SINE WAVE TEST OF ANALOG TO DIGITAL CONVERTERS

János MÁRKUS
Advisor: István KOLLÁR
Technical University of Budapest
Department of Measurement and Information Systems

I. Introduction

Nowadays most measuring instruments are digital. This means that these instruments use analog to digital converters (ADC's).

ADC's have been in use for more than 20 years, however there is still no measurement and testing method standard, which could be used either by the manufacturers or by the users. So, two ADC's made by two different manufacturers are often not comparable, because of the different testing and measuring methods.

To fill this gap in the industry standard, IEEE has begun new projects a few years ago. The aim of the projects is to standardize the terminology and test methods for both the digitizing waveform recorders [1] and the analog to digital converters [2]. There is also a European Workgroup, EUPAS[1], whose task is to manage these standardization projects in Europe [3]. Our department takes part in the examination of the existing test methods described in the draft standard [4] and has already implemented some of them in a MatLab environment [5].

II. The sine wave test method

Using only a few general methods, most of the tests presented in the IEEE standard can be performed. Maybe the most prevalent method is the sine wave test. The basic idea of the test is the following: a computer, using the ADC under test measures an excitation analog sine signal. From the samples the sine wave's parameters are determined (using signal processing methods, e. g. DFT or parameter fitting). Finally, subtracting the calculated sine wave from the samples, a residual vector is taken, suitable to describe several ADC's parameters, e. g. SINAD or THD [2], [4]. Further advantages of using a sine wave is that appropriate sine wave sources are readily available and it is relatively easy to establish the quality of the sine wave.

III. The LabView software

To get the parameters of the applied sine wave there is a LabView software (a *Virtual Instrument*) available, which has been made by a workgroup working in the IEEE TC-10 [6]. The output of the program – which is a graphical "display" of a virtual instrument – contains information about the input data vector, and shows different computed parameters. It utilizes a 3-parametric (known frequency) LS

[1] European Project on ADC Standardization

fitting [2] to find the parameters of the measured sine wave (amplitude, phase, DC) and from the residuals it calculates some other parameters, too (SINAD, THD, residuals-plot and power spectral distribution function).

IV. MATLAB realization

As today's quasi-standard program is MATLAB in signal processing, it is worth to implement this test program also in a MATLAB environment. The first aim is to make a graphically and algorithmically LabView equivalent software. The advantage of such a program is that both MATLAB and LabView users can use the same language and the same algorithm when they talk about ADC testing. Further aim is to implement some other features, which can make this software package more useful and interactive. Some example:

- The implemented LabView software is not platform-independent. Testing it on a PC, several graphical problems offer (buttons, figures disappear sometimes, etc.). Furthermore, the graphical interface is not really user-friendly. E. g. it would be very useful to plot the input data vector, and enable the user to select the program's input graphically from the record.
- The program does not support 4-parametric sine wave fitting yet. There are also other computing methods in the standard (e. g. DFT, windowing) to get the same and other ADC-related parameters, which are not easy to implement in a VI environment, but very easy to implement in MATLAB [4], [5].

V. Future plans

The aim of the current project is to implement in MATLAB all the functions has the LabView program and extend the program with the desired features.

Furthermore, as the ADC tester MatLab program applies the newest standards and recommendations, it is a daily, common, free and useful tool for all of those engineers, who works in the field of signal processing.

VI. References

[1] *IEEE Standard 1057*, "IEEE Standard for Digitizing Waveform Recorders", published December 1994.

[2] *IEEE UNAPPROVED DRAFT Standard 1241*, "IEEE Standard for Terminology and Test Methods for Analog-to-Digital Converters", edited May 1999.

[3] IMEKO TC-4 EUPAS and "A/D and D/A Metrology" Workgroup,
URL: *http://remlab.dis.unina.it/Vpages/ADCWG.htm*

[4] I. Kollár, "Evaluation of Sine Wave Tests of ADC's from Windowed Data" *4th IMEKO TC4 Workshop on ADC Modeling and Testing*, Sep. 9–10, 1999, Bordeaux, France.

[5] B. Vargha, "3-parametric fitting of a sine wave as described in the 1241 IEEE Standard" MatLab-based program, *TUB, Dept. of Measurement and Information Systems*, Budapest, 1998.

[6] STD 1241 Home Page
URL: *http://grouper.ieee.org/groups/1241/*