# Corners Truncated Microstrip Patch Antenna

**Taha İmeci , Anıl Saral**

Department of Electronics and Comunication Engineering
Haliç University, İstanbul , TURKEY
tahaimeci@halic.edu.tr , anilsaral@halic.edu.tr

**Abstract:** Mobile personal communication systems and wireless computer networks are commonly used nowadays and they need antennas in different feequency bands. For this purpose, in this work, an antenna which operates at center frequency of 1791 MHz, is designed and simulated. In order to integrate the antenna to those systems, a microstrip patch antenna has been chosen and designed for a certain polarization. Design steps are given in details and results are presented in graphs obtained by a CAD (Computer Aided Design) tool which in this case is an electromagnetic simulation program.

**Keywords:** Microstrip, rectangular, patch, antenna, corners truncated, planar, slit.

## 1. Introduction

Technologies concerning microwaves caused them to be used commonly in the beginning of the 1990's in wireless and mobile communication systems. Personal and corporate usage needs increased drastically in particular, that's why RF devices have been used almost everywhere in human life [1]. Among those technologies, microstrip patch antennas took a large part in various applications due to their thin, conformal structures and easy fabrication features.

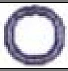
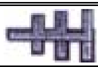
## 2. Patch Antenna Overview

As one can understand due to their common usage, microstrip patch antennas have a lot advantages such as being thin, conformal, light, low cost and low RCS. They do have some disadvantages including narrow bandwidth, low power handling capacity, higher loss when arrayed at higher frequencies (the loss is mostly in power dividers). They can be used in the frequency range of UHF (100 MHz) to 100 GHz [1]. Different analysis techniques can be applied. Among those, Transmission Line Equivalent Circuit Method is very simple, but not very accurate. Cavity model (Multimode Theory) provides more physical insight, but is not the most accurate. Integral Equation (Moment Method) gives accurate results with help of 2.5D CAD tools such as Ansoft Designer and Sonnet Software. Finite Element, FDTD and TLM are most accurate, 3D, but takes more time such as HFSS and Microstripes. These packages aid in the circuit layout design of arrays and also compute the antenna input impedance, radiation patterns, antenna efficiencies etc. [2]. Mutual coupling between patch elements are included in the analysis. These CAD tools are needed to

- Accurately compute the input impedance
- Take into account the mutual coupling between patches in an array
- Analyze multilayer configurations.

Table 1 explains different shape of microstrip patch antennas in terms of their various antenna parameters [3].

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** |

## 3. Design and Equations

In this work, a circularly polarized microstrip patch antenna at a resonance frequency of 1791 MHz is designed and simulated. As a CAD tool, Sonnet Software has been used [4]. Figure 1 shows the dimensions and top view of the antenna and Figure 2 shows the 3-dimensional view.

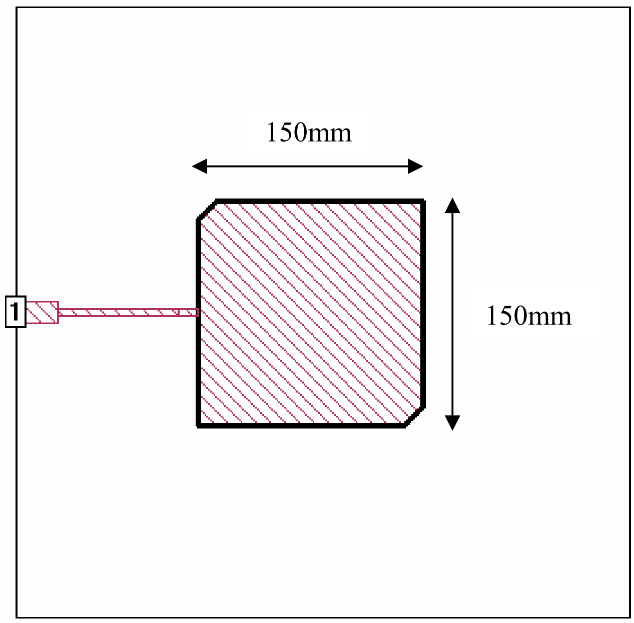



Fig. 1. Top view of the antenna.

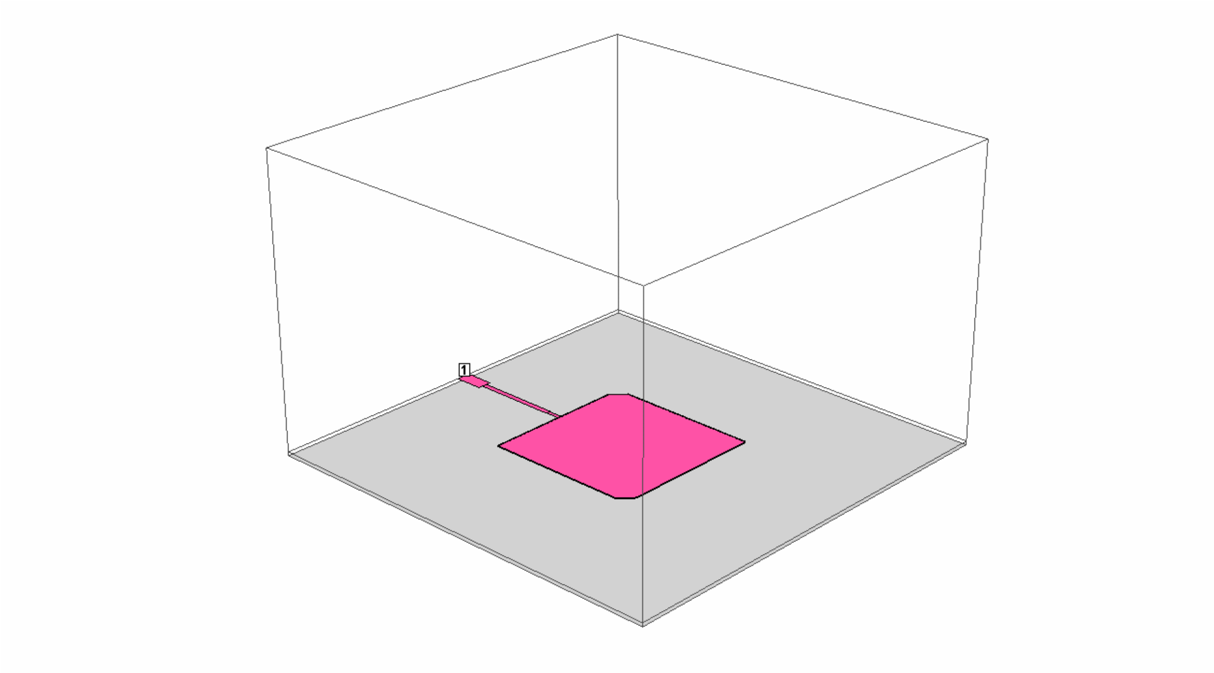



Fig. 2. 3D view of the antenna.

Microstrip patch antennas are usually designed to eliminate the imaginary part of the input impedance. Edge fields are also important and they bring an additional length to the antenna. This length depends on the relative permittivity of the dielectric, dielectric height and patch width. One of the most used formulas is given here [5];

$$L \approx 0.49\ (\lambda_d / \varepsilon_r) \quad (1)$$

where,

$\lambda_d$ = wavelength in dielectric
$\varepsilon_r$ = dielectric constant

Impedance bandwidth is calculated such as;

$f_u$ = 1,799 GHz,
$f_l$ = 1,780 GHz.

$$BW = [(f_u - f_l) / f_c] \times 100 = \%1{,}06 \quad (2)$$

### 4. Simulation Results

The designed microstrip patch antenna has been simulated by an electromagnetic simulation software. Return loss of the antenna is seen on Figure 3. It is clearly seen on Figure 4 that the imaginary part of the input impedance is very close to zero, which is one of the design goals at the resonant antennas. Figure 5 has radiation patterns of right-handed and left-handed circular polarization. Since this antenna is right-hand polarized (RHP), related gain is 6.6 dB.

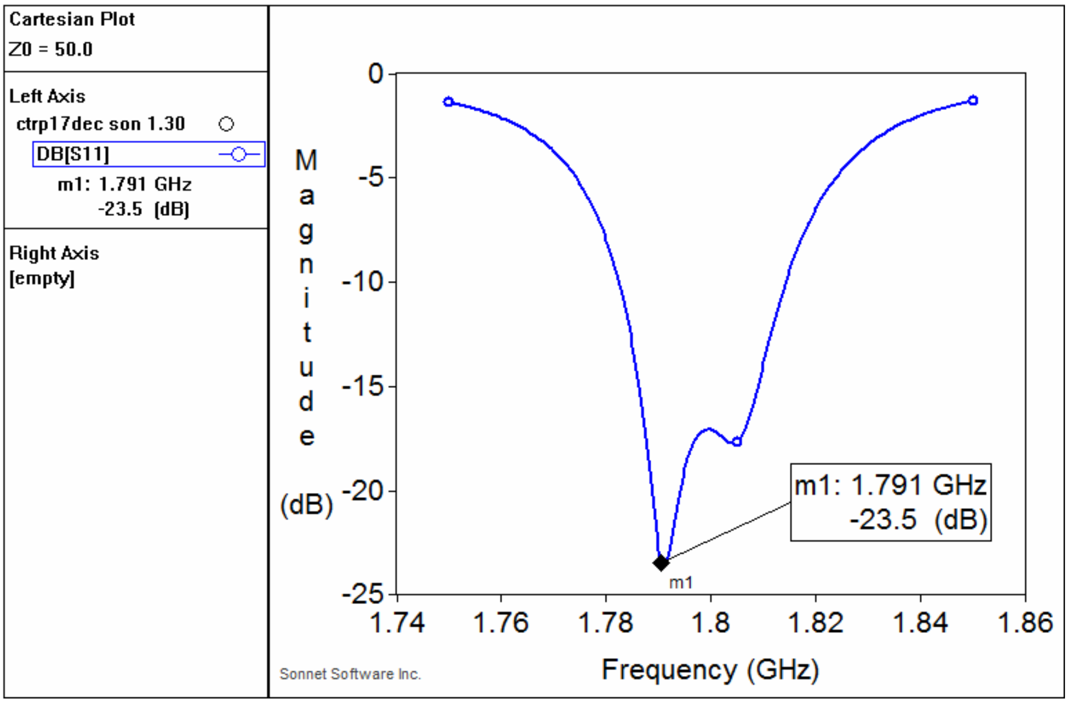



Fig. 3. Input reflection coefficent of the antenna.

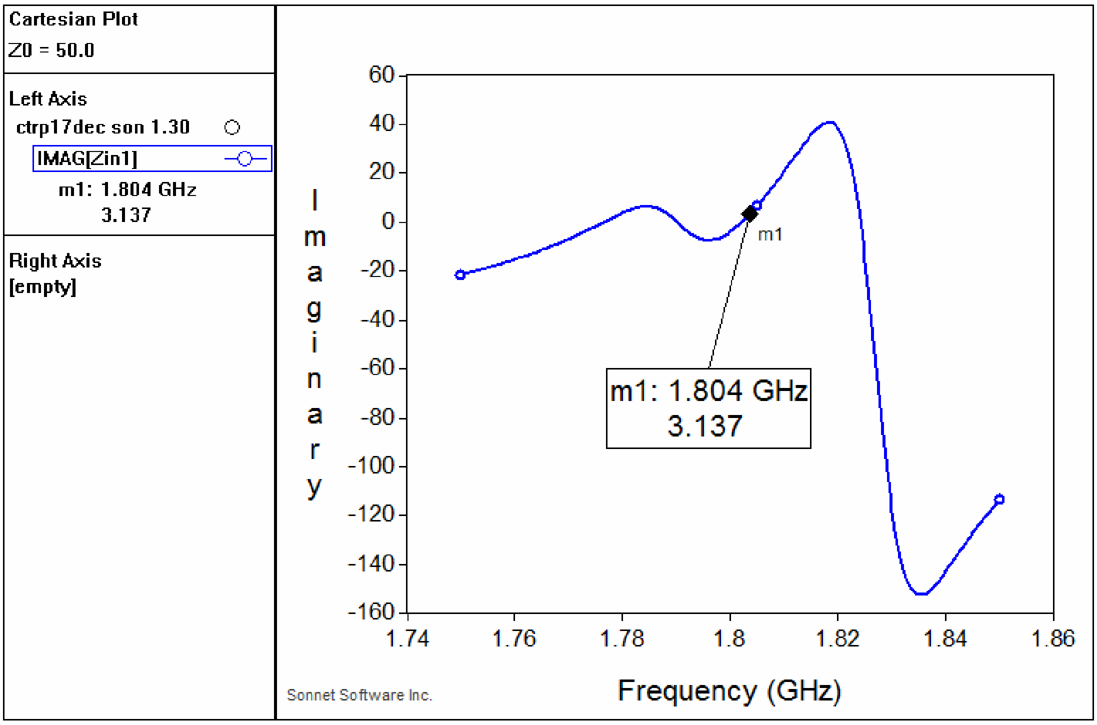



Fig. 4. Imaginary part of the input impedance.

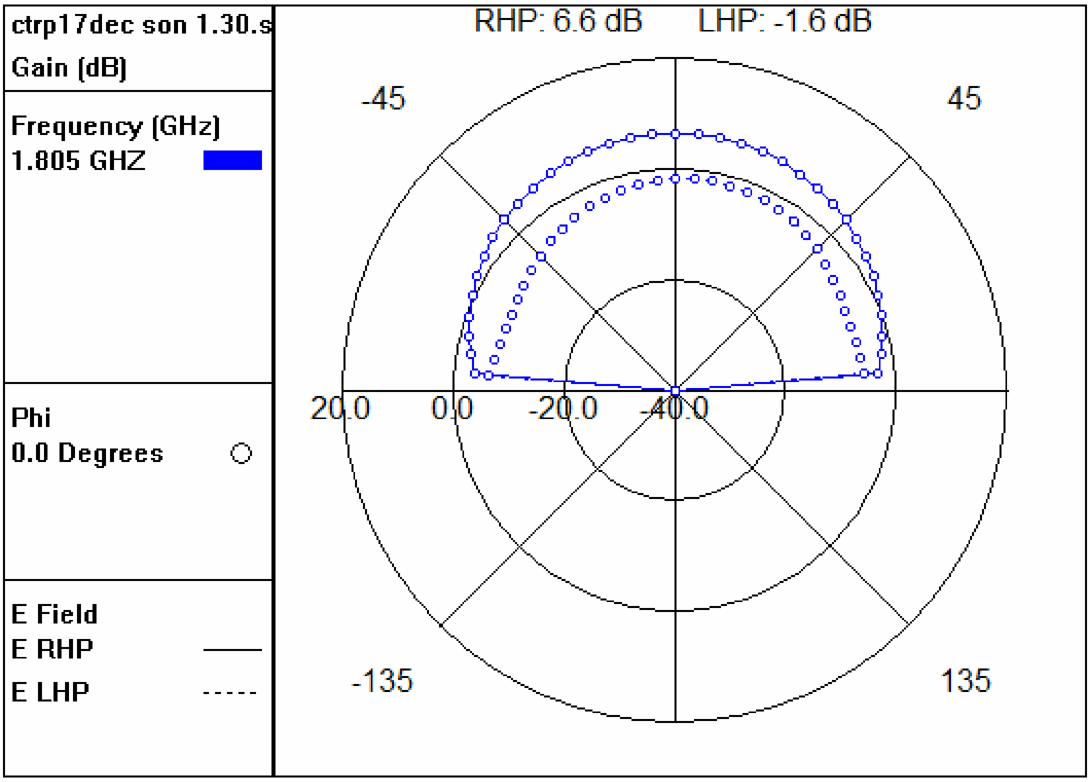



Fig. 5. Radiation Paterns, RHP and LHP of the antenna.

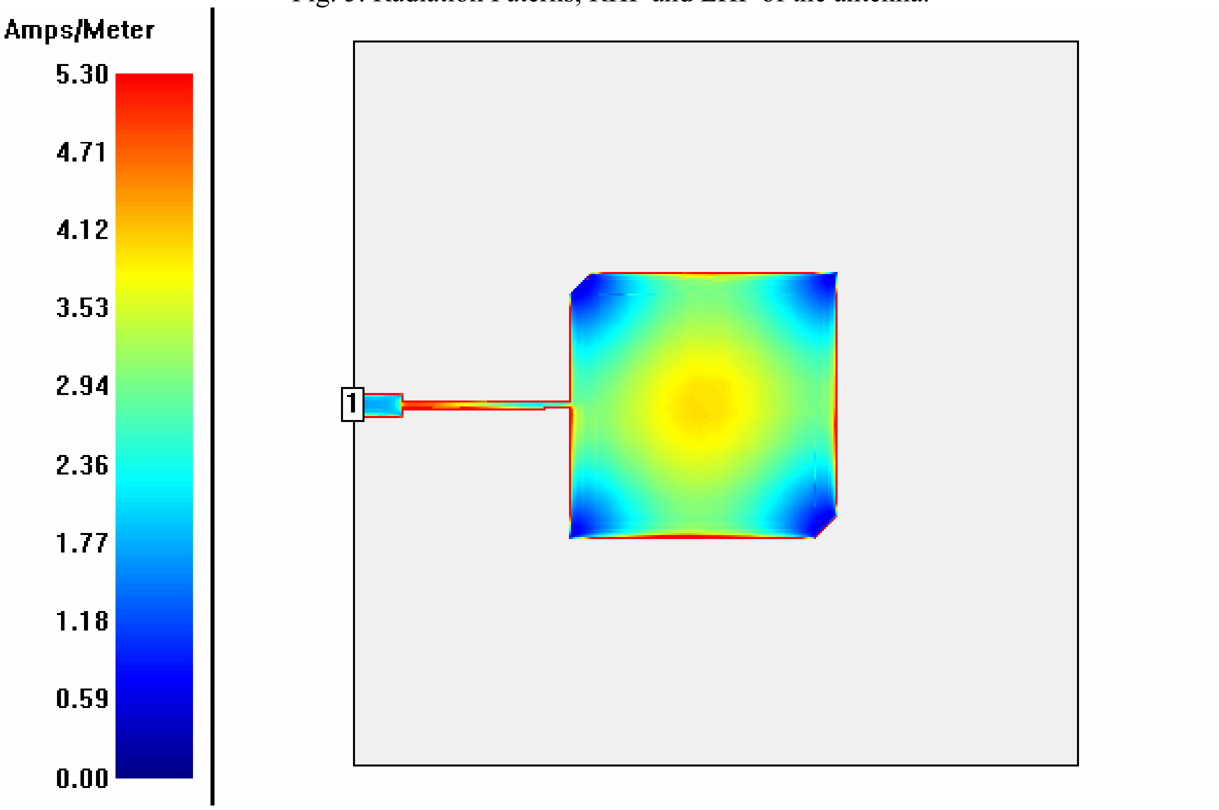



Fig. 6. Current Distribution on the antenna.

Figure 6 shows the current distribution on the patch. As it is seen on the graph, while current is crowded on the center of the antenna it is much less, at the corners.

## 5. Conclusion

In this work, the goal was to design and simulate a circularly polarized microstrip patch antenna which has a resonant frequency of 1.791 GHz. As it is seen on Section 4, simulation results are satisfactory in terms of input reflection coefficent, input impedance, radiation patterns and current distribution. Input reflection coefficent (return loss) is under 20dB on the resonance frequency. Input impedance's real part is close to 50 ohm and imaginary part is almost zero ohms. Radiation patterns for two polarisation are presented on polar plots. Dominant one (right-handed) is 6.6 dB, the other one (left-handed) is minus 1.6 dB as expected.

## 6. Acknowledgments

Special thanks are due for Greg Alton from Sonnet software who has promptly issued licenses for Haliç University.

## References

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