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Parametric Equalization

for Paging and Intercom Applications

White Paper

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Parametric Equalization for Paging and Intercom Applications

A Parametric Equalizer (EQ) gets its name from the characteristics of its three controls (gain, frequency, and Q/bandwidth), each of which can be adjusted individually. The adjustment of any one control can be made without affecting the intended sonic result of the remaining two of these controls. This allows equalization to be made more precisely.

With this type of EQ, you can make reductions in gain (cuts) or increases in gain (boosts) to relatively narrow bands of the frequency spectrum. The frequency response curve that a parametric EQ creates at each band resembles the shape of a bell. These bell-shaped regions of cut and boost can be made at a desired frequency and Q (bandwidth).

The Three Controls of a Parametric Equalizer

GAIN: The gain parameter on a parametric equalizer allows you to control the amount of boost or cut that you are applying–typically in the range of +15 dB to -15 dB, respectively.

CENTER FREQUENCY: The center frequency refers to the frequency which resides at the very center of the bell-shaped boost or cut that you are making to the audio signal. The frequency adjustment can range from as much as 2 or 3 octaves, to as fine as 1/3 octave depending on how many frequency bands the EQ possesses.

Q or BANDWIDTH: Q refers to how narrow or wide your boost or cut is. Bandwidth is usually controlled by a 'Q' setting, which stands for 'quality factor'. The higher the value of the Q setting, the narrower the bandwidth will be. Conversely, the lower the Q value, the wider the bandwidth will be.

Mathematically, Q can be calculated simply by dividing the center frequency of the filter by the difference of the two frequencies at the -3 dB points on either side of the center frequency. For instance, if the filter's center frequency is set to say 980 Hz, and the two frequencies on either side of 980 Hz where the amplitude is -3 dB down are observed to be 856 Hz and 1122 Hz, then Q equals 3.68. The equation looks as follows: **Q = 980/(1122-856) = 3.68**

Why Use a Parametric Equalizer?

Parametric Equalizers offer an unparalleled level of flexibility over the kind of equalization you create. By giving you control over the equalizer's gain, center frequency, and bandwidth parameters, you can make precise, surgical-like EQ alterations to suit the needs of your sound application. Alternatively, you can also make changes to broad portions of the frequency spectrum to change the overall sound. This ability to make such varied alterations makes a parametric equalizer a very versatile equalizer to use.

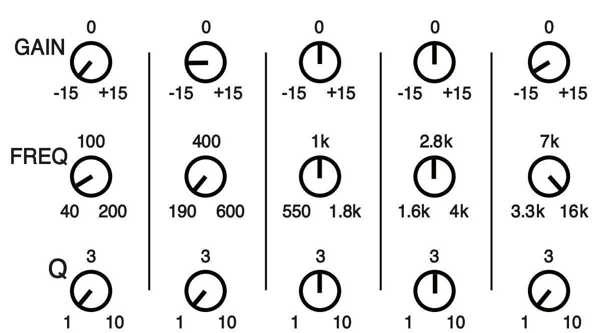
The **Bogen Communications Platinum Series** amplifiers have five bands, or distinctive sets of parametric equalizer filters. In the following examples, the default settings for each filter band is Gain of 0, Frequency at the centerpoint of the range, and Q of 3. These correspond to the 12 o'clock position of each band filter control knob.

For Public Address and General Paging

Use equalization to make voices sound more natural in these situations. For this application, roll-off (i.e., cut) frequencies between 20 Hz - 300 Hz and above 10 kHz.

In this example, we will need to set three (3) different filters at the low-end and high-end ranges (center frequencies of 100, 400, and 7k Hz):

- Use the widest Q setting possible (1 in the case of the **Platinum Series**) for each of the 3 filters.
- For the lowest frequency filter (centered at 100 Hz), set the gain to minimum (-15 dB), and its center frequency to about 50 Hertz.
- For the next higher frequency filter (centered at 400 Hz), set the gain to about -7 dB, and its center frequency to about 190 Hertz.
- For the frequency roll-off above 10 kHz, set the highest frequency filter's (centered at 7 kHz) gain to about -10 dB, and its center frequency to about 16 kHz.

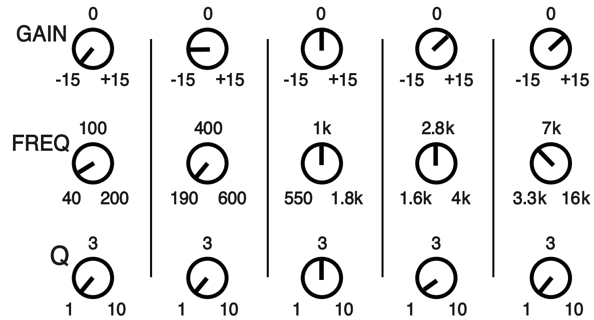


High-Noise Environments

Speech intelligibility declines with increasing background noise levels and a given voice power level. Parametric equalizers can improve intelligibility by increasing the gain (boost) of the key voice frequencies. You can begin by providing a modest boost in the 2 kHz to 6 kHz range to help make speech more intelligible in a high-noise environment.

Let's assume you've set the parameters for a public address application, but it turns out to be a high noise environment, like a school cafeteria. Building on the previous example:

- We will combine the use of two different filters to achieve the desired effect for this scenario: 2.8 kHz and 7 kHz. Since we want to boost between 2 kHz and 6 kHz, set the 2.8 kHz gain to about +5 dB. Widen its Q to 1.
- Changing from the example above, set the highest frequency filter's (centered at 7 kHz) gain to about +5 dB, and its frequency to about 5 kHz.



The goal here is to accentuate the vocal frequency region (2 kHz - 6 kHz) for clarity of voice. This is relatively easy to do in most situations. However, in a high-noise environment, the overall boost bandwidth may have to be narrower in order to overcome the background noise.

Feedback Control

Feedback occurs when a device such as a microphone "hears" the speaker(s) to which it is supplying the source audio, creating an acoustically coupled loop (i.e., feedback).

The initial solution to remove this form of acoustic feedback is to physically break the path that allows the microphone to hear its own audio from the speaker(s) by repositioning one or both. If that is not possible, then EQ can be used to reduce the gain at a crucial frequency that breaks the audio feedback loop.

The offending feedback signal is primarily sinusoidal in form. This is good, because it makes it much easier to dial-in a narrow Q notch (cut) to eliminate it. If an audio spectrum analyzer is present, then it can be used to visually find the offending frequency. If not, then finding the offending frequency can be done by making an educated guess as to which filter band the feedback frequency might exist within.

In this scenario, let's assume that the feedback frequency might be within the 2.8kHz filter's range.

- With the Q in its "default" position of 3, start by reducing the gain of the 2.8kHz filter about -6 dB.
- Rotate the frequency control either upward or downward until the feedback is diminished or eliminated.
- Increase the gain back to about -3 dB, keeping in mind that the feedback may re-occur at this point.
- Repeat rotating the frequency control upward or downward in a narrow range to zero-in on the offending feedback frequency.
- Further refinement can be made without adversely affecting the audio by increasing the Q above the setting of 3 to help narrow-in on the feedback frequency.
- If the feedback reoccurs, fine-tune its attenuation by adjusting the frequency control again.

All too often users start by simply reducing an amplifier's Master gain in an attempt to stop the feedback. This has the unfortunate effect of reducing the amplitude of all the other frequencies in the audio spectrum that are not involved with the feedback. Keep in mind that feedback elimination only requires a 3 dB reduction in gain—that's half the power at the offending frequency. Once that offending frequency is found, there is no need to compromise the adjacent audio spectrum by making the feedback attenuation notch too deep.

The offending feedback frequency will often change in the listening space due to the presence of people and/or the movement of reflective surfaces in that space. As such, widening the bandwidth (Q), and/or gently moving the notch frequency above or below its present setting, may need to be repeated in order to fine-tune the listening space.

For additional information regarding the finer points of parametric equalization, consult our website paper: ***"Attributes and Tuning of a Parametric Equalizer."***

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