Meat Grinder Fuzz

Design By Erik Vincent

A dirty octave up fuzz is what you need to complete your doom metal pedal board mission!

Inspired by the Univox Super Fuzz and the FZ-2 with loads more versatility.

This all-silicon transistor fuzz consists of many unique features:

- Several gain sections
- Sine wave doubler to give a little extra somethin'
- An adjustable hard-clipping section
- A versatile, scooping tone control

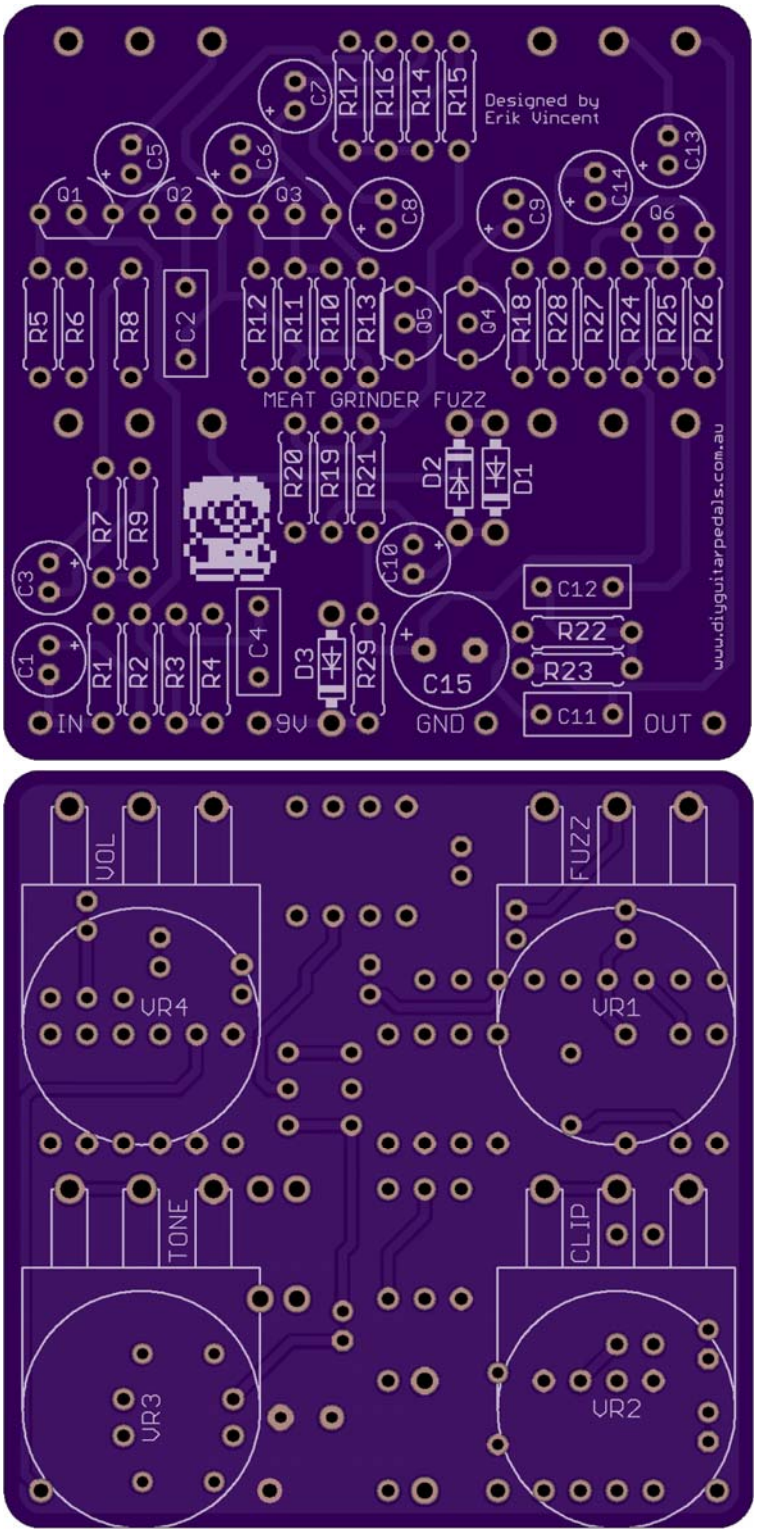
Octave fuzzes, by default, can be very abrasive sounding. With the clipping control you can tame it.

The original Univox Super Fuzz incorporated a Tone switch as the tone control for the effect. This has been converted to a vastly more versatile tone potentiometer, a bridged-Tee notch filter. This filter is not just the best logical choice for this circuit, but also adjusts the tonal characteristics of the circuit nicely in person.

The PCB is designed for a 125B enclosure or a 1590b with some planning.

Bill of Materials, Stock Meat Grinder Fuzz

Capacitor		Resistor	
C1	10µF (Electrolytic)	**R1**	2.2M
C2	1nF (film)	**R2**	22K
C3	10µF (Electrolytic)	**R3**	100K
C4	100nF (film)	**R4**	100K
C5	10µF (Electrolytic)	**R5**	1.8K
C6	10µF (Electrolytic)	**R6**	47K
C7	10µF (Electrolytic)	**R7**	470K
C8	10µF (Electrolytic)	**R8**	10K
C9	10µF (Electrolytic)	**R9**	47K
C10	10µF (Electrolytic)	**R10**	150K
C11	1nF (film)	**R11**	220K
C12	56nF (film)	**R12**	10K
C13	10µF (Electrolytic)	**R13**	10K
C14	10µF (Electrolytic)	**R14**	470
C15	100µF (Electrolytic)	**R15**	470
		R16	100K
Diode		**R17**	22K
D1	1N5817	**R18**	1.8K
D2	1N5817	**R19**	10K
D3	1N4001	**R20**	22K
		R21	100K
Transistor		**R22**	22K
Q1	2N3904	**R23**	10K
Q2	2N3904	**R24**	100K
Q3	2N3904	**R25**	15K
Q4	2N3904	**R26**	10K
Q5	2N3904	**R27**	1K
Q6	2N3904	**R28**	100K
		R29	47
		Potentiometer	
		Fuzz	50kb (16mm)
		Clip	10kb (16mm)
		Tone	10kb (16mm)
		Volume	50ka (16mm)



PCB Spacing
The Meat Grinder Fuzz PCB is spaced for 125B sized enclosures or larger

Pot Spacing
The Meat Grinder Fuzz PCB mounted potentiometers are spaced for Alpha 16mm potentiometers without dust covers

Assembly.

1. Soldering Order.

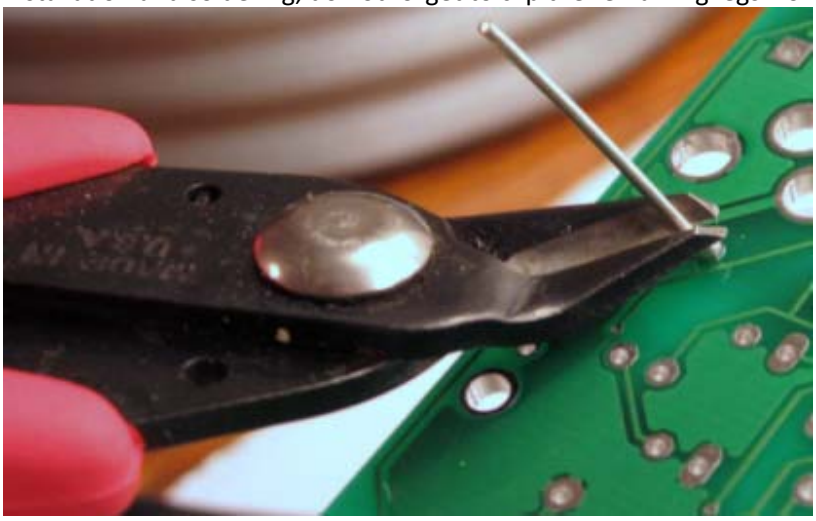
When soldering things to the PCB, the idea is to solder things on from lowest profile to tallest.

For the Meat Grinder, the best order would be: resistors, diodes, transistor/FETs, film capacitors, electrolytic capacitors, wiring, and then potentiometers.

1.1 Resistors.

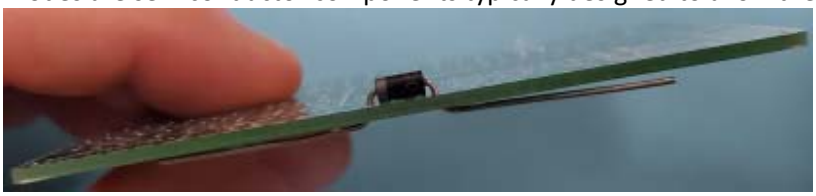
Resistors are small passive components designed to create a resistance of passage of an electric current.

For this pedal we will be using 1/4 Watt resistors. These can either be 5% tolerance carbon resistors, or 1% tolerance metal film resistors. Orientation of “which way is up” doesn’t matter, so you can install them either way. After installation and soldering, do not forget to clip the remaining legs from the PCB.

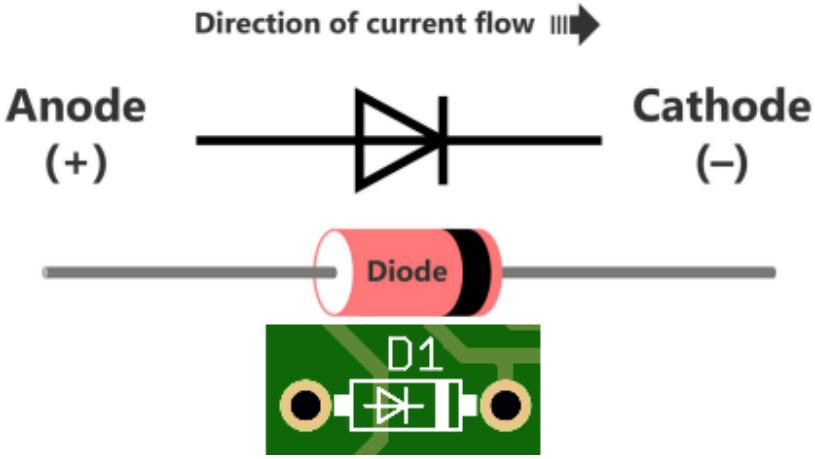


1.2 Diodes.

Diodes are semiconductor components typically designed to allow the flow electric current to go in one direction only.

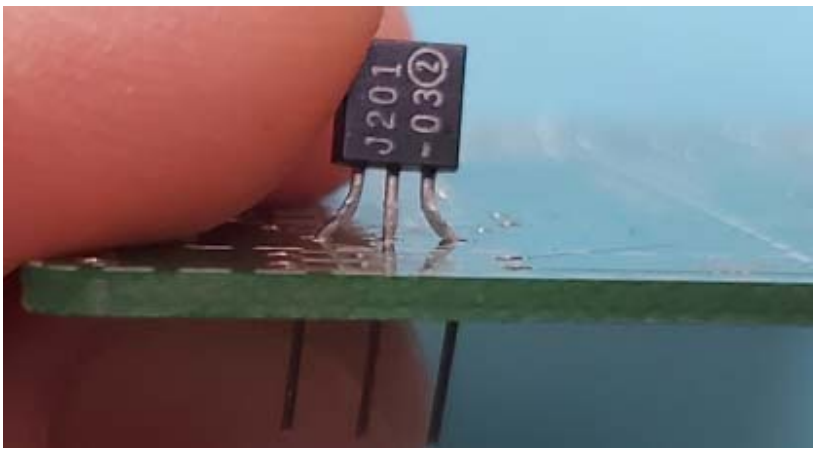


The orientation of a diode does matter based on the cathode and anode of the diode in the circuit. Make sure the stripe on the diode lines up with the stripe on the PCB's silkscreen. After installation and soldering, do not forget to clip the remaining legs from the PCB.

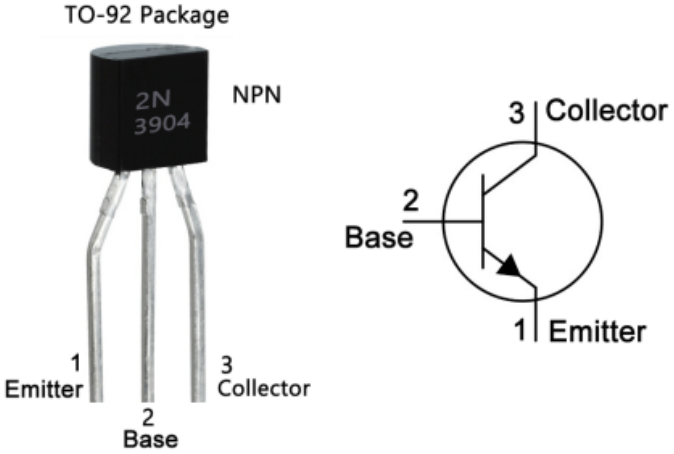


1.3 Transistors/FETs (silicon).

These semiconductor devices come in a few categories, such as BJT, JFET, MOSFET, and IGBT and are used for a variety of functions



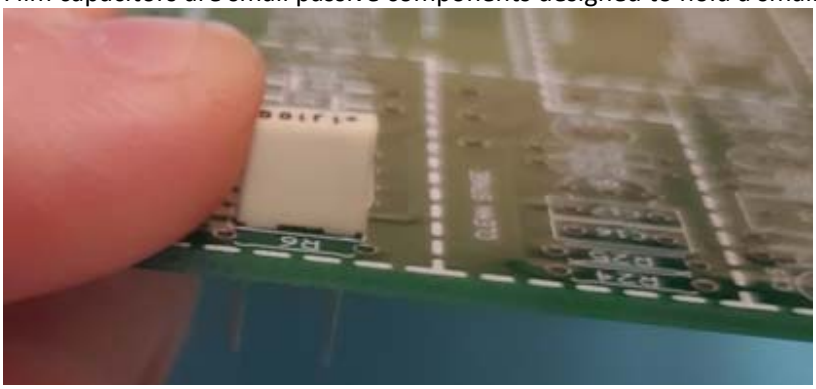
These devices typically only install one way, but pinouts can differ from different part numbers, so if using a different part number transistor than the one called out in the bill of materials will require that you check the datasheet of the transistor and check which legs are what pins for it to function properly.



After installation and soldering, do not forget to clip the remaining legs from the PCB.

1.4 Capacitors (film).

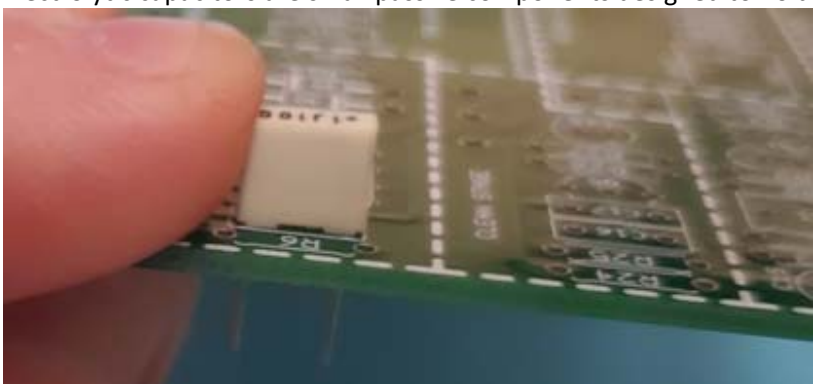
Film capacitors are small passive components designed to hold a small amount of charge in a circuit.



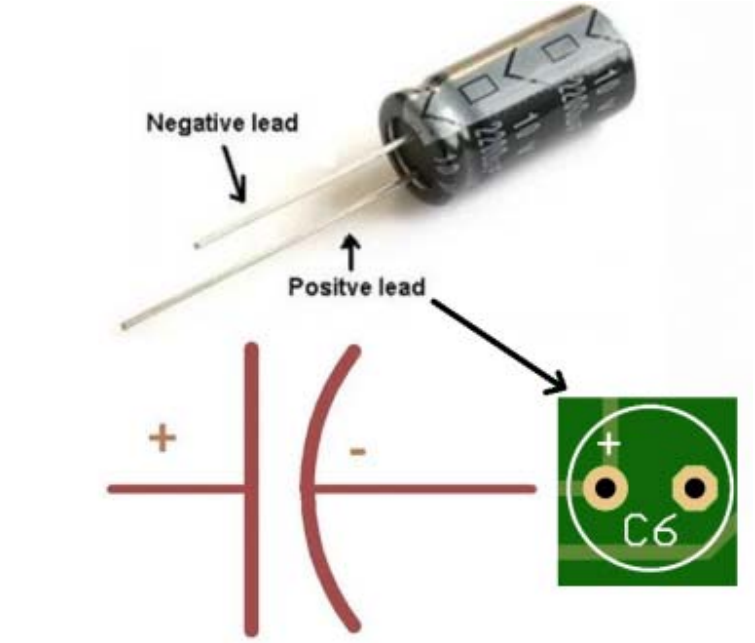
Orientation of “which way is up” doesn’t matter, so you can install them either way. After installation and soldering, do not forget to clip the remaining legs from the PCB.

1.5 Capacitors (electrolytic).

Electrolytic capacitors are small passive components designed to hold a small amount of charge in a circuit.



Electrolytic capacitors are typically polarized, so orientation will matter.

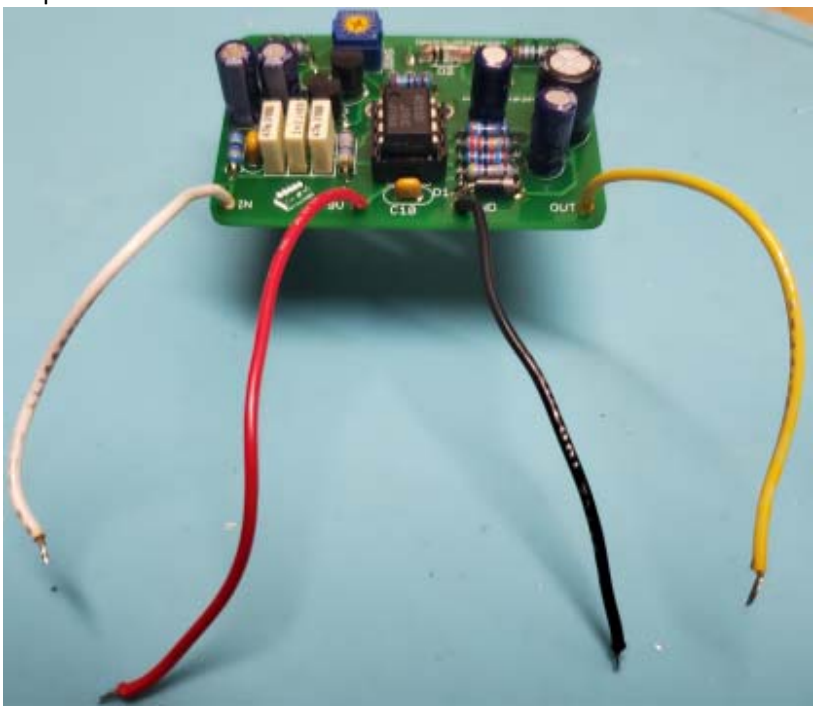


Polarized Electrolytic Capacitor and its electric Symbol

After installation and soldering, do not forget to clip the remaining legs from the PCB.

1.6 Wiring.

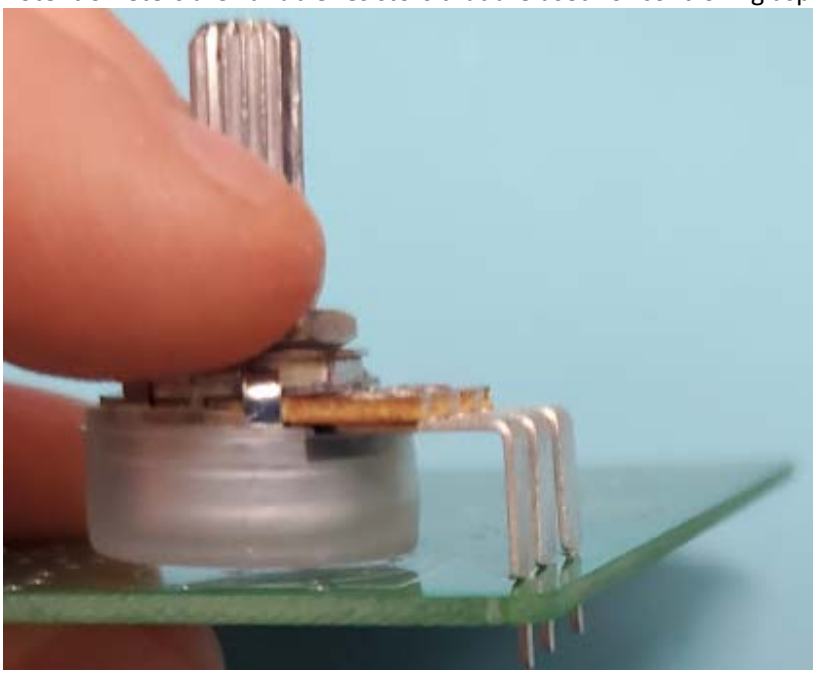
Wires used for the pedal are for delivering power over the hot and ground wires as well as signal for the input and output.



These can be installed at the very end, but in some situations, installing them before potentiometers are soldered in place can be advantageous. Colored wire doesn't change the properties, but using color codes for hot and ground wires, like red being hot, and black being ground, are common place. Typically, stranded hook-up wire, AWG 24 or 22 is used for this task. Using wire strippers, strip away about 1/8" (3mm) of the wire from either end and then using a soldering iron, tin the exposed tips with solder before installing into the PCB.

1.7 Potentiometers.

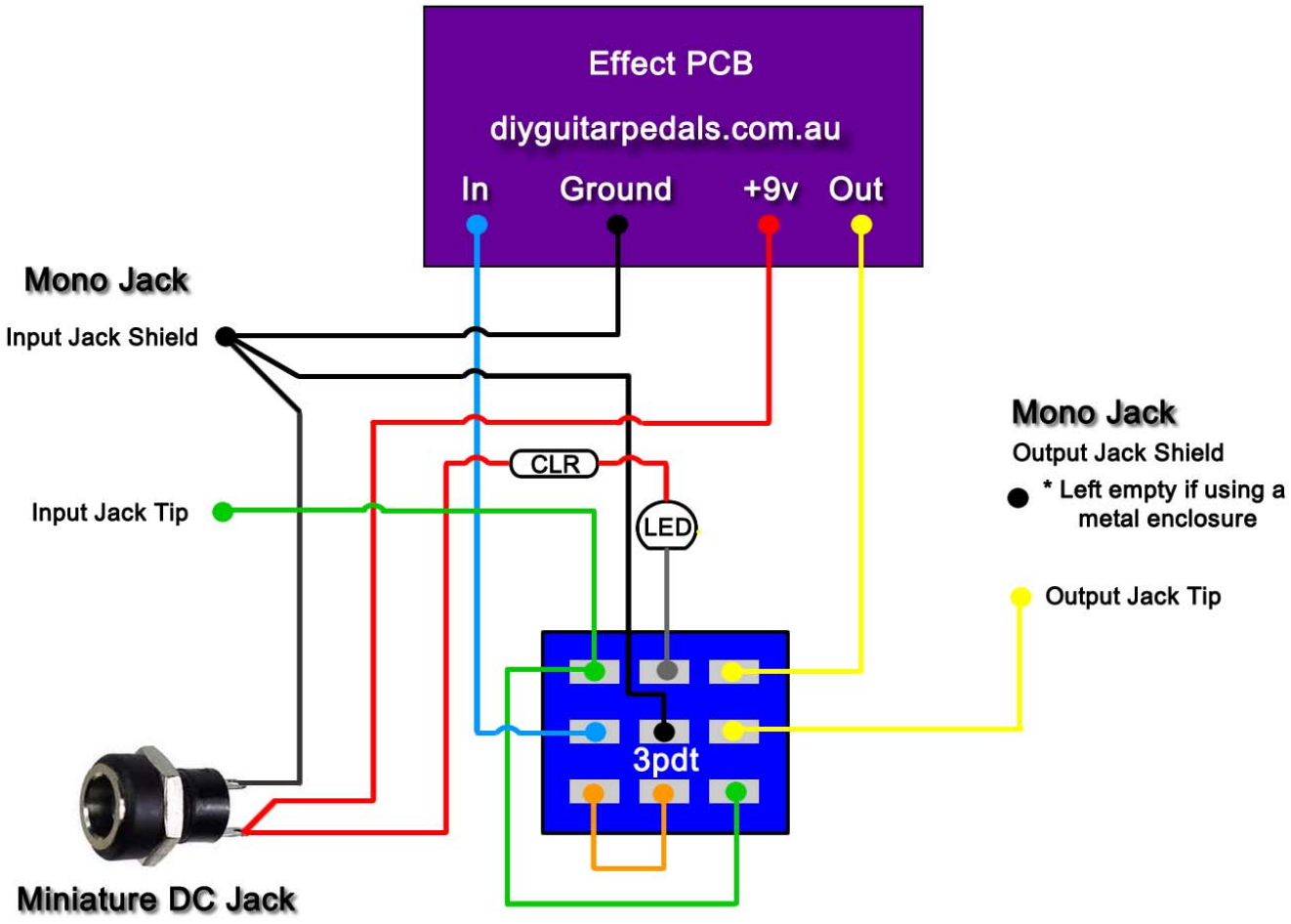
Potentiometers are variable resistors that are used for controlling aspects of the pedal.



This pedal can utilize 16mm pots. These are typically installed on the backside of the PCB and uses the included washer and jam-nut to mechanically secure the PCB to the enclosure via a strategically drilled hole on the enclosure. Orientation of potentiometer is preferred to line up the knob on the silk screen with the knob of the potentiometer.

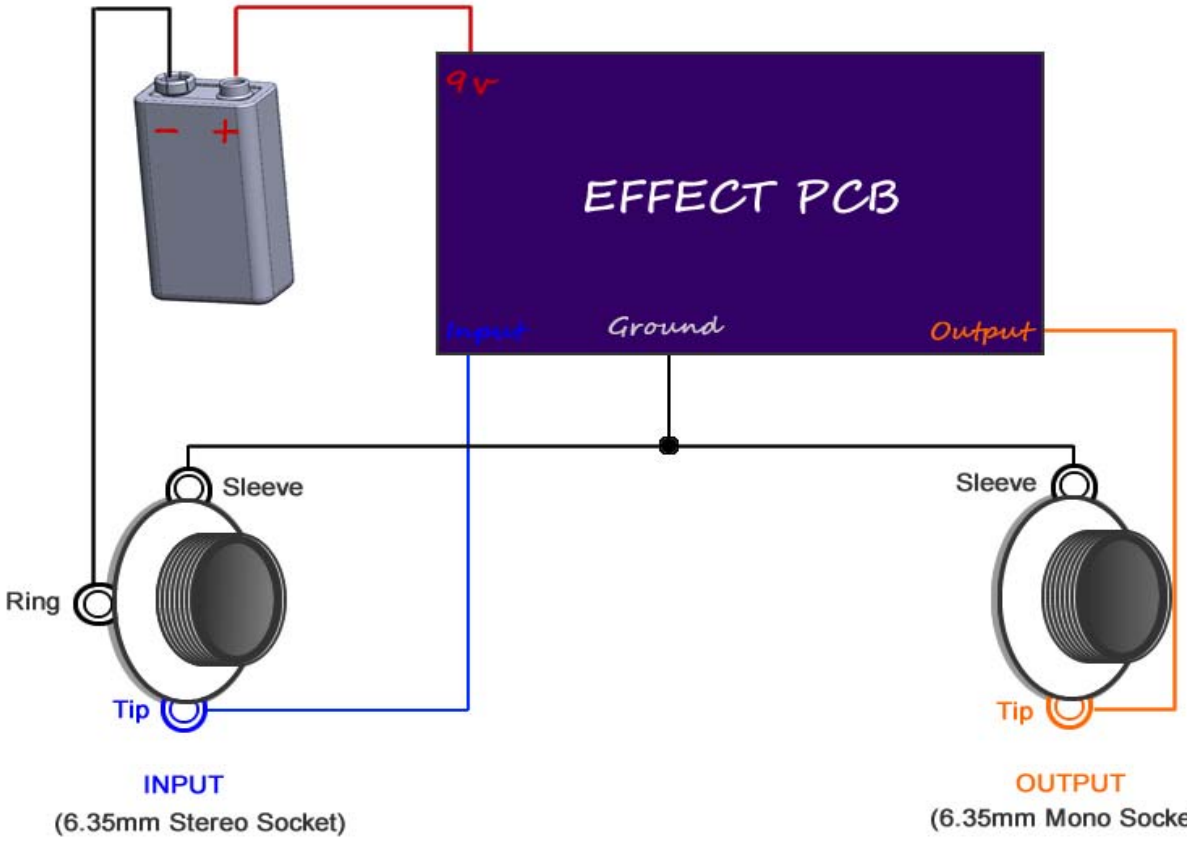
1.8 Off Board Wiring Diagram.

Potentiometers are variable resistors that are used for controlling aspects of the pedal. Using a non-switched miniature DC Jack and 2 Mono Jacks



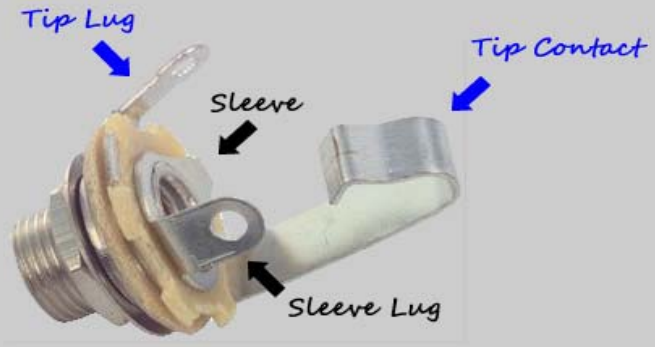
Testing Your Effect

Using aligator clips or soldering directly, wire your effect as in the following...



Input and Output Sockets

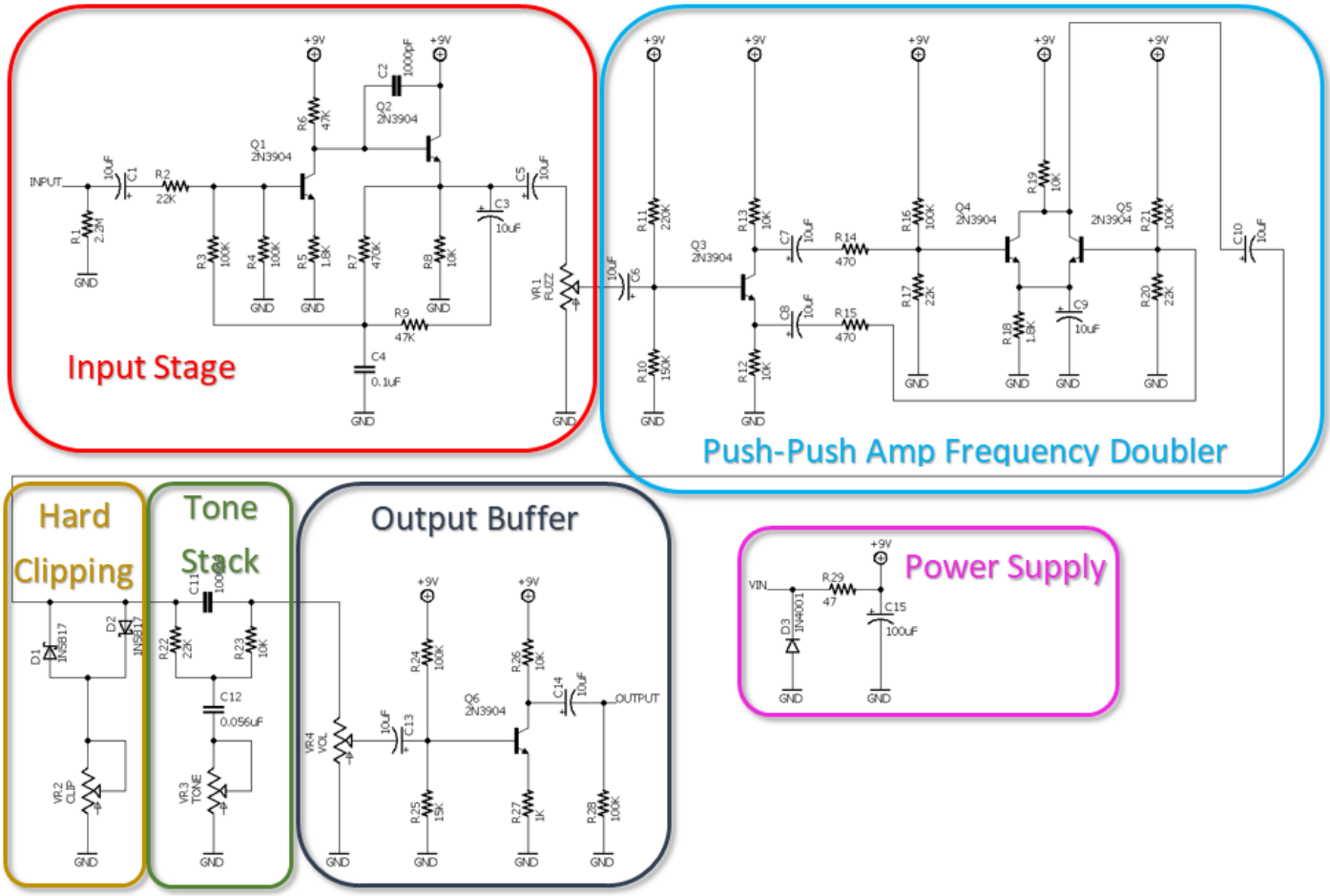
Pay close attention to the lugs of your sockets. Look at them side on so that you can distinguish the sockets individual layers. For instance the tip lug is connected to tip contact. The stereo jack looks the same as the socket below except it has an extra lug and contact for “Ring”.



Meat Grinder Fuzz Circuit Analysis for modifying purposes.

2. Meat Grinder Fuzz Circuit.

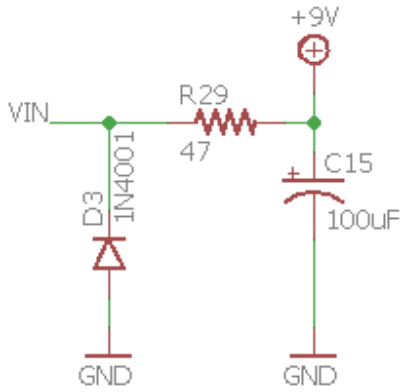
The Meat Grinder Fuzz schematic can be broken down into some simpler blocks: Power Supply, Input Stage, Push-Push Amp Frequency Doubler, Hard Clipping Stage, Tone-stack, and Output Buffer.



The input impedance on the Meat Grinder Fuzz is close to 67K Ω, which is pretty low, but higher than many other transistor fuzz pedals.

3. Power Supply.

- The Power Supply Stage provides the electrical power to all the circuitry, the whole power consumption is estimated around 8mA:



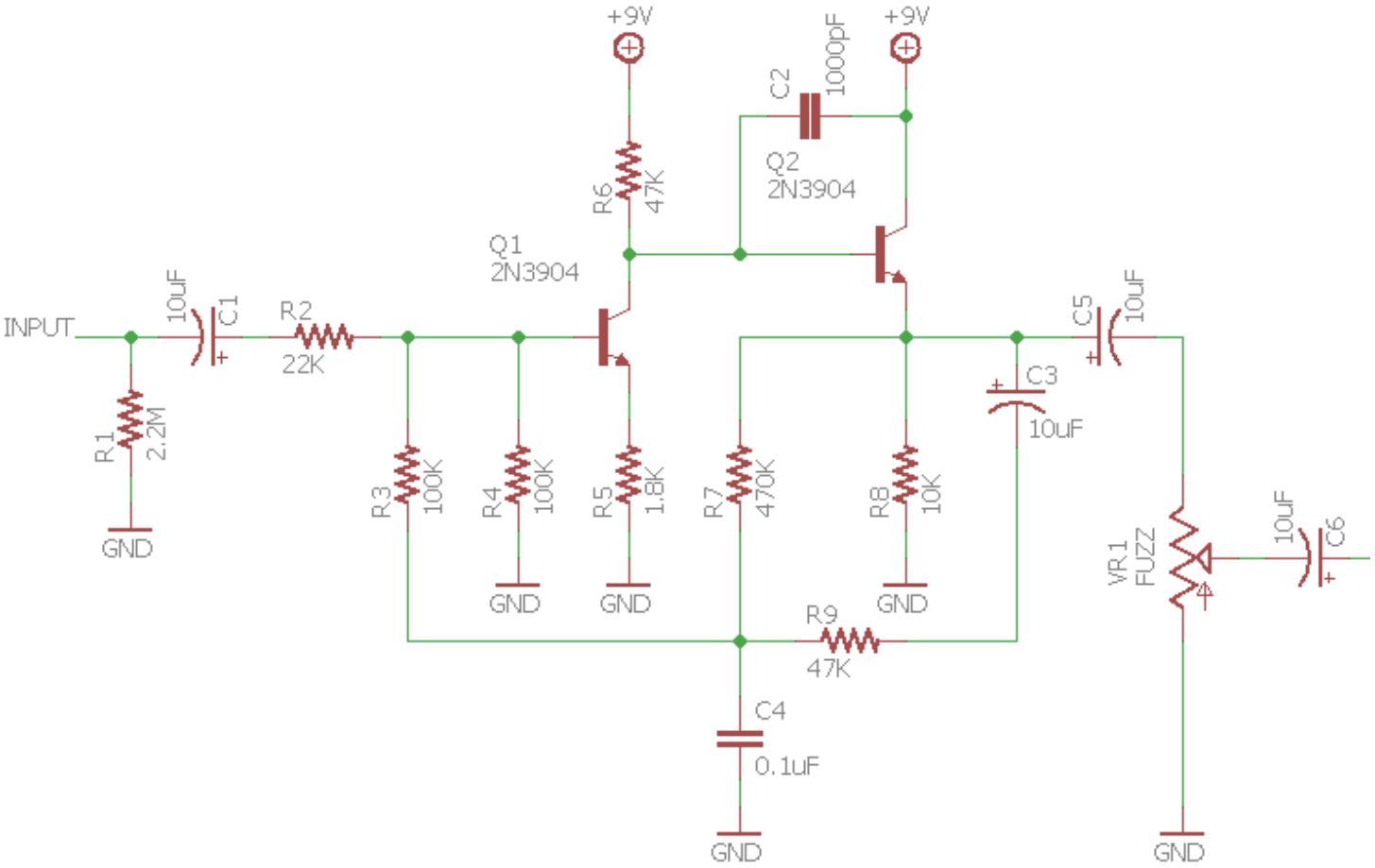
- The diode D3 protects the pedal against adapter reverse polarity connections.

- The 47 ohm resistor R29 along with bulk capacitor C15 create a low pass filter of 33 Hz making sure no high frequency switching noise from a rogue power supply is able to bleed into the power rails. It also provides a small voltage drop of around 375mV.

- C15 is a large electrolytic capacitor used for bulk capacitance as well as a low pass filter for power.

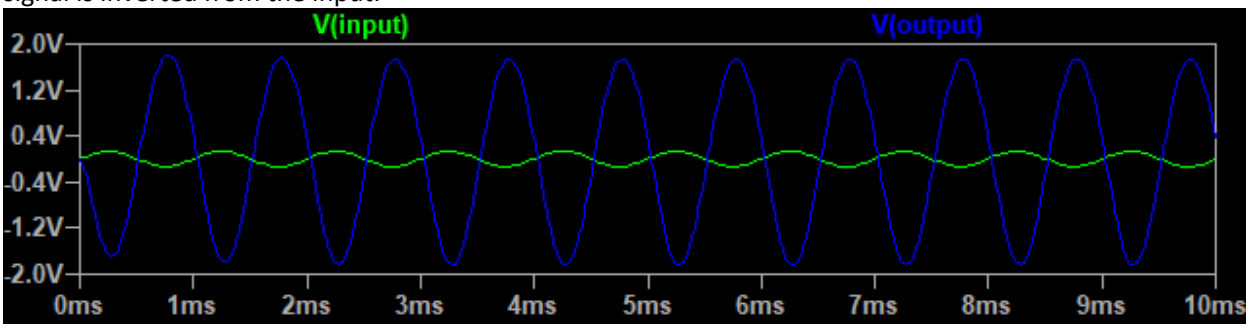
4. Input Buffer Stage.

The input buffer stage is made of a dual transistor gain stage to provide an AC and DC feedback network along with a small bypass capacitor to suppress high frequency oscillations. This in turn makes an amplification section with a gain of a little over 13 (22.3dB)



The 2.2MΩ R1 resistor from the input to ground is an anti-pop resistor, it will avoid abrupt pop sounds when the effect is engaged.

Because we are Q1 is setup as an inverting amplifier, whereas Q2 is setup as a non-inverting amplifier, the output of this signal is inverted from the input.



Q1 is biased up by the 100K feedback resistor (R3) that makes a DC path through the 470K resistor (R7), up to Q2's emitter. AC feedback takes a separate path through the 10µF (C3) and 47K (R9) path in parallel to the 470K (R7) resistor, however some of this just gets bypassed to ground via the 100nF cap (C4). Q1 will bias a little higher than ½ the power supply voltage of 9V (or more exactly, 8.625V due to the R29 voltage drop). Typically, a voltage of 5.5V will be found at the collector of Q1, but the voltage at the emitter of Q2 will drop it to 4.8V, which is close to the ½ mark.

4.1 Input Impedance.

The input impedance is defined by the formula:

$$Zin = (R1 \parallel R3 \parallel R4) + R3 + Z_{inQ1}$$

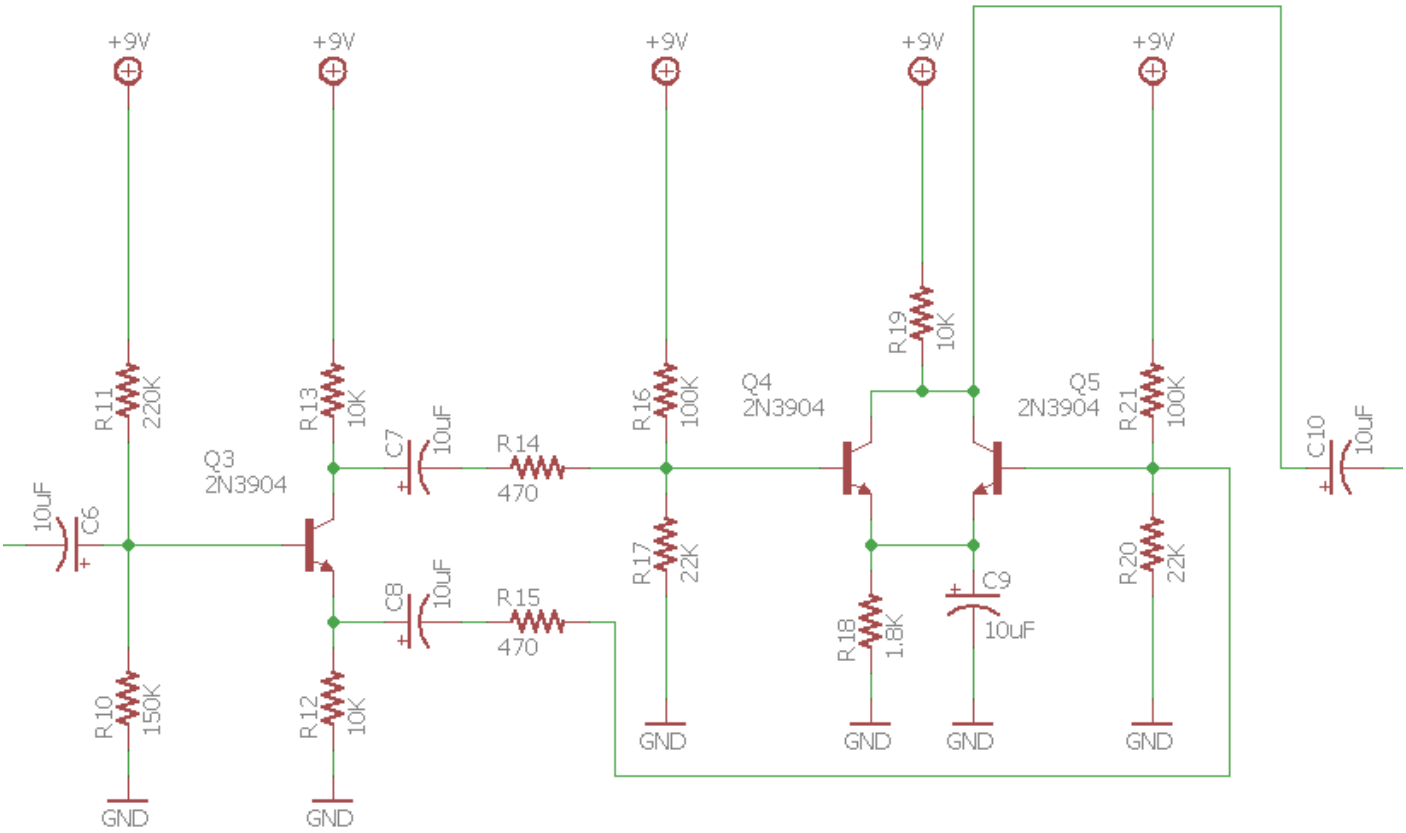
If you look up the datasheet for the 2n3904, under the small signal characteristics, the input impedance is between 1K and 8K. We will use the worst case, 1K for our calculation.

$$Zin = (2{,}200{,}000 \parallel 100{,}000 \parallel 100{,}000) \parallel + 22{,}000 + 1{,}000$$
$$Zin = 48{,}888 \parallel 23{,}000$$
$$Zin = 71{,}888\Omega$$

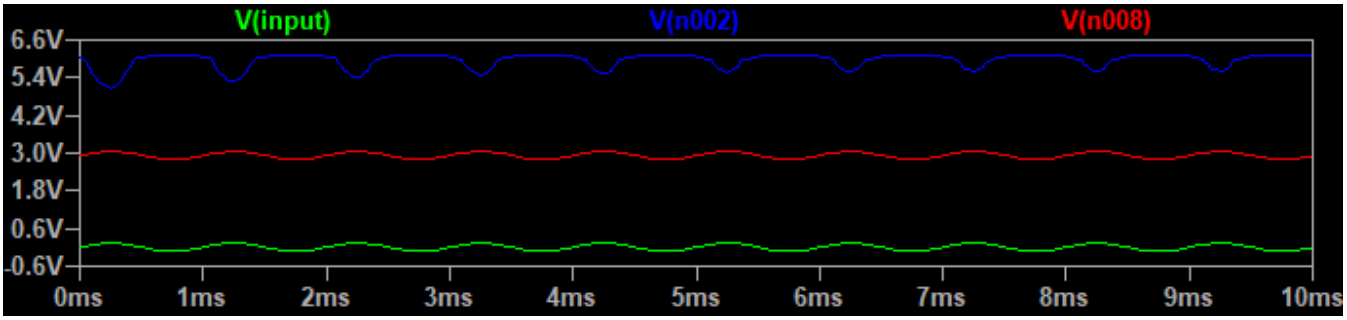
However, due to the negative feedback loops, a further drop of about 5K occurs giving a closer input impedance value of 66.9K. Therefore, the Meat Grinder Fuzz input resistance is 67K, which is pretty low and will likely load the pickups. It is recommended that this pedal go right after the guitar in your pedal chain.

5. Push-Push Amp Frequency Doubler.

The Push-Push Amp allows for a fully active full wave rectifier. The BJT splitter (Q3) gives roughly unity gain ac signals of opposing polarity, and the following transistor pair (Q4 & Q5) both rectifies and amplifies the combined signals. This topology is notable for providing gain (and plenty of it) during rectification:

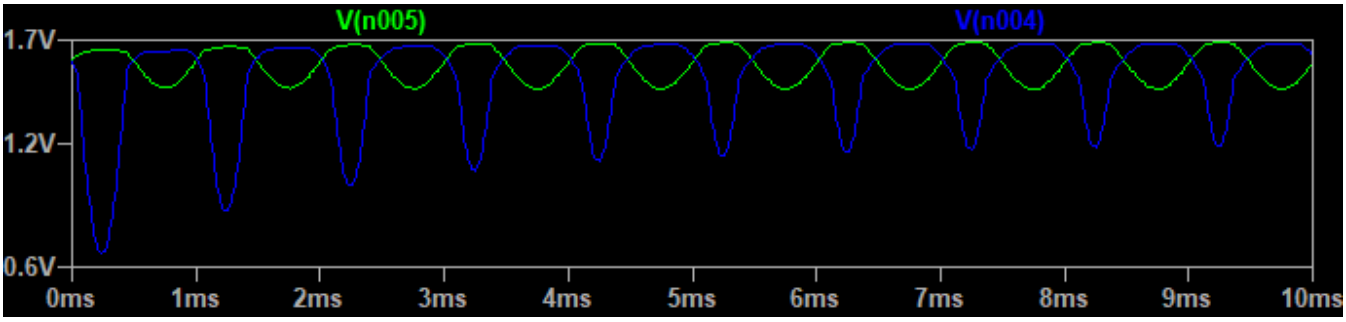


The signal leaving C6 are biased coming into Q3, where they are split to the higher and lower voltage ranges:

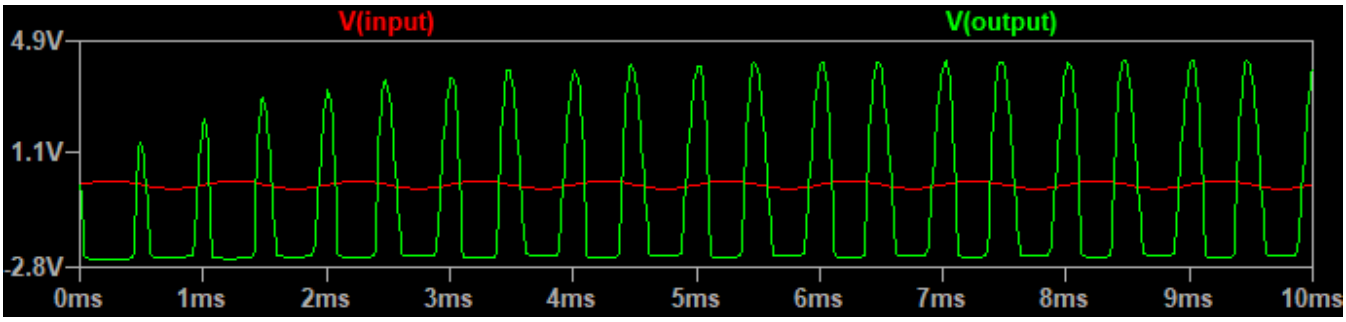


Both signals kept at unity gain of its input signal. The upper signal leaving the collector of Q3 begins to clip due to the transistor.

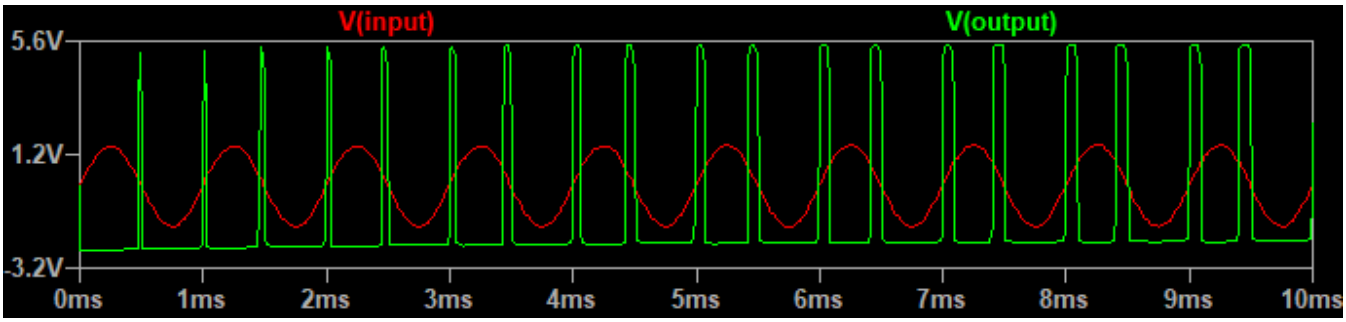
Both signals are fed into two transistors who have their collector and emitter pins tied together.



And thus doubles the frequency of the original signal:

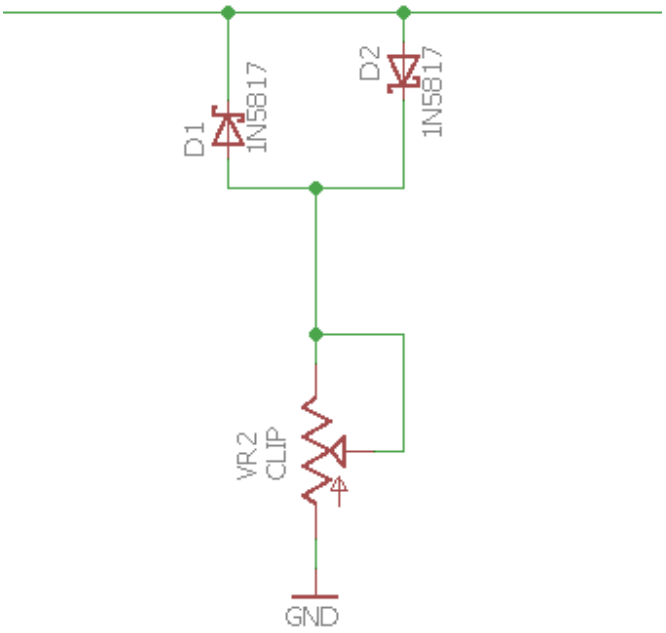


From a more loud note coming from the previous section:



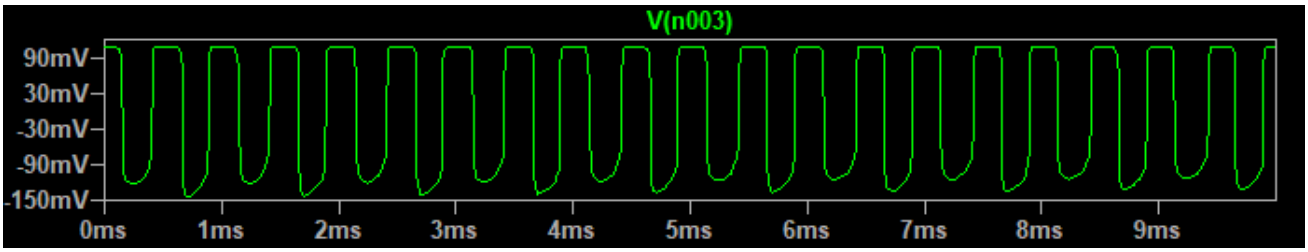
6. Hard Clipping Stage.

The Meat Grinder Fuzz uses a hard clipping circuit to further harshen its sound.

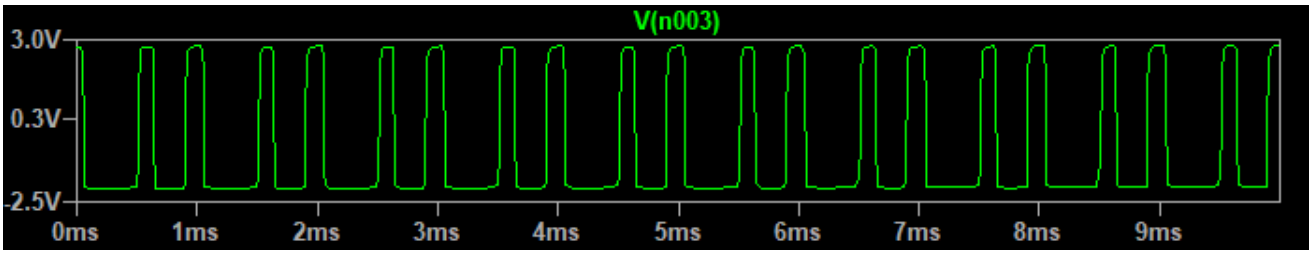


However, due to the 50K clip potentiometer, as resistance increases to ground, the clipping happens less and less.

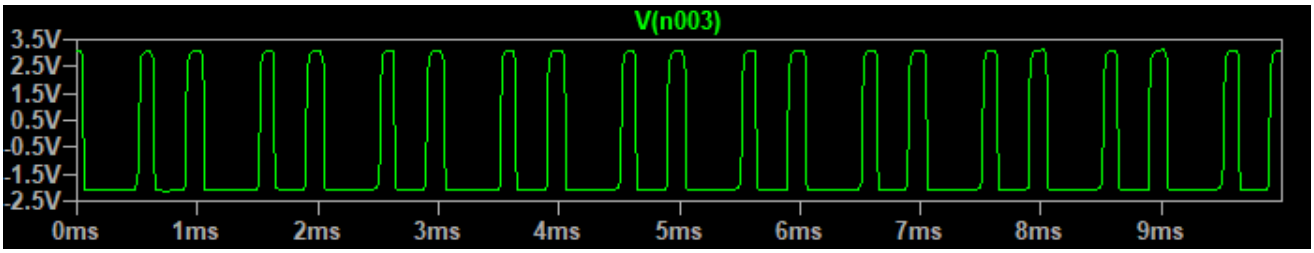
So, with the potentiometer creating a variable resistance of almost 0, we get a clipped signal that looks like this



As we turn the clip pot to noon, we create a variable resistance of 25K, creating less of a square wave, but also due to less clipping, the remaining signal is much more amplified

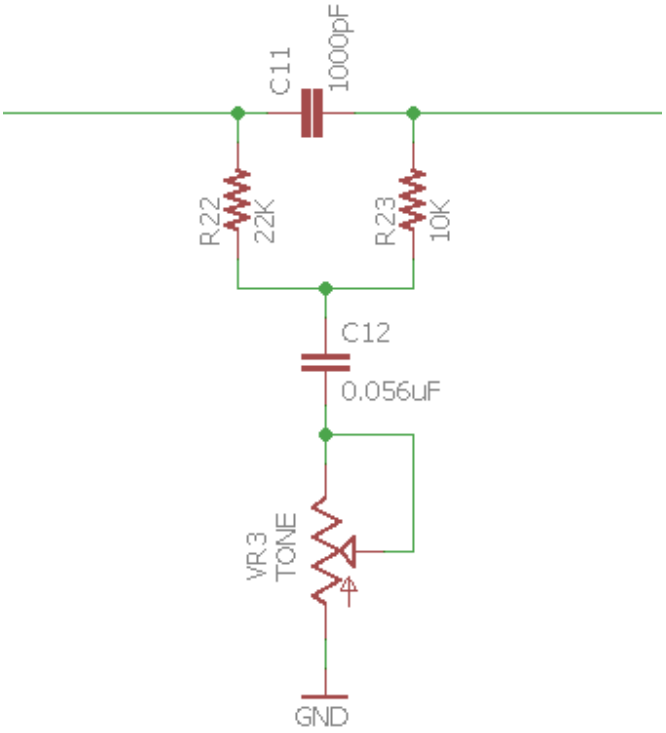


As the clipping potentiometer reaches max, it creates a variable resistance of 50K, which further drops clipping of a square wave and allows the remaining signal to be even further amplified as the diodes are barely cutting it.



7. Tone Stack.

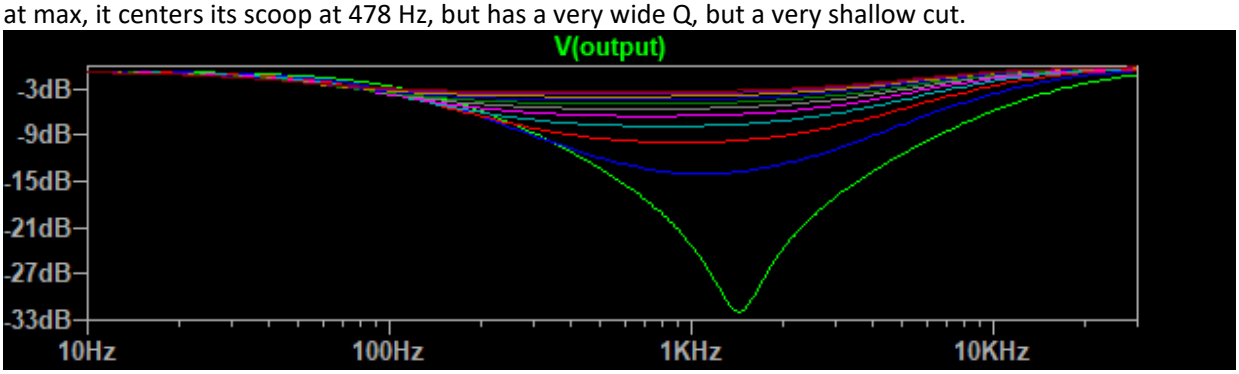
The Meat Grinder Fuzz uses a passive Bridged-Tee Notch filter.



The bridged-tee (bridged-T) notch is often used for equalization and other places where a fairly shallow (and broad) notch is acceptable. Strictly speaking, it's not an active filter, other than the requirement for a high impedance output buffer.

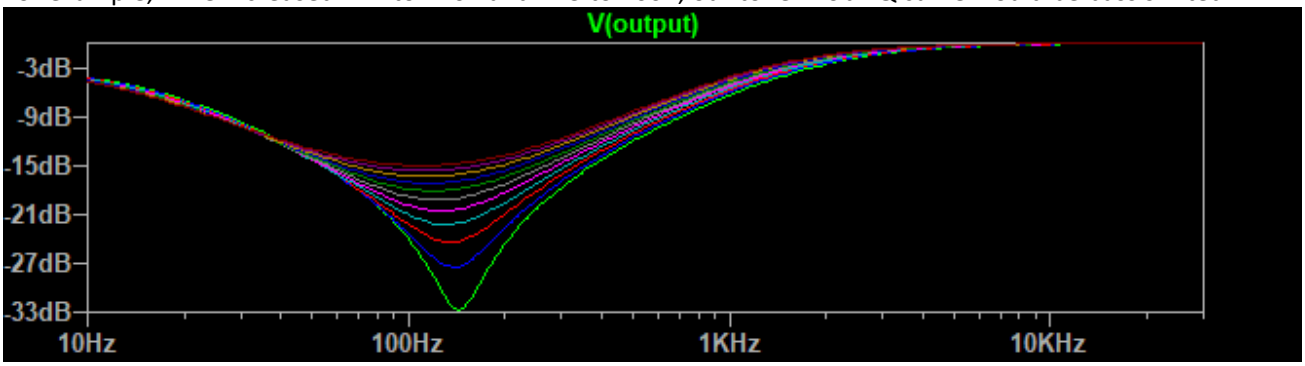
7.1 Scooped Frequency Response

The tone knob centers its scoop at 1.4 kHz, where it also has its tightest Q and deepest cut, however with the tone knob at max, it centers its scoop at 478 Hz, but has a very wide Q, but a very shallow cut.

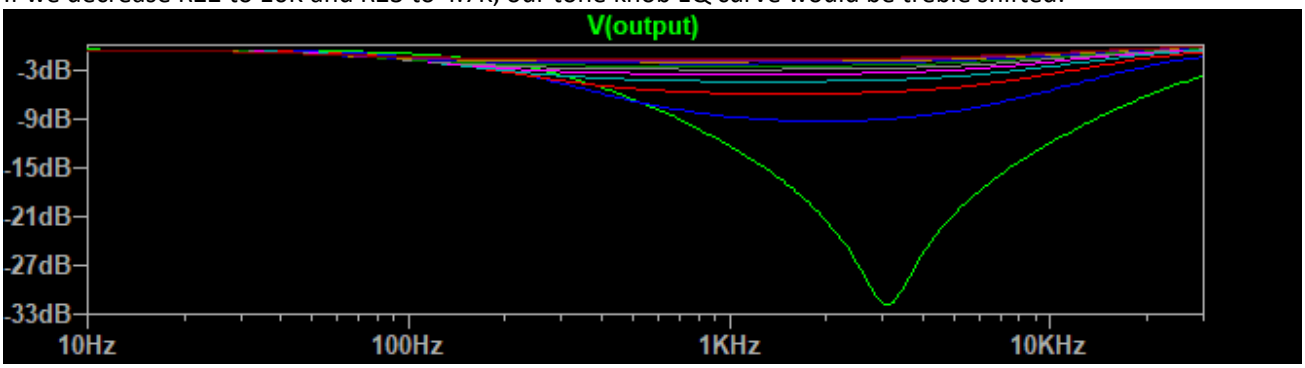


Reducing the values of resistors R22 and R23 will shift the centers of the notches into higher frequencies while increasing the values of these resistors will shift the centers of the notches into the lower frequencies.

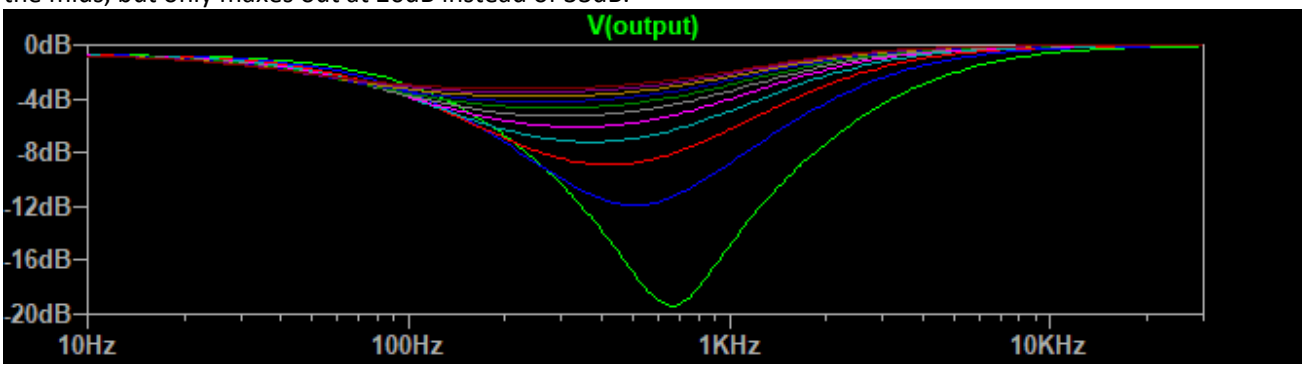
For example, if we increased R22 to 220K and R23 to 100K, our tone knob EQ curve would be bass shifted:



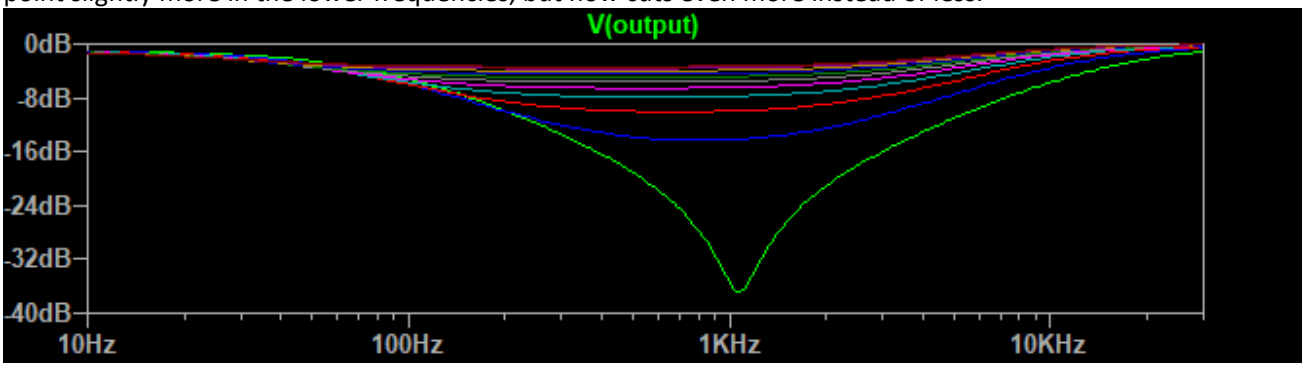
If we decrease R22 to 10K and R23 to 4.7K, our tone knob EQ curve would be treble shifted:



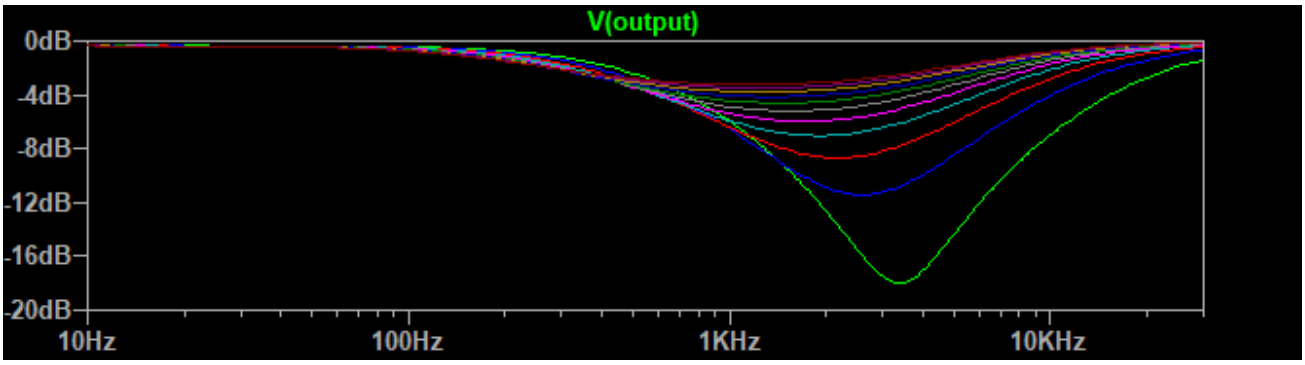
Changing capacitor C11 will also effect the center point. If we increase the capacitance, it will move the center point towards the lower frequencies, but also makes it cut less as you do so. For example, increasing C11 to 4.7nF cuts more in the mids, but only maxes out at 20dB instead of 33dB.



Similarly, changing capacitor C12 will also move the center point. Increasing it from 56nF to 100nF moves the center point slightly more in the lower frequencies, but now cuts even more instead of less.

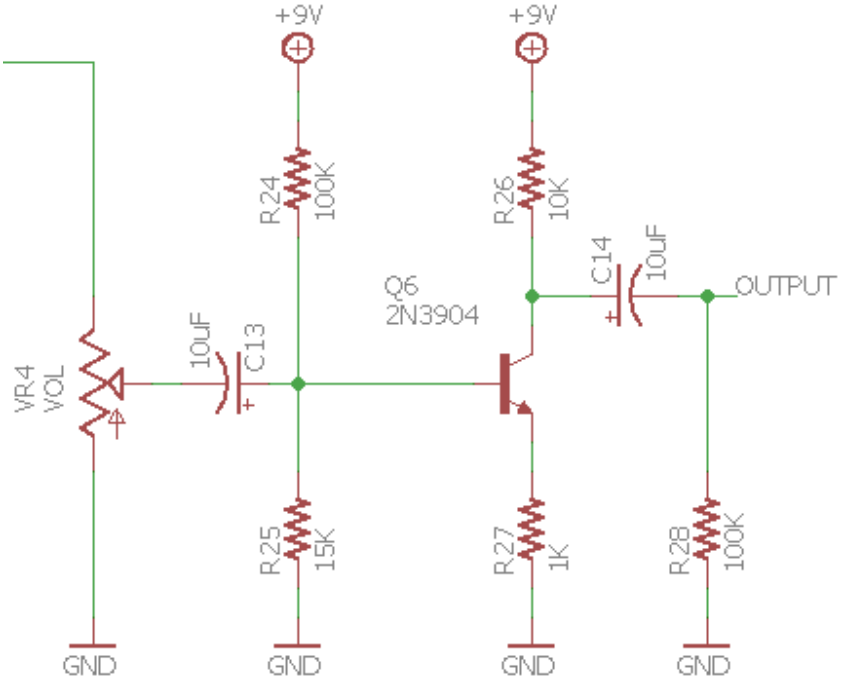


Whereas changing capacitor C12 down to 10nF moves the center into the high frequencies but it doesn't cut as much of it.



8. Output Buffer.

Here, we have the volume knob being sent to ground before going through one more gain stage.



Q6 is the final gain stage, inverting the signal to match the phase of the original signal, albeit highly distorted. With a gain of about 10, this is needed as a recovery from the signal cutting of the previous two sections.

8.1 Output Impedance.

The output impedance is determined by the collector resistor R26 in parallel with the pull-down resistor, R28.

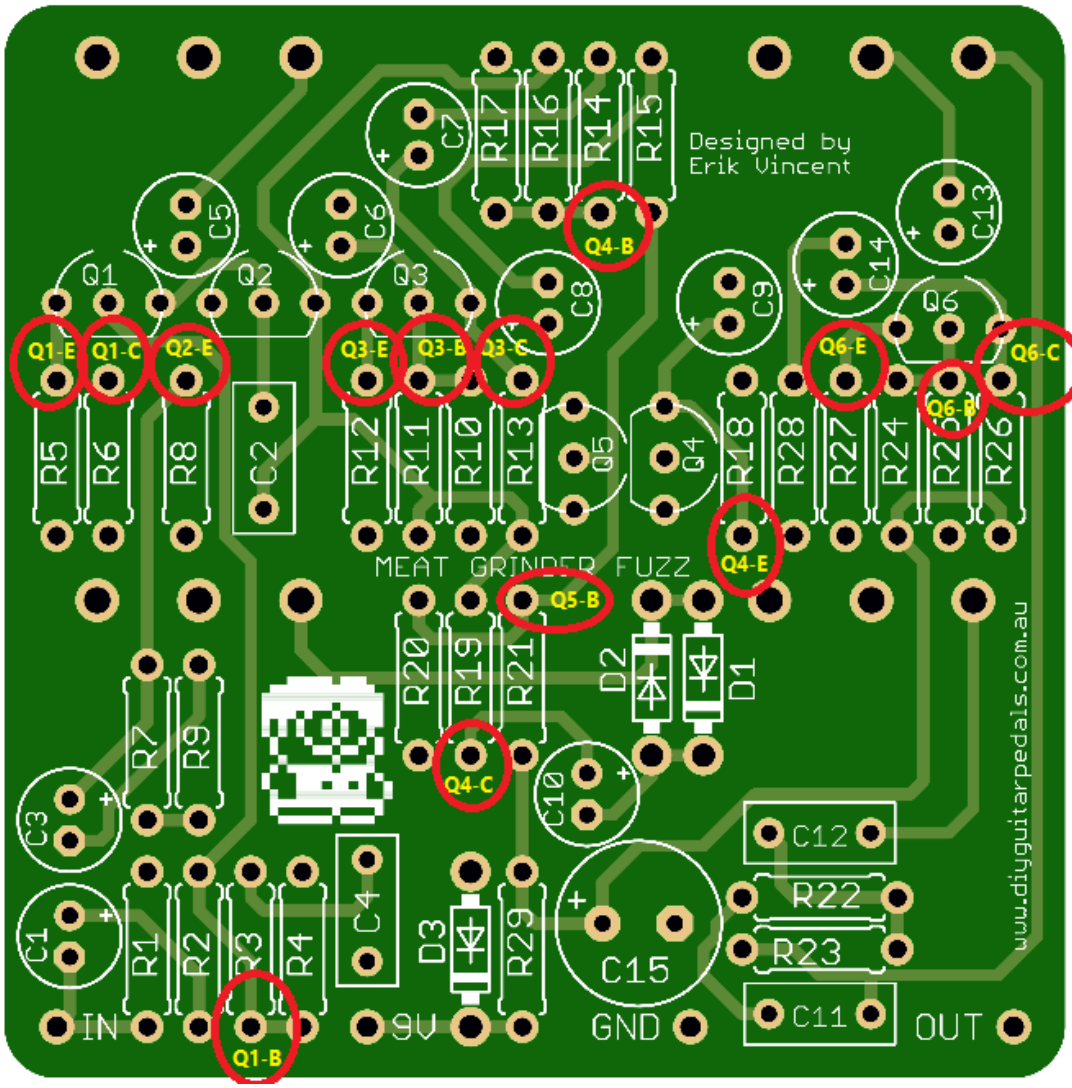
$$Zout = R26 \,||\, R28$$
$$Zout = 10K \,||\, 100K$$
$$Zout = 9{,}091\Omega$$

Therefore, the Meat Grinder Fuzz output resistance is about 9K, which is good, keeping signal fidelity. As a rule of thumb, it is good practice to keep output resistance of a pedal below 10K. If concerned with the output impedance, lowering R26 to 8.2K will help without cutting the amplification down much.

9. Voltage Readouts.

Below are the voltage readouts of the ICs onboard, assuming 9V Power Supply

Transistor read-outs



Q1-C: 5.512V
Q1-B: 0.705V
Q1-E: 0.128V

Q2-C: 8.910V
Q2-B: Same as Q1-C
Q2-E: 4.891V

Q3-C: 6.044V
Q3-B: 3.477V
Q3-E: 2.890V

Q4-C: 3.527V
Q4-B: 1.592V
Q4-E: 0.966V

Q5-C: Same as Q4-C
Q5-B: 1.579V
Q5-E: Same as Q4-E

Q6-C: 4.376V
Q6-B: 1.115V
Q6-E: 0.460V

KNOBS

- VOL: MAX
- TONE: MAX
- FUZZ: MAX
- CLIP: MAX

10. Modifications

Following is a couple of worthwhile modifications that can be applied to the Meat Grinder Fuzz.

10.1 Resistors

Changing the value of R29 from 47 ohms up to 330 can emulate voltage sag without actually sagging the battery, dropping the 9V down to 6.45V. This tends to bias the Meat Grinder more uniformly, assuming tight tolerances have been met.

Changing the values of R22 and R23 can shift the center focus cut of the tone knob. For making the pedal more bass friendly, increasing R22 to 100K and R23 to 12K will scoop at around 400 - 500 Hz, while further increasing the values to 220K and 100K, for R22 and R23 respectively, will create notch out more bass frequencies, potentially making it more guitar centric as a treble fuzz.

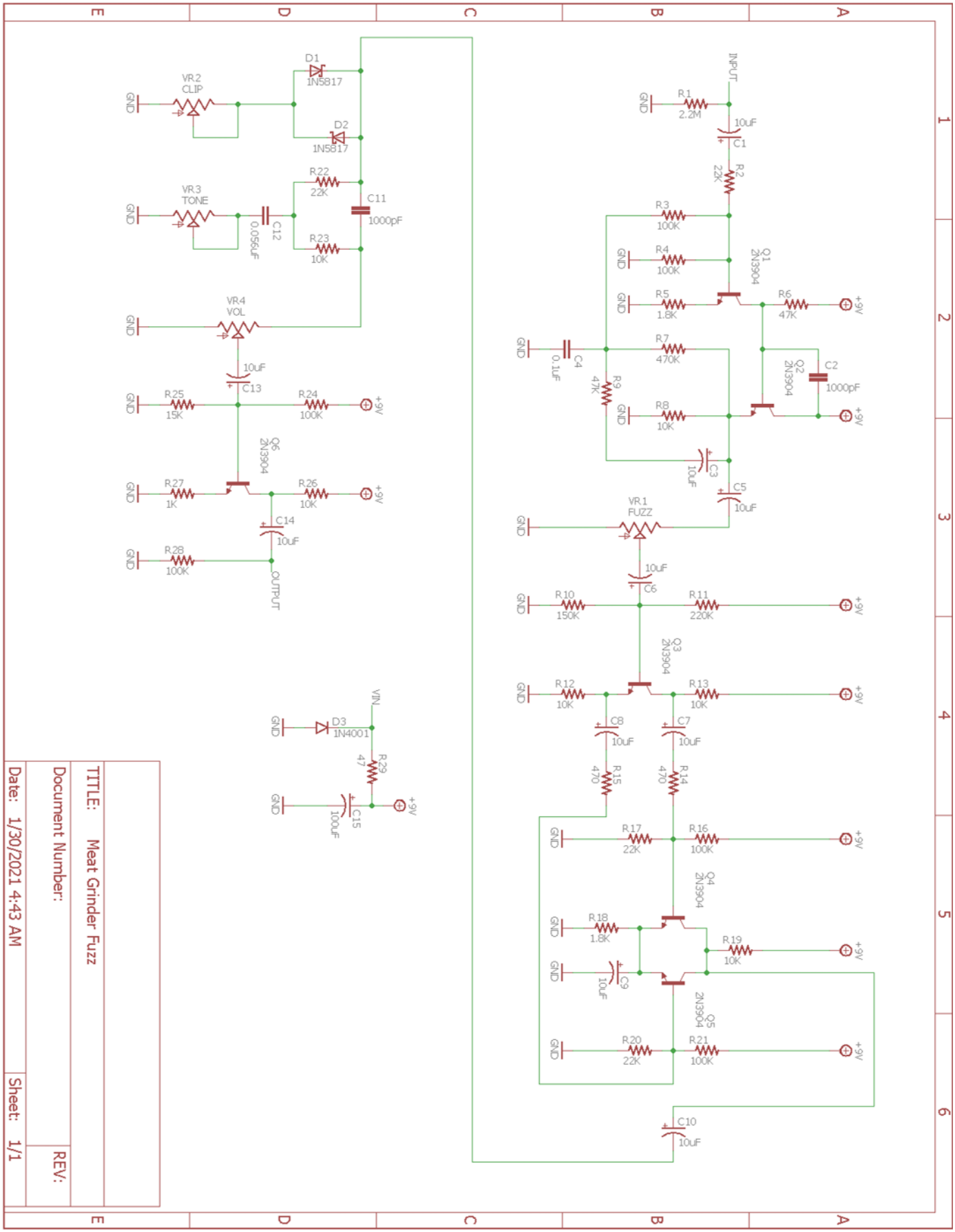
10.2 Capacitors

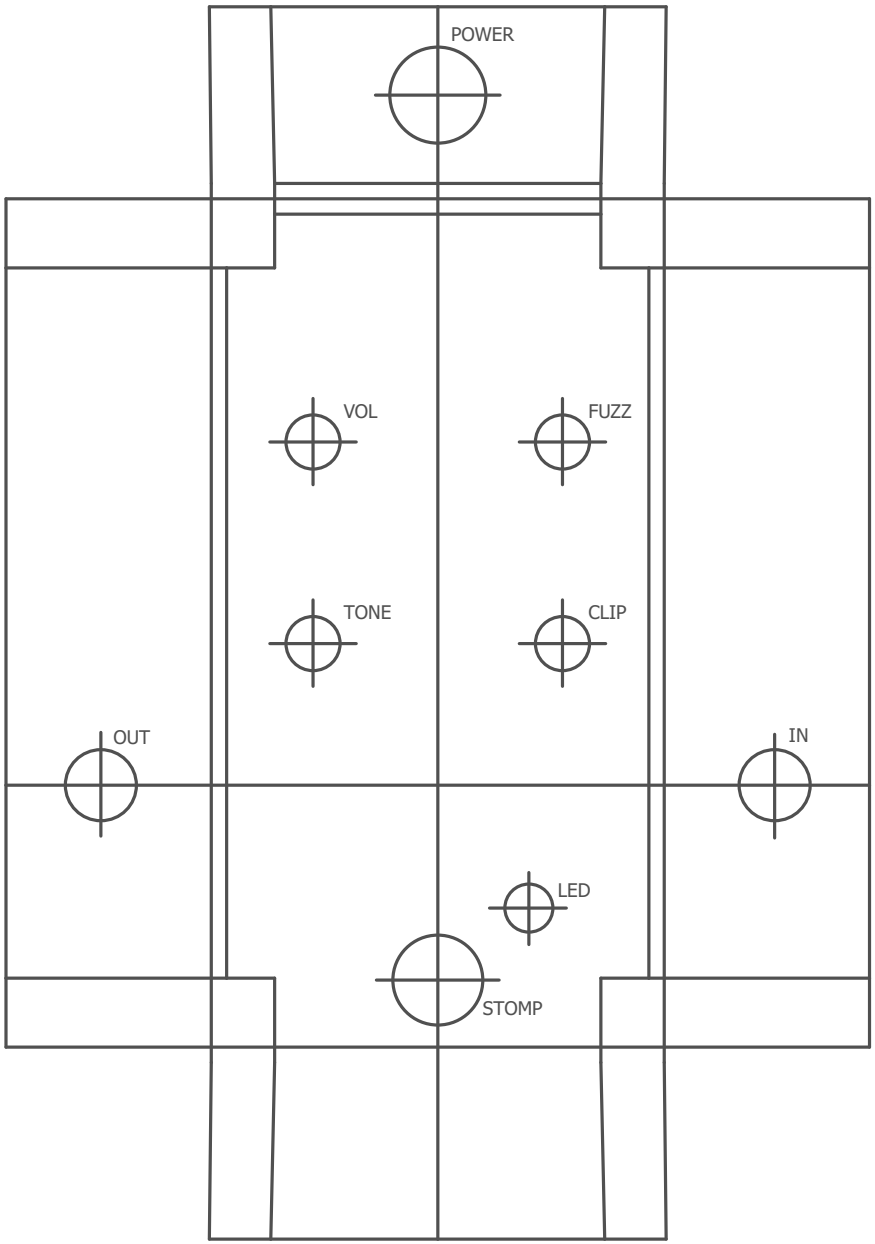
Changing C11 and C12 can also change the response to the tone control. See the tone stack section for more details.

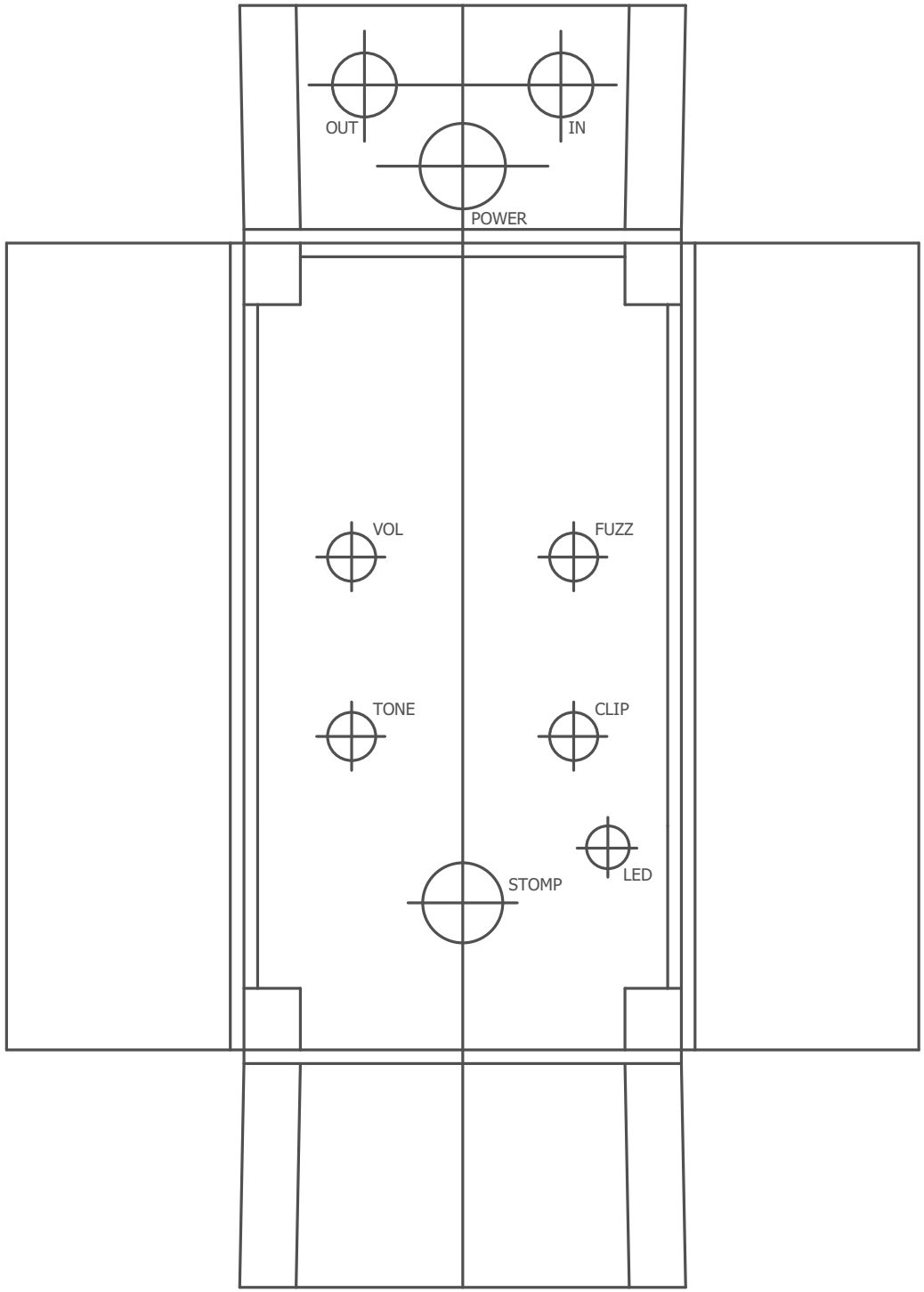
10.3 Diodes

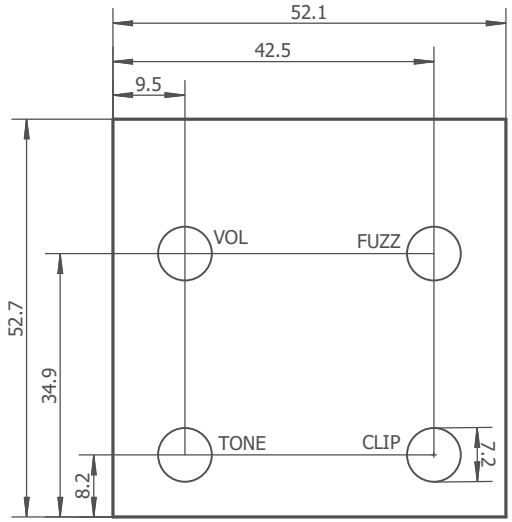
Changing diodes in the clipping stage can affect the clipping tone. Changing out the Schottky diodes to germanium will be a tad less harsh and allow for more volume. Similarly, changing them to a 1N4001 or 1N4148 would also retain more volume, but be as harsh as the Schottky's.

11. Schematic




POWER
VOL
FUZZ
TONE
CLIP
OUT
IN
LED
STOMP


OUT
IN
POWER
VOL
FUZZ
TONE
CLIP
LED
STOMP


52.1
42.5
9.5
VOL
FUZZ
TONE
CLIP
52.7
34.9
8.2
2.2