HALT and HASS

Test Equipment For Highly Accelerated
Life Test and Stress Screen Applications

Vötsch
Industrietechnik

Competence in temperature and climate

Vötsch was founded in Berlin in 1929 and has produced at today's location in Balingen-Frommern since 1944.
We at Vötsch develop and build test systems for quality assurance at the state-of-the-art of technology and taking the future into account.

With our products, we also take on responsibility for the safety and quality of products in many branches of industry. Since 1995, Vötsch has been a member of the Schunk Group. Combined know-how is the basis for trend-setting developments.

HALT/HASS Systems Highly Accelerated Life Test and Stress Screen Applications

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.

Highly Accelerated Life Test and Stress Screen Applications

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.

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).

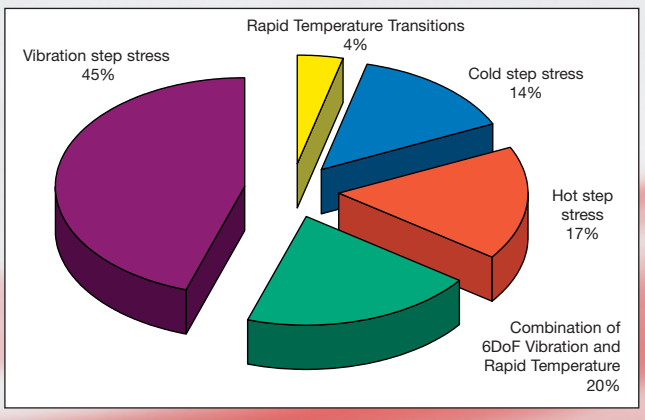
The main goal of HASS is to precipitate and detect hidden or latent failures. It is used to verify that no new "weak link" has crept into the product, since HALT, that has shifted the limits found in HALT. Ultimately, its purpose is to prevent flawed units from reaching the end-user/customer.

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
- Exposes process related variations in manufacturing
- Uncovers problems caused by changes to both software and firmware
- Uncovers component supplier quality issues and revision changes
- Increases customer satisfaction

HALT precipitated defects by stress environment



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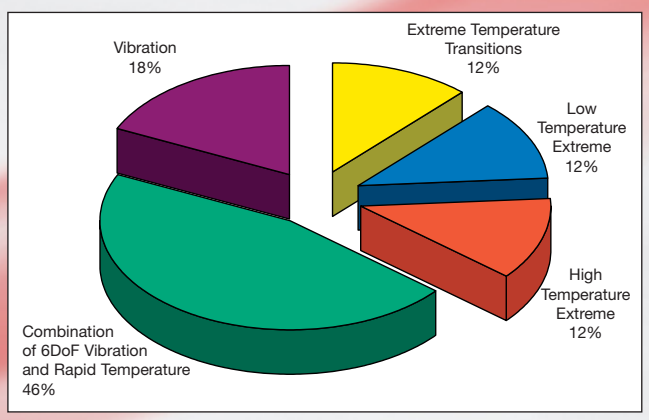


HALT-HASS Profiles

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.

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.

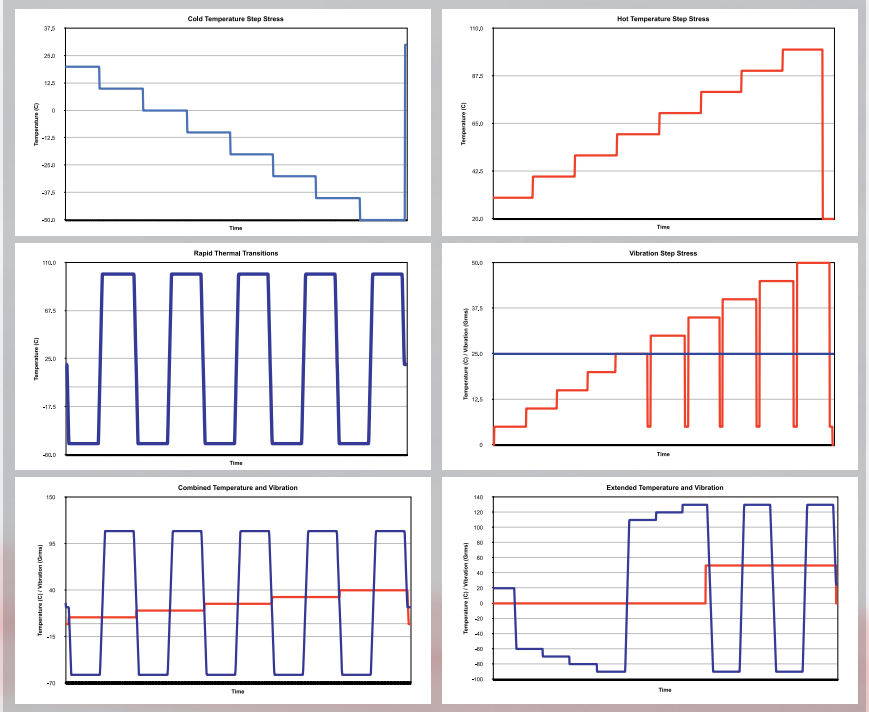
With our powerful StarView software, you have the ability to monitor your product response as well as the table vibration levels.

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.

Examples of typical HALT profiles



HALT and HASS profile graphs appear courtesy of Reliant Labs.

HALT-HASS Profiles

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.

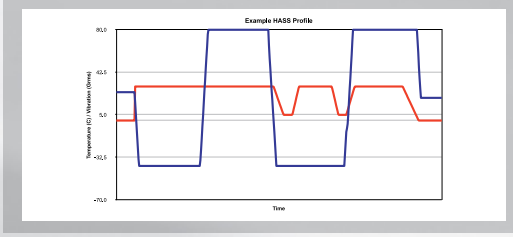
Other uses for HALT chambers

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.

Galaxy 28/36/44

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

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

The Star Galaxy chambers are equipped with a Liquid Nitrogen (LN_2) 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.

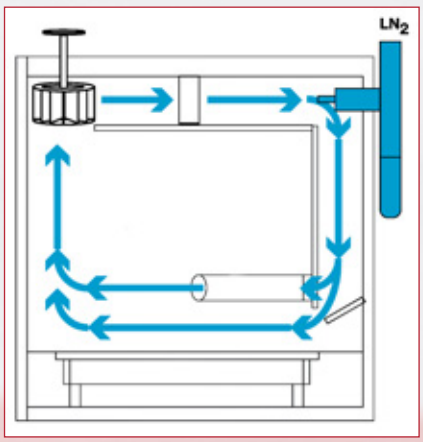
Our adjustable air flow package allows the user to redirect and concentrate airflow to the product under test for maximum product temperature cycling stress.

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.

The vibration table is a state-of-the-art, six degree-of-freedom (6DoF) triaxial 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.

The 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.

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



Function air space system

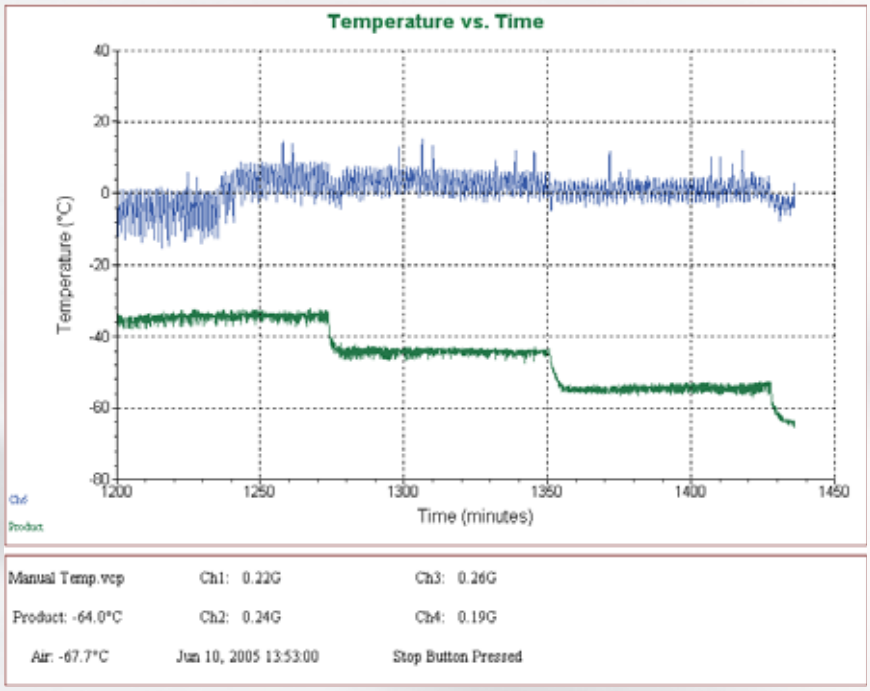
Component Control

Diagnostic/Debugging Option for the Galaxy HALT/HASS Systems

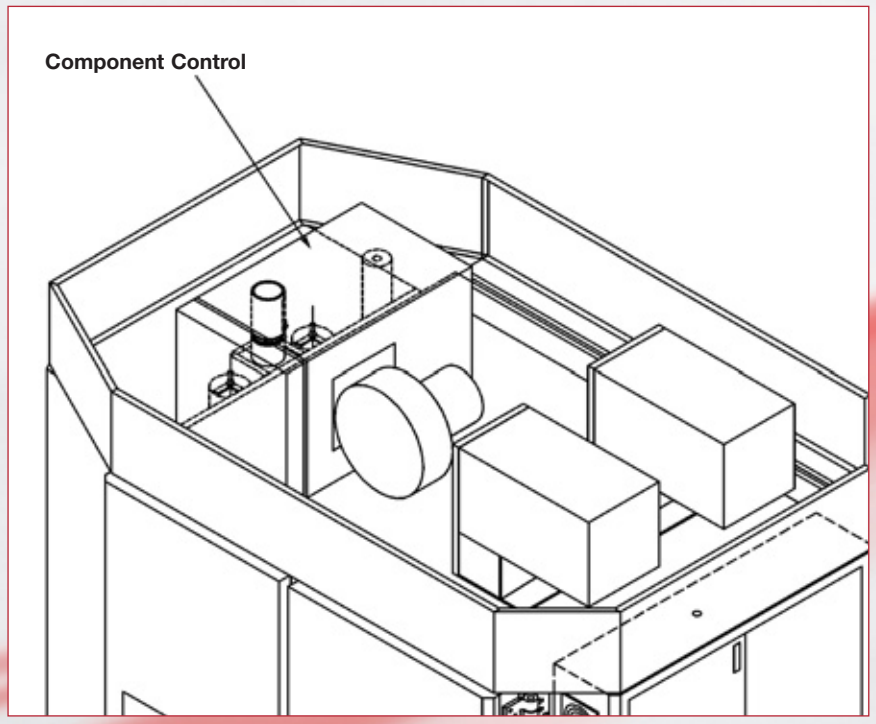
During HALT testing, test engineers must perform temperature step stress tests on products until failures occur. Certain components may limit the engineer's ability to test beyond a temperature extreme.

With the 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.



Installation Component Control

Star 28/36/44

Pneumatic Vibration Table

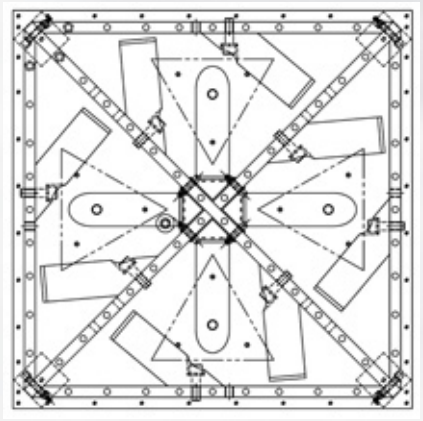
The heart of the Star Galaxy System is the Star pneumatic vibration table which produces quasi-random, six degree-of-freedom (6DoF) – three linear (X, Y, Z) and three angular (roll, pitch and yaw) – vibration accelerations in the frequency range of 5 Hz to 10 kHz. The table can deliver axis-specific 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 mouted 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 his movability, the table can be used independently from the chamber.



Function Vibration Table

Temperature and climatic test systems Series VTV/VCV

Stress Screening with vibration, temperature and climate

In case of demanding vibration tests – that require temperature change rates of up to 25 K/min. or the simulation of climatic conditions – it is possible to combine the Star Vibration Table with our VTV or VCV vibration systems. Random vibrations are among the most effective methods of Environmental Stress Screening (ESS). Temperature and climate have an influence on the vibration behaviour of tested materials, therefore, both constant and cyclically alternating temperatures and climates are of central importance for vibration and random tests.

The proven results obtained from the temperature and climatic test systems form the basis for our high quality standard.

For supplying/measuring connection to your modules/devices thermally decoupled entry ports fitted into the chamber side walls can be utilized.

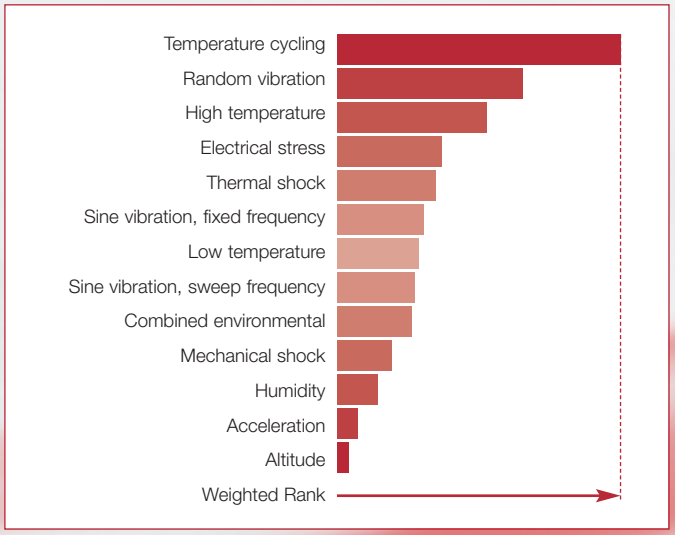
The test chamber with its vapour-tight welded stainless steel container can be turned into a fully functional climatic test chamber with the help of exchangeable floor elements.

The design of our special seals for doors, floor elements and vibrator ducts are based on decades of experience.

The optimized airflow, which has been specially developed for this application, ensures rapid temperature cycles and a high heat compensation.

This ensures consistent temperature conditioning for the specimen along with minimum deviations in temperature distribution.

Further information is available in our brochure on temperature and climatic test chambers of series VTV and VCV and on our website **www.voetsch.info**



Effectiveness of different environmental screening methods

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. 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

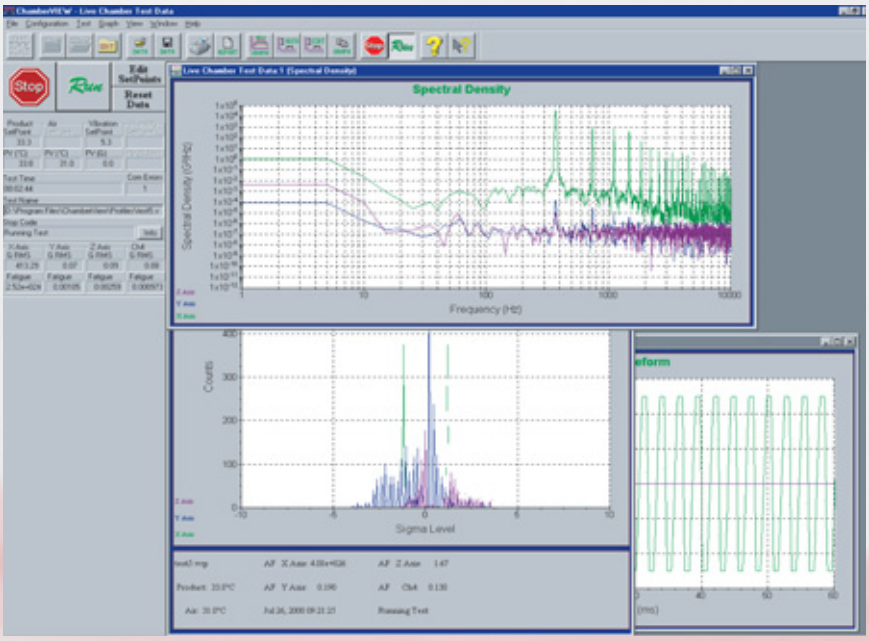
The StarView software also controls the repetitive shock shaker table. The vibration gRMS level can be driven by the X, Y or Z-axis; or by an average of the three values. Used to monitor HALT Vibration Stress Step Test. The unique StarView Control Software allows you to control from a single axis or 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.



Technical data

Type			Star Galaxy 28			Star Galaxy 36			Star Galaxy 44		
			Standard	Deluxe	Premiere	Standard	Deluxe	Premiere	Standard	Deluxe	Premiere
Test space volume		ltr.	1230			1680			2330		
Temperature range		°C	-100 to +200			-100 to +200			-100 to +200		
Heating / Cooling performance max.		K/min.	70			70			70		
Vibration table performance (standard)*											
Max. gRMS z-axis			60			60			60		
Frequency range		Hz	5 – 10.000			5 – 10.000			5 – 10.000		
Test space dimensions	W	mm	965			1220			1370		
	D	mm	1145			1295			1370		
	H	mm	1120			1065			1245		
Table dimensions	W	mm	710			915			1120		
	D	mm	710			915			1120		
Numbers of pneumatic actuators			8			12			16		
Shaker table access height		mm	760			760			760		
Exterior dimensions	W	mm	1790	1790	2085	2045	2045	2335	2195	2195	2490
	D	mm	1475	1475	1475	1625	1625	1625	1700	1700	1700
	H	mm	2595	2595	3005	2615	2615	3025	3200	3200	3225
Instrument console	W	mm	610			610			610		
exterior dimensions	D	mm	865			865			865		
	H	mm	1755			1755			1755		
Shipping dimensions	W	mm	2045	2045	2335	2300	2300	2590	2450	2450	2745
chamber	D	mm	1725	1725	1725	1880	1880	1880	1955	1955	1955
	H	mm	2775	2775	3180	2795	2795	3200	2995	2995	3405
Shipping weight		kg	1800			2090			2250		
Power supply requirements			3/N/PE AC 400 V 10 % 50 Hz								
Rated power		kW	68			90			100		
Rated current		A	105			135			150		
Compressed Air Supply Requirements											
Air pressure min.		bar	8			8			8		
Max. air consumption at max. gRMS		l/min	2100			2800			4200		
Liquid Nitrogen Supply Requirements											
Pressure min.		bar	4			4			4		
Max. consumption		l/min	23			42			53		

* Vibration table performance can be increased up to 100 gRMS z-axis.

Subject to technical changes. Some devices are illustrated with options.

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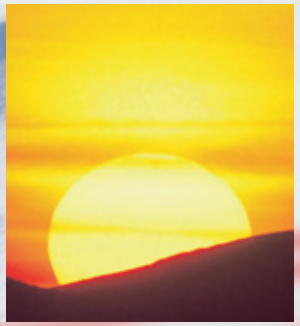

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