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A Directional Dual-band Slotted Semi-Circular Inverted-F Antenna For WLAN Applications

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A simple and compact directional dual-band semi-circular inverted-F antenna for WLAN applications is reported. Two pairs of semi-circular slots as well as a pair of arms are employed to generate the dual resonances in the 2.4-2.48 and 5.2-5.8 GHz bands. The measured results show that the proposed antenna can provide two 10dB impedance bandwidths of 160 MHz (2.40-2.56 GHz) and 900 MHz (4.95-5.85 GHz), respectively. Nearly constant directivities (about 4.7 dBi) are observed in the lower band, while directivities in the upper band vary between 6.3 and 8.6 dBi.

Introduction: Multiband antennas have increasingly attracted great attention as indoor wireless technologies develop rapidly, such as the smart home system based on wireless sensor networks technology. A large number of antennas have been designed for wireless local area network (WLAN) applications [1]-[3], most of which have omnidirectional radiation patterns as applied to various wireless terminals. However, it is in some cases required that the antenna is directional to allow the installation against a wall or on a ceiling surface, particularly for indoor wireless access points or point-to-point communications [4]-[5]. Slotted structures are often utilized in the multi-band antennas [6]-[7]; as for dual-band patches in [8]-[9], the first resonance is due to the fundamental mode of the main patch, while the second is due to the currents flowing along the slot edges.

In this article, we present a new directional dual-band slotted semi-circular inverted-F antenna, which is compact, low-cost and capable of covering the 2.4-2.48/5.2-5.8GHz WLAN bands. It is designed for a smart wireless gateway in a WLAN-based smart home system.

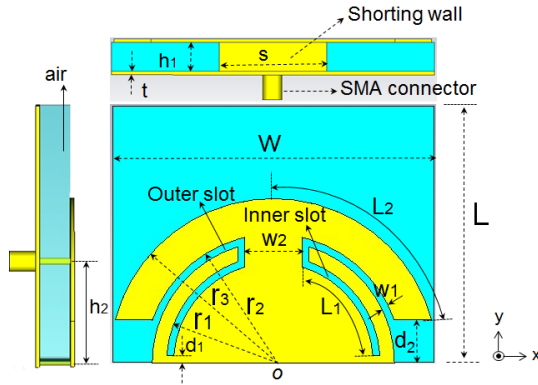


Fig. 1 Geometry of the proposed antenna (yz -plane is the E -plane while xz -plane is the H -plane)

Table I Geometric parameters for the proposed antenna

parameter	value	parameter	value
S	21.0 mm	t	0.1 mm
L	41.4 mm	d_1	1.2 mm
w	51.8 mm	d_2	7.0 mm
r_1	17.3 mm	w_1	1.2 mm
r_2	20.7 mm	w_2	9.2 mm
r_3	26.5 mm	h_1	4.6 mm
h_2	20.0 mm		

Antenna structure: Fig. 1 and Table I show the geometry of the proposed dual-band slotted semi-circular inverted-F antenna. As can be seen, its total size is $41.4 \times 51.75 \times 4.6 \text{ mm}^3$, which is much thinner than that ($43 \times 26 \times 12 \text{ mm}^3$) of a 2.4/5.8GHz dual-band directional antenna proposed in [4] for RFID reader applications, and much more compact than that ($57 \times 57 \times 21 \text{ mm}^3$) of a 2.5-4.8GHz slot antenna designed for WLAN systems in [5].

Results and discussion: The proposed antenna is simulated and optimized by using CST MWS. The surface current distribution shown in Fig. 2 implies that dual-band performance can be obtained by tuning the length of the inner semi-circular slots (L_1) and the outer semi-circular arms (L_2).

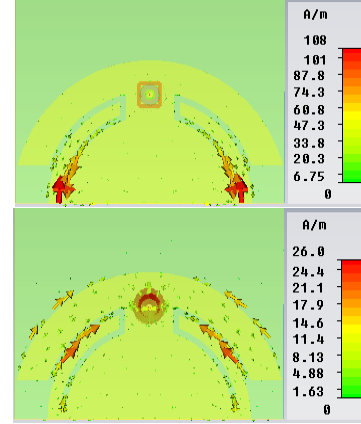


Fig. 2 Surface currents at lower (top) and upper (bottom) band

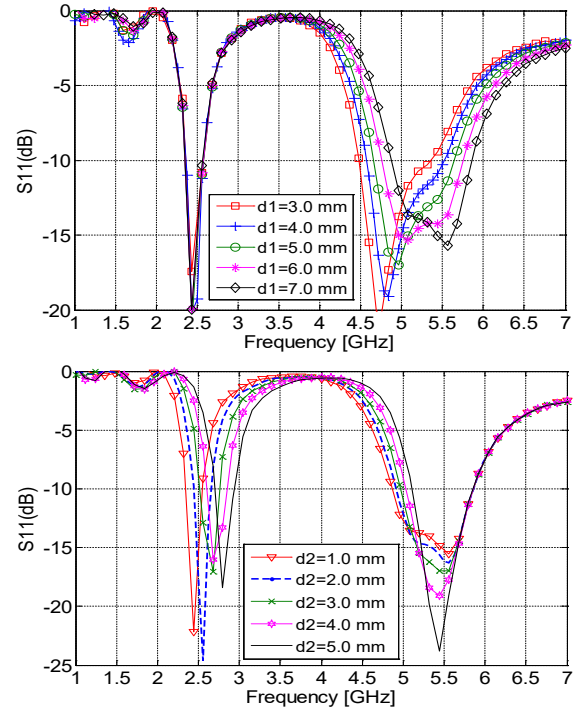


Fig. 3 Single parameter d_1 (top) and d_2 (bottom) sweeping for S_{11}

Parametric sweeps have been performed, where one parameter is swept at one time while the others are fixed. The critical lengths L_1 and L_2 are primarily associated with d_1 and d_2 , respectively, and the results of d_2 and d_1 sweeps are exhibited in Fig. 3. The outer slots can provide so-called isolation between the semi-circular arms and the inner slots. When the length of the inner slots is changed, the length of the outer semi-circular arms remains unchanged, and vice versa. As indicated from Fig.3, d_1 and d_2 could be used to fine-tune the dual resonance dips in a nearly separate way.



Fig.4 Top/bottom/side view of the fabricated antenna prototype.

As can be seen in Fig. 4, the fabricated trapezoidal inverted-F antenna is made of copper and probe-fed through an air cavity by an SMA connector.

Fig. 5 shows the measured and simulated return loss of the proposed antenna. Good agreement between simulation and measurement results is achieved. The measured 10dB impedance bandwidth in the dual-band are 160 MHz (2.40-2.56 GHz) and 900 MHz (4.95-5.85 GHz); the antenna can thus fully cover the dual WLAN bands.

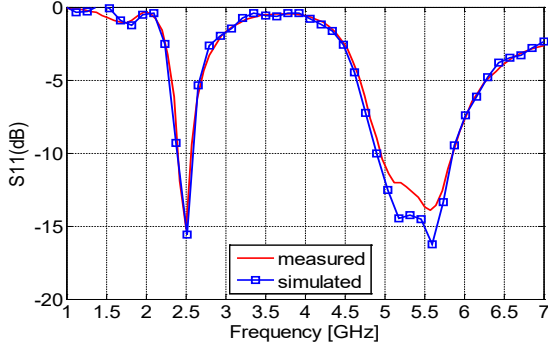


Fig. 5 Simulated and measured S_{11} of the proposed antenna

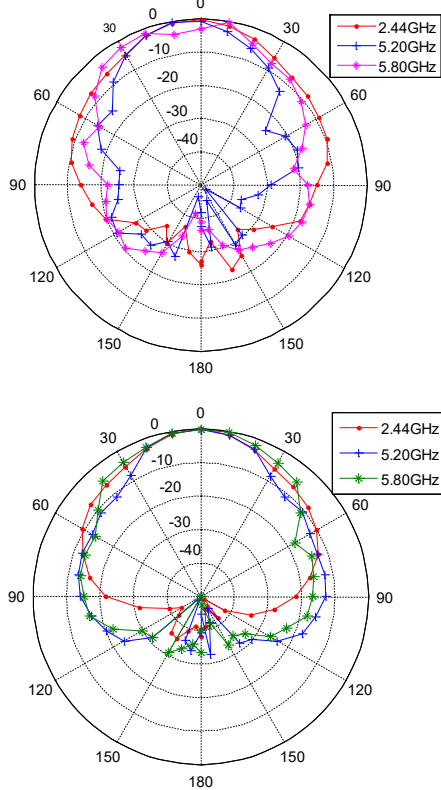


Fig. 6 Measured co-polar patterns in E-plane (top) and H-plane (bottom) at different frequencies

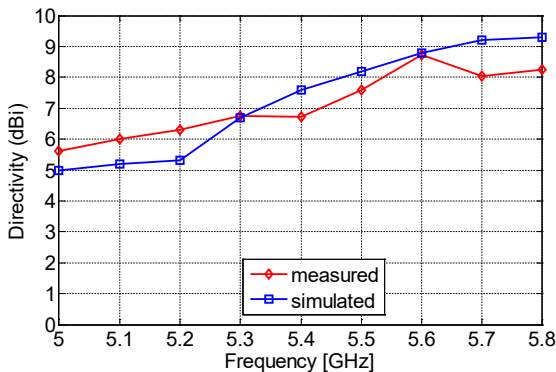


Fig. 7 Measured directivity spectrum in the upper band

The measured co-polar patterns in the E- and H-planes are displayed in Fig. 6. It can be seen clearly that the proposed antenna has good directional radiation patterns for all frequencies. The measured directivity is 4.7 dBi at 2.44 GHz. The measured and simulated directivity spectrums are compared in Fig.7. It can be observed that the measured directivities vary from 6.3 to 8.6 dBi at the upper band.

Conclusion: A new directional dual-band slotted semi-circular inverted-F antenna has been proposed and investigated in this article. The measurement results of the prototype agree quite well with the simulation results. According to the measurement results, about 160MHz and 900MHz bandwidths defined by a return loss better than 10 dB are observed at the lower and upper WLAN bands, respectively; the directivities are about 4.7 dBi at the lower band (2.4-2.48 GHz) while vary from 6.3 to 8.6 dBi at the upper band (5.2-5.8 GHz). Besides, the proposed antenna is compact, low cost and easy to fabricate, making it ready to be applied in a WLAN-based smart home system.

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