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Analysis and design Rectangular patch with half Rectangular Fractal Techniques

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Abstract

In this paper, rectangular patch with half rectangular fractal geometry is designed. The proposed antenna is fabricated on RT/duroid 5880 with relative permittivity 2.2 and having dimensions 40mm x 30mm x 1.56mm. HFSS software is used for the design of this antenna. It operates at four frequency bands 3.19-3.29 GHz, 3.98-4.09GHz, 5.4-5.46GHz and 5.97-6.06GHz. The proposed antenna can be used in the military for meteorological purpose and satellite communications. The proposed design has return loss –18.5061dB, -22.1394 dB, -4.7404 dB and -36.2199 dB in frequency bands 3.19-3.29 GHz, 3.98-4.09GHz, 5.4-5.46GHz and 5.97-6.06GHz.

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1. Introduction

In modern wireless communication need for small sized compact wideband and multiband antennas have raised. Normally an antenna operates at single or dual frequency bands. So according to the requirement the antenna is designed. Hence sometimes the problem with the size of antenna arises. To overcome this multiband antenna is used. In this a single antenna is made to operate at many frequency bands. This is designed by applying fractal shape into the antenna geometry [1]. The main requirement for modern communication systems is small size and wideband antennas. Fractal geometries have been used to fabricate multi-band and broad-band antennas. By the design of

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fractal geometry the perimeter of antenna increases hence large surface area is available for radiating or receiving the electromagnetic radiations [2].

To fulfill the requirements of low profile, low cost, small size, ease of fabrication and multiband characteristics, microstrip antenna are employed [3]. The commonly available shapes for microstrip antenna are rectangular, square, oval, elliptical etc. When we compare microstrip antennas with conventional antennas then more advantages are offered by microstrip antennas. A number of miniaturization technique such as high dielectric substrate [4], reactive loading [5], increasing the electrical length of antenna by optimizing its shape [6] have been proposed. The main application of fractal antenna is to reduce the overall geometrical size [7].

There are a number of available shapes for fractal antenna such as Sierpinski carpet, Sierpinski gasket, Koch, Hilbert curves etc that are meant for designing the antennas. Their main purpose is to increase the electrical length of antenna without affecting the radiation characteristics of the conventional antenna. The space-filling properties of some fractal shapes the fractal dimension might allow fractal shaped small antennas better to take advantage of the small surrounding space [8].

2. Design of Antenna

For the design of rectangular microstrip antenna there should be knowledge of resonant frequency (f_r), dielectric constant of material (ε_r) and height of substrate (h). Proposed antenna is designed at 3.2 GHz resonant frequency.

Patch width of antenna is calculated by using transmission line model equations as given in [12-14].

$$W = \frac{1}{2 f_r \sqrt{\mu_0 \varepsilon_0}} \sqrt{\frac{2}{\varepsilon_r + 1}} = \frac{v_0}{2 f_r} \sqrt{\frac{2}{\varepsilon_r + 1}} \tag{1}$$

ε_r= 2.2 (Rogers RT/duroid)
f_r = 3.2GHz
Co = 3x10^8 m/sec
With this equation the width comes to be, W= 21.94 mm
Effective dielectric constant of material is calculated using equation as given in [12-14]:

$$\varepsilon_{eff} = \frac{\varepsilon_r + 1}{2} + \frac{\varepsilon_r - 1}{2} \left[1 + 12 \frac{h}{W} \right]^{-\frac{1}{2}} \tag{2}$$

Effective length of patch is calculated using equations as given in [12-14]:

$$\Delta L = h \frac{(\varepsilon_{reff} + 0.3)\left(\frac{W}{h} + 0.264 \right)}{(\varepsilon_{reff} - 0.258)\left[\frac{W}{h} + 0.8 \right]} \tag{3}$$

$$L_{eff} = \frac{1}{2 f_r \sqrt{\varepsilon_{reff}} \sqrt{\mu_0 \varepsilon_0}} - 2\Delta L \tag{4}$$

Effective length becomes, L= 28.53 mm