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AN-20
CDK8307 Noise Performance in Ultrasound Applications

Introduction

When evaluating the performance of an Analog-to-Digital Converter (ADC), the parameters indicated in the data sheet might not be specific enough to address the performance when used in ultrasound applications.

This application note evaluates the noise density of the CDK8307 over the Ultrasound frequency band, and over the Doppler frequencies.

The results in this application note are based on measurements taken using a CEB8307 evaluation board. The following parameters were measured:

- Sampling Frequency (FS) = 40MHz
- Input Frequency = 8MHz
- SINAD = 70.9dBc (71.76dBFS)
- Noise Density = 44.8nV/√Hz

The Noise Density is defined as:

$$V_n = \frac{V_{pp\_rms} \times 10^{\frac{-SINAD}{20}}}{\sqrt{BW}}$$

Where BW is the bandwidth where the noise density is calculated.

CDK8307 Performance

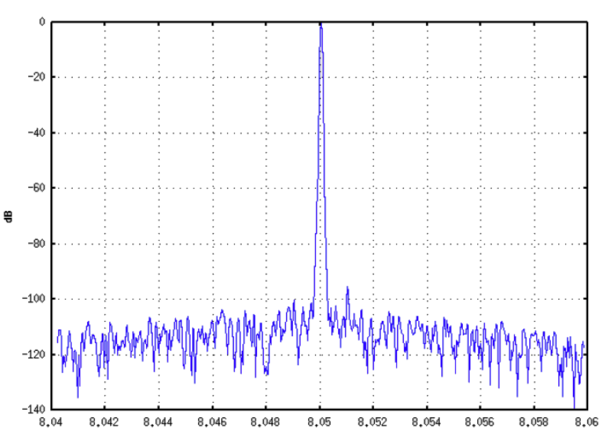

Figure 1: FFT of CDK8307 Output - Doppler Band

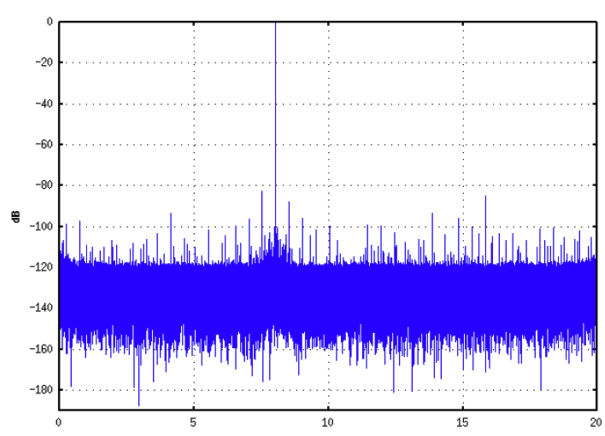

Figure 2: FFT of CDK8307 Output - Entire Nyquist Band

SINAD in the Ultrasound Band

In ultrasound, the lower frequency is normally between 0.7MHz and 1.3MHz. In these calculations, 1MHz was used for the Ultrasound start frequency.

The upper ultrasound frequency is normally between 15MHz and 20MHz. In these calculations, 19.8MHz was used.

By using these numbers, the total ultrasound frequency band becomes BW=19.8MHz-1MHz = 18.8MHz. The following results were obtained:

- SINAD = 71.4dBc (72.3dBFS)
- Noise Density = 43.6nV/√Hz

The reason for the deviation between the noise density in the entire band end versus the ultrasound band, is that the frequency band between DC and the lower Ultrasound frequency has a higher noise density. The noise density is caused by low frequency sources like flicker noise in ADC and measurement setup. When these are omitted from the calculation, the average noise density is reduced.

SINAD in the Doppler Band

When performing doppler measurements, a full scale signal is applied, and the noise is calculated in the frequencies very close to the carrier.

For the lower Doppler frequency (Fdop_lo), a frequency shift of 200Hz and 1kHz is used.

For the upper Doppler frequency (Fdop_hi), a 10KHz frequency shift is used.

Since both positive and negative frequency shifts must be taken into account, the total Doppler frequency band becomes:

BW = 2 x (Fdop_hi - Fdop_lo)

Doppler BW: 1kHz-10kHz

When integrating the noise from 1kHz to 10kHz on both sides of the carrier, the Doppler frequency band is:

BW = 2 x (10kHz - 1kHz) = 18kHz

And the following results are obtained:

- SINAD = 89.8dBc (90.7dBFS)
- Noise Density = 169nV/√Hz

Doppler BW: 200Hz-10kHz

When integrating the noise from 200Hz to 10kHz on both sides of the carrier, the Doppler frequency band is:

BW = 2 x (10kHz - 200Hz) = 19.6kHz

And the following results are obtained:

- SINAD = 88.3Bc (89.1dBFS)
- Noise Density = 195nV/√Hz

The noise density is higher in this band for two reasons:

- Close to the carrier, the noise from the signal generator will not be filtered and will contribute to the output noise
- Internal low frequency noise from clock and ADC references will have a high density in this band

Resulting FFT plots are shown in Figures 1 and 2.

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