VORSIS Application Note

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Measuring the Stereo Separation of Vorsis Broadcast Audio Processors

(i.e., how to do it correctly)

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Background

Vorsis customers sometimes ask our technical support staff “why do your on-air processors have such poor measured stereo separation?”

The answer is: “actually, they don’t!”

Stereo separation in *all* Vorsis audio processors exceeds 90dB through the discrete *analog* left/right signal chain, is well in excess of 100dB through the discrete left/right *digital* path, and in the *composite* domain is in excess of 55dB (typically 65dB) through our FM processor’s stereo generator.

Because of our unique processing architecture, measuring stereo separation the way it might be done on less sophisticated products will net quite unusual and undesirable results. This is because certain parts of the signal processing chain in our Vorsis processors operate in the Sum and Difference domain where the L+R and L-R signals may be processed somewhat differently and therefore will almost always have differing gains.**

We utilize this processing technique because it affords *superior* control over the stereo sound field as well as the ability to customize stereo enhancement effects to create *any* desired on-air sound.

As experienced audio processor designers with many decades of experience in the professional sound and broadcast audio fields we intimately know and understand the up *and* downsides of *all* of the methods for accomplishing stereo enhancement for FM broadcast. That is why we chose to utilize Sum and Difference processing, but *only in parts of our signal processing chain where it makes technical sense to do so*.

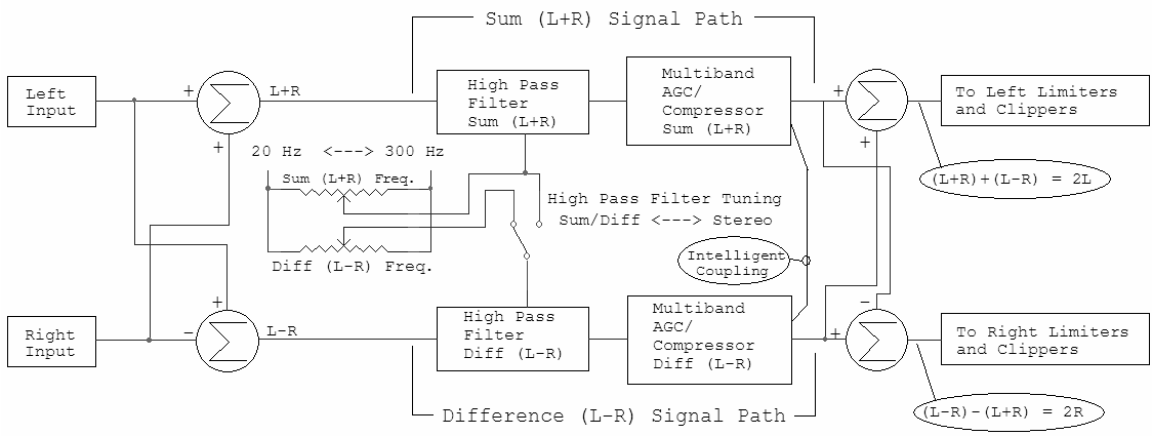
Understanding Stereo Sound Field Enhancement

The basic idea behind all forms of stereo enhancement is to widen the stereo sound field by altering the ratio of the L+R (sum) and L-R (difference) signals. When this is tastefully done a more pleasing listening experience is possible in a typical listener’s acoustical environment.

However, in order to increase perceived stereo separation the difference signal (L-R) path must have a gain greater than unity. What this means is that if ‘stereo enhancement’ is enabled somewhere in our processing structure, applying a signal to the left input will result in an in phase signal coming out of that channel but also a smaller *out of phase* signal coming out of the opposite channel!

*** Please see the notes at the end of this document.*

Why should this be? Please see the following simplified signal path diagram of how Sum and Difference processing is accomplished in Vorsis processing.



Let's consider how this structure behaves with test tones…

- A signal applied to the left channel appears at the left channel output in phase with the input. An *out of phase* replica *also* appears at the *right* channel output at a lesser amplitude.

- A signal applied to the right channel appears at the right channel output in phase with the input. An *out of phase* replica *also* appears at the *left* channel output at a lesser amplitude.

- The same signal applied to both left and right channels in phase will appear at the left and right channel outputs in phase with the input. All of the signal will appear in the sum or L+R channel - no signal will be present in the L-R signal path under this condition.

- The same signal applied to both left and right channel inputs but with the phase reversed on the right channel results in the left channel output in phase with the left input. The right channel output will also be in phase with its input. However, *all* of the signal will be present in the *L-R* signal path – no signal will be present in the L+R signal path under this condition.

The above examples describe the behavior of audio processing utilizing stereo matrices to deconstruct the L and R signals into Sum and Difference components and reassemble them afterwards into L and R signals. In fact, such seemingly odd behavior is *mathematically required* in order for the Sum and Difference matrix to operate!

This behavior is why "one channel driven at a time" separation measurements *cannot* be made on our audio processors unless all Sum/Difference processing is defeated. Otherwise unintentional crosstalk will exist on the undriven channel *regardless* of which input channel is being driven.

Setting Up for Stereo Separation Measurements

Step 1 - Disable the High Pass Filter in the INPUT Screen

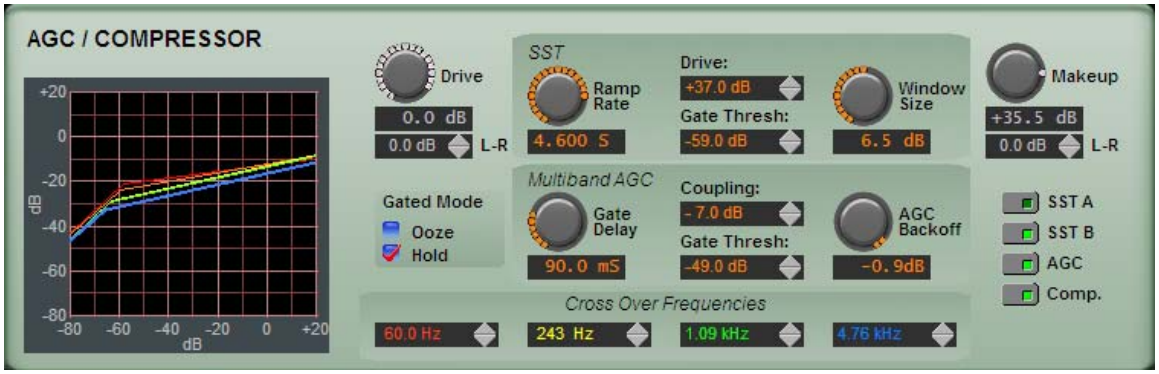
Because Sum and Difference processing is available in several sections of the signal path it is important that all processing associated with it be disabled. This is easily accomplished with a few clicks of the mouse.

In the above graphic of the INPUT screen notice that the High Pass Filter and Stereo checkboxes are checked. This means that the High Pass Filter is in circuit and that identical filter frequencies are being used for the Sum and Difference channels. The High Pass Filters always operate in Sum and Difference mode but in Stereo mode the filters operate with identical filter frequencies tracking the single “Frequency” control. This is mathematically equivalent to operating the filters as a pure L/R pair.

In the above screen the High Pass Filter Sum Freq and Diff Freq are checked and the Stereo checkbox is *not* checked. This means that the High Pass Filter is in circuit and that *different* filter frequencies may be set for the Sum and Difference channels.

It is necessary to uncheck both High Pass Filter checkboxes in order for the High Pass Filters to be *completely* out of circuit.

Step 2 - Disable the Sum/Difference Dynamics Processing



In the above screen the SST B, AGC, and Compressor checkboxes are checked which indicates that dynamics processing is active - the Sum and Difference channels *may* have unequal gains under certain program conditions!

To disable all Sum/Difference processing it is necessary to ***uncheck*** the SST, AGC, and Compressor (Comp.) functions in order for the Sum/Difference processing to be ***completely*** out of circuit.

Step 3 - Disable the Stereo Width Limiter

Our FM audio processors are equipped with a dynamic Stereo Width Limiter whose task it is to manage the maximum permitted width of the stereo sound field as program conditions change. This algorithm prevents over-enhancement of the stereo sound field, moderating inappropriate multipath-like or multipath-induced receiver behavior.

The control for the Stereo Width Limiter is located in the Stereo Encoder screen as shown below.

In order to disable this function it is necessary to adjust the Stereo Width Limiter control until it displays “OFF” in its value window.

What happens if these functions are not turned off?

Excellent question!

When Sum/Difference processing is enabled somewhere in the Vorsis processor's signal chain the measured stereo separation under the 'one channel driven the other channel measured' scenario might be as low as 20dB or perhaps even worse(!) depending on how certain processing and filter controls have been set. The measured separation value highly depends on control settings in the screens we've just discussed and might vary widely with frequency.

Regardless of the desire to quantify the stereo separation of Vorsis processors 'through the processing', measurements made with *any* of the aforementioned processing sections enabled, are, completely meaningless and *invalid*.

Summary

If Stereo Separation measurements are attempted on Vorsis audio processors *without* disabling all of the Sum/Difference processing the measurements will bear no resemblance to the product's true stereo separation performance!

If poor stereo separation is measured then surely one or more of the controls just discussed are not at the settings required for valid stereo separation measurements.

*** The gain of the Difference, or L-R signal can never be greater than that of the Sum or L+R signal path because band-by-band and channel-to-channel ganging techniques in our multiband AGC architecture prevent it. Therefore highly unnatural enhancement of the Difference or L-R signal is impossible.*

(In fact, ANY audio processor utilizing stereo enhancement will exhibit "poor stereo separation" behavior if such enhancement is not completely disabled prior to attempting stereo separation measurements. This is because stereo enhancement creates intentional crosstalk in order to accomplish its effect!)

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