# Technically Speaking

## Equalizers

You are about to speak when a high pitched squeal, eminating from your sound system, sends the audience scrambling to cover their ears.
- Or
You have been able to hear and understand everything that was being said from the wired microphone until the speaker decides to exercise the new found freedom afforded him by his new high tech wireless microphone system and he steps away from the lectern - suddenly the sound becomes thin and undistinct.
- Or
Your sound system sounded great at the last event but when you moved it to your new larger facility it became muddy and was hard to understand.

You could be the perfect candidate for an equalizer. There are however many things that an equalizer will not fix. It is only one tool in the audio arsenal and it is designed solely to adjust the amplitude (volume) of a specific frequency (tone or note.) This can be a difficult thing to explain on an entry level without writing a 12 chapter book, or a made for TV mini-series, so what I have set out to do is shed some light on a somewhat complex topic.

There are many different types of equalizers that are used for a wide variety of applications. Equalizers will range from simple "tone controls" (bass and treble) which you will find on almost every record player or Hi-Fi system to the more sophisticated types of equalizers, such as the graphic or parametric. An equalizer can place a great deal of flexibility at your fingertips. When used properly equalizers are excellent tools, but they are often misused and provide less than desirable results. To help determine if you need an equalizer, as well as which type to consider, it is very helpful to have an overview of equalizers: how they work, the various types available, which types are best suited for various applications, and some simple guidelines for their use.

If you are using audio equipment and desire to hear something louder, you turn up a level (volume) control. When such a control is adjusted for a louder level, the level of all audible frequencies (entire audible frequency spectrum) is increased by the same amount. This simple level control is no respecter of frequencies; turn it up and the result is an audible increase in overall loudness (over the entire audible frequency range). However, when you turn up the "bass control" on a record player, only the low frequencies are increased in level, which will usually make the sound richer and fuller. When you turn down the "bass control", low frequencies are decreased, and the sound is usually thinner or even tinny. When you turn up the "treble control", high frequencies are increased, and the sound becomes bright or brilliant; turn it down and the sound will be dull and sometimes even muddy. These common bass and treble controls are "equalizers". In simple terms, an equalizer is a volume control (to increase or decrease level) for specific frequency ranges. To further expand our understanding, let us take a close look at frequencies and the audible frequency spectrum.

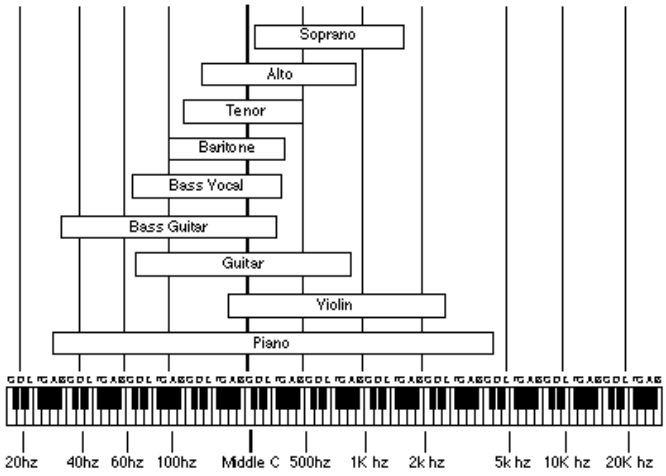
**Frequencies -** Sound is made up of vibrations. These vibrations are referred to as "cycles". The number of these vibrations (cycles) that take place in one second are referred to as "cycles per second". One vibration (cycle) in one second would be called one cycle per second. 15,000 vibrations in one second would be 15,000 cycles per second. The number of cycles per second determine the actual frequency (pitch) of any audible sound. For those who are musicians, concert "A" is 440 cps (cycles per second).

**Frequency to musical note Chart**

| Hz | Note |
|---|---|
| 27 | A |
| 30 | B |
| 32 | C -3 |
| 36 | D |
| 41 | E |
| 43 | F |
| 49 | G |
| 55 | A |
| 61 | B |
| 65 | C -2 |
| 73 | D |
| 82 | E |
| 87 | F |
| 98 | G |
| 110 | A |
| 123 | B |
| 130 | C -1 |
| 146 | D |
| 164 | E |
| 174 | F |
| 196 | G |
| 220 | A |
| 246 | B |
| 261 | Middle C |
| 293 | D |
| 329 | E |
| 349 | F |
| 392 | G |
| 440 | A |
| 493 | B |
| 523 | C +1 |
| 587 | D |
| 659 | E |
| 698 | F |
| 783 | G |
| 880 | A |
| 987 | B |
| 1046 | C +2 |
| 1174 | D |
| 1318 | E |
| 1396 | F |
| 1567 | G |
| 1760 | A |
| 1975 | B |
| 2093 | C +3 |
| 2349 | D |
| 2637 | E |
| 2793 | F |
| 3135 | G |
| 3520 | A |
| 3951 | B |
| 4186 | C +4 |

For many years the term "cps" (cycles per second) was commonly used in the music and audio industries. In recent years the term "cycle" was substituted for another term called "Hertz", abbreviated "Hz". Hertz (Hz) is the unit of measure of frequency (cycles per second). One Hertz is one cycle per second. The range of human hearing is usually considered to be from 20 to 20,000 Hz for a person with very good hearing. When frequencies are in the thousands of Hertz, they are often indicated with a "k" (designating thousand) prior to the symbol Hz. Therefore, 20,000 Hz would be indicated as 20 kHz.

**Know the fundamental frequencies of voices and musical instruments -** It is possible to equalize the sound of an instrument or voice and not obtain the desired effect - if any effect at all. This is usually due to the fact that the boosting or cutting occurred at frequencies above or below the dominant energy of that voice or instrument. If you are to utilize equalizers effectively, you must know what frequency ranges can be equalized. For this purpose the chart is shown in figure below may be used. It is important to point out that the information on this chart only applies to the fundamental frequencies. All musical sounds have harmonics which will go beyond the frequency ranges shown below.




These harmonics affect the sound of voices and instruments; however, they are usually much lower in level than the fundamental frequency. At times good effects can be obtained by boosting or cutting in the frequency range of these harmonics rather than in the frequency range of the fundamental frequency. In any case, it is preferable to always start your equalization in the fundamental frequency region. If you do not like the sound, try equalizing at surrounding frequencies until you get the desired effect.
When using a mixer with simple bass and treble controls, only the low and high frequencies of the voice can be equalized. Often the low frequency sections of such equalizers will have little if any effect on female vocals because they are above the equalizer's effective frequency range. However, this low frequency control will usually prove quite effective on male vocals. One must be careful with the amount of treble correction that is used because the high frequency section of basic two knob equalizers are most effective in the 5 kHz region or above. Excessive equalization of vocals (male or female) in this frequency range will increase the amount of sibilance in the voice and will usually cause a "spitting" or "hissing" sound when the singer pronounces words with the letter's". If a vocalist has an excessive amount of sibilance even when not using equalization, an equalizer can also cure this problem. Try cutting in the 4 kHz to 7kHz region to reduce the undesired effect. However, you must not use too much cut in as it can sometimes cause a dramatic loss in the presence of the voice. A great deal of presence can be added to vocals with the use of mid-range equalization (boost) usually in the 1 kHz to 3 kHz region (depending upon the particular voice). Again, one must be careful because too much boost in this frequency range can cause excessive amounts of sibilance. The boosting of lower frequencies in the 500 Hz to 800 Hz frequency range will often add a warmth to the sound of a vocal. The boosting of frequency

ranges that are either above or below the frequency range of the voice will rarely have any audible effect and will often cause the *unwanted* sounds of other instruments (which are in that frequency range) to be picked up by the vocal microphone.

**Room Control -** Equalizers can be used between mixers and power amplifiers in environments such as recording studios, auditoriums, listening rooms, and theaters, to contour the overall frequency response of a speaker system within a room. In professional installations where a real-time analyzer (a piece of test equipment used to show the total energy present at all frequencies on an instantaneous basis) is available, the frequency response can be measured to determine what equalization will be needed to obtain a desirable frequency response. Even though the speaker system may produce an acceptable response alone, the room usually modifies the response and creates peaks and dips in various frequency ranges. A graphic equalizer can remove many of these peaks and dips by boosting and cutting in the appropriate frequency ranges. The 1/3 octave graphic equalizer is a popular choice for this application because of its large number of available frequencies. In most cases where a real-time analyzer is not available, another analyzer can be used - the ear. One approach is to play recorded music you are familiar with through the system and adjust the equalizer for the desired sound. When the "EQ" is adjusted for the best sound, just be sure that no portion of the audio spectrum is given an extreme amount of boost or cut. Note as a special case that attempting to boost the output below the speaker system's low frequency capability will not produce much improvement and may cause damage to the woofer due to excessive excursion.

**Feedback Reduction -** Another popular use of graphic, parametric, or paragraphic equalizers is to reduce feedback in sound reinforcement or stage monitoring systems. One method of achieving this is to make a sound check with all the "EQ" controls set flat. After a good mix is obtained, slowly increase the system gain until feedback or ringing begins to develop. When feedback occurs, it will often initially start in one portion of the frequency spectrum. The frequency range at which feedback will initially occur varies, depending upon the equipment used and the particular acoustical environment. The frequency at which the system is ringing, or beginning to feedback, may be reduced by lowering or cutting the appropriate frequency band of the equalizer. Which frequency band? It will be necessary to search for the correct one. The ringing will diminish when you adjust its corresponding frequency band - you will know when you find it. Now the overall sound level of the sound reinforcement system can be increased until feedback occurs again, when the same procedure is repeated. When the process is done several times, there will be a number of frequency ranges that have been "cut" (usually only by a few dB). This will now give the sound reinforcement or monitor system the ability to generate a higher sound level before reaching feedback. The operator must be careful because cutting the frequency response at these various frequencies places audible holes in the frequency spectrum. Sometimes after this procedure is done, things just don't sound right. It is often necessary to utilize smaller amounts of cut to enable the sound system to sound natural. This method of acoustic feedback suppression is a process of trial and error, and one of compromise (amount of additional gain before feedback versus the overall audible quality of the system).

**Do not use equalization to excess -** Equalizers give you the ability to change the frequency characteristics of instruments and vocals, but excessive amounts of equalization can make things sound very strange. This can be useful only when you desire an unnatural or freaky effect. When equalization is used in the boost mode, you are making certain frequency ranges louder, and this will reduce the amount of available headroom in your mixer or audio system, which can lead to distortion. This does not mean that using an equalizer will usually cause distortion, but that excessive equalization can in some instances cause problems. Equalizers, when used properly, are valuable tools providing that they are used with care and moderation. Take the time to know the frequency content of the various musical instruments and voices. Spend time working and experimenting with your equalizer to become more familiar with it and the effects that can be obtained.