A Dual Polarized Dual Band Antenna With Omni Directional Radiation Patterns With Modified Loops

Dr.S.Anand ME.,Ph.D.[1], Baby [2], Keerthana[3], Nivetha Vijayan[4]
[1, 2, 3, 4] Dept of Electronics and Communication Engineering
[1, 2, 3, 4] MEPCO SCHLENK ENGINEERING COLLEGE, Sivakasi.

Abstract- *A Dual polarized dual band (DPDB) Omni directional antenna was proposed. It consists of circular patch with eight open slots, eight shorted metal pins and a central feed coaxial probe. At TM01 mode eight shorted metal pins and open slots can radiate theta and phi components, which generate circular polarization. When basic TM02 mode is excited, the Omni directional linear polarization is generated. The circular patch antenna with substrate with radius 48mm and has a low profile of 4mm. the measured results has the impendence band width for VSWR<2 are 14MHZ and 36MHZ.This antenna has the good application for Wireless broad band communication.*

I. INTRODUCTION

Antenna with different polarization is used for different communication standard, so dual polarized dual band (DPDB) antennas are of great use. Wireless access can be realized anywhere when Omni directional radiation pattern in horizontal plane in antenna is achieved. More over multi band miniaturized Omni directional antenna can work a multiple bands where one single antenna operate at different bands simultaneously. The Omni directional DPDB antennas can significantly improve the antenna system.

It is noted that Omni directional circularly polarized antennas have created much attention due to their Omni directional and CP characteristics. Several kind of such antenna has been proposed in recent years. In [3], an Omni directional CP antenna is realized by two printed substrate where a metal sleeve acts as a monopole and printed spoke like metal strips which are fabricated on two substrates act as loop. Then an Omni directional CP array is proposed in [4], where the CP element is composed of an electric dipole and a zero phase shift line loop so such antenna is for high gain. A dielectric resonator Omni directional CP antenna is proposed in [5]-[7] in which dielectric resonator provide vertical polarization while other structures such as parasitic strip or the top loaded Alford loop provide horizontal polarization.

The dual band Omni directional antenna was proposed in [8]-[11]. In [8] Omni directional pattern in both vertical and horizontal polarization in the azimuthally plane were achieved by positioning two orthogonal slots cut into the walls of a slender columnar cuboids where as [10] used reshaped monopole for vertical polarization and circular current loop for horizontal current loop, while [10] used a modified printed dipole for horizontal polarization and monopole for vertical polarization.

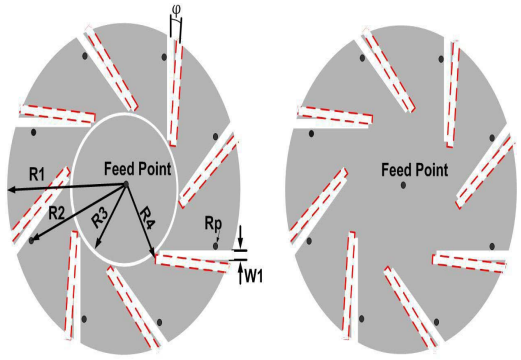
Based on the TM01 mode and TM02 mode of the patch, CP conical beam antenna [12], Omni directional CP antenna [13] and Omni directional linear polarized antenna [14] have been proposed. To excite TM01 and TM02 the shorted pins are added to the circular patch. These antennas have the property of low profile. Moreover it is meaningful that one single antenna not only generated Omni directional CP radiation but also generates Omni directional linear polarized radiation at both working band.

A low profile DPDB antenna with Omni directional property is proposed in this communication. This antenna consists of eight slotted metal pins, a top patch, and a bottom patch with 8 open slots. The basics TM02 mode of the patch antenna can be excited to generate linearly polarized wave the higher band, while the TM01 mode of the patch antenna can be excite to generate CP wave over the lower band, where as both are Omni directional in lower band, vertical polarization is provided by the slotted pins and horizontal polarization provided by asymmetrically placed slotted on the top and bottom plane, CP radiation is formed. In higher band linearly polarized radiation is formed by the centre patch which is kept apart by the cut loop on the top plane. The proposed antenna achieves the impendence bandwidth of 14 and 36 MHZ. An antenna has low profile of 4mm.

II. ANTENNA DESIGN

The proposed antenna is printed on a substrate with a relative dielectric constant of 2.2, a height of h, and a radius of R1. The geometry of the antenna is shown n fig.1, where the top and bottom views are presented. The antenna is fed by a coaxial cable at the center. A loop is cut on the top patch with a width of Wc. The top patch and the bottom patch are both cut with eight asymmetrical open slots. The slots on the top and bottom planes are not completely overlapped from the top

view, and the bottom slots can be seen as the top slots rotated by ϕ. All of the slots have the same length and width of L1 and W1. Eight sorted pins are placed near the slots with a radius of Rp. The detailed dimensions of marked parameters in fig.1 are shown in table I.

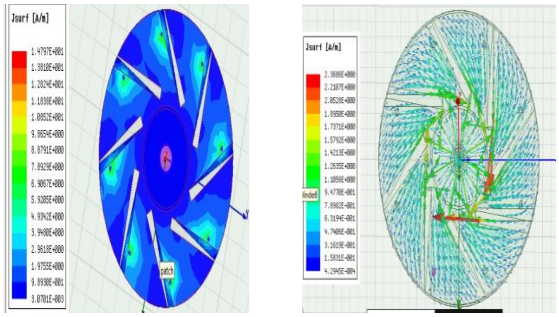


(A) (b)

Fig.1 Geometry of the proposed antenna. (a) Top view. (b) Bottom view.

TABLE I DETAILED DIMENSIONS OF PARAMETERS MARKED IN FIG.1

parameter	R1	R2	R3	R4	RP	W1	Wc
Values(mm)	48	40	18	19.5	1	4	1



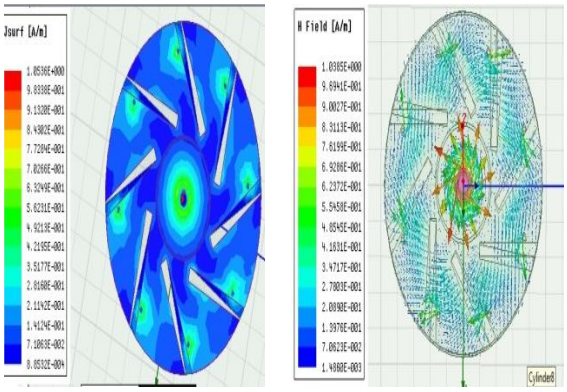
(a) (b)

Fig.2. (a) current distribution and (b) magnetic fields of the antenna at 1.51GHZ (TM01 mode)

The basic principle to generate Omni directional circular polarization in lower band utilizes a short monopole and short current loop. On one hand a eight shorted pins can excite the TM01 mode of the patch to create vertical polarization, on the other hand the open slots cut on the top and bottom patch that are placed asymmetrically can form current loop in the horizontal plane. As presented in [3], the far fields of a short monopole and a small loop which are excited by the same current are Omni directional CP radiation.

From the current distribution at 1.51GHZ in fig. 2(a), the counterclockwise current appears on the overlapped conductor formed by the slots on the top and bottom planes. Horizontal polarized fields ($E\phi$) are dominated by the slots. According to the boundary conditions vertical polarized fields ($E\theta$) are dominated by shorted pins due to the magnetic fields around the shorted pins in fig 2(b). By adjusting the dimensions, balanced amplitudes between vertical and horizontal polarization ($E\phi$ and $E\theta$) can be achieved.

In the higher band, the basic TM02 mode can be generated by the original central circular patch is apart from the cut loop to make the patchwork as a monopole. Thus the Omni directional property is achieved. For the TM02 mode the current mainly concentrates on the enter patch. Vertical polarized fields ($E\theta$) are determined by the center coaxial probe due to the magnetic fields around the coaxial probe in fig 3(b). in order to generate another resonance frequency, a loop is used here to make the patchwork in its basic mode while it has little effect on the Omni directional CP property over the lower band. The use of the loop and eight shorted pins will be demonstrated in detail in the following sections.



(a) (b)

Fig 3 (a) current distribution and (b) magnetic fields of the antenna at 2.43 GHZ

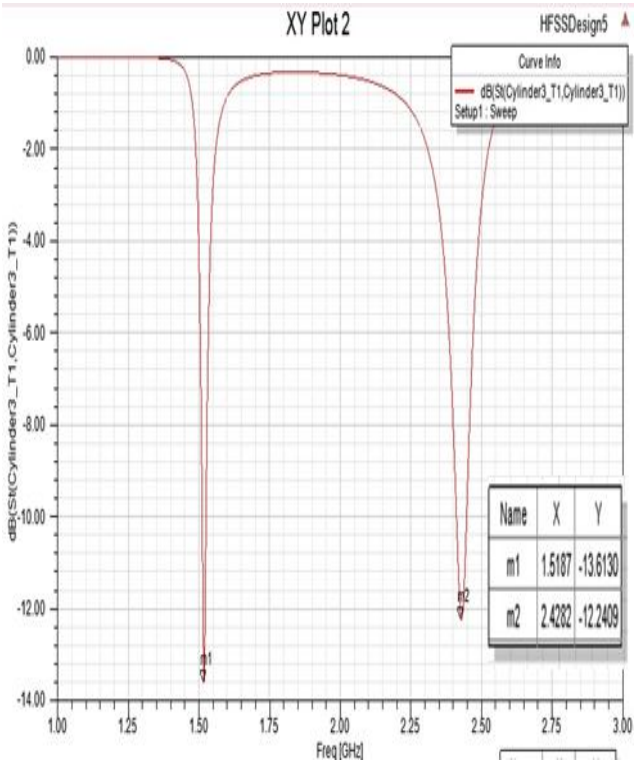
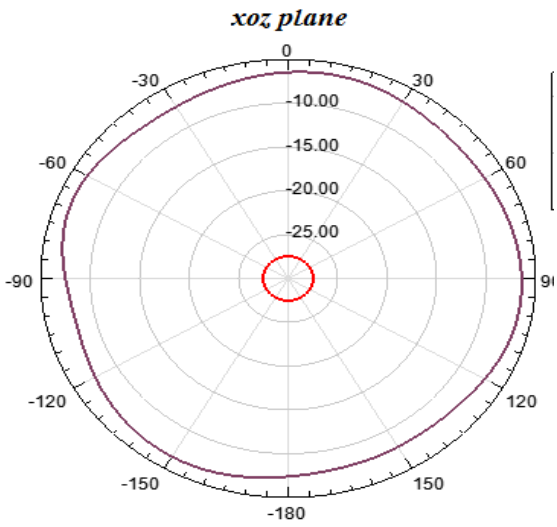


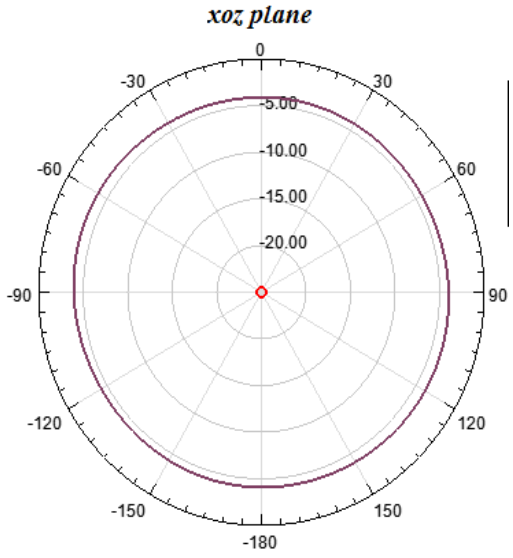
Fig. 4 simulated and measured |S11| of the proposed antenna.

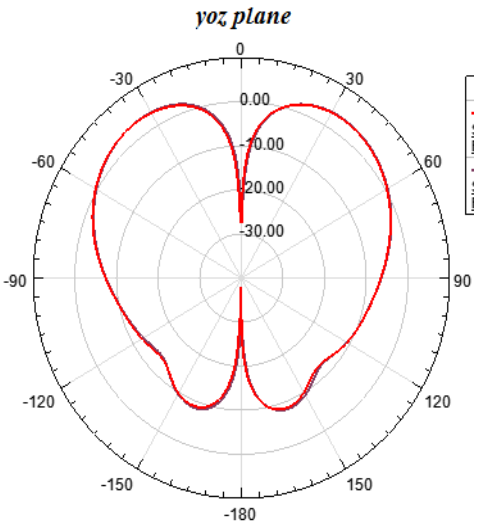
III. SIMULATED AND MEASURED RESULTS

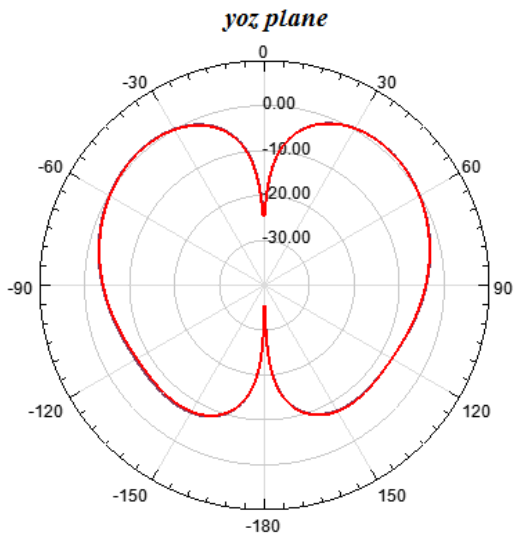
The proposed antenna is simulated bby HFSS. To confirm its DPDB and omni-directional property, the antenna is measured. The measured results show the antenna is worked at 1.5161 and 2.4363 GHZ and the impendance bandwidths are 14 and 36 MHZ respectively. The radiation pattern is omni directional. In the higher band, the linearly polarized property is presented. Less than 3db circular polarized property is presented. The difference between the measured and simulation is due to the unstable dielectric constant and imperfect enviroment. Morever, with better fabrication, the measured results an also be improved.

RADIATION PATTERN:









The measured maximum gains 2.06 db at 1.5161 GHZ and 5.2463 db at 2.43GHZ. The measured antenna effiency 98% at 1.5161GHZ and 99% at 2.4363GHZ. reasonable agreements between measurement and simulation are obtained.

IV. STUDY OF THE KEY STRUCTURES AND SOME PARAMETERS

To deeply understand the proposed antenna, the analysis of the cut loop, and shorted metal pins are carried out by HFSS. The advantage of the proposed antenna is also studied in this section.

A.LOOP

Here the bottom patch is without the loop and top patch with the loop. The antenna has a dual band property without the loop because the center patch formed by the end of the ut slots xan still excite the TM01 mode. The problem is the impedance is not matched well at the working bands. In the horizontal plane, the omni directional circular polarization can be ahieved in the lower band. The conclusion that omni diretional circular polarization is generated by the TM02 mode provided by eight shorting pins and the slots cut on the top cut on the top plane can adjust the impendance matching at working bands which less effects onomnidiretional circular polarization at 1.5161 GHZ.

B.SHORTED METAL PINS

The shorted metal pins can excite the TM01 mode of the patch and the shorted pins and the open slots cut on the top and bottom planes forming omni directional CP waves that have been mentioned in the former sections. Once without the shorted pins the antenna cannot radiate CP waves over the lower band. The ARs nearly 15db without the shorted metal pins while being less tha 3 db with thw shorted metal pins. It can be concluded that the shorted metal pins indeed provide vertical polarization to form circular polarization over the lower band.

The position of the metal pins and the number of the slits and the pins are important for the antenna property. With the number of slits and shorted metal pins inreasing, the resonant frequencies of both TM01 and TM02 modes inrease. Because the shorted metal pins an decrease the capacitance of each sector the frequencies therefore increase. The resonant frequency of the TM02 mode decreases and the resonant frequency of the TM01 mode increases when the shorted metal pins come away from the center point.

C.ADVANTAGES

Omni directional CP radiation is achieved at 1.5161GHZ, and omni diretional linearly polarized radiation is achieved at 2.4363GHZ. the measured radiation effiency is 98% at 1.5161GHZ and 99% at 2.4363 at 2.4363GHZ and the antenna an be worked in GPS and WLAN systems as a portable device. Relatively DPDB antennas work with omni diretional CP radiation and omni driectional lineraly polarized radiation. The size is comparely small. It can be a good candiate for poratable use or indoor system.

V.CONCLUSION

The proposed antenna with omni directional radiation is proposed. The proposed antenna achieves the impedence bandwidth of 14 and 36 MHZ. In the lower band, the shorted metal pins can excite the TM02 mode of the patch to provide vertical polarization while the eight asymmetrical placed open slots provide horizontal polarization. The omni directional CP property is obtained. In the higher band, the centeral patch can be excited through the TM01 mode to generate omni directional linear polarization. A cut loop is used here to match the impendence of the antenna. In the horizontal plane, the ARs of the antenna are less than 3 db at 1.5161 GHZ and the co-polarization is 15 db stronger than the cross polarization at 1.5161 and 2.4363 GHZ. Both of the radiation patterns at 1.5161 and 2.4363 GHZ are omni directional. Maximum gains of the antenna are 2.06 and 5.2463 GHZ, respectively.

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