PROJECT NAME

SKYWAVE

aion DIY GUITAR EFFECTS

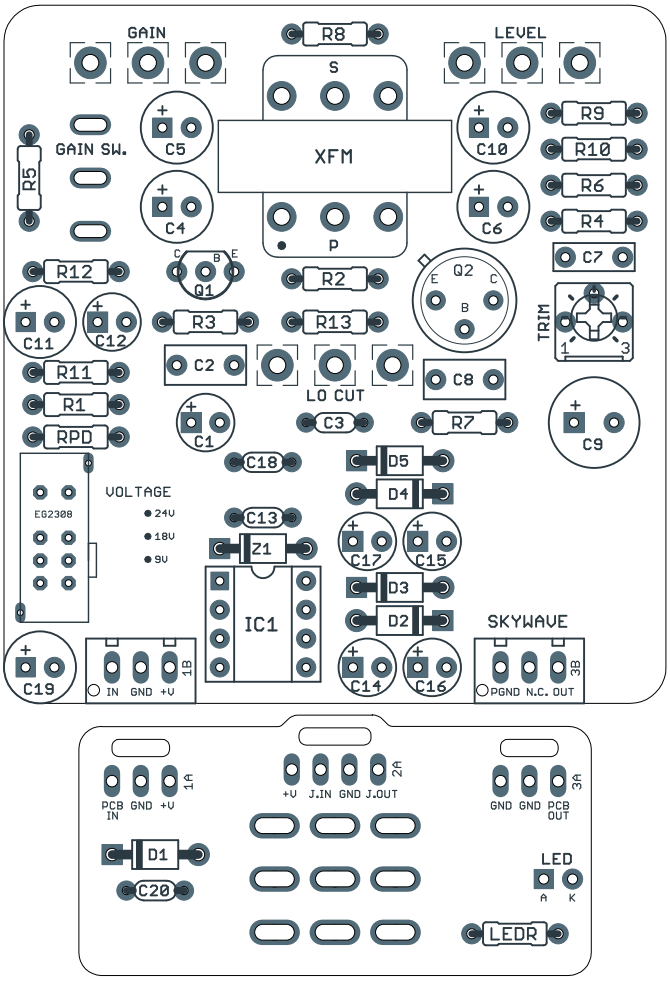
BASED ON
Hudson Electronics Broadcast

BUILD DIFFICULTY
Intermediate

EFFECT TYPE
Germanium fuzz/overdrive

DOCUMENT VERSION
1.1.0 (2024-01-21)

PROJECT SUMMARY
A hybrid silicon/germanium boost & drive pedal with a transformer-coupled output, with tones spanning the decades from vintage to modern.



Actual size is 2.3” x 2.43” (main board) and 1.78” x 0.90” (bypass board).

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INTRODUCTION

The Skywave Germanium Drive is an adaptation of the Hudson Electronics Broadcast, a germanium preamp/overdrive pedal based on vintage broadcast consoles from the 1960s. It uses a hybrid of silicon and germanium transistors in class-A configuration, plus a transformer at the output that saturates on higher drive levels.

The Broadcast was originally released in 2015, and has since had a few new variants including one that runs on 24V and another with a second footswitchable gain mode with its own level control. (There was also a limited-run version that combined both of these features into one.)

The Skywave is primarily based on the original Broadcast, but it adds a voltage-tripler circuit to allow selectable 18V or 24V power from a standard 9V supply. It also incorporates a 3-way gain switch, adding an extra position adapted from the 24V version of the Broadcast.

USAGE

The Skywave has three knobs, one toggle, and one internal slide switch:

- **Gain** sets the amount of feedback from the germanium transistor stage that is fed back into the initial silicon transistor stage.
- **Low Cut** cuts the bass frequencies as it's turned up, going from mushy or flabby to tight, with the right mix of fullness somewhere in between.
- **Level** is an output volume control.
- **Gain Mode** (toggle) selects between three gain ratios for the first transistor stage—low, medium and high—which affect the range of the Gain knob.
- **Voltage** (slide switch) selects between 9V, 18V and 24V supply voltages.

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	220k	Metal film resistor, 1/4W	
R2	5k6	Metal film resistor, 1/4W	
R3	5k6	Metal film resistor, 1/4W	
R4	68R	Metal film resistor, 1/4W	
R5	470R	Metal film resistor, 1/4W	
R6	5k6	Metal film resistor, 1/4W	
R7	4k7	Metal film resistor, 1/4W	
R8	5k6	Metal film resistor, 1/4W	
R9	15k	Metal film resistor, 1/4W	
R10	33k	Metal film resistor, 1/4W	
R11	1k	Metal film resistor, 1/4W	
R12	56k	Metal film resistor, 1/4W	
R13	33k	Metal film resistor, 1/4W	
RPD	1M	Metal film resistor, 1/4W	Input pull-down resistor.
LEDR	10k	Metal film resistor, 1/4W	LED current-limiting resistor. Adjust value to change LED brightness.
C1	OMIT	Electrolytic capacitor, 5mm	Recommended to omit and use C2 instead. See build notes.
C2	1uF	Film capacitor, 7.2 x 3.5mm	Film alternative to C1. See build notes.
C3	330pF	MLCC capacitor, NP0/C0G	
C4	100uF	Electrolytic capacitor, 6.3mm	
C5	100uF	Electrolytic capacitor, 6.3mm	
C6	100uF	Electrolytic capacitor, 6.3mm	
C7	1n	Film capacitor, 7.2 x 2.5mm	
C8	330n	Film capacitor, 7.2 x 2.5mm	
C9	330uF/35V	Electrolytic capacitor, 8mm	See build notes for sourcing information.
C10	100uF	Electrolytic capacitor, 6.3mm	
C11	120uF/35V	Electrolytic capacitor, 6.3mm	See build notes for sourcing information.
C12	10uF	Electrolytic capacitor, 5mm	Power supply filter capacitor.
C13	470n	MLCC capacitor, X7R	Power supply filter capacitor.
C14	10uF	Electrolytic capacitor, 5mm	Power supply filter capacitor.
C15	10uF	Electrolytic capacitor, 5mm	Power supply filter capacitor.
C16	10uF/35V	Electrolytic capacitor, 5mm	Power supply filter capacitor. 35V minimum voltage rating.
C17	10uF/35V	Electrolytic capacitor, 5mm	Power supply filter capacitor. 35V minimum voltage rating.

PARTS LIST, CONT.

PART	VALUE	TYPE	NOTES
C18	470n	MLCC capacitor, X7R	Power supply filter capacitor.
C19	220uF	Electrolytic capacitor, 6.3mm	Power supply filter capacitor.
C20	100n	MLCC capacitor, X7R	Power supply filter capacitor.
D1	1N5817	Schottky diode, DO-41	
D2	1N4001	Rectifier diode, DO-41	
D3	1N4001	Rectifier diode, DO-41	
D4	1N4001	Rectifier diode, DO-41	
D5	1N4001	Rectifier diode, DO-41	
Z1	1N4742A	Zener diode, 12V, DO-41	
Q1	2N5088	BJT transistor, NPN, TO-92	Original uses BC549C, but 2N5088 is the USA equivalent.
Q2	2N404A	Transistor, PNP germanium	See build notes. Original uses either Russian MP20 or NTE 2N404A.
IC1	LT1054CP	Operational amplifier, single, DIP8	Can also use TC1044SCPA.
IC1-S	DIP-8 socket	IC socket, DIP-8	
TRIM	1k trimmer	Trimmer, 10%, 1/4"	
GAIN	250kA	16mm right-angle PCB mount pot	
LO CUT	10kA	16mm right-angle PCB mount pot	
LEVEL	100kA	16mm right-angle PCB mount pot	
GAIN SW.	SPDT cntr off	Toggle switch, SPDT on-off-on	
XFM	TY-141P	Transformer, audio, 10KCT/10KCT	Triad Magnetics TY-141P.
VOLTAGE	DP3T slide	Slide switch, DP3T	E-Switch EG2308
LED	5mm	LED, 5mm, red diffused	
IN	1/4" mono	1/4" phone jack, closed frame	Switchcraft 111X 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

Silicon transistor selection

The Broadcast uses a BC549C for Q1, the NPN transistor. The Skywave layout uses the USA E-B-C convention, so the 2N5088 is specified as an equivalent, but if you want to use the BC549C then just rotate it 180 degrees from the silkscreen.

Germanium transistor selection

The manufacturer has used different types of germanium transistors for Q2 across the different models. The most common type is the Russian МП20 (MP20), which are typically in the range of 60 to 80 hFE with less than 100µA of leakage current. Others including the Dual Broadcast use the NTE 2N404A, a new-production germanium that is anywhere from 50 to 250 hFE. The 2N404A taken from a Broadcast in this video measured at 216 hFE with 125µA leakage.

With this said, given the ranges in the originals, the gain of the germanium transistor likely does not make a big impact on the sound. Just use what you can find, taking care that the leakage isn't too high (perhaps 200-300µA maximum).

C1 and C2 input capacitors

The original Broadcast uses a 10µF electrolytic capacitor at the input. Film is generally better than electrolytic for signal coupling, and 1µF is more than enough in this application, so for the Skywave project we have included C2 in parallel with C1. It's recommended to use C2 and omit C1 altogether, but if you want it to be exactly like the original then use 10µF for C1 and omit C2. You can also use both together if you want.

C1 orientation

On version 1.0 of the Skywave, the C1 electrolytic capacitor was reversed, with the positive side pointing away from Q1's base. This won't cause any harm if it's reversed due to the low currents involved, but it's possible it could degrade more quickly in the long term (though we're still talking in terms of many years if not decades) so it's better to have it oriented properly.

If you have version 1.1, this capacitor's orientation has been updated on the PCB. This version will say "v1.1" in the lower right next to Skywave. For version 1.0, which does not have a version number, C1 should be reversed from what is shown on the board so the positive side faces to the right.

Gain trimmer

The internal gain trimmer sets the gain of the silicon transistor in the first amplifier stage. This gain setting applies to all three toggle switch modes. As you turn it up, resistance is reduced and the transistor gain increases.

This is purely a set-to-taste control, not a bias, so there is no calibration procedure or target voltage. In the original Broadcast, it's set to the minimum position by default, but is intended to user-adjustable. Listen to all three modes of the gain switch across the range of the Gain knob, and adjust the trimmer until each mode is useful.

C9 capacitor (330µF)

The Broadcast uses a 330µF electrolytic capacitor for C9, the low-cut section. It's unlikely that there would be an audible difference between this and a lower value such as 220µF, but we'll assume they chose it for a reason even though it is a somewhat uncommon value.

The Mouser parts list provides a part number that will fit the Skywave layout, but if you source a different one, it may be physically larger than the one we designed around. If this is the case, there is plenty of space for it to be folded over and lay flat on the board if needed.

C11 capacitor (120µF)

C11 is a 120µF capacitor. This is a very uncommon value. We've listed a part in the Mouser spreadsheet that is the correct size and voltage, so it's recommended to use that one if you can. However, if it's out of stock or you are sourcing from elsewhere, you can substitute a 100µF. It's only used for power filtering, so there won't be any impact on the sound.

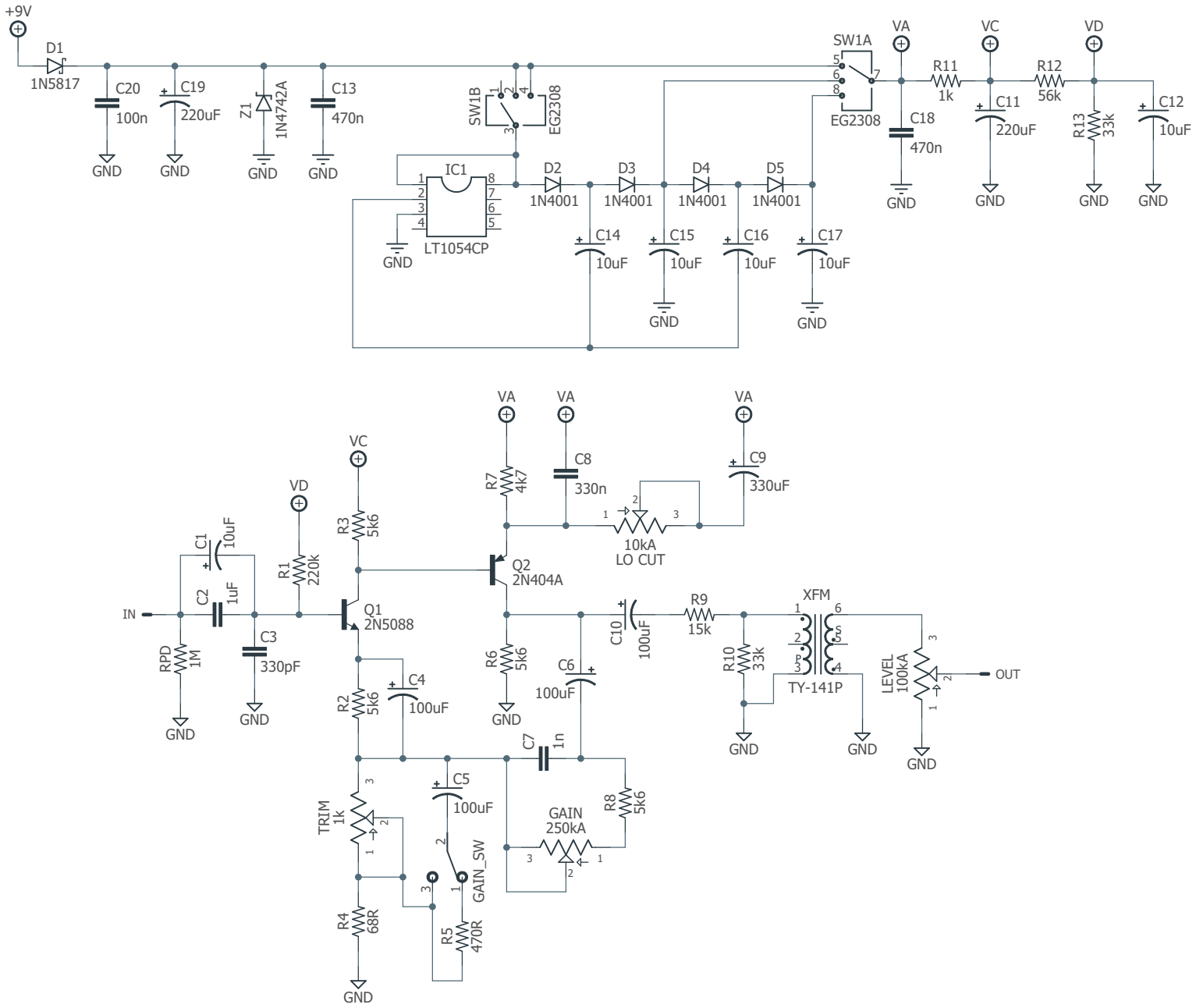
More capacitance is fine as well, but we weren't able to find any that were small enough to fit the PCB layout (maximum diameter of 6.3mm) so it may be difficult.

Capacitor voltage

Make sure C9, C11, C16 and C17 are rated for at least 35V since they connect directly to the positive supply or very close to it. Many of the capacitors we routinely use for pedals are only rated for 25V, especially the ones with higher capacitance, but it's possible that the nominally-24V supply voltage may actually exceed 25V depending on the input voltage—not to mention that it's bad practice to use components near the upper end of their specification like that.

The Mouser parts spreadsheet lists parts with the correct minimum voltage, so once again it's recommended to use those if you can. If not, check the size first and ensure that they will fit the PCB. All capacitors other than C9 have a maximum diameter of 6.3mm.

SCHEMATIC


+9V
D1
1N5817
C20
100n
C19
220uF
Z1
1N4742A
C13
470n
SW1B
EG2308
SW1A
EG2308
VA
VC
VD
R11
1k
R12
56k
C18
470n
C11
220uF
R13
33k
C12
10uF
IC1
LT1054CP
D2
D3
D4
D5
1N4001
C14
C15
C16
C17
10uF
GND
C1
10uF
C2
1uF
C3
330pF
R1
220k
R2
5k6
R3
5k6
R4
68R
R5
470R
R6
5k6
R7
4k7
R8
5k6
RPD
1M
C4
100uF
C5
100uF
C6
100uF
C7
1n
C8
330n
C9
330uF
10kA
LO CUT
Q1
2N5088
Q2
2N404A
IN
TRIM
1k
GAIN
250kA
GAIN_SW
C10
100uF
R9
15k
R10
33k
XFM
TY-141P
LEVEL
100kA
OUT

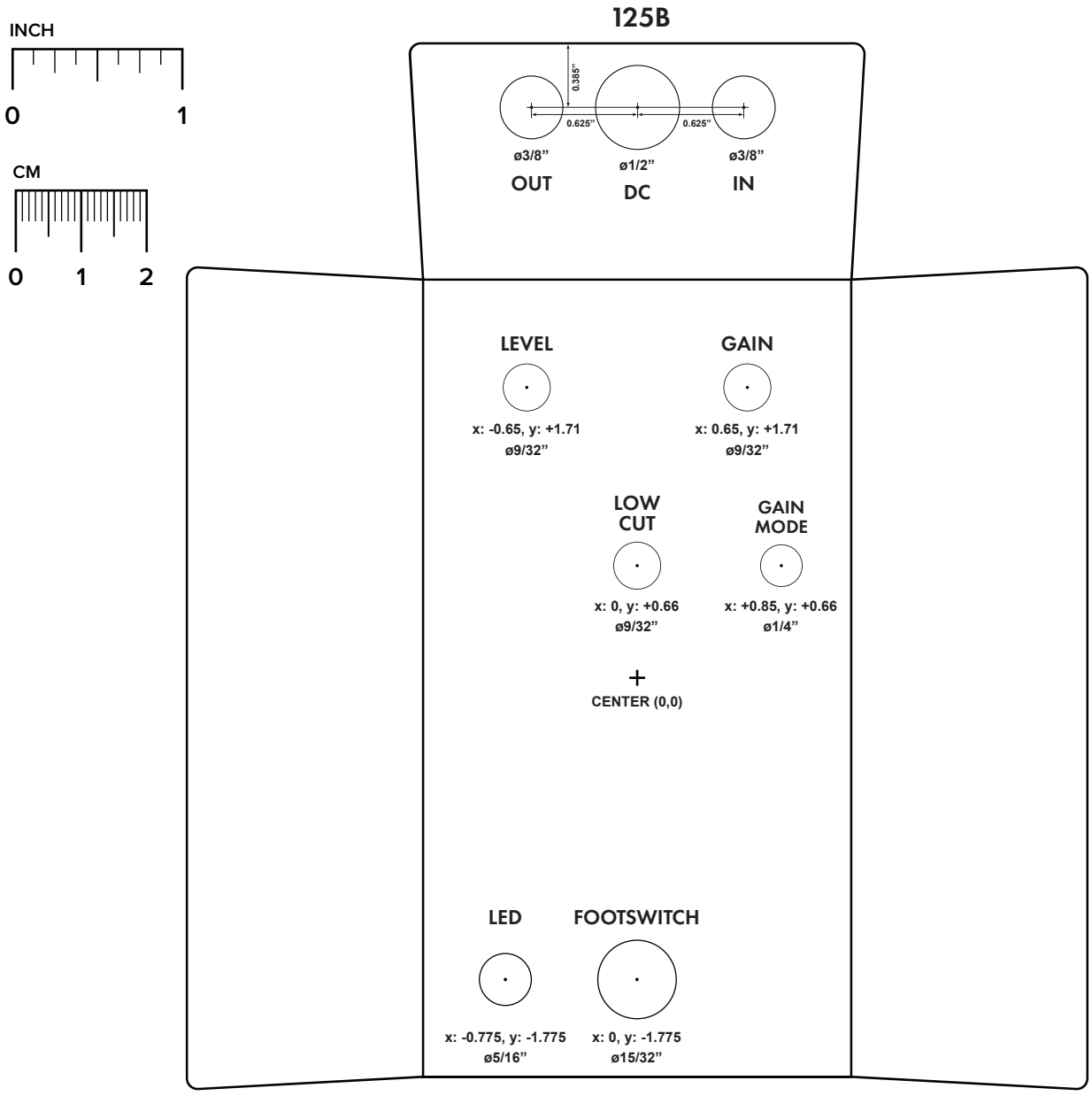
DRILL TEMPLATE

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.

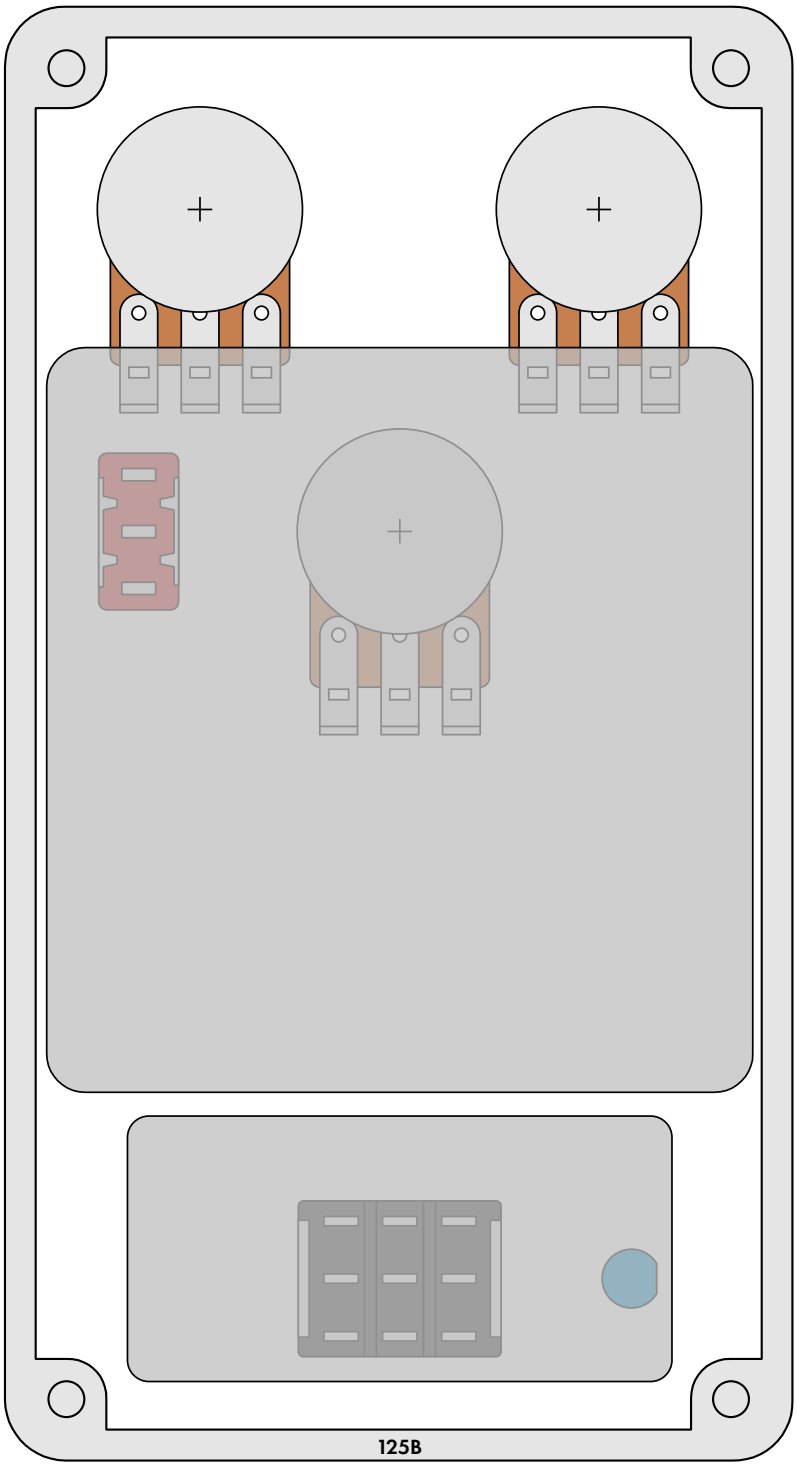
Top jack layout assumes the use of closed-frame jacks like the Switchcraft 111X. If you'd rather use open-frame jacks, please refer to the Open-Frame Jack Drill Template for the top side.

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.

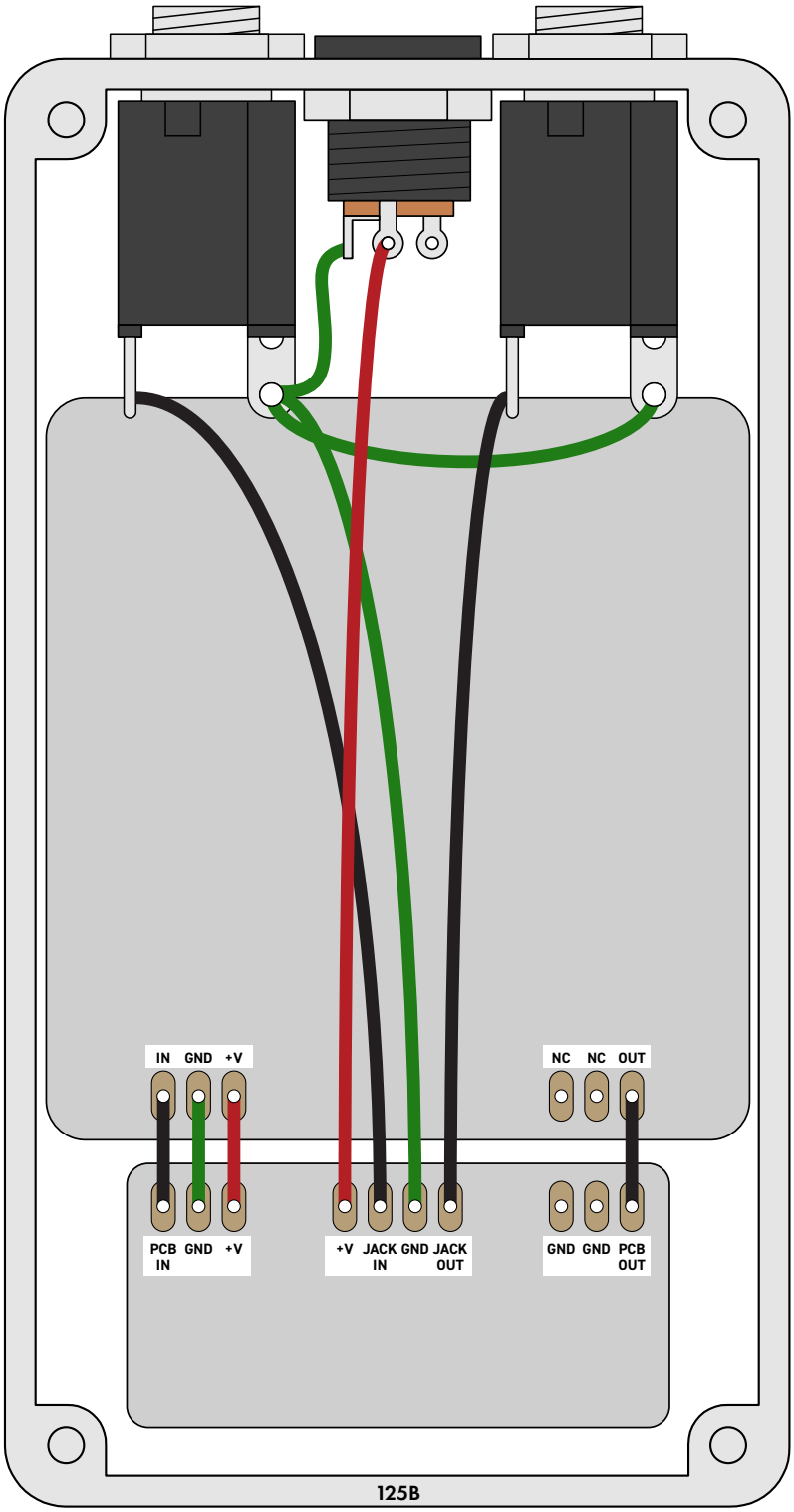


ENCLOSURE LAYOUT

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

1.1.0 (2024-01-21)
Reversed the orientation of the C1 input capacitor.

1.0.0 (2023-07-04)
Initial release.