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Slotted UWB Antenna for Bandwidth and Gain Enhancement

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Abstract - *A novel written ultrawideband (UWB) slot antenna with reconfigurable band-notch characteristics is bestowed during this letter. The projected antenna consists of a modified rectangular radiation patch with a circular and 3 rectangular-shaped slots etched thereon. in addition, by cutting 2 triangular-shaped slits on a changed ground plane, sensible halfway information measure of additional than a hundred and twentieth (3.12–12.51 GHz), outlined by ten decibel come loss, is achieved. so as to come up with single and twin band-notch characteristics, two p-i-n diodes ar mounted across the circular slot. The designed antenna has tiny size of twenty twenty millimetre with switchable single notched bands of three.12–3.84 gigacycle per second WiMAX and 5–6.07 GHz WLAN, once diode one and diode a pair of ar severally on. Also, dual bands of 3.12–3.82 and 4.9–6.06 gigacycle per second ar eliminated from whole frequency band once each diodes ar at the same time on.*

Key Words: Band-notch, microstrip slot antenna, reconfigurable, p-i-n diodes.

1. INTRODUCTION

Due to the rapid growth of ultrawideband (UWB) communication systems and their inherent properties such as ultra-wide impedance bandwidth, omnidirectional radiation pattern, constant gain, high radiation efficiency, constant group delay, low profile, and easy manufacturing [2], which distinguish them among other systems, there is an essential call for efficient communication devices to work in such environments.

Among newly proposed antenna designs, slot antennas are good candidates with very high radiation efficiency, less dispersion, and easy integration of switches. Also, there are assigned frequency bands such as WLAN (5.15–5.35) and (5.725–5.825) GHz and WiMAX (3.3–3.6) GHz, which are also operated in UWB portion, so the problem of interference emerges. As a solution, several UWB antennas have been attempted to overcome the interference problem using frequency band-rejected function designs. In [4], parasitic structure in a monopole antenna with wideband to single and dual band-notch functionality is proposed. Also in [7], notch function is done by the means of parasitic patches. A slotted patch (i.e., inverted V-shaped slot with folded ends) has been designed to omit WLAN band [2]. In [6], bandstop filter is used to obtain desired band-notch characteristics. Fractal structure [8] and defected ground structure (DGS) [9] are other approaches used for band-notch purposes.

In this letter, a novel microstrip-fed slot antenna with modified radiation patch and ground plane is suggested to provide band-notch purpose. Etching a circular slot with three arms on a radiating patch leads to improvement of bandwidth, and then by biasing one diode or both of them, single and dual band-notch function is achieved, respectively. The ground plane has also two symmetrical triangular-shaped slits to improve bandwidth and two extra rectangular slots to get better notch function. Additionally, a single rectangular slot is etched under the feedline on the ground plane to get a better impedance bandwidth according to [5] and [9]. The proposed design controls width and the position of notched frequencies. Dimensions of the designed antenna are small, and its structure has less complexity and better functionality. Additionally, novelty in comparison to previously presented antennas is another specification of this design, and with just two p-i-n diodes, three band-notch states are investigated.

2. ANTENNA CONFIGURATION AND DESIGN

The proposed slot antenna fed by a 50- microstrip line is as shown in Fig. 1, which is printed on an FR4 substrate, with dimensions of 20 (x -axis) *20 (y-axis) 0.8 mm , permittivity 4.4, and loss tangent of 0.018. The width of the microstrip feedline is fixed at Wn=1.6 mm. The antenna also consists of a modified rectangular radiation patch and ground plane with novel shapes of slots as shown in Fig. 1.

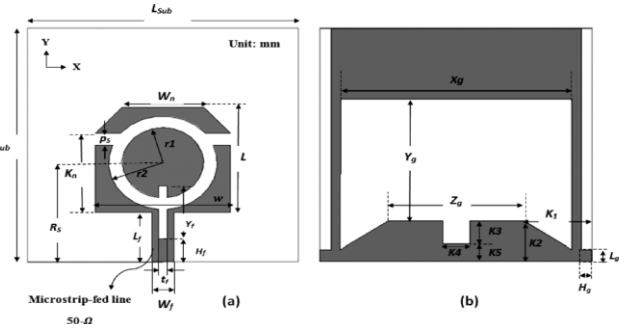

Fig. 1. Geometry of the proposed microstrip slot antenna. (a) Front view (including a microstrip-fed slotted modified patch). (b) Bottom view (including modified ground plane with slots).

Signal transmission is mainly done by the means of an SMA connector attached to the slot antenna. In this letter, the three-armed circular slot has an important role in widening bandwidth and enhancing notch characteristics.

One of these arms placed on the feedline disperses surface currents and causes new paths, so the notch function focuses on desired frequency bands. Considering the effect of a truncated ground plane as a capacitive load and the inductive nature of the patch, a slot is added. The capacitive load counteracts the inductive load and produces almost pure resistive input impedance and matches the patch with the feedline [5]. The triangular-shaped slots are used to improve bandwidth and return-loss level. This is done because capacitance between the patch and ground plane changes. Optimal dimensions of the desired antenna are as shown in Table I.

Table -1: PARAMETERS OF ANTENNA (UNIT: MILLIMETER)ample Table format

L_{Sub}=20		W_{Sub}=20	
Patch		Ground plane	
r1=3	ps =1	Y_g =10.5	K2 =3.5
r2 =4	R_S = 8.5	X_g =17	K3 =2
W_n =6	Y_f=4.5	Z_g =10	K4 =2
K_n=6.75	L_f=4.25	L_g =1	K5 =1.5
L=9	H_f=2	H_g =0.8	
W=10	t_f=0.6	K_1 =5	

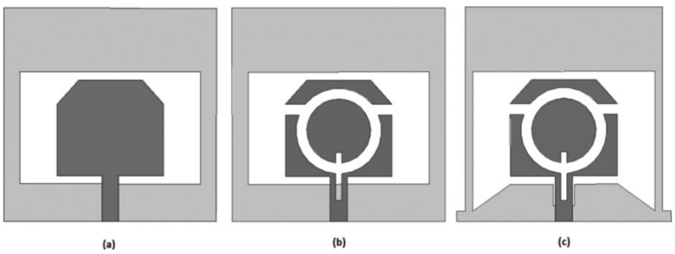

Fig. 2. (a) Ordinarymodified rectangular patch. (b) Antenna with slotted patch. (c) Proposed antenna with defected ground plane.

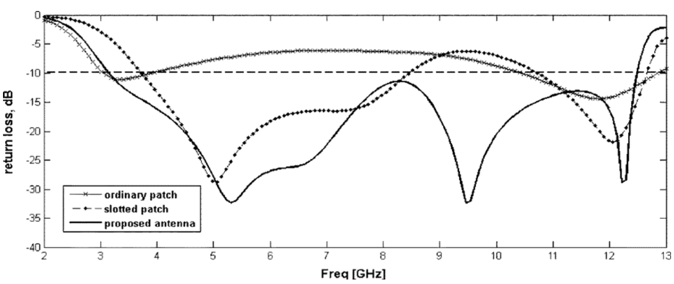

Fig. 3. Simulated return-loss characteristics for antenna shown in Fig. 2.

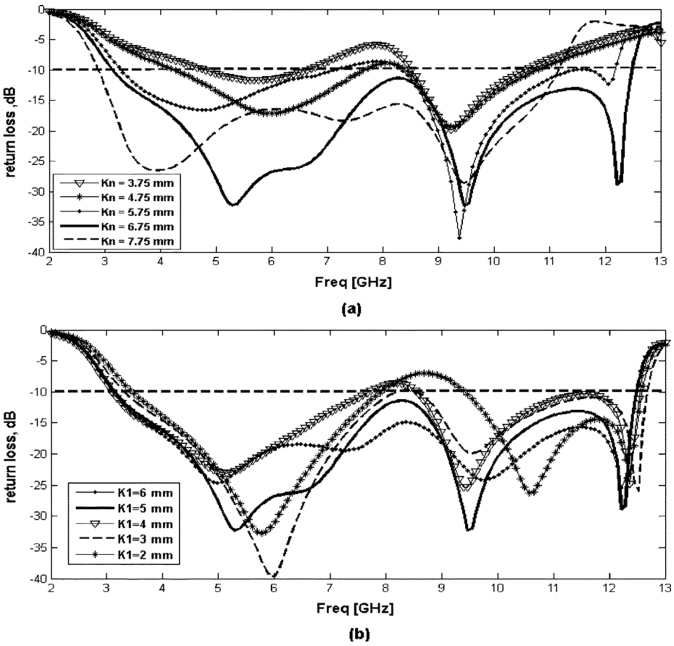

Fig. 4. Simulated return-loss characteristics of the proposed antenna with different values of (a) (Kn and K1 is fixed at 5 mm) and (b) (K1 and Kn is fixed at 6.75 mm).

3. MEASUREMENT RESULTS AND DISCUSSION

3.a Full-Band UWB Slot Antenna Design

Capability of operating over wide frequency bands and good radiation characteristics lead to choosing a rectangular radiation patch as a basic structure of the slot antenna. Modifications have been applied to the radiation patch to manage the current distribution in order to achieve a wide bandwidth. As a result, by inserting a circular slot with three rectangular-shaped ners of the ground plane, bandwidth is increased up to 120% (3.12–12.51 GHz). Fig. 2 shows the structure of the designed antenna in three steps used for simulation studies. Comparisons among return-loss characteristics for an ordinary modified slot antenna [Fig. 2(a)], slotted patch [Fig. 2(b)], and the proposed antenna with defected ground structure [Fig. 2(c)] are respectively considered in Fig. 3. Essential parameters for UWB mode of the proposed antenna are , and . By carefully adjusting these parameters, desired wideband characteristics are achieved.

Ansoft HFSS electromagnetic (EM) simulation tool was used for the parametric analysis and optimization of designs. In Fig. 4(a), alternation of has been illustrated as a key parameter in controlling the resonances of the antenna. While swaps from 2.75 to 6.75 mm, additional resonance will be added at 12.3 GHz, but the first and second resonances have almost fixed positions. In order to study the effects of , the width of the triangular slot in the ground plane, different values of this parameter have been investigated. As it is presented in Fig. 4(b), the optimum value of to reach UWB characteristics is 5 mm. Another significant factor is the rectangular slot on the ground plane, which has operative effects on matching in whole frequencies and is considered with and K3 and K4[5].

3.b Single and Dual Band-Notch UWB Slot Antenna

A UWB reconfigurable slot antenna with three band-notch modes is introduced here by using the proposed structure depicted in Fig. 1 and inserting two p-i-n diodes across the circular slot on the radiation patch. Positions of switches, and , are determined in order to create desirable frequency notched bands. For the proposed design, three operating states are investigated. By turning diode 1 on and diode 2 off, the first rejected band of 3.12–3.84 GHz WiMAX is obtained. Also by turning diode 1 off and diode 2 on, the band-notch of 5–6.07 GHz WLAN is clearly observed. Finally, by activating both p-i-n diodes, dual bands of 3.12–3.82 and 4.9–6.06 GHz are notched, which cover WiMAX and WLAN simultaneously.

Fig. 5 shows a parametric study of simulated results of input reflection coefficient for different states of p-i-n diodes. As shown in Fig. 5(a) and (b), optimized parameters are fixed.

The E and H plane radiation patterns are as shown in Fig 6.

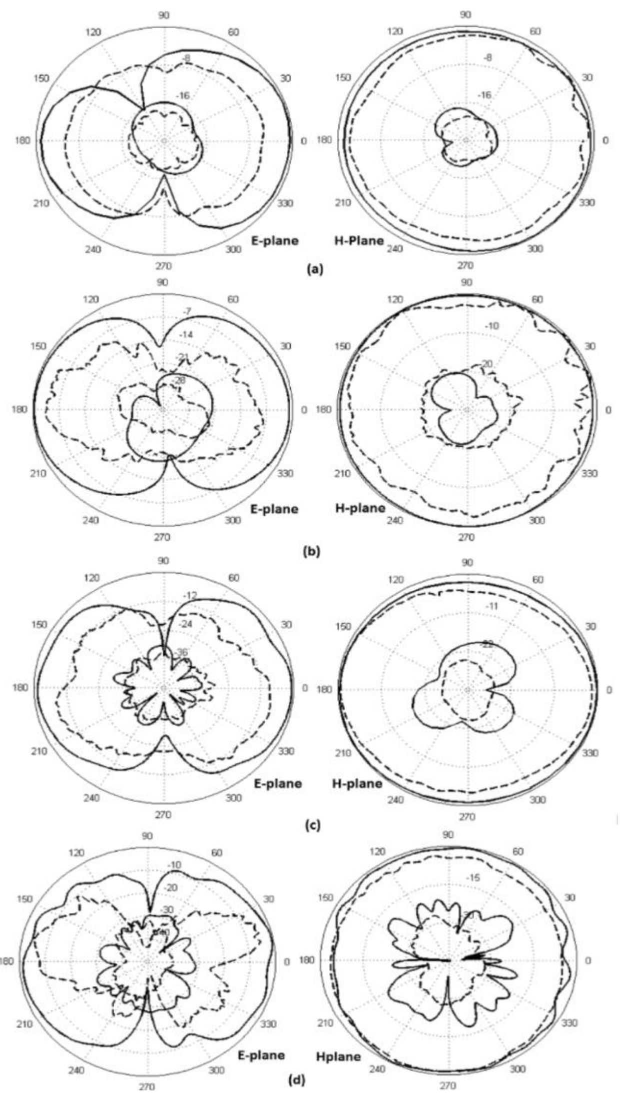

Fig. 6. Simulated and measured H and E-plane radiation patterns of proposed antenna when diodes are off at (a) 3.5, (b) 4.5, (c) 5.5, and (d) 10 GHz.

4 CONCLUSIONS

This letter has presented a novel printed UWB slot antenna with switchable band-notch characteristics supporting various wireless applications. It has been shown that using a circular slot with three arms etched on the patch can enhance bandwidth from 3.12 to 12.51 GHz over 120%. In addition, using reduced ground plane by two triangular-shaped slots can also improve input reflection coefficient. Embedding a pair of p-i-n diodes in proper situations across the slotted patch will create single and dual stopbands, which are exempt from interfaces with existing WiMAX and WLAN bands. The proposed antenna is small and has three operating ranges, and it is applicable in a variety of wireless systems.

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