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Quad Staircase Shaped Microstrip Patch Antenna for S, C and X Band Applications

Sandeep Singh Sran^a, Jagtar Singh Sivia^b^a*Yadavindra College of Engineering, Punjabi University GKC Talwandi Sabo 151302, Bathinda, Punjab, India*^b*Associate Professor ECE, YCOE, Punjabi University GKC Talwandi Sabo 151302, Bathinda, Punjab, India*

Abstract

This paper presents miniaturization by introducing staircase shape at each edge of the patch of Microstrip Patch Antenna (MPA) which operates in S-band (2-4 GHz), C-band (4-8 GHz) and X-band (8-12 GHz). The proposed antenna operates at 2.44 GHz, 5.53 GHz, 7.79 GHz and 9.39 GHz with up to 37% size reduction compared to the basic MPA. Design frequency for the proposed antenna is 2.4 GHz which supports multiband behavior. The Rogers RT/Duroid 5880 with relative permittivity 2.2 and height 1.6 mm is used as substrate material for design of proposed antenna. Transmission line model is applied to calculate the dimensions of the proposed antenna. Coaxial probe feed is used to feed the proposed antenna because this type of feed provides better impedance matching to source by varying the feed position. Ansoft HFSS V13 (High Frequency Structure Simulator) software is used for the design and simulation of the proposed antenna. The results of the proposed antenna are obtained in terms of Return Loss, Voltage Standing Wave Ratio, Gain and Radiation Pattern which have acceptable values of return loss less than -10 dB, VSWR less than 2 at each resonant frequencies and Gain more than 3 dB.

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Keywords: Multiband; Coaxial probe feed; High Frequency Structure Simulator (HFSS); Return loss; VSWR; Gain

1. Introduction

Microstrip Patch Antenna can be used in various wireless communication applications such as satellite, Radar, missile and aircraft. MPAs are called low profile antenna because these can be flush mounted on curved surface and they only require space for the feed line [3]. Microstrip antennas are popular at frequencies above 100 MHz [2]. Improper impedance matching and narrow bandwidth are two main disadvantages of MPA's. There are two techniques to enhance the bandwidth, one is by using thick dielectric substrate and the second is by using slotted

patch. The first technique is limited because the thick substrate require increased length of the probe feed which introduces large inductance and increase only a few percentage of bandwidth. The second technique (slotted patch) increases the bandwidth more than the first method, reduces the size of the patch and also shifts the fundamental resonant frequencies to lower side [7].

MPA consist of a thin metallic patch which is kept on dielectric substrate and below the dielectric substrate there is a conducting ground plane. A microstrip patch is generally of cooper placed on the top of the dielectric substrate. Ground plane is at the bottom side of the dielectric substrate as shown in Fig. 1[4] [5].

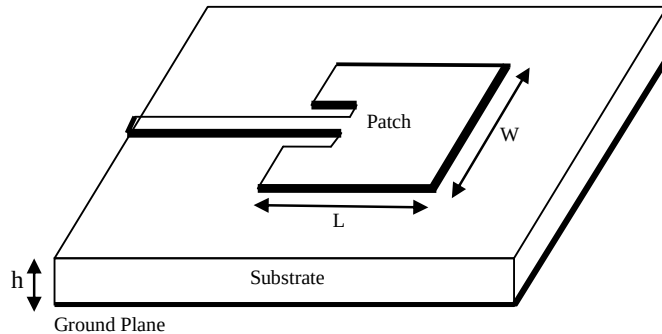


Fig. 1. Microstrip Patch Antenna [1].

2. Antenna Design

The shape of the patch resembles the staircase shape hence the name “Staircase shaped patch antenna” is given. The size reduction of 37% is achieved by cutting the staircase at each side of the patch. Geometry of proposed antenna is shown in Fig. 2.

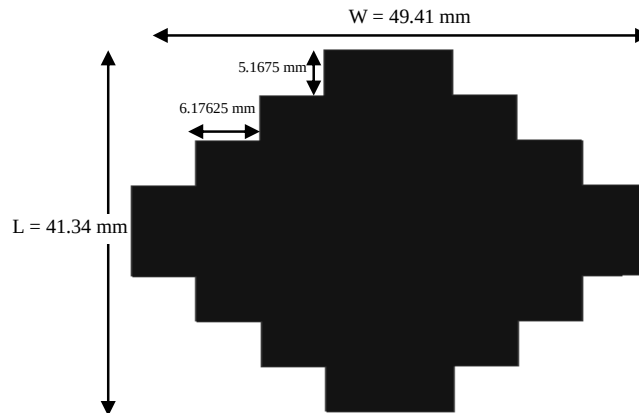


Fig. 2. Geometry of Quad Staircase Shaped MPA

2.1. Rectangular Patch Design

Frequency, thickness and material of the substrate are three necessary parameters for designing the MPA. The resonant frequency 2.4 GHz is chosen, because this frequency locates in ISM band, low atmospheric attenuation and low cost components. This frequency is used in RFID, WLAN and Bluetooth based wireless systems [6] [9]. The Rogers dielectric material with relative permittivity 2.2, height 1.6 mm and loss tangent 0.0009 is taken as substrate material. Coaxial probe feed is employed to feed the proposed antenna in which the inner conductor is

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