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CIRCULARLY POLARISED MICROSTRIP PATCH ANTENNA FOR WIRELESS COMMUNICATION

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Abstract

This paper represents a circularly polarised microstrip antenna with pentagonal slot. The main aim of this paper is to increase the bandwidth of the antenna. Circular polarisation can be achieved with asymmetries. Pentagonal slot microstrip antenna then associated with some characteristics like triangular slits inserted at the corners, corners of the patch truncated. These operations increased the bandwidth of the antenna as well as provided dual band circular polarised antenna. The operating frequency is 2 GHz. Coax feeding has been used. Roger RT/duroid substrate is used with dielectric constant of 2.2. The proposed antenna is simulated by HFSS 11 Software.

Keywords: *Circular Polarisation, Bandwidth, Coax Feed, HFSS.*

1. Introduction

A microstrip patch antenna is a type of antenna that offers a low profile, i.e. thin and easily manufacturability, which provides great advantages over traditional antennas [1-2]. However, patch antennas have a main disadvantage i.e. narrow bandwidth [3]. Researchers have made many efforts to overcome this problem and many configurations have been presented to extend the bandwidth.

In modern wireless communication systems, small circularly polarized microstrip antennas with good performance are desirable mainly at low microwave frequencies. Design of the compact CPMA is attractive for handheld/portable device applications. Small size of the CPMA can be achieved at the cost of limited gain and narrow 3-dB axial ratio (AR) bandwidth/ 10 dB return loss impedance bandwidth. Using slits/slots on a radiating patch two orthogonal modes can be generated at around resonance frequency with 90^0 phase-shifts for CP radiation requirements. The single-feed circularly polarized microstrip antennas are generally compact when compared with the dual-feed CPMAs. Single feed CPMA is simple, compact structure, easy manufacture, and low-cost. Asymmetric cross-slot provides necessary perturbation to excite two orthogonal modes with 90^0 phase-shifts to generate CP radiation. A coaxial probe type feed is to be used in this design. The feed point must be located at that point on the patch, where the input impedance is 50 ohms for the resonant frequency. Hence, a trial and error method is used to locate the feed point.

2. V-Shaped Slits Microstrip Patch Antenna

V-Slit microstrip antenna is proposed for circular polarized radiation. Location of four V-shaped slits are located at (P,P) along diagonal directions from center of the square microstrip patch. 1,2,3,4 are areas of the slit along the diagonal directions.. 1 and 3 are same as well as 2 and 4 are also same. For CP radiation of the patch antenna, 1/3 should be not equal to 2/4. The geometry is shown in Fig.2.1 and Fig 2.2.

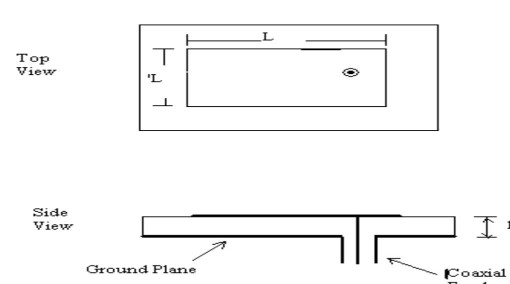

Figure 2.1 Microstrip Antenna Probe Fed

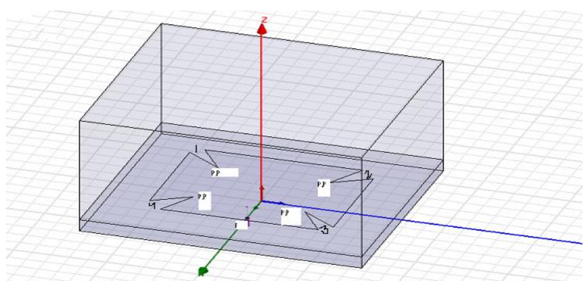

Figure 2.2 Geometry of the V-shaped slits microstrip Patch antenna with Probe Fed

The patch is fed at position F by a coaxial probe. The antenna is symmetrical along diagonal axis.

3. Design Of Single Patch V Shaped Slit Microstrip Antenna

The proposed antenna has been designed using Roger RT/duroid substrate with Dielectric constant of 2.2. The antenna size is 4.572mm. This antenna is designed for 2 GHz. The proposed antenna designed using probe fed simulated by HFSS'11. The dimensions of the optimized antenna element are given as follow:

(i) The Dimensions Of The V Shaped Slit Patch In Mm

Substrate Height h: 4.572mm
Ground Dimensions: 66x76 mm^2
Patch Dimensions: 50x50x4.572mm^3
Dielectric constant: 2.2
Feed point F: 11.5mm
V slits Areas:
For 1 and 3: 3x3mm^2
For 2 and 4: 4x4mm^2

4. Simulated Results

Figure 1 shows the variation of return loss versus the frequency of designed antenna. The return loss of antenna is -27dB. It is observed that, the antenna resonates at 1.88 GHz, which is close to the designed frequency of 2 GHz.

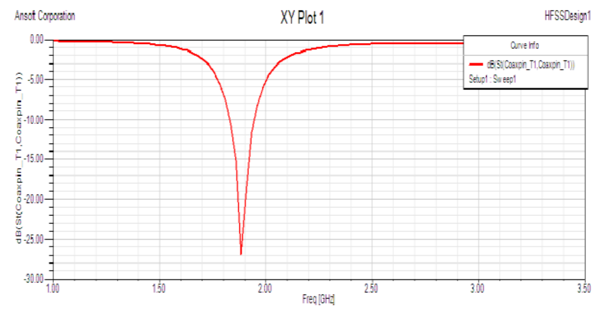

Figure 1 Simulated Return loss S_{11} V/S Frequency

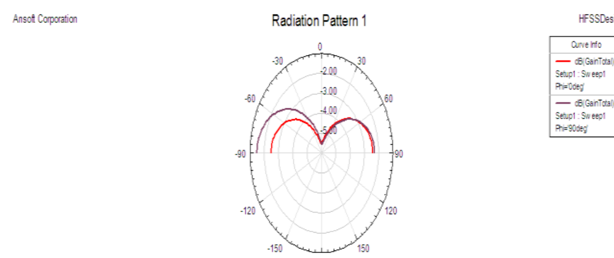

Figure 2 Radiation Pattern for V Slit Patch Antenna

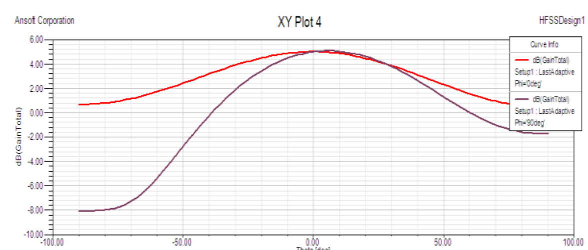

Figure 3 For Gain

The percentage of experimental impedance bandwidth is calculated by using the following relation:

$$\text{Impedance bandwidth (\%)} = f_2 - f_1 / f_c \text{ x100\%}$$

Where, f_2 and f_1 are upper and lower cut off frequency of the resonated band when its return loss reaches -10 dB and f_c is a center frequency between f_2 and f_1. The measured impedance bandwidth is 6.32%.The gain is 5.2dBi.

5. Design of Single Patch Pentagonal Slot Microstrip Antenna

In this designed antenna a pentagonal slot has been cut in the patch. The length of the patch in x-direction is 33 mm, 14 mm in y-direction and 7 mm in z-direction. The width of pentagonal slot is 1 mm. This antenna gives circular polarization. Pentagonal slot reduced the size of antenna.

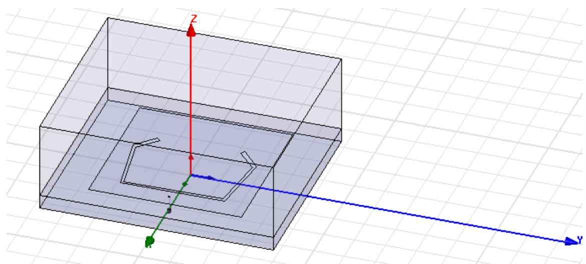

Figure 4 Pentagonal Slot Antenna with Coax Probe Feed

(i)The Dimensions Of The Pentagonal Slot Patch In Mm

Substrate Height h: 4.572mm
Ground Dimensions: 66x76 mm^2
Patch Dimensions: 50x50x4.572mm^3
Dielectric constant: 2.2

6.SIMULATED RESULTS

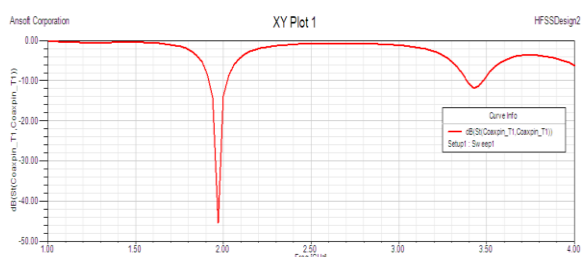

Figure 5 Simulated Return loss S_{11} V/S Frequency

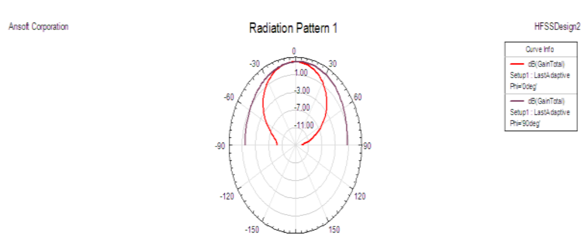

Figure 6 Radiation Pattern for Pentagonal Slot

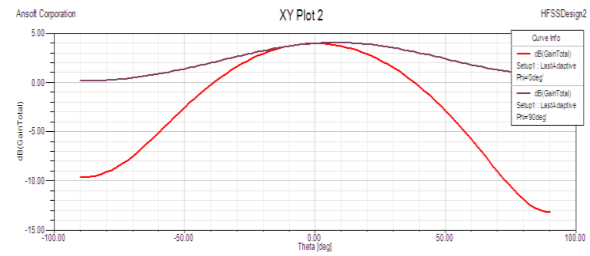

Figure 7 Gain

The resulted antenna reduces the size of the antenna. Figure 7 shows the graph for gain, the measured gain is 4.13 dBi. This antenna resonates at 1.96 GHz frequency, which is very close to the designed frequency and provides return loss of -45 dB. The measured impedance bandwidth is 5.16%.

7. Design Of Single Patch Pentagonal Slot With V-Slit Microstrip Antenna

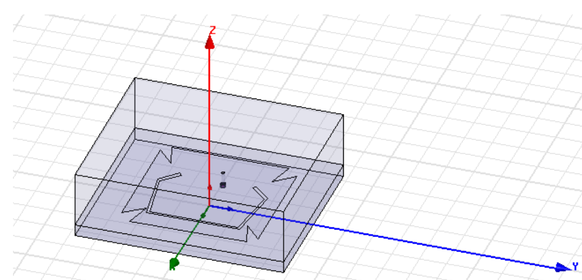

Figure 8 Pentagonal V Slit with Coax Probe Feed

In this antenna a pentagonal slot is cut in the patch as well as V shaped slits also cut at the corners of the patch to provide circular polarization. These slits are asymmetrical in size, which gives a phase shift of 90 degree, resulted in circular polarized antenna.

(i)The Dimensions Of The Pentagonal With V Slot Patch In Mm

Substrate Height h: 4.572mm
Ground Dimensions: 66x76 mm^2
Patch Dimensions: 50x50x4.572mm^3
Dielectric constant: 2.2

8. Simulated Results

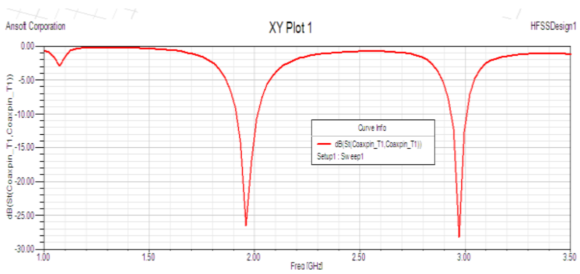

Figure 9 Simulated Return loss S_{11} V/S Frequency

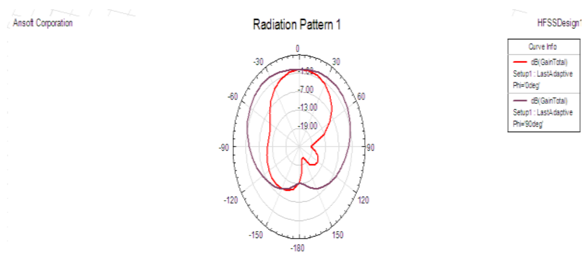

Figure 10 Radiation Pattern for Pentagonal Slot with V-slit

The resulted antenna provides circular polarization. This antenna gives two resonant frequencies at 1.98 GHz and 2.97 GHz, thus gives dual band patch antenna. The return losses are -26 dB and -28 dB. The bandwidth for 1.98 GHz is 5.46% and for 2.97 GHz is 2.5%

9. Design of Single Patch Pentagonal Slot With Truncated Corners Microstrip Antenna

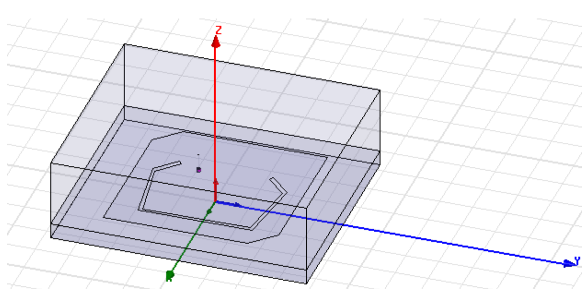

Figure 11 Pentagonal Slit with Truncated Corners using Coax Probe Feed

In this antenna a pentagonal slot has been cut out from the patch along with the corners have been truncated to provide circular polarization. The truncated square patch provides two orthogonal modes for circular polarization. The height of the truncated corners is 6 mm.

(i)The Dimensions of the Pentagonal Slot Patch with Truncated Corners in Mm

Substrate Height h: 4.572mm
Ground Dimensions: 66x76 mm^2
Patch Dimensions: 50x50x4.572mm^3
Dielectric constant: 2.2

10. Simulated Results

This antenna provides two resonant frequencies so it is also known as dual-band circular polarized antenna. The impedance bandwidth is 4.95% at 2.03 GHz and 2.65% at 2.61GHz frequency. The return losses are -35 dB and -22 dB respectively for 2.03 GHz and 2.61 GHz frequencies.

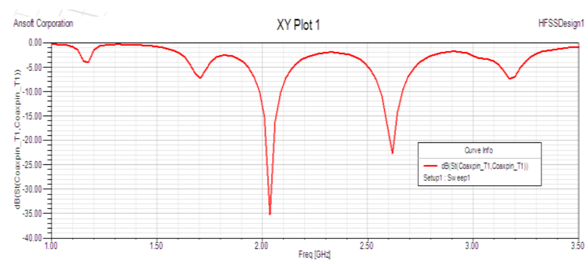

Figure 12 Simulated Return loss S_{11} V/S Frequency

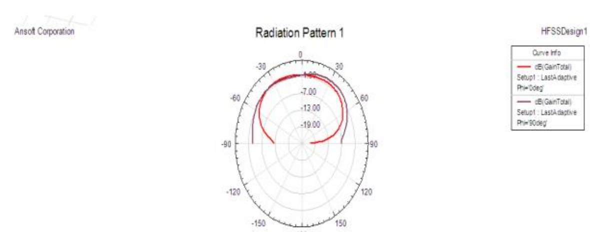

Figure 13 Radiation Pattern for Pentagonal Slot with Truncated corners

11. Conclusion

Table 1

	Frequency	Return Loss	Bandwidth
V- Slot	1.88GHz	-27dB	6.32%
Pentagonal	1.96 GHz	-45dB	5.16%
Pentagonal with V-Slot	1.98 GHz 2.97 GHz	-26dB -28dB	5.46% 2.5%
Pentagonal Slot with Truncated	2.03 GHz 2.61 GHz	-35 dB -22 dB	4.95% 2.65%

Corners			

The all above designed antenna reduces the size of the antenna as well as provide increased bandwidth with dual band circular polarization. These small antennas can be used for various wireless communication applications. Thanks to its compactness and circular polarization which can be used in mobile communications.

12. References

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