A novel multi-notch compact monopole antenna for UWB applications

Hossein Mardania) and Sajjad Abazari Aghdamb)

Islamic Azad university south Tehran branch, Tehran, Iran
a) h.mardani@urmia.ac.ir
b) sajjadabazarei@gmail.com

Abstract: A microstrip-fed printed monopole antenna having band-notch characteristics is proposed. The fullband antenna introduces 2.5-10.6 GHz bandwidth covering the FCC frequency band for UWB applications. Six inverted L-shaped stubs on the bottom of the substrate, which are connected to the radiating patch through via pins, are used to create flexible multi-band filtering function. Using this technique it is possible to reject one to six different frequency bands.

Keywords: antenna, notched band, band filtering, band rejection,

Classification: Microwave and millimeter wave devices, circuits, and systems

References

1 Introduction

Due to small size, simple structure and wide bandwidth the printed monopole antennas have attracted great attention in recent years. As these antennas are sensitive to emissions of nearby channels specially applications working at WLAN and WiMAX frequency bands, it is necessary to add band rejection capability to avoid interference. One common technique to develop band-notch function is to use different shaped parasitic elements [1, 2, 3]. Another approach makes use of slots on the radiating patch [4, 5, 6] or ground plane [7]. Sometimes a combination of these techniques is used to create multi-notch function [8]. All introduced printed UWB antennas in the open literature until now, which use the mentioned techniques in rejecting bands, only offer one to three notches. In the present technique which we use resonant L-shaped stubs connected to the radiating patch it will be possible to achieve various frequency bands. The present technique doesn’t impose much negative effect on the antenna’s radiation characteristics.

2 Antenna design

The geometrical configuration of the proposed antenna is shown in Fig. 1.(a), (b), (c) The antenna is printed on an FR4-epoxy substrate with thickness of H=1.6 mm and relative permittivity $\varepsilon_r=4.4$. The printed monopole antenna with a basic rectangular patch having dimensions of 11.5×7 mm on the top of the substrate is connected to a two-step microstrip feed line. This two-step microstrip feedline acts as an Impedance transformer which boosts the impedance bandwidth of the proposed antenna. The optimal design parameters obtained by parametric study for the proposed antenna are shown in Fig. 1. (a), (b), (c).

By connecting these parasitic elements to the patch, through via pins having diameter of .4 mm, multi-band filtering capability is added to the full
Fig. 1. (a), (b), (c) Geometry of the proposed antenna. (a) Rear view; (b) side view and (c) front view (all units in mm). (d) Simulated and measured return loss of the proposed fullband monopole antenna. (e) Measured gain of the full-band and single band-notched antennas.

Six Γ-shaped strips printed on the bottom of substrate are depicted in Fig. 1 (a).

3 Results and discussion

The proposed full-band monopole antenna was designed so that gives the proper bandwidth for UWB applications (3.1-10.6 GHz). The simulated and measured return loss of the full-band antenna is depicted in Fig. 1. (d) Then, the main capability of the antenna -single to multi-band filtering of different bands- were offered using Γ-shaped strips.

Fig. 2 (a)-(f) shows the simulated return loss of different configurations which offer from 1 to 6 notches. In Fig. 2 (a) each Γ-shaped strip introduces one notch while in other configurations two or more Γ-shaped strips might take part in creating a notch. Table. I gives the vertical-part-lengths of the Γ-
Table I. The vertical-part-lengths of the Γ-shaped strips and the corresponding number of notches created.

<table>
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<th>Number of notches</th>
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<th>$\gamma_2$</th>
<th>$\gamma_3$</th>
<th>$\gamma_4$</th>
<th>$\gamma_5$</th>
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Fig. 2. Simulated return loss of different configurations. (a) To (f) figures show 6 to 1 notched antennas respectively. The right hand pictures depict the configuration of Γ-shaped strips which introduces the corresponding $S_{11}$ in the left hand picture.
shaped strips and the corresponding number of notches created and depicted in Fig. 2. From this table, one can tell which Γ-shaped strips are associated to which notch. It is obvious that the shorter strips introduce the upper-frequency-band notches and vice versa. Fig. 3 depicts the radiation patterns of the proposed monopole antenna at two different frequencies, which are similar to the radiation patterns of a typical monopole. This figure proves that the present antenna shows good radiation patterns stability at different frequencies. The measured gain of the full band and single band-notched antennas is illustrated in the Fig. 1. (e) in which it is clear that the proposed antenna has reasonable gain flatness in the whole band. It is also concluded that the proposed technique for creating rejected bands doesn’t impose much effect on the radiation characteristics of the band-notched antenna. Results are obtained using CST Microwave studio [9].

Fig. 3. Measured radiation patterns of the proposed antenna, (a) 3.5 GHz, and (b) 8.5 GHz.

4 Conclusion

A novel compact microstrip monopole antenna was proposed. Using a two step microstrip feedline the proper bandwidth for UWB applications was obtained. A novel technique was adopted to add multi-band-rejection function to the proposed monopole antenna. Owing this technique one to 6 deferent frequency bands can be filtered in the proposed antenna.