Wide Scan Angle Massive MIMO Antenna for 5G communication

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***Abstract*—28 GHz is very strong candidate frequency for 5G communication. Tightly coupled dipole array (TCDA) has a characteristic of broadband and wide scanning. This paper introduces a simple prototype antenna operating at 28 GHz using tightly coupled dipole array. It can be used for base station antenna. The array is implemented by using bowtie antenna which has wide bandwidth. Simulation of this array demonstrates VSWR < 3 for a 8.6 % while scanning up to 55°.**

Keywords—5G, Tightly coupled dipole array, bowtie antenna, broadband, scanning angle;

I. INTRODUCTION

The interest in the 5G communication is arising. Much higher data rate in 5G is required than 4G. For higher data rate, the number of antenna should be. The another main difference between 4G and 5G is frequency range. It should be higher than 6 GHz and 28 GHz is influential. In high frequency, path loss problem arises and it can be seen below [1].

$$PL(d_0) = 20 \cdot \log_{10}\left(\frac{4\pi d_0}{\lambda}\right)$$

PL : Free-space path loss (dB),

d_0 : Distance from the transmitter (meters),

λ : Signal wavelength (meters).

In order to overcome this loss, 5G antenna should have high gain. But, high gain antenna means the beamwidth of an antenna is narrow and it cannot operate in various directions. Thus, the narrow beamwidth of the antenna should be steerable for a wide angle.

These requirements can be solved by using Tightly Coupled Dipole Array (TCDA) antenna. TCDA fundamentally has broadband [2]. Briefly, following describes it. A ground plane behind the array has inductive reactance in the circuit viewpoint. And the array has coupling capacitance between elements. Thus, in the input impedance viewpoint, these reactances compensate each other so the array has broadband. Also, TCDA has wide scanning angle. According to recent studies, TCDA has about 45° scanning angle in broadband [3], [4], [5].

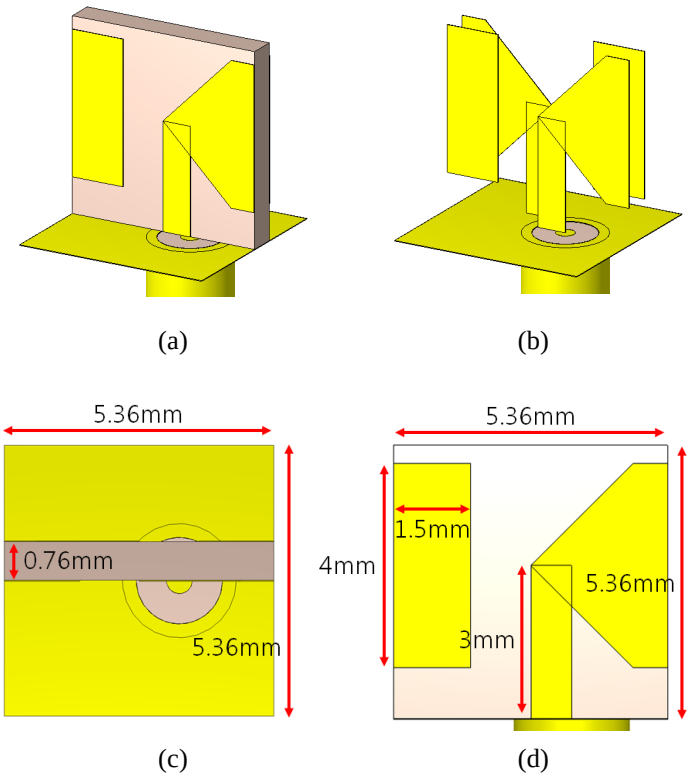

Fig. 1. Unit cell of the TCDA prototype. (a) 3D view of TCDA and (b) 3D view dielectric is hidden for convenience. (c) upper view of TCDA. (d) side view of TCDA.

II. Design and Simulation Result

The simple design of an unit cell of the infinite array is presented in Fig. 1. Prototype array is designed by using bowtie antenna which has broadband. Although a ground plane of an unit cell is connected to another ground plane of unit cell, there is a gap between bowtie antenna elements of each unit cell. It is intended to increase the capacitance of array as mentioned above. Dielectric is implemented by Rogers RO3006 (ε_r = 6.15). Feed line is designed on PCB and coaxial cable (RG-405) is used. The design is processed with CST STUDIO SUITE 2016.

VSWR of an ∞ by ∞ TCDA at broadside and 55° scanning angle is viewed on Fig. 2. The scanning is conducted in the E-plane. 8 elements are designed in x-direction and periodic boundary is used in y-direction refer to Fig. 3.

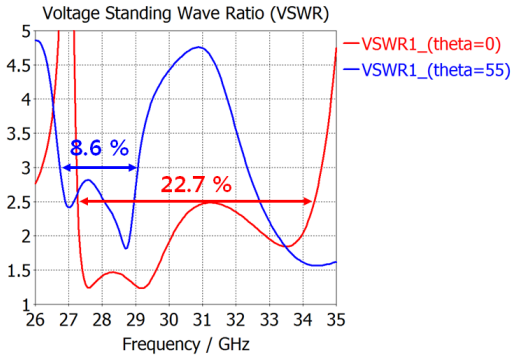

Fig. 2. VSWR of an ∞ by ∞ TCDA. The red line is VSWR at broadside and the blue line is VSWR at 55° scanning angle in E-plane.

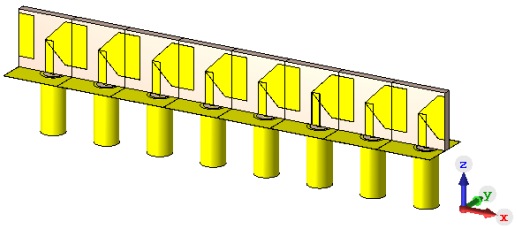

Fig. 3. 3D view of 1 by 8 TCDA. Periodic boundary is used in y-direction.

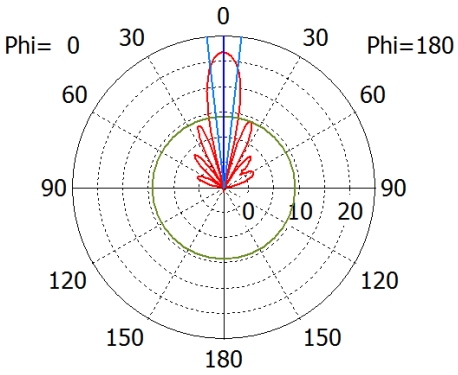

Fig. 4. Realized gain of broadside at 28 GHz of Fig. 3. In y-direction, periodic boundary is used that 8 elements are assumed. Side lobe level is -12.6 dB.

In y-direction, 8 elements are assumed. Thus, 8 by 8 array is simulated. Realized gain at 28 GHz is viewed on Fig. 4. Side lobe level is -12.6 dB. Realized gain of 55° scanning angle can be seen in Fig. 5 also.

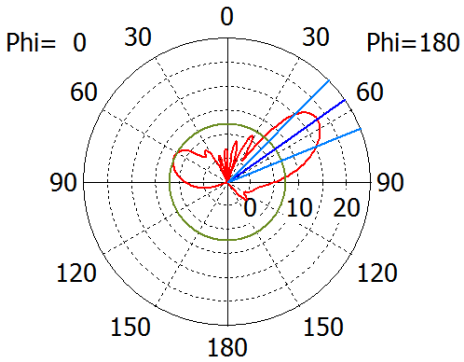

Fig. 5. Realized gain of 55° scanning angle in E-plane at 28 GHz of Fig. 3 In y-direction, periodic boundary is used that 8 elements are assumed. Side lobe level is -10.7 dB.

III. Conclusion

The suitability of TCDA for Massive MIMO antenna for 5G base station has been shown. 5G base station antennas should have beam forming capability for wide scanning angle and TCDA can fulfill this requirement. A prototype array is designed and it has wide scanning angle up to 55° in E-plane. And balun is not required for this array so the design of the array is simple. For wide scanning in two principal planes, the dual polarization should be implemented [5].

Acknowledgment

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