so much so that the auto factories guard their methods like the Crown Jewels. However, there are some basic techniques that will give good results consistently in a home shop. If this is your first build, try decorating as shown here. Then, by all means, experiment with other materials and processes.

The smallest speck of dust or grease will cause a void, so the first step is Always a thorough cleaning with Acetone. **ACETONE IS VERY FLAMMABLE AND SOME PEOPLE ARE ALLERGIC TO IT. Read and follow all the precautions on the can.** It will strip the oils from skin, so I keep a pair of solvent-resistant gloves available for protection. I do a wipe with a soft cloth and then a wash, pouring a little over the piece and letting it evaporate. From here forward, don't touch with bare hands the surface you will paint.



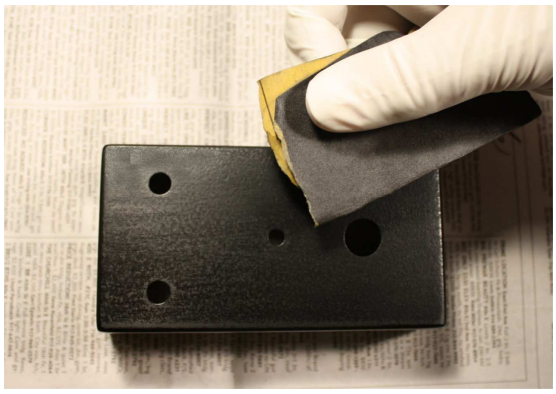
For painting, I have found that a fairly large, corrugated box makes a good disposable "booth." The round platform is a "Lazy Susan" from the local housewares store, and supports for the work can be any convenient pieces of wood or cardboard.

I have found that using a hair dryer to warm the surface before painting helps adhesion and reduces voids. Time and setting will depend on your model; this is one of the variables that you will find ideal values for as you do more pieces.



If it's available where you live, use a self-etching primer; again, better adhesion. Marine-supply and auto-body shops typically stock it. "Shpritz" on a light, but complete, coat, turning the piece frequently to make sure that coverage is even. Let dry thoroughly a couple of hours before you continue.

If you wind up with a few "zits" in spite of all your care, check the label on the can of primer and see if it is sandable; many are, and a little wet sanding with 600 grit abrasive can save re-doing the step. Rinse with clean water when done and blot with a paper towel. Now repeat these steps for the lid.



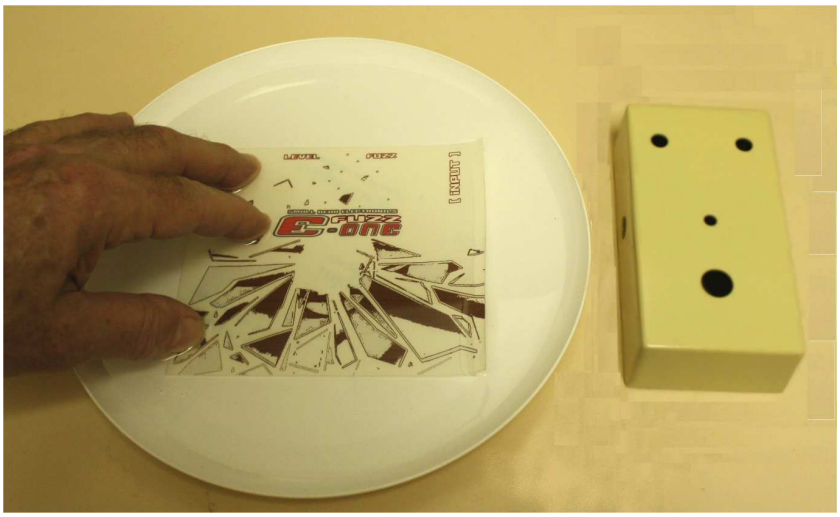
If all is OK, apply color. Again, I always warm the surface before painting. The last step before applying the decal is baking the finish to harden it. I have a toaster oven that I keep specifically for this purpose. Find a model with a built-in timer and a continuously-variable temp setting; those controls make it easy to get repeatable results. I typically bake for a half hour at 180 degrees F.

Applying The Decal

The decal that comes with the kit has been printed on ink jet-compatible, water-slide-release stock. It has already been sprayed with clear lacquer to allow it to be wetted and is ready to apply. Just cut it to exact size with a sharp scissor.

Set up a dish of warm water as shown here.

Slide the decal into the water and hold it under.



You'll feel the film start to peel away from the backing paper within a minute or so. At that point, slide the decal out of the water onto the enclosure. Slowly and gently, begin to slide the film off the backing paper and onto the painted surface.

Slide the backing paper completely out from under the decal, and finish sliding the decal into place. While the film is wet, you have some control of its exact position. Blot the whole piece with a paper towel so as to dry it, squeeze all of the water out and get rid of air bubbles. Give the decal a couple of hours to set. Using a razor blade, slice off any overhanging decal film.

Back to the paint booth to finish. Seal the decal to the enclosure by spraying with a clear lacquer like Krylon. It is most important to begin with a very light first coat “shpritzed” on. If you try for a heavier coat too soon, the decal film will buckle. Wait a minute, then apply another very light coat. Wait again, and apply a third, light coat. Wait again, and then apply a final, heavier coat. In a similar way, spray a clear coat on the lid. Let the lacquer cure for several hours.

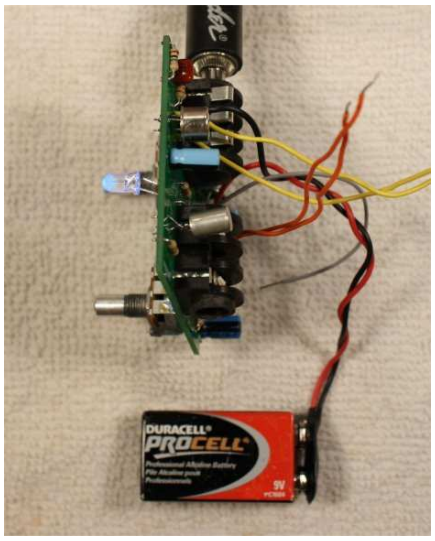
You are now at a delicate stage, because you have put a lot of work into finishing the enclosure. Slips, falls and mistakes with tools can ruin the finish and cause you grief, so **stay focused and work patiently**. Set up a towel or soft cloth on your bench to protect the face of the enclosure while you work.

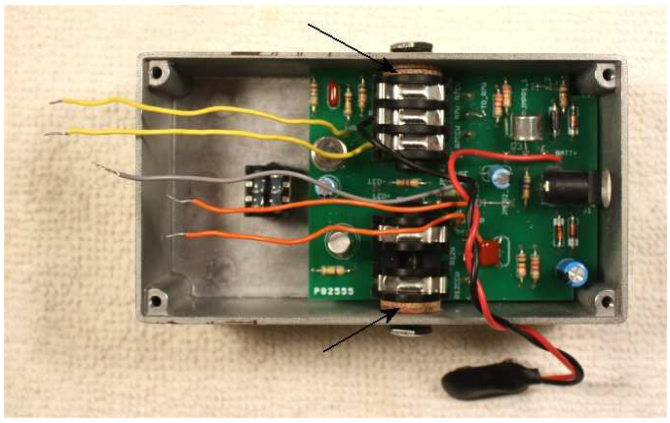
With an X-acto or similar knife, carefully cut out the holes for the pots, jacks, LED and stomp switch.

Final Assembly

One small piece of wiring remains. Solder a short lead to the hole labeled “I-use.” It’s the gray one in the pics that follow. We tested the operation of the LED driver circuit earlier by connecting a battery (with a guitar plug in the input jack) and noting that the LED illuminated. Set up this test again, and confirm that the LED extinguishes when the gray lead is grounded. A convenient ground point is the center contact of the DC power jack. If this does not happen, check for mistakes on the board before you go further.

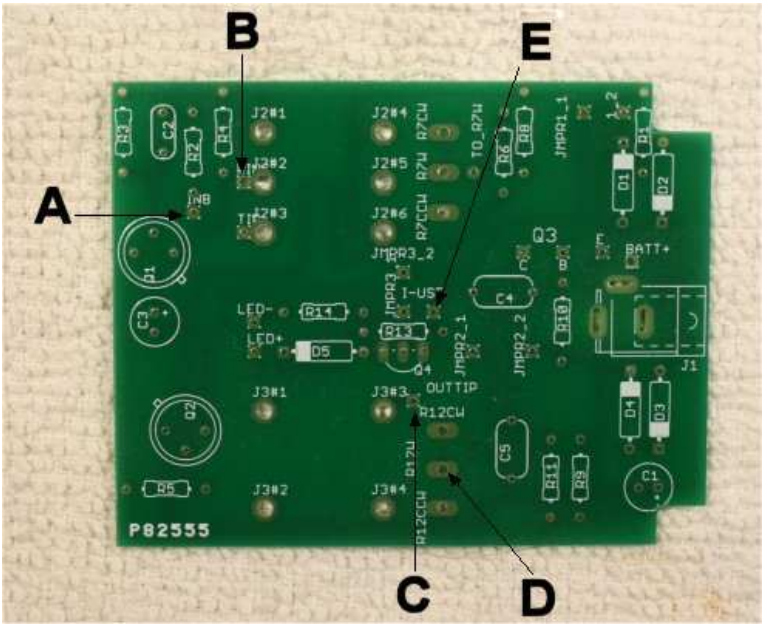
If the board passes that test, install two fiber washers onto the bushing of each jack, and slip the board into the enclosure. Slip the black bezels onto the chrome ferrules and screw the ferrules in place finger-tight.



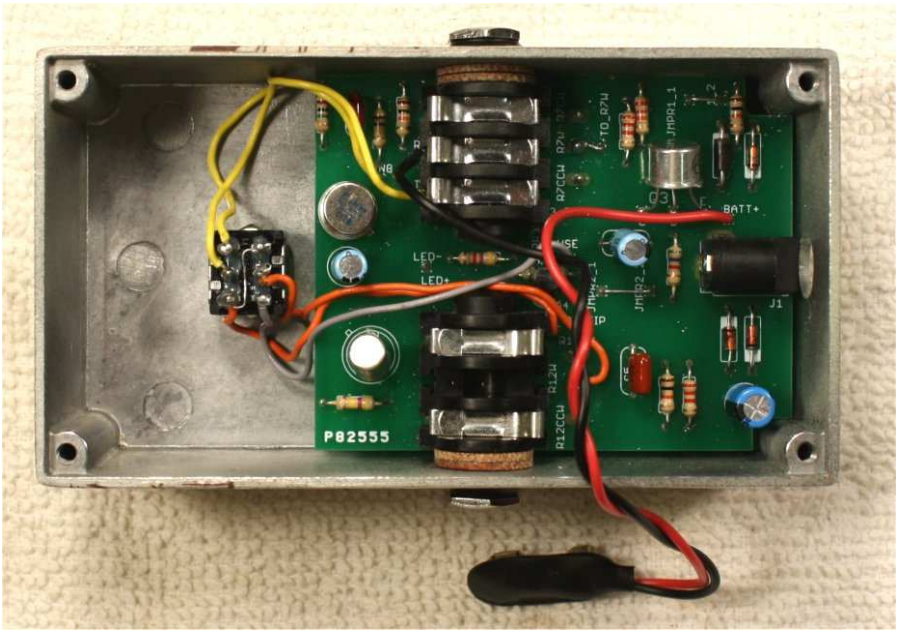


Here is a diagram for wiring the stomp switch:

and a pic of the unassembled board to make it easy to see which lead goes where.



A very short length of bare wire connects pins 3 and 4. The finished wiring should look something like this:



Plug in a power supply and a battery and give the pedal one more thorough test before you finish up. All OK? Once again, **CONGRATULATIONS!**

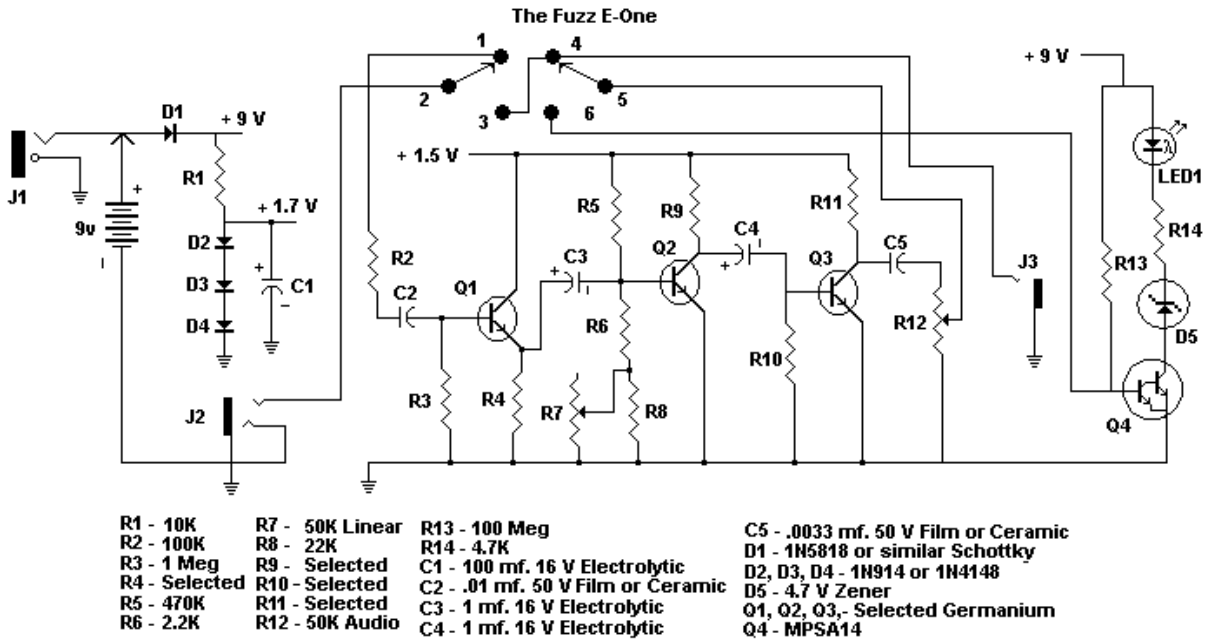
You may want to apply a bead of epoxy cement as a strain relief for the battery snap. Rubber feet go on the bottom of the lid. Slip the hardware on the pots, add knobs and tighten everything up.

Decal By Adriano Vasquez
Adrian3585@yahoo.com

I hope you have enjoyed building the Fuzz E-One and that you now feel inspired to build other designs. Comments and suggestions are welcome at smallbearelec@ix.netcom.com.

Reference Information

Here is the schematic:



and here is a list of everything that should be in the kit:

Quantity	Description	Desi	SKU
	Resistors 5% Carbon Film		
1	10K	R1	0903
1	100K	R2	0904
1	1 Meg	R3	0905
1	470K	R5	0905
1	2.2K	R6	0902
1	22K	R8	0903
1	100 Meg	R13	
1	4.7K	R14	0902
4	Selected Bias Resistors	R4, R9, R10, R11	
	Potentiometers 16mm		
1	50K Linear	R7	1005A
1	50K Audio	R12	1005A
	Capacitors		
1	100 mf. 16 Volt Electrolytic	C1	1404
1	.01 mf. 50 Volt Poly Film	C2	1101B
2	1 mf. 16 Volt Electrolytic	C3, C4	1405H
1	.0033 mf.50 Volt Poly Film	C5	1150

	Transistors and Diodes		
1	Schottky Diode 1N5818	D1	2215A
3	Silicon Diode 1N914	D2, D3, D4	2208
1	Zener Diode 4.7 Volt	D5	2211
1	Set of Matched Transistors	Q1, Q2, Q3	0102N
1	Darlington Transistor MPSA14	Q4	2025
1	High-Brightness LED	LED1	2302
	Fittings and Case		
1	Jack, DC Power	J1	0611C
1	Jack, Stereo	J2	0604D
1	Jack, Mono	J3	0604C
1	DPDT Stomp Switch	S1	0203
1	Battery Snap		0619
1	Enclosure		
2	Knobs		0824
1	Decal		
1	PC Board		
1	Hookup Wire Sample		