Specifications for:

OSOP 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

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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- OSOP, S.A. 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 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**
Versioning	V3
Dimensions (estimated)	110x100x65 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
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	Wifi-enabled 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+ 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

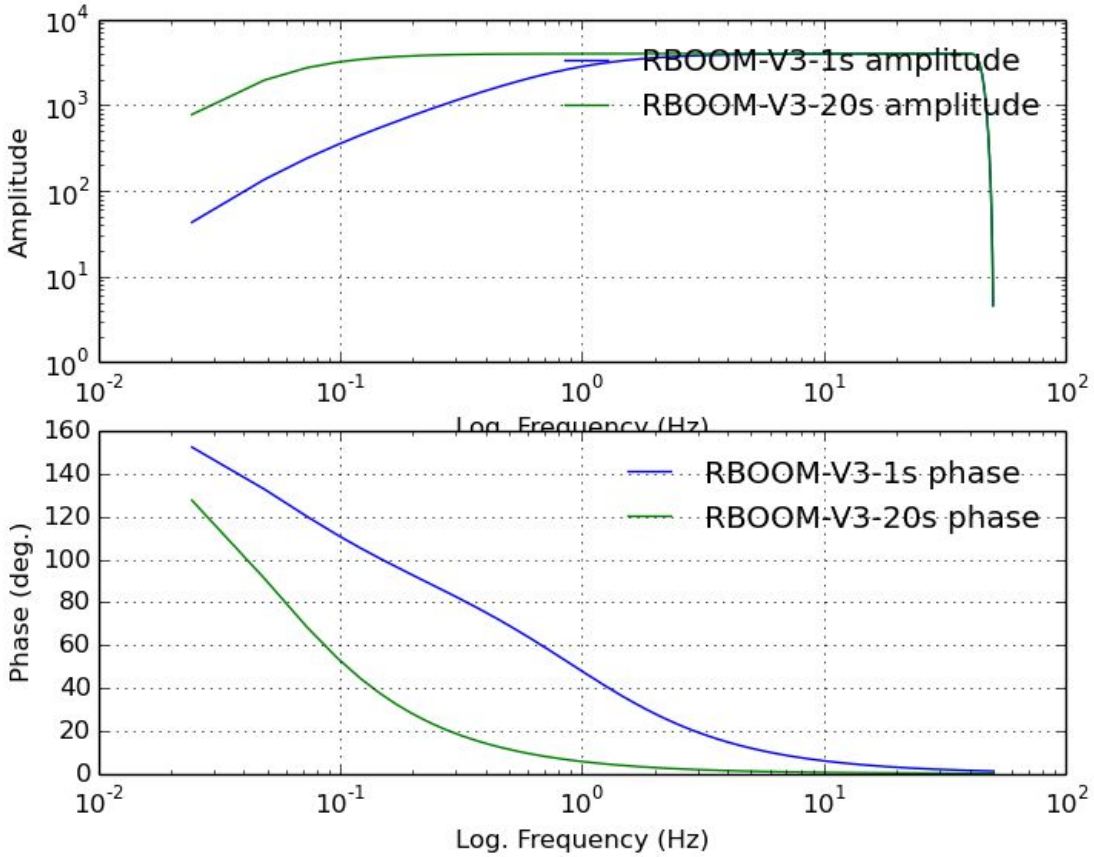
Parameter	**Value**
Type	Differential pressure transducer
Samples per second	100
Data packet transmission rate	Data packets shipped across serial port at a rate of 4 packets/ second (250 ms/ packet)
Bandwidth (estimate)	-3dB points at 1 Hertz (1 seconds) to 44 Hertz (for 1s mechanical filter, default). -3dB points at 0.08 Hertz (13 seconds) to 44 Hertz (for 20s mechanical filter). Rolloff past low frequency corners: 2 poles or 40dB/decade

Poles (estimate)	There is a hardware single-pole high-pass filter with a -3 dB point around 0.05 Hz. With 1s mechanical filter attached: -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: -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)	0,0
Sensitivity (estimate)	4000 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 ΣΔ 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, 20s (all units ship with both)
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


RBOOM-V3-1s amplitude
RBOOM-V3-20s amplitude
Amplitude
Log. Frequency (Hz)
RBOOM-V3-1s phase
RBOOM-V3-20s phase
Phase (deg.)
Log. Frequency (Hz)

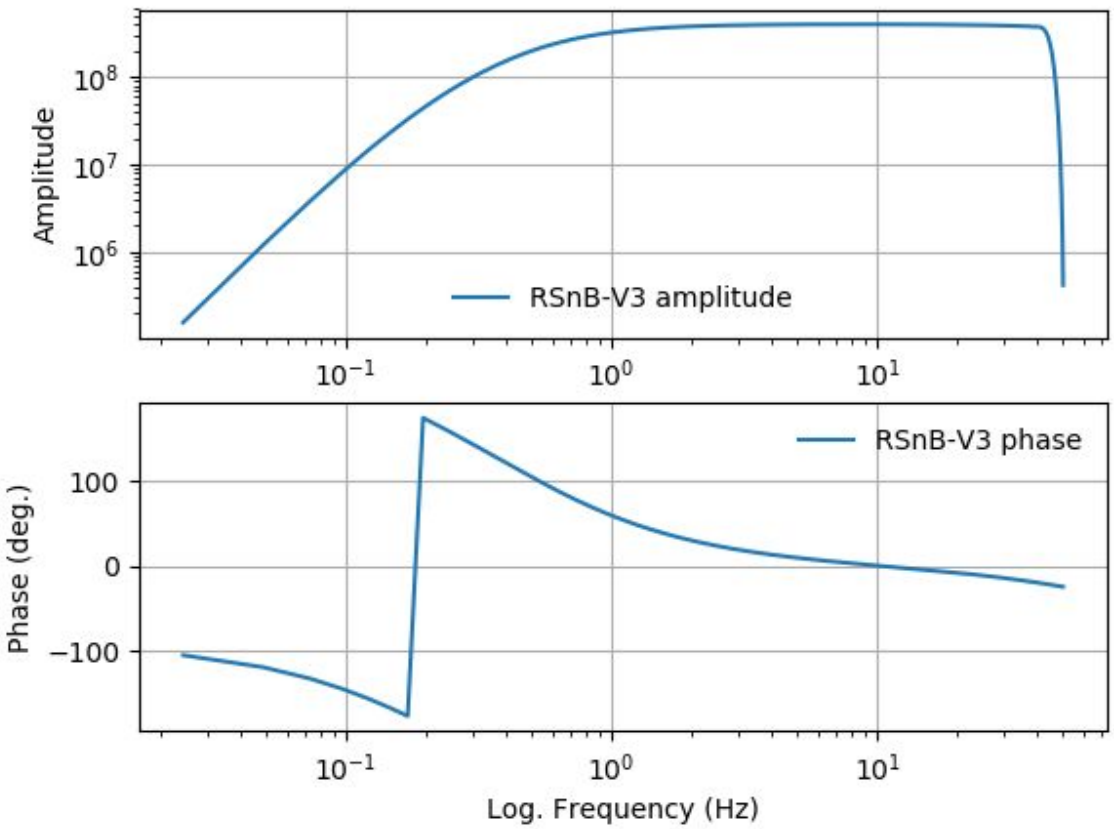
Seismograph

Raspberry "Shake and Boom" only

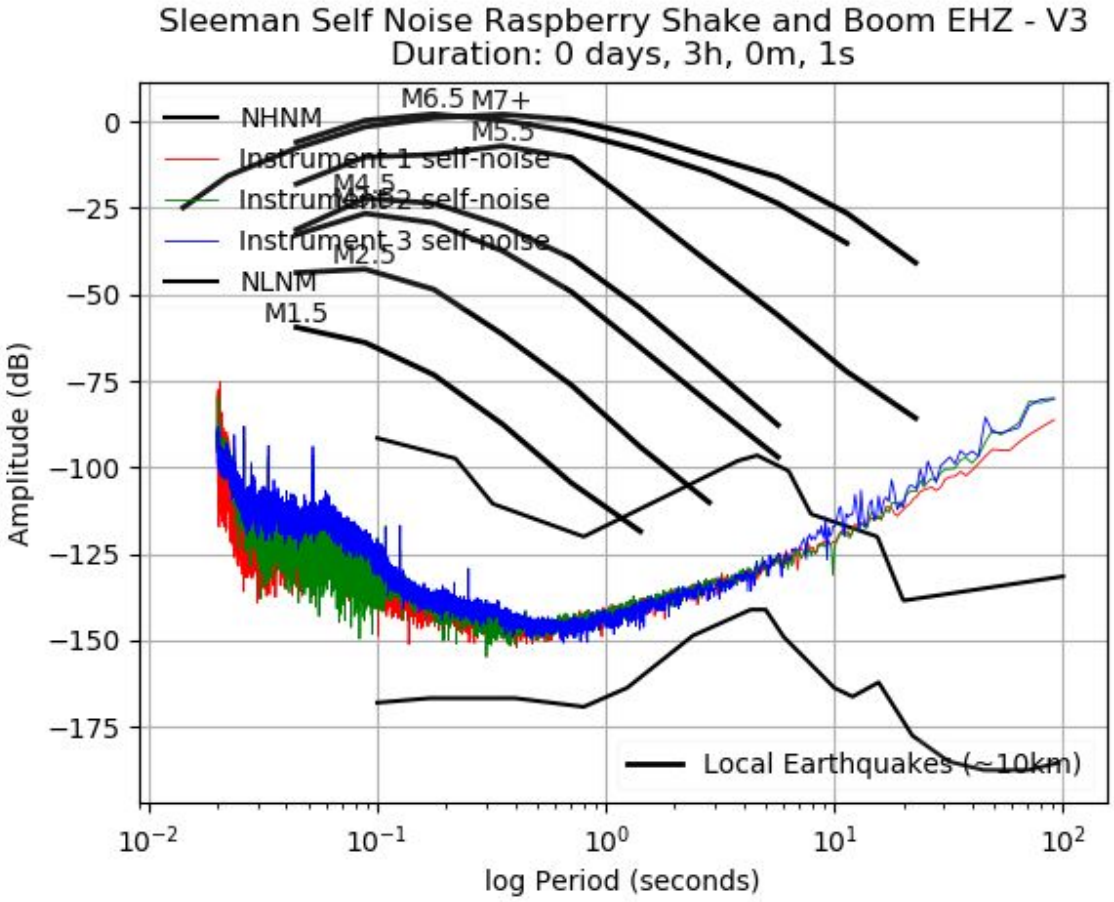
Parameter	Value
Type	Single-component 4.5 Hz 395 Ohm vertical Racotech RGI-20DX geophone with electronic extension to lower frequencies (<1 Hz)
Samples per second	100
Earthquake Early Warning (EEW) compatible *data packets shipped across serial port at a rate of 4 packets/ second (250 ms/ packet)*	
Bandwidth (estimate)	-3dB points at 0.7 to 44 Hz
Poles (estimate)	-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)	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 **ΣΔ** 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 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, per channel (estimated)	Incoming rates RX: ~24.0 kbits/s Outgoing rates TX: ~94.0 kbits/s TCP Flow rate: 8.4 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)	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).

Questions?

Email us at sales@raspberryshake.org