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Micro Strip Patch Antenna Characteristics Using Different Dielectric Substrates

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ABSTRACT: In the recent times with the advent and progress of technology, dimension of things has been smaller and much smaller. We have different applications in microwave frequency range such as GSM, Bluetooth, and WLAN etc.in order to use this applications we need different antenna lengths, but as technology is being advanced the demand of making an antenna which operates in all the above applications is required. To fulfill the demand of above stated antenna, a design of micro strip patch antenna which works under multi frequency of operation using serrated structures has been introduced. This antenna maintains a maximum gain of 7-8dB. The designed antenna has a small overall size of 13×13×0.67 cm, and operates over the frequency ranges, 1.45 GHz,-1.85 GHz, 2.10–2.70 GHz, and 2.82–3.74 GHz making it suitable for GSM 1.8GHz, Bluetooth 2.4GHZ, WLAN 2.4 GHz and Wi-MAX 3.5 GHz applications. Experimental results show that remarkable antenna gains over the operating bands with efficient radiation patterns are obtained.

KEY WORDS- Serrated structures, WLAN, microstrip,Bluetooth, SWR and GSM.

I.INTRODUCTION

At micro wave frequencies the physical size of the antenna is very small, enough to produce desired directivity. Various applications like Bluetooth, Wi-Fi, WLAN, etc requires an antenna which consumes very less space and which can be easily mounted in communication system. One such design is micro strip patch antenna. Some of the advantages of microstrip antennas over other antennas are thin profile configuration, low fabrication cost, flexibility with circular or linear polarization and they can be easily made compatible to work with microwave integrated circuits. Recently, the demand for the design of a micro strip patch antenna with triple- or multiband operation has increased since such an antenna is vital for integrating more than one communication system in a single compact system to effectively promote the portability of a modern personal communication system. For this demand, the developed antenna must not only be with a triple/multiband operation but also have a simple structure, compact size, and easy integration with the circuit. Among the known triple/multiband antenna prototypes, serrated structured patch antenna is widely used because of its ease of integration, low cost, and versatile structure for exciting wide impedance bandwidth, dual- or multi resonance mode, and desirable radiation characteristics in a variety of applications[1].

In this paper a design of micro strip patch antenna which works at multiple frequencies is proposed. Micro strip patch antenna uses patches on the top, a dielectric substrate at middle and a conductive layer ground as bottom layer. The required design is obtained by using serrated structure, which means the patch is reformed in to different shapes. The dimensions of the patch, length and breadth and height of substrate are key requirements for a design of micro strip patch antenna[2].

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II. DESIGN CONSIDERATIONS

A micro strip antenna basically consists of a two parallel conducting layers separated by a single thin di electric substrate. The lower conducting substance acts as ground plane and the upper conductor acts as radiator. Larger ground plane gives better performance but off course makes antenna big size. Micro strip antenna has different shapes like rectangle, circular, square, triangle, for better performance we use rectangle micro strip patch antenna. The resonant frequency is determined by resonance frequency. The difference between electrical and physical size is mainly depends on PCB thickness and dielectric constant. For the performance evaluation different patch that we used here is quartz glass, Taconic, RD 4003, quartz crystal and RT duroid 5880. The size of the substrate determines the performance of the micro strip patch antenna.

In this paper the substrate dimensions taken along x- axis and y- axis is 13 cm. the substrate thickness is 0.67 cm. The coaxial inner and outer radius is 0.104 cm and 0.354 cm. For a good performance, a substrate having low dielectric constant is preferred because it provides good efficiency, larger gain and good radiation[5].

III. SUBSTRATES

Different substances are used in this present simulation work and their properties are mentioned as follows. RT/ duroid 5880LZ filled PTFE(Poly-tetrafluoro-ethylene) composites are designed for exacting strip line and micro strip circuit applications. The RT-duroid is a low density, lightweight material for high performance weight sensitive applications. The very low dielectric constant of RT/duroid 5880LZ laminates is uniform from panel to panel and is constant over a wide frequency range. Applications include airborne antenna system, lightweight feed networks**,** Military radar systems**,** Missile guidance systems and Point-to-point digital radio antennas [3]. The RT-duroid substrate of dielectric constant 2.2 and loss tangent of 0.0009 is taken in this present work.

Roger 4003 series high frequency circuit materials are designed for remarkably performance sensitive, high volume application, and suitable for broad band applications thus making serrated microstrip patches good choice for high frequency applications. This material is a rigid, thermoset laminate that is capable of being processed by automated handling systems and scrubbing equipment used for copper surface preparation[4].

Quartz glass applications mainly include poly silicon substrates for LCD and fiber optics, substrates for high frequency RF applications, micro fluidic substrates, Nano imprint templates etc. Fig.1 shows the radiation mechanism along the two sides of a patch or serrated antenna.

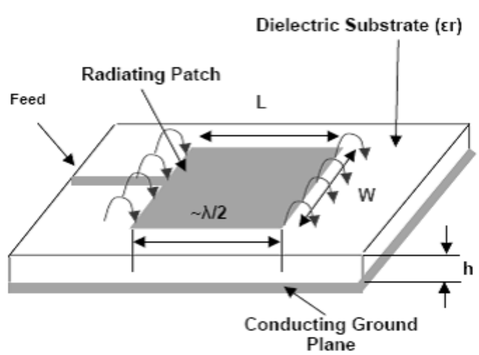

Fig 1. Radiation mechanism of patch antenna

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IV.SIMULATION RESULTS

Design structures using different patch serrated shapes are simulated using HFSS(High frequency structure simulator) software, employing different dielectric materials and these micro-strip antennas can be used for multi-frequency bands, thus offering wider applications.The simulated design is shown in Fig.2.

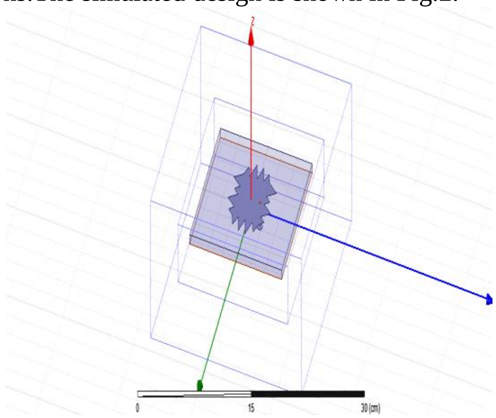

Fig.2 HFSS simulated design using serrated structures.

The below Table (1) shows the various dielectric substrates used in the work with their corresponding dielectric constant values.These can be made to work in a wide range of frequencies in serrated structures, making patch antennas very superior. The serrated aperture patch antennas can be used for dual band, triple band and multiband applications by employing hybrid complex structures of different shapes.

Substrate	Di electric constant	Frequencies of operations (in GHz)
RT Duroid -5880	2.2	1.8513,2.6955,3.5397
Taconic RF- 35(tm)	3.45	1.5136,2.2010,2.905
Quartz	3.78	1.4533,2.1166,2.8040
Roger rd 4003(tm)	3.55	1.5015,2.1769,2.8764
Rubber hard	3	1.6221,2.3698,3.1055

Table (1) Substrate materials with permittivity

Serrated Microstrip antennas are gaining their importance in the applications of dual and multiband antenna systems. A Serrated cutting edge has many small points of contact with the material being cut. Serrations, by having less contact area than a smooth blade or other edge, the applied force at each point of contact is relatively greater and the points of contact are at a sharper angle to the material being cut.[5]

Return loss is related to both standing wave ratio (SWR) and reflection coefficient (Γ). Increasing return loss corresponds to lower SWR. Return loss is a measure of how well devices or lines are matched. A match is good if the return loss is high. A high return loss is desirable and results in a lower insertion loss. Insertion loss is the loss of signal power resulting from the insertion of a device in a transmission line or optical fiber and is usually expressed in decibels (dB).

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Return loss for RT Duroid shows that as the operating frequency is increased from 1.85GHz to 3.53GHz, the return loss values in decreased gradually, measured in decibels. This is illustrated in Table(2).In Table(3),return loss for Taconic dielectric substrate is noted down. In the next Table (4),return loss for Quartz has been calculated in the experiment. Similarly, in the Table(5) and Table(6), the return loss values for Roger rd and Rubber hard is tabulated for some range of frequencies.

Serrated structures find extensive use because of attractive features such as low cost and small weight and ease of fabrication. The antenna radiation pattern is the display of the radiation properties of the antenna, and such structures are resonating at different frequencies with acceptable return loss and VSWR<2. The Figure(3) shows the return loss simulation results using these substrate materials, namely RT duroid, Taconic RF, Quartz, Roger rd and Rubber hard.

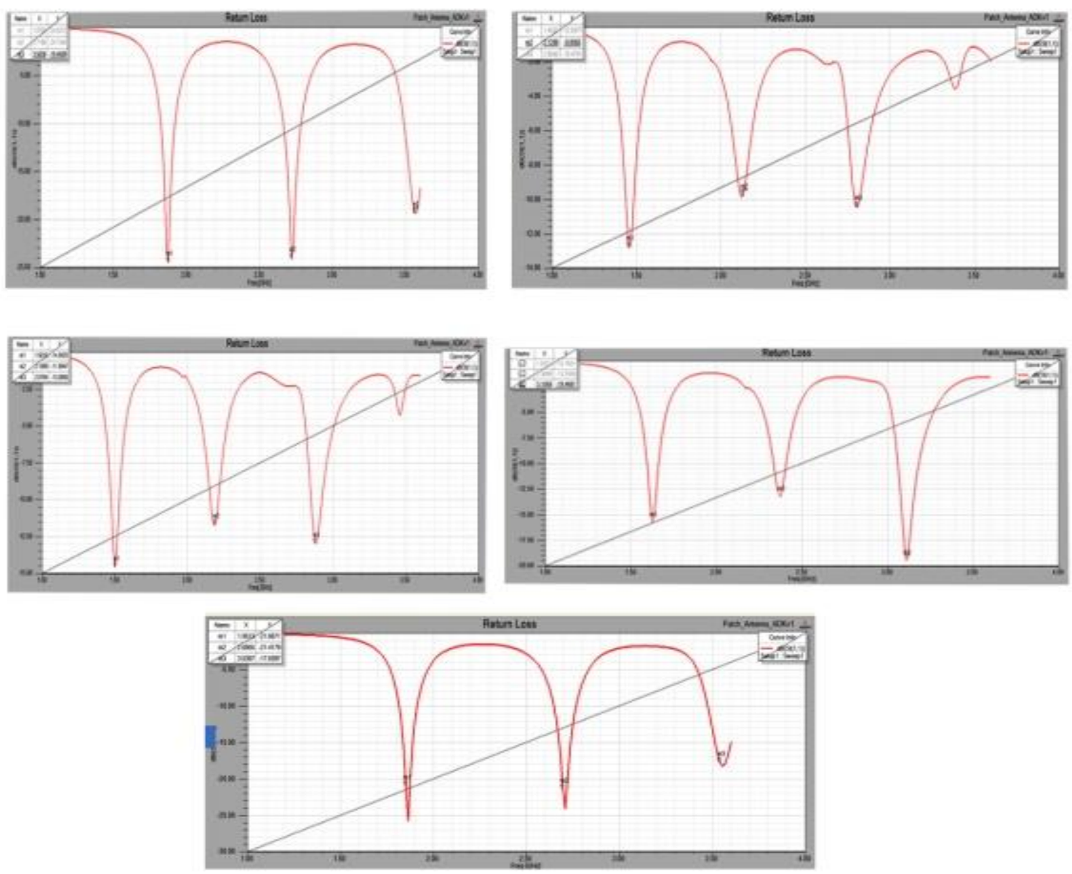

Fig.3 Return loss of different substrates

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Frequency of operation in GHz	Return loss(in dB)
1.8513	-21.0671
2.6955	-21.4179
3.5397	-17.8997

Table (2)-Return loss of RT Duroid 5880

Frequency of operation(GHz)	Return loss (in dB)
1.5136	-14.5496
2.2010	-11.5362
2.9005	-13.4510

Table (3)-Return loss for Taconic RF-35(tm)

Frequency of operation (GHz)	Return loss (dB)
1.4533	-12.916
2.1166	-9.9399
2.8040	-10.3.78

Table (4) - Return loss for Quartz

Frequency of operation (GHz)	Return loss (dB)
1.5015	-14.5135
2.1769	-11.6566
2.8764	-12.9608

Table (5) – Return loss of Roger RD4003 (tm)

Frequency of operation in (GHz)	Return loss (dB)
1.6221	-15.8594
2.3698	-12.9783
3.1055	-18.9061

Table (6) – Return loss for Rubber hard

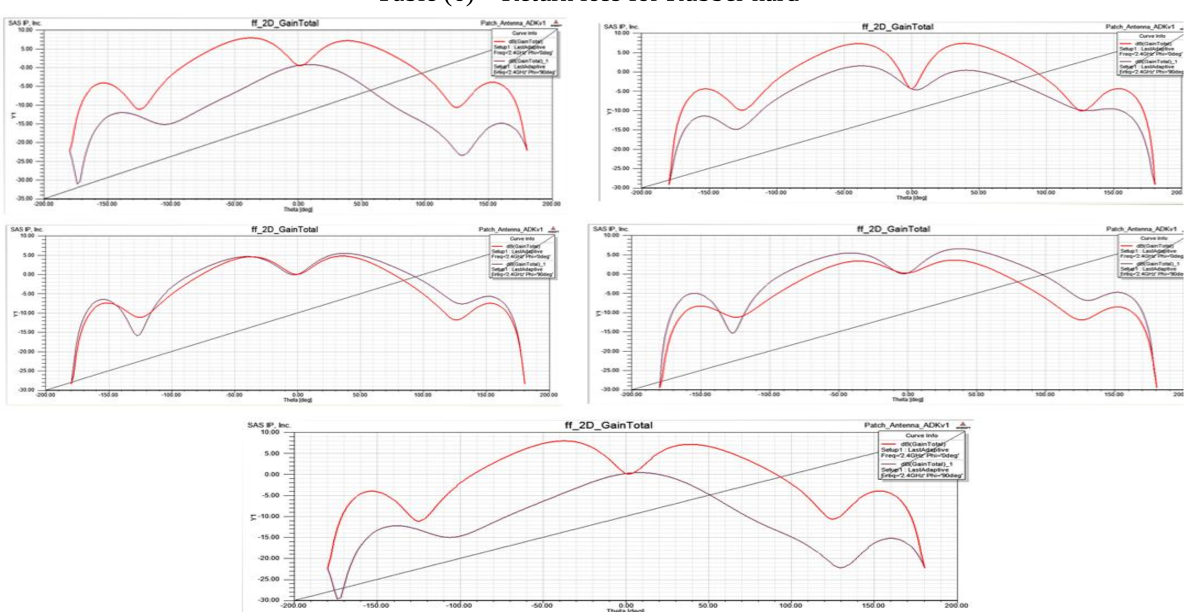

Fig.4 – Gains of different substrates.

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Substrate name	Gain in dB
RT duroid 5880	8
Quartz	3.8
Rubber hard	7.3
Roger RD 4003(tm)	4.9
Taconic RF 35(tm)	5.02

Table(7)-Different gain values of substrates

The Figure (4) gives the gains of different substrates with different dielectric constant values. The gains of different substances are as follows 8 dB, 3.8 dB, 7.3dB, 4.9dB, 5.02 dB for different dielectric constant values of 2.2, 3.78, 3,3.55and 3.45, respectively.

Radiation pattern is a mathematical function or graphical representation of the radiation properties of the antenna as a function of space coordinates. Radiation properties include power flux density, radiation intensity, field strength, directivity phase or polarization state of a particular patch antenna.

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V. CONCLUSIONS

Performance of micro strip serrated patch antenna characteristics based on different materials is investigated and their performance characteristics are shown, simulated and tabulated in this paper. We observed that by increasing the di - electric constant of a substrate material , the gain values are modified. Such serrated structures find wide use because of attractive features such as low cost and small weight and ease of fabrication. Efficient radiation patterns and remarkable gains above 3 dB is obtained for different frequencies of operation, making such serrated patch antennas very much demanding in real time applications employing a wide range of microwave frequencies.

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