Paper ID: 4439
student

ASTRODYNAMICS SYMPOSIUM (C1)
Attitude Dynamics, Modelling and Determination (6)

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SMALL SATELLITE ATTITUDE DETERMINATION WITH RF CARRIER PHASE MEASUREMENT

Abstract

Attitude determination is a crucial feature of any aerospace system and as such requires dedicated and redundant sensors for better precision and reliability. These sensors infer the spacecraft position from different parameters and with different techniques, like observing Sun's position or using gyroscopes. While this approach is feasible in commercial applications, constraints of small-satellites like size, weight and power consumption pose a limit on the available number of sensors.

This paper focuses on an attitude determination technique for small-satellites based on phase measurements of the incoming radio-frequency signals using a common downlink antenna. The antenna is formed by a patch array and attitude of the satellite is calculated with measurements of phase difference between the signals received by the elements. This is common on tracking antennas, but while traditional approaches involve the use of RF hybrid circuits, to enhance the noise immunity of the system the measurement is done after a down-conversion of the incoming signal. In the low-frequency section, COTS components are used to compute the spacecraft attitude reducing power consumption and cost.

Furthermore, with a proper feeding of the elements, the antenna remains usable by the RF transceiver as a single radiator and the radiation pattern is designed taking into account different subsystem requirements. A good beam simmetry is needed to simplify attitude determination algorithms and to obtain optimum precision in any direction. A proper radiation pattern along orthogonal planes, with maximum gain toward Earth's horizon, enhances communication reliability when link attenuation is higher.