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ANALYSIS OF TRIANGULAR SLOT MICROSTRIP PATCH ANTENNA FOR MULTIBAND APPLICATIONS

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Abstract – *A triangular slot is introduced at the upper edge of the patch to reduce the resonant frequency a small piece of triangular patch is grown within the triangular slot to improve the gain bandwidth performance of the patch and ground plane. Patch antennas have narrow bandwidth and the improvement of bandwidth is essential for most applications. The antenna parameters like Return loss, VSWR, Radiation pattern are verified and stimulated on CST Microwave Studio.*

Key Words: Directivity, Gain, Return loss, Bandwidth

1. INTRODUCTION

Two microstrip patch antennas (MPAs) are presented, one is conventional MPA and another is metamaterial based MPA which is made by introducing three dual isosceles triangular slots on the copper patch of the conventional MPA. Metamaterial properties of the designed and proposed isosceles triangular slotted structure are investigated and proved as metamaterial by using Nicolson Ross Weir (NRW) approach. The proposed slotted structure exhibits double negative (DNG) property of metamaterial and the proposed metamaterial antenna shows improved bandwidth, greater directivity, lower return loss, comparatively more suitable VSWR than the conventional MPA.[1]. Microstrip patch antennas have made a great progress in the recent years. Compared with the conventional antennas, microstrip patch antennas have more advantages and better prospects. A microstrip patch design of a probe- fed antenna is presented for simultaneously Wireless Local Area Network (WLAN).The growth of wireless systems and booming demand for a variety of new wireless applications such as WLAN (Wireless Local Area Network), it is important to design broadband and high gain antennas to cover a wide frequency range. The design of an efficient wide band small size antenna, for recent wireless applications, is a major challenge. In applications like high performance aircraft, satellite, missile, mobile radio and wireless communications small size, low-cost fabrication, low profile, conformability and ease of installation and integration with feed networks are the main constraints. Also, with advancement of the technology, the requirement of an antenna to resonate at more than one frequency i.e. multi-banding is also increasing day by day[2]. A rectangular microstrip antenna is conceived for a UWB system communication application, which is operating at a frequency of 4.1 GHz. The microstrip UWB antennas is one of the most commonly used antennas in radar applications. It has attracted a lot of attention because of their advantages such as ease of fabrication simple structure, easy integration with microwave integrated circuits. Geometric shape of a microstrip antenna comprises a radiating element on the dielectric substrate and on the other side a ground plane. There are several category of the microstrip patch antenna, can be cited some example the circular, a square radiating element, triangular, semicircular..., but the most common is rectangular element[3]. A lot of UWB antenna has been proposed since past years, but not many of them are compact in size. The FR4 is used as substrate material and the width of the substrate is 1.63 mm. The patch width is kept 0.035 mm. The width of the feed line is different over the whole feed line. On the backside of the antenna, the partial grounding technique is applied to triangular slots within the ground plane. The partial ground plane has an impact behind providing wide bandwidth. The triangular shaped microstrip patch antenna is designed and simulated under CST Microwave Studio environment. Partial ground is used for the antenna for grounding purpose. The triangular shaped slots are used to enhance the bandwidth for the antenna[4]. In general an antenna is a part of transmitting or receiving system that can transmit or receive electromagnetic waves. There are different kinds of antenna that used in several applications. Some of them are: wire antenna, aperture antenna, printed antenna, array antenna, reflector antenna, and lens antenna. Among these antennas printed antenna is fabricated using photolithography technique. Most common version of the printed antenna is microstrip antenna. It is constructed using conventional microstrip fabrication technique. Microstrip antenna consist of a radiating patch on one side of a dielectric substrate and has a ground plane on the other side. There are three types in microstrip antenna.Microstrip

slot/travelling antenna and Printed dipole antenna. Among the above three types microstrip patch antenna can have any shape. Microstrip slot/travelling antenna is mostly rectangular or circular shape. Printed dipole antenna have triangular and rectangular shape. The most important thing in antenna design is to select the appropriate substrate material[5]. The conducting strip is smaller in width as compared to the patch. This kind of feed arrangement has the advantage that the feed can be etched on the same substrate to provide a planar structure. An inset cut can be incorporated into the patch in order to obtain good impedance matching without the need for any additional matching element[6].Triangular patch antenna provide radiation characteristics which is similar to rectangular patches with smaller size. The antenna size can be further reduced by loading it with a short and/or slot. The simplest triangular shape considered to be equilateral triangle with grounded dielectric substrate[7].

2. METHODOLOGIES

a)Microstrip patch antenna with triangular slot

The aim of this work is to design and analysis the performance of a metamaterial (MTM) based microstrip patch antenna (MPA) by introducing three dual isosceles triangular slots on the metallic patch. At First, a conventional microstrip patch antenna is designed using Isola FR-408 (loss free) substrate material having dielectric constant of 3.75. Then the slotted microstrip patch antenna has been designed and verified as left handed metamaterial (LHM) with the help of Nicolson Ross Weir (NRW) method. All the simulations have been accomplished by CST microwave studio 2011. The bandwidth of the proposed MTM antenna is enhanced by 464.93% compared to our designed conventional MPA (77 MHz for conventional MPA and 435 MHz for metamaterial MPA) and the return loss is reduced from -11.89 dB to -55.34 dB and directivity is increased from 6.713 dB to 7.187 dB. The voltage standing wave ratio (VSWR) of the proposed metamaterial antenna is of 1.0034 which is very close to unity.

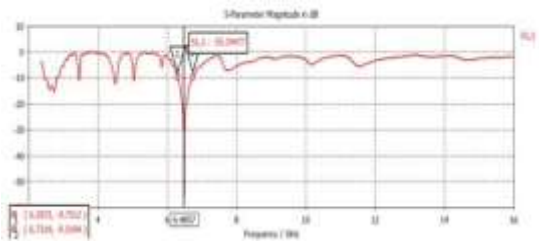

Fig-1: Return loss characteristics.

From the above figure 1 it shows that, the conventional microstrip patch antenna possesses return loss of -11.89 dB.

b)Microstrip patch antenna with rectangular slot

In this paper, the performance of a rectangular microstrip patch antenna fed by microstrip line has been designed to operate for multiband applications. It consists of a rectangular patch with four L-slots at the corners and one rectangular- slot in the center. The antenna has designed using FR-4 lossy substrate material with relative permittivity I:r is 4.3 and thickness of 1.6mm. Simulation has realized by using CST microwave studio software and the results shows that the antenna resonates at the frequencies of 2.4GHz, 3.8GHz, 4.9GHz, 6.5GHz, 7.2GHz and 8.1GHz.

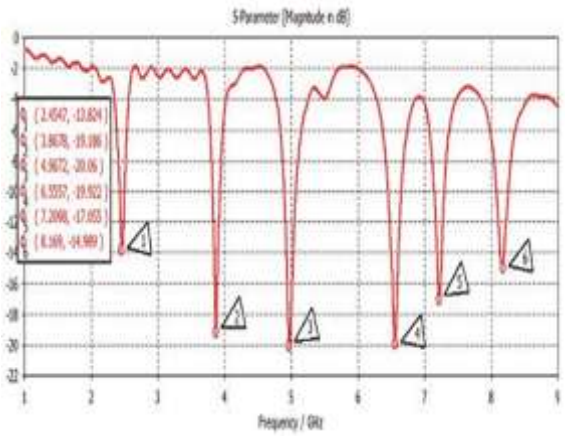

Fig-2: Return loss charactersticss

From the above Figure 2 it shows that at 2.4GHz, 3.8GHz, 4.9GHz ,6.5GHz, 7.2GHz and 8.1GHz freuencies has return loss of 13.8dB,19.1dB,20dB,19.9dB,17dB,14.9dB.

c)Rectangular Microstrip Patch Antenna

In this paper at 2.4835 GHz same RMPA is designed with different types of feed line. By designing antenna with 3 types of feeding some remarkable changes in reflection coefficient, resonant frequency, gain, VSWR, directivity is observed. RMPA is a narrow band Antenna with low profile. The comparison of all the parameters is done. This antenna most widely used in Wi-Fi applications for transmitting and receiving signals. Hence this paper describes the design of RMPA Wi-Fi antenna.

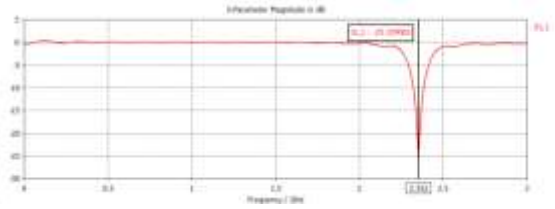

Fig-3: Return loss for RMPA

The return loss for RMPA is shown in figure 3 and its value is -25.3390 dB.

d) Triangular shaped Microstrip Patch Antenna

This paper is aimed to present a very small sized patch antenna for UWB applications. The antenna used here is microstrip feed-line. It is a very small sized patch antenna for UWB applications.. This antenna is very small in dimension. The total size of the antenna is 20×18mm^2. Triangular slots in the partial ground plane, are used to get a better bandwidth. The antenna has VSWR<2 over the bandwidth. The whole designing and simulation process of the antenna is done by CST Microwave Studio software.

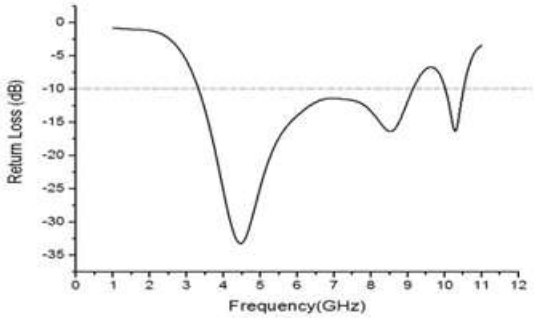

Fig-4: Return loss of the proposed antenna.

Figure 4 shows the return loss of the proposed UWB antenna, the mentioned operating bandwidth remained under -10dB of the return loss curve. The return loss is resonant at 4.46 GHz.

e)Microstrip Patch Antenna with shape of Triangle and Circle

In this paper, proposed rectangular microstrip patch antenna loaded with metamaterial structure is used for bandwidth improvement at dual band operation. The proposed antenna is designed at a height 3.2 from the ground plane by using CST MICROWAVE STUDIO. The bandwidth of Microstrip patch antenna is 12 MHz and return loss is -10.36 dB at dual band. The bandwidth of desired antenna is increased up 22.8MHz at 1.824 GHz. and up 56.2 MHz at 2.85 GHz. The return loss of proposed antenna is reduced up to -36.922 dB at 1.824 GHz and up to-29dB at 2.85 GHz. This proposed design has small size, easy to fabricate and better directivity.

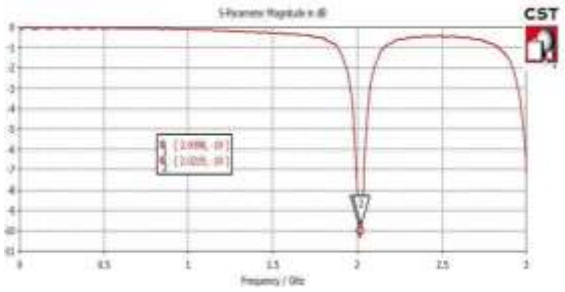

Fig-5: Return loss and bandwidth of RMPA

The above figure 5 shows that Bandwidth and Return loss of Rectangular microstrip patch antenna (RMPA) are 12 MHz and -10.36 dB respectively.

f)Various feeding techniques of Microstrip antenna

In the context of microstrip patch antennas which can be fed by a variety of methods. These methods can be classified into two categories- contacting and non-contacting. In the contacting method, the RF power is fed directly to the radiating patch using a connecting element such as a microstrip line. In the non-contacting scheme, electromagnetic field coupling is done to transfer power between the microstrip line and the radiating patch. Here we study the four most popular feed techniques used are the microstrip line, coaxial probe (both contacting schemes), aperture coupling and proximity coupling (both non-contacting schemes).

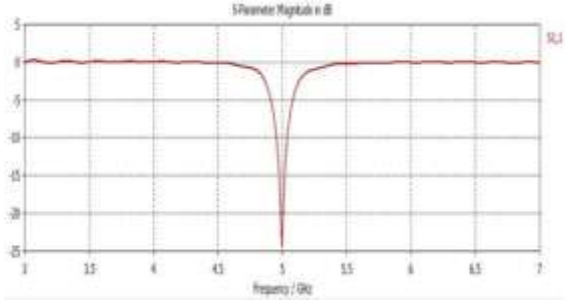

Fig-6: Return loss characteristics

Figure 6 shows the return loss curve which has frequency 5GHz simulated at -25dB.

g) Microstrip Triangular Patch Antenna

In this paper, the microstrip patch antennas are used in various applications for the high performance in the wireless communication system. The simple method is designed and analysis of triangular shape microstrip antenna by varying FR-4 substrate with CST (Computer Simulation Technology) to obtain various results. We have taken the rectangular substrate FR-4 of dimension 7×7 mm. The antenna operates between 5 GHz to 25GHz range. The design of an antenna is described and simulated results for the main parameters like return loss, directivity, and radiation patterns are discussed. These antennas are useful for the applications like UMTS, ISM.

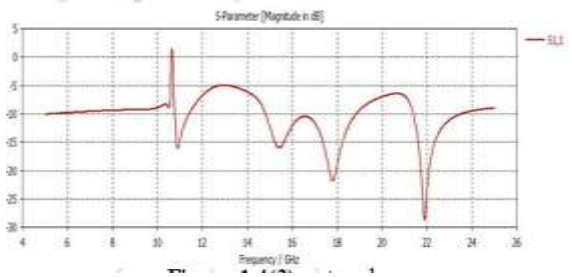

Fig-7: Return loss characteristics for triangular patch antenna

From the above Figure 7 represents the return loss at four different frequencies i.e. (10.8, 15.4, 17.8, 21.8 GHz) which are used as ultra wide band for different applications.

Fig-8: VSWR for triangular patch antenna

Figure 8 shows the VSWR curve which has frequency 10 GHz to 24 GHz simulated at frequency 10.72 GHz which shows the good impedance matching between the antenna and transmission line.

3. RESULT AND DISCUSSION

In this paper, the different antennas structures such as microstrip patch antenna with triangular slot, microstrip patch antenna with rectangular slot, rectangular microstrip patch antenna, triangular shaped microstrip patch antenna, microstrip triangular patch antennas designs were analyzed. From the above observation it is inferred that microstrip patch antennas provide less return loss.

4. CONCLUSION

In this survey paper, various antennas designs were analyzed. From the observation it was found microstrip patch antenna produced lower return loss of -35dB.

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