

Specifications for: [Raspberry Shake RS4D](#)

- Your RS4D Personal Seismograph & Accelerograph -

An IoT home-automation device

Born on: February, 2017

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

sales@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 that 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 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	All versions
Dimensions (estimated)	<i>Standard enclosure: 135x110x50 mm</i> <i>IP67 enclosure: 160x90x90 mm</i>
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,</i>

	<p>HDMI, Micro SD, CSI Camera port, Composite video and audio output jack</p> <p><i>IP67 enclosure:</i> Ethernet (RJ45), Power</p>
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	<p>0 to 60 C (limited by RPi, the Raspberry Shake itself can go to -20C)</p>
On Board Computer	<p>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> <p>4 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>

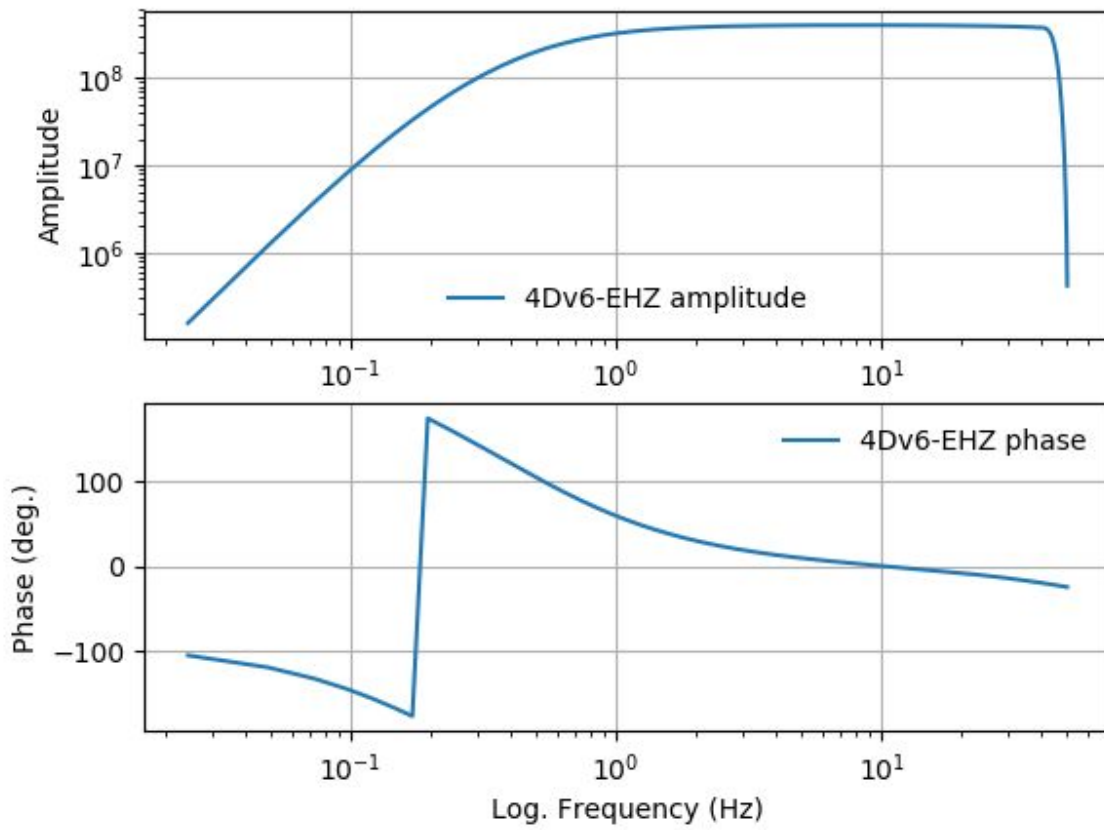
	GPS timing supported
Timing Quality	NTP timing quality remains within 1 sample of accuracy versus startup accuracy: +/- 10 ms or better @ 100 sps

Seismograph

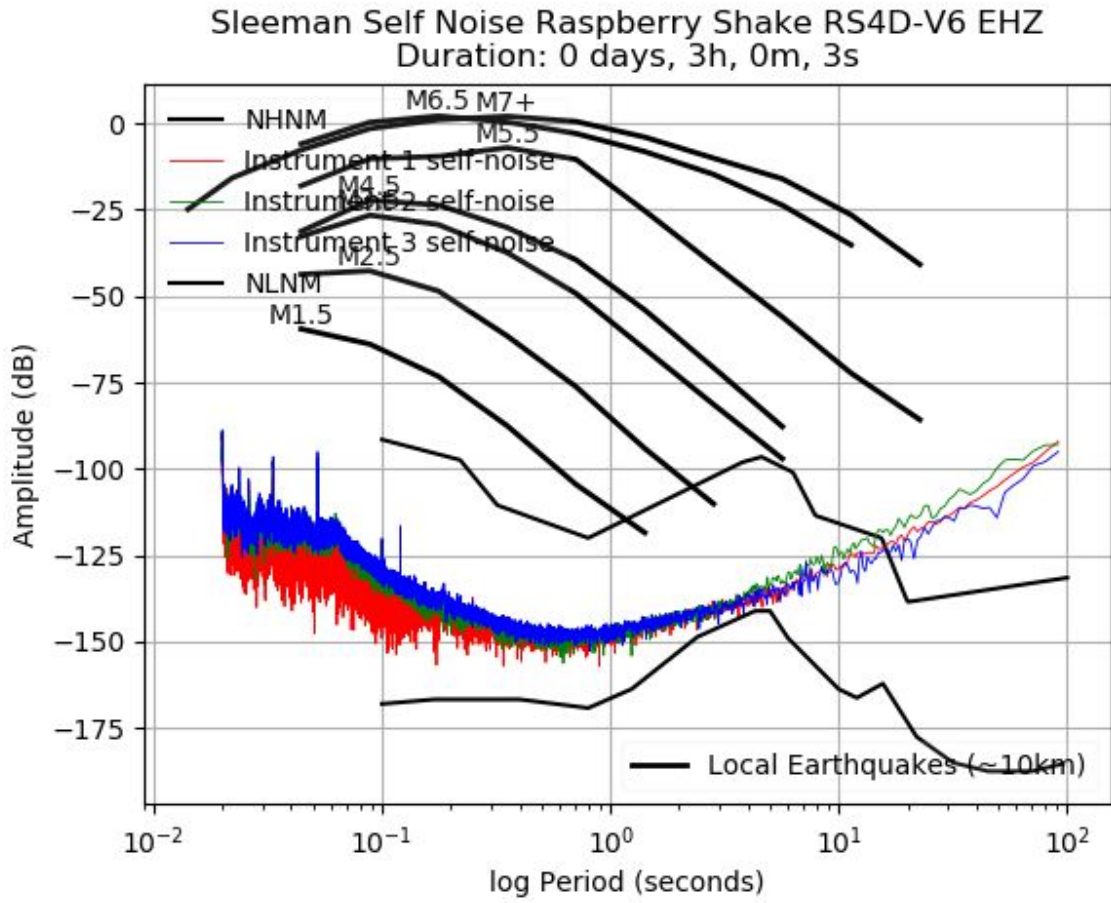
Parameter	Value
Type	Single-component 4.5 Hz 395 Ohm vertical Racotech RGI-20DX geophone with electronic extension to lower frequencies (<1 Hz)
Samples per second	100
<p><i>Earthquake Early Warning (EEW) compatible</i></p> <p><i>data packets shipped across serial port at a rate of 4 packets/ second (250 ms/ packet)</i></p>	
Bandwidth (estimate)	<p>V6+: -3dB points at 0.7 and 44 Hz</p> <p>V5: -3dB points at 0.7 and 26 Hz, possibly higher</p> <p>V4: -3dB points at 0.7 and 40 Hz</p>
Poles (estimate, radians/ second)	<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, radians/ second)	<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)	<p>V6+: 3.996500E+08 counts/ meter/ second +/- 10% precision</p> <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+: 0.08 $\mu\text{m/ s}$ 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:



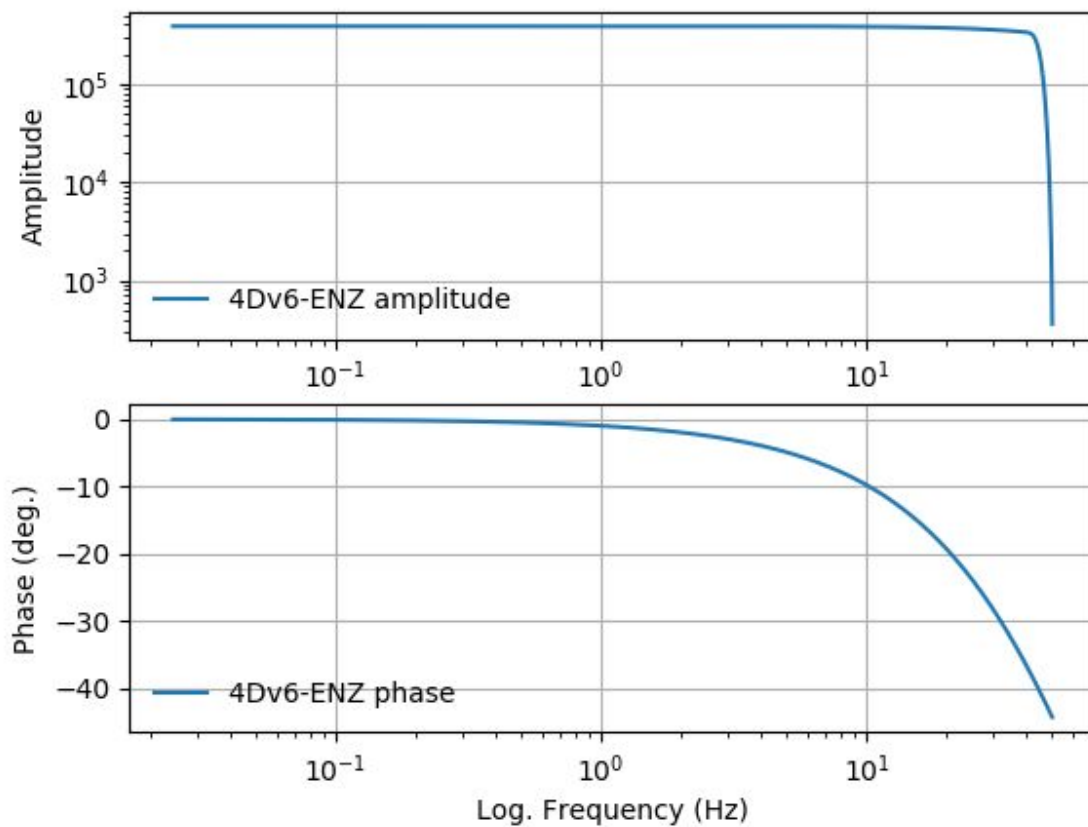
Accelerograph: MEMs

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.

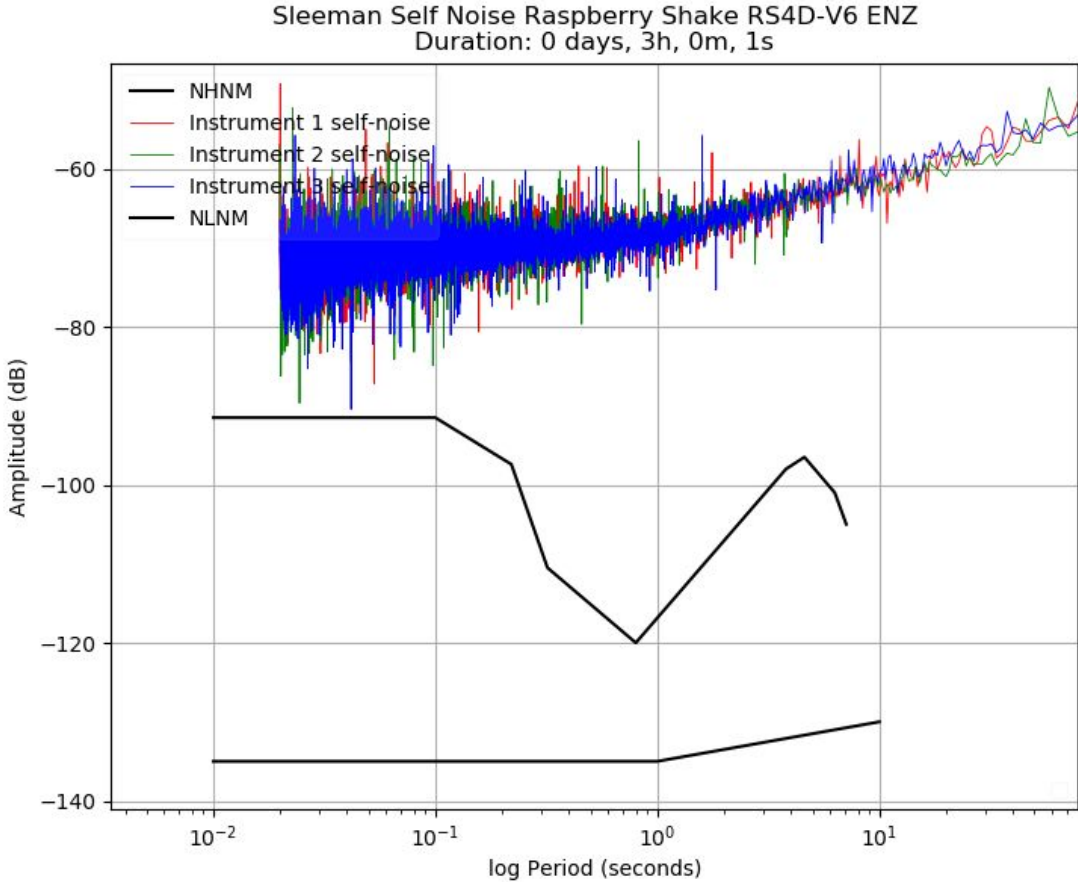
Parameter	Value
Sensor	3-component, orthogonally placed +/- 2g MEMs sensor (Class C)
Samples per second	100
<p><i>Earthquake Early Warning (EEW) compatible</i></p> <p><i>data packets shipped across serial port at a rate of 5 packets/ second (200 ms/ packet)</i></p>	
Flat Frequency Range (estimate, -3dB 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 Raspberry Shake's 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, per channel	Average: 820 bytes/ second 71 megabytes/ day Max: 1420 bytes/ second 123 megabytes/ day
TCP/IP compatible	
Compatible with Ethernet, Cell, GPRS, Satellite modems	

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@raspberrypi.org