Dual-Polarized Dual-Band Square Slot Antenna With A U-Shaped Printed Tuning Stub For Wireless Communications

Abdelnasser A. Eldek*, Atef Z. Elsherbeni, and Charles E. Smith
aneldek@olemiss.edu, atef@olemiss.edu, cese@olemiss.edu
Center of Applied Electromagnetic Systems Research (CAESR)
Department of Electrical Engineering, The University of Mississippi
University, MS 38677, USA

This paper presents an antenna design for wideband wireless communications. The proposed antenna consists of a square slot and is fed by two orthogonal microstrip feedlines with U-shaped tuning stubs. The antenna operates on two wide bands. The bandwidth is 18% in the first band and 82% in the second one. It can serve the wireless communication applications that operate at 0.9, 1.8, 1.9 and 2.4 GHz and require wide band characteristics.

Introduction

In recent years, wireless communications have gained a wider and wider popularity. Presently, the trend is to provide a wireless link to every kind of electronic device. In this framework, personal digital assistants (PDAs), PCMCIA, and cellular phones are becoming constitutive elements of new generation networks. In particular, there is a specific need for greater capacities and transmission speeds, which, together with a growing demand from users for more complicated services, require the design of higher performance systems. In this context, multi- and wide-band antennas are required. Many researchers investigated the design of multi-band antennas to cover different frequency ranges, and other researchers investigated techniques to improve the antenna bandwidth [1-6].

This paper presents a new design that can simultaneously support operations of dual and wide-band, and dual and circular polarizations. The return loss, VSWR and far field radiation characteristics of this antenna are presented. The simulation and analysis for the presented antennas are performed using the commercial computer software packages, Ansoft HFSS, which is based on the finite element method. Verification for the return loss is performed using the commercial software Momentum of advanced design system (ADS) of Agilent Technologies, which is based on the method of moments.

Geometry and Results

The proposed antenna is printed on a Rogers RT/Duroid 6010/6010 LM substrate of a dielectric constant of 10.2 and a conductor loss (tan δ) of 0.0023. The antenna consists of a wide square slot sandwiched between two identical dielectric substrates, and fed by two orthogonal identical microstrip-fed-two-arm feedlines, as illustrated in Fig. 1, and is printed on a finite ground plane of a 75×75 mm².
size, and the edge of the square slot is $W$, where $W = 50$ mm. Each substrate has a thickness $h = 50$ mil. The microstrip feedline is placed symmetrically with respect to the centerline of the square slot. The dimensional parameters of the microstrip-fed-two-arm feedline are shown in Fig. 1, where $W_1$, $W_2$, $W_3$, $W_4$, $L_1$, $L_3$, $L_3$ and $L_4 = 2.5$, $2$, $3$, $12$, $8.5$, $3$, $27$ and $3$ mm, respectively, and the width of the microstrip feedline $W_f$ equals $1.18$ mm for an approximate characteristic impedance of $50 \, \Omega$.

The proposed antenna is simulated using Ansoft HFSS and ADS Momentum. Fig. 2 shows comparisons between the resulting return loss and VSWR for the presented antenna using Ansoft HFSS and ADS Momentum. Very good agreement between the results is obtained, which verifies the results of this antenna. In HFSS, the exact geometry of the antenna is simulated with a finite substrate and ground plane of a $75 \times 75$ mm$^2$ size. In ADS Momentum, an infinite substrate and ground plane are considered. As shown in Fig. 2, the HFSS results show that the antenna operates in two bands in the range from 0.5 to 3.5 GHz. The first band spans from 0.82 to 0.98 GHz, with a wide bandwidth of 18%, and the second band spans from 1.4 to 3.36 GHz, with a very wide bandwidth of 82%. According to ADS results, the first band spans from 0.87 to 1.02 GHz, with a wide bandwidth of 16%, and the second band spans from 1.36 to 3.4 GHz, with a very wide bandwidth of 86%. The radiation patterns are presented in Fig. 3, at 0.9, 1.9, and 2.4 GHz with only Port 1 excited. The lower half of all patterns is cropped because they are almost symmetrical.

![Fig. 1. Geometry and parameters of the proposed antenna.](image-url)
Fig. 2. Comparison between the (a) return loss, and (b) VSWR, for the dual-polarized dual-band microstrip-fed square slot antenna, computed by HFSS and ADS.

Fig. 3. Computed radiation patterns in the H-plane (x-z) and the E-plane (y-z) at (a) 0.9, (b) 1.9, and (c) 2.4 GHz, when only Port 1 excited.

The aforementioned results show that the antenna is a very good candidate for the modern wireless communication applications that require wideband characteristics. This type of antenna gives these systems the ability to serve simultaneously the frequency bands of the GSM 900, GSM 1800 and GSM 1900, and both industrial, scientific and medical ISM band around 2.4 GHz, in addition to WLAN and Bluetooth applications operating at 2.4 GHz.

Conclusion

A wideband dual-polarized dual band antenna is designed and presented for the recent wireless communication applications at 0.9, 1.8, 1.9, and 2.4 GHz. The
antenna has a relatively small size and operates over two wide bands with bandwidths of 18% and 82%, with good radiation characteristics.

References