Integrated Communications Antenna and Solar Arrays for Interplanetary CubeSats

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Interplanetary exploration requires a viable communication and tracking system that enables commanding, send telemetry and sending back meaningful science data to Earth. Small-satellites and CubeSats aim to cut down on the cost and complexity of interplanetary exploration. However, mass, volume and power are premium on these small platforms. We propose an innovative solution to reduce the after deployment volume of the CubeSat communication and power subsystem. Upcoming Interplanetary CubeSat missions such as MarCO include the use of X-band reflectarray antenna. Using a reflectarray antenna and a solar array independently for communications and power generation respectively could increase risk during complex maneuvers, such as aerobraking and science operations. Moreover, it also increases the after deployment volume and the risk due to multiple deployments (i.e. one for the antenna and one for the solar panels). A credible solution is to integrate both into a single component. A similar solution – Integrated Solar Array and Reflectarray Antenna (ISARA), is currently in testing for Ka-band. We propose a similar hybrid of the NASA JPL X-band reflectarray antenna and MMA E-HaWK solar array. These two components can be modified and integrated together into a single component since they both share a similar form factor (6U x 3U after deployment). This can reduce the risks during aerobraking since the effective surface area after deployment would be lower than if they are used independently. Transmitting the data generally consumes more power and hence it is difficult to keep a CubeSat in transmit mode for a long time. Using the gimbal system, the reflectarray antenna located on one of the sides of the CubeSat can be Earth facing while the solar array can be Sun-facing. This will enable simultaneous operations of both, the solar panels and the refectarray. This simultaneous operation can maintain longer communications link between Earth and the CubeSat. This is presuming continuous availability of the Deep Space Network (DSN) and limited blackouts during this period. We also study the use of Mars assets as an alternative to sending data back to earth, in addition to the direct X-band communication link to Earth. A UHF Transceiver designed to fit into a CubeSat could provide proximity communication with ExoMars, TGO and MRO. This can further increase the amount of data downlinked since the CubeSat data can be piggybacked to Earth via the higher data rate X-band communication link of the new and existing Mars orbiter assets.