

SIGNAL PROCESSORS

A signal processor is a device that alters some characteristics of a sound. Whereas analog processors directly modify signals as they enter the device, digital signal processors (*DSPs*) first digitize the signal using an *A/D converter*. As the signal enters a *DSP*, it is anti-aliased, sampled, quantized, and coded just as an analog signal is modified before it is recorded in the digital recording process. The digital code is then processed by using a calculation method called an *algorithm*. Next, the altered digital numbers are then directed through a *D/A converter* which converts the information back to the analog realm. This new analog information carries with it the signal processing that was imposed by the algorithm.

We sometimes use signal processors to correct certain problems with sound, such as an inferior-sounding instrument, or microphone. Other times we use them for purely creative reasons – we just like the sound a certain way. However we use them, they play an important part in shaping our recorded sounds and are integral tools that increase our control over the process of recording and the recorded product. Whereas analog processors tend to look very different, *DSPs* tend to look very much alike because they all process the information in pretty much the same manner – digitize, apply an algorithm, and convert back to analog. The only thing that changes from one digital processor to another is basically the algorithm.

Just as a painter uses lightness, darkness, size, perspective, color, texture, shape, composition, and subject to create a graphic work of art, an audio engineer uses a variety of signal processors to enhance an audio work of art.

There are four basic categories of signal processors:

<i>CATEGORY</i>	<i>FUNCTION</i>	<i>EXAMPLES</i>
SPECTRUM PROCESSORS	Affect timbre by altering the spectral balance (frequency / amplitude response pattern)	Equalizers Filters
TIME PROCESSORS	Affect the acoustic environment by altering the time between a signal and its repetitions	Reverbs Delays Choruses Phase Shifters
AMPLITUDE PROCESSORS	Affect the dynamic range	Compressors Limiters Noise Gates
NOISE PROCESSORS	Reduce analog tape hiss	Dolby dBX

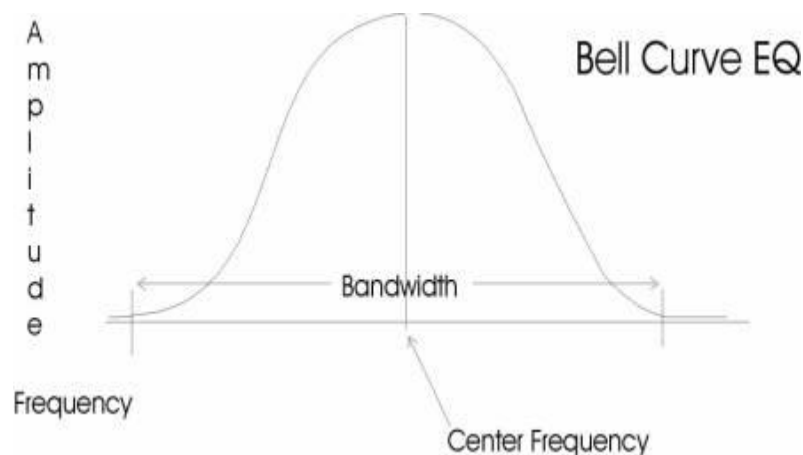
1. SPECTRUM PROCESSORS

Spectrum processors affect the “spectral balance” of a sound. This means that they modify the frequency/amplitude response pattern of a sound, and whenever we change the relative volumes of individual or groups of frequencies, we ultimately change the timbre.

EXAMPLES OF SPECTRUM PROCESSORS

EQUALIZERS are a common type of spectrum processor. In fact EQ (a synonym for equalization) is the most common form of signal processing. They allow us to exercise gentle to moderate timbral control over sound by boosting or attenuating the amplitude of selected frequencies. An equalizer works very much like the volume control on your car radio except that whenever you turn your radio up or down, you turn all frequencies up or down. Equalizers are amplifiers that turn individual frequencies (or groups of frequencies) up or down.

As it turns out, whenever we try to boost or cut a specific frequency, we also affect adjacent frequencies. The closer another frequency is to the target or “center” frequency, the more it is affected. The farther away, the less. In fact the most common kind of EQ is called bell-curve EQ because the graph of the curve of the effect is in the shape of a bell, like this:



The range of frequencies affected by equalization is called “bandwidth.”

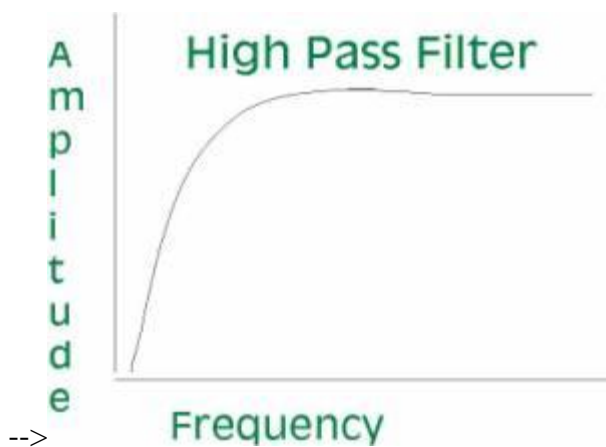
Equalizers come in two main categories. Fixed frequency equalizers have a pre-determined selection of frequencies from which to select a center frequency. They also have a pre-determined bandwidth. Parametric equalizers, on the other hand, have a continuous (or sweep-able) selection of frequencies from which to choose. Parametrics also have an adjustable bandwidth. Some hybrid equalizers have features that are common to both categories.

The Quality Factor, “Q,” is a measure of the bandwidth. The smaller the bandwidth, the higher the Q, and vice-versa.

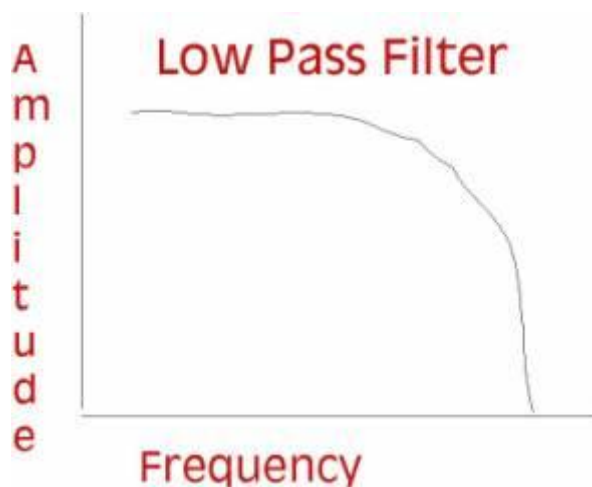
Equalizers are used for a variety of reasons. One is to overcome problems with the sound because of a poor microphone, bad acoustic environment, or an inferior-sounding instrument. Another use is to affect a better blend between instruments. And finally, for purely creative reasons.

FILTERS are also spectrum processors and are used to control timbral qualities of sound. However, they are much more drastic in their effect. Also, they only attenuate (or decrease) the amplitude of selected frequencies, never boost. Usually we use equalizers first, and then if their effect isn't great enough we will employ filters.

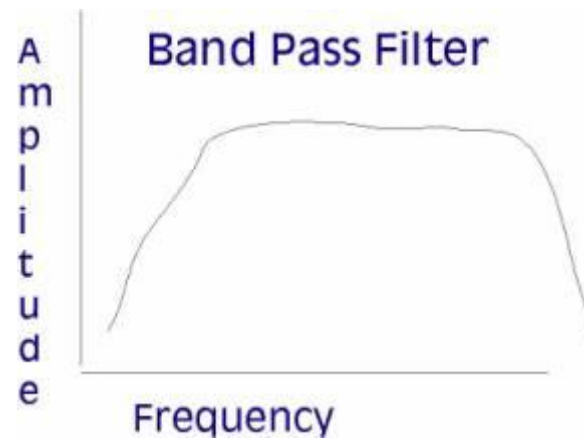
A High Pass Filter attenuates all of the frequencies below a given point. This is the device that is used in microphones called a "bass roll-off switch."



A Low Pass Filter attenuates all of the frequencies above a given point. This is the device in digital recorders and processors that removes the high frequencies in anti-aliasing.



A Band-Pass Filter is a combination high-pass and low-pass filter.



2.TIME PROCESSORS

Time processors are used to modify the relationship between a direct sound and its reflections. When we do this, we are ultimately changing the acoustic environment. We can create the sense that we are in a large room, a small room with tile walls, an auditorium, outdoors, or almost any other surroundings that one can imagine. We control the size of the acoustic environment by modifying the time relationships between a sound and its first repetition (echo or pre-delay). We control the texture of an environment (that is the surface qualities) by modifying the reverberation decay time (the time it takes a sound to decrease 60 dBs. The space of time between the reflections of sound are called delay.

EXAMPLES OF TIME PROCESSORS

Successively repeating delays creating closely spaced echoes is called reverberation. Reverb Units are common time processors. The first ones to be used professionally were acoustic echo chambers. These consisted of small, isolated rooms with highly reflective surfaces. A signal was sent via an auxiliary send to a set of speakers in the room. There was also a microphone in the room that picked up the reflected sounds and returned it to the console via an aux return where it was then mixed with the original signal. That way you could mix in as much reverb as you wanted.

From the acoustic echo chamber we graduated to spring reverbs and then plate reverbs. Plate reverbs are large metal plates that are suspended in a protective framework. The signal is sent to a driver on the plate and then a contact mic at the other end of the plate picks up the reflections of the sound. The signal is then returned to the console and treated in the same manner it was from the acoustic echo chamber. Although we still use plate reverbs in professional studios, spring reverbs have limited usage because they tend to sound somewhat cheesy, or artificial. They are used in vintage guitar amps such as the Fender Twin-Reverb, producing a rather distinctive sound.

The most versatile of all the reverb units and the one that enjoys the most widespread use is digital reverb. Unlike the analog reverbs mentioned above which are one-trick ponies, this type of reverb can create any number of acoustic environments. A \$500 to \$ 1,000 reverb unit often has hundreds of quality, pre-set reverbs that it is hard to beat the value, and because the sound is so good, this type of reverb is rapidly replacing its predecessors.

The Delay Unit is another time processor. The first ones were actually spare analog ATRs that weren't being used in the studio. A signal would be sent to the spare recorder that was placed in record, and then the signal was returned back to the console. The "sent" signal was recorded at the record head and the "returned" signal from the playback head, there was a time delay – the same amount of time it took the tape to move from the record head to the playback head. You could change the time delay by using the ATR's vari-speed: faster to decrease delay time and slower to increase it.

We now use digital delay, which is often found within digital reverb units. We can use delay to fatten a sound or give it more body. We can also use it for special effects. One of these special effects is called "slapback." Slapback is delay that has been held back long enough that the attack of the delayed sound is perceptible.

3.AMPLITUDE (DYNAMIC) PROCESSORS

Amplitude processors are devices that alter or use the dynamic range of a sound. The dynamic range of a sound can be defined as the range of amplitude from the highest to the lowest.

EXAMPLES OF AMPLITUDE PROCESSORS

Probably the most popular amplitude processor is the compressor. A compressor is an amplifier whose output decreases proportionally to its input and vice-versa. Although this may sound like a complicated process to understand, it really isn't. If you have ever used a small, inexpensive cassette recorder to record a class you probably noticed several unusual aspects of the recording. When the professor was talking everything sounded fine, but when he stopped, all of a sudden you could hear things like paper shuffling, desks creaking, people breathing. Then when the professor began speaking again, everything sort of "shut down" and you heard just the professor's voice again. What happened was the compressor in the cassette recorder automatically increased the output (paper shuffling, etc.) when the input (professor quit talking) decreased. Think of it this way. When a singer in the studio sings an intimate verse, she sings softly. However when she gets to the emotional chorus she really belts it out. We could "ride the fader" to make sure she's loud enough to hear in the verses and then not too loud in the choruses by moving the fader up and down. Or, we can use a compressor to do it for us. When the singer increases volume, the compressor decreases the output and vice-versa. Actually, a compressor does this same kind of thing with each word and phrase the singer sings, making it easier to understand the words, and keeping the stronger vocals from overpowering us, and the weaker deliveries "up" in the mix. Since a compressor has a "leveling" influence on volume, it is sometimes referred to as a "leveling amplifier." When we set it to do this very gently, it's very difficult to tell that compression is being used.

Another amplitude processor is a limiter. A limiter is just a compressor whose output level stays below a given point.

Yet another amplitude processor is called a *Noise Gate*. A noise gate works like an on-off switch for a microphone. We can set it at a threshold that allows signals of sufficient amplitude to trigger the gate open, yet insufficient amplitude signals fail to trigger the gate open. For example, if we put a noise gate on the bass drum sound, we can adjust it so that no other sound in the drum booth will trigger the gate except the bass drum. This keeps other sounds out of the bass drum signal in between kicks. We can also set up the snare mic with a noise gate so that only the amplitude of the snare triggers that gate. This way we are able to record “cleaner” signals of the sounds on isolated tracks. By the way, don’t confuse noise gates and noise processors. Noise gates are amplitude processors.

The last amplitude processor is the expander. An expander is an amplifier which increase the dynamic range of a signal, so it does the opposite of what a compressor does. Whenever the input increases, the output increases even more. Whenever the input decreases, the output decreases even more. This process increases the dynamic range and is used to make a sound more interesting or “bigger.”

4. NOISE PROCESSORS

Noise processors are designed to do one thing – reduce analog tape hiss. That’s why we don’t use them with digital recording. Noise processors use a device called a “compander,” which is a combination compressor and expander. By using this device the signal is compressed “upward” and expanded “downward” to diminish the amount of “hiss” inherent in all analog audio recording. (Note: don’t confuse noise processors with noise gates. These are two different animals.)