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DYNAMIC CHARACTERISATION OF ANALOGUE-TO-DIGITAL CONVERTERS

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Preface

The present book is one of the outcomes of the project DYNAD - Methods and Draft Standards for the Dynamic Characterization and Testing of Analogue-to-Digital Converters. This project was held between 1997 and 2000, supported by the European Commission under the Standards, Measurements and Testing Programme, reference SMT4-CT98 2214, within the Framework IV activities. Its consortium comprised the University of Parma - Italy, the École Nationale Superieure d’Electronique, Informatique & Radiocommunications de Bordeaux - France, Thales (former TTM-Thomson CSF) - France, Italtel Spa - Italy, Infineon Technologies-Development Center Villach - Austria, and INESC-Porto - Portugal. Besides the authors of the different chapters of this book, other people contributed with their work to the start and success of the initiative. We acknowledge the efforts of Hubert Pernull, Otto Wiedenbauer, and Andreas Bertl from Infineon, Roberto Scotti from Italtel, Jorge Duarte and José Matos from INESC-Porto, M. Heuber and M. Zirnheld from Thales, and C. Rebai from ENSEIRB.

A state of the art overview of the methods and procedures employed for characterising the dynamic performance behaviour of analogue-to-digital converters using sinusoidal stimuli, is presented in this book. The three classical methods — histogram, sine wave fitting, and spectral analysis — are thoroughly described, and new approaches are proposed to circumvent some of their limitations.

This is a must-have compendium, which can be used by both academics and test professionals, to understand the fundamental mathematics underlining the algorithms of ADC testing, and as a handbook to help the engineer in the most important and critical details for their implementation.

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ROY, Pierre-Yves received the Engineer Diploma of the Ecole Nationale Superieure De Telecommunication de Bretagne ENSTB in 1995. He started his career working for Thomson-CSF (Thales now); first for Thomson-CSF Airsys (Thales Air Defence Systems) as a radar receiver designer, and then for Thomson-CSF Technologies and Methods (Thales research and Technology) as an expert in data conversion. When he was in Thales, his main areas of interest concerned high dynamic signal receivers and the functional testing of ADCs. In 2000, he joined EADS Telecom to manage the design of the architecture (and of the associated components) of their 3G secured radiocommunication terminals. He is now terminal architect for EADS Telecom.
Introduction

José Machado da Silva

ADCs are, eventually, the most pervasive analogue blocks in electronic systems. With the advent of powerful digital signal processing and digital communication techniques, ADCs are fast becoming critical components for system’s performance and flexibility. Knowing accurately all the parameters that characterise their dynamic behaviour is crucial, on one hand to select the most adequate ADC architectures and characteristics for each end application, and on the other hand, to understand how they affect performance bottlenecks in the signal processing chain.

At present, most of the signal processing performed in electronic systems is becoming digital, and the role of the ADCs placed at the borders of the digital domain acquires a particular relevance, since the signal degradation introduced by these components cannot normally be recovered by subsequent processing. Both the markets of stand-alone ADCs and of ADC macrocells to be embedded in complex systems-on-chip, benefit from the availability of performance parameters accurately describing their expected behaviour, and of clearly specified test methods to be used for their measurement.

When the project DYNAD started, the standardization of ADC test procedures was not so well developed. Two standards existed, in particular, at that time — the IEC 60748 and the IEEE Std 1057. The former covers only quasi-static operation, while the second deals with dynamic testing but, being addressed at digital waveform recorders requires some adaptations to cover ADCs. A first aim of DYNAD project was then, to contribute to the improvement of the European rules concerning test methods for ADCs, by proposing an integration within IEC 60748 addressing the parameters specifying the dynamic behaviour of ADCs, measurement conditions, and data processing algorithms. By the end of year 2000 a working group from the IEEE Instrumentation and Measurement Society Technical Committee (TC-10) completed the IEEE 1241 Standard for Analog to Digital Converters. This standard, as well as...
contributions from the DYNAD project, are now being incorporated into an IEC standard on dynamic testing of ADCs. Other initiatives have been carried-out concerning standardization of ADC testing methods. One can also mention EUPAS (EUropean Project for ADC-based devices Standardization), and the IMEKO Technical Committee 4 (A/D and D/A Metrology WorkGroup).

The main objective of the DYNAD project was the study and evaluation of ADC testing methods based on the use of sinewave test stimulus. A second aim was to investigate and propose new test methods to circumvent the limits of the measurement instrumentation, which is strongly challenged by today’s high resolution, high speed converters. Techniques for the measurement of parameters required by specific applications (e.g. audio hi-fi) and for the debugging of new converter designs were also investigated. Dissemination of the knowledge gathered during the activity was the third objective.

That work is now compiled in this book, which is structured in two main parts. Part one comprises chapters one to six. The first one provides an overview of the most important ADCs’ architectures and respective fields of application. An introduction to the most relevant nomenclature and definitions of terms is also presented. Chapter two describes the generic architecture of an ADC test setup, and guidelines and best practice procedures are proposed in order to guarantee reliable test results. Chapters 3, 4, and 5 are devoted to the description of dynamic test techniques using sinewaves, respectively, sinewave fitting (time domain data analysis), discrete Fourier transform (frequency domain analysis), and code histogram test (statistical domain analysis). These techniques are thoroughly described, as well as the fundamental mathematical background behind the equations to be used to obtain ADCs’ characterization parameters provided in each case. A comparison among these three methods is presented in chapter 6. The objective is not to find the best or the worst methods, but mainly to compare how they behave when test conditions are not ideal and to identify their requirements in terms of test time and volume of data. Examples of ATE implementation are also included.

The second part comprises chapters 7 to 10, which provide additional information to test for other relevant parameters, such as jitter, differential gain and phase, step and transient response, and hysteresis.