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## The Equalization Primer

(The Complete Lesson On Getting Started With EQ)

by Robert Dennis

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### Definitions/Explanations:

Equalization is the increase or decrease of signal strength for a portion of (a band of) audio frequencies. The audio we record (the sound made by instruments or voices) is *complex*. By this we mean that it is composed of energy at different audio frequencies. If we take a bass control (a simple equalizer) and turn the knob clockwise, we will get an increase in strength of the signal (or the signal component) that has lower frequencies (usually any component below about 500 Hz). Thus equalization effects the tone because it changes the level relationship of the [fundamental](#) and [harmonic](#) frequencies.

A Shelf Equalizer boosts (or reduces) energy at the set frequency *and all audio frequencies above it (a high-frequency self control) or all audio frequencies below it (a low-frequency shelf control)*.

A Peak Equalizer boosts (or reduces) at the set frequency and a band of frequencies close to the set frequency.

The "Q" control sets the width of the band of frequencies that will be boosted or reduced; in other words it affects the amount of frequencies around the center frequency which will have a similar amount of boost or reduction. The width of the band is given in octaves. Q affects this width, but high Q numbers mean a narrower band of frequencies will be affected. To start, you will need to be able to identify the "Q" settings that go as narrow as 1/2 octave to as wide as 2 octaves. The conversion chart below relates Q settings to bandwidth.

Q Setting	Bandwidth
0.7	2 Octaves
1.0	1 1/3 Octaves
1.4	1 Octave
2.8	1/2 Octave

The amount of boost or cut is determined by the "dB" setting of the equalizer. Most equalizers can boost or reduce energy by 12 dB (up to 4 times/one-quarter the level). Some equalizers can boost or reduce up to 15 dB.

### Tips/Guidelines on determining Shelf/Peak/Q & Amount of EQ:

1	Shelf equalizers are good for general tone changes in the bottom or top three octaves of the audio frequencies. Thus a low-frequency shelf control could be used effectively at 320 Hz or below and a high frequency shelf control at 2500 Hz or higher.
2	Shelf equalizers are best used for reducing rather than boosting energy. The very top octave (10 kHz - 20 kHz) often has more noise component (hiss) than useful sound. The same is true for the lowest octave (20 Hz to 40 Hz) except the noise is rumble rather than hiss. When boosting for general increase in brightness or general increase in bass, use a peak equalizer.  <b>Suggested settings:</b> For general increase in brightness, boost 5 kHz with a 2

	octave bandwidth ( $Q=0.7$ ). For general increase in bass, boost 80 Hz with a two octave bandwidth ( $Q=0.7$ ).
3	The Q setting of 1.0 (1 1/3 octaves), I call the "Magic Q". In general this is a bandwidth that matches how the different instruments cover the different frequency ranges of audio. For more percussive instruments (such as drums), you can narrow the bandwidth with Q settings as high as about 2.8. For more melodic instruments, such as voices and stringed instruments, you can broaden the bandwidth down with Q settings as low as 0.7.
4	In general, boost less and cut more. The ear is accustomed to hearing reduction in energy in a band (due to sound-absorbing material for instance), thus the ear will hear a boost easier than a cut (a reduction). In general, a 6 dB boost is about as apparent as a 9 dB reduction. When equalizing during mixing try to reduce unwanted frequencies more than you boost desired frequencies. This will result in "clarity" with less "falseness" to the sound. If you look at a console after a mix that has been done by an experienced engineer, you will find more reduction settings than boosting settings.
5	Equalization is all too often misused to compensate for poor level settings. If you find you want your settings to be more than 6 dB boost, investigate and see if a readjustment of levels could help, reducing the amount of boost at the equalizer.  <i>Training hint: I recommend to someone new to use the "6 dB rule" - Never, while recording or mixing, boost more than 6 dB with the equalizer, period for the first 50 mixes you do.</i>

## Recommended Frequencies - Expanded

Use the following Recommended Expanded Frequencies Chart as a starting point.

FREQUENCY:	USES:
50Hz	<ol style="list-style-type: none"> <li>Increase to add more fullness to lowest frequency instruments like foot, toms, and the bass. <b>Peak equalization with a 1.4 Q.</b></li> <li>Reduce to decrease the "boom" of the bass and will increase overtones and the recognition of bass line in the mix. This is most often used on loud bass lines like rock. <b>Shelf equalization.</b></li> </ol>
100Hz	<ol style="list-style-type: none"> <li>Increase to add a harder bass sound to lowest frequency instruments. <b>Peak Equalization with a Q of 1.0 to 1.4..</b></li> <li>Increase to add fullness to guitars, snare. <b>Peak Equalization with a Q of 1.0..</b></li> <li>Increase to add warmth to piano and horns. <b>Peak Equalization. For piano use a Q of 1.0. With horn use a Q of 1.4..</b></li> <li>Reduce to remove boom on guitars &amp; increase clarity. <b>Peak Equalization with a Q of 1.0 to 1.4..</b></li> </ol>
200Hz	<ol style="list-style-type: none"> <li>Increase to add fullness to vocals. <b>Peak Equalization with a Q of 0.7 to 1.0..</b></li> <li>Increase to add fullness to snare and guitar (harder sound). <b>Peak Equalization with a Q of 1.4.</b></li> <li>Reduce to decrease muddiness of vocals or mid-range instruments. <b>Peak Equalization with a Q of 1.0.</b></li> <li>Reduce to decrease gong sound of cymbals. <b>Peak Equalization with a Q of 1.0.</b></li> </ol>
400Hz	<ol style="list-style-type: none"> <li>Increase to add clarity to bass lines especially when speakers are at low volume. <b>Peak Equalization with a Q of 1.0.</b></li> <li>Reduce to decrease "cardboard" sound of lower drums (foot and toms). <b>Peak Equalization with a Q of 1.4.</b></li> <li>Reduce to decrease ambiance on cymbals. <b>Peak Equalization with a Q of 0.7 to 1.0. Alternately try a shelf EQ with a 320 Hz frequency setting.</b></li> </ol>
800Hz	<ol style="list-style-type: none"> <li>Increase for clarity and "punch" of bass. <b>Peak Equalization with a Q of 1.4.</b></li> <li>Reduce to remove "cheap" sound of guitars. <b>Peak Equalization with a Q of 1.0.</b></li> </ol>

<b>1.5KHz</b>	<ol style="list-style-type: none"> <li>1. Increase for "clarity" and "pluck" of bass. <b>Peak Equalization with a Q of 1.4.</b></li> <li>2. Reduce to remove dullness of guitars. <b>Peak Equalization with a Q of 1.0.</b></li> </ol>
<b>3KHz</b>	<ol style="list-style-type: none"> <li>1. Increase for more "pluck" of bass. <b>Peak Equalization with a Q of 1.4.</b></li> <li>2. Increase for more attack of electric / acoustic guitar. <b>Peak Equalization with a Q of 1.4.</b></li> <li>3. Increase for more attack on low piano parts. <b>Peak Equalization with a Q of 1.0.</b></li> <li>4. Increase for more clarity / hardness on voice. <b>Peak Equalization with a Q of 1.0.</b></li> <li>5. Reduce to increase breathy, soft sound on background vocals. <b>Peak Equalization with a Q of 1.0.</b></li> <li>6. Reduce to disguise out-of-tune vocals / guitars. <b>Peak Equalization with a Q of 1.0.</b></li> <li>7. Increase for more attack on the snare or other drums. <b>Peak Equalization with a Q of 1.4 to 2.8.</b></li> </ol>
<b>5KHz</b>	<ol style="list-style-type: none"> <li>1. Increase for vocal presence. <b>Peak Equalization with a Q of 1.0.</b></li> <li>2. Increase low frequency drum attack ( foot / toms). <b>Peak Equalization with a Q of 1.4 to 2.8.</b></li> <li>3. Increase for more "finger sound" on bass. <b>Peak Equalization with a Q of 1.4.</b></li> <li>4. Increase attack of piano, acoustic guitar and brightness on guitars (especially rock guitars). <b>Peak Equalization with a Q of 1.4.</b></li> <li>5. Reduce to make background parts more distant. <b>Peak Equalization with a Q of 1.0.</b></li> <li>6. Reduce to soften "thin" guitar. <b>Peak Equalization with a Q of 1.0.</b></li> </ol>
<b>7KHz</b>	<ol style="list-style-type: none"> <li>1. Increase to add attack on low frequency drums ( more metallic sound ). <b>Peak Equalization with a Q of 1.4 to 2.8.</b></li> <li>2. Increase to add attack to percussion instruments. <b>Peak Equalization with a Q of 1.4 to 2.8.</b></li> <li>3. Increase on dull singer. <b>Peak Equalization with a Q of 1.0.</b></li> <li>4. Increase for more "finger sound" on acoustic bass. <b>Peak Equalization with a Q of 1.4.</b></li> <li>5. Reduce to decrease "s" sound on singers. <b>Peak Equalization with a Q of 2.8.</b> <b>Sweep frequency slightly (between 7 kHz and 8 kHz) to find the "exact" frequency of the S</b></li> <li>6. Increase to add sharpness to synthesizers, rock guitars, acoustic guitar and piano. <b>Peak Equalization with a Q of 1.0 to 1.4.</b></li> </ol>
<b>10KHz</b>	<ol style="list-style-type: none"> <li>1. Increase to brighten vocals. <b>Peak Equalization with a Q of 1.0.</b></li> <li>2. Increase for "light brightness" in acoustic guitar and piano. <b>Peak Equalization with a Q of 1.0.</b></li> <li>3. Increase for hardness on cymbals. <b>Peak Equalization with a Q of 1.4.</b></li> <li>4. Reduce to decrease "s" sound on singers. <b>Peak Equalization with a Q of 1.4.</b></li> </ol>
<b>15KHz</b>	<ol style="list-style-type: none"> <li>1. Increase to brighten vocals (breath sound). <b>Peak Equalization with a Q of 1.0.</b></li> <li>2. Increase to brighten cymbals, string instruments and flutes. <b>Peak Equalization with a Q of 1.0.</b></li> <li>3. Increase to make sampled synthesizer sound more real. <b>Peak Equalization with a Q of 1.4 to 2.8.</b></li> </ol>

## Frequency Octaves

Use the description of octaves to determine where you want to set your equalizer's frequency control. Click [here](#) to open the description in another browser window.

## Equalization Techniques

<b>1 Boosting Harmonic Frequencies</b>	
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Boosting harmonics is one of the first techniques an engineer learns to increase clarity and distinction on instruments. This is a very valid method of equalizing. Some of the suggested equalizer settings from equalization frequency chart used these techniques:

Instrument	Frequency	Description
Bass	400 Hz	"Increase to add clarity to bass lines..."
Bass	1500 Hz	" Increase for 'clarity' & 'pluck..."
Guitar	3 kHz	"Increase to add attack..."
Guitar	5 kHz.	"Increase 'brightness..."
Vocal	5 kHz	"Increase for vocal presence."
Vocal	10 kHz	"Increase to brighten vocals."

Notice that there are at least two frequencies in the harmonic range of the above instruments that could be accented for "clarity" or "brightness"

## 2 Boosting Fundamental Frequencies

The boosting of fundamental frequencies is also one of the first things a new engineer tries, but boosting of fundamentals should be the last thing ever considered.

Accenting fundamental frequencies usually makes the instrument indistinct and muddy sounding. The fundamental frequencies of two instruments playing the same part are the same, therefore, accenting the fundamental of instruments playing the same part makes both instruments closer to sounding the same (indistinction). When two instruments are playing similar parts in the same key they also get indistinct when the fundamental of either instrument is boosted.

If an instrument sounds "thin" or "small" one can carefully boost fundamental frequencies to correct this. The microphone could have been poorly placed and/or the harmonics over-boosted with EQ. Another application for boosting fundamental frequencies would be to do so when an instrument was playing by itself (in solos etc.).

## 3 Reducing Fundamental Frequencies

Reducing fundamental frequencies in an instrument tends to accent all of the harmonics and is a good alternative to boosting harmonics. The method is most often used in rock recording but works well for all styles of music. This technique found its way to the suggested frequencies chart:

Instrument	Frequency	Description
Bass	40 Hz	"Reduce to decrease "boom" and increase recognition."
Guitar	100 Hz	"Reduce to decrease boom and increase clarity."
Vocal	200 Hz	"Reduce to decrease muddiness of vocals."

## 4 Complimentary Equalization

One of the hardest things to overcome in mixing is the hearing limitation known as masking. Masking is one sound covering up all or part of another sound because the frequencies of the two sounds are close. The sound that is slightly louder sort of "wipes out" the other sound.

The way this works with music is that one instrument will make the other instrument sound dull and indistinct. It is frustrating to both the novice and the experienced engineer that an instrument sounds so great by itself and so "lifeless" in the mix.

An equalizer is a "level control" for certain rangers of frequencies. When you boost a frequency with EQ, you are making the dialed up frequency louder than others (as well as

frequencies that are close to the frequency set on the equalizer). When you dip or cut with an equalizer you are reducing level of frequencies in that range.

When you have indistinct sound between two instruments, you can use a method called "complimentary equalization." The idea is to boost a certain frequency on one instrument and dip that same frequency on another instrument. This will get both instruments distinct, when properly done.

Some key conflicts that come up often in mixes include:

<i>Foot Drum Vs. Bass</i>	Dip between 350 Hz and 400Hz on the foot drum (to remove the "cardboard" sound) and increase the same frequency on the bass (to add bass presence).
<i>Lead Vocals Vs. Background Vocals</i>	Dip between 3 kHz and 4 kHz on the background vocals to give them an "airy" sound and increase the same frequency on the lead vocal.

When using this method you will be surprised that you get a lot of change with only a little amount of equalization. Use between 3 dB and 6 dB of boost and cut.

### A Typical Example:

The following example uses all of the techniques discussed. instrumentation is Drums, Bass, Electric Guitar, Keyboard with Lead and Background Vocals. "+" indicates boost and "-" indicates reduction at given frequency.

Instrument	EQ Settings	Notes
Foot	-6 @ 400 Hz +4 @ 5 kHz	Reduces box quality. Increases attack
Snare	+4 @ 7 kHz +2 @ 100 kHz	Increases snap. Adds fullness to high-tuned snare
All Drums	-4 @ 400 Hz +4 @ 15 kHz	Decreases ambiance & increases bass clarity. Increases cymbal sizzle.
Bass	-2 @ 50 Hz +4 @ 400 Hz +2 @ 1.5 kHz	Increase clarity of bass Adds clarity to bass line and recognition at low volume. Increases pluck and recognition.
Guitar	-4 @ 100 Hz +2 @ 3 kHz	Increases guitar vs. bass distinction. Increases attack ( 3 kHz needs much less boost once 100 Hz is reduced).
keyboards	+4 @ 5 kHz	Increases clarity & brightness.
Lead Vocal	+4 @ 10 kHz +2 @ 5 kHz ? @ 200 Hz	Brightens and adds presence. At 200 Hz, reduce 2 or 4 to add clarity to low vocals increase 2 or 4 to fill out high vocals.
Bkg. Vocal	-6 @ 5 kHz	Sets background back and increases lead vs. background distinction

This "textbook" EQ can't be expected to work on all sessions. On the right session, however, it would give a very natural sounding recording or mix with surprising clarity and punch. Notice that boosting two instruments at the same frequency was carefully avoided. Notice that reductions were generally larger than boosts.

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