Detection and the Dynamics Duo (Or Why Do Some Compressors Sound Great While Others Just Plain Don't?)

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dbx® PROFESSIONAL PRODUCTS

Detection and the Dynamics Duo (or Why Do Some Compressors Sound Great While Others Just Plain Don't?) A Discussion of the Benefits of True RMS Level Detection and True RMS Power Summing

Detection? Dynamics Duo? Sounds like a confidential Gotham City document that Cat Woman or the Riddler would like to get a hold of for blackmail purposes. Perhaps the terms "sidechain" and "compression" sound a little more familiar. In this paper, we talk about these terms and explain the important role that "detection" plays in a well-designed "dynamics processor". Although we briefly mention VCA's, the purpose of this paper is to highlight various detection schemes used by manufacturers, as well as the methods used to link channels for stereo operation. We describe our True RMS Level Detection and True RMS Power Summing methods that we at dbx profess to be the correct and logical, not to mention best sounding ways to do dynamics processing.

1. Viscerally Compressed Amplitude

No, that's not what "VCA" stands for, as anyone familiar with compressors could tell you, but we have a gut feeling you already knew that (pun intended)! VCA, of course, means "Voltage Controlled Amplifier." The guts of any dynamics processor (compressor, limiter, expander, gate, ducker, dynamic filter, modulator, etc.) contain, among other things, a VCA. As a pioneer in the field of VCAs, dbx created the patented industry standard chip used by the zillions by many major manufacturers of professional and consumer audio equipment. You'll find our chips in dbx noise reduction systems throughout the world.

But this paper is not about VCA's. We know that it takes more than a great VCA to make a great compressor. Much more. And that's where the years of leadership and expertise in dynamics processing design make all the difference.

2. Dynamics Duo

The real art in making a great compressor is not only in the design and implementation of the VCA, but in the design of the other, more important half of the

compressor. Any dynamics processor consists of the "Dynamics Duo"" or two signal paths: an audio path through the VCA that needs to be as clean as possible--low noise, low distortion--and a detector path that contains the smarts to figure out what to tell the VCA to do.

The detector path is often referred to as the "sidechain." (Sounds like a wallet protection device). The sidechain consists of an audio level detector that converts the audio signal from which the compressor is "keying" to a control voltage. This control voltage is then modified by the threshold, ratio, attack, release, (etc.) controls which follow the detector. This modified voltage controls the gain of the VCA.

If it sounds like Mr. Sidechain is the real brains of the Dynamics Duo, while Mr. VCA is just the brawn, you're absolutely right. The particular sound of any dynamics processor is due more to the way Mr. Sidechain handles his affairs than how well Mr. VCA carries out his orders. Common problems such as the proverbial "pumping" and "breathing" in some compressors results from sidechain circuitry design, not from VCA deficiencies. But, lest we fail to give credit where credit is due, never underestimate the essential role that Mr. VCA plays in providing a clean signal free of noise and distortion.

3. Detection: RMS —True or False?

The principal component of the sidechain is the detector, and its ability to accurately detect audio levels in the proper way considerably affects the dynamics of the processed signal. Common sense would tell you that, given a particular audio signal, the detector must compute a result that corresponds to the result computed by the human ear, if that detector is to truly function as an audio detector.

There are many ways to do audio level detection, and as you may surmise, different detection methods yield different results. While some compressor/limiters use peak detection and fast response characteristics, their action is frequently displeasing to the ear, even at modest compression ratios, as rapid gain changes result in unnatural signal dynamics. This is due to the psychoacoustic phenomenon that the human ear responds, not to the peaks, but to the average power of the signal. In other words, the ear responds to the sum of the energies of all frequency components present.

Other processors use averaging circuits for level detection, created by simple resistor-capacitor (RC) filters which may approximate average power with some waveforms, but in general will not coincide with the way the human ear and brain interpret sound. This is because there is not a one-to-one correspondence between the average amplitude of a waveform and the average power of that same waveform, resulting in a mismatch between the detector's calculated signal level and your ear's perceived level. It's as if the averaging detector is looking at the signal world through "fun house" mirror lenses.

A related method that has gained some popularity of late, due mainly to the availability of these particular detector chips to the general public, is the "log average" method. But, again, using averaging techniques, these logarithmic detectors exhibit the same error in calculating signal level as illustrated above. Given these explanations, perhaps we have shed some light on reasons why most processors work great only in certain situations with certain types of signals.

Obviously, this is not the dbx way. Our processors use True RMS Level Detection for signal sensing to most closely emulate human hearing response. Without going into a detailed technical explanation, the mathematical concept of RMS (Root Mean Square) describes an effective value of voltage or current that results in average power. This effective value is called RMS because we take the square root of the mean of the squared values. Disregarding the technical mumbo jumbo, just remember that the RMS value inherently corresponds to the average power of the signal, as does the response of the human ear. With sophisticated chips developed at dbx, utilizing patented integrated circuit designs to calculate the RMS value of the signal, we are able to create unrivaled dynamics processors with natural sound with the most listenable results over the widest range of signals. Those who have used dbx processors know this to be true.

4. Duo Dynamics

What about stereo dynamics processing? Is there a special way required to link two channels of compressors for processing a stereo signal, or do we just run each channel through its own independent compressor? Those familiar with compressors know that for processing stereo signals, each channel must react identically--that is, their VCA's must be

locked together so that their gains change identically--otherwise, the stereo image will shift to the side with less gain reduction occurring at that instant.

We agree that the VCA's must react identically when linked, but which detector controls both VCA's? Do they react to the left channel detector, or to the right channel detector, or both? And, if to both, how? Do they react to the greater of the two signals? Do they react to the sum of the signals? At this point you're probably asking, "Who the @%&!*% cares?!" Well, for starters, your ears and brain care. Bottom line: the detectors of both channels need to be linked in an intelligent way. Let's take a look at some not-so-intelligent ways and, of course, the dbx way.

5. The Sum Of The Squares Of The Average of the Hypotenuse Sounds Bad! (Or Why We Do It The Way We Do!)

One way to do stereo linking is to ignore one of the channels, either the left one or the right one, and have both VCA's react to the signal on that one channel only. So which channel signal do you choose to pay attention to and which one do you ignore, allowing damaging peaks, speaker overexcursions, or fatal jaunts into digital 0 VU land? If this seems like a pointless question because no manufacturer would be stupid enough to implement this method on a stereo processor, guess again. A particular manufacturer with a German-sounding name whose boxes are made in China has implemented this method on their "stereo" box. Hmm? Incidentally, their chosen method of detection on this box is the log average method.

Another way to link detectors is to sum the left and right channel signals together before going into one detector as suggested in an application note of a particular manufacturer of another VCA. On the surface, this may seem like an acceptable way and will sometimes give acceptable results, especially if the left and right signals are identical. The problem is that the signals are, by definition, stereo! There is no problem detecting mono signals since they add together without phase cancellation, but we're not processing mono signals when we're in stereo link mode!

Stereo signals are, of course, different to some degree and will combine with some phase cancellation. In other words, peaks in phase add together while peaks out of phase cancel. Therefore, using this method, the detector will not calculate the correct level of the

combined power of the left and right signals. The more dissimilar the left and right signals are, the more error in the detector's calculated level. It's as if someone's continuously messing with the threshold knob! A much better method, although still deficient, is to link log average detectors. This results in the sum of the average signal amplitudes, but, as we have stated before, does not correspond with average power and therefore does not sound as good.

6. True RMS Power Summing

The dbx way, of course, is different. With our True RMS Power Summing, the linked detectors respond to the sum of the energy (power) of each channel's RMS signal. The intelligence of these RMS detectors allows the signals to be converted to the power domain, then summed together in the power domain. This produces a true sum of the energies. The more total energy, the higher the detectors calculate the combined signal to be. This is how your ears work--the more screaming children in one room (i.e., the more total energy), the more irritated you get!

This sum of energies will gain track accurately over a wide dynamic range providing excellent response at low or high signal levels. No phase cancellation, no inaccurate modeling of human hearing response, and heaven forbid, no ignoring one channel of signal information. When detectors are linked intelligently and sum signals the same way that your ears do, compression, limiting, or expansion will sound the way it should!

7. Conclusion

No need for a conclusion here. You make your own. Thousands upon thousands of industry professionals have already made theirs, making dbx the most respected and most used dynamics processing line on the planet.

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