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# Metamaterial-Inspired Electromagnetic Band Gap Structure for Isolation Improvement of Microstrip Patch Antenna

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***Abstract*—The microstrip patch antenna arrays are widely used in the wireless communication applications. Mutual coupling between the antenna elements affects the array performance, and reduction of the coupling and improvement of the isolation are important tasks for an array system. In this paper, some compact, metamaterial-based electromagnetic band gap (EBG) structures are proposed, which are an alternative to the existing EBGs used in various applications, to reduce the mutual coupling effect between the antennas in an array. The design is obtained by using a simulation program and the simulation results show that the isolation between the elements can be enhanced with the proposed EBGs.**

***Keywords*—microstrip patch antenna array, electromagnetic band gap structure, metamaterials, mutual coupling, isolation.**

## I. Introduction

The concept and application of metamaterials, which are artificial materials that show left-handed properties with negative permittivity and permeability, have drawn significant attention in recent years. The use of metametarials or metamaterial-inspired structures in mirostrip antenna systems also becomes popular due to the needs in wireless communication systems, which become more challenging everyday.

It is well known that the mutual coupling and the surface waves can degrade the efficiency and affect the radiation pattern of an array of microstrip antennas. The reduction of both the mutual coupling effect and the generation of the surface waves can be obtained by electromagnetic band gap (EBG) structures [1]. EBGs are artificial periodic objects that can filter the propagation of electromagnetic waves in a specified band of frequency and has ability to suppress the surface waves.

In this paper, the reduction of both the mutual coupling effect and the surface waves, thereby the isolation of the elements in a two-element array of microstrip antennas is achieved with the EBGs placed between the antennas. The shape of the elements in the EBG structure is metamaterial-inspired, which are different forms of the split rectangular loops. The proposed antenna systems are simulated by CST Microwave Studio software, and the simulation results are show that the designed EBGs can increase the bandwidth of the antenna while suppressing the coupling between the antenna elements.

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## II. EBG Design and Numerical Results

The basic structure that is adopted is an array of two standard, probe-fed planar rectangular microstrip antennas, shown in Figure 1. The antenna geometry that has been chosen is as simple as possible. This serves the purpose of a fundamental and general assessment of the metamaterial-inspired enhancement with EBGs. However the use of more elaborate antenna elements is also possible.

The dielectric substrate has the dielectric constant 10.2 and its thickness is 1.92 mm. The distance between patch arrays is 0.75 λ and the resonance frequency is 5.9 GHz. Before the design considerations with EBGs, the mutual coupling between the two antennas is first quantified. This preliminary study will set the necessary specifications for the metamaterial-inspired inclusions. The return loss is also provided for the sake of completeness. In Figure 2 and Figure 3, the reflection and transmission coefficients for the antenna system are presented, respectively.

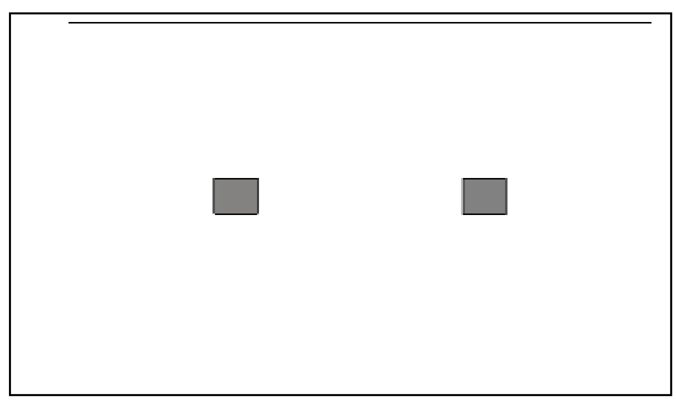

Figure 1. Patch Array without Electromagnetic Band Gap Structure

In this paper an EBG element in the shape of split rectangular loop [2] is designed shown as in Figure 4. The EBG structures of four columns of split rectangular loop are inserted between the antennas to reduce the mutual coupling.

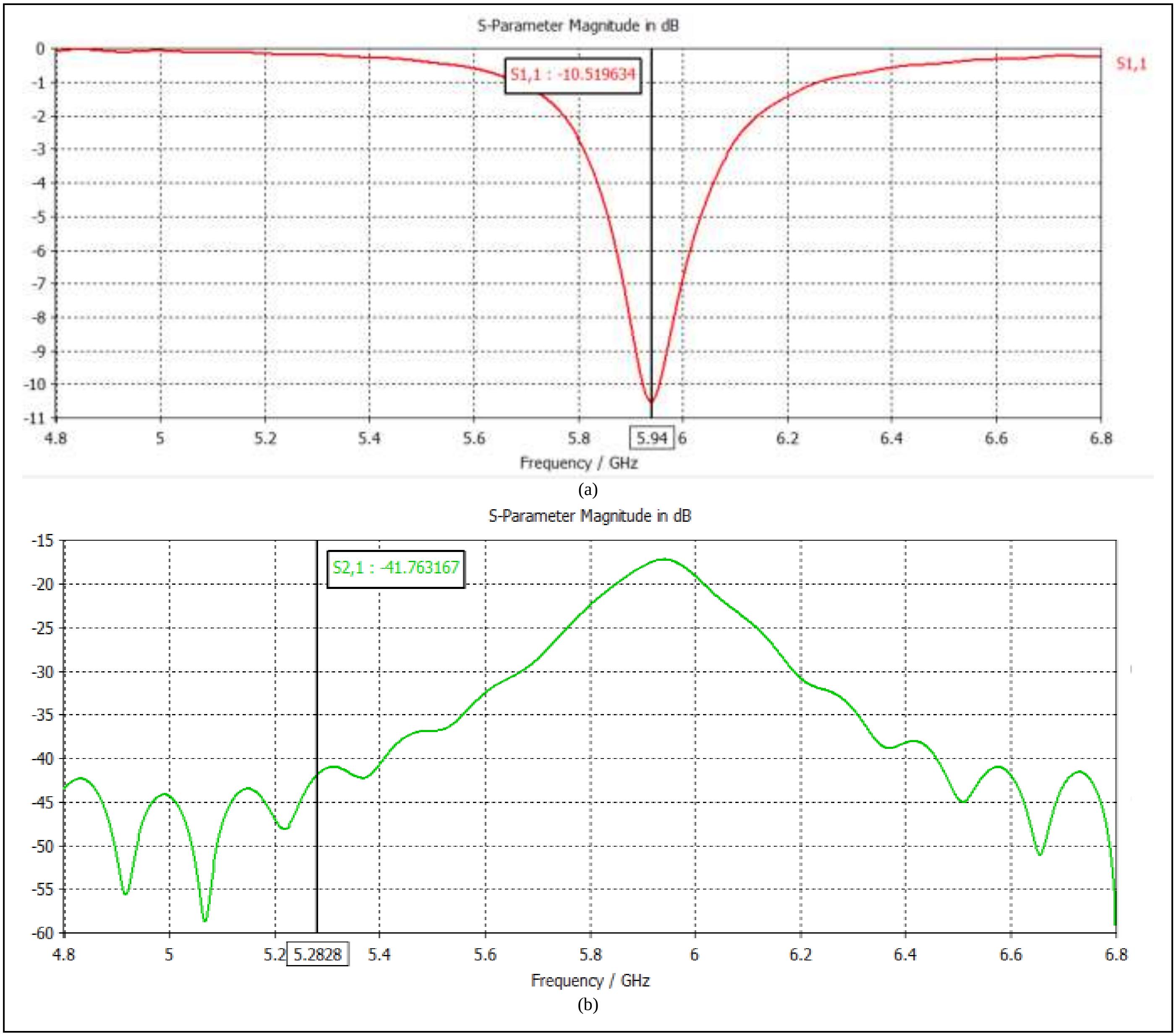


Figure 2. (a) Reflection and (b) transmission coefficients for the two-element microstrip antenna array

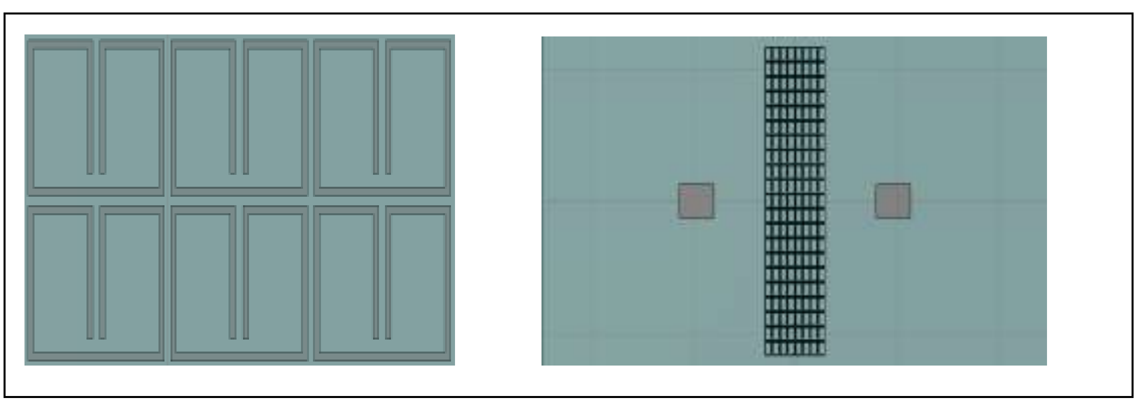

Figure 3. Split rectangular loop electromagnetic band gap structure

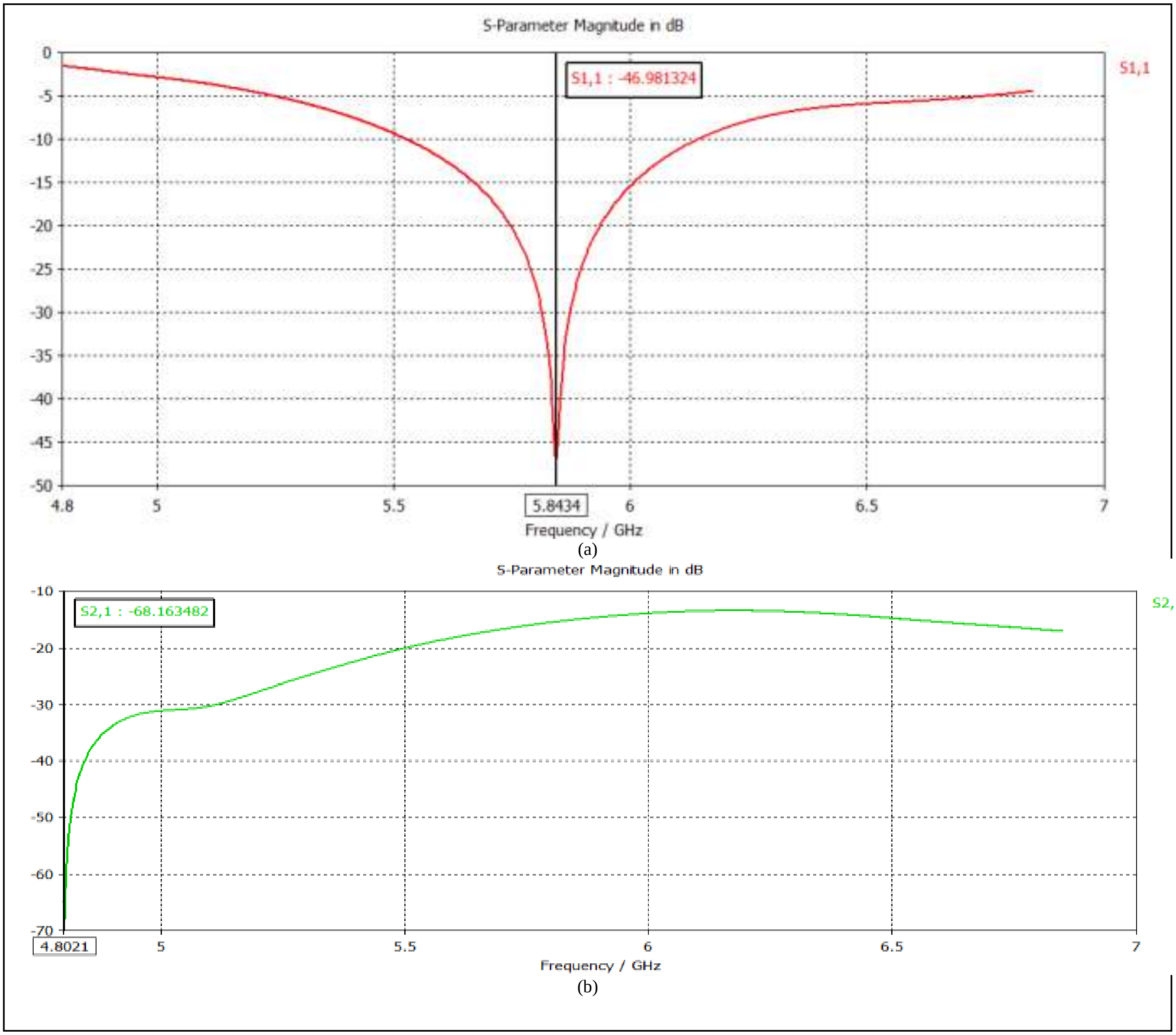


Figure 4. (a) Reflection and (b) transmission coefficients for the two-element microstrip antenna array with EBGs.

As seen from simulated results, the resonance frequency of the array with split rectangular loop EBGs is shifted slightly. If we compare Figure 2(a) and Figure 4(a), it is obvious that the array with EBG has a wider band. The mutual coupling effect is also reduced on a wider range of frequency.

The work in this paper and other results with different EBG structures will be presented during the conference.

## *Acknowledgment*

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