Performance Analysis of Circular Shape Microstrip Antenna for Wireless Communication System

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Abstract: In this paper proposes a broad band circular strip antenna based on numerical techniques. For the operating frequencies, a circular patch antenna is installed on FR-4 substrate material 4.2. The proposed antenna uses the finite element method to design an operating frequency from 2GHz to 10GHz. Substrate height is 1.6mm. The circular patch has a circumference of 8.82mm. The antenna displays good output below -16dB is the return loss value and the antenna gain is obtained in the range from 2.4dBi to 10.02dBi. The proposed circular patch antenna is designed and analysed the various parameters like VSWR, Gain, Return Loss, Directivity and Radiation pattern.

1. Introduction
Most of the microstrip antennas have different applications, particularly in the communications, defence and medical fields. In nature, the microstrip antennas are small in size and light in weight. The microstrip antenna is demand due to its more bandwidth available for wireless applications with the correct operating frequency. Most microstrip antennas are used to operate at lower lever frequencies to the higher frequency frequencies of microwave frequencies. The microstrip antenna consists of a patch above the dielectric substratum, and is grounded below the dielectric material [1]-[5]. In, a small rectangular double-band microstrip two separate slotted antennas are produced rectangular single-band microstrip antennas of L and plane slotted. It consists of a rectangular feed patch. The radiation pattern in the height is directional Azimuth plane and Omni-directional. The detailed analysis of patch antenna and how a probe is built and rendered of the IE3D circular microstrip patch antenna [6]-[8].

Microstrip square patch antenna was proposed are medium weight, low profile, low development expense, durability and manufacturing ease. Wireless technology convergence allows it appealing for applications such as high efficiency for aircraft, spacecraft, satellite applications, rocket applications and embedded applications. They have poor radiation quality, however, low power, high Q and very small bandwidth frequency. Microstrip patch antennas are named according to their shape of the patch of radiation. There are various radiation patch types available, including rectangle, rectangular, circular, elliptical, triangular, circle and ring, square, rectangular and circular antennas are simple to use to build and evaluate all antenna parameters. Patch antenna is better to build and can easily be monitored for radiation [9]-[14]. Furthermore the physical size circular patch antenna at the same design frequency is 16 percent smaller than the rectangular antenna. Microstrip antenna has a radiation patch on one part of the dielectric substrate and has a floor plane. The other hand of the substratum and its radiation from the fringing areas between the parchment periphery and plane of the field.

2. Mathematical Model Design of Proposed Antenna
The antenna have modelled with the aid of electromagnetic simulator on circular microstrip patch antenna with acceptable operating frequencies from 2GHz to 10GHz using finite element model theory. The proposed antenna is designed to operate the different frequencies on a FR4 substratum with a dielectric constant 4.2 and substrate height 1.6mm. The patch antenna is a material used for copper conductors that operates on the finite element model theory. The surface mesh is used for triangular
shaped mesh, and for tetrahedron shaped with two and three dimensional regions, respectively. The design parameter is shown in Figure 1 only for the patch radius with the help of dominant $\text{TM}_{10}$ mode.

![Figure.1. Circular Patch Antenna Structure](image)

The radius of an antenna with circular patch is 8.22mm and the circular patch antenna length ($L$) and width ($W$) are measured by using the formula at 8.4mm and 4.2mm, respectively. The feed location is used for impedance of the microstrip line at 50ohm. Many of the microstrip patch antenna nowadays have revolutionary ideas of miniaturization design and production. The greater part of the microstrip patch antenna is used as simple and also presented with the EBG structure.

The proposed antenna has the operating frequencies that are typical for GPS applications with the slot radiation. The circular patch antenna is used in microwave applications with wireless links and other sources. The proposed antenna has been designed to miniaturize the antenna size for wide bandwidth GPS applications. Narrow bandwidth is the greatest drawback of the microstrip patch antenna. The proposed antenna is used to build the emphasis to increase the bandwidth and the limit is also low return loss with antenna performance. Table 1 shows design parameters of circular patch antenna.

| Sl.No | Parameters          | Range          |
|-------|---------------------|----------------|
| 1.    | Operating Frequencies | 2 GHz to 10 GHz |
| 2.    | Radius of the Patch      | 8.82 mm        |
| 3.    | Substrate dielectric material | FR4          |
| 4.    | Dielectric Constant    | 4.2            |
| 5.    | Thickness of Substrate | 1.6mm         |
| 6.    | Feeding techniques     | Line fed       |
| 7.    | Ground Plane          | 30mm X 30mm    |
| 8.    | $L\times W$           | 8.4mmX4.2mm    |
| 9.    | Impedance             | 50Ω            |
| 10.   | Bandwidth             | 180MHz         |

Most satellite applications require the antenna which is a gain feature to enhance the unidirectional, and the multidirectional is used to analyze the system. The patch antenna width increases, and efficiency, as well as bandwidth decreases. The antenna proposed for FEM model can be designed to be resonant in transverse magnetic modes. The various applications are used in everyday life for antenna design with the necessary wireless requirements, small in size and light weight. The microstrip patch antenna is used for different shape antenna designed with suitable
configurations and is modified using different with rectangular, circular and triangular patches. Based on the electromagnetic spectrum the various parameters are analysed with the help of different slots in TM_{10} is shown in the Figure 2.

![Block Diagram of the Proposed Circular Patch Antenna](image)

**Figure 2.** Block Diagram of the Proposed Circular Patch Antenna

The radius patch of the antenna is measured by using the formula. The radius patch of the antenna is measured by using the formula

$$a = \frac{F}{1 + \frac{2h}{\pi \varepsilon_r F} \left( \ln \left( \frac{\pi F}{2h} \right) + 1.7726 \right)^2}$$  \[1\]

Where

$$F = \frac{8.791 \times 10^9}{f_r \sqrt{\varepsilon_r}}$$  \[2\]

DGS is carried out by applying a defected form to a floor plane such that the shielded current delivery can be disrupted based on the shape and the dimension of the defect. The interruption of the shielded current distribution will impact antenna input impedance and current flow. The agitation and electromagnetic waves may also be regulated by the layer of the substrate. The simple TM_{11} resonant mode for a non-slotted circular patch microstrip antenna may be divided into two independently resonant modes similar to one another and the antenna has characteristics for a dual band antenna by choosing different sizes of the circular slots in the patch.

### 3. Results and Discussion

The proposed antenna shows 2GHz to 10GHz at resonant frequency and obtained a return loss value of less than -16dB is shown in Figure 3. The proposed antenna of VSWR is achieved in the order of 2 as shown in figure 4. The results indicate that the patch and feed lines match perfectly with impedance. Figure 5 shows the antenna gain of the proposed antenna being achieved for 2.2dBi to 10.2dBi. The various parameters analysis of the proposed circular patch antenna is shown in table 2. The antenna is an essential element of the transmission chain since it affects the signal propagation and receiving in free space depends on the form of protected area network and pollution standards to select a circular antenna. Table 1 analyzes the various design parameters and shows Design Parameters of Circular Patch Antenna strong results of VSWR, Gain, Return Loss, Directivity and Radiation pattern.
Figure 3. $S_{11}$ of the Circular Patch Antenna

Figure 4. VSWR of the Circular Patch Antenna

Figure 5. Gain of the Circular Patch Antenna

Figure 6. 3D Gain Plot of Circular Patch Antenna

Table 2. Analysis of the Proposed Circular Patch Antenna

| Operating Frequency (GHz) | Gain (dB) | $S_{11}$ (dB) | VSWR | Efficiency (%) |
|--------------------------|-----------|---------------|------|----------------|
| 2.5                      | 1.2       | -5            | 1.18 | 60             |
| 3.5                      | 1.4       | -8            | 1.28 | 65             |
| 4.5                      | 2.6       | -9.5          | 1.3  | 72             |
| 5.5                      | 3.2       | -10.25        | 1.35 | 78             |
| 6.5                      | 5.6       | -12.5         | 1.56 | 80             |
| 7.5                      | 7.8       | -14.68        | 1.68 | 82             |
| 8.5                      | 8.2       | -15.25        | 1.89 | 85             |
| 9.5                      | 10.2      | --16          | 1.98 | 88             |

An antenna is associated with the source through a function of impedance transfer line 50Ohms to ensure the optimal transmitting of power between power and antenna, so it is important to ensure matching impedance the adaptation makes the cancellation of the reflective coefficient $S_{11}$ the antenna input. Figure 7 shows the radiation efficiency of the proposed antenna at 89.1 percent for E-field. Figure 8 shows the radiation efficiency of the proposed antenna at 88.1 percent for H-field. The antenna proposed is to design the number of circular slots to be displayed and the parameters obtained for the various features for the wireless. During the coupling period the isolation was achieved with the help of electromagnetic signal to reduce the fading of the signal and gain is also reached to the maximum level. The return loss for the different circular slots is estimated in the order of less than -16dB with a bandwidth of 180MHz.
4. Conclusion
This paper shows strong results for taking advantage of the low profile antenna in various antenna parameters. The antenna patch and feed position measurements are used to realize matching with the antenna output and impedance. The antenna displays good output below -16dB is the return loss value and the antenna gain is obtained for 2.2dBi to 10.02dBi. VSWR is achieved in the range of 2. The results of the designed antenna are also used to measure the performance of the proposed antenna for Wireless applications.

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