International Journal of Scientific & Engineering Research, Volume 4, Issue 11, November-2013
ISSN 2229-5518

Bandwidth Enhancement of Microstrip Antenna Using Partial Ground

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Abstract— Microstrip antennas have become the favorite choice of antenna designers because of advantages such as low profile, light weight, easy fabrication and easy integration with circuits. Although microstrip antenna has several advantages, also it has several disadvantages such as low gain and narrow bandwidth. Intensive research is going on to develop bandwidth enhancement techniques by keeping its size small. This paper gives comparision of simple rectangular microstrip antenna and microsrip antenna with partial ground. One is the simple rectangular Microstrip antennas and another is, rectangular Microstrip antennas with modifying the ground plane is designed and simulated .This paper describes the design of Microstrip antenna resonate at frequency 2.4 GHz using coaxial feeding for high speed networks. The antenna is constructed on material with dielectric constant of 4.4. The advantages of Microstrip antennas have made them a perfect candidate for use in the wireless local area network (WLAN) applications. Though bound by certain disadvantages, Microstrip antennas can be tailored so they can be used in the new high-speed WLAN systems. This project concentrates on manufacture enhancement of bandwidth of Microstrip antennas for the 2.4 GHz ISM band. Finally, simulation is done using software HFSSv13. HFSS is employed to analyze the proposed antenna and simulated results on return loss, input impedance, 3D radiation pattern and VSWR plot is presented.

Index Terms— Bandwidth Enhancement, Circular polarization, Microstrip antenna, VSWR, Return Loss, 3D gain, HFSSv13.

1 INTRODUCTION

Now the world is coming closer with 3G Network & entering into the Networks of 4th Generation. Behind this there is big hand of Wireless Communication Systems (WCS) and there is a very large demand by the end user for integrated wireless digital application because of its mobility. Wireless technology is one of the main areas of research in the world of communication systems today and a study of communication systems is incomplete without an understanding of the operation of antennas. [4]. Antennas which are used in these applications should be low profile, light weight, low volume and broad range of frequency to meet these requirements, microstrip antenna is preferred. Microstrip antennas have several advantages compared to conventional microwave antennas and therefore many applications cover the broad frequency range from 100 MHz to 100 GHz. The patch can take any shape but rectangular and circular configurations are the most commonly used configuration. Microstrip patch is one of the most widely used radiators for generating circular polarization. Circular polarization of microstrip antenna depends upon various patch shapes such as square, circular, pentagonal, equilateral triangular, ring.

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In recent days, there has been strong demand to increase research and application interests in wirelessMultimedia systems.But improvements are still required to provide higher data-rate links, for instance, the transmission of video signals. Therefore, ultra-wideband (UWB) communication systems are currently under investigation and the design of a compact wideband antenna is very essential. Demand on the wireless personal area network is increasing, such as high-speed internet access, video streaming, and fixed broadband wireless access system are rapidly growing up V- and W-band millimeter-wave (MMW) applications. In the MMW band, an on-chip antenna is very attractive due to the system integration. A simple structure like dipole or monopole antenna has been achieved on the Si-based substrate in the previous literatures. An active integrated antenna (AIA) is an adaptive option for the MMW design since the chip size of the antenna decrease with frequency. So far, a few AIAs have very compact area.

To overcome the inherently narrow bandwidth of microstrip antennas, various techniques have been developed to cover the entire UWB bandwidth, such as L-/F-shaped probe to feed the patch[11], modified circular patch[14], U-/V-slot monopoles[5][4],tapered slot[2], Electrically thick substrate using thick foam or air substrate, the bandwidth can be achieved up to 15% .But for thicker substrates, it is difficult to design antenna arrays in the curved surfaces (of aircraft, space craft, missiles and so on). In the papers [1][2][4], Authors have been proposed various impedance matching and feeding techniques such as quarter wave transformer, hybrid coupler for array configuration to improve the bandwidth.

The section I give introduction and related work. The section II gives antenna design and geometry

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2 Antenna Design And Geometry

The material with dielectric constant 4.4(FR4 Epoxy) is used as backplane conductor to form Microstrip antenna. The thickness of the substrate is 1.6 mm. However, the same configuration when realized with other low loss substrate gives better performance. The antenna is probe fed which is the most widely used feeding method in Microstrip antenna. The patch is resonating at 2.4 GHz.

We presented first singly fed circularly polarized rectangular Microstrip antennas with various configurations. To begin with, a nearly rectangular patch is designed followed by modified patch in the form of four slots around the centre of patch along the axis. The patch length (L=28mm) and width (W=38mm) determines the orthogonal resonant frequencies for the fundamental TM10 mode, the L should be slightly less than $\lambda/2$, where λ is the wavelength in the dielectric medium.[9]

The fundamental TM10 mode implies that the field varies one $\lambda/2$ cycle along the length, and no variation along the width of the patch. A nearly rectangular MSA operating at TM10 mode can be visualized as a transmission line, because the field is uniform along the width and varies sinusoidal along the edge length. [8,9]

1.1 Simple Rectangular Microstrip Antenna

A Rectangular Microstrip Antenna, as shown in Figure 1, is designed with length (Lg) = 40mm and width (W) = 50mm of ground plane. The patch and ground plane is separated by the dielectric substrate with thickness (h) = 1.6mm. The patch is fed at point (-1,-8) which is near to diagonal of the patch. Return loss -19.44 dB is obtained at 2.4606 GHz frequency. The antenna can be made compact which gives gain of 6.458 db and bandwidth 71.4 MHz.

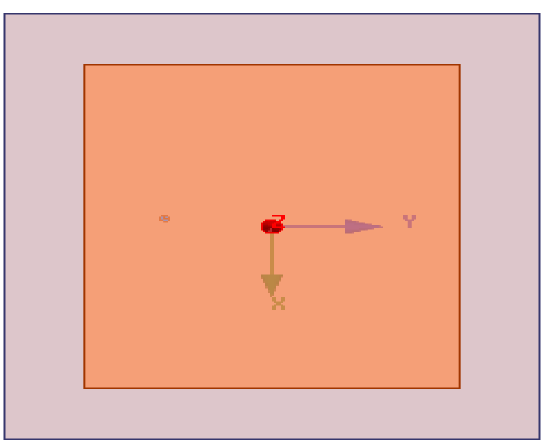

Fig 1 Simple Rectangular Microstrip Antenna

2.1 Microstrip Antenna With Modified Ground Plane

Microstrip antenna as shown in figure 2, is designed by modifying the ground plane (Lg=40mm and Wg=40mm) this modification in patch gives gain of 6.450 dB with the bandwidth 83.5 MHz.

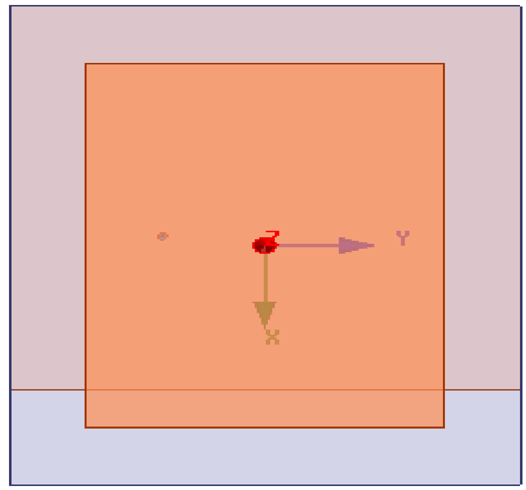

Fig 2 Microstrip Antenna with Modified Ground Plane

3 Simulation And Result

The High Frequency Structure Simulator (Ansoft HFSS) software used to model and simulate the microstrip patch antenna and it also used for calculating and plotting Return Loss, VSWR, Radiation Pattern. The HFSS is based on the Finite Element Method (FEM)

3.1 Simple Rectangular Microstrip Antenna

As shown in fig 1 design a Simple Rectangular Microstrip Antenna we decide the substrate material and thickness of it. Design an antenna for the IEEE 802.11b/g, in the band of 2.4 - 2.48GHz.

A. Retuen Loss And Antenna Bandwidth

As shown in fig 3 the best result of return loss can be found for the value below -10dB. The Return Loss is observed -19.44 dB at resonant frequency 2.4606GHz and bandwidth observed is 71.4MHz.

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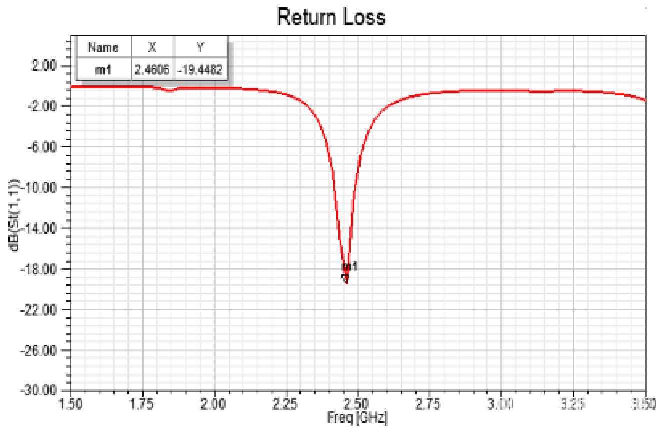

Fig 3 Return Loss versus Frequency Plot

B. VSWR And Input Impedance

Fig 4 shows VSWR versus frequency plot, the VSWR is obtained 1.85 at frequency 2.4606 GHz.

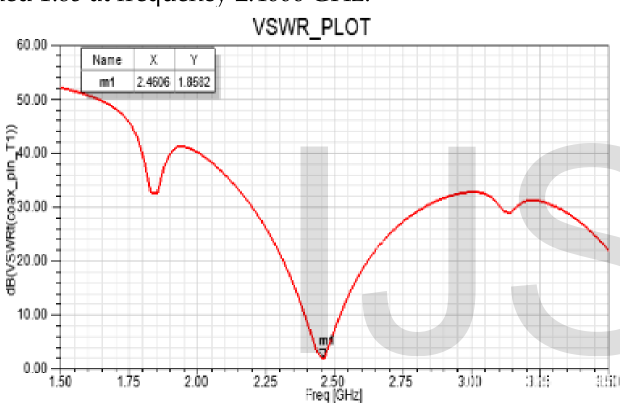

Fig 4 VSWR versus Frequency Plot

Fig 5 shows input impedance plot, observed as 44.22ohm at 2.4606 GHz.

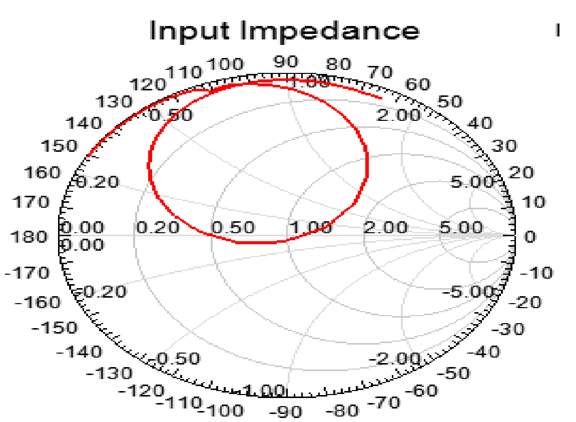

Fig 5 Input Impedance Plot

C. 3D Radiation Pattern Plot

Fig 5 shows that 3D Radiation Pattern which is nothing but gain 6.4587dB at 2.4606 GHz.

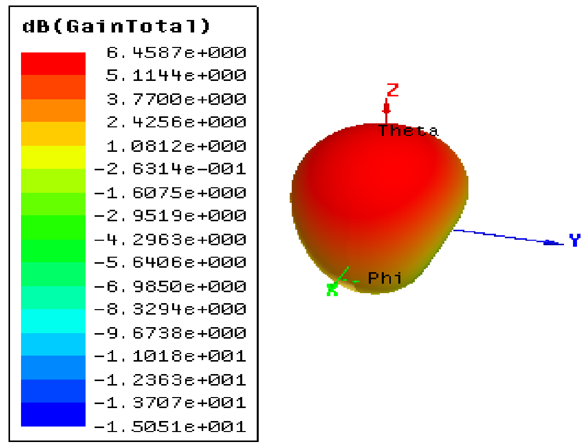

Fig 6 3D Radiation Pattern plot

3.2 Microstrip Antenna With Modified Ground Plane

Fig 2 shows the design a Partial ground plane (Lg=Wg=40mm) of Rectangular Microstrip Antenna is simulated in HFSS.

A. Retuen Loss And Antenna Bandwidth

As shown in fig 7 the best result of return loss can be found for the value below -10dB. The Return Loss is observed -27.41dB at resonant frequency 2.4364GHz and bandwidth observed is 83.9MHz.

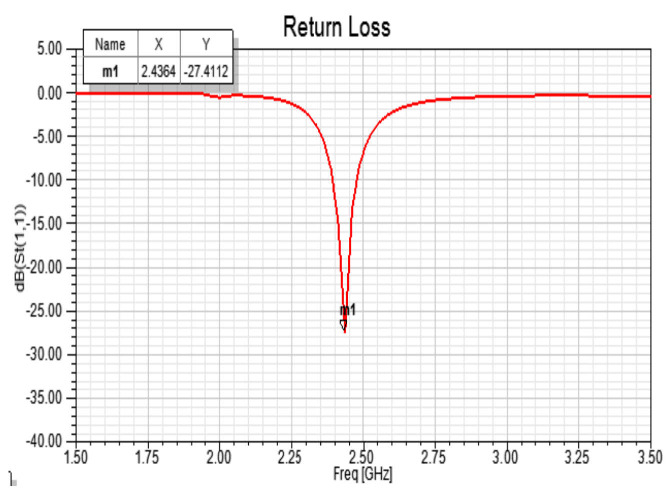

Fig 7 Return Loss versus Frequency Plot

B. VSWR And Input Impedance

As shown in fig 8. VSWR is obtained 0.7407 at frequency 2.4364GHz.

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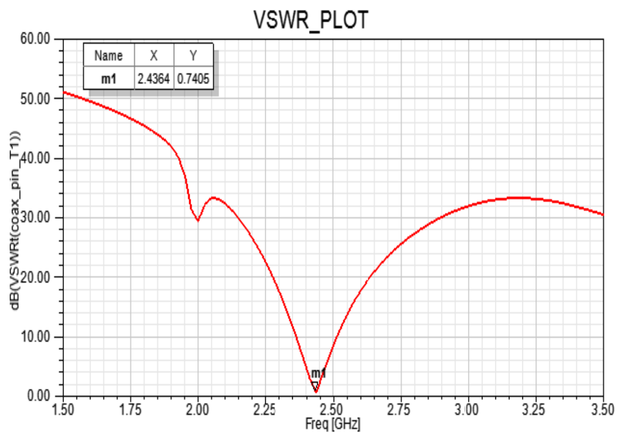

Fig 8 VSWR versus Frequency Plot

Fig 9 shows input impedance plot, observed as 49.11ohm at 2.4364 GHz.

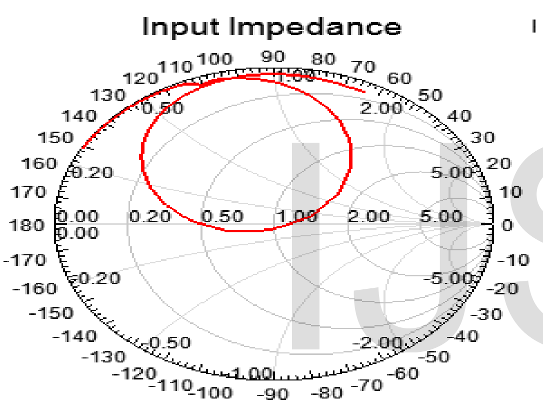

Fig 9 Input Impedance Plot

C. 3D Radiation Pattern Plot

Fig 10 shows that 3D Radiation Pattern which is nothing but gain 6.4587dB at 2.4364GHz.

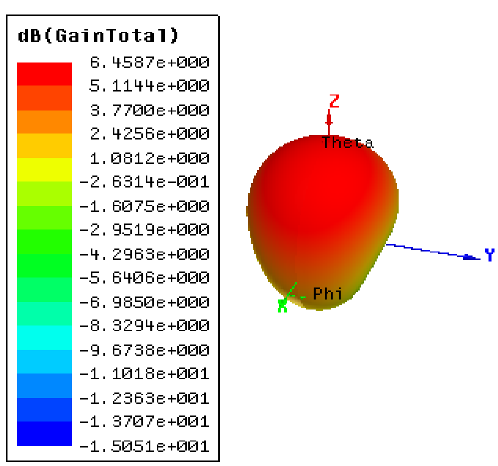

Fig 10 3D Radiation Pattern plot

Table 1 Enlist the various parameters for Microstrip antenna with modifying the ground plane

Lg mm	Wg mm	f_r GHz	BW MHz	Gain dB	Input Imped
40	50	2.4606	71.4	6.458	44.22
40	40	2.4364	83.5	6.450	49.11
40	45	2.4364	80	6.058	53.46
30	45	2.4364	63	6.758	53.90

Table 1 shows the performance of simple rectangular microstrip antenna and the microstrip antenna with the modified ground plane is compared.

Table 2 Comparison of VSWR, Return Loss, Gain, Bandwidth of two design Microstrip Antenna

	VSWR	BW MHz	Gain dB	Return Loss dB
Simple RMSA (Lg=40mm, Wg=50mm)	1.8583	71.4	6.458	-19.44
MSA with modified ground plane (Lg=40mm, Wg=40mm)	0.7405	83.5	6.458	-27.41

Table 2 shows bandwidth of modified ground plane (Lg=Wg=40mm) of microstrip antenna is enhanced which is 83.5 MHz with the slightly reduction in gain. It is almost negligible. The impedance of modified ground plane microstrip antenna is well matched to the input port.

4 Conclusion

A singly-fed wideband MSA has been successfully simulated. The proposed antenna is circularly polarized and operates in ISM band of frequency 2.4 to 2.48 GHz. The impedance bandwidth with an input VSWR of 2:1 is obtained. By loading the ground plane enhanced the BW.

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ISSN 2229-5518

ACKNOWLEDGEMENT

The authors would like to thank Prof. Mrs. S. A. Shirsat, Sinhgad College of Engineering, Pune, and Dr. R. S. Kawitkar, Sinhgad college of engineering, Pune and Dr. Shankar B. Deosarkar, Principal, VPCOE, Baramati for his encouragement and valuable guidance for this current research topic and for making software required and laboratory available.

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