Microstrip Antennas for CubeSats

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Typically, bulky and obtrusive antennas (e.g., whip antennas) are used on CubeSats. In this research, low-profile integrated antennas are explored, based on microstrip technology. These antennas will not require mechanical deployment and thus allow CubeSats to avoid potential mechanical problems and therefore improve mission reliability.

CubeSats are typically covered with solar panels, and it is important not to block them. A normal microstrip antenna placed on the top of solar panels will block the light. In this research, two strategies are used to overcome this problem: (1) transparent microstrip antennas, and (2) sub-solar microstrip antennas. Two ISM bands are used: 2.4 GHz to 2.5 GHz, and 433.05 MHz to 434.79 MHz.

In the first approach, the antennas are designed to be transparent (with transparency typically greater than 80%), so that the antennas can be placed on top of the solar panels. A quartz substrate is used with a thickness of 2.25 mm, a relative permittivity of 3.9, and a loss tangent of 0.0009. The patch and ground plane are fabricated from a meshed metal surface formed by silver epoxy, to make them transparent as well. This strategy has proven beneficial at the higher 2.45 GHz band, where the antennas are smaller and occupy less space above the solar panels. Circularly-polarized designs having more than 4% bandwidth are achieved by using a dual resonance. The circular polarization will allow for improved communications regardless of the orientation of the CubeSat or the receive antenna at the Earth station.

The sub-solar approach has proven beneficial at both frequency bands. In this case, the antennas are not transparent and are placed below the solar panels. The antenna size is tailored to cover the entire face of a CubeSat. Solar panels can then be placed on top of the antenna, just as they would normally be placed on the CubeSat frame. The antenna, in essence, actually becomes part of the CubeSat frame. The microstrip antenna radiates from its edges, which run along the CubeSat edges, which are not blocked by the solar panels. Therefore, the antennas can still radiate well even though they are below the solar panels. Because the top of the microstrip antenna is metal, the solar panels do not disturb the antenna. Circularly-polarized designs using this approach are obtained for the 2.45 GHz band, and linearly-polarized designs are obtained for the 434 MHz band.