Bandwidth Enhancement of Hybrid Tri-Rect Slotted Microstrip Patch Antenna

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Abstract: **In this paper a new hybrid tri-rect slotted micro-strip patch antenna operating at 5.1 GHz is proposed. An aperture coupling technique is used to check the performance of proposed antenna. This antenna seems to be useful for C-band application. The proposed antenna is designed and simulated using Ansoft HFSS software.**

***Keywords: aperture coupling, return loss, bandwidth, microstrip patch antenna*.**

I. INTRODUCTION

Microstrip patch antennas are commonly used in modern communication systems because it offers low profile, light weight, ease of fabrication and compatibility with printed circuits. It has big disadvantage of narrow bandwidth & low gain [1-4]. The aperture-coupled configuration provides the advantage of isolating spurious feed radiation by use of a common ground plane [5]. Microstrip patch antenna consists of metallic patch over grounded dielectric substrate. The resonant frequency of patch depends on length & width of patch, dielectric constant and height of substrate [6]. Now a days there are many techniques to increase the bandwidth of antennas. It can be enhanced by using thick substrate or by cutting slots of different shapes like H shape [7], U shape [8], annular ring shape [9], L shape [10, 11], Inverted F Shape [12] and triangular cut [13] in the metallic patch.

In this paper a triangular slotted technique is used to improve the bandwidth of antenna. Hybrid tri-rect is efficient to enhance the bandwidth of antenna.

This paper consists of four sections as follows: brief introduction & related work are presented in section I. Section II explains basic design geometry of the antenna. Simulation results & comparative analysis of return loss is presented in section III. Conclusion of the proposed work is presented in section IV.

II. ANTENNA DESIGN

A. Basic Design

A microstrip patch antenna as shown in Fig. 1 fundamentally consists of a radiating patch on one side of a dielectric substrate and a ground plane on the other side. The patch is generally made of high conducting material such as copper or gold and no restriction on the shape.

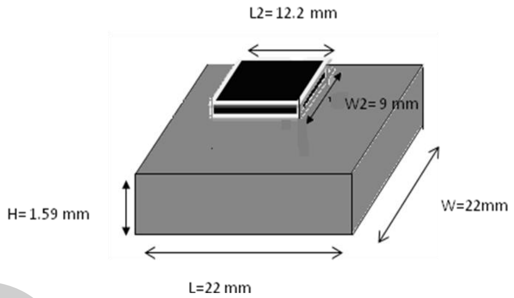

Fig. 1. Microstrip patch antenna

B. Proposed Design

The geometry of the proposed hybrid tri-rect microstrip patch antenna is shown in table I. A rectangular patch of dimensions 9*12.2 mm^2 is printed on the ground plane. Dimension of substrate is 22*22 mm^2 with thickness 1.59 mm and dielectric constant ε_r =4.4. Substrate is divided into two equal parts and ground is sandwich between them.

TABLE I. BASIC PARAMETERS FOR HYBRID TRI-RECT SLOTTED RECTANGULAR MICROSTRIP ANTENNA

Relative permittivity dielectric	4.4
Substrate Material used	Glass epoxy-FR4
Height of Upper substrate	0.759 mm
Height of lower substrate	0.759 mm
Feed line dimension	11*3 mm^2
Stub line dimension	2.1*3 mm^2
Triangle dimension	3.5*3.5*3.5 mm^3

In this proposed design modification is done step by step by cutting one, two and three triangles from the patch. At last four triangular slots at the edges were cut. A rectangular slot of dimension 6.101 * 0.8 mm^2 at the centre of patch is common for all designs. All the added up triangles are symmetric. Step by step proposed designed antenna is shown in Fig. 2a-d.

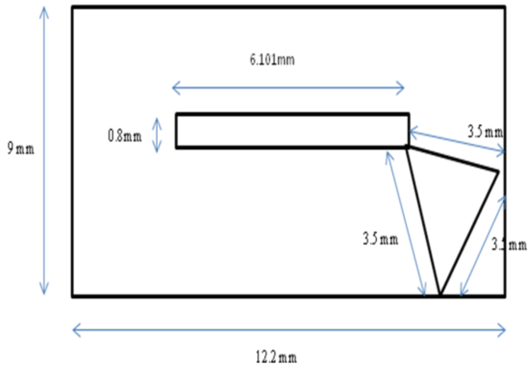

Fig. 2(a)

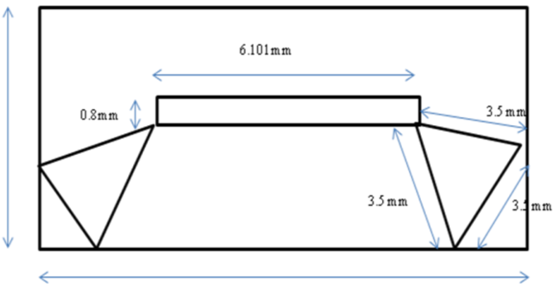

Fig. 2(b)

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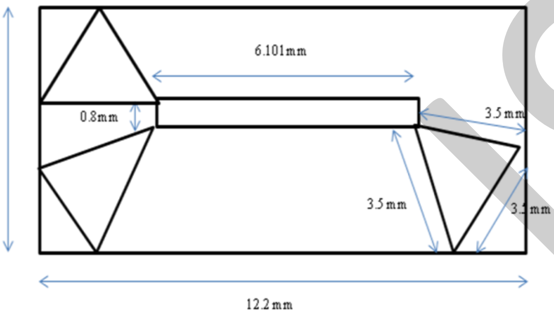

Fig. 2(c)

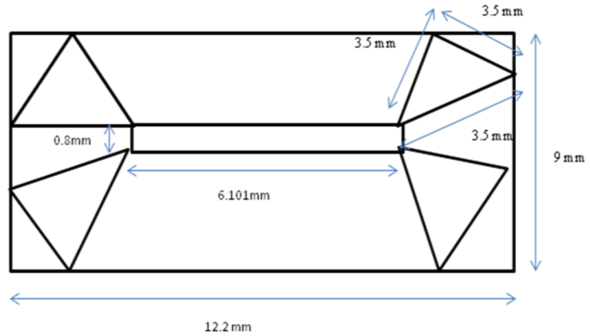

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Fig. 2. Geometry of microstrip antenna with (a) single tri-rect (b) dual tri-rect (c) triple tri-rect (d) Quad tri-rect

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III. ANTENNA ANALYSIS & RESULT

The simulation of antenna is done by Ansoft HFSS software. Firstly stub is adjusted to get return loss because it cancels out undesired reactance at the antenna and tunes it to resonant. From table II a comparison is done between different designs of antenna. Return loss is measured below -10 dB. For maximum coupling, a rectangular slot parallel to the two radiating edges is used for all designs. The measured impedance bandwidth of all antenna designs is shown in table II. It can be further observed from table II that increase in no. of triangle cut in patch, increases bandwidth.

TABLE II. BANDWIDTH ANALYSIS OF DIFFERENT DESIGNS

Design	Lower frequency (GHz)	Upper frequency (GHz)	Bandwidth (%)
Single tri-rect	6.0611	6.4229	5.72
Dual tri-rect	5.2925	5.4267	9.32
Triple tri-rect	4.8092	6.1981	25.92
Quad tri-rect	4.8884	6.4860	31.37

A comparative graph is plotted between bandwidth and different antenna designs as shown in Fig. 3. It may be observed from Fig. 3 that quad tri-rect has maximum bandwidth (31.37%) at 5.1 GHz.

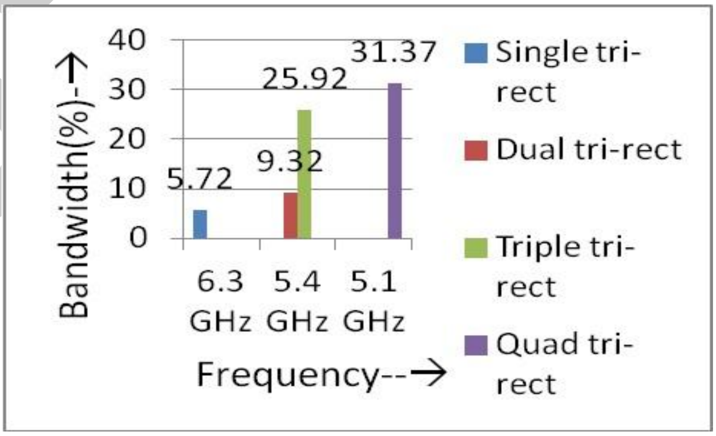

Fig. 3. Bandwidth v/s different antenna design.

Return loss of proposed antenna design is shown in Fig. 4. Return loss is measured below -10 dB and measured bandwidth at 5.1GHz resonant frequency is 31.37%.

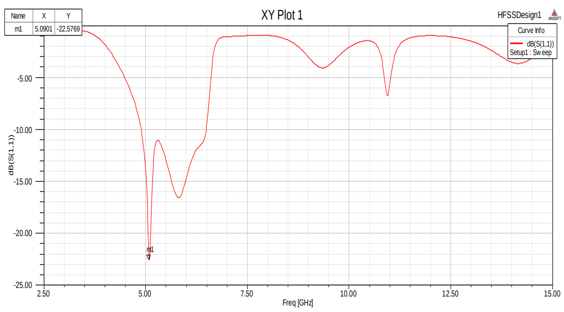

Fig4. Return loss of the proposed hybrid tri-rect slotted rectangular microstrip antenna.

VSWR value of proposed antenna is within 1 to 2 in the operating range i.e. 1.16 at 5.1GHz as shown in Fig. 5.

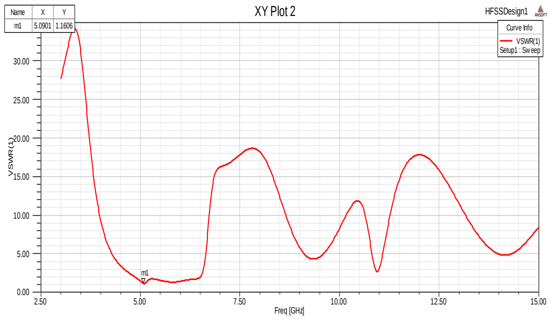

Fig. 5. VSWR of the proposed hybrid tri-rect slotted rectangular microstrip antenna.

The Radiation pattern in 2D is shown in Fig. 6. In Fig. 6, some back lobes are observed which is due to partial ground plane. Gain of an antenna is 13.55 dBm at which it is operating.

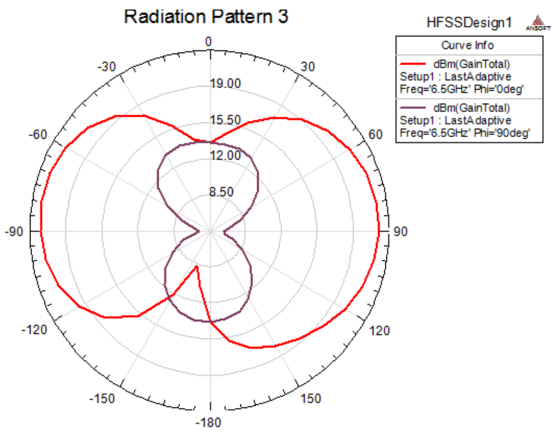

Fig. 6. Radiation pattern of the proposed hybrid tri-rect slotted rectangular microstrip antenna in 2D.

Smith chart represents the actual impedance of an antenna.

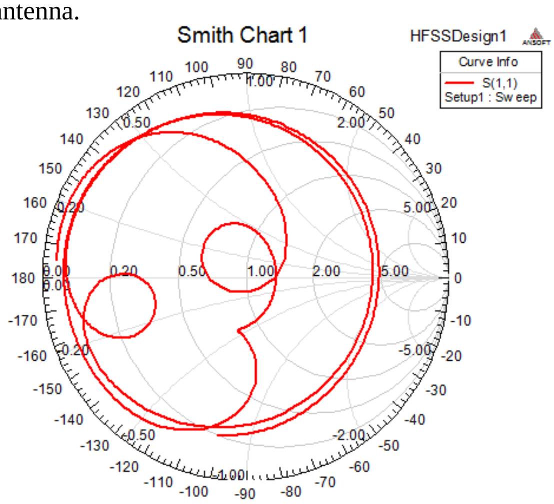

Fig7. Smith chart of the proposed hybrid tri-rect slotted rectangular microstrip antenna.

Proposed antenna design is showing (Fig. 7) a proper impedance matching of 50Ω.

IV. CONCLUSION

A simulation result of hybrid tri-rect antenna has 31.37% bandwidth between 4.89 GHz and 6.49 GHz frequencies with 13.55 dBm gain. Proposed antenna justifies its application for wi-fi devices, weather radar system and satellite communication for C-frequency band.

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