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A Review on Circular Microstrip Patch Antenna

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Abstract – *This review article presents an overview of design of circular microstrip antenna. These antenna are very useful due to their low profile structure, compact size, low weight, conform to any shape, easy fabrication, low cost. Different feeding techniques are available like coaxial, strip line, aperture coupling or proximity coupling to excite antenna.*

Keywords- *Circular, microstrip antenna, strip line*

1. INTRODUCTION

In this paper we review on a microstrip patch antenna. A microstrip patch antenna comprises of a trace of copper or any other metal of any geometry on one side of a standard printed circuit board substrate with other side grounded. The antenna is fed using various feeding techniques like coaxial, strip line, aperture coupling or proximity coupling techniques.

The microstrip patch antenna is widely used military, industrial and commercial sectors. Circular microstrip patch antenna with different slot for the WLAN & BLUETOOTH Application, The operating frequency of antenna is 1.5-2.5 GHz. The antenna design consists of a single layer of substrate with thickness 1.6 mm with dielectric constant of 2.4.The simulation results of circular microstrip patch antenna for different slots are done by the help of IE3D Zealand Software.[1]

2. LITERATURE SURVEY

This paper presented by author Anuj Mehta on overview of the microstrip patch antenna and its design techniques. Basically a microstrip patch antenna comprises of a trace of copper or any other metal of any geometry on one side of a standard printed circuit board substrate with other side grounded. The antenna is fed using various feeding techniques like coaxial, strip line, aperture coupling or proximity coupling techniques. The working principle and the radiation mechanism have also been described. The microstrip patch antenna is widely used military, industrial and commercial sectors.[1] A FORTRAN program was developed to simulate the basic parameters of a microwave circular patch antenna. These parameters are the actual radius of patch, effective radius of patch, conductance due to radiation, conductance due to conduction, conductance due to dielectric loss, directivity, input resistance and quality factors due to conduction, dielectric loss, and radiation. Alongside, these parameters were manually computed. Four substrates were selected - Galium Arsenide, Duroid, Indium Phosphide and Silicon. Deductions made from the results showed that Galium Arsenide is suitable when smaller antenna size and low power handling capability is apriori. However, when size is not a constraint, Duroid is exceptional especially in directivity and high power radiation. Patch radius decreases as the resonant frequency increases (0.2374cm at 10.0GHz and 0.05079 cm at 45.0GHz for GaAs). The results obtained in this design compare favorably with results obtained from manual computation of the same parameters and these agree with other designs such as the rectangular patch. This paper is presented by author B. J. Kwaha, O. N. Inyang & P. Amalu [2] This paper Presented by Keshav Gupta, Kiran Jain, Pratibha Singh Here they made an attempt to maximize the gain of microstrip patch antenna. To achieve this they used microstrip circular patch antenna at 5.8 GHz frequency ISM Band Application. Single FSS (frequency selective surface) substrate is used to increase efficiency. Parameters are set accordingly and results of microstrip patch antenna with FSS layer and microstrip patch antenna without substrate later compared on the basis of return loss, directivity, radiation pattern and gain. they used HFSS (high frequency structured simulator) software for simulation of antenna and to find out the results. they keep changing the design of antenna as our motive was to achieve miniature antenna with better results than conventional antenna's. Thickness of substrate has been minimized to achieve the same. Coaxial feeding technique has been used as it is easier to implement.[3] In this paper author Deepender Dabas 1, Abhishek present the design and analysis of circular microstrip patch antenna with different slot for the WLAN & Bluetooth Application is presented.The shape of proposed antenna is circular. The operating frequency of antenna is 1.5-2.5 GHz, The antenna design consists of a single layer of substrate with thickness 1.6 mm with dielectric constant of 2.4.The simulation results of proposed circular microstrip patch antenna for different slots are done by the help of IE3D Zealand Software. For the analysis of antenna we used the cavity model This antenna is fed by a co-axial probe feeding. The effects of different parameters like return loss, radiation pattern are studied.[4]

3. BASIC ANTENNA

An antenna is a transducer that converts radio frequency (RF) fields into alternating current or vice versa. There are both receiving and transmission antennas for sending or receiving radio transmissions. Antennas play an important role in the operation of all radio equipment. Microstrip antennas have profound applications especially in the field of medical, military, mobile and satellite communications.

3.1 Antenna Properties

The antenna forms a critical component in a wireless communication system. A good design of the antenna can relax system requirements and improve its overall performance [5]. The performance of the antenna is determined by several factors that also called antenna properties as follows:

3.1.1 Input Impedance

Generally, input impedance is important to determine maximum power transfer between transmission line and the antenna. This transfer only happen when input impedance of antenna and input impedance of the transmission line are match. If not match, reflected wave will be generated at the antenna terminal and travel back towards the energy source. This reflection of energy results causes a reduction in the overall system efficiency. It is also important that the input impedance of the antenna is mostly resistive, so that most of the power introduced to the antenna is radiated. Input impedance has real and complex parts and its general form is:

$$Z_{in} = R_{in} + jX_{in} \quad \text{.........(1)}$$

where,

R_{in} = resistance or power radiating portion of the impedance.

X_{in} = reactive portion or power storage component of the impedance.

3.1.2 VSWR

Voltage Standing Wave Ratio (VSWR) is the ratio between the maximum voltage and the minimum voltage along transmission line. The VSWR, which can derived from the level of reflected and incident waves, is also an indication of how closely or efficiently an antenna terminal input impedance is matched to the characteristic impedance of the transmission line. Increasing in VSWR indicates an increase in the mismatch between the antenna and the transmission line. A decrease VSWR means good matching with minimum VSWR is one. Most wireless system operates at 50 Ohm impedance. Hence the antenna must be designed with an impedance as close to 50 ohm as possible. A VSWR of 1 indicate an antenna impedance of exactly 50 ohms. Mostly, the ratio of VSWR≥1.5:1 is needed for antenna functional

3.1.3 Gain

The gain of an antenna is essentially a measure of the antennas overall efficiency. If an antenna is 100% efficient, it would have a gain equal to its directivity. There are many factors that affect and reduce at the overall efficiency of an antenna. Some of the most significant factors that impact antenna gain include impedance, matching network losses, material losses and random losses. By considering of all factors, it would appear that the antenna must overcome a lot of adversity in order to achieve acceptable gain performance. Gain is a directional function; it changes with position around the antenna and is defined As

$$G(6,\varphi) = \frac{4\pi U(6,\varphi)}{Pin} \quad \text{......(2)}$$

where

(σ ,φ) = radiation intensity

Pin = input power to the antenna

Gain is usually measured in decibels with reference to another antenna either an isotropic radiator (dBi) or to a simple dipole (dBd)

3.1.4 Radiation Pattern

The radiation patterns of an antenna provide the information that describes how the antenna directs the energy it radiates. All antennas, if 100% efficient, will radiate the same total energy for equal input power regardless of pattern shape. Radiation patterns are generally presented on a relative power scale. It can be show in polar plot 360 degree. Example of radiation pattern is shown in Fig. In many cases, the convention of an E-plane and H-plane pattern is used in the presentation of antenna pattern data. The E-plane is the plane that contains the antenna‟s radiated electric field potential while the H-plane is the plane that contains the antenna‟s radiated magnetic field potential. These planes are always orthogonal [6]

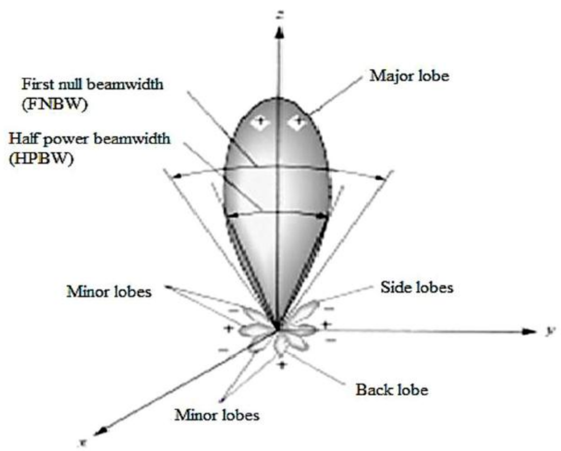

Fig.1. Example of radiation Pattern

3.1.5 Directivity

Directivity, D, is important parameter that shows the ability of the antenna focusing radiated energy. Directivity is the ratio of maximum radiated to radiate reference antenna. Reference antenna usually is a isotropic radiator where the radiated energy are same in all direction and have directivity of 1. Directivity can be definition as

$$D = \frac{U\max}{Uo}$$

……….(3)

Where,

Umax = maximum radiated energy

Uo = isotropic radiator radiated energy

3.1.6 Polarization

The polarization of an antenna describes the orientation and sense of the radiated waves electric field vector. There are three types of basic polarization:

- Linear polarization
- Elliptical polarization
- Circular polarization

Generally most antennas radiated with linear or circular polarization. Antennas with linear polarization radiated at the same plane with the direction of the wave propagate For circular polarization, the antenna radiated in circular form.

3.1.7 Frequency Bandwidth (FBW)

The term bandwidth simply defines the frequency range over which an antenna meets a certain set of specification performance criteria. The important issue to consider regarding bandwidth is the performance trade-offs between all of the performance properties described above. Antennas form three classes in terms of frequency coverage:

- Narrow band – These antennas cover a small range of the order of few percent around the designed operating frequency.

$$FBW = \frac{f\max - f\min}{fo} \times 100\%$$

…..(4)

where,

fmax,fmin = the maximum and minimum frequencies

fo = the center frequency.

- Wideband or broadband – These antennas cover an octave or two range of Frequencies

$$FBW = \frac{f\max}{f\min}$$

……..(5)

- Frequency independent these antennas cover a ten to one or greater range of frequencies.

3.1.8Front to Back Ratio (FBR)

Front to back isolation ratio is defined as the difference in gain from the front of the antenna and the gain from the back of the antenna. FBR is of concern to communication engineers when the antenna is to be used in a crowded frequency band. Amateur radio operators frequently use front to-back isolation as a parameter when comparing Yagi-Uda antennas.

3.1.9 3 dB Beamwidth
(Half Power Beam Width, HPBW)

Once the antenna pattern information is detailed in a polar plot, some quantitative aspects of the antenna pattern properties can be described. These quantitative aspects include the 3 dB beamwidth (1/2 power level), directivity, side lobe level and front to back ratio. To further understand these concepts, first consider the fundamental reference antenna, the point source. A point source is an imaginary antenna that radiates energy equally in all directions such that the antenna pattern is perfect sphere. These antennas is said to be an omnidirectional isotropic radiator and has 0 dB directivity. In practice when antenna is said to be an omnidirectional, it is inferred that this is referenced only to the horizontal or azimuth sweep plane. For any practical the 3 dB beamwidth of antenna is simply a measure of the angular width of the -3dB points on the antenna pattern relative to the pattern maximum. These -3dB points on the pattern represent the point on the pattern where the power level is down 3 dB of the value at the pattern maximum. Generally, the 3 dB beamwidth is expressed separately for each of the individual pattern sweep planes antenna, there will always be some specific direction of maximum radiated energy

3.1.10 Return Loss

Return Loss is a measure of the reflected power from an impedance discontinuity, such as the input port of an antenna, and can be defined in terms of ZA as

$$\text{Return Loss(dB)} = -20\log\frac{Z_A - Z_o}{Z_A + Z_o}$$

…….(6)

where

ZA = antenna input impedance

Z0 = measurement characteristic impedance.

Since the reflected power from an antenna input port reduces the radiated power, it is a good practice to minimize return loss for maximizing antenna efficiency. Return loss can be measured accurately by using a calibrated network analyzer. A comparison of the measured results with the predicted data can then provide a guideline for how to proceed with the rest of the design process.

4. CONCLUSION

After this literature review it is concluded that the circular microstrip antenna for different frequency band can be designed and also different feeding methods of different substrate material are available.Insted of that Strip line fedding is easy to fabricate as compare to other method.

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