WISEPOWER

WS-SHM

Multi-sensor monitoring system
for structural health

Datasheet

Energy Harvesting Technology

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WISENSING GENERAL DESCRIPTION

The WiseSensing sensor nodes provide a reliable, easy-to-mount and cost effective solution, which is designed for dynamic and static structural health monitoring of large structures. They measure:

- 3-axes accelerations
- polar angles inclinations, with a sensitivity of 0.02°;
- temperature, with a sensitivity of 0.5°C.

Two versions are available, one with and one without GPS synchronisation.
Data communication can be performed by exploiting:

- Zigbee (gateway needed)
- LoRa
- Cellular (4G-LTE, NB-IOT, 3G)
- WiFi (coming soon, access point needed)

The data are then set to a remote server, to be available for analysis.

The main WiseSensing operation's parameters are reconfigurable from remote, such as:

- the range of measure and ODR for the accelerometer data acquisition;
- the axis/axes to acquire;
- the number of samples to acquire;
- the frequency of measurements during the day;
- the threshold and range for the shock accelerometer.
- The threshold for shock triggering a further acquisition
- The number of datapoints and the ODR for this acquisition.

WiseSensing operation does not rely on any battery replacement, being powered by solar and vibrational energy.

WiseSensing is IP67, ROHS 3 and UV-rays resistant, so it is suitable to be installed outside without any additional protection.

WISENSENSING APPLICATION CASES

WiseSensing is designed in order to enable Structural Health Monitoring for large structures.
Its usage is recommended (but it is not limited) for monitoring:

- bridges, viaducts;
- aerial pipelines;
- wind turbines, and in particular wind blades;
- telecommunications antennas' poles;
- power grid poles.
- Hystorically / artistically valuable or civilbuildings

In each of these cases, WiseSensing installation is easy and fast, and can be done either by screw-mounting (optionally exploiting a specifically designed mounting-plate, that guarantees flatness and stability over rough sourfaces), or simply by gluing the sensor to the structure.
Based on the communication protocol, the installation of a Gateway can be needed to transfer the data on a dedicated server: the Gateway can be self- or externally powered.

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TECHNICAL SPECIFICATIONS

Product reference	
WiseSensing -PWR-COM-MO	
PWR- power supply technology	COM- Communication WiFi technology
VibPV: Non linear vibrational energy harvester transducer + Integrated solar panel (1W) + Li-Ion rechargeable battery (2.6Ah)	ZB : ZigBee radio LR : LoRa radio
PV: Integrated solar panel (1W) + Li-Ion rechargeable battery (2.6Ah)	CELL : 4G/LTE- 3G-NB-IOT
48V: external power supply of 48 Volts input.	WIFI: 802.11/b/g/n, TCP/IP
MO - Mounting Option SM - Screw Mounting Lid SMO - Screw Mounting Lid Orthogonal	
Example n°1: WiseSensing-VibPV-ZB-SM, WiseSensing with vibrational harvester PV cell andrechargeable battery, ZigBee wifi module and screw mounting lid option Example n°2: WiseSensing-PV-LR-SMO, WiseSensing with PV cell and rechargeable battery, LoRawifi module and screw mounting lid option	

Environmental and Mechanical Features	
Casing	Waterproof casing
	Dimensions in mm (LxWxH): 120x120x50 mm Weight in grams : 500 g
IP Rating	IP67
Operating Temperature	-30 °C to +75 °C
Norms & Radio Certifications	CE Labelling Directive
	FCC/IC (North America)
	ETSI (Europe)
	ROHS - Directive 2002/95/EC

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Sensors specification	
Accelerometer for SHM	
Accelerometer Technology	Low power MEMS technology
Scalable measurement range	±2g / ±4g/ ±8g
Measurement resolution	3.9 µg/digit @±2g , 7.8 µg/digit @±4g , 15.6 µg/digit @±8g
Typical non-linearity	±0.1% FS
Sensitivity change Vs temperature	±0.01%/°C (-40°C to +125°C)
Zero-g level change vs temperature	±0.02 mg/°C (-40°C to +125°C)
Typical zero-g level offset accuracy	±25 mg
Noise spectral density @ BW 500Hz	25 µg/√Hz
Accelerometer for Shock	
Accelerometer Technology	Low power MEMS technology
Scalable measurement range	±2g / ±4g/ ±8g
Measurement resolution	1 mg/digit @±2g, 2 mg/digit @±4g, 4 mg/digit @±8g
Typical non-linearity	±0.5% FS
Sensitivity change Vs temperature	±0.05%/°C (-40°C to +85°C)
Zero-g level change vs temperature	±0.5 mg/°C (-40°C to +85°C)
Typical zero-g level offset accuracy	±50 mg (Z axis) ±35 mg (X, Y axes)
Noise spectral density @ BW 100Hz	920 µg/√Hz
Temperature	
Measurement range	from -40°C to +125°C
Accuracy	±0.5°C

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RF Specifications	
ZigBee©	
Wireless Protocol Stack	ZigBee©
WSN Topology	Star
Data rate	250 Kbits/s
RF Characteristics	ISM 2.4GHz
TX Power	+8 dBm
Receiver Sensitivity	-103 dBm
Maximum Radio Range	600m (Line of Sight) , 40m (Non Line of Sight)
LoRa™	
Wireless Protocol Stack	LoRa® Technology modulation
Data rate	10937 bps
RF Characteristics	863.000 MHz to 870.000 MHz
TX Power	+14 dBm
Receiver Sensitivity	-146 dBm
Maximum Radio Range	10 km (Line of Sight), 3km (Non Line of Sight)
Cellular	
Carrier and Technology	4G LTE CAT-M1/NB-IoT
Supported Bands	FDD-LTE B1/B3/B5/B8/B20/B28
Wi - Fi	
Wireless Protocols Stack	IEEE 802.11b/g/n, TCP/IP
Data Rate	From 11 to 54 Mbps
RF Characteristics	From 2.412 to 2.484 GHz

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TX Power	From 16 to13 dBm
Receiver Sensitivity	From -90 dBm to -67dBm
RF Options	
Gateway ZigBee©	XGI-20CZ7-E00-W0 [WiFi + ETH0] XGI-20CZ7-EU7-W0 [WiFi + ETH0 + Cellular]

GPS (optional)	
Acquisition time	· <1s (hot start, Outdoor) · <30s (hot start, Indoor) · <15s (max 32s) Open sky, cold start
Protocol Support	NMEA 0183 (GGA, GLL, GSA, GSV, RMC, VTG)
Sync Time Accuracy	· <100ns (Typical) · <800ns (Max)
	· 1ms (not synced)

Over-the-air configuration (OTAC) parameters	
ODR SHM Accelerometer	from 31.25 Hz up to 500 Hz
Acquisition interval	from every hour up to every 8 hours
Samples to acquire	from 1024 up to 32768
Data transmission	1 axis, 2axes or 3 axes
Shock detection threshold	from 1.1g up to 8g
Post-shock acquisition threshold	from 1.1g up to 8g
Samples for post-shock acquisition	from 1024 up to 32768
ODR for post-shock acquisition	from 31.25 Hz up to 500 Hz

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Current consumption @ 3 V	
During data acquisition	from 3mA up to 5mA
During ZigBee© TX	30mA @ 8dBm
During ZigBee© RX	10mA
During LoRa™ TX	45 mA @14dbm
During LoRa™ RX	10mA
During Cellular TX	134 mA @23dBm
During Cellular RX/Listening	18mA @3.3V
During sleep mode (shock ON)	7□A

Power supply	
Energy havesting	High precision voltage and current monitor of PV and Vibrational harvester
Environmental battery charger	Integrated Lithium-ion battery solar and vibrational battery charger with high precision battery monitoring: · Overvoltage Protection, Overcurrent/Short-Circuit Protection, Undervoltage Protection · Battery Temperature monitoring

3rd party components	
Zigbee Communication	Industrial Gateway Digi (or equivalent) 4G/Ethernet Connection + power supply
WiFi Communication	· Router 4G + power supply · WiFi Repeater for wide ranges
Self-powering kits for gateways	· Pole mounting kit for 80W solar panel (at least) · Waterproof cabinet · Rechargeable battery · Solar charge regulator · Power supply converter

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INCLINOMETER TEST

A test was performed, mounting the sensor on a micrometric screw with minimum stepof 0.02°. The progressive inclination measured by theaccelerometer was calculated, in degrees,by applying the following geometrical rulesto the RMS accelerations on the three measurement axes:

The results, when changing the inclination progressively with steps of 0.02° θ , areillustrated in Table 1 for the measured and acquiring 1024 samples with ODR = 500Hz,and when changing the inclination ϕ under the same conditions, in Table 2.

After repeating the test with 32768 samples, the sensitivity over the inclination angle was demonstrated to lower to 0.001 deg.

This is due to the fact that a single measure of rms acceleration on one axis is given by computing the rms of the samples in one measurement for the same axis, and therefore the precision of a single rms measurement increases by increasing thenumber of samples.

Experimental Inclination θ	Measured	Experimental inclination ϕ	Measured
0.02° ± 0.005°	0.023° ± 0.003°	0.000 ° ± 0.005°	0.0027 ± 0.0015°
0.04 ± 0.005°	0.040 ± 0.003°	0.000 ° ± 0.005°	0.0017 ± 0.0015°
0.06 ± 0.005°	0.064 ± 0.003°	0.000 ° ± 0.005°	0.0005 ± 0.0015°
0.08 ± 0.005°	0.085 ± 0.003°	0.000 ° ± 0.005°	0.0016 ± 0.0015°

Table 1: Sensitivity test for inclinometer. 1024 samples with ODR = 500Hz. Inclination θ

Experimental Inclination θ	Measured	Experimental inclination ϕ	Measured
0.000° ± 0.005°	-0.003° ± 0.003°	0.060° ± 0.005°	0.063 ± 0.002°
0.000 ± 0.005°	-0.002 ± 0.003°	0.080° ± 0.005°	0.084 ± 0.002°
0.000 ± 0.005°	-0.001 ± 0.003°	0.10 ° ± 0.005°	0.107 ± 0.002°
0.000 ± 0.005°	-0.007 ± 0.003°	0.12 ° ± 0.005°	0.129 ± 0.002°

Table 1: Sensitivity test for inclinometer. 1024 samples with ODR = 500Hz. Inclination ϕ

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Optionally, and under a careful evaluation from Wisepower's technical team, customisation of theproduct can be discussed.

For any additional information, please contact us at info@wisepower.it or call the number +39 075 584 7210.

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