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Designing of E-shaped Microstrip patch antenna for better performance

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***Abstract*— In this paper, the rectangular and E shaped microstrip patch antenna are designed and simulated using MATLAB simulator. The operating frequency is 2.6 GHz. The FR4 is a dielectric substrate. The dielectric constant is 2.2. The height of the substrate is 1.6 mm. After designing the different parameters such as gain, return loss, VSWR, directivity are calculated and compared. After comparison the E shape has gain 60.0573 dB, return loss -26.199 dB and 1.1030 VSWR.**

***Index Terms*— Microstrip patch antenna, wireless communication, Gain, return loss, directivity.**

I. INTRODUCTION

The concept of micro strip antennas was first demonstrate in 1886 by Heinrich Hertz and its practical application by Guglielmo Marconi in 1901 and it can be newly proposed by Decamps in 1953 [1].

Wireless communication is rapidly growing in various sectors, so use of mobile is increased. Mobile devices give efficient communication due to their high performance using low return loss and high bandwidth. These mobiles should be small in size and light weight. Due to small size, light weight, low profile, and low cost, microstrip antenna become popular. Microstrip antenna technology us a emerging trend in antenna field. These antennas are simple to manufacture. They are suited for planar and non-planar surfaces. Also they can be easily integrated with circuits and provides conformability to mounting hosts which makes them excellent candidates for satisfying the design consideration.

There are many methods of analysis for microstrip antenna. The most popular models are the transmission-line, cavity and full-wave. The transmission-line model is the easiest of all, it gives good insight and it is adequate for most engineering purposes and requires less computation. However, it is less accurate. The cavity model is more accurate and gives good physical insight but is complex [5]. The full-wave models are very accurate, very versatile, and can treat single elements, finite and infinite arrays, stacked elements, arbitrary shaped elements and coupling. However, they are the most complex models and usually give less physical insight [2].

II. DESIGNING OF THE ANTENNA

The length and width of the patch antenna are calculated using the design procedure mentioned below [3]. The width of the patch can be find out using,

$$W = \frac{C}{2fr} * \sqrt{\frac{2}{\varepsilon r + 1}} \quad .....(1)$$

Where C is the speed of light, εr is dielectric constant, fr is resonant frequency.

The effective dielectric constant is,

$$\varepsilon reff = \frac{\varepsilon r + 1}{2} + \frac{\varepsilon r - 1}{2} * \left(1 + 12 * \frac{h}{W}\right)^{-\left(\frac{1}{2}\right)} \quad .....(2)$$

The length extension is calculated as,

$$\Delta L = 0.412\, h \frac{(\varepsilon reff + 0.3)\left(\frac{W}{h} + 0.264\right)}{(\varepsilon reff - 0.258)\left(\frac{W}{h} + 0.8\right)} \quad .....(3)$$

The effective length is,

$$Leff = \frac{C}{2 * f0 * \sqrt{\varepsilon reff}} \quad .....(4)$$

The actual length of the patch is,

$$L = Leff - 2\Delta L \quad .....(5)$$

III. GEOMETRY OF RECTANGULAR ANTENNA

The rectangular antenna is designed in this section. The operating frequency is 2.6 GHz. The dielectric constant is 2.2, height of the substrate is 1.6 mm. the antenna is designed using above equations.

Rectangular antenna geometry is shown in figure1.

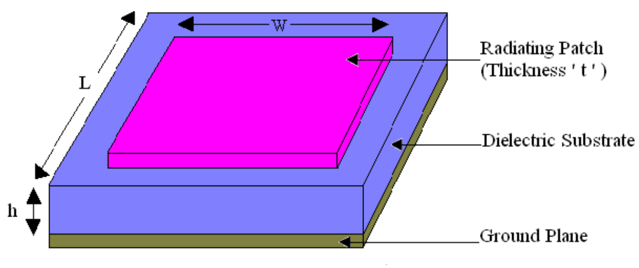

Fig.1: Rectangular microstrip patch antenna

The different parameters are as shown in the table I.

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Table I: Parameters of rectangular patch antenna

Parameters	Values
Operating frequency	2.6 GHz
Dielectric constant	2.2
Substrate height	1.6 mm
Patch width	45.5 mm
Patch length	38.069 mm
Loss tangent	0.0009
Patch width	45.609 mm
Patch length	38.1547 mm
Slot width	14.35 mm
Slot length	30.42 mm

IV. GEOMETRY OF E-SHAPED PATCH ANTENNA

For designing the E shape, firstly a rectangular microstrip patch antenna is designed using standard equation to find Length and Width of the patch. The E shaped patch antenna can be constructed by cutting two rectangular slots at the edges on a rectangular patch [3] as shown in Fig 2.

The operating frequency is same, 2.6 GHz. Two parallel slots are integrated to disturb the surface current path. This introduces local inductive effect responsible for excitation of a second resonant mode. The slot length Ls, slot width Ws and center arm width and length of E shaped patch antenna control the frequency of the second resonant mode and achievable bandwidth.

In the E shaped antenna, the current from the feed flows in two different paths generating two resonant frequencies. These two resonant frequencies are coupled each other, thus resulting in improved bandwidth, compared to a rectangular patch antenna. The antenna bandwidth can be improved by controlling the following antenna parameters the width (W) and length (L) of the patch, the height between the feeding line and the patch element, the height of the air gap, and the dimensions of the ground plane and substrate [4].

The geometry of E shape is shown in the figure2.

The width of E shape is mm, length is mm. the slot width Ws is mm, slot length is mm, middle slot width Wm is mm, and length Lm is mm.

The parameters of E shaped patch antenna are shown in the table II.

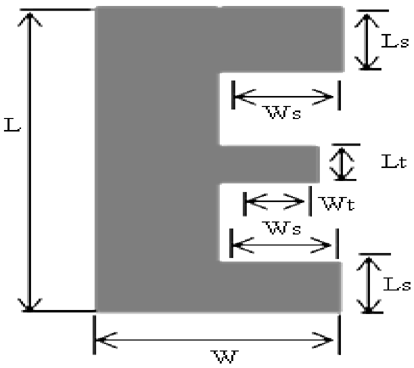

Fig. 2: Geometry of E shaped antenna

Table II: Parameters of E shaped patch antenna.

Parameters	Values
Operating frequency	2.6 GHz
Dielectric constant	2.2
Substrate height	1.6 mm

V. RESULTS AND DISCUSSION

A. Results of Rectangular patch antenna

Figure 3 shows the radiation pattern of rectangular patch antenna. At 2.6 GHz frequency the gain is 29.79 dB, return loss is -20.48 dB, VSWR is 1.1045, and reflection coefficient is 0.0946.

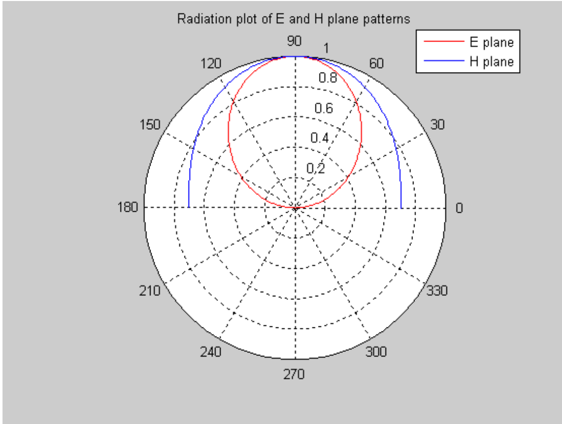

Fig. 3: Radiation pattern for rectangular antenna

B. Results of E shape patch antenna

The figure 4 shows the radiation pattern for E shaped patch antenna.

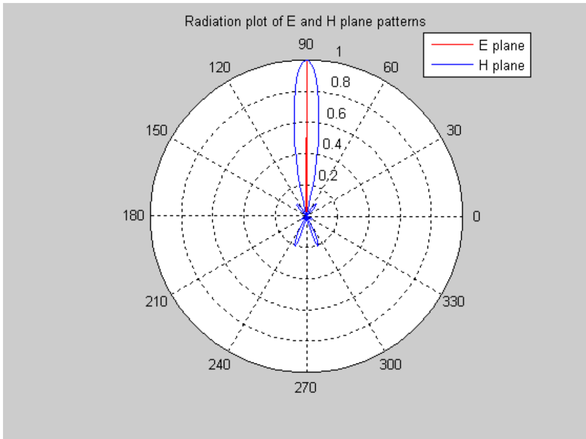

Fig. 4: Radiation pattern for E shaped antenna

From simulation the obtained values are gain is 60.0573 dB, return loss is -26.1996, VSWR is 1.103, and reflection coefficient is 0.0496.

C. Comparison of Antennas

After comparing both the antennas it is observed that E shape patch antenna gives good results compared to rectangular patch antenna. The different parameters of rectangular and E shaped patch antenna are specified in the table III.

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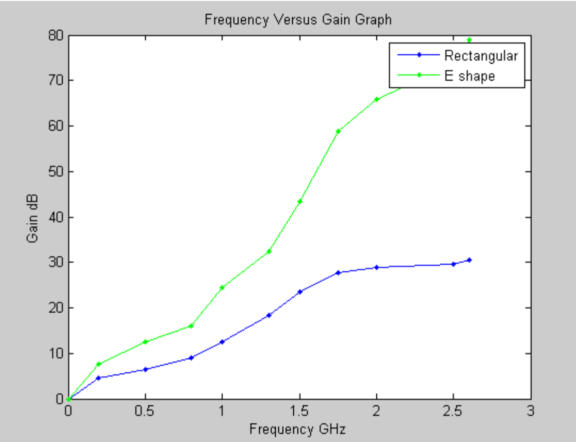

Fig.5: Plot of frequency v/s gain

The table III shows the improved values of E shaped antenna.

Table III: Comparison table

Parameters	Rectangular antenna	E shaped antenna
Gain	29.75	78.711
Return loss	-20.48	-26.1996
VSWR	1.1045	1.103
Reflection coefficient	0.0946	0.0490

VI. CONCLUSION

The two different shapes of microstrip patch antenna are designed. The length and width of patch is kept same at operating frequency 2.6 GHz. After simulation, the gain, return loss, VSWR, directivity of rectangular patch antenna are 29.75 dB, -20.48, 1.1045 and 0.0946 respectively and for E shaped patch antenna gain, return loss, VSWR, directivity are 78.711 dB, -26.1996 dB, 1.103, 0.049 respectively. The simulated results of both the antennas are compared. The result shows that E shaped patch antenna gives better performance at 2.6 GHz frequency. This antenna can be used for wireless communication.

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