DESIGN OF SINGLE FEED DUAL POLARIZED AND DUAL FREQUENCY RECTANGULAR PATCH ANTENNA

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Abstract:

In this paper, a design of compact single layer dual polarized and dual frequency rectangular patch antenna is presented. The proposed antenna is a simple structure of dimension 30.4mmX23.4mmX1.6mm and fed by 50Ω probe feed. The impedance matching and radiation characteristics of design structure investigated by MOM Based IE3D^{TM}simulation package. The simulation results show that the antenna offers dual polarization and dual frequency .The proposed antenna is exited by a single probe feed that is on the corner of the rectangular slot and the antenna frequency (f_1)at 2.9GHz is operated in linear polarization .The frequency (f_2) at 3.9GHz is operated at circular polarization. It gives proper impedance matching at the feed Point. This antenna configuration would be quiet useful for satellite and mobile communication as it is easy to fabricate and integrated with RF circuitry.

Key words: Rectangular patch, dual frequency, slotted and dual polarized.

I. INTRODUCTION

In recent years the demand for broad-band antennas has increased for use in high frequency and high speed data communication. Printed antennas are economical and can be accommodated in the device package. Microstrip antennas are best form of printed antennas because they are light weight, low profile, low cost, ease to analyze and fabricate and are compatible with the integrated circuit.

In this paper, dual-polarized and dual frequency design of a single-feed rectangular microstrip antenna with a square slot is placed close to its probe feeding point. The two operating frequencies, having different radiation characteristics and different polarization planes i.e. one is linear polarization and other is circular polarization. Here dual-polarized radiation can be obtained with a reduced antenna size at a fixed operating frequency. Many prototypes of the proposed compact dual polarized antenna can be obtained by exciting the patch using a coaxial probe feed along the diagonal line of the rectangular patch. It is seen that dual-frequency operation [1, 2] based on the two resonant frequencies $f_1$and $f_2$of the perturbed TM10 and TM01 modes can be generated.Linear polarization is used for mobile communication and circular polarization used for satellite communication.

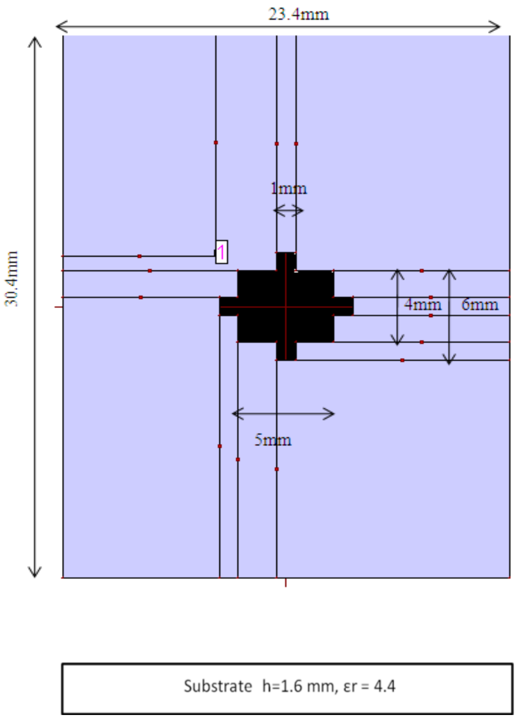

Fig.1/ Geometry of the proposed Probe-fed square slot antenna.

The dual-polarized patch antenna has been a popular research topic during recent years; the proposed antenna can double the capacity of Communication systems by means of the frequency reuse, and reduce the multipath fading of received signals in land-based mobile-communication systems by means of the polarization diversity. The new proposed design has a greater area reduction compared to the placard-shaped [3], arrow-shaped [4], slotted square shaped [5] antennas reported earlier. Two parameters affect the resonant frequency of the antenna, the slot width and slot length structure and changes vswr position. Here, the low-frequency ratio and area reduction mainly depends on the slot parameters. The design has been successfully implemented, and simulated results are presented.

II ANTENNA GEOMETRY

The geometry of the proposed antenna is shown in fig.1. The rectangular patch of dimensions L x W separated from the ground plane with a substrate of εr =4.4, thickness (h) and the square slot (approximately) placed at the center. The location of the approximate square slot on the patch can be specified by parameter W_S and L_S. The width and length of the slots are denoted by Ws and Ls. The rectangular patch is fed using 50Ω probe feed with radius is 0.25mm.

A typical proposed antenna design is implemented and investigated. It has dimensions L=23.4mm, W=30.4mm, Ls=5mm, Ws=4mm and is simulated on a substrate of $\varepsilon_{r=}$4.4 and h=1.6 mm. A good impedance matching of the two operating frequencies can be obtained by using a microstrip feedline of length with arm length Lsr and width Wsr etched on a substrate of the same thickness and permittivity, and kept below the antenna to provide electromagnetic coupling.

TABLE 1

PARAMETER VALUE OF ANTENNA

Parameter	Description	Value
L	Length of the Patch	23.4mm
W	Width of the Patch	30.4mm
L_S	Length of Square slot	5mm
W_S	Width of Square slot	4mm
R_P	Probe radius	0.25mm
L_{SR}	Slot arm Length	2mm
W_{SR}	Slot arm Width	1mm

III SIMULATED AND RESULT ANALYSIS

In order to evaluate the performance of the proposed antenna, the antenna is simulated through the simulation tool IE3D^{TM} (Version: 14). The analysis of the antenna for different physical parameter values has been done by varying one of them and keeping others as constant. It is carried out here to expose the flexibility in designing this antenna.

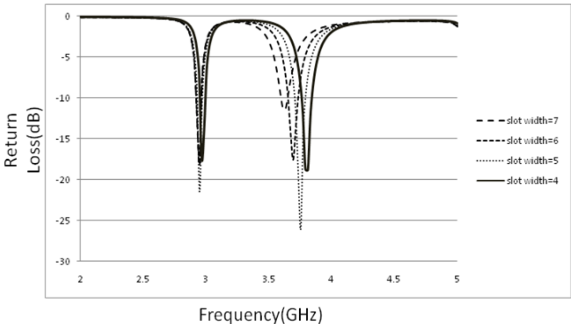

Fig: 2/ Simulated return loss curves for different Ws values

Figure 2 and 3 show the return loss Vs frequency of the antenna. The antenna is found to be resonating at two frequencies viz. 2.934 and 3.86 GHz. The simulated result showed that the radiation at 2.934 GHz is linearly polarized, and that at 3.86 GHz is circularly polarized. By changing slot width Ws=5mm and slot length is fixed i.e. Ls=5mm. So that the first resonant frequency is constant at F_1=2.934GHz and the second resonance frequency decreases from F_2=3.86 to 3.72 GHz. Increasing the value of slot width Ws=6mm and slot length is same at F_1=2.934GHz and decreases F_2=3.86 to 3.62GHz. The bandwidth of the antenna decreases from 2.24% to 1.8%. Therefore the best result for the -10dB bandwidth is obtain with Ws=4mm and Ls=5mm, where F_1=2.934 GHz and F_2=3.86 GHz.

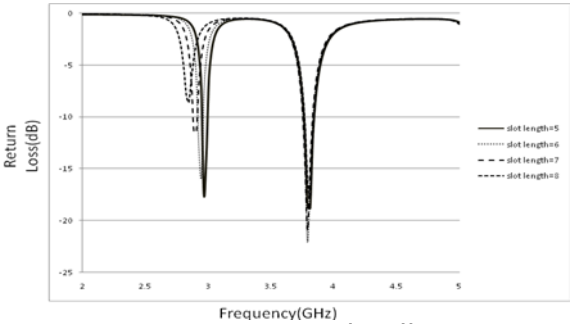

Fig 3/ simulated return loss curves for different Ls values

The effect of various values of Ls on the resonant frequency is investigated & shown in Fig. 3. It shows that increasing the value of Ls from 5 mm to 6 mm, the frequency F_2 stays the same at F_2=3.86GHz and F_1 decreases from 2.934GHz to 2.81 GHz. Increasing the value of Ls from 5mm to 7mm, frequency F_2=3.86 GHz, and F_1 decrease from 2.934GHz to 2.73 GHz. According to figure 3 the antenna becomes dual band with increasing in Ls from 5mm to 6mm while the bandwidth is slightly decreased and again we increase in Ls from 5mm to 7mm bandwidth also decreases. Hence the best value of Ls is equal to 5mm.

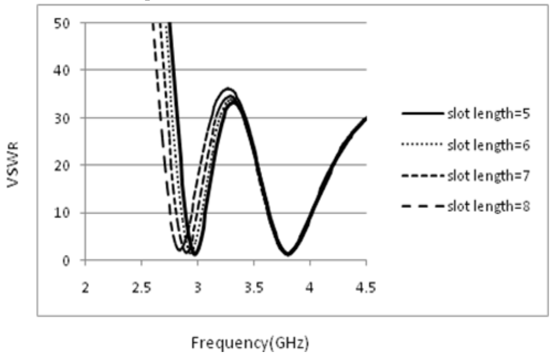

Fig. 4/ Simulated vswr curves for different Ls values

In fig. 4, it is observed that by changing the value of Ls from 5mm to 6mm, position of vswr at F_2 is same but at F_1 position of vswr changes 1.7to 2.2. By decreasing the value of Ls from 5mm to 4mm, position of vswr at F_1 remains same and at F_2 is also same. But Axial ratio is changing from 1.3 to 1.8 at F_2=3.86GHZ. Because of circular polarization, axial ratio should be closed to be unity. When the axial ratio is infinite or zero, the polarization becomes linear with the tilt angle defining the orientation .So Ls=5mm gives better result.

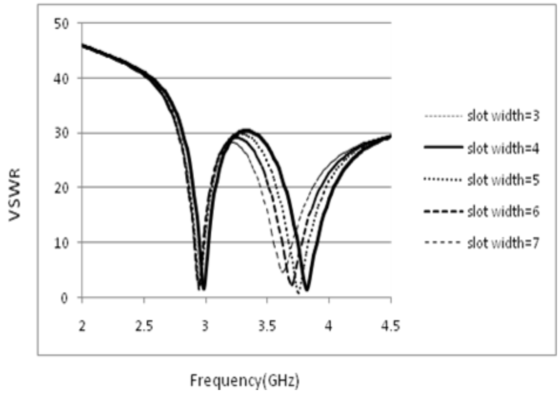

Fig. 5/ Simulated vswr curves for different Ws values

In fig. 5, By decreasing the value of Ws from 4mm to 3mm, position of vswr at F_1 is same and at F_2 position of vswr changes from 1.5 to 2.By increasing the value of Ws from 4mm to 5mm, position of vswr decreases from 1.5 to 1, which is better result of vswr. Since resonant frequency F_2 decreases from 3.86 to 3.7GHz, Ws=4mm gives better result. The radiation pattern of E & H plane is obtained at 2.93GHz and 3.86GHz. It is shown in Fig.6 (a) & 6(b) which confirms the Omni directional radiation pattern of the proposed antenna.

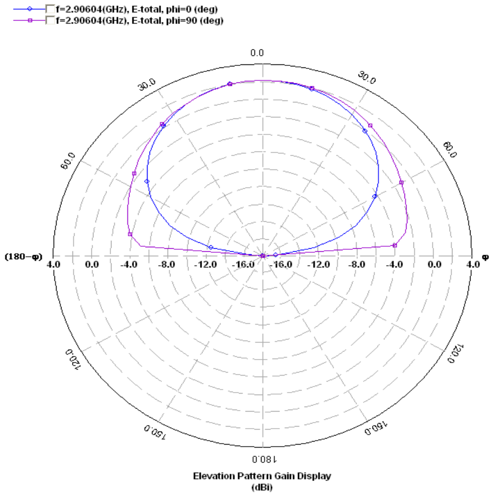

Fig.6 (a)/ E&H Field radiation pattern at frequency 2.93GHz linearly polarized.

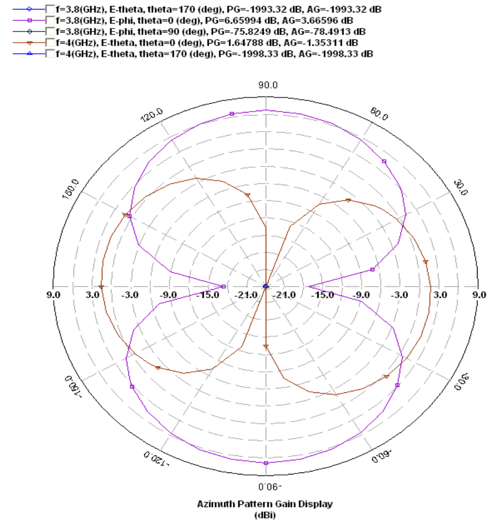

Fig.6 (b)/ E&H Field radiation pattern at frequency 2.93GHz linearly and at frequency 3.86 circularly polarized

The axial ratio Vs frequency curve is shown in fig.7

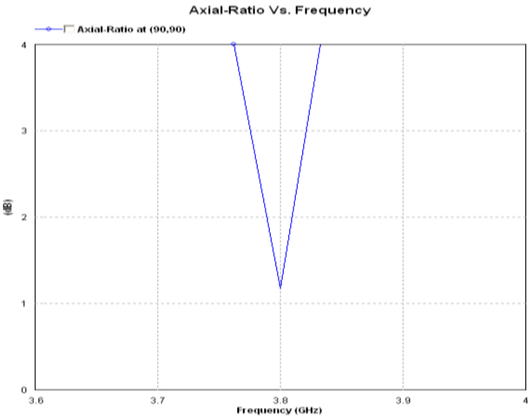

Fig.7/ Simulated 3dBAxial ratio for F_2 3.86GHz.

IV CONCLUSION

The proposed antenna achieved -10dB impedance bandwidth cover about 2.24%. Moreover, this antenna has a size reduction of ≈50% for the dual-polarized, dual frequency operation compared to a standard square patch. This antenna is capable of satisfying the requirements of a data communicator for specific terisstial and satellite communication systems.

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