Design of U-shape microstrip patch antenna at 2.4GHz

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***Abstract*—In this paper we have design and simulated a microstrip patch antenna which operating at a frequency of 2.4 GHz. It is an antenna having patches of conducting materials eatched on one side of a dielectric substrate, the other side of a board is a metal ground plane. The structure is planar in configuration and advantages of printed circuit technology, the feed lines and matching networks are fabricated simultaneously with the antenna structure. The main advantages of using microstrip patch antenna are that linear and circular polarizations are possible with simple change in feed position and dual frequency antenna can be made possible [1].**

***Keywords*—bandwidth of antenna, gain of antenna, reflection coefficient, return loss, VSWR of antenna.**

1. INTRODUCTION

The U-slot microstrip patch antenna was introduced in 1995 by Huynh and Lee. The U-slot patch can significantly improve the bandwidth of microstrip antenna.

The U-slot patch antenna can be designed not only for wideband applications, but also for dual and, triple-band applications with small and wide frequency ratio. The microstrip patch is designed so that its pattern maximum is normal to the patch (broadside radiator).this is done by properly choosing the (i.e. field configuration) of excitation beneath of the patch [2].

The radiating elements and feed lines are produced by the process of photo etching on the dielectric substrate ,similar to printed circuit board .as the resulting printed circuit board is very thin (about 1mm thick),these antenna are also known as paper thin antenna[3].

For antenna better performance, a thick dielectric substrate having a low dielectric constant is desirable since this provides better efficiency, larger bandwidth and better radiation.

In general these microstrip patch antennas are also known as "PRINTED **ANTENNA"**.

Micro strip patch antenna or patch antenna is a narrowband wide-beam antenna. The general structure of microstrip patch antenna is shown below in fig 1.

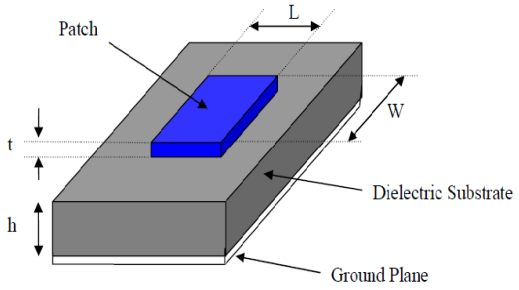

Fig 1: microstrip patch antenna

2. RELATED WORK

Microstrip patch antenna are widely used because of low profile, light.it increase the bandwidth and gain using U-shape microstrip patch antenna. Andthis antenna is mainly used for mobile radio and wireless types of communications that have similar specifications. In this paper a microstrip patch antenna in U-shape is designed having substrate material as copper. A edge feed techniques is to design microstrip patch antenna which operating at the range of frequency 2.4GHz.The substrate material which are using for these design is FR4 material which having dielectric constant 4.4 and loss tangent is 0.02mm and having thickness 1.6mm.

3. GEOMETRY OF ANTENNA

The design of U shaped microstrip patch antenna is as shown below in fig 2.the material which used as a

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patch is FR4 material which having dielectric constant 4.4 and loss tangent 0.02.the dimension of patch material is (38.04*29.44)mm.And the material which used as a substrate is copper which having thickness of 1.6mm.the dimension of substrate is (1.6*66.7*128.59)mm.The edge feed technique is used in that which having dimension of width 0.723mm and length 17.971mm.

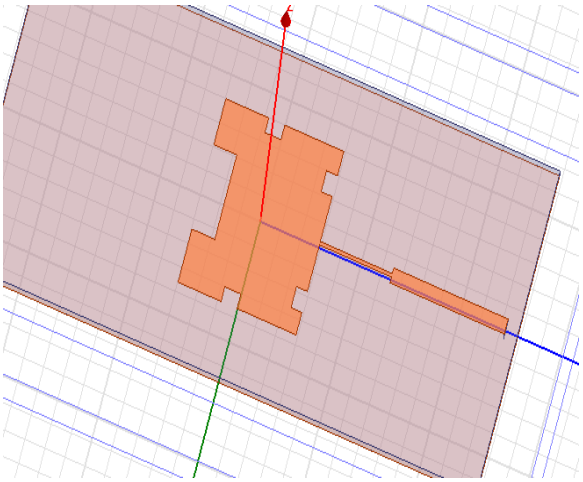

Fig 2: geometry of microstrip patch antenna in U-shape

MATHEMATICS CALCULATION

For design of microstrip patch antenna, the standard formula to calculate width and length of antenna at particular operating frequency as given below.

Step 1: for an efficiency radiator practical width that leads to good efficiency is given:

$$W = \frac{1}{2Fr\sqrt{\mu 0 \varepsilon 0}}\sqrt{\frac{2}{\varepsilon r + 1}}$$

Step 2: calculation of effective dielectric coefficient is given ($\varepsilon reff$):

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

Step 3: calculation of effective length is given as:

$$Leff = \frac{c}{2f0\sqrt{\varepsilon reff}}$$

Step 4: calculation of length extension is given as:

$$\frac{wL}{h}0.472\frac{(\varepsilon reff + 0.3)\left(\frac{w}{h} + 0.264\right)}{(\varepsilon reff - 0.3)\left(\frac{w}{L} + 0.8\right)}$$

Step 5: Calculation of actual length of patch is given as:

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

4. SIMULATION RESULTS

The simulation result of microstrip patch antenna with the help of HFSS (high frequency structural simulator) software. The dimensions of substrate and patch are used to simulate the antenna in U-shape. The operating frequency of these antennas is 2.4 GHz.

- Return loss:

The antenna start working from 2.3809GHz which mark as (m5) and stop working at 2.4249GHz which mark as (m6).the center frequency is 2.4060GHz.
The return loss is -17.5366.
The return loss is shown below in fig 3:

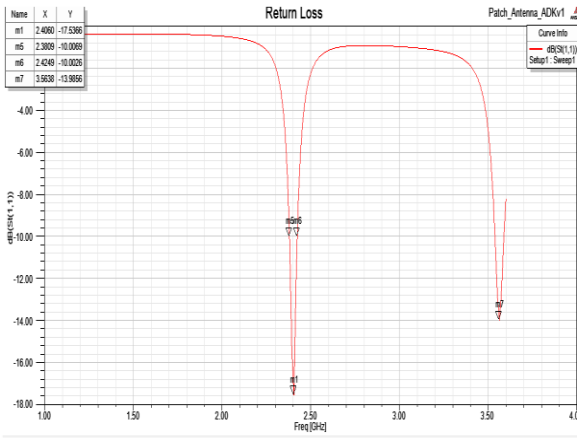

Fig 3: return loss

- Gain:

The fig 4 shows the simulated result of gain of the proposed antenna. The maximum achievable gain is 2.5017db.

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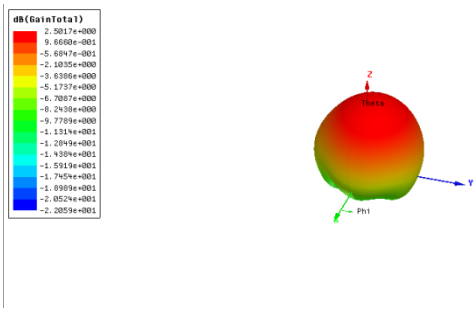

Fig 4: gain of antenna

- Radiation pattern of antenna:

It shows gain of 2.5017db.The 2D radiation pattern of antenna is shown in fig 5 which indicates a unidirectional radiation pattern which having a major lobe & back lobe.

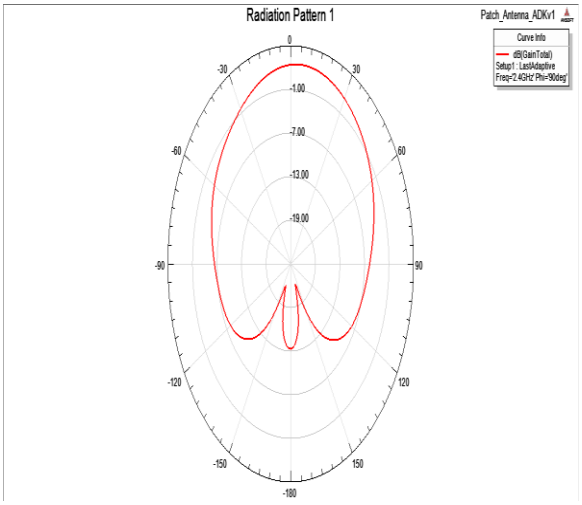

Fig 5: radiation pattern of antenna

- VSWR vs frequency graph:

The 2.40GHz frequency the VSWR IS 1.3062 which shown in fig 6:

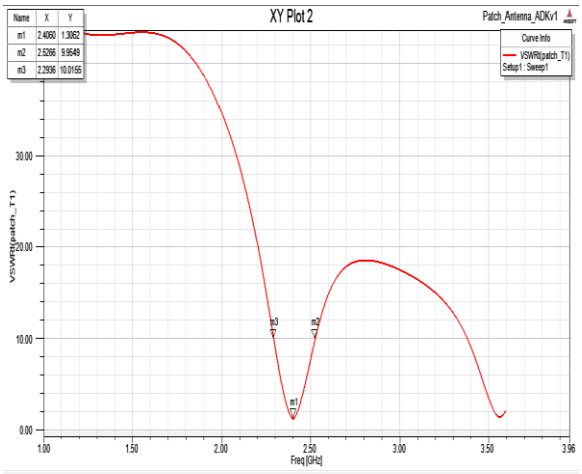

Fig 6: VSWR vs frequency graph

- Current distribution

The current distribution of simulated microstrip patch antenna in U-shape is shown in fig.7; the maximum value of current is 3.79 A/m, at 2.4GHz frequency.

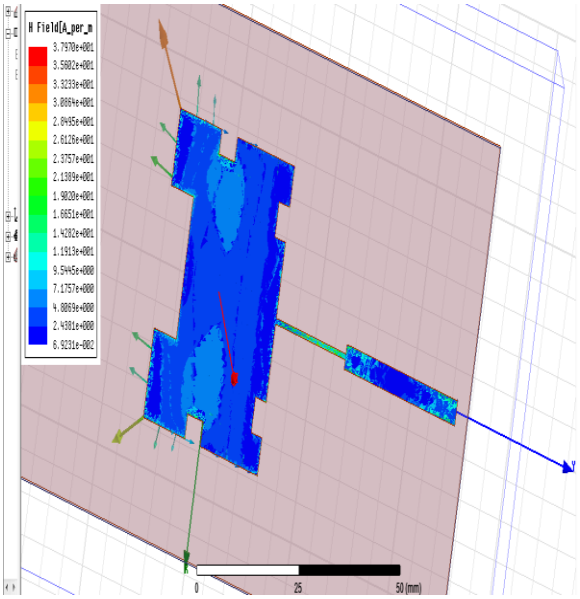

Fig 7: current distribution of antenna

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5. CONCLUSION

in these paper we have simulated microstrip patch antenna in U-shape at range of frequency 2.4GHz with the help of HFFS software.in that project we have using 2 material, one is FR4 material and other is copper material.so, in that we have design and simulated microstrip patch antenna at particular range of frequency at 2.4GHz and also calculated the parameter such as return loss, gain, bandwidth, current distribution and VSWR of antenna.

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