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Study of Micristrip Patch Antenna with Truncated Corners

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Abstract: In the last few years the Global Positioning System (GPS) has been used in a variety of applications for which new and more restrictive requirements in the design of the receiving antenna have been introduced. In particular, for high precision GPS application, such as differential GPS, GPS-based space graft altitude determination or geodetic surveying, receiving antenna with superior rejection to multipath signals is required. Multipath arises when the GPS transmitted signal takes different paths to receiving antenna and being the signals from these paths added with different spaces, this result in a significant amplitude and phase distortion.

Keywords: Truncated Corners, Patch Antenna, GPS Antenna, Truncated Corners.

INTRODUCTION

Low-profile, low-cost antennas support the operation of many modern communication systems. Microstrip patch antennas represent one family of compact antennas that offers the benefits of a conformal nature and the capability of ready integration with a communication system's printed circuitry. Miniaturized communication systems need a small-sized microstrip patch antenna. The size of the regularly shaped microstrip antenna operating in the UHF band is quite large because its resonant length is inversely proportional to frequency. To design a smaller antenna at these frequencies conventional microstrip antenna configurations, such as rectangular and circular configurations, need to be modified. Also, to design a broadband antenna array the element should have large BW. The planar multiresonator broadband antennas generally have a large size that makes them unsuitable to be used as elements in an array. Compact broadband elements need to be designed for this purpose.

Compact microstrip antennas can be designed with substrate having a higher dielectric constant ξr.In this case the size of the regularly shaped microstrip antennas will be much smaller than that of the low dielectric constant substrate at a given resonance frequency, but the BW is small. Here we describe the various compact microstrip antenna configurations that are obtained by modifying regular shapes such as rectangular circular and triangular patches by using shorting posts or cutting slots in the metallic patch.

In its most basic form a Microstrip patch antenna consists of a radiating patch on one side of a dielectric substrate which has a ground plane on the other side as shown in figure 1.The patch is generally made of conducting material such as copper or gold and can take any possible shape. The radiating patch and the feed lines are usually photos etched on the dielectric substrate.

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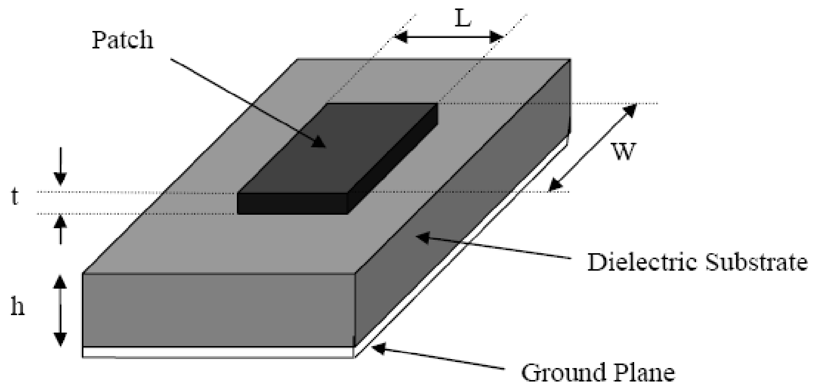

Figure 1: Structure of a Microstrip Patch Antenna

In order to simplify analysis and performance prediction the patch is generally square, rectangular, circular, triangular, and elliptical or some other common shape as shown in Figure 3.2.For a rectangular patch the length L of the patch is usually 0.33330λo <L<0.5 λo where λo is the free-space wavelength. The patch is selected to be very thin such that t<< λo (where t is the patch thickness).The height h of the dielectric substrate is usually 0.003 λo ≤h ≤0.5 λo.The dielectric constant of the substrate (er) is typically in the range 2.2 ≤er≤12.

The basic shapes that the patch can take are square, rectangle, dipole, circle, triangle, circles and ellipse.

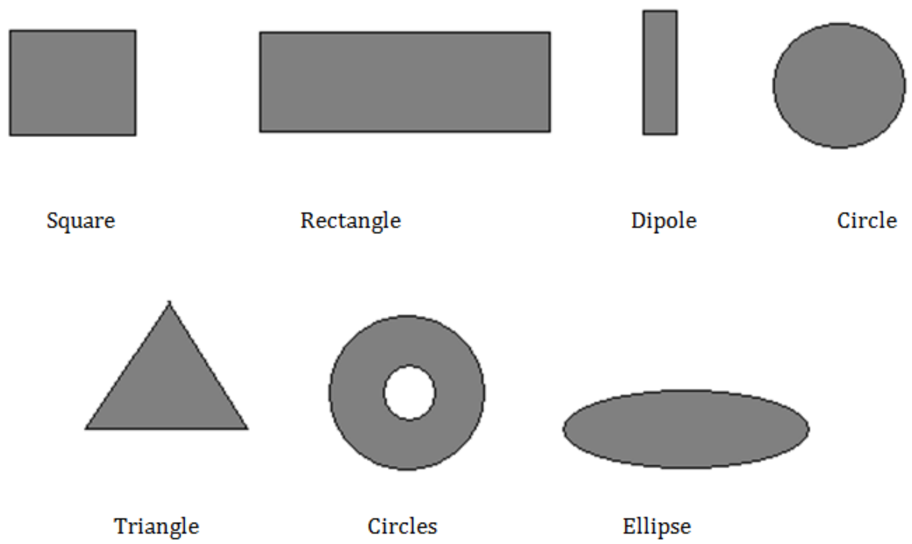

Figure 2: Different shapes of Microstrip patch Antenna

GPS ANTENNA

As discussed in the previous section the GPS antenna should be right hand circular polarized (RHCP).In this section we discuss some of the methods to create RHCP. Circular polarization is used on GPS signal to avoid Faraday rotation problems associated with L-band propagation through the earth's ionosphere. It also has the additional benefit of not requiring rotational alignment of the antenna at the user terminal. The signal transmitted from the satellites is right-hand circularly polarized and therefore the terminal antenna must also use RHCP in order to have the maximum received signal strength.

The purity of the circular polarization has direct impact on the receive gain of the antenna. The higher the axial ratio of the antenna the less efficient the antenna will be at receiving the circularly polarized signal. Circular polarization typically has the drawback of being slightly more difficult to create than simple linear polarization in an antenna.

A simple yet didactic example of how circular polarization works and how to create it is the crossed dipole antenna. The crossed dipole consists of two orthogonally crossed dipoles antenna. The crossed dipole consists two orthogonally crossed dipoles fed in phase quadrature. The spatial rotation of the two antennas with the combination of the two feed signals 90° out of phase produces the desired circular polarization.

The difficulty with this and many similar configurations is the need for two feed structures and complicated power combiners. Many popular CP antennas use this two-feed method but for the design presented here it is desirable to use only a single feed configuration.

TRUNCATED CORNERS

Another similar way of achieving circular polarization from a single feed patch is to feed the path on one sides and truncate the corners of a square patch, as shown in the figure2.4

If the corners were not truncated one resonance mode will occur from the side that is feed to the opposite side. This would create linear polarization as described in the previous section. When the corners are truncated the resonance will not occur from one side to the other side but along the diagonals.

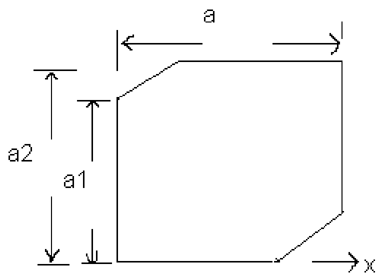

Figure 3: Microstrip patch antenna with truncated corners

Since one of the diagonals is shorter than the other the resonance frequencies will differ slightly for the two modes. If the corners are truncated exactly the same amount the phase difference in frequencies will cause the 90° phase shift exactly in the same way as far the square patch. The antenna in figure 2.4 is a corner truncated square patch. Two opposing corners are trimmed a small amount, Δs.This antenna creates circular polarization in much the same way as the antenna in figure4.6 (a) does by creating two orthogonally degenerate modes from the slight perturbation in antenna geometry due to the truncated corners.

In this case however the antenna must be fed from point 1 or 3 from some point along either of the antenna center lines. Both right and left hand sense circular polarization may be established with this geometry depending on which feed point is chosen. If the antenna is fed along the diagonals, only linear polarization will be produced.

DESIGN EQUATIONS

We use the following formula in order to calculate the width of the square patch

To calculate the patch width:

$$w = \frac{1}{2\,fr\sqrt{\varepsilon 0 \mu 0}}\sqrt{\frac{2}{\varepsilon r + 1}}$$

Where

Fr-resonant frequency=1.575 GHZ

ε_r - Relative dielectric constant = 4.6

SIMULATION RESULTS

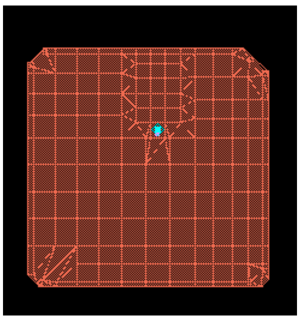

Figure 4: Microstrip patch Antenna – ADS Layout

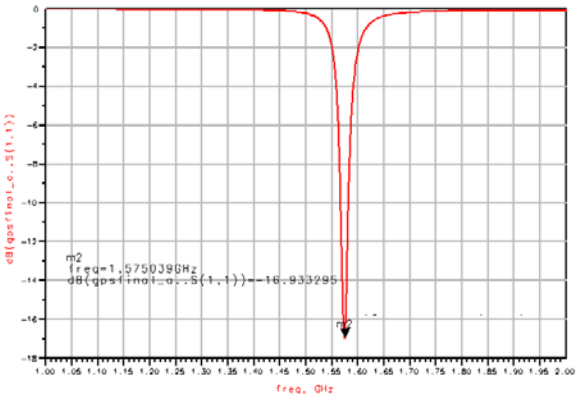

Figure 5: Microstrip patch Antenna – Simulation Results

CONCLUSION

This paper includes coverage of broadband techniques and the design of optimum broadband microstrip antenna configurations. The advantages such as lightweight, low volume benefits of these antennas are presented by providing clear explanations of the various configurations and simple design equations that helps to analyze and design microstrip antennas.

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