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A SYSTEMATIC APPROACH TO THE STRUCTURAL DESIGN VERIFICATION FOR SPACE PAYLOADS, LESSONS LEARNED FROM SOLAR ORBITER EPT-HET INSTRUMENT

Abstract

The main functions of the space instrument structural subsystem are to enclose, protect and support the other instrument subsystems integrity and to provide a mechanical interface with the spacecraft. Depending on the mission requirements and the mechanical load envelope defined by the spacecraft, the structure should sustain the severe stresses and loads experienced during the launch. The main challenge for a successful structural design is to consider an appropriate verification method during the design phase, which discards or minimizes the potential hardware failures during the qualification tests. This is not always trivial because the design inputs and requirements at the preliminary design phase (phase B) may change when reaching to the stage that the instrument is built and needs to be qualified by test (phase D). In this paper, based on the lessons learned in the scope of the EPT-HET instrument development for ESA's Solar Orbiter mission, a systematic approach for a successful structural design is presented. The proposed systematic approach not only includes the structural stress and strength analysis but also involves the fatigue life and shock damage verification for sensitive parts such as electronic components. Predicting the fatigue life resulting from random vibrations and the threshold of the shock damage uses Steinberg method and is involved in the verification process. Based on the experience from EPT-HET instrument design verification, the Steinberg method is able to predict the damage survival threshold of the sensitive electronic parts. In addition, it is demonstrated that, a reliable manual notch can be applied using this method. This is valuable because the classical force limiting vibration test is not always possible. The proposed systematic approach for the structural design verification considers the guidelines from the ECSS Hand Book for the mechanical shock design and verification as well as the ECSS Hand Book for

mechanical load analysis. The successful application of each of the verification steps is presented based on the results of the EPT-HET instrument structural verification results.