# Special Feature

Advances in Reliability Testing

# Success in Reliability Test: Proper Use, Proper Gear

HALT and HASS provide a speedy path to improved product reliability testing. But the success of such methods depends on how they're used and the equipment available to perform sophisticated testing.

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An essential part of the COTS movement is the shift in focus toward meeting requirements instead of following detailed military specifications. That opened the door for system developers to embrace new environmental test methods. Such methods have been slow to gain the degree of following they should partly because of a reliance on Mil-Specs, most of which tend to be more than a decade out of date. Military contracts, for example, still make reference to MIL-STD-810F, the specification for environmental testing. But that spec doesn't make any mention of advanced environment screening methods like highly accelerated life testing (HALT) and highly accelerated stress screening (HASS). Conversely, consumer devices like rugged cell phones and laptops now even put "MIL-STD-810F" as a feature bullet point.

Testing systems to withstand pre-production thermal ramping and random vibration stimulation is collectively called HALT. An ability to withstand post-production highly accelerated stress screening (HASS) is likewise critical. While HASS and HALT aren't new—they've been in practice since the early '80s—their strict adherence is by no means universal among military system designers. An important concept in HALT/HASS is that a system can behave differently to vibration tests depending on whether the temperature is hot, cold or changing. QualMark and some other test chamber vendors are able to combine thermal stressing and vibration stress in the same unit. Qualmark's line of Typhoon Chambers, for instance, incorporates liquid nitrogen cooling into a high ramp rate thermal system, with an integral six degrees of freedom repetitive shock vibration system.

Another area within HASS and HALT—and one that's starting to gain awareness—is random vibration. Random vibration test calls for multi-axis excitation rather than traditional single-axis-at-a-time shaking. The traditional method was to use a mechanical shaker to shake a system in x direction, and then along its y direction, and then its z axis. Such tests are far from realistic because in the real world vibrations in different directions exist simultaneously. Multiple-axis shaking can be done using electrodynamic shakers (ED Shakers)—which are, in principle, like overgrown loudspeakers. Test labs that can do all six axes of shaking using electrodynamics are rare, but growing in number.

More realism can be achieved with additional shakers to provide roll, pitch and yaw torsional vibration motions. Total laboratory motion thus provides six degrees of freedom, which better simulates in-flight vibrations. These are not new ideas. We might mention here that 6-axis input motions routinely mimic road inputs to automotive vehicles. The auto industry employs six or more relatively long-stroke electrohydraulic shakers, rather than the electrodynamic shaker. The multi-axis inputs of seismic events are modeled in some labs by multiple electrodynamic shakers, and in other labs by multiple electrohydraulic shakers.

Board-level systems—the printed circuit boards and their onboard components (PCBs)—are a particularly complex item when it comes to multi-axis shaking. Boards can be very flexible or can be stiffened, and the chips and components on board affect that stiffness. Under random vibration, stresses from multiple mode shapes combine. All these complexities affect component life. Random vibration affects circuit boards in a way similar to a shaken trampoline. Shake a trampoline's supporting frame and the trampoline would flex along many axes at once.

Consulting firm and tool vendor CirVibe makes a tool for establishing, evaluating and optimizing environmental vibration stress screens for assurance of quality of components, PCBs and electronic assemblies. The tool performs detailed Finite Element Analysis (FEA) and does automated FEA model generation, modal analysis and detailed component stress calculations, and fatigue evaluations are performed from simple geometric descriptions of the hardware. ▮

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