

Engineering project

System-Level Thermal Simulation and Structural Integration of the Jetson Orin Nano Thermal Control System in the EventSat CubeSat

Start date: ASAP

Duration: 3 months, approx. 150 hours (concentrated work)

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This project closes the last two gaps before the EventSat payload thermal control system can be frozen for flight: a complete system-level thermal simulation, and a validated fixation of the heat dissipation system to the CubeSat structure.

EventSat is a 6U CubeSat for space object observation. Its payload combines an NVIDIA Jetson Orin Nano with a neuromorphic (event-based) camera. Without convection in vacuum, the Jetson's heat must be conducted through a passive path to the spacecraft panels and radiated to deep space. Two student works are close to completion and form the baseline:

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- Bachelor thesis (passive thermal control system): analytical and ANSYS models of the junction-to-panel path, sizing of the copper conductor and interfaces, and contact conductance studies.
 - Engineering project (Jetson-side thermal interface): CAD, manufacturing and validation of the attachment between the heat dissipation system and the Jetson module, including thermal vacuum testing.
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What remains open is the other end of the heat path and the wider system. The simulation still covers a simplified model of the spacecraft. On the structural side, the joint between the heat dissipation system and the CubeSat structure has not yet been verified as both a thermal and a load-carrying interface.

The student will take over both models, extend the thermal simulation to the full set of mission conditions, and test the structural fixation. The outcome is a correlated thermal model and a flight-representative mounting concept, with clear recommendations for spacecraft integration. The work is about 150 hours concentrated over three months.

Research Objectives

- Clearly state the overall objective of the thesis.

The overall objective is to extend the thermal simulation of the Jetson Orin Nano thermal control system to system level and to validate the fixation of the heat dissipation system to the CubeSat structure, delivering a flight-ready recommendation for the integrated thermal and mechanical design.

- What is the main scientific or engineering objective?

On the thermal side, the objective is to extend the existing model to system level, including the structure, panels, adjacent electronics and radiating surfaces, and to verify temperature limits and margins for worst-case hot and worst-case cold conditions across all payload operational modes. On

the structural side, the objective is a fixation of the heat dissipation system to the CubeSat structure that is both an efficient thermal path and a robust load path, and its validation.

- Is the goal implementation, analysis, comparison, optimization, or validation?

Goal type: analysis and validation, supported by design and testing.

- How will success be measured?

Success is measured by four outcomes: (i) an updated system-level thermal model with mesh convergence evidence and a documented margin policy; (ii) CAD models and drawings of the structural fixation, released by the end of week 4; (iii) FEM verification of the fixation and, if the vibration table is available, vibration test results; and (iv) a test-to-model correlation of the thermal model.

Project Tasks and Timeline

Weeks 1-2: Model Handover & Interfaces (approx. 25 h)

- Review and take over the existing analytical and ANSYS models, including material properties, contact conductances and the TIM specification.
 - Run a mesh convergence study on the critical regions (junction, TIM, copper conductor, panel interface), within the available licence limits.
 - Collect the interface requirements and develop CAD concepts for fixing the copper conductor and heat dissipation system to the structure.
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Deliverables: reviewed and converged reference model; fixation concepts.

Weeks 3-4: System-Level Model & Detailed Design (approx. 30 h)

- Integrate the structure, panels, adjacent subsystems and radiating surfaces into the model.
 - Define boundary conditions for worst-case hot and cold orbits, including sunlit and eclipse phases and beginning- and end-of-life optical properties.
 - Analyse the selected design by FEM: modal analysis, quasi-static loads, bolted-joint verification and the thermal contact at the joint.
 - Prepare manufacturing documentation and release the drawings to manufacturing (critical milestone).
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Deliverables: system-level thermal model; FEM report; drawings released to manufacturing.

Weeks 5-7: Mission-Case Simulations & Test Preparation (approx. 35 h)

- Run hot and cold, transient and multi-mode simulations.
 - Support manufacturing and assembly, if something else needs to be manufactured.
 - Write the test procedures and prepare the test fixtures.
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Deliverables: simulation results for all mission phases and operational modes; test procedures.

Weeks 8-9: Sensitivity Analyses & Vibration Testing (approx. 25 h)

- Perform sensitivity analyses, propose and apply a margin policy, and identify thermal bottlenecks or unwanted heat accumulation.
 - Design and perform vibration tests (sine and random; if the vibration table is available), with resonance search before and after qualification levels.
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Deliverables: sensitivity and margin assessment; vibration test results.

Weeks 10-11: Thermal Testing & Correlation (approx. 25 h)

- Measure the temperature distribution and joint thermal resistance on the integrated assembly, in vacuum where chamber time allows.
 - Correlate test results with the simulation and update the model.
 - Inspect the fixation after testing and update the design.
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Deliverables: test-to-model correlation report; updated design.

Week 12: Final Report & Presentation (approx. 10 h)

- Document failure modes, design trade-offs and recommendations for flight implementation.
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Expectations

- Conduct independent and systematic engineering work as part of the EventSat thermal and structure teams
 - Availability for concentrated work of about 12-13 hours per week over the three months
 - Critically analyse design choices and results; question assumptions inherited from previous work and justify every model choice
 - Maintain weekly progress meetings with the supervisory team, close coordination with the students working on the payload, and regular presence at the chair and in the lab
 - Version and document all models, analyses, test protocols and results in GitLab, so that they can be reused in the flight design
 - Solid knowledge of heat transfer and structural mechanics, and working knowledge of ANSYS (or a comparable FEM tool) and CAD, are required given the compressed schedule
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Advisor

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