Microstripline-Fed Printed Wide-Slot Antenna with Notch-Band for UWB Applications

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Abstract—**A compact printed wide-slot (PWS) antenna is proposed for UWB applications. The proposed UWB-PWS antenna basically consists of a stepped microstrip feed-line with a rectangular patch stub and a rectangular wide-slot element at the aperture. Additional parasitic split-ring elements are placed along the patch stub to achieve notch-band characteristics. As the proposed antenna in absence of the ring elements offers ultra-wideband performance (VSWR < 2) over the band of 2.4–11 GHz, the inclusion of those elements results in a notch-band around 3.3–3.8 GHz, which covers one of the designated bands for WiMAX operations. The proposed antenna exhibits bi-directional and omni-directional radiation patterns in the E–plane and in the H–plane, respectively. In the paper, numerical results for the proposed antenna are presented.**

Keywords*– *printed antenna; wide slot; ultra-wide band (UWB); band-notched; split-ring element

I. Introduction

There has been a lot of interest in the utilization of ultra-wideband (UWB) devices since the Federal Communication Commission (FCC) officially issued the regulation for UWB technology in 2002 [1]. In this specification, 3.1–10.6 GHz frequency-band is allocated for unlicensed UWB communication. Having remarkable advantages such as, high data transmission rate, low-power consumption, low-cost, low-interference, the UWB systems have been the focus of attention for researches both in academia and industry. In this context, printed antennas have been preferred in the UWB systems owing to their low-profile, low-cost, low-loss and ease-of-fabrication features. Hence, the related studies have recently employed a variety of microstrip antennas [2–10], such as rectangular wide-slots [2–4], modified monopoles [5–7], elliptical slots [8], patches [9], and slots [10] for UWB applications. In particular, notch-band characteristics may be required in UWB operations in order to avoid interferences due to the WiMAX or WLAN users [4–9].

In this study, a compact printed wide-slot (PWS) antenna is introduced for UWB applications. The proposed PWS antenna consists of a stepped microstrip feed-line with a rectangular patch stub excites a rectangular wide-slot element at the aperture. To achieve notch-band characteristics, additional two parasitic split-ring elements are placed along the patch stub. We note that the full-wave analysis of the proposed design has been carried out using CST Microwave Studio. In the paper, simulation results for the proposed antenna are presented.

II. Antenna Design

The proposed ultra-wide band PWS configuration is depicted in Fig. 1. As seen, a stepped microstrip feed-line with a rectangular patch stub excites a rectangular wide-slot element at the aperture. In addition, the feed structure has two parasitic split-ring elements, each of which is placed along the patch stub, to achieve notch-band characteristics. Note that in Fig. 1 is the upside-down configuration shown (i.e., the wide slot appears at the bottom) so as to visualize each element in the structure better.

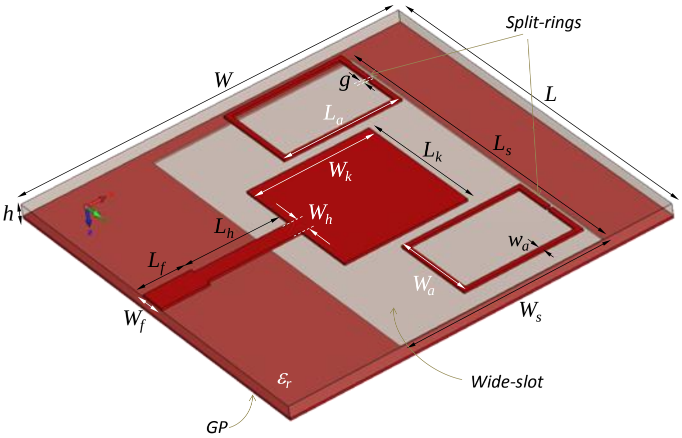

Figure 1. The PWS configuration: L=W=32, L_s= *29.5*, W_s=17, L_k=11.6, W_k=10.4, L_f=4, W_f=2.2, L_h=7.9, L_a=10, W_a=7.3, W_h=1.5, w_a=0.4, h=0.79 (all in mm), ε_r=2.2.

The comparative VSWR characteristics of the PWS designs with and without the split-ring elements are shown in Fig. 2. As can be observed from Fig. 2, while the antenna in absence of the ring elements shows ultra-wideband performance (VSWR < 2) over the band of 2.4–11 GHz, the inclusion of those elements results in a notch-band around 3.3–3.8 GHz, which covers one of the designated bands for WiMAX operations. In addition, the surface current distribution at the center frequency of the notch-band is shown in Fig. 3. As can be seen, the current distribution at 3.5 GHz is mainly confined over the split-ring elements, rather than the patch-stub, thus showing the key role of those elements in occurrence of the reject-band.

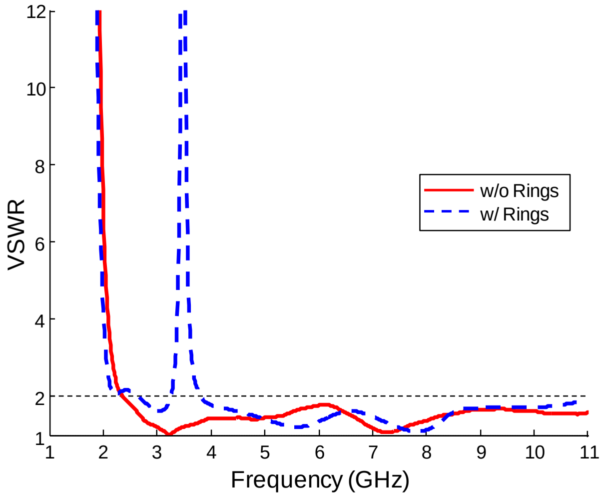

Figure 2. VSWR characteristics of the proposed PWS design with and without the split-ring elements.

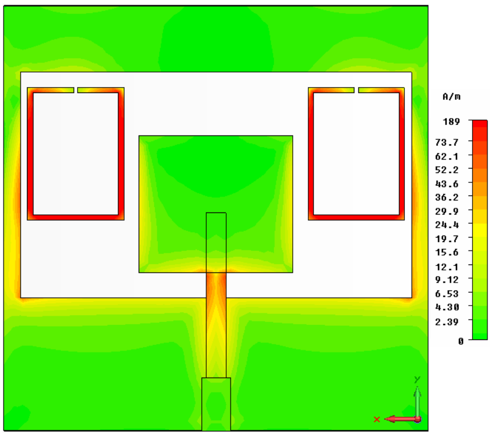

Figure 3. The surface current distribution at 3.5 GHz.

The computed *E*–plane and *H*–plane radiation patterns of the PWS antenna at 3, 5, 7, 9, and 11 GHz are displayed in Fig. 4. As seen, the proposed design exhibits bi-directional and omni-directional radiation patterns in the E–plane and in the H–plane, respectively, over the band of interest. Also note that the cross-polarization levels are negligible, and the computed radiation efficiency of the antenna is about 90% over the bands of interest.

Also, the predicted realized-gain (IEEE gain × mismatch losses) of the PWS is displayed in Fig. 5. As shown, the PWS antenna has gain levels around 2–4.5 dBi over the whole band, excluding the notch-band where a sharp gain dip occurs.

Moreover, in a wideband antenna system, a linear phase response along with a stable group delay response of the radiated field is desirable for a distortion-free communication. Fig. 6 shows the computed group delay of the PWS antenna. Apart from the notch-band, the group delay over 3–11 GHz band is less than 1 ns, which is reasonable for distortion-free UWB communication.

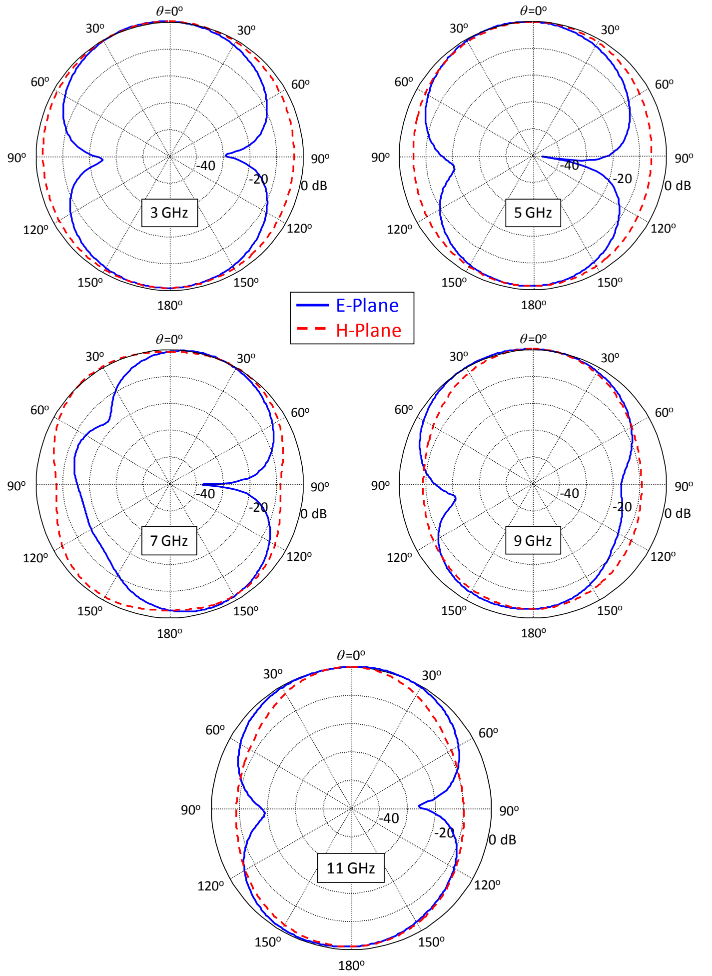

Figure 4. The radiation patterns of the PWS antenna.

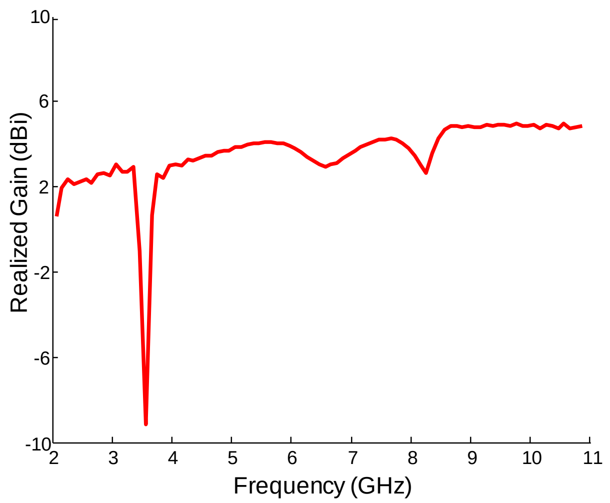

Figure 5. The realized gain of the PWS design.

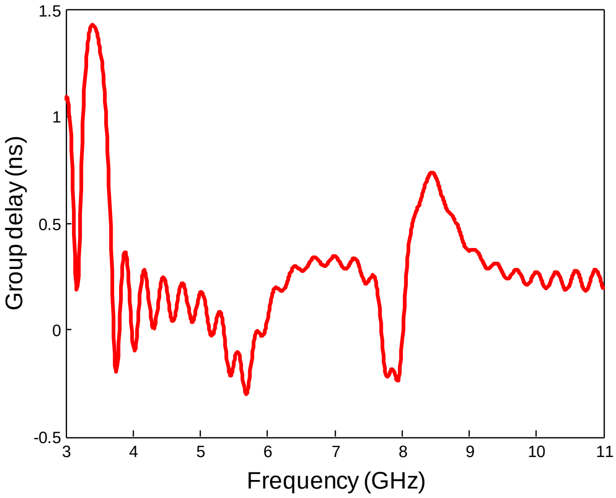

Figure 6. The group delay vs. frequency for the PWS antenna.

III. CONCLUSION

In the paper, a novel PWS antenna with a notch-band has been introduced for UWB applications. The compact PWS antenna has a planar size of $0.25\lambda_0 \times 0.25\lambda_0$ @ 2.4 GHz. The proposed antenna offers an ultra-wide band performance over 2.4–11 GHz with a notch-band around WiMAX frequency of 3.5 GHz. In addition, the antenna has a dipole-like E-plane radiation pattern, and provides 2–4.5 dBi gain over the band of interest. In the context of UWB standards, the proposed antenna can be a good candidate for UWB applications. Besides the simulation results, the measured data for a fabricated prototype will be presented at the conference.

ACKNOWLEDGMENT

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