SSSRA — Variable Reference

Stacked Solar-Shade Radiator Architecture

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Complete definition of all variables and terms used in the thermal math framework of the Stacked Solar-Shade Radiator Architecture document. All values correspond to the nominal parameters and ranges specified in Sections 4–5 of the architecture reference document.

Radiator Surface Properties

Symbol	Name	Definition	Nominal
ε_{rad}	Radiator surface emissivity	Fraction of blackbody radiation emitted by the radiator coating. Clean: 0.85–0.92; degraded (21-day dust): 0.70–0.80.	0.88 (clean) 0.75 (degraded)
α_s	Radiator solar absorptance	Fraction of incident solar flux absorbed by the radiator surface. Drives parasitic heating. Clean white coatings (AZ-93, Z-93P): 0.09–0.15; dust-degraded: 0.20–0.30.	0.12 (clean) 0.25 (degraded)
T_{rad}	Radiator operating temperature	Bulk temperature of the radiator panel surface during active thermal rejection. Set by the fluid loop outlet temperature.	310 K (300–320 K)
A	Radiator area	Total projected radiating area of the horizontal flat-plate radiator (m^2). Sized to meet the heat rejection requirement at degraded end-of-mission conditions.	Mission-dependent

Solar Environment

Symbol	Name	Definition	Nominal
S	Solar constant at 1 AU	Irradiance of the Sun at Earth–Moon distance. Provides the baseline solar flux incident on any exposed surface.	1,361 W/m^2
α	Solar elevation angle	Angle of the Sun above the local horizon. At the lunar south pole, typically 1.5–15°. Determines the projected solar flux on a horizontal surface via $\sin(\alpha)$.	6° nominal (1.5–15°)

Fundamental Constants

Symbol	Name	Definition	Nominal
σ	Stefan-Boltzmann constant	Proportionality constant in the Stefan-Boltzmann law governing radiative heat transfer between surfaces.	5.67 × 10■■ W/m²K■
T_{sink}	Effective sink temperature	Equivalent blackbody temperature of the thermal environment seen by the radiator. Deep space provides ~4 K; contributes negligibly to the radiation balance.	~4 K

Solar Array / Shade Tier Properties

Symbol	Name	Definition	Nominal
ε_{back}	Array backside emissivity	Emissivity of the solar array's downward-facing surface. Uncoated: 0.75–0.85. With vacuum-deposited aluminum or gold low-ε coating: 0.05–0.20. Key enabler of the architecture.	0.10 (low-ε) 0.82 (uncoated)
T_{array}	Array backside temperature	Temperature of the solar panel's underside during sunlit operation. Tracks with front-face temperature; depends on cell efficiency, substrate, and thermal coupling.	330 K (320–370 K)
F_{array}	View factor, radiator to array	Fraction of the radiator's upward hemisphere occupied by the solar array underside. Depends on clearance gap, panel sizing, and edge geometry.	0.30 (0.20–0.40)

Derived Geometric Terms

Symbol	Name	Definition	Nominal
$F_{space,eff}$	Effective view factor to space	Remaining fraction of the radiator's upward hemisphere that sees deep space after the array occupies F_{array}. Defined as $1 - F_{array}$.	0.70 (0.60–0.80)

Heat Flux & Performance Terms

Symbol	Name	Definition	Nominal
Q_{rad}	Gross radiative rejection	Total heat radiated by the radiator to its thermal environment before accounting for solar absorption. Governed by Stefan-Boltzmann law.	W
Q_{solar}	Solar parasitic load	Solar flux absorbed by the radiator surface. The primary thermal penalty eliminated by the shade configuration.	W
q_{solar}	Projected solar flux on horizontal surface	Solar irradiance incident on a horizontal surface at elevation angle α. Equal to $S \times \sin(\alpha)$.	W/m²
q_{abs}	Absorbed solar flux	Net solar power absorbed per unit area: $\alpha_s \times S \times \sin(\alpha)$. Represents the parasitic load on an unshaded radiator.	W/m²
q_{back}	IR backradiation from array	Infrared flux radiated downward from the array underside onto the radiator. Equal to $F_{array} \times \varepsilon_{back} \times \sigma \times T_{array}^4$.	W/m²
$q_{net,unshaded}$	Net rejection capacity (unshaded)	Heat rejection per unit area for a radiator with no shade, after subtracting solar absorption.	W/m²
$q_{net,shaded}$	Net rejection capacity (shaded)	Heat rejection per unit area for the stacked configuration, accounting for reduced view to space and IR backradiation.	W/m²
$q_{net,benefit}$	Net shade benefit	Difference in rejection performance: solar flux eliminated minus IR backradiation penalty minus view factor loss. Positive = shade improves performance.	W/m²

Key Equations

Projected solar flux on horizontal surface

$$q_{solar} = S \times \sin(\alpha)$$

Solar parasitic absorbed by radiator

$$q_{abs} = \alpha_s \times S \times \sin(\alpha)$$

Gross radiative rejection (unshaded)

$$Q_{rad} = \varepsilon_{rad} \times \sigma \times A \times (T_{rad}^4 - T_{sink}^4)$$

Net rejection per unit area (unshaded)

$$q_{net,unshaded} = \varepsilon_{rad} \times \sigma \times (T_{rad}^4 - T_{sink}^4) - \alpha_s \times S \times \sin(\alpha)$$

IR backradiation from array underside

$$q_{back} = F_{array} \times \varepsilon_{back} \times \sigma \times T_{array}^4$$

Effective view factor to space

$$F_{space,eff} = 1 - F_{array}$$

Net rejection per unit area (shaded)

$$q_{net,shaded} = \varepsilon_{rad} \times \sigma \times T_{rad}^4 \times F_{space,eff} - q_{back}$$

Net shade benefit

$$q_{net,benefit} = q_{solar,eliminated} - q_{IR,backrad} - q_{view\ factor\ loss}$$