The Art of EQUALIZATION

An expert tells how to "sweeten" instruments and achieve that special recorded "sound"

BY ETHAN WINER

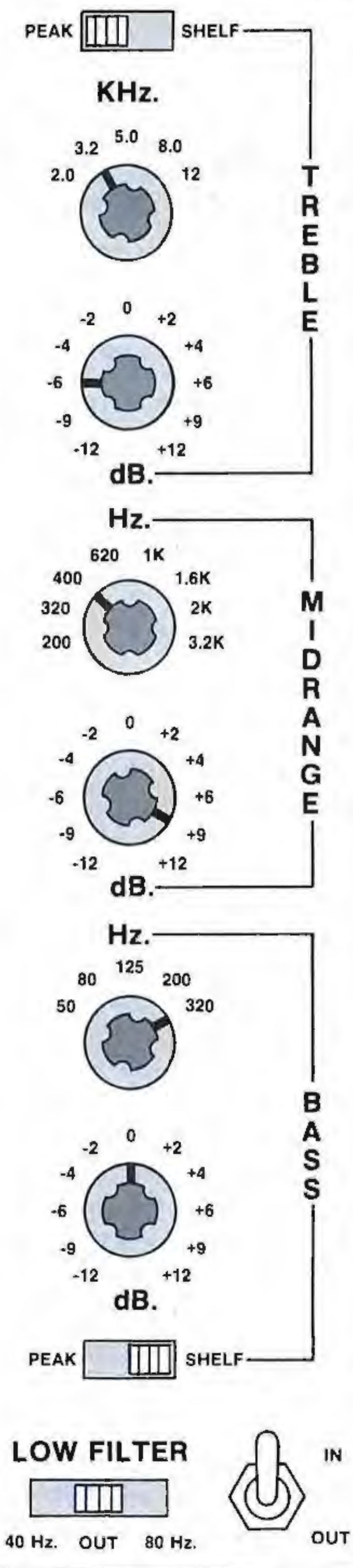
¶ A growing number of audio enthusiasts are using equalizers to shape a stereo system's frequency response, whether to "adjust" a room or for creative recording purposes.

¶ An equalizer is nothing more than a device to allow frequency response of an audio signal path to be adjusted in some way. Thus, conventional bass and treble controls qualify as charter members of the club. More often, however, the term implies equipment that is more complex and sophisticated, such as that used by a mixing engineer. Let's take a look at some of the reasons equalization (EQ) is useful and how its implementation has developed into a high art.

¶ Standard bass and treble tone controls are broadband devices that have greatest effect at the frequency extremes; that is, the highest highs and the lowest lows. While this is fine for touching up reproduction, it is of virtually no help in correcting for narrowband colorations, which are often highly disturbing. For example, a peak in the response of an audio system in the low-to-middle treble region can produce a shrill or scratchy quality that a normal treble control cannot effectively tame. Turning down the control enough to eliminate the shrillness kills too much of the highest treble, robbing music of clarity and sparkle. Similarly, using a bass control to correct tubbiness or muddy bass response also falls short of success. Turning the control down to relieve such midbass exaggeration would simply remove the deepest frequencies so important to lifelike reproduction, while perhaps still allowing some muddiness to persist. There's got to be a better way—and there is.

(continued overleaf)

Fig. 1. Layout of a typical front panel for an equalizer. Note that it has controls for treble, midrange, and bass as well as a 3-position low-cut filter.



Enter the Graphic Equalizer. The graphic equalizer has become very popular in recent years. It is called "graphic" because, as the front-panel sliders are adjusted, their positions give an approximate display of the resultant frequency response. Each of the five to ten or more frequency bands into which the audible spectrum is divided by these devices is adjustable via its own boost/cut control. Instead of broad adjustments of treble, bass, and maybe the midrange (presence), we now have independent control over the low bass, midbass and high bass, low midrange, etc.

If we attack that shrill midtreble emphasis with an octave-band graphic equalizer, we should be able, more or less, to correct for only the troublesome peak. We'll have to settle for "more or less" because it is highly unlikely that any response anomaly could correspond exactly to the adjustments of even a ten-band device. Therefore, many professional sound contractors, recording studios and audio enthusiasts seeking precise results use the even greater resolution afforded by 1/3-octave equalization. The 1/3-octave graphics usually have 27 or so bands, and can, when teamed up with the proper measuring equipment, be used to make just about any high-quality speaker system flat to within a dB or so over much of the audible range. But there's much more to EQ than simply correcting nonideal loudspeakers or listening rooms.

EQ In the Studio. Now, let's look at the professional recording studio with its abundant knobs, lights, and buttons. This is where the multiple original tracks are adjusted in level and equalized before being mixed together to comprise the final two-track product. The key phrase is "before being mixed." Whereas the home listener can alter the program only in its entirety, the recording engineer can—and must—equalize sounds picked up by each microphone separately. The tool of choice for this application is yet another equalizer referred to by many as the "console type." Virtually all professional mixing consoles use this sort of device, with one available for each mike or line input. Additional equalizers are often devoted to echo and reverb lines.

A typical front panel for such an equalizer (Fig. 1) shows that we're back to the bass-mid-and-treble format. But there are no less than five different frequency choices for treble, eight for midrange, and another five for bass. In addition, a 3-position low-cut filter is provided, as is an in/out switch for instant comparison of "before" and "after." Here we have a device that can exercise control over fifteen different frequency ranges and also be made small enough to fit in quantity into a single mixing board. (A large console will have some 30 or more of these, so size is an important factor.) Though all 15 frequencies cannot be adjusted simultaneously as with the graphic, this rarely is needed in a "one-for-each-mike" situation. Besides, you can always "patch-in" a graphic if you absolutely have to.

The last control, the PEAK/SHELF switch, changes the basic shape of the response curve being created. This is shown in Fig. 2, where in both cases treble frequency has been set to 3.2 KHz and 12 dB of boost is applied. The upper curve represents the switch in the PEAK position while the lower curve shows a SHELF. Notice that, while the treble peak affects mainly the specified frequency, there is still some influence on nearby frequencies, whether boosting or cutting. In the SHELF position, the boost or cut reaches its maximum at that frequency and remains there for all higher frequencies. The same principle applies to the bass control. The boost or cut reaches maximum at the named frequency but instead continues downward thereafter. The midrange has no shelf capability, but more expensive consoles generally have a second, additional midrange control for added flexibility. Fig. 3 contains bass shelf cuts at four different frequencies. Fig. 4 illustrates the effect of varying the bandwidth of a midrange dip. Bandwidth? Well now we're talking about the "parametric equalizer," the most recent addition to the EQ machine family.

Parametric Power. In a sense, the parametric equalizer is the most powerful of the equalizer types, allowing continuous adjustment of all equalization parameters (hence the name). It is

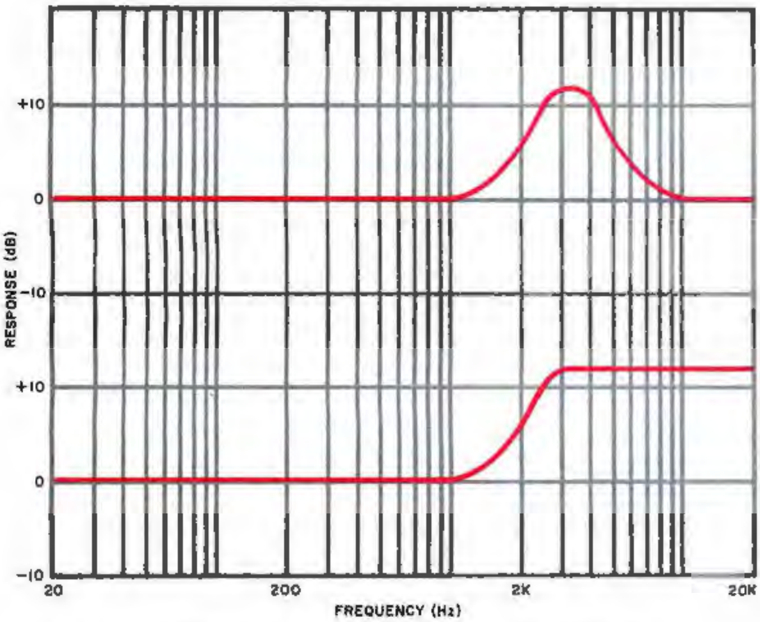


Fig. 2. The top switch in Fig. 1 changes the basic shape of the response as shown here to a peak (top) or shelf (bottom).

structured similarly to the console equalizer, but there are differences worth elaborating. First, and probably most important, all controls of a parametric are continuously adjustable. Potentiometers, rather than discrete, switch-related resistors, are employed as the tuning elements, allowing a choice of virtually any center frequency. Boost and cut controls are also continuous and typically offer a range of ±20 dB, more than is characteristic of other equalizer types.

Another important difference is the inclusion of a bandwidth control. It was explained previously that in boosting or cutting a peak, the effect "spills over" to adjacent frequencies. How far away from the indicated center this influence extends is determined by the setting of the bandwidth control. When set to NARROW, it allows only a small range of frequencies to be influenced. This is particularly useful for suppressing ringing or removing extraneous tones from, say, drums without changing the basic sound character. On the other side of the coin, this narrowband setting can be used to emphasize a single tone and can often effectively "purify" a muddy-sounding tom tom. Of course, this is not a substitute for proper tuning of the drums, but when all else fails. . . .

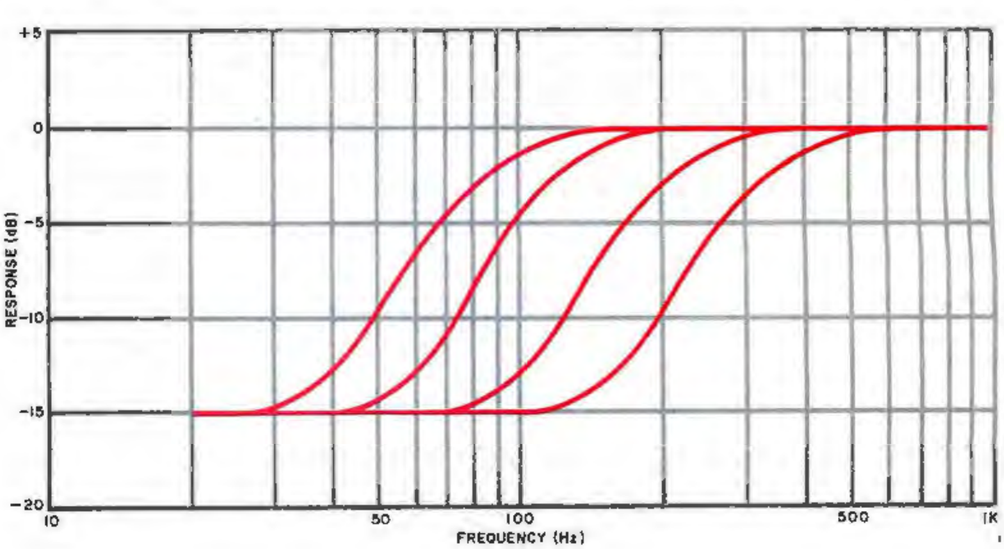
Except when dealing with drums and perhaps some tuned percussion instruments like triangles or cowbells, narrow-bandwidth boosts should usually be avoided because unpleasant resonances or other bad effects may show up when the mix is heard on different speakers. In fact, most recording studios have alternate speaker systems available for making instant comparisons.

Broad-bandwidth settings accentuate a larger range of frequencies. Parametric equalizers are inherently peaking rather than shelving devices, but a wide setting can reasonably approximate a shelf. Do not confuse peaking with boosting, though. Peaking refers only to the shape of the curve, not to whether it is being boosted or attenuated.

All this newfound versatility, however, is not without some potential drawbacks. Probably the most obvious is the lack of precise repeatability. Since the operating controls are continuously variable, it may be difficult to recreate settings exactly to perhaps undo something you later don't like. Another factor is noise. Parametric equalizer designs generally use more op amps per frequency band than do graphic and console types. This means that cumulative noise can be more of a problem, especially when large amounts of boost are used. Distortion can build up in a similar fashion, though the latest high-slew, low-noise FET input op amps are bringing both of these factors under better control. Still, most commercially available units have a switch to bypass each band or section if it's not needed.

While studios have not unanimously traded in all their old equalizers for parametrics, many have added at least one or two. And some of the newer mixing boards are showing up with equalizers having a sweepable midrange band or a two-position switch for sharp or broad peak shape selection. So a few of the

Fig. 3. Response curves show changes for bass shelf cuts at four different frequencies.



conveniences are added without having to go to a full parametric design.

Now that we've looked at the different types of devices and know how they operate, how can we use EQ to best advantage? When and how would a professional recording engineer use it? Well, first we should note that equalization can be used in two basic ways: as a tool and for personal taste.

EQ As A Tool. If you reflect on the task of a recording engineer, the idea that he is going to run into problems in his work will not seem surprising. The difficulties encountered may lie in the areas of instrumental balances, equipment overload, signal-to-noise ratio, and frequency response, to name a few possibilities. When the problem can be traced to frequency response—and quite a few can—the equalizer becomes an extremely valuable tool.

For example, one problem that occurs regularly is caused by the "proximity effect," a bass boost that happens when using a directional microphone in close-miked situations. Here, the low filter would be your best bet. First, it will attenuate the excessive low-frequency signal before it enters the actual EQ circuitry, minimizing the chance of overload; second, it will leave the bass control free for other uses if needed. (If the mike has its own switchable low-cut filter built in, using that to keep the unwanted frequencies out of the preamp as well will give even more overload protection.)

Another proper occasion to use the low filter is when recording vocals close-up. Not only because of the proximity effect just mentioned, but also to minimize "popping" P's, which contain a lot of low-frequency energy. Moreover, rumble and low-frequency mud can enter your recordings owing to extraneous vibrations such as walking on non-concrete floors, operating air conditioners, and the like.

Treble is often accentuated to increase clarity or to enhance the presence of a vocal or string part that might otherwise be lost in the mix. Horns, cymbals, acoustic guitars and many other instruments can also be greatly enhanced in this way, but the engineer must know where the formants (the most important characteristic frequencies for the various instruments) lie. Boosting high treble on an instrument with little output in that region will do nothing but add hiss. In fact, when dealing with such an instrument, it is often possible to make a substantial improvement in the signal-to-noise ratio by carefully reducing the unnecessary high-frequency bandwidth with treble control on each channel for frequencies beyond the range of interest. This is most effective when done in mixdown, as tape hiss will also be reduced. For this same reason, when treble *boost* is employed, it is usually best applied ahead of the recorder.

EQ can also help to correct for poor room acoustics. Recording live, even the most accurate mike may not capture that terrific sound you hear when you stand right next to the instrument. Close-miking may help, but in many cases this is impractical since many instruments do not radiate sound from a single point source.

Consider a grand piano, string bass, xylophone, or gong. All of these radiate sound from a large surface area, leaving no single mike position that would be close to all parts of the source. Such large instruments require a more distant microphone placement if a well-balanced pickup is to be had. Unfortunately, as the distance between source and mike increases, acoustics of the room begin to affect the sound. This isn't always bad—a good room might add a warmth and character unobtainable in any other manner. But when a close-up sound with lots of presence is desired, equalization in the form of treble boost or midrange cut can often do the trick.

Seasoning To Taste. While no one yet has found a definitive way to tell what sounds good and what doesn't, recording engineers have developed various techniques for emphasizing what they consider to be the more pleasant qualities of musical sounds. In fact, many engineers pride themselves on "getting their own sound." This is an area of taste, so naturally there are no hard, fast rules to apply. Some good starting points can be established, though, as follows. Generally speaking, you would boost treble for clarity or presence (the midrange can affect this too), and bass for fullness or punch. Sometimes it seems that no matter how much top or bottom you add, something is still not right. Often what is involved is one or more unpleasant resonances caused, as mentioned earlier, by either microphone characteristics or placement, or even by bad qualities within the instrument itself, especially if it is out of adjustment or of low quality. Eliminating these midrange resonances will often improve the sound and may minimize a need to boost highs and/or lows.

To find these magic EQ settings, start by turning off all but the principal microphone that can pick up the instrument you're working with. If it's the snare drum, for example, shut off the tom and kick mikes. They'll interact later anyway, but the less you need to concern your-

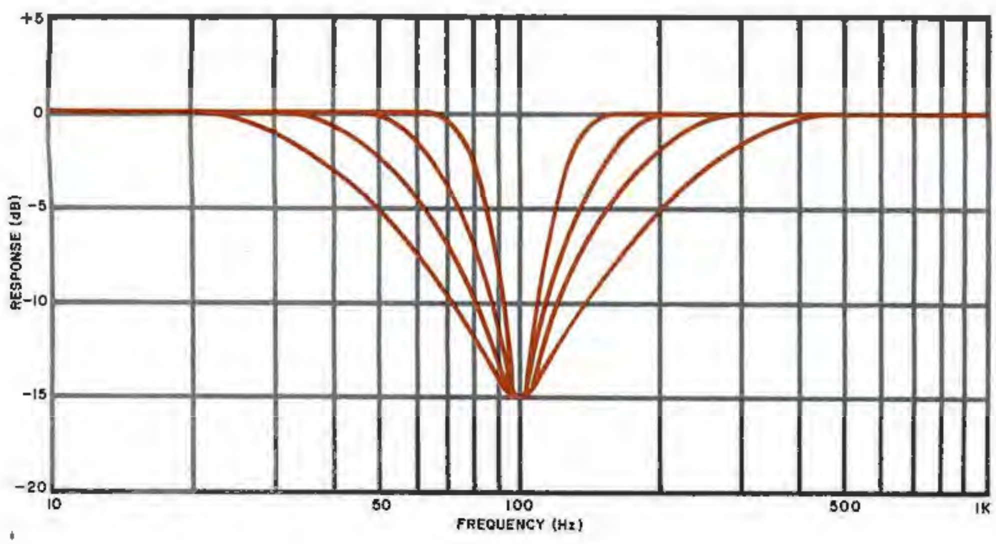


Fig. 4. Response curves showing the effect of varying the bandwidth of a midrange dip.

SPECIFIC INSTRUMENTS AND THEIR CHARACTERISTIC FREQUENCIES

The chart given below lists some common instruments with frequencies at which boost or cut can be effectively applied to cure various problems or obtain certain effects. Indicated frequencies are necessarily approximate, as no two instruments sound exactly alike. The column marked "comments" gives cautions or observations based on experience. They should be taken as guidelines rather than prescriptions, for every situation is different and every recordist has his own sonic goals.

A few general hints may contribute to the effective use of equalization: (1) Your memory is shorter than you think; return to a flat setting now and then to remind yourself where you began.

(2) Make side-by-side comparisons against commercial releases; this will help you in judging overall blend.

(3) You can tailor the sound of an instrument only so far without losing its identity; every instrument can't be full, deep, bright sparkly, etc., all at once. Leave some room for contrast.

(4) Take a break once in a while. Critical listening tends to numb one's senses after awhile, especially if you like to run monitors at high levels. Sounds may appear very different to you the next morning

(5) Don't be afraid to experiment. If you can't find just what you want with equalization, try moving the mike a little, if that won't work, move the instrument. But most of all, keep trying.

COMMON FREQUENCIES FOR EQUALIZATION

Instrument	Cutting	Boosting	Additional Comments
Human Voice	Scratchy at 2 kHz. Nasal at 1 kHz. Popping p's below 80 Hz.	Hot at 8 or 12 kHz. Clarity above 3 kHz. Body at 200-400 Hz.	Tend towards thin when blending many voices.
Piano	Tinny at 1-2 kHz. Boomy at 320 Hz.	Presence at 5 kHz. Bottom at 125 Hz.	Not too much bottom when mixing with rhythm section.
Electric guitar	Muddy below 80 Hz	Clarity at 3.2 kHz. Bottom at 125 Hz.	
Acoustic guitar	Tinny at 2-3.2 kHz. Boomy at 200 Hz.	Sparkle above 5 kHz. Full at 125 Hz.	
Electric bass	Tinny at 1 kHz. Boomy at 125 Hz.	Growl at 620 Hz. Bottom below 80 Hz.	Sound varies greatly depending on type of strings used.
String bass	Hollow at 620 Hz. Boomy at 200 Hz.	Slap at 3.2-5 kHz. Bottom below 125 Hz	
Snare drum	Annoying at 1 kHz.	Crisp above 2 kHz. Full at 125 Hz. Deep at 80 Hz.	Also try adjusting tightness of snare wires.
Kick drum	Floppy at 620 Hz. Boomy below 80 Hz.	Slap at 3.2-5 kHz. Bottom at 80-125 Hz.	Usually recorded with front drum head removed. Place blanket inside of drum resting against head.
Tom toms	Boomy at 320 Hz.	Slap at 3.2-5 kHz. Bottom at 80-200 Hz.	Tuning head tension is extremely important.
Cymbals, bells, tambourines	Annoying at 1 kHz.	Sparkle above 5 kHz.	Record these instruments at conservative levels, especially at slower tape speeds.
Horns and strings	Scratchy at 3.2 kHz Honky at 1 kHz. Muddy below 125 Hz	Hot at 8 or 12 kHz. Clarity above 2 kHz Lush at 320-400 Hz.	

self with now, the better. Next, try boosting some different midrange frequencies, adding at least 10 or 15 dB, to make the changes obvious. Where you start will naturally depend on the instrument. Since physical resonances of instruments usually fall between, say, 100 Hz and 1 or 2 kHz, these frequencies are likely starting points. After determining which one sounds the *worst*, return to the flat setting momentarily to allow your ears to readjust, and then cut the chosen frequency in small steps until the optimum point is reached. The same general plan can work for boosting, although then you'd be looking for frequencies that make the sound better when boosted.

When adding treble or bass, be sure the controls are doing what you expect them to. If you don't obtain an appreciable improvement, move on to a different frequency. Remember, a lot of boost at the extreme low end can route excessive infrasonic energy to the loudspeakers, which could damage them. Similarly, too much ultrasonic content can damage tweeters and overload the tape deck. Even with VU meter indicators in the black, safety is not guaranteed; limited meter frequency response sometimes prevents them from giving a true picture. Also, VU meters tend to miss sharp transients from drums and other percussion instruments; the pointer simply cannot move fast enough. Preemphasis within the deck also can aggravate the situation, so be particularly careful at the slower tape speeds. ◇