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Bandwidth Improvement by Using Array of Triangular Shaped Patch Antenna

Umesh Chandra Gupta, Paritosh Kumar

Department of Electronics & Communication Engineering, Institute of Technology and Management, GIDA, Gorakhpur- 273209, Uttar Pradesh, India

Abstract

This paper includes design and analysis of triangular shaped patch antenna using IE3D simulation software to achieve different parameter. However to increase the bandwidth of patch antenna an array of triangular patch is used. Using proposed antenna design and Coaxial feed line at proper position, the resultant bandwidth is obtained. We have observed that using array of triangular patch and coaxial feed line at proper location we can get better bandwidth. Proposed antenna is designed for wireless communication system and Wi-max applications.

***Key Words*: Directivity, Gain, Return Loss, Triangular shaped rectangular Microstrip patch antenna, VSWR**

INTRODUCTION

Antenna is a circuit which converts electrostatics energy into electromagnetic energy. There are many types of antenna such as Yagi Uda antenna, Helical and horn antennas which have higher bandwidth but also due to its large size it is not suitable for wireless systems [1]. Microstrip antenna plays a major role in wireless communication. It is preferred over other antennas because of its size, compactness, less expensive, ease of fabrication and installation [2]. One of the major disadvantages of microstrip antenna is its narrow bandwidth which is a major challenge for engineers to achieve higher data rate for various broadband application [3,4].

However, bandwidth of antenna can be increased by various methods such as by increasing the thickness of substrate with low dielectric constant, by probe feeding, by cutting slot and by array of antenna [5].

This paper includes analysis of triangular shape and array of triangular shaped patch antenna. The objective of the paper is to improve impedance bandwidth by using array of triangular shape.

METHODOLOGY

The resonant frequency of antenna must be selected properly. For wireless application the frequency ranges from 2-3 GHz [6].

The frequency selected for design is 2.4 GHz. The dielectric constant of material selected is 4.4. The height of dielectric selected is 6mm. Loss Tangent is 0.0005.

The width of patch selected is calculated as

$$W = \frac{c}{2f_r\sqrt{\{(\epsilon_r+1)/2\}}} \quad (1)$$

W=38mm

The effective dielectric constant is calculated as

$$\epsilon_{eff} = \frac{\epsilon_r+1}{2} + \frac{\epsilon_r-1}{2}\sqrt{\frac{1}{\left[1+12\frac{h}{W}\right]}} \quad (2)$$

$$\epsilon_{eff} = 3.7$$

The length extension is calculated as

$$\Delta L = 0.412h\frac{(\epsilon_{eff}+0.3)(\frac{W}{h}+0.264)}{(\epsilon_{eff}-0.258)(\frac{W}{h}+0.813)} \quad (3)$$

$$\Delta L = 2.44mm$$

The effective length is calculated as

$$L_{eff} = \frac{c}{2f_r\sqrt{\epsilon_{eff}}} \quad (4)$$

$$L_{eff} = 32.5\ mm$$

The actual length of patch is obtained by

$$L = L_{eff} - 2\Delta L \quad (5)$$

L= 27.6 mm

Ground plane dimension is calculated as

$$L_{ground} = L + 6h \quad (6)$$

$L_{ground} = 63.6\ mm$

$$W_{ground} = W + 6h \quad (7)$$

$W_{ground} = 74\ mm$

Table 1: Ground Plane and Patch Size.

Parameter	Size (in mm)
Ground Plane	63.6mm ×74mm
Patch	27.6mm × 38mm

Initially triangular shape antenna is designed with the above parameter and simulated to get the appropriate bandwidth. Then array of triangular shaped antenna is used to enhance the bandwidth. The design of antenna is as follows:

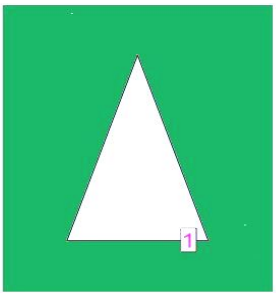

Figure 1: Triangular shaped patch antenna

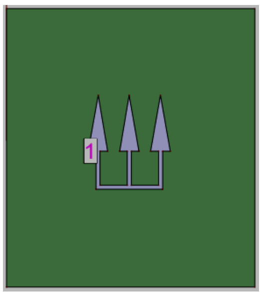

Figure 2: Array of triangular shaped patch antenna (proposed antenna)

RESULT & DISCUSSION

The minimum value of return loss is -10dB which can be observed from s parameter graph. The bandwidth is calculated as

$$Bandwidth\% = \frac{f_H - f_L}{f_C} \times 100$$

f_L = Lower Frequency

f_H = Higher Frequency

f_C = Central Frequency= $\frac{f_H + f_L}{2}$

Result and discussion of Triangular Shaped antenna:

The return loss graph of triangular shaped patch antenna is shown in fig 3.

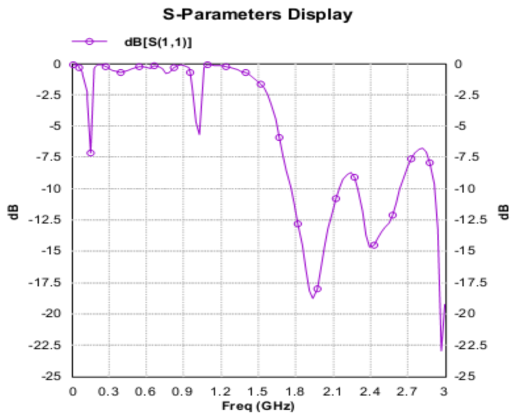

Figure 3: Return loss Vs Frequency for the Triangular shaped antenna

Calculation of bandwidth:

For Frequency band 1:

f_L = 1.7575 GHz

f_H = 2.1212 GHz

f_r = 1.9393 GHz

f_C = 1.93935 GHz

BW = 18.7%

For Frequency band 2:

f_L = 2.3030 GHz
f_H = 2.6363 GHz
f_r = 2.3939 GHz
f_C = 2.46965 GHz
BW= 13.59%

Based on the return loss curve and calculation above it can be clearly observed that the designed antenna structure can be operated in two different frequency bands with a bandwidth of 18.7% at 1.9393 GHz resonant frequency and 13.59% at 2.3939 GHz resonant frequency.

The proposed antenna is designed by using triangular array to enhance the bandwidth.

Result and discussion of Triangular array Shaped antenna:

The return loss graph of triangular shaped patch antenna is shown in fig 4

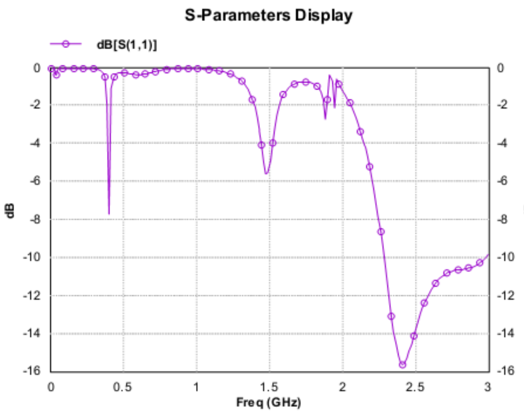

Figure 4: Return loss Vs Frequency for the Triangular array shaped antenna

Calculation of bandwidth:

f_L = 2.2914 GHz
f_H = 2.98 GHz
f_r = 2.4020 GHz
f_C = 2.6357 GHz
BW = 26.12%

Based on the return loss curve and calculation above it can be observed that the designed antenna structure provides bandwidth of 26.12% at 2.40 GHz resonant frequency.

The VSWR of the antenna must be below 2. It can be observed from figure 5 that VSWR is below 2 in the operating range of frequency [7-9]. The VSWR curve of proposed antenna is shown below.

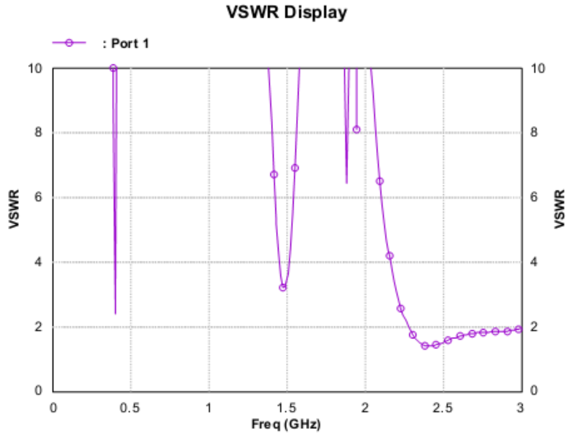

Figure 5: VSWR Vs Frequency curve for the Proposed Antenna

Efficiency of the proposed antenna is shown in fig 6. It can be observed from the graph that max antenna efficiency 92% is and max radiation efficiency is 100%.

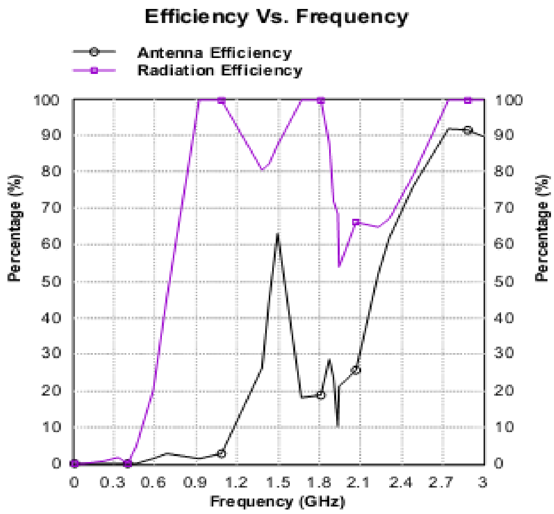

Figure 6: Efficiency Vs Frequency of proposed antenna

Analyzing the directivity curve shown in fig 7, it can be observed that directivity of the proposed antenna is 5.6 dBi.

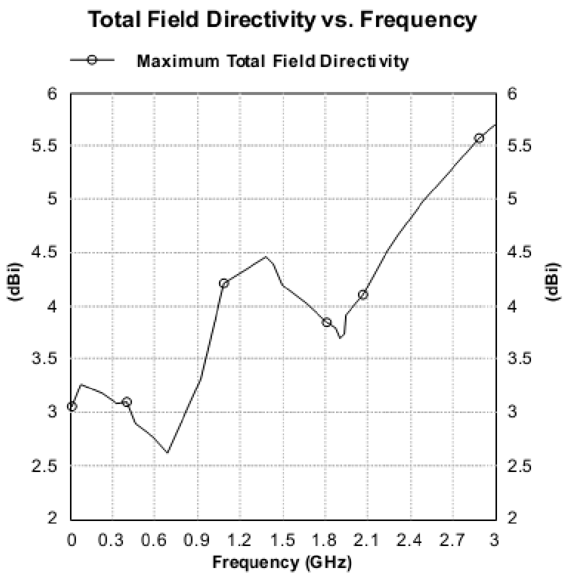

Figure 7: Directivity Vs frequency of proposed antenna

Analyzing the Gain curve as shown in figure 8, it can be observed that gain of the proposed antenna is 5.2 dBi.

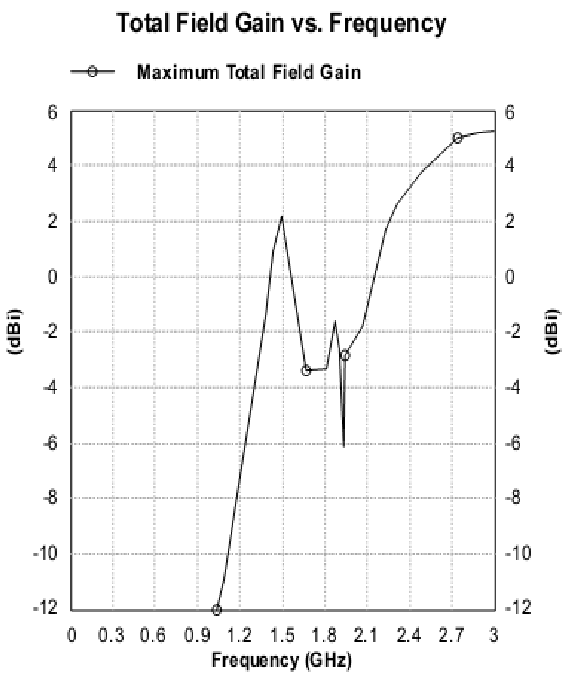

Figure 10: Gain Vs frequency for proposed antenna

CONCLUSION

The designed antenna is simulated over IE3D simulation software of version 15.2. A triangular shaped antenna is designed for resonant frequency of 2.4 GHz and is simulated to achieve bandwidth of 13.59% at resonant frequency 2.4 GHz. However this bandwidth is enhanced by using array of triangular shaped patch to about 26.12%. The dielectric constant used is 4.4 and loss tangent is .0005.

CONFLICT OF INTEREST: None

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