LATERAL VIBRATIONS OF A BEAM

Laboratory experience - course of *Mechanical Vibration*

Components specifications and certificates

May 8, 2018

Accelerometers calibration certificates

The experiment setup includes three accelerometers to collect accelerations in three specific points of the beam. Accelerometer's technical draw is shown in figure 1. The main specifications of the accelerometers are shown in figure 2.

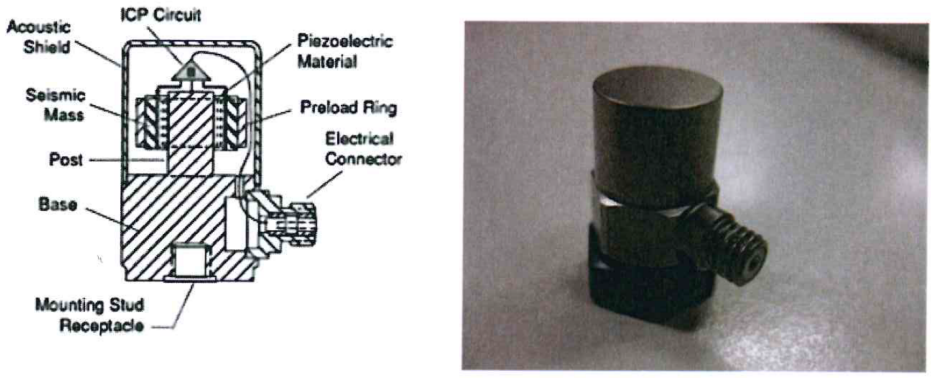


Figure 1: Accelerometer technical draw

Proprietà	Valore numerico
Accelerazione massima	$\pm 490\ [m/s^2]$
Range di frequenze utilizzabili	$0.3 \div 15000 \pm 10\%\ [Hz]$
Sensibilità	$10.2 \pm 10\%\ [mV/(m/s^2)]$
Massa	$0.0058\ [kg]$

Figure 2: Table of the main specs of the accelerometers

In the following there are the certificates of the three accelerometers.

~ Calibration Certificate ~

Per ISO 16063-21

Model Number: 352C33

Serial Number: LW143587

Description: ICP® Accelerometer

Manufacturer: PCB

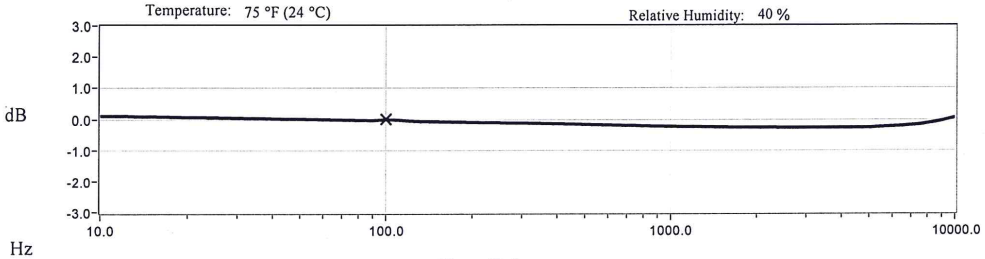
Method: Back-to-Back Comparison AT-401-3

Calibration Data

Sensitivity @ 100 Hz	**102.2 mV/g**	Output Bias	11.0 VDC
	(10.4 mV/m/s²)	Transverse Sensitivity	3.7 %
Discharge Time Constant	1.6 seconds	Resonant Frequency	58.1 kHz

Sensitivity Plot

Temperature: 75 °F (24 °C) Relative Humidity: 40 %



Data Points

Frequency (Hz)	Dev. (%)	Frequency (Hz)	Dev. (%)	Frequency (Hz)	Dev. (%)
10	1.1	300	-1.5	7000	-2.2
15	0.9	500	-2.0	10000	0.6
30	0.4	1000	-2.7		
50	-0.0	3000	-3.1		
REF. FREQ.	0.0	5000	-3.1		

Mounting Surface: Beryllium w/Silicone Grease Fastener: 10-32 Female Fixture Orientation: Vertical
Acceleration Level (pk)[1]: 10.0 g (98.1 m/s²)
[1]The acceleration level may be limited by shaker displacement at low frequencies. If the listed level cannot be obtained, the calibration system uses the following formula to set the vibration amplitude; Acceleration Level (g) = 0.008 x (freq)². [2]The gravitational constant used for calculations by the calibration system is; 1 g = 9.80665 m/s².

Condition of Unit

As Found: n/a

As Left: New Unit, In Tolerance

Notes

1. Calibration is NIST Traceable thru Project 681/280472 and PTB Traceable thru Project 10065.
2. This certificate shall not be reproduced, except in full, without written approval from PCB Piezotronics, Inc.
3. Calibration is performed in compliance with ISO 9001, ISO 10012-1, ANSI Z540.3 and ISO 17025.
4. See Manufacturer's Specification Sheet for a detailed listing of performance specifications.
5. Measurement uncertainty (95% confidence level with coverage factor of 2) for frequency ranges tested during calibration are as follows: 5-9 Hz; +/- 2.0%, 10-99 Hz; +/- 1.5%, 100-1999 Hz; +/- 1.0%, 2-10 kHz; +/- 2.5%.

Technician: Monty Manning Date: 3/13/2012

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CAL48-3414517553.976+0

~ Calibration Certificate ~

Per ISO 16063-21

Model Number: 352C33

Serial Number: LW143199

Description: ICP® Accelerometer

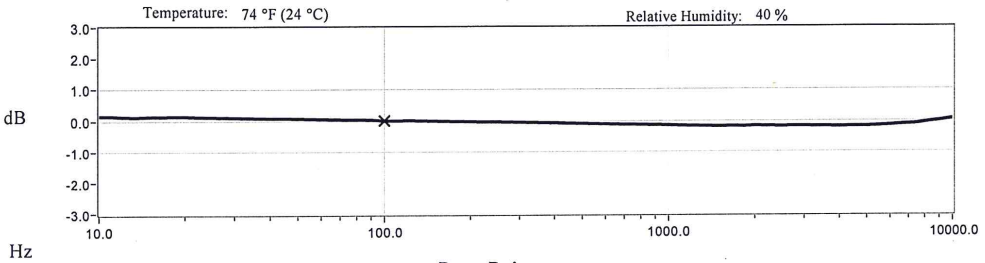
Manufacturer: PCB

Method: Back-to-Back Comparison AT-401-3

Calibration Data

Sensitivity @ 100 Hz	**100.1 mV/g**	Output Bias	11.0 VDC
	(10.2 mV/m/s²)	Transverse Sensitivity	2.2 %
Discharge Time Constant	2.1 seconds	Resonant Frequency	52.4 kHz

Sensitivity Plot



Data Points

Frequency (Hz)	Dev. (%)	Frequency (Hz)	Dev. (%)	Frequency (Hz)	Dev. (%)
10	1.6	300	-0.7	7000	-1.5
15	1.4	500	-1.2	10000	0.5
30	1.1	1000	-1.9		
50	0.7	3000	-2.2		
REF. FREQ.	0.0	5000	-2.3		

Mounting Surface: Beryllium w/Silicone Grease Fastener: 10-32 Female
Fixture Orientation: Vertical
Acceleration Level (pk)[1]: 10.0 g (98.1 m/s²)

[1]The acceleration level may be limited by shaker displacement at low frequencies. If the listed level cannot be obtained, the calibration system uses the following formula to set the vibration amplitude; Acceleration Level (g) = 0.008 x (freq)². [2]The gravitational constant used for calculations by the calibration system is; 1 g = 9.80665 m/s².

Condition of Unit

As Found: n/a

As Left: New Unit, In Tolerance

Notes

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Technician: Monty Manning

Date: 3/13/2012

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CAL48-3414518549.461+0

~ Calibration Certificate ~

Per ISO 16063-21

Model Number: 352C33

Serial Number: LW143337

Description: ICP® Accelerometer

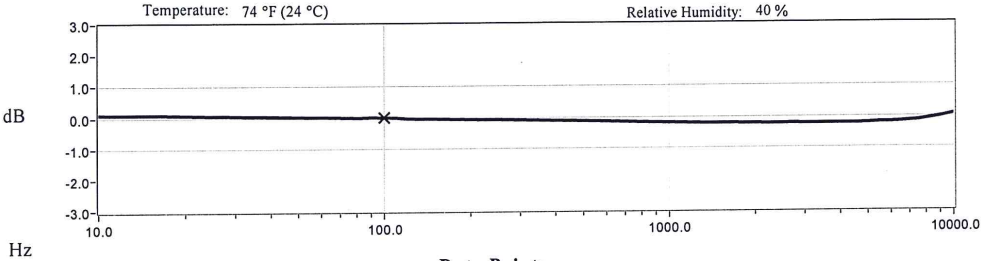
Manufacturer: PCB Method: Back-to-Back Comparison AT-401-3

Calibration Data

Sensitivity @ 100 Hz	**99.9 mV/g**	Output Bias	10.8 VDC
	(10.2 mV/m/s²)	Transverse Sensitivity	2.8 %
Discharge Time Constant	1.8 seconds	Resonant Frequency	58.5 kHz

Sensitivity Plot

Temperature: 74 °F (24 °C) Relative Humidity: 40 %



Data Points

Frequency (Hz)	Dev. (%)	Frequency (Hz)	Dev. (%)	Frequency (Hz)	Dev. (%)
10	1.1	300	-1.1	7000	-1.9
15	1.1	500	-1.6	10000	0.7
30	0.6	1000	-2.3		
50	0.2	3000	-2.7		
REF. FREQ.	0.0	5000	-2.7		

Mounting Surface: Beryllium w/Silicone Grease Fastener: 10-32 Female
Acceleration Level (pk)[1]: 10.0 g (98.1 m/s²) Fixture Orientation: Vertical

[1]The acceleration level may be limited by shaker displacement at low frequencies. If the listed level cannot be obtained, the calibration system uses the following formula to set the vibration amplitude; Acceleration Level (g) = 0.008 x (freq)².

[2]The gravitational constant used for calculations by the calibration system is; 1 g = 9.80665 m/s².

Condition of Unit

As Found: n/a

As Left: New Unit, In Tolerance

Notes

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Technician: Robert Zsebehazy RZ. Date: 3/8/2012

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CAL48-3414103176.094+0

Amplifier specifications

1. INTRODUCTION

1.1 General

The Ling Dynamic Systems (LDS) PA25E is a nominal 48 VA dc coupled, convection cooled, linear, FET power amplifier using Class B circuit techniques. It has been designed primarily to drive the LDS 100 and 200 series vibration generators.

Note: ***If the equipment is used for any other purposes the protection provided to the user may be impaired.***

The amplifier is driven from an external signal source via an isolated triaxial socket located on the rear panel.

The output is protected primarily by an overcurrent circuit, set to operate at 3.5 amps. Backup protection is also provided by an output fuse in series with the 'high' output connection.

The amplifier incorporates a signal clamp circuit to operate during power-up and overcurrent conditions. This prevents potentially transients being applied to the vibration generator armature circuit. Reset of the signal clamp is performed by a RESET switch located on the front panel.

The unit is supplied as standard for bench or 19 in rack mounted.

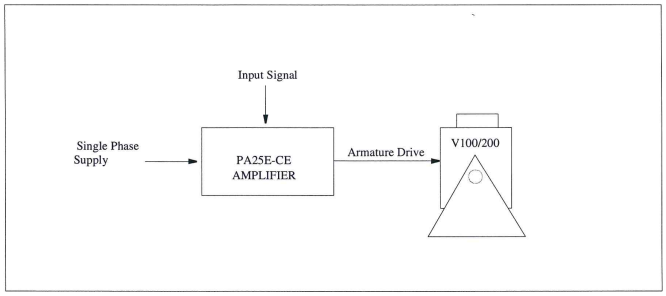

Figure 1.1 PA25E-CE Amplifier - System Connections

2. SPECIFICATION

2.1 Amplifier Performance

	Metric Units	American Units
Amplifier	**PA25E-CE**	**PA25E-CE**
Classification	Class B linear amplifier, air cooled	
Input supply:		
Single phase, 50/60 Hz	100, 110, 120, 200, 220, 240 V +/- 6%	100, 110, 120, 200, 220, 240 V +/- 6%
Amplifier performance:		
Rated sinusoidal power output into a resistive load of 5.3 ohms	48 W	48 W
Maximum continuous sinusoidal VA output into any reactive load, 0.5 pf leading or lagging at $t_{amb} = 25^0C$	48 VA	48 VA
Frequency range of rated power output	10 Hz to 10 kHZ	10 Hz to 10 kHz
Total harmonic distortion at rated output 20 Hz to 10 kHz	Typically < 0.5% ,	Typically < 0.5%
Maximum output voltage	16 V rms	16 V rms
Maximum no load voltage at the nominal ac power supply voltage	24 Vrms	24 Vrms
Voltage regulation foe a step change of current 0 - 3 amps	99%	99%
Output current at rated VA output	2.7 A rms	2.7 A rms
Maximum output current	3 A rms	3 A rms
Input sensitivity for maximum output (400 Hz)	1.0 V rms	1.0 V rms
Signal to noise ratio at maximum sinusoidal output, measured across the rated resistive load with input short circuited	>75 dB	>75 dB
Amplifier efficiency(maximum output) at 400 Hz	59%	59%

2. SPECIFICATION (cont.)

2.2 Environmental Data

	Metric Units	American Units
Amplifier	**PA25E-CE**	**PA25E-CE**
Heat rejected to environment at maximum power output	67 W	67 W
Generated sound power level at maximum power output. Measured at 2 metres with signal frequency = 1000 Hz	0 dBA	0 dBA
Ambient temperature range at maximum power output	0^0 to 35^0 C (above 35^0 C derate by 2% per ^{0}C)	32^0 to 95^0 F (above 95^0 F derate by 2% per ^{0}F)
Working ambient pressure	900 - 1100 mbar	27 - 33 in Hg
Relative humidity (non-condensing)	0 - 95%	0 - 95%
Amplifier cooling	Natural convection cooling via rear mounted, high density, aluminium dissipator.	
Electrical Power Requirement		
AC input power will not exceed	90 VA	90 VA
Input fuse (20 mm antisurge) 200-240 V 100-110-120 V	2.5 A 5 A	2.5 A 5 A
Input voltage (single phase supply)	100, 110, 120, 200, 220, 240 V - 50/60 Hz	
Power connection	Rear panel mounted 3 pin IEC filter connector with integral fuse	
Dimensions and Weight		
Height Width Depth	92 mm 488 mm 337 mm	3.6 in 19.2 in 13.3 in
Weight (packed)	9 kg	20 lb

Hammer specifications

The hammer used has a interchangeable tip.

Model Number	IMPACT HAMMER	Revision: L ECN #: 32387

Performance	ENGLISH	SI	
Sensitivity(± 15 %)	10 mV/lbf	2.25 mV/N	
Measurement Range	± 500 lbf pk	± 2224 N pk	
Resonant Frequency	≥ 22 kHz	≥ 22 kHz	
Non-Linearity	≤ 1 %	≤ 1 %	
Electrical			
Excitation Voltage	20 to 30 VDC	20 to 30 VDC	
Constant Current Excitation	2 to 20 mA	2 to 20 mA	
Output Impedance	<100 ohm	<100 ohm	[1]
Output Bias Voltage	8 to 14 VDC	8 to 14 VDC	
Discharge Time Constant	≥ 2000 sec	≥ 2000 sec	[1]
Physical			
Sensing Element	Quartz	Quartz	
Sealing	Epoxy	Epoxy	
Hammer Mass	0.34 lb	0.16 kg	
Head Diameter	0.62 in	1.57 cm	
Tip Diameter	0.25 in	0.63 cm	
Hammer Length	8.5 in	21.6 cm	
Electrical Connection Position	Bottom of Handle	Bottom of Handle	
Extender Mass Weight	2.6 oz	75 gm	
Electrical Connector	BNC Jack	BNC Jack	

CE [2]

All specifications are at room temperature unless otherwise specified.
In the interest of constant product improvement, we reserve the right to change specifications without notice.

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OPTIONAL VERSIONS

Optional versions have identical specifications and accessories as listed for the standard model except where noted below. More than one option may be used.

T - TEDS Capable of Digital Memory and Communication Compliant with IEEE P1451.4

TLD - TEDS Capable of Digital Memory and Communication Compliant with IEEE 1451.4

NOTES:
[1] Typical.
[2] See PCB Declaration of Conformance PS068 for details.

SUPPLIED ACCESSORIES:
Model 081B05
Model 084A08
Model 084B03
Model 084B04
Model 084C05
Model 084C11
Model 085A10
Model HCS-2

Entered:	Engineer:	Sales:	Approved:	Spec Number:
Date: 2/24/10	Date: 12/8/09	Date: 2/17/10	Date: 2/17/10	15273

Figure 3: Hammer specifications

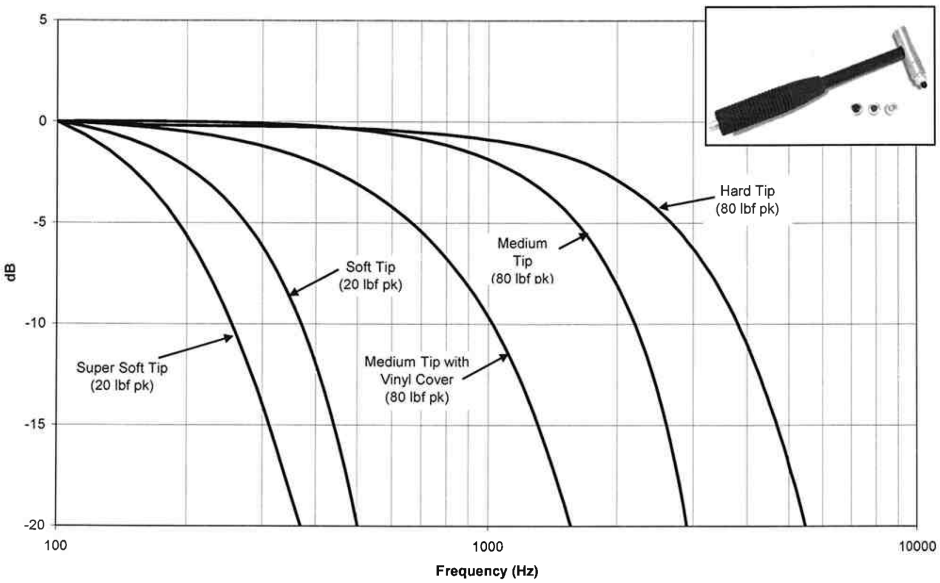
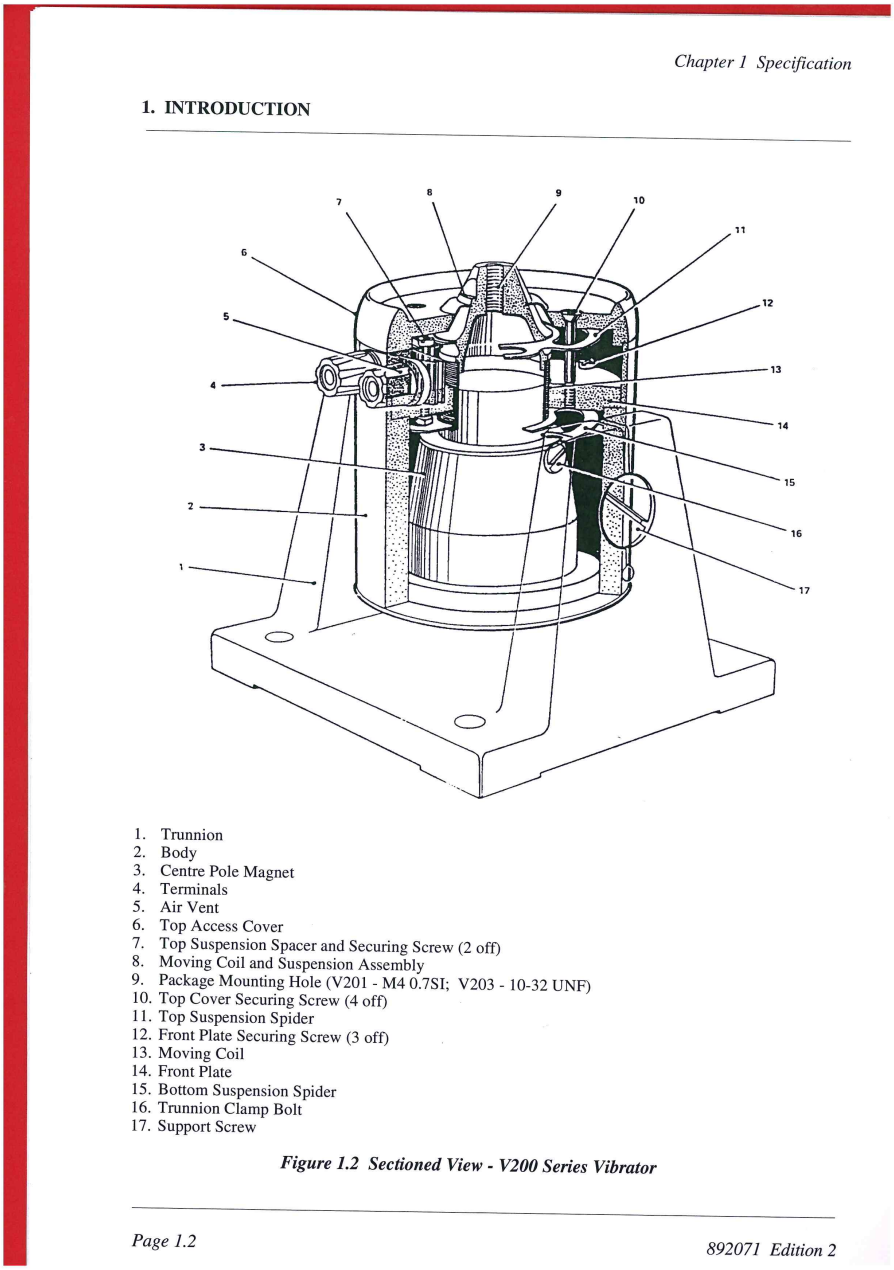


Figure 4: Hammer response curve, function of the tip type: from SuperSoft to Hard

Shaker specifications and calibration certificate



Chapter 1 Specification

1. INTRODUCTION

1. Trunnion
2. Body
3. Centre Pole Magnet
4. Terminals
5. Air Vent
6. Top Access Cover
7. Top Suspension Spacer and Securing Screw (2 off)
8. Moving Coil and Suspension Assembly
9. Package Mounting Hole (V201 - M4 0.7SI; V203 - 10-32 UNF)
10. Top Cover Securing Screw (4 off)
11. Top Suspension Spider
12. Front Plate Securing Screw (3 off)
13. Moving Coil
14. Front Plate
15. Bottom Suspension Spider
16. Trunnion Clamp Bolt
17. Support Screw

Figure 1.2 Sectioned View - V200 Series Vibrator

Page 1.2 *892071 Edition 2*

Figure 5: Shaker components

2. SPECIFICATION

2.1 Specification - V200 Series Vibrators

	Metric	American
Model	**V201/203**	**V201/203**
Sine force, peak	(Note 2) 17.8 N	4.0 lbf
Maximum Sine force peak	(Note 3) 26.7 N	6.0 lbf
Armature Resonance Frequency	13000 Hz	13000 Hz
Useful Frequency Range	5 - 13000 Hz	5 - 13000 Hz
Effective Mass of Moving Element	0.020 kg	0.044 lb
Velocity Sine Peak	(Note 2) 1.49 m/s	58.7 in/s
Maximum Velocity Sine Peak	(Note 3) 1.83 m/s	72.0 in/s
Maximum Acceleration Sine Peak Maximum Acceleration Sine Peak	(Note 2) 890 m/s^2 (Note 3) 1335 m/s^2	90.7 gn 136 gn
Amplifier rating	0.048 kVA	0.048 kVA
LDS Amplifier	PA25E	PA25E
Suspension axial stiffness (nominal) Stiffness with auxiliary suspension	2.8 N/mm 12.3 N/mm	16 lbf/in 70 lbf/in
Displacement (continuous) pk-pk	5.0 mm	0.2 in
Max. Displacement (cont.) pk-pk	5.0 mm	0.2 in
Cooling Air Flow Rate	0.001 m^3/s	2.1 ft^3/min
Max. working ambient temperature	30^0C	86^0F
Heat rejected to air	48 W	48 W
Electrical requirement - Amplifier	0.13 kVA	0.13 kVA
Max. acoustic noise (Ref. Figure 1.4)	75 dBA	75 dBA
Impedance at 500 Hz	(Fig. 1.3) 2.0 ohm	2.0 ohm

	(base)	(trunnion)	(base)	(trunnion)
Vibrator mass, (mounting)	1.81 kg	3.17 kg	4.0 lb	7.0 lb
Height	96 mm	128 mm	3.78 in	5.06 in
width	78 mm dia.	102 mm	3.06 in	4.00 in
Length	- - -	117 mm	- - -	4.63 in

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 (with another amplifier)

(11)

Figure 6: Shaker specifications table

Proprietà	Valore numerico
Forza massima	17.8 $[N]$
Range di frequenze utilizzabili	$5 \div 13000$ $[Hz]$
Accelerazione massima	890 $[m/s^2]$
Spostamento massimo	5.0 $[mm]$
Massa	4.98 $[kg]$

Figure 7: Shaker model main specifications table