Guest Editors’ Introduction:

Mixed Analog and Digital Systems

The rapid development of communication, computer, and video technologies as well as other high-performance applications demand ever-faster techniques and tools for design and test. All these applications must contend with an intermingling of analog and digital signals that will most likely increase.

Why mix at all?

Generally, a design uses analog components for two reasons: to interface digital processing with application-specific environments and to accelerate processing in high-performance systems.

Many applications include interactions among electronics and various sensors and actuators; such interactions imply analog signals. To further complicate the task of mixed-signal design, many of these applications require high quality and reliability since an individual’s safety may depend on them.

Processing analog signals and images will be important to information delivery technologies in the 21st century. However, slow analog processing and transmission limit performance, and we need to develop mixed-signal design, test, and integration methodologies to alleviate this problem.

Finally, decreasing the size of integrated circuits leads to higher frequencies in general, and hence to more analog behavior of even digital signals.

The analog side

Over the last few years, the design and test community has devoted more effort to the analog side and to the interface between analog and digital circuits. This requirement stems from the application-specific nature of analog circuits as well as the multitude of signal specifications for and the large variety of analog signals. (The number of analog specifications far exceeds the available digital waveforms.) This variety implies changing design techniques and, consequently, changing test and integration environments.

During the First Mixed-Signal Testing Workshop (June 1995), attendees discussed the scope of mixed signals and asked, What type of analog signals should be of interest to the design and test community?

To accommodate different applications, we currently use typical digital signal processing techniques for test purposes. However, for high-performance, high-quality system test, digital signal processing has many drawbacks. So, should the scope of our discussion include, for example, optical signals (present in communication, imaging, and interconnects), signals from common automotive-industry and robotics sensors, or signals describing environmental conditions (radiation or electromagnetic fields)?

Our answer

For high-performance system development, it seems absolutely indispensible to consider all system and environmental signals. Only by considering a spectrum of these signals can we achieve a high-performance, optimized design that fulfills system integration requirements. This must occur despite the...
fact that, to some extent, the nature of analog signals determines a design style, design and test requirements, and system integration techniques.

Interfaces for design, testability, and packaging, and those between tools and methodologies are also important. This further reinforces that only fully integrated environments will permit effective, high-quality, competitive system development. We therefore sought articles for this special issue that contributed to this vision of mixed-signal design and test.

**This special issue**
Olbrich and Richardson pay particular attention to the switched-current design technique, already recognized for its exceptional performance in interfacing between the real world and silicon systems. Switched currents is a relatively new sampled-data technique operating from a reduced supply voltage. Users can employ a standard digital VLSI process to implement it.

Balivada, Chen, and Abraham present a simple test generation technique to derive sinusoidal test waveforms. Such stimuli aid detection of a large class of faults using steady-state sinusoidal time response parameters.

Chatterjee, Kim, and Nagi introduce a DC built-in self-test using checksums. Their technique is particularly effective in detecting catastrophic failures such as opens and shorts in a line.

Recently, off-chip current testing has been the topic of several digital circuit studies that have uncovered many attractive characteristics. Miura describes an approach for testing A/D converters in real time using current measurements. He first revised standard current testing for analog circuits and then applied his techniques to an A/D converter.

**Challenges and opportunities** will continually develop in this field, and new application areas promise exciting environments in mixed-signal design and test for future systems. The most challenging areas include optoelectronic systems, multimedia services, microsystems, and wireless communication.

This special issue Olbrich and Richardson pay particular attention to the switched-current design technique, already recognized for its exceptional performance in interfacing between the real world and silicon systems. Switched currents is a relatively new sampled-data technique operating from a reduced supply voltage. Users can employ a standard digital VLSI process to implement it.

Balivada, Chen, and Abraham present a simple test generation technique to derive sinusoidal test waveforms. Such stimuli aid detection of a large class of faults using steady-state sinusoidal time response parameters.

Chatterjee, Kim, and Nagi introduce a DC built-in self-test using checksums. Their technique is particularly effective in detecting catastrophic failures such as opens and shorts in a line.

Recently, off-chip current testing has been the topic of several digital circuit studies that have uncovered many attractive characteristics. Miura describes an approach for testing A/D converters in real time using current measurements. He first revised standard current testing for analog circuits and then applied his techniques to an A/D converter.

**This special issue**
Olbrich and Richardson pay particular attention to the switched-current design technique, already recognized for its exceptional performance in interfacing between the real world and silicon systems. Switched currents is a relatively new sampled-data technique operating from a reduced supply voltage. Users can employ a standard digital VLSI process to implement it.

Balivada, Chen, and Abraham present a simple test generation technique to derive sinusoidal test waveforms. Such stimuli aid detection of a large class of faults using steady-state sinusoidal time response parameters.

Chatterjee, Kim, and Nagi introduce a DC built-in self-test using checksums. Their technique is particularly effective in detecting catastrophic failures such as opens and shorts in a line.

Recently, off-chip current testing has been the topic of several digital circuit studies that have uncovered many attractive characteristics. Miura describes an approach for testing A/D converters in real time using current measurements. He first revised standard current testing for analog circuits and then applied his techniques to an A/D converter.

**Challenges and opportunities** will continually develop in this field, and new application areas promise exciting environments in mixed-signal design and test for future systems. The most challenging areas include optoelectronic systems, multimedia services, microsystems, and wireless communication.

**Coming next issue**
**Rapid Prototyping**
Prepared by guest editors Vijay Madisetti and Mark Richards, the Fall issue will feature
- Prototyping Embedded Signal Processors: Current Practice, New Approaches, and Road Map (Georgia Tech and SCRA)
- A RASSP Approach to Rapid Prototyping of Signal Processors (Sanders, Motorola, Hughes)
- VHDL Modeling for Board Level Simulations (European Space Research and Technology Center)
- DFT and Verification of Embedded Signal Processors (Lockheed Martin ATL Labs)
- Conceptual Prototyping of Embedded Signal Processors (Georgia Tech)
- Hardware-Software Co-design of Embedded Systems (TRW Avionics)

**Also**
- Test for Deep-Submicron Technology—A D&T Roundtable held at ITC95

**Design & Test of Computers**
Practical information for design engineers