PROJECT NAME

PROTOLITH

aion
DIY GUITAR EFFECTS

BASED ON
Mad Professor Stone Grey Distortion

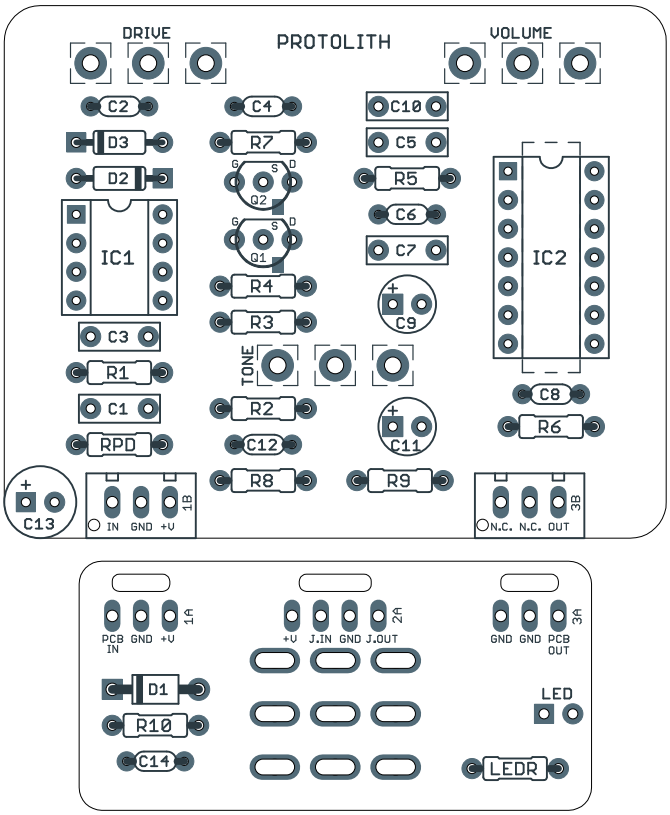
BUILD DIFFICULTY
▮▮▯▯▯ Easy

EFFECT TYPE
Overdrive / distortion

DOCUMENT VERSION
1.0.1 (2022-08-09)

PROJECT SUMMARY

Originally derived from a Japanese electronics textbook from the 1980s, it uses cascaded CMOS stages alongside traditional diode clipping for its unique drive tone.



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

TABLE OF CONTENTS

INTRODUCTION

The Protolith CMOS Distortion is based on the Mad Professor Stone Grey Distortion, a high-gain drive circuit designed by Bjorn Juhl (BJFe) and first released in 2011.

The Stone Grey Distortion was originally derived from a distortion circuit called the "CMOS Driver" from a Japanese electronics book published in the early 1980s (look for the file named "cmos-driver.gif" in this directory). It was initially called the Cliff Hanger and later the Cliff Hanger II, and sold by BJFe in extremely limited numbers beginning in 2009 before it was licensed to Mad Professor and released in 2011 as a regular production model.

Along the way, the CMOS Driver circuit was tweaked somewhat from the Japanese circuit, notably by changing the op-amp gain method, adding clipping diodes in the op-amp stage, and adding a tone control. However, the final Stone Grey circuit still strongly resembles the CMOS Driver and there is no doubt as to its origins.

Since it's intended for high-gain operation, the Stone Grey has a significant amount of low cut. This makes it very "tight" when used with certain types of amps and playing styles, but for some it's too thin. Mad Professor released the Custom Shop "Modernized Mod" in 2020 to help counteract this, adding 3 parallel parts on the solder side of the PCB to increase bass frequencies and gain. See build notes for details on building the Modernized version.

The Protolith is based on the final version of the Mad Professor Stone Grey Distortion with no modifications or circuit changes.

USAGE

The Protolith has three controls:

- **Drive** controls the gain of the op-amp gain stage that precedes the CMOS inverters.
- **Tone** is hi-cut filter that comes after the CMOS stages.
- **Volume** sets the overall output of the effect.

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	14k7	Metal film resistor, 1/4W	Can substitute 15k with no difference.
R2	470k	Metal film resistor, 1/4W	
R3	4k7	Metal film resistor, 1/4W	Use 1.1k (or 4k7 + 1k5 parallel) for Modernized mod.
R4	200k	Metal film resistor, 1/4W	
R5	470k	Metal film resistor, 1/4W	
R6	1M	Metal film resistor, 1/4W	
R7	10k	Metal film resistor, 1/4W	
R8	1M	Metal film resistor, 1/4W	
R9	1M	Metal film resistor, 1/4W	
R10	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	2n2	Film capacitor, 7.2 x 2.5mm	Use 22n (or 2n2 + 22n in parallel) for Modernized mod.
C2	100pF	MLCC capacitor, NP0/C0G	
C3	47n	Film capacitor, 7.2 x 2.5mm	
C4	15pF	MLCC capacitor, NP0/C0G	
C5	10n	Film capacitor, 7.2 x 2.5mm	
C6	100pF	MLCC capacitor, NP0/C0G	
C7	47n	Film capacitor, 7.2 x 2.5mm	Use 100n (or 47n + 47n in parallel) for Modernized mod.
C8	100pF	MLCC capacitor, NP0/C0G	
C9	4.7uF	Electrolytic capacitor, 4mm	
C10	22n	Film capacitor, 7.2 x 2.5mm	
C11	47uF	Electrolytic capacitor, 5mm	Reference voltage filter capacitor.
C12	100n	MLCC capacitor, X7R	Reference voltage filter capacitor.
C13	100uF	Electrolytic capacitor, 6.3mm	Power supply filter capacitor.
C14	100n	MLCC capacitor, X7R	Power supply filter capacitor.
D1	1N5817	Schottky diode, DO-41	
D2	1N914	Fast-switching diode, DO-35	Alternative to Q1. See build notes.
D3	1N914	Fast-switching diode, DO-35	Alternative to Q2. See build notes.
Q1	OMIT		Original uses 2N3819 as a diode. Recommended to use D2 instead.
Q2	OMIT		Original uses 2N3819 as a diode. Recommended to use D3 instead.

PARTS LIST, CONT.

PART	VALUE	TYPE	NOTES
IC1	TL051	Operational amplifier, single, DIP8	
IC1-S	DIP-8 socket	IC socket, DIP-8	
IC2	CD4069UBE	CMOS hex inverter, 6 circuit, DIP14	
IC2-S	DIP-14 socket	IC socket, DIP-14	
DRIVE	1MA	16mm right-angle PCB mount pot	
TONE	50kA	16mm right-angle PCB mount pot	
VOLUME	50kA	16mm right-angle PCB mount pot	
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

Modernized Mod

In 2020, Mad Professor released the "Modernized Mod", which was modified at the shop in Finland for more gain and more bass. Since the pedals are fully assembled offsite, the factory modification is done by adding resistors and capacitors on the solder side of the PCB in parallel with existing parts rather than actually changing existing components. Here are the changes:

PART	STOCK VALUE	PARALLEL VALUE	COMBINED VALUE	NEAREST VALUE
R3	4.7k	1.5k	1.13k	1.1k or 1.2k
C1	2n2	22n	24.2n	22n or 27n
C7	47n	47n	94n	100n

The parallel parts are just for efficiency, not because the exact combined values are important—so while the combined values are up to 10% different from the nearest standard value, it's recommended to just substitute the nearest-value parts from the last column instead of soldering them in parallel.

Thanks to Michael McSwiney for taking apart a Modernized Mod and providing the modified values.

Clipping diodes

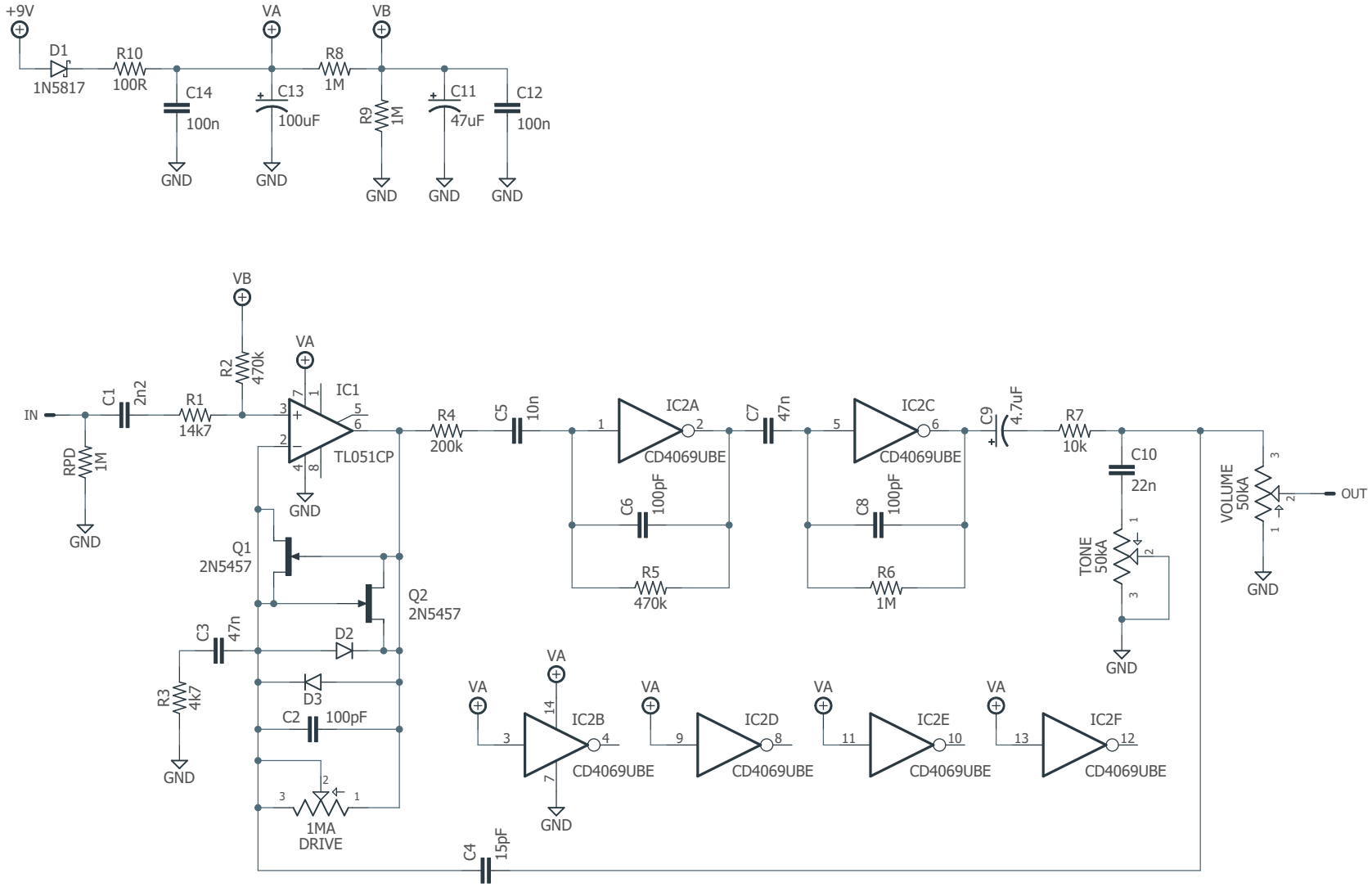
The original Stone Grey Distortion used 2N3819 JFETs wired so that the body diodes are used for clipping. These body diodes are nearly identical to the standard 1N914 type, so there is no real benefit to using JFETs here—although the ones we tested had a very slightly higher forward voltage (0.8V compared to 0.7V) so they aren't indistinguishable.

However, just be aware that a JFET body diode is just a normal silicon type, so it's not going to impart any special characteristics like true JFET clipping. Other than the forward voltage, there is no difference. Q1/Q2 and D2/D3 are in parallel with each other, so you can use either the JFETs or the diodes and omit the other pair entirely.

Op-amp selection

While the original Cliff Hanger and Cliff Hanger II have never been traced, it's been rumored (or maybe just speculated) that they used the CA3130EZ op-amp instead of the TL051 as in the Mad Professor circuit. BJFe has been known to use the 3130 in other circuits such as the Honey Bee Overdrive, so it's plausible that this is the case and worth experimenting.

SCHEMATIC


+9V
D1
1N5817
R10
100R
C14
100n
GND
VA
C13
100uF
GND
R8
1M
VB
R9
1M
GND
C11
47uF
GND
C12
100n
GND
VB
R2
470k
VA
IC1
TL051CP
GND
IN
C1
2n2
R1
14k7
RPD
1M
GND
R4
200k
C5
10n
IC2A
CD4069UBE
C6
100pF
R5
470k
C7
47n
IC2C
CD4069UBE
C8
100pF
R6
1M
C9
4.7uF
R7
10k
C10
22n
TONE
50kA
GND
VOLUME
50kA
OUT
GND
Q1
2N5457
Q2
2N5457
C3
47n
D2
D3
R3
4k7
GND
C2
100pF
1MA
DRIVE
C4
15pF
VA
IC2B
CD4069UBE
GND
VA
IC2D
CD4069UBE
VA
IC2E
CD4069UBE
VA
IC2F
CD4069UBE

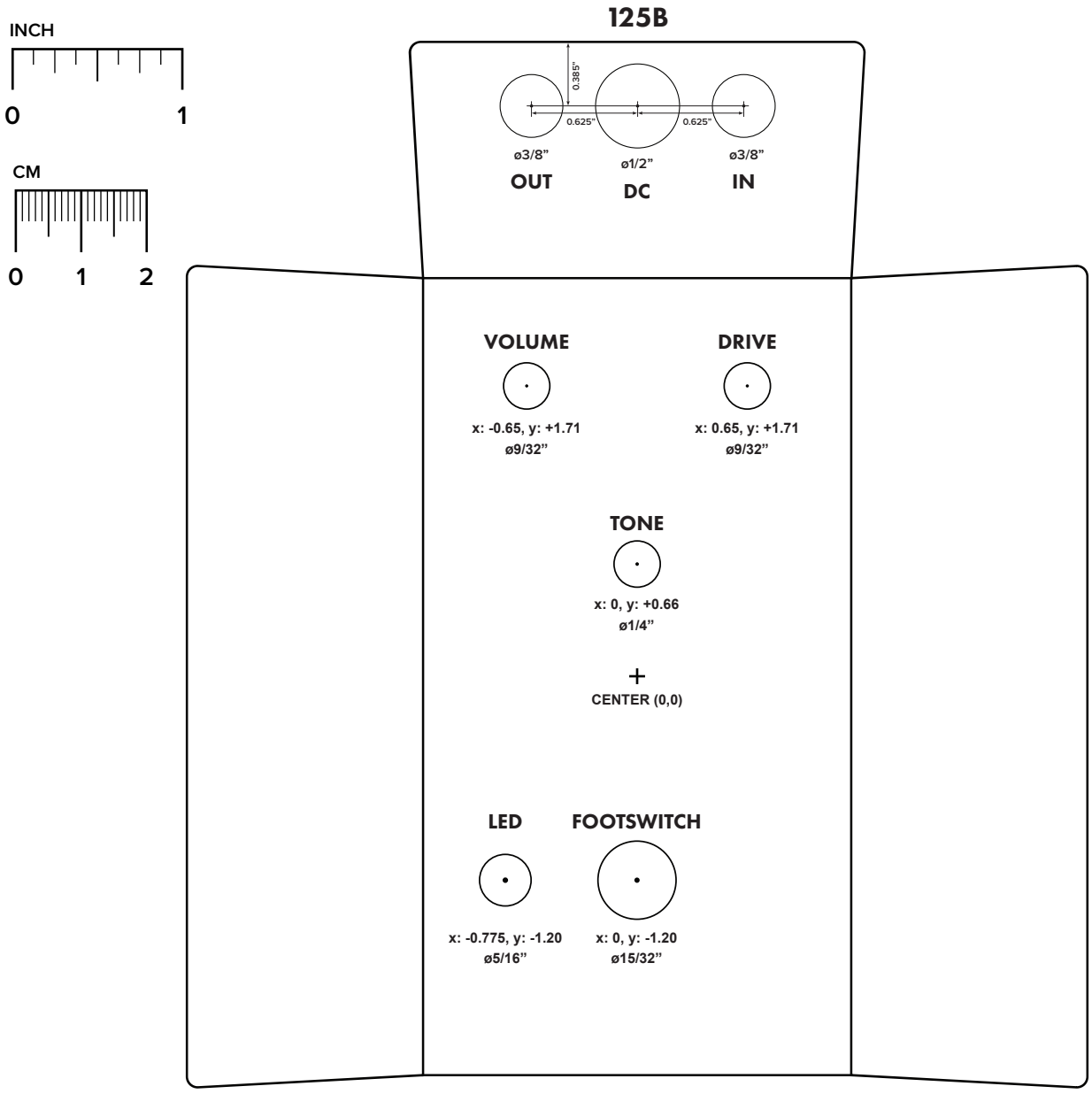
DRILL TEMPLATE

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.

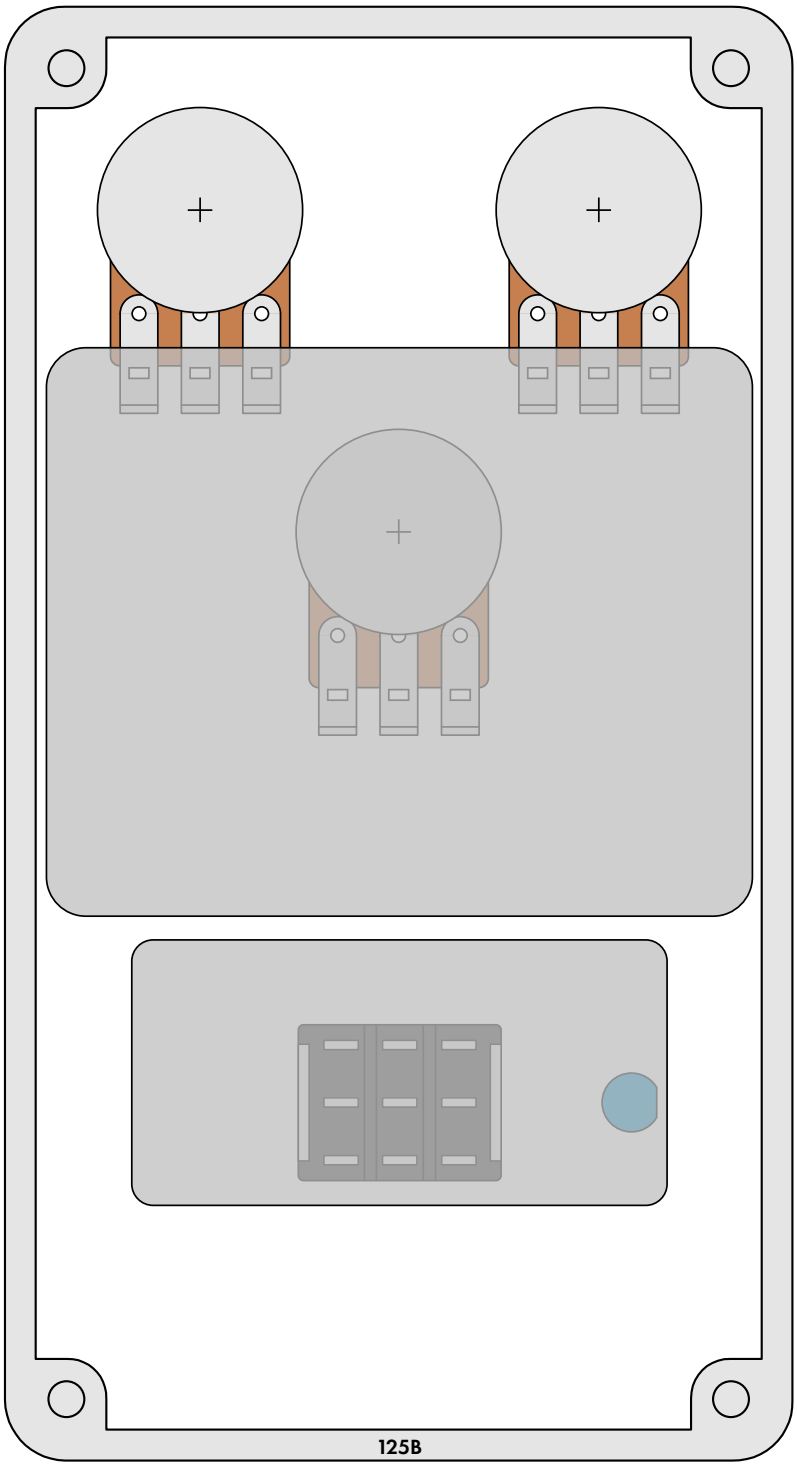
Top jack layout assumes the use of closed-frame jacks like the Switchcraft 111X. If you'd rather use open-frame jacks, please refer to the Open-Frame Jack Drill Template for the top side.

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.

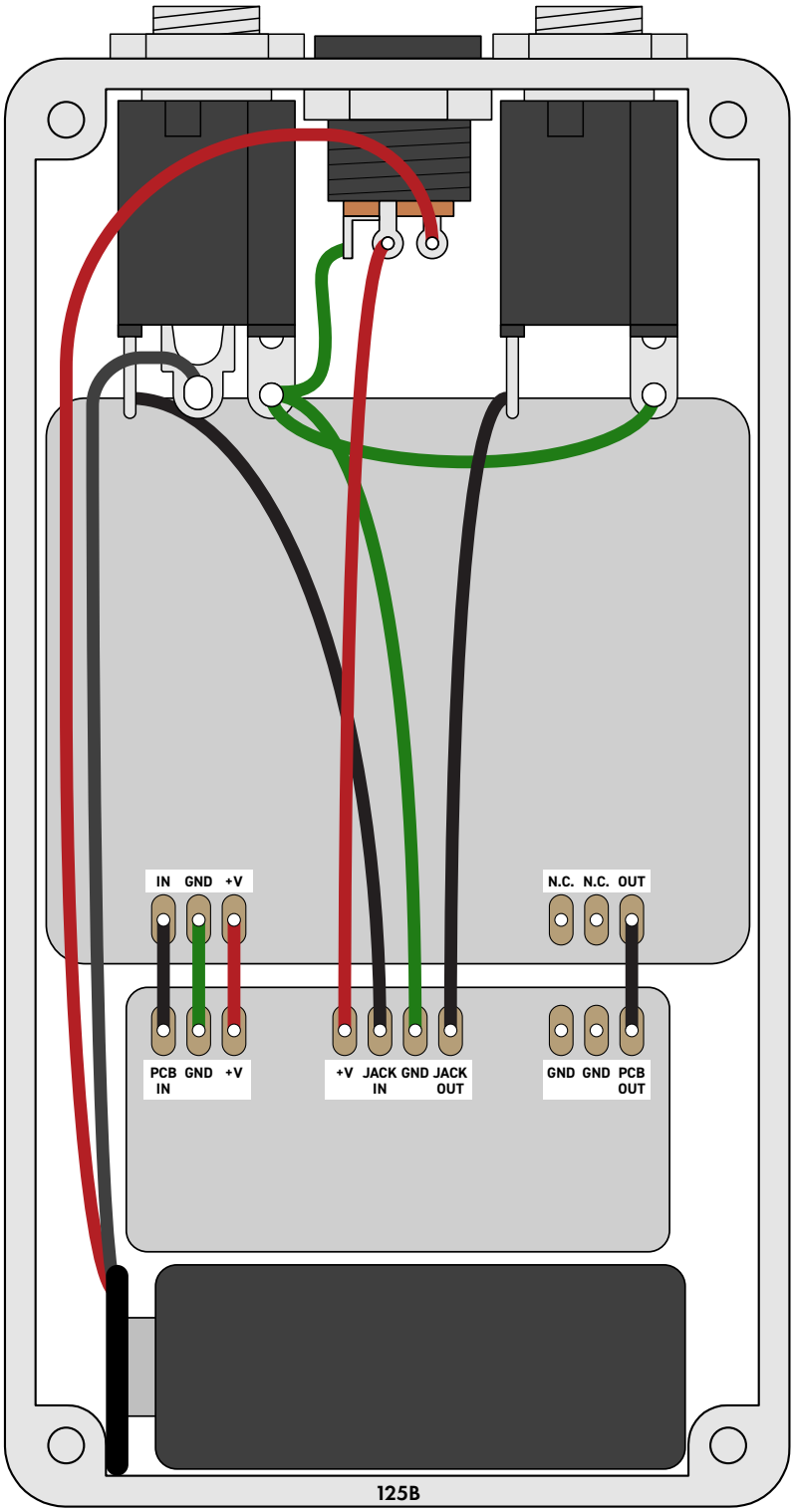


ENCLOSURE LAYOUT

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 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

1.0.1 (2022-08-09)
Added alternate parts for the Custom Shop "Modernized Mod".

1.0.0 (2021-11-12)
Initial release.