Journal of Positive School Psychology http://journalppw.com
2022, Vol. 6, No. 2, 5664 – 5670

Parametric Study of Circularly Polarized Antenna Constructed on a Circular Microstrip Patch

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Abstract

In mobile and portable wireless application where wireless devices regularly change their position and angle it is almost unmanageable to continuously match the spatial orientation of the devices. Circularly polarized antennas could be harmonized in wide-ranging range of angles. The Microstrip antenna is some of the best commonly used antennas in applications that need circular polarization. This work offers the proposal of a circularly polarized Microstrip antenna that will work for 2.4 GHz. This range is normally used by WLAN, WPAN devices such as the 802.11 WIFI and the 802.15.4 Zigbee. We achieved polarization through the introduction of a perturbation to a basic circular Microstrip patch. Results indicate that designed Microstrip fed antenna can produce 8.11 dB directive gains.

Keywords: Wireless Local Area Network, Wireless Personal Area Network, Radio Frequency, High-frequency Structure Simulator.

1. INTRODUCTION

1.1 Reconfigurable Antenna

Usually wireless systems are considered for single predefined operation. So, the antennas of these arrangements likewise keep some static constraints such as rate of recurrence band, emission pattern, polarity, and gain. In recent times reconfigurable antennas have achieved remarkable exploration attention for several different applications, e.g., cellular wireless arrangement, locating system, satellite TV communication, flying machine, and unmanned in-flight vehicle radar, nifty missile defense [1] [9].

1.2 Design of Reconfigurable Micro-strip patch radio Antenna

Micro-strip patch radio antenna is generally utilized in current specialized gadgets over traditional receiving antennas chiefly due to their size [2] [3]. Micro-strip patch radio antennas are of much interest in receiving antenna applications. They are simple and modest to produce. Micro-strip patch receiving antennas are equipped for being planned as a solitary component or as a feature of an exhibit. Though, these benefits don't conceal the low effectiveness and restricted transfer speed of miniature strip fix radio wire. Lately research has additionally been done to utilize the single receiving antenna in numerous applications that is radio antenna must shows the property of changing starting with one application then onto the next upon setup demand and such radio wires are called reconfigurable receiving antennas. Late patterns have seen the advancement of wideband radio wires, multi-band receiving antennas or reconfigurable radio antennas getting a lot of regard for satisfy various applications in only one single terminal [4] [5]. Reconfigurable micro-strip radio antenna gives various application and offer greater adaptability when contrasted with ordinary receiving antennas which offer one capacity in a solitary radio antenna. They can give variety work in working recurrence, radiation example and polarization to versatile correspondences. The principle detriments of micro-strip patch radio antenna radiation

execution including restricted data transmission. Different strategies have been incorporated to conquer these inconveniences [6] [12] [13] [14].

2. FEEDING TECHNIQUES

Micro-strip patch receiving antenna can be taken care of by an assortment of strategies. These techniques can be ordered into two classifications reaching and non-reaching. In the reaching technique, the RF power is taken care of straightforwardly to the originating patch utilizing an associating component, for example, a micro-strip line. In the non-reaching technique, electromagnetic field coupler is never really power between the micro-strip line and the emanating patch. There are four most well-known strategies employed now these are 1) Micro-strip 2) Coaxial stripe 3) inaugural coupler 4) nearness coupling. Micro-strip patch radio antennas need communicating module on single side of a dielectric substrate and hence might be taken care of by any of these four procedures. Coordinating is typically needed between the fed line and the receiving wire input impedances [7] [8] [11].

2.1 Micro-strip Line Feed

Micro-strip line took care of is directing strip, ordinarily of a lot more modest width contrasted with fix. It is not difficult to manufacture, easy to coordinate by governing the inserted location. On the off chance that we expand the thickness of the substrate surface waves and misleading took care of radiation increments. Furthermore, its transmission capacity is exceptionally restricted. The motivation behind the inset slice in the fix is to coordinate with the impedance of the fed line to the fix, without the requirement for any extra coordinating with component. This is accomplished by appropriately controlling the inset position

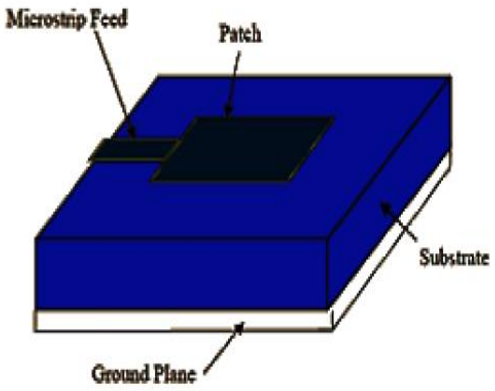


Figure 1: *Micro-strip line feed [3]*

2.2 Coaxial Feed

It is a typical procedure employed for taking carefulness of micro-strip patch radio antenna. Inner channel of the coaxial connector expanses out over the dielectric and are bound to the transmitting patch, though the outside channel is connected with the earth level. The benefit of this sort of taking care of plan is that the fed can be set at any ideal area inside the fix to coordinate with its info impedance. Its significant hindrance is that it give restricted data transmission and is hard to demonstrate since an opening must be penetrated in the substrate and the connector juts external the earth level, accordingly not building it completely planar for dense substrates.

2.3 Aperture Couple Feed

Coupling between the fix and the feed stripe is prepared over a space or a gap in the ground plane. In this method transmission line is safeguarded from the radio wire by a directing plane with an opening to send energy to receiving antenna as revealed in figure 2.

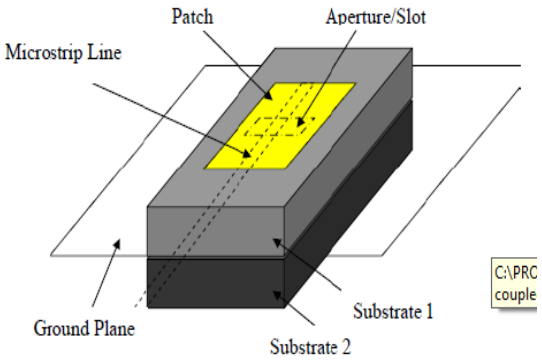


Figure 2: *Aperture Couple Feed [5]*

The upper substrate can be made with a lower permittivity to create inexactly bound bordering fields, yielding better radiation. The lower substrate can be freely made with a high worth of permittivity for firmly coupled fields that don't create false radiation. The disservice of this technique is expanded trouble in manufacture.

2.4 Proximity Couple Feed

This sort of feedstuff process is likewise titled as the electromagnetic coupler plan. It has the biggest data transfer capacity, has low fake radiation. Creation of closeness coupling is exceptionally troublesome. Length of taking care of substrate and width to length proportion of fix is utilized to control the match. Its coupling system is capacitive in nature [6] [10].

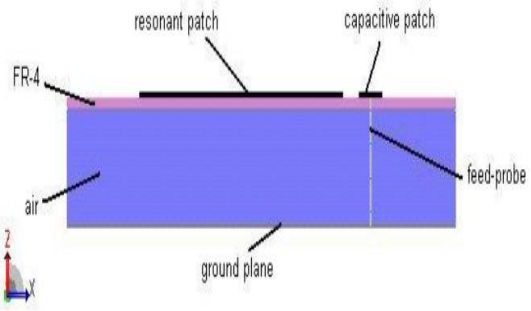


Figure 3: *Proximity Couple Feed [6]*

3. PROPOSED WORK

We present a proposal for a circularly polarized antenna constructed on a circular Microstrip patch. This is single fed circularly polarized Microstrip antenna which works at 2.4 GHz. Single feeding is used as it is simple, stress-free to manufacturing, small in cost and compact in construction.

3.1 Circularly-Polarized-Patch-Antenna

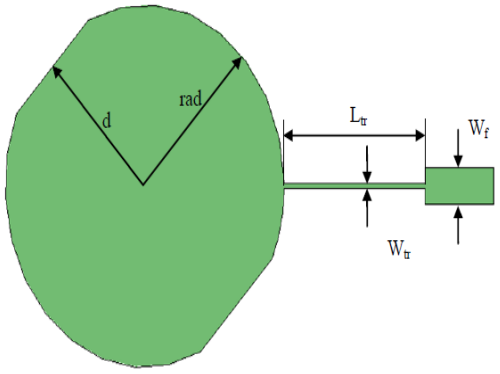


Figure 4: *Antenna with Microstrip feed*

Using HFSS a perfect circle radius 23.966 mm and fed directly with 50 Ω with width (Wf) = 4.88 mm is simulated . The circular patch antenna with the above mentioned dimensions resonates at 2.43 GHz. Since the antenna radius controls the antenna operating frequency, tweaking the antenna radius until the antenna operates at 2.4 GHz. The antenna radius and the frequency are inversely proportional, so the radius has to be increased till the resonance frequency is 2.4 GHz. A parametric study is conceded out to govern the perfect circle radius. Figure 5 shows the radius that makes the antenna resonates at 2.4 GHz is 23.96 mm.

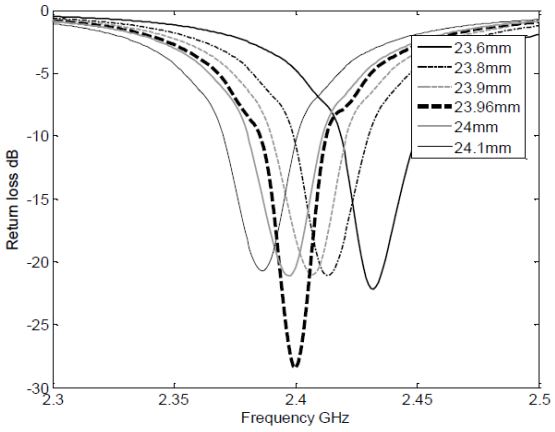
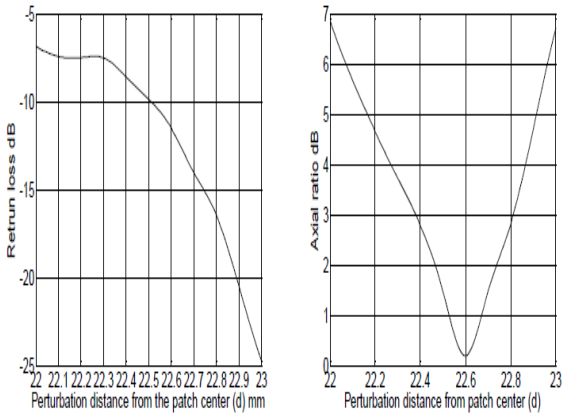


Figure 5: *circle radius - Microstrip feeding*

The distance (d) is chosen to give the most acceptable axial ratio and reoccurrence cost at the design frequency. Figure 6 shows the best reoccurrence cost and axial proportion at 2.4 GHz occurs at (d) = 23 mm, and (d) = 22.6 mm respectively.



(i)Retrun loss versus (d) (ii) Axial ratio versus (d)

Figure 6: *Analysis of (d) at 2.4 GHz - Microstrip feeding*

The antenna served with Microstrip stripe feed parameters are, (rad) = 23.96 mm, the measurement of the quarter wavelength transformer (Ltr) = 23.5 mm, and its width (Wtr) = 1.15 mm, the space among the perturbation segment and the patch centre (d) = 22.6 mm, and the width of the 50 Ω line (Wf) = 4.88 mm is simulated.

Table 1: *Dimensions and Radiation Characteristics*

rad mm	23.96
d	22.6
Wf	4.88
Impedance bandwidth %	2.92
Axial ratio bandwidth %	0.833
Directive antenna gain dB	8.11
Design frequency GHz	2.4
Difference between co and cross-polarization in E-plane dB	31.08
Difference between co and cross-polarization in H-plane dB	31.08
Half power beam width in the E-plane °	70
Half power beam width in the H-plane	73

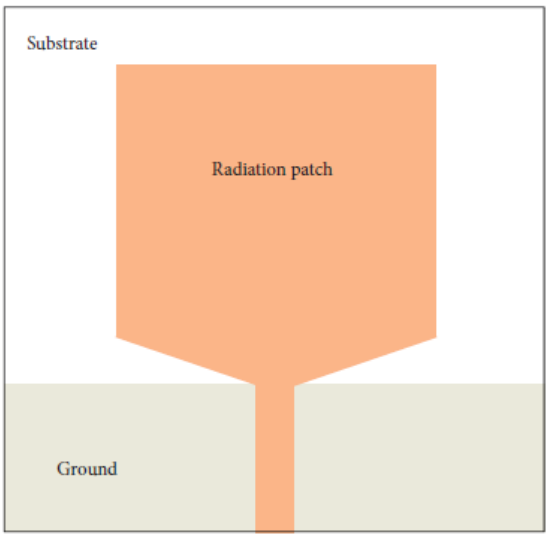


Figure 7: *structure diagram of the linear polarization*

(LP) UWB antenna

Rectangular radiating patch is connected with the feed line through the tapered microstrip. At the bottom of the substrate, there is a rectangular ground plate with the same length as the feed line. FR4 substrate is used in the design, with the thickness of 1 mm, the relative dielectric constant of 4.4, and the loss tangent of 0.02. Size of the substrate is 24 × 25mm2 and the size of the radiating patch is 12.5mm× 15 mm. width of is 2.12 mm.

3.2 Simulation Tool

Ansys HFSS 15.0

4. RESULTS AND DISCUSSION

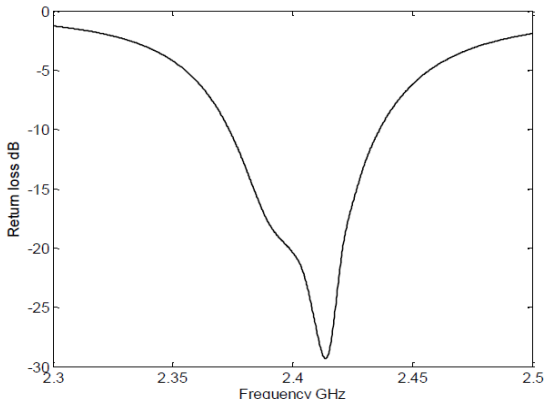


Figure 8: *Reoccurrence cost vs. frequency*

Figure 8 shows the antenna reoccurrence cost versus frequency with 10 dB impedance bandwidth is 2.92 % using HFSS.

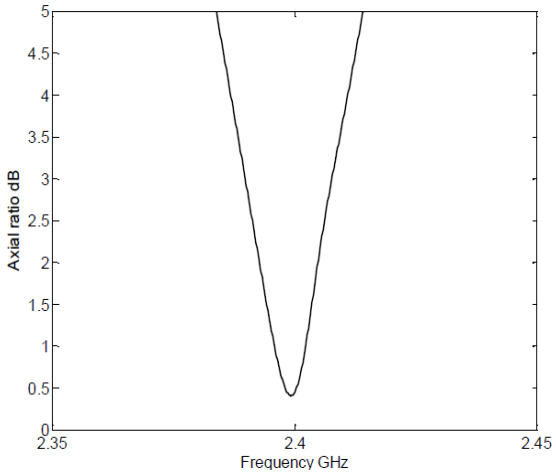


Figure 9: *Axial proportion vs. frequency*

Figure 9 shows the antenna axial proportion versus frequency with 3 dB axial proportion bandwidth is 0.833 %. The Microstrip stripe served antenna yields directive gain 8.11 dB gains.

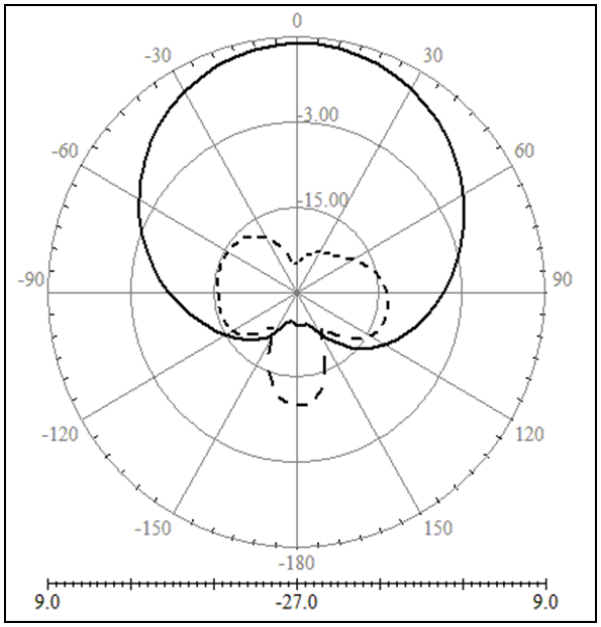


Figure 10: *E-plane emission pattern @ fr = 2.4GHz*

The co and cross-polarization in the E-plane and H-plane are presented in Figure 10 and Figure 11 respectively using HFSS. The figures show that the antenna is right hand circularly polarized with half power beam width ≈ 70° in the E-plane(φ = 0°, 180°) and ≈ 73°in H-plane (φ = 90°, 270°).

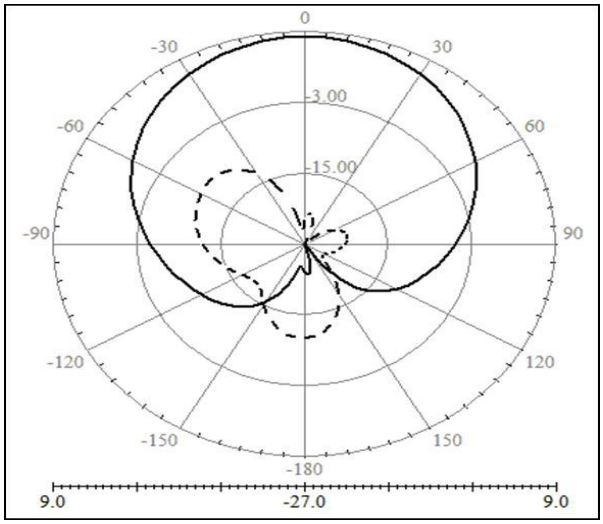


Figure 11 *H-plane emission @fr = 2.4GHz*

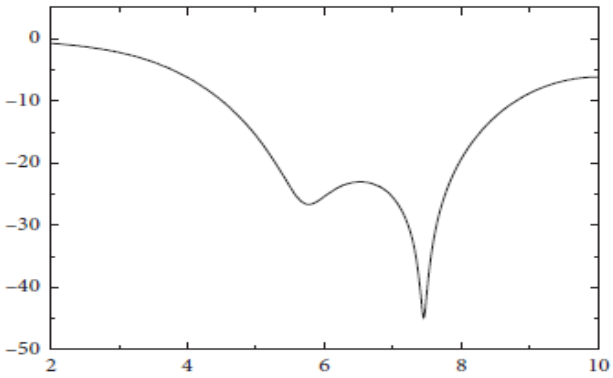


Figure 12: *Reflection Coefficient*

As shown in figure 12 when the reflection constant is less than −10 dB, frequency band is from 4.52 GHz to 8.7 GHz.

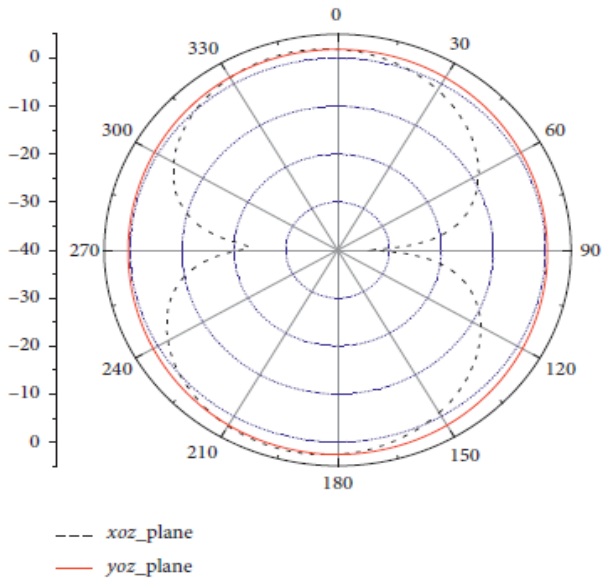


Figure 13: *Emission patterns at 6.5 GHz.*

As shown in figure 13 it has omnidirectional emission presentation on the yoz plane and the directional emission in xoz plane.

CONCLUSION AND FUTURE SCOPE

Currently circular polarization is very imperative in the antenna design engineering, it removes the standing of antenna angle in the plane at right angles to the transmission direction, it offers considerable additional elasticity to the angle among conveying & receipt antennas, too it improves climate perception and motion. Single fed circularly polarized Microstrip antennas are considered to be some of the modest antennas that can yield circular polarization. The Microstrip fed antenna is the easiest to model and fabricate. It has the 10 dB impedance bandwidth. Microstrip feeding needs a quarter wave length transformers between the antenna and the 50 line feed. The return loss value rises with growing the distance between the antenna radius and the perturbation segment.

Some of the key benefits of a single fed Microstrip antenna are that it can be used in the production of antenna array. This effort can be extended by exploring the scheme of an antenna array that uses the existing antenna as its unit element.

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