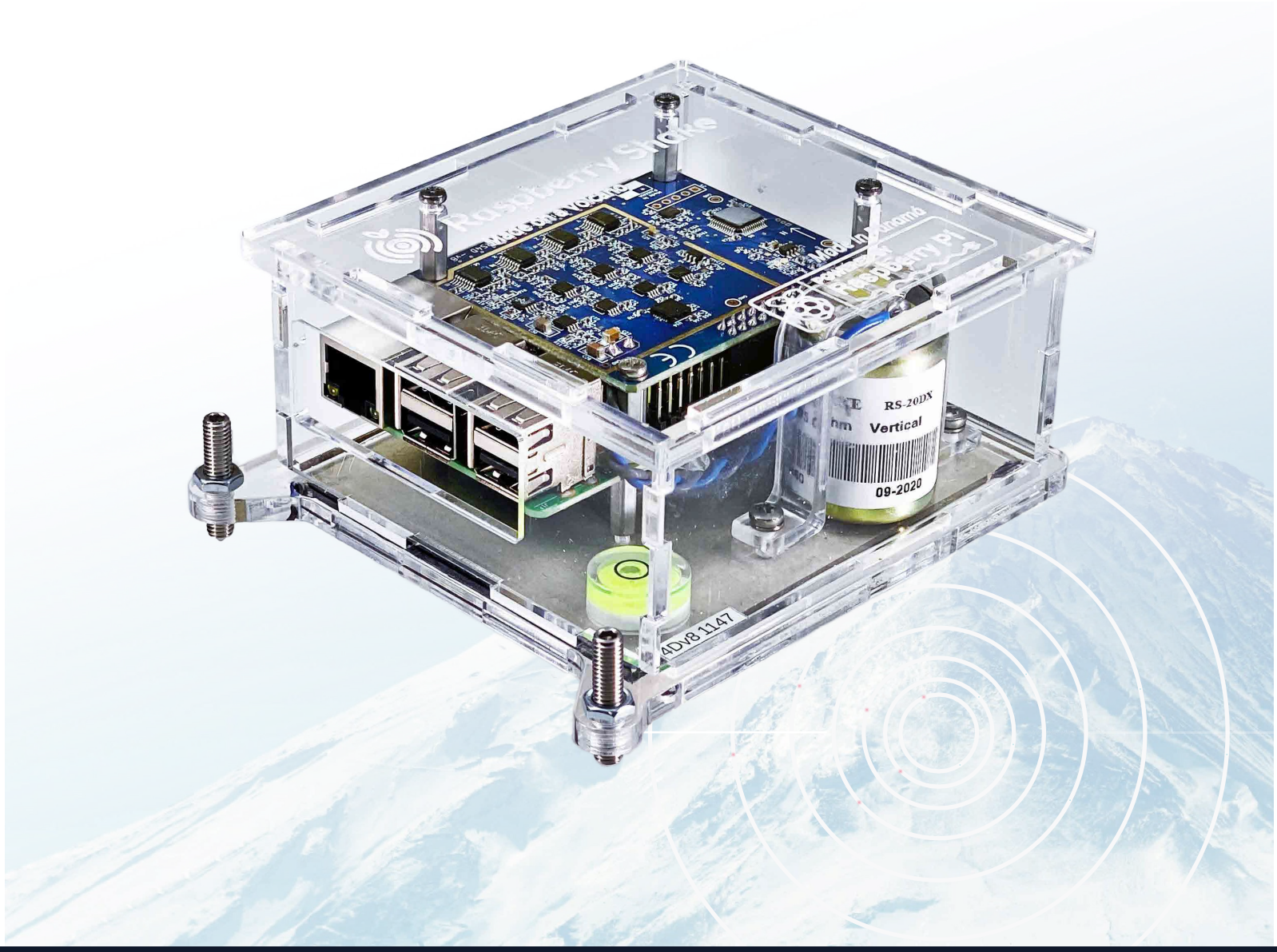
Raspberry Shake®
Watch the Earth Move

Raspberry Shake Technical Specifications



Website: raspberryshake.org

Contact us: sales@raspberryshake.org

Specifications for:

The Original (1D) Raspberry Shake

- Your Personal Seismograph -

An IoT home automation device

Born on: October, 2016

https://shop.raspberryshake.org/
sales@raspberryshake.org

Last updated: 5-aug-2021

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)	*Standard enclosure*: 135x110x50 mm *IP67 enclosure*: 160x90x90 mm
Weight (estimated)	0.35 kg
Immersion rating	*Standard enclosure*: IP10 *IP67 enclosure available upon request at additional cost*
Connectors	*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 *IP 67 enclosure: Ethernet (RJ45), Power. Note: the supported standard for the IP67 LAN connector is 100 Mbit/s (4-wired LAN cable).*
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	Raspberry Pi 3 Model B *The Raspberry Shake board/ Software is also compatible with:* 00[10,13],900032: Model B+ a[01040,01041,21041,22042]: 2 Model B 9000[92,93],9200[92,93]: Zero a[02082,22082,32082,52082]: 3 Model B a020d3: 3 Model B+ 4 Model B 9000c1: Zero W(H)
Storage Device	8 Gb or + micro SD card *Est. # days of disk space:* OS/ software: ~3 Gb Remaining space for data: ~5 Gb V5/ V4 (50 sps): # days (7.5 Mb/ day/ channel [x1]): ~660, more if you use a bigger SD V6+ (100 sps):

	# days (15 Mb/ day/ channel): ~320, more if you use a bigger SD
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

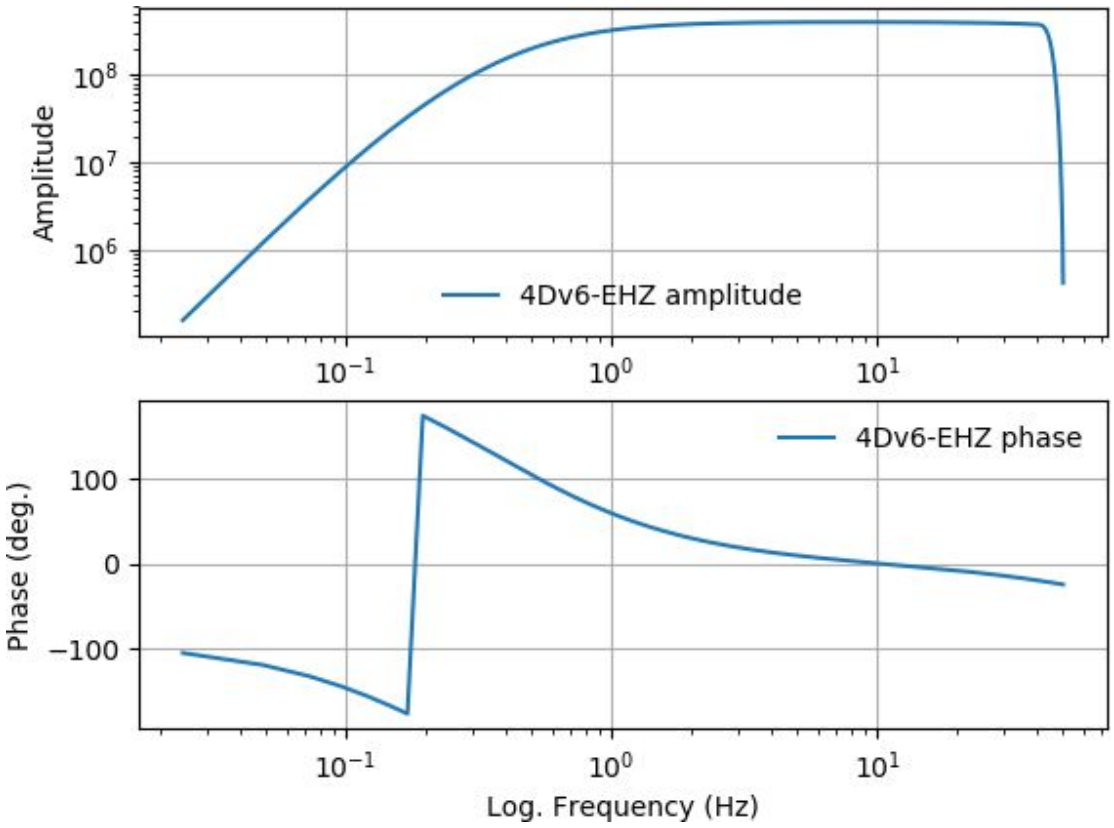
Parameter	Value
Type	Single-component 4.5 Hz 395 Ohm vertical Racotech RGI-20DX geophone with electronic extension to lower frequencies (<1 Hz)
Samples per second	V6+: 100 sps V5 / V4: 50 sps
*Earthquake Early Warning (EEW) compatible** *V6: data packets shipped across serial port at a rate of 4 packets/ second (250 ms/ packet)* *V5/ V4: data packets shipped across serial port at a rate of 1 packet/ second (1000 ms/ packet)*	
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)	V7+: 3.996500E+08 counts/ meter/ second +/- 10% precision V6: 3.81E+08 counts/ meter/ second +/- 10% precision V5/V4: 4.69E+08 counts/ meter/ second +/- 10% precision
Clip Level (estimated)	+/- 8,388,608 counts (24-bits) V7+: 21 mm/s peak-to-peak from 0.1 to 10 Hz V6: 22 mm/s peak-to-peak from 0.1 to 10 Hz V5/V4: 18 mm/s peak-to-peak from 0.1 to 10 Hz
Minimum Detection Threshold (estimate)	V7+: 0.08 µm/ s RMS from 1 to 20 Hz @ 100 sps V6: 0.03 µm/ s RMS from 1 to 20 Hz @ 100 sps V5/V4: 0.14 µm/ s RMS from 1 to 20 Hz @ 50 sps *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.*
Digitizer Dynamic range	24-bit ADC Sigma-Delta $\Sigma\Delta$ 144 dB (24 bits)
Effective bits (estimated)	V6+: 21 bits (126 dB) from 1 to 20 Hz @ 100 sps V5/V4: 18.5 bits (110.5 dB) from 1 to 20 Hz @ 50 sps (for the entire analog to digital hardware chain). *Note: Whereas most manufacturers report this for their digitizer only, we are reporting it for the entire sensor + ADC*

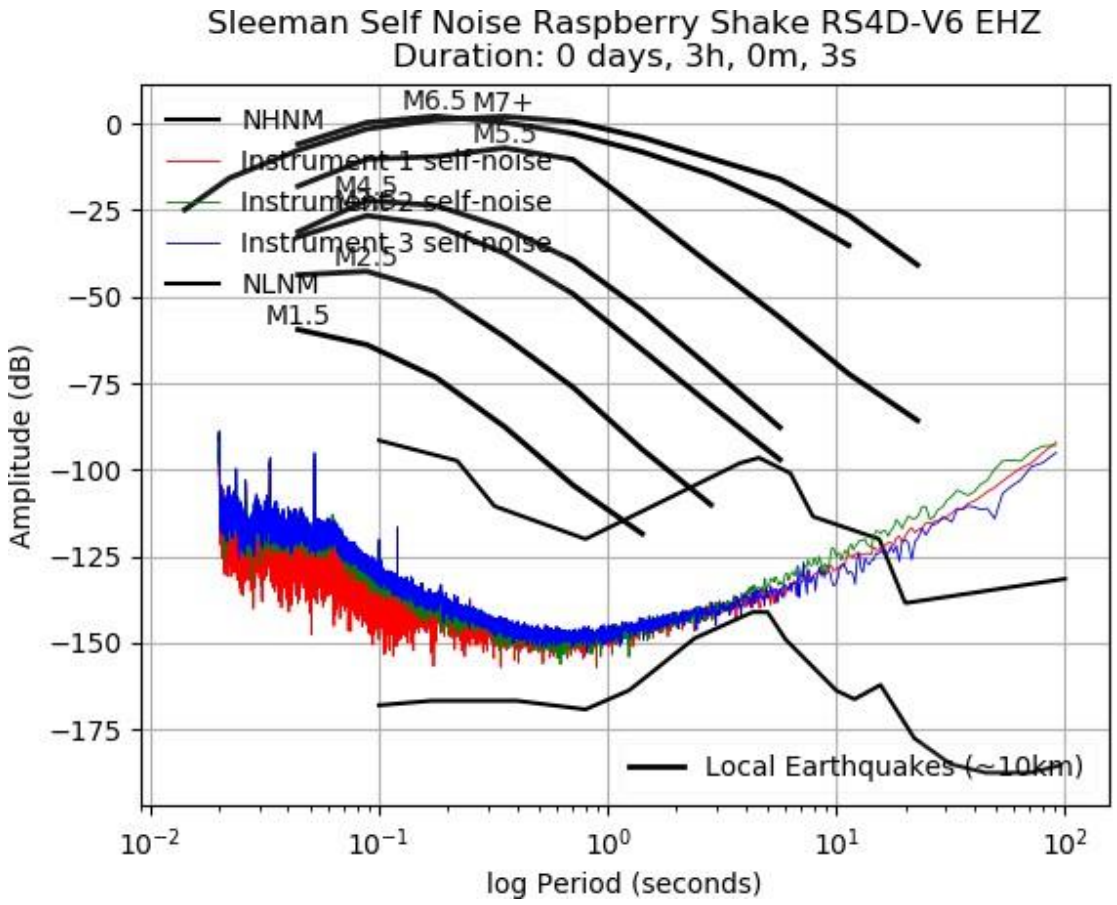
	hardware chain. The effective bits of the digitizer itself are necessarily better. This parameter is also commonly known as “Dynamic Range”; “RMS to RMS noise"; or "noise free bits".

**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@raspberryshake.org

Last updated: 21-sept-2020

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)	*Standard enclosure*: 140x135x60 mm *IP67 enclosure*: 160x90x90 mm
Weight (estimated)	0.6 kg
Immersion rating	*Standard enclosure*: IP10 *IP67 enclosure available upon request at additional cost*
Connectors	*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

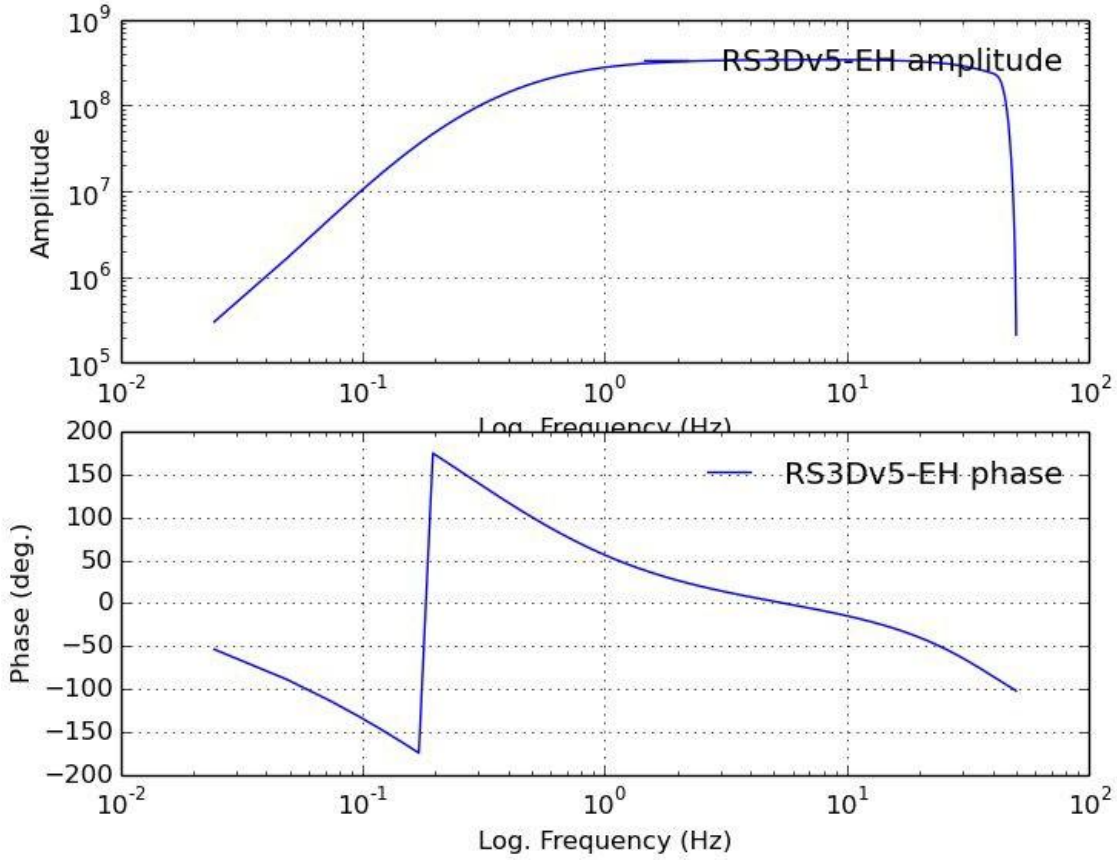
	IP 67 enclosure: Ethernet (RJ45), Power. Note: the supported standard for the IP67 LAN connector is 100 Mbit/s (4-wired LAN cable).
Installation Considerations	Designed for plug-and-go installation
Operating Temperature	0 to 60 C (limited by RPi, the Raspberry Shake itself can go to -20C)
On Board Computer	Raspberry Pi 3 Model B *The Raspberry Shake board/ Software is also compatible with:* 00[10,13],900032: Model B+ a[01040,01041,21041,22042]: 2 Model B a[02082,22082,32082,52082]: 3 Model B a020d3: 3 Model B+ 4 Model B
Storage Device	8 Gb or + micro SD card *Est. # days of disk space:* OS/ software: ~3 Gb Remaining space for data: ~5 Gb # days (15 Mb/ day/ channel [x3]): ~110, more if you use a bigger SD
Timing	Network Timing Protocol, NTP (default) GPS timing supported
Timing Quality	NTP timing quality remains within 1 sample of accuracy versus startup accuracy: +/- 10 ms or better @ 100 sps

Seismograph

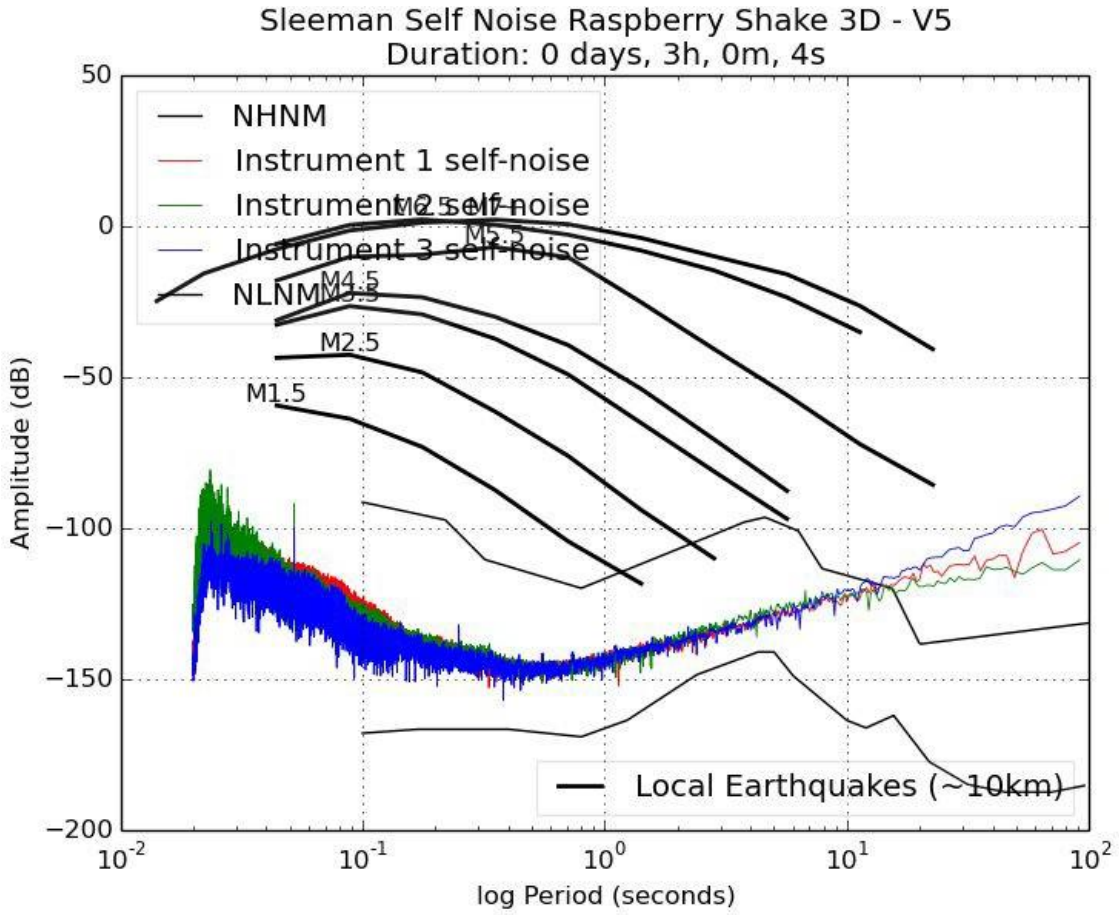
Parameter	Value
Type	3-component, orthogonally placed 4.5 Hz (electronically extended down to 2 seconds) Sunfull PS-4.5B geophones, 375 Ohm *Note: These are not the same geophones used in the 1D and 4D versions of Raspberry Shake*
Samples per second	100
Earthquake Early Warning (EEW) compatible *data packets shipped across serial port at a rate of 4 packets/ second (250 ms/ packet)*	
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)	+/- 8,388,608 counts (24-bits) V5+/ V3: 24 mm/s peak-to-peak from 0.1 to 10 Hz
Minimum Detection Threshold (estimate)	V5+: 0.03 µm/ s RMS from 1 to 20 Hz @ 100 sps V3: 0.06 µm/ s RMS from 1 to 20 Hz @ 100 sps *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.*
Digitizer Dynamic range	24-bit ADC Sigma-Delta $\Sigma\Delta$ 144 dB (24 bits)
Effective bits (estimate)	V5+: 21 bits (124 dB) from 1 to 20 Hz @ 100 sps (for the entire analog to digital hardware chain). V3: 20 bits (120 dB) from 1 to 20 Hz @ 100 sps (for the entire analog to digital hardware chain). *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.* This parameter is also commonly known as “Dynamic Range”; “RMS to RMS noise"; or "noise free bits".

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@raspberryshake.org

Last updated: 1-feb-2021

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)	*Standard enclosure*: 135x110x50 mm *IP67 enclosure*: 160x90x90 mm
Weight (estimated)	0.35 kg
Immersion rating	*Standard enclosure*: IP10 *IP67 enclosure available upon request at additional cost*
Connectors	*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 *IP 67 enclosure: Ethernet (RJ45), Power. Note: the supported standard for the IP67 LAN connector is 100 Mbit/s (4-wired LAN cable).*
Installation Considerations	Designed for plug-and-go installation Mounting screw anchor slot provided Alignment: with axis of building or magnetic. North arrow provided.
Operating Temperature	0 to 60 C (limited by RPi, the Raspberry Shake itself can go to -20C)
On Board Computer	Raspberry Pi 3 Model B *The Raspberry Shake board/ Software is also compatible with:* 00[10,13],900032: Model B+ a[01040,01041,21041,22042]: 2 Model B a[02082,22082,32082,52082]: 3 Model B a020d3: 3 Model B+ 4 Model B
Storage Device	8 Gb or + micro SD card *Est. # days of disk space:* OS/ software: ~3 Gb Remaining space for data: ~5 Gb # days (15 Mb/ day/ channel [x4]): ~80, more if you use a bigger SD
Timing	Network Timing Protocol, NTP (default)

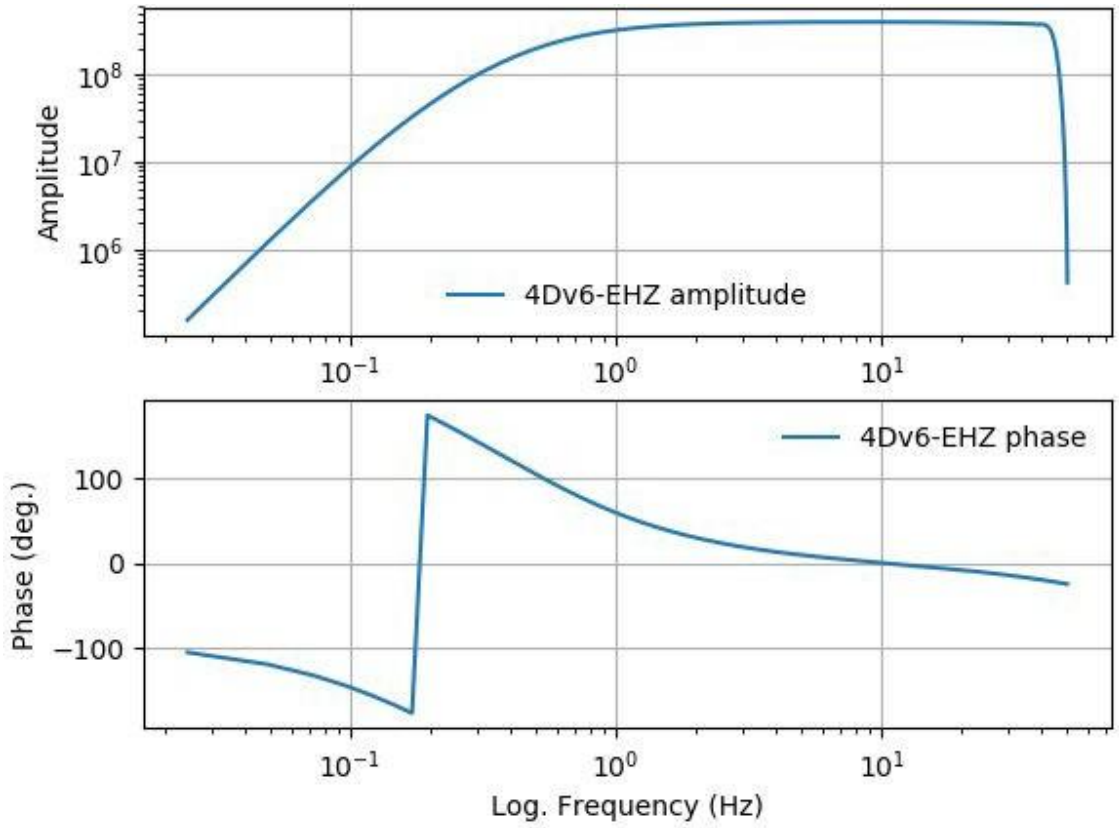
	GPS timing supported
Timing Quality	NTP timing quality remains within 1 sample of accuracy versus startup accuracy: +/- 10 ms or better @ 100 sps

Seismograph

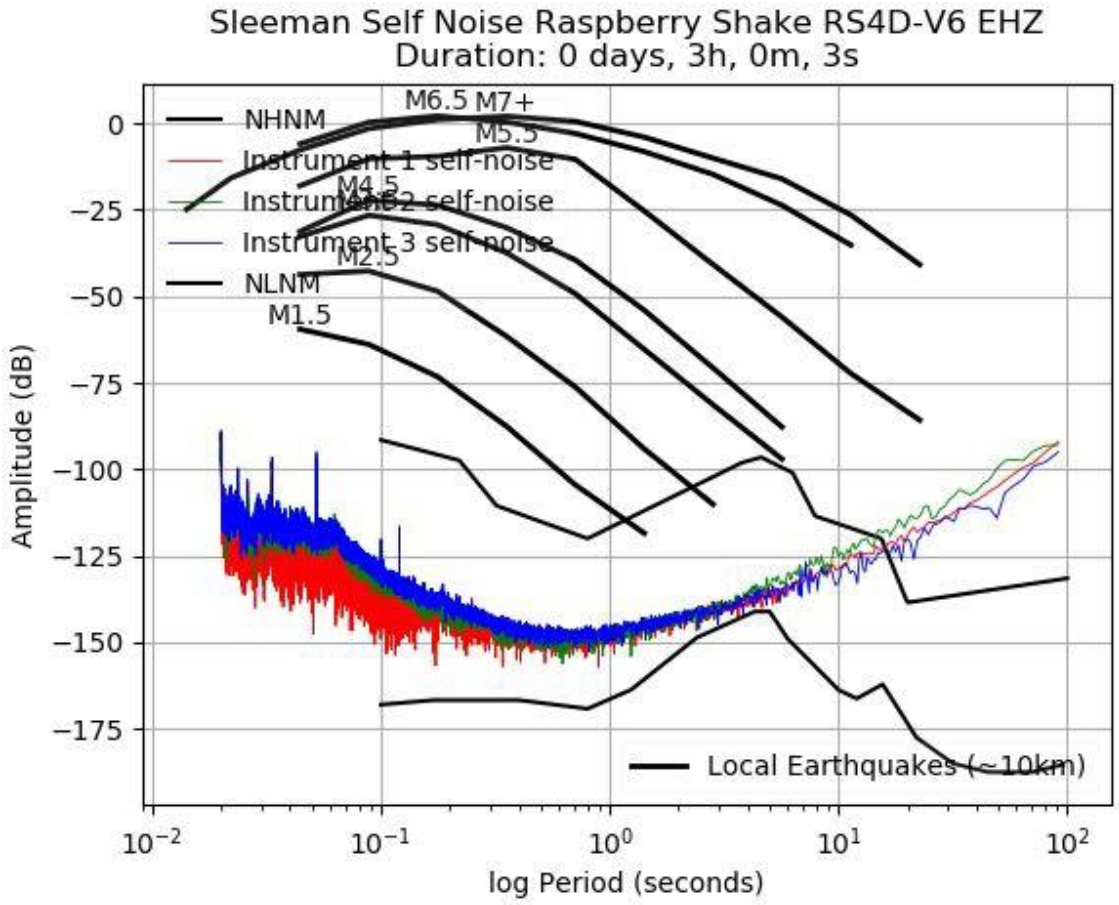
Parameter	Value
Type	Single-component 4.5 Hz 395 Ohm vertical Racotech RGI-20DX geophone with electronic extension to lower frequencies (<1 Hz)
Samples per second	100
Earthquake Early Warning (EEW) compatible *data packets shipped across serial port at a rate of 4 packets/ second (250 ms/ packet)*	
Bandwidth (estimate)	V6+: -3dB points at 0.7 and 44 Hz V5: -3dB points at 0.7 and 26 Hz, possibly higher V4: -3dB points at 0.7 and 40 Hz
Poles (estimate, radians/ second)	V6+: -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) V5: -1.63E+02 +/- 1.02E+02; -3.61; -1.41 +/- 4.11E-01 V4: 1.82E+02 +/- 3.43E+02; 4.56E-01; 0
Zeros (estimate, radians/ second)	V6+: 0; 0; 0 V5: -5.78E+03; 0; 0; 0 V4: -3.60E+02 +/- 8.29E+02; -3.04 +/- 8.48E-01

Sensitivity (estimate)	V6+: 3.996500E+08 counts/ meter/ second +/- 10% precision V5: 3.36E+08 counts/ meter/ second +/- 10% precision V4: 4.05E+08 counts/ meter/ second +/- 10% precision
Clip Level (estimate)	+/- 8,388,608 counts (24-bits) V4+: 21 mm/s peak-to-peak from 0.1 to 10 Hz
Minimum Detection Threshold (estimate)	V5+: 0.08 µm/ s RMS from 1 to 20 Hz @ 100 sps V4: 0.16 µm/ s RMS from 1 to 20 Hz @ 100 sps *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.*
Digitizer Dynamic range	24-bit ADC Sigma-Delta $\Sigma\Delta$ 144 dB (24 bits)
Effective bits (estimate)	V5+: 21 bits (126 dB) from 1 to 20 Hz @ 100 sps (for the entire analog to digital hardware chain). V4: 18 bits (109 dB) from 1 to 20 Hz @ 100 sps (for the entire analog to digital hardware chain). *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.* This parameter is also commonly known as “Dynamic Range”; “RMS to RMS noise"; or "noise free bits".

Velocity Channel Instrument Response:



Sleeman Self-Noise:



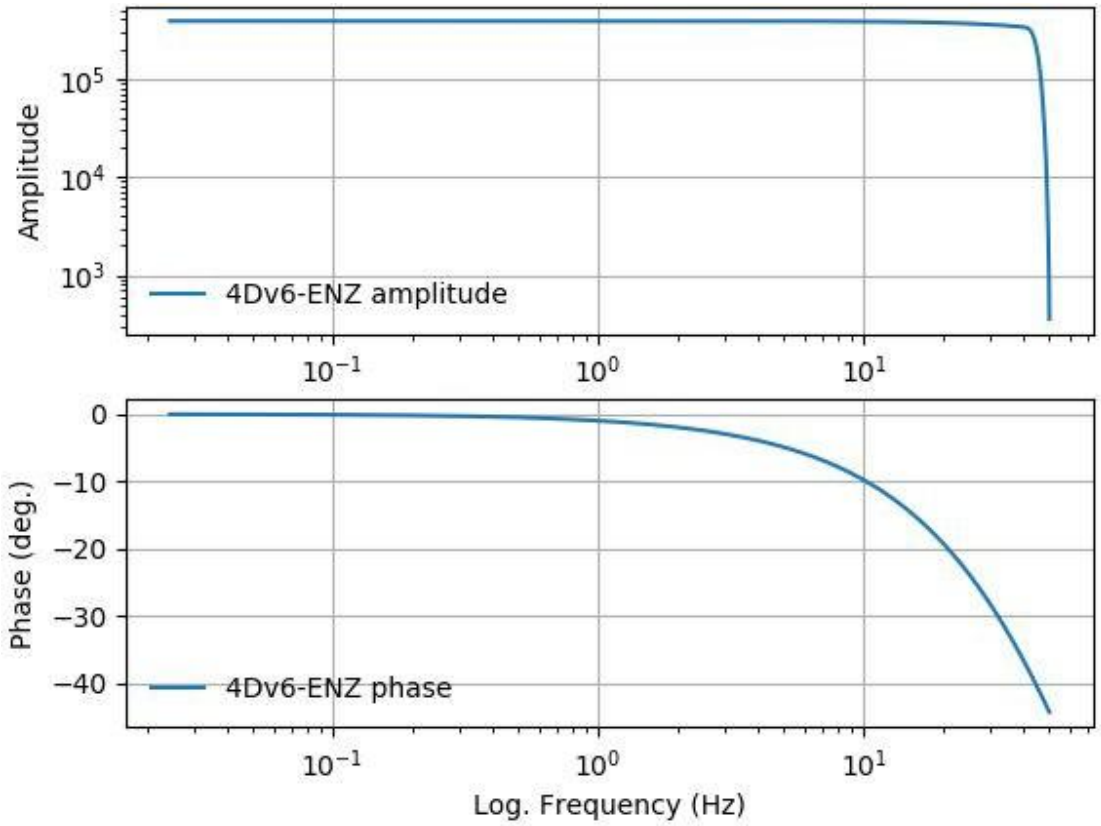
Accelerograph: MEMs

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.

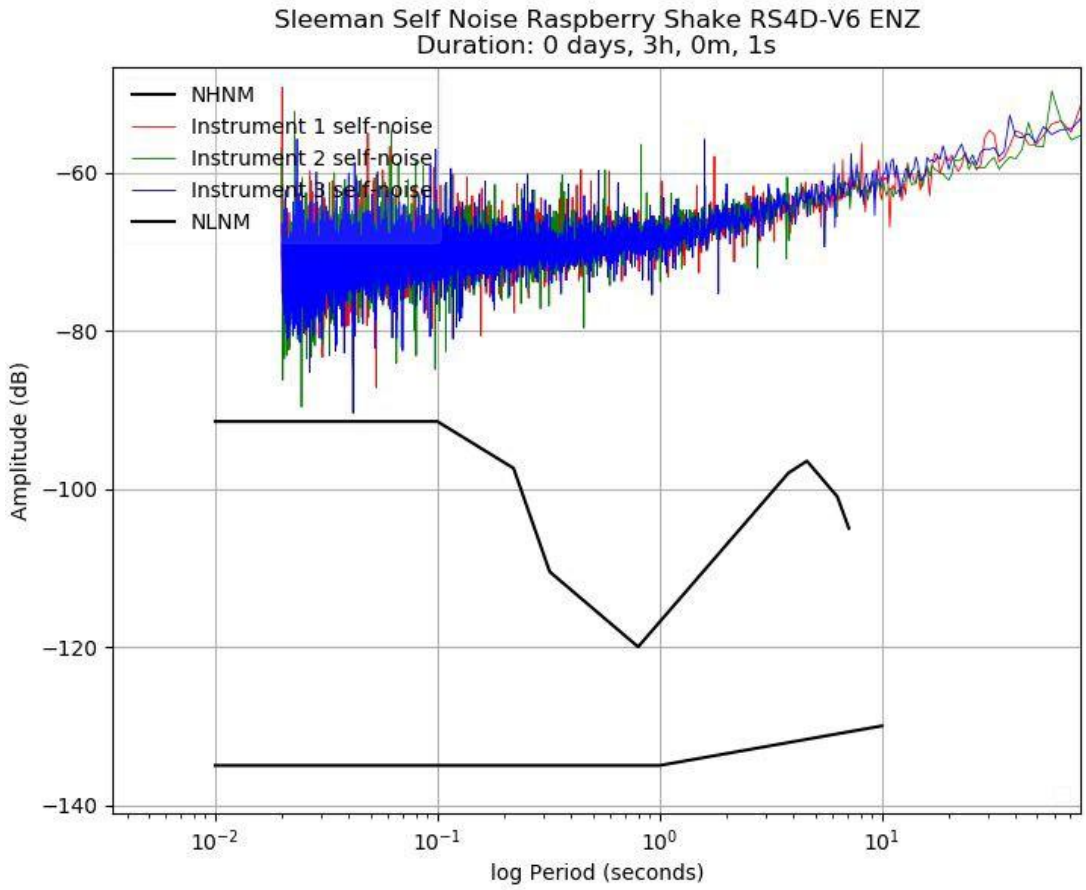
Parameter	Value
Sensor	3-component, orthogonally placed +/- 2g MEMs sensor (Class C)
Samples per second	100
Earthquake Early Warning (EEW) compatible *data packets shipped across serial port at a rate of 5 packets/ second (200 ms/ packet)*	
Flat Frequency Range (estimate, -3dB points)	V6+: DC to 44 Hz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

Sensitivity (estimate)	V6+: 3.845E+05 counts/ meter/ second squared +/- 10% precision V5: 3.87E+05 counts/ meter/ second squared +/- 10% precision V4: 3.96E+05 counts/ meter/ second squared +/- 10% precision
Clip Level (estimate)	V5+/ V4: +/-2G (21-22 m/s^2 peak-to-peak from 0.1 to 10 Hz)
Digitizer Dynamic range	24-bit ADC Sigma-Delta $\Sigma\Delta$ 144 dB (24 bits)
Effective bits (estimate)	V4+: 14 bits (84 dB) from 1 to 10 Hz @ 100 sps (for the entire analog to digital hardware chain). *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.* This parameter is also commonly known as “Dynamic Range”; “RMS to RMS noise"; or "noise free bits".
Noise Level	V4+: 3000 µm/ 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. 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 0.460 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).

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.raspberryshake.org/

sales@raspberryshake.org

Last updated: 9-February-2022

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)	*Standard enclosure*: 135x110x70 mm *IP67 enclosure*: 160x90x90 mm
Weight (estimated)	0.4 kg
Immersion rating	*Standard enclosure*: IP10
Connectors	*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 *IP 67 enclosure: Ethernet (RJ45), Power. Note: the supported standard for the IP67 LAN connector is 100 Mbit/s (4-wired LAN cable).*
Installation Considerations	Designed for plug-and-go installation Mounting screw anchor slot provided (for RBOOM) Alignment: no alignment required (the infrasound sensor is omnidirectional and the velocity sensor, vertical)
Operating Temperature	0 to 60 C (limited by RPi, the Raspberry Boom itself can go to -20C)
On Board Computer	Raspberry Pi 3 Model B *The Raspberry Shake board/ Software is also compatible with:* 00[10,13],900032: Model B+ a[01040,01041,21041,22042]: 2 Model B 9000[92,93],9200[92,93]: Zero a[02082,22082,32082,52082]: 3 Model B a020d3: 3 Model B+ 4 Model B 9000c1: Zero W(H)
Storage Device	8 Gb or + micro SD card *Est. # days of disk space:* OS/ software: ~3 Gb Remaining space for data: ~5 Gb

	# days Raspberry Boom (15 Mb/ day/ channel): ~320, more if you use a bigger SD # days Raspberry Shake and Boom (15 Mb/ day/ channel): ~160, more if you use a bigger SD
Timing	Network Timing Protocol, NTP (default) GPS timing supported
Timing Quality	NTP timing quality remains within 1 sample of accuracy versus startup accuracy: +/- 10 ms or better @ 100 sps

Microbarograph (Infrasound)

Applies to both Raspberry Boom & Raspberry Shake and Boom

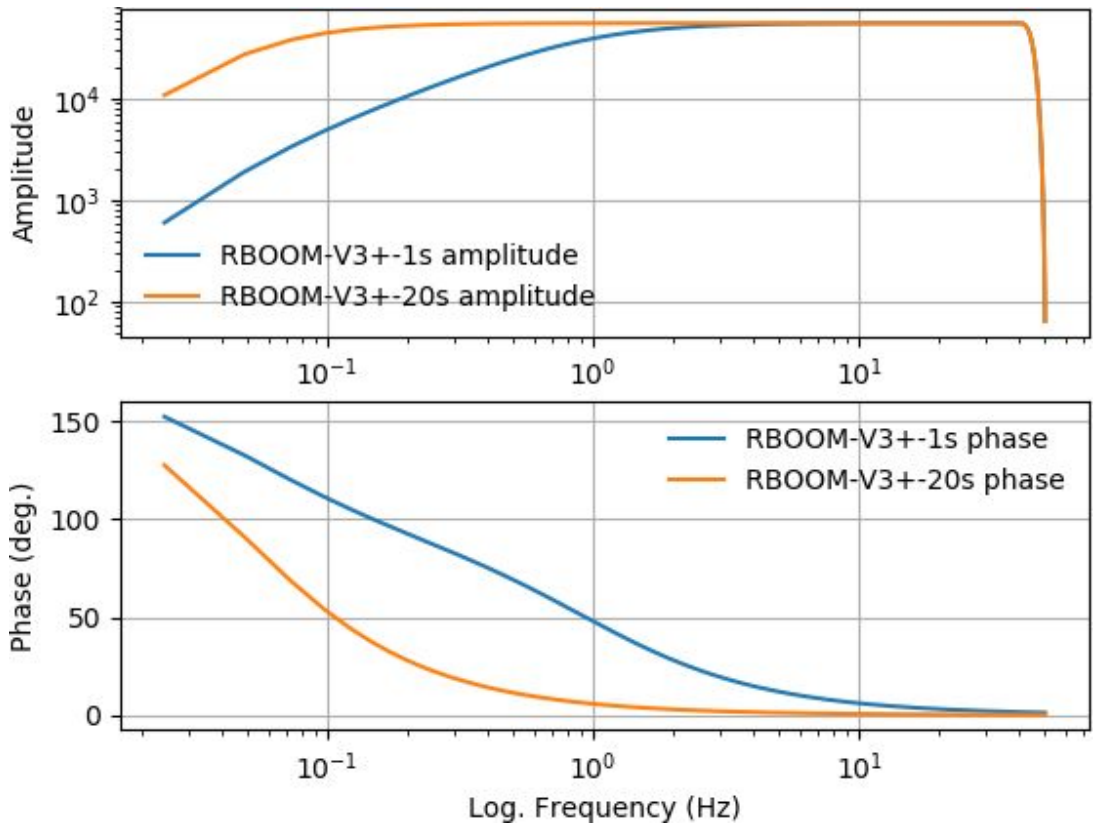
Parameter	Value
Type	MEMS temperature compensated differential pressure transducer
Samples per second	100
Data packet transmission rate	Data packets shipped across serial port at a rate of 4 packets/ second (250 ms/ packet)
Bandwidth (estimate)	-3dB points at 1 Hertz (1 seconds) to 44 Hertz (for 1s mechanical filter, default). -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). Rolloff past low frequency corners: 2 poles or 40dB/decade
Poles (estimate, radians/ second)	There is a hardware single-pole high-pass filter with a -3 dB point around 0.05 Hz. With 1s mechanical filter attached (default): -0.312 (20 seconds, single pole high pass filter, from hardware) -6.289 (1 Hz, single pole high pass filter, from mechanical filter) With 20s mechanical filter attached (not included by default with order, available upon special request only):

	-0.312 (20 seconds, single pole high-pass filter, from hardware) -0.312 (20 seconds, single pole high pass filter, from mechanical filter)
Zeros (estimate, radians/ second)	0,0
Sensitivity (estimate)	56,000 counts/ Pascal +/- 10% precision
Clip Level (estimate)	+/- 8,388,608 counts (24-bits) 0.5 inches of water, corresponding to +/- 125 Pa
Digitizer Dynamic range	24-bit ADC Sigma-Delta $\Sigma\Delta$ 144 dB (24 bits)
Effective bits (estimate)	21 bits (126 dB) from 1 to 20 Hz @ 100 sps (for the entire analog to digital hardware chain). *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.* This parameter is also commonly known as “Dynamic Range”; “RMS to RMS noise"; or "noise free bits".
Error band	~1%
Linearity of the pressure measurement (included in total error band measurement)	<0.5%
Gain Calibration	Automatic

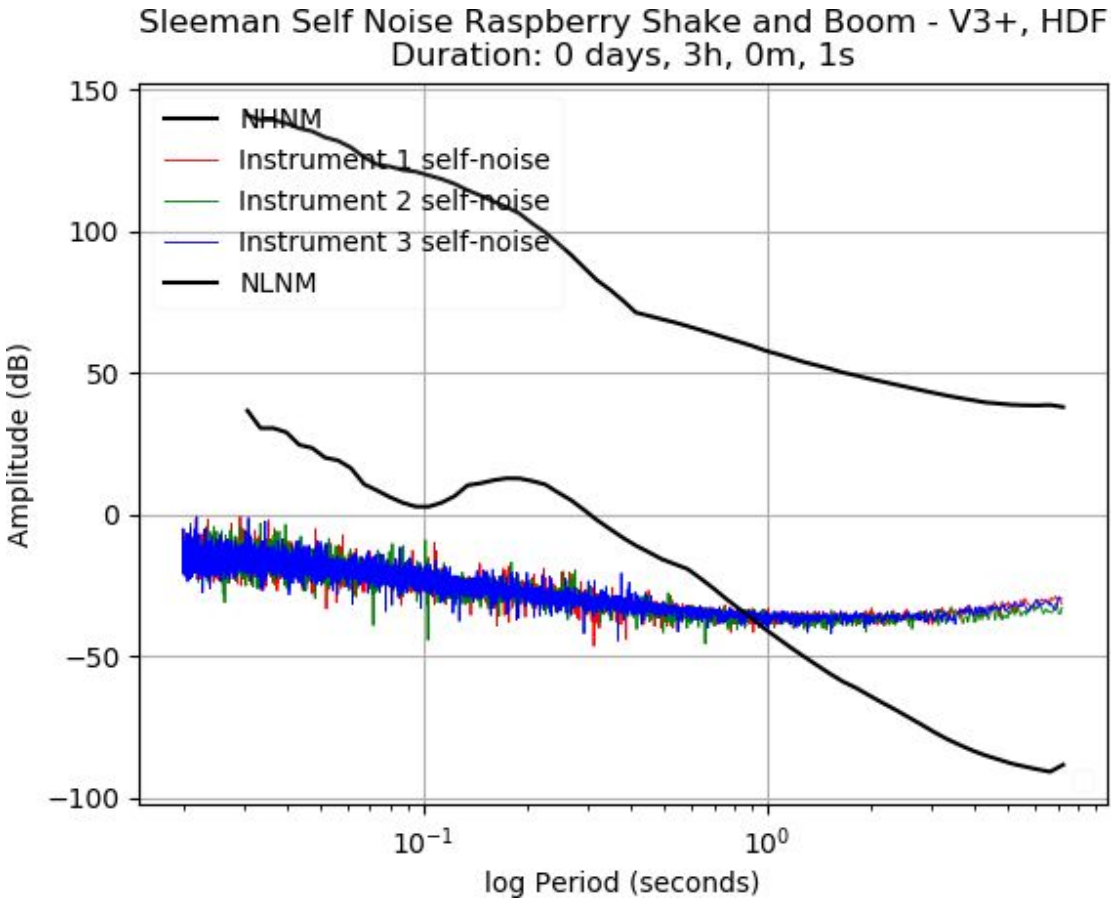
Mechanical filter High Pass filter options	1s (default, included with order), 20s (available upon special request only)
Operating Temperature of sensor	Compensated operating range: 0 to 50 C Max. operating range: -25 to 85 C (though the rest of the electronics are limited to 0-60C)

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



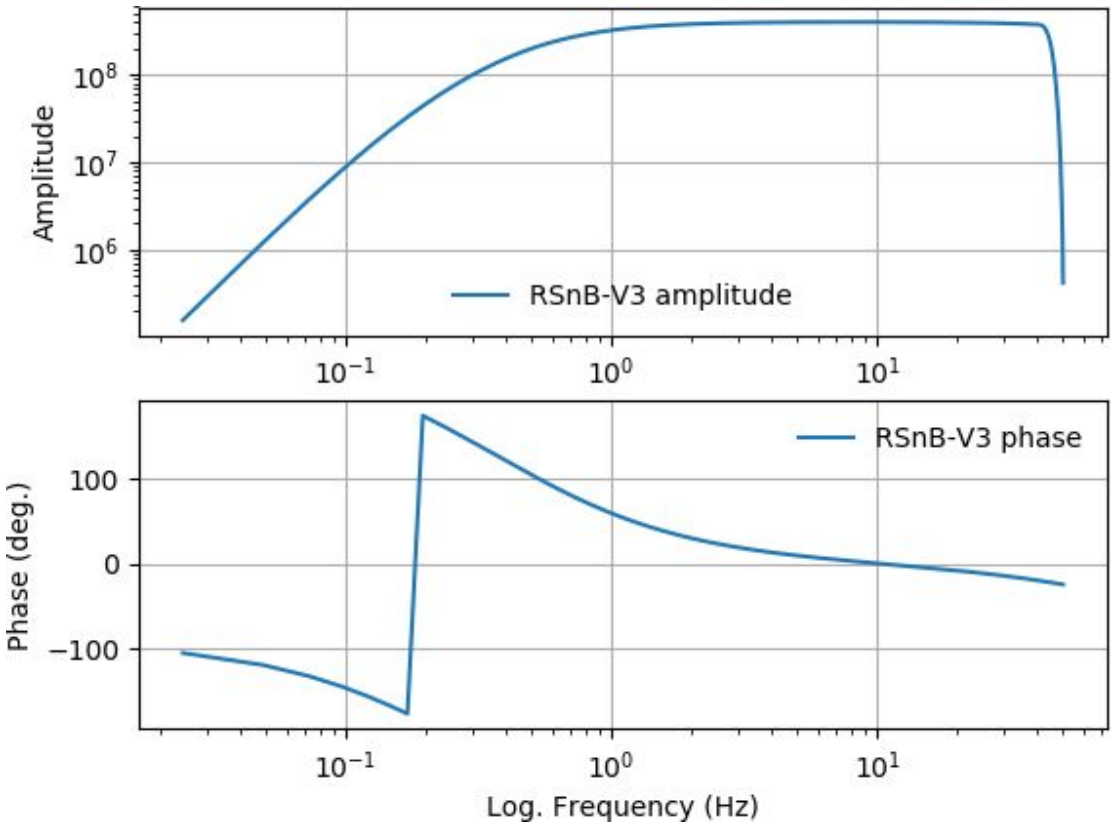
Seismograph

Raspberry "Shake and Boom" only

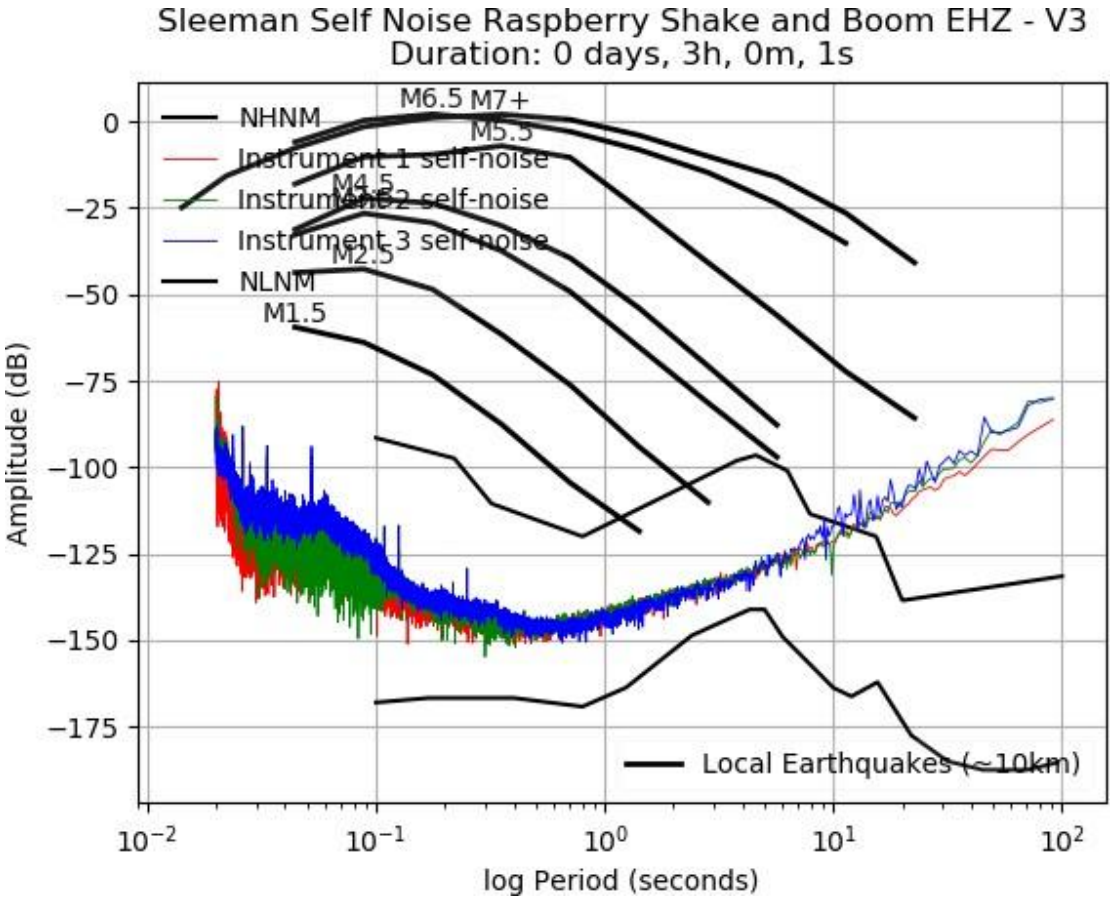
Parameter	Value
Type	Single-component 4.5 Hz 395 Ohm vertical Racotech RGI-20DX geophone with electronic extension to lower frequencies (<1 Hz)
Samples per second	100
Earthquake Early Warning (EEW) compatible *data packets shipped across serial port at a rate of 4 packets/ second (250 ms/ packet)*	
Bandwidth (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 µm/ s RMS from 1 to 20 Hz @ 100 sps

	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.
Digitizer Dynamic range	24-bit ADC Sigma-Delta $\Sigma\Delta$ 144 dB (24 bits)
Effective bits (estimate)	21 bits (126 dB) from 1 to 20 Hz @ 100 sps (for the entire analog to digital hardware chain). *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.* This parameter is also commonly known as “Dynamic Range”; “RMS to RMS noise"; or "noise free bits".

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).