Circular Microstrip Patch Antenna Using Coaxial Feed for S-Band Application

[1]Shyam Sunder Sonkar, [2]Pammi Kumari
[1]Research Scholar, [2]Research Scholar,
Department of Electronics & Communication Engineering
[1]M.M.M.University of Technology Gorakhpur
[2]Invertis University Bareilly

[3]Akhilesh Kumar, [4]R. K. Prasad
[3]Research Scholar, [4]Associate Professor
[2,3]Department of Electronics & Communication Engineering
M.M.M.University of Technology Gorakhpur

Abstract— **In wireless communication system antenna plays vital role. Therefore, there is demonstrated need that antenna used in any communication system should be low weight, low profile, low cost, smaller in dimension and conformity. A microstrip patch antenna fulfills all these requirements. In this paper a circular microstrip patch antenna with coaxial feed that operates at S band has been presented. The antenna is tuned at resonance frequency of 3.2 GHz and its bandwidth is from 3.14 GHz to 3.26 GHz. Application of proposed antenna is in the field of satellite communication, wireless networking, consumer electronics and mobile TV etc. Moreover, the radiation pattern symmetry possessed by proposed antenna configuration makes it best suitable candidate for primary feed of reflector antennas. Roger Duroid 5880 material with dielectric constant 2.2 and loss tangent 0.0009 has been as dielectric substrate. Various antenna parameters like Return loss, VSWR, directivity, gain, etc. has been computed and analyzed using 3D CAD software HFSS 13.0..**

Keywords— Circular Microstrip Patch Antenna, Coaxial feed, S-band

I. INTRODUCTION

Antenna is a transducer which converts guided electromagnetic wave (EM) into free space electromagnetic waves and it is one of the fundamental parts of modern wireless communication networks. Commercial wireless communication system requires low profile, light weight and low cost antenna[1]. This demonstrated need can be fulfilled by microstrip patch antenna which are suitable for many wireless system applications.

Microstrip antennas consist of a very thin metallic strip (patch) placed a small fraction of a wavelength above a ground plane. These antennas are low profile, conformable to planar and nonplanar surfaces, simple and inexpensive to manufacture using modern printed-circuit technology, mechanically robust when mounted on rigid surfaces, compatible with MMIC designs, and when the particular patch shape and mode are selected, they are very versatile in terms of resonant frequency, polarization, pattern, and impedance [1]. The patch is generally made of conducting material such as copper or gold. The radiating patch and the feed lines are usually photo etched on the dielectric substrate. Radiation from Microstrip patch Antennas takes places because of the fringing fields between the patch edge and the ground plane [1].

There are two methods for feeding a microstrip patch antenna, one is contact method and other is non contact method. In the contacting method, the RF power is fed directly to the radiating patch using a connecting element such as a microstrip line or probe feed [2]. In the non-contacting scheme, electromagnetic field coupling is done to transfer power between the microstrip line and the radiating patch this includes proximity feeding and aperture feeding.

Major operational disadvantages of microstrip antennas are their low efficiency, low power, high Q (sometimes in excess of 100), poor polarization purity, poor scan performance, spurious feed radiation and very narrow frequency bandwidth, which is typically only a fraction of a percent or at most a few percent [5].

II. CIRCULAR MICROSTRIP PATCH ANTENNA

The patch could be of different shapes viz. square, rectangular, circular, triangular or elliptical. Usually rectangular and circular microstrip resonant patches are used in array configurations due to their simple geometry and ease of design. Microstrip patch *antennas* support both linear as well as circular polarization and capable of dual and triple frequencies. Circularly polarized antennas have been developed with single and dual feed arrangement. In this paper design of a circularly microstrip patch antenna with single feed which shows good pattern symmetry in E and H plane has been proposed.

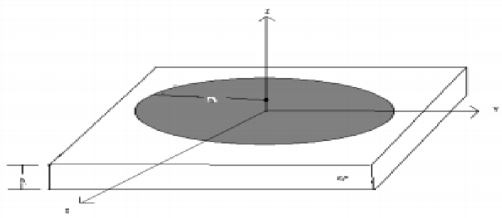


Fig. 1. Circular Microstrip Patch Antenna

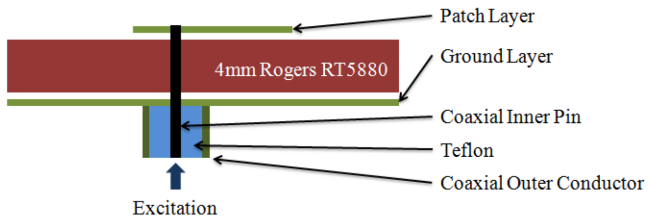
III. DESIGN PARAMETERS OF CIRCULAR PATCH ANTENNA

The designing of Microstrip patch antenna depends upon three parameters which are dielectric constant of substrate, thickness of the substrate and dimension of patch. Depending on the dimension, the operating frequency, radiation efficiency, directivity, return loss are influenced. Due to presence of fringing fields between patch and ground plane, geometrical dimensions of patch are smaller than electric dimension [3].

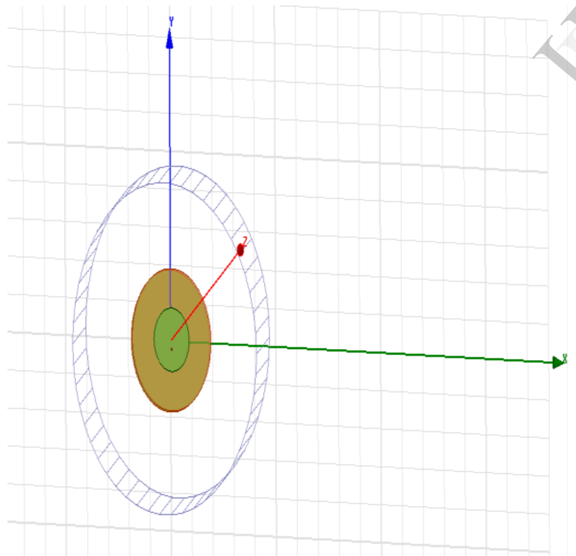
Design parameters of proposed circular microstrip patch antenna are as following,

Radius of substrate	37.5mm
Thickness of substrate	4mm
Radius of patch	16.7mm
Feeding point (x,y)	(0, -5mm)

Dielectric material used for the proposed antenna is Rogers Duroid 5880 which has dielectric constant of 2.2 and loss tangent of 0.0009. Fig. 2(a) shows layer stackup and feeding mechanism for proposed antenna configuration. Fig. 2(b) and fig. 3 shows the top and side view of the proposed antenna.



(a)



(b)

Fig. 2. (a) Layer Stackup of proposed antenna, and (b) 3D View of circular microstrip patch antenna

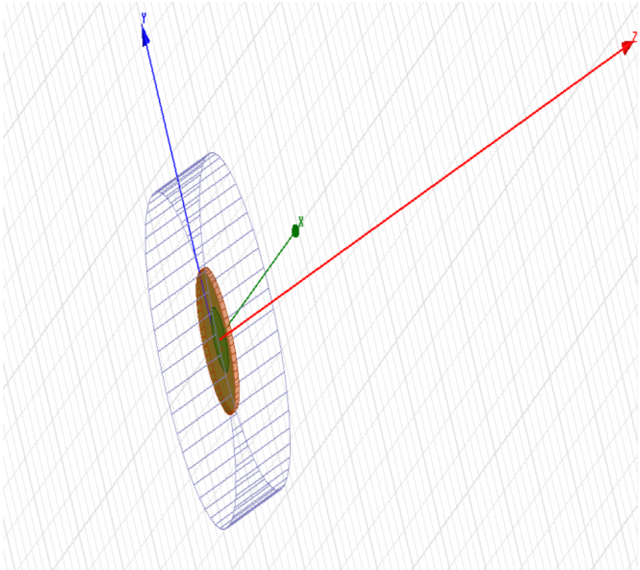


Fig. 3. Side view of circular microstrip patch antenna

IV. Simulation And Results

The proposed antenna configuration has been simulated using 3D CAD software HFSS 13.0. Various antenna parameters are plotted and discussed in following topics.

A. Return loss and Bandwidth

The plot of return loss for the proposed antenna is shown in fig. 4. From fig. 4, it can be observed that, antenna is resonating at 3.2 GHz frequency and has return loss of -14.7 dB at resonating frequency. Moreover, achieved 10-dB return loss bandwidth is approximately 4%.

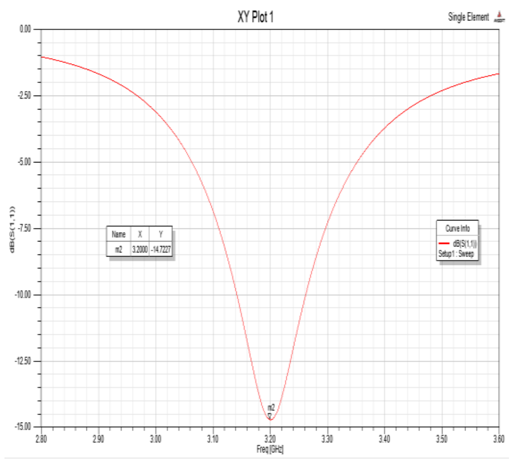


Fig. 4. Return loss

B. Voltage Standing Wave Ratio (VSWR)

Corresponding voltage standing wave ratio for the designed antenna is also plotted in fig. 5. Theoretically, VSWR should be 1 at resonating frequency, but VSWR better than 1.9 which is equivalent to 10 dB return loss is acceptable. From fig. 5, it can be said that VSWR attains its minimum value at 3.2 GHz, which is below 1.9.

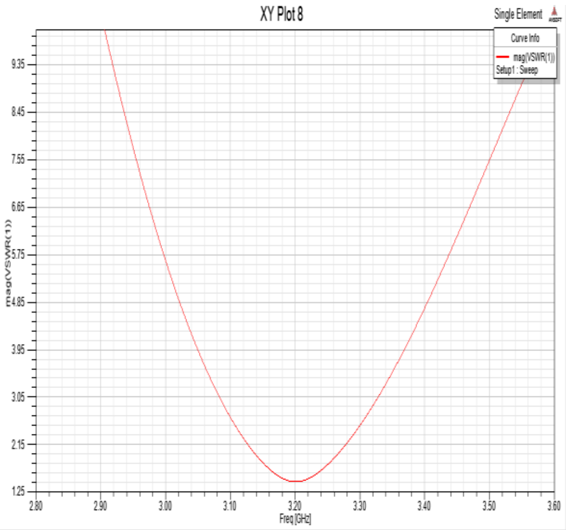


Fig. 5. VSWR

C. Directivity

The plot of directivity of proposed antenna configuration is shown in fig. 6. From fig. 6, it can be observed that, E, H and D plane patterns show very good pattern symmetry. This effect is attributed to size of ground plane. Therefore, in order to achieve required pattern symmetry, ground plane size can be optimized. The pattern symmetry provided by this configuration makes it best suitable for primary feeds of reflector antenna.

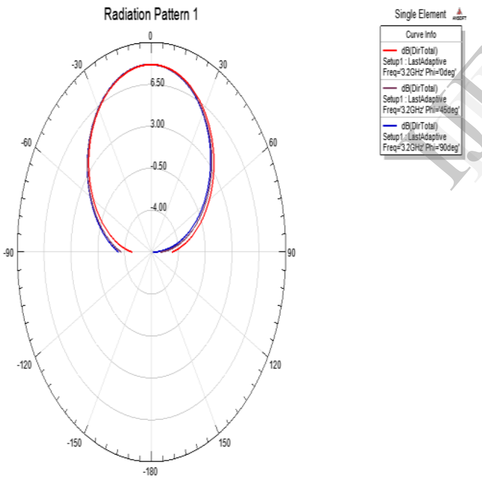


Fig. 6. Directivity

D. Gain

Gain is the ratio of maximum radiation intensity in a given direction to the maximum radiation intensity from the reference antenna produced in the same direction with the same power input. Gain is closely related with directivity and directivity depends on the shape of radiation pattern The total gain of the proposed antenna is plotted in fig. 6. From fig. 6, it can be observed that total gain of the proposed antenna is approximately 8.18 dB which is sufficient for commercial wireless systems.

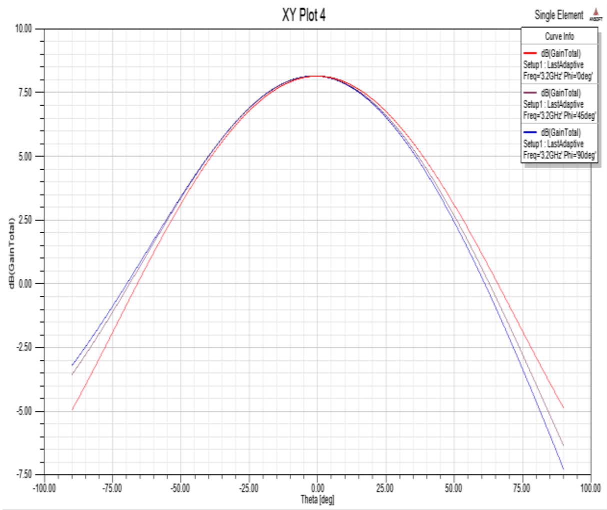


Fig. 7. Total gain

.E. Gain Bandwidth

The variation of gain with frequency is also one of the important parameters which is plotted in fig. 8. From fig. 8, it can be concluded that antenna has maximum gain at 3.2 GHz and variation of gain in the frequency range 3.14GHz to 3.26 GHz is nearly constant and better than 8 dB.

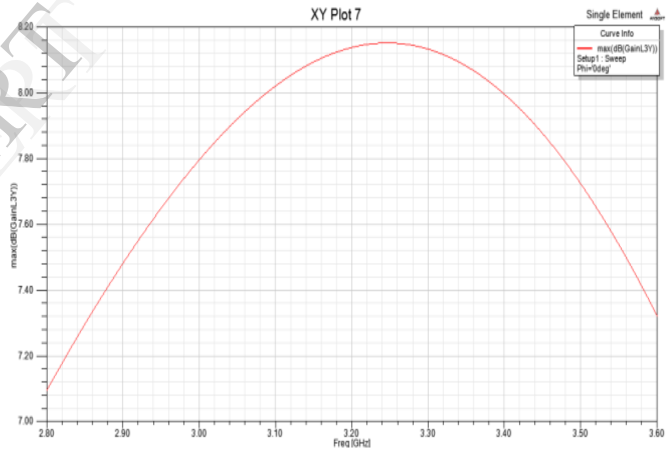


Fig. 8.Gain Bandwidth

V. CONCLUSION

The design of circular microstrip patch antenna which operates at S-band frequency spectrum has been presented in this paper. It has been shown that the designed circular microstrip patch antenna produces a bandwidth of approximately 4% with a stable radiation pattern within the frequency range. The proposed antenna has good return loss performance and efficiency over the frequency range. Gain of the antenna is ~8.18dB. The bandwidth of the antenna can further improved by optimizing the parameters of the antenna. The simple coaxial feeding technique has been used for antenna design which makes this antenna as a good choice in many communication systems.

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