

# Dual Polarized Antenna Using a Part of Spherical Reflector with a Rim

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**Abstract** – Deploying small cell base stations in the advanced Centralized Radio Access Network architecture is important to increase the radio capacity and user throughput. Antennas used at such small cells need to be downsized and optimized to have equal radiation pattern for each MIMO branch. In this viewpoint, we propose a dual polarized dipole antenna that uses a part of spherical reflector with a rim for small cell deployments. We can minimize the difference in the HPBW between the V and H polarizations by selecting optimal antenna parameters. Based on calculations and measurements, we show that the radiation pattern of the proposed antenna is close to theoretical values and an ideal pattern.

**Index Terms** — Spherical reflector, A dual polarization dipole antenna, A rim, Small cell

## 1. Introduction

In recent years, accessing the Internet has become much easier through the use of smartphones that enable anytime and anywhere access for many people. This increased accessibility has caused a substantial increase in the amount of mobile network traffic. The Advanced Centralized Radio Access Network (C-RAN) architecture [1] - [3] was previously proposed to achieve higher speeds and higher capacity for mobile communications. In the Advanced C-RAN architecture, small cells have been introduced within the coverage area of a macrocell [4].

There are many reports pertaining to small base station antennas for use in small cells [5], [6]. Small base station antennas need to be downsized because they are often affixed to building walls, telephone boxes, and the ceilings of underground walkways.

Dual-polarized antennas are used to reduce the installation footprint and achieve the MIMO effect at base stations. Therefore, it is very important to actualize compact and dual-polarized antennas for these small cells. For small dual-polarized antennas, however, it is often hard to keep the same half power beam width (HPBW) for the vertical (V) and horizontal (H) polarizations. It is also very important, therefore, to provide antennas whose radiation patterns are adjustable by changing the antenna parameters. To this end, this paper investigates a dual polarized antenna that employs a part of spherical reflector with a rim.

## 2. Proposed Antenna

Fig. 1 shows the proposed antenna. This antenna comprises a dual polarized dipole antenna (a cross dipole

antenna) at its center, and a part of spherical reflector. The reflector has angle  $\theta$ , radius  $R$ , and a reflector rim with height  $h_r$ . In calculations of numerical examples, the parameters for this antenna are set as follows: the length of half wavelength dipole antenna  $l_d$  is  $0.42\lambda$ ; the distance from the reflector peak to feed point  $h_d$  is  $0.21\lambda$ ; and  $h_r$  is set to (a)  $0.06\lambda$  or (b)  $0.12\lambda$ .

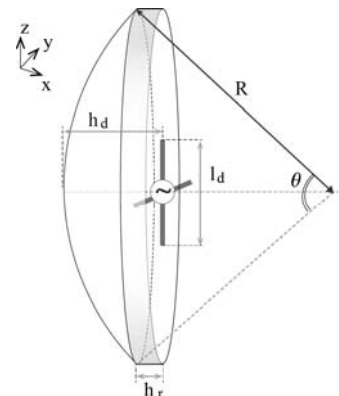


Fig. 1. Structure of proposed antenna ( $l_d = 0.42\lambda$ ,  $h_d = 0.21\lambda$ ).

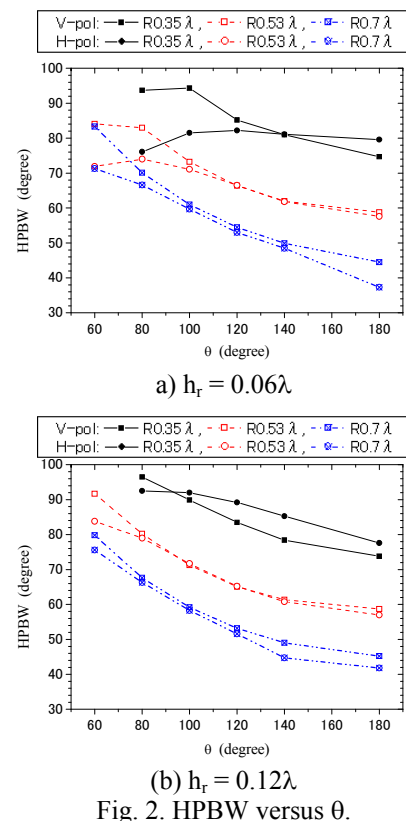


Fig. 2. HPBW versus  $\theta$ .

Fig. 2 shows the HPBW calculated using the moment method (MM) with respect to R. Fig. 2 shows that we can reduce the difference between the V and H polarizations by selecting R and  $\theta$ .

If the height of  $h_r$  is greater than  $0.06\lambda$  and then the difference in HPBW between the V and H polarizations is needs to be less than 10 degrees, the HPBW is adjustable within the range of 50 to 90 degrees by selecting appropriate R and  $\theta$  values.

### 3. Detailed Calculation and Prototype Experiments

The basic behavior of the proposed antenna with respect to the design parameters is confirmed by numerical calculations using the MM in Section 2. This section describes the calculation results using MW-Studio and the measurement results using a prototype.

The antenna parameters are set as follows: R is  $0.58\lambda$ ;  $h_r$  is  $0.12\lambda$ ; and  $\theta$  of the spherical reflector is 120 degrees.

#### (1) Beamwidth Characteristics

Fig. 3 shows the HPBW characteristics obtained through the MM calculations, the MW-Studio calculations, and measurements. This figure indicates that the HPBW calculation results are very close to the HPBW measurement results.

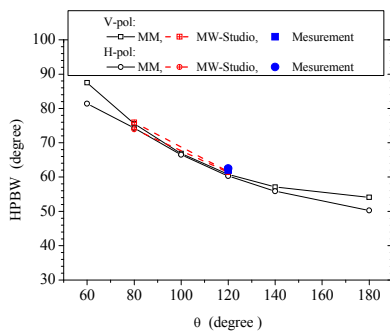


Fig. 3. HPBW versus  $\theta$  ( $h_r = 0.12\lambda$ ).

#### (2) Voltage Standing-Wave Ratio (VSWR)

Fig. 4 shows the VSWR characteristics obtained using MW-Studio and measurements. Although there is a very slight difference in the resonant frequency, the measurement results denote the same tendency as the calculation results.

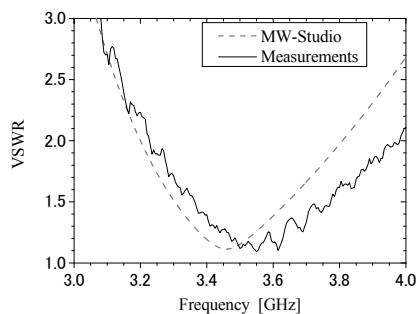


Fig. 4. VSWR.

#### (3) Radiation Pattern and Gain

Fig. 5 shows the radiation patterns. The figure indicates that the measurement and calculation results are almost

identical, although there are very slight differences in the back-lobe.

Table I gives the values for the HPBW and gain. The table indicates that the simulation and measurement results for the proposed antenna agree very well.

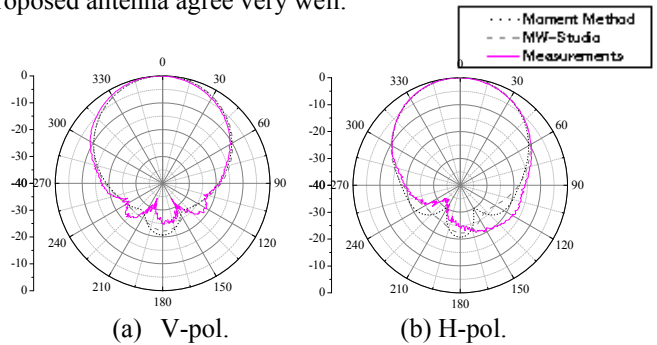


Fig. 5. Radiation characteristics in horizontal plane.

TABLE I  
Calculation and Measurement Comparison

	HPBW		Gain
	V-pol.	H-pol.	
MM	60.8°	60.3°	9.9 dBi
MW-Studio	61.6°	61.4°	9.6 dBi
Meas. results	62.0°	62.5°	9.4 dBi

### 4. Conclusion

This paper investigated a dual polarized dipole antenna using a part of a spherical reflector with a rim for use in small cell deployments. We showed that the difference in the HPBW between the V and H polarizations can be minimized by selecting the optimal antenna parameters. The range of the adjustable HPBW is 50 to 90 degrees if the 10-degree HPBW difference between the V and H polarizations is acceptable. Since the radiation patterns for the calculation and measurement results are very similar, detailed design of the proposed antenna can be carried out by calculation or simulation.

### References

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