Design and Analysis of Circular Slotted MSA for Wireless Communication

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Abstract: **This paper proposes slotted microstrip patch antenna using single band frequency with a circular slot .The single operating frequencies increases with decreasing circular slot dimensions and single frequency operation with a reduced antenna size can be obtained. For the design with a circular slot it has been observed that there will be 20% antenna size reduction possible. It has been developed to be used in future Wi-max technology. This simulation has been proposed using CST Microwave studio, Which is commercially available electromagnetic simulator based on the method of finite difference time domain technique.**

Keyword: Microstrip patch antenna (MSA), circular slot, Wi-MAX antenna , CST Microwave Studio

I.INTRODUCTION

Modern wireless communication system requires low profile, light weight, high gain, and simple structure antennas to assure reliability, mobility, and high efficiency characteristics [1, 2]. The key features of a microstrip antenna are relative ease of construction, light weight, low cost and either conformability to the mounting surface or, an extremely thin protrusion from the surface [2, 3]. This antenna provides all of the advantages of printed circuit technology. These advantages of microstrip antennas make them popular in many wireless communication applications such as satellite communication, radar, medical applications, etc [3]. Choosing the design parameters (dielectric material, height and frequency, etc) is important because antenna performance depends on these parameters. Radiation performance can be improved by using proper design structures. The use of high permittivity substrates can miniaturize microstrip antenna size. Thick substrates with lower range of dielectric offer better efficiency and wide bandwidth but it requires larger element. And it depends on the feeding technique the parameters like VSWR return loss bandwidth will vary [1].

In this research work, antenna patch is to be designed into is microstrip circular slot patch along with the coaxial feed. There are many other types of patches used but they are so complex, e.g. Bow Tie, E shape, U slot, S shape, C shape, Folded dipole, Rectangular slotted ,Circular slotted, which are used to enhance the bandwidth[6].

The remaining paper is organised as follows: section 2 gives some information about types of patch and feed. Section 3 includes antenna design analysis of single band circular and square shaped microstrip patch geometry. Section 4 gives analysis circular patch with coaxial feed over the microstrip antenna with its results. Section 5 and 6 gives conclusion and references respectively.

II.MICROSTRIP ANTENNA DESIGN

The proposed antenna based on the patch antenna which must be designed first for rectangular patch antenna depends upon three parameters. In this paper, selected three parameters are: Resonant Frequency =1 to 6 GHz, Dielectric constant = 4.4, Height of the dielectric substrate = 1.6 mm. Fig.1 represents the design of Circular Microstrip Patch antenna. This patch is designed by using Transmission Line Model [5] .The initial parameter of this design can be calculated using transmission line model(TEM) approximation in which microstrip radiating element is viewed as transmission line resonator with no transverse field variation .The approximation states that length and width of patch can be modeled according to the specified target central frequency.

A. Calculation of Width:

The width of microstrip antenna is given by

$$W = \frac{C}{2\,fo\sqrt{\left(\frac{\in r+1}{2}\right)}}$$

B. Calculation of Effective dielectric constant

$$\in reff = \frac{\in r+1}{2} + \frac{\in r-1}{2}\left[1+12\frac{h}{w}\right]^{1/2}$$

C. Calculation of Length Extension (ΔL)

$$\Delta L = 0.412\,\frac{\left(\in reff \pm 0.3\right)\left(\frac{w}{h}+0.264\right)}{\left(\in reff - 0.258\right)\left(\frac{w}{h}+0.8\right)}$$

D. Calculation of actual Length of Patch (L)

The actual length of radiating patch is obtained by

$$L_{eff} = L - 2\Delta L$$

E. Calculation of Effective Length (L_{eff})

The effective length is

$$L_{eff} = \frac{c}{2 f_o \sqrt{\epsilon_{reff}}}$$

F. Calculation of Ground Dimensions (Lg, Wg)

$$L_g = 6h + L$$

$$W_g = 6h + W$$

III.ANTENNA DESIGN

The radiating circular patch is printed on the upper side of the first substrate. The two substrates used are of same material and have same height. The radius of the circular patch is 12.2mm. The substrate is made up of material having dielectric constant 4.4 and height of the substrate is 1.6mm. The following parameters for antenna design are calculated by using the above steps of the antenna design using the transmission line model equations. All design parameters are calculated by a reference book of antenna design [4].

Table 1. Dimensions of the Patch Antenna Design

Variables	**Values**
Frequency(f_r)	5.2GHz
Dielectric Constant(ϵ_r)	4.4
Substrate Height(h)	1.6mm
Radius of the patch (Rp)	12.2mm
Height of the patch (Hp)	1.6mm
Width of the ground (Wg)	26.94mm
Length of the ground (Lg)	22.654mm

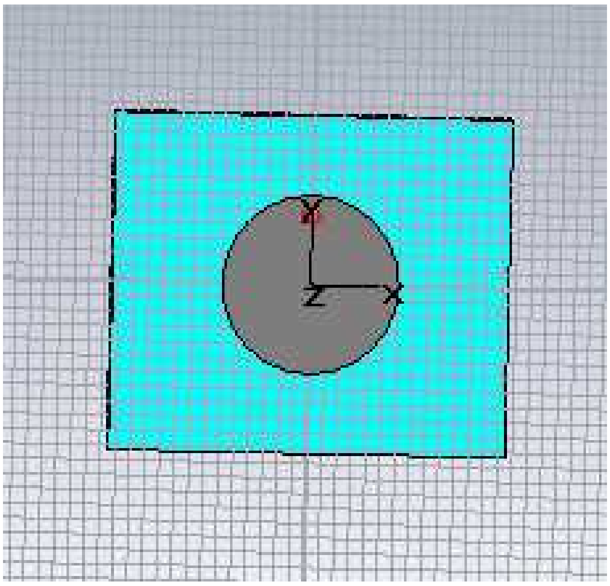

Figure 1(a). Geometry of Proposed Antenna using coaxial feed on CST Microwave Studio resonating at 5.2 GHz

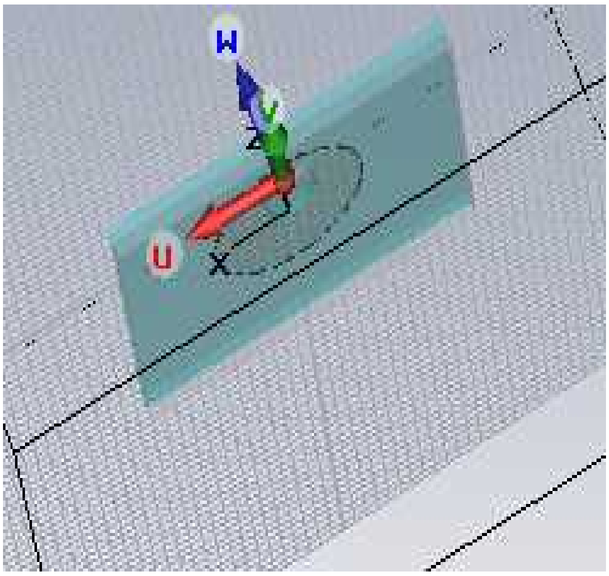

Figure 1 (b) Side view of Single Band Circular Microstrip Patch Antenna

IV.SIMULATION RESULTS

The simulation results of the above designed antenna of various parameters like return loss, impedance, gain, directivity and VSWR are given by using CST microwave studio2010[5].

(a)Return Loss of coaxial feed antenna

The return loss obtained for circular patch antenna resonating at 5.2 GHz is -34.57

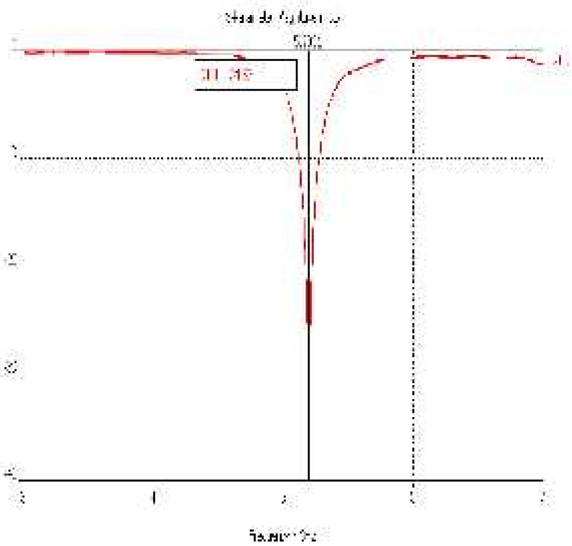

Figure 2. Simulated Return Loss of MSA Resonating at 5.2 GHz

(b)Bandwidth of coaxial feed antenna

The bandwidth of the antenna bandwidth of antenna can be calculated from return loss versus frequency plot. The bandwidth of the proposed patch antenna is 160 MHz is shown in Figure 4.4 and resonant frequency is 5.2 GHz which is very close to WLAN standard.

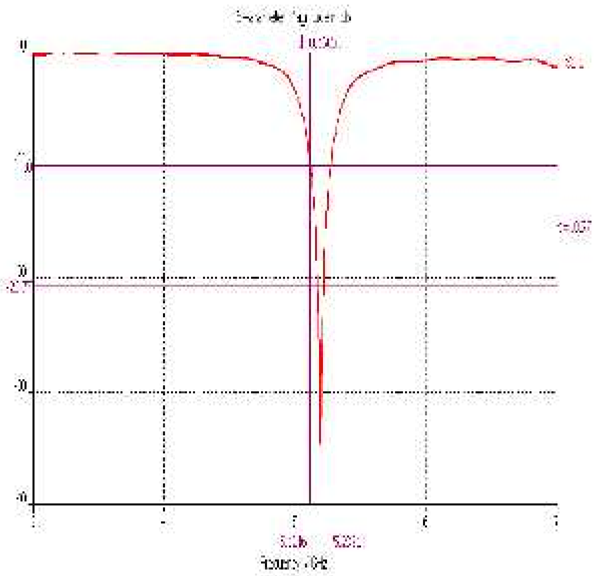

Figure 3. Bandwidth plot of MSA Resonating at 5.2 GHz

(c)Smith Chart of coaxial feed antenna

The Smith Chart plot represents that how the antenna impedance varies with frequency. The value of impedance should lie near 50 ohms in order to perfectly match the port with the antenna, as shown in Figure 4. The antenna impedance for this antenna is 50.43 Ω.

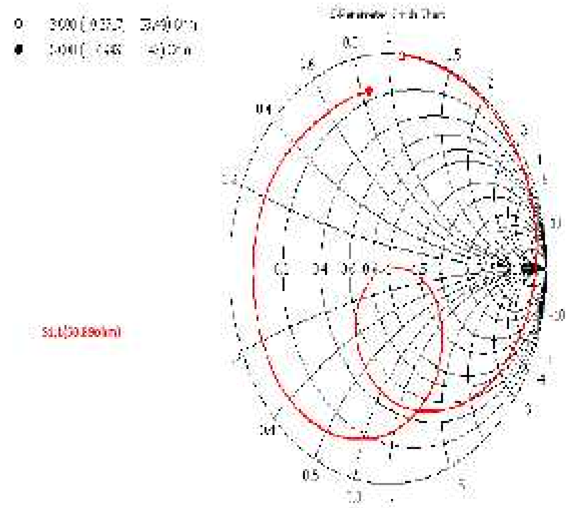

Figure 4. Smith Chart of MSA Resonating at 5.2 GHz

(d)Voltage Standing Wave Ratio (VSWR)

The VSWR plot for coaxial feed antenna is shown in Figure 4.6. Ideally, VSWR must lie in the range of 1-2 which has been achieved for the frequency 5.2 GHz, near the operating frequency value. The value for VSWR is 1:1.038.

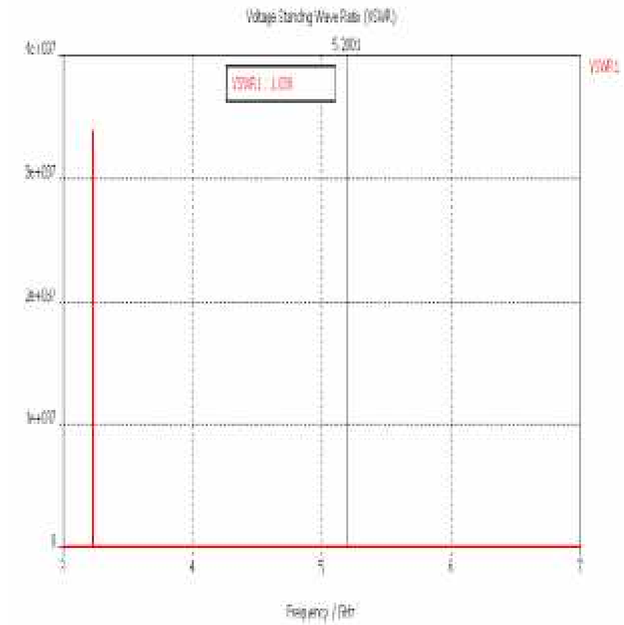

Figure 5. Simulated VSWR of MSA at 5.2 GHz

The simulation results of Gain in 3D and 2D is given below, the value of gain 5.393 dB at 5.2 GHz frequency.

(e) Farfield Representation

The simulation results of Directivity in 3D and 2D is given below.

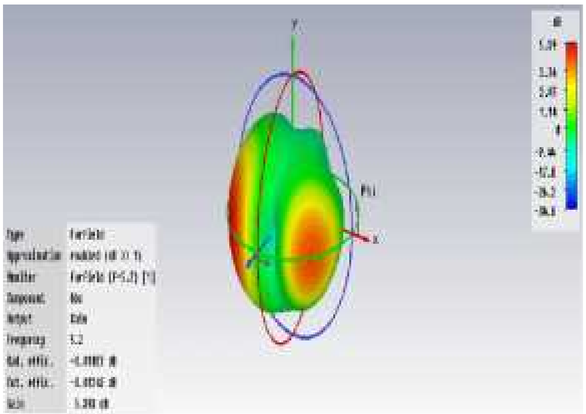

Figure 6 (a.)Simulated 3D Gain at 5.2 GHz

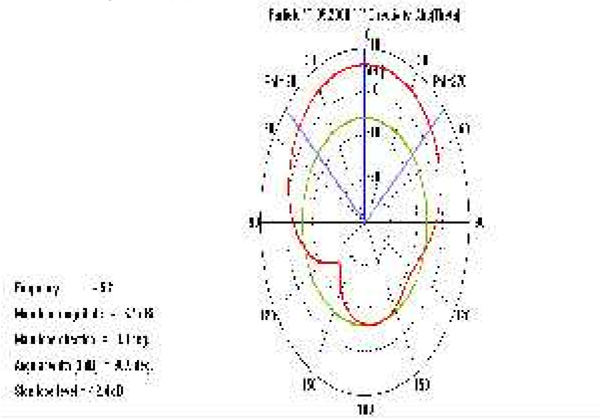

Figure 6(b). Simulated 2D Gain at 5.2 GHz

The results of the above designed antenna are in the following table.

Table 2. Parameter Values of Designed Antenna at 5.2 GHz frequency

Parameters	Values
Operating Frequency	5.2GHz
Return Loss	-34.56
Impedance	50.43 ohm
VSWR	1:1.038
Bandwidth	160GHz
Gain	5.393dB

V.CONCLUSION

This research was aimed at designing and implementing circular microstrip patch antenna using transmission model. In coaxial feed antenna with Circular Microstrip patch antenna the return Loss is -34.56 dB, bandwidth is 160 GHz, the antenna impedance is 50.43 ohm and the VSWR ratio is 1:1.038. The antenna achieves good directivity, radiation patterns and a peak gain of 5.393 dB.

VI.REFERENCES:

[1] Kashwan K R, Rajeshkumar V, Gunasekaran T and Shankar Kumar K R, "Design and Characterization of Pin Fed Microstrip Patch Antennae", IEEE proceedings of FSKD'2011

[2] M. T. I. Huque, et al., "Design and Simulation of a Low-cost and High Gain Microstrip Patch Antenna Arrays for the X-band Applications," in International Conference on Network Communication and Computer –ICNCC 2011, New Delhi, India., March 21-23, 2011.

[3] N. Kanniyappan, Dr.R. Indra Gandhi, "Design and Analysis of Microstrip Patch Antenna Feeding Techniques", IEEE proceedings of International Conference on Computational Intelligence and Computing Research'2011.

[4] C. Balinies,"Antenna Theory", Wiley, 2nd addition chapter - 14 ISBN 0-471-59268-4., (1997).

[5] /www.cst.com/content/products/mws/overview.aspx © 2010 CST Computer Simulation Technology AG

[6] M.T.Islam, M.N.Shakib,N Misran "Multi-Slotted Microstrip Patch Antenna For Wireless Communication" in Pier Vol-10,pp11-18, 2009

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