PROJECT NAME

LUNA

DIY GUITAR EFFECTS

BASED ON
4ms Tremulus Lune

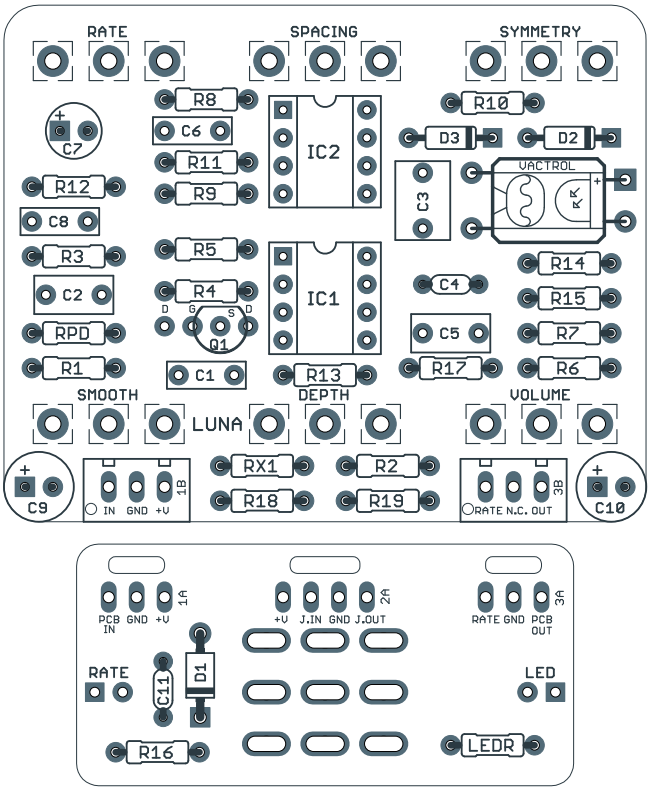
BUILD DIFFICULTY
Intermediate

EFFECT TYPE
Tremolo

DOCUMENT VERSION
1.0.0 (2019-03-14)

PROJECT SUMMARY

An all-analog tremolo featuring six knobs for fine control over every aspect of the waveform.



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

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INTRODUCTION

The Luna Optical Tremolo is a modified version of the 4ms Tremulus Lune, a classic DIY optical tremolo circuit that allows fine-grained control over the LFO shape.

Several of the Tremulus Lune circuit's optional modifications are included standard in this PCB, including the Symmetry control as well as an external gain adjustment control so you can achieve unity volume with any setting.

The Luna adds a few improvements to the original design, including an input buffer to reduce noise and some added filtering to counteract ticking from the LFO. All of the knobs are located on the front panel in an efficient layout that is easy to build.

The new version of the Luna now uses standard 16mm potentiometers, which should make it easier to source parts than the last version. It also now has the Rate LED integrated into the footswitch board.

USAGE

The Luna has the following controls:

- **Rate** is the speed at which the tremolo modulates.
- **Depth** sets the volume of the tremolo at the lowest peak of the waveform. You can turn it all the way up for a choppy sound, all the way down for a clean boost with no modulation, or anything in between.
- **Symmetry** allows you to adjust the position of the peak of the LFO in the cycle. On one end, there will be a fast rise and a slow fall, like the attack of a piano. On the other end there will be a slow rise and a fast decay, like a swell effect. The middle position is a normal tremolo sound with equal rise and fall times.
- **Smooth** lets you set the shape of the LFO. On one end of the knob's range, it's a triangle wave. In the middle, it's a sine wave, and on the far end it's a square wave.
- **Spacing** allows you to space out the LFO cycles. The width of the LFO pulse is the same, but there is a delay between cycles—creating a unique effect that is very uncommon in tremolo designs.
- **Volume** sets the volume of the tremolo at the highest peak of the waveform.

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	1k	Metal film resistor, 1/4W	
R2	1M	Metal film resistor, 1/4W	
R3	1k	Metal film resistor, 1/4W	
R4	47k	Metal film resistor, 1/4W	
R5	47k	Metal film resistor, 1/4W	
R6	1k	Metal film resistor, 1/4W	
R7	1M	Metal film resistor, 1/4W	
R8	220k	Metal film resistor, 1/4W	
R9	150k	Metal film resistor, 1/4W	
R10	220k	Metal film resistor, 1/4W	
R11	220k	Metal film resistor, 1/4W	
R12	2k7	Metal film resistor, 1/4W	
R13	330R	Metal film resistor, 1/4W	
R14	1k	Metal film resistor, 1/4W	
R15	1k	Metal film resistor, 1/4W	
R16	1k	Metal film resistor, 1/4W	
R17	1k	Metal film resistor, 1/4W	
R18	100k	Metal film resistor, 1/4W	
R19	100k	Metal film resistor, 1/4W	
RPD	2M2	Metal film resistor, 1/4W	Input pulldown resistor. Can be as low as 1M.
LEDR	4k7	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	1uF	Film capacitor, 7.2 x 3.5mm	
C3	2.2uF	Film capacitor, 7.2 x 5mm	
C4	330pF	MLCC capacitor, NP0/C0G	
C5	1uF	Film capacitor, 7.2 x 3.5mm	
C6	10n	Film capacitor, 7.2 x 2.5mm	
C7	10uF	Electrolytic capacitor, 5mm	
C8	33n	Film capacitor, 7.2 x 2.5mm	
C9	100uF	Electrolytic capacitor, 6.3mm	Power supply filter capacitor.

PARTS LIST, CONT.

PART	VALUE	TYPE	NOTES
C10	47uF	Electrolytic capacitor, 5mm	Reference voltage filter capacitor.
C11	100n	MLCC capacitor, X7R	Power supply filter capacitor.
D1	1N5817	Schottky diode, DO-41	
D2	1N914	Fast-switching diode, DO-35	
D3	1N914	Fast-switching diode, DO-35	
Q1	2N5457	JFET, general purpose, TO-92	Can sub with a more common BJT transistor. See build notes.
VACT	VTL5C3	Photocoupler, fast on/fast off	See build notes for more information on photocoupler selection.
IC1	TL072	Operational amplifier, DIP8	
IC1-S	DIP-8 socket	IC socket, DIP-8	
IC2	TL022	Operational amplifier, DIP8	
IC2-S	DIP-8 socket	IC socket, DIP-8	
DEPTH	1kB	16mm right-angle PCB mount pot	
RATE	100kC	16mm right-angle PCB mount pot	
SMTH	500kB	16mm right-angle PCB mount pot	
SPACE	500kB	16mm right-angle PCB mount pot	
SYM	500kB	16mm right-angle PCB mount pot	
VOL	50kA	16mm right-angle PCB mount pot	
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	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

Vactrol selection

The Luna sounds best with a VTL5C3 workalike. Since the original VTL5C3 is no longer made, you'll likely need to find a substitute. Xvive and CoolAudio make their own version under the same part number, VTL5C3, and both are available from Small Bear Electronics as well as several international retailers. Alternately, Small Bear Electronics sells the Macron MI1210CLF-R which works just as well.

It's possible to also "roll your own" photocoupler by using an LED and an LDR. However, this is outside the scope of this documentation and you'll have to ask for help on a forum if you're not sure what to do.

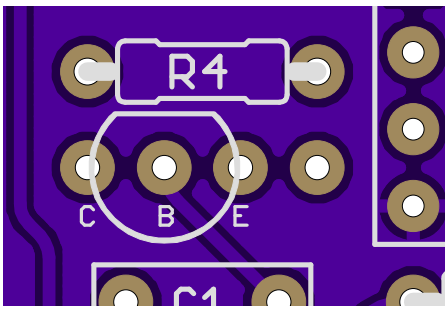
Note: Do not use a low "on" resistance photocoupler such as the NSL-32. The resistance (500 ohms to 1k) is so low that the gain ratio will be thrown off balance in the following gain stage. The volume control will be unusable, and the combined high-pass filter with C3 will cut the bass significantly at the higher-volume end of the cycle.

Input buffer

The original Tremulus Lune does not have an input buffer. Since the first op-amp stage is in an inverting configuration, this means the source impedance directly affects the gain of the effect, and you will have drastically different behavior if the pedal is connected straight to a guitar vs. coming after a buffer.

The Luna adds an input buffer to counteract this. The default configuration from the parts list & layout is to use a JFET. However, due to the scarcity of TO-92 JFETs, the buffer can be configured to instead use a more common NPN bipolar transistor such as a 2N5088 or 2N3094 with only one resistor change.

To use a BJT, **omit R2 and use 470k for RX1**. Then, insert the transistor as shown below:

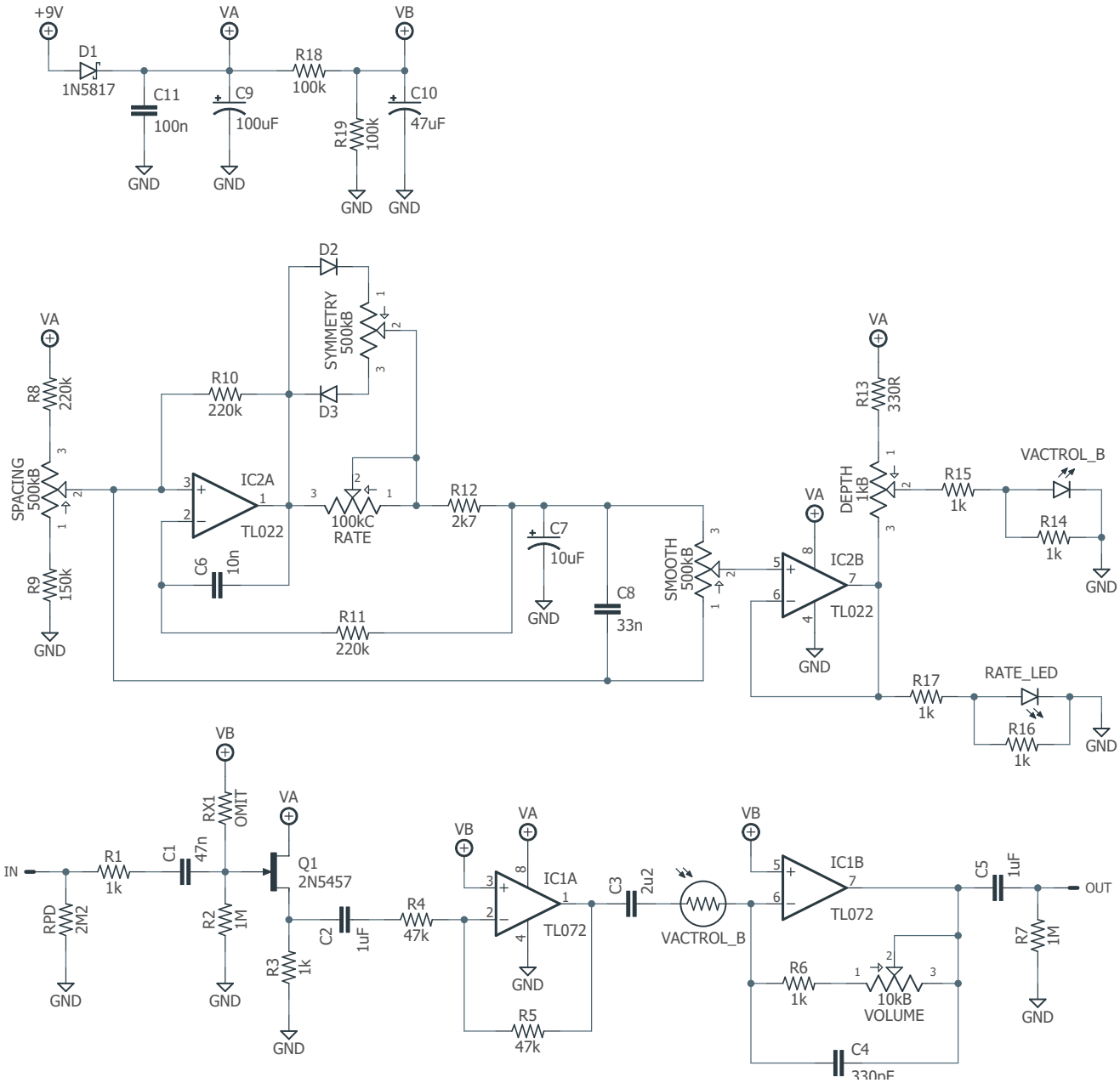


Assuming E-B-C pinout, you just shift it to the left by 1 pin from where the JFET would normally go.

JFET selection

The 2N5457 is a great general-purpose JFET, but anything with a high $V_{GS(off)}$ value (also known as V_P or pinch-off voltage) will work well here. Other options include 2N5458, MPF102, PN4303, PN4304, BF244A, BF245A among many more.

SCHEMATIC


+9V
VA
VB
D1
1N5817
C11
100n
C9
100uF
R18
100k
R19
100k
C10
47uF
GND
D2
D3
SYMMETRY
500kB
R10
220k
R8
220k
SPACING
500kB
R9
150k
IC2A
TL022
100kC
RATE
R12
2k7
C6
10n
C7
10uF
C8
33n
R11
220k
SMOOTH
500kB
R13
330R
DEPTH
1kB
R15
1k
VACTROL_B
R14
1k
IC2B
TL022
R17
1k
RATE_LED
R16
1k
RX1
OMIT
IN
R1
1k
C1
47n
RPD
2M2
R2
1M
Q1
2N5457
R3
1k
C2
1uF
R4
47k
IC1A
TL072
R5
47k
C3
2u2
VACTROL_B
IC1B
TL072
R6
1k
10kB
VOLUME
C4
330nF
C5
1uF
R7
1M
OUT

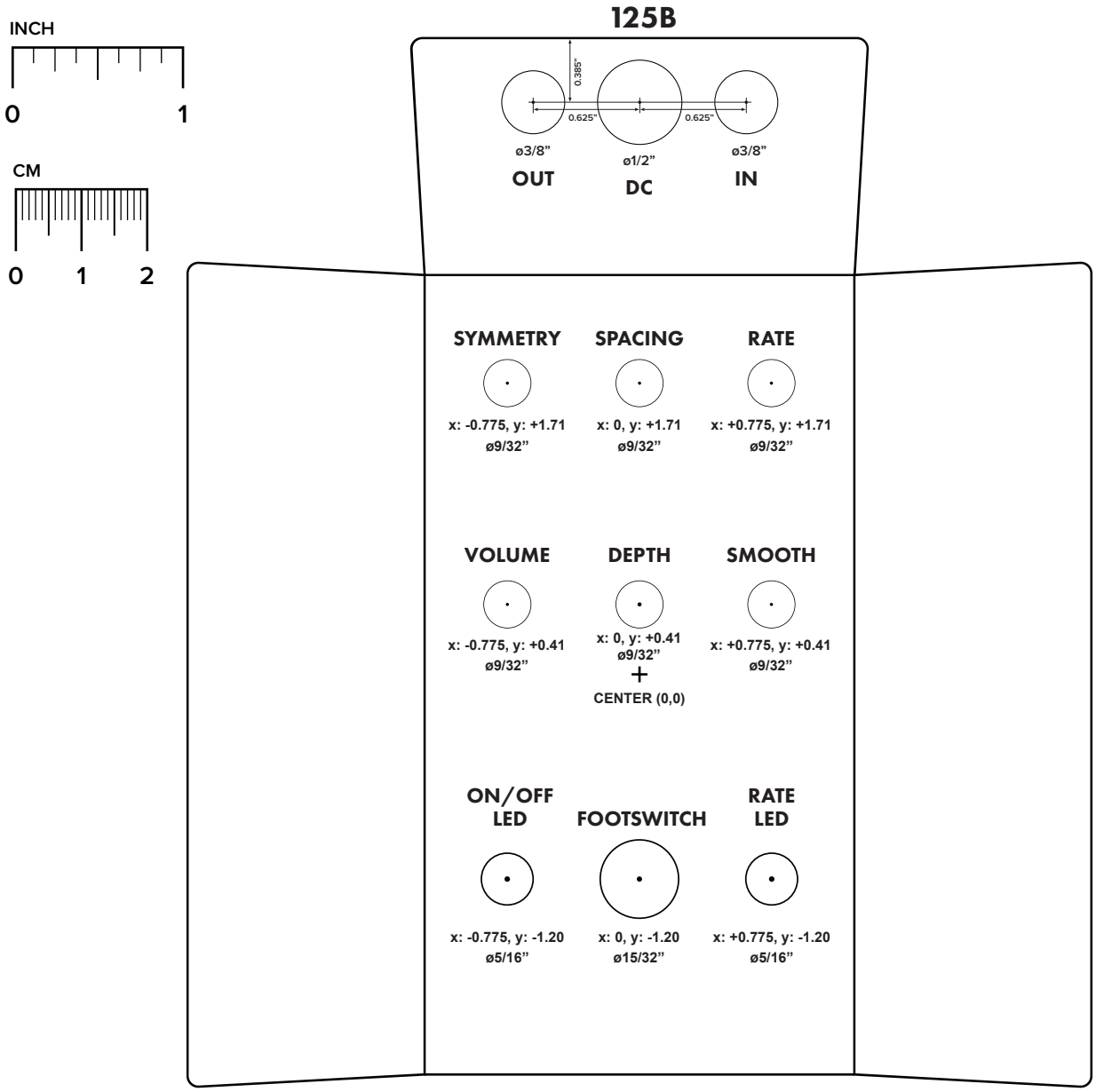
DRILL TEMPLATE

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.

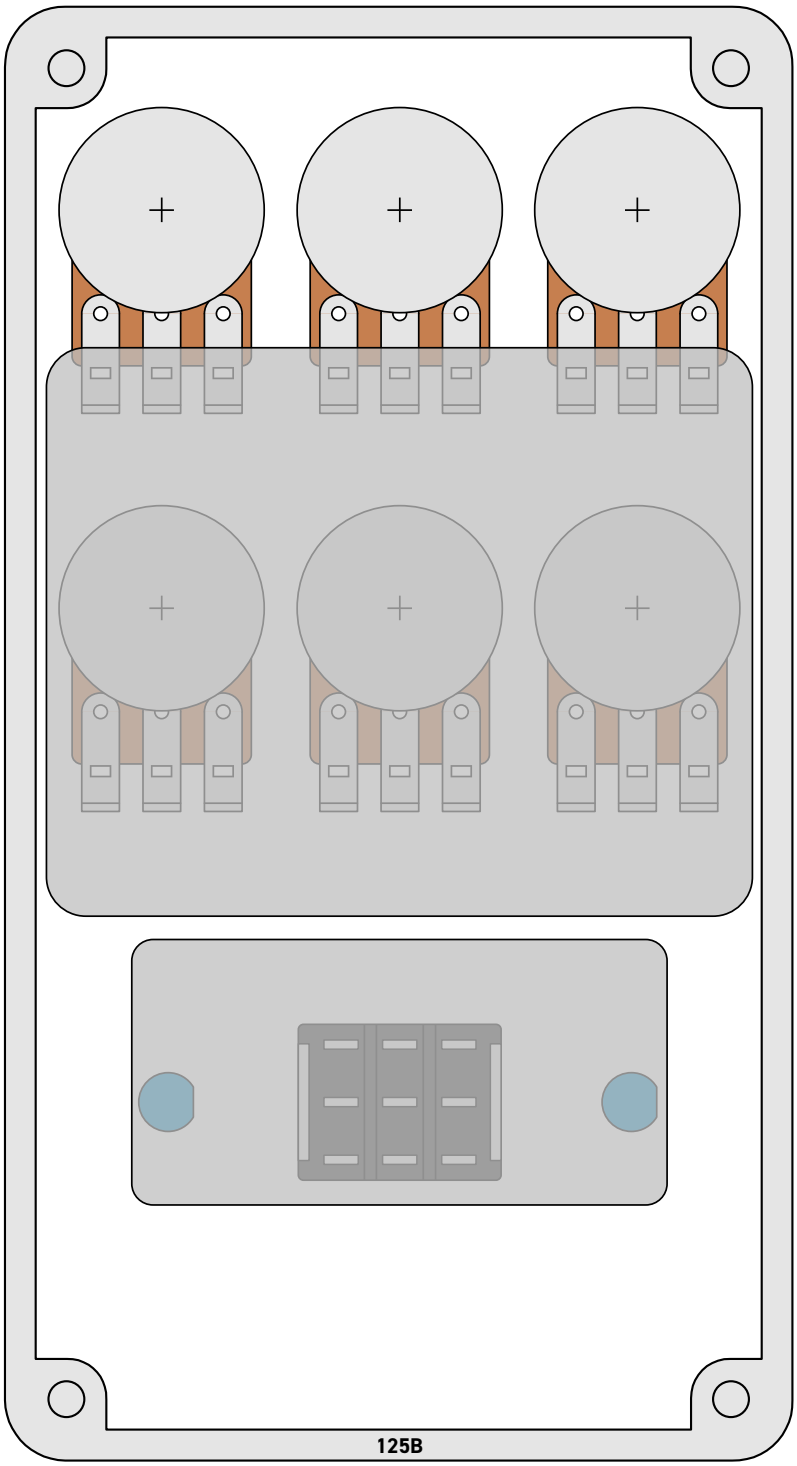
Top jack layout requires the use of closed-frame jacks like the Switchcraft 111X. Open-frame jacks will not fit in layouts with 5 or more knobs due to the placement of the DC jack.

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.

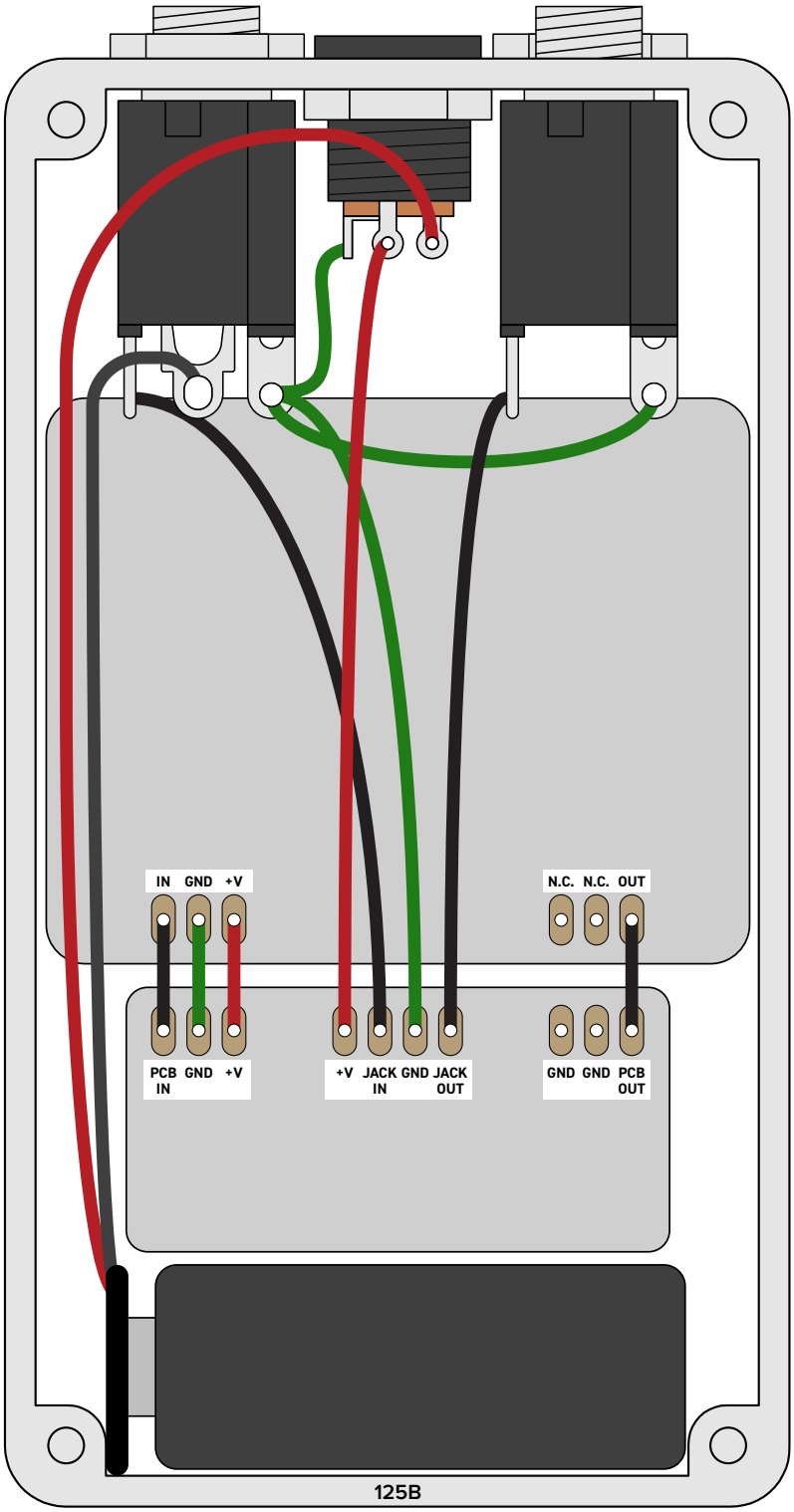


ENCLOSURE LAYOUT

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

1.0.0 (2019-03-14)
Initial release.