A Planar Half-Circle Shaped UWB Notch Antenna Design

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1. INTRODUCTION

An ultra wide band (UWB) communication system is a wireless communication technology developed by U.S. Department of Defense for a military purpose at 1960s. The UWB communication system provides fast transmission speed i.e., 500Mbps to 1Gbps, which is 10 times faster than a transmission speed of wireless local area network (WLAN) standard, IEEE 802.11a (54Mbps). Also, the UWB communication system uses less electric power because the UWB communication systems use 10s GHz of ultra wide frequency band.

An ultra wide band (UWB) antenna is one of major factors of the UWB communication system. The UWB antenna requires a non-directional characteristic for all frequencies in target band, a small phase variation, no distortion of signal for pulse communication, a constant attenuation in a target band, a small size for mobility, and less cost for manufacturing. Also, the UWB communication system uses 3.1 to 10.6 GHz of frequency bands which include a frequency band of WLAN (5.15 to 5.825 GHz). Therefore, the UWB communication system may generate an interference with the WLAN frequency band. Accordingly, the UWB antenna must have a notch characteristic at 5.15 to 5.35 GHz in order to prevent the UWB antenna to transmit/receive signals of WLAN frequency band.

Various UWB antennas having a notch function have been developed for UWB communications [1, 2, 3, 4, 5]. The CPW and microstrip feeds for a half-disk antenna structure are proposed and compared [1]. Kerkhoff and Ling [2] proposed a planar monopole antenna having a band-notched characteristics for UWB applications. Also, a novel UWB circular monopole type notch antenna [3] and CPW-fed planar UWB antenna having a frequency band notch function [4] have been studied for UWB applications. Recently, a novel CPW-fed UWB antenna was designed by using a trapezoidal patch and two step technique for ultra-wideband impedance matching [5].

In this paper, we have proposed a micro-miniature, light weighted and low cost ultra wide antenna having an ultra wide band characteristics and a notch characteristics in 5 GHz WLAN band by using a planar half-circle shape patch, a two step matching stub, a CPW feed type and a hat-shaped slot.

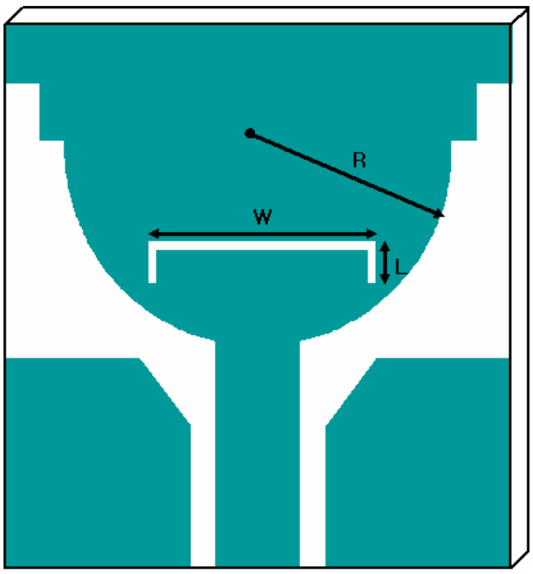

Fig. 1 Geometry of the planar half-circle shaped UWB notch antenna.

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2. ANTENNA DESIGN AND MEASURED RESULTS

Fig. 1 is a diagram illustrating a planar half-circle shape ultra wide band patch antenna. As shown in Fig. 1, the ultra wide band patch antenna includes a planar half-circle shape patch having a hat-shaped slot, a two step matching stub, a ground, a coplanar waveguide (CPW) feeding line and a dielectric substrate. That is, the ultra wide band patch antenna is embodied by forming the planar half-circle shape patch on the dielectric substrate and using the CPW feeding line and the matching stub. The proposed antenna has a half-circle of radius R and the ground having a size of 12.85 x 10.9 mm^2 and the dielectric substrate having a size of 30 x 30 mm^2. Also, the dielectric substrate has a thickness of 0.762 mm and a TMM 4 manufactured by "Rogers" is used as the dielectric substrate, where the TMM 4 has a 4.5 of a dielectric constant and 0.002 of loss tangent. A CPW feeding structure is formed on a front side of the dielectric substrate for providing an ultra wide band characteristic.

The proposed patch antenna has a shape of planar half-circle. The shape helps to flow electric smoother comparing to a shape of rectangle. Accordingly, the planar half-circle shape patch antenna has wide band characteristics wider than a patch having a rectangle shape.

The two step matching stub is used for impedance matching at the unfed end portion. Therefore, by using the matching stub, the ultra wide band characteristic is provided and a narrow band characteristic of a patch antenna is complemented.

Furthermore, the ground is arranged at front of the antenna where the planar half-circle shape patch is formed in order to decrease loss of feeding electric power. Accordingly, a serial/parallel circuit having a passive element and an active element can be implemented without using via holes. Therefore, a surface of the antenna may be effectively used comparing to a conventional antenna.

Meanwhile, the hat-shaped slot is formed on the planar half-circle shape patch for providing the notch characteristic at 5GHz WLAN band (5.15 to 5.825 GHz). A size of the notch slot is the following parameters (W=13.4 mm, L=2.3 mm).

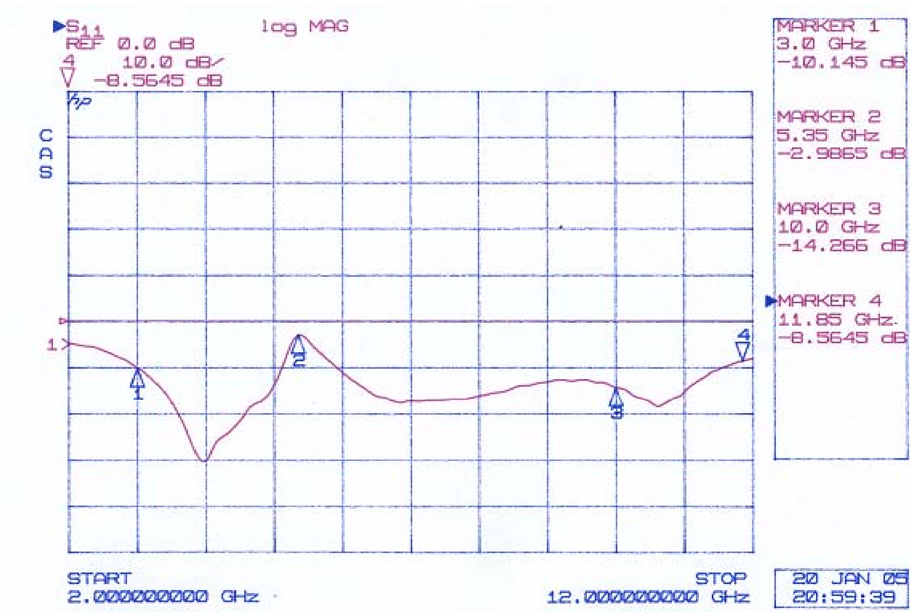

Fig. 2 Measured reflection loss versus frequency for the proposed antenna.

Fig. 2 is a graph showing a reflection loss of a planar half-circle shape ultra wide band patch antenna in Fig. 1. The graph shows the reflection loss measured by a network analyzer. As shown in Fig. 2, the proposed UWB patch antenna has 3.0 to 11.8 GHz of bandwidth at below -10 dB where the VSWR is 2:1. A fractional bandwidth of the planar half-circle shape ultra wide band patch antenna is 119%.

Fig. 3 is a graph showing a gain of the proposed antenna. As shown in Fig. 3, a variation of gain in a target band is 2.6 dBi (2.5 - 5.1 dBi).

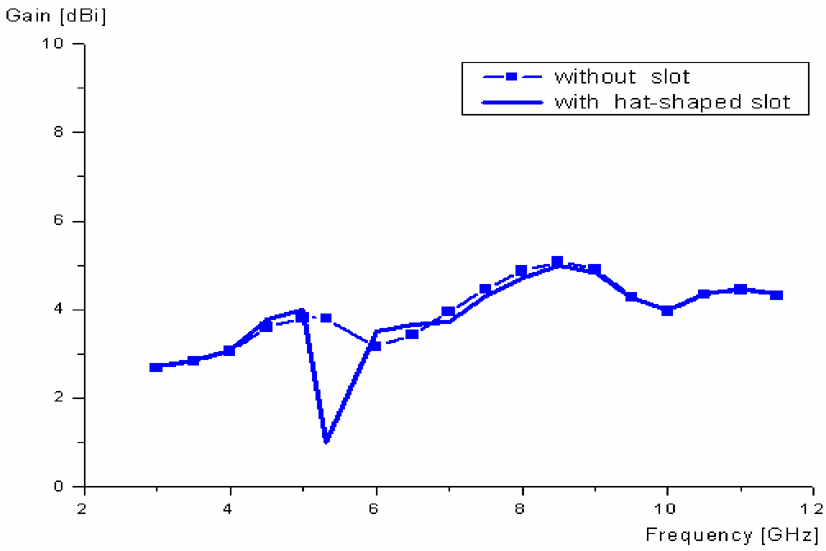

Fig. 3 Simulated antenna gain versus frequency for the proposed notch antenna.

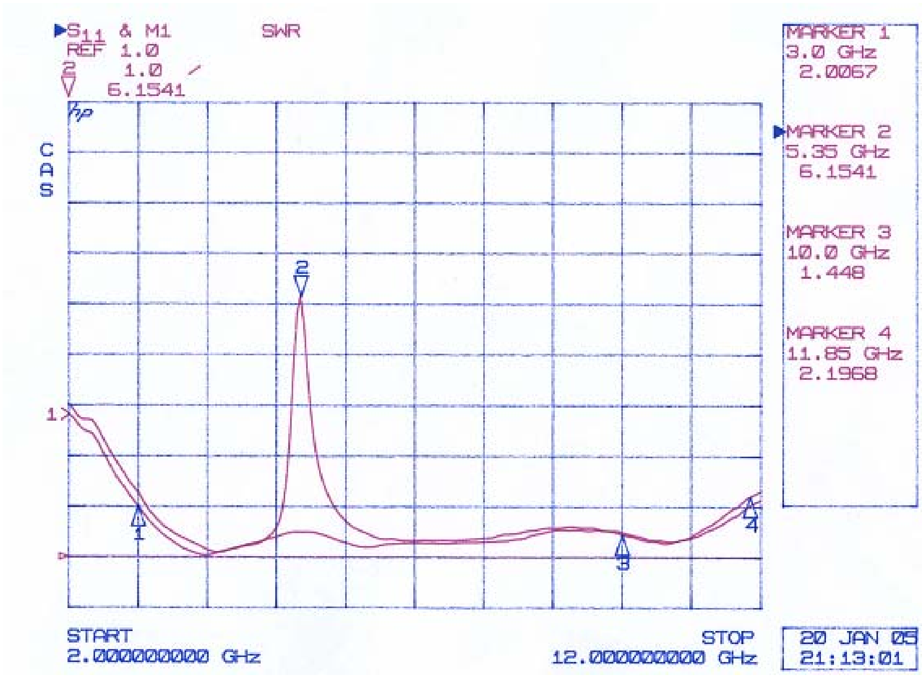

Fig. 4 Measured VSWR comparisons as a function of slot

Fig. 4 is a graph showing a variation of voltage standing wave ratio (VSWR) between the proposed antenna with a hat-shaped slot and without a hat-shaped slot. As shown in Fig. 4, the proposed antenna provides the notch characteristics at 5GHz WLAN band (5.15 to 5.825 GHz) by forming the hat-shaped slot on the planar half-circle shape patch.

Fig. 5 is a graph showing a variation of voltage standing wave ration (VSWR) among three proposed UWB antenna having different size of a hat-shaped slot. As shown in Fig. 5, a location of notch frequency is varied according to the lengths of the hat-shaped slots 3.3 mm, 2.3 mm, 1.3 mm.

That is, the planar half-circle shape ultra wide band patch antenna can provide desired notch characteristics at target band by controlling the length of the hat-shaped slot.

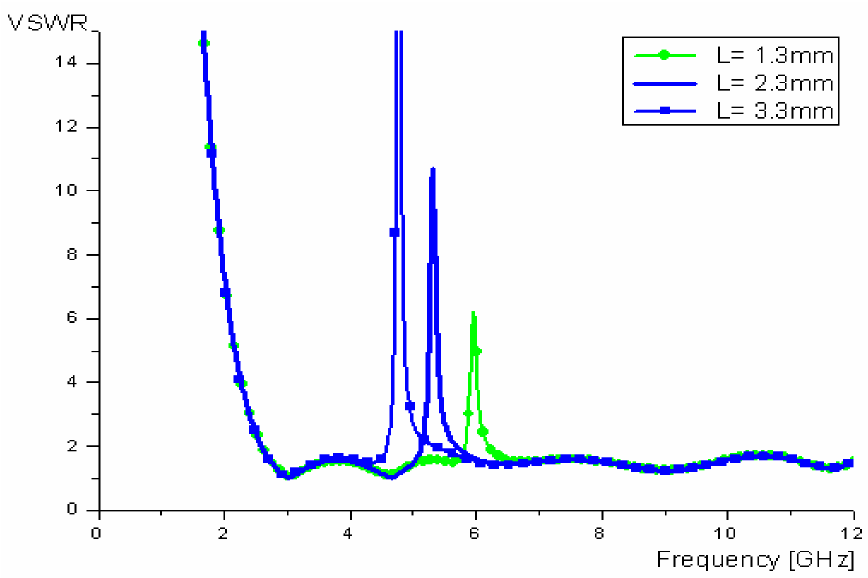

Fig. 5 Notch frequency variations as a function of slot length.

3. CONCLUSION

A planar half-circle shape UWB antenna having a notch function is proposed for UWB applications. To obtain a frequency notched UWB antenna, we have incorporated a hat-shaped slot into the antenna. The notch frequency can be adjusted by changing the slot length and the proposed antennas show a good gain flatness except the 5GHz WLAN band.

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