A MATLAB TOOL TO USE AND TEST THE ADC-STANDARD

János MÁRKUS
Advisor: István KOLLÁR

I. Introduction

In 1996 IEEE1 began a new project. The aim of this project is to standardize the test methods and also the terminology for analog-to-digital converters [1] and it is based on the approved standard of digitizing waveform recorders [2]. At the time of writing this paper the standard [2] is entering the balloting phase and will be approved by the summer of 2001 or later.
Studying the draft standard, it can be quickly concluded that even the one-step algorithms may have different implementations (e.g. because of the different number representations and calculation methods). The problem is even more complicated using iterative algorithms (e.g. with the 4-parameter fitting). Furthermore, the currently available version of the standard [1] contains no exact suggestions about the selection of initial values or the stop criterion of the four-parameter fitting. These problems cause that users with different programs may conclude at different results, even using exactly the same data.

II. Conception

The problem described in the previous section can be solved by providing standard programs, which can be used by anybody for data processing or for comparison. Hence, our aim was to develop an internationally available program, which implements all the tests and calculates all of the parameters, which can be derived from measured data. For this purpose we have chosen the quasi-standard engineering tool, MATLAB because of its portability and availability.
To make the program more useful, we plan that it will have four different modes. These are as follows:

1. LabView test evaluation program compatible mode

In this mode the software uses the same algorithm and the same user interface as the already developed LabView one. For more information about this mode see [3]. We have already publicized this mode as a stand-alone program [4] [5].

2. IEEE-STD-1241 mode

Using this mode, the software uses only the algorithms described in the standard. The algorithms and all non-determined steps will be fully and carefully documented.
Some example:

- 3 and 4 parameter sine wave fitting [1, 4.1.4]
- Windowed/non-windowed DFT2 [1, 4.1.5]
- Static transfer curve determining [1, 4.1.6]
- Intermodulation distortion [1, 4.4.6]
- Noise Power Ratio measurement [1, 4.5.4]
- Step response parameters [1, 4.6]
- Frequency Response parameters (Bandwidth, Gain error) [1, 4.7]

[1] The Institute of Electrical and Electronics Engineers
[2] Discrete Fourier Transformation

3. Graphical mode

The graphical mode is an extended version of mode 2. This means that some additional useful graphical plots [6],[7] can be selected to display. Fig. 1 shows the Modulo Time Plot which plots the residuals (the error vector) wrapped, as a function of the fitted sine wave phase instead of the time.

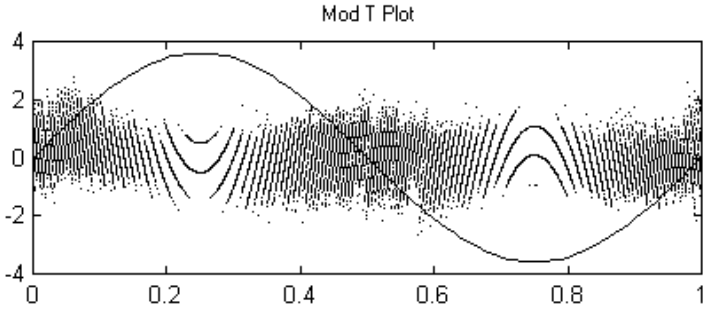

Figure 1: An example: the Modulo Time Plot [6]

4. Advanced mode

In this mode some non-standardized calculation is available. Two example of this mode:

- Improved sine-wave fitting using better initial frequency estimation [8]
- SIDAC[3], an alternate method to determine the applied sine wave and to give better result [9]

III. Summary

The project described in the previous sections has several advantage:

- everybody uses the same algorithm for testing
- the program defines the non-definite details of the standard
- easier and faster convergence to the standard methods of testing
- new algorithms and test methods can be realized and compared to the existing standard within the same program (international co-operation for standardization)

At the time writing this abstract, a first release of this software can already be downloaded through the Internet, from the website described in [5].

References

[1] IEEE Draft Standard 1241, "IEEE Standard for Terminology and Test Methods for Analog-to-Digital Converters", February 2000.

[2] IEEE Standard 1057, "IEEE Standard for Digitizing Waveform Recorders", Dec. 1994.

[3] J. J. Blair, "Sine-fitting Software for IEEE Standards 1057 and 1241", *Proc. IEEE Instrumentation and Measurement Technology Conference, IMTC/1999*, Venice, May 24–26, 1999. pp. 1504–1506.

[4] Kollár, J. Márkus, "Sine Wave Test of ADC's: Means for International Comparison", IMEKO TC4 Workshop on ADC Modeling and Testing, Vienna, Sep. 26–28, 2000. Proc. Vol. X., pp. 211–216.

[5] "*ADC Test Data Evaluation Program for Matlab*" Home Page, http://www.mit.bme.hu/services/ieee/ADC-test

[6] F. H. Irons, D. M. Hummels, "The Modulo Time Plot – A Useful Data Acquisition Diagnostic Tool", *IEEE Trans. on Instrumentation and Measurement*, Vol. 45, No 3, pp. 734–738. June 1996.

[7] J. J. Blair, "A Method for Characterizing Waveform Recorder Errors Using the Power Spectral Distribution" *IEEE Trans. on Instrumentation and Meas.*, Vol. 41, No 5, pp. 604–610. Oct. 1992.

[8] Kollár, "Evaluation of Sine Wave Tests of ADC's from Windowed Data" *Computer Standards and Interfaces,* Vol. 22, pp. 261-68, 2000.

[9] G. Vandersteen, Y. Rolain, J. Schoukens, "System Identification for Data Acquisition Characterization", IEEE Instrumentation and Measurement Technology Conference May 18–21, 1998, St. Paul, USA, pp. 1211–1216.

[3] Signal Identification for Data Acquisition Characterization