International Journal of Computer Applications® (IJCA) (0975 – 8887)
Proceedings on Emerging Trends in Electronics and Telecommunication Engineering (NCET 2013)

"Designing of wideband Microstrip patch antenna for wireless applications"

Asmita Mhamane
SVERI's,Pandharpur

Meenakshi Pawar
ENTC Department
SVERI's Pandharpur

ABSTRACT
This paper presents the design and simulation of suspended E-shape microstrip patch antenna. Thisshape will provide the wide bandwidth by introducing two parallel slots in to rectangular patch. The antenna design is simulated using HFSS software. The performance of the designed antenna was analysed in terms of bandwidth, gain, return loss, VSWR and radiation pattern (3D).Dielectric Substrate FR4 having dielectric constant of 4.4 is used.This antenna design is simulated using HFSS simulator (High Frequency Structure Simulator). The antenna is able to operate from2.405 GHz to 2.525 GHz frequency band.

Keywords
Suspended E Shape MSA, Coaxial probe feeding

1. INTRODUCTION
MPA consists of a radiating patch on one side of a dielectric substrate with a ground plane on other side.Microstrip patch antennas are widely used in wireless communications due to their various advantages of low profile, less weight, and low cost, together with ease of integration with microstrip circuits. However, the main disadvantage of microstrip antennas is the narrow bandwidth.

Different techniques have been applied to overcome this problem such as increasing the substrate thickness, introducing parasitic elements i.e. co-planar or stack configuration, or modifying the patch's shape itself.

Modifying patch's shape includes designing an E-shaped patch antennas or a U-slot patch antenna. E-shaped patch antenna by introducing two parallel slots in to rectangular patch provides wide bandwidth [1].

To improve the bandwidth suspended E shaped microstrip patch antenna is used. The air gap is introduced in between dielectric substrate and ground plane.Researchers have designed compact capacitivefed microstrip antenna suspended above theground plane wireless communication [2, 3, and 4].

The bandwidth of the antenna can be increased by introducing tapered slots in to E shape antenna [6].The E & U shape wideband antenna which is able to operate at higher frequency range from 8.80 GHz to 13.49 GHz frequency band with optimum frequency at 8.73 GHz [7].The E shaped antenna with widened slot can be used for achieving wide bandwidth [8]. Good enhancement in bandwidth and gain can be achieved with dual E shaped antenna [9].

By adding square slot in the ground plane of rectangular microstrip antenna also produce wideband characteristic [10].

2. DESIGN SPECIFICATION
The three essential parameters for the design of a rectangular microstrip Patch Antenna are:

- **Frequency of operation(*fo*)**:

The resonant frequency of the antenna must be selected appropriately. The resonant frequency selected for design is 2.4 GHz.

- **Dielectric constant of the substrate (ε *r*)**:

The dielectric material selected for design is glass epoxy which has a dielectric constant of 4.4.

- **Height of dielectric Substrate (h*)*:**

For the microstrip patch antenna to be used in cellular phones, it is essential that the antenna is not bulky. Hence, the height of the dielectric substrate is selected as 1.6 mm.

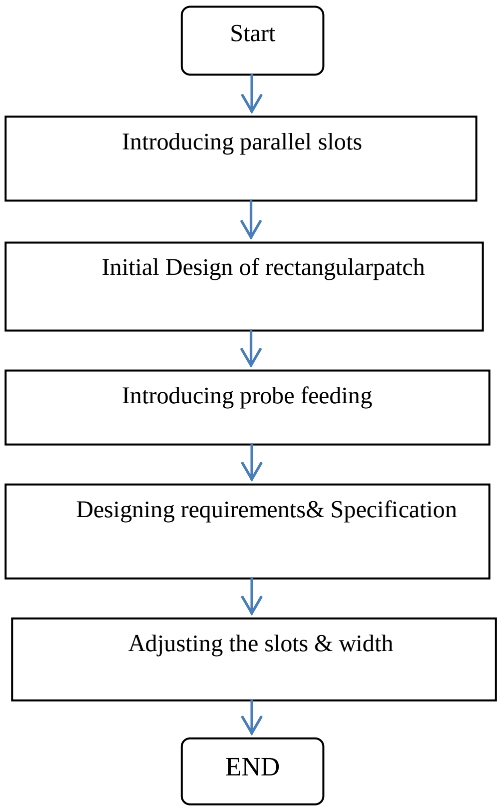

Figure 1 Flow chart of antenna designing

2.1 Antenna Configuration

2.1.1 Calculation of the width of Patch(W):

The width of the microstrip patch antenna is given as

$$W = \frac{c}{2\,fo\sqrt{\frac{\varepsilon r+1}{2}}}$$

For c=3*10^11 mm/s, *fo*=2.4GHz,ε *r*=4.4

We get W=38.22 mm.

2.1.2 Calculation of effective dielectric constant:

An effective dielectric constant is introduced, given as:

$$\varepsilon reff = \frac{\varepsilon r+1}{2} + \frac{\varepsilon r-1}{2}\left[1+12\frac{h}{W}\right]^{-1/2}$$

For ε*r*=4.4, h=1.6mm, W=38mm

We get *εreff*=3.99

2.1.3 Calculation of Length of Patch (L):

c=3*10^11 mm/s, ε*reff*=3.99, *fo*=2.4GHz

We get *Leff* **=**30.25 mm

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

$$\Delta L = 0.412h\frac{(\varepsilon reff+0.3)\left(\frac{W}{h}+0.264\right)}{(\varepsilon reff-0.258)\left(\frac{W}{h}+0.8\right)}$$

For W=38.22 mm, h, =1.6mm, ε*reff*=3.99

We get Δ*L*=0.70mm

L= Leff-2Δ*L*=28.4 mm

2.1.4 Calculation of Substrate dimension:

For this design this substrate dimension would be

Ls=L+2*6h=59mm

Ws=W+2*6h=50mm

2.1.5 Calculation of feed point:

For this feed would be given L/4 distance.i.e. 7.5mm

3. COMPARISONS OF BANDWIDTH DIFFERENT PATCH SHAPES

In suspended E shaped MPA the air gap is introducedin between ground and dielectric substrate. The Bandwidths of probe fed MSA, E shaped MSA &Suspended E shape MSA are compared.

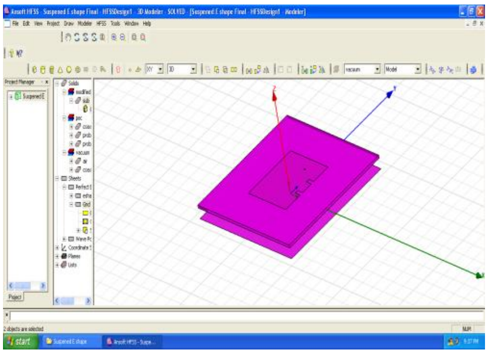

Figure 2 Suspended E shaped MPA

The bandwidth achieved with probe feed rectangular patch is 70 MHz with above antenna design parameters.

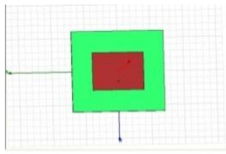

Figure 3 Probe fed MPA

The bandwidth achieved with probefeed E shaped patch is 120 MHz with above antenna design parameters.

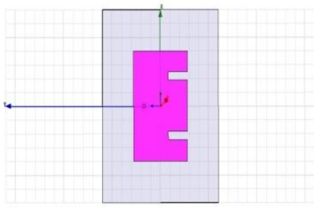

Figure 4 E shaped MPA

We have seen Suspended E shape gives more bandwidth can be seen in figure 3

4. RESULT

Results of suspended E shape MPA

4.1 Return Loss

Return loss is the power of the reflected signal in a transmission line. It is given in dB.

$$RL\text{dB} = -20\log 10\,\Gamma$$

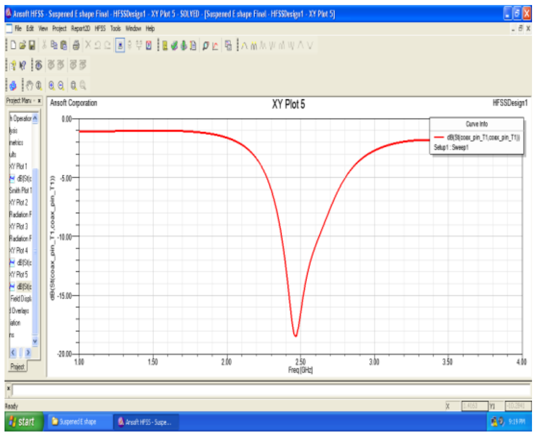

Figure 5 Return LossVs. Frequency

4.2 VSWR

VSWR is the ratio between the maximum voltage and minimum voltage in the transmission line, and can be defined as

$$VSWR = 1+\rho/1-\rho$$

Where $\rho = |\Gamma|$.

When the system is matched the reflection coefficient approaches 0, while VSWR approaches to 1.

VSWR

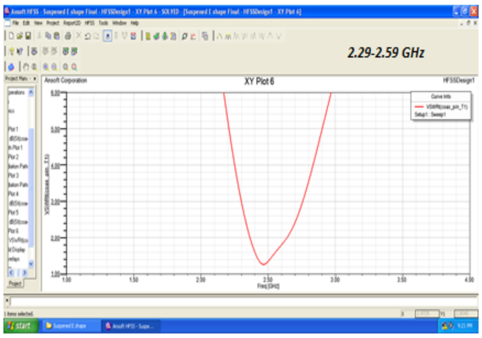

Figure 6 VSWR VS Frequency

4.3 Radiation Pattern

The Antenna Radiation Pattern is a graphical representation of the antennasradiated electrical performance. This wave of energy (electromagnetic in origin) emitted from the antenna that propagates through space is measured at a defined Angle, Amplitude, and Frequency. The measurement of this performance is commonly presented in a graphical format.

It is measured in db. The figure 7 shows the radiation pattern of antenna.

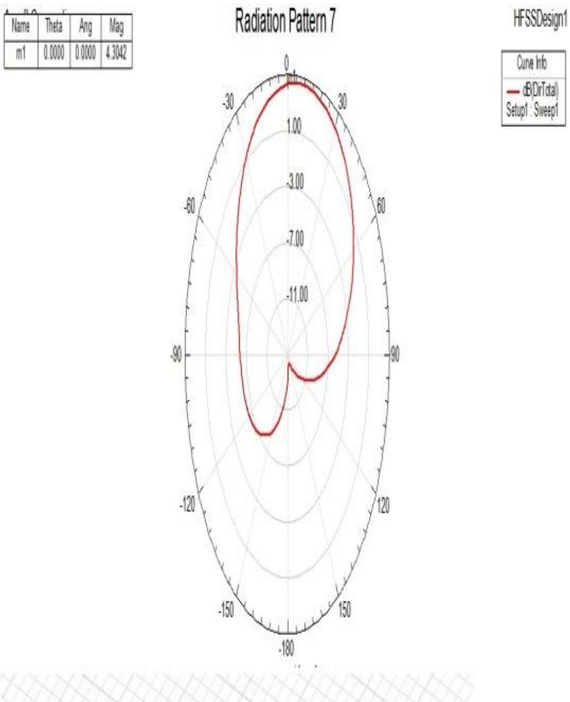

Figure 7 Radiation Pattern

5. CONCLUSION

Regarding the simulated results, it is concluded that the suspended E-shaped patch antenna using probe feed provides 300 MHz bandwidth.The effect of various parametersof E-shaped patch antenna have been studied without changing the permittivity and the height of the substrates.

6. REFERENCES

[1] Fan Yang, Xue-Xia Zhang, Xiaoning Ye, and YahyaRahmat-Samii,,"Wide-Band E-Shaped Patch antennas for wireless communication" IEEE TRANSACTIONS ON ANTENNA AND PROPOGATION VOL. 49,July 2001

[2] Parmesh S. Pawar Prof. DeeplaxmiV.Niture2013 "Design of Suspended E-Shaped Capacitively Fed Microstrip Patch" Antenna Volume : 2 | Issue : 6 | ISSN No 2277 – 8179

[3] T.Shanmuganantham, Dr. S. Raghavan, May 2010, "Suspended Microstrip Patch Antenna for Wireless Applications", International Journal of Microwave and Optical Technology

[4] Dr. Ravi M. Yadahalli, December 2012 "Compact Broadband Coplanar Capacitive Coupled Probe Fed Microstrip Antenna for wireless Applications"International Journal of Emerging Technology and Advanced Engineering

[5] Ajay Yadav, BhadrasheelaChauhan, Aanchal Jain. December 2012, "Microstrip Symmetrical E-Shape Patch Antenna for the Wireless Communication Systems International Journal of Emerging Technology and Advanced Engineering

[6] A.A. Deshmukh and G. Kumar September 2005. "Compact broadband E-shaped microstrip antennas" ELECTRONICS LETTERS 1st Vol. 41 No. 18

[7] InduBalaPauria, Sachin Kumar, Sandhya Sharma "Design and Simulation of E-Shape Microstrip Patch Antenna for Wideband Applications", July 2012. International Journal of Soft Computing and Engineering (IJSCE) ISSN: 2231-2307, Volume-2, Issue-3

[8] SabaKazemiAlishahi, , MassoudDousti"Designing, Simulating and Fabricating a Novel E-Shaped Microstrip Antenna**"** Australian Journal of Basic and Applied Sciences, 7(4): 9-13, 2013

[9] Amit Kumar Gupta, R.K. Prasad, Dr. D.K. Srivastava**,** 2012 "Design and development of dual E shaped microstrip patch antenna for bandwidth and gain enhancement", International Journal of Electronics and communication engineering and technology

[10] Xu-bao Sun, Mao-yong Cao, Jian-junHao, Yin-jingGuo,October 2011. "A rectangular slot antenna with improved bandwidth" International Journal of Electronics andCommunications.

[11] Amritesh, Kshetrimayum Milan Singh "DESIGN OF SQUARE PATCH MICROSTRIP ANTENNA FOR CIRCULAR POLARIZATION USGING IE3D SOFTWARE"

[12] MursyidulIdzamSabran, S. K. A. Rahim, M, Amuda Yusuf , Muhammad and Evizal "A Dual-Band Diamond-Shaped Antenna for RFID Application" IEEE ANTENNAS AND WIRELESS PROPAGATION LETTERS, VOL. 10, 2011