

USERS MANUAL

NEXAWAVE TiltSense

Model EAN-95MW



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TUNNELS



HYDROELECTRIC



CONSTRUCTION



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1 INTRODUCTION

1.1 NexaWave TiltSense overview

Encardio-rite model EAN-95MW NexaWave TiltSense is suitable for long term monitoring of inclination and vertical rotation of structures. Continuous data logging and real-time monitoring helps to provide early warning in case of impending failure allowing time for corrective action to be taken or if necessary for safe evacuation of the area.

Tilt change in a structure may be caused by construction activity like excavation, tunneling or de-watering that may affect the ground supporting the structure. Change in tilt could also result from loading of the structure, such as loading of a dam during impoundment, loading of a diaphragm wall during excavation or loading of a bridge deck due to wind and traffic. Data from the tilt meter provides early warning of threatening deformation of the structures.

1.2 Tilt meter applications

EAN-95MW NexaWave TiltSense 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 tilt meter 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 tilt meters are interfaced with the long range, low power radio frequency network to **gateway**. The tilt meter 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/Canada/Singapore/Australia	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 tilt meters 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 tilt meter 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 EAN-95MW NexaWave TiltSense

Model EAN-95MW NexaWave TiltSense combines high precision Micro-Electro Mechanical System (MEMS) sensor with radio transmission network to provide accurate tilt data. The unit is mounted inside a compact weatherproof enclosure. The tilt sensor provides a 20-bits digital output proportional to the sine of tilt angle measured by the beam. The sensor can measure tilt in all the 3-axes (X, Y and Z). Tilt sensor measurement range is $\pm 30^\circ$. 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 $\pm 0.1^\circ\text{C}$.

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 NexaWave TiltSense measures change in tilt of a structure to which it is attached. The tilt meter 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 tilt meters (or other geotechnical sensors) to the remote server. The gateway enabled with wireless network provides reliable data transfer over long 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 tilt meters and gateway, information about the slightest of change taking place at specific location is available. This allows timely decisions, increased safety and cost effectiveness.

3 TECHNICAL SPECIFICATION

Basic			
Internal Battery	2X3.6V Li-Ion Battery (D-cell ER34615M)		
External Power	9V Standard adaptor or EBS-01(available on order)		
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	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)
	14 dBm	13.51 dBm	20 dBm
Baud Rate	9600 bps(Max)		
Receiver Sensitivity	-132 dBm		
Transmission Distance	(1 ~ 15 KM)*		

* 800 meter in urban areas

Antenna	
Frequency	902-930 MHz
Gain	4.44 dBi
SWR	≤1.5
Polarization	Vertical
Radiation Direction	Omnidirectional
Input Impedance	50Ω
Power Capacity	20W
Height	203 mm
Total Weight	21g
Coat Material	TPEE
Working Temperature	-40°C ~ +85°C
Storage Temperature	-40°C ~ +85°C

4 PRE-INSTALLATION PREPARATIONS

4.1 Pre-installation checks

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

4.2 Selecting location for Gateway and Tilt meter

Selecting correct locations for Gateway and tilt meter is important, especially in case more than one tilt meter 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 tilt meters or in line of sight with most tilt meters. The best location will have to be determined at the site itself. For best results, the link between the gateway and the tilt meter 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 & Tilt meter

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

The gateway configuration needs to be done before tilt meter. For setting up and configuring the gateway, refer to User's Manual # WI6002.117 on Gateway. Configuration of tilt meter 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 Tilt meter 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 tilt meter (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 Tilt meter node is:

$$\text{Sampling Interval (Seconds)} = (20 * \text{No. Tilt meter Node}) + 180$$

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:** Turn ON the Smartphone Bluetooth
- Step 8:** Press on [Scan](#) option to search nearby Bluetooth devices
- Step 9:** Press on "[EWG-01 Serial Number](#)" found from the scanned device list. Gateway serial no. is written on the PCB.
- Step 10:** Pair the Gateway with Android phone using passkey = [6982698076](#)
- Step 11:** Now open EWA-01 application on Android phone
- Step 12:** Select the paired Gateway to connect the application with gateway.
- Step 13:** 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 14:** 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 15:** 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 Tilt meter Node Setup

Use step by step procedure to configure the Tilt meter Node.

Step 1: Open the tilt meter 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 tilt meter and wait for 30 sec.

Step 5: **Connecting the tilt meter to phone:**

1. Through Bluetooth Modem

- Insert the RS-232 Bluetooth Modem (provided with supply) into DB9 connector and switch on the Bluetooth modem
- Go to android phone's [Settings>>Connections](#)
- Turn ON the Smartphone Bluetooth
- Press on [Scan](#) option to search nearby Bluetooth devices
- Press on "[ERB-01 Serial Number](#)" found from the scanned device list. Node serial no. is written on the PCB.
- Pair the Node with Android phone using passkey = [6982698076](#)
- Now open EWA-01 application on Android phone
- Select the paired Node to connect the application with Node.

2. Through RS-232 –USB-OTG Cable

- Switch on the tilt meter 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 tilt meter node will appear. Refer to the section 6.4.2 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 >> Start Test](#) to see the signal strength and test packet status and then [Stop test](#).

Step 8: 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 9: 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 10: 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 TILT METER

6.1 Setting up Tilt meter

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

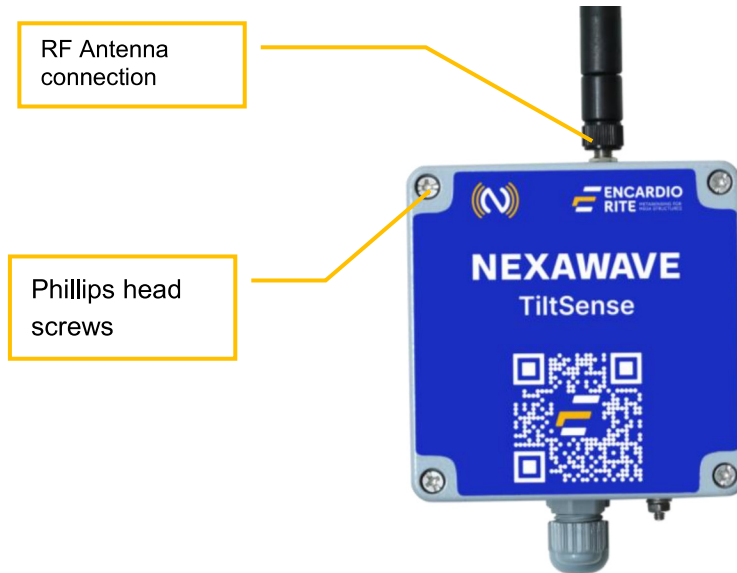


Figure 6-1

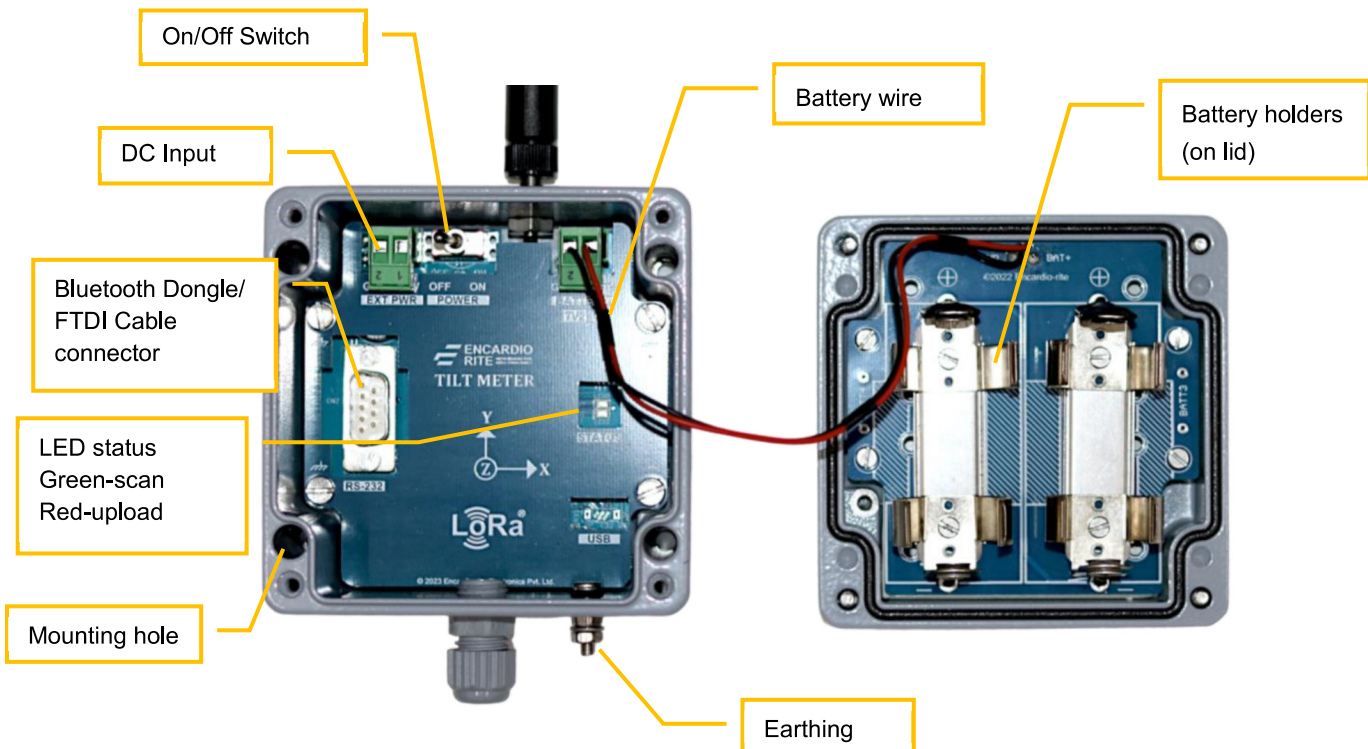


Figure 6-2 Wireless tilt meter details

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

6.2 System components

Provided by Encardio-rite:

- Model EAN-95MW- Wireless tilt meter with antenna
- Model EWG-01 Gateway with antenna
- Gateway and Node mounting accessories
- RS-232 Bluetooth modem/USB to RS-232 FTDI cable
- Application software for Android Smartphone
- Application software for Windows

To be arranged by Client:

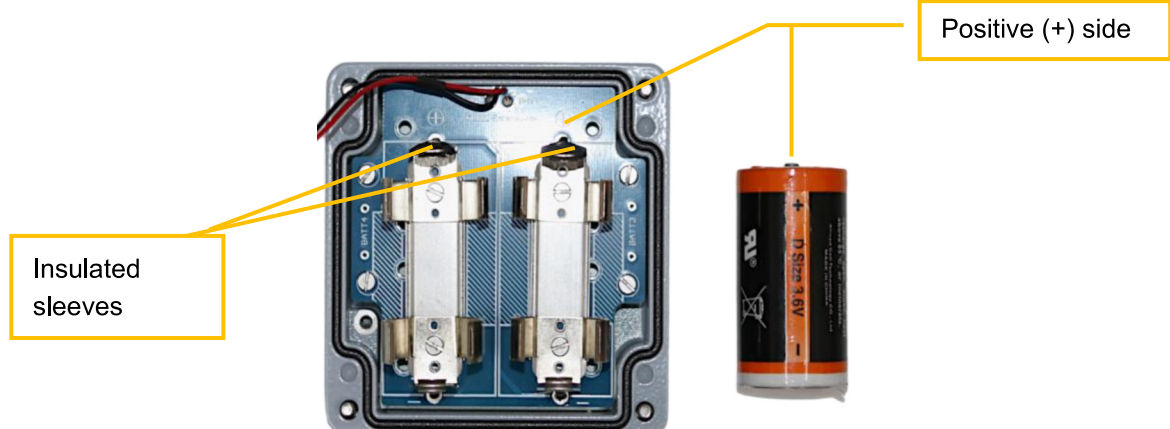
- Laptop or Android Smartphone
- Activated data SIM card – 1 no. for Gateway
- D-Cell Li-SOCI2 3.6 V 14.5 Ah batteries - 4 no (2 no. each for tilt meter and Gateway)
- Power supply unit 9-30 V, 1 A for Gateway (12 V, 1 A power supply easily available can be used)

6.3 Battery Installation

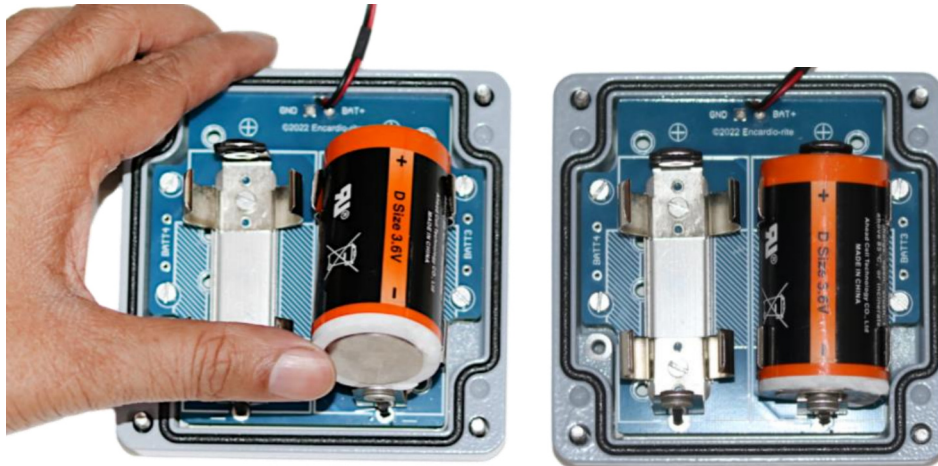
- Open the device by unscrewing the four Phillips head screws on the front of the enclosure.



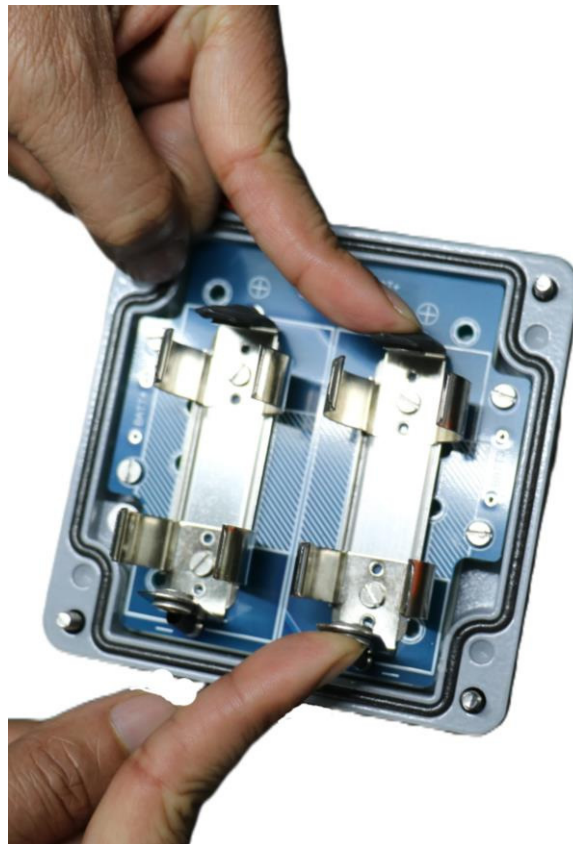
- Align the positive (+) side of the batteries with the + indicator in the battery holder.



- Slide the positive end of the battery inside the compartment first. Installing the positive end first allows the battery to slide into the compartment more easily. Just push the positive end of the battery into the lever, flattening it down into the holder. Apply a bit more pressure, if necessary, to snap the negative end of the battery securely into place.



- Check for any looseness in the positive and negative clip terminals of the holder. If they are loose, press them down to ensure proper contact with the battery.



- 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 tilt meter performs internal operations.

6.4 Connecting tilt meter 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.

6.4.1 Connection using Bluetooth

The tilt meter node can be connected with mobile by using Bluetooth. Plug Bluetooth modem (provided with supply) at 9 pins D-sub connector of the Node. Make sure that modem must be configured for 115200 baud rate and hardware flow must be OFF. Verify DIP switch settings with following figure 6-3.

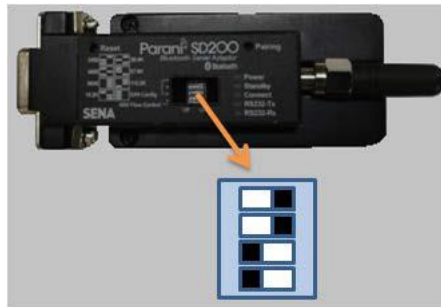
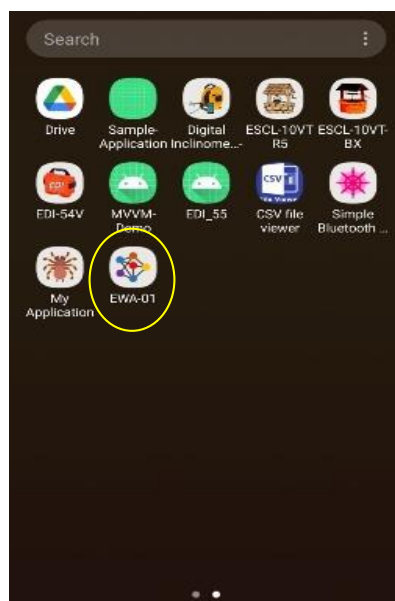
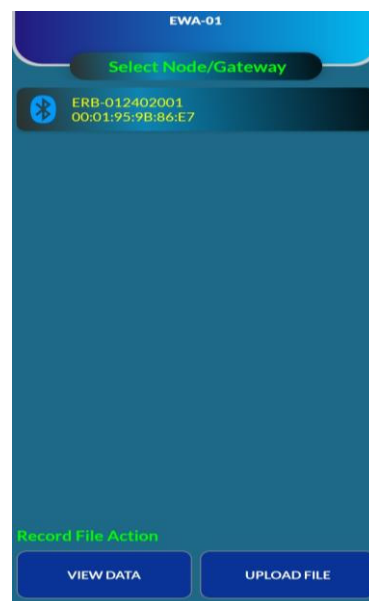


Figure 6-3: Bluetooth modem DIP switch settings

- Turn-on the Bluetooth modem by pressing ON/OFF switch located near modem's battery compartment. The power indicator of Bluetooth modem will glow in GREEN color to ensure that Bluetooth modem is ON.
- Turn on Bluetooth of the android phone and go to Bluetooth settings. Click on “scan” button. Phone will show the list of Bluetooth devices found. Find the Node Name and serial number on phone screen and click for pairing the phone with Node. Once pairing button is pressed it will ask to enter passkey for authentication.
- Enter pairing code “6982698076” and then press OK. On successful authentication, it will show that device is paired. Now phone is paired with Node.



(a)



(b)

Figure 6-4

- Open the “EWA-01” apk installed on phone. It will show the list of paired Nodes as shown in the figure 6-4 (b). Select the node paired from the list. It will take you to the home screen of the node as shown in figure 6-6 (b).

6.4.2 Connection using OTG

- Switch on the tilt meter 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 Tilt meter 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 meter 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

6.5 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.