Design and Analysis of Defected Ground Structure Microstrip Patch Antenna with Parasitic Resonator for Multiple Applications

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Abstract - In this paper, two antennas; one is linearly-polarized microstrip patch antenna and other having defected ground structure in it,is designed and simulated with using HFSS simulation software for 3.9 GHz. Antenna parameters are examined in this which includes resonating frequency, impedances,VSWR, directivity and gainof the designed and comparative analysis is made with defect ground structure with probe feed. The antenna is proposed for wireless communication applications for WiMax of 3.9 GHz provided with one more band for 3.6 GHz. This paper focuses on the designing of microstrip antenna with probe feed and analyses the results like return loss S_{11}, VSWR, impedance,etc. with defect ground structure.

Keywords: Defect Ground Structure,Triple band, Rectangular,Micro strip Patch Antenna, Parasitic Resonator.

I. INTRODUCTION

The evolution of IMAX presented is one of the foundational techniques in the IT and telecommunication sector. Common trend in telecommunication systems is to develop low cost, low profile, low weight dielectric material Rogers RT/duroid 5870 (ε_r=2.33) has capability of maintaining high performance over a wide spectrum of frequencies [1]. The very simple and easy geometry of micro strip patch antennas provide several upper hands not commonly exhibited in other antenna designs. The micro strip resonating structures are low profile, cost effective, compact and comfortable to fabricate using present technology of printed circuit board, compatible with microwave circuits; and have the ability to match to structures[1]. Prototype becomes definite in terms of operating frequency, return losses,and other parameters and this is also possible with microstrip antenna that it probably exceeds that of any other type of antenna segment [2]. Using the multi band micro strip patch antenna concept, in this paper on triple band micro strip antenna with defect ground structure is designed for 5.498, 6.228 and 6.537 GHz for multiple wireless applications. Ansys HFSS is essential for the results of parameters of simulated antenna. The microstrip patch antenna in its basic mode should radiate linearly polarized waves. But some degree of orthogonally polarized, known as, cross-polarized (XP) fields has always been associated with main radiations and are primarily occurring due to higher order modes predominantly over the H-plan [3]-[5]. This cross polarization radiation is a main concern for micro strip antenna arrays as well as single radiating antenna. In the last few decades, various techniques came to handle this issue in which the use of the defected ground structure (DGS) is the most new one. DGS, introduced to reduce XP radiation [6]. In this paper, a pair of shaped defects designs is aligned to the H-plane [6]–[13], which has been deliberately inserted in close to the patch boundary. The purpose of the designing was to use the orthogonally oriented higher modes of wave and hence closeness of the DGS was a necessary requirement. Because of the nearness, the defects had to be cut near the E-plane to maintain the primary radiation of the rectangular patch[6]. In this paper, a DGS and the parasitic resonator has been used with a motive to nullify the effects of the above mentioned defects. The proposed design is basically meant for a rectangular/ square patch, where the defect is introduced surrounding the element maintaining uniform symmetry and considerable spacing from the patch boundary. Thus, the DGS takes a symmetric shape as shown in Fig. 1.

II. ANTENNA DESIGN

The microstrip antenna structure using a defect ground antenna rather than a regular one have better response due to dual band for 5.576 and 6.26 GHz applications whereas the introduction of parasitic resonator further helped in increasing the bandwidth of the resonant peaks. However, the design methods of this antenna using the dual-mode defect ground structures are not common [4].

The design of the first simulated rectangular patch antenna is shown in fig.1 and proposed antenna with defect ground structure is shown in Figure 2, which is designed on a Rogers RT/duroid 5870 (ε_r= 2.33, tan loss=0.01) substrate with a height of 1.575 mm. The antenna is comprised of a probe feed ,a defect ground structure but no parasitic resonator. The antennas consists rectangular patch of 34x34 mm shown in Figure 1.The magnitude of the transmission parameter of S_{11} (reflection coefficient or return loss in dBs) for the antenna is calculated by the commonly used electromagnetic simulation software HFSS.

The radius of probe is chosen to 1.3mm with impedance 50 Ω. Proposed design for DGS with parameters :

Lp=14.22, ρ=2.45, g=6, w1=9, a=4, t= 2.89, d=1.3, h=1.575

Finally, the overall size of the antenna including ground dimension is 50 x 50 mm [2].

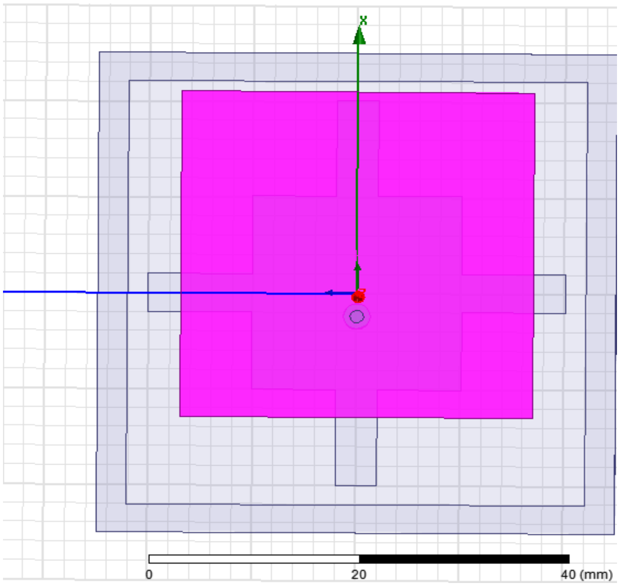

Fig 1 Conventional patch antenna

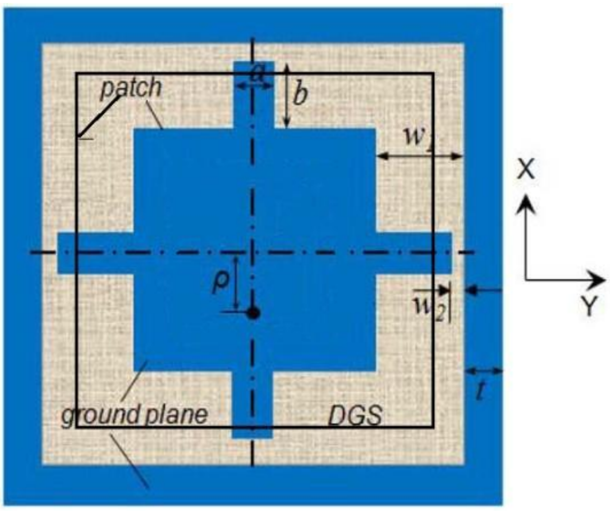

Fig 2 Proposed designs for DGS with parameters

L_p=14.22, ρ=2.45, g=6, w_1=9, a=4, t= 2.89, d=1.3, h=1.575

The simulated results for first antenna are shown in Figure 3 and 4 i.e in the red line, where two resonant frequencies 5.576 and 6.260 GHz with optimum return loss values can be clearly distinguished. The resonant frequencies of the microstrip patch with Defect Ground Structure.The selection of the dielectric material here the Dielectric Rogers RT/duroid 5870 (ε_r=2.33), substrate of thickness 1.575 mm, is used which is common and easily available. The material used as substrate plays an important in the performance characteristics of the patch antenna. Each dielectric material has a specific dielectric constant which affects the output characteristics and desired parameters of the microstrip antenna.

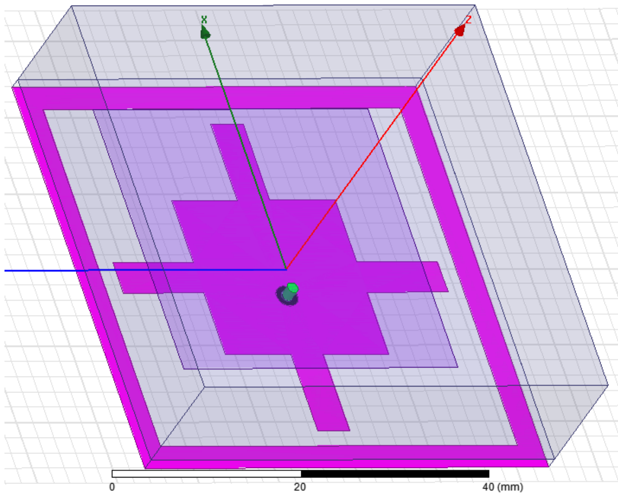

Fig. 3 First antenna design overview

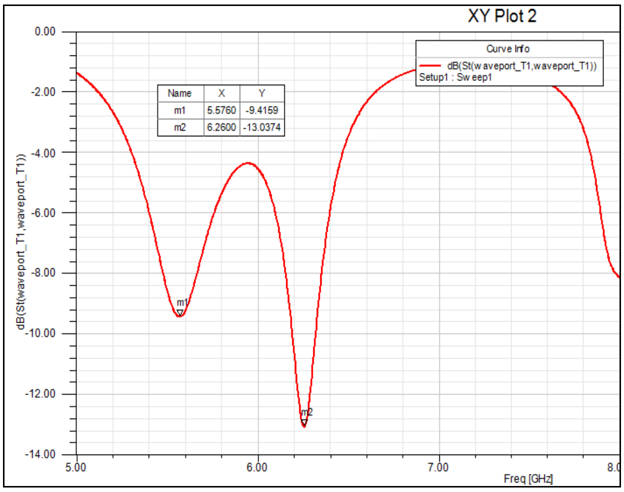

Fig. 4 Return loss vs. Freq. For First patch antenna is dual band

A parasitic resonator is an antenna element that is indirectly fed by being placed near the driven element, ie. Patch, of an antenna but never does physically touch it. Fields are capacitively coupled onto the resonator, which then gives rise to its own radiation. Second antenna model has been tuned by using parametric analysis by which the simulated results bettered by itself .The resonators add additional bands in the system but if the resonator, whose resonating frequency is a function of its size, shape and positioning, has its resonant frequency closer to the resonant peak exhibited by the driven antenna solely then resonant peak due to parametric will be closer to it and it will increase the bandwidth instead.

2nd antenna design further includes a parasitic resonator of dimension 2 x 30mm and at a distant of 3mm from the border of the driven patch element in the X direction ,as X and Y axis assumed in the model .

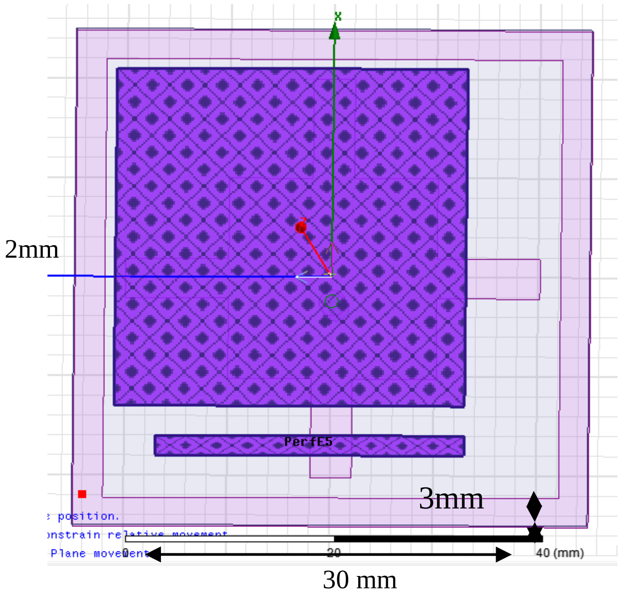

Fig. 5 Patch model consisting of driven and parasitic element with dimensions of parasitic element specified

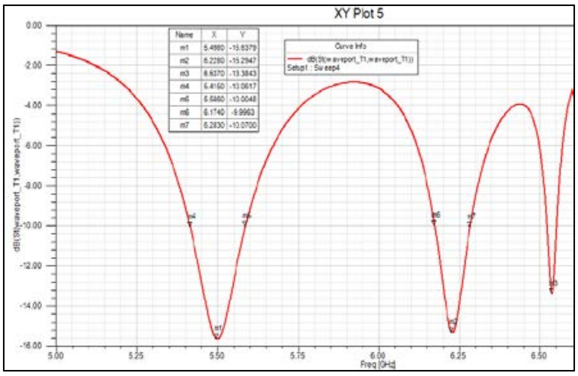

Fig. 6 Return loss vs. Frequency for Second patch antenna is triple band

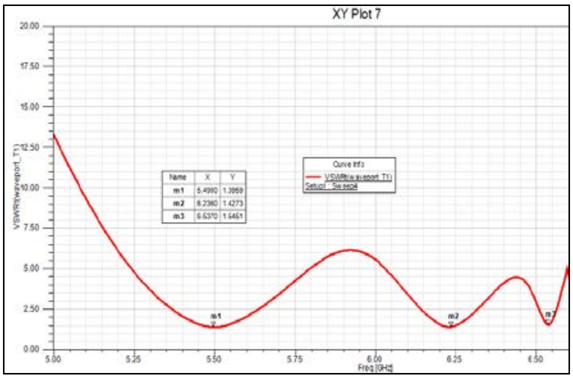

Fig. 7 VSWR vs Frequency for Second patch antenna is triple band

The second model results in 3 bands at 5.498, 6.228 and 6.537 GHz for -15.63,-15.29 and -13.38 dBs respectively. Parasitic resonators are also known to give better bandwidths with their introduction in the antenna model.

III. SIMULATION/EXPERIMENTAL RESULT

HFSS,the antenna simulation software has simulated and computed results of S_{11} parameter (return loss) are shown in figure 7 where three operating frequency bands are resulted for the proposed antenna. The antenna exhibits the characteristics of the triple-band operation, i.e a measurement at 5.498, 6.228 and 6.537 GHz of -15.63 ,-15.29 and -13.38 dBs respectively. The outcome of return loss, VSWR and impedance are shown:

TABLE 1. RESULT OF ALL PARAMETERS FOR SECOND ANTENNA

S. No.	Antenna parameters	Simulation		
		f_1	f_2	F3
1.	Resonant frequency(GHz)	5.498	6.228	6.537
2.	Return loss(dB)	-15.63	-15.29	-13.38
3.	VSWR	1.395	1.423	1.545
4.	Bandwidth(MHz)	171	109	30

IV. CONCLUSION

In this section conclusion of the research work should be explained.

We have designed and simulated tri-band microstrip antenna with parasitic resonator structure which has a resonating frequency of 5.498, 6.228 and 6.537 GHz for return loss -15.63,-15.29 and -13.38 dBs respectively. This triple-resonating band antenna has wide application in W-CDMA, Wi-Max, Wi-Fi/WLAN of wireless communication. Further optimizations are also possible by optimizing the size of the parasitic element alongwith its postion to improve its bandwidth and gain operating frequencies. The special feature of this parasitic microstrip antenna is its compactness and conciseness. This paper presents a geometric configuration of the Microstrip patch antenna for various wireless applications, which provides a means to gain multiple bands by having slots on ground plane without using special techniques [7].

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