TRIPATH

CLIPPING CHARACTERISTICS OF TRIPATH CLASS-T AMPLIFIERS

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High Frequency Characteristics

If you have measured the output waveforms of Tripath amplifiers using traditional equipment and methods, you may have observed an unusual characteristic in the output waveform when the amplifier is driven close to its maximum output. This characteristic (see Figure 1) appears to be a high frequency oscillation near the waveform peaks.

In reality, this oscillation is an audio quality enhancement characteristic of Tripath digital amplifiers. The observed oscillations are well outside of the audio bandwidth. This application note will explain this characteristic and offer measurement procedures for displaying true audio-bandwidth sound quality.

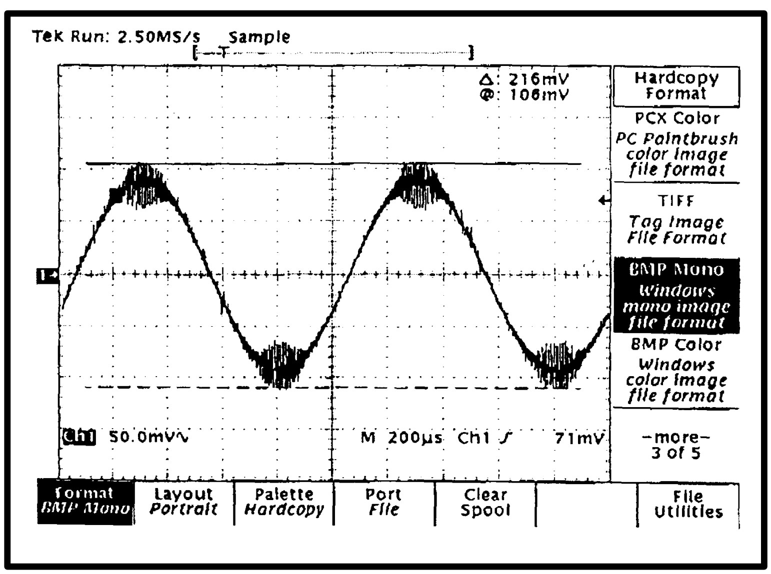


Figure 1: High Frequency Characteristic

Figure 1 is the differential output from the TA1101 driving an 8   load and 12V supply. The differential probe has an attenuation factor of 100 so the output swing is actually 21V peak to peak differential. This scope photo was taken using the simple two-pole l0uH inductor and .22uF output filter normally supplied with the demo board. This output filter has a -3dB bandwidth of 88kHz.

Clipping Noise Detected by DPP - Intelligent Feedback Possible

The output characteristic shown in Figure 1 is normal for all Tripath amplifiers and is a feature of the Tripath unique Digital Power Processor (DPP). The near rail to rail swing of the amplifier output results in overflow conditions within the DPP. These overflow conditions are periodically reset resulting in the observed output characteristic. As the occurrences of this overflow condition increase (by increasing the input signal level), the DPP intelligently outputs an indication on the OVERLOADB pin. Further signal increases will result in higher distortion as the amplifier is pushed towards clipping.

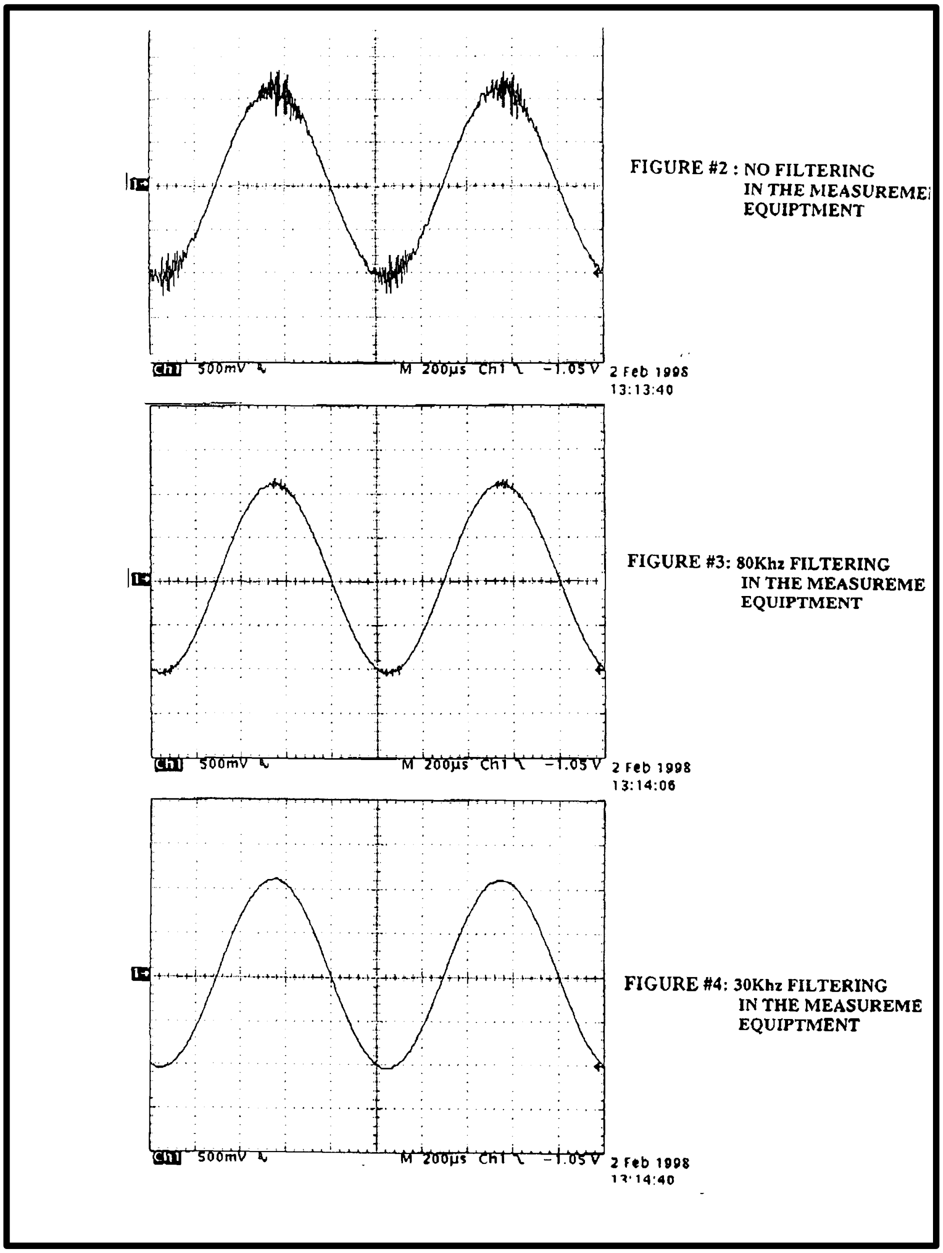
System designers may use this OVERLOADB signal to actively reduce pre-amp gain to avoid clipping. Alternatively an indicator may be designed to notify the listener that clipping is occurring.

Clipping Noise is Beyond Audio Bandwidth

As the input signal to any audio amplifier is increased at some point the output of the amplifier will start to distort and clip. This is a natural condition of all amplifiers that are driven from a fixed voltage power source. When linear amplifiers go into this distortion region they start to clip at the peaks. When the Tripath amplifier goes into this distortion region it exhibits the high frequency breakup of the peaks as shown in Figure 1. A benefit of the Tripath design is its ability to achieve nearly rail to rail swings on the output of the amplifier. It achieves this by gently going into this high distortion region by resetting the processor overloads *at a* ***frequency above the audible range****.*

The output characteristic illustrated in Figure 1 is not an instability or oscillation nor does it degrade the performance of the amplifier in any audible way. The DPP has been designed in such a way as to reset the overflow at ***frequencies well above the audible bandwidth***. Close examination of the frequency of this characteristic indicates that the mixed signal processor is being reset at approximately a 100kHz rate.

In order to examine the effect of low pass filtering the audio output, the output of the TA1101 was passed through an Audio Precision System JI audio analyzer. The Audio Precision analyzer allows for different bandwidth low pass filters to be applied to the output.



Figures 2, 3 and 4: Affect of Filtering

Figure 2 is the audio output (1kHz applied to the input of the TA1101) passed through the Audio Precision equipment without any low pass filtering beyond 88kHz built onto the TA1101 demo board. The input signal level to the TA1101 was increased until the peaks of the output signal exhibited the characteristic breakup.

Figure 3 is the audio output passed through an 80kHz 6-pole roll off low pass filter built into the Audio Precision analyzer (and the same 88kHz 2-pole filter on the TA1101 demo board). Notice how the low pass filter drastically reduces the magnitude of the breakup of the signal peaks.

Figure 4 is the audio output passed through a 30kHz 6-pole roll off low pass filter built into the Audio Precision (and the same 88kHz 2-pole filter on the TA1101 demo board). Notice how the 30kHz low pass filter completely eliminates the breakup of the signal peaks. This confirms that the breakup of the signal peaks is inaudible. (i.e. the frequency of the breakup exceeds 20kHz).

Measuring Total Harmonic Distortion

The technique to accurately measure the THD of a Tripath amplifier is different than a linear amplifier. A detailed explanation for testing switching amplifiers can be found in Application Note 6 – Parametric Measurement of Class-T Amplifiers. This application note describes the signal characteristics of the Tripath amplifier both in and out of the audible range and details methods for accurate measurement in the audio band.

No Intermodulation Noise Generated

The overflow of the mixed signal processor that generates the breakup does not generate any undesired intermodulation effects. Figure 5 shows the FFT of the output of a TA1101 supplied with 9kHz and 10kHz input signals. The input signals are sufficiently large as to cause the mixed signal processor to overflow. Intermodulation distortion would show up as a 1kHz tone (i.e. 1kHz = 10kHz - 9kHz). The FFT illustrates that the 1kHz intermodulation product is 75dB down from the 9kHz and 10kHz input signals.

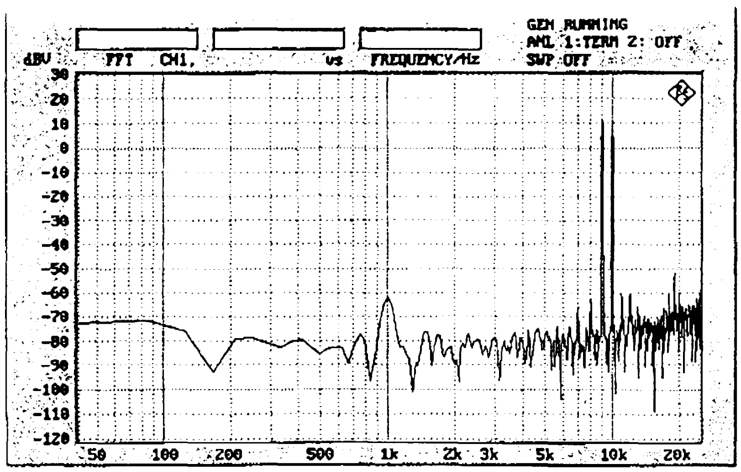


FIGURE #5: FFT OF INTERMODULTION PERFORMANCE

Figure 5: Intermodulation Performance