A Compact UWB Slot Antenna with Band-Notched Design Using Parasitic Stripe

W. Kueathaweekun¹, C. Benjangkaprasert¹, N. Anantrasirichai², and T. Wakabayashi³
¹Faculty of Engineering, King Mongkut’s Institute of Technology Ladkrabang (KMITL),
Ladkrabang, Bangkok, 10520, Thailand
E-mail: kanoppin@kmitl.ac.th, kkweerat@kmitl.ac.th
²The Institute for the Promotion of Teaching Science and Technology (IPST), Bangkok, Thailand
E-mail: a_nop@hotmail.com
³School of Information Science and Technology, Tokai University, Hirasuka, Kanagawa,
259-1292, Japan
E-mail: wakaba@et.u-tokai.ac.jp

1. Introduction

Ultra-wideband technology is specified in IEEE 8.02.15a standard of frequency range from 3.1 GHz to 10.6 GHz of bandwidth 7.5 GHz by the Federal Communications Commission (FCC) [1]. This technology is developed for use in wireless communication systems, particularly wireless LAN multimedia and low power communication system. Thus, the topic in UWB systems have highly interested for telecommunication research groups. The main UWB slot antenna design is impedance matching, compact size, radiation stability, and the low manufacturing cost. Many researches on antenna are designed single band and dual band antennas used in WLAN applications cover standard of IEEE 802.11 b/g/j/a and IEEE 802.16d. Therein, most bandwidths of dual band antenna less than 50%, while the bandwidth of widen single band antenna more than 90% cover from frequency range 2.4 GHz to 6 GHz [2-3]. The other papers often use wide slot with various shape of tuning stub for excitation to achieve a widen bandwidth. Therefore, the wide slot antenna can be developed and increased bandwidth from wideband to ultra wideband by using some technique includes shape of feed line and tuning stub [4-5]. Over the designated bandwidth of UWB systems, there are existing bands used in wireless local-area network (WLAN) of IEEE802.11a and HIPERLAN/2 at operating frequency band from 5.15–5.825 GHz. For this reason, it is desirable to design the UWB antenna with a band-notched at frequency range 5–6 GHz to minimize the potential interferences.

In this paper, we propose a design of compact microstrip-fed slot antenna with band-notched. The measured result of the impedance matching of the proposed antenna on bandwidth determined by -10 dB return loss approximated 125% (2.8-12.20 GHz) for UWB applications. Developed UWB antenna to band notched UWB by insert parasitic strip in slot antenna mainly rejection band from 5 GHz to 6 GHz for avoid the interferences between UWB system and other narrowband communications systems is proposed in this paper.

2. Antenna Design

Figure 1 shows the geometry of the proposed antenna. The rectangular slot antenna is etched out from the ground plane that is used as its radiator, and there is a microstrip line with rectangular-ring tuning stub on the other side for excitation. The return loss of the antenna was simulated by Zeland’s IE3D software [6] and measured results using HP8510C network analyzer. The optimal designed antenna used low-cost FR4 substrate with thickness (h) of 1.6 mm, relative permittivity (\(\varepsilon_r\)) of 4.5, and loss tan \(\delta\) of 0.02. The radiation patterns were measured in a far-field anechoic chamber.

The wavelength \(\lambda_g\) [7-8] at design frequency 3.0 GHz is given by
\[ \lambda_g = \frac{\lambda_0}{\sqrt{\varepsilon_{\text{eff}}}} \]  

(1)

Where

\[ \varepsilon_{\text{eff}} \approx \frac{\varepsilon_r + 1}{2} \]  

(2)

![Diagram of slot antenna and UWB antenna with band-notched](image)

(a) UWB antenna. (b) UWB antenna with band-notched.

Figure 1: Structure of the proposed slot antenna

3. Simulation and Measurement Results

The dimension parameters of slot antenna, microstrip line, and ground plane were obtained to be \( L=21 \text{ mm} \), \( W=12 \text{ mm} \), \( W_m=3 \text{ mm} \), \( S_1=11 \text{ mm} \), \( S_2=7 \text{ mm} \), \( S_3=6 \text{ mm} \), \( S_4=4 \text{ mm} \), where \( W_m \) corresponds to the 50 Ω of the transmission line. Fig. 2 shows comparison of measurement and simulation result of the return loss. The measured results of return loss, approximate 125% coverage the frequency rage from 2.8 to 12.20 GHz for UWB applications.

![Graph of simulation and measurement return loss](image)

Figure 2: Simulation and measurement returns loss of the UWB antenna.
Developed the UWB antenna to UWB with band-notched design by insert parasitic strip in slot antenna mainly rejection band from 5 GHz to 6 GHz. The simulation and measurement result of the UWB antenna with band-notched design, as shown in Fig. 3.

![Simulation and measurement returns loss of the antenna with band-notched.](image)

The radiation patterns of compact microstrip-fed slot antenna with rectangular-ring tuning stub at 3.5 GHz, 5.0 GHz, 7.5 GHz and 10 GHz are shown in Fig. 4.

![Measurement radiation patterns of UWB antenna](image)

Figure 4: Measurement radiation patterns of UWB antenna

Figure 4 (a)-(d), show the radiation pattern in x-z plane (H-plane) and y-z plane (E-plane) at frequency 3.5 GHz, 5.0 GHz, 7.5 GHz, and 10 GHz, respectively. The radiation pattern in x-z plane (H-plane) is bi-directional and omni-directional pattern in y-z plane (E-plane) and the maximum gain is 6 dBi at frequency 9.0 GHz.
4. Conclusion

In this paper, a compact UWB slot antenna with band-notched is proposed. The antenna structure is simple and compact size. The simulation and measurement results of the proposed antenna show a good agreement in terms of the return loss and radiation patterns. Developed band-notched (5-6GHz) structures from the UWB antenna design by insert parasitic strip in the slot antenna. Then, band-notched design of antenna can be applied in the UWB communication systems to avoid interference with other wireless communication systems. The proposed antenna can use for UWB applications.

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References