International Journal of Computer Applications (0975 – 8887)
International Conference on Advancements in Engineering and Technology (ICAET 2015)

Rectangular Microstrip Patch Antenna with Triangular Slot

Sandeep Singh Sran
Yadavindra College of Engineering
Punjabi University GuruKashi Campus
Talwandi Sabo, Punjab, India

Jagtar Singh Sivia
Yadavindra College of Engineering
Punjabi University GuruKashi Campus
Talwandi Sabo,Punjab, India

ABSTRACT
This paper describes the design of Rectangular Microstrip Patch Antenna with Triangular Slot (RMPATS) at a frequency of f = 2.4 GHz. The proposed antenna has been designed by introducing a triangular slot in the rectangular patch. The FR4-Epoxy with relative permittivity 4.4 and height 1.6 mm is used as substrate material. Antenna is fed by coaxial probe feed. The proposed antenna have acceptable value of return losses (RL) and gain. HFSS software is used for simulation of proposed antenna.

Keywords
Microstrip; Patch; Triangular; Slot; Antenna; Return loss; Gain.

1. INTRODUCTION
Microstrip patch antennas are widely used in many applications in wireless communication. Because microstrip antenna has very attractive features such as low profile, light weight, high efficiency and low cost. But the disadvantages of microstrip antenna has its narrow bandwidth [1]. The techniques used to enhance bandwidth are to choose a thick substrate with low dielectric constant [2] and slotted patch [3-4]. The first technique is limited because the thich substrate require the increased length of the probe feed which introduces large inductance and resulting in increase only a few percentage in the bandwidth at resonant frequency.

By using the second technique (slotted patch) the size of the patch reduces and also results in lowering the antennas fundamental resonant frequency.

Microstrip antennas are also called the patch antennas. The microstrip antenna consist of three layers. The substrate is sandwitched betwen a gound plane and metallic patch [5-6]. The radiating element and the feed line are made by process of photo etching on the dielectric substrate. The patch configuration may be square, rectangular, dipole, circular, elliptical, triangular or any other shapes as shown in Fig 1. Square, rectangular, dipole and circular are the most common because of ease of analysis and fabrication and their attractive radiation characteristics, especially low cross-polarization radiation [3]. In its simplest form a microstrip antenna consists of a patch of metal, usually rectangular or circular (though other shapes are sometimes used) on top of a grounded substrate.

Due to their advantages, they become suitable for various applications like, vehicle based satellite link antennas [7], global positioning systems (GPS) [8], radar for missiles and telemetry [7] and mobile handheld radios or communication devices.

Basically there are four feeding techniques available to us while designing of antenna. These are line feed, probe feed, aperture coupled feed and proximity coupled feed. The feed that is used here is probe feed (or coaxial feed).

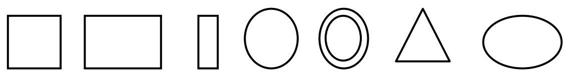

Fig 1: Common available shapes of Microstrip

In this paper we proposed the rectangular microstrip patch antenna with triangular slot. The triangular slot is cut in the which is mounted on the substrate. We use here the FR4 epoxy as the substrate material with height of 1.6 mm, relative permittivity of 4.4 and loss tangent of 0.02.

2. DESIGN OF PROPOSED ANTENNA
The Geometry of proposed antenna is shown in Fig 2.

2.1 Without Slot

Substrate:	Material: FR4 epoxy
	Width: 60 mm
	Length: 60 mm
	Height: 1.6 mm
	Position: -30, -30, 0
Patch:	Width: 38.04 mm
	Length: 29.44 mm
	Position: -19.02, -14.72, 1.6
Feed Line:	Location: offset from center in y direction (0, 7, 1.6)
	Coaxial inner radius: 0.3 mm
	Coaxial outer radius: 0.5 mm

2.2 With Slot
All the dimensions are same as without slot. But the dimensions of the slot are given below:

Slot:	Traingle
	1st line length 12.80 mm
	From Point 1(0, -2, 1.6) to Point 2(-10, -10, 1.6)
	2nd line length 20 mm
	From Point 1(-10, -10, 1.6) to Point 2(10, -10, 1.6)
	3rd line length 12.80 mm
	From Point 1(10, -10, 1.6) to Point 2(0, -2, 1.6)

Feed Line: Location: offset from center in y direction (5, 7, 1.6)

Coaxial inner radius: 0.3 mm

Coaxial outer radius: 0.5

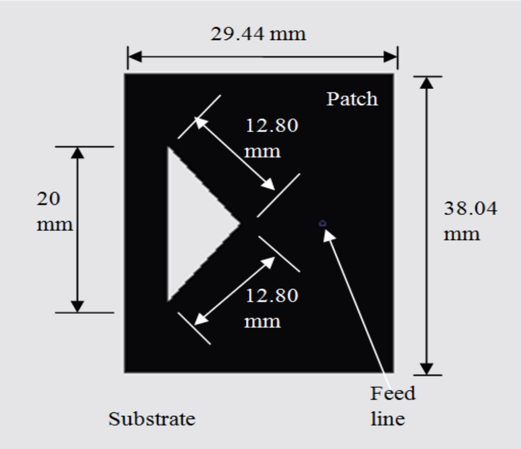

Fig 2: Geometry of RMPATS

3. RESULTS

The Results of Rectangular Microstrip Patch Antenna (RMPA) without triangular slot and With triangular slot in terms of performance parameters such as RL, gain, directivity & bandwidth are shown in Table 1 and Table 2 respectively.

Table 1. Perfoemance parameters of RMPA without slot

Freq. GHz	Return Losses db	Lower Freq. GHz	Upper Freq. GHz	Gain db	BW MHz
2.35	-13.19	2.3194	2.3821	+2.08	62.7
3.70	-11.57	3.6643	3.7451	+1.20	80.8
4.49	-10.06	4.4855	4.5004	-3.20	14.9
7.00	-11.42	6.9678	7.0417	+7.77	73.9
7.42	-20.70	7.3302	7.4972	+6.14	16.7

Table 2. Performance parameters of RMPA with slot

Freq. GHz	Return Losses db	Lower Freq. GHz	Upper Freq. GHz	Gain db	BW MHz
2.15	-15.27	2.1213	2.1881	+7.37	66.8
3.69	-18.58	3.6646	3.7480	+1.11	103.4
5.43	-30.73	5.3610	5.4953	+6.22	134.3
6.10	-12.51	6.0473	6.1432	+2.57	95.9
6.80	-24.65	6.6690	6.9116	+4.13	242.6
8.19	-43.98	8.1225	8.2573	+3.56	134.8
9.79	-29.97	9.6028	10.000	+4.72	397.2

From the table it is clear that with adding triangular slot it is clear that without slot upper two and lower two resonant frequencies 2.35 GHz, 3.70 GHz, 7 GHz, 7.42 GHz are shifting to lower side 2.15 GHz, 3.69 GHz, 6.10 GHz, 6.80 GHz. Also the antenna without slot has negative gain on 4.49 GHz frequency but by adding triangular slot the gain of antenna at all resonant frequencies becomes positive. Triangular slot there antenna has more frequency bands than without slot Antenna. The gain at Frequency 2.15 GHz is 7.37 db.

3.1 ReturnLosses

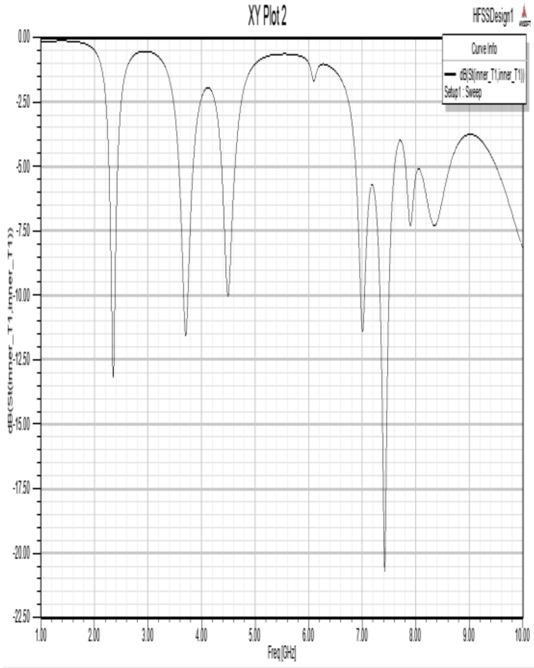

Fig 3: Return loss versus frequency plot without slot

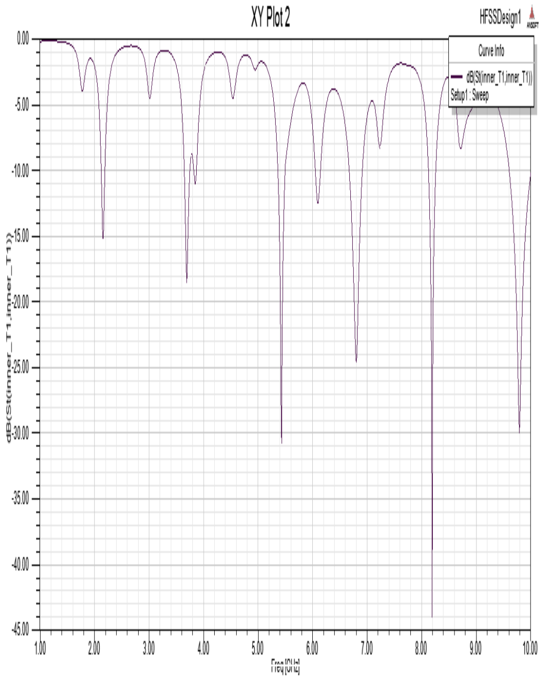

Fig 4: Return loss versus frequency plot with slot

RL versus frequency plot for the proposed antenna without slot and with slot are shown in Fig 3 and Fig 4 From the graph it is clear that return loss has been improved by cutting a slot than without cutting a slot.

3.2 Gain

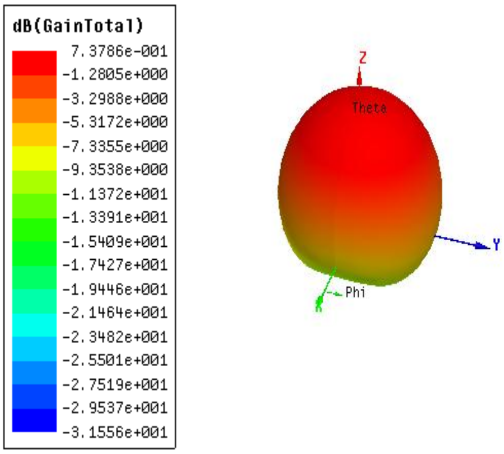

Fig 5: Three dimension radiation pattern

Three dimension radiation pattern of proposed antenna at one resonant frequencies 2.15 GHz is shown in figure 5, which shows that the proposed antenna has gain of 7.37 db at 2.15 GHz frequency.

3.3 Bandwidth

We measured the bandwidth with reference to the -3dB points on the S11 curve. The -10 dB of return loss is an acceptable level of value to describe the loss of the power which reflects back from the antenna [7]. Bandwidth of antenna without & with slot at different frequencies are shown in Table 1 and Table 2 respectively.

4. CONCLUSION

From the simulation analysis of propoed antenna it can be easily observed that the designed RMPATS has a gain of 7.37 db and optimized return loses -15 db at a frequency of 2.15 GHz. It has also improved values of return losses, gain and bandwidth and no. of bands of resonant frequencies. RMPATS can be used for Wireless Communication applications. The proposed antennas have achieved good impedance matching, stableradiation patterns, and high gain.

5. REFERENCES

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