PROJECT NAME

EPSILON

aion
DIY GUITAR EFFECTS

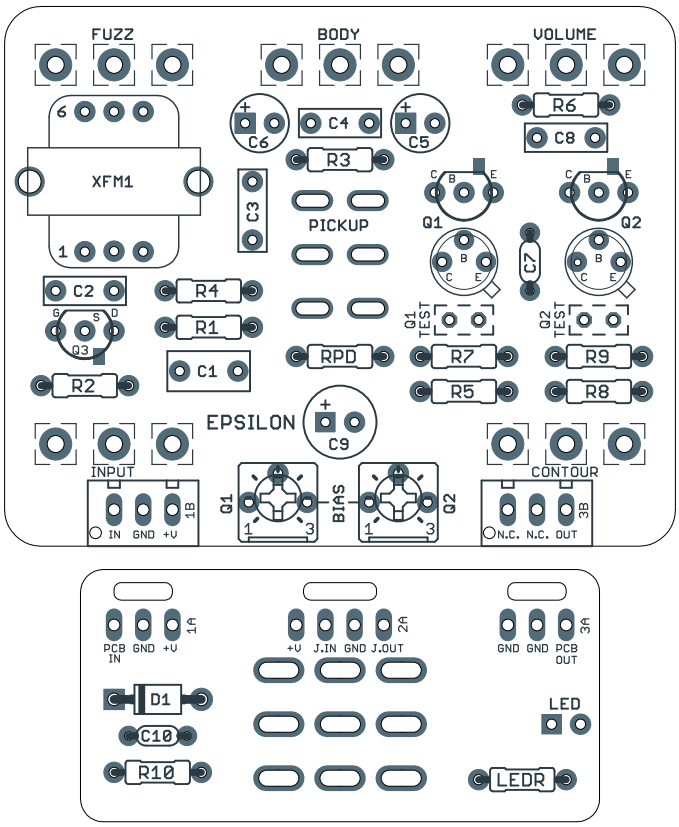
BASED ON
Dallas-Arbiter Fuzz Face (1970)

BUILD DIFFICULTY
Intermediate

EFFECT TYPE
Silicon fuzz

DOCUMENT VERSION
1.0.2 (2022-10-28)

PROJECT SUMMARY
A hot-rodded adaptation of the 1970 version of the classic fuzz pedal, redesigned to use silicon transistors instead of germanium.



Actual size is 2.3" x 1.86" (main board) and 2.3" x 0.86" (bypass board).

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INTRODUCTION

The Epsilon Silicon Fuzz is based on the 1970 version of the Dallas-Arbiter Fuzz Face, the first to use uses NPN silicon transistors. While Dallas had made the shift from germanium to silicon in 1969, the first versions used PNP transistors in a positive-ground arrangement just like the germanium version.

The Epsilon PCB includes a switchable pickup simulator at the input. The Fuzz Face was originally designed to connect directly to an electric guitar, and as a result it is notoriously picky about where it's placed in the signal chain. If it's fed a low-impedance signal (e.g. if there's another pedal before it) then it loses much of its character.

The pickup simulator solves this problem by adding a transformer, resistor and capacitor to convert the source signal into the higher impedance that the Fuzz Face likes. This pickup simulator was invented by Jack Orman of AMZ and has been used in commercial pedals such as the Earthquaker Devices Erupter.

The Epsilon joins two other Aion FX projects also based on the Fuzz Face. The Proteus is based on the 1966 PNP germanium version of the pedal and includes a voltage inverter and the same pickup simulator. The Solaris is a hot-rodded version of the Proteus with three additional knobs.

USAGE

The Epsilon has five controls and one toggle:

- **Fuzz** controls the amount of gain from the second transistor where the clipping occurs.
- **Volume** is the output volume of the effect.
- **Contour** affects the midrange by varying the Q2 bias.
- **Input** allows you to attenuate the input signal, mimicking the effects of turning down your guitar volume. This way you can get similar volume-knob tones even if the fuzz is not the first effect in your chain. Joe Gagan, who came up with this control, recommends turning the Fuzz knob all the way up and using only this knob for the amount of distortion.
- **Body** is an input capacitor blend, which controls the amount of bass.
- **Pickup** enables or disables the pickup simulator.

PARTS LIST

This parts list is also available in a spreadsheet format which can be imported directly into Mouser for easy parts ordering. Mouser doesn't carry all the parts—notably potentiometers—so the second tab lists all the non-Mouser parts as well as sources for each.

View parts list spreadsheet →

PART	VALUE	TYPE	NOTES
R1	1M	Metal film resistor, 1/4W	
R2	1M	Metal film resistor, 1/4W	
R3	10k	Metal film resistor, 1/4W	
R4	1k	Metal film resistor, 1/4W	
R5	10k	Metal film resistor, 1/4W	
R6	100k	Metal film resistor, 1/4W	
R7	1k	Metal film resistor, 1/4W	
R8	220R	Metal film resistor, 1/4W	
R9	1k	Metal film resistor, 1/4W	
R10	100R	Metal film resistor, 1/4W	
RPD	2M2	Metal film resistor, 1/4W	Input pulldown resistor.
LEDR	4k7	Metal film resistor, 1/4W	LED current-limiting resistor. Adjust value to change LED brightness.
C1	1uF	Film capacitor, 7.2 x 3.5mm	
C2	100n	Film capacitor, 7.2 x 2.5mm	
C3	1n	Film capacitor, 7.2 x 2.5mm	
C4	10n	Film capacitor, 7.2 x 2.5mm	
C5	10uF	Electrolytic capacitor, 5mm	
C6	22uF	Electrolytic capacitor, 5mm	
C7	10pF	MLCC capacitor, NP0/C0G	
C8	10n	Film capacitor, 7.2 x 2.5mm	
C9	100uF	Electrolytic capacitor, 6.3mm	
C10	100n	MLCC capacitor, X7R	
D1	1N5817	Schottky diode, DO-41	
Q1	2N5089	BJT transistor, NPN, TO-92	Can also use BC549C (rotate 180 degrees) or 2N3903 for a lower-gain variety. See build notes.
Q2	2N5089	BJT transistor, NPN, TO-92	Can also use BC549C (rotate 180 degrees) or 2N3904 for a lower-gain variety. See build notes.
Q3	2N5457	JFET, N-channel, TO-92	Any general-purpose JFET can be used here.
XFM1	42TL019	Transformer, audio, 10KCT/600CT	
Q1BIAS	100k trimmer	Trimmer, 10%, 1/4"	
Q2BIAS	10k trimmer	Trimmer, 10%, 1/4"	

PARTS LIST, CONT.

PART	VALUE	TYPE	NOTES
FUZZ	1kC	16mm right-angle PCB mount pot	Original uses linear (B) taper, but reverse (C) gives better control range.
VOL.	500kA	16mm right-angle PCB mount pot	
INPUT	250kB	16mm right-angle PCB mount pot	
BODY	100kB	16mm right-angle PCB mount pot	
CONT.	1kB	16mm right-angle PCB mount pot	
PICKUP	DPDT	Toggle switch, DPDT	
LED	5mm	LED, 5mm, red diffused	
IN	1/4" stereo	1/4" phone jack, closed frame	Switchcraft 112BX or equivalent.
OUT	1/4" mono	1/4" phone jack, closed frame	Switchcraft 111X or equivalent.
DC	2.1mm	DC jack, 2.1mm panel mount	Mouser 163-4302-E or equivalent.
BATT	Battery snap	9V battery snap	Optional. Use the soft plastic type—the hard-shell type will not fit.
FSW	3PDT	Stomp switch, 3PDT	
ENC	125B	Enclosure, die-cast aluminum	Can also use a Hammond 1590N1.

BUILD NOTES

Transistor selection

Outlines have been provided on the PCB for either TO-18 or TO-92 transistors. Only one of these outlines should be used for Q1 and Q2 and the other left empty. SOT-23 (surface mount) parts can also be used—note the added square pad on the TO-92 outlines.

Original specifications

The original 1970 Fuzz Face used **BC108C** transistors. These are extremely high-gain devices with an hFE (gain) spec of 420 to 800. They are still available from a few manufacturers such as Central Semiconductor or Multicomp, but they're expensive.

2N5089 is a great substitute with similar gain range as the BC108C. You can also use **BC549C**, but note that the TO-92 outline on the PCB uses the USA E-B-C convention, so the BC549C will need to be rotated 180 degrees.

Lower-gain alternatives

There are also some really good sounds to be had by experimenting with other types of transistors. Some low-gain options, e.g. a 2N3903 for Q1 and 2N3904 for Q2, provide a very different character that's a little closer to the germanium version.

There's some anecdotal evidence that the gain ratio between Q1 and Q2 is more important than the actual gain spec itself. Some have reported a night-and-day difference when Q2's hFE was approximately 40 to 60% higher than Q1. If you want to try this, the **2N3903** and **2N3904** make a great combination. The 2N3903 is around 100-130 on average while the 2N3904 is more like 150-190, so chances are good that any two of these devices would work well together with no selection needed.

Biasing

The Epsilon is set up to allow for easy biasing of the two transistors via trim pots without having to swap out resistors. As a starting point, turn the Q1 bias trimmer to 9:00 and the Q2 trimmer to around 2:00. Set the Contour knob just above 9:00. Then, with a multimeter, touch the black and red leads to the two pads marked "TEST" below Q1. Turn the Q1 trimmer until the multimeter reads **1.4V**.

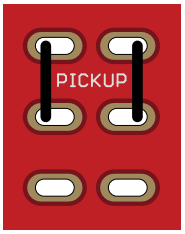
Next, moving to the test pads under Q2, turn the Q2 bias trimmer until the multimeter shows **4.5V**. Then, measure each leg on all three of the transistors. You're looking for something near these voltages.

- **Q1:** Collector 1.4V, Base 0.6V, Emitter 0V
- **Q2:** Collector 4.5V, Base 1.4V, Emitter 0.8V

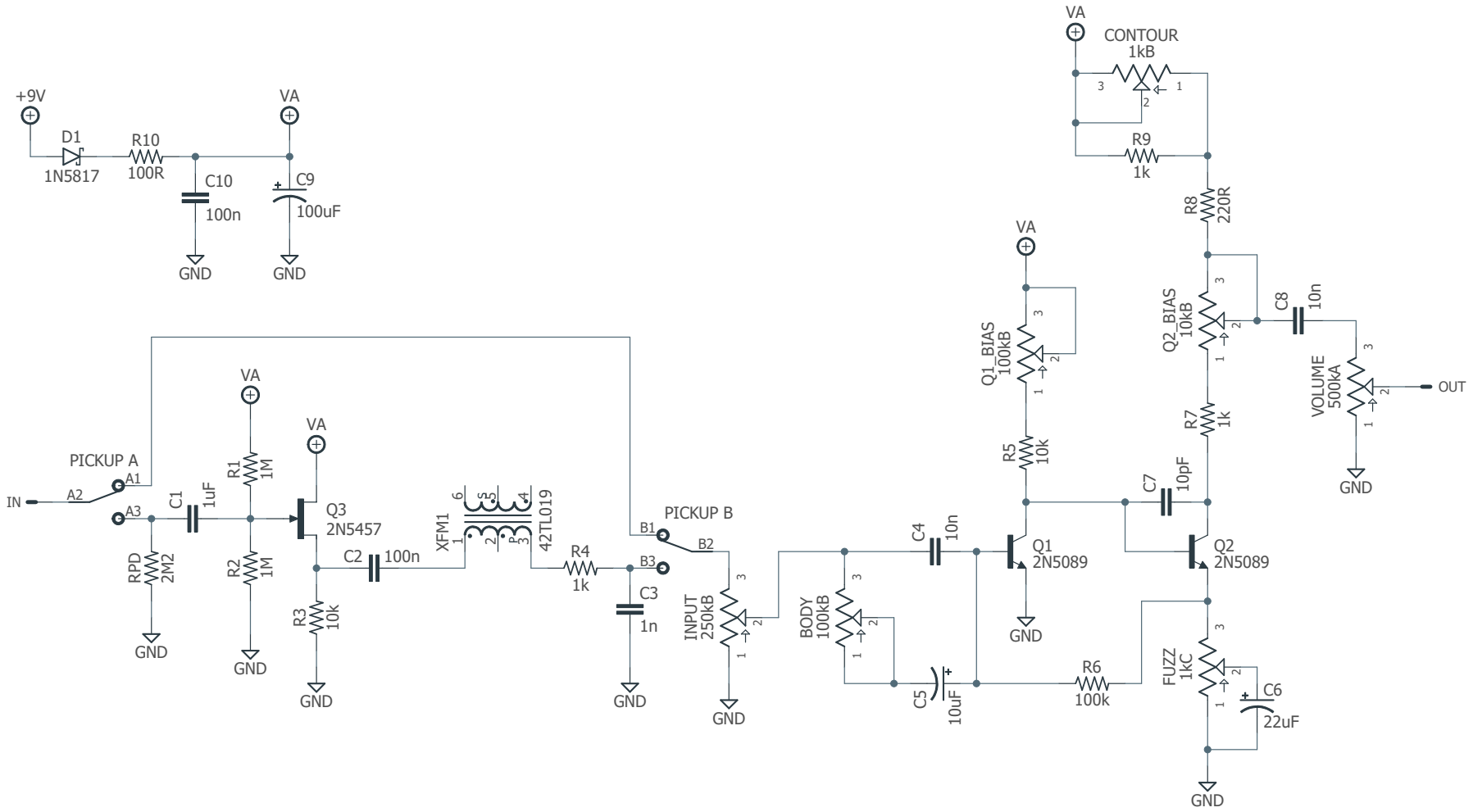
The voltages don't need to be anywhere near exact, this is just a benchmark. Let your ears be the judge. Some people prefer the Q2 voltage to be higher, around 5.5V.

Omitting the pickup simulator

The 42TL019 transformer is readily available from Mouser, but at times they may be out of stock. Or, you may just not want this option in your build. To omit the pickup simulator, leave off C1-3, R1-4, Q3, and the transformer. Then, solder jumpers across the toggle switch pads as shown in the diagram to the right.



SCHEMATIC


+9V
D1
1N5817
R10
100R
C10
100n
C9
100uF
GND
GND
VA
VA
CONTOUR
1kB
R9
1k
R8
220R
VA
Q1_BIAS
100kB
R5
10k
Q2_BIAS
10kB
C8
10n
VOLUME
500kA
OUT
R7
1k
C7
10pF
GND
PICKUP A
A1
A2
A3
IN
C1
1uF
R1
1M
VA
Q3
2N5457
RPD
2M2
R2
1M
R3
10k
C2
100n
XFM1
42TL019
R4
1k
PICKUP B
B1
B2
B3
C3
1n
INPUT
250kB
BODY
100kB
C4
10n
Q1
2N5089
Q2
2N5089
C5
10uF
R6
100k
FUZZ
1kC
C6
22uF
GND
GND
GND
GND
GND
GND
GND

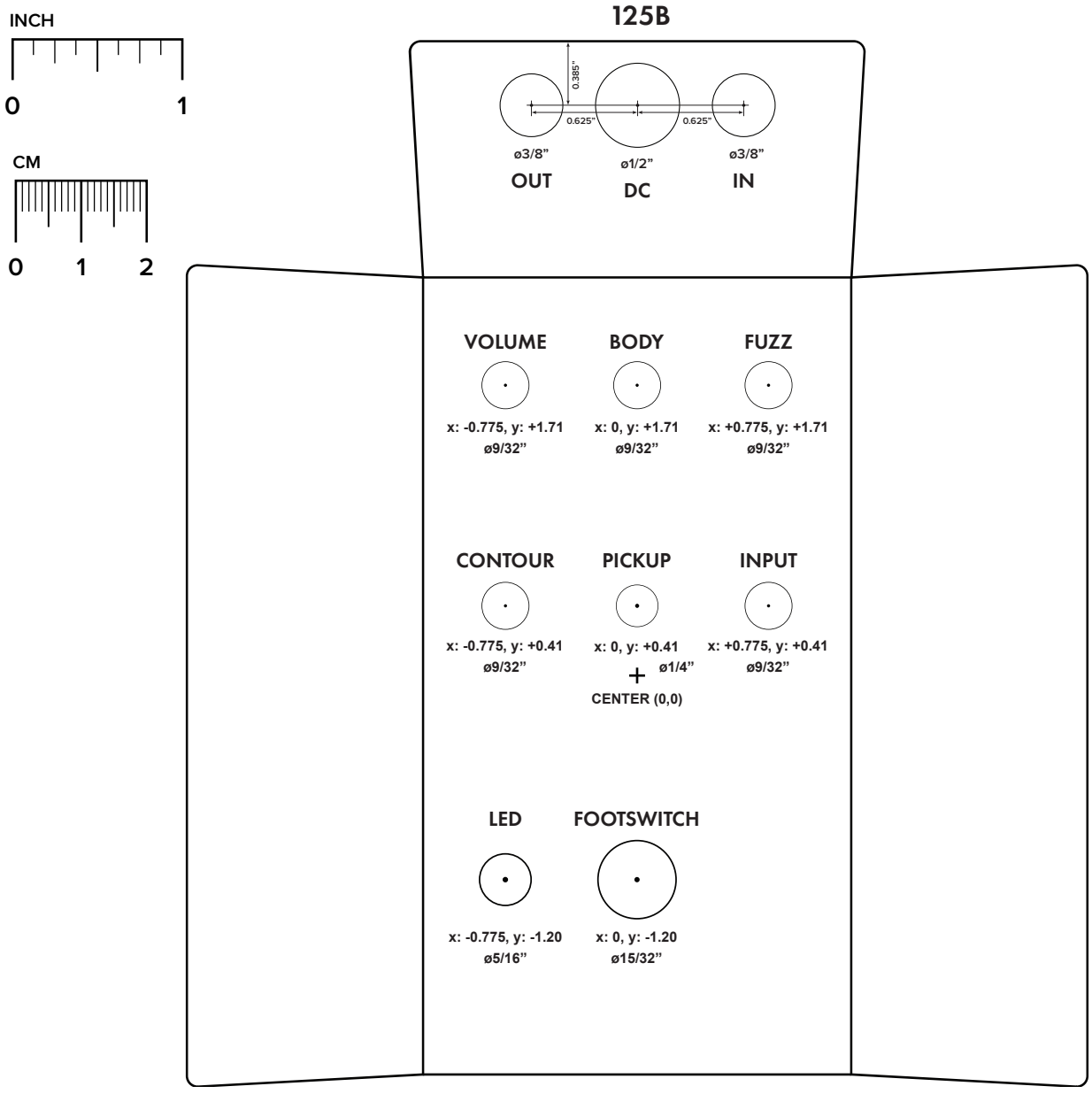
DRILL TEMPLATE

Cut out this drill template, fold the edges and tape it to the enclosure. Before drilling, it's recommended to first use a center punch for each of the holes to help guide the drill bit.

Ensure that this template is printed at 100% or "Actual Size". You can double-check this by measuring the scale on the printed page.

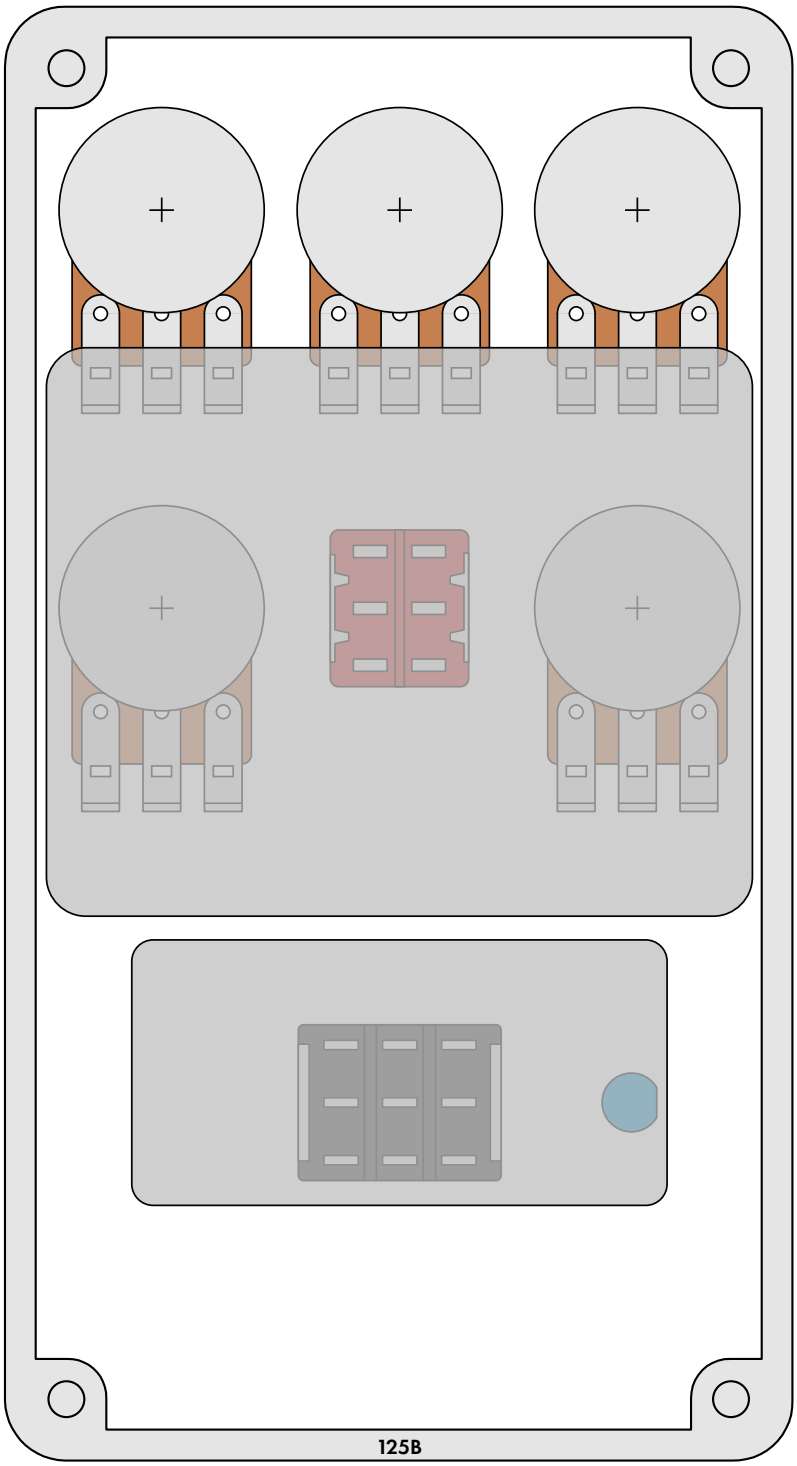
Top jack layout assumes the use of closed-frame jacks like the Switchcraft 111X. Open-frame jacks will not fit in layouts with 5 or more knobs due to the placement of the DC jack.

LED hole drill size assumes the use of a 5mm LED bezel, available from several parts suppliers. Adjust size accordingly if using something different, such as a 3mm bezel, a plastic bezel, or just a plain LED.

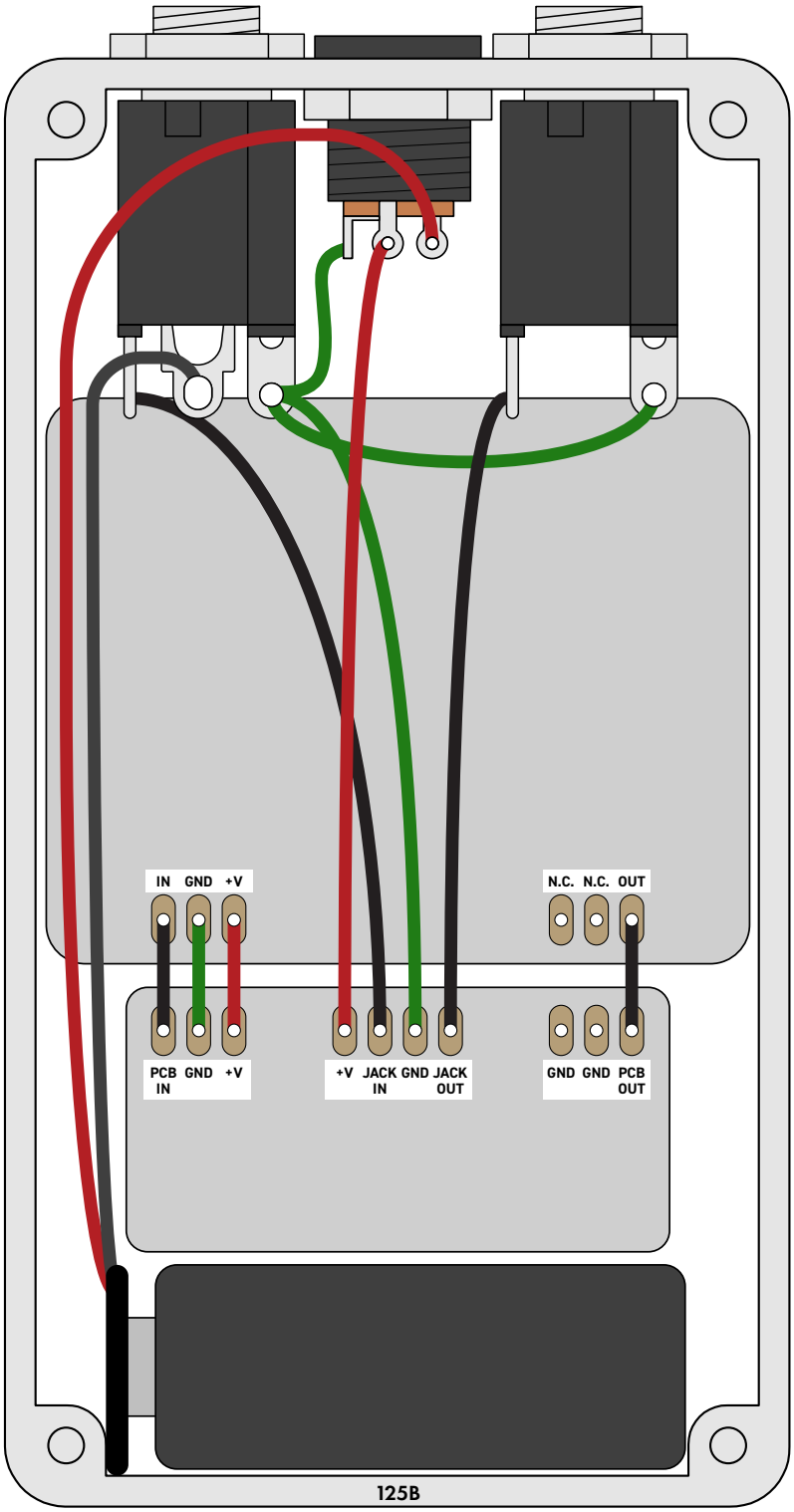


ENCLOSURE LAYOUT

Enclosure is shown without jacks. See next page for jack layout and wiring.



WIRING DIAGRAM



Shown with optional 9V battery. If battery is omitted, both jacks can be mono rather than one being stereo. Leave the far-right lug of the DC jack unconnected.

LICENSE & USAGE

No direct support is offered for these projects beyond the provided documentation. It's assumed that you have at least some experience building pedals before starting one of these. Replacements and refunds cannotbe offered unless it can be shown that the circuit or documentation are in error.

All of these circuits have been tested in good faith in their base configurations. However, not all the modifications or variations have necessarily been tested. These are offered only as suggestions based on the experience and opinions of others.

Projects may be used for commercial endeavors in any quantity unless specifically noted. No attribution is necessary, though a link back is always greatly appreciated. The only usage restrictions are that **(1) you cannot resell the PCB as part of a kit without prior arrangement**, and **(2) you cannot "goop" the circuit, scratch off the screenprint, or otherwise obfuscate the circuit to disguise its source**. (In other words: you don't have to go out of your way to advertise the fact that you use these PCBs, but please don't go out of your way to hide it. The guitar effects industry needs more transparency, not less!)

DOCUMENT REVISIONS

1.0.2 (2022-10-28)
Changed recommended transistors to 2N5089 to avoid confusion. BC549C can still be used but must be rotated 180 degrees from the silkscreen.

1.0.1 (2021-09-18)
Corrected target transistor bias voltages, which were mistakenly transferred from the Solaris (germanium) instructions.

1.0.0 (2021-05-28)
Initial release.