Rectangular Patch with Rectangular and I-shaped Slot AMC-HIS Design at 0.92GHz and 2.45GHz

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Abstract

A new structure of the dual-band Artificial Magnetic Conductor (AMC) is proposed called rectangular patch with the rectangular and I-shaped slot. This AMC is designed at 0.92GHz and 2.45GHz using the dielectric substrate of TLC-32. The properties of the AMC such as the reflection phase, reflection magnitude and surface impedance are carried out. The design parameters that influence the AMC frequencies are also discussed in this paper.

Keyword: Artificial Magnetic Conductor (AMC)

1. Introduction

Artificial Magnetic Conductor (AMC) is known as Perfect Magnetic Conductor (PMC) and it is categorized as metamaterial structure that exhibit novel electromagnetic properties not exist in nature [1-2]. It is called as “artificial” magnetic conductor because it is “artificial engineered material” with a magnetic conductor surface at certain frequency range where it has zero tangential magnetic fields. Thus, AMC is a high impedance surface (HIS) structures, a lossless and can approximate as an open circuit due to the very high surface impedance it has at the resonant. Generally, AMC is realized within a limited frequency range. It is characterized when its reflection phase and magnitude is zero and +1 at the resonant. The useful AMC bandwidth is obtained when the reflection phase is ±90°. More than that, the AMC is a subclass of metamaterials known as Electromagnetic bandgap (EBG) material [3].

2. Dual-band AMC Design

Based on the simulation set-up explained in [4-5], a new structure of the dual-band AMC is carried out by the rectangular patch with the rectangular and I-shaped slot as shown in Figure 1. A graph of the reflection phase is obtained by simulating a unit cell of the structure with periodic boundary along its four sides and backed by a perfect electric conductor (PEC) using a transient solver of Computer Simulation Technology (CST). The reflection magnitude and the surface impedance of the designed AMC are then obtained by simulating a unit cell with electric and magnetic boundary condition at the vertical and horizontal walls. This textured structure is printed on TLC-32 substrate having a substrate permittivity of 3.2 and thickness of 6.35mm to resonate at 0.92GHz and 2.45GHz. To achieve the desired operating frequencies, this structure is designed with a rectangular slot width (ws) of 1mm at the centre of the rectangular patch, Ix of 7mm and Iy of 4.5mm. The simulated reflection magnitude and the surface impedance of the rectangular patch with rectangular and I-shaped slot are plotted in Figures 2 and 3 respectively. The reflection magnitude of 0.95 and 0.90 is obtained at low and upper frequency. As can be seen in Figure 3, high surface impedance is plotted at the resonant frequencies.

3. Parametric Study

From the simulated frequency range of 0 to 3GHz, only one resonant frequency appears at 1GHz for 62mm x 30mm rectangular patches AMC. By remaining at this rectangular patch size, the rectangular slot with the slot width of 1mm is introduced to the centre of the rectangular patch with the size of 34mm x 14mm. At similar simulated frequency range, two AMC frequencies are recorded which are 0.94GHz and 2.4GHz. The simulated AMC bandwidth is 10.65% at the lower band and 2.50% at the upper band. The I-shaped slot is then introduced to the perpendicular of the rectangular slot. The two resonant frequencies are slightly changed to 0.91GHz and 2.43GHz. This structure resonates well at the desired first AMC band of 0.87GHz – 0.96GHz and at the second band of 2.38GHz – 2.47GHz. Figure 4 plots the reflection phase graph of the three studied structures shown in Table 1. The aim of this section is also to investigate the parameters that influence the lower and upper AMC frequencies. In this case, three parameters are involved; the length of I_x and I_y and the width of rectangular slot. In Figure 5(a), there is a clear trend of downward movement in the lower and upper AMC frequencies when the length of I_x is increased. Figure 5(b) then shows the simulated AMC frequencies for several lengths of I_y. It is observed that, the lower and upper AMC frequencies are slightly changed as I_y changes. Next, when the slot width is increased, the lower AMC frequency decreases slightly but the upper AMC frequency increases steadily.

4. Conclusion

In this paper, a new design of the dual-band AMC is presented. The slot is loaded in the rectangular patch to achieve multiband AMC. The designed AMC is simple, low profile, low cost and less complexity. The proposed AMC only require a single layer dielectric substrate and without the need of shorting pin or vias.

5. Figures and Tables

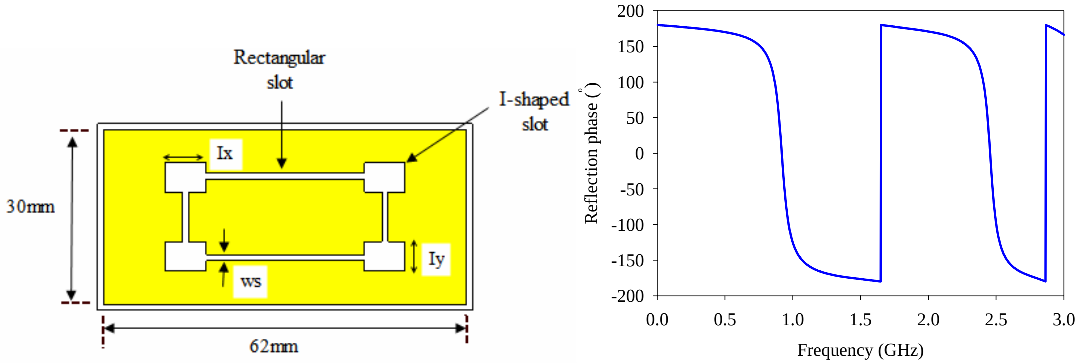


Figure 1: A unit cell and reflection phase of the rectangular patch with the rectangular and I-shaped slot AMC design at 0.92GHz and 2.45GHz

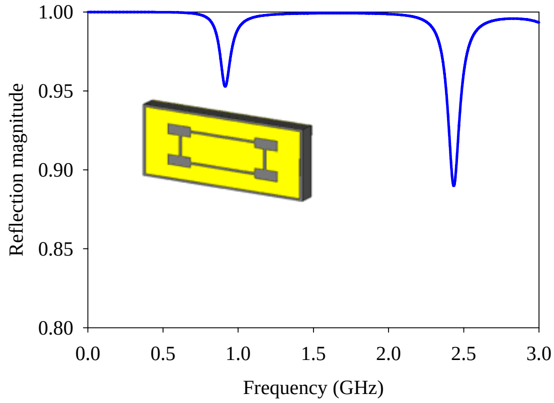
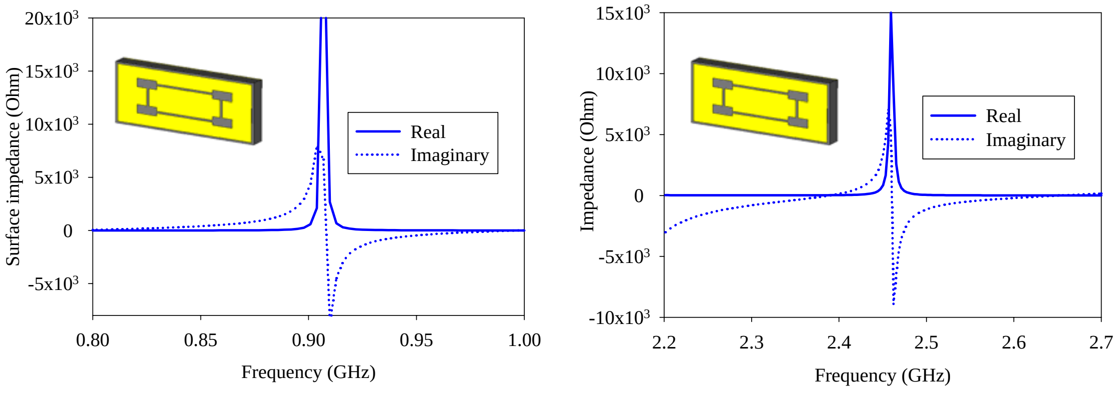


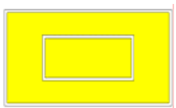
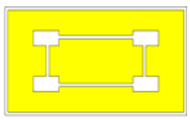
Figure 2: The reflection magnitude of the rectangular patch with the rectangular and I-shaped slot AMC design at 0.92GHz and 2.45GHz.



(a) (b)

Figure 3: The surface impedance of the rectangular patch with the rectangular and I-shaped slot AMC-HIS at the (a) lower and (b) upper band.

Table 1: The resonant frequency and bandwidth of the rectangular patch, rectangular patch with rectangular slot and rectangular patch with rectangular and I-shaped slot AMC

AMC Design	Resonant frequency	Bandwidth
	1.0GHz	0.94GHz – 1.07GHz (12.96%)
	0.94GHz and 2.40GHz	0.89GHz – 0.99GHz (10.65%) and 2.37GHz – 2.43GHz (2.50%)
	0.91GHz and 2.43GHz	0.87GHz – 0.96GHz (9.85%) and 2.38GHz – 2.47GHz (3.71%)

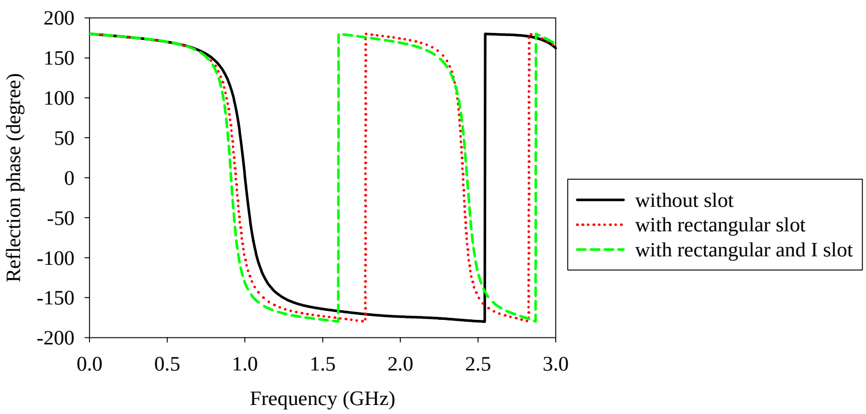


Figure 4: The reflection phase of the rectangular patch, the rectangular patch with rectangular slot and rectangular patch with rectangular and I-shaped slot AMC.

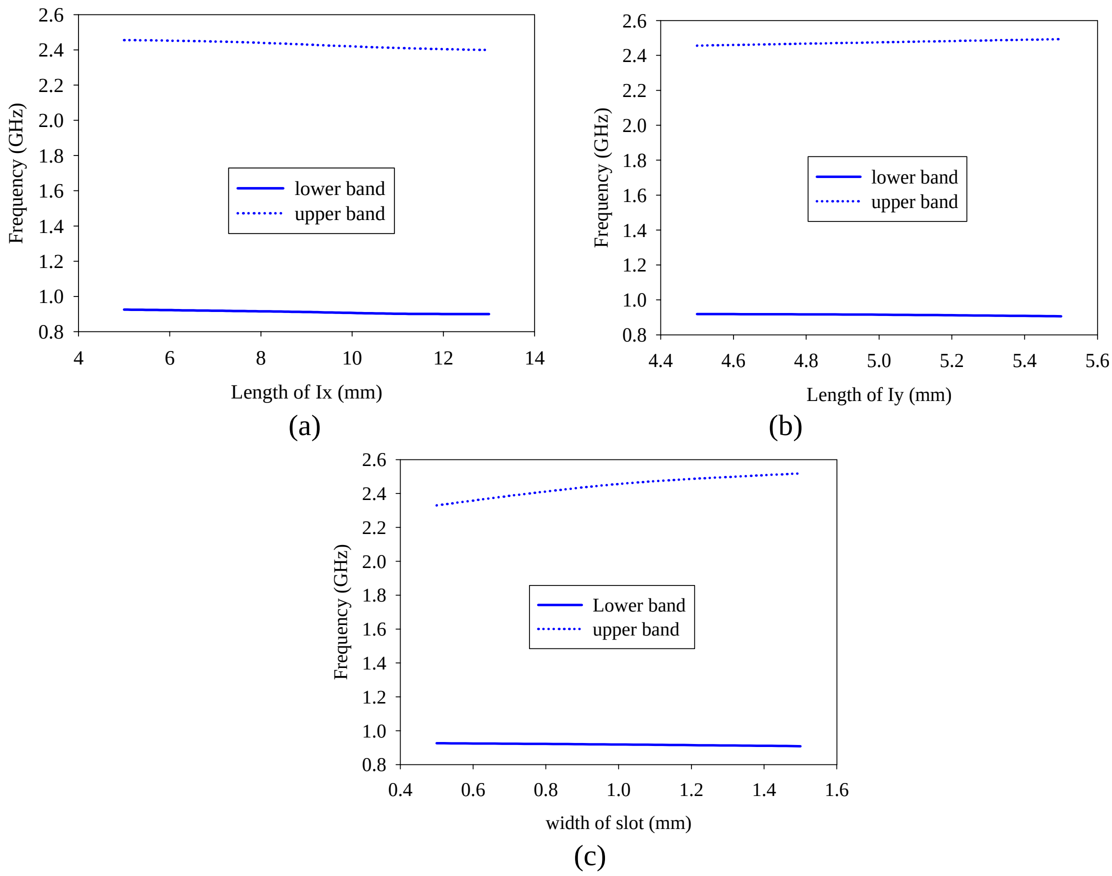


Figure 5: The parameters that influence the lower and upper AMC frequencies of the rectangular patch with the rectangular and I-shaped slot AMC

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Acknowledgments

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