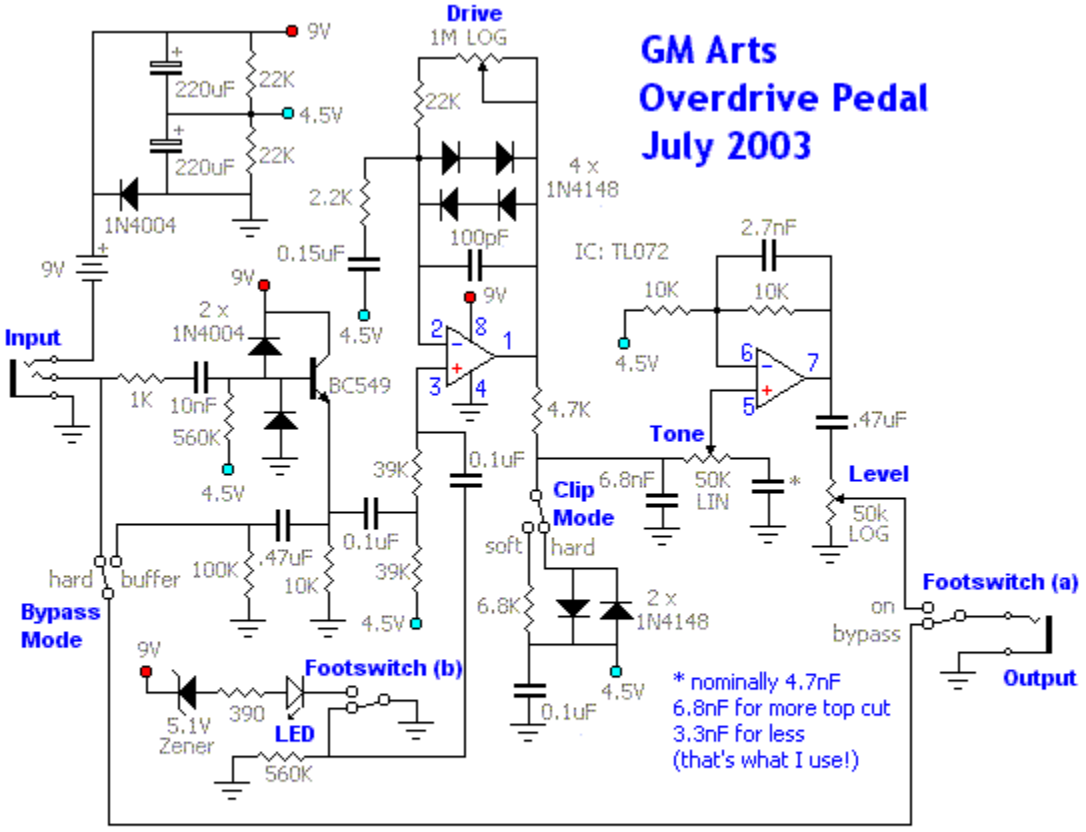
Final Project Report UIUC Physics 406 Spring Semester, 2012

GM Arts Overdrive Pedal

James A. Kolthoff

Introduction

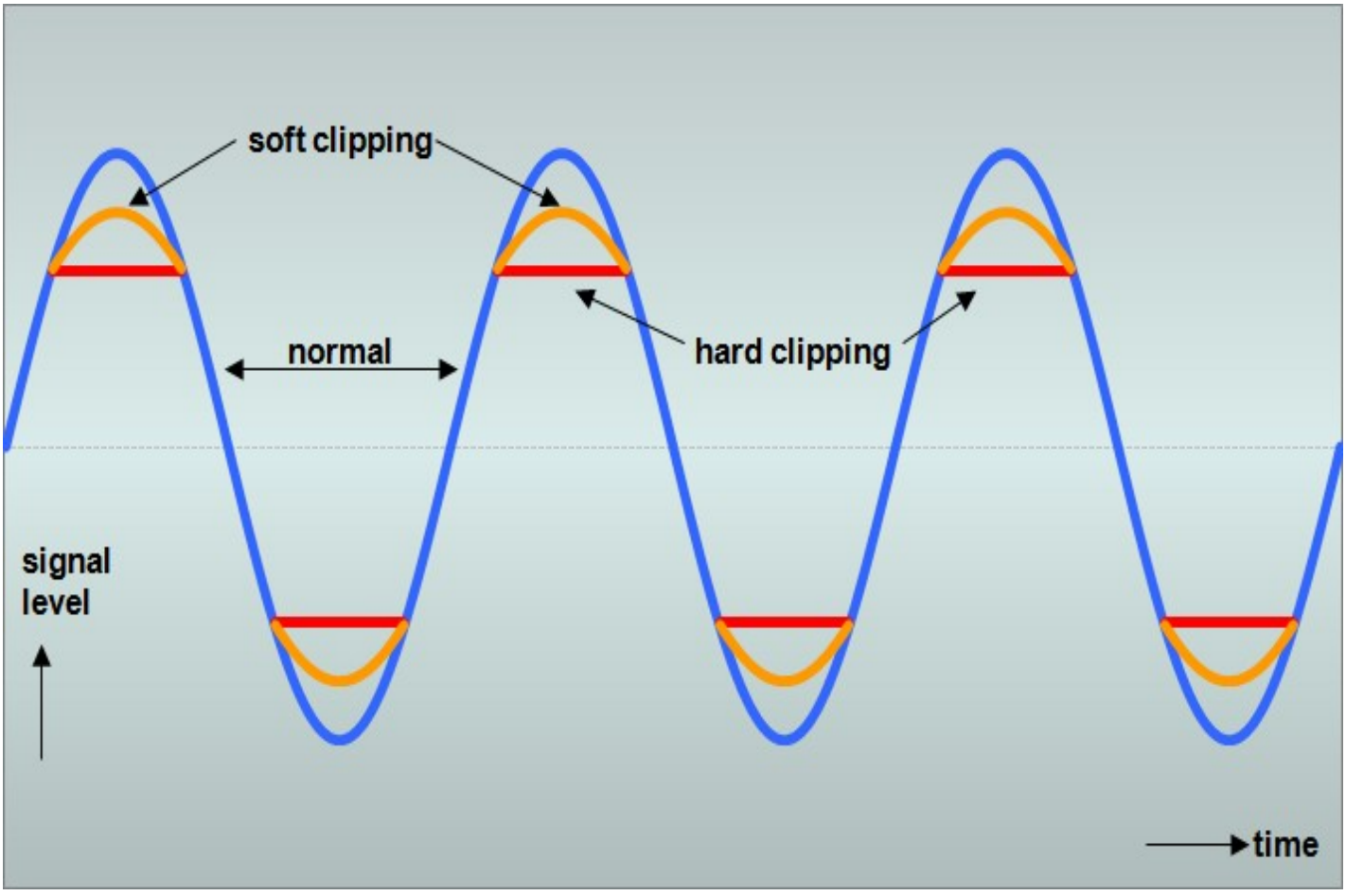
I took this class primarily because I wanted to learn more about sound equipment for musical instruments, especially guitars. I wanted to build something that I would use once the class was over. Since I did not have a distortion pedal, I chose to build one for my project. However, I did not want to simply buy a kit. I wanted to be more involved in the design process. I looked online for explanations of how distortion pedal works and found a design that I wanted to build for myself. Here is the circuit that I found:



How It Works

What distortion does to a sound wave is simple. If you have a standard sinusoidal sound wave such as the blue one on the picture below, what a distortion circuit does is it uses diodes to “clip” the edges of the signal. You can uses different diodes and combine them in different ways to get different kinds of clipping. Soft clipping has a less steep curve (in orange in the picture), while hard clipping has very sharp edges (red in the picture). What kind of clipping is used has a very distinct effect on the resulting sound. The sharper peaks of hard clipping devices create many higher frequency harmonics, while softer clipping devices do not have many high frequency harmonics. Which one sounds better depends entirely on the listener.

Effect of Distortion:

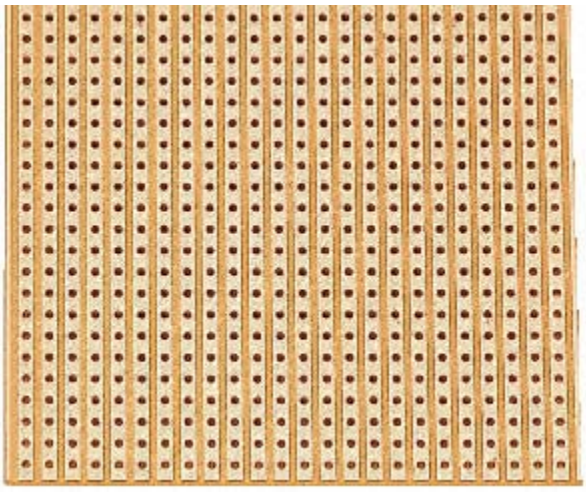


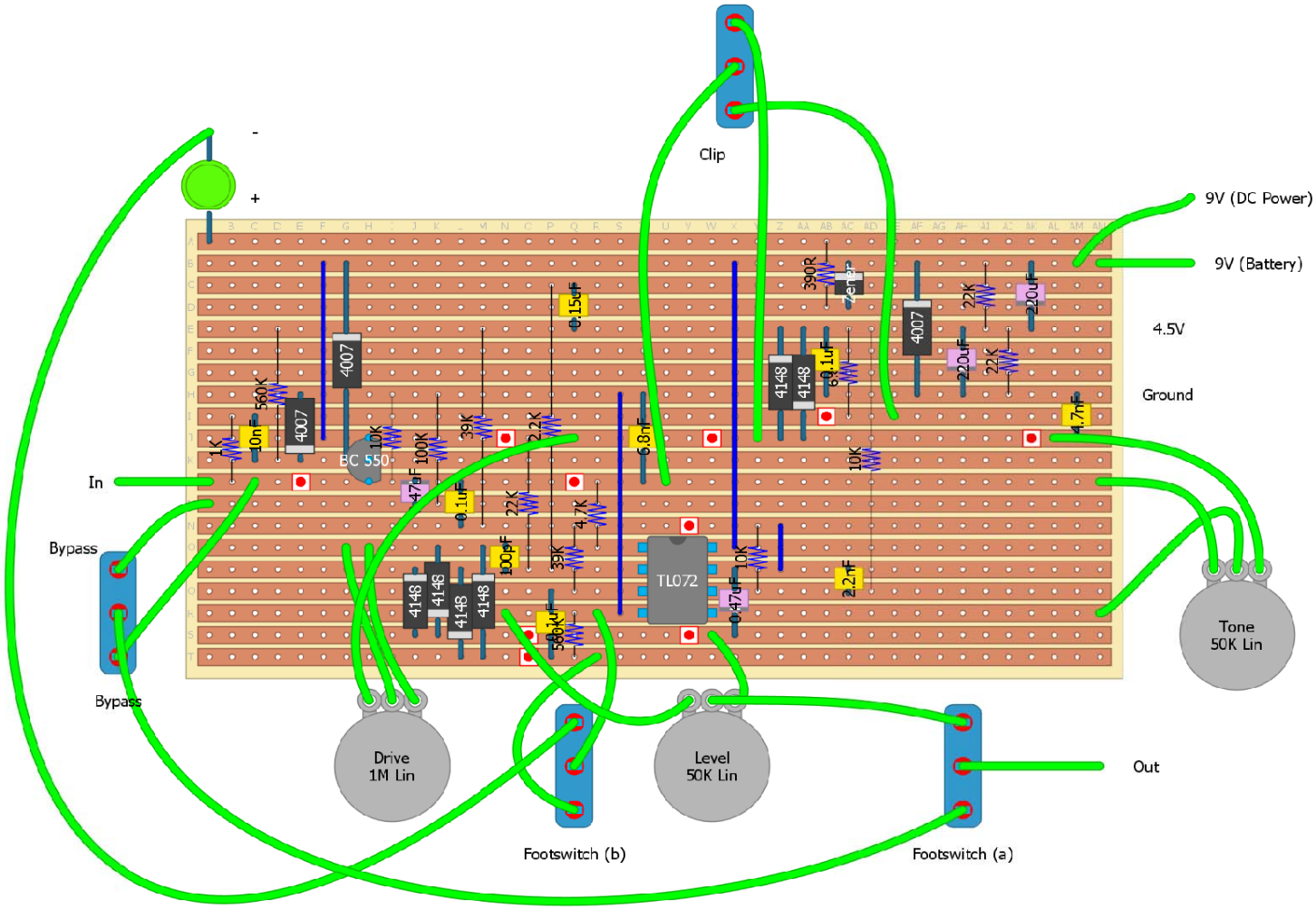
The Building Process:

I obtained most of my parts from BYOC, a website specifically designed for musicians that want to build their own fx kits. I was able to get 4.78”L x 2.61”W x 1.4”D enclosure with pre-drilled holes through this website, which reduced the amount of work that I needed to do. To build the actual circuit, I used a vero board, which is a circuit board that contains long strips of copper that connect the holes of an entire row together. While it was a very effective design for a circuit board, arranging the components according to a circuit diagram is quite tedious. For this reason, I used a program called DIY layout creator that allowed me to create a physical diagram of my circuit using a vero board. This helped to organize my circuit physically before actually soldering the components. Since vero boards require trace cuts (which cannot be undone) to separate different nodes within a same row, this was extremely helpful. The program is absolutely free and can be found at http://code.google.com/p/diy-layout-creator/downloads/detail?name=diylc-3.2.0-beta.zip&can=4&q=. Once I finished drawing the circuit, it was simply a matter of putting the components together.

Getting the pedal to work was a bit difficult simply because the positioning of the circuit became so messy on the vero board that I made several mistakes in wiring. This blew out the op-amp which in turn created more problems. For anyone attempting such a project, I would recommend buying more than one op-amp and using a different type of bread board to simplify the translation from circuit diagram to physical circuit.

Vero board

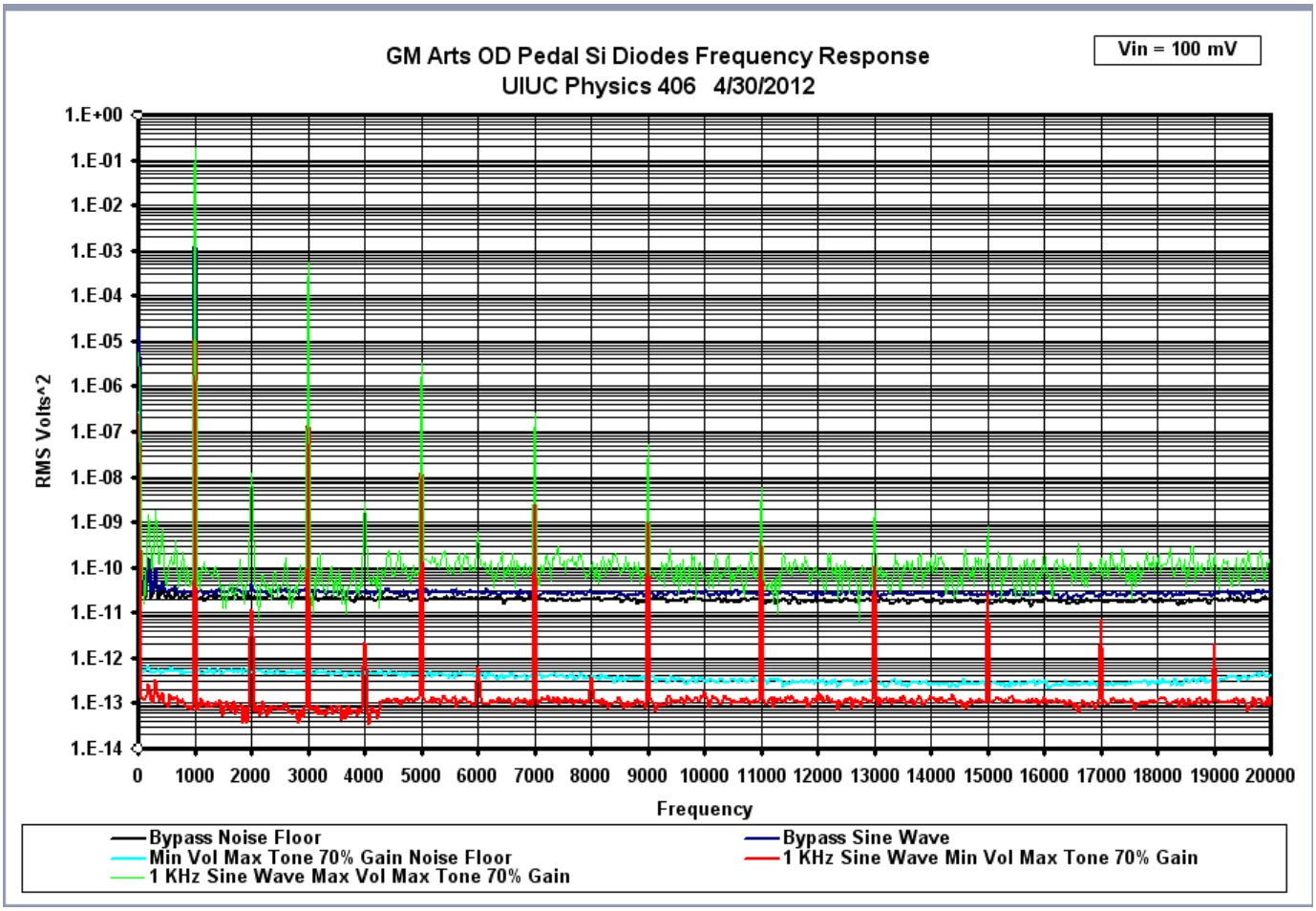


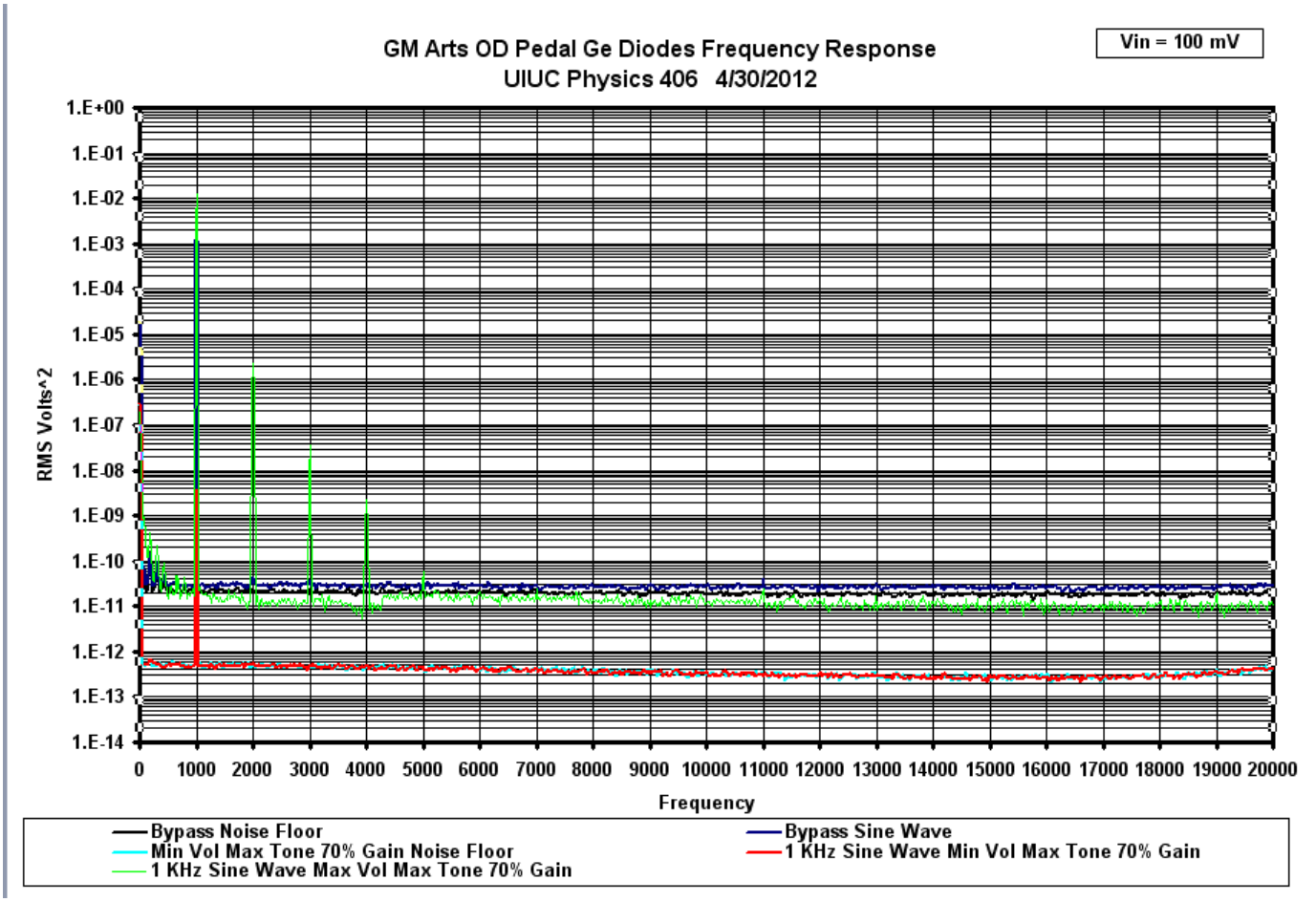

-
+
Clip
9V (DC Power)
9V (Battery)
4.5V
Ground
In
Bypass
Bypass
Tone
50K Lin
Drive
1M Lin
Level
50K Lin
Out
Footswitch (b)
Footswitch (a)
TL072
BC 550
4007
4148
560K
10nF
1K
10K
100K
47nF
39K
2.2K
0.1uF
22K
4.7K
100pF
0.15uF
6.8nF
390R
4.7nF
220uF
10K
0.47uF
2.2nF

Conclusion, Alterations, and Possible improvements:

One alteration that I wanted to make and explore was using germanium diodes versus the silicon diodes originally part of the design. This create a more soft clipping kind of effect. This is due to the fact that the IV curve for a germanium diode is much less steep than that of a silicon diode. The result is that the germanium diode circuit has less higher frequency harmonics than the silicon diode circuit, as shown by the data plots taken in the lab. Another possible alteration that can cause a similar effect with silicon diodes is to place a resistor between the diodes to increase the resistance in the IV curve of the diode. This causes a less steep IV curve. I would like to add potentiometers that can vary this resistance later on so that the user of this pedal can fine tune the clipping to his/her liking.

Overall, the pedal was a success. I decided to stick with the germanium diodes rather than the silicon diodes but I would also like to experiment with placing both types of diodes together in different combinations and to see the result of this.


GM Arts OD Pedal Si Diodes Frequency Response
UIUC Physics 406 4/30/2012
Vin = 100 mV
RMS Volts^2
1.E+00
1.E-01
1.E-02
1.E-03
1.E-04
1.E-05
1.E-06
1.E-07
1.E-08
1.E-09
1.E-10
1.E-11
1.E-12
1.E-13
1.E-14
0 1000 2000 3000 4000 5000 6000 7000 8000 9000 10000 11000 12000 13000 14000 15000 16000 17000 18000 19000 20000
Frequency
Bypass Noise Floor
Bypass Sine Wave
Min Vol Max Tone 70% Gain Noise Floor
1 KHz Sine Wave Min Vol Max Tone 70% Gain
1 KHz Sine Wave Max Vol Max Tone 70% Gain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