Convergence Instruments

VSEW_mk4

VSE_mk4

Data Sheet

August 5 2023

Bruno Paillard

1 Product Description

The VSEW_mk4 and *VSE_mk4* are new models in the VSE series of smart vibration dataloggers. They can record accelerations, vibrations, velocities and inclinations. They include a 3-axis MEMS accelerometer, an accurate date/time clock and a non-volatile 128 Mb recording memory. Depending on the settings they can record acceleration or velocity signals and/or RMS levels for months. Their very small size allows them to be attached to, or embedded within, the monitored equipment.

The *VSE_mk4* is identical to the *VSEW_mk4* but does not have a WiFi transceiver.

The *VSEW_mk4* model is an evolution of the *VSEW_mk2* model. It has the following new features:

- Virtual COM port interface that allows configuration and measurements to be read by a custom application (see *VSEW_mk4_Com_Protocol.pdf*)
- Added filters and settings to support the DIN4150-2 standard directly.
- Frequency response equalization is performed in firmware, so it does not need to be performed in post-processing.
- *WiFi*™ connection can use any open access point if the specified access point is not working ("W" model only).
- Email alerts can now be sent to multiple addresses ("W" model only).

The *VSEW_mk4* includes the following features:

- 3-Axis integral MEMS accelerometer
- Measures and records:
  - Raw acceleration or velocity signals
  - Acceleration or velocity statistics
  - Vibration or velocity levels
  - Inclinations
- All-digital design.
- Integrated oscilloscope function that can show the vibration or velocity signals in real time.
- Allows the observation of recorded data while the recording is ongoing.
- Works standalone, or USB or WiFi connected ("W" model only) for setup and data transfer to PC.
- Long life internal rechargeable battery that recharges from USB.
- Self-calibrated using the earth's gravity as a reference.
- Observes and records 100% of the acceleration signals (no missed samples).
- Editable individual custom ID for easier instrument management.
- Completely sealed weatherproof enclosure (IP57-certified).

2 Applications

- Building-health monitoring on construction sites.
- Compliance to DIN4150-2.
- Long-term seismic monitoring.
- Long-term inclination monitoring.
- Long-term measurement and recording of acceleration signals, velocity signals, signal statistics (peaks and average) and RMS levels.
- Continuous monitoring of machinery wear.

3 Specifications

Category	Specification
Number of Axes	• 3
Acceleration Sensor	• MEMS Digital 3-axes
Dynamic Range (-8g)	• +-8 g
Bandwidth High Limit	• Adjustable, up to 2 kHz (@ 4 kHz Sampling Rate)
Bandwidth Low Limit	• DC (High-Pass Filter Bypass) • Adjustable from 10 mHz to *Fs/2* (High-Pass Filter On)
Acceleration Noise X-Y Axes (Typical)	*Note: Acceleration noise is primarily affected by the sampling rate. The higher the sampling rate, the higher the noise.* • 110 µg RMS @ 125 Hz Sampling Rate • 750 µg RMS @ 4 kHz Sampling Rate
Acceleration Noise Z Axis (Typical)	*Note: Acceleration noise is primarily affected by the sampling rate. The higher the sampling rate, the higher the noise.* • 140 µg RMS @ 125 Hz Sampling Rate • 900 µg RMS @ 4 kHz Sampling Rate
Velocity Noise X-Y Axes (Typical)	*Note: Velocity noise is primarily affected by the high-pass cutoff frequency. The lower the cutoff frequency, the higher the noise.* • 25 µm/s RMS @ 1 Hz High-Pass Cutoff • 8 µm/s RMS @ 10 Hz High-Pass Cutoff
Velocity Noise Z Axis (Typical)	*Note: Velocity noise is primarily affected by the high-pass cutoff frequency. The lower the cutoff frequency, the higher the noise.* • 32 µm/s RMS @ 1 Hz High-Pass Cutoff • 10 µm/s RMS @ 10 Hz High-Pass Cutoff
Inclination Angle Noise	*Note: Measured using acceleration average, with a log interval of 1s, with the instrument positioned with the Z axis vertical, and X and Y axes horizontal* • $1\,E-3°$
Inclination Angle Temperature Stability	*Note: Measured using acceleration average, with a log interval of 1s, with the instrument positioned with the Z axis vertical, and X and Y axes horizontal* • $0.2°$ over the temperature range -20 °C to 60 °C
Sampling Clock Accuracy (Typ)	• 1%
Date-Time Clock Accuracy (Typ)	• 30ppm
Connectivity	• USB (includes a virtual Com port interface with documented protocol) • WiFi ("W" Model only)

WiFi Radio Standard	• IEEE 802.11 b/g/n (2.4GHz-only transceiver)
WiFi Radio Certification	• FCC • IC • Japan • Korea • CE
WiFi Band	• 2.4 GHz band (Channels 1 to 11, 2412MHz to 2462MHz)
WiFi Max Power	• 100 mW (20 dBm)
Measurements	• Raw Acceleration (g or m/s^2) • Raw Velocity (m/s) • Min, Max and Avg Acceleration values (g or m/s^2) • Min, Max and Avg Velocity values (m/s) • Inclinations • Min, Max and Avg RMS Vibration level (g, m/s^2 or dB) • Min, Max and Avg RMS Velocity level (m/s or dB)
Alarm Emails	• Acceleration Signal Threshold (X, Y, Z axis) • Velocity Signal Threshold (X, Y, Z axis) • RMS Acceleration Level Threshold (X, Y, Z axis) • RMS Velocity Level Threshold (X, Y, Z axis) • Battery
Duty Rate of Signal Capture	• 100% - No Missed Samples
Spectral Display	• 3-Axes 1024-point Power Spectrum – dB or Lin Scale.

Modes of Operation	• Idle (Micro-Power)
	• USB-Connected (Active)
	• Recording (Stand-alone)
	• Auto-Rec (Stand-Alone)
	  ○ Idle when no activity
	  ○ Recording while activity is present

Calibration	• Self-Calibration using the earth's gravity as a reference
Battery Type	• Integral Li-Poly - USB-Rechargeable
Recharge Time	• 2 H 30 (Typical)
Battery Autonomy (Full-Charge)	• Up to one year while in *Idle* • 10 days to 70 days while recording, depending on settings
Battery Life	• > 300 Charge/Discharge Cycles
Temperature Range	• -20 degC to 60 degC (-4 degF to 140 degF)
Recording Memory	• Non-Volatile Flash Memory

Recording Memory Capacity	• 128 Mb • Ex: can continuously record single-axis raw signals for 17 min @ 4 kHz Sampling Rate • Ex: can continuously record 3-axes full-statistics levels at 1s intervals for 5 days • Ex: can continuously record 3-axes full statistics levels a 1min intervals for 10 months.
Recording/Erasure Cycles	• Greater than 100 000
Data Retention	• Greater than 20 Years
Dimensions	• 76.2 mm x 39.4 mm x 20.6 mm • (3" x 1.55" x 0.81")
Weight	• 65 g
Construction	• Integrally Potted Weather-Proof ABS Enclosure
Ingress Protection (IP) Rating	• IP57: Protected against dust and temporary immersion in water

Table 1

3.1 Frequency Response

3.1.1 Upper Frequency Limit

Figure 1 shows the response of the accelerometer sensor and its acquisition chain, along the Z axis, at sampling rates of 4000 Hz (white), 2000 Hz (purple), 1000 Hz (orange) and 500 Hz (blue). The curves show the Z axis response, but the X and Y axes are very similar.

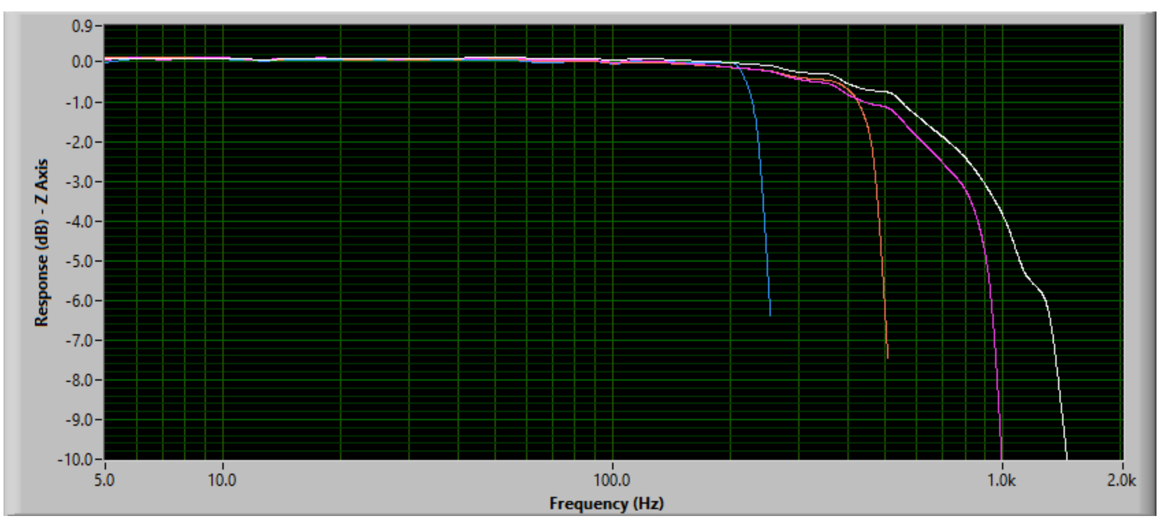

Figure 1 Z axis

3.1.2 Low-Pass Filter

An optional digital low-pass filter can optionally be applied to the acceleration or velocity signal. *Figure 2* shows the response of the accelerometer structure and its acquisition chain, along the Z axis for a 100 Hz cutoff, at sampling rates of 4000 Hz (white), 2000 Hz (purple), 1000 Hz (orange) and 500 Hz (blue). The curves show the Z axis response, but the X and Y axes are very similar.

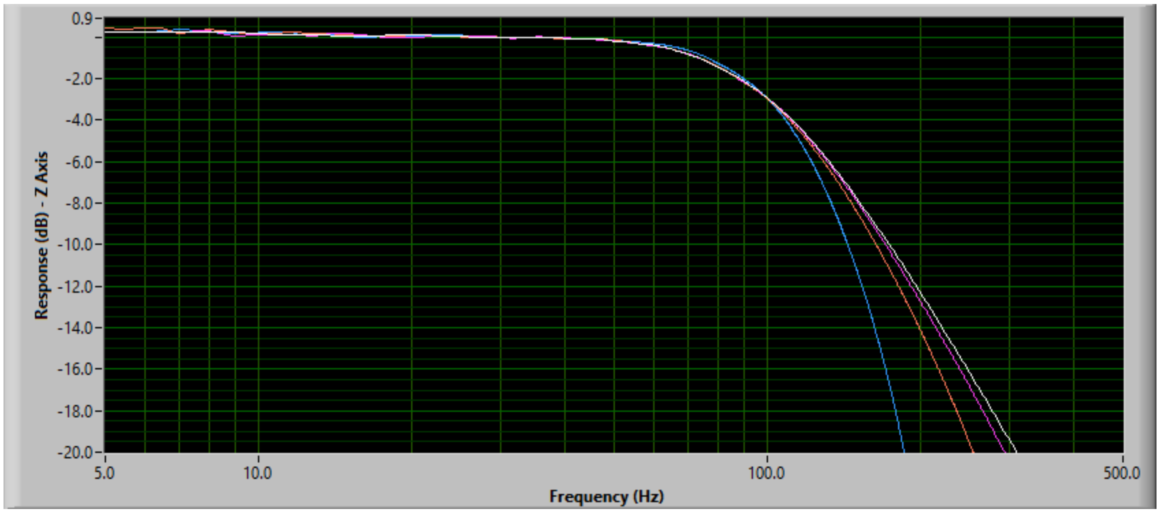

Figure 2 Low-Pass Filter

3.1.3 High-Pass Filter

The DC component and low-frequencies can optionally be limited by the digital high-pass filter. The cutoff frequency is adjustable and can be adjusted to extremely low frequencies (Fs/10000), thanks to the filter's exceptionally high resolution. *Figure 3* shows the low-frequency response for a high-pass filter adjusted to 1 Hz, 5 Hz and 10 Hz, and operating at 4 kHz sampling frequency.

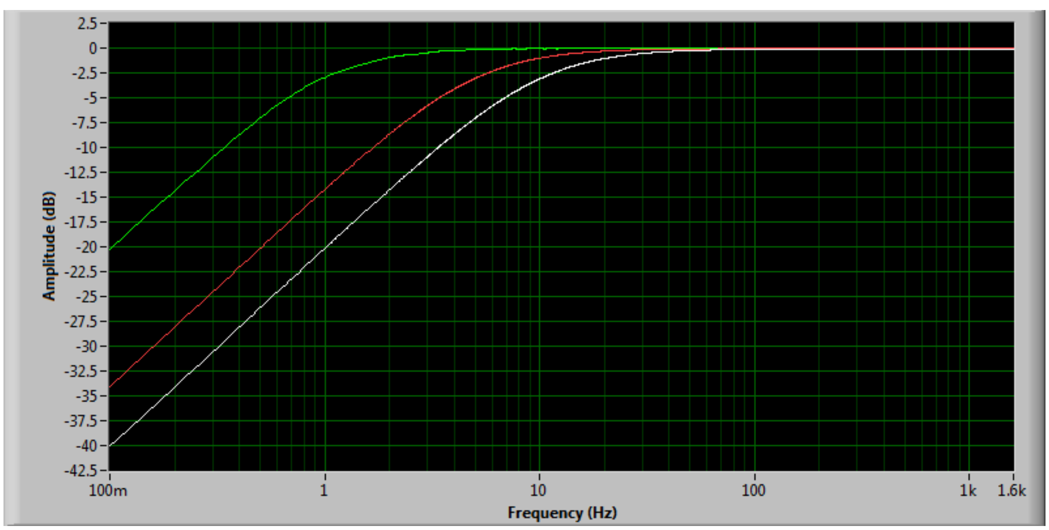

Figure 3 High-Pass Filter

3.2 Noise

3.2.1 Acceleration Noise

Acceleration noise is mostly influenced by the sampling frequency.

Figure 4 shows the total RMS noise along the three axes, as a function of sampling frequency.

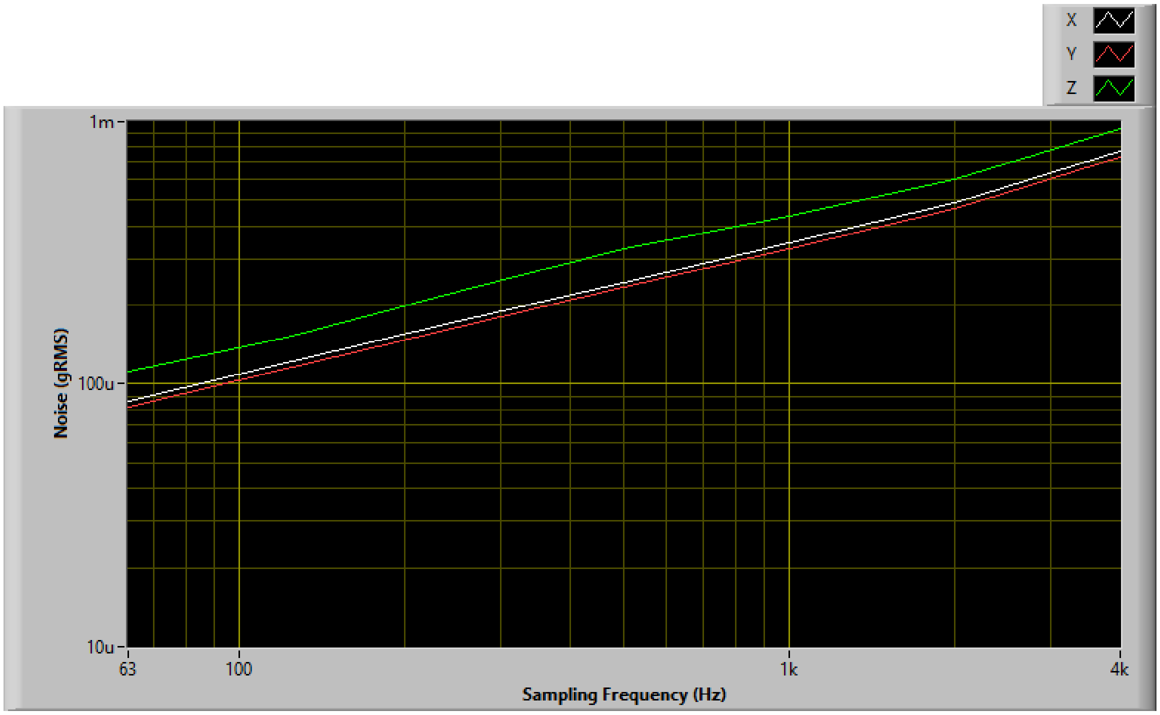

Figure 4

Figure 5 shows the acceleration noise spectrum when the accelerometer is sampling at 4 kHz, with a high-pass filter at 1Hz. X is white, Y is red, Z is green. The noise spectrum is approximately flat, so the total RMS noise is reduced by 3dB for every halving of the sampling frequency.

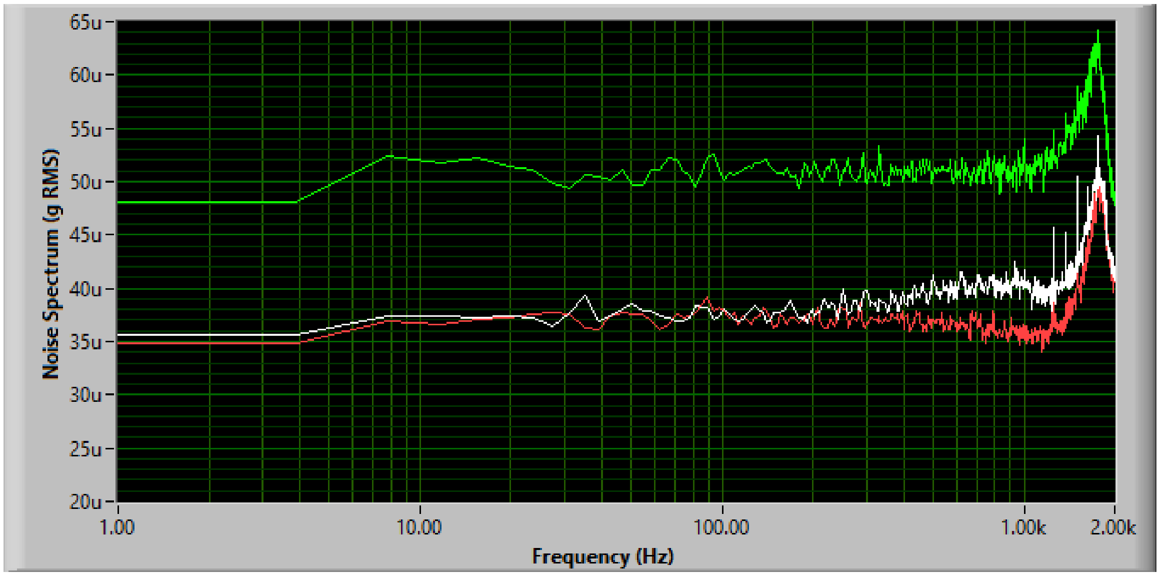

Figure 5

3.2.2 Velocity Noise

The velocity noise is not significantly influenced by sampling frequency, because the noise spectrum goes down as frequency goes up. It is mostly influenced by the cutoff frequency of the high-pass filter.

Figure 6 shows the RMS velocity noise spectrum with a high-pass filter at 1Hz.

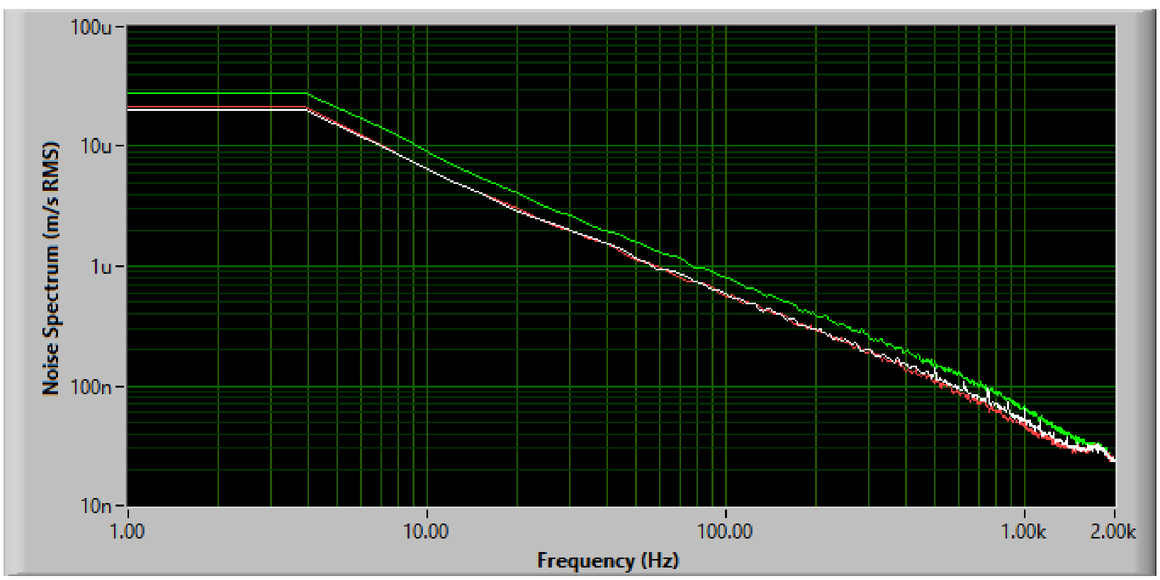

Figure 6

Figure 7 shows the RMS velocity noise spectrum as a function of the high-pass filter cutoff.

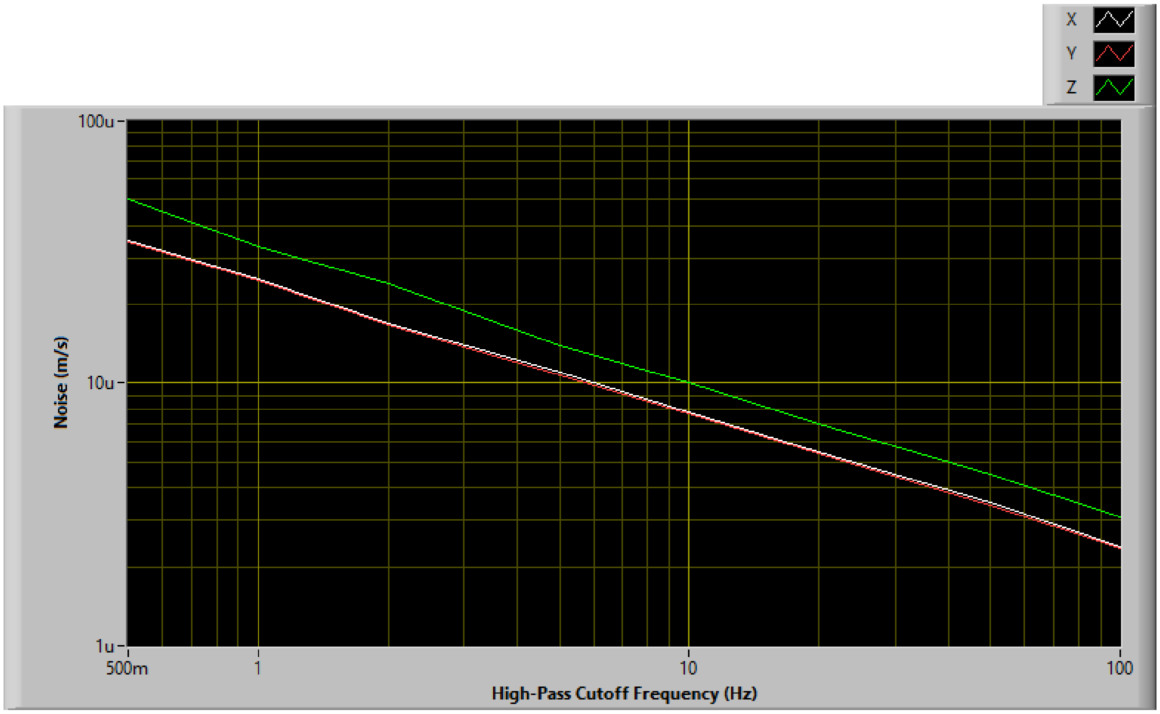
X
Y
Z
100u
10u
1u
Noise (m/s)
500m
1
10
100
High-Pass Cutoff Frequency (Hz)

Figure 7