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Analog, Mixed-Signal, and Heterogeneous System Design
Introduction

The design of analog and mixed-signal (AMS) systems has—unfortunately—never been done in a really systematic way. Until now, analog design is done rather bottom up and in an intuitive way. Therefore, the design of analog circuits has often been compared with “black magic”. The lack of methodology was—and is—acceptable for small, stand-alone analog circuits that are functionally well separated from digital components.

Today’s AMS systems no longer fulfil these conditions. Therefore, AMS designers face a number of challenges.

- The shrinking of analog circuits causes increasing process variations. This requires a more complete and more systematic verification, especially applying Monte Carlo Simulation, corner-case analysis, and regression tests. However, for reliable results many simulation runs (100–100,000) are needed. Considering the run time for numerical analog simulation, new methods like importance sampling, symbolic analysis, or even formal verification might become interesting complements.

- Analog circuits are more closely coupled and functionally linked with digital hardware or even software. Therefore, design and verification requires an overall system simulation. Despite attractive languages and simulators like very high speed integrated circuit (VHSIC) hardware description language (VHDL)-AMS or cosimulation environments, the mixed-domain and mixed-level modeling and simulation are still an issue and require especially appropriate modeling and verification methodologies.

- Many requirements (very low voltage, very low power, etc.) are hard to meet by the well-known analog circuit topologies. Available tools support the dimensioning and optimization of given topologies, but lack support for the more creative topology design. This task requires expert and application knowledge. Analog topology synthesis might solve the problem in the future. Today’s designers must reuse the topologies once designed and adapt them to new requirements.
Using “black magic” from SPICE days for the design of AMS systems results in low design productivity and frequent redesigns. However, the application of new tools and languages can also be a challenge without the right knowledge, methodology, and design flow. The following part of the book contains some chapters that describe successful application of methodologies and tools. They give the reader valuable hints for solving the issues mentioned earlier.

Chapter 8 deals with the abstract modeling of micro mechanical components for system-level verification. Here, a behavioral model is created by reduced-order modeling methods and formulated in the language VHDL-AMS. This permits an overall system simulation with—despite the complexity—sufficient simulation speed.

Chapter 9 introduces a new kind of analysis that goes beyond simulation: semisymbolic simulation. Although not yet available in commercial simulators, the methods described seem to be an appropriate approach to deal with increasing process variations and to get better verification coverage.

Chapter 10 entitled “SystemC-WMS: mixed-signal simulation based on wave exchanges” introduces an extension to SystemC—originally intended for system-level analysis of hardware/software systems. This extension allows designers to include analog circuits into the system-level simulation, modeling the overall system in a single language—SystemC-WMS.

Besides the cosimulation based on specific languages, simulator coupling is an important issue. For simulator coupling, especially the interfaces between different languages and simulators require a lot of effort. Chapter 11, “Automatic generation of a verification platform”, gives an overview of an approach that supports the automatic generation of interfaces.

Finally, the application of Universal markup language (UML) for reuse of analog circuits is introduced in Chapter 12, “UML/XML-based approach to hierarchical AMS synthesis”.

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