Editorial

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I ended my editorial of the June 2011 issue of *JETTA*, our last special issue on mixed-signal testing, with a hope for another similar issue in 2012. So, here it is. I see several new topics appearing in this issue. However, I will let you be the judge of how the state of the art is advancing and what directions it is taking.

We observe that specification-based test continues to be the backbone of analog test. Digital signal processing will also remain an integral part of the measurement instrumentation. More can be found in the classic book:

M. Mahoney, *DSP Based Testing of Analog and Mixed-Signal Circuits*, IEEE Computer Society Press, 1987.

Major concerns are test time, which translates into manufacturing costs, and the process variation related defects in modern technologies. One way to deal with the test time issue is parallel or multi-site test. Although we are beginning to see the use of embedded sensors to make the test efficient and effective, a satisfactory solution is yet to emerge.

What about alternatives to specification-based test? At least two methods deserve attention. These are model-based test and “alternate test.”

In the model-based test, we model faults in components (resistor, capacitor, transistor, etc.) of the circuit. A modeled fault can be catastrophic (such as short or open resistor) or can be a greater than expected variation (such as a resistor whose value changes so as to push the device characteristic out of specification range). The model retains the flavor of a

single fault and testing consists of measuring circuit parameters that constitute specifications such as gain or frequency. Parameters most sensitive to a faulty component value are selected for testing. An analysis using sensitivities defined as derivatives selects a minimal set of measurements to test modeled faults. The model-based test can be more efficient than the specification-based test, but the cost reduction must be balanced against a non-zero defect level and the yield loss resulting from the single faulty component assumption. Details of the sensitivity analysis and model-based test may be found in the paper:

N. Ben Hamida and B. Kaminska, “Multiple Fault Analog Circuit Testing by Sensitivity Analysis,” *Journal of Electronic Testing: Theory and Applications*, vol. 4, no. 4, pp. 331–343, November 1993.

In “alternate test”, we may choose measurements having no direct correspondence to the parameters in the specification. For example, an alternate test of an operational amplifier may measure the steady-state current rather than the voltage gain or bandwidth. Main requirements are that the measurements should be inexpensive and the resulting values should be strongly correlated with the relevant specifications of the device under test. The last requirement is usually verified by Monte Carlo simulation, which also helps determine the pass-fail thresholds for measured parameter values that will simultaneously minimize the defect level and yield loss. The success of an alternate test rests on finding a minimal set of measurements that will insure low defect level and yield loss for all specifications of the device under test. More can be found from two papers:

P. N. Variyam, S. Cherubal and A. Chatterjee, “Prediction of Analog Performance Parameters Using Fast

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Transient Testing,” *IEEE Transactions on Computer-Aided Design*, vol. 21, no. 3, pp. 349–361, March 2002.

H.-G. Stratigopoulos and Y. Makris, “Error Moderation in Low-Cost Machine-Learning-Based Analog/RF Testing,” *IEEE Transactions on Computer-Aided Design*, vol. 27, no. 2, pp. 339–351, February 2008

Future developments in this field will determine how long the good old specification-based testing will prevail. I hope this special issue will throw some light. Its planning began in the middle of 2011 when we issued a call for papers. We are grateful to Sherman Chang and David Keezer, the two Guest Editors, for organizing this effort and carrying it to completion. Their Guest Editorial gives a complete summary of the contents.