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Wideband Omnidirectional Circular Patch Antenna with Circular Polarization

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Abstract: ***In recent years antenna design field is achieving a great interest in several advanced technological applications..several technologies are brought to transmit information over different bandwidth. A low-profile antenna that has a number of advantages over other antennas. Circularly polarized (CP) antennas are widely used in modern wireless systems because they can suppress multipath interferences. Omnidirectional radiation patterns are generally desirable since they can provide larger signal coverage and stabilize the signal transmission. Most modern WLAN's are based on ieee 802.11(2.4ghz) standards and are marketed under the wi-fi brand name.Here a low profile circular patch antenna is designed and several methods are studied in order to improve the bandwidth and to obtain circular polarization. Among the studied methods, the proposed antenna is designed with circular patch over a circular ground plane and vias are introduced in the patch which connects the patch and the ground plane to improve the bandwidth, also some curved branches are attached to the patch in a circular manner in order to obtain circular polarization.***

Keywords: Circular polarization, Omnidirectional pattern,vias

1. Introduction

Antenna is an important device which is used in the developing modern wireless communication areas. It will always keeps the property of reciprocity where they maintain the same characteristics whenever it is transmitting or receiving. It will transform the RF signal to electromagnetic waves and vice-versa. Several properties of antennas including the polarization, directivity, radiation pattern etc… gives the efficiency information and characteristics of the designed antenna structure.

Among the properties of antenna, polarization can be of three types namely circular, elliptical and linear polarizations. Circular polarization have several advantages over the other two types of polarizations including that they enhances the stability of the receiving information signal and reduce the multipath fading effects. CP antennas are generally not used in small devices applications because of its complex it They are generally preferred in base station applications.[1]. Omnidirectional antennas can be used in order for effectively radiate the power in all directions. They can provide a free alignment between the transmitter and receiver antennas [2]. Omnidirectional CP antennas are widely used in automobile communication sysytems. The circular polarization can be achieved by providing 90 degree phase shift between the horizontally and vertically polarized waves.. Several antenna structures are proposed in order to get an omnidirectional CP field. A Microstrip antenna with shorting wire which connects the ground plane and patch is reported in [5]. A CP antenna with rectangular loop elements attached over a hollow cylinder is proposed in [1].Another antenna with L shaped conducting walls are proposed in [3],In [4] they propose a microstrip antenna with several shorting vias which connects the patch with the ground plane is studied and they gives a good result in the eye of bandwidth enhancement. Another antenna with curved branches over the patch is reported in [6] which will give a CP field. In [7] they propose a microstrip antenna with shorting vias along with curved branch and branches attached in the patch as in [6] which gives better performance than antenna proposed in [4] and [6].

2. Antenna Design

The proposed antenna design includes a circular patch with shorting vias and curved branches attached aover the circular patch in order to obtain a CP field. A microstrip patch antenna is proposed due to their advanatges over other antennas including lightweight and less expensive for installation. The bandwidth of antenna is determined by the parameter of height in between the patch and the ground plane. It consists of patch with circular geometry and a circular ground plane with several number of shorting vias which connects the patch with the ground plane ,inorder to obtain the wider bandwidth along with omnidirectional CP pattern. The patch radius is represented as *rp* the ground plane center piece has radius of *rg* the extended branch width is represented as *w* and branch length is represented as *l* .The shorting vias over the patch are uniformly distributed . The antenna is fed by coaxial probe. The patch antenna has a fundamental mode of TM02 and by introducing the shoring vias a new classical mode of TM01 is created , and along with the combination of these two modes of TM01 and TM02 a wideband is created and the antenna will become more efficient. The orthogonal CP fields are formed when the electric fields of electric and magnetic dipole have same magnitude and 90 degree phase shift.The LHCP and RHCP fields are formed based on the alignment of the curved branches. If they are arranged in clockwise direction a RHCP fields are formed and if it is in anticlockwise direction LHCP fields are formed.

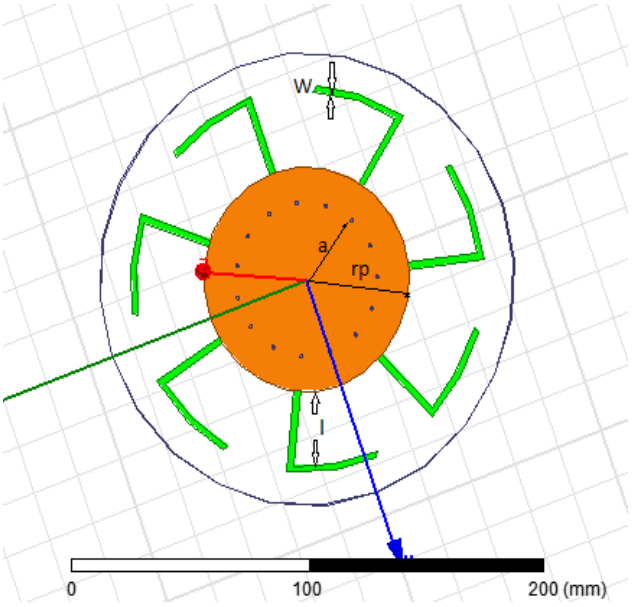

Figure 1: Structure of proposed antenna with vias and curved branches

3. Simulation Results

Fig 1 represents the proposed antenna designed for a frequency of 2.4 GHZ used for WLAN applications. The parameters are given by *w*=2.8mm,R=90mm,a=30.3mm, N=15 ,rp=44.3mm, h=3mm, rg=43.1mm, l=33.9mm. The number of vias can be changed based on our output requirements.Fig2 represents the reflection coefficients of the proposed antenna.The -10db impedence bandwidth of the proposed antenna varies from 2.26GHZ to 2.75GHZ.The initial values can be found based on the theory presented in [5].

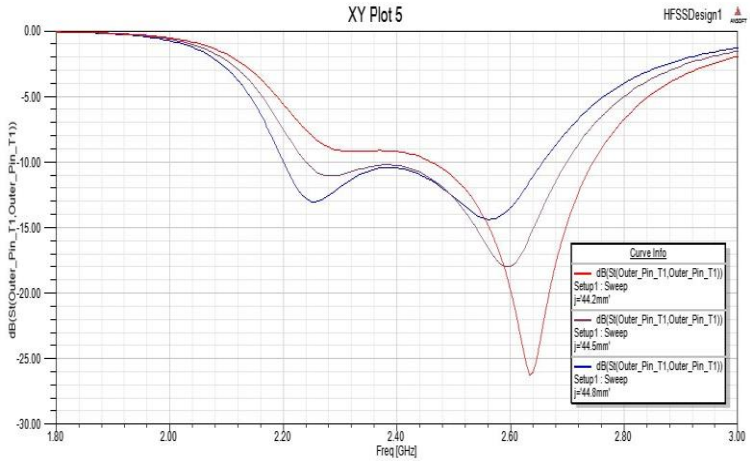

Figure 2: Simulated Refletion coefficient of proposed antenna for different values of rp

From the graph two resonant modes can be observed. The first mode in the figure represents the TM01 mode which denotes the structure with shorting vias on the patch which connects to the ground plane and the second resonant mode denotes TM02 which is that of simple patch structure without any shorting vias. By combining these two modes we will get a wide bandwidth operation.

Fig 3 represents the 3D polar plot of the proposed antenna. From the figure it is clear that it gives an omnidirectional pattern with a gain of 5.62db.Fig 4 represents the graph showing the Axial Ratio of the proposed antenna. The axial ratio less than 3db represents the circular polarization effect. Here the axial ratio of proposed antenna is 2.52db.Fig 5 represents the radiation pattern of the proposed antenna . As in the figure it will give an omnidirectional radiation pattern.

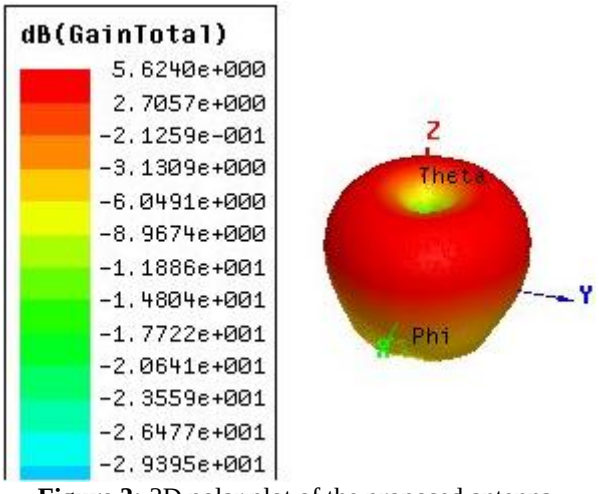

Figure 3: 3D polar plot of the proposed antenna.

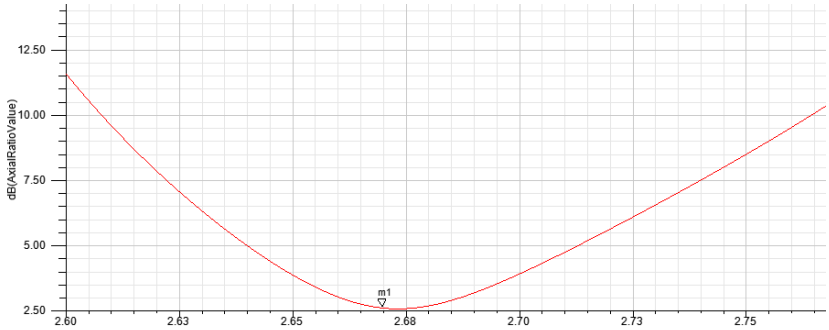

Figure 4: Axial Ratio of proposed antenna

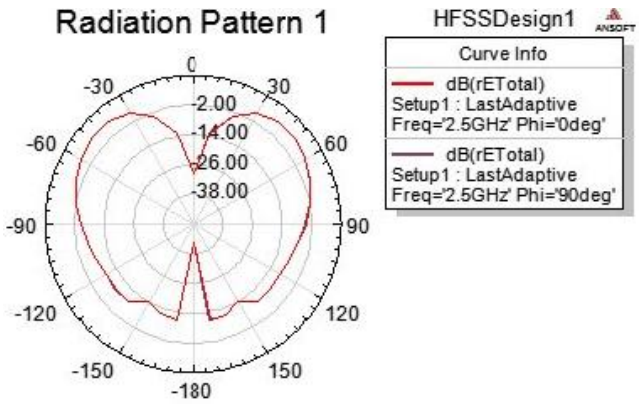

Figure 5: Stimulated radiation pattern of proposed antenna

The reflection coefficient donot depend on the value of *w*,but AR depends on the same as follows, as the *w* increases the AR value go above 3 db and which is not appropriate. So that in order to achieve a better result maintain *w* as low as possible without affecting other parameters of the antenna. One of the main advantage of the proposed antenna is that the vias mainly affect the impedence match and the curved branches affect the AR. So that the matching and the tuning of antenna can be done separately.

4. Conclusion

A low profile wideband circularly polarized omnidirectional radiating antenna has been proposed which is designed at 2.4GHZ for WLAN applications. Its structure consists of circular patch and ground plane with shorting vias which connects the patch to the ground plane and some curved extended branches attached over tte patch inorder to obtain a CP filed. The vias will generate a classical mode over the fundamental TM02 mode of the patch antenna which is that of TM01 mode and by combining these two modes we will get a wider bandwidth operation. The alignment of extended curved branches will give a CP field and omnidirectional radiation pattern. One of the main advantage of the proposed design is that the tuning and matching can be done separately because the matching is influenced by the vias and AR depends on *w*. The CP fields can generate in many ways of having any structure which influences to flow the current in a circular pattern. Here curved branches are chosen because of its simple structure and its easiness for installation. The structure provide a wider bandwidth and the obtained AR is less than 3db (2.52db) and it achieves a gain of 5.62db which is efficient for WLAN applications.

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