Review on different E shaped microstrip antennas for better performance

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Abstract— **In this paper the performances of two different E shaped microstrip patch antenna are compared. The dielectric constant for first antenna is 4.6 and for second antenna is 2.8. The operating or radiating frequency for both the antenna is 3.5 GHz. The main objectives of this paper is to find the required parameters for designing the E and Rectangular shaped microstrip antenna for comparison, also to find out the values of parameters for better performance. After comparing both the antenna's parameter values, the better antenna is found which gives enhancement in the gain, directivity, efficiency and return loss.**

Keywords — **E-shaped microstrip antennas, dielectric constant, gain, directivity, efficiency, return loss.**

I. INTRODUCTION

The transmission of information or messages like pictures, music, speech etc with electrical signal is known as electrical communication. A picture can be transmitted over a small distance by light or optical waves. Speech and music can be sent by sound or acoustic waves over a small distance. But when long distance communication is required, wire and radio communications are used. For radio or wireless communication special device, Antenna is used. Antenna converts electrical power in to electromagnetic waves i.e. radio waves. These waves can carry the signal at the speed of the light ($3x10^8$m/s) through the space or air.

In recent years, the radio or wireless communication has been popular. The aim of the wireless communication is to provide the high speed networking. The need of wireless communication has increased rapidly in recent years demanding quality of service, security, handover and increased throughput for high speed working networks [3]. Nowadays microstrip antennas are getting more importance in wireless communication. Many of the researchers are moving their attention towards the microstrip antenna, as they are famous for having some advantages. They are small in size, having low cost. They are easy to design.

However, their narrow bandwidth is a drawback. To increase the bandwidth of the antenna few techniques are used. These techniques are surface meandering, making slots, aperture coupled patches or by near frequency resonators [4,5]. By increasing the substrate height, this problem can be sorted out, but this creates the appearance of surface waves, which causes a reduction in antenna efficiency [6]. This paper presents the comparative study of two e shaped microstrip antenna and finds the better values of different parameters for better results.

This paper reviews two E shape microstrip antennas having different dimensions. The different parameters are studied and compared. This study shows that if we increase the dielectric constant then bandwidth decreases and antenna becomes narrow bandwidth. Also if we increase the thickness of the substrate then resonating frequency of the antenna decreases but the gain, return loss and bandwidth increases.

The comparative study of two E shaped microstrip antennas gives the better values of different parameters for better results.

II. MICROSTRIP ANTENNA

The concept of microstrip antenna was first demonstrates in 1886 by Heinrich Hertz. Its practical applications by Guglielmo Marconi in 1901 and it can be newly proposed by Decamps in 1953. Howell and Munson developed the first practical antenna in the early 1970's [7]. Microstrip antennas are also known as "Printed Antennas".

A patch of the microstrip antenna is made from the radiating material. Generally it is of conducting material such as copper or gold and can take any possible shape. The patch can be of any shape like circular, triangular, rectangular [8,9] and even alphabets like H, U, E, C, F etc as shown in the fig. 1.

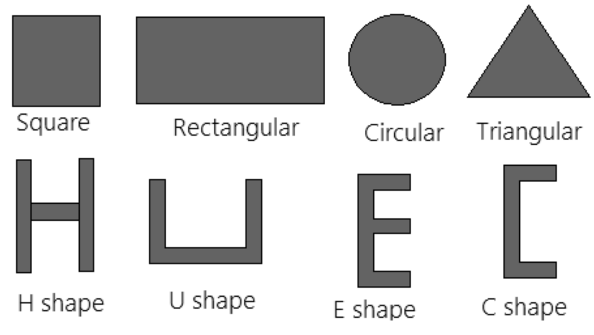

Fig. 1: Different shapes of microstrip patch antenna

A simple microstrip antenna configuration is shown in fig. 2.

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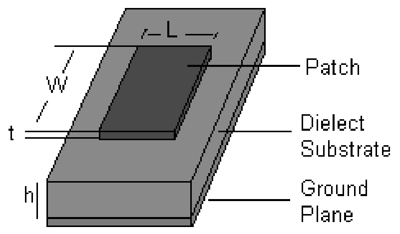

Fig. 2: Geometry of Microstrip antenna

In a microstrip patch antenna, the dielectric substrate is sandwiched between a radiating patch and a ground plane. The dielectric constant (Єr) of the substrate must be in the range of 2.2< (Єr) <12.

When the antenna is excited a strong field is created. This is an electromagnetic field. It not only contained within the microstrip patch but also propagate outside of the patch [10]. Microstrip patch and ground plane are act as a two parallel plates of capacitor. There is some field outside the patch, known as fringing field. This field is responsible for the radiation. The radiation in antenna is as shown in fig. 3.

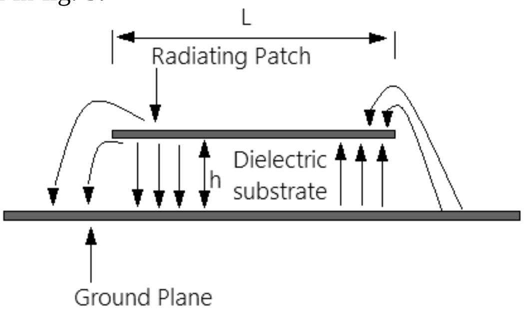

Fig. 3: Radiation in antenna

III. Proposed System

The proposed system is based on the microstrip antenna. In the proposed system we are comparing the E shaped patch antenna with rectangular patch antenna. The shape of the patch is like the letter "E" hence the name E shaped patch antenna. For comparison we have to consider some parameters which are studied from this paper. As the microstrip antenna has narrow bandwidth, to overcome this drawback and to improve the bandwidth some parameters are studied.

IV. Different Equations for Antenna Design

Both the antennas can be design by using following equations. By using these equations we can easily find out the values for dimensions of E shape patch. The slot length and width are important parameters to control the performance of E shaped patch antenna.

1. Calculation of Width (W) :
   The width of the patch is given as:

$$W = \left(\frac{C}{2fr}\right) * \sqrt{\frac{2}{\epsilon r + 1}}$$

Where C is the speed of the light which is 3×10^8 meter per second, fr is the operating or radiating frequency of the antenna. From above equation we get the value of width in mm.

2. Calculation of Effective Dielectric constant (Єreff):

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

3. Calculation of Effective Length (L eff):

$$Leff = \frac{C}{2fr\sqrt{\epsilon reff}}$$

4. Calculation of Length Extension (ΔL):
   The dimensions of the patch are extended along the length L at each end by ΔL.

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

   Hence ΔL depends on the effective dielectric constant (Єreff) and width to height ratio (w/h).

5. Calculation of Actual length of Patch (L):
   The actual length of the patch can be determine by,

$$L = Leff - 2\Delta L$$

V. Designing of Two Antennas

By cutting two symmetrical parallel slots into the rectangular microstrip antenna, it becomes an E shaped patch. The slot width Ws and slot length Ls was varied to get the optimized results at the desired frequency [11].

Geometry of first Antenna:

In the paper [1] authors have introduced E shape patch antenna having the geometry as shown in fig 4. This antenna is fabricated on FR4 substrate having thickness (or height) of 3.2mm, dielectric constant (Єr) of 4.6. The FR4 substrate is used due to less cost and easy to fabricate the antenna. Hence it is widely preferred.
From above equations we get the values as:
Antenna patch width (W) is 25.7 mm.
The patch length is (L) 19.5 mm.

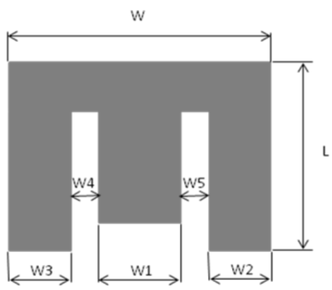

Fig. 4: Geometry of first antenna

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Geometry of Second Antenna:

The authors of paper [2] had presented an antenna using lanthanides (Dy-Sm) doped Magnesium ferrite with very low dielectric constant. This substrate is sandwiched between FR4 substrates [12].
The design patch has a thickness of 2.38 mm. The dielectric constant of a substrate is 2.8.

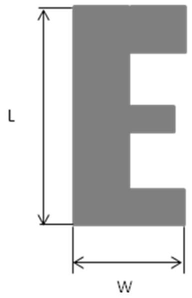

Fig. 5: Geometry of second antenna

By using above equations, we get the following parameter values for this antenna as:

The Length of this antenna is 19 mm.
The patch width of this antenna is 57 mm.

The geometric parameter values of the antenna are as follows:

For the first antenna:
W1 = 8.1 mm, W2 = 5.9 mm, W3= 6.1 mm, W4 & W5= 2.8 mm and L1=16.5mm.

The dimensions of both antennas are tabulated in bellow table I:

Table I: Dimensions of both the antennas

Sr. No.	Parameter	Value for Antenna 1	Value for Antenna 2
1	Width (W)	25.7 mm	57 mm
2	Length (L)	19.5 mm	19 mm
3	Thickness (h)	3.2 mm	2.38
4	Dielectric constant	4.6	2.8

VI. Result Analysis

The above two antennas were designed to operate at frequency 3.5 GHz. For the first antenna, the simulation was carried out in Advanced Design System (ADS) [1]. The gain of this antenna is 4.55 dB, directivity is 6.86386 dB, efficiency is 58.3% and return loss is -33.913 dB. For the second antenna, the simulation was performed using EM simulator IE3D [2]. The gain of this antenna is 6.23 dB, directivity is 7.58 dB, and efficiency of the antenna is 73.32% and gives return loss -9.8 dB.

All these values can be written in the table II as:

Table II: Comparison of two antennas parameters

Sr. No.	Parameters	Antenna 1	Antenna 2
1	Gain	4.55 dB	6.23dB
2	Directivity	6.86386 dB	7.58 dB
3	Efficiency	58.3%	73.32%
4	Return Loss	-33.913 dB	-9.8 dB

VII. Conclusion

In this paper, we have investigated the dimensions and parameters for designing of E shaped Microstrip Patch Antenna. Also comparative analysis of both the antennas for enhancing the performance of Microstrip patch antenna is done.

After comparing both the antenna's parameter we can conclude that the second antenna has improved results. This is due to low value of dielectric constant, as dielectric constant of a substrate controls bandwidth, antenna efficiency and radiation pattern. Also high return loss of second antenna indicates a close impedance match.

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