ZiFiSense
纵行科技

User Manual

ZETA Edge-AI Vibration Sensor（Raw Data）User Manual

ZAIoT-VTC10



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1 Introduction



The ZETA Wireless Vibration Raw Data Collection Sensor ZAIoT-VTC10 (hereinafter called VTC10) is specially designed for industrial machine condition monitoring in plants by measuring both vibration and temperature data. VTC10 is a compact device, composed of a MEMS acceleration sensor, a temperature sensor, data collector, MCU, radio and battery, which is approved for use in hazardous areas requiring IECEx Zone 0 certification. VTC10 provides balance-of-plant or host equipment monitor, wirelessly transmitting both static and dynamic data to the SaaS Platform (ZETA Server, ZETA AIoT Facility Management Platform) or customer's existing process monitoring and control systems.

VTC10 uses the ZETA-H communication protocol, offering a simple, reliable and secure means of expanding condition-based maintenance into plant areas where the cost to install wired systems is prohibitive, making data available to existing process control and information systems. With the benefits of ZETA communication, ZETA Mote can be set as router nodes, which can easily wireless blind area, allowing sensors in insufficient radio reception to relay data normally.

2 Benefits

Compact sensor with small physical footprint

Reduced installation costs – no wires or cables

Certified for hazardous areas

Quick and scalable deployment

Cost effectively monitor large plant areas

3 Sensor features

Certified to IECEx Zone 0

Overall and dynamic vibration data

Velocity RMS for detecting faults such as imbalance, misalignment, and looseness

Acceleration RMS for detecting bearing and other impact type faults

Periodic measurements

Up to 2 year battery life

Low power consumption radio operating on ZETA-H protocol

4 Specifications

Data acquisition

Static data: Triaxial axis vibration velocity RMS and acceleration RMS

Dynamic data: Triaxial time waveforms of N samples by sampling rate of fs, N is 2.56 times FFT lines of resolution(LOR), LOR can be set as follow:

LOR:	800	1600	3200	6400(default)	12800
N:	2048	4096	8192	16384	32768

Fs is about 26667Hz

Temperature

Data acquisition modes:

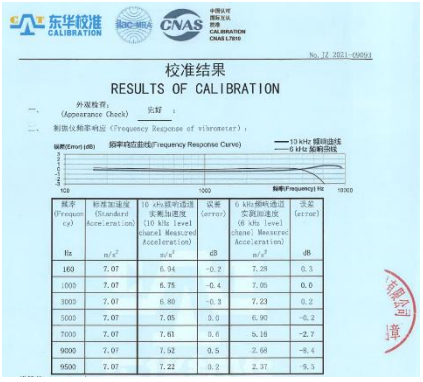
– Polling (triggered over radio)

– Bursting (programmable interval)

Measurements

Temperature:

Range: –40 to +125 °C



Accuracy: ±2 °C

Vibration:

Frequency range: 1 Hz to 5 kHz, ±3dB

Amplitude range: ±16g

Accuracy at 20° C (see Fig):

Wireless Communications

ZETA LPWA protocol H

Frequency: 920MHz-925MHz

Firmware update via ZETA Network (OTA)

Range: 700m(line of sight), 300-500m typically in plant (actual range depends on specific site topology and device placement)

Certifications

Radio:

FCC: Part 15 Subpart C IDENTIFIER:2BMWA-ZAIOTVTC10

CE: RED 2014/53/EU IDENTIFIER:DL-20210311003C

Hazardous area certification

IECEx Zone 0

– II 1G Ex ia IIC T4 −40 °C≤Ta≤60 °C

Physical

Dimensions : (see Fig. below)

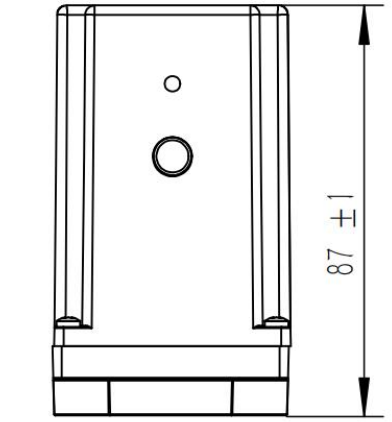
Weight: 240 g

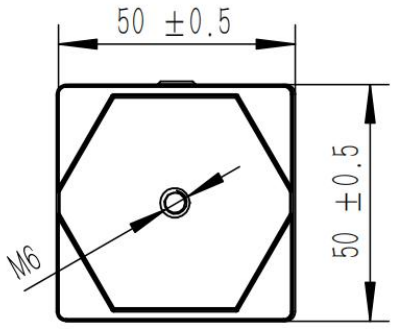
Case material:

– Base: Stainless steel

– Cover: Thermoplastic

Sealing: IP 66





Environmental

Operating temperature: −30 to +80°C

Storage temperature: -40 to +85°C

Power

Internal 3.6 V primary lithium-thionyl chloride (Li-SOCl2) bobbin cell, type: ER26500

Up to 2 year battery life, depending on settings, usage and operating temperature.

Estimated battery life at different operating temperatures and dynamic data (a single set of time waveforms) upload intervals, at default sensor configuration (see notes 1 and 2):

Dynamic data Upload interval / Operating temperature	4h	6h	12h	24h
-30℃~-20℃	2	2.5	3	3
-20℃~0℃	2	2	2.5	3
0-℃~40℃	2.5	3	3.5	4
40℃~70℃	2	2	2.5	3

Note 1: The unit of the table is "year":

Note 1: Default sensor configuration of VTC10 is:

Temperature measurement every 1 hour.

Vibration measurement overall data (velocity RMS and acceleration RMS) every 1 hour, and raw data every 6 hours. The default sampling rate is 26667Hz (16384 samples).

Note 2: Continuous operation in the +70°C to +85°C (+158°F to +185°F) temperature range is not recommended as it will dramatically shorten battery life.

5 Applications

The low deployment costs make this wireless solution ideal for:

5.2 Expanding walk-around routes

Collect data automatically and more frequently from plant areas where it is uneconomic, impractical, or unsafe to retrieve data manually.

5.3 Troubleshooting

Install the sensor on valuable or suspect equipment to track failing components closely.

5.4 Difficult to reach areas

Collect basic vibration data in locations that are difficult to monitor with fixed wired systems or hand-held devices.

6 A complete system

The ZETA Wireless Machine Condition Sensor is designed for use in a system consisting of the following components:

- ZETA Wireless Machine Condition Sensors

- ZETA-H Gateway and Mote

- ZETA Server Platform, for wireless device (gateway, relay and sensor) management

- ZETA AIoT Facility Management Platform, for sensor and monitored machine management

ZETA mesh network is a robust and secure wireless system, which navigates around obstacles, is formed automatically. The ZETA Gateway continuously analyzes and optimizes the network to implement the most efficient paths and balance load across alternative paths.

For its entire life, the radio of the VTC10 remains on. This allows it to communicate with other ZETA field devices at all times. Key advantages of using the ZETA communication protocol are:

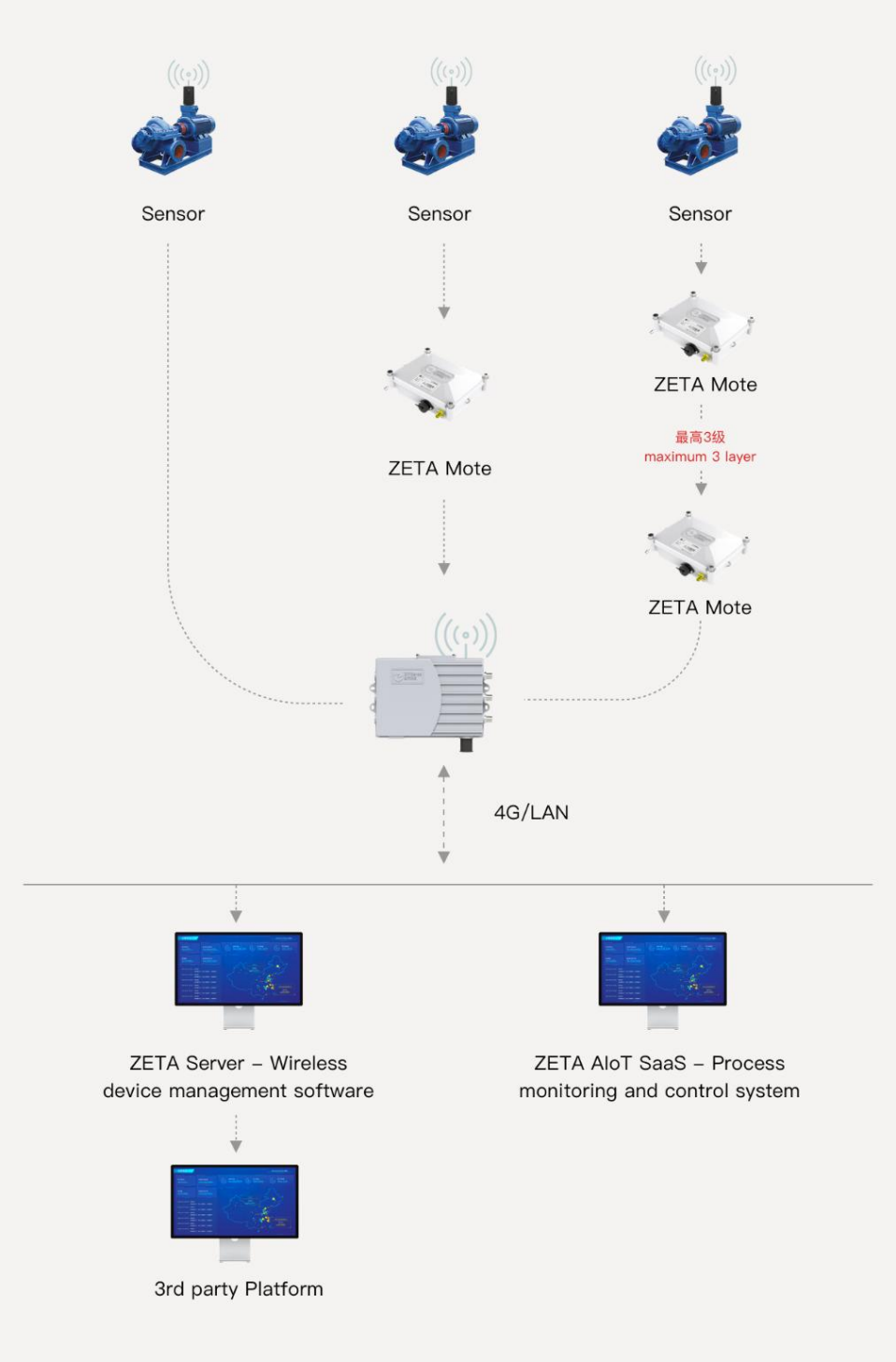
• **Flexibility -** Even in complex plant situations, thanks to MESH Access, the network can be easily extended to dead zones with ZETA Mote.

• **Reliability –** The ZETA-H protocol is designed to ensure data reliability as the first priority. Even if the network connection is lost or the transmission is interrupted, the sensor will save the data to RAM and send it again after connecting to the network to ensure that the data will not be lost.

• **Security and Privacy –** network communications are secured through industry-standard practices of authentication, encryption and verification to

ensure the highest level of security.

• **Effective power management –** making low power consumption and long battery life possible.



ZETA enables users to quickly and easily gain the benefits of wireless technology while maintaining compatibility with existing devices and tools. An added benefit is that overall vibration and temperature data collected with the VTC10 is available to customer's existing process monitoring and control systems.

6.2 ZETA Gateway

ZETA AP (Gateway) is the ZETA network element which receive data from VTC10 and other ZETA sensors, and uplink data to the ZETA network management platform. According to different usage scenarios, costs, and performance requirements, multiple APs are available to choose.

Name		ZETA AP (Outdoor)		ZETA AP (Explosion-proof)	
Model		APZT-GO01	APZT-GO02	APZT-IN01-Ex	APZT-IN02-Ex
	Protocol	ZETA-P, ZETA-S			



APZT-GO01/02



APZT-IN01/02-Ex

Wireless	Frequency	470~510Mhz 920-925Mhz			
	Tx Power	Sub-GHz, adjustable according to local regulations			
	Rx sensitivity	-130dBm±3dBm(@300bps)			
	Channel	Single	3-channel	Single	3-channel
	Antenna	0.4m Fiberglass Antenna (902~928Mhz)			
	Typical coverage	1,000,000 ㎡ industrial field			
	Upload	4G/Ethernet			

feature				
Electrical feature	Power supply	POE / AC100-240V to DC 5V		
	Maximum standby power	⩽5w		
Physical feature	Weight	1.5kg		41.5kg
	Size	256*200*86mm		395mm*350mm*230mm
	Material	Aluminum alloy		316L Stainless steel
	IP level	IP66		IP67
	IECEx	-	-	Ex dB IIB T6 Gb/Ex tb IIIC T85℃
Operate temp		-20℃~75℃		
Storage temp		-30℃~85℃		

***Wireless reference:** The line-of-sight transmission distance is 500-700m, and the typical factory environment covers about 100m-300m. The specific coverage performance is related to many factors such as the wireless environment, terminal transmit power, and antenna type. The exact value needs to be measured according to the scene.*

6.3 ZETA Mote

In order to solve the problems of fragmentation of LPWAN and reduce the cost of blind area coverage, ZETA-P/ZETA-S protocol design includes intelligent routing, adopts low-power MESH design, battery-powered, plug-and-play, convenient installation, and supports multi-hop networking , OTA, etc.



Product name		ZETA Mote
Model		MTZT-IN01
Wireless feature	Protocol	ZETA-P, ZETA-S
	Frequency	902-928Mhz
	Tx power	Sub-GHz, adjustable according to local regulations
	Channel	Single
	Antenna	0.4m Fiberglass Antenna (902~928Mhz)
	Typical	250,000 ㎡ industrial field

	coverage	
Electrical feature	Power supply	Battery，2*ER34615/DC 5-12V
	Current	⩽70mA
	Stand by Current	⩽5μA
	Life-time	3 years
Physical feature	Weight	0.6kg
	Size	148.5*113.5*43.9mm
	Material	ADC12 Aluminum alloy
	IP level	IP66
	IECEx	Ex ia IIC T4 Ga
Operate Temp		-20℃~75℃
Storage Temp		-30℃~85℃

**Wireless reference:* *the specific coverage performance is related to many factors such as wireless environment, terminal transmit power, antenna type, etc. The exact value needs to be measured according to the scene.*

**Different temperatures will cause different battery performance, and the battery performance will drop sharply below 0°C or higher than 70℃.*

6.4 ZETA Server Platform

The IoT PaSS platform for unified network management provides remote network device management functions according to the characteristics of the ZETA network, which greatly reduces project maintenance costs, and can diagnose most ZETA network anomalies without going to the site. It provides standard API interfaces including MQTT push and HTTP query interfaces. Users can choose to access the cloud platform or support independent deployment, and meet customer data physical isolation requirements.

6.5 ZETA AIoT Facility Management Platform

Unify the management platform of industrial facilities and equipment, obtain data through the ZETA Server API interface, and manage equipment for different formats. At the same time, it supports analysis of vibration and temperature sensor data, timely reminders of alarms, and display of historical data charts. Users can choose to access the cloud platform or support independent deployment, and meet customer data physical isolation requirements.

7 Mounting considerations

The ZETA Wireless Machine Condition Sensor is preferably stud mounted on the measurement location for best mechanical coupling and frequency response, alternatively can be adhesively or magnetically mounted. If stud mounted, use of a thread adhesive is recommended as well as the use of a coupling fluid between the mating surfaces as this optimizes frequency response by further increasing the stiffness of the coupling. When installed in a hazardous area, the sensor must be mounted in such a way that it is grounded to the machine, which can be achieved with either stud, adhesive or magnet mount.

Required spanner size for sensor mounting: 33.3 mm

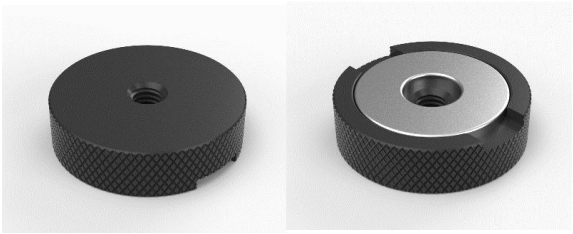
Internal M6 thread

7.2 Optional accessories for adhesive mounting

Instead of adhesively mounting the ZETA Wireless Machine Condition Sensor directly onto the machine, you can use mounting pads. The mounting pads are adhesively mounted or welding mounted onto the machine and the ZETA Wireless Machine Condition Sensor is torqued with a mounting stud onto the mounting pad, thereby allowing for easy replacement.



Weld Mount



Magnet Mount

**Note: The thickness of the mount may affect the accuracy of the sensor temperature measurement.*

8 No Surprises

For early detection of abnormal machine conditions, and analysis of detected problems, ZETA AIoT Facility Management Server platform provides fast, efficient and reliable storage, analysis and reporting on overall and dynamic machine vibration data (FFT and time waveform) collected with the ZETA

Wireless Machine Condition Sensor. A wide range of customizable reports can be automatically scheduled, making your machine data accessible throughout your organization. Overall machine data can also be integrated into existing plant control systems and asset monitors.

9 Order Information

	Vibration Sensor (Basic)	Edge-AI Vibration Sensor (Pro)	ZETA Edge-AI Vibration Sensor
Model	ZAIoT-VTD10	ZAIoT-VTD01	ZAIoT-VTC10
Frequency Range	3-axis 5-5.0k Hz（±3dB）	1-axis 1-10k Hz（±3dB）	Primary axis: 1-10k Hz (±3dB) Secondary axis: 1-6kHz (±3dB)
Sampling frequency	12.8kHz	25.6kHz	Primary: 25.6kHz (adjustable) Secondary: 26.6kHz
Measurement range	±16g	±100g	Primary: ±100g Secondary: ±16g
Operate Temp	-30~75℃		
IP Level	IP67、IECEx		
Installation	Magnetic adsorption/glue/thread M6		
Size	50*50*87mm		
Weight	<250g (with battery)		
Battery	9000mAh (Replaceable)		
Life-time	>2 year		
Edge-AI	Yes	Yes	No

10 Why ZETA

10.1 Edge-AI: Smart alarm and AI diagnosis with better accuracy

Standards such as ISO can only roughly classify equipment into limited categories (such as 4 categories) based on parameters such as the model and power of the equipment, and then each category is given several critical values that reflect the health status of the equipment. However, in actual scenarios, the types, functions, loads, environments, installation methods and installation locations of vibration sensors vary widely. Using a limited threshold to judge the health status of many devices is not accurate and reliable enough, which cannot be timely and efficiently find out equipment failure alarm and execute predictive maintenance.

The AI algorithm adopted by the ZETA vibration sensor does not depend on the data that needs to be manually marked, so that the sensor can realize data processing and analysis on the sensor side, and allow the device to achieve self-supervision and fault diagnosis (as shown in the following table).

Content		Function Available
User-defined threshold		√
AI self-learning alarm		√
Diagnosis (Mechanism)	Misalignment	√
	Unbalance	√
	Loosen	√
	Poor lubrication	√
	Bearing fault	√
	Gear fault	√
Equipment Shutdown		√

10.2 ZETA Edge-AI Design: Data Driven + Device Mechanism

Device mechanism: It has carried out strategic cooperation with Shanghai Jiaotong University, Tongji University and other colleges and universities to conduct in-depth research on equipment operation and failure mechanism to reduce dependence on data, and has accumulated a large amount of data through simulation and experimental testing, and established more than ten kinds of failures. Model. Common fault types of automatic diagnosis equipment include unbalance, misalignment, loose installation, bearing fault, gear fault, poor lubrication, etc.

Data-driven: use probability and statistics methods, unsupervised algorithms (such as GMM), time series analysis algorithms (such as ARMA, LSTM), anomaly detection algorithms (isolated forest) and other algorithms that do not depend on data that need to be manually labeled to further realize data The intelligence of accumulation and analysis greatly reduces the dependence on manual labor, allowing equipment to realize self-supervision and diagnosis.

Through the effective combination of traditional experience knowledge (device mechanism) and big data AI algorithm (data-driven), on the basis of 0 requirements for the relevant professional quality of operation and maintenance personnel, the ZETA-side intelligent vibration temperature sensor realizes the intelligent monitoring of equipment, and the abnormality is timely. Alarms, automatic fault diagnosis, create large-scale general-purpose rotating machinery equipment AIoT upgrade solutions for customers, and help industrial equipment digital and intelligent management.

10.3 ZETA Alliance: Strong support of technology and products

As the world's first LPWAN (Low Power Wide Area Network) communication standard that supports distributed networking, ZETA uses the ultra-narrowband technology with Advanced M-FSK debugging and demodulation, combined with the ZETA standard protocol stack, with "low power consumption, universal connectivity" , low cost, wide coverage, strong security" and other advantages. Committed to helping customers build a safe, reliable and high-performance industrial wireless private network, and solve the bottleneck of industrial non-real-time data wireless transmission. In addition, with ZETA technology as the core and relying on the ZETA China-Japan alliance, ZiFiSense Technology has established a complete ecological chain from underlying technology to chips, network products, intelligent terminals, and application scenarios, with the high scalability of Industry 4.0.



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This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

Any Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

Note: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

-Reorient or relocate the receiving antenna.

-Increase the separation between the equipment and receiver.

-Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.

-Consult the dealer or an experienced radio/TV technician for help.

FCC Radiation Exposure statement

The device has been evaluatec to meel general RF exposure requirement. The device can be used in portable exposure condition without restriction.