

Specifications for: [OSOP Raspberry Shake RS4D](#)

- Your RS4D Personal Seismograph & Accelerograph -

An IoT home-automation device

Born on: February, 2017

<http://shop.raspberrysshake.org/>

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Unit

The “Raspberry Shake RS4D” Personal Seismograph & Accelerograph is an all-in-one, IoT plug-and-go solution for personal seismology- [OSOP, S.A.](#) integrates a single vertical velocity sensors with a 2G orthogonal MEMS accelerometer, the digitizers, the hyper dampers, and the computer into *a single box*. The Raspberry Shake RS4D is manufactured in Volcán, Panamá using cutting-edge 3D printing and laser-cutting technology.

Warranty: 1 year from ship date

Specifications subject to change without notice.

| Parameter | Value |
|----------------------------|--|
| Raspberry Shake 4D Version | V6, V5, V4 (Current version: V6) |
| Dimensions (estimated) | 100x120x50 mm |
| Weight (estimated) | 0.35 kg |
| Immersion rating | <i>Standard enclosure: IP10</i> <i>IP67 enclosure available upon request at additional cost</i> |
| Connectors | <i>Standard enclosure: Ethernet (RJ45), Power Micro USB (5V, 2.5 Amps), USB 2 ports x4, HDMI, Micro SD, CSI Camera port, Composite video and audio output jack</i> |

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|-----------------------------|---|
| | <i>IP67 enclosure: Ethernet (RJ45), Power</i> |
| Installation Considerations | <p>Designed for plug-and-go installation</p> <p>Mounting screw anchor slot provided</p> <p>Alignment: with axis of building or magnetic. North arrow provided.</p> |
| Operating Temperature | 0 to 60 C (limited by RPi, the Raspberry Shake itself can go to -20C) |
| On Board Computer | <p>Wifi-enabled Raspberry Pi 3 Model B</p> <p><i>The Raspberry Shake board/ Software is also compatible with:</i></p> <p>00[10,13],900032: Model B+</p> <p>a[01040,01041,21041,22042]: 2 Model B</p> <p>a[02082,22082,32082,52082]: 3 Model B</p> <p>a020d3: 3 Model B+</p> |
| Storage Device | <p>8 Gb or + micro SD card</p> <p><u><i>Est. # days of disk space:</i></u></p> <p>OS/ software: ~3 Gb</p> <p>Remaining space for data: ~5 Gb</p> <p># days (15 Mb/ day/ channel [x4]): ~80, more if you use a bigger SD</p> |
| Timing | <p>Network Timing Protocol, NTP (default)</p> <p>GPS timing supported</p> |

Timing Quality

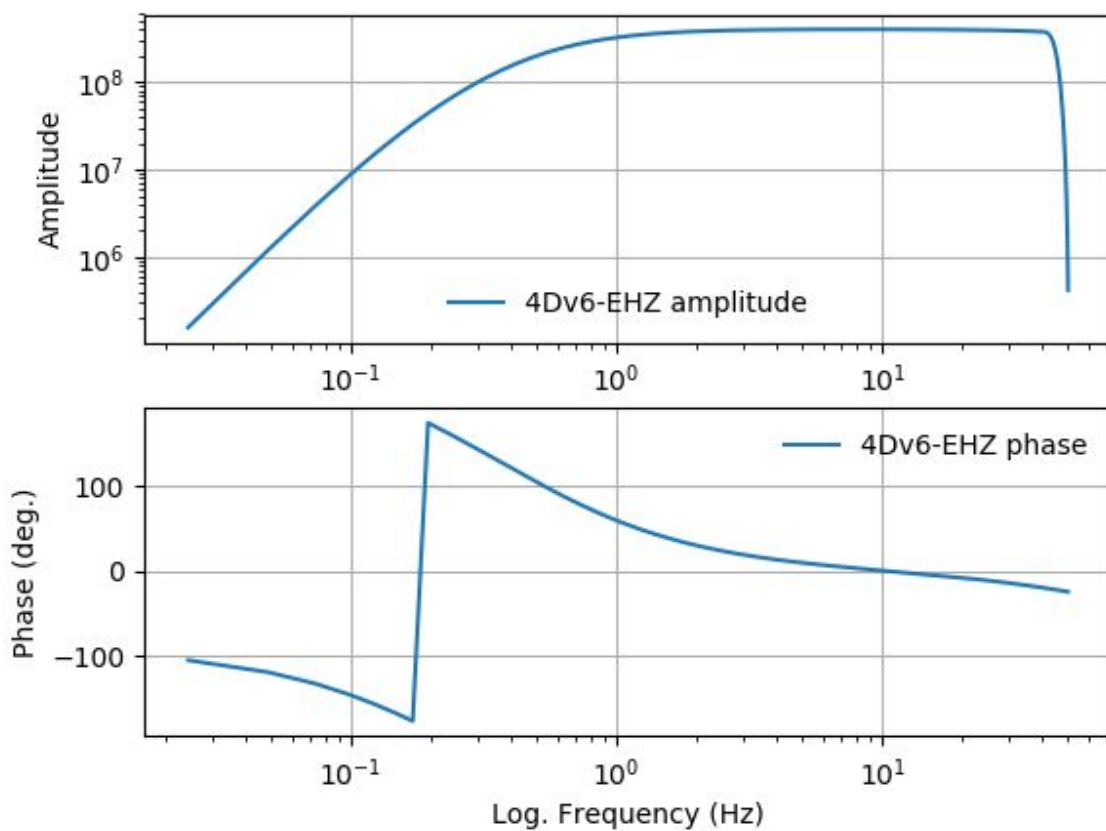
NTP timing quality remains within 1 sample of accuracy versus startup accuracy: +/- 10 ms or better @ 100 sps

Seismograph

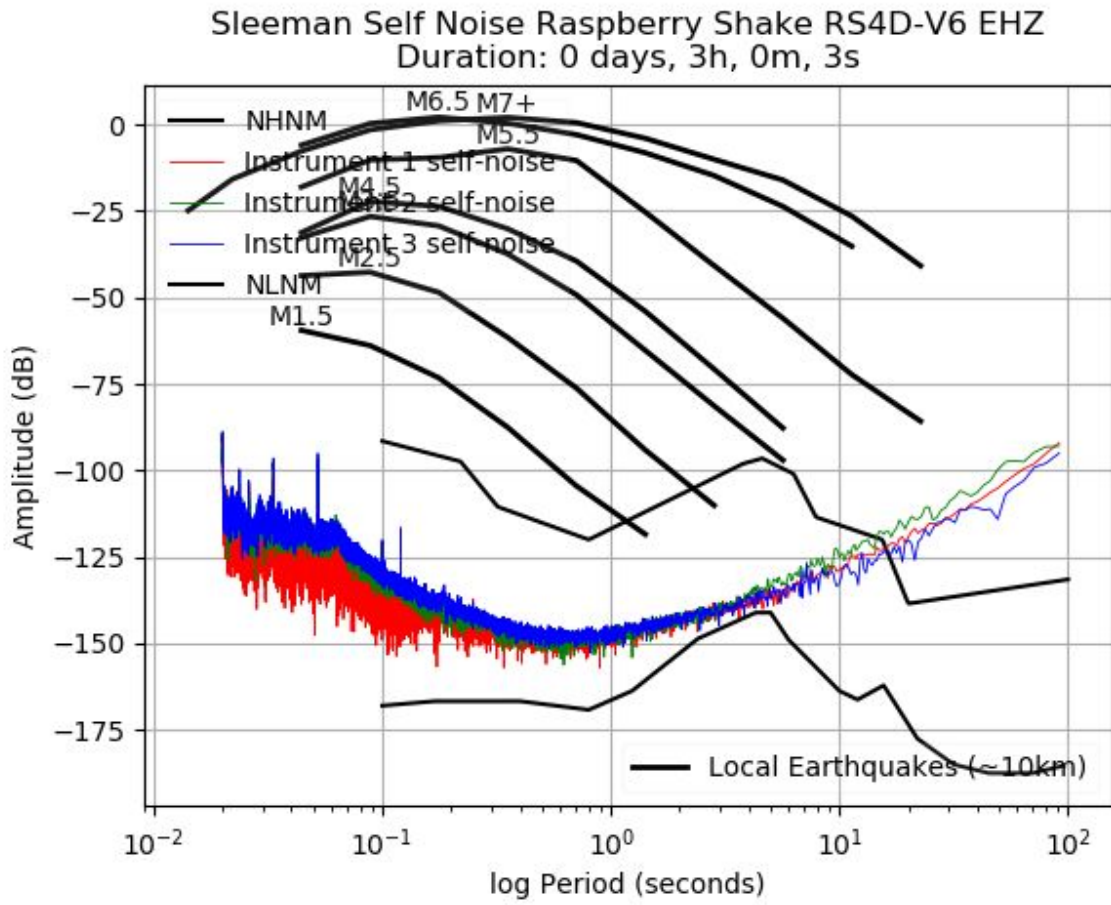
| Parameter | Value |
|---|---|
| Type | Single-component 4.5 Hz 395 Ohm vertical Racotech RGI-20DX geophone with electronic extension to lower frequencies (<1 Hz) |
| Samples per second | 100 |
| <p><i>Earthquake Early Warning (EEW) compatible</i></p> <p><i>data packets shipped across serial port at a rate of 4 packets/ second (250 ms/ packet)</i></p> | |
| Bandwidth (estimate) | <p>V6: -3dB points at 0.7 to 44 Hz</p> <p>V5: -3dB points at 0.7 to 26 Hz, possibly higher</p> <p>V4: -3dB points at 0.7 to 40 Hz</p> |
| Poles (estimate) | <p>V6:</p> <ul style="list-style-type: none"> -1 (0.16 Hz, single pole high pass filter) -3.03 x2 (0.48 Hz, double pole high pass filter) -666.67 (106 Hz, single pole low pass filter) <p>V5: -1.63E+02 +/- 1.02E+02; -3.61; -1.41 +/- 4.11E-01</p> <p>V4: 1.82E+02 +/- 3.43E+02; 4.56E-01; 0</p> |
| Zeros (estimate) | <p>V6: 0; 0; 0</p> <p>V5: -5.78E+03; 0; 0; 0</p> <p>V4: -3.60E+02 +/- 8.29E+02; -3.04 +/- 8.48E-01</p> |
| Sensitivity (estimate) | V6: 3.996500E+08 counts/ meter/ second +/- 10% precision |

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| | <p>V5: 3.36E+08 counts/ meter/ second +/- 10% precision</p> <p>V4: 4.05E+08 counts/ meter/ second +/- 10% precision</p> |
| Clip Level (estimate) | <p>+/- 8,388,608 counts (24-bits)</p> <p>V4+: 21 mm/s peak-to-peak from 0.1 to 10 Hz</p> |
| Minimum Detection Threshold (estimate) | <p>V5+: 0.03 $\mu\text{m/ s}$ RMS from 1 to 20 Hz @ 100 sps</p> <p>V4: 0.16 $\mu\text{m/ s}$ RMS from 1 to 20 Hz @ 100 sps</p> <p><i>Note: The minimum detectable level is considered to be 10 dB above the noise RMS. Dynamic range is the full scale sinusoid RMS over the noise RMS in dB.</i></p> |
| Digitizer Dynamic range | <p>24-bit ADC Sigma-Delta $\Sigma\Delta$</p> <p>144 dB (24 bits)</p> |
| Effective bits (estimate) | <p>V5+: 21 bits (126 dB) from 1 to 20 Hz @ 100 sps (for the entire analog to digital hardware chain).</p> <p>V4: 18 bits (109 dB) from 1 to 20 Hz @ 100 sps (for the entire analog to digital hardware chain).</p> <p><i>Note: Whereas most manufacturers report this for their digitizer only, we are reporting it for the entire sensor + ADC hardware chain. The effective bits of the digitizer itself are necessarily better.</i></p> <p>This parameter is also commonly known as "Dynamic Range"; "RMS to RMS noise"; or "noise free bits".</p> |

Velocity Channel Instrument Response:



Sleeman Self-Noise:



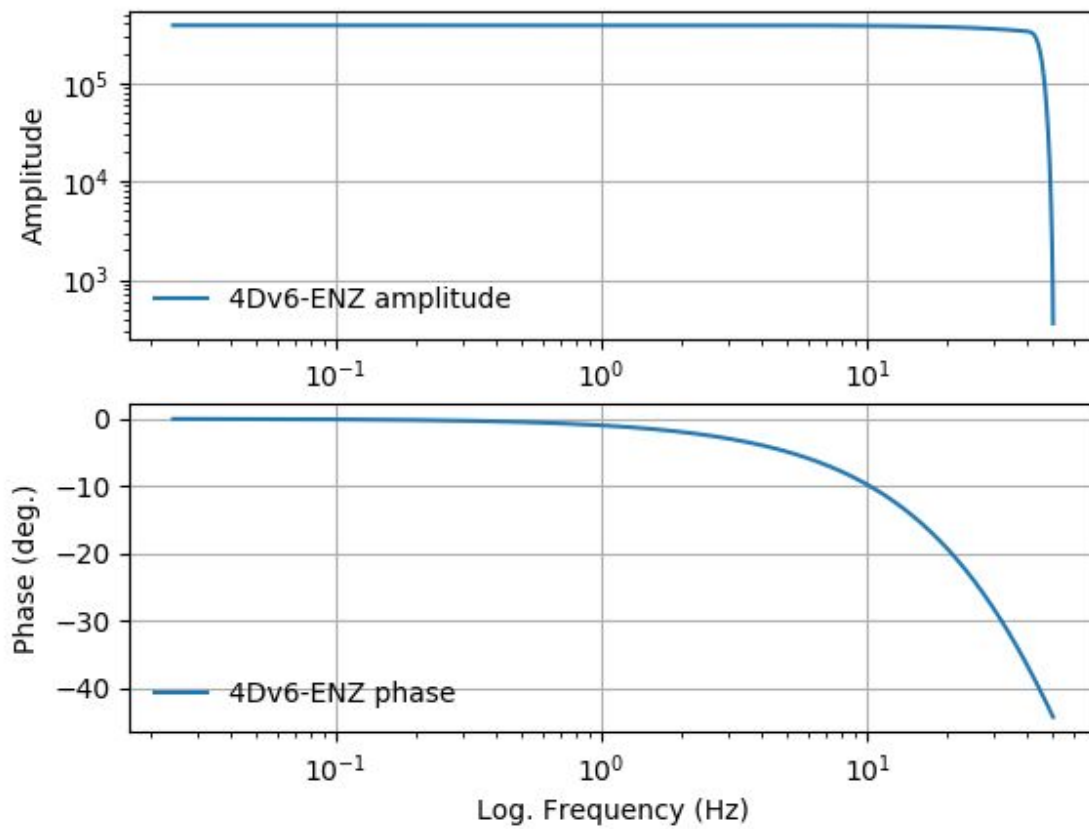
Accelerograph: MEMs

Think of the addition of the MEMs sensor as your insurance plan to guarantee that the Raspberry Shake remains on-scale for big earthquakes or smaller, local ones where the Raspberry Shake is located near the source, as often happens in settings like Oklahoma.

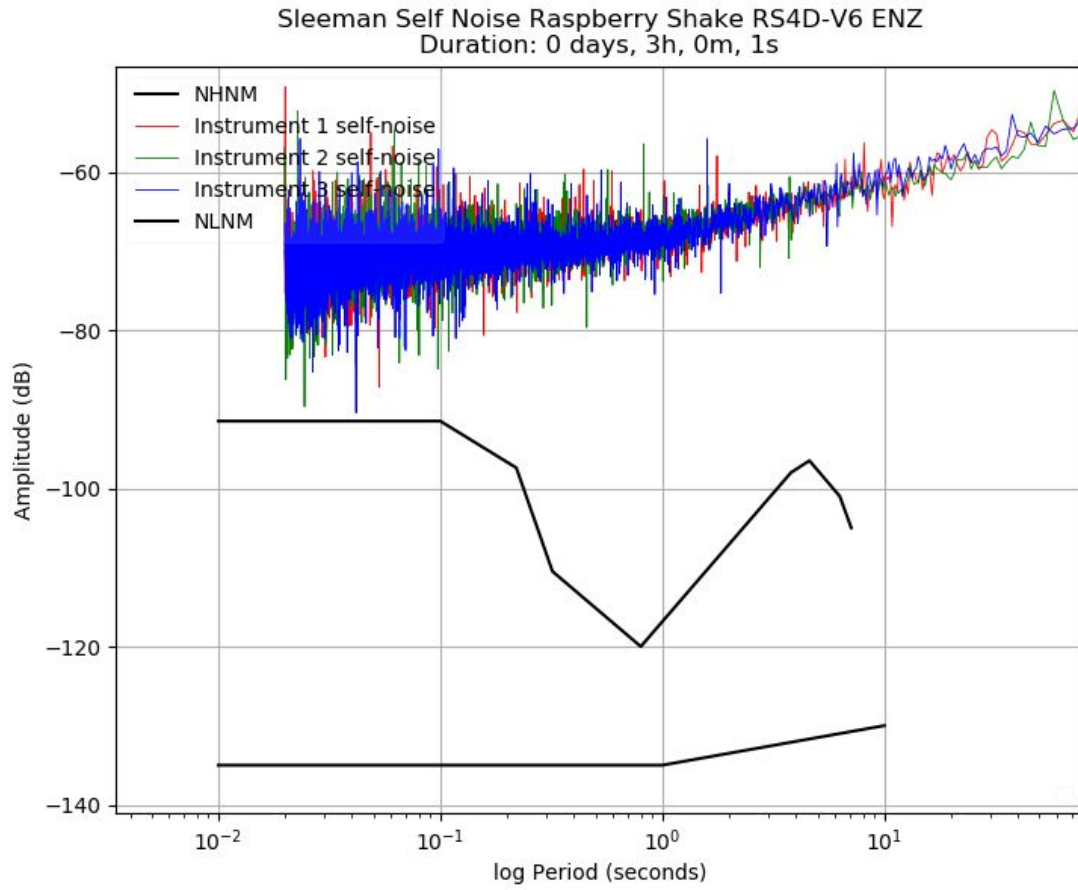
| Parameter | Value |
|---|--|
| Sensor | 3-component, orthogonally placed +/- 2g MEMs sensor (Class C) |
| Samples per second | 100 |
| <p><i>Earthquake Early Warning (EEW) compatible</i></p> <p><i>data packets shipped across serial port at a rate of 5 packets/ second (200 ms/ packet)</i></p> | |
| Flat Frequency Range (estimate, -3dB points) | <p>V6: DC to 44 Hz</p> <p>V5: DC to 23 Hz, possibly higher</p> <p>V4: DC to 29 Hz, possibly higher</p> |
| Poles (estimate) | <p>V6:</p> <p style="padding-left: 40px;">-459.56 (73 Hz, single pole low pass filter)</p> <p style="padding-left: 40px;">-1785.71 (284 Hz, single pole low pass filter)</p> <p>V5: 6.57E+02 +/- 1.20E+03; 0</p> <p>V4: 5.06E+01 +/- 2.86E+02; 0</p> |
| Zeros (estimate) | <p>V6: None</p> <p>V5: -1.26E+02 +/- 1.02E+02; -6.24E-05</p> <p>V4: -4.33E+02; -1.45E+02 +/- 2.78E+02; 3.94E-02</p> |

| | |
|----------------------------|---|
| Sensitivity (estimate) | <p>V6: 3.845E+05 counts/ meter/ second squared +/- 10% precision</p> <p>V5: 3.87E+05 counts/ meter/ second squared +/- 10% precision</p> <p>V4: 3.96E+05 counts/ meter/ second squared +/- 10% precision</p> |
| Clip Level (estimate) | V5+ V4: +/-2G (21-22 m/s ² peak-to-peak from 0.1 to 10 Hz) |
| Digitizer Dynamic range | <p>24-bit ADC Sigma-Delta $\Sigma\Delta$</p> <p>144 dB (24 bits)</p> |
| Effective bits (estimate) | <p>V4+: 14 bits (84 dB) from 1 to 10 Hz @ 100 sps (for the entire analog to digital hardware chain).</p> <p><i>Note: Whereas most manufacturers report this for their digitizer only, we are reporting it for the entire sensor + ADC hardware chain. The effective bits of the digitizer itself are necessarily better.</i></p> <p>This parameter is also commonly known as "Dynamic Range"; "RMS to RMS noise"; or "noise free bits".</p> |
| Noise Level | V4+: 3000 $\mu\text{m/s}$ (0.3 Gal, 0.0003 g) RMS from 1 to 10 Hz @ 100 sps |

Acceleration Channel Instrument Response:



Sleeman Self-Noise:



Software

| Software installed on Raspberry Shake's RPi computer |
|--|
| 100% SeisComP3 compatible Also: AQMS, Antelope, Earlybird, Earthworm, Hydra, ObsPy, SEISAN, ... |
| Native SeedLink Server (source: GEOFON) with OSOP Data Flow Message Router |
| Tight and automatic integration with SeisComP |
| Web-interface (HTML) for easy configuration |
| Software to store continuous seismic data in miniSEED format |
| Web-based helicorder plot generator (source: USGS) |
| Swarm (source: USGS) |
| Software distributed with Docker |
| Automatic updates |
| Operating System: Debian 8 (Linux) |

Communications

| Parameter | Value |
|---|--|
| Digital bandwidth consumption at 100 Hz, 4 channels (estimated) | Incoming rates RX: ~96.0 kbits/s Outgoing rates TX: ~376.0 kbits/s TCP Flow rate: 33.6 kbits/s |
| TCP/IP compatible | |
| Compatible with Wifi, Ethernet, Cell modem, GPRS, Satellite | |

Power

| Parameter | Value |
|--|---|
| Power Supply Voltage | 5 Volts DC (2.5 Amp supply) |
| Power Consumption (RPi + Raspberry Shake, estimated) | Startup: 5 Volts x 0.550 A = 2.8 Watts Run-time: 5 Volts x 0.460 A = 2.3 Watts |

Calibration Mechanism: Calibration not required over time but can be verified using the [OSOP Calibration Table](#). All seismographs are verified prior to shipping to ensure that their gain is within 10% of the nominal instrument response (up to 10% variation attributable to geophones and capacitors).

Questions?

Email us at sales@raspberrysake.org