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ADC test library in LabVIEW

Ján Šaliga, Jozef Lipták, Vojtech Vitkovič, Linus Michaeli

Technical University of Košice, Letná 9, 04200 Košice, Slovakia
{jan.saliga, jozef.liptak, linus.michaeli}@tuke.sk

***Abstract* – ADC testing requires post processing of the acquired data for the estimation of ADC parameters. LabVIEW, as a very popular tool for development of various control and measurement applications, offers many specialized toolkits and libraries, but a specialized library of functions focused at data processing from ADC testing has been missing until now. Therefore, on the basis of previous works and experience, the Authors have developed a specialized library fully programed in LabVIEW, which offers a variety of high and low level functions – VIs or Virtual Instruments – which markedly simplify the development of any data processing software based on standard test methods. One example of application of the library is the demonstration software accessible across the Internet in the form of web application. It enables performing simulated measurements according to all basic ADC test methods (static, histogram, and dynamic, with processing in time domain and spectral domain). By choosing from among different test condition, the user can also learn and find out how the test conditions can affect the achieved results.**

I. INTRODUCTION

ADC testing means not only to build a convenient test stand with high quality instrumentations but also to implement digital signal processing of the measured data. The test standards [1], [2] and recommendation [3] define the basic formulas for the processing and also other formulas for setting up the test conditions. The Authors have been working in the field for years and developed in the past a specialised class of functions in C language for such a data processing [4]. In the last years LabVIEW by National instruments has become more and more popular for many different applications in industry and research and therefore the Authors decided rebuild the library according to newest versions of relevant standards and rewrite it in LabVIEW. The library is compatible in data file format with different similar tools, e.g., Matlab toolbox [5].

Moreover, based on previous experience [6], the Authors decided to disseminate the achieved results and making them available especially for students, letting them meet with ADC testing and with the influence of ADC test conditions on final estimation of measured parameters, by using the web based demonstration software.

II. ADC TEST LIBRARY

The library employs the formulas published in the newest ADC test standards as well as formulas from the older EU project DYNAD. In highest-level VIs, the user can simply choose the standards according which the calculation has to be performed. The Authors aim was to make the structure of the library as simple as possible, i.e., to create very restricted systems of high-level functions with embedded multifunctionality, which can be easily configured by the user (Express VI). The library offers also “medium” level functions, which are subVIs of highest level multifunctional VIs.

The library consists of the following classes:

- Static test
- Sinewave histogram processing two subclasses
    - Test conditions
    - Histogram test
- Dynamic test with two subclasses
    - Test in time domain
    - Test in spectral domain including coherent and incoherent sampling

For easy building of applications with reading and saving data, the library was spread by File class with high level Read and Write VIs, supporting a wide variety of data file formats. Moreover, for users who only want to simulate ADCs, the library offers a VI which simulates complex hardware including ADC with ideal properties, as well as with a chosen nonlinearity typical for some common ADC architectures such as Sigma-delta, successive approximation and flash parallel architecture, including stochastic behaviour given by additional input noise. The simulated ADC is stimulated by a simulated signal generator. Parameters of the signal can be set by the user.

The library is followed by help in standard Microsoft .chm format, which can be simply integrated in LabVIEW help structure. For the illustration of the achieved results, a few examples of VIs from the library are described in following.

A. Hardware simulation VI

This VI (Fig. 1) simulates complex hardware in ADC

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testing. The cluster "Input parameters" allows user to determine basic parameters of stimulus signal and ADC working conditions such as:

- Sampling rate,
- Number of samples,
- Frequency of stimulating signal,
- Amplitude of stimulating signal,
- Offset of stimulating signal,
- Standard deviation of additive Gaussian noise standard deviation,
- Phase of stimulating signal.

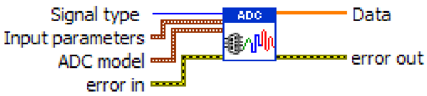

Fig. 1 Icon of the hardware simulation VI.

The cluster "ADC model" allows user to determine characteristics of simulated ADC under the test:

- ADC resolution
- ADC architecture is a selection from the required ADC architecture:
  - o Sigma-delta,
  - o Flash,
  - o Successive approximation.
- Maximum nonlinearity specifies the maximum deviation of the ADC transfer characteristics from the ideal one in LSB.

B. Express Test conditions VI

This VI (Fig. 2) allows the user easily calculate test conditions for sinewave histogram test.

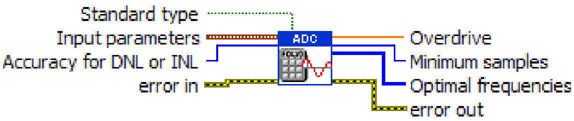

Fig. 2 Icon of Express Test conditions VI.

The input "Standard type" determines the standard according which the test conditions have to be determined (IEEE/DYNAD). The cluster "Input parameters" contains requirements of the user, uncertainty, and some additional information describing the test stand such as:

- Standard deviation of additive Gaussian noise,
- ADC resolution in bits,
- Tolerance of code bin,
- Ideal code bin with,
- Confidence level.

"Accuracy for DNL or INL" defines what type of histogram test has to be performed. On the VI output, the user will obtain the array of optimal frequencies fulfilling the condition of coherent sampling, minimal length of record for correct histogram test, and value of signal overdrive at the ADC input.

C. Express Test in frequency domain

This VI (Fig. 3) allows processing of the record from dynamic test, and calculation of ADC parameters in spectral domain according to the chosen standard.

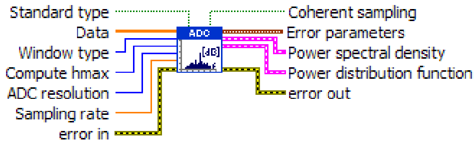

Fig. 3 Icon of Express Test in frequency domain.

The VI automatically determines what sampling condition was applied while testing, and chooses a convenient – coherent or incoherent – signal processing method for calculation of ADC error parameters.

III. CONCLUSION

The developed library allows very fast and effective development of software in LabVIEW for ADC testing according to the standards. The library is accessible on http://meas-lab.fei.tuke.sk/ADC_test.

As an example of application of the library, software demonstrating all common ADC test methods accessible across the Internet was developed. Here any user can perform simulated test, change ADC characteristics and test conditions, and can learn how these condition influence results of testing.

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