Compact wideband antenna for 2.4 GHz WLAN applications

M. Joseph, B. Paul, R.K. Raj and P. Mohanan

A novel compact wideband antenna for wireless local area network (WLAN) applications in the 2.4 GHz band is presented. The proposed low profile antenna of dimensions 15 × 14.5 × 1.6 mm offers 18.6% bandwidth and an average gain of ~5 dBi. The antenna can be excited directly using a 50 Ω coaxial probe.

Introduction: Wireless local area networks (WLAN), which facilitate wire-free communication between PCs, laptops and other equipment within a local area, have made tremendous advancements in recent years. Compactness, simplicity and ease of integration, coupled with superior reflection efficiency and radiation performances are the challenges posed in designing antennas for the above application. Various methods used to overcome the inherent narrow bandwidth of microstrip patches include using stacked parasitic elements, coplanar parasitic elements, aperture coupling and slots in the patch. A coaxial probe fed patch antenna with dual shorting pins and slots, offering 21.5% bandwidth and 2.2 dBi gain is proposed in [1], on a substrate of thickness 12.5 mm. The planar inverted F configuration proposed in [2] offers 42% bandwidth, with an over all size of 30 × 10 × 2 mm on an FR4 substrate and a via hole for impedance matching. The 50 Ω coaxial line fed narrow flat plate antenna with an inverted *L* slit [3] for WLAN operation in the 2.4 GHz band (2400–2485 MHz) gives a gain of 3.6 dBi. In this Letter a novel compact wideband antenna, which offers a gain of 5 dBi in the above band is proposed. The antenna can be excited directly through a simple probe extending from the WLAN circuit board, allowing its easy integration with the communication module. The proposed geometry and the experimental results are presented.

Antenna design: The geometry of the proposed antenna is shown in Fig. 1. It is etched on a substrate of dielectric constant $\varepsilon_r = 4.7$ and $h = 1.6$ mm. The antenna has a small rectangular portion ABCD of length $L = 15$ mm and width $W = 4.9$ mm. Two similar arms of dimensions $a = 9.6$ mm, $b = 0.3$ mm are placed symmetrically on side AB of the rectangle at an offset $s = 0.3$ mm from corners A and B respectively as shown in the Figure. The optimum feed point of the antenna is along side AD of the rectangle at a distance $d = 1.9$ mm from A. Impedance matching is achieved by changing the length of arm 1 and frequency tuning by adjusting the length of arm 2. In the above design, length and position of the arms are optimised experimentally for 2.4 GHz WLAN band with a wide 2:1 VSWR bandwidth of 460 MHz.

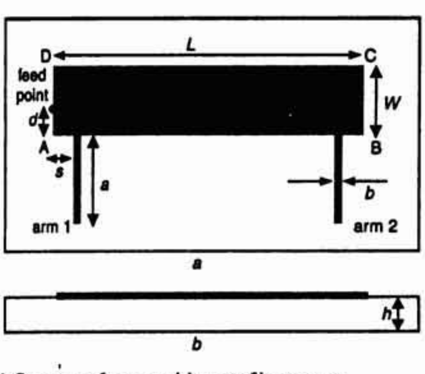

Fig. 1 *Geometry of proposed low profile antenna*

a Top view
b Side view
$L = 15$ mm, $W = 4.9$ mm, $h = 1.6$ mm, $d = 1.9$ mm, $s = 0.3$ mm, $a = 9.6$ mm, $b = 0.3$ mm

Results: The experimental return loss of the above antenna is shown in Fig. 2. The antenna resonating at 2.47 GHz offers −10 dB return loss from 2260 to 2720 MHz, covering the 2.4 GHz WLAN band, exhibiting 18.6% bandwidth. The experimental radiation patterns at 2.47 GHz in the *yz*, *xz* and *xy* planes, respectively, are depicted in Fig. 3. The patterns are nearly omnidirectional in the elevation planes (*xz* and *yz* planes). Radiation patterns at other frequencies across the operating band are similar to those shown in Fig. 3, suggesting the usefulness of the antenna in the entire band. The antenna gain measured in the 2.4 GHz WLAN band gives a peak gain of 6 dBi at 2.485 GHz as shown in Fig. 4. Characteristics of the proposed antenna are compared with that of a standard circular patch in Table 1. The proposed configuration has an area reduction of ~73% with respect to the circular patch resonating at the same frequency. From the experimental studies it is found that the design parameters of the antenna are $L = 0.123\ \lambda_0$, $W = 0.0403\ \lambda_0$, $a = 0.079\ \lambda_0$, $b = 0.00247\ \lambda_0$, $d = 0.0156\ \lambda_0$ and $s = 0.00247\ \lambda_0$, where λ_0 is the free space wavelength at the operating frequency. The design parameters given above are confirmed by conducting experimental observations on patch antennas operating in other frequency bands.

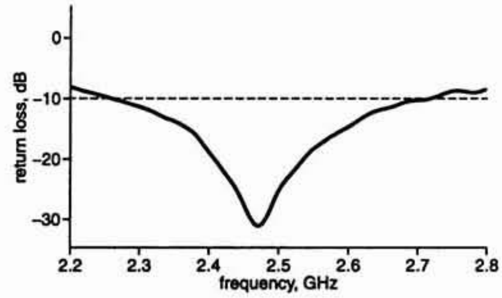

Fig. 2 *Return loss characteristics of antenna*

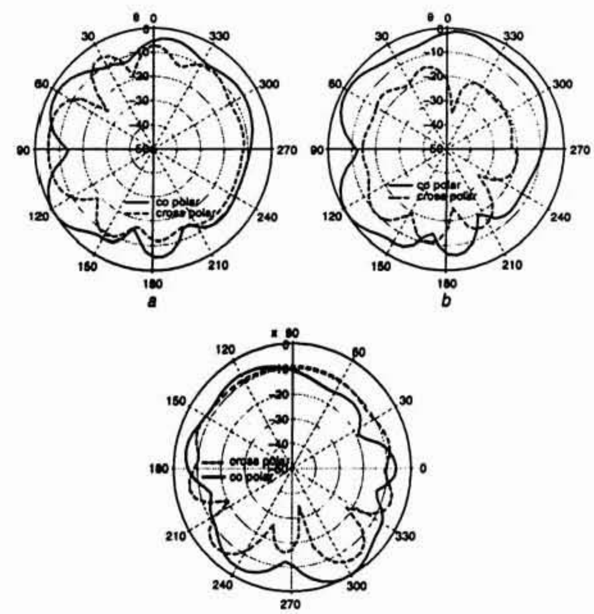

Fig. 3 *Radiation patterns at centre frequency of operating band*

a *yz* plane
b *xz* plane
c *xy* plane

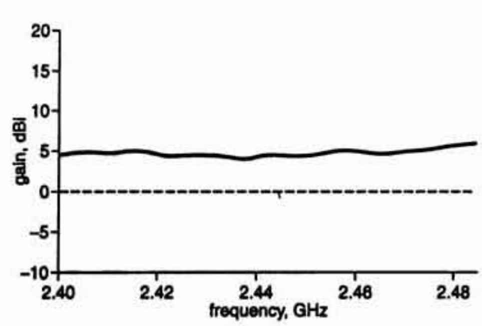

Fig. 4 *Gain of antenna in 2.4 GHz band*

Table 1: Comparison of proposed antenna and a standard circular patch

Antenna	% Bandwidth	Gain (dBi)	Area (mm^2)	Pattern coverage
Circular patch	1.12	5.11	829	Broadside
Proposed antenna	18.6	5	218	Omnidirectional

Conclusion: A compact wideband antenna with a novel geometry is proposed. The antenna exhibits moderate gain and excellent radiation coverage. These features make the proposed antenna suitable for WLAN operations.

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M. Joseph, B. Paul, R.K. Raj and P. Mohanan (*Department of Electronics, Cochin University of Science and Technology, Kochi 682022 Kerala, India*)

E-mail: drmohan@cusat.ac.in

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