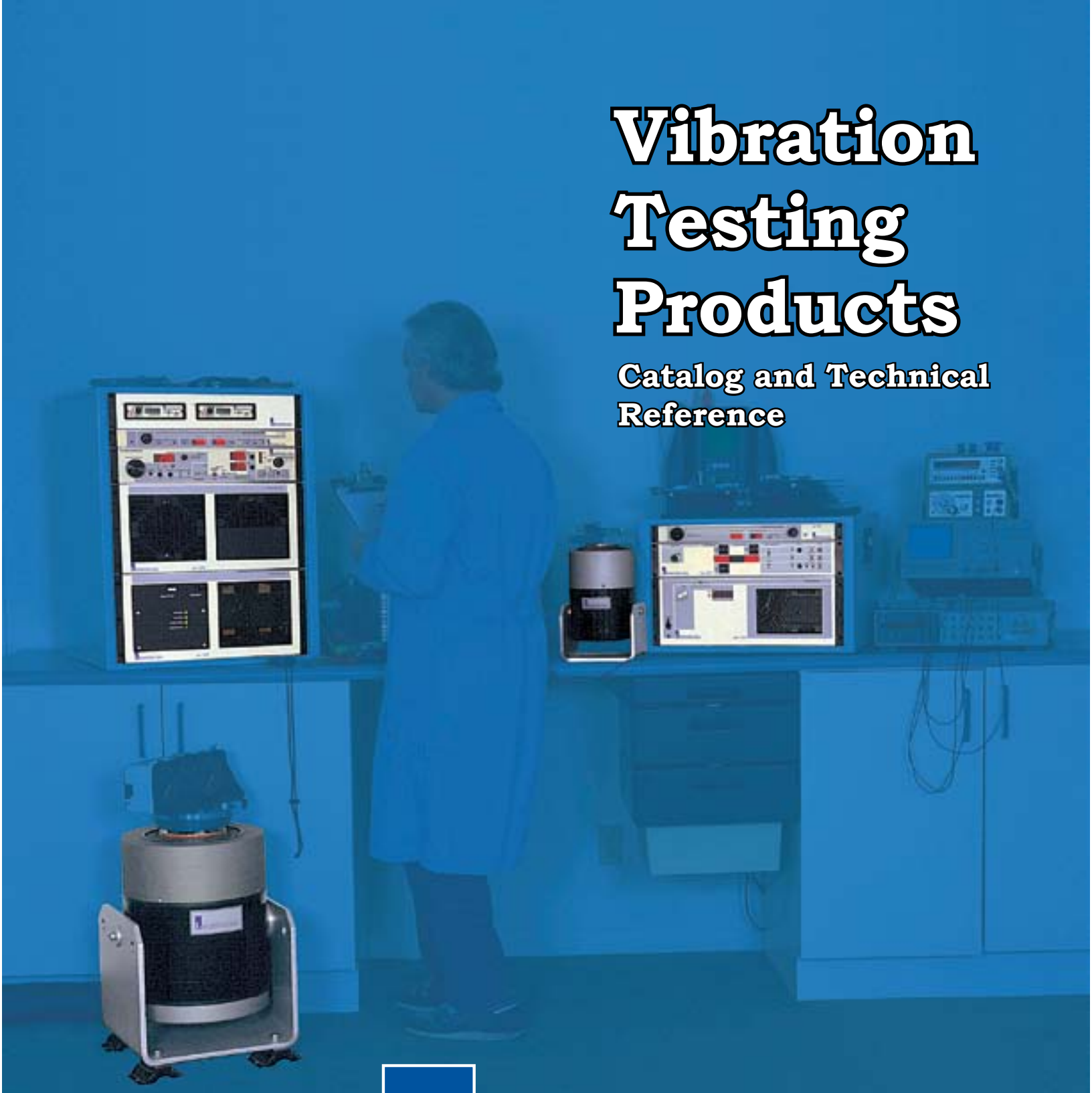
# Vibration Testing Products

## Catalog and Technical Reference



**Shakers**
**Amplifiers**
**Controllers**
**Instrumentation**

Labworks Inc.

Catalog 181

# About Labworks

Labworks is a complete engineering and manufacturing facility, specializing in electromechanical equipment for vibration testing systems and programs.

Founded in 1983, Labworks has been supplying high performance laboratory and production vibration testing equipment since its inception. Our customers benefit from our broad experience and background ranging from microprocessor- and analog-based control system design, to sophisticated dynamic mechanical design and analysis. This broad-based engineering talent is combined with practical field experience to produce products that are known for ease of use and inherent reliability.

We have been awarded several engineering patents for electronic and electromechanical designs. Our practice of using the latest in technology and materials has brought high reliability and high performance products to our customers through innovative design.

We have developed a line of vibration test shakers, amplifiers, controllers, and accessories designed for ease of use and maintenance. Our reputation for high-quality products, coupled with on-time deliveries, friendly technical assistance, and excellent after sales service, has made our company the vibration equipment solution.

# Service and Technical Assistance

Service at Labworks begins at the product design stage of development. We maintain the highest design and manufacturing standards ensuring that our customers experience superior reliability with our products.

The Labworks service group is centralized at the manufacturing facility allowing continuous communication between engineering and manufacturing. This ensures consistent feedback and feed-forward for all technical issues. Our service group is readily available to answer any questions relating to the use of our products.

Click here for service and technical assistance contact information.

Labworks Inc.

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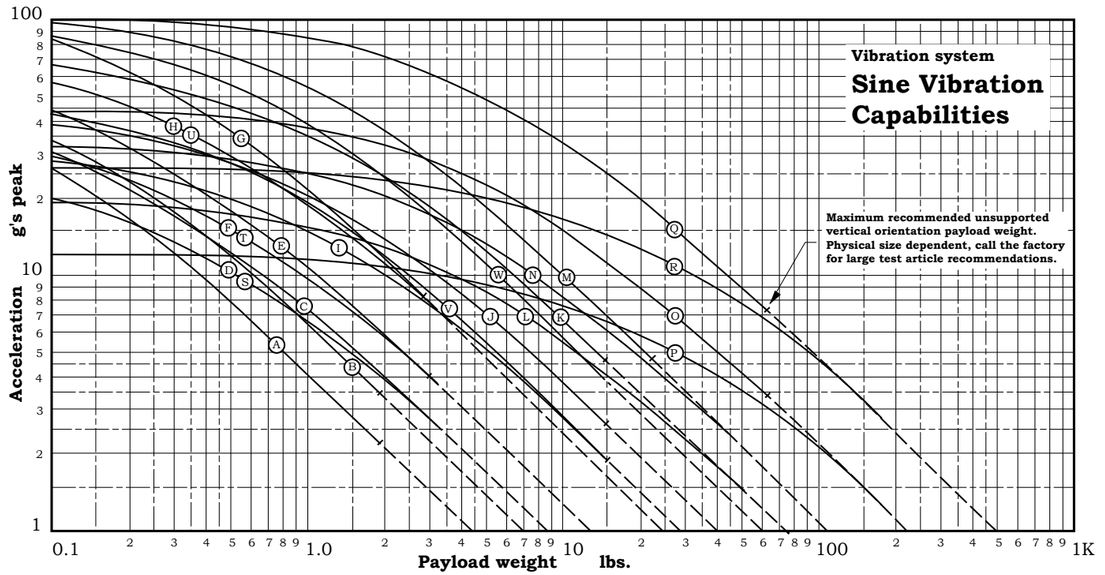
# System Selector – Sine & Random Vibration Capabilities




System selection: Follow this simple three step procedure to select the proper Labworks vibration system for your application.

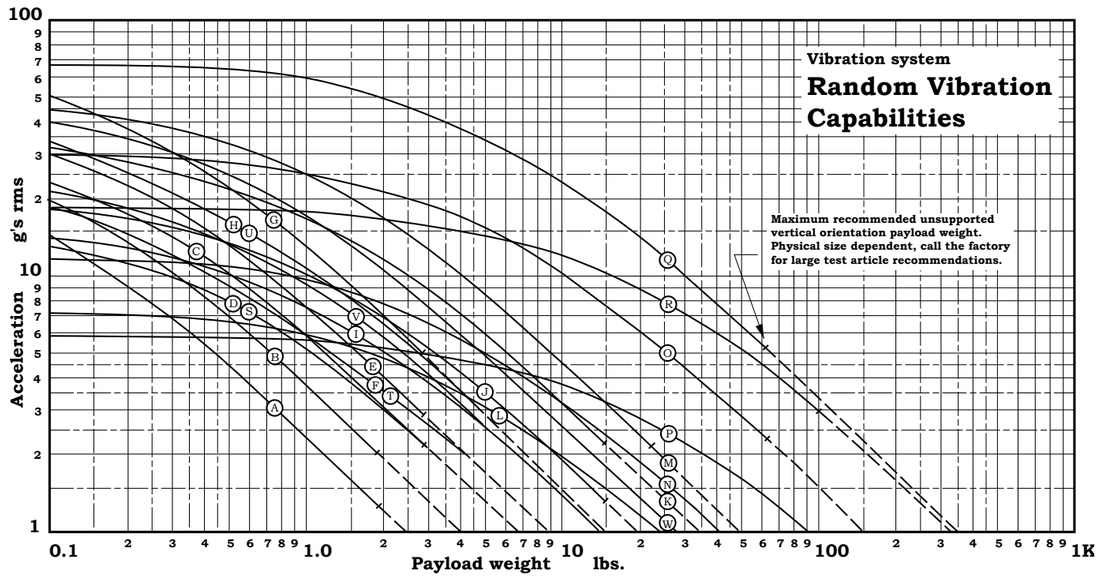
**1. Determine the payload weight.** Add the weight of the test specimen to any adaptors or fixtures that will be used. You cannot drill additional mounting holes in the shaker armature, therefore, an adaptor/fixture may be required to mount your test specimen. Be sure to include the weight of any components that will move with the shakers vibration such as cables, connectors, hold down bolts, etc.

**2. Determine the required vibration acceleration.** Convert your vibration specification data into acceleration units of g's peak for sine testing or g's rms for random testing. Remember: 1 g = 32.2 ft/sec$^2$ = 9.8 m/sec$^2$. Determine the maximum displacement and acceleration that will be required for the desired testing. If either of these is not known, it can be determined by referring to the engineering information section of this catalog.

**3. Select a Labworks system** using either the **Sine** or **Random Vibration Capabilities** charts below. Plot the point that corresponds to your payload weight and required acceleration. Your testing can be done with any system whose capability line passes to the right and above your plotted requirements point. Refer to the **System Components/Specifications** table below to insure that the system you have selected has adequate peak to peak displacement capability and frequency range.

**Refer to the engineering section of this manual for additional detailed information.**

**Have a question or need some help?** Call us and talk to one of our vibration engineers for special applications or just to insure your selection.



## System Components/Specifications:

| Graph Curve | SYSTEM NUMBER | SHAKER MODEL | AMPLIFIER MODEL | SINE FORCE | RANDOM FORCE | DISP. PK-PK | ARM. WEIGHT | FREQ. LIMIT | FLEX. STIFF. | SHAKER COOLING |
|---|---|---|---|---|---|---|---|---|---|---|
| **General Purpose Test Systems** | | | | | | | | | | |
| A | LW132.203.151-4.5 | ET-132-203 | PA-151 | 4.5 | 3.0 | .20 | .07 | 11.0 K | 15 | N |
| B | LW132.151-7 | ET-132-2 | PA-151 | 7.0 | 5.0 | .50 | .10 | 9.0 K | 15 | N |
| C | LW126.151-9 | ET-126-4 | PA-151 | 9.0 | 7.0 | .75 | .20 | 8.5 K | 15 | N |
| D | LW126HF.151-9 | ET-126HF-4 | PA-151 | 9.0 | 7.0 | .75 | .35 | 14.0 K | 15 | N |
| E | LW126.138-13 | ET-126-1 | PA-138 | 13.0 | 9.0 | .75 | .20 | 8.5 K | 15 | N |
| F | LW126HF.138-13 | ET-126HF-1 | PA-138 | 13.0 | 9.0 | .75 | .35 | 14.0 K | 15 | Y |
| G | LW126.141-25 | ET-126-4 | PA-138 | 13.0 | 9.0 | .75 | .20 | 8.5 K | 15 | Y |
| H | LW126HF.141-25 | ET-126HF-4 | PA-141 | 25.0 | 15.0 | .75 | .35 | 14.0 K | 15 | Y |
| I | LW139.151-30 | ET-139 | PA-151 | 30.0 | 15.0 | 1.00 | 1.00 | 6.5 K | 60 | N |
| J | LW139.138-40 | ET-139 | PA-138 | 40.0 | 17.0 | 1.00 | 1.00 | 6.5 K | 60 | N |
| K | LW139.141-75 | ET-139 | PA-141 | 75.0 | 28.0 | 1.00 | 1.00 | 6.5 K | 60 | Y |
| L | LW139.141-75D6 | DB-139 | PA-141 | 75.0 | 28.0 | 1.00 | 3.80 | 4.5 K | 60 | Y |
| M | LW140.141-110 | ET-140 | PA-141-140 | 110.0 | 45.0 | 1.00 | 1.00 | 6.5 K | 90 | Y |
| N | LW140.141-110D6 | DB-140 | PA-141-140 | 110.0 | 45.0 | 1.00 | 3.80 | 4.5 K | 90 | Y |
| O | LW127.141-225 | ET-127 | PA-141-127 | 225.0 | 110.0 | 1.15 | 5.00 | 4.5 K | 250 | Y |
| P | LW127.141-225D12 | DB-127 | PA-141-127 | 225.0 | 110.0 | 1.15 | 19.00 | 3.5 K | 250 | Y |
| Q | LW127.123-500 | ET-127 | PA-123-500 | 500.0 | 350.0 | 1.15 | 5.00 | 4.5 K | 250 | Y |
| R | LW127.123-500D12 | DB-127 | PA-123-500 | 500.0 | 350.0 | 1.15 | 19.00 | 3.5 K | 250 | Y |
| **Modal Test Systems** | | | | | | | | | | |
| S | LW161.151-9 | MT-161-4 | PA-151 | 9.0 | 7.0 | .75 | .35 | 10.0 K | 15 | N |
| T | LW161.138-13 | MT-161-1 | PA-138 | 13.0 | 8.0 | .75 | .35 | 10.0 K | 15 | N |
| U | LW161.141-25 | MT-161-4 | PA-141 | 25.0 | 11.0 | .75 | .35 | 10.0 K | 15 | Y |
| V | LW160.151-30 | MT-160 | PA-151 | 30.0 | 15.0 | 1.40 | .60 | 10.0 K | 15 | N |
| W | LW160.141-60 | MT-160 | PA-141 | 60.0 | 28.0 | 1.40 | .60 | 10.0 K | 15 | Y |
| **Inertial Shaker Systems** | | | | | | | | | | |
| X | LW142.151-4 | FG-142 | PA-151 | 4.0 | 2.8 | .25 | .33 | 2.0 K | n/a | R |

**Sine force** = pounds force, vector (peak).

**Random force** = pounds force, RMS, 2.5σ min.

**Disp. pk-pk** = Maximum relative displacement between stops, peak to peak, inches.

**Arm. weight** = Shaker armature weight, pounds.

**Freq. limit:** DC to upper frequency limit, Hz, derate approximately 10% for heavy loads. Systems may be usable above this limit at reduced force levels.

**Flex. stiff.** = Shaker flexure stiffness, lb/inch.

**Shaker cooling** = Y=Cooling blower supplied. R=Customer supplied air.





# Vibration Systems Engineering Information

### General

Labworks manufactures a range of electrodynamic transducers (shakers) as well as a series of high dissipation shaker power amplifiers and vibration controllers. These shakers and amplifiers, in various combinations, yield a wide variety of vibration performance levels. Labworks has selected several combinations (or systems) that yield cost effective solutions to the most common requirements. These systems include all necessary shaker to amplifier interconnecting cables as well as a cooling blower and hose when cooling is required. Systems with PA-123 series amplifiers are supplied with an amplifier rack panel cabinet.

When shakers are matched with different amplifiers, systems with specific vibration capabilities are produced. The current system specifications, rather than the individual component specifications reflect these capabilities. Of course, the system specifications will be equal to or less than the individual shaker maximum ratings.

In addition to the basic Labworks system consisting of a shaker and an amplifier, we also offer vibration controllers and other accessories to tailor the system to specific needs.

Labworks shakers, amplifiers and controllers can be purchased separately, if desired, to upgrade existing test setups. See the individual data sheets in this catalog for specific data relative to these components. Feel free to call us and talk to one of our vibration engineers if you have any questions regarding our components.

### Sine Vibration

Shaker systems are usually rated by their sinusoidal vibration peak force capabilities. Since electrodynamic shakers are primarily force generators, a shaker system must provide the force necessary to produce the accelerations required on the test specimen and its mounting fixture. This required force is readily calculated by multiplying the sinusoidal peak acceleration desired by the total moving mass. The total moving mass includes the test specimen, its mounting fixture and the shakers armature. The system selector graphs and procedure in this catalog include the shaker's armature, therefore, only the test specimen and its fixture weight is used on the payload axis of these graphs. If an exact calculation is desired, Labworks armature weights can be found on the shaker individual data pages as well as on the system selector pages. A short cut to this calculation is generally practiced in the industry by specifying the acceleration in g's pk (acceleration of gravity) and then using the total moving weight in place of mass in the normal F = ma equation and the related equations of motion for velocity and displacement.

For example:
Test specimen weight: 3 pounds
Test fixture weight: 0.5 pounds
Test specification: sine sweep, 20 to 200 Hz, 10 g pk

From the **Sine Vibration Capabilities** graph, the intersection of 3.5 pounds and 10 g pk falls just above the LW-139-40 and below the LW-139-75 curves. From the **System Components** table, both of these systems utilize the ET-139 shaker which has a 1.0 pound armature. To check the requirement:

10 gpk x (3.0 lb + 0.5 lb +1.0 lb) = 45 lb force pk

The LW-139-75 system should be selected because the force required is above the capability of the LW-139-40 system. To check the required displacement for the specification, use the formula for sine displacement from the engineering section of this manual and calculate it for the lowest specification frequency (which is the highest displacement for constant acceleration).

From above: 10g pk @ 20 Hz

$D_{req}$ = g / .0511 $f^2$ + 2 w/k*
= 10 / (.0511 x $20^2$)+ (2 x 4.5 / 60)
= 0.639 inch pk-pk

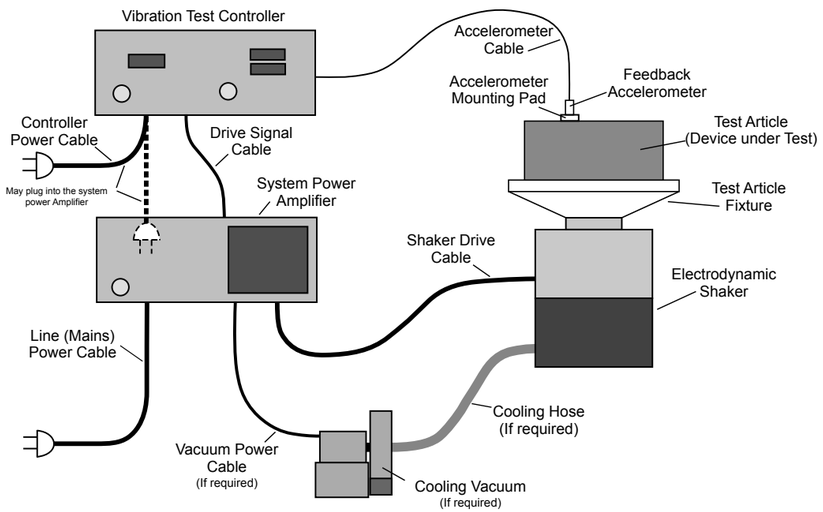
*the 2w/k term for vertical operation only
w = total load, k = shaker flexure stiffness

Checking the **System Components** table shows the Displacement for the LW-139-75 system to be 1.0 inch pk-pk maximum and therefore it is a suitable system for this requirement.

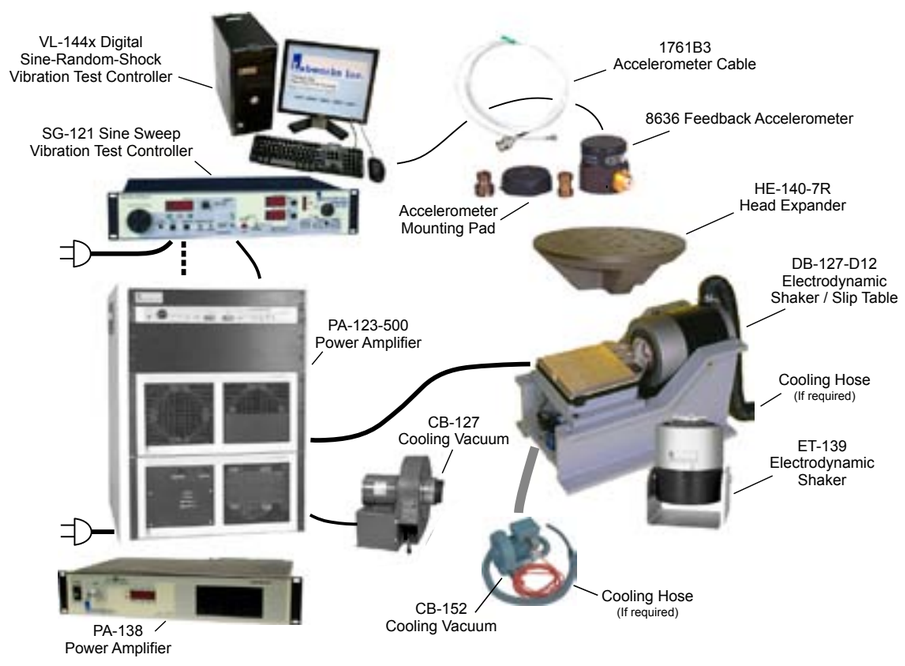
### Random Vibration

Random vibration calculations proceed exactly the same as sine except that the **Random Vibration Capabilities** graph and **System Specifications** random force must be substituted. Acceleration in g's RMS and displacement in inches pk-pk must be known or calculated using the engineering equations found in the engineering section of this manual.

## Vibration System Hook-up: Block Diagram




## Vibration System Hook-up: Typical Hardware Components







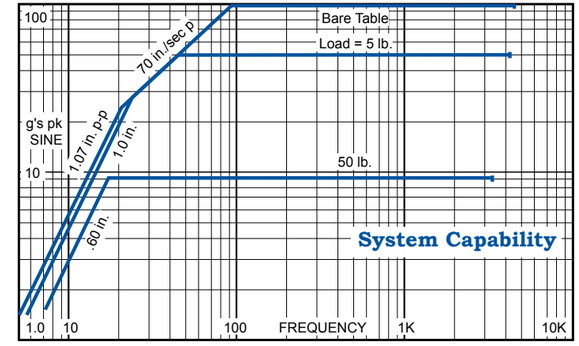

# LW127.123-500 Vibration System

The LW127.123-500 is the largest of the current family of Labworks vibration test systems. Electrodynamic shaker systems consist of a shaker and a matching linear direct coupled power amplifier. Additional components are then added to the basic system to tailor it to your specific needs.

Your small system concerns deserve the same attention given to larger, more expensive system requirements. Unlike other manufacturers, Labworks has designed and manufactures both its shakers and matching amplifiers in-house. This insures that the components will provide optimal performance across the broad range of possible applications and that application and service information is available with one call to the source.

## General Specifications

| | |
|---|---|
| **Sine Force:** | 500 lbs force pk |
| **Random Force:** | 350 lbf rms random |
| **Shock Force:** | 1,000 lbf pk shock |
| **Frequency Range:** | DC to 4,500 Hz |
| **Max. Acceleration:** | 100 g pk, bare table<br>50 g pk, 5 lb. load<br>11 g pk, 40 lb. load |
| **Max. Displacement:** | 1.0 inch pk-pk, bare table |
| **Cooling:** | Amplifier: forced air<br>Shaker: cooling blower |
| **Power Requirements:** | 5200 VA @ 208- 230V, 1ø, 50/60 Hz. |




Standard trunnion allows shaker operation in any position from vertical to horizontal. CB-127 shaker cooling vacuum.

## System Components*

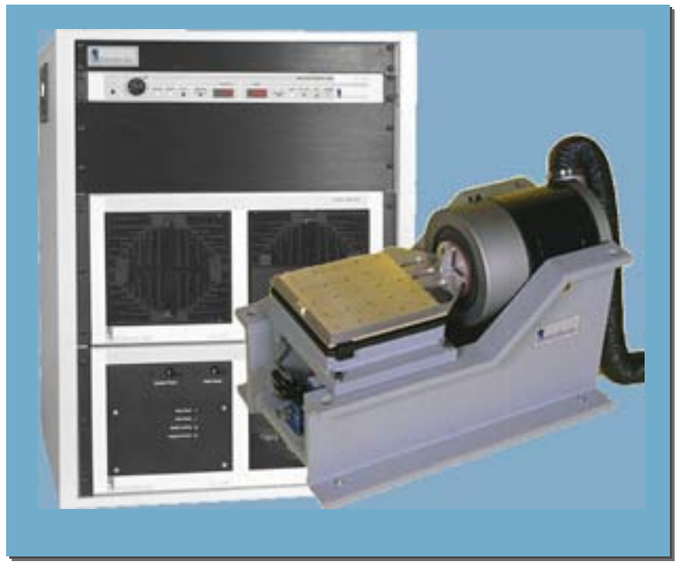
- ET-127 Electrodynamic Shaker w/De-Gauss Coil
- PA-123-3/2-500 Amplifier, De-Gauss & Field Supply
- CB-127 Cooling Blower
- Amplifier Cabinet
- Interconnect Cables and Hoses

## System Options*

- VL-144 2 Ch. Sine, Random and Shock Controller
- VL-145 1 Ch. Digital Controller
- DB-127 DuoBase
- HE-127 Head Expander
- SC-121 Sine Servo Controller
- SG-135 Manual Controller
- CS-123 Current Source Signal Conditioner

*See individual components for more detailed specifications and options.

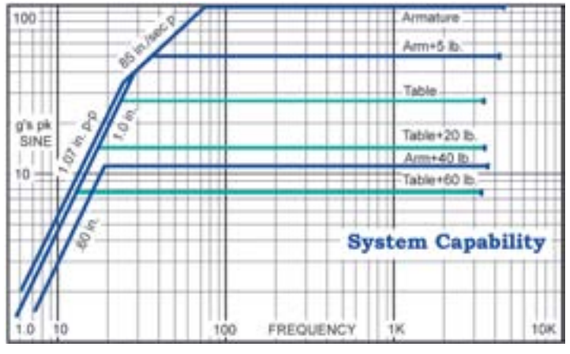
# LW127.123-500D12 DuoBase System



The LW-127-500D12 is the largest of the current family of Labworks vibration test systems. Its large 12 inch Square oil film Slip Table mounting surface provides high load and off-center moment capability for applications where heavy or large loads are to be tested. The DB-127 also allows the ET-127 shaker to be uncoupled from the slip table and rotated into its vertical position allowing normal vertical testing of smaller components directly on the shakers armature. The Shakers internal high lateral stiffness carbon composite armature suspension reduces problems associated with off-center loads when operating vertically. The ET-127 Shaker in this system is equipped with a degauss coil to ensure low stray magnetic field for sensitive applications. The modular air cooled PA-123 amplifier is direct coupled to the shaker to give the maximum performance at low and high frequencies. Digital meters display the system operating levels and complete shaker and user interlocks help protect the system from accidental abuse.

## General Specifications

| | |
|---|---|
| **Sine Force:** | 500 lbs force pk |
| **Random Force:** | 350 lbf rms random |
| **Shock Force:** | 1,000 lbf pk shock |
| **Frequency Range:** | |
| Horizontal, w/Slip Table | DC to 3,000 Hz |
| Vertical, w/o Slip Table | DC to 4,500 Hz |
| **Max. Acceleration:** | |
| Horizontal, w/Slip Table | 26 g pk, bare table |
| | 13 g pk, 20 lb. load |
| | 6.3 g pk, 60 lb. load |
| Vertical, w/o Slip Table | 100 g pk, bare table |
| | 50 g pk, 5 lb. load |
| | 11 g pk, 40 lb. load |
| **Max. Displacement:** | 1.0 inch pk-pk, bare table |
| **Cooling:** | Amplifier: forced air |
| | Shaker: cooling vacuum |
| **Power Requirements:** | 5200 VA @ 208- 230V, |
| | 1ø, 50/60 Hz. |




## System Components*

- DB-127-12 Electrodynamic Shaker w/12” sq Slip Table Base
- PA-123-3/2-500 Amplifier, De-Gauss & Field Supply
- CB-127 Cooling Blower
- Amplifier Cabinet
- Interconnect Cables and Hoses

## System Options*

- VL-144x 2 Ch. Sine, Random and Shock Controller
- VL-145x 1 Ch. Sine and Random Digital Controller
- SC-121 Sine Servo Controller
- SG-135 Manual Controller
- HE-127 Head Expander
- AI-127 Pneumatic Base Isolation Kit

*See individual components for more detailed specifications and options.

VL-144x/145x option

AI-127 option





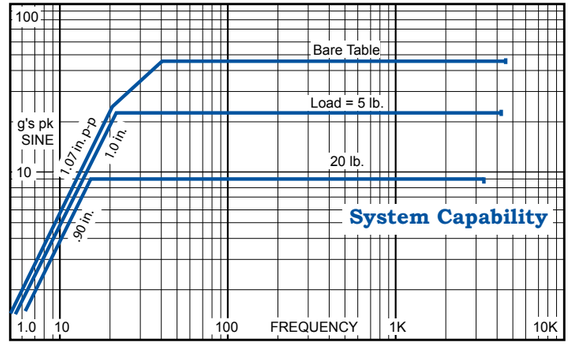
# LW127.123-225 Vibration System

The LW-127-225 system is used when the test article size makes the ET-127 shaker the correct choice but test requirements do not demand the full rated shaker performance available from the LW-127-500 system.

## General Specifications

| | |
|---|---|
| **Sine Force:** | 225 lbs force pk |
| **Random Force:** | 110 lbf rms random |
| **Shock Force:** | 240 lbf pk shock |
| **Frequency Range:** | DC to 4,500 Hz |
| **Max. Acceleration:** | 45 g pk, bare table |
| | 32 g pk, 2 lb. load |
| | 15 g pk, 10 lb. load |
| **Max. Displacement:** | 1.0 inch pk-pk, bare table |
| **Cooling:** | Amplifier: forced air |
| | Shaker: cooling blower |
| **Power Requirements:** | 3500 VA @100-125*, 200-240V, |
| | 1ø, 50/60 Hz. |

*Consult factory for low line voltage operation.




Standard trunnion allows shaker operation in any position. from vertical to horizontal. The PA-141 amplifier features switched 115 Vac power.

## System Components*

- ET-127 Electrodynamic Shaker
- PA-141 Linear Power Amplifier
- FS-127 Integrated Field Supply
- CB-127 Cooling Blower
- Interconnect Cables and Hoses

## System Options*

- VL-144 2 Ch. Sine, Random and Shock Controller
- VL-145 1 Ch. Digital Controller
- SC-121 Sine Servo Controller
- HE-127 Head Expander
- AI-127 Pneumatic Base Isolation Kit
- Rack Cabinet
- Accelerometer Package

*See individual components for more detailed specifications and options.

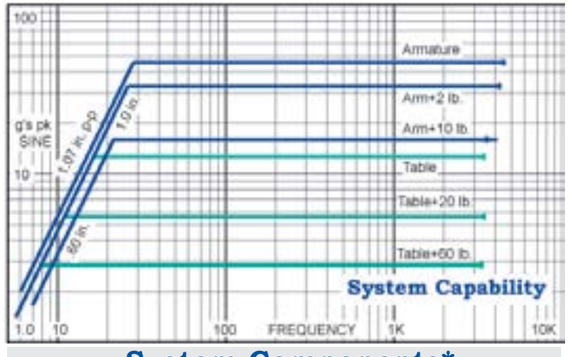
# LW127.141-225D12 DuoBase System

The LW127.141-225 system utilizes the ET-127 shaker in a lower force output system. Suitable for larger loads that don't require high vibration levels, the 225 system offers the benefits of the larger shaker at a reduced price to give the maximum performance at low and high frequencies. Its large 12 inch Square oil film Slip Table mounting surface provides high load and off-center moment capability for applications where heavy or large loads are to be tested. The DB-127 also allows the ET-127 shaker to be uncoupled from the slip table and rotated into its vertical position allowing normal vertical testing of smaller components directly on the shakers armature. The Shakers internal high lateral stiffness carbon composite armature suspension reduces problems associated with off-center loads when operating vertically.. Dual meters display the system operating levels and complete shaker and user interlocks help protect the system from accidental abuse.

## General Specifications

| | |
|---|---|
| **Sine Force:** | 225 lbs force pk |
| **Random Force:** | 110 lbf rms random |
| **Shock Force:** | 240 lbf pk shock |
| **Frequency Range:** | |
| Horizontal, w/Slip Table | DC to 3,000 Hz |
| Vertical, w/o Slip Table | DC to 4,500 Hz |
| **Max. Acceleration:** | |
| Horizontal, w/Slip Table | 12 g pk, bare table |
| | 5.8 g pk, 20 lb. load |
| | 2.9 g pk, 60 lb. load |
| Vertical, w/o Slip Table | 45 g pk, bare table |
| | 32 g pk, 5 lb. load |
| | 15 g pk, 10 lb. load |
| **Max. Displacement:** | 1.0 inch pk-pk, bare table |
| **Cooling:** | Amplifier: forced air |
| | Shaker: cooling vacuum |
| **Power Requirements:** | 3500 VA @ 100-125*, 200-240V, 1ø, 50/60 Hz. |

*Consult factory for low line voltage operation.




## System Components*

- DB-127-12 Electrodynamic Shaker w/12" sq Slip Table Base
- PA-141-127 Amplifier & Field Supply
- CB-127 Cooling Blower
- Interconnect Cables and Hoses

## System Options*

- VL-144x 2 Ch. Sine, Random and Shock Controller
- VL-145x 1 Ch. Sine and Random Digital Controller
- SC-121 Sine Servo Controller
- SG-135 Manual Controller
- HE-127 Head Expander
- Amplifier Cabinet
- AI-127 Pneumatic Base Isolation Kit

*See individual components for more detailed specifications and options.

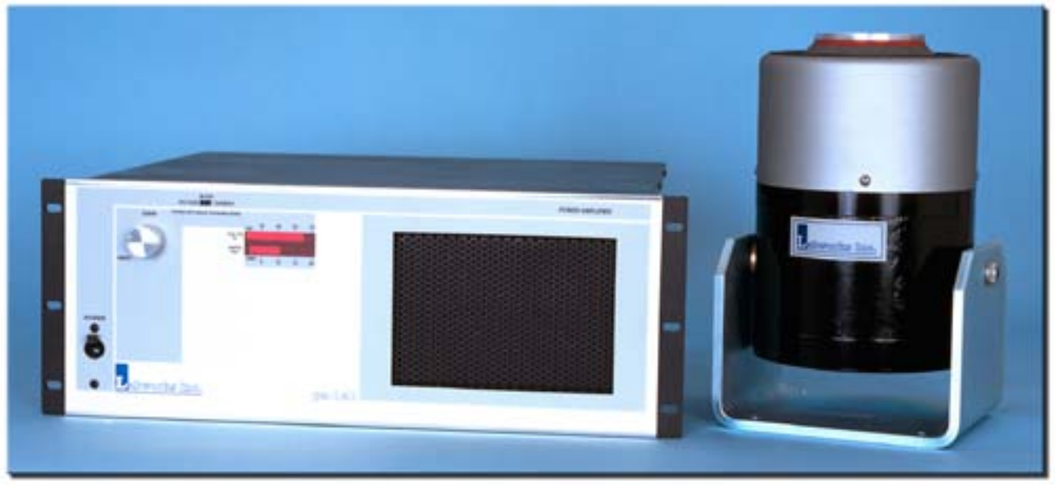
VL-144x/145x option

AI-127 option





# LW140.141-110 Vibration System



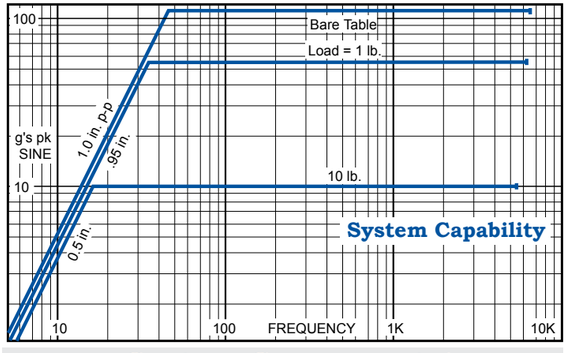
The LW-140-110 is a high performance system capable of very high acceleration (110 g, bare table). It is used for general purpose as well as modal testing. The shaker field supply is integrated into the power amplifier and includes a cooling interlock to protect the shaker.

## General Specifications

| | |
|---|---|
| **Sine Force:** | 110 lbs force pk |
| **Random Force:** | 45 lbf rms random |
| **Shock Force:** | 110 lbf pk shock |
| **Frequency Range:** | DC to 6,500 Hz |
| **Max. Acceleration:** | 110 g pk, bare table |
| | 55 g pk, 1 lb. load |
| | 10 g pk, 10 lb. load |
| **Max. Displacement:** | 1.0 inch pk-pk, bare table |
| **Cooling:** | Amplifier: forced air |
| | Shaker: cooling blower |
| **Power Requirements:** | 3300 VA@100-125*, 200-240V, 1ø, 50/60 Hz. |

*Consult factory for low line voltage operation.

Standard trunnion allows shaker operation in any position from vertical to horizontal. The PA-141 features switched 115 Vac power provided on the amplifier for shaker cooling and optional instrumentation.




## System Components*

- ET-140 Electrodynamic Shaker
- PA-141 Linear Power Amplifier
- FS-140 Integrated Field Supply
- CB-152-140 Cooling Blower
- Interconnect Cables and Hoses

## System Options*

- VL-144 2 Ch. Sine, Random and Shock Controller
- VL-145 1 Ch. Digital Controller
- SC-121 Sine Servo Controller
- SG-135 Manual Sine Controller
- HE-140 Head Expander
- Rack Cabinet
- Accelerometer Package (use with Controller option)

*See individual components for more detailed specifications and options.

# LW140.141-110D6 DuoBase System

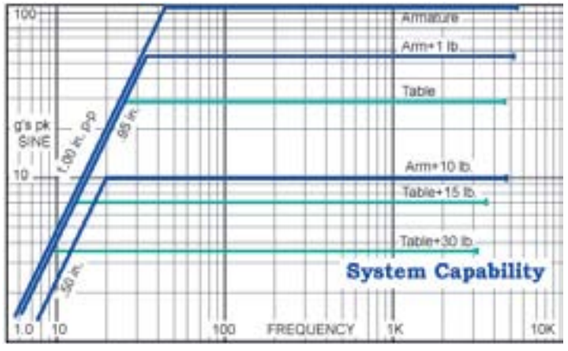
The LW140.141-110D6 Flexure Table system combines our ET-140 shaker and PA-141 amplifier together with our 6 inch square Flexure suspension Table. This combination provides a large mounting surface with increased load carrying capacity for larger or heavier than normal test specimens not requiring the force of a larger Shaker system. The unique flexure suspension table guidance eliminates the requirement for the oil found in slip table systems. This oil-less design allows operation at other than the horizontal orientation, and adds increased suspension guidance reducing the effects of heavy and off-center loads on the shakers armature suspension system.. The Table flexures are fully rated for 1 inch p-p operation, and the shaker can be uncoupled from the table for operation in its normal vertical orientation with specimens mounted directly to the shakers armature.

The air cooled PA-141 amplifier is direct coupled to the shaker to give the maximum performance at low and high frequencies. Dual meters display the system operating levels and complete shaker and user interlocks help protect the system from accidental abuse.

## General Specifications

| | |
|---|---|
| **Sine Force:** | 110 lbs force pk |
| **Random Force:** | 45 lbf rms random |
| **Shock Force:** | 110 lbf pk shock |
| **Frequency Range:** | DC to 6,500 Hz |
| **Max. Acceleration:** | |
| Horizontal, w/Slip Table | 29 g pk, bare table |
| | 7 g pk, 15 lb. load |
| | 3.5 g pk, 30 lb. load |
| Vertical, w/o Slip Table | 110 g pk, bare table |
| | 55 g pk, 1 lb. load |
| | 10 g pk, 10 lb. load |
| **Max. Displacement:** | 1.0 inch pk-pk, bare table |
| **Cooling:** | Amplifier: forced air |
| | Shaker: cooling vacuum |
| **Power Requirements:** | 3300 VA @ 100-125*, 200-240V, 1ø, 50/60 Hz. |

*Consult factory for low line voltage operation.




## System Components*

- DB-140 Electrodynamic Shaker w/6” sq Flexure Table Base
- PA-141-141 Amplifier & Field Supply
- CB-152-140 Cooling Blower
- Interconnect Cables and Hoses

## System Options*

- VL-144x 2 Ch. Sine, Random and Shock Controller
- VL-145x 1 Ch. Sine and Random Digital Controller
- SC-121 Sine Servo Controller
- SG-135 Manual Controller
- HE-140 Head Expander
- Amplifier Cabinet

*See individual components for more detailed specifications and options.

CB-152 included

SC-121 option





# LW139.141-75 Vibration System

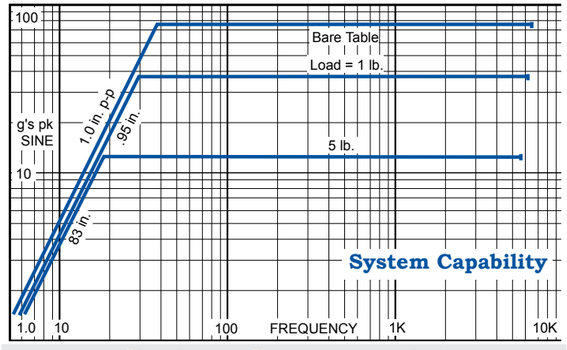
The LW139.141-75 is our most powerful permanent magnet shaker system. This system is intended for use when test specifications require full performance from the ET-139 shaker. It is used for general purpose as well as modal testing because the linear power amplifier can be operated in either voltage or current source mode as test specifications require.

## General Specifications

| | |
|---|---|
| **Sine Force:** | 75 lbs force pk |
| **Random Force:** | 28 lbf rms random |
| **Shock Force:** | 80 lbf pk shock |
| **Frequency Range:** | DC to 6,500 Hz |
| **Max. Acceleration:** | 75 g pk, bare table |
| | 38 g pk, 1 lb. load |
| | 13 g pk, 5 lb. load |
| **Max. Displacement:** | 1.0 inch pk-pk |
| **Cooling:** | Amplifier: forced air |
| | Shaker: cooling blower |
| **Power Requirements:** | 2200 VA @100-125*, 200-240V, 1ø, 50/60 Hz. |

*Consult factory for low line voltage operation.

Standard trunnion allows shaker operation in any position from vertical to horizontal. The PA-141 features switched 115 Vac power provided on the amplifier for shaker cooling and optional instrumentation.




## System Components*

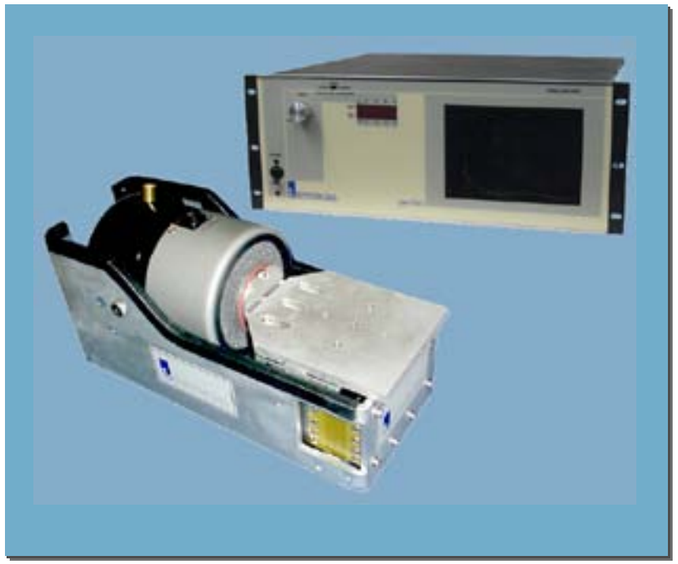
- ET-139 Electrodynamic Shaker
- PA-141 Linear Power Amplifier
- CB-152-139 Cooling Blower
- Interconnect Cables and Hoses

## System Options*

- VL-144 2 Ch. Sine, Random and Shock Controller
- VL-145 1 Ch. Digital Controller
- SC-121 Sine Servo Controller
- SG-135 Manual Sine Controller
- HE-139 Head Expander
- Rack Cabinet

*See individual components for more detailed specifications and options.

# LW139.141-75D6 DuoBase System



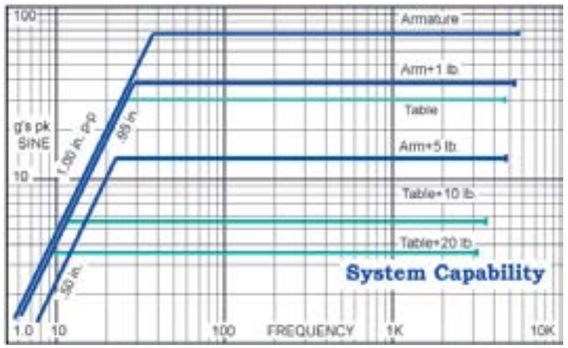
The LW139.141-75D6 Flexure Table system combines our ET-139 permanent magnet field shaker and PA-141 amplifier together with our 6 inch square Flexure suspension Table. This combination provides a large mounting surface with increased load carrying capacity for larger or heavier than normal test specimens not requiring the force of a larger shaker system. The unique flexure suspension table guidance eliminates the requirement for the oil found in slip table systems. This oil-less design allows operation at other than the horizontal orientation, and adds increased suspension guidance reducing the effects of heavy and off-center loads on the shakers armature suspension system.. The Table flexures are fully rated for 1 inch p-p operation, and the shaker can be uncoupled from the table for operation in its normal vertical orientation with specimens mounted directly to the shakers armature.

The air cooled PA-141 amplifier is direct coupled to the shaker to give the maximum performance at low and high frequencies. Dual meters display the system operating levels and complete shaker and user interlocks help protect the system from accidental abuse.

## General Specifications

| | |
|---|---|
| **Sine Force:** | 75 lbs force pk |
| **Random Force:** | 28 lbf rms random |
| **Shock Force:** | 75 lbf pk shock |
| **Frequency Range:** | DC to 6,500 Hz |
| **Max. Acceleration:** | |
| Horizontal, w/Slip Table | 20 g pk, bare table |
| | 5.5 g pk, 10 lb. load |
| | 3.2 g pk, 20 lb. load |
| Vertical, w/o Slip Table | 75 g pk, bare table |
| | 38 g pk, 1 lb. load |
| | 13 g pk, 5 lb. load |
| **Max. Displacement:** | 1.0 inch pk-pk, bare table |
| **Cooling:** | Amplifier: forced air |
| | Shaker: cooling vacuum |
| **Power Requirements:** | 2,200 VA @ 100-125*, 200-240V, 1ø, 50/60 Hz. |

*Consult factory for low line voltage operation.




## System Components*

- DB-139 Electrodynamic Shaker w/6” sq Flexure Table Base
- PA-141-139 Amplifier & Field Supply
- CB-152-139 Cooling Blower
- Interconnect Cables and Hoses

## System Options*

- VL-144x 2 Ch. Sine, Random and Shock Controller
- VL-145x 1 Ch. Sine and Random Digital Controller
- SC-121 Sine Servo Controller
- SG-135 Manual Controller
- HE-139 Head Expander
- Amplifier Cabinet

*See individual components for more detailed specifications and options.

CB-152 included

SC-121 option



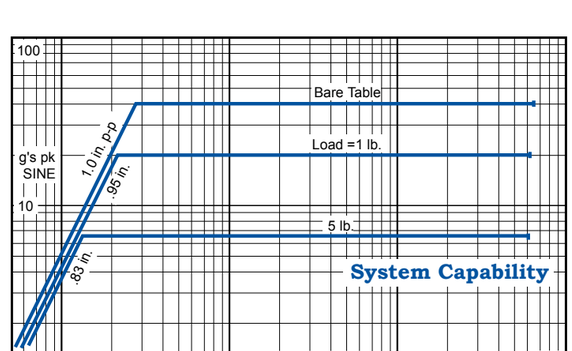


# LW139.138-40 Vibration System

The LW139.138-40 system is an excellent choice for modal testing due to the small shaker size, large displacement and absence of cooling hoses. Due to its compact size, this system is highly portable. The power amplifier has the option of being operated in the current source mode to facilitate modal testing. The large armature table facilitates general vibration testing of components and subassemblies with the amplifier in voltage source mode.

## General Specifications

| | |
|---|---|
| **Sine Force:** | 40 lbs force pk |
| **Random Force:** | 17 lbf rms random |
| **Shock Force:** | 75 lbf pk shock |
| **Frequency Range:** | DC to 6,500 Hz |
| **Max. Acceleration:** | 40 g pk, bare table |
| | 20 g pk, 1 lb. load |
| | 6.7 g pk, 5 lb. load |
| **Max. Displacement:** | 1.0 inch pk-pk, bare table |
| **Cooling:** | Amplifier: forced air |
| | Shaker: natural convection |
| **Power Requirements:** | 1000 VA @100, 120, 220, or 240V, 1ø, 50/60 Hz. |




Standard trunnion allows shaker operation in any position from vertical to horizontal. The hook-up requirements on the PA-138 are simple making the system highly portable.

## System Components*

- ET-139 Electrodynamic Shaker
- PA-138 Linear Power Amplifier
- Interconnect Cables and Hoses

## System Options*

- VL-144 2 Ch. Sine, Random and Shock Controller
- VL-145 1 Ch. Digital Controller
- SC-121 Sine Servo Controller
- SG-135 Manual Sine Controller
- Rack Cabinet
- HE-139 Head Expander

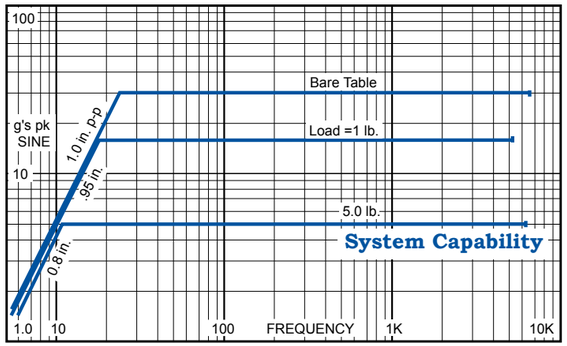
*See individual components for more detailed specifications and options.

# LW139.151-30 Vibration System

The LW139.151-30 system utilizes the Labworks ET-139 shaker in our lowest force 3 in. table shaker system. Suitable for larger loads that don't require high vibration levels, this system offers the benefits of the larger shaker with a lower system price. The shaker's full 1-inch armature stroke capability is ideal for many modal as well as low frequency general purpose applications. The convection cooled PA-151 amplifier is direct coupled to the shaker to give the maximum performance at both low and high frequencies and can be easily switched from voltage source mode for general testing to current source mode for modal testing applications. Dual bar graphs display the system operating levels and internal and external interlocks help protect the system from accidental abuse.

## General Specifications

| | |
|---|---|
| **Sine Force:** | 30 lbs force pk |
| **Random Force:** | 15 lbf rms random |
| **Shock Force:** | 45 lbf pk shock |
| **Frequency Range:** | DC to 6,500 Hz |
| **Max. Acceleration:** | 30 g pk, bare table |
| | 15 g pk, 1 lb. load |
| | 5.0 g pk, 5 lb. load |
| **Max. Displacement:** | 1.0 inch pk-pk, bare table |
| **Cooling:** | Amplifier: natural convection |
| | Shaker: natural convection |
| **Power Requirements:** | 300 VA @95-125, 190-250V, 1ø, 50/60 Hz. |




## System Components*

- ET-139 Electrodynamic Slhaker
- PA-151 Linear Power Amplifier
- Interconnect Cables and Hoses

## System Options*

- VL-145 Single Channel Digital Controller
- SC-121 Sine Controller
- SG-135 Manual Sine Servo Controller
- HE-139 Head Expander
- Amplifier Rack Mount Brackets
- MS-129 Modal Stinger Kit

*See individual components for more detailed specifications and options.

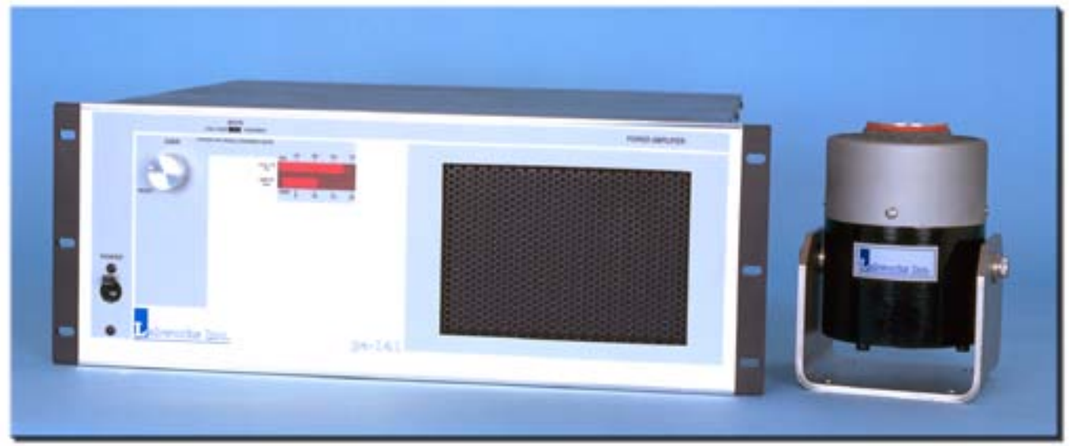
MS-129
option

Standard trunnion allows shaker operation in any position from vertical to horizontal. The hook-up requirements on the PA-151 are simple making this system highly portable.





# LW126.141-25 Vibration System

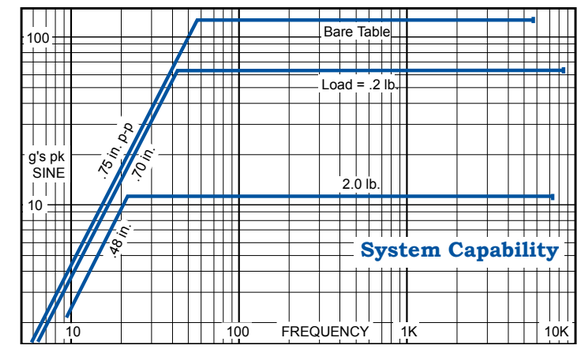


The LW126.141-25 system offers a combination of the maximum force available from the light-weight armature ET-126 shaker to yield the highest acceleration in our line. This system is perfectly suited for high accleration testing of small transducers as well as electrical and mechanical assemblies. The ET-126 also satisfies high frequency requirements with operation up to 8,500 Hz. The combination of high acceleration, high frequency range as well as high force with good load carrying ability and desktop convenience, makes this the most universal vibration test system of its size.

## General Specifications

| | |
|---|---|
| **Sine Force:** | 25 lbs force pk |
| **Random Force:** | 11 lbf rms random |
| **Shock Force:** | 27 lbf pk shock |
| **Frequency Range:** | DC to 8,500 Hz |
| **Max. Acceleration:** | 125 g pk, bare table |
| | 62 g pk, 0.2 lb. load |
| | 21 g pk, 1 lb. load |
| **Max. Displacement:** | 0.75 inch pk-pk, bare table |
| **Cooling:** | Amplifier: forced air |
| | Shaker: cooling vacuum |
| **Power Requirements:** | 3000 VA @100-125*, 200-240V, 1ø, 50/60 Hz. |

*Consult factory for low line voltage operation.




## System Components*

- ET-126-4 Electrodynamic Shaker
- PA-141 Linear Power Amplifier
- CB-152-126 Cooling Vacuum and Hose Assembly
- Interconnect Cables and Hoses

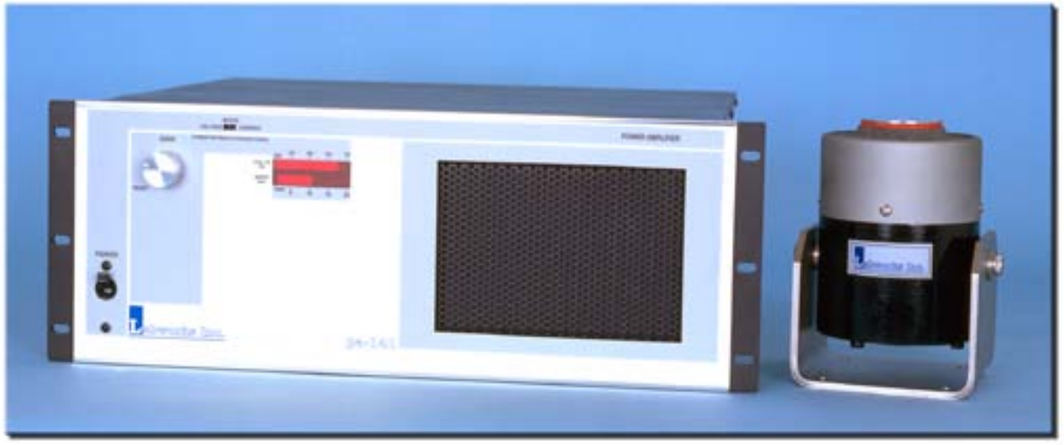
## System Options*

- VL-144 2 Ch. Sine, Random and Shock Controller
- VL-145 1 Ch. Digital Controller
- SC-121 Sine Servo Controller
- SG-135 Manual Sine Controller
- Rack Cabinet

*See individual components for more detailed specifications and options.

Standard trunnion allows shaker operation in any position from vertical to horizontal. The PA-141 features switched 115 Vac power provided on the amplifier for shaker cooling and optional instrumentation.

# LW126HF.141-25 High Frequency Vibration System



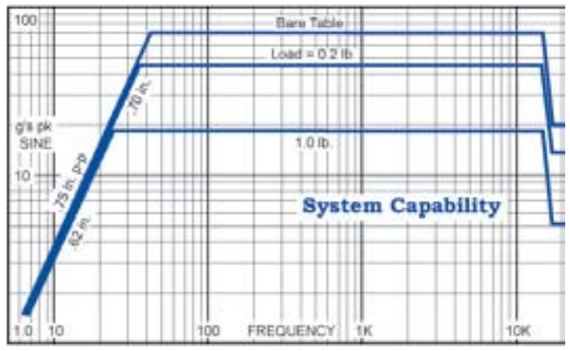
The LW126HF.141-25 is a high performance system which makes full use of the compact ET-126HF high frequency shaker performance. This system offers full performance up to 14,000 Hz with operation at up to 7 lbf to 20,000 Hz. This system is used for both general purpose testing and transducer calibration requirements. The larger mounting surface of the ET-126HF easily supports the calibration of larger vibration transducers and smaller high frequency assemblies and components for general purpose testing. The shaker can support relatively heavy loads and is perfectly matched to the amplifier, which makes this the most versatile system of its size.

## General Specifications

| | |
|---|---|
| **Sine Force:** | 25 lbs force pk |
| **Random Force:** | 11 lbf rms random |
| **Shock Force:** | 27 lbf pk shock |
| **Frequency Range:** | DC to 14,000 Hz (20,000 @ 7 lbf) |
| **Max. Acceleration:** | 70 g pk, bare table<br>45 g pk, 0.2 lb. load<br>18.5 g pk, 1 lb. load |
| **Max. Displacement:** | 0.75 inch pk-pk, bare table |
| **Cooling:** | Amplifier: forced air<br>Shaker: cooling blower |
| **Power Requirements:** | 3000 VA @100-125*, 200-240V, 1ø, 50/60 Hz. |

*Consult factory for low line voltage operation.

CB-152 included




## System Components*

- ET-126HF-4 Electrodynamic Shaker
- PA-141 Linear Power Amplifier
- CB-152-126 Cooling Blower and Hose Assembly
- Interconnect Cables and Hoses

## System Options*

- VL-144 Dual Channel Sine, Random and Shock Controller
- VL-145 Single Channel Digital Controller
- SC-121 Sine Servo Controller
- SG-135 Manual Sine Controller
- Rack Cabinet

*See individual components for more detailed specifications and options.



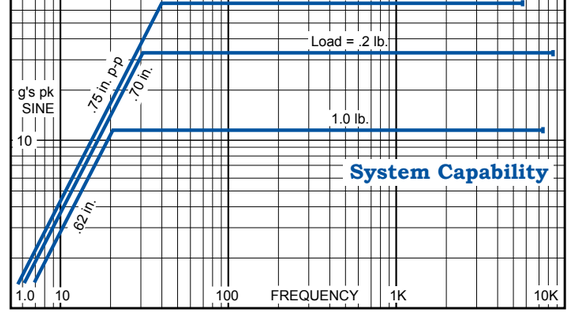


# LW126.138-13 Vibration System

The LW126.138-13 system offers the maximum force available, without forced air cooling, from the light-weight armature ET-126 shaker. This compact desktop system is perfectly suited for general purpose testing of small transducers as well as electrical and mechanical assemblies. The ET-126 also satisfies most high frequency test requirements with operation up to 8,500 Hz. The combination of high acceleration, high frequency range as well as high force with good load carrying ability and desktop convenience, makes this a popular choice for medium acceleration level testing.

## General Specifications

| | |
|---|---|
| **Sine Force:** | 13 lbs force pk (17 w/blower) |
| **Random Force:** | 8.0 lbf rms random |
| **Shock Force:** | 21 lbf pk shock |
| **Frequency Range:** | DC to 8,500 Hz |
| **Max. Acceleration:** | 65 g pk, bare table<br>32 g pk, 0.2 lb. load<br>11 g pk, 1 lb. load |
| **Max. Displacement:** | 0.75 inch pk-pk, bare table |
| **Cooling:** | Amplifier: forced air<br>Shaker: natural convection |
| **Power Requirements:** | 1000 VA @100, 120, 220, or 240V, 1ø, 50/60 Hz. |




Standard trunnion allows shaker operation in any position from vertical to horizontal. The hook-up requirements on the PA-138 are simple, making the system portable.

## System Components*

- ET-126-1 Electrodynamic Shaker
- PA-138 Linear Power Amplifier
- Interconnect Cables and Hoses

## System Options*

- VL-144 2 Ch. Sine, Random and Shock Controller
- VL-145 1 Ch. Digital Controller
- SC-121 Sine Servo Controller
- SG-135 Manual Sine Controller
- Rack Cabinet
- Accelerometer Package
- CB-126 Cooling Blower (>13 lbf)

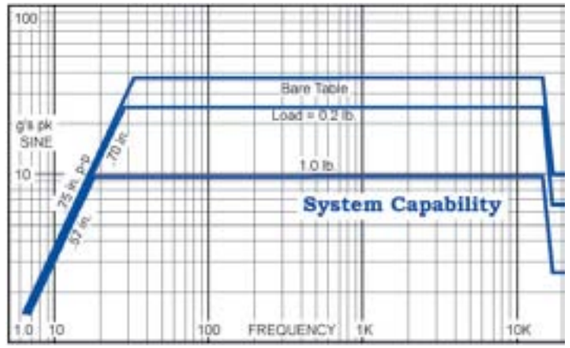
*See individual components for more detailed specifications and options.

# LW126HF.138-13 High Frequency Vibration System

The LW126HF.138-13 is a high performance system which incorporates the compact ET-126HF high frequency shaker. This system offers the maximum performance from the ET-126HF shaker without a cooling blower. Full system ratings are provided up to 14,000 Hz with reduced operation up to 20,000 Hz. This system is used for both general purpose high frequency testing and transducer calibration requirements. The larger mounting surface of the ET-126HF easily supports the calibration of most vibration transducers and smaller assemblies and components for general purpose testing not requiring high acceleration. The shaker can support relatively heavy loads and is perfectly matched to the amplifier, which makes this the most versatile system of its size.

## General Specifications

| | |
|---|---|
| **Sine Force:** | 13 lbf pk (17 w/ opt. blower) |
| **Random Force:** | 8.0 lbf rms random |
| **Shock Force:** | 21 lbf pk shock |
| **Frequency Range:** | DC to 14,000 Hz (usable to 20,000 Hz) |
| **Max. Acceleration:** | 37 g pk, bare table<br>24 g pk, 0.2 lb. load<br>9.6 g pk, 1 lb. load |
| **Max. Displacement:** | 0.75 inch pk-pk, bare table |
| **Cooling:** | Amplifier: forced air<br>Shaker: natural convection |
| **Power Requirements:** | 1000 VA @100, 120, 220, or 240V, 1ø, 50/60 Hz. |




CB-152
option

## System Components*

- ET-126-1 Electrodynamic Shaker
- PA-138 Linear Power Amplifier
- Interconnect Cables and Hoses

## System Options*

- VL-145 1 Ch. Digital Controller
- SC-121 Sine Servo Controller
- SG-135 Manual Sine Controller
- Rack Cabinet
- CB-152 Cooling Blower (>13 lbf)

*See individual components for more detailed specifications and options.



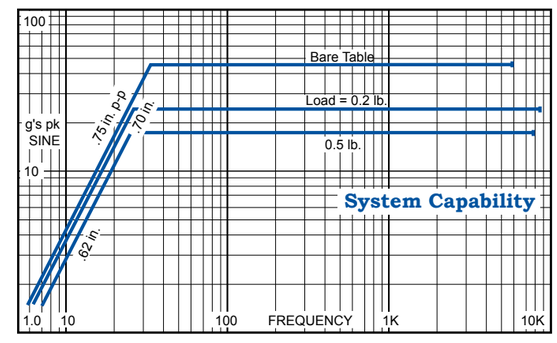


# LW126.151-9 Vibration System

The LW126.151-9 provides an economical test system solution when larger test loads require the large head of the ET-126 shaker operating at reduced acceleration levels. This system has excellent high frequency capabilities and is used for both modal and general purpose testing. Compact size, light weight and convection cooled components make this system a good choice for desktop applications.

## General Specifications

| | |
|---|---|
| **Sine Force:** | 9.0 lbs force pk |
| **Random Force:** | 7.0 lbf rms random |
| **Shock Force:** | 21 lbf pk shock |
| **Frequency Range:** | DC to 8,500 Hz |
| **Max. Acceleration:** | 45 g pk, bare table<br>23 g pk, 0.2 lb. load<br>17 g pk, 0.5 lb. load |
| **Max. Displacement:** | 0.75 inch pk-pk, bare table |
| **Cooling:** | Amplifier: natural convection<br>Shaker: natural convection |
| **Power Requirements:** | 300 VA @95-125, 190-250V, 1ø, 50/60 Hz. |




PA-151
Rear Panel

Standard trunnion allows shaker operation in any position from vertical to horizontal. The hook-up requirements on the PA-151 are simple, making the system portable.

## System Components*

- ET-126-4 Electrodynamic Shaker
- PA-151 Linear Power Amplifier
- Interconnect Cables and Hoses

## System Options*

- VL-145 1 Ch. Digital Controller
- SC-121 Sine Servo Controller
- SG-135 Manual Sine Controller
- Amplifier Rack Mount Brackets
- MS-129 Modal Stinger Kit
- CB-126 Cooling Blower (>13 lbf)

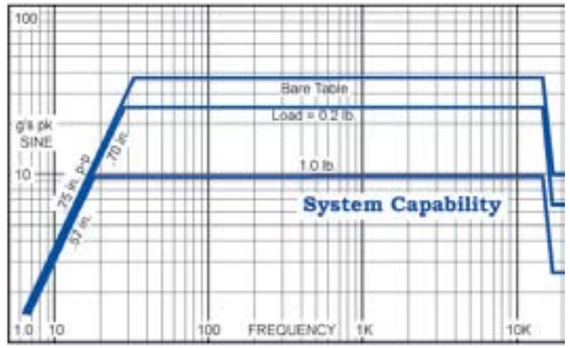
*See individual components for more detailed specifications and options.

# LW126HF.151-9 High Frequency Vibration System

The LW126HF.151-9 provides an economical test system solution when higher frequency testing or transducer calibration requires the high frequency response of the ET-126HF shaker. This system offers full system performance up to 14,000 Hz with operation at reduced force levels up to 20,000 Hz. This system is used for both general purpose testing and transducer calibration requirements. Compact size, light weight and convection cooled components make this system a good choice for desktop applications.

## General Specifications

| | |
|---|---|
| **Sine Force:** | 9 lbs force pk (17 w/blower) |
| **Random Force:** | 7.0 lbf rms random |
| **Shock Force:** | 21 lbf pk shock |
| **Frequency Range:** | DC to 14,000 Hz |
| **Max. Acceleration:** | 26 g pk, bare table<br>16 g pk, 0.2 lb. load<br>10.5 g pk, 0.5 lb. load |
| **Max. Displacement:** | 0.75 inch pk-pk, bare table |
| **Cooling:** | Amplifier: natural convection<br>Shaker: natural convection |
| **Power Requirements:** | 300 VA @95-125, 190-250V,<br>1ø, 50/60 Hz. |




SC-121
option

## System Components*

- ET-126HF-4 Electrodynamic Shaker
- PA-151 Linear Power Amplifier
- Interconnect Cables and Hoses

## System Options*

- Amplifier Rack Mount Brackets
- VL-145 Single Channel Digital Controller
- SC-121 Sine Servo Controller
- SG-135 Manual Sine Controller
- Rack Cabinet

*See individual components for more detailed specifications and options.



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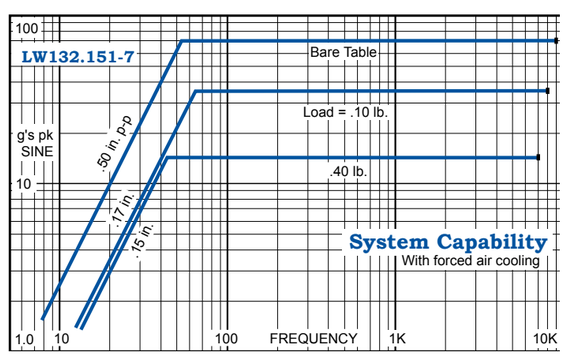
# LW132.151-7 Vibration System

Specify the LW132.151-7 system when a light weight, portable system with maximum force is desired for general purpose testing, actuation, and calibration of small components. This system is popular because of its low cost, high force and high displacement capability, with DC coupled low frequency performance. This system can be operated in constant force mode for modal test applications.

## General Specifications

| | |
|---|---|
| **Sine Force:** | 7.0 lbf pk (natural convection) |
| **Random Force:** | 4.0 lbf rms (natural convection) |
| **Shock Force:** | 12.0 lbf pk shock |
| **Frequency Range:** | |
| Voltage Source Mode | DC to 9,000 Hz |
| Current Source Mode | DC to 2,000 Hz |
| **Max. Acceleration:** | 70 g pk, bare table<br>35 g pk, 0.1 lb. load<br>14 g pk, 0.4 lb. load |
| **Max. Displacement:** | 0.20 inch pk-pk, bare table |
| **Cooling:** | Amplifier: natural convection<br>Shaker: natural convection |
| **Power Requirements:** | 300 VA @95-125, 190-250,<br>1ø, 50/60 Hz. |

Standard trunnion allows shaker operation in any position from vertical to horizontal. The hook-up requirements on the PA-151 are simple, making the system very portable.




## System Components*

- ET-132-2 Electrodynamic Shaker
- PA-151 Linear Power Amplifier
- Interconnect Cable

## System Options*

- SC-121 Sine Servo Controller
- SG-135 Manual Sine Controller
- CB-152-132 Cooling Blower Assembly (recommended for continuous duty applications over 4.5 lbf.)
- Amplifier Rack Mount Brackets
- MS-129-132 Modal Stinger Kit

*See individual components for more detailed specifications and options.

# LW132-203.151-4.5 Vibration System


Specify the LW132-203.151-4.5 system when a light weight, portable system with maximum high frequency is desired for the general purpose testing and calibration of small components. This system is popular because of its low mass armature, high frequency capability, enhanced random vibration performance, and it is one of the smallest shakers available capable of DC (linear actuator) operation.

## General Specifications

**Sine Force:** 4.5 lbs force pk
**Random Force:** 3.2 lbf rms random
**Shock Force:** 9.6 lbf pk shock
**Frequency Range:**
Voltage Source Mode DC to 11,000 Hz
Current Source Mode DC to 14,000 Hz
**Max. Acceleration:** 64 g pk, bare table
26 g pk, 0.1 lb. load
9.6 g pk, 0.4 lb. load
**Max. Displacement:** 0.20 inch pk-pk, bare table
**Cooling:** Amplifier: natural convection
Shaker: natural convection
**Power Requirements:** 200 VA @95-125, 190-250V, 1ø, 50/60 Hz.

SC-121 option


## System Components*

- ET-132-203 Electrodynamic Shaker
- PA-151 Linear Power Amplifier
- Interconnect Cables and Hoses

## System Options*

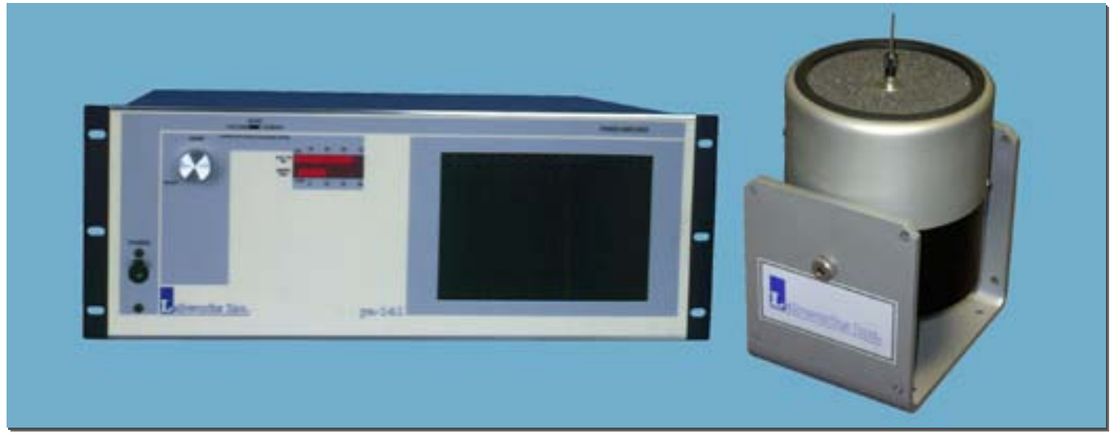
- Amplifier Rack Mount Brackets
- SC-121 Sine Servo Controller
- SG-135 Manual Sine Controller
- Rack Cabinet
- MS-129-132 Modal Stinger Kit

*See individual components for more detailed specifications and options.





# LW160.141-60 Modal Test System




The LW160.141-60 system utilizes the Labworks MT-160 thruster and PA-141 linear power amplifier to form our highest performance modal test system. The thruster's full 1.4 inch stroke capability, low suspension spring rate and light-weight armature makes this system ideal for most modal test applications. The thruster body features a through hole, and a single collet or thread load attachment to accommodate both tension wire and stinger modal testing. The PA-141 amplifier is direct coupled to the shaker to give the maximum performance from DC through high frequencies and can be easily switched from voltage source mode to current source mode for force input testing applications. The amplifiers voltage-proportional-to-current amplifier signal output facilitates servoed force operation. Dual bar graphs display the system operating levels and internal and external interlocks help protect the system from accidental abuse.

## General Specifications

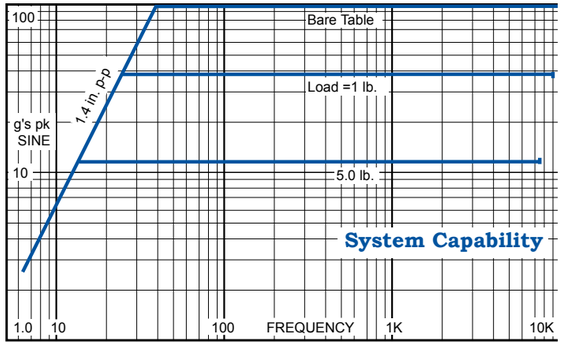
**Sine Force:** 60 lbs force pk
**Random Force:** 28 lbf rms random
**Shock Force:** 70 lbf pk shock
**Frequency Range:** DC to 8,000 Hz
**Max. Acceleration:** 100 g pk, bare table
38 g pk, 1 lb. load
11 g pk, 5 lb. load
**Max. Displacement:** 1.4 inch pk-pk, bare table
**Cooling:** Amplifier: forced air
Shaker: cooling blower
**Power Requirements:** 2200 VA @100-125*, 200-240V, 1ø, 50/60 Hz.

*Consult factory for low line voltage operation.

PA-141 Rear Panel

MS-129

Standard trunnion allows shaker operation in any position from vertical to horizontal. Shaker body and trunnion through-hole allows long stinger and tension wire modal testing.




## System Components*

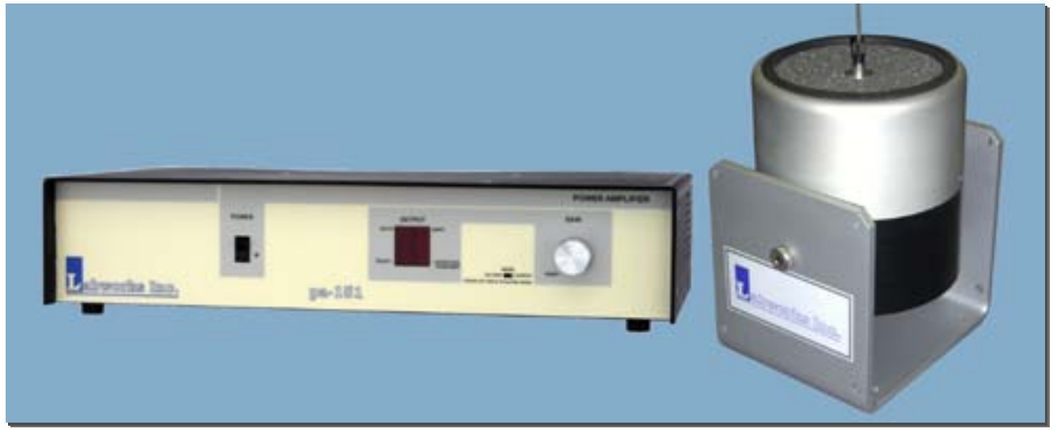
- MT-160 Electrodynamic Shaker
- PA-141 Linear Power Amplifier
- CB-146-160 Cooling Vacuum
- MS-129-160 Modal Stinger Kit

## System Options*

- VL-144 2 Ch. Sine, Random and Shock Controller
- VL-145 1 Ch. Digital Controller
- SC-121 Sine Servo Controller
- SG-135 Manual Sine Controller
- Rack Cabinet

*See individual components for more detailed specifications and options.

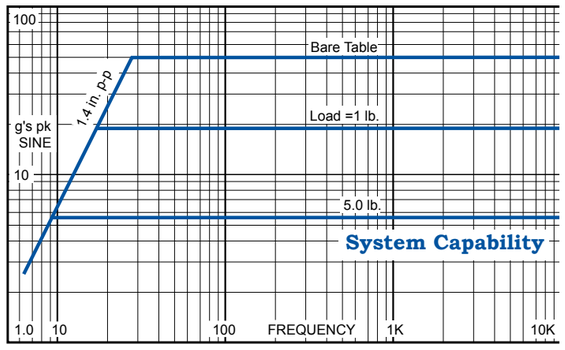
# LW160.151-30 Modal Test System



The LW160.151-30 system utilizes the Labworks MT-160 thruster and convection cooled PA-151 linear power amplifier to form our most popular convection cooled permanent magnet field modal test system. The thruster's full 1.4 inch stroke capability, low suspension spring rate and light weight armature makes this system ideal for most modal test applications. The thruster body features a through hole, and a single collet or thread load attachment to accommodate both tension wire and stinger modal testing. The convection cooled PA-151 amplifier is direct coupled to the shaker to give the maximum performance at both low and high frequencies and can be easily switched from voltage source mode to current source mode for force input testing applications. The amplifiers standard voltage-proportional-to-current amplifier signal output facilitates servoed operation. Dual bar graphs display the system operating levels and internal and external interlocks help protect the system from accidental abuse.

## General Specifications

| | |
|---|---|
| **Sine Force:** | 30 lbs force pk |
| **Random Force:** | 15 lbf rms random |
| **Shock Force:** | 38 lbf pk shock |
| **Frequency Range:** | DC to 8,000 Hz |
| **Max. Acceleration:** | 50 g pk, bare table |
| | 19 g pk, 1 lb. load |
| | 5.4 g pk, 5 lb. load |
| **Max. Displacement:** | 1.4 inch pk-pk, bare table |
| **Cooling:** | Amplifier: natural convection |
| | Shaker: natural convection |
| **Power Requirements:** | 300 VA @95-125, 190-250V, 1ø, 50/60 Hz. |




MS-129

## System Components*

- MT-160 Electrodynamic Shaker
- PA-151 Linear Power Amplifier
- MS-129-160 Modal Stinger Kit
- Interconnect Cables and Hoses

## System Options*

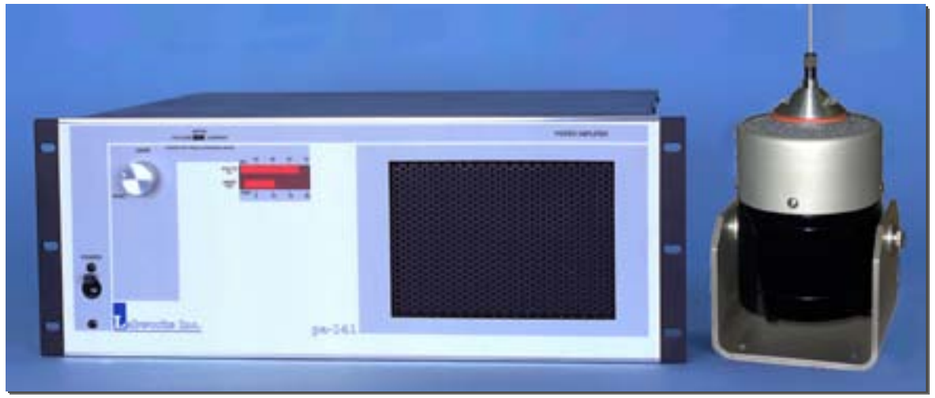
- VL-144 2 Ch. Sine, Random and Shock Controller
- VL-145 1 Ch. Digital Controller
- SC-121 Sine Controller
- SG-135 Manual Sine Servo Controller
- Amplifier Rack Mount Brackets

*See individual components for more detailed specifications and options.





# LW161.141-25 Modal Test System

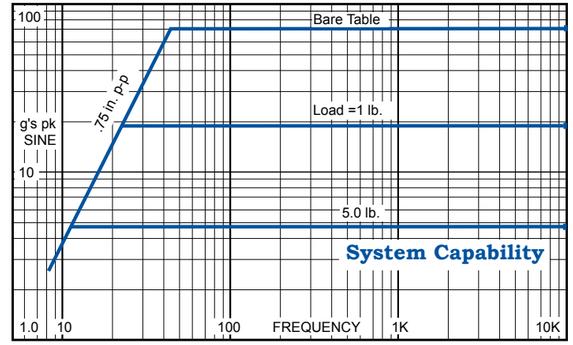


The LW161.141-25 is a compact high performance modal test system which makes full use of our smaller MT-161modal test shaker performance. The thruster's full .75 inch stroke capability, low suspension spring rate and light-weight armature makes this system ideal for most smaller modal test applications. The thruster body features a through hole, and a single collet or thread load attachment to accommodate both tension wire and stinger modal testing. The PA-141 amplifier is direct coupled to the shaker to give the maximum performance at DC through high frequencies, and can be easily switched from voltage source mode to current source mode for force input testing. The amplifiers voltage-proportional-to-current output signal facilitates servoed force test operation. Dual bar graphs display the system operating levels and internal and external interlocks help protect the system from accidental abuse.

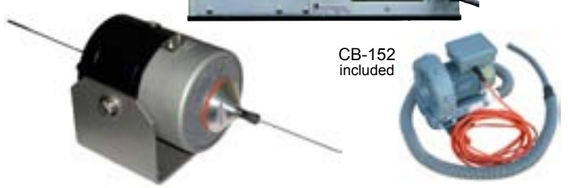
## General Specifications

| | |
|---|---|
| **Sine Force:** | 25 lbs force pk |
| **Random Force:** | 11 lbf rms random |
| **Shock Force:** | 27 lbf pk shock |
| **Frequency Range:** | DC to 10,000 Hz |
| **Max. Acceleration:** | 70 g pk, bare table |
| | 18.5 g pk, 1 lb. load |
| | 4.7 g pk, 5 lb. load |
| **Max. Displacement:** | 0.75 inch pk-pk, bare table |
| **Cooling:** | Amplifier: forced air |
| | Shaker: cooling vacuum |
| **Power Requirements:** | 2200 VA @100-125*, 200-240V, 1ø, 50/60 Hz. |

*Consult factory for low line voltage operation.




PA-141
Rear View



CB-152
included

Standard trunnion allows shaker operation in any position from vertical to horizontal. Shaker body and trunnion through-hole allows long stinger and tension wire modal testing.

## System Components*

- MT-161-4 Electrodynamic Shaker
- PA-141 Linear Power Amplifier
- CB-152-161 Cooling Vacuum and Hose Assembly
- MS-129-161 Modal Stinger Kit
- Interconnect Cables and Hoses

## System Options*

- VL-144 2 Ch. Sine, Random and Shock Controller
- VL-145 1 Ch. Digital Controller
- SC-121 Sine Servo Controller
- SG-135 Manual Sine Controller

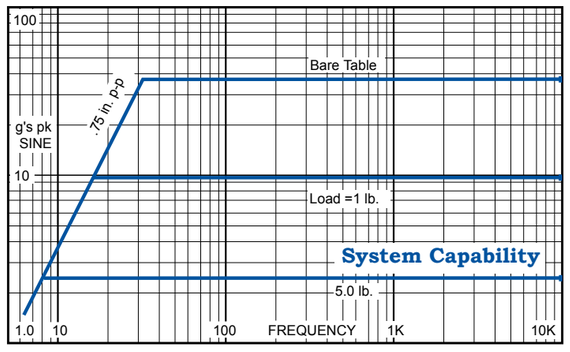
*See individual components for more detailed specifications and options.

# LW161.138-13 Modal Test System

The LW161.138-13 modal test system makes full use of our smaller MT-161 modal test shakers natural convection cooled performance. The thruster's full .75 inch stroke capability, low suspension spring rate and light-weight armature makes this system ideal for most smaller modal test applications not requiring the MT-161's full force. The thruster body features a through hole, and a single collet or thread load attachment to accommodate both tension wire and stinger modal testing. The PA-141 amplifier is direct coupled to the shaker to give the maximum performance at DC through high frequencies, and can be easily switched from voltage source mode to current source mode for force input testing. The amplifiers voltage-proportional-to-current output signal facilitates servoed force test operation. Dual bar graphs display the system operating levels and internal and external interlocks help protect the system from accidental abuse.

## General Specifications

| | |
|---|---|
| **Sine Force:** | 13 lbs force pk (17 w/opt. blower) |
| **Random Force:** | 8.0 lbf rms random |
| **Shock Force:** | 21 lbf pk shock |
| **Frequency Range:** | DC to 10,000 Hz |
| **Max. Acceleration:** | 37 g pk, bare table<br>6 g pk, 1 lb. load<br>2.4 g pk, 5 lb. load |
| **Max. Displacement:** | 0.75 inch pk-pk, bare table |
| **Cooling:** | Amplifier: forced air<br>Shaker: natural convection |
| **Power Requirements:** | 1000 VA @100, 120, 220, or 240V, 1ø, 50/60 Hz. |




PA-138
Rear View

MS-129

Standard trunnion allows shaker operation in any position from vertical to horizontal. The hook-up requirements on the PA-138 are simple, making the system portable.

## System Components*

- MT-161-1 Electrodynamic Shaker
- PA-138 Linear Power Amplifier
- MS-129-161 Modal Stinger Kit
- Interconnect Cables and Hoses

## System Options*

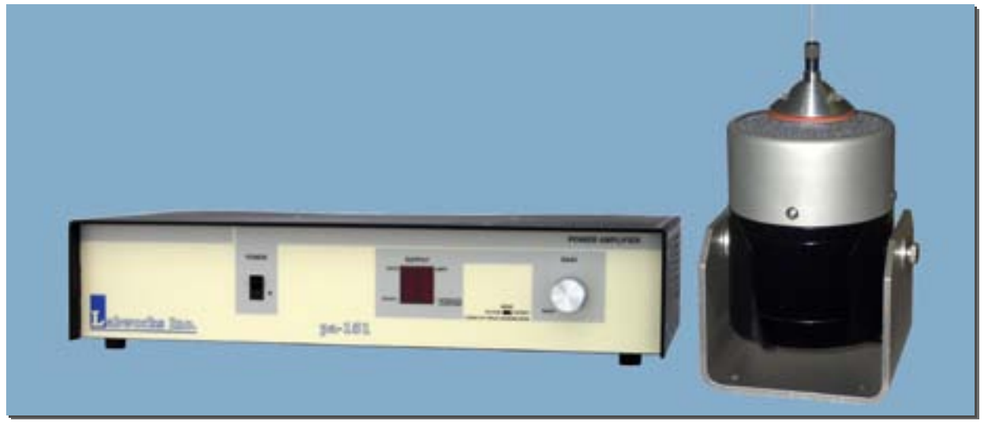
- VL-144 2 Ch. Sine, Random and Shock Controller
- VL-145 1 Ch. Digital Controller
- SC-121 Sine Servo Controller
- SG-135 Manual Sine Controller

*See individual components for more detailed specifications and options.





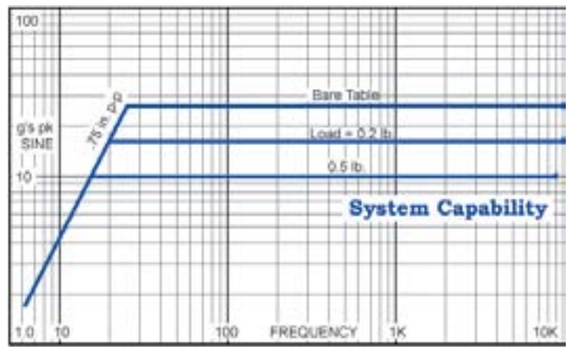
# LW161.151-9 Modal Test System



The LW161.151-9 system utilizes the compact Labworks MT-161 thruster and convection cooled PA-151 linear power amplifier to form our smallest dedicated modal test system. The thruster's full 0.75 inch stroke capability, low suspension spring rate and light weight armature makes this system ideal for most small modal test applications. The thruster features a through hole, and a single collet or thread load attachment to accommodate both tension wire and stinger modal testing. The convection cooled PA-151 amplifier is direct coupled to the shaker to give the maximum performance at both low and high frequencies and can be easily switched from voltage source mode to current source mode for force input testing applications. The amplifiers standard voltage-proportional-to-current output signal facilitates servoed test operation. Dual bar graphs display the system operating levels and internal and external interlocks help protect the system from accidental abuse.

## General Specifications

| | |
|---|---|
| **Sine Force:** | 9.0 lbs force pk |
| **Random Force:** | 7.0 lbf rms random |
| **Shock Force:** | 21 lbf pk shock |
| **Frequency Range:** | DC to 10,000 Hz |
| **Max. Acceleration:** | 26 g pk, bare table<br>16 g pk, 0.2 lb. load<br>10 g pk, 0.5 lb. load |
| **Max. Displacement:** | 0.75 inch pk-pk, bare table |
| **Cooling:** | Amplifier: natural convection<br>Shaker: natural convection |
| **Power Requirements:** | 300 VA @95-125, 190-250V, 1ø, 50/60 Hz. |




PA-151
Rear View

MS-129

Standard trunnion allows shaker operation in any position from vertical to horizontal. The hook-up requirements on the PA-138 are simple, making the system portable.

## System Components*

- MT-161-4 Electrodynamic Shaker
- PA-151 Linear Power Amplifier
- MS-129-161 Modal Stinger Kit
- Interconnect Cables and Hoses

## System Options*

- Amplifier Rack Mount Brackets
- VL-145 1 Ch. Digital Controller
- SC-121 Sine Servo Controller
- SG-135 Manual Sine Controller
- Rack Cabinet

*See individual components for more detailed specifications and options.

# LW142.151-2 Inertial Shaker System

The LW142.151-2 system is the smallest in our expanding line of Inertial Shaker systems. The PA-151 amplifier easily supplies the power required to gain the maximum performance from the shaker, The mounting convenience of the FG-142 makes this system ideal when a light-weight, portable system is desired for general purpose testing as well as modal excitation of larger test specimens. The inertial shaker concept eliminates the need for fixturing, in most cases, because of its insensitivity to mounting postion and internal reaction mass design. Since there is no external armature mounting surface, (the whole transducer vibrates) simply mount the FG-142 to the test specimen, utilizing its single through hole mounting, in any orientation desired and commence testing. Multiple shakers can be implemented on complex or compliant structures to gain a more uniform excitation than can be had from traditional shakers under these conditions. Operation up to 2 lbf is possible without cooling further simplifying the installation to that of running two small wires between the amplifier and the shaker. A small amount of filtered shop / small compressor air allows full force operation of the FG-142 up to 4 lbf.

## General Specifications

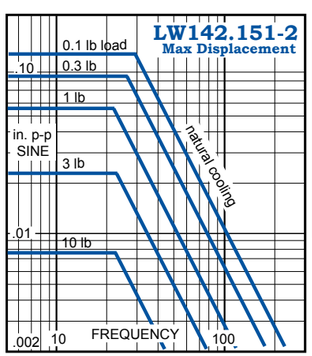
| | |
|---|---|
| **Sine Force:** | 2 lbf pk (nat. convection)<br>4 lbf pk (forced air cooling) |
| **Random Force:** | 1.4 lbf rms (nat. convection)<br>2.8 lbf pk (forced air cooling) |
| **Frequency Range:** | 10 to 3,000 Hz |
| **Max. Acceleration:** | (2 lbf / 4 lbf)<br>6.0 / 12.0 g pk, bare table<br>4.6 / 9.3 g pk, 0.1 lb. load<br>2.7 / 5.5 g pk, 0.4 lb. load |
| **Max. Displacement:** | 0.20 inch pk-pk, bare table<br>0.35 inch pk-pk, resonant load |
| **Cooling:** | Amplifier: natural convection<br>Shaker: natural / forced air |
| **Power Requirements:** | 300 VA @95-125, 190-250V,<br>1ø, 50/60 Hz. |


PA-151
Rear View



## System Components*

- FG-142 Inertial Shaker
- PA-151 Linear Power Amplifier
- Interconnect Cables




## System Options*

- SC-121 Sine Servo Controller
- SG-135 Manual Sine Controller
- Amplifier rack mount brackets
- Amplifier rack cabinet

*See individual components for more detailed specifications and options.

The thru-hole on the FG-142 allows single screw or easy stinger mounting, simplifying load attachment requirements. The two wire Hook up connection on the PA-151/FG-142 is simple, making this system very portable.





# Shaker Engineering Information

### Electrodynamic Shakers

Labworks shakers utilize normal current/force motor principles to generate vibratory force. Electrodynamic force is inherently linear, and offers wider bandwidth with lower noise and harmonic distortion than mechanical or hydraulic based vibration generation. Labworks shakers are air cooled eliminating requirements for oil and water used in conjunction with other types of shaker cooling.

Labworks electrodynamic shakers offer frequency response down to DC to insure good low frequency force capability. Upper frequency limits are controlled by the shaker armature's mechanical resonances and are extended by careful design to reach frequencies higher than most test specimen vibration test requirements.

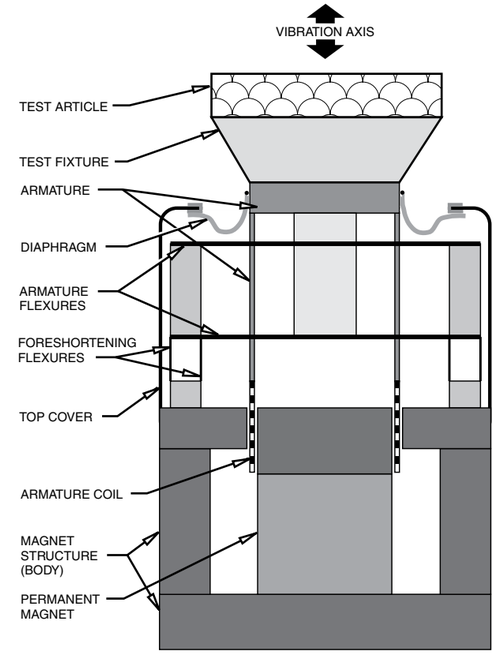
### General Description

Labworks Electrodynamic shakers use a construction similar to common loudspeakers to convert electrical current flow into mechanical force over the widest frequency range with minimal spectral distortion of the input waveform. This moving "voice coil" configuration offers a large test article attachment surface with a lightweight moving mass.

The shaker's voice coil is attached to a suspended aluminum support and test article attachment structure called the "armature". The shaker's armature is guided so that it is allowed to move relatively easily in the direction of the generated force and have the highest stiffness possible in all other directions. In this respect, shakers are primarily unidirectional vibration devices. It is extremely important that the armature suspension be stiff in all transverse directions to minimize any lateral deflections caused by load attachment that could cause lateral armature coil deflection.

Labworks shakers utilize a "single-end" magnet structure configuration. This configuration offers several significant advantages over other types of magnet structures. Optimized, single-end shaker designs yield a larger armature coil diameter, giving these shakers a larger mounting surface, which is desirable for easy test article attachment. The single-end magnet structure also offers the easiest physical access for inspection and maintenance. No shaker body disassembly is required to service any dynamic component of the shaker.

Carbon fiber flexure components are used in the armature suspension to maximize the available dynamic stroke while maintaining high lateral stiffness. Minimal use of rubber in the armature suspension reduces velocity related damping




SHAKER CROSS-SECTION

losses, therefore allowing higher velocity and better low frequency distortion characteristics.

### Force Generation

Electrodynamic shakers are inherently force generators. Electrical current flowing in the armature coil interacts with the strong DC magnetic field of the shaker's magnet structure (body) to produce physical force. This force can be taken as being generated between the armature coil and the shaker's body. In this respect, since the armature is free to move relative to the body in the direction of the force, both the shaker's armature (and its attached test article) and the shaker's body are subjected to the generated force. If the armature coil current is varied, as in alternating vibration excitation, both the armature and the shaker body will be accelerated in response to

this force and will each respond according to their inherent mass, with vibratory motion, each independent of the other.

Shaker magnetic structures are designed to have extremely high magnetic fields concentrated in the internal area of the armature coil. Further, since high magnetic fields can be detrimental to some test article operation and test results, the magnet structure is usually designed to have a minimum of “stray” magnetic flux outside of the shaker body. This is especially significant in the area of test article attachment at the “top” of the armature. Exclusive use of high energy, centrally located magnets or field coils is extremely effective in both these areas.

Force generated by the interaction of the armature coil and the body DC field is proportional to the current flowing in the coil and the strength of the DC field. The generated force can be found from the following equation.

$F=KBLI$

where: F=Armature coil force
K=.885 x$10^{-7}$ (English units)
B=DC magnetic flux density
L=Length of armature coil
I =Armature coil current

**Displacement Limitations**

Electrodynamic shaker armature displacement is limited only by the axial length of the armature coil and the physical limitations of the armature suspension system. Since most shakers are provided with an adequate axial coil length to maintain linear force generation at low frequencies, the primary limitation is that of physical interference of the suspension components. Since shakers have an available operating displacement window, it is most common to rate and discuss vibration test displacement in peak to peak terms. For this reason, most engineering equations of motion involving vibration test will utilize displacement peak to peak (sometimes called “double amplitude displacement”).

The rated displacement of electrodynamic shakers is usually the maximum relative displacement available between the armature and the shaker body/suspension. When considering the suitability of a shaker for a given test, it is important to consider the various factors that may reduce the available test article absolute displacement.

Since the same force that is applied to the armature coil is also applied to the shaker body, the shaker body is also accelerated and has a displacement definable by the normal equations of motion. This body motion can have the exact opposite phase relative to the armature motion and therefore, must share the available relative (rated) shaker armature displacement with the armature and test article. In other words, the test article displacement added to the shaker body displacement must be less than the rated shaker displacement.

Another factor reducing the available displacement is the natural deflection of the armature suspension when a test article and fixture are placed on a shaker in the vertical shaker orientation. The weight of this added load offsets the armature downward and therefore reduces the available downward armature displacement. Reducing the available stroke on one end of symmetrical alternating vibration reduces the allowable displacement by double the amount of the deflection.

For most test articles, the shaker body weight is significantly heavier than the test article, fixture and armature and its displacement motion can be ignored. In that case, the required displacement equation found in the Systems Engineering section applies:

$$D_{req}=g/.0511\ f^2 + 2w/k.$$

A normal maximum unsupported load weight for a shaker in vertical orientation is that which will reduce the available test article absolute displacement to 1/2 the rated, neglecting shaker body motion. This corresponds to the weight that will depress the suspension by 1/4 of the rated displacement. Labworks shakers are all designed with unusually large relative displacements to better accommodate unsupported vertical operation.

**Velocity Limitations**

Shaker velocity limitations stem primarily from internal inductive heating of conductive armature components and damping loss heating of over-damped suspension components. Labworks shakers are designed with low stray magnetic fields which reduces the inductive heating. Minimal suspension damping is utilized and for most applications, Labworks shakers have no velocity limitation other than that imposed by the maximum acceleration and displacement specifications.

Shaker systems, however, can have velocity limitations due to back emf requirements on the system amplifier. Velocity limitations are rarely a concern with Labworks systems. Please call with your specifications if extremely high velocities are required.



phone (714) 549-1981 • fax (714) 549-8041 • e-mail info@labworks-inc.com


# ET-127 Electrodynamic Shaker

- 500 pounds pk sine force
- 1.0 inch stroke
- 6.0 inch diameter table
- Unsupported Payloads up to 50 lbs
- Low stray magnetic field
- Frequency range[2] DC-4,500 Hz
- Trunnion mounting base

The ET-127 Electrodynamic Transducer is well suited for testing mechanical assemblies, packaging and printed circuit boards, as well as modal applications. The shaker incorporates the latest high-tech composite materials and features a revolutionary “side load” restraint design in the armature suspension and guidance system. A host of “big shaker” options allow the ET-127 to be easily adapted to specific testing applications.

## General Specifications[1]

### Performance

| | |
|---|---|
| Sine force | 500 lbf pk |
| Random force | 350 lbf rms |
| Shock force | 1000 lbf pk |
| Max displacement | |
| Continuous pk-pk | 1.0 in |
| Between stops | 1.2 in |

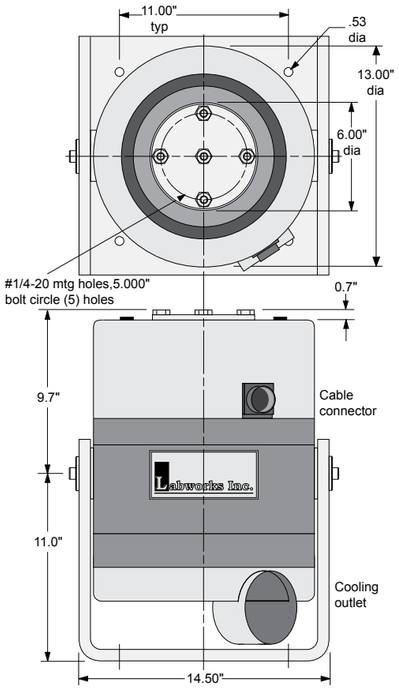
### Physical

| | |
|---|---|
| Armature weight | 5.0 lb |
| Suspension stiffness | 250 lb/in |
| Dimensions | 21" H x 14.5" W x 14" D |
| Shaker weight | 475 lbs |

### Options

- AI-127 (5 Hz) & SI-127 (10 Hz) Vibration Isolation Mounts.
- LS-127 Pneumatic Payload Support.
- DB-127 DuoBase Horizontal/Vertical Table.
- TA-127 Thermal Chamber Interface.
- M6 x 1 Metric Inserts.
- Head Plates and Fixtures

[1] Please see systems ratings for additional specifications.
[2] Load dependent.
Specifications subject to change.



# DB-127 DuoBase Shaker

- Large mounting surface
- 1.0 inch p-p stroke
- Integral oil moat and pump
- Horizontal and vertical testing
- Lightweight magnesium table

## General Specifications[1] DB-127-12 (-18)

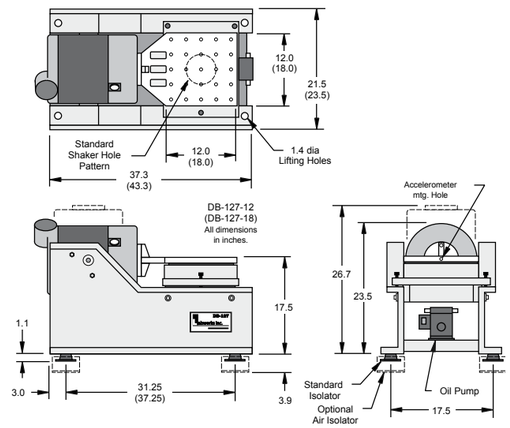
| | | |
|---|---|---|
| Moving Element Weights | -12 | (-18) |
| Slip Table weight | 14 lbs | (35 lbs) |
| Shaker Armature weight | 5 lbs | |
| Maximum Recommended Loads | | |
| Table vertical/horizontal | 100 lbs | (200 lbs) |
| Table mounting CG moment | 100 in-lb | (150in-lb) |
| Table Mounting Surface (in.) | 12 x 12 | (18 x 18) |
| Max. Bare Table Acceleration* | 26 g pk | (12 g pk) |
| Bare Table Resonance Freq. | 2300 Hz | (2000 Hz) |
| Maximum Useable Freq. | 3000 Hz | (2500 Hz) |
| Displacement | 1 inch pk-pk | |
| Table Mounting Hole Pattern | Same as shaker | |
| Oil Reservoir Capacity | .4 gal | (.8 gal) |
| Complete Base + Shaker Wt. | 1000 lb | (1200 lb) |
| Overall Dimensions (in.) | 37.3 L x 23.5 H x 19.5 W | |

### Options

- Additional Mounting Holes
- AI-DB127 Pneumatic (5 Hz) Isolation Mounts

[1] Please see appropriate Shaker or System data sheet for performance specifications.

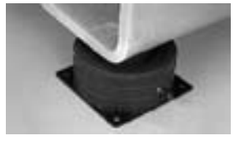
The DB-127 DuoBase Slip Table offers a large mounting surface with high load carrying capability for applications where lower acceleration levels are needed for large or heavy loads. The slip table utilizes a low pressure mineral oil film and rigid granite plate to provide support and guidance for the table. High rotational moments are reacted through the oil film to the base, allowing testing of high CG loads without risk of shaker suspension damage. The shaker can also be disconnected from the table, rotated to the vertical position, and then used as a normal vertical shaker without the additional weight of the Table. The base is supplied with standard machinery (15 Hz) isolation mounts.




# ET-127 Load Support & Isolation Mounts

Left...LS-127 Pneumatic Armature Payload Support is used when full displacement is required with heavy loads.

Standard 10 Hz, SI-127 Solid Vibration Isolation Mounts.
Far left...SI-127 mounted to ET-127 trunnion.



Optional 5 Hz, AI-127 Pneumatic Vibration Isolation Mount.
Far left...AI-127 mounted to ET-127 trunnion.

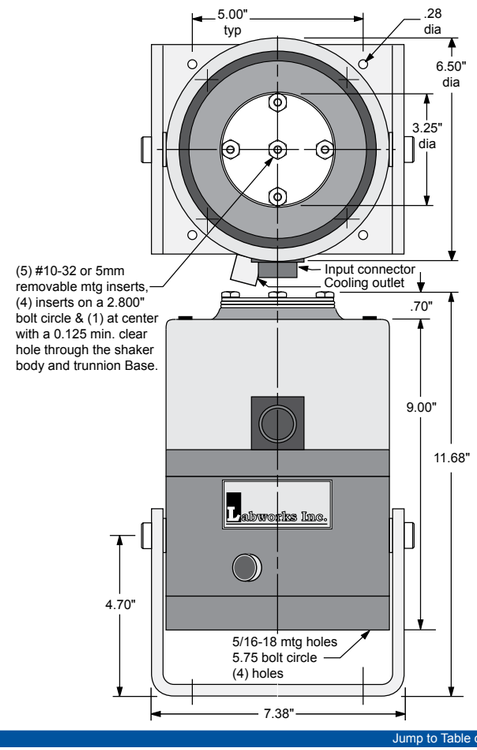




# ET-140 Electrodynamic Shaker

- 110 pounds pk sine force
- 1.0 inch stroke
- 3.25 inch diameter table
- Payloads up to 25 lbs
- Low stray magnetic field
- Frequency range[2] DC-6,500 Hz.
- Trunnion mounting base
- Through-hole design

The ET-140 shaker's compact size, long stroke and lightweight armature make it well suited for modal as well as general vibration testing. Features include a rugged suspension system which minimizes test fixture requirements and related fixture guidance problems. The standard trunnion allows operation in any position from vertical to horizontal. It also facilitates bolting the shaker in place either with or without vibration isolation mounts. The shaker body's through-hole design allows operation with modal stingers as well as tension wire set ups.




## General Specifications[1]

### Performance

| | |
|---|---|
| Sine force | 110 lbf pk |
| Random force | 75 lbf rms |
| Shock force | 225 lbf pk |
| Max displacement | |
| Continuous pk-pk | 1.0 in |
| Between stops | 1.03 in |

### Physical

| | |
|---|---|
| Armature weight | 1.0 lb |
| Suspension stiffness | 90 lb/in |
| Dimensions | 11.5" H x 7.4" W x 6.5" D |
| Shaker weight | 56 lbs |

### Options

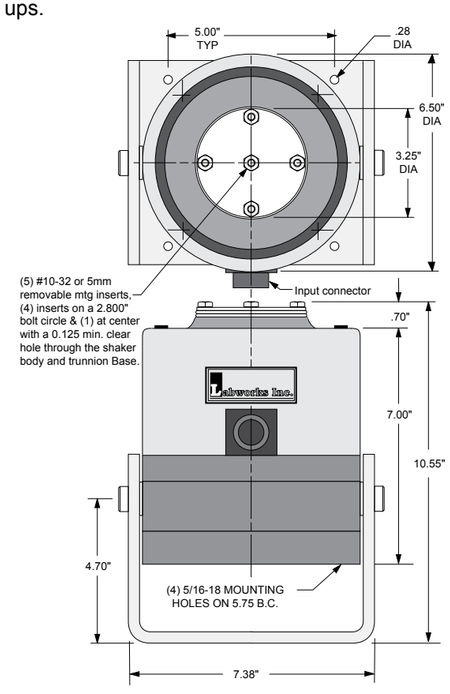
- Vibration isolation mounts.
- Modal stingers and mounts.
- DB-140 Duobase Flexure Table

[1] Please see systems ratings for additional specifications.
[2] Load dependent.
Specifications subject to change.

# ET-139 Electrodynamic Shaker

- 75 pounds pk sine force
- 1.0 inch stroke
- 3.25 inch diameter table
- Payloads up to 7 lbs.
- Low stray magnetic field
- Frequency range[2] DC-6,500 Hz.
- Trunnion mounting base
- Through-hole design

The ET-139 is our most powerful permanent magnet shaker. It is an excellent choice for modal testing due to its compact size and long stroke. A large armature makes the shaker ideal for general vibration testing of components and subassemblies. The standard trunnion allows operation in any position from vertical to horizontal. A unique, all flexure, armature suspension design provides excellent axial compliance with high lateral stiffness. There are no rolling or sliding components to wear out and/or produce unwanted noise and distortion. The shaker body's through-hole design allows operation with modal stingers as well as tension wire set ups.




## General Specifications[1]

### Performance

| | |
|---|---|
| Sine force | |
| Natural cooling | 40 lbf pk |
| With blower | 75 lbf pk |
| Random force | |
| Natural coolling | 28 lbf rms |
| With blower | 50 lbf rms |
| Shock force | 150 lbf pk |
| Max displacement | |
| Continuous pk-pk | 1.0 in |
| Between stops | 1.03 in |

### Physical

| | |
|---|---|
| Armature weight | 1.0 lb |
| Suspension stiffness | 60 lb/in |
| Dimensions | 10.4" H x 7.4" W x 6.5" D |
| Shaker weight | 28 lbs |

### Options

- Vibration isolation mounts. Modal stingers and mounts.
- Cooling vacuum recommended continuous for operation above 35 lbf.
- DB-139 Duobase Flexure Table

[1] Please see systems ratings for additional specifications.
[2] Load dependent.
Specifications subject to change.

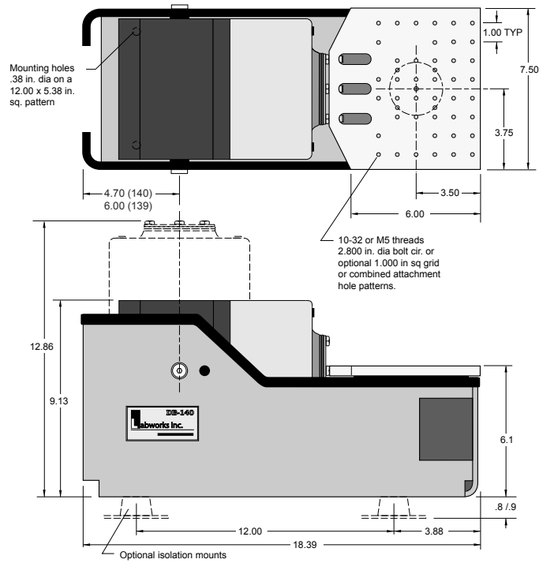




# DB-140/DB-139 DuoBase Shaker

- Large mounting surface
- 1.0 inch p-p stroke
- Horizontal and vertical testing
- Lightweight magnesium table

The DB-140 and -139 flexure tables offer a larger mounting surface with high-load carrying capability for applications where lower acceleration levels are needed with large or heavy loads. The flexure tables suspension systems utilize highly damped, oversized linear flexures and dynamic absorbers to provide support and guidance without the use of heavy granite surface plates or oil. Since no oil is used, the complete base system can be rotated into the vertical position to facilitate vertical axis guided testing. Base mounting holes are provided on the bottom as well as the rear of the base to facilitate vertical flexure table operation. The shaker can also be disconnected from the table, rotated to the vertical position, and then used as a normal vertical shaker without the additional weight of the table. Rotating the base with the shaker in this position also allows horizontal operation without the flexure table. These bases are supplied with removable carrying handles.



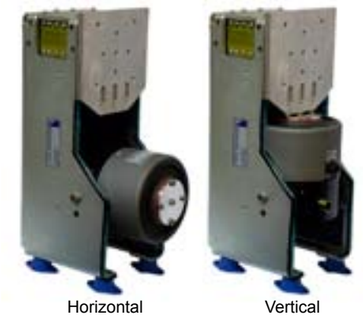

## General Specifications[1]

| | |
|---|---|
| Moving Element Weights | |
| Flexure Table weight | 2.8 lbs |
| Shaker Armature weight | 1.0 lb |
| Total Moving Element Weight | 3.8 lbs |
| Maximum Recommended Loads | |
| Table vertical/horizontal | 40 lbs |
| Table mounting CG moment | 20 in-lb |
| Shaker Only Vertical | 15 lbs |
| Table Mounting Surface (in.) | 6 L x 7.5 W |
| Max. Bare Table Acceleration* | 29 gpk(140) / 20 gpk(139) |
| Bare Table Resonance Freq. | 3000 Hz |
| Maximum Useable Freq. | 4500 Hz |
| Displacement | 1 inch pk-pk |
| Table Mounting Hole Pattern | Same as shaker |
| Complete Base + Shaker Wt. | 100 lb (140) / 70 lb (139) |
| Overall Dimensions (in.) | 18.4 L x 9.1 H x 7.5 W |

### Options

- Additional Mounting Holes
- SI-DB140 / SI-DB139 Isolation Mounts

[1] Please see appropriate Shaker or System data sheet for performance specifications.

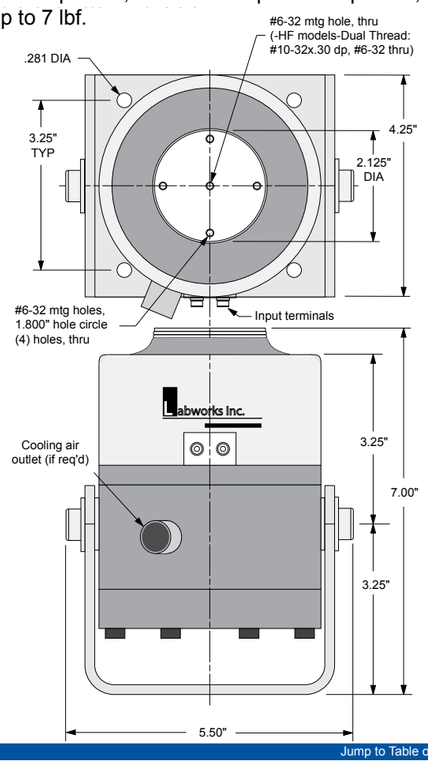


Horizontal Vertical

# ET-126/ET-126HF Electrodynamic Shaker

- 25 pounds pk sine force
- .75 inch stroke
- 2.125 inch diameter table
- Payloads up to 3 lbs.
- Low stray magnetic field
- Frequency range[2] DC-10 KHz. DC-14 KHz (HF)
- Trunnion mounting base
- Body and Trunnion Through hole

The Labworks ET-126 Electrodynamic Shaker is a rugged, full featured, small permanent magnet shaker. It is ideally suited for the production screening of small components or for larger transducer calibration systems. The shaker features a 2.125 inch diameter table with multiple attachment points, and an extraordinary 0.75 inch stroke. The ET-126 has a linearly compliant armature suspension that is particularly well suited to modal testing with a current source amplifier. The shaker body and trunnion through-hole allow operation with modal stingers as well as tension wire set ups. The HF version of the ET-126 offer full performane up to 14,000 Hz with operation up to 20,000 Hz at up to 7 lbf.




## General Specifications[1]

### Performance

| | |
|---|---|
| Sine force | |
| Natural cooling | 13 lbf pk |
| With blower | 25 lbf pk |
| Random force | |
| Natural coolling | 8 lbf rms |
| With blower | 17.5 lbf rms |
| Shock force | 53 lbf pk |
| Max displacement | |
| Continuous pk-pk | 0.75 in |
| Between stops | 0.75 in |
| Maximum velocity | 120 ips pk (100 ips pk / -HF) |

### Physical

| | |
|---|---|
| Armature weight | 0.20 lb (0.35 lb / -HF) |
| Suspension stiffness | 15 lb/in |
| Dimensions | 6.5" H x 4.8" W x 4.25" D |
| Shaker weight | 11 lbs |

### Options

- Vibration isolation mounts.
- Modal stingers and mounts.
- CB-152 Cooling Vacuum (required for operation above 13 lbf).

[1] Please see systems ratings for additional specifications.
[2] Load dependent.
Specifications subject to change.

CE

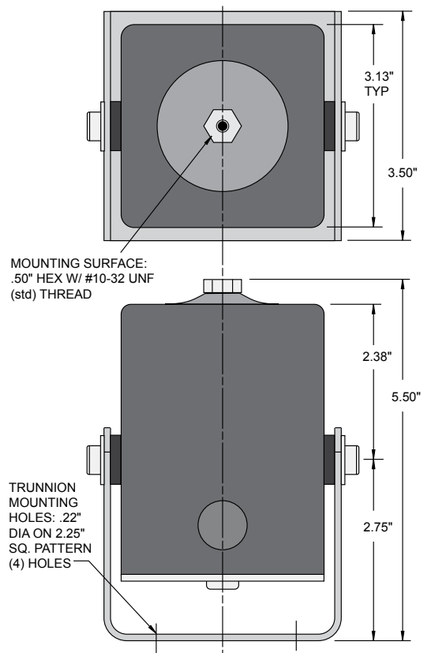




# ET-132-2 ET-132-203 Electrodynamic Shaker

- Up to 7 pounds pk sine force
- .5 inch stroke
- Threaded load mounting insert
- Payloads up to 2 lbs.
- Low stray magnetic field
- Frequency range[2] DC-11 KHz.
- Trunnion mounting base

Labworks ET-132-2 and ET-132-203 Electrodynamic Transducers are truly portable (only 6 pounds) permanent magnet shakers. With standard trunnions, they are ideally suited for the production screening of small components, modal testing or as displacement generators for, academic, biomedical and laboratory research. These shakers feature extremely rugged suspension systems. Carbon fiber composite leaf flexures and isolated linear bearings provide low distortion and eliminate the need for reaction wrenches when mounting loads to the armature.




## General Specifications[1]

| Performance | -203 | -2 |
|---|---|---|
| Sine force | 4.5 lbf pk | 7 lbf pk |
| Random force | 3 lbf rms | 5 lbf rms |
| Shock force, 11 msec | 9 lbf pk | 21 lbf pk |
| Max displacement | | |
| Continuous pk-pk | .2 in | .5 in. |
| Between stops | .35 in | .55 in. |
| **Physical** | | |
| Armature weight | .07 lb | 0.1 lb |
| Suspension stiffness | 15 lbs/in | 15 lbs/in |
| Dimensions | 5.38" H x 3.6" W x 3.5" D | |
| Shaker weight | 6 lbs | 6 lbs |

### Options

- Modal stingers and mounts.
- Load attachment threads (#10-32 std): #6-32, #8-32,M4x.7.
- Cooling blower recommended for continuous operation above 4.5 lbf.

[1] Please see systems ratings for additional specifications.
[2] Load dependent.
Specifications subject to change.

# MT-160 Modal Thruster

- 60 pounds pk sine force
- 1.5 inch stroke
- .005” to .125” dia. Collet
- Stinger and Wire Through-Hole
- Low stray magnetic field
- Frequency range[2] DC-8,000 Hz.
- Trunnion mounting base

## General Specifications[1]

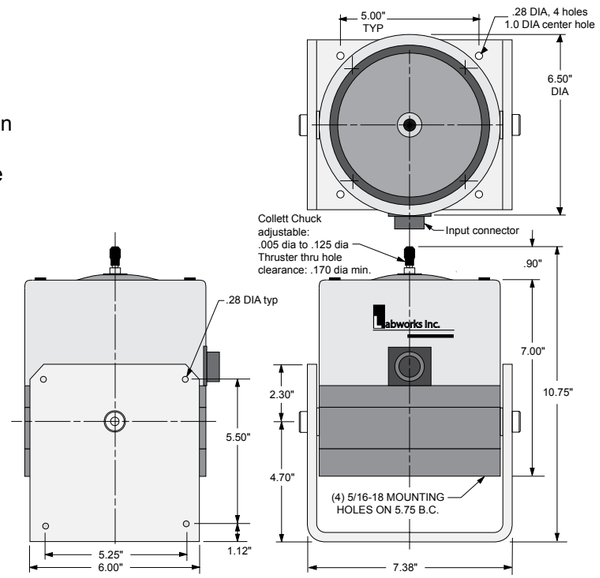
### Performance

| | |
|---|---|
| Sine force | |
| Natural cooling | 30 lbf pk |
| With blower | 60 lbf pk |
| Max displacement | |
| Continuous pk-pk | 1.50 in |
| Between stops | 1.53 in |
| Max velocity | 120 ips pk |
| Max Acceleration | 200 gpk (resonant load) |
| Frequency Range[2] | DC-8,000 Hz |
| Fundamehntal Resonance[2] | 5,000-6,000 Hz |
| Stray magnetic fiels | <15 gauss @ 1.5” |
| Cooling @>13lbf | 37 cfm /30 in $H_2o$ |

### Physical

| | |
|---|---|
| Armature weight | 0.60 lb |
| Suspension stiffness | 20 lb/in |
| Dimensions | 10.8" H x 7.4" W x 6.5" D |
| Shaker weight | 28 lbs |

The MT-160 thruster’s compact size, long stroke and lightweight armature make it well suited for all types of modal testing. The thruster has a compression collet and features a central through-hole suitable for modal stinger and pre-tensioned wire testing applications. The standard shaker trunnion allows the shaker to be operated in any axis from vertical to horizontal as well as easily mounted in wire tensioning tripods. The trunnion base also facilitates bolting the shaker in place for rigid applications or the use of adjustable mounting feet.




## Options

- Vibration isolation mounts. Modal stingers and mounts.
- Cooling blower required for operation above 30 lbf.

[1] Please see systems ratings for additional specifications.
[2] Load dependent.
Specifications subject to change.





# MT-161 Modal Thruster

- 25 pounds pk sine force
- .75 inch stroke
- .005” to .125” dia. Collet, #10-32, M5x.75 & 5/16-18 Thds.
- Stinger and Wire Through-Hole
- Low stray magnetic field
- Frequency range[2] DC-10,000 Hz.
- Trunnion mounting base

## General Specifications[1]

### Performance

| | |
|---|---|
| Sine force | |
| Natural cooling | 13 lbf pk |
| With blower | 25 lbf pk |
| Max displacement | |
| Continuous pk-pk | .70 in |
| Between stops | .75 in |
| Max velocity | 120 ips pk |
| Max Acceleration | 200 gpk (resonant load) |
| Frequency Range[2] | DC-10,000 Hz |
| Fundamehntal Resonance[2] | 9,000-10,000 Hz |
| Stray magnetic fiels | <10 gauss @ 1.5” |
| Cooling @>13lbf | 30 cfm / 22 in $H_2o$ |

### Physical

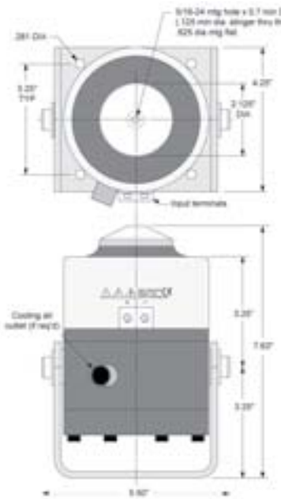
| | |
|---|---|
| Armature weight | 0.35 lb |
| Suspension stiffness | 15 lb/in |
| Dimensions | 7.13" H x 4.8" W x 4.25" D |
| Shaker weight | 11 lbs |

The MT-161 thruster’s compact size, long stroke and lightweight armature make it well suited for all types of modal testing. The thruster has a compression collet and features a central through-hole suitable for modal stinger and pre-tensioned wire testing applications. The standard shaker trunnion allows the shaker to be operated in any axis from vertical to horizontal. The trunnion base also facilitates bolting the shaker in place for rigid applications or the use of adjustable mounting feet.

Reliability is assured through the use of the latest composite materials in the unique, all flexure, armature suspension design. The design provides for low axial stiffness while retaining high lateral stiffness and has no rolling or sliding components to wear out and/or produce unwanted harmonics or distortion. When combined with the correct Labworks linear power amplifier, the system is unmatched for reliability, performance and cost.

## Options

- Vibration isolation mounts. Modal stingers and mounts.
- Cooling blower required for operation above 13 lbf.



[1] Please see systems ratings for additional specifications.
[2] Load dependent.
Specifications subject to change.

# FG-142 Inertial Shaker


- 4 pounds pk sine force[1]
- 2.8 pounds pk random force[1]
- Low stray magnetic field
- Frequency range 20-3,000 Hz.
- Convenient through hole mounting

The inertial shaker concept eliminates the need for fixturing, in most cases, because of its insensitivity to mounting postion and internal reaction mass design. Since there is no external armature mounting surface, (the whole transducer vibrates) simply mount the FG-142 to the test specimen, utilizing its single through hole mounting, in any orientation desired and commence testing. Multiple shakers can be implemented on complex or compliant structures to gain a more uniform excitation than can be had from traditional shakers under these conditions. Operation up to 2 lbf is possible without cooling further simplifying the installation to that of running two small wires between the amplifier and the shaker. A small amount of filtered shop / small compressor air allows full force operation of the FG-142 up to 4 lbf.

## General Specifications[2]

### Performance

| | |
|---|---|
| Sine force | |
| Natural cooling | 2.0 lbf pk |
| Forced air cooling | 4.0 lbf pk |
| Random force | |
| Natural cooling | 1.4 lbf rms |
| Forced air cooling | 2.8 lbf rms |
| Shock force | 4.5 lbf pk, 20 msec |
| Max displacement | |
| Continuous pk-pk | .35 in |
| Between stops | .35 in |

### Physical

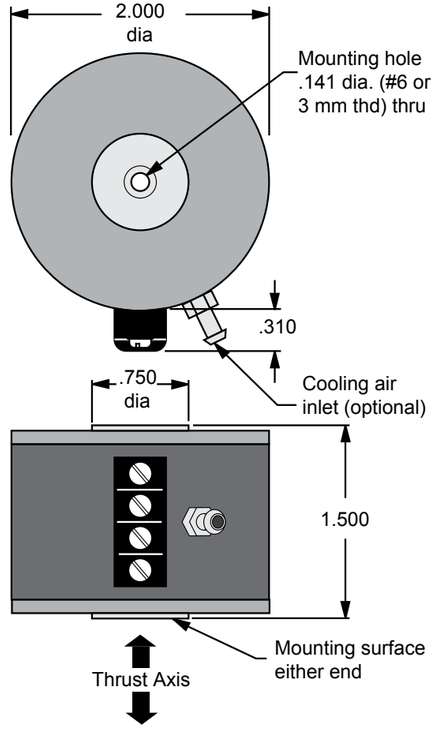
| | |
|---|---|
| Dynamic element weight | 0.33 lb |
| Mounting | .141 in dia. through hole |
| Dimensions | 2.0” D, 1.5” L |
| Generator weight | .56 lbs |

### Options

- Cooling air inlet.

[1] Cooling air required for operation above 2 lbf. sine, 1.4 lbf random.
[2] Please see systems ratings for additional specifications.

Specifications subject to change.








# Shaker Audio Power Amplifiers

### General

Labworks manufactures a range of Audio Power Amplifiers primarily intended for use in driving vibration shakers. These amplifiers are high quality, low distortion, low noise units that can be used for any audio frequency application requiring high output current capability. All Labworks amplifiers are designed to tolerate highly reactive loads and will recover automatically from short circuit and over-temperature conditions.

Unlike standard public address power amplifiers, these amps have DC output capability. The heat rejection ability of Labworks amplifiers is between 3 and 10 times that of amplifiers designed to drive loud speakers. The combination of high output current, self protection, high heat rejection, DC output, power-on interlock, and voltage or current source capability is what sets these amps apart from other high power audio amplifiers. It is just this combination of characteristics that make these amplifiers suitable for use with vibration shaker and other transducer applications.

### Linear Power Output Stage

Most Labworks power amplifiers utilize class AB1 linear power output stages. This type of output configuration offers the maximum electrical efficiency consistent with the inherent low noise and wide bandwidth associated with class A operation.

Smaller shakers and vibration transducers are often used in reduced force applications with sensitivity to both conducted and radiated noise associated with Class D amplifiers. Further, these applications will usually benefit from a highly damped voltage source amplifier. The direct coupled solid state output of Labworks amplifiers, with no reactive or filter components in the output signal path, provides for maximum output damping with minimum conducted and radiated noise.

### Heat Rejection

One by-product of high quality audio and Labworks linear power amplifiers, with linear output stages, is a higher heat rejection rate. To maintain high output currents at low output voltages, these types of amplifiers must dissipate significant amounts of heat. Along with limited or nonexistent low frequency output ability, the extremely limited heat rejection rate of public address amplifiers makes them all but unusable for shaker or high current transducer applications. These amplifiers are designed to drive loudspeakers which are made intentionally inefficient with higher impedance to maintain flat frequency response. Amplifiers like these will usually falt on over-temperature or over-current when trying to drive shakers or high current transducers.

Some public address amplifiers can be used for shaker applications if low frequency operation is not needed and their cooling can be enhanced by adding extra cooling fins, cooling fan packages, etc. All Labworks amplifiers come standard with oversize heat sinks. All but our smallest amplifier, the PA-151, have low noise, variable speed, high volume cooling fans to insure unhindered performance in high current applications.

### Shaker/Transducer Protection

Unlike speaker applications, it is important that the shaker amplifier never be switched on or be automatically reset with its gain up. Uncontrolled, spurious output turn-on transients or automatic output restoration after an amplifier or interlock fault can result in a broken shaker.

Labworks amplifiers provide for external customer assignable shutdown interlocks as well as power on interlock protection. This interlock protection insures that the amplifier gain must be fully down before the amplifier output is enabled. The external interlock can be used in conjunction with a vibration controller or other critical test article parameters to shut the system power amplifier down.

### Current Source Capability

In some applications involving constant force (instead of acceleration, displacement, etc.) it is desirable to have a completely undamped force source at the shaker. For these applications, the most desirable amplifier output characteristic is that of a current source instead of a voltage source.

Unlike many amplifiers available, most Labworks models have dual mode operation capability and can be simply switched to operate as either a high frequency, highly damped voltage source or as a high impedance, low damping current source.

# Labworks Inc. Standard System Audio Power Amplifiers

## PA-123-500

**2600 VA (65V,40A)**

Used in:

| | |
|---|---|
| LW127.123-500 | 500 lbf |

## PA-141

**1000 VA (50V,20A)**

Used in:

| | |
|---|---|
| LW127.141-225 | 225 lbf |
| LW140.141-110 | 110 lbf |
| LW139.141-75 | 75 lbf |
| LW126(HF).141-25 | 25 lbf |
| LW160.141-60 | 60 lbf |
| LW161.141-25 | 25 lbf |

## PA-138

**500 VA (25V,20A)**

Used in:

| | |
|---|---|
| LW139.138-40 | 40 lbf |
| LW126(HF).138-13 | 13 lbf |
| LW161.138-13 | 13 lbf |

## PA-151

**180 VA (24V, 7.5A)**

Used in:

| | |
|---|---|
| LW139.151-30 | 30 lbf |
| LW126(HF).151-9 | 9 lbf |
| LW132.151-7 | 7 lbf |
| LW132-203.151-4.5 | 4.5 lbf |
| LW160.151-30 | 30 lbf |
| LW161.151-9 | 9 lbf |
| LW142.151-2 | 2 lbf |



phone (714) 549-1981 • fax (714) 549-8041 • e-mail info@labworks-inc.com



# PA-123 Modular Single & Multi-Channel Power Amplifier Series

1 Channel, 8,000 VA

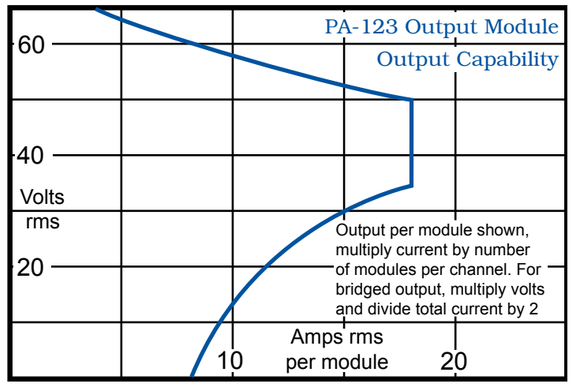
6 Channels, 1,000 VA / Channel

- **Output: 65V/130V**
- **750 to 8000 VA**
- **DC/direct coupled linear output**
- **Adjustable current limiter**
- **Multiple channel capability**
- **Direct reading output meters**
- **Flexible modular construction**

PA-123 Power Amplifiers utilize state-of-the-art linear technology to bring quiet direct coupled capability to vibration or audio frequency systems. Flexible modular design enables tailoring of the amplifier to any application requiring from 1,000 to 8,000 VA.

Individual 1,000 VA power modules are connected to a common PS-123 Power Supply and are wired in either single ended or bridged configurations. Oversized power supplies can be provided, enabling expansion of the amplifier through the simple addition of additional power modules.

Linear output stages insure minimum RF radiation to accompanying instrumentation and very low output impedance to maximize system damping. Adjusting the power




## Amplifier Options

- **CS-123 Current Source chassis**
- **CP-123 Remote/Slave control panels**
- **Rack panel cabinets**
- **Soft start, 3 phase power supply**
- **Shaker field power supplies**

## General Specifications*

| | Single end : Bridge |
|---|---|
| **Output voltage** | 65 V rms : 130 V rms |
| **Output current/module** | 18 A rms : 9 A rms |
| **Max. cont. dissipation** | 850 W/module |
| **Frequency response** | |
| DC input: DC to 10 KHz | -1 dB |
| AC input: 1.0 to 10 KHz | -1 dB |
| **Max. voltage gain** | 40 dB |
| **Cooling** | 2-speed fans, automatic |
| **Input impedance** | 10 kΩ/channel |
| **Meters** | |
| Volts, pk | 3 digit ± 1 lsd |
| Amps, rms/pk | 3 digit ± 1 lsd |
| **Interlock circuit** | N.O./N.C. switch or TTL |
| **Input power** | 1800 VA / module max |
| Voltage | 208 or 230 Vac |
| Frequency | 48 to 62 Hz |

*Specifications subject to change. Call factory for latest specifications.

# Linear Power Amplifiers

supply rail voltage, to properly match the amplifier output impedance to the load, assures efficient, direct coupled, operation.

Oversize heat sinks dissipate internal energy with minimum air flow rates. Dual-speed cooling fans provide quiet operation during idle or normal dissipation conditions with plenty of additional capacity when needed.

Power up soft start relays and line power sensing interlock circuitry eliminate accidental output transients during turn-on and turnoff.

Complete self protection for over-temperature, over-current, and instantaneous dissipation, as well as normally open and normally closed external interlock loops are standard. This provides maximum system compatibility and reliability.

For additional information on single or multichannel modular amplifiers, please call the Labworks technical support staff.

## CP-123 Control Panel

- Digital voltage and current meters
- Full internal and user interlocks
- AC and DC inputs provided
- Adjustable current limiter
- Anti-phase outputs for bridge or push-pull operation
- Master/slave connection capable
- Flexible modular construction

The CP-123 Control Panel is a compact, rack mounted instrument, which provides convenient drive signal control. The CP-123 provides gain control (pre-amplification), power amplifier output voltage and current metering, adjustable output current limiting for transducer protection, and full function system safety interlocks.

The CP-123 may be used as a remote control panel, connected in master-slave configuration, if more than one control location is desirable. For multiple channel amplifiers, CP-123 Control Panels provide independent control for each channel. Power modules are simply connected into appropriate groups.

## CS-123 Current Source Chassis

The CS-123 current source chassis is designed to interface transparently with the CP-123. This combination along with any of the PA-123 series amplifiers forms a dependable high impedance current source amplifier. A front panel switch on the CS-123 allows switching between voltage and current source amplifier output modes.

CS-123 Current Source Chassis

CP-123 Rear panel



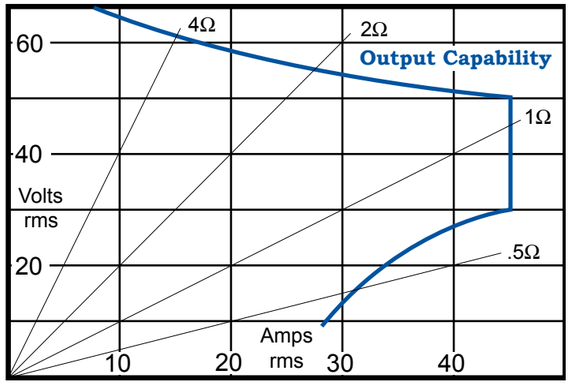


# PA-123-3/2-500 Linear Power Amplifier

- Output: 65V, 2600 VA.
- DC/direct coupled linear output
- Adjustable current limiter
- Field and De-Gauss power for the ET-127 shaker

The PA-123-3/2-500 houses a field and De-Gauss power supply specifically designed to drive the ET-127 shaker. It's a class AB, air-cooled unit with a power output of 2,600 VA, and is made up of three separate interconnected chassis. The flexible PA-123 modular design allows this amplifier to be configured for use with other shakers.

The CP-123 Control Panel features a low noise preamplifier, amplifier output voltage and current metering, adjustable output current limiting, and complete interlock circuitry. The power and field supply chassis houses input power transformers, power supply circuitry, the shaker interface, shaker cooling blower power source, and field cooling interlock.




## Amplifier Options

- **CS-123 Current Source chassis**

## General Specifications*

| | |
|---|---|
| **Output voltage** | 65 V rms |
| **Output current** | 40 A rms |
| **Max. cont. dissipation** | 2250 W |
| **Frequency response** | |
| DC input: DC to 10 KHz | -1 dB |
| AC input: 1.0 to 10 KHz | -1 dB |
| **Max. voltage gain** | 40 dB |
| **Cooling** | 2-speed fan, automatic |
| **Input impedance** | 10 kΩ |
| **Meters** | |
| Volts, pk | 3 digit ± 1 lsd |
| Amps, rms/pk | 3 digit ± 1 lsd |
| **Interlock circuit** | |
| Shaker, internal | Over travel, cooling |
| External, user | N.O./N.C. switch or TTL |
| **Shaker field power** | 1,250 W |
| **Input power** | 5,200 VA max |
| Voltage | 208 or 230 Vac, 1ø |
| Frequency | 48 to 62 Hz |
| **Dimensions** | 28" H x 21" W x 20" D |
| **Weight** | 280 lbs |

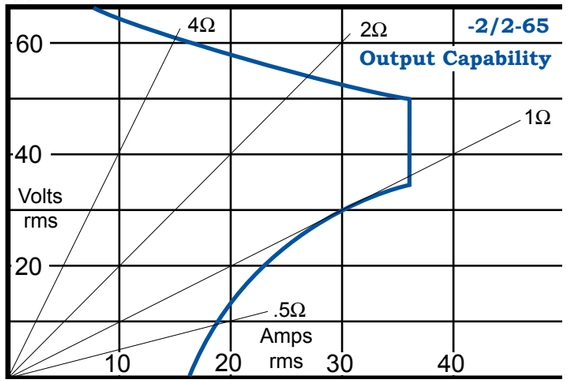
*Specifications subject to change. Call factory for latest specifications.

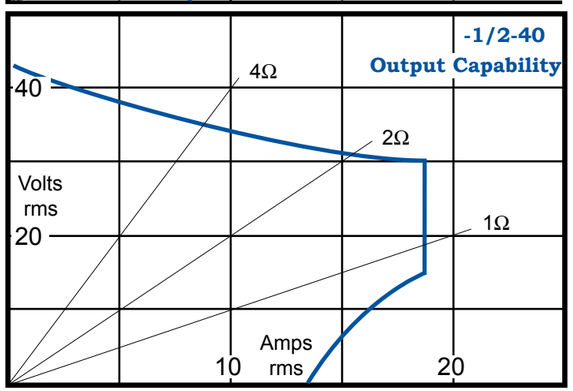
# PA-123-2/2-65
# PA-123-1/2-40
## Linear Power Amplifiers

- Output: 65V, 2000 VA, or 40V, 750 VA.
- DC/direct coupled linear output
- Adjustable current limiter
- CP-123 control panel
- Full external interlock circuit

The PA-123-X/2 amplifiers utilize standard PA-123 output modules and a CP-123 control panel/preamplifier. The number of output modules and power supply voltage is varied to match the load requirements. The PA-123-2/2-65 uses two output modules and full supply voltage. The PA-123-1/2-40 uses one output module and reduced supply voltage to match low impedance loads. The 2/2-65 can be configured to supply up to 130 Volts/18 Amps if required for high voltage loads.

A single chassis houses both the power supply as well as the output module(s) and is designed to mount in a standard 19" rack panel.




## General Specifications*

| | 2/2-65 : 1/2-40 |
|---|---|
| **Output voltage** | 65 V rms : 40 V rms |
| **Output current** | 36 A rms : 20 A rms |
| **Max. cont. dissipation** | 1,700 W : 850 W |
| **Frequency response** | |
| DC input: DC to 10 KHz | -1 dB |
| AC input: 1.0 to 10 KHz | -1 dB |
| **Max. voltage gain** | 40 dB |
| **Cooling** | 2-speed fan, automatic |
| **Input impedance** | 10 kΩ |
| **Meters** | |
| Volts, pk | 3 digit ± 1 lsd |
| Amps, rms/pk | 3 digit ± 1 lsd |
| **Interlock circuit** | N.O./N.C. switch or TTL |
| **Input power** | 3,500 VA : 1750 VA |
| Voltage | 208 or 230 Vac, 1ø |
| Frequency | 48 to 62 Hz |
| **Dimensions** | 10.5" H x 19" W x 20" D |
| **Weight** | 85 lbs : 70 lbs |

*Specifications subject to change. Call factory for latest specifications.

## Amplifier Options

- CS-123 Current Source chassis
- Rack mount cabinet

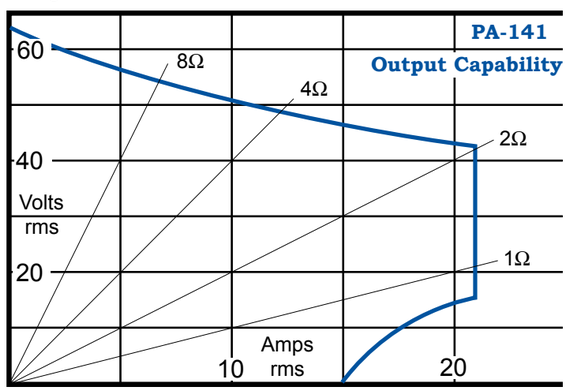




# PA-141
## Linear Power Amplifier

- Output: 50V, 1000 VA
- Direct coupled linear output
- Voltage and current source mode
- External interlock circuitry
- Optional shaker field supplies

The Labworks PA-141 Linear Power Amplifier has two operational modes. The amplifier can be used as either a wide-band, highly damped voltage source, or as a high impedance current source. Optional, internal DC field power supplies can be supplied for use with Labworks ET-140 and ET-127 Shakers. These options provide the convenience of a single chassis, as well as fully integrated power-up and cooling interlocks.




## General Specifications*

| | |
|---|---|
| **Output voltage** | 50 V rms |
| **Output current** | 20 A rms |
| **Max. cont. dissipation** | 900 W |
| **Frequency response** | |
| DC input: DC to 10 KHz | -.6 dB |
| AC input: 1.0 to 10 KHz | -.6 dB |
| **Max. voltage gain** | 36 dB |
| **Cooling** | 2-speed fan, automatic |
| **Input impedance** | 10 kΩ |
| **Meters** | |
| Volts, pk | 19 segment ± 5 % |
| Amps, rms | 19 segment ± 5 % |
| **Interlock circuit** | |
| External, user | F.O. switch or TTL |
| Shaker, internal, optional | cooling |
| **Optional field power** | 1000 W max |
| **Input power** | 2000 VA (3000 w/field) |
| Voltage | 208 or 230 Vac, 1ø |
| Frequency | 48 to 62 Hz |
| **Dimensions** | 7" H x 19" W x 17" D |
| **Weight** | 48 lbs |

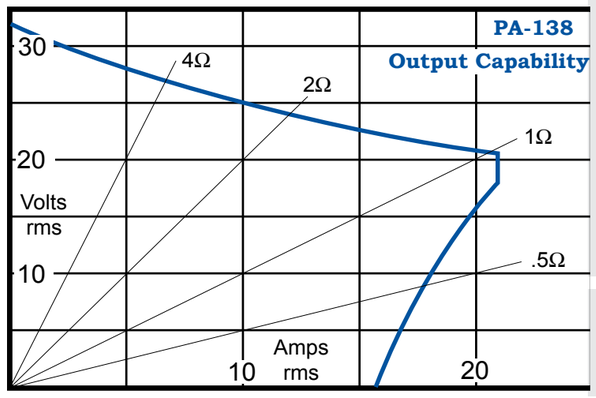
*Specifications subject to change. Call factory for latest specifications.

# PA-138 Linear Power Amplifier


- **Output: 25V, 500 VA**
- **Direct coupled linear output**
- **Output voltage and current meters**
- **Voltage and current source modes**
- **Small size, high power**

The Labworks PA-138 Linear Power Amplifier is a high quality, air-cooled, direct-coupled audio amplifier primarily intended for use with small vibration systems. Although this amplifier has been designed to directly drive low impedance loads, it can be used in any application requiring continuous duty, high quality, audio power.

PA-138 Amplifiers feature protection from both over current and over temperature insuring long term reliability. The amplifier has full interlock capabilities as well as peak voltage and RMS current bar graphs to monitor output.




## General Specifications*

| | |
|---|---|
| **Output voltage** | 25 V rms |
| **Output current** | 20 A rms |
| **Max. cont. dissipation** | 450 W |
| **Frequency response** | |
| Voltage source: DC to 10 KHz | -0.6 dB |
| Current source: DC to 2 KHz | -2 dB @ 4Ω |
| **Max. voltage gain** | 30 dB |
| **Cooling** | 2-speed fan, automatic |
| **Input impedance** | 10 kΩ |
| **Meters** | |
| Volts, pk | 19 segment ± 5 % |
| Amps, rms | 19 segment ± 5 % |
| **Interlock circuit** | |
| External, user | F.O. switch or TTL |
| **Input power** | 1000 VA max |
| Voltage | 100,120, 220, 240 V,1ø |
| Frequency | 48 to 62 Hz |
| **Dimensions** | 3.5" H x 19" W x 13" D |
| **Weight** | 24 lbs |

*Specifications subject to change. Call factory for latest specifications.

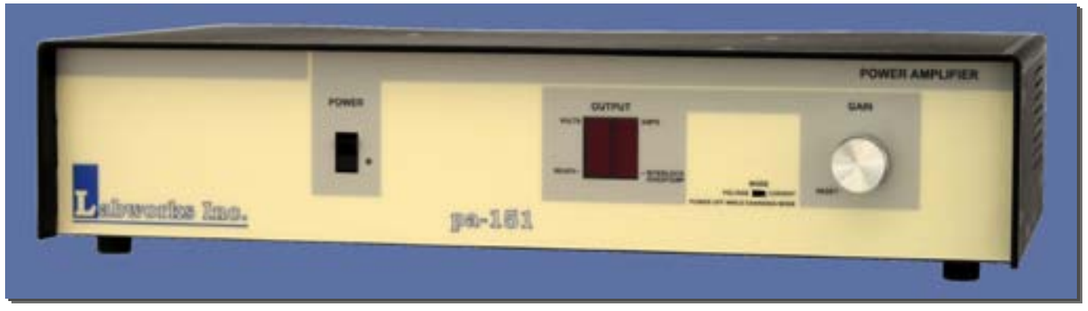
## Amplifier Options

- Rack panel cabinet
- BNC signal cables





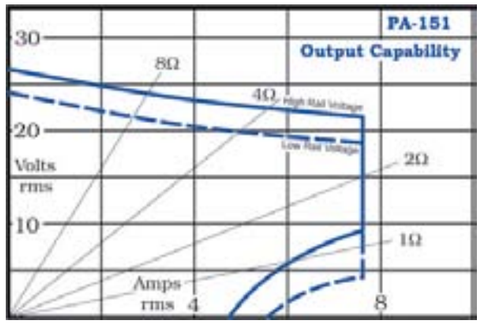
# PA-151 Linear Power Amplifier

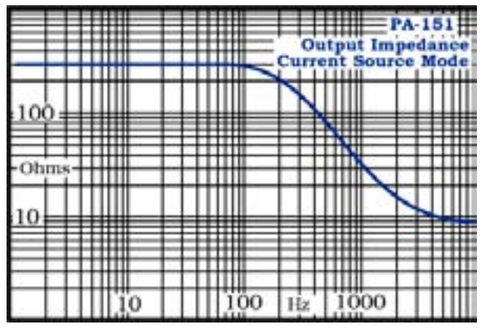



- **Output: 25V or 20V, 180 VA[1]**
- **Direct coupled linear output**
- **Output voltage and current meters**
- **Voltage and Current source modes**
- **Convection cooling, no fans**
- **Light weight, desktop amplifier**

The Labworks PA-151 Linear Power Amplifier is a high quality, convection-cooled, direct-coupled audio amplifier primarily intended for use with small vibration systems. Although this amplifier has been designed to directly drive low impedance loads, it can be used in any application requiring continuous duty, high quality, audio power.

PA-151 Amplifiers feature protection from both over current and over temperature insuring long term reliability. The amplifier circuitry uses soft start technology for load protection and has external interlock capabilities as well as output voltage and current bar graphs. A voltage-proportional-to-output-current signal output is provided for modal test and other applications requiring force monitoring. A unique dynamic output drive circuit provides high random peak output current for increased random and shock vibration system performance.




## General Specifications[2]

| | |
|---|---|
| **Output voltage** | 25 or 20 V rms |
| **Output current** | 7.5 A rms |
| **Max. cont. dissipation** | 180 W |
| **Frequency response** | |
| Voltage Source: DC to 10 KHz | -1 dB |
| Current Source: DC to 2 KHz | -2 dB @ 4Ω |
| **Max. voltage gain** | 28 dB |
| **Max. current gain** | 22 A/V |
| **Cooling** | Natural convection |
| **Input impedance** | 10 kΩ |
| **Meters** | |
| Volts | 9 segment bar graph |
| Amps | 9 segment bar graph |
| **Interlock circuit** | |
| External, user | F.C. switch or TTL, F.C. |
| **Input power** | 300 VA max |
| Voltage | 100-120, 200-240 V,1ø |
| Frequency | 48 to 62 Hz |
| **Dimensions** | 3.5" H x 17" W x 13" D |
| **Weight** | 19 lbs |

[1] Switch selectable internal rail voltage allows impedance matching to load requirements
[2] Specifications subject to change. Call factory for latest specifications.

## Amplifier options

- Rack mount brackets
- Rack panel cabinet

# Shaker System Controllers

## General

Several factors are present in vibration test systems that make the use of a vibration controller desirable. One of the most compelling factors is the effects of the complex transfer function between amplifier input voltage and the acceleration response of a control accelerometer. Most vibration tests involve testing at a specified vibration level: acceleration, displacement, etc. The transfer characteristics for these levels vary with frequency due to the complexity of the system components.

## Complex System Impedance

If the system power amplifier is used in its voltage source mode, the signal to the shaker will be a relatively good representation of the input signal voltage with some constant gain factor dependent upon the setting of the amplifier front panel gain control.

The transfer function from shaker drive voltage to armature coil current is a complex result of both electrical and reflected mechanical impedance characteristics. Low frequency impedance is dominated by back EMF voltage. Mid frequency impedance is typically dominated by the shaker's AC resistive component, which is not constant. High frequency impedance is usually controlled by armature coil inductance and reflected mechanical reactances.

The transfer characteristics between armature coil current and coil force are relatively linear at all but the lowest, high displacement frequency regions. However, the acceleration at any particular point on the shaker armature or the test article is dependent upon the combined armature, fixture and test article mechanical compliance and stiffness matrix. Resonances, damping, etc. produce transfer functions that are not only frequency dependent but are also accelerometer position dependent.

This extremely complex combination of transfer characteristics make it impractical to operate vibration systems open loop. Some repetitive testing with constant or nearly identical loads can be done after characterization with a closed loop system, but this is usually not practical. Also, if the desired output level is not acceleration, but displacement or velocity, then there is another layer of complication involving non-linearities in the shaker suspension system, as well as the normal unity or squared relation of velocity or displacement relative to acceleration vs. frequency.

## Feedback

All of the complications mentioned so far can be made relatively transparent if some form of vibration level feed back is utilized. Although some systems are controlled using displacement, velocity or force monitoring for feed back, most systems utilize acceleration for their feed back information. Light weight, electronic accelerometers are available from many manufacturers with a full range of sizes, sensitivities, bandwidths and configurations that make getting a high quality acceleration signal relatively easy.

Accelerometers can be placed in critical positions on the shaker or test article and multiple accelerometers can be used to monitor different locations on complex systems.

## Controllers

The simplest types of controllers depend on the operator to read and evaluate the feedback signal and adjust the amplifier signal input voltage accordingly. This type of system can be as simple as a sine wave signal generator and an accelerometer monitored by a voltmeter. It is left to the operator to manually make the necessary gain compensation for changes in frequency or desired level specifications.

Since most modern accelerometers require a constant current source/buffer amplifier, and most voltmeters read in either average or RMS voltage for AC signals, it can be difficult to read and adjust for peak acceleration with this setup. If the accelerometer has a sensitivity that is not convenient for conversion to voltage, mistakes are easy to make. Random acceleration can be monitored in this fashion more directly because of the RMS nature of most random acceleration specifications, however, an average reading, RMS calibrated meter will inject another error when monitoring Gaussian signals. If the vibration specification involves displacement (pk-pk), it becomes virtually impossible to use this method.

"Shaker controllers" vary in sophistication, but usually provide feed back calibrated in acceleration and displacement units useful to vibration testing. Simple manual units are available that provide for frequency and gain adjustment while providing a calibrated acceleration signal in g's peak. More complex units will feature automatic servo controlled levels with programming and frequency sweep capabilities. Top end controllers utilizing computer technology are available that can control to almost any specification with multiple accelerometers, etc.





# Labworks Shaker System Controller Features

See the individual data sheets following this page for detailed specifications and features

### VL-144x Digital Dual Channel, Sine, Random and Classical Shock Controller

**General**

+One analog signal output channel
+Two acceleration input channels, Integral electronics Accelerometers or signal voltage
+External control connector: Test run Start, Stop, Alarm and Emergency Stop
+Optional Monitor panel w/ channel acceleration, sync. output signal
+Full digital program, test, and report save, recall and graphical print capability

**Sine**

+Linear and Logarithmic Frequency: sweep, stepped to Break Point, stepped 1 Hz
+Resonance search and dwell
+Transducer Calibration mode
+Control on Ch1, Ch2, extremal, or average or open loop

**Random**

+5-2000 Hz, 2 Hz/line or 2-500 Hz 0.5 Hz/line
+Control on Ch1, Ch2, extremal, or average
+Low level Open loop mode
+Output signal clipping and Kurtosis peak enhancement, standard

**Shock**

+Pulse length: 1-750 mS @ 1.4 Hz resolution or 1-1500 mS @ 0.7 Hz resolution
+Control on Ch1, Ch2, extremal, or average
+Classical shock pulse shapes: Half Sine, leading and trailing edge saw tooth, rectangular
+Shock response pulse: 1 displacement optimized fixed shape pulse
+Analysis: Time and Frequency domain, Shock response spectrum

### VL-145x Digital Single Channel, Sine and Random Controller
### VL-145s Digital Single Channel, Sine Only Controller
### VL-145r Digital Single Channel, Random Only Controller

**General**

+One analog signal output channel
+One acceleration input channel, Integral electronics Accelerometers or signal voltage
+External control connector: Test run Start, Stop, Alarm and Emergency Stop
+Optional Monitor panel w/ channel acceleration, sync. output signal
+Full digital program, test, and report save, recall and graphical print capability

**Sine**

+Linear and Logarithmic Frequency: sweep, stepped to Break Point, stepped 1 Hz
+Control on Ch1 or open loop

**Random**

+5-2000 Hz, 2 Hz/line
+Output signal clipping standard

### SC-121 Digital Assist Analog Dual Channel Swept Sine Servo Controller

**General**

+One analog signal output channel
+Two acceleration input channels, Integral electronics Accelerometers or signal voltage
+Calibrated acceleration signal output channels: 10 or 100 mV/g
+Logarithmic frequency sweep, 0.5 to 8 Oct/min sweep rates @ 0.5 Oct/min resolution
+Control on Ch1 or Average: Ch1-Ch2
+Analog DC voltage outputs proportional to Log Acceleration and Log Frequency
+Digital (TTL) sweep start and sweep stop signal output
+On board, 3 Program non-volatile memory up to 4 D-A-D-A breakpoints each

### SG-135 Manual Analog Single Channel Sine Controller

**General**

+One analog signal output channel
+One acceleration input channel: Integral electronics accelerometer or signal voltage
+Manual "Smart frequency" knob encoder with single logarithmic range: 1-10,000 Hz
+Manual 3 decade logarithmic signal output control with signal off detent
+3 digit, 0-100g, digital acceleration feedback meter

# SC-121 Sine Servo Controller

- Dual microprocessor design
- Digital signal synthesis & filtering
- Flexible programming
- Nonvolatile memory
- Two-channel acceleration input and control

The self contained SC-121 Sine Servo Controller provides an economical solution to modern sinusoidal vibration testing with a remarkably convenient operator interface and dual microprocessor design. Crystal controlled digital signal synthesis and filtering insures performance found only in the best controllers available.

Two channel acceleration feedback enables control of large head shakers, slip plates or large fixtures by averaging signals from two strategically placed accelerometers. The difference output makes transfer function determination and calibration tests as easy as running a simple sine test.

Flexible programming allows internal storage of up to three independent 1, 2, 3, or 4 level test profiles. Stored test profiles are easy to modify or replace. Digitally generated analog outputs facilitate plotting or recording test data.

## General Specifications

### Frequency Generator

| | |
|---|---|
| Range @ Resolution: | 2 to 6,553 Hz @ 0.1 Hz Res. or 4 to 10,000 Hz @ 0.2 Hz |

### Feedback Analysis

| | |
|---|---|
| Acceleration Range: | 0 to 99.9 g pk |
| Displacement Range: | 0 to 2.50 in pk-pk or 0 to 50.0 mm pk-pk |
| Input Channels: | 2 |
| Calibrated Inputs: | 10 or 100 mV/g |
| Variable Inputs: | 10 or 100 mV/g ±20% |

### Sweep, Logarithmic

| | |
|---|---|
| Modes: | Manual, Continuous or Single Sweep |
| Rate: | 0.5 to 8 octaves/min |
| Sweep Speed Resolution: | 0.5 octaves/min |
| Sweep Cycle Counter: | -999 to 9,999 sweep cycles |
| **Control Servo** | |
| Dynamic Range: | 70 dB min |
| Speed: | 3 ranges |

### Outputs

| | |
|---|---|
| Servo Voltage: | 0 to 2.5 V rms @ 50Ω |
| Constant Sine Voltage: | 0.60 V rms |
| Normalized Acceleration: | 10 mV/g @ 50Ω (both channels) |
| Data: | |
| Acceleration: | |
| Log control, Log ch 2: | 2 Vdc/decade |
| Linear difference: | 1.0 Vdc ±.01 Vdc/% difference. |
| Frequency: | |
| Log: | 2 Vdc/decade |
| Sweep/Pen Lift Logic: | TTL, low during sweep |

### Physical/Environmental

Power: 110 ±15 Vac or 220 ±30 Vac, 50/60 Hz
Dimensions: 3.5" H x 19" W x 12" D (Rack Mount)





# SG-135 Manual Sine Controller

- Low cost unit with manual operation and control
- Built in acceleration monitoring up to 100 g-pk
- Wide continuous frequency range: 1.0 to 10 KHz w/digital meter
- Built in accelerometer power supply, fixed and variable sensitivity
- Dynamic frequency control gives fast, high resolution settings
- Very low distortion output
- Fixed and variable sine outputs

The Labworks SG-135 Sine Generator/Monitor is a low cost, single-channel, manual sine controller. The SG-135 generates a low distortion sine wave signal suitable for use with electrodynamic shakers of all sizes.

Manual controls feature logarithmic frequency adjustment from 1.0 Hz to 10 KHz in one continuous range and a locking 60+ dB output signal amplitude control. A four digit frequency meter shows the output frequency with 0.2 Hz resolution.

The built in acceleration monitor takes either voltage calibrated acceleration signals or integral electronics accelerometers directly and displays the monitored acceleration up to 100 g pk.

The SG-135 is the perfect manual controller for the smaller shaker system, the manual calibration station, engineering evaluation and general sine testing applications.

## Signal Generator Options

- Rack panel cabinet
- Accelerometers, cables, mounts
- BNC cables

## General Specifications

### Signal Output Frequency

| | |
|---|---|
| Range @ Resolution: | 1.0 to 10,000 Hz @ 0.2 Hz |
| Accuracy: | ±0.004% |
| Temperature Stability: | ±100 pm/°C |

### Acceleration Meter

| | |
|---|---|
| Range: | 0 to 99.9 g pk |
| Frequency Range: | 2.0 to 10,000 Hz |
| Accuracy: | 0.2 dB ± LSD/5 to 7,000 Hz<br>1.0 dB ± LSD/2 to 10,000 Hz |
| Input Connector: | BNC |
| Calibrated Input: | 10 or 100 mV/g |
| Variable Input: | 10 or 100 mV/g ±30% |
| Accelerometer Bias: | 3 mA nominal (on-off) |

### Outputs

Variable Out Voltage @ Impedance: 0 to 2.5 V rms @ 50Ω
Variable Out Sine Distortion (1.0 V Out):
<0.1% THD, 5 to 5,000 Hz
<0.3% THD, 1 to 10,000 Hz
3rd harmonic <-50 dB typical
Constant Sine Voltage @ Impedance: 1.3 V rms @ 2KΩ
Normalized Acceleration: 10 mV/g @ 50Ω

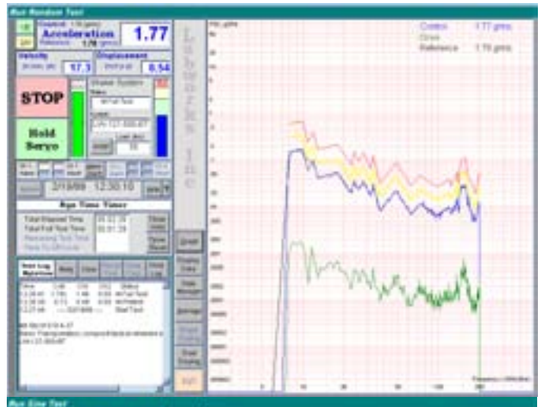
### Physical/Environmental

| | |
|---|---|
| Power: | 110 ±15 Vac or 220 ±30 Vac, 50/60 Hz |
| Dimensions: | 1.8" H x 19" W x 6" D (Rack Mount) |

# VibeLab™ Pro VL-144x

## Digital Sine, Random, and Shock Vibration Controller


- Straightforward Virtual Instrument operating under Windows™
- Automatic calculation of Acceleration, Velocity, and Displacement
- Programmed test requirements automatically compared to system capabilities and accelerometer sensitivity
- Online help for both novice and experienced users
- Password protection and extensive report generating capabilities
- Comes assembled with everything you need including computer, monitor, printer, keyboard, and accelerometer. Ready to Run, Not a Kit





### Complete Controller System Includes:

- Computer
- VibeLab™ and Windows™ software and license installed and calibrated
- Monitor
- Keyboard
- Mouse
- Printer
- VibeLab™ Shaker interface PC Board with accelerometer power supply factory installed
- (1) Accelerometer package: accelerometer, cable, stud, and mounting base





## General Description

The VibeLab Digital Sine, Random, and Shock Vibration Controller is a pc-based vibration test controller. Running under the Windows operating system, the controller generates and runs user-defined vibration tests. The electrical output of the VibeLab controller is a real-time analog voltage signal suitable for use in driving most commercially available wide band vibration test systems. VibeLab utilizes vibration acceleration feedback from one or two accelerometers mounted on the shaker, fixture, and/or test article.

VibeLab's straightforward user interface allows creation and running of vibration tests with minimal learning time. All critical settings are software interlocked and cross checked to insure that only valid tests are generated. The virtual instrument approach to the controller user interface puts all of the user-required settings and parameters in view, with minimal hidden menu activity required when defining or running a vibration test.

While running a test, VibeLab can be configured to monitor the vibration system operating level and even abort its operation if system limits are exceeded. Most common Labworks vibration systems are included in the VibeLab system library or the user can easily define and store custom system parameters.

VibeLab's primary report output is graphical. Either a single large or two smaller graphs can be prepared and printed directly, or copied, to the Windows clipboard, for inclusion on other Windows-based applications. Each graph carries its own notation field that prints automatically in the direct print mode. The test log header includes the name of the parent test program for reference. Any two data sets can be displayed on each graph with crosshairs provided for specific level or frequency identification, if required. The data files saved are spreadsheet compatible for custom report generation. The chronological test log is also available for incorporating into reports.

Detailed specifications and feature descriptions are available on our internet web site: www.Labworks-inc.com

## General Specifications

### Frequency Range

| | |
|---|---|
| Random | 5 to 2,000 Hz or 2 to 500 Hz |
| Sine | 2 to 10,000 Hz |
| Shock Pulse Duration | 1 to 750 mSec |
| Display Units | English or Metric units with automatic conversion |

### Reports

Graphical, Tabular, Current or Post Analysis

### Signal Input

| | |
|---|---|
| Number of Input Channels | 2 |
| Acceleration Range | Random: 0.2 to 100 grms<br>Sine: 0.1 to 200 gpk<br>Shock: ±2,000 gpk |
| Acceleration Resolution | 24 Bit |
| Maximum Input Voltage | 5 V |
| Connectors | BNC |
| Dynamic Range | 80 dB minimum |

### Vibration System Protection

| | |
|---|---|
| System Checker | Automatic cross check of program with the vibration system force and displacement capabilities |
| Sensitivity Checker | Automatic cross check of program with accelerometer dynamic range and sensitivity |
| Run-Time and Output Level Monitors | Show the vibration system operating level and VibeLab signal output voltage level |

### Test Article Protection

| | |
|---|---|
| Acceleration | Open loop/low gain + rate detection |
| Random, Shock | Over and/or under acceleration alarm and abort levels |
| Sine | System operation level, maximum acceleration and displacement |
| Manual Abort | Red "STOP" keyboard key and external crowbar shutdown terminals |
| External Interlock | Normally open switch or Logic Low |

### Password Access/Training

Up to 3 password levels plus demonstration/learning mode

### Operating Modes

Manual, Timed, Timed Cycle, Sweep Cycle, External Switch/TTL

### Control

| | |
|---|---|
| Random & Shock Modes | Single channel, average, or extremal technique |
| Sine Modes | Single channel, average, extremal, resonant search and dwell, transducer calibration. All modes use a tracking harmonic comb analysis filter |

### Program

| | |
|---|---|
| Random Spectrum Entry | Break point or line segment slope, graphical display, with Kurtosis, std. |
| Sine Sweep Profile Entry | Break point or constant level, graphical display of acceleration, velocity, displacement, and frequency |
| Shock Profile Entry | Pulse shape: half sine; terminal pk sawtooth; initial pk sawtooth, triangle, trapazoid, mil-810 shock spectrum, pk accel., vel., disp., pulse duration, pre/post pulse shape |
| Other Parameters | Virtual intrument design, minimum hidden menus |

### Test

| | |
|---|---|
| Save and Recall | All parameters, user named including all program parameters, data, and display settings |
| Last Test | The last test run is automatically saved at test termination and can be recalled and continued or analyzed |

### Run Time Display

| | |
|---|---|
| Graphical Data | Single or dual graphs with up to 2 acceleration/data channels or output drive data sets/graph: Ch 1, Ch 2, Control, Drive, Transmissibility: Ch 1/2 and Ch 2/1 (ch1/drive, sine) |
| System Monitor | Vibration system operation level meter |
| Timers | Cycle timers and sweep cycle counter |

### Graph/Data Save & Print

Save a full data set to disk, print direct, or clipboard the Test Log or any Graph

### Post Analysis

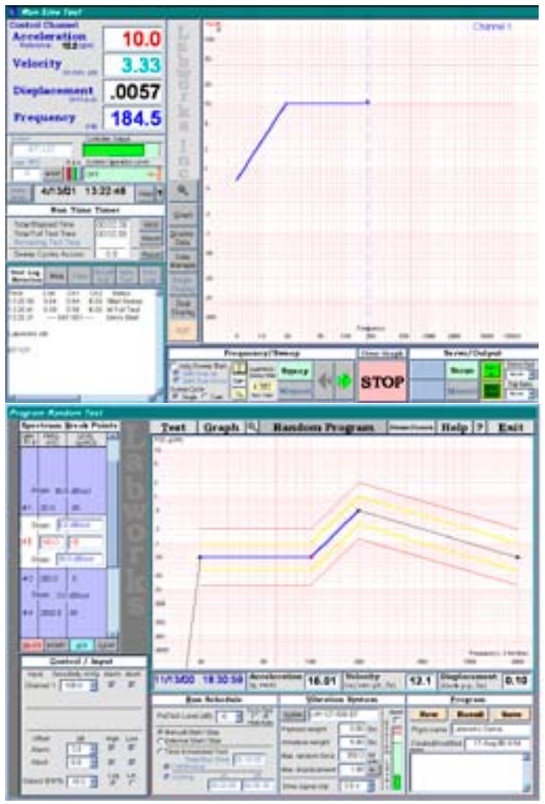
Any saved test can be recalled and the data re-configured for report printing or saving to the clipboard for incorporation into other Windows applications

# VibeLab™ VL-145 Series

## Digital Vibration Controllers

**145x – Sine and Random**
**145s – Sine Only**
**145r – Random Only**


- **Straightforward Virtual Instrument operating under Windows™.**
- **Automatic calculation of Acceleration, Velocity and Displacement.**
- **Programmed test requirements automatically compared to system capabilities.**
- **Online help for both novice and experienced users.**
- **Generate reports to use with your preferred software.**
- **Accelerometer power supply built in.**
- **Comes completely assembled with everything you need including computer, monitor, printer, keyboard, and accelerometer with built-in signal conditioning. Not a kit.**




### Complete Controller System Includes:

- Computer, Monitor, Keyboard, Mouse
- VibeLab™ and Windows™ software and license installed and calibrated
- Printer
- VibeLab™ Shaker interface PC Board w/accelerometer power supply, factory installed
- Accelerometer package: accelerometer, cable, stud, and mounting base





## General Description

The VL-145 series VibeLab controllers are pc-based (Windows™) vibration test controllers. These controllers generate an analog output signal suitable for input to a vibration test system amplifier in response to specific user-defined test parameters. Vibration acceleration feedback from an accelerometer mounted on the shaker, fixture, and/or test article is compared with the desired test levels and the controllers internal servo adjusts its output to produce the desired vibration at the accelerometers location.

The VL-145 virtual instrument user interface layout, with its use of minimal hidden menus and straight forward terminology, is easy to use and the intuitive layout reduces the time required to learn, program, and run specific tests. Most critical system functions are automatically cross-checked during the program phase against the vibration system capabilities, accelerometer sensitivities, etc. to prevent erroneous or harmful tests. Previously defined test profiles can be recalled and saved at will as well as defined as the default start-up profile.

Three versions of the VL-145 single channel controller are available. The VL-145x single channel sine and random controller, VL-145s single channel sine only version and the VL-145r single channel random only controller. The controller can be configured to monitor the operating level of the vibration test system and can be programmed to shut the system down if maximum operating levels are exceeded. The system parameters can be recalled from the complete Labworks system library or entered and saved to suit any vibration system limitations.

VibeLab's primary report output is graphical. Either a single large or two smaller graphs can be prepared and printed or copied to the clipboard for use with other Windows™-based applications. Data files saved are spreadsheet compatible for custom report generation. The chronological test log is also available for direct printing or inclusion in custom reports.

Detailed specifications and feature descriptions are available on our internet web site: www.Labworks-inc.com

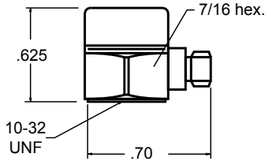
## General Specifications*

| | |
|---|---|
| **Model Configuration*** | |
| VL-145x | Sine and random |
| VL-145s | Sine only |
| VL-145r | Random only |
| **Frequency Range** | |
| Random* | 6 to 2,000 Hz |
| Sine* | 2 to 10,000 Hz |
| Display Units | English or metric units with automatic conversion |
| **Reports** | Graphical, tabular, current or post analysis |
| **Signal Input** | |
| Number of Input Channels | 1 |
| Acceleration Range | Random: 0.2 to 100 grms* Sine: 0.1 to 200 gpk* |
| Acceleration Resolution | 24 Bit |
| Maximum Input Voltage | 5 V peak |
| Connectors | BNC |
| Dynamic Range | 80 dB minimum |
| **Vibration System Protection** | |
| System Checker | Automatic cross check of program with the vibration system force and displacement capabilities |
| Sensitivity Checker | Automatic cross check of program with accelerometer dynamic range and sensitivity |
| Run-Time and Output Level Monitors | Show the vibration system operating level and VibeLab signal output voltage level |
| **Test Article Protection** | |
| Acceleration Random* | Open loop/low gain + rate detection Over and/or under acceleration alarm and abort levels |
| Sine* | System operation level, maximum acceleration and displacement |
| Manual Abort | Red "STOP" keyboard key and external crowbar shutdown terminals |
| External Interlock | Normally open switch or Logic Low |
| **Training** | Demonstration/Learning mode |

| | |
|---|---|
| **Run Modes** | |
| Random* | Manual, timed, timed cycle, external switch/TTL |
| Sine* | Manual, timed, sweep cycle, external switch/TTL |
| **Program** | |
| Random Spectrum Entry* | Break point or line segment slope, graphical display |
| Sine Sweep Profile Entry* | Break point or constant level, graphical display of acceleration, velocity, displacement, and frequency |
| Other Parameters | Virtual intrument design, minimum hidden menus |
| **Test** | |
| Save and Recall | All parameters, user named including all program parameters, data, and display settings |
| Last Test | The last test run is automatically saved at test termination and can be recalled and continued or analyzed |
| **Run Time Display** | |
| Graphical Data | Single or dual graphs with acceleration or output drive data: Ch 1, control, drive |
| System Monitor | Vibration system operation level meter |
| Timers | Cycle timers* and sweep cycle counter* |
| **Graph/Data Save and Print** | Save a full data set to disk, print direct, or clipboard the Test Log or any Graph |
| **Post Analysis** | Any saved test can be recalled and the data re-configured for report printing or saving to the clipboard for incorporation into other Windows applications |

*Sine specifications apply only to the VL-145x and VL-145s.
*Random specifications apply only to the VL-145x and VL-145r.

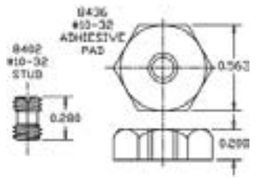
## 105-00008 Accelerometer




### 105-00008 Accelerometer Specifications

| | |
|---|---|
| **Weight:** | 12 grams |
| **Sensitivity:** | 100 mV/g ±3% |
| **Full Scale Range:** | ±5V, 50 g |
| **Frequency Range:** | 0.5-5,000 Hz, ±5% |
| **Threshold:** | .001 g's rms |
| **Max Shock:** | 2,000 g pk |
| **Transverse Sensitivity:** | <1% |
| **Temperature Range:** | +32 to +150 °F |
| **Discharge Time Constant:** | 1.0 second |
| **Connector:** | 10-32 |
| **Case Material:** | Stainless steel |
| **Electrical Isolation:** | yes, 10 MΩ min |

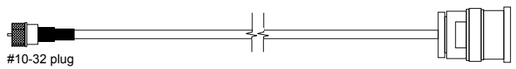
## Accelerometer Mounting




### Mounting Stud & Pad Material:

| | |
|---|---|
| 105-00002 Stud | Beryllium Copper |
| 105-00005 Pad | Black Anodized Aluminum |

## 105-00003 Accelerometer Cable

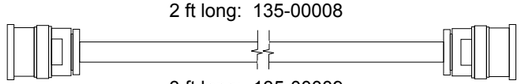



3 meters long: 1761B3

### Accelerometer Cable Specifications

| | |
|---|---|
| **Cable diameter:** | 0.090 in. |
| **Insulation/Color:** | Teflon/White |
| **Temperature range:** | -100 to +200°C |
| **Conductor:** | Stranded copper |
| **Type:** | RG196A/U |

## BNC Cable




1 ft long: 135-00007
2 ft long: 135-00008
3 ft long: 135-00009
6 ft long: 135-00010

### Signal (BNC) Cable Specifications

| | |
|---|---|
| **Cable diameter:** | 0.195 in. |
| **Insulation Color:** | Black |
| **Temperature range:** | -40 to +80°C |
| **Conductor:** | Stranded copper |
| **Type:** | RG58C/U |





## SI-126/SI-139/SI-140 Base Isolation Mounts

Shaker attachment hardware is included (not shown).

Rubber isolation mounts isolate shaker body vibration from user's floor or bench.

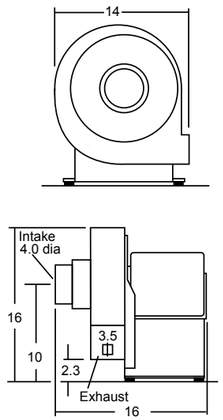
| | |
|---|---|
| **Sine:** | > 20 Hz |
| **Random:** | > 10 Hz |

## MS-129-XXX* Modal Stinger Kit

| | |
|---|---|
| **Rod Collet Chuck:** | #10-32 x Collet |
| **Collets:** | .03, .06 and .125 in. |
| **Threaded stingers (1 ea.):** | |
| **3/16 in. Dia. Stainless steel** | 3 in. and 10 in. long |
| **1/4 in. Dia. Stainless steel** | 3 in. and 10 in. long |
| **Rod stingers (3 ea.):** | |
| **.062 in. Dia.** | 11 in. long |
| **.093 in. Dia.** | 11 in. long |

*Specify Labworks Inc. shaker model number

## CB-127 Cooling Vacuum




### General Specifications

| | |
|---|---|
| **Blower Type:** | Suction |
| **Flow @ Pressure:** | 200 cfm @ 4" $H_2O$ |
| **Motor:** | 1/3 Hp |
| **Power:** | 115 Vac, 60 Hz |
| **Intake:** | 4" dia. (5" dia. w/o adapter) |
| **Hose Length:** | 12.5', flexible vacuum, std |
| **Pressure Drop:** Maximum allowable combined ducting pressure drop with ET-127 | 1" $H_2O$@200 cfm |

## CB-152 Delux, Long Life, Quiet, Cooling Vacuum

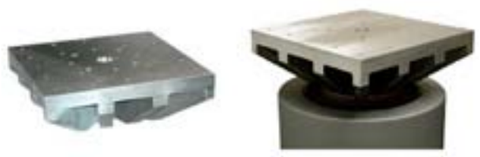
**Std:** LW140-110, LW139-75, LW126-25, LW160-60, LW161-25

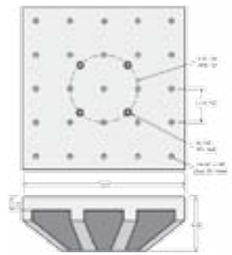
**Opt:** ET-139, ET-126, ET-132, ET-160, ET-161

### General Specifications

| | |
|---|---|
| **Blower Type:** | Suction (vacuum turbine) |
| **Flow @ Pressure:** | 35 cfm @ 30" $H_2O$ |
| **Motor:** | 250 W, Brushless |
| **Power:** | 115/230 Vac, 50 or 60 Hz (Specify) |
| **Intake:** | .75" and .63" dia. |
| **Noise Level:** | < 71 dB @ 1 M |
| **Hose Length:** | 7.5', flexible vacuum |
| **Blower Weight:** | 30 lbs. |
| **Minimum Blower Life:** | > 25,000 Hrs |
| **Dimensions:** | 11H x 9.5W x 11L in. |

# HE-127-12S Head Expander





This 12 inch square magnesium head expander is specifically designed for use with the Labworks ET-127 Electrodynamic Transducer shaker. The increased table size platform offered by the head expander allows attachment of larger, less dense, test loads by providing an increased mounting footprint with the ability to place mounting holes anywhere on the tables mounting surface. To reduce moving mass while maintaining high frequency operation, this expander is machined from a proprietary magnesium alloy casting. The expander comes standard with the shakers hole pattern repeated on its top mounting surface, and can be supplied with additional threaded mounting holes in either our standard grid pattern, completely custom pattern, or a combination of both.

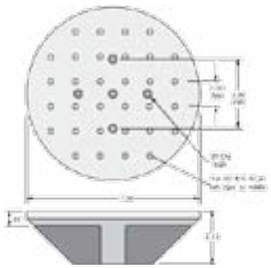
**General Specifications**

| | |
|---|---|
| **Shaker mounting:** | Labworks ET-127 |
| **Weight:** | 21 lbs. |
| **Dimensions:** | 12x12x4 inches |
| **Mounting surface thickness:** | 1.0 inch |
| **Frequency range:** | |
| **Uniform Acceleration, all standard grid mounting holes** | |
| | ±1 dB: 1500 Hz |
| | ±3 dB: 2000 Hz |

# HE-140-7R Head Expander



This 7 inch round magnesium head expander is specifically designed for use with the Labworks ET-139 and ET-140 Shakers. The increased table size platform offered by the head expander allows attachment of larger, less dense, test loads by providing an increased mounting footprint with the ability to place mounting holes anywhere on the tables mounting surface. To reduce moving mass while maintaining high frequency operation, this expander is machined from a proprietary magnesium alloy casting. The expander comes standard with the shakers hole pattern repeated on its top mounting surface, and can be supplied with additional threaded mounting holes in either our standard grid pattern, completely custom pattern, or a combination of both.



**General Specifications**

| | |
|---|---|
| **Shaker mounting:** | Labworks ET-139, ET-140 |
| **Weight:** | 2 lbs. |
| **Dimensions:** | 7 dia x 2.1 inches |
| **Mounting surface thickness:** | 0.63 inch |
| **Frequency range:** | |
| **Uniform Acceleration, all standard grid mounting holes** | |
| | ±1 dB: DC - 1800 Hz |
| | ±3 dB: DC - 3500 Hz |





# Engineering Data/Reference

**Shaker Force** The shaker force required is independent of frequency and is calculated by the following force equation using weight in place of mass and acceleration in normalized units of standard g's.

**Shaker Force** = (**Payload** weight + **Fixture** weight + shaker **Armature** weight) X **Acceleration**

Units:
Sine: pounds force peak = (pounds + pounds + pounds) X G's peak
Random: pounds force rms = (pounds + pounds + pounds) X G's rms

**Shaker Displacement** The shaker displacement required is a function of frequency. The following table of sinusoidal motion equations can be used to calculate the required displacements for sine vibration. Random displacement must be calculated from integrated acceleration spectra information. The simplified equations elow can be used in some cases. Refer to the engineering reference material on random for more complex spectrum shapes.

**Sinusoidal Equations of Motion** Acceleration, Velocity, Displacement and Frequecy are all inter-dependent functions and specifying any two fully defines the motion including the remaining two variables.

| To Find: \ Knowing: | g & f | v & f | d & f | d & g | v & g | d & v |
|---|---|---|---|---|---|---|
| g (g's) peak acceleration | | $f\,v/61.45$ | $f^2\,d/19.56$ | | | $v^2/193.0\,d$ |
| v (inch/sec.) peak velocity | $61.45\,g/f$ | | $\pi\,f\,d$ | $13.89\sqrt{g\,d}$ | | |
| d (inch) pk-pk displacement | $19.56\,g/f^2$ | $v/\pi\,f$ | | | $v^2/193.0\,g$ | |
| f (Hz) frequency | | | | $4.423\sqrt{g/d}$ | $61.45\,g/v$ | $v/\pi\,d$ |

## Random Vibration Equations (Gaussian)

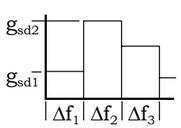
### Basic

$g_{rms} = (g_{sd}\,\Delta f)^{1/2}$ $\quad g_{sd} = g^2_{rms}/\Delta f$

where: $g_{rms}$ = Acceleration,rms (g's)
$g_{sd}$ = Accel. Density ($g^2$/Hz)
$\Delta f$ = Frequency Bandwidth. (Hz, flat psd)

### Combined Bands

$g_{rms}=(g_{sd1}\Delta f_1+g_{sd2}\Delta f_2+ g_{sd3}\Delta f_3+\ldots)^{1/2}$

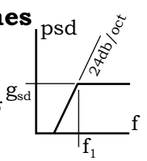



### Displacement, rms, inches

$d_{rms} = 7.14\,(g_{sd}/f_1^2)^{1/2}$

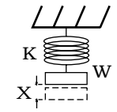
### Displacement, pk-pk, 3σ

$d_{pk\text{-}pk} = 42.8\,(g_{sd}/f_1^3)^{1/2}$




## Mechanically Resonant Systems

### Single Mass System




$F_n=(386\,K/W)^{1/2}/2\pi$
$F_n=3.127(1/X)^{1/2}$

W=Weight of suspended mass, lbs.
K=Spring rate, pounds/inch
X=Static deflection (1 g), inch
$F_n$=Fundamental resonant frequency

### Two Mass System

$F_n=[386\,K(W1+W2)/W1W2]^{1/2}/2\pi$

### Distributed Mass & Stiffness System, Longitudinal Resonance of a Bar

$F_n=(386\,E/\partial)^{1/2}(n/2L)$
$F_n=10^5\,n/L$ (for aluminum, steel, mag)

E=Modulus of Elasticity (lbs/in$^2$)
n=Mode number (1,2,3,...)
L=length (inches) $\partial$=density (lbs/in$^3$)

# Sine Vibration Testing

## General

The relationship between acceleration, velocity and displacement under stationary vibration conditions is often misunderstood. Since the implications of these requirements on vibration test equipment requirements should be understood to insure that the correct size and type of equipment is specified, the following tutorial may prove useful.

## Sinusoidal Motion

It is important to understand that with sinusoidal vibration, the relationship between acceleration, velocity and displacement is fixed and frequency dependent. It is not possible to vary any one of these three parameters without affecting another, and for this reason, one must consider all of them simultaneously when specifying or observing sine vibration.

The three parameters of acceleration, velocity and displacement are all linear scalar quantities and in that respect, at any given frequency, each has a constant, proportional relationship with the other. In other words, if the frequency is held constant, increasing or decreasing the amplitude of any one of the three parameters results in a corresponding proportional increase or decrease in both of the other two parameters. However, the constant of proportionality between the three parameters is frequency dependent and therefore not the same at different frequencies.

In general, sinusoidal vibration testing uses the following conventions for measurement of vibration levels.

*Acceleration* is normally specified and measured in its peak sinusoidal value and is normally expressed in standardized and normalized dimensionless units of ***g***'s peak. In fact, a g is numerically equal to the acceleration of gravity under standard conditions, however, most engineering calculations utilize the dimensionless unit of g's and convert to normal dimensioned units only when required.

*Velocity* is specified in peak amplitude as well. Although not often used in vibration testing applications, velocity is of primary concern to those interested in machinery condition monitoring. The normal units of velocity are inches per second in the English system or millimeters per second in the metric system of units.

*Displacement* is usually expressed in normal linear dimensions, however, it is measured over the total vibration excursion or peak to peak amplitude. The normal units of displacement are inches for English or millimeters for the metric system of units.

As mentioned previously, these quantities are not independent and are related to each other by the frequency of the vibration. Knowing any one of the three parameter levels, along with the frequency of operation, is enough to completely predict the other two levels. The sinusoidal equations of motion stated in normal vibration testing units are as follows.

$$g = 0.0511\ f^2\ D$$

$$g = 0.0163\ V\ f$$

$$V = \pi\ f\ D$$

where:
g= acceleration, g's peak
D= displacement, inches, peak to peak
V= velocity, inches per second, peak
f = frequency, Hz

Inspection of the above equations shows a couple of important relationships that, if understood, will make using and specifying vibration tests easier.

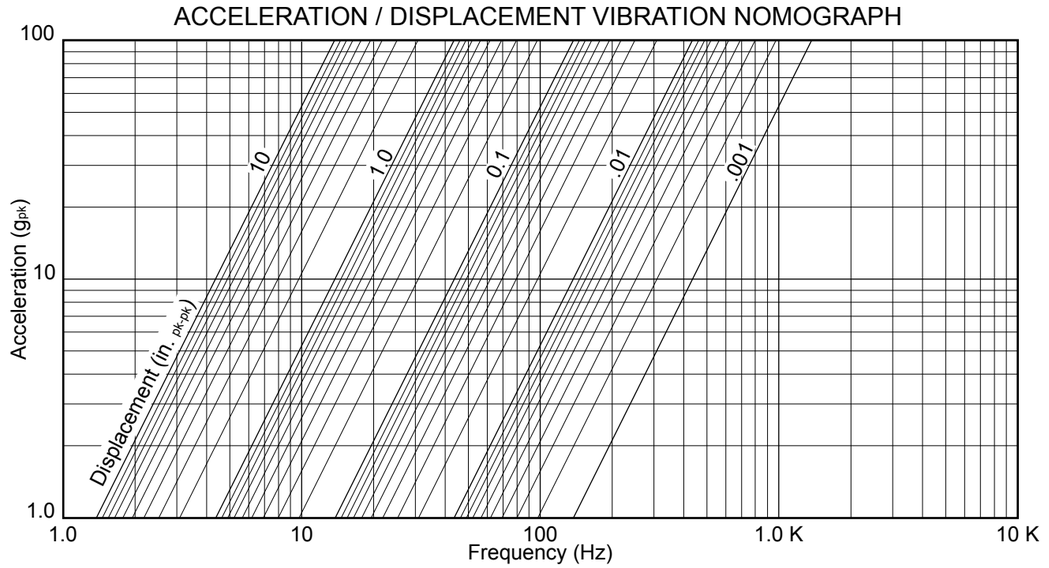
The first is the squared frequency relationship between displacement and acceleration. Analysis shows that for normal sine testing, the displacements above 80 or 100 Hz are generally small. Conversely, if acceleration is held constant and the frequency is lowered, displacement increases rapidly with the frequency change. This can come as a surprise to those new to vibration and has resulted in more than one damaged system and test article.

The second is that velocity has a proportionally increasing (or decreasing) relationship with either displacement or acceleration. In other words, the velocity will increase (or decrease) in direct proportion to the frequency if either of the other parameters are held constant. Velocity is of interest when damping components or back EMF issues are important to the testing.

A complete matrix of the sinusoidal equations of motion is presented in the Engineering Data Reference section of this catalog.








## Sine Tests

By far the most common type of sine testing involves a logarithmic frequency sweep holding a specified acceleration constant at the base of a test article or its mounting bosses on the test fixture. A control feedback accelerometer is mounted in the desired position on the fixture and the level is maintained as the frequency of vibration is swept. This method insures excitation at all frequencies between the sweep end frequencies. This type of testing usually will cycle up and down repetitively between frequency limits for a specified time or number of sweep cycles to ensure that adequate reliability levels are attained.

If the testing requires low frequencies, the limitation of the shaker/system available displacement may require lowering the test acceleration. From the nomograph above, displacement limitations are often required and specified. A typical sine test specification might be as follows.

*Typical sine sweep test specification:*
Sinusoidal vibration with bidirectional 1.0 octave/minute logarithmic swept frequency between 5 and 1000 Hz, maintaining a level of 10 g's pk except as limited by .75 inches pk-pk, 20 sweep cycles total.

It can be seen from the graph above and the previous engineering equations that the vibration level should be 10 g above 16.2 Hz and .75 inches pk-pk below this "Crossover frequency". Most servo sweep oscillators are designed to facilitate this type of testing.

Also common are single frequency dwell tests that specify a single critical frequency and acceleration or displacement level and a dwell time. Less common are manual resonance survey, automatic resonance dwell, sine-on-random and many other sine test specifications requiring sophisticated control systems often involving multiple feedback accelerometers.

## Force Requirement

Once the vibration level requirements are defined for testing purposes, a vibration system can be specified. Since electrodynamic shakers are primarily force generators, the available systems use force output as their primary rating. The maximum required force for any given specification generally will correspond to the portion of the specification having the highest acceleration. It is common to size a shaker system for a given test by assuming that the load is non-resonant and calculating the requirement for a dead mass load of equivalent weight.

All of the elements connected to the armature must be considered part of the dynamic load. This includes the shaker armature itself, any test article mounting fixture and the test article itself.

Refer to the equations shown in the system ratings section of this catalog for the applicable calculations.

# Random Vibration Testing

## General

Many vibration environments are not related to a specific driving frequency and may have input from multiple sources which may not be harmonically related. Examples may be excitation from turbulent flow as in air flow over a wing or past a car body, or acoustic input from jet engine exhaust, wheels running over a road, etc. With these types of vibration, it may be more accurate, or of more interest to analyze and test using random vibration.

Unlike sinusoidal vibration, acceleration, velocity and displacement are not directly related by any specific frequency. Of primary concern in random testing is the complete spectral content of the vibration being measured or generated. Most random vibration testing is conducted using Gaussian random suppositions for both measurement and specification purposes. With Gaussian assumptions, there is no definable maximum amplitude, and the amplitude levels are measured in RMS (root-mean-squared) values.

## Peak Levels

In true Gaussian random vibration, the amplitude value at any given time is a statistical relationship with time. The classic bell-shaped amplitude distribution curve shows that most of the time, the instantaneous vibration values will be in the areas adjacent to zero. Higher amplitudes will be experienced for lower portions of the measured time. This postulation implies that there is some statistically significant amount of time that vibration amplitudes will be at extremely high values.

Since systems designed to measure and to generate vibration levels must have some finite maximum capability, a common modification of pure Gaussian random is usually specified limiting the peak amplitude excursions. The most common maximum amplitude specification holds the peak amplitude between plus and minus three times the RMS value of the level being considered. This specification is normally called by its statistical name: 3σ (sigma) peaks. In fact, ignoring or not generating peaks above the 3σ level accounts for less than .04% of the test time, and can normally be completely ignored. Many specifications can be found at the 2.5σ level and some even lower.

## Vibration Levels

With random vibration levels, acceleration is usually specified in g's RMS. Likewise, velocity and displacement are usually specified in units of inches/second RMS and Inches RMS or their metric equivalents. For vibration testing applications, almost all test specifications specify the vibration level in terms of acceleration. Although a random vibration specification may indicate an overall level in g's RMS, it cannot be considered a complete specification if it does not delineate the spectral content of the vibration. The overall level is important for consideration of the magnitude of the equipment that must be used to measure or generate the random vibration, but actual testing must consider the specific frequency content if it is to provide meaningful testing or information.

## Spectral Content

Random vibration can be thought of as containing excitation at all frequencies within the specified frequency band but no excitation at any specific single frequency. This concept can be difficult to understand. However, the equations that follow may help. Suffice it to say that one can realize amplitude values only if a spread of frequency (bandwidth) is considered. Acceleration spectra is normally specified in terms of its' acceleration density using the units of $g^2$ per Hz. Acceleration density is defined as:

$$g_d = \text{limit of } a^2/\Delta f \text{ as } \Delta f \to 0$$

where $g_d$=acceleration density
a=rms acceleration
Δf=bandwidth

A plot of the acceleration density for each component frequency verses frequency gives a curve of $g^2$/Hz over the frequency spectrum of interest. This curve is known as the PSD or Power Spectral Density curve. The PSD curve is the normal method used to describe random vibration specifications. Since the PSD curve is a plot of acceleration density, the overall rms acceleration can be found by summation of the density over frequency.

$$g^2_{rms} = \sum_{f_1}^{f_2} g_d \, \Delta f \quad \text{or} \quad g_{rms} = \left[ \int_{f_1}^{f_2} g(f) \, df \right]^{1/2}$$

where $g_{rms}$=overall acceleration
f1 & f2=band frequencies





If a random specification calls for a flat PSD curve, the overall acceleration level is easily calculated from the following equation.

$$g_{rms} = \left[ (f_2 - f_1) \, g_d \right]^{1/2}$$

For example: $g_d$= .01 $g^2$/Hz, 20 - 2000 Hz
gives $g_{rms}$ = 4.45 g

Bands of spectra with non-flat, but straight line (log-log), acceleration density characteristics can substitute the following equation for overall acceleration.

$$g_{rms} = \left[ \left( \frac{g_1}{f^S} \right) \frac{f_2^{S+1} - f_1^{S+1}}{S+1} \right]^{1/2}$$

where $g_{rms}$=overall acceleration
f1 & f2=band frequencies
g1 & g2=band limit levels
$S = \log(g_2/g_1)/\log(f_2/f_1)$ or
S=.3322(dB/oct)

Bands of different acceleration density can be added as the areas under the PSD curve as follows:

$$g_{rms} = \left[ (f_{21} - f_{11}) \, g_{d1} + (f_{22} - f_{12}) \, g_{d2} + \ldots \right]^{1/2}$$

Random displacement is important to those specifying a shaker system to insure that the shaker system selected has sufficient relative armature displacement to avoid over travel conditions. Displacement can be found from:

$$D^2_{rms} = 95.6 \sum_{f_1}^{f_2} g_d \, \Delta f / f^4$$

where D = displacement

Which leads to:

$$D_{rms} = 5.6450 \left[ g_{01} \left( \frac{1}{f_1^3} - \frac{1}{f_2^3} \right) + g_{02} \left( \frac{1}{f_2^3} - \frac{1}{f_3^3} \right) + \ldots \right]^{1/2}$$

Since we are interested in the peak to peak displacement, and if we assume that there will be 3σ displacement peaks, then $D_{3\sigma p\text{-}p} = 2 \times 3 \times D_{rms}$ or:

$$D_{3\sigma p\text{-}p} = 33.87 \left[ g_{d1} \left( \frac{1}{f_1^3} - \frac{1}{f_2^3} \right) + g_{d2} \left( \frac{1}{f_2^3} - \frac{1}{f_3^3} \right) + \ldots \right]^{1/2}$$

If the lowest spectrum shape specifies a rectangular acceleration density profile, allowance must be made for non perfect filter roll-off below the lowest frequency specified. Common practice is to use a displacement multiplier of 42.8 instead of 33.87 in the previous equation, which will compensate for an approximate 24 dB/octave low frequency filter characteristic.

## Vibration System Performance

Because vibration specifications are usually expressed in terms of acceleration peak for sine and acceleration rms for random, most vibration systems will have an apparent lower force capability for random vibration. Further random derating comes from the ability of the system amplifier to deliver peak voltage and current to supply the random peak force requirements. Labworks linear amplifiers can usually supply significant peak current for short durations and this limitation is not as severe as that formed by their peak voltage capability. In common with most vibration system manufactures, Labworks maximum performance random ratings are often based on passing 3σ current peaks and 2.5σ voltage peaks. If the force requirements are reduced, the peak voltage capability of the amplifier remains fixed thereby allowing for full 3σ (or higher) voltage peaks to be generated. It can be shown that the non-flat transfer characteristics of electrodynamic systems will generate 3σ acceleration peaks even if the voltage is severely clipped, and in fact the effects of clipping voltage at 2.5σ are normally completely negligible.

Some vibration system random ratings are specified with a specific wide bandwidth spectrum. This can be misleading in that they may be taking advantage of shaker resonances to supply acceleration levels at reduced shaker drive current. If a narrower random bandwidth is needed, or does not include the shakers resonance, the system must be further derated. Labworks systems' random ratings are independent of bandwidth and can be counted on for all bandwidths below their operational upper frequency limit.

## Ground Isolation

Since most random vibration specifications have lower frequency limits above 10 Hz the amount of force concentrated below 30 Hz is minimal. Most shakers used for random vibration testing can be effectively isolated from the ground by using solid type rubber machinery mounts having resonance frequencies between 10 and 20 Hz.

## Sine System Worksheet

1. Determine the approximate test article and attachment fixture weight (pounds).
2. Determine the maximum acceleration required for your testing. This may be an acceleration specification, or may be expressed in terms of displacement. Using the formulas shown in the engineering reference section, acceleration can be found from the displacement and the highest frequency at that displacement. Convert the acceleration to normalized units of g's peak.
3. If the displacement is not specified, use the formulas shown in the engineering reference section along with the lowest frequency and acceleration to determine the required peak to peak displacement.
4. From the Sine system selector on page 3, determine the system with the closest **solid** capability line above the intersection of the combined test article and fixture weight and the acceleration.
5. From the table on page 4, scan across to the Disp. pk-pk column on the **System Components/Specifications** line determined in step 4. Check that the displacement is at least double that required for the desired test. If it is, refer to the specific system shaker data sheet and verify that the combined height or the maximum width of the test article and attachment fixture do not greatly exceed the shakers height dimension. If OK, this is the smallest system required for the test specification. **Note: If relatively heavy loads are to be operated at low frequencies, the shaker body resonance may produce large body motion which must be included in the displacement requirements. This resonance is usually located between 10 and 20 Hz if machinery type mounts are used under the shaker, and between 2 and 4 Hz if pneumatic type mounts are used.**
6. If the displacement required exceeds the the system capabilities, scan down the **Disp. pk-pk.** column to find a system with sufficient shaker displacement. If the weight calculated in step 1 above, is well below the maximum recommended unsupported load, or the shaker is to be operated horizontally, use the **Vibration Systems Engineering** equations on page 5 to calculate the lower exact shaker displacement needed.
7. For unusually large test articles with center of gravity to shaker armature mounting surface dimensions greater than 1/2 the shaker height, consult the factory technical staff for recommendations.





# Product Index



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- Labworks maintains a staff of qualified technical sales personnel that are available for consultation on current prices, availability and technical application information.
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