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EFFECT OF EXCITATION TECHNIQUES ON THE RADIATION PARAMETERS OF MULTIBAND MICROSTRIP PATCH ANTENNA: DESIGN AND ANALYSIS

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Abstract: This paper presents effect of excitation techniques on the radiation parameters of multiband micro strip patch antenna design. The antenna with a novel structure is designed on Epoxy FR4 substrate having dielectric constant 4.4. In this work we are considering four different feed methods such as strip line feed, coaxial feed, inset feed and edge feed and their effects on radiating characteristics are analyzed on comparing with one to each other. All the models are designed and simulated using Finite Element Method based antenna designing software And soft HFSS.

Keywords: Micro strip Patch Antenna, Stripline-Feed, Inset-feed, Edge-feed, Probe-feed**.**

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INTRODUCTION

Recently, the demand for antennas with compact size and multiband operation has increased because such antennas are important for integrating more than one communication standard in a single system to effectively improve the portability of modern wireless devices. This multi functionality provides users the options of connecting different kinds of wireless services for different purposes at different times. A number of approaches have been reported to obtain multiband microstrip antenna such as loading of rectangular, circular and triangular patches by shorting pins, crossed slot, fractal structures and the use of pin diodes, varacter diodes [1].

The excitation technique of patch antenna also affects the radiation characteristics of radiating element, hence while designing an antenna care must taken while deciding the proper feed [2].

Many theoretical studies on microstrip antenna have been published [3]-[6]. In [7] multiband PIFA is designed with slotted ground plane to improve the bandwidth at both low and high frequencies without increasing the volume of the antenna. In [8]

E shaped fractal patch antenna is presented which can cover LTE and S bands.

This paper presents effect of excitation techniques such as stripline feed, inset feed, coaxial feed and edge feed on the radiation parameters of multiband microstrip patch antenna with their simulated performance characteristics.

proposed antenna design geometry

The conventional rectangular microstrip patch antenna is designed on FR4 Epoxy substrate material having height 1.6 mm and dielectric constant 4.4. Size of the patch is decided using transmission line design equations.

The width of the microstrip patch antenna is given as:

$$W = \frac{c}{2 f_0 \sqrt{\frac{\varepsilon_r + 1}{2}}}$$

where ε_r = dielectric constant of substrate,

f_0 = frequency of operation.

The effective dielectric constant is:

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

where h=height of substrate.

The effective length is given as:

$$L_{eff} = \frac{c}{2 f_0 \sqrt{\varepsilon_{reff}}}$$

The length extension is:

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

The actual length is obtained by:

$$L = L_{eff} - 2\Delta L$$

The proposed rectangular patch has length and width 36.56 mm and 46.81 mm respectively. Four narrow slits are taken out from the patch to improve the performance of antenna as multiband functionality.

Excitation Techniques

Micro strip patch antenna's excitation techniques can be classified into two types- contacting and non-contacting. In the contacting method, RF power is fed directly to the radiating patch using a connecting element. In the non-contacting scheme, electromagnetic field coupling is done to transfer power between the micro strip line and the radiating patch [9].

In this work, proposed patch antenna geometry is designed with strip line feed, edge feed, inset feed and coaxial feed techniques. All these four techniques come under contacting type feeding scheme.

In micro strip line feeding technique, a conducting strip is connected directly to the edge of the micro strip patch. This kind of feed arrangement has the advantage that the feed can be etched on the same substrate to provide a planar structure.

In coaxial probe feeding technique, the inner conductor of the coaxial connector extends through the dielectric and is soldered to the radiating patch, while the outer conductor is connected to the ground plane.

RESULT & ANALYSIS

This section presents the simulation results of proposed microstrip patch antenna with four feeding techniques. All the models are designed and simulated using Ansoft HFSS software.

Stripline feeding

In stripline fed patch antenna the feed line is connected directly with the patch. The feed point must be located at that point on the patch, where the input impedance is 50 ohms for the resonant frequency (Fig. 1).

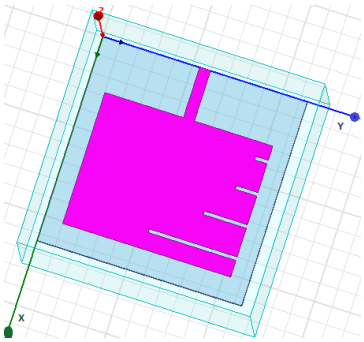

Fig.1 Strip line fed rectangular patch antenna

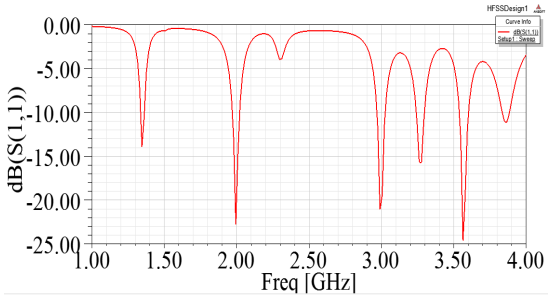

Fig.2 S parameter Vs frequency plot of strip line fed antenna

Fig.2 shows S parameter Vs frequency plot of strip line fed patch antenna. The plot indicates that strip line fed proposed antenna provides six bands of operation and all the resonant frequencies achieve the return loss less than -10dB. Maximum achieved return loss is -24.64dB.

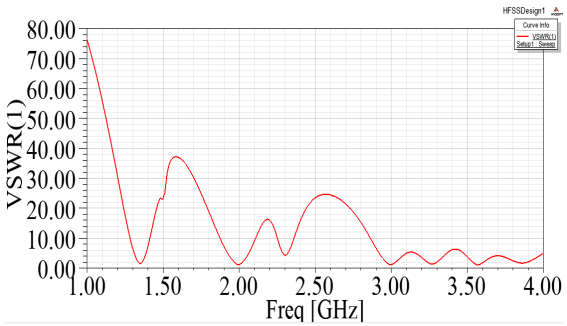

Fig.3 VSWR curve of strip line fed antenna

VSWR stands for voltage standing wave ratio. It describes the power reflected from the antenna. Plot (Fig. 3) indicates that stripline fed patch antenna gives six resonant frequencies at which VSWR parameter is between 1 and 2.

Inset feeding

In this inset fed patch antenna (Fig. 4) 12 mm long inset is cut out from the radiating edge. The purpose of this inset cut is to match the impedance of the feed line to the patch without the need of any additional matching element. This is achieved by properly controlling the inset position.

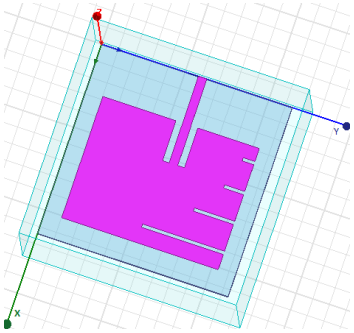

Fig.4 Inset fed rectangular patch antenna

Proposed design with inset fed scheme provides two bands of operation which have the return loss parameter less than -10dB as can be seen from Fig.5.

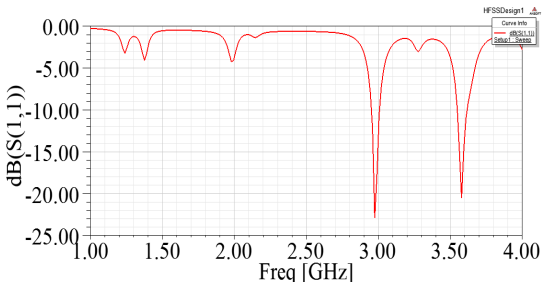

Fig.5 S parameter Vs frequency plot of inset fed antenna

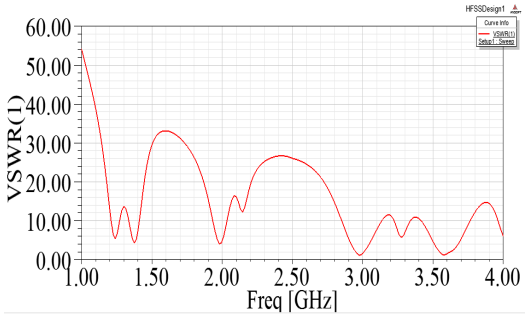

Fig.6 VSWR curve of inset fed antenna

VSWR curve (Fig.6) of inset fed patch antenna indicates that there are only two frequencies at which VSWR is between 1 and 2.

Edge feeding

In the edge fed patch antenna the feed line is connected with edge strip line and the width of this edge strip line is less than the width of the feed line as shown in Fig 7.

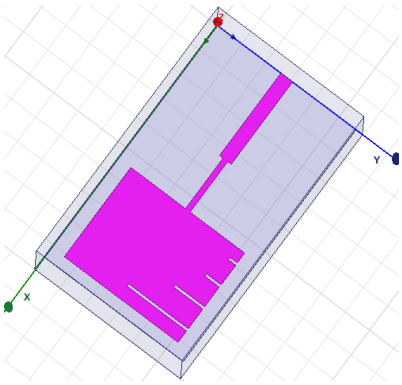

Fig.7 Edge fed rectangular patch antenna

The graph in Fig.8 shows that proposed patch antenna with edge feed technique gives five resonating frequencies and the maximum value of S parameter is -20.82dB.

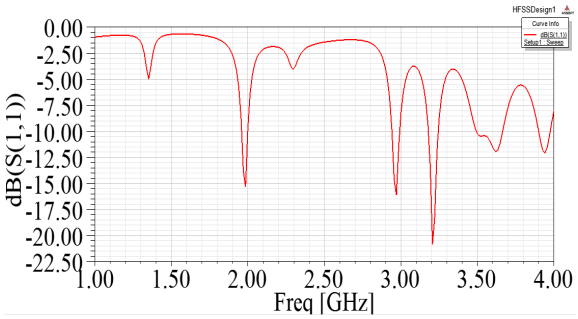

Fig.8 S parameter Vs frequency plot of edge fed antenna

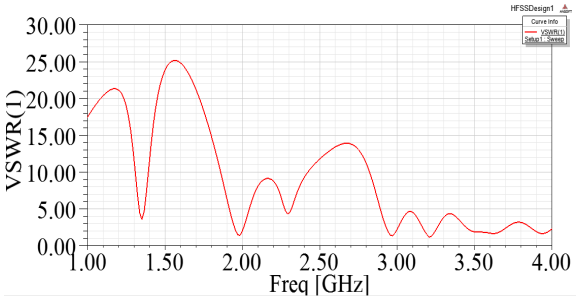

Fig.9 VSWR curve of edge fed antenna

VSWR plot (Fig.9) of edge fed patch antenna indicates five frequencies having VSWR parameter between 1 and 2.

Coaxial feeding

In coaxial probe feeding scheme, as shown in Fig 10, the feed can be placed at any desired location inside the patch in order to match with its input impedance. The antenna has been fed using 50 Ω coaxial probes to main stem.

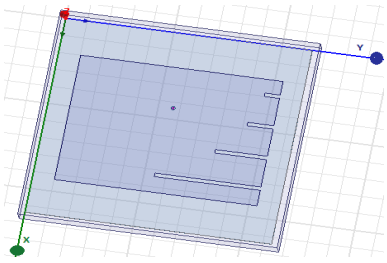

Fig.10 Coaxial probe fed rectangular patch antenna

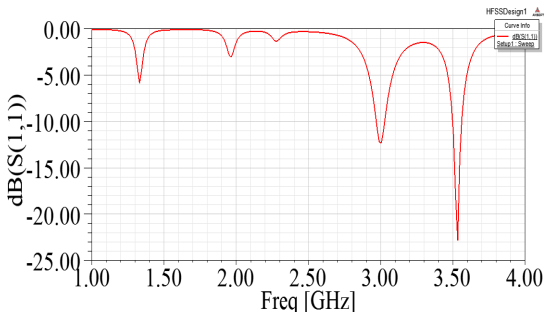

Fig.11 S parameter Vs frequency plot of probe fed antenna

The return loss plot, in Fig. 11, of probe fed antenna presents two bands of operations. Maximum achieved return loss is -23dB.

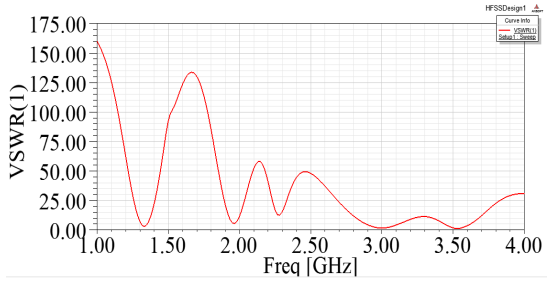

Fig.12 VSWR curve of probe fed antenna

Curve (Fig. 12) shows VSWR plot of probe fed patch antenna, which indicates two resonating frequencies which have VSWR between 1 and 2.

CONCLUSION

The comparative study of excitation techniques describes that various feeding techniques affect the performance of proposed multiband patch antenna design. After observing the results and antenna parameters, we can say that out of these four excitation techniques i.e. strip line feed, inset feed, edge feed and probe feed, the stripline fed proposed patch antenna provides efficient results. This stripline fed patch antenna operates between 1.0 to 4.0 GHz at six different frequency bands and VSWR for all these bands are between 1 and 2. This antenna is suitable for UMTS, WLAN, WiMAX and other wireless applications.

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