

# LONG STROKE SHAKER

6.25-in, 158-mm p-p Stroke  
10-in, 254-mm p-p Version



## ELECTRO-SEIS®

The **APS 113 ELECTRO-SEIS** is a 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.

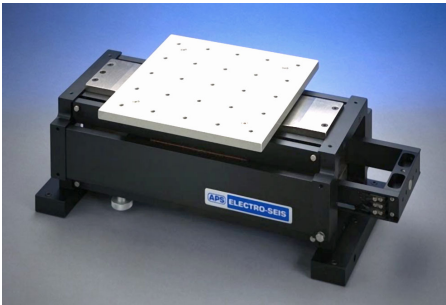
### APPLICATIONS

- 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
- Excitation for transmissibility measurements
- Seismic simulation for components
- Calibration and test for seismic instruments

### FEATURES

- Generates sinewave, swept sinewave, 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
- Rugged standard armature and linear guidance system carries full weight of body
- One-Man Portability - less than 80-lb total weight
- Optional Air Bearings, Lightweight Armature and Stroke





APS 113 with 0052 Auxilliary Table

## DESCRIPTION AND CHARACTERISTICS

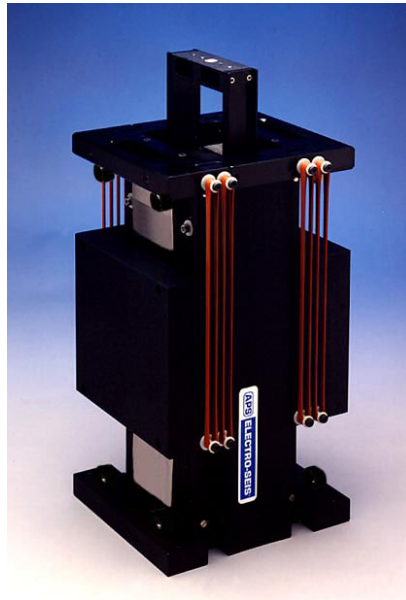
The APS 113 **ELECTRO-SEIS** has been optimized for driving structures at their natural resonance frequencies. It is an electrodynamic force generator, the output of which is directly proportional to the instantaneous value of the current applied to it, independent of frequency and load response. It 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 provided by the user.

A low frequency amplifier, such as the APS 114 or APS 124 **DUAL-MODE™** Power Amplifier, is required to provide armature drive power.

## MODES OF OPERATION

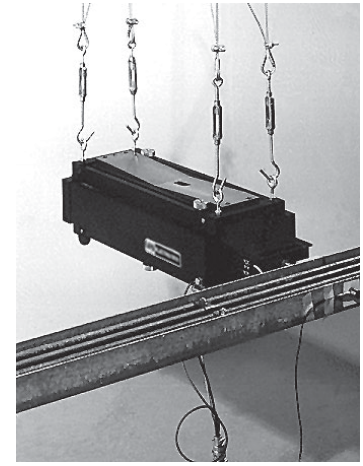
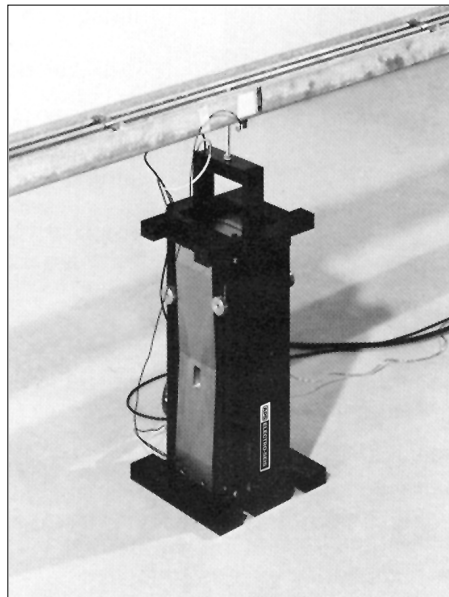
**Free Armature Mode** In this mode, the armature provides the reaction mass for force delivered to the test structure via the shaker body. Auxiliary reaction mass may be added to the armature to decrease the low frequency limit for rated



APS 113 with 0112 Reaction Mass

force operation. The APS 113 and 0112 Reaction Mass may be used in a vertical or horizontal free armature mode with rated force down to 2 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.



**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 attached to the body - or the shaker may be supported from



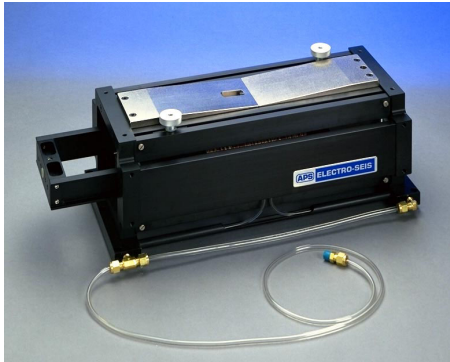
beneath by the APS 0072 Cradle Assembly which supports the armature directly and the body via the guidance system. This provides a convenient mounting for introducing force parallel to a horizontal mounting surface. Examples of such surfaces include floors, roofs, platforms, cabinets, bridges and tanks.



**Shaker Table Mode** Auxiliary tables are available which attach directly to the armature and enable the basic



shaker to provide long stroke, low frequency excitation to components or model structures mounted on the tables. APS 0052 Auxiliary Table provides a 10 in x 10 in horizontal load mounting surface for horizontal motion rated for 50 lb test loads. The APS 0077 Auxiliary Table provides the same load mounting surface for vertical motion. The APS 0078 provides for both vertical and horizontal applications.



APS 113 Air Bearing Shaker

## OPTIONAL CONFIGURATIONS

### APS 113-AB Air Bearing Model

Air lubricated bushings replace the linear ball bushings used in the basic **ELECTRO-SEIS** armature guidance system. In addition an air distribution system, tie down and leveling base are provided.

The near zero friction of the air bushings is an essential feature for measuring resonance decay rates in very lightly damped structures.

The Air Bearing configuration extends the application of the basic APS 113 to include the calibration and evaluation of accelerometers and other motion transducers in the seismic frequency range.

### APS 113-LA Lightweight Armature and APS 113-AB-LA Air Bearing-Lightweight

The body of the **ELECTRO-SEIS** Shaker is retained but the armature and guidance system are replaced with elements offering substantial weight reduction. The drive coil is lightened - with corresponding reduction in maximum force - and the armature guidance system elements are reduced in size and weight. This results in a corresponding reduction in cross axis stiffness and load carrying ability. The long stroke capability is retained and the frequency range for maximum force output is extended to 1000 Hz.

**APS 113-AB-ES Air Bearing - Extended Stroke** Used for Modal Excitation of structures where a longer stroke is required.

The Lightweight Armature is a desirable



APS 113-AB-ES Extended Stroke

feature when using the shaker for exciting structures having low modal mass.

### APS 113 LZ Low Impedance Coil

All features of the basic **ELECTRO-SEIS** Shaker are retained. The drive coil is wound in a manner which allow series or parallel connection, offering the user the choice of standard or low impedance. This option is required if the shaker is to be used with the APS 124 **DUAL-MODE** Power Amplifier for extended frequency range or random noise excitation.

**APS 113-HF High Force Coil** All features of the basic **ELECTRO-SEIS** Shaker are retained as in the APS 113-LZ. The drive coil is provided to match the APS 124 **DUAL-MODE** Power Amplifier for 40% increase in force with a 50% duty cycle (1 / 2 hr cycle).

SPECIFICATIONS	Model 113	Model 113-AB	Model 113-LA	Model 113-AB-LA	Model 113-AB-ES	Model 113-LZ	Model 113-HF
Maximum force, Vector	30 lb, 133 N	30 lb, 133 N	20 lb, 90 N	20 lb, 90 N	14 lb, 62 N	30 lb, 133 N	42 lb, 186 N*
Maximum Velocity, Vector	30 in/s, 760 mm/s	30 in/s, 760 mm/s	30 in/s, 760 mm/s	30 in/s, 760 mm/s	30 in/s, 760 mm/s	30 in/s, 760 mm/s	30 in/s, 760 mm/s
Maximum Stroke, p-p	6.25 in, 158 mm	6.25 in, 158 mm	6.25 in, 158 mm	6.25 in, 158 mm	6.25 in, 158 mm	6.25 in, 158 mm	6.25 in, 158 mm
Armature Weight	4.9 lb, 2.2 kg	5.1 lb, 2.3 kg	1.0 lb, .45 kg	1.0 lb, .45 kg	1.1 lb, 0.5 kg	5.0 lb, 2.27 kg	4.9 lb, 2.20 kg
Maximum Overhung Load at Armature Attachment Point	20 lb, 9 kg	2 lb, 0.9 kg	2 lb, 0.9 kg	2 lb, 0.9 kg	2 lb, 0.9 kg	20 lb, 9 kg	20 lb, 9 kg
Air Pressure Required	N/A	30 psig, 2 kg cm <sup>2</sup>	N/A	30 psig, 2 kg cm <sup>2</sup>	30 psig, 2 kg cm <sup>2</sup>	N/A	N/A
Armature Coil Impedance	8 Ohm	8 Ohm	4 Ohm	4 Ohm	6 Ohm	8 Ohm / 2 Ohm	4 Ohm
Total Shaker Weight	80 lb, 36 kg	80 lb, 36 kg	75 lb, 34 kg	76 lb, 35 kg	84 lb, 38 kg	80 lb, 36 kg	80 lb, 36 kg
Shipping Weight	89 lb, 41 kg	90 lb, 41 kg	85 lb, 39 kg	86 lb, 39 kg	94 lb, 43 kg	89 lb, 41 kg	89 lb, 41 kg
Overall Dimensions							
Length	20.7 in, 526 mm	20.7 in, 526 mm	20.7 in, 526 mm	20.7 in, 526 mm	24.7 in, 627 mm	20.7 in, 526 mm	20.7 in, 526 mm
Width	8.4 in, 213 mm	8.4 in, 213 mm	8.4 in, 213 mm	8.4 in, 213 mm	8.4 in, 213 mm	8.4 in, 213 mm	8.4 in, 213 mm
Height	6.6 in, 168 mm	6.6 in, 168 mm	6.6 in, 168 mm	6.6 in, 168 mm	6.6 in, 168 mm	6.6 in, 168 mm	6.6 in, 168 mm
Matching Power Amplifier							
Sinewave	APS 114	APS 114	APS 124	APS 124	APS 124	APS 124	APS 124
Random			APS 124-EP	APS 124-EP	APS 124-EP	APS 124-EP	APS 124-EP

\*50% Duty Cycle





**PERFORMANCE**

One application of the **APS 113 ELECTRO-SEIS** 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 30 in/s and a force of 30 lb is required to sustain the vibration level, then the shaker will be delivering approximately 50 watts 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 30 lb ÷ 30 in/s, the full 50 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 performance of the **APS 113 ELECTRO-SEIS** with various mass loads is shown in the lower graph for the 30-lb rating.

**SYSTEM EQUIPMENT**

- Model 114 DUAL-MODE™ Power Amplifier (125 V-A)
- Model 124 DUAL-MODE™ Power Amplifier (250 V-A)
- Interconnect Cables

