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Design of High gain Microstrip Patch Antenna for Military Applications

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Abstract: *The study of microstrip patch antennae has made great progress in recent years. A simple microstrip patch antenna consists of metallic patch and ground between which is a dielectric medium called the substrate. Microstrip patch antennae are used for communication purposes especially in military applications. They are lighter in weight, low volume, low cost, low profile, smaller in dimension and ease of fabrication and conformity. In this paper a simple microstrip patch antennae designed in CST microwave studio at a resonant frequency of 3.45 GHz for WiFi applications. The gain of antenna is 6 dB and directivity is 7.5 dB.*

Keywords: Radiation Pattern; Directivity; Gain; Bandwidth.

I. Introduction

Microstrip antennas became very popular in the 1970s primarily for space borne applications. Today they are used for government and commercial applications. These antennas consist of a metallic patch on a grounded substrate [1][2]. The metallic patch can take many different configurations. However, the rectangular and circular patchesare the most popular because of ease of analysis and fabrication, and their attractive radiation characteristics, especially low cross-polarization radiation [1].

The microstrip antennas are low profile, conformable to planar and nonplanar surfaces, simple and inexpensive to fabricate using modern printed-circuit technology, mechanically robust when mounted on rigid surfaces, compatible with MMIC (Monolithic Microwave Integrated Circuit) designs, and very versatile in terms of resonant frequency, polarization, pattern, and impedance. These antennas can be mounted on the surface of high-performance aircraft, spacecraft, satellites, missiles, cars, and even handheld mobile telephones [1][2][3].

II. DESIGN EQUATIONS

Width of patch is given by

$$W = \frac{c}{2f_0\sqrt{\frac{\varepsilon_r+1}{2}}} \qquad (1)$$

$\varepsilon_r =$ Effective Dielectric Constant

Due to Fringing effect, it makes the microstrip look wider as compared to its physical dimensions. Since, some of the waves travel in substrate, and some of the waves travel in air, an effective dielectric constant is introduced to define fringing and wave propagation in antenna. The effective dielectric constant is defined such that the area where electric fields travel has approximately equivalent characteristics making calculations simpler.

For W/h>1, the effective dielectric constant is defined by the equation [4],

$$\varepsilon_{reff} = \frac{\varepsilon_r+1}{2} + \frac{\varepsilon_r-1}{2}\left[1+12\frac{h}{W}\right]^{-\frac{1}{2}} \qquad (2)$$

The electrical length of a patch antenna is greater than the physical length. This normalized extension in the length is calculated using equation,

$$\Delta L = 0.412h\,\frac{(\varepsilon_{reff}+0.3)\left(\frac{W}{h}+0.264\right)}{(\varepsilon_{reff}-0.258)\left(\frac{W}{h}+0.8\right)} \qquad (3)$$

Using this equation Δ is calculated. The actual length of the patch can now be determined by solving the equation for L [5]

$$L = L_{eff} - 2\Delta L \qquad (4)$$

Frequency of operation is given by

$$f_r\,\frac{c_0}{2(L+2\Delta L)\sqrt{\varepsilon_{reff}}} \qquad (5)$$

Center frequency will be defined as

$$fo = \frac{c}{2\sqrt{\varepsilon_{reff}}}\left[\left(\frac{m}{L}\right)^2 + \left(\frac{n}{W}\right)^2\right] \quad (6)$$

Variation of Input Impedance throughout Patch Antenna

$$Z_{in}(R) = cos^2\left(\frac{\pi R}{L}\right) Z_{in}(0) \quad (7)$$

Input –Output Impedance Relation

$$Z_{in} = Z_0 = \frac{Z_1^2}{Z_A} \quad (8)$$

III. DESIGN AND SIMULATED RESULTS

Here we are taking Fr-4 dielectric material which has a dielectric constant of 4.6 and height of substrate is taken as 1.6 mm.The Operating Frequency of antenna is 3.5 GHz which is selected for WiMax applications. By these parameter we can calculate the length(L), Width(W) of patch easily [6].

Layout

Figure 1: Layout of 1x1 Patch Antenna with Inset Feed

IV. Simulated Results

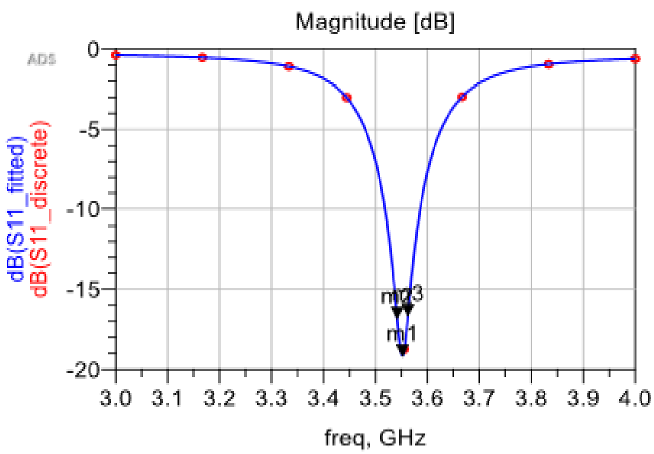

Figure 2: S_{11} Parameter plot

Figure 3: Radiation Pattern

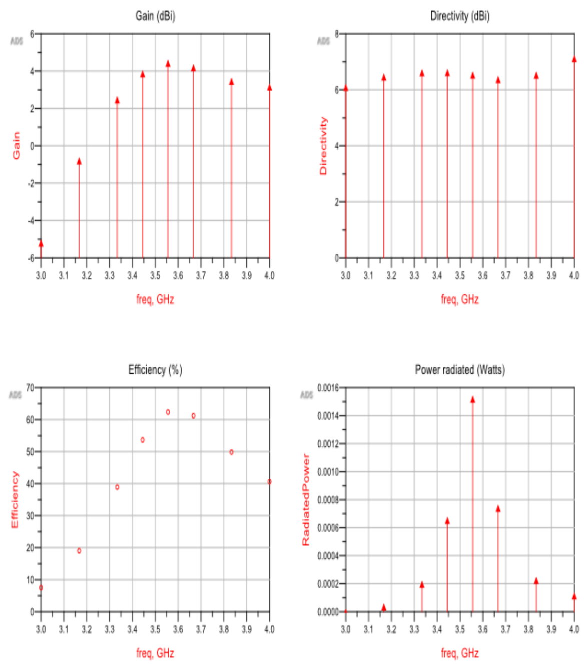

Figure 4: Antenna Parameters Vs Frequency

We can see from the graph, the return loss has decreased to a large level i.e. -19 dB which is good outcome and simultaneously, it have a bandwidth of up to 20 MHz, which is still usable as Wi-max working at 3.5 GHz as it have a BW of 1.5-20MHz.

V. Conclusion

In this paper, a microstrip patch antenna WLAN application, Satellite communications and WiFi applications. We achieved the gain and directivity of propose antenna is 6 dB and 7.5 dB respectively.

References

[1] Balanis, C.A., Antenna Theory: Analysis and Design, John Wiley & Sons, Inc, 1997.

[2] Stutzman, W.L. and Thiele, G.A., Antenna Theory and Design, John Wiley & Sons, Inc, 1998.
[3] Balanis, C.A., Advanced Engineering Electromagnetics, John Wiley & Sons, New York, 1989.
[4] Dr. Debmalya Bhattacharya, "Ultra Wide Band Microstrip Patch Antenna Design for Wireless Application", International Journal of Engineering Research &Technology,Vol. 2, Issue 9, November 2012.
[5] Ramna, Amandeep Singh Sappal , "Design of Rectangular Microstrip Patch Antenna using Particle Swarm Optimization" ,International Journal of Advanced Research in Computer and Communication Engineering Vol. 2, Issue 7, July 2013.
[6] Joshua Madhukar Singh, Mayank Mishra, Prafull Sharma "Design & Optimization Of Microstrip Patch Antenna" IJETTCS VOL. 2 Issue 5, Oct-2013.
[7] U. Chakraborty, S. Chatterjee, S. K. Chowdhury , P. P. Sarkar "A Compact Microstrip Patch Antenna for Wireless Communication" Progress In Electromagnetics Research C, Vol. 18, pp. 211–220, 2011.
[8] Muhammad Aamir Afridi "Microstrip Patch Antenna − Designing At 2.4 Ghz Frequency" Biological And Chemical Research, Volume 5, pp.128-132, 2015.
[9] SumanNath, Somnath Rana "The Design And Development of Microstrip Patch Antenna Using Simulation Studies By ADS" IJESS VOL.1 pp. 212-215, Issue 2, 2012.