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TUMnanoSAT, 1U KiboCube Nanosatellite Developed at the Technical University of Moldova

Viorel BOSTAN[1], Nicolae SECRIERU[1], Valentin ILCO[1], Vladimir MELNIC[1], Alexei MARTINIUC[1], Vladimir VARZARU[1]
[1] National Center Space Technologies, Technical University of Moldova, Chisinau, Rep. of Moldova
*Corresponding authors: nicolae.secrieru@cnts.utm.md; ilco.valentin@cnts.utm.md

INTRODUCTION

The National Center for Space Technologies (NCST) of Technical University of Moldova (TUM) has been oriented towards a series of nanosatellites, according to the international standard CubeSat. In 2019, NCST participated in the fourth round of the KiboCUBE Program with the nanosatellite "TUMnanoSAT".

KiboCUBE Program is a collaboration between UNOOSA and JAXA that aims to provide to the United Nations Organization members opportunity to launch CubeSat satellites developed for educational and research purposes.

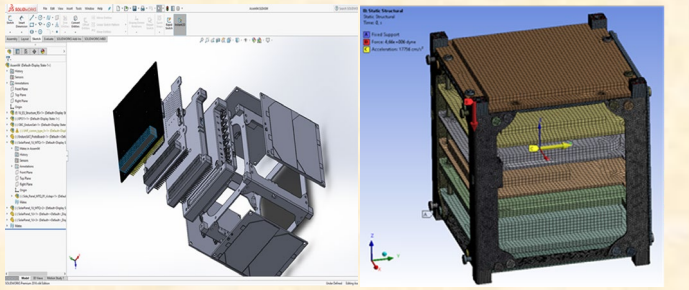
The NCST team was selected by the Japan Aerospace Agency (JAXA) and the United Nations Office for Outer Space Affairs (UNOOSA) for the fourth round of the KiboCUBE Program for the launch of the TUMnanoSAT nanosatellite from the International Space Station (ISS) in 2021, with the Japanese experimental Kibo module.

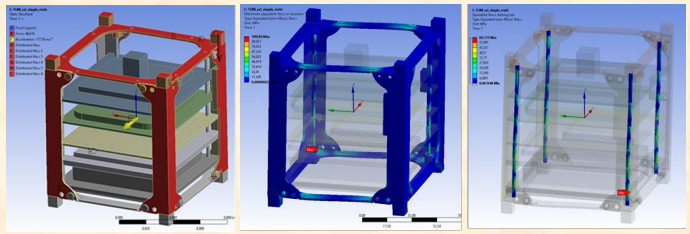
The Japanese Space Agency's Kibo module on the ISS was designed to be used as both a microgravity laboratory, as well as a launch pad for low-Earth-orbit services. This ISS module includes a small satellite-deployment system called the J-SSOD. Deploying nanosatellites from ISS has a number of benefits. Launching the vehicles aboard the logistics carrier of ISS visiting vehicle reduces the vibration and loads they have to encounter during launch. In addition, they can be packed in protective materials so that the probability of CubeSat damage during launch is reduced significantly. In addition, the lower orbit allows a natural decay of the satellites, thus reducing the build-up of orbital debris.

KiboCube program for The National Center for Space Technologies (NCST) of Technical University of Moldova (TUM) has a major impact on the improvement of the quality of engineering studies based on modern space technologies, attracting young students to develop and strengthen scientific research in space exploration. The scope of this poster is to present the conceptual architecture and overall system overview of TUMnanoSAT, to describe software and hardware modules for the implementation of nanosatellite.

STRUCTURE ANALYSIS

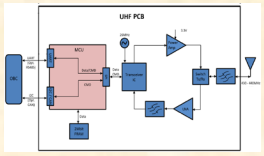
Structural analysis was performed for the necessary experiments and the improvement of the hazard ratio of the structure failure regarding the risk of rupture, the results being within the required limits.

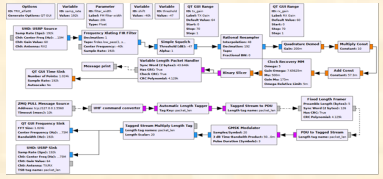


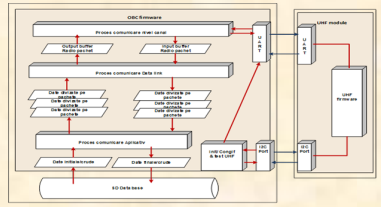


COMMUNICATION SUBSYSTEM

Procedures and algorithms for communication were developed in order to ensure link between satellite and ground station at different transmission rates, with different ways of packing and encoding messages for an efficient and reliable communication.

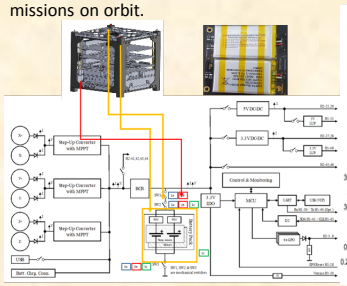


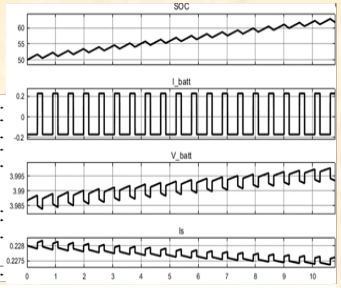


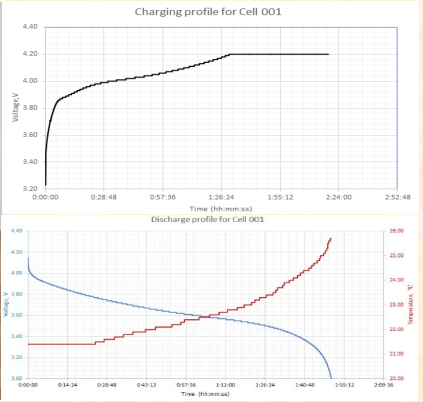


POWER SUBSYSTEM

The power subsystem of TUMnanoSAT has one integrated Li-Po battery pack that contains two Varta Li-Po cells with a total capacity of 10 Wh. Also in EPS (Electrical Power Subsystem) are five solar panels. Each Solar Panel Channel has a DC-DC step-up converter with Maximum Power Point Tracking (MPPT). The output energy for each solar panel is monitored. There were performed algorithms for accumulation and efficient distribution of electricity, the basis of plans to carry out satellite missions on orbit.



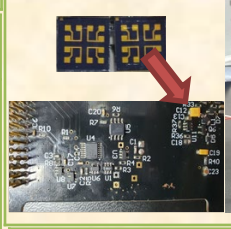


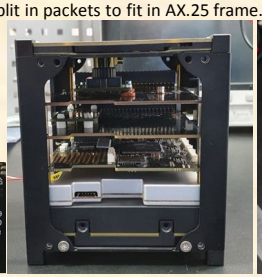


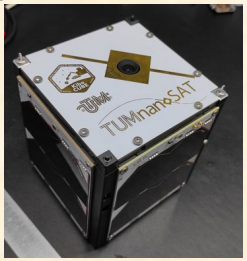
PAYLOAD MODULES

The payload of the "TUMnanoSAT" for this mission realization contains the following components:

1. Attitude determination equipment, including the MPU-9150, that combines two chips: the MPU-6050, which contains a 3-axis gyroscope, 3-axis accelerometer, and an onboard Digital Motion Processor™ (DMP™) capable of processing complex MotionFusion algorithms and the AK8975, a 3-axis digital compass. The part's integrated 6-axis MotionFusion algorithms access all internal sensors to gather a full set of sensor data.
2. Testing of nanowire sensors behavior in the space conditions developed by the TUM Nanomaterials Research Center in the fields of material science and nanotechnologies. The results of testing will be useful focused on the development of new nanomaterials and nano-devices for various applications, including electronics, photonics, bio-medicine etc.
3. Image capture module include a micro-CAM-II, which is an integrated serial camera module with a CMOS VGA color sensor along with a JPEG compression chip that provides a low cost and low powered camera system. The module has an on-board serial interface (TTL) that is suitable for a direct connection to OBC UART port. The micro-CAM-II is capable of outputting both format: low resolution (160x120) single frame raw images or high resolution (640x480) JPEG images. It is used the 56 degree lens. The image camera module is intended for capturing low resolution images of the land surface in the local area. The images will be split in packets to fit in AX.25 frame.







TESTING and VERIFICATION

The TUMnanoSAT for KiboCube design is compliant with the Safety Requirements reported in the "JEM Payload Accommodation Handbook Small Satellite Deployment Interface Control Document (JX-ESPC-101133)", especially the specific ones related to the operations inside the ISS, including the possibility to be handled by astronaut on board.