Development Of Circular Polarization 5.5 Ghz Microstrip Antenna E-Shaped For Synthetic Aperture Radar Communication

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Abstract. This paper presents development of circular polarization 5.5 GHz microstrip antenna E-shaped for synthetic aperture radar Communication. Microstrip antenna designed Truncated E-shaped the centered frequency is 5.5 GHz and bandwidth that is wide 200 Mhz for Synthetic Aperture Radar communication. The proposed antenna on 1.6 mm thickness of FR-4 substrate with the dielectric constant 4.6. The best simulated result can achieve -10dB reflection coefficient bandwidth 600 Mhz, VSWR 1,578, gain 5,67 dbiC and axial ratio 2,947 with left-handed circular polarization. The best measurement result can achieve -10 dB reflection coefficient bandwidth 951 MHz (5.304-6.255), VSWR 1,25, gain 6,17 dBiC with left-handed circular polarization.

Keywords: Circular Polarization, Radar Communication, Microstrip Antenna

1 Introduction

Technology in microstrip antennas is currently many used because of its size and shape, it is light in weight, easy to integrate into suitable telecommunication devices and easy fabrication [1] – [4]. Synthetic aperture radar system can operate in various conditions and weather [5] – [7]. In general, the C-band frequency (4-8GHz) for research is widely used as communication [8], [9]. In general, SAR is used as a sensor for mapping and its use is in uav, airplanes, satellites and others [5]-[7],[10] – [19]. The material used in this antenna is FR-4, because this material is cheap and easy to fabricate [20]. This study uses circular polarization because circular polarization in uncertain weather conditions is better than linear polarization [8].

Circular polarization in microstrip antennas is widely used in mapping, communication and so on. Microstrip antenna is very popular used wirelessly [21]. The design for this microstrip antenna is E-shaped with a truncated corner. For provisions, the center frequency is at 5.5 GHz, bandwidth is 200 MHz, return loss is -10 dB, axial ratio is 3 dB, 1 VSWR 2 and uses circular polarization.

2 Design and Configuration

There are several stages carried out to carry out the research as shown in Figure 1. In the first stage, namely determining the specifications on the microstrip antenna. The second stage is to calculate the design of

the microstrip antenna. The third stage is Simulating the antenna using the CST Studio Suite 2019 software. The fourth stage is fabricating the appropriate antenna. The fifth stage is simulating the fabrication of the antenna in the anechoic chamber.

Fig. 1. Flowchart

The detail configuration is shown in figure 2. The antenna is designed with two substrate-of dielectric constant, the top of the substrate is a patch that can later electro magnetic waves.

Fig. 2. Design microstrip antenna

Below the top substrate there is a feed line which serves as a liaison for electromagnetic waves from the power supply to the patch. The backside second layer set a ground plane. Material substrate used FR-4 with 4.6 dielectric constant, 1.6 mm thickness and total thickness 3.2 mm. Material patch antenna used copper with 0.035 mm thickness.

The patch of antenna is formed truncated corner with E-Shaped from rectangular patch aims as make circular polarization. Length at the cutting angle of the patch is 1.8 mm. The top hole is used to increase width of antenna bandwidth and aims as make circular polarization.

The following is a table of calculation results at three design microstrip antenna.

Table 1 calculation result

Nilai (mm)			Keterangan
1	2	3	
30	30	30	Ground and substrate length and width
0.035	0.035	0.035	Thickness <i>patch</i>
1.6	1.6	1.6	Thickness <i>subsrat</i>
3.2	3.2	3.2	Total thickness double <i>subsrat</i>
10.5	10.8	10.6	Length <i>patch</i>
10.5	10.8	10.6	Width <i>Patch</i>
3	3	3	Width <i>feedline</i> (1)
7.7	9	9	Length <i>feedline</i> (1)
2.5	2.1	4	Width slot E-Shape
1.5	1.2	4	Length slot E-Shape
3.2	2.5	1.5	Width top slot / lebar rectangular slot (3)
2.6	2	1	Length top slot / width rectangular slot (3)
4	4	4	side shape
1.8	2.8	2.6	Size on side <i>truncated corner</i> (1)
6	4.5	4	Width <i>feedline</i> (2)
6	4.3	4.2	Length <i>feedline</i> (3)
0.6	0.5	0.5	Size on side <i>truncated corner</i> (2)
1.6	1.6	1.6	Hole diameter

Fig. 3. Fabricated microstrip antenna

This double layer antenna is combined by four plastics screws at each corner. The fabricated antenna with total dimension 30 mm x 30 mm is shown in figure 3.

3 Result and Discussion

The proposed antenna has been done through simulation and measurement. The results tested in this experiment are coefficient reflection, bandwidth, gain, vswr and axial ratio.

3.1 Simulated

The following are the results of the 2019 CST Studio Suite simulation in the three designs, which contain the results of return loss, vswr, bandwidth, gain and axial ratio. Each design has a different color design 1 (blue), 2 (green), 3 (red).

Fig. 4. Return loss and bandwidth

Fig. 5. VSWR

Fig. 6. Gain

Fig. 7. Axial ratio

The following is a table of simulation results at three design microstrip antenna.

Table 2. Simulation results

Desain	Return loss	Bandwidth	VSWR	Axial Ratio	Gain
1	-12,978 dB	600 MHz	1,578	2,947 dB	5,67 dBiC
2	-12,671 dB	639,2 MHz	1,61	1,479 dB	5,82 dBiC
3	- 12.203 dB	639 MHz	1,65	0,901 dB	5,88 dBiC

The simulation results that have been carried out in the 2019 cst studio suite show results that are in accordance with the provisions of this research.

3.2 Measurements

At this time the measurements were carried out in the anechoic chamber at the LAPAN satellite technology center. The measurement proses this time produces results that are quite different from the simulation in the cst studio suite. The following is the result of the measurement process in the anechoic chamber.

Fig. 8. Return loss and bandwidth (measurements)

This result is a different result than that done in the simulation cst studio suite. For design 1 the results are better and also for the width range is wider than in the simulation. In the second design the results are shifted than in the simulation. In the third design, the results do not match what was done in the simulation. For bandwidth, it can be seen from the results of return loss with a wide range of frequencies in the first design resulting in 951 MHz, this result is better than that done in the simulation. For the second design, which produces 915 MHz, this result is in accordance with the provisions, but this result is shifted from the simulation. For the third design to produce 7 MHz this result is not in accordance with the provisions and also different from the results in the simulation.

Fig. 8. VSWR

VSWR (Voltage Stage Wave Ratio) results are different for each design with a center frequency of 5.5 GHz. The first design produces 1.25, this result is in accordance with the provisions and is better than the

simulation. In the second design the results of 2.34 are not in accordance with the provisions due to the shift in the results of the measurement. The third design produces a value of 1.97, this result is appropriate and not better than in the simulation.

There are Gain results in the first design that are in accordance with the provisions of return loss, vswr and bandwidth. This gain focuses on the center frequency of 5.5 GHz. The result of this Gain is 6.17 dBiC, this result is also better than what was done in the simulation which produces 5.67 dBiC.

Fig. 9. Gain

4 Conclusion

For the analysis that I got from these three designs, the results from the simulation in the cst studio suite software and measurements in the anechoic chamber there are quite a lot of differences. In the first design results for measurement the results are better than the simulation in the cst studio suite. In the second design result for the cst studio simulation the results are better than the measurement, due to the shift in the results in the frequency to the right, because there is a problem in the cavity between the two substrates that is not properly attached. In the third design result for the simulation of cst studio suite the results are better than the measurement, because there are problems in the cavity of the two substrates that are not tightly attached and the SMA connector is different from the two previous designs.

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