EVALUATION OF SHORT-TIME INSTABILITY OF GENERATORS USED FOR ADC TESTING

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Abstract – A quality of an evaluation of dynamic parameters of ADCs and AD modules is strongly dependent on the quality of testing signal generator. The most important parameters are SNR and the spectral purity (THD). Besides, the short-time frequency and amplitude stability is also necessary to take into consideration, but it is often marginalized. However, it also influences an accuracy of the further evaluation. The possibility, how to estimate this imperfection, is presented in the paper.

Keywords: ADC testing, testing signal, short-time instability

1. INTRODUCTION

Low-distortion generators are usually used for testing of the dynamic quality of ADCs and AD modules. Generators based either on classical tuned low-distortion oscillators or on digital frequency synthesis are used for this purpose. Because more than one sinus period is usually sampled (several tens or hundreds), a problem of the short-time instability (frequency and amplitude) of testing signal arises. It concerns primarily the non-coherent sampling, of course, and it could be proved not only by the testing of the ADCs in the time domain (best sinewave curve fit test) but also by the testing in the frequency domain (DFT/FFT test). The short-time instability of testing signal results in decrease of a quality of the testing procedure, which causes a worsening of the measured parameters of tested ADCs.

2. BEST SINWAVE CURVE FIT METHOD

Provided a very good short-time stability of the gain and the sampling frequency of the tested AD module, a side effect of the best sinewave curve fit test can be used for the evaluation of the short-time instability of a testing signal. This method fits an ideal sinus function to the measured data, which correspond to the real waveform including all instabilities. Then it is easy to count residuals (differences between measured and fitted waveforms) and to observe their time dependence, which corresponds to the instability of the used generator. The transportable reference AD device designed and developed in FEE CTU for a comparison of ADC testing systems [1] was used for this purpose. The typical results are shown in the Fig. 1. There is no visible instability in the case of the Fig. 1a. The results in the Fig. 1b and 1c indicate an instability, but it is not possible to evaluate the type of it (either amplitude or frequency). However, it enables the Fig. 2, where the
residuals of all samples are recalculated and displayed to one period of the testing signal.

The position of maximal residuals depends on the type of the instability (see Fig. 3). If residuals achieve their maximums in the location of peak values of the testing signal, the amplitude instability is detected (Fig. 3a). Maximums of residuals near zero crossings of the testing signal indicate the frequency instability (Fig. 3b). How it follows from the comparison of the Fig. 2 and 3, the residuals displayed in the Fig. 2a correspond to the signal with an amplitude instability, whereas the residuals displayed in the Fig. 2b to a frequency instability.

3. FFT METHOD

Significant short-time frequency instability is visible also in the frequency spectrum of testing signal. It appears like a slight deviation from the first harmonic component (see Fig. 4b). The less significant instability is hardly noticeable (Fig. 4c) though it can influence the test results.
4. HOW INFLUENCES SHORT-TIME INSTABILITIES THE EFFECTIVE NUMBER OF BITS EVALUATION

The short-time instabilities influence the credibility of results of the both methods used for the effective number of bits (ENOB) evaluation. A random character of the arising errors causes a great dispersion of results. The irregularities in the graphs published in the Fig. 5 and 6 are an outgrowth of it.

The best sinewave curve fit test is more sensitive to the short-time instabilities (compare the Fig. 5a and 5b). An significant error can cause even such small short-time instability, which is not visible in the frequency spectrum (compare the Fig. 5a and 4c).

Concerning the FFT method, it partially suppresses the both short-time instabilities. It is an effect of the used algorithms of ENOB evaluation, where several bins around the first harmonic are eliminated because of windowing (width of the window-lap in the frequency domain). Only a greater instability influences the results by using this method (Fig. 5b, generator KH 4400A).

Using the both methods, the more samples are processed, the more both instabilities prove. This is visible especially in case of applying the best sinewave curve fit test method (Fig. 6a). FFT graphs are essentially smoother because FFT method eliminates the influence of the instabilities (Fig. 6b).

5. CONCLUSION

The described method, which utilises the side effect of the best sinewave curve fit test, enables a good detection of short time instabilities of a sinusoidal signal. The type of instability can be determined form the position of maximal residuals. It is more sensitive then the evaluation of the short-time frequency instability using frequency spectrum. Concerning the short-time amplitude instability, it is also heavily traceable using classical methods of measurement (RMS value measurement etc.).

The short-time instability can be one of reasons of a possible difference between the results by application of the FFT test and of the best sinewave curve fit test. The results for one input signal frequency (2333 Hz) and two different numbers of samples are published in Table I as an example (32 kSa correspond to the sampling of 470 periods and to the time about 200 ms). The ENOB of the transportable reference AD device was measured using different
generators and different numbers of samples applying both methods for the data processing.

Table I. The determined value of ENOB of the transportable reference AD device (the input signal frequency 2333 Hz)

<table>
<thead>
<tr>
<th></th>
<th>SR DS 360</th>
<th>KH4400</th>
<th>R&amp;S UDP</th>
</tr>
</thead>
<tbody>
<tr>
<td>32 kSa</td>
<td>32 kSa</td>
<td>128 kSa</td>
<td>32 kSa</td>
</tr>
<tr>
<td>128 kSa</td>
<td>128 kSa</td>
<td>32 kSa</td>
<td>128 kSa</td>
</tr>
<tr>
<td>FFT</td>
<td>14.0</td>
<td>14.0</td>
<td>13.1</td>
</tr>
<tr>
<td>sine fit</td>
<td>14.0</td>
<td>14.0</td>
<td>12.1</td>
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<tr>
<td>difference</td>
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<td>1.0</td>
</tr>
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</table>

REFERENCES


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