WISENMESHNET® Omni Tilt & Distance 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 & Distance 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 laser distance sensor and tilt angle detection sensor;

➢ Form a time-synchronized Wireless Sensor Network with others nodes in the system;

➢ Transmit the data packet to a gateway.

Scope：

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

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1. Product Introduction

The WISENMESHNET® Omni Tilt & Distance 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 distance change between any two points in space of a structure to the information centre.

The WISENMESHNET® Omni Tilt & Distance Sensor Node operates using our core technology, i.e., the WISENMESHNET® Low Power, Intelligent, Wireless Sensor Network protocol, together with its internal high precision Laser Distance and MEMS Omni tilt sensing module plus 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.
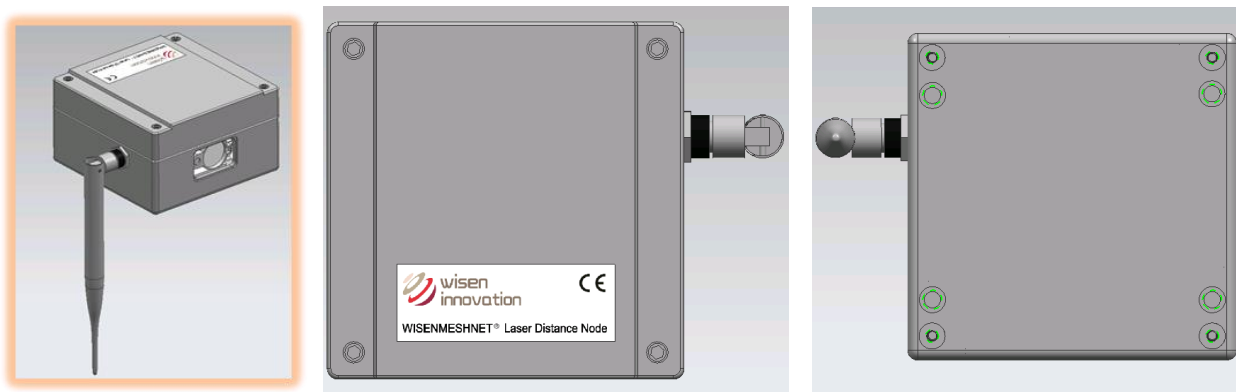
Figure 1. Omni Tilt & Distance Sensor Node Overview.

WISENMESHNET® Omni Tilt Sensor Node is often used in long term distance monitoring between two specific points, such as horizontal convergence of a tunnel.
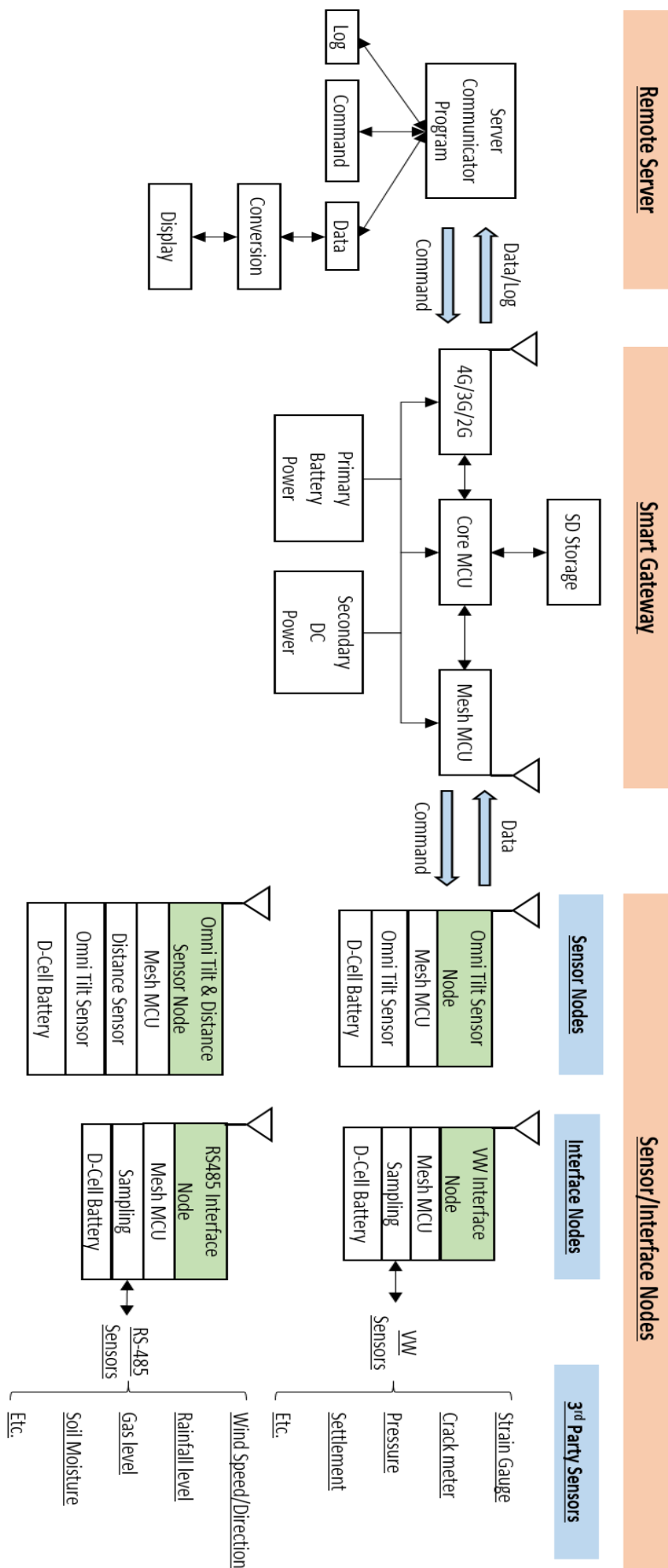
2. System Structure Layout

Figure 2. System Structure Layout.

3. Node & Radio Features

Node Features:

Basics	1F0X
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	100 x 100 x 60mm
Weight	<= 0.65kg
Primary Sensor	
Sensor Type	Distance
Laser Class	Class 2
Laser Range	0.05m-300m
Laser Accuracy	Better than +/-1.0mm (Typical 0.5mm)
Laser Resolution	0.1mm
Laser Lens Durability	>= 500Hrs@3Hz@50°C or 2500Hrs@3Hz@25°C
Standard System Parameter	
Tilt Sensor	X-axis; Y-axis; Z-axis Tilt Values
Tilt Range	Range: -90° to +90°; Accuracy: better than 0.01° (36'' or 0.1745mm/m) over 1°; Resolution: 0.001°.
Temperature	Range: -40 to 85°C; Accuracy: +/-1°C; Resolution: 0.1°C
Voltage	Accuracy: +/-0.1V
WSN Interface	
WSN Protocol	WISENMESHNET® Protocol
Re-Calibration Method	
Inspection Period	Every 3 Years by Manufacturer (or inspected by arranged methods)
Industrial Standard	
Casing and Painting Materials	Aluminium-Alloy Die Castings 12 (Epoxy Polyester Powder Coating)
IP Rating	>= IP66

Operating Temperature	-10 to 50°C

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)

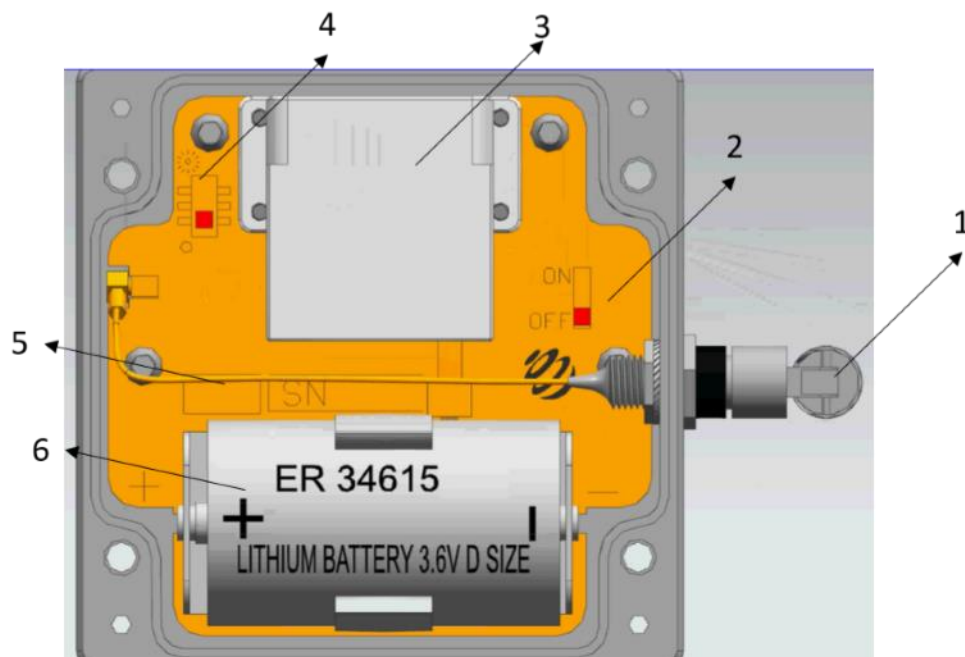* E.g., the radio link from a gateway to the 1st layer node is called the 1st hop.

4. Terminologies

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

No.	Terminology

1	Mesh Antenna
2	On/Off Switch
3	Laser Distance Sensor
4	Laser Pointer Switch, i.e., laser constantly on during installation
5	Mesh Program Port
6	ER 34615 3.6V D Cell Battery

5. Operation Procedures

5.1．System Deployment Notifications

1) Location: The deployment location of a Omni Tilt & Distance Sensor Node is usually determined by the desired monitoring or inspection location;

2) Before any Omni Tilt & Distance 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:

<p align="center"><u>Gateway first, then nearby nodes, then further nodes.</u></p>

3) All the Omni Tilt & Distance Sensor Node should face to the same direction, and clear notes must be taken so that the Laser Distance Sensor direction of a monitored structure can be correctly interpreted;

4) The Omni Tilt & Distance Sensor Nodes must be oriented with at least one axis marked on the label parallel to the horizontal plane, so that the tilting angle data can be easily recognized and interpreted;

5) All the Serial Numbers of the Omni Tilt & Distance 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.
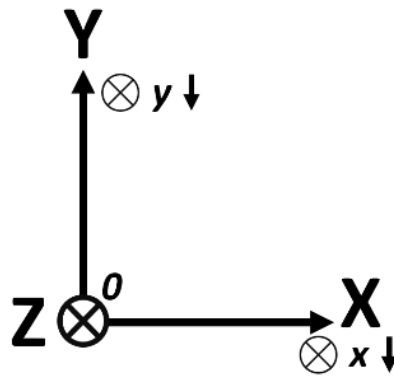
Figure 4. Axis marks on the product label.

### 5.3．Laser Distance Warning and Error Code

| Warning!	
A. This is an automated system, the laser beam must be set to point at an appropriate non-reflective surface; B. The protection window glass on a node must be kept clear all the time; C. Distance 0mm starting plane: plane of the protection window glass.	
Special Notice	

Laser_Pointing_Mode Switch: It sets laser into pointing mode. By default, it is in switched off state (i.e., empty circle sign). Switch location is highlighted in the figure below.
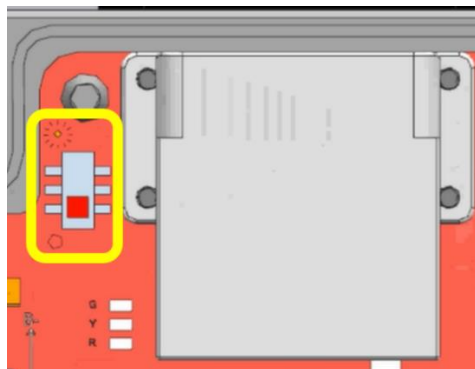
It can be switched on/off before/after a node's power-on. This pointing mode only becomes active after a valid laser reading is achieved.

Note: please do switch it off after an installation is completed, otherwise, the battery life is significantly shortened.

Laser front Lenses Protection Cover: All our laser nodes are shipped with their individual Protection Cover (of a 3M Double Coated Tissue Tape at one side). Once a battery is installed, node is powered on, and lid is screwed on properly. Then glue the cover onto the node as shown in the figure below. It protects the lenses from dust, heat and potential damage.
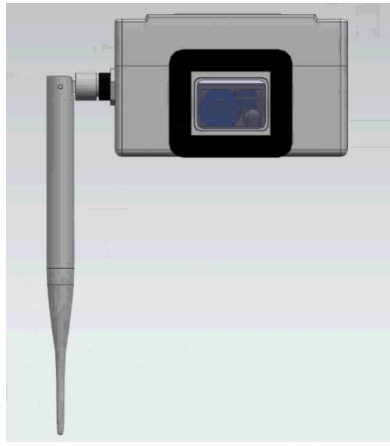
Error Code Instructions

Code_Info	Description	Notice
00	Node is working in a good condition	-
01	Target moving too fast or beam interrupt	Repeat measurement, use tripod (@E260)
02	Signal too low or distance out of range	Use special target plate (@E255)
03	Signal too high	Avoid high reflecting surfaces (@E256)
04	Time out on reply	Cable may have gone loose or check if there is any bad physical connection or too far out of range (e.g., point to the sky) (Wisen)
05	Single reading achieved	Single success on the sampling procedure.
06	Max-Min>2xError Tolerance	The difference of sample values is too large, repeat measurement or use tripod. (Wisen)
07	Unknown command or wrong parameter	Use correct syntax (@E203)
08	Error on serial communication	Check communication (@E220)
09	Temperature too high	Cool down module (@E252)
10	Temperature too low	Warm up module (@E253)
11	Voltage supply too low	Improve voltage supply quality (@E254)
12	Too much background light	Protect target against sunlight (@E257)
13	Laser error	Module defect (@E284)
14	APD-voltage can't be adjusted correctly	Module defect (@E288)
15	Flash configuration error	Power down and up again (@E289)
16	Unknown command or wrong parameter from laser module	Change to a new battery (Wisen)
24	Checksum error	Change to a new battery (@E224)

74	No EEPROM detected, code has to be loaded by GSI	Change to a new battery (@E274)
76	Read of code from EEPROM wrong	Change to a new battery (@E276)
78	EEPROM error which appears if something goes wrong during the flashing of the firmware	Change to a new battery (@E278)
90	Calibration signal out of range	Change to a new battery (@E290)
Laser Time	The time period (in the unit of seconds) that a laser module has been switched on at each T. Typically, of value: 2-3s.	
Sampling Status	The number of samples that has been successfully measured. Typically, of value: 5.	

5.4．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;

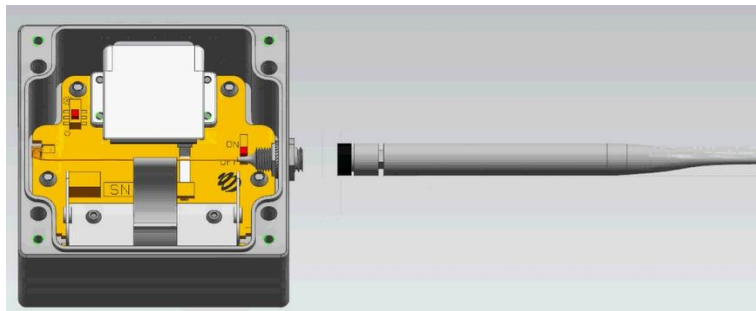3) Antenna Installation: screw the antenna tightly onto the node;

Figure 4. Mesh Antenna.

4) Power On: switch on the Omni Tilt & Distance Sensor Node by On/Off Switch. Now you should be able to see 3 LEDs flashing 3 times, this means the node is on. Then switch off the node to save power if the gateway is off;

5) Tighten the 4 Cap-Hex-Head screws of the lid to secure the enclosure IP rating;

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

5.5．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 & Distance Sensor Nodes must be oriented with at least one axis marked on the label parallel to the horizontal plane, so that the tilting angle data can be easily recognized and interpreted.

6. General Maintenance and Notification

1) Once an Omni Tilt & Distance 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) Please do take special notice on Laser Radiation matter with this lase node. Do NOT start into beam.

4) 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;

5) 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;

6) 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 Omni Tilt & Distance Sensor 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 & Distance Sensor Node	100x100x60	1
2	Mesh Antenna	200	1
3	Dust Cover for Laser Front Glass	-	1
4	Cap-Hex-Head Screw	M6x14	4
5	User Manual*	Downloadable from WISENMESHNET® Visualisation Platform.	
6	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 communication cable and the case

must be grounded.

➤ This product has been designed to meet a certain water-proof level. However, it becomes water vulnerable when the lid is open or if the cable gland has not been sealed properly.

2) Electric 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.

➤ 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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