



ST | Structural Testing



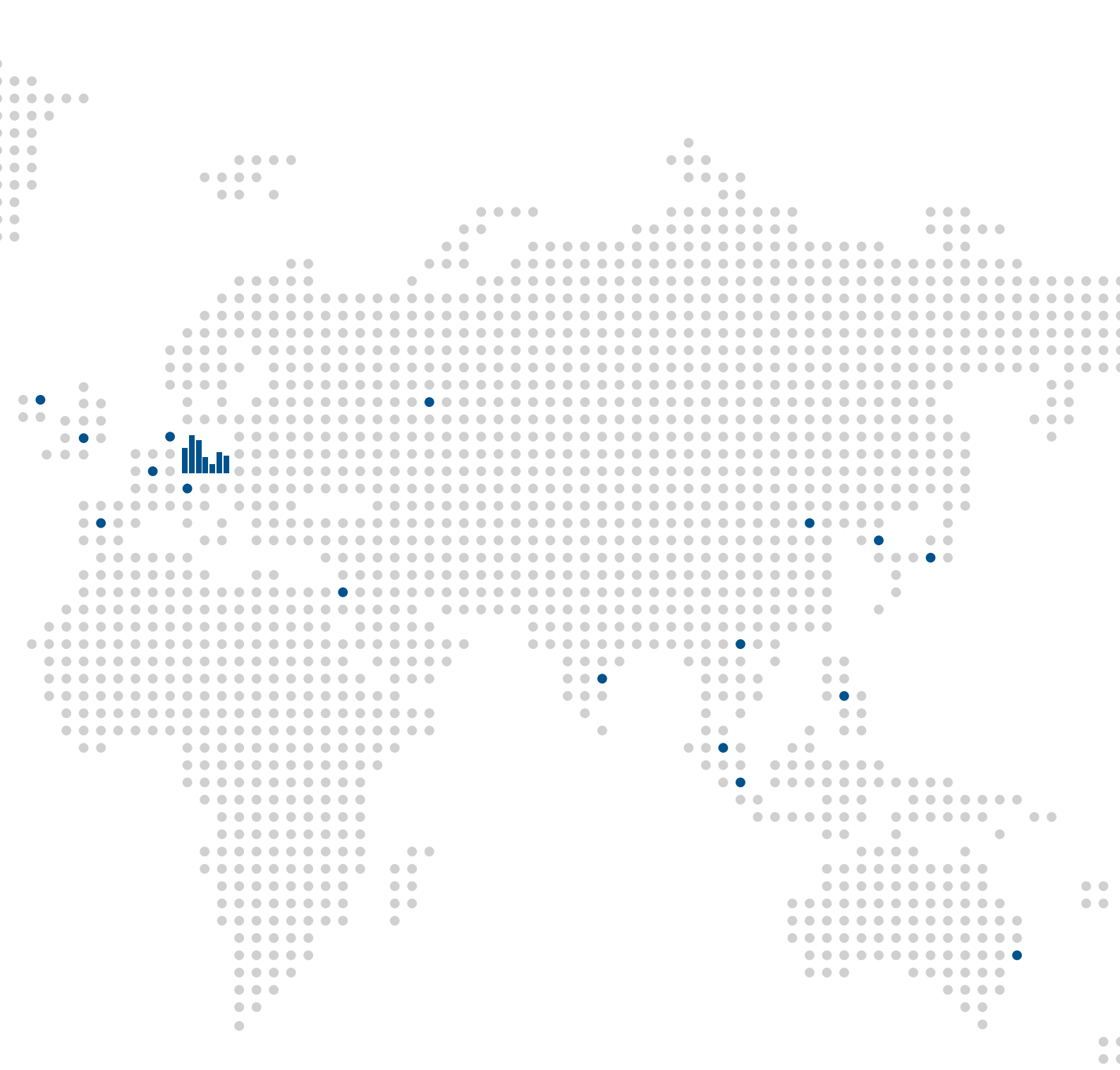
Edition 10-2018



a brand of SPEKTRA



Outstanding
**international
Performance**



Who we are.

In **1994** three engineers employed at a successor of former state-owned VEB Robotron Messelektronik Dresden - Department of sound, vibration and force measurement were dissatisfied with the progress of the enterprise. Willing to seize the opportunities provided by the new dynamic economy of a reunified Germany, they decided to launch their own business, **SPEKTRA Dresden**, Germany. It all started with the development and manufacturing of a final test system for the production of the first generation of MEMS-based airbag sensors. In 2008 SPEKTRA joined

forces with the renowned manufacturer of long-stroke shakers **APS Dynamics, USA** to extend the product portfolio and strengthen the international sales force. Since then SPEKTRA has developed into a stable, mid-sized enterprise in the field of testing, calibration and characterization of sensors for the measurement of dynamic mechanical quantities. With expertise in mechanical, electrical and software engineering, SPEKTRA develops target-oriented, customized solutions that address the challenges of laboratory and volume production applications.



CS | Calibration Solutions



DT | Device Testing



ST | Structural Testing



ES | Engineering Solutions

ST | Structural Testing

Based on the 45 years of experience of **APS Dynamics**, we offer mobile shakers that exhibit their best performance in the low frequency range. Typical applications are modal testing of buildings, bridges and other large structures. Combined with SPEKTRA vibration controllers, complete systems are also available.

Portfolio

45 Years of Experience in Modal Excitation
Your One-Stop-Shop for Measurement Tasks

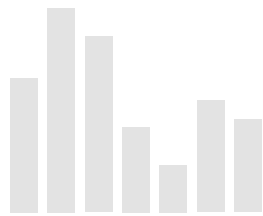
System Concept

Exciter
Dual-Mode Amplifier
Accessories for APS shaker
Modes of Operation
APS 4001 - Horizontal Reaction Mass System
Controller & Software

Featured Protection Functions

Applications

Selected References



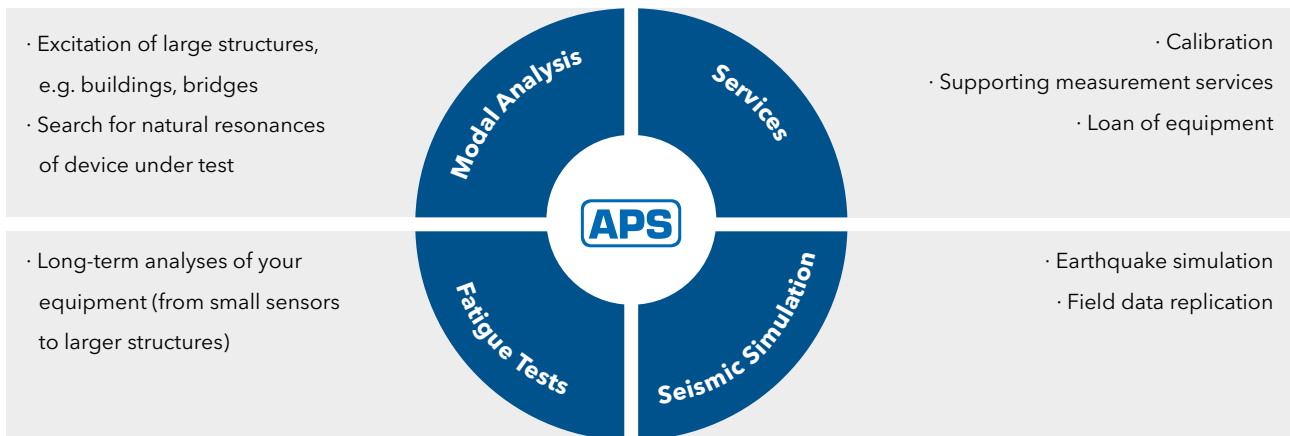
Ready for TESTelligence!



Portfolio

45 Years of Experience in Modal Excitation

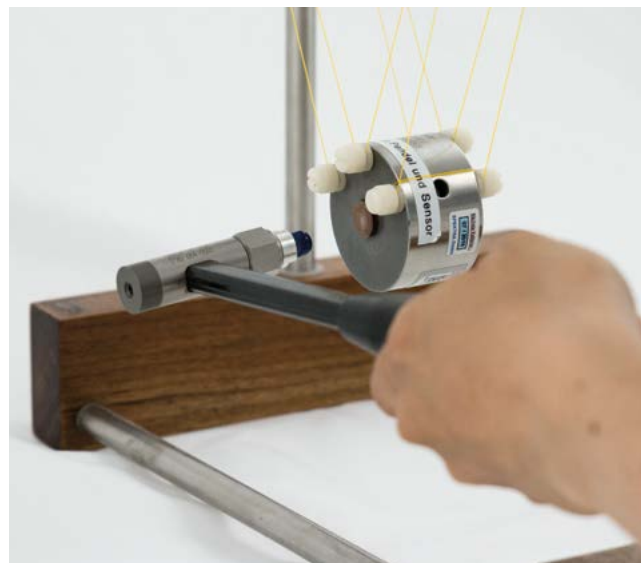
APS has been a well-known supplier of modal exciter for 45 years. In 2008 SPEKTRA and APS joined forces and together have built a new generation of even stronger exciter together - based on decades of know-how from both sides. Do you need to ensure the structural stability and endurance of your equipment under stress? Would you like to verify your product's properties? Do you need modal exciters for tests in your laboratory or in the field? SPEKTRA will find a solution for your individual measurement task.



Portfolio APS

Your One-Stop-Shop for Measurement Tasks

- ✓ Professional and qualified consultation for your system selection
- ✓ Complete turnkey solution including DAkkS calibration
- ✓ Modular system with rich choice of accessories
- ✓ DAkkS calibration including the following devices under test: impact hammers, impedance sensors, accelerometers, seismometer, force transducers, et al.



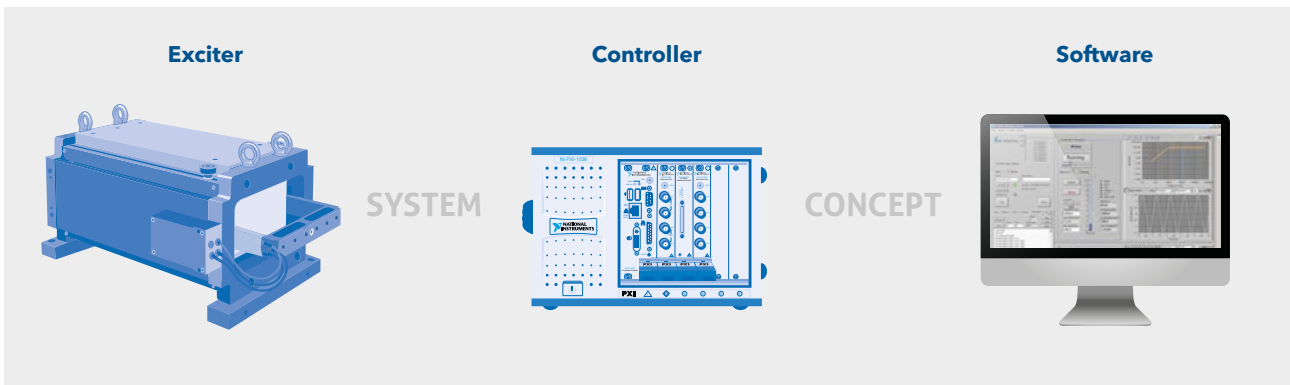
Calibration of impact hammer



System Concept

We provide well-balanced sets of exciter, amplifier, controller and sensor to get optimal performance and high precision in a wide range of applications. The software is dedicated to structural test solutions and ready for synchronization and system

integration. Various multi-channel control options are available. Possible modes are manual control for investigation, script based control to perform test rows and remote control by DLL, ethernet or digital I/O to be a part of a test system.



System concept

Exciter

Based on your requirements you may choose from our portfolio of modal exciters. Various optional accessories allow different modes of operation and facilitate handling of the equipment.

Controller

The controller is based on National Instruments hardware. High flexibility allows configuring the system according to your individual demands.

Software

The software is based on LabVIEW. So various applications are made possible with high flexibility.



Advantages

- ✓ Highest force at low frequencies
- ✓ MIMO capabilities - up to 8 control channels and scaleable number of input channels
- ✓ Locked phase with adjustable and controlled phase shift for multiple I/O channels
- ✓ Dual-Mode amplifiers (current / voltage mode) with lowest backlash on testing structure
- ✓ Integrated overload protection (temperature, travel, current)



Exciters

* detailed values can be found in our datasheets

	Attributes*	APS 113
	Frequency	0 Hz ... 200 Hz
	Stroke	158 mm
	Armature / body weight	2.3 kg / 35 kg
	Force	186 N
	Attributes*	APS 400
	Frequency	0 Hz ... 200 Hz
	Stroke	158 mm
	Armature / body weight	2.7 kg / 70 kg
	Force	445 N
	Attributes*	APS 420
	Frequency	0 Hz ... 200 Hz
	Stroke	150 mm
	Armature / body weight	3.8 kg / 136 kg
	Force	900 N

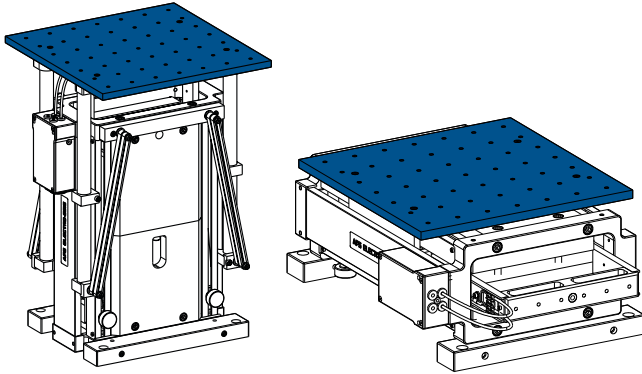
Dual-Mode Amplifiers

* detailed values can be found in our datasheets

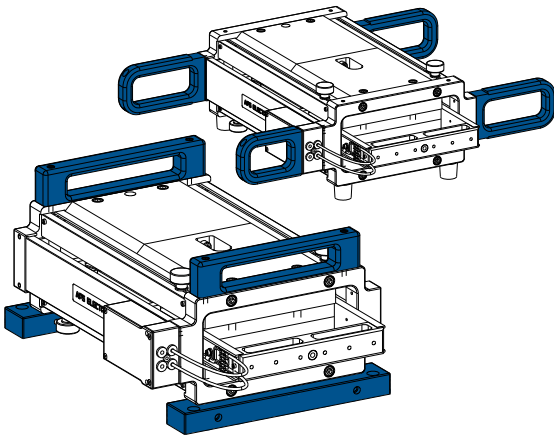
	Attributes*	APS 125
	Power Output	500 VA
	Voltage Output	45 V RMS
	Current Output	11 A RMS
	Frequency Range	DC ... 15 kHz
	Attributes*	APS 145
	Power Output	810 VA
	Voltage Output	45 V RMS
	Current Output	18 A RMS
	Frequency Range	DC ... 10 kHz

Accessories for APS Shaker

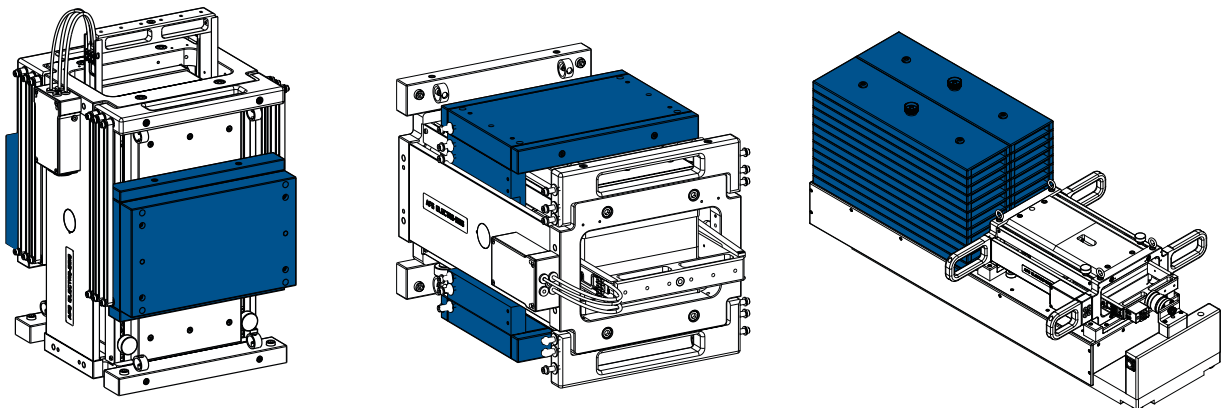
+ Auxiliary Table Kit



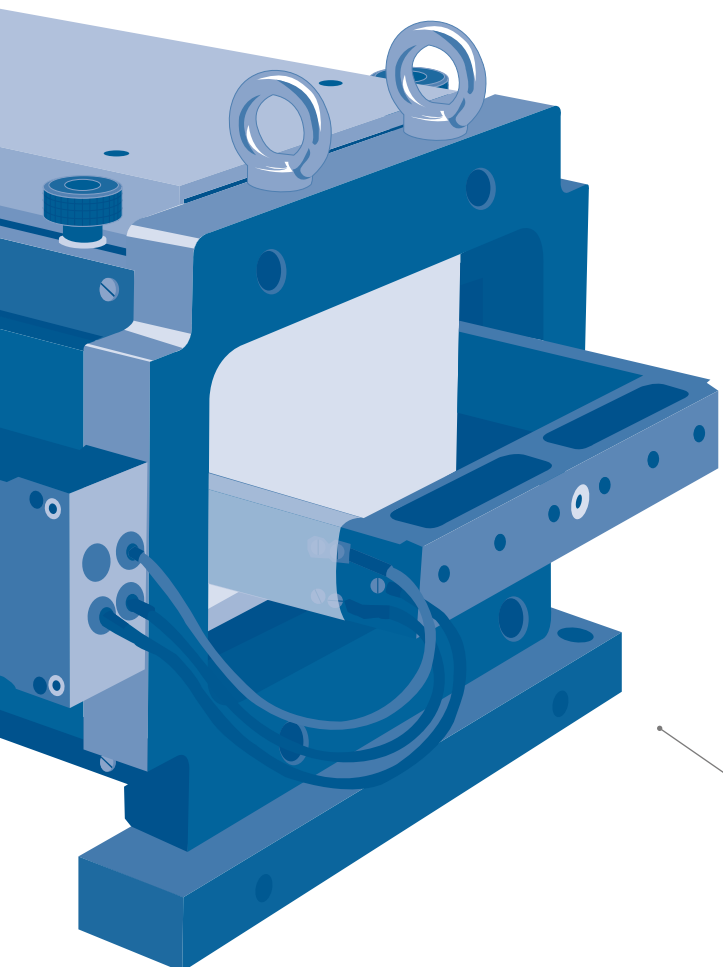
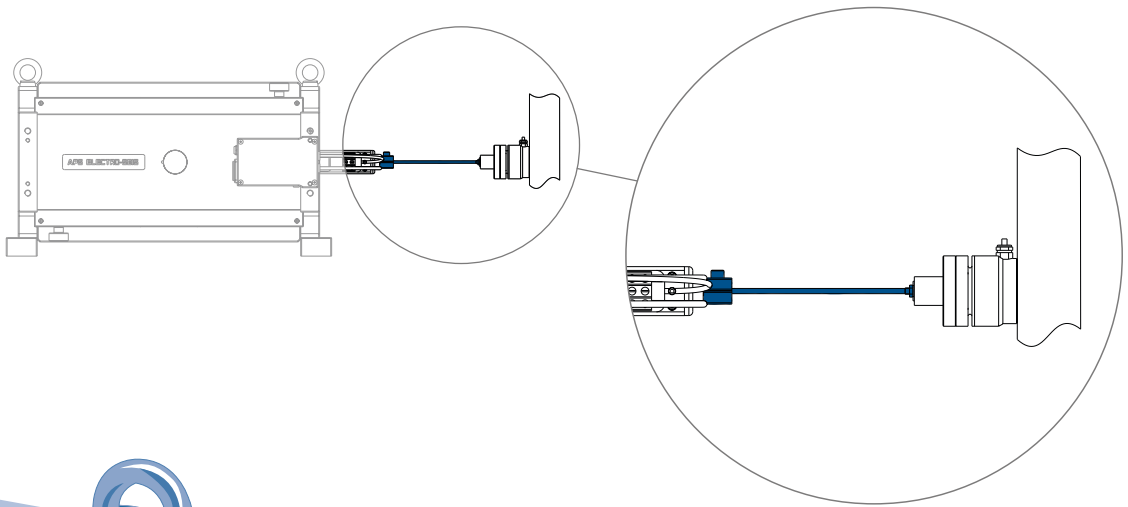
+ Handles



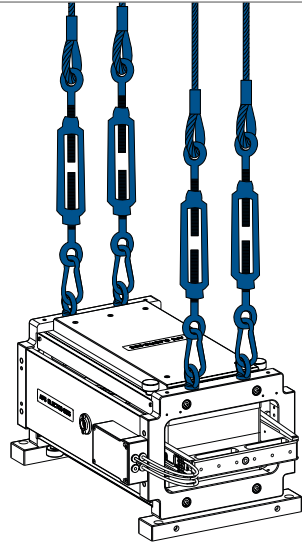
+ Reaction Mass



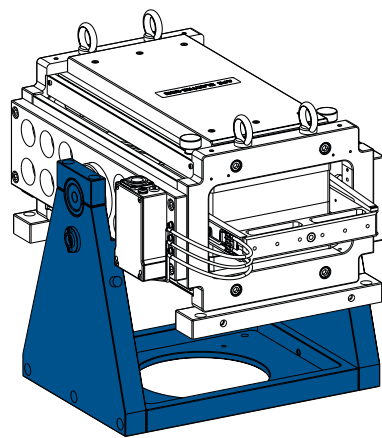
Modal Stinger Kit



Steel Cable Kit



Trunnion Base



Modes of Operation

Fixed Body Mode



In the Fixed Body Mode, the shaker body is fixed and the armature is attached to the test structure. So shaker force is delivered directly in the test structure. In this mode, force delivered to the test structure can be measured by inserting a force transducer in the thrust linkage between the armature and test structure. Alternatively, with

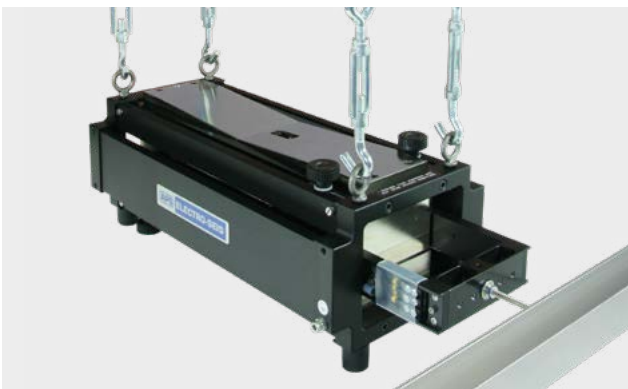


Key Features

- ✓ (Generated) shaker force applied directly to structure
- ✓ Low influence on structure due to low armature mass
- ✓ Measurement of delivered force by force transducer or shaker current

the armature / body suspension bands removed, shaker current can be used as a direct measure of the generated force. The generated force is approximately equal to the force delivered to a resonant test structure, because the armature mass is typically small compared to the modal mass of most large test structures.

Free Body Mode



The desired force input points on many test structures lie at a considerable distance above ground level. For tests on such items, it becomes difficult and expensive to use Fixed Body Mode support structures. For such applications, the Free Body Mode can be employed. In this mode the shaker body is used as the reaction mass by suspending the shaker from an overhead support.



Key Features

- ✓ Suitable if the test object is in high altitude
- ✓ Accelerated shaker body inserts reaction force in the test structure
- ✓ Measurement of inserted force by a force transducer or the acceleration of the shaker body

Besides using a force transducer a very convenient measure of the load force is the axial acceleration of the shaker body. This allows simplification of the test system instrumentation, in that force can be measured with an accelerometer system which is identical to that used to measure the structural response.

Reaction Mass Mode



★ Key Features

- ✓ Inertial vibration exciter
- ✓ Vertical or horizontal operation
- ✓ Easy to install reaction mass

Many large test structures having horizontal surfaces such as floors require vertical or horizontal force applied to these surfaces to generate resonant modes of vibration. The APS shakers may be used in a vertical or horizontal Free Armature Mode by resting the shaker body on the horizontal surface. The moving armature provides a reaction mass that allows for delivery of the shaker force via the

shaker body to the surface (inertial shaker). Below a certain cross-frequency the shaker stroke limits the acceleration of the armature and thus the maximum force. Additional masses, e.g. APS 0112 or 4001, lower this frequency. The force applied to the structure can be measured by a force transducer or by measuring the acceleration of the moving masses.

Shaker Table Mode



★ Key Features

- ✓ Horizontal and vertical long stroke tables
- ✓ Rugged design for harsh environment
- ✓ High payload - up to 20 kg

Auxiliary table accessory units for both horizontal and vertical use employ the high load capability of the APS 113 armature guidance and suspension systems to provide long stroke tables for excitation of test loads. Each auxiliary table has a pattern of threads with helical inserts to mount the test load directly or a fixture on the table. The mechanical input

impedance at the base of a test load that is resonant in the operating frequency range can vary significantly. Thus, the acceleration response of the table and test item base will exhibit the familiar „peaks“ and „notches“ as frequency is varied. So it is recommended to observe the response of the structure using accelerometers.

APS 4001 - Horizontal Reaction Mass System



Assume you have to identify lateral modal modes of a bridge or building that may be well damped in a frequency range down to 1 Hz or lower. Thus, a modal test by means of an inertial shaker would require passing the full rated exciter force horizontally into the building. An APS 400 long stroke shaker can be equipped with reaction masses for this purpose, but can develop its full force only down to 3.7 Hz. Below this frequency the maximum force decreases with 12 dB/Octave due to the limited stroke.

Increasing the reaction mass significantly can compensate this limitation. The APS 4001 - Horizontal Reaction Mass System provides a means of extending the rated force output for the APS 400 Shaker to frequencies as low as 0.5 Hz. For this purpose, the system can be equipped with up to 700 kg moving mass. In spite of its high weight, the APS 4001 can be easily dismantled into subassemblies that can be carried by man. Thus, it is still a mobile solution.



Advantages

- ✓ Horizontal excitation with 400 N rated force from 0.5 Hz ... 20 Hz
- ✓ Up to 700 kg reaction mass attachable
- ✓ Easy to disassemble and transport to a test location
- ✓ Can be equipped with a reference force transducer (option)

Controller & Software

Our software is a perfect match to the National Instruments hardware. It is a LabVIEW-based software solution. So it can easily be integrated into your environment. The LabVIEW software package allows for driving several exciters

to achieve different physical measurements in parallel and updating the test system for further purposes as required. In addition you can use it for laboratory applications and scale it up to an automated test system.

Flexible Software Components

- ✓ Scalable technology, from a very simple control unit up to a very high-performance, multi-channel controller
- ✓ Operation modes: sine, random, shock, Chart, FDR, ...
- ✓ Coordinated synchronized multi-channel excitation, also synchronized 3-dimensional excitation possible
- ✓ Customer-specific individual extensions on request



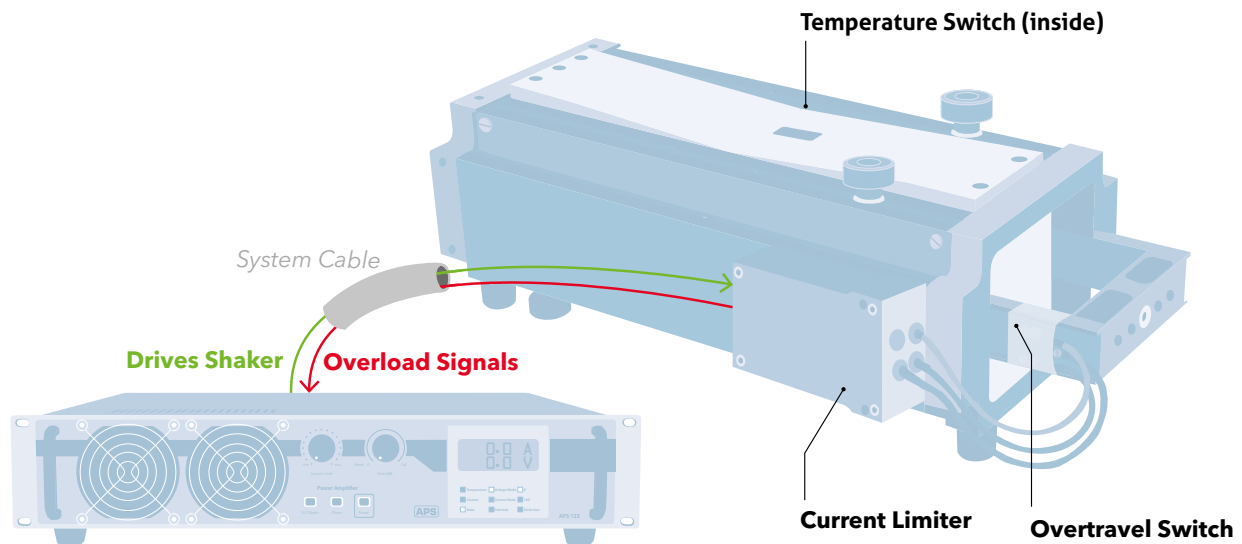
Advantages

- ✓ Single and multichannel excitation
- ✓ Synchronized or individual channels
- ✓ Locked phase with adjustable and controlled phase shift for multiple I/O channels
- ✓ Earthquake simulation
- ✓ Field data replication (FDR)
- ✓ Multi-channel data acquisition
- ✓ Intuitive handling
- ✓ Database
- ✓ Remote control
- ✓ Synchronizing and trigger signals
- ✓ Reports & monitoring
- ✓ Frequency range 0.01 Hz - 95 kHz
- ✓ Integration of laser vibrometer

Featured Protection Functions

Since APS Shakers are used for multiple purposes and test scenarios, this can lead to situations where the shaker needs to be driven to its limits. SPEKTRA spent a lot of effort to protect the shaker and power amplifier against damages when operating in the limit range or due to accidental events. For this purpose, the shaker is connected with the corresponding APS power amplifier by means of

a special system cable. Besides the regular power transmission from the amplifier to the shaker, this cable additionally allows transmitting signals from the shaker to the amplifier. Receiving an overload signal from the shaker, the power amplifier will immediately shut down the output signal and thus protect the shaker.



Temperature Switch

- ✓ Temperature switch attached to the coil to prevent an overheating
- ✓ Useful if tests require only a low armature displacement amplitude and thus lead to a reduced forced cooling of the coil

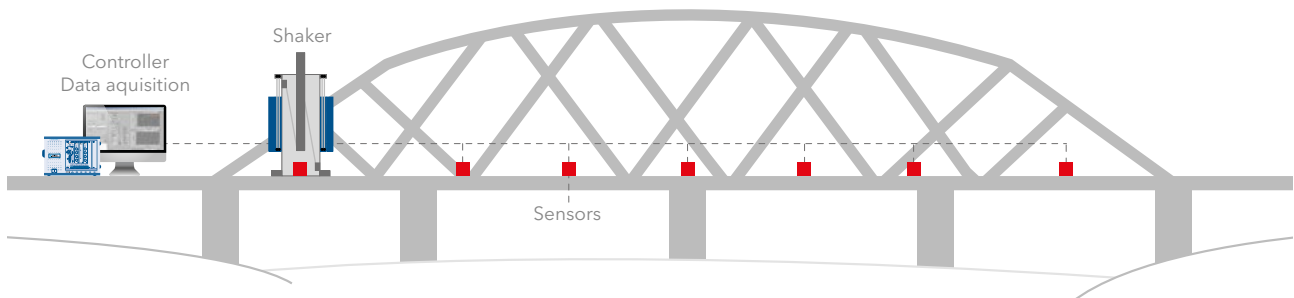
Overtravel Switch

- ✓ Overtravel switch attached to the armature to prevent mechanical damages due to an exceeding stroke.
- ✓ Useful if tests require a maximum displacement amplitude or may accidentally exceed the stroke limits due to resonances

Current Limiter

- ✓ Current limiter of the APS power amplifier is programmed by the shaker in order to protect the shaker against a too high current through the coil
- ✓ Useful if tests require a maximum generated force from the shaker and/or if a particular power amplifier is used to drive different types of APS shakers

Applications



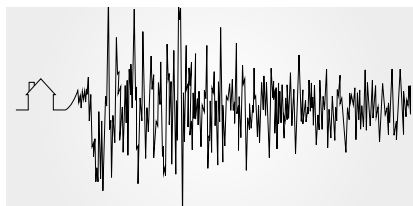
Excitation of bridges to test dynamic properties

Have you ever heard of the tragic collapse of Tacoma Narrows Bridge in 1940 which was later called the “Pearl Harbor of engineering”? Unfortunately, the structure of the bridge had not been tested the way our APS shakers can test its dynamic properties.



Airplane wing

Determination of dynamic properties, fatigue testing of substructures



Seismic Simulation

Earthquake Simulation,
Field data replication



Forklift

Sine excitation of forklift structure



How can the Amplifier support your Application?

✓ Application tailored Dual-Mode Amplifiers

The Voltage Mode is used for general shaker operation. This mode produces high internal damping in the shaker armature motion due to the low amplifier source impedance. The Current Mode is normally used in modal test excitation or whenever it is desired that the shaker has minimum effect on the system damping. This is particularly important during measurement of damping by the decay method. For this reason, a Mute function is provided which retains the current mode operation with the drive signal removed. This function provides a convenient means for initiating system response delay.

Selected References

SPEKTRA Dresden is globally well positioned. Together with our distribution partners, we serve a wide variety of customers worldwide with very individual requirements in modal excitation, calibration and characterization of components and sensors.



University of Michigan



PennState University



Apple



US Geological Survey



The Boeing Company



Bell Helicopter



Google



Airbus S.A.S.



German Navy



Bauhaus University Weimar



Indian Institute of Technology



Defence Science & Technology Group



University of Warwick



Università di Trento



Osaka University



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