Introducing Embedded Patterned Layers for Improved Broadband Performance of High Density Transmission Line Routing

Arghya Sain, Ian P. Armstrong, Marcos A. Vargas and Kathleen L. Melde*
Department of Electrical and Computer Engineering
University of Arizona, Tucson, USA
Email: melde@email.arizona.edu

The gate lengths in metal oxide semiconductor field effect transistors (MOSFETs) have shrunk from 10um in 1970s to 28nm in 2011, which is the result of intensive research in the field of active device physics and fabrication. Smaller transistor features have increased the transistor density in high frequency integrated circuits (ICs) allowing the semiconductor industry to follow Moore's Law. High frequency circuit designs, such as those used in T/R modules, take advantage of increased circuit transistor density to boost the number of processes and functionalities. So, the number of signal input/output (I/O) must also increase in tandem to support these functionalities and to meet the demands of higher transmission rates. However, real estate is limited on chip, package and at the system level, which requires creative solutions to route interconnects in close proximity to one another. This makes electromagnetic effects due to interconnect delay, crosstalk noise etc. performance limiting factors that must be addressed.

This work involves the placement of a metallic embedded patterned layer (EPL) in the substrate (between the signal and ground layer) of two tightly spaced microstrip lines to improve insertion loss (IL) and reduce coupling, given in terms of far end cross talk (FEXT). The pictures below show a top view and transverse section of the setup under consideration. The microstrip line pair with an EPL is analyzed in the frequency domain using commercial full wave solvers like High Frequency Structure Simulator (HFSS). The effect of the EPL on the effective permittivity is studied. EPL presence however deteriorates return loss (RL) and near end coupling. Analysis of the impact of different EPL pattern density, shapes and location in the substrate on IL, RL and coupling is provided. Results indicate that optimizing EPL geometry can result in performance enhancement. A parametric study of EPLs with single ended conductor backed coplanar waveguide (CBCPW) is done to analyze the impact of EPLs on per unit length transmission line parameters, effective dielectric permittivity and characteristic impedance of the CBCPW.