Development of a Spacecraft Antenna Pointing Gimbal

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Abstract

The development of the pointing gimbal in the high-gain antenna system (HGAS) of the Solar Dynamics Observatory spacecraft is described. The gimbal was designed for 5 years of service in Geo-Synchronous orbit. The hardware incorporates multiple levels of redundancy, allows harnessing and waveguide along its full length across its two axes of rotation and points with an accuracy of better than 0.065°. Significant issues with actuator alignment, Electrical Contact Ring noise, pointing budget, and waveguide failures are described, along with their respective resolutions.

Introduction

This paper outlines requirements, design and development activities of the SDO gimbal. Several hardware anomalies and their resolution are described. The critical reliability level was a driver for most of the issues uncovered during the gimbal development.

Significant design areas include the actuator and contact-ring mechanisms and waveguide. Unique events and lessons-learned include the encoder alignment to the actuators, noise during component-level testing, replacing flex waveguide and accommodating the harness.

Background

The Solar Dynamics Observatory (SDO), shown in Figure 1, is a NASA spacecraft that will collect data from the Sun during its 5-year life. The spacecraft was designed by and is being integrated at NASA Goddard Space Flight Center in Greenbelt, MD. Universities and industry provide its science instruments.

This observatory transfers 150Mbps (millions of bits per second) of solar imagery (with overhead) per day from its 28.5° inclination, geosynchronous orbit at 36,000 km (22,400 mile) altitude, to the ground station in White Sands, New Mexico. The gimbal geometry that is most conducive to this end is a two-axis azimuth/elevation configuration. The azimuth axis will rotate once per orbit (once per day), and the elevation axis will rotate up to ±65 degrees to allow the antenna to point to the desired Earth coordinates at the SDO Ground Station. To avoid excessive spacecraft roll maneuvers, a dual HGAS approach was taken, with antenna systems on opposite sides of the spacecraft, allowing selection of the optimum gimbal for downlink via scheduled hand-offs.

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