

Accelerated Stress Testing Methods

FMVT®

In today's manufacturing environment, companies must use cutting edge technology to be leaders in their field. In the testing realm, manufacturers who make the commitment to advanced technologies are also reducing testing time & costs and improving efficiency, which help bring their products to market faster. A new method of accelerated stress testing, Failure Mode Verification Testing (FMVT), can help achieve all of these results. And while FMVT has been proven to effectively cut testing time and costs in the short-term, it can also result in higher quality components, parts and systems; with huge overall costs savings in the long run.



What is FMVT?

FMVT is a patented process to employ highly accelerated test methods. FMVT reveals inherent design weaknesses first predicted by the FMEA (Failure Mode & Effects Analysis) process. By exposing a design to a combined set of amplified environments/stresses, multiple failure modes (and their sequence and distribution) are produced in as little as one day.

FMVT brings disciplines together:

- Design engineering
- Reliability engineering
- Computer modeling
- Failure analysis

And because it can be completed in a day or two, FMVT makes it logistically and economically possible to bring people from all these areas into the testing process.

Advantages of the FMVT process include:

- Provides state-of-the-art validation information for better engineering and business decisions.
- Identifies real failure modes and their root causes.
- Increases product quality by exposing failure modes that may not be detected in traditional testing.
- Reduces development time by identifying failure modes at design verification.
- Reduces testing time and costs. FMVT allows for earlier and fewer tests.
- Reduces number of required prototypes for testing.
- Complements planned design iteration sequences.

FMVT Applications:

- Risk Management
- Product Validation
- Continuous Improvement
- Campaign Avoidance
- Design Verification
- Reliability Growth
- Warranty Reduction
- Late Design Changes

FMVT Key Principals

Test to Failure: By testing to failure, we can verify a design's or redesign's performance and manage the reliability growth and risk mitigation of the program.

DMFEA Drive Test Development: Test the design based on what can break it. Bring DFMEA to life.

Produce Multiple Failure Modes: Random stress provides the opportunity to induce multiple failure modes on a single product.

Conduct Failure Analysis: Root cause analysis tells the designer not just what failed but how and why and may give insight on how to correct.

Estimate Design Maturity: Calculate the design's opportunity for improvement and its technological limits.

HALT/HASS (Highly Accelerated Life Test/Highly Accelerated Stress Screen)

HALT

During the HALT process, a product is subjected to increasing stress levels of temperature and vibration (independently and in combination), rapid thermal transitions, and other stresses specifically related to the operation of the product.

The information goals of HALT are to:

- Determine multiple failure modes and root causes.
- Determine functional operating limits.
- Determine functional destruct limits.
- Focuses on thermal and vibration stresses (first separately, then combined).

HALT was developed specifically for solid state electronics, but can be applied to any product, with the correct equipment.

In general, the information goal of HALT is most effectively met by testing at the lowest possible sub-assembly:

- Consider a balance between a "functional assembly" and determining the technological limit of a product feature .
- Consider removing structure that dampens vibration or blocks air flow; reducing the applied stresses to sub-assemblies .
- Consider that loss of critical circuitry or connections may affect the sub-assembly tested.



HALT is a process of measuring limits: Operating limits represent the range a product will operate in, destruct limits represent the range a product can survive but may not operate within. The failure modes found at the edges of these limits is valuable information for improving the product.

HASS

Once the HALT process has been completed, and the product has been ruggedized, Intertek can develop a custom production screen to identify process defects.

Running HASS:

- Apply all stresses simultaneously. During vibration, continuously ramp temperature between brief dwells at extremes.
- HASS Stress levels are based on HALT limits.
- Include any "critical" additional product stresses (as determined from HALT, e.g. product power).

- Conduct precipitation screen and evaluate product beyond operating limits, near destruct limits. Precipitate failures in product due to "latent" defects.
- Conduct detection screen and evaluate product near operating limits. Confirm and explore precipitation screen failures, and other hard and soft failures

HALT/HASS RESULTS

Results identify/precipitate/eliminate failures due to:

- Poor solder quality
- Socket failures
- Bent or broken leads
- Incorrect or missing components
- Incorrect component location
- Failed fixtures
- Program errors
- Loose, missing, failed fasteners
- Lifted pins
- Worn, broken connectors
- Intermittent connections

HALT/HASS Product Applications

- Electronic Circuit Boards
- Electronic Sub-assemblies
- Electronic Components



Accelerated Reliability

Accelerated reliability uses a simple premise and some complex math to achieve a reliability estimate of a product for particular conditions.

As a particular source of stress is increased, time-to-failure exponentially decreases. This effect is used to design the accelerated reliability test. A simple example of this effect is the fatigue curves of steel.

As the stress level rises, the time to failure drops exponentially. Also the logarithmic rate of change is affected by the change in the physics of accelerated reliability.

In an accelerated reliability test, several sets of parts are tested at stress levels much higher than the expected service level. For example, 8 parts might be tested simultaneously (Test One) until four parts failed. This would establish one point on the accelerated reliability graph. Then another 8 parts would be tested at a slightly different stress level until four parts failed (Test Two). Testing of groups of parts at different stress levels would continue until enough data was collected to extrapolate the service condition time to failure.

MEOST (Multiple Environment Over Stress Testing)

Multiple Environment Over Stress Testing is a test method similar to FMVT. MEOST takes multiple stress and applies it to the product in a short period of time and elevates those stresses towards two-thirds of the destruct limit. The primary objective of MEOST is to find the failure modes so they can be addressed.