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Reverse Engineering of Juno Mission

Homework 5

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Group 5

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Notation

TCS	Thermal Control System
SYM	to remove this cite[1]
TP	Thermal Phase
LEOP	Launch and Early Orbit Phase
IC	Inner Cruise
S/C	SpaceCraft
SPM	Sun Pointing Mode
EPM	Earth Pointing Mode
HGA	High Gain Antenna
SOI	Sphere of influence

1 Introduction of TCS

The Thermal Control System of Juno adopts various strategies in order to maintain the instrumentation within operative ranges of temperature. This is done through both active and passive systems, which will be analyzed in section 3. First thing first, an analysis of the mission will be conducted to enlighten the thermal conditions the satellite is exposed to, which range from really hot environment nearby the Sun to extremely cold environment nearby Jupiter. A selection of the two most extreme situations will be done through a preliminary evaluation of the heat fluxes in these phases. In the light of this, the architecture of the Juno's TCS will be studied and justified through a brief rationale analysis. Finally, a reverse sizing will be carried out imposing some simplifying assumptions in order to find the temperatures on Juno and to verify the compliance with its mission.

2 Analysis of thermal conditions along the mission

2.1 Thermal phases analysis

Different thermal conditions have been encountered by Juno during its cruise. In previous chapters, the mission was divided into phases by different attitude and communication constraints. These phases will be now grouped by the means of thermal constraints to better analyze their evolution during the mission time.

- **TP-1**: in this first phase, which comprehends both LEOP and IC-1, the S/C is in SPM due to thermal and power requirements. In particular, since the trajectory is relatively close to the Sun, Juno has to protect the vault with the HGA (as already explained in the previous chapters). Even if TP-1 is considered a hot phase, it is not the most critical as other phases present more stringent requirements, facing longer periods closer to external heat sources (i.e. Sun and Earth).
- **TP-2**: this second phase, among the ICs, is the longest, the only featuring EPM and does not call for any particular thermal requirement being Juno farther from both Sun and Earth, but closer than during the jovian phase. No specific attitude is required to thermally control the S/C during the different manuevers performed during IC-2. Neither hot nor cold phase is considered along TP-2.
- **TP-3**: the third thermal phase consists mainly of IC-3, performed in SPM to protect the electronics inside the vault as the S/C passes through the perihelion at 0.88 AU. This phase differs from IC-3 since the EGA belongs to a different TP and will be analyzed separately. During TP-3, Juno was found to face the most relevant hot environment, occurring at the closest approach to the Sun.
- **TP-4**: the fourth phase analyzed consists only of the EGA, from the entrance till the exit of Juno from Earth's SOI. According to the model that will be described inside subsection 2.2, TP-4 faces the highest incoming thermal flux, however this condition is only experienced for a few minutes, making it less relevant than the perihelion condition, which is hance the design point.
- **TP-5**:
- **TP-6**:

2.2 Heat flux analysis

3 Architecture and rationale of TCS

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.