DJENTRIFICATION: DISTORTION AND DYNAMICS FOR MODERN METAL

CONVERGENCE AUDIO ADVANCEMENT

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PEDAL DESIGN COMPONENTS

One of the more recent trends in heavy music is that of “djent”, characterized by the use of syncopated 7 and 8 string guitars and polyrhythms. The tone is distinct and its characteristics differ significantly from traditional heavy metal guitar. While traditional metal guitar focuses on warm low end with heavily distorted high end, the djent sound is focused around the mid range and despite use of distortion, has an emphasis on clarity and responsiveness.

Getting the “djent” sound is largely in the playing technique, as well as the amp. However, effects pedals are usually used to accentuate the characteristics of the sound. Most pedal setups for this genre use effects designed for traditional heavy distorted guitar, in very specific orders at very specific settings. Djentrification aims to combine all the necessary components for getting the “djent” sound into one pedal, with the optimal settings hard-wired, so that getting the sound is a push of a button away.

WHAT IS IN THE PEDAL?

A lot of musicians throw around a group of different words to describe what “djent” really is. Our aim was to examine these words closely, and figure out how to bring them to life.

One of our biggest findings was that "clarity” is a huge part of the sound, which seems to directly conflict with the distortion added to the sound. The word “clarity” in this context refers to the ability for each note in each chord to be heard distinctly. Distortion adds both harmonics to a note, and sustain. The sustain occurs because, at the beginning of a guitar strum, the peak amplitude will be clipped to a lower level. As the signal decays, there will be less distortion, but the overall level will remain similar to the level of the initial strum, creating a perceptually longer strum. In order to increase clarity, an overdrive effect is used to boost the gain before the tube amplifier. However, in order to maintain the most clarity, the mids and low mids are boosted the most, providing sustain and moderate distortion to this region and passing the low frequencies and high frequencies unchanged. For 7 and 8 string guitars, too much distortion of the very low fundamental frequencies can muddy up the sound. In order to get a clearer sound, the low mid range, which contains the lower harmonics of these notes is boosted to get a crisp and resonant sound.

The second component common to “djent”, possibly the component that sets it apart from other guitar tones the most, is a very metallic resonance where the name itself comes from. This resonance is around 1.4-1.5 kHz. This resonance is obtained first of all with picking technique, but can be emphasized with a boost on a parametric EQ. Instead of using a separate parametric equalizer pedal as would be the case in a traditional guitar pedal setup, Djentrification has a built-in boost at 1.45 kHz that allows you to start djenting right away without tinkering with equalizers to find the optimum sound.

Lastly, another component that sets djent apart from other styles of metal is a very rapid start and stop picking style, where notes go from peak amplitude to completely quiet just by muting the strings. Introducing distortion earlier on in your pedal chain will make mutes much noisier and less rapid, so gating later on in the signal chain helps solve this problem. Along with accentuating the characteristics of djent, using a noise gate will help eliminate noise caused by the guitar, cables, and other effects.

OVERDRIVE

The overdrive is an ideal circuit for adding gain and distortion without sacrificing clarity for a variety of reasons. The main components of an overdrive circuit are the clipping portion, followed by a tone stack. Both of these components are active and provide gain, which will ultimately be used to drive a tube amplifier. The tone component occurs following the clipping circuit, so that any harmonics generated by the clipping circuit can be controlled, allowing a balance between clarity and distortion to be found. Following the overdrive, a highly band passed signal consisting of mostly the fundamental frequency and low harmonics of the guitar signal will be used to drive the tube amp. This means the overtones generated by the tube amp will be less noisy and will have a higher energy in the mid and lower end of the spectrum. All of these factors make the overdrive a good choice for high clarity with moderate distortion.

The circuit is based on the classic TSE 808 circuit, whose values have been tweaked to obtain the desired results. The total harmonic distortion is relatively low, because the bulk of the distortion comes from driving the amp. The band passing created by the circuit provides clarity to the mid range. The mid range frequencies are the most amplified, while the bass and highs are still at unity. This means that the mid frequencies will drive the amp and distort, while the highs and lows will still be audible, but will remain much cleaner. As distortion also adds natural compression to a signal, the mids will have the longest sustain, allowing each note of the chord to be heard clearly without a wash of distorted and compressed highs or the muddiness of distorted, compressed low frequencies.

RESONANT FILTER

One key to the djent sound is the resonance created by the picking style present in the mid range, around 1.4-1.5kHz. In order to accentuate this sound, a hard-wired active bandpass filter centered at 1.5kHz is located after the overdrive. Here is the equations for choosing the values of each of the components in the band pass filter:

For center frequency at 1.5 kHz:
C1 = C2 = .01uF
R1 = R4: $\underline{\qquad 1 \qquad\qquad}$.

$$= \frac{1}{2\pi \cdot C1 \cdot \text{frequency}}$$

$$= \frac{1}{2\pi \cdot .1uF \cdot 1500}$$

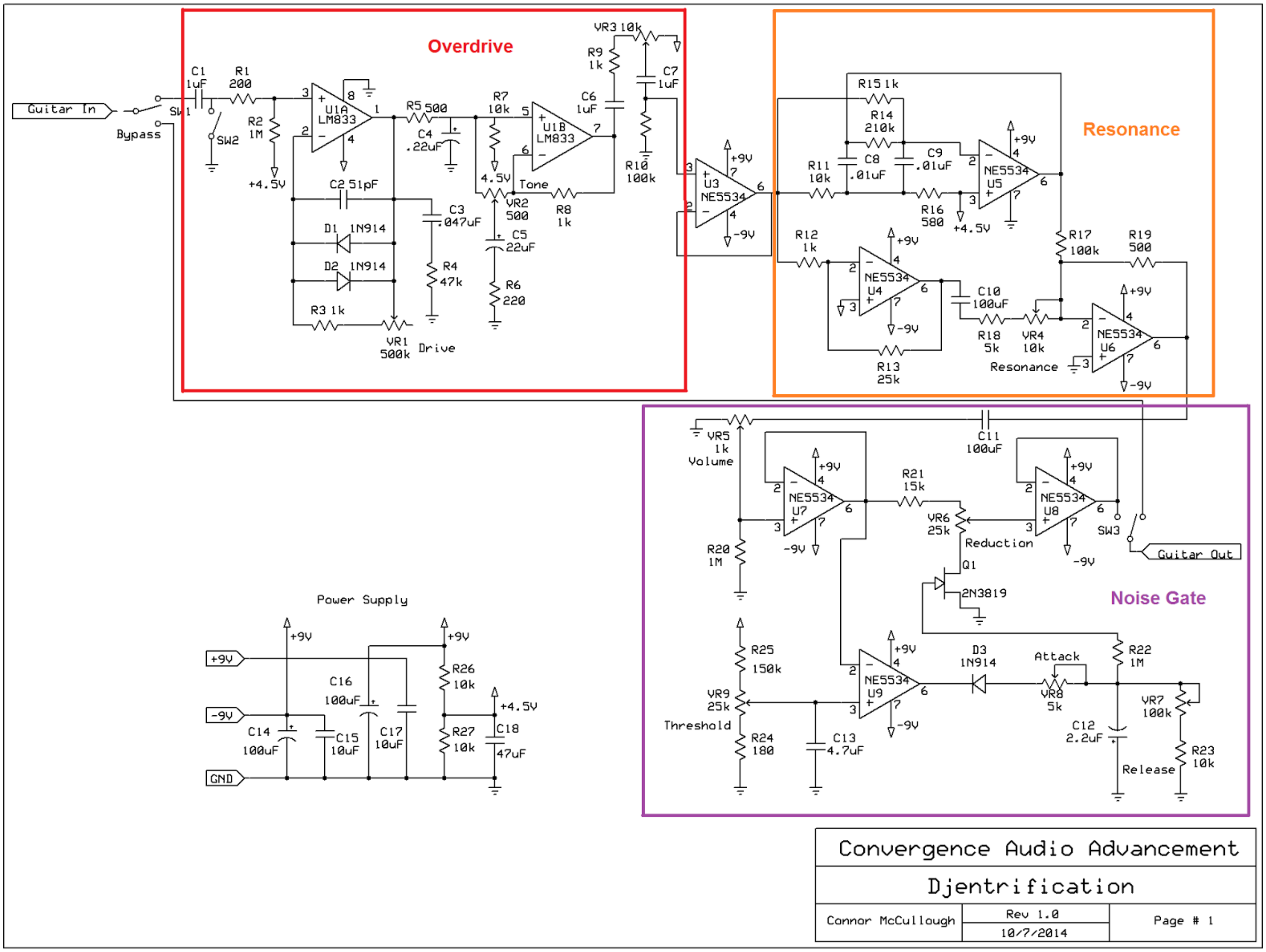
R1 = R4 = 10kHz
R3 = 19*R1 = 200K
R2 = R1/19 = 580
Cin = Cout = C1 *100 = 10uF

This design gives a bandpass filter with all frequencies outside of the pass region attenuated. However, the intent for this design is a boost in the pass region with all other frequencies remaining the same as the input. In order to do this, a basic inverting amplifier circuit was placed in parallel with the bandpass filter. These two signals were summed together using a summing amplifier. Since the inverting amplifier amplifies all frequencies equally, and the bandpass filter passes only the pass region, the result of the summation is unity gain outside of the passband and a resonant peak at 1.4kHz. The input resistor of the summing amplifier for the unity gain portion was made a potentiometer so that the size of the resonant peak in proportion to the original signal can be controlled by the user.

NOISE GATE

The noise gate achieves two goals: to remove excess noise from the guitar cables, overdrive, and EQ, and to facilitate the distinct stop-start riffing style of djent. An optimal setup would be to have an additional noise gate on the effects send of the guitar amplifier, but for use in a single pedal, the noise gate is most effective after all other effects. The noise gate has controls for pre-gate volume, reduction, threshold, release, and attack. The gate functions by creating a control voltage using a comparator comparing the threshold and input, with attack and release potentiometers determining the amount of gain applied.

SCHEMATIC


Overdrive
Resonance
Noise Gate
Power Supply
Guitar In
Bypass
Guitar Out
Drive
Tone
Volume
Reduction
Threshold
Attack
Release
Convergence Audio Advancement
Djentrification
Connor McCullough
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10/7/2014
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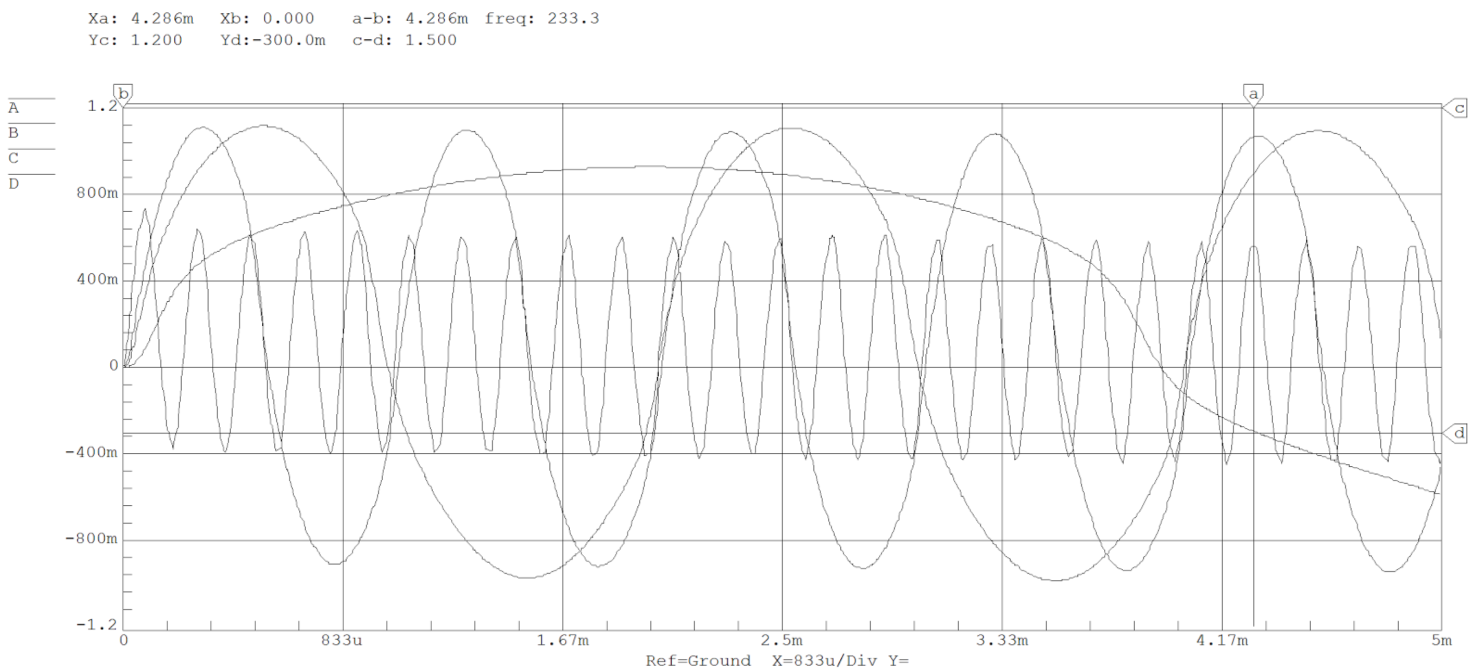
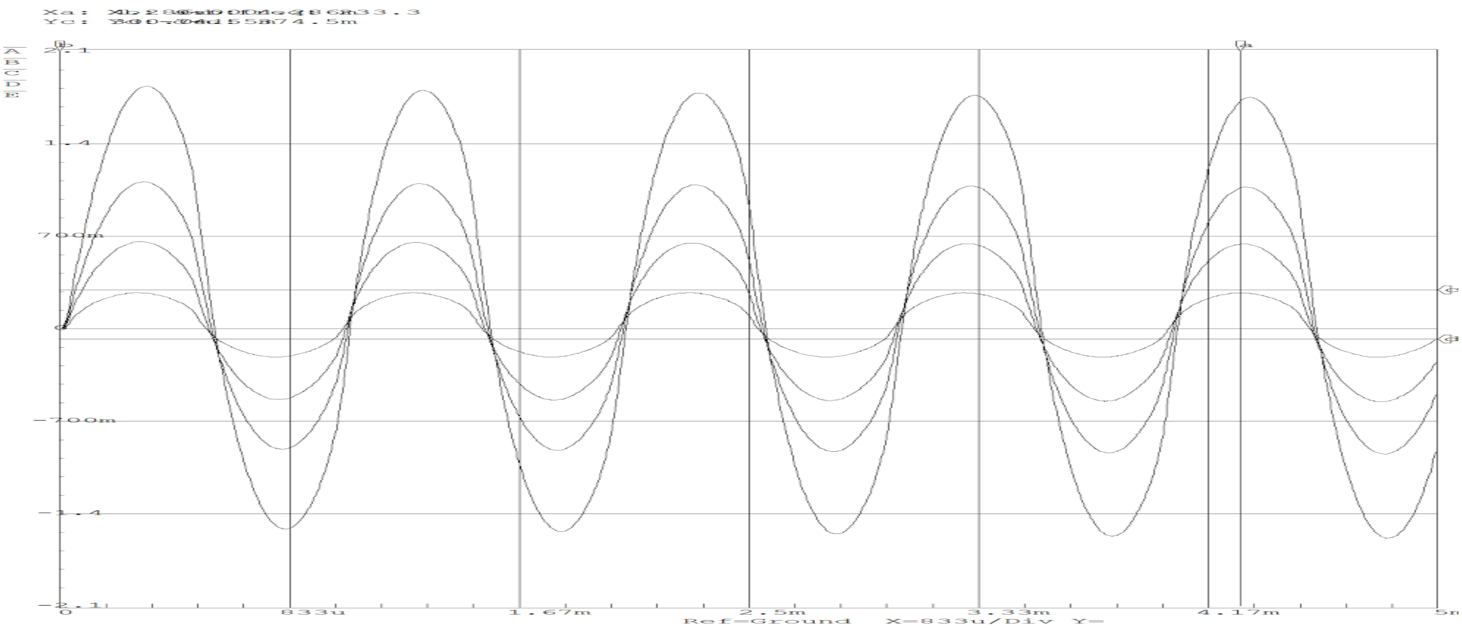
TEST RESULTS - OVERDRIVE

Transient Response (Variable Input Frequency):



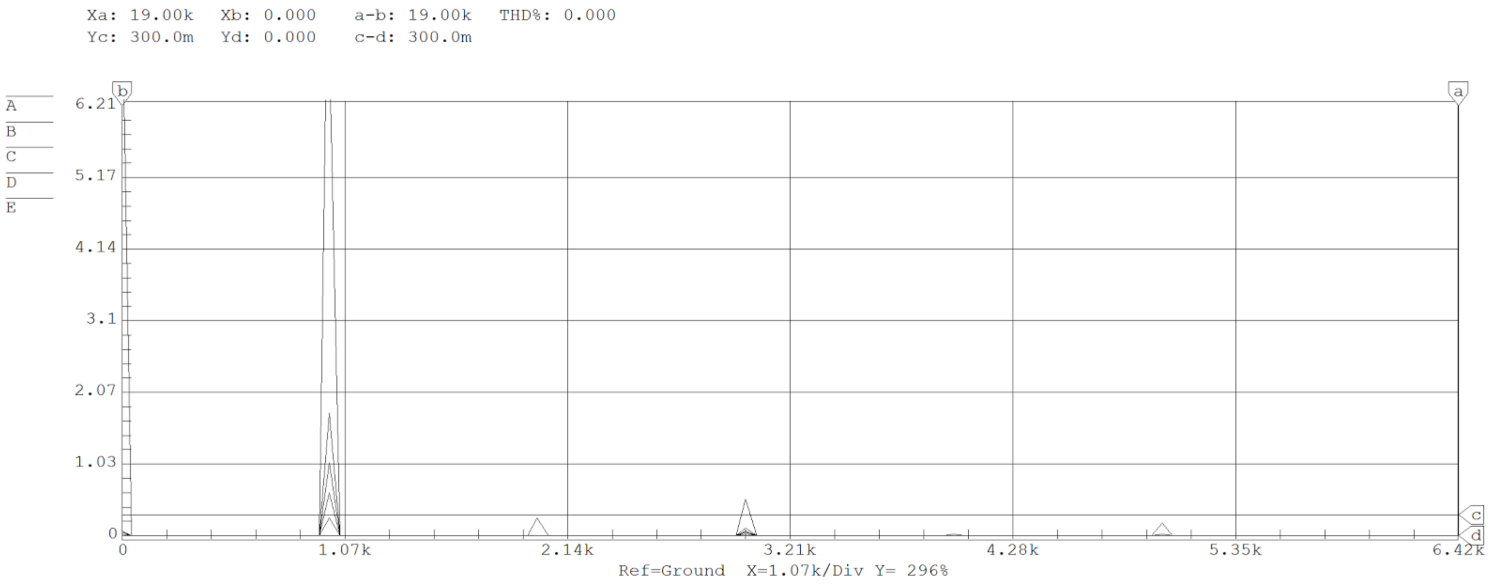
The high frequency (5 kHz) had the lowest amplitude and least distortion, with the low-mid frequencies (110 Hz, 440 Hz) having the highest amplitude and most distortion and the fundamental (55 Hz) having slightly lower amplitude than the low-mids.

Transient Response (Variable Tone):



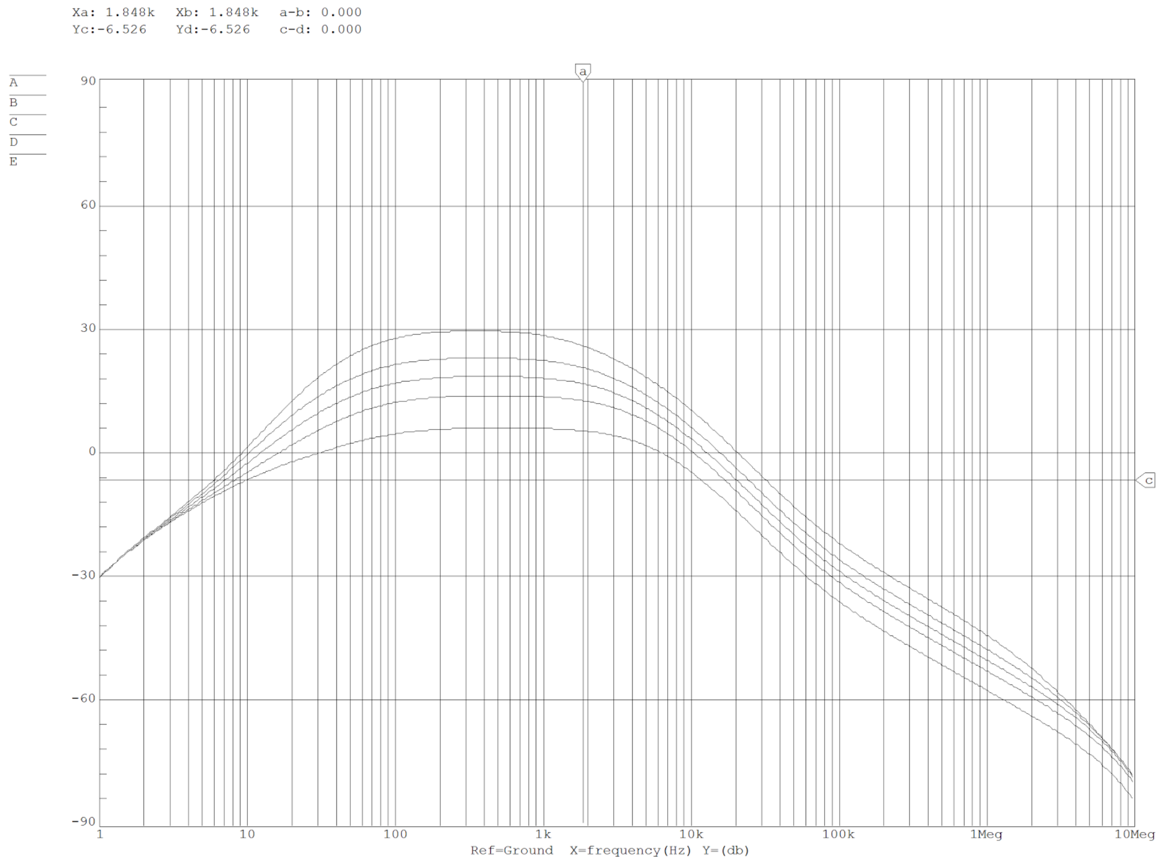
At 1%, the gain is highest and total harmonic distortion is lowest, and as the knob is turned up, the gain decreases and the harmonic distortion increases. However, because the pedal will be used to drive an amp, whose distortion also serves as compression, the gain increase will not serve as an actual volume increase. Instead, it serves as fading between the distortion of the pedal, and the distortion from the amp being overdriven.

Fourier Response (Variable Tone):



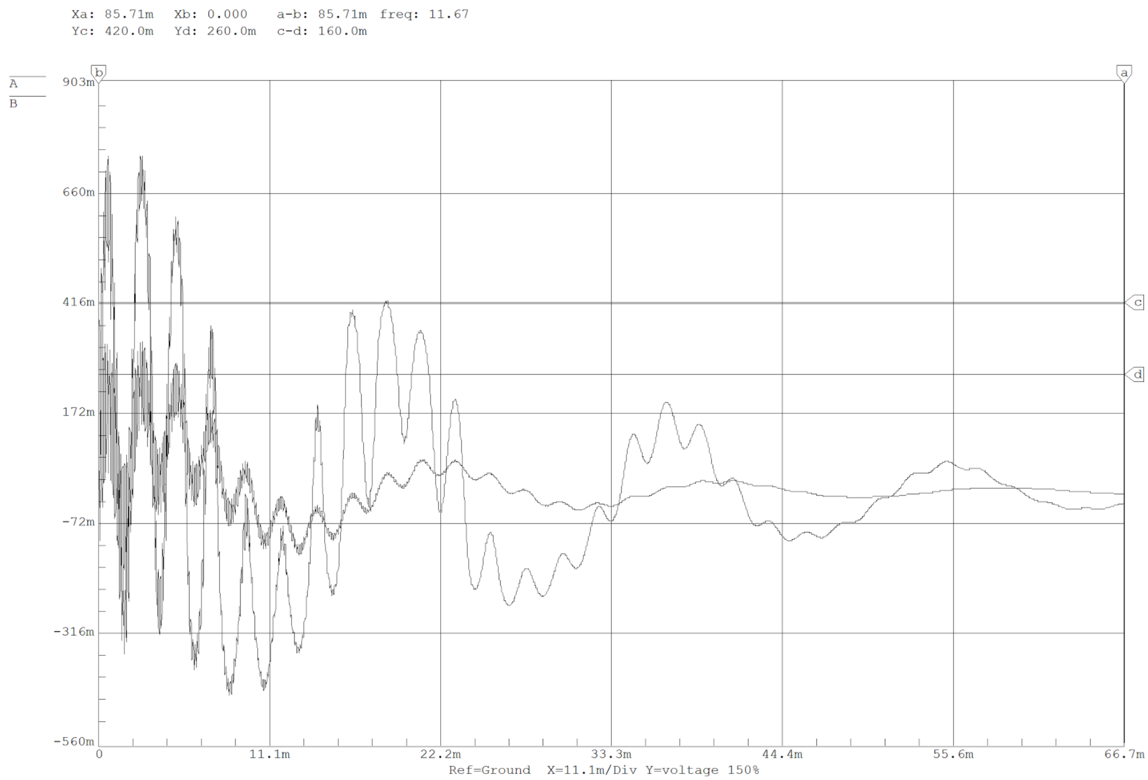
The higher peaks represent the response while the tone knob is at 1%, and the smaller peaks occur as the tone knob is turned up.

AC Response (Variable Tone):



The top curves are the frequency response when the tone knob is set to 1%, with the lower curves as the knob is turned up. The biggest change in tone is that the overall gain increases, changing the amount of distortion from the amplifier that the pedal is driving. The peak in the low mids and roll off in the lows and highs give the desired clarity. The only audible frequencies that are actually cut though are the very high highs, so the lows and highs will still be present, they will lack the distortion and compression that the mids will experience from driving the amplifier.

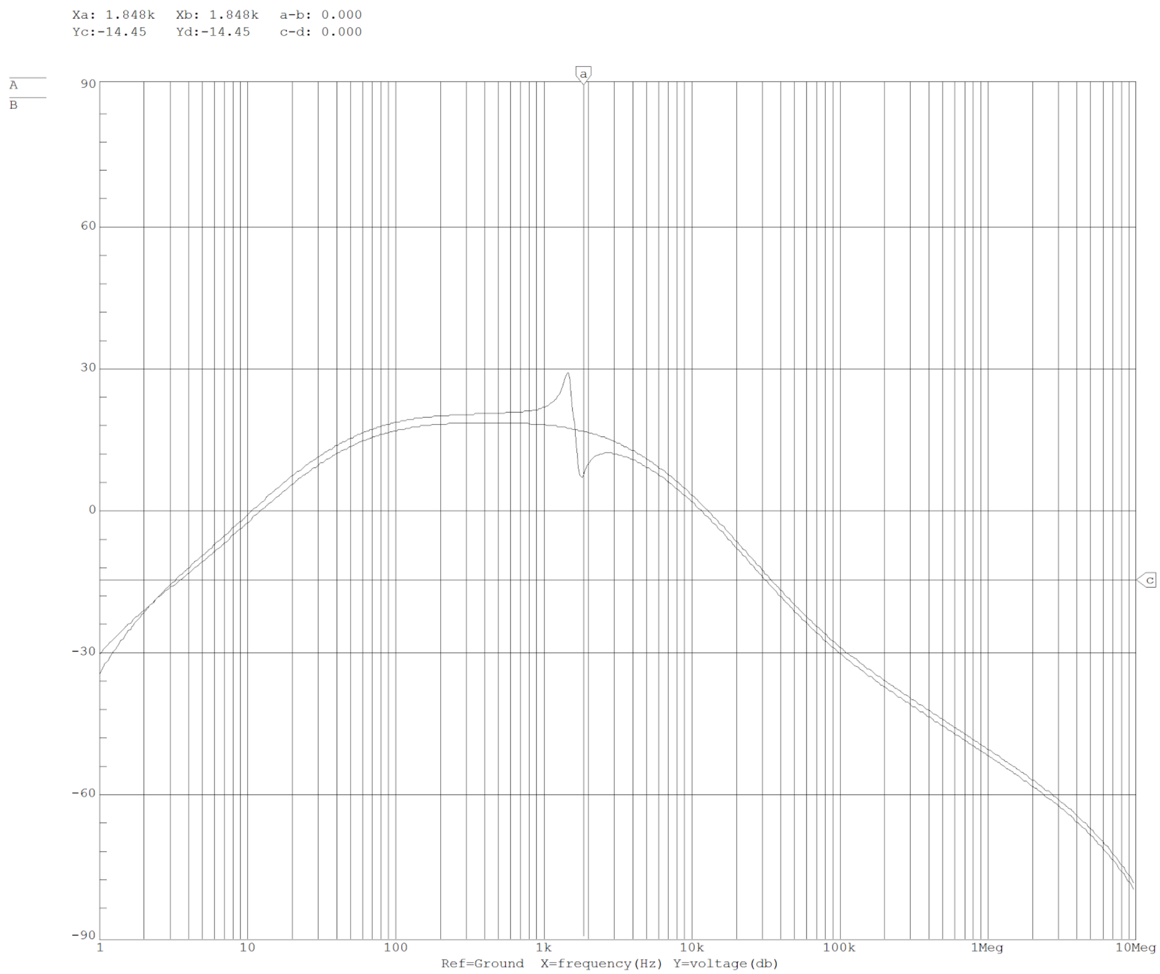
Transient Response (Input/Output Guitar Pluck)



While the harmonic distortion is difficult to see when multiple frequencies are summed together, the output (larger signal), along with increased overall gain, has increased sustain.

TEST RESULTS - RESONANCE

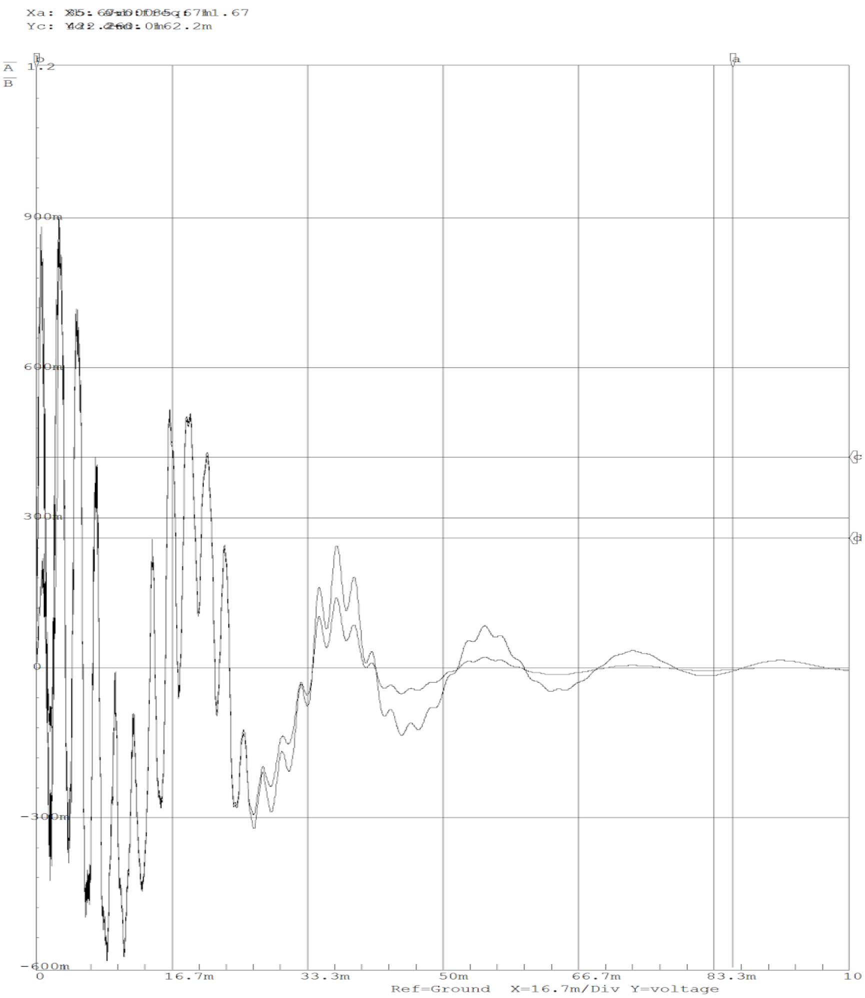
Frequency Response (Input/Output)



The goal of the resonant filter circuit was to boost around 1.4-1.5kHz without affect any of the surrounding frequency response. This design goal was met, as the only differences are the dip slightly above 1.4-1.5, and very small boost to the highs and attenuation to the lows.

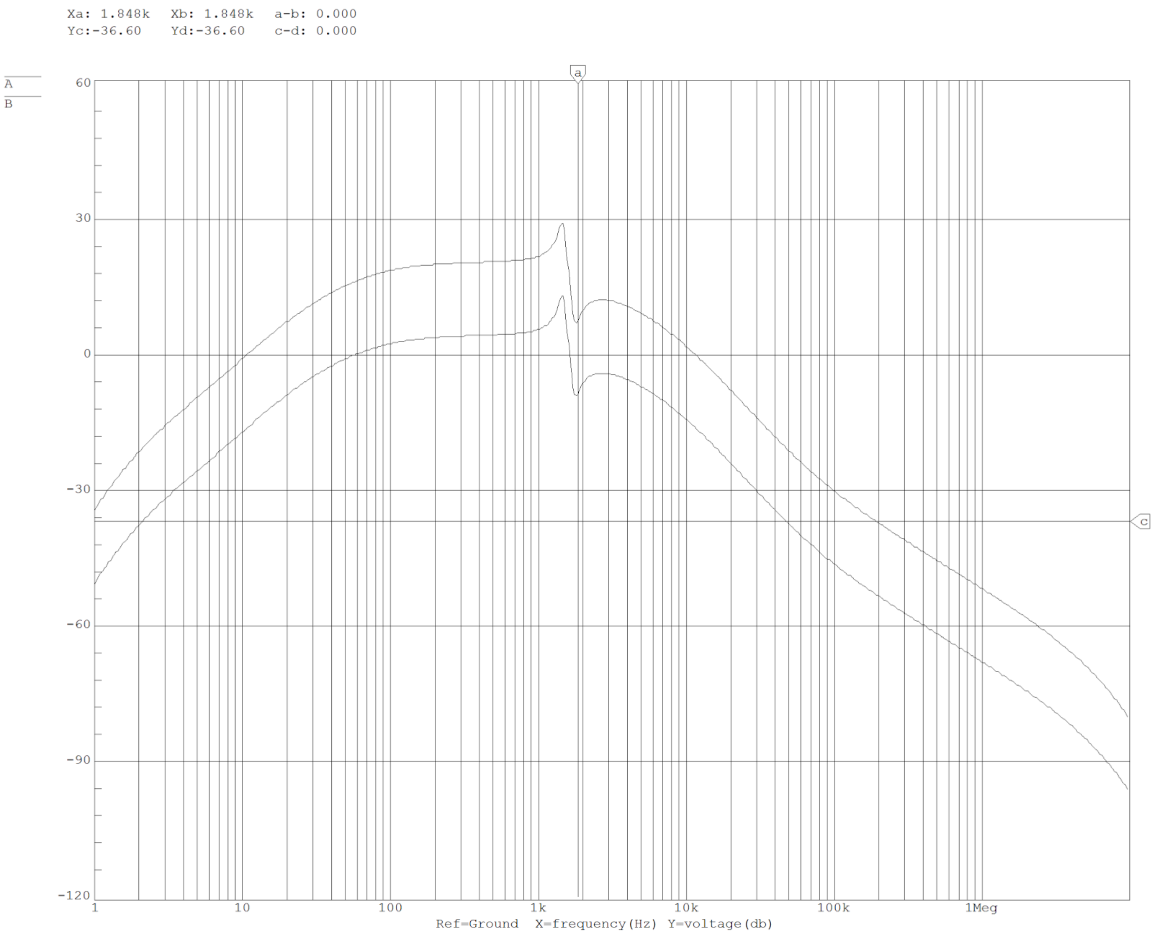
TEST RESULTS - NOISE GATE

Transient Response (Input/Output)



At high amplitudes, the two signals are at very similar levels to one another. At very low amplitude levels however, the signal that has been processed by the noise gate begins decaying much quicker. This doesn't affect the sustain at higher amplitudes, only causing the signal to delay quicker at very low amplitudes. While the gate does not completely shut off the channel, which would cause audible artifacts, the lowered amplitude as the note decays makes the choppy riffing style of djent much cleaner.

Frequency Response (Input/Output)



As stated before, a transparent and clear sound is important to getting the djent tone. It is undesirable for every component to be coloring sound along with performing their given function. This graph shows the output and input frequency responses of the noise gate to show that they are just scaled versions of each other without any sort of coloration.

CONCLUSION

While most pedals are designed for traditional distorted guitar playing and adopted for playing in the “djent” genre, Djentrification is a pedal which includes all the necessary effects for facilitating the djent sound, optimized for easy use. The use of heavy band passing in the overdrive circuit leads to a distorted yet clear sound. A resonant frequency boost serves to increase the defining frequency band of the tone, while maintaining the remainder of the frequency response. At the end of the chain, a noise gate helps to clean up the sound, and also faciliate the tight, staccato riffing style of the genre. Although the djent sound largely comes from picking technique and the amp you choose, Djentrification is an easy to use all in one pedal that helps you achieve the sound you are looking for.

APPENDIX A: BILL OF MATERIALS

Bill of Materials	Component	Value	Quantity
	R	1M	3
	R	210k	1
	R	150k	1
	R	100k	2
	R	47k	1
	R	25k	1
	R	15k	1
	R	10k	4
	R	5k	1
	R	1k	5
	R	580	1
	R	500	2
	R	220	1
	R	200	1
	R	180	1
	C	100uF	4
	C	47uF	1
	C	22uF	1
	C	10uF	2
	C	4.7uF	1
	C	2.2uF	1

	C	1uF	3
	C	.22uF	1
	C	.047uF	1

	C	51uF	1
	Diode	1N914	**3**
	FET	2N3819	1
	Switch	SPDT	2
	Switch	SPST	1
	Op Amp	NE5534	7
	Op Amp	LM833	2
	Potentiometer	500k	1
	Potentiometer	100k	1
	Potentiometer	25k	2
	Potentiometer	10k	2
	Potentiometer	5k	1
	Potentiometer	1k	1
	Potentiometer	500	1

APPENDIX B: REFERENCES

Filter Design
http://www.ti.com/lit/an/sloa093/sloa093.pdf

Info on "Djent" Tone
http://www.sevenstring.org/forum/beginners-faq/219326-guide-djent-tone-updated-march-7-13-a.html

Tube Screamer Design
http://www.freeinfosociety.com/electronics/schemview.php?id=1136
http://www.geofex.com/article_folders/tstech/tsxtech.htm
http://gaussmarkov.net/layouts/ts808/ts808-schem.png

APPENDIX C: LIST OF "DJENT" BANDS

Periphery
Meshuggah
Tesseract
Vildjahrta
Volumes
Animals as Leaders
Monuments
Born of Osiris
After the Burial
Intervals