

MASTER'S THESIS REVIEW

Student: Bc. Ning Yang

Diploma Thesis Title: Telemetry, Tracking & Commanding Subsystem for the CzechTechSat Picosatellite

Diploma Thesis Supervisor: Ing. Jaroslav Laifr, Dept. of Measurement, CTU FEE, Technicka 2, CZ-16627, Prague, Czech Republic

The main goal of the thesis was to perform research, design, development and summary of achieved results of the Telemetry, Tracking & Commanding (TT&C) subsystem intended to transfer data to and from the CzechTechSat CubeSat-class picosatellite. Objectives of this student's satellite are to design, develop and test the conventional but the first so-called Space-Friendly satellite subsystems in real harsh space environment.

Ning Yang entered the team in mid summer 2013 as a first Space Master student in this project. He started to work on the magnetically clean Magnetic Levitation Device which was finished two months after as a completely successful task. One degree of freedom in rotation in the air isolated levitation is being used by the CzechTechSat team to test algorithms and actuators of the onboard Attitude Determination and Control Subsystem. However, data from this and other flying experiments are needed to be transferred to the ground station in wireless way.

In this thesis Ning Yang describes the workflow of the TT&C board development, from components selection, throughout the printed circuit board (PCB) design, soldering, software development and testing. For the ground and stratospheric link he proposed to use the commercial license-free radio module which had to be properly configured to establish the link with the lowest possible packet loss. To bring the best solution, Ning was also in contact with the manufacturer of these modules to ensure the best data transfer performance.

He calculated the ideal radio link budget and determined the maximum expected downrange between the satellite and the CzechTechSat ground station in the case of the stratospheric balloon flight. Student also participated on the ESA REXUS/BEXUS Selection Workshop in ESTEC, Netherlands in December 2013, where he presented his approach how to communicate with our satellite and its electronics during the balloon test flight.

Second part of the thesis is dedicated to the design of the radio communication board intended for the space flight, including FSK transceiver, preamplifiers, and power amplifiers together with schematic design. This work will be fully used as a base for the next generation of the TTC board development.

Finally, 31th of May, this year his license-free TT&C subsystem helped to the CzechTechSat team to download over the 380 kB of telemetry data during the stratospheric balloon test flight to the top altitude of 33 000 meters.

Due to the mentioned facts, I declare that the student Ning Yang fulfilled the thesis goals, helped to move forward the CzechTechSat project and deserves to be encouraged to pass the thesis defence with the degree A.

Prague, 17.6. 2014

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Ing. Jaroslav Laifr



181 Box 812 – SE-98 128 Kiruna – Sweden

Czech Technical University Faculty
of Electrical Engineering
Department of Control Engineering
Examination board

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Division of Space Technology
Department of Computer Science, Electrical
and Space Engineering
Luleå University of Technology

Phone +46 980 79100
Fax +46 980 79190
Email anita.enmark@ltu.se

**CTU Diploma Project review- 2nd reviewer's evaluation of master thesis with title
"Telemetry, Tracking and Commanding subsystem for the CzechTechSat Picosatellite" by Space
Master student Ning Yang.**

I find that the goal of the thesis project fulfils the requirements of a master thesis in space technology. The project includes implementation and testing of the TT&C board for the CubeSat applications (CzechTechSat Picosatellite).

The thesis includes theory, implementation and testing during flight. I judge that the student has put sufficient effort in the task.

The literature survey is brief regarding other similar projects. There are numerous CubeSats and all of them have a TT&C system, so it should be relevant to include an overview.

The background part of a thesis is intended to give the reader background knowledge and to show that the student understands the problem and has knowledge within the whole process of the performed project. Even if main parts are copied word by word from data sheets and other sources, altogether the background part together with the rest of the thesis show that the student has a relevant insight.

The layout of the thesis is not good. It is very difficult to follow the design process and the design considerations. Many decisions are implicit in the text and not clearly stated. Parts of the thesis is not very well written.

The strength of the thesis is that the hardware has been designed, built and tested, and interfacing to other parts of the project (groundstation etc) is managed during the project

The oral presentation is still to be graded. If the oral presentation is sufficient and the student show proper background and and shows an ability to further motivate design choices I recommend grading the thesis by B.

This review serves solely for the purposes of the diploma project defense at cru. LTU official evaluation for the SpaceMaster double degree will follow the thesis defense and may differ from this review report and suggested grade.

Dr. Anita Enmark
Luleå University of Technology