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IN-ORBIT AODCS PERFORMANCE OF SUMBANDILASAT AN EARTH OBSERVATION SATELLITE FOR SOUTH AFRICA

Abstract

The paper describes the commissioning and in-orbit performance results of the attitude and orbit determination and control system to support the multi-spectral earth observation imager payload of the SumbandilaSAT microsatellite. The satellite has been designed as a single string mission with little redundancy due to mass and volume restrictions and early in the mission the only Z-axis reaction wheel was lost due to a power switch failure. The paper will demonstrate how full 3-axis stability is achieved without the use of a Z-wheel. The pushbroom imager is still able to scan target areas accurately using a forward motion compensated method (FMC4) simultaneously doing a roll offset manoeuvre for cross track scanning. Target tracking by pointing the high data rate S-band antenna is also successfully demonstrated, while allowing the satellite to freely rotate around the antenna boresight (body Z-axis) during these periods.

The satellite has only a single main Y-body mounted solar panel and the attitude control system must always ensure a sufficient level of solar energy collected during the sunlit part of each orbit. The only control actuators employed are 3-axis magnetic torquer rods and X- and Y-axis reaction wheels. During initial detumbling and safe mode operations a simple magnetic control law is used to bring the satellite to a sun pointed Y-Thompson spinning attitude for maximum solar power collection. From this sun-pointed, spinning attitude an intermediate control mode is entered when the Y-reaction wheel is utilised as a momentum wheel, to absorb the body spin rate and to inertially stabilise the angular momentum vector initially towards the sun direction and finally aligned with the orbit normal. During the intermediate mode the magnetic rods are used to maintain the momentum vector size and pressesion direction and to do nutation damping. The pitch angle is also controlled using the Y-wheel, to keep the main imager payload as close as possible to an earth pointed attitude and to thermally stabilise the imager telescope.

The final and nominal attitude control mode is entered when a low Y-momentum biased 2-axis reaction wheel and magnetic controller is enabled, for: 1) a nominal nadir pointing attitude to ensure a sufficient level of solar energy to be collected, 2) target tracking during view finder use or during imaging download communication with a ground station and 3) pushbroom imager scanning with a forward motion compensation capability. During the nominal mode the magnetic rods are used to maintain the Y-axis angular momentum, to dump the X- reaction wheel momentum and to zero any yaw angular offsets.

The in-orbit performance will be presented of newly developed 2-axis sun and earth sensors, an autonomous star tracker and SGPS receiver. A Butane resistojet propulsion system performance will be discussed, showing the results of circularising and raising a slightly eccentric 490 by 505 km initial orbit.