CHAPTER: 16

PARAMETRIC ANALYSIS OF A MOON SHAPE SLOTTED MICROSTRIP PATCH ANTENNA FOR TRIPLE BAND 5G WIRELESS APPLICATIONS

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ABSTRACT

In this article author designs a new and compact patch antenna with the dimensions 40x21x1 mm^3 on substrate called FR4 with a dielectric constant of 4.4, sandwiched between a patch and a copper ground plane. Microstrip feedline is used to link the Moon-shaped antenna to the coaxial cable connection and the antenna's impedance is matched. Slotted antenna has been found to resonate between the frequency bands of 23.67-24.82 GHz,25.46 -26.44GHz and 26.77-27.92 GHz at resonant frequency of 24.32 GHz ,25.91GHz and 27.36 GHz respectively.

At all the resonant frequencies of 24.32 GHz ,25.91GHz and 27.36 GHz, VSWR of the proposed antenna is same with the value 1.06 dB. Microstrip feeding technique is used to create this microstrip patch design. This patch is being researched because it has a low VSWR at all the three resonant frequencies with high bandwidth. This design is suitable for triple band operations for wireless communication in the range of 5G frequency bands. By adopting an appropriate feeding mechanism and use of proper cutting slots in the rectangular patch, frequency band width can be increased.

The electromagnetic simulation of the proposed antenna has been done using CST software. The analysis of performance will be based on changing the geometry of the patch and the obtained results are gain, VSWR, antenna efficiency and radiation pattern. After parametric analysis it is observed that this design is perfectly suitable for 5G wireless applications.

Keywords: *Moon Shape, Patch Antenna, Gain, 5g.*

INTRODUCTION

Satellite and wireless communication have advanced rapidly in recent decades, and they have already had a significant impact on human life. Many applications in communications and local area network require a means for transmitting and receiving electromagnetic waves. Microstrip antenna technology's adaptability has resulted in a wide range of designs and ways to meet this need. Small mobile phone handsets are becoming more and more in demand. Smaller mobile phones are starting to become available. Compact handset demand will rise along with overall demand. The antenna size is one of the most important factors in portable communication systems. The MPA is often utilized due to its low volume and low profile. The magnitude of MPA is mostly controlled by the resonance's length and width. The new 5G generation of mobile technology, can operate at extremely high speeds with very little delay and very high reliability. The 5G New Radio (5GNR) interface is positioned to satisfy the more stringent requirements for the very varied usage scenarios of 2020 and beyond, including explosive increases in connectivity and traffic density and volume. To accommodate such a diverse range of usage scenarios and requirements, enough 5G spectrum availability is necessary. An antenna works like a transducer. It transforms RF signals into electromagnetic waves with the same frequency (EM). It is a component of both the transmitter and the receiver circuits. Resistance, inductance, and capacitance are elements that define its equivalent circuit.

This work offers a revolutionary millimeter wave antenna design that can be used for a number of purposes, such as cellular communications and transfer the large amounts of data quickly.

DESIGN ANALYSIS

Step 1: Calculation of the Width (*W*):

The width of the Microstrip patch antenna is given as:

$$\mathbf{W} = \frac{\mathbf{C}}{\mathbf{2fo}\sqrt{\frac{\in \mathbf{r}+\mathbf{1}}{\mathbf{2}}}}$$

Step 2: Calculation of Effective dielectric constant (ε_{reff}):

The effective dielectric constant is:

$$\mathcal{E}\mathbf{reff.} = \frac{\in \boldsymbol{r}+\mathbf{1}}{\mathbf{2}} + \frac{\in \boldsymbol{r}+\mathbf{1}}{\mathbf{2}}\sqrt{\mathbf{1}+\mathbf{12}\frac{\boldsymbol{h}}{\boldsymbol{w}}}$$

Step 3: Calculation of the Effective length (L_{eff}):

The effective length is:

$$Leff = \frac{c}{2fo\sqrt{\mathcal{E}\text{reff.}}}$$

Step 4: Calculation of the length extension ($\triangle L$):

The length extension is:

$$\triangle L = 0.412h\frac{(\mathcal{E}\text{reff}+0.3)(\frac{w}{h}+0.264)}{(\mathcal{E}\text{reff}-0.258)(\frac{w}{h}+0.8)}$$

Step 5: Calculation of actual length of patch (L):

The actual length is obtained by:

$$L = Leff - 2.\triangle L$$

Figure 1 shows the design of slotted antenna. Inner and outer curve has a diameter of 16,55 mm and 11.55 mm. angular displacement between these two curves is 23.36 degrees

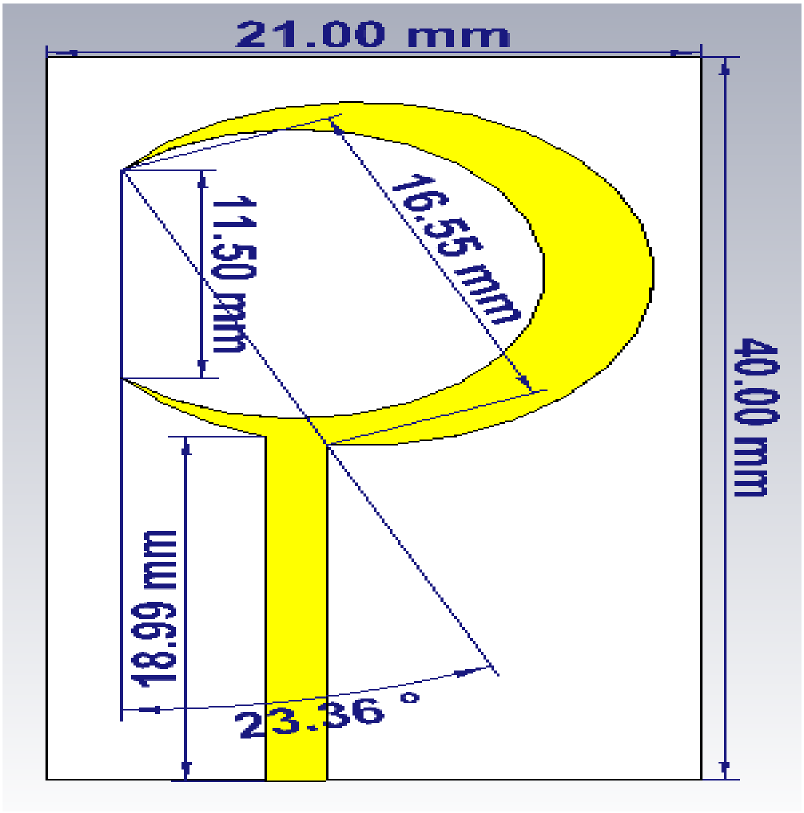

Fig.1 Slotted Moon shaped structure of Proposed Antenna

Parametric Result Analysis

The simulation of micro-strip patch antenna is done by using CST software. The VSWR graph for a slotted Moon shaped patch antenna is shown in figure (2). The VSWR indicates the mismatch between the antenna and the transmission line. For perfect matching the VSWR value should be close to unity. For all the resonance frequencies, VSWR of the proposed antenna is same with the value 1.06 dB, The return loss graph is shown in figure (3), the far field directivity at angle theta =90 degree is shown in figure (4), the E-field is shown in figure (5), gain of the proposed antenna shows in figure (6) and the H-field is shown in figure (7).

Table.1:-Result Analysis

Antenna Geometry (in mm³)	VSWR	Resonance frequency (f_r) in GHz	Antenna 1 Bandwidth (in GHz)	S_{11} Parameter (in dB)	Number of Bands
40x21x1 mm³	1.06	f_r=24.32	23.67-24.82	-30.40	Triple
	1.06	f_r=25.91	25.46 -26.44	-30.30	Triple
	1.06	f_r = 27.36	26.77-27.92	-30.68	Triple

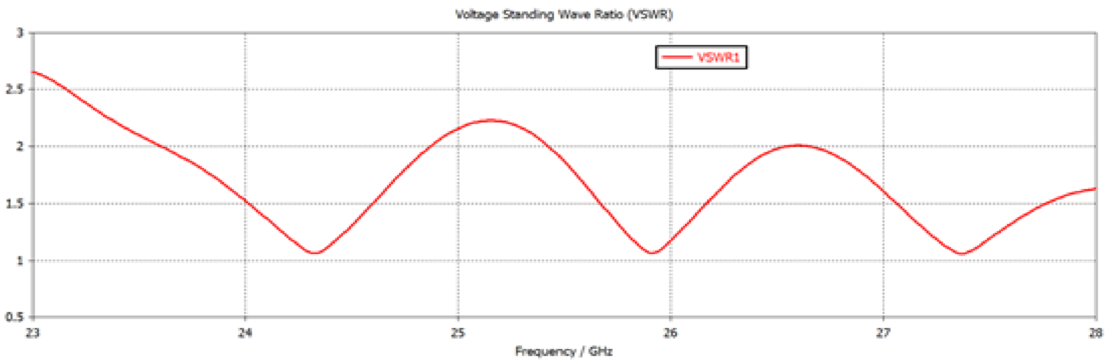

Fig.2 VSWR of the Proposed Antenna at resonant frequencies of (a) 24.32 GHz (b) 25.91GHz (c) 27.36 GHz

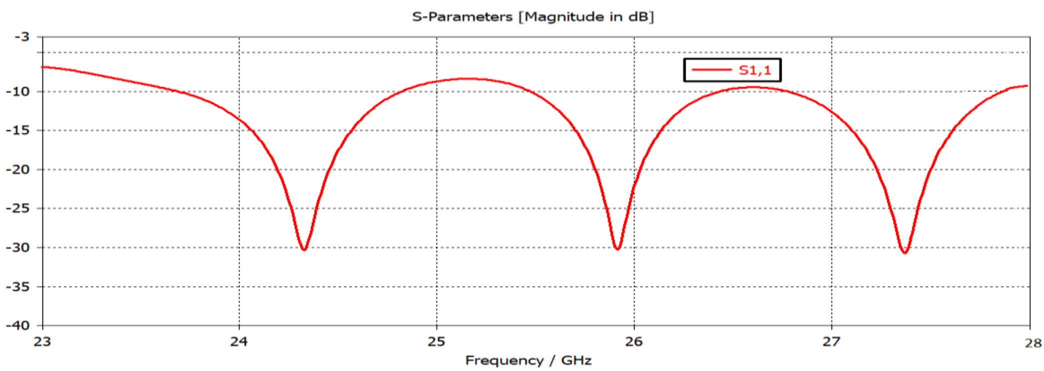

Fig.3 Return Loss of the Proposed Antenna at resonant frequencies of (a) 24.32 GHz (b) 25.91GHz (c) 27.36 GHz

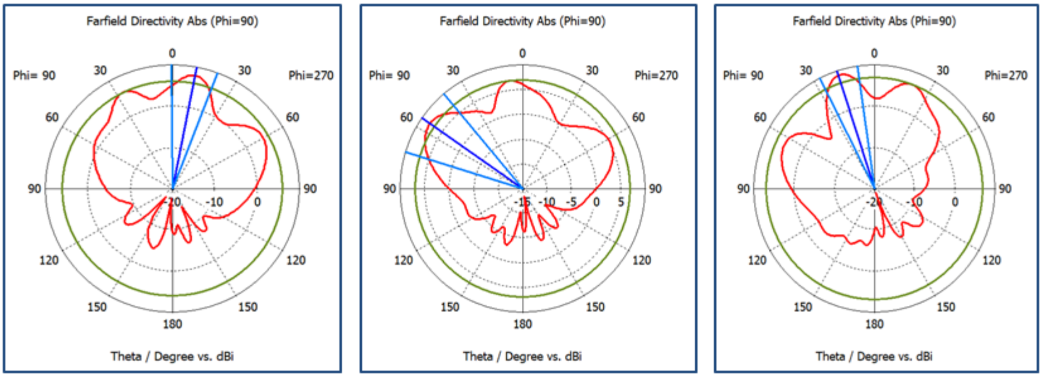

Fig.4 Total far field Directivity of proposed antenna at resonant frequencies of (a) 24.32 GHz (b) 25.91GHz (c) 27.36 GHz

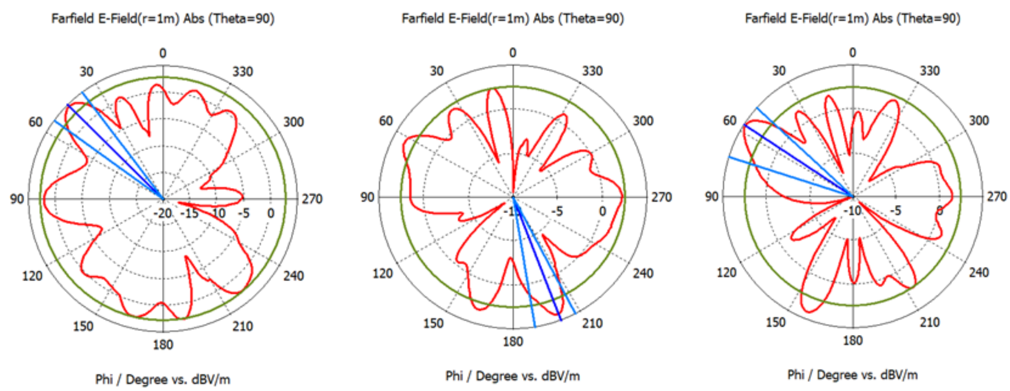

Fig.5 Total E-field of proposed antenna at resonant frequencies of (a) 24.32 GHz (b) 25.91GHz (c) 27.36 GHz

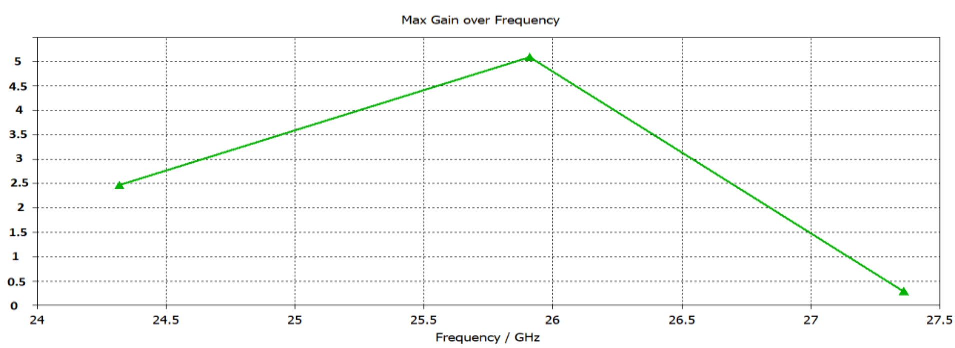

Fig.6 Gain of the proposed antenna at resonant frequencies of (a) 24.32 GHz (b) 25.91GHz (c) 27.36 GHz

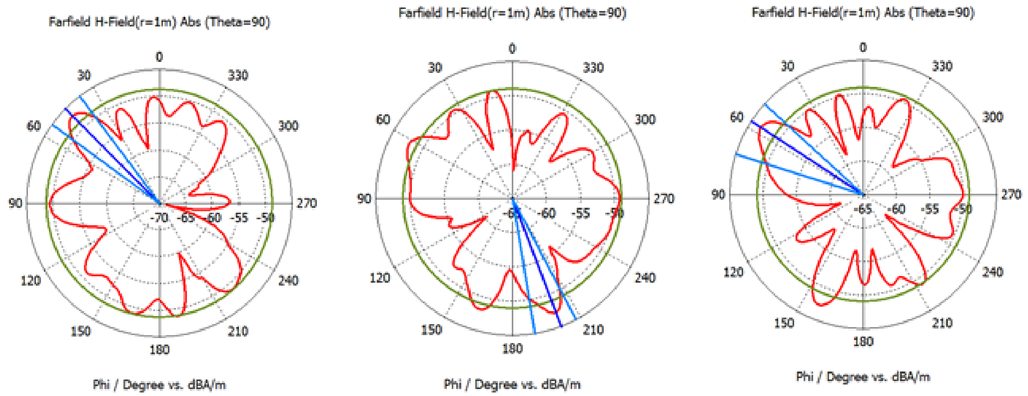

Fig.7 Total E-field of proposed antenna at resonant frequencies of (a) 24.32 GHz (b) 25.91GHz (c) 27.36 GHz

CONCLUSIONS

A unique and effective microstrip patch antenna with moon slot constructed to deliver the necessary results, The suggested antenna is compact and has Triple bands, which resonant between 5G frequency bands (20-28 GHz) at resonance frequency of 24.32 GHz ,25.91GHz and 27.36 GHz. All the triple bands are suitable for 5G wireless applications. This Moon shape slotted design give the desired results for 5G network applications.

FUTURE SCOPE

This unique design has three high frequency bands 23.67-24.82 GHz,25.46 -26.44 GHz and 26.77-27.92 GHz, by reducing the size of the antenna and taking a material with lower dielectric constant, the range of frequency band will be increased, which will increase the range of resonant frequencies, it can have used in more upcoming wireless applications.

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