Specifications for: OSOP Raspberry Shake 4D

- Your 4D Personal Seismograph & Accelerograph -

An IoT home-automation device

Born on: February, 2017

Last updated: 21-october-2017

Unit

The “Raspberry Shake 4D” 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 4D 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	V5, V4 (Current version: V5)
Dimensions (estimated)	100x120x50 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

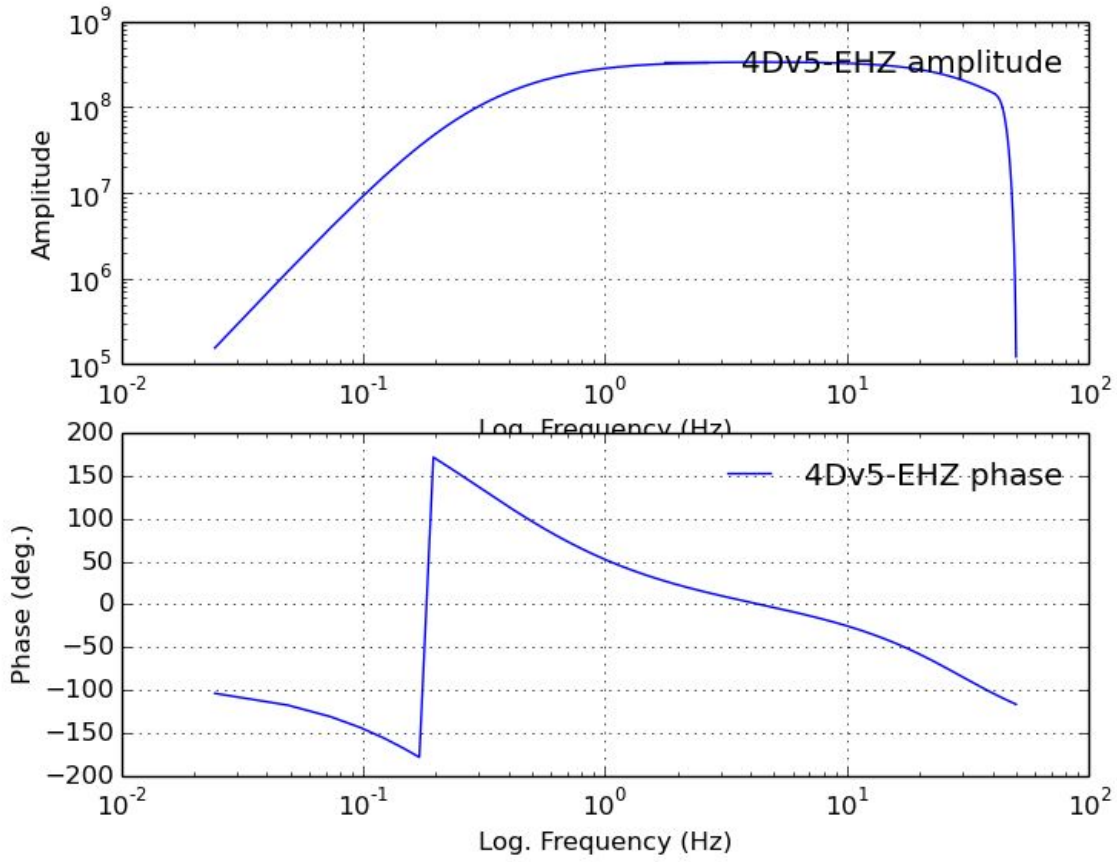
	IP67 enclosure: Ethernet (RJ45), Power
Installation Considerations	Designed for plug-and-go installation Mounting screw anchor slot provided Alignment: with axis of building or magnetic. North arrow provided.
Operating Temperature	0 to 60 C (limited by RPi, the Raspberry Shake itself can go to -40C)
On Board Computer	Wifi-enabled Raspberry Pi 3 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
Timing Quality	NTP timing quality remains within 1 sample of accuracy versus startup accuracy: +/- 10 ms or better @ 100 sps

Seismograph

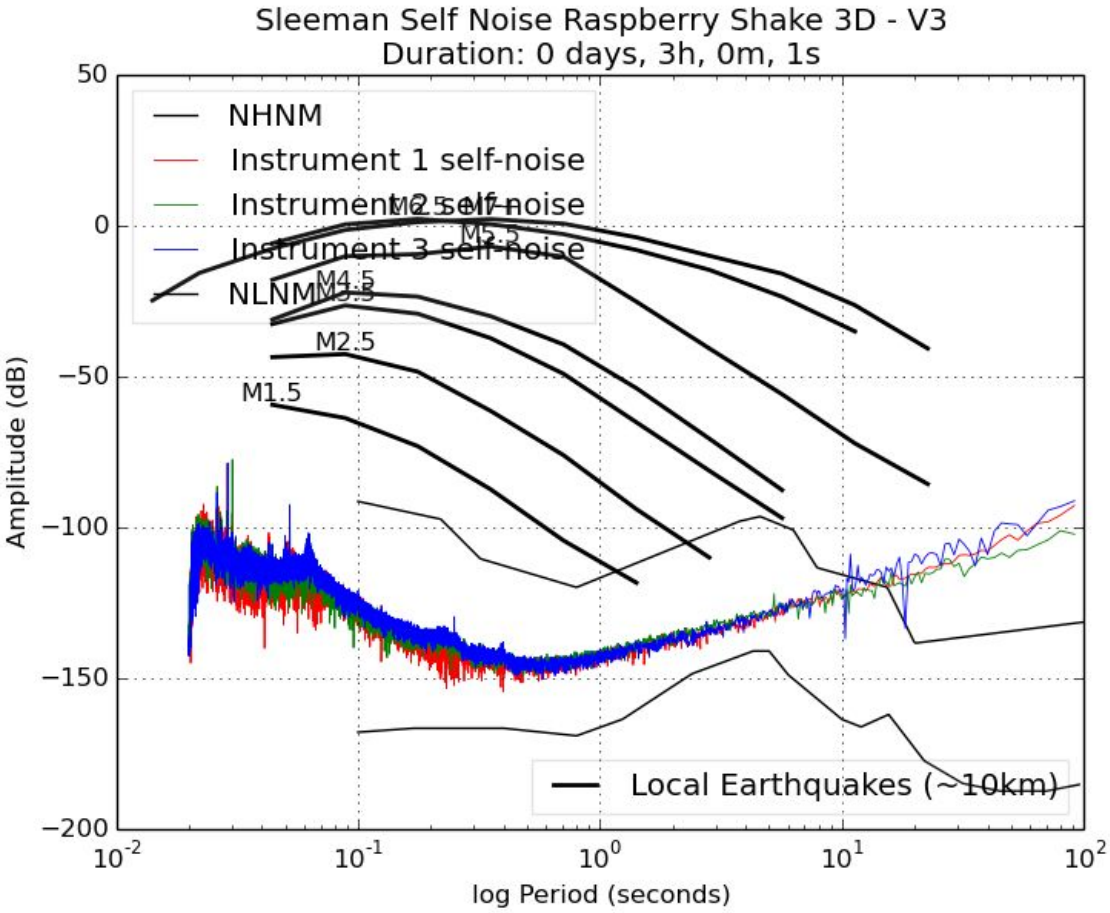
Parameter	Value
Type	Single-component 4.5 Hz 395 Ohm vertical Racotech RGI-20DX geophone with electronic extension to lower frequencies (<1 Hz)
Samples per second	100
Earthquake Early Warning (EEW) compatible *data packets shipped across serial port at a rate of 4 packets/ second (250 ms/ packet)*	
Bandwidth (estimate)	V5: -3dB points at 0.7 to 26 Hz, possibly higher V4: -3dB points at 0.7 to 40 Hz
Poles (estimate)	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)	V5: -5.78E+03; 0; 0; 0 V4: -3.60E+02 +/- 8.29E+02; -3.04 +/- 8.48E-01
Sensitivity (estimate)	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) V5: 25 mm/s peak-to-peak from 0.1 to 10 Hz V4: 21 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 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 **ΣΔ** 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” or “RMS to RMS noise”.

Velocity Channel Instrument Response:



Sleeman Self-Noise:

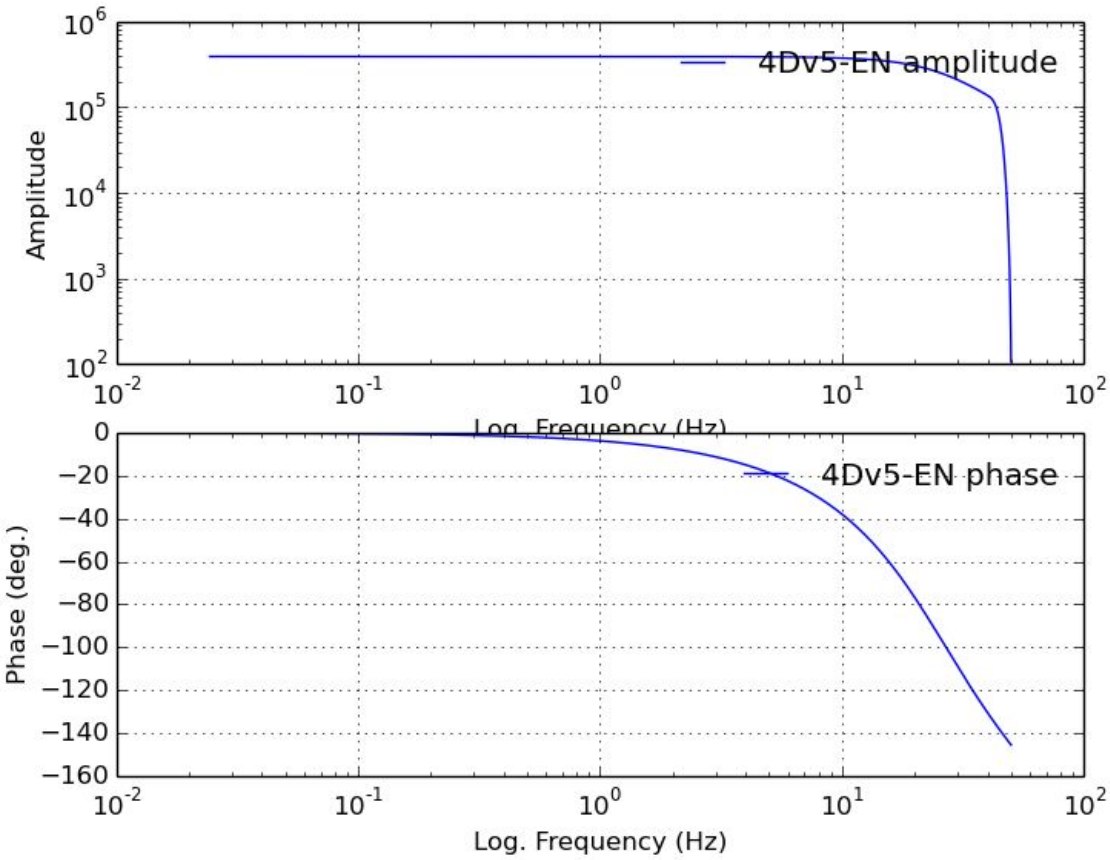


Accelerograph: MEMs

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)	V5: DC to 23 Hz, possibly higher V4: DC to 29 Hz, possibly higher
Poles (estimate)	V5: 6.57E+02 +/- 1.20E+03; 0 V4: 5.06E+01 +/- 2.86E+02; 0
Zeros (estimate)	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)	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 m/s^2 peak-to-peak from 0.1 to 10 Hz)
Digitizer Dynamic range	24-bit ADC Sigma-Delta ΣΔ 144 dB (24 bits)

Effective bits (estimate)	V5/ 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” or “RMS to RMS noise”.
Noise Level	V5/ V4: 3000 µm/ s (0.3 Gal) RMS from 1 to 10 Hz @ 100 sps

Acceleration Channel Instrument Response:



Software

Software installed on Raspberry Shake's RPi computer
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)	5.14 Volts x 0.270 A = 1.4 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).