Ideal Graphic Equalization

Lake Contour Application Notes
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The Lake Contour introduces an entirely new method for graphic equalization. Using raised cosine filters instead of a traditional filter implementation, the Lake Contour's Ideal Graphic Equalizer provides a new level of control and precision. The Contour Controller touchscreen interface provides rapid controls for the Ideal Graphic Equalizer.

Introduction

Graphic equalizers are commonly used in professional audio applications to tailor the loudspeaker system frequency response to taste. It would be difficult to find a live sound system without a graphic equalizer inserted between the mixing console and the speaker system. One of the problems with graphic equalizers is that the equalizer controls do not accurately represent the equalizer's effect on the audio signal. Ideally, the effect of the equalizer on the audio signal should be reflected in the equalizer's controls. The Lake Contour Ideal Graphic Equalizer provides the solution. This application note reviews currently available graphic equalizer implementations,

and compares these equalizers to the Lake Contour Ideal Graphic Equalizer.

Graphic Equalizers

Graphic equalizers are currently provided by a variety of manufacturers. You can easily find analog and digital graphic equalizers for your application and budget. In either the analog or digital case, these equalizers are implemented using similar techniques. A set of filters is provided with a specific resolution. The most common resolutions are octave band and third-octave band graphic equalizers. For this discussion, we focus on third-octave graphic equalizers, as these are most commonly used for professional applications.

Graphic equalizers get their name from the notion that you can slide the graphic equalizer controls to create a shape that provides a desired frequency response. The visual representation of the graphic equalizer's front panel or software interface controls should reflect what is happening to the audio signal. Unfortunately this is not the case.

Graphic Equalizer Measurements

Using SIA Software's SmaartLive™ measurement and analysis system, a number of measurements were performed of commonly available analog and digital graphic equalizers. Transfer function measurements using FFT-based techniques were used to provide the high resolution frequency responses of these processors. For the sake of brevity, measurements of a few different equalizer settings were performed.

For the first measurement, a range of frequencies was boosted by 6 dB on an analog graphic equalizer. Figure 1 shows the front panel controls, and figure 2 shows the measured frequency response of the resulting audio signal. The resulting audio signal is not what we expect by looking at the front panel controls. The frequency response is not flat, it is not providing a boost of 6 dB, and it does not provide a sharp transition from one band to another as the controls depict.

For the second measurement, one band was boosted by 6 dB, and the next band was cut by 6 dB. This was done for a couple more alternating bands. Figure 3 shows the front panel controls, and figure 4 shows the measured frequency response of the resulting audio signal. The resulting audio signal is not what we expect by looking at the front panel controls. The frequency response does not provide 6 dB boosts or cuts.

Traditionally implemented graphic equalizers suffer from these problems, because each filter interacts with the other filters around it. Other implementations with different filters exist, but they still exhibit similar problems. For our third and final measurement, a range of frequencies was boosted by 6 dB on a digital graphic equalizer. Figure 5 shows the software interface controls, and figure 6 shows the measured frequency response of the resulting audio signal. Again, the response of the equalizer is not what we expect by looking at the controls. The frequency response exhibits a different behavior compared to the first measurement, but it is still not accurate compared to the controls.

Lake Contour Ideal Graphic Equalizer

The Lake Contour introduces a new method for graphic equalization. The Ideal Graphic Equalizer provides a user interface whose controls exactly match the resulting effect on the audio signal. The Ideal Graphic Equalizer filters also combine to provide perfectly flat frequency responses. Neighboring filters do not interact like existing graphic equalizers, providing more precise control.

The Lake Contour implements filters using raised-cosines. A raised-cosine filter has a better selectivity than can be realized using traditional methods. Figure 7 shows a comparison between a third-octave raised-cosine filter and a third-octave traditionally implemented filter. As can be readily seen in figure 7, the raised-cosine filter does not leak into other third-octave bands like the traditional filter. The raised-cosine filter provides a new level of precision not previously available.

Ideal Graphic Equalizer Measurements

The same measurements performed in the previous section were performed on the Lake Contour's Ideal Graphic Equalizer. Figure 8 shows the Ideal Graphic Equalizer's controls for boosting the same range of frequencies by 6 dB. Figure 9 shows the measured response of the resulting audio signal. It is easy to see that the Ideal Graphic Equalizer's controls and resulting audio response are identical. The Ideal Graphic Equalizer produces a perfectly flat 6 dB boost of the desired frequency range. Also, the Ideal Graphic Equalizer does not leak into other frequency bands.

Figure 10 shows the Ideal Graphic Equalizer's controls for boosting and cutting neighboring bands by 6 dB. Figure 11 shows the measured

response of the resulting audio signal. Again, the Ideal Graphic Equalizer's controls exactly match the measured audio response.

Conclusion

Traditionally implemented analog and digital graphic equalizers suffer from interaction problems. These interaction effects result in audio responses that do not match the controls of the equalizer. Since raised-cosine filters do not interact like traditional filters, the Lake Contour Ideal Graphic Equalizer provides controls that exactly match the resulting audio response. Through the use of the Ideal Graphic Equalizer, sound engineers can now intuitively adjust loudspeaker system frequency responses.

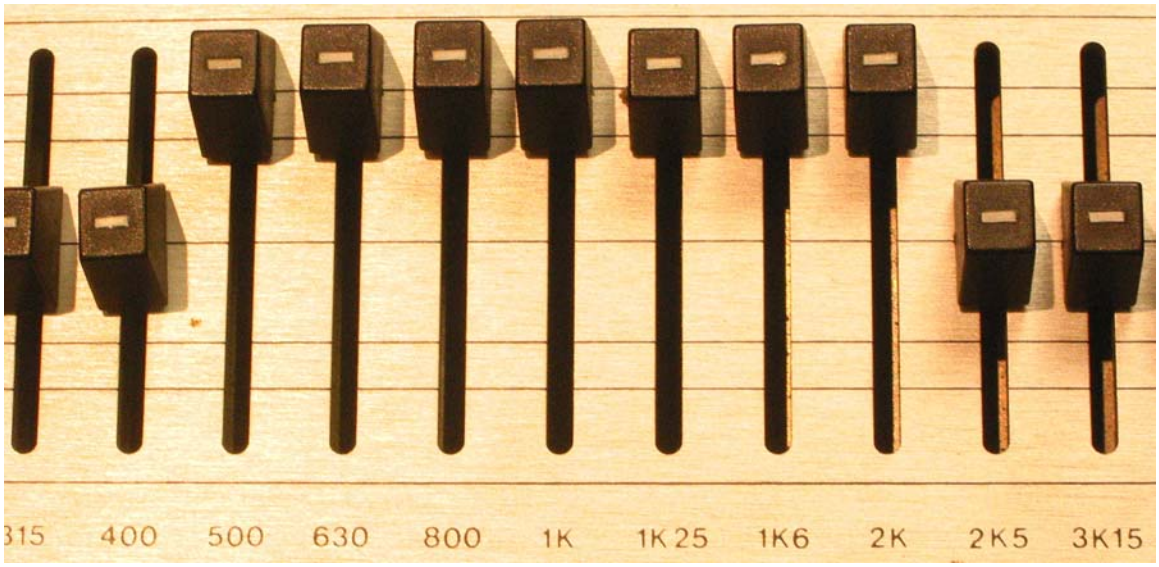

Figure 1: 6 dB boosts from 500 Hz to 2 kHz on analog graphic equalizer

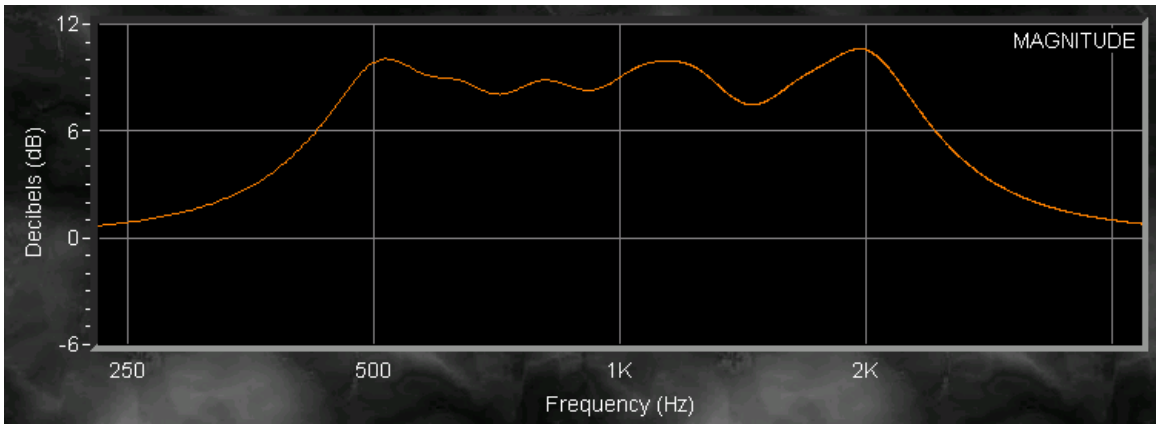

Figure 2: Frequency response measurement of analog graphic equalizer

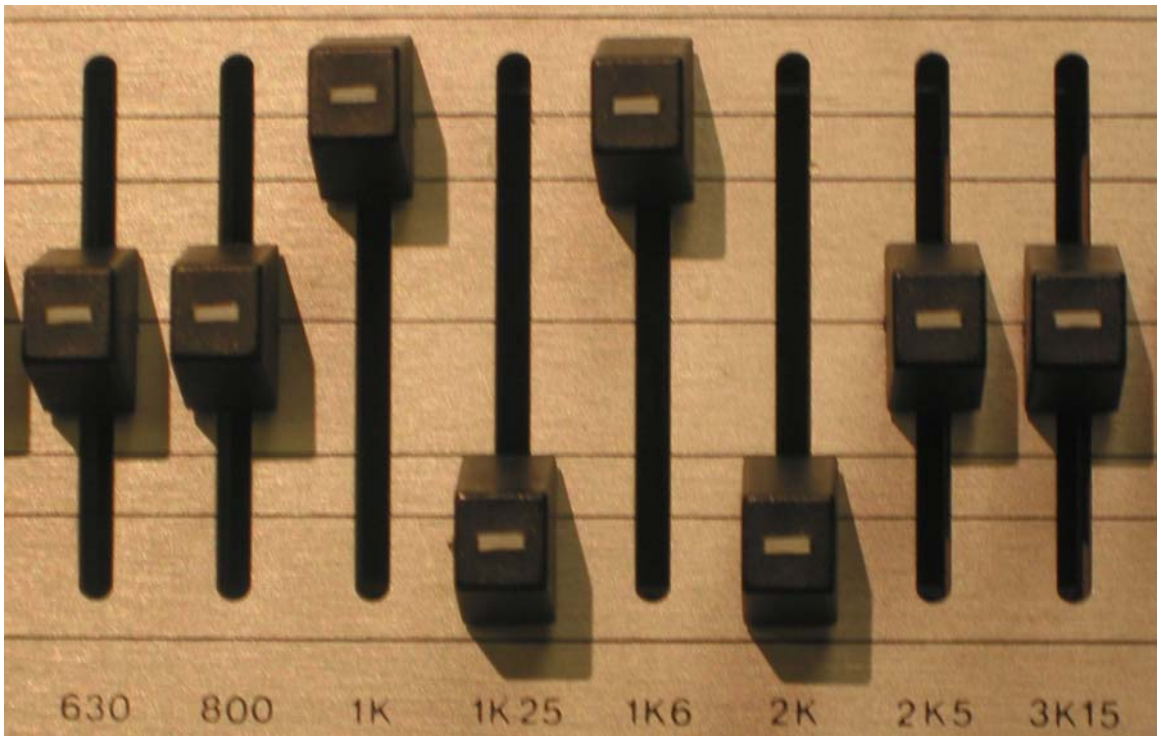

Figure 3: 6 dB boosts and cuts on analog graphic equalizer

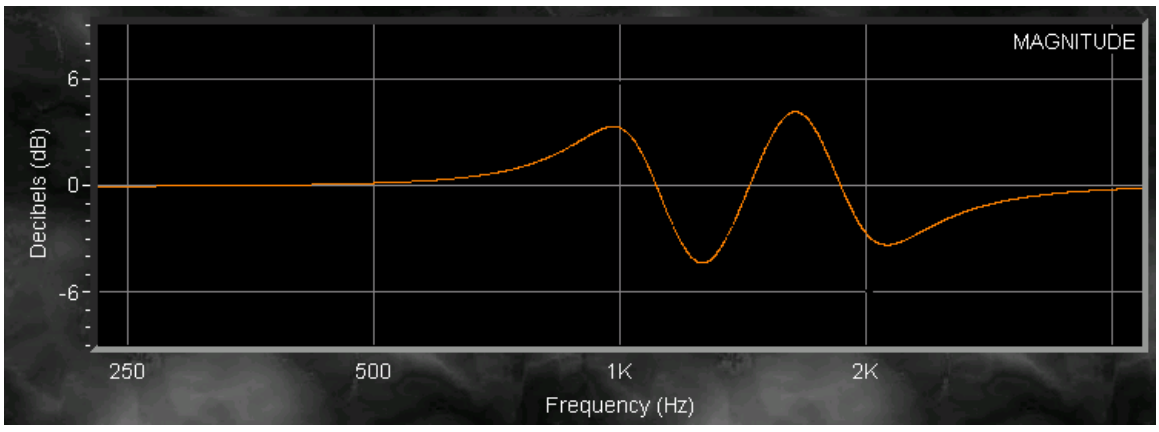

Figure 4: Frequency response measurement of analog graphic equalizer

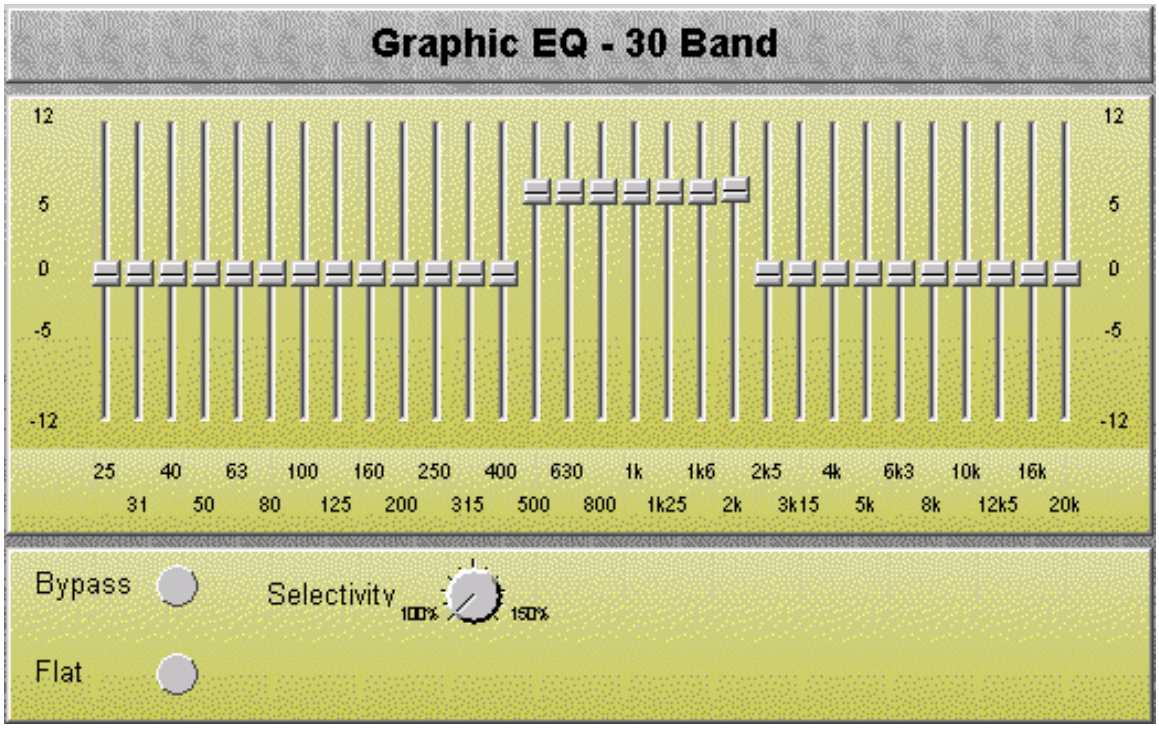

Figure 5: 6 dB boosts from 500 Hz to 2 kHz on digital graphic equalizer

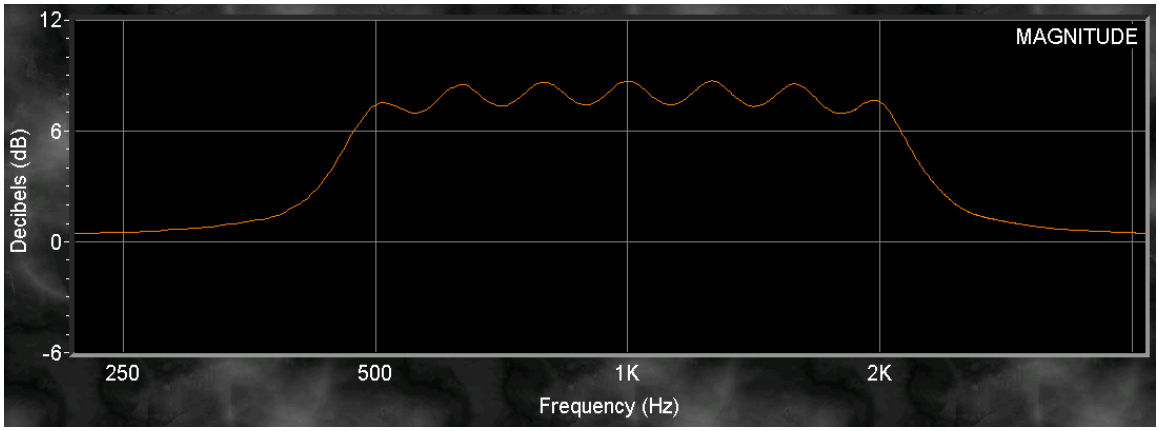

Figure 6: Frequency response measurement of digital graphic equalizer

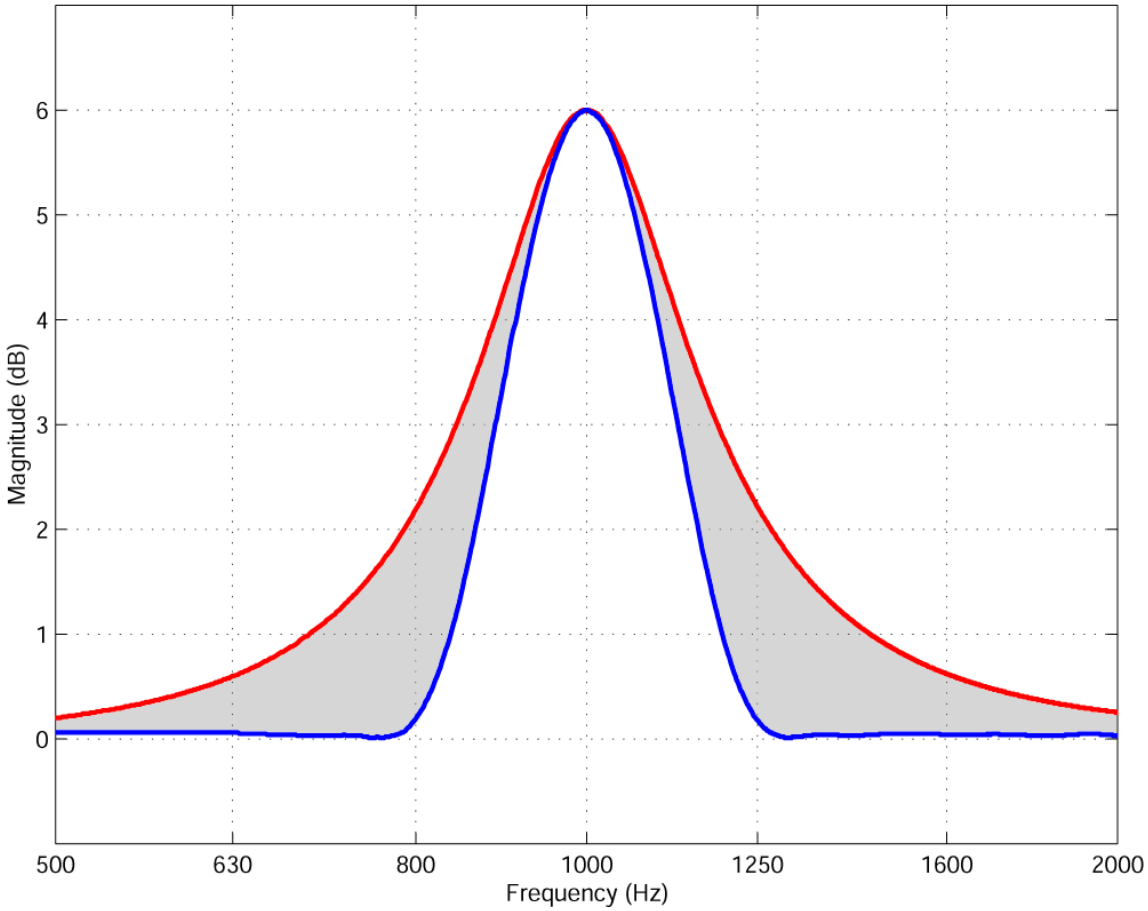

Figure 7: Third-octave traditional parametric vs. third-octave raised cosine

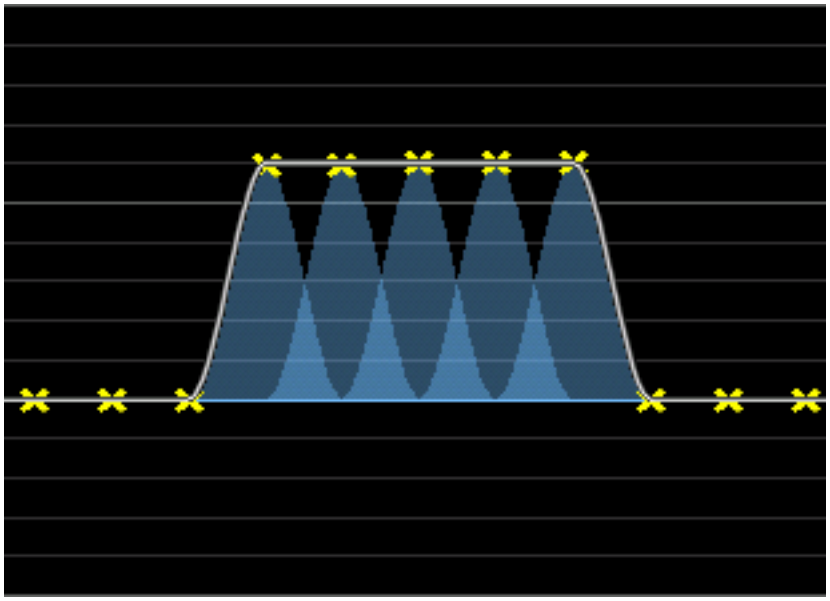

Figure 8: 6 dB boosts from 500 Hz to 2 kHz on Ideal Graphic EQ

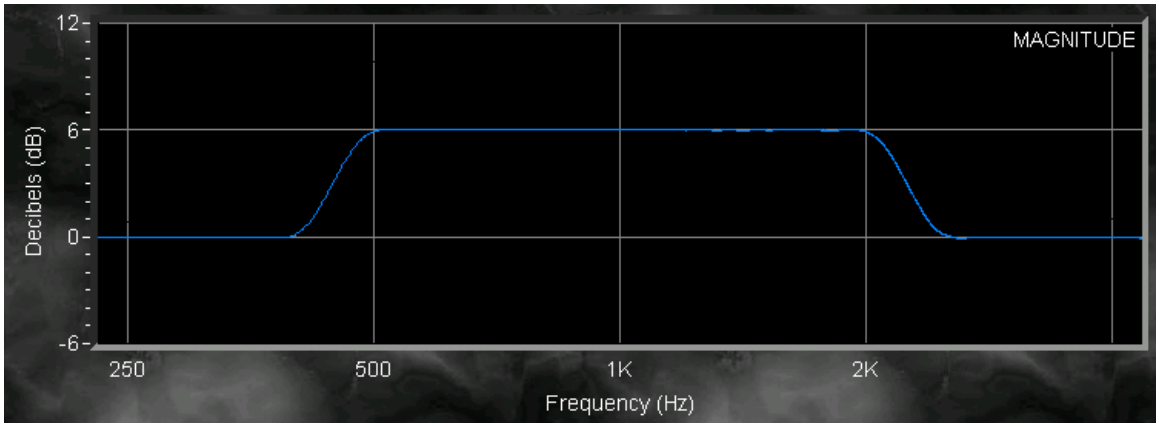

Figure 9: Frequency response measurement of Ideal Graphic EQ

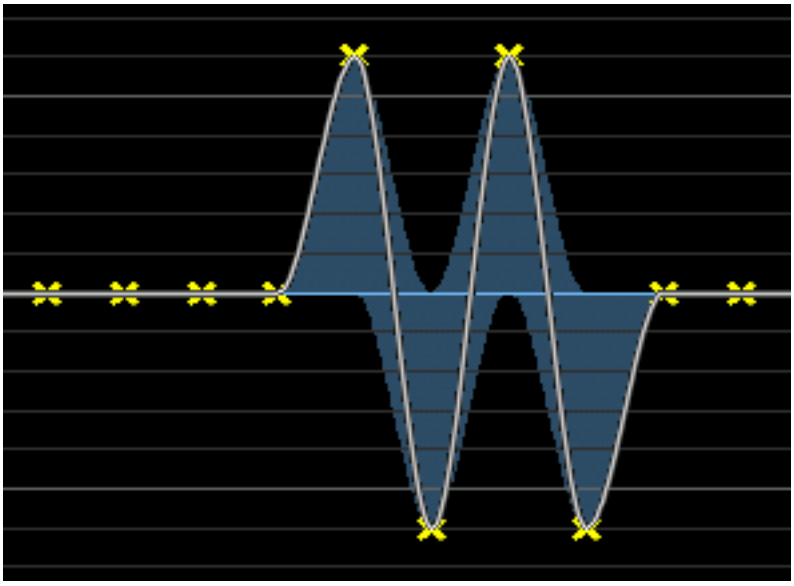

Figure 10: 6 dB boosts and cuts on Ideal Graphic EQ

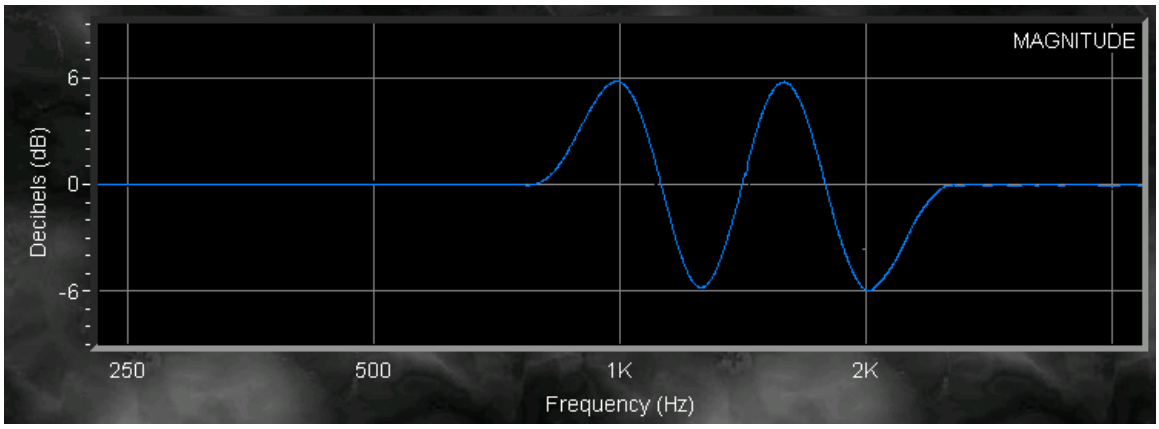

Figure 11: Frequency response measurement of Ideal Graphic EQ