Institute of Environmental Sciences and Technology

IEST-RP-DTE019.1

Design, Test, and Evaluation Division
Recommended Practice 19.1

Vibration Controller Selection

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This Recommended Practice was prepared by and is under the jurisdiction of Working Group 019 of the IEST Design, Test, and Evaluation Division.

Second printing, July 2017

ISBN 978-0-9841330-4-8

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1 SCOPE AND LIMITATIONS

1.1 Purpose

This Recommended Practice (RP) is meant to provide rudimentary guidelines for those tasked with selecting a closed-loop digital shaker control system (DSCS) for use in vibration or shock testing, or both. This RP is concerned with single shaker operation only. It is not meant to be a specification for a specific purchase, but rather a focused treatise on factors that should be considered when setting out to specify a new vibration control system. It is assumed this system will be used for critical qualification of military or commercial products, for example, according to MIL-STD-810, and will be based on valid engineering design and exhibit robust performance.

1.2. Basic Control Concepts

In a professional closed-loop digital shaker control system, a desired power spectral density (PSD), sine profile, transient waveform, or shock response spectrum (SRS) is stored as a reference and compared, online, with one or more measured control responses. The drive signal is updated as necessary, each control loop, to maintain the specified test function. Typically, the control loop gain is measured prior to random or sine tests. When performing transient or SRS tests, both gain and phase of the control loop should be measured during system characterization to avoid unwanted pulse distortion during testing. In random control, both the spectrum shape and the root-mean-square (RMS) value of the test should be simultaneously controlled. In random and sine tests, control may be established using multiple control transducers to control to the average, the maximum, or the minimum of the measured responses.

Also, limit channels may be specified to avoid over testing of sensitive test articles. A combination of sine-on-random, random-on-random, or sine plus random-on-random may also be required. In these tests, control of all test components—including tones, bands, and broadband random—should be specified to avoid out of control conditions.

Occasional independent analysis of the control loop performance is encouraged as a means to assure uniform test results from a variety of available shakers and control systems.

A multi-pole, analog, anti-aliasing filter should be furnished at the input of each control channel of the DSCS to avoid downstream aliasing of measured control signals. Similarly, an analog anti-imaging filter should be present in the drive signal path from the DSCS digital/analog (D/A) to the shaker power amplifier to reduce or eliminate transition steps from the output D/A converter as well as unwanted low frequency drive energy.

The basic block concept of a closed-loop, controlled vibration test is shown in Figure 1.