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Bandwidth Enhancement in Microstrip Patch Antenna Using Slotted Triangular Patch

KEYWORDS: Triangular MPA, Slotted MPA, Bandwidth, Return Loss, Coaxial probe feed.

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ABSTRACT The narrow bandwidth of microstrip antenna is one of the important features that restrict its wide usage. This paper presents techniques for improvement in bandwidth. The maximum bandwidth can be achieved by controlling the distance between the two patch antennas and by adjusting the length of the transmission feed line 50 Ohm. In this paper a new geometry of Slotted Triangular MPA (Microstrip Patch Antenna) is designed to improve Bandwidth at the range of 2.5 GHz to 5 GHz which can be used for Wireless LAN applications.

I. INTRODUCTION

Antenna is heart of Wireless Communication. Now a day's wireless communications have progressed very rapidly in recent years and mobile devices become smaller. To meet the requirement of the mobile we should change the dimension of the antenna accordingly. The narrow bandwidth of the antenna restricts its wide usage.

Microstrip antenna consists of very thin metallic strip which is known as Patch which is placed above ground plane by fabrication. Patch is work on the principle to create flat radiating structure on the top of a ground plane [5]. The main advantages of such type of structure are resulting in low manufacturing cost and high reliability. There is too much improvement in properties of dielectric material in design technique make popularity of Microstrip Patch Antenna. Many shapes of patches are possible according to the application of the antenna. But generally Rectangular, Square, Triangular type shape of patch are used.

Rectangular Microstrip Patch Antenna have several advantage like low cost, thin profile, light weight, easy to fabricate, conformable to mounting surface and being integrated in active devices [2]. Coaxial probe fed microstrip antennas making good isolation between the feeding network and the radiating elements and due to this we will getting good front to back ratios. Due to these advantages the Microstrip Patch Antenna is used in many applications. The Microstrip antenna is used in several applications like space technology, aircrafts, missiles, tracking, mobile communication, GPS systems, remote sensing and satellite Broadcast.

The Rectangular Microstrip Patch Antenna suffers from narrow bandwidth, low efficiency, low gain, and low power handling capabilities. The narrow bandwidth is the most drawbacks of such type antennas. The easiest way to increase the bandwidth is increasing the substrate thickness [3]. But by increasing the substrate thickness the antenna size is increases and the surface wave power is increases and radiating power is decreases and result in poor radiation efficiency.

Triangular Microstrip Patch Antennas are providing similar radiation characteristics as the Rectangular patches and with a smaller size. The major disadvantages of Triangular MPA are narrow bandwidth typically 1-5% [4]. This problem can be solved by making slot in different shapes in triangular MPA. The bandwidth is improved 2 times compared to conventional Rectangular MPA when we make U-slot in the Triangular MPA [2].

II. SLOT ANTENNA CONCEPT

The conventional Triangular MPA is taken as reference antenna shown in Figure 1.In this Triangular antenna we have not make any slot so there is no any air gap. Here the height of patch h= 25mm and base=25mm. The height of the substrate is 1.50 mm. A coaxial probe is used to connect the microstrip patch conventional and the Slotted Triangular MPA.

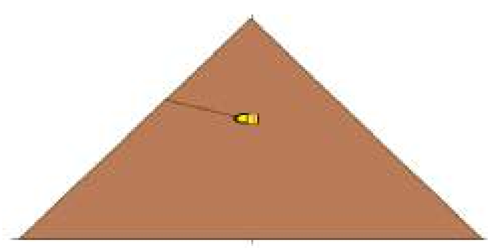

Fig. 1 Triangular Microstrip Patch Antenna

The bandwidth can be increased by embedding slot in Triangular Microstrip Patch antenna. The geometry of embedding slot is shown in Figure 2. The wider bandwidth can be obtained by such type of slotted structure in Triangular Microstrip Patch antenna [1].

By embedding a pair of properly-bent narrow slots in an equilateral-triangular microstrip patch, broadband operation of' microstrip antennas with an inset microstrip-line feed can be achieved. Some simple design rules for the proposed antenna have also been determined experimentally. The design rules and experimental results are presented and discussed.

III. ANTENNA DESIGN CONFIGURATION

The patch antenna is constructed on two layers with the same dielectric substrate. On the first layer, the patch antenna is realized on FR 4 substrate and the microstrip feed line is realized on the second layer.

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DESIGN EQUATIONS

1. Width of Patch (W)

The width of the Triangular Microstrip Patch antenna is given by

$$W = \frac{1}{2 f_r \sqrt{\mu_0 \varepsilon_0}} \sqrt{\frac{2}{\varepsilon_r + 1}} \qquad (1)$$

where fr = resonant frequency

2. Effective Dielectric Constant of the Substrate (εr):

$$\varepsilon_{reff} = \frac{\varepsilon_r + 1}{2} + \frac{\varepsilon_r - 1}{2}\left[1 + 12\frac{h}{W}\right]^{\frac{1}{2}} \qquad (2)$$

Where, h = height of substrate
εr = dielectric constant of substrate

3. Extension in Length :

$$\frac{\Delta L}{h} = 0.412 \frac{(\varepsilon_{reff} + 0.3)(\frac{W}{h} + 0.264)}{(\varepsilon_{reff} - 0.258)(\frac{W}{h} + 0.8)} \qquad (3)$$

4. Length of Patch (L) :

$$L = \frac{1}{2 f_r \sqrt{\varepsilon_{reff}} \sqrt{\mu_0 \varepsilon_0}} - 2\Delta L \qquad (4)$$

5. Effective Length of Patch :

$$L_e = L + 2\,\Delta L \qquad (5)$$

IV.SOFTWARE SIMULATION

Simulation of antenna can be done by number of simulator. High Frequency Structure Simulator (HFSS) Integral Equation 3-Dimension (IE3D), and Computer Simulation Technology (CST) are well known simulator for antenna simulation. HFSS is a high-performance full-wave electromagnetic (EM) field simulator for arbitrary 3D volumetric passive device modeling. By using HFSS you can solve the 3D EM problems quickly and accurately. HFSS is used to calculate S parameter, Resonant Frequency, Directivity, gain etc.

V.SIMULATION RESULT

1. Return Loss and Bandwidth: We get return loss of -24.266224 dB at 4.9 resonant frequency using triangular patch in Micro strip patch antenna, which is shown in Figure 3. We get improvement in bandwidth by 3.099% as compared to reference paper [1] which is of 2.69%. We are going to improve the bandwidth in obtained result by using slotted Triangular Patch in Microstrip Patch Antenna.

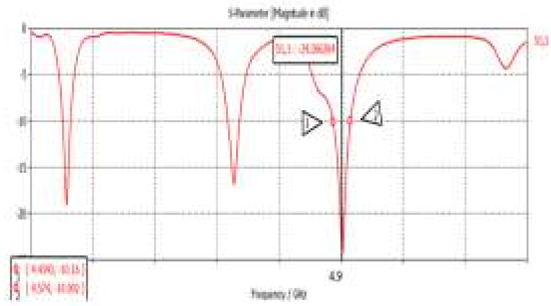

Fig. 3 Return Loss and Bandwidth

2. VSWR: We get Voltage Standing Wave Ratio of 1.1303585 at 4.9 resonant frequency which is shown in Figure 4. Hence we can say that the antenna will radiate power effectively.

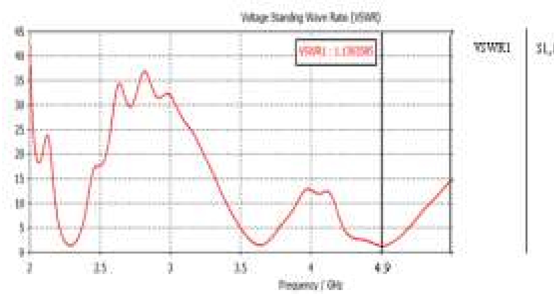

Fig. 4 VSWR Measurement

VI.CONCLUSION

A configuration to increase the bandwidth of triangular is experimentally studied. By using triangular slot, we get improved bandwidth in MPA. The radiation pattern of the antenna will remain stable over the entire bandwidth. Due to method of making slot in Triangular Microstrip Patch antenna we will see small improvement in gain. The impedance and return loss will also achieved by making such type of configuration. It can be used for Wireless LAN applications. Such type of antenna configuration is used in C band Bandwidth performance of the antenna is also depends on various antenna parameters such as substrate thickness and substrate permittivity so we have to examine the bandwidth in terms of substrate permittivity and substrate thickness. It is concluded that for higher value of permittivity the percentage bandwidth significantly decreases with increasing thickness.

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