

Thermal Specifications

1. SCOPE This specification is for the thermal subsystem of a CubeSat. This subsystem will monitor and control the temperatures of the satellite and its other subsystems such that all components are maintained in their respective operating and non-operating required range.
- 1.1 General. This specification establishes the design, construction, performance, development, and test requirements for the thermal subsystem of the CubeSat.
2. APPLICABLE DOCUMENTS The following documents of the exact issue shown shall form part of this specification to the extent specified herein. In the event of conflict between the requirements of this specification and any referenced document the order of precedence shall be 1. The contract, 2. This specification, 3. Referenced documents.
- 2.1 Government Documents.
TBD
- 2.2 Industry Documents.
P-POD Payload Planner's Guide, Section 2.2.3, Rev C, 6/5/00
One Stop Satellite Solutions, Launch Services Specifications Excerpts, 2/22/01
Systems Requirements Document, 3/7/01
Other documents TBD
3. REQUIREMENTS
- 3.1 Item definition. This specification defines the thermal subsystem of the CubeSat. The thermal subsystem shall use mainly passive control techniques to keep the satellite and its subsystems within the allowable temperature limits. However, further analysis may show that it will be necessary to use active control. The primary control techniques being examined are insulation, radiating surfaces, temperature sensors and heaters. Specific devices are TBD.

The subsystem shall be turned off during ground operations, launch, and ascent of the satellite. It will be in passive mode in orbit, with the active control turned on as needed.
- 3.1.1 Functional Block Diagram. The functional block diagram for the thermal subsystem appears in Figure 1. It shows the functional interfaces between environmental effects, internal thermal behavior of the satellite, and the power, structure, C&DH, and other integral subsystems.
- 3.1.2 Interface Definition.
- 3.1.2.1 Physical. Insulation, temperature sensors, and heaters shall be mounted to the specific subsystems. Type of mounting shall be epoxy.
- 3.1.2.2 Informational. Temperature sensors will relay relevant thermal information to C&DH, which shall switch the active thermal controls either on or off.
- 3.1.2.3 Electrical. TBD
- 3.2 Characteristics.

3.2.1 Performance Characteristics.

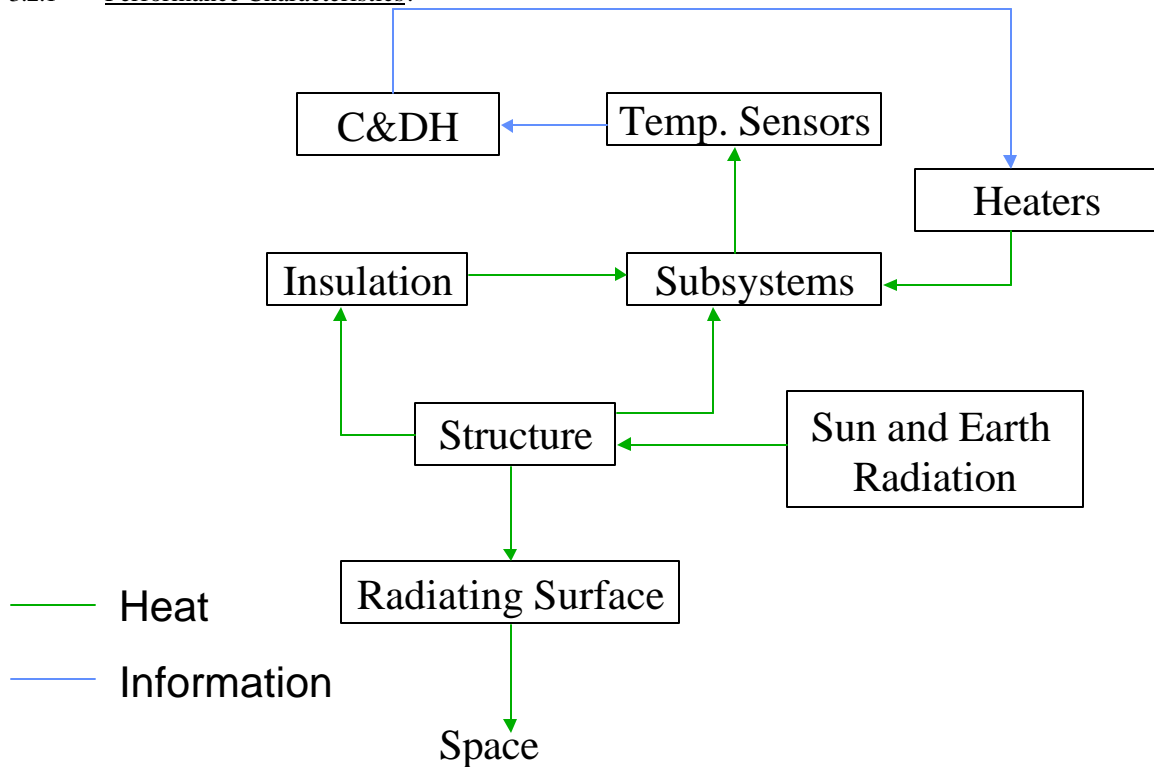


Figure 1 Thermal subsystem block diagram

Characteristics of active control devices TBD.

3.2.2 Physical characteristics.

The thermal subsystem shall have a total mass of no more than TBD.

The thermal subsystem shall have a power usage of no more than TBD W orbital average.

The thermal subsystem shall have a volume of no more than TBD.

Aluminum:

$$k = 237 \text{ W/(m}\cdot\text{K)}$$

Solar panels:

$$\alpha = 0.67$$

$$\epsilon = 0.83$$

All other characteristics TBD

3.2.3 Maintainability. No maintenance shall be required.

3.2.4 Environments.

3.2.4.1 Natural Environments. The item shall meet the requirements of this specification during and after exposure to any combination of any of the following natural environments. The item may be packaged to precluded exposure to any environments that would control the design.

$$\text{Solar flux} = 1418 \text{ W/m}^2$$

Earth IR = 258 W/m²

Albedo = 35%

Temperature of space = 3 K

Other requirements TBD

- 3.2.4.2 Induced Environments. The item shall meet the requirements of this specification during and after exposure to any logical combination of the following natural environments.

Pre-launch conditions of 5 °C to 30 °C, humidity of 40% - 80%

P-POD conditions of -40 °C to 80 °C

Orbit conditions: TBD

-67 °C to 47 °C

-69 °C to 44 °C

Subsystem temperature limits are listed in Table 1.

Internal heat:

Q = TBD

There will be TBD thermal cycles during the lifetime of the satellite.

Thermal shock TBD

Other requirements TBD

- 3.3 Design and construction.

- 3.3.1 Parts, materials, and processes.

TBD

- 3.3.2 Outgassing and venting. TBD.

Subsystem	Operating Limits (deg C)	Survival Limits (deg C)
C&DH	-40 to 85	-40 to 85
GPS board	-30 to 70	-40 to 85
GPS patch antenna	-40 to 105	-40 to 105
DC probe and PIP probe	-40 to 80	-55 to 100
Power		
Solar cells	-80 to 100	-80 to 100
Batteries	0 to 40 (charge) -20 to 60 (discharge)	-20 to 45 (storage)
DC/DC converters	-55 to 125	
Comm/Nav		
Transceiver	-30 to 60	-30 to 60

Guess

Analysis