

Small Satellite Thermal Louvers

Project Overview

Thermal management is a crucial component to satellite missions. A system that provides heat rejection and insulation without consuming power is ideal. The product is a passive thermal management system for small satellites that uses louvers on a radiator.

Customer Constraints

The louver system shall:

- Vary heat rejection from a radiator surface
- Remain closed below -20°C and open above 30°C
- Interface to a radiator on a 5 cm x 5 cm grid
- Use basic approach outlined in NASA patent (US Patent No. #9862507)
- Survive environment of space and space launch
- Have no single point failures
- Meet NASA outgassing standards
- Be buildable in a repeatable fashion

Customer Requirements

The louver system shall:

- Reduce heat rejection from radiator surface by 20x (Open vs Closed)
- Be scalable from 10 cm x 10 cm to 0.5 m x 0.5 m
- Be visually pleasing and simple
- Be cost effective to manufacture
- Be light weight

Performance Review

Several tests and analyses were performed to verify the effectiveness of the system to fulfill customer requirements. The most important methods are outlined below.

Thermal Analysis – Computational methods were used to verify the 20x heat rejection and determine optimal surface coatings.

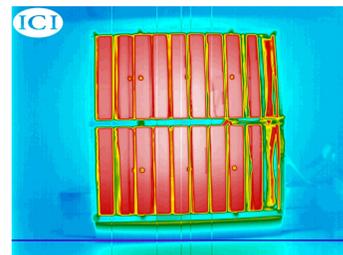
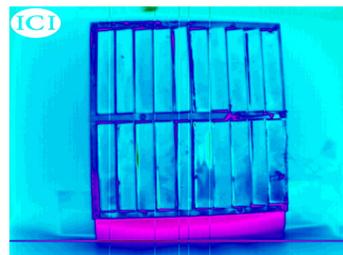
Spring Testing – Bimetal springs were tested to ensure 90° rotation over desired temp. range

Structural Analysis – Model tested in SolidWorks to ensure it could withstand 50G on all axes

Thermal Cycle Testing – Atmosphere testing performed on prototype over many thermal cycles to verify thermal performance.

Conclusion

Results



- Thermal and Structural analysis demonstrate model fulfills their respective requirements
- Spring testing demonstrates the spring's ability to open over the correct range
- Thermal cycle testing was successful, though proving some assembly flaws

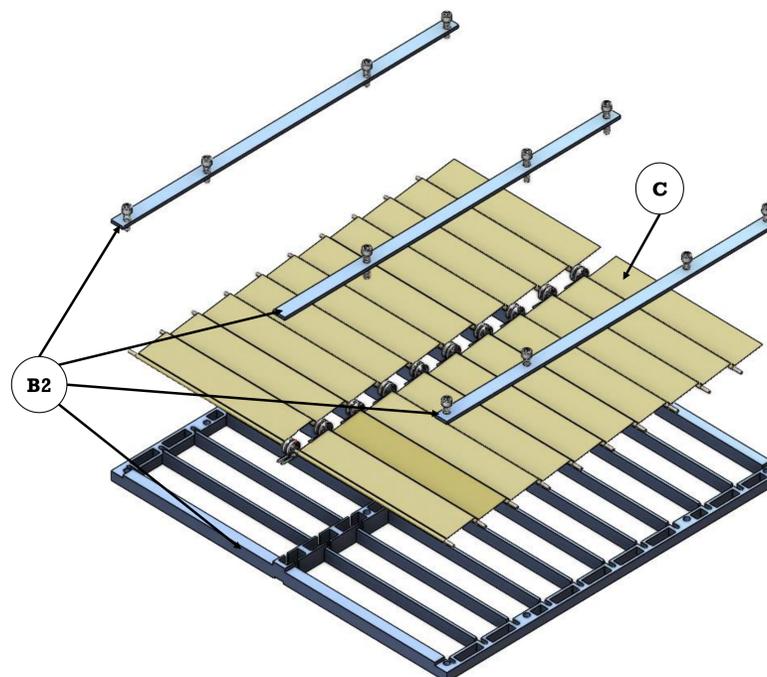
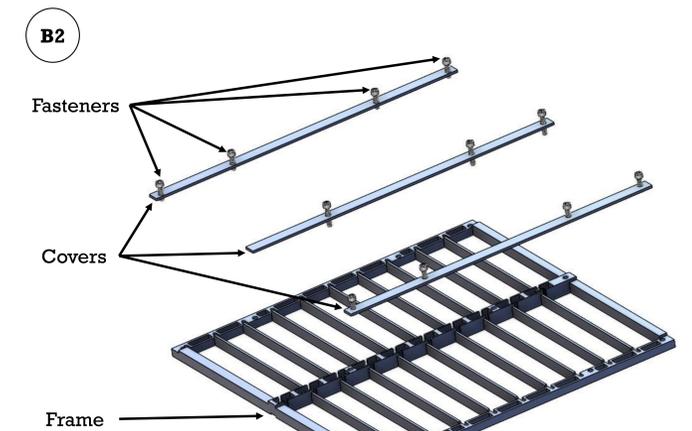
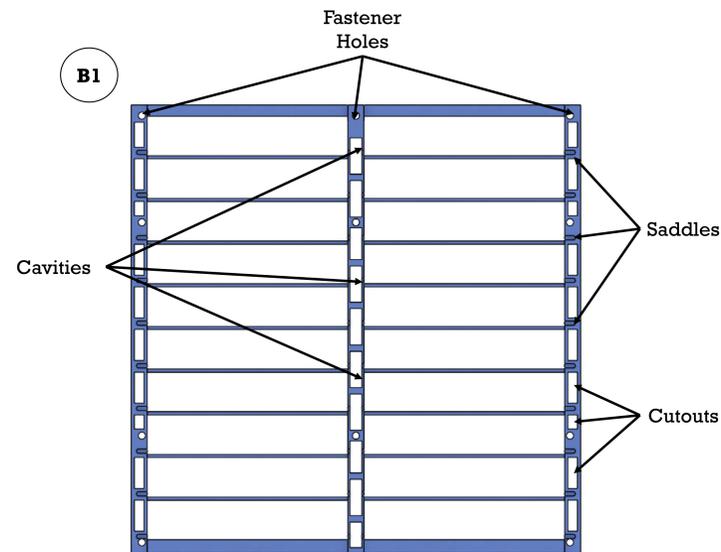
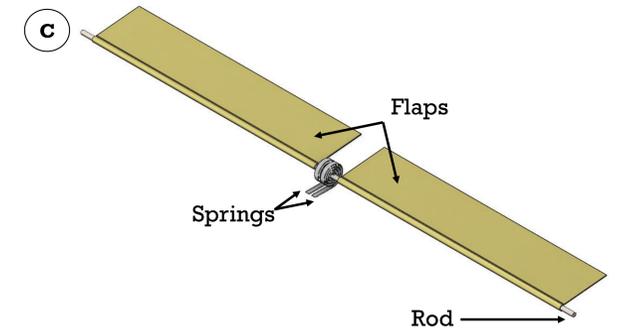
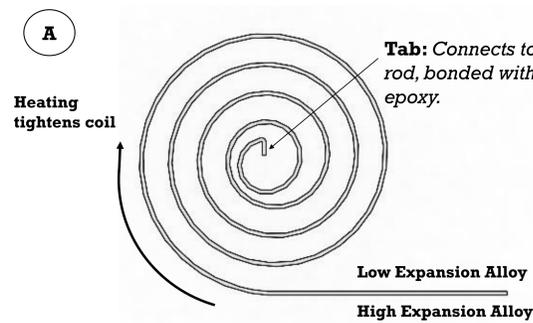
Lessons Learned

- More precision and quality control during assembly would greatly benefit the performance, particularly with the flap and spring bonding

Moving Forward

- Vacuum chamber testing to validate model
- Vibration testing to validate structural requirements, ensure launch survival

Design Overview



System Components

- (A) – *Bimetal Spring*: The main component of the louver assembly that allows for passive control of heat flux from the surface. As the radiator heats, the springs tighten, opening the louvers.
- (B1) – *Frame (Bird's Eye)*: Cutouts and saddles to hold louvers shown.
- (B2) – *Frame (Exploded)*: Holds louver assembly and attaches it to the radiator surface. Constructed from machined 6061 aluminum and attached with fasteners.
- (C) – *Louver Assembly*: Consists of aluminum louver flaps, slotted aluminum rods, and bimetal springs. This component opens to allow heat to leave the radiator and closes to maintain heat.



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