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# Design of Suspended E-Shaped Capacitively Fed Microstrip Patch Antenna

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## ABSTRACT

*Micro strip antennas have been the subject of some inventive work in recent years, and are currently one of the most dynamic fields in antenna theory. Suspended E shaped microstrip antenna with a capacitive coupling feed is designed in order to be employed for high speed WLANs & Wireless communication applications. Employing only a single patch, a high impedance bandwidth is achieved. The simulated percentage bandwidth is about 23.1% from (2.26 GHz to 2.83GHz) for VSWR<2, which is four times greater than conventional rectangular patch antenna. Satisfactory radiation patterns have also been obtained through simulation. The structure of the antenna consists of a perfect conductor on the top of a substrate (Modify-epoxy) with a dielectric constant of about 4.4 and a height of 11 mm, which is backed with a perfect conductor ground plane. The impacts of different parameter of antenna are also studied. Simulations are carried out in HFSS Software.*

## I. INTRODUCTION

The miniaturized receiving and transmitting antenna in small size and light weight is required in many mobile telecommunication application. Microstrip antennas with low profile planar configuration,ease of fabrication and integration with RF device ,are being used for many application due to key advantage over conventional antennas[1],[2]. While installing on the stiff surface, they will have good durability. Microstrip antenna has diversity at the resonant frequency, polarization, pattern and impedance requirements.

The main disadvantages of microstrip antenna are low efficiency, low gain, low throughput, narrow bandwidth and low frequency range. However, it is desirable to use it in some low bandwidth applications. Of course, increasing the thickness of the substrate with low permittivity constant, can expand the bandwidth efficiency [3]. In particular, the U-slot, L-probe, and E-shaped patches have gained a lot of popularity [4],[6] .This is because compared to other method , they do not require a complex matching network or stack configuration.

In this paper, a broadband E-shaped MSA is proposed. The bandwidth of the antenna is broadened by inserting a pair of rectangular slits into appropriate radiating edge of the rectangular patch antenna. Results shows that a bandwidth of 4.9% is obtained.

Laterally a suspended E-shape Microstrip antenna was designed. Due to the air gap between substrate and ground plane of 11mm, bandwidth of 12.1% is obtained. Finally using capacitive coupling feed technique bandwidth has been increased to 23%.

## II. Antenna Geometry and Design

The geometry of the E-Shaped patch is shown in figure 1. The microstrip patch is fabricated on modify-epoxy substrate of dielectric constant **ε**r = 4.2 and loss tangent = 0.02.The substrate is suspended over the ground plane with an air gap of 11mm, giving a total thickness of 12.6mm.

The initial calculation starts from finding the width of the patch which is given as:

**Step 1: Calculation of the width of Patch (W)-**

The width of the Microstrip patch antenna is given as [13]

For c=3*1011 mm/s, f o=2.4GHz, ε r=4.4

We get W=38.22 mm.

**Step 2: Calculation of effective dielectric constant-**

Fringing makes the microstrip line look wider electrically compared to its physical dimensions. Since some of the waves travel in the substrate and some in air, an effective dielectric constant is introduced, given as:

For εr=4.4, h=1.6mm, W=38mm

We get εreff=3.99

**Step 3: Calculation of Length of Patch (L)-**

The effective length due to fringing is given as:

For c=3*1011 mm/s, εreff=3.99, f o=2.4GHz

We get Leff **=**30.25 mm

Due to fringing the dimension of the patch as increased by ΔL on both the sides, given by:

For W=36.4mm, h, =1.53mm, εreff=3.99

We get ΔL=0.70mm

Hence the length of the patch is:

L= Leff-2ΔL=28.4 mm

Two parallel slots are introduced into the rectangular microstrip patch antenna to increase the bandwidth as shown in figure 1.

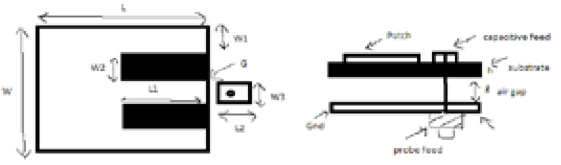


**Figure 1. Geometry of the E-shaped microstrip patch antenna**

The E-shaped microstrip patch antenna has the width of W1=6.5mm, two outer patch strips of the length of L1=5mm and the width of W1=6.5mm, one central patch strip of the the width of W2=3mm, and also, two slot are introduced symmetrically. Capacitive radiator whose length L2=6mm and width is W3=4mm is used for coupling to the patch. Employing a coaxial probe, the patch is excited by capacitive feed, and dielectric substrate materials are employed to fabricate the antenna element. The upper substrate is selected to be with high dielectric constant for compact size and an air gap of 11mm is let between the ground & substrate to optimize the wide bandwidth.

## III. PARAMETRIC ANALYSIS-

The following section deals with the effects of various parameters. By increasing L, the whole VSWR curve shifts towards lower frequencies. The change is higher in resonant frequency of higher mode, since the relative change in current path length for higher mode is greater than the lower mode current path, as

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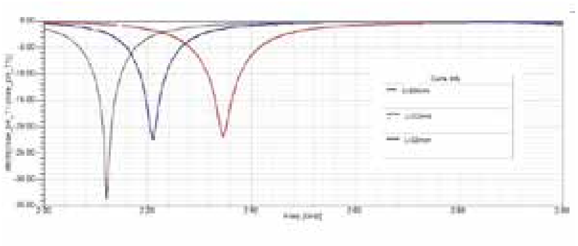
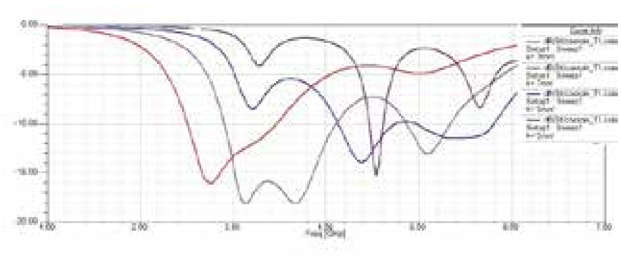
shown in Figure 2. The width W has a significant effect on the matching to the input impedance. Increasing the height of air gap it helps to improving the Bandwidth of MSA.



(a)

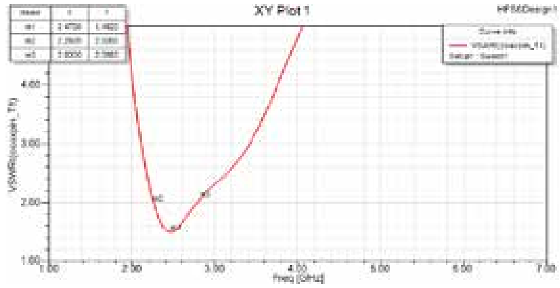


(b)

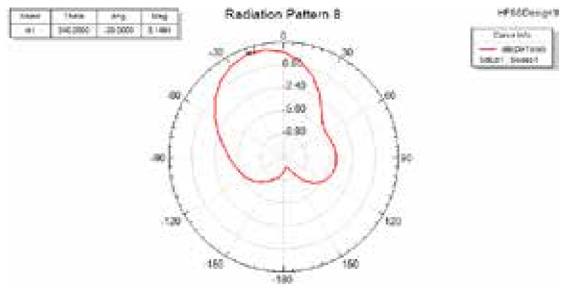
**Figure 2. Effect of (a) length (b) air gap height**

**IV. RESULTS**

The numerical simulation and optimization are performed with the commericial software Ansoft HFSS 11. By scanning the length and width of the slot , the feed point location and the distance between the two slots, the resulting antenna yield excellent return loss and radiation character. The simulated 2:1 VSWR bandwidth is 23 % covering 2.26 – 2.83 GHz frequency band, which is presented in Fig. 3.




(a)




(b)

Figure 3 (a) VSWR Bandwidth and (b) E-Radiation Pattern

**V. CONCLUSION**

Regarding the simulated results, it is concluded that the suspended E-shaped patch antenna using capacitive feed geometry provides wide bandwidth with single patch. By capacitive loading it helps to reduce size of antenna. The effect of various parameters of E-shaped patch antenna have been studied without changing the permittivity and the height of the substrates.

## REFERENCE

[1] Kaizhong Zhan ,Qinggong Quo,and Kama Huang, "A novel kind of Bluetooth and UWB antenna ," Microwave and Millimeter Wave Technology (ICMMT), 2010 International conference on, pp.1038 1041,2010. | [2] Y.T.Lo,D.Solomon and W.F Richards,"Theory and experiment on microstrip antenna,"IEEE Transaction on Antennas and Propagation ,Vol.27,no.2,pp. 137-145,1979. | [3] Ramesh Garg, Prakash Bartia, Inder Bhal and Apsiak Ittipiboon, "Microstrip Antenna DesignHand Book," Artech House, Norwood, MA, 2001. | [4] K.M.Luk,Y.X.Guo,K.F.Lee and Y.L Chow ,"L-probe proximity fed U-slot patch Antenna " Elecronic Letters,Vol.34,pp.1806-1807,sep1998[7] | [5] Yikai Chen ,Shiwen Yang, and Zaiping Nie , "Bandwidth Enhancement method for low profile E-Shaped microstrip patch Antenna" IEEE Transaction on Antenna and Propagation, vol.58,no.7,pp.2442,2447,2010. | [6] K. Wong and W. Hsu, —A broadband patch antenna with wide slits, in IEEE Antennas and PropagationInternational Symposium, vol. 3, (Salt Lake City, Utah),pp. 1414– 1417, IEEE, July 2000. | [7] Constanantine A Balanis, "Antenna Theory Analsis and Design," John Weily&Sons, New York, 1997 | [8] Fan Yang, Xui-Xia Zhang, Xioning Ye, and Yahya Rahmat-Sami, "Wideband E-shaped Patch Antenna for Wireless Communications," IEEE Transactions on Antennas and Propagation, vol. 49, no.7, July 2001. | [9] Dr Anubhuti Khare, Rajesh Nema, Puran Gour, Rajeev Kumar Thakur "New Multiband E-Shape Microstrip Patch Antenna on RT DUROID 5880 Substrate and RO4003 Substrate for Pervasive Wireless Communication"International Journal of Computer Applications (0975 – 8887), Volume 9– No.8, November 2010 | [10] D.M.Pozzar "Microstrip Antenna Coupled to Microstripline," Electron Lett., vol. 21, no.2, pp. 49-50, January 1995.