ICE, CLOUD, and Land Elevation Satellite (ICESat-II) Project

ATLAS Thermal Model Delivery Report Template Revision A

Prepared By: Matthew B. Garrison/Code: 545

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Goddard Space Flight Center
Greenbelt. Marvland

National Aeronautics and Space Administration

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1.0 Overview

1.1 Introduction / Purpose

(An overview of the project and the purpose of the report should be stated here.)

1.2 Thermal Design Philosophy

(This section should include information regarding the thermal design and why it was chosen such as "radiators were sized for the hot case and make-up heater power is used for the cold case and survival". Reasons for using particular optical and thermophysical properties should also be specified here. Include information regarding any special design features, such as doublers, heat straps, interface materials, two-phase thermal control systems, etc., that are being utilized in the thermal design.)

1.3 Reference Documents

(Any governing documents should be listed as well as other sources of information on the thermal model such as PDR/CDR/ICD packages for informational purposes.)

1.4 Interface Definition

(Any interfaces should be explicitly identified including heat flow and interface temperature requirements. The hardware mounting assumptions should also be discussed.)

1.5 Model Files / Formats

(At a minimum, all files required to run the model should be included along with results created by the model right before delivery. The format of each file should be listed as well.)

Table 1-1: Model Files/Formats

Filename	Description	Format

1.6 Units

(This is just an example of common units used in a thermal model. The units can be adjusted to fit the specific parameters as designated by the project.)

Table 1-2: Thermal Model Units

Parameter	Unit
Area	in^2
Heat	J
Heat Flux	W/in^2-C
Heat Transfer Coefficient	W/in^2-C
Length	in

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Mass	kg
Power	W
Specific Heat	J/kg-C
Stefan-Boltzmann Constant	$W/in^2\text{-}C^4$
Temperature	°C
Thermal Capacitance	J/C
Thermal Conductance	W/C
Thermal Conductivity	W/in-C
Thermal Resistance	C/W
Time	s

1.7 Limits

(All component temperature limits and any gradient limits should be specified here.)

Table 1-3: Component Temperature Limits

	Temperature Limits (°C)					Goal Temperature (°C)	
Component	**Cold Surv**	**Cold Op**	**Hot Op**	**Hot Surv**	**Cold Turn-on**	**Cold Op**	**Hot Op**

Table 1-4: Gradient Limits

Gradient Description	From Node(s)	To Node(s)	ΔT (°C)

2.0 Geometric Math Model (GMM)

2.1 Summary Description

(Provide an overview of the GMM including the total number of nodes/surfaces used in the model and any information necessary to complete radiation case runs.)

2.2 Drawings of Component Locations

(This section should include drawings showing locations of the various components in the model. Internal and external views from various angles should be shown in the drawings with labels for each component. There is a small example below.)

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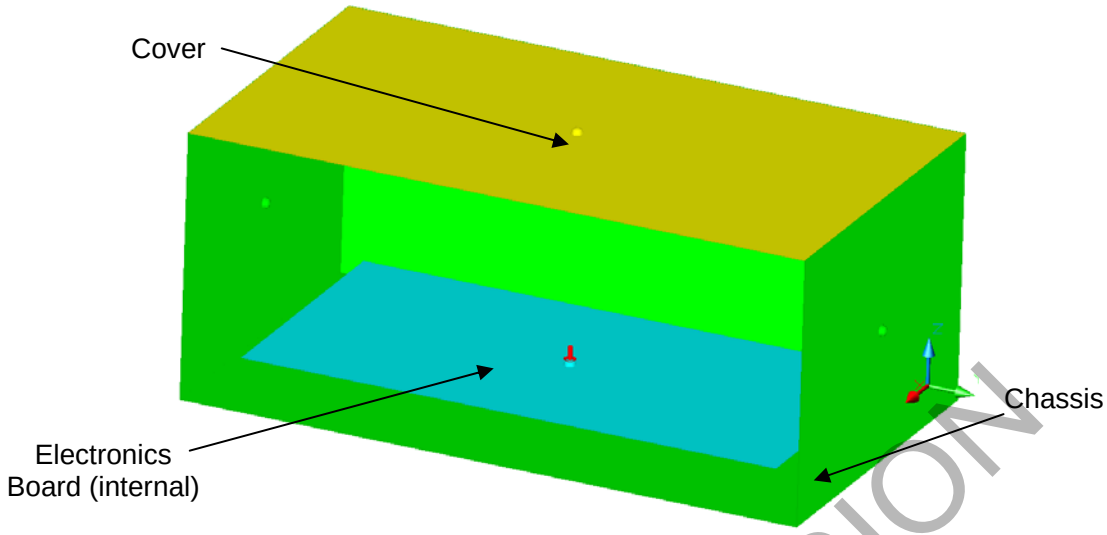

Figure 2-1: GMM

2.3 Optical / Thermophysical Properties

(Any optical or thermophysical properties that are new and need to be added to the program database should be highlighted for easier recognition. Sources for each property should be listed for verification purposes.)

Table 2-1: Optical Properties

Description	Property Name	Cold Case (BOL)		Hot Case (EOL)		Source / Reference
		α	ε	α	ε	

Table 2-2: Thermophysical Properties

Description	Property Name	k (W/cm°C)	C_p (J/kg°C)	r (kg/cm^3)	Source / Reference

2.4 Orbital Environmental Parameters

(The hot and cold case environmental parameters should be indicated here as designated by the project.)

Table 2-3: Environmental Parameters

Description	BOL / EOL	Beta Angle	Solar (W/m2)	Albedo	Planetshine (W/m2)

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2.5 Symbols / Registers

(Any symbols or registers that are used in the model should be provided in the table along with instructions on when and how to change the values for different cases.)

Table 2-4: Symbols

		Symbol Value		
Symbol Name	**Description**	**Survival**	**Cold**	**Hot**

2.6 Radiation Analysis Groups / Active Sides

(If the model utilizes different radiation analysis groups, they should be specified in the table with a description of the components in each group. Drawings of the active sides for each radiation analysis group should be depicted below.)

Table 2-5: Radiation Analysis Groups

Group Name	Description	Associated Components

3.0 Thermal Math Model (TMM)

3.1 Summary Description

(Provide an overview of the TMM including any key nodes that are designated for output such as nodes representing temperature sensor locations. Also include any special information that is required to run the model.)

3.2 Nodes / Components

(Each component of the model should be listed in the table with associated node numbers, mass, and material and optical properties. The total mass of the components should be added at the bottom for verification purposes. Key output nodes should be highlighted or instructions should be included if a temperature average of many nodes is used for a component.)

Table 3-1: Node/Component Information

Node/Component

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Description	Node #'s	Mass (kg)	Material Property	Optical Property
	Total Mass =			

3.3 Power Dissipations

(All component steady-state power dissipations should be listed in the table with any transient power profiles added as figures in this section.)

Table 3-2: Power Dissipations

Power Dissipation (W)				
Component	**Node #**	**Cold Case Value**	**Hot Case Value**	**Survival Case Value**
Total Power				

3.4 Heaters

(Both operational and survival heaters should be listed as well as a note regarding the bus voltage for which the heaters were sized. Drawing should also be included depicting the location of the heater in the model and the location of the temperature sensor. If special logic is used for any heaters, it should be indicated in this section as well.)

Table 3-3: Heaters

Heater Description	Heater Type	Temp Sensor Node	Heat Applied Node	Heater Size (W)	Close Setpoint (°C)	Open Setpoint (°C)

3.5 Interface Conductors

(The calculated interface conductances should be illustrated here with the details regarding the hardware interface and any assumptions that were made. If the model is tied to an interface boundary node, indicate the boundary temperature that was used.)

Table 3-4: Interface Conductors

Description	Hardware / Assumptions	Conductor Value (W/K)		Boundary Temperature
		Cold Case	Hot Case	

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4.0 Results

4.1 Conclusions / Recommendations

(This section should consist of an overview of the results discussing whether or not all components are within limits and what proposed actions are necessary to mitigate any temperature violations.)

4.2 Temperature Maps

(Temperature maps of the model should be included for easy visualization of gradients and any temperature limit violations.)

4.3 Heat Flow Maps

(Heat flow maps should be included to verify that the heat is flowing through the model as expected.)

4.4 Component Temperatures

(This section should include detailed tables of all the node/component temperatures, limits, and margins with negative margins shown in red.)

Table 4-1: Nominal Case Temperature Results

Nominal Cases		Temperature (°C)					
Description	Node #	Min	Max	Cold Case	Margin	Hot Case	Margin

Table 4-2: Survival Case Temperature Results

Survival Cases		Temperature (°C)					
Description	Node #	Min	Max	Cold Surv	Margin	Hot Surv	Margin

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APPENDIX A Acronyms and Abbreviations

Abbreviation/ Acronym	DEFINITION