External EMI Reduction in High-Frequency Electronics Systems Using Metamaterials

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Abstract

GHz Electromagnetic interference in integrated circuits has had significant interest within the content of high power electromagnetic (EM) effects on electrical systems and equipment. High-power ultra wide-band (UWB) pulses coupled through transmission lines into various integrated circuit components causing system break-down are becoming a serious threat in military and commercial electronics systems. There is a need to reduce the coupling effects on electronic circuits and systems at all scales. There are significant efforts in microwave applications of periodic structures in recent years. The use of periodic metallic loading, either with arrays of vias (pins) or patch and vias combinations (mushrooms) could produce a wide surface-wave band-gap by eliminating the fundamental TM mode of a grounded substrate (not a Bragg diffraction band-gap). Metamaterials, evolved from photonic crystals or photonic band-gap (PBG) materials, are artificial materials made of periodic arrays of metallic elements within common materials. The use of metamaterials for RF, particularly in planar integrated structures presents many opportunities for major technology advances.

For high-density integrated circuits where circuit components are packed closely, the cross coupling is mainly due to electromagnetic coupling (or near fields) rather the surface-waves. In this work, we propose a new approach for electromagnetic interference reduction by using metalized substrates (or metamaterials), where periodic metallic elements such as shorting vias are placed surrounding circuit elements. Rigorous electromagnetic simulations based on the Zeland IE3D and Anisoft HFSS are used to analyze the shielding effects of the metalized dielectric substrate. The examples are plane-wave scattering from terminated microstrip transmission-line elements that are surrounded by the periodic metallic loading. It is demonstrated that with the use of metamaterials the energy coupled into the electronics circuits is reduced significantly over a wide frequency range of interest.