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Reverse Engineering of Juno Mission
Homework 5

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Group 5

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Contents

Notation

TCS Thermal Control System

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1 Introduction of TCS

2 Analysis of thermal conditions along the mission

3 Architecture and rationale of TCS

The TCS of Juno must tackle a wide range of thermal environments, as discussed in **REFERENCE** . The cold case however is the most critical condition for the S/C, so TCS is mainly designed on this situation: the vault, the main body and the external hardware are all thermally insulated and decoupled. Heaters are also present on each individual section/sensor. This guarantees flexibility in order to ensure the operating temperature for each component. Despite the insulation, more than half of the power generated at Jupiter is demanded by the TCS just to heat up the S/C.
Three main zones were identified for the following analysis:

- **Vault**: all the main electronic hardware is contained here. The size of this box is 0.8 m × 0.8 m × 0.7 m. The lower surface is attached to the main body while the top surface is linked to the HGA, lateral surfaces points outwards and mainly to deep space. The walls are made of 1 cm thick titanium walls. This metal has a low conductivity value ($\approx 6.7 \div 7.4$ W/mK) which is a positive feature for the cold case at Jupiter. Also, major heat generation happens during science orbits since all the instrument electronics is powered on. In addition, the low external thermal flux during science imposes additional requirements in relation to the optical properties of the lateral vault surfaces. It can be assumed that low emissivity and high absorptivity blankets were chosen for this reason. However, during the phases in which the thermal flux is at its highest (TP3), the vault shall be able to dissipate enough power. This is in contrast with the above mentioned design choices. To ensure compatible thermal environment in the vault, three louvers were applied on its external lateral surfaces in order to point deep space and have an efficient IR emission. The dimension of a single louvre is 0.53 m × 0.40 m, two of them are placed vertically while one of them is placed horizontally, the motivation for this choice is relative to the internal configuration of the electronics. The opening of the louvre'shutters raise the emissivity value from 0.14 to 0.74 (**REFERENCE** produttore), enabling higher out-going radiative heat flux. The justification for this passive and low complexity solution was mainly due to the fact that the hot case scenario was encountered only during a restricted time of the overall mission. Moreover, the louvre technology effectiveness was tested and ensured by previous interplanetary mission such as Rosetta and New Horizons.
- main body
- solar panels

4 Reverse sizing of TCS

Bibliography

[1] Richard Grammier. *Overview of the Juno Mission to Jupiter*. Site: `https://www.jpl.nasa.gov/missions/juno`. 2006.