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Electrical Engineering

Elixir Elec. Engg. 52 (2012) 11302-11304

ISSN: 2229-712X

# A compact printed antenna for quad band Applications in wireless communication

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ARTICLE INFO

**Article history:**
Received: 24 September 2012;
Received in revised form:
23 October 2012;
Accepted: 3 November 2012;

**Keywords**
Compact,
Conventional,
Patch,
Slit .

ABSTRACT

A single feed compact rectangular microstrip antenna is presented in this paper. L & H slits are introduced on the edge of the patch to study the effect of the slit on radiation behavior with respect to a conventional microstrip patch. The resonant frequencies are obtained at 2.21, 2.4, 4.36 & 6.41 GHz with corresponding bandwidth 15.18 MHz, 11.85 MHz, 15.14 MHz, 78.91 MHz and return loss of about -23.62, -13.58, -11.46 & -15.65 dB respectively. The antenna has been reduced by 61% when compared to a conventional rectangular microstrip patch. The characteristics of the designed structure are investigated by using MoM based electromagnetic solver, IE3D.



## Introduction

In recent year demand for small antennas in wireless communication system has increased the interest of research work in compact microstrip antennas [1-4]. It is highly desirable to integrate several RF modules for different frequencies into one piece of equipment. Hence, multi-band antennas that can be used simultaneously in different standards have been in the focus points of many research projects [5-7] . To reduce the size of the antenna one of the effective technique is cutting slit in proper position on the microstrip patch. The proposed quad band antenna (substrate with $\varepsilon_r$=4.4) is simulated for the frequency of 2.21, 2.4, 4.36 GHz and 6.41 GHz. It has maximum gain of 5.01 dBi at 6.41 GHz and presents a size reduction of about 61 % when compared to a conventional microstrip patch. The simulation has been carried out by IE3D [10] software which uses the MOM method. Due to the Small size, low cost and low weight this antenna is a good candidate for the application of wireless communication systems, mobile phones and laptops.

## Antenna Design

The configuration of the proposed antenna is shown in Figure 1. The antenna is a 26mm (W) x 20 mm (L) patch. The dielectric material selected for this design is an FR4 epoxy with $\varepsilon_r$=4.4 and substrate height =1.6 mm. A 50 Ω inset microstrip line feed is attached to the patch and has a width $w_3$ (1 mm) and length $l_1$ (8mm).

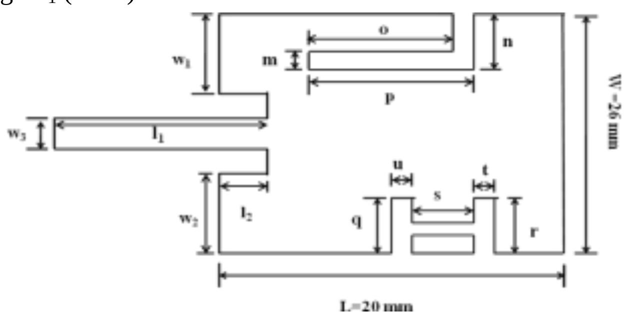


**Figure 1. Antenna Configuration**

The optimal parameter values of the antenna are listed in Table I.

**Table I**

| Parameters | m | n | o | p | $w_1$ | $l_2$ | q | r | s | t | u | $w_2$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Values (mm) | 1 | 6.25 | 5.5 | 6.5 | 11 | 1.5 | 10 | 10 | 4.5 | 1 | 1 | 11 |

## Simulated results and discussion

The simulated return loss (using IE3D [10]) of the conventional & proposed antennas is shown in Figure. 2 & 3.

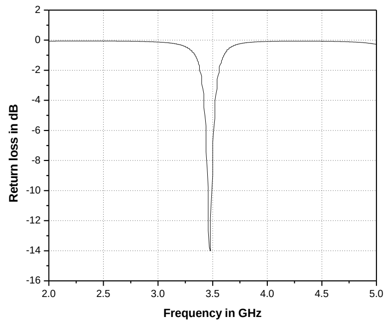


**Figure 2. Simulated return loss of the conventional antenna**

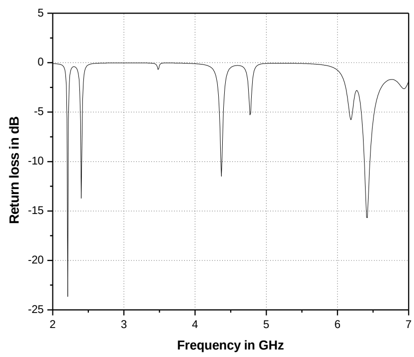


**Figure 3. Simulated return loss of the proposed antenna**

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In conventional antenna return loss found of about -13.88 dB at 3.47 GHz & corresponding bandwidth is 35.48 MHz. For antenna 2 return losses -23.62 dB is obtained at 2.21 GHz, -13.58 dB at 2.4 GHz, -11.46 dB at 4.36 GHZ and -15.65 dB at 6.41 GHz and corresponding 10 dB bandwidth is 15.18 MHz, 11.85 MHz, 15.14 MHz and 78.91 MHz respectively.

**Simulated radiation pattern**

The simulated E plane and H plane radiation patterns for antenna 2 are shown in Figure 4-11.

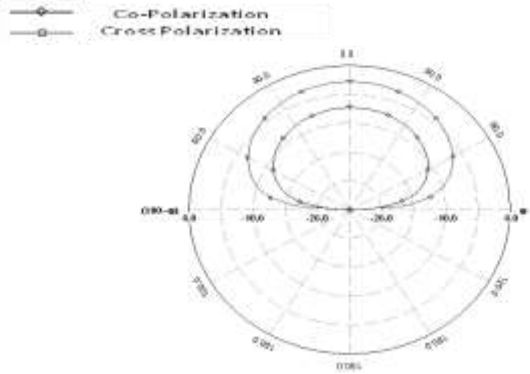


**Figure 4 . E plane Radiation Pattern of the antenna 2 for 2.21 GHz**

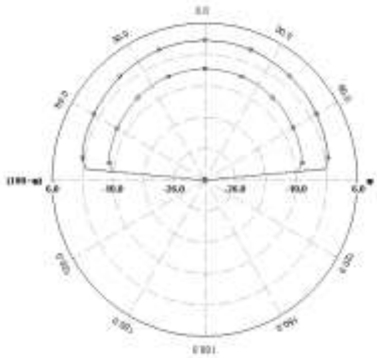

**Figure 5 . H plane Radiation Pattern of the antenna 2 for 2.21 GHz**

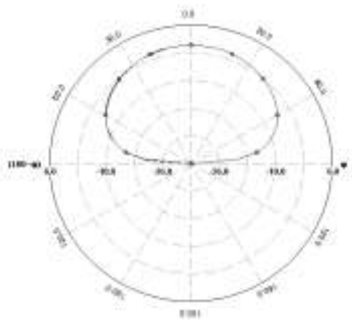

**Figure 6 . E plane Radiation Pattern of the antenna 2 for 2.4 GHz**

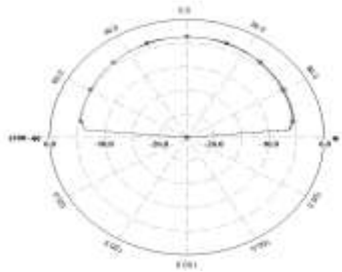

**Figure 7 . H plane Radiation Pattern of the antenna 2 for 2.4 GHz**

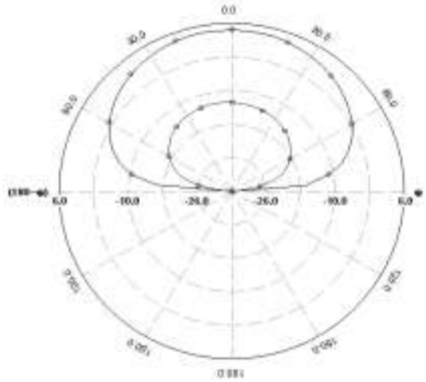

**Figure 8 . E plane Radiation Pattern of the antenna 2 for 4.36 GHz**

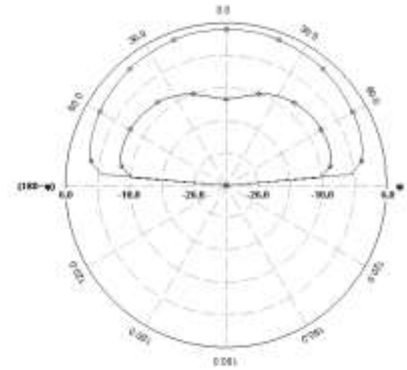

**Figure 9 . H plane Radiation Pattern of the antenna 2 for 4.36 GHz**

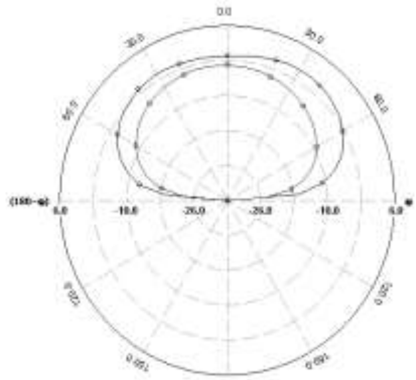

**Figure 10 . E plane Radiation Pattern of the antenna 2 for 6.41 GHz**

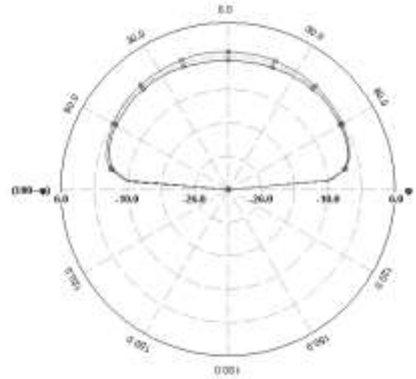

**Figure 11 . H plane Radiation Pattern of the antenna 2 for 6.41 GHz**

Figure 12 shows the Gain versus frequency plot for the antenna 2.It is observed that gain is about .82 dBi for 2.21 GHz, 3.23 dBi for 2.4 GHz , 4.55 dBi for 4.36 GHz & 5.01 dBi for 6.41 GHz.

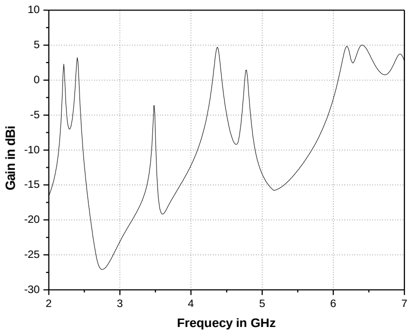


**Figure 12. Gain versus frequency plot for the antenna 2.**

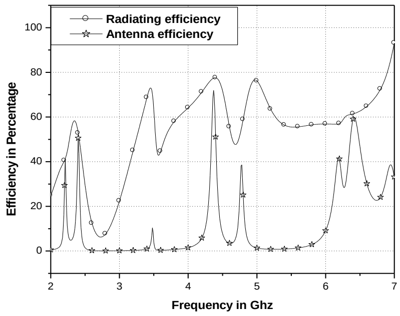


**Figure 13. Antenna efficiency versus frequency plot for the antenna 2.**

Efficiency of the antenna 2 with the variation of frequency is shown in figure 13. It is found that antenna efficiency is about 41.07 % for 2.21 GHz, 50.35 % for 2.4 GHz, 71.78 % for 4.36 GHz & 59.64 % for 6.41 GHz.

## IV. Experimental results

Comparisons between the measured return losses with the simulated ones are shown in Fig.14 and 15. All the measurements are carried out using Vector Network Analyzer (VNA) Agilent N5 230A.The agreement between the simulated and measured data is reasonably good. The discrepancy between the measured and simulated results is due to the effect of improper soldering of SMA connector or fabrication tolerance.

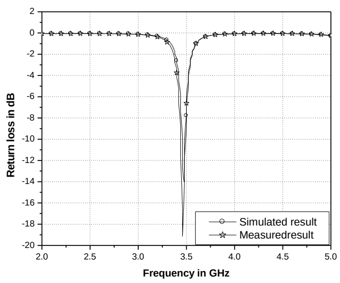


**Figure 14. Comparison between measured and simulated return losses for antenna1**

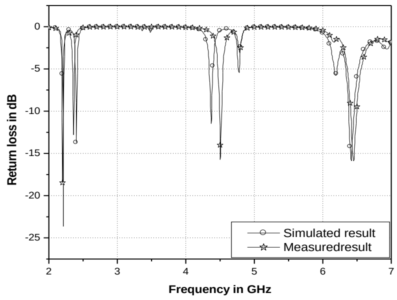


**Figure 15. Comparison between measured and simulated return losses for antenna2**

## Conclusion

A single feed single layer L & H slit microstrip antenna has been proposed in this paper. It is shown that the proposed antenna can operate in quad frequency bands. The slit reduced the size of the antenna by 61 % and increase the bandwidth up to 78.91 MHz with a return loss of -15.65 dB, absolute gain about 5.01 dBi . Efficiency of antenna has been achieved 71.78 %. An optimization between size reduction and bandwidth enhancement is maintained in this work.

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