PROJECT NAME

HYPERCUBE

aion DIY GUITAR EFFECTS

BASED ON
BOSS® FZ-2 Hyper Fuzz

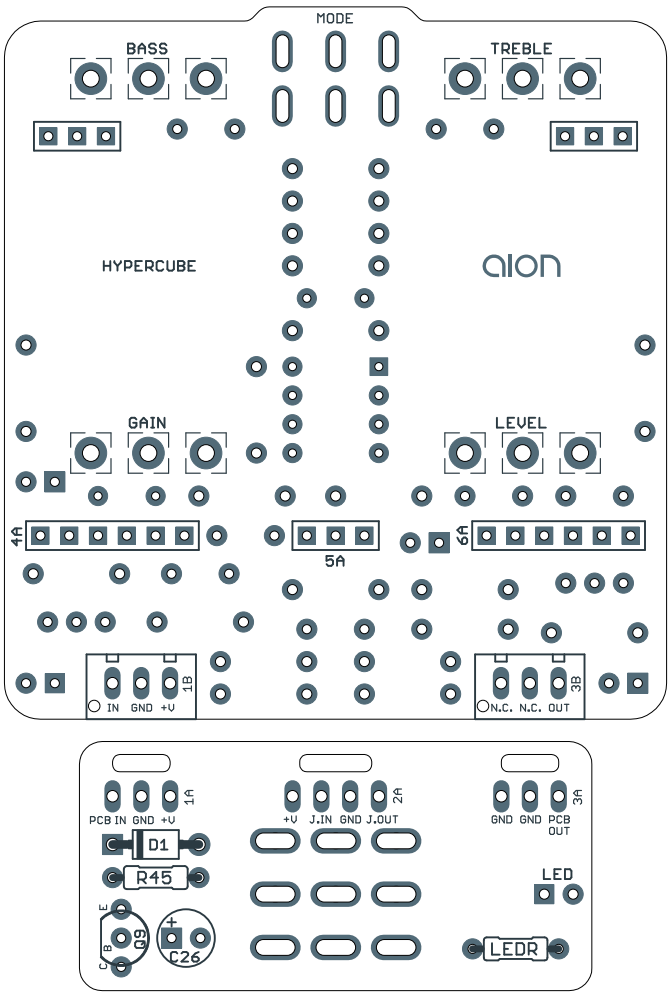
BUILD DIFFICULTY
Advanced

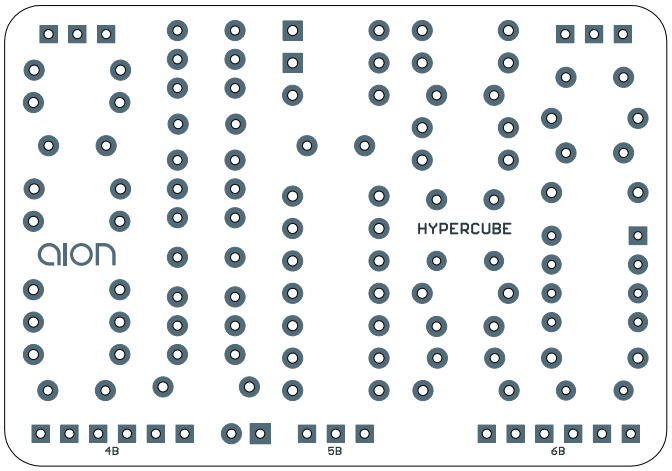
EFFECT TYPE
Fuzz / Distortion

DOCUMENT VERSION
1.0.0 (2021-05-28)

PROJECT SUMMARY

A vintage-flavored octave fuzz with some modern improvements, this pedal has enjoyed increased popularity in recent years due to the association with bands such as Electric Wizard and Deftones.





Actual size is 2.3" x 1.86" (bottom board), 2.3" x 1.6" (top board), and 1.78" x 0.87" (bypass board).

Since most of the components are mounted on the reverse side, a diagram of this side can be found on page 11.

IMPORTANT NOTE

This pedal has a specialized method of assembly that is different from most DIY builds, and because of this there are a lot of ways to make mistakes that are hard to fix. Please make sure to familiarize yourself with the assembly instructions on pages **6-7** before installing any of the components.

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INTRODUCTION

The Hypercube Fuzz/Distortion is an adaptation of the BOSS FZ-2 Hyper Fuzz from 1993. The FZ-2 was not particularly successful and was discontinued without much fanfare a few years later in 1997, but has lately risen in popularity as one of Boss's rare cult classics, in the same category as the HM-2 Heavy Metal or DC-2 Dimension C. Today, they routinely sell for USD$250 or more.

A switch selects between Fuzz I (flat) and Fuzz II (scooped) tone modes, and a third mode called Gain Boost that disengages the middle fuzz stages and connects the boost directly to the active tone stack.

The Hypercube is an exact replica of the FZ-2 in effect mode. The buffered bypass has been converted to true bypass, but the rest is the same.

The rotary switch has been replaced by a 3-way toggle switch, with one slight difference: in Gain Boost mode, the original circuit disables the volume control, presumably because it is somewhat redundant with the gain (boost) control—but it's confusing and causes a large volume jump when switching between fuzz and boost.

The Hypercube preserves the output volume functionality across all three positions. If you want to use Gain Boost mode exactly the way it is in the original unit, just turn the volume control all the way up while in that mode.

USAGE

The Hypercube has the following controls:

- **Gain** controls the gain level of the initial boost stage, which pushes the fuzz stage when in Fuzz I or Fuzz II modes.
- **Bass** allows frequencies to be boosted or cut at the 100 Hz band.
- **Treble** allows frequencies to be boosted or cut at the 3.2kHz band.
- **Volume** is the overall output.
- **Mode** (toggle switch) allows switching between Gain Boost (clean boost), Fuzz I (flat), and Fuzz II (scooped) modes.

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 (most 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	10k	Metal film resistor, 1/4W	
R2	1M	Metal film resistor, 1/4W	
R3	10k	Metal film resistor, 1/4W	
R4	22k	Metal film resistor, 1/4W	
R5	4k7	Metal film resistor, 1/4W	
R6	2k2	Metal film resistor, 1/4W	
R7	1k5	Metal film resistor, 1/4W	
R8	2k2	Metal film resistor, 1/4W	
R9	1k	Metal film resistor, 1/4W	
R10	10k	Metal film resistor, 1/4W	
R11	220k	Metal film resistor, 1/4W	
R12	100k	Metal film resistor, 1/4W	
R13	4k7	Metal film resistor, 1/4W	
R14	10k	Metal film resistor, 1/4W	
R15	1k	Metal film resistor, 1/4W	
R16	100k	Metal film resistor, 1/4W	
R17	27k	Metal film resistor, 1/4W	
R18	1k	Metal film resistor, 1/4W	
R19	100k	Metal film resistor, 1/4W	
R20	27k	Metal film resistor, 1/4W	
R21	1k8	Metal film resistor, 1/4W	
R22	10k	Metal film resistor, 1/4W	
R23	10k	Metal film resistor, 1/4W	
R24	47k	Metal film resistor, 1/4W	
R25	10k	Metal film resistor, 1/4W	
R26	10k	Metal film resistor, 1/4W	
R27	120k	Metal film resistor, 1/4W	
R28	1k	Metal film resistor, 1/4W	
R29	10k	Metal film resistor, 1/4W	
R30	10k	Metal film resistor, 1/4W	
R31	27k	Metal film resistor, 1/4W	

PARTS LIST, CONT.

PART	VALUE	TYPE	NOTES
R32	1k	Metal film resistor, 1/4W	
R33	100k	Metal film resistor, 1/4W	
R34	10k	Metal film resistor, 1/4W	
R35	3k3	Metal film resistor, 1/4W	
R36	3k3	Metal film resistor, 1/4W	
R37	100k	Metal film resistor, 1/4W	
R38	10k	Metal film resistor, 1/4W	
R39	100k	Metal film resistor, 1/4W	
R40	10k	Metal film resistor, 1/4W	
R41	100k	Metal film resistor, 1/4W	
R42	1k	Metal film resistor, 1/4W	
R43	10k	Metal film resistor, 1/4W	
R44	10k	Metal film resistor, 1/4W	
R45	2k2	Metal film resistor, 1/4W	
RPD	2M2	Metal film resistor, 1/4W	
LEDR	4k7	Metal film resistor, 1/4W	
C1	47n	Film capacitor, 7.2 x 2.5mm	
C2	1uF	Film capacitor, 7.2 x 3.5mm	
C3	2.2uF	Electrolytic capacitor, 4mm	
C4	47pF	MLCC capacitor, NP0/C0G	
C5	33n	Film capacitor, 7.2 x 2.5mm	
C6	1uF	Film capacitor, 7.2 x 3.5mm	
C7	1uF	Film capacitor, 7.2 x 3.5mm	
C8	1uF	Film capacitor, 7.2 x 3.5mm	
C9	47uF	Electrolytic capacitor, 5mm	
C10	1uF	Film capacitor, 7.2 x 3.5mm	
C11	1n	Film capacitor, 7.2 x 2.5mm	
C12	47n	Film capacitor, 7.2 x 2.5mm	
C13	4n7	Film capacitor, 7.2 x 2.5mm	
C14	1uF	Film capacitor, 7.2 x 3.5mm	
C15	47pF	MLCC capacitor, NP0/C0G	
C16	15n	Film capacitor, 7.2 x 2.5mm	
C17	1uF	Film capacitor, 7.2 x 3.5mm	
C18	47pF	MLCC capacitor, NP0/C0G	
C19	15n	Film capacitor, 7.2 x 2.5mm	
C20	150n	Film capacitor, 7.2 x 2.5mm	

PARTS LIST, CONT.

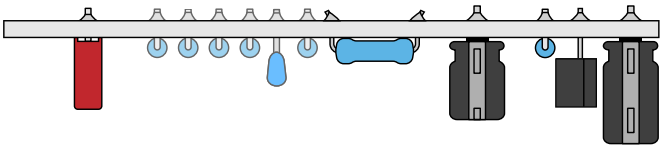
PART	VALUE	TYPE	NOTES
C21	47n	Film capacitor, 7.2 x 2.5mm	
C22	47pF	MLCC capacitor, NP0/C0G	
C23	1uF	Film capacitor, 7.2 x 3.5mm	
C24	1uF	Film capacitor, 7.2 x 3.5mm	
C25	10uF	Electrolytic capacitor, 5mm	
C26	47uF	Electrolytic capacitor, 5mm	Power supply filter capacitor.
C27	100uF	Electrolytic capacitor, 6.3mm	Power supply filter capacitor.
C28	47uF	Electrolytic capacitor, 5mm	Reference voltage filter capacitor.
D1	1N5817	Schottky diode, DO-41	
D2	1N914	Fast-switching diode, DO-35	
D3	1N914	Fast-switching diode, DO-35	
Q1	J201	JFET, N-channel, SOT-23	Substitute. Original uses 2SK184-GR.
Q2	J201	JFET, N-channel, SOT-23	Substitute. Original uses 2SK184-GR.
Q3	J201	JFET, N-channel, SOT-23	Substitute. Original uses 2SK184-GR.
Q4	2N3906	BJT transistor, PNP, TO-92	Substitute. Original uses 2SA1335-GR.
Q5	2N5088	BJT transistor, NPN, TO-92	Substitute. Original uses 2SC3378-GR.
Q6	2N5088	BJT transistor, NPN, TO-92	Substitute. Original uses 2SC3378-GR.
Q7	2N5088	BJT transistor, NPN, TO-92	Substitute. Original uses 2SC3378-GR.
Q8	2N5088	BJT transistor, NPN, TO-92	Substitute. Original uses 2SC3378-GR.
Q9	2N5088	BJT transistor, NPN, TO-92	Substitute. Original uses 2SC3378-GR.
IC1	JRC4558D	Operational amplifier, DIP8	
IC1-S	DIP-8 socket	IC socket, DIP-8	
IC2	JRC4558D	Operational amplifier, DIP8	
IC2-S	DIP-8 socket	IC socket, DIP-8	
BASS	50kB	16mm right-angle PCB mount pot	
TREBLE	50kB	16mm right-angle PCB mount pot	
GAIN	50kA	16mm right-angle PCB mount pot	
LEVEL	50kA	16mm right-angle PCB mount pot	
MODE	DPDT on-on-on	Toggle switch, DPDT on-on-on	
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.

ASSEMBLY INSTRUCTIONS

The Hypercube uses a unique “sandwich” PCB design so that it can fit inside a 125B enclosure. It’s not particularly difficult, but there’s only one right way to put it together and several wrong ways that may ruin your build if you’re not careful. Make sure you have a good understanding of what the end result should look like before you begin installing any components.

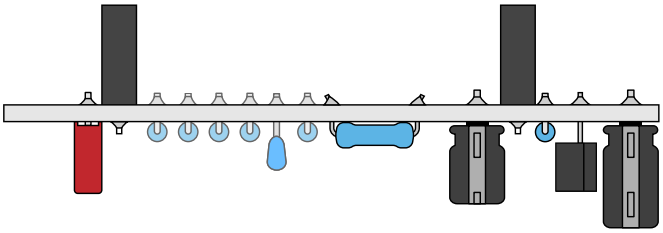
Step 1

Populate the PCBs according to the silkscreen. Unlike most other Aion FX projects, the components mount on the underside of both the main and secondary boards, the same side as the potentiometers and toggle switch. (The components on the bypass PCB mount on the top side as with other projects.)



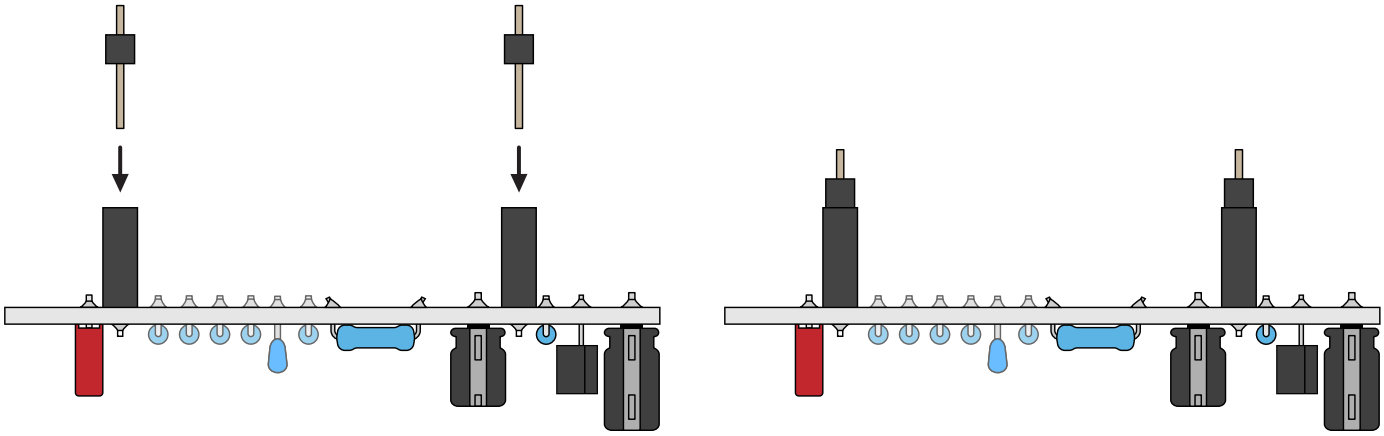
Step 2

Install the header sockets on the bottom PCB. It’s recommended to turn the PCB upside down to hold all of them in place while soldering. Solder one leg of each header, then check them from the side to make sure they are straight and perpendicular with the PCB before soldering the remaining legs. If any of them are crooked, reflow the solder and adjust them as needed.



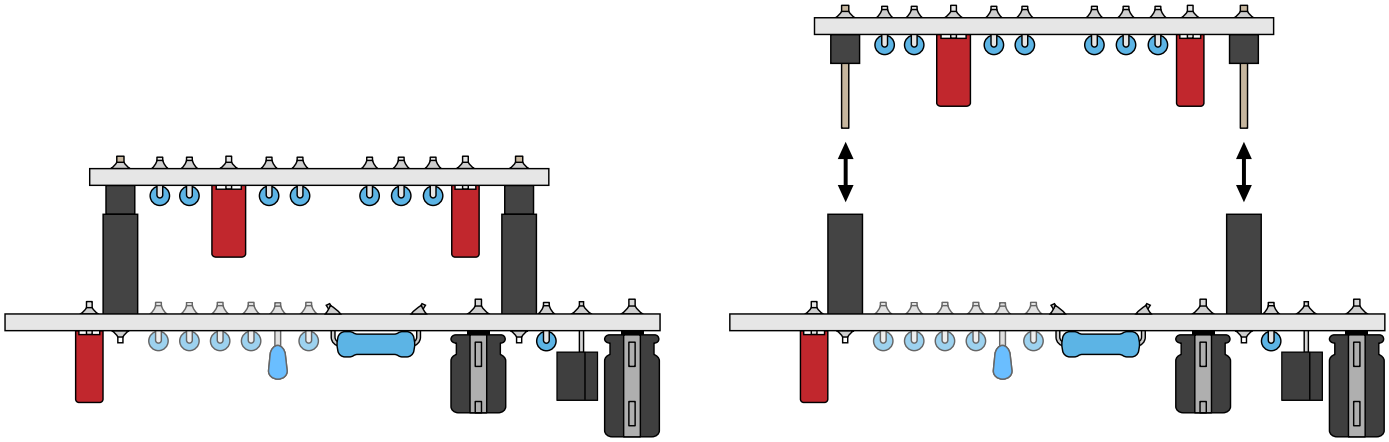
Step 3

With the header sockets installed to the bottom PCB, insert the male headers. The long side goes into the socket and the short side faces up.



Step 4

With the male header sockets in place, put the top PCB in position, components facing down. (The headers and pins should always mount to the side with the rectangular outline on the PCB silkscreen.) Once everything is in place, solder the pins to the top PCB. The top PCB can then be removed and set aside until final assembly.



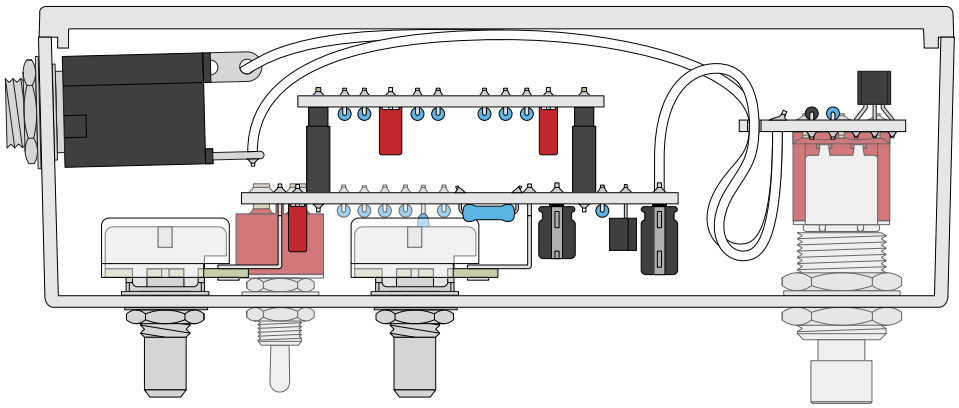
It's done in this order so that that the pins are perfectly coupled with the headers. If they were soldered separately from each other, the slight misalignments between the pins and headers would create stress that could potentially cause cracked solder joints over time.

From here, you can proceed with the rest of the build as normal. It's recommended to first attach the potentiometers and switch to the drilled enclosure and then solder the lower PCB in place.

This way, the enclosure acts as a template that ensures the pots and switch are mounted at the correct height, and it will help compensate for any slight drilling inaccuracies in the enclosure.

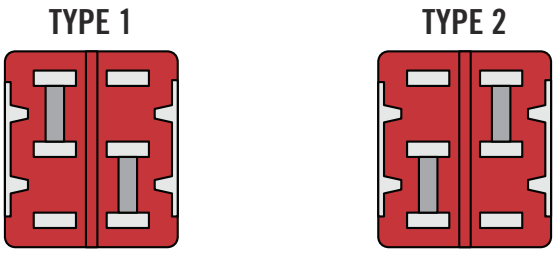
Even if you decide to remove the PCB to test outside the enclosure before final boxing, this method will ensure there is no long-term stress on the joints of the PCB-mounted components once everything is reassembled.

Here is a diagram of the completed pedal once it's installed and wired in the enclosure:



Mode switch

The mode switch is a DPDT on-on-on toggle. For this type of switch, depending on the manufacturer, there are two different types of configurations for the center position, which are as follows:



The Hypercube requires the **Type 2** configuration, which is used by most major manufacturers such as Taiway. If you're considering a different brand, make sure to check the configuration of the center position. Many of the on-on-on switches sold by Tayda or Love My Switches are Type 1 and will not work, but Love My Switches does sell Taiway-branded Type 2's.

In addition, make sure you're using an on-*on*-on switch and not an on-*off*-on switch, which has the same appearance and also has 3 positions, but will not work in this circuit.

JFET selection

The original FZ-2 uses Toshiba **2SK184-GR** JFETs for Q1-3, which are no longer produced and hard to find. The **2SK209-GR** is the SMD version which is still in production and will perform identically. SMD pads have been provided so you can solder these directly to the PCB without an adapter.

The 2SK184 is also very similar in characteristics to the **J201**, which is a direct substitute. The J201 is available from Aion FX pre-soldered on adapter boards so they can easily be used as through-hole parts.

Transistor selection

The fuzz section of the Hyper Fuzz is adapted from the Univox Superfuzz. The original Superfuzz circuit produces the best octave effect when the long-tail transistor pair (the equivalent of Q6 and Q7 in the Hypercube) are closely matched in gain, or h_{FE}.

In developing the Hypercube, we measured the transistors from an actual FZ-2 to see whether BOSS made any attempt at matching them in their adaptation. One of them measured 289 h_{FE} and the other was 231, so they were not even close.

Based on this, we can safely say that **Q6/7 do not need to be matched for an authentic Hyper Fuzz**. You can still match them if you want a stronger octave effect, and probably some Hyper Fuzz units have a more pronounced octave than others, but BOSS did not consider this an essential quality of the pedal.

Headers and sockets

The Hypercube uses standard pin headers and sockets that are also used in many other types of DIY electronics such as Arduino shields. You'll need two 6-pin sockets, three 3-pin sockets, and one snap-apart male header that can be broken in to the matching sizes.

The best ones we've found are from Tayda Electronics. They're cheaper than the ones from Mouser and also make a much tighter connection with more tension. Here are the links:

- 3-Pin Female Header (3 needed)
- 6-Pin Female Header (2 needed)
- 40-Pin Snap-Apart Male Header (1 needed)

Securing the top PCB

When the pedal is in playing position, gravity will be pulling against the top PCB, and it could potentially be knocked loose with enough shock. Once the pedal is fully tested and working, you may want to attach some non-conductive adhesive foam to the inside of the lid that is thick enough to press down against the PCB when it's closed. Make sure the offboard wires are routed around it so that they aren't pressed up against the PCB.

Alternately, you could also use some hot glue on the headers, or any other ideas you may have. Just ensure you've secured it somehow if you're planning on using the pedal in a live environment.

Oscillation

The original FZ-2 is the only BOSS pedal that uses shielded input wire, likely because the extraordinarily high gain of the circuit made it prone to noise and oscillation in certain scenarios. In prototyping the Hypercube, we did not experience any oscillation at any of the control settings, and so shielded input wire is probably not necessary for this adaptation. However, it's the first thing to try if you are having this issue.

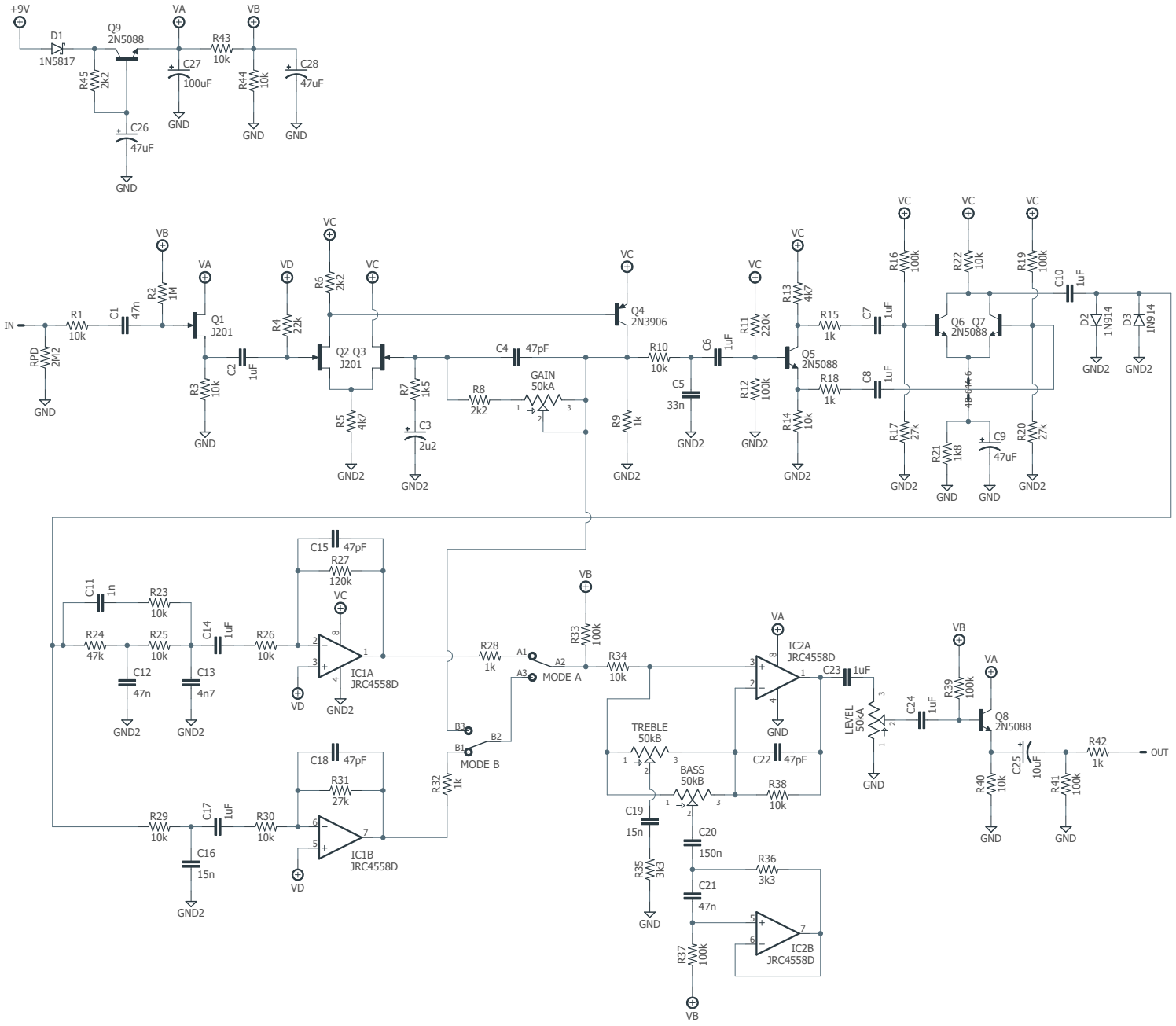
It's also worth mentioning that this type of oscillation is usually only seen with high-impedance input signals, e.g. coming directly from a guitar with passive pickups. If the input signal is from a low-impedance source such as a buffer or another pedal, it should not be susceptible to oscillation.

Capacitance multiplier

The extra components on the footswitch PCB are what is called a capacitance multiplier, a method of using a transistor to boost the performance of a filtering capacitor to levels that would otherwise require the capacitor to be impractically large. In this case, C26 (47uF) acts as the boosted filter capacitor, while C27 provides more localized decoupling on the main PCB.

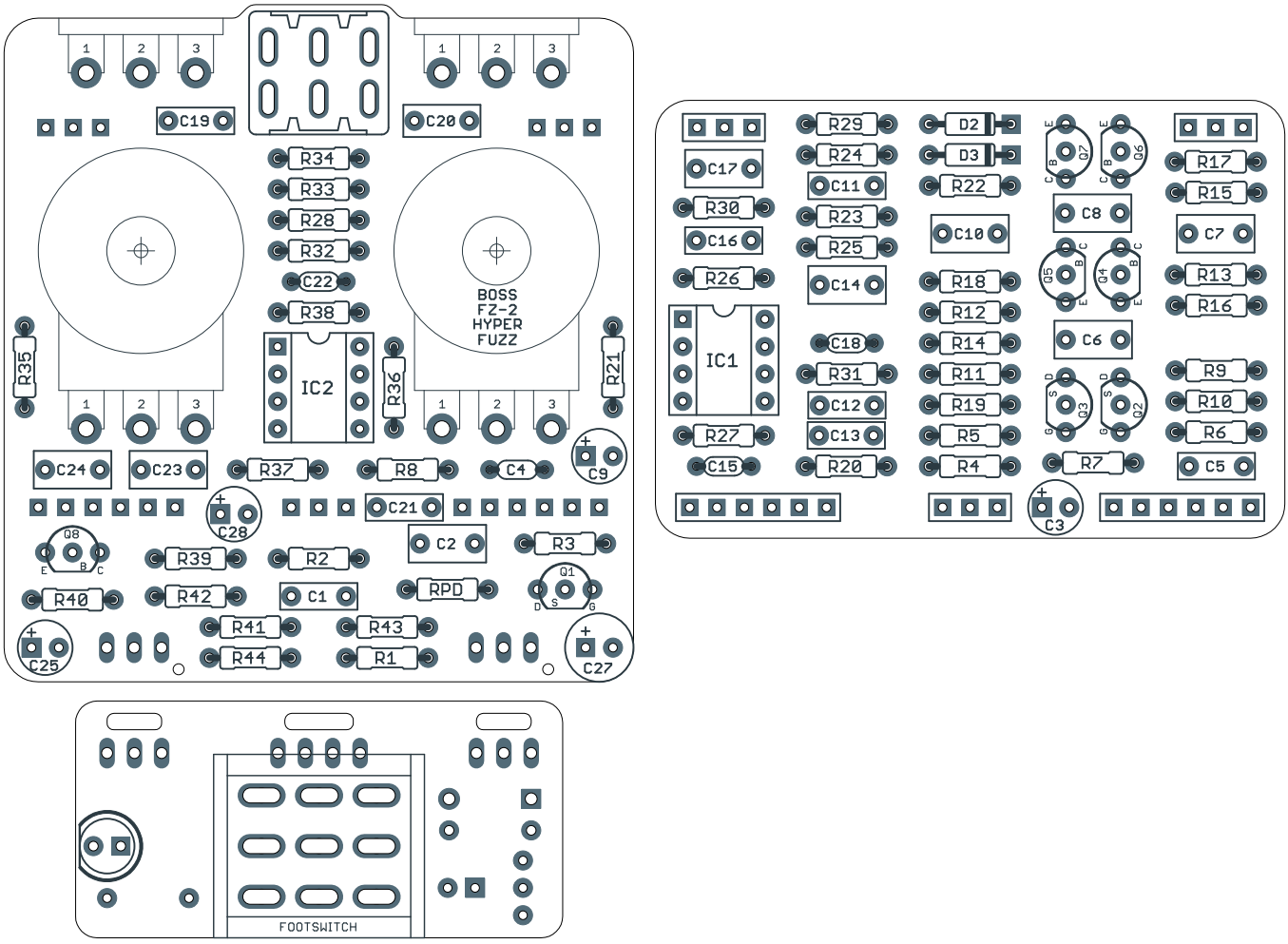
This is adapted directly from the Hyper Fuzz circuit. Presumably the BOSS engineers implemented it as another way to reduce noise as much as possible, similar to the shielded input wire noted above. While it has no impact on the audio portion of the circuit, it's recommended to build it as shown since it's cheap and effective.

SCHEMATIC


+9V
D1
1N5817
Q9
2N5088
R45
2k2
R43
10k
C27
100uF
R44
10k
C28
47uF
C26
47uF
GND
VA
VB
IN
RPD
2M2
R1
10k
C1
47n
R2
1M
Q1
J201
R3
10k
C2
1uF
VD
R4
22k
R6
2k2
Q2 Q3
J201
R5
4k7
R7
1k5
C3
2u2
GND2
VC
C4
47pF
R8
2k2
GAIN
50kA
Q4
2N3906
R10
10k
R9
1k
C5
33n
C6
1uF
R11
220k
R12
100k
R13
4k7
R14
10k
Q5
2N5088
R15
1k
R18
1k
C7
1uF
C8
1uF
R16
100k
R17
27k
R22
10k
Q6 Q7
2N5088
R21
1k8
C9
47uF
R19
100k
R20
27k
C10
1uF
D2
1N914
D3
1N914
C11
1n
R23
10k
R24
47k
R25
10k
C12
47n
C13
4n7
C14
1uF
R26
10k
C15
47pF
R27
120k
IC1A
JRC4558D
R28
1k
A1
A2
A3
MODE A
R33
100k
R34
10k
IC2A
JRC4558D
C23
1uF
C18
47pF
R31
27k
R32
1k
B1
B2
B3
MODE B
R29
10k
C17
1uF
R30
10k
C16
15n
IC1B
JRC4558D
TREBLE
50kB
BASS
50kB
C22
47pF
R38
10k
C19
15n
C20
150n
R35
3k3
R36
3k3
C21
47n
R37
100k
IC2B
JRC4558D
LEVEL
50kA
C24
1uF
R39
100k
Q8
2N5088
C25
10uF
R40
10k
R41
100k
R42
1k
OUT

PCB DIAGRAM (REVERSE SIDE)

The diagram on page 1 shows the front or top-facing side of the PCB, but since very few of the components are actually mounted on the front, it may be helpful to have a reference for the bottom side of the PCB as well.



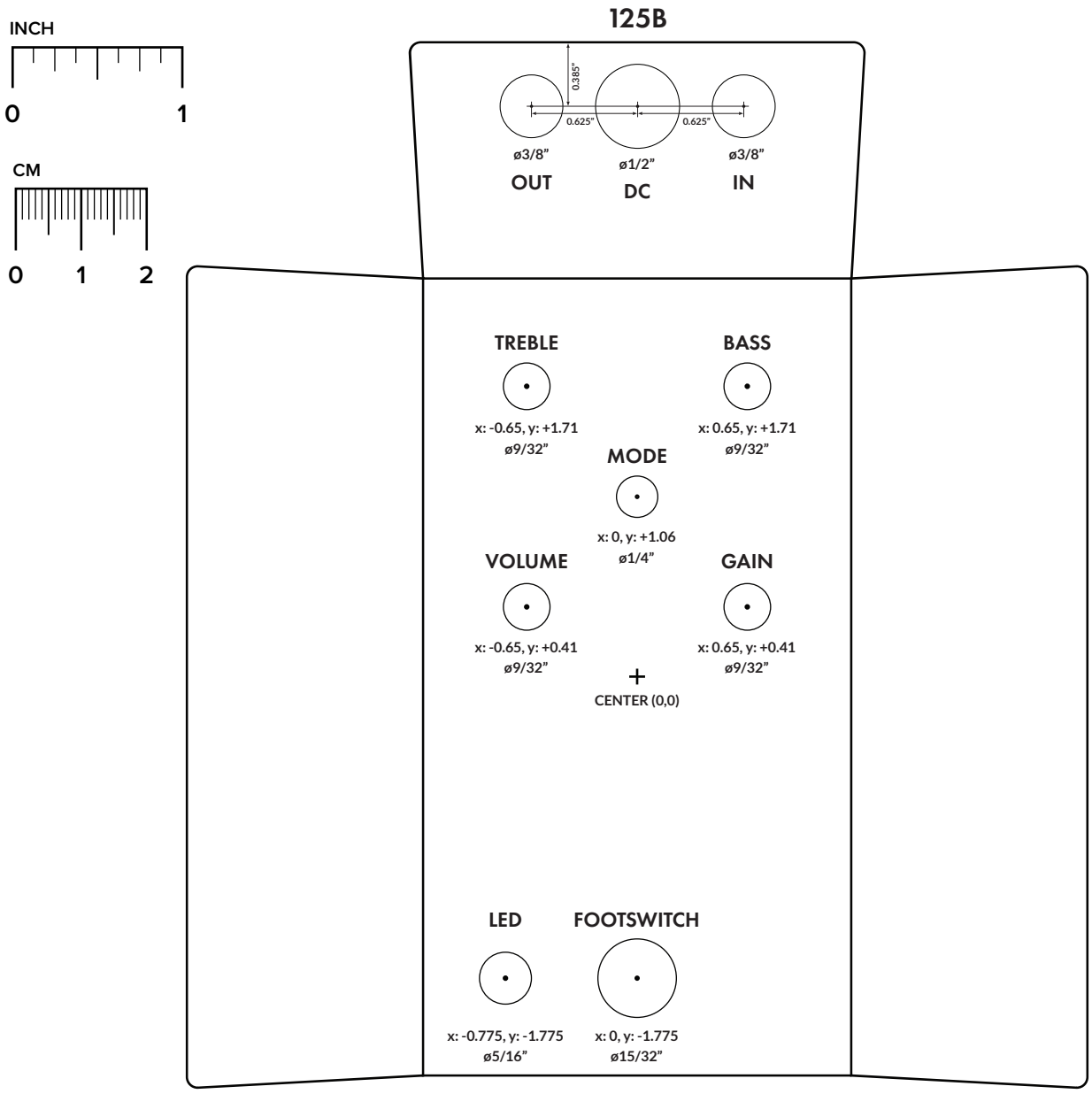
DRILL TEMPLATE

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.

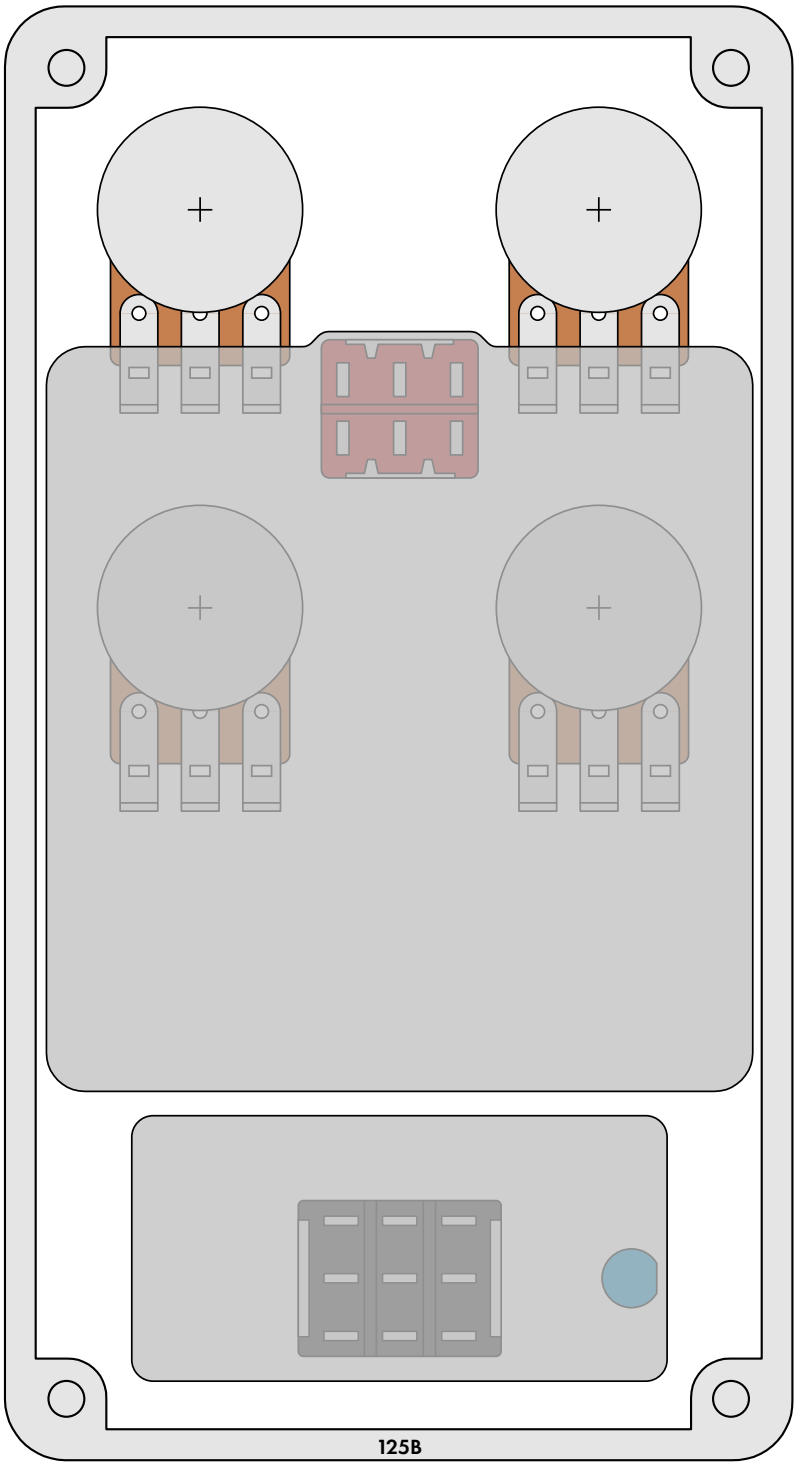
Top jack layout assumes the use of closed-frame jacks like the Switchcraft 111X. If you'd rather use open-frame jacks, please refer to the Open-Frame Jack Drill Template for the top side.

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.

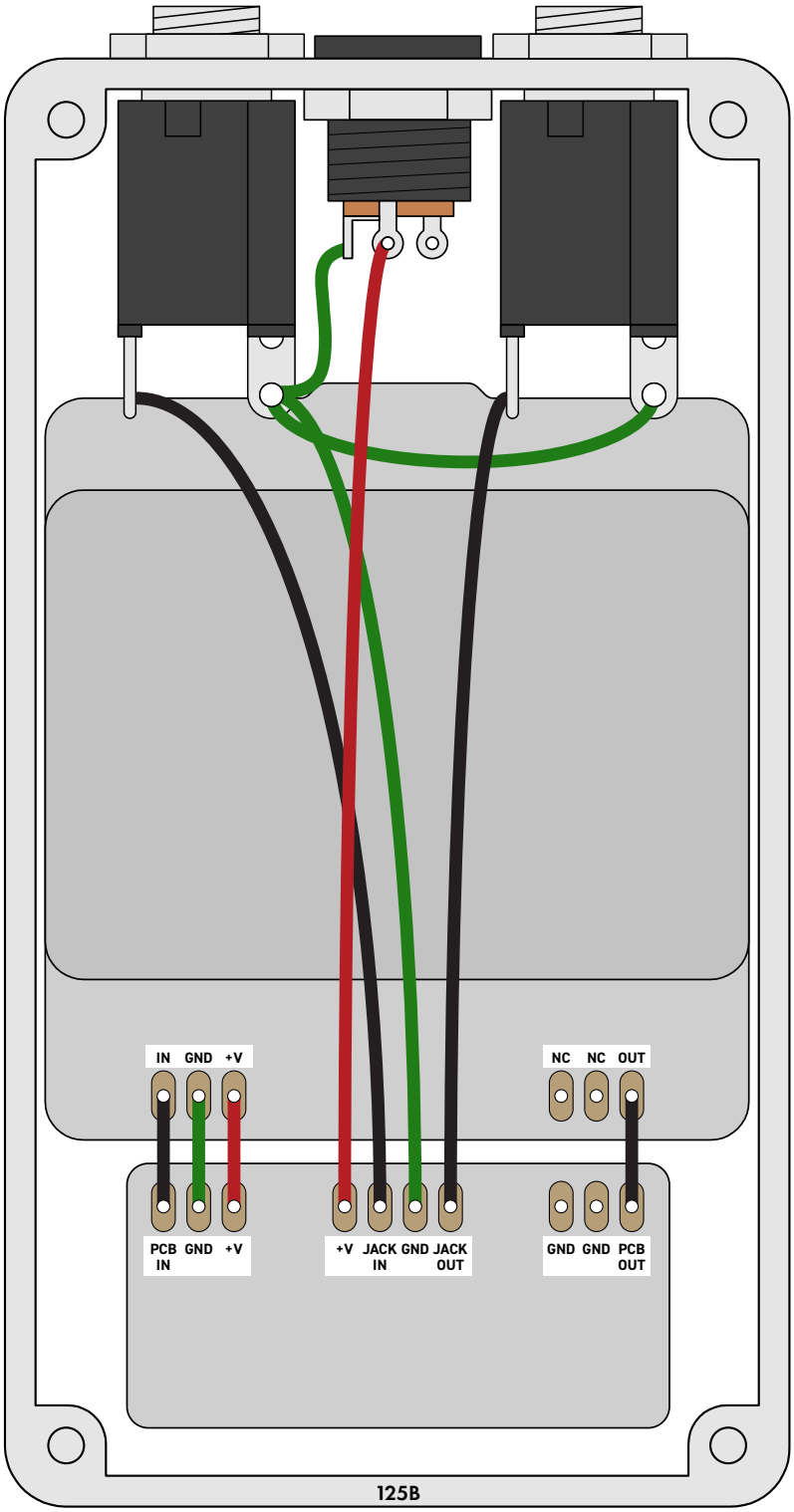


ENCLOSURE LAYOUT

Enclosure is shown without jacks and top PCB. See next page for jack layout and wiring, and see page 7 for a full side-profile view of the assembled pedal.



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 (2021-05-28)

Initial release.