WISENMESHNET® Displacement Sensor Node User Manual

Wuxi Wisen Innovation Co., Ltd.

February 2021

Revision History and Clarification

Rev.	Issue Date	Revisions	Written By	Revised By
V1.0	19/11/2020	1st Issue	Xiaoyan Huang	Dr. Yan Wu
V1.1	26/02/2021	Minor wording changes.	Xinhu Nie	Dr. Yan Wu

Document Definition:

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

➢ External displacement sensor, for railway track vertical movement or crack development;

➢ External temperature sensor, for railway track temperature monitoring;

➢ A vibration threshold trigger value can be set on a node switch, so that once the vibration threshold is reached, such as a train passes by, a node can sample at 33Hz rate, and report to a gateway of maximum, minimum, average over a time interval.

Scope：

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

Table of Contents

1. Product Introduction

The WISENMESHNET® Displacement Sensor Node is one of the key products in our patented WISENMESHNET® geotechnical safety monitoring system. Working together with the WISENMESHNET® gateway product and the specified voltage type sensors, it intelligently delivers the real-time data of voltage typed sensors and NTC thermistor reading to the information centre.

The WISENMESHNET® Displacement Sensor Node operates using our core technology, i.e., the WISENMESHNET® Low Power, Intelligent, Wireless Sensor Network protocol, together with its internal sample 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.
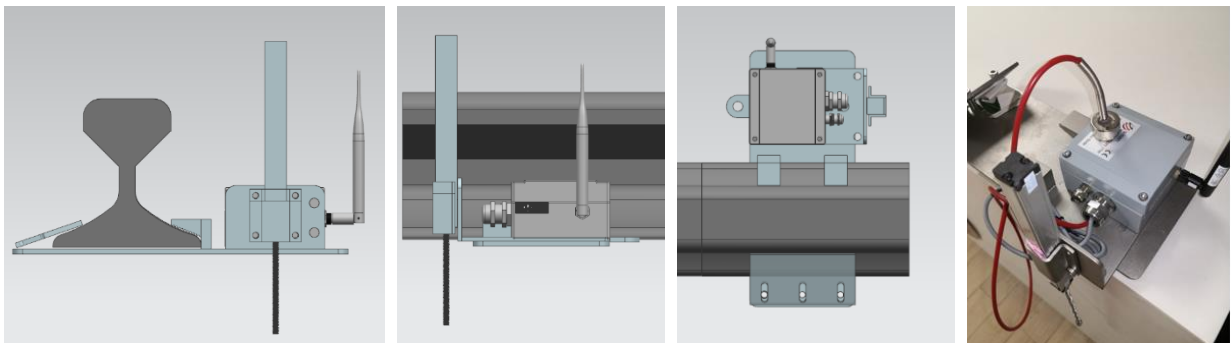
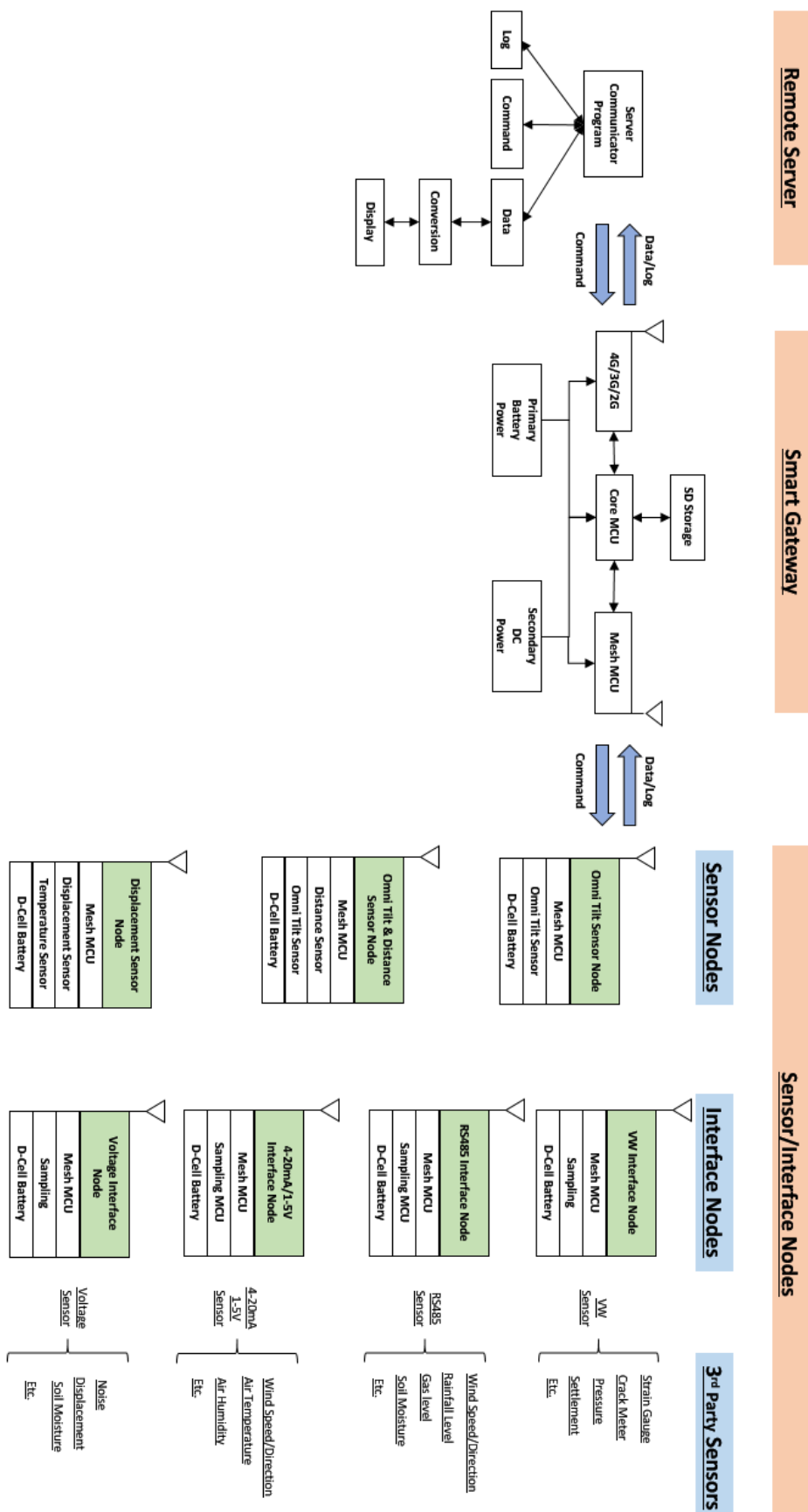Figure 1. Displacement Sensor Node.

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
Working Current	Max. 28mA (Typ. 9mA) @ Mode=0
Alternative DC Input	3.6VDC
Local Storage	Min. 450 Messages during Meshing
L x W x H	100 x 100 x 60mm
Weight	Node: 0.4kg Displacement Sensor (1.0m cable) + NTC temperature Sensor with strong magnet fixing (1.0m cable): 0.25kg
Cable Gland	Qty. 1 x EMC-CMA12 - Extend Power Qty. 1 x EMC-CMA16 – Displacement and Temperature Sensor
Wire Connection	Spring type wiring terminal

WSN Interface	
Mesh Wireless Interface	WISENMESHNET® Protocol

External Primary Sensor		
Sensor Type	**External Displacement**	**External NTC Temperature**
Range	0 to 50/100/150/200mm Overload cause irreversible damage	-40 to 85°C
Accuracy	0.1%FS	<1°C@[-40, 40]°C & <2°C@(40, 85]°C
Resolution	0.0015%FS	0.1°C

Standard System Parameter	
Internal Temperature	Range: -40 to 85°C; Accuracy: ±1°C, typical: ±0.5°C; Resolution: 0.1°C
Voltage	Accuracy: ±0.1V

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	-40 to 85°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.
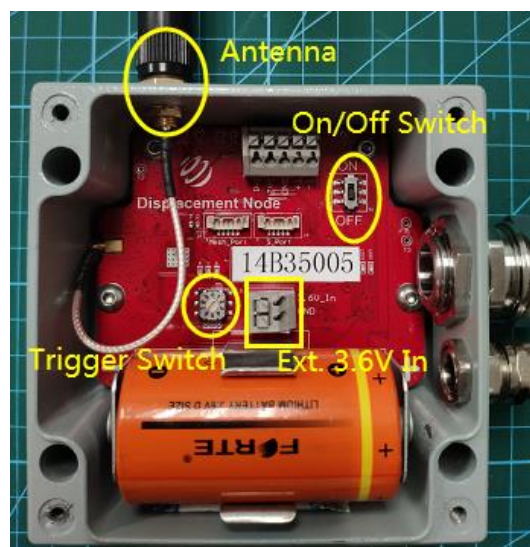
4. Terminologies

Figure 4. Displacement Sensor Node Internal Configuration Terminologies

5. Operation Procedures

5.1．System Deployment Notifications

1) Location: The deployment location of a Displacement Sensor Node is usually determined by the required monitoring or inspection location;

2) Before any Displacement Sensor Node is switched on, two tasks will need to be carried out:

   A. Unlike the Tilt Node which has a MEMS tilt sensor embedded in the node, the Displacement and NTC thermistor sensors must be connected to the Displacement Sensor Node;

   The connections between a customer chosen Voltage sensor and a Displacement Sensor Node must strictly follow the rules stated in this document;

   B. A gateway must be deployed, powered on and proven to be working properly. Otherwise, the nodes will need to be switched off, then switched on again after a gateway is switched on. So simply speaking, the rules to follow to correctly deploy a WISENMESHNET® system are:

   Gateway first, then nearby nodes, then further nodes.

3) During deployment, the Serial Number, i.e., SN of a node and the orientation of the sensors deployed against their site references must be recorded;

4) All the node should have its antenna point upwards.

5.2．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, special attention must be paid to avoid shorting the battery by the battery holder.

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

4) Sensor connections to Node:

   A. Strip the cable sleeve back by 8mm.

   B. The 5 wires from the cable are In1, In2, GND (of displacement sensor), T+ and T- (of NTC thermistor). Please refer to the sensor datasheet to identify the purpose of the stripped wires.

C. Untighten the gland cover, insert cable through the gland, then connect the 5 wires accordingly.

D. Once the wires are connected, please tighten the gland cover firmly to ensure its IP rating on that channel.

Notice 1: The cable gland diameter of the Displacement Sensor Node is 8mm.

Notice 2: All the 5 wires must be connected, to minimise electrical interference and possible loss of precision.

Notice 3: Within any electrically noisy environment, nodes with sensors must be >= 0.3m away from the source of the noise.

5) Vibration Trigger Settings:

"Trigger Switch" is used to set vibration trigger, once the vibration threshold is reached by any object, such as a train passes by, a node can sample at 33Hz rate, and report to a gateway of maximum, minimum, average over a time interval.

Monitoring Mode	Hardware Switch Setting	Trigger Threshold
Dynamic (used for real-time track vertical movement monitoring over a short/medium term)	0	Continuous sampling used during initial trigger value identification
	1 (default)	> 1.1g (default)
	2	> 1.3g
	3	> 1.5g
	4	> 2.0g
	5	> 2.5g
	6	> 3.0g
	7	> 3.5g
	8	> 4.0g
Static Displacement (used for condition monitoring over a long term)	9	Only Samples at every T

Table. Trigger Setting.

6) Power On: once all the Voltage sensors are connected, turn the switch on. Now you should be able to see 3 LEDs flashing 3 times, which means the node is on. Then switch off the node to save power if the gateway is off;

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

8) To validate the sensor data, please visit Wisen Visualisation Platform for further details.

5.3．Mounting Options

Displacement Sensor Node can be deployed with various methods. However, the priciple is to make sure it is firmly attached to the installation surface.

6. General Maintenance and Notification

1) Once Displacement 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 showing 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 a 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.

        g) Make sure the 3 wires are connected properly, if necessary, please disconnect the wires to inspect.

Notices:

  i. Case One: If any change has been made from the list above, please inspect the data at 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® Displacement Sensor Node	100x100x60	1
2	Mesh Antenna	200	1
3	Cap-Hex-Head Screw	M6x14	4
4	User Manual*	Downloadable from Wisen 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 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

- Wuxi Wisen Innovation Co., Ltd.: www.wisencn.com

- Email: support@wisencn.com