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A COMPACT DUAL SQUARE RING SLOTS MICROSTRIP ANTENNA FOR DUAL BAND WIRELESS APPLICATION

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ABSTRACT

This paper presents the simulation study of dual square slots ring antenna for dual band wireless application. The proposed antenna geometry exited by a single probe fed connected to the patch directly. The proposed geometry consists of two concentric, coplanar square slots ring at different position from the center of the patch. For dual frequency operation two square slots ring is etched on patch. The radiating elements of the proposed geometry of antenna operate at dual frequencies 3.8 GHz, and 10 GHz. The antenna size is very compact 16 x 16 x 3.12 mm^3, which can be easily integrated with RF circuit. The proposed antenna design is simulated and optimized using IE3D simulation software.

KEYWORDS: Dual Band, Impedance Bandwidth, Microstrip Antenna

INTRODUCTION

Today microstrip antennas plays an important role in several wireless applications (GSM, Wi- Max, RFID etc.) because of there advantages like easy to design and fabrication [1-3] and very suitable for multi-band operation. With few serious limitations such as low impedance bandwidth, and gain. But in literature we have numerous techniques to improve these, especially improving the impedance bandwidth. There are different techniques such as cutting slot in basic geometry [4]. Bandwidth can also be improved by etching dummy electromagnetic band gap (EBG) [5], or by modifying ground plane [6]. On the other hand, a suspended microstrip antenna [7] gives another technique to improve impedance bandwidth. However, the use of air gap increases the overall volume of the antenna which is undesired in several applications [8]. So, for some application we need to reduce or remove the air-gap reported in [8].

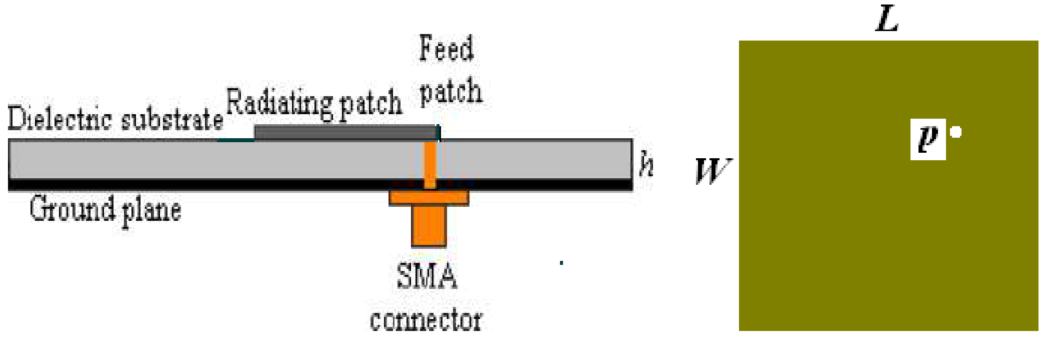
Many compact microstrip antennas are reported which operates at dual or multi-band operation [9-16]. For example antenna reported in [9, 10] are microstrip ring antenna operating at dual frequency band. Whereas in [11] slots are implemented in patch to get multi-band. On the other hand dual fed technique is reported in [12, 13], or a stub is loaded to a rectangular patch [14] to achieve dual frequency band.

As we have already discussed in the above paragraph, some of the application required compact antenna geometry which occupy very small space in wireless devices. Hence in this paper we proposed very compact geometry, which uses slots for similar design reported earlier. The proposed antenna developed is suitable for wireless applications, where dual band is needed.

The basic geometry and position of feed point are presented in section 2. The basic antenna design starts with selection of center frequency and optimized using IE3D simulation software. The proposed antenna geometry with two concentric coplanar square slots ring is presented in section 3. The simulation studies of different parameters are discussed in section 4. Conclusions of these studies are given in section 5.

BASIC ANTENNA GEOMETRY

Basic antenna geometry is as shown in (figure 1) starts with selection of central frequency of operation using simple technique explained in [1]. This is basically square patch etched on FR-4 substrate having relative dielectric constant ε_r = 4.4, loss tangent tan δ = 0.02, and thickness 'h' = 3.12mm. The basic geometry is designed to operate at central frequency 5.7GHz. Feed point is optimized using IE3D simulation software. The effect of fed position 'p' on S_{11} parameter is as shown in (figure 2).



(a) (b)

Figure 1: Basic Antenna Geometry (a) Cross Sectional View (b) Top View

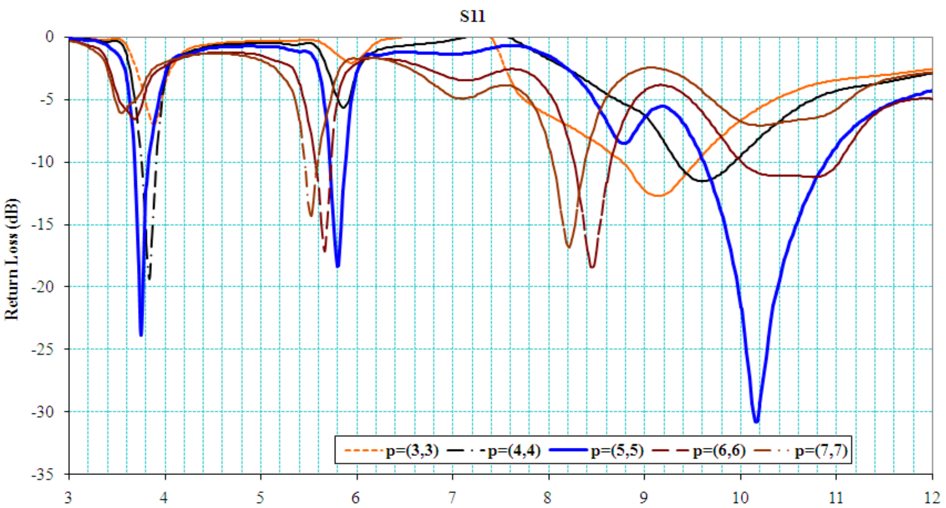


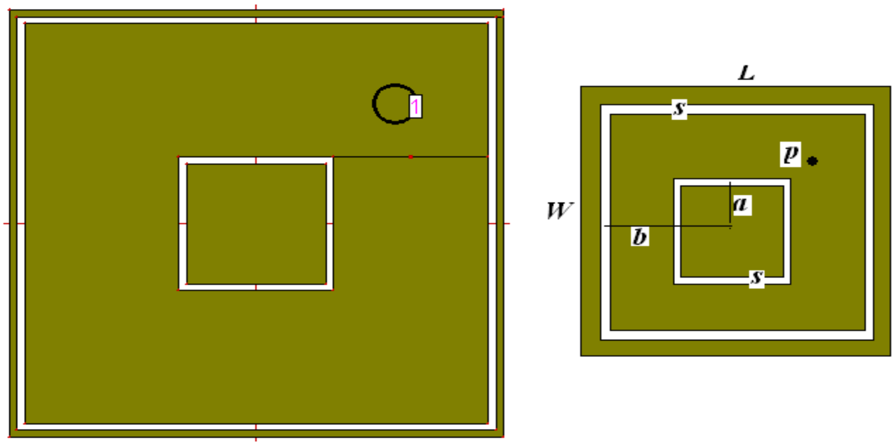
Figure 2: Return Loss Characteristics for Different Position of the Fed

The radiator patch dimensions are calculated from standard design expressions explained in [1, 3].

A thick substrate is used to increase the impedance bandwidth of proposed antenna design. The optimized position of fed is 'p'= (5mm, 5mm) from the center of the patch in order to achieve dual band configuration. The proposed antenna design and simulation study are explained in subsequent section.

PROPOSED ANTENNA GEOMETRY

In the proposed antenna design study we use a glass epoxy substrate (dielectric constant = 4.4, tan δ = 0.02, and thickness = 3.12mm), the patch dimension of proposed antenna is same as basic geometry explain in previous section, with two square slots ring etched on the same surface of patch. A square slots ring in the basic geometry can increase the impedance bandwidth. (Figure 3) Shows that the proposed antenna geometry, all physical parameters with square slots ring is optimized with the IE3D, which is a method of moment (MoM) based software, and optimized value is listed in (table 1). The detail simulation study of different parameter is explained in next section.



(a) (b)

Figure 3: (a) Simulated Geometry on IE3D (b) Top View of Proposed Antenna Geometry

Table 1: Optimized Dimension of the Proposed Antenna

Length of proposed geometry '*L'*	16.0mm
Width of proposed geometry '*W'*	16.0mm
Position of fed point '*p'*	(5,5)mm
Position of inner ring from center of the patch '*a*'	2.0mm
Position of outer ring from the center of patch '*b*'	7.5mm
Width of inner slot and outer slots '*s*'	0.25mm

SIMULATION RESULTS AND DISCUSSIONS

The proposed geometry shown in (figure 3) is simulating using IE3D, which uses method of moment (MoM) based electromagnetic (EM) software. All physical parameter (length '*L',* width '*W'*, slot position '*a*' and '*b*', feed position '*p*', and slot width '*s*') have been investigated to analyzed the effect on antenna performances are discussed in subsections.

Effect of Outer Square Slots Ring Position and Slot Width

The effect of outer square slots ring on S_{11} parameter is as shown in (figure 4). In this study first take a fixed slot width and change the position of slot with respect to the center of patch, and analyze the change in return loss parameter of the proposed antenna. We can get more optimized value when slot width decreases to 0.25mm and making slot position '*b*'= 7.5mm from the center of the patch. The optimized value of slot width, and slot position is shown in (figure 5).

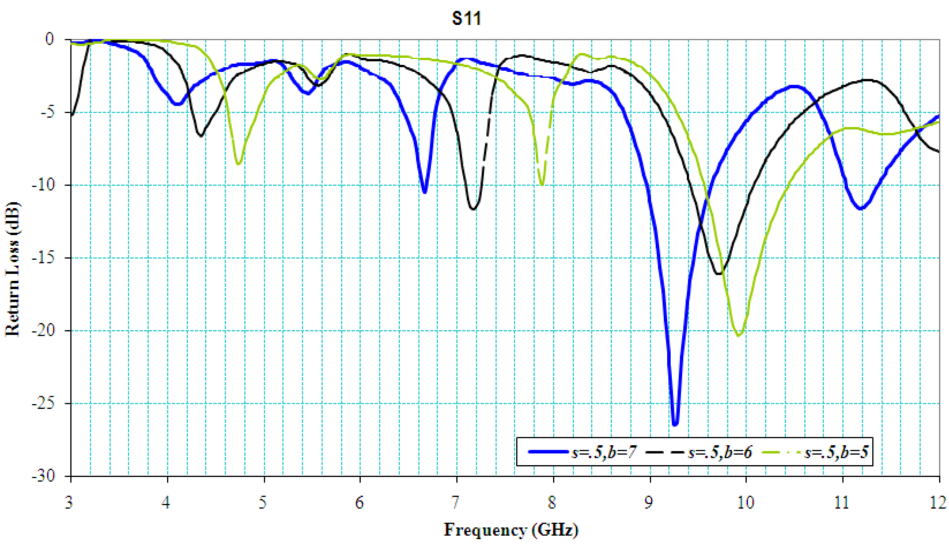


Figure 4: Return Loss Characteristics of Antenna with Different Value of '*b*' Kipping's' = 0.5mm

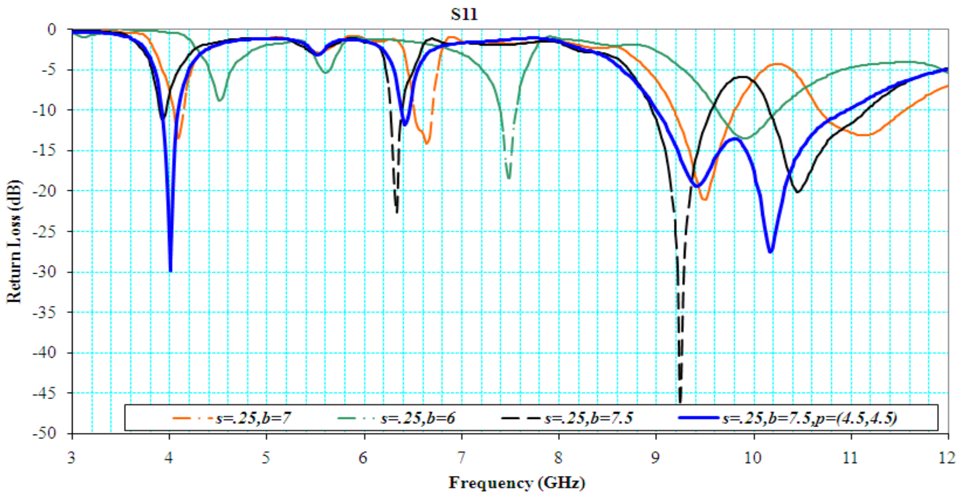


Figure 5: Return Loss Characteristics of Antenna with Different Value of ‘*b*’ Kipping‘s’ = 0.25mm

From all these cases studied, the optimized set of outer slot dimension and slot position is ‘*b*’ = 7.5mm, slot width‘s’= 0.25mm. Also, at both the resonant frequencies, more than 5 dB gain is observed as shown in (figure 6)

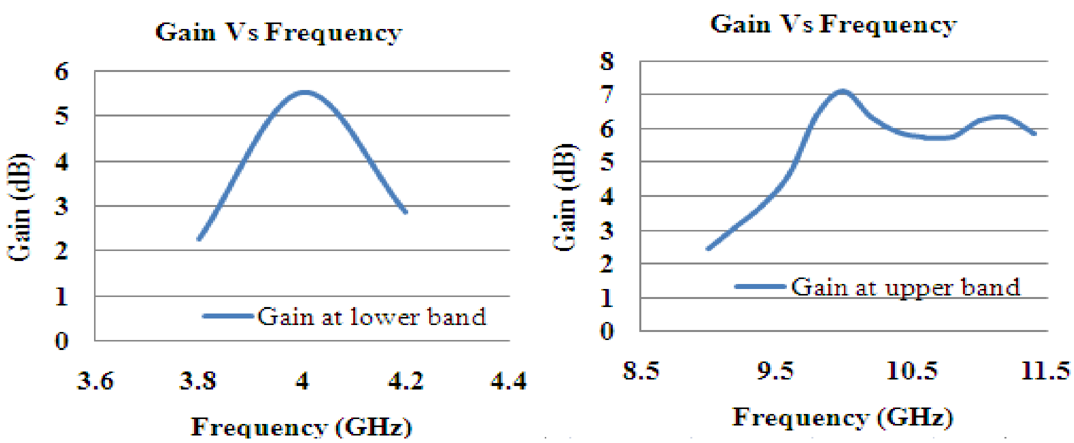


Figure 6: Gain vs Frequency Curve of Proposed Antenna Geometry with Outer Slot Only

Effect of Inner Square Slots Ring Position and Slot Width

The effect of change in position of inner slot ring with slot width‘s’= 0.5mm and with slot width‘s’= 0.25mm on return loss characteristics as shown in (figure 7) and (figure 8.) respectively.

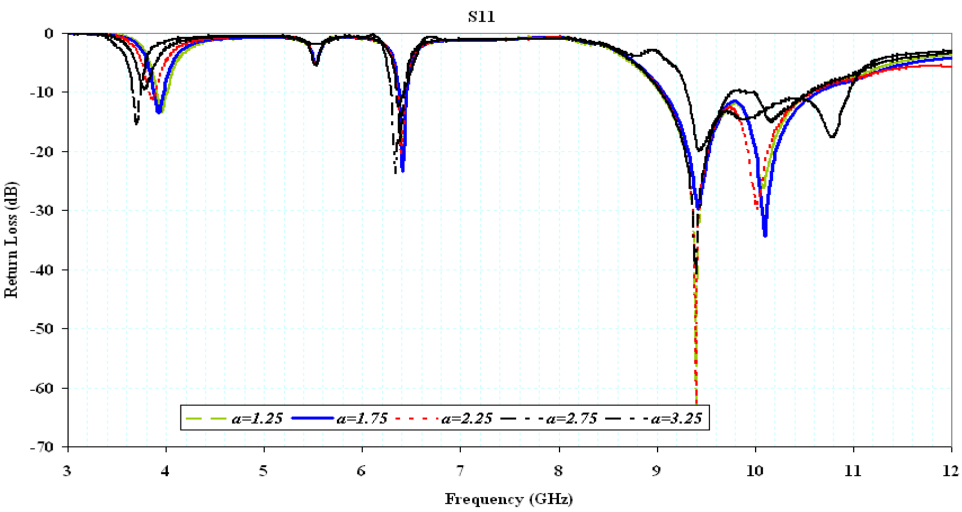


Figure 7: Return Loss Characteristic at Different Value of ‘*a*’ with‘s’ =0.5mm

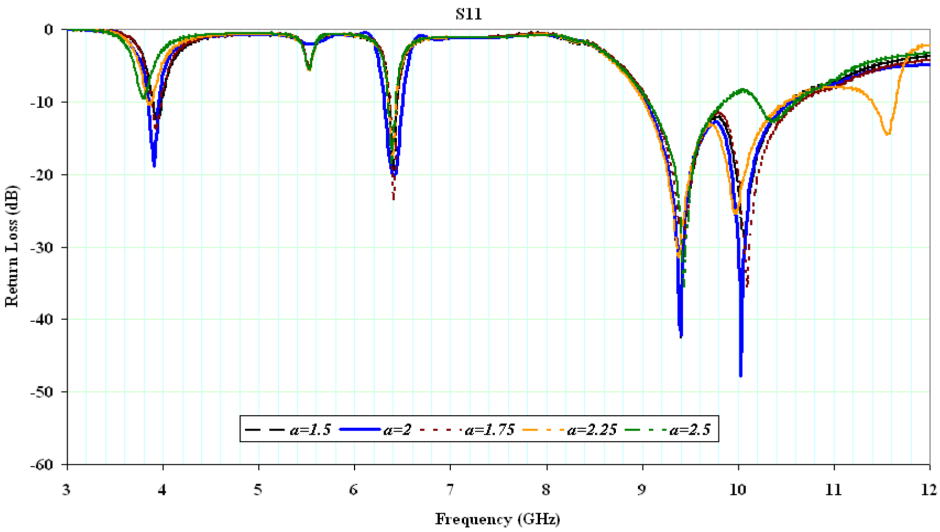


Figure 8: Return Loss Characteristic of Antenna at Different Value of ‘*a*’ with‘s’= 0.25mm

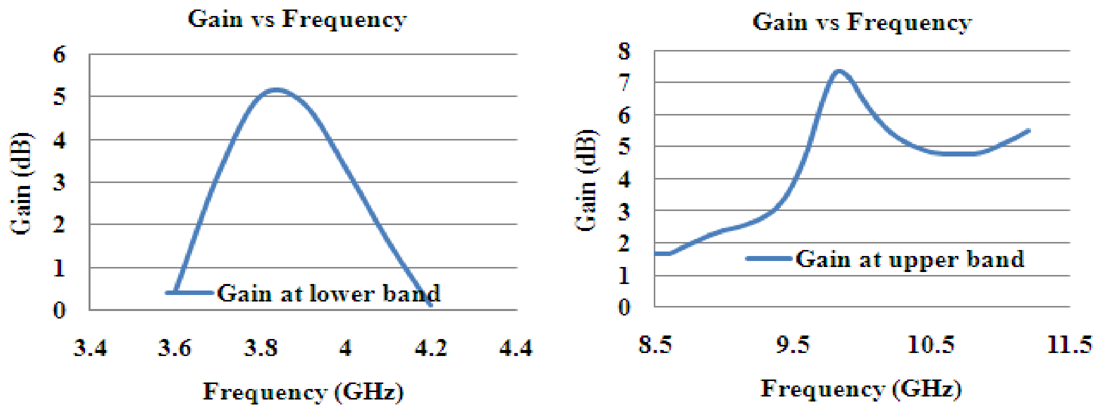


Figure 9: Gain vs Frequency Curve of Proposed Antenna Geometry with Both the Slots

A outer square slot was introduce on the patch to increase the impedance band width and gain of the radiating patch, and Inner Square of same width is to increase the depth of return loss. The gain of the antenna designed with both inner and outer square slots ring of same width is shown in (figure 9), we can observe that the gain of antenna is grater than 5 dB.

CONCLUSIONS

A square patch with two concentric coplanar square slots ring antenna embedded on it has been proposed for dual band application. The proposed antenna gives good gain, and return loss characteristics in all the parameter studded. Also proposed design is very simple, compact, and required very less parameter to optimize. The propose antenna needs to fabricated and tested for its practical validation, require to investigate return loss, gain, radiation pattern. The Antenna presented is very compact and is the best candidate for dual resonant frequency application.

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