PROJECT NAME

CASCADE

aion DIY GUITAR EFFECTS

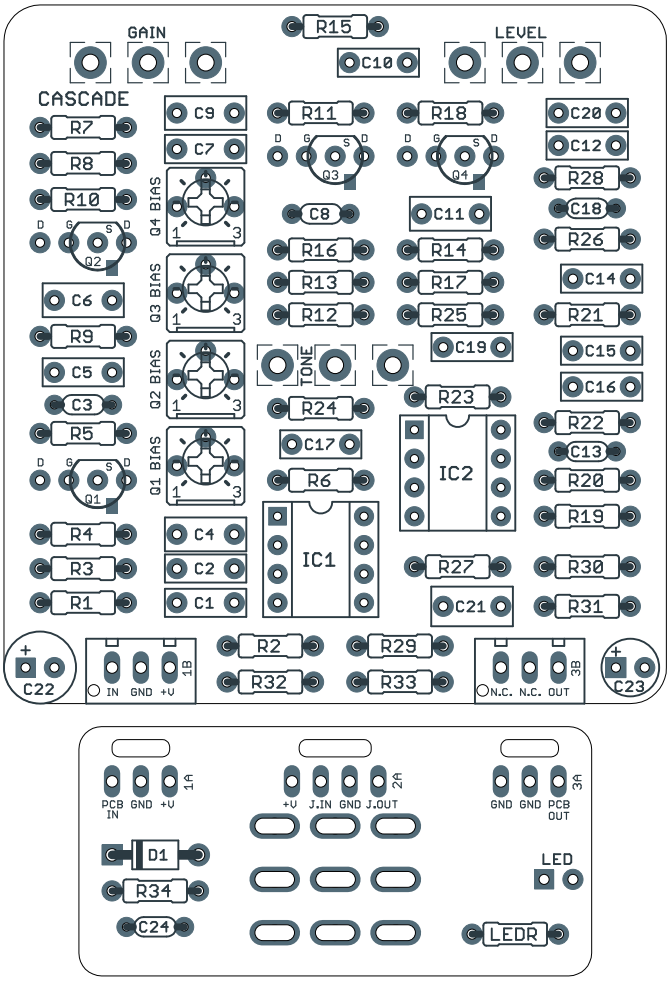
BASED ON
Washburn® A-D3 Stack in a Box

BUILD DIFFICULTY
Intermediate

EFFECT TYPE
Amp-like overdrive

DOCUMENT VERSION
1.0.0 (2022-04-08)

PROJECT SUMMARY
The first drive pedal that used JFETs to simulate the topology of cascaded tube gain stages for natural amp-like breakup.



Actual size is 2.3” x 2.42” (main board) and 1.78” x 0.86” (bypass board).

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INTRODUCTION

The Cascade Amp Overdrive is based on the Washburn® A-D3 Stack in a Box, a drive pedal first released in 1984 and intended to simulate an overdriven tube amp.

This description has become cliche in describing overdrive pedals, but this design was the first we're aware of that used cascaded JFET gain stages to simulate the topology of a tube amp. There are no diodes: all the drive is created organically. These JFET stages are followed by op-amp gain recovery and tone-shaping, including a Baxandall-style active treble boost/cut control.

In the mid-2000s, JFETs finally caught on as a great way to emulate tubes in small-signal format, and these amp-sim circuits have a remarkable resemblance to this one. However, the Stack in a Box came 20 years earlier than the first of these, so there's no doubt who got there first. As a result, the design looks remarkably modern—even anachronistic.

It was re-released a couple of years later as the SX:3 as part of Washburn's "X series". The appearance is very different, but the circuit is nearly the same as the A-D3. The only change is that the type of JFET was changed from the 2SK30A-GR to the 2SK30A-Y, which has a lower Vgs(off), but the bias resistors have been increased so they clip at roughly the same point.

There have never been any clones of this pedal, although at the time of its release it was also white-labeled under other brand names such as Digiplay, Panther and Stinger and called the "Tube Stack".

The Stack in a Box is notable as a favorite of Don Morris, the designer of the MXR Phase 90, as mentioned in a 2015 interview by ElectroSmash.

The Cascade is a direct clone of the Stack in a Box, initially based on the factory schematic but confirmed accurate based on our own trace of both an A-D3 and an SX:3. The JFET switching was removed and some extra power filtering was added, but otherwise it is identical.

USAGE

The Cascade has three controls:

- **Gain** sets the amount of drive or distortion. This is a pre-gain control that precedes the four JFET stages whose clipping depends on the input signal level.
- **Tone** is an active treble boost/cut, essentially half of a Baxandall tone stack.
- **Volume** controls 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	1M	Metal film resistor, 1/4W	
R2	470k	Metal film resistor, 1/4W	
R3	15k	Metal film resistor, 1/4W	
R4	1M	Metal film resistor, 1/4W	
R5	5k6	Metal film resistor, 1/4W	Q1 bias resistor. See build notes.
R6	15k	Metal film resistor, 1/4W	
R7	10k	Metal film resistor, 1/4W	
R8	15k	Metal film resistor, 1/4W	
R9	5k6	Metal film resistor, 1/4W	Q2 bias resistor. See build notes.
R10	15k	Metal film resistor, 1/4W	
R11	1M	Metal film resistor, 1/4W	
R12	100k	Metal film resistor, 1/4W	
R13	5k6	Metal film resistor, 1/4W	Q3 bias resistor. See build notes.
R14	15k	Metal film resistor, 1/4W	
R15	220k	Metal film resistor, 1/4W	
R16	5k6	Metal film resistor, 1/4W	Q4 bias resistor. See build notes.
R17	10k	Metal film resistor, 1/4W	
R18	220k	Metal film resistor, 1/4W	
R19	10k	Metal film resistor, 1/4W	
R20	100k	Metal film resistor, 1/4W	
R21	470k	Metal film resistor, 1/4W	
R22	10k	Metal film resistor, 1/4W	
R23	100k	Metal film resistor, 1/4W	
R24	10k	Metal film resistor, 1/4W	
R25	10k	Metal film resistor, 1/4W	
R26	100k	Metal film resistor, 1/4W	
R27	10k	Metal film resistor, 1/4W	
R28	10k	Metal film resistor, 1/4W	
R29	470k	Metal film resistor, 1/4W	
R30	220R	Metal film resistor, 1/4W	
R31	100k	Metal film resistor, 1/4W	
R32	10k	Metal film resistor, 1/4W	

PARTS LIST, CONT.

PART	VALUE	TYPE	NOTES
R33	10k	Metal film resistor, 1/4W	
R34	100R	Metal film resistor, 1/4W	Power supply filter resistor.
LEDR	4k7	Metal film resistor, 1/4W	LED current-limiting resistor. Adjust value to change LED brightness.
C1	22n	Film capacitor, 7.2 x 2.5mm	
C2	4n7	Film capacitor, 7.2 x 2.5mm	
C3	100pF	MLCC capacitor, NP0/C0G	
C4	470n	Film capacitor, 7.2 x 3mm	
C5	33n	Film capacitor, 7.2 x 2.5mm	
C6	470n	Film capacitor, 7.2 x 3mm	
C7	33n	Film capacitor, 7.2 x 2.5mm	
C8	100pF	MLCC capacitor, NP0/C0G	
C9	470n	Film capacitor, 7.2 x 3mm	
C10	33n	Film capacitor, 7.2 x 2.5mm	
C11	470n	Film capacitor, 7.2 x 3mm	
C12	47n	Film capacitor, 7.2 x 2.5mm	
C13	47pF	MLCC capacitor, NP0/C0G	
C14	10n	Film capacitor, 7.2 x 2.5mm	
C15	10n	Film capacitor, 7.2 x 2.5mm	
C16	100n	Film capacitor, 7.2 x 2.5mm	
C17	1n	Film capacitor, 7.2 x 2.5mm	
C18	47pF	MLCC capacitor, NP0/C0G	
C19	100n	Film capacitor, 7.2 x 2.5mm	
C20	47n	Film capacitor, 7.2 x 2.5mm	
C21	1uF	Film capacitor, 7.2 x 3.5mm	
C22	100uF	Electrolytic capacitor, 6.3mm	Reference voltage filter capacitor.
C23	47uF	Electrolytic capacitor, 5mm	Power supply filter capacitor.
C24	100n	MLCC capacitor, X7R	Power supply filter capacitor.
D1	1N5817	Schottky diode, DO-41	
Q1	2N5457	JFET, N-channel, TO-92	Substitute. Original uses 2SK30A-Y or 2SK30A-GR. See build notes.
Q2	2N5457	JFET, N-channel, TO-92	Substitute. Original uses 2SK30A-Y or 2SK30A-GR. See build notes.
Q3	2N5457	JFET, N-channel, TO-92	Substitute. Original uses 2SK30A-Y or 2SK30A-GR. See build notes.
Q4	2N5457	JFET, N-channel, TO-92	Substitute. Original uses 2SK30A-Y or 2SK30A-GR. See build notes.
IC1	RC4558P	Operational amplifier, DIP8	
IC1-S	DIP-8 socket	IC socket, DIP-8	
IC2	RC4558P	Operational amplifier, DIP8	
IC2-S	DIP-8 socket	IC socket, DIP-8	

PARTS LIST, CONT.

PART	VALUE	TYPE	NOTES
Q1_BIAS	5k trimmer	Trimmer, 10%, 1/4"	Optional. See build notes.
Q2_BIAS	5k trimmer	Trimmer, 10%, 1/4"	Optional. See build notes.
Q3_BIAS	5k trimmer	Trimmer, 10%, 1/4"	Optional. See build notes.
Q4_BIAS	5k trimmer	Trimmer, 10%, 1/4"	Optional. See build notes.
GAIN	500kA	16mm right-angle PCB mount pot	Original uses 500kB, but audio taper is smoother.
TONE	500kB	16mm right-angle PCB mount pot	
LEVEL	100kA	16mm right-angle PCB mount pot	Original uses 100kB, but audio taper is smoother.
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

JFET selection

The Stack in a Box used two different types of JFETs during its production run, each with their own corresponding bias resistors.

The A-D3 (first version) used the Toshiba 2SK30A-GR. The modern equivalent is the 2SK208-GR. These are only available in SMD, but SMD pads have been included on the PCB (see next section). They have a typical Vgs(off) range of -2.2V to -2.5V, and the bias resistors (R5, R9, R13, R16) are 3.9k.

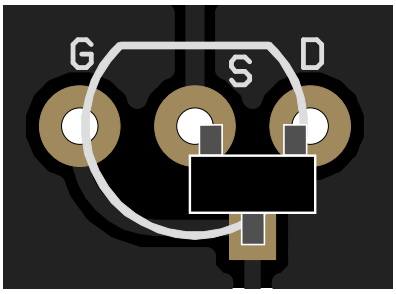
The SX:3 (second version) used the Toshiba 2SK30A-Y. The modern equivalent is the 2SK208-Y, again only available in SMD. Their typical VGS(off) range is much lower, around -1.2V to -1.4V, and the bias resistors are 5.6k.

The onsemi 2N5457 is nearly identical to the 2SK30A-Y and is the recommended JFET to use. Aion FX does sell the 2SK208-GR, but these are matched for phasers and are therefore more expensive. They'll work just fine in this circuit though.

Using SMD JFETs

The 2SK30A JFET is no longer available from Toshiba in through-hole format. This PCB uses a hybrid through-hole/SMD outline for each JFET. An extra "G" (gate) pad is included to accommodate the 2SK208 surface-mount version without the need for adapters.

SMD JFETs should be oriented as follows:



All surface-mount JFETs use the same pinout, so this configuration will fit any type that we're aware of. However, always check the datasheet if you're uncertain—they're difficult to desolder.

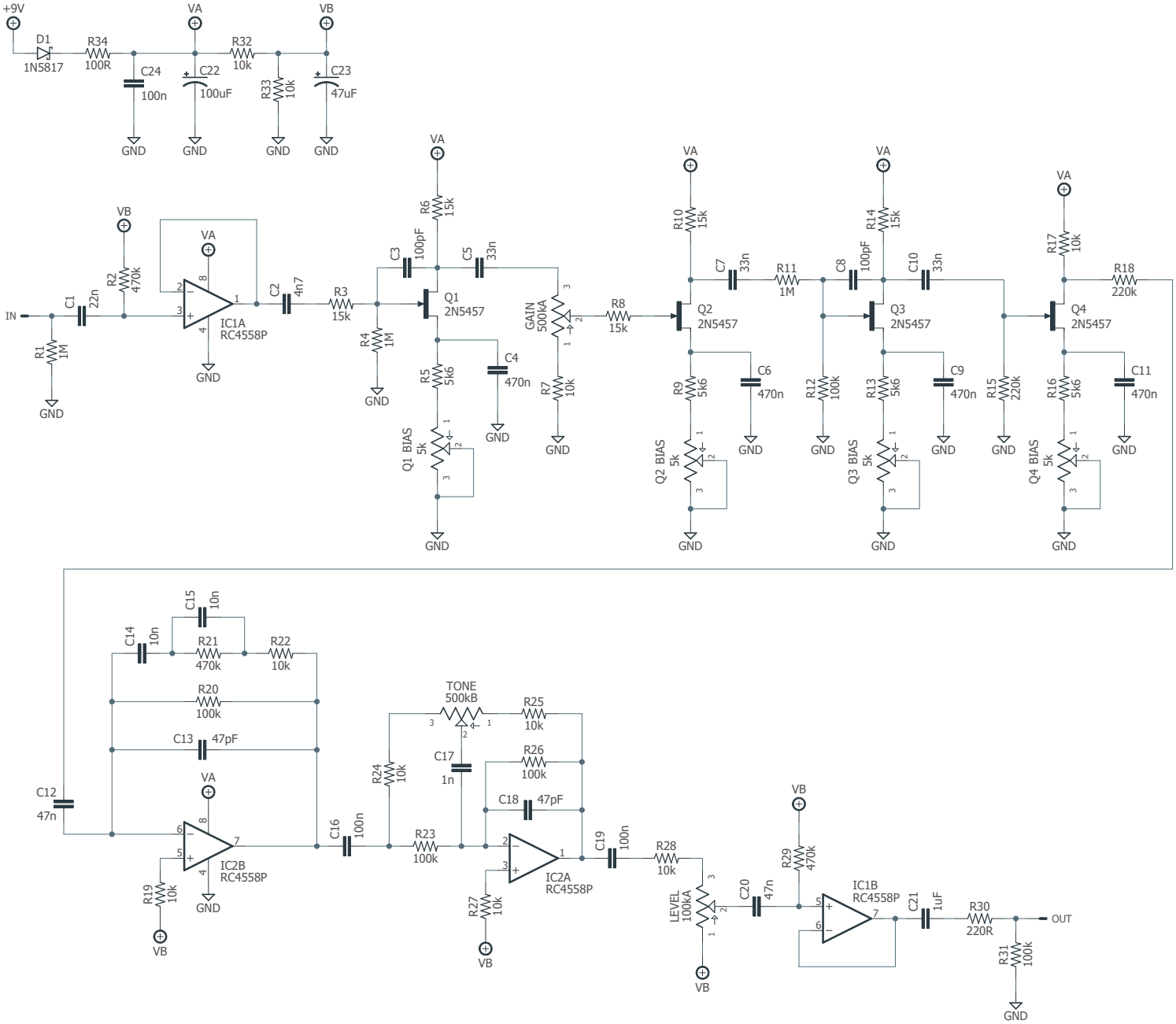
Trimmers

Each of the four JFET stages has a trimmer in series with the bias resistor. These are optional. If you use the right type of JFET (2N5457, 2SK208-Y or 2SK208-GR) then you can just use a fixed resistor and not worry about the exact bias. The manufacturer definitely didn't!

To omit the trimmers, jumper the left and top pad of each (pins 1 and 2).

If you want to experiment with different types of JFETs, or you want to hear the effect of different bias points, they may be useful. It's recommended to reduce the value of the fixed resistors (R5, R9, R13 and R16), e.g. to 2k2, so that you can use the trimmer to go above and below the stock resistance value.

SCHEMATIC


+9V
D1
1N5817
R34
100R
C24
100n
VA
C22
100uF
R32
10k
R33
10k
VB
C23
47uF
GND
IN
C1
22n
R1
1M
R2
470k
IC1A
RC4558P
C2
4n7
R3
15k
C3
100pF
R4
1M
Q1
2N5457
C5
33n
R6
15k
R5
5k6
C4
470n
Q1 BIAS
5k
GAIN
500kA
R7
10k
R8
15k
R10
15k
Q2
2N5457
C7
33n
R9
5k6
C6
470n
Q2 BIAS
5k
R11
1M
R12
100k
C8
100pF
R14
15k
Q3
2N5457
C10
33n
R13
5k6
C9
470n
Q3 BIAS
5k
R15
220k
R17
10k
Q4
2N5457
R18
220k
R16
5k6
C11
470n
Q4 BIAS
5k
C15
10n
C14
10n
R21
470k
R22
10k
R20
100k
C13
47pF
C12
47n
IC2B
RC4558P
R19
10k
C16
100n
TONE
500kB
R25
10k
R24
10k
C17
1n
R26
100k
C18
47pF
R23
100k
IC2A
RC4558P
R27
10k
C19
100n
R28
10k
LEVEL
100kA
C20
47n
R29
470k
IC1B
RC4558P
C21
1uF
R30
220R
R31
100k
OUT

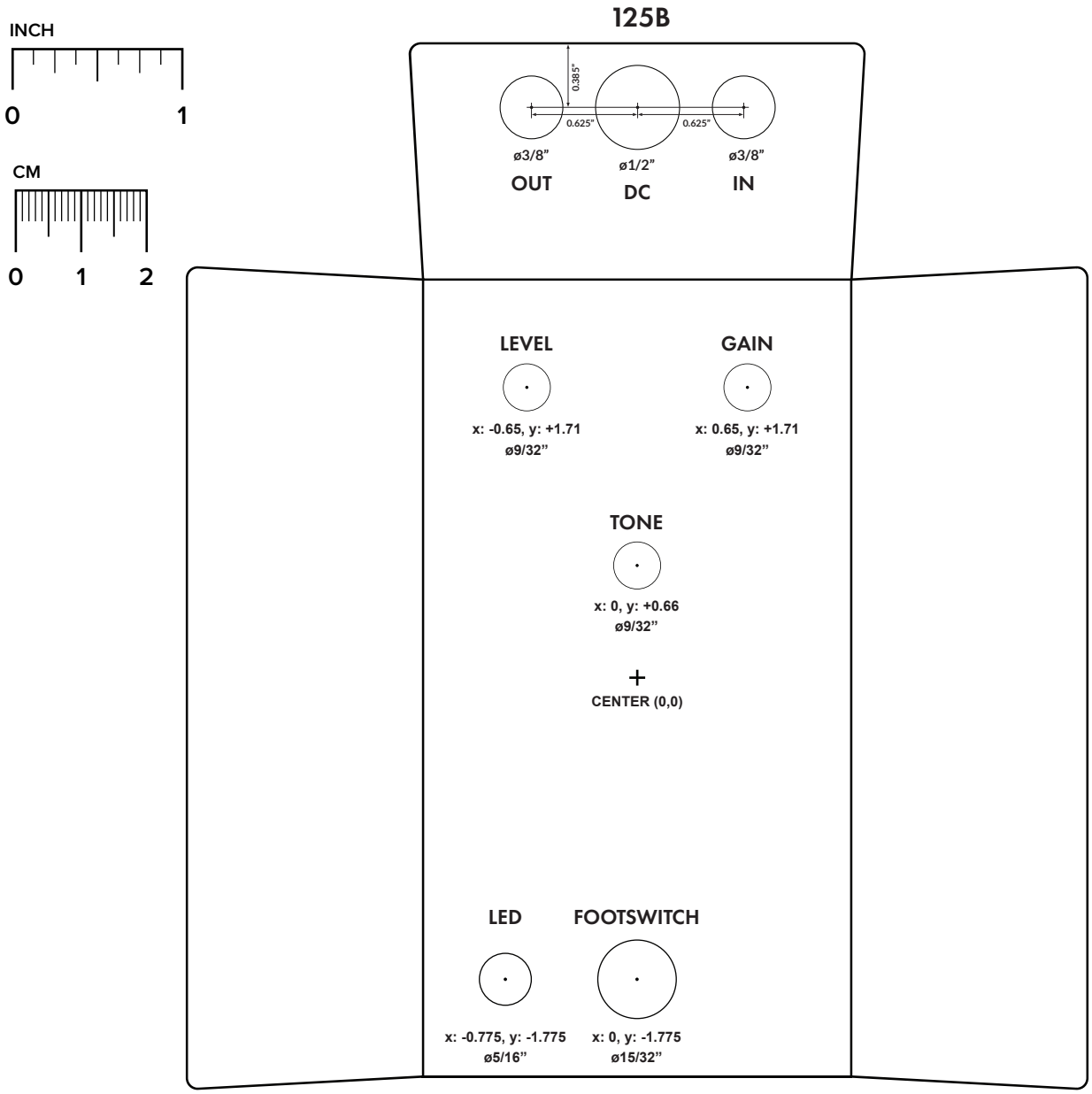
DRILL TEMPLATE

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.

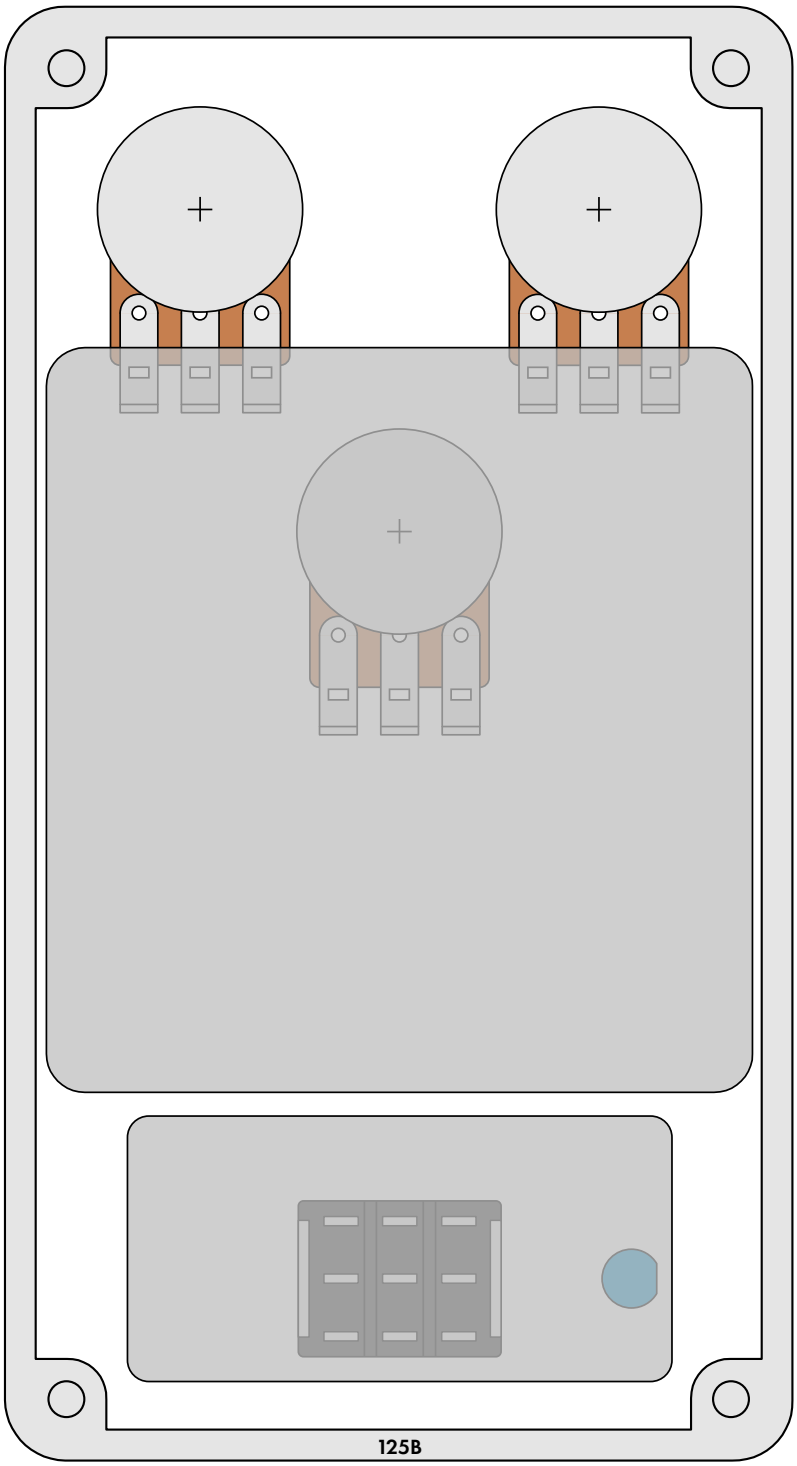
Top jack layout assumes the use of closed-frame jacks like the Switchcraft 111X. If you'd rather use open-frame jacks, please refer to the Open-Frame Jack Drill Template for the top side.

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.

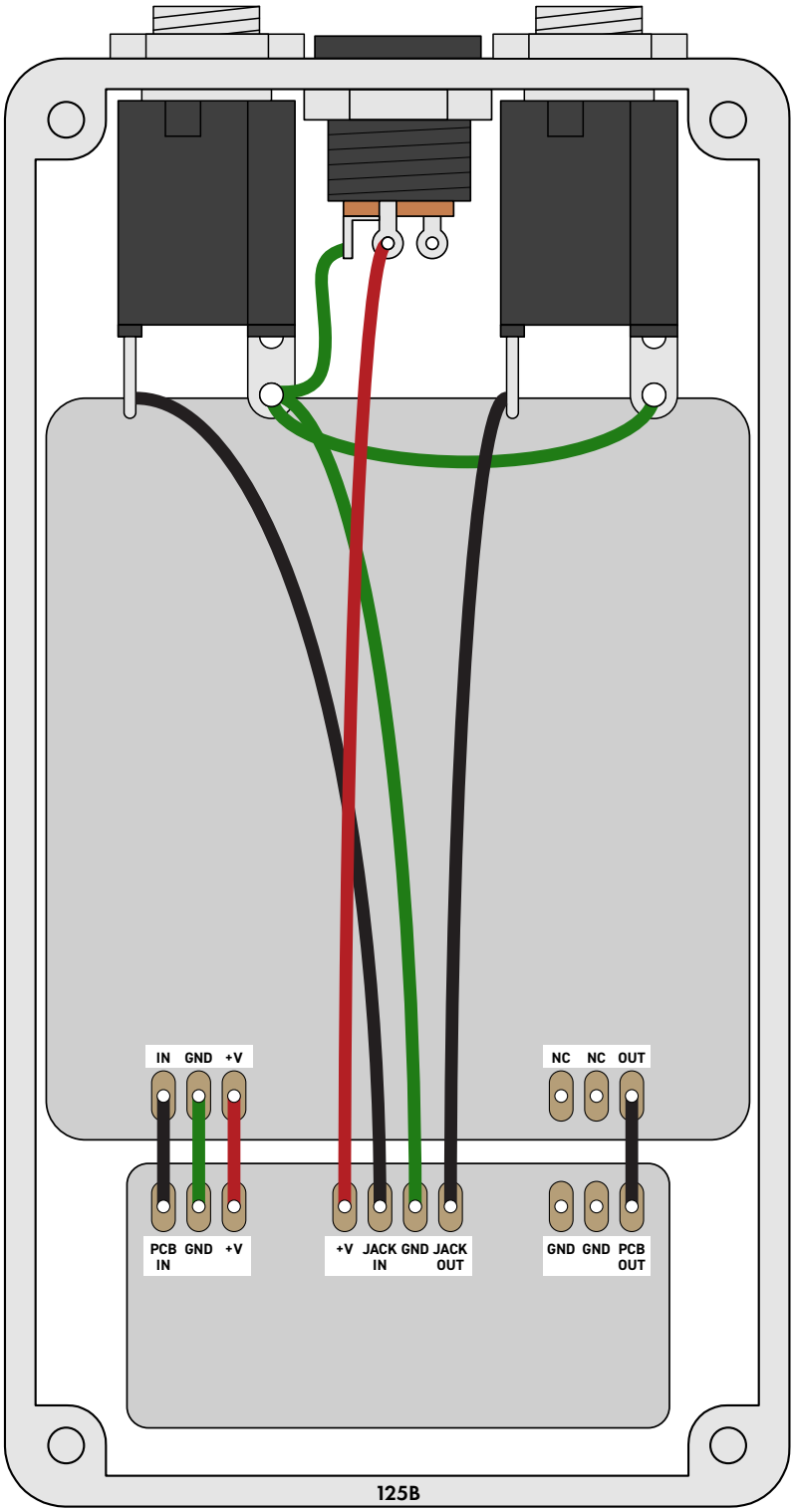


ENCLOSURE LAYOUT

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

1.0.0 (2022-04-08)
Initial release.