INSTALLATION AND OPERATING MANUAL

V400 SERIES VIBRATORS

Manual Number 892301

Edition 2
Amendment No. 17

SYSTEM MANUAL

LING DYNAMIC SYSTEMS

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LDS MANUALS

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AMENDMENT RECORD PAGE

V400 SERIES VIBRATORS

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Date	*Amendment Number*	*Serial Nos Affected*	*Pages Affected*	*Brief Details*	*LDS ECO*
6.1.95	*10*	*ALL*	*ALL*	*Edition 2 introduced to include CE approval requirements*	*6680*
17.7.95	*11*	*ALL*	*Preface*	*Introduction of Appendix A (Auxiliary Suspension)*	*6728*
20.7.95	*12*	*ALL*	*Preface*	*Declaration of Conformity corrected*	*6787*
21.12.95	*13*	*ALL*	*1.3*	*Note re: Maximum performance and Spec. for heat rejected to air added.*	*6810*
26.3.96	*14*	*ALL*	*4.3*	*Base fixing hole size corrected*	*6890*
1.4.95	*15*	*ALL*	*Preface*	*Declaration of Conformity updated to show EMC compliance*	*6890*
11.6.96	*16*	*ALL*	i, v, x	*To add warning notice re: the effect of Low Frequency Fields on humans*	*6949*
16.8.96	*17*	*ALL*	*2.1*	*Change to selection of drive cable*	*7040*

HEALTH AND SAFETY NOTICES - GENERAL

CONFORMITY

This equipment has been designed specifically for the purpose of vibration testing and should not be used for any other purpose unless by agreement with Ling Dynamic Systems (LDS).

The equipment complies with the following applicable European Community directives:

Machinery	89/392/EEC
Low Voltage	73/23/EEC
EMC	89/336/EEC

For installation, use and maintenance of this equipment, the responsibilities of employer and employee are specified in the European Community directive 89/655/EEC, Work Equipment Directive. This directive is implemented in the United Kingdom by statutory regulations 'Provision and Use of Work Equipment Regulations 1992' and refers to suitability of work equipment, maintenance, specific risks, information & instructions and training. Similar regulations exist in all European Community countries to implement the directive.

LDS product design provides personal protection in accordance with the relevant directives listed above. Care has been taken to minimise the risks associated with all products constituting a vibration test system. However, due to the fact that the vibrator (or combo) contains moving parts and can exert large forces to jigs, fixtures and payloads, the area surrounding the vibrator/combo should be declared a DANGER ZONE (see Definitions) and suitable precautions taken by operators working there.

LDS DOES NOT ACCEPT RESPONSIBILITY FOR RISKS INTRODUCED BY JIGS, FIXTURES AND PAYLOADS.

FOR JIGS AND FIXTURES DESIGNED BY LDS SEE THE APPROPRIATE MANUAL.

This equipment as supplied by LDS meets the essential requirements of all applicable European Directives. To maintain compliance the equipment must only be maintained and serviced by personnel certified by LDS. Certified personnel are those having successfully completed, and passed, an LDS approved training course relating to the equipment. Only parts and components issued under an LDS part number or, in the case of an emergency, parts and components approved by LDS, shall be used in the maintenance and servicing of this equipment.

HEALTH AND SAFETY NOTICES - GENERAL

DEFINITIONS

For the purpose of this manual:

Danger Zone means a zone extending 2 metres from the periphery of the vibrator and cabling.

Note: Outside this zone noise may still be a risk to health and safety.

Exposed Person means any person either wholly or partially in the danger zone.

Operator means any person transporting, installing, adjusting, operating, cleaning, maintaining or repairing the vibration system.

Main control position is next to the vibration control unit.

Payload means the test piece, part or assembly under test including any jigs, fixtures, accelerometers and fastenings used to mount it to the vibrator moving element.

SELV means Safe Extra Low Voltage

TRAINING

Vibration test systems encompass a wide variety of technological disciplines and it is a requirement that personnel who are authorized to work on a system are properly qualified and trained. The LDS 'Introduction to Vibration' two day course provides a practical introduction to the subject of vibration testing for technicians/engineers new to the subject. Access to areas where vibration test systems are located should be restricted to authorized personnel only.

MAINTENANCE

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

RESPONSIBILITIES

When specifying, siting, installing and operating a vibration system it is the responsibility of the customer to observe the following:

1. For off loading, unpacking and siting the equipment to its designated position.
2. Ensuring that the floor surface where the equipment is to be located is suitable for the equipment.
3. Ensuring that access to the equipment is adequate.
4. For providing all service requirements such as water, air lines, electrical power etc. to the point of entry to the equipment and ensuring that such supplies conform to company specifications.
5. For supplying all test equipment necessary to complete acceptance testing.
6. For making available consumable materials such as distilled water, oil, cleaning material etc.
7. Any special tools required for commissioning the system such as lifting equipment etc.
8. The pre-installation check list is to be completed prior to commencement.
9. On completion of all installations or commissioning, the commissioning certificate must be signed by the customer and returned to LDS to validate warranty.
10. PAYLOADS (AS PREVIOUSLY DEFINED) AND THEIR EFFECT ON THE VIBRATOR ARE THE RESPONSIBILITY OF THE CUSTOMER.

USE

LDS vibrator/amplifiers are designed to provide a controlled vibration testing environment for quality and reliability testing of components and assemblies, within the limits stated in the Specification. Any other use, e.g. in an explosive or corrosive environment, unusual loading, etc, may invalidate contractual agreements. Any doubts regarding the fitness for purpose of the equipment should be referred to the Technical Department of LDS before the equipment is used.

HEALTH AND SAFETY NOTICES - OPERATING

INSTALLATION

From the main control position it must be possible to ensure that there are no exposed persons in the danger zone. For vibration systems in which there is no direct line of sight between the control position and the vibrator, it is recommended that an audible warning device is fitted at the vibrator 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 prevent vibrator operation.

EMERGENCY STOP

For most vibration test systems, the vibrator is fitted with a minimum of one locking EMERGENCY STOP pushbutton, and includes the facility for additional EMERGENCY STOP pushbuttons at other locations. It is recommended that on large systems (with the vibrator in the horizontal mode) or with combos, the additional EMERGENCY STOP(S) are located adjacent to the payload position, in easy reach of an operator working in that area.

Additional emergency stop switches must comply with BS EN418-1992.

If an emergency arises, the EMERGENCY STOP should be activated immediately.

Remote Control Operation

For vibration test systems which include a remote control unit (RCP), operation is only permitted from one selected control position (i.e. amplifier or RCP). On some systems control is selected by keyswitch operation, the key being common for both positions. Although LDS provide more than one key, it is strongly recommended that only one is issued and its use restricted to the authorised operator. This will provide added protection against system mal-operation or mis-use.

Other systems provide similar protection by means of software selection of the operating position.

RISKS

Noise

Exposure of the human body to high noise levels can damage health. Electrodynamic vibration test equipment can generate significant noise levels (see Specification) and ideally should be sighted within a soundproof cell. The operator control position, together with signal generation, control and monitoring equipment should be located outside the soundproof cell. Power amplifiers, cooling units and other ancillary equipment can also generate significant noise levels and should be located away from the operator control position. If the ideal situation is impractical, all personnel at risk must be made aware of the hazards involved and a directive issued that ear defenders should be worn.

Mechanical

It must be remembered that vibrators can be used to test equipment to destruction and that the forces available can be considerably amplified by local resonances. Precautions must be taken to ensure that any parts of 'items under test' which may become detached cannot cause injury to personnel.

Payloads must be designed and mounted such that they cannot overturn the vibrator either statically or under test. Further, they must not exceed the rated load of the vibrator bearings (see Specification Section).

In so far as their purpose allows, payloads should have no sharp edges, no sharp angles and no rough surfaces likely to cause injury. Payloads should also have no trapping points , e.g. where fingers or hands might be trapped during test.

It is recommended that all persons entering the DANGER ZONE, whether the vibrator is energised or not, are aware of the risks (see also EMERGENCY STOP) and that appropriate protective clothing is worn. Other risks specific to siting and operation of the vibrator are identified in the relevant sections of this manual.

Electrical

All equipment constituting a vibration test system contains voltages above SELV and are potentially lethal. During normal operation, it is not necessary for an operator to access areas containing voltages above SELV. Access to the areas containing high voltages can only be gained by removing panels or covers, or by opening doors with the use of a tool (including a key).

It is the policy of LDS to supply two keys for each lock position. To ensure that access to the interior of equipment is restricted to designated personnel, it is strongly recommended that all keys are held by a responsible person, authorised to issue keys for service/maintenance purposes.

With the exception of during calibration or fault diagnosis, by qualified personnel, with equipment power applied, equipment should be completely isolated from the supply before gaining access.

HEALTH AND SAFETY NOTICES - OPERATING (cont.)

Pneumatic

Some vibrators 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 subsequently setting armature and body positions. (see relevant Manual section).
It is recommended that the air supply has a shut-off valve adjacent to the vibrator for use in emergencies or when the vibration system is not being used e.g. overnight. In such cases the payload should be supported by other means e.g. armature lock-out plates or overhead crane.

Hydraulic

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

Water

Some vibrators are water cooled with the cooling system self contained within the vibrator, hoses and cooling unit. Although water can only be released (leak) due to a failure in the system, operators should be made aware of the temperatures attained during normal operation (see below).

Temperature

The heat generated by all equipment in the vibration test system should be considered before siting. Measures should be taken to ensure that the temperature of the working environment for the system and operating personnel is within allowable limits. Operators should also be made aware that some equipment, particularly water cooled vibrators, can attain high surface temperature during normal operation.

Blower Outlet (Air cooled vibrators)

The air outlet port from the cooling blower in air cooled vibrator systems should be positioned such that an operator cannot stand directly in line with the airflow. This is a precaution to prevent injury in the event of small objects, e.g. nuts or screws becoming detached in the vibrator and ejected at high velocity from the blower.

Cables and Hoses

Where practical, all cables and hoses used in the vibration test system should be sited in ducts or trunking to give clear unimpeded access to the vibrator, 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, Protection Of Workers From The Risks Related To Exposure To Carcinogenic Substances At Work, which is implemented in the UK by the COSHH regulations.

HEALTH AND SAFETY NOTICES - OPERATING (cont.)

Before operating any vibration system, check:

* **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 cooling medium (if applicable) is sufficient.**
* **the hydraulic oil supply (if applicable) is correctly topped-up.**
* **the 'item under test' is correctly secured to the vibrator or slip table.**
* **That all personnel are clear of the DANGER ZONE**

SAFETY WARNING

EFFECT OF LOW FREQUENCY FIELDS ON THE HUMAN BODY

Vibrators and associated power products produce DC and low frequency magnetic fields by virtue of their mode of operation. Current medical research is inconclusive as to the effect of low frequency electromagnetic fields on the human body. LDS is continuously monitoring the results of this research which presently cannot provide proof of either risk or zero risk.

(16)

It is our recommendation that all personnel, particularly those with medical implants, do not enter the 2 metre DANGER ZONE whilst the vibrator is running. LDS cannot accept responsibility for the results of electromagnetic field hazards present with vibration systems but strongly advise that all precautions, as defined in the product handbooks, are followed.

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CONTENTS (cont.)

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LIST OF FIGURES & TABLES

ASSOCIATED PUBLICATIONS:

PA500L Amplifier, Installation and Operating Manual Manual No. 846681

CHAPTER 1 - SPECIFICATION

1. INTRODUCTION

The V400 Series vibrators are wide frequency band electro-dynamic transducers capable of producing a sine vector force of 196 N when force cooled. They are also suitable as non-seismic pick-ups and are widely used in educational and research establishments to investigate the dynamic behaviour of structures and materials. Other applications include fatigue and resonance testing, used as velocity transducers or high speed actuators and various medical purposes.

V400 series vibrators can be driven by any suitable oscillator/amplifier combination, but the Ling Dynamic Systems PA500L amplifier is specially recommended for this purpose. Being of the permanent magnet design, the V400 series vibrators do not require a field power supply. A typical system incorporating the V400-PA500L combination is shown in Figure 1.1.

The vibrator can be base or trunnion mounted and an auxiliary suspension is available, at extra cost, for use when the weight of the test package exceeds the table suspension rating (see Figure 4.2).

To allow maximum performance to be obtained from the vibrator, provision is made for the vibrator body to be force air cooled. A remote fan unit for this purpose can be obtained from LDS.

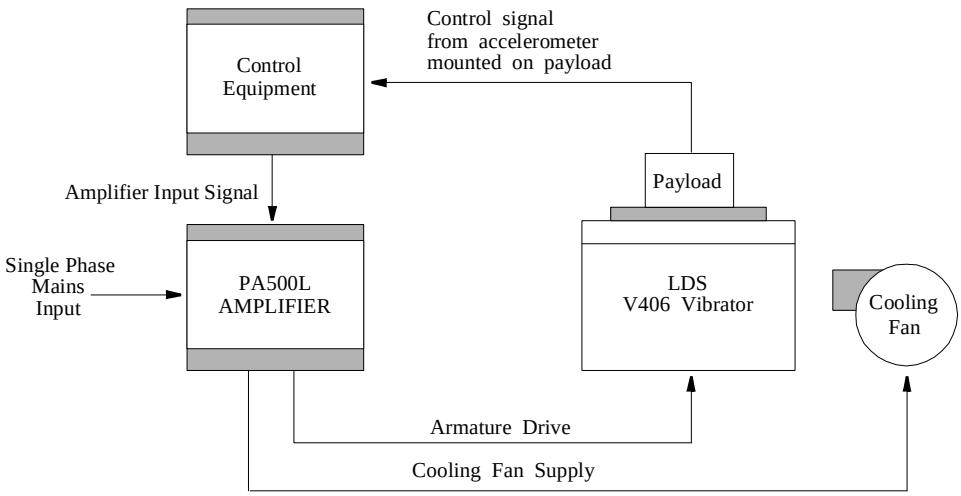
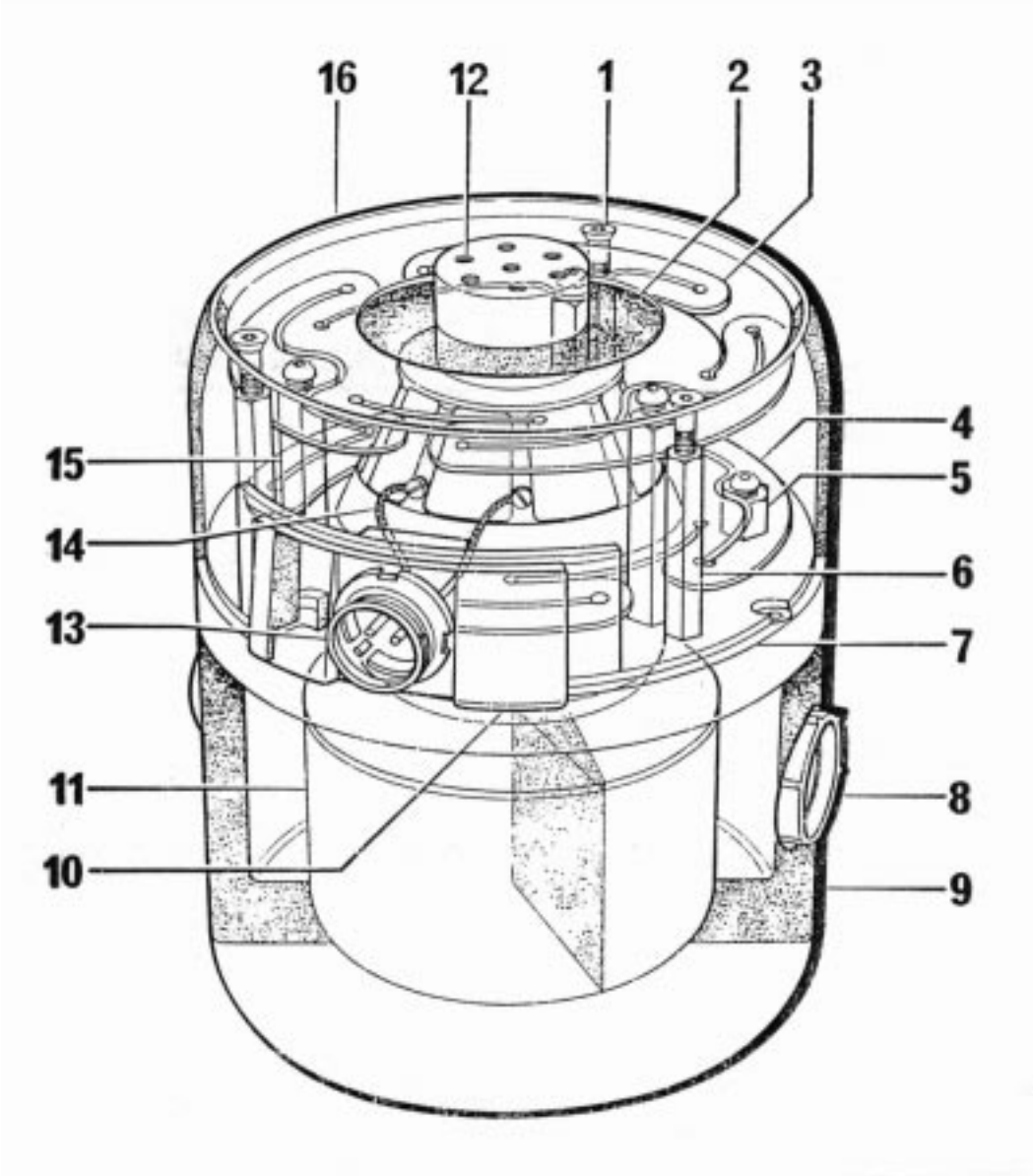


Figure 1.1 Typical System -V400 Series Vibrator with PA500L Amplifier

1. INTRODUCTION



1. Top cover retaining screws
2. Dust seal
3. Upper flexure (bonded to moving coil assembly)
4. Lower flexure (bonded to moving coil assembly)
5. Lower flexure support pillars
6. Top cover retaining pillars
7. Flexure support ring
8. Trunnion attachment and air cooling inlets
9. Magnet housing
10. Cooling air exhaust ports
11. Columax permanent magnet
12. Moving platform and drive coil assembly
13. Vibrator input drive socket
14. Electrical drive leads
15. Upper flexure support pillars
16. Top cover

Figure 1.2 Sectioned View - V400 Series Vibrator

2. SPECIFICATION

2.1 Specification - V400 Series Vibrators

	Metric		American	
Model (armature dia.)	**V406/408 (38 mm)**		**V406/408 (1.5 in)**	
Sine force, peak	(Note 2) 98.0 N		22.0 lbf	
Maximum Sine force peak	(Note 3) 196 N		44.0 lbf	
Armature Resonance Frequency	9000 Hz		9000 Hz	
Useful Frequency Range	5 - 9000 Hz		5 - 9000 Hz	
Effective Mass of Moving Element	0.20 kg		0.44 lb	
Velocity Sine Peak	1.78 m/s		70 in/s	
Maximum Velocity Sine Peak	1.78 m/s		70 in/s	
Maximum Acceleration Sine Peak Maximum Acceleration Sine Peak	(Note 2) 490 m/s^2 (Note 3) 980 m/s^2		50 gn 100 gn	
Amplifier rating	0.72 kVA		0.72 kVA	
LDS Amplifier	PA500L		PA500L	
Suspension axial stiffness Stiffness with auxiliary suspension	12.3 N/mm 35.1 N/mm		70 lbf/in 200 lbf/in	
Displacement (continuous) pk-pk	17.6 mm		0.69 in	
Max. Displacement (cont.) pk-pk	17.6 mm		0.69 in	
Cooling Air Flow Rate	0.014 m^3/s		30 ft^3/min	
Max. working ambient temperature	30^0C		86^0F	
Heat rejected to air	340 W		340 W	
Electrical requirement - Amplifier - Cooling fan	1.30 kVA 0.25 kVA		1.30 kVA 0.25 kVA	
Max. acoustic noise (Ref. Figure 1.4)	(Note 2) 82 dB (Note 3) 105 dB		82 dB 105 dB	
Impedance at 500 Hz	(Fig. 1.3) 2.5 ohms		2.5 ohms	
Vibrator mass, (mounting)	(base)	(trunnion)	(base)	(trunnion)
	14.1 kg	22.7 kg	31 lb	50 lb
Height	198.4 mm	273.8 mm	7.81 in	10.78 in
width	165.0 mm dia.	165.0 mm	6.50 in	6.50 in
Length	- - -	259.0 mm	- - -	10.19 in

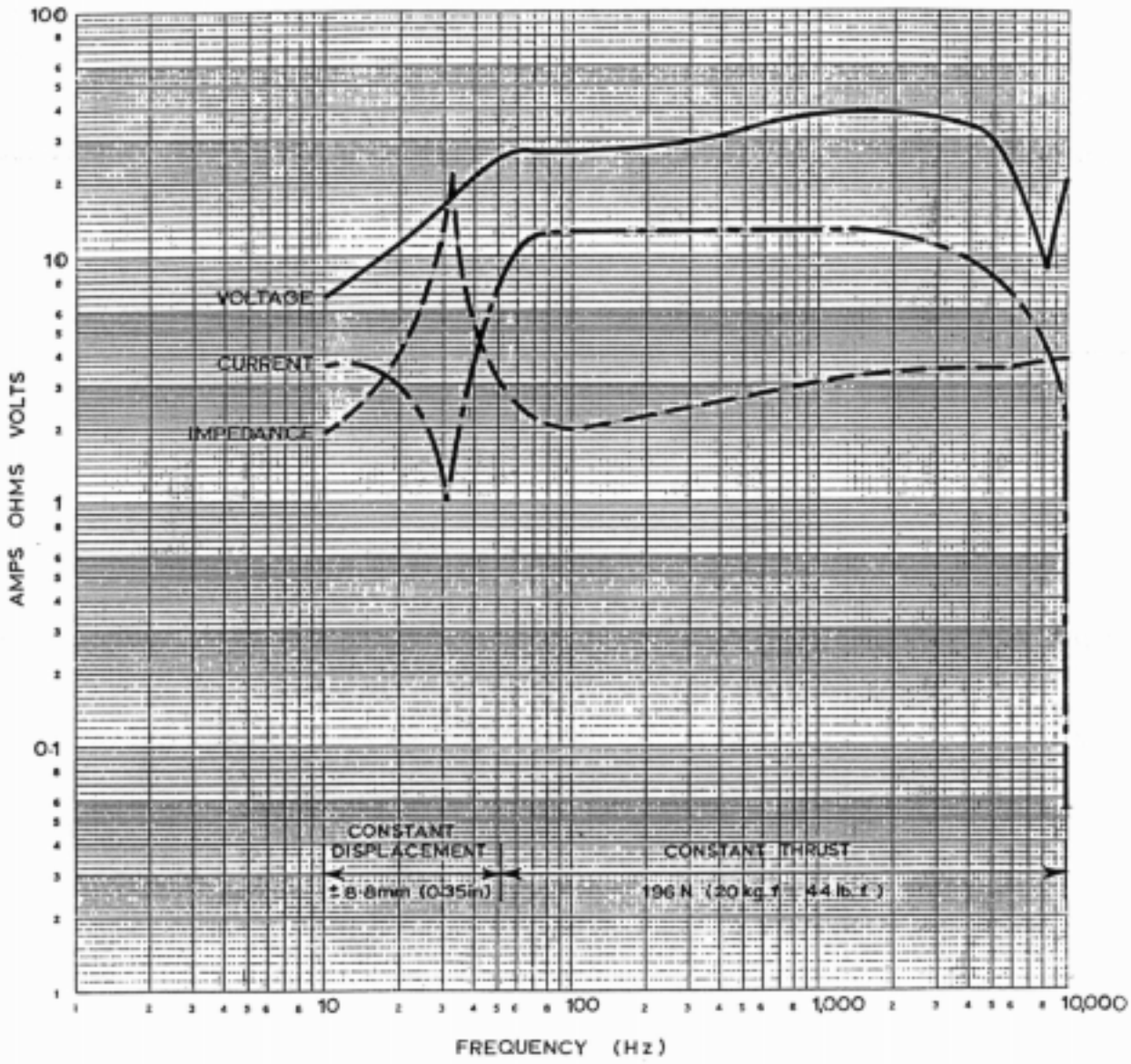
(13)

Notes: 1. Details not applicable to this range of vibrator shown - n/a.
2. Performance available with LDS amplifier, naturally cooled.
3. Maximum performance with forced air cooling - maximum duration 40 minutes, (167 N maximum sine force continuous). *(13)*

2. SPECIFICATION (cont.)

	Metric	American
Model (armature dia.)	**V406/408 (38 mm)**	**V406/408 (1.5 in)**
Current at mid frequency for thrust of 98 N (22 lbf)	6 amps	6 amps
D.C. force factor (force/A)	11.1 N/A	2.58 lbf/A
Armature D.C. resistance (cold)	1.2 ohm	1.2 ohm
Maximum working current:		
Naturally cooled	6 amps	6 amps
Force cooled	13 amps	13 amps
Spring/mass resonance (nominal)	35 Hz	35 Hz

2. SPECIFICATION (cont.)



Typical characteristics of the V400 series vibrator (forced cooling) with PA500L series amplifier.

Data plotted for a thrust of 196 N (44 lbf) vector, with displacement limit 8.8 mm (0.35 in) peak-to-peak. Maximum acceleration 100 g

Figure 1.3 Typical Performance Curves

3. ENVIRONMENTAL DATA

3.1 Environmental Notes

3.1.1 Electrical supply input figures are worst case demands. Average power under swept sine or random test conditions will be lower.

3.1.2 Amplifier supply voltages over the range are catered for by means of taps on the supply transformer. Other voltages can be catered for by special order.

3.1.3 The determination of noise levels is a varied and complex procedure. Figure 1.4 shows the conditions under which the values stated on the specification sheet were obtained.

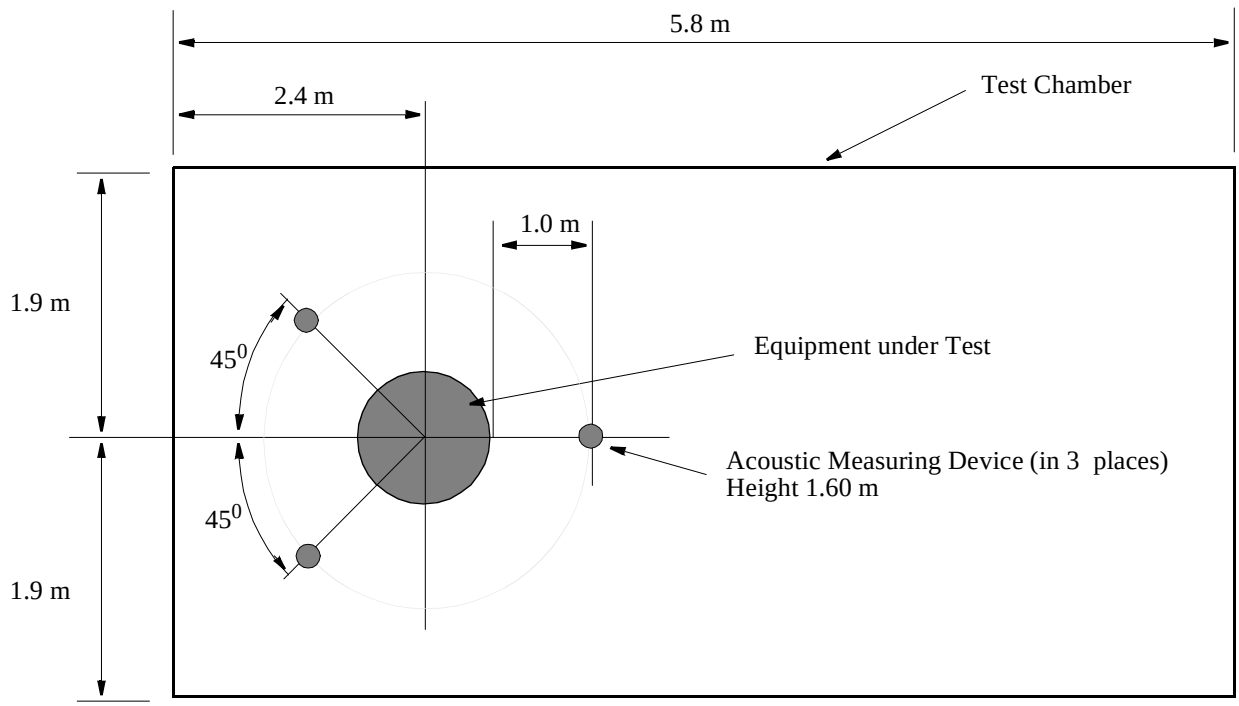


Figure 1.4 Noise Level Measurement Chamber

CHAPTER 2 DESCRIPTION

1. Construction

The V400 series vibrators consist of a magnet housing which contains a COLUMAX permanent magnet. A magnetic field is thus produced in the annular gap surrounding the armature drive coil. The Armature and Drive Coil Assembly is suspended on two laminated fibre flexures; and the flexures are attached to the vibrator body by support pillars. A top cover, fitted with a dust seal, prevents the ingress of potentially damaging grit (see Figure 1.2).

The armature assembly consists of a cylindrical copper coil bonded to a cast aluminium radial finned structure. The armature is located around the top of the centre pole assembly and occupies part of the air gap in the magnetic structure. The two laminated flexures bonded to the armature provide axial support for the armature as well as providing lateral and rotational restraint.

Armature drive current is applied to the vibrator via the vibrator drive input socket; an appropriate cableform is supplied with whichever LDS amplifier is selected. *(17)*

When current is applied to the armature coil conductors, which are at right angles to the magnetic flux in the air gap, a resulting force is produced which is mutually perpendicular to the air gap flux and direction of the armature current. An alternating current thus produces an alternating force.

2. Cooling

Blower cooled versions of the vibrator have a hose connection fitted to one of the trunnion pivot holes located in the vibrator body. Cooling air enters the vibrator through intakes in the top cover, passes over the armature coil, and is exhausted through the hose connection by the external blower unit.

IMPORTANT

The remaining pivot hole in the vibrator body must be fitted with the plug provided. If this plug is not fitted the armature coil will overheat and rapidly fail.

3 INSTALLATION

3. Installation

3.1 Unpacking

Check the equipment received against the packing list to ensure a complete shipment.

Carefully inspect the vibrator for damage which may have occured while in transit and notify the shipping agent (carrier) immediately of any damage.

3.2 Site Selection and Preparation

The V400 series vibrator should be installed in a location which is free of airborne ferromagnetic particles. Any operation which produces such by-products in the installation area should only be performed after adequate protective measures are taken. Although the vibrator is completely sealed around the armature, an accumulation of abrasive material at the armature diaphragm seal can substantially shorten the life of the seal. If the seal is broken, a build-up of ferromagnetic particles in the air gap could result in eventual breakdown of the armature coil.

The physical location of the vibrator is restricted only by the lengths of the inteconnecting cables. It is recommended that the vibrator should be placed close to the control unit for quick and easy monitoring of the vibrator by the operator.

3.3 Installation

All dimensions necessary for the installation of the V400 series vibrator are shown in Figure 4.1.

It is recommended that in a permanent installation, the vibrator base (or trunnion base when supplied) is secured to the surface on which the vibrator stands, to prevent the body of the vibrator vibrating.

CHAPTER 3 OPERATION

1. General

The V400 series vibrators, when part of a vibration test system, can handle relatively large amounts of power. Incorrect application of power can have a devastating effect on the vibrator and load-under-test.

The Ling Dynamic Systems model PA500L amplifier with suitable oscillator is recommended as a source for the V406 and V408 vibrators.

THIS EQUIPMENT SHOULD ONLY BE OPERATED BY PERSONS WHO ARE TRAINED IN THE TECHNIQUES OF VIBRATION TESTING.

The operating procedure for a vibrator is relatively simple but it is necessary to take elementary precautions to avoid overloading the vibrator, electrically and mechanically, and damaging the vibrator or the driving equipment or both.

2. Load Attachment

The vibrator load mounting table is provided with 7 tapped holes for load attachment (see Figure 4.1). The best dynamic performance will result if all the holes are used.

CAUTION

DO NOT DRILL ADDITIONAL HOLES IN THE LOAD MOUNTING TABLE. DRILLING OF ADDITIONAL HOLES WILL WEAKEN THE TABLE AND MAY RESULT IN DAMAGE TO THE EQUIPMENT.

Screws used in mounting test fixtures or loads on to the mounting table should not exceed more than 2 to 2.5 times the diameter of the screws and should be tightened to the manufacturers recommended torque value for the particular class of fastener used. The table should be firmly gripped while the screws are tightened to prevent a rotating movement which could cause damage to the internal suspension. Looseness or excessive compliance in any of the mechanical connections between the driving coil and the test load will cause erratic uncontrolled test levels and frequency components. Difficulties caused by such looseness can be detected with an oscilloscope connected to the accelerometer output. Serious departure from a sinusoidal response, or more particularly, the addition of

3. OPERATION (cont.)

high frequency non-harmonic noise components superimposed on the waveform is nearly always an indication of decoupling between the armature and fixture; fixture and load; or looseness within the fixture. Bolted connections within the fixture should always be avoided as much as possible, welded or casting is preferable.

Care must be exercised in locating the load over the armature table. The fixture height should be minimised to keep the centre of gravity as close to the table as possible. Driving a complicated fixture and load causes coupled modes of vibration which can only be reduced by vigorous symmetry and careful alignment of the load over the thrust axis of the armature. Load attachment is a specialised problem which must be solved for each load. The motion of the table and fixture with the load in place may be checked with a series of measurements taken with lightweight crystal accelerometers.

3. Vertical Operation

For vertical operation the mass of the test load and subsequent deflection of the suspension system must be considered when calculating the available displacement. If necessary an auxiliary suspension system can be supplied which will increase the load carrying capacity as shown below. Alternatively, a low stiffnes spring, such as rubber shock cords, can be used to support the load at the mean working height.

$$\text{Maximum travel available peak-to-peak} = d = s - \left[\frac{2w}{k} \right]$$

Where:	d = Maximum travel available, peak-to-peak	=	..... mm
	s = Maximum travel permitted, peak-to-peak	=	8.8 mm
	k = Suspension stiffness, basic vibrator	=	12.3 N/mm
or	k = Stiffness, with auxiliary suspension	=	35.1 N/mm
	w = Load on armature (mass x 9.81)	=	..... N

An optional auxiliary suspension unit is available for fitting to the V400 series vibrators. The increased suspension stiffness allows heavier payloads to be supported. Alternatively, the vibrator may be freely suspended from the test specimen. However, it must be taken into consideration that due to the increased suspension stiffness, both the displacement and the thrust available to accelerate the payload will be reduced.

4. Pre-operational Check-out

Observation of the waveform through the use of a lightweight crystal accelerometer and an oscilloscope is the most sensitive test for proper vibrator operation. The following test is recommended:

a. Mount an accelerometer on the armature table. In the case of installations where the vibrator is earthed, the accelerometer should be insulated from the vibrator armature to prevent ground loops.

3. OPERATION (cont.)

b. Connect the accelerometer output to an appropriate amplifying system with the accelerometer amplifier output connected to an oscilloscope.

c. With the accelerometer mounted and connected as described, scan the frequency range at several different levels noting waveform.

It is necessary to be able to differentiate between normal and abnormal distortion. Serious departure from a sine wave is usually an indication of armature or suspension misalignment or damage. Some distortion at sub-mulitiples of the resonance frequency may be expected due to the amplification of a small percentage of the amplifier distortion. It is strongly recommended that a record should be made of the armature resonance frequency and harmonic wave form when the vibrator is received. A check with this record will enable trained personnel to differentiate between normal and abnormal distortion. A periodic check with this record will minimise trouble shooting time and is also a very good preventative maintenance check.

5. Operation

It is important that care should be taken when operating the vibrator to avoid damage to the suspension or armature coil. Damage can be caused by transients in the supply waveform or by exceeding the displacement, acceleration, or force limits. Therefore, the following points should be borne in mind:

a. If the vibrator is being controlled manually through the frequency range, this should be done slowly with a watch being kept on acceleration as the armature resonance frequency is approached.

b. Avoid switching the oscillator to a different range without first reducing the amplifier output to zero, otherwise the resulting transient could exceed the acceleration limit.

c. Care must be taken at the low frequency end to see that the maximum displacement is not exceeded, otherwise the armature will strike the mechanical stop with an impact which exceeds the acceleration limit.

d. It is important that the maximum armature current or force limits for the vibrator and cooling condition is not exceeded, otherwise overheating will result. Reference should be made to Chapter 1, Section 2.1 for permissible maximum force and current limits.

Figure 1.4 shows the performance of the vibrator at full thrust, bare table. The velocity limit with any particular vibrator/amplifier configuration will depend entirely on available amplifier voltage.

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CHAPTER 4 SERVICING

1.1 Maintenance Policy

The LDS maintenance policy is that the user should be able to perform routine maintenance and simple repair tasks to keep the equipment operational. It is strongly recommended that a full maintenance contract is taken out with Ling Dynamic Systems. This contract provides for an annual comprehensive service 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.

1.2 Daily Log

Users are strongly advised to keep an equipment log, recording the following detail. The equipment's history can prove invaluable, should advice be sought from LDS:

Number of hours run
Timetable of system faults/interlock trips
Cause of faults/interlock trips (if known)
Action taken to rectify faults
Any matters of concern.

1.3 Service and Spares

Various levels of recommended spares holdings, tools and general service advice are available on request from:

The Service Department
Ling Dynamic Systems
Baldock Road
ROYSTON
Herts. SG8 5BQ
England

Telephone:UK(0763)242424
Fax:UK(0763)249715
Telex:81174 LDS BEC G

2. SERVICING

2.1 User Servicing

In cases where the user has a sufficiently comprehensive repair organisation to permit work of this type to be carried out, the spares listed in this Chapter are obtainable from the manufacturer.

To dismantle the vibrator (refer figure 1.2) proceed as follows:

1. Disconnect the external electrical connections via the plug and socket connection on the vibrator body.

2. Remove the three top cover retaining screws and ease off the cover.

3. Examine the upper and lower flexures for signs of fatigue cracks, which can be caused when the weight of a test package has not been evenly distributed over the moving table. If scraping sounds have been heard from the vibrator during operation, it is important to inspect the moving coil for damage and also the annular gap. To facilitate this, the flexure support plate assembly can be lifted out as one complete unit after removal of the two socket head screws.

4. Should damage have been sustained to the moving coil, it is advised that the armature and flexure assembly complete be replaced, which will greatly simplify the overhaul procedure.

5. During re-assembly, ensure that the moving coil is accurately located within the annular gap, and that it can be manually moved up and down without touching the magnet or pole piece top plate).

6. Re-connect the external electrical connections.

3. OUTLINE DETAILS

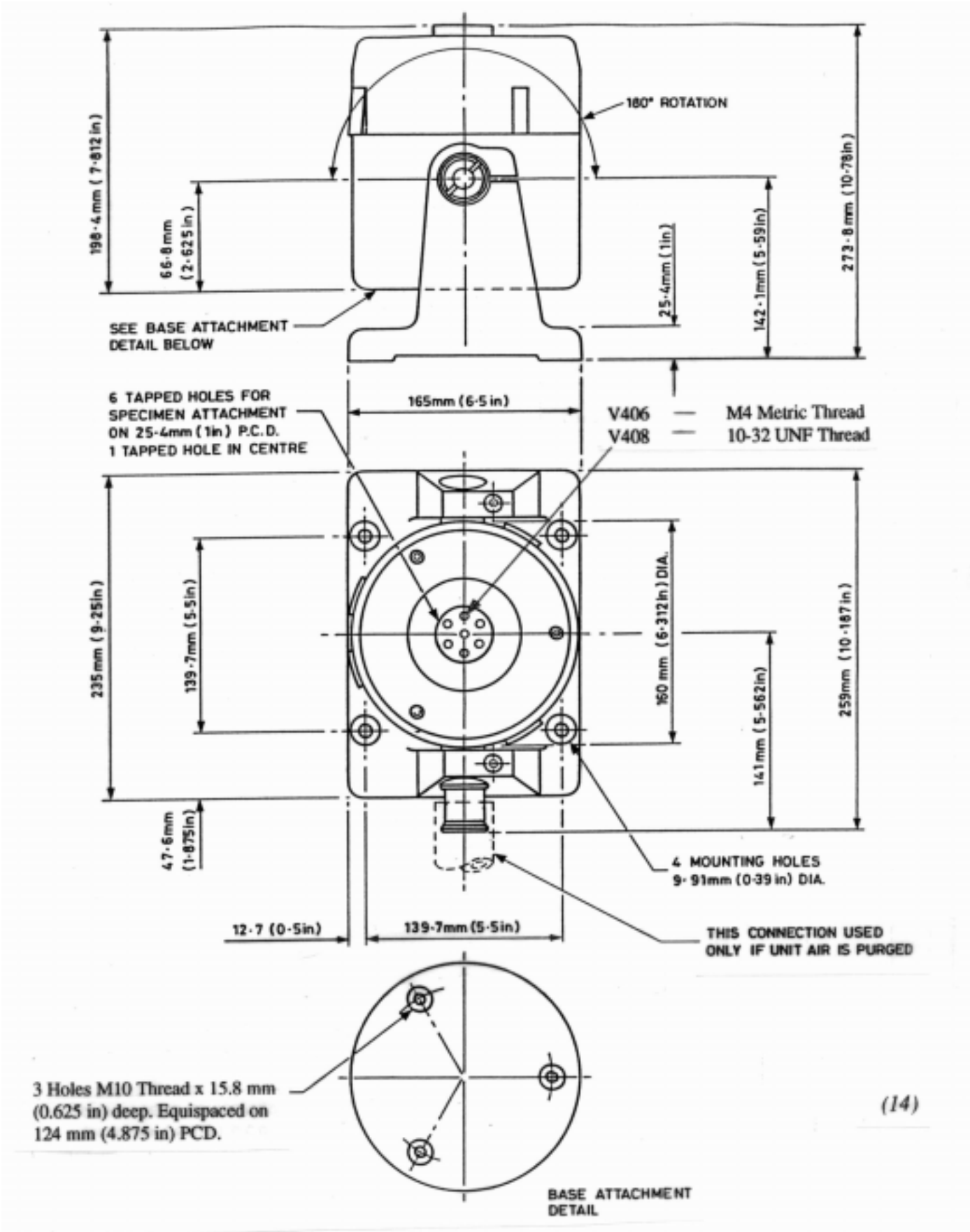

Figure 4.1 Outline Dimensions - V400 Series Vibrators

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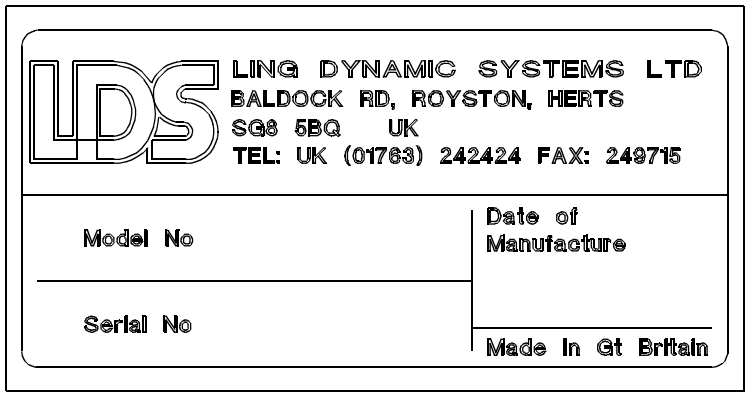
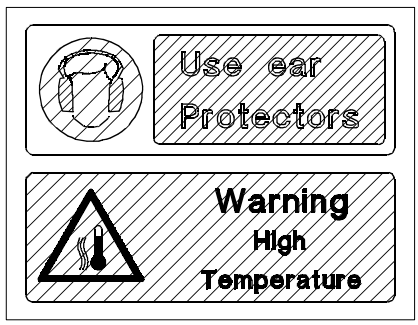
4. WARNING LABELS



(a)



(b)

Figure 4.2 Warning labels - V400 Series Vibrators

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APPENDIX A

AUXILIARY SUSPENSION AUX400
FOR USE WITH V406/408 VIBRATORS

1. General

The auxiliary suspension kit, Part No. 896510, provides additional stiffness to the standard vibrator suspension, which increases payload capacity, or permits the vibrator to be vertically suspended from the test structure.

2. Changes to Specification

Suspension axial stiffness	12.3 N/mm (70 lbf/in)
Stiffness with auxiliary suspension:	35.1 N/mm (200 lbf/in)

3. Installation

To avoid possible damage to the vibrator's moving coil and suspension assembly, it is recommended that the AUX400 is fitted to the vibrator as follows:

3.1 Disconnect the vibrator at the input terminals from the amplifier and remove any accelerometers or payload. If the vibrator is trunnion mounted ensure body is in the vertical axis.

Note which header type is fitted:

Vibrator Model Number	Adaptor Thread	Letter Code Identity	Vibrator Table Thread
V406	M6	M	M4 x 6.3 mm deep
V408	1/4 UNC	A	8-32 UNC

3.2 Examine figure 1 showing the complete assembly and note the position of the spider (1) in relationship to the rest of the assembly.

3.3 Commence by attaching the spider (1) together with the appropriate clamping adaptor (2) to the test specimen mounting platform with the six socket-head screws (3). Do not tighten down these six screws at this stage.

3.4 The support ring (4) halves are lightly clamped to the vibrator body with two socket-head screws (5). Ensure that the cut-outs in the support ring are directly under the exhaust ports to permit the cooling air to pass from the vibrator. Note also the position of the flange on the clamp ring.

3.5 Attach the four spacers (6) between the spider (1) and support ring (4) with the four socket-head bolts (7), plain washers (8) and aero-tight nuts (9), do not tighten at this stage.

3.6 Complete assembly by securing all nuts and bolts in the following order.

Commence with the six socket-head screws (3) recessed in the clamping adaptor (2) remembering to tighten diagonally across from one bolt head to the other in pairs.

Tighten the four socket-head bolts (7) to secure the spider (1) to the support ring (4). Care must be taken not to twist the spider by over-tightening the retaining nuts.

Tighten the two remaining socket-head screws (5) which secure the support ring to the vibrator body. Ensure manually that ther is still free 'up and down' movement of the header before connection to the drive amplifier.

4. Payload Support Capability

The maximum allowable payload, mass, which can be self supported by the V406/408 suspension, when fitted with auxiliary suspension, is as follows:

VERTICAL OPERATION relates to displacement required at lowest operating frequency.

$$d = s - \left[\frac{2w}{k}\right]$$

Where	d	=	Maximum travel available	=	..... mm
	s	=	Maximum travel permitted	=	17.6 mm
	k	=	Stiffness, with auxiliary suspension	=	35.1 N/mm
	w	=	Payload weight (mass x 9.81)	=	..... N

Also: $w = \frac{k}{2}(s - d)$

Where	w	=	Max. Payload weight (mass x 9.81)	=	..... N
	d	=	Travel permitted	=	..... mm

If the required payload weight exceeds the value of w in the above equation, in respect of the required displacement, additional means of load support will be necessary, i.e. rubber shock cords such that armature is returned to its original neutral position.

Refer to vibrator Installation and Operating manual for further Information.

APPENDIX A (cont.)

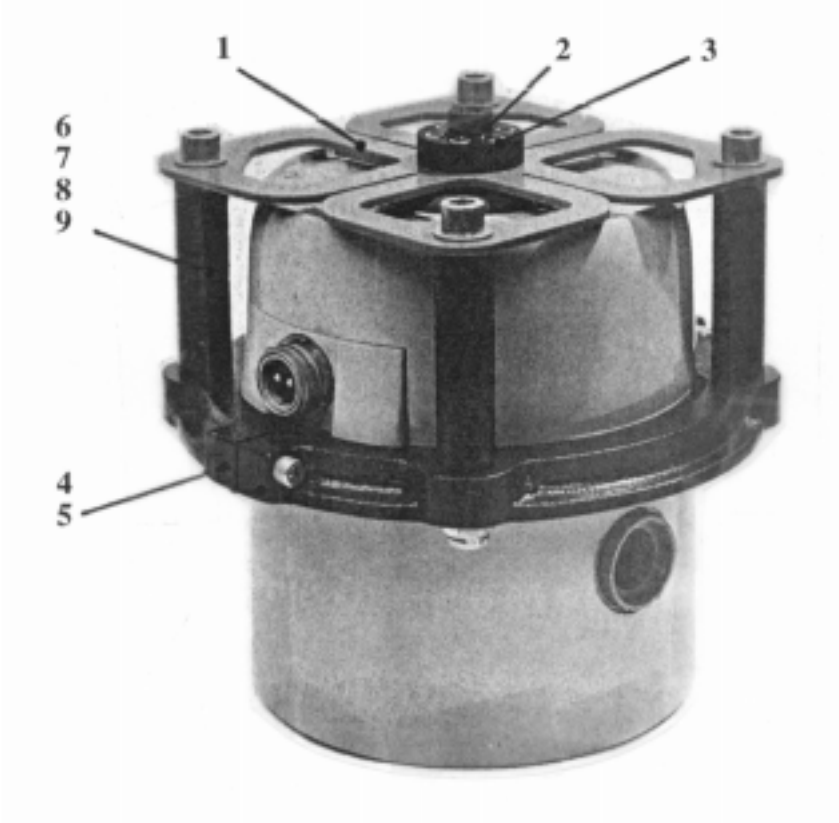

Figure 1 Auxiliary Suspension AUX400

APPENDIX A (cont.)

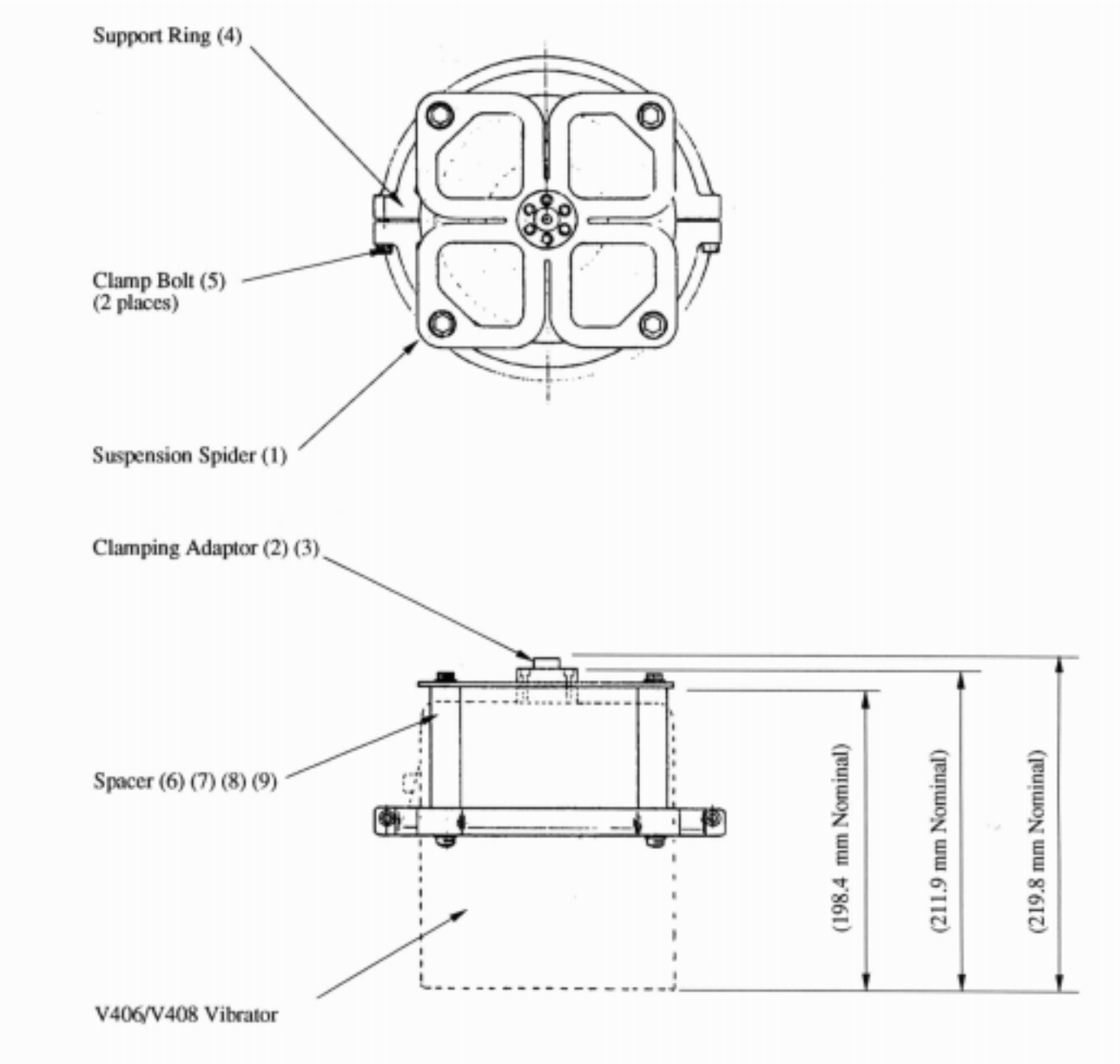

Figure 2 Auxiliary Suspension AUX400 - Reference Dimensions