Comparative Study & Designing of Different Patch of Microstrip Patch Antenna at High Frequency

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Abstract

In this paper, Microstrip patch Antenna with five different shapes i.e. circular, triangular, corner truncated, T shape & H shape are designed using Ansoft HFSS software. These antennas are designed on Rogers RO 4003 substrate material at dielectric constant 3.5. This material is suitable at high frequency range after analysis in last paper [1].The different performance parameter such as return loss, VSWR, gain & bandwidth of these antennas are compared. The operating frequency is taken as 6 GHz. It is found that H-shaped patch antenna has a better result as compared to other shapes.

Keywords- Microstrip Antenna, Different Shapes of Patch, HFSS, Dielectric Substrate, Gain, Return Loss, VSWR

I. INTRODUCTION

The wireless communication provides less expensive alternative & flexible way of communication. An Antenna is one of the important tool or device of wireless communication. According to the IEEE standard definition, the antenna is defined as "a means of transmitting or receiving radio waves in free space".

A Microstrip patch Antenna consists of thin layer known as a patch which is placed on ground separated by substrate material. The radiating patch that may be any desired shape as square, circle, rectangular, truncated, pentagonal, hexagonal ,elliptical, H,T etc. as shown in Fig 1.A dielectric material having a low dielectric constant provides better efficiency, larger bandwidth and better radiation. There are different feeding methods such as line feed, coaxial feed, aperture coupled feed & proximity coupled feed [2].

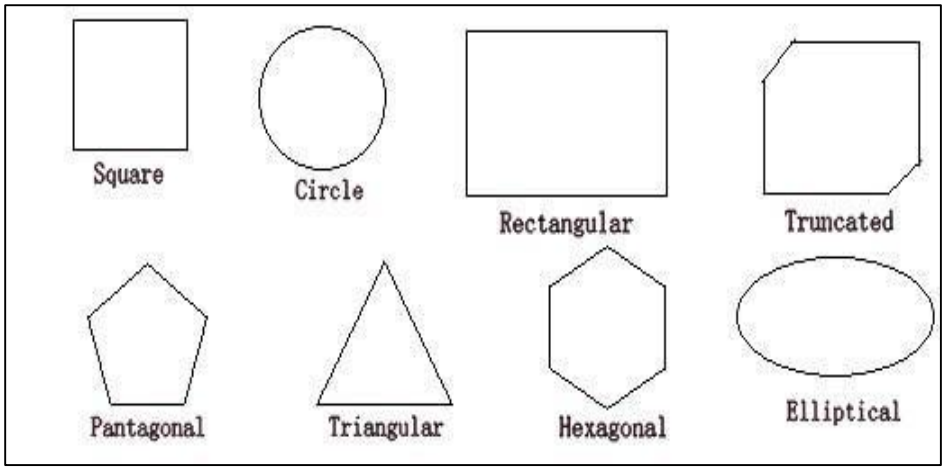

Fig. 1: Common Available Shapes of Microstrip

II. SELECTION OF SUBSTRATE

A dielectric material is an electrical insulator that can be contrasted by applying electrical field. The selection of proper substrate material is an important effort in designing of Microstrip patch Antenna. After analysis & comparison of different substrate material, Roger RO4003 substrate material is being used. It has dielectric constant of 3.4. Roger RO4003 is used for commercial application. It has dielectric constant of 3.4.It provides low cost circuit fabrication. It has low loss tangent. The selection of this material is excellent choice for high frequency application. Dielectric Constant of substrate affects on different shapes of patch in microstrip antenna. The thickness of substrate is same in all shapes of patch [3].

III. DESIGNING

A Microstrip patch Antenna consists of two conducting layer patch & ground separated by a single dielectric substrate. The conducting patch can take any shape. It may be square, rectangular, circular, elliptical, and triangular and corner truncated or any other configuration. The most popular are rectangular, circular because of the ease of analysis and fabrication and their attractive radiation properties. In this paper, five radiating patches which are taken as circle, triangle, truncated, T-shaped and H-shaped. These designs were simulated and analyzed by HFSS software. The substrate material used is Roger RO4003 with dielectric constant ϵr = 3.4[4].

A brief description is given for each of the five patches designed.

A. Circular Patch

A circular patch antenna is designed on a finite grounded dielectric substrate. In this case, by varying radius of the circular patch the resonant frequency can be varied. The radius is 9 mm & substrate thickness is 5 mm. The designing of circular patch antenna is shown in Fig 2.

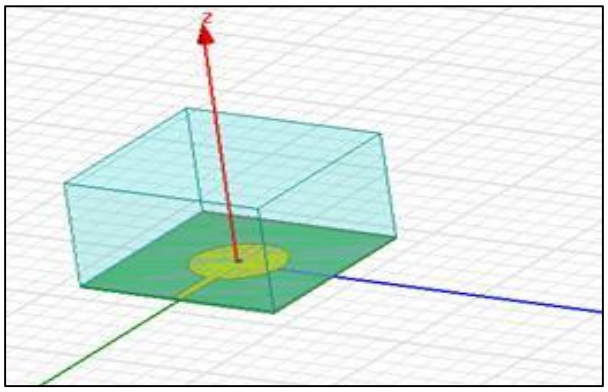

Fig. 2: Circular Patch Antenna

B. Triangular Patch

The triangular patch antenna is designed using polyline on rectangular shape patch. The substrate thickness is 5 mm. A perspective view of triangular microstrip patch antenna is shown in Fig 3.

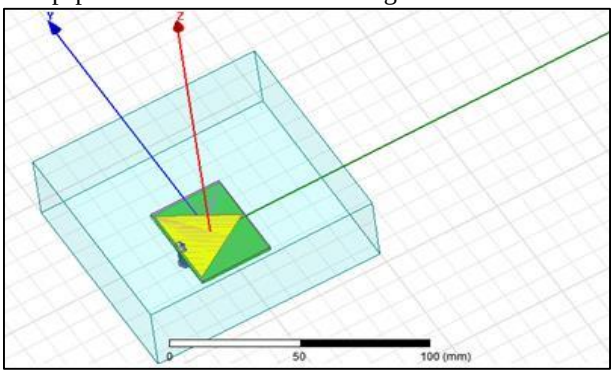

Fig. 3: Triangular Patch Antenna

C. Side Truncated Patch

Fig.4 shows the geometry of antenna with a side corner truncated rectangular patch antenna. These sides are opposite to each other. The substrate thickness is 5 mm.

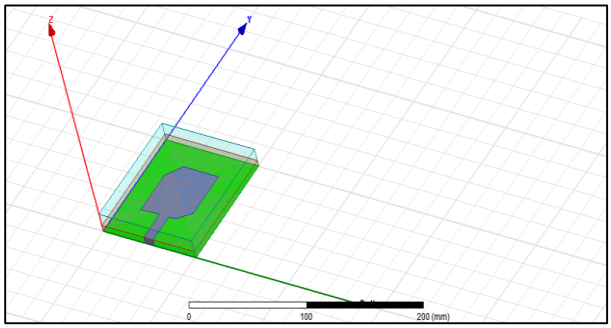

Fig. 4: Side Truncated Patch Antenna

D. T-Shaped

This antenna consists of a section of two standard rectangular patches ending with in form of the T shape. The substrate thickness is 5 mm. This antenna is shown in
Fig 5.

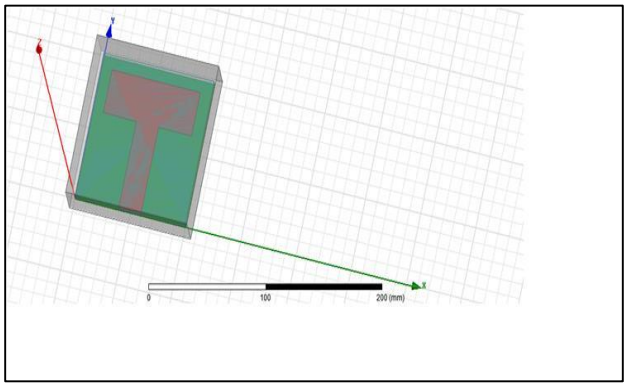

Fig. 5: T-Shaped Patch antenna

E. H-Shaped Patch

It can be designed by joining of two rectangular patch antennas on substrate layer. The thickness of substrate layer is about 5 mm. This antenna is shown in Fig 6.

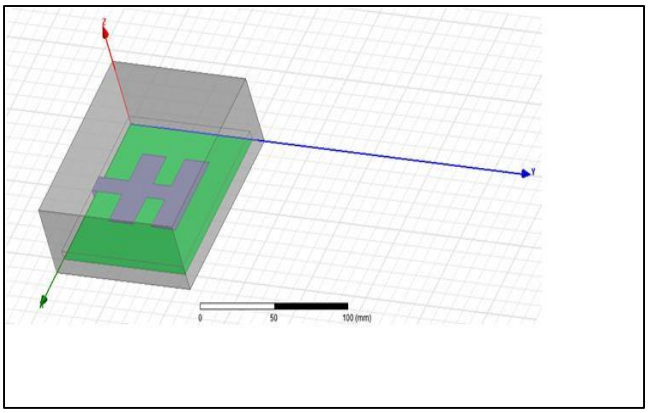

Fig. 6: H-Shaped Patch Antenna

IV. IMPLEMENTATION & SIMULATED RESULTS

A. Return Loss vs. Frequency & 3D Radiation Pattern of Different Shapes of Patches

The following diagram shows the simulated result of return loss graph of all five different shapes of patches after designing using Ansoft HFSS software.

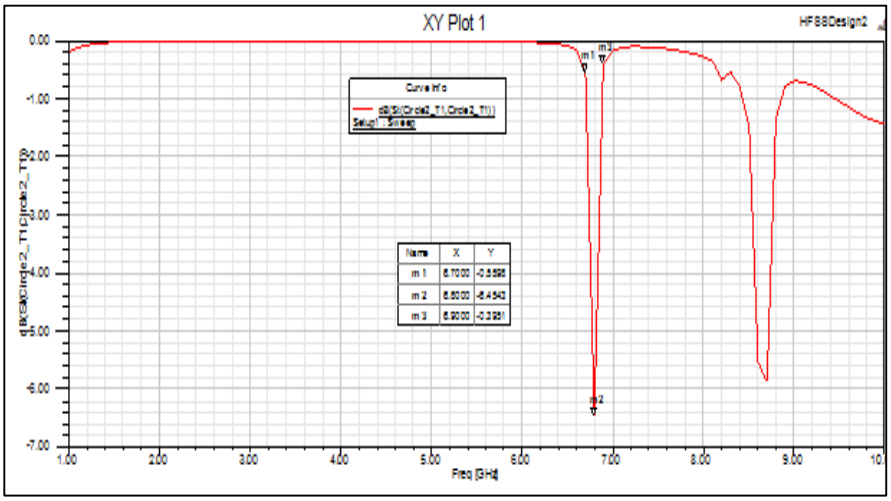

Fig. 7: Return Loss vs. Frequency graph of circular patch

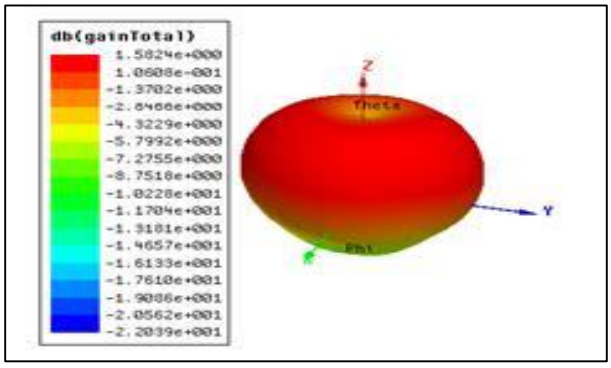

Fig. 8: 3D Radiation Pattern of circular patch

The above figure shows that the circular patch antenna provides a gain of around 1.584 dB.

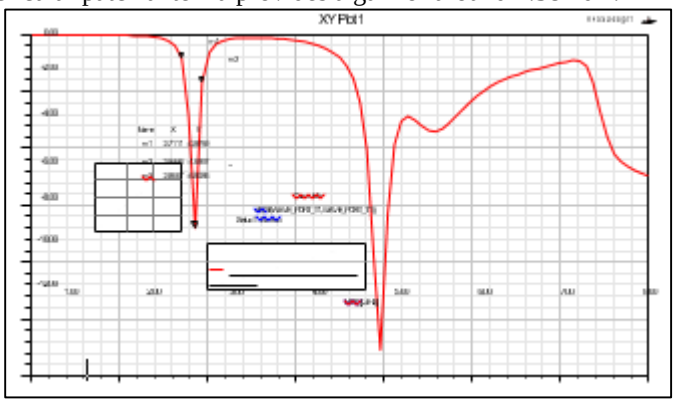

Fig. 9: Return Loss vs. Frequency graph of triangular patch

The above figure shows that the antenna resonates at 6 GHz return loss being -6.8dB0.It provides bandwidth of 233 MHz.

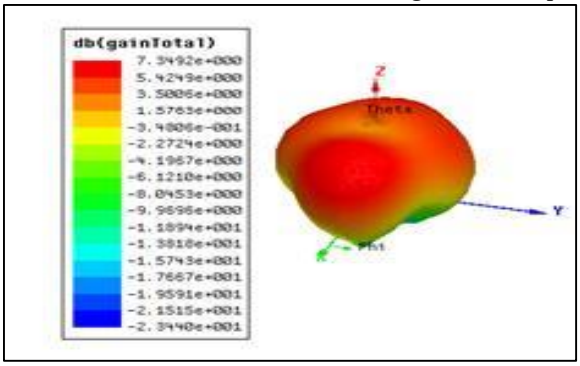

Fig. 10: 3D Radiation Pattern of triangular patch

The above figure shows that the triangular patch antenna provides a gain of around 7.34 dB.

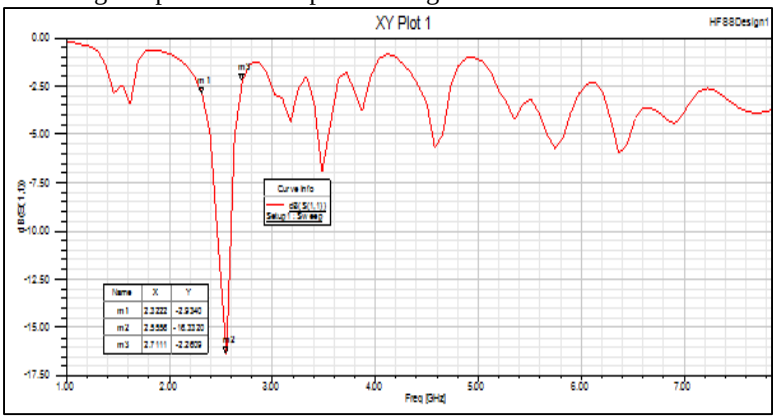

Fig. 11: Return Loss vs. Frequency graph of corner truncated patch

The above figure shows that the antenna resonates at 6 GHz return loss being -16.33dB. It provides bandwidth of 389 MHz.

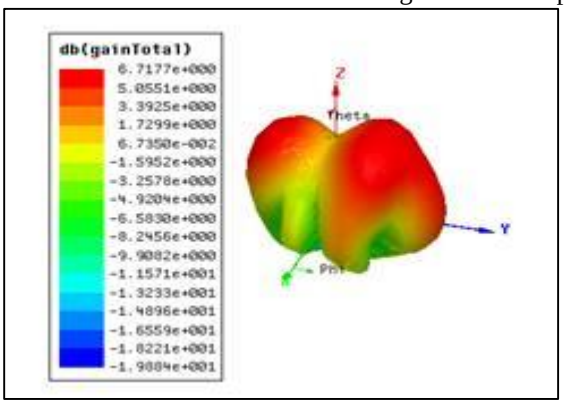

Fig. 12: 3D Radiation Pattern of corner truncated patch

The above figure shows that the truncated patch antenna provides a gain of around 6.71 dB.

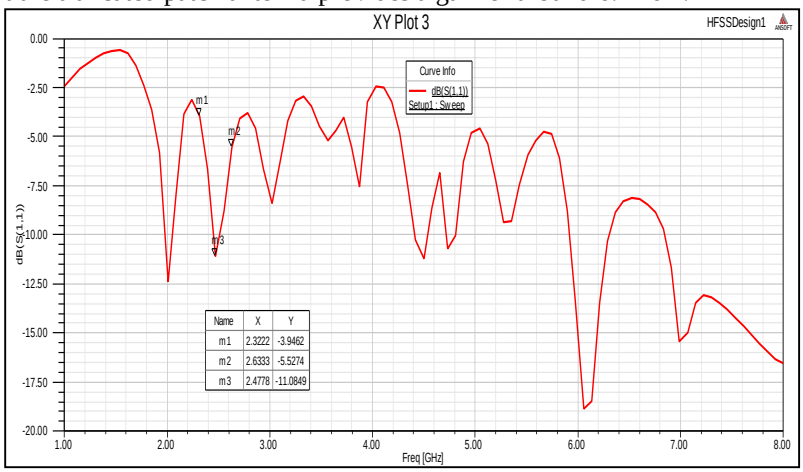

Fig. 13: Return Loss vs. Frequency graph of T shaped patch

The above figure shows that the antenna resonates at 6 GHz return loss being -11.08 dB. It provides bandwidth of 311 MHz.

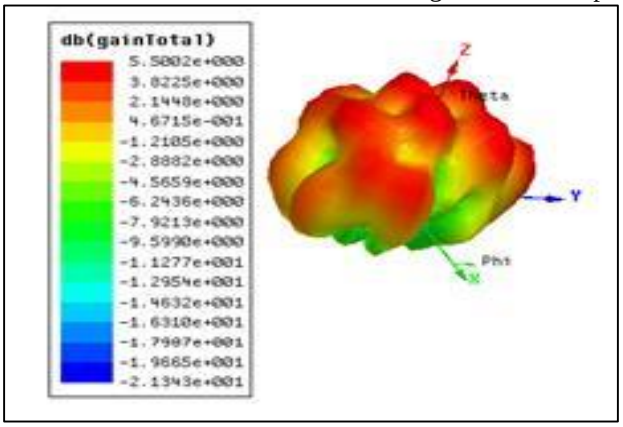

Fig. 14: 3D Radiation Pattern of T shaped patch

The above figure shows that the T shaped patch antenna provides a gain of around 5.50 dB.

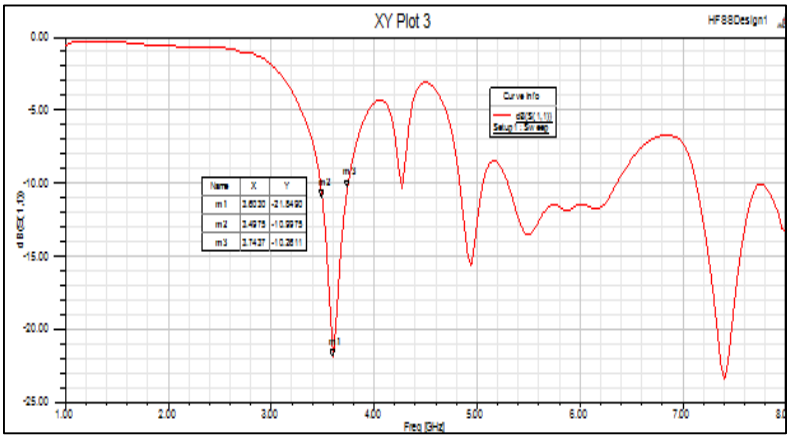

Fig. 15: Return Loss vs. Frequency graph of H-shaped patch

The above figure shows that the antenna resonates at 6 GHz return loss being -21.84 dB. It provides bandwidth of 527 MHz .

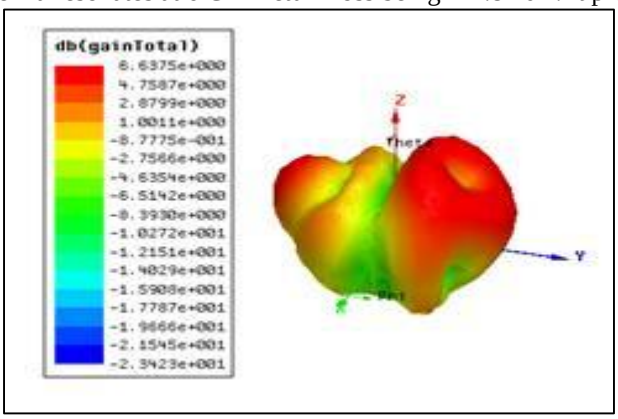

Fig. 16: 3D Radiation Pattern of H-shaped patch

The above figure shows that the H-shaped patch antenna provides a gain of around 6.637dB.
The comparison between the five radiating patches in terms of different parameters is shown in table 1.

Table 1: Comparison between Different Patches of Microstrip Patch Antenna Designs

Sr. No	*Parameters*	*Circular*	*Triangular*	*Corner Truncated*	*T Shaped*	*H Shaped*
1	*Return loss(dB)*	*-6.36*	*-6.80*	*-16.33*	*-11.08*	*-21.84*
2	*VSWR*	*2.85*	*2.86*	*1.36*	*1.77*	*1.25*
3	*Gain (dB)*	*1.58*	*7.34*	*6.71*	*5.50*	*6.637*
4	*Bandwidth (MHz)*	*200*	*233*	*389*	*311*	*527*

From the table all the parameters have been analyzed. After comparative analysis the maximum gain is achieved in case of triangular shape antenna as shown in Fig 10. But the value of VSWR is 2.86 which is greater than 2. If the impedance matching between transmitter & antenna is perfectly matched then the value of VSWR should be lower than 2. So the triangular shaped patch antenna is not providing better result. The next highest gain is achieved by corner truncated shaped patch antenna as shown in Fig 12 which gives best result as VSWR is lower than 2 that means impedance matching is perfectly matched between transmitter & antenna. But the value of bandwidth is low than H-shaped patch antenna. H-shaped patch antenna has medium VSWR which is lower than 2, highest return loss, gain is medium & high bandwidth. The result shows that H-shaped patch antenna gives perfect result as compared to triangular & corner truncated patch.

V. CONCLUSION

All the five antennas resonant at around same frequency. The gain is highest for triangular shaped patch antenna but it suffers from poor value of VSWR. For perfect, H- shaped patch antenna has good return loss & VSWR, medium gain & high bandwidth. So it can be taken as the patch element for the array. Such antenna very much demanding in real time application employing a wide range of microwave frequencies.

VI. FUTURE DEVELOPMENT

Though new designs for radiating patch is shown in this paper, it can further be explored by introducing more new shapes of patch antennas such as linear or array pattern for the future research. This may also include different type of substrates with diverse permittivity. Although the return loss of the patches are increased, there are still rooms for improvement such as the overall size of the antenna including the substrate is not much reduced by using this method, future investigation and research need to be done in order to reduce overall size of the antenna while maintaining another antenna performances.

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