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DESIGN, CONSTRUCTION AND TESTING OF A 2 DEGREE OF FREEDOM KA-BAND ANTENNA POINTING MECHANISM

Abstract

The Institute of Astronautics at the Technische Universität München is developing a high-data rate intersatellite link antenna system in the Ka-band. This lightweight intersatellite link antenna (LISA) will allow crosslinks (transmit and recieve) between operating satellites and communication relay satellites like TDRS (tracking and data relay satellite) or EDRS (european data relay satellite). Those stationary data relay satellites will then forward the data to a ground station. Such a system extends the available data transmit time from 7 minutes for a direct downlink to approximately 45 minutes.

The LISA itself is a compact passive antenna with a emitting area of 40x40 cm. Together with the high Ka-band frequency this results in a narrow angle of beam (approx. 1.5). For a continuous link between the satellites the antenna must be accurately pointed. The pointing itself is accomplished by two independent degrees of freedom (2dof), which allow the antenna to cover a hemisphere. This the main function of the antenna pointing mechanism introduced in this paper.

The goal is the development of a high accuracy pointing system, which is capable of angular velocites between 0.05deg/s to 5deg/s in both degrees of freedom while always maintaining the required pointing accuracy. This involves the usage of roller bearings lubricated with vacuum compatible grease, high gear ratio harmonic drives and stepper motors. One of the key features of this mechanism is a especially designed and purpose-built Ka-band rotary joint. It allows the transduction of the Ka-band signal through the 2dof mechanism.

This paper will explain the design and development of this mechanism together with the mechanical properties. Additionally the results of functional tests with the engineering model and a qualification strategy will be explained.