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USERS' MANUAL

Wireless Tilt meter

MODEL EAN-95MW

Doc. # WI 6002.116 Rev. 01a | Jan 2020

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Declaration of Conformity

FCC Declaration of Conformity

FCC Caution: Any changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate this equipment.

This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

FCCRF Radiation Exposure Statement:

1. This Transmitter must not be co-located or operated in conjunction with any other antenna or transmitter.
2. This equipment complies with FCC radiation exposure limits set forth for an uncontrolled environment.
3. This equipment should be installed and operated with a minimum distance of 20cm between the radiator& your body.

Contents

1 INTRODUCTION

Encardio-rite model EAN-95MWwirelesstilt meter is suitable for long term monitoring 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 deformations, allowing time for corrective action to be taken or if necessary for safe evacuation of the area.

1.1 Applications

EAN-95MWtilt meter is widely used in 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.

1.2 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.

1.3 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

Model EAN-95MW wireless tilt meter 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 bipolar DC voltage output proportional to the sine of tilt angle measured by the beam. The sensor gives 4 V nominal output at ± 15°. The output is zero volts for a truly vertical or horizontal position.

This output can be transmitted through mesh wireless network over long distances without any signal degradation. Each unit is individually calibrated to provide high system accuracy and repeatability.

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.

The EAN-95MW tilt meter is not intended for absolute determination of tilt of structures. It measures change in tilt of a structure to which it is attached. The initial tilt reading for each tilt sensor is recorded after it has been mounted on the structure to be monitored. Subsequent tilt readings will be displayed w.r.t. initial reading.

2.1 System components

Provided by Encardio-rite

- Model EAN-95MW- wireless tilt meter with antenna
- Model EWG-01 Gateway with GSM antenna
- OTG cable type B
- Application software for Android Smartphone

To be arrange by Client

- Laptop
- Android smartphone
- Activated data SIM card (for Gateway)
- D-Cell Li-SOCl2 3.6 V 14 Ah batteries nominal Voltage - 2 no (1 no. each for tilt meter and Gateway)

3 SAMPLE TEST CERTIFICATE

TEST CERTIFICATE
(for 'A' axis calibration)

Item	:	Tilt meter	Date	:	23.10.2019
Model	:	EAN-95MW	Temperature	:	25ºC
Range	:	±15º			
Serial no.	:	19100101			
Device ID	:	6726			

Next calibration due on : 22.10.2020

Test data

Test position Arc degrees (A)	SinA	*Calculated output (V_1) Volts	**Ideal output (V_2) Volts	Observed output (V_3) Volts	Offset corrected output (V_4) Volts	Error (V_4 - V_2) Volts	Non-conformance % fs
15	0.2588	4.1408	4.1130	4.1170	4.1160	0.0030	0.073
12	0.2079	3.3264	3.3041	3.3060	3.3050	0.0009	0.023
9	0.1565	2.5032	2.4864	2.4860	2.4850	0.0014	0.034
6	0.1046	1.6728	1.6616	1.6610	1.6600	0.0016	0.038
3	0.0524	0.8376	0.8320	0.8320	0.8310	0.0010	0.024
0	0.0000	0.0000	0.0000	0.0010	0.0000	0.0000	0.000
-3	-0.0524	-0.8376	-0.8320	-0.8300	-0.8310	0.0010	0.024
-6	-0.1046	-1.6728	-1.6616	-1.6580	-1.6590	0.0026	0.062
-9	-0.1565	-2.5032	-2.4864	-2.4810	-2.4820	0.0044	0.107
-12	-0.2079	-3.3264	-3.3041	-3.3000	-3.3010	0.0031	0.075
-15	-0.2588	-4.1408	-4.1130	-4.1090	-4.1100	0.0030	0.073
					Max non-conformance (% fs) :		0.11

Sensor gauge factor 'A' Axis : 15.893 Volts/Sin(90)

Calculation of tilt value (arc degree) :

SinA = Observed output / gauge factor

A = Sin^{-1}(observed output / gauge factor)

Note :

* Calculated output Voltage (V_1) worked out based on nominal gauge factor of 16.000 V/g (i.e. 16V X Sin A).

** Ideal output Voltage (V_2)' calculated from sine curve passing through sensitivity calibration points (@ ±15º)

Tested by :

TEST CERTIFICATE
(for 'B' axis calibration)

Item	:	Tilt meter	Date	:	23.10.2019
Model	:	EAN-95MW	Temperature	:	25ºC
Range	:	±15º			
Serial no.	:	19100101			
Device ID	:	6726			

Next calibration due on : 22.10.2020

Test data

Test position Arc degrees (A)	SinA	*Calculated output (V_1) Volts	**Ideal output (V_2) Volts	Observed output (V_3) Volts	Offset corrected output (V_4) Volts	Error (V_4 - V_2) Volts	Non-conformance % fs
15	0.2588	4.1408	4.1025	4.1460	4.1010	0.0015	0.037
12	0.2079	3.3264	3.2956	3.3390	3.2940	0.0016	0.040
9	0.1565	2.5032	2.4800	2.5210	2.4760	0.0040	0.099
6	0.1046	1.6728	1.6573	1.6990	1.6540	0.0033	0.081
3	0.0524	0.8376	0.8299	0.8720	0.8270	0.0029	0.070
0	0.0000	0.0000	0.0000	0.0450	0.0000	0.0000	0.000
-3	-0.0524	-0.8376	-0.8299	-0.7860	-0.8310	0.0011	0.028
-6	-0.1046	-1.6728	-1.6573	-1.6110	-1.6560	0.0013	0.032
-9	-0.1565	-2.5032	-2.4800	-2.4330	-2.4780	0.0020	0.050
-12	-0.2079	-3.3264	-3.2956	-3.2500	-3.2950	0.0006	0.015
-15	-0.2588	-4.1408	-4.1025	-4.0590	-4.1040	0.0015	0.037
					Max non-conformance (% fs) :		0.10

Sensor gauge factor 'B' Axis : 15.852 Volts/Sin(90)

Calculation of tilt value (arc degree) :

SinA = Observed output / gauge factor

A = Sin^{-1}(observed output / gauge factor)

Note :

* Calculated output Voltage (V_1) worked out based on nominal gauge factor of 16.000 V/ g (i.e. 16V X Sin A).

** Ideal output Voltage (V_2)' calculated from sine curve passing through sensitivity calibration points (@ ±15º) .

Tested by :

4 PRE-INSTALLATION PREPARATIONS

4.1 Pre-installation checks

- Check the tilt meter and gateway for any physical damage.
- Open the tilt meter box and check if the internal wiring is intact.
- Install the "ER_Wireless_Tiltmeter" application (provided with the tilt meter supply) on the Android smartphone

4.2 Setting up the Gateway

NOTE: For setting up and configuring the gateway, refer to user's manual # WI6002.117 on gateway.

5 INSTALLATION PROCEDURE

5.1 Tilt meter installation

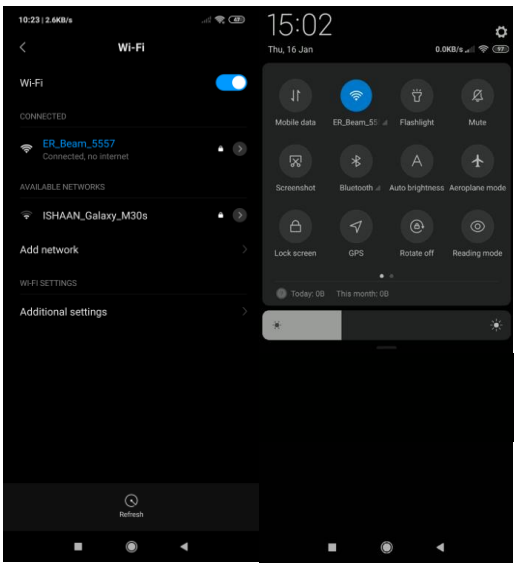
The EAN-95MW tilt meter (biaxial) is used to measure rotation of structures in the plane parallel as well as perpendicular to the surface/wall on which the tilt meter is mounted.

- The tilt meter box is provided with mounting holes as in figure below.

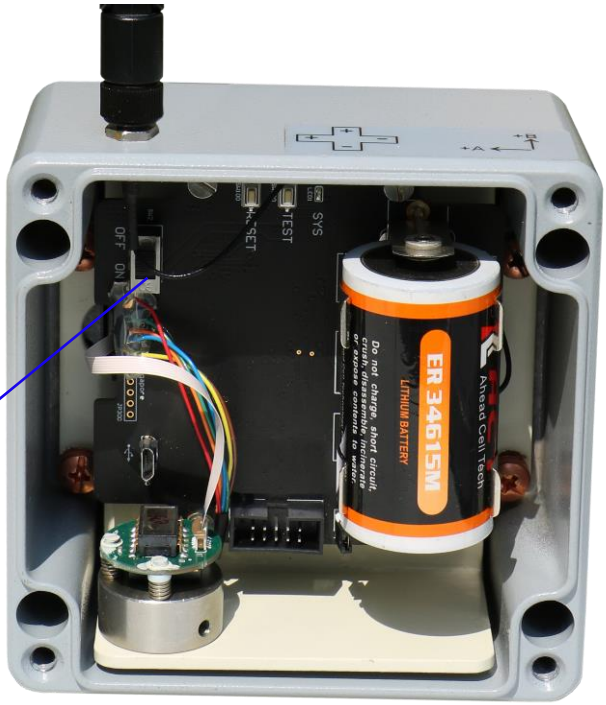
- For installing the tilt meter on wall, mark locations of the four mounting holes. Ensure that position of the holes are aligned vertically using a spirit level.
- Drill holes depending on the mounting fasteners being used for fixing the tilt meter and fix the tilt meter on wall ensuring its vertical position. (Do not close the box before configuring it. Configuration details are given in next section)

5.2 Configuring tilt meter

- Connect the Android smartphone to the ER_BeamWiFi network. (Refer to the users' manualof Gateway to learn about switching on the ER_BeamWiFi network.)

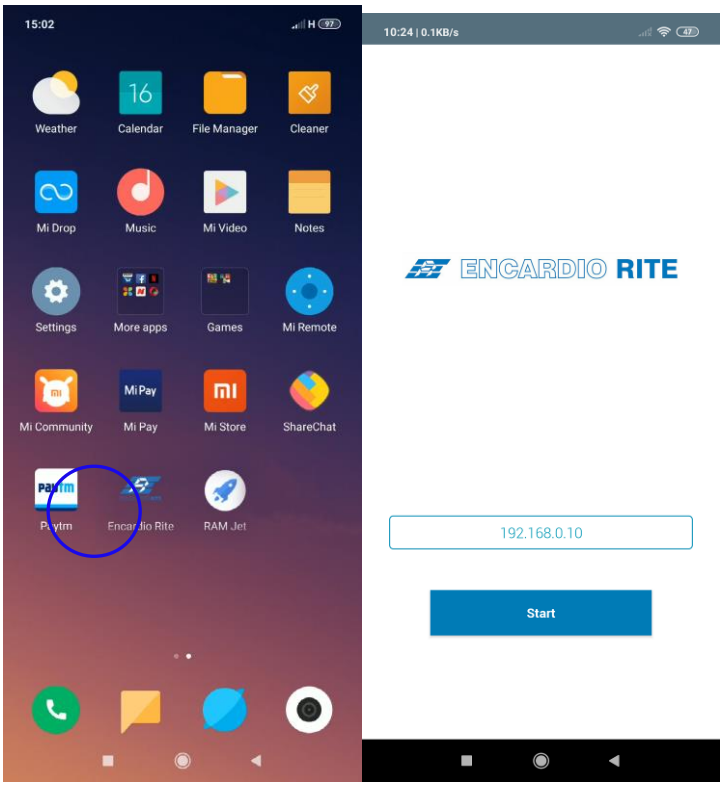


- Connect the Smartphone to tilt meter's RF node using the OTG cable provided with supply. Ensure that the node switch is turned off before connecting the phone..



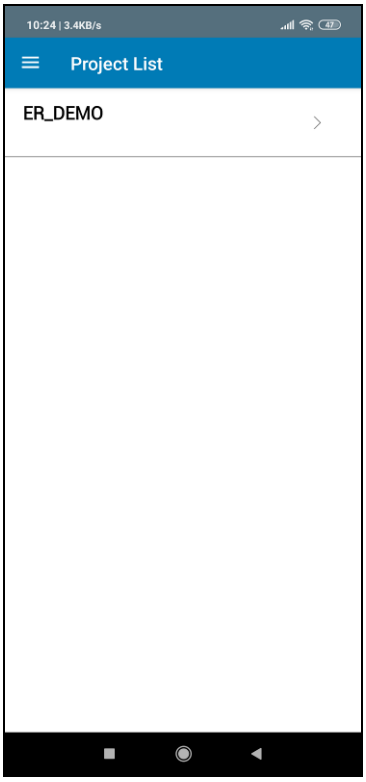
On-Off switch of RF node section

- Switch on the Node.
- Open the ER_Wireless_Tiltmeter app on the phone.

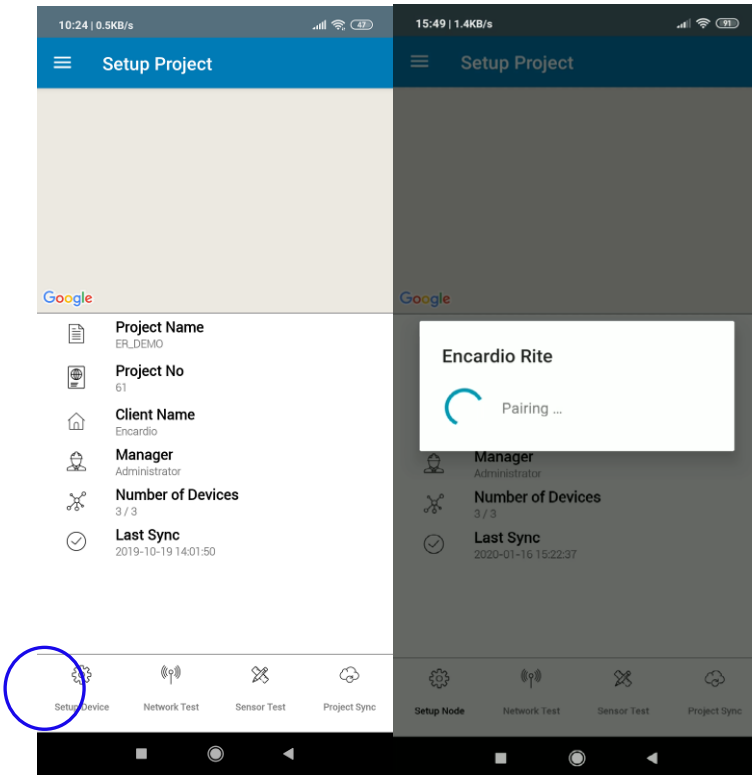


NOTE: You **need to add the Node and create the project first before you commission the tilt meter. Please refer to 'Gateway Setup' section in the users' manual for Gateway for details.**

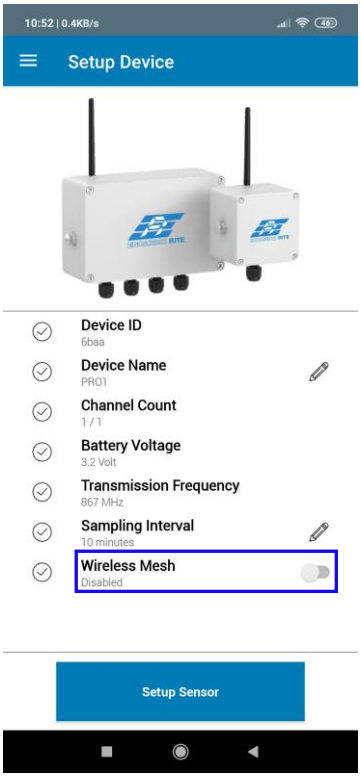
- Search for the project which you have already created once you open your ER_Wireless_Tiltmeter app. Click the button to download the project and enter in the project, where the project details would be mentioned.



- Click on "Setup Device" on the menu (at the bottom of screen), the app will show connected node information.

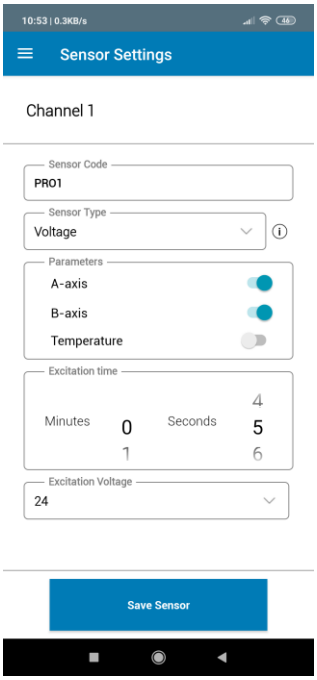


- Optional Step: If Wireless Mesh (Relay) function is to be deployed, click on "Wireless Mesh" toggle button to enable. Once done, click on "Setup Sensor", you can now configure the sensor settings.

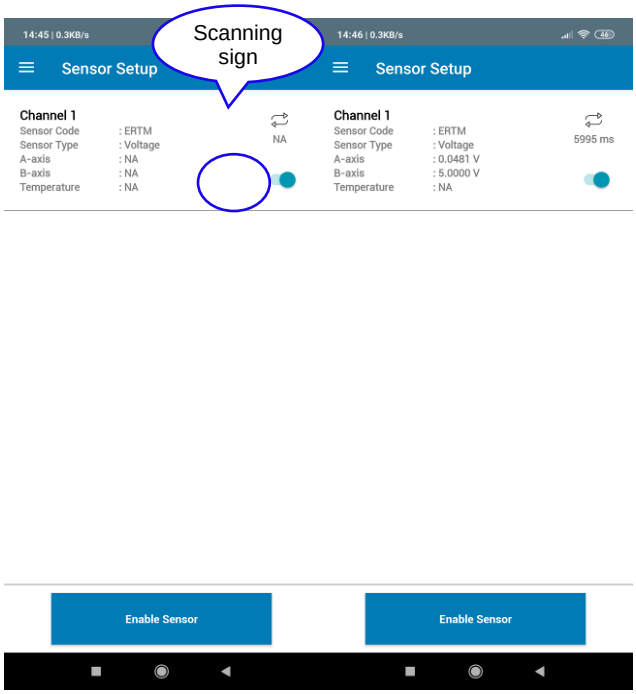


- Sensor setting can be made as follows:

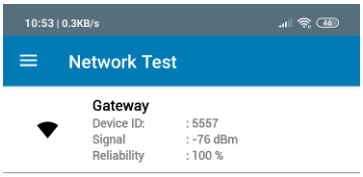
  Sensor Code: Your desired sensor name.
  Sensor Type: Select respective sensor type.
  Parameters: Turn on the parameters as connected to the Node.
  Excitation: Set the warm up time required for the sensor (for tilt meter, it can be set as 5 seconds).
  Excitation Voltage: Select 24 (for tilt meter)

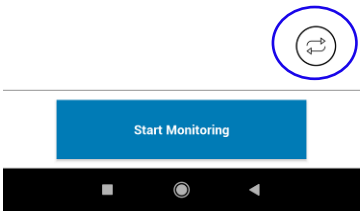


- Click Save Settings. The Node will now read the configured sensor.
- The next page, you will be seeing the readings of the sensor.Turn on blue color icon to enable the sensor and press the scanning sign

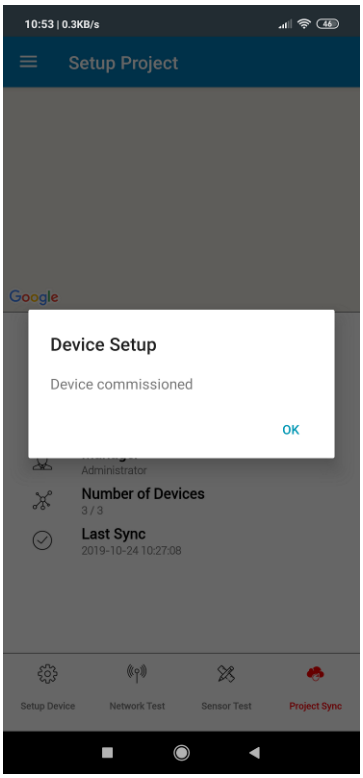


- Once the tilt meter is configured, click on "Enable Sensor", it will take you to next page "Scanning Network" which will scan the wireless signal strength (RSSI) between the Node and Gateway. After you get the Network Test information, if you need to, you can refresh by pressing the button located at the lower right corner.

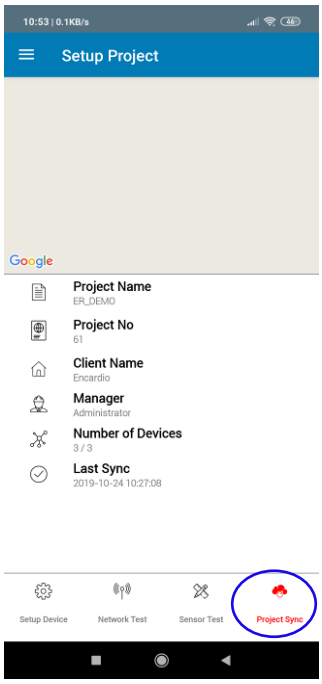




- Click "Start Monitoring" button then the app will prompt "Device commissioned". Click OK.



- Press the Project Sync button at lower right area to send all the configuration information back to the gateway.



- Tilt meter's RF node configuration is now complete. Close the tilt meter box.
- The field engineer can now leave the site. The remaining configuration/changes can be done with the Gateway software dashboard on your laptop by selecting the related project. You willsee the commissioned device under "Device Summary" Section.
- Refer to section 4 of the users' manual on Gateway and the test certificate provided with the tilt meter to put the gage factor and final configuration of the tilt meter for taking readings.

5.2.1 *Protection of tilt meter*

Avoid installation of tilt meter in parts of the structure exposed to direct sunlight. If this is not feasible, a box made from Thermocole or similar heat insulating material should be installed covering the tilt meter and protecting it from direct sunlight.

If certain degree of mechanical protection is also required, wooden or fibreglass protection boxes may be considered. Heat insulating tape can be fixed to the inner surface of such boxes for thermal insulation.

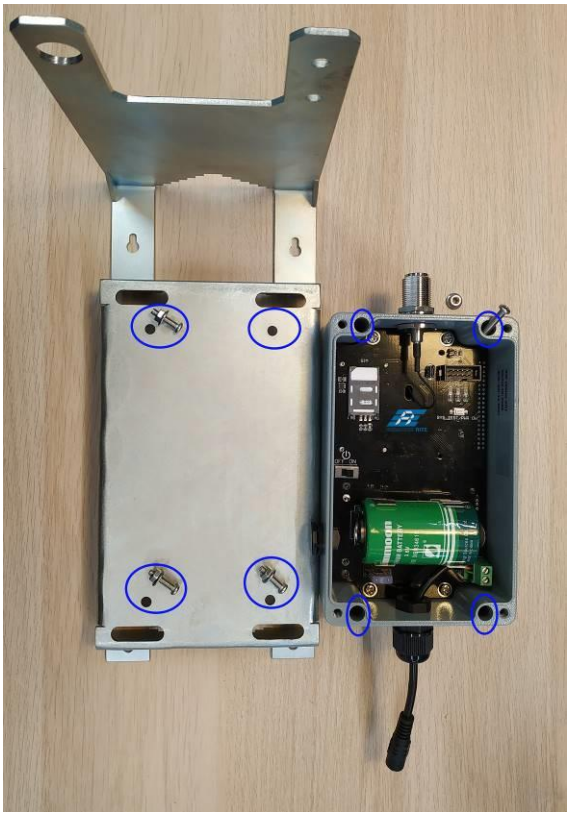
5.2.2 *Other considerations*

Install tilt meter on a structural member of a building and not on the façade or boundary wall which may behave in a different manner than the main building. Do not install it at a location having vibrations, for example caused by a heavy rotary machinery. Avoid installing at location where it can be vandalized or get hit by pedestrians.

5.3 Gateway installation

The gateway can be directly affixed to a flat surface using M3 screws. However, for more sophisticated mounting scenarios, we recommend using the gateway bracket. The gateway bracket can be used to easily mount the gateway on flat surfaces, on pipes using U-bolts, or in other complicated settings. (One of our clients hung it using cable ties as well!)

If you are using the bracket, first fix the gateway device to the bracket using M3 screws and nuts as shown below.



Four screws and nuts to attach the gateway to the bracket

Gateway antenna & Cellular (GSM) antenna positioning

Fix the gateway antenna and the cellular antenna to the bracket as shown above. Note that the Gateway has two identical ports at the bottom for GPS and Cellular (GSM) antennas. Therefore, connect the cellular antenna to the correct port.

6 MEASUREMENT OF TILT

The output of model EAN-95MW tilt meter is transmitted via mesh wireless (RF) network. The tilt meter is interfaced with the long range, low power wireless mesh network that allows tilt meter to send recorded datato the Gateway. The Gateway thenuploads all the collected sensor data to the central/cloud server.

Thedata management and applicationsoftwareis provided with the supply to configure and manage thetilt meter data.

6.1 Sign convention

Carefully orient the tilt sensor during installation. A (+) sign is on the top right side of the enclosure. If the enclosure is tilted counter-clockwise then readings show an increase (with positive sign)Figure 1 (left). If the enclosure tilts clockwise then readings show a decrease(with a negative sign)-Figure 1 (right).

If the tilt meter is installed on the plane of a building, the B (+) sign is towards the plane and B (-) sign is away from the plane.

Figure below shows view from side and convention used for direction/output signal polarity. After the enclosure is fixed to the structure, the sensor is adjusted to the zero reading (initial). Subtracting the initial tilt reading from the subsequent tilt reading gives change in tilt of structure over a period of time.

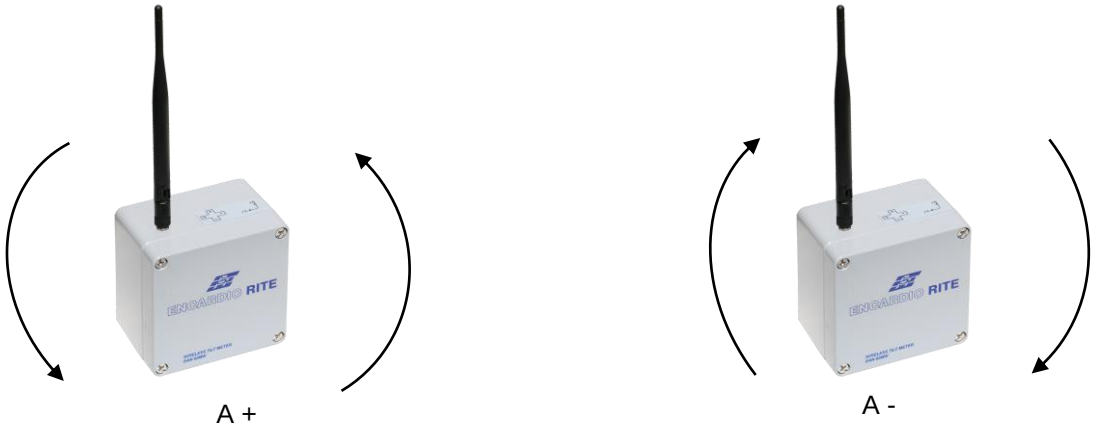


Figure 1 Sign Convention of tilt for EAN-95MW tilt meter

6.2 Environmental factors

Several factors can influence the behavior of the structure being monitored for change in tilt using the tilt meter. Having a knowledge of the factors influencing the behavior of the structure is essential for analyzing the tilt meter data. Data related to factors such as rain fall, tidal or reservoir levels, excavation or fill levels, construction activities nearby the structure, movement of traffic near the structure and its type, wind, ambient temperature, barometric pressure etc. should also be observed and collected along with the tilt meter data.