Equalizer Basics – A Basic Overview

Proper Equalization can allow music or speech to be heard as it was intended to be heard. If appropriately used, Equalization can improve the intelligibility of a sound system and help with controlling feedback. When starting the EQ process, it is recommended that you always start with "small" changes and remember that too much EQ can make the sound system sound worse than when you started. Whether you are using an Analog or Digital EQ, the functions are basically the same for both.

The EQ shown above is a dual channel 31 band Graphic EQ. Like all other Sound Processors, equalizers can be Outboard (standalone physical units) or Digital (software-based, built into a mixing board, DAWs). DAWs (Digital Audio Workstations) are covered on a different Handout.

Audio Frequency Band / Spectrum notes:

A frequency band is a "range" of frequencies. The accepted and recognized audio spectrum range is 20Hz-20,000 Hz (20kHz). The majority of listeners cannot hear the entire "set" of frequencies in this range, and some of the lower frequencies are "felt" more than they are "heard." The 20-20kHz frequency range is explained in more detail on Page 24. The Audio Frequency Spectrum range can be divided into groups (see below left).

The Audio Frequency Spectrum range can be divided up into smaller frequency groups / bands. The group below has been divided into 7-Groups / Bands for this demonstration.

Sub = 20-80Hz

Bass = 80 – 200Hz

Lower Midrange = 200 – 500Hz

Midrange = 500 – 1200Hz

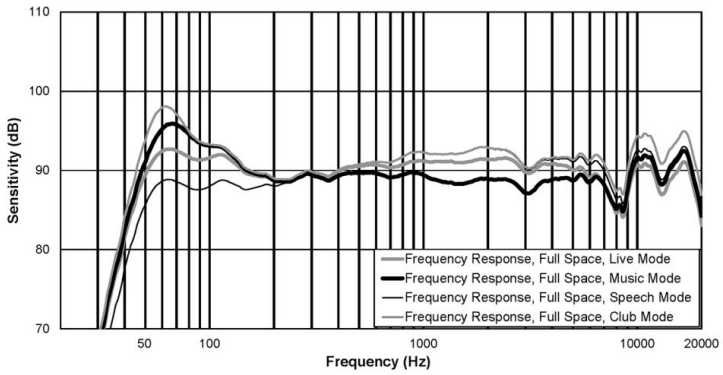
High Midrange = 1200 – 2400Hz

Lower Highs = 2400 – 4800Hz

Upper Highs = 4800 – 20,000Hz

Note: There are different versions of how to divide up the Frequency range into different size groups. We chose a "7-Groups" version.

Frequency response:



This is a screenshot of a Frequency Response Curve of an ElectroVoice "Evolve 50M" speaker system. When you adjust an equalizer, you are basically changing the Frequency Response of the sound system. Use Caution.

There are different types of Equalizers (EQs) used in audio systems, but these are the two most popular used in setting up sound systems, monitor systems, and recording. There is more info on the following pages.

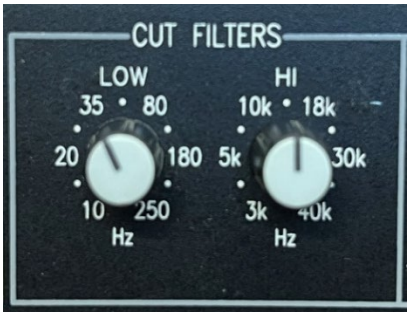
- **→ Graphic EQs – Use separate sliders for the individual frequencies. Great for live sound, monitor mixes, tuning a room, very easy to set up and use.**
- **→ Parametric EQs – Allows the user to select, move, and adjust (boost or lower, remove) frequency bands. Most versatile of all the EQ types, and mainly used in music production, studios, live performances, etc.**

What are Filters?

Every Equalizer uses filters in order to cut, boost, and shape the audio signals passing through it. There are different types of filters – the most common are Low Pass Filters (LPF), High Pass Filters (HPF), Notch Filters, Bell Filters, Bandpass, and Shelf Filters, to name a few. We will only cover a few of these filter types in this booklet – High and Low pass filters, Bandpass, and Notch Filters (the ones you need to be familiar with as a beginner audio technician). We will also explain some EQ basics, such as Q, Slope, and how Equalizer adjustments can affect the "Gain" of an audio signal. Filters can sound confusing and intimidating at first, so we will keep it as "simplified" as possible while still trying to ensure that the reader understands the concepts.

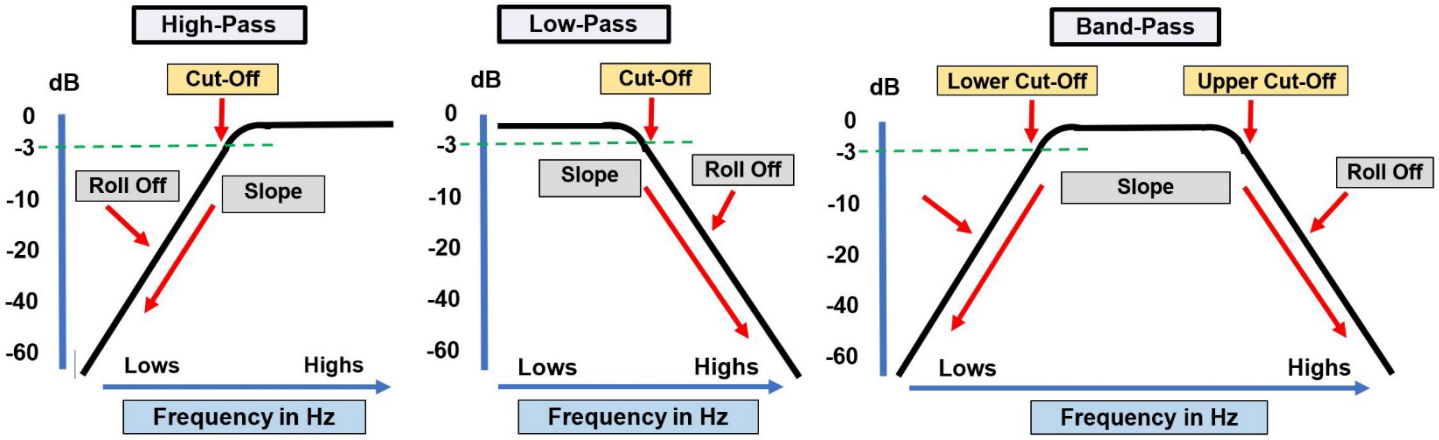
High Pass Filter (or Low-Cut Filter) – A High Pass Filter passes High Frequencies and "attenuates" the Low Frequencies below the "Cut-Off" Frequency point. There is some lingering confusion here because when you need to "Cut" some low frequencies, you would use a High-Pass Filter (which is also technically called and referred to as a "Low-Cut" filter). Both terms are used to get the same result. Make sure you understand the references noted above.

Low Pass Filter (or High-Cut Filter) – The opposite can be said regarding a Low-Pass Filter which will pass Low Frequencies and "attenuate" the High Frequencies below the "Cut-Off" point. Again, if you need to "Cut" some high frequencies, you would use a Low-Pass Filter (which is also technically called and referred to as a "High-Cut" filter). Similarly, these terms are both used to get the same result. Make sure you understand the references noted above.



Typical Low and High Cut Filters on a Mixing Console.

Band Pass Filter – This type of filter removes (or attenuates) a specific range (band) of frequencies below or above a center frequency. A Bandpass filter can actually be thought of as a combination of High-Pass and Low-Pass filters. This type of filter is "controlled" by a High and a Low setting (Cut-Off).



Roll Off is in dB / Octave

Cut-Off Attenuation is -3dB

Example of a typical 100Hz High-Pass Filter on a mixing board (shown right). When you press this switch, it activates a "steep" 18dB per Octave filter that attenuates the level of the Low-end frequencies only (Bass). This filter is mainly used in Live Sound situations to help "clean up" a mix – such as reducing stage rumble or even popping from microphones.

What is Slope? Slope is commonly used interchangeably with "Roll Off." Slope references how fast "attenuation" occurs by a filter once the frequencies pass the selected "Cut-Off" point. Slope is measured in dB / Octave (decibels per octave). Typical filter slopes are 6dB, 12dB, and 24dB.

Notch Filters – A type of filter that removes a single frequency or a very narrow band of frequencies, and has a very high "Q" value (narrow bandwidth). You will find Notch Filters on most larger Mixing Board input channels.

Equalizer Gain – This is the amount of "Cut" or "Boost" you use when setting up your EQ. The main point that you need to remember regarding EQ Gain is that it will affect the "overall" levels (gain) of the sound system.

What does "Q" Mean?

"Q" is short for "Quality Factor" as it relates to Equalization. It is the "width" of an EQ band that you adjust – the ratio of center frequency to bandwidth. When adjusting a "wider" area band of frequencies, it means a lower Q Value. These Lower Q Values allow a boost or a cut in a wider range of frequencies. When adjusting a "narrower" area band of frequencies, it means a higher Q Value (narrower bandwidths). Narrow bandwidth is ideal for removing (notching out) unwanted tones and for boosting pleasing / desired tones. While the subject of "Q" can continue, our goal is to ensure that you understand the concept. As a technician, you will most likely not be dealing with "Q" a whole lot. On the other hand, a Sound Board Operator must understand "Q" and how it affects their "mix." And that usually takes years and years of hands-on training.

Graphic / Parametric Equalizers – A Few Basics

Graphic Equalizers

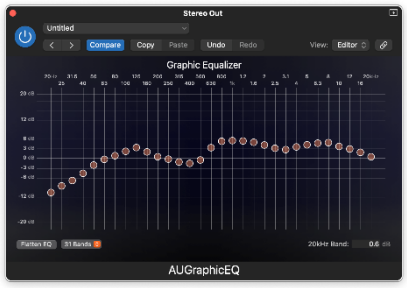
Graphic Equalizers can have anywhere between 3 and 31 "sliders" (faders) and each of these sliders will represent certain frequency ranges. The most used variations of Graphic Equalizers are:

- **10 Sliders, One-Octave – Is an Equalizer with 10 Sliders for frequencies on a one-octave basis. The "center" frequencies are one octave apart. Each adjustment you make will affect a whole octave of frequencies. See image on page 34.**
- **15 Sliders, 2/3 Octave – Is an Equalizer utilizing 15 Sliders for frequencies in 2/3rd octave increments between bands. See image on page 34.**
- **31 Sliders, 1/3 Octave – An Equalizer with 31 Sliders for frequencies in 1/3rd octave increments between bands. Dual 31 Band Shown below.**

→ Graphic EQs are great for live performances, and to identify and remove frequency's causing feedback.

→ Graphic EQs are also used for "tuning" a venue. One of the most important points to remember regarding adjusting a Graphic EQ fader (up or down) is that it will also affect neighboring frequencies as well. This type of EQ is usually less expensive than a Parametric EQ, and is the easiest to set up, learn and operate.

The Equalizer above is a Dual Channel 31 band Graphic EQ. If you are using Stereo (Left / Right) outputs from your Mixing Board, the Mixing Boards "Left" output would go to the Channel 1 input of the EQ, and the Mixing Boards "Right" output would go to the Channel 2 input of the EQ. Typically the EQ's Channel 1 and Channel 2 outputs would feed the Power Amplifiers Channel 1 and Channel 2 inputs (See last page).



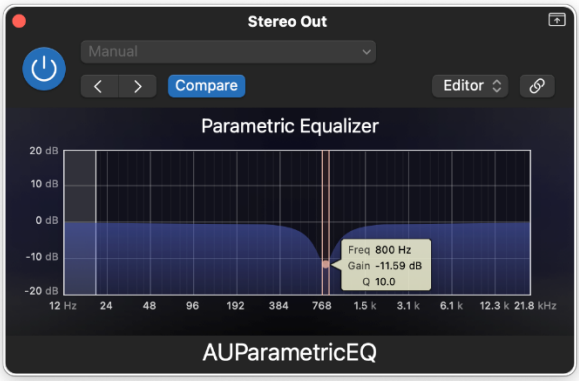
This is a screenshot of a "Digital" Graphic Equalizer used in a DAW (Digital Audio Workstation). The above image is from a popular Apple DAW called "Logic Pro"

Parametric Equalizers

This type of EQ is widely used for recording and live sound and is more "involved" than Graphic EQs. Parametric EQs are more versatile and offer more "precise control" than a Graphic EQ. A Parametric EQ allows the user to control each frequency bands amplitude, bandwidth, and center frequency (control over the Q). You can make gain adjustments and control bandwidth/sloping that affects neighboring frequencies. You get way more control over the equalization of the audio signal than you do with a Graphic EQ. Parametric EQs can take sound board operators and studio engineers years to master. As an audio technician, you need to understand the basic operation/connectivity of a Parametric EQ. This will ensure you're in a good position to troubleshoot any EQ issues, verify if the EQ is working correctly, and replace the EQ when needed.

2 – Channel Parametric Equalizer (Small Scale)

These are just a few of the different EQs and Filters you will encounter as an Audio Technician. It would be very beneficial for any Audio Technician to do further research and training on as many types of Equalizers as they can get their hands on. Learning how to set up a sound system and be able to "EQ" and "Tune" a room (system) would also be a "valuable" skill set to acquire. The more you know, the more indispensable you become to your team, job, and boss!



This is a screenshot example of a Parametric Equalizer used in a DAW. This screenshot is from the Apple DAW "Logic Pro"

Important Equalization Notes

→ There's no amount of equalization that can help a poorly designed sound system (or room) that has reverberation and delay issues, excessive background noise, distortion evident in your system, poor quality music tracks (stems), vocalist singing out of tune, musicians that have tuning or tone issues or playing wrong notes or in the wrong key, or if someone is giving a speech at a podium and standing way too far from the microphone.

→ Keep in mind that during "Live Performances" your ears will "De-Sensitize" as the night goes on.

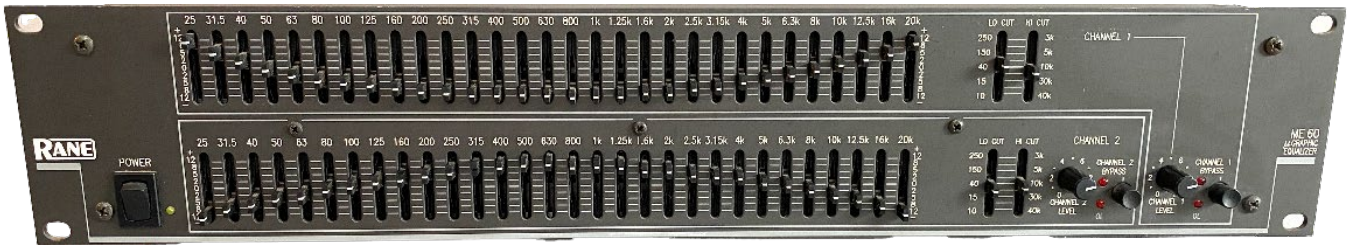
→ You cannot fix poor low frequency issues due to the speakers being "out of phase" with equalization – this can damage the speakers. Equalization cannot correct polarity / phase issues.

Here are some proper / proven ways to approach equalization

a) **Use Subtractive EQ** [Video Clip!] **– If there's too many highs, don't turn up the bass, turned down the highs.**
b) **All adjustments should be small, once an adjustment is made, sit back and listen to the adjustment before making the next adjustment, and so on. Listening is a very important aspect of proper Equalization.**
c) **There is a cutoff point with equalization – there is only so much equalization that a sound system can take before the system's sound quality starts suffering and sounds worse than when you started.**
d) **Feedback – There are a few ways to deal with feedback with the first approach being to turn down the fader on the channel that seems to be the culprit (use this approach as a quick, temporary fix). Once you stop the feedback from annoying everyone in the audience – you can now start to troubleshoot further.**

- **Is the microphone too close or in front of the speakers? Move the microphone!**
- **Is the singer too far away from the microphone? Tell the singer to get closer to the microphone!**
- **Is the talker or singer projecting at an unusually low level? Ask them to talk or sing louder or you should look for a microphone that is more sensitive than the one you are using.**
- **Is the monitor speaker in the proper orientation for the type of microphone being used? Move the monitor as close into the microphone's "rejection" area as possible (refer to the microphone's documentation). Note: Sticking a monitor on stage where-ever you want to is not how it's done (See bottom of Page 52).**
- **Is there an open microphone that should be muted? Mute the open microphone!**

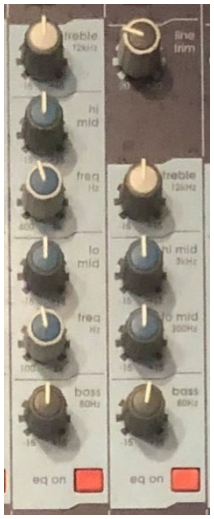
Remember – small changes are always the best approach with Channel EQs, and you also need to keep in mind that there is a point at which the sound systems quality will start degrading if you are not careful.



The "Smiley Face" and "Sad Face" EQ Strategy: In the image above, you will notice that Channel 1 (top half) sort of has a "Smiley Face" pattern going on. Channel 2 (lower half) has a "Sad Face" pattern. I cannot count how often these "canned" patterns were used by the so-called Audio Professionals I have dealt with over the years. I would spend hours working on the main EQ for the house system with an RTA (Real Time Analyzer) and pink noise. When finished - I've had several "Audio Pros" walk in afterward and change the EQ settings to either a Smiley or Sad face and think it's better! I've included this example to make a point – there's a right way to EQ and a wrong way to EQ a system. Walking in and changing 4-5 hours' worth of EQ work without listening to the system is not the way to approach system EQ. Everyone will hear the system differently, and we should understand that Equalization can be a very "subjective" process! My point is that no "one setting" works for all audio systems when it comes to Equalization. You want the "Main" system EQ to be as "Flat" as possible (then leave it alone), then only adjust the EQs on the individual Mixer channels as needed.

Tech Tip: The best way to develop expertise and knowledge regarding audio systems is to listen! Use your Ears! Levels need to change as audiences become larger and smaller. Don't ever settle with "canned" adjustments (which means marking the Mixing Board and setting the fader to the same mark every time). Adjust with your Ears to what's going in the audience right now! In Real Time!

Equalization Notes - Other



Typical Equalizers used on various Mixing Boards (small-scale and / or large-scale Mixing Boards) that you may come across.

Typical Tone Controls used on various Guitar, Bass, and Keyboard instrument amplifiers.

These are screenshot examples of Channel Equalizers used in a DAW (Digital Audio Workstation). The above screenshot is from the Apple DAW called “Logic Pro”

This is a screenshot example of a 10-Band Equalizer used in a DAW (Digital Audio Workstation). The above screenshot is from the Apple DAW “Logic Pro”

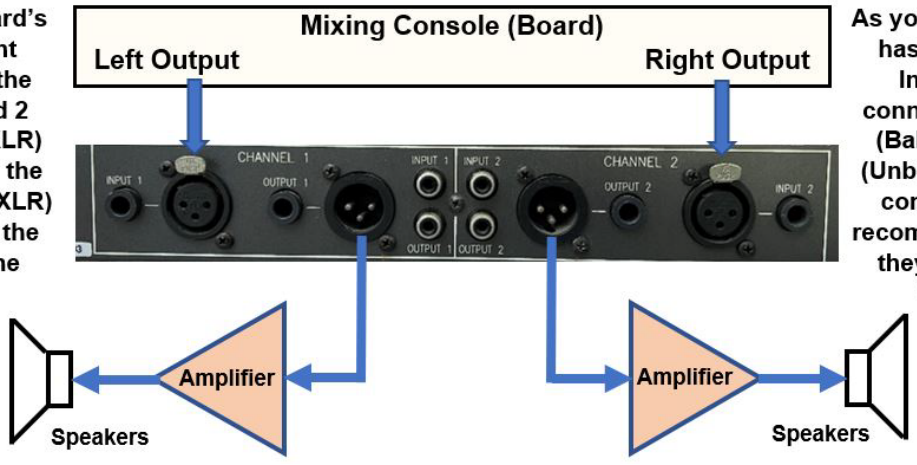
10 Band / 15 Band Equalizers Each type of EQ can work great for a specific application. EQ selection can be a very “subjective” process as each audio guru / musician has their own set of ears and understands what they are looking for. Which EQ do you need? It depends!

Dual 15 Band Graphic Equalizer

15 Sliders, 2/3 Octave Per Side – This type of EQ is easier to use than a 31 Band, but will not give you the same ability to reduce feedback or tune a room as efficiently as you can with a 31-Band EQ.

Typical Graphic Equalizer (Outboard unit) connection from Mixing Console all the way to the speakers.

The Mixing Board’s Left and Right Outputs feed the Channel 1 and 2 “Inputs” (Ex: XLR) on the EQ, and the “Outputs” (Ex: XLR) of the EQ feed the “Inputs” to the Amplifiers.



As you can see – The EQ has several different Input and Output connections. XLR, TRS (Balanced), and RCA (Unbalanced). The RCA connections are not recommended for use as they are Unbalanced Connections.

I spent a reasonable amount of time on this Equalizer section, and there is enough basic information here for a beginner Audio Technician to get started (and survive). I wanted to ensure that the reader understands that an Equalizer is a significant piece of the puzzle regarding the overall sound quality of a final mix. Whether it’s Live Sound, installed systems, outdoor systems, theater systems, a two-piece band, or just one instrument – Equalizers can “make or break” the overall quality presentation for the listening audience.