INSTALLATION AND OPERATING MANUAL

V550 SERIES VIBRATORS

Manual Number 877351

Edition 2
Amendment No. 13

SYSTEM MANUAL

LING DYNAMIC SYSTEMS

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AMENDMENT RECORD PAGE

V550 SERIES VIBRATORS

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Serial Number of your equipment: ________________

Date	*Amendment Number*	*Serial Nos Affected*	*Pages Affected*	*Brief Details*	*LDS ECO*
23.3.95	*7*	*ALL*	*ALL*	*Edition 2 introduced to include CE approval requirements*	*6680*
20.7.95	*8*	*ALL*	*Preface*	*Declaration of Conformity corrected*	*6787*
14.3.96	*9*	*ALL*	*App. A*	*Formulae corrected*	*6890*
1.4.95	*10*	*ALL*	*Preface*	*Declaration of Conformity updated to show EMC compliance*	*6890*
11.6.96	*11*	*ALL*	i, v, x	*To add warning notice re: the effect of Low Frequency Fields on humans*	*6949*
1.9.97	*12*	*ALL*	i, v, 6.11, 6.12	*To update the spares list.*	*7361*
13.1.00	*13*	*ALL*	i, v, 1.4	*Corrections to armature mass and maximum payload*	*8071*

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. (11)

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.

CONTENTS

Page

PREFACE

LDS Manuals ... iii
Amendment Record Sheet ... v
HEALTH AND SAFETY NOTICES ... vii
Contents ... xi

CHAPTER 1 SPECIFICATION

1. Introduction ... 1.1
2. Specification ... 1.3
3. Environmental Data ... 1.8

CHAPTER 2 DESCRIPTION

1. Mechanical ... 2.1
2. Electrical ... 2.2

CHAPTER 3 INSTALLATION

1. General ... 3.1
2. Lifting Details ... 3.2
2. Air Switch Adjustment ... 3.3

CHAPTER 4 OPERATION

1. Pre-operational Checks ... 4.1
2. Load Attachment ... 4.1
3. Operation ... 4.6
3.1 Starting and Shutting Down ... 4.6
3.2 Precautions ... 4.6
3.3 Performance ... 4.6

CHAPTER 5 MAINTENANCE

1. General ... 5.1
2. Armature - Removal and Fitting ... 5.5
3. Centre Bearing - Removal and Fitting ... 5.8
4. Load Support Rolling Diaphragm - Removal and Fitting ... 5.8
5. Field Coil ... 5.9
6. Component Identification, Drawing No. 877350 ... 5.10
7. Warning Labels ... 5.11

CHAPTER 6 APPENDICES

A. Cross Axis Acceleration Limits and Resonance ... 6.1

B. Spares List ... 6.11

CONTENTS (cont.)

Page

LIST OF FIGURES & TABLES

Figure 1.1 Typical System, V555-PA1000L-FPS10L 1.1
Figure 1.2 Sectioned View, V550 Series Vibrator 1.2
Figure 1.3 Performance Curves - V550/551 ....1.6
Figure 1.4 Performance Curves - V555/556 ....1.7
Figure 1.5 Noise Level Measurement Chamber 1.8

Figure 2.1 Electrical Schematic Diagram 2.3

Figure 3.1 Air Switch Detail 3.2

Figure 4.1 V550/555 Offset Load Graph (horizontal operation) 4.5

Figure 5.1 Warning Labels 5.11

A3 DRAWINGS (bound at end of manual)

Outline and Installation Details, V550/555	Drawing No. 987590
Common Parts, Vibrator	Drawing No. 877350

ASSOCIATED PUBLICATIONS:

PA1000L Amplifier, Installation and Operating Manual	Manual No. 846801
Field Power Supply, FPS10L, Installation and Operating Manual	Manual No. 846921
PA1000L Series Amplifiers-V550 Series Vibrators, System Manual	Manual No. 933111
HPAK Amplifier, Installation and Operating Manual	Manual No. tba

CHAPTER 1 - SPECIFICATION

1. INTRODUCTION

The V550/555 Series vibrators are wide frequency band electrodynamic transducers capable of producing a sine vector force of 670 N (V550) and 940 N (V555). Both vibrators normally operate in the frequency range of 5 to 6300 Hz, from either a sinewave or random signal input, and are driven by power amplifiers of up to 2.5 kVA output. Operation below 5 Hz is possible with a suitable amplifier. They are fitted with a built-in air load support with a maximum payload capacity of 25 kg (55 lb) with full relative displacement.

The Vibrator consists of a magnetic structure which houses and supports the armature and field coils. The field and armature coils are suction air cooled by means of a remotely located fan. Degauss coils are fitted to reduce the stray field above the armature table.

The Vibrator is trunnion mounted and can be locked in the vertical or horizontal position by means of clamp bolts. As an optional extra, the trunnion can be supported by four rubber isolation mounts. An armature overtravel switch is fitted.

V550 series vibrators can be driven by any suitable oscillator/amplifier/field power supply combination, but the Ling Dynamic Systems PA500L or PA1000L amplifiers are specially recommended for this purpose: the V550 model is fitted with a low impedance armature and is suited for use with the PA500L amplifier, the V555 model is fitted with a high impedance armature and is suited for use with the PA1000L amplifier. The V550 series vibrators require a field power supply and the LDS model FPS10L is recommended. A typical system incorporating the V555-FPS10L-PA1000L combination is shown in Figure 1.1.

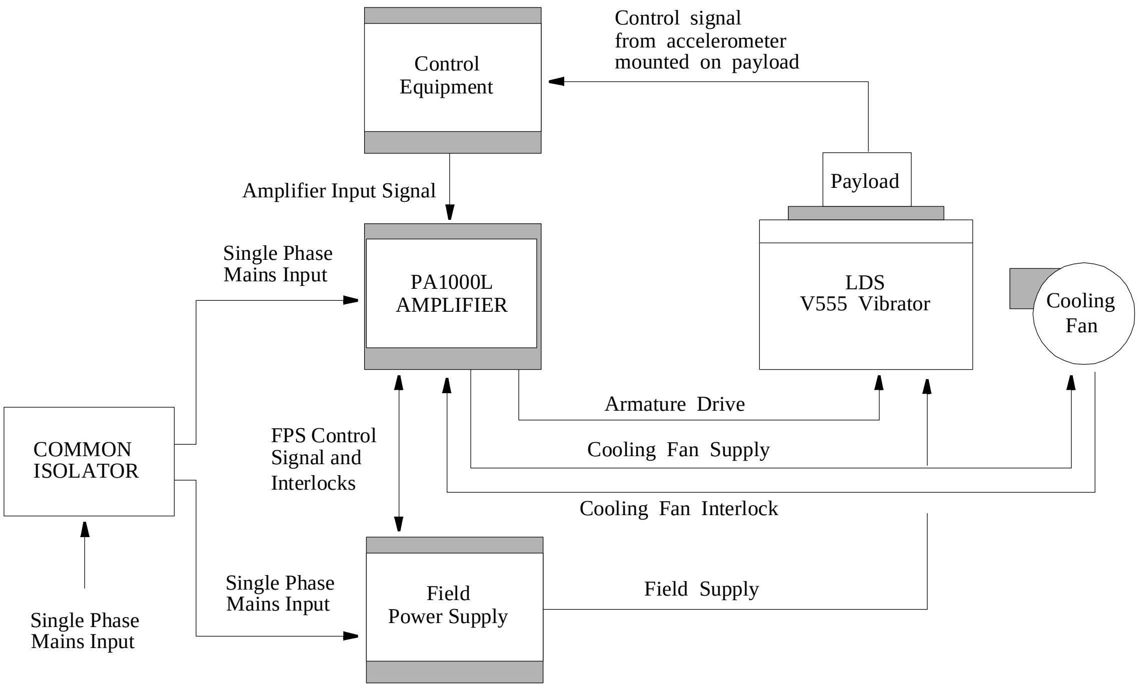
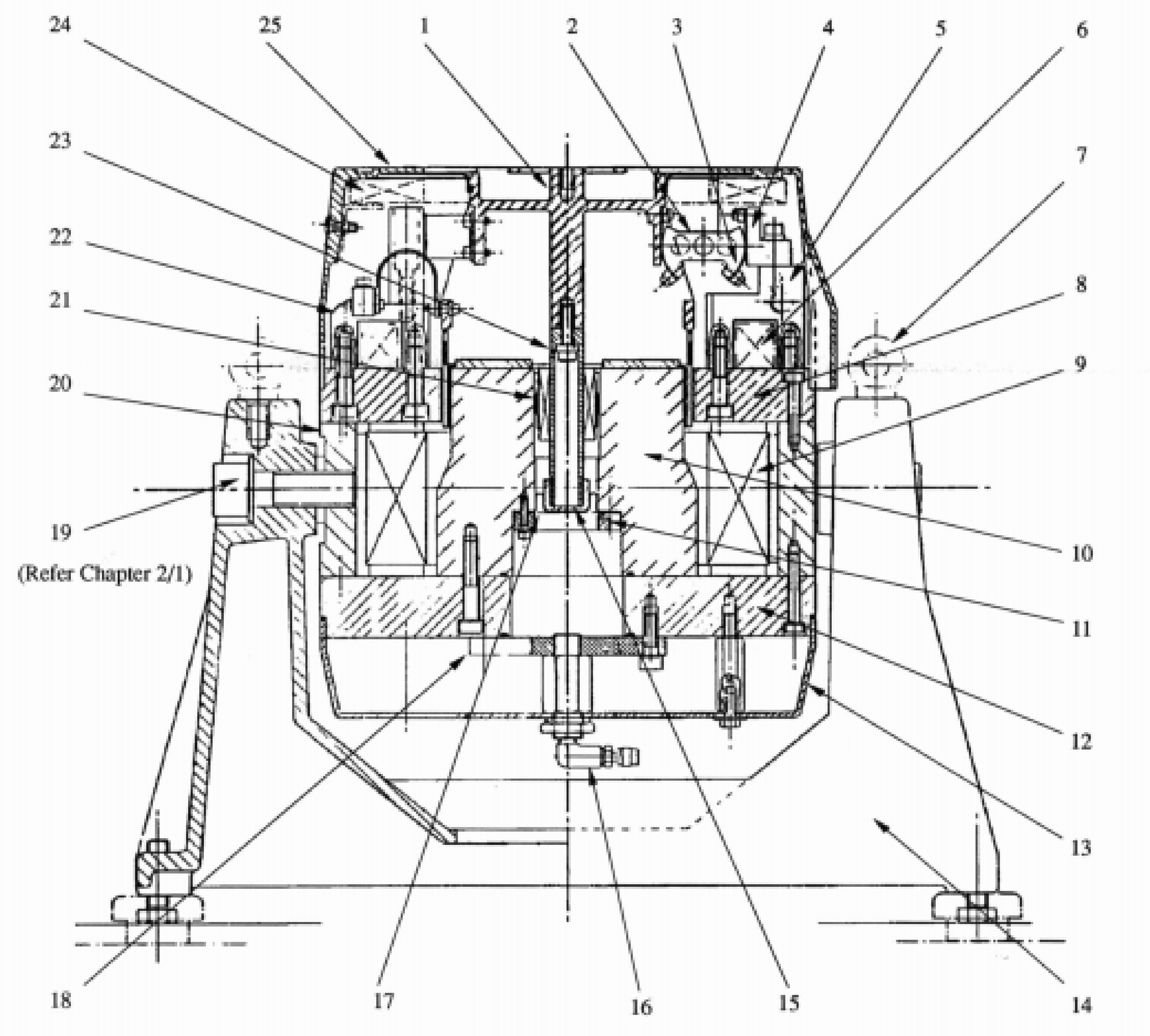


Figure 1.1 Typical System -V555 Series Vibrator with PA1000L Amplifier and FPS10L Field Power Supply

1. INTRODUCTION



1. Armature
2. Suspension Roller
3. Flexure
4. Suspension Mounting Block
5. Support Block
6. Lower Degauss Coil
7. Lifting Eyebolt
8. Top Plate Assembly
9. Field Coil
10. Centre Pole Assembly
11. Clamp Ring, Seal
12. Bottom Plate
13. Bottom Cover
14. Trunnion
15. Retaining Cap
16. Load Support Air Inlet
17. Rolling Diaphragm
18. Base Plate, Seal
19. Clamp Screw
20. Body Ring
21. Linear Ball Bearing
22. Mounting Support Block
23. Guide Shaft
24. Upper Degauss Coil
25. Top Cover

Figure 1.2 Sectioned View - V550 Series Vibrator

2. SPECIFICATION

2.1 Specification - V550 Series Vibrators

2.1.1 Performance

Peak Force - Sine	V550 -	670 N (150 lbf)
	V555 -	940 N (211 lbf)
Random Force (rms)	V550 -	556 N (125 lbf)
	V555 -	636 N (143 lbf)
Armature mass (nominal)	V550 -	0.94 kg (2.1 lb)
	V555 -	0.99 kg (2.07 lb)
Frequency range (useful)		5 - 6300 Hz
Maximum acceleration (bare table)	V550 -	672 m/s^2 (68.5 g)
	V555 -	981 m/s^2 (100 g)
Maximum velocity	V550 -	1.06 m/s (41.7 in/s)
	V555 -	1.5 m/s (59.1 in/s)
Maximum displacement (peak to peak)		25.4 mm (1.0 in)
Overtravel protection (peak to peak between normally closed contacts)		27mm (1.06 in)
Fundamental resonant frequency (bare table) nominal		4850 Hz

Maximum offset payload (horizontal operation) = $P = \frac{A}{(B + x)} = \frac{567}{(44 + x)}$

where

P = Maximum payload mass, kg

x = distance in mm from payload mounting face to centre of gravity of payload

A = Bearing Load Factor

B = Distance from mounting face to bearing centre, mm.

For performance curves see Figure 1.3 and 1.4.

2. SPECIFICATION (cont.)

2.1.2 Armature

Armature guidance :	upper		4 rollers running on polypropylene flexures and two rubber shear mounts	
	lower		Linear bearing system	
Armature moving mass (nominal)		V550 - V555 -	0.99 kg (2.1 lb) 0.94 kg (2.07 lb)	*(13)*
Suspension stiffness (nominal):				
Axial stiffness			15.8 kN/m (90 lbf/in)	
Cross axial stiffness (at table level)			2280 kN/m (13000 lbf/in)	
Rotational stiffness			8.13 kNm/rad (72000 lbfin/rad)	
Maximum payload with built in air load support			25 kg (55 lb)	*(13)*
Rated current			15A rms	
DC armature resistance at 20^{o}C (nominal)		V550 - V555 -	0.62 ohm 1.45 ohm	
Table diameter			110 mm (4.33 in)	
Load mounting			1 central hole and 8 holes on 125mm P.C. Dia. M8 ISO metric coarse on V550 an V555, 1/4 in UNF on V551 and V556.	

2.1.3 Field

Rated current dc		6.8A
Rated voltage dc		70V
Resistance at 20^{o}C (nominal)		10.3 ohm
Stray field 50mm above table:		
	No degauss coils	< 6.0 mT
	With degauss coils	< 0.5 mT

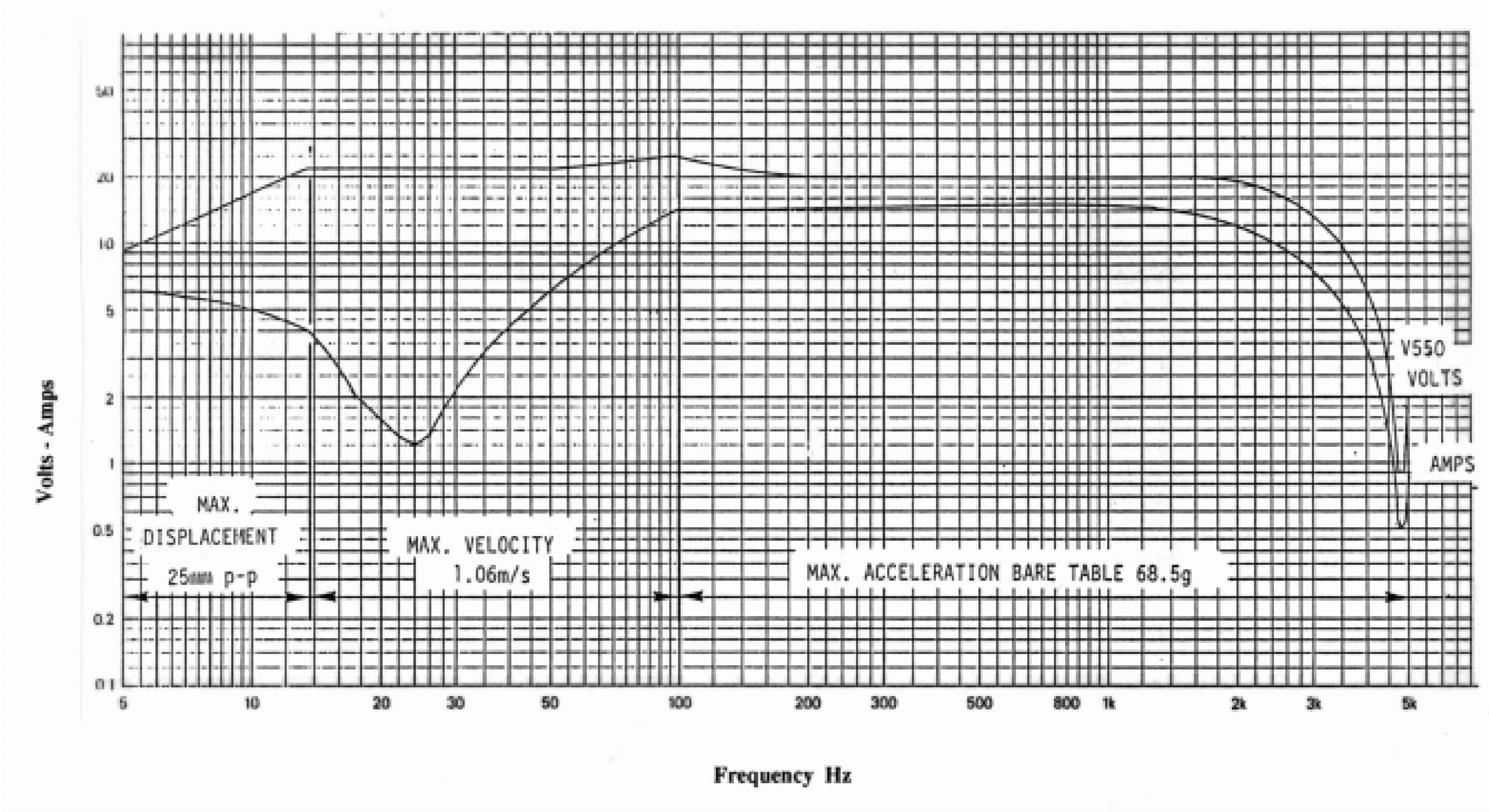
2. SPECIFICATION (cont.)

2.1.4 Degauss Coils

Rated current dc	upper coil	0.77A
	lower coil	0.64A
Nominal resistance at $20^{o}C$	upper coil	91 ohm
	lower coil	110 ohm

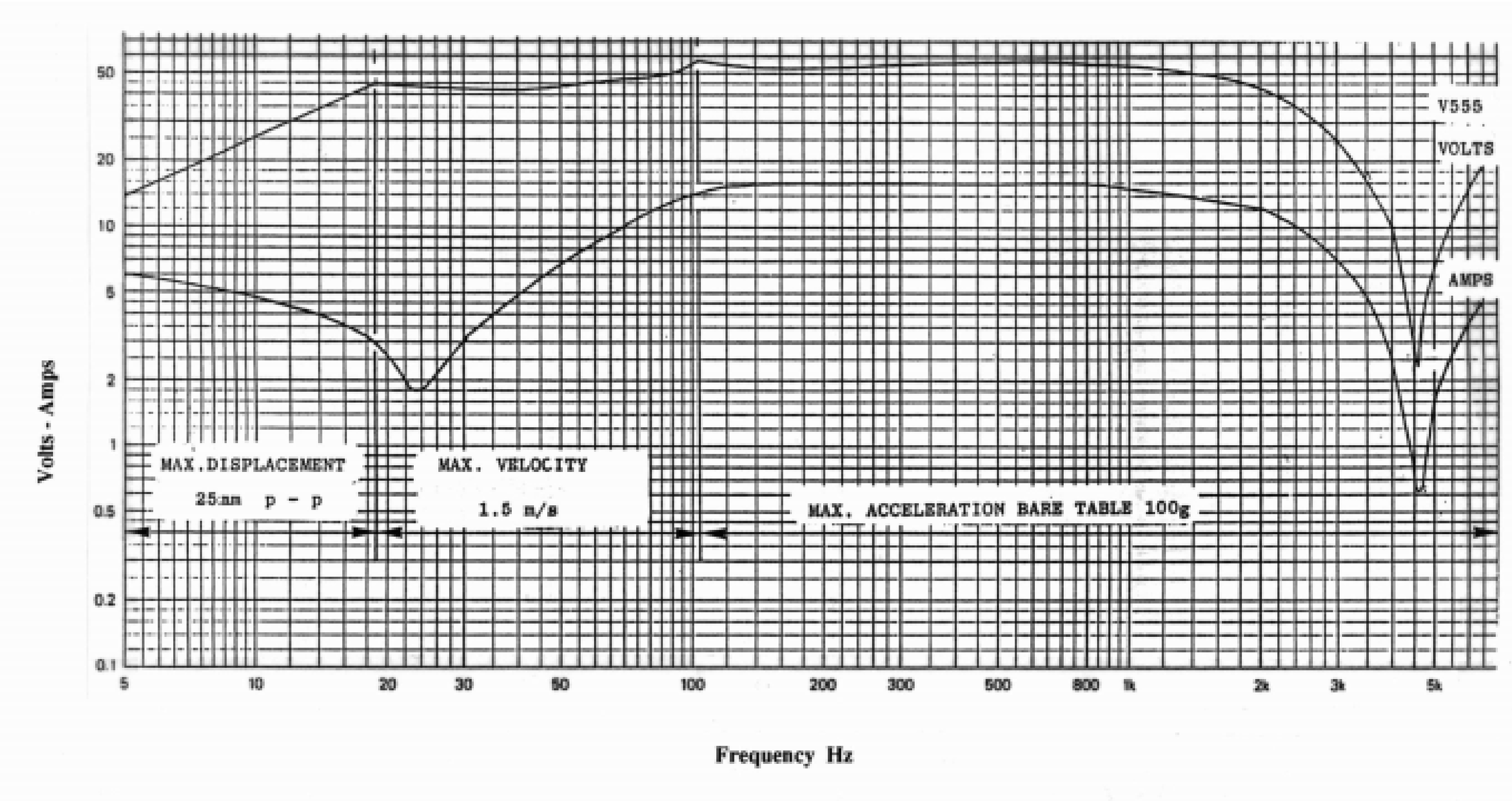
2.1.5 Air

Cooling air flow requirement	0.047 m^3/s (100 ft^3/min)
Compressed air supply pressure	5.5 bar (80 lbf/in^2)



Maximum Force, Sine:	670 N (150 lbf)
Maximum Acceleration (bare table)	68.5 g
Armature Mass	0.99 kg (2.2 lb)
Displacement	25.4 mm (1.0 in) peak-to-peak
Maximum Velocity	1.06 m/s (41.7 in/s)

Figure 1.3 V550/551 Performance at Full Thrust, Bare Table



Maximum Force, Sine:	940 N (211 lbf)
Maximum Acceleration (bare table)	100 g
Armature Mass	0.94 kg (2.1 lb)
Displacement	25.4 mm (1.0 in) peak-to-peak
Maximum Velocity	1.5 m/s (59.1 in/s)

Figure 1.4 V555/556 Performance at Full Thrust, Bare Table

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 When used with the PA500L or PA1000L amplifier, a 1-phase a.c. supply is provided for the vibrator's cooling fan.

3.1.4 Where a field power supply is used, it is recommended that its mains power supply is fed from a common isolator with the amplifier [see Figure 1.2(b)].

3.1.5 The vibrator's earth connection is via the drive cable.

3.1.6 Customer responsibilities are tabulated on the Environmental Data Sheets, and are shown in dotted detail on interconnection diagrams.

3.1.7 The determination of noise levels is a varied and complex procedure. Figure 1.5 shows the conditions under which the values stated on the environmental data sheet were obtained.

3.1.8 Dimensions/weight will vary according to options fitted.

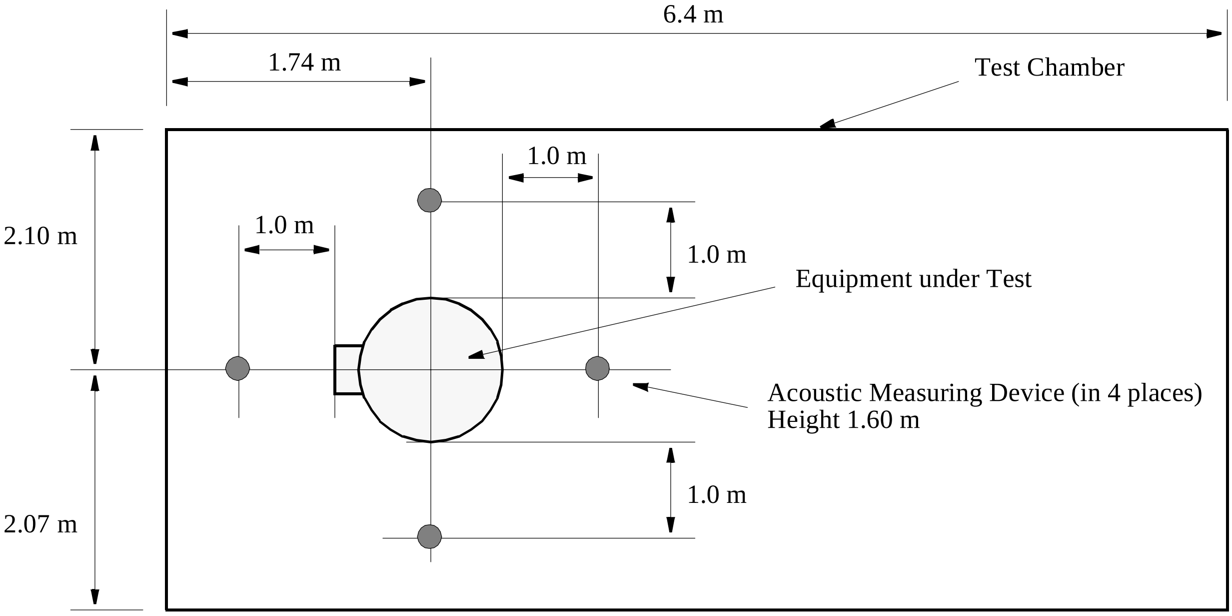


Figure 1.5 Noise Level Measurement Chamber

3.2 - ENVIRONMENTAL DATA - VIBRATOR

		Metric Units		American Units		Vibrator Cooling Fan (metric units) (50 Hz)	Note Ref
Vibrator		**V550/551**	**V555/556**	**V550/551**	**V555/556**		
Amplifier		**PA500L**	**PA1000L**	**PA500L**	**PA1000L**		
Electrical Supply:(Note 3)							
	kVA	- -		- -		0.19 kVA	
1-phase (HPAK)	V	- -		- -		240 V	
(Japanese Option)	V	- -		- -			
Line Current	A	- -		- -			
Recommended Fuse Rating	A	- -		- -			
Earth Cable Size		- -		- -			
Environmental:(Note 3)							
Maximum heat rejected to air	kW	1.30	1.52	1.30	1.52		
Max. heat rejected to air (via cooling fan)	kW	1.10	1.35	1.10	1.35		
Working ambient temperature		0 to +30^{0}C		+32 to +86^{0}F		0 to +30^{0}C	
Working ambient pressure		900 to 1100 mbar		27 to 33 in Hg		900 to 1100	
Relative humidity (non condensing)		0 to 90%		0 to 90%		0 to 90%	
Maximum acoustic noise (Ref. Figure 1.4)		104 dBA		104 dBA		<70 dBA	3.1.7
Cooling air flow (through vibrator-fan)		0.094 m^3/s		200 ft^3/min			
Temperature range of air flow at vibrator inlet		0 to +30^{0}C		+32 to +86^{0}F		-----	
Air line supply required (compressed air)		5.5 bar		80 psi		-----	
Shipping: Mass (approx)		97.5 kg		215 lb		17.0 kg	3.1.8
Height		438 mm		17.2 in		430 mm	
Width		300 mm		11.8 in		350 mm	
Length		530 mm		20.9 in		395 mm	

Notes:
1. Cooling fan is supplied from the amplifier therefore total input kVA for amplifier includes fan rating.
2. The Note Ref. column refers to the environmental notes listed in Chapter 1, Section 3.1.
3. **The Customer is responsible for: Mains supply, mains input cables, mains isolation switch, mains fuses, earth cable, all trunking or conduit, air conditioning, ventilation and soundproofing, air supply with water trap.**

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CHAPTER 2 - DESCRIPTION

1. Mechanical (refer Figure 1.2)

The vibrator consists of a cylindrical steel magnetic structure designed to mechanically support and contain an armature assembly, field coil and degauss coils. The centre pole and the bottom plate are secured to each other by screws forming a single unit which extends from the bottom of the Vibrator to the top. The Vibrator body ring and top plate assembly complete the magnetic structure.

The armature assembly consists of a cylindrical coil bonded to a cast radial-finned structure. The armature coil is located in the annular gap between the top plate and the centre pole. The armature shaft slides axially in a rubber mounted linear ball bushing . This bearing restricts the lateral movement of the armature. Four suspension rollers running on polypropylene flexures provide lateral and rotational restraint for the armature assembly while two load supports with bonded rubber shear mounts provide axial stiffness.

The armature and payload are supported by a built-in air load support requiring a clean dry compressed air supply at 5.52 bar (80 psi). A pressure regulator controls the armature static position and this, together with a pressure gauge, is mounted on the Vibrator trunnion. The air load support is of the rolling diaphragm (Bellofram) type and is easily accessible for replacement through the bottom of the Vibration Generator.

The Vibration Generator support trunnion allows the thrust axis to be locked in the vertical or horizontal position. To change the thrust axis from vertical to horizontal, or vice versa,

- loosen the two M20 trunnion clamp screws
- rotate the body
- Tighten the clamp screws in the new body position.

CAUTION

MAINTAIN FULL CONTROL OF THE BODY DURING ROTATION TO ENSURE THAT IT DOES NOT ROTATE OUT OF CONTROL EITHER SIDE OF THE POINT OF BALANCE. FAILURE TO COMPLY WITH THE CORRECT PROCEDURE CAN RESULT IN SERIOUS PERSONAL INJURY.

To prevent the armature winding overheating, the heat dissipated within the vibrator must be removed. This is done by an external cooling fan that draws ambient air through the Vibrator. The air flows through four intake ducts formed in the top cover, into the space above the top plate. There it divides: some flows through the annular spaces inside and outside the armature winding, and some flows through holes in the top plate to the field coil. Finally, all the air flows through holes in the bottom plate and emerges from the Vibrator through a pipe formed in the bottom cover. The pipe is connected to the cooling fan by a flexible hose.

Isolation mounts can be fitted as an option.

2. DESCRIPTION (cont.)

2. Electrical (refer Figure 2.1)

All electrical connections are made to the vibrator through a nine-pin input socket in the top cover. The connections to this socket, including those to the degauss coils, are shown in Figure 2.1. A plug with a 6 metre (19.7 ft) long cable is provided with the vibrator to fit this socket.

Magnetic flux in the air gap is established by passing direct current through the field coil winding. When current is applied to the armature coil conductors, which are at right angles to the magnetic flux in the air gap, a force is produced which is perpendicular to the air gap flux and to the direction of the armature current. An alternating current thus produces an alternating force.

To reduce the stray field above the armature table, two degauss coils are fitted. The upper coil is internally mounted, beneath the top cover. It is held in place by four mounting brackets, which are bolted to the top cover. When the vibrator is dismantled, the coil should be left in place i.e. secured to the top cover. To enable the top cover and the upper degauss coil to be removed as a unit, line connectors are fitted between the coil and the multi-pin socket. The lower coil is internally mounted, to the top plate. As Figure 2.1 shows, the upper coil is connected in series with a variable resistor. The lower coil is connected in parallel with the field coil. With two degauss coils the stray field is reduced to a low value, typically 0.5 mT at 50 mm above the table, centre to edge.

Armature overtravel protection is provided through normally closed mechanically actuated contacts wired into the amplifier interlock circuit. Should the armature exceed the rated stroke, the overtravel switch will make physical contact with a striker on the armature, open the amplifier interlock circuit and initiate amplifier shut down.

The cooling fan is also interlocked with the amplifier so that in the event of a fan failure the vibrator will be shut down, thereby preventing the armature winding being damaged by overheating. An Air Switch, mounted on the fan casing, is actuated by a spring- loaded diaphragm. The interlock circuit is closed when the fan is running and open when the fan is not running. Instructions for adjusting the Air Switch are given in Chapter 5.

2. DESCRIPTION (cont.)

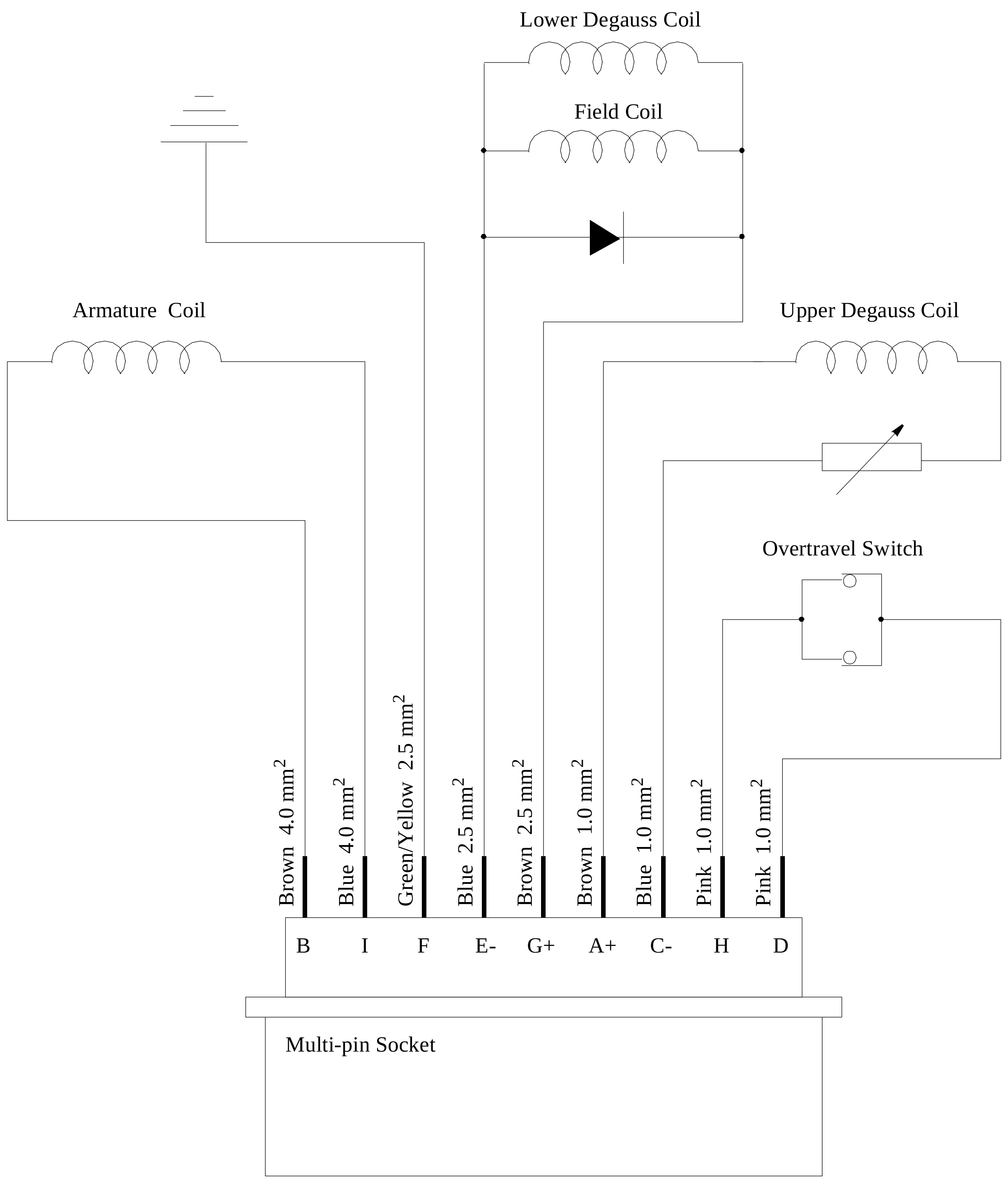

Figure 2.1 Electrical Schematic Diagram

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CHAPTER 3 - INSTALLATION

WARNING

INCORRECT LIFTING METHODS CAN CAUSE SERIOUS PERSONAL INJURY, AND DAMAGE TO THE EQUIPMENT.

ATTENTION IS DRAWN TO THE SAFETY PRECAUTIONS AND HAZARD WARNINGS CONTAINED WITHIN THE PREFACE TO THIS MANUAL.

LETHAL VOLTAGES AND HIGH TEMPERATURE METALIC AREAS ARE PRESENT WITHIN THE EQUIPMENT CABINET. BEFORE ATTEMPTING TO ALTER ANY LINKS OR CONNECTIONS THE SUPPLY MUST BE SWITCHED OFF AT THE INCOMING ISOLATOR.

IF IT IS NECESSARY TO ACCESS THE EQUIPMENT WITH COVERS OPEN AND THE AMPLIFIER SWITCHED ON, PRECAUTIONS MUST BE TAKEN TO ENSURE THAT ONLY COMPETENT, LDS TRAINED, ELECTRONIC OR ELECTRICAL ENGINEERS ARE ALLOWED TO WORK ON THE EQUIPMENT

1. General (refer to Outline Drawing)

The Vibration Generator should be installed in a location which is free of airborne ferromagnetic particles. Any operation that produces such by-products in the installation area should be performed only after adequate measures to protect the Vibration Generator have been taken.

From an interconnection standpoint, there are two constraints on the siting of the vibration Generator:

- the length of the cable is 6 metres (19.7 ft),
- the length of the air suction hose between the Vibration Generator and the fan should not exceed 3.0 metres (9.8 ft).

It is recommended that the Vibration Generator be placed close to the control console for quick and easy monitoring of the equipment by the operator.

The compressed air supply for the support system must be clean and free of water particles which can cause malfunction of the pressure regulator. The required pressure is 5.52 bar (80 lbf/in^2).

All dimensions necessary for the installation of the Vibration Generator are shown on the outline drawing.

1. GENERAL (cont.)

The Vibration Generator is supplied mounted on a solid cast iron trunnion for vertical and horizontal operation. The trunnion base has holes for floor mounting but optional rubber isolation mounts can be supplied. The Vibration Generator may be levelled by adjusting the four M12 levelling screws.

2. Lifting Details

This trunnion mounted vibrator is provided with two M12 holes to accommodate lifting eyebolts (Refer to Outline Drawing and Figure 1.2). To lift the vibrator, a crane having a minimum lifting capacity of 125 kg together with suitable lifting slings and spreader must be used. No attempt must be made to lift the vibrator using attachment points other than the two eyebolt attachment points.

NOTE: SPECIAL LIFTING INSTRUCTIONS FOR ANY PARTICULAR CONFIGURATION WILL BE PRINTED ON THE OUTER PACKAGING. WHERE THEY EXIST THEY MUST BE STRICTLY ADHERED TO.

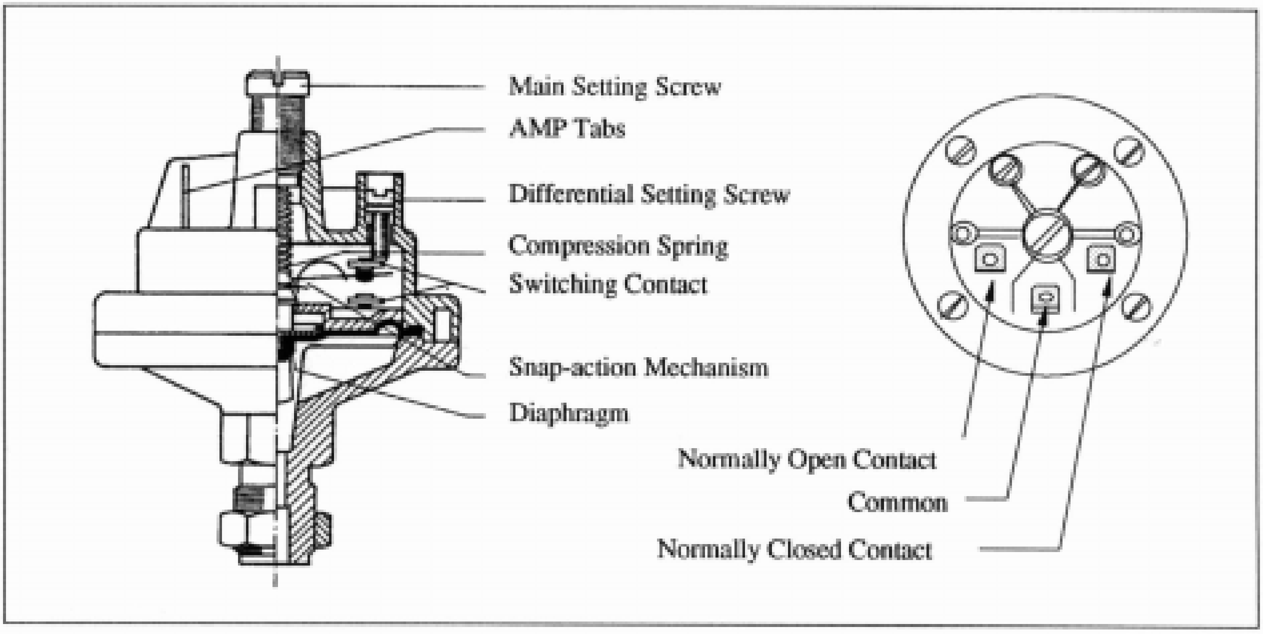

Figure 3.1 Air Switch Detail

3. AIR SWITCH

3.1 Air Switch Adjustment

The function of the Air Switch is explained in Chapter 2/2. It is mounted on the fan casing.

The procedure for adjusting the Air Switch is as follows:

a. Short circuit the Air Switch leads to the amplifier interlock.

b. Attach the cooling fan to the vibrator. Check that its direction of rotation is correct.

c. Remove the cover from the Air Switch.

d. Attach a resistance meter across terminals "1" and "2". (The terminal numbers are marked on the plastic housing).

e. Turn the nylon main setting screw (centre of the switch) anticlockwise until fully backed off.

f. Switch on the cooling fan. The switch contacts should be CLOSED CIRCUIT. If not, repeat operations (d), (e) and (f) with the resistance meter across terminals "1" and "3".

g. Turn the nylon main setting screw CLOCKWISE until the contacts just OPEN CIRCUIT.

h. Carefully turn the nylon main setting screw ANTICLOCKWISE until the contacts resume CLOSE CIRCUIT condition. Turn the screw a further 1/4 of a turn ANTICLOCKWISE.

i. Switch off the cooling fan. Within five seconds the contacts should be OPEN CIRCUIT.

j. Switch on the cooling fan again and test for repeated CLOSED CIRCUIT of contacts.

k. Disconnect the resistance meter.

l. Replace the cover.

m. Remove the short circuit from the leads to the amplifier interlock.

Note: The differential (hysteresis) setting screw is factory set and in normal circumstances should not need adjustment.

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CHAPTER 4 - OPERATION

1. Pre-Operational Checks

1.1 Insulation Resistance

Before operation, check the insulation resistance of the vibrator and cables. Make this check at the amplifier end of the vibrator cable with the cables disconnected from the amplifier. Use a 500V megger insulation tester. See the circuit diagram (Figure 2.1).

A resistance above one megohm should be obtained in all cases. A resistance of 100,000 ohm or less may be obtained if the equipment has been stored in an area of high humidity. Where such a condition exists, the vibrator field and air cooling system should be energised for a short period of time to allow the interior to dry.

1.2 Overtravel Protection

Check the overtravel protection circuit to ensure proper operation of the switch and correct cable connections. The overtravel switch is preset at the factory. Check the operation of the switch as follows:

a. Set up the necessary equipment to monitor displacement. An optical wedge may be used.

b. Set the Vibration Generator thrust axis to the vertical position.

c. Increase the load support air pressure until the armature is in its mean position, which occurs when the payload mounting face is flush with the top cover rim.

d. Follow the starting procedure set out in Chapter 4, Section 3 and establish a frequency of 10Hz.

e. Gradually increase the amplifier output to increase the Vibration Generator armature displacement.

f. If the proper cable connections have been made, the amplifier will automatically shut down when the Vibration Generator armature exceeds the rated displacement. If the amplifier fails to shut down and the monitor indicates the rated displacement has been exceeded, manually stop the system and check the cable connections for proper installation.

1.3 Waveform

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 procedure is recommended:

1. PRE-OPERATIONAL CHECKS (cont.)

a. Mount an accelerometer on the armature table. To prevent ground loops, make sure that the accelerometer is insulated from the vibrator armature.

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 through the frequency range at several different levels noting the waveform.

d. It is necessary to be able to differentiate between normal and abnormal distortion. Serious departure from a sine wave at low frequencies is usually an indication of armature bearing misalignment or damage. Some distortion at sub-multiples of the resonant frequency may be expected due to the amplification of a small percentage of the drive amplifier distortion.

e. It is strongly recommended that a record be made of the armature resonant frequency and harmonic waveform when the vibrator is received. With this record trained personnel will be able to differentiate between normal and abnormal distortion. A periodic check with this record will minimise trouble-shooting time and is also a very good preventive maintenance check

2. Load Attachment

When attaching a payload to the armature, avoid possible damage to the suspension by progressively applying pressure to the air load support as the load is applied so as to maintain the armature approximately in its mean position. Take care not to apply the load suddenly as this could bottom the armature on to its stops.

Lastly, adjust the pressure regulator to maintain the armature in its mean position. This is when the payload mounting face is flush with the top cover rim.

It is inadvisable to leave a heavy payload attached to the vibrator for a long period, because air line pressure failure could result in damage to the suspension system. Hence, if a heavy payload must unavoidably be left attached to the vibrator for a long period, use an alternative method of support.

The magnesium armature table has nine payload fixing holes (one central and eight peripheral) each fitted with helicoil inserts for the ISO metric M6 (V550/555) or 1/4" UNF (V551/556) load attachment screws. Nine screws and a hexagonal key are delivered with the equipment in a plastic bag attached to the Vibration Generator. The best dynamic performance results when all nine screws are used. The hole pattern is shown on the Outline Drawing.

Screws used in mounting test fixtures or loads to the armature table should be tightened to the manufacturer’s recommended torque value for the particular fastener used.

2. LOAD ATTACHMENT (cont.)

CAUTION

DO NOT DRILL ADDITIONAL HOLES THROUGH THE WEB OF THE ARMATURE TABLE. DRILLING ADDITIONAL HOLES WILL WEAKEN THE TABLE STRUCTURE AND MAY RESULT IN DAMAGE TO THE EQUIPMENT.

The recommended torque values for the load attachment screws supplied by LDS with the vibrator are as follows:

Screw Thread	Recommended Torque
M6 metric (V550/555)	11 Nm (8 lbf.ft)
1/4" UNF (V551/556)	10 Nm (7 lbf.ft)

The distance between the underside of the screw head and the top of the tapped hole in the armature table should not exceed 2.5 times the diameter of the shank.

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

Note: A test fixture design and manufacturing service is available at LDS.

Take care when positioning the load over the armature table. The fixture height should be minimised to keep the centre of gravity as close to the table surface as possible. Driving a complicated fixture and load causes coupled modes of vibration which can only be minimised by rigorous 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 light-weight crystal accelerometers.

During horizontal operation the rubber shear mounts centre the armature and mass axially. Care must be taken to ensure that excessive torque or shear load is not applied to the armature and bearings by an overhanging mass, which would result in rapid wear or failure, and possible scuffing of the armature in the air gap.

2. LOAD ATTACHMENT (cont.)

For overhanging masses in excess of the allowable figure independent suspension of the mass is necessary.

A method of calculating the maximum cross axial loading which will not overload the bearings is described in Appendix A (Cross Axis Acceleration Limitation in Electrodynamic Vibration Generators). For the V550 series vibrators, the formula is:

$$P = \frac{A}{(B + x)} = \frac{567}{(44 + x)}$$

where,

where,	P	=	Maximum payload, in kgf
	A	=	Bearing Load Factor
	x	=	distance in mm from the payload mounting surface to the centre of gravity of the payload.
	B	=	distance from mounting surface to bearing centre, in mm

The results applicable to horizontal operation of the V550/V555 are presented in Figure 4.1.

Note: The uppermost face of the armature and the top cover are level at the mid position. This factor should be taken into account when designing a load attachment.

2. LOAD ATTACHMENT (cont.)

Offset Load Graph
Horizontal Operation

$$P = \frac{567}{(44 + X)}$$

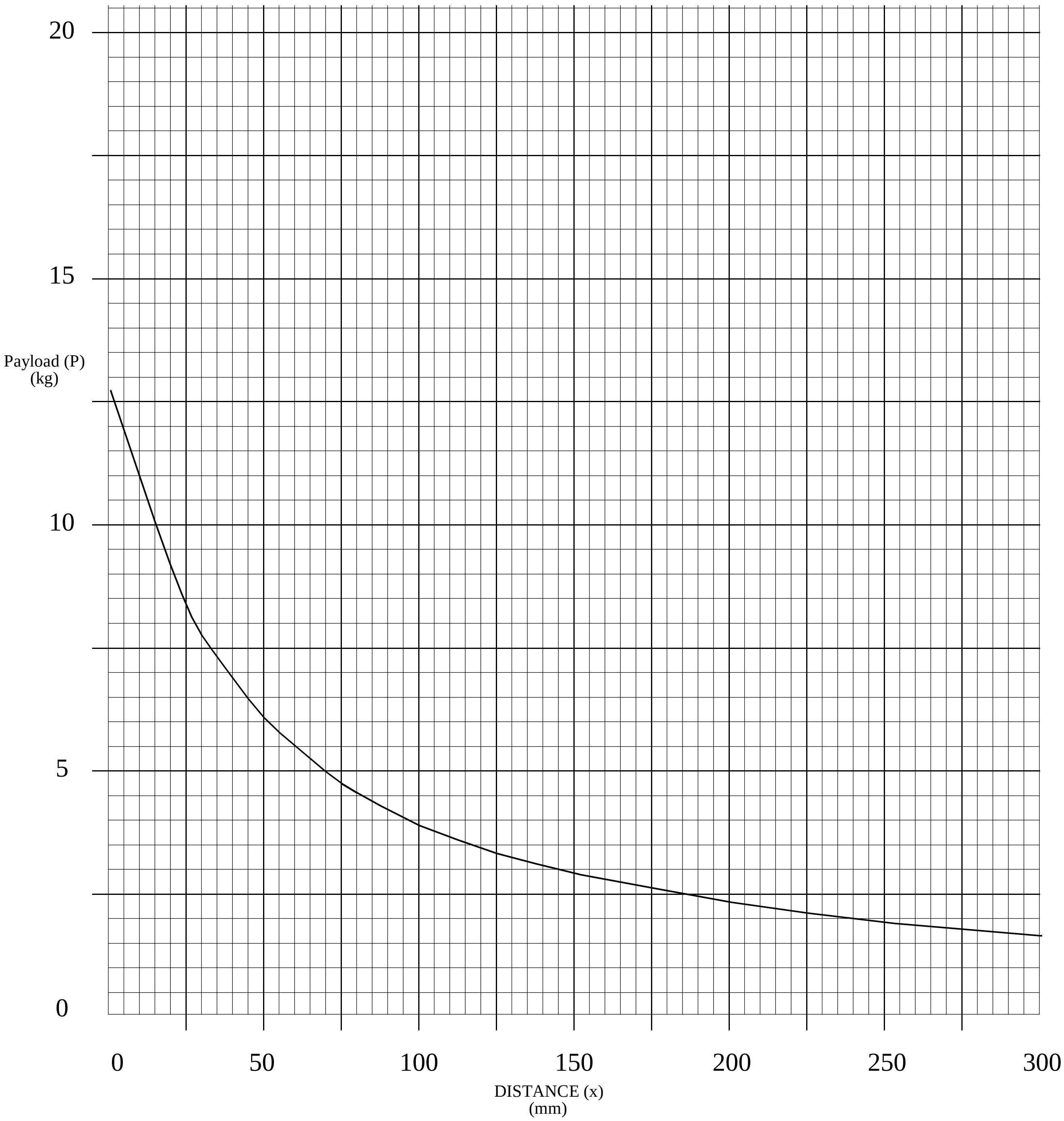


Figure 4.1. V550/V555 Offset Load Graph (Horizontal Direction)

3. OPERATION

3.1 Starting And Shutting Down

To prevent damage to the equipment, the following starting procedure must be followed.

a. Mount the load on the vibrator table using the inserts provided, pressurising the air load support to return the armature to its mean position as defined in Chapter 4, Section 2.

b. Start the air cooling fan. ENSURING THAT THE DIRECTION OF ROTATION IS CORRECT.

c. Apply field power.

d. Apply armature power progressively to the level required.

Note: This starting sequence is automatic if the vibrator is supplied as part of an LDS system.

To shut down the Vibrator it is recommended that the above starting procedure be reversed.

3.2 Precautions To Be Taken

When operating the vibrator take care to avoid damage to the suspension or to the armature coil. This can be caused by transients in the supply waveform or by exceeding the displacement and/or acceleration limits. Therefore bear the following in mind.

* If the Vibrator is being controlled manually through the frequency range, this should be done slowly, monitoring the acceleration as the fundamental resonant frequency of the armature is approached.

* Avoid switching the oscillator to a different range without first reducing the amplifier output to zero. Otherwise the resulting transient could cause the acceleration limit to be exceeded.

* High transients at the low frequency end could cause the displacement limit to be exceeded to such an extent that, although the amplifier may shut down (overtravel switch), the armature strikes the mechanical stop with an impact that exceeds the acceleration limit.

3.3 Performance

The Vibrator performance curves (Figure 1.3 and 1.4) show the performance of the Vibrator at full thrust. The velocity limits with a Vibrator/amplifier system will depend entirely on the available amplifier voltage.

CHAPTER 5 - MAINTENANCE

1. GENERAL

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(01763)242424
Fax:UK(01763)249715

1. GENERAL (cont.)

1.4 Serviceability Check

IMPORTANT NOTE

Continuous testing in high displacement mode may cause accelerated component wear.

A degree of continuous testing in high displacement (<5 mm) may cause a higher degree of wear in some components. Also, when light payloads are used, the bellofram is particularly prone to wear through buckling in high displacements.

Other components which may require increased maintenance are:

Suspension flexures
Load Support Bellofram (diaphragm)
Armature current leads and earth straps
Armature dust seal

Duty cycling is too variable to define, as it is dependent on a number of factors such as: level of displacement, payload, swept or fixed frequency testing and degree of repeated testing over time. Therefore, as a guide, greater than repeated 1 hour in 10 hours high displacement testing may lead to increased maintenance.

1.5 Routine Maintenance

The following routine activities are recommended by LDS at the stated intervals. Note however that local operating conditions may require the activities be performed at more frequent intervals than those stated:

Daily Activities

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

1.5.1 Ensure the area around the amplifier is clear of obstructions which could prevent adequate airflow into the air intake grills.

1.5.2 Ensure the area around the amplifier is clean, and free of dust.

1.5.3 Switch on the mains supply at the mains isolator. Ensure that all cooling fans are operating. Switch off the mains supply at the mains isolator.

1.5.4 Check that all cabinet panels are correctly fitted and locked.

1. GENERAL (cont.)

Monthly Activities

1.5.6 Inspect the air intake grills. Brush off, or wash with warm soapy water, any dust or fluff that has accumulated. Ensure that the dust filters are clean and free from accumulated dirt. Replace any filters that cannot be fully cleaned (see Note below).

1.5.7 Inspect all the cooling fans. If dirty, clean the blades with a dry soft cloth; do not use fluids of any kind.

1.5.8 Check that all power connections to the amplifier (field supply, armature supply and mains supply) are secure. Check the earth connection is secure.

1.5.9 Switch on the mains supply at the mains isolator. Ensure all cooling fans are operating. Listen for any noise which suggests a cooling fan is not operating smoothly.

1.5.10 Run up the amplifier. Press the Emergency Stop control; check that the amplifier 'shuts down'.

Six-Monthly Activities

Check the interior of the amplifier for accumulations of dust or dirt. Clean, as required, with a soft brush or dry lint-free cloth; do not use fluids of any kind.

Yearly Activities

Replace **all** dust filters (see Note below).

NOTE

To ensure trouble free operation of the LDS range of amplifiers it is ESSENTIAL that the airflow to the power modules and rectifier assemblies is kept to a maximum. It is therefore imperative that all airways are kept clear of obstruction and that any dust filter which cannot be adequately cleaned is immediately replaced.

1. GENERAL (cont.)

1.6 Electrical Connections

The tightness of electrical connections and screws should be checked periodically. The recommended maximum torque values for screws fitted into steel components are given in the following table.

RECOMMENDED TORQUE VALUES

Thread Size	Torque for Self Colour Socket Screws fitted into steel components	
M3	2.4 Nm	21 lbf.in
M4	5.5 Nm	49 lbf.in
M5	11.2 Nm	99 lbf.in
M6	19.0 Nm	14 lbf.ft
M8	46.0 Nm	34 lbf.ft
M10	91.2 Nm	67 lbf.ft
M12	159.1 Nm	117 lbf.ft

CAUTION

THE STATED TORQUES, IN THE ABOVE TABLE, SHOULD BE MULTIPLIED BY A FACTOR OF 0.8 FOR SCREWS TO BE FITTED INTO ALUMINIUM COMPONENTS THAT HAVE HELICOIL INSERTS AND BY A FACTOR OF 0.3 FOR SCREWS TO BE FITTED INTO ALUMINIUM COMPONENTS THAT HAVE NO INSERTS

1.7 Recommended Spares and Special Tools

A list of recommended spares is obtainable from LDS. Customers wishing to replace major components themselves can obtain the following tools from LDS:

Part Number	Quantity	Description
344970	1 set of 4	Suspension-Setting Jig
346610	1 set of 4	Gap Setting Pin, Centre Pole/Top plate
575160	1 set of 4	Armature Setting Shim (V550)
575170	1 set of 4	Armature Setting shim (V555)
794710	1	Armature Support Jig Assembly
920780	1	Extended hexagonal Socket Wrench 3 mm A/F
920790	1	Extended hexagonal Socket Wrench 6 mm A/F
920800	1	Guide Shaft End Cap Fitting Tool

2. ARMATURE REMOVAL AND FITTING

2.1 Removing The Armature

Refer to Drawing No. 877350, Sheets 1 and 2. References to component numbers on this drawing are given in brackets below.

a. Before commencing any maintenance work remove the multi-pin plug and cable assembly and reduce the load support air pressure to zero.

b. Position the vibrator with the thrust axis horizontal. (The procedure was described in Chapter 2, Section 1).

c. Disconnect the cooling fan hose from the bottom cover (1/25).

d. Take off the load support air inlet elbow and remove the lock nut (3/10) and copper washer (3/9) from the inlet adaptor.

e. Remove the four M6 screws (3/15) and washers (5/4) and carefully pull off the bottom cover (1/25) and sealing ring (2/21).

f. Take off the base seal plate (1/21) complete with inlet adaptor . The ’O’ ring (3/6) seal is bonded to the bottom plate (2/4) and should not therefore be removed.

g. Using the extended hexagon-drive-key remove the six M4 screws (3/19) securing the rolling diaphragm seal clamp ring (1/19 to the centre pole (1/8) assembly. Carefully withdraw the seal clamp ring (1/19) and the rolling diaphragm (2/9).

h. Using the guide-shaft end-cap-fitting tool (part no. 920800) unscrew the armature-shaft end-retainer-cap (1/20).

i. If the armature or the armature shaft/bearing are to be renewed, use the extended hexagon-drive key to remove the M6 screw (3.24) and the special washer (1/14) which secures the shaft to the armature. Carefully withdraw the shaft from the bearing. If these components are not being renewed, do not remove the armature shaft.

j. Position the vibrator with the thrust axis vertical (The procedure was described in Chapter 2, Section 1).

k. Read the description of the upper degauss coil (Chapter 2, Section 2).

l. Remove the eight screws securing the top cover. Raise the cover high enough to give access to the connectors. Disconnect the degauss coil and then lift the cover off. Be careful not to damage the seal (2/18) which is bonded to the top cover..

2. ARMATURE REMOVAL AND FITTING (cont.)

m. Remove the two screws securing the overtravel switch (1/2), allowing it to be moved to one side, but leave intact the electrical connections.

n. Loosen the eight M6 screws (3/25) clamping the four suspension blocks (1/24).

o. Remove the sixteen M3 screws securing the flexures to the armature.

p. Disconnect the two armature current leads from the lead out block (2/7) and the earthing lead from the mounting support block (1/23).

q. Remove the two M8 screws (4/3) clamping the rubber load supports (1/1) to the mounting support block (1/18).

r. The armature assembly may now be lifted vertically from the vibrator complete with guide shaft (1/22) if not removed, rubber load supports 81/1) and current and earth lead-outs (1/03).

s. Having proceeded to this stage and the vibrator has to be left for any length of time, protect it with the dust cover provided.

t. With the armature assembly removed inspect the rubber load supports (1/1), current lead outs (1/3) and earth lead out for damage and renew as necessary.

2.2 Replacing The Armature

a. Before re-assembling the armature to the vibrator, remove the four suspension roller/flexure/adjuster block assemblies from the support blocks. Examine the polypropylene flexures (2/18) for wear and renew as necessary.

b. Lower the armature assembly into the vibrator taking care that the armature guide shaft (1/22) enters the ball bushing (3/7) smoothly. Make sure that the armature is correctly positioned so that the current lead outs (1/3) are lined up with the lead out block (2/7).

c. Support the armature assembly, by fitting the Armnature Support Jig (Part No. 794710) to the armature table.

d. Re-assemble the four suspension roller/flexure/adjuster block assemblies to the support blocks and armature assembly but do not as yet tighten the M6 suspension block clamping screws (3/25) or the M3 screws (3/16) that secure the flexures (2/18) to the armature and suspension blocks (1/24).

2. ARMATURE REMOVAL AND FITTING (cont.)

e. Centralise the armature coil in the gap, equally spacing four plastic shims around the outer air gap. For the V550 use shims Part No. 575160; for V555 use shims Part No. 575170.

f. Fit the suspension setting jigs (part no. 344970) to the four adjustment support blocks (1/23).

g. Equally adjust the setting jig knurled screws, in opposite pairs, until the suspension rollers (1/15) are lightly clamped between the armature and the suspension blocks. Check that the armature is still equally supported by the support jig assembly. If the armature is not equally supported, then readjust, as required, the knurled screws of the setting jig.

h. While putting downward pressure on the suspension rollers (1/15), to align the flexures (2/18), tighten the M3 flexure clamping screws (3/16).

i. Tighten the knurled setting screws one eighth of a turn to preload the polypropylene flexures.

j. Making sure that the armature is still equally pressed down on the support jig assembly, and with downward pressure on the suspension rollers (1/15), progressively tighten the M6 suspension block screws (3/25).

k. Remove the four plastic shims and the support jig assembly. Check that the armature coil is still centralised in the gap and that the suspension rollers (1/15) are aligned and operating smoothly. If they are not, repeat the setting procedure.

l. Remove the four suspension setting jigs. Secure the two rubber load supports (1/1), replace the overtravel switch (1/2), and reconnect the armature current leads (1/3) and earthing lead.

m. Replace the top cover (2/1), fitting the bead of the dust seal (2/20) into the armature groove.

n. Reconnect the upper degauss coil before finally securing the top cover.

o. Rotate the vibrator to the horizontal position.

p. Replace the armature shaft end retainer cap (1/20), rolling diaphragm (2/9) (fabric side towards the end cap) and seal clamp ring (1/19).

q. Replace the base seal plate (1/21), bottom cover (1/25), sealing ring (2/21), load support air connector (1/16) and cooling air hose. Fit the multi-pin plug and cable assembly. The vibrator is now ready for operation.

3. CENTRE BEARING REMOVAL AND FITTING

3. Renewing the Centre Bearing

Refer to Drawing No. 877350, Sheets 1 and 2. References to component numbers on this drawing are given in brackets below.

Note: Although the armature guide shaft (1/22) and the centre bearing can be renewed individually, it is recommended that both are renewed while the vibrator has been dismantled.

a. It is first necessary to remove the armature as described in Section 2.1, also removing the guide shaft as in Section 2.1 (i).

b. With the armature removed, rotate the vibrator to the horizontal position. The ball bushing (3/7) may now be pushed out of the centre pole (1/8) assembly, from underneath, by using a suitable mandrel, which should rest on the bearing outer shell and not on the bearing retaining plates.

c. Fit the resilient mount (3/8) to the new bearing and apply a small amount of silicone grease to the rubber. Press the bearing into the centre pole (1/8) assembly, using the mandrel, until the end of the bearing is level with the top of the centre pole.

d. Re-assemble the vibrator, as described in Section 2.2 but do not fit and secure the new armature shaft until after operation in Section 2.2 (j).

e. If the armature is not centralised in the gap, slacken off the guide shaft screw (3/24), replace the plastic shims and tighten the shaft screw again, see operation in Section 2.2 (k).

4. Renewing the Load Support Rolling Diaphragm

Refer to Drawing No. 877350, Sheets 1 and 2. References to component numbers on this drawing are given in brackets below.

a. The rolling diaphragm (2/9) may be easily removed from underneath without disturbing the top assembly or armature suspension and guide shaft settings.

b. With the thrust axis horizontal, remove the bottom cover (1/25), sealing ring (2/21), base plate seal (1/21) and seal clamp ring (1/19) as described in Section 2.1, operations (c) to (g).

c. Fit the new rolling diaphragm, fabric side towards the armature guide shaft end cap.

   Fit the seal clamp ring.

d. Re-assemble the vibrator as described in Section 2.2 operations (p) and (q).

5. FIELD COIL REMOVAL AND FITTING (cont.)

5. field Coil Removal

Refer to Drawing No. 877350, Sheets 1 and 2. References to component numbers on this drawing are given in brackets below.

Note: The field coil (1/5) assembly should not required renewal with normal use.

(1) Unsolder/remove the field coil connections to the diode (6/17).

(2) Remove the armature as described in Section 2.1.

(3) Mark the top plate (1/7) to ensure correct orientation on re-assembly. Remove the eight M6 securing screws (4/1) and lift off the top plate assembly. The field coil assembly may now be lifted out.

(4) Re-assembly will require the top plate (1/7) to be concentrically fitted to the centre pole (1.8) assembly. For this purpose, four gap setting pins (Part No. 346620), will be required to position the top plate while the securing screws (4/1) are tightened.

6. COMPONENT IDENTIFICATION - DRAWING No. 877350

Sheet 1

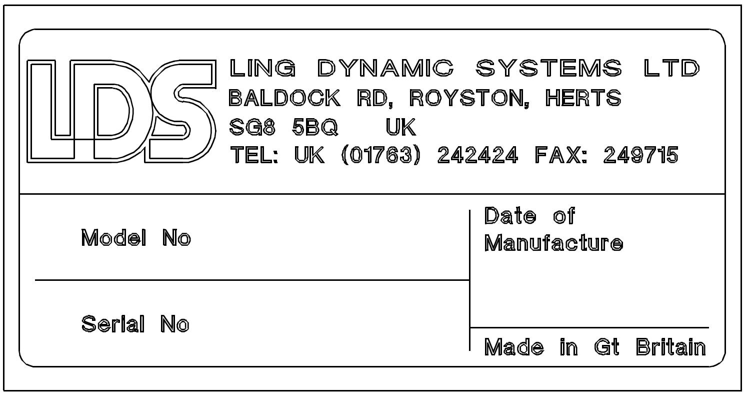
1/1	Load Support Assembly *
1/4	pneumatic Circuit Assembly
1/5	Field Coil Assembly
1/7	Top Plate
1/8	Centre Pole
1/14	Washer M6
1/15	Suspension Roller
1/16	Air Connector, Load Support
1/17	Stud, Bottom Cover
1/18	Mounting Support Block
1/19	Seal Clamp Ring
1/20	Retainer Cap
1/21	Base Seal Plate
1/22	Shaft Armature Guide *
1/23	Adjustment Support Block
1/24	Suspension Block
1/25	Bottom Cover
2/1	Top Cover
2/2	Body Ring
2/4	Bottom Plate
2/5	Trunnion
2/6	Flexure Clamp
2/9	Rolling Diaphragm *
2/13	Pressure Pad, Field Coil
2/14	Pressure Pad, Field Coil
2/15	Pressure Pad, Field Coil
2/17	Ferodom Washer
2/18	Flexure *
2/19	Bumper Pad
2/20	Seal, Top Cover
2/21	Seal, Bottom Cover
3/1	Eyebolt M16
3/4	Adhesive
3/5	Adhesive
3/6	‘O’ Ring
3/7	Ball Bushing *
3/8	resilient Mount
3/9	Copper Washer
3/10	Locknut
3/14	Screw M6 x 16 mm
3/16	Screw M3 x 12 mm
3/19	Screw M4 x 16 mm
3/20	Screw M4 x 10 mm
3/24	Screw M6 x 25 mm
3/25	Screw M6 x 30 mm
4/1	Screw M6 x 35 mm
4/3	Screw M8 x 25 mm
4/4	Screw M8 x 35 mm
4/5	Screw M8 x 30 mm
4/6	Screw M20 x 60 mm
4/8	Screw M12 x 40 mm
5/4	Washer M6
5/5	Washer M20
5/12	Insert M5 Helicoil
5/13	Insert M6 Helicoil
5/14	Insert M8 Helicoil
5/12	Insert M8 Helicoil

Sheet 2

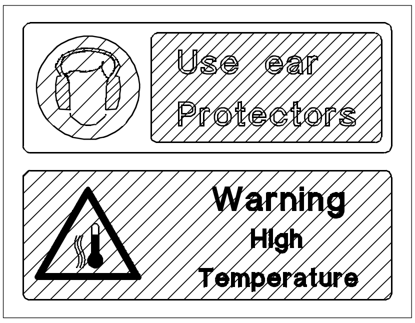
1/2	Overtravel Switch Assembly *
1/3	Lead Out Assembly *
1/8	Pneumatic Circuit Assembly
2/7	Lead Out Block
2/8	Bracket, Socket Mounting
2/10	Diode Bracket
2/12	Escutcheon, Trunnion
2/22	Insulation Collar
2/23	Insulation Pad
3/2	Fixed Plug
3/15	Screw M4 X 10 mm
3/18	Screw M3 X 20 mm
3/20	Screw M4 x 10 mm
3/21	Screw M5 X 12 mm
3/22	Screw M5 X 16 mm
4/2	Screw M6 X 65 mm
4/20	Nut M3
5/1	Washer M3
5/2	Washer M5
5/3	Washer M6
5/4	Washer M6
5/6	Washer M4
6/6	Sleeve
6/11	Ring Terminal
6/12	Ring Terminal
6/13	Ring Terminal
6/14	Ring Terminal
6/17	Diode *

***** These items are on the list of recommended spares (Section 1.7).

7. WARNING LABELS



(a)



(b)

Figure 5.1 Warning labels - V550 Series Vibrators

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APPENDIX A

CROSS AXIS ACCELERATION LIMITATIONS

1.1 General

An electrodynamic vibrator is designed to produce sinusoidal (or random) movement in one axis only. The armature assembly is the moving part of the vibrator and is guided by a suspension system which maintains the armature coil in the centre of the magnetic air gap. The armature suspension system is designed to have low stiffness along the vibration axis, and high stiffness in the direction at right angles (cross axis) to the vibration axis.

The suspension system however does have limitations in the cross axis direction. Any excessive cross axial loading can cause destructive forces to be exerted on the bearings and suspension system**.**

Two constants have been derived for each LDS vibrator:

A = The Bearing Load Factor

B = The distance from the bearing centre to the armature mounting face, mm

The two constants are applied to produce the Offset Load formula, for horizontal operation.

$$P = \frac{A}{(B + X)}$$

Where:

P = Maximum payload, kg

X = The distance from the mounting face to the payload's centre of gravity, mm

For the V550/1 series vibrators, the constant A = 567, and B = 44. The formula thus becomes:

$$P = \frac{567}{(44 + X)}$$

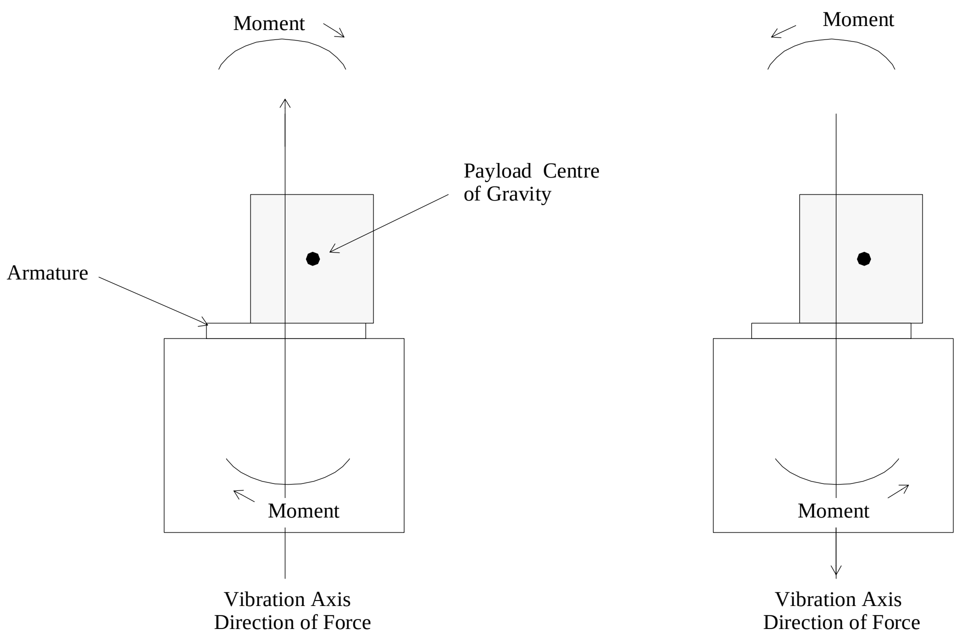
See section 1.3 for an example of the use of this formula.

APPENDIX A (cont.)

1.1 General (cont.)

Attention to the method of mounting a payload to the vibrator is vital. An unsatisfactory fixture can cause severe cross axial forces on the vibrator, and can subject the payload to forces beyond which they are designed, or required to be tested.

Central mounting is of prime importance. Every effort must be made to position the payload's centre of gravity on the armature's axis; unless the payload is correctly positioned an alternating force of high magnitude can result, as shown in the following diagram:



The following sections describe methods of determining the maximum cross axial acceleration allowed. It is recommended to monitor this in practise to prevent excessive wear or damage to the armature suspension.

APPENDIX A (cont.)

1.2 Vertical Operation

The following equation calculates the maximum permitted cross axial acceleration for a particular frequency. The lower the frequency, the lower the permitted acceleration. Therefore, the minimum test frequency should be used to determine the maximum cross axial acceleration value.

For V550 Series:

A	=	Bearing load factor	=	567
B	=	Distance from armature face to bearing centre	=	44 mm
C	=	Bearing cross axial stiffness	=	2280 N/mm
f	=	Lowest test frequency	=	Hz
a_c	=	Maximum permitted cross axial acceleration	=	g

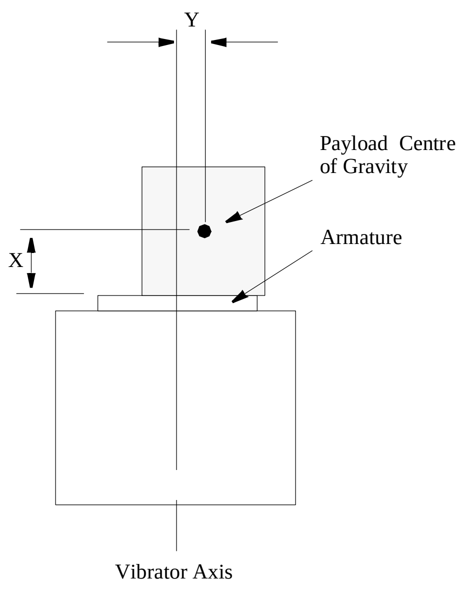
$$a_c = \frac{A \pi^2 f^2}{250\,B\,C}$$ at the armature mounting face

(where 250 is a conversion factor to obtain acceleration in g from displacement in mm).

In practise, the cross axial acceleration should be monitored during tests to help prevent overloading the bearings. Every effort should be made to align the payload centre of gravity with the vibrator axis, to minimise cross axial acceleration.

Note: Resonances may occur at certain frequencies and can cause the cross axial acceleration to rise suddenly.

If a small offset is unavoidable, the equation is modified as follows:



Where:

L	=	Offset payload factor
Y	=	Offset distance from vibrator axis, mm
M	=	Mass of payload, kg
X	=	Distance from armature to C of G, mm

So:

$L = MY$ *(9)*

Therefore:

$$a_c = \frac{(A - L)\,\pi^2 f^2}{250\;B\;C}$$

APPENDIX A (cont.)

EXAMPLE

A 5 kg mass is to be vibrated between 80 Hz and 500 Hz. Its centre of gravity is offset by 10 mm and is 25 mm from the armature. *(9)*

M	=	payload mass	=	5 kg
f	=	lowest frequency	=	80 Hz
Y	=	offset distance	=	10 mm
L	=	5 x 10	=	50

$$a_c = \frac{(567 - 50) \times \pi^2 \times 80^2}{250 \times 44 \times 2280} = 1.3 \text{ g}$$

This is the maximum cross axial acceleration allowed for this example. Every effort should be made to mimimise this in practise by payload alignment and good fixture design.

To determine the cross axial acceleration at the payload centre of gravity, a_{pc} , assuming a rigid payload:

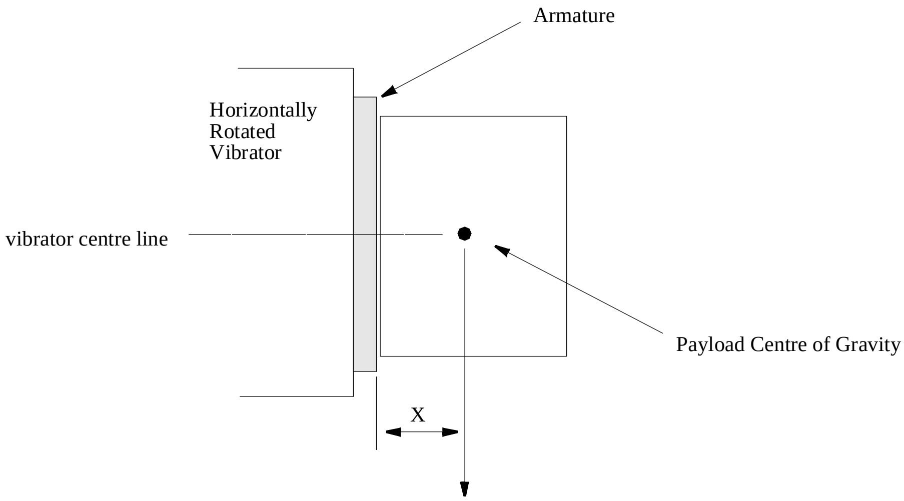
$$a_{pc} = \frac{a_c\,(B + X)}{B} = \frac{1.3\,(44 + 25)}{44} = 2.0 \text{ g}$$

However, this should be used with great caution as payloads are rarely rigid during vibration testing.

APPENDIX A (cont.)

1.3 Horizontal Operation

For horizontal operation, care must be taken not to overload the armature bearings, due to the overhung mass of the payload.



The offset load equation is used to determine the maximum permitted payload:

Where:

X	=	Distance from armature to payload C of G	=	mm
P	=	Maximum payload mass	=	kg

$$P = \frac{A}{(B + X)} \quad \text{for V550} \quad P = \frac{567}{(44 + X)}$$

The overhung payload produces a turning moment which must be taken into account when calculating the maximum cross axial acceleration.

Where:

L	=	Overhung payload factor		
M	=	Mass of payload	=	kg

$$L = M\,(B + X)$$

Therfore:

$$a_c = \frac{(A - L)\,\pi^2 f^2}{250\,B\,C}$$

APPENDIX A (cont.)

Offset Load Graph
Horizontal Operation

$$P = \frac{567}{(44 + X)}$$

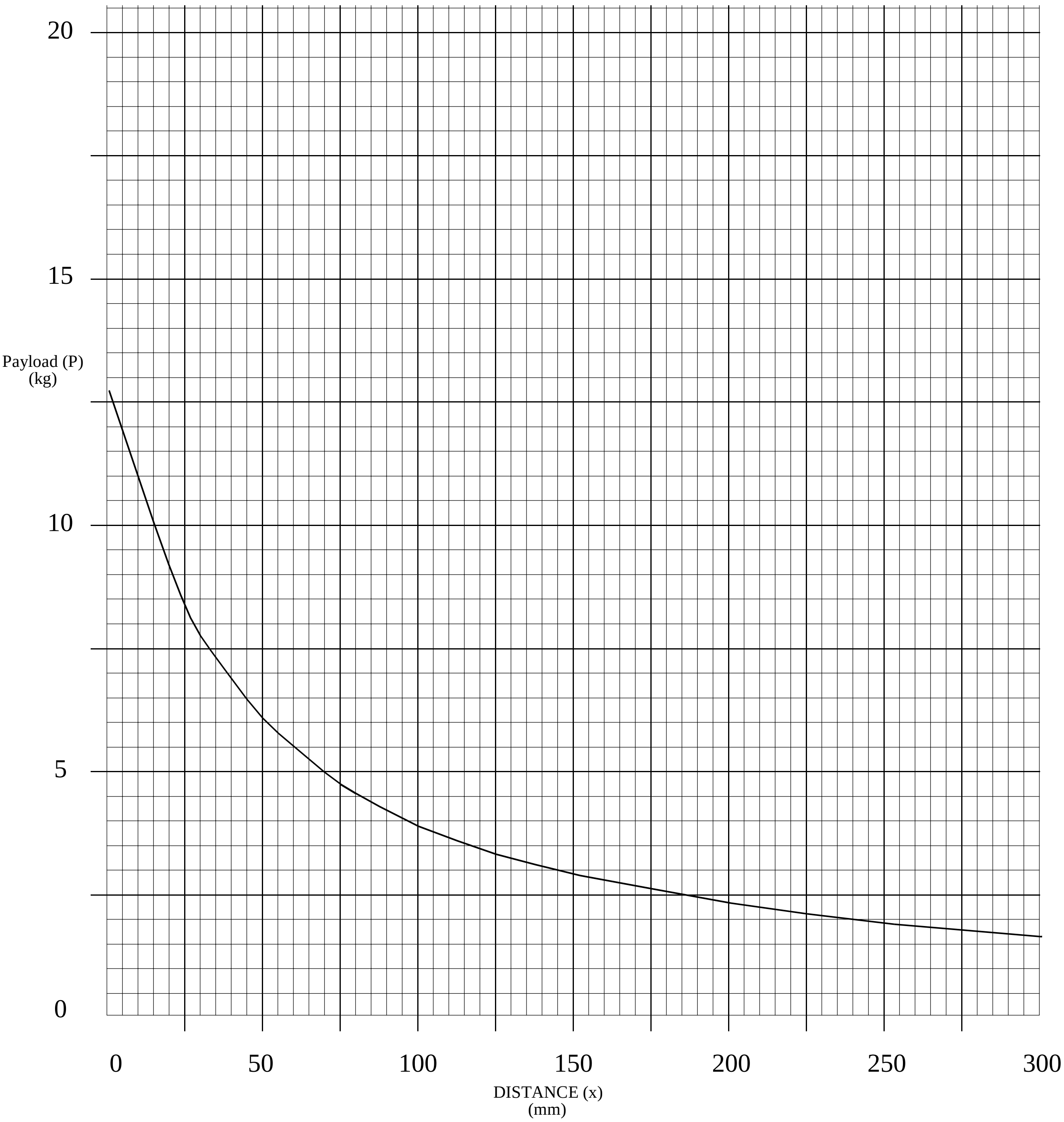


Figure 6.1   Offset Load Graph for V550/V555

APPENDIX A (cont.)

EXAMPLE

A payload of 5 kg has its centre of gravity 20 mm from the armature mounting face. it is to be vibrated between 50 Hz and 1000 Hz.

M	=	Mass	=	5 kg
X	=	Distance	=	20 mm
f	=	Lowest frequency	=	100 Hz

Maximum permitted payload:

$$P = \frac{567}{(44 + X)} = \frac{567}{(44 + 20)} = 8.9 \text{ kg}$$

So the 5 kg payload may be safely mounted onto the armature.

To calculate the maximum cross axial acceleration:

$$L = M\,(B + X) = 5\,(44 + 20) = 320$$

$$a_c = \frac{(567 - L) \times \pi^2 f^2}{250 \times 44 \times 2280} \quad \text{(for V550/555)}$$

$$= \frac{(567 - 330) \times \pi^2\, 100^2}{250 \times 44 \times 2280} = 1.0 \text{ g}$$

This is the maximum cross axial acceleration allowed for this example. Every effort should be made to mimimise this in practise by payload alignment and good fixture design.

Assuming a rigid payload, the cross axial acceleration, a_{pc} , at the payload centre of gravity can be found:

$$a_{pc} = \frac{a_c\,(B + X)}{B}$$

For V550, $a_{pc} = \frac{a_c\,(44 + X)}{44} = \frac{1.0\,(44 + 20)}{44} = 1.5 \text{ g}$

However, this should be used with great caution as payloads are rarely rigid during vibration testing.

APPENDIX A (cont.)

2. Resonance

It is essential that the payload be rigidly mounted. If it is not, the required acceleration level will not be transmitted to the payload; if the acceleration level is monitored on the payload, a thrust level, far in excess of that necessary, will be required. Additionally, a flimsy support structure will allow high resonances to occur which will be apparent in the thrust and cross axis directions.

Particular attention must be paid to the payload mounting screws. They should be as short as possible to avoid de-coupling due to stretching. As a general rule, the distance between the underside of the screw head and the tapped hole should not exceed 2.5 times the shank diameter.

If the payload mounting fixture behaves as a spring allowing relative movement of the payload and armature, a major resonance will occur at the frequency given by the formula:

$$f = \frac{1}{2\pi}\sqrt{\frac{K}{M}}$$

where, f = the natural frequency of the mounted system.

M = the payload's mass (kg).

K = the stiffness of the system.

For example, if the fixing screws are too long: $K = \frac{EA}{L}$

APPENDIX A (cont.)

Example,

Six M10 screws, 100 mm long

$E = 2 \times 10^{11}$ N/m^2 (typical steel vaue)

Payload Mass = 1000 kg

$$K = \frac{EA}{L} = 2 \times 10^{11}\ \mathrm{N/m^2} \times (58\ \mathrm{mm^2} \times 10^{-6} \times 6) \times \frac{10^3}{100}$$

$$= 2 \times 10^{11}\ \mathrm{N/m^2} \times 3.48 \times 10^{-3}\ \mathrm{m}$$

$$= 696 \times 10^{6}\ \mathrm{N/m}$$

$$f = \frac{1}{2\pi}\sqrt{\frac{K}{M}}$$

$$f = \frac{1}{2\pi}\sqrt{\frac{696 \times 10^6}{1000}} = 133\ \mathrm{Hz}$$

Note that the natural frequency of the system depends on:

* the screws (material, area and length)

* the payload (mass)

It does not depend on the thrust of the Vibration Generator.

Note: Calculations provide a rough estimate of resonant frequencies; however, they should always be verified experimentally.

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APPENDIX B

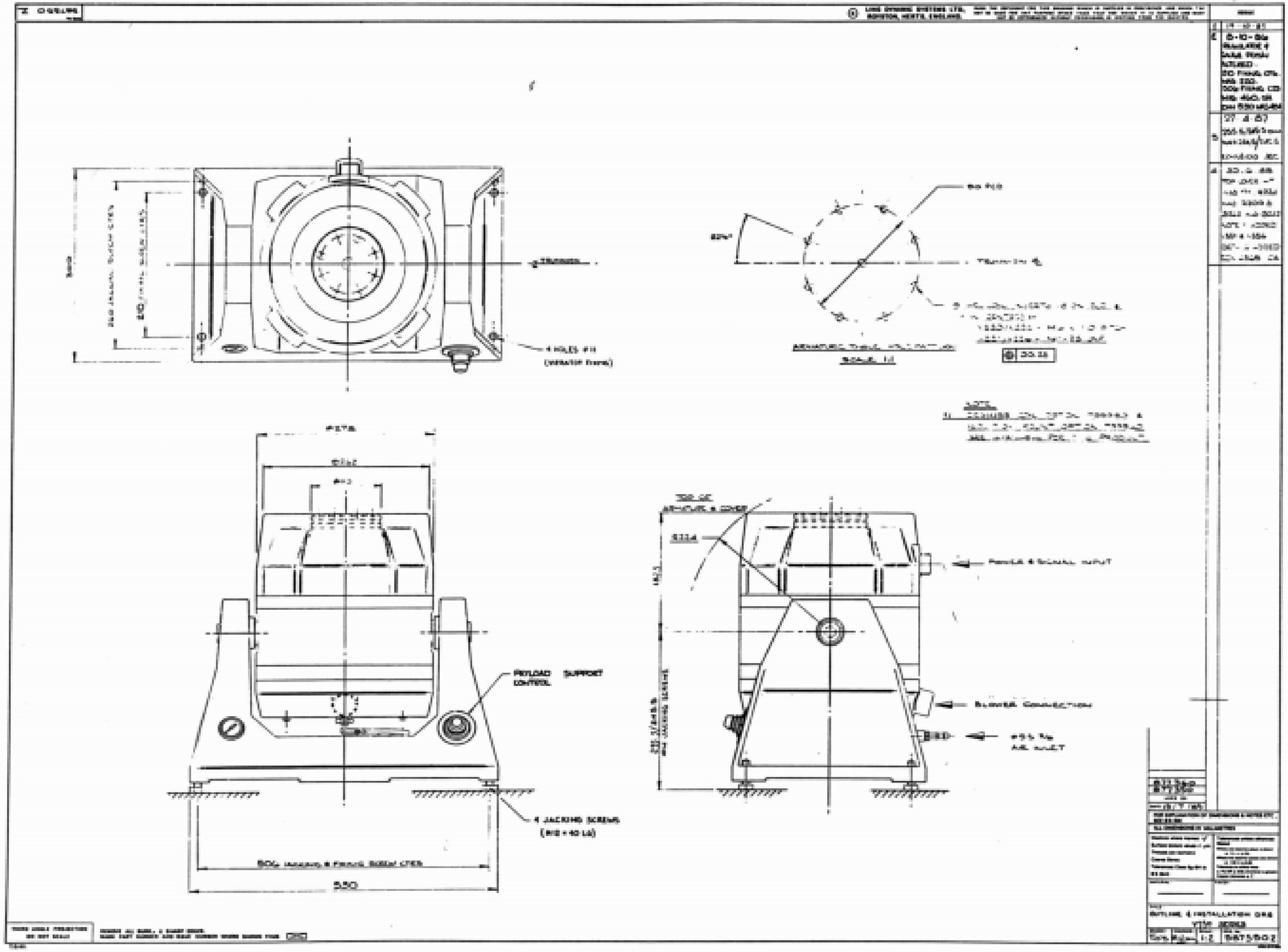
SPARES LIST (3 YEAR) V555

Part No.	Description	Qty.	
345700	Shaft, Armature Guide	2	
487890	Rolling Diaphragm, (rework 658710)	1	
572000	Pressure Pad, 1/8 in	3	
572010	Pressure Pad, 3/16 in	3	
572020	Pressure Pad, 1/4 in	3	
574820	Flexure	8	
574890	Insulating Bush	2	*(12)*
615390	Fixed Plug, Type MS 3102A-20-18-P	2	
641900	Gauge, Type 111/40.0-100PSI,1/8 in CBC, P/M	1	
655460	O/T Spring, (gold plate)	2	
658900	‘O’ Ring, BS:4518-0695-30	2	
658930	Keensert, Type KNCM 3 x 0.5	8	
658940	Keensert Install. Tool, Type T KN C M3 x O	1	
659400	Nylon tube, 4.76 mm O/D, Type 40-0032-03	3	
694480	Tubing nut, 3/16 in, Type 34-0279-03	10	
694490	Tubing sleeve 3/16 in, Type 34-0278-03	10	
698310	Ball bushing, Ref. A122026 C/W nylon ball	2	
698850	Resilient Mount, Type RSL 750	2	
705610	Hose Clip, 2.5 in /D, Size 3	2	
710900	Hose, 2.5 in I/D x 2 M, Flexflyte, U,I, CUFF/CUF	1	
714660	Regulator, Minature, Type R06-200-RNKD (-GAUGE)	1	
793330	Load Support, Manuf. Assy. V550-721, D/S 482	4	
793390	Lead Out Assembly, V550/V650/V721	1	*(12)*
794110	Field Coil Assembly,V550/V555	1	
794150	Armature Assembly, V555	1	
869380	Diode, Type 40HFR20	2	
964830	Braid, Connector, LH	1	*(12)*
965840	Braid, Connector, RH	1	
582250	Collar, Insulating	2	
580980	Insulating washer	2	

APPENDIX B (cont.)

SPARES LIST (3 YEAR) V550

Part No.	Description	Qty.	
345700	Shaft, Armature Guide	2	
487890	Rolling Diaphragm, (rework 658710)	1	
572000	Pressure Pad, 1/8 in	3	
572010	Pressure Pad, 3/16 in	3	
572020	Pressure Pad, 1/4 in	3	
574820	Flexure	8	
575080	Contactor, SHI	1	
574890	Insulating Bush	2	*(12)*
575150	Seal, Bottom Cover	5	
615390	Fixed Plug, Type MS 3102A-20-18-P	2	
641900	Gauge, Type 111/40.0-100PSI,1/8 in CBC, P/M	1	
655460	O/T Spring, (gold plate)	2	
658900	‘O’ Ring, BS:4518-0695-30	2	
658940	Keensert Install. Tool, Type T KN C M3 x O	1	
659400	Nylon tube, 4.76 mm O/D, Type 40-0032-03	3	
694480	Tubing nut, 3/16 in, Type 34-0279-03	10	
694490	Tubing sleeve 3/16 in, Type 34-0278-03	10	
698310	Ball bushing, Ref. A122026 C/W nylon ball	2	
698840	Ball bushing	1	
698850	Resilient Mount, Type RSL 750	2	
705610	Hose Clip, 2.5 in /D, Size 3	2	
710900	Hose, 2.5 in I/D x 2 M, Flexflyte, U,I, CUFF/CUF	1	
714660	Regulator, Minature, Type R06-200-RNKD (-GAUGE)	1	
793330	Load Support, Manuf. Assy. V550-721, D/S 482	4	
793390	Lead Out Assembly, V550/V650/V721	1	*(12)*
794110	Field Coil Assembly,V550/V555	1	
794140	Armature Assembly, V550	1	
869380	Diode, Type 40HFR20	2	*(12)*
964830	Braid, Connector, LH	1	
965840	Braid, Connector, RH	1	
582250	Collar, Insulating	2	
580980	Insulating washer	2	


LING DYNAMIC SYSTEMS LTD.
ROYSTON, HERTS, ENGLAND.
4 HOLES
TOP OF ARMATURE & COVER
POWER & SIGNAL INPUT
BLOWER CONNECTION
AIR INLET
PAYLOAD SUPPORT CONTROL
4 JACKING SCREWS
530
ARMATURE TABLE MOUNTING
SCALE 1:1
NOTE
OUTLINE & INSTALLATION DRG

877350-B

LING DYNAMIC SYSTEMS LTD.
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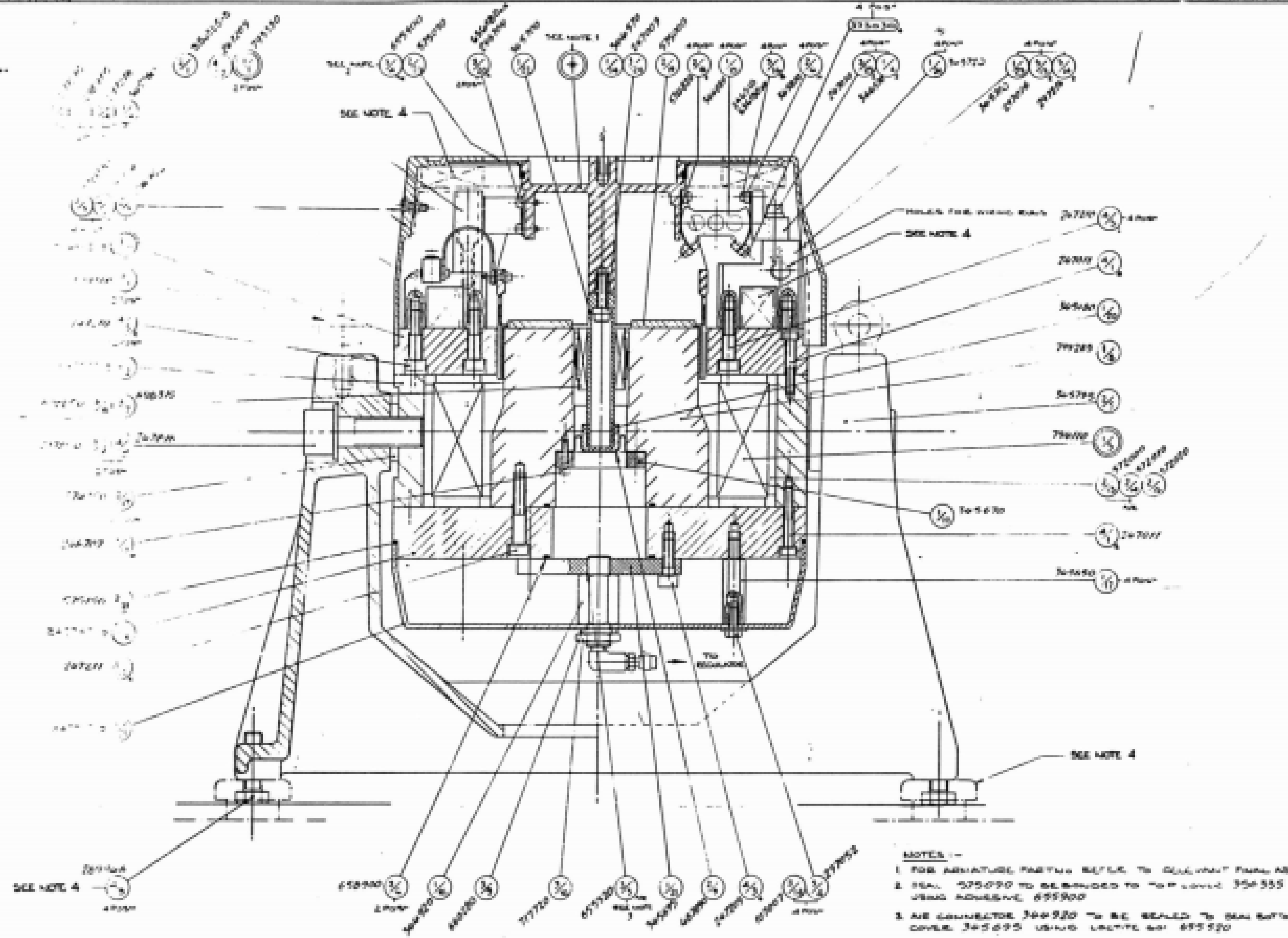


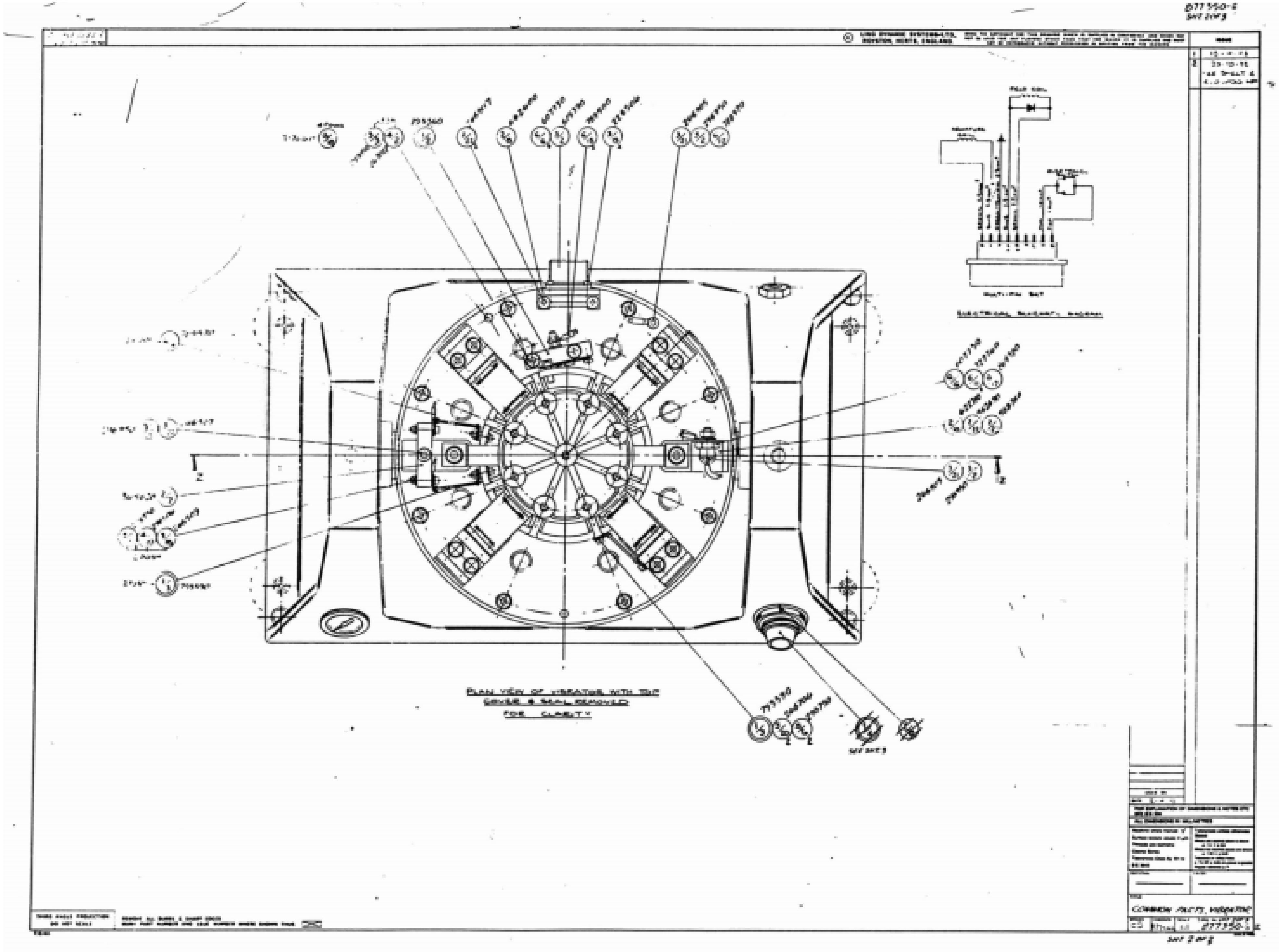
SECTION Z-Z

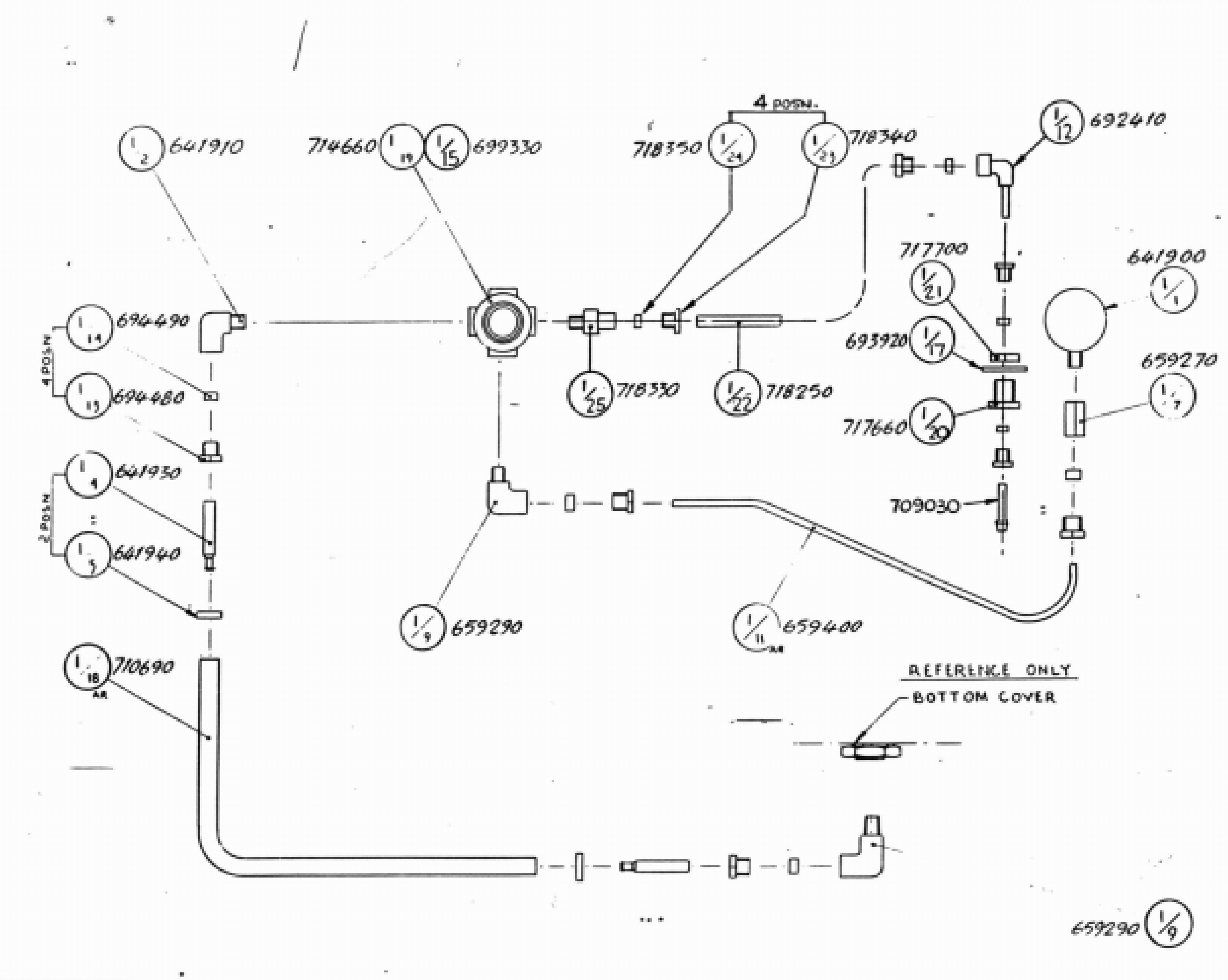
NOTES:-

1. FOR ARMATURE PARTS REFER TO [illegible] FINAL ASSY
2. SEAL 575090 TO BE BONDED TO TOP COVER 350555 USING ADHESIVE 655900
3. AIR CONNECTOR 344980 TO BE SEALED TO BASE BOTTOM COVER 345695 USING LOCTITE ON 655550
4. ISOLATION MOUNTS AND DRAINING COILS CAN BE FITTED AS AN OPTION.

THIRD ANGLE PROJECTION
DO NOT SCALE

877350-B


B77350-E
SHT 2 OF 3
PLAN VIEW OF VIBRATOR WITH TOP COVER & SEAL REMOVED FOR CLARITY
ELECTRICAL SCHEMATIC DIAGRAM
SEE SHT 3
COMMON PARTS, VIBRATOR
B77350
SHT 2 OF 3
THIRD ANGLE PROJECTION
DO NOT SCALE



ISSUE	
1	15-9-93
2	20-3-93 SEE SHEET 2 ECO 6100 NP

USED ON

DATE 15-9-93

FOR EXPLANATION OF DIMENSIONS & NOTES ETC SEE B.S 308

ALL DIMENSIONS IN MILLIMETRES

Machine where marked ∇
Surface texture values in µm
Threads are Isometric
Coarse Series
Tolerance Class 6g/6H to B.S 3643

Tolerances unless otherwise Stated
Where one decimal place is shown i.e. 1.0 = ± 0.3
Where two decimal places are shown i.e. 1.00 = ± 0.05
Tolerance on drilled holes ± 1% OR ± 0.05 whichever is greater
Angular tolerance ± 1°

MATERIAL:

FINISH:

TITLE: COMMON PARTS, VIBRATOR

DRAWN	CHECKED	SCALE	DRG No. SHT 3 OF 3
CD	M Young	—	877350-8

ANGLE PROJECTION
DO NOT SCALE

REMOVE ALL BURRS & SHARP EDGES
MARK PART NUMBER AND ISSUE NUMBER WHERE SHOWN THUS

877350
SHT 3 OF 3