Circularly Polarized Broadband Patch Antenna Using Artificial Ground Structure and Meandered Probe for Low Cross-Polarization

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Abstract—Artificial ground structure can convert linear polarization to circular polarization working as a artificial magnetic conductor. the proposed structure achieves a 10-dB S_{11} bandwidth of around 50% and a 3-dB AR bandwidth of 20%, respectively. The average gain of 7.8 dBic is achieved covering the AR bandwidth. Furthermore, off-boresight XPOL decreases by around 10 dB compared to the previous structure with the extended coaxial structure in ± 30°directions.

I. INTRODUCTION

Broadband CP antenna using an artificial ground structure (AGS) have been studied actively[1]-[3]. with rectangular unit cells has been proposed in [2]. This antenna has advantages such as broadband impedance and 3-dB AR characteristics even though the structure is low-profile. When the reflection phases of the AGS are +90◦ and -90◦ for *x*- and *y*-polarizations respectively, the antenna can radiate CP wave converted from linear polarization (LP) at 45◦ in the off-band of 3-dB AR band. This is because the combination of the directly radiated wave from the patch antenna and the reflected wave from the AGS can make the 90◦-phase difference between two orthogonal modes [2]-[4]. Furthermore, the broadband CP antenna needs to have a feeding structure for impedance matching in order to keep a suitable impedance between the two parallel resonances separated with a large ratio of resonant frequencies [2]. In previous reports [2] [3], a coaxial structure with an extended outer conductor was used for the matching commming in the substrate from the ground plane to feed the antenna. However, off-boresight cross-polarization (XPOL) level is still high because the current on the extended outer conductor deteriorates the AR [3].
On the other hand, a meandering probe-fed wideband patch antenna has been proposed in [5][6]. In this paper, a meandering probe (M-probe) is installed in the CP antenna with the AGS, and the effect of the structure with both the AGS and the meandering probe is discussed.

II. STRUCTURE

Fig. 1 shows the geometry of proposed antenna structure. The antenna consists of a radiating patch, an AGS, an M-probe, three dielectric substrates (Rogers RT/Duroid 5880) with a permittivity of "r = 2.2 and a dielectric loss of tan = 0.001. As a result, there are four levels of metallic element such as the ground plane, the lowest part of the meandering line, the AG patches, and the radiating patch.
The radiating patch element with a dimension of 14.5 mm x 14.5 mm is truncated at the diagonal corners with a size of 5 mm. The radiating element is printed on the top of the substrate. The AGS consists of 6 x 4 unit cells with an overall dimension of 40 mm x 39 mm. Furthermore, the width and the length of the unit cell are 6.5 mm and 10 mm, respectively. The unit cell has a rectangular metal patch which has a width of 4.2 mm and a length of 9.25 mm. However, two AG patches around the feeding probe are removed as shown in Fig. 1 in order not to make the current focus on the two patches.

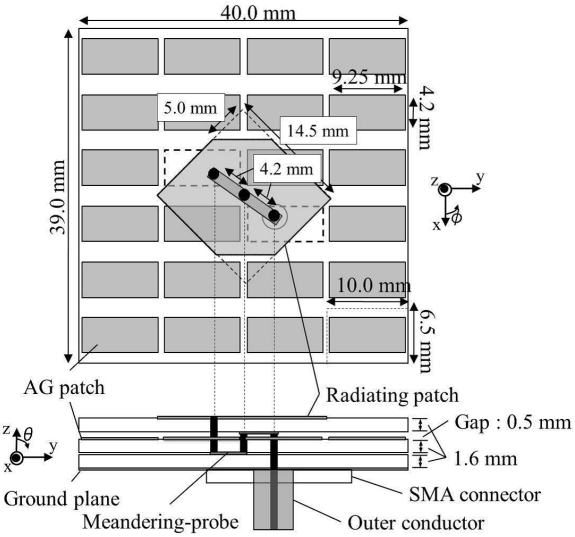

Fig. 1 Top and side views of the proposed antenna.

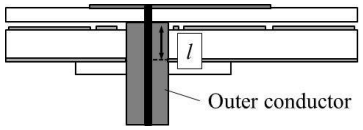

Fig. 2 Structure of the reference antenna [2][3].

III RADIATION PATTERNS

Fig.3 shows the radiation patterns of the three structures at two different frequencies of 5.7 GHz and 6.5 GHz in the *xz*- and *yz*-planes. As seen in the radiation patterns, XPOL in off-boresight directions of the

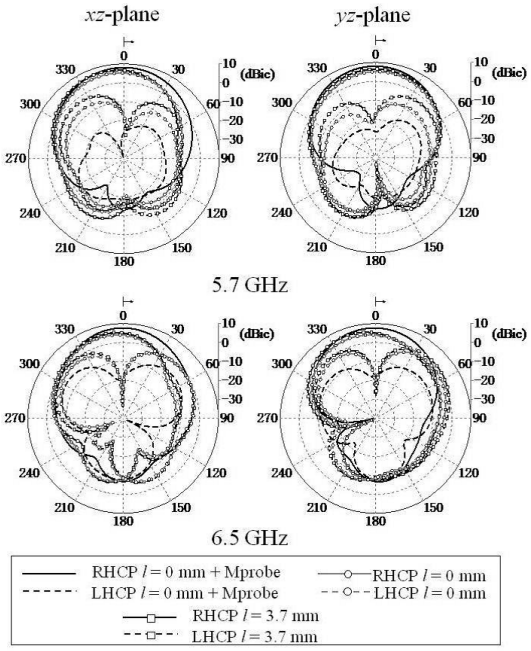

Fig. 3 Radiation patterns compared to the reference antennas.

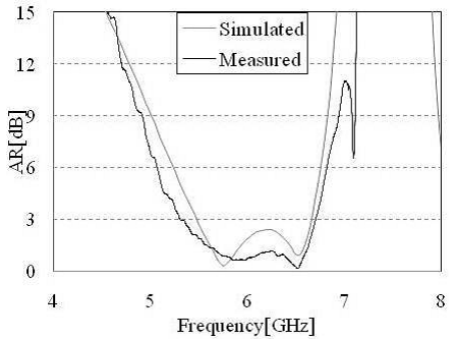

Fig. 4 Simulated and measured AR characteristics.

proposed structure decreases by 15 dB at 5.7 GHz in both planes compared to the structure with l = 3.7 mm. On the other hand, XPOL decreases by 10 dB in the higher frequency at 6.5 GHz. As a result, we can see that the M-probe is effective to reduce XPOL in the operating frequency.

The measured AR characteristics is shown in Fig. 4. As seen in this figure, the 3-dB AR bandwidth is 23.3% (5.31-6.71 GHz). There is a small difference of 3.7% compared to the simulated AR bandwidth. This may be due to a small air gap between the AGS patches and the upper substrate.

IV. Conclusions

This paper has presented a low XPOL broadband CP patch antenna with an AGS and a meandering probe. In the AGS, two patches are removed around the feeding probe. The antenna with such structures can obtain broad -10-dB S_{11} characteristics of 49.6/45.7% (simulated/measured), AR characteristics of 19.6/23.3% and almost constant gain characteristics at around 7.8/6.8 dBic. As a result, XPOL in off-boresight direction can be reduced by around 10 dB compared to that of previous structure [2][3]. The measured results finally show reasonable agreements with the simulated results.

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