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Design of Mimo Microstrip Patch Antenna

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Abstract:

In the modern communication technology where high speed data transmission, better receiver reception is required and better bit error rate is required .This research work has been proposed. As MIMO antenna technology promises better receive reception, better bit error rate, high speed data transmission but problem of mutual coupling is the one area which needs to sort out with MIMO design. In this paper we have designed and analysis of a MIMO antenna. The center frequency of the antenna is between 2.4 to 5.3GHz.

Keywords **—** *Patch antenna, Multiple Input Multiple Output (MIMO)*

1 INTRODUCTION: Now a days wireless communication systems, there is high demand for high data transfer rate and fast access with best quality for cellar connection by MIMO (multi-input-multi-output) communication [1]. Microstrip antenna is a popular type of antenna for its good features such as planar structure, low cost, easy fabrication, ability to use in integrated circuits and compact devices.

Multiple-input-multiple-output (MIMO) systems provide the suitable technology for these requirements without the necessity of additional bandwidth or transmit power by spreading multiple antennas, with su□cient element spacing, the correct number of element. In its simplest form, the use of multiple antennas is known as spatial diversity, and the element spacing factor a□ects the overall performance of the system. In cases where there are limitations of the size and the cost, the spacing between the antennas is insu□cient [2]. The current wireless communication systems have to fulfill the demands such as high data rates, increased capacity, high quality, and high reliability for different applications. Multiple-input-multiple-output (MIMO) systems provide the suitable technology for these requirements without the necessity of additional bandwidth or transmit power by spreading multiple antennas, with sufficient element spacing, the correct number of elements, and appropriate array geometry or topology [3]. In its simplest form, the use of multiple antennas is known as spatial diversity, and the element spacing factor affects the overall performance of the system. In cases where there are limitations of the size and the cost, the spacing between the antennas is insufficient, and this results in mutual coupling

In this work, a dual-band rectangular patch antenna is designed for 2.5GHz and 5.4GHz. The dual-band rectangular patch antenna is used as a single element of a 1×2 MIMO configuration [4]. Two antenna elements are closely placed (λmax/8) distance and an isolation of better than -25 dB is achieved [5]. Wavelength of higher operating band 5.4GHz. Since, the far-field region of the higher band is larger, so how to suppress the mutual coupling for this band [6]. The dual band patch antennas in between swastik type mushroom EBG introduced.so the antenna elements are placed on a common substrate in such a way that it slightly cancels the fields at 5.4 GHz bands from each other leading to lower mutual coupling at higher band Later, a dual-band modified swastika mushroom type EBG is placed in between two antenna elements resulting in excellent isolation in both operating bands [7]. When MIMO antennas are very close to each other when designed. Antennas close to each other mutual coupling occurs. So to reduce the mutual coupling.different techniques to reduce the mutual coupling. When mutual coupling occurs the total gain decreased. So to increase the gain multiple antennas are used at the transmission side and to receive the signal same antennas are used at the receving side. When two antennas very close to each other mutual coupling occur. So here two antennas are desined. In higher frequency band coupling occurred.

2. MIMO PATCH ANTENNA

Here, a dual-band single element micro strip patch antenna is designed which is further used to realize a 1×2 MIMO antenna. The layout of the antenna 1×2 MIMO is shown in Fig. 1. The proposed antenna is built on a commonly used FR4 substrate of thickness 1.6 mm and dielectric constant of 4.4. Initially, band 2.5 GHz rectangular microstrip patch antenna is designed. Dimensions, width (W), and length (L) of the conventional rectangular patch antenna is calculated using the following expressions

$$W = \frac{c}{2f_0\sqrt{\frac{(\varepsilon+1)}{2}}}$$

$$L = \frac{c}{2f_0\sqrt{\varepsilon_{eff}}} - 0.824h\frac{(\varepsilon_{eff}+0.3)(\frac{W}{h}+0.264)}{(\varepsilon_{eff}-0.258)(\frac{W}{h}+0.8)}$$

The substrate dimensions of the ground plane is equal to width and length. . Thereafter, an optimized thin rectangular slot is placed along the length of the rectangular patch to excite another 5.4 GHz band [8]. By inserting rectangular slots into patches dual-band operation is achieved. However, incorporating a slot into the patch shift the actual operating frequency of conventional 5.4 GHz band, as shown in Fig. 2. Thus, the length (L) of the patch and length of the slot is precisely optimized to achieve exact 2.5 GHz and 5.4 GHz bands. It is evident that the optimized length of the patch and length of the slot meet the exact desired 2.5 GHz and 5.4 GHz bands.Using the length and width dimensions the antennas are designed. Here without EBG structure coupling is occur [9]. Fig2 shows the frequency versus return loss. This graph shows the coupling at higher frequency and gain is also less compare to the with EBG structure. The gain of the array antenna is shown in fig 3. Without EBG. Without EBG structure the gain will be less. The total gain is less compared to the with EBG total gain. Using the dimensions the micro strip antenna resonates dual band of frequencies that frequencies are 2.5GHz and 5.4GHz.

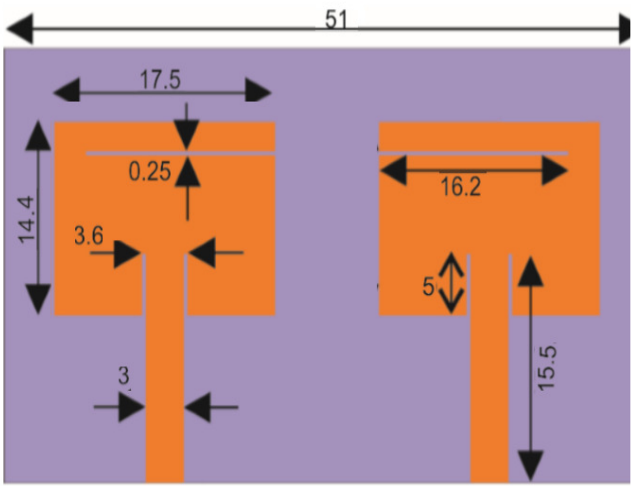

Fig1: Dual band MIMO antenna

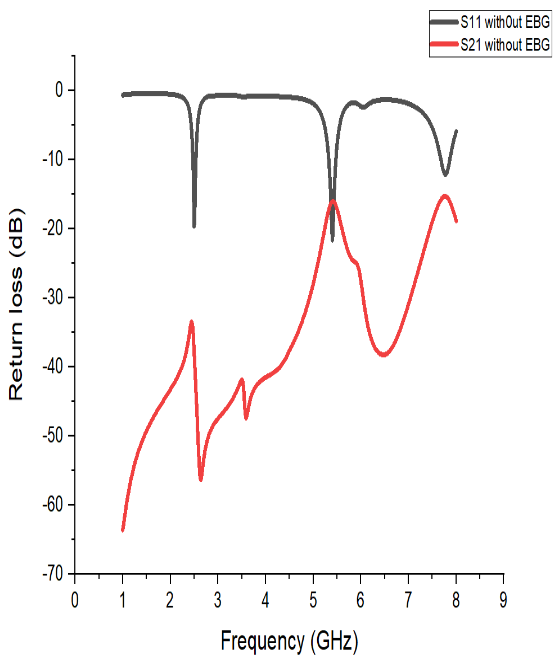

Fig2: Return loss Vs Frequency without EBG structure

Fig2 shows return loss Vs frequency without EBG. Without EBG structure at higher frequency band i.e 5.4GHz frequency mutual coupling occur. In low frequency band 2.4GHz there is no mutual coupling[10]. So in high frequency band to reduce the mutual coupling. Fig3 shows the total gain of antenna array. Here due to mutual couplig the total gain is reduced. So to increase the gain designed Swasik type mush room EBG designed.

3. RESULTS AND DISCUSSION

Here designed reduced mutual coupling MIMO antenna with swastika type mushroom EBG structure. The results are excellent. Reduced mutual coupling at higher frequencies using swastik type EBG structure inserted between the antennas. At frequency 5.4GHz there is no mutual coupling. The ouput return loss is -25dB. The total gain is also increased around 3.9dB .The total gain shown in fig 6 and the discussion is designed simple EBG structure designed .so many coupling mechanism are there nowdays like DGS (defected ground structure),Decoupling network,Meta materials, parasititic elements but this EBG structure is simpe to design. Using the lengh and width of the patch antenna one frequency generated and one slot in the patch other band of frequency is generated. Using HFSS calculated s11 and s12.

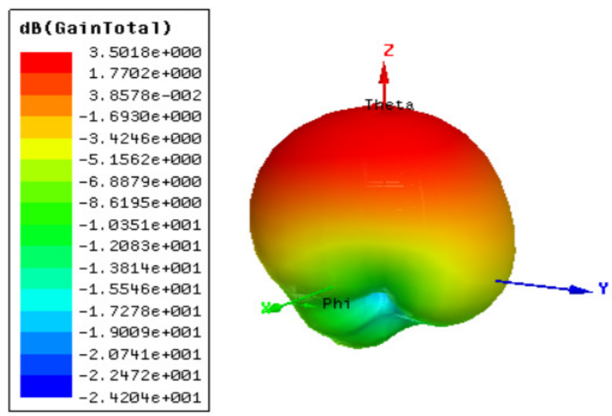

Fig3: Gain of an array antenna without EBG

4. CONCLUSION

This paper presents a reduced mutual coupling using a swastik type mushroom EBG structure. The swastik type mush room EBG structure reduced the mutual coupling. Mutual Coupling between the two rectangular patch antennas is decreased by inserting swatik type mushroom EBG. The proposed EBG structure is simple and easy to fabricate. The antenna has been designed for easy integration with existing wireless communications. A MIMO Microstrip patch antenna has been successfully designed with EBG. It can be concluded from the above results, while designing, a proper feed network and impedance matching are very important parameters in Microstrip patch antenna design. Good isolation is suitable for communications. These frequencies 2.5 GHz and 5.4 GHz are suitable for various wireless communication systems.

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