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DEVELOPMENT, COMPLEX INVESTIGATION, LABORATORY AND FLIGHT TESTING OF THE MAGNETO-GYROSCOPIC ACS FOR THE MICROSATELLITE

Abstract

The key-problems of design, examination, laboratory and flight testing of the attitude control system (ACS) dedicated for a microsatellite are considered. The system consists of three pairs of the reaction wheels, three magnetorquers, set of Sun sensors, three-axis magnetometer and a control unit. It, on one hand, is subjected to high accuracy and reliability requirements, and, on the other, power consumption, total mass and volume limitations. It is aimed for the LEO satellite with mass between 10 and 50 kg. The problems are solved within several steps, i.e. preliminary study of the satellite dynamics using asymptotical and numerical techniques, hardware and software design, testing of each actuator and sensor and the whole ACS on test-bench dedicated specially for such a laboratory simulation. Finally flight testing has been carried out to validate ACS functioning.

In this paper both dynamics of the microsatellite with ACS and mock-up of ACS operation are studied. Reaction wheels control law parameters are chosen to provide the maximum degree of stability. The evolution of the reaction wheels angular momentum is also studied and the problem of the desaturation with use of the magnetorquers is solved. Attitude accuracy is estimated in terms of closed-form formulae. Solar arrays Sun-pointing algorithm implemented by magnetorquers is offered and analytically studied. It is named “Sdot” similar to “Bdot”.

Some aspects of in-flight ACS exploitation onboard the Russian microsatellite “Chibis-M” developed, designed and fabricated by the Institute of Space Research of RAS and orbited from SC “Progress’ on 25th of January, 2012 are presented. Flight showed a good correspondence between analytical, numerical and laboratory study with in-flight testing.