

PROJECT NAME

COMET

BASED ON

BOSS® DS-1 Distortion

EFFECT TYPE

Distortion

BUILD DIFFICULTY

■■■■■ Easy

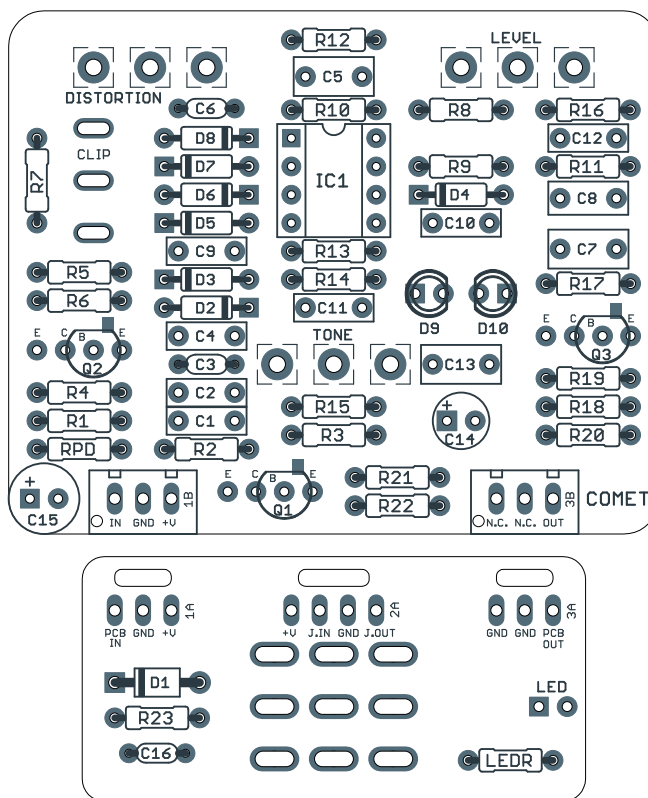
DOCUMENT VERSION

1.0.3 (2025-02-16)

aion
DIY GUITAR EFFECTS

PROJECT SUMMARY

A classic distortion pedal that has been in continuous production for over 40 years, blending ideas from the Big Muff, RAT and Distortion+.



Actual size is 2.3" x 1.86" (main board) and 2.3" x 0.86" (bypass board).

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INTRODUCTION

The Comet Vintage Distortion is a clone of the classic orange BOSS® DS-1 Distortion, one of their earliest compact effects in continuous production since 1978.

The DS-1's design is an amalgamation of a few different ideas. The initial transistor gain stage is very similar to the Big Muff, as is the tone section with its bass/treble balance control. The IC gain stage followed by diode-to-ground hard clipping is similar to early op-amp distortion circuits like the [MXR Distortion+](#) or [Pro Co RAT](#).

During the past four decades, it has undergone several revisions. The basic schematic structure has stayed the same throughout its production, but when the original IC was discontinued in the early '90s, the op-amp gain stage was redesigned to use a standard dual op-amp. Previously it had used a Toshiba TA7136P special-purpose "RIAA preamp" that was technically not even a true op-amp, so this necessitated several changes. They also re-voiced the circuit at the same time, reducing the bass and increasing the treble slightly.

The result is that there is a significant difference between the "pre-1994" and "post-1994" versions of the circuit. The pre-'94 version remains highly regarded, while the post-'94 circuit is responsible for the DS-1's reputation as a poor-quality beginner's pedal. The good news is that the voicing changes are fully reversible, and it's possible to get the post-'94 dual op-amp version to sound just as good as the pre-'94 version with a handful of capacitor changes.

The Comet is based on the dual op-amp version of the circuit. The default build makes a few parts substitutions to make it nearly identical to the pre-'94 circuit. If you want to use the TA7136P chip for an exact replica of the pre-'94 DS-1, the [legacy version of the Comet](#) is still available and supports either configuration. However, this updated version drops support for the old IC because it's almost impossible to find today and the build process is much more streamlined without the option.

USAGE

The Comet has three controls and one toggle:

- **Distortion** controls the amount of gain from the op-amp stage that is clipped by the diodes.
- **Tone** pans between a bass emphasis and a treble emphasis, with a mid-scoop centered at 550 Hz.
- **Level** sets the overall output of the effect.
- **Clipping** selects between three different sets of hard-clipping diodes.

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	1k	Metal film resistor, 1/4W	
R2	470k	Metal film resistor, 1/4W	
R3	10k	Metal film resistor, 1/4W	
R4	100k	Metal film resistor, 1/4W	
R5	470k	Metal film resistor, 1/4W	
R6	10k	Metal film resistor, 1/4W	
R7	22R	Metal film resistor, 1/4W	
R8	100k	Metal film resistor, 1/4W	
R9	47k	Metal film resistor, 1/4W	
R10	100k	Metal film resistor, 1/4W	
R11	4k7	Metal film resistor, 1/4W	
R12	2k2	Metal film resistor, 1/4W	
R13	6k8	Metal film resistor, 1/4W	
R14	2k2	Metal film resistor, 1/4W	
R15	6k8	Metal film resistor, 1/4W	
R16	10k	Metal film resistor, 1/4W	
R17	1M	Metal film resistor, 1/4W	
R18	10k	Metal film resistor, 1/4W	
R19	1k	Metal film resistor, 1/4W	
R20	100k	Metal film resistor, 1/4W	
R21	10k	Metal film resistor, 1/4W	
R22	10k	Metal film resistor, 1/4W	
R23	47R	Metal film resistor, 1/4W	
RPD	2M2	Metal film resistor, 1/4W	Input pulldown resistor.
LED R	10k	Metal film resistor, 1/4W	LED current-limiting resistor. Adjust value to change LED brightness.
C1	47n	Film capacitor, 7.2 x 2.5mm	
C2	47n	Film capacitor, 7.2 x 2.5mm	
C3	250pF	Ceramic capacitor, X5F	
C4	OMIT		Use 100n for the Big Muff clipping mod. Leave empty otherwise.
C5	470n	Film capacitor, 7.2 x 3.5mm	Use 68n for post-1994 version.
C6	250pF	MLCC capacitor, NP0/C0G	Use 100pF for post-1994 version.
C7	1uF	Film capacitor, 7.2 x 3.5mm	Use 470n for post-1994 version.

PARTS LIST, CONT.

PART	VALUE	TYPE	NOTES
C8	470n	Film capacitor, 7.2 x 3mm	
C9	10n	Film capacitor, 7.2 x 2.5mm	
C10	22n	Film capacitor, 7.2 x 2.5mm	
C11	100n	Film capacitor, 7.2 x 2.5mm	
C12	47n	Film capacitor, 7.2 x 2.5mm	
C13	1uF	Film capacitor, 7.2 x 3.5mm	
C14	47uF	Electrolytic capacitor, 5mm	Reference voltage filter capacitor.
C15	100uF	Electrolytic capacitor, 6.3mm	Power supply filter capacitor.
C16	100n	MLCC capacitor, X7R	Power supply filter capacitor.
D1	1N5817	Schottky diode, DO-41	
D2	OMIT		Use 1N914 for the Big Muff clipping mod. Leave empty otherwise. See build notes for more info.
D3	OMIT		
D4	1N914	Fast-switching diode, DO-35	Only used with NJM3404 for IC1. Omit if using NJM4580 or other types (TL072, JRC4558) for IC1.
D5	1N914	Fast-switching diode, DO-35	
D6	1N914	Schottky diode, DO-35	
D7	1N914	Fast-switching diode, DO-35	
D8	1N914	Schottky diode, DO-35	
D9	3mm LED	LED, 3mm, red diffused	
D10	3mm LED	LED, 3mm, red diffused	
Q1	2N5088	BJT transistor, NPN, TO-92	Substitute. Original uses 2SC2248.
Q2	2N5088	BJT transistor, NPN, TO-92	Substitute. Original uses 2SC2248.
Q3	2N5088	BJT transistor, NPN, TO-92	Substitute. Original uses 2SC2248.
IC1	NJM3404AD	Operational amplifier, DIP8	Can substitute NJM4580D (JRC4580D), in which case omit D4.
IC1-S	DIP-8 socket	IC socket, DIP-8	
DIST.	100kB	16mm right-angle PCB mount pot	
TONE	25kB	16mm right-angle PCB mount pot	The original uses 20kB if you can find it, but 25kB is much more common and will work the same.
LEVEL	100kB	16mm right-angle PCB mount pot	
CLIP	SPDT cntr off	Toggle switch, SPDT center off	
LED	5mm	LED, 5mm, red diffused	
IN	1/4" stereo	1/4" phone jack, closed frame	Switchcraft 112BX 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	Lumberg NEB/J21C or equivalent.
BATT	Battery snap	9V battery snap	Optional. Use the soft plastic type—the hard-shell type will not fit.
FSW	3PDT	Stomp switch, 3PDT	Available from Aion FX .
ENC	125B	Enclosure, die-cast aluminum	Can also use a Hammond 1590N1.

BUILD NOTES

Pre-1994 and post-1994 versions

The default parts list for the Comet is for the pre-1994 version, the only difference being the op-amp since the original TA7136P IC is no longer produced and hard to find.

If you'd like to build the post-1994 version of the DS-1, make the following substitutions:

- **C5:** 470n → 68n
- **C6:** 250pF → 100pF
- **C7:** 1uF → 470n

This will reduce the amount of bass throughout the circuit and add a little bit of high-end at the upper end of the distortion control.

Diode selection

The original DS-1 used 1S2473 diodes. These have been the subject of a lot of discussion in the DIY community over the past two decades, with speculation that they are critical to the pre-'94 sound.

One source in particular, the [Build Your Own DS-1 Distortion](#) document by Brett Miller, points out that the 1S2473 datasheet lists the forward voltage as 0.92 to 1.2V, which is significantly higher than the 0.7-0.8V of standard small-signal silicon diodes such as the 1N914.

Earlier versions of the Comet build document repeated this information, but we have since realized that the 1S2473 (a rectifier diode) lists this forward voltage specification at a test current of 100mA. Forward voltage increases with current, and it turns out that most other silicon diodes including the 1N914 will also have a forward voltage of around 1V if the test current is 10mA or higher.

Real-world testing confirms this. The 1S2473 is unremarkable and would not have any significant differences with a 1N914 or any other typical silicon diode. (The DS-1 document is otherwise excellent and we strongly recommend it if you want to learn more about the circuit.)

With that said, the 1V mod still an interesting modification and easy to do. If you want to try it, we recommend using BAT46 for D6 and D8. The "up" position of the switch will engage this pair of diodes in series with D5 and D7 for a clipping threshold of approximately 1V. There will be more of a volume jump between the diodes and the LEDs, but less between the stock clipping mode and the in-between setting.

Big Muff clipping mod

The amplifier stage formed by Q2 is identical to the first transistor stage of the Big Muff. The stock DS-1 does not have any clipping in this stage, but if you want to experiment, space has been provided to add the two diodes and capacitor and convert it into something more like stage 2 or 3 of the Big Muff with feedback diode clipping. This reduces some of the fizziness that comes from overloading the op-amp.

To try this modification, use **1N914** for D2 and D3 and a **100n film capacitor** for C4. Omit these three parts for the stock DS-1 circuit (either the pre-'94 or post-'94 version).

BUILD NOTES, CONT.

Modifications

Owing to the entry-level price as well as the genuinely awful changes that Boss made to the circuit in the late 1990s, the DS-1 is one of the most frequently-modded pedals out there. Robert Keeley and Analogman would modify your unit for a fee, and Monte Allums sells mod kits so you can make the changes yourself if you are so inclined.

Many of these mods are intended to solve the issues in the post-'94 circuit and make the DS-1 regain some of its past glory. If you build the Comet according to the parts list above, it will be very close to the pre-'94 version, and in our opinion it does not need any further modification.

However, if you'd like to experiment, here are some value changes adapted from the Keeley, Analogman and Monte Allums mods.

Mod 1

PART	OLD VALUE	NEW VALUE	DESCRIPTION
IC1	NJM3404AD	OPA2134	Higher fidelity op-amp with better parameters, but much higher current draw.
C1	47n	100n	Input capacitor. Higher value increases bass level at input.
C2	47n	100n	Q1-Q2 coupling capacitor. Increases bass slightly, but may not be noticeable with C1 change.
C10	22n	47n	Lowers tone control treble side frequency to reduce harshness.
C12	47n	100n	Output stage coupling capacitor. Increases bass slightly.

Mod 2

PART	OLD VALUE	NEW VALUE	DESCRIPTION
<i>All changes from Mod 1, plus the following:</i>			
C3	250pF	470pF	Q2 gain stage feedback capacitor. Cuts highs slightly.
C5	470n	100n	Cuts bass slightly at the input of the op-amp.
C6	250pF	220pF	Reduces hi-cut slightly, most noticeable when Distortion is at full.
R9	47k	20k	Reduces signal impedance going into the first op-amp stage.
R11	4k7	2k4 or 2k2	Doubles the gain range of the Distortion control.
R12	2k2	1k5	Slight changes to clipping characteristics.

Of these, the two that will have the biggest impact are **C10** from Mod 1 and **R11** from Mod 2. The rest are fairly subtle or would not be noticeable in the Comet, and would have much more of an impact on an actual post-'94 DS-1.

Also note that if you change the IC, it will likely also require a change to D4. See next section for more details on this.

D4 diode

The D4 diode should only be used with the NJM3404 op-amp, the default in the parts list. If using the NJM4580 or any other type not listed above—e.g. JRC4558 or TL072—it should be omitted (left empty) or else the op-amp may distort in a very unpleasant way.

This diode is present in every version of the DS-1 from 1994 through 2016 because all of the chips are related to the LM358, and the diode placement is specific to the way that op-amp is designed. In the post-2016 DS-1, presumably the diode has either been omitted or else moved between the inverting and non-inverting inputs of the op-amp. This is a much more common practice and would have a similar effect on non-358 op-amps.

IC selection

The DS-1 has undergone a few other minor circuit changes after the major revision in 1994, mostly related to the IC:

- 1994-2000: Rohm BA728N
- 2000-2006: Mitsubishi M5223AL
- 2006-2016: New Japan Radio NJM2904L, later changed to NJM3404L, exact year unknown
- 2016-present: New Japan Radio NJM4580 (JRC4580)

The first four are single-in-line (SIL) dual op-amps, although the NJM2904 and NJM3404 have a DIP-8 version available. Since 2016 when BOSS made the switch to SMD, the DS-1 has used the SOIC version of the NJM4580.

It's recommended to use the **NJM3404** in this project. We have not seen a schematic for a post-2016 DS-1, but as discussed above, the D4 diode was almost certainly changed along with the NJM4580, so there may have been other changes as well.

COMET VINTAGE DISTORTION



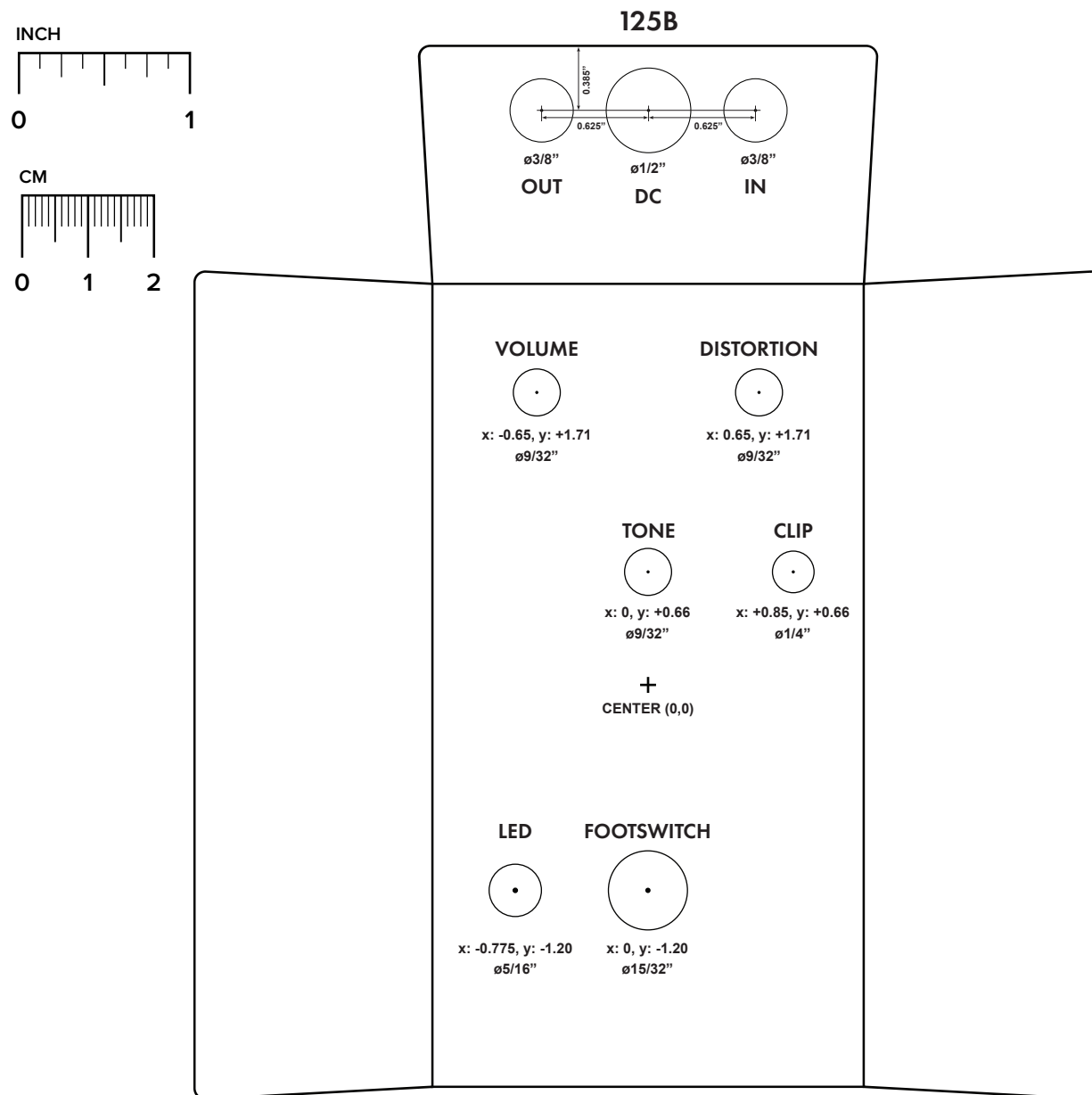
DRILL TEMPLATE

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.

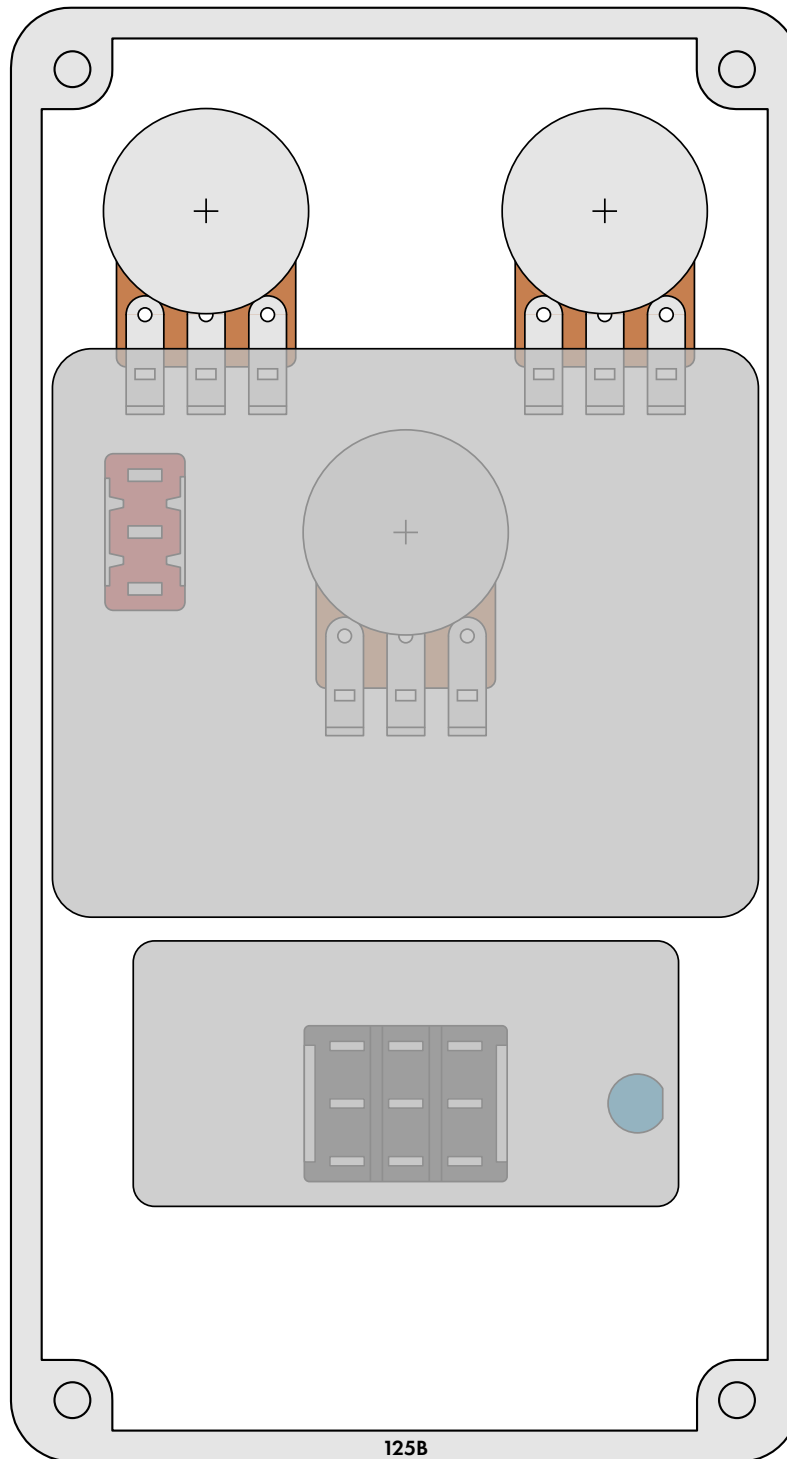
Top jack layout assumes the use of closed-frame jacks like the [Switchcraft 111X](#). If you'd rather use open-frame jacks, please refer to the Open-Frame Jack Drill Template for the top side.

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.

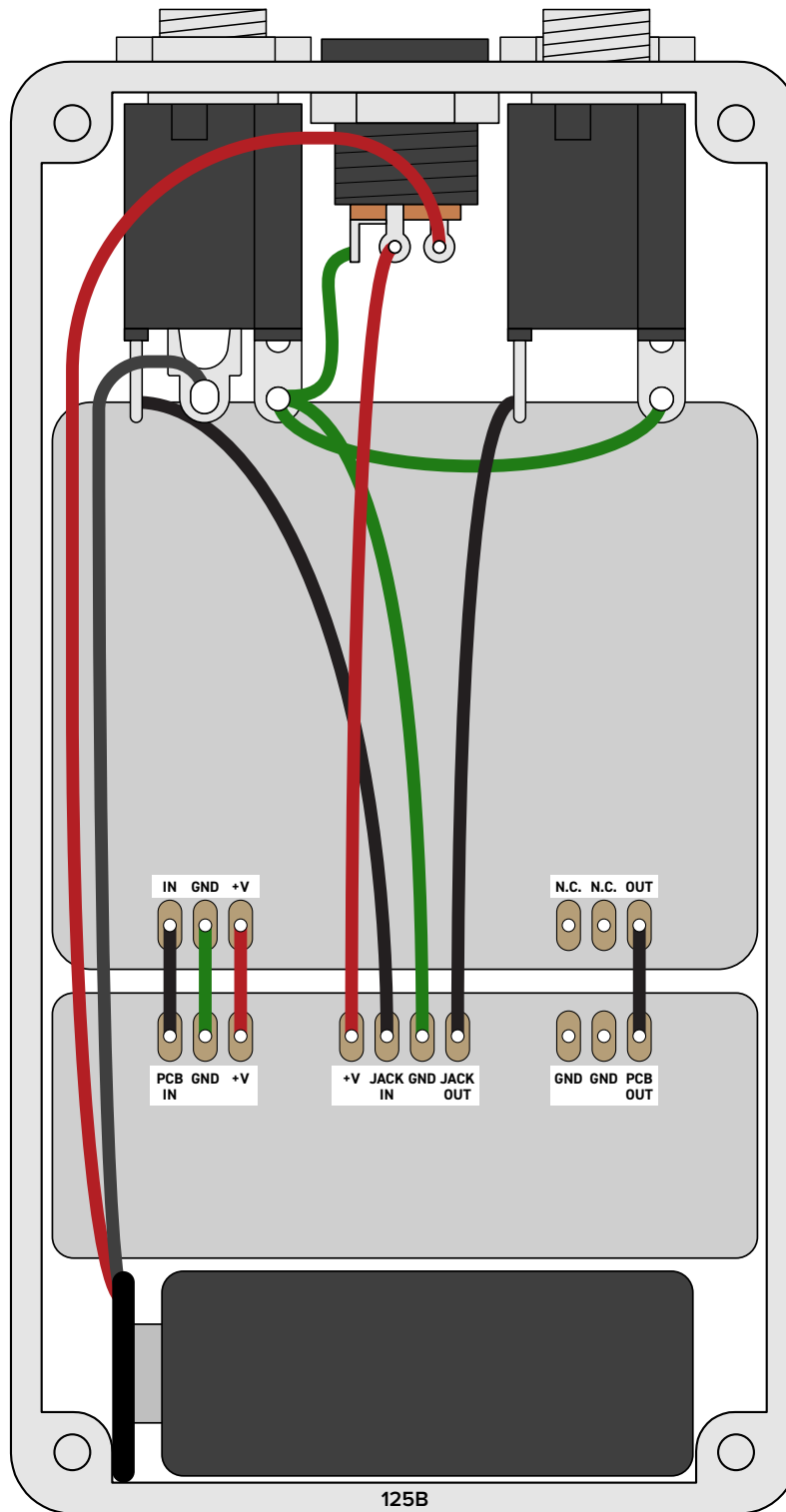


ENCLOSURE LAYOUT

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



WIRING DIAGRAM



*Shown with optional 9V battery. If battery is omitted, both jacks can be mono rather than one being stereo.
Leave the far-right lug of the DC jack unconnected.*

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

1.0.3 (2025-02-16)

- Added build notes on Keeley, Analogman and Monte Allums mods.
- Added notes on D4 diode in conjunction with IC selection.

1.0.2 (2024-08-19)

- Updated build notes with more information on diodes used in the original pre-'94 version.
- Changed D6 and D8 to 1N914.
- Changed LEDR to 10k to work better with a wide variety of LEDs.
- Changed R23 to 47R to increase supply voltage slightly.

1.0.1 (2021-11-22)

Corrected some discrepancies on the parts list for the pre-'94 and post-'94 circuits. The Mouser spreadsheet was correct.

1.0.0 (2021-10-22)

Initial release.