# Dual-Band Planar Helical Antenna for WLAN Operation

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**Abstract –** A novel dual-band planar helical antenna is proposed. The antenna is in the form of a rectangular helix, and is obtained by printing a plurality of linear metal strips on both sides of a dielectric substrate and then connecting the strips at their ends by shorting pins through via-holes in the substrate. The total length of the rectangular helix controls the antenna's first or fundamental resonant frequency, and by adjusting the first turn spacing of the helix, the antenna's second resonant frequency can be adjusted. A constructed prototype with its first two resonant frequencies excited at about 2.4 and 5.2 GHz suitable for WLAN operation is presented and studied. [Report and Opinion. 2009;1(2):78-79]. (ISSN: 1553-9873).

**Index Terms:** planar antennas, printed antennas, helical antennas, mobile antennas

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## I. Introduction

Helical antennas are generally formed by winding a wire conductor into a right-hand or left-hand coil and have a much shorter linear dimension than the straight monopole antennas. They have also been widely used in cellular phones for mobile communications [1], [2]. In this paper, we present a novel design of planar helical antenna suitable to be printed and integrated on the system circuit board of a communication device. The proposed planar helical antenna includes several sections of a rectangular helix printed on two sides of a circuit board. In addition, the proposed antenna has two different turn spacings along the helix such that the first two resonant frequencies of the antenna can be adjusted to meet the desired dual-band operation for cellular mobile communications (such as in the 900 and 1800 MHz bands) or WLAN (wireless local area network) operations (such as in the 2.4 and 5.2 GHz bands). In this study, the proposed antenna integrated on the top portion of a dielectric substrate about the size of the system circuit board of a practical PDA (personal digital assistant) device for dual-band WLAN operation in the 2.4 GHz (2.4–2.484 GHz) and 5.2 GHz (5.15–5.35 GHz) bands was presented and experimentally studied.

## II. Antenna Design

The results showed that the proposed dual-band planar helical antenna printed and integrated on the top portion of a 0.8 mm grounded FR4 substrate (relative permittivity 4.4), which can be considered as the system circuit board of a practical PDA device. Notice that the ground plane (a size of width 70 mm and length 100 mm) printed on the back surface of the FR4 substrate does not cover the top portion of the substrate's back surface (a size of about $70 \times 9.5$ mm$^2$ in this study). On the front and back surfaces of the top no-ground portion of the substrate, the proposed planar helical antenna is printed.

The antenna comprises a rectangular helix occupying an area of $5 \times 7.5$ mm$^2$ and a connection metal strip of length 2 mm, which connects the helix to a 50 Ω microstrip feed line printed on the substrate's front surface. The rectangular helix is formed by printing linear metal strips on the front and back surfaces of the substrate and then connecting the strips at their ends by shorting pins through via-holes in the substrate. In this design the rectangular helix has about 4 turns with a cross-sectional area of $0.8 \times 5$ mm$^2$. Also note that the metal strips printed on the front surface are oriented horizontally, and the metal strips on the back surface are inclined such that each strip is connected at its two ends to two adjacent strips on the front surface.

All the strip widths of the proposed antenna are set to 1 mm. The spacing between each turn are all selected to be 0.5 mm, except that of the first turn is 1 mm, that is, nonuniform turn spacings are designed for the proposed antenna. The detailed dimensions of the proposed antenna are studied, which are obtained with the aid of the commercially available software Ansoft HFSS (High Frequency Structure Simulator). In this design, the total length of the rectangular helix is about 43.5 mm, which controls the antenna's first or

fundamental resonant frequency (about 2.4 GHz in this study), and by adjusting the first turn spacing of the helix (1 mm here), the antenna's second resonant frequency is tuned to be at about 5.2 GHz. [Note that, when the first turn spacing is set to 0.5 mm (that is, a uniform turn spacing of 0.5 mm along the helix), the antenna's first resonant frequency remains at about 2.4 GHz, but the second resonant frequency will be shifted to a frequency (about 5.5 GHz) higher than 5.2 GHz.] This property is similar to that of the nonuniform wire helical antenna studied in [1]. Accordingly, the first and second resonant modes of the proposed antenna can be easily controlled, which makes it capable of dual-band WLAN operation in the 2.4 and 5.2 GHz bands.

**III. Experimental Results and Discussion**

Two separate wide resonant modes at about 2.4 and 5.2 GHz are obtained. The simulated results are obtained from Ansoft HFSS, and good agreement between the measurement and the simulation is observed. From the measured results, the 10 dB return-loss bandwidths obtained are 208 MHz (2366–2574 MHz) and 252 MHz (5143–5395 MHz) for the lower and the upper modes, respectively, which cover the required bandwidths of the 2.4 and 5.2 GHz bands.

The radiation characteristics were also studied. The study plots the radiation patterns at the center operating frequencies (2442 and 5250 MHz) of the 2.4 and 5.2 GHz bands, respectively. In the *x*–*y* plane, the measured radiation patterns at the two frequencies are close to omnidirectional. Other frequencies across the 2.4 and 5.2 GHz bands were also measured, and similar radiation patterns as plotted here are observed. The study presents the measured peak antenna gain across the two operating bands. For the 2.4 GHz band, a stable peak antenna gain of about 2.9 dBi is measured. For the 5.2 GHz band, the peak antenna gain ranges from about 2.4–2.7 dBi.

**IV. Conclusions**

A novel planar helical antenna with nonuniform turn spacings for dual-band operation has been proposed, and a prototype printed and integrated on a grounded dielectric substrate about the size of the circuit board of a PDA device for 2.4/5.2 GHz WLAN operation has been constructed and studied. Results show that two separate wide resonant modes at about 2.4 and 5.2 GHz are excited for the constructed prototype, and good radiation characteristics have been obtained.

**References**

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2/15/2009