Design and Analysis of Rectangular Microstrip Patch Antenna and S Slot Dual Band Frequency Microstrip Patch Antenna

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Abstract:- **This paper describes the design of rectangular microstrip patch antenna and S- slot dual band frequency rectangular microstrip patch antenna. The main objective of this paper is to enhance the rectangular microstrip patch antenna gain, and bandwidth. These antennas are designed using dielectric substrate with the permittivity εr = 3.4. In this analysis, we have compared the antenna parameters such as gain, impedance, Radiation Pattern, Polar Plot, VSWR and further the performance of these discussed. The antenna has been designed for the range 2.4 GHz; hence this antenna is highly suitable for various applications such as satellite communication, Radar, Medical applications, and other Wireless systems.**

Keywords: Gain, HFSS, Return loss, VSWR, S- slot.

I. INTRODUCTION

Microstrip antennas are attractive due to their light weight, conformability and low cost. These antennas can be integrated with printed strip-line feed networks and active devices. This is a relatively new area of antenna engineering. The radiation properties of micro strip structures have been known since the mid 1950's. The application of this type of antennas started in early 1970's when conformal antennas were required for missiles. Rectangular and circular micro strip resonant patches have been used extensively in a variety of array configurations. Feed line and matching networks are fabricated along with antenna structure. If the substrate is flexible, conformal antennas are possible. Etching is done with the standard photolithographic processes [3]. The accuracy of etching process also ensures uniformity of different parts over a production run. The main reason for using micro strip patches is the ability to construct array antennas with the feed network and the radiating elements on a single surface. This arrangement means that the antennas are fed by a micro strip connected directly to the patch [4].

The advantages of microstrip antennas make them suitable for various applications like, vehicle based satellite link antennas [2], global positioning systems (GPS) [3], radar for missiles and telemetry [2] and mobile handheld radios or communication devices [3]. In its simplest form a microstrip patch antenna consists of a patch of metal, generally rectangular or circular (though other shapes are sometimes used) on top of a grounded substrate [9]. Basically there are four feeding techniques available to us while designing of antenna. These are line feed [5], probe feed [1 and 8], aperture coupled feed [4] and proximity coupled feed [6]. The feed that is used here is probe feed (or coaxial feed). The WiMAX (Worldwide Interoperability for Microwave Access) system [1] is becoming increasingly popular to allow broadband wireless internet access for private and business users. WiMAX is based on the IEEE 802.16 family of standards [2]. The first system implementations, based on the 802.l6-2004 specifications intended for fixed wireless access, are already being tested and even used. Antenna play paramount role in present developing communication system. A microstrip antenna consists of conducting patch on a ground plane separated by dielectric substrate. The antenna array is designed using standard equations and simulated by professional software called, High Frequency Structural Simulator (HFSS). It proves to be the tool for analyzing the working of any antenna [7]. Before designing of any antenna, its working and simulation is checked by this software such that any kind of change if required could be made. Microstrip patch antenna are used for mobile phones, satellites, radio, radars, global positioning system (GPS), television, multiple input multiple output (MIMO), radio frequency identification (RFID), medical imaging and guidance of missiles are few examples of the military and industrial applications [3]. Microstrip antennas are most popular because of its numerous advantages in wireless communication systems that typically require antennas with small size, light weight, low profile, and low cost, and that are easy to fabricate and assemble [6]. Now-a-days, antennas with multiband capabilities have been widely required in satellite and mobile communication systems to meet the growing system complexity [5]. A good design of the antenna can relax system requirements and improve overall system performance.

II. RELATED WORK

In this paper a compact size Z shaped antenna has been designed having good impedance matching as well as high antenna; efficiency of about 95% is achieved. The proposed antenna has larger impedance bandwidth of 43.578%

covering the frequency range from 1.696 GHz to 2.646 GHz which is suitable for PCS-1900, GSM and WLAN (802.11b) applications. Obviously there are some limitations of Z shape antenna some of them are listed below:

- Its effective dielectric constant is lower.
- Layout is very compact.
- Shunt element is quite low.

The antenna's resonant properties were predicted and optimized using High Structure simulation software Ansoft version 13. The design procedure begins with determining the length, width and the type of dielectric substance for the given operating frequency. Then using the measurements obtained above simulation has been setup for the basic rectangular micro strip antenna and the parameters are optimized for the best impedance matching. Further more two parallel slots are incorporated and optimized such that it closely resembles E shape; this increases the gain of the antenna. After that two more parallel slots and one perpendicular slot are incorporated and optimized such that it closely resembles U shape. Then dielectric substrate of dielectric constant of 1.0006 introduces to decrease the size of the antenna and to further enhance the bandwidth. At last the probe feeding is introduced for attaining a required bandwidth, resonating frequency and gain value.

The antenna is made of a single patch on top, one layers of dielectric (air) and a vertical probe connected from ground to the upper patch. The main E shaped patch has Wa x La dimension while the outer patch has Wb x Lb dimension. The antenna is fed by a SMA connector positioned at the center arm. The center of probe is positioned at (Wc/2,Lf). The H-shaped microstrip antenna [8] consists of an H shaped patch; supported on a grounded dielectric sheet of thickness h and dielectric constant εr. An S-shaped microstrip patch antenna, shown in figure 2 is obtained by cutting equal rectangular slots along both the non-radiating edges of the rectangular MSA. The S-shaped patch antenna [8] reported here has a size about half that of the rectangular patch, with larger bandwidth. The S-shaped microstrip patch antenna, because of its considerably smaller size, could replace the rectangular patch at UHF frequencies. When they are applied in the frequency range below 2 GHz, the sizes of conventional rectangular microstrip patches seem to be too large.

III. ANTENNA DESIGN PARAMETERS

The dielectric constant of the substrate is closely related to the size and the bandwidth of the microstrip antenna. Low dielectric constant of the substrate produces larger bandwidth, while the high dielectric constant of the substrate results in smaller size of antenna. A trade-off relationship exists between antenna size and bandwidth [4]. HFSS is a higher awarding full wave electromagnetic (EM) field simulator for random 3D volumetric inactive device model that takes advantage of the well-known Microsoft Windows graphical user interface.

IV. SIMULATION RESULTS

The major limitation in micro strip antenna is the narrow bandwidth, which can be stated in terms of antenna's quality factor, Q. Micro strip antennas are high-Q devices with Qs sometimes exceeding 100 for the thinner elements. High-Q elements have small bandwidths. Also the higher the Q of an element the lower is its efficiency. HFSS is commercial finite element solver for Electromagnetic structures like antenna, RF electronic circuit including filters, transmission lines etc.

A. GAIN

Three-dimension radiation patterns of H & Rectangular Microstrip Patch Antennas at 2.4GHz are shown in figure 1 & 2 respectively. From Figure 1 it is clear that H-slot Rectangular Microstrip Patch Antenna has a gain of 7.46dB, on the other hand Rectangular Microstrip Patch Antenna has a gain of 2.50dB.

The values of return loss, gain, substrate thickness, tangential loss are given the below output table.

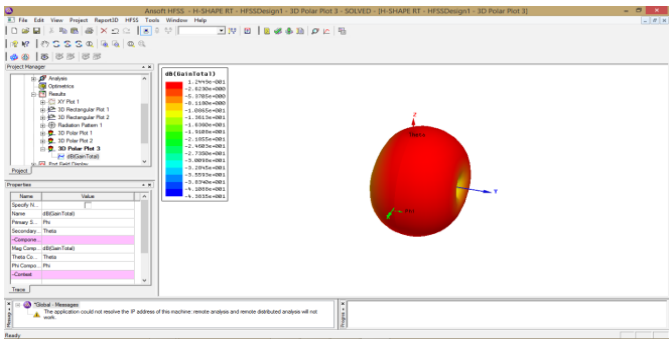

Fig 1: Three-dimension radiation pattern of H-slot RMPA

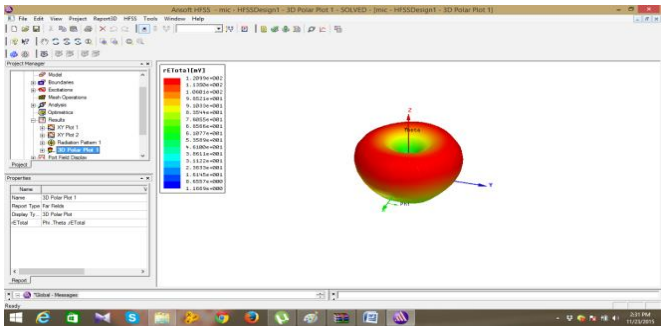

Fig 2: Three-dimension radiation pattern of RMPA

B. RETURN LOSS

Return loss versus frequency plot of S slot & Rectangular Microstrip Patch Antennas are shown in figure 3 & figure 4 respectively. The simulation of above design is being done using HFSS software. The substrate used here is RT-Duroid5880 having relative permittivity 3.4. The above given dimensions are used to simulate the structure. The operating frequency of this design is 2.34 GHz and the obtained return loss.

Return loss of s slot antenna are shown in given below

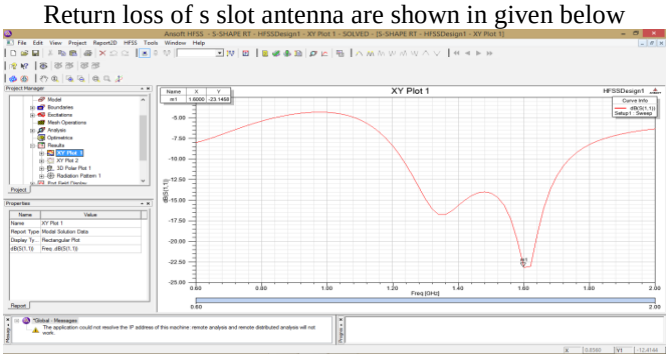

Figure 3: Return loss of S-slot dual frequency rectangular microstrip patch antenna

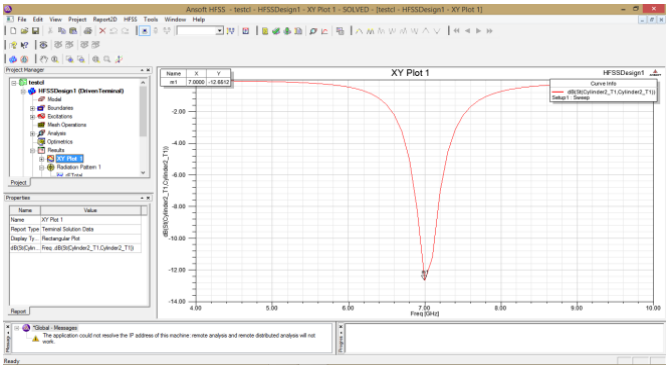

Figure 4: Return loss of rectangular microstrip patch antenna

The radiation patterns of the antenna have been measured in the anechoic chamber at 10 GHz.

In table1.contains the information about comparison of return loss values for both rectangular and H-slot microstrip patch antenna.

PARAMETER	RMPA	S-SLOT RMPA
Length	100mm	100mm
Width	75mm	75mm
substrate	RT-duroid 5880	RT-duroid 5880
Tangent	0.02	0.02
Return loss (dB)	-12.6 dB	-23.54dB
Gain (dB)	2.5 dB	7.46dB

Table 1 Comparison of Measure of RMPA and H-slot RMPA

V. CONCLUSION

In this paper, rectangular microstrip patch antenna and S-slot rectangular microstrip patch antenna was designed. These antennas operate frequency at 2.4 GHz. From the Three-dimension radiation plot it is clear that S- slot antenna has -23.6 dB return loss whereas rectangular antenna has -12.6dB. Thus it is conclusion that S- slotted Rectangular Microstrip Patch Antenna better performance than Rectangular Microstrip Patch Antenna. The gain and return losses were good in comparison to conventional antennas for these bands. The antenna is designed to be used for multi-band and Wi-Max applications. Finally, the optimum dimension of dual frequency rectangular patch antenna has been investigated. The performance properties are analyzed for the optimized dimensions.

REFERENCES

[1] Balanis,C. A. Antenna Theory, John Wiley & Sons, Inc. , 1997.
[2] Motin, M. A., Hassan, Md. Imran and Islam, Md. S., "Design And Simulation Of a Low Cost Three Band Microstrip Patch Antenna for the X-band, Ku- Band and K- Band Applications," 7th International Conference on Electrical and Computer Engineering, pp.397-400, 20-22 December, 2012 IEEE.
[3] Panusa, S. and Kumar, M. "Quad Band H-slot Microstrip Patch Antenna for WiMAX Application," International Journal of Computer Applications, Volume 103 – No.12, October 2014.
[4] Tarange, V., Gite, T., Musale, P. and Khobragade, S. V., "A U- Slotted H- Shaped Microstrip Antenna with Capacitive Feed For Broadband Application," International Conference on Emerging Trends in Networks and Computer Communications, pp. 182-184, April 2011 IEEE.
[5] T. Durga Prasad et.al.(2011). Comparisons of Circular and Rectangular Microstrip Patch Antennas. International Journal of Communication Engineering Applications, Vol. 2, No. 4, pp. 187-197.
[6] Vilas Mapare, S. V. Mapare, ―Non radiating edges Gap-Coupled Multiple Resonator Dual and Tri-Band Microstrip", International Journal of Computer Applications (0975 – 8887) Volume 56– No.3, October 2012.
[7] Vilas Mapare, S. V. Mapare, ―Non radiating edges Gap-Coupled Multiple Resonator Dual and Tri-Band Microstrip", International Journal of Computer Applications (0975 – 8887) Volume 56– No.3, October 2012.
[8] Ahamed Maruf et.al." Rectangular Microstrip Patch Antenna at 2GHz on Different Dielectric Constant for Pervasive Wireless Communication". International Journal of Electrical and Computer Engineering, Vol. 2, No. 3, pp. 31-39, 2012.
[9] M. Tolstrup, Indoor Radio Planning: A Practical Guide for GSM, DCS, UMTS and HSPA, 2nd Ed. Hoboken, NJ, USA: Wiley, 2011.