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## 5.8 GHz Circular Polarized Microstrip Feeding Antenna for Solar Panel Application

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**Abstract.** Circular polarized microstrip antenna have been proposed to establish connection among distributed solar farms. The base station antenna of each solar farm permits more precise on the targeting the radio signal and usually is placed at the open area or at a height place so that the radio waves to be transmitted will not be interrupted. For this paper, circularly polarized microstrip patch antenna (CPMSA) is designs and being reviewed. The patch antenna is based on low-cost, but lossy, and the substrate is made of Rogers RT 5880 (lossy). It consists of a rectangular radiator patch, which is fed by microstrip transmission line. In order to realized circularly polarized antenna, the patch has undergone some design modification to achieve circular rotation. Some technique is proposed to achieve CP antenna. The results indicate that the antenna that uses micro strip feed line technique yields 8.55 dB directive gain, return loss and axial ratio at -24.4 dB and 2.05 dB respectivel. The resonance frequency of 5.8 GHz is being selected since it is suitable used for point to point communication among distributed solar farms that located far from each others.

### 1. Introduction

Microstrip antenna (MSA) are currently growth at a fastest segment in telecommunication industries. It is able to indicate good signal and has a compact structure for ease of installation for base station application. Microstrip patch antenna is low profile antenna with a light weight and simple to manufacture as well as easy to be mounted on a various device [1,2]. Usually, base station antenna is placed at an open area or at a height place to avoid interference and easy for power transmission between antenna. Microstrip patch antenna is choose in this project because it is more reliable compare to other. The advantages of microstrip antenna make it suitable use in this application.

The basic structure of microstrip antenna consists of a radiating patch on one side of a dielectric substrate and a ground plane on the other side of the substrate [3,4]. MSA has a radiating patch is made

from copper and the dielectric substrate used is Rogers RT 5880. Rectangular shape is choosing for the antenna design because it has a simple shape and also to avoid longtime computation due to shape



complexity [5]. The MSA is feed by microstrip feedline with the characteristic impedance of 50 ohms.

This type of feeding is a simple and easy to construct. Circular polarization of microstrip patch antenna is introduced to allow the receiver to constantly receive the power signal at any wave angle. Polarization is important to limit the wireless communication distance due to the resulting wave having an angular variation [1,6]. It also can make the connection between two antennas (receive and transmit) is more constant if the antenna having some interferences. A circularly polarized antenna with a low profile, small size, and light weight is required in wireless communications. There are many techniques of microstrip antennas have been proposed and investigated to achieved CP antenna [7].

Circular polarization can be obtained if the axial ratio of the antenna is below than -3 dB at 90 phase shift [8]. This can be accomplished for instance by adjusting the physical dimensions of the microstrip

patch or various feed arrangements. Truncating corner of the rectangular patch is one of the technique used to get CP antenna [9,10]. The patch is trimmed both orthogonal so that it will radiate energy in both horizontal and vertical planes and all planes in between. Besides, making an inclined slot or diagonally slot at the centre of the radiating patch is also can improved the result of axial ratio in order

to generate CP rotation [8,11].

## 2. Antenna Design and Performances

The geometry of the proposed antenna having a resonance frequency at 5.8 GHz is shown in figure 1 with various dimensions. The antenna is mounted on a Rogers RT 5880 (lossy) substrate having thickness 1.53 mm with relative permittivity of 2.2. The patch and the ground plane is made up of radiating element like a copper having a thickness of 0.053mm with a dimension 70 X 70 mm<sup>2</sup>. The antenna is fed by microstrip transmission line having a width of 4.8 mm. The corners of the rectangular

patch are truncated to reduce the size of the proposed antenna as well as to obtain CP rotation [9,12].

The equation that is used in designing the rectangular micro strip patch antenna is given as below [13]. The width of the patch is calculated by using equation (3.1) and it gives the initial value for the width of a rectangular micro strip antenna to utilize at 5.8 GHz [14].

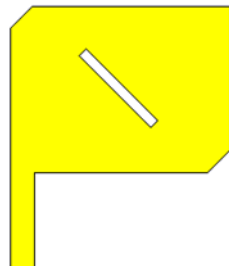
$$= \frac{c}{2fr \sqrt{\frac{\epsilon_r + 1}{2}}} \quad (1)$$

By using equation (3.1), the width for the rectangular patch micro strip antenna operating at 5.8 GHz is calculated and the width is equal to 20.6 mm while the length of the patch has the value of 18.47 mm. After the width and the length of the patch are discovered, the next step is to generate circular polarization for the antenna. In this paper, the patch will apply perturbation segment where both of the opposite edges of the rectangular patch are truncated with a cutting angle of 45° in order to obtain circular polarization with an axial ratio of  $\leq 3$  dB. By applying truncated technique to the patch, this will alter the design parameter of the antenna that may lead to adjustment in the calculated value for the patch width and length. The rectangular patch antenna with truncated corner usually has the range about 2 mm to 10 mm for the cutting edge with 45° of cutting angle. Table 1 shows the initial dimensions for the rectangular patch antenna design.

Parameter	Value of parameter (mm)
W	20.6
L	18.47
w	4.1

**Table 1: Initial parameter of rectangular patch antenna**

The third stage is where slot is added at the centre of the rectangular patch. By cutting a slot in the micro strip patch, this will contribute in the reduction for the size of the antenna thus making the antenna more compact. This is because by increasing the length of the slot, the resonant frequency will also decrease. The outcome from the decrease in the value of resonant frequency will result in the decreasing in the antenna size. It is also used to enhance the value for return loss.



**Figure 1.** The original designed of antenna

Some of the initial parameters have been optimized in order to obtain the best results for the working frequency of 5.8 GHz. Table 2 shows the final dimension for the micro strip rectangular patch antenna design.

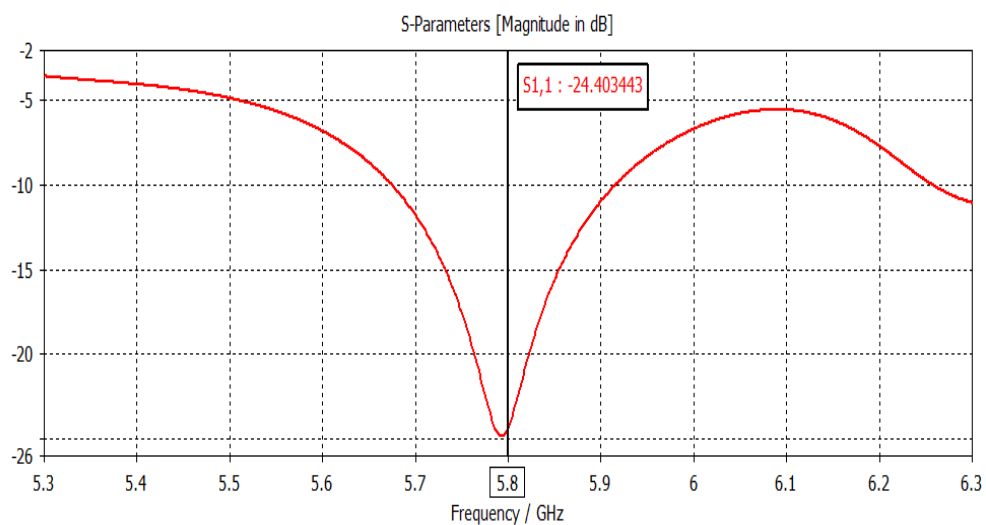
**Table 2: Final dimension of Micro strip Rectangular Patch Antenna**

Parameter	Value of parameter (mm)
W	39.2

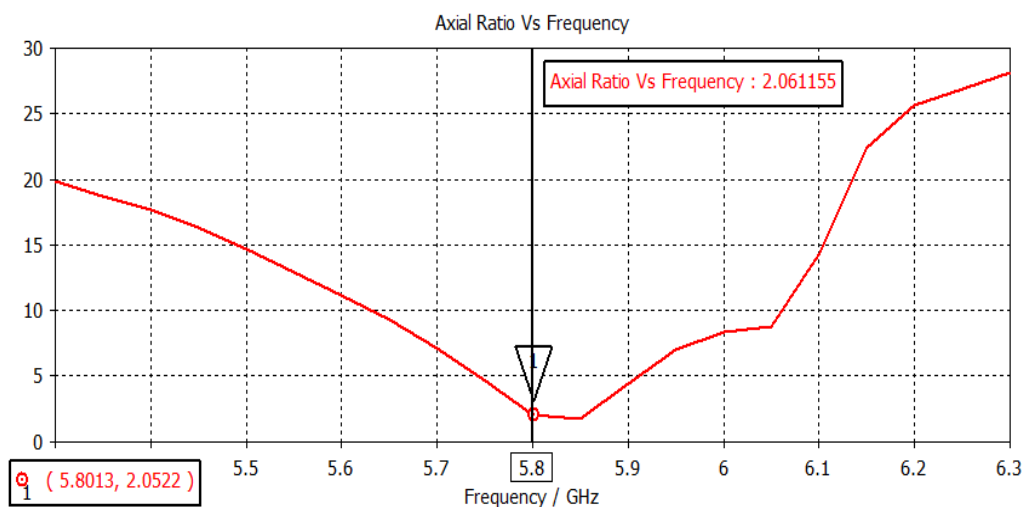
L	28.4
w	4.1
$\Delta L$	3.5
Slot length	2.3

### 3. Simulation results

Figure 2 shows the simulation result of return loss versus frequency for patch antenna with micro strip feed while Figure 3 shows the value of axial ratio of the proposed antenna.

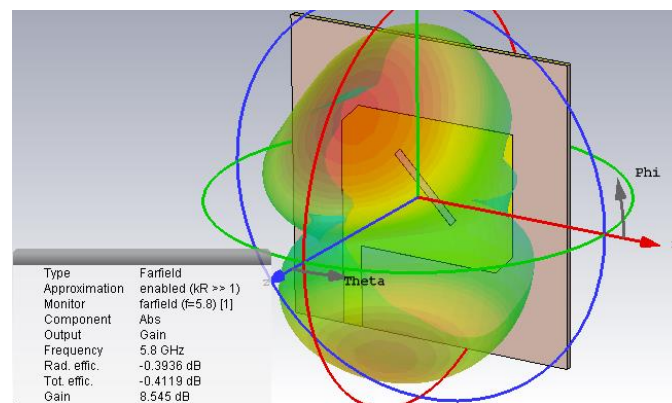


**Figure 2.** The Return Loss of Designed Antenna



**Figure 3.** The Axial Ratio of Designed Antenna

For S-Parameter plot, the simulated value of return loss (S11) for micro strip feed patch is -24.4 dB at 5.8 GHz which is good as the value is more than -10 dB at the desired frequency. As for the axial ratio, the proposed antenna has a value of 2.05 dB. Radiation pattern is a representation of the power or the energy that is radiated by the antenna. It is used to determine the directivity and also the gain of an antenna. For an antenna to be considered as a good antenna, it should have a high directivity in which it measures the degree of the radiated emitted that is focused on a single direction only [7]. From the radiation pattern plot above, the directivity and the gain of the antenna can be determined. The micro strip feed line patch antenna has the gain value of 8.55 dB as shown in Figure 4 below.



**Figure 4.** The directivity of the proposed antenna

#### 4. Conclusion

This paper presents the design of circularly polarized microstrip patch antenna for 5.8 GHz base station antenna among distributed solar farms that located far from each others. In order to realize the circular polarization and increase the gain, some truncation of patch is placed perpendicular each other and a slot is placed at the centre of the rectangular patch. Additional technique of truncated successfully realize the circular polarized antenna with operating frequency of 5.8 GHz. The antenna recorded 8.55 dB directive gain, return loss and axial ratio at -24.4 dB and 2.05 dB respectively. The simulation result is considering a good antenna and will continue to be fabricate and measured.

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