A UWB Antenna design with Adjustable Second Rejection Band using a SIR

Hyung-Seok Choi, Tae-Woo Kim, Hee-Yong Hwang, Kyung Choi

School of Electrical and Electronics Eng., Kangwon National Univ., Chuncheon 200-701, Korea

***Abstract*— A UWB(ultra wide band) antenna using a SIR(Step Impedance Resonator) that eliminate signal interference at 5 GHz WLAN as the first rejection band and can adjust the second rejection band is proposed. The proposed antenna is satisfied to cover full UWB band with return losses less than -10 dB and push the second rejection band to out of band. The design process is done with numerical analysis and the optimization is given by PSO(particle swarm optimization) algorithm. The radiation patterns show +y directivity characteristics in H-plane and the group delay variations are within 1.0 ns.**

***Index Terms*— ultra wideband antenna, resonator filters**

I. INTRODUCTION

The designs of antenna for UWB applications face many challenges including their impedance matching, radiation stability, compact size, low manufacturing cost and electromagnetic interference (EMI) problems. The EMI problems are quite serious for UWB systems since there are several other existing narrowband services which occupy frequency bands within the UWB bandwidth [1]. A few examples of hostile systems are WiMAX (3.3–3.7 GHz), WLAN 5GHz (5.15–5.825) and ITU 8GHz (8.025–8.4 GHz) band [2]. For the band rejecting, many methods have been reported. The most popular approach is to embed resonance slots in the radiating patch or in its ground plane [3]. Those designs are with flat skirt characteristics and can not control bandwidth and ripple because they have one-pole rejection characteristics using one or more resonators. To overcome these shortcomings, the two-pole band-rejected UWB antenna using two resonators have been proposed [4-5].

In this paper, we propose a new band-stopped Bow-Tie monopole UWB antenna with second rejection SIR. The size of the resonator is determined by the center frequency of rejecting band and the second harmonic frequency is arisen according to the ratio of the step impedance. We placed the SIR at the side of the Bow-Tie antenna and optimally design parameters by numerical analysis to reject full range of WLAN and push the second reject band out of UWB range. The SIR can be placed around the radiating patch without degradation on the operation of the main UWB antenna except the band-rejection band. Also they need no extra space for adoption.

II. DESCRIPTION OF FILTER AND ANTENNA

Fig. 1 shows the model of the proposed Bow-Tie antenna. The angle values α, β and γ are corresponded with the return loss in the high and low frequency band. And please note that the start edge is overlapped to get an impedance matching with feeding line.

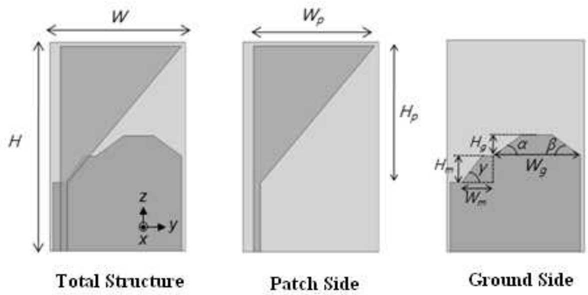


Fig. 1. The Bow-Tie UWB antenna

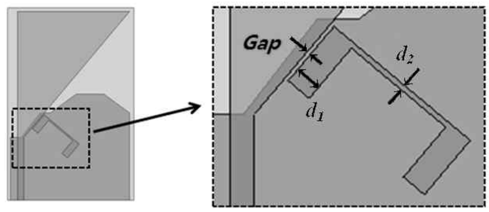


Fig. 2. The Proposed Antenna Structure and the Coupling structure between Bow-Tie antenna and SIR

Fig. 2 depicts the whole proposed antenna structure. The proposed antenna is a kind of minimized half-structure bow-tie monopole using the perfect magnetic wall condition [5]. The antenna is designed on a two-layered printed circuit board (PCB). The main radiation patch is etched on the top layer. The ground plane is etched on the bottom layer of the PCB. To control the primary characteristics of antenna with return loss distribution, a flat ground patch was replaced with an uneven structure of angle α, β and γ and heights H_g, H_m [6]. The SIR is applied as shown in Fig. 2 to give resonant coupling to the main structure, which does not need any extra space for the adoption. The pre-determined parameters for the main antenna are as given; $W = 18.0$ *mm*, $H = 27.5$ *mm*, $W_p = 16.0$ *mm*, $H_p = 18.0$ *mm*, $W_g = 11.3$ *mm*, $H_g = 2.7$ *mm*, $W_m = 4.2$ *mm*, $H_m = 3.5$ *mm*, $\alpha = 36.1°$, $\beta = 36.1°$, $\gamma = 52.4°$. The length of the SIR is also pre-determined by the center frequency of the stop band. The weighty design parameters to be decided are *Gap and* d_1, d_2 of SIR as shown in Fig. 2. We adopted the PSO to find the optimal values.

III. RESULTS AND DISCUSSION

The proposed antenna is printed on the Taconic RF60-A substrate with thickness of 0.64 mm, relative dielectric constant of 6.15 and loss tangent 0.0025. The EM-simulation tool is the commercial HFSSTM. And the Particle Swarm

Optimization algorithm is implemented to find final values. Fig. 3 shows the effect of Gap to return loss, for primary research. As the Gap goes narrow, the rejection band is lowered and has high rejection characteristics. And as the Gap goes wide, the frequency of the rejection band is raised and has poor rejection characteristics

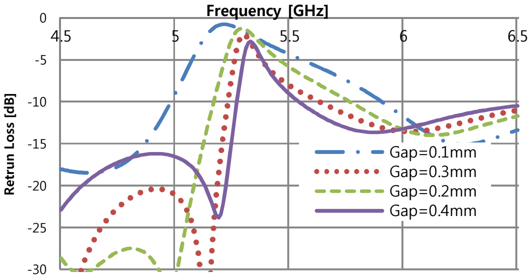


Fig. 3. The return loss distribution according to the Gap

Table 1 and Fig. 4 illustrate several types of SIRs and the resulting return losses each. The second rejection band is varied by SIR type and parameters. For SIR type1, it rejects 8 GHz band, and the band goes up to 13 GHz in case of Type 2 and 4. Thus, it is denoted that the second rejection band is controllable by SIR .

TABLE I
THE TYPES OF THE SIR AND PARAMETERS

State	Type1	Type2	Type3	Type 4	Conv.
Type					
Z_1	92	48	92	65	50
Z_2	25	92	48	92	92
K	3.68	0.52	1.92	0.71	0.54
Gap	0.2	0.2	0.2	0.2	0.1

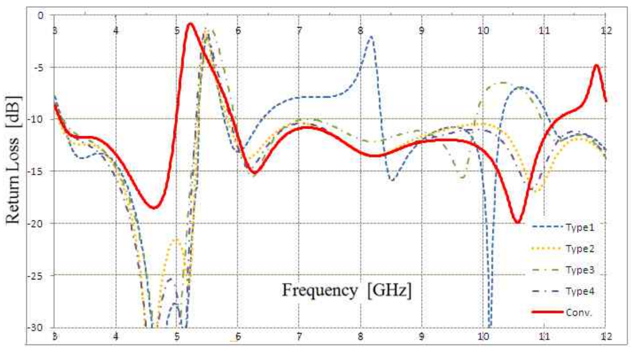


Fig. 4. The return loss according to the types of SIR

Using the above data as initial values, we obtain the optimal values as shown in Fig. 4, also. It has improved characteristics with the broad rejection bandwidth at WLAN band and lower return losses over the whole UWB range, and has the second rejection band above the 12GHz area.

The return loss and the group delay are measured using Anritsu vector network analyzer 37397C. They agree pretty well with each other in spite of fabrication error. The radiation patterns of the proposed antenna are shown in Fig. 6 at 3.5 GHz, 5.5 GHz, and 10.5 GHz, respectively. The 3.5 GHz and 10.5 GHz are on the radiation band and the 5.5 GHz is on the rejection band. The group delay variations are within 1.0 ns except rejection band.

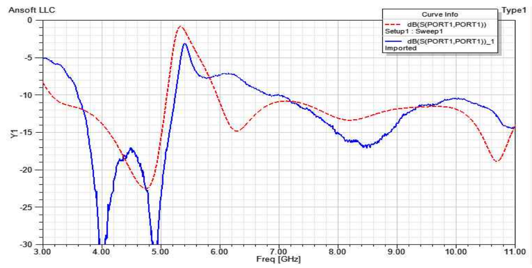
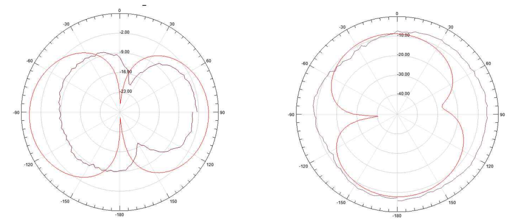
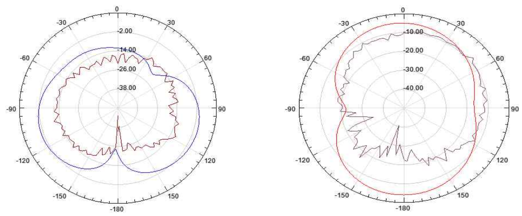


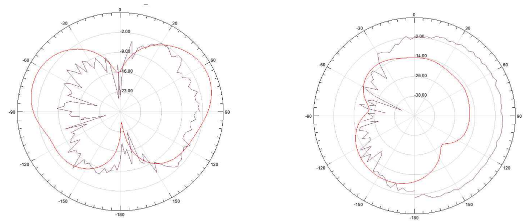
Fig. 5. The simulated and measured return loss



(a) 3.5 GHz, E-plane and H-plane



(b) 5.4 GHz, E-plane and H-plane



(c) 7.5 GHz, E-plane and H-plane

Fig. 6. The radiation pattern of the simulated and the measured one

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