

Raspberry Shake Technical Specifications



Specifications for: The Original (1D) Raspberry Shake

- Your Personal Seismograph -

An IoT home automation device

Born on: October, 2016

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

sales@raspberrysshake.org

Last updated: 15/08/2023

Unit

The Raspberry Shake Personal Seismograph is an all-in-one, IoT plug-and-go solution for personal seismology that integrates a vertical (1D) velocity sensor, the digitizer, the hyper damper, and the computer into *a single box*. The Raspberry Shake Personal Seismograph is manufactured in China 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 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>IP 67 enclosure: Ethernet (RJ45), Power. Note: the supported standard for the IP67 LAN connector is 100 Mbit/s (4-wired LAN cable).</i></p>
Installation Considerations	Designed for plug-and-go installation
Operating Temperature	0 to 60 C (limited by RPi, the Raspberry Shake itself can go to -20C)
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>9000[92,93],9200[92,93]: Zero</p> <p>a[02082,22082,32082,52082]: 3 Model B</p> <p>a020d3: 3 Model B+</p> <p>4 Model B</p> <p>9000c1: Zero W(H)</p>
Storage Device	<p>8 Gb micro SD card</p> <p><u><i>Est. # days of disk space:</i></u></p> <p>OS/ software: ~4 Gb Remaining space for data: ~3 Gb</p> <p>V5/ V4 (50 sps): # days (7.5 Mb/ day/ channel [x1]): ~410</p> <p>V6+ (100 sps):</p>

	# days (15 Mb/ day/ channel): ~200
Timing	Network Timing Protocol, NTP (default) GPS timing supported
Timing Quality	NTP timing quality remains within 1 sample of accuracy versus startup accuracy: V6+: +/- 10 ms or better @ 100 sps V5 / V4: +/- 20 ms or better @ 50 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	V6+: 100 sps V5 / V4: 50 sps
<p><i>Earthquake Early Warning (EEW) compatible*</i></p> <p><i>V6: data packets shipped across serial port at a rate of 4 packets/ second (250 ms/ packet)</i></p> <p><i>V5/ V4: data packets shipped across serial port at a rate of 1 packet/ second (1000 ms/ packet)</i></p>	
Bandwidth (estimated)	V7+: -3dB points at 0.7 and 44 Hz V6: -3dB points at 0.8 and 29 Hz V5/V4: -3dB points at 0.8 and 23 Hz
Poles (estimate, radians/ second)	V7+: -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) V6: -4.88+/-3.06E+02, -2.22+/-1.18E+02, -3.33+/-1.98E+02 V5/V4: -4.21, -2.33, -1.30
Zeros (estimate, radians/ second)	V7+: 0; 0; 0 V6: -4.51+/-3.08E+02, 0, 0

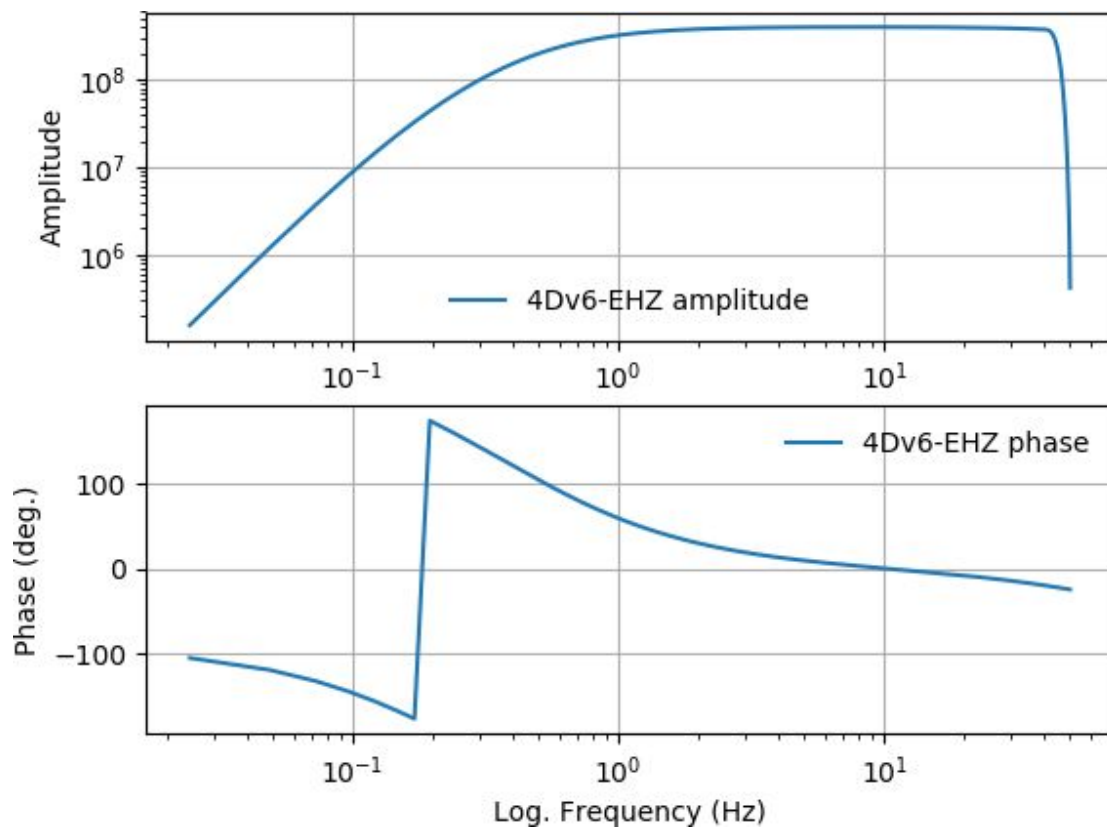
	V5/V4: -6.75, 0, 0, 0
Sensitivity (estimated)	<p>V7+: 3.996500E+08 counts/ meter/ second +/- 10% precision</p> <p>V6: 3.81E+08 counts/ meter/ second +/- 10% precision</p> <p>V5/V4: 4.69E+08 counts/ meter/ second +/- 10% precision</p>
Clip Level (estimated)	<p>+/- 8,388,608 counts (24-bits)</p> <p>V7+: 21 mm/s peak-to-peak from 0.1 to 10 Hz</p> <p>V6: 22 mm/s peak-to-peak from 0.1 to 10 Hz</p> <p>V5/V4: 18 mm/s peak-to-peak from 0.1 to 10 Hz</p>
Minimum Detection Threshold (estimate)	<p>V7+: 0.08 $\mu\text{m/ s}$ RMS from 1 to 20 Hz @ 100 sps</p> <p>V6: 0.03 $\mu\text{m/ s}$ RMS from 1 to 20 Hz @ 100 sps</p> <p>V5/V4: 0.14 $\mu\text{m/ s}$ RMS from 1 to 20 Hz @ 50 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 (estimated)	<p>V6+: 21 bits (126 dB) from 1 to 20 Hz @ 100 sps</p> <p>V5/V4: 18.5 bits (110.5 dB) from 1 to 20 Hz @ 50 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</i></p>

hardware chain. The effective bits of the digitizer itself are necessarily better.

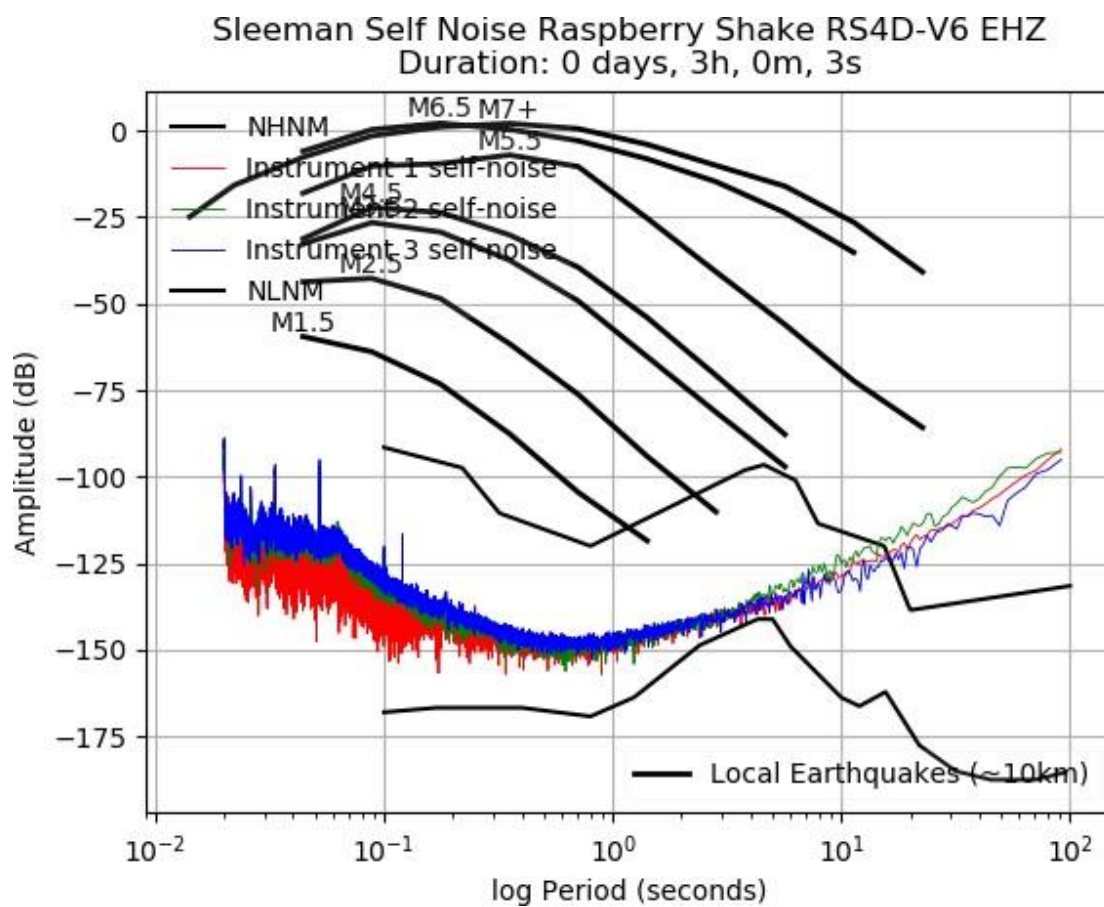
This parameter is also commonly known as “Dynamic Range”; “RMS to RMS noise”; or “noise free bits”.

**Applies to firmware versions 2.X.X and higher and units shipped purchased after July, 2017*

Velocity 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. The supported standard for the IP67 LAN connector is 100 Mbit/s (4-wired LAN cable).	

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 0.290 A = 1.5 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).

Specifications for: Raspberry Shake 3D

- Your 3D Personal Seismograph -

An IoT home-automation device

Born on: February, 2017

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

sales@raspberrysshake.org

Last updated: 15/08/2023

Unit

The Raspberry Shake 3D Personal Seismograph is an all-in-one, IoT plug-and-go solution for personal seismology that integrates a 3 orthogonal velocity sensors, the digitizers, the hyper dampers, and the computer into *a single box*. The Raspberry Shake 3D Personal Seismograph is manufactured in China 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 3D Version	All versions
Dimensions (estimated)	<i>Standard enclosure: 140x135x60 mm</i> <i>IP67 enclosure: 160x90x90 mm</i>
Weight (estimated)	0.6 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>

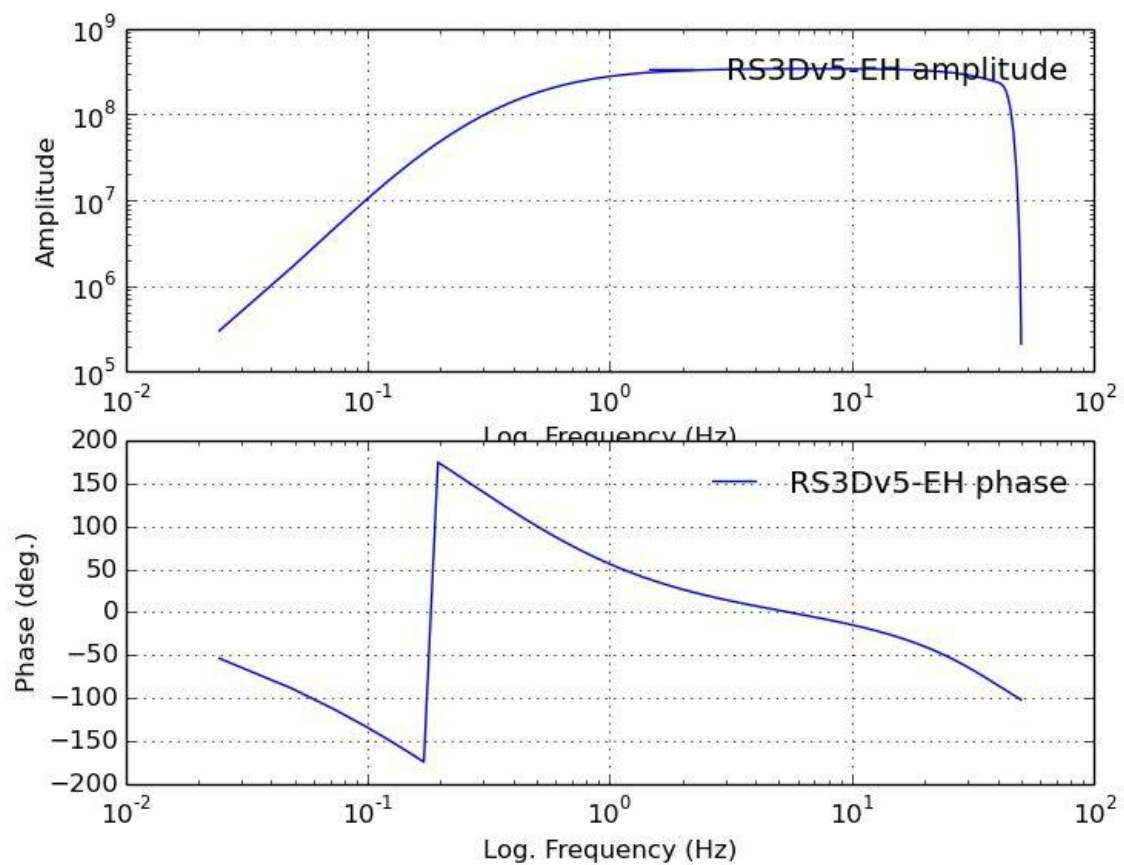
	<i>IP 67 enclosure: Ethernet (RJ45), Power. Note: the supported standard for the IP67 LAN connector is 100 Mbit/s (4-wired LAN cable).</i>
Installation Considerations	Designed for plug-and-go installation
Operating Temperature	0 to 60 C (limited by RPi, the Raspberry Shake itself can go to -20C)
On Board 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 micro SD card</p> <p><u><i>Est. # days of disk space:</i></u></p> <p>OS/ software: ~4 Gb</p> <p>Remaining space for data: ~3 Gb</p> <p># days (15 Mb/ day/ channel [x3]): ~68</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

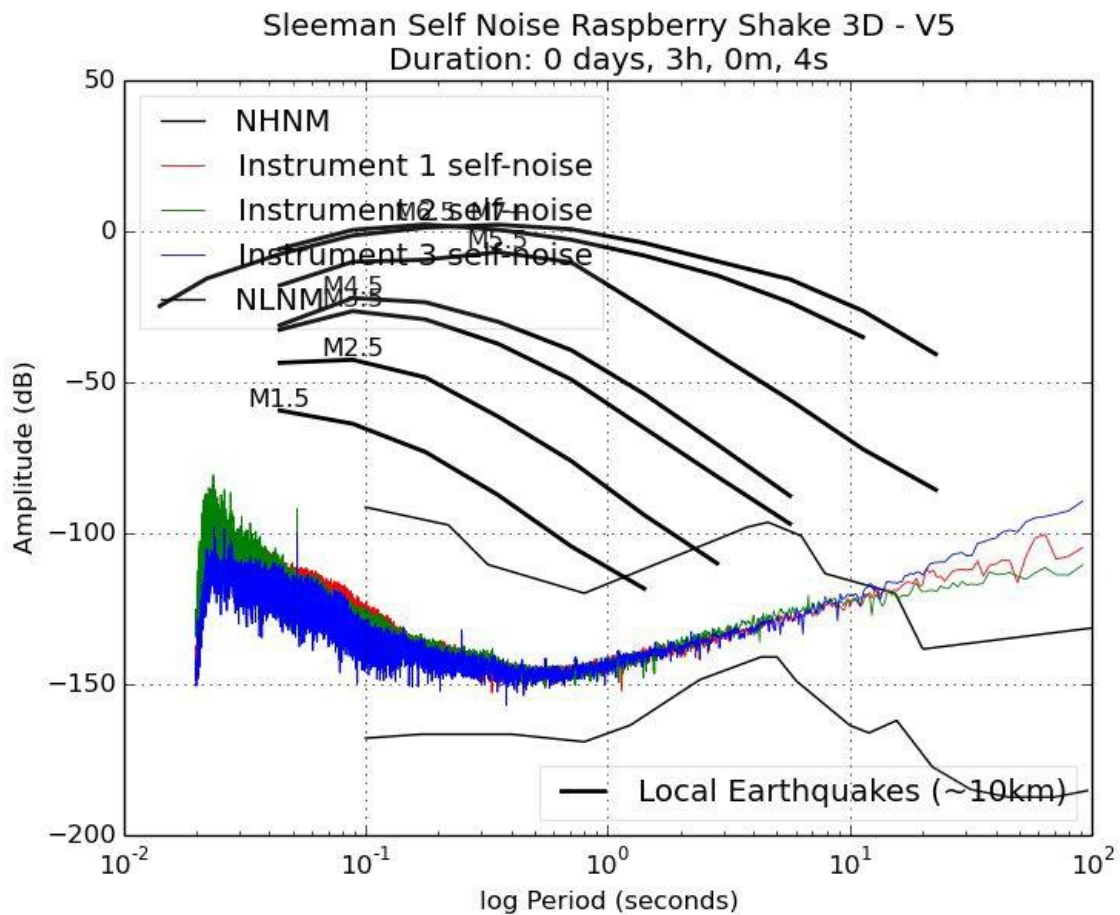
Parameter	Value
Type	3-component, orthogonally placed 4.5 Hz (electronically extended down to 2 seconds) Sunfull PS-4.5B geophones, 375 Ohm <i>Note: These are not the same geophones used in the 1D and 4D versions of Raspberry Shake</i>
Samples per second	100
<i>Earthquake Early Warning (EEW) compatible</i> <i>data packets shipped across serial port at a rate of 4 packets/ second (250 ms/ packet)</i>	
Bandwidth (estimate)	V5+: -3dB points at 0.7 to 39 Hz V3: -3dB points at 0.6 to 34 Hz
Poles (estimate, radians/ second)	V5+: -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) V3: 2.23E+02 +/- 2.95E+02; 3.76E-01; 0
Zeros (estimate, radians/ second)	V5+: 0, 0, 0 V3: -1.96E+02 +/- 1.55E+02; 2.65 +/- 6.83E-01
Sensitivity (estimate)	V5+: 3.60E+08 counts/ meter/ second +/- 10% precision V3: 3.53E+08 counts/ meter/ second +/- 10% precision

Clip Level (estimate)	<p>+/- 8,388,608 counts (24-bits)</p> <p>V5+/ V3: 24 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>V3: 0.06 $\mu\text{m/s}$ 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 (124 dB) from 1 to 20 Hz @ 100 sps (for the entire analog to digital hardware chain).</p> <p>V3: 20 bits (120 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:



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. The supported standard for the IP67 LAN connector is 100 Mbit/s (4-wired LAN cable).	

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 0.320 A = 1.6 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).

Specifications for: [Raspberry Shake RS4D](#)

- Your RS4D Personal Seismograph & Accelerograph -

An IoT home-automation device

Born on: February, 2017

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

sales@raspberrysshake.org

Last updated: 15/08/2023

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 China 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>IP 67 enclosure: Ethernet (RJ45), Power. Note: the supported standard for the IP67 LAN connector is 100 Mbit/s (4-wired LAN cable).</i></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>8 Gb micro SD card</p>
Storage Device	<p>8 Gb micro SD card</p> <p><u>Est. # days of disk space:</u> OS/ software: ~4 Gb</p> <p>Remaining space for data: ~3 Gb</p> <p># days (15 Mb/ day/ channel [x4]): ~51</p>
Timing	<p>Network Timing Protocol, NTP (default)</p>

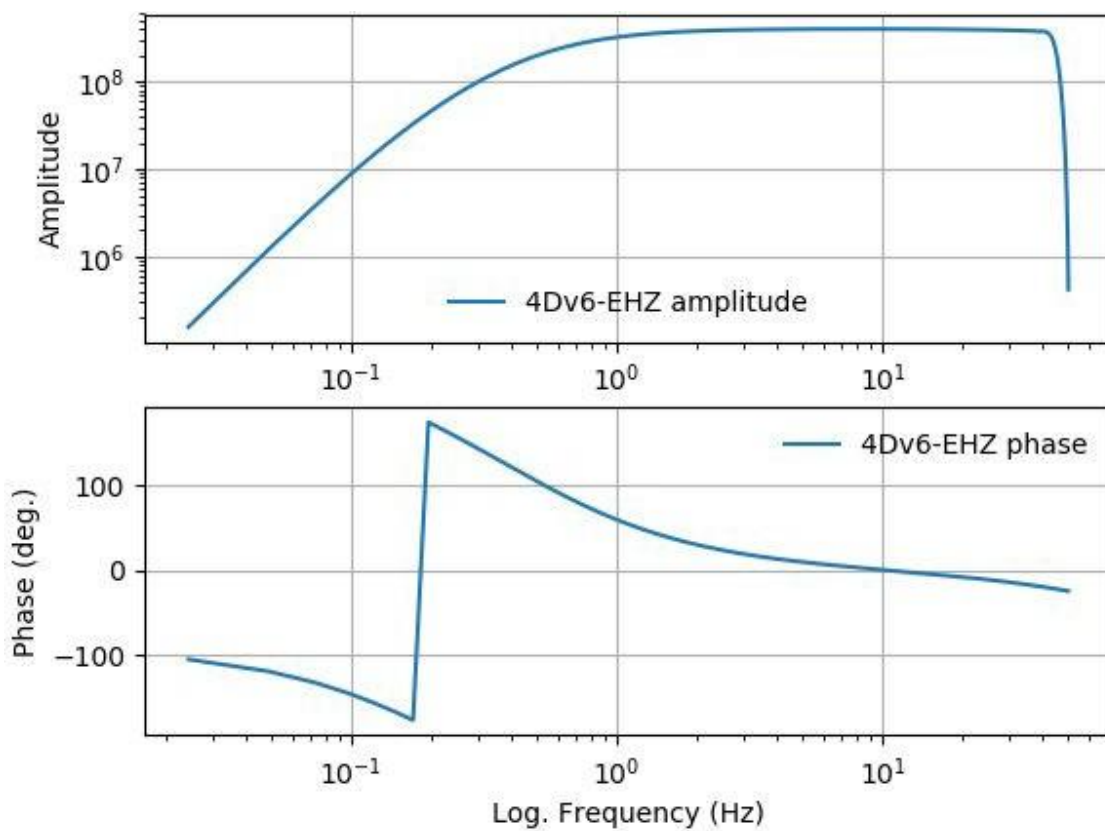
	GPS timing supported
Timing Quality	NTP timing quality remains within 1 sample of accuracy versus startup accuracy: +/- 10 ms or better @ 100 sps

Seismograph

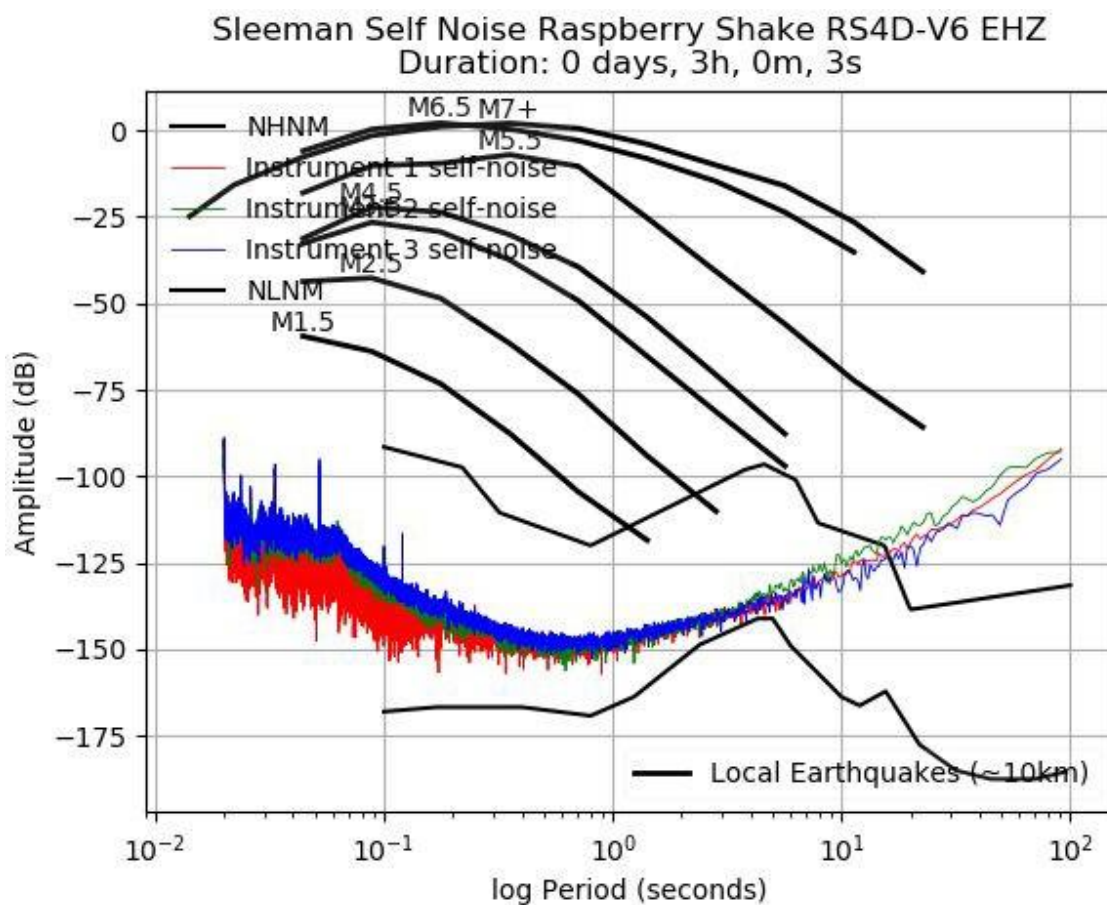
Parameter	Value
Type	Single-component 4.5 Hz 395 Ohm vertical Racotech RGI-20DX geophone with electronic extension to lower frequencies (<1 Hz)
Samples per second	100
<p><i>Earthquake Early Warning (EEW) compatible</i></p> <p><i>data packets shipped across serial port at a rate of 4 packets/ second (250 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> <p>-1 (0.16 Hz, single pole high pass filter)</p> <p>-3.03 x2 (0.48 Hz, double pole high pass filter)</p> <p>-666.67 (106 Hz, single pole low pass filter)</p> <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:



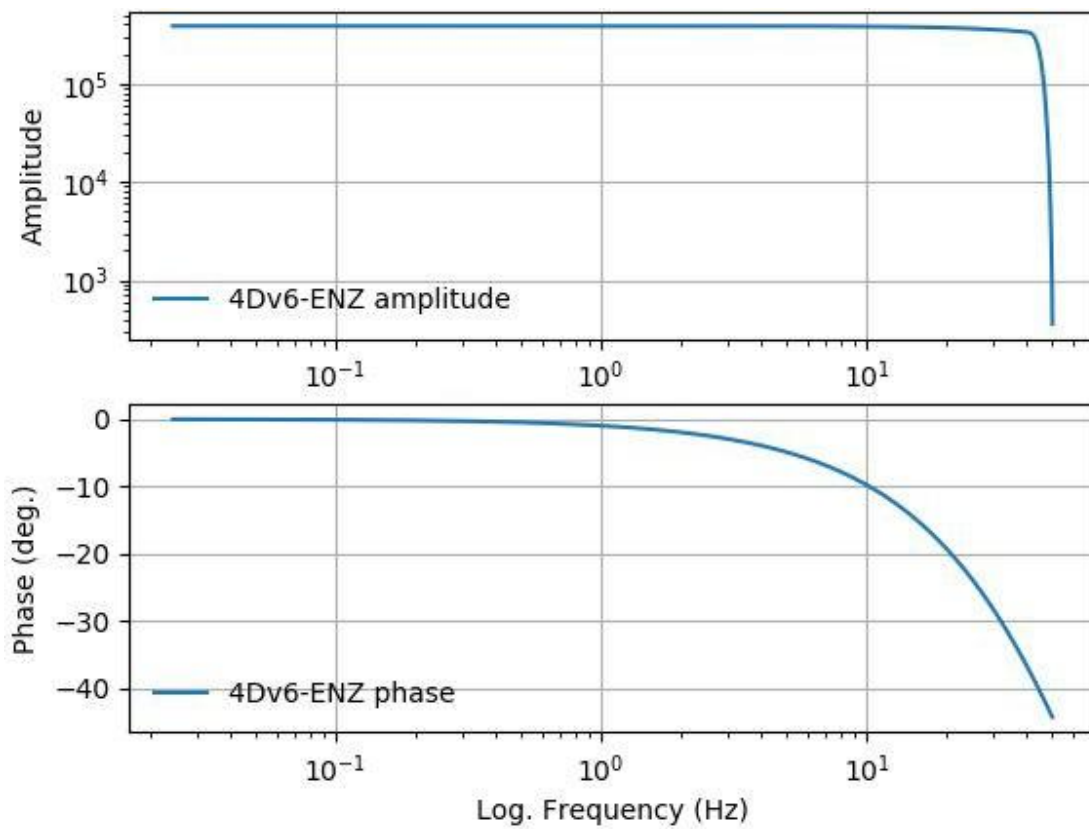
Accelerograph: MEMs

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.

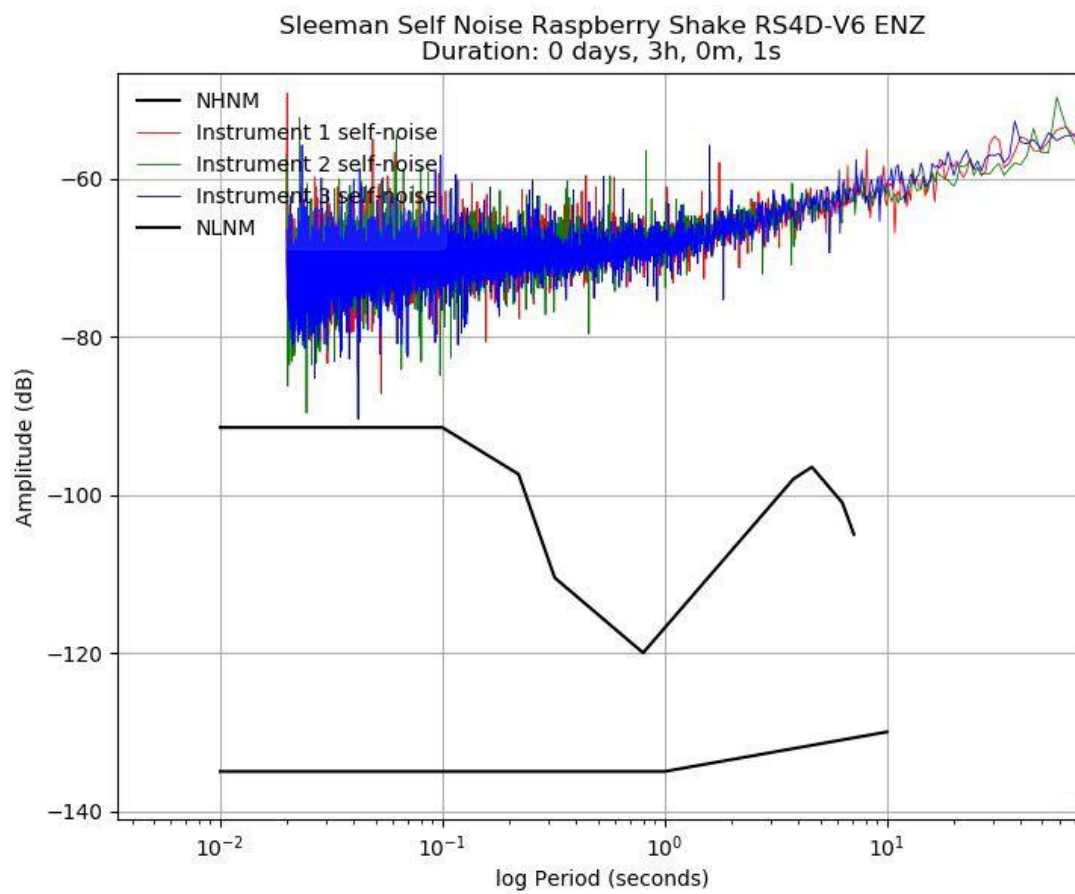
Parameter	Value
Sensor	3-component, orthogonally placed +/- 2g MEMs sensor (Class C)
Samples per second	100
<p><i>Earthquake Early Warning (EEW) compatible</i></p> <p><i>data packets shipped across serial port at a rate of 5 packets/ second (200 ms/ packet)</i></p>	
Flat Frequency Range (estimate, -3dB 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>-459.56 (73 Hz, single pole low pass filter)</p> <p>-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	<p>Average:</p> <p>820 bytes/ second</p> <p>71 megabytes/ day</p> <p>Max:</p> <p>1420 bytes/ second</p> <p>123 megabytes/ day</p>
TCP/IP compatible	
Compatible with Ethernet, Cell, GPRS, Satellite modems. The supported standard for the IP67 LAN connector is 100 Mbit/s (4-wired LAN cable).	

Power

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

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).

Specifications for: Raspberry Boom (RBOOM) and 'Shake and Boom' (RS&BOOM)

- Your Personal Acoustic and Seismo-Acoustic Home Science Monitors -
An IoT home-automation device

Born on: July, 2017

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

sales@raspberrysshake.org

Last updated: 15/08/2023

Unit

The “Raspberry Boom” (RBOOM) personal infrasound and "Raspberry Shake and Boom" (RS&BOOM) personal seismo-acoustic monitors are all-in-one, IoT plug-and-go solutions for personal infrasonics and seismology that integrates a single vertical velocity sensors with an acoustic pressure transducer, the digitizers, the hyper dampers, and the computer into *a single box*. These monitors are manufactured in China using cutting-edge 3D printing and laser-cutting technology.

Warranty: 1 year from ship date

Specifications subject to change without notice.

Parameter	Value
Versioning	All versions
Dimensions (estimated)	<i>Standard enclosure:</i> 135x110x70 mm <i>IP67 enclosure:</i> 160x90x90 mm
Weight (estimated)	0.4 kg
Immersion rating	<i>Standard enclosure:</i> IP10
Connectors	<i>Standard enclosure:</i> Ethernet (RJ45), Power Micro USB (5V, 2.5 Amps), USB 2 ports x4,

	<p>HDMI, Micro SD, CSI Camera port, Composite video and audio output jack</p> <p><i>IP 67 enclosure: Ethernet (RJ45), Power. Note: the supported standard for the IP67 LAN connector is 100 Mbit/s (4-wired LAN cable).</i></p>
<p>Installation Considerations</p>	<p>Designed for plug-and-go installation</p> <p>Mounting screw anchor slot provided (for RBOOM)</p> <p>Alignment: no alignment required (the infrasound sensor is omnidirectional and the velocity sensor, vertical)</p>
<p>Operating Temperature</p>	<p>0 to 60 C (limited by RPi, the Raspberry Boom itself can go to -20C)</p>
<p>On Board Computer</p>	<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>9000[92,93],9200[92,93]: Zero</p> <p>a[02082,22082,32082,52082]: 3 Model B</p> <p>a020d3: 3 Model B+</p> <p>4 Model B</p> <p>9000c1: Zero W(H)</p>
<p>Storage Device</p>	<p>8 Gb micro SD card</p> <p><u><i>Est. # days of disk space:</i></u></p> <p>OS/ software: ~4 Gb</p> <p>Remaining space for data: ~3 Gb</p>

	<p># days Raspberry Boom (15 Mb/ day/ channel): ~200</p> <p># days Raspberry Shake and Boom (15 Mb/ day/ channel): ~100</p>
Timing	<p>Network Timing Protocol, NTP (default)</p> <p>GPS timing supported</p>
Timing Quality	<p>NTP timing quality remains within 1 sample of accuracy versus startup accuracy: +/- 10 ms or better @ 100 sps</p>

Microbarograph (Infrasound)

Applies to both Raspberry Boom & Raspberry Shake and Boom

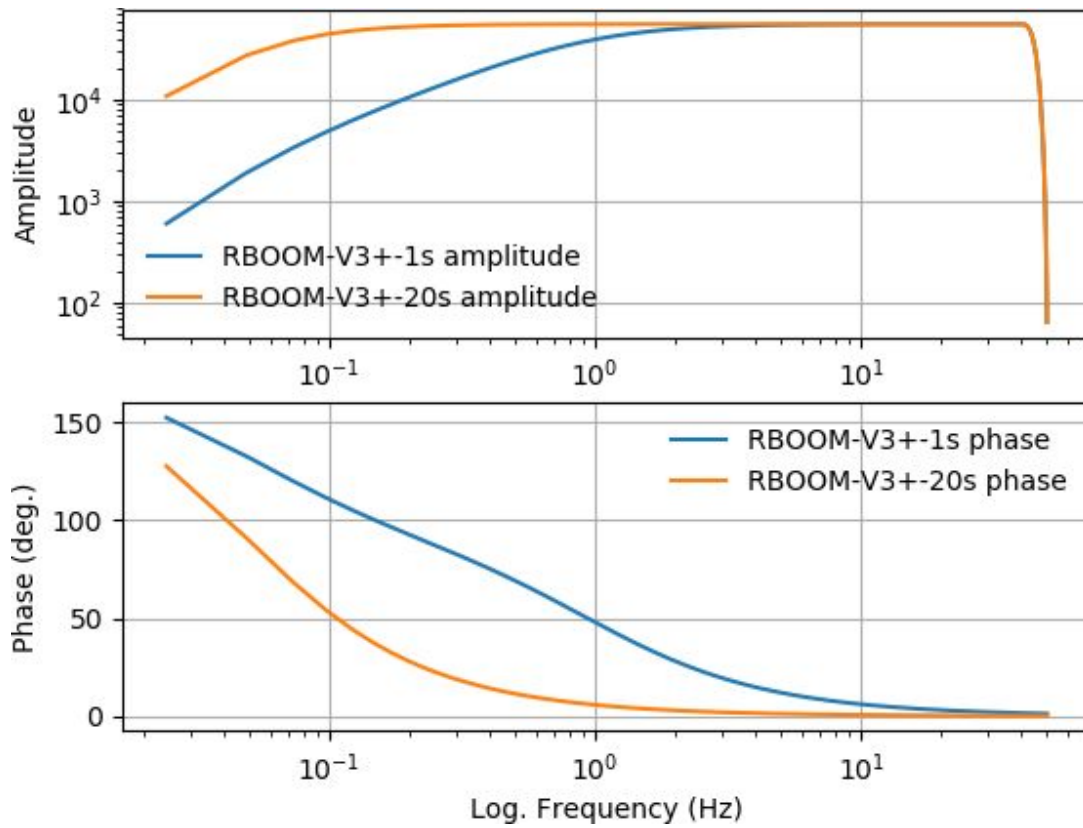
Parameter	Value
Type	MEMS temperature compensated differential pressure transducer
Samples per second	100
Data packet transmission rate	Data packets shipped across serial port at a rate of 4 packets/ second (250 ms/ packet)
Bandwidth (estimate)	<p>-3dB points at 1 Hertz (1 seconds) to 44 Hertz (for 1s mechanical filter, default).</p> <p>-3dB points at 0.08 Hertz (13 seconds) to 44 Hertz (for 20s mechanical filter, not included by default with order, available upon special request only).</p> <p>Rolloff past low frequency corners: 2 poles or 40dB/decade</p>
Poles (estimate, radians/ second)	<p>There is a hardware single-pole high-pass filter with a -3 dB point around 0.05 Hz.</p> <p>With 1s mechanical filter attached (default):</p> <ul style="list-style-type: none"> -0.312 (20 seconds, single pole high pass filter, from hardware) -6.289 (1 Hz, single pole high pass filter, from mechanical filter) <p>With 20s mechanical filter attached (not included by default with order, available upon special request only):</p>

	<p>-0.312 (20 seconds, single pole high-pass filter, from hardware)</p> <p>-0.312 (20 seconds, single pole high pass filter, from mechanical filter)</p>
Zeros (estimate, radians/second)	0,0
Sensitivity (estimate)	56,000 counts/ Pascal +/- 10% precision
Clip Level (estimate)	<p>+/- 8,388,608 counts (24-bits)</p> <p>0.5 inches of water, corresponding to +/- 125 Pa</p>
Digitizer Dynamic range	<p>24-bit ADC Sigma-Delta $\Sigma\Delta$</p> <p>144 dB (24 bits)</p>
Effective bits (estimate)	<p>21 bits (126 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>
Error band	~1%
Linearity of the pressure measurement (included in total error band measurement)	<0.5%
Gain Calibration	Automatic

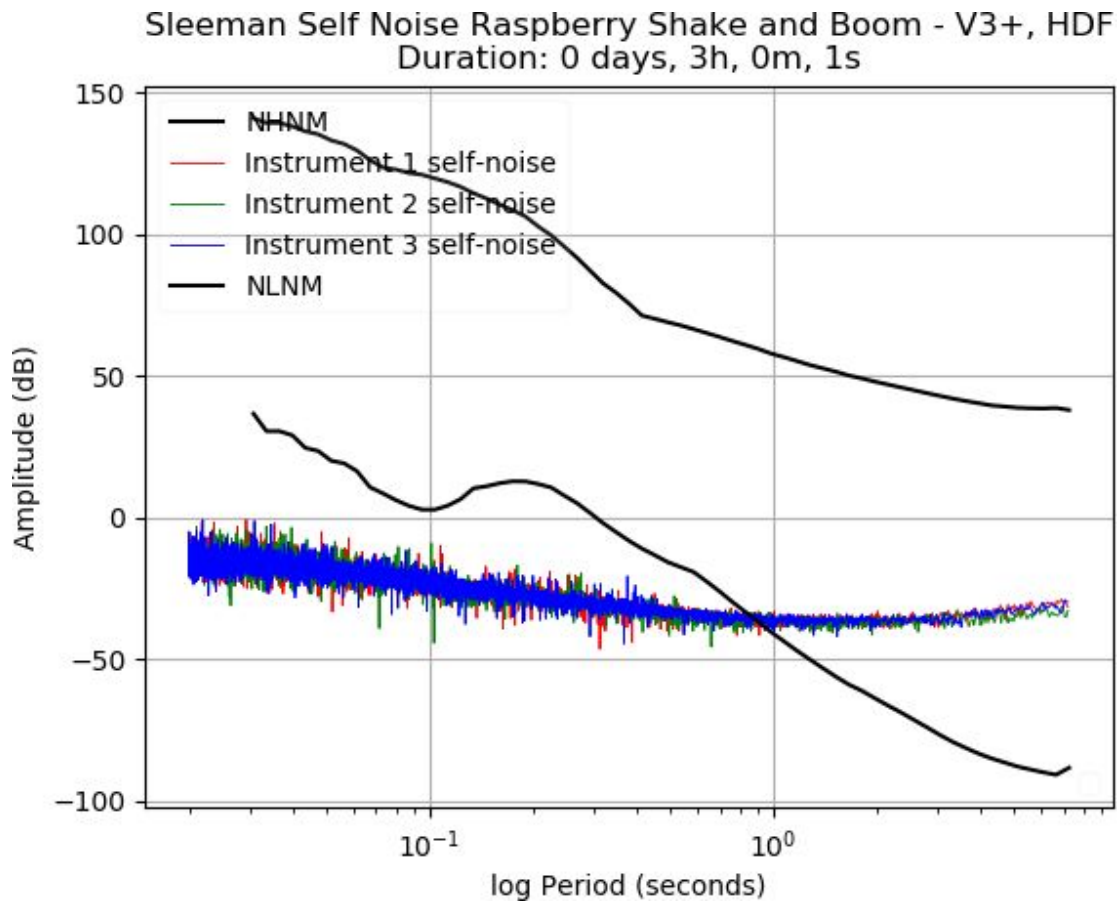
Mechanical filter High Pass filter options	1s (default, included with order), 20s (available upon special request only)
Operating Temperature of sensor	Compensated operating range: 0 to 50 C Max. operating range: -25 to 85 C (though the rest of the electronics are limited to 0-60C)

The Raspberry Boom infrasound sensor was based on Jeffrey Johnson's [infraBSU](#) sensor and the work published in (1) Marcillo, O., Johnson, J.B., and Hart, D. (2012) Implementation, Characterization, and Evaluation of an Inexpensive Low-Power, Low-Noise Infrasound Sensor Based on a Micromachined Differential Pressure Transducer and a Mechanical Filter, *Journal of Atmospheric and Oceanic Technology* 29:1275-1284; and (2) Johnson, J.B. and Ripepe, M. (2011) Volcano Infrasound: A review, *Journal of Volcanology and Geothermal Research* 206:61-69.

Microbarograph: Acoustic Channel Instrument Response



Microbarograph: Sleeman Self-Noise



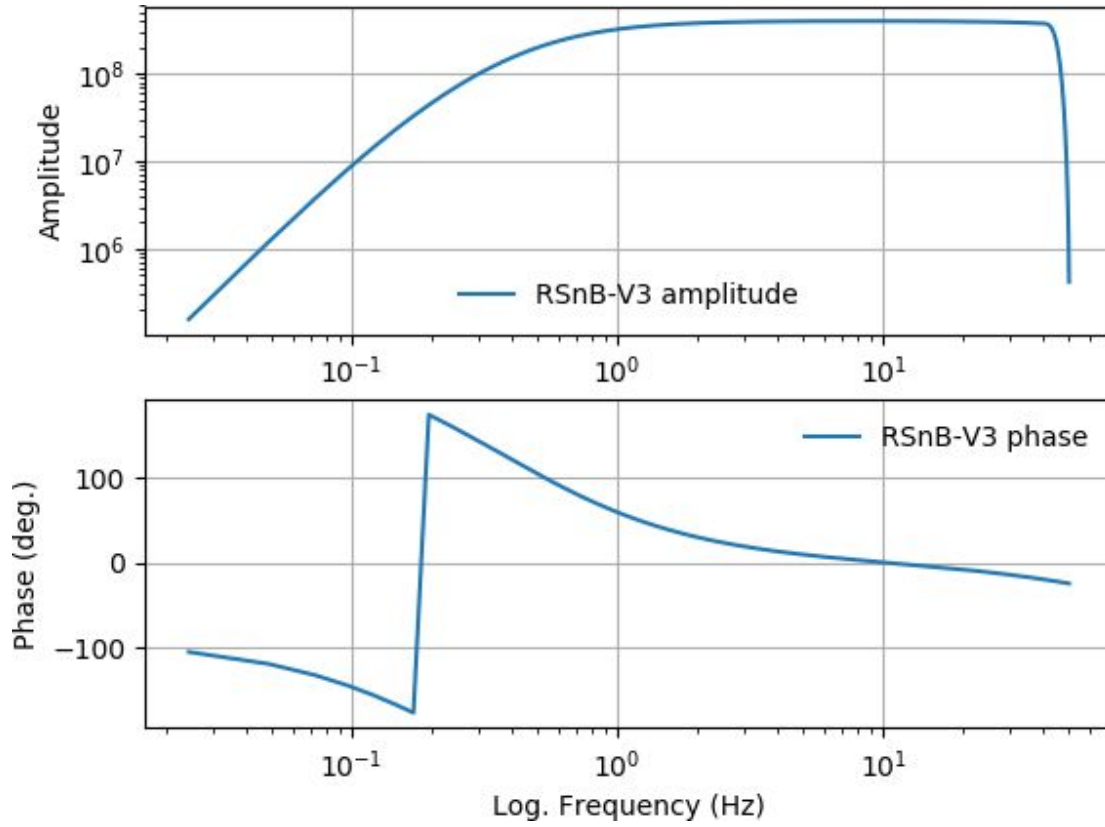
Seismograph

Raspberry "Shake and Boom" only

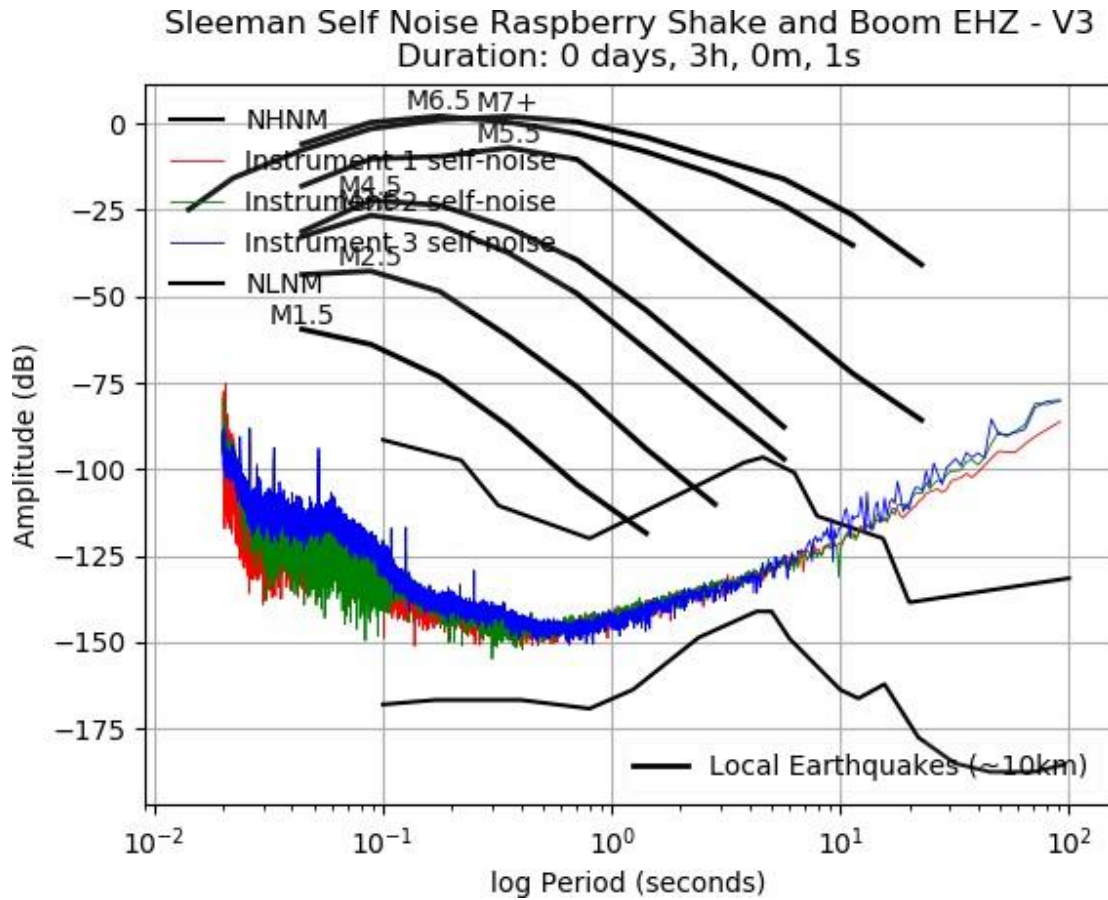
Parameter	Value
Type	Single-component 4.5 Hz 395 Ohm vertical Racotech RGI-20DX geophone with electronic extension to lower frequencies (<1 Hz)
Samples per second	100
<p><i>Earthquake Early Warning (EEW) compatible</i></p> <p><i>data packets shipped across serial port at a rate of 4 packets/ second (250 ms/ packet)</i></p>	
Bandwidth (estimate)	-3dB points at 0.7 to 44 Hz
Poles (estimate, radians/ second)	-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)
Zeros (estimate, radians/ second)	0; 0; 0
Sensitivity (estimate)	3.996500E+08 counts/ meter/ second +/- 10% precision
Clip Level (estimate)	+/- 8,388,608 counts (24-bits) 21 mm/s peak-to-peak from 0.1 to 10 Hz
Minimum Detection Threshold (estimate)	0.08 μ m/ s RMS from 1 to 20 Hz @ 100 sps

	<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	24-bit ADC Sigma-Delta $\Sigma\Delta$ 144 dB (24 bits)
Effective bits (estimate)	<p>21 bits (126 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>

Seismograph: Velocity Channel Instrument Response



Seismograph: 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. The supported standard for the IP67 LAN connector is 100 Mbit/s (4-wired LAN cable).	

Power

Parameter	Value
Power Supply Voltage	5 Volts DC (2.5 Amp supply)
Power Consumption (RPI + Raspberry Shake, estimated)	Raspberry Boom: Startup: 5 Volts x 0.550 A = 3.0 Watts Run-time: 5 Volts x 0.290 A = 1.8 Watts

Raspberry Shake and Boom:

Startup: 5 Volts x 0.550 A = 3.1

Watts

Run-time: 5 Volts x 0.290 A = 1.9

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).