System Manual

L0315M-PAS103 Vibration Test System

Revision 004

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ISSUE HISTORY

System Manual, L0315M-PAS103 Vibration Testing System

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Amendments

Date	Revision	Sections Affected	Brief Details	ECN
01/04/2015	r001	Chapter 1 & 6	Power Requirement, Drawings updated	
04/01/2016	r002	Chapter 1 & 6	Minor update and drawing updates	
09/11/2018	r003	Chapter 6	Minor Corrections	
06/19/2019	r004	Chapter 1 – 6		

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HEALTH AND SAFETY NOTICES

Glossary

For the purpose of this manual:

Danger Zone A zone within 2 meters away from any system component.

Note: Noise levels may still be dangerously high.

Operator Position Vibration controller operating location.

Operator Any person performing the installation, operation, and maintenance of the system.

Payload Any parts and assemblies (including the fixtures) that are directly mounted on the armature during a vertical operation or parts and assemblies that are directly mounted on the slip plate if the slip table is used.

SELV separate extra low voltage

RISKS & HAZARDS

It is important to be aware about the potential risks and hazards during installation, operation, and maintenance of the vibration test system.

Noise

High-level of noise can be hazardous to the human body. Vibration systems can generate significant noise levels during operation and therefore should be placed within a sound dampened room. The operator position, and the vibration controller, signer generators, and other monitoring equipment should be located outside this soundproofed zone. Significant noise can also be generated from the power amplifier and the blower unit. These two system components should be placed away from the operator position. If the ideal setup is impractical, all personnel should be aware of the hazards before operating the system and appropriate safety equipment, including ear protection should be worn.

Mechanical

Destruction of the payloads may occur at any point during a vibration test, and the input force can be amplified considerably by local resonance. All operators should be made aware of this potential hazard and extra caution must be taken to prevent any injury to personnel.

Payloads should not exceed the maximum static payload limit of the shaker. In addition, the shaker maximum displacement, acceleration, and eccentric moment should also be considered when designing and mounting the payloads.

Care must be taken around payloads with sharp edges or pinch points where fingers may become trapped.

Any person who enters the danger zone, whether the shaker is energized or not, should be aware of the risks and should wear appropriate eye protection. Other risks that are associated with installation, operation, and maintenance of the vibration test system are described in relevant sections of this manual.

Electrical

All system equipment has areas that contain voltages above SELV and can cause severe human injury. Operators should not access these high-voltage

areas during normal operation. These high-voltage areas are enclosed within the equipment bodies and can only be accessed by removing the protective panels or covers.

With the exception of calibration or fault diagnosis by qualified personnel, equipment should be completely isolated from the supply voltage source before gaining access. The isolation point should be locked out and tagged for the duration of the work to prevent mistaken re-energization. Residual hazardous voltages may be present immediately after isolation.

Pneumatic

Some shakers rely on a compressed air supply for armature and body support. Due care and attention must be given when fixing loads to the armature and when setting armature and body positions.

The air supply should have a shut-off valve adjacent to the shaker for use in emergencies or when the vibration test system is not being used. When the air supply is shut off, all payload mass should be supported by other means such as armature lock-out plates or overhead crane.

Hydraulic

Some shakers and all combos use Shell Tellus 68 oil or equivalent. While this oil does not pose a direct health and safety hazard, care should be taken to clean up any spills which may occur during filling, draining or operating the system. It is also recommended that any oil making skin contract is washed off as soon as possible.

Water

Some shakers are water-cooled with the cooling system self-contained within the shaker assembly. Although water will not be released during normal operation of the system, leakage can occur, and operators should be made aware of the temperatures this water can attain.

Temperature

The vibration test system generates considerable heat during operation. Measures should be taken to ensure the temperature of the working environment is within allowable limits. Operators should also be made aware that some equipment, particularly water-cooled shakers, can attain high surface temperature during normal operation.

Blower Outlet

The air outlet port from a blower unit in an air-cooled shaker should be positioned such that an operator cannot stand directly in line with the airflow. Proper setup of the blower unit will prevent personnel injury in the event of small detached parts getting ejected at high speed from the blower.

Cables and Hoses

Where practical, all cables and hoses used in the vibration test system should be placed in ducts or floor cable troughs to give clear unimpeded access to the shaker, power amplifier, cooling unit and other ancillary equipment.

Chemicals

The hazards of chemicals/cleaning agents are dependent not only upon the toxicity of materials but also upon the degree and nature of exposure. Users should adopt procedures conforming to the requirements of the European Directive 90/394/EEC.

IMPORTANT NOTE: In special cases where shaker rolling seals are required to have resistance to fuel oil the standard white SILICON shaker seal may be

replaced by a black VITON seal. In the event of a fire, anyone handling residues of VITON must wear Neoprene protective gloves to avoid skin contact with possibly highly corrosive residues which are likely to include hydrogen fluoride. DISCARD GLOVES AFTER USE.

Magnetic fields

DC and low-frequency magnetic fields can be produced during the operation of the vibration test system. While current medical research is inconclusive as to the effect of low-frequency electromagnetic fields on the human body, Sentek Dynamics recommends that personnel, particularly those with medical implants, do not enter the danger zone while the shaker is running.

Sentek Dynamics cannot accept responsibility for any effects on health due to electromagnetic fields but strongly advises that all precautions as defined in this notice and product manuals are followed.

Using Third-Party Equipment

If using equipment produced by other manufactures in conjunction with this vibration test system, read all pertinent user manuals and follow all precautions set forth by these manufacturers.

INSTALLATION

Line of Sight

The danger zone should be visible from the control position so the operator can ensure the area is clear before running a test. For vibration systems in which there is no direct line of sight or video monitoring system link between the operator position and the shaker, it is recommended that an audible warning device is fitted at the shaker location to give notice of impending operation. This will give personnel in the danger zone opportunity to vacate the area, or actuate the emergency stop to abort shaker operation.

Emergency Stop

For most vibration test systems, the shaker is fitted with one or more locking emergency stop pushbuttons and includes the facility for additional emergency stop pushbuttons at other locations. It is recommended that on large systems (especially with the shaker in horizontal mode) and with combos, additional emergency stop(s) are located adjacent to the payload position, in easy reach of an operator working in that area. If an emergency arises, the emergency stop should be activated immediately.

Before-use Checks

Before operating any vibration test system, check that:

- The vibration test area is clear of unnecessary obstructions.
- All terminal covers are correctly fitted.
- All equipment doors are correctly closed and secure.
- The supply of the cooling medium (air or water) is sufficient.
- The hydraulic oil supply (if applicable) is adequate.
- The item under test is correctly secured to the shaker or slip table.
- All personnel are clear of the danger zone.

TRAINING

Vibration test systems encompass a wide variety of technological disciplines and it is essential that personnel are properly qualified and trained before being authorized to work on such a system. Access to areas where vibration test

systems are located should be restricted to authorized personnel. Sentek Dynamics offers short training courses providing a practical introduction for technicians/engineers new to vibration testing.

MAINTENANCE

A program of planned maintenance, carried out by fully trained and qualified personnel, is essential to maintain the safety of the equipment. Safety interlocks must be frequently checked for correct operation. Under no circumstances should protective grounding conductors be left disconnected; they should be frequently checked to ensure good earth bonding of all equipment. Frequent checks on armature and field coils insulation should be carried out in accordance with the detailed shaker maintenance section of this manual.

CUSTOMER RESPONSIBLITIES

When planning, installing and operating a vibration system the customer is responsible for the following:

1. Off-loading, unpacking and moving the equipment to its designated position.
2. Ensuring that the floor surface where the equipment is to be located is suitable for the equipment.
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6. Ensuring that the floor surface where the equipment is to be located is suitable for the equipment.
7. Ensuring that access to the equipment is adequate.
8. Providing all service requirements such as water and pneumatic supplies, electrical power, etc. to the point of entry to the equipment and ensuring that such supplies conform to the required specifications.
9. Supplying all test equipment necessary to complete acceptance testing.
10. Making available consumable materials such as distilled water, oil, cleaning material, etc.
11. Procuring any special tools required for commissioning the system such as lifting equipment.
12. Completion of the pre-installation check list prior to commencement of installation.
13. To validate warranty, return the signed DELIVERY AND ACCEPTANCE FORM to Sentek Dynamics on completion of installation or commissioning.
14. PAYLOADS AND THEIR EFFECT ON THE SHAKER ARE THE RESPONSIBILITY OF THE CUSTOMER.

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CONFORMITY

This equipment has been designed specifically for vibration testing and should not be used for any other purpose except by agreement with Sentek Dynamics.

This equipment complies where applicable with the following European Union (EU) directives:

For installation, use and maintenance of this equipment the responsibilities of employer and employee are specified in EU Work Equipment Directive 89/655/EEC which refers to suitability of work equipment, maintenance, specific risks, information & instructions and training. The directive is implemented in the United Kingdom by statutory regulations ‘Provision and Use of Work Equipment Regulations 1992’ and by similar regulations in other EU countries.

Sentek Dynamics' product design provides personal protection in accordance with the applicable directives listed above, and care has been taken to minimize the risks associated with all equipment constituting a vibration test system. Since however the shaker and other equipment contains moving parts and can exert large force on jigs, fixtures and payloads, the area surrounding such equipment should be declared a Danger Zone (see Definitions) and suitable precautions taken by operators working there.

SENTEK DYNAMICS DOES NOT ACCEPT REPONSIBILITY FOR RISKS INTRODUCED BY JIGS, FIXTURES AND PAYLOADS.

FOR JIGS AND FIXTURES DESIGNED BY SENTEK DYNAMICS SEE THE APROPRIATE MANUAL.

This equipment as supplied by Sentek Dynamics meets the essential requirements of all applicable EU directives. To maintain compliance the equipment must be maintained and serviced by personnel certified by Sentek Dynamics as having successfully completed a Sentek Dynamics approved training course relating to the equipment. Only parts and components supplied or approved by Sentek Dynamics shall be used in the maintenance and servicing of the equipment.

CHAPTER 1 SPECIFICATIONS

This chapter covers the specification of the L0315M-PAS103 electrodynamic vibration test system. The system consists of three main components:

- L0315M vibration shaker
- PAS103 power amplifier
- BU-1 blower unit

This chapter covers the following sections

- Specification for L0315M shaker
- Specification for PAS103 power amplifier
- Environmental specification for shaker and amplifier
- Details of labels attached to the equipment

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1 L0315M Shaker

1.1 Specifications

Rated Sine Force (Note 1)	3 kN (660 lbf)
Random Force, rms (Note 2)	3 kN (660 lbf)
Half-Sine Shock Force (Note3)	6 kN (1320 lbf)
Velocity, Sine, Peak	2.0 m/s (79 in/s)
Acceleration, Sine, Peak	980 m/s^2 (100 g)
Acceleration, Random, rms	980 m/s^2 (100 g)
First Resonant Frequency (bare table)	3000 Hz (±5%)
Useable Frequency Range	5 ~ 4500 Hz
Armature Diameter	150 mm (5.9in)
Effective Armature Mass	3 kg (6.6 lbs)
Stray Magnetic Field	< 1 mT (10 gauss)
Cross-Axial Allowable Eccentric Moment	196 N-m (144.6 ft-lbs)

Notes:

1 *The force and velocity ratings are given when the L0315M system is driven by the PAS103 power amplifier.*

2 *Random force is measured with a test load having approximately twice the mass of the armature.*

3 *Actual shock force may vary depending on payload, pulse width and the actual power input.*

Displacement	
Continuous pk-pk	40 mm (1.6 in)
Shock	40 mm (1.6 in)
Body Suspension Resonance	3.5 Hz
Shaker Body Mass	370 kg (814 lb)
Max Static Payload	120 kg (264 lb)
Field and Degauss Coils Power Requirement (DC)	
Maximum Current (cold)	8.5 ADC
Nominal Current (hot)	8 ADC
Nominal Voltage	270 VDC

1.2 Controls

- Manual adjustment of trunnion air-spring pressure
- Visual indication of mid-position for armature surface alignment
- Manual adjustment of internal load support

1.3 Compatibility with Environmental Chamber

The shaker is suitable for use with standard environmental chambers. Accessories for thermal insulation and chamber floor support are also available as options. Adding any environmental chamber and accessories will not block the access to any main control units.

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2 PAS103 Amplifier

2.1 Performance

Model Number	PA103 Power Amplifier
Cooling	Air-Cooled
Input Sensitivity	3.0 V_{rms} for 100 V_{rms} output
Rated Output Voltage	100 VAC
Rated Output Current	32 A_{rms}
Rated Output Power	3 kVA
Field Power Supply Voltage	270 VDC
System Required Power	5 kVA
Frequency Response	± 1dB, DC ~ 3000 Hz
Input Impedance	> 10 kΩ
Signal to Noise Ratio	80 dB
Efficiency	> 90%
Module Efficiency	> 96%
Output Offset Voltage	± 100 mV, 5 ~ 40℃ (41 ~ 104℉)
Total Harmonic Distortion	See Table 1
Switching Frequency	100 kHz
Modulation Range	DC ~ 10 kHz
Continuous Output Current	50 A_{rms} (sine and random) per 5 kVA increment
Transient Output Current	150 A per 5 kVA increment for 100 ms
Full Power Bandwidth	20 ~ 5000 Hz
Power Factor	0.96

Table 1 Amplifier Total Harmonic Distortion		
Output Voltage	DC ~ 500 Hz	500 ~ 5000 Hz
100 V	0.5%	0.8%
10 V	1.0%	1.0%

2.2 Features

Local Controls

- Mains switch
- Amplifier ON and OFF buttons
- Emergency stop button
- Master gain control
- LCD display providing indication of output voltage, output current and system/interlock status

Interlocks

See Chapter 4, Section 4 “Interlocks" for detailed description of the safety interlocks.

External Interfaces

- Dual circuit external emergency stop
- Two external interlocks

Automatic Control Facilities

- AAC-1 automatic centering device
- Blower unit ON and OFF
- “Line” signal
- “Cooling” signal
- “Operate” signal
- “Trip” signal

Safety

Certified to meet requirements for EMC and safety as follows:

EMC Directive 2004/108/EC:

- EN 61000-6-2:2005/AC:2005
- EN 61000-6-4:2007/A1:2011

Low Voltage Directive 2006/95/EC:

- EN 60204-1:2006+A1:2009

Machinery Directive 2006/42/EC

- EN ISO 12100:2010

2.3 System Data

Table 2 Amplifier Maximum Output		
Sinusoidal Output Current A_{rms}	Peak Current (Random) A	Maximum Output into Reactive Load kVA
30	90	3

Table 3 Amplifier Environmental Data		
Heat Rejected to Air W (btu/hour)	Max Acoustic Noise dB	Weight kg (lb)
150 (512)	70	200 (440)

3 Environmental

3.1 Notes

1. The customer is responsible for: mains supply, input cables to power disconnect, power disconnect slow-blow fuse, grounding cables, necessary cable conduit, air-conditioning, ventilation, soundproofing, and pneumatic supply with water trap.
2. For detail grounding requirements see Appendix A “Grounding, Supply and Cabling”, Section 1. The shaker is grounded via the armature drive cable.
3. Shaker dimensions and weight may vary according to options fitted.
4. Compressed air-supply should conform to ISO 8573-1: class 1.7.1, with maximum particle size of 0.01 microns and remaining oil content of 0.01 ppm.

3.2 Shaker and Blower Unit

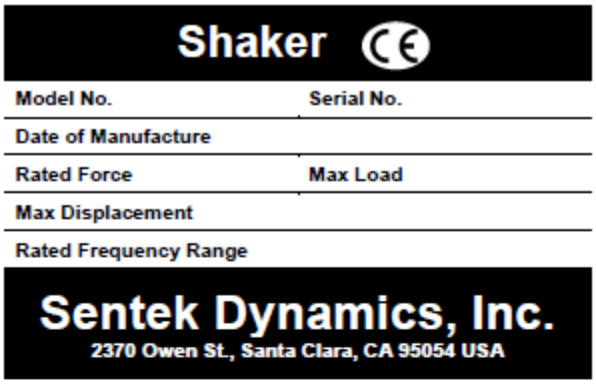
Environmental Working Ambient Temperature	5 ~ 30 ˚C (41 ~ 86 ˚F)	
Working Ambient Pressure Relative Humidity (Non-Condensing)	0.9 ~ 1.1 atm (13.2 ~ 16.2 psi) 0 ~ 90%	
Maximum Acoustic Noise	70 dB at 5 meters	
Pneumatic Supply	0.6 ~ 0.8 MPa (90 ~ 110 psi)	
Blower		
Air-Flow Rate	4 m^3/min (2.35 ft^3/s)	
Weights and Dimensions	Shaker	Blower
Weight	370 kg (704 lb)	26 kg (57.32 lb)
Height	630 mm (24.82 in)	370 mm (14.58 in)
Width	720 mm (28.35 in)	430 mm (16.94 in)
Depth	530 mm (20.88 in)	450 mm (17.73 in)

3.3 Amplifier

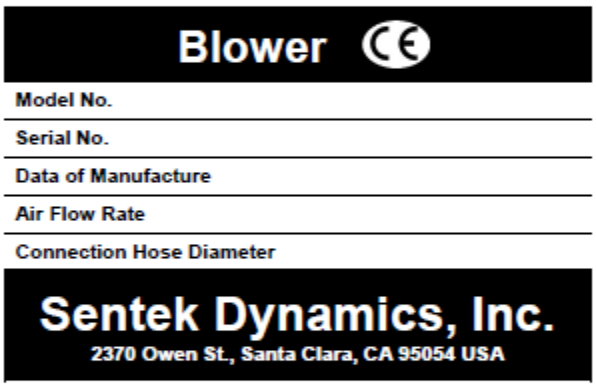
Electrical supply	
Voltage 3-Phase- Standard	380 VAC, 50 Hz Or 480 VAC, 60 Hz
Line Current	See Appendix A, Section 2
Earth Cable Size (see Note 3)	< 10 Ω, 6 mm^2 (.0093 in^2) min
Environmental	
Working Ambient Temperature	5 ~ 30 ˚C (41 ~ 86 ˚F)
Working Ambient Pressure	0.9 ~ 1.11 bar (13.2 ~ 16.2 psi)
Relative Humidity (Non-Condensing)	0 ~ 90%
Weight and Dimensions	
Weight	See Table 3
Height	1550 mm (61.0 in)
Width	580 mm (22.8 in)
Depth	850 mm (33.5 in)

4 Labeling

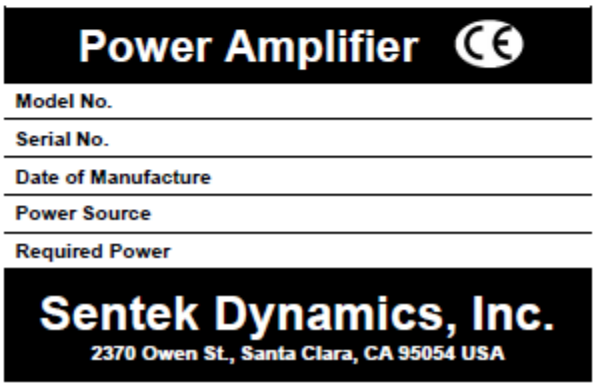
4.1 Nameplates



a) Shaker – Model No.; Serial No.; Date of Manufacture; Rated Force; Max Load; Max Displacement; Rated Frequency Range



b) Blower – Model No.; Serial No.; Date of Manufacture; Air Flow Rate; Connection Hose Diameter



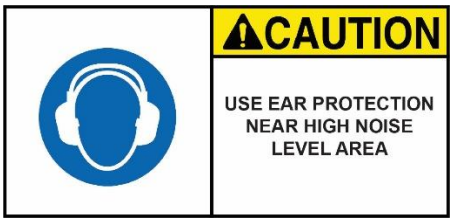
a) Power Amplifier – Model No.; Serial No.; Date of Manufacture; Power Source; Required Power

4.2 Shaker Warning Labels

a) Warning – danger zone; no unauthorized personnel allowed within 2 meters of this equipment

b) Warning – high voltage; turn power off before servicing

c) Warning – refer to the manual before rotating the shaker



d) Caution – use ear protection near high noise level area

e) Caution – high level of vibration when operating; keep safe distance

f) Warning – high temperature; do not touch to avoid injury

g) Warning – highly magnetic; do not place metal objects nearby

h) Warning – high radio frequency radiation; do not remove cover; other equipment may malfunction

4.3 Amplifier Warning Labels

a) Danger – hazardous voltage/current; contact may cause electric shock or burn; turn off and lock out system power before servicing.

b) Warning – unit can overturn during transportation; secure unit for transportation

c) Warning – rotating fan; keep hands clear

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CHAPTER 2 DESCRIPTIONS

This chapter describes the main components of the L0315M-PAS103 electrodynamic vibration test system.

Chapter 2 is divided into following sections:

- L0315M Vibration Shaker System
- PAS103 Switching Amplifier

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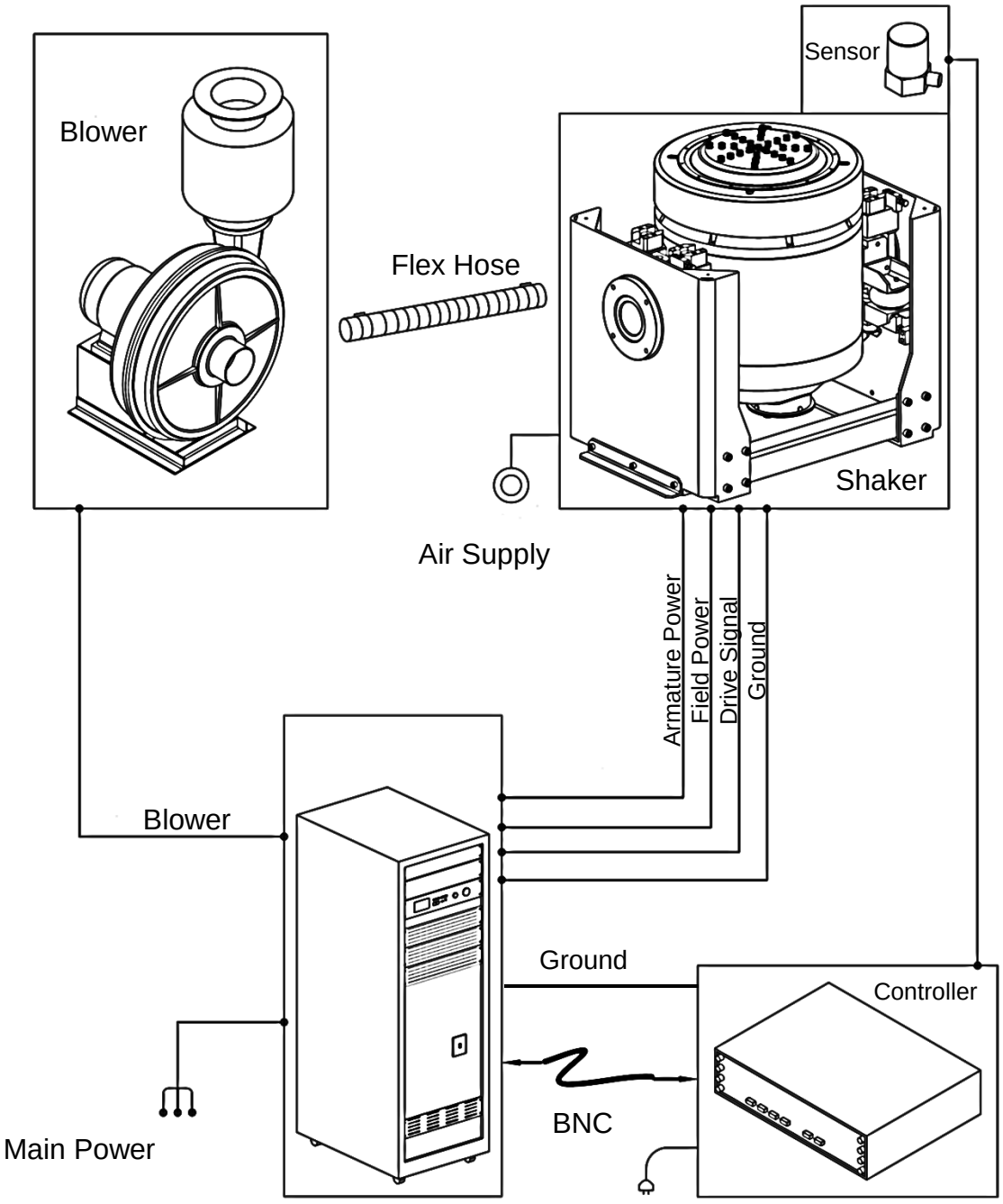

Figure 2.1 General System Setup Chart

1 L0315M Shaker

1.1 Features and Options

The L0315M is a digitally controlled vibration shaker which is able to produce vibration over a wide range of frequencies. A complete vibration test system includes a shaker, an amplifier, a blower unit, and a system controller.

The standard features of this shaker include:

- Raised (hexagonal) or flush payload securing inserts
- Adjustable internal load support
- Trunnion vibration isolation
- Vertical axial guidance system

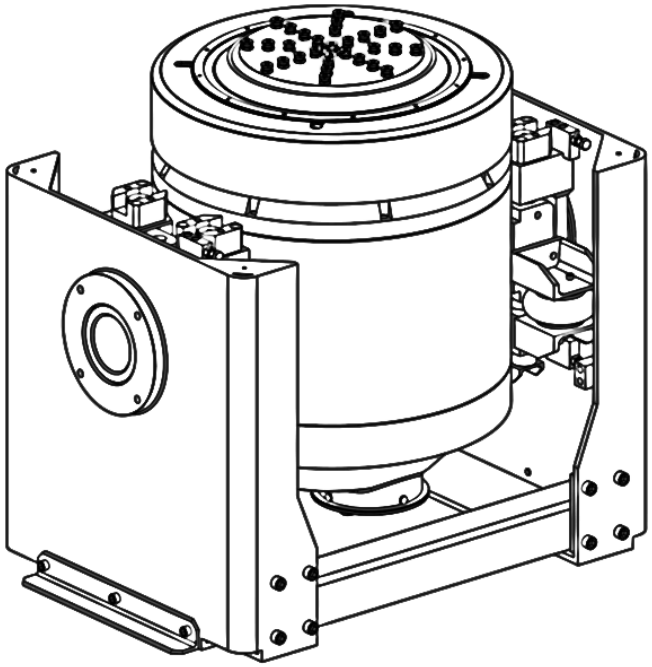

Figure 2.2 Typical Shaker Assemblies

The following options are available:

- Air-Isolation Feet
- Air-Isolation Pads
- Remote Control Panel
- Head Expander
- Maintenance Toolkit

1.2 Power and Electric Input

All electrical inputs for the vibration shaker and the blower are provided by the system amplifier. The electrical inputs for the shaker and the blower include:

- DC field-coil power
- AC blower power
- Armature drive signal
- Safety interlock circuitry

The complete vibration test system also includes a signal source/controller (such as a Crystal Instruments Vibration Controller). The amplifier is driven by the drive signal generated from the signal source/controller.

1.3 Principle of Operation

The operating principle of an electrodynamic shaker is based on the same theory for the audio speakers. When electrical current passes through a coil within a static magnetic field, there will be force acting on the coil perpendicular to both directions of current flow and the magnetic field. If an alternating current is supplied to the coil, an alternating force will be acting on the coil as a result.

In each shaker, there are upper and lower field coils. Electrical current is supplied from the power amplifier to these coils to generate the stationary magnetic field. The armature, which is the movable part of the shaker, is suspended with its own coils inside this field. When the amplifier supplies alternating current to the armature coils, the armature will move up and down. By controlling this armature current, the vibration force generated by the shaker can be controlled.

The key components of the shaker body include: Armature, Top Cover, Upper Armature guidance system, Upper Plate, Field Coils, Bottom Plate, Center Pole, Duct Case, Air Chamber, Air-Spring, Bottom Armature Guidance System, Center Connected Screw, and Wedge.

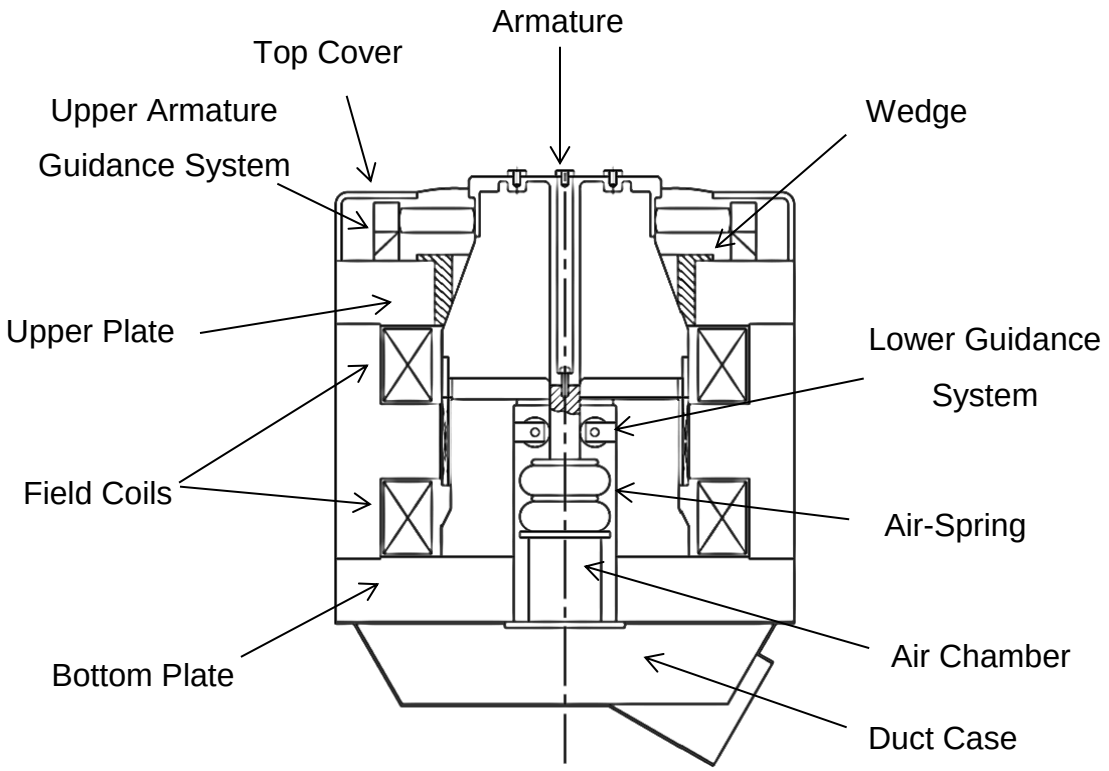

Figure 2.3 Main Shaker Components

1.4 Armature Assembly and Suspension

The main armature frame is made of either magnesium or aluminum alloy with the armature coils wrapped around the button portion. The armature coils fill the gap between the field coils and the center pole.

Stainless steel inserts are fitted on the surface of armature table. Test payloads and head expander can be directly mounted on the armature using these inserts, and custom insert patterns are available as options. An environmental chamber can also be mounted on the armature table as a payload or it can be mounted with a separate connector to improve the thermal efficiency.

The upper and lower guidance sets are mounted to suspend the armature within the shaker body. The lower part of the armature fits over the center pole, and the bottom of the armature is supported by the internal load support system. This suspension system allows the armature to move freely in the vertical direction while having rigidity in the cross-axial directions

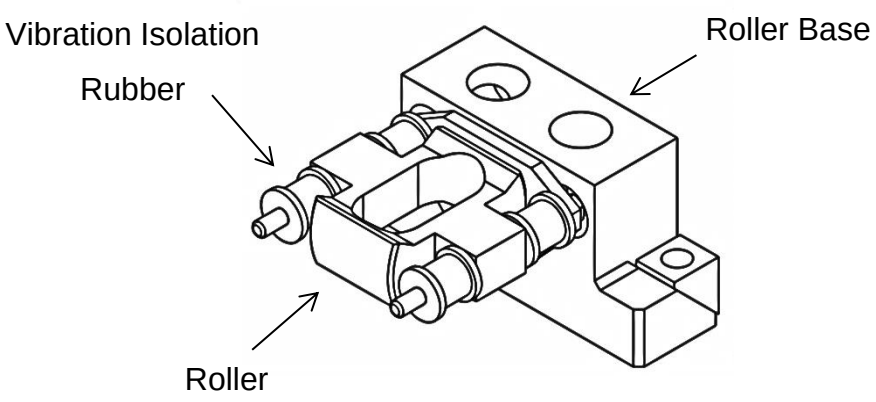

Figure 2.4 Upper Guidance Set

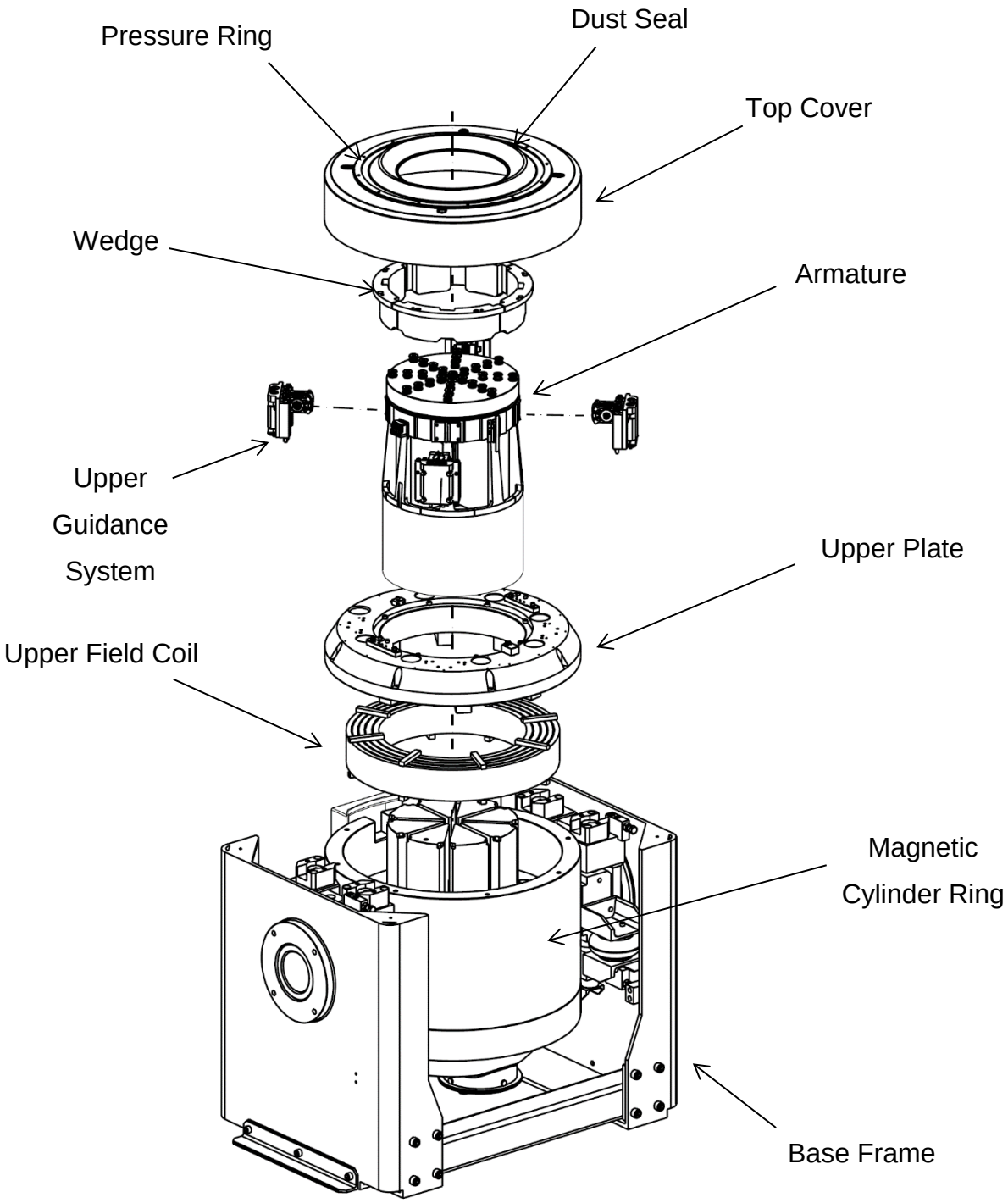

Figure 2.5 Upper Shaker Exploded View

1.5 Internal load support

The armature of the shaker should always be adjusted to a known position level called “the mid-position” before any operation. When the armature is at the mid-position, it has the greatest displacement capacity during the vibration test. However, addition of payload will cause the armature to move away from the mid-position. A system is needed to compensate the weight of the payload and keep the armature centered.

The Internal Load Support (ILS) system is designed for maintaining the armature at the mid-position. Shakers from Sentek Dynamics are all equipped with ILS system. An ILS system comprises a guidance column, an air-spring, and an air chamber. The guidance column is connected to the bottom of the armature. Compressed air is supplied to the air-spring through the air chamber, and the armature position can be adjusted by varying the air pressure.

In order to achieve the best performance of the shaker, the air-spring should be slightly pressurized when operating the shaker horizontally.

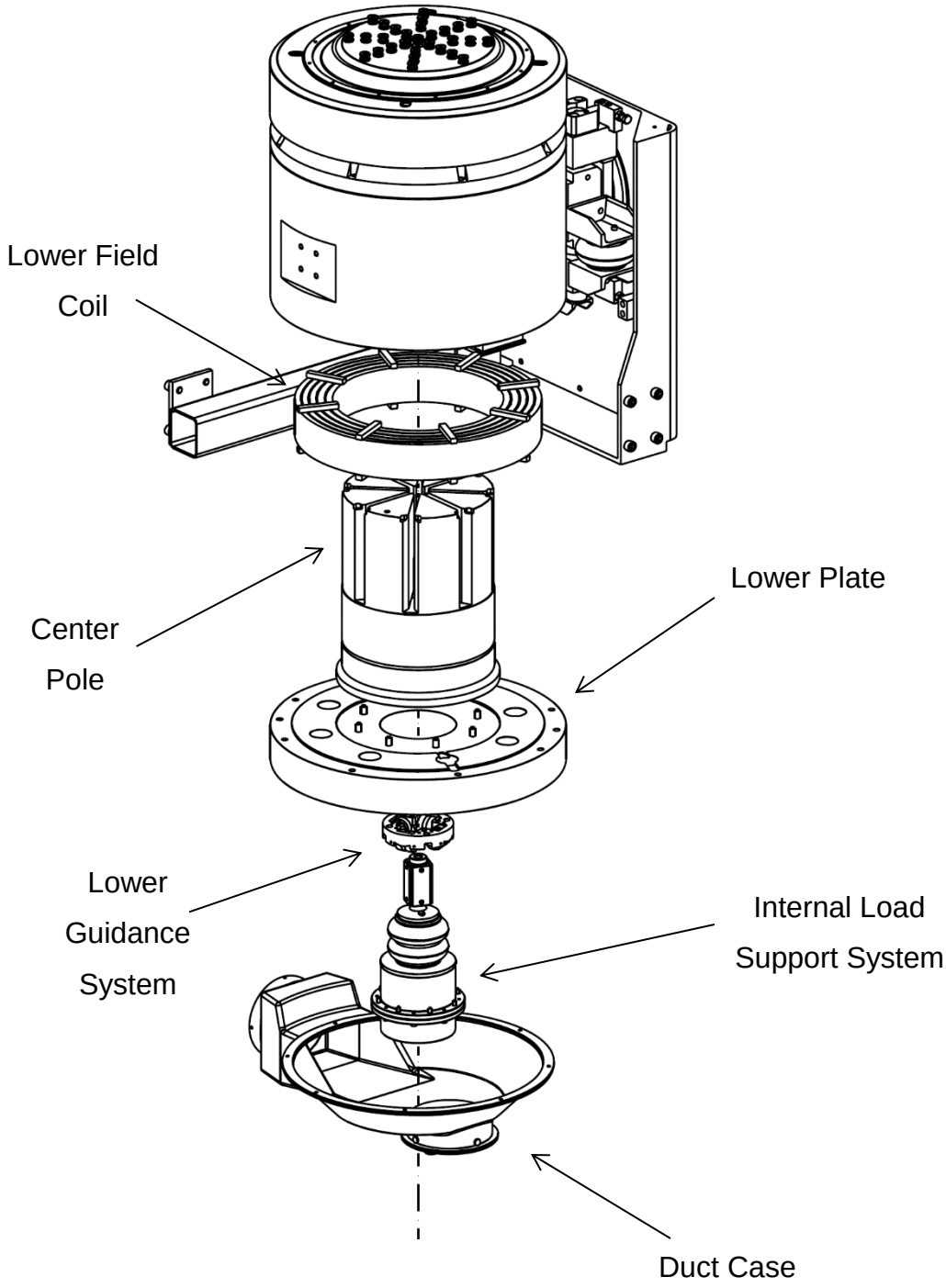

Figure 2.6 Lower Shaker Exploded View

1.6 Trunnion Mounting

The trunnion system of L0315M is designed to isolate the base frame from the reaction force of the shaker body through two air-spring sets added on each side of the trunnion. In addition, the trunnion system also enables the shaker to rotate and operate in either vertical or horizontal positions. A securing screw is mounted on each trunnion shaft to secure the shaker from rotation when the system is operating. To safely rotate the shaker between the vertical and horizontal position, please follow the procedure for rotating the shaker given in Chapter 4, “Operation”. In order to achieve the best isolation result, the vertical and horizontal trunnion-position indicators located on each side of the trunnion should be re-aligned before operating the system. This can be done by regulating the trunnion air-spring pressure.

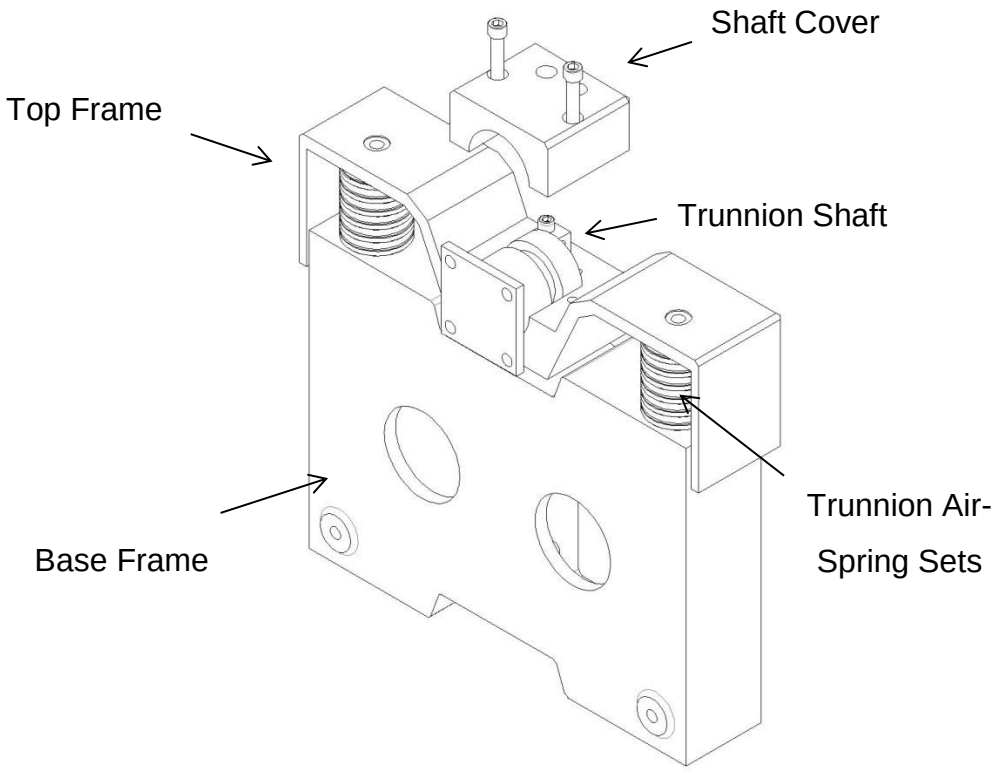

Figure 2.8 Trunnion Assembly

1.7 Cooling and Noise Reduction

The magnetic fields used to generate the armature forces are produced by passing large electrical currents in the armature and field coils, which generates a significant amount of heat as a byproduct. This excessive heat must be dissipated from the armature and field coils, or high temperature may damage the internal components.

The L0315M-PAS103 system uses a BU-1 centrifugal blower for air-cooling. The shaker has an air inlet design which significantly improves the cooling efficiency compare to the conventional single inlet design.

Air is sucked into the shaker body through openings below the top cover. The air then flows past the armature coils and space between the field coils. Air exits the shaker through the duct case and is exhausted through the blower.

A safety interlock circuit prevents shaker operation if there is no air flow through the system.

WARNING

FORCED AIR MAY EJECT DEBRIS AT HIGH SPEED. NEVER BLOCK THE EXHUAST OPENING OF THE BLOWER.

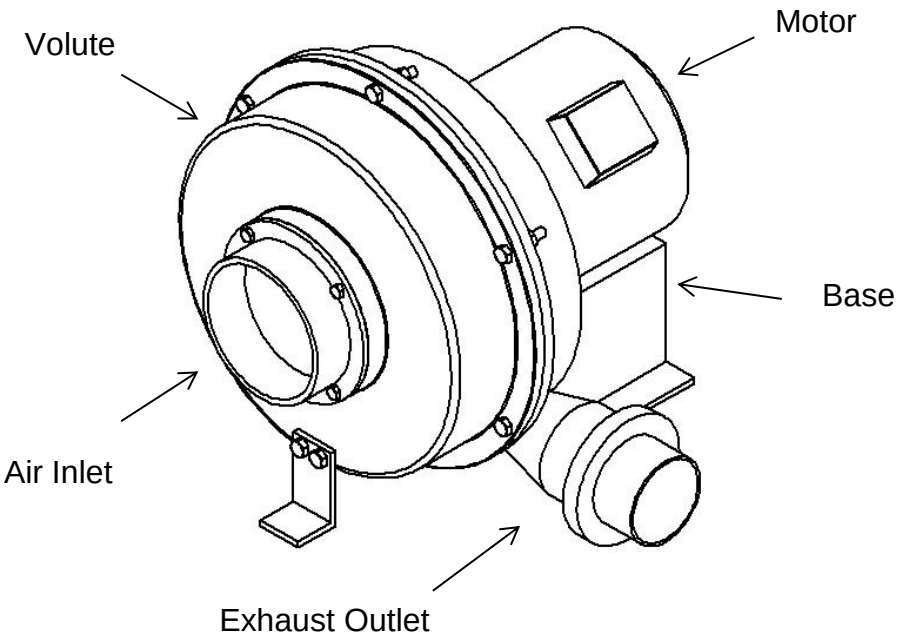

Figure 2.9 Typical Blower for L0315M Shaker

(Note Page)

2 PAS103 Amplifier

2.1 Function

Amplifier functions include:

- To amplify the drive signal
- To drive the shaker
- To power the blower unit
- To monitor the system status
- To monitor safety interlocks and automatically respond if an interlock trips

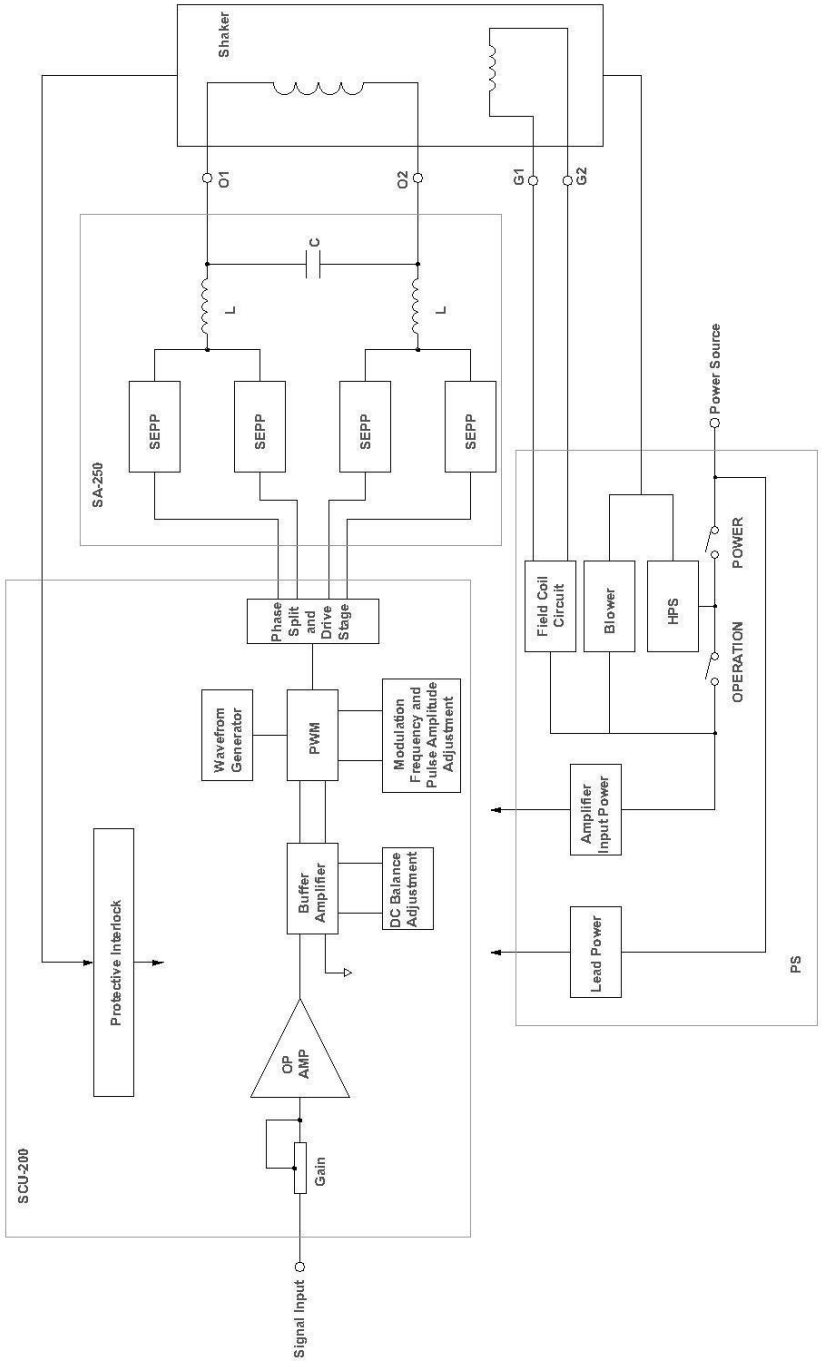

Figure 2.10 Typical System Electrical Schematic

2.2 PAS103 Amplifiers

Sentek Dynamics PAS Series switching amplifiers can be used with a wide range of air-cooled Sentek Dynamics' shakers or as replacement amplifiers for similar electrodynamic shakers produced by other companies. The PAS Series of switching amplifiers are comprised of three main components: logic module unit, power module unit, and power supply unit. The logic module unit controls the operation of the amplifier and shaker system. The power module unit provides high-power low-impedance output for the shaker. The power supply unit supplies DC-regulated power to the power module, field coils, and auxiliary equipment, and AC 3-phase power to the blower. It includes a mains switch (the main circuit breaker) and thermal relays as protective interlocks.

The protective interlocks ensure the safe operation of all components in the system. If an interlock is tripped, the amplifier shuts down immediately in a controlled manner and a corresponding interlock indication will illuminate on the control panel.

The following power supplies are provided by the amplifier:

Field power supply	The field coils are supplied with high-power DC current to produce the desired magnetic fields.
Blower supply	380 VAC, 3-phase, 50 Hz Or 480 VAC, 3-phase, 60Hz (Typically powered by Amplifier)
Auxiliary supplies	Provides DC voltages required by low-power components within the amplifier and shaker system.

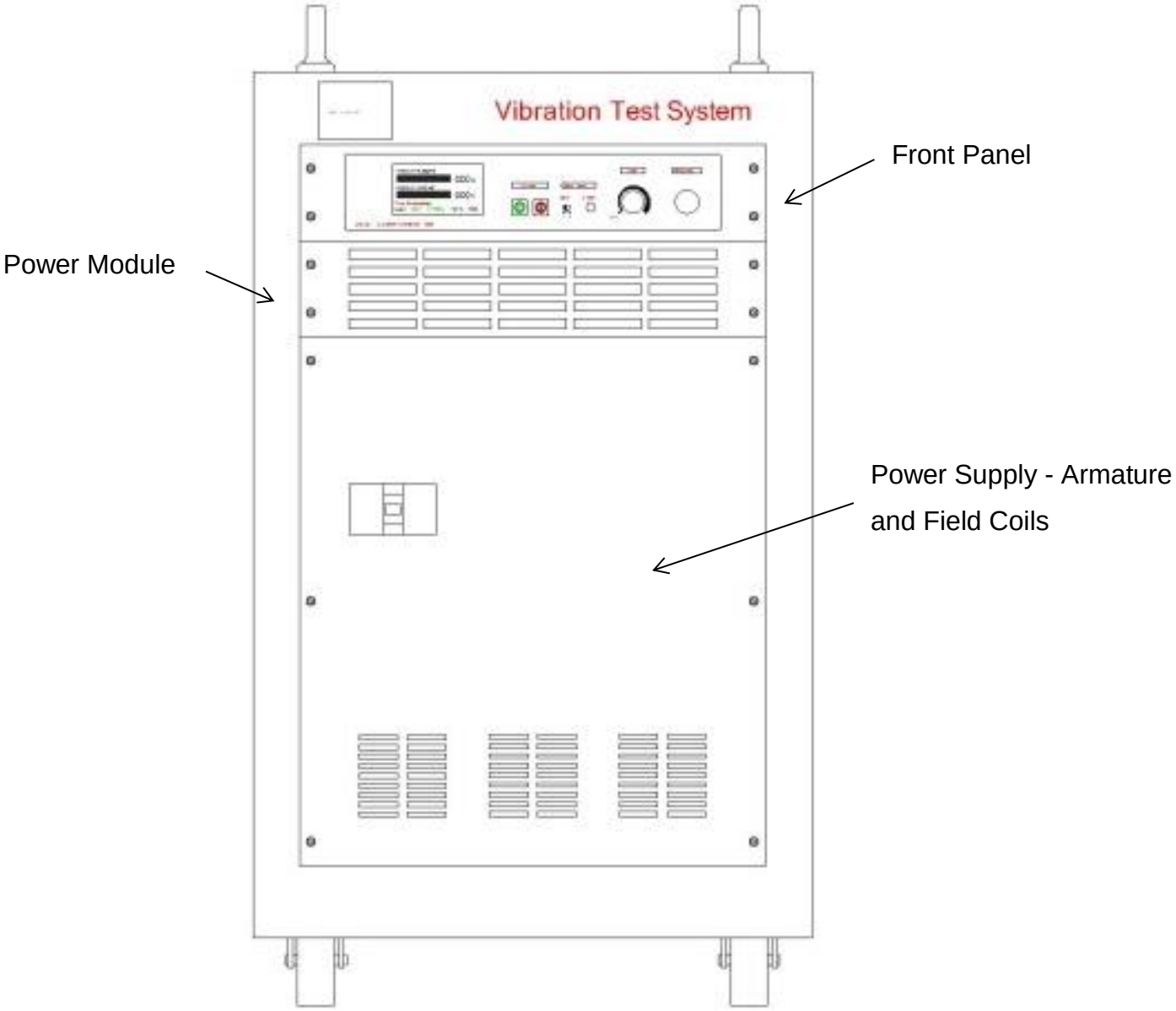

Figure 2.11 PAS103 Amplifier Front View

2.3 Main Control Panel

The control panel provides the controls and indicators required for local operation of the amplifier.

The controls shown in Figure 2.8 below produce the following effects:

ON and OFF	Switches the amplifier on and off.
Emergency stop	Shuts down the amplifier and stops the shaker from operation to avoid damage to the system for an emergency need.
Master gain	Adjusts the amplifying level of the output power from the amplifier
Input B	Front BNC connector (input channel B)
Input switch	Switch input channel A and B

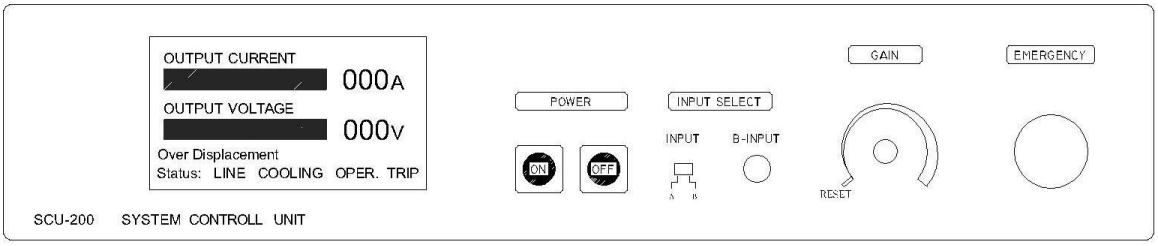

Figure 2.12 SCU-200 Control Panel Front View

OUTPUT VOLTAGE AND OUTPUT CURRENT

The output voltage and output current are displayed on the LCD panel. They are shown with both percentage bars and in numerical measurements.

Gain and Reset

Master gain controls the amplifier gain. The master gain must be turned counter-clockwise to “RESET” before start-up and shut-off of the system. When the TRIP indicator illuminates on the LCD screen, make sure the master gain is turned to RESET before restarting the system.

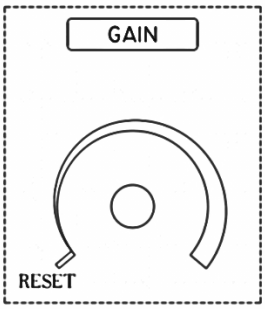

Figure 2.13 Master Gain

Input Select

Input switch allows user to select input A or B as the input channel. Input A is located behind the amplifier cabinet, and input B is next to the input switch on the control panel.

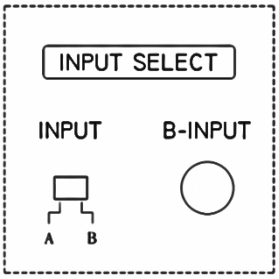

Figure 2.14 Input Selections

WARNING

DO NOT SWITCH INPUT SELECTION DURING OPERATION! DOING SO MAY CAUSE SEVERE DAMAGE TO THE SYSTEM.

Emergency Stop

Press the emergency stop button when the power amplifier, shaker or the test payload acts abnormally. “TRIP” indicator will not appear since the power supply will cut be off in this case. Reset method: Switch OFF the mains switch; reset the master gain to RESET; turn off any signal input; and restart the system normally.

2.4 Remote Control

Remote control is enabled by the use of Sentek Dynamics’ optional remote-control box which provides the following features:

- Amplifier ON and OFF Control
- Remote Monitoring Including Display of Interlocks
- Amplifier Gain Control
- System Emergency Stop
- Signal Input Terminals

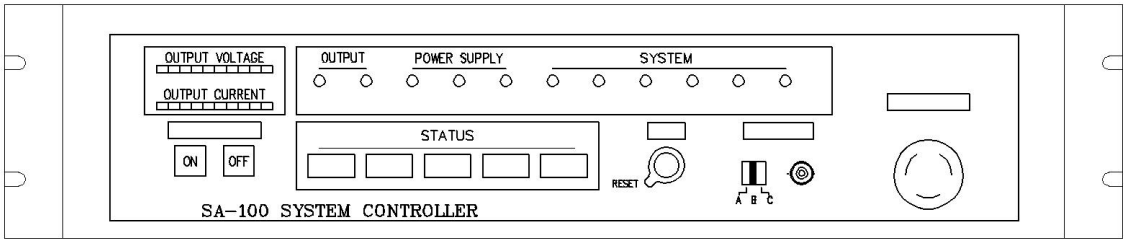

Figure 2.15 SA-100 Remote Control Panel Front View

2.5 Power Supply Unit

The power supply unit includes three main control components: mains switch (circuit breaker), contactor, and thermal relay. The amplifier is powered when the mains switch is switched on, and “Line” indicator will appear on the control panel LCD display after amplifier finishes checking the system.

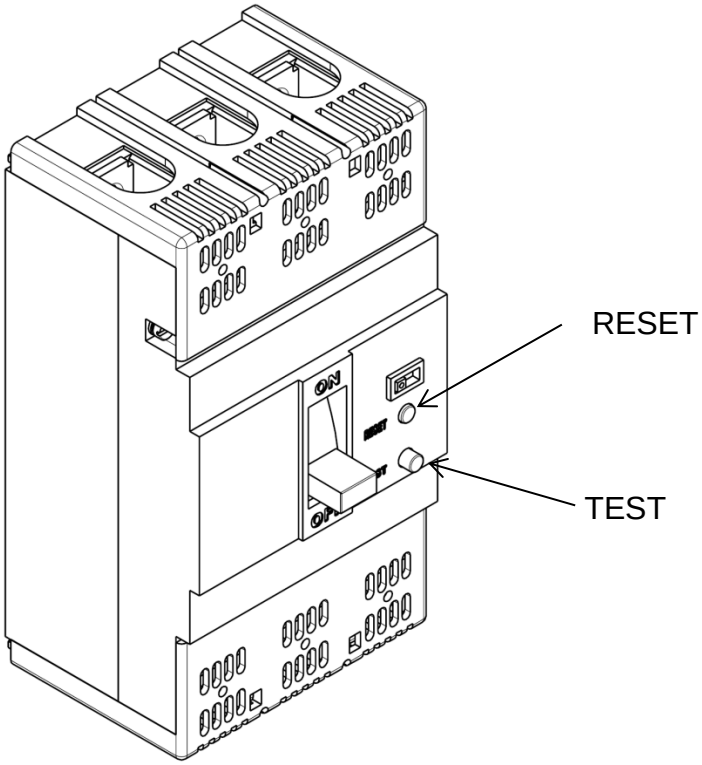

Figure 2.16 Mains switch

The contactor and the thermal relay are bundled together to control the power load supplied to the system. If the current passing through the thermal relay is over loaded, the thermal relay interlock will trip, and the contactor will cut off the power supply.

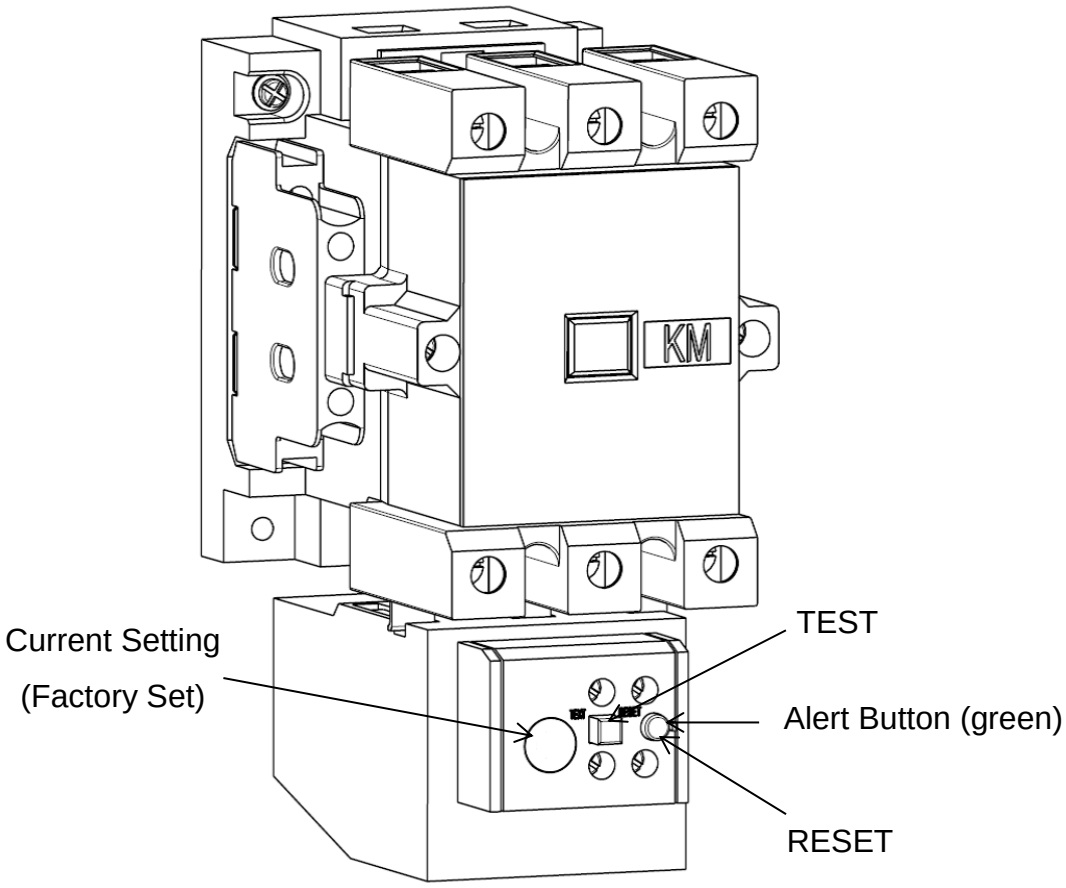

Figure 2.17 Contactor and Thermal Relay

2.6 Location of Components

Amplifier major components are shown in following pages.

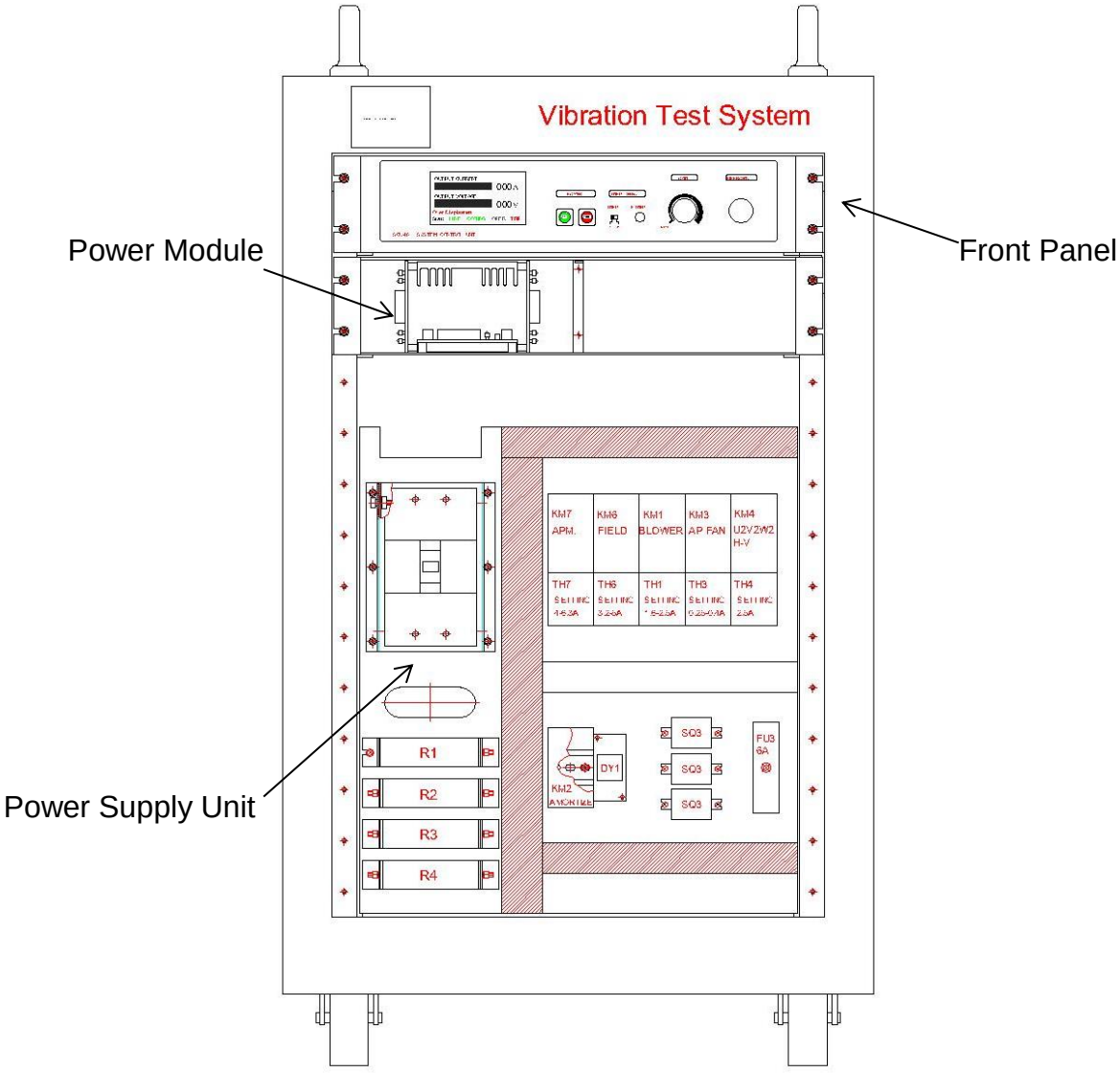

Figure 2.19 PA103 Amplifier Front View with Cover Off

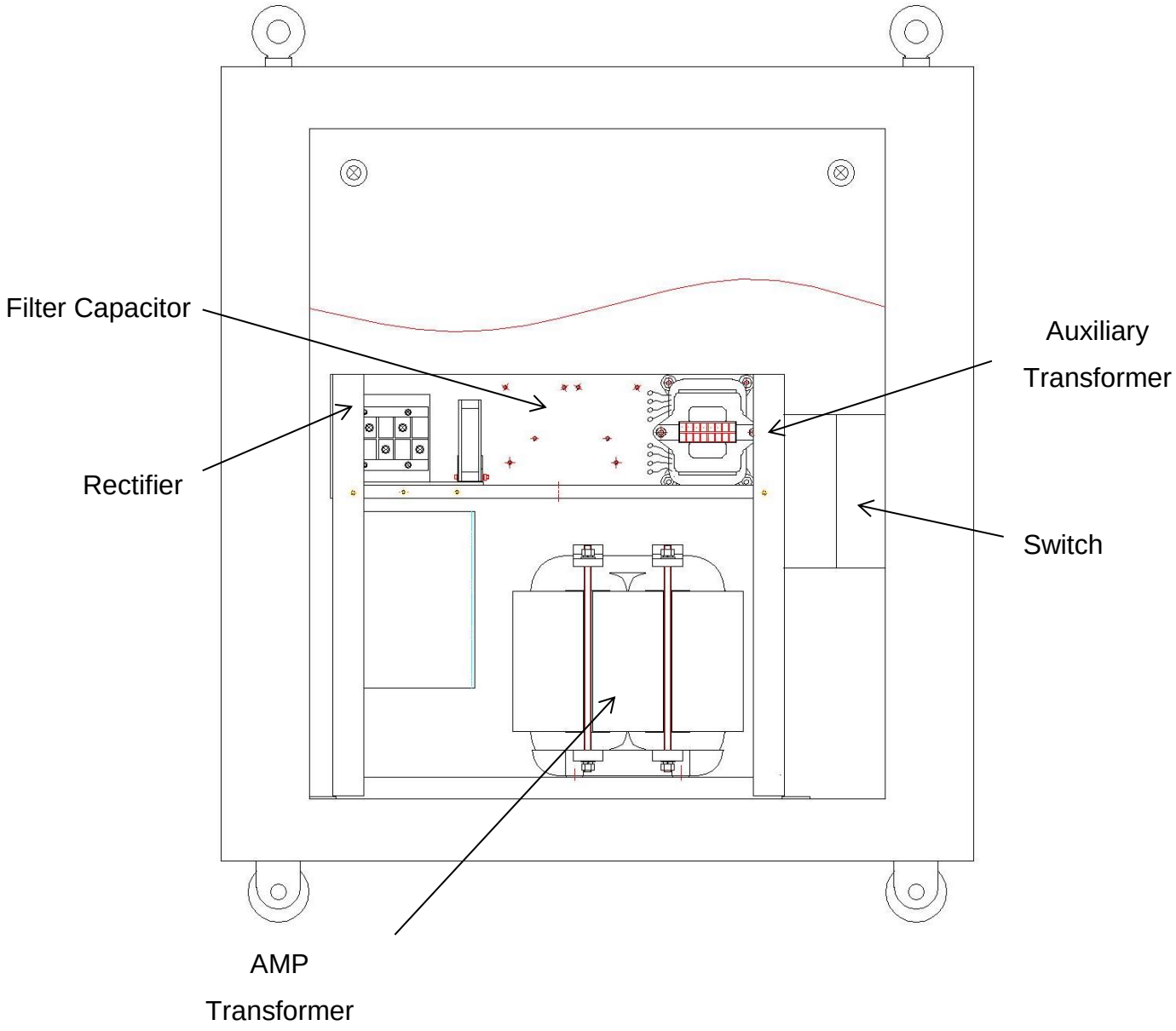

Figure 2.20 PA103 Amplifier Side View with Cover Off

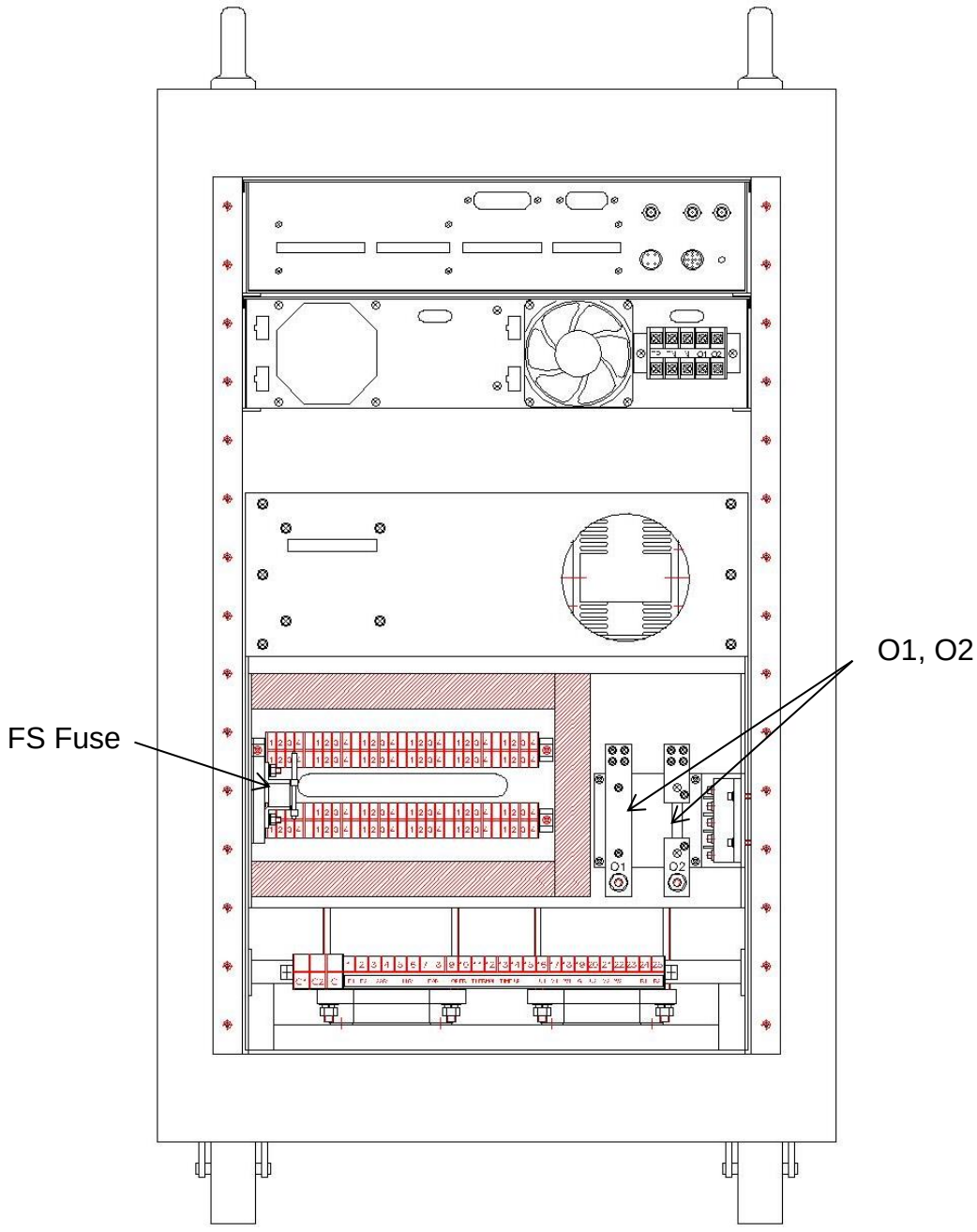

Figure 2.21 PAS103 Amplifier Rear View with Cover Off

(Note Page)

CHAPTER 3 INSTALLATION

This chapter lists specific detailed procedures on how to install the L0315M-PAS103 system. Refer to the system setup diagram, the component drawings, and the signal source/controller documents included with this manual for additional information.

Before installing any equipment, the customer-supplied components and services listed in Chapter 1 should be prepared.

WARNING

OPERATION AND INSTALLATION OF THIS EQUIPMENT MAY EXPOSE PERSONEL TO HAZARDS SUCH AS HIGH VOLTAGES AND HIGH TEMPERATURES. PLEASE READ AND UNDERSTAND ALL GUIDELINES AND PRECAUTIONS SPECIFIED IN THE HEALTH AND SAFETY NOTICE OF THIS MANUAL. FAILURE TO FOLLOW SAFE PROCEDURES MAY RESULT IN INJURY.

WARNING

INSTALLATION OF THIS SYSTEM REQUIRES LIFTING AND MOVING HEAVY EQUIPMENT. PROPER LIFTING PROCEDURES SHOULD BE USED TO PREVENT INJURIES FROM OVERSTRAINING OR DROPPING OBJECTS. ALWAYS REMAIN CLEAR FROM LIFTED OR SUPSENDED EQUIPMENT.

(Note Page)

CONTENTS OF THIS CHAPTER

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1 General

1.1 Location

All system components should be placed on a flat and stable floor. In order to maintain adequate airflow through the amplifier, the amplifier shall be placed at least 1 meter (3 feet) away from walls and other equipment, and the space underneath the amplifier should be clear at all time.

The installation area should be kept clear of any ferromagnetic particles to prevent contamination.

Check the packing list and make sure all listed equipment and components are present. Contact Sentek Dynamics for any problems, including any transit damage, within 48 hours of receipt of system.

Have all required electrical and pneumatic services prepared as described in Chapter 1.

Prepare the necessary tools and equipment for lifting the shaker and other components during the assembly process.

The interconnection cables should be long enough to allow proper positioning of the components. The cables should be routed in such a way to provide protection and prevent tripping.

1.2 Lifting

Shaker

An M24 eyebolt can be mounted on the side of the magnetic cylinder to assist in lifting. To lift the shaker, a crane with a minimum lifting capacity of 370 kg (814 lb) together with suitable lifting slings, spreader bars, and rigging must be used. Position the shaker in the desired location for set up. No attempt must be made to lift the shaker using attachment points other than the eyebolt attachment point.

Amplifier

The complete amplifier system is housed in a single cabinet. It can be lifted with a fork or pallet type lift, or by crane using the eyebolts on top of the cabinet. The crane should have a minimum lifting capacity of 1.5 times the amplifier weight.

CAUTION

LIFTING INSTRUCTIONS ARE PRINTED ON THE EQUIPMENT OUTER PACKING. THESE INSTRUCTIONS SHOULD ALWAYS BE FOLLOWED TO PREVENT ANY DAMAGE TO THE EQUIPMENT.

1.3 System Configuration

The L0315M-PAS103 vibration system must be configured by Sentek Dynamics trained personnel in accordance with the shaker specifications before operation.

WARNING

DAMAGE MAY OCCUR IF SYSTEM IS USED BEFORE BEING PROPERLY CONFIGURED.

2 Installation Procedures

2.1 L0315M Shaker and Blower Unit

1. Connect cables to the terminals on the shaker by following the connection drawings in this chapter.
2. Remove trunnion locking screws and nuts (4 sets) to unlock the trunnions.
3. The top isolator bolts (4 total) should be tight during all operations.
4. The bottom isolator bolts (4 total) should be tight during operation below 10 Hz and backed-off loose 0.5 inch (13 mm) for operation above 10 Hz.

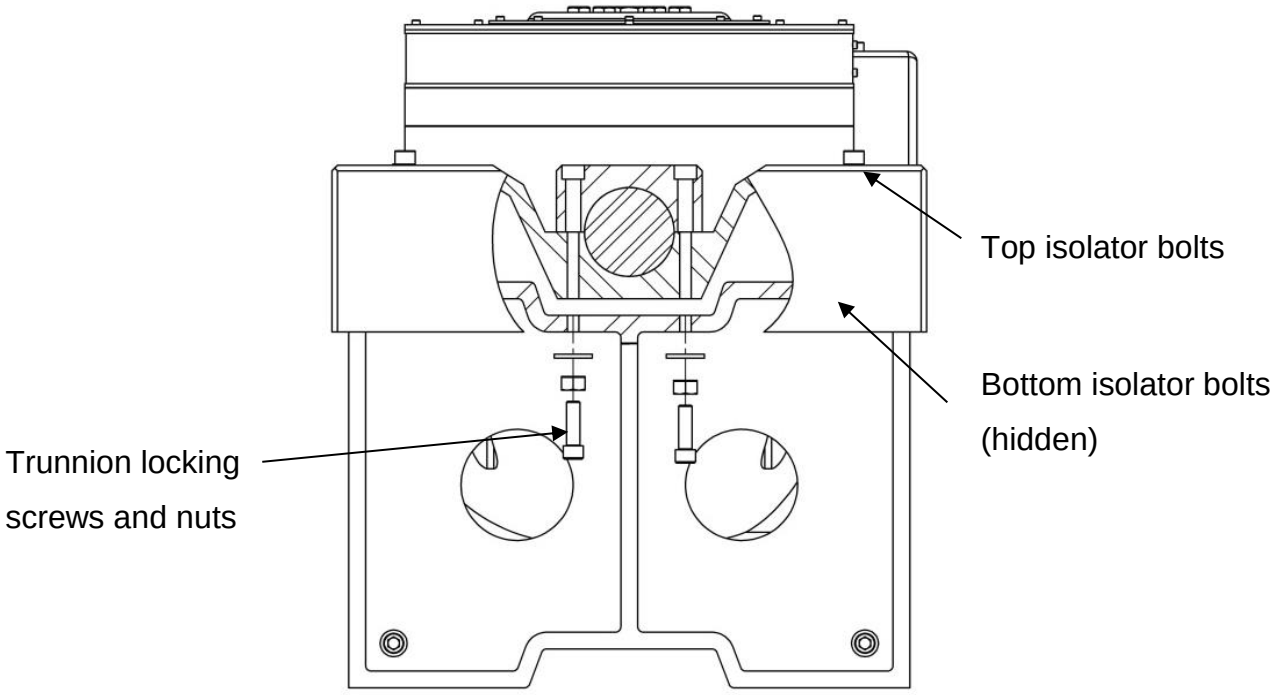


Figure 3.1 Trunnion Locking Screws and Nuts

5. Identify the location of the emergency stop button (on the amplifier control panel). It should be easily accessible in the event of an emergency; otherwise an additional emergency stop button should be set up at a different location.
6. Connect the three blower unit power wires according to the connection drawings.

2.2 Amplifier

Refer to the operation and connection diagrams for the electrical connections required for the amplifier. Remove rear covering panels to access power and signal connection points and tap settings.

Mains Connection

An external 3-phase power disconnect should be used for providing the main electrical supply for the amplifier. Separate power disconnects should be used for power supplies to additional equipment. All power disconnects should be placed at easily accessible locations.

If possible, use only one power supply for all system components.

2.3 Connections Setup

This section describes the power and signal connection setup for L0315M-PAS103 system. The two connection points for a single connection are indicated by the same number in following figures. Connection details are listed in Table 3.1

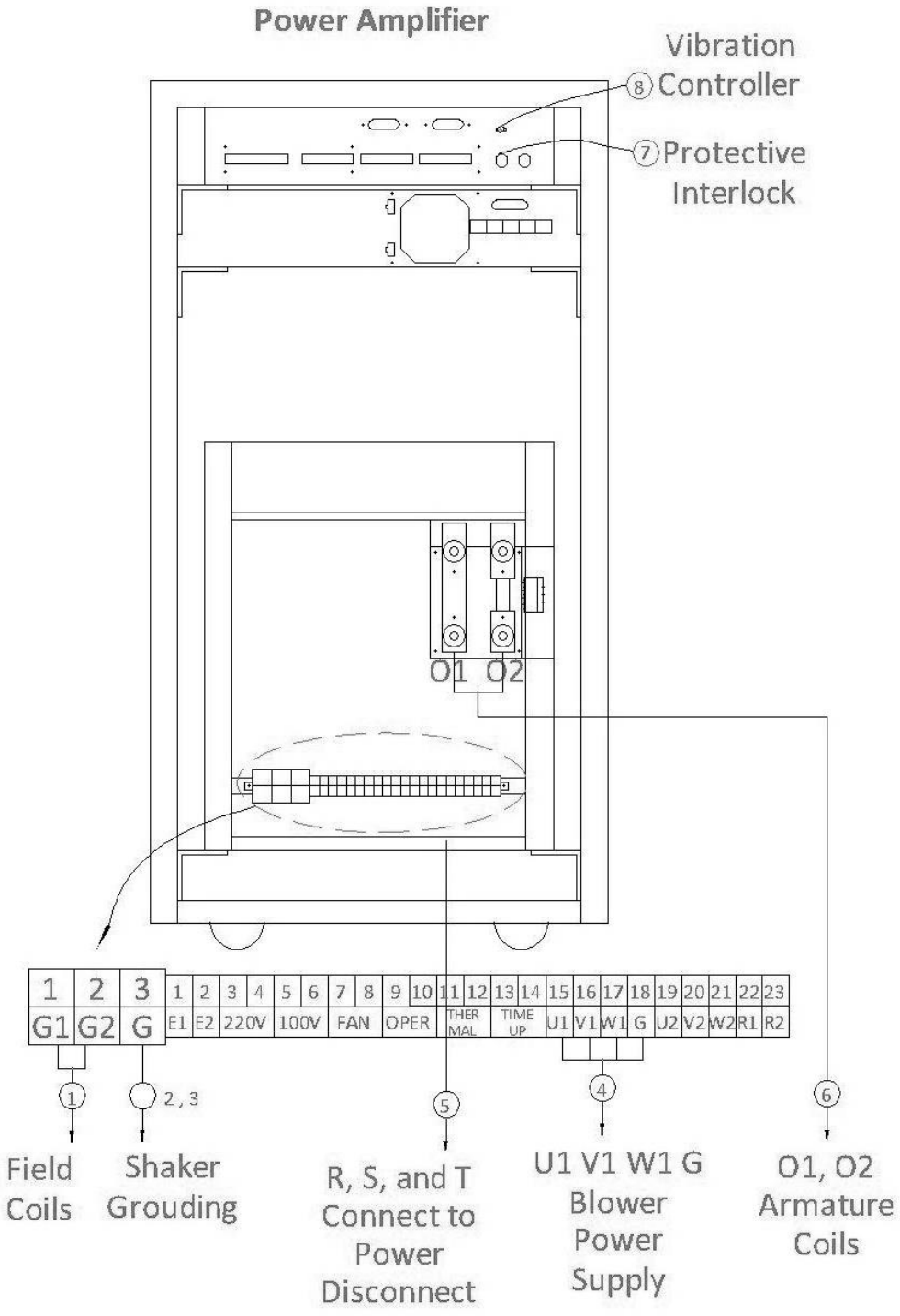


Figure 3.2 Amplifier Power and Signal Connections

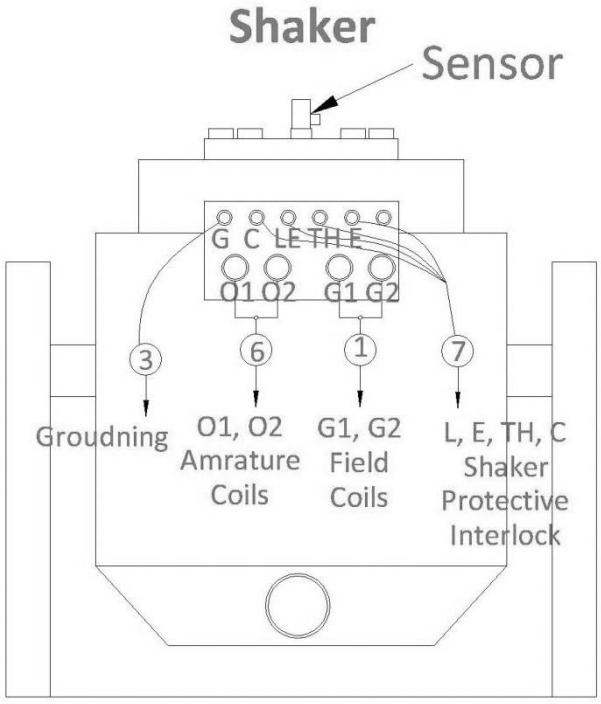


Figure 3.3 Shaker Power and Signal Connections

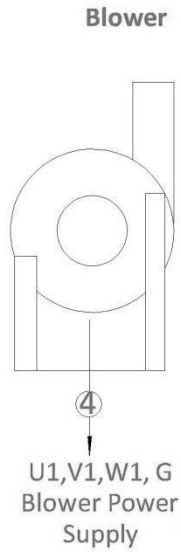


Figure 3.4 Blower Power and Signal Connections

No.	Code	Name	Unit	Material	Comment
1	G1, G2	Field Coils	1	Two Cores Multi-Strand Flex Cable	
2	G	Incoming Grounding Cable	1	Single Core Multi-Strand Flex Cable	
3	G	Shaker Grounding	1	Single Core Multi-Strand Flex Cable	
4	U1, V1, W1, G	Blower Power Supply	1	Four Cores Multi-Strand Flex Cable	
5	R, S, T	Main Power Supply	1	Three Cores Multi-Strand Flex Cable	
6	O1, O2	Armature Coils Drive Power	2	Welding Machine Cable	
7	L, E, TH, C	Shaker Protective Interlock	1	Four Cores Multi-Strand Flex Cable	
8		Vibration Controller Drive Signal	1	Low Noise Shield Cable	To Controller

3 Post-Installation Checks

1. Perform the “Pre-Use Checks” described in Chapter 4.
2. Switch on the amplifier mains switch. If the mains switch trips and the control panel display indicates a phase failure, check that the phase connections are not reversed, and voltages are at the correct level.
3. Check and make sure the blower is rotating in the correct direction. Direction of blower rotation can be easily reversed by switching any two phases of the blower connection on the amplifier output terminals.

(Note Page)

CHAPTER 4 OPERATION

This chapter describes the pre-use check procedure for the shaker, the system operation procedures, and the operation of the protective interlocks.

The chapter is divided into the following sections:

- General operating notes
- Shaker operation
- Amplifier operation
- Interlocks and basic failure diagnosis

(Note Page)

CONTENTS OF THIS CHAPTER

(Note Page)

1 General Operating Notes

1.1 General

All personnel should remain outside the DANGER ZONE when the system is in operation.

CAUTION

ALL OPERATORS SHOULD BE FAMILIAR WITH THE TECHNIQUES OF VIBRATION TESTING. THE OPERATORS SHOULD ALSO BE FAMILIAR WITH ALL THE HEALTH AND SAFETY PRECAUTIONS LISTED IN THIS MANUAL.

WARNING

WHENEVER THE SHAKER IS MOVED, RAISED, OR LOWERED, ALL PERSONNEL SHOULD REMAIN CLEAR FROM ALL MOVING PARTS AND FROM UNDERNEATH THE SHAKER BASE.

1.2 Operation Conditions

The vibration shaker could be damaged if the system is operating under the following conditions for extended periods:

- high acceleration, high velocities or displacements
- fixed frequency
- horizontally without a slip table
- vertically with a large eccentric moment
- in a high humidity and/or high temperature work environment
- in an adverse atmosphere such as with solvent vapor

1.3 Payloads and Fixtures

WARNING

DRILLING ADDITIONAL MOUNTING HOLES IN THE ARMATURE TABLE WILL WEAKEN THE ARMATURE STRUCTURE. THIS WILL HAVE AN ADVERSE EFFECT ON THE DYNAMICS OF THE TEST SYSTEM, AND MAY DAMAGE THE TEST PAYLOADS.

Armature maximum displacement, acceleration, and eccentric moment vary according to the dimensions, mass, and mounting setup of the payloads. These limits should be calculated according to Appendix B “Displacement, Acceleration, and Eccentric Moment Limits” and should be considered for setting up the vibration test to prevent damage to the system.

2 Shaker Operation

2.1 Pre-Use Checks and Setup

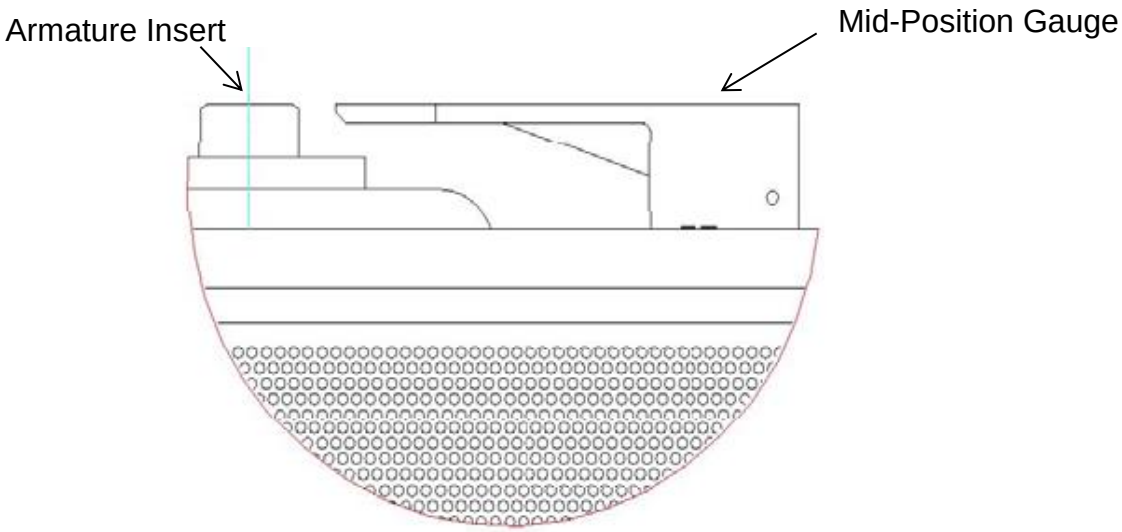
Please follow the procedures below before performing any testing with the vibration shaker:

1. Check the pneumatic supply satisfies the requirements described in Chapter 1, and make sure the compressed air supply is sufficient.

WARNING

SEVERE VIBRATION LEVELS MAY BE TRANSMITTED AS A RESULT OF INDAEQUATE AIR-SUPPLY AND MAY CAUSE DAMAGE TO THE SYSTEM STRUCTURE.

2. Make sure the armature table is evenly leveled.
3. Rotate the shaker to the desired position as needed according to the required operation. Further details are described in “Rotation of Shaker Body”
4. Attach and secure the payload to the armature using the armature inserts. Use as many inserts as possible and make sure all screws match the insert threads and are adequately tightened.
5. Attach and secure the control accelerometers to the shaker as required, and make sure the accelerometer is properly connected with the control system.
6. Adjust the armature height by setting the ILS pressure, and ensure the armature is at mid-position by checking with the mid-position gauge.



7. The equipment may now be operated as described in “Amplifier Operation” later in this chapter.

IMPORTANT NOTE

ALL OPERATORS SHOULD BE FAMILIAR WITH THE ALL EMERGENCY STOP LOCATIONS BEFORE USING ANY OF THE SYSTEM EQUIPMENT.

2.2 Rotation of the Shaker Body

Use the following procedures for rotating the shaker body between horizontal and vertical positions.

WARNING

OPERATING PERSONNEL COULD BE SEVERELY INJURED IF THIS PROCEDURE IS NOT PROPERLY FOLLOWED.

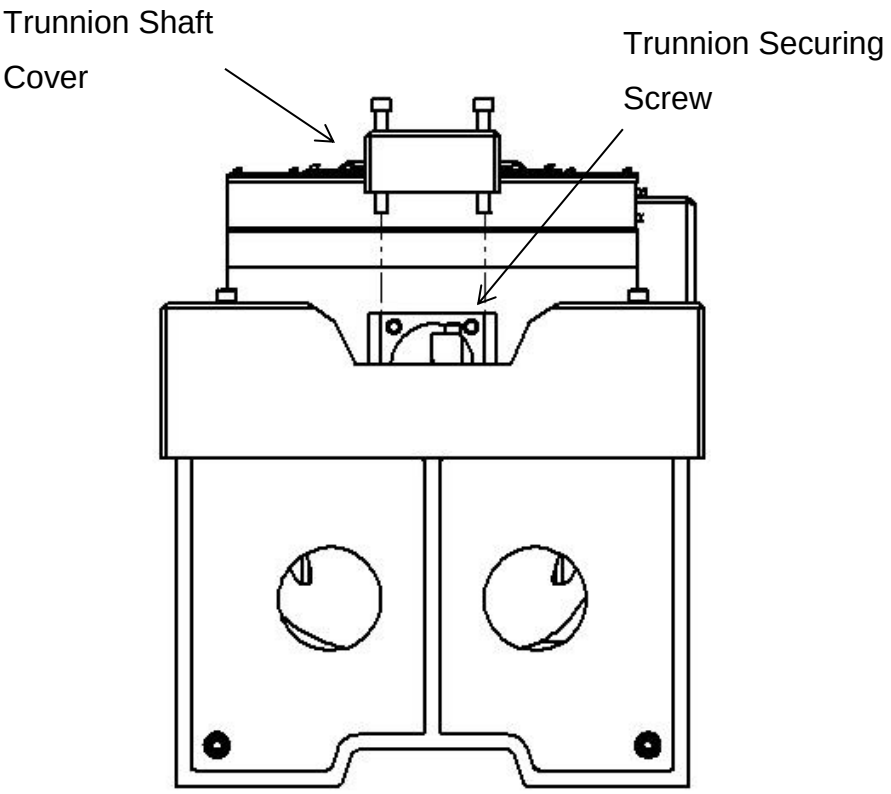


Figure 4.1 L0315M Trunnion Securing Screws

Vertical to Horizontal Position

1. Confirm the amplifier is not in operation, and the blower unit is off.
2. Remove the hose connector from the cooling air outlet located on the back side of the shaker body.
3. Remove the trunnion securing screws (2 total) in the positions near the blower outlet connection side (rear).
4. Slowly rotate the shaker to the horizontal position by hand.

5. Refit the trunnion securing screws (2 total) in the positions away from the blower outlet connection side (front).
6. Remove the cooling air outlet cover located on the bottom end of the shaker body and fit it to the other cooling air outlet.
7. Fit the hose connector to the cooling air outlet located on the bottom end of the shaker body.

Horizontal to Vertical Position

1. Make sure the amplifier is not in operation, and the blower unit is off.
2. Remove the hose connector from cooling air outlet located on the bottom end of the shaker body.
3. Remove the cooling air outlet cover located on the back side of the shaker body and fit it to the air outlet located on the bottom end of the shaker body.
4. Remove the two securing screws near the front side of the shaker.
5. Slowly rotate the shaker to the vertical position by hand.
6. Refit the trunnion securing screws to positions near the rear side of shaker.
7. Fit the hose connector to the cooling air outlet on the back side of the shaker body.

(Note Page)

3 Amplifier Operation

3.1 General

The operator will control the amplifier and monitor the system status through the control panel interface.

WARNING

DURING THE OPERATION OF THE VIBRATION SYSTEM, COMPONENTS WITH-IN THE AMPLIFIER CABINET WILL CONTAIN HIGH VOLTAGES AND WILL BE AT HIGH TEMPERATURES.

IMPORTANT

FOR SAFETY PURPOSES, THE AMPLIFIER SHOULD ALWAYS BE ELECTRICALLY CONNECTED TO GROUND BEFORE OPERATION.

The amplifier operation can be categorized into following parts:

- Power on and start-up
- Normal shut-off
- Emergency shut-off
- Safety interlocks

3.2 Operation Modes

The main control panel SCU-200 is located on the front of the amplifier main cabinet. The SCU-200 provides all necessary controls and indications for operating the amplifier.

Sentek Dynamics also provides amplifier remote control box SA-100. The SA-100 allows the user to remotely perform the same operation functions and system monitoring as the SCU-200.

IMPORTANT

1. **AFTER FIRST TIME START-UP OR RE-INSTALLATION OF THE SYSTEM, MAKE SURE THE BLOWER IS ROTATING IN THE CORRECT DIRECTION. IF THE BLOWER ROTATION IS INCORRECT, PLEASE SWITCH THE PLUG-IN TERMINALS OF THE BLOWER POWER SUPPLY.**
2. **DURING THE START-UP PROCESS, THE VIBRATION CONTROLLER SHOULD BE POWERED ON BEFORE SWITCHING ON THE AMPLIFIER MAINS SWITCH. DURING THE SHUT-OFF PROCESS, THE AMPLIFIER SHOULD BE TURNED OFF BEFORE THE VIBRATION CONTROLLER.**
3. **THE AMPLIFIER SHOULD NOT BE IN 'OPERATION' STATUS DURING ROTATION OF THE SHAKER AND WHILE FITTING OR REMOVING THE DRIVER BAR, THE HEAD EXPANDER, OR THE PAYLOADS.**
4. **CHECK THE TRUNNION-POSITION INDICATOR TO MAKE SURE THE SHAKER BODY IS AT MID-LEVEL.**

WARNING

THE MASTER GAIN KNOB SHOULD ALWAYS BE AT 'RESET" POSISTION BEFORE THE "OPERATE" INDICATOR ILLUMINATES. STARTING UP THE SYSTEM WHILE THE MASTER GAIN IS AT MAXIMUM POSITION MAY CAUSE POWER SUPPLY RESISTORS TO BURN OUT.

3.3 Start-Up Procedure

1. Perform “Pre-Use Check”.
2. Switch on the power disconnects.
3. Check and select the proper input using the input switch and make sure the BNC cables are connected to the designated terminals.
4. Turn on the vibration controller or signal generator and make sure the vibration controller software or signal generator has a zero output.
5. Check and make sure the master gain is turned to “RESET”.
6. Switch on the mains switch on the amplifier and wait until the “LINE” indicator appears on the control panel LCD.
7. Set up the control software for the designed testing purpose.
8. Press “ON” button on the control panel; the fans of the amplifier and the blower will start, and the “COOLING” indictor will illuminate. Continue to wait until the “OPERATION” appears on the control panel LCD. This indicates the field coils are powered, and the system is ready for use.
9. Slowly turn the master gain knob to maximum.

3.4 Shut-Off Procedure

At the conclusion of a test session, the amplifier must be switched off in following manner:

1. Turn the master gain to “RESET”.
2. Press the “OFF” button on control panel.
3. Turn off the vibration controller after the “OPERATION” indicator on the amplifier turns off.
4. Wait for few minutes until all fans and the blower stop running and the “COOLING” indicator turns off.

5. Switch off the mains switch.
6. Switch off the power disconnect.

3.5 Emergency Stop

Press the emergency stop (E-stop) button when the power amplifier, shaker, or test payload acts abnormally. Amplifier will be immediately turned off in a controlled manner.

Reset method: Switch off the mains switch; set the master gain to “RESET”; turn off any signal inputs; and restart the system according to the start-up procedure described above.

4 Interlocks

4.1 Interlock Trip Indication

If any protection interlock is tripped during operation, “TRIP” indication will appear on the control panel LCD and the input signal will be cut off internally.

4.2 Interlock Faults Displayed on the Control Panel LCD

The interlock status displayed on the control panel LCD provides indication of faults arising within the amplifier or in the vibration test system.

Interlock	Description
OVER VOLTAGE	The output voltage exceeds the defined limit
OVER CURRENT	The output current exceeds the defined limit.
PS HIGH VOLTAGE	The input DC electric voltage to the power module exceeds the defined maximum limit
PS OVER CURRENT	The input DC electric current to the power module exceeds the defined maximum limit
PS LOW VOLTAGE	The input DC electric current to the power module exceeds the defined minimum limit
OVER DISPLACEMENT	Armature travel exceeds the defined limit.
OVER HEAT	Shaker temperature is in excess of the defined maximum temperature
FIELD SUPPLY	Power supply to field coils acts abnormal
FUSE THERMAL	Fuse failed, or thermal relay triggered
MODULE	Power module failed
WATER LEAK	Water leak detected (only for water-cool system)
HEAT EXCHANGER	Heat exchanger failed (only for water-cool system)
EXTERNAL STOP	Stop signal received from external component
OTHERS	Other interlock

4.3 Interlock Details

OVER VOLTAGE AND OVER CURRENT

If the output voltage and current of the power amplifier exceeds the defined value, the protection interlock of the power amplifier be tripped, and the corresponding interlock indicator will appear on the control panel LCD at the same time. If this interlock is tripped, it means the output voltage or current exceeds the allowed value and the power amplifier may be damaged. Check the charge amplifier and test controller's sensitivity, and the vibration displacement, velocity and acceleration setting to make sure the value does not exceed the rated value.

Over voltage and over current of the amplifier may occur when the mass of the test payload is very small, causing the test level to not be carried out under the rated test condition. For example, the vibration test with a small payload performed at a low frequency, such as 5 Hz, this setup may cause over current problem and could lead to short circuits within the system.

When these interlock indictors appear, check for:

- The system calibration and vibration test program
- The connections between the amplifier and shaker armature
- The shaker field fuses
- Short circuits on the output terminals of the amplifier
- The connections between the amplifier and shaker armature
- The shaker field fuses

PS HIGH VOLTAGE, OVER CURRENT, LOW VOLTAGE

PS HIGH VOLTAGE: The power amplifier input voltage exceeds the defined maximum limit; thus, the amplifier output would have an excessive voltage.

PS OVER CURRENT: The power amplifier input current exceeds the defined maximum limit. The power supply parts can be damaged as a result.

PS LOW VOLTAGE: The input voltage of the power amplifier exceeds the defined minimum limit; thus, the amplifier would output a current that is too low. This is usually caused by the mismatch of the power supply components within the amplifier.

OVER DISPLACEMENT, OVER HEAT, FIELD SUPPLY, FUSE THERMAL, OTHER AND EXTERNAL STOP

OVER DISPLACEMENT: Armature displacement exceeds the specified limits. Check the limits against the figures quoted in the appropriate shaker manual.

OVER HEAT: This interlock will trip when the temperature of the field coils exceeds 110 ˚C (230 ˚F). Please check and make sure the blower is operating normally, and the flex hose for the amplifier is straight and has nothing blocking the inlet or outlet.

FIELD SUPPLY: This interlock is usually triggered as field coils fuses burn out. Please check for the reasons that cause the burn out, change the fuses or contact Sentek Dynamics for further assistance.

FUSE THERMAL: This interlock is triggered when current across the thermal relay or fuse exceeds the defined limits. Identify the burned-out parts, replace new parts, and reset the system.

OTHERS: Other interlocks

EXTERNAL STOP: External component stop signal. For example, the over pressure protective signal by the oil source system.

MODULE

Power module fail. For diagnosis and repairing guidance, refer to Chapter 5 Section “Power Module Failure”.

WATER LEAK

Check and make sure the water bucket for the heat exchanger is set up as required, and check and make sure water hose connectors are fully sealed without any leaking. Note: Not applicable to air-cooled L0315M-PA103 vibration testing system.

HEAT EXCHANGER

There is no power supply to the heat exchanger, or the inner loop pressure hasn’t achieved the defined value. Check the power supply for the heat exchanger and any potential water leak for the inner loop. Note: Not applicable to air-cooled L0315M-PA103 vibration testing system.

(Note Page)

CHAPTER 5 MAINTENANCE

This chapter details the routine serviceability checks and scheduled maintenance required for the L0315M-PA103 vibration test systems. It also includes additional guidance for system maintenance.

The chapter is divided into the following sections:

- General
- L0315M Shaker
- PAS103 Amplifier

CONTENTS OF THIS CHAPTER

(Note Page)

1 General

1.1 Maintenance Policy

Sentek Dynamics’ maintenance policy requires the user should be able to perform routine maintenance and simple repairs to keep the equipment operational. Sentek Dynamics' maintenance contract is recommended to ensure comprehensive annual servicing of the equipment.

Routine maintenance is designed to prevent faults before they arise. Repair maintenance allows the equipment to be restored to a fully serviceable condition after a fault has occurred.

Daily Log

Keeping a daily log is extremely important for the best maintenance of the system. Sentek Dynamics recommends all users keep a daily log which includes the following information:

- Operation time
- Faults/interlock trips record
- Cause of faults/interlock trips
- Action taken to fix the system
- Important details of the performed test
- Any matter of concerns

Note: Some of the daily log information may be required for warranty claim.

1.2 Routine Maintenance

Routine activities are very important for maintaining the best system condition. The following activities are recommended by Sentek Dynamics for given time intervals. For extreme working environment, the activities may need to be performed more frequently.

Sentek Dynamics should be contacted for any concerns about the system.

Daily Activities

The following checks should be completed daily, before using the equipment:

Amplifier

1. Check and make sure all system components are turned off and isolated from the power supply.
2. Check and make sure all cables are properly connected and are unworn and undamaged.
3. Check and make sure the area around the amplifier is clear without anything blocking the airflow into the amplifier cabinet.
4. Check the cabinet for any loose parts and incorrect fittings.
5. Power on the amplifier and verify the correct rotations of all internal fans.
6. Check and make sure all emergency stops are properly functioning.
7. Switch off the power supply at the power disconnect.

Shaker

1. Check and make sure all cables and hoses are properly connected to the shaker, and they are unworn and undamaged.
2. Ensure the area around the shaker is clear from obstructions.
3. Switch on the power disconnect.
4. Ensure the armature is at the mid-position.

5. Switch on the amplifier main switch, and then press “ON” to start the system.
6. Check and make sure the blower motor begins to rotate in the correct direction.
7. Check and make sure the blower components are unworn and undamaged.
8. Perform a bare table run and listen for any abnormal noise.
9. Shut off the system according to the procedure described in Chapter 4 “Operation” and then switch off the power disconnect.

Monthly Activities

Amplifier

1. Remove the front panel covers of the amplifier cabinets and check for dust and fluff accumulated on the panels and dust filters. Clean the dust filters and make sure the filters are dry before fitting them back on the cabinet. Replace the dust filters which cannot be cleaned thoroughly.

IMPORTANT

IN ORDER TO MAINTAIN THE BEST OPERATIONAL CONDITION OF THE AMPLIFIER, IT IS IMPORTANT TO KEEP THE AIR-INLET FREE OF DUST OR ANY OBSTRUCTION SO THAT THE MAXIMUM AIRFLOW THROUGH THE AMPLIFIER CABINETS IS MAINTAINED.

2. Clean all fans with dry cloth.
3. Check the condition of the mains supply and grounding connections.

Shaker

1. Check the conditions of the armature table, armature inserts, top cover, and dust seal; replace any worn or damaged components.

Six-Month Activities

Amplifier

1. Clean the amplifier interior with a soft brush or dry lint-free cloth.

Shaker

1. Inspect all top suspension components: the upper guidance sets, armature frame, wedge, and etc. Replace any worn or damaged component.
2. Check the function of all safety interlocks and make sure the corresponding indicators illuminate on the amplifier.
3. Check for condensation accumulated on the bottom of the pressure regulators.

Yearly activities

Amplifier

Replace all dust filters.

Shaker

Check the conditions of all services required for operation of the system.

(Note Page)

2 L0315M Shaker

2.1 Serviceability check

IMPORTANT

CONTINUOUS HIGH-DISPLACEMENT VIBRATION TEST MAY CAUSE SOME COMPONENTS TO WEAR FASTER.

Increased maintenance may be required for following component:

- Upper guidance sets
- Wedge
- Internal load support system
- Power input and grounding connections

The following procedures list the necessary serviceability checks which need to be performed before the initial operation of the system and at regular maintenance periods. The maintenance period depends on regular operation frequency, duty cycle, and work conditions. Contact Sentek Dynamics' Service Department for any concerns.

1. Ensure the amplifier mains switch and all the power disconnects are switched off.
2. Follow the procedure listed below to check the resistance between field coils and ground, and between the armature coils and grounding.
    a) Disconnect the power supply cables for the armature coils and field coils from terminals on amplifier end.
    b) Insulate the open end of each cable
    c) Check and make sure the resistance between each disconnected cables and ground is larger than 1 MΩ.

Note: If the shaker was left powered off in a high-humidity condition, allow shaker to dry before taking the measurement. Shaker should only be used after the resistance values were measured.

3. Follow the procedure listed below to check the over-travel interlock circuit.
    a) Prepare displacement monitoring tools.
    b) Ensure the armature is at mid-position.
    c) Start up the shaker with bare table and minimum power supply.
    d) Gradually increase the armature displacement with small power increments.
    e) Check that the indicator illuminates on the amplifier control panel when the armature displacement exceeds the maximum limit and shaker stops operating.
    f) If the shaker continues to vibrate, turn the master gain to “Reset” and then turn off the amplifier. Check the over-travel interlock connection. Make sure the cables are properly connected and are in good condition. For further assistance, please contact Sentek Dynamics’ Service Department.
4. Check the condition of the pneumatic supply.
5. Follow the procedure listed below to check the shaker distortion.
    a) Install an accelerometer on the armature table and make sure it is insulated from the table surface.
    b) Connect the output terminal of the accelerometer to a vibration controller (such as Crystal Instruments’ controller).
    c) Check the distortion by comparing the recorded waveform from the accelerometer to the input waveform throughout the working frequency range of the shaker for several levels.

Note: Normal distortion due to the magnification of amplifier distortion should be identified. A seriously distorted sine wave at low frequencies could be caused by misalignment or damage of the armature.

2.2 Armature Removal and Fitting

Removal

1. Make sure shaker is in vertical position.
2. Switch off all electrical and pneumatic supplies.
3. Unscrew the armature center screw.
4. Disassemble the dust proof film, pressure ring, and upper cover.
5. Disassemble the upper guidance sets (four sets) from the upper plate.
6. Carefully lift both the armature and the wedges.
7. Carefully remove the wedges (four pieces) from the armature frame after the wedges rise above the upper plate.

Fitting

1. Make sure shaker is in vertical position.
2. Switch off all electrical and pneumatic supplies.
3. Before fitting the armature, check all shaker components for any worn-out parts.
4. Ensure no small objects fall into the center of shaker.
5. Carefully lower the armature and fit into the center pole until all armature coils are below the surface of upper plate.
6. Fit the wedges onto the armature frame.
7. Continue lowering the rest of the armature down with the wedges attached.

8. Assemble the upper guidance sets to the upper plate.
9. Assemble the dust proof film, pressure ring, and upper cover to the upper plate.
10. Tighten the armature central screw.
11. Switch on all electrical and pneumatic supplies.
12. Perform a bare table test run.

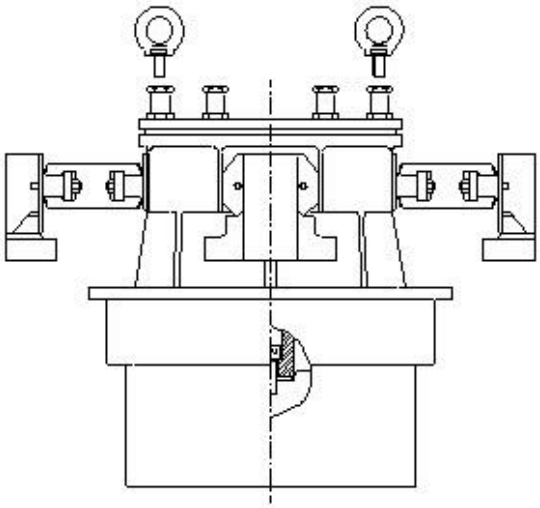


Figure 5.1 Armature and Upper Guidance System

2.3 Upper Guidance Set Removal and Fitting

Removal

1. Remove the armature as described in “Armature Removal and Fitting”.
2. Disassemble all four upper guidance set from the armature.
3. Replace any worn and damaged parts.

Fitting

1. Assemble all four upper guidance sets to the armature.

2. Refit the armature and other components as described in “Armature Removal and Fitting.

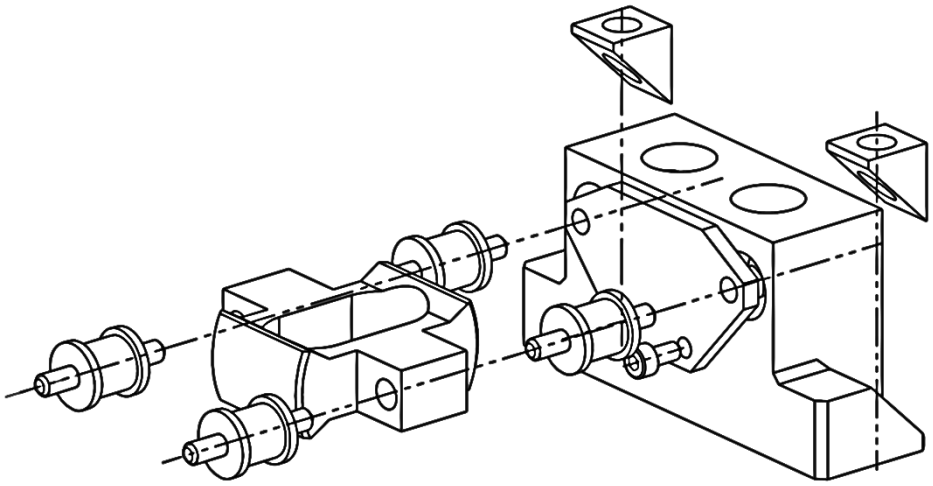


Figure 5.2 Upper Guidance System

2.4 Internal Load Support and Lower Guidance System

Removal

1. Ensure the system is at horizontal position.
2. Switch off all electrical and pneumatic supplies.
3. Disassemble the duct cases.
4. Disassemble the internal load support system.
5. Disassemble the lower guidance set.

Fitting

1. Ensure the system is at horizontal position.
2. Switch off all electrical and pneumatic supplies.
3. Assemble the lower guidance set to the shaker.
4. Assemble the internal load support system to the shaker.
5. Assemble the duct case to the shaker.

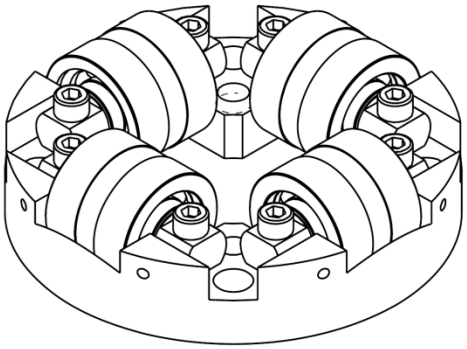


Figure 5.3 Lower Guidance Set

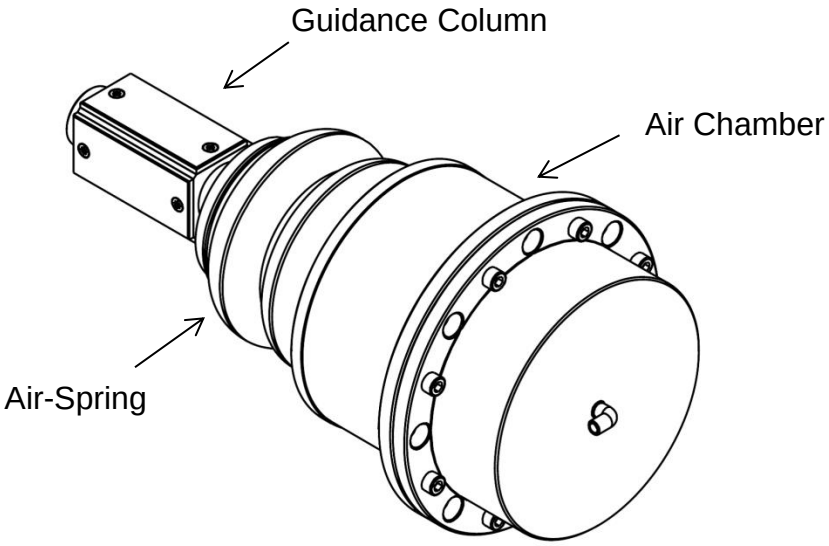


Figure 5.4 Internal Load Support

(Note Page)

3 PA103 Amplifier

3.1 Fuses

Part-No.	Rated Value	Location and Function	Unit
RGS11Z 30A	30 A	Power module, DC work power connection, FP and FN fuses	2 per sub-module
RGS11Z 50A	50 A	Power module output, O1 and O2 fuses	2 per sub-module
LA 10A	10 A	Power module IGBT fuses	10 per sub-module
LA 0.5A	0.5 A	Power module circuit power fuses	4 per sub-module
gF3 20A	20 A	Power supply unit, system control work power fuse	1
RS94G 250A	250 A	Power module power supply fuse	3
RS94G 75A	75 A	Field coils power supply fuse	3
RGS11Z 100A	100 A	Field power output, field power fuse	2

3.2 Power Module Failure

If the power module fails, do not restart the amplifier repeatedly. After remove the front cover of the amplifier, the front side of the power modules will be exposed. There are several LED indicators for failure indication located on the front side of each sub-module. The LEDs may illuminate as power module fails.

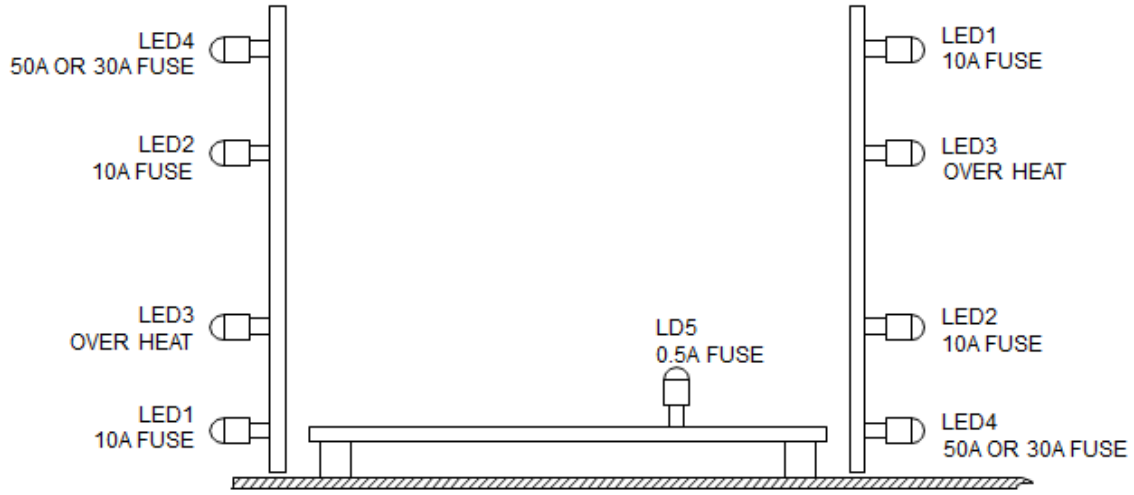


Figure 5.5 Power Module Failure Indicator Locations

When a power module fails, the “TRIP” indicator will appear on the amplifier control panel LCD and the corresponding LED indicator will light up in the sub-module that that failed.

LED1 and LED2: 10A fuse blow or MOSFET fail;

LED 3: Module overheat

LED4: 50A or 30A fuse blow

LED5: 0.5A fuse blow

Module overheat can be caused by module fan failure. The power sockets and cables for module fans should be checked to determine whether module fans

need replacement. The module fans are located on the back side of the module unit.

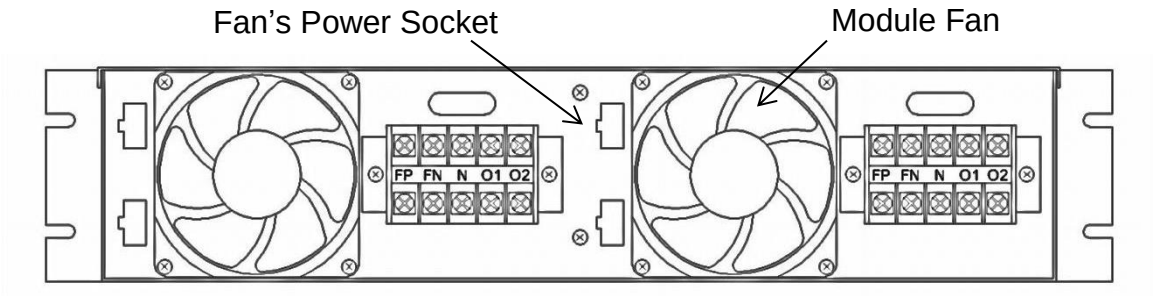


Figure 5.6 Module Fans Setup

3.3 Mains switch

When the safety interlock for the mains switch trips, the power input will be cut off, and the "RESET" button on the mains switch will pop out. The following issues may cause the mains switch to trip:

a) Electricity leak in the system

   Check for electricity leak for all system components. The leaking component should be replaced before restarting the system.

b) "Emergency Stop" was pressed

   Before resetting the "Emergency Stop" button, ensure the "RESET" button at the mains switch is not broken.

c) The "Mains Switch" malfunction

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CHAPTER 6 APPENDICES

These appendices provide the general information on topics/specifications related to L0315M-PAS103 vibration test systems.

This chapter contains the following appendices:

Appendix A Grounding, Supply and Cabling

Appendix B Displacement, Acceleration, and Eccentric Moment Limits

Appendix C Torque Values

Appendix D Recommended Spares

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CONTENTS OF THE APPENDICES

Appendix A - Grounding, Supply and Cabling

Grounding, mains supply and routing of cables are essential for the proper operation of the system.

This appendix describes the details of following topics of a system which comprises a PAS103 system:

- Grounding
- Mains Supply
- Routing of Armature Drive and Field Supply Cables.
- Routing of Signal Cables

1 Grounding

All components of the system, including the vibration controller should have a proper grounding connection using suitable sized grounding cables. All grounding cables should be connected to one common grounding point. It is recommended to ground all components to the grounding cable provided by the power disconnects. All grounding cables shall have low impedance at 50/60 Hz.

2 Mains Supply

2.1 Main Power Disconnect

High inrush current can cause severe damage to the amplifier. Although all PA amplifiers are equipped with the protective interlocks at the amplifier mains switch (main circuit breaker), it is still essential to have an integral trip sensor such as a slow-blow fuse at the main power disconnect.

The power disconnect should be clearly marked and easily accessible to the operator, and it should be lockable in the off position only.

The supply current requirement is given through following equation:

$$P = \sqrt{3} \times V \times I_l$$

P: total required system power input

V: line voltage

I_l: maximum line current

3 Armature Drive and Field Supply Cables

IMPORTANT

IN ORDER TO MAINTAIN A MINIMUM TEMPERATURE LEVEL FOR THESE CABLES, THE FOLLOWING RECOMMENDATION MUST BE ADHERED TO. FAILURE TO COMPLY MAY CAUSE THE CABLES TO OVERHEAT.

3.1 Routing of Cables

- Cables should be placed in trays and ducts to prevent any damage to the cables.
- For cables passing through the wall, insulation must not wrap around the cables at the entry and exist points of the enclosure duct.

4 Signal Cables

The following items should be kept in mind when routing and installing system signal cables.

4.1 Amplifier Signal

It is recommended by Sentek Dynamics that all drive signals to the amplifier should be supplied using a low noise cable. The drive signal connections are located on the front and back of the amplifier control unit.

4.2 Routing of Cables

High levels of electromagnetic interference can be generated from the PA103 switching amplifier. The built-in filters in Sentek Dynamics' amplifiers are able to suppress most of the electromagnetic interference. In addition, all Sentek Dynamics cables are shielded to protect the carried signal from interference caused by other equipment and devices.

For the other cables which are connected to the amplifier, it is essential to properly ground the equipment connected by the cables.

The armature drive cable may interfere with the signal cables due to high current flow. For this reason, signal cables should be kept away from the drive cable.

4.3 Installing Cables

To avoid excessive strain at the connection points, it is essential to allow the cables to have sufficient length for the selected route. The excess cable at each of the connection points should be coiled.

When routing the cables, avoid any sharp edges which could cause damage to the cable insulation.

The following are extra guidelines when installing fiber optic cables:

- Cables should not be bent.
- To avoid potential damage to the connectors, provide a strain relief at each end of the cable.
- Make sure cables are secure at both ends.

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Appendix B - Displacement, Acceleration, and Eccentric Moment Limits

1 Displacement Limit

The displacement limit for testing with specific payloads should be calculated using the following equation:

$$D = D_{max} \times \left(1 - \frac{m_a}{m_b}\right) \times 0.9$$

m_a: mass of the test payloads

m_b: mass of the shaker

D_{max}: maximum displacement of the system

D: displacement limit for specific payload.

Example:

m_a=1000kg

m_b=4000kg

D_{max}=51 mm (pk-pk)

D≈34.4 mm (pk-pk)

If the test requires a displacement larger than this value, please lock the trunnions.

2 Maximum Acceleration Limit

The maximum acceleration limit for testing with specific test payloads is given by the following equation:

$$a = \frac{F}{M}$$

a: maximum acceleration allowed

F: rated pushing force of the shaker

M: total mass of payloads, fixture, and moving parts

3 Eccentric Moment Limit

For specific payloads, the maximum eccentric moment has a relationship as follows:

$$A > m \times a \times L$$

A: acceptable eccentric moment

m: mass of the payloads

L: eccentric distance

a: vertical acceleration of the armature

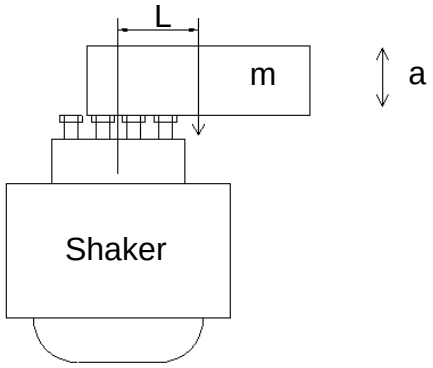

Figure B.1 Variables for Calculating the Eccentric Moment

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Appendix C - Torque Values

Torque values for securing socket-head cap screws:

Size	Class 8.8 or 9.8 Torque Value			
	Lubricated		Dry	
	N-m	lbf-ft	N-m	lbf-ft
M6	9	6.5	11	8.5
M8	22	16	28	20
M10	43	32	55	40
M12	75	55	95	70
M14	120	88	150	110
M16	190	140	240	175
M18	260	195	330	250
M20	375	275	475	350
M22	510	375	650	475
M24	650	475	825	600
M30	1300	950	1650	1200
M36	2250	1650	2850	2100

(Note Page)

Appendix D - Recommended Spares

1 L0315M-PA103 Shaker System Recommended Spares

Tools	Unit
L0315M 4.01A Vibration Isolation Rubber	8
CE-3102. EF-003 Cylindrical Vibration Isolation rubber	16
Lower Guidance Set	1 set
Dust Seal	1
PAS103 Fuses	2 sets
PAS103 Sub-modules	2