International Journal of Engineering Research and Applications (IJERA) ISSN: 2248-9622
International Conference on Industrial Automation and Computing (ICIAC-12-13th April 2014

RESEARCH ARTICLE OPEN ACCESS

Bandwidth Enhanced Triangular Microstrip Antenna for Wireless Application

Parmita Patil[1],
Electronics and communication Department, Jhulelal Institute of Technology, Nagpur, Maharashtra, India
parmitapatil@gmail.com

ABSTRACT
In this paper two different microstrip antenna's are proposed .The first antenna is designed by using a foam substrate of thickness 14.3mm and permittivity εr =1.07 , the second antenna is designed by placing a U shaped slot in the previously designed antenna. Both the proposed antenna are simulated by using CADFEKO software. Various parameters related to antenna such as input impedance, vswr, return loss, bandwidth are measured for both the antenna separately and compared. The results show that by embedding a U shaped slot the bandwidth is enhanced.

***Keywords* -** Triangular microstrip antenna (TMP), Slotted Microstrip Antenna, Radiation Pattern, Returns Loss Equilateral Microstrip Antenna (ETMP).

I. Introduction

Patch antenna possesses many advantages such as low profile, light weight, small volume and capability withMicrowave integrated circuit (MIC) and monolithicMicrowave integrated circuit (MMIC). However, the narrow bandwidth is the major obstacle in wide applications for the microstrip antenna. In general, the impedance bandwidth of the traditional microstrip antenna is only a few percent (2% for the 5%)[1]. Therefore, it becomes very important to develop broadband technique to increase the bandwidth of the microstrip antenna. In principal, wide bandwidth of microstrip patch antennas (MPAs) or bandwidth enhancement can be achieved by several efficient approaches , namely (i) increasing the substrate thickness (ii) optimizing impedance matching (iii) reducing the substrate effective permittivity or (iv) incorporating multiple resonance.

At the same time, MPAs need to be extremely small and compact to satisfy the severe size constraints of some critical applications such as mobile cellular handsets, cardless phones and blue tooth devices. The miniaturization of normal MPA size has typically been accomplished by loading, which can take various forms, such as (i)using a high permittivity substrates, (ii) Using shorting posts or shorting pins, or (iii) modifying the basic patch shape micros trip antenna. Although rectangular and circular geometries are most commonly used other geometries having greater size reduction find wide applications in modern communication systems, where the prime concern is compactness. The triangular patch antenna configuration is chosen because it has the advantage of occupying less metalized area on substrate than other existing configurations.

1.1 Feed Methods

There are various feed methods which are categorised as 1) Contacting and 2) Non contacting .The contacting methods include coaxial or probe feed and inset feed, whereas the non contacting include proximity feed and aperture coupled feed. The coaxial or probe feed is very common method for feeding microstrip patch antennas. The inner conductor of coaxial cable is connected to the radiating patch and the outer conductor is connected to the ground plane. This feed is also easy to match, and it has low spurious radiation.

In this paper, coaxial feed techniques are applied to the triangular microstrip patch antenna. Because, coaxial feed is a widely used one.

However, it has a narrow bandwidth and is difficult to model, especially for very thick substrates. The advantage of this feed is that it occupies less space than the other feeds.

1.2Mathematical Analysis

Following the cavity model analysis by Helszajn [2], a simple and more general expression for theresonant frequencies of TMnml modes of an equilateral triangular microstrip patch antenna with and without air gaps can be given as:

$$f_{r,nm}=2c/3r_{eff\sqrt{\varepsilon r,eff}}(n^2{}_+ nm+m) \qquad (1)$$

where *c* is the velocity of light in free space, *reff* is the effective side length of the ETMP in presence of a dielectric superstrate and ∑*r,eff* is the effective relative permittivity of the medium below the patch.One or more dielectric layers above a microstrip patch cause the change in the fringing fields between the patch and the ground plane and that effect is accounted for by the effective relative permittivity∑*r,eff* .

The general formulations obtained for a circular patch which can be extended to calculate$\sum r,eff$ for a triangular patch sandwiched between two dielectric layers using the formulation:

$$a=3r/2\prod \quad (2)$$

$$r_{eff}=2\prod/3*a_{eff} \quad (3)$$

Equation (2) is derived from an equivalence relation between a circular patch (radius = *a*) and a triangular patch with side length *r*. Equal circumference was considered as the basis of equivalence to account for equal static fringing fields.

II. Antenna Design

Two different TMP antenna are designed, the first is a triangular microstrip antenna with substrate thickness h=14.3mm for the resonant frequency of 1.9 GHZ the length of patch is a=91mm obtained from the resonant frequency formula based on cavity model with a Foam substrate having permittivity εr =1.07 the radius of feed is 0.5mm. The second antenna is designed by embedding a U shaped slot inside the patch antenna..

Both the antenna are designed by using a foam substrate.Foam is a special type of composite material made from various synthetic materials with many microscopic air filled pockets although their density and permittivity is particularly low. Foam materials exhibit mechanical rigidity, structural stability and the excitation of surface waves is to be avoided but foam is not well defined, making it impractical to deposit metal directly on it.Fig 1shows the geometry and feeding arrangement of triangular microstrip antenna with coaxial feed.

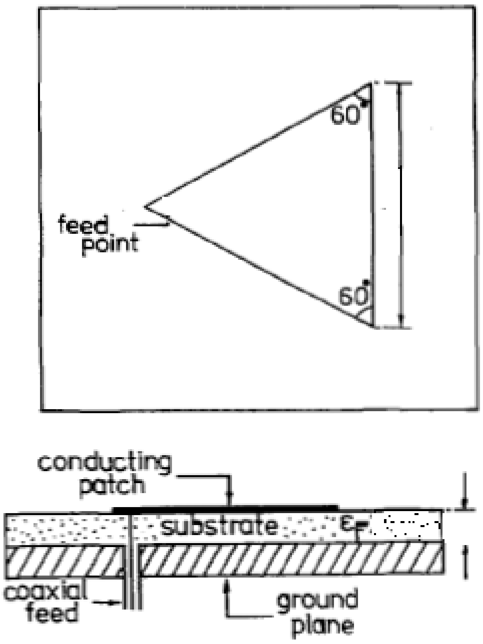

Fig.1: Geometry and feeding arrangement of triangular microstrip antenna with coaxial feed

For both the antennas the feeding method used is coaxial feed.

Both the proposed antenna are simulated by using CADFEKO software. Various parameters related to antenna such as input impedance, vswr, return loss, bandwidth are measured.fig 2 shows the return loss vs frequency plot of first antenna.fig3 shows the measured VSWR vs. frequency plot for the first antenna.

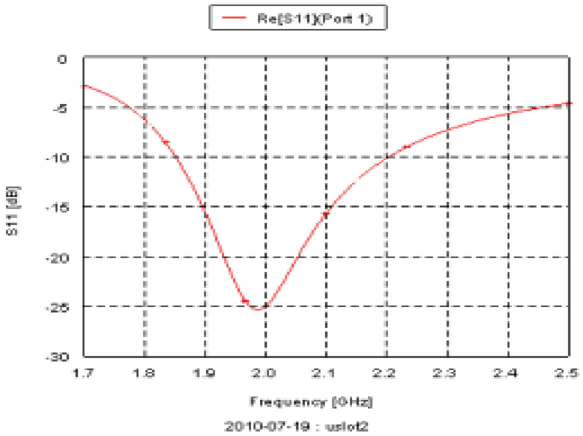

Fig 2: Return loss vs. frequency plot for first antenna having a=91mm εr=1.07 feed_rad=0.5mm h=14.3mm

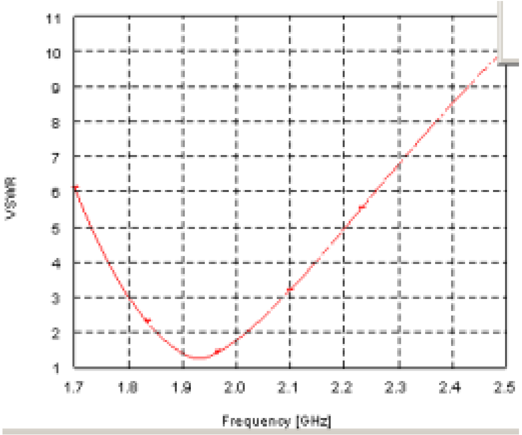

Fig:3 vswr vs. frequency for first antenna

III. Triangular Microstrip Antenna With U Shaped Slot

Bandwidth enhancement by cutting a U-shaped slot in rectangular patch or circular patch antennas has recently been demonstrated[3]. By introducing a proper size of the U-shaped slot in the patch, two adjacent resonant modes with similar radiation characteristics near the fundamental resonant frequency of the simple patch antenna without the slot can be excited, which significantly enhances the operating bandwidth of the patch antenna. Also, due to the introduced slot in the patch, the large inductive reactance component of the input impedance for a probe feed associated with a thick substrate is found to be reduced, making the impedance matching more easy to obtain. In this paper, we demonstrate that such a design is also applicable for a triangular patch antenna, which has similar radiation properties, with the advantage of being physically smaller than a rectangular patch antenna. Fig. 1 shows the geometry of a triangular microstrip antenna with a U-shaped slot; the latter consists of a pair of parallel slots of dimension l1*w1, and a horizontal slot of dimension of l2*w2, connecting the two parallel slots. This U-shaped slot can be oriented with its horizontal slot facing the triangle tip or the bottom side of the triangular patch.In the present study the former arrangement is studied. The case of an equilateral triangular patch antenna is first investigated. Fig.4 The slotted triangular patch is mounted on a foam substrate of thickness 14.3) and the feed position is selected to be close to the null-voltage point for the TM10 mode (the fundamental mode) of the patch.

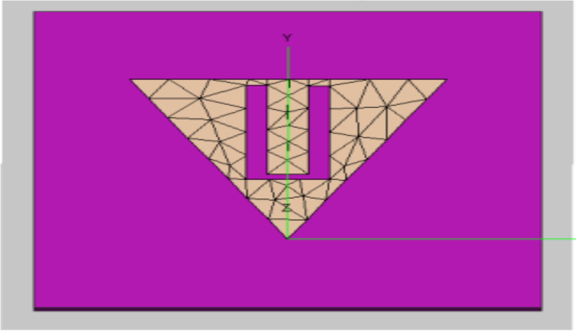

Fig 4:- Antenna design by using CADFEKO

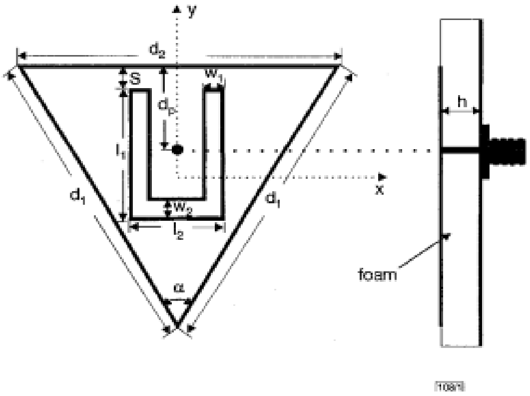

Fig 5:geometry of coaxial feed triangular microstrip antenna with Ushaped slot with foam substrate

It is also observed that, although all the dimensions ***(l1,w1,l2 w2,)*** of the U slot affect the broadband performance, the higher resonant mode is most sensitive to a variation in the length of the horizontal slot, while the lower resonant mode strongly depends on the perimeter of the U-shapedslot.

3.1 Determination of U Shaped Slot Dimensions

1) length of sides of patch d1,d2=91mm
2) Substrate thicknessh = 14.3mm
3), S = 3.2mm, d1, = d2 = 91mm,
dp, = 26.2mm w1=6mm,w2=2.5mm
l1=46.2mm,l2=24mm

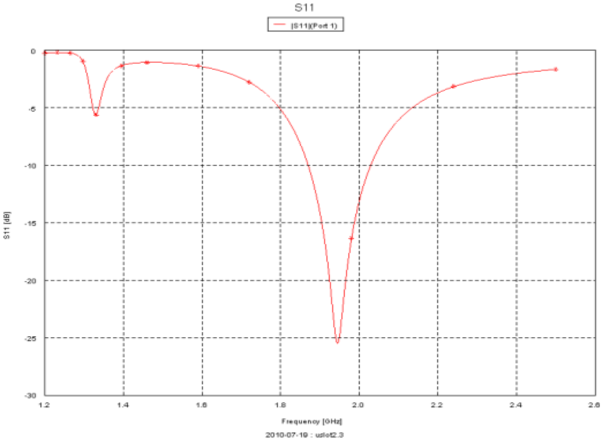

Fig 6. Fig 2: Return loss vs. frequency plot for antenna with U shaped slot .

IV. Conclusion

In this paper both the antennas that are designed simulated and measurement of various parameters is shown for the first antenna with foam substrate return loss of -25db is obtained with bandwidth increased up to 17% in comparision to conventional microstrip antenna and vswr 1.25 with impedance matching of 46.57,then by embedding a U shaped slot two resonant modes are obtained the variation of higher resonant modes depend on the length of slots whereas the lower resonant mode depends on the perimeter of the U shaped slot. Due to the two resonant modes the bandwidth is further enhanced.

References

[1] H.R. Hassani, D. Mirshekar Syahkal, “Analysis of triangular patch antennas including radome effects”IEE Proceedings H, vol. 139, no. 3, pp.251-256, June 1992.

[2] D. Guha and J.Y. Siddiqui, “Resonant frequency of circular micro strip antenna covered with dielectric superstrate,”IEEE Trans. Antennas Propagat., vol. 51, no.7, pp.1649-1652, July 2003.

[3] Kin-Lu Wong and Wen-Hsiu Hsu,“Broadband triangular micro strip antenna with U-shaped slot", *Electronic Letters 4th December 1997 Vol. 33 No. 25*

[4] Bahl and P. Bhartia, *Micro strips Antennas:* Dedham, MA: Artech House, 1980.

[5] C. A. Balanies, *Antenna Theory: Analysis & Design*, John Willey & Sons, Inc., 1997.

[6] Kumar, G. and Ray, K. P., *Broadband Micro strip Antennas*, Artech House, Inc., 2003