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DESIGN CONSIDERATIONS FOR SMALL SATELLITES SUPPORTING AIS AND ADS-B MISSIONS

Abstract

The Automatic Identification System (AIS) for vessels and the aeronautical ADS-B system (Automatic Dependence Surveillance – Broadcast) utilize GNSS for automatic reporting of position, course and other relevant data of ships and aircraft, respectively. These systems developed for ground-based services have significantly improved maritime and aeronautical safety. Monitoring these signals from Space provides a significant improvement in the extension of the coverage. Micro- and nanosatellites would allow to demonstrate and validate such novel concepts under realistic conditions at low cost and with short implementation time. To solve the problem of unavoidable signal collisions at the input of the Space-borne AIS or ADS-B receivers, a phased array antenna approach is mandatory. On-board or ground-based signal processing has to be traded off with respect to power and mass limitations on a very small spacecraft. When ground processing of the phased array signals is adopted, the contributions from the individual antenna elements have to be simultaneously downlinked in a phase-coherent manner. This also requires a highly linear transmitter. If ten antenna elements are used, a bandwidth of roughly 20 MHz is required for an ADS-B system. This is far more than the spectrum available in S-band for a single spacecraft. Therefore X-band must be considered for the downlink. In order to implement a phased array on the spacecraft, light-weight deployable booms are required. As an example, for ADS-B signals (operating at 1090 MHz) booms with a length of approx.1.5 m will be needed. The paper focuses on the design requirements of a nanosatellite in the 10 kg class (similar to the TUGSAT-1/BRITE-Austria spacecraft) in support of AIS or ADS-B missions. The on-board systems in terms of AIS/ADS-B receivers and a preliminary design of a linear, efficient X-band transmitter are presented. In addition, the standard subsystems such as attitude determination and control system (ADCS, power subsystem, telemetry and on-board computer are addressed. Mass, power and link budgets are elaborated. A comparison between on-board and ground processing of the phased-array signals will be presented. Furthermore, mechanical solutions for suitable deployable booms, satisfying the requirements of the phased-array antenna, currently elaborated in cooperation with Austrian Space industry are outlined.