USERS MANUAL

NEXAWAVE TILTRANGE

Model EWN-01ML

TUNNELS   HYDROELECTRIC   CONSTRUCTION   STRUCTURAL   METRO & RAIL   BRIDGES   MINING

1   INTRODUCTION

1.1   NexaWave TiltRange overview

The Encardio rite model EWN-01ML NexaWave TiltRange sensors are designed to provide both distance and tilt measurements for monitoring the stability, deflections, and deformation of structures. It monitors the 3-axis inclination in relation to the direction of gravity and provides information on the two axes of rotation from the horizontal plane in any orientation. These sensors operate in conjunction with the NexaWave gateway Hub and nodes, creating an intelligent system that facilitates real-time distance change measurements between any two points in space within a structure with inclination.

This system enables continuous data logging and real-time monitoring, offering the advantage of early detection and warning in the event of potential structural failure. This early warning capability allows for prompt corrective action to be taken, ensuring the structural integrity and safety of the monitored area.

1.2   NexaWave TiltRange applications

EWN-01ML NexaWave TiltRange is widely used in the following applications:

- Monitoring vertical rotation of retaining walls.

- Monitoring inclination and rotation of dams, piers, piles and other structures.

- Monitoring stability of structures in landslide areas.

- Monitoring tunnels for convergence and other movement.

- Monitoring safety of structures around zones of excavation or tunnelling.

- Monitoring deflection in bridges and struts under different loading conditions.

1.3   Wireless network

Wireless sensors are vital in monitoring construction sites, large structures and landslide areas. They are extensively used in applications where geotechnical and other sensors are used for data collection and transfer it to a central server for access by multiple users. Encardio rite offers an innovative network solution that allows real-time monitoring of not only wireless TiltRange but also other geotechnical and structural sensors in challenging conditions with reliable data transfer without any delay.

In an end-to-end wireless monitoring system from Encardio-rite, the TiltRange are interfaced with the long range, low power radio frequency network to **gateway**. The TiltRange sends recorded data to the gateway through the RF network with utmost reliability. The gateway then uploads the collected data from sensors to the central/cloud server.

The system operates on ISM sub 1 GHz operating frequency bands adjustable to requirement of each territory. The system can be adjusted to different frequency bands; for example:

India   865 – 868 MHz

Europe   868 MHz

USA   903 - 927 MHz

A detailed reference for frequency bands allowed in different Countries is available at:

https://www.thethingsnetwork.org/docs/lorawan/frequencies-by-country.html

The gateway also has provision to set the frequency band, depending upon the Country.

1.4   Conventions used in this manual

WARNING! Warning messages calls attention to a procedure or practice that if not properly followed could possibly cause personal injury.

CAUTION: Caution messages calls attention to a procedure or practice, that if not properly followed may result in loss of data or damage to equipment.

NOTE: Note contains important information and is set off from the regular text to draw the users' attention.

1.5   How to use this manual

This users' manual is intended to provide you with sufficient information for making optimum use of TiltRange in your applications.

To make the manual more useful we invite valuable comments and suggestions regarding any additions or enhancements. We also request to please let us know of any errors that are found while going through the manual.

NOTE: Installation personnel must have a background of good installation practices and knowledge of fundamentals of geotechnics. Novices may find it very difficult to carry on installation work. The intricacies involved in installation are such that even if a single essential but apparently minor requirement is ignored or overlooked, the most reliable of instruments will be rendered useless.

A lot of effort has been made in preparing this instruction manual. However best of instruction manuals cannot provide for each and every condition in field that may affect performance of the sensor. Also, blindly following the instruction manual will not guarantee success. Sometimes, depending upon field conditions, installation personnel will have to consciously depart from written text and use their knowledge and common sense to find solution to a particular problem.

Installation of a TiltRange requires expertise. It is recommended that potential users themselves practice all the operations laid down in this manual by repeated installations.

NOTE: The sensor is normally used to monitor site conditions and will record even a minor change that may affect behaviour of structure being monitored. Some of these factors amongst others, are, seasonal weather changes, temperature, rain, barometric pressure, nearby landslides, earthquakes, traffic, construction activity around site including blasting, tides near sea coasts, fill levels, excavation, sequence of construction and changes in personnel etc. These factors must always be observed and recorded as they help in correlating data later on and also may give an early warning of potential danger or problems.

2   GENERAL DESCRIPTION

2.1   Model EWN-01ML NexaWave TiltRange

Model EWN-01ML NexaWave TiltRange combines high precision Micro-Electro Mechanical System (MEMS) sensor and laser distance meter with radio transmission network to provide accurate tilt and displacement data. The unit is mounted inside a compact weatherproof enclosure. The TiltRange provides a 20-bits digital output proportional to the sine of tilt angle.

The NexaWave TiltRange system, model EWN-01ML, is installed at a specific location with its laser directed towards a chosen natural surface. This configuration allows for the measurement of the distance between these two points. Concurrently, the 3-axis tiltmeter measures changes from the vertical level, providing information about the inclination. The output of any axis is zero for a truly horizontal position. The unit has a built-in thermistor to measure temperature. Temperature is measured using 24-bit ADC which provides accurate temperature within ± 0.1°C.

The measured values are transmitted through the long range, low power radio frequency network to the gateway without any signal degradation. Each unit is individually calibrated to provide high system accuracy and repeatability.

The model EWN-01ML wireless TiltRange measures change in tilt and distance of a structure to which it is attached. The TiltRange can be fixed to any vertical surface, horizontal floor or ceiling by means of suitable mounting accessories consisting of anchors (and brackets – optional). These are available separately when ordered.

2.2   Model EWG-01 NexaWave Hub

Encardio rite model EWG-01 wireless gateway is used as a main networking hardware, which uploads data gathered from all the TiltRange (or other geotechnical sensors) to the remote server. The gateway ea wireless network provides reliable data transfer over long distancesg distances, without any delay. The wireless system eliminates the need for running lengthy cables. This is especially useful at locations where sensors are distributed over a wide area and running cables to long distances can be tricky and risky.

The data is accessible 24 x 7 to all the stakeholders. With Proqio, a cloud-hosted data management and configuration software, the system can be programmed to generate automatic reports and provide automated alerts over SMS or email for any reading crossing the pre-defined alert levels.

With the real-time data collected from wireless TiltRange and gateway, information about the slightest of change taking place at specific location is available. This allows timely decisions, increased safety and cost effectiveness.

2.3   System components

Provided by Encardio-rite:

- Model EWN-01ML- Wireless TiltRange with antenna

- Model EWG-01 Gateway with antenna

- Gateway and Node mounting accessories

- USB to RS-232 FTDI cable

- Application software for Android Smartphone

- Application software for Windows

To be arranged by Client foe node and gateway:

- Laptop or Android Smartphone

- Activated data SIM card – 1 no. for Gateway

- D-Cell Li-SOCl2 3.6 V 14.5 Ah batteries - 4 no (2 no. each for TiltRange and Gateway)

- External Power supply unit 9-30 V, 1 A for Gateway (12 V, 1 A power supply easily available can be used) and 8-20V for the node.

3   TECHNICAL SPECIFICATION

Basic	
Internal Battery	7.2Vdc (2X3.6V Li-Ion Battery (D-cell ER34615M))
External Power	8-20Vdc Standard DC power supply)
Operating Current	25 mA (max)
Dimension	120X100X81(LXWXH) without antenna 159X100X187(LXWXH) with antenna
Weight	0.807 Kg (Without Battery) 1.0045 Kg(With Battery)
Storage	3 Million data points
Primary Sensor	
Sensor Type	Distance
Laser Class	Class 2
Laser Range	0.05 m-33 m, 0.05 m-100 m
Laser Accuracy	+/-1.0 mm
Laser Resolution	0.1 mm
Laser Lens Durability	>= 500Hrs@3Hz@50°C or 2500Hrs@3Hz@25°C
Standard System Parameter	
Sensor Type	MEMS Accelerometer
No. of axis	3-Axes (X, Y and Z)
Accuracy	± 0.1% FS
Resolution	20 bit
Sensitivity	± 10 arc seconds
Range	±30 deg
Temperature Sensor	
Sensor Type	3K thermistor
Accuracy	0.1°C
Range	-20°C to +70°C
Enclosure	
Material	Aluminium-Alloy Die casting 12(Epoxy Polyester Powder Coating)
IP Rating	IP-65(IS-60947 Part-1:2004)
Fire Proof	Approved
Protocol	
ER Protocol	Proprietary Encardio Protocol
Radio	
LoRa Chipset	SX1276

Frequency	**EU**	**US**	**ROA**
	863-870 MHz	903-927 MHz	920-928 MHz

Transmit Power	863-870 MHz (EU)	903-927 MHz(US)	920-928 MHz(ROA)
	Up to 14 dBm	15.8 dBm	20 dBm
Antenna Gain	4.44dBi		
Baud Rate	9600 bps(Max)		
Receiver Sensitivity	-132 dBm		
Transmission Distance	(1 ~ 15 KM)*		

* 800 meter in urban areas

4   PRE-INSTALLATION PREPARATIONS

4.1   Pre-installation checks

- Before installation please check the TiltRange and Gateway for any physical damage.
- Open the TiltRange and gateway box to check if the internal wirings are intact.

4.2   Selecting location for Hub and TiltRange

Selecting correct locations for Gateway and TiltRange is important, especially in case more than one TiltRange are being installed at site and connected to single gateway.

The first step is to install the Gateway at a location that is in line of sight with all the installed TiltRange or in line of sight with most TiltRange. The best location will have to be determined at the site itself. For best results, the link between the gateway and the TiltRange should be strong, preferably better than -100 dBm. Please note, the stronger the link better will be the results.

4.3   Setting up the Gateway & TiltRange

It is recommended that the setting up and configuration of TiltRange and gateway is done before mounting the sensors and gateway at respective installation location.

The gateway configuration needs to be done before TiltRange. For setting up and configuring the gateway, refer to User's Manual # WI6002.117 on Gateway. Configuration of TiltRange is discussed in Section 6 of this manual.

For convenience, a "Quick Start Guide" is included in Section 5 to give a brief and quick idea.

4.4   Sampling Interval for TiltRange node

When configuring the Encardio rite wireless system, it is crucial to select appropriate sampling intervals to ensure the network operates smoothly without any data loss. The table below provides guidance on sampling interval selection based on the network size.

The wireless TiltRange (RF) with in-built node:

Number of nodes	Minimum Sampling interval (Minutes)
1	4
10	7
50	20
100	37
150	53
200	70

The General formula to calculate Sampling interval for TiltRange is:

Sampling Interval (Seconds) = (20*No. TiltRange Node) + 180

Please note that these recommended sampling intervals serve as general guidelines. Depending on specific project requirements, environmental conditions, and data collection needs, adjustments to the sampling intervals may be necessary. It is advisable to consult with the Encardio rite technical support team for further guidance on fine-tuning the sampling intervals for your particular network setup.

5   QUICK START GUIDE

5.1   Gateway Setup

Use step by step procedure to configure the gateway.

Step 1:   Open the gateway box. Insert the 4G Sim card. Connect both the antenna's into their respective connector.

Step 2:   Insert the battery into battery holder with their correct polarity.

Step 3:   Connect any standard DC Power (9-30 V, 1 A) into Connector named as "IN" on the PCB with correct polarity.

Step 4:   Switch on the Gateway and wait for 1 minute.

Step 5:   Install the EWA-01 apk file (provided with supply) into android phone and allow all the permissions asked during apk installation. After installation close the application.

Step 6:   Go to android phone's Settings>>Connections

Step 7:   Press on "EWG-01 Serial Number" found from the scanned device list. Gateway serial no. is written on the PCB.

Step 8:   Pair the Gateway with Android phone using passkey = 6982698076

Step 9:   Now open EWA-01 application on Android phone

Step 10:   Select the paired Gateway to connect the application with gateway.

Step 11:   Once connected go to Config Gateway >> Edit

Enter Gateway ID, Installation date and select Network ID, Frequency plan

Enter Latitude and Longitude information either manually or through map.

Note down the Network ID.

Click on save button.

Step 12:   Go to Cellular Setup>>Turn on modem to check for the signal strength then >>Turn off modem

Go to EDIT enter the FTP credentials for data upload and then UPDATE

Go to EDIT enter the FTP credentials for two way communication and then UPDATE

Enter APN of the network service provider and UPDATE

Click the FTP TEST tab to verify the communication between Gateway and FTP server

Step 13:   Go back to previous screen and Click on Scheduler Setup>> Update Date/Time or Sync with Phone to set the clock of the gateway.

Click on the Erase Gateway Memory to erase residual data if any.

Configure the Next Scan start time and scan interval by clicking on the clock icon's provided in line with them and then update. Go back to the home screen and press the back button to disconnect the gateway from mobile phone.

With this, the basic configuration of gateway is completed. Now we will move forward to configure the node.

5.2   TiltRange Node Setup

Use step by step procedure to configure the TiltRange Node.

Step 1:   Open the TiltRange box. Connect the RF antenna (Provided with supply).

Step 2:   Insert the batteries into battery holder with their correct polarity.

Step 3:   Optional - Connect any standard DC Power (9V, 1A) into Connector named as "EXT" on the node PCB with correct polarity.

Step 4:   Switch on the TiltRange and wait for 30 sec.

Step 5:   Connecting the TiltRange to phone:

1. Through RS-232 –USB-OTG Cable

- Switch on the TiltRange node and connect it to the Smartphone using the FTDI to OTG adaptor provided with supply. Once connected a prompt window will appear. Tap the FTDI button, Home screen of TiltRange node will appear. Refer to the section 6.2.2 of this users manual for more details on this.

Step 6:   Once connected through any one methods explained in Step 5 go to Config Node >> Edit

Enter Node ID, Installation date and select Network ID (same as Gateway network Id), Frequency plan(Same as selected in Gateway).

Enter Latitude and Longitude information either manually or through map. Click on Save button.

Step 7:   Go to Node Diagnostic >> RF Diagnostic >>Start Test to see the signal strength and test packet status and then Stop test.

Step 8:   Go to Node Diagnostic >> Laser pointing >>select Laser ON duration >>Turn on laser to set the laser point.

Step 9:   Go back to previous screen and Click on System Setup>> Update Date/Time or Sync with Phone to set the clock of the node.

Click on the Erase Node Memory to erase residual data if any.

Click on the Edit under Edit Sensor Parameter to enable/disable the parameter to report along with their units of choice, click on Save.

Step 10:   Go back to previous screen and click on Sensor Reading >>Start to monitor the parameters selected in step 8. After monitoring click on the >> Stop.

Step 11:   Go back to Home screen click on Register Node at Gateway and wait for some time. If everything has been followed as per the steps stated above the node will successfully registered to the gateway With this, we have completed the basic configuration of Encardio rite wireless systems. User can close the box.

6   CONFIGURING TILTRANGE

6.1   Setting up TiltRange

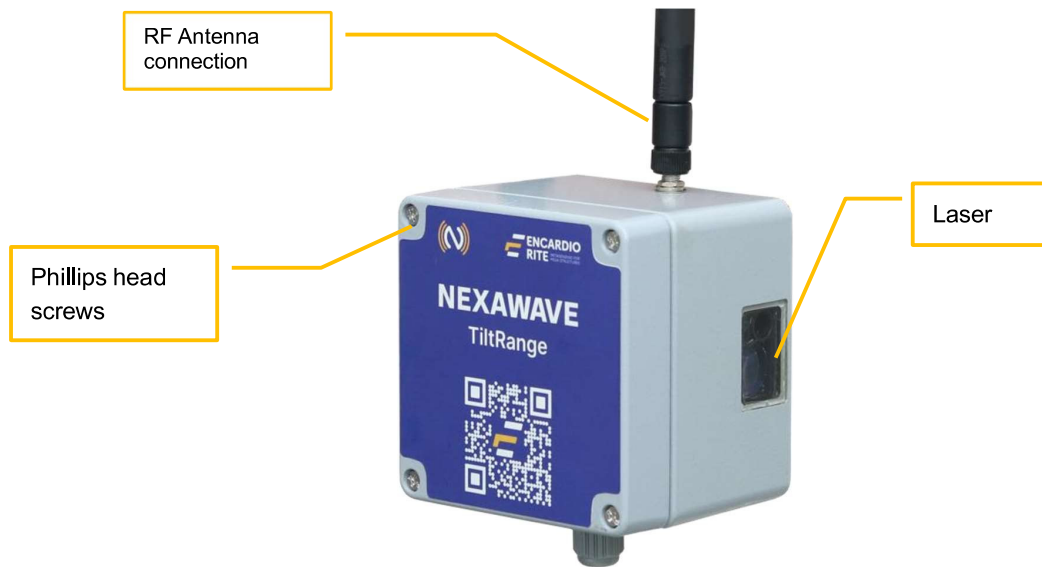- Open the top cover with screw driver. Description of each part of the TiltRange is given in the figure 6-2.
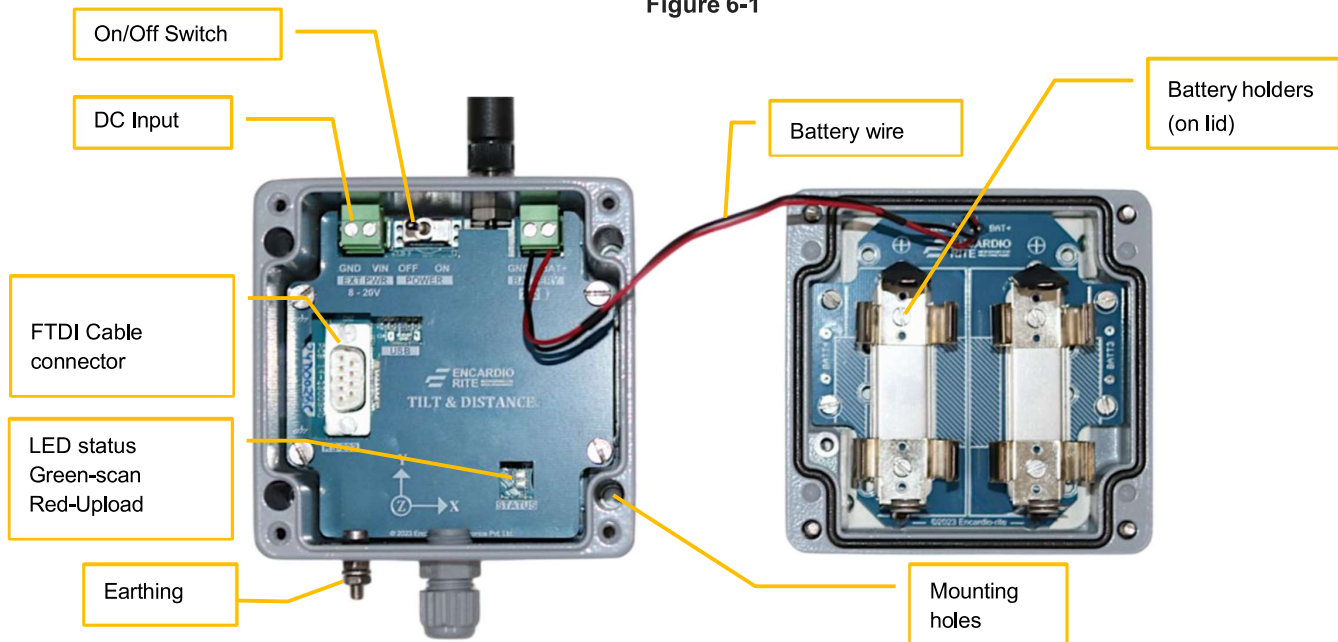

RF Antenna connection

Laser

Phillips head screws

Figure 6-1

On/Off Switch

DC Input

Battery wire

Battery holders (on lid)

FTDI Cable connector

LED status
Green-scan
Red-Upload

Earthing

Mounting holes

Figure 6-2 Wireless TiltRange details

- Connect the RF antenna (provided with supply) to the TiltRange properly.

- Insert the batteries carefully into Battery holder with their correct polarity. Ensure that the positive "+" and negative "-" are correctly connected, then switch on the node.
  - In case fast scanning is required, connect any standard DC power adaptor (9 V, 1 A) to "DC Input".
  - Or, Encardio rite make solar battery charger can also be used (available against order).

- After power up, wait for 30 seconds as during this time TiltRange performs internal operations.

6.2   Connecting TiltRange to phone

Install the apk file (provided with the supply) for "EWA-01" app on the phone. App shortcut will be available in the list of application software, as shown in figure 6-4 (a). Open the application and allow all the permissions required for proper functioning.

6.2.1   Connection using OTG

- Switch on the NexaWave TiltRange node and connect it to the Smartphone using the FTDI to OTG adaptor provided with supply, as shown in figure 6-5 below.

Figure 6-5 NexaWave TiltRange connected to Android phone with FTDI cable via OTG adaptor

- Once connected a prompt window will appear as shown in the figure 6-6 (a). Click on the FTDI button, Home screen of Tilt & Distance node will appear, as shown in figure 6-6 (b).

- At the home screen, various information about the node can be seen. Detailed description of each segments required for configuration is given in the subsequent sections.

(a)   (b) Home Screen

Figure 6-6 Home screen

6.3   Config Node

▪ Click on the "CONFIG NODE" tab from Home screen, a window as shown in the figure 6-7 (a) will appear. Click on 'Edit' button to input the information as per the requirement.
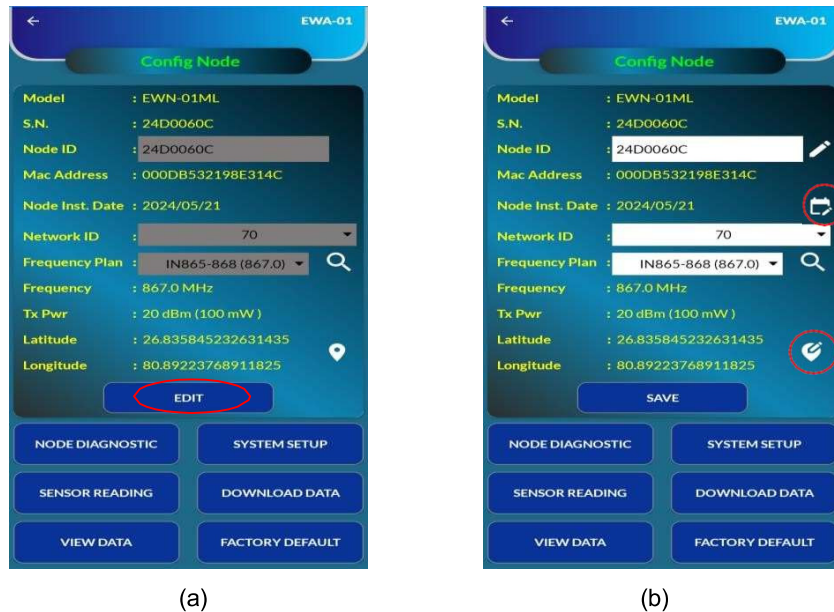

(a)   (b)

Figure 6-7 Config node

▪ User can input the "Node ID" of their choice. Try to input some meaningful ID so that it becomes convenient for other users also.

▪ Click on the Calendar Icon as shown in figure 6-7 (b) to enter the "Node Inst. date".

▪ User can select the "Network ID" from the drop down menu. Select the same Network ID what was selected during Gateway configuration.

▪ Select the "Frequency Plan" from the drop down, as was selected for gateway. This depends on the installation location, to comply with the local regulations. User can select the region and associated frequency by tapping on the search icon.

▪ For setting Latitude and Longitude of respective installation location, click on the location icon as shown in figure 6-7 (b). A prompt window will appear as shown in figure 6-8 (a)

   ▪ If user knows the installation location coordinates, select the button "Set location manually" and enter the Latitude and Longitude information as shown in figure 6-8 (b). Click on "OK" to set the coordinates manually.

   ▪ If user does not know the installation location coordinates, select the button "Set location from map" for automatic location setup. This needs to be done at the installation site location only. Ensure that the internet connectivity is there in the phone during this process. Once location is selected, click on the "SAVE" button to store all the information inside node.
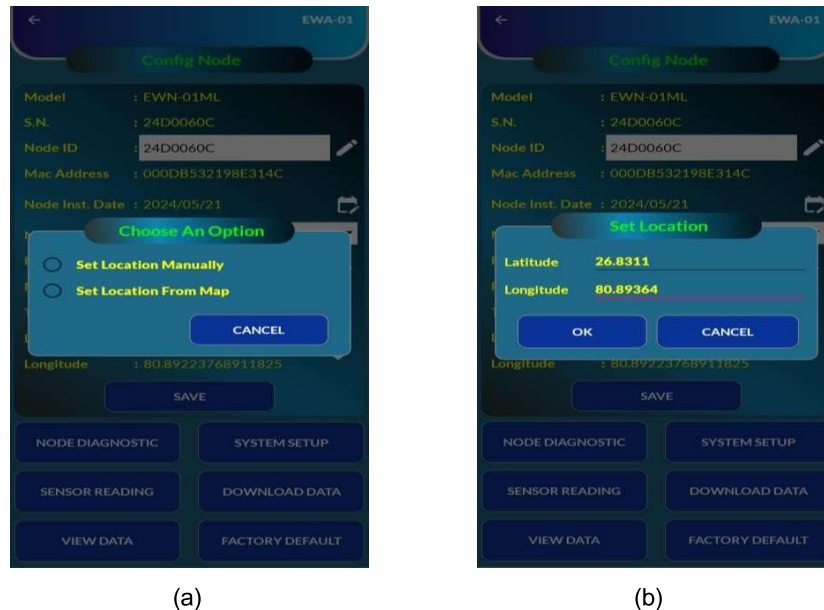
<center>(a)   (b)</center>

Figure 6-8 Location Coordinates

6.4   Node Diagnostic

Node diagnostic feature is provided to test the RF communication between Node and Gateway and set laser pointing mode. This feature is quite helpful during installation of node.

- Click "NODE DIAGNOSTIC" tab from "Config Node" screen (figure 6-7 (a)). A window as shown in figure 6-14 will appear.

- Click "RF Diagnostic" button. Check the communication by clicking on the "START TEST" tab.

  - Node will send the test packets to the gateway and display the acknowledgement from gateway.

  - The status of each packet can be seen under test packet status.

  - Other information like RSSI, transmit power could also be seen while testing.

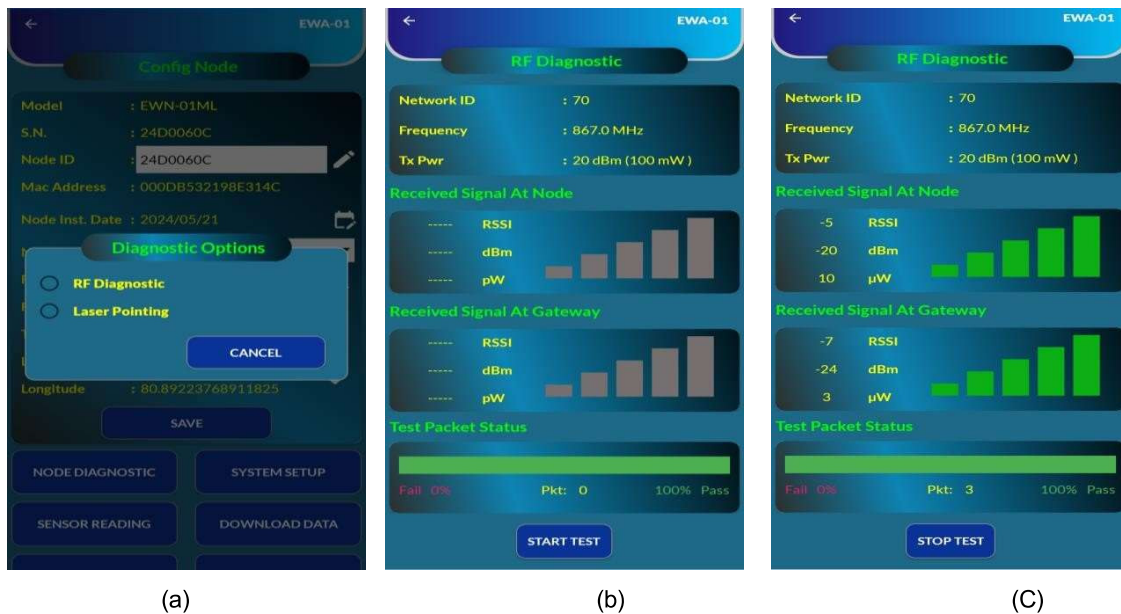- After successful communication, click on the "STOP TEST" button.

| (a) | (b) | (C) |

Figure 6-9 RF diagnostic

- Click "NODE DIAGNOSTIC" tab from "Config Node" screen (figure 6-7 (a)). A window as shown in figure 6-9 (a) will appear.

- Click "Laser pointing" button. Screen as shown in figure 6-10 will appear. Select laser "ON Duration" to set the laser point.
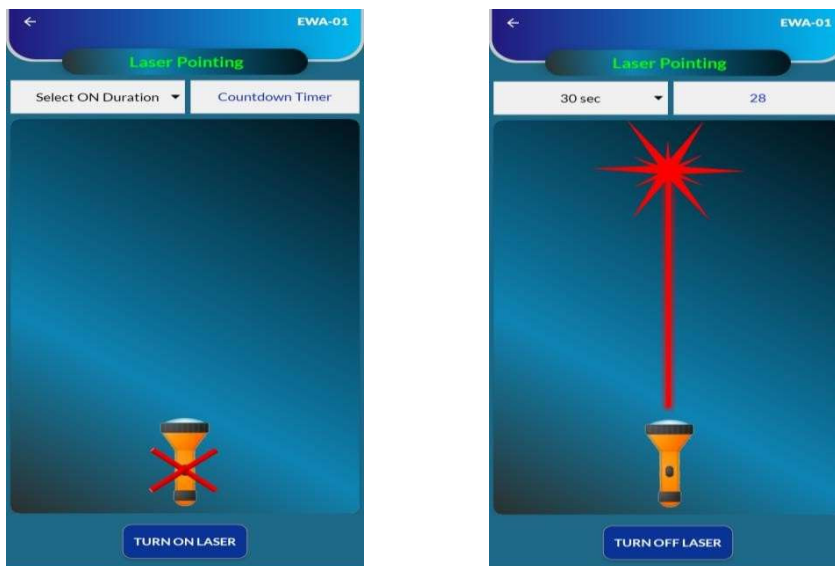

Figure 6-10 Laser Pointing

6.5   System Setup

Clock and parameter related information can be edited and modified under system setup.

- Tap the "SYSTEM SETUP" button from "Config Node" screen (figure 6-7 (a)). A new window will appear as shown in figure 6-11.

Figure 6-11 System Setup

- Set the "Clock Settings" either manually or through auto sync option. Remember that during auto synchronization, the smart phone must have the updated RTC clock settings.

- Any previous log can be erased by clicking on "ERASE NODE MEMORY". Be cautious while doing so as erased data cannot be recovered later.

- User can also control and configure the parameter along with their units of choice. Just tap the "EDIT" button, do the configuration and save the changes through "SAVE" button.

6.6   Sensor Reading

Live reading of all the parameters selected under "system setup" can be seen through "Sensor Reading". Live readings will help during installation of the node.

- Tap the "SENSOR READING" tab from "Config Node" screen (figure 6-7 (a)) to see the live readings of tilt and temperature. Screens as shown in figures 6-12 (a) & (b) will appear.

- It will display data from the two sensors. Tiltmeter readings, including the 3-axis inclination measurement in relation to gravity's direction, and the laser readings, distance in meters with the internal temperature of the node.
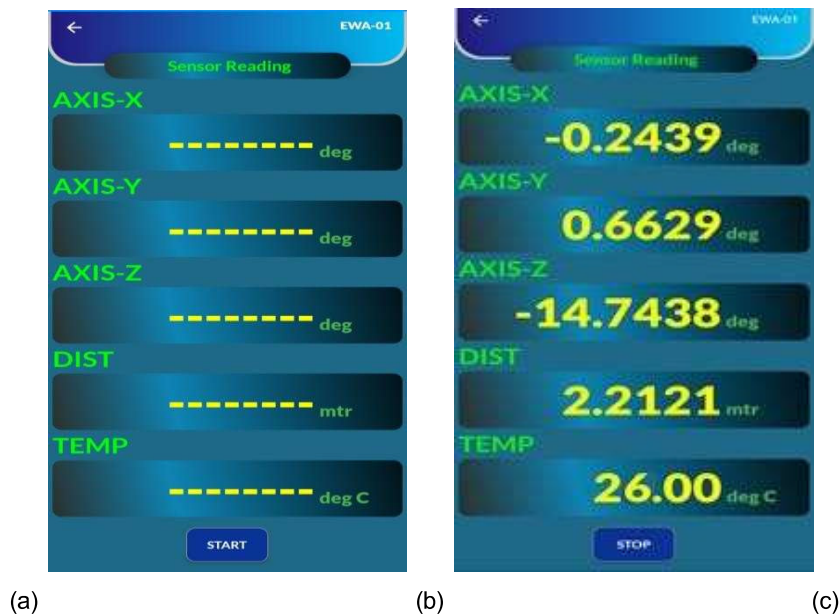
| (a) | (b) | (c) |

Figure 6-12 Sensor reading

6.7   Register node at gateway

After configuring the node by following all the above steps, it is time to register the node to gateway.

NOTE: While the setting up of TiltRanges (nodes) and gateway can be done before installation, registering of the TiltRanges to gateway must be done after installation of all TiltRanges and gateway (of same network)

- Click on the "Register Node At Gateway" tab from the main menu. While registering, a progress bar will popped up as shown in the figure 6-13 (a) to confirm the process.

- Once the node is registered with the gateway, a prompt window for successful registration will pop-up as shown in the figure 6-13 (b).
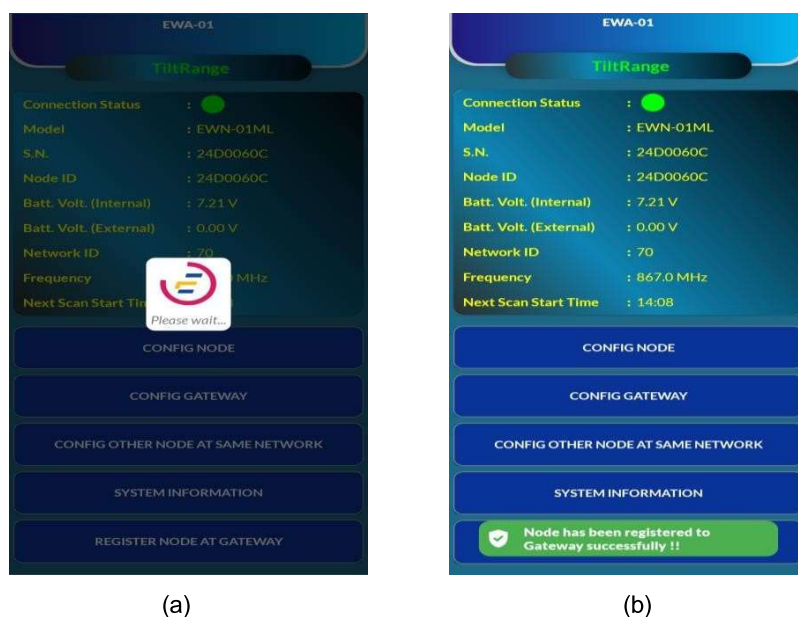

| (a) | (b) |

Figure 6-13

6.8   Download Data

- Press "Download Data" button from "Config Node" screen (figure 6-7 (a)). A window as shown in figure 6-14 will appear. Two options are provided to download the data:

  1. Since Beginning
  2. Since Last Download

  Select the first option if data is downloaded for the first time otherwise select the second option.

- Click on the "DOWNLOAD & SAVE FILE" tab to start downloading the data. A progress bar will appear to display the download progress. Data download time depends on records size. After successful download, an information window pops-up indicating the successful download.

Figure 6-14 Download data

6.8.1   File format

The downloaded data format from the TiltRange node is as shown below:

000DB532198E314C,-20,"NODE ID","DATE/TIME","BATTV(INT)","BATTV(EXT)","AXIS-X(deg)","AXIS-Y(deg)","AXIS-Z(deg)","DIST(mtr)","TEMP(deg C)"
000DB532198E314C,-25,"24D0060C","2024/05/21   15:31:05",7.16,0.00,1.2048,1.0199,-84.5996,-0.0085,27.31
000DB532198E314C,-24,"24D0060C","2024/05/21   15:37:01",7.21,0.00,1.1550,1.0304,-84.7519,0.6691,27.19
000DB532198E314C,-22,"24D0060C","2024/05/21   15:52:02",7.20,0.00,1.1728,1.0375,-84.5996,0.4405,27.27

6.9   View Data

The downloaded records can be viewed using "View Data" option.

- Press the "VIEW DATA" tab from "Download" screen (figure 6-10 (c)). A window as shown in figure 6-15 (a) will appear.
- Select the desired node from the dropdown.
- Select different parameters from the dropdown to view corresponding data for those parameters..