Circularly Polarized Microstrip Patch Antenna with Slits

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Abstract: A compact circular-polarized square microstrip antenna with four slits and a pair of truncated corners is designed and simulated. In addition, the size reduction of the patch approximately 29% as compared to the conventional corner-truncated square microstrip antennas at a given operating frequency, obtained. There is also an analysis of tolerance in order to see possible fabrication errors which includes different dielectric heights and relative permittivity. Details of the simulation results using a commercial electromagnetic simulation software called Sonnet software [1], are presented and discussed.

Keywords: Microstrip, patch, antenna, compact, slit

1. Introduction

Traditionally, a single-feed circular-polarization (CP) operation of the corners truncated square microstrip antenna is extensively used in single patch and array designs [2]. In this work, we obtain the compactness of the proposed CP design due to inserting four slits of equal lengths at the corners [2]. These inserted slits at the corners of the square patch result in meandering of the excited fundamental-mode patch surface current path, which effectively lowers the resonant frequency of the modified square patch [3]. Details of the proposed compact CP design are described. Moreover, the results of the simulation with Sonnet software is presented and discussed.

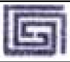
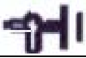
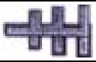
2. Design procedure

The specifications require the right hand side circularly polarized microstrip patch antenna at 2.184 Ghz. More importantly, the physical requirement is to reduce the size of the patch antennas [4]. Two different types of commercial substrates which are Duroid 5880 (ε_r = 2.2, h=125mils) and Arlon Cu 233LX (ε_r =2.33, h=125mils) are chosen. The design procedure of those antennas are followed. First, we design the conventional corners truncated microstrip patch antennas at 2.184 Ghz. Subsequently, we designed the proposed antenna which have four slits of the equal lengths at the patch corners to achieve the size reduction [2]. Geometry of the proposed microstrip antennas is shown in Figure 1 which is designed with Duroid 5880 (ε_r = 2.2, h=125mils).

The 50-Ω feeding line has a width 9.89 mm and 10 mm length. All the inserted slits are of length 18 mm and width 1mm along the directions of ±45 degree. The square patch has a side length L=39 mm and a pair of truncated corners of dimensions 8.5 mm × 8.5 mm [2].

Table 1 discusses different type of microstrip patch antennas in terms of pattern, directivity, polarization, bandwidth etc.

Table 1. Microwave Planar antenna overview.

		Pattern	Directivity	Polarization	Bandwidth	Comments
Patch		Broadside	Medium	Linear/Circular	Narrow	Easiest design
Slot		Broadside	Low/Medium	Linear	Medium	Bi-directional
Ring		Broadside	Medium	Linear/Circular	Narrow	Feeding Complicated
Spiral		Broadside	Medium	Linear/Circular	Wide	Balun& Absorber
Bow-Tie		Broadside	Medium	Linear	Wide	Same as Spiral
TSA(Vivaldi)		Endfire	Medium/High	Linear	Wide	Feed transition
Yagi Slot		Endfire	Medium	Linear	Medium	Two layer design
Quasi Yagi		Endfire	Medium/High	Linear	Wide	Uniplanar, Compact
LPDA		Endfire	Medium	Linear	Wide	Balun Two Layer
Leaky-Wave		Scannable	High	Linear	Medium	Beam steering Beam-tilting

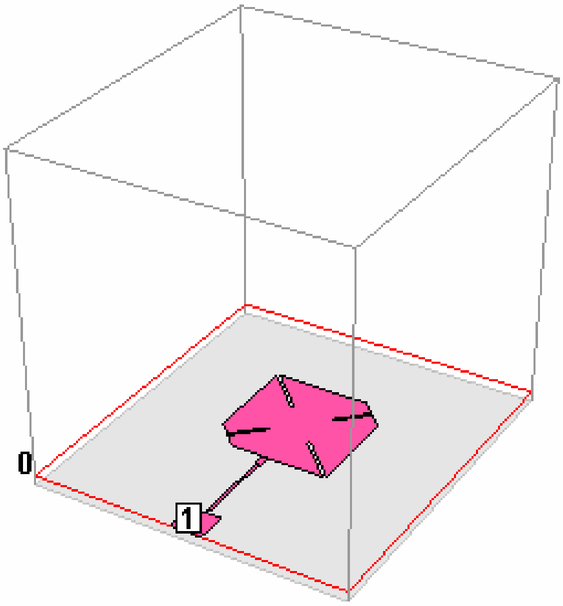


Fig. 1. 3D View of the antenna.

3. Test and Simulation Results

The simulation results of the return loss is shown in Figure 2. Figure 3 and 4 has the imaginary and real part of Z_{in}, Figure 5 shows the radiation patterns and finally Figure 6 has the current distribution.

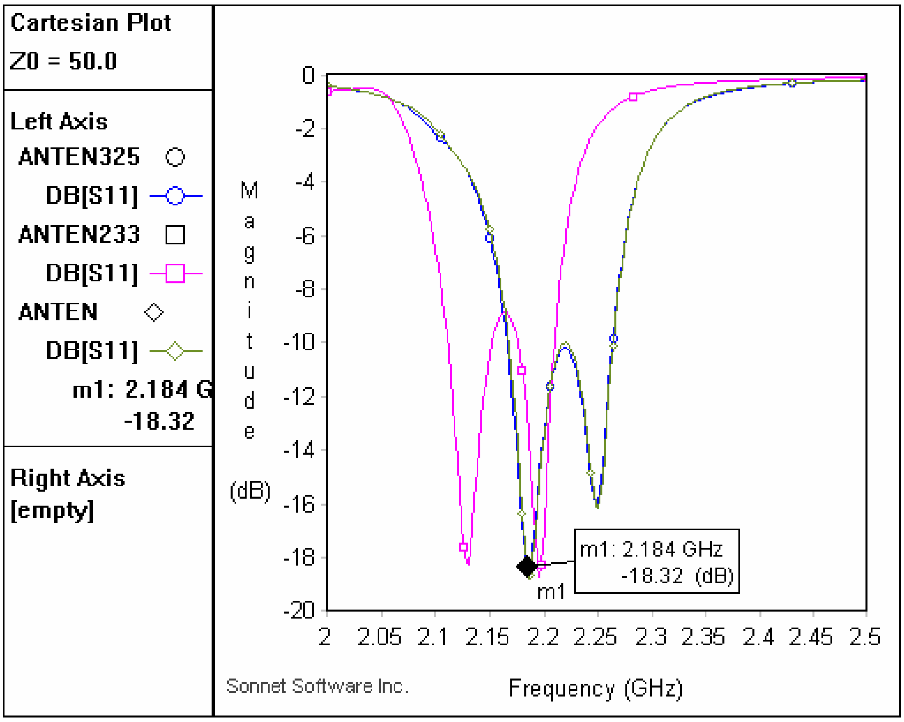


Fig. 2. Return loss for the proposed patch antenna with different dielectric heights.

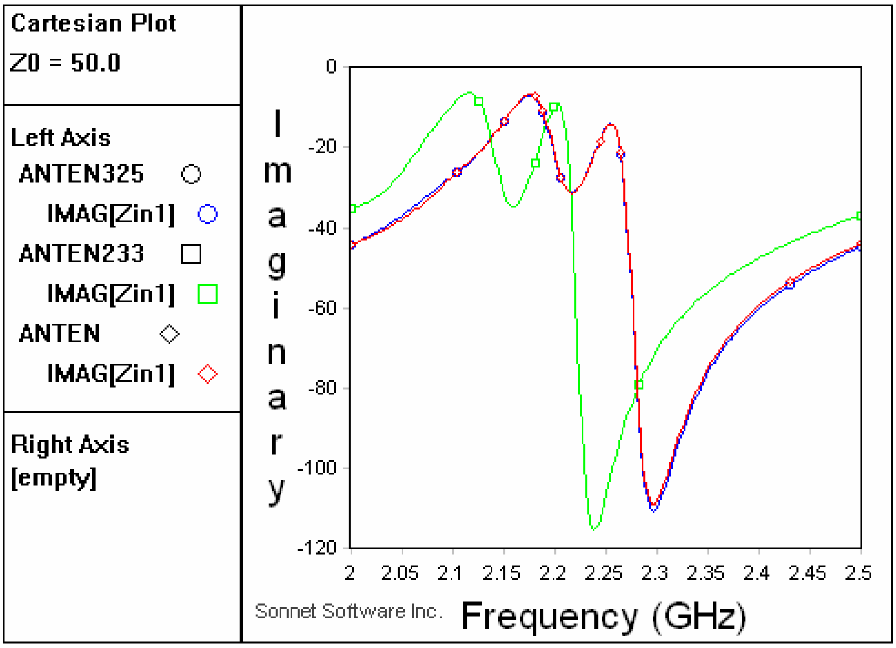


Fig. 3. Imaginary part of Z_{in} for the proposed patch antenna.

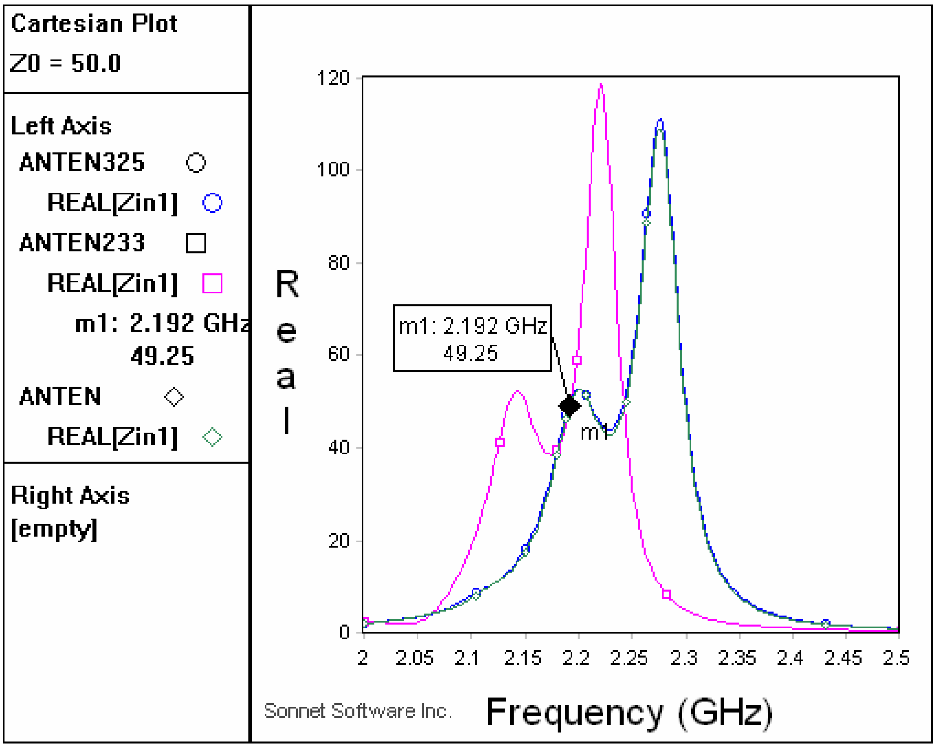


Fig. 4. Real part of Zin for the proposed patch antenna.

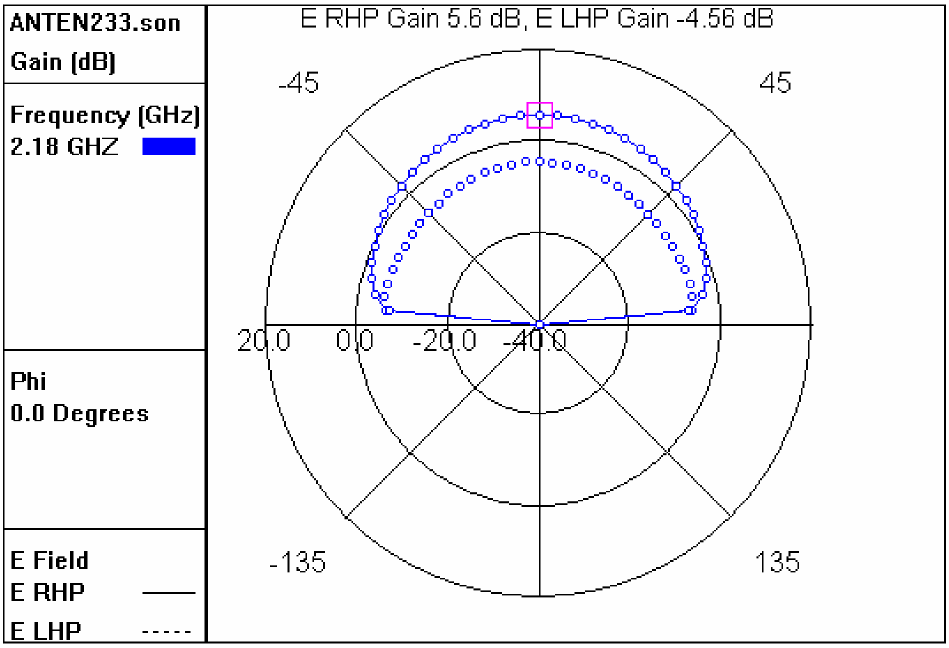


Fig. 5. Far field radiation pattern of the antenna.

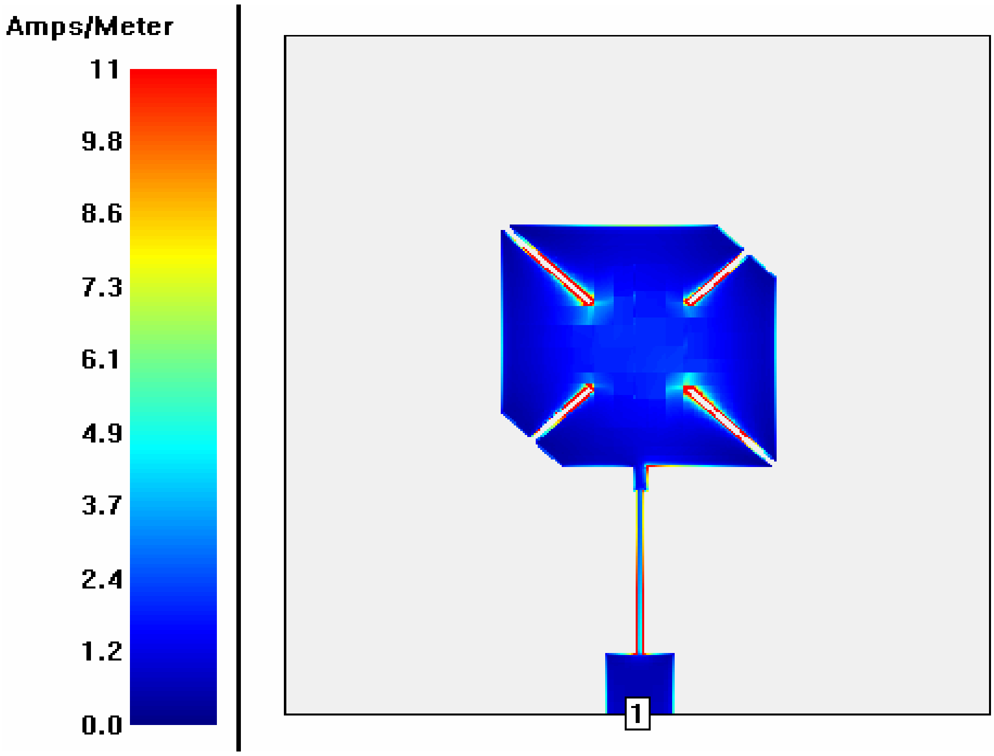


Fig. 6. Current distribution on the antenna.

As it is seen on Figure 2, dielectric height does not affect the results much, but when we changed the dielectric material (permittivity changed from 2.2 to 2.33) a slight frequency shift occurred. In both cases return losses at the resonance frequency is satisfactory. Figure 3 and 4 show the imaginary part of the input impedances, which are close to zero, as expected for the resonant antennas, and the real part of the input impedances are almost 50 ohm for the 3 different values of the dielectrics. In Figure 5, right-hand circularly polarized radiation pattern has 5,6 dB gain and left hand circularly polarized radiation pattern has a value of minus 4,56 dB in polar plot. Figure 6 shows the current distribution on the surface of the patch.

4. Conclusions

In this work a compact size microstrip patch antenna which has four slits at each corner is designed, simulated. Slits helped to reduce the antenna dimensions about 29%. The design requirements are met and simulated results which were discussed on Section 3 are satisfactory. Simulated results with different parameters show that antenna is tolerant for changes of possible fabrication losses.

5. Acknowledgments

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References

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