Microstripline-Coupled Printed Wide-Slot Antenna with Loop Loadings for Dual-Band WiMAX/WLAN Operations

Mustafa H. B. Ucar and Yunus E. Erdemli
Electronics & Computer Education Department
Kocaeli University, Kocaeli, Turkey
{mhbucar, yunusee}@kocaeli.edu.tr

Abstract—A microstripline-coupled printed wide-slot antenna with loop loadings is presented for WiMAX/WLAN applications. The proposed compact antenna has a planar size of $38 \times 39$ mm$^2$. The antenna is comprised of a stepped microstrip feedline along with strip loadings which are coupled to a pair of concentric rectangular loop elements inserted in the center of a slotted ground plane. The slot antenna alone shows wideband $S_{11}$ performance $(2.1\text{–}6.8 \text{GHz})$. By inclusion of the loops, the antenna exhibits a dual-band $(2.4\text{–}4 \text{GHz} / 5.1\text{–}5.95 \text{GHz})$ operation where undesired bands around $4.5 \text{GHz}$ and $6.1 \text{GHz}$ are rejected, thus covering the assigned bands for WiMAX and WLAN operations. The numerical design results are presented in the paper.

I. INTRODUCTION

The communication technologies of worldwide interoperability for microwave access (WiMAX) and wireless local area network (WLAN) are designated to have broadband fast-access with a high mobility at either local or wide scale. Recent researches focusing on these applications have led to a variety of multiband or wideband microstrip antennas [1–9], namely, modified monopoles [1, 2], slots [3, 4], rectangular wide-slots [5–7], annular slots [8], and dipoles [9].

In general, conventional monopoles, dipoles, or slots are shown to exhibit inherent narrow bandwidth characteristics. Hence, it is necessary to tailor either feed structure or antenna element or both to achieve multi-bandwidth operation. In particular, wide-slot antennas, recently, have been preferred due to their flexibility in designing and practical implementation [5–7]. In this study, a novel loop-loaded printed wide-slot (LLPS) antenna is proposed for WiMAX/WLAN applications. The LLPS antenna consists of a stepped microstrip feedline along with strip loadings which are coupled to a pair of concentric rectangular loop elements placed in a slotted ground plane. While the slot antenna alone shows wideband $S_{11}$ performance $(2.1\text{–}6.8 \text{GHz})$, the inclusion of the loops results in a dual-band operation, namely, $2.4\text{–}4 \text{GHz} / 5.1\text{–}5.95 \text{GHz}$, which covers all designated bands for WiMAX and WLAN operations.

We note that the full-wave analysis of the proposed design has been carried out using CST Microwave Studio. In the paper, optimum simulation results based on numerous parametric studies are presented.

II. ANTENNA DESIGN

The proposed LLPS antenna configuration is depicted in Fig. 1. As seen, the slotted ground plane $(W \times L)$ is etched on a low-loss thin substrate with a thickness of $h=0.79 \text{mm}$ and $\varepsilon_r=2.2$. The rectangular wide-slot element $(W_i \times L_i)$ with a pair of concentric rectangular loop elements is excited by a stepped microstrip placed on the backside of the substrate. The feedline has two sections with $50\Omega$ $(W_f \times L_f)$ and $100\Omega$ $(W_f \times L_f)$ characteristic impedances. As also seen in Fig. 1, additional strip loadings $(W_s \times L_s)$ are located nearby to the feedline for matching purposes, particularly, in $5.5 \text{GHz}$ band.

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![Figure 1. The LLPS configuration: (a) front, (b) side, (c) back views: $h=0.79$, $W=39$, $L=38$, $L_f=17$, $t=0.05$, $L_r=16$, $L_i=12$, $L_s=9$, $W_f=1.3$, $W_s=2.1$, $W_i=2.2$, $W_{s1}=0.8$, $W_{s2}=1.4$, $L_s=9.68$, $L_b=24.4$, $L_r=8$, $g=0.2$, $k=1.9$ (all in mm), $\varepsilon_r=2.2$.](image-url)
Fig. 4 shows the computed $E$–plane and $H$–plane radiation patterns at 2.6 GHz, 3.5 GHz, and 5.5 GHz. As seen, at the respective frequencies, the design has a broadside radiation pattern with a directivity of about 7 dBi. Also note that the cross-polarization levels are negligible, and the computed radiation efficiency of the antenna is about 95% over the bands of interest.

Finally, the predicted realized gain (IEEE gain × mismatch losses) of the LLPS is displayed in Fig.5. As shown, the antenna has about 6.2 dB and 7.4 dB gains in the lower-band (2–4 GHz) and in the upper-band (5.1–5.95 GHz), respectively.

III. CONCLUSION

In the paper, a novel wide-slot antenna for WiMAX/WLAN applications has been presented. The LLPS design has a rectangular wide-slot element with loop loadings, and is excited by a coupled microstripline with parasitic strips. The proposed design is compact, low-loss, and low-cost. The LLPS design demonstrates dipole-like radiation pattern in the E-plane and offers about 7 dB gain at the designated bands. Besides the simulation results, the measured data for a fabricated prototype will be presented at the conference.

REFERENCES