

Equalization Demo

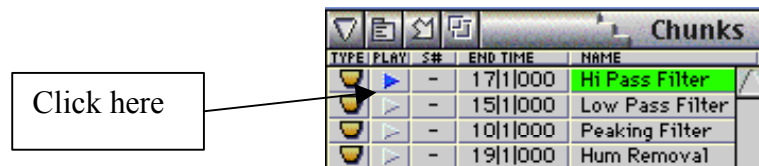
Parametric equalizers allow you to select the type, bandwidth, gain and cut off frequency for each filter circuit. There are three filter types available:

1. **High or low pass filters.** Since these passive circuits are true filters, they can only attenuate frequencies. The cut-off frequency and slope are adjustable.
2. **Shelving filters.** These active circuits are similar to the bass and treble tone controls found on consumer stereos. The adjustable parameters include the turn-over frequency and the amount of boost or cut.
3. **Peaking filters.** These circuits, which are sometimes called bell, band pass or notch filters, are only found in professional equipment. The adjustments include center frequency, bandwidth and gain. Bandwidth may be measured in octaves or as the ratio Q. These two measurement can be confusing because they seem contradictory: A peaking circuit 5 octaves wide is very broad while a filter with a Q of 5 is a rather narrow. The EQ plug-in in Digital Performer measures bandwidth in octaves, not Q. You'll be able to see the equalization curve change as you adjust the circuit's parameters.

The High Pass Filter

High pass filters remove unwanted rumble and low frequency noise. The first example contains a lot of traffic noise. Our goal is to remove as much as possible without thinning out the narrator's voice.

1. Click the play enable arrow next to the Hi Pass example in the Chunks Window.

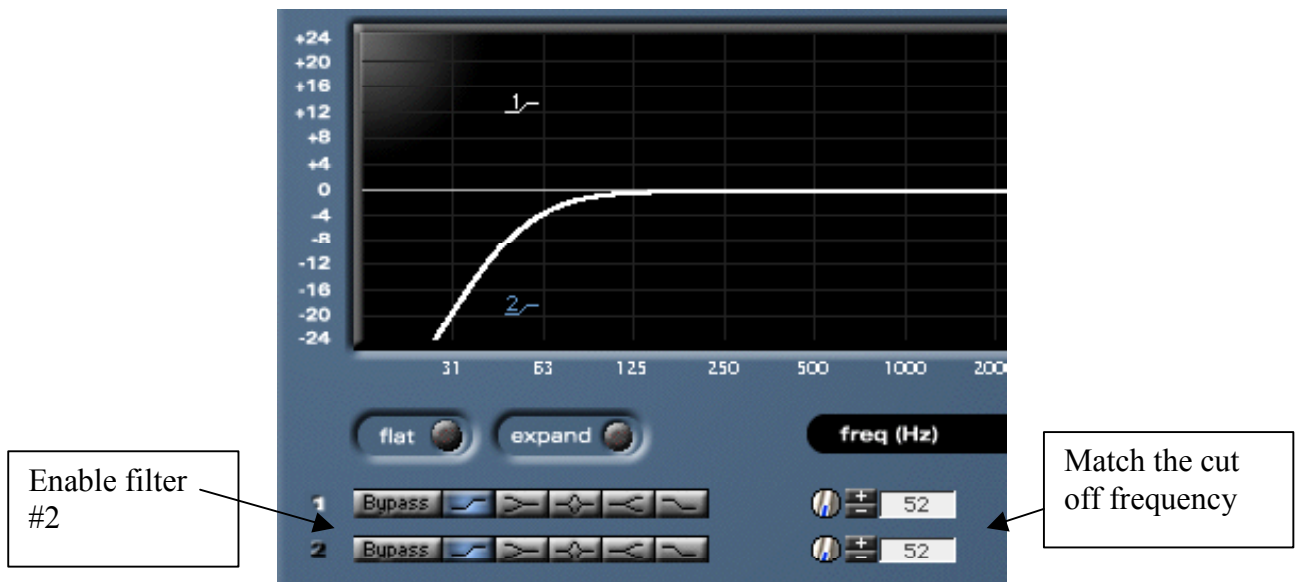


2. Press the space bar to play the example.
3. Slowly move filter #1 to the right until the narrator's voice begins to sound thin. Then bring it back until the voice sounds full again.



Question: What is the highest frequency you can use without thinning out the narrator's voice? ____ Hz.

4. You can add a second filter to make the roll off curve steeper. Enable filter #2 and match its cut off frequency to filter #1.



Nowadays, high pass filters are more important than ever. Unlike analog recorders, which cannot record below 30 Hz, digital recorders capture frequencies well below 10 Hz. Since few loud speakers reproduce sounds below 25 Hz, these very low frequencies simply waste amplifier power and may actually damage woofers.

Recording engineers often use high pass filters to keep drum leakage out of vocal mics, air conditioning noise out of room mics and reduce the proximity effect of cardioid and bi-directional mics.

The Low Pass Filter:

The low pass filter remove hiss and sizzle from recordings. The second example has the narrator buried in tape hiss. Our goal is to remove as much hiss as possible while maintaining the clarity of the narrator's voice.

1. Click on the play enable arrow next to the Low Pass Filter example.
2. Press the space bar to play the example.
3. Slowly lower Filter #1 to the left until you can't understand the words. Then, raise the filter until the voice is clear.

Question: What cut off frequency removed hiss without dulling the narrator's voice? _____ Hz.

4. As with the high pass filter, you can gang low pass filters together to make the roll off curve steeper. Enable filter #2 and match its cut off frequency to filter #1.

Shelving Filters

The bass and treble controls of your stereo are the simplest type shelving filters. With them you can adjust the amount of boost or cut but you can't change the frequency range affected. The shelving filters of Digital Performer have adjustable turnover frequencies so you can change their range as well as their gain. Bass shelving filters boost or cut all frequencies below the turn over frequency. Treble shelving filters boost or cut frequencies above the turn over frequency.

1. Play enable the example Shelving Filters
2. Press the space bar to play the music
3. Drag Filter #1 around the graph and listen to how it changes the mix. This is the Bass shelving filter.

Question: At what frequency does Filter #1 begin to affect the snare sound? _____ Hz.

4. Drag Filter #2 around the graph and listen to how it changes the mix. This is the Treble shelving filter.

Question: At what frequency does Filter #2 begin to affect the hi-hat sound? _____ Hz.

Peaking Filters.

Peaking filters also called ‘band pass’, ‘bell’, ‘notch’ or ‘midrange’ filters and they are the most adjustable of all filter types. You can change their center frequency, bandwidth and gain. The peaking filter example uses two variations of _____. Filter #1 has a moderately wide bandwidth of one octave; changing its gain affects many instruments in the mix. Filter #2 has an extremely narrow bandwidth of 1/10 octave, so it only affects a few frequencies. If these frequencies are not in the music, the filter will have little effect.

1. Play enable the example ‘Peaking Filter.’
2. Press the space bar to hear it play.
3. Enable Filter #1 by deselecting the Bypass button.
4. Drag the filter around the graph and listen to its affect on the mix.

Question: What center frequency and gain setting cut out most of the hi-hat? _____ Hz. _____ dB.
(Remember to put a positive or negative sign in front of the gain setting.)

Filters with a very narrow bandwidth are useful in removing unwanted resonances, ring and feedback in sound systems. In this example, though, we’ll explore some unusual characteristics of extremely narrow filters so we can better understand how they work.

1. Bypass Filter #1 and enable Filter #2
2. Press the space bar to hear the example play.
3. You should hear a steady ring or hum at a frequency of 110 Hz.
4. Stop the playback with the space bar. The ringing should continue for a second or two even after the music stops.

The filter’s center frequency is set to 110 Hz. The song you hear has lots of energy at 110 Hz because it is in the key of A minor. (A-110 is two octaves below the note A-440. The is the pitch instruments tune to.) You will hear this frequency ring during the song because the bass guitar is playing the note A-110.

The reason why the tone continues after the music stops is this: a side effect of boosting signal with extremely narrow filters is resonance. The circuitry needed to make the narrow bandwidth regenerates tones near the center frequency. (This is a type of feedback.) When the signal stops, the regeneration takes a few seconds to fade away. Let’s hear what happens when we tune filter to a frequency missing from the mix:

1. Lower the center frequency of Filter #2 to 91 Hz.
2. Play the example – you should hear very little ringing.
3. Stop the playback – any ringing you hear will be softer (and lower in pitch.)
4. Start playback
5. Click and drag slowly upward on the Center Frequency number box. (The numbers will



increase as you drag up.) Listen to how suddenly the ringing begins as you near 110 Hz.

You have probably guessed that other octaves of the note A are very strong in the mix. Let’s use a little math to figure out these frequencies. Complete the simple multiplication table below:

1. $110 \times 2 = 220$
2. $110 \times 4 = \underline{\hspace{2cm}}$
3. $110 \times 8 = \underline{\hspace{2cm}}$
4. $110 \times 16 = \underline{\hspace{2cm}}$
5. While playing the music, click and drag up in Filter #2's frequency box while listening for resonance.

Question: What frequencies resonated for you? Hz, Hz, Hz, Hz.

Your answer might have included other frequencies besides octaves of the note A. The frequency 330 Hz, for example, is also emphasized in the mix. This frequency, the third harmonic of A-110, happens to be the note E. (Harmonics of A-110 are frequencies such as 220, 330, 440 and so forth.)

Hum Removal

60 cycle hum is a common problem in the recording studio. Electric guitars are particularly susceptible to this noise. While it is true that specialized software is available to remove hum, they are often expensive or unavailable. If you don't have these, you can reduce hum considerably by chaining several notch filters together and tuning them to the harmonics of 60 Hz.

The 60 Hz hum present in this last example contains strong odd ordered harmonics. (This hum is a ground loop and due to its square waveshape it has very weak even ordered harmonics.) Let's use a little math to figure out a few of these frequencies. Complete the questions below.

1. $60 \times 1 = 60$
2. $60 \times 3 =$
3. $60 \times 5 =$
4. $60 \times 7 =$
5. $60 \times 9 =$
6. $60 \times 11 = 660$.

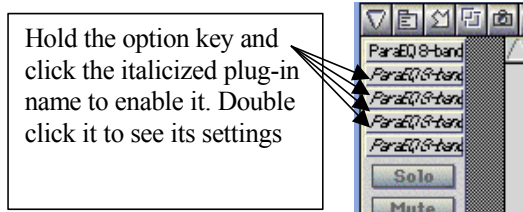
The Hum Removal example uses 5 plug-in equalizers that chain 40 filters together. Each filter is tuned to an odd harmonic of 60 Hz. The bandwidth of each filter is set as narrow as possible.

1. Play the example
2. Starting with Filter #1, bypass each one by one to hear the hum harmonics. (The effect is rather musical.)



3. Starting with Filter #1, enable one filter after another to hear them work together.

4. For more hum removal, enable the other four plug-ins by ‘option-clicking’ the italicized names over the channel. You also may double click a plug-in to see or experiment with its settings.



You’ll notice that last two or three plug in equalizers changed the tone quality of the narrator a lot. The higher harmonics of the hum form close together, so removing them removes other sounds as well. If the only tool you have are filters, you will have to decide how much hum removal is too much.

Question: What number of plug-in filters gave the best compromise in sound quality? _____

Remember to give your lab to your instructor after you complete the answers.