

PROJECT NAME

HEXERACT

BASED ON

Electro-Harmonix® Hot Tubes

BUILD DIFFICULTY

■■■■■ Easy

EFFECT TYPE

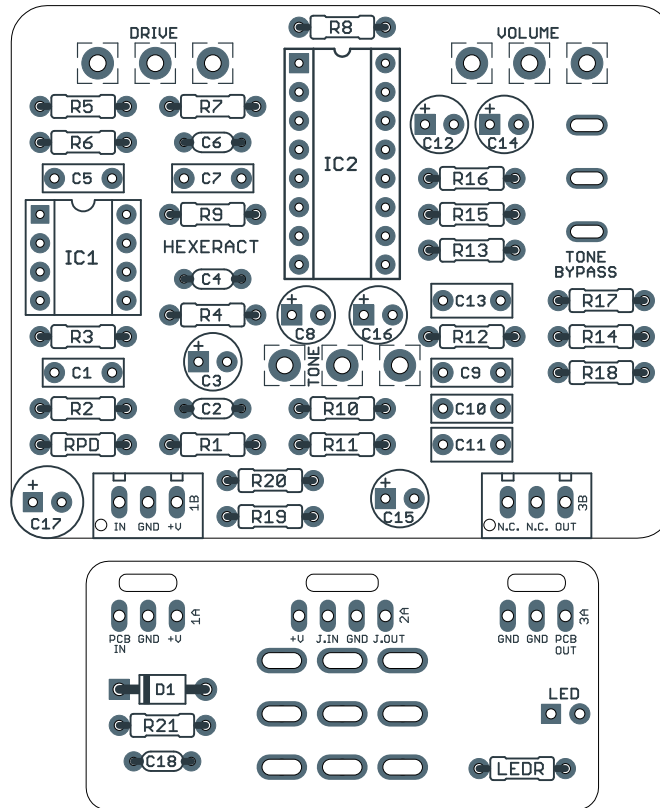
Overdrive

DOCUMENT VERSION

1.0.0 (2021-11-12)

PROJECT SUMMARY

The first commercial pedal to use cascaded CMOS inverters for overdrive, a technique that lends an asymmetric warmth very different from traditional clipping diodes.



Actual size is 2.3" x 1.86" (main board) and 1.78" x 0.87" (bypass board).

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INTRODUCTION

The Hexeract CMOS Drive is based on the Electro-Harmonix Hot Tubes, a CMOS-based overdrive first released in 1978. It was perhaps the first commercial product that used overdriven hex inverters, a method invented by Craig Anderton a year earlier in his “Tube Sound Fuzz” DIY project.

The Hot Tubes took this core idea and wrapped it in a few extra op-amp stages and a tone control, resulting in a full-featured overdrive with a sound all its own. It was given the name “Hot Tubes” because overloaded CMOS inverters give a softer and more asymmetric clipping than diode-based circuits, reminiscent of overdriven vintage tube amplifiers.

The Hot Tubes was discontinued in 1981 when EHX ran into financial troubles. From 1978 to 1981, there were at least three different color schemes for the enclosure, but there are no known circuit changes throughout this time.

EHX muddied the waters in 2005 by releasing a true tube overdrive in 2005 that was also called the Hot Tubes, in this case using the name in a literal sense instead of metaphorically. They even reused the cosmetics, but despite this, the 2005 pedal had nothing whatsoever to do with the 1978 CMOS Hot Tubes.

EHX later created a real reissue of the CMOS circuit in 2013 as part of their Nano series, and later in 2017 they combined it with the Crayon as the “Hot Wax” dual pedal.

The Hexeract is a reproduction of the original Hot Tubes. A small amount of additional filtering has been added, but otherwise it’s the same as the vintage 1978 circuit.

USAGE

The Hexeract has three knobs and one toggle:

- **Drive** controls the gain ratio of the first CMOS inverter stage.
- **Tone** is a Big Muff-style “balance” control that pans between a treble emphasis and a bass emphasis.
- **Volume** sets the overall output of the effect.
- **Tone Bypass** (toggle) bypasses the tone section altogether for a rawer and more aggressive tone.

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	120k	Metal film resistor, 1/4W	
R2	20k	Metal film resistor, 1/4W	
R3	20k	Metal film resistor, 1/4W	
R4	75k	Metal film resistor, 1/4W	
R5	8k2	Metal film resistor, 1/4W	
R6	1M8	Metal film resistor, 1/4W	
R7	150k	Metal film resistor, 1/4W	
R8	2M2	Metal film resistor, 1/4W	
R9	200k	Metal film resistor, 1/4W	
R10	5k6	Metal film resistor, 1/4W	
R11	1k2	Metal film resistor, 1/4W	
R12	150k	Metal film resistor, 1/4W	
R13	1M	Metal film resistor, 1/4W	
R14	47k	Metal film resistor, 1/4W	
R15	430k	Metal film resistor, 1/4W	
R16	1M	Metal film resistor, 1/4W	
R17	47k	Metal film resistor, 1/4W	
R18	150R	Metal film resistor, 1/4W	
R19	220k	Metal film resistor, 1/4W	
R20	220k	Metal film resistor, 1/4W	
R21	100R	Metal film resistor, 1/4W	
RPD	1M	Metal film resistor, 1/4W	
LEDR	4k7	Metal film resistor, 1/4W	LED current-limiting resistor. Adjust value to change LED brightness.
C1	100n	Film capacitor, 7.2 x 2.5mm	
C2	180pF	MLCC capacitor, NP0/C0G	
C3	4.7uF	Electrolytic capacitor, 4mm	
C4	47pF	MLCC capacitor, NP0/C0G	
C5	100n	Film capacitor, 7.2 x 2.5mm	
C6	27pF	MLCC capacitor, NP0/C0G	
C7	150n	Film capacitor, 7.2 x 2.5mm	
C8	10uF	Electrolytic capacitor, 5mm	
C9	120n	Film capacitor, 7.2 x 2.5mm	

PARTS LIST, CONT.

PART	VALUE	TYPE	NOTES
C10	120n	Film capacitor, 7.2 x 2.5mm	
C11	220n	Film capacitor, 7.2 x 2.5mm	
C12	4.7uF	Electrolytic capacitor, 4mm	
C13	220n	Film capacitor, 7.2 x 2.5mm	
C14	4.7uF	Electrolytic capacitor, 4mm	
C15	47uF	Electrolytic capacitor, 5mm	Reference voltage filter capacitor.
C16	47uF	Electrolytic capacitor, 5mm	Power supply filter capacitor.
C17	220uF	Electrolytic capacitor, 6.3mm	Power supply filter capacitor.
C18	100n	MLCC capacitor, X7R	Power supply filter capacitor.
D1	1N5817	Schottky diode, DO-41	
IC1	RC4558P	Operational amplifier, DIP8	
IC1-S	DIP-8 socket	IC socket, DIP-8	
IC2	CD4049UBE	CMOS hex inverting buffer, DIP16	
IC2-S	DIP-16 socket	IC socket, DIP-16	
TONE	10kB	16mm right-angle PCB mount pot	
DRIVE	1MC	16mm right-angle PCB mount pot	Original uses 2MC, but 1MC will work the same. See build notes.
VOL.	10kA	16mm right-angle PCB mount pot	
TONE BYP.	SPDT on-on	Toggle switch, SPDT on-on	
LED	5mm	LED, 5mm, red diffused	
IN	1/4" stereo	1/4" phone jack, closed frame	Switchcraft 111BX 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.
FSW	3PDT	Stomp switch, 3PDT	
ENC	125B	Enclosure, die-cast aluminum	Can also use a Hammond 1590N1.

BUILD NOTES

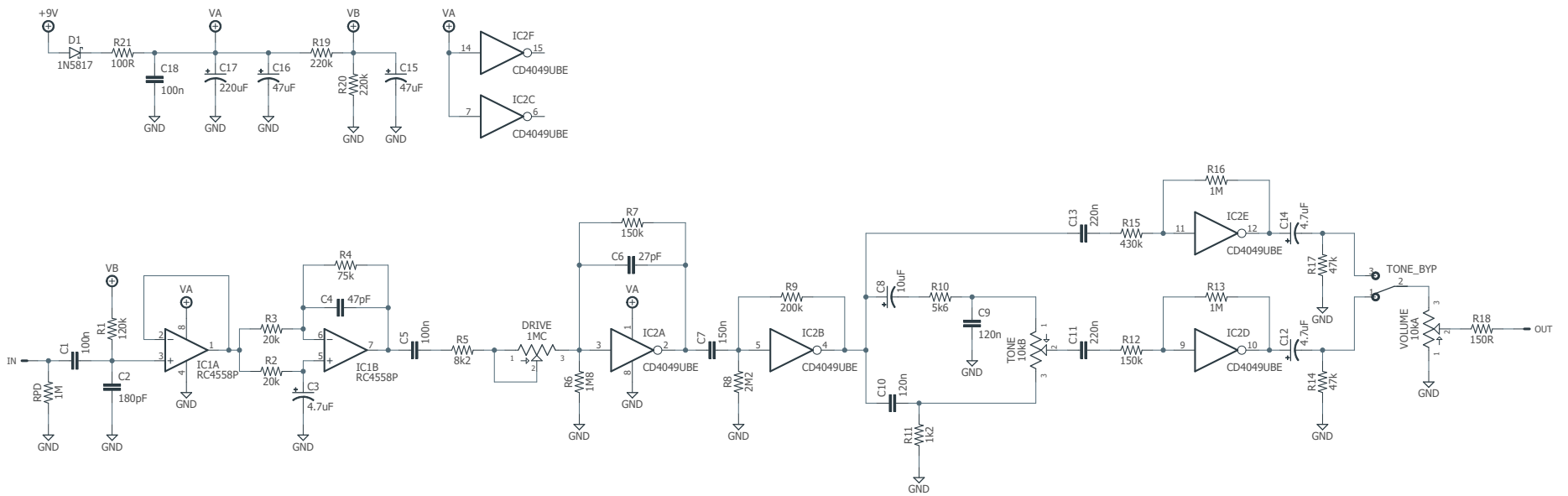
Drive potentiometer value

The factory schematic shows the drive pot as “2M” with no taper listed. We took apart an original Hot Tubes and found two things: first, the taper is reverse audio (“C”), and second, the total measured value was 4.75M (!).

These days, it’s difficult to source any potentiometers above 1M in value, so 2MC or 5MC is out of the question. The good news is that the way this circuit is set up, a higher value only means a tiny bit more available clean range at the bottom end of the rotation, since resistance decreases as it’s turned up and full gain is equal to zero resistance.

So if you use 1MC or even 500kC, the useful range is unaffected. With 1MC you’ll theoretically lose the lower 10% of the rotation, and with 500kC you’d lose the lower 20%—but the Hot Tubes doesn’t start sounding interesting until at least 30%, so you won’t miss it.

SCHEMATIC



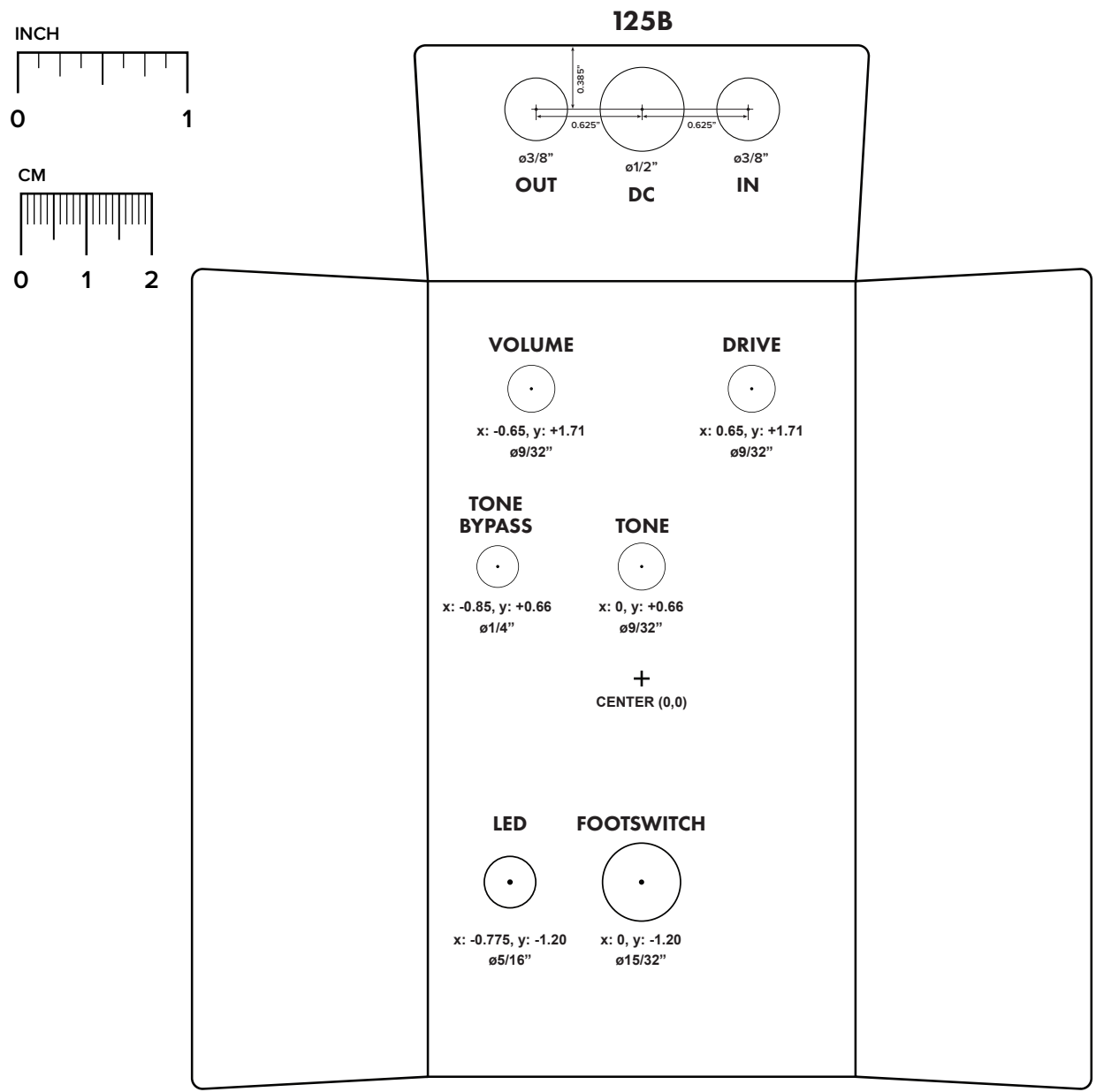
DRILL TEMPLATE

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.

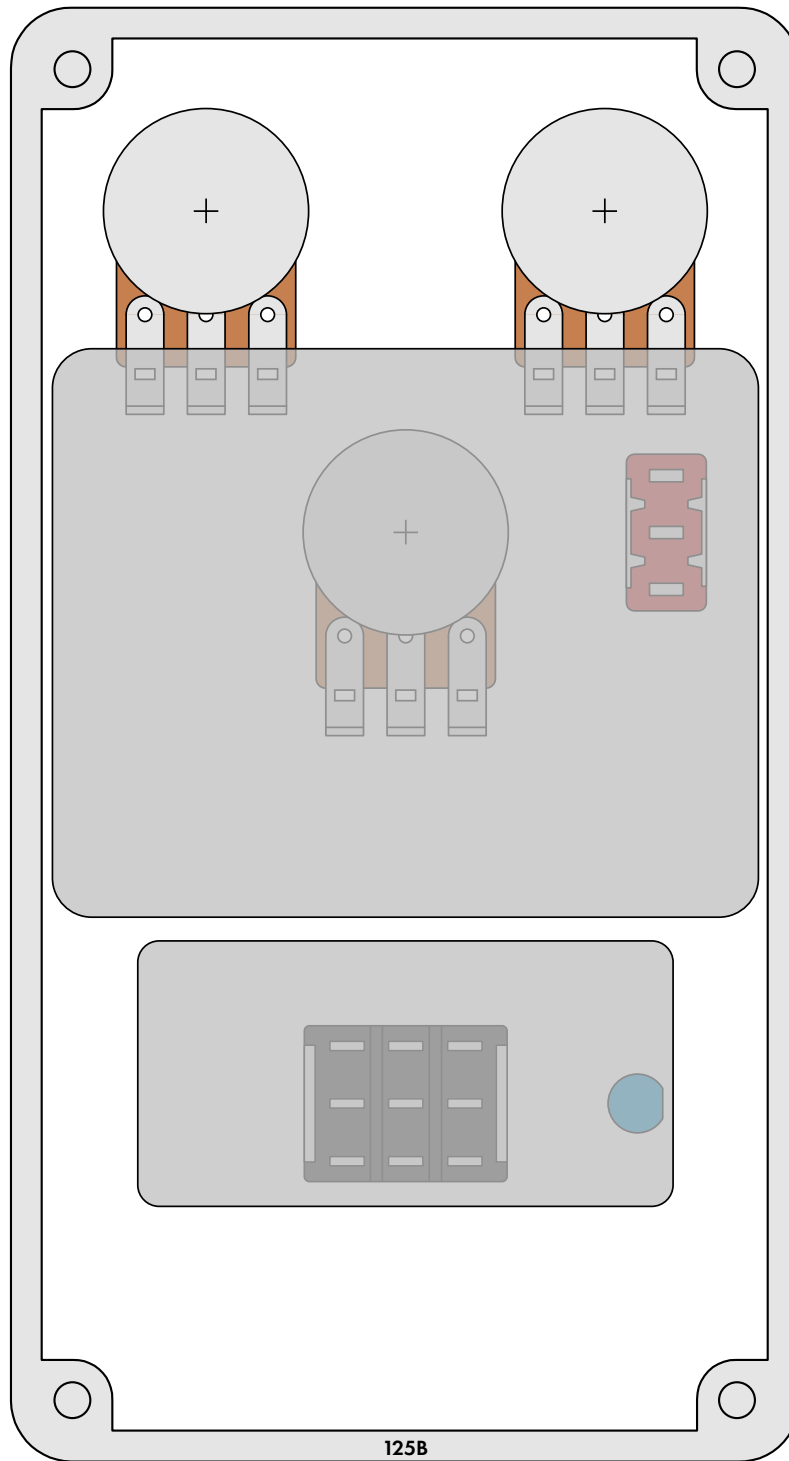
Top jack layout assumes the use of closed-frame jacks like the [Switchcraft 111X](#). If you'd rather use open-frame jacks, please refer to the Open-Frame Jack Drill Template for the top side.

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.

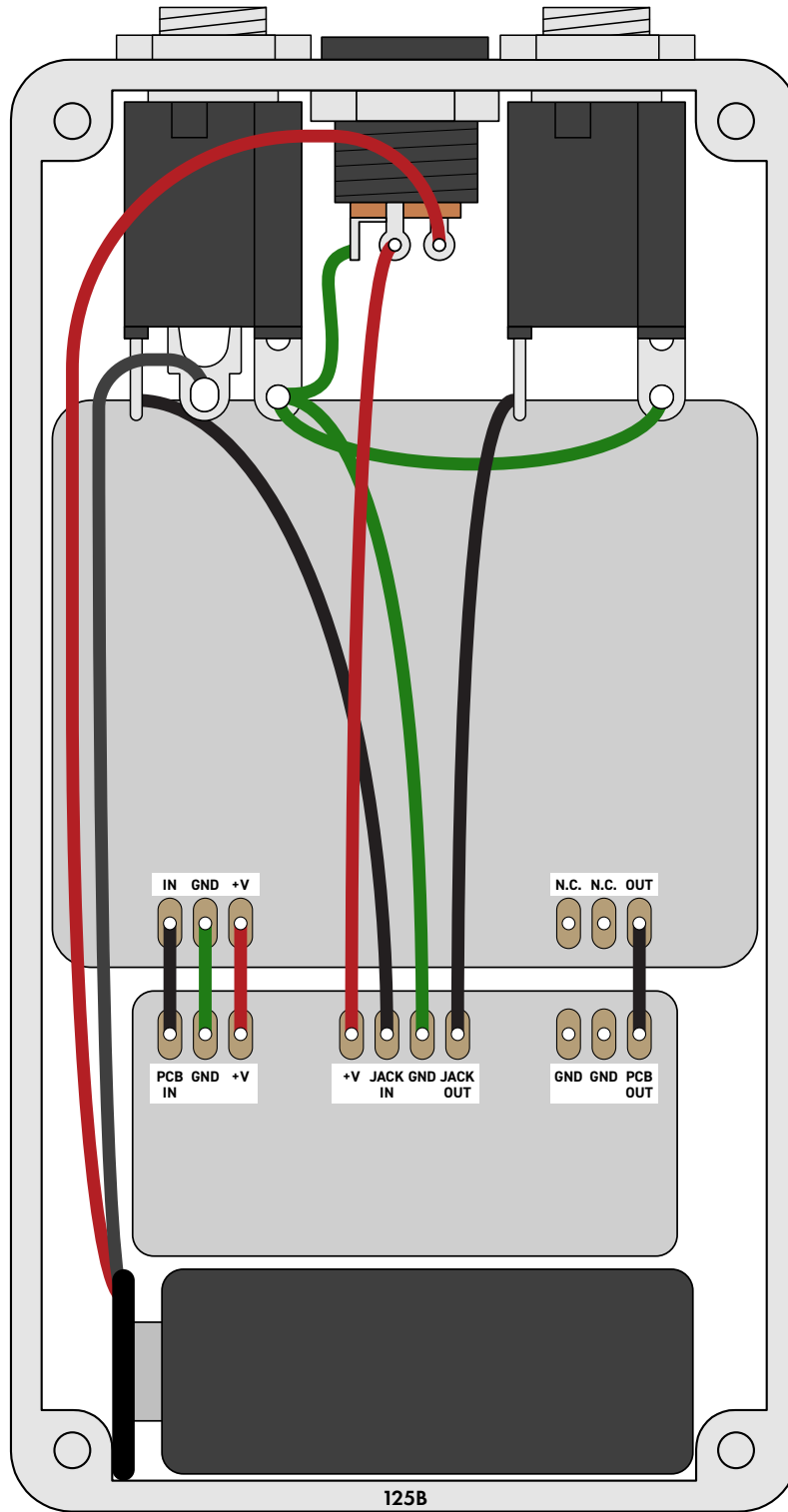


ENCLOSURE LAYOUT

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



WIRING DIAGRAM



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 cannot be 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

1.0.0 (2021-11-12)

Initial release.