Dual-Band Microstrip-Fed Monopole on RO4003 Substrate

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Abstract: The design of a novel dual-monopole antenna that demonstrates dual-band operation and omni-directional radiation patterns in both frequencies of operation is discussed in this paper. The bands of operation exceed the officially designated bands for both the IEEE 802.11a and IEEE 802.11b wireless communication protocols. The effect of the geometry characteristics on the return loss and the radiation behavior is briefly explained. The proposed antenna is designed on 1.52 mm thick RO 4003 material with overall board dimensions of 40 mm x 40 mm.

I. Introduction

The Wireless Local Area Network (WLAN) protocol, using the spectrum assigned from FCC to the IEEE 802.11 standards [1], is a mature technology used from a wide variety of applications. The technology trends lead towards multi-operation devices which use different communication standards. As a result, the design of multi-frequency antennas has attracted a lot of attention in the recent years. The fat monopole solution that was proposed by some researchers [2-3] is more suitable fore wideband applications than for multi-band applications. A different approach, the multi-segments broadband antennas proposed in [4-5] seems to be more suitable. In this paper, a microstrip-fed, compact dual-monopole is proposed on Rogers RO4003 substrate which operates at two frequency bands that exceed the 802.11a and 802.11b frequency bands of operation. The simple antenna design and the consistent radiation patterns allow the use of the antenna for many different applications.

II. Antenna Design

The dual monopole antenna was designed on 1.52 mm thick Rogers RO4003 material (ε_r=3.38, tanδ=0.0027) with overall board dimensions 40 x 40 mm^2. The prototype schematic is presented in fig. 1 and its dimensions are summarized in Table 1.

The 50 Ω feed line is a microstrip line with 3.5 mm width and length of 10 mm. The ground metal rectangle has dimensions 40 mm x 11 mm. There are two L-shaped monopoles attached on the microstrip feed line. The smaller left one is placed at a distance H1=10mm from the edge of the board and its width is 2mm. The segment which is perpendicular to the feed line has length L1=4.25 mm and the segment which is parallel to the feed line has length L2=9mm. The right, longer L-shaped monopole is connected with the feed line at a distance H2=12

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mm, and it also has width w=2 mm. It has a perpendicular to the feed line segment with length R1=12.25 mm and a parallel to the feed line segment with length R2=21 mm.

III. Discussion of Simulated Results

For simulation and optimization of the antenna design, Ansoft HFSS [6] is used. The simulated return loss for the proposed dual-monopole antenna is presented in fig. 2. It demonstrates two major radiating resonances one with central frequency at 2.3 GHz and bandwidth that exceeds the designated frequency band for IEEE 802.11b and another one, more wideband with central frequency at 5.5 GHz and bandwidth that exceeds the 5.15-5.875 GHz frequency range which is the frequency range for IEEE 802.11a protocol. The position of any of the resonances is related to the total length of the L-shaped monopoles in a way which is consistent with the reported behavior in [7]. Generally the longer the segment is, the lower the corresponding resonance appears. For the dual-monopole antenna the smaller, left, L-shaped monopole is responsible for the 5.5 GHz resonance and the right longer monopole is responsible for the lower 2.3 GHz resonance. This behavior is verified from figs. 3a and 3b which demonstrate the surface current distribution on the antenna at f_1=2.3 GHz and at f_2=5.5 GHz. Is is obvious that the 2.3 GHz signal is radiated from the right segment and the 5.5 GHz is radiated from the left, smaller segment.

Simulated radiation patterns for the proposed antenna at 2.3 and 5.5 GHz, which are the central frequencies for the two bands, are presented in figs. 4 and 5. Fig 4a presents the E plane (y-z) patterns, where $\theta=0^o$ corresponds to z-axis and $\theta=90^o$ corresponds to the y-axis at 2.3 GHz. The H plane (x-z) plots are presented in fig. 4b, where $\theta=0^o$ is the z-axis and $\theta=90^o$ is the x-axis.The orientation of the antenna with respect to the axes can be seen in fig. 1. Fig. 5 shows the plots on E and H planes, at f_2=5.5 GHz. It is seen that the H plane patterns for the antenna under test are nearly omni-directional for both frequencies, at 2.3 GHz and at 5.5 GHz.

IV. Conclusion

A compact, dual-band monopole on Roger RO4003 material suitable for integration with other passive and active components is introduced and proposed for the WLAN range. The presented antenna has nearly omni-directional radiation patterns for both IEEE 802.11a and IEEE 802.11b frequency bands. Return loss simulations indicate that the proposed antenna is well matched in a frequency band that overlaps the FCC designated WLAN range. The dual-monopole, can be easily fabricated with relatively low cost method and is a good candidate for a large number of mobile handheld devices.

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Table I: Dual-monopole antenna dimensions

H1	10.00 mm	S	3.50 mm
H2	12.00 mm	w	2.00 mm
R1	12.25 mm	d1	7.00 mm
R2	23.00 mm	d2	2.00 mm
L1	4.25 mm	d3	21.00 mm
L2	9.00 mm	S1	11.00 mm
		S2	40.00 mm

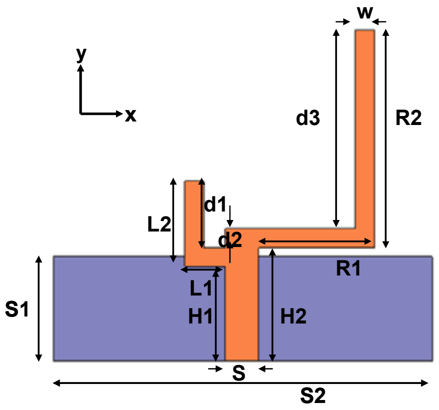

Fig. 1: Antenna Schematic

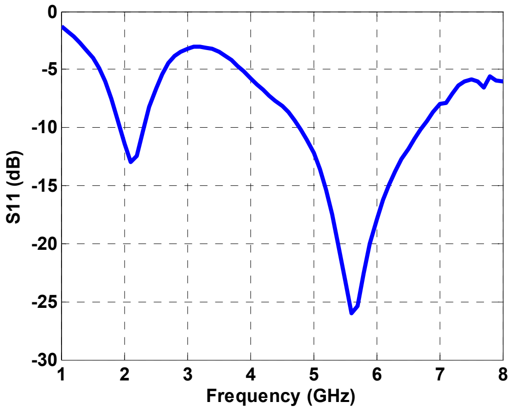

Fig. 2: Return Loss S11

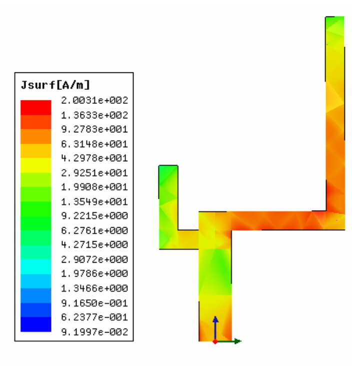

Fig. 3a: Surface current distribution at 2.3 GHz

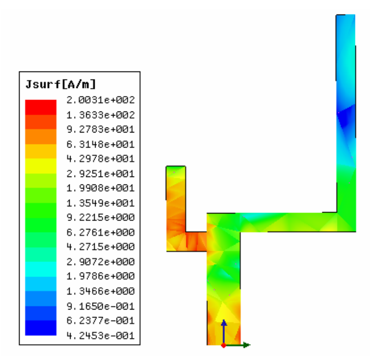

Fig. 3b: Surface current distribution at 5.5 GHz

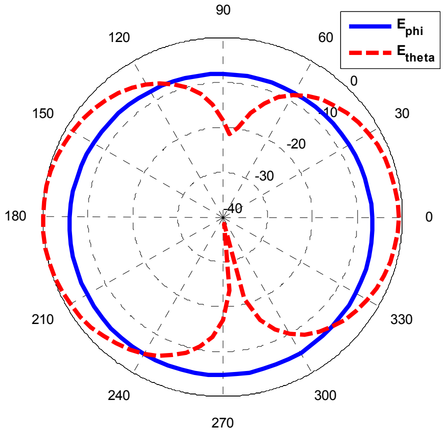

Fig. 4a: E plane at 2.3 GHz

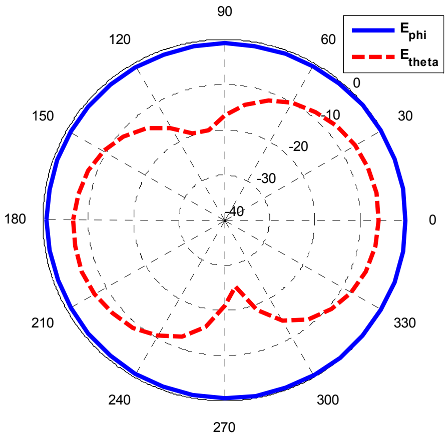

Fig. 4b: H plane at 2.3 GHz

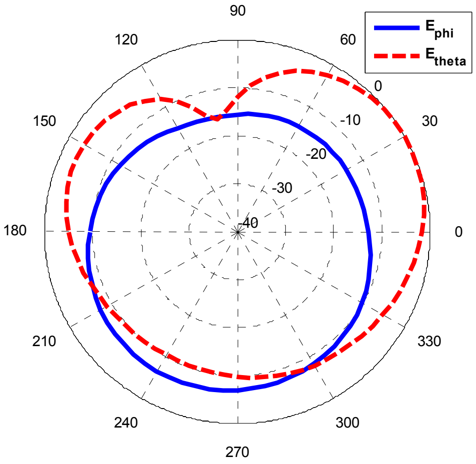

Fig. 5a: E plane at 5.5 GHz

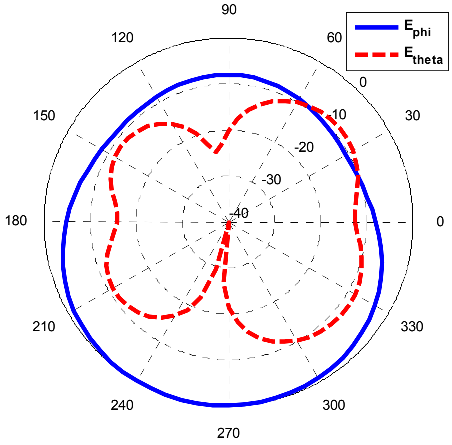

Fig. 5b: H plane at 5.5 GHz