Reverse Engineering of Juno Mission

Homework 7

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Group 5

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Notation

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1 Introduction of Juno's configuration

Juno is the first spin-stabilized solar-powered spacecraft to conduct science operations around Jupiter, featuring different instruments with various requirements and limitations. Given the harsh environment it faces around the planet, the longevity of the mission and the required power to conduct operations, both packed and unpacked configuration of the payloads, antennas, internal hardware and power sources required special attention. Mass distribution is also a critical factor in the accuracy of the different measurement as Juno spins at 2 RPM during science operations.

2 Shape and appendages

The main body of the S/C has the shape of a regular hexagonal prism with sides of 1.77 m and and high of 1.52 m: in its interior the ME, tanks of fuel and oxidizer are stored. The interior of the prism is divided into six bays thanks to honeycomb composite walls that allow, together with MLIs and thermal blanket, to decouple each section from their surroundings. A tank is placed in each bay.

On the top deck are installed the two 55 Ah Li-Ion batteries, the two SRUs, all the cabling for the instruments, JEDI and JADE. Moreover two of the four REMs are placed on the top deck along the Y-axis, the titanium vault is placed on the center of the prism, aligned with the Z-axis. Inside the vault all the important electronics is stored in order to keep it shielded from the radiations. At last, the 2.5 m diameter HGA to transmit and receive in X-band and Ka-band is mounted on top of the vault. Alongside the HGA, the front LGA and the MGA are placed. On three of the six lateral faces of the main body the three solar arrays are mounted and spaced 120° apart. Under the solar array along the +X-axis **REFERENCE** the WAVES antennas are placed, while on a fourth face both the JunoCam and the UVS instruments are mounted. The last two lateral faces are occupied by the Microwaves Radiometer.

The three solar arrays are composed by a different number of panels: A1 has three panels while A2 and A3 are composed by 4 panels each. In fact on the edge of A1 the MAG suites of instruments is mounted.

The aft deck, aligned with the -Z-axis, features the ME cover, the last two REMs for the ADCS, the aft LGA, the TLGA and JIRAM.

3 Configuration inside the launcher

As mentioned in section 1, the cross section of Juno's main body is an hexagon with 1.77 m sides. The circumscribed circumference has thus a diameter of 3.54 m. The solar arrays have a total area of about 60 m^2 and their total aperture when deployed is more than 20 m. Given that the needed launcher, the Atlas V, has as an option a fairing of diameters up to 4.57 m, the three arrays had to be folded, thus their division in multiple panels. The adopted fairing has also a limited maximum height of 10.18 m, that is the smallest fairing among the 5 m family. The smallest possible fairing to be mounted on to the Atlas V had an internal available diameter of 3.75 m and an available height of 1.58 m which was not compliant with dimensions of the S/C. Furthermore the packed configuration features also the Waves antennas to be retracted: together with the solar arrays they will be deployed soon after separation from the Centaur upper stage.

The adapter used to connect the launcher to the spacecraft was found to be the type D1666, composed by two pieces of machined aluminum. The capabilities of the adapter vary depending on the position of the CG of the spacecraft with respect to the separation plane. Due to the mass distribution of Juno at launch, the CG was found to be inside the main body, at around 1.4 m from the said plane. From the Atlas V user manual, this values imply a maximum payload capability of 6.5 tons, above the $\approx$ 3.62 tons of Juno at launch. **REFERENCE**

Separation of Juno from the adapter is carried out by a system of springs, a clamp band and a release mechanism: the system allows to safely separate the S/C and provides the needed energy to obtain positive separation, which in the case of Juno implies reaching an orbit with a speficic energy of 31.1 km^2/s^2.

4 External configuration

5 Internal configuration

Bibliography

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