U-Shaped Microstrip Patch Antenna

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Abstract: In this work, a different U shaped microstrip patch antenna at 11.02 GHz is designed and simulated. Simulated results are presented by using Sonnet software [1], a planar 3D electromagnetic simulator. Among those results, the real part of the input impedance is almost 50 ohms, theta-polarized electric field radiation pattern gain is 8.23 dB, and the –10 dB return loss bandwidth is 2.63%. Details of the simulation results are presented and discussed.

Keywords: Microstrip, Patch, Antenna, U Shaped, Bandwidth

1. Introduction

There are some works in the literature about the antennas around 11 GHz. One of them uses impedance matching method in order to increase the bandwidth at different frequencies. They applied this method to their design and achieved 20% bandwidth stacked patch antenna at 7GHz [2]. Bandwidth increasing is one of the design challenges in the design of microstrip patch antennas. Several techniques are formulized for different input geometries [3]. There are designs of probe-fed rectangular patch antennas as compared to this study [4]. The antenna is used for many applications in recent wireless communications, such as radar, microwave and space communications [5]. This work uses some similar and other different approaches as compared to previous work.

2. Design Procedure

The antenna is in a 3000 x 3000 mils box. The patch dimensions are 378 x 360 mils. Dielectric thickness is 120 mils and dielectric constant is 2. Change in S11 and the center frequency with the geometry is seen in Table 1. The work started with low gain. When the return loss is increased, the gain has also increased. This situation caused to make changes on the geometry. While the S11 was -9.39 dB in the first step, it is lowered to -73.51 dB at the last step. Table 1 summarizes those changes. The affects of the changes for the design parameters are mentioned in Table 2.

Table 1: Change in S11 and the center frequency with the geometry

Steps	Magnitude (S11:dB)	Resonance Freq. (GHz)
I	-9.39	12.9
II	-17.55	11.5
III	-15.6	11.8
	-15.61	14.35
IV	-16.22	12.25
V	-22.68	11.74
VI	-20.28	11.7
VII	-45.98	11.02
VIII	-64.38	11.015
IX	-73.51	11.015

Top view of the antenna can be seen on Figure 1. Figure 2 has the 3-D view of the antenna.

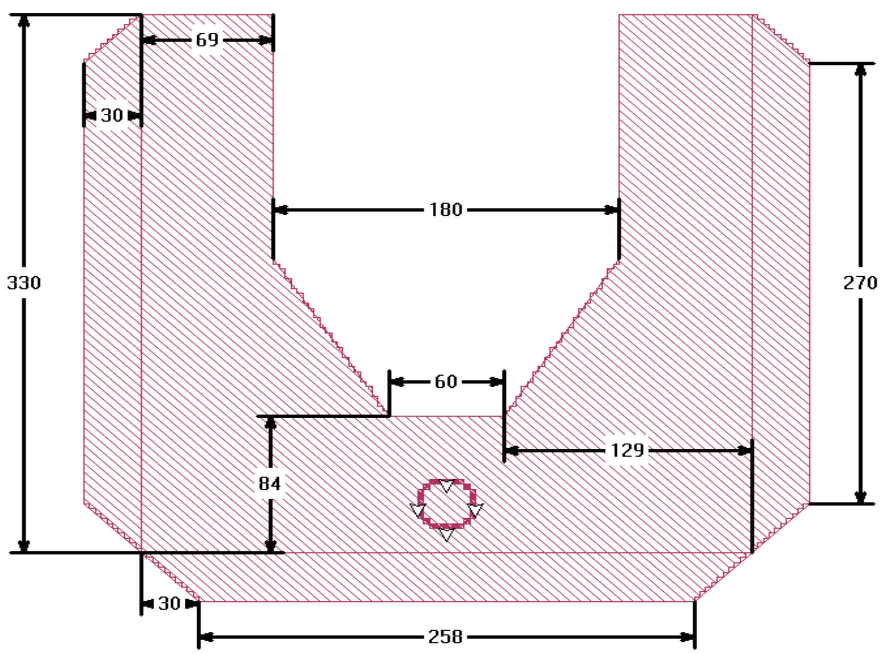


Fig. 1. Top view of the antenna.

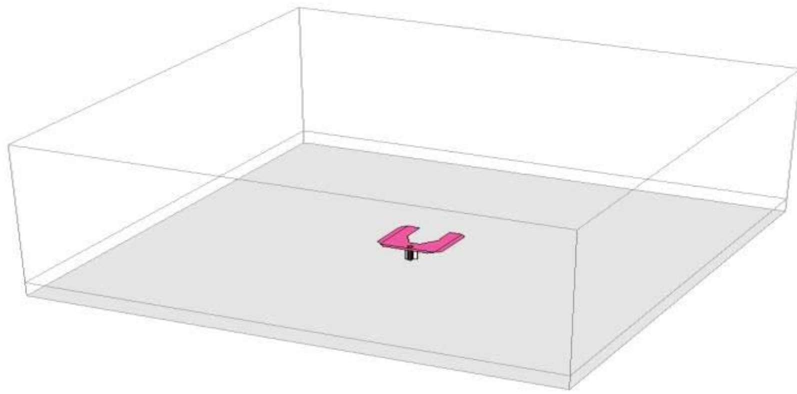


Fig. 2. 3D view of the antenna.

The changes which are; cell size, box size, patch size, dielectric thickness and dielectric constant; made in the patch geometry helped to improve design parameters such as return loss, gain, resonance frequency and impedance. Note that, there were two resonance frequencies in step III and VI.

Table 2: Optimization of the design parameters

Steps	Cell Size	Box Size	Thickness/Erel	Patch Size	Magn. S11(dB)	Freq. GHz	Gain (dB)	Real Z_{in}	Imag. Z_{in}
I	10x10	2200x2750	800 / 1.0	320x330	-9.39	12.9	5.93	29.49	18.57
			80 / 2.3						
II	10x10	2200x2750	800 / 1.0	320x330	-17.55	11.5	5.76	56.39	-22.31
			80 / 2.2						
III	5x5	3000x3000	800 / 1.0	320x330	-15.66	11.8	6.26	54.38	-16.86
			80 / 2.0		15.61	14.35	1.30	69.34	4.13
IV	3x3	3000x3000	1200 / 1.0	318x330	-16.22	12.25	8.53	43.78	-13.23
			80 / 2.0						
V	3x3	3000x3000	1200 / 1.0	318x330	-22.68	11.74	8.27	54.76	-6.05
			120 / 2.0						
VI	3x3	3498x3630	1200 / 1.0	318x330	-20.28	11.7	8.16	59.48	4.74
			120 / 2.0		-20.58	11.48	6.74	47.08	8.62
VII	3x3	3000x3000	1200 / 1.0	378x340	-45.98	11.02	8.23	49.63	0.34
			120 / 2.0						
VIII[1]	3x3	3000x3000	1200 / 1.0	378x350	-64.38	11.015	8.22	49.97	0.05
			120 / 2.0						
IX[1]	**3x3**	**3000x3000**	**1200 / 1.0**	**378x360**	**-73.52**	**11.02**	**8.25**	**49.55**	**0.53**
			120 / 2.0						

3. Simulation Results

A very low input match is seen in Figure 3. -10 dB return loss bandwidth is 2.63%. The real part of the input impedance is (49.55 Ω) in Figure 4, and imaginary part of the input impedance is (0.54 Ω)in Figure 5. Figure 6 has the electric field radiation pattern gain, which is 8.25 dB.

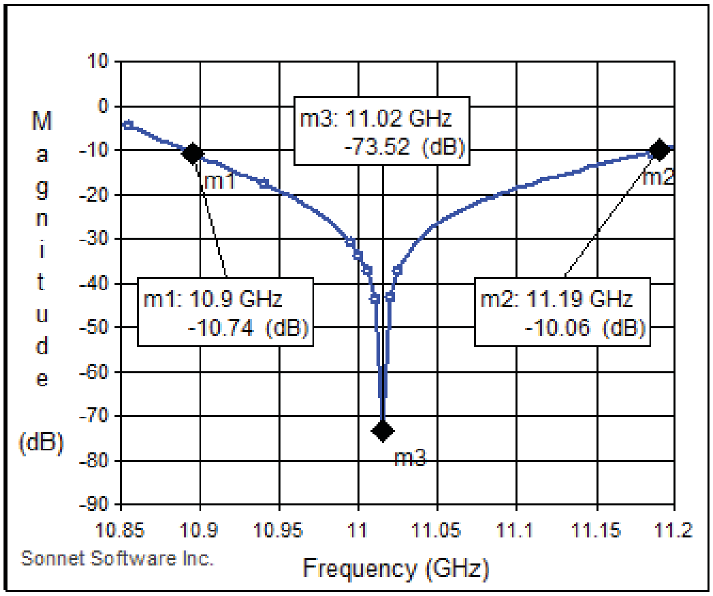
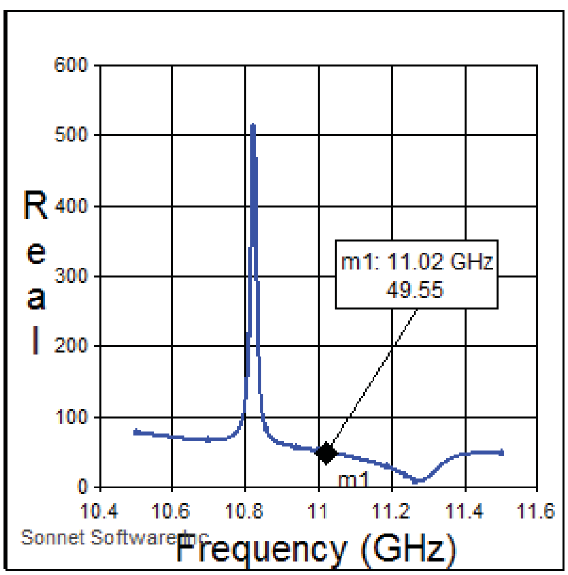


Fig. 3. Return loss of the patch antenna.



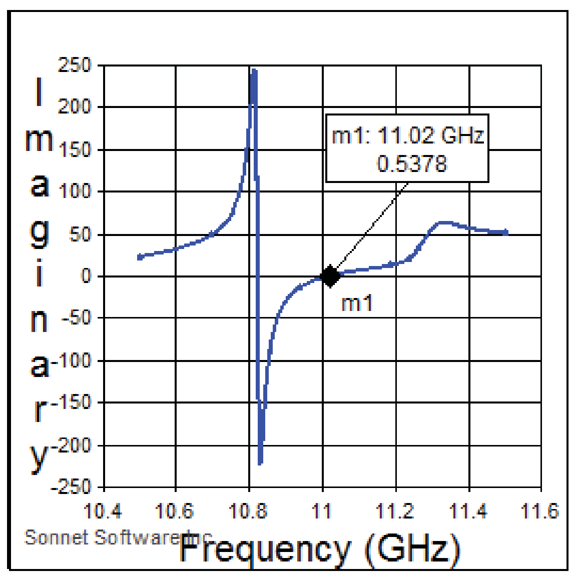


Fig. 4. The real part of the impedance.

Fig. 5. The imaginary real part of the impedance.

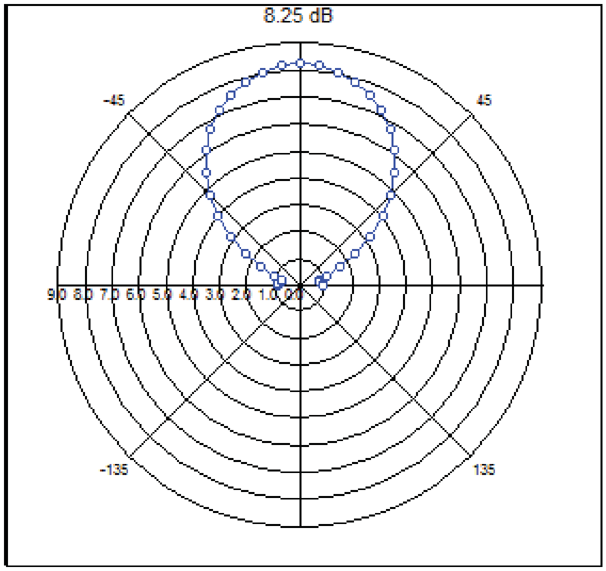


Fig. 5. Far field radiation pattern of the antenna at 11.02 GHz.

Figure 7 has the current on the antenna which shows that main radiated elements are inside and outside edges of the U-shape arms, and near the probe feed point for the resonance frequency at 11.02 GHz.

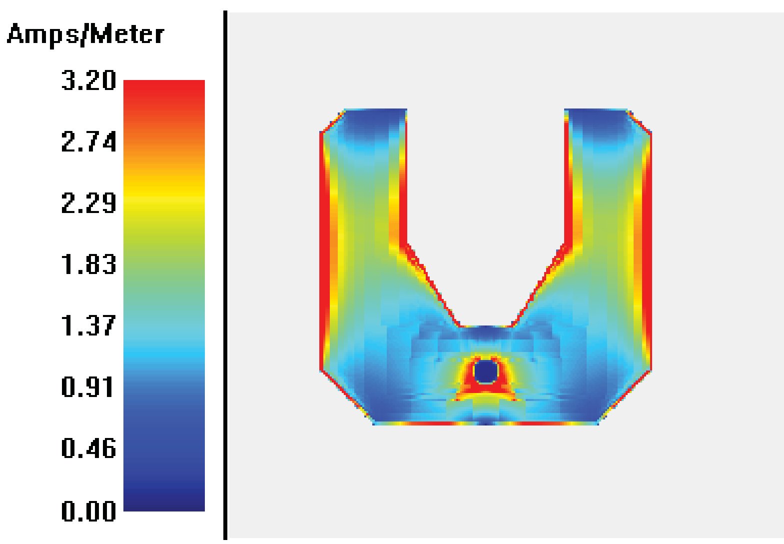


Fig. 6. Current distribution on the antenna at 11.02 GHz.

4.Conclusions

A microstrip patch antenna at a resonance frequency of 11.02 GHz, with 50.3 Ω real input impedance, 2.63% of bandwidth, and 8.25 dB of gain is achieved. Design is modified by changing the geometry in order to reach the design specifications. Next goal is to increase the bandwidth value of 2.63%, and afterwards fabricate the antenna.

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