

Microstrip antenna integrating TM₁₁/TM₂₁ mode elements designed in Ka-band

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Satellite communication is attracting attention as an important communication infrastructure for NTN (Non-terrestrial network) in next-generation communication systems. The Ka band is becoming more widely used as a frequency band for satellite communication systems to increase communication speed.

There was a demand for planar antennas because conventional reflector-based beam steering antennas are large and not suitable for installation on aircraft or vehicles. Microstrip antennas are widely used as planar antennas and TM₁₁ mode microstrip antennas (MSAs) are commonly used. Since TM₁₁ mode MSA has a unidirectional pattern in the normal direction of the MSA, there was a problem where the gain would decrease if the communication satellite was positioned in a direction close to parallel to the surface of the MSA. As a structure that improves the gain reduction in that direction without increasing the size of the antenna, an antenna that integrates a TM₁₁ mode antenna with a beam in the zenith direction and a TM₂₁ mode antenna with a conical beam in the low elevation direction has been proposed [1][2]. However, the operating frequencies of both antennas were in the 1.2 GHz or 2.5 GHz bands.

This paper reports the design results of a circularly polarized antenna element that integrates a TM₂₁-mode ring MSA and a TM₁₁-mode circular MSA operating in the Ka-band uplink frequency range (29.22-30.00 GHz) using an electromagnetic field simulator based on the moment method. As in [2], each antenna is fed at four points in order to improve the symmetry of the pattern in the azimuth plane. In addition, the TM₂₁ mode ring MSA is placed at a higher layer than the TM₁₁ mode MSA to improve the bandwidth of the TM₂₁ mode antenna. Furthermore, the feeding circuits for both the antennas are separated by the ground plane and metal walls are arranged between feed pins of both antennas. These contribute to reduce the distortion in the radiation patterns of the both antennas. The final structure and calculated 3D radiation patterns are shown in Figure 1. It can be seen that the symmetry of the radiation pattern has been significantly improved by the metal wall. This antenna has achieved the operating bandwidths of 3.41 % for the TM₁₁ mode circular MSA and 7.86 % for TM₂₁ mode ring MSA.

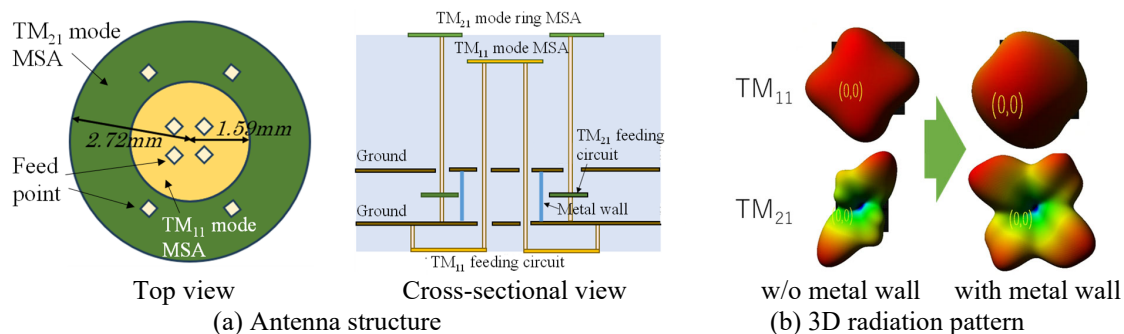


Figure 1. Structure and radiation pattern of TM₁₁/TM₂₁ mode integrated antenna.

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- [2] Wei Lin, Hang Wong, and Richard W. Ziolkowski, "Circularly polarized antenna with reconfigurable broadside and conical beams facilitated by a mode switchable feed network," *IEEE Trans. Antennas and propag.*, vol.66, no.2, pp.996-1001, 2018.