m+p
international

Experts in Vibration

Vibration Testing
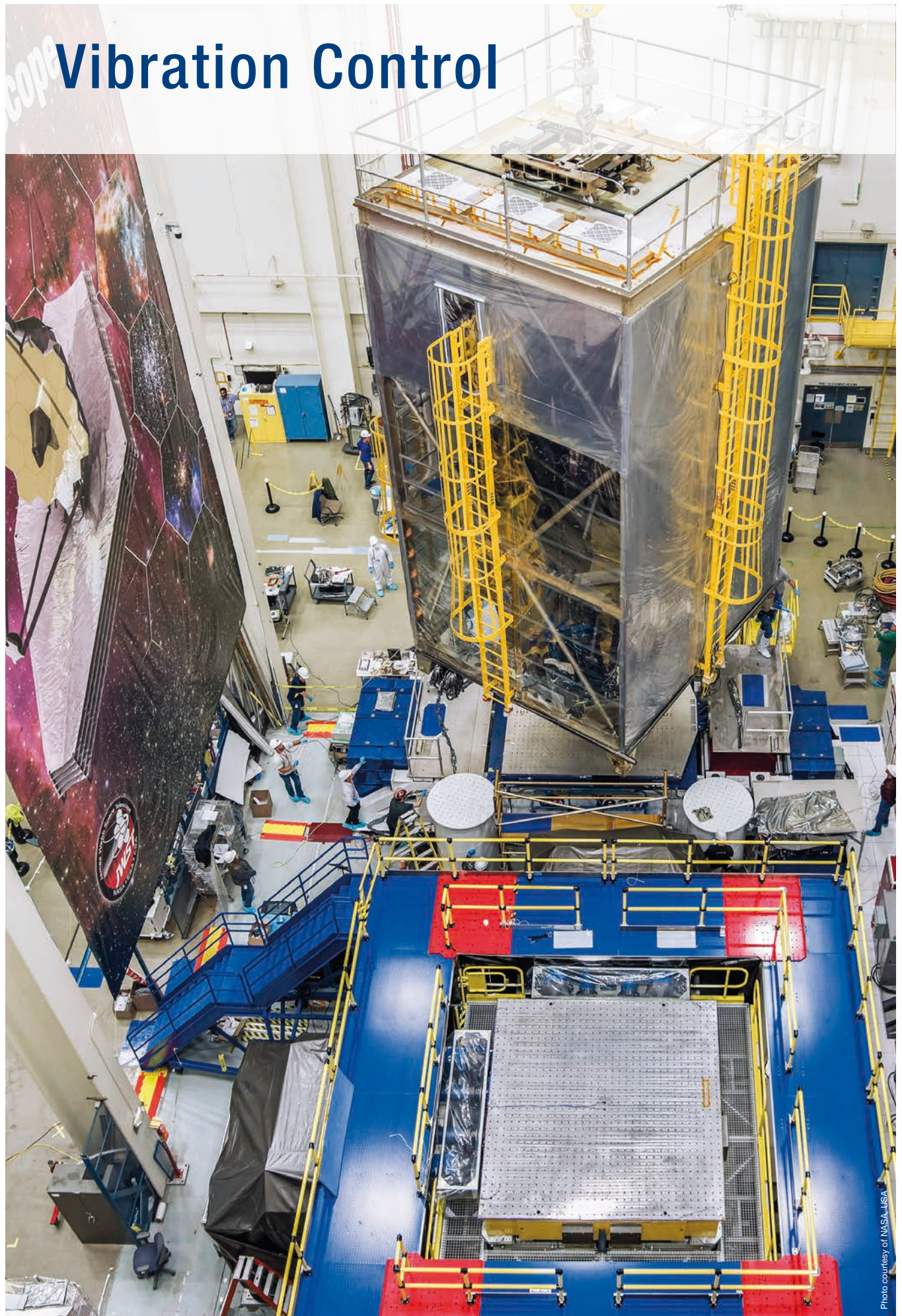# m+p VibControl

Vibration Control

YOUR BENEFITS

- **Full range of excitation modes available**
- **Compliant with all relevant industrial standards (MIL-STD 810, DIN EN 60068, et al.)**
- **All current Microsoft Windows (32-/64-bit) operating systems supported**
- **Scalable software and hardware from 4 to 256 channels with the same user interface and functionality**
- **Vibration monitoring for maximum protection of specimen and equipment**
- **Time domain displays and data storage for all excitation modes**
- **Notching/Force Limiting for sine and random minimizes overtesting**
- **Multi-monitor support for high channel counts**
- **Automated and customizable report generation**
- **Test schedules and external hardware control with digital I/O**
- **Selectable user interface languages**

The m+p VibControl products for advanced vibration and shock testing from four to hundreds of input channels are used by many of the leading environmental test laboratories throughout the world. End users appreciate the simple operation, extensive analysis and reporting functions, and powerful upgrade possibilities, as well as the excellent stability and high quality of the systems.

In cooperation with renowned partners, m+p international provides complete vibration test systems including shaker and accessories as well as combined climatic and vibration test stands.

Photo courtesy of Atlas Elektronik, Germany

Vibration testing of a PC

Future-Proof Software and Hardware

Thanks to the modular design of software and hardware, m+p VibControl can be configured and expanded at any time to tackle other measurement tasks and higher channel counts. Software add-ons are possible for all test modes, including special post-processing functions, automatic test sequencing, etc.

m+p international regularly adds enhancements to its m+p VibControl software. These software revisions ensure that you always benefit from the latest technology, helping to increase testing efficiency.

Our state-of-the-art, high-precision measurement hardware ensures long-term support and system longevity. What if you want to replace the measurement front-end you have used for many years with the latest hardware technology? No problem, we will equip your existing m+p vibration controller with the newest generation of m+p hardware without making changes to the familiar user interface.


m+p measurement hardware from 4 to hundreds of input channels

Common User Interface

All m+p VibControl systems are controlled by the same proven Microsoft Windows-based software. A single interface with the same look and feel means that test specifications can be transferred from engineering to production without change or error and test data can be compared directly between one system and another. Common reporting formats improve communication and data can easily be shared over a network and accessed from anywhere.

This makes intra- and inter-company data sharing simple and straightforward and improves productivity. Since the user interface is common across the whole platform, features typically integrated in high-end systems (e. g. notching in sine and random test mode) are also available for low-channel count system configurations.
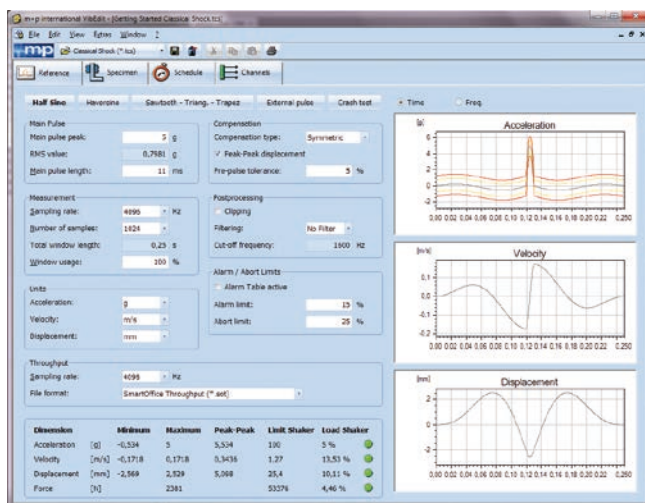
Single interface from four to high-channel count vibration control systems simplifies communication and data sharing

The m+p VibControl solutions for data reduction with time history recording to throughput disc and acoustic testing in a reverberant chamber are based on the same user interface and hardware platform as the shaker control systems. Therefore they can be configured for different applications simply by adding software modules, significantly reducing purchase costs and operator training.

Our user interface is multi-language.

Test Item Protection and Safety

Protecting your valuable unit under test is our top priority. Our software and hardware utilize many safety features to ensure reliable closed-loop vibration control – from pre-test checks to abort checking, notching and controlled shutdown.

The self-check function is an extremely powerful tool for detecting possible set-up problems before your test is started. During closed-loop control the m+p VibControl software performs RMS and line-by-line abort checks, sigma clipping and drive limitation and continuously checks for open channels and overloads. Notching limits the upper vibration level on any number of control or measurement channels, thus minimizing overtesting of the structure. m+p international's hardware ensures rapid, safe shutdown under any circumstances.
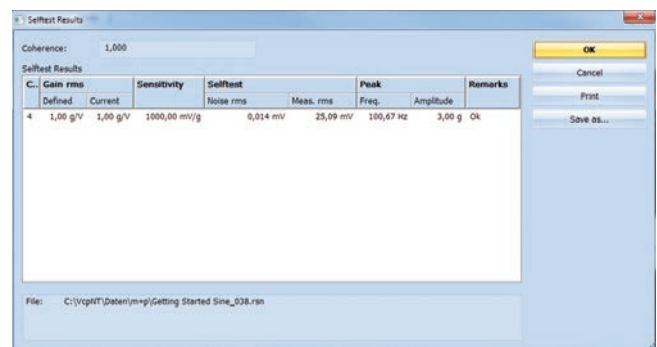
The self-check results indicate that the test was properly configured

True Multi-Tasking

Since the real-time measurement and control processes are independent of the user interface, you can utilize all the capabilities of the host computer, e. g., generate and print out a test report or set up a new test while the front-end performs the measurement and vibration control tasks.

This multi-tasking concept not only guarantees powerful and time-efficient vibration testing even with time-critical tests but is also an important safety feature, as any unwanted computer command or failure cannot affect the vibration controller.

> *We selected m+p international following the good experience of other Continental Automotive Labs and also because the technical specification of the controller completely matched our needs. I'd also like to commend the very good support we received from them.*
>
> Christian Tibke, Group Leader Qualification Laboratory at Continental Automotive, Timisoara, Romania

Automated Functional and Climatic Testing

With the m+p VibUtil module, our vibration controllers offer a versatile tool for automated vibration testing and combined climatic and functional testing. m+p VibUtil easily combines individual vibration tests of identical or different test modes in any complexity of nested loops.

Test status reports can be sent via email or SMS text message to your mobile phone. A protocol file documenting the most important test events is attached.

m+p VibUtil can be easily extended to control eight digital input channels and eight digital output channels which provide links to external equipment such as environmental chambers for combined testing. You can automatically control the power amplifier, i. e., shut it down at the test end and switch it on when a new vibration test is to be started.
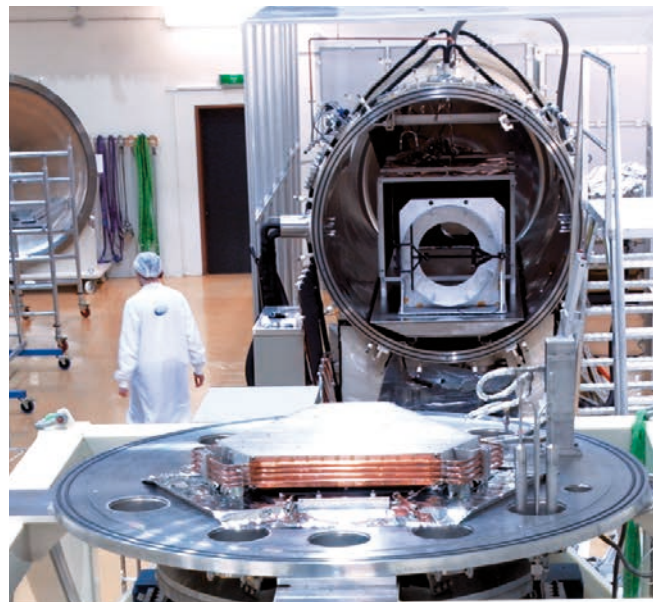

Always in control: test status report via SMS text message

Remote Client

The m+p VibControl systems also provide an optional remote client licence which is invaluable to many operators. Often a controller is crowded by engineers trying to view a vibration test during the test run. However, with the remote client, live data can be viewed during an actual test via network or wireless network on a tablet or desktop PC in an entirely different area. The licence allows full m+p VibControl functionality except running the test.
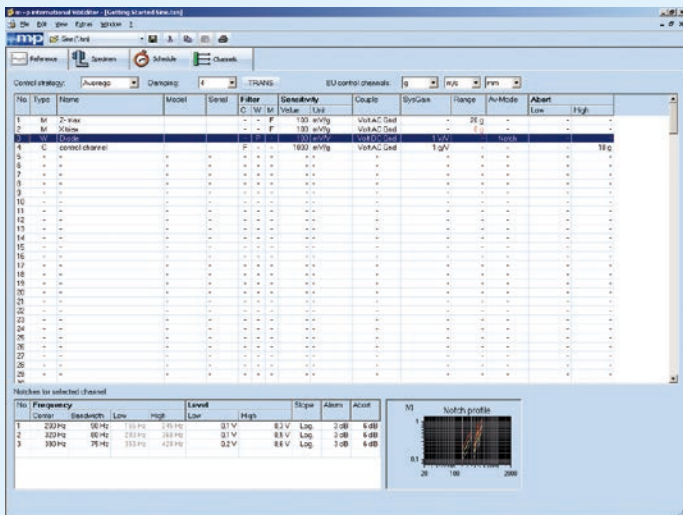
Transducer Calibration

m+p SensCal program provides a quick and simple process for calibrating accelerometers (piezo-electric with charge output or IEPE, piezo-resistive, capacitive) in your laboratory, as well as velocity or displacement transducers. We offer the m+p SensCal program as an add-on to a wider m+p vibration test system for checking its transducers without any additional acquisition hardware; or it can be utilized as a standalone calibration system. The results (amplitude and phase) are automatically recorded and output to a detailed calibration certificate for later reference.

Photo courtesy of Centre Spatial de Liège, Belgium

Reliable, high-speed multi-channel vibration controller for spacecraft testing
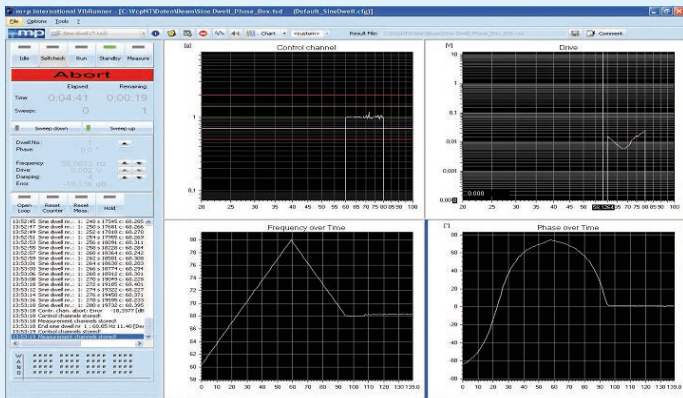
Transducer calibration in your laboratory

Setting up a random test

Notching on defined channels to protect against over-testing

Sine dwell test run with frequency/phase over time charts

Multi-Screen Support

The highly flexible online display capabilities are expandable, thus making monitoring of high-channel count systems quicker and easier. Operators can open up to 16 online graphics windows on a single monitor to display 64 channels and see all the necessary information at a glance. The remote monitoring function enables customers to observe the channel information on remote PCs without any measurement hardware connected. If you need to observe more than 64 channels, simply use the multi-screen option. A system can be configured with the multi-screen module and a dual or quad graphics card for support of up to four monitors and 256 channels; if required, even more monitors are supported. Channel layouts for each monitor can be set up and stored for quick access.

Displaying 32 online graphics windows on two screens

Vibration Monitoring and Overtest Protection

Vibration tests must be safe and reliable and this is especially true for high value specimens in critical testing applications. Here, our monitoring system offers maximum safety: It captures and records data such as acceleration, temperature and strain continuously during the vibration test. Each channel can be configured separately for total flexibility. m+p international's monitoring system protects the specimen and shaker reliably, e.g. against misconfiguration. If required, the shaker will be switched off immediately. Alarm events are entered into a log file and can be reviewed at any time. Continuous monitoring before, during and after a test with m+p VibControl online or offline is also provided.

Excitation Modes

m+p VibControl supports all control modes used in today's vibration testing – everything from simple ESS random to mixed mode gunfire, drop table capture and unlimited time data replication. All tests are fully compliant with ISO, DIN, MIL-STD 810 and many other standards. In sine and random modes, you can designate all input channels as control, watchdog and/or measurement channels. DC signals can be measured and monitored for functional testing in all test modes.

Random incl. Notching/Force Limiting
Resolution up to 25,600 lines, selectable in 8 steps. Frequency range up to 12.8 kHz or 40 kHz, hardware dependent. Control strategies: average, maximum or minimum. Frequencies or frequency bands can be defined where limiters take control if the response vibrations exceed a predetermined limit. Kurtosis control increases the peak level content to enable a wider range of real-world situations to be simulated.

Sine incl. Notching/Force Limiting
Frequency range up to 20 kHz or 40 kHz, hardware dependent. Measurement filters: RMS, peak, averaged or digital tracking filter. Control on acceleration, velocity, displacement and force.

Sine Resonance Search & Dwell
Control criteria: fixed frequency, fixed phase, defined phase, auto phase, peak amplitude.

Sine Displacement and Velocity Control
For sine testing starting at very low frequencies, displacement transducers can be used. At a defined frequency, the control changes automatically from a displacement transducer to an accelerometer.
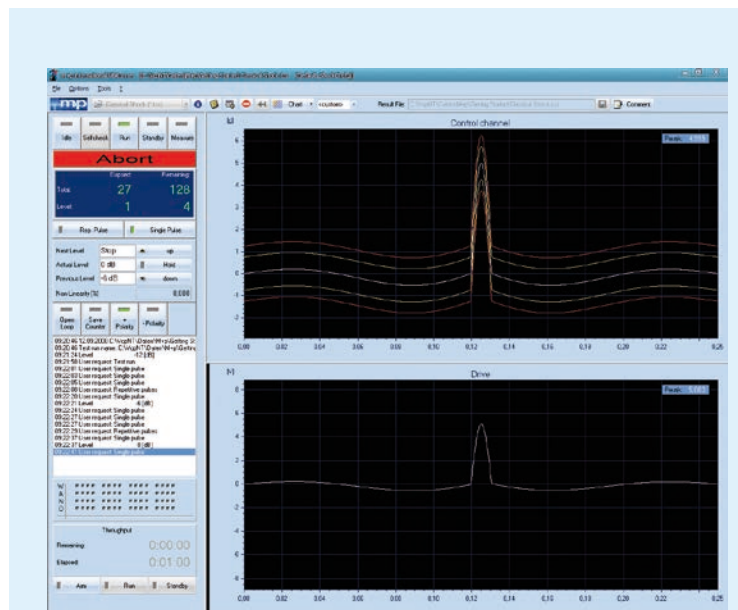
Classical Shock
Reference waveforms: half-sine, haversine, sawtooth, triangle, rectangle, trapezoid. Alarm limits as per MIL-STD 810, DIN, GAM-EG 13 and user-defined. Peak-to-peak displacement to guarantee the best shaker performance.

Shock Response Spectrum (SRS)
Frequency range up to 20 kHz. Calculation of maximax, positive and negative SRS. Automatic SRS optimization. Wavelets and damped sine components. 1/1-1/24 octave analysis.
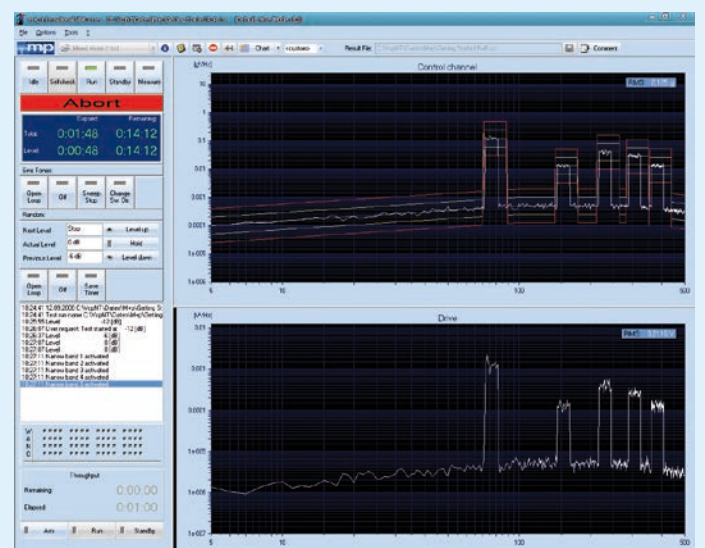
External Pulse
Import of ASCII data for replication with pulse editor. Synthesis of any pulse form. Kinematic compensation for minimum shaker displacement.

Classical shock test run

Setting up a shock response spectrum (SRS) test

Mixed mode testing: the ultimate in vibration control

Road load simulation provides an easy way to transfer data from the true environment to the test lab for reproduction on the shaker table

Online random data reduction with throughput to disc recording

Photo courtesy of ACS Group, France

Combined climatic and vibration testing of car sunroofs

Sine-on-Random (SoR)

Up to 10 independently sweeping sine tones are overlaid onto a random background. Sine tones and broadband random signal are generated separately. Gunfire burst simulation.

Random-on-Random (RoR)

Up to 25 independently sweeping narrowband random signals are overlaid onto a random background. Each narrowband has its own profile and limits.

Sine-on-Random-on-Random (SoRoR)

Sine-on-random is combined with random-on-random.

Multi-Sine Excitation

Simultaneously sweeping up to 10 sine tones at different levels across the desired frequency range using different levels and profiles. Also known as "no random option for mixed mode".

Time Domain Replication (e. g. Road Load Simulation)

Complete solution for the transfer of data from the true environment to the vibration test lab. Unlimited time data replication. Continuous closed-loop control.

Time History Recording to Throughput Disc

For the most critical tests time sample data can be recorded in parallel to control with no reduction in control performance. Complete time domain history is available, recorded with high sample rate. This facility is also available in recorder modes without closed-loop control. Post-analysis of the time history data is possible using the Sine and Random Data Reduction modules with the benefit of using the same familiar user interface. Data can be exported for analysis to m+p Analyzer package or other advanced analysis systems.

Data Reduction Modes

Random Data Reduction

Online analysis of measured data or taped random data (PSD averaging). Measured data can be recorded on throughput disc.

Sine Data Reduction

Track and online analysis of measured data or taped swept sine data using a COLA signal. Time data can be recorded on throughput disc.

Transient Capture

Capture of transient signals such as drop table or pyroshock pulses with calculation and overlay of SRS or classical shock limits. For applications with high "g" hammer/tap impact. Scope function. Various triggers. Measured data can be recorded on throughput disc.

Analysis

m+p VibControl's post-testing includes extensive data handling, advanced cursor functions, single and multiple data graphing, peak search, mathematical functions, and transfer function analysis, as well as displaying and printing traces from different sources in a single window.

Transfer Function and Transmissibility
Linking the behaviour of control and measurement channels in the test run.

Mathematical Functions
Converting the measured acceleration signal into velocity and displacement, or vice versa (sine and random test mode).

Automatic Peak Search
Peak values will be marked automatically in the graphics and listed with their numerical data in a table, single or multiple plots. Q-factor calculation in sine.

### Graphical and Numerical Measurement and Reference Data Analysis
- Control and response spectra with reference, alarm, abort and notch limits
- Error
- Drive
- FFT amplitude and phase in sine and random
- Coherence in random

Printouts
- Multiplot: displaying and printing traces from different test types, several test runs or multiple test specimens in one graphic window.
- Peak search
- Autoplot: automatically printing a preselected series of graphics.
- Printing a list of preselected test parameters.
- Printing directly to MS Word using a customer-defined template.

Reporting

The presentation of the test results is as important as a successful test completion. The m+p vibration controllers are perfectly positioned to meet the most demanding requirements. The reports are generated online while running a test or upon test completion. User comments, company logos and graph markers can all be added to create a complete report-ready display. Data and graphics are copied and pasted to standard Microsoft Windows applications such as Word and Excel and can be exported into Universal File Format. The ultimate step in electronic report generation is using the m+p eReporter software package to which the m+p VibControl data can be directly exported.
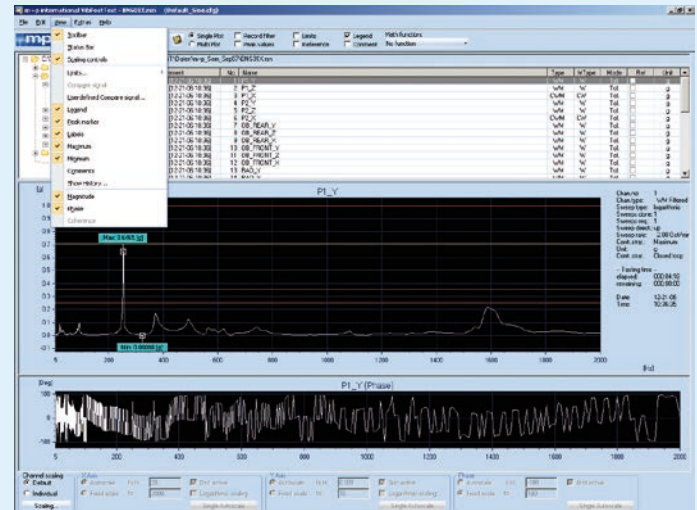
Comprehensive analysis functions
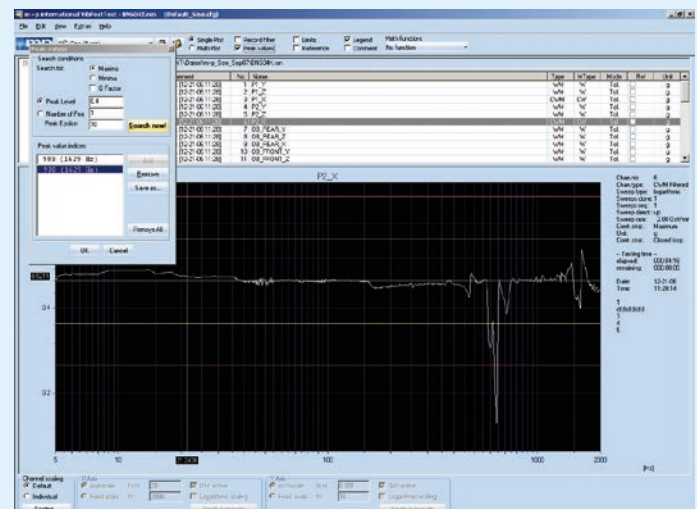
Automatic display of peak values
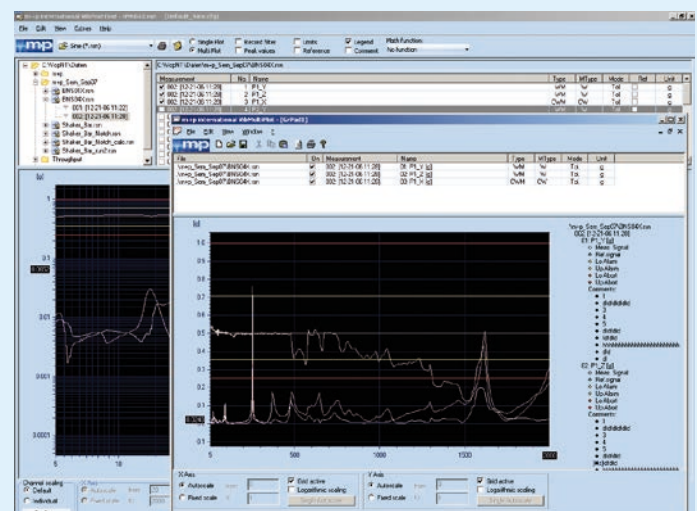
Multiplot with data from different result files
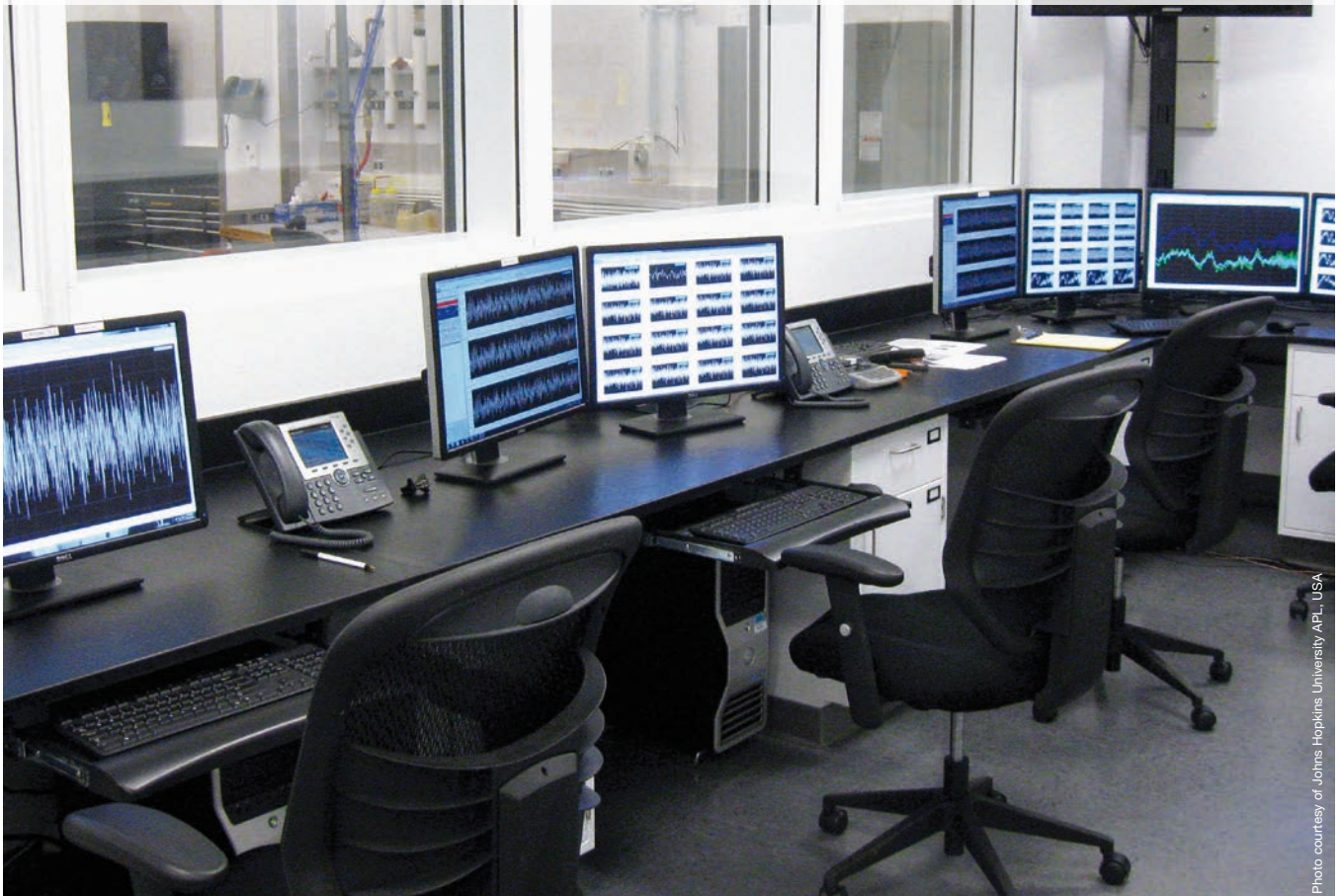
Data Reduction and Throughput to Disc

High-channel count data acquisition and vibration control system for large-scale spacecraft testing

Photo courtesy of Johns Hopkins University APL, USA

Data Reduction for High-Channel Count Systems

Data reduction systems with or without time history recording are frequently used in critical aerospace testing applications where complete measurements of a high number of channels are required for post-test and possible failure analysis. The m+p VibControl data reduction system configurations are tailored to the specific needs of high-performance measurement applications requiring hundreds or thousands of input channels.

The online analysis and display functions give a fast overview of the test results during the test or when stored data are replayed. Advanced data analysis tools include the m+p Analyzer post-processing software for random, sine, shock and acoustic data, providing seamless integration with Microsoft Office products for comprehensive test reporting.

Data formats and data plots of the m+p VibControl data reduction and vibration control systems are the same allowing for a common reporting environment.
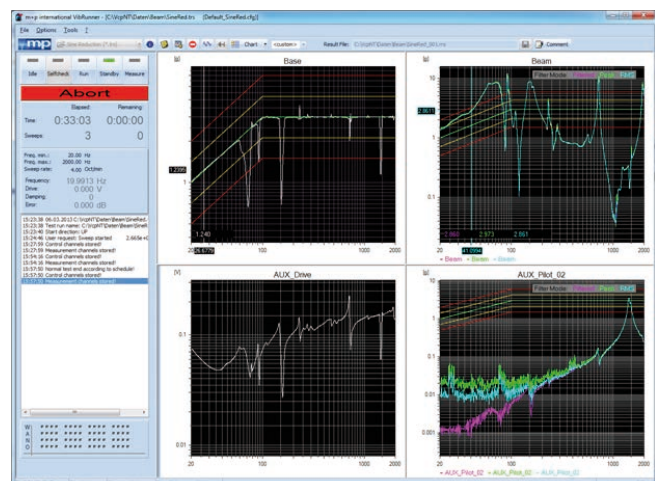
Online data reduction during closed-loop sine vibration test
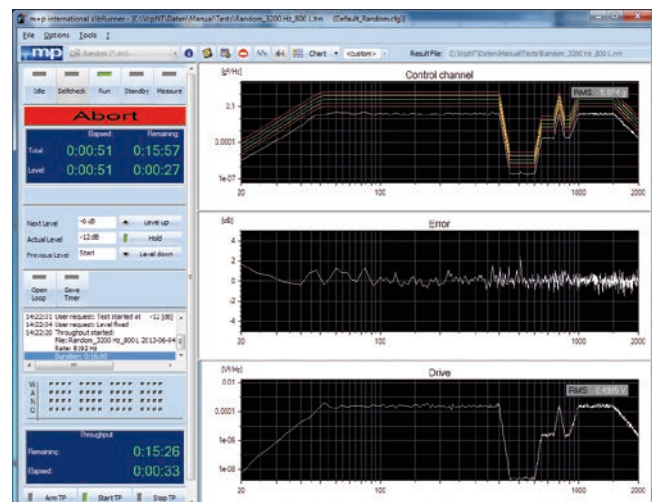
YOUR BENEFITS

- **Online data reduction for sine/random/transient capture testing**
- **Fully replaces tape recorder**
- **Time history recording to throughput disc in parallel with data reduction**
- **Instant online results**
- **Common hardware platform and user interface with m+p's vibration control system**
- **Post-test tools including file format conversion and data export**
- **Common data and plot formats of m+p VibControl data reduction and vibration control systems for transparent test reporting**
- **Multi-monitor support enables easy online monitoring of up to 1,280 channels**
- **High sample rates for time domain data storage: up to 32,768 Hz for sine and random and 102.4 kHz for transient capture (per channel)**

Gap-Free Time History Recording during Vibration Control

For the most critical tests time history data can be recorded in parallel with vibration control with no reduction in control performance. This facility is also available in recorder modes without closed-loop control. The real-time through-put data capture function allows you to record all selected channels continuously in the time domain on the embedded data server ("throughput to disc") irrespective of the channel count and the frequency range utilized. This means that you can always access all the original data for analysis purposes.

One method which is still widely used consists of the time data recording of a vibration test to a second measurement acquisition system in parallel with the usual frequency data recording. This results in additional costs for hardware and more complex system operation. Using m+p international's throughput function simplifies the process and, in addition, you can easily post-process the recorded time data after the test run. The throughput function can be started and stopped independently of the vibration control process. The time data are analyzed using the data reduction software.

Parallel time data recording and random vibration testing

Solar array testing

With data reduction, throughput data capture and vibration control running in parallel in one m+p VibControl system, laboratories can reduce their test costs and operator training significantly.

Photo courtesy of Airbus Defence and Space, Germany

Multi-Axis Vibration Control
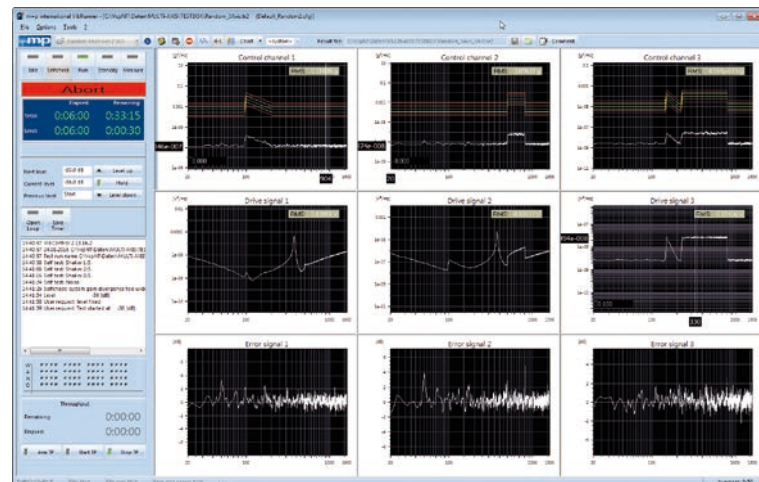

Photo courtesy of IABG mbH, Germany

Multi-axis sine testing
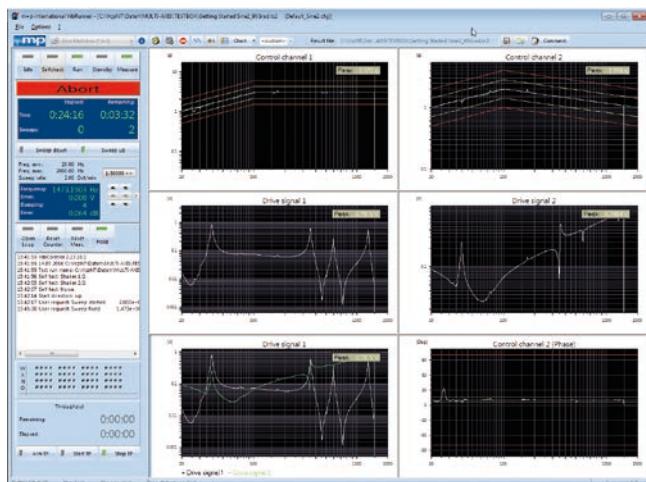
Multi-axis random testing

YOUR BENEFITS

- MIMO test modes: random, sine, shock including SRS, time domain replication (road load simulation)
- Control using unique vibration profiles for each shaker
- Combine multiple vibration profiles and excite all frequencies at the same time using true random
- Kurtosis control for decoupled systems
- Reproduce measured time histories at each load input
- True multi-tasking without loss of real-time control increases test efficiencies
- Cross-coupling compensation of dynamic responses from multiple shakers
- Test sequencing for automated long-term durability testing
- Powerful m+p eReporter analysis tool for browsing, viewing, editing, analyzing and reporting data
- Easy-to-use GUI with familiar Microsoft Windows style
- Seamless import/export of test results into Microsoft Windows applications makes plenty of analysis options available
- Phase and amplitude control unit for up to four shakers

Simulating the real-world vibration environment for a structure in the laboratory is complex and sometimes requires simultaneous force inputs along several axes. Testing two or more axes in parallel reduces traditional test times considerably and reproduces the true environment more closely than with classical single-axis, single-shaker excitation.

m+p VibControl provides coupled and uncoupled multi-axis vibration testing (MIMO) in a closed control loop. Test modes include random, sine, shock and time domain replication (road load simulation). Multi-axis motions are characteristic of field environments. The more a vibration test can replicate the field environment, the more realistically it can induce a vibration stress loading equivalent to that experienced by the product in the field.

Applications of the m+p VibControl multi-axis controller include vehicle road load simulations for durability tests, testing of large and complicated structures for operational loading as well as earthquake simulation as per IEEE 344. Components and sub-assemblies are tested on specially designed shaker tables with motion in several degrees of freedom. For seismic qualification the test specimen is fixed to a multi-axis earthquake shake table. Large structures such as complete automobiles, aircraft, rockets and railroad cars are excited on multiple shakers each directly attached to a load input point. This simulates the real-world vibration environment in a precise and realistic way.

Multi-axis shock testing
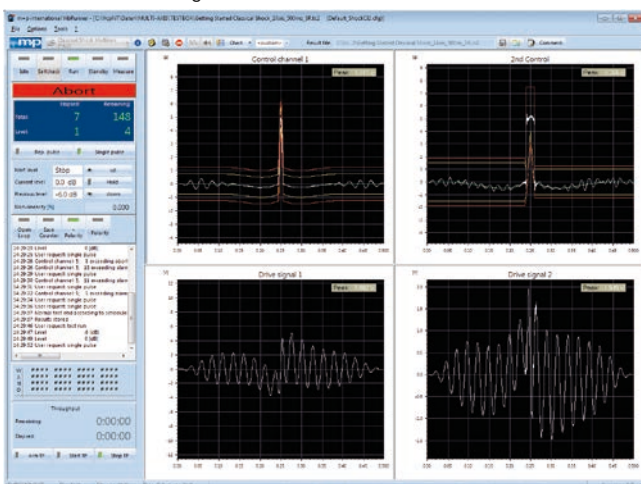
Multi-axis time domain replication testing
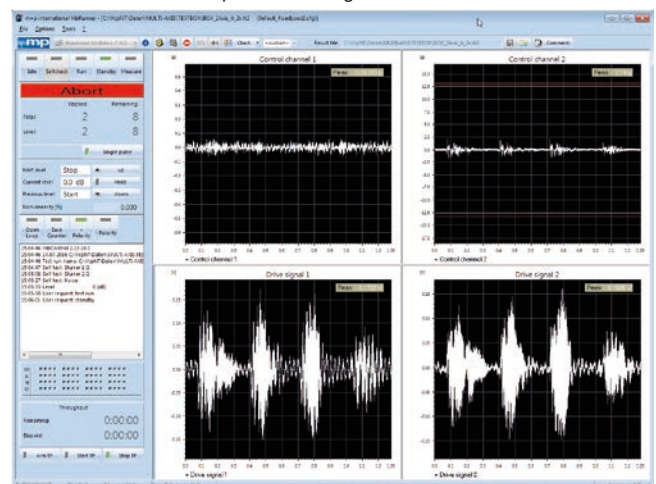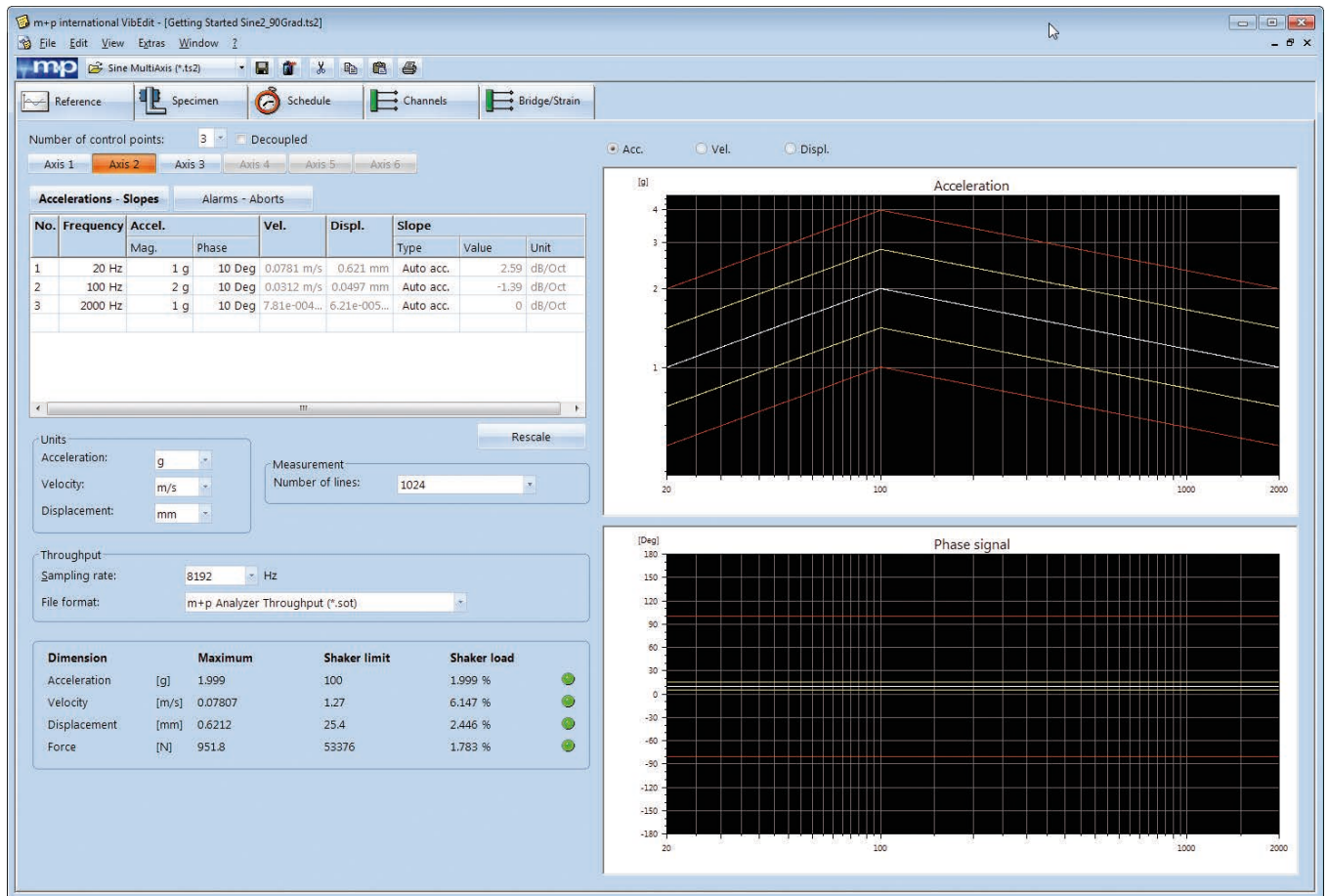
Clearly arranged set-up window simplifies multi-axis test definition

Multi-axis seat testing

Focus on the Essentials

Whereas a single-axis random or sine test can be defined by a single value at each frequency, a multi-axis test requires the definition of a complex matrix at each frequency representing all the demand levels, as well as the coherence and cross-phases between each pair.

The flexible display arrangements allow tailoring to show just the required information for maximum clarity during test operation, while all measured data is recorded and available for later analysis.

Where the cross-phases and coherences are defined, m+p VibControl will verify that the demanded control values are feasible and also within the capabilities of the system.
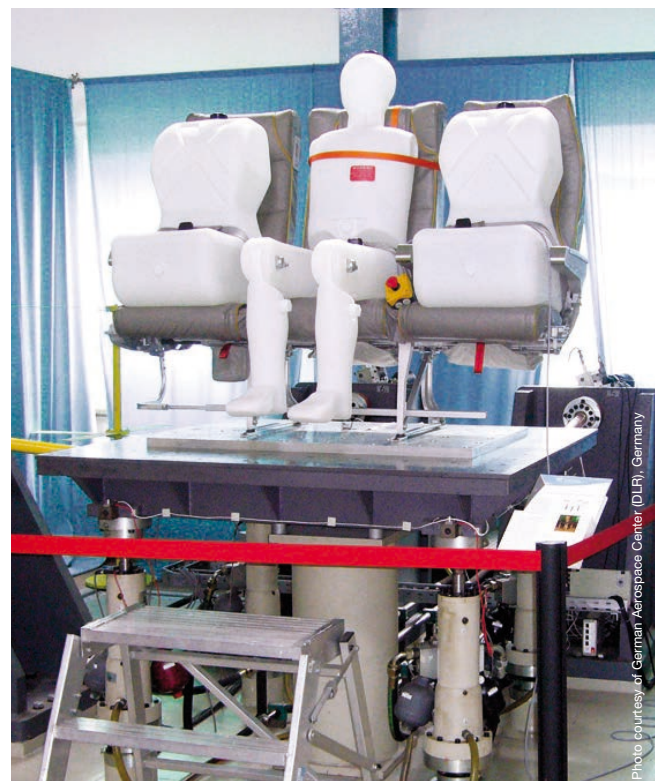
m+p PCU4 front panel

Phase and Amplitude Control

The m+p PCU4 phase and amplitude control unit ensures that up to four shakers are reliably synchronized and coupled together to act as one system. It processes sine, random and shock data in a frequency range from 5 Hz to ca. 3 kHz (typical 5 to 500 Hz for hydraulic shakers or 20 to 2,000 Hz for electrodynamic ones). Low- and high-frequency phases as well as magnitude and gain are accurately controlled.

Features of the m+p PCU4 include selectable push-pull and push-push configuration, master gain selectable by input range setting, overload protection and 4-channel supervisor. A bypass configuration switch and interlock reset as well as LEDs for phase and magnitude status ensure ease of use and test safety.

This specialist phase and amplitude control unit is used for optimization of the effective shaker force in the special application case where shakers are rigidly coupled via a head expander or slip table.

m+p PCU4 rear panel
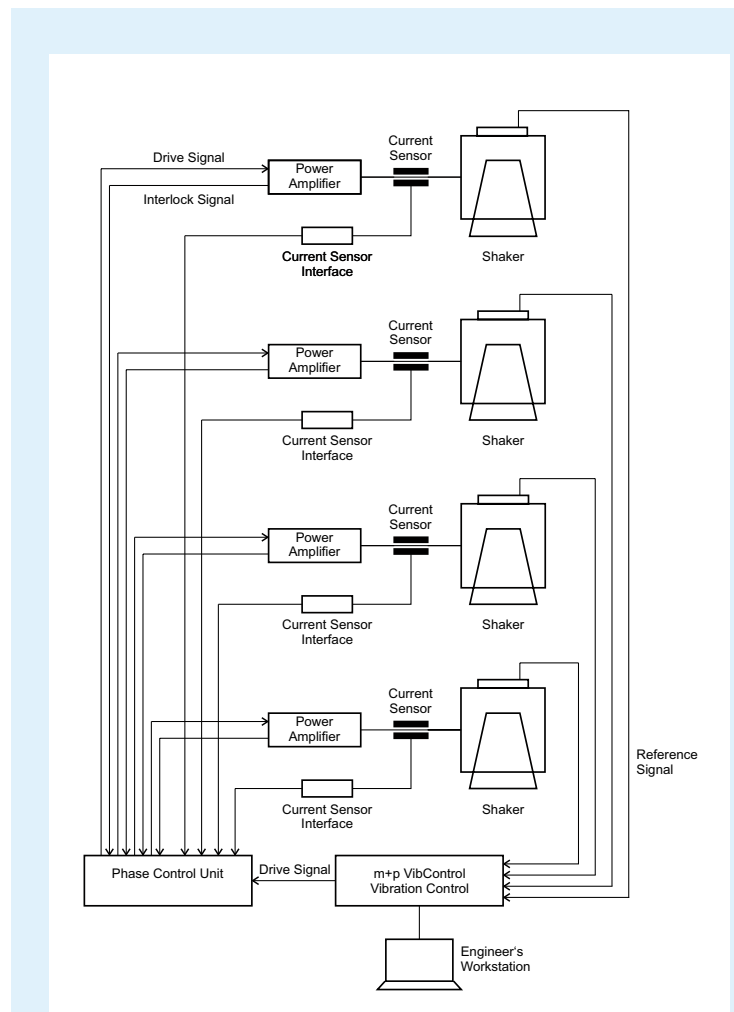
Schematic functioning diagram

Acoustic Control

Photo courtesy of NASA, USA

m+p international is considered the market leader for reverberant chamber excitation. Our m+p VibControl performs acoustic testing in reverberant chambers and direct field environments as well as progressive wave tube testing. It is a fully automatic digital control system, providing fast, accurate and repeatable control of high-level noise to a reference octave band spectrum and the overall sound pressure level (OASPL). The control guarantees a high level of product safety.

The m+p VibControl acoustic control system provides features such as support for up to 40 microphones for control and/or measurement, continuous time domain octave analysis in 1/3 and 1/1 octave bands, a control bandwidth up to 10 kHz with multi-horn control, equalizer

tool, calibration tool, automatic microphone drop-out detection and exclusion from control, extensive octave band and OASPL alarm and abort checks for safe testing as well as comprehensive post-test analysis and reporting functions in 2D and 3D.
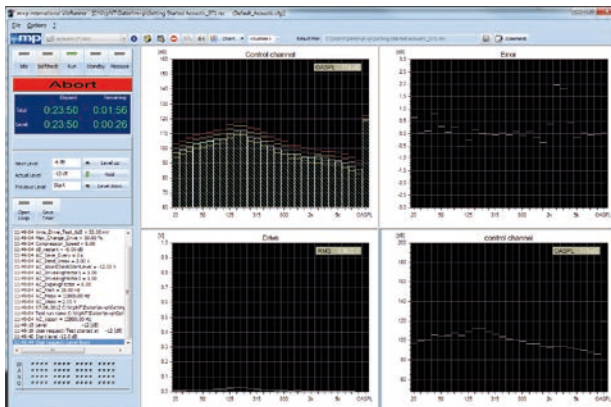
In addition to the stored octave spectra, PSD's are calculated and stored for individual measurement channels. They allow monitoring of the mechanical response of the structure to be tested.

Supporting the same Ethernet-based m+p VibRunner hardware, m+p VibControl for acoustic control can be configured as a shaker control system by simply adding software modules.
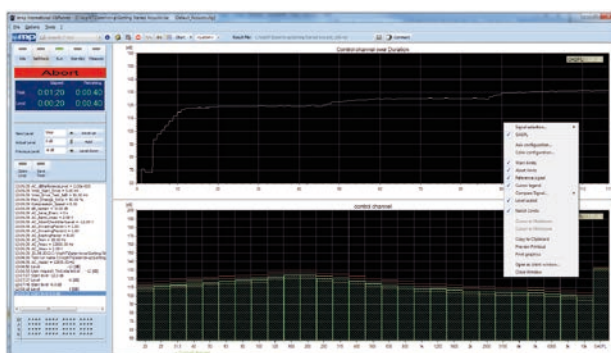
YOUR BENEFITS

- **Fully automatic closed-loop acoustic fatigue testing in a reverberant chamber**
- **1/1 and 1/3 octave bands usable for control and measurement**
- **PSD measurements for monitoring mechanical responses during acoustic load**
- **Protection against open loop/drive runaway**
- **Easy runtime display configuration**
- **Display of min, max and average for each octave band over a period of time with a few mouse clicks**
- **Visual time domain signal verification for each channel**
- **OASPL over time displays for full test documentation**
- **Continuous time history recording during test run to stream all raw time data to throughput disc**
- **Advanced time domain data analysis using m+p Analyzer software**
- **Direct field acoustic control system for satellite testing**
- **Progressive wave tube (PWT) testing**

OASPL over time display

Revolutionizing the acoustic testing of minisatellites, m+p international developed a direct field acoustic control system. This high-end system greatly reduces test time and costs. The software controls the complete test procedure and logs all steps of the process. In most cases, the test period during which the satellite is subjected to the 146 dB sound pressure field is only one minute. The satellite test scenario does not require any specially prepared environment or test stand. Considering certain specifications, a multitude of different rooms will instead suffice to ensure significant results that are accepted by experts.

Acoustic control test run
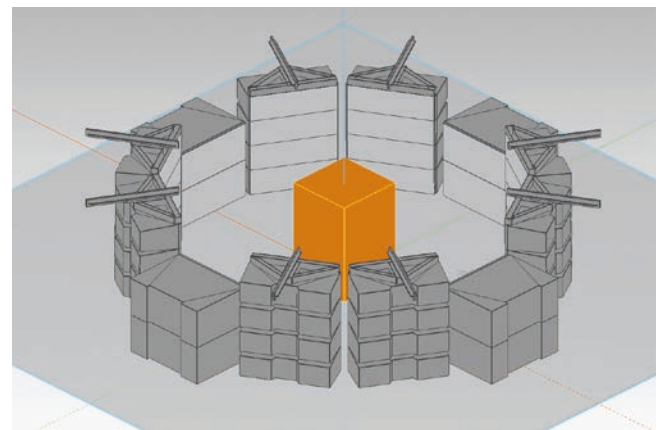
Minisatellite testing: loudspeakers circularly positioned around the specimen to create a sound pressure field

> **"The m+p acoustic control system in place at NASA Plum Brook, which can drive all of our reverb chamber's 36 noise modulators (23 hydraulic type, and 13 electro-pneumatic type), suits our needs very well. I have been relying on the m+p acoustic control system at NASA, and elsewhere, since 2003 and I have always been given attentive and accurate support from the m+p office."**

Aron Hozman, Vibroacoustic Test Systems Manager at NASA Glenn Research Center, Sandursky, Ohio/USA

m+p
INTERNATIONAL

m+p international

Founded in Hannover, Germany in 1980, m+p international develops and manufactures test and measurement systems for vibration testing, dynamic signal analysis, multi-channel data acquisition and monitoring and test stand engineering. Our product reputation and broad experience coupled with valuable user feedback have led to significant market share in numerous key industries worldwide.

The company has its headquarters in Hannover, Germany with sales/marketing subsidiaries in New Jersey (USA), England, France and China, along with representatives and agents in many countries.

Learn more on the full range of m+p international products and services and their applications. Select the m+p literature library on our website and download the desired product literature.

m+p VibControl, m+p Analyzer, m+p Coda, m+p VibPilot, m+p VibRunner, m+p VibMobile, m+p HFDST-3000-E and m+p ACON are products of m+p international.

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