ISSN: 2278 – 909X
International Journal of Advanced Research in Electronics and Communication Engineering (IJARECE)
Volume 6, Issue 12, December 2017

Design of a novel tri-band microstrip patch antenna for radar applications

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Abstract

A redesign of compact microstrip feed triple band patch antenna for radar and satellite application is suggested. The basic antenna structure consist of rectangular patch with different radios of circular edges of one side and square shape partial ground place at other side of substrate. The feed line is exact center of patch antenna to provide batter radiation pattern and impedance bandwidth. The antenna operated frequency 8821-9532 MHz, 11321-12282 MHz, 12872-13391MHz and respective resonates at 9152 MHz, 11813 MHz and 13102 MHz.

Key Words: Microstrip, triple band antenna, radar and satellite application, patch antenna .

1. INTRODUCTION

Microstrip patch antennas are the latest or one of the most innovative antenna design topics with numerous applications in microwave systems. Recent revolution in printed circuit technology has provided an edge for this class of low cost, smaller size and low profile antennas. In high-performance Application like spacecraft, aircraft, missile and satellite where weight, size, performance, cost, aerodynamic profile and ease of installation are constraints and low profile antennas may be required. Innovation of this class of antennas, different shapes, structures and feeding methods have been studied to improve their radiation characteristics. In this study, a microstrip patch antenna configuration is proposed to enhance the antenna bandwidth and multiple bandwidths without producing additional surface waves in the structure. This configuration also allowed the antenna to operate in multiple bands, as required radar and satellite communication.

2. ANTENNA DESIGN AND CONFIGURATION

The proposed multi band microstrip patch antenna structure with its design is shown in Fig. 1 and its final modified design parameter values are presented in Table 1. The designed antenna is printed on an FR4 substrate with a thickness of 1.6 mm, permittivity of 4.4 and loss tangent of 0.018. The antenna structure consists of a rectangular ground plane other side of substrate. A microstrip feed-line and a radiating patch which itself consist of four etched circle arranged in square manner and microstrip feed-line is placed in center of the patch. The source is connected to center of feed-line for signal transmission, as can be observed in Fig.1.

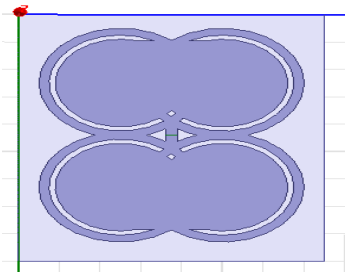

Fig. 1- multi band microstrip patch antenna structure.

No	Element	Parameters	Dimension in mm
1	Ground	L	18
		W	15
2	Substrate	L	18
		W	15
		H	1.6
3	Patch	L	15.5
		W	12.5
4	Feed line	L	0.9
		W	0.6

Table 1- final modified design parameter values

In the proposed antenna structure in order to design a tripel band antenna, instead of using conventional rectangular or circular shaped patches a combination of four square manner arranged etched circles with a microstrip centered feed-line. Using this structure leads to surface current paths which results a particular three resonance frequency. The initial radius of circles are chosen corresponding to the radar and satellite application frequency (lg/4 at center frequency band 9152 MHz, 11813 MHz and 13102 MHz) where lg is guided wavelength. To give more clear view about the design step of proposed antenna, various structure used in simulation are shown in Fig. 2.

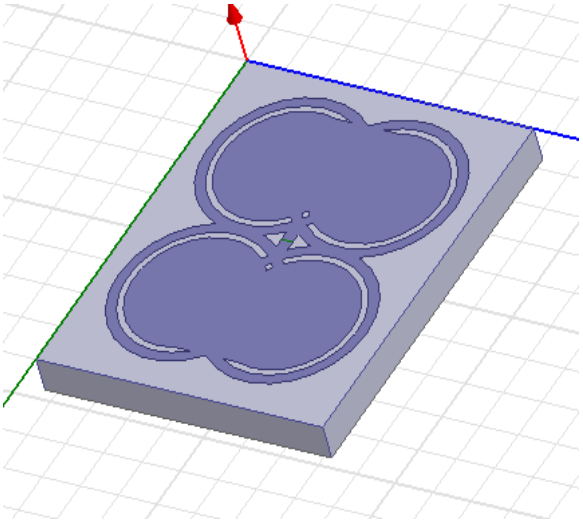

Fig. 2- 3D structure of patch antenna(top side).

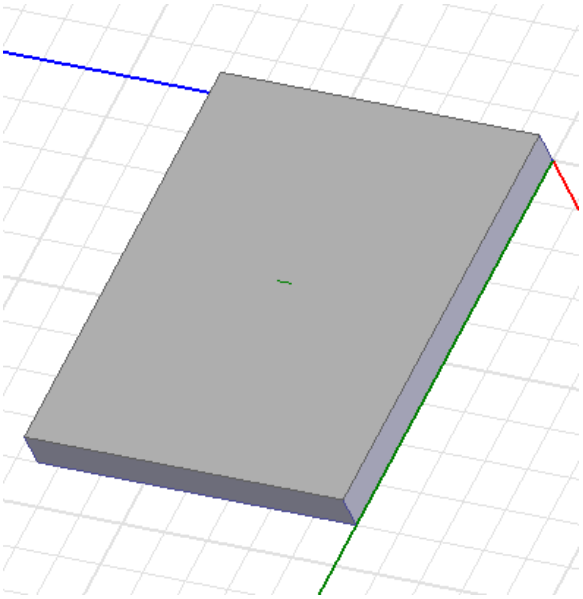

Fig. 2- 3D structure of patch antenna(bottom side).

3 SIMULATIONS AND RESULTS

In proposed triple band microstrip patch antenna design, radiation patterns were simulated using Ansoft HFSS software. Among all the patch antenna design simulation and antenna combination analyzed, only one design was suitable for the radar and satellite. the simulated Directivity for the above design model are given as follows.

A. Return Loss

The patch design model graph plot of reflection coefficient (dB) vs frequency (GHz) for the depicted model is given as follows. From the Fig., it is designed that the proposed antenna resonates under frequency 9152 MHz, 11813 MHz and 13102 MHzwith -24.5db, -25.45db and -23.7db return loss.

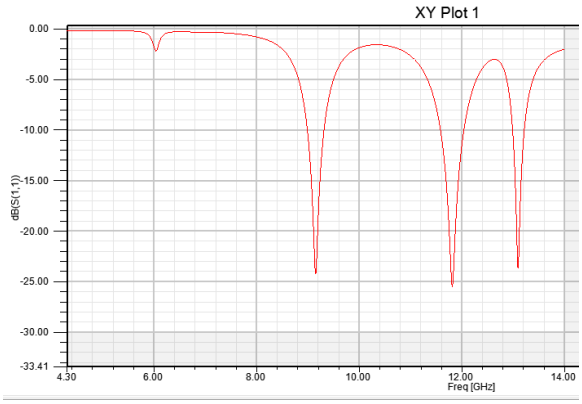

Fig. 3- S Parameter of patch model.

B. Gain

The proposed antenna 3D polar plot for total gain calculation is given Fig.4a and Fig.4b. The gain is defined as the total power radiated in a particular direction for the transmitting antenna and is the total power received by the receiving antenna from a particular direction. At resonant frequency the total gain is given in Fig. 4a. By the simulated 3D polar plot the maximum value is -2.44 dB at resonant frequency.

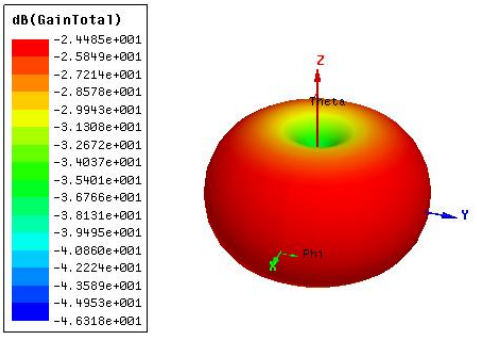

Fig. 4a- Antenna gain pattern

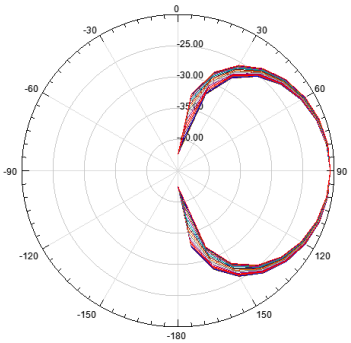

Fig. 4b- Antenna radiation pattern

4. CONCLUSION

The rapid development of wireless communication systems is bringing about a wave of new wireless devices and systems to meet the demands of multimedia applications. In particular, the bandwidths for impedance, polarization or axial ratio, radiation patterns and gain are becoming the most important factors that affect the application of antennas in contemporary and future wireless communication systems. In this paper, a compact triple band microstrip patch antenna for radar and satellite application is reported. By using high frequency structural simulator (HFSS) software antenna has been designed and simulated. The multiband antenna is very thin and compact with the low dielectric constant substrate material. There feature are useful in low weight spacecraft for high speed communication and due to small in size worldwide portability of wireless communication system.

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