Recent Developments of Millimeter-Wave Antennas and Arrays for Compact CubeSat Systems

(Invited)

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Abstract

CubeSats are an emerging solution for non-terrestrial networks for the small sizes and low weight, attracting intensive interests recently. Low Earth Orbit (LEO) satellites and communication networks are popular with strong interests in today's market, leading to extensive demand of high-performance antenna systems.

Conventional uplink and downlink antennas are separately allocated in the same surface of a CubeSat. Due to the limited physical dimension, the gain of both links is suffering and leading to increased requirements to RF systems. Usually, an approach of shared aperture arrays could solve this problem by using the whole CubeSat surface for both links with doubled gain. However, the Ku downlink and uplink bands are so close that a wide band array is more preferrable. Thus, we studied a planar array with a wide bandwidth covering both links, high efficiency and gain. An S-shape dipole antenna excited by an aperture from a SIW cavity is investigated [3] to achieve circular polarization and wide band. It works well for each up- or down-link but not sufficiently regarding the bandwidth and total antenna efficiency. An innovative approach is proposed by loading grounded vias [4]. These two vias not only moderate the dipole impedance in a very wide band, but also concentrate the coupled electromagnetic fields to reduce the coupling between elements. A unit cell is modelled with periodic boundaries in CST and demonstrates that the impedance bandwidth has been broadened from 1.5 to 3.8 GHz (10.7-14.5 GHz). The total antenna efficiency has been significantly improved as well, e.g., from 50% to 95% at 14.5 GHz so as to a 3-dB gain enhancement, which has great potential for future non-terrestrial networks.

Reflectarrays are another emerging technology for the CubeSats with great potential. Up to now, most of the feedings for the reflectarrays are horns, which has limited flexibility on the field illumination, such as the magnitude and phase electric fields. Hence, we proposed a novel reflectarray fed by a conformal leaky-wave antenna [5] and 2D arrays [6]. With such leaky-wave feeding, the electric-fields illuminated onto the reflectaaray can be manipulated to achieve multiple goals, such as high aperture efficiency, high gain and low side-lobe levels. Moreover, bandpass filtering effect is also able to be enabled into the leaky-wave feedings [7].

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