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ScienceDirect

Procedia Engineering 185 (2017) 359 – 365

Procedia Engineering

www.elsevier.com/locate/procedia

6th Russian-German Conference on Electric Propulsion and Their Application

Experience in operating a constellation of AIST type small satellites with Samara University ground control center and perspective of managing a constellation of satellites using a distributed network of control centers based on multiagent approach

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Abstract

This paper presents the results of verification of ground testing of the AIST-type small spacecraft thermal control system (TCS) based on telemetry data received during their in-orbit testing and operation by the ground control station (GCS) of Samara University.
The study into the efficiency and operability of the TCS was done on the AIST series of small spacecrafts AIST#1 (RS-43as), launched on April 19, 2013 from Baykonur Cosmodrome as a by-cargo of Bion-M #1 spacecraft, and an experimental sample of AIST #2 (RS-41at) small spacecraft launched by Soyuz-2.1v with Volga insertion module on December 28, 2013, from the Plesetsk Cosmodrome.

Peer-review under responsibility of the scientific committee of the 6th Russian-German Conference on Electric Propulsion and Their Application

Keywords: small spacecraft; multiagent system; aerodynamic drag; design parameters; telemetry data.

1. Introduction

This paper is dedicated to the experience of operating a small satellite constellation, consisting of AIST-type spacecraft (Fig. 1). AIST spacecraft is a joint development of Samara University and the Space-Rocket Centre “Progress” [1].

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Peer-review under responsibility of the scientific committee of the 6th Russian-German Conference on Electric Propulsion and Their Application
doi:10.1016/j.proeng.2017.03.316

2. Experience of operating a constellation of AIST series small spacecraft

The spacecraft were launched into orbit on April 19, 2013 (RS43-as, orbit height 575 km, inclination 64,9°) and December 28, 2013 (RS41-at, orbit height 625 km, inclination 82,4°). During operation (by September 30, 2016) there were 7828 communication sessions for the RS-43as, and 4874 sessions for RS-41at. Fig. 2. shows the map of the Earth with the AIST constellation flight courses.

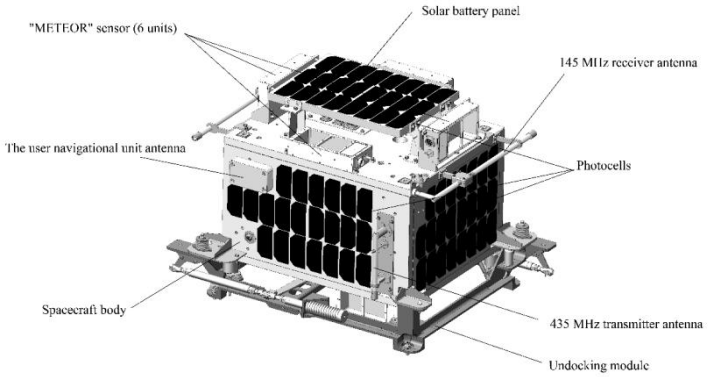

Fig. 1. Small spacecraft "AIST".

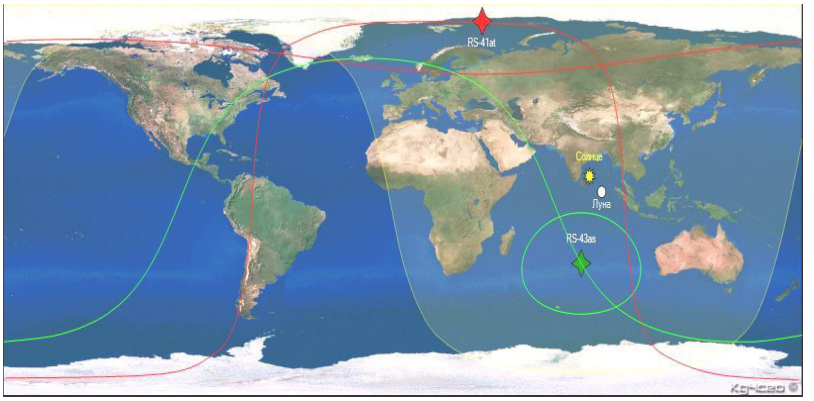

Fig. 2. Flight course of AIST small spacecraft constellation.

Since September 2015 the control of AIST constellation was passed over to Samara University small spacecraft ground control complex (GCC). The main functions of the GCC as refers to the spacecraft are:

- reception, primary and secondary processing of telemetry data;
- control of scientific instruments:
- reception and processing of research data;
- introduction of real-time telemetry data into the educational process at the university.

The experience of AIST small spacecraft operation proves that all on-board support systems of the space platform are fully functional.

2.1. The power supply system of the spacecraft

The power supply system consists of solar panels, mounted on all external panels of the spacecraft, accumulating battery and distributor. The system ensures adequate power supply to all spacecraft systems and scientific instruments for the spacecraft's lifetime.

2.2. Thermal Control System

The thermal control system is a passive type with heat pipes on external panels and film electric heaters on some of the on-board equipment housings. For both satellites we observed some overheating, which does not have a significant negative impact on their function. Overheating is caused by uncontrolled rotation of the satellites and