RESEARCH ARTICLE OPEN ACCESS

Dual Bandwidth Duo Triangular Shaped Microstrip Antenna for Multi-Band Frequencies

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ABSTRACT: *This paper presents the increase in bandwidth of a microstrip patch antenna by using a duo triangular shaped probe-feed patch. The main focus of this paper is to achieve a wideband microstrip patch antenna with the reduction in size. The dual bandwidth of 8.68% & 37.56% by covering the range from 1.845-1.894GHz and 3.228-4.228GHz has been obtained. The dimensions and position of the duo-triangular patch as well as shifting of probe-feed coordinates have been modified to obtain the wide bandwidth. The proposed patch of antenna is designed and all parameters are simulated on the Zeland IE3D software.*
Keywords: *WiMAX, wideband, probe-feed, microstrip patch antenna*

Date Of Submission: 13-01-2018 Date Of Acceptance: 03-02-2018

I. INTRODUCTION

Electromagnetic spectrum is widely used natural resource for humankind, and an antenna has been involved in exploit this resource. Hence, an antenna finds a dominant role In creating a communication link in current communication industry. In the race to become a popular, all compact and portable communication apparatus are necessary in antenna of good shape and design to let them connect to everywhere available wireless connections. Microstrip patch antennas are being studied substantially for past many years because of their low profile structure, light in weight and low cost. They are also compatible with MIMIC designs and mechanically robust when scaled on rigid surfaces. By using the PCB technique, it is very easy to install an antenna with embedded circuit board for any system. Microstrip patch antennas are well suited in satellites, missiles and aircrafts, radars, biomedical applications and reflector feeds. They are also compatible for embedded antennas in handheld wireless devices such as cellular phones and pagers etc.

Size reduction bandwidth and gain enhancement are becoming the major design challenges for microstrip patch antennas to meet the miniaturization of mobile units. Narrow bandwidth from printed microstrip patches is one of the most significant factors limiting the widespread applications. The conventional microstrip patch antenna could not fulfil this requirement. The requirement is from 5 to 5.23 GHz operating frequency; at least double the bandwidth is necessary to avoid expensive tuning and to cause noncritical manufacturing. Therefore, it is necessary to enhance the bandwidth of the microstrip patch antenna for wideband and multiband applications.

This paper presents directional dual wideband microstrip patch antenna with compact size for multi-band applications. An antenna has been designed on glass epoxy substrate to give a dual wide bandwidth of 8.68% & 37.56% by covering the range from 1.845-1.894GHz and 3.228-4.228GHz and maximum radiating efficiency of about 90%

II.

II. ANTENNA DESIGNS AND PERFORMANCE

The geometryof the duo-triangular-shaped patch antenna is shown in figure-1. It is composed of rectangle with cut corners-shaped ground plane and the dielectric substrate with relative permittivity, εr of 4.4. Here transmission line model is used as technique of study to infinite ground plane. Practically we must have finite ground plane and it can be acquire such as the size of the ground plane is bigger than the patch dimensions by approximately six times the substrate thickness. The thickness of the substrate is h=1.6mm (with operating frequency, fo= 2.72 GHz). We have used probe feed technique which is the form of original excitation methods proposed in the mid-1970. All thecoordinates of the microstrip patch antenna are shifted in the entire area to achieve wide bandwidth. In this proposed paper probe-feed to patch coordinate is (24.8, 28). Dimensions of ground plane are calculated from equations (1& 2).The patch length and patch width are obtained by equations (3-6).

$$W_g = W + 6(h) = 33.56 + 6(1.6) = 43.16 \text{ mm} \quad (1)$$

$$L_g = L + 6(h) = 25.91 + 6(1.6) = 35.51 \text{mm} \quad (2)$$

$$W = \frac{c}{2f\sqrt{(\varepsilon_r+1)/2}} \quad (3)$$

$$L = \frac{c}{2f\sqrt{\varepsilon_{eff}}} - 2\Delta l \quad (4)$$

$$\varepsilon_{eff} = \frac{(\varepsilon_r+1)}{2} + \frac{(\varepsilon_r-1)}{2}\left[1+10\frac{h}{W}\right]^{-\frac{1}{2}} \quad (5)$$

$$\Delta l = 0.412h\frac{(\varepsilon_{eff}+0.300)\left(\frac{W}{h}+0.262\right)}{(\varepsilon_{eff}-0.258)\left(\frac{W}{h}+0.813\right)} \quad (6)$$

Where
c=velocity of light
ε_r= dielectric constant of the substrate
f=antenna operating frequency
w= width of the patch
L=length substrate of the patch
h=height of substrate
Δl= Normalized extention of length of the patch

Table 1.Proposed antenna design parameters.

Parameters	Value
f	5.23 GHz
ε_r	4.4
h	1.6 mm
W_g	27.04 mm
L_g	22.71 mm
L	13.11 mm
W	17.44mm
L_1	10mm
W_1	3 mm

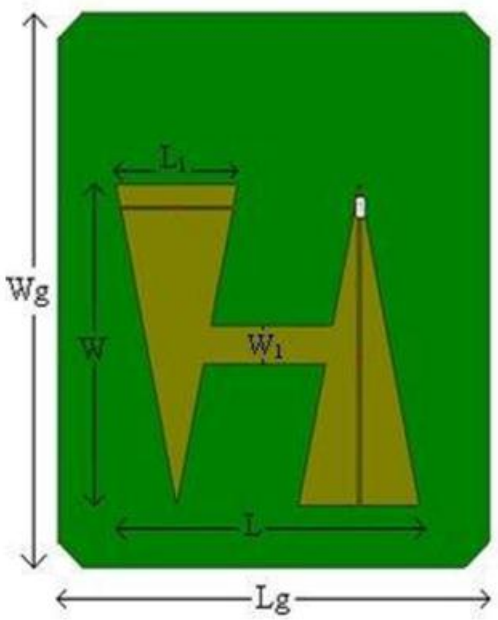

Fig.1 geometry of proposed microstrip antenna

III. RESULT AND DISCUSSION

Figure 2 shows the return loss plot of proposed microstrip antenna. The proposed antenna has been designed on glass epoxy substrate to achieve dual wide bandwidth of 7.68% and 36.56% covering the range from 1.845-1.894 GHz and 3.228-4.228 GHz. It is suitable for WiMAX lower band application. Figure 3 shows the smith chart & Figure 4 shows the 3D radiation pattern which is obtained from IE3D.The proposed microstrip antenna have better gain and good radiation efficiency of about 90%. Fig 7 shows elevation pattern plot which is unidirectional. The component E theta at phi = 90 is shown giving a power gain of 1.87616 dB and Average gain of0.101136 dB at 5.23 GHz. The component E phi at phi = 90 is shown giving a power gain of 2.94098 dB and Average gain of 6.37881dB at 5.23 GHz.

Table 2.Results of Proposed antenna design

Parameters	Obtained Results
Band Width	8.68 % and 37.56 %
Frequency Range	1.845-1.894 GHz and 3.228-4.228 GHz
Maximum Directivity at 4.75 GHz	7 dBi
Maximum Antenna Efficiency	90 %

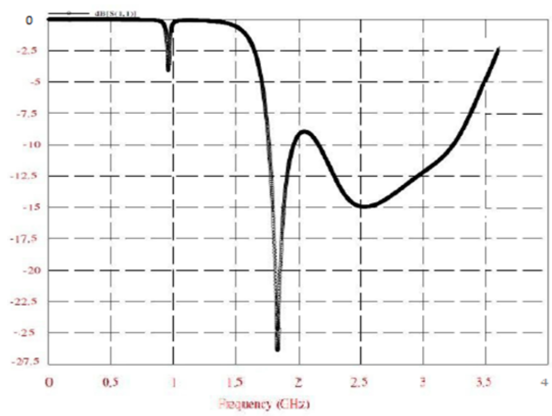

Fig. 2 Return loss Vs frequency of proposed microstrip patch antenna

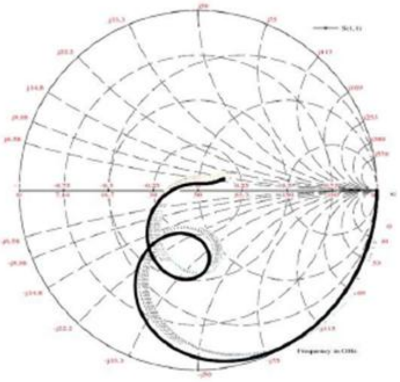

Fig. 3. Smith chart plot of proposed microstrip antenna

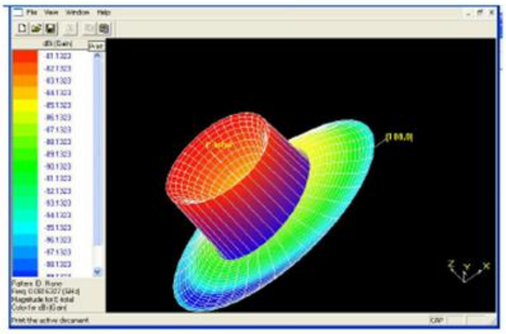

Fig. 4. 3D radiation pattern of proposed microstrip antenna

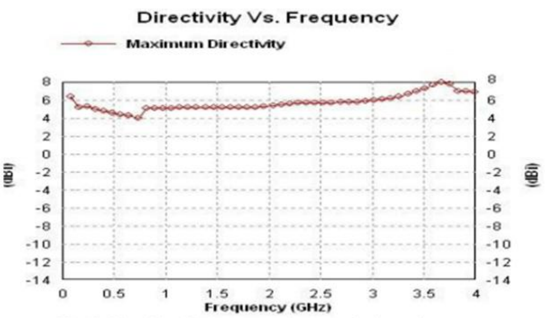

Fig. 5. Directivity Vs frequency of proposed microstrip antenna

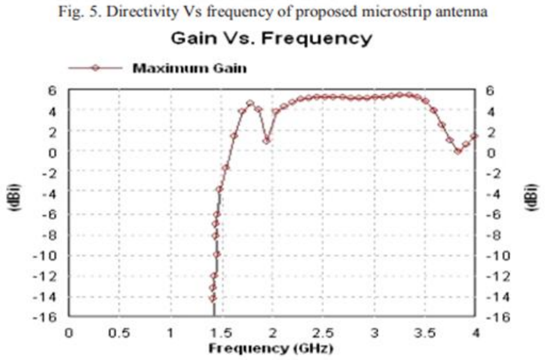

Fig .6 Gain Vs frequency of microstrip antenna

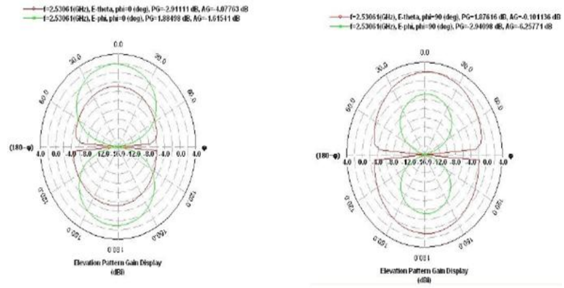

Fig.7. Elevation pattern of proposed microstrip antenna

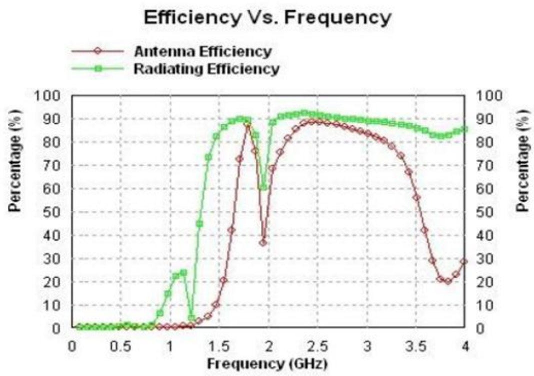

Fig. 8. Efficiency Vs frequency of proposed microstrip antenna

IV. CONCLUSION

A dual wide band probe fed duo-triangle-shaped patch antenna is simulated & designed on substrate of dielectric constant 4.4 and operating on the frequency below 6 GHz. The proposed antenna has been designed on glass epoxy substrate to achieve dual wide bandwidth of 8.68% and 37.56% covering the range from 1.845-1.894 GHz and 3.228-4.228 GHz and maximum radiating efficiency of about 90% which is best suitable for multi-band application.

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* Madhu Suman. "Dual Bandwidth Duo Triangular Shaped Microstrip Antenna for Multi-Band Frequencies." International Journal Of Engineering Research And Applications (IJERA), vol. 08, no. 01, 2018, pp. 51-54.