



# Model PM100 Electrodynamic Vibration Exciter



## User's Manual

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**Table of Contents**

<b>Section</b>	<b>Contents</b>	<b>Page #</b>
1	PERFORMANCE SPECIFICATIONS	1
1.1	OPERATIONAL RATINGS	1
1.2	MECHANICAL SPECIFICATIONS	1
1.3	UNPACKING	2
1.4	CALCULATING MAXIMUM RESPONSE	2
1.5	COIL CURRENT VERSUS FREQUENCY	3
1.6	OPTIONAL EQUIPMENT	3
2	INTRODUCTION	4
2.1	DESIGN PRINCIPLES	4
2.2	PERMANENT MAGNET CONSIDERATIONS	4
2.3	SUSPENSION	4
2.4	COOLING	5
2.5	BASE	5
3	EXCITER OPERATION	6
3.1	MAXIMUM ACCELERATION	6
3.2	COIL CONNECTIONS	6
3.3	OPERATING CONTROLS	6
3.4	MOUNTING ORIENTATION	7
3.4.1	VERTICAL MOUNTING	7
3.4.2	HORIZONTAL MOUNTING	7
4	EXCITER MAINTENANCE	8
4.1	REMOVAL OF MOVING ELEMENT	8
4.2	INSTALLATION OF MOVING ELEMENT	8
4.3	RECOMMENDED SPARE PARTS	9
4.4	RETURN INSTRUCTIONS	9
5	PRINCIPLES OF OPERATION	10
5.1	ELECTROMECHANICAL RELATIONSHIPS	10
5.2	ELECTRODYNAMIC EXCITER CONSTRUCTION	11
5.3	VIBRATION LEVEL MEASUREMENT	11
5.4	COOLING REQUIREMENTS	11
5.5	MOVING ELEMENT WIRING	12
6	DESIGN GOALS AND CONSIDERATIONS	13
6.1	DISPLACEMENT	13
6.2	VELOCITY	13
6.3	ACCELERATION	13
6.4	FORCE	13
6.5	FREQUENCY	14
6.6	MECHANICAL RESONANCES	14
6.7	DISTORTION	14
6.8	CROSS AXIS RESPONSE	15
6.9	STRAY FLUX	15
7	EXCITER PERFORMANCE CHARACTERISTICS	16
7.1	NON-RESONANT LOAD	16
7.2	LOAD RESONANCE BELOW ELECTRICAL RESONANCE	16
7.3	LOAD RESONANCE BETWEEN ELECTRICAL AND AXIAL	17
7.4	OPERATION WITH HEAVY LOADS	17
8	COMBINED ENVIRONMENT OPERATION	18
	WARRANTY	19

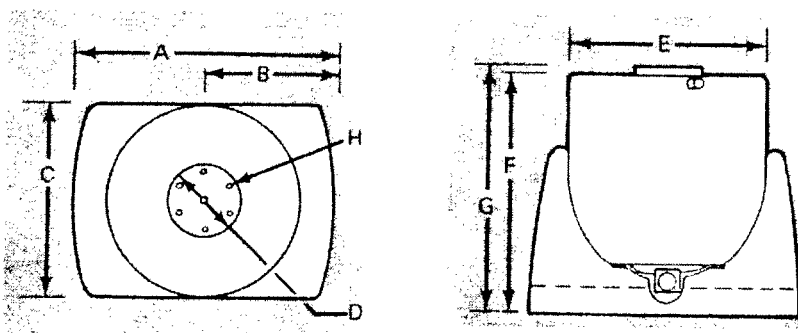
**SECTION 1: PERFORMANCE SPECIFICATIONS  
PM100 SHAKER/SS530 AMPLIFIER**

**1.1 OPERATIONAL RATINGS**

Force Output**	100 pounds Peak
Displacement	0.5 inches Double Amplitude
Velocity	70 inches/second
Acceleration	100 g's
Frequency Range	DC - 7000 Hz (useable to 20kHz)
Cooling Requirements	26 SCFM at 12 inches H <sub>2</sub> O
Rated Drive Coil Current	8 Amperes nominal
Drive Coil Resistance	2.6 Ohms
Suspension Stiffness	75 pounds/inch (approximate)
Stray Field	Less than 8 gauss, 1 inch over center

\*\* Rated output with forced air cooling derate 50% for natural convection cooling.

**1.2 MECHANICAL SPECIFICATIONS**



Dimensions (in inches):

A	B	C	D (BOLT CIRCLE)	E	F	G	H	COOLING
10.00	5.00	7.50	2.25	7.38	13.22	13.47	10-32	0.5 INCH NPT

Moving Element Diameter	2.7 inches
Moving Element Resonance	6000 Hz minimum (structural)
Surface Mounting Holes	10-32 threads
Surface Mounting Pattern	2.25 inch bolt circle
Mounting Contact Area	5.5 square inches
Weight, Moving Element	0.94 pounds typical
Weight, Exciter	80 pounds
Weight, Base	15 pounds
Base Type	2 Position rigid, Trunnion optional

1.3 UNPACKING

**NOTE:**  
If the crate has suffered extensive shipping damage notify the shipper and contact MB Dynamics.

Place the crate containing the exciter on a flat, stable surface or table, in the proper position as indicated by "THIS SIDE UP".

**NOTE:**  
THE CRATE PROVIDED WAS SPECIFICALLY DESIGNED TO PROTECT THE EXCITER, AND IF CARE IS TAKEN IN UNCRATING, IT CAN BE USED AGAIN IF YOU NEED TO SHIP THE EXCITER TO A TEST SITE OR TO FACTORY SERVICE.

1.4 CALCULATING MAXIMUM RESPONSE

The maximum attainable shaker acceleration is dependent upon total load, defined as the mass of the moving element PLUS the mass of the test article PLUS the mass of any required fixturing. This maximum acceleration may be calculated from the following equation:

$$A_{MAX} = F_R / (W_{ME} + W_{TA} + W_F)$$

Where:

- $A_{MAX}$  = Maximum allowable table acceleration, in g's peak
- $F_R$  = Rated force (in this case, 100 pounds peak)
- $W_{ME}$  = Weight of the moving element, in pounds (in this case, ~ 1)
- $W_{TA}$  = Weight of the test article, in pounds (user supplied number)
- $W_F$  = Total weight, in pounds, of fixturing and bolts (user supplied)

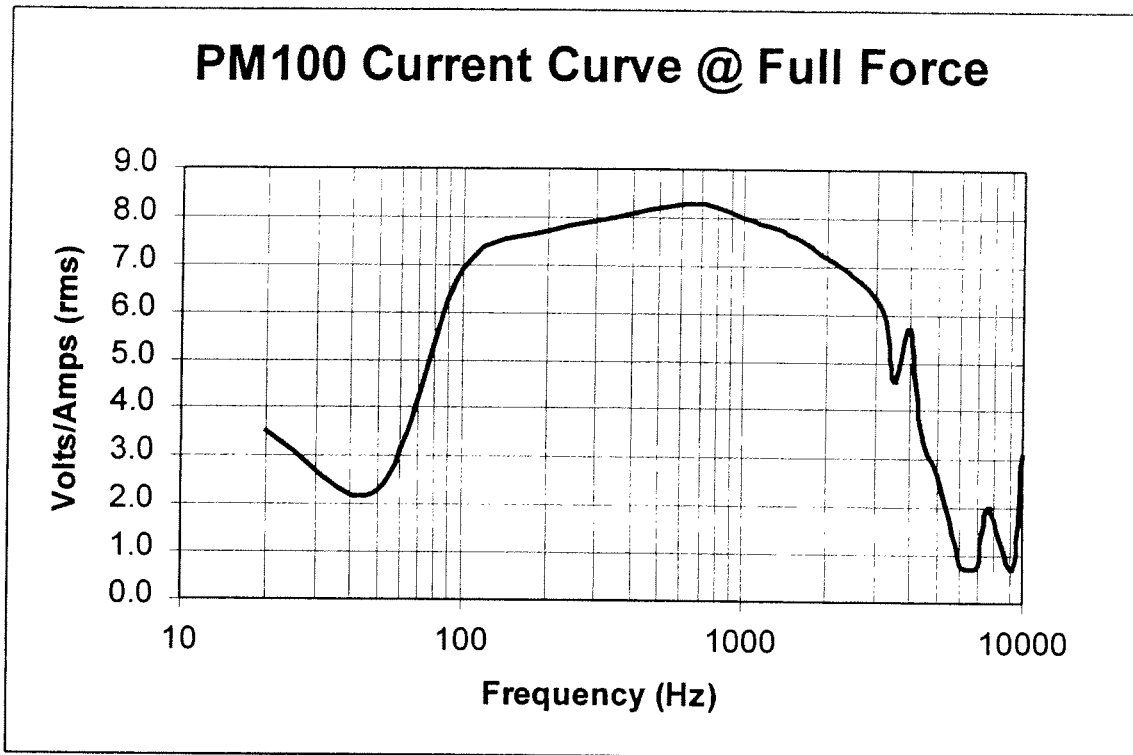
The maximum allowable table acceleration must be calculated for each different test setup. If there was no test object connected to the table ( $W_{TA} + W_F = 0$ ) the value of  $A_{MAX}$  would be at a maximum. All other calculated values will be smaller than  $A_{MAX}$  for additions of test article weight.

From the preceding equation, if we round the moving element weight to 1.0 pounds, the upper limit of  $A_{MAX}$  becomes:

$$A_{MAX} = 100 / (1 + 0 + 0) = 100g's \text{ pk}$$

This value of  $A_{MAX}$  and the value of driver coil current given previously must be taken as upper limits only. They may vary from zero to these maximum values. Never attempt to achieve either limiting value independent of the limit imposed by the other.

1.5 COIL CURRENT VERSUS FREQUENCY



1.6 OPTIONAL EQUIPMENT

Available as extra cost options with any MB PM100 are:

1.6.1 Model SL500VCF Power Amplifier (101603)

This is a 450 Watt rms output power supply matched to the performance of the PM100 when connected for LOW impedance (see Page 12). It includes output short circuit protection, thermal protection, and provides for a clean source of both voltage and current for the PM100.

1.6.2 Model SL600VCF Power Amplifier (9381006)

This is a 425 Watt rms output power supply matched to the performance of the PM100 when connected for HIGH impedance (see Page 12). It includes output short circuit protection, thermal protection, and provides for a clean source of both voltage and current for the PM100.

1.6.3 Internal Accelerometer Kit (9380286)

This option provides a low impedance voltage mode accelerometer mounted to the underside of an insert in the moving element table. The accelerometer provides an output proportional to the table surface acceleration.

## SECTION 2: INTRODUCTION

Vibration testing of small components, subassemblies, and larger structures requires an exciter that delivers:

- OPERATIONAL SIMPLICITY
- RELIABILITY
- PORTABILITY

The compact design of MB permanent magnet exciters, combined with their matched solid state amplifiers, provide the optimum solution for such testing needs. In instances where testing is intended to surface noise problems in the test article (such as automotive squeak and rattle testing) this combination is essential, in that it provides a solution where the vibration generation equipment generates extremely low output noise levels, so that the noises emitted by the test article are not "masked" by the equipment causing the motion.

### 2.1 DESIGN PRINCIPLES

Passing electric current through a wire surrounded by a magnetic field produces mechanical motion or force. Familiar applications include the electric motor, instruments, string galvanometer, and loudspeaker. The electrodynamic vibration exciter is one application of this principle.

### 2.2 PERMANENT MAGNET CONSIDERATIONS

Where high strength magnetic fields are required, permanent magnets have many inherent advantages. They produce a constant field and eliminate the need for a power source (and its associated cooling system) required to keep an electromagnet energized. This is a major factor in simplification when the device is to be portable. Also, the permanent magnet introduces no additional heat into the device since it requires no supply of external energy.

Ceramic magnets offer many advantages such as smaller size, longer effective life, lower cost, and improved performance. Ceramic magnets have a high energy product to weight ratio. They also have a very high coercive force. Incremental permeability is also lower for the ceramic magnet. This is an important consideration where external fields are encountered which would tend to cause an excessive reduction in flux.

The simplified construction of the permanent magnet exciter reduces maintenance. The body assembly of MB permanent magnet exciters, which provides the magnetic field, requires no servicing. The magnets are bonded in place and charged at the factory. No attempt should be made to separate them. No attempt to service the unit by disassembling the body structure should be attempted.

### 2.3 SUSPENSION

The suspension system consists of a set of three bonded Beryllium copper flexures. Two of the flexures are used as current carrying members for the moving element.

2.4 COOLING

The exciter system may be operated up to 50% of its rated force output using natural convection cooling. When operating above this level, forced air cooling is required.

Forced cooling may be accomplished by means of dry, oil-free shop-air. A source, capable of providing 26 SCFM of air at a pressure of 12 inches of water is required. An 0.5 inch port for air connection is provided at the bottom of the exciter. To obtain correct flow, one of the screws which attaches the bottom plate to the exciter may be removed, a pressure gage held there manually, and the air flow adjusted to obtain the required static pressure. If convenient, the pressure required to provide this flow can be measured at some other point in the supply system, and that value duplicated for later cooling air adjustment.

2.5 BASE

The rigid base supports the exciter in either horizontal or vertical orientations. If fixturing requires orientations at other angles, the optional trunnion base should be used.

### SECTION 3: EXCITER OPERATION

The force generated by an exciter is dependent upon the permanent magnetic field strength as well as the current flowing through the moving element coil. The amplitude of response depends not only on the generated force, but also on the dynamic properties of the system, including the moving element weight, its resonance characteristics, and the mechanical structural characteristics of the parts (the test article and fixturing) attached to it.

#### 3.1 MAXIMUM ACCELERATION

The PM100 exciter should not be operated at accelerations that would require developed forces in excess of the exciter's force ratings. Any weight added to the table, such as a vibration pickup, accelerometer, balance weight, wedge, screw, attaching adapter, etc., is an important factor in determining maximum acceleration. Refer to the equation in Paragraph 1.3 to determine the maximum acceleration as a function of exciter loading.

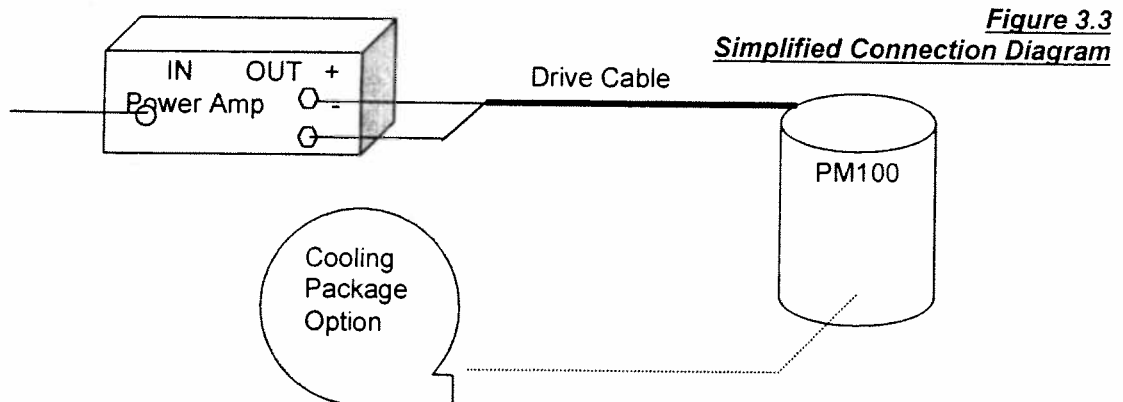
#### 3.2 COIL CONNECTIONS

While MB prefers to supply a matched Power Amplifier for driving the Model PM100, many audio amplifiers capable of supplying 500VA (continuous rating) into an 8 ohm nominal load may be capable of suitably driving the exciter. In many tests, low frequency performance is required. As a result, the amplifier should have acceptable output at these low frequencies. The Model PM100 is normally supplied with driver coil jumpers connected to match impedance with the Model SL600VCF amplifier. For operating at other impedances, consult with MB Customer Service.

The Model PM100 Exciter may be driven to full performance with an audio amplifier capable of supplying 50 volts rms at 10 amps rms. The Model SL600VCF power amplifier is designed specifically for this purpose. The Model SL600VCF may be operated from power lines ranging from 100VAC to 240VAC. It is normally supplied wired for 120VAC. If the available line voltage deviates from this voltage by more than 10%, internal jumpers should be changed to accommodate the actual AC line voltage. Refer to the instruction manual supplied with the SL600VCF for proper connections.

#### 3.3 OPERATING CONTROLS

After the amplifier has been properly setup, connect the signal source to the amplifier audio input connector, and connect the amplifier power output terminals to the exciter (as shown in Figure 3.3, Electrical Hookup). The system is now ready for use.



**Figure 3.3**  
**Simplified Connection Diagram**



The exciter is now connected to the amplifier output and the system is ready to operate. Turn the amplifier "ON". The AMPLITUDE control may be turned to a convenient level, high enough to assure that sufficient drive voltage/current can be created by the amplifier for the input signal level being routed to the amplifier input connector. If the vibration amplitude is being controlled manually, this input amplitude control can be used to adjust the vibration level at the exciter table. If the vibration amplitude is being controlled by a closed loop control system (such as an MB *Win2001* or other vibration controller) it is advisable to set the AMPLITUDE control somewhere near mid-range as a first estimate. If the controller cannot produce sufficient output voltage to drive the exciter to required vibration levels, the gain can be increased by increasing (turn clockwise) the AMPLITUDE control. If the controller exhibits difficulty in acquiring control, or if the control seems to "wander" this may indicate that the amount of signal required to force the programmed vibration level is low, and therefore the drive signal from the controller is low. If this is the case, the signal to noise ratio can be improved by decreasing (turning counter clockwise) the AMPLITUDE control.

When driving the exciter do not exceed its rated peak force. If forced air cooling is not being used, the drive level should not exceed 50% of the rated peak force (50 pounds peak or 35 pounds rms random for the PM100) for more than a few seconds.

**NOTE:**

Refer to amplifier manual for operating instructions and proper electrical hookup. Observe any precautions regarding potential ground loops between the amplifier and the signal source

3.4 MOUNTING ORIENTATION

3.4.1 Vertical Mounting

When the mounting position of the exciter is to be vertical and the exciting force is to be applied to the test structure from below, the exciter may be installed by setting its base on the floor, or on a platform or table if additional height is required. Caution should be used to assure that platforms or tables used to support the system are capable of adequately reacting the forces generated by the combined armature and test article moving mass. Isolation may be required between the base and the platform or floor if the transmitted level of vibration is too high.

3.4.2 Horizontal Mounting

As outlined above, the exciter base may be positioned on the floor or a suitable platform. The exciter body can be mounted horizontally in its rigid base. When mounted horizontally, the lateral forces generated by the exciter may cause the base to skid or rock. This can result in offsetting the armature from its center of stroke position, thereby reducing the total stroke available. Care should be taken to minimize any such motion. On tile floors, a thin sheet of rubber may increase the coefficient of friction sufficiently to restrain it. While this same method may be used on a concrete surface, in some instances (particularly when installing an array of exciters around a structure) a more permanent method of mounting may be desired.

## **SECTION 4: EXCITER MAINTENANCE**

The Model PM100 is a rugged machine requiring virtually no preventive maintenance provided that the user exercises reasonable care when handling and operating the unit. Should damage occur to the exciter body or magnet structure, the user should not attempt to effect repairs. Broken magnets or body misalignment requires special tooling available only at MB Dynamics.

Damage to the armature due to overdriving, either electrically or mechanically, may be handled by replacing the whole moving element with a spare unit or by sending the damaged element to MB Dynamics to be rebuilt. In the uncommon event that a flexure leaf in the suspension should fail, it may be replaced with a spare unit. Care must be taken if the moving element is removed to assure that the voice coil is not damaged during removal. The voice coil is comprised of small diameter wires that if inadvertently caught by any internal parts of the exciter during extraction can cause de-bonding of the coil to occur. Service is recommended to be referred to qualified personnel.

### **4.1 REMOVAL OF MOVING ELEMENT**

Remove the upper and lower covers. Each is attached to the body by three flat head screws. The top flexible seal will easily pull free, since it is not bonded to the table assembly. Remove the center stud cap that disconnects the lower flexure assembly from the table assembly.

Remove the screws clamping the upper flexures to the flexure isolators. Raise the moving element slightly. Assemble #6-32 jacking screws in the flanges of the split sleeve that is assembled between the top cover and pole segments. Jack the split sleeve halves out of the gap and remove them from the exciter. Use care to prevent excessive misalignment of the split sleeve during retraction. This might cause contact with the table and create large side loads. The moving element can now be removed from the body.

### **4.2 INSTALLATION OF MOVING ELEMENT**

The moving element is installed by reversing the procedure of Section A above. Leave the upper flexure screws loose and insert six long narrow strips of .010 nonmagnetic shim stock between the table ribs and pole segments at the top. Use three equally spaced table ribs and use one strip of the shim on each side of each rib. Insert the strips as far as possible into the exciter. Tighten the flexure screws and reassemble the bottom flexure assembly with the center stud cap. Then remove the shims. Replace the top and bottom covers making sure that the top seal edge is flush with the table surface.

#### **CAUTION:**

CARE SHOULD BE TAKEN TO PREVENT MAGNETIC CHIPS FROM ENTERING THE AIR GAP. IF SUCH CHIPS ARE FOUND ON THE PERMANENT MAGNET MATERIAL, THEY MAY BE REMOVED BY USING ADHESIVE TAPE TO LIFT THEM FROM THE MAGNET SURFACE.

4.3 RECOMMENDED SPARE PARTS

<u>DESCRIPTION</u>	<u>QUANTITY</u>	<u>MB PART NO.</u>
Moving Element Assembly	1	9380255
Flexure Assembly	1	9380272
Seal (Dome)	1	9380267
Exciter Cable Assembly	1	9356220

4.4 RETURN INSTRUCTIONS

When your unit becomes inoperative and must be repaired, to expedite repairs and to insure prompt return shipment, kindly follow the procedure outlined below.

- A. Contact MB Dynamics by phone (216/292-5850).
- B. Explain the problem and provide us with the system model and serial number. MB engineers will attempt to isolate the area of the problem. If possible, a solution may be offered over the phone. Otherwise, a service representative will provide a Return Authorization Number and instructions for shipment to MB Dynamics.
- C. Provide the following information with your shipment:
  1. Model number and serial number of the unit being returned, and (if applicable) the model and serial numbers of the parent MB product of which the unit is a sub-component.
  2. Model number and serial number of the unit being returned
  3. Symptoms observed with the unit connected to the system
  4. List any attempted repairs, including components changed or procedures followed
  5. Provide any historical data which may impact the repair
- D. Package the unit carefully in a carton or crate, using the original packing containers if available.
- E. Unit(s) must be shipped prepaid.

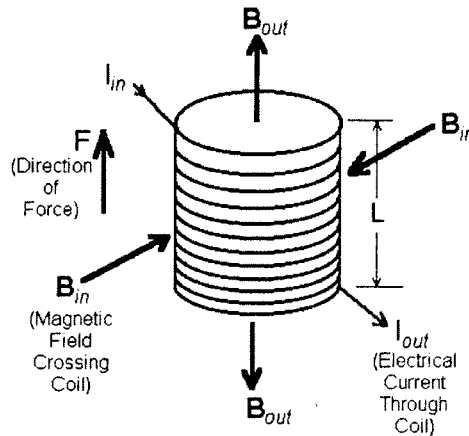
**SECTION 5: PRINCIPLES OF OPERATION**

5.1 ELECTROMECHANICAL RELATIONSHIPS

A brief review of electromechanical relationships will aid in the understanding of force generation by electrodynamic exciters. A current carrying wire or conductor exhibits a concentric magnetic field. The direction of the magnetic flux lines is said to be clockwise when the current is passing into the plane of a clock face. If this current carrying wire is placed perpendicular to a magnetic field, a force is exerted on the wire. The force acts in the direction of minimum field strength that results from the interaction of imposed flux lines and conductor flux lines. This phenomenon is characterized by Fleming's left-hand rule and is illustrated below. The force magnitude  $F$  can be expressed by:

$$F = Blni$$

where  $B$  is the flux density,  $l$  is the conductor length,  $n$  is the number of turns in the air gap, and  $I$  is the current.



**Figure 5.1  
Magnetic Structure  
and  
Electromagnetic Relationships**

If this wire is moved through the magnetic field, a voltage is generated opposing that which induced the original current. Hence the designation "counter electromotive force" or simply "back emf" is applied. Faraday's right hand rule defines the directions of motion, field, and current flow. In both Faraday's and Fleming's rules the thumb represents the direction of motion, the forefinger represents the direction of the applied magnetic field, and the center finger represents the direction of current flow. Counter emf ( $e$ ) can be expressed as:

$$e = Blnv$$

where  $B$ ,  $l$ , and  $n$  are as in the previous equation, and  $v$  is equal to the induced velocity.

5.2 ELECTRODYNAMIC EXCITER CONSTRUCTION

Electrodynamic exciters produce motion, as outlined in the last paragraph, by producing a force in the voice coil which is reacted against an intense static magnetic field. This static field cuts through the cylinder of the voice coil structure. In MB's "PM" class of vibration exciters, this magnetic field is established using permanent magnets. The fixed field effected by the magnets interacts with the variable magnetic field produced electrically by the voice coil to generate a controllable, time-varying force. The driver coil is firmly attached to the table assembly so that test articles attached to the upper table surface vibrate in the direction of the generated forces.

The table assembly, driver coil and certain other moving parts comprise the armature or moving element. The moving element and suspension must be rugged and essentially resonance-free within the wide frequency spectrum of operation. The moving element is supported in the axial direction by an elastic suspension system of rubber mounts, called "flexure blocks" or "shear mounts". The flexure assemblies are used to support loads normal to the driven axis and to constrain the moving element so that it moves only in that driven axis, minimizing motion in all cross-axes. Two of the flexure assemblies are used to route current to the voice coil leads.

5.3 VIBRATION LEVEL MEASUREMENT

Moving element motion may be monitored by vibration transducers that provide a signal proportional to either the velocity or acceleration of the moving table and mounted test article. The transducer may be located within the table structure or may be externally mounted on the test article. For non-resonant loads a table-mounted transducer can measure the acceleration level at all points throughout the test article with good precision. For resonant loads, however, the transducer output will be dependent on its proximity to nodes or anti-nodes. Laboratory personnel must determine where specimen acceleration maxima and minima occur so that proper vibration levels can be maintained at these points, without exceeding vibration exciter limits.

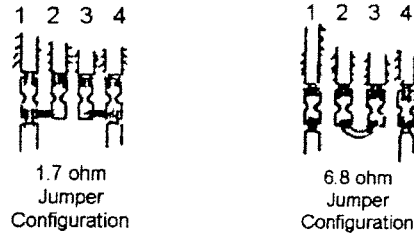
5.4 COOLING REQUIREMENTS

During exciter operation, heat is generated in the voice coil due to electrical losses. Heat can also be produced in the suspension components (flexures and mounting blocks) due to hysteresis and friction. MB's PM Series Vibration Generators are capable of adequately cooling the voice coil with naturally convected air provided the force produced is less than one half (1/2) of the full rated force for the vibration exciter. For test conditions requiring more than one half of the full rated force, forced air cooling is required. In the PM Series, cooling may be effected by connecting either a blower or a source of dry compressed air. Permanent magnet exciters should be derated to 50% of their specified maximum force output if no source of cooling air is supplied to the exciter body. See Paragraphs 1.1 and 2.4 for cooling specifications.

5.5 MOVING ELEMENT WIRING

For moving element assemblies (MB Part No. 9380255) manufactured after April 1, 1988, the impedance of the coil assembly may be changed to accommodate power amplifier output characteristics. Figure 5.5.1 shows the Coil Jumper Locations for these elements.

Note that the 6.8 ohm connection is compatible with the amplifier's having a relatively high voltage output (e.g., MB Model SL600VCF), while the 1.7 ohm connection is suited to amplifiers having a high current output (e.g., MB Model SL500VCF).



**Figure 5.5.1**  
**Coil Jumper Locations**

## SECTION 6: DESIGN GOALS AND CONSIDERATIONS

### 6.1. DISPLACEMENT

The PM100 is limited to a maximum double amplitude stroke of one inch. Double amplitude includes stroke in both directions from the zero-reference starting position. By example, 1 inch "double amplitude" is the common method to describe a stroke of + and - 0.5 inches from the center stroke location. This stroke limit has been found to be acceptable for a most test requirements. When using the PM100 (or any flexure-based electrodynamic shaker) at or near its stroke limit, it is common for the distortion on the output acceleration waveform to become distorted. This is due primarily to the non-linear nature of the "springs" which form the linear motion constraint system for the unit. The PM100 does not incorporate electrical protection against overtravel. As such, the user is cautioned to be watchful for conditions that would cause the PM100 moving element to "hit" its stroke limiting cushions. Although the unit has rubber bumpers at the extremes of the stroke of the moving element, repeated or excessively large impacts can cause the voice coil to debond, forcing the exciter to be repaired.

### 6.2 VELOCITY

The PM100 is limited to an absolute maximum velocity of 70 inches per second peak. When used in conjunction with an MB SS530 Power Amplifier, the unit is limited to 55 inches per second peak. This limit is caused in part by the power amplifier, which has a fixed voltage output. As detailed in Paragraph 5.1 above, the velocity produced at the exciter output is proportional to the voltage applied to the voice coil. Higher velocities require higher voltages. Another limitation on higher velocities is the heat developed within the flexure mounts and other suspension parts due to hysteresis or dynamic loss effects.

### 6.3 ACCELERATION

Maximum acceleration, A, is determined from the relation:

$$A = F/W$$

Where F is the maximum available force and W is the total moving weight of the Moving Element assembly, including all items attached! The user is cautioned to remember that F=100 pounds **ONLY WHEN FORCED AIR COOLING IS APPLIED!** If no forced air cooling is used, the total force available must be limited to 50 pounds! See Paragraph 1.4 above for calculating the maximum response.

### 6.4 FORCE

The design goal, and the limiting force of the PM100 is 100 pounds peak when cooled by forced air, and 50 pounds peak when no forced air cooling is applied. If forces greater than these levels are required, multiple exciters may be used to drive a single payload by connecting the exciters "in parallel" to the test payload. Contact MB Customer Service for assistance in such testing applications.

## 6.5 FREQUENCY

While the PM100 can be driven to any frequency within the "useable frequency range" defined in Paragraph 1.1, the actual useable frequency range is determined by the combined exciter-amplifier system characteristics. Due to stroke limitations, the low frequency limit is usually 5 Hz. However, when using an MB supplied SS530, operation at DC possible. This permits the amplifier to be used to offset heavy payloads (within reason) so that the moving element can be placed at the center of the stroke extremes. The "limits" referred to are related to keeping the total force output below maximum limits, both for non-forced-air cooled and forced-air cooled conditions. The upper frequency limit depends directly upon the power available for driving the exciter to useful levels above the moving element axial resonance.

## 6.6 MECHANICAL RESONANCES

Exciter output is optimized if disturbing resonances are absent from the operating range. Mechanical resonances can cause unnecessarily high drive currents if they exist near the exciter's maximum power point. Furthermore, waveform distortion occurs when a resonance is excited by a harmonic of the desired signal. Great care is taken in exciter design and construction to eliminate from the useable bandwidth any resonances in the moving element assembly, including the table, driver coil, leads, and suspension.

Axial resonance of the moving element is usually defined as the lowest frequency at which the phase difference between driver coil current and table top acceleration is equal to 90 degrees. At this frequency, current minimum coincides with acceleration maximum. This normally occurs at frequencies much higher than the resonance of the armature suspension system. Axial resonance is designed to occur at as high a frequency as practical and yet be within the full force operating range. This is desirable because the mechanical magnification of the input signal results in lower power requirements during wide band noise operation. For the PM 100, this frequency is usually somewhere between 7000 and 8000 Hz.

A resonance which can directly affect the specimen is diaphragming - a condition in which the vibration level is not uniform or, perhaps, not in phase along the mounting surface. The diaphragming frequency can be designed to occur sufficiently above the axial resonance to be insignificant in most testing applications.

## 6.7 DISTORTION

While, in general, the exciter will produce a force exactly proportional to the input current, output distortion may occur at low frequencies where large table excursions can subject the driver coil to variable flux levels and the suspension non-linearities. Distortion can be increased by high drive levels out of the power amplifier, requiring current or voltage near the limits of the amplifier. This usually involves harmonics of the fundamental frequency, which in turn will be amplified by exciter resonances. The user is cautioned to assure that tests are conducted at levels below maxima for both the exciter and for the connected power amplifier.



6.8 CROSS AXIS RESPONSE

Exciter performance specifications demand unidirectional motion along the exciter's principal axis. Acceleration normal to the principal axis is referred to as cross-axis motion. A typical specification is "less than 10% cross-axis motion from 20 to 2,000 Hz". Below 20 Hz the principal acceleration signal is generally so small that the cross-axis measurements are masked by instrumentation noise. Above 2,000 Hz, cross-axis response tends to climb steeply as various structural elements, which are stiff at lower frequencies, become resonant. Furthermore, displacement amplitude varies inversely as the square of frequency. At 2,000 Hz and 50 g, for example, the double amplitude stroke is 250 micro-inches. Very small lateral forces can now introduce deflections equivalent to the stroke even with the stiffest practical lateral restraints. Therefore, at high frequencies the suspension contributes very little to cross-axis motion reduction from a constraint point of view. At these frequencies low cross-axis motion is more a matter of careful moving element balance and lack of unsymmetrical resonances. It must be pointed out that low cross-axis motion with an unloaded table does not guarantee a similar value with the table loaded because test package resonances or unbalances can predominate. Low values of cross-axis motion with a resonant test package have been attained by placing the specimen on a large non-resonant and well-balanced mass and by locating the drive point at the center of gravity of the combined specimen-fixtured mass. Adequate lateral constraint is necessary to support the combined moving masses along the exciter's drive axis.

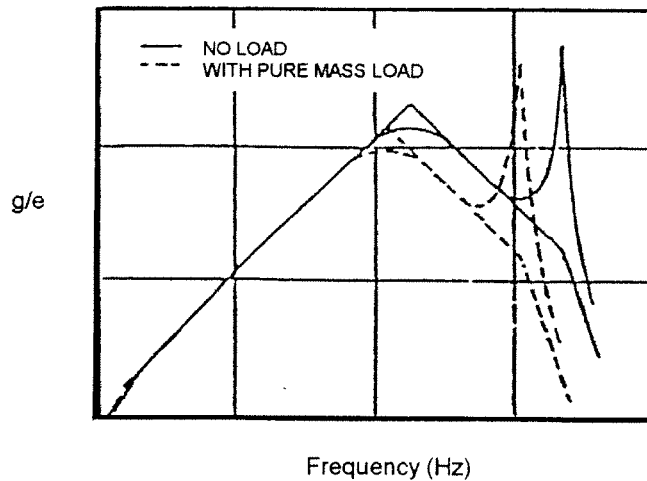
6.9 STRAY FLUX

A magnetic field exists outside all exciter bodies. Flux in the vicinity of the test article mounting surface may be undesirable if it reacts in any way with the test specimen. On exciters with the mounting surface close to the air gap, the problem is usually greatest. Avoiding the use of magnetic materials in the mounting surface vicinity has made reductions in stray flux levels.

**SECTION 7: EXCITER PERFORMANCE CHARACTERISTICS**

**7.1 NON-RESONANT LOAD**

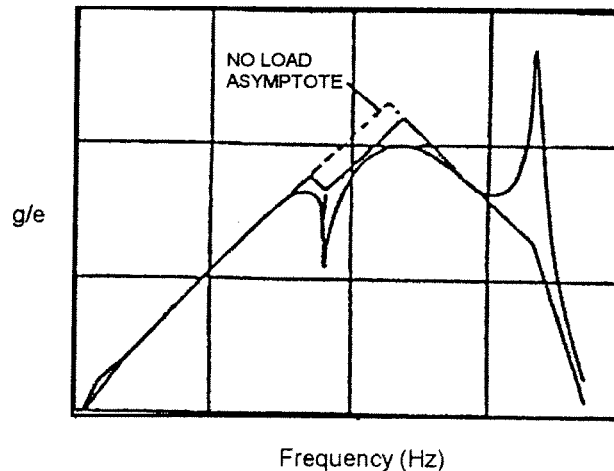
The response of an electrodynamic exciter is usually expressed graphically as the log of output acceleration divided by the drive voltage versus the log of the frequency. This produces a graph that displays the output acceleration level for constant voltage input at each frequency. A typical graph is shown in Figure 7.1 for an electrodynamic vibrator without load and with a non-resonant load.



**Figure 7.1**

**7.2 LOAD RESONANCE BELOW ELECTRICAL RESONANCE**

The response of an exciter with a load that has a major resonance below its electrical resonance is shown in Figure 7.2.



**Figure 7.2**

7.3 LOAD RESONANCE BETWEEN ELECTRICAL AND AXIAL RESONANCES

Figure 7.3 shows the response of the exciter when the major load resonance is between the electrical and axial resonances.

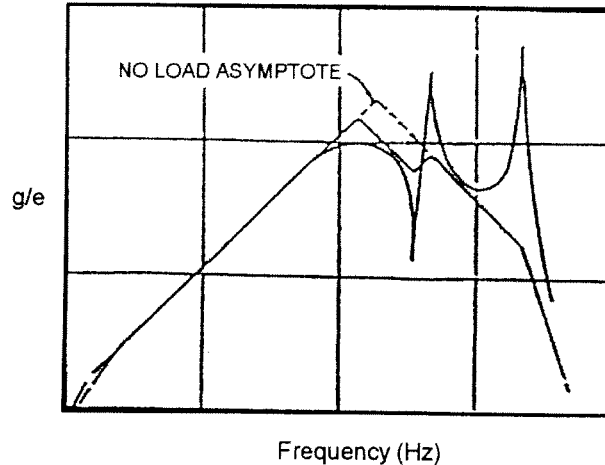


Figure 7.3

If the exciter is to be useful for wide band random vibration simulation, a flat response curve is required. Compensation for exciter and load characteristics must be made in order to attain the flat or "equalized" response. The correction consists of voltage adjustments over contiguous small frequency bands.

7.4 OPERATION WITH HEAVY LOADS

Low moving element weight is desirable in order to maximize the ability to move higher test load weights. The stiffness or spring constant of the moving element suspension system, however, directly regulates test load weight for a given exciter. As the suspension system must have a certain amount of compliance or "give" to be effective, all test loads mounted on exciters limit the maximum displacement capability to some extent. When the displacement capability is undesirably limited, external auxiliary suspension methods must be employed.

For example, since the suspension axial stiffness is 75 pounds per inch, a test load of 10 pounds would deflect the moving element assembly 10/75 or 0.133 inches. Since the exciter's rated stroke is 0.5 inches double amplitude, this would leave 0.25 - 0.133 or 0.116 inches of available DOWN stroke, due exclusively to the weight of the test article and fixturing. A total payload of 18.75 pounds would cause ALL available DOWN stroke to be consumed! Under such conditions, external load support may be required. Within limits, DC centering from an MB supplied power amplifier can be employed. MB recommends that no more than 10% of the total force capability of the shaker be "offset" using such DC currents. For the PM 100, this would mean < 10 pounds of payload offset.

**SECTION 8: COMBINED ENVIRONMENTAL OPERATION**

A partial list of the environments supported by the PM100, and the exciter modifications required to support these environments, is listed below:

<b>ENVIRONMENT</b>	<b>MODIFICATIONS</b>
<b>High Temperature</b>	Auxiliary cooling Special paint Heat Shields Special cable/insulation
<b>High Altitude</b>	External Load Support Special Insulation
<b>Radiation</b>	Shielding Special Materials
<b>High Humidity</b>	Special paint Special sealing Water separators

When used in conjunction with an environmental test chamber, most of these special requirements are eliminated if the exciter is placed outside the chamber. This so-called "piggy-back" arrangement results in lower chamber and exciter costs. The disadvantage, however, is the loss of close coupling of exciter and test article.

An interesting application of a combined environment is the exciter mounted on a centrifuge for simulation of combined vibration and sustained acceleration. In this case, provision for table recentering is required if the load is to be vibrated in line with the sustained acceleration. If the sustained acceleration is perpendicular to the exciter axis, auxiliary table or load support may be necessary.

### **WARRANTY**

All items that MB manufactures are warranted to be free from defects in material and in workmanship and to conform to the specifications, if any, listed within the quotation. The warranty period is one year from the date of original delivery. We must receive notice of defect within the above stated warranty period. The customer must pay packing and transportation costs to and from our factory. Our liability is limited to servicing or adjusting any item returned to the factory for that purpose, including replacing any defective parts therein. On-site warranty service is available. However, the customer must pay for all travel and out-of-pocket expenses incurred during such service. If a fault has been caused by improper installation by the customer or alterations to the installation not approved by the Company or by use or by abnormal conditions of operation, parts and labor to repair the equipment will be billed at current service rates.

If any fault develops, the following steps should be taken:

- A. Notify MB by giving the item model number, serial number, and details of the difficulty. On receipt of this information, you will be given service data or shipping instructions.
- B. On receipt of shipping instructions, forward the item prepaid. If the item or the fault is not covered by warranty, an estimate of charges will be furnished before work begins.

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