Advances in Aircraft and Spacecraft Science, *Vol. 5, No. 2 (2018) 177-186*
DOI: https://doi.org/10.12989/aas.2018.5.2.177

Transient testing from LV / SC coupled analysis by new shock synthesis

Alain Girard*, Etienne Cavro and Paul-Eric Dupuis

INTESPACE, 2 Rond-Point Pierre Guillaumat, 31029 Toulouse Cedex 4, France

(Received November 8, 2016, Revised September 9, 2017, Accepted October 4, 2017)

Abstract. This paper deals with the idea to replace the usual high-level sine sweep test on shaker at system level, very severe, by a low level one completed by a transient test in the same configuration, in order to be more representative of the real environment, thus limiting over testing and improving the payload comfort. The problem of the transient test specification is first discussed. The proposed solution is to derive from LV/SC coupled analyses a shock response spectrum corresponding to two damping ratios. Then, the question of adequate shock synthesis is tackled. A new method with a given spectrum is considered for better potential and accuracy than the usual wavelets. A campaign on the Intespace bi-shaker devoted to system level showed its capability to perform the resulting test with one spectrum. First investigations to extend this approach to two spectra are in progress.

Keywords: SRS; shock synthesis; transient testing; fast sine sweep

1. Introduction

Spacecraft structures need to be qualified with respect to their dynamic environments. Various events can provide significant levels which must be taken into account. To cover the low frequency range, the current practice at system level is the sine sweep test which requires the use of notching to avoid over testing in the vicinity of the main resonances (see discussion in Girard *et al*. 2012).

This practice is appropriate to cover sustained vibrations, but not the transients which generate the most severe levels for the spacecraft primary structure. Replacing one environment by another whose nature is very different always involves risks related to the assumptions used to define the equivalence.

In order to be more representative of the real environment, the idea here is to replace the usual high-level sine sweep test on shaker at system level by a low level one covering residual sustained vibrations (noise), completed by a transient test in the same configuration to cover the real expected transients. This should limit over testing in the low frequency range, thus improving the payload comfort.

Some illustrations are given in Sec. 2 to show the gap between real and simulated environments in the current practice. The problem of the transient test specification is then discussed in Sec. 3, followed by the question of adequate shock synthesis in Sec. 4, and test results obtained on the

---

*Corresponding author, E-mail: ac.girard@orange.fr

http://www.techno-press.org/?journal=aas&subpage=7 ISSN: 2287-528X (Print), 2287-5271 (Online)

6. Conclusions

Examining the real dynamic environment of a spacecraft structure shows the interest to replace the usual high-level sine sweep test by a low level one completed by a transient test to cover the real transients.

The transient test specification could be derived from coupled load analysis results providing a SRS related to two Q factors.

As the current methods for shock synthesis are probably inefficient with this kind of data, a new strategy with more potential was investigated: a fast sine sweep considered as a transient.

The feasibility of elaborating this kind of time history related to a given SRS, then performing the corresponding test on shaker, was demonstrated on a simple case, half-sine SRS on a dummy specimen.

The next step is to consider a real spacecraft with its coupled load analysis results providing a SRS related to two Q factors, to derive the corresponding fast sine sweep, and to reproduce it on shaker. The key point is the elaboration of the time history. First investigations are in progress and have shown encouraging results.

References

ESA-ESTEC, ECSS-E-HB-32-26A (2013), *Spacecraft Mechanical Load Analysis Handbook*.

Girard, A., Dupuis, P.E. and Bugeat, L.P. (1998), “Improved shock characterisation”, *Proceedings of the European Conference on Spacecraft Structures, Materials and Mechanical Testing*, Braunschweig, Germany.

Girard, A., Roy, N. and Calvi, A. (2012), “Notching in sine testing: Understanding and practice”, *Proceedings of the European Conference on Spacecraft Structures, Materials and Environmental Testing*, ESA-ESTEC, Noordwijk.

Lalanne, C. (2009), *Mechanical Vibration and Shock Analysis*, John Wiley & Sons, 2nd Edition, **2**, Mechanical Shock.

CC