Broadband Waveguide Antenna using L-shaped Probe for Wide-Angle Circular Polarization Radiation

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1. Introduction

Recently, some circularly polarized (CP) antennas using L-shaped probes have been reported [1]-[2]. The L-shaped probe is bent at a bending point having a distance of λ/4 from the feeding point to make the 90-degree phase difference between the two orthogonal modes. However, its asymmetrical structure easily generates XPOL. In order to reduce the XPOL to widen the angle for radiating CP, some techniques are discussed for a circular waveguide antenna using an L-shaped probe in this paper.

2. Structure

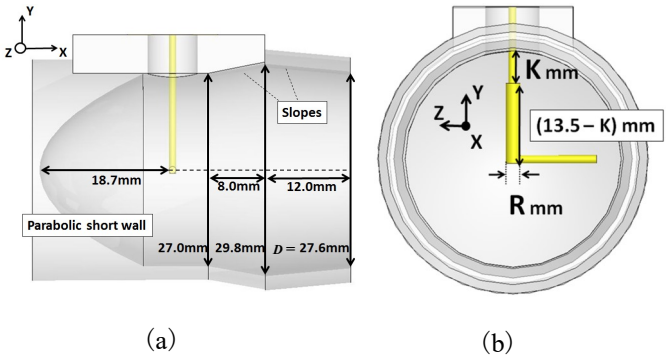
Fig. 1 shows the an antenna structure with a parabolic wall in the short wall [1]. As a initial values, K= 0 and the diameter R = 0.8 mm are assumed. Furthermore, a step structure is installed in the aperture to reduce higher order modes [2]. The proposed CP waveguide antenna consists of three techniques to reduce XPOL over a wide angle in the radiation pattern. At first, a parabolic short wall with x = 0.8 (y^2+z^2) is installed based on the technique reported in [1]. This brings better reflected wave, because the variation in distance between the L-shaped probe and short wall is with respect to angle. As a second, the entire length L along x is optimized to be chosen at 43.7mm considering the AR behavior with respect to L . With a decrease in L from 57.7 mm to 43.7 mm, AR in higher frequency band around 9.40 GHz is gradually improved. As the third technique, we have made the diameter of aperture D smaller to be 27.6 mm than the diameter inside. As a result, the AR has been lower as shown in Fig. 2 and XPOL is reduced as shown in Fig.3.

As seen in the obtained results, this structure offers CP with 3dB AR covering a wideband from 7.35 GHz to 9.75 GHz. However, this frequency range is narrower than that in [2] covering from 7.1 GHz to 10.1 GHz. Therefore, we have tried widening the 3dB AR bandwidth by modifying the probe structure.

Now the AR characteristics with K = 7.5 mm and R = 1.8 mm (proposed 2) is compared with the characteristics with K= 0 and R = 0.8 mm (proposed 1). As seen in the Fig. 4, the 3-dB AR bandwidth was expanded to be from 7.0 to 10.4 GHz. We can see the effect of probe modification for expanding the 3-dB axial ratio bandwidth.

3. Conclusion

The proposed structure has only one feeding point, and it can achieve CP in a wideband frequency range with a wide azimuth angle with low XPOL. Now adopting some techniques, CP radiation is available in the UWB high-band (7.25-10.25 GHz in Japan).



(a) (b)

Fig. 1 Proposed antenna structure

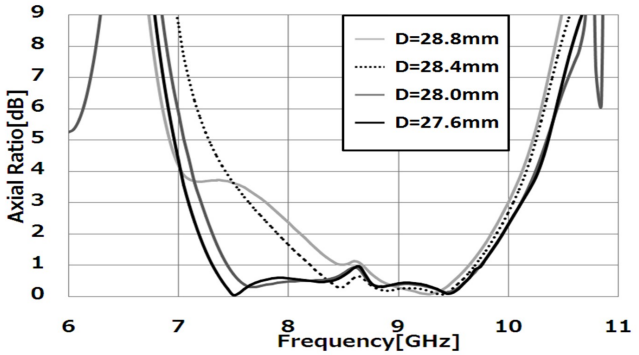


Fig. 2 Variation in AR characteristics in the bore-sight direction as a function of D.

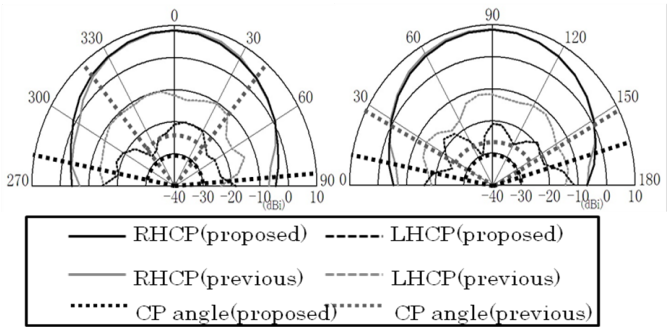


Fig. 3 Radiation patterns at 8 GHz. The XPOL of the proposed structure has been reduced compared to that of previous structure [2].

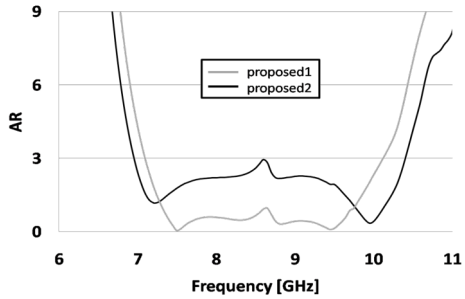


Fig. 4 Radiation patterns at 8 GHz. The XPOL of the proposed structure has been reduced compared to that of previous structure [2].

Reference

[1] S. Yamaura and T. Fukusako, "Reduction of Cross Polarization in Higher Frequency for Circularly Polarized Broadband Antenna With L-Shaped Probe and Parabolic Short Wall ", IEICE Communication Express, vol 2, 5, pp.180-185, May 2013.

[2] T. Fukusako, N. Noguchi and S. Yamaura, "Bandwidth enhancement of circular polarization generated from circular waveguide and L-shaped probe" 2013 IEEE International Workshop on Electromagnetic (iWEM2013), pp.5-8, Hong Kong, China, Aug 2013.