ABSTRACT

The accurate and efficient modeling of monolithic inductors continues to pose a significant challenge. Numerical EM solvers can offer accurate results, but can take a long time to run and must be set up carefully to avoid numerical instabilities. Data fitting techniques require the inductor to be fabricated multiple times leading to increased design time and cost. Accurate lumped circuit models for inductors also exist, but the formulas used to calculate their component values are inaccurate by more than 20 %.

In this thesis, a lumped pi-circuit is proposed. The lumped pi-circuit is obtained by applying two low frequency approximations and a high frequency approximation to the Partial Element Equivalent Circuit (PEEC) model circuit of the monolithic inductor. The resulting formulas are based on the partial inductance matrix, the partial capacitance matrix, and the resistance matrix for the inductor. The resulting lumped pi0circuit shows good agreement with measured values of effective inductance and inductor Q.

This thesis consists of a review of current monolithic inductor modeling techniques and a description of terminology. A discussion is presented on how to simulate monolithic inductors using the Method of Moments. A review of the derivation of the PEEC technique is presented. Improvements to the resistance matrix including eddy current effects and internal inductance are presented. The implementation of the two low frequency approximations and the high frequency approximations to derive the lumped pi-circuit are presented. Measured data from a set of inductors is compared to data from the Method of Moments and the proposed pi-circuit model. Finally, recommendations for future research are given.