WISENMESHNET® Omni Tilt & Compass Sensor Node User Manual

Wuxi Wisen Innovation Co., Ltd.

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Revision History and Clarification

Rev.	Issue Date	Revisions	Written By	Revised By
V1.0	01/01/2020	1st Issue	Xiaoyan Huang	Dr. Yan Wu

Document Definition:

It defines the specifications (i.e., introduction, technical features, deployment and maintenance methods) of the WISENMESHNET® Omni Tilt & Compass Sensor Node, which is one of the key components in WISENMESHNET® Low Power, Intelligent, Wireless Sensor Network (WSN) system. It is responsible to:

- Sample data from its internal tilt angle detection sensor and geomagnetic sensor;
- Form a time-synchronized Wireless Sensor Network (WSN) with others nodes in the system;
- Transmit the data packet to a gateway.

Scope：

Customer Site Project Managers and Engineers, Wisen Service Engineers, etc.

Table of Contents

1. Product Introduction

The WISENMESHNET® Omni Tilt & Compass Sensor Node is one of the key products in our patented WISENMESHNET® geotechnical safety monitoring system. Working together with the WISENMESHNET® gateway product and node products, it intelligently delivers the real-time pitch, roll and yaw deformation of a structure to the information centre.

The WISENMESHNET® Omni Tilt & Compass Sensor Node operates using our core technology, i.e., the WISENMESHNET® Low Power, Intelligent, Wireless Sensor Network protocol, together with its internal high precision MEMS Omni tilt sensing module and power unit. This product satisfies the three fundamental identities of the system:

A. Network Life Span: to maximise battery life across the mesh network as a whole;

B. Network Data Arrival Rate: to minimise data packet loss;

C. Single Node Environmental Coverage: to maximise radio coverage.

Our product has IP66 and is designed to work in a tough environment. It is small in size, reliable in performance, easy for maintenance, has high precision during sampling, and has strong immunity to radio-interference.

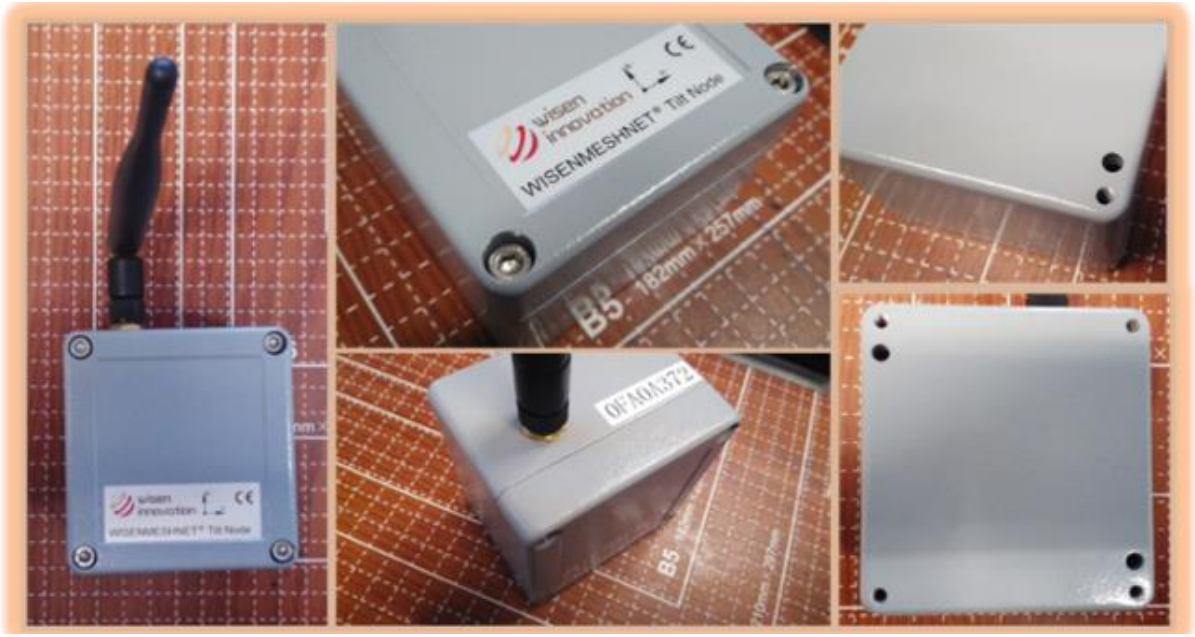


Figure 1. Omni Tilt & Compass Sensor Node Overview in Photos.

WISENMESHNET® Omni Tilt & Compass Sensor Node is often installed in none-magnetisable structure for long term Euler angles (Yaw, Pitch and Roll) monitoring, such as Tree monitoring.

2. System Structure Layout

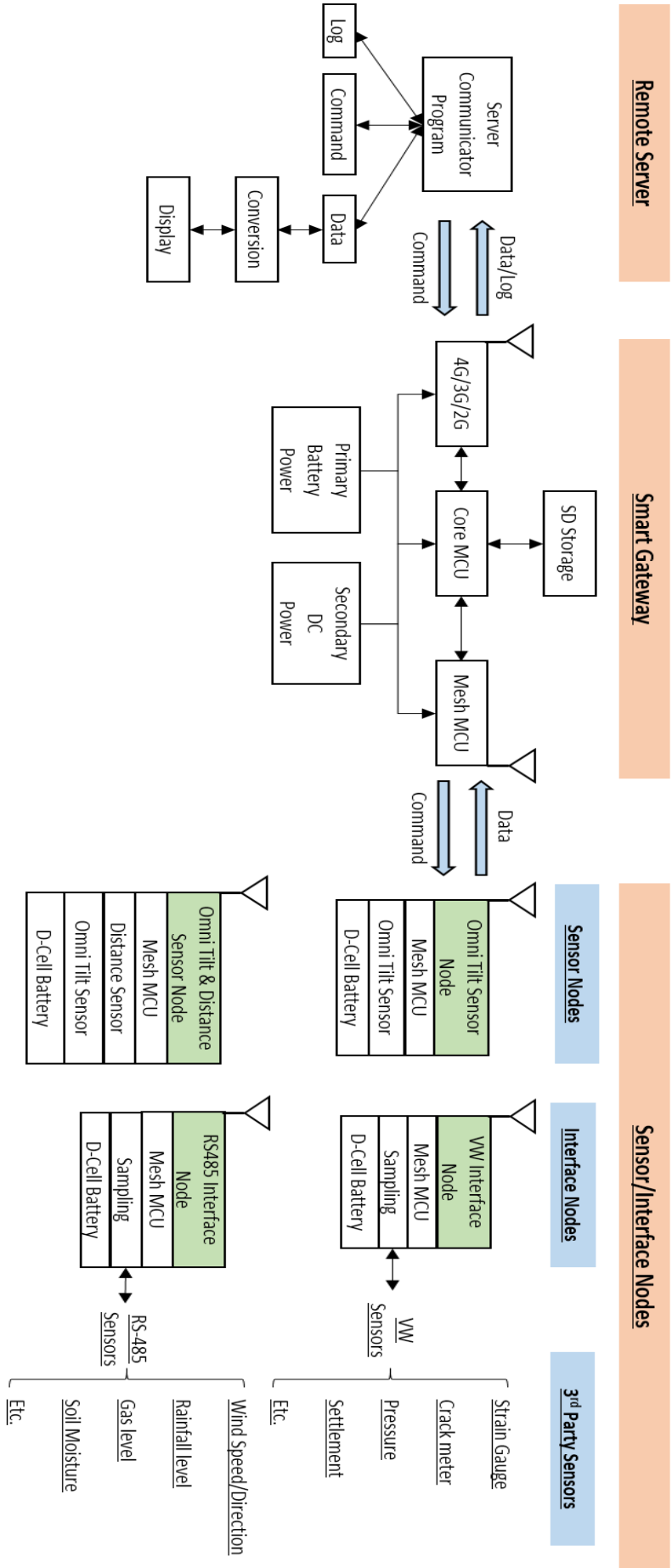


Figure 2. System Structure Layout.

3. Node & Radio Features

Node Features:

Basics		
Battery Power	Qty. x 1 (3.6V Lithium primary D-Cell ER34615)	
Accuracy Stop Voltage	2.7VDC	
Mesh Stop Voltage	2.1VDC	
Battery Connection	Standard Aluminium Battery Holder	
Local Storage	Min. 450 Messages during Meshing	
L x W x H	80 x 75 x 57mm	
Weight	0.43kg	
Primary Sensor		
Sensor Type	Yaw / Azimuth(North-based)	Pitch + Roll / X-axis; Y-axis; Z-axis Tilt
Range	[0°, 360°)	-90° to +90°
Accuracy	Better than +/-1.0°	Better than 0.01° (36” or 0.1745mm/m) over 1°
Resolution	0.1°	0.001° (3.6” or 0.01745mm/m)
Standard System Parameter		
Temperature	Range: -40 to 85°C; Accuracy: +/-1°C, typical: 0.5°C; Resolution: 0.1°C	
Voltage	Accuracy: +/- 0.1V	
WSN Interface		
WSN Protocol	WISENMESHNET® Protocol	
Industrial Standard		
Casing and Painting Materials	Aluminium-Alloy Die Castings 12 (Epoxy Polyester Powder Coating)	
IP Rating	>= IP66	
Operating Temperature	-40 to 85°C	
Fire Proof	Approved	
Certificates	-	
Re-Calibration Method		
Inspection Period	Every 3 Years by Manufacturer (or inspected by arranged methods)	

Radio Features:

Radio Band	**2405-2480MHz**	
Central Frequency (**Default**)	2405/2410/2415/2420/2425/2430/2435/2440/2445/2450/2455/2460/2465/2470/2475/**2480**	
Default Transmit Power	<2dBm	
Receive Sensitivity	-90dBm	
Bandwidth	2.8MHz	
Transmission Speed	250kb/s	
No. of Mesh Hop* Supported	10 Hops	
Sampling Interval	1-60mins	
Antenna Description	Mesh Antenna	Omni-directional (20cm in length) or Customised
	Antenna Connector	SMA (M)

* E.g., the radio link from a gateway to the 1st layer node is called the 1st hop.

4. Terminologies

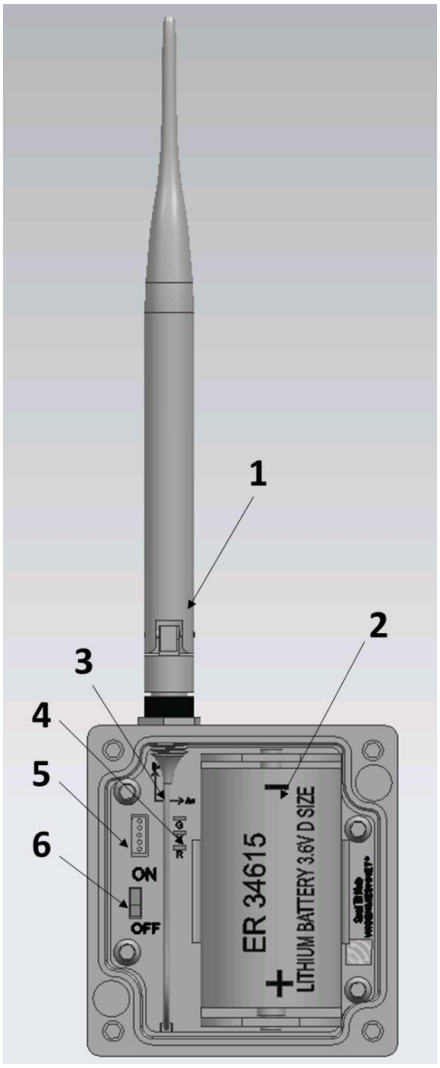


Figure 3. Omni Tilt & Compass Sensor Node Internal Configuration Terminologies, where:

No.	Terminology
1	Mesh Antenna
2	ER34615 3.6V Lithium primary D Cell Battery
3	Coaxial Cable
4	Mesh LEDs (R/Y/G)
5	Mesh Program Port
6	On/Off Switch

5. Operation Procedures

5.1. System Deployment Notifications

1) Location: The deployment location of an Omni Tilt & Compass Sensor Node is usually determined by the desired monitoring or inspection location;
2) Before any Omni Tilt & Compass Sensor Node is switched on, a gateway must be deployed, powered on and proven to be working properly. Otherwise, the nodes will need to be switched off and on again after a gateway is switched on. So simply speaking, the rules to follow when deploying and turning on a WISENMESHNET system are:

Gateway first, then nearby nodes, then further nodes.

3) All the Omni Tilt & Compass Sensor Node should ideally face to the same direction, and clear notes must be taken so that the tilt direction of a monitored structure can be correctly interpreted;
4) The Omni Tilt & Compass Sensor Nodes must be oriented with any two axis marked on the label parallel to the horizontal plane, so that the data can be easily recognized and interpreted;

   Notice: This can be done by two methods, i.e., using a spirit level or using readings from the Node itself.
5) All the Serial Numbers and the orientation of the Omni Tilt & Compass Sensor Nodes must be recorded against their site references;
6) All the node should have its antenna point upwards/downwards.

5.2. Reading Conversion to Structural Tilt Direction

When holding the User Manual page horizontally, then when X-axis arrow rotates around 0-dot into the paper plane, the readings of "***x***" decreases; It also applies to both Y/Z-axis;

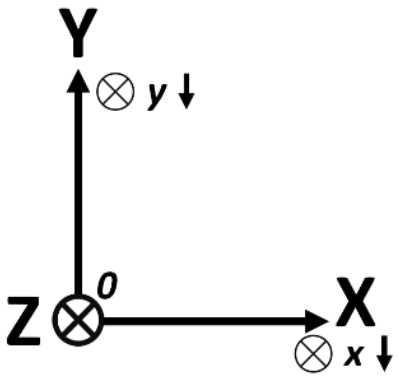
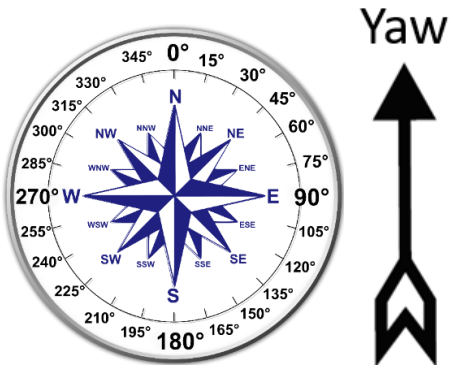


Figure 4. Axis marks on the product label.



Yaw: North: 0/360°(identical direction as the Yaw Arrow on the product label); East: 90°; South: 180°; West: 270°

5.3. Deployment Procedures

1) Open the box: Take the node out of the package and open its lid;

2) Insert Battery: By default, a node does not contain a D-Cell battery. Therefore the battery needs to be inserted.

   Notice : +ve and –ve orientation must be correct, otherwise, the internal circuit may be damaged;

3) Measurement Reference:

   At the exact installation position, measure the surface orientation (i.e., Yaw) by a compass or the App on a smart phone, write down the reading (i.e., Yaw_ref).

4) 90s Slow Preparation Buzzer (0.5s on + 1.5s off)

   Fix the brackets and accessories (such as, screws and antennas) onto a node, power the node on and see all three mesh LEDs flashing 3 times. Then close the lid by tightening the 4 screws, then overturn the nodes 3 times so that the lid surface and the bottom surface can face upward 3 times respectively.

5) 120s Quick **Calibration** Buzzer (0.5s on + 0.5s off):

Seq.	Lid Orientation	Antenna Connector Orientation	Slowly rotate a node around one axis shown on the label for 3 full circles (3s/circle)
1	Face to the customer	Points up	Round X-axis.
2		Points left	Round Y-axis shown on the label.
3		Points right	Round Y-axis shown on the label.

Note: iterate according to Seq. 1, 2 & 3 shown in the table above until “Confirmation Buzzer” is on.

6) 10s Confirmation Buzzer:

Sound	Confirmation Flag in Data	Calibration Result
Single Beep (10 times)	Flag=0	Success
Double Beep (10 times)	Flag≠0. Redo calibration.	Failed

7) Mesh Data Comparison:
Ensure the installed node is within +/-8° offset from Yaw_ref recorded in Step 1;

8) Error Flag Diagnostics: For all the Flag≠0, please refer to "Flag ID Diagnostics Table".

Flag ID Diagnostics Table

Basis: Based on the latest Specification for on-site calibration and the observation of at least 3 continuous sets of data, then carry out the analysis as stated below:

Flag ID	Description	Suggested Solution
0	Working	---
***9**	Calibration Failure due to incorrect calibration.	**Strictly** follow the procedures in "Specification" and recalibrate.
***16**	Node is restarted, no calibration is performed, the latest calibration has been successful and the latest calibration setting is reused.	**Compare** the Yaw°, X°, Y°, Z° data with their historic sets: - if the data stays relatively unchanged, then no need for any further actions; - or **strictly** follow the procedures in "Specification" and recalibrate.
***24/25/26/27**	Module of Magnet Vector > 2500uT.	Keep node away from the **magnet disturbance**, then **strictly** follow the procedures in "Specification" and recalibrate.
***1/2/3/4/5/6/7/8/ 10/11/12/13/14/15/ 17/18/19/20/21/22/23**	Module of Magnet Vector ∉ [20uT, 61uT), or Module of Acceleration Vector ∉ [0.9g, 1.1g], or Self-test failed.	If the data cannot be recovered by itself or remain unacceptable, then revisit the site, and keep the node away from the **magnet/vibration disturbance**, then **strictly** follow the procedures in "Specification" and recalibrate.
Rest	Cases such as Water ingress, damage on the node etc.; Data is lost or shown unexpected behaviors.	Hardware fault, please contact Technical Support.

* After 2-3 rounds of recalibrations, if the Error Flag is identical among themselves, then it leads to a potential hardware failure, which is usually caused by a direct contact to a strong magnet.

9) To validate the sensor data, please visit WISENMESHNET® Visualisation Platform for further details.

5.4. Mounting Options

The node fixings must be rigid for the sensor to measure accurate data. Movement in the fixings will affect the readings.

The Omni Tilt & Compass Sensor Nodes must be oriented with any two axis marked on the label parallel to the

horizontal plane, so that the data can be easily interpreted.

Principle:

1. Accuracy: The Yaw value is merely depending on the correct measurements of Earth Magnetic Intensity;
2. Calibration: Any magnetic distortion that affects a node at a fixed relative direction of a fixed value (e.g., X uT) (providing X uT is < < the up limit of the sensor, i.e., 2500uT in this case), then the distortion can be calibrated;
3. Stability: the measurements of Yaw can only be stable if the magnetic fields has no change (apart of the Earth Magnet due to node rotation) after the calibration.

Notice:

Magnetisable parts that is **NOT** able to fit into Principle 2, then it will severely affect the level of Calibration and hence the Yaw Accuracy. In this case, these parts must be **kept at a minimum 30cm plus away from a Omni Tilt & Compass Sensor Node**; Examples:

A. Typical magnetisable parts: e.g., reinforced concrete, fence, etc.;
B. Typical parts that can be calibrated: the accessories on a node, e.g., the stainless steel screws, rotation brackets, antennas, etc.

However please note! Accessories **MUST** be fixed on a node before any calibration begins (hence Principle 2).

6. General Maintenance and Notification

1) Once an Omni Tilt & Compass Sensor Node is installed in the field, please minimise any man-made disturbance so that data quality can be maintained;

2) Radio communication will be impaired if the antenna is covered by metal or very moist soil material;

3) Due to the discharge characteristics of the recommended battery, a battery replacement should be carried out when a node reported voltage reaches 2.7V, at which point you have approximately 3 weeks to change the battery;

4) Our product will use all the possible capacity in a battery down to a stop (minimum) voltage, which has been specified in the Features table. When this occurs, our WISENMESHNET protocol will send you a warning then it will enter a deep sleep mode until a new battery is installed;

5) If the data from nodes are shown unexpected results or are not being sent back to the Wisen gateway, then please carry out investigation using the following two stage procedure:

A. Remote Inspection of historical data, to identify the following:

a) Whether the heart-beat message has been sent back successfully at each time interval;

b) Whether the battery voltage is too low, if yes, please change the battery unit;

c) Whether the signal strength has become significantly weaker than it was previously. If yes, please check the antenna has been screwed on firmly.

B. On-site Inspection: If all the above are good, please arrange an on-site inspection to check:

a) Whether the Tilt Node has visible external damage;

b) Check the box lid to see if it is firmly tightened;

c) Whether the antenna is bent or damaged and that the node is not blocked by new construction, e.g., hoardings;

d) When it is possible, check that the signal strength is normal by using a spectrum analyser;

e) Open the lid, to see whether the battery is firmly attached to its holder;

f) Use a multi-meter to measure the battery voltage. If it is below the stop (minimum) voltage, replace the battery.

Notices :

i. Case One: If any change has been made from the list above, please inspect the data from the remote server;

ii. Case Two: If all the actions from the list above have not cured the problem, please contact Wisen. We will be happy to help.

7. Package and Accessories

Standard:

No.	Items	Dimension (mm)	Qty.
1	WISENMESHNET® Omni Tilt & Compass Sensor Node	100x100x60	1
2	Mesh Antenna	200	1
3	Cap-Hex-Head Screw	M6x14	4
4	User Manual*	Downloadable from WISENMESHNET® Visualisation Platform.	
5	Inspection Report*		

8. Safety and Warning

Warning: Please read the following instructions carefully.

1) Operation Safety

- Before taking any action, please read all the information provided carefully, and keep the guidance documents safe;
- Ensure that any procedures and installations are correctly carried out. The case and any mountings should be grounded where practicable.
- This product has been designed to meet a certain water-proof level. However, it becomes vulnerable to water ingress when the lid is open or if the cable gland has not been sealed properly.

2) Electrical Safety

- To install the battery into a holder, please follow the "+" (positive) and "-" (negative) signs in any Wisen product. Wrong orientation of a battery could potential cause unit damage. Notice: The orientation of battery can vary among products.
- When disconnecting the battery, please take special care not to apply excessive force, otherwise the battery holder and the nearby circuitry may be damaged.

3) Warning

- The battery in the product has a relatively high capacity, so please take special care during storage and usage.
- This product must not be disassembled under any circumstances, to do so will void the warranty and may leave the product in a dangerous state;
- If all the above are not followed, the manufacturer cannot be held responsible for any damage and injury caused to the users.

4) Caution

- Danger of explosion if battery is incorrectly replaced. Replace only with the type recommended by the manufacturer. Observe any warnings specified by the battery manufacturer.
- When disposing of the batteries, please contact your local authorities or dealer and ask for the correct method of disposal.

9. Contact

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