Multi Broadband Circularly Polarized Annular Slot Antenna for WLAN Applications

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Abstract- In this study we generate a multi broadband circularly polarized antenna which operates at 5.7G, 8.3G, 9G and 12.3GHZ for Wireless Local Area Networks (WLAN) applications. To cover the X-band, the inner circular patch of the aforementioned design is modified as an inner ring patch loaded with a varying position of a narrow U-shaped strip. A crescent parasitic element is embedding into the circular slot of the inner ring patch; the cp band is drastically broadened to 5.7G, 8.3G, 9G and 12.3GHZ. This design shows two wide 3dB axial ratio bands of 44.64% (4.5-7GHZ) and 11.1% (8.5-9.5GHZ) and their corresponding 10dB impedance bandwidths are 17.5%(6.1-5.1GHZ) and 8.43%(8-8.7GHZ). For WLAN applications this proposed designs having compact size, low cost, easy integration and multi-broad bands are more suitable.

Keywords- Ring slot, lightning shaped slot, ARSA (Annular Ring Slot Antenna), Circular Polarization, U-shaped strip line, impedance matching.

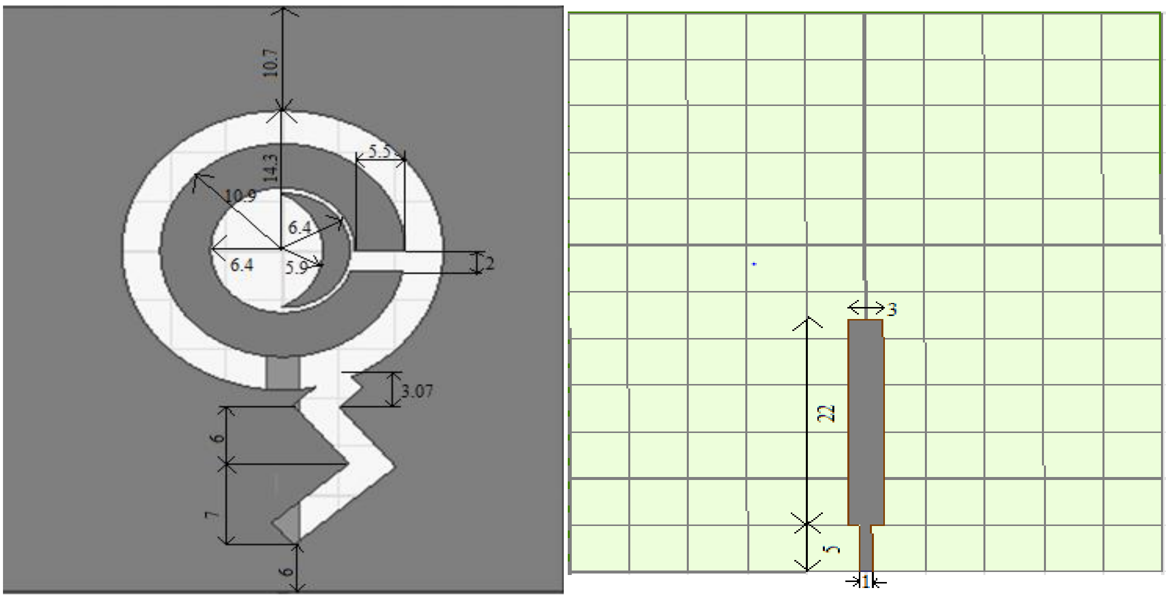
I. INTRODUCTION

The circularly polarized antennas are very useful for many wireless communication applications because they can overcome Faraday rotation effects and mitigate multipath interferences. From the reference antenna we observed that it Generates 2.4/5.2/5.8 GHz. With some modifications we generate the frequencies Such as 5.7/8.3/9/12.3 GHz which operates in X-band. By the use of high frequency bands in wireless applications the existing designs are not satisfied.

This design has the advantages of low cost, compact size; easy integration & the distance communication are most suitable for wireless technologies. Therefore, it is a big challenge to realize a Multi band cp antenna to cover the entire WLAN band by using this structure. Most works are based on the stacked method. However, these antennas are more in use but this structure is slightly difficult.

Some printed designs for multi band are shown in Fig: 1 (a) and (b) these are based on patch antennas, slot antennas, monopole antennas. Even though these designs satisfies the requirements of WLAN (5.7/8.3)GHz but they are unable to cover the upper band in WLAN 9/12.3GHz. Unfortunately, these bands are not enough for WLAN.

By loading a lightning shaped slot at the bottom of the ring slot we observed that it has the cp bandwidth of 44.64% (4.5-7) GHz and 11.1% (8.5-9.5) GHz. To achieve multi band operation, the inner circular patch of the annular ring structure is modified and an additional higher band to cover the WLAN 12.3GHz, this modified multi band is referred as proposed antenna 1(a). Crescent parasitic element is loaded into the circular slot of the inner ring patch, then the cp band is significantly broadened and their corresponding bandwidth. This band of frequencies can cover the entire X-band.



a **b**

Fig.1: (a). Proposed Antenna (b). Micro Strip Feed

By loading a lightning shaped slot at the bottom of the ring slot we observed that it has the cp bandwidth. To achieve multi band operation, the inner circular patch of the annular ring structure is modified and an additional higher band to cover the WLAN 9GHz. This modified multi band is referred as proposed antenna 1(a) crescent parasitic element is loaded into the circular slot of the inner ring patch, then the cp band is significantly broadened to cover the 12.3 and their Corresponding 10dB bandwidths are 17.5%(6.1-5.1GHZ) and 8.43%(8-8.7GHZ). These bands of frequencies can cover the entire X-band.

II. PRPOSED ANTENNA "WLAN" 5.7/8.3/9/12.5 GHz:

A. Geometry of Proposed Antenna

Proposed antenna is a modified version of ARSA as mentioned in the Previous discussion. The geometry of proposed antenna shown in Fig 1. It is fabricated on a thin FR4 substrate with a relative permittivity of 4.4 and a loss tangent of 0.02 with a size of 60mm×50mm. The micro-strip feeding consists of two sections namely upper and lower sections. The length and width of upper and lower sections are 22×3mm and 3×1mm. The feed line works as an impedance transformer and connects directly to a 50Ω SMA connector. The radii of inner outer slots are 14.3and 10.9mm respectively. The full inner circular patch in has been modified as a ring patch by inserting a circular slot with a radius of 6.4mm in proposed antenna. A narrow U-shaped strip line, composed of two horizontal strip lines (w=4.4mm) and a vertical strip line (2mm in length), is used to reconnect this open gap. Detailed dimensions of the lightning slot (LS) is ¼ wavelength at 2.4GHz, and the connecting

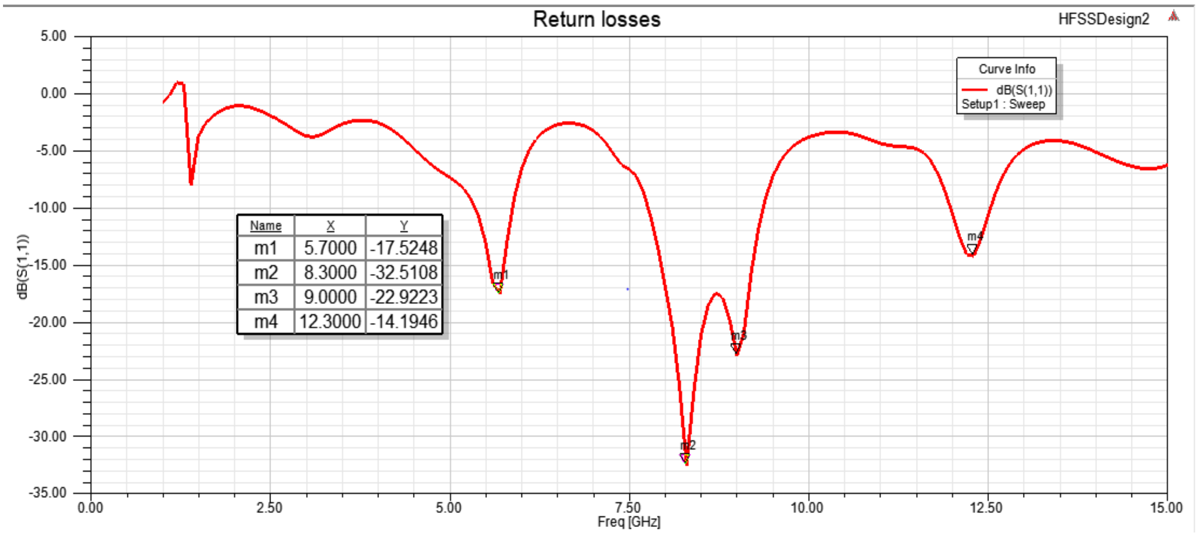


Fig.2: Simulated Results for Return Losses

Angle between the LS and angular slot is 45°. The narrow protruded slot section extended from the bottom of the LS slot, with the size of tuning the cp frequency in the low band. The design process of proposed antenna is shown in Fig 1. The simulated return losses of both proposed has exhibited an additional resonant mode at 5.7/8.3GHz, without affecting the performances in the low band.

An additional crescent parasitic element is loaded into the circular slot of proposed antenna to increase the cp bandwidth in the high band, and two symmetric stubs protruded from the bottom of the micro strip line with a length of ws and a width of 0.5mm are introduced for achieving good impedance matching.

The upper and lower sections of the micro strip line are altered to (22mm×3mm and (5mm×1mm), respectively, which are also for the impedance matching in the high band. The crescent parasitic element is designed by drawing a circle with a radius of 6.4mm centered at coordinate q(25 and -25mm), followed by drawing another circle With a radius of 5.9mm centered at coordinate P (25,-22mm). Their interested area is the crescent parasitic element. This crescent parasitic element can introduce a Higher order slot mode at 12.3GHz which contributes to the cp radiation at 12.5 GHz. With the crescent parasitic element, better cp performances can be achieved in the high band. Detailed parametric studies of Ws will be given later.

B. Parametric Studies Of Proposed Antenna

The simulation conducted in this work is realized by commercial electromagnetic software- Ansys HFSS. The first parameter is the length w of the U-shaped strip line. Since the value of w does not affect the return losses of the antenna, it is shown for brevity. Optimum w is chose as 5.5*2mm. The geometry of proposed antenna is shown in Fig.1 (a) and (b).

According to the aforementioned parametric analysis, the following conclusions are obtained. (i) Adjusting the position of lightning shape can control the cp frequency in the low band and the cp bandwidth in the high band.(ii).tuning w can slightly control the cp frequencies in the low and high bands.(iii).By placing proper radius to the crescent parasitic element we can control the CP frequencies in high band.

III. RESULTS AND DISCUSSION OF PROPOSED ANTENNA

Fig.2. shows the simulated and measured return losses of proposed antenna. The return losses are shown the band of frequencies which can generate by the proposed antenna. The simulation and measurement agree well with each other, and the slight difference is due to the fabrication tolerance. As shown in Fig.2, the measured 10 dB impedance bandwidths for 5.7 and 8.3 in the low and high bands were (4.5-7) GHZ and (8.5-9.5) GHZ respectively. Fig 3 also shows the VSWR (Voltage Standing Wave Ratio) of the proposed antenna. As shown in Fig. 3, the measured peak gains in the low band across 5.7 and 8.3GHz were between 0.37 and 3.9dB, and its corresponding efficiencies for axial ratio are 44.64% and 11.1%. Notably, the Radiation pattern in 2D and 3D plots of proposed antenna was performed. Fig. 5. Shows the magnetic current distributions (at phases 0°, 90°, 180° and 270°) of proposed at 5.7 and 8.3GHz respectively. As observed from these figures, the operating mode in the low band can be considered as the fundamental mode, and the mode in the high band can be considered as the higher order mode.

Here the sense of rotation of proposed antenna (in the low and high bands) is left handed circular polarization (LHCP), because the magnetic current flows in a left hand orientation (counter clockwise direction) along the z-axis. The simulated and measured radiation patterns in two principle planes (x-z and y-z axis) shown in Figs 4 broadside radiation pattern (LHCP) were observed in both low and high bands at the z-axis direction. The magnetic current distributions of antenna are shown in fig.4.

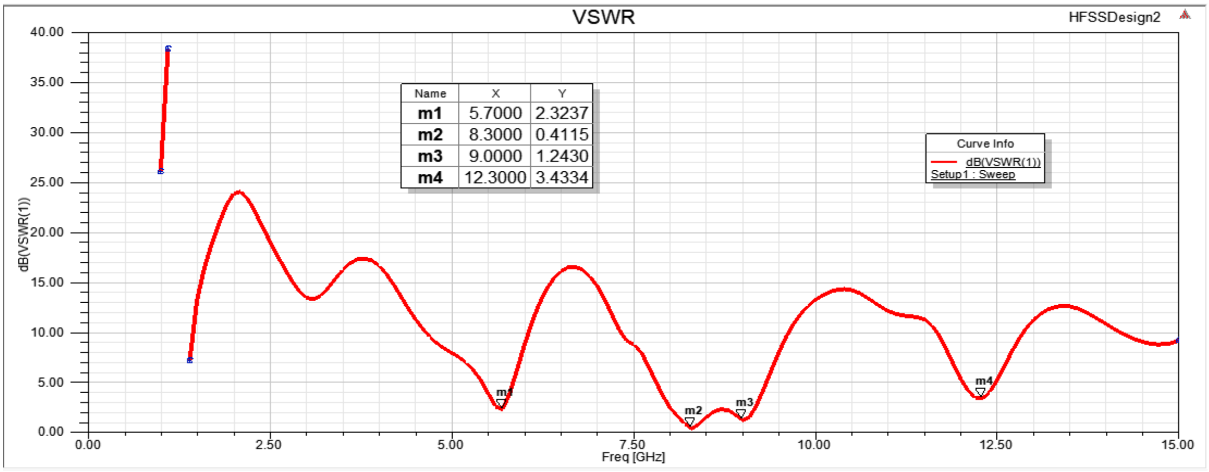
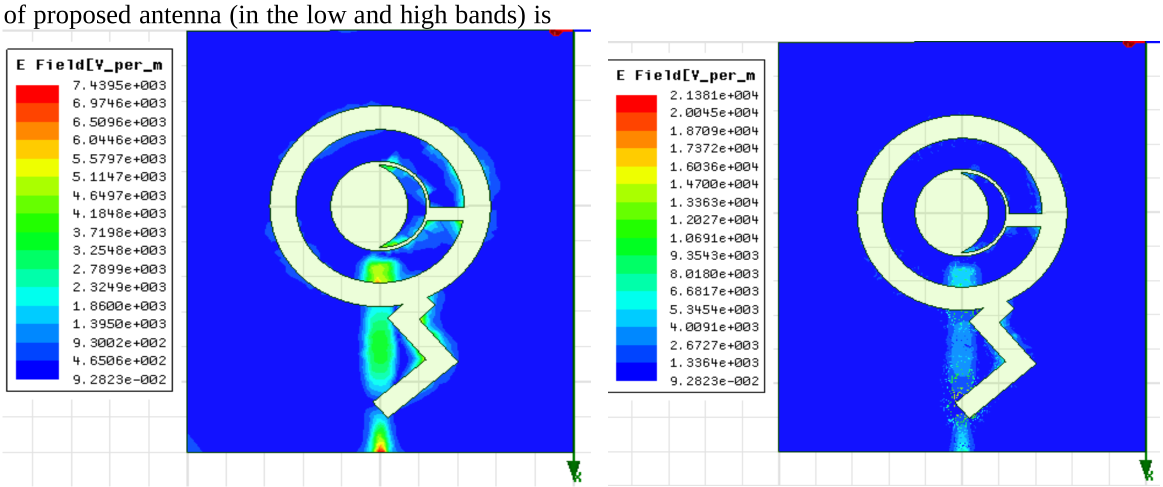


Fig.3: Simulated Results of VSWR (Voltage standing wave ratio)

Figs. 4 show the magnetic current distributions (at phases 0°, 90°, 180° and 270°) of proposed antenna at 5.7 and 8.3GHz respectively. As observed from these figures, the operating mode in the low band can be considered as the fundamental mode (TM11 mode), and the mode in the high band can be considered as the higher order mode (TM21). Here the sense of rotation of proposed antenna (in the low and high bands) is left handed circular polarization (LHCP), because the magnetic current flows in a left hand orientation (counter clockwise direction) along the z-axis. Fig .5shows the magnetic current distributions



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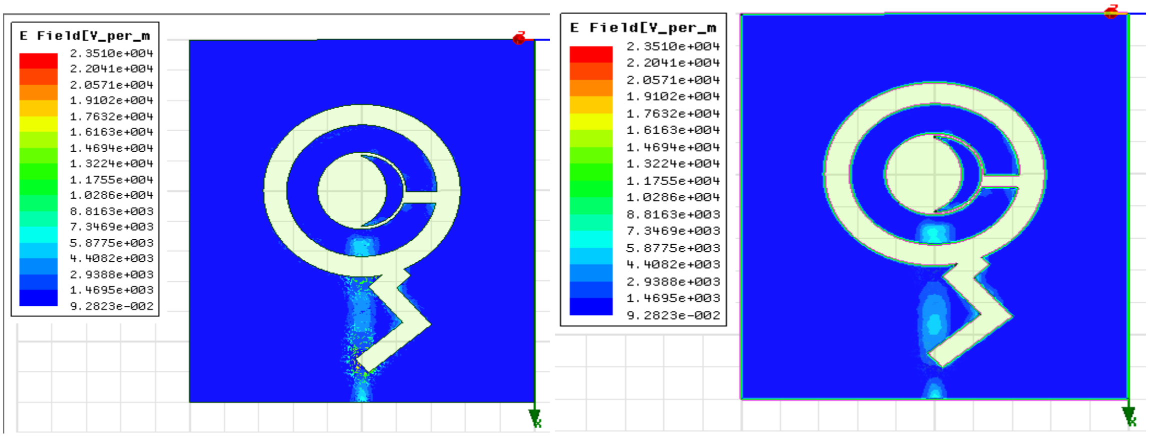

c d

Fig.4: Magnetic Current Distributions

(a). at 0^0 degrees (b). At 90^0 degrees (c). At 90^0 degrees (d). At 90^0 degrees

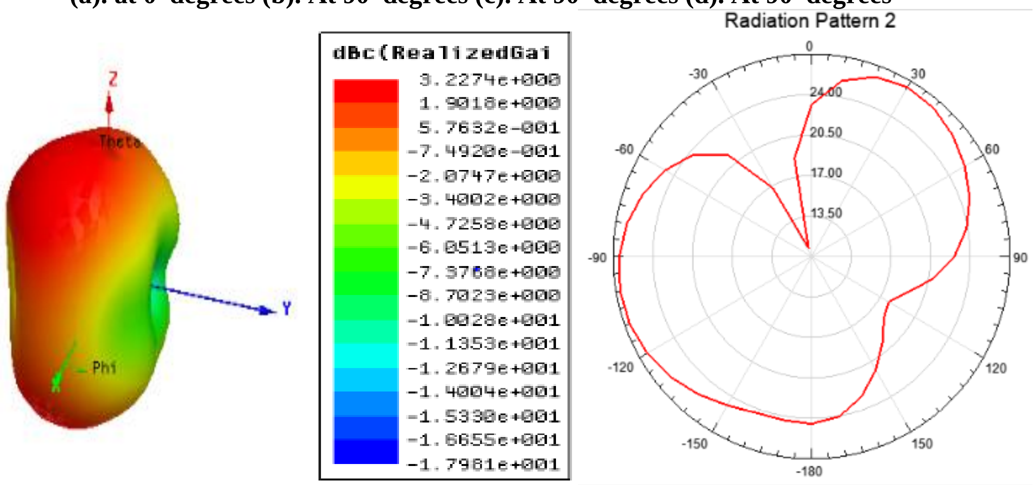

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Fig.5: (a): Radiation pattern in 3D Plot (b). 2D Plot

IV. FABRICATED RESULTS

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Fig.6: (a): Proposed Antenna Front View (b): Back View

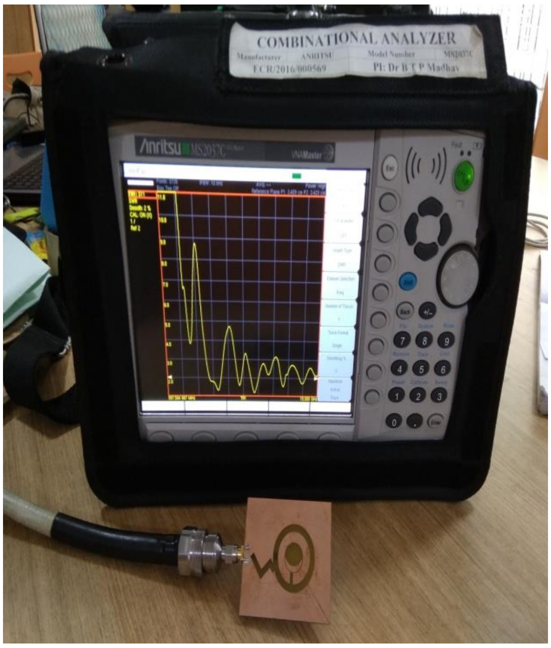

Fig.7: Characterization Results for VSWR

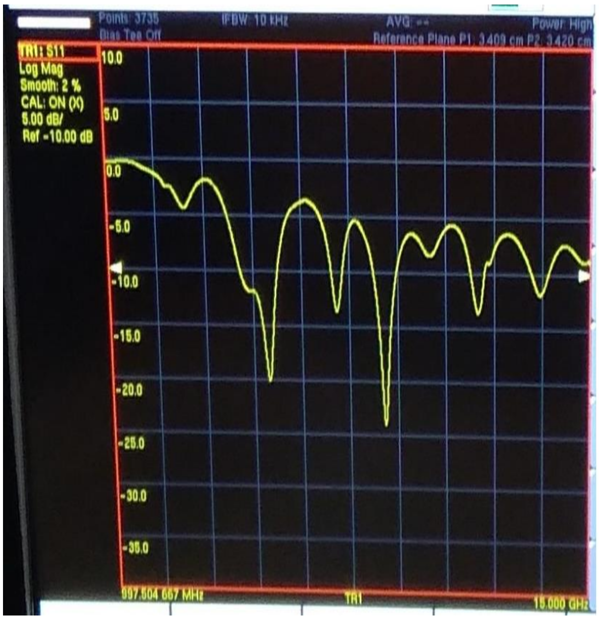

Fig.8: Return Losses

V. CONCLUSTION

This paper has successfully proposed two dual-band annular-slot antennas for WLAN operations. The first design (reference antenna) has successfully achieved CP operation over the WLAN 2.4/5.2/5.8 GHz band. Unfortunately, it is Unable to cover the CP high bands in WLAN. Modified from the first design, the second design has been proposed to exhibit two broad CP bands to cover the whole WLAN 5.7/8.3/6/12.3 GHz band. Desirable gains and efficiencies across the entire WLAN band of interest are obtained.

In addition, the proposed designs are fabricated by only a low-cost single-layer substrate. With the advantages of compact size, low-cost, easy integration and dual-broad CP bands, the proposed designs are very attractive for modern wireless communication systems, especially for WLAN applications.

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