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Fast Coupled Loads Analysis Method: Norton-Thevenin Receptance Coupling

A new method called Norton-Thevenin Receptance Coupling (NTRC) has been developed to perform coupled loads analysis (CLA). NTRC provides a tool that payload developers can use to obtain launch loads at a fraction of the cost of a CLA any time it is required in the payload design cycle. NTRC combines the frequency domain component coupling method of Receptance Coupling with the Norton and Thevenin theory used in force limiting to derive an alternate method for performing CLA.

The Need for Rapid CLA

NTRC attempts to reduce the dependency of the payload organization on high CLA costs, long analysis schedules, lack of standard capabilities to evaluate multiple payload configurations, and unavailability of launch loads from the launch vehicle (LV) provider when needed. While NTRC is not intended to replace the formal load cycles performed by the LV provider, it can provide the ability to reduce the conservatism in defining preliminary design loads, assess the impact of design changes between formal load cycles, perform trade studies, and perform parametric loads analysis where many different design configurations can be evaluated with a minimum amount of data required from the LV provider.

NTRC Methodology

NTRC condenses all the necessary information into the launch vehicle to payload/s connection points or boundary degrees-of-freedom (BD). The LV model is represented by its impedance at its BDs; its forcing functions are represented by the acceleration at those BDs when the payload is absent; and the payload is represented by its impedance at the same BDs. Payload responses are represented by transfer functions of selected response to interface BDs.

The NTRC methodology is exact in the frequency domain, while time domain replication and accuracy can be within +5% as shown in the time domain plot. In summary, NTRC is an alternate coupling approach that can be used to replicate a standard LV CLA and was developed as a design tool for the payload community with the minimum information required from LV providers.

References

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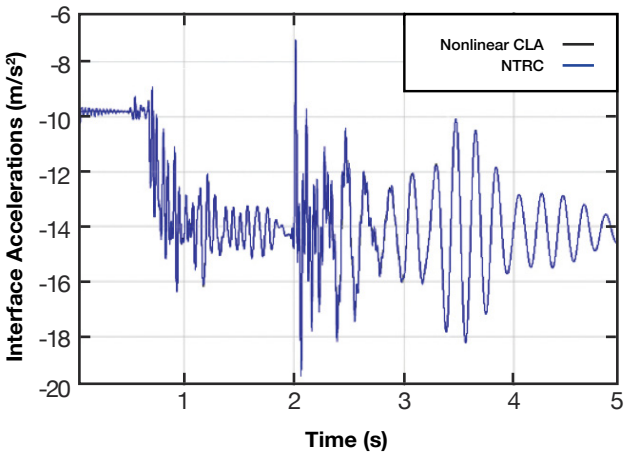

Interface accelerations in LV thrust direction capturing all relevant characteristics of Pad Separation CLA.

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