Abstracts

Period-doubling analysis and chaos detection using commercial harmonic balance simulators

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Two of the most common phenomena leading to chaos are the period-doubling cascade and the formation of transverse homoclinic orbits. In this paper, a bifurcation analysis technique is presented for the prediction of both phenomena in microwave circuits. The fact that the technique is based on the use of commercial harmonic balance software constitutes a major advantage for the circuit designer. The accuracy of the method relies on the capability to detect and calculate the successive period doubling, which, in period-doubling cascades, provides a good estimation of the parameter values for the onset of chaos. Another important aspect of the new method is the equilibrium point determination, necessary for the prediction of the homoclinic chaos. The accuracy in the calculation of the limit cycle, taking into account the most influential period doublings, ensures a good estimation of the parameter values for the formation of possible homoclinic orbits. In order to validate the method, it is initially applied to an RL-diode circuit, with a period-doubling route to chaos. A practical microwave frequency doubler is then analyzed, determining its parameter ranges for stable operation. Excellent results are obtained in comparison with the time-domain simulations. As an example of the method's capabilities for the prediction of homoclinic chaos, the bifurcation loci of Chua's circuit, with a cubic nonlinearity, are obtained and they agree closely with time-domain simulations.

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