

PROJECT NAME

# REFRACTOR



BASED ON

Klon Centaur / KTR

BUILD DIFFICULTY

■■■■□ Intermediate

EFFECT TYPE

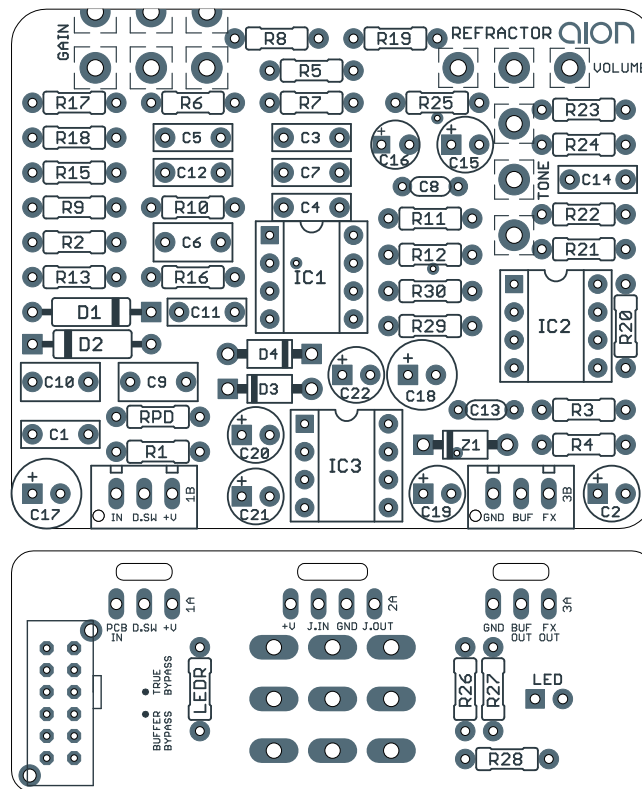
Overdrive

DOCUMENT VERSION

1.0.2 (2018-10-24)

## PROJECT SUMMARY

A part-for-part replica of a mythical overdrive effect noted for its high-end tone and price. The Klon Centaur and its successor, the KTR, remain highly original designs in an industry full of clones and tweaks to existing circuits.



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

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## INTRODUCTION

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The Refractor Professional Overdrive is a clone of the Klon® Centaur Professional Overdrive and its successor, the KTR.

While the original Centaur was buffered bypass, the newer KTR added the option to switch between buffered bypass (called “Almost Always Better” by the designer) and true bypass (called “Almost Always Worse”). There were an overwhelming number of requests for this to be added to the Refractor, so this updated version implements the switch.

As of its release, the Refractor is the only DIY version of the Centaur or KTR that uses the correct true/buffer switch wiring from the original unit. Several other projects use a simpler wiring method that does not preserve the original circuit in buffered mode, which was one of the inventor’s stipulations.

Aside from the addition of the true bypass / buffer switch, the KTR is identical to the original Centaur circuit except for two components:

1. A pulldown resistor, RPD, has been added to counteract switch pop in the true-bypass mode.
2. R2 has been changed from 1M to 2M so that the input impedance stays the same with the addition of RPD (since two 2M resistors in parallel make 1M, which was the original value).

## USAGE

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The Refractor has the traditional Gain, Tone (Treble) and Volume controls. What’s notable about this effect, though, is that the dual-potentiometer gain control does two things at once: it increases the gain like a normal drive pedal, while also blending from a clean, unclipped signal to the clipped signal.

For example, at minimum gain, the gain stage is out of the circuit entirely. At 50%, the gain has been increased while also mixing 50% clean with 50% gain. At 100%, the gain is at maximum and the clean signal is fully out of the mix. The gain control still feels very natural, but provides a unique and innovative way of controlling the overdriven sound of the effect.

With that said, the unit was originally designed to be run fairly clean (around 9-10:00 on the drive setting) with the volume turned up, acting as a clean boost with a slight amount of grit to slam the frontend of a Fender tube amp. It’s much more versatile than just this, but that’s the “expensive tone” that people will spend lots of cash to get.

## PARTS LIST

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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	10k	Metal film resistor, 1/4W	
R2	2M	Metal film resistor, 1/4W	
R3	100k	Metal film resistor, 1/4W	
R4	560R	Metal film resistor, 1/4W	
R5	5k1	Metal film resistor, 1/4W	
R6	10k	Metal film resistor, 1/4W	
R7	1k5	Metal film resistor, 1/4W	
R8	1k5	Metal film resistor, 1/4W	
R9	1k	Metal film resistor, 1/4W	
R10	2k	Metal film resistor, 1/4W	
R11	15k	Metal film resistor, 1/4W	
R12	422k	Metal film resistor, 1/4W	
R13	1k	Metal film resistor, 1/4W	
R15	22k	Metal film resistor, 1/4W	
R16	47k	Metal film resistor, 1/4W	
R17	27k	Metal film resistor, 1/4W	
R18	12k	Metal film resistor, 1/4W	
R19	15k	Metal film resistor, 1/4W	
R20	392k	Metal film resistor, 1/4W	
R21	1k8	Metal film resistor, 1/4W	
R22	100k	Metal film resistor, 1/4W	
R23	4k7	Metal film resistor, 1/4W	
R24	100k	Metal film resistor, 1/4W	
R25	560R	Metal film resistor, 1/4W	
R26	68k	Metal film resistor, 1/4W	
R27	68k	Metal film resistor, 1/4W	
R28	100k	Metal film resistor, 1/4W	
R29	27k	Metal film resistor, 1/4W	
R30	27k	Metal film resistor, 1/4W	
RPD	2M	Metal film resistor, 1/4W	Input pulldown resistor for true bypass mode.

## PARTS LIST, CONT.

PART	VALUE	TYPE	NOTES
LEDR	4k7	Metal film resistor, 1/4W	LED current-limiting resistor. Adjust value to change LED brightness.
C1	100n	Film capacitor, 7.2 x 2.5mm	
C2	4.7uF	Electrolytic capacitor, 4mm	
C3	100n	Film capacitor, 7.2 x 2.5mm	
C4	68n	Film capacitor, 7.2 x 2.5mm	
C5	68n	Film capacitor, 7.2 x 2.5mm	
C6	390n	Film capacitor, 7.2 x 2.5mm	
C7	82n	Film capacitor, 7.2 x 2.5mm	
C8	390pF	MLCC capacitor, NP0/C0G	
C9	1uF	Film capacitor, 7.2 x 3.5mm	
C10	1uF	Film capacitor, 7.2 x 3.5mm	
C11	2n2	Film capacitor, 7.2 x 2.5mm	
C12	27n	Film capacitor, 7.2 x 2.5mm	
C13	820pF	MLCC capacitor, NP0/C0G	
C14	3n9	Film capacitor, 7.2 x 2.5mm	
C15	4.7uF	Electrolytic capacitor, 4mm	
C16	1uF	Tantalum capacitor, 044A	Be sure to get the polarity right when soldering! Look for the "+" symbol.
C17	100uF	Electrolytic capacitor, 6.3mm	Power supply filter capacitor.
C18	47uF	Electrolytic capacitor, 5mm	Voltage reference filter capacitor.
C19	10uF	Electrolytic capacitor, 5mm	
C20	10uF	Electrolytic capacitor, 5mm	
C21	10uF	Electrolytic capacitor, 5mm	
C22	10uF	Electrolytic capacitor, 5mm	
D1	BAT41	Diode, Schottky, DO-35	Substitute for original germanium diodes. If you want to use real germaniums, the Russian D9 series is recommended (D9E, D9F, etc.)
D2	BAT41	Diode, Schottky, DO-35	
D3	1N4001	Diode, rectifier, DO-41	Can sub 1N4002, 1N4003, etc.
D4	1N4001	Diode, rectifier, DO-41	
Z1	1N4742A	Diode, zener, 12V, DO-41	Overvoltage protection for the TC1044. If using a LT1054, you can instead use a 1N4744A (15V zener).
IC1	TL072IP	Operational amplifier, DIP8	Can also use TL072CP. No sound difference, but TL072IP was cheaper at the time this document was put together.
IC2	TL072IP	Operational amplifier, DIP8	
IC3	TC1044SCPA	Charge pump, DIP8	Can also use LT1054. Better specs, but more expensive.
LED	5mm	LED, 5mm	Adjust LEDR resistor to set brightness depending on the LED used.

## PARTS LIST, CONT.

PART	VALUE	TYPE	NOTES
SLIDE	4PDT	Slide switch, 4PDT	E-Switch EG4208 (4mm lever) or EG4208A (6mm lever)
VOL	10kB	Potentiometer, 16mm right-angle	Linear taper.
GAIN	100kB dual	Potentiometer, 16mm right-angle	Linear taper, dual right-angle PCB mount.
TREB	10kB	Potentiometer, 16mm right-angle	Linear taper.
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	Mouser 163-4302-E 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	
ENC	125B	Enclosure, die-cast aluminum	Can also use a Hammond 1590N1.

# BUILD NOTES

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## Parts Substitutions

Here are a few part substitutions you can experiment with to get some different sounds.

**Tone capacitor mod:** A very common and well-regarded modification is to change C14 to either 6n8 or 8n2. It fixes a complaint of Centaur clones that the treble is a little thin, and nearly everyone who's done it says it's a huge improvement.

**Socket the op amps.** The original uses TL072s, but many people have reported good things from mixing these up, such as an LF353 or JRC4558D for IC1 and a NE5532 for IC2.

**Bass guitar mod:** Use a 390n film capacitor for C1 if you're going to use it as an overdrive for bass.

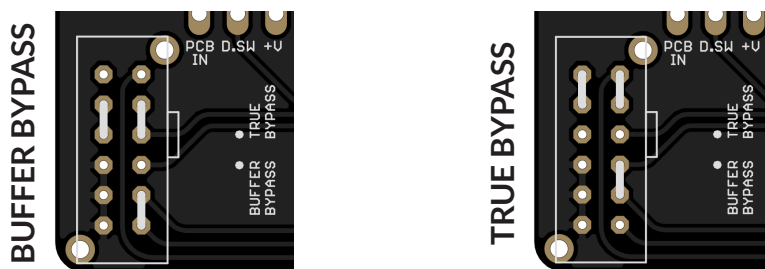
## The "Magic Diodes"

The original uses 1N34A germanium diodes for clipping. However, the exact originals are no longer available and 1N34A diodes from other suppliers do not sound the same. (Germanium diodes have a very imprecise manufacturing process, so the actual part numbers are usually just an approximation and not an indication that they will perform the same as others with the same name.) The one important thing to know is that the Centaur's diodes have been measured at around **0.35v** forward voltage.

Many have tried the Russian **D9E** diodes and found them to be a near-exact match. (D9B, D9D, D9J, D9K and D9L are equivalents and can usually be found cheaper.) People have used other types of diodes and some have found that they preferred them over standard germaniums. A good one that is often tried is the **BAT41**, a Schottky diode that is very widely available.

## Bypassing the true bypass / buffer switch

The E-Switch EG4208 slide switch used for the true bypass/buffer selector is available from Mouser Electronics but may not be accessible to everyone. If you are unable to obtain it, you can hard-wire the switch to either true bypass mode or buffered mode by soldering jumpers to the switch pads.

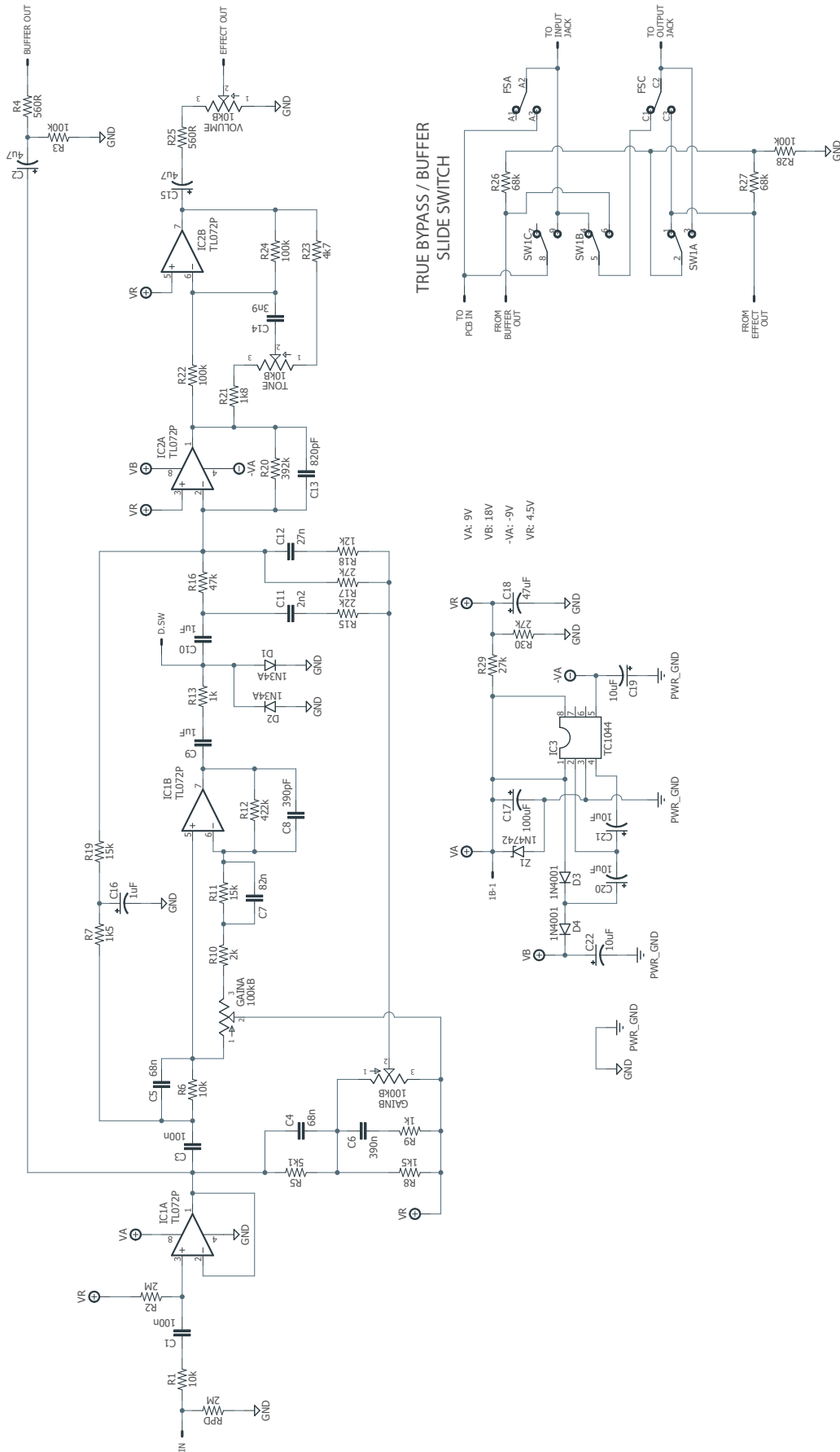


## Making the true bypass / buffer switch accessible from outside the enclosure

If you're confident in your drilling skills, you could make the switch accessible from the outside. Make sure to use the **EG4208A** switch, the one with the longer 6mm lever, and rotate it 180 degrees so the lever faces to the left instead of the right. (The switch is symmetrical, so it's electrically identical regardless of orientation.) Cut a slot through the enclosure in this spot and you'll be able to reach it.

Be aware that this will require very precise measurements. It has not been tested, so Aion FX cannot offer any assistance or advice on how best to execute it.

# SCHEMATIC



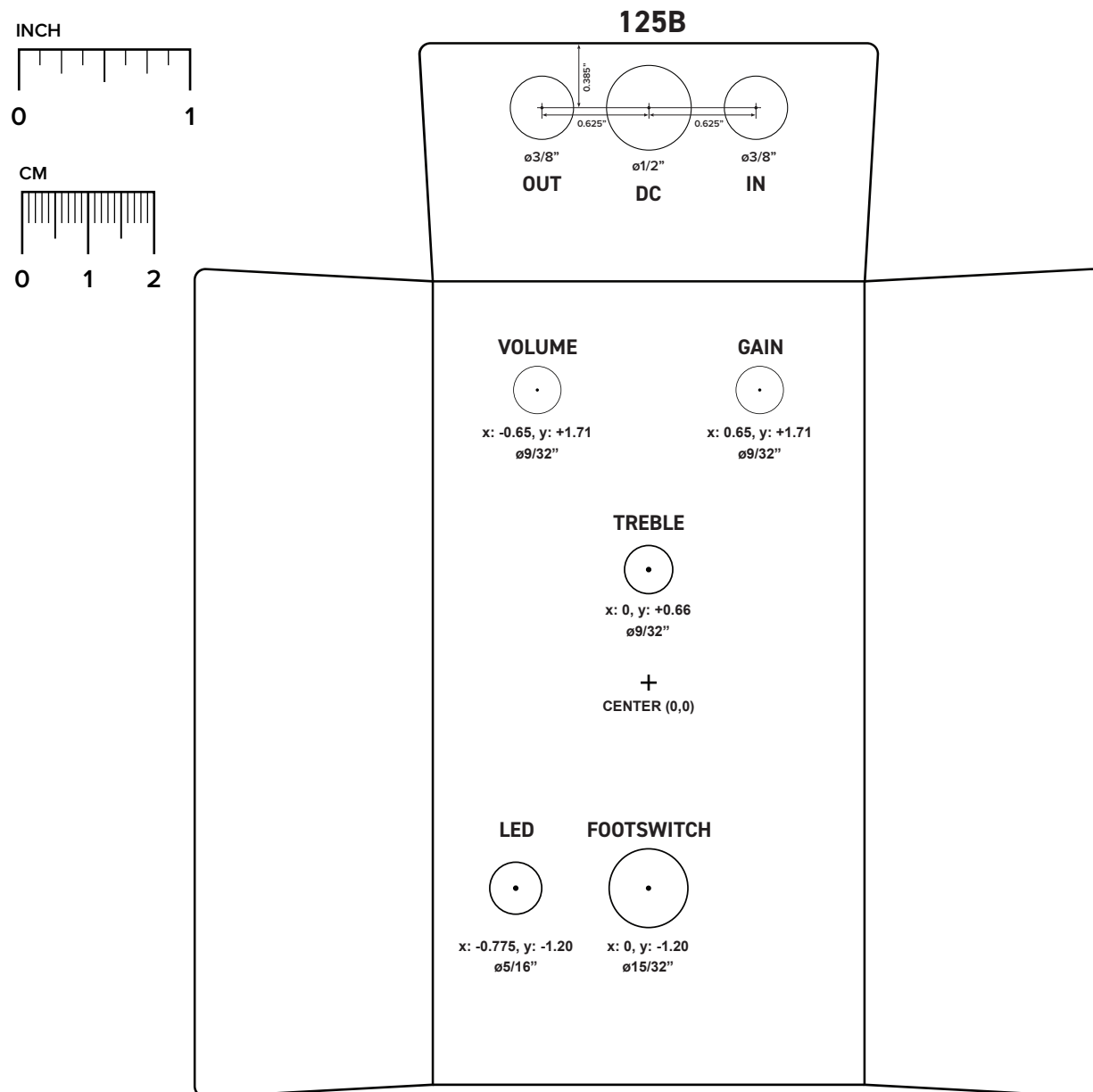
# DRILL TEMPLATE

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.





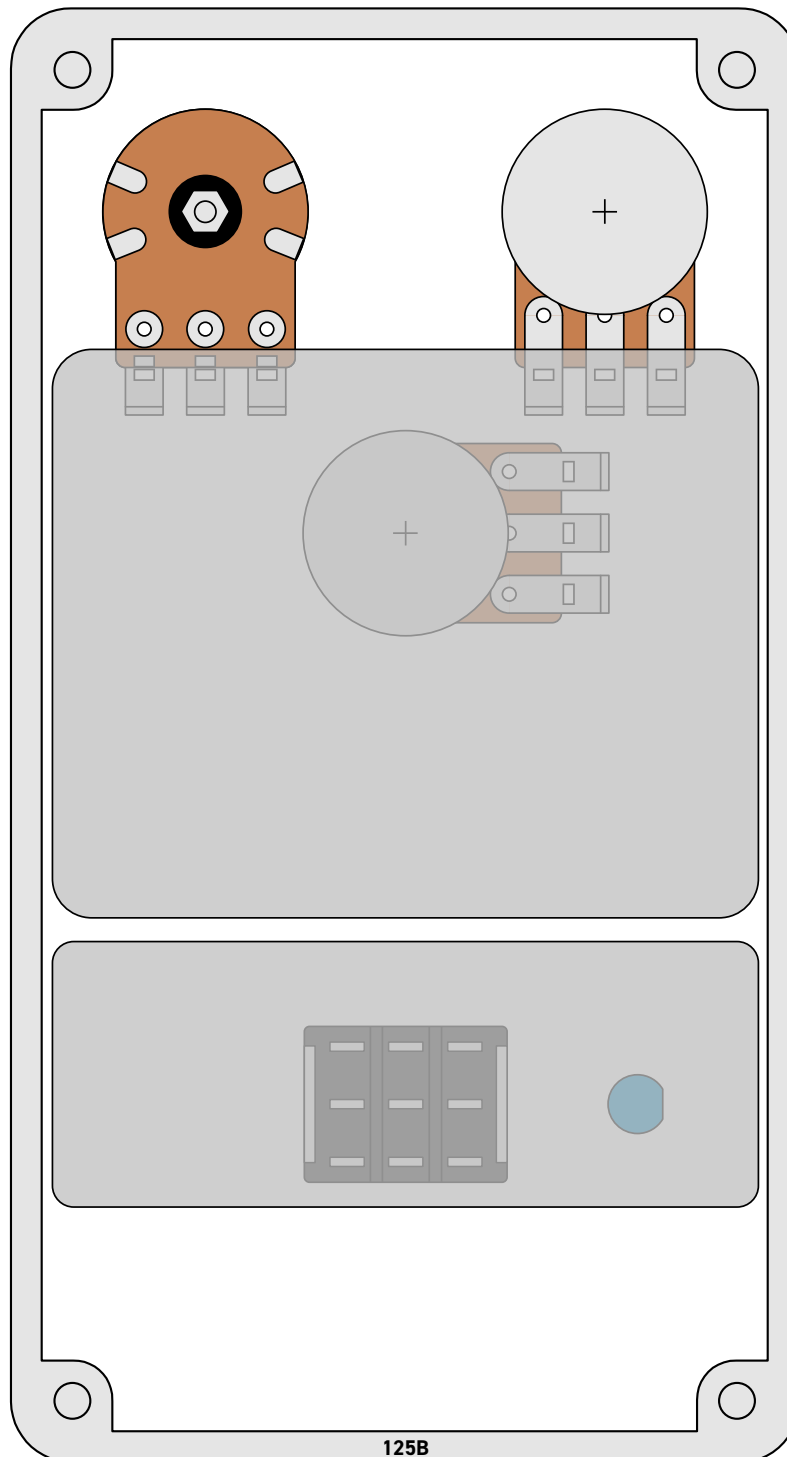
## ENCLOSURE LAYOUT

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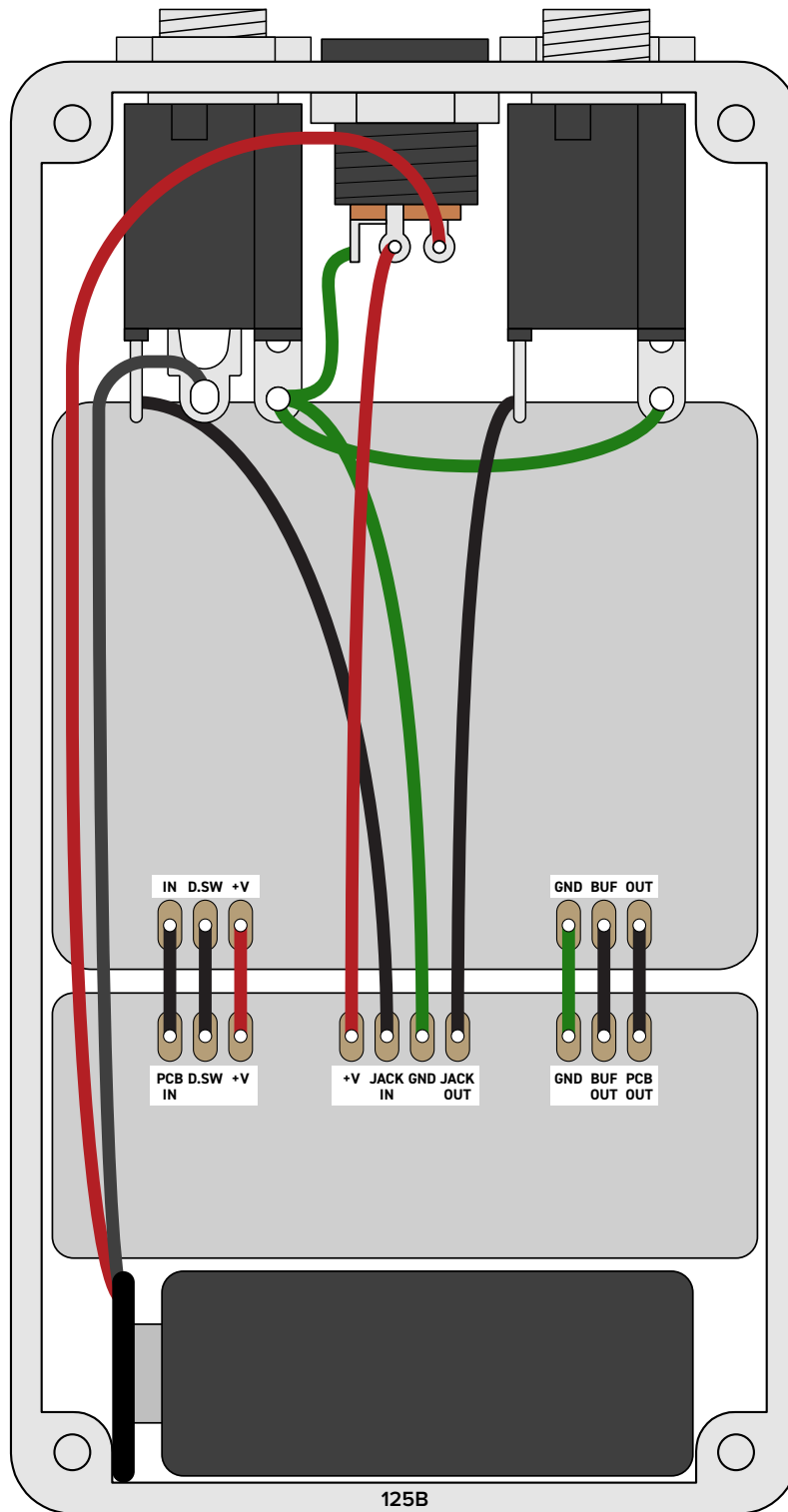
Enclosure is shown without jacks. See next page for jack layout and wiring.

**Note:** The upper pads for the dual-gang gain potentiometer appear to be cut in half. **This is intentional!** It's called a *plated half-hole* or *castellated hole*, and it's used so that the PCB can lay flat across the pots instead of angling upward for the dual pot.

Solder it like you would if they were normal pads, but bend the top pins forward slightly so they make contact with the edge of the pads.



# 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

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**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

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### 1.0.2 (2018-10-24)

Corrected a minor error in the schematic (not present in the PCB) and re-drew portions for clarity.

### 1.0.1 (2018-07-17)

Added note explaining the plated half-holes used for the gain potentiometer.

### 1.0.0 (2018-07-04)

Initial release.