A Band-rejected UWB Planar Monopole Antenna with a Ring-shaped parasitic patch

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***Abstract-* A novel UWB antenna with a band elimination characteristic is presented. The proposed antenna is fed by microstrip line, and it consists of the planar monopole type with a ring-shaped parasitic patch rejecting 5.15~5.825GHz band limited by IEEE 802.11a and HIPERLAN/2. The fabricated antenna can achieve the broad bandwidth covering from 2.2 to 11.8GHz with VSWR below 2. The proposed antenna performances are very suitable for the UWB applications.**

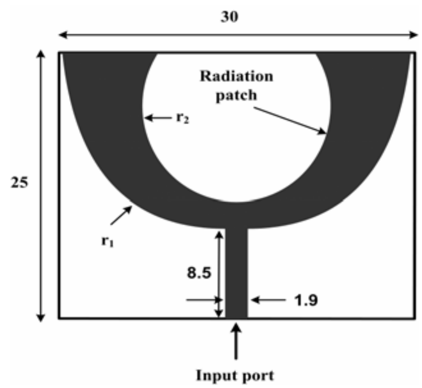
I. INTRODUCTION

The commercial uses of frequency band from 3.1GHz to 10.6GHz for radar, location tracing, and data transmissions were approved by Federal Communications Commission (FCC) in 2002 [1]. According to the regulations released by FCC, the UWB systems have been collocated to the bandwidth from 3.1 to 10.6GHz. However, the use of 5.15~5.825GHz band is limited by IEEE 802.11a and HIPERLNA/2. Therefore, a filter which rejects the limited bandwidth (5.15~5.825GHz) should be necessary in UWB RF front-ends, and this will give complication to UWB systems.

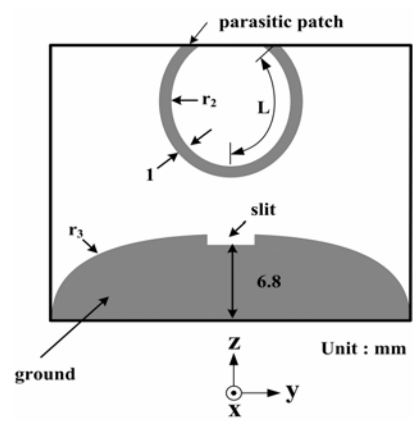
To resolve this problem, many antennas with band rejection characteristic have been researched with the utilization of the advantages of composing more simply RF front-ends [2]. The proposed antenna is designed to eliminate the limited band (5.15~5.825GHz) by attaching a ring-shaped parasitic patch on the bottom layer of the antenna. The proposed antenna satisfies all UWB band (3.1~10.6GHz) and rejects the limited band in order to avoid the possible interference with the existing 5.15~5.825GHz band. Moreover, the proposed antenna has a planar structure of small size and omni-directional pattern. To understand the behavior of the antenna model and obtain the optimum parameters, the simulation was performed with CST MICROWAVE STUDIO based on the finite integration method. The measurement was carried out using the Agilent 8510C Network Analyzer. In this design, a 2.2~11.8GHz frequency range for VSWR < 2 is obtained.

II. ANTENNA CONFIGURATION

Fig. 1 shows the proposed antenna structure. This antenna is composed of a partial ground, radiation patch, and ring-shaped parasitic patch. This antenna is printed on an FR4 substrate with thickness of 1mm and relative permittivity of 4.6. This antenna size is 30 x 25 mm2 and has feeding structure of a 50Ω microstrip line. The physical structure of the inversed



(a)



(b)

Fig. 1. Configuration of the proposed antenna (a) front view (b) back view

bell shape is adapted to increase the effective electrical length at the lower frequency band. The dimension of the slit is 4 x 1 mm2 as shown in Fig. 1(b). By adjusting the size of the slit on the ground plane, good impedance matching over a very wide frequency band can be achieved. The ring-shaped parasitic patch has the length of 15mm and width of 1mm. It plays a role as filter to eliminate the limited band, 5.15~5.825GHz. Fig. 2(a) shows the simulated VSWR results for the proposed antenna in terms of different lengths L of the ring-shaped parasitic patch. For L = 13, 15, and 17mm with other fixed dimensions, their lengths correspond approximately to a quarter-wavelength of the frequency at about 6, 5.5, and 5GHz,

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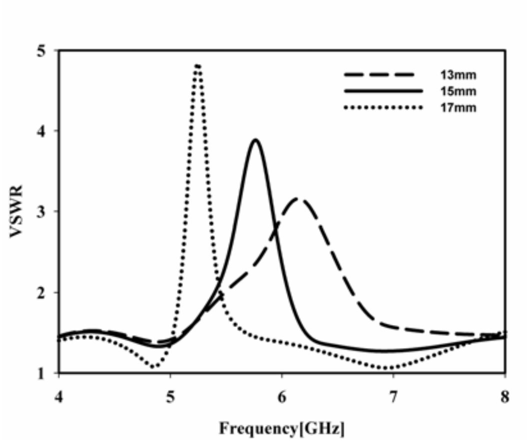
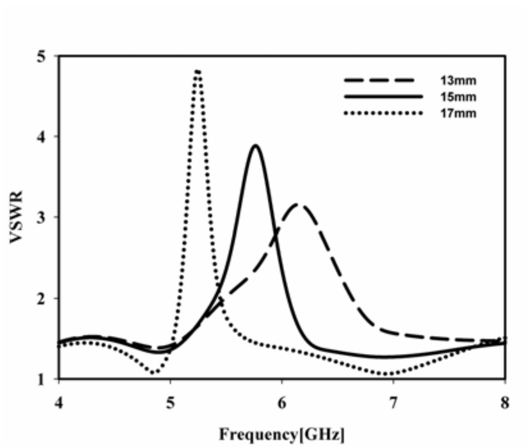


(a)



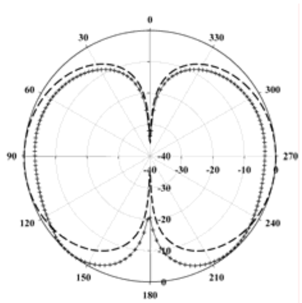
(a)

Fig. 2. (a) The simulated VSWR for the propose antenna in terms of *L*
(b) The comparisions of the measured and simulated VSWR values

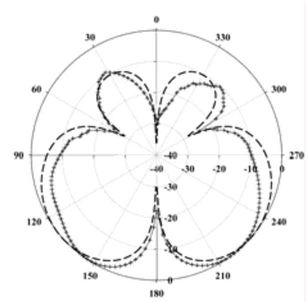
respectively. We have selected L = 15mm owing to eliminating the limited band (5.15~5.825GHz). The optimized parameters are as follows; L = 15mm, r1 = 26-mm-radius, r2 = 12-mm-radius, and r3 = 14-mm-radius. By continuously adjusting these parameters, it is possible to tune the impedance matching level. To design this antenna, we have applied four techniques to the proposed antenna: the use of the inversed bell shape, slit on the ground, partial ground, and ring-shaped parasitic patch. As a result, the proposed antenna have a broad bandwidth (about 2.2~11.8GHz) below VSWR <2.

III. RESULTS

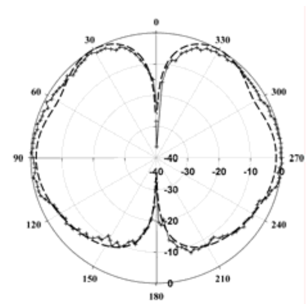
Fig. 2(b) shows the measured and simulated VSWRs for the fabricated prototype. Results for the antenna without the ring-shaped parasitic patch are also shown for the comparison. It is apparent that the proposed antenna can satisfy the UWB band (3.1~10.6GHz) for VSWR<2 with rejecting 4.9~5.9GHz band. By attaching the ring-shaped parasitic patch on the bottom layer, it is clearly observed that the proposed antenna has not only the rejected band, but also improved the VSWR values at the 7~9GHz frequency range. The measured and simulated radiation patterns in E-plane are shown in Fig. 3 at the frequency of 3, 5, and 9GHz. The measured and simulated results have a good agreement with each other. Fig. 4 shows the simulated gains of the proposed antenna with and without the parasitic patch. A sharp decrease of antenna gain in the notched frequency band at 5.6GHz can be seen.



(a) 3GHz



(b) 5GHz



(c) 9GHz

Fig. 3. Measured and simulated E-plane radiation patterns
(++++ : Measured results, —— : Simulated result)

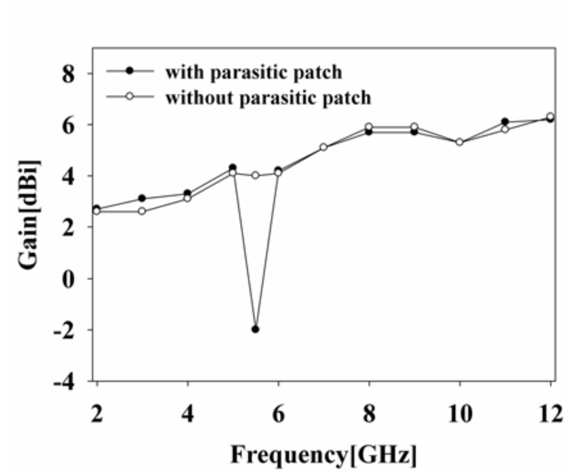


Fig. 4. The measured gains of the proposed antenna with and without the ring-shaped parasitic patch

IV. Conclusions

A band-rejecting UWB planar monopole antenna with the ring-shaped parasitic patch for obtaining the band-rejected characteristic has been implemented. The proposed antenna exhibits a broad bandwidth and a good radiation performance while retaining the small volume of $30 \times 25 \times 1$ mm^3. These characteristics are very attractive for UWB applications.

REFERENCES

[1] Anon., FCC First Report and Order on Ultra-Wideband Technology, Feb. 2002.

[2] Kim, Y. and Kwon, D. H.: 'CPW-fed planar ultra wideband antenna having a frequency band notch function', IEE Electron. Lett., vol. 40, no. 7, pp 403-405, 2004.