Mixed-Signal System Verification: A High-Speed Link Example

Jaeha Kim

Center for Integrated Systems, Stanford University
Room 128, Paul G. Allen Building
420 Via Palou Mall, Stanford, CA 94305-4070, U.S.A.
jaeha@ieee.org

Abstract. This tutorial begins by visiting various mixed-signal circuit examples in high-speed interfaces, of which verification cannot be done via the established methods for digital systems and instead has relied on exhaustive time-domain circuit simulations. While recognizing the vast literature on trying to extending the prevailing digital verification methods to analog and mixed-signal systems, this tutorial suggests that a promising approach might be to extend the way that digital methods leverage the *design intent* and choose the proper abstraction for it. After examining the properties that the designers would most want to verify for the high-speed interface circuits, it is claimed that those are mostly the properties of a linear or weakly-nonlinear system, e.g. gain, bandwidth, local stability, etc. It is because most of the mixed-signal circuits in high-speed links are motivated by the need to replace analog circuits with digital for the ease of process migration. Although in digital forms, the resulting circuits are still supposed to have analog functionalities which are best described in linear or weakly-nonlinear system models. Therefore, a possible formal verification for those circuits might be to extend the traditional small-signal linear analysis. For example, this tutorial will demonstrate ways to extend the linear AC analysis in SPICE to measure the phase-domain transfer functions of PLLs or the noise transfer functions of delta-sigma ADCs. It also examines the limitations of linear analysis, for instance, the inability to detect start-up failures, which is the problem that can be more properly addressed by extending the digital verification methods and coverage concepts.

Keywords: analog and mixed-signal verification, analog design intent, linear system models.

A. Bouajjani and O. Maler (Eds.): CAV 2009, LNCS 5643, p. 16, 2009.