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# Design of Circular Microstrip Patch Antenna for WiMAX Application

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**ABSTRACT:** Antenna plays a vital role in wireless communication systems. This paper aimed at designing a circular microstrip patch antenna for WiMAX application. It is tuned to operate at a frequency of 2.6 GHz. The antenna is fabricated on FR4 substrate. This paper consists of the design of a circular microstrip patch antenna and calculation of feed position. Antenna is designed using the software CST Microwave Studio and the parameters of the antenna are observed.

**KEYWORDS:** Antenna, Circular patch antenna, WiMAX, 2.6 GHz, CST Microwave Studio.

## I. INTRODUCTION

Antenna is an important element of wireless communication systems. The antenna used in any communication system should be of light weight, low cost, low profile and smaller in dimension. A microstrip patch antenna fulfils all these requirements. Microstrip patch antenna has been widely used in modern applications, since it can be easily designed to operate in dual-band and multi-band applications. It consists of very thin metallic patch placed at a small fraction of a wavelength above the ground plane. The patch is generally made of conducting materials like copper or gold. The radiation from the patch antennas takes place due to the fringing fields between the patch edge and the ground plane. For a microstrip patch antenna, the patch could be of different shape viz. square, rectangular, triangular, circular or elliptical over which circular patch antenna is designed here. The ground plane and the patch are made of the same material. FR4 substrate is used here as the substrate between the patch and the ground plane due to its availability.

## II. DESIGN METHODOLOGY

### Parameters used for design

- Operating Frequency  $f_r$  – 2.6 GHz
- Dielectric Constant of FR4  $\epsilon_r$  – 4.4
- Height of the substrate  $h$  – 1.6 mm
- Copper Thickness  $T_c$  – 0.035 mm

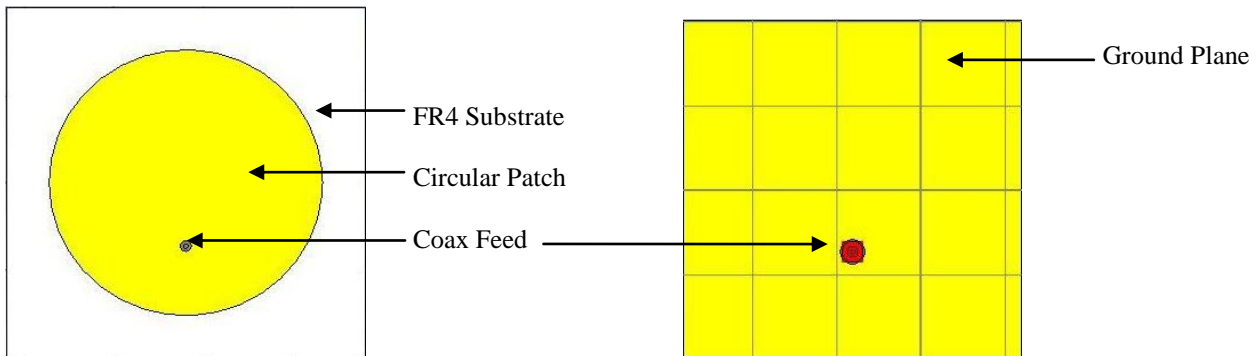
### Calculation of Patch radius

Since we are designing a circular microstrip patch antenna, the primary stage of design is the calculation of the radius of the patch. The radius can be calculated using the following equation:

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

Where,

$$F = \frac{8.791 \times 10^9}{f_r \sqrt{\epsilon_r}}$$



A patch antenna consists of patch, substrate ground plane and feed point. Ground plane and the substrate are taken in square shape with equal dimensions. The radius of the patch is calculated from the above equation. By adding 2 mm to it the sides of the substrate and ground plane can be obtained.

### Calculation of Feed point position

Feed point is the position through which the signal is applied to an antenna. Here coax feed is used. Thus the coax connector is placed at this point. Due to high impedance properties, the feed point should not be positioned at the centre and the edges of the patch. The feed point can be at any point inside the patch other than these. The feed point for this circular patch can be calculated using the following equation:

$$X \text{ coordinate can be calculated as, } X_f = \frac{L}{2\sqrt{\epsilon_{eff}}}$$

$$Y \text{ coordinate can be calculated as, } Y_f = \frac{W}{2}$$

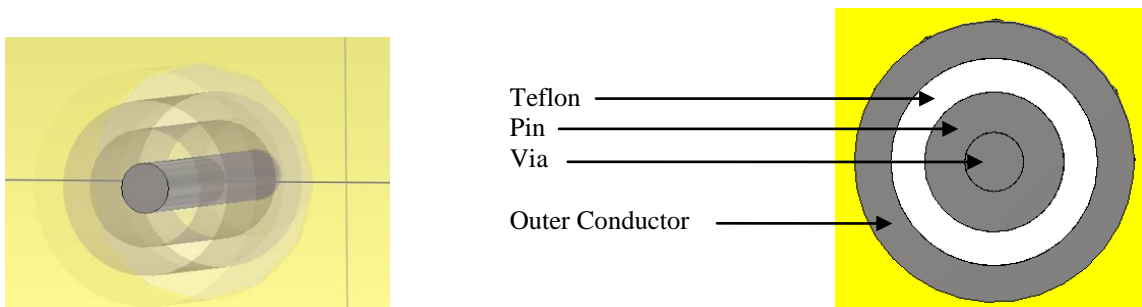
These equations are generally used to determine the feed position of rectangular patch antenna. Consider the circular patch as a rectangular patch with diameter of circular patch as length (L) and width (W) of rectangular patch. That is, the circle becomes square. Thus the equation becomes:

$$X \text{ coordinate can be calculated as, } X_f = \frac{a}{\sqrt{\epsilon_{eff}}}$$

$$Y \text{ coordinate can be calculated as, } Y_f = a$$

### Coaxial connector dimensions

SMA connectors are also called as female coaxial connectors. The connector has 50Ω impedance. SMA connector is designed for used from DC (0 Hz) to 18 GHz. An SMA connector is shown in figure below.



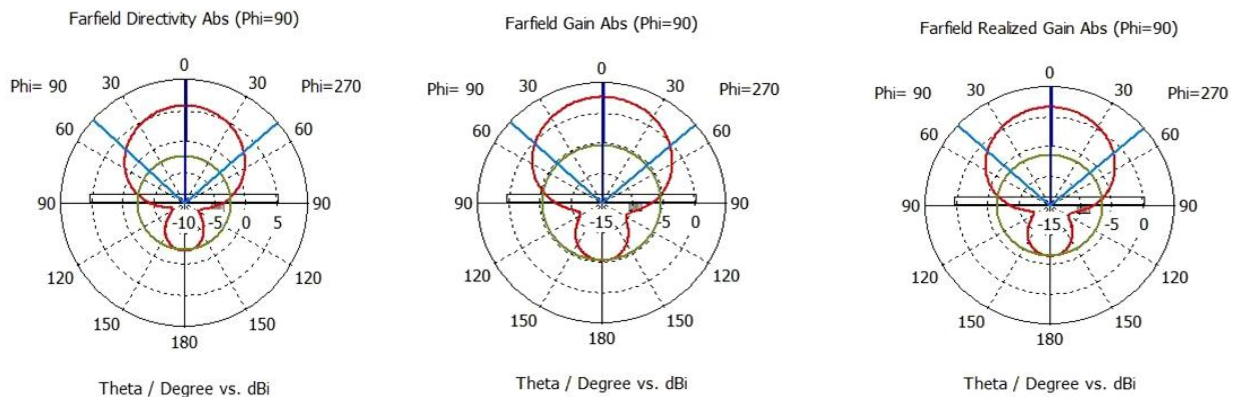
It consists of an inner conducting material, an insulating material and an outer conducting material. The inner conducting material has two parts via and pin, both are connected to the patch. They are made with PEC. The insulating material is made with Teflon (PTFE lossy in CST). The outer conducting material is also made with PEC and is connected to ground. The dimensions required for an SMA connector are:

Part	Radius (mm)
Via	0.265
Pin	0.625
Teflon	0.925
Outer Conductor	1.25

The waveguide port is set up at the end of SMA connector. The connector is excited and the antenna is simulated. The far field results are observed.

### III. EXPERIMENTAL RESULTS

After simulation the farfield radiation pattern for the patch antenna operating at 2.6 GHz frequency is obtained. The other parameters of circular patch antenna are also observed and are shown in figure below:



The parameters of the proposed antenna design are listed in the following table.

Parameters	Value
Frequency	2.6 GHz
Patch Radius	15.61 mm
Directivity	5.72 dBi
Gain	2.56 dBi
Realized Gain	1.5 dBi
VSWR	1.7
Return loss	-12 dB
Main lobe Direction	1.0 deg
Angular Width (3 dB)	96.4 deg
Side lobe level	-8.0 dB

#### IV. CONCLUSION

This paper presents the design and simulation of a circular microstrip patch antenna. It deals with the fabrication of microstrip antenna with coax feed. The design methodology is quite similar to that of existing methods. The feed point calculation makes use of the expressions for the feed point calculation of rectangular patch. The circular patch antenna for WiMAX is designed and simulated using CST Microwave studio and the results are verified.

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