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Designing of Multiband Antenna with Modified Bandwidth using Meta-material

Sumit Nigam, Research Scholar, Bhagwant University, Ajmer, India, nigamcnb11@gmail.com
Dr. Ashutosh Sharma, Principal, Globus Engineering College, Bhopal, India, ashu.vidisha@gmail.com

ABSTRACT: In this research article designing of a multiband antenna and simulation result of the same is presented. Initially a rectangular microstrip antenna was designed and then bandwidth and other parameters along with its operating bands were modified using the modification technique which is widely known as metamaterial. Designed antenna was radiating at 2.32GHz frequency with -10dB return loss and bandwidth was very nominal i.e. 17MHz only. Later after keen literature review it was found that various techniques are available to modify such low-quality antennas. Metamaterial technique was found more superior along with the other available techniques. After implementing metamaterial parameters drastically modified, single band antenna converted into 4 bands with bandwidth of each band was greater than previous one.

Keywords: Metamaterial, MPA, return loss, multiband, bandwidth.

1. INTRODUCTION

The microstrip antennas are very popular and useful antenna for small charge and solid design for RF uses and Wi-Fi systems. In Wi-Fi cellular phone call and satellite uses, MPA has magnetized a lot interest because of less dimension, cheap on mass production, less burden, short profile and simple incorporation with other parts. Though MPA have extremely attractive characteristics, they usually endure from inadequate bandwidth. Consequently, the very essential drawback of MPA is their narrow bandwidth. To conquer this difficulty without troubling their main benefit (for instance plain structure of printed circuit, less burden and economical), numerous schemes and configurations have just been examined. The patch behaves like a transducer which contains resonant like cavity having its barriers like short circuit elements on front and back of the substrate [1]. In a confined space or cavity there is only assured forms are permitted to be present, at unusual radiating frequencies. If frequency is applied to the antenna, a powerful ground is set up within cavity and a powerful current on the (base) ground of the patch. This generates important radiation (perfect antenna). This type of antennas of very low cost and easy to fabricate and possess very large number of qualities.

Microstrip patch antennas converts the electromagnetic waves into the electrical signal at the time of receiving and do vice versa at the time of transmission of the signal. The wireless networks also include wireless local area networks (WLAN). The standard group for wireless LAN in IEEE is IEEE 802.11.In this paper, design and simulation of MPA alone at 2.32GHZ was carried out. Later MPA has been modified into multiband microstrip antenna for wireless communication applications, which is able to deliver power at four distinguished frequencies of 2.35, 2.53, 2.72& 2.82GHz. This significant transition shows that a single patch antenna with an implementation of metamaterial will be able to generate power in 4 different frequencies while driving by a single supply of operating frequency 2.32 GHz with better bandwidth.

It has been defined that metamaterial is a material which physically not existed in social media but this artificial material produces a negative index of refraction. The theory presented by veselago [3] used in many studies; one of them is microstrip patch antenna.

2. CALCULATION

Designing was started from calculating dimensions of patch antenna for the operating frequency of 2.32 GHz. Substrate used was FR4 lossy which has dielectric constant of 4.3 and height 1.6mm.After dimension’s calculation, rectangular microstrip patch antenna was designed on microwave studio tool of CST. Length and width of the proposed RMPA were calculated by using formulas listed in [2], and the designed RMPA is shown in figure 1.

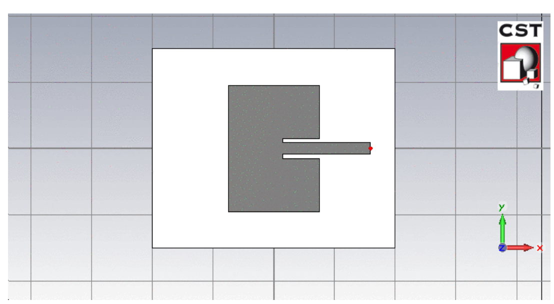

Figure 1: Designed MPA at 2.32 GHz.

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The simulated results of the RMPA, which is shown in figure 1, are presented in figure 2 and 3.

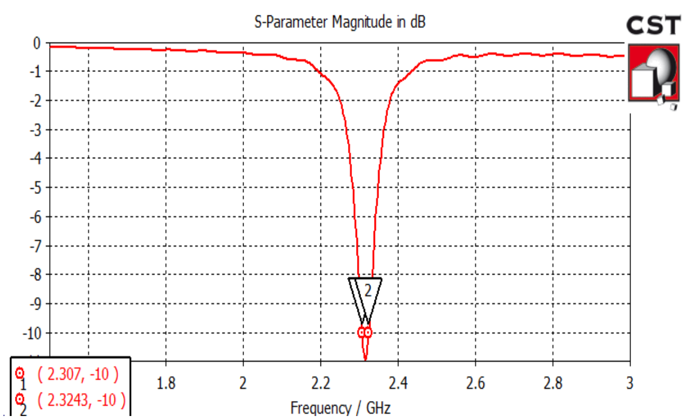

Figure 2: Simulated result of MPA showing return loss of -10.5 dB and

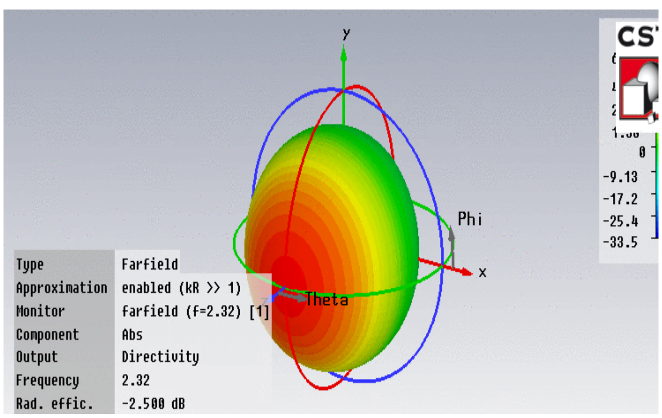

Figure 3: Radiation pattern of MPA showing Directivity of 6.1dBi.

These simulated results of proposed antenna are not fulfilling the requirement of good propagation and bandwidth therefore metamaterial has to be implemented over patch, which is shown in figure 1. This implementation brings various changes in antenna performance and its conductivity; it modifies the antenna parameters to a great extent. e. g. single band antenna converted into multiband antenna as proposed in [6-8], bandwidth of all the modified bands also increased than the bandwidth of MPA alone, efficiency also increased than former. The structure of metamaterial which was implemented on the patch is shown in figure 4 and simulated results after metamaterial introduction also shown in subsequent figures for analysis.

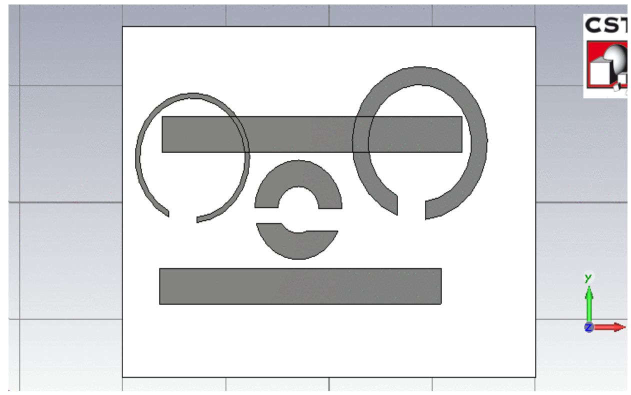

Figure 4: Proposed metamaterial design implemented above MPA.

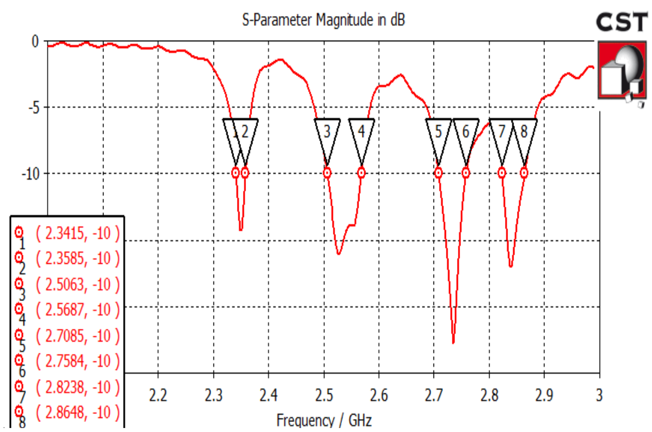

Figure 5: S parameter graph of simulated patch with metamaterial design in figure 4, showing 4bands at2.35, 2.53, 2.72 & 2.82GHz.

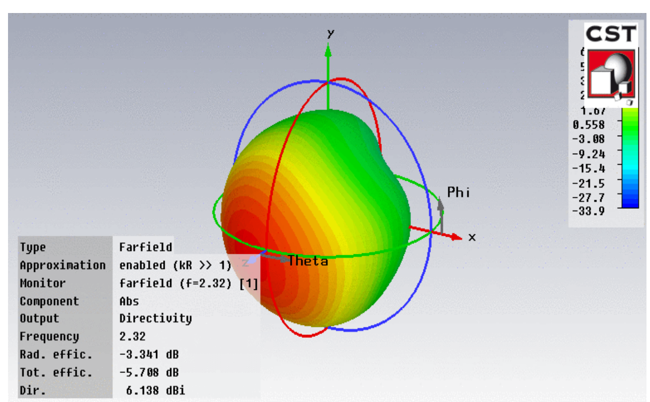

Figure 6: Suggested LH material cover placed among the pair of Waveguide Ports.

Volume 5, Issue 1 | Pages 6-8 | Date of Publication: 31 March 2017 | ID: FPEER-050102

Above shown simulated result after metamaterial cover implementation, this modifies the antenna parameters into a significant manner. These simulated results show that the antennas now not only radiate on 4 distinguished frequencies but each operating band has better bandwidth and directivity as well. Further detail on each band is discussed in next section.

3. RESULT

It has been observed by comparing the simulated results before and after metamaterial implementation that there is dramatic increment in return loss and bandwidth. And single band antenna converted into a multibandantenna. These results are compared w.r.t. the parameter variation. Comparative chart is shown below in table 1.

Table 1. Comparison Chart

S. no.	Parameters	MPA without Metamaterial	Multiband MPA after metamaterial introduction			
			at 2.35GHz	2.53 GHz	2.72 GHz	2.82 GHz
1	Return loss	-10.5dB	-19.1dB	-22 dB	-28 dB	-23.3dB
2	Bandwidth	17MHz	17MHz	62.4 MHz	49.9 MHz	41 MHz
3	Directivity	5.138 dBi	6.517 dBi	6.221 dBi	6.008 dBi	5.952 dBi

After the comparison, it has been observed that the proposed metamaterial structure converted the single band antenna to multiband without affecting its parameters and bandwidth has also increased as desired.

4. CONCLUSION AND FUTURE SCOPE

After the comparison, it has been examined that the projected metamaterial structure ameliorates the parameters up to a great level; the projected metamaterial method improves the return loss and increased the bandwidth around four times.

This proposed MPA was designed for the applications of S band. Initially only MPA parameters were not significantly fulfilling the requirement of the targeted applications but when a SRR and TW shaped metamaterial was implemented above the patch with substrate in between patch and metamaterial cover, a significant improvement is achieved. Bandwidth and directivity was highly improved. Modified patch can be used in S band applications like WLAN and Satellite applications [9-11]. Bandwidth has been modified up to 350%.The designed antenna could be used in wireless communication for L band and even for S band. Antenna will be able to propagate in four different frequencies by applying a resonant frequency of 2.32 GHz. This proposed design by authors can reduce the number of antennas required.

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