

TACHAMMER™

Haptic actuator with Linear Magnetic Ram (LMR) technology. Features traditional and impact haptic generation

High-fidelity simulation of real world haptics

25 G minimum acceleration in Impact mode

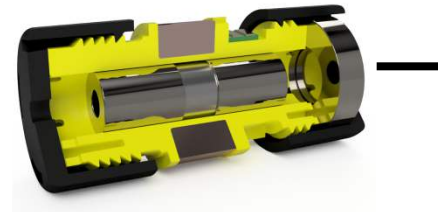
High operating efficiency: <2 μ Amp-hour / click

Operating voltage: 3.6 - 10 Vp-p

Operating frequency:

Impact: 0.5 - 155Hz / Traditional: 0.5 - 200Hz

Compatible with standard haptic drive electronics



TACHAMMER

LMR CLASS HAPTIC ACTUATOR

3 HAPTIC MODES:

IMPACT | VIBRATION | PULSE

Product ID: C-151L337V5R2

Revised October 01, 2020

TACHAMMER



LMR CLASS HAPTIC ACTUATOR

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Product ID: C-151L337V5R2
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1 Getting Started

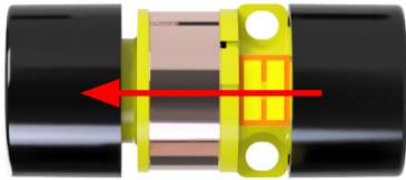
1.1 Operating Principles

The TacHammer™ haptic actuator provides two different haptic sensations based on the actuation direction of the ram.

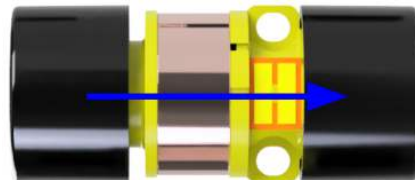
A “**hit**” is an impact haptic produced when striking the ram on a mechanical feature. This feature may be internal or external to the component (ie part a housing). Hits may produce audible effects which can be tuned through variations in the struck material.

A “**pulse**” is a non-impact haptic effect produced by driving the ram towards a magnetic brake within the component. Pulses are silent and do not produce audible effects. The haptics generated in this mode are similar to ERM & LRA effects.

Direction of Impact Mode Operation



Direction of Traditional Mode Operation



Both hits and pulses have variable intensities and actuation durations. Hits are used to generate sharp, momentary g-forces (like a click), and pulses are typically used to generate force sensations (like a bump).

Hits and pulses may be used in combination. A typical alert vibration for example is created through a chain of pulses actuated at a specified frequency. Combinations of hits and pulses provide for a range of new effects, like the snap of a latch, or the creaking of a door.



2 Specifications

2.1 Performance Specifications (ES1-3)

| PARAMETER | IMPACT HAPTIC MODE | | | TRADITIONAL HAPTIC MODE | | | UNIT |
|---|--------------------|--------|-------------|-------------------------|--------|-------------|--------|
| | MIN | TYP. | MAX | MIN | TYP. | MAX | |
| Minimum Acceleration | 25 | - | | 3.60 | - | | G |
| Acceleration Frequency (Resonance) ¹ | 35 | 45 | 55 | 60 | 70 | 80 | Hz |
| RMS Current at Tested Acceleration Frequency ² | - | 125 | 138 | - | 122 | 134 | mA |
| RMS Power at Tested Acceleration Frequency ^{2,3} | - | 110.94 | 135.21 | - | 105.68 | 127.49 | mW |
| Acceleration Efficiency ² | - | 377.69 | 366.83 | - | 55.83 | 61.97 | G/W |
| Click Energy ⁴ | - | 0.77 | 0.85 | - | 0.67 | 0.74 | μAh |
| Latency ⁵ | - | - | 10 | - | - | 0.75 | ms |
| Rise Time ⁵ | - | - | 0.75 | - | - | 9 | ms |
| Fall Time ⁵ | - | - | 13 | - | - | 6 | ms |
| dbA level at Tested Acceleration Frequency ⁶ | - | 81 | 82 | - | 68 | 70 | dbA |
| Operating Life ⁷ | | | 100 million | | | 100 million | cycles |

Notes:

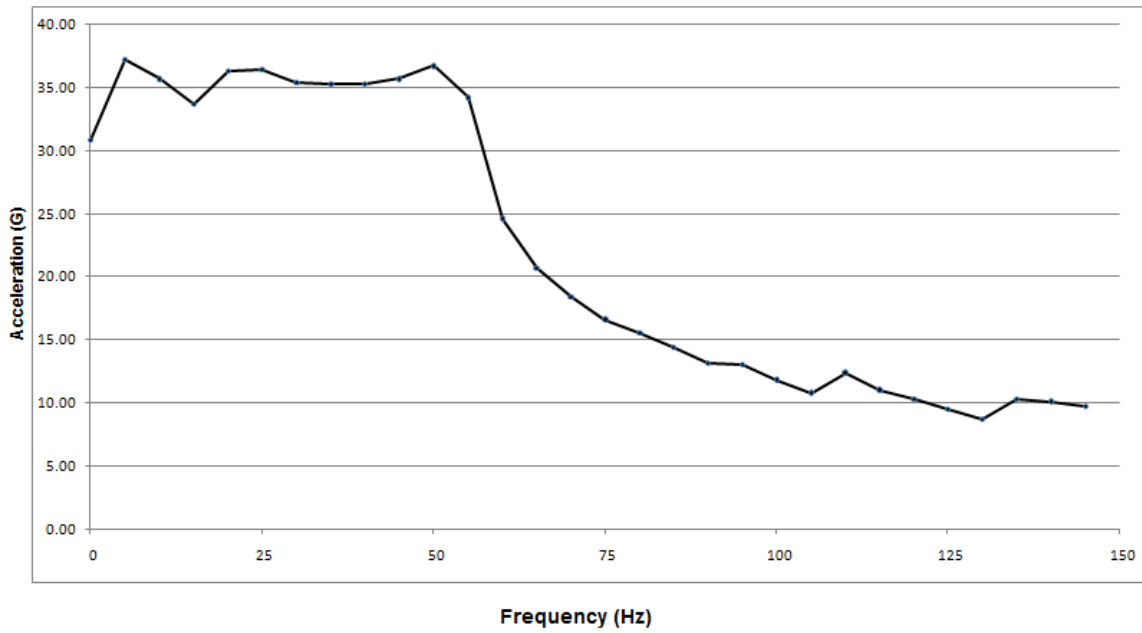
1. Resonance defined as the frequency that yields the highest tested acceleration at 10 Vp-p
2. Measured at 10 Vp-p, 100g jig, at tested acceleration frequency. mass driven towards accelerometer
3. Power calculated as $P = I_{rms}^2 \cdot Resistance$
4. Click Energy defined as the energy to perform a single click.

$$ClickEnergy = \frac{I_{instantaneous} \cdot PulseWidth}{3600}$$
 Calculated as
5. See section 4.2 *Response Time Note* for additional details
 Impact measured at: 5V, 100g jig, 1Hz, 7.8ms pulse width
 Traditional measured at: 5V, 100g jig, 1Hz, 7.8ms pulse width
6. Measured from 10cm
7. 1 Cycle is defined as one complete movement of the actuator from rest to rest. Tested at 10 Vp-p, 50Hz@40% duty cycle

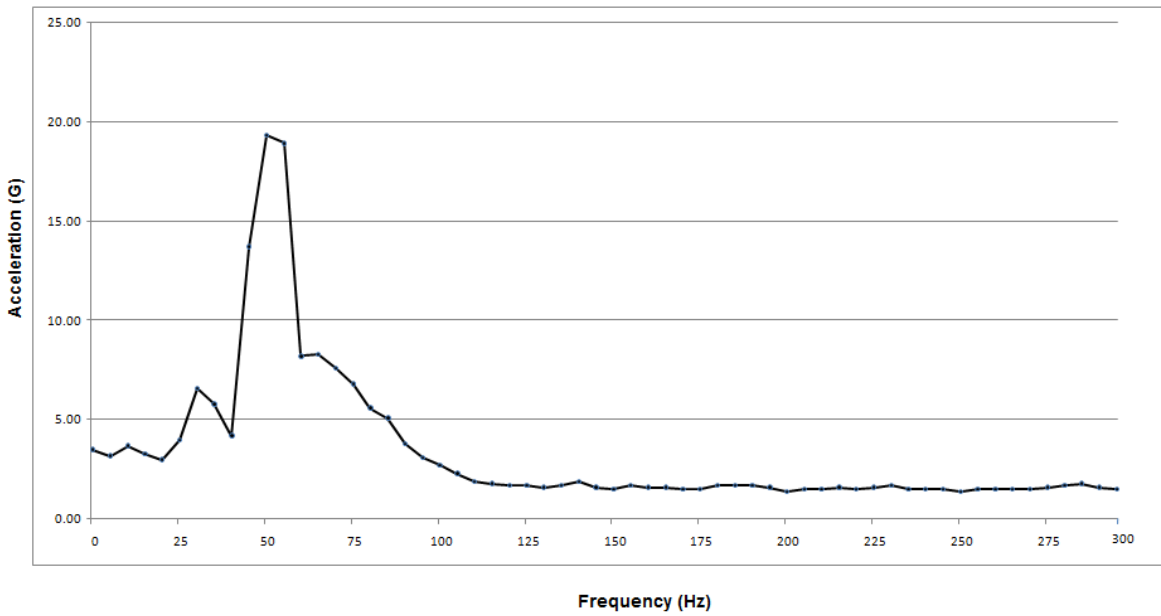


2.2 TacHammer™ Frequency Response

TacHammer Performance (Impact Mode)



TacHammer Performance (Traditional Mode)



2.3 Recommended Operating Conditions

| PARAMETER | MIN | MAX | UNIT |
|------------------------------|-----|-----|------|
| Operating Voltage | 3.6 | 10 | Vp-p |
| Drive Frequency (Impact) | 0.5 | 155 | Hz |
| Drive Frequency (Non-Impact) | 0.5 | 200 | Hz |
| Operating Temperature | -20 | 60 | °C |

2.4 Electrical Characteristics

| PARAMETER | MIN | TYP | MAX | UNIT |
|----------------------------|------|------|------|------|
| Coil Resistance @ 20°C | 6.85 | 7.10 | 7.35 | Ω |
| Inductance @ 100 KHz, 0.1V | 1.09 | 1.20 | 1.31 | mH |

2.5 Mechanical Characteristics

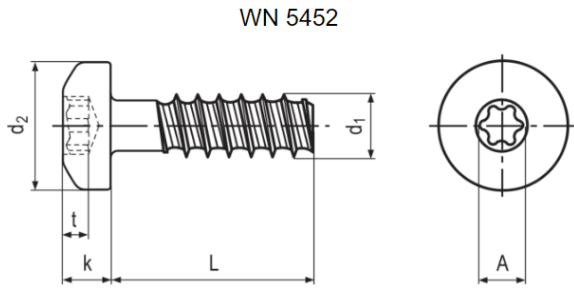
| PARAMETER | SPECIFICATION |
|----------------|-----------------------------|
| Dimensions | 15.5 mm x 15.5 mm x 34.3 mm |
| Total Weight | 15 g |
| Connector Type | Flying Lead |

2.6 Mounting Boss Specification

SCREW DIMENSIONS

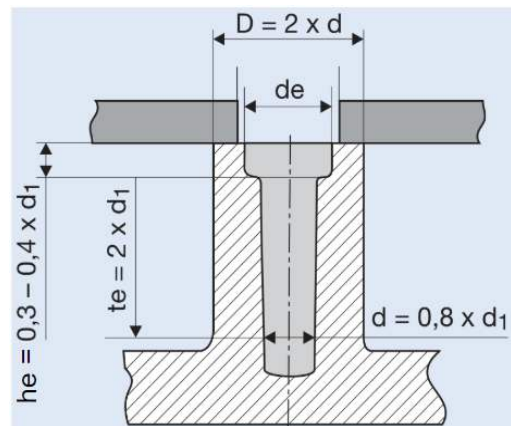


| DIMENSION | SYMBOL | VALUE (mm) |
|------------------------|--------|------------|
| Recess Width | A | 1.75 |
| Nominal Screw Diameter | d1 | 2 |
| Screw Head Diameter | d2 | 3.5 |
| Screw Height Height | k | 1.6 |
| Thread Length | L | 6 |
| Recess Depth | t | 7 |



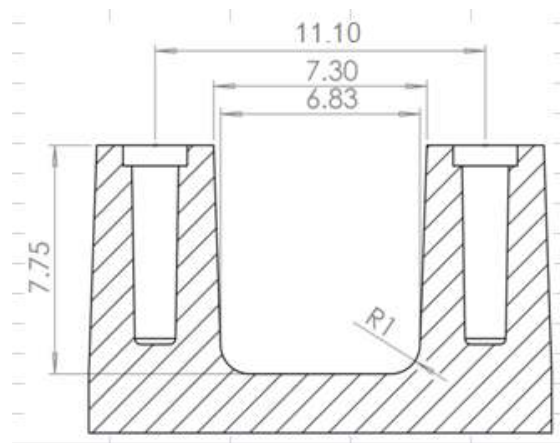
BOSS DIMENSIONS

| DIMENSION | SYMBOL | VALUE (mm) |
|------------------------|--------|------------|
| Nominal Screw Diameter | d1 | 2 |
| Boss Diameter | D | 4 |
| Edge Relief | de | 2.2 |
| Edge Relief Height | he | 0.6-0.8 |
| Thread Engagement | te | 4 |
| Pilot Hole | d | 1.6 |



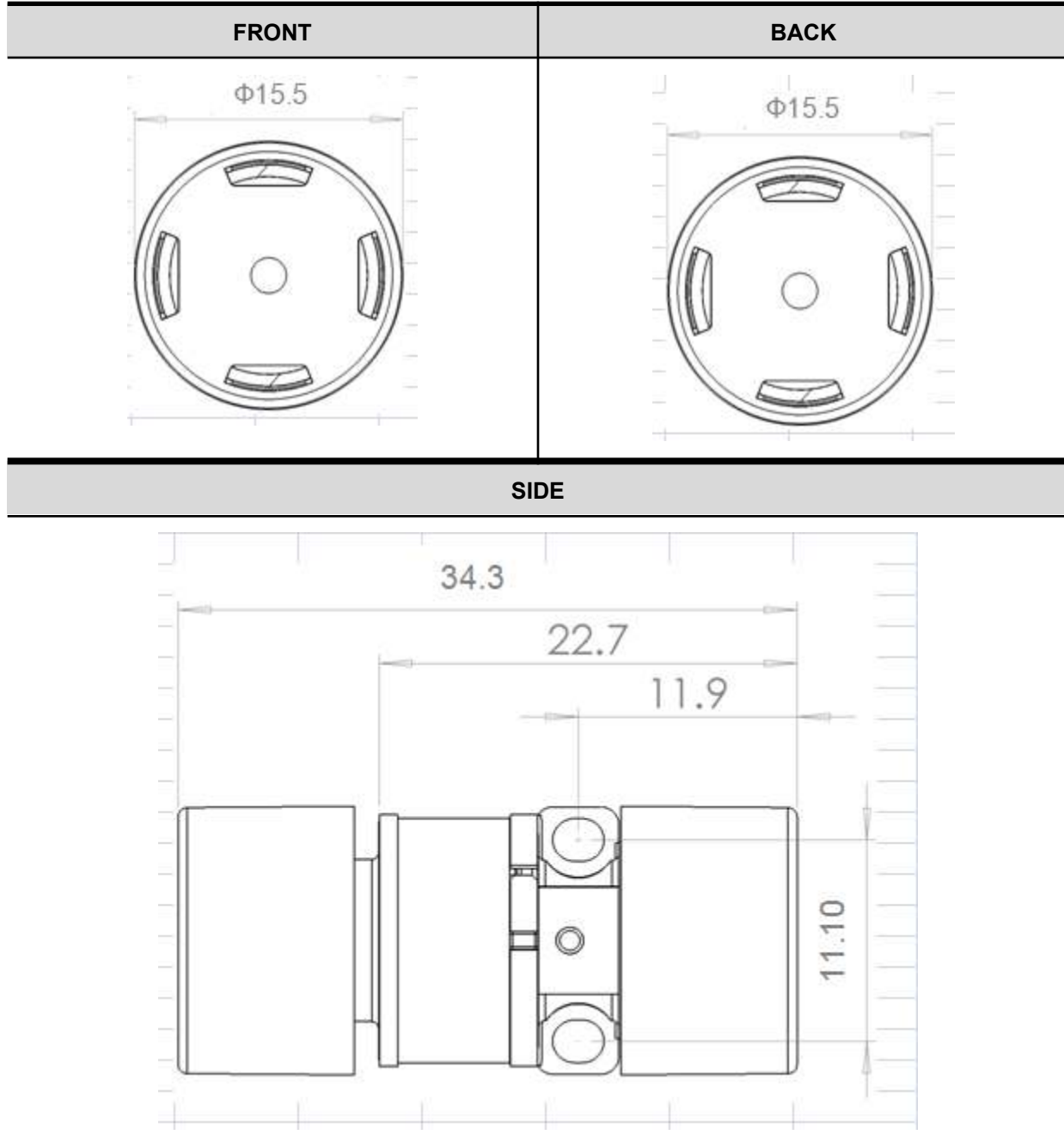
Recommended minimum 1° draft

SCREW MOUNT DIMENSIONS



2.7 Product Dimension Specification

*All dimensions in mm



3 Impact Tuning

Discs can be installed in the TacHammer unit to modify and tune the haptic quality of the impact mode haptics. It should be noted that the following listed materials are a suggested starting point and not a comprehensive list of materials compatible with the TacHammer. The sections below will detail the materials included as well as offer suggestions on how to use them.

3.1 Impact Materials

3.1.1 Soft Materials Overview

These materials soften the blow of the impact, primarily reducing the sound created when generating haptics and changing the quality of the haptic to be heavier and less sharp. Suggested materials to be used include:

| MATERIAL | COLOR | THICKNESS (MM) |
|-------------|-------|----------------|
| Poron 1/32" | Black | 0.8 |
| Poron 1/16" | Black | 1.6 |
| Silicon 10A | Red | 1.6 |
| Silicon 20A | Red | 0.8 |

3.1.2 Hard Materials Overview

These materials enhance and sharpen the quality of the haptic on impact. Suggested materials to be used include:

| MATERIAL | COLOR | THICKNESS (MM) |
|-------------------------|--------|----------------|
| Aluminum | Silver | 1 |
| Copper | Copper | 1 |
| Acrylic | Clear | 1 |
| Delrin | Black | 1 |
| Phosphor Bronze - 0.1mm | Bronze | 0.1 |
| Phosphor Bronze - 0.2mm | Bronze | 0.2 |



4 Application Notes

4.1 Driving Signal

4.1.1 Single Haptics

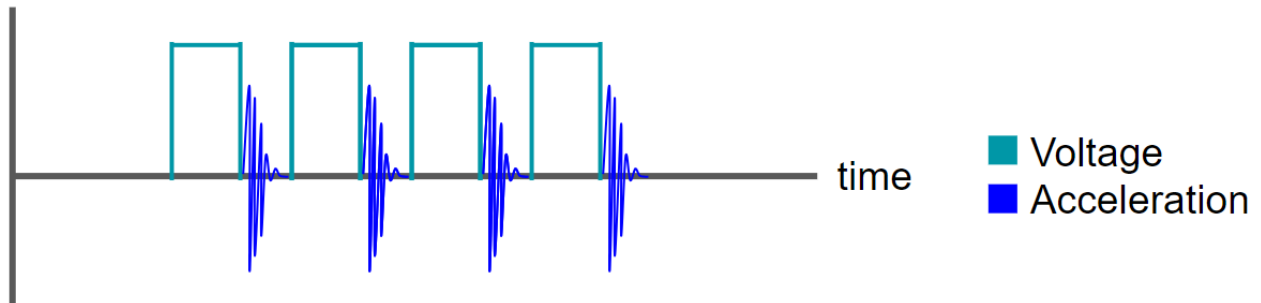
Single haptics such as a single Hit or Pulse is optimally driven with a single pulse. The following table lists the recommended duration for the respective haptic.



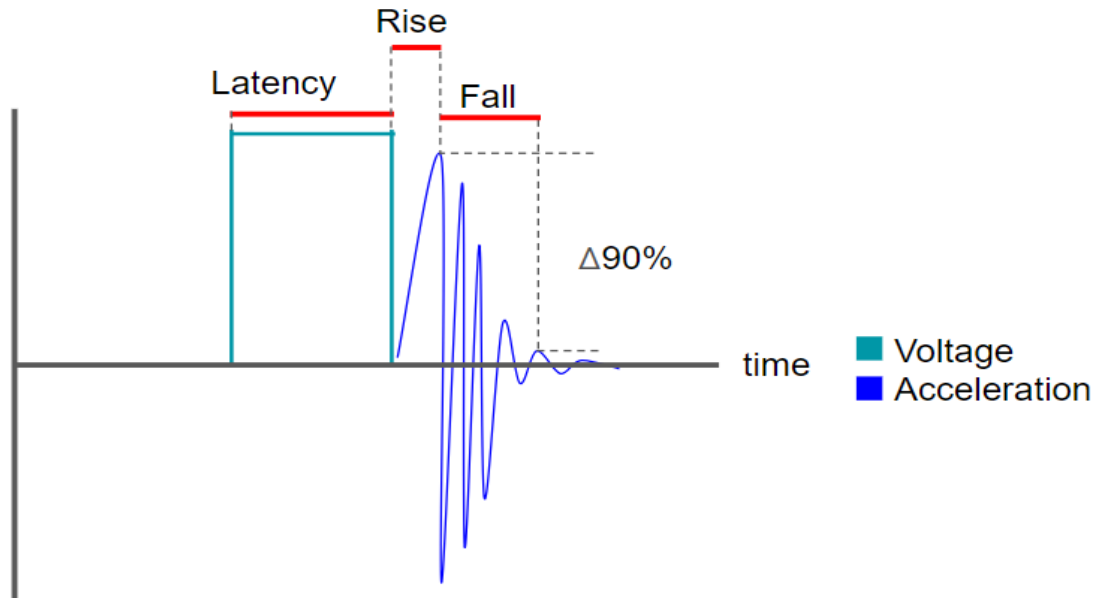
| HAPTIC | DURATION | UNIT |
|--------|----------|------|
| Hit | 10 | ms |
| Pulse | 10.91 | ms |

4.1.2 Repeated Haptics

For repeated haptics such as vibrations, the TacHammer™ haptic actuator is optimally driven with a square wave input. The following tables list recommended frequencies and duty cycles.



4.2 Response Time Note



Note: Above image is a representation of the driving signal and corresponding acceleration waveform for a single impact haptic.

4.3 Driving Note

This device may be driven using off the shelf haptic driver ICs such as the TI DRV2605 in PWM mode or by a simple H-Bridge.

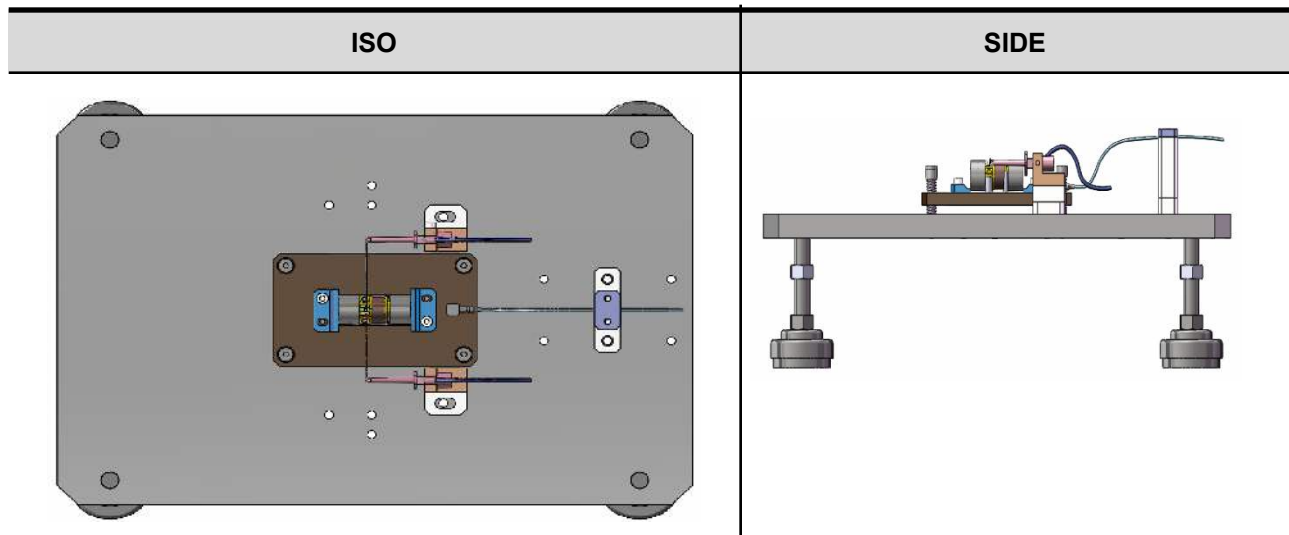
Additionally, the device is compatible with LRA wave forms and libraries, such as used those on the TI DRV2605.

4.4 Measurement Method

4.4.1 Test Equipment

| FUNCTION | MANUFACTURER | MODEL NUMBER |
|-------------------------------|-----------------|---------------------|
| Accelerometer | Dytran | 3133D1T(500g range) |
| Power Supply | CHINT | TNDI(SVC)-1 |
| Signal Generator | Rigol | DG1022U |
| Signal Amplifier | Rigol | PA1011 |
| DAQ (Data AcQuisition) system | One Measurement | DEWESoft-SIRIUS-M |

4.4.2 Test Fixture Setup



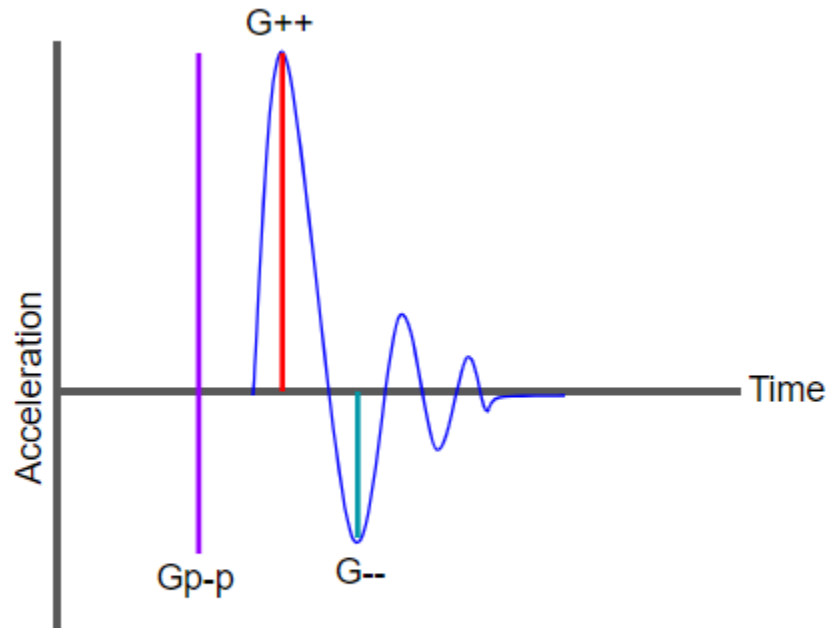
The TacHammer unit is firmly mounted with the use of a fixture to the 100g jig. An accelerometer is also firmly mounted along the axis of the TacHammer. The entire structure is suspended on 4 corners with springs (detailed below), providing freedom of movement freedom in all directions.

Spring specification:

Type : Closed Ends S/S Compression Spring (Not Ground)
Dimensions : OD=8mm, L=10mm, Wire OD = 0.35mm
Brand : YHDFA
Model : YWY-8-10



4.4.3 Acceleration Impulse Response



Acceleration values are computed by taking the resultant of the maximum absolute values of the acceleration in all three axes. In the case above, the G++ value would be taken. Assuming the waveform is similar in the X, Y, Z axes, the calculation for the acceleration is as follows:

$$Acceleration = \sqrt{G_x^2 + G_y^2 + G_z^2}$$



5 Standard Test Conditions

5.1 Test Environment

- Standard measurement environment is 25°C ± 3°C & 65% RH ± 20% RH unless otherwise marked
- All temperatures < 0 °C are +0 °C/-3 °C standard unless otherwise marked
- All temperatures > 0 °C are +3 °C/-0 °C standard unless otherwise marked
- All tests to be performed in Impact mode unless otherwise marked
- All duty cycles are better than +/- 0.05 % unless otherwise marked
- All frequencies are better than +/- 200 ppm (or 0.02 %) unless otherwise marked

5.2 Reliability Tests and Criteria

This section contains a detailed list of tests and success criteria

| TEST NAME | TEST DESCRIPTION | TEST STANDARD | SUCCESS CRITERIA |
|---|---|---------------|--|
| Drop Test | Drop JIG : 180g including the Actuator and assembly screws. Drop from 1.0m in specified drop buck onto 6 face. Actuator is not powered. | | Performance specifications within 20% of typical (after 4hours of recovery after test) |
| Life Test - Impact | 25°C/50%RH. The life test cycle, 1s on, 1s off, 200 Hours | | Performance specifications within 20% of typical (after 4hours of recovery after test) |
| Life Test - Non-Impact | 25°C/50%RH. The life test cycle, 1s on, 1s off,silent mode, 200 Hours | | Performance specifications within 20% of typical (after 4hours of recovery after test) |
| High Temperature Storage | 80°C, 96 hours. Actuator is not powered. | EIA-364-17 | Performance specifications within 20% of typical (after 4hours of recovery after test) |
| Low Temperature Storage | -40°C, 96 hours. Actuator is not powered. | EIA-364-17 | Performance specifications within 20% of typical (after 4hours of recovery after test) |
| High Temperature and Humidity Life Test | 60°C/95%. The life test cycle, 1s on, 1s off, 40 Hours. | EIA-364-17 | Performance specifications within 20% of typical (after 4hours of recovery after test) |
| Low Temperature Life Test | -20°C. The life test cycle, 1s on, 1s off, 72 Hours. | EIA-364-17 | Performance specifications within 20% of typical (after 4hours of recovery after test) |
| Long Life Test | 25°C/50%RH. The life test cycle, 1s on, 1s off, 1200 Hours | | Performance specifications within 20% of typical (after 4hours of recovery after test) |
| Thermal Shock Test | 5 cycles of -20°C for 30 minutes then +70°C for 30 minutes. The life test cycle, 1s on, 1s off, 5 temperature cycles. | EIA-364-32 | Performance specifications within 20% of typical (after 4hours of recovery after test) |



| | | | | |
|---------------------------------|--------|--|--------------|--|
| Salt Spray Test | | 35°C and 5% salt solution concentration. The life test cycle, 1s on, 1s off, 8 Hours. | EIA-364-26 | Performance specifications within 20% of typical (after 4hours of recovery after test) |
| Non-Operating Vibration Test | Random | JIG:180g including the Actuator and assembly screws. 3 axes, 10 minutes per axis, 6 g, 10-2000Hz. Actuator is not powered. | EIA -364-28 | Performance specifications within 20% of typical (after 4hours of recovery after test) |
| Shock Test | | JIG: 180g including the Actuator and assembly screws. Half sine shock plus,+X/-X/+Y/-Y/+Z/-Z axis,each axis 3 times,500G,Actuator is not powered. | EIA -364-27B | Performance specifications within 20% of typical (after 4hours of recovery after test) |
| Solderability Test | | Subject connector to the solder pot Temperature:245±5°C.3~5 sec. | EIA-364-52 | Performance specifications within 20%of typical (after 4hours of recovery after test) |

