Multiband Compression
Using a different kind of compressor.
By Lionel Dumond – Recording Magazine

Dynamics controllers—compressors, limiters, expanders, and gates—are among the most useful signal processing devices. We need them to add punch to a vocal track, increase sustain on cymbals, reduce extraneous background noise and hiss, or increase the overall apparent loudness of a mix. And that's only the beginning—the ability to control audio levels transparently and automatically is indispensable in the quest to create good-sounding audio.

Broadband vs. multiband
Despite their usefulness, however, "normal" dynamics controllers have their limitations. They are broadband (sometimes called wideband) by design, meaning that they can be triggered by any portion of the input signal regardless of frequency, and that they operate on all frequencies of the input signal equally.

While many broadband dynamic controllers provide sidechain capabilities, allowing triggering from an external source (JB: like another effects plugin in your mix), this isn't a very convenient or flexible method in trying to isolate given frequencies. There are cases where we may need to prevent a dynamics controller from being triggered by certain frequency components of the input signal, or to cause the device to be triggered by certain frequencies and not others, for example. *(JB: imagine there is a track with bass and vocals. The vocal part is ok, but the bass notes are occasionally too loud. EQ adjustment to lower the bass frequencies won't work very well because it takes the bass down even on the notes where the bass is not too loud. But if you use a normal compressor, when the louder bass notes tell the compressor to compress, it makes the vocal part change with it. And you like the vocal part as it was!)* Enter the multiband dynamics processor.

What's a Multiband Dynamics Processor?
Like so many of the whiz-bang production tools we use on a daily basis, multiband compressors were originally developed by the broadcast industry to address a specific need. Since the inception of AM (amplitude modulation) radio, the modulation levels of broadcasts have been tightly controlled to remain within rigidly specified legal operating limits that vary from station to station. At first, broadband dynamics controllers were used to output as loud a signal as possible while staying legal—with intermodular distortion often being the result.

Intermodular or intermodulation distortion (IM) is a fancy term for what happens in a broadband compressor when a certain frequency band of the input signal produces unwanted compression in other bands (*JB: as in my example above*). It wasn't long before engineers figured out how to split input signals into multiple [frequency] bands using a crossover, apply dynamics control [compression] to each band separately, and bus [combine] the results back together. Once all of these functions had been incorporated into a single piece of gear, the multiband dynamics processor was born (see figure 1).

Explore multiband compressors
Today, multiband dynamics processing is vitally important in nearly all audio fields, including speakerphone design, teleconferencing, hands-free cellular technology, speech recognition, and hearing aids. Multiband processors have also found wide use in audio production work, especially in mastering and post-production.

With the proliferation of affordable mastering processors, powerful DAW plug-ins and other gear aimed at project and home studios, multiband dynamics have found their way into almost every production environment. But despite their ready availability I've found that many engineers avoid their use, usually out of unfamiliarity.

What's a multiband compressor good for? What can I do with it? In which situations is its use most appropriate? Well, fret not, dear reader, keep reading, and the answers will become apparent. As you'll soon see, in many cases multiband processors can be a far more intelligent tool for dealing with audio dynamics than the typical broadband compressor. In the following paragraphs we'll outline some examples of their practical use in real-world situations. Get ready to shed your fear of multiband dynamics processors forever!

Knobs and Buttons

First, let's talk briefly about the basic functions and controls you'll find on a typical multiband dynamics processor.

The input signal first passes through a crossover that splits the signal into a number of different, adjacent frequency bands. In most units designed for studio use, three to five bands are common (though many units designed for broadcast offer more than that). A number of controls are available, such as the ability to adjust the crossover frequencies between the various bands, making them wide or very narrow (the latter is used for de-essing, for example—more on this later).

Software versions often let the user alter the slope of the crossover filters, reducing (or increasing) overlap between the bands. As with conventional crossover technology, steep filters are generally preferred, as they tend to minimize undesirable artifacts which could occur near frequency band edges. Another handy feature is the ability to mute and solo individual bands. Soloing a band is extremely useful when setting compression parameters, so as to more closely hear what's happening to your sound.

Threshold, ratio, attack, and release controls, as well as makeup gain, are the user parameters, just as they are on typical dynamics processors. However, keep in mind that since each band gets treated separately, you would need a set of controls for each band! That would be a heck of a lot of buttons and knobs, which in most cases wouldn't be practical.

Therefore, to keep the user interface (hardware or software) manageable, many manufacturers have implemented some pretty clever designs that cram a whole lot of functions into a compact package. Cases in point are the Waves C4 and TC MasterX plug-ins, each of which allow the user to manipulate an onscreen graphical display to control multiple functions simultaneously.

While these "non-standard" interfaces usually take a bit of patience to learn, they do a pretty good job of balancing simplicity with functionality, while providing a good deal of useful visual feedback (see figure 2).

(Un)Pump Up The Jams

The intermodulation problem addressed above isn't merely limited to radio broadcasting. It's a problem that often creeps into mix situations.

Almost all of us have heard mixes that have low-end problems, especially an untamed bass or kick drum that just doesn't sit well in an otherwise decent mix. Perhaps applying a broadband compressor to the offending track at mixdown might have solved the problem. But what if you're the mastering guy and all you have to work with are the results of the two-track mix?
Your first instinct may be to apply a broadband compressor to the overall mix. You carefully set the threshold, ratio, and attack and release to bring that kick under control. You find, however, that whenever the kick triggers the compressor, the level of the whole track sinks. It quickly rises to its original level (according to the release time), only to be forced down again by the next errant thud—up and down, up and down, like a weather buoy in a hurricane!

This type of IM, often called pumping, is exactly the type of problem a multiband compressor was made to solve. Simply set the lowest crossover band of the processor to catch the meat of the kick, say, 20 Hz to 120 Hz, and compress that band alone, while leaving the rest of the frequency spectrum untouched. You'd probably use a fairly fast attack time (not so fast that you cut off the "snap," though) and time the release to work smoothly within the tempo of the piece.

Of course, you always want to listen closely to whatever other instrumentation (say, the bass) is present in the frequency band you're working on, and what's being done to its sound. With careful setting of bandwidth and compression parameters (don't forget to use that solo capability!) you should end up with far better results than would be possible from a regular ol' compressor.

Vocal tricks
The use of multiband compression in vocal processing deserves special attention, as vocals are so often a very prominent part of a mix, and because compression is so often used on them. Applying broadband compression can create intermodulation in even a soloed vocal track. A good voice, captured with a great mic, will result in a signal with a tremendously wide range of frequencies, as well as a good deal of dynamic fluctuation. While most of the energy will be in the mid frequencies, there will be some lows generated by resonances in the mouth and chest, as well as the rich and varied highs that give the voice its unique timbre.

It's natural to reach for a broadband compressor for a vocal, but if you listen carefully, you might notice that as you compress the track, the mids will appear louder, while the highs will start to diminish in comparison. This is classic IM. The more plentiful mids are keying the broadband compressor, pushing down the level of the entire signal.

Eq problems
Many engineers, noting this, will then reach for an equalizer to restore the high end. But is an equalizer really the right tool for this job? Think about it—what we are trying to do here is to restore the original spectral balance that has been distorted by the compressor. In doing that, during passages when the compressor is working only a little, you may need to boost highs by only a very small amount. On the other hand, when there is a lot of compression going on, you may need a bigger boost.

An eq, being a static device, can't do this—the eq will boost the top end of the signal during the whole track, and by the same amount regardless of level. Even when the compressor isn't working at all (say, during quiet passages, or during fades), you're boosting the high band by the same number of dB as when the compressor is pushing full out, attenuating the highs the most.

This isn't a workable solution at all. In attempting to address the IM problem, you've merely created yet another problem! Of course, we haven't even mentioned the phase anomalies and added noise an equalizer may introduce.

By using a multiband compressor instead of a standard compressor/equalizer combination, you can control the dynamics of a vocal track while preserving frequencies prone to intermodulation. By compressing the mid band separately, where most of the energy is located, you'll use less eq than you thought you needed, while preserving the singer's original timbre as well as the sonic "color" you paid so much for when you bought that expensive mic!

Of course, this technique isn't limited just to vocals. It works just as well on any audio source with broad frequency response that might need dynamics control, such as acoustic guitar, horns, winds or strings.

De-essing and de-popping

It is common to think of a multiband dynamics processor as a "dynamic equalizer." As with a conventional equalizer, the frequency response of the input signal is altered. However, as we've already pointed out, an equalizer boosts or cuts without regard to the dynamics, or loudness fluctuations, of the various frequency components at the input. For example, if you set an equalizer to cut 4 dB at one octave around 7 kHz, it will do so regardless of the energy present in that band. Now, let's say you wanted to cut 4 dB at and around 7 kHz, but only if the level at that frequency exceeds -6 dB. Otherwise, you'd like the signal to remain untouched. A multiband processor will allow you to do that, cutting or boosting at various frequencies like an equalizer, but only when the dynamics in the band exceed, or fall below, a certain level.

One of the most common applications of the multiband compressor as a dynamic eq is in de-essing and de-popping applications. Consonant vocal sounds such as "s" and "t" contain a lot of high frequency energy called *sibilance*. Vocal sibilance is often most prominent between 5 kHz and 8 kHz. An equalizer employed here, as in the example above, will cut the offending frequencies, but will do so on the whole track, regardless of whether sibilance is actually present. Cutting enough to tame the occasional sibilant passages will also suck a lot of the high frequencies out of the track, creating an audible "hole" in that band, which is probably not what you want.

Setting your multiband compressor to act on the sibilance within a specific range of frequencies, if and only if they exceed a given level, will push those high-energy peaks down whenever they occur, leaving the track alone otherwise (see figure 3). When setting parameters, solo the active band and carefully set your frequency and bandwidth to "zero in" on the sibilance you want to extinguish, without carving out too much of the rest of the signal. Go for a hard, fast attack and a quick release. Un-solo and listen to the result, and experiment with threshold and ratio to maintain a natural sound.

Because you can specifically target the sibilant peaks, you can apply a lot more cut than you would with an eq, without the unpleasant and unintended results. Be careful not to overcut though, as this will usually result in a unnatural, lispy vocal.

Of course, by lowering the target frequency band, you can easily turn a de-esser into a de-popper. Pops can be introduced with the over-pronunciation of "p," "b," and other like consonants that produce low frequency blasts of air. Parameter setting for de-popping is the same as described above, except that the offending frequencies will usually lie around 80 Hz to 200 Hz.

Making It Loud
(J*B: this process is part of what is called "mastering"]* The introduction of affordable digital brickwall limiters such as the Waves L1 plug-in into home and project studios has seemingly sparked a race to see who can make the loudest CD possible. By reducing the peak-to-average level of an audio signal (which is what limiters do), engineers can increase the apparent volume of that signal by several dB.

But as we all soon learn, unchecked broadband limiting can bring on some unwanted results pretty quickly. You soon find that the louder bands are getting a lot more "peak-to-average" reduction than the softer ones, throwing off the entire spectral balance you were going for in the first place. High energy peaks in the mids or bass may exhibit audible distortion, even while there is still plenty of headroom in the higher frequencies. Drums lose their punch. Cymbals lose their sizzle. The vocal becomes less intelligible, its high end overcome by the rest of the track. Somehow, the tune sounds a lot less "in your face" than you were hoping to achieve.

Using a compensating eq curve to trim off lows might help bring down those peaks a little, with the result of removing a lot of desired material from the track at the same time. The peaks in the low end might now be lower, but somehow the bass doesn't "growl" as much as it did before; that neat rumbling in the kick that you so carefully preserved during mixdown doesn't seem to be there anymore, either; and that ominous synth drone in the background suddenly sounds a lot tinnier than you remembered it.

Multiband dynamics processing to the rescue again! By running the signal through a multiband limiter in this situation, or, alternatively, by using a multiband compressor before the broadband limiter, you can control the peak-to-average reduction in each band separately. If, for example, you want to preserve (or even fatten up) the bass, you can do so by limiting the peaks and bring the overall level up in that band without fear of shredding your woofers.

If you want to bring the high end of the vocal out more, you can apply a lower threshold and more makeup gain in the appropriate band. You may find that by controlling dynamics with a multiband processor in this way, you can apply even more limiting than you were able to before, with fewer undesirable artifacts. Whoopee—even louder CDs!

Compensating for the Equal Loudness Contour
Another example of the use of a multiband dynamics processor as a dynamic equalizer is in enhancing a mix by applying a "loudness" eq curve to program material when the overall volume falls below a certain level.

Numerous studies have shown that the human ear is most sensitive to midrange frequencies. When material containing a wide range of frequencies is lowered in overall level, both lower and higher frequencies become more difficult to hear, thus altering perceived frequency balance in favor of the mids.

As you turn down the volume, your ears tell you that you've lost some bass and highs. And if you keep mixing at that lower volume (maybe the kids are in bed, the neighbor just came home?), you'll overcompensate by adding bass and highs that you'll be surprised to hear the next day when you go back to your regular volume levels.

Once you turn the signal back up to a sufficient volume, the ear more readily perceives both the lows and highs, resulting in a flatter perceived response. The series of frequency response graphs which describe this phenomenon is known as the equal loudness contour. (Dave Moulton wrote in depth about this effect in an article called, interestingly enough, "Equal Loudness Contours", which you'll find in this library!

The loudness button

You may have experienced the equal loudness contour first hand if you have ever used a playback system with a "loudness" button (in full this is really called "loudness compensation" button.) At high volumes, engaging the loudness button has no effect—the frequency response of the music remains unaltered from the original source. At lower volumes, however, the loudness button boosts both lows and highs, to more closely emulate the flat high-level response.

The effect is that of a "dynamic eq," one that somehow "knows" how loud the music is, and tailors the frequency response of the signal accordingly. It might seem like magic, but in fact, the circuit being used is a basic multiband dynamics processor.

This is something you can easily create in the studio, so that your mix sounds spectrally "balanced" regardless of level. You can think of this as applying a different eq curve to softer program material than to the loudest material, using a device that morphs between these eq curves automatically! The idea is to set up the processor to apply a more pronounced "loudness" curve to low-level audio, with the curve gradually flattening out at louder levels and becoming completely flat at maximum level (see figure 4). This is, in fact, a commonly used mastering technique.

Applying a loudness curve

Let's talk a bit about how it's done. First, set up your bands to accurately capture the lows, mids, and highs. Of course, the more bands you have to work with, the more precisely you can isolate these frequencies. With a three-band processor, good crossover starting points are 200 Hz, and 4 kHz; with a four-band device, try going with 100 Hz, 1 kHz, and 6 kHz. Again, these are just starting points, not hard and fast rules; experiment to determine the best settings for the tune you're working on.

Next, carefully set the threshold, ratio and makeup gain on the low and high bands only, such that the dynamics processors act as upward compressors (see figure 5). At high levels, the signal remains unaltered. Near the threshold there is some slight compression taking place. At low levels, no compression is taking place, but the output level is increased. This results in a gain boost in these bands when the levels are below the threshold. There is no effect when levels exceed the threshold.

Obviously, this works best on material with fairly wide dynamic range. If you're limiting your mix so hard that the meters hardly move, the level won't ever be low enough to make the upward compression on the low and high bands kick in!