Ka-Band Multibeam Antenna Technology

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Abstract

The Advanced Communication Technology Satellite (ACTS), launched in September 1993 introduces several new technologies including a multibeam antenna (MBA) operating at Ka-Band. The multibeam antenna (MBA) with fixed and rapidly reconfigurable spots beams serves users equipped with small aperture terminals within the coverage areas. The antenna produces spot beams with approximately 0.3 degrees beamwidth (150 miles diameter) and gains of approximately 50 dBi. On the ground, transportable and very small aperture terminals (VSAT) for transmitting and receiving voice, video, facsimile and data are employed. This type of communication system puts a very stringent requirement on spacecraft antenna beam pointing stability (<0.0025 degrees).

A number of MBA performance evaluations have been performed since the ACTS launch. These evaluations were designed to assess MBA performance (e.g., beam pointing, gain, and polarization loss) in the space environment. The on-orbit measurements found systematic environmental perturbations to the MBA beam pointing. These perturbations were found to be imposed by satellite attitude control system, antenna and spacecraft mechanical alignments, on-orbit thermal effects, etc. As a result, the footprint coverage of the MBA may not exactly cover the intended service area at all times. Other parameters like peak gain, cross polarization and sidelobe level will also vary but they did not contribute to any measurable performance degradation. In order to restore pointing stability and general antenna performance, several compensation approaches were tested and evaluated. The best compensation approach for the on-orbit pointing error was found to be combination of autotrack and earth sensor control. This approach minimizes the effects of thermal distortions on beam pointing.

This paper addresses al aspects of the MBA characterization, effects of thermal distortion on beam pointing, compensation for antenna thermal distortions and recommendations for designing future communication satellites using multibeam antennas at Ka-Band.