APS 400 ELECTRO-SEIS®

Long stroke shaker with linear ball bearings



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

Range of use

- ✓ seismic simulation for components
- ✓ test and calibration for seismic instruments
- ✓ geological services, science, physics and seismology

Features

- ✓ force: 445 N (100 lbf)
- ✓ stroke: 158 mm (6.25 in) peak-peak
- ✓ frequency range: DC…200 Hz
- ✓ sine wave, swept sine wave, random or impulse force waveforms
- ✓ test set-up flexibility – fixed body, free body, free armature and shaker table modes of operation
- ✓ adjustable armature re-centering for horizontal and vertical operation or other external pre-loads

Specifications

The APS 400 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. Further-more it can be used for low frequency vibration testing of components and assemblies.

Technical data

Force rating [1) 2)]	445 N (100 lbf)
Displacement (peak-peak)	158 mm (6.25 in)
Frequency range	DC…200 Hz
Direction of excitation	horizontal or vertical
Armature weight	2.8 kg (6.2 lbs)
Overhung load at armature attachment point, max.	9.0 kg (20 lbs)
DC coil resistance	1.6 Ω
Weight (net weight)	73.0 kg (161 lbs)
Dimensions L × W × H	526 mm × 314 mm × 178 mm (21 in × 12 in × 7 in)
Temperature range (in operation)	+5 °C…+40 °C, ±2 K (+41 °F…+104 °F, ±2 K)

1) Sine peak

2) Interval mode of operation

Description and characteristics

The APS 400 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, thereby ensuring 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 PA 800 DM power amplifier, is required to provide armature drive power.

Accessories (optional)

Power amplifier	PA 800 DM
System interconnect cable	APS 0082-6E
Center position controller for vibration exciters	CPC
Reaction mass assembly	APS 0412
Lifting handles (set of 4)	APS 0414
Carrying handles and tie-down bars	APS 0421
Trunnion base	APS 0422
Auxiliary table kit – horizontal	APS 0452
Auxiliary table kit – vertical	APS 0477
Auxiliary table kit – horizontal and vertical	APS 0478
Horizontal reaction mass system	APS 4001
Overtravel switch[1)]	APS 8543
Overtemperature switch	APS 8544
Modal stinger kit	APS 8610
Steel cable kit	APS 8612

Additional accessories available
1) Cannot be installed, if the CPC is used.

Performance

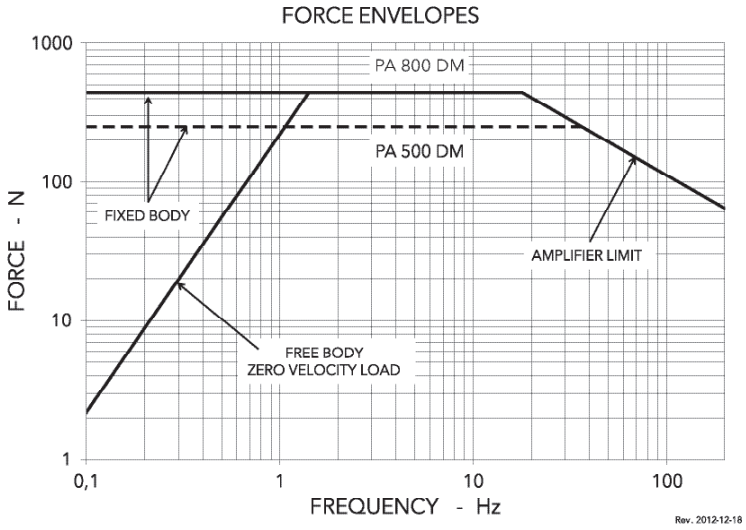
The primary purpose of the APS 400 ELECTROSEIS® shaker is to determine the dynamic characteristics of mechanical structures. At resonance, a large amount of energy is contained in the structure, and the shaker must accommodate the resulting motion. However, it need only supply the real mechanical power dissipated by damping mechanisms within the structure.

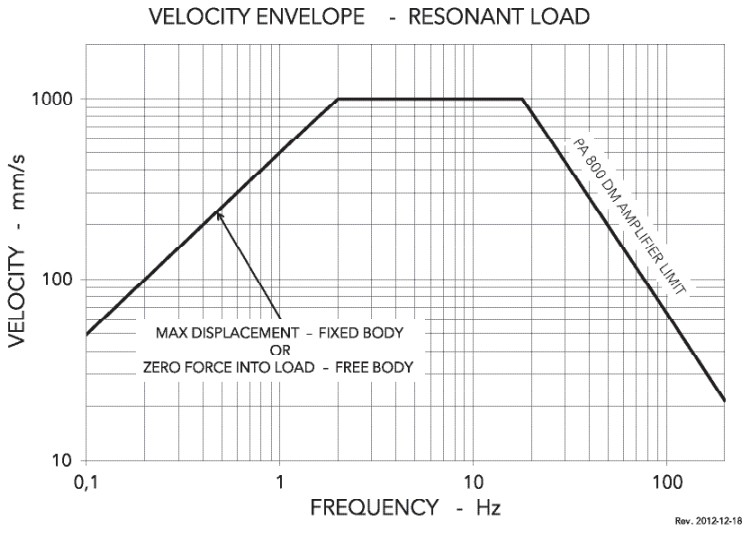
If a drive point on a structure in resonance is vibrating with a velocity of 1 000 mm/s (39 in/s) peak and a force of 445 N (100 lbf) peak is required to sustain the vibration level, then the shaker will be delivering approximately 220 W RMS to the structure. Such a load on the shaker is termed a matched 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 445 N × 1 000 mm/s, the full 220 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.

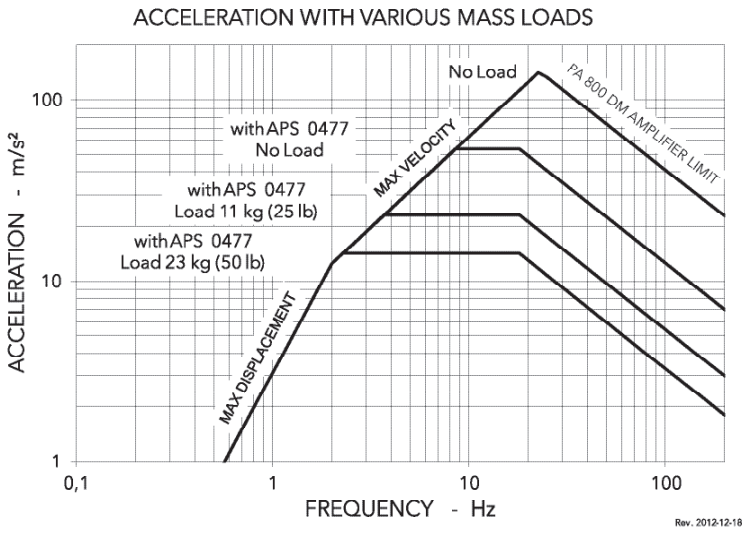
Within the limitations of maximum force and velocity, the actual power delivered to a structure is a function of the input mechanical impedance at the drive point. In typical modal testing, this input impedance varies widely in magnitude and phase angle. At different frequencies, the input impedance 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 400 ELECTRO-SEIS® shaker with various mass loads are shown in this graph for the 445 N rating.



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.

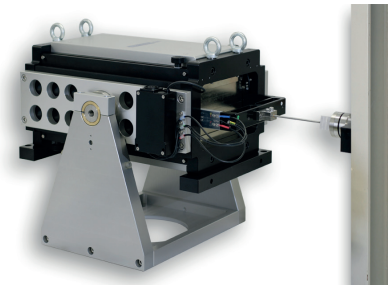
The APS 400 shaker and APS 0412 reaction mass may be used in a vertical or horizontal free armature mode with rated force down to less than 3 Hz. Feet and carrying handles are provided for ease in placement of the shaker on horizontal test surfaces.



APS 400 with reaction mass assembly (APS 0412)

Fixed body mode

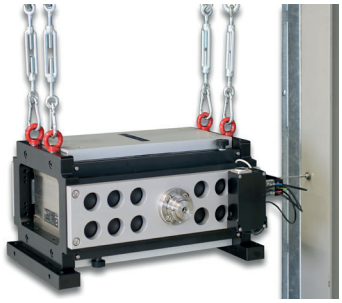
By providing a rigid attachment between the body and ground, the full relative velocity and stroke capability is available for load motion. Maximum rated force can be delivered down to 0.01 Hz and 70 % maximum to 0 Hz.



APS 420 with trunnion (APS 4222) and modal stinger (APS 8610)

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 modal stinger (APS 8610) and steel cable kit (APS 8612) 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 0452 auxiliary table kit provides horizontal motion, the APS 0477 auxiliary table kit provides vertical motion and the APS 0478 auxiliary table kit provides either the vertical or horizontal motion configuration.



APS 400 with auxiliary table kit – horizontal (APS 0452) …



… and with auxiliary table kit – vertical (APS 0477)