

# APS 420 ELECTRO-SEIS®

## Long Stroke Shaker with Linear Ball Bearings



The **APS 420 ELECTRO-SEIS®** shaker is a long stroke, electrodynamic force generator specifically designed to be used alone or in arrays for studying dynamic response characteristics of various structures. It finds use in modal excitation of complex structures, particularly when low frequencies are required. Furthermore it can be used for low frequency vibration testing of components and assemblies.

### Applications

- Determination of natural mode frequencies, shapes, damping ratios, and stress distributions
- Excitation of manufactured equipment in the factory or installed in the field to demonstrate compliance with seismic specification criteria
- Seismic simulation for components
- Test and calibration for seismic instruments
- Geological Services, Science, Physics and Seismic

### Features

- Can be used to generate sine wave, swept sine wave, random or impulse force waveforms, fully adjustable at source
- Test set-up flexibility - operates fixed body, free body, free armature
- Optimized to deliver power to resonant load with minimum shaker weight and drive power
- Adjustable armature re-centering for horizontal and vertical operation or other external pre-loads

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### Description and Characteristics

The APS 420 ELECTRO-SEIS® shaker has been optimized for driving structures at their natural resonance frequencies. It is an electrodynamic force generator, the output of which is directly proportional to the instantaneous value of the current applied to it, independent of frequency and load response. It can deliver random or transient as well as sinusoidal waveforms of force to the load. The armature has been designed for minimum mass loading of the drive point. The ample armature stroke allows driving antinodes of large structures at low frequencies and permits rated force at low frequencies when operating in a free body mode.

The unit employs permanent magnets and is configured such that the armature coil remains in a uniform magnetic field over the entire stroke range - assuring force linearity. The enclosed, self-cooled construction provides safety and minimum maintenance. Attachment of the armature to the drive point is accomplished by a simple thrust rod like the APS 8610 - Modal Stinger.

An amplifier, such as the APS 145 - Power Amplifier, is required to provide armature drive power.



APS 420 with APS 4212 Reaction Mass Assembly

### Modes of Operation

#### Free Armature Mode

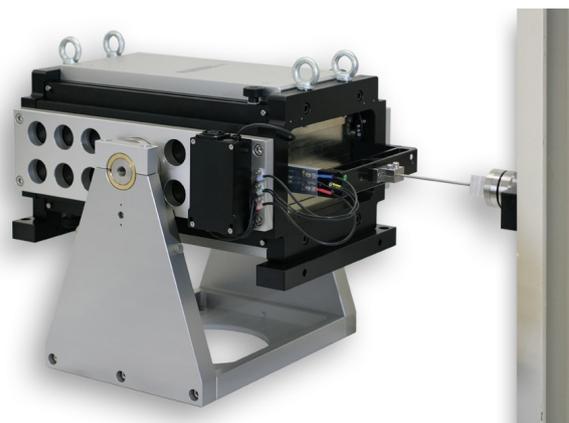
In this mode, the armature provides the reaction mass for force delivered to the test structure via the shaker body. Auxiliary reaction mass may be added to the armature to decrease the low frequency limit for rated force operation.

The APS 420 and APS 4212 - Reaction Mass may be used in a vertical or horizontal free armature mode with rated force down to less than 4 Hz. Feet and carrying handles are provided for ease in placement of the shaker on horizontal test surfaces.

#### Fixed Body Mode

By providing a rigid attachment between the body and ground, the full relative velocity and stroke capability is available for load motion. Maximum rated force can be delivered down to 0.01 Hz and 70 % maximum to 0 Hz.

When choosing the best shaker location for tests, the APS 4222 - Trunnion Base allows the shaker to be set up in any axis from vertical to horizontal.



APS 420 with APS 4222 - Trunnion Base and APS 8610 Modal Stinger

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### Free Body Mode

In this mode, the body provides the reaction mass. Load and body motion are accommodated within the total relative velocity and stroke. Because of the high cross-axis stiffness provided by the armature linear guidance system, the shaker may be supported above ground level by means of suspension lines (APS 8612 - Steel Cable Kit) attached to the body. This provides a convenient mounting for introducing force parallel to a horizontal mounting surface. Examples of such surfaces include floors, roofs, platforms, cabinets, bridges and tanks.



APS 420 with APS 4252 - Auxiliary Table Kit – Horizontal



APS 420 with APS 8610 - Modal Stinger and  
APS 8612 - Steel Cable Kit prepared for  
Free Body Mode operation

### Shaker Table Mode

Auxiliary Table Kits are available which, when installed on the basic shaker, enable the shaker to provide long stroke excitation to components or model structures mounted on the table.

The APS 4252 Auxiliary Table Kit provides horizontal motion, the APS 4277 Auxiliary Table Kit provides vertical motion and the APS 4278 Auxiliary Table Kit provides either the vertical or horizontal motion configuration.



APS 420 with  
APS 4277 - Auxiliary Table Kit - Vertical

### Performance

The primary purpose of the APS 420 ELECTRO-SEIS® shaker is to determine the dynamic characteristics of mechanical structures. At resonance, a large amount of energy is contained in the structure, and the shaker must accommodate the resulting motion. However, it needs only supply the real mechanical power dissipated by damping mechanisms within the structure.

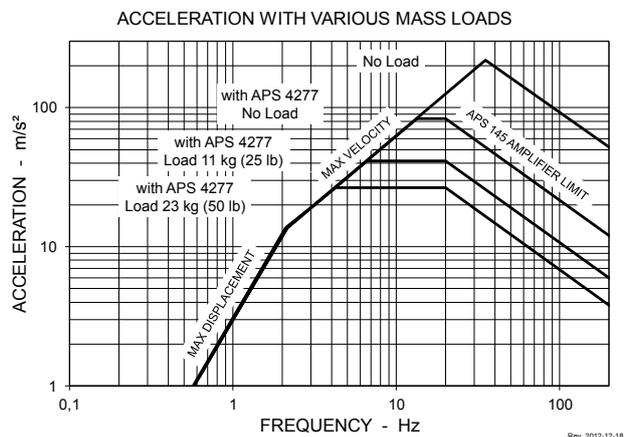
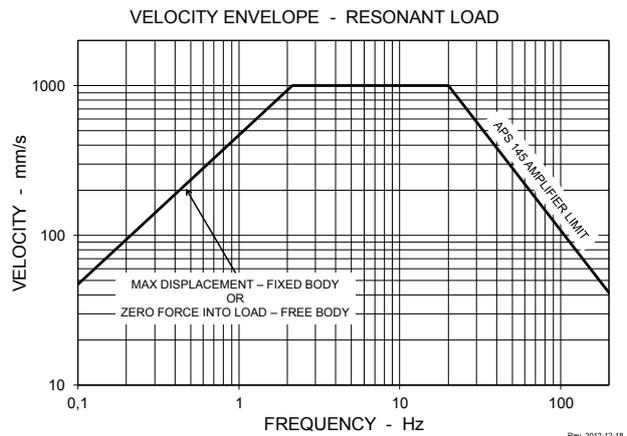
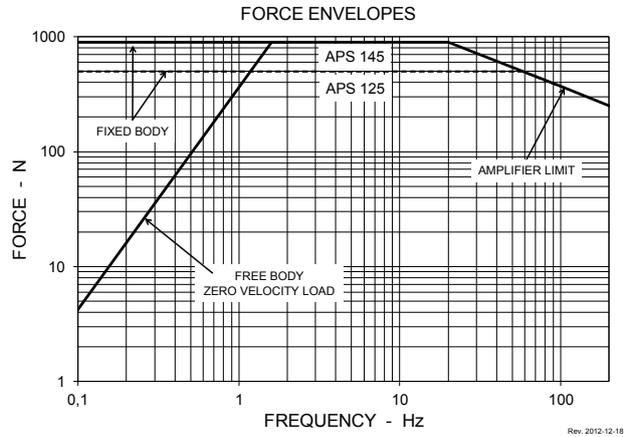
If a drive point on a structure in resonance is vibrating with a velocity of 1,000 mm/s (39 in/s) peak and a force of 900 N (200 lbf) peak is required to sustain the vibration level, then the shaker will be delivering approximately 450 W RMS to the structure. Such a load on the shaker is termed a matched resonant load, and it is purely resistive since the force is in a phase with the velocity.

If the resonant load input is other than 900 N x 1,000 mm/s, the full 450 watts of mechanical power cannot be delivered to the structure, the system being either force or velocity limited. If the resulting maximum response level is not great enough, the user may have the option of moving the shaker to a drive point having an impedance closer to the matched value, or adding more shakers to the array driving the structure.

Within the limitations of maximum force and velocity, the actual power delivered to a structure is a function of the input mechanical impedance at the drive point. In typical modal testing, this input impedance varies widely in magnitude and phase angle. At different frequencies, the input impedance of the drive point may appear predominately spring-like, mass-like, or resistive. Since the object of the tests is to establish resonant modes, at which the input mechanical impedance of all drive points are resistive, the shaker's maximum performance capability is most meaningful stated in terms of the force and velocity that can be obtained when driving a matched resistive load.

Therefore, performance is given in the form of graphs which present the envelopes of maximum force and velocity delivered to a resonant structure as functions of the resonance frequency of the structure.

Another application is the excitation for sensor calibration. Acceleration envelopes of the APS 420 ELECTRO-SEIS® shaker with various mass loads is shown in the lower graph for the 900 N rating.



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### Specifications

Shaker	APS 420
Force (Sine Peak)	900 N (200 lbf)
Velocity (Sine Peak)	1,000 mm/s (39 inch/s)
Stroke (Peak - Peak)	150 mm (5.9 inch)
Frequency Range	DC ... 200 Hz
Operation	horizontal or vertical
Armature Weight	3.6 kg (8.0 lb)
Max. Overhung Load at Armature Attachment Point	9.0 kg (20 lb)
DC Coil Resistance	1.1 $\Omega$
Total Shaker Weight	140 kg (310 lb)
Shipping Weight	165 kg (365 lb)
Overall Dimension L x W x H	591 x 360 x 280 mm (23.3 x 14.2 x 11.0 inch)
Operating Temperature	5 ... 40 degrees C
Storage Temperature	-25 ... 55 degrees C

### Accessories (optional)

Shaker	APS 420
Power Amplifier	APS 145
System Cable for Connecting Shaker to Amplifier	APS 0082-6E
Zero Position Controller for Vibration Exciters	APS 0109
Reaction Mass Assembly	APS 4212
Handles	APS 4221
Trunnion Base	APS 4222
Auxiliary Table Kit – Horizontal	APS 4252
Auxiliary Table Kit – Vertical	APS 4277
Auxiliary Table Kit – Horizontal and Vertical	APS 4278
Over Travel Switch	APS 8543
Over Temperature Switch	APS 8544
Modal Stinger Kit	APS 8610
Steel Cable Kit	APS 8612

Additional accessories available