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DESIGN OF MICROSTRIP PATCH ANTENNA USING PARASITIC RING RESONATORS FOR MULTI BAND APPLICATIONS

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ABSTRACT – In this paper, rectangular microstrip patch antenna for multi-band applications is proposed. The simulated results show that the proposed antenna operates at multiband resonance frequencies, which covers different wireless communication applications. The proposed antenna consists of a quasi-modified rectangular radiating patch with a partial ground plane and two parasitic elements (open-loop-ring resonators) to serve as coupling-bridges. A stepped cut at the partial ground plane is used, to achieve the multi-band features. The proposed antenna is simulated and optimized using ANSYS electronic desktop 19.2. The antenna topology possesses an area of 41.04×29.98×1.6 mm ^{3}. The measured results demonstrate that the proposed antenna has impedance bandwidths for -10 dB return loss which meet the requirements of wireless local area network (WLAN), worldwide interoperability for microwave access (Wi-MAX), L, C, X and Ku band applications. An Acceptable agreement is obtained between measurement and simulation results. Experimental results show that the antenna is successfully simulated and measured.

Key words rectangular microstrip patch antenna, HFSS, parasitic ring resonators and multiband.

I. INTRODUCTION

Antenna is the metallic structure and it is the major component of the communication. An antenna is used to transmit and receive the electromagnetic wave signals using some band of frequencies. Copper is a best suited material for base antenna.

Compact antennas with low cost, light weight, less fragile and easy fabrication techniques are in huge demand for this applications. The size of the patch antenna has a direct impact on its characteristics. The length of the antenna is determined by the wavelength of the radio waves it is used. In recent years the cellular phone handset antennas are required to be of small size, and installed inside the handset in proximity to a large PCB which acts as a ground plane. The parasitic rings addition can increase the strip helix antenna gain of 0.021dB and improves the performance of return loss, VSWR, and bandwidth despites that the ground plane size reduction. Actually decreases the gain value. The purpose of the parasitic elements is to modify the radiation pattern of the radio waves emitted by the driven element, directing them in a beam in one direction, increasing the antennas directivity(gain). A parasitic element is an element, which is depends on others feed. It does not have own feed. Hence in this type of arrays we employ such elements which help in the radiation indirectly. These elements are not directly connected to the feed. The effect of the adding parasitic elements in the patch of the antenna is the parasitic elements are elements which are inactive in nature. The direction of the main lobe in the beam can be changed by varying the length, width, location and number of the parasitic elements. Moreover, the presence of the parasitic elements has a significant effect in the impedance matching of the patch. Impedance mismatching can be compensated by changing the dimensions of the patch, or adjusting the location of the feed point. The proposed antenna is also a patch antenna which has micro strip patch and is printed on a FR4 epoxy using micro strip feed line. The multiband antenna has many applications in the communications such as weather monitoring, radar and communication, etc. Antenna which can work properly in more than one frequency region either for transmitting and receiving electromagnetic (EM) waves, are termed as multiband antennas. In this paper using rectangular patch. The simulation was carried out using ANSYS electronic desktop version 19. The proposed antenna has radiation pattern with sufficient and suitable gain. Antenna geometry has been explained in section II. Parametric analysis of various antenna parameters has been discussed in section III. Simulated results and analysis has been presented in section IV while section V concludes the paper.

II. ANTENNA DESIGN AND GEOMETRY

The antenna proposed structure is presented in Fig.1.

The geometry of the proposed rectangular micro strip patch antenna design printed on FR4 EPOXY substrate having dimensions of 41.04×29.98mm², thickness of 1.6mm and relative permittivity 4.4.

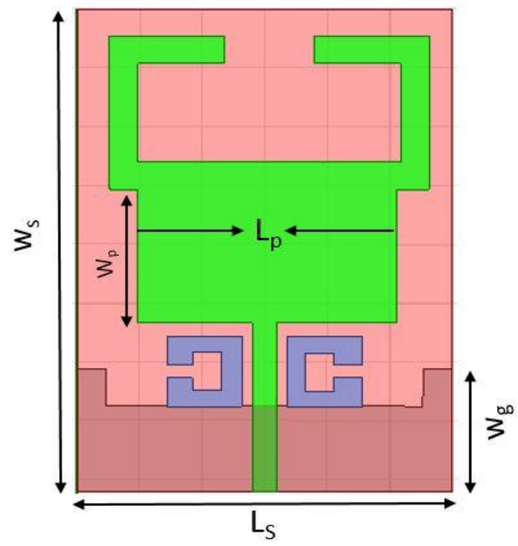

FIGURE 1. The geometry of proposed antenna structure.

The substrate has dimension is $L_s \times W_s$. A rectangular microstrip antenna fed by 50Ω. A rectangular patch ($L_P \times W_P$) is added to the feed-line which is connect the patch. On the other side of substrate is partial ground plane is placed. Width of the microstrip patch feed line is fixed at 2mm.

Table. 1. Optimized Dimensions of Monopole Microstrip patch antenna

PARAMETERS	VALUES(in mm)
W_s	41.04
L_s	29.98
W_P	13.67
L_P	20.75
h	1.6
W_g	10.378
L_g	29.98

III. RESULTS

The solution frequencies of the proposed antenna are 1.9GHz (1.46-3.55), 5.4GHz (4.63-5.38) 9.6GHz (9.19-10.012) and 16GHz (15.39-16.50) the HFSS model is modal. The simulation and validation are done using ANSYS Electronic desktop version 19.2. The S parameter and VSWR are analysed through the rectangular plot in modal solution. The radiation pattern is analysed through the 3D polar plot in the far field report. The simulation results are discussed below.

RETURN LOSS

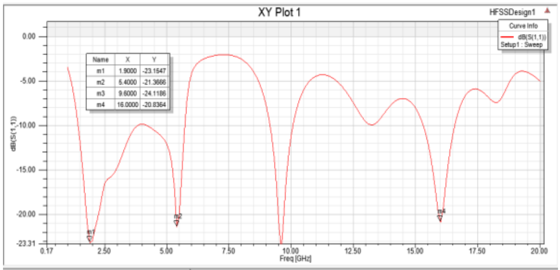

FIGURE. 2. S parameter of proposed antenna

The S Parameter (Scattering parameter) values are achieved less than -10dB for the proposed antenna is designed to resonate at 1.9GHz, 5.4GHz 9.6GHz and 16 GHz frequencies. This shows that the maximum power is reflected from transmitter to the antenna.

VSWR

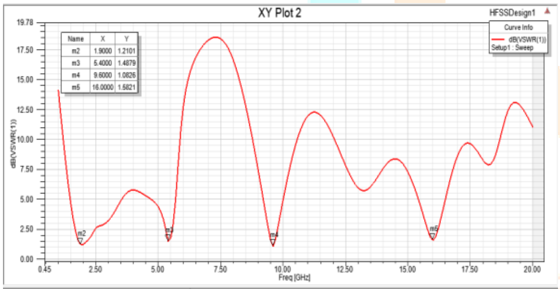

FIGURE. 3. VSWR of proposed antenna

The VSWR (Voltage Standing Wave Ratio) value of the proposed antenna are 1.86 at 1.9GHz, 1.21 at 5.4GHz, 1.48 at 9.6GHz and 1.08 at 16GHz at 1.58 frequencies. The voltage standing wave ratio is calculated to know that how much mismatch between an antenna and the feed line.

RADIATION PATTERN

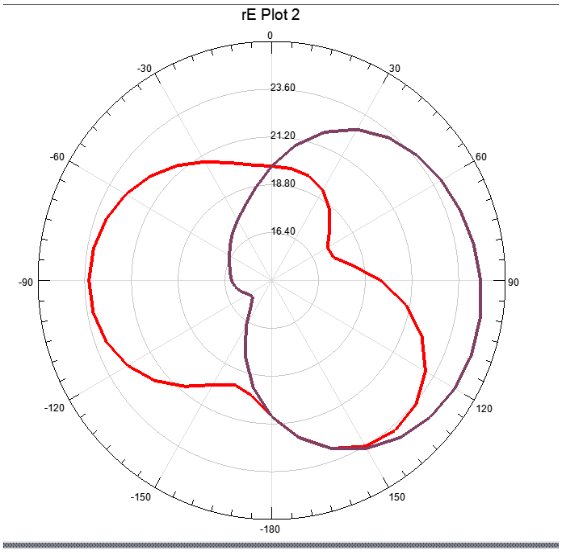

FIGURE.4. Radiation pattern of proposed antenna at 0 and 90 degrees

GAIN

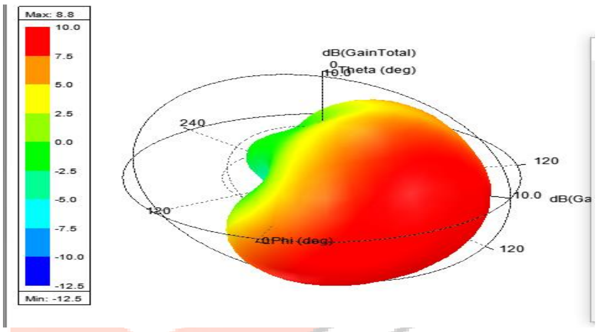

FIGURE. 5(a). Gain of proposed antenna at 1.9GHz

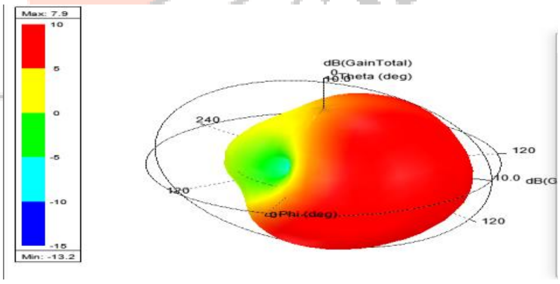

FIGURE.5(b) gain of proposed antenna at 5.4GHz

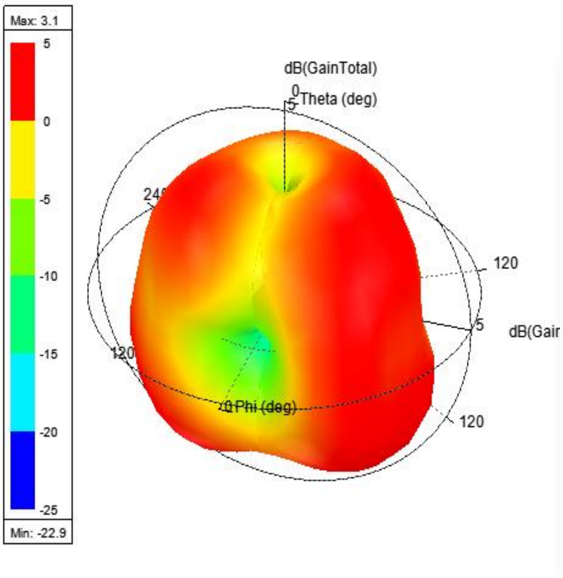

FIGURE. 5(c). Gain of proposed antenna at9.6GHz

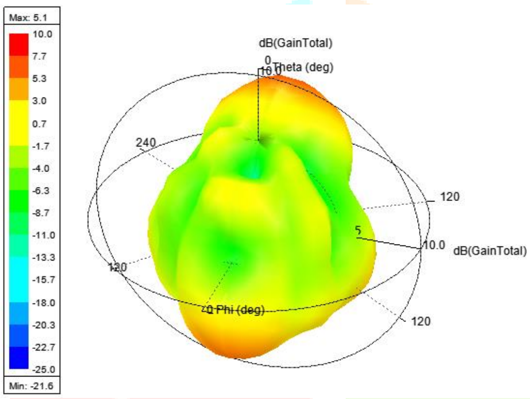

FIGURE. 5(d). Gain of proposed antenna at16GHz

The proposed antenna achieved a maximum gain of 8.8dB at 1.9GHz, 7.6 dB At 5.4GHz, 3.1dB at 9.6GHz and 5.6dB at 16GHz for multiband applications

IV. EVOLUTION OF MICROSTRIP PATCH ANTENNA

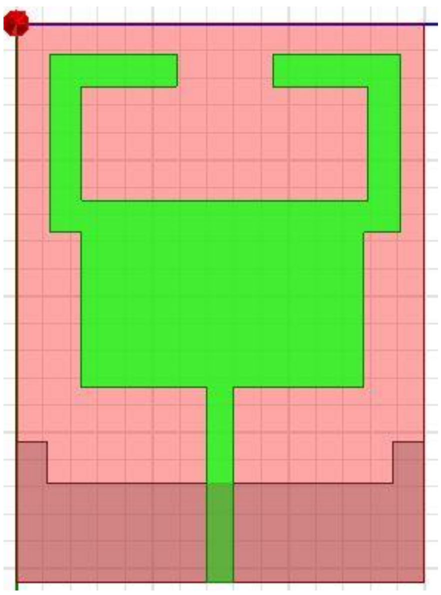

FIGURE. 6(a) Antenna without parasitic ring resonators

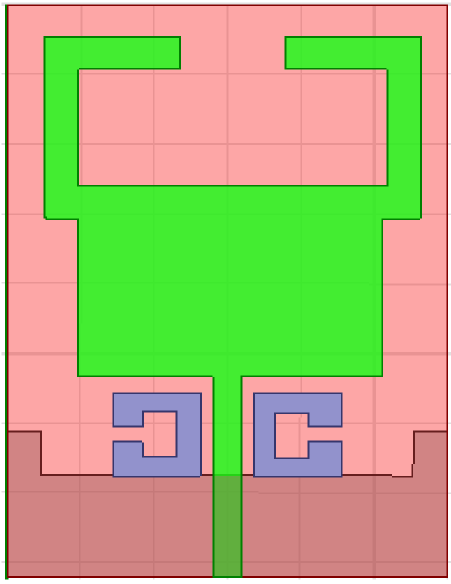

FIGURE. 6(b) Antenna with parasitic ring resonators

FIGURE. 6. Evolution of a monopole microstrip rectangular patch antenna (a) to (b) as follows Antenna 1 and Antenna2 models.

The evolution of microstrip rectangular patch antenna design illustrated with Figure 6(a) and 6(b). In the first evaluation of the process, antenna without parasitic ring resonators of the rectangular patch antenna with defective ground structure and its resonance at 1.7GHz 3.1GHz frequency and 15.7GHZ at -37.2dB, -13.8dB and 27.9dB of S11 and 1.44, 1.65 of VSWR in the respective frequencies are observed. An antenna 2 consists of the parasitic ring resonators which are used to increase the performance of the gain and radiation pattern all the parameters of the antenna. In this antenna different operating frequencies to operate the frequencies. The return loss of the antenna S11 is below -10dB respective frequencies are 1.7GHz, 5.2GHz,9.8GHz and 14.7GHz of patch antenna designs is illustrated with Figure. The proposed antenna voltage standing wave ratio is presented at the figure 3 the values are observed in the antenna at different resonance frequencies with partial ground plane. The ground which is used to multiband features but there are only two bands at that ground that's why we are using the parasitic ring resonators in this antenna and observe the results.

V. CONCLUSION

In this paper, the design of compact monopole antenna for multiband application is presented in this project work. The antenna operates at different frequencies at 1.9GHz.5.4GHz, 9.6GHz and 16GHz.In order to improve the bandwidth and radiation pattern and to minimize the size of rectangular microstrip patch antenna, at lower corners are added to the radiating patch and partial ground plane has been etched on the metallic ground plane The proposed antenna is simulated on the FR4 substrate with a measured area of 41.04×29.98mm²×1.6mm antenna is observed.

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