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Design of a Novel Coaxial Feed Triple Frequency Patch Antenna with Slots and Shorting Pin

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Abstract

This paper presents a detailed explanation on the design of a novel triple frequency rectangular slot antenna for wireless local area network (WLAN) applications in IEEE 802.11b/g/a systems. This proposed antenna operates in ISM band at frequency of 2.4 Ghz and also in C band at 4.85 Ghz AND 6.1Ghz. The antenna has been designed and simulated on a foam substrate with dielectric constant of 1.06 and a thickness of 7 mm. The design is analysed by Finite Element Method based HFSS Simulator Software (version 13.0) by which return loss, 3D polar plot and Gain of the antenna are computed. In addition, the measured results show good radiation characteristics at the three operating frequencies, proving the dual-band operation of the proposed antenna.

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Keywords: Rectangular patch, Ka band, coaxial feed, slots, HFSS, Return loss, Gain;

1. Introduction

An Antenna is usually a metallic device used for radiating or receiving radio waves. Microstrip patch antennas consists of metallic patch on grounded substrate which are used for spectrum applications, government and commercial applications because of its low profile in expensive to fabricate and simple. It is used to transport electromagnetic energy from transmitting source to antenna or from antenna to receiver.

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Rectangular patch antennas are most popular because of ease of analysis and fabrications, attractive radiation characteristics and low cross polarisation. The implementation of the Microstrip patch antenna is a milestone in wireless communication systems and is continuing to fulfil the changing demands of the new generation of antenna technology. The design of Microstrip patch antenna operating in dual bands is a difficult task. By introducing rectangular and L shaped slots, triple frequency can be achieved which is our present topic of discussion.

2. Design Considerations

Design considerations for Microstrip Rectangular patch antenna are as follows.

A. Frequency of Operation:
The WLAN and Bluetooth applications uses the C-Band with frequency range from 4-8GHz and ISM band of 2.4Ghz. Hence the antenna designed must be able to operate at these frequencies.

B. Dielectric Constant of Substrate:
The dielectric material selected is foam which has a dielectric constant of 1.06.

C. Height of Dielectric Substrate:
As the thickness of substrate increases, surface waves are induced within the substrate. Surface waves results in undesired radiation and decreases the efficiency of the antenna. Hence the height of the substrate in this experiment is considered to be 7 mm which is an optimized value.

D. Length and Width of the Dielectric Substrate:
Both the length and width of the substrate are taken as 2λ.

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

$$\text{where, } L_{eff} = \frac{C}{2Lf_0\sqrt{\epsilon_{reff}}}$$

E. Fringing Factor:

$$\Delta L = 0.412h\frac{(\epsilon_{reff} + 0.3)(\frac{W}{h} + 0.264)}{(\epsilon_{reff} - 0.258)(\frac{W}{h} + 0.8)}$$

3. Design of Proposed Antenna

In this paper the Dual band slot antenna has been modelled and simulated at three frequencies. The patch is the dominant figure of a Microstrip antenna. The other components are the substrate and ground, which are below the patch. The slotting technique and shorting pin technique is employed for obtaining triple frequency.

The analysis of patch antenna for triple frequencies has been done using HFSS Software. The bandwidth of the patch antenna can be increased by inserting slots in the patch. This slotting technique is also used to reduce the size of the antenna. The Proposed antenna design is as follows.