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Comprehensive Study and Design Of Rectangular And Circular Microstrip Patch Antenna

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ABSTRACT

The comparison between parameters of the rectangular and circular patch antenna is presented in this paper. For different wireless applications, the selected range of frequency is 2.3GHz to 2.5GHz. For design antenna, FR4 material is used as a dielectric medium. CAD-FEKO software tool is used for design and compare the performance of the presented antennas. This detailed study gives the result that the rectangular patch antenna shows higher VSWR that is 1.099 than the VSWR of circular patch antenna that is 1.45. The rectangular patch antenna has a better reflection coefficient value than that of the circular patch antenna. This paper shows contrastive analysis of various performance parameter of patch antenna like VSWR, Reflection coefficient, Bandwidth, and Gain.

Keywords
FR4 material, VNA, Rectangular microstrip, Circular microstrip, CAD-FEKO software

INTRODUCTION

The antenna plays an energetic role in the field of radio communication system. An antenna is a transceiver device which is able to transmit as well as receive the microwave signals, radio signals, and satellite signals. An antenna which have the high gain capability that increases signal strength. The low gain antennas are used over a wide range for receiving and transmitting. The microstrip patch antenna pointers to a very innovative evolution in the world of miniaturization. It is having a broad range of application in microwave systems like biomedical systems, missile system, navigation, mobile and satellite communications, GPS system for remote sensing etc. Microstrip patch antenna has a compact size, light weight, small volume, and can be easily fabricated on a printed circuit board (PCB). The structure is based on conducting material microstrip which a separates from the ground plane by adding substrate between them. There are many feeding techniques but we have used co-axial feeding. The design and simulation of both the rectangular and circular microstrip patch antennas are done by using CAD-FEKO software tool.

II. CAD-FEKO SOFTWARE

FEKO is a software tool which is developed by Altair Engineering. The acronym of FEKO is "FEldberechnungfür Körpermitbeliebiger Oberfläche", which can be explained as "field calculations involving bodies of arbitrary shape". It is used as general purpose 3D electromagnetic (EM) simulator. FEKO is suitable for the analysis and simulation of various types of antennas like microstrip antennas, wire antennas, horn and aperture antennas, reflector antennas, phased array antennas, broadband antennas, conformal antennas etc. FEKO software is invented by Dr. Ulrich Jakobus in 1991 at the University of Stuttgart, Germany. CAD-FEKO software tool is useful in the many areas like telecommunication, automobile, space, and defense industries.

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III. PARAMETERS

1] Voltage Standing Wave Ratio

The process of achieving the particular configuration of an antenna to perform efficiently there is always a reflection of the power which points to the standing waves, which is characterized by the VSWR (Voltage Standing Wave Ratio). The VSWR

range from 1 to ∞. VSWR is used to define how well the antenna is matched to radio or transmission line which is connected to the antenna. Value of VSWR should be minimum. The ideal value of VSWR is 1.

2] Reflection Coefficient

This parameter describes how much of an electromagnetic wave reflected back by impedance discontinuity. All power supplied to the antenna is reflected back when the values of reflection coefficient is 1. From the value of reflection coefficient, we can determine another antenna parameter that is VSWR. There is a resistance which is associated with each transmission line that comes with the structure of the transmission line. This is called as character impedance (Z0). The standard value of this impedance is 50 ohm. Every transmission line is being terminated with a random load ZL and this is not equivalent to the character impedance i.e. Z0. Here arises the reflected wave.

3] Gain

The gain of an antenna is the quantity which describes the performance of that antenna or the capability to concentrate energy through a direction to give a better radiation performance. When both the antennas are fed by the same input power then ratio of the intensity of an antenna's radiation in the direction of strongest to that of a reference antenna, is nothing but the gain of that antenna. If the reference is an isotropic antenna the gain is often expressed in units of dBi. The gain of the antenna is a passive phenomenon- power is not added to the antenna. Basically, the measurement of gain is done in dB.

4] Bandwidth

Bandwidth can be said as the frequencies on both the sides of the center frequency. When the ratio of fL to fH is 2 then the antenna is said to be broadband. Unit of bandwidth is Hz. The particular range of frequency or bandwidth over which antenna performs efficiently. Outside this range antenna not work properly because of low impedance. Bandwidth is generally determined by measuring parameters such as SWR or radiated power over that frequency range.

III. DESIGN PARAMETERS

The antenna is designed on a substrate named as FR4. It is having dielectric constant 4.4. The other parametric configurations are given below. The Figure.1 and Figure.2 shows the rectangular and circular microstrip patch antenna respectively designed by CAD-FEKO. The design parameters dimensions of antenna are listed in following Table.1.

Table.1 Design parameters dimension

Parameter	**Rectangular**	**Circular**
Patch size	L=38.6 mm W=27.4 mm	a= 17mm
Substrate size	Lg=46.7 mm Wg=46.7 mm	Lg=46.7 mm Wg=46.7 mm
Substrate height	h=1.8 mm	h=1.8 mm
Dielactric constant	Ɛr=4.4	Ɛr=4.4

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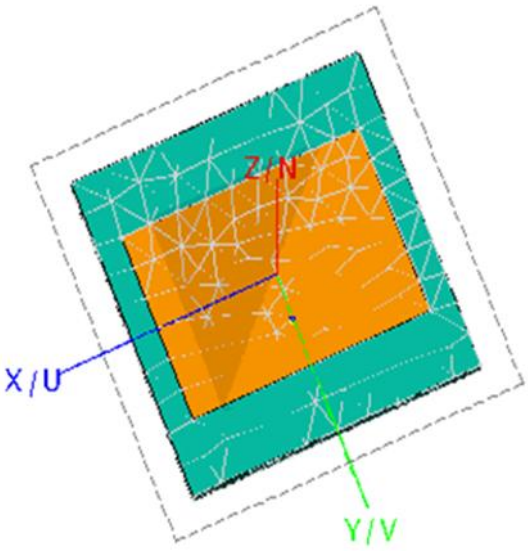

Figure 1: Rectangular microstrip patch antenna

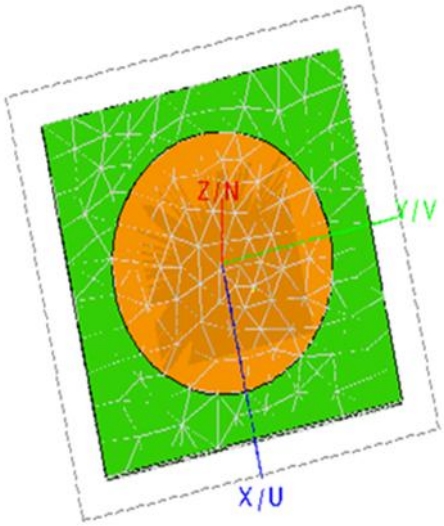

Figure 2: Circular microstrip patch antenna

V. SIMULATION RESULTS ANALYSIS

The simulated resonant frequency of rectangular and circular microstrip patch is 2.41 GHz and 2.36 GHz respectively. The simulated VSWR plots of rectangular and circular microstrip antennas are shown in Figure 3 and 4, VSWR values are 1.099 and 1.43 respectively. Figure 5 and 6 shows the analysis of reflection coefficient of both the antennas. Reflection coefficient of rectangular microstrip patch antenna is -25.31 dB. The reflection coefficient for circular microstrip patch antenna is -14.60 dB. The gain of the rectangular and circular patch antenna is 5.66 dB and 5.67 dB respectively. The bandwidth of rectangular and circular patch antenna is 62.16 MHz and 41.76 MHz respectively at -10dB.

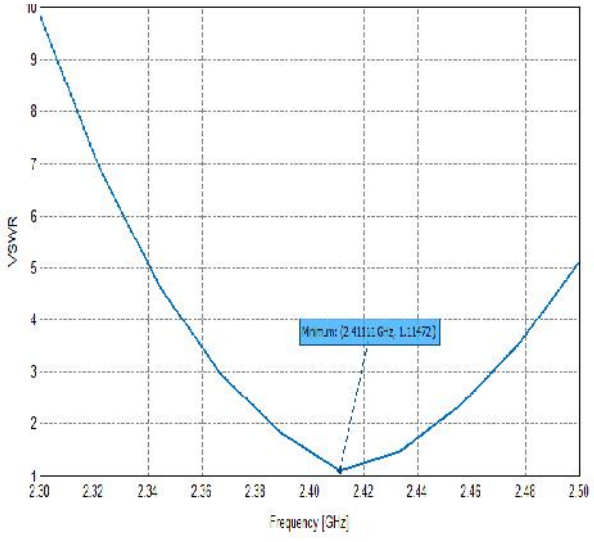

Figure 4: VSWR of circular patch antenna

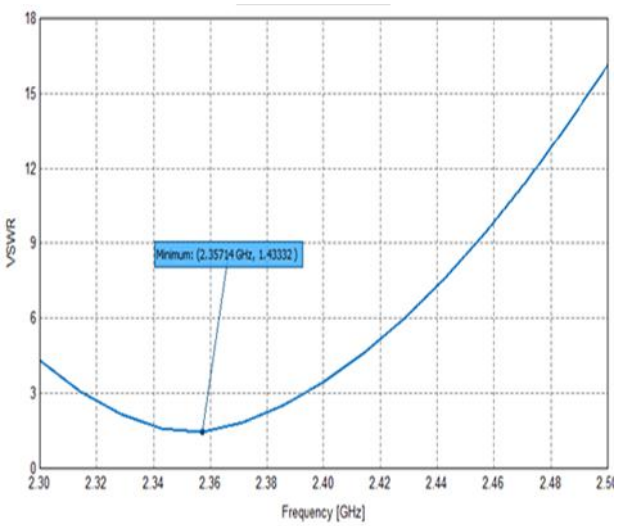

Figure 3: VSWR of rectangular patch antenna

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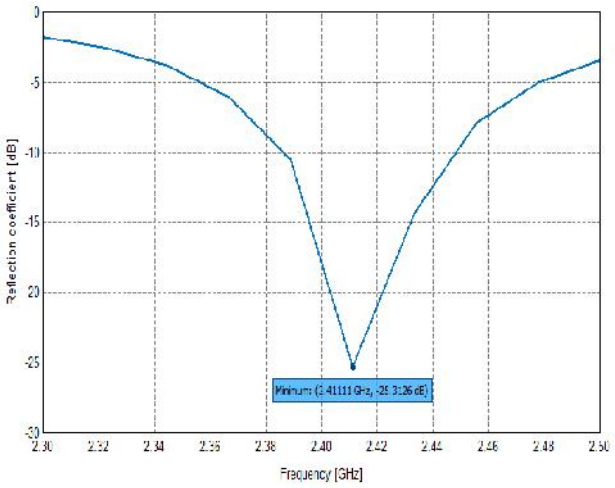

Figure 5: Reflection coefficient of rectangular patch antenna

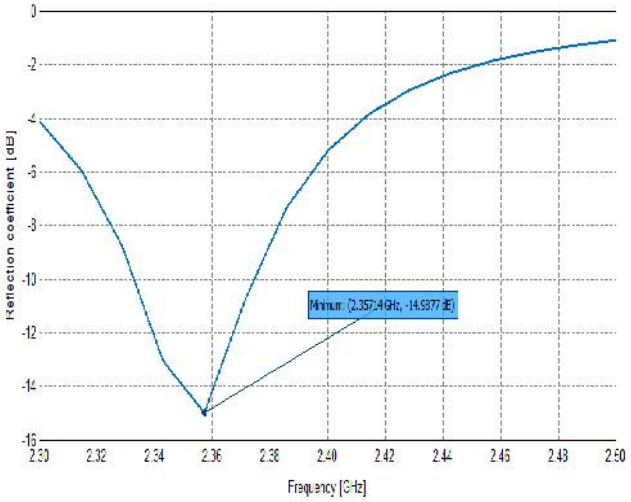

Figure 6: Reflection coefficient of circular patch antenna

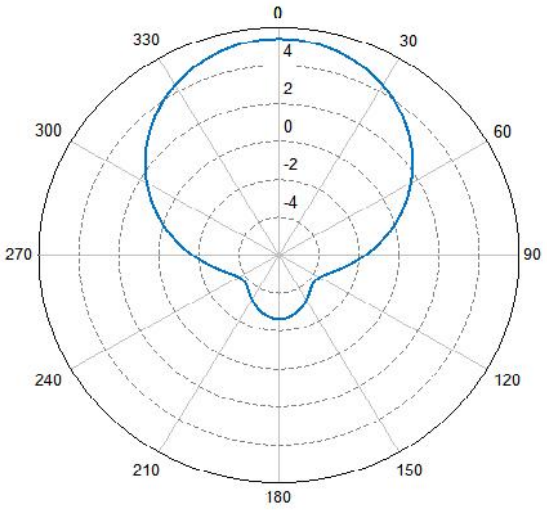

Figure 7: Gain of rectangular patch Antenna on polar plot

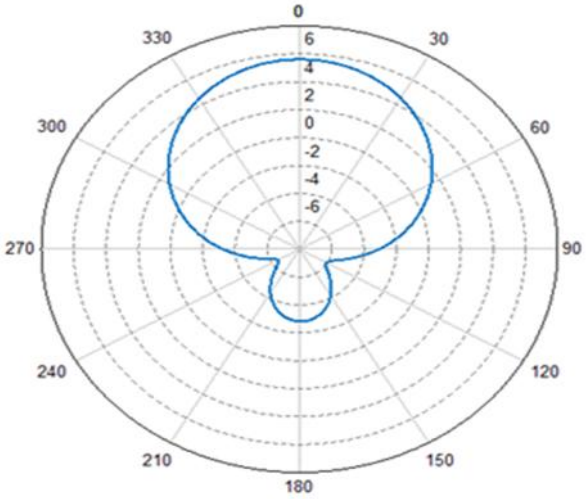

Figure 8: Gain of circular patch Antenna on polar plot

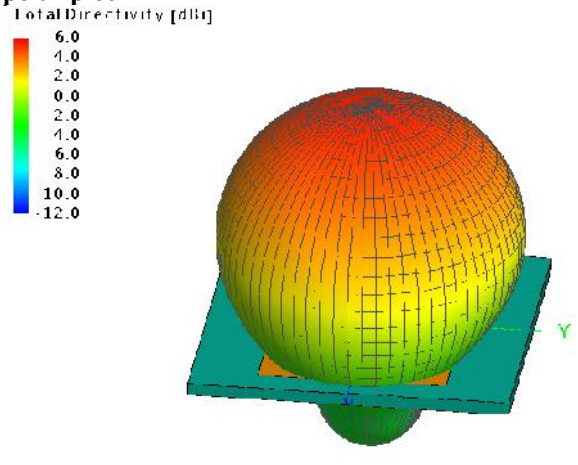

Figure 9: 3D view for Gain of rectangular patch Antenna

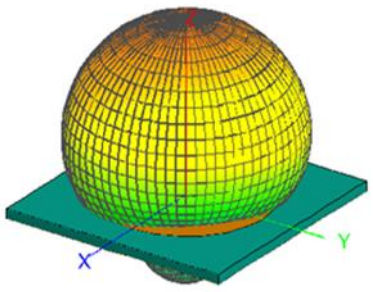

Figure 10: 3D view for Gain of circular patch Antenna

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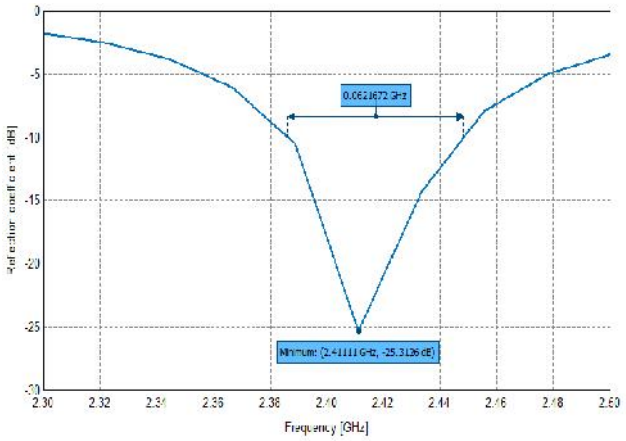

Figure 8: Band Width of rectangular patch antenna

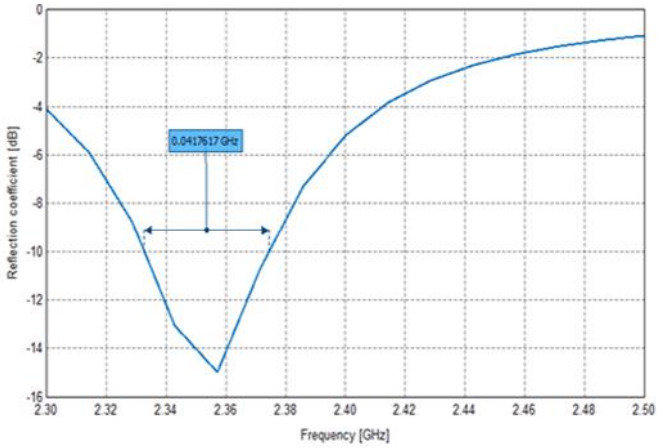

Figure 8: Band Width of rectangular patch antenna

Table.2 Comparison of Performance Parameters

Parameter	Rectangular	Circular
Resonant frequency	2.41 MHz	2.36 MHz
VSWR	1.099	1.45
Reflection coefficient	-25.31 dB	-14.60 dB
Gain	5.66 dB	5.67 dB
Bandwidth at -10dB	62.16 MHz	41.76 MHz

CONCLUSION

The comprehensives study of both the rectangular and circular patch antenna has been carried out with the help of CAD-FEKO software tool. Both the antennas show good result in accordance with the VSWR, reflection coefficient, gain, and bandwidth. From the perspective of bandwidth, VSWR, as well as reflection coefficient rectangular microstrip patch antenna shows better performance than circular microstrip patch antenna. That's why the rectangular microstrip patch antenna is more popular and can be efficiently used as compared to another microstrip antenna i.e. circular microstrip patch antenna.

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