TEST POINT SELECTION METHOD FOR MIXED SIGNAL TESTING

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Test time is a major cost item in mixed-signal integrated circuit (IC) testing. Built-in-self-test (BIST) is able to verify design correctness (functional testing) as well as to detect manufacturing defects (structural testing) in many complex mixed-signal ICs. BIST uses on-chip built-in stimulus generators or complex-response analyzers, which allows different parts of a mixed-signal IC to be tested in parallel, thereby reducing the total test time and hardware complexity requirements of the automatic test equipment. For some mixed-signal ICs where additional on-chip BIST circuitries become a significant cost burden, a test time reduction technique offers an alternative avenue of reducing test time. This paper reviews two different test point selection methods, the NIST and wavelet transform methods for testing of mixed signal integrated circuits. The NIST test point selection method uses the actual values measured from a few selected test points and a reduced model, which is obtained from the full linear model, to obtain the full predictions. Thereafter, a matrix decomposition to select out maximally linear independent representative devices is used. The wavelet transform test point selection method uses wavelet decomposition to increase possible values which may simulate the performance of the mixed-signal devices under test. This process always successively decomposes the original low frequency signal into a low frequency signal and a high frequency signal until the maximally possible decomposition level. In this presentation, the implementation of test point selection methods in data converter and programmable gain amplifier (PGA) is discussed to illustrate its validity in reducing test time for mixed-signal ICs.

Using only a few test points, the NIST test point selection method helps reducing test time by predicting the linearity response of a data converter. The Rademacher/wavelet method is shown to be a good method for measuring integral nonlinearity (INL) and differential nonlinearity (DNL) for a binary weighted digital-to-analog converter (DAC) and a successive approximation analog-to-digital converter (ADC). It is also demonstrated that the test point selection method is reliable enough for production.

Both the NIST and wavelet transform test point reduction methods are implemented to reduce the number of test points, and hence, the test time, for a programmable gain amplifier (PGA). The use of integral nonlinearity (INL) to predict the performance of the PGA is proposed. The NIST method retains the original properties of the INL of the PGA and is able to predict the test responses of the PGA much more accurately than the wavelet transform method using only 3 test points instead of the 155 test points as required in a conventional full PGA test.
Speaker Biography

Simon S. Ang received the B.S.E.E. degree with highest honors from the University of Arkansas (USA), M.S.E.E. degree from the Georgia Institute of Technology (USA), and the Ph.D. degree from the Southern Methodist University (USA). He was a product engineer for switching converters/voltage regulators and an engineering manager for power integrated circuits at Texas Instruments, Inc., Dallas, from 1981 to 1988. Since 1988, he has been with the University of Arkansas where he is currently a Professor of Electrical Engineering, the Director of the High Density Electronics Center, and Associate Director of the National Center for Reliable Electric Power Transmission. He was associated with the National University of Singapore (2001-2002), Nanyang Technological University (2013), Nanjing University of Aeronautics and Astronautics (2003-2007), Xi’an Aeronautical Polytechnic College (2003-2005), and Fudan University (2006). His current research interests are mixed-signal circuit design and test, sensors, microelectronic and power electronic module packaging, switching converters, nanotechnology, and batteries. He has authored and co-authored more than 290 journal papers and presentations. He is a Fellow of the Institute of Electrical and Electronic Engineers (IEEE), the Institution of Engineering and Technology (United Kingdom), the Electrochemical Society (USA), and the City and Guilds of London Institute (United Kingdom).