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Space Structures I - Development and Verification (Space Vehicles and Components) (1)

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STRUCTURE DEVELOPMENT OF THE HP3 INSTRUMENT SUPPORT SYSTEM FOR THE MARS
MISSION INSIGHT

Abstract

On May 05, 2018 NASA JPL will launch its mission to Mars called “InSight”. Main objective of this mission is to gain more knowledge of the evolution of terrestrial planets. Beside a number of different scientific instruments onboard the lander there are two instruments that will perform measurements on the Martian ground. One of the instruments is HP3 (Heat Flow and Physical Properties Package), which was developed by the German Aerospace Center (DLR) to measure the heat flow of the Martian outer crust. It uses a hammering mechanism equipped with heating foils on the outer hull to pull a tether approx. 5 m into the soil. The tether is equipped with temperature elements for the determination of temperature gradients in the ground.

There is the need of a separate system to be able to perform those activities on the surface. This system is called the “HP3 Support System”. Its main task is to ensure a stable, nearly perpendicular position of the hammering mechanism relative to the soil on the Martian surface before initial penetration. It furthermore houses the instruments for length measurement and serves as electrical connection to the lander.

The paper will give an overview of the development and the qualification of the structure of the Support System. It will focus on the mechanical design, the analysis of the structural dynamics but in particular on the testing which includes standard environmental testing but also numerous development tests that are very mission specific.

The mechanical design of the Support System is mainly driven by a unique set of requirements derived from the working environment on Mars, the deployment from the lander deck and the mechanically separated operation on the surface. The instrument design will be explained to show, which design elements were implemented to ensure proper functionality.

Various development tests had to be performed during the Support System structure development. Besides the standard qualification tests, special tests were developed to show compliance of the instrument design to the requirements. Such tests are: Separation Tests from the lander deck in cold environment under various tilt angles, Tether Deployment Tests, under various temperatures, foldings and routings, Feet Sliding Resistance Tests on sand with different slopes. The paper will give an overview on all tests necessary for the support system qualification and will describe test setups and the results.