

# Dual Edge-Fed Left Hand and Right Hand Circularly Polarized Rectangular Micro-Strip Patch Antenna for Wireless Communication Applications

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**Abstract:** Presently a days the remote correspondence framework advancement requires the ease, low profile, insignificant weight radio wire improvement which is cultivated of proceeding with incredible introduction finished a wide recurrence range. The MSPA architecture has facilitated this forward thinking skills trend. Within this paper work a 4.85 GHz circular polarization operating frequency is planned and simulated for RMSPA. The proposed antenna is capable of designing and inducing Left Hand Loop Polarization (LHCP) and Right Hand Loop Polarization (RHCP) using a cross-coupler that is directly attached to the micro-strip antenna to polarize the circular. The proposed paper work working recurrence is 4.85 GHz which is essentially utilized for satellite interchanges, full-time satellite TV organizations. This working recurrence is the IEEE 802.11a variation C band recurrence and this C band recurrence is utilized in Wi-Fi gadgets and Radio LAN. The proposed FR-4 roundabout polarization rectangular miniature strip fix radio wire is 1.6 mm thick. The proposed rectangular micro strip fix radio wire is planned and mimicked utilizing CSTMWS (Computer Simulation Technology Micro Wave Studio) programming. The full or working recurrence of proposed radio wire presents at 4.85 GHz for remote correspondences that gives S boundaries, data transmission and radiation example of Gain and directivity.

**Keywords:** Dual-fed, Micro Strip, Circular Polarization, FR-4, TV, LHCP, RHCP, CSTMWS, Gain, Bandwidth.

## 1. Introduction

A remote neighbourhood is a little space correspondence framework most prominent habitually utilized for interfacing at least two remote methodologies inside an inadequate arrangement [6]. WLANs follow the IEEE802.11 standards which has so far recorded the recurrence use in band i.e., 4.85 GHz. The proposed paper work contains of plan and recreation of high increase reception apparatuses for 4.85 GHz and great data transmission at 4.85 GHz working recurrence. The rudimentary WLAN development incorporates of the wired LAN arrangement, remote systems and a contact point which exhibitions as connection between the two. Higher the increase of the radio wire extra will be the assortment that can be ensured. Henceforth, high increase radio wires creation indispensable part in WLAN applications [8]. The proposed reception apparatus has great addition and transmission capacity. In translation of the above facts, we future the plan and re-enactment of high increase double took care of circularly enraptured rectangular miniature strip fix reception apparatus with left half and right half circularly polarization in the current work.

In the previous years, miniature strip radio wires frameworks are utilized in an enormous number of microwave correspondence applications because of the savvy structures of ease, similarity with incorporated circuits and loosened up manufacture. Typically, they are intended to invigorate either roundabout or straight enraptured waves. This paper is concentrated to plan and re-enactment double edge took care of a circularly enraptured reception apparatus at 4.85 GHz for satellite correspondence applications. The hugest bit of leeway of utilizing round polarization is that independent of recipient direction, it will continually get a part of the sign.

### 1.1 Circular Polarization

The waves are peripatetic in helpful z-direction, the EF apparatuses in x direction and y direction are  $E_x \rightarrow E_1 \sin(\omega t - \beta z)$  and  $E_y \rightarrow E_2 \sin(\omega t - \beta z + \delta)$ ; where  $E_1$  and  $E_2$  are wave magnitudes linearly in x and y directions and  $\delta$  is the angle of phase. Combining the above two equation we get total electric field expression  $E \rightarrow E_1 \sin(\omega t - \beta z) \mathbf{a}_x + E_2 \sin(\omega t - \beta z + \delta) \mathbf{a}_y$ .

When this is polarized circularly, the x and y direction magnitudes are equal and  $\delta = \pm\pi/2$ . For left hand circularly polarized wave, the phase angle  $\delta$  is  $\pi/2$  and for right hand circularly polarized wave, the phase angle  $\delta$  is  $-\pi/2$ .

## 2. Design Aspects of Dual-Fed

So as to plan any MSPA, we need some arrangement of boundaries. The above all else thing is working recurrence or reverberating recurrence  $f_0$  or  $f_r$ , in this proposed work the resounding recurrence is 4.85 GHz, the subsequent thing is stature of the substrate typically the tallness of the substrate ( $h$ ) is consider as 1.6 mm and third thing is sort of the substrate material, here the kind of the dielectric substrate material worth is 4.4.

### 2.1 MSPA Formulation

The program parameters of the planned RMSPA are Operating often ness,  $f_r = 4.85$  GHz. Generally, FR4 see varies from 4.3 to 4.7, here the material perpetual of FR4 stratum,  $\epsilon_r = 4.4$  and  $h = 1.6$  mm.

$$W = \frac{c}{2f_r \sqrt{\frac{\epsilon_r + 1}{2}}} \quad (1)$$

The patch width is  
 Where  $c \rightarrow 3 \times 10^{11}$  mm

$$L = L_{eff} - 2 \times \Delta L \quad (2)$$

$$\text{Where, Effective length, } L_{eff} = \frac{c}{2f_r \sqrt{\epsilon_{reff}}}$$

Where Effective Dielectric Constant,

$$\epsilon_{reff} = \frac{\epsilon_r + 1}{2} + \frac{\epsilon_r - 1}{2} \left[ 1 + 12 \frac{h}{W} \right]^{-1/2}$$

The Length Extension,

$$\Delta L = 0.412h \times \left\{ \frac{(\epsilon_{reff} + 0.3) \left( \frac{W}{h} + 0.264 \right)}{(\epsilon_{reff} - 0.258) \left( \frac{W}{h} - 0.8 \right)} \right\} \quad (3)$$

Determine the ground plane width and lengths

- Length of Ground plane,  $L_g \rightarrow 2 * L$  (4)

- Width of Ground plane,  $W_g \rightarrow 2 * W$  (5)

### 2.2 MSPA Manual Calculation

The calculation of proposed rectangular patch width is

$$W = \frac{c}{2f_r \sqrt{\frac{\epsilon_r + 1}{2}}} = \frac{3 \times 10^{11}}{2 \times 4.85 \times 10^9 \sqrt{\frac{4.4 + 1}{2}}}$$

$$W = \frac{c}{2f_r \sqrt{\frac{\epsilon_r + 1}{2}}} = 18.83 \text{ mm}$$

The calculation of  $h/W$  and  $W/h$  are

$$\frac{h}{W} = \frac{1.6 \text{ mm}}{18.83 \text{ mm}} = 0.085$$

$$\text{And } \frac{W}{h} = \frac{1}{\frac{h}{W}} = \frac{1}{0.085} = 11.763$$

The calculation of effective dielectric constant is

$$\epsilon_{reff} = \frac{\epsilon_r + 1}{2} + \frac{\epsilon_r - 1}{2} \left[ 1 + 12 \frac{h}{W} \right]^{-1/2}$$

$$\epsilon_{reff} = \frac{4.4 + 1}{2} + \frac{4.4 - 1}{2} \left[ 1 + 12 \frac{1.6 \text{ mm}}{18.83 \text{ mm}} \right]^{-1/2}$$

$$\epsilon_{reff} = 3.896$$

The calculation of length extension is

$$\Delta L = 0.412h \times \left\{ \frac{(\epsilon_{reff} + 0.3) \left( \frac{W}{h} + 0.264 \right)}{(\epsilon_{reff} - 0.258) \left( \frac{W}{h} - 0.8 \right)} \right\}$$

$$\Delta L = 0.412 \times 1.6 \text{ mm} \times \left\{ \frac{(3.896 + 0.3)(11.763 + 0.264)}{(3.896 - 0.258)(11.763 - 0.8)} \right\}$$

$$\Delta L = 0.834 \text{ mm}$$

The calculation of effective length is

$$L_{eff} = \frac{c}{2f_r \sqrt{\epsilon_{reff}}} = \frac{3 \times 10^{11} \text{ mm}}{2 \times 4.85 \times 10^9 \times \sqrt{3.896}}$$

$$L_{eff} = 15.668 \text{ mm}$$

The calculation of proposed patch length is

$$L = L_{eff} - 2 \times \Delta L$$

$$L = 15.668 \text{ mm} - 2 \times 0.834 \text{ mm} = 14.0005 \text{ mm}$$

### 2.3 RMSPA Design Parameters

The table 1 shows the plan particular of round captivated rectangular micro strip fix cluster reception apparatuses with corporate feed organization.

Table 1. RMSPA Specifications

Description & Short Name	VALUE
Operating frequency ( $f_r$ or $f_o$ )	4.85 GHz
Dielectric Constant ( $\epsilon_r$ )	4.4
Width of the patch (W)	18.83 mm
Length of the patch (L)	14.00 mm
Loss tangent ( $\tan\delta$ )	0 mm
Feed line width ( $W_f$ )	3.102 mm
Feed line length ( $L_f$ )	8.302 mm
Input impedance	50 ohms

### 2.4 Directional Coupler

The outlet line mixture coupler is a 3-dB directional coupler with a stage move of 90 degrees between through yields and coupled port and port number 4 is separated port. The mathematical deliveries are:

$$\frac{w_2}{h_2} = \begin{cases} \frac{2}{\pi} \left[ B - 1 - \ln(2B - 1) + \frac{\epsilon_r - 1}{2\epsilon_r} \left\{ \ln(B - 1) + 0.39 - \frac{0.61}{\epsilon_r} \right\} \right] \\ \frac{8e^A}{e^{2A} - 2} ; \frac{w_2}{h_2} < 2 \end{cases}$$

$$B = \frac{377\pi}{2Z_0\sqrt{\epsilon_r}} ; \frac{w_2}{h_2} > 2 ; l = \frac{90^\circ (\pi \times 180^\circ)}{\sqrt{\epsilon_{reff}} \times k_0} ; k_0 = \frac{2\pi f}{c}$$

Where  $l \rightarrow$  hybrid length. The branch line coupler s-matrix is given by

$$[S] = -\frac{1}{\sqrt{2}} \begin{bmatrix} 0 & j & 1 & 0 \\ j & 0 & 0 & 1 \\ 1 & 0 & 0 & j \\ 0 & 1 & j & 0 \end{bmatrix}$$

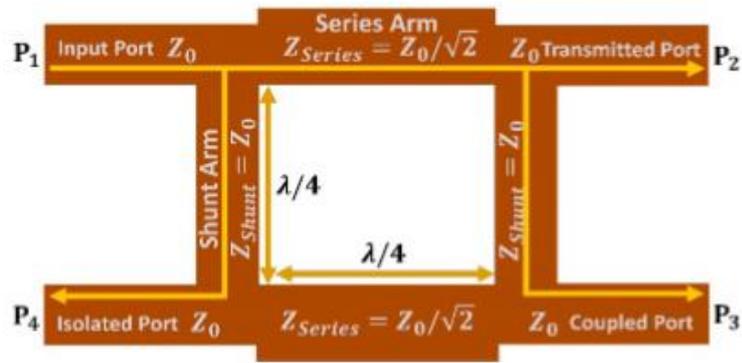


Figure 1. Geometry of a conventional branch line coupler.

### 3.Design of MSA Polarization

In circular polarization, the energy can be radiated into two planes that are horizontal plane and vertical plane. The left hand roundabout polarization can be characterized as two signals or waves has equivalent size qualities yet  $90^\circ$  stage move. In left hand round polarization wave is turning in hostile to clock insightful or counter clockwise bearing. Then again, in the correct hand roundabout polarization the wave is pivoting clockwise way.

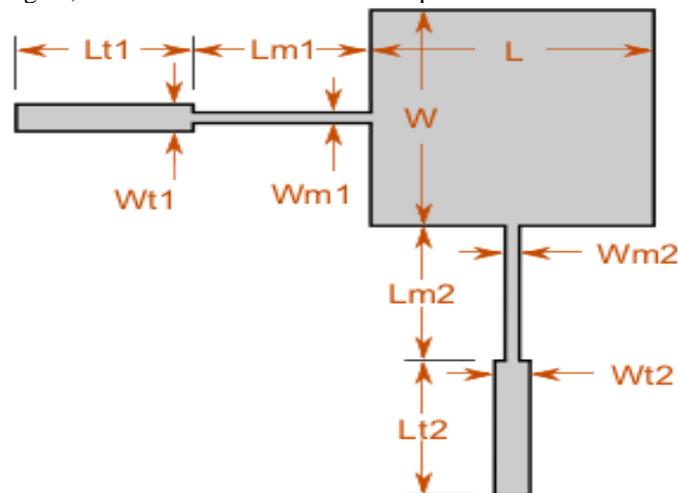


Figure 2. Geometry of the proposed dual-fed antenna.

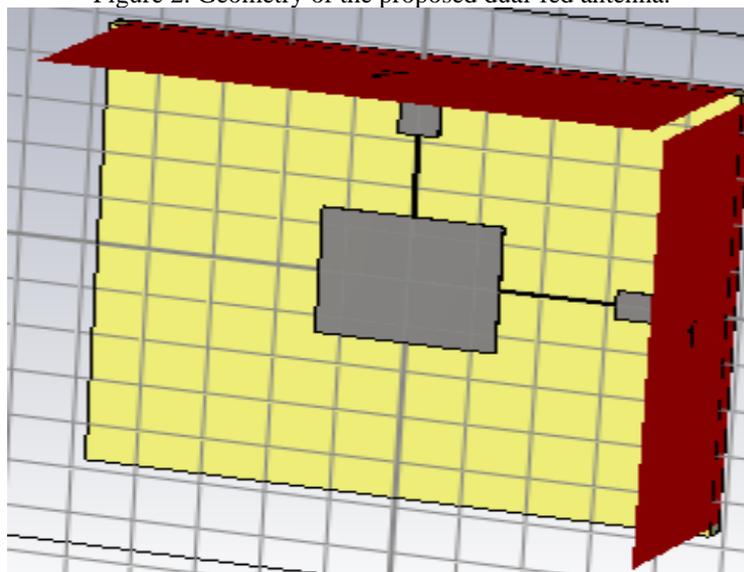


Figure 3. 3D view Dual-Edge-Fed Left Hand Circularly Polarized RMSPA.

Table 2. Proposed Dual-Fed Antenna Specifications

Description & Short Name	VALUE
Patch Width (W)	18.83 mm
Patch Length (L)	14.00 mm
Port1 length (Lm1)	8.841 mm
Port1 width (Wm1)	0.2051 mm
Port1 feed length (Lt1)	8.214 mm
Port1 feed width (Wt1)	3.059 mm
Port2 length (Lm2)	8.841 mm
Port2 width (Wm2)	0.2051 mm
Port2 feed length (Lt2)	8.214 mm
Port2 feed width (Wt2)	3.059 mm

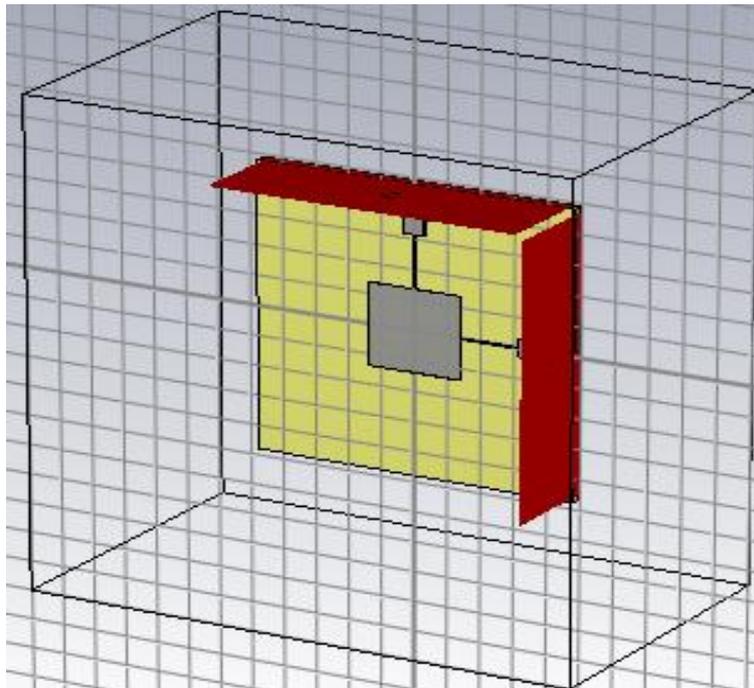


Figure 4. 3D view Dual-Edge-Fed Right Hand Circularly Polarized RMSPA.

From the geometrical design view Lm1 is the port1 length which is the length of matching transmission line, Wm2 is the width of port 1 which is the transmission line width, Lt1 is the port 1 feed which is transmission line feed, Lm2 is the port2 length which is the length of matching transmission line, Wm2 is the width of port 2 which is the transmission line width, Lt2 is the port 2 feed which is transmission line feed.

The left-hand circular polarization and right hand circular polarization rectangular patch width and length are same that are 18.83 mm × 14.00 mm. length of port 1 and port 2 are same. The 3D perspective on double edge-took care of left hand round polarization rectangular miniature strip fix radio wire as appeared in figure 3. The figure 4 shows the double edge-took care of right hand roundabout polarization rectangular miniature strip fix reception apparatus 3D see.

#### 4.Simulation Results And Discussion

Present days, the decoration and representation results are very valuable travail to reckon the action of system through software model tools before the sincere abstraction executing. CST MWS simulator software supports to process the value of untruth since exclusive the tentacle through the large execution would be invented.

Here, reproduce and examine the proposed reception apparatus plan execution, the recreation aftereffects of s-boundary, transmission capacity, addition and directivity are assessed at 4.85 GHz working recurrence. The proposed radio wire has FR-4 epoxy substrate, which dielectric consistent 4.4, thick ness of the substrate is 1.6 mm and 0 mm misfortune digression. In this administrative work, we select the base recurrence go is 3 GHz and

greatest recurrence run is 7 GHz. Superior the example area solver parameters that are Topology type is Hexahedral, Quality is -40 dB, Author Identify is all ports, Modality is all type, normalized to leaded impedance consider is 50 ohms and finally depression the start add.

#### 4.1 S-Parameters

The general representation of scattering parameter is  $S_{ij}$ . In this general representation, the first subscript indicate the output of the port and second subscript indicate the input of the port. The hypothetical reflection coefficient worth ought to be not exactly -10 dB. In this administrative work the reflection coefficient ( $S_{11}$ ) esteem is -15.985891 dB at 4.85 GHz, this return misfortune esteem conveyed at port 1 when the info is applied at port 1. The inclusion misfortune ( $S_{21}$ ) esteem at port 2 is -14.13546 dB at 4.85 GHz when the info is applied at port 1. As indicated by return plot or reflection coefficient plot for left hand roundabout polarization has magnificent incentive than -10 dB in the chose working recurrence. The return misfortune plot of double edge-took care of LHCP is appeared in figure 5. From the LHCP return loss plot maximum return loss output value at port 1 is -16.35 dB at 4.86 GHz and at port 2 is -14.497 dB at 4.84 GHz.

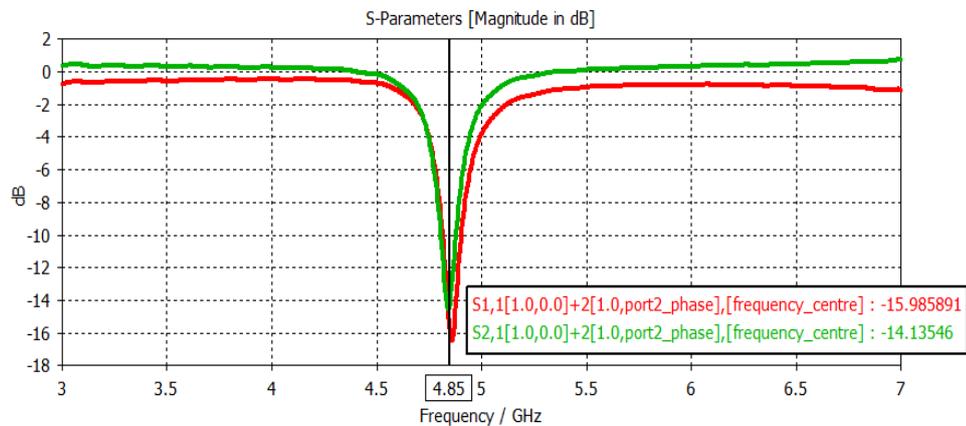


Figure 5. Return Loss plot of dual-edge-fed LHCP.

The proposed dual-edge-fed rectangular micro strip antenna simulation part is done. The reflection coefficient ( $S_{11}$ ) value is -14.135472 dB at 4.85 GHz, this return loss value delivered at port 1 when the input is applied at port 1. The insertion loss ( $S_{21}$ ) value at port 2 is -15.985903 dB at 4.85 GHz when the input is applied at port 1. According to return plot or reflection coefficient plot for right hand circular polarization has excellent value than -10 dB in the selected operating frequency. The return loss plot of dual-edge-fed RHCP is shown in figure 6. From the RHCP return loss plot maximum return loss output value at port 1 is -14.471 dB at 4.83 GHz and at port 2 is -16.363 dB at 4.86 GHz.

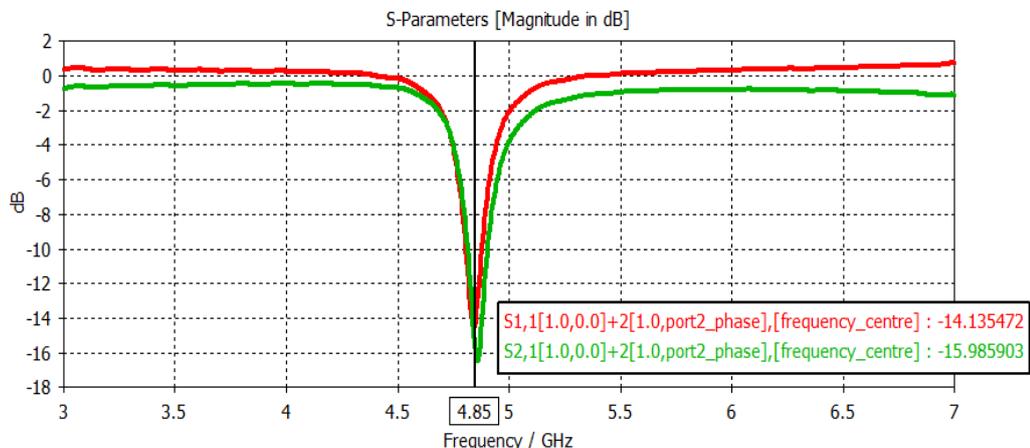


Figure 6. Return Loss plot of dual-edge-fed RHCP.

Table 3. Return Loss for LHSP and RHCP

S.N	Frequency in GHz	Input	Output in dB	
			Port 1 (RL)	Port 2 (IL)
<b>Left Hand Circular Polarization</b>				
1	4.85	Port 1	-15.985891	-14.13546
2	4.86 & 4.84		-16.35	-14.497
<b>Right Hand Circular Polarization</b>				
1	4.85	Port 1	-14.135472	-15.985903
2	4.83 & 4.86		-14.471	-16.363

**4.2 Bandwidth**

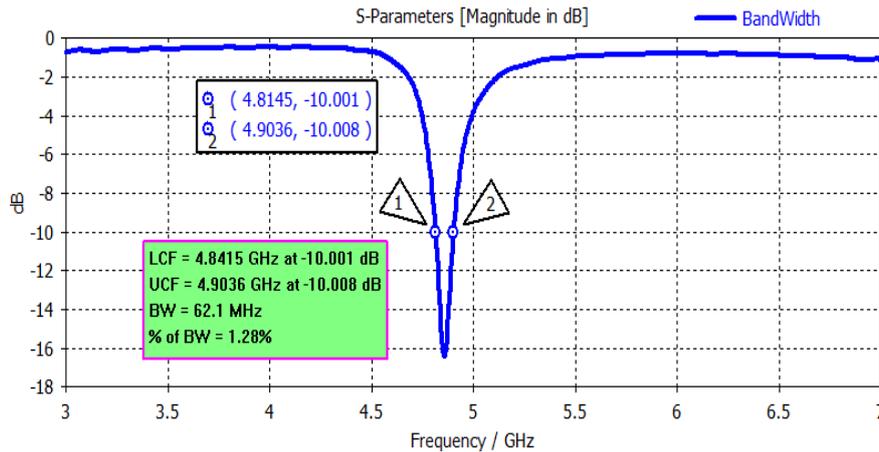


Figure 7. Bandwidth plot of dual-edge-fed LHCP.

The % of bandwidth is given by  $BW = \frac{(f_L - f_H)}{f_c} \times 100$ . From the LHCP bandwidth strategy the arrival expiration value is -15.985891 dB at 4.85 GHz, the lower cut-off frequency view is 4.8415 GHz at -10.001 dB, upper cut-off frequency treasure is 4.9036 GHz at -10.008 dB and bandwidth and % of bandwidth is 62.1 MHz and 1.2804 %. The bandwidth plot of dual-edge-fed port sailor advertisement polarization micro undress repair antenna as shown in amount 7.

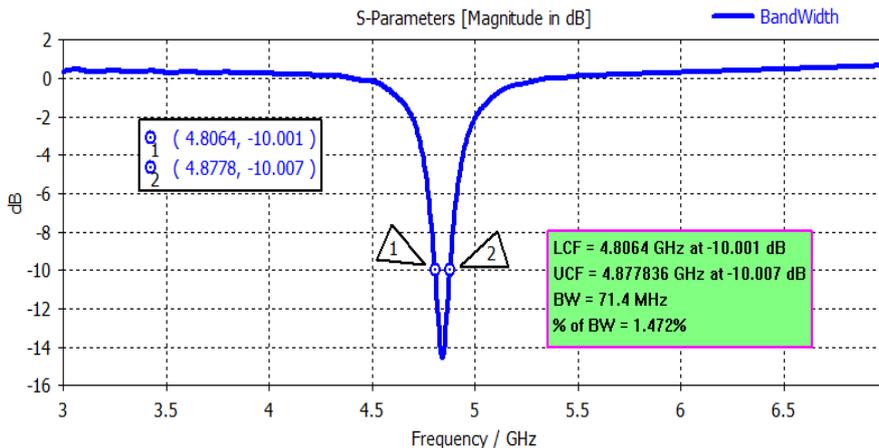


Figure 8. Bandwidth plot of dual-edge-fed RHCP.

From the RHCP bandwidth plot the return loss value is -14.135472 dB at 4.85 GHz, the LCF frequency → 4.8064 GHz at -10.001 dB, UCF frequency → 4.8778 GHz at -10.007 dB and BW and % of BW is 71.4 MHz and 1.4722 %. The BW plot of dual-edge-fed right hand circular polarization MSPA as shown in figure 8.

Table 4. Band Width and % of BW for LHSP and RHCP

S.N	Resonant Frequency	Type of Circular Polarization	Band Width	% of BW
1	4.85 GHz	Left Hand	62.1 MHz	1.2804%
2		Right Hand	71.4 MHz	1.4722 %

### 4.3 Smith Chart

The smith outline plot of double edge-took care of left hand and right hand round polarization micro strip fix reception apparatus as appeared in figure 9.

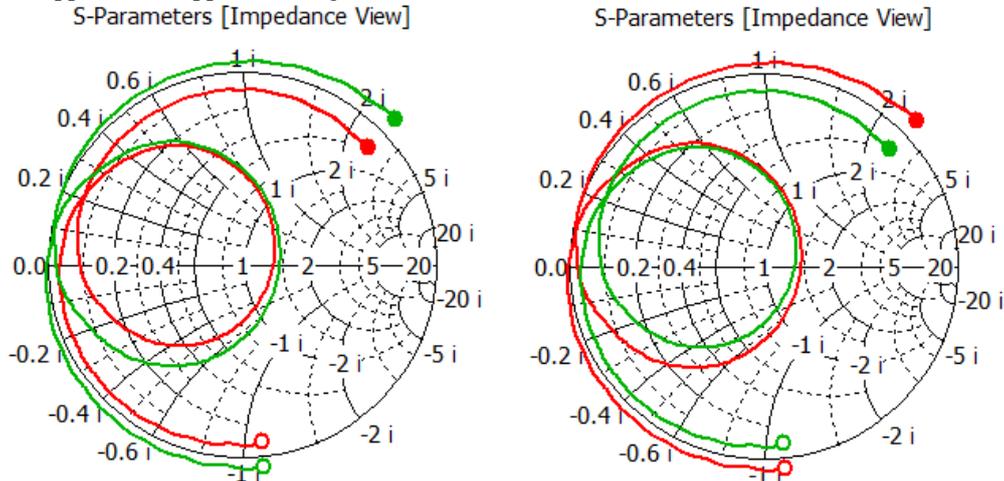


Figure 9. Smith chart plot of dual-edge-fed LHCP and RHCP.

### 4.4 Far Field Gain and Directivity

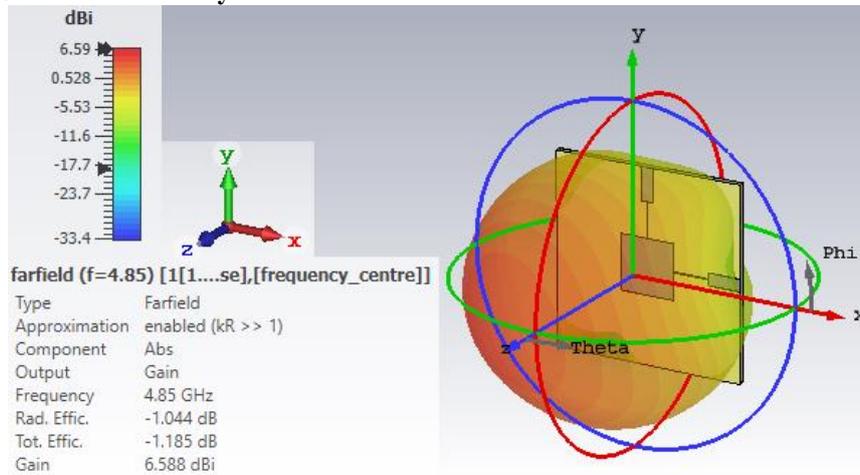


Figure 10. 3D Far Field Gain Pattern for dual-edge-fed LHSP.

The 3D far field gain radiation example and directivity radiation example of double edge-took care of left hand round polarization and right half-roundabout polarization miniature strip fix reception apparatus are appeared in figure 10 to figure 13. As indicated by figure 10, the far field gain is 6.59 dBi at 4.85 GHz, which is the increase of LHCP. As per figure 11, the far field gain is 6.59 dBi at 4.85 GHz, which is the increase of RHCP. According to figure 12, the far field directivity is 7.632 dBi at 4.85 GHz, which is the directivity of LHCP. According to figure 12, the far field directivity is 7.632 dBi at 4.85 GHz, which is the directivity of RHCP. Observe the LHCP and RHCP figures, the simulated resultant gain and directivity value is same at the specified operating frequency. The proposed antenna gain and directivity is suitable for wireless communication requirements.

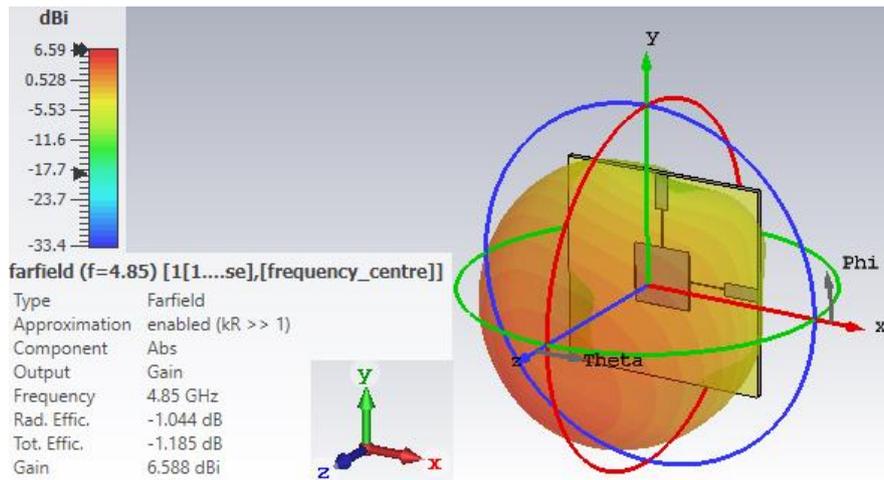


Figure 11. 3D Gain Pattern for dual-edge-fed RHSP.

The 2D far field gain radiation example and directivity radiation example of double edge-took care of left hand roundabout polarization and right half-round polarization miniature strip fix radio wire are appeared in figure 14 and figure 15. According to figure 14 and figure 15, the main lobe magnitudes are -15.0 deg. And -4.0 deg. In addition, side lobe magnitudes are -12.7 dB & -15.3 dB.

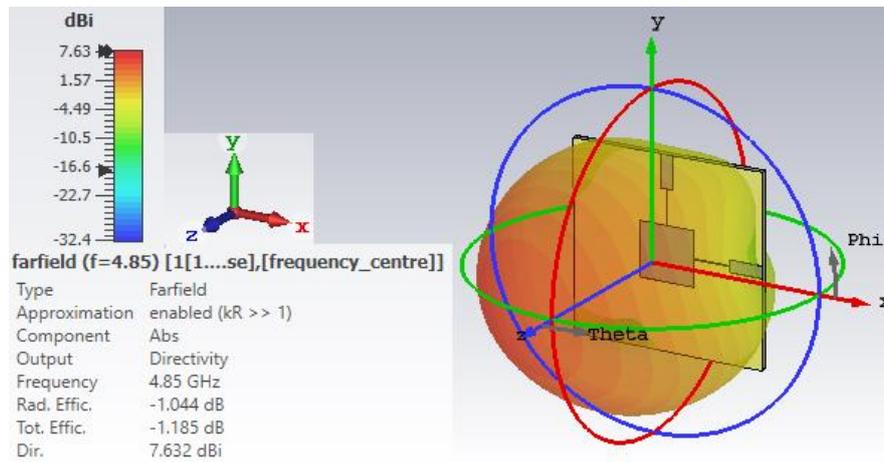


Figure 12. 3D Directivity Pattern for dual-edge-fed LHSP.

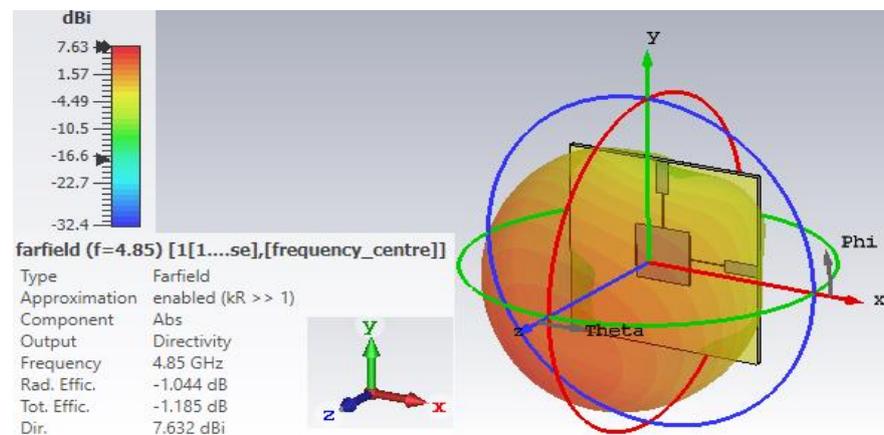


Figure 13. 3D Far Field Gain Pattern for dual-edge-fed RHSP.

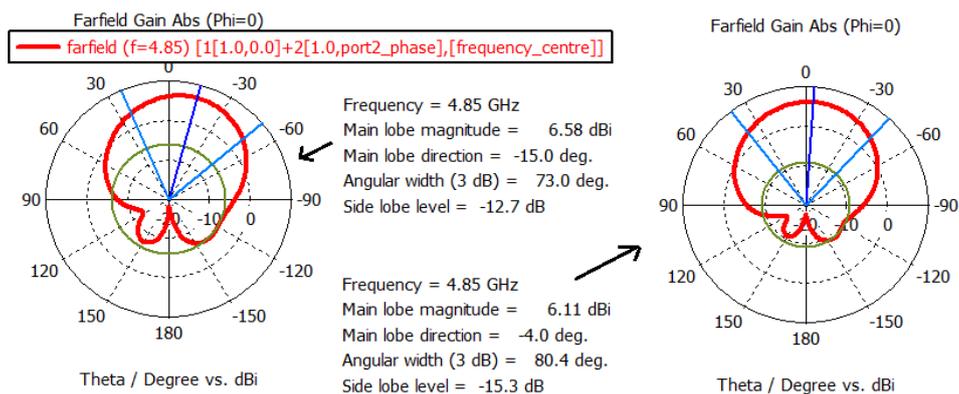


Figure 14. 2D Gain Pattern of LHCP and RHCP.

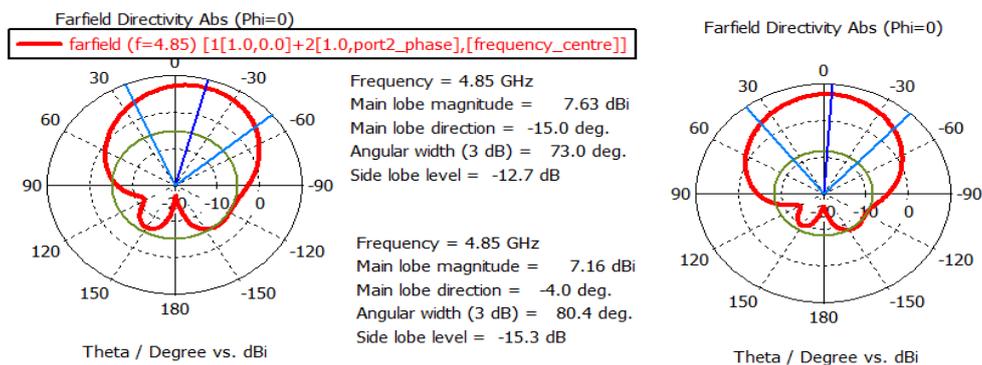


Figure 15. 2D Directivity Pattern of LHCP and RHCP.

Table 5. Gain and Directivity for LHSP and RHCP

S.N	Parameters	Type of Circular Polarization	
		Left Hand	Right Hand
1	Gain	6.59 dBi	6.59 dBi
2	Directivity	7.63 dBi	7.63 dBi
3	Radiation Efficiency	-1.044 dB	-1.044 dB
4	Total Efficiency	-1.185 dB	-1.185 dB

### 5. Conclusion

There are several categories of micro strip antenna arrangement that are stimulate a circular polarization. In this administrative work, we arranged a double edge-took care of captivated rectangular miniature strip reception apparatus. This proposed structure has been utilized for a remote correspondences framework at 4.85 GHz, the dual-edge-fed left hand and right hand circular polarization micro strip antenna is effectively simulated and got the excellent simulation results at specified operating frequency. The return loss value is -15.985891 dB, Band width is 74.1 MHz, gain value is 6.59 dBi and directivity is 7.632 dBi. According to this good results the circular polarization intellects varieties the proposed construction suitable for practical wireless communication applications needful circular polarization diversity.

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