# ABSTRACT

In self-biasing circuits, designers often use feedback to reduce the power-supply sensitivity and minimize the effects of process and temperature variations. Many self-stabilized circuits are used in SOC circuits even when the SOC has small AMS content. It is well-known that these self-stabilized circuits are vulnerable to not “starting-up” correctly so start-up circuits are often included to prevent the circuit from getting stuck in an undesired stable operating point. Determining the uniqueness of an operating point in a circuit is challenging since circuit simulators only give a single operating point rather than all operating points. Moreover, this problem is very closely related to the mathematical problem of finding all solutions to a set of nonlinear equations. Both the mathematical and computer science communities recognize this as an open problem with no solution in sight. In circuits with multiple operating points, when a circuit simulator always gives the desired operating point throughout the design and verification process, there is little evidence that one or more undesired operating points even exist. In semiconductor industry, designers use experience and intuition to identify start-up problems. Some self-stabilized circuits designed by trusted engineers unpredictably get stuck in an undesirable operating point. Engineers often attempt to verify start-up effectiveness with transient simulations. This approach is heuristic and time consuming. Moreover, multiple operating points may still exist in circuits.

A graphical method for identifying positive feedback loops in analog circuits is presented for the purpose of identifying the stable equilibrium points. Firstly, since our method is based on graphical concepts, some key terminology from graph theory will be reviewed. Secondly, Graphical models for key analog components are developed and then hierarchically used to obtain a graphical representation of an analog circuit. Thirdly, the concept of determining positive feedback loops from the small-signal resistive Directed, Weighted, Multi-Graph Graph (DWM Graph) of a circuit will be addressed. The three-step process will be used to determine the positive feedback loops. Lastly, a method for breaking positive feedback loop and how to apply the Homotopy method to create a return map for the positive feedback loop is introduced.