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Study of Microstrip Rectangular Patch Antenna and its various parameters

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Abstract

Today in the communication world microstrip antennas plays a vital role due to its millimeter dimensions. Today's generation require many applications on a single device. The multiband small antenna can be easily fitted in mobile which can be used for various applications. Here we have studied the microstrip rectangular patch antenna and its various parameters. Here primarily the antenna parameters are mentioned and secondary the necessary ranges are define for antenna performance.

1. Introduction

Microstrip patch antenna have a radiating patch ,dielectric substrate and ground[7].Many types of dielectric materials like Duroids [3], FR4 are used for many types of applications.

It has many advantages like comfort ability, very light weight, dimensions in millimeter, low cost.

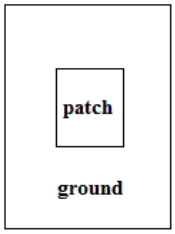

Fig: 1. Microstrip rectangular patch antenna

2. Antenna Parameters

(a) **Radiation Pattern:** It is a graphical representation of the radiation properties of the antenna as a function of coordinates of space.

(b) **Gain:** It can be measured by comparing the maximum power density of the antenna under test with a reference antenna of known gain.

(c) **Directivity:** It is the ratio of the radiation intensity in a given direction from the antenna to the radiation intensity averaged over all directions.

(d) **Antenna efficiency:** It is a ratio of total power radiated by an antenna to the power at input of an antenna.

(e) **Return loss:** It is the reflection of signal in transmission line.

(f) **VSWR:** Voltage standing wave ratio is given by VSWR=Vmax/Vmin.

3. Antenna Characteristics

Length of the patch is $0.3333\lambda_0<L<0.5\lambda_0$[1] ,So when designing antenna firstly calculate the wavelength from the desired frequency and verify the above equation .Equation for height of the dielectric substrate above ground is given as $0.003\lambda_0 \leq h \leq 0.05\lambda_0$..Also the equation for dielectric constant of substrate is given as $2.2 \leq \varepsilon_r \leq 12$[1].Thick dielectric substrate having low dielectric constant is desirable, it provides good efficiency, larger bandwidth, better radiation, But larger antenna size also .For compact

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microstrip patch antenna ,substrates with higher dielectric constants, may be used, which are less efficient and results in narrow bandwidth. So there is a tradeoff between dimensions and performance.

4. Important Formulas

$$w = \frac{c}{2f_o\sqrt{(\frac{\varepsilon_r+1}{2})}}$$

$$\varepsilon_{reff} = \left\{\frac{\varepsilon_r+1}{2}\right\} + \frac{\{\varepsilon_r-1\}}{2} * \frac{1}{\sqrt{(1+\frac{12*h}{w})}}$$

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

$$L_{effective} = \frac{c}{(2f_o\sqrt{\varepsilon_{reff}})}$$

$$L = L_{effective} - 2\Delta L$$

$$L_g = 6h + L$$

$$W_g = 6h + W$$

Where w is patch width, L is patch length, L_g is ground length, W_g is ground width, ε_r substrate dielectric constant, and h is substrate height above ground, $L_{effective}$ is effective length, f_0 is resonant frequency, c is speed of light, ε_{reff} is the effective dielectric constant, ΔL is length extension.

5. Minimum Required Ranges of Various Antenna Parameters

Generally the field gain should lie in between 6dBi-9dBi, Antenna and radiation parameters are also the most important parameters and these should be more than 80% for the antenna. VSWR lies between 1and 2, VSWR near to unity is excellent for impedance matching point of view. Last and most important one is Return loss, it should less than 9.5dB.It is also helpful in the calculation of bandwidth.

S. No.	Parameter	Range
1	Field Gain	Should be more than 6dBi
2	Antenna efficiency	Should be more than 80%
3	VSWR	Should lie in between 1&2
4	Return Loss	Should be less than -9.5dB
5	Radiation efficiency	Should be more than 80%

6. Conclusion

A theoretical analysis on designing of rectangular patch antenna is explained in paper. From table V the minimum required ranges of various antenna parameters can be seen. If all of these parameters are in same range as given in the table, the performance of antenna will be well satisfying.

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