# Development of 5GHz Circularly Polarized Slot Antenna

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***Abstract* – A novel design of a wideband circularly polarized slot antenna for 5GHz band wireless local network (WLAN) operation. Proposed slot antenna is fabricated on a thin dielectric substrate and attached a floating metal laver on the back of the substrate. Circularly polarized radiation was realized by dividing the one-wavelength slot dipole antenna. In order to realize the wideband operation, slot size and substrate size is optimized. RF signal is injected through the half cut of the coplanar wave guide (CPW) feed line. The antenna size is 21 × 16 × 1.636 mm$^3$. The measured bandwidth ($S_{11}$ < -10dB) of the antenna is 5.0-5.8GHz and axial ratio (*AR* < 3dB) of the antenna is 4.8-6.1GHz.**

***Index Terms* —Circularly polarized antenna, slot antenna, 5GHz WLAN.**

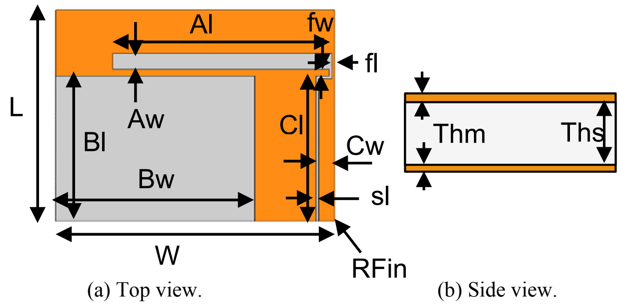
## I. INTRODUCTION

The demand for WLAN is increasing in mobile communication such as portable devices or tablets, and the traffic and data rate of the WLAN also increases because there is a lot of transmitting data such as move or streaming data. WLAN system of 2.4GHz band is widely used, however, there are a lot of interferences because of few separating channels and other license free applications. On the other hand, 5GHz WLAN system has a promising because the hand width is about 1GHz and realizing the high data rate and high speed data transition. In the 5GHz-band mobile application, wideband, circularly polarized and miniaturized antenna should be necessary.

Patch antennas are applied as circularly polarized antennas such ad 5GHz circularly polarized antenna, multi-band antenna of 2.4GHz and 5GHz band [1-3]. However, patch antennas have large bottom ground and thicker dielectric substrate.

In our previous report, one-sided directional slot dipole antenna [4] was developed which is composed of top center taped radiating slot layer, bottom floating metal layer and coplanar waveguide (CPW) feed line [5]. In this antenna, one-sided directional radiation was realized by optimizing the size of the bottom floating metal. Moreover, narrow band one–sided directional circularly polarized antenna for 5.8GHz DSRC application was designed [6]. In this antenna, circularly polarized radiation was realized by dividing in half of the one-wave length slot antenna.

In this paper, we designed the wide band circularly polarized slot antenna by optimizing the slot and bottom metal layer size. Radiation pattern and frequency response of the proposed antenna are measured




(a) Top view. (b) Side view.

Fig. 1. Layout of the proposed Antenna.
*W*=21, *L*=16, *Bw*=15, *Bl*=11, *Cw*=1.2, *Cl*=11, *sl*=0.2, *fw*=0.2, *fl*=0.5, *Aw*=1.2, *Al*=16.5, *Ths*=1.6, and *Thm*=0.018 (unit=mm)

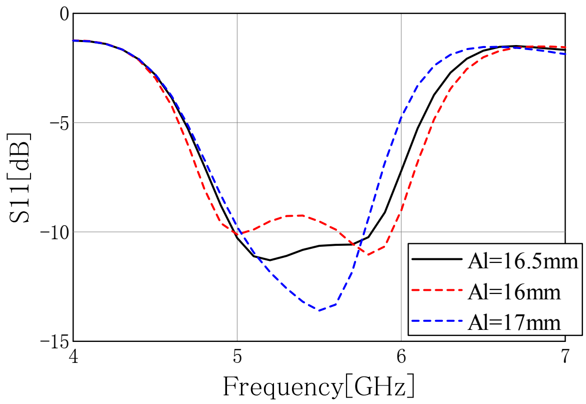



Fig. 2. Simulated $S_{11}$ with different *Al*.

## II. ANTENNA DESIGN

Fig. 1 shows the layout of the proposed circularly polarized slot antenna for 5GHz WLAN. This antenna is composed of FR4 substrate which has $\varepsilon_r$ = 4.4 and tanδ = 0.02, and the top radiating and bottom metal layar are copper. In order to realize the circularly paralyzed radiation *W* is one-half of the one wave length slot antenna. RF signal is injected in the half cut of the CPW feed line. The width of the signal line is *Cw* and gap of the left side of the slot of the CPW is *Sl*. The dimension of the antenna is 21 × 16 × 1.636 mm$^3$. The metal layer on the back side of substrate is not connected to the top metal layer, electrically, namely, floating metal layer. Circularly polarized radiation is realized by the 90 degree phase difference between the slot (*Al*) and feed line (*Cl*) [7].

In order to improve the band width at 5GHz band, *Al* is optimized. Fig. 2 shows the simulated radiation coefficient ($S_{11}$) of the proposed antenna. Two peaks of the $S_{11}$ are obtained in the pass band and operated by changing the *Al*. As a result, it was possible to optimize $S_{11}$ in wideband. As shown in Fig. 2, bandwidth are suitable when *Al*=16.5 mm.

## III. ANTENNA FABRICATION AND MEASUREMENT RESULT

Fig. 3 shows the photograph of the proposed antenna. RF signal is injected through the MMCX connector.

Fig. 4 and Fig. 5 show the simulation and measurement results of the $S_{11}$ and axial ratio (*AR*). *AR* is the ratio of the magnitude of the polarization of vertical and horizontal direction. When *AR* < 3dB, circularly polarized radiation is realized. Bandwidth ($S_{11}$ < -10dB) is 5.0-5.8 GHz in the simulation and measured bandwidth ($S_{11}$ < -7.3dB) is 5.0-6.4GHz which is shifted to higher frequency. However, this antenna has wideband operation. In addition, *AR* is 4.8-6.1 GHz in the simulation and 4.5-6.5 GHz in the measurement. Our proposed circularly polarized antenna can work at 5.0-6.4GHz.

Fig. 6 shows the simulation and measurement results of radiation pattern at 5GHz. Solid lines show the simulation and, broken lines show the measurement. Bleu Lines show the left-hand circularly polarized radiation (LHCP). In Fig. 6, LHCP is larger than that of RHCP (right-hand circularly polarized radiation) at the 0 degree direction.

## IV. CONCLUSION

This paper presents the development of 5GHz circularly polarized planer slot antenna. The size of the proposed antenna is 21 × 16 × 1.636 mm$^3$, and measured bandwidth is 5.0-6.4 GHz. Oure proposed antenna is suitable for 5GHz wideband application.

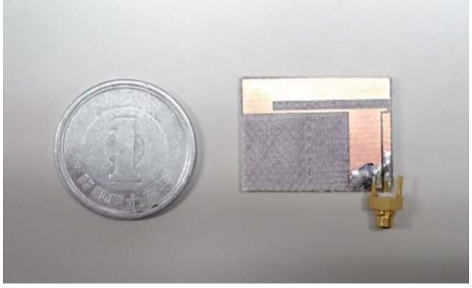


Fig. 3 Photograph of the proposed antenna.

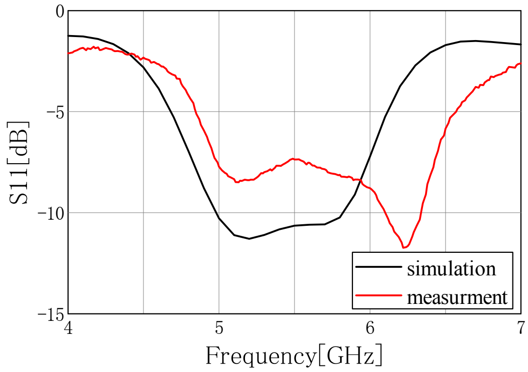



Fig. 4. Frequency responses of the measured and simulated reflection coefficient ($S_{11}$).

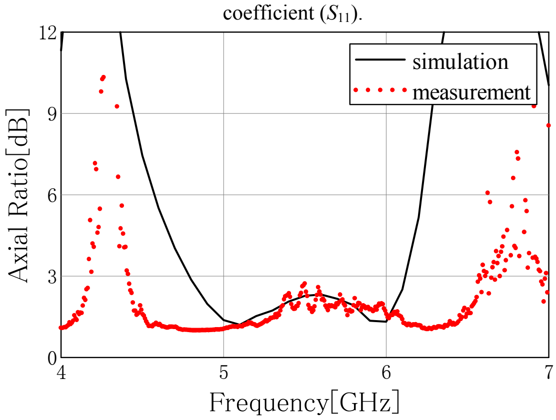



Fig. 5. Measured and simulated *AR*.

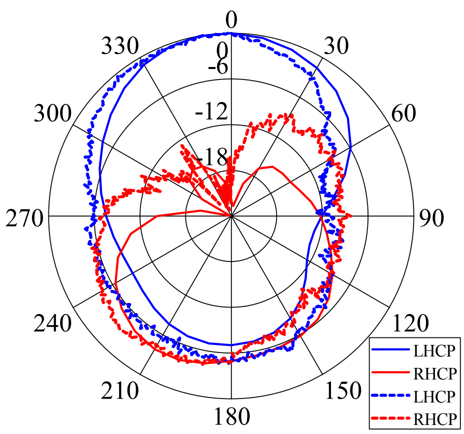



Fig. 6. Measured and simulated radiation of the proposed antenna.

## REFERENCES

[1] Ahmed Khidre, Kai-Fong Lee, Atef Z. Elsherbeni, and Fan Yang, “Wide band Dual-Beam U-Slot Microstrip Antenna,” IEEE TRANSACTIONS ON ANTENNAS AND PROPAGATION, VOL. 61, NO. 3, MARCH 2013.

[2] J.S. Roy and M. Thomas, “DESIGN OF A CIRCULARLY POLARIZED MICROSTRIP ANTENNA FOR WRAN,” Progress In Electromagnetics Research M, Vol. 3, 79-90, 2008.

[3] W. Ren, “CONPACT DUAL-BAND SLOT ANTENNA FOR 2.4/5GHZ WLAN APPLICATIONS,” Progress In Electromagnetics Research B, Vol 8, 319-327, 2008.

[4] H. Kanaya S. Tsukamoto et al, “Energy Harvesting Circuit on a One-side Directional Flexible Antenna”, IEEE Microwave and Wireless Components Letters,23 (3),pp. 164-166, 2013.

[5] H. Kanaya T. Shinto, K. Yoshida, T. Uchida, and Z. Wang, “Miniaturized HTS coplanar waveguide bandpass filters with highlypacked meanderlines”, IEEE Trans. Applied Superconductivity, 11 (1), 481-484, 2001.

[6] T Ijiguchi, D. Kanemoto, K. Yoshitomi, K. Yoshida , A. Ishikawa, S Fukagawa, N. Kodama, A. Tahira, and, H. Kanaya, “Circularly Polarized One-Sided Directional Slot Antenna With Reflector Metal for 5.8-GHz DSRC Operations”, IEEE Antennas and Wireless Propagation Letters, Vol. 13, pp.778-781. 2014.

[7] T. Ijiguchi, H. Kanaya, et. Al, “Development of Circularly Polarized Planar Slot Antenna for 5.8 GHz-DSRC Application”, proc. APMC, pp. 1079-1081, 2013.