Corecloud WLVS5101 Series Wireless Low-Frequency Vibration and Tilt Monitor

——Specification

2026-03-16

Rev.C

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Revision History

Version	Date	Description	Status
Rev.A	2025-04-11	Initial release	Released
Rev.B	2025-11-11	Optimized performance	Released
Rev.C	2026-03-16	Added temperature compensation notes	In Preview

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1 Product Overview



Figure 1-1Product Photo

The Corecloud WLVS5101 series wireless low-frequency vibration and tilt monitor is a wireless low-frequency monitoring instrument integrating triaxial vibration, triaxial tilt and temperature measurement, designed for structural health monitoring (SHM). One device replaces three separate sensors - a vibration sensor, a tilt sensor and a thermometer - greatly simplifying on-site installation and data integration, and is especially suitable for field structural monitoring scenarios with dense measurement points and difficult power supply and wiring.

The core uses a MEMS accelerometer to achieve a 0 Hz DC frequency response, with noise density as low as 45 μg/√Hz and triaxial synchronous acquisition at up to 1100 Hz; the built-in tilt engine has an accuracy of ±0.05° and temperature drift of 0.005°/℃; measuring range -50 ℃~+150 ℃, typical accuracy ±0.5 ℃. The sensor computes acceleration/velocity/displacement feature values and up to 4096-point FFT spectrum analysis, with internal memory storing 100,000 waveform points per axis, supporting event triggering and store-and-forward.

Communication uses 4G Cat.1 all-network + MQTT 3.1.1 protocol for direct connection to mainstream IoT platforms. Three-tier intelligent power management achieves up to 2 years of battery life, supporting vibration/timer dual wake-up. The IP68 fully sealed aluminum alloy housing with HBM 8 kV/15 kV ESD protection supports both bolt and steel cable tie mounting.

2 Key Features

2.1 Synchronized Triple Measurement

Vibration, tilt and temperature are integrated into a single device, reducing the number of on-site sensors and wiring complexity.

- **Triaxial low-frequency vibration:**±2.5 g range, 0 Hz~235 Hz bandwidth, noise 45 μg/√Hz, capturing weak structural vibration from static to low and mid frequencies
- **Triaxial tilt:**Static accuracy ±0.05°, temperature drift 0.005°/℃, suitable for quasi-static structural deformation monitoring
- **Wide-range temperature measurement:**-50 ℃~+150 ℃, 0.0625 ℃ resolution, ±0.5 ℃ accuracy, providing a temperature compensation reference for vibration and tilt

2.2 On-Sensor Edge Computing

All signal processing is completed on the sensor, which directly outputs engineering-ready physical quantities and reduces host computing power and bandwidth overhead.

- **Direct physical quantity output:**Acceleration (m/s²), velocity (mm/s), displacement (μm), no post-processing required
- **Multi-dimensional feature values:**Acceleration/velocity peak and RMS, frequency peak, instantaneous temperature, pushed automatically
- **4096-point FFT:**Multi-scale spectrum analysis for precise identification of structural natural frequencies and modes
- **Dual-mode push:**Feature values and waveform data are independently configured with separate intervals, balancing trend monitoring and in-depth diagnosis

2.3 Large-Capacity Storage and Store-and-Forward

100,000 waveform points cached locally per axis, ensuring transient event capture and offline data integrity.

- **Event-triggered recording:**Automatically captures the complete waveform before and after a trigger when vibration exceeds the threshold
- **Store-and-forward:**Locally buffers data during communication interruption and automatically retransmits after recovery, with zero data loss
- **Precise timestamping:**Precise alignment of multi-node data supports correlation analysis

2.4 Ultra-Low Power Consumption and Field Power Supply

The 7000 mAh lithium battery with three-tier power management achieves up to 2 years of autonomous operation, eliminating on-site power dependency.

- **Three-tier power consumption:**Standard mode ~350 h / Sleep mode ~950 h / Power-off + wake-up mode ~2 years
- **Dual wake-up:**Vibration-triggered immediate acquisition start and timer-based periodic health reporting
- **Dual-channel charging:**9~30 VDC wide voltage + USB 5 V, compatible with solar panels and other power supply schemes
- **Real-time battery status reporting:**MQTT pushes battery level and voltage, supporting proactive maintenance

2.5 Industrial-grade environmental adaptability

Fully sealed aluminum alloy structure, IP68 protection, wide operating temperature range, suitable for long-term harsh outdoor deployment.

- **IP68:**Fully sealed against dust and continuous immersion; the waterproof aviation connector retains its seal through repeated mating cycles
- **Aluminum alloy housing:**Excellent heat dissipation, corrosion resistance and UV resistance, with a designed service life exceeding 10 years
- **Wide temperature -20 ℃~60 ℃:**Extended-temperature component screening for all-climate use
- **Flexible mounting:**Φ7 bolt holes + steel cable tie slots, suitable for concrete, steel structures, pipes, etc.
- **Power interface:**Input undervoltage, overvoltage, overcurrent and reverse-polarity protection
- **communication interface:**30 kV ESD protection for both air discharge and contact discharge, with input overvoltage protection

2.6 Plug-and-Play System Integration

Zero-threshold USB flash-drive configuration and standard MQTT protocol for seamless integration with mainstream cloud platforms.

- **MQTT 3.1.1:**Direct connection to AWS IoT, Alibaba Cloud IoT, EMQX, etc., no custom development required
- **USB flash-drive configuration:**Plug-and-play recognition; edit a text file to set parameters, no driver or dedicated software required
- **4G Cat.1 global version:**CN/EU/NA/LA multi-region versions, optimizing both cost and power consumption
- **RS485 alarm interlocking:**Outputs a configurable alarm signal through the RS485 interface to interlock with external devices (cameras, sound-light alarms, PLCs, etc.), closing the monitoring-alarm-response loop
- **OTA upgrade:**MQTT remote firmware update, no on-site operation required

3 Applications

- **Geological hazard monitoring and early warning**
  Landslides and collapses are progressive hazards that manifest as slight tilt changes and low-frequency microseisms before failure. Monitoring points are typically located in remote mountainous areas without mains power or wired networks. The WLVS5101 ±0.05° tilt accuracy detects millimeter-level slope displacement, and the 0 Hz vibration response captures microseism precursors; 2-year battery life eliminates the power dependency, 4G direct cloud connection requires no gateway; the IP68 aluminum alloy housing withstands extreme mountain weather and strong UV radiation.
  Typical monitoring targets: expressway/railway slopes · open-pit mine waste dumps · tailings dams · reservoir banks · debris flow source areas · deep foundation pit support structures

- **Civil engineering structural health monitoring**
  Bridges, tunnels, high-rise buildings and dams require simultaneous monitoring of dynamic response (vibration) and quasi-static deformation (tilt/settlement). The WLVS5101 provides vibration + tilt dual-dimension data from a single device with temporal correlation, supporting modal analysis and damage identification. The 4096-point FFT precisely identifies structural natural frequencies. Large-capacity local storage ensures monitoring continuity during network interruption.
  Typical monitoring targets: bridge piers and bearings · tunnel linings · high-rise building wind-induced vibration · dam crest displacement · stadium trusses · historic buildings

- **Power transmission and distribution infrastructure monitoring**
  Transmission towers face multiple threats - wind vibration, conductor galloping, icing and foundation settlement - and are located in remote areas without power or networks. The WLVS5101's triaxial vibration captures wind-induced tower response, triaxial tilt detects foundation differential settlement, and temperature monitoring provides thermal expansion correlation data for conductor sag. Two-year battery life eliminates solar panels, and 4G direct connection avoids fiber deployment.
  Typical monitoring targets: HV/UHV transmission towers · distribution poles in unstable geological areas · substation gantries · wind farm collector line towers

- **Rail transit infrastructure monitoring**
  Track foundation degradation, bearing wear and lining deformation develop progressively over millions of load cycles and must be detected early. The WLVS5101's up to 1100 Hz sampling covers the key frequency bands of train-induced vibration; event triggering automatically records waveforms at each train passage without continuous streaming. Tilt monitoring tracks long-term track settlement and pier deflection. Battery power avoids cabling operating lines.
  Typical monitoring targets: metro tunnel segments · elevated bridge piers and bearings · track subgrade transition zones · railway turnouts · vibration impact assessment of adjacent construction

- **New energy facility structure monitoring**
  Wind turbine towers bear complex loads from wind thrust and wave action; tower tilt indicates foundation

integrity, and <1 Hz low-frequency vibration corresponds to the tower's natural frequency, a key parameter for resonance avoidance. The WLVS5101's 0 Hz response captures sub-Hz tower oscillation, ±0.05° tilt detects verticality changes caused by foundation settlement, and temperature monitoring distinguishes thermal expansion from structural deformation. MQTT integrates directly into SCADA systems.

Typical monitoring targets: onshore/offshore wind turbine towers · photovoltaic tracker bracket foundations · solar thermal heliostat foundations

- **Hydraulic and marine engineering structure monitoring**

  Hydraulic structures such as sluices, pumping stations, embankments and offshore platforms experience low-frequency vibration and tilt caused by flow pulsation, wave impact and water level changes. The WLVS5101 IP68 protection withstands continuous immersion, 0 Hz frequency response captures flow-induced structural vibration, ±0.05° tilt detects differential settlement and tilting trends. Battery power eliminates the safety risks and construction difficulty of wiring near water.

  Typical monitoring targets: sluice piers · pumping station housings · embankments/flood walls · offshore platform jackets · cross-sea bridge foundations

4 Specifications

Unless otherwise specified, all parameters are tested at room temperature (25 ℃).

Table 4-1 Specifications

Basic Parameters	Operating temperature range		-20℃~60℃
	Storage temperature range		-20 ℃~45 ℃ (short-term storage) (1) 15 ℃~35 ℃ (long-term storage)
	IP protection rating		IP68
	Dimensions		146 × 69 × 48.8 mm
	Weight		Approx. 600 g
	Housing material		Aluminum alloy
	ESD rating		HBM 8 kV contact discharge, 15 kV air discharge
	Applicable standards		GB/T 17799.2 / 4208 / 2423.1 / 2423.2
System power supply	Internal power supply		3.7V 7000 mAh ternary lithium battery
	External power supply	DC / USB	9~30VDC / 5VDC
	Charging power/time		5 W / typ. 8 h@5V1A
	Rated power	Off / Sleep / Running	50 μW / 30 mW / 85 mW (typ.)
	Operating time	Standard / Sleep / Power-off + Wake-up	approx. 350 h / approx. 950 h / approx. 2 years
Communication interface	Communication standard		4G Cat.1 all-network
	Communication speed		Typ. 50 KB/s (2)
	Communication protocol		MQTT 3.1.1
	RS485 alarm output	Configurable alarm signal	Interlocking with cameras, sound-light alarms, PLCs and other external devices
Configuration	Configuration interface		Waterproof USB aviation connector

	Configuration protocol	USB flash-drive file configuration
	Firmware update	Local USB flash-drive firmware upgrade / online OTA
System resources	Memory	512KB+8MB
	CPU	240 MHz, 800 CoreMark®
	Storage	100,000 waveform points per axis
Sensor Performance	Sensor type	MEMS accelerometer (digital output)
	Axes	X / Y / Z triaxial
	Range	±2.5g
	Resolution	0.076mg
	3 dB frequency response	0Hz~235Hz (3)
	Noise density	Typ. 45 μg/√Hz
	0-g / 1-g accuracy	±1mg
	Non-linearity	2% FS
	Temperature drift	0.075mg/℃
Signal processing	Sampling rate	1100 / 550 / 275 / 110 / 100 / 50 / 25 / 20 Hz
	FFT points	128 / 256 / 1024 / 2048 / 4096 points
	Feature value output	Acceleration/velocity peak and RMS, frequency peak, instantaneous temperature
	Waveform output	Acceleration/velocity time-domain and frequency-domain waveforms
	Velocity range	0~500mm/s
	Velocity resolution	0.02mm/s
	Velocity peak accuracy	±5mm/s (25Hz guaranteed above)
	Velocity RMS accuracy	±0.1mm/s (0.1Hz guaranteed above)
	Displacement range	0~50 mm
	Displacement resolution	0.02mm
	Displacement peak accuracy	±0.5mm (10Hz guaranteed above)
	Displacement peak-to-peak accuracy	±0.5mm (5Hz guaranteed above)
Tilt measurement	Axes	X / Y / Z triaxial
	Range	±90°
	Resolution	0.001°

	Static accuracy	±0.05° (4)
	Temperature drift	0.005°/℃ (5)
Temperature measurement	Range	-50℃~+150℃
	Resolution	0.0625℃
	Accuracy	-20℃~85 ℃: typ. ±0.5℃ -50℃~150 ℃: typ. ±0.75℃
	Thermal response time	≤100s (6)

⚠Precautions

(1) Short-term storage is less than 1 month.

(2) MQTT protocol, QoS2 service level, sending 1 MB of data, average of 100 runs.

(3) The upper 3 dB frequency response is limited by the configured sampling rate and is always below 0.5× the sampling rate.

(4) Aging and other factors within the operating range are considered at constant temperature.

(5) Maximum drift over the -20 ℃~60 ℃ temperature range.

(6) Time required at 25 ℃ room temperature for the sensor, placed in 85 ℃ silicone oil, to reach 63% of the final stable value.

⚠Velocity and displacement accuracy notes

Velocity peak accuracy ±5 mm/s (guaranteed above 25 Hz), velocity RMS accuracy ±0.1 mm/s (guaranteed above 0.1 Hz), displacement peak accuracy ±0.5 mm (guaranteed above 10 Hz), displacement peak-to-peak accuracy ±0.5 mm (guaranteed above 5 Hz). Below the above frequencies, MEMS non-linearity errors are amplified by 1/f and $1/f^2$integration, exceeding the guaranteed accuracy range; outputs may deviate from the true value and should be used for trending only, not for precise quantitative measurement.

5 Interface and LED



Figure 5-1Interface and LED Position

The device is equipped with two LEDs, one power key and two waterproof aviation connectors; the 4G antenna uses an SMA female connector.

Table 5-1 Interface and LED Definition

Interface name		Definition
Power key		Click to power on/wake, press and hold to power off
USB aviation connector	DP / DN	USB signals
	VBUS / GND	5 VDC power supply
RS485 aviation connector	A / B	RS485 signals
	VDC / GND	9~30 VDC power supply
Status LED		Green blinking (normal)/ Red blinking (server not connected)
Power LED		Red solid (charging)/ green solid (fully charged)
4G antenna		SMA female connector

6 Mechanical Dimensions

Outline dimensions: 146 × 69 × 48.8 mm. Bottom Φ7 × 4 mounting holes (7 mm diameter, compatible with common M6 expansion anchors) and steel cable tie slots, supporting bolt fastening and binding on irregular surfaces.

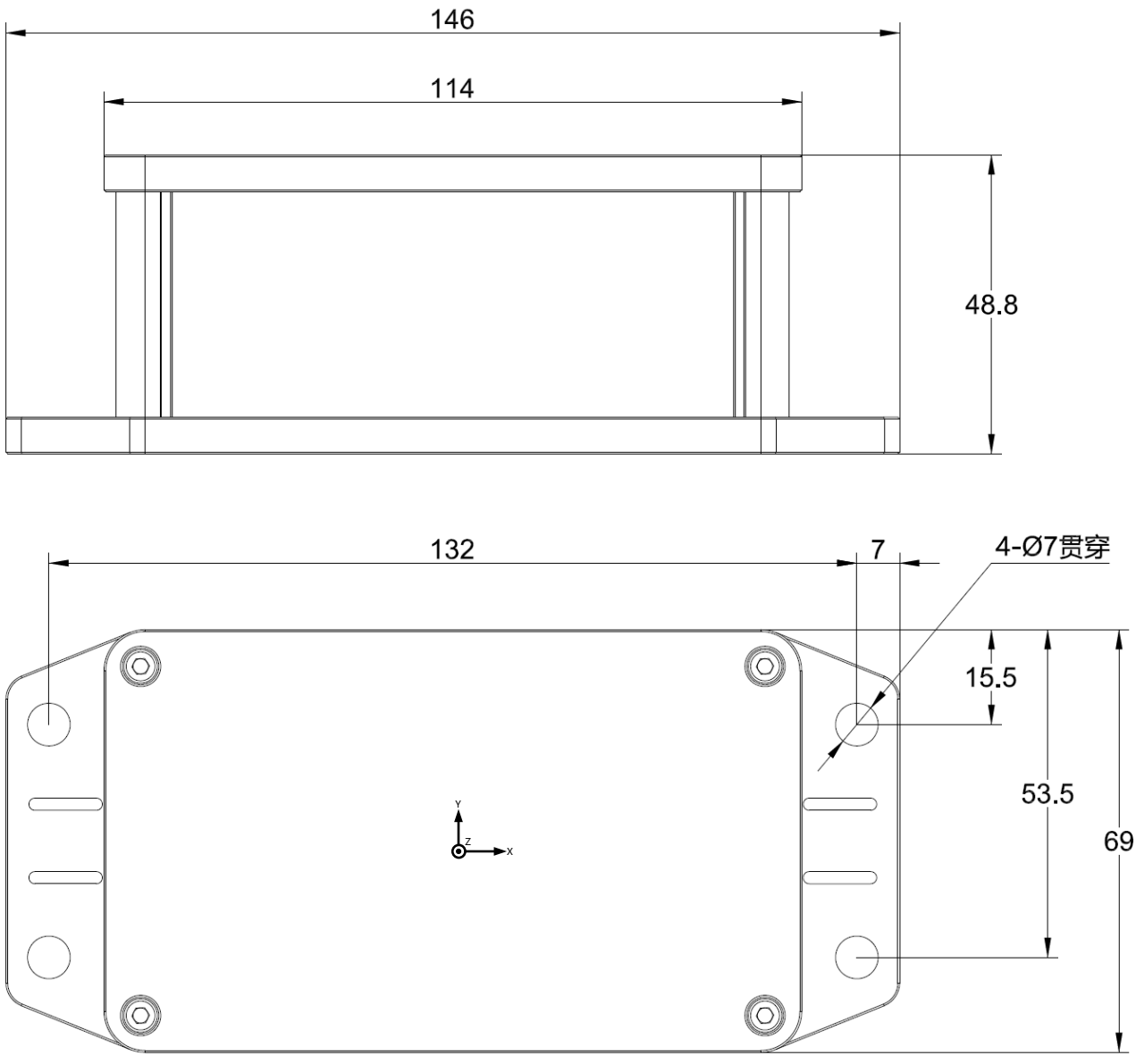
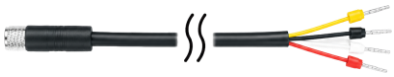


Figure 6-1Mechanical Dimensions (unit: mm)

7 Accessories and Mounting

Table 7-1 Accessories and Mounting

Name	Specification	Image	Description
Aviation connector	M5 4-pin female to terminal block Wire color code: yellow (9-30VDC), white (GND), red (RS485-A), black (RS485-B)		Standard, RS485 and power connection
L-shaped bracket	Material: 201 stainless steel Thickness: 4 mm Mounting holes: Φ7×4		Optional, vertical mounting bracket

8 Installation Notes

- Clean the mounting surface; fill rough surfaces with thermal grease to ensure tight contact.
- Align the sensor X/Y axes with the principal directions of the structure, keep the tilt measurement surface parallel to the measured surface, and calibrate the zero point after installation.
- Φ7 mounting holes compatible with M6 expansion anchors; tightening torque 3~5 N·m.
- Keep the 4G antenna vertical and away from metal obstructions; use a high-gain antenna in weak-signal areas.
- Tighten the locking nut of the aviation connector; for long-term outdoor use, add waterproof tape at the cable root as secondary protection.

9 Precautions

- Impact during use is prohibited.
- Long-term storage above 105 ℃ environment, otherwise sensor accuracy will be seriously degraded.
- Do not insert sharp objects into the silicone parts, to prevent damage to the IP68 protection and product reliability.
- Excessive torque during installation is prohibited to prevent thread damage.
- The device contains a lithium battery; do not throw it into fire or short-circuit the battery contacts, and recycle the battery according to local regulations when discarded.
- For long-term storage (over 3 months), charge the battery to 50%~60% and store it in a dry 15 ℃~25 ℃ environment, recharging every 6 months.

10 Ordering Information

Model code: WLVS5101-[Bandwidth]-[Region]
Bandwidth: 235T = 235 Hz triaxial
Region: EU/NA/LA

Table 10-1 Ordering Information Overview

Name	Model	Specification
Wireless low-frequency vibration and tilt monitor	WLVS5101-235T-EU	235 Hz bandwidth, Europe version 4G
Wireless low-frequency vibration and tilt monitor	WLVS5101-235T-NA	235 Hz bandwidth, North America version 4G
Wireless low-frequency vibration and tilt monitor	WLVS5101-235T-LA	235 Hz bandwidth, Latin America version 4G