# Design of the Dual-Polarized Dipole Antenna for Small Base Station

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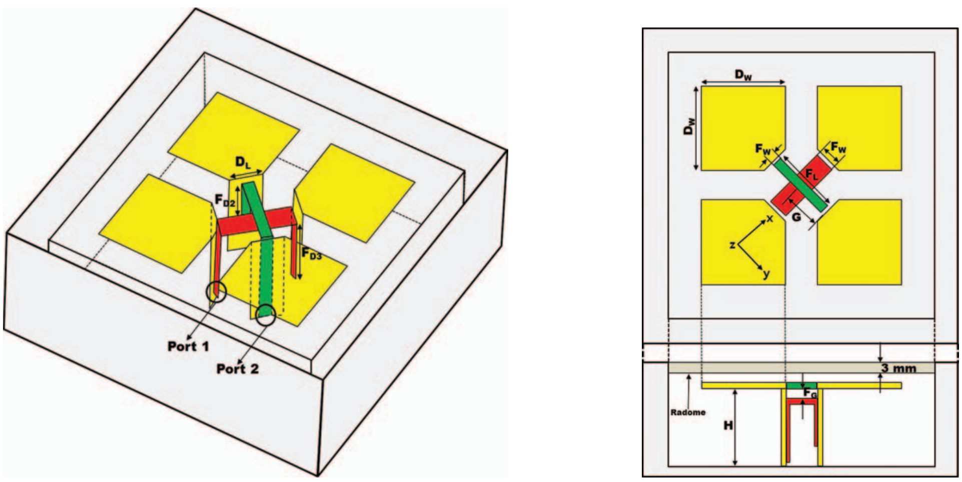
## 1. Introduction

Presently, the wireless communication market is the tendency that the consumer request increases it desires the faster service with the saturation of the radio communication. In the near future, the mobile traffic increases and the new mobile service appearance are predicted. Many radio communications can be used one base station and the size small and technology considering the environment-friendly is needed. The technology generated by this request is the light-radio technology [1]. Each small-sized base station is connected to the optical cable and the speed of the light is implemented and it is called as the light-radio. The core technology for comprising light-radio is the miniaturization of the base station. It has within the RF part and antenna in one small square cube and the base station has to be miniaturized. Particularly, the miniaturization of the antenna is very important. The dual-polarized antenna using the electric and magnetic field is used [2-6]. However, it is very difficult to comprise two antennas inside the cube where there is the restriction of the space not being free space.

In this paper, we have modified the dual-polarized dipole antenna of [7]. The proposed antenna had the size smaller than published paper [7] and applied inside the cube. The proposed antenna induced the coupling characteristic of the radiator and feeding line and expanded the frequency bandwidth. To antenna matching, we changed distance and width of two feed lines. We changed width of the shorting plate and length of the feed line and the operating frequency was moved. In spite of being the small sized antenna mounted inside cube, the proposed antenna obtained the wide bandwidth, the high isolation and antenna gain.

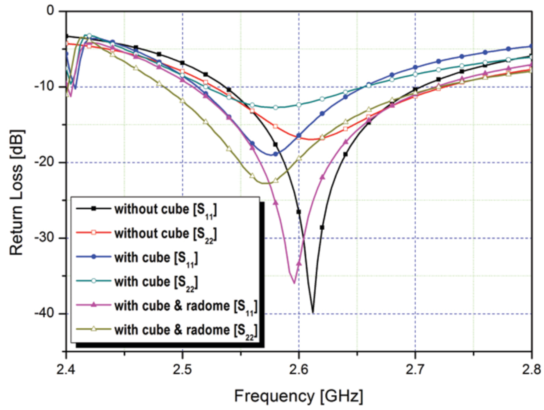
## 2. Antenna Design and Simulated / Measured Results



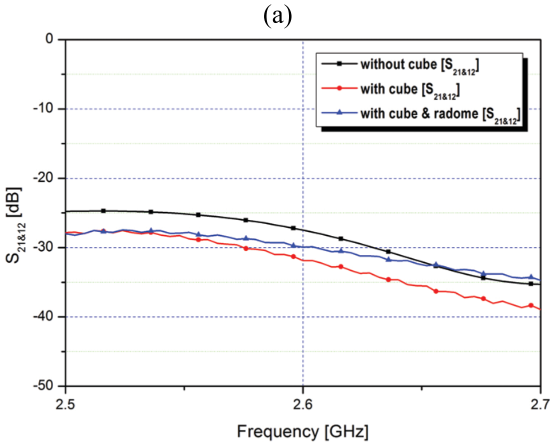

(a) (b)

Figure 1: Geometry of the proposed antenna: (a) 3D view, and (b) top and side view

Figure 1 shows the dual-polarization dipole antenna for compact base station. The size of the cube is 50 mmX50 mmX22 mm and the dipole antennas consisting of the orthogonal each other inside the cube is positioned. The proposed antenna induced the coupling characteristic of the radiator and feeding line and expanded the frequency bandwidth. The port 1 and port 2 are separated as the optional distance and port 1 is positioned in the lower part of the port 2. The optimal parameters can be chosen as $D_W$ = 15 mm, $F_{W(p1)}$ = 4 mm, $F_{W(p2)}$ = 2 mm, $F_L$ = 13 mm, G = 7 mm, H = 14 mm, $F_G$ = 3 mm, $D_L$ = 5 mm, $F_{D2}$ = 7 mm, $F_{D3}$ = 6 mm based on the extensive simulation using HFSS.



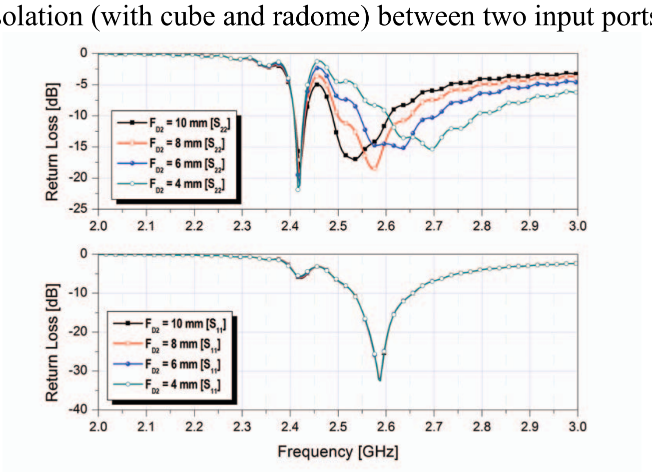

(a)



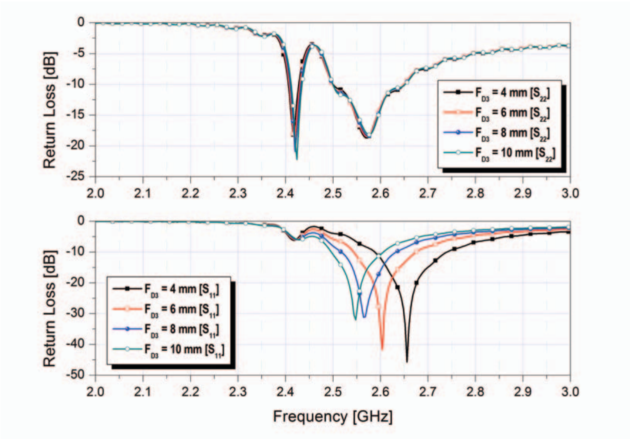

(b)

Figure 2: Simulated results of the proposed antenna: (a) return loss, and (b) isolation

Figure 2 shows the simulated result of the return loss and isolation. It is observed that the simulated frequency bandwidth is 2.5 ~ 2.73 GHz and 2.48 ~ 2.73GHz at port 1 and port 2 (with cube and radome), respectively. The proposed antenna is satisfied B4G (Beyond 4G, 2.5 ~ 2.695 GHz) frequency band. The isolation (with cube and radome) between two input ports is more than 30 dB.



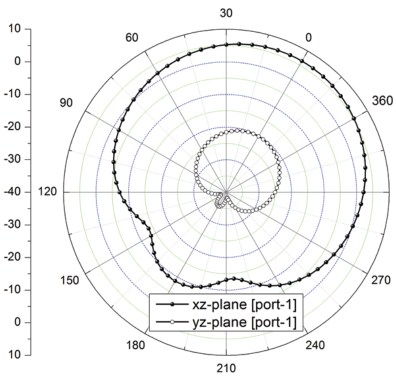

(a)



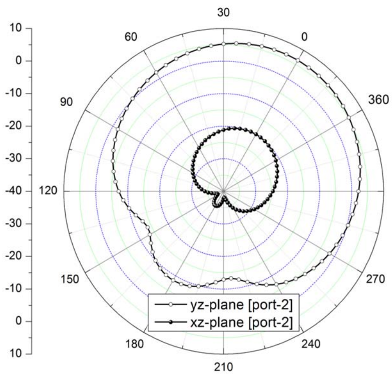

(b)

Figure 3: Effect of the feed line length on the return losses: (a) $F_{D2}$, and (b) $F_{D3}$

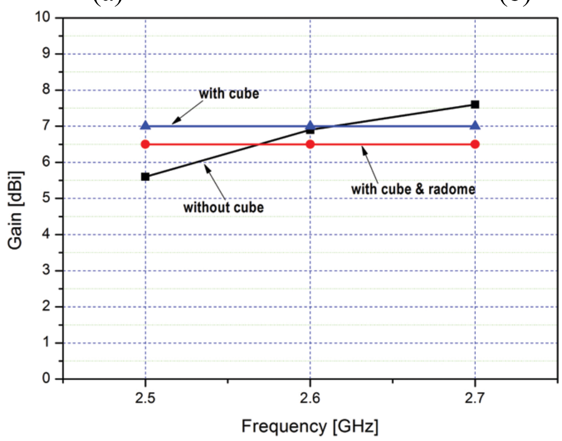
We have studied the effects of the antenna geometry ($F_{D2}$ and $F_{D3}$) on the return losses. The effects of the feed line length on the return losses are shown in Figure 3. Figure 3(a) shows the length of the $F_{D2}$ (port 2). As shown in figure, as the length of the $F_{D2}$ increases, the frequency moves to the lower band and the characteristic of the $F_{D3}$ does not have the changed. Figure 3(b) shows the length of the $F_{D3}$ (port 1). Contrary to the foregoing, as the length of the $F_{D3}$ increases, the frequency moves to the lower frequency band and the characteristic of the $F_{D2}$ is constant.




(a)




(b)




(c)

Figure 4: Simulated radiation patters and gain: (a) port 1 (2.6 GHz), (b) port 2 (2.6 GHz), and (c) antenna gain

The simulated radiation patterns of the proposed antenna at frequency of 2.6 GHz. The simulated 3-dB beam-widths in the port-1 and port-2 at 2.6 GHz are 97° and 98°, respectively. The back-lobe level is less than -10 dB over the operating frequency. It has a maximum cross polarization level of

-20 dB. Figure 4 (c) shows the simulated antenna gain over the operating frequencies. The proposed antenna simulated about 3-cases (without cube, with cube and with cube & radome). As shown in Figure, the average antenna gain is 6.5 dBi.

## 3. Conclusion

The dual-polarized dipole antenna is proposed. The antenna has 2.5 ~ 2.7 GHz frequency band, and the isolation is more than 30 dB over the whole impedance bandwidth. The average gain is 6.5 dBi. The radiation pattern across the operating bandwidth is stable. It has a maximum cross polarization level of -20 dB. It is suitable for B4G (Beyond 4G, 2.5 ~ 2.695 GHz) small base station.

## References


[1] F. Mullany and A. Pascht, "Bell labs and light-radio; Active antenna arrays and CPRI compression," Bell Labs.

[2] J. Granholm and K. Woelders, "Dual polarization stacked microstrip patch antenna array with very low cross polarization," IEEE Transactions on Antennas and Propagation, Vol. 49. No. 10, October 2001.

[3] Y. –X. Guo, K. –M. Luk and K. F. Lee, "Broadband dual polarization patch element for cellular-phone base stations," IEEE Transactions on Antennas and Propagation, Vol. 50. No. 2, February 2002.

[4] K. –M. Mak, H. Wong and K. M. Luk, "A shorted bowtie patch antenna with a cross dipole for dual-polarization," IEEE Antennas and Wireless Propagation Letters, Vol. 6, 2007.

[5] L. Siu, H. Wong and K. M. Luk, "A dual-polarized magneto-electric dipole with dielectric loading," IEEE Transactions on Antennas and Propagation, Vol. 57. No. 3, March 2009.

[6] A. K. Skrivervik, J. –F. Zurcher, O. Staub and J. R. Mosig, "PCS antenna design: The challenge of miniaturization," IEEE Antennas and Propagation Magazine, Vol. 43, No. 4, August 2001.

[7] B. Q. Wu and K. M. Luk, "A broadband dual-polarized magneto-electric dipole antenna with simple feeds," IEEE Antennas and Wireless Propagation Letters, Vol. 8, 2009.