A Simple Tunable Monopole Antenna with Sharp Controlled Notched Bands

Zhenlong Liu, Changjun Liu
School of Electronics and Information Engineering
Sichuan University
Chengdu, 610064, China

***Abstract*- A simple tunable antenna with controlled band-notched characteristics is presented. The impedance bandwidth matching is tunable by a single tapered transmission line and the controlled sharp band-notched characteristic is realised by meander line. The largest operating bandwidth covers the entire frequency band from 2.6 to 20 GHz (relative bandwidth>160%). The sharp controlled notched bands was alleviated WLAN interferences at 5.15-5.35GHz and 5.725-5.825GHz. Also, Monopole-like radiations with excellent omnidirectional radiation patterns in the H-plane have been achieved.**

I. INTRODUCTION

Monopole antenna has become a highly competitive solution for indoor wireless radio, mobile device and radar, because of its high-speed data rates, immunity to multipath effects and low power consumption [1]. With the rapid expansion of its applications. The circular monopoles [2], which could achieve good impedance bandwidth, omni-directional far-field beam patterns, and simply integrate with associated electronics, are one of the ideal candidates. However, in all designs involved the bandwidth is generally limited within the FCC defined UWB frequency range. Besides, to match the whole frequency bands is still difficulty especially when the bandwidth is over than 125%, even though bandwidth enhancement techniques [3, 4] have been introduced. On the other hand, bandwidth enhancement techniques was often not easily to tune the desired bandwidth. Furthermore, the electromagnetic interferences is inevitable because of its wide frequency band and low power emission level [5], so the controlled notched bands performance and selectivity are needed [6]. For example, the WLAN interferences at 5.15-5.35GHz and 5.725-5.825GHz should be alleviated to void the extra filter used in receiver.

In this article, a simple tunable antenna with controlled band-notched characteristics is proposed. The impedance bandwidth matching is tunable by a single tapered transmission line and the controlled sharp band-notched characteristic is realised by meander line. It is easier to controlled antenna bandwidth and notch bands by change the length of corresponding microstrip line. Details of tunable antenna with controlled band-notched characteristics antenna design and results are also presented and discussed.

II. ANTENNA DESIGN

The geometry and photographs of the proposed antenna are shown in Figs. 1. It is fabricated on a FR4 substrate with size of 24mm×32mm, thickness h = 1.6mm, relative permittivity = 4.4, dielectric loss tangent = 0.02. The antenna consists of a gold-ingot-shaped UWB patch, simple microstrip transition and embedded band-rejected structures on the front side. The tapered line is used to tune the impedance matching characteristics and two pairs of modified meander line symmetrically placed at a distance of g_1 or g_2 from the microstrip feed line are employed to generate notches in the lower and upper bands and specific notched-band frequency and bandwidth for the antenna are only determined by the dimensions and locations of snake-shaped EBG structures. In this paper, we just show the optimal operating bandwidth of the proposed antennas covers the entire frequency band from 2.6 to 20 GHz (relative bandwidth>160%), except the sharp dual-notched bands covering 5.05-5.35GHz and 5.7-5.9GHz. Moreover, the needless spurious stopband over should be suppressed by adjusting tapered line. Lastly, the dimensions of the optimised antenna are given as follows: W=24, L_0=32, L_1=15, L_f=12, R_1=7, R_2=3.5, g_1=0.35, g_2=0.55, d_0=1.85, d_1=1.6, d_2=,d_3=0.3, R_{via}=0.3.where all units are in millimetres.

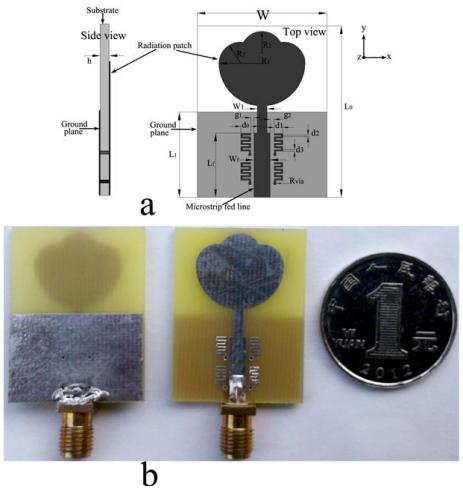

Fig. 1 Geometry of the proposed antenna
a. Antenna configuration
b. Photographs of proposed antenna

III. RESULTS AND DISCUSSION

Fig. 2 shows measured return losses of the proposed antenna. The antenna exhibits an impendence bandwidth from

978-1-5386-1608-6/17/$31.00 ©2017 IEEE

2.6 to over 20 GHz with very effective dual-notched bands. The bandwidths of the notched bands are from 5.05 to 5.35GHz and 5.7 to 5.9GHz, which shows an efficient rejection to 5.2/5.8GHz WLAN with available frequencies (5.35 – 5.7GHz) between the two bands. The ratio between the -5dB notched bandwidth and -10 dB notched bandwidth are 0.63 （5.2GHz）and 0.60（5.8GHz）, which is improved compared with previous published works [7].

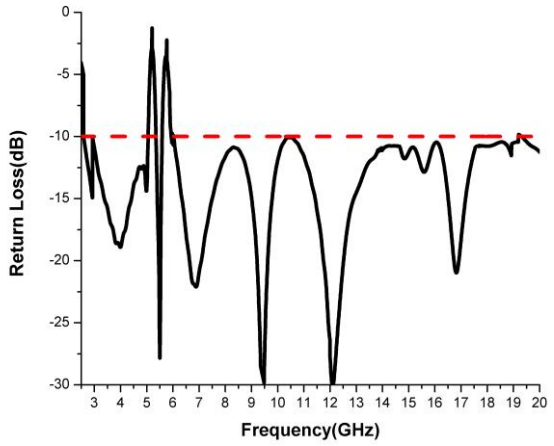

Fig. 2 Measured return losses of proposed antenna

Figs. 3a and b show the measured radiation patterns including the vertical (E Θ) and the horizontal (E Φ) polarisation in the elevation cuts (E-plane)and the azimuth cut (H-plane) when operating at 4GHz and 7GHz. It can be seen from Figs. 3 that the patterns in the H-plane are quite omnidirectional over the entire UWB frequency range, In the E-plane, the radiation patterns remain roughly a dumb-bell shape like a small dipole.

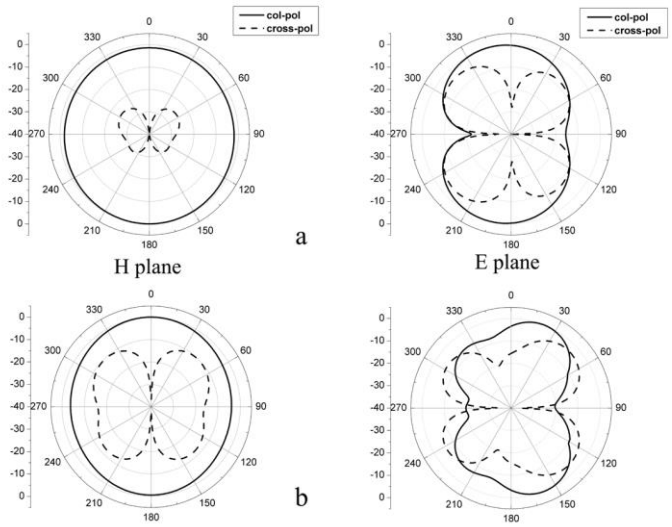

Fig. 3 Far-field radiation patterns of the proposed antenna
a. 4 GHz
b. 7GHz
——— EΘ
– – – EΦ

IV. CONCLUSION

A simple tunable antenna with controlled band-notched characteristics is presented. The impedance bandwidth matching is tunable by a single tapered transmission line and the controlled sharp band-notched characteristic is realised by meander line. The optimal operating bandwidth of the proposed antennas covers the entire frequency band from 2.6 to 20 GHz (relative bandwidth>160%), except the sharp dual-notched bands covering 5.05-5.35GHz and 5.7-5.9GHz. The far-field radiation patterns are quite omnidirectional over the entire frequency range and the cross-polarisation levels are very small in H plane. Thus, the proposed simple antenna is suitable for wireless communication applications.

ACKNOWLEDGMENT

This work was supported in part by the 973 program 2013CB328902, and NSFC 61271074.

REFERENCES

[1] D Jiang, Y Xu, R Xu, W Lin.: 'Compact dual-band-notched UWB planar monopole antenna with modified CSRR', Electronics Letters, 2012,vol. 48, No.20, pp. 1250 - 1252.
[2] Y. Yang, Y.Z. Yin, A.F. Sun, and S.H. Jing.: 'Design of a UWB Wide-slot Antenna With 5.2/5.8GHz Dual Notched Bands Using Modified Electromagnetic Band-Gap Structures', Microwave and Optical Technology Letters, April 2012, Vol. 54, No. 4.
[3] A. M. Abbosh and M. E. Bialkowski. : 'Design of ultrawideband planar monopole antennas of circular and elliptical shape', IEEE Trans. Antennas Propag, Jan. 2008, Vol. 56, No.1, pp. 17–23.
[4] Ch.Ch. Chiaw, M.R. Kamarudin. : 'Novel Design of Circular UWB Antenna', Microwave Conference, 2009, APMC 2009. Asia Pacific.
[5] L. Peng and C.L. Ruan. : 'UWB Band-notched Monopole Antenna Design Using Electromagnetic-Bandgap Structures', IEEE Trans. On Microwave Theory and Techniques, 2011, Vol. 59, No.4, pp. 1074–1081.
[6] Farrokh-Heshmat, N., Nourinia, J., and Ghobadi, C.: 'Band-notched ultra-wide band printed open-slot antenna using variable on-ground slits', Electronics Letters,2009, vol.45, No.21.
[7] Q.X. Chu and T.G. Huang. : 'Compact UWB antenna With Sharp Band-notched Characteristics For Lower WLAN Band', Electronics Letters, July 2011, Vol. 47 No. 15.