Information

Ideal Graphic Equalization

The Dolby® Lake® Processor introduces an entirely new method for graphic equalization. Using raised cosine filters instead of a traditional filter implementation, the Dolby Lake Processor's provides a new level of control and precision. The Dolby Lake Controller touch screen interface provides rapid controls for the Ideal Graphic EQ.

1. 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 Dolby Lake Processor Ideal Graphic EQ provides the solution. This application reviews currently available graphic equalizer implementations, and compares these equalizers to the Dolby Lake Processor Ideal Graphic EQ.

2. 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. 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 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.

3. 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 high-resolution frequency responses of these processors. For the sake of brevity, measurements of a few different equalizer settings were performed.

Dolby Laboratories, Inc. 100 Potrero Avenue • San Francisco, CA 94103-4813 • Telephone 415-558-0200 • Fax 415-863-1373
Wootton Bassett • Wiltshire SN4 8QJ • England • Telephone (44) 1793-842100 • Fax (44) 1793-842101

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.

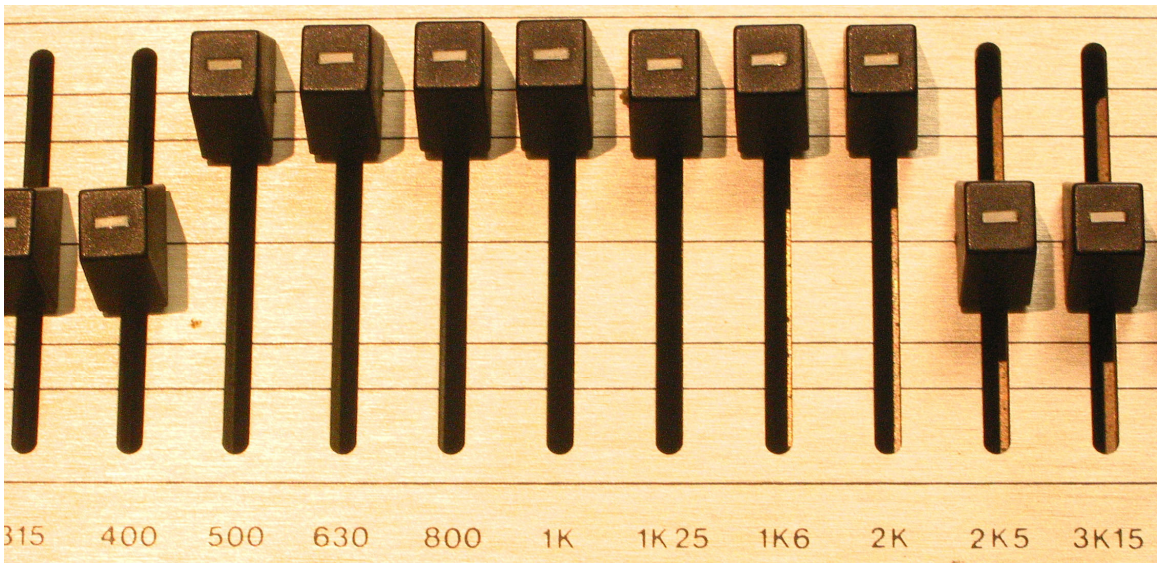

Figure 1 6 dB Boosts from 500 Hz to 2 kHz on Analog Graphic Equalizer

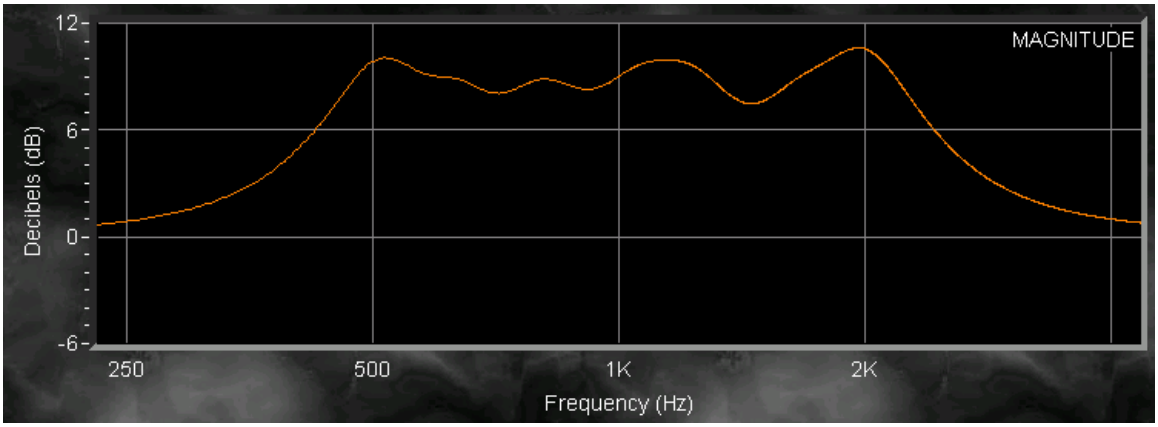

Figure 2 Frequency Response Measurement of Analog Graphic Equalizer

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 third-octave 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.

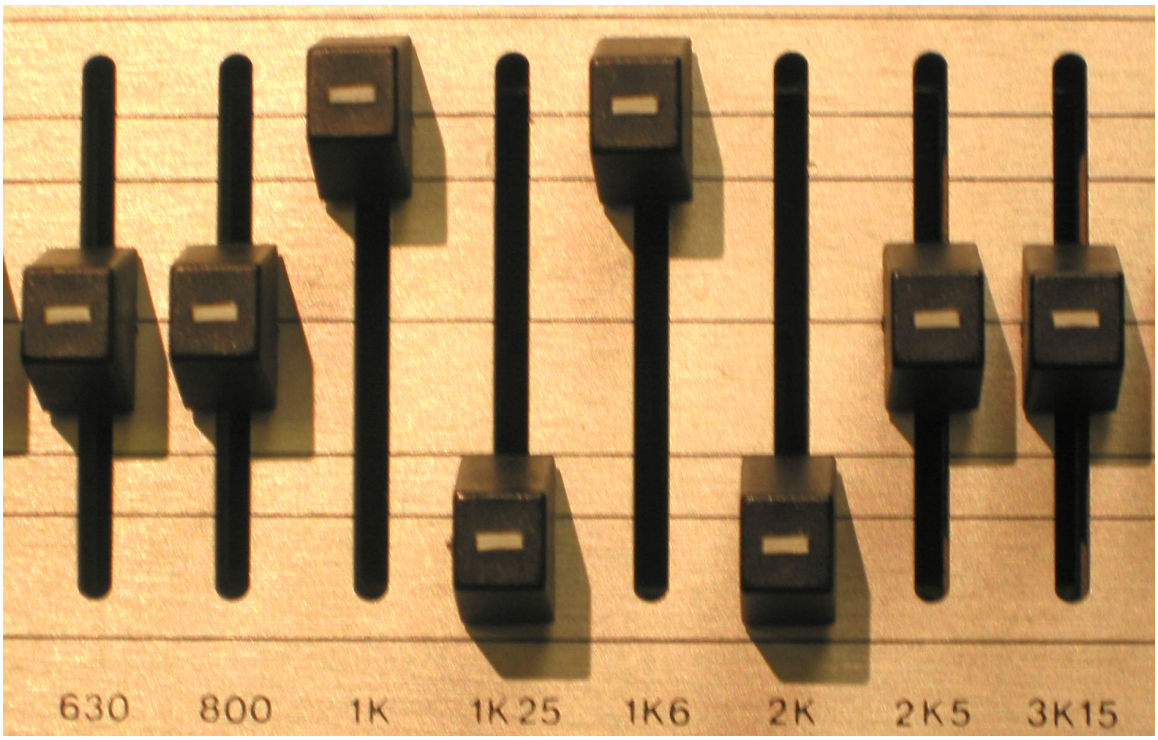

Figure 3 6 dB Boosts and Cuts on Analog Graphic Equalizer

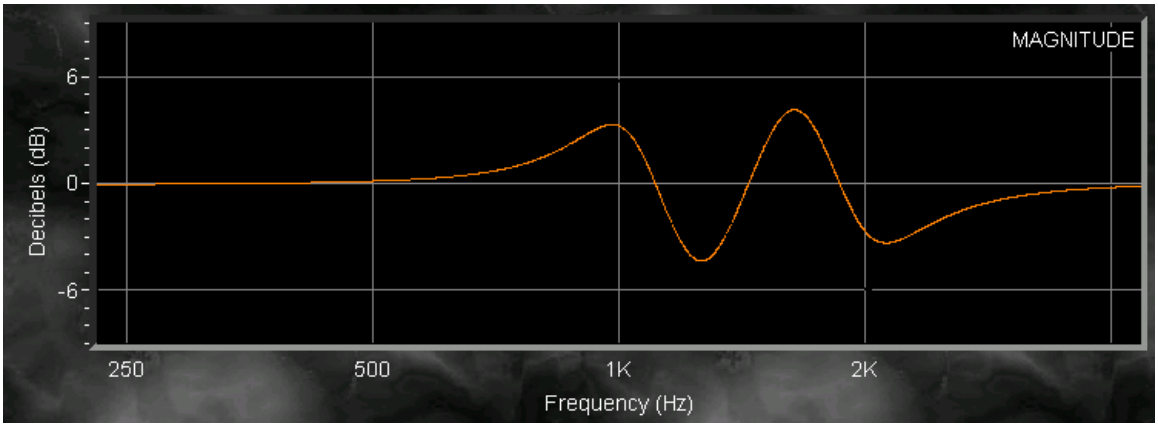

Figure 4 Frequency Response Measurement of Analog Graphic Equalizer

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.

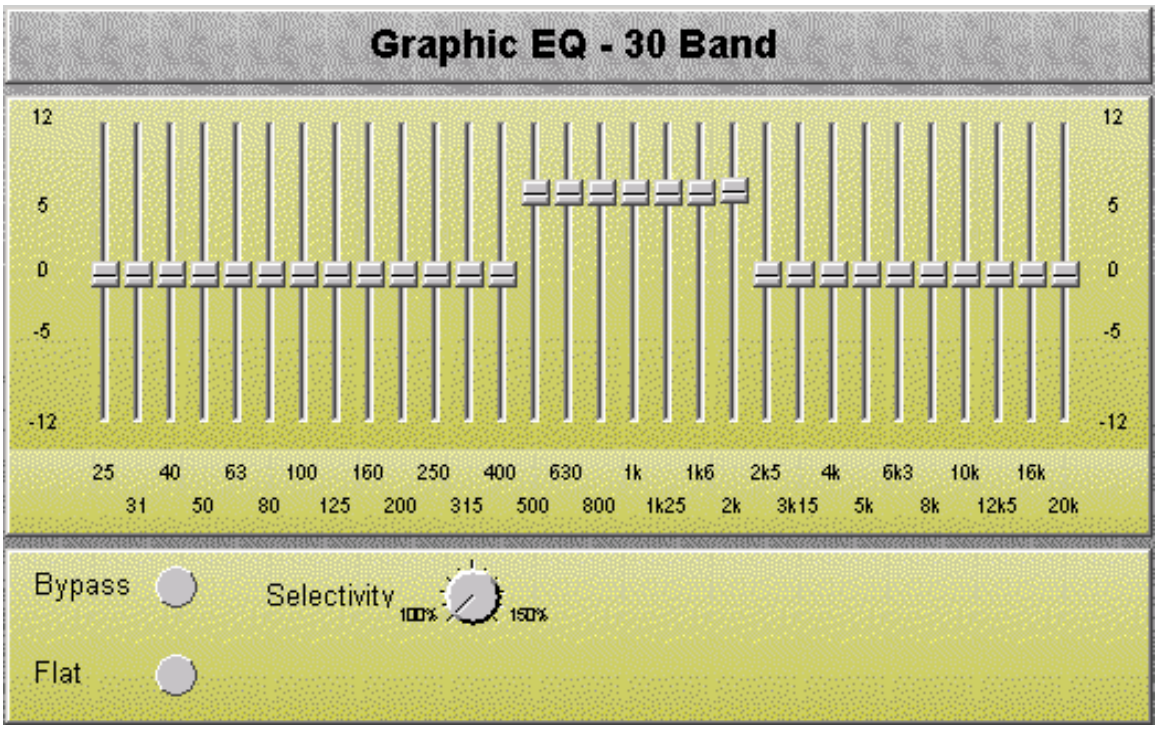

Figure 5 6 dB Boosts from 500 Hz to 2 kHz on Digital Graphic Equalizer

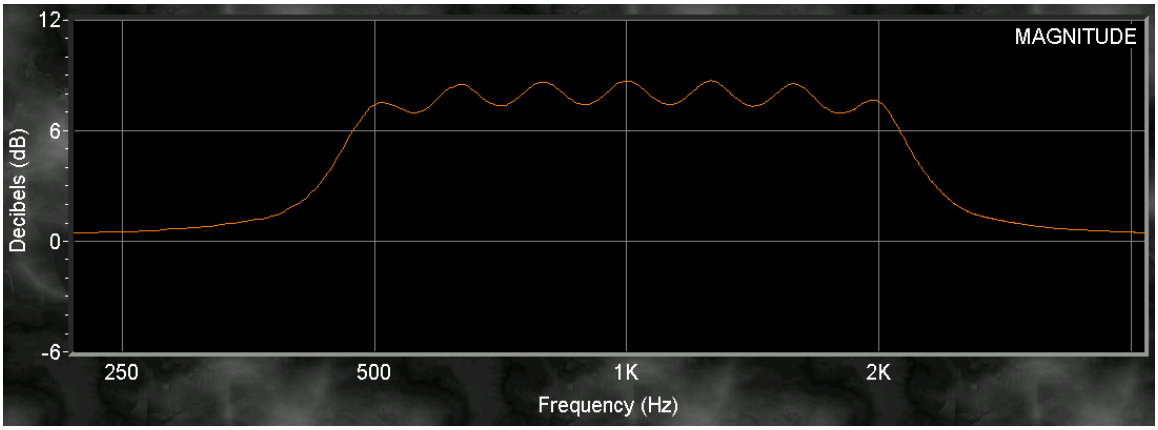

Figure 6 Frequency Response Measurement of Digital Graphic Equalizer

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.

4. Dolby Lake Processor Ideal Graphic EQ

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

The Dolby Lake Processor implements filters using raised cosine filters. 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 (in blue) and a third-octave traditionally implemented filter (in red).

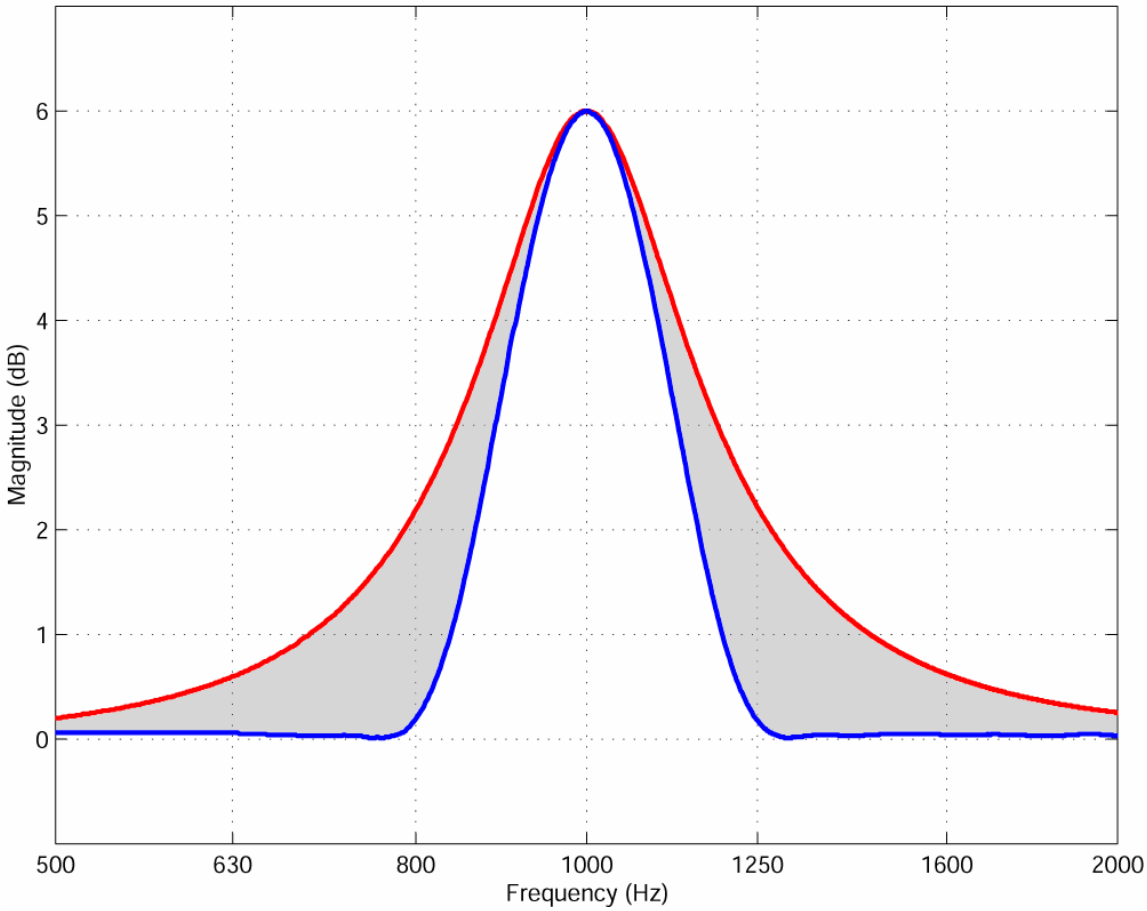

Figure 7 Third-Octave Traditional Parametric vs Third-Octave Raised Cosine

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.

5. Ideal Graphic EQ Measurements

The same measurements performed in the previous section were performed with the Dolby Lake Processor's Ideal Graphic EQ. Figure 8 shows the Ideal Graphic EQ's controls for boosting the same range of frequencies by 6 dB. Figure 9 shows the measured response of the resulting audio signal.

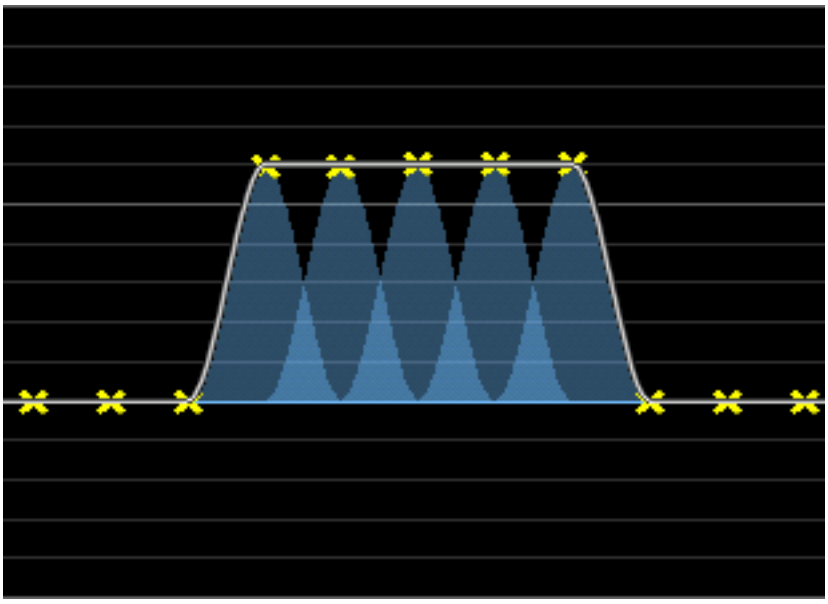

Figure 8 6 dB Boosts from 500 Hz to 2 kHz on Ideal Graphic EQ

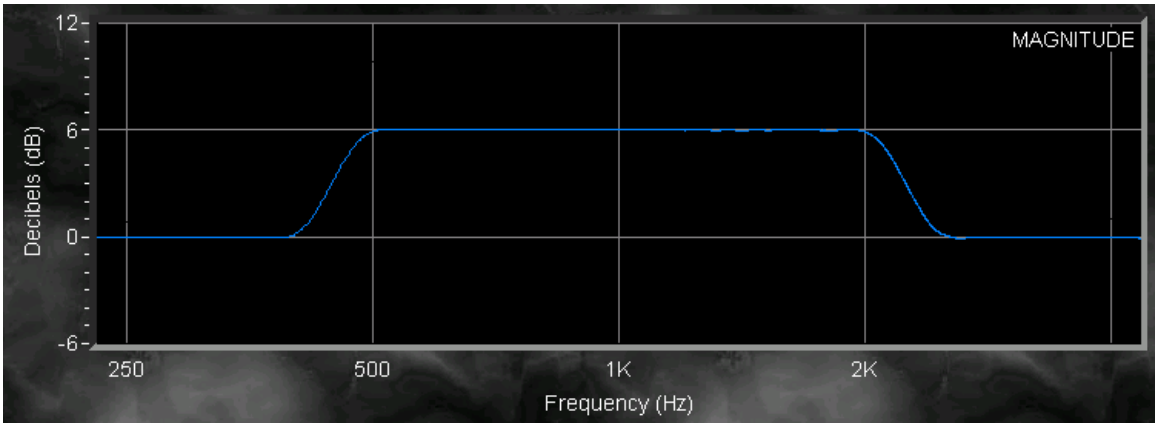

Figure 9 Frequency Response Measurement of Ideal Graphic EQ

It is easy to see that the Ideal Graphic EQ's controls and resulting audio response are identical. The Ideal Graphic EQ produces a perfectly flat 6 dB boost of the desired frequency range. Also, the Ideal Graphic EQ does not leak into other frequency bands.

Figure 10 shows the Ideal Graphic EQ's controls for boosting and cutting neighboring bands by 6 dB. Figure 11 shows the measured response of the resulting audio signal.

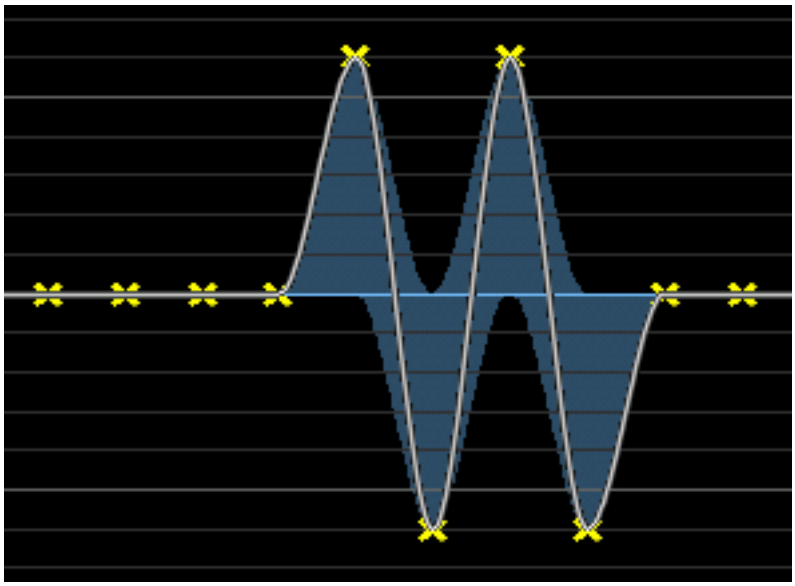

Figure 10 6 dB Boosts and Cuts on Ideal Graphic EQ

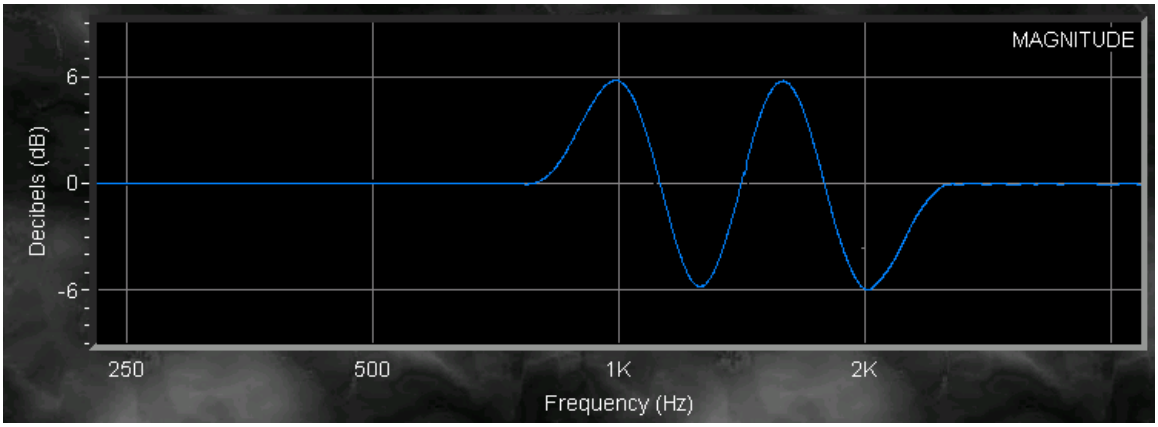

Figure 11 Frequency Response Measurement of Ideal Graphic EQ

Again, the Ideal Graphic EQ's controls exactly match the measured audio response.

6. 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 Dolby Lake Processor Ideal Graphic EQ provides controls that exactly match the resulting audio response. Through the use of the Ideal Graphic EQ, sound engineers can now intuitively adjust loudspeaker system frequency responses.