Why 64-bit processing?

The ARTA64 is an experimental version of ARTA that uses a 64-bit floating point data format for Fast Fourier Transform processing (FFT). Normal version of ARTA uses 32-bit floating point data format.

Both versions will give the same result for spectrum and frequency response estimation as long as we use them for processing of analog data that has been acquired with standard AD converters. Then we can refer to ARTA as a system that is capable of measuring THD+N of the order of -110dB.

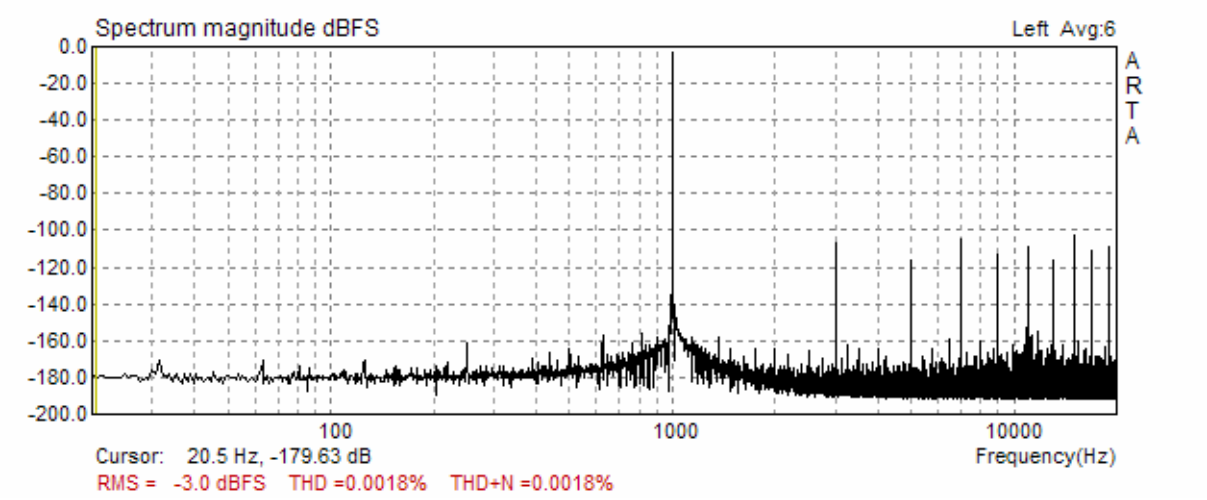

Figure 1 ARTA 32-bit processed FFT spectrum of a 1 kHz signal - measured with Terratec EWX 24/96 SPIDF I/O (loop-back-mode, 16-bit resolution with no dither applied, Kaiser window).

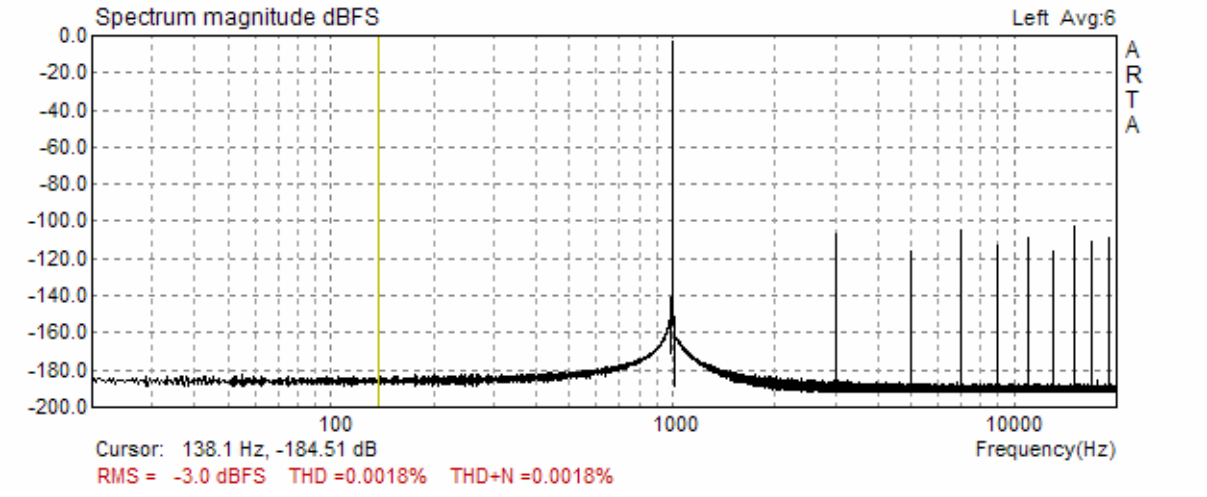

Figure 2 ARTA 64-bit processed FFT spectrum of a 1 kHz signal - measured with Terratec EWX 24/96 SPIDF I/O (loop-back mode, 16-bit resolution with no dither applied, Kaiser window)

A lot of sound cards have digital I/O channels (SPIDF and AES/EBU). It means that ARTA should be also capable for the analysis of digital discrete signals. In that case it is necessary to have a processing engine that is capable of measuring THD+N in the order of -140dB. ARTA64 is targeted for that purpose: the analysis of digital transmission and applied dithering algorithms.

We will show that by the following example.

Figure 1 and 2 shows the FFT spectrum of a 1 kHz signal calculated with 32-bit and 64-bit processing- measured with Terratec EWX 24/96, SPIDF I/O in loop-back-mode. A 16-bit resolution without application of dither is used in both measurements.

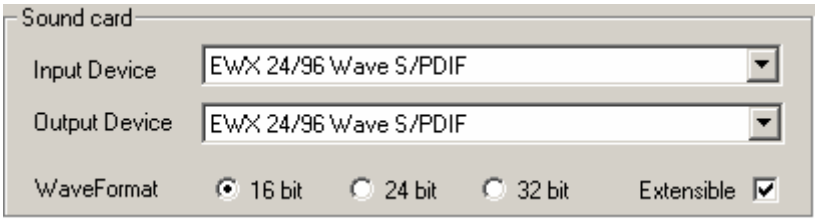

Figure 3 Soundcard 16-bit resolution setup

Results for THD and THD+N are same in both cases, but it is clearly visible that 64-bit processing gives much less "numerical noise". Also obvious is that the harmonic distortion is much higher than the noise level.
Now we demonstrate the idea of dither. Simply spoken, dither is a noise that is intentionally added to the signal in order to lower harmonic distortions that are results of signal quantization.

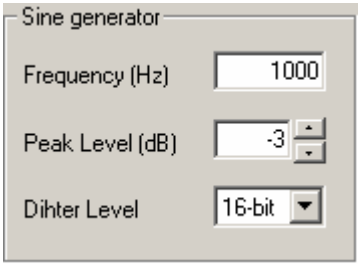

Figure 4 Adding dither noise to sine generator output

Figure 5 and 6 shows a spectrum with added dither (at level of 18-bit and 16-bit LSB). The measurements clearly show that THD is much lower with added dither, but THD+N is slightly larger. Note that 16-bit dithering has totally eliminated the higher harmonic components and all distortions are due to the noise.

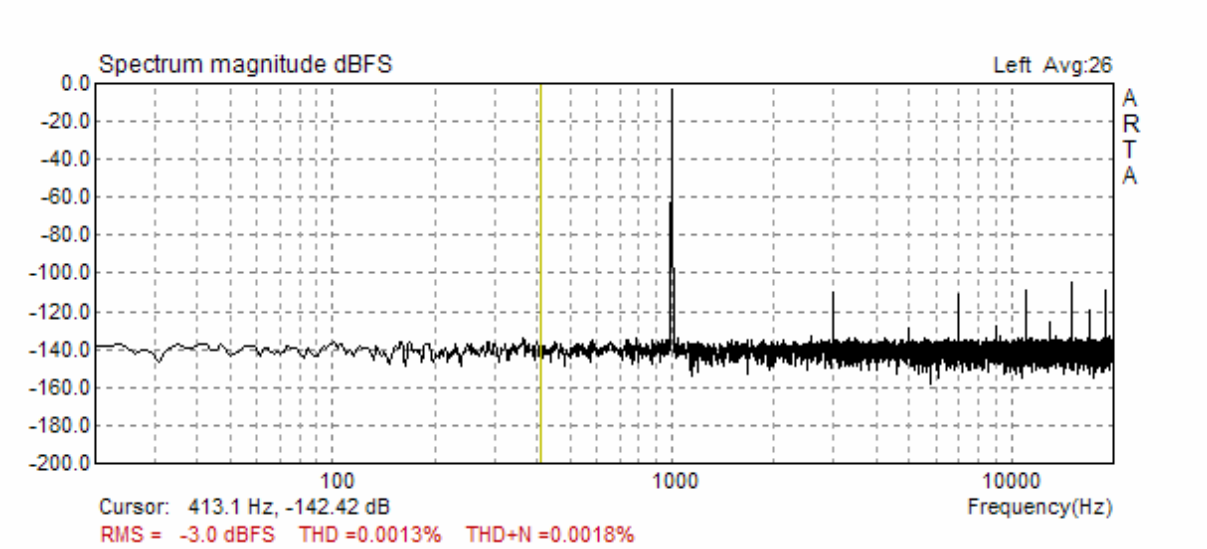

Figure 5 ARTA 64-bit processed FFT spectrum of a 1 kHz signal - measured with Terratec EWX 24/96, SPIDF I/O (loop-back-mode, 16-bit resolution with 18-bit dither applied)

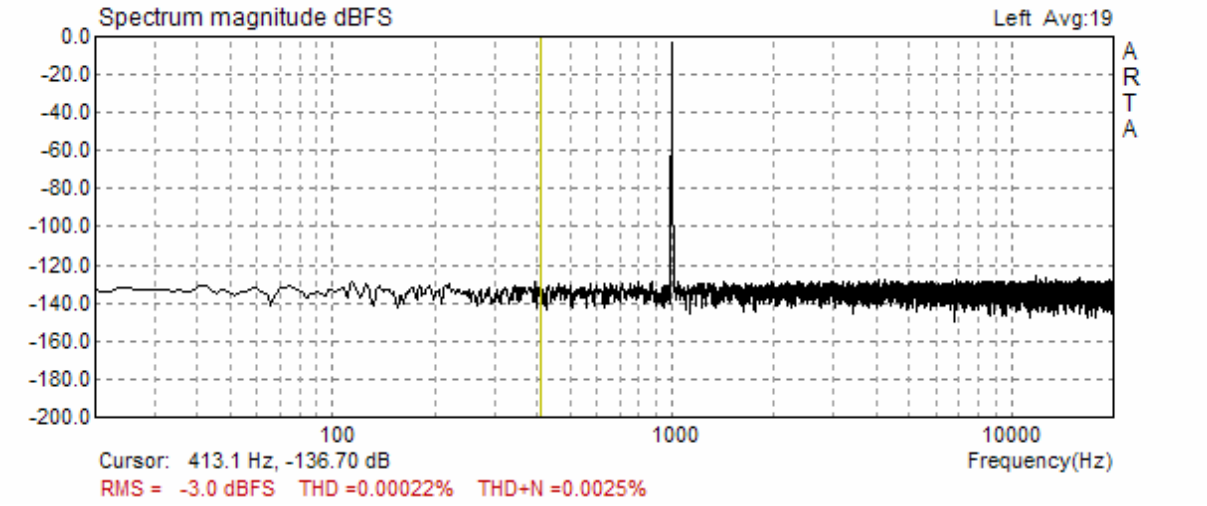

Figure 6 ARTA 64-bit processed FFT spectrum of a 1 kHz signal - measured with Terratec EWX 24/96, SPIDF I/O (loop-back-mode, 16-bit resolution with 16-bit dither applied)

Now if we put ARTA in 24-bit resolution mode we get the spectrum of a 1 kHz sine signal as shown in Fig. 8.

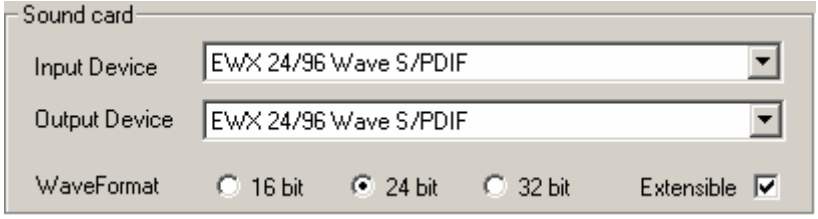

Figure 7 Soundcard 24-bit resolution setup

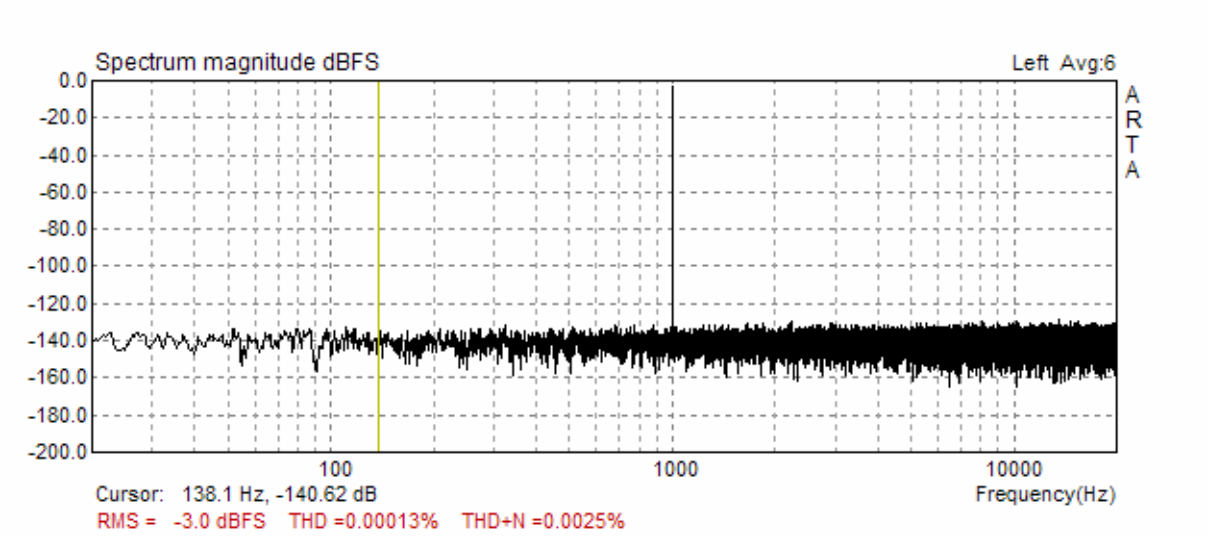

Figure 8 ARTA 64-bit processed FFT spectrum of a 1 kHz signal - measured with Terratec EWX 24/96, SPIDF I/O (loop-back-mode, 24-bit resolution with no dither applied in ARTA)

Although the measurements A/D resolution is much higher than with 16-bit resolution we get the same results as with 16-bit resolution and applied dither. It is obvious that the manufacturer of the soundcard has applied a dithering algorithm in the card's driver software. We can conclude that in this case of 24-bit resolution it is not necessary to apply additional dither, as it already has been applied. We also can conclude that in this case there is no benefit of using a 24-bit resolution in signal generation, as the card itself gives the same resolution as in the dithered 16-bit resolution mode.

Finally, we can ask what is the best results we can expect from an ideal system with a 24-bit resolution.

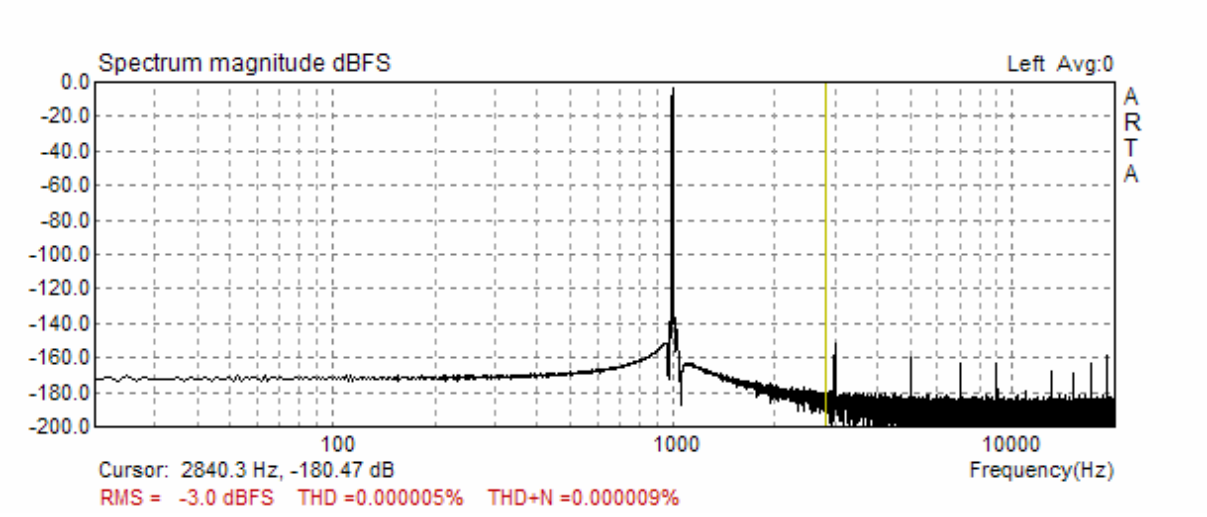

Figure 9 Numerical simulation of a spectrum and quantization distortions of a 1kHz sine signal in an ideal system with a 24-bit resolution (Kaiser window).

Figure 9 shows numerical simulation of a spectrum and quantization distortion of 1kHz sine signal in an ideal system with 24-bit resolution. Simulation shows that THD and THD+N are lower then 0.00001% (-140dB).

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The ARTA64 uses 1MB memory more than the ARTA. It also uses more processor time for FFT processing, but it gives more precise evaluation of modern high resolution audio systems. It enable us to make measurement of harmonic distortions that are lower than -140dB.

In practical acoustical measurements there is no need to use the ARTA64.