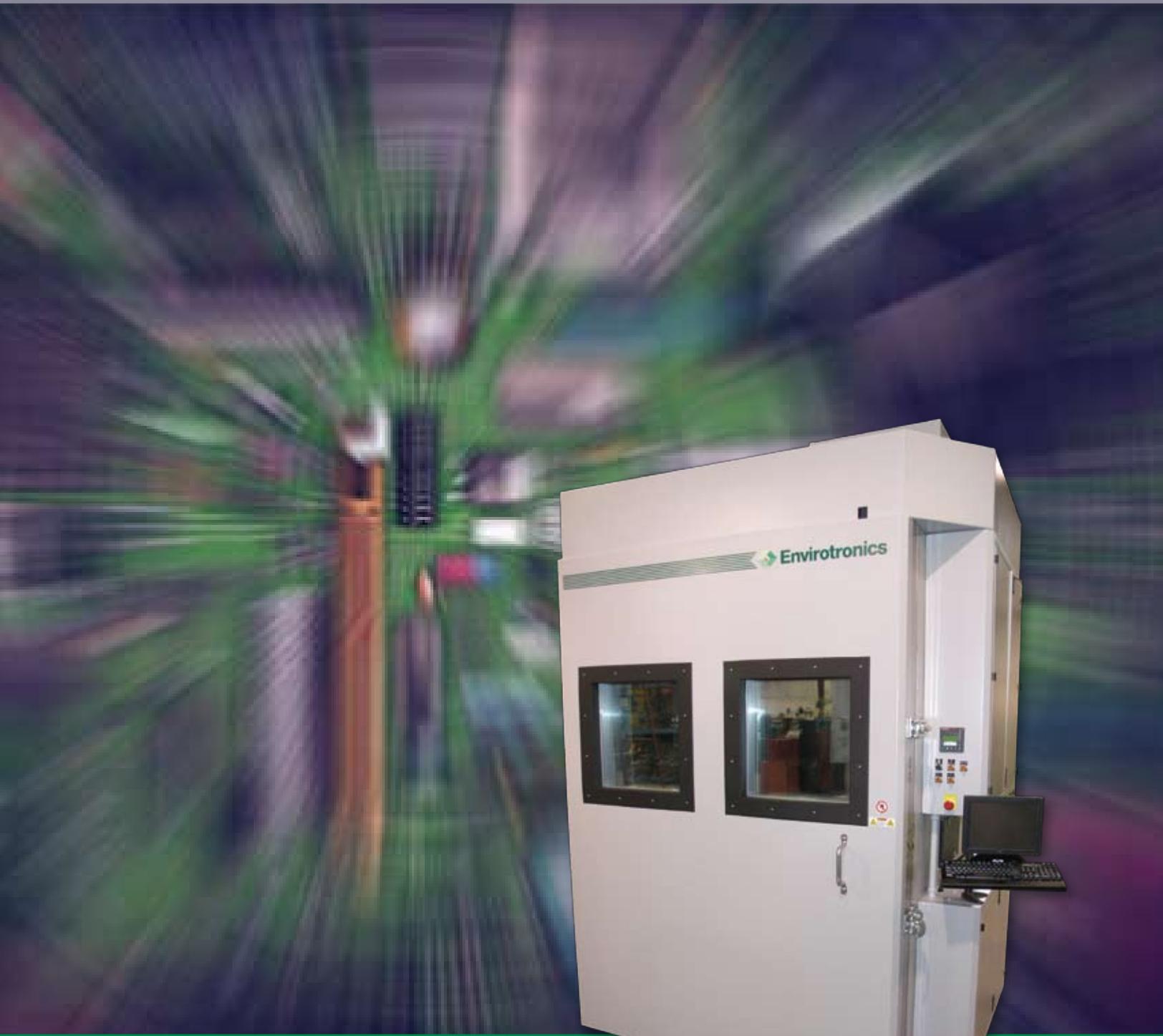


HALT and HASS



► **HALT/HASS Systems**

Test Equipment For Highly Accelerated
Life Test and Stress Screen Applications

Highly Accelerated Life Test

The goal of every manufacturing company is to bring a product of world-class quality to market in the shortest time and for the least expense. On top of that there is a further incentive to improve field reliability and lower warranty costs. Many manufacturers use HALT and HASS to help them achieve these goals.

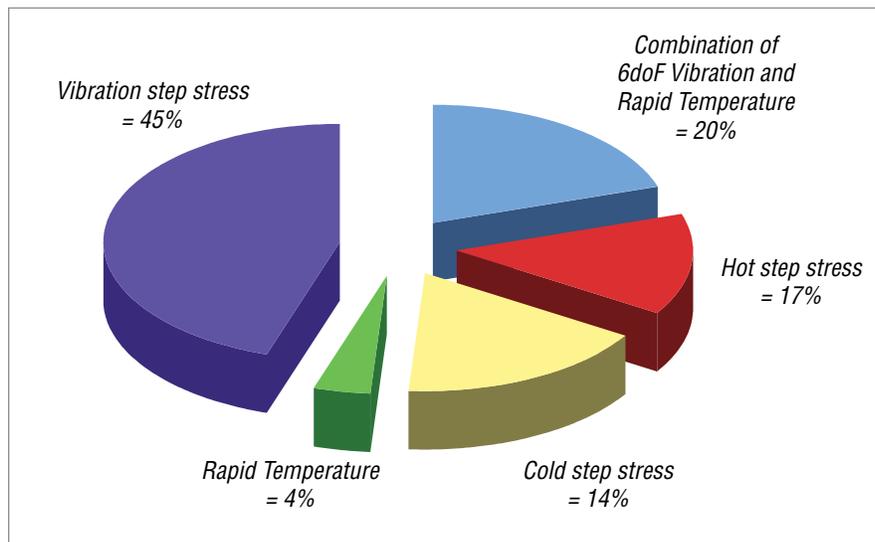
HALT is a step stress process performed during the product's **prototype** phase that determines a product's operating limits, identifies design weaknesses, and identifies weak components. The prototype phase is the fastest and least expensive point to make improvements.

In the HALT process, the test sample is subjected to progressively higher stress levels. Thermal dwells, rapid temperature transitions, vibration, and a combination of temperature and vibration are employed to precipitate latent, inherent defects in the design, at the component level, or in the manufacturing process.

Beyond the precipitation of defects, HALT stresses the product sample to failure. Robustness of design and margin above the product's intended operating level are determined. HALT is not a Pass/Fail test. It is process of discovery and design optimization.

HALT is a success when failures are produced, the root cause is understood, corrective action is implemented and product limits are understood and expanded. Information learned during the HALT process is used to develop a HASS screen for monitoring deviations in the manufacturing process.

HALT precipitated defects by stress environment



Highly Accelerated Stress Screen

HASS is a **post-production** process that can be performed on 100% of product or a partial sample of units (HASA - Highly Accelerated Stress Audit).

The main goal of HASS is to precipitate and detect hidden or latent failures. It is used to verify that no new “weak link” has crept into the product, since HALT, that has shifted the limits found in HALT. Ultimately, its purpose is to prevent flawed units from reaching the end-user/customer.

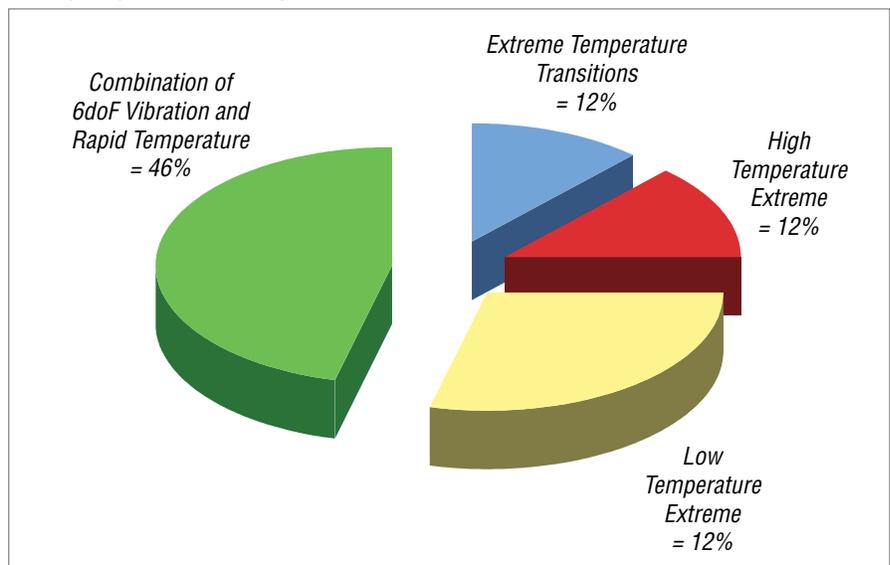
Typically, HASS stress levels are less than those used in HALT. However, they are generally more severe than anticipated in actual service. The goal is to use enough stress to find faults - but not enough to remove a significant amount of the product's life.

The benefits of HASS include:

- Precipitates hidden or latent failures caused by poor workmanship or manufacturing processes
- Verifies integrity of mechanical interconnects
- Prevents flawed units from reaching the end-user/customer (infant mortality/ out of box failure)
- Detects changes in components and processes
- Decreases warranty and field service costs
- Increases customer satisfaction
- Exposes process related variations in manufacturing
- Uncovers problems caused by changes to both software and firmware
- Uncovers component supplier quality issues and revision changes



HASS precipitated defects by stress environment



>The HALT Process

In HALT, product prototypes are subjected to high levels of environmental stress from least destructive to most destructive. The HALT procedure employed will vary based on the type of product being tested. Typically these would be cold step test, hot step test, thermal shock, vibration and combined temperature and vibration.

Along with environmental stresses, product specific stresses should also be applied to the product, such as power cycling, line voltage margining, line frequency margining, DC supply voltage margining, output loading, onboard oscillator margining and any other applicable stresses.

Test repeatability is the ability to reproduce a failure mode; however, exact stress levels to produce the failure may vary. Reproducing a failure mode at a specific stress level is not expected or required. In HALT what is important is the failure, not the stress level

Example: Temperature-Step Portion of HALT

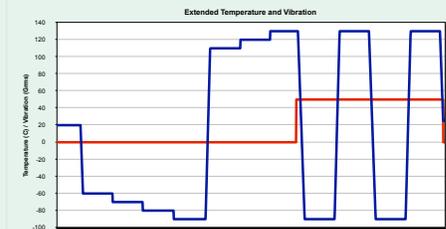
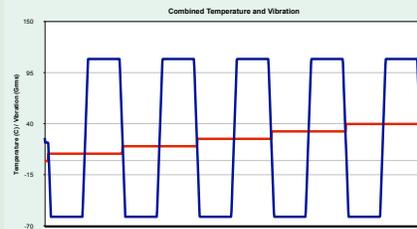
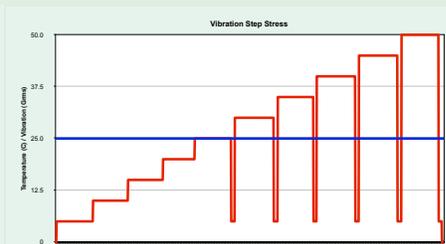
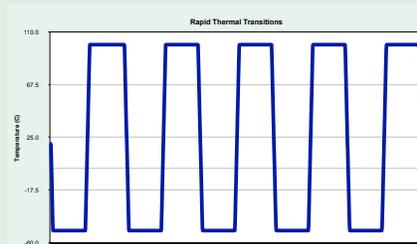
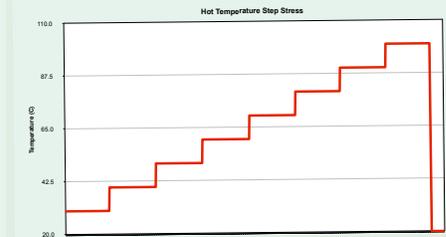
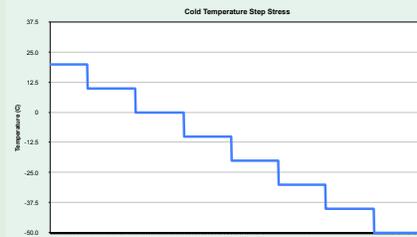
- Cold or Hot step stresses in 10°C steps
- Power cycling performed at minimum operating temperature +10°C.
- Add power cycling and voltage margining to find additional failures. Voltage margins should be tested beyond specifications to expose design problems.

Example: Thermal Shock Portion of HALT

- 5 thermal cycles with thermal change rates of 50°C per minute (or greater).

Rapid thermal cycling causes materials in the product to expand and contract at different rates, inducing stress and uncovering weak spots in the design.

Examples of typical HALT profiles



HALT and HASS profile graphs appear courtesy of Reliant Labs

Example: Vibration-Step Portion of HALT

- Step stress vibration in 5 gRMS increments, starting at 5 gRMS.

Once a diagnostic check has been completed, vibration testing continues at the next level.

With Envirotronics' powerful StarView software, you have the ability to monitor your product response as well as the table vibration levels.

Example: Combined Temperature and Vibration Portion of HALT

- Perform thermal cycles with thermal change rates of 50°C per minute (or greater).
- Increase in 20% increments of the operating limit. Dwell times of 15 minutes.

If no failure is produced, the rate of temperature change is increased and the vibration levels are increased.

When a failure occurs, the test is stopped and the failure mode and stress level is recorded. The failure is identified and documented. Root Cause Failure Analysis is employed.

At this point a temporary “fix” is implemented and the test continues on to higher levels of stress to uncover more failures.

HALT testing stops when the limits of the test equipment are met, when multiple failures occur in rapid succession with small increases in the stress level, or when the maximum level of the materials or technology has been reached.

Information learned from the HALT test will provide the product’s operating limits and it may also provide destruct limits.

The operational limit is defined as the stress necessary to cause a product to malfunction, but the product returns to normal operation when the stress is removed. The destruct limit is the stress necessary to cause a permanent or “hard” failure.

The difference between these limits is the margin for that particular stress. As the failure modes are found and eliminated, the limits are pushed further and further out, maximizing margins and increasing the product’s life and reliability.

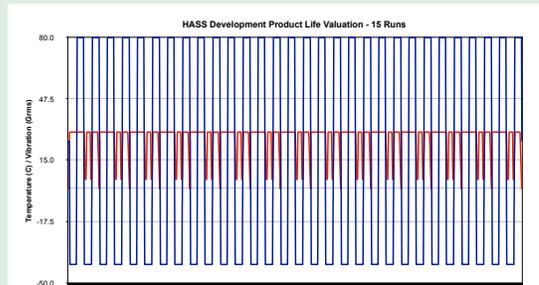
OTHER USES FOR HALT CHAMBERS

HALT Chambers are the perfect tool for returned products having failures that are hard to expose. Returned products are valuable because they contain a flaw.

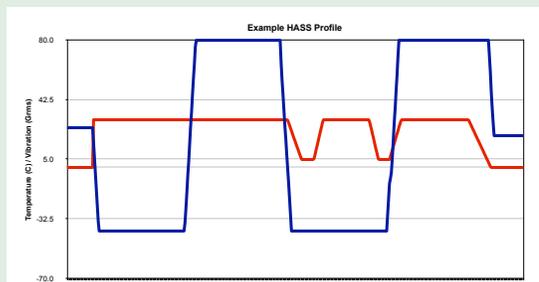
Temperature and vibration testing in a HALT chamber can often find these failures!

Examples of typical HASS profiles

HASS Development Proof of Screen (POS) - 15 Runs



HASS Profile



>The HASS Process

The HASS procedure employed will vary based on the type of product being tested. HASS is not just a test, it is a process – each product has its own process.

Problems uncovered may range from manufacturing mistakes to supplier quality issues. Root Cause Failure Analysis is performed on all failures. If no failures occur, the product passes – unlike HALT, HASS is a pass/fail test.

HASS stress levels are less than those used in HALT, but are generally more severe than anticipated in actual service. The goal is to use enough stress to find faults without removing a significant amount of the product’s life

Testing will begin with the HASS profile determined to be the most effective during the **Proof of Screen (POS)** process. POS is a process showing that a screen does not damage good hardware and that the screen is effective in finding the defects present in a product.

This consists of running the desired HASS process 15 to 30 times to verify that the screen is not removing excessive life from the product. By performing the proof of screen successfully it is determined that the HASS profile will not remove more than 1/15th of the product’s life.

Common defects revealed through HASS may include soldering problems, component failures, incorrect components, timing problems, IC Process change, IC Process problem, bent IC leads, electrical tolerance, mechanical tolerance and raw board problems.



Standard Test Chamber Solutions

Star Series™

> Galaxy 28/36/44

Integrated Pneumatic Vibration Table & Temperature Test Chamber HALT/HASS System



Envirotechnics Star Galaxy™ HALT/HASS Systems are integrated Test Chamber/ Vibration Table packages.

The surface mounting areas of the Star Series pneumatic random vibration tables allow great flexibility in mounting the product or fixturing. Our improved-efficiency pneumatic vibrators deliver the required vibration energy while utilizing 20% less air. This can translate into energy cost savings.

The Envirotechnics Star Galaxy chambers are equipped with a Liquid Nitrogen (LN₂) cooling system, which provides the rapid thermal change rates required to achieve maximum product stress.

The Galaxy system efficiently delivers high velocity conditioned air to the test space for unmatched temperature cycling performance. Our adjustable air flow package allows the user to redirect and concentrate airflow to the product under test for maximum product temperature cycling stress.

Galaxy system rapid thermal change rates are accomplished with smaller space requirements, lower audible noise, no water requirement, lower maintenance costs and greater efficiency than a typical refrigeration system.

Envirotechnics' unique control system gives the user the flexibility to control via one accelerometer or any combination of four accelerometers. The "brains" of the Galaxy System is the powerful StarView Software.

Envirotechnics' exclusive diagnostic and debugging **Component Control Option** is available to enhance each of the Galaxy models.



Star Series™

>Component Control

Diagnostic/Debugging Option for the Galaxy HALT/HASS Systems



During HALT testing, test engineers must perform temperature step stress tests on products until failures occur. Certain components may limit the engineer's ability to test beyond a temperature extreme.

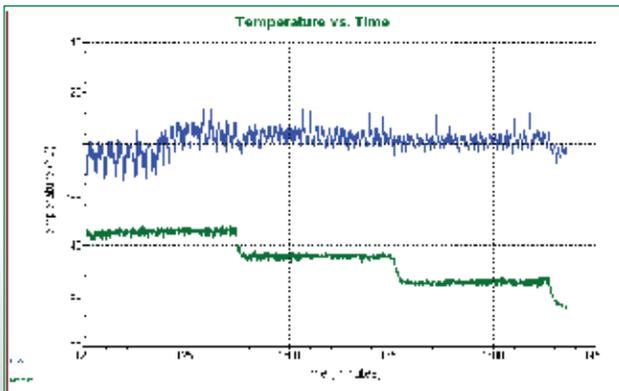
Envirotronics is the first HALT chamber manufacturer to successfully provide customers with a unique diagnostic component control feature that keeps components at ambient while stepping temperature.

With the Envirotronics' dynamic Component Control feature, you can keep these limiting components at an ambient temperature in order to continue temperature stress step testing beyond the point where testing would normally cease.

The Component Control feature includes a separate controller and thermocouple. With staged heating and a proportional control valve, Component Control provides accurate temperature control to allow testing to continue beyond normal product limitations. Flexible ducting allows this optional feature to be utilized on a wide variety of products.



The component control option provides you with a "second chamber" using its own controller, thermocouple, heaters and cooling system. We typically locate the "second chamber" on top of your HALT system.



The small component control duct can keep components like power supplies at ambient while you step hot or cold – keeping the UUT running when it would normally fail.



Standard Test Chamber Solutions

Star Series™

> Star Plus System 28/36/44 Pneumatic Vibration Table & Temperature Test Chamber HALT/HASS System



The Envirotronics AGREE-style chamber has been the chamber of choice for HASS/HALT testing for years due to its unsurpassed reliability and superior performance characteristics.

The Star Plus chambers are equipped with an LN₂ cooling system. This system, used in conjunction with the modulating valve and directed air flow to the product, provides the rapid thermal change rates required to achieve maximum product stress with smaller space requirements, lower audible noise, no water requirement, and lower maintenance costs than a typical mechanical refrigeration system.

The chamber enclosure is insulated with sound dampening material to keep operating noise levels of the vibration equipment well below 76 dBA. Access to the chamber is through the large, full-access front and rear doors.

The vibration table featured in the Star Plus System is a state-of-the-art, six degree-of-freedom (6DoF) tri-axial pneumatic vibration table. A benefit of its patented unique proprietary construction, this vibration table has one of the most consistent acceleration levels per unit area of any table presently on the market.

Due to ease with which the table can be moved, the two main components of the Star Plus System can be used independently from one another. The Star System's AGREE chamber can be used in one test application while the Star vibration table can be used as a stand alone unit in another application. The Star Plus System can almost be considered two test systems in one.

Vibration is controlled via Envirotronics' **StarVIEW** software.



Star Series™ >Star 28/36/44 Pneumatic Vibration Table



The heart of the Star Plus System is the Star pneumatic vibration table which produces quasi-random, six degree-of-freedom (6DoF), six axis, three linear (X, Y, Z) and three angular (roll, pitch and yaw) vibration accelerations in the frequency range of 20 Hz to 10 kHz. The table can deliver axis-specific vibration levels in a range from 2 gRMS to greater than *60 gRMS.

Due to its patented unique proprietary construction, this vibration table produces very consistent acceleration levels per unit area. The benefit of this is that multiple products tested on the table will all receive almost identical vibration forces, regardless of where they are mounted to the table. This is not true of most other vibration tables.

Table acceleration level can be monitored and controlled via a tri-axial accelerometer block (X, Y and Z axis) or via single Z-axis control. Use of tri-axial control/monitoring provides a much more accurate indication of the overall vibration levels your product is experiencing, compared to the Z-axis-only control used by some manufacturers.

The Star Series tables are equipped with an Airfloat™ pneumatic glide system. The table virtually floats when the pneumatic glide is activated, making it very easy to maneuver the table in and out of the chamber. Raising and lowering the table is so easy you can literally do it with one finger!

Due to ease with which the table can be moved, the table can be used independently from the chamber.

*Specifications for export models may vary.



Powerful Intuitive Control

> StarView Software Temperature and Vibration Control and Analysis



StarVIEW is a user-friendly Microsoft Windows™-based operating system that provides easy “point and click” program writing. The test profile is drawn on a graph as the program is written, allowing the user to check for errors as work progresses. *Ideal for creating custom HALT tests and HASS Profiles.*

Test Chamber Control

The StarVIEW software works in conjunction with a Watlow F4 chamber controller to monitor the air temperature and product temperature. *Used to monitor HALT Hot/ Cold Stress Step Test. Fourteen additional thermocouples and Thermocouple Patch Bridge are included with the Star Galaxy Deluxe and Premier Models.*

Vibration Table Control

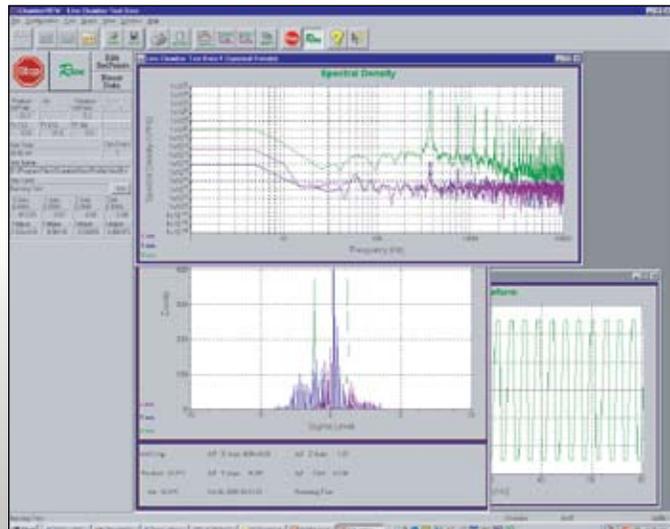
The StarVIEW software also controls the repetitive shock shaker table. The vibration gRMS level can be driven by the X, Y or Z-axis; or by an average of the three values. *Used to monitor HALT Vibration Stress Step Test. The unique StarView Control Software allows you to control from a single axis or from an average of multiple axes. Star Galaxy Deluxe and Premier models include one additional four-channel vibration system input module with cables (customer to supply additional accelerometers).*

Auto Spectrum

The vibration waveform is captured and the fast Fourier transform applied, resulting in the PSD graph which shows where the vibration energy lies in the spectrum. *The resonant frequency of the Star Galaxy vibration table is tuned to the optimal frequency range for small electronics components, typically between 900 and 2600 Hz.*

Vibration Waveform

A histogram of the acceleration vs. time shows the actual vibration g-levels that were reached on the table during that period. Peak spikes as high as 10X the indicated g-level can be shown in the histogram.



>AGREE - Style

Fast Thermal Change Rate Combined Temperature/Vibration Test Chambers



Available in standard sizes ranging from 12 to 110 cubic feet (400 L to 3100 L), the EV Series AGREE-Style test chambers can accommodate electrodynamic, repetitive shock and mechanical vibration systems and/or roll-in product carts. These chambers can also be used as standard reach-in style chambers with the use of a floor plug.

These chambers are designed for rapid temperature change rates. Mechanical refrigeration and LN₂ cooling systems are available to achieve the type of performance you require. All systems are high pressure leak tested and operationally tested to performance specifications prior to shipment.

Standard Features

- Cable slot and stainless steel access port with plugs
- Diaphragm and frame assembly, shaker to chamber interface
- Dual air circulation system with solid stainless steel jack shafts
- Automatic programming with linking and looping of individual programs
- Digital indication of set-point and temperature
- Type "T" thermocouple sensor
- RS232 and RS422 digital communications
- Event or alarm outputs
- Guaranteed soak and automatic hold

EV & EVH Temperature change rates*

Model	Volume	No Load Maximum Thermal Change Rate
EV 12	400 L	10°C/min.
EV 37	1000 L	20°C/min.
EV 53	1500 L	20°C/min.
EV 70	2000 L	20°C/min.
EV 82	2300 L	20°C/min.
EV 110	3100L	20°C/min.

*Specifications for export models may vary.



In this photo a Star 44 pneumatic vibration table is mated with an EV 70 test chamber



We'll find you a *Solution*

Our slogan, "we'll find you a Solution" says it all about what we do here at Envirotronics.

We find solutions for our customers' environmental test chamber requirements through innovative and intelligent design, quality customer service, and our commitment to excellence.

The images shown here represent a sample of the equipment solutions we provide for our customers. We would be delighted to discuss your test chamber requirements and how Envirotronics can provide a successful solution for you.

Let Envirotronics find a solution for you!



Temperature and Temperature/Humidity Test Chambers



Environmental Stress Screen Test Chambers



Altitude and Altitude/Humidity Test Chambers



Solid Construction and Modular Panel Construction Walk-In and Drive-In Test Chambers



Salt Spray and Corrosion Test Chambers



Mini- and Benchtop Temperature and Temperature/Humidity Test Chambers



Custom Designed and Manufactured Test Chambers



Solar Panel and Photovoltaic Module Test Chambers



Thermal Shock Test Chambers



Pharmaceutical Stability Chambers



Sand and Dust Test Chambers



Hydraulic Cement and Concrete Moist Cabinet Curing Chamber



AGREE-Style Test Chambers



Pneumatic Vibration Tables



Complete HALT/HASS Test Systems



ENV 0109 HLT



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