

Spiral Electromagnetic Bandgap Structure for EMI Reduction

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Abstract— The concept of using Electromagnetic Band Gap (EBG) structures is to provide excellent suppression of noise or interference (EMI) at GHz frequencies. In this work, a 3x3 spiral EBG planar structure was developed to achieve suppression of electromagnetic interference covering frequency range of 4 to 6 GHz considering the integration of EBG structure into the High Speed printed Circuit Board design (HSPCB).

Keywords— Electromagnetic band gap (EBG), Electromagnetic Interference (EMI), optimization, genetic algorithm (GA), CST Microwave Studio (CST MWS), Printed Circuit Board (PCB).

I. INTRODUCTION

Electromagnetic radiation of high-speed digital and analog circuits is considered one of the most critical challenges to the electromagnetic interference, compatibility and reliability of electronic systems. The world of electromagnetic interference (EMI) and electromagnetic compatibility (EMC) design has undergone significant changes as the speed of processors, clocks, and digital communications links has increased. Electromagnetic interference is a complex mechanism that takes place at different levels including the chassis, board, component, and finally, the device level [1-4]. Switching noise is one of the major concerns for electromagnetic compatibility engineers in modern designs and that could cause serious signal integrity (SI) and power integrity (PI) problems in the form of EMI for the high-speed circuits. Electromagnetic interference is the lack of EMC [5], since the essence of interference is the lack of compatibility. EMI is the process by which disruptive electromagnetic energy is transmitted from one electronic device to another via radiated or conducted paths (or both). In common usage, the term refers particularly to RF signals. EMI can occur in the frequency range commonly identified as anything greater than DC to daylight. Periodic structures are abundant in nature, which have fascinated artists and scientists alike [15-20]. When they interact with electromagnetic waves, exciting phenomena appear and amazing features result. In

particular, characteristics such as frequency stop bands, pass bands and band gaps could be identified using Electromagnetic Band gap Structure [6-14]. Generally speaking, (EBG) structures are defined as artificial periodic (or sometimes non-periodic) objects that prevent/assist the propagation of electromagnetic waves in a specified band of frequency for all incident angles and all polarization states [9].

II. SPIRAL EBG STRUCTURE

A. Lumped Elements Structure

The proposed model of EBG unit cell is spiral with 15 lines trace to be represented mathematically using Greenhouse Formulas using lumped elements representations as in Fig1.

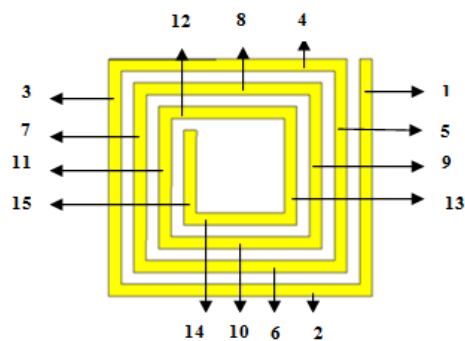


Fig. 1. : Metallic Network of spiral EBG

B. Greenhouse Formulas for Lumped Elements

Greenhouse [23] has provided expressions for inductance for both rectangular and circular geometries based on self-inductance of inductor sections and mutual inductances between sections. These relations are also known as Greenhouse formulas for spiral inductors as shown in equations (1), (2) and (3).

$$L(nH) = 2 \times 10^{-4} Li \left[\ln \left(\frac{Li}{w+t} \right) + 1.193 + \frac{w+t}{3Li} \right]. Kg \quad (1)$$