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DUALBAND MIMO ANTENNA WITH SLOTTED EBG STRUCTURE FORWIRELESS APPLICATIONS

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Abstract

In this paper dual band mimo antenna with slotted EBG is designed. This antennais used in wireless communication applications. Here the proposed antenna is operated in two different bands that are 2.5GHz and 5.3GHz. The proposed MIMO antenna suppresses the mutual coupling in the antenna designed using slotted EBG *(Electronic Band Gap)* structure .The slotted EBG is placed in between the antennas. The designed antenna gives excellent results like return loss above -10dB, gain increased to 3.734dB and S12 is increased to greater than -20dB.VSWR is greater than 1.Theproposed MIMO antenna is designed using HFSS(High Frequency Structure) Software.

Keywords: *EBG, HFSS, MIMO*.

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1. Introduction

In wireless communication data can be transferred from one place to another. Different generations like 1G,2G,3G,4G,5G etc[1].1G is the first generation of wireless telephone technology, namely mobile communications. It uses analog signals and has a speed of up to 2.4kbps. Phone with no screen could make calls. 2G (GPRS)is the second-generation mobile technology. It uses digital telecommunications standards. The data rate is between 56-114kbps. 2G realizes the digitization of voice communication, and feature phones can send text messages with a small screen.3G (WCDMA/CDMA 2000/TD-SCDMA) is the third-generation mobile communication technology [2]. It provides a data rate of 384kbps. So you can easily browse websites and stream music.4Gis the fourth generation of mobile technology, known as LTE (Long Term Evolution). Compared to 1G-3G, it is the best among these types. And it is stable and fast like Wi-Fi at home or office.5G is the fifth-generation mobile communication technology and an extension of the 4G system [3]. On June 13, 2018, the San Diego 3GPP meeting set the first international 5G standard. Compared with the former, 5G networks have

three main characteristics extremely high speed (eMBB), extremely large capacity (mMTC), and extremely low latency (URLLC). Currently, we use low-frequency bands for 4G [4]. Its advantages are good performance and wide coverage, which can effectively reduce the operator's investment in base stations and save money. But the disadvantage is that if there are more people, the 'road' of data transmission will be narrow. Although the existing technology has been optimized, the rate is still limited [5]. While 5G uses high-frequency bands, the use of high frequency can not only relieve the tension of low-frequency resources but because there is no congestion phenomenon, the 'roads' are wider and the bandwidth rate is increased[6].

To solve the propagation problem of high-frequency communication, it requires relying on the massive antenna (massive MIMO) [7]. MIMO stands for 'multiple input multiple output'. Here one more important parameter microstrip patch antenna is used [8]. This patch antenna is light weight. Here main components of the design are patch, substrate, ground plane and feed. VSWR is voltage standing wave ratio. VSWR is always greater than 1 is good for design. Different types of feeding methods are available likeproximity coupled feeding method, coaxial feed, microstrip line feed, and aperture coupled feed [9]. Here using microstrip line feed method [10]. The microstrip line feed. This feeding is interface between the conducting strip and the edges of the rectangular patch. The feeding strip is width is smaller as compared to the rectangular patch and this type of microstrip line feed is advantagecompare with other feeding structure

2. MIMO Technology:

MIMO (multiple input multiple output) means more number of antennas at the input side and more number of antennas at the output side [11].

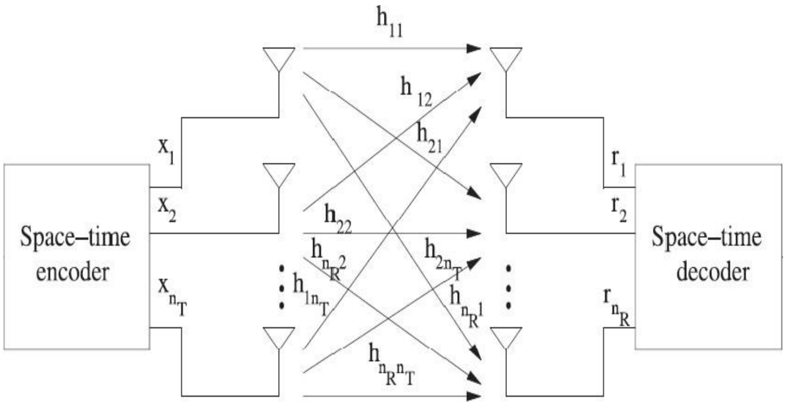

Figure 1: MIMO Antenna

MIMO antenna shows in fig 1. Here encoder at the transmitting side and decoder at the output side arranged [12]. The above figure 1 inputs are x1,x2…xn are at the transmitting end and at the receiving end r1,r2….rn.. Here h11 indicates the signal is transferred from transmission antenna1 end to receiving end antenna1 and h12 indicates transmitting antenna 1 to receiving antenna 2[13]. Microstrip antenna consists different types of patches [14]. Different types of patches available like rectangular,triangle, square, circular, ellipticle, circular ring, dipole [15].

3. AntennaDesign: Microstrip rectangular patch antenna with slotted EBG shown in fig1. The designed antenna is 2X2 MIMO .The antenna givesresults in terms of gain, return loss, mutual coupling. Here first substrate used is FR4. The dimensions of the substrate selected width and length are 51mm and 29.6mm. Height of the substrate is 1.6mm. Measurents of length and width of the patch antenna is calculated using these formulas. The dielectric constant 4.4mm

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

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

In the above two equations we can calculate the width and length of the rectangular patch. Here f0 is the resonating frequency. The height of the substrate 1.6mm.The rectangular patch dimensions are W=17.5mm and L=14.4mm. Depending on patch dimensions the designed antenna resonates. This antenna resonates at two different bandsof frequencies 2.5GHz and 5.3GHz. Here using microstrip line feeding. This feeding connects between external supply and resonating patch antenna. Between the MIMO antennas slotted EBG is incorporated. Initially rectangular patch design width and length dimensions are same in EBG.

Another band of frequency is 5.3GHz. One slot is placed on rectangular patch. That length (L) is 15.5mm and width (W) is

0.25mm. Depending upon the length and width dimensions the antenna resonates at the desired band. In this band the simulation results are good. There is no mutual coupling in this band. The inside of the feeding dimension is 4.9mm with microstrip line feeding. The slotted EBG dimensions are 2.2mm both the sides. Full structure is divided into four the internal dimensions are less than the outside dimensions of the EBG.

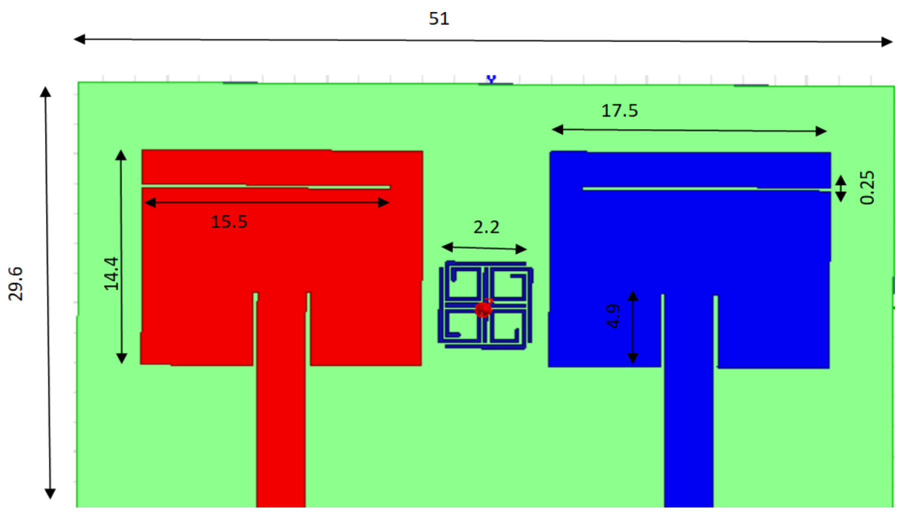

Figure 2: Layout of the dual-band antenna. (Units mm).

One more slot incorporated on patch that patch will radiate one more frequency 5.3GHz. Same antenna is placed side by side. The two antennas radiate same frequency bands. If two antennas are operated in same frequency band interference will occur. So one of the main important parameter in MIMO antenna is suffering with mutual coupling. So to reduce the mutual coupling between antennas. So one structure is required. Varity of structures are available like DNG (Double Negative), Meta material, EBG etc. Here slotted EBG structure used for to reduce mutual coupling between multiband MIMO antennas.

4. Results and Discussion

The simulation results are shown from fig 3 -6. By using HFSS the MIMO antenna is designed. Fig 3 showsthe returnloss versus frequency. The antenna return loss achieved in this design is greater than -10dB.The antenna resonates at two different frequency bands that are 2.5GHz and 5.3GHz. These two frequency bands the return loss is accurate. Table 1 shows the frequency versus S11 and S12. At different frequencies the values of S11 and S12 are shown. The desired frequency 2.5GHz and 5.3 GHz the simulation results are good.

Table 1: MIMO antenna with slotted EBG

Frequency(GHz)	S11(dB)	S12 (dB)
1	0	-58
2.15	-5	-37
2.5	**-18**	**-27.5**
4	-2	-40
5.3	**-14**	**-32.5**
5.5	-2.5	-15
5.6	-9.8	-19

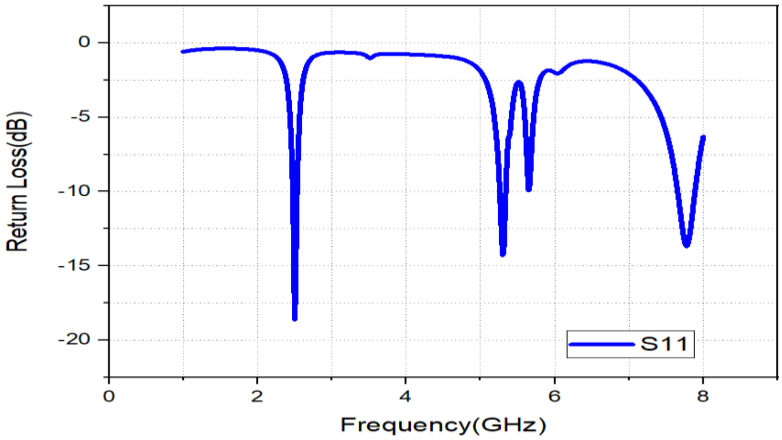

Figure3: frequency versus return loss

The mutual coupling versus frequency shown in fig 4. The coupling is greater than -20dB.

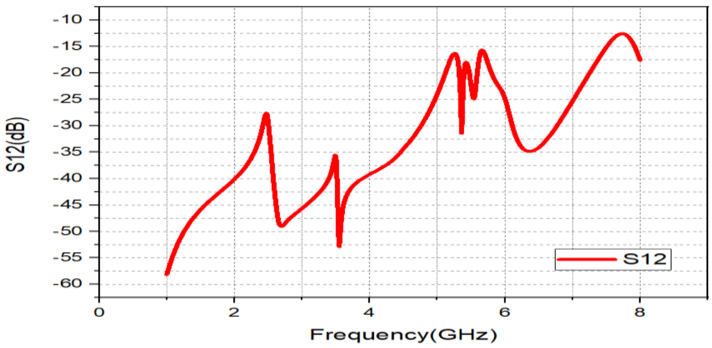

Figure 4: frequency versus coupling

The two frequency bands i.e.2.5GHz and 5.3GHz.In these two frequency bandsthe coupling is greater than -20dB. When both the S-parameters are combined S11 and S12 with frequency shown in Fig 5. There is no mutual coupling between the designed antennas in desired frequency bands. Using slotted EBG structure reduced mutual coupling between the antennas.

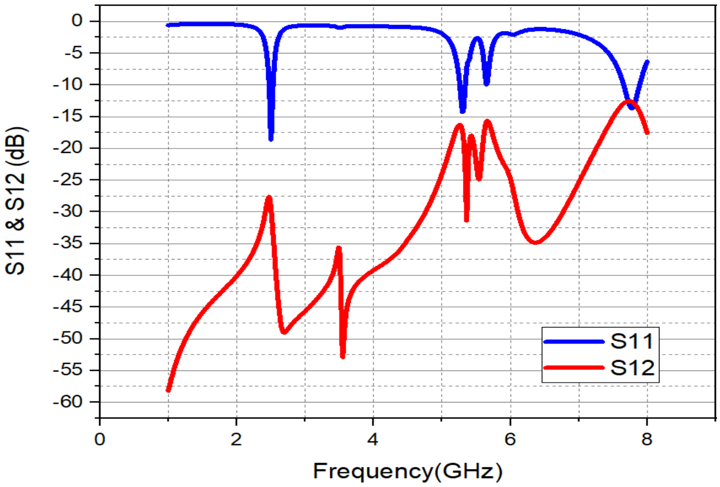

Figure5: frequency versus S11 and S12

The simulated 3D radiation pattern shown in fig 6. The total gain of the antenna is 3.742dB with EBG. Without slotted EBG the antenna gain is less. In 3-Dimensional radiation pattern the antenna radiates in particular direction only. The final designed antenna is combination of two antennas. After combining and optimization the above results are shown. The simulated VSWR is also calculated i.e. greater than 1.

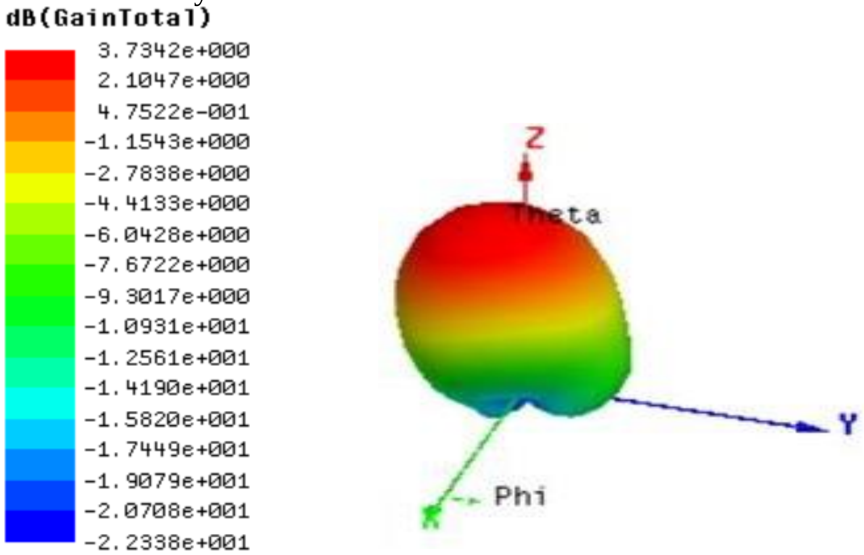

Figure 6: Simulated3Dradiationpattern

5. Conclusion: The proposed antenna dual band slotted EBG MIMO array is designed for wireless communication with FR4-epoxy substrate.Mutual coupling improvement is achieved using this designed structure. The mutual coupling between the MIMO antennas has been suppressed using slotted EBG structure. The antenna performance is improved. The return loss results also greater than -10dBand s12 is above -20dB. The designed antenna resonating two different frequency bands that are 2.5GHz and 5.3GHz.

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