A Square Patch with L and Inverted L shaped slotted AMC structure for Wi-Fi Applications

Devi Perla, N Sai Harshitha, B Dharma Praneeth, S Vinay Kumar, P Sudheer Kumar

Abstract*: *To improve the antenna characteristics in terms of bandwidth, gain and its radiation characteristics without providing any phase reflections, Artificial Magnetic Conductor (AMC) are used in antenna designing. This paper initially designed AMC structure for 2.4GHz frequency. The proposed AMC structure consists of three L shaped and inverted L shaped slots and provides zero degrees phase reflection at 2.4GHz resonant frequency. This proposed AMC structure is incorporated on conventional micro strip square patch antenna and results are simulated in High Frequency Structure Simulator (HFSS) software. The Proposed AMC incorporated patch antenna, return loss is improved from -16.16dB to -31.75dB, VSWR is from 1.42 to 1.05, the band width is increased from 16.5 MHz to 348.1 MHz This design resonates at a frequency of 2.4GHz and applicable to Wi-Fi applications.

Keywords* : *Artificial Magnetic Conductor, Microstrip Patch antenna, Phase reflection co-efficient, Radiation Characteristics.

I. INTRODUCTION

The unwanted surface waves have a serious impact on micro strip antennas. These waves reduce antenna efficiency, gain, return loss, bandwidth which limits the performance of an antenna. This problem is avoided by introducing Artificial Magnetic Conductors (AMCs), it is called "Artificial" because it's a man-made material. Artificial Magnetic Conductors (AMCs) are composite structures, they will act like magnetic mirror and they will reflect the incident electromagnetic waves in-phase and these AMCs will have small physical thickness. These structures are used to improve the performance of antenna characteristics in terms of radiation characteristics, gain and bandwidth. When AMCs are employed as ground plane of one antenna, it can reflect a normal incident plane wave in phase like a Perfect Magnetic conductor and also provides good input impedance matching. Antenna arrays with AMC planes, improves the bandwidth and gain. In [1] aperture coupled, patch antenna is used, this paper is based on the relationship between patch antennas and PMC surfaces, this method reduces the parallel plate mode and side lobe suppression. In [2] CLL based metamaterial used as AMC, when the gaps of CLL are facing towards the source, this structure produced un-phase reflection at desired frequency.

The interaction of dipole antenna with this AMC, improved the strength of radiating fields and front to back ratio. Considered AMC as planar periodic metallic arrays [3], discussed the operation of single layered array without via, used ray model approach and observed very high gain performance. AMC antenna applicable to radar cross section application is proposed in [4], the design is a combination of AMC and PEC cells and AMC structure consists of array of Sievenpiper's mushrooms. The PEC part formed by full metallic patches. This design reduced the RCS value. In [5], AMC is integrated with a radiator (crossed dipole antenna) and obtained low back radiation and good axial ratio performance near horizon. AMC with canonical FSS type shapes are discussed in [6], a low profile inverted L shaped monopole antenna is placed on AMC and by reducing the size of AMC ground plane, and the broadband characteristics are achieved. A planar antenna with AMC that consists of single metallization layer with no vias [7], this integrated antenna provides, large bandwidth and small form factor. Genetic programming software is used to synthesize 3D artificial magnetic conductor ground plane. In [8] allows, the unit cell patterning to extend into neighbouring cells and obtained true 3D patterning without reducing the PMC ground plane. This design provides high gain with impedance matching over entire band of interest. In [9], a slot dipole is located in the ground plane, textile antenna with AMC is proposed. This design provides good reflection coefficient and high front to back ratio. This paper proposed a novel AMC structure applicable to Wi-Fi applications. In section, AMC antenna design structure is discussed. In section 3, conventional antenna and its simulation results are described and finally in section 4, proposed AMC structure is incorporated on conventional patch and simulated their results characteristics and compared conventional and proposed design results.

II. DESIGN OF AMC STRUCTURES

Initially AMC structure consists of L and inverted L slots, designed for 2.4GHz. The Fig. 1 shows AMC design 1, AMC structure consists only one L and inverted L slots. The substrate was made up of FR4_epoxy material having the relative permittivity of 4.4, dielectric loss tangent of 0.02 and a thickness of 1.6mm. The design is simulated with master and slave boundaries and floquet port excitation. The simulated results are shown in Fig. 2. The proposed design operating frequency is 2.4GHz, where an AMC surface exhibits a 0° reflection phase. The phase reflection coefficient of AMC structure 1 crosses 0° at 1.65 GHz frequency and at

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2.4GHz it is having -180° phase reflection.

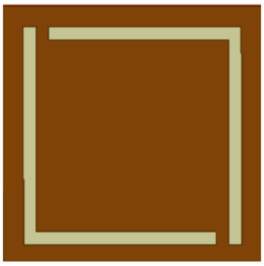

Fig. 1.AMC structure 1

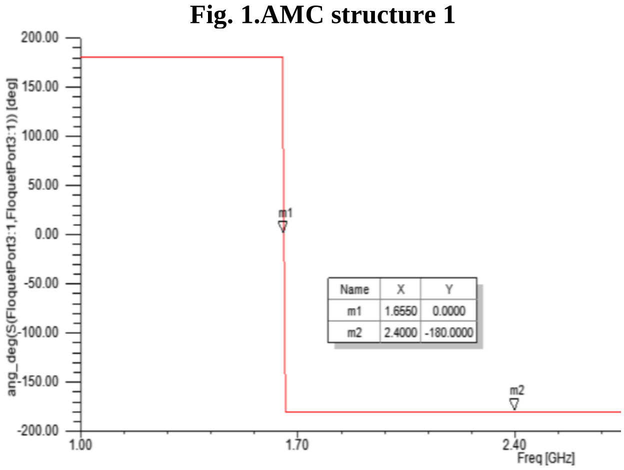

Fig. 2. Reflection phase characteristics of AMC structure 1.

So in order to get 0° phase reflection at desired frequency, another L and inverted L slots are incorporated on AMC structure 1. Due to these additional slots on structure, its results are varied. The AMC design 2 is shown it Fig. 3 and their results are shown in Fig. 4. This design crosses 0° phase reflection at 2.22 GHz which is somewhat closer to desired frequency when compared with AMC design1. At 2.4GHz frequency it has a phase reflection of 176.52°. In order to get 0° phase reflection at 2.4GHz, additional slots are introduced in the design. The AMC design 3 is shown in Fig. 5.

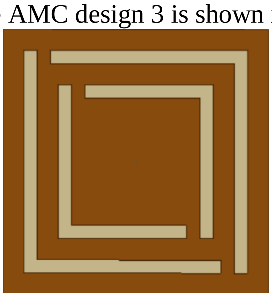

Fig. 3. AMC structure 2

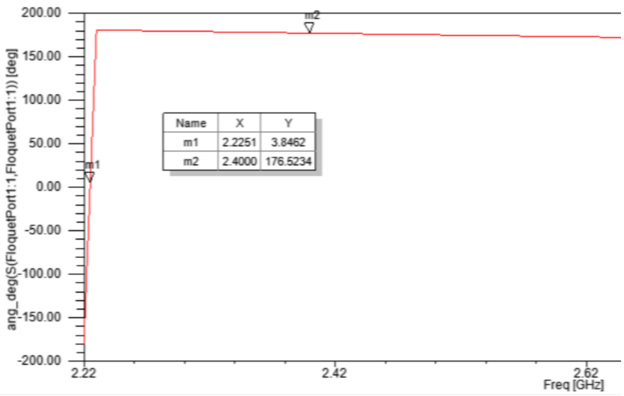

Fig. 4. Reflection phase characteristics of AMC structure 2

Fig. 5. AMC structure 3

Finally, this design 3 resonated at a frequency of 2.4GHz having 0° phase reflection as shown in Fig. 6. This structure has been incorporated with conventional patch antenna resonating at a frequency of 2.4 GHz. The conventional patch antenna characteristics are shown in the section 3.

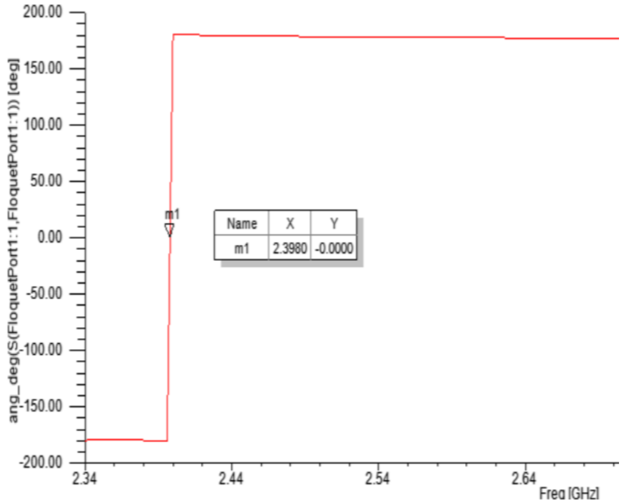

Fig. 6. Reflection phase characteristics of AMC structure 3.

III. CONVENTIONAL PATCH ANTENNA

The conventional antenna is designed for an operating frequency of 2.4GHz. The substrate was made up of FR4_epoxy material having the relative permittivity of 4.4, dielectric loss tangent of 0.02 and a thickness of 1.6mm on which the rectangular patch is created. The rectangular patch is having a width of 38.03mm and a length of 29.44 mm. The input is given by using stripline feed.

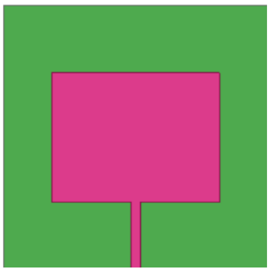

Fig. 7. Conventional rectangular patch antenna design

The design is simulated and results are shown in Fig. 8, 9,10 and 11. This conventional antenna has a return loss of -16.16dB, VSWR of 1.42, Bandwidth 16.5MHz and gain 2.65dB at 2.4GHz frequency.

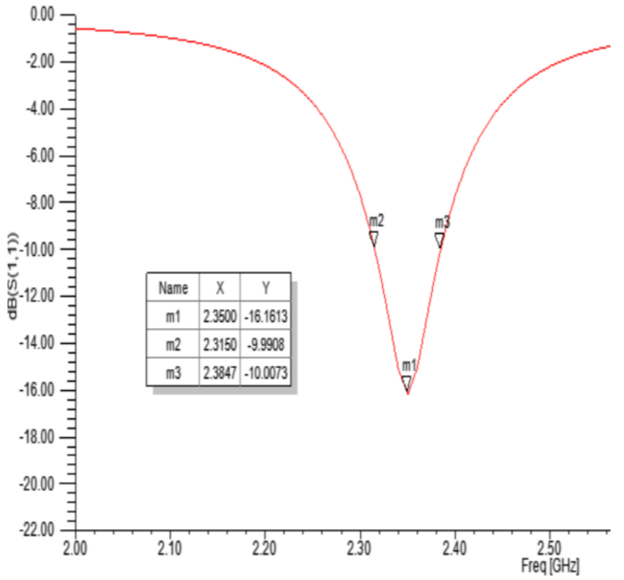

Fig. 8. Return loss plot

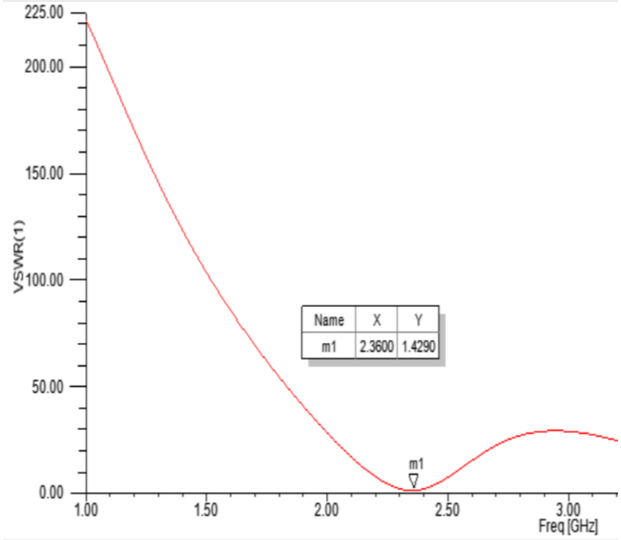

Fig. 9. VSWR plot

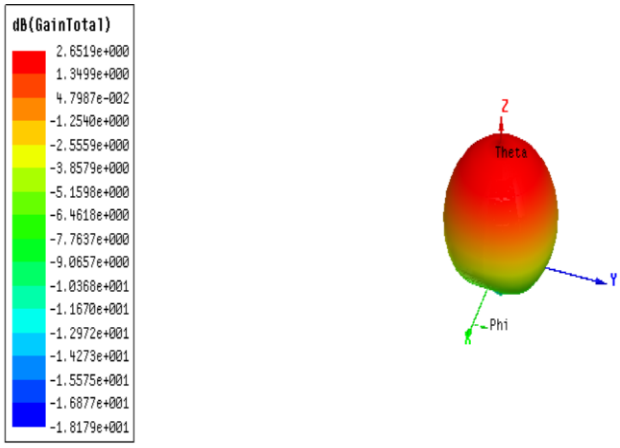

Fig. 10. Gain plot.

IV. PROPOSED ANTENNA

To attain better characteristics, conventional antenna is placed on proposed AMC design 3. The proposed antenna with AMC is shown in Fig. 11. In this case, when compared to conventional antenna, the AMC incorporated design shows the better performance.

The results are shown in Fig. 12, 13 and 14. At 2.4GHz frequency, the return loss is -31.75 dB and VSWR is 1.05 and Bandwidth of 348.1 MHz with impedance matching.

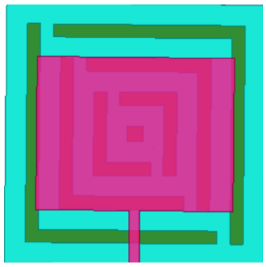

Fig. 11. Proposed antenna design.

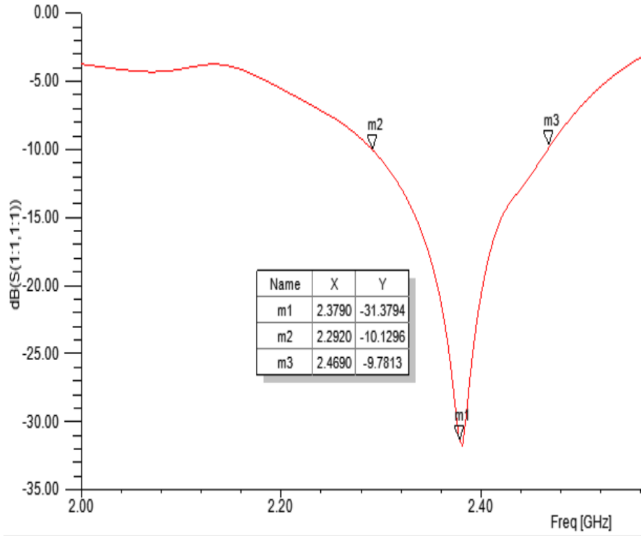

Fig. 12. Return loss plot

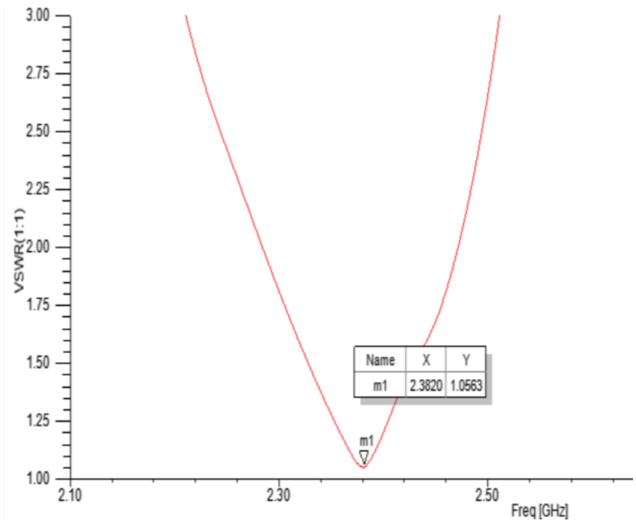

Fig. 13. VSWR plot.

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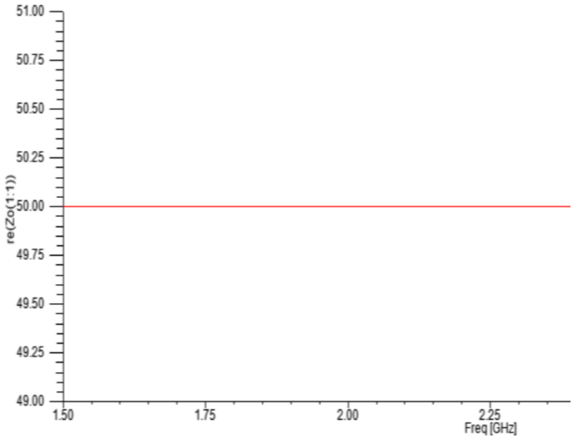

Fig. 14. Impedance plot.

V. COMPARSION

The comparison results of conventional antenna and proposed antenna are tabulated in the below Table. 1

Table. 1 Comparison of Results:

PARAMETERS	CONVENTIONAL DESIGN	PROPOSED DESIGN
Return loss	-16.16 dB	-31.75 dB
VSWR	1.42	1.05
Gain	2.65 dB	4.15 dB
Impedance	50	50
Band width	16.5 MHz	348.1 MHz

VI. CONCLUSION

Initially, a Rectangular structure with L and inverted L slot is considered, this AMC structure provides 0° phase reflection at 1.65 GHz but at 2.4 GHz it has phase reflection -180°. In order to get a phase reflection of 0° at 2.4 GHz, another 2 slots are incorporated on structure. This AMC structure provides 0° reflection phase at 2.2 GHz. Again slots are added to the AMC structure, Now this AMC structure 3 provides 0° reflection at 2.4 GHz. This proposed AMC structure 3 is incorporated on conventional patch antenna. After simulating, the Return loss is varied from -16.16dB to -31.75dB, the gain is varied from 2.65dB to 4.15dB, the VSWR is decreased from 1.42 to 1.05, the band width is increased from 16.5 MHz to 348.1 MHz.

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