



Instruction Manual

Sensors for structural health monitoring of civil works



Quick installation guide and system operation

Important safety, compliance and warranty information

Instruction Manual

English

Read Manual Before Product Use

Move S.r.l.

Piazza Cavour 7, 20121 Milan - Italy

Via Guglielmo Lippi Francesconi 1256/J, 55100 Lucca - Italy

P.IVA: 09887990969

MOVE SOLUTIONS CUSTOMER ASSISTANCE SERVICE

Visit the website at www.movesolutions.it for contact information relating to office addresses and telephone numbers.

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NOTICE OF PUBLICATION:

The manual for these products has been written and published to provide the latest safety information available at the time of publication. The information contained in this manual may be subject to change. For further instructions, more detailed information, product specifications or, in case, to download manuals more up-to-date, visit our website at www.movesolutions.it.

Index

1. Manual user guide	4
2. Introduction to the Structural Monitoring System	6
3. Use and safety guidelines	8
4. Guide to load tests	12
5. DECK device	16
5.1 Quick guide to use	17
5.2 DECK unpacking instructions	19
5.3 DECK orientation	20
5.4 DECK installation guide	23
6. Triaxial Tiltmeters	28
6.1 Quick guide to use	29
6.2 In-depth analysis of the Tiltmeter output	30
6.3 Tiltmeter unpacking instructions	33
6.4 Tiltmeter orientation	34
6.5 Tiltmeter installation guide	35
7. Triaxial Accelerometer	40
7.1 Quick guide to use	41
7.2 Accelerometer unpacking	43
7.3 Accelerometer orientation	44
7.4 Accelerometer installation guide	45
8. Triaxial Accelerometer SHM	48
8.1 Quick guide to use	49
8.2 Accelerometer SHM unpacking	51
8.3 Accelerometer SHM orientation	52
8.4 Accelerometer SHM installation guide	53
9. Analog Communication Node	56
9.1 Quick guide to use	57
9.2 Analog node unpacking	59
9.3 Analog node orientation	60
9.4 Analog node installation guide	63
10. Gateway SHM	70
10.1 Quick guide to use	71
10.2 Gateway SHM unpacking	73
10.3 Gateway SHM configuration	74
10.4 Gateway SHM installation guide	79
11. Dimensions and overall dimensions	88
12. Warranty	94
13. Frequent problems in use	95
14. Note	96

Manual user guide

It is important that any user responsible for the installation, configuration, use and maintenance of the Move Solutions™ structural monitoring system in the civil field has read this manual in advance.

HOW TO USE THIS MANUAL:

1. Before installing and using the product, please read this entire manual and keep it for later reference.
2. Carefully follow the instructions in this manual and always make sure to follow all warnings and instructions marked on the product.
3. If you have any doubts regarding the use of the product after reading this manual, you can contact the Customer Service at support@movesolutions.it.
4. For an optimal understanding of all instructions, it is advisable to study the symbols and conventions used throughout the documentation.



IMPORTANT

- Any improper use not described in these instructions is prohibited. Failure to follow these instructions could result in an increased risk of personal injury or property damage.
- Move Solutions™ cannot be held responsible for damage resulting from failure to follow the instructions in this guide by the product owner.

NOTE

- In case of deterioration or loss of this manual, a compliant copy may be requested by the customer from the manufacturer. For increased security, we suggest that you keep a copy of this manual in a place where it cannot be damaged or lost.

Symbols and provisions used in the documentation

The following symbols and conventions are used throughout the documentation. Please follow all warnings and instructions marked on the product.



CAUTION

CAUTION indicates a potentially hazardous situation which, if not avoided, can result in minor or moderate injury.



Fire Danger icons warn of the possibility of fire.



Electrical Danger icons warn of the risk of electric shock.



IMPORTANT

IMPORTANT indicates a potentially hazardous situation which, if not avoided, can result in property damage or loss of product functionality.



Prohibition icons indicate actions that must not be performed.

NOTE

NOTE specifies the operating environment, installation conditions, or special conditions of use.

Bold

Bold text highlights an important point or keywords for understanding the context.

Italic

The text in italics refers to a related topic.

Introduction to the Structural Monitoring System

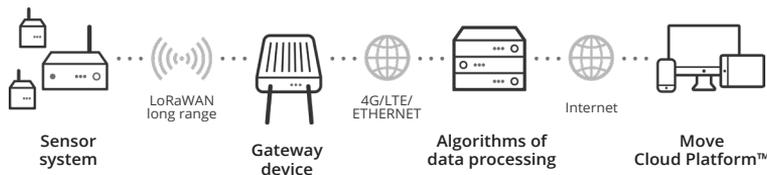
2

With the Move Solutions™ monitoring system it is possible to detect and analyze the level of stress, pressures and vibrations that any civil work or building endures over the years. There are many monitoring solutions available, that differ based on the structure being analyzed. Both in dynamic and static conditions, continuous monitoring is possible in multiple contexts, such as:

- Bridges;
- Viaducts;
- Buildings;
- Dams;
- Construction sites and works under construction;
- Tunnel;
- Railways and subways;
- Telecommunication towers.

SYSTEM OPERATION

The Move Solutions™ monitoring system consists of multiple types of wireless sensors bundled with a software suite - the Move Cloud Platform™ - for displaying and managing data and devices.



Once the wireless sensors and Gateways are correctly installed on site, the system is ready to detect, send and store data.

The data collected can be viewed in real time thanks to the Move Cloud Platform™ provided by Move Solutions™, which allows users to remotely monitor the site of interest. With the Move Cloud Platform™, the user can set different operating parameters of each individual sensor, including sampling rates, resolution, alarm thresholds, activation thresholds and much more.

The system guarantees a constant monitoring of the structure's health and the creation of historical records of the collected data which can be accessed at any time.

Sensor package

DECK - DISPLACEMENT SENSOR

The DECK device is the only patented wireless sensor on the market capable of measuring the mono-axial oscillations of the structure by providing displacement values, with an accuracy of 0.01 mm. Samples at 100 Hz, constantly and remotely. It is also capable of detecting temperature and vibration frequency.

TRIAxIAL TITLMETER

The triaxial tiltmeter is a wireless sensor capable of measuring the inclination and the static angular variation of the structure with respect to the horizontal plane, or perpendicular to the gravitational axis. By installing an entire system, it is possible to reconstruct the deformation of the deck.

TRIAxIAL ACCELEROMETER SHM

The SHM triaxial accelerometer is a wireless sensor capable of measuring the acceleration of the point where it is installed on the three axes and at high resolution. All installed Accelerometers can be perfectly synchronized with each other. Thanks to this feature, it is possible to measure the Vibration Frequencies and perform a Modal Analysis of the structure. The accelerometer also integrates a temperature sensor.

ANALOG COMMUNICATIVE NODE

The Analog Node is a device that enables all connected (originally wired) sensors or probes for wireless communication via LoRaWAN. The Analog Node supports a maximum of 4 sensors and is compatible with most of the analog interfaces used for geotechnical sensors, such as: strain gauges, temperature sensors, load cells, crack meters, humidity sensors, piezometers, anemometers, inclinometer probes, rain gauges and radar.

GATEWAY SHM

The SHM Gateway is a communication control unit with which it is possible to receive data from dozens of devices simultaneously via LoRaWAN. It is equipped with LoRa, LTE, GPS and Wi-Fi antennas. It implements a Wi-Fi hotspot and a GPS for a very precise synchronization and for the geolocation of the product. Automatic detection of the APN.

GATEWAY SHM PRO

The Gateway SHM Pro is a communication control unit with which it is possible to receive data from dozens of devices simultaneously via LoRaWAN. It can use up to two external LoRa antennas. The LTE, GPS and Wi-Fi antennas are integrated inside the body. It implements a Wi-Fi hotspot and a GPS for a very precise synchronization and for the geolocation of the product. Optimized configuration thanks to the automatic detection of the APN and the status LED interface.

Use and safety guidelines

3

INTENDED USE OF THE SYSTEM

For correctly operating the Move Solutions™ monitoring system, follow the exact procedures and instructions given in the chapters “*Intended use*” and “*Installation guide*” of each specific sensor.

The general installation steps for correctly operating the Move Solutions™ structural monitoring system, to be carried out in their exact order, are:

1. Correct orientation and installation of all sensor devices, see chapters “*Intended use*” and “*Installation guide*” of each specific sensor.
2. Installation of the Gateway receiving device in line of sight (i.e. no obstacles in the signal trajectory) with all the other devices installed on the structure.
3. Configuration of the operating parameters of each individual sensor and device installed on the Move Cloud Platform™.



IMPORTANT

- Each single device of the monitoring system must be installed and oriented correctly, in such a way that communication and data exchange are optimized.
- Failure to follow this installation guide could cause interference, radio problems and/or alterations in the signal and recorded data.

Before proceeding with handling, installation and subsequent use of each device and to ensure the correct operation of the system, make sure that:

- The operating temperature range is between -40 ° C and + 85 ° C;
- The storage temperature range is between -40 ° C and + 85 ° C;
- 99% is the maximum relative humidity conditions.
- The use area and storage area of the devices cannot be hit by water, steam jets and corrosive acids. The device must never be subjected to atmospheric agents before being correctly installed.

NOTE

- The manufacturer cannot be held responsible under any circumstances for accidents or damage resulting from improper use of the device, or as a result of negligence on the part of a user.
- Failure to comply with the rules of use and the methods of intervention, installation, configuration, use and maintenance of each single device that are contained in this manual also results in the cancellation of the warranty terms.

UNINTENDED USE OF THE SYSTEM

No use other than those described in this manual is allowed. No use other than those described in the chapter “*Introduction to the Structural Monitoring System*” and “*Use and safety guidelines*” is allowed.

It is absolutely forbidden to make any changes to any of the devices of the monitoring system. Any damage to people, animals or things deriving from the use of the device improperly modified by an unauthorized operator relieves the manufacturer of any responsibility.



IMPORTANT



- DO NOT modify the device (neither hardware nor firmware).
- DO NOT use the device with incompatible accessories.
- DO NOT use the device for applications other than those indicated in this manual.
- DO NOT let the electrical connections of the device come in contact with sources of direct water or other liquids.
- DO NOT place the product near chemicals or in places where chemicals can spill onto the product. Any contact of the product with chemicals may result in a risk of fire or electric shock. Such substances could ruin and damage the antenna contact, resulting in the risk of product malfunction, fire or electric shock.
- DO NOT install the device near high voltage cables.
- DO NOT attempt to repair the product yourself. Opening or removing the cover will invalidate the warranty. For technical assistance, please contact Customer Service directly at support@movesolutions.it.



IMPORTANT



- DO NOT install the device near large metal structures that can cause interference by interrupting or modifying the radio communication signal.
- DO NOT place objects around the product. Such objects could interfere with the radio communication signal.
- DO NOT place the product in a heavily trafficked area. If you need to place the product in a trafficked area, make sure it is positioned in a protected place and safe from accidental drops that can cause serious damage to people and the product.
- DO NOT place heavy objects on the product.
- DO NOT place the product near devices that contain or generate magnetic fields. They could interfere with the operation of the product, causing problems with the data detections' quality.
- DO NOT place the product near radio wave sources. Interference with the operation of the electronic components of the product may occur.
- If the external structure of one of the devices of the Move Solutions™ monitoring system presents sharp edges following an accidental damage, such that the component may result dangerous or its IP protection degree may result affected, it is necessary to contact the Customer Service and carefully follow their instructions.
- The reuse of any unit after decommissioning the device relieves the manufacturer from any liability deriving from its use.
- The product has been designed, manufactured and tested to meet all specific standards if and only if installed, oriented and configured perfectly.
- If the installation, configuration, use and/or maintenance of the device are not carried out according to the manual, anomalies may occur during its use.

NOTE

- The manufacturer cannot in any case be held responsible for accidents or damage resulting from the installation and use of the product in an electrical power system that does not comply with legal requirements.

OPERATIONS INVOLVING RISKS FOR THE OPERATOR

During installation and start-up operations, comply with the general accident prevention regulations.

NOTE

- The manufacturer cannot be held responsible under any circumstances for accidents or damage resulting from improper use of the device, or as a result of negligence on the part of a user.
- Failure to comply with the rules of use and the methods of intervention, installation, configuration, use and maintenance of the devices contained in the manual results in the cancellation of the warranty terms.

RESIDUAL RISKS

During the design phase, Move Solutions™ carried out an in-depth risk analysis on the system in question. From this analysis emerged risks that cannot be eliminated by their nature. These risks have therefore been examined individually, and guidelines on how to avoid them have been emphasized in this manual. It is therefore important that any user responsible for the installation, configuration and maintenance of the structural monitoring system has previously read and then followed this manual.

4

Guide to Loading tests

The Load tests on bridges and viaducts are aimed at checking the elastic characteristics of the structures in both static and dynamic conditions. It is essential to determine the maximum deformation (under load), the percentage of residual deformation (after the removal of the load) and the response of the structure to any dynamic action acting with known characteristics.

4.1 Static load tests

By installing a minimum of six Tiltmeters on a span of a bridge or a viaduct, it is possible to reconstruct the static deflection of the span during a Load Test. In order to obtain and visualize the exact lowering of the span it is necessary to correctly follow these steps:

1. INSTALLATION ON THE STRUCTURE:

Install a Tiltmeter for each of the following distances, normalized to the span length:

- 0.00 L - 0.15 L - 0.30 L - 0.70 L - 0.85 L - 1.00 L

It is not strictly necessary that the positions are exactly those indicated, an installation similar to those shown can also be defined as correct. For example, the Tiltmeter to be positioned in 0.15 L could also be installed in 0.13 L, the important thing is to indicate its exact positioning (in this case 0.13 L) during the settings set-up on the Move Cloud Platform™.

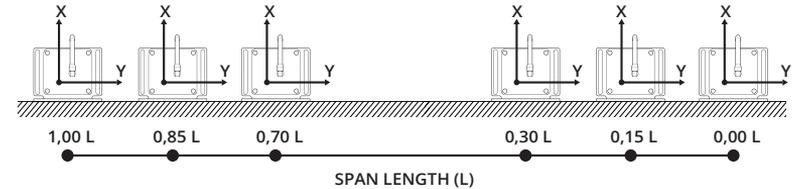
It is therefore essential to keep track of the installation positions of each specific Tiltmeter device, since these must be entered in the "Static Deflection" tool of the Move Cloud Platform™.

2. ORIENTATION TILTMETERS:

- The X axis of the label oriented upwards; see "Tiltmeter Orientation".
- The Y axis of the label aligned along the direction of travel of the span.
- The start of the span (normalized position 0.00) and consequently its end (normalized position 1.00) are arbitrary.

To have consistency between the signs of the detected data and those displayed, it is necessary that the Y axis of each sensor points towards the position that has been chosen as the start (normalized position 0.00) of the span.

These operations are used to make sure that the sensors correctly detect the direction of the deformation and to avoid incorrect data displays in the graphs (for example, an elevation in the bridge span under load).



3. PRELOAD OF THE BRIDGE FOR SETTLING:

Tiltmeter devices take angular measurements with respect to a reference position. It is therefore advisable, after installation on the structure, to reset all the Tiltmeters immediately before the beginning of the load test, so as to see the deformations of the structure compared to the ones immediately preceding the entry of the vehicles. In this way, the deformations are induced only and only by the stationing of the vehicles themselves on the structure. It must be considered that, especially in the case of newly built bridges, after the first loading phase there is a settlement following which the structure does not return to its original position.

Move Solutions™ therefore recommends carrying out a preloading operation on the structure in question, after which to reset the offset. By doing this, it will be possible to obtain more precise measurements, as they are purified from this settlement phenomena. To correctly perform this adjustment procedure of the structure under consideration, it is necessary to follow these steps:

- Preload the bridge.
- Wait for the span to settle in the new position, it is possible to monitor this phase via the Move Cloud Platform™.
- Unload the bridge span and wait again for the time necessary for it to return to its initial position, it is possible to monitor via the Move Cloud Platform™.
- Access the "Settings" window of the Move Cloud Platform™, in the "Tiltmeters" section, select the "Compensation" submenu, and reset the compensation using the "Reset Offset" button for all the Tiltmeters involved in the load test.

From this moment, the data collected are different from a correct position of the unloading deck.

4. START OF THE LOADING TESTS:

After settling the bridge through the Preload, it is now possible to carry out each scheduled load test.

From this moment, for the entire duration of the test, it is essential to monitor the data detected in real-time using the "Static Deformation" tool (located in the Dashboard on the Move Cloud Platform™). The data packets detected are visible and selectable through the "List of events" and are continuously updated according to the sampling frequency set. Make sure that the sampling frequency of all the Tiltmeters sensors set is the same, it is recommended to select "every 2 minutes". To correctly perform a Load Test it is recommended to follow these steps:

- Place the load on the spans under analysis.
- Wait for the span to settle under the load.
- Monitor the received data until at least 3 packets are equal, net of sensor sensitivity.
- It is possible to view a graph of the Deformation for each data packet detected, for more information see the manual "Move Cloud Platform™ Tutorial".
- Unload the bridge, and wait for the structure to settle in its original position.
- It is recommended, between one load test and the next, to perform a complete reset of the offset of the Tiltmeter sensors. Access the "Settings" window of the Move Cloud Platform™, in the "Inclinometers" section, select the "Compensation" submenu, and reset the compensation using the "Reset Offset" command.

NOTE

- For more information regarding the operation and use of the Static Deformed see the manual "Move Cloud Platform™ Tutorial".
 - For more information regarding the operation and use of the Move Cloud Platform™ see the manual "Move Cloud Platform™ Tutorial".
 - Visit the website at www.movesolutions.it to download additional documentation relating to tutorials, technical specifications and / or information on the Move Solutions™ structural monitoring system.
-

4.2 Dynamic load tests

To understand the exact amplitude of the oscillation of the dynamic arrow and the acceleration of a span, thus carrying out a dynamic load test, it is recommended to use both the DECK sensors and the Accelerometer sensors.

DECK

Displacement values measured expressed in mm. Data acquisition from the previous 10 seconds to the next 20 seconds (tot. 30 seconds) of each solicitation of the structure when the activation threshold previously set via the Move Cloud Platform™ is exceeded. For more information see "DECK device".

Therefore, in order to obtain and view the exact dynamic displacement of the span it is necessary:

- Install at least 2 DECK devices per span.
- To install and orient the DECK devices correctly see "DECK orientation" and "DECK installation guide".
- Correctly set the activation threshold value through the Move Cloud Platform™ so that it is exceeded only at each desired transit.
- Make sure not to stimulate the devices during the 4 minutes prior to a dynamic load test. This time is necessary for DECK devices to send any previous acquisition to the Gateway. Then wait 4 minutes between one dynamic load test and the next.

ACCELEROMETERS

Acceleration values measured expressed in mg. Data acquisition of 10 seconds following each stress on the structure when the activation threshold previously set via the Move Cloud Platform™ is exceeded. For more information see "Triaxial Accelerometer". Therefore, in order to obtain the exact acceleration of the span it is necessary:

- Install at least 2 accelerometers per span.
- To install and correctly orient the Accelerometer devices see "Accelerometer Orientation" and "Accelerometer Installation Guide".
- Correctly set the activation threshold value through the Move Cloud Platform™ so that it is exceeded only at each desired transit.
- Make sure not to stimulate the devices during the 4 minutes prior to a dynamic load test. This time frame is necessary for the Accelerometer devices to send any previous acquisition to the Gateway. Then wait 4 minutes between one dynamic load test and the next.

5

DECK device

The DECK device is the only patented wireless sensor on the market capable of measuring the uniaxial oscillations of the structure providing displacement values with an accuracy equal to 0.01 mm. The DECK device samples at 100 Hz, constantly and remotely. It is also capable of detecting temperature and vibration frequency. DECK is battery powered and uses the LoRaWAN wireless communication protocol.



OUTPUT DECK

DECK acquires data from 10 seconds before to 20 seconds after (tot. 30 seconds) each stress of the structure when the activation threshold - previously set on the Move Cloud Platform™ - is exceeded. The displacement values measured are expressed in mm. It also acquires temperature data.

DOWNLOAD DOCUMENTATION

Visit the website at www.movesolutions.it to download further documentation relating to technical specifications and/or information on the Move Solutions™ structural monitoring system.

5.1 Quick guide to use

The DECK sensor is “plug and play”; by screwing the special antenna on its cover, the device will immediately start trying to communicate with the Gateway. To ensure that the device is working properly, see the chapter “*DECK orientation*” and “*DECK installation guide*”, the DECK device must be oriented and installed correctly, following these specific steps:

1. ORIENTATION:

- The symbol shown in the center of the label indicates which is the axis of the structure (X; Y; Z) with respect to which the DECK device collects measurements. This symbol also shows the orientation and direction of that axis. Therefore:
 - The axis of the structure of interest to the measurement must be aligned and oriented according to the representation of the symbol.
 - The letter identifies DECK’s specific measurement axis.
Z axis = Gravitational axis.
X - Y axes = Longitudinal or transverse axis of the structure.

2. INSTALLATION ON THE STRUCTURE:

- The installation location may vary depending on the orientation label on the device. Agree with the supplier company on the correct place of installation of the DECK device on the structure.
- Securely install the DECK device on the wall, ceiling or floor using the special plate and screws/wall plugs supplied.
- Install all sensors on the structure before powering and turning on the Gateway device.

3. SCREWING THE ANTENNA:

- Before activating the Gateway, screw the LoRaWAN 868 Mhz antenna onto the DECK device cover.

After meeting these orientation and installation requirements, the DECK device will be able to detect and forward data to the Gateway without interference or data alteration. Verify, via the Move Cloud Platform™, if the sensor just installed is working properly. From the moment the Gateway is powered up, and therefore from the actual start-up and activation moment, a maximum waiting of about an hour is required before it is possible to correctly view all the sensors online.

DECK'S INTENDED USE

First of all, for the DECK to work properly (see the chapter *"DECK installation guide"*), it must be firmly installed on a wall, ceiling or floor of any structure, in specific and targeted points, in accordance with the supplier company. Each specific DECK device must be oriented following the directions on the orientation label located on the cover, as described in the chapter *"DECK installation guide"*.

DECK'S UNINTENDED USE

No use for the device other than those described in this manual is intended. The device is not intended for any use other than those described in the chapter *"Use and safety guidelines"* and *"DECK installation guide"*.

It is absolutely forbidden to make any changes to the Move Solutions™ monitoring system. Any damage to people, animals or things deriving from the use of the device improperly modified by an unauthorized operator is not to be attributed to the manufacturer which is therefore relieved of all responsibility.



- DO NOT use the device with batteries other than those supported and indicated in the chapter *"DECK Technical Specifications"*.



- DO NOT disassemble this product. Disassembling this product may cause electric shock or fire, or create anomalies in sensor measurements.

BATTERY CHANGE INSTRUCTIONS

To change the batteries of the Deck sensor, follow these steps:

1. Unscrew the sensor cover using a torx screwdriver.
2. Disconnect the central power connector of the PCB to which two wires arrive, one red and one black.
3. Remove all batteries present.
4. Replace with 4 new D 3.6V lithium batteries, paying attention to respect the polarity indicated on the battery holders, it is advisable to contact Move Solutions™ directly for battery supplies.
5. Re-insert the central connector (enters in one direction only).
6. Close the sensor cover by tightening all the screws.

5.2 DECK unpacking instructions

All devices manufactured by Move Solutions™ are tested and fine-tuned by the manufacturer before being shipped and delivered to the customer.

Make sure that the package contains the following components:

DECK components	Number of pieces
DECK sensor	1 pz.
LoRaWAN 868 Mhz antenna	1 pz.
Installation plate	1 pz.
Countersunk screws M6	4 pz.
Nut M6	4 pz.
Screws TCEI M8	4 pz.
Washers M8	4 pz.
Dowels for concrete	4 pz.
CE material	1 pz.

Check for any damage to the device. Check that the various parts of the device do not show physical damage due to impacts, tears or abrasions.

In particular, check that there are no marks or dents that may indicate impacts occurred during transportation and that the input and output ports are not damaged.

NOTE

- The components included in the package may vary depending on the model or version purchased. The components indicated refer to the following device models:
 - DECK001-V-FU
 - DECK001-V-FD
 - DECK001-V-FW
 - DECK001-H-UD
 - DECK001-H-WP
 - DECK001-H-WF

5.3 DECK Orientation

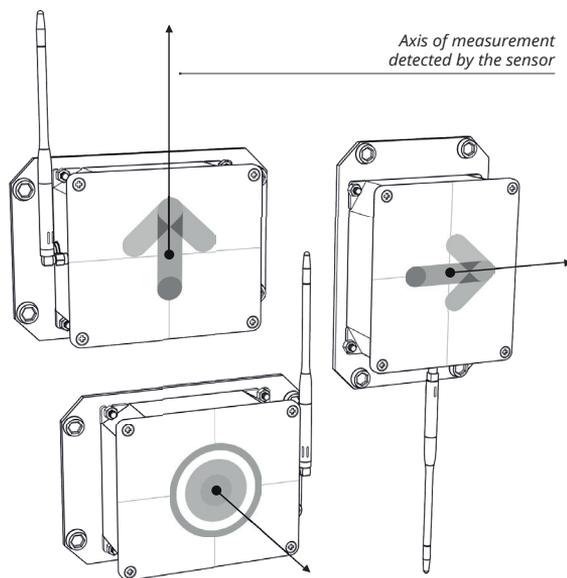
ORIENTATION LABEL

For the DECK device to perform a correct measurement, its installation and orientation are required to be equally correct.

The orientation label has the function of indicating which is the axis of the structure (X; Y; Z) with respect to which the DECK device can collect measurements. This symbol also communicates the orientation and direction of said axis. The DECK device must therefore be rotated and oriented following the instructions given on this label. The orientation label can represent, according to each installation needs, two different symbols that specify the direction and the orientation of the measuring axis of the DECK device.

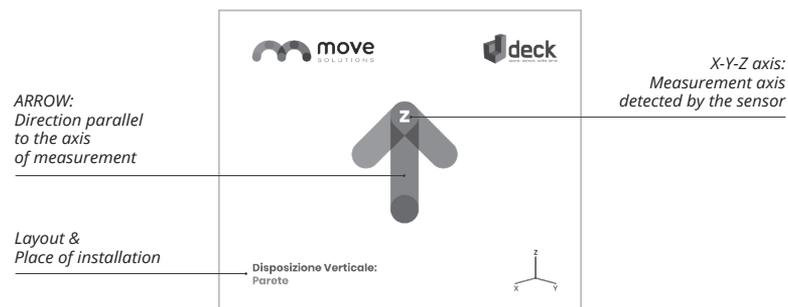
Before permanently installing the device on the structure of interest, it is necessary to understand how to orient it correctly so that:

- The axis involved in the measurement is aligned with the symbol shown in the center of the orientation label on the device.



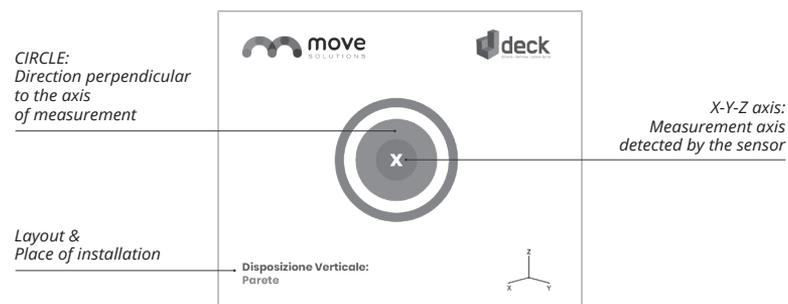
ARROW LABEL

The “Arrow” element communicates that the device must be installed with the cover parallel to the axis involved in the measurement. The letter (X; Y; Z) shown on the “Arrow” symbol indicates to which specific axis the device must be oriented accordingly, see section “Correspondence of the axes”.



CIRCLE LABEL

The “Circle” element, being a representation in top view of one of the Cartesian axes, indicates that the axis figuratively comes out of the lid. The device must therefore be perpendicular to the axis involved in the measurement. The letter (X; Y; Z) shown on the “Circle” symbol indicates which specific axis the device must be oriented accordingly, see section “Correspondence of the axes”.



ARRANGEMENT OF THE SENSOR

The place where the device must be installed with respect to the structure is specified in the lower left section of the label:

- Vertical arrangement: DECK must be installed on the wall.
- Horizontal arrangement: DECK must be installed on the floor or ceiling.
- Vertical / Horizontal arrangement: DECK can be installed both on the floor/ceiling, and on the wall.

CORRESPONDENCE OF THE AXES

The three Cartesian reference axes are shown in the lower right section of the label. Each of them corresponds to a measurement axis of the structure:

- Z axis = Gravitational axis.
- X - Y axes = Longitudinal or Transverse axis of the reference structure.

SPECIFIC CASE

If the DECK device has the indicative label "Arrow" with measurement axis "Z" and "Wall installation":

- Make sure that the "Arrow", parallel to the gravitational axis, points upwards.



IMPORTANT

- Periodically check the status of the labels installed on the product and restore them if they are damaged (if necessary, contact the authorized assistance).
- The product has been designed, manufactured and tested to meet all specific standards if and only if installed, oriented and configured perfectly.
- If the installation, configuration, use and/or maintenance of the device are not carried out according to the manual, anomalies may occur during use.

5.4 DECK installation guide

INSTALLATION ON THE STRUCTURE

It is possible to proceed with the installation of each device after having agreed with the supplier company on the specific installation site and having understood how to correctly orient each individual DECK sensor. Depending on the type of structure and the measuring axis, the DECK monitoring device can be installed on the structure with two different arrangements:

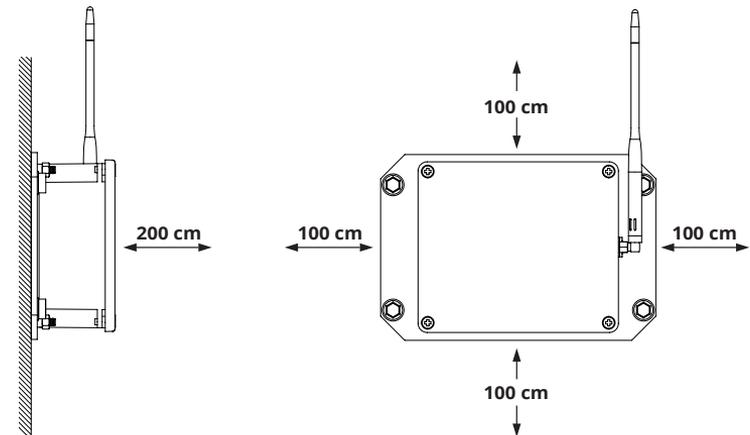
- Vertical arrangement - fixed to the vertical wall.
- Horizontal arrangement - fixed to the floor or ceiling.

Installation must be carried out by specialized personnel who must first check that:

- The zone is such that the device is able to forward data to the Gateway communication unit with which it will be coupled.
- The holes for housing wall plugs are not drilled using the plate attached to the DECK device as a reference.

OVERALL AREA

Install the device where there is free space around it, as shown in the illustration. This space must be free of obstacles that could cause interference; this is essential for optimizing the operation of the device.





IMPORTANT

- DO NOT install the device near large metal structures that can cause interference by interrupting or modifying the radio communication signal.
- DO NOT place objects around the product. Such objects could interfere with the radio communication signal.
- DO NOT place the product in a heavily trafficked area. If you need to place the product in a trafficked area, make sure it is positioned in a protected place and safe from accidental drops that can cause serious damage to people and the product.
- DO NOT place heavy objects on the product.
- DO NOT place the product near devices that contain or generate magnetic fields. They could interfere with the operation of the product, causing problems with detections' quality.
- DO NOT place the product near radio wave sources. Interference with the operation of the electronic components of the product may occur.
- If the external structure of one of the components of the DECK device presents sharp edges following an accidental damage, such that the component may result dangerous or make its IP protection degree may be affected, it is necessary to contact the authorized assistance and carefully follow their instructions.



- DO NOT subject the electrical connections of the device to sources of direct water or other liquids.



- DO NOT place the product near chemicals or in places where chemicals can spill onto the product. Any contact of the product with chemicals may result in a risk of fire or electric shock. Such substances could ruin and damage the antenna contact, resulting in the risk of product malfunction, fire or electric shock.
 - DO NOT install the device near high voltage cables.
-



IMPORTANT

- The product has been designed, manufactured and tested to meet all specific standards if and only if installed, oriented and configured perfectly.
 - Failure to comply with the warnings indicated in this section could alter the data detected by the sensors.
 - If the installation, configuration, use and/or maintenance of the device are not carried out according to the manual, anomalies may occur during its use, and safety problems may also occur. Inappropriate installation, configuration and maintenance will void the warranty.
-

Triaxial Tiltmeter

6

The triaxial Tiltmeter is able to measure the variation of the static angular inclination of the structure with respect to the horizontal plane, i.e. perpendicular to the gravitational axis. By installing an entire system it is possible to reconstruct the static deflection of the structure. All Tiltmeters can be perfectly synchronized with each other, which is perfect for static load tests. The Tiltmeter is also able to measure temperature. It is battery powered and has a LoRaWAN wireless transmission. The data acquisition methods can be set by the user through the Move Cloud Platform™.



OUTPUT TILTMETER

The Tiltmeter outputs angles that describe the variation in inclination of the body on which the device is installed. The calculation of these angles is based on the projections of the gravity vector on the three axes of the sensor, averaged over an acquisition interval of one minute. The sensor also acquires the temperature.

By installing an entire system it is possible to reconstruct the static deflection of the structure during a load test.

DOWNLOAD DOCUMENTATION

Visit the website at www.movesolutions.it to download further documentation relating to technical specifications and/or information on the Move Solutions™ structural monitoring system.

6.1 Quick guide to use

The triaxial Tiltmeter device is “plug and play”; by screwing the special antenna on the cover, the device will immediately start to detect and send data. To ensure correct operation, see the chapter “*Tiltmeter Orientation*” and “*Tiltmeter Installation Guide*”, the Tiltmeter sensor must be correctly oriented and installed, following these specific steps:

1. ORIENTATION:

- The axes shown on the orientation label, which is placed on the sensor cover, must be aligned as the axes of interest of the structure.
- The X axis must always be oriented upwards.
- The X axis must be as parallel as possible to the gravitational axis.
- The plane formed by the Y - Z axis must be parallel to the horizontal plane.

2. INSTALLATION ON THE STRUCTURE:

- Agree with the supplier company on the correct place of installation on the structure of the Tiltmeter device.
- Securely install the Tiltmeter on the wall, ceiling or floor using the special plate and screws/wall plugs supplied. It is possible to rotate the plate relative to the device to keep the X axis parallel to the gravitational axis and oriented upwards, regardless of the agreed installation location.
- To ensure correct installation, the X axis must have a maximum inclination of 85° with respect to the gravitation axis.
- Install all sensors on the structure before powering and turning on the Gateway device.

3. SCREWING THE ANTENNA:

- Before activating the Gateway, screw the LoRaWAN 868 Mhz antenna onto the device cover.

After meeting these orientation and installation requirements, the Tiltmeter device will be able to detect and forward data to the Gateway without interference or data alteration. Verify, through the Move Cloud Platform™, the correct functioning of the sensor just installed. From the moment the Gateway is powered up, and therefore from the actual start-up and activation moment, a maximum waiting of about an hour is required before it is possible to correctly view all the sensors online.

6.2 In-depth analysis of the Tiltmeter output

To have a precise and accurate view of the three-dimensional movement of the structure on which the Tiltmeter device has been installed, it is necessary to observe two different angles provided by the device, "Phi - φ " and "Theta - θ ", in pairs or, alternatively, a third angle defined as "3D variation angle".

φ - PHI ANGLE

It represents the angle between the Z axis, represented on the orientation label, and its projection on the horizontal plane.

θ - THETA ANGLE

It represents the angle between the Y axis, represented on the orientation label, and its projection on the horizontal plane.

$\Delta\varphi$ - $\Delta\theta$ - INCLINATION COMPENSATION

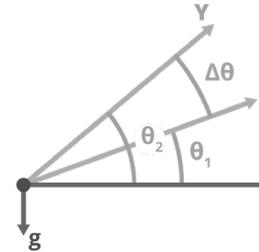
With the Move Cloud Platform™, it is possible to activate or deactivate (it is activated by default) a feature called "Data compensation", thanks to which compensation is activated with respect to the installation position. In this way, it is possible to view the variation of inclination of the structure. The data displayed in the respective graphs therefore refer to the angular variations of Phi ($\Delta\varphi$) and Theta ($\Delta\theta$) with respect to the initial installation position.

If the "Data Compensation" feature is deactivated, the Move Cloud Platform™ will display the absolute angles with respect to the horizontal plane. These absolute angles may carry on measurement errors caused by an incorrect installation - not completely parallel to the horizontal plane - of the Tiltmeter device.

It is recommended to keep the "Data compensation" option always active; the measurement of the variation ($\Delta\varphi$ and $\Delta\theta$) is to be considered more accurate.

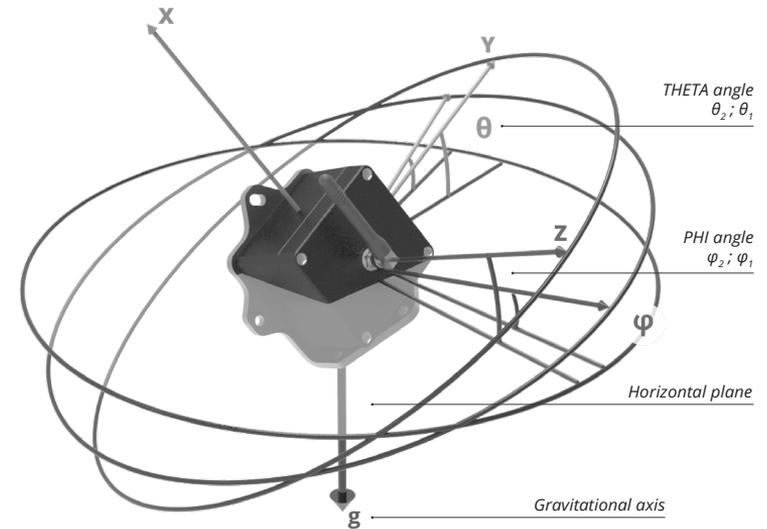
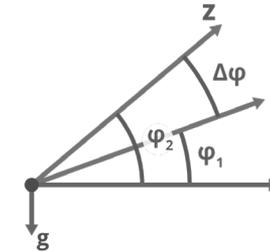
THETA ANGULAR VARIATIONS

$$\theta_2 - \theta_1 = \Delta\theta$$



PHI ANGULAR VARIATIONS

$$\varphi_2 - \varphi_1 = \Delta\varphi$$



INTENDED USE OF THE TILTMETER

For correct operation of the device, see the chapter *“Tiltmeter Orientation”* and *“Tiltmeter Installation Guide”*, first of all the Tiltmeter device must be firmly installed on a wall, ceiling or floor of any structure, with a specific and targeted position, in agreement with the supplier company.

Each specific Tiltmeter device must be oriented following the indications given on the orientation label located on the lid, see chapter *“Tiltmeter Orientation”*.

NON INTENDED USE OF THE TILTMETER

No use other than those described in this manual is intended for the device. The device is not intended for any use other than those described in the chapter *“Use and safety guidelines”* and *“Intended Use of the Tiltmeter”*.

It is absolutely forbidden to make any changes to the Move Solutions™ monitoring system. Any damage to people, animals or things deriving from the use of the improperly modified device by an unauthorized operator, is not attributable to the manufacturer which is therefore relieved of all responsibility.



- DO NOT use the device with batteries other than those supported and indicated in the chapter *“Tiltmeter Technical Specifications”*.



- DO NOT disassemble this product. Disassembling the product may cause electric shock or fire, or create anomalies in sensor measurements.

BATTERY CHANGE INSTRUCTIONS

To change the batteries of the inclinometer, follow the steps below:

1. Unscrew the sensor cover using a Phillips screwdriver.
2. Gently open the cover, taking care not to break the connector that connects the antenna on the cover to the electronic board.
3. Remove the existing battery.
4. Insert a new D 3.6V lithium battery, paying attention to respect the polarity indicated on the battery holder, it is advisable to contact Move directly to obtain batteries that maximize the life of the sensor.
5. Close the sensor cover making sure that the antenna connector does not get squeezed between the cover and the body of the case.

6.3 Unpacking Instructions Inclinometer

All devices manufactured by Move Solutions™ are tested and fine-tuned by the manufacturer before shipping and delivery to the customer.

Make sure that the package contains the following components:

Tiltmeter components	Number of pieces
Tiltmeter sensor	1 pz.
LoRaWAN 868 Mhz antenna	1 pz.
Countersunk screws M6	2 pz.
Installation plate	1 pz.
Screws TCEI M6	2 pz.
Washers M6	2 pz.
Brass anchors for concrete	2 pz.
CE material	1 pz.

Check for any damage to the device. Check that the various parts of the device do not show physical damage due to impacts, tears or abrasions.

Check in particular that there are no marks or dents, indicative of impacts occurred during transport and that the inputs and outputs are not damaged.

NOTE

- The components included in the package may vary depending on the model or version purchased. The components shown refer to the model of the DECKT-LT-STD monitoring device.

6.4 Tiltmeter Orientation

ORIENTATION LABEL

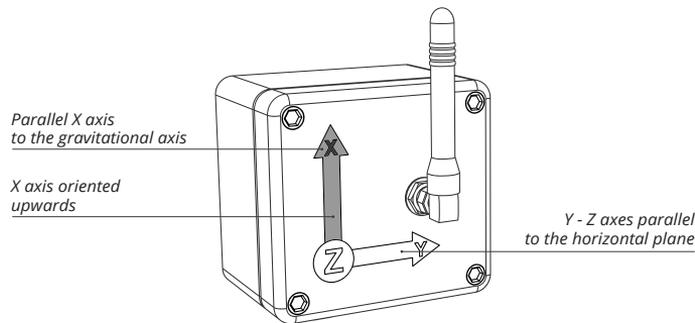
Before installing the device on the structure it is necessary to understand how to correctly orient the axes shown on the orientation label located on the device cover. The orientation label acts as an indicator of the direction in which the Tiltmeter device must be rotated and oriented. The label depicts the three Cartesian axes in relation to the device, specifically with the X axis facing upwards and with the Z axis coming out of the Tiltmeter cover.

SENSOR ORIENTATION

To correctly install the Tiltmeter device on the structure, make sure that the axes shown on the device label are installed as indicated below:

- The X axis as parallel as possible to the gravitational axis.
- The X axis always oriented upwards.
- The plane formed by the Y - Z axes parallel to the horizontal plane.
- The relative axes of the device oriented as the absolute axes of the structure.

The orientation of the Tiltmeter device does not vary depending on where it is installed (wall, ceiling or floor). The X axis shown on the label must always be oriented upwards, as parallel as possible to the gravitational axis and perpendicular to the horizontal plane of the ground.



NOTE

- The label shown is for illustrative purposes only, may vary from device model or version.

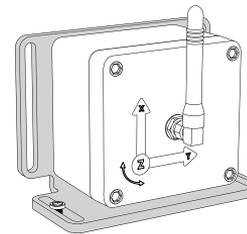
6.5 Tiltmeter installation guide

INSTALLATION ON THE STRUCTURE

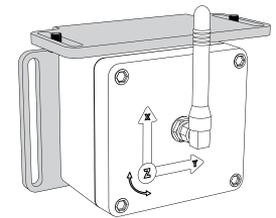
To allow the Tiltmeter device to perform a correct measurement, it is necessary to carry out an equally correct installation and orientation of the sensor.

Based on the context and the morphology of the structure, the Tiltmeter device can be installed in any arrangement:

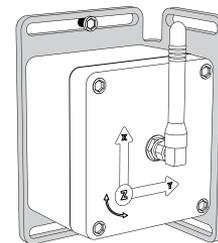
- Rear or side wall installation.
- Floor installation.
- Ceiling installation.



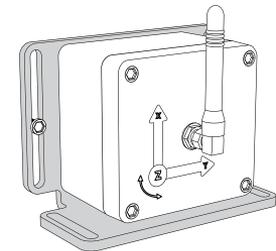
Floor installation



Ceiling installation



Side wall installation



Rear wall installation



IMPORTANT

- The X axis shown on the label must always be oriented upwards, resulting as parallel as possible to the gravitational axis and perpendicular to the horizontal plane (i.e. the ground).

In order to install the Tiltmeter sensor in any of the described configurations, while maintaining the correct alignment of the X axis with the gravitational axis, it is necessary to:

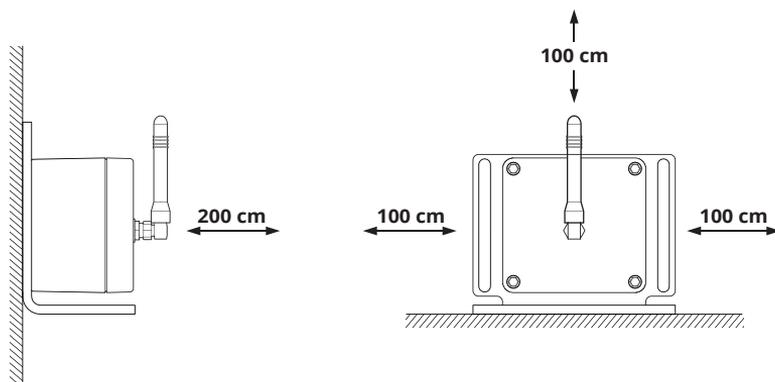
1. Unscrew the two M6 screws connecting the plate/sensor.
2. Rotate the installation plate to the correct arrangement.
3. Screw the two M6 screws connecting the plate / sensor.

After having agreed with the supplier company on the specific place of installation, and after understanding how to correctly orient each individual Tiltmeter sensor, it will be possible to proceed with the actual installation of the devices. Installation must be carried out by specialized personnel who must first check that:

- The zone is such that the device is able to communicate data with the Gateway communication devices to which it will be paired.
- That the surface of the structure on which the sensor will be installed is able to accommodate the 2 plugs and 2 screws required for installation.
- That the holes for housing the plugs are not made using the plate attached to the Tiltmeter device as a reference.

SPACE NEEDED FOR INSTALLATION

Install the device where there is free space around it as shown in the illustration. This space must be free of obstacles that could cause interference; this is essential for optimizing the operation of the device.



The weight of the device is shown in this manual in the "Tiltmeter Technical specifications" chapter and on the CE label glued under it. Given its size and weight, the device can be moved manually by a single person.



IMPORTANT



- DO NOT install the device near large metal structures that can cause interference by interrupting or modifying the radio communication signal.
- DO NOT place objects around the product. Such objects could interfere with the radio communication signal.
- DO NOT place the product in a heavily trafficked area. If you need to place the product in a trafficked area, make sure it is positioned in a protected place and safe from accidental drops that can cause serious damage to people and the product.
- DO NOT place heavy objects on the product.
- DO NOT place the product near devices that contain or generate magnetic fields. They could interfere with the operation of the product, causing problems with detections' quality.
- DO NOT place the product near radio wave sources. Interference with the operation of the electronic components of the product may occur.
- If the external structure of one of the components of the Tiltmeter device presents sharp edges following an accidental damage, such that the component may result dangerous or make its IP protection degree may be affected, it is necessary to contact the authorized assistance and carefully follow their instructions.



- DO NOT subject the electrical connections of the device to sources of direct water or other liquids.
- DO NOT place the product near chemicals or in places where chemicals can spill onto the product. Any contact of the product with chemicals may result in a risk of fire or electric shock. Such substances could ruin and damage the antenna contact, resulting in the risk of product malfunction, fire or electric shock.
- DO NOT install the device near high voltage cables.

CORRECT INSTALLATION

When installing the Tiltmeter sensor on the structure, make sure that the X axis (always oriented upwards) is positioned within the "Region of correct positioning" (see "Figure 1" and "Figure 2" on page 34).

The extent of the region of correct positioning is defined by the total sum of the possible inclinations in which the installation on the structure can be defined as correct. This totality of possible inclinations refer to the X axis of the Tiltmeter with respect to the absolute gravitational axis.

We can therefore state that:

- In case of need due to an inclined surface, it is possible to install the device with the X axis having a maximum inclination of 85° with respect to the gravitational axis.
- The X axis must always be oriented upwards.

WRONG INSTALLATION

Failure to comply with the installation methods described above inevitably causes serious alterations in the data recorded by the sensor, thus making the Tiltmeter device to be considered unusable. Specific cases in which the installation on the structure of the Tiltmeter device is defined WRONG:

- The X axis is inclined more than 85° with respect to the gravitational axis.
- The X axis is oriented downwards.
- The X axis is oriented parallel to the horizontal plane.



IMPORTANT

- The product has been designed, manufactured and tested to meet all specific standards if and only if installed, oriented and configured perfectly.
- Failure to comply with the warnings indicated in this section could alter the data detected by the sensors.
- If the installation, configuration, use and/or maintenance of the device are not carried out according to the manual, anomalies may occur during its use, and safety problems may also occur. Inappropriate installation, configuration and maintenance will void the warranty.

Figure 1 - Front view of the Tiltmeter

Display of the "Region of correct positioning".

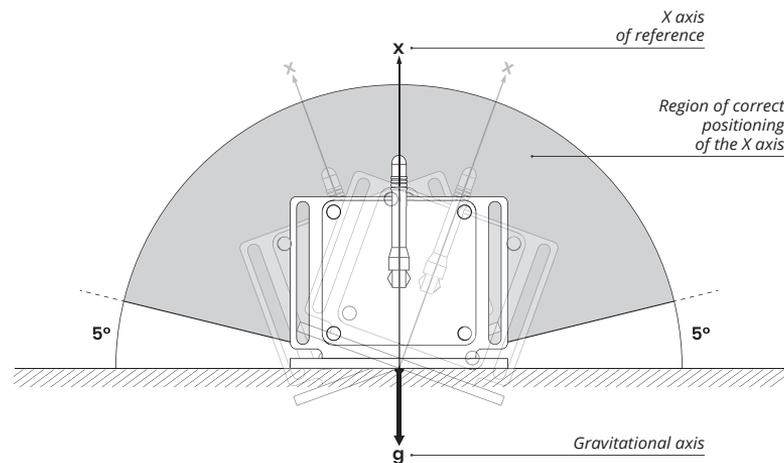
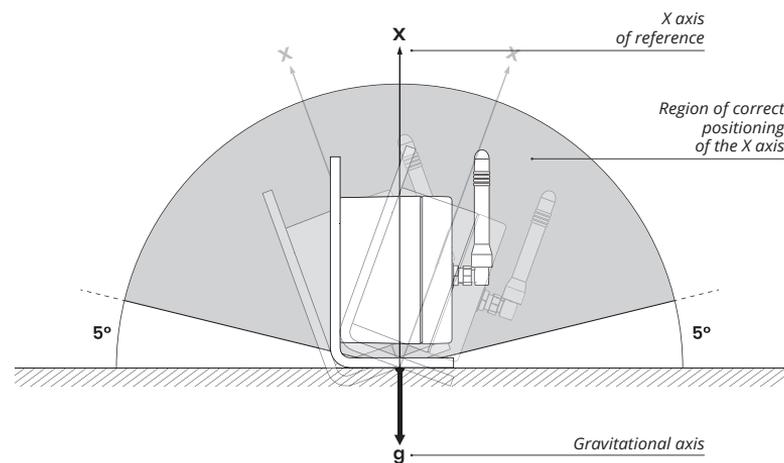


Figure 2 - Tiltmeter side view

Display of the "Region of correct positioning".



Triaxial Accelerometer

7

The triaxial accelerometer is able to measure the acceleration of the point where it is installed, which is essential for measuring the vibration frequencies and for carrying out a modal study of the structure. With the use of Accelerometer devices it is possible to highlight any seismic vibrations. It is also possible, through the interface of the Move Cloud Platform™, to set the acquisition frequency of each sensor. All sensors also detect the temperature, are battery powered and use the LoRaWAN wireless communication protocol.



ACCELEROMETER OUTPUT

The Accelerometer acquires 10 seconds of data for each stress on the structure whenever the activation threshold - previously set on the Move Cloud Platform™ - is exceeded. The measured acceleration values are expressed in mg.

The acquisition methods can be set by the user through the Move Cloud Platform™. It is possible to take advantage of an operating mode with programmed acquisition, with a fixed frequency set by the user, lasting 180 seconds. The device also acquires temperature data.

DOWNLOAD DOCUMENTATION

Visit the website at www.movesolutions.it to download further documentation relating to technical specifications and/or information on the Move Solutions™ structural monitoring system.

7.1 Quick guide to use

The triaxial Accelerometer device is “plug and play”; by screwing the special antenna on the cover, the device will immediately start to detect and try to send data to the Gateway device. To ensure correct operation, see the chapter “*Accelerometer Orientation*” and “*Accelerometer Installation Guide*”, the Accelerometer sensor must be correctly oriented and installed, following these specific steps:

1. ORIENTATION:

- The three axes shown on the orientation label, placed on the sensor cover, must be aligned as the axes of interest of the structure.
- The Accelerometer device can be rotated freely on the structure.

2. INSTALLATION ON THE STRUCTURE:

- Agree with the supplier company on the correct place of installation on the structure of the Accelerometer device.
- Firmly install the Accelerometer on the wall, ceiling or floor using the special plate and screws/wall plugs supplied. It is possible to rotate the plate relative to the device.
- To install multiple Accelerometers on the same structure, use the same orientation convention, i.e. with the axes shown on the label of each specific device oriented in the same way.
- Install all sensors on the structure before powering and turning on the Gateway device.

3. SCREWING THE ANTENNA:

- Before activating the Gateway, screw the LoRaWAN 868 Mhz antenna onto the device cover.

After meeting these orientation and installation requirements, the Accelerometer device will be able to detect and send data to the Gateway without interference or data alteration.

Verify, via the Move Cloud Platform™, the correct functioning of the sensor just installed. From the moment the Gateway is powered up, and therefore from the actual start-up and activation moment, a maximum waiting of about an hour is required before it is possible to correctly view all the sensors online.

INTENDED USE OF THE ACCELEROMETER

For correct operation of the device, as described later in the chapter *“Accelerometer installation guide”*, first of all the Accelerometer device must be firmly installed on a wall, ceiling or floor of any structure, in specific and targeted points, according to the supplier company instructions.

Each specific Accelerometer device must be oriented following the directions given on the orientation label located on the cover, as described in the *“Accelerometer Installation Guide”* chapter.

NOT INTENDED USE OF THE ACCELEROMETER

No use other than those described in this manual is intended.

The device is not intended for any use other than those described in the chapter *“Use and safety guidelines”* and *“Intended Use of the Accelerometer”*.

It is absolutely forbidden to make any changes to the Move Solutions™ monitoring system. Any damage to people, animals or things deriving from the use of the device modified improperly by an unauthorized operator, is not attributable to the manufacturer which is therefore relieved of all responsibility.



- DO NOT use the device with batteries other than those supported and indicated in the *“Accelerometer Technical Specifications”* chapter .



- DO NOT disassemble this product. Disassembling this product may cause electric shock or fire, or create anomalies in sensor measurements.

BATTERY CHANGE INSTRUCTIONS

To change the Accelerometer batteries, follow the steps below:

1. Unscrew the sensor cover using a Phillips screwdriver.
2. Gently open the cover, taking care not to break the connector that connects the antenna on the cover to the electronic board.
3. Remove the existing battery.
4. Insert a new D 3.6V lithium battery paying attention to respect the polarity indicated on the battery holder, it is recommended to contact Move Solutions™ directly to supply batteries.
5. Close the sensor cover making sure that the antenna connector does not get squeezed between the cover and the body of the case.

7.2 Unpacking Instructions Accelerometer

All devices manufactured by Move Solutions™ are tested and fine-tuned by the manufacturer before shipping and delivery to the customer.

Make sure that the package contains the following components:

Accelerometer components	Number of pieces
Accelerometer sensor	1 pz.
LoRaWAN 868 Mhz Antenna	1 pz.
Countersunk screws M6	2 pz.
Installation plate	1 pz.
Screws TCEI M6	2 pz.
Washers M6	2 pz.
Brass anchors for concrete	2 pz.
CE material	1 pz.

Check for any damage to the device. Check that the various parts of the device do not show physical damage due to impacts, tears or abrasions.

In particular, check that there are no marks or dents that may indicate impacts occurred during transportation and that the input and output ports are not damaged.

NOTE

- The components included in the package may vary depending on the model or version purchased. The components shown refer to the model of the DECKA-XE-STD monitoring device.

7.3 Accelerometer orientation

ORIENTATION LABEL

The Accelerometer orientation label acts as an indicator of the direction of the device axes.

DEVICE ORIENTATION

Being a device with triaxial acquisition, its relative orientation and arrangement do not affect in any way the detected data. Consequently:

- The Accelerometer device can be freely rotated, oriented and installed on the structure.

Following the axes shown on the device label, it is recommended to:

- Orient and align the axes shown on the device label with the axes of interest of the structure.
- **SPECIFIC EXAMPLE:** The Y axis shown on the label must be aligned with the longitudinal axis of the structure.

In the event that multiple Accelerometers sensors are installed on the same structure, in order to facilitate the comprehensibility and display of the data collected on the Move Cloud Platform™, it is recommended to:

- Install the multiple Accelerometer devices according to the same convention, with the axes shown on the label of each specific device oriented in the same way.
- **SPECIFIC EXAMPLE:** All the Y axes shown on the label must be aligned with the longitudinal axis of the structure.

NOTE

- These specifications are **RECOMMENDED** only and solely to facilitate the comprehension and visualization of the data collected. Failure to comply with the specifications indicated in this section **DOES NOT** alter the data collected by the sensors.
-

7.4 Accelerometer installation guide

INSTALLATION ON THE STRUCTURE

Depending on the context and the morphology of the structure, the Accelerometer device can be installed in any arrangement:

- Rear or side wall installation.
- Floor installation.
- Ceiling installation.

In order to install the Accelerometer sensor in any of the configurations described, it is necessary to:

1. Unscrew the two M6 screws connecting the plate/sensor.
2. Rotate the installation plate to the correct arrangement.
3. Screw the two M6 screws connecting the plate/sensor.

After having agreed with the supplier company on the specific place of installation of each single Accelerometer sensor, it will be possible to proceed with the actual installation of the devices. Installation must be carried out by specialized personnel who must first check that:

- The zone is such that the device is able to communicate data with the Gateway communication devices to which it will be paired.
- That the surface of the structure on which the sensor will be installed is able to accommodate the 2 plugs and 2 screws required for installation.
- That the holes for housing the plugs are not made using the plate attached to the Accelerometer device as a reference.



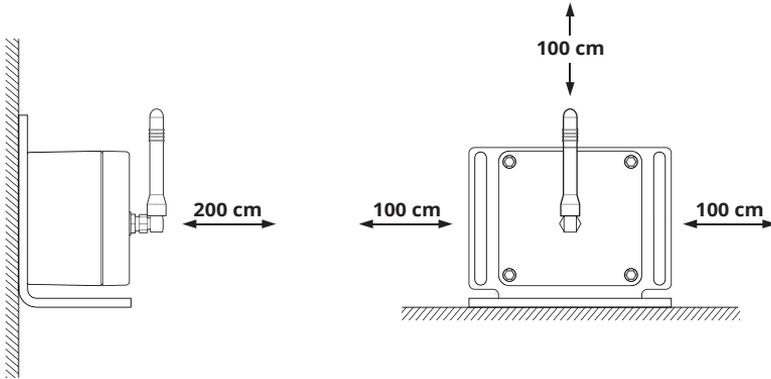
IMPORTANT

- The Accelerometer can be freely rotated, oriented and installed on the structure.
 - It is recommended to align the axes shown on the device label with the axes of interest of the structure.
 - To install multiple Accelerometers on the same structure, use the same orientation convention.
-

SPACE NEEDED FOR INSTALLATION

Install the device where there is free space around it as shown in the illustration. This space must be free of obstacles that could cause interference; this is essential for optimizing the operation of the device.

The weight of the device is shown in this manual in the "Accelerometer Technical specifications" chapter and on the CE label glued under it. Given its size and weight, the device can be moved manually by a single person.



IMPORTANT

- Failure to comply with the warnings indicated in this section could alter the data detected by the sensors.
- If the installation, configuration, use and/or maintenance of the device are not carried out according to the manual, anomalies may occur during its use, and safety problems may also occur. Inappropriate installation, configuration and maintenance will void the warranty.



IMPORTANT



- DO NOT install the device near large metal structures that can cause interference by interrupting or modifying the radio communication signal.
- DO NOT place objects around the product. Such objects could interfere with the radio communication signal.
- DO NOT place the product in a heavily trafficked area. If you need to place the product in a trafficked area, make sure it is positioned in a protected place and safe from accidental drops that can cause serious damage to people and the product.
- DO NOT place heavy objects on the product.
- DO NOT place the product near devices that contain or generate magnetic fields. They could interfere with the operation of the product, causing problems with detections' quality.
- DO NOT place the product near radio wave sources. Interference with the operation of the electronic components of the product may occur.
- If the external structure of one of the components of the Accelerometer device presents sharp edges following an accidental damage, such that the component may result dangerous or make its IP protection degree may be affected, it is necessary to contact the authorized assistance and carefully follow their instructions.



- DO NOT subject the electrical connections of the device to sources of direct water or other liquids.
- DO NOT place the product near chemicals or in places where chemicals can spill onto the product. Any contact of the product with chemicals may result in a risk of fire or electric shock. Such substances could ruin and damage the antenna contact, resulting in the risk of product malfunction, fire or electric shock.
- DO NOT install the device near high voltage cables.

SHM Triaxial Accelerometer

8

The SHM Triaxial Accelerometer is able to measure the acceleration of the point where it is installed, which is essential for measuring the vibration frequencies and for carrying out a modal study of the structure. With the use of Accelerometers devices it is possible to highlight any vibrations. It is also possible, through the interface of the Move Cloud Platform™, to synchronize the acquisitions of each sensor, an optimal feature for dynamic load tests.

All sensors also detect the temperature, are battery powered and use the LoRaWAN wireless communication protocol.



ACCELEROMETER SHM OUTPUT

The Accelerometer SHM acquires 10 seconds of data for each stress on the structure whenever the activation threshold - previously set on the Move Cloud Platform™ - is exceeded. The measured acceleration values are expressed in mg.

The acquisition methods can be set by the user through the Move Cloud Platform™. It is possible to take advantage of an operating mode with programmed acquisition, with a fixed frequency set by the user, lasting 180 seconds. The device also acquires temperature data.

DOWNLOAD DOCUMENTATION

Visit the website at www.movesolutions.it to download further documentation relating to technical specifications and/or information on the Move Solutions™ structural monitoring system.

8.1 Quick guide to use

The triaxial Accelerometer device is “plug and play”; by screwing the special antenna on the cover, the device will immediately start to detect and try to send data to the Gateway device. To ensure correct operation, see the chapter “*Accelerometer Orientation*” and “*Accelerometer Installation Guide*”, the Accelerometer sensor must be correctly oriented and installed, following these specific steps:

1. ORIENTATION:

- The three axes shown on the orientation label, placed on the sensor cover, must be aligned as the axes of interest of the structure.
- The Accelerometer device can be rotated freely on the structure.

2. INSTALLATION ON THE STRUCTURE:

- Agree with the supplier company on the correct place of installation on the structure of the Accelerometer device.
- Firmly install the Accelerometer on the wall, ceiling or floor using the special plate and screws/wall plugs supplied. It is possible to rotate the plate relative to the device.
- To install multiple Accelerometers on the same structure, use the same orientation convention, i.e. with the axes shown on the label of each specific device oriented in the same way.
- Install all sensors on the structure before powering and turning on the Gateway device.

3. SCREWING THE ANTENNA:

- Before activating the Gateway, screw the LoRaWAN 868 Mhz antenna onto the device cover.

After meeting these orientation and installation requirements, the Accelerometer device will be able to detect and send data to the Gateway without interference or data alteration.

Verify, via the Move Cloud Platform™, the correct functioning of the sensor just installed. From the moment the Gateway is powered up, and therefore from the actual start-up and activation moment, a maximum waiting of about an hour is required before it is possible to correctly view all the sensors online.

INTENDED USE OF THE ACCELEROMETER

For correct operation of the device, as described later in the chapter “*Accelerometer installation guide*”, first of all the Accelerometer device must be firmly installed on a wall, ceiling or floor of any structure, in specific and targeted points, according to the supplier company instructions.

Each specific Accelerometer device must be oriented following the directions given on the orientation label located on the cover, as described in the “*Accelerometer Installation Guide*” chapter.

NOT INTENDED USE OF THE ACCELEROMETER

No use other than those described in this manual is intended.

The device is not intended for any use other than those described in the chapter “*Use and safety guidelines*” and “*Intended Use of the Accelerometer*”.

It is absolutely forbidden to make any changes to the Move Solutions™ monitoring system. Any damage to people, animals or things deriving from the use of the device modified improperly by an unauthorized operator, is not attributable to the manufacturer which is therefore relieved of all responsibility.



- DO NOT use the device with batteries other than those supported and indicated in the “*Accelerometer Technical Specifications*” chapter .



- DO NOT disassemble this product. Disassembling this product may cause electric shock or fire, or create anomalies in sensor measurements.

BATTERY CHANGE INSTRUCTIONS

To change the Accelerometer batteries, follow the steps below:

1. Unscrew the sensor cover using a Phillips screwdriver.
2. Gently open the cover, taking care not to break the connector that connects the antenna on the cover to the electronic board.
3. Remove the existing battery.
4. Insert a new D 3.6V lithium battery paying attention to respect the polarity indicated on the battery holder, it is recommended to contact Move Solutions™ directly to supply batteries.
5. Close the sensor cover making sure that the antenna connector does not get squeezed between the cover and the body of the case.

8.2 Unpacking Instructions Accelerometer

All devices manufactured by Move Solutions™ are tested and fine-tuned by the manufacturer before shipping and delivery to the customer.

Make sure that the package contains the following components:

Accelerometer components	Number of pieces
Accelerometer sensor	1 pz.
LoRaWAN 868 Mhz Antenna	1 pz.
Countersunk screws M6	2 pz.
Installation plate	1 pz.
Screws TCEI M6	2 pz.
Washers M6	2 pz.
Brass anchors for concrete	2 pz.
CE material	1 pz.

Check for any damage to the device. Check that the various parts of the device do not show physical damage due to impacts, tears or abrasions.

In particular, check that there are no marks or dents that may indicate impacts occurred during transportation and that the input and output ports are not damaged.

NOTE

- The components included in the package may vary depending on the model or version purchased. The components shown refer to the model of the DECKA-XE-SHM monitoring device.

8.3 Accelerometer orientation

ORIENTATION LABEL

The Accelerometer orientation label acts as an indicator of the direction of the device axes.

DEVICE ORIENTATION

Being a device with triaxial acquisition, its relative orientation and arrangement do not affect in any way the detected data. Consequently:

- The Accelerometer device can be freely rotated, oriented and installed on the structure.

Following the axes shown on the device label, it is recommended to:

- Orient and align the axes shown on the device label with the axes of interest of the structure.
- **SPECIFIC EXAMPLE:** The Y axis shown on the label must be aligned with the longitudinal axis of the structure.

In the event that multiple Accelerometers sensors are installed on the same structure, in order to facilitate the comprehensibility and display of the data collected on the Move Cloud Platform™, it is recommended to:

- Install the multiple Accelerometer devices according to the same convention, with the axes shown on the label of each specific device oriented in the same way.
- **SPECIFIC EXAMPLE:** All the Y axes shown on the label must be aligned with the longitudinal axis of the structure.

NOTE

- These specifications are **RECOMMENDED** only and solely to facilitate the comprehension and visualization of the data collected. Failure to comply with the specifications indicated in this section **DOES NOT** alter the data collected by the sensors.
-

8.4 Accelerometer installation guide

INSTALLATION ON THE STRUCTURE

Depending on the context and the morphology of the structure, the Accelerometer device can be installed in any arrangement:

- Rear or side wall installation.
- Floor installation.
- Ceiling installation.

In order to install the Accelerometer sensor in any of the configurations described, it is necessary to:

1. Unscrew the two M6 screws connecting the plate/sensor.
2. Rotate the installation plate to the correct arrangement.
3. Screw the two M6 screws connecting the plate/sensor.

After having agreed with the supplier company on the specific place of installation of each single Accelerometer sensor, it will be possible to proceed with the actual installation of the devices. Installation must be carried out by specialized personnel who must first check that:

- The zone is such that the device is able to communicate data with the Gateway communication devices to which it will be paired.
- That the surface of the structure on which the sensor will be installed is able to accommodate the 2 plugs and 2 screws required for installation.
- That the holes for housing the plugs are not made using the plate attached to the Accelerometer device as a reference.



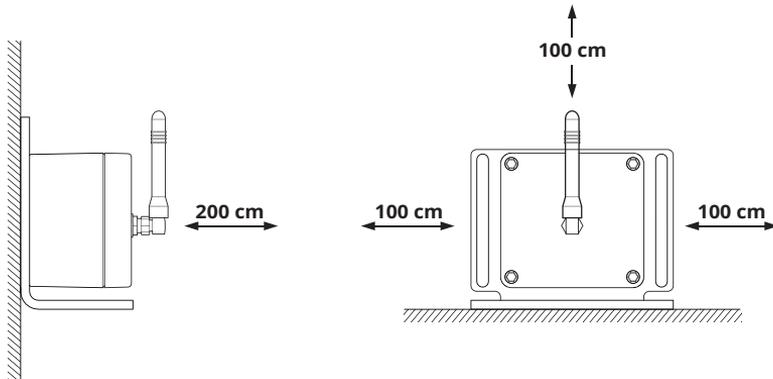
IMPORTANT

- The Accelerometer can be freely rotated, oriented and installed on the structure.
 - It is recommended to align the axes shown on the device label with the axes of interest of the structure.
 - To install multiple Accelerometers on the same structure, use the same orientation convention.
-

SPACE NEEDED FOR INSTALLATION

Install the device where there is free space around it as shown in the illustration. This space must be free of obstacles that could cause interference; this is essential for optimizing the operation of the device.

The weight of the device is shown in this manual in the "Accelerometer Technical specifications" chapter and on the CE label glued under it. Given its size and weight, the device can be moved manually by a single person.



IMPORTANT

- Failure to comply with the warnings indicated in this section could alter the data detected by the sensors.
- If the installation, configuration, use and/or maintenance of the device are not carried out according to the manual, anomalies may occur during its use, and safety problems may also occur. Inappropriate installation, configuration and maintenance will void the warranty.



IMPORTANT

- DO NOT install the device near large metal structures that can cause interference by interrupting or modifying the radio communication signal.
- DO NOT place objects around the product. Such objects could interfere with the radio communication signal.
- DO NOT place the product in a heavily trafficked area. If you need to place the product in a trafficked area, make sure it is positioned in a protected place and safe from accidental drops that can cause serious damage to people and the product.
- DO NOT place heavy objects on the product.
- DO NOT place the product near devices that contain or generate magnetic fields. They could interfere with the operation of the product, causing problems with detections' quality.
- DO NOT place the product near radio wave sources. Interference with the operation of the electronic components of the product may occur.
- If the external structure of one of the components of the Accelerometer device presents sharp edges following an accidental damage, such that the component may result dangerous or make its IP protection degree may be affected, it is necessary to contact the authorized assistance and carefully follow their instructions.



- DO NOT subject the electrical connections of the device to sources of direct water or other liquids.
- DO NOT place the product near chemicals or in places where chemicals can spill onto the product. Any contact of the product with chemicals may result in a risk of fire or electric shock. Such substances could ruin and damage the antenna contact, resulting in the risk of product malfunction, fire or electric shock.
- DO NOT install the device near high voltage cables.

Analog Communication Node

9

The Analog Communication Node is a device that enables all connected sensors (originally wired) or probes for wireless communication. It is possible to transmit accurate readings from all sensors connected to the Gateway via the LoRaWAN wireless communication protocol. The Analog Node supports a maximum of 4 sensors and is compatible with most of the analog interfaces used for geotechnical sensors. This communication device is able to read and digitize geotechnical sensors in static regime such as: strain gauges, temperature sensors, load cells, crack meters, humidity sensors, piezometers, anemometers, inclinometer probes, rain gauges and radar. These sensors can be purchased through Move Solutions™ or other channels. Each Analog Node has 4 pre-configurable channels capable of reading the same type of interface. These interfaces can be: 4-20mA; mV / V; or Pt100.



ANALOG NODE OUTPUT

The output data of the Analog Node are raw data acquired through a 24-bit ADC. The detected data is converted and displayed on the Move Cloud Platform™. The conversion factors and data units of measurement can be set by the user via the Move Cloud Platform™ provided in the service.

DOWNLOAD DOCUMENTATION

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9.1 Quick use guide

To ensure correct operation, see the chapters “Remote configuration of the Analog Node” and “Installation Guide for the Analog Node”, the device must be configured, connected and installed correctly, following these specific steps:

1. REMOTE CONFIGURATION:

- Configure the device via the Move Cloud Platform™, see chapter “Remote configuration of the Analog Node”.
- Take note of the correspondence between the configured sensor and the channel of the Analog Node (CH.1; CH.2; CH.3; CH.4) to which it will be connected during installation.

2. INSTALLATION ON THE STRUCTURE:

- Install the Analog Node to the structure. The device can be installed in any orientation.
- Unscrew the cover and access the inside of the Analog Node.
- Turn off the device by moving the “On / Off” jumper to OFF.
- Correctly connect the sensor wires to the terminals of the Analog Node by passing them through the appropriate cable glands, see the chapter “Analog Node Installation Guide”.
- Check the exact position of the “Yes / No” Jumper next to the terminal, see the “Analog Node Installation Guide” chapter.
- Turn on the device by moving the “On / Off” jumper to ON.
- Verify the correct functioning of the devices through the Move Cloud Platform™. A maximum wait of 30 minutes may be required before the device can be viewed correctly online.
- Tighten the cable glands and close the cover.

3. SCREWING THE ANTENNA:

- Before activating the Gateway, screw the LoRaWAN 868 Mhz antenna onto the lid of the Analog Node device.

It is recommended to configure the device via the Move Cloud Platform™ before connecting the sensors with the Analog Node. After meeting the installation and configuration requirements, the device will be able to forward data to the Gateway without interference or data alteration. From the moment the Gateway is powered and activated, a maximum wait of about 30 minutes is required before it is possible to correctly view all the sensors online.

INTENDED USE ANALOG NODE

For proper operation, as described later in the chapter *“Analog Node Installation Guide”*, first of all the Analog Node device must be correctly configured, installed and connected to the wired sensors.

Multiple Analog Node devices can be installed on the same structure. Due to the wireless operation of the Move Solutions™ monitoring system, no wiring is required between the various Analog Nodes.

NOT INTENDED USE ANALOG NODE

There is no intended use other than those described in this manual. No use other than those described in the chapter *“Safety and Use Guide”* and *“Intended Use Analog Node”* is envisaged.

It is absolutely forbidden to make any changes to the Move Solutions™ civil structural monitoring system. Any damage to people, animals or things resulting from the use of the device improperly modified by an unauthorized operator, is not attributable to the manufacturer which is therefore relieved of all responsibility.



- DO NOT use the device with batteries other than those supported and indicated in the chapter *“Analog Node Technical Specifications”*.



- DO NOT disassemble this product. Disassembly of this product may cause sensor measurement abnormalities.

BATTERY CHANGE INSTRUCTIONS

To change the batteries of the Analog Node follow these steps:

1. Unscrew the sensor cover using a Phillips screwdriver.
2. Place the ON / OFF jumper on the “OFF” position.
3. Remove the 2 batteries present.
4. Insert two new D 3.6V lithium batteries paying attention to respect the polarity indicated on the battery holder, it is advisable to contact Move Solutions™ directly to supply batteries.
5. Place the ON / OFF jumper in the “ON” position.
6. Close the sensor cover.

9.2 Unpacking Instructions Analog Node

All devices manufactured by Move Solutions™ are tested and fine-tuned by the manufacturer before shipping and delivery to the customer.

Make sure the package contains the following components:

Analog Node Components	Number of pieces
Analog Node device	1 pz.
LoRaWAN 868 Mhz Antenna	1 pz.
Universal nylon anchor with screw	4 pz.

Check for any damage to the device. Check that the various parts of the device do not show physical damage due to impacts, tears or abrasions.

Check in particular that there are no marks or dents, indicative of impacts occurred during transport and that the inputs and outputs are not damaged.

NOTE

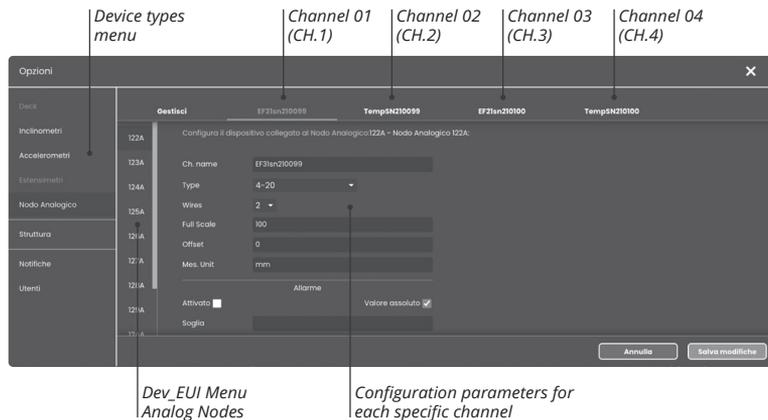
- The components included in the package may vary depending on the model or version purchased. The components indicated refer to the model of the DECKAN-STD monitoring device.

9.3 Remote configuration of Analog Node

ACCESS TO THE MOVE CLOUD PLATFORM™

To correctly view the data detected by the sensors connected to the Analog Node and obtain a reliable conversion, it is necessary to correctly set all the configuration specifications through the Move Cloud Platform™, then:

1. Log in to the Move Cloud Platform™ using the credentials provided.
2. Access the “Options” panel from the side navigation menu.
3. Select the type of device “Analog Node” from the side menu inside the Options panel.
4. Select the specific Dev_EUI of the Analog Node you want to configure from the menu alongside that of the types of devices.
5. Select the channel corresponding to the sensor to be configured from the upper menu (CH.1; CH.2; CH.3; CH.4) of the Options panel.
6. Set the configuration parameters for each specific channel.
7. Take note of the correspondence between the configured sensor and the chosen channel. This correspondence must also occur during mechanical installation, see the chapter “Installation Guide Analog Node”.



NOTE

- To facilitate the reading of the data, as in example, it is advisable to rename each channel with the name of the sensor connected through the “Ch. name”.

REMOTE CONFIGURATION BY INTERFACE TYPE

A single Analog Node is not compatible with multiple types of interfaces at the same time, therefore each connected sensor must use the same interface. The compatible interfaces can be of 3 types, such as:

- 4-20 mA interface
- MV / V interface
- Pt100 interface

To understand the type of interface used by a sensor, consult the product datasheet or contact the supplier company.

The configuration options listed in the “Options” panel of the Move Cloud Platform™ are totally dependent on the type of sensor interface. You can select the sensor interface in the “Type” field.

Therefore, depending on the type of interface, a different configuration and compilation process is required.

SENSOR CONFIGURATION WITH 4-20 mA INTERFACE

- **Sensor Type:** type of sensor interface, select 4-20.
- **Wires:** select the number of wires inside the sensor connection cable.
- **Full Scale:** maximum measurement detectable by the sensor, must be consistent with the Mes parameter. Unit.
- **Offset:** numeric value to be subtracted from the converted measure, field used for corrections or particular situations. This parameter must be consistent with the Mes parameter. Unit.
- **Mes. Unit:** unit of measurement of the sensor.

SENSOR CONFIGURATION WITH mV / V INTERFACE

- **Sensor Type:** type of sensor interface, select mV / V.
- **Full Scale:** maximum measurement detectable by the sensor, must be consistent with the Mes parameter. Unit. For mV / V sensors the measuring range is bipolar, and the Full Scale value is intended as the greatest positive value measurable by the sensor.
- **Offset:** numeric value to be subtracted from the converted measure. This parameter must be consistent with the Mes parameter. Unit.
- **Gain:** sensor gain in mV / V.
- **Mes. Unit:** unit of measurement of the sensor.

SENSOR CONFIGURATION WITH Pt100 INTERFACE

- **Sensor Type:** type of sensor interface, select PT100.
- **Offset:** numeric value to be subtracted from the converted measure. This parameter must be consistent with the Mes parameter. Unit.
- **Gain:** resistance variation with temperature in Ohm / °C. For Pt100 it is recommended to enter 0.385, unless otherwise indicated by the manufacturer.
- **Mes. Unit:** unit of measurement of the sensor, in this case enter "°C".

SPECIFIC CASE

Full Scale configuration based on the desired unit of measurement of a load cell with 4-20 mA interface and the full scale of 2000 kN:

- Option n° 1: insert "MN" in Mes. Unit. and set the Full Scale to "2".
- Option n° 2: insert "kN" in Mes. Unit. and set the Full Scale to "2000".
- Option n° 3: insert "N" in Mes. Unit. and set the Full Scale to "2000000".



IMPORTANT

- The default acquisition time corresponds to a sample every 2 minutes, but can be set to 2 minutes, 10 minutes, 30 minutes, 1 hour to optimize battery life. To make this change contact Move Solutions™.
-

9.4 Analogue Node Installation Guide

DEVICE LOCATION

Before proceeding with the actual installation on the structure, establish the exact position in which you want to install the various sensors connected to the Analog Node and take note of the correspondence between sensor and channel.

To determine the installation position of the Analog Node it is necessary to pay attention to the length of the sensor cables.

To maximize the efficiency of the radio link, check that the Analog Node device is in Line of sight with the Gateway and make sure there are no extraneous antennas, power cables or metal structures in the immediate vicinity of the device.

DEVICE ORIENTATION

Being a data communication device and not a survey device, its relative orientation and arrangement with respect to the structure does not affect in any way the data collected, therefore:

- The Analog Node device can be freely rotated, oriented and installed on the structure.

INSTALLATION ON THE STRUCTURE

Based on the context and the morphology of the structure, the Analog Node device can be installed with the following methods:

- Fixing to the wall, floor or ceiling.
- Pole fixing.



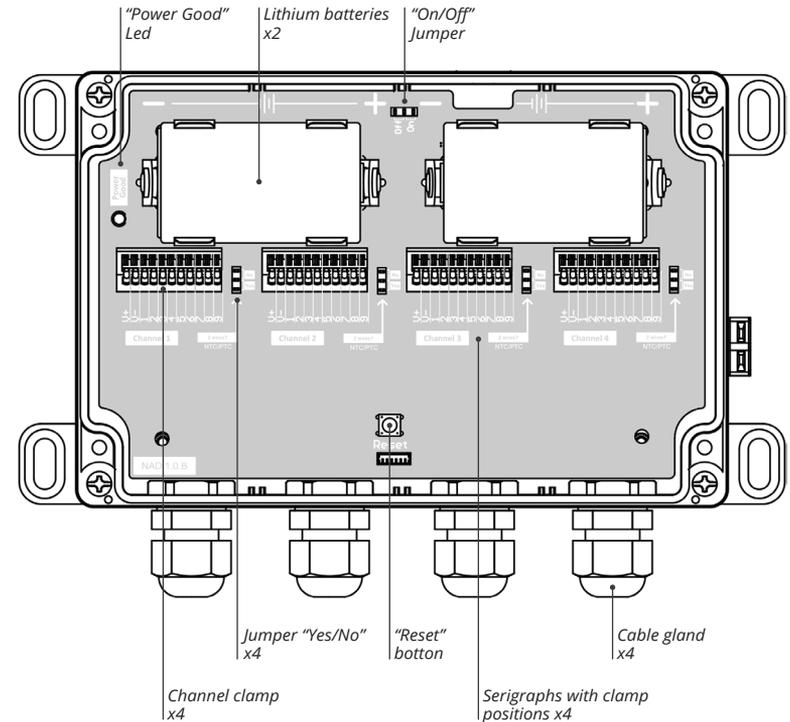
IMPORTANT

- Failure to comply with the warnings indicated in this section could generate the risk of altering the data detected by the sensors.
 - If the installation, configuration, use and / or maintenance of the device are not conducted as per manual, anomalies may occur during use, and safety problems may also occur. Inappropriate installation, configuration and maintenance will void the warranty terms.
-

CONNECTION OF SENSORS TO THE ANALOG NODE

To ensure the operation of the devices connected to the Analog Node and therefore a correct detection of the monitoring data, it is essential to follow exactly the following procedure:

1. Securely install the Analog Node on the wall, ceiling, floor or pole using screws and plugs or cable ties.
2. Open the cover of the Analog Node device. The use of an electric screwdriver is not recommended.
3. If necessary, strip the sensor cable by removing the insulating sheath without damaging the internal wires.
4. Before proceeding with the connection of a wired sensor, make sure that the Analog Node is turned off. If necessary, move the "ON / OFF" jumper, positioned at the top between the two batteries, to the OFF position.
5. Insert the sensor cable through one of the cable glands located on the underside of the Analog Node.
6. Proceed with the connection of the sensor wires with the corresponding terminals of the Analog Node. The correspondence between the clamp clip and the sensor wires may vary according to the type of analogue interface of the sensors to be connected, see the next chapter "Connection to the terminals":
 - Press and hold the clamp clip with a flat-blade screwdriver.
 - Insert the wire at a 45 ° angle to the clip.
 - Release the clip.
7. Make sure the correct position of the "Yes / No" jumper located next to each terminal, see the next chapter "Connection to the terminals".
8. It is essential that the correspondence between the sensor and the channel of the Analog Node (CH.1; CH.2; CH.3; CH.4) is the same previously chosen during the configuration via the Move Cloud Platform™.
9. Turn on the Analog Node by moving the "ON / OFF" jumper, located at the top between the two batteries, to "ON". If the connection has been made correctly, the "Power Good" LED on the left side of the card will be on for 2 seconds. If the "Power Good" LED does not light up, check the charge of the batteries and their correct installation.
10. Tighten the cable glands making sure not to over-tighten the sensor wires. Finally close the cover with the appropriate screws making sure that the insulating sheath does not come out of its housing.



IMPORTANT

- Be sure to move the Analog Node off before installing a sensor and then, if necessary, move the "ON / OFF" Jumper to the OFF position.
- Be sure to turn on the Analog Node after installation and then move the "ON / OFF" Jumper to the ON position.

CONNECTION TO THE TERMINALS

As previously described, it is possible to connect a maximum number of 4 wired sensors to the Analog Node and each of these must have the same type of analog interface. Therefore a specific Analog Node device cannot be compatible with multiple types of interfaces at the same time.

In the process of connecting and mechanically installing a sensor with an Analog Node, it is necessary to pay attention to the type of interface used by the sensor and the number of wires coming out of the sensor cable. These wires must be manually connected to the internal terminal of the Analog Node.

The possible configurations can be:

- 4-20mA with 2 wires;
- 4-20mA with 3 wires;
- mV / V with 4 wires;
- Pt100 with 4 wires.

Each sensor connection cable will have a variable number of wires with different colors inside. The intended use and the consequent identification of a cable is managed through a color coding; thus each conductor is distinguished by a sheath of a different color:

- VCC (Power) = Red
- GND = Black
- Signal - / Signal + = Chromatically variable

To understand the color convention used by a sensor to distinguish the connectors, consult the product datasheet or contact the supplier company directly.

NOTE

- The chromatic distinction used in electrical cables may vary according to the manufacturer. Any operating error resulting from incorrect or improper connection is not attributable to Move Solutions™.
-

To ensure correct operation of the sensors connected to the Analog Node, it is essential to pay particular attention to the installation of the sensor connectors according to the analog interface they adopt, following certain combinations.

CONNECTION WITH 4-20 mA - 2 WIRE INTERFACE

Sensor connectors	Position in the Analog Node terminal
VCC (Power)	V+
GND	5
Jumper "Yes/No"	Position "NO" (or not present)

CONNECTION WITH 4-20 mA - 3 WIRE INTERFACE

Sensor connectors	Position in the Analog Node terminal
VCC (Power)	V+
GND	V-
Signal / Output	5
Jumper "Yes/No"	Position "NO" (or not present)

CONNECTION WITH mV / V INTERFACE - 4 WIRES

Sensor connectors	Position in the Analog Node terminal
VCC (Power)	V+
GND	V-
+ Signal	4
- Signal	3
Jumper "Yes/No"	Position "NO" (or not present)

CONNECTION WITH Pt100 INTERFACE - 4 WIRES

Pt100s usually have two wires of one color and two wires of another color. Arbitrarily choose one color as "Signal +" and one as "Signal -".

Sensor connectors	Position in the Analog Node terminal
+ Signal	6
+ Signal	7
- Signal	8
- Signal	9
Jumper "Yes/No"	Position "NO" (or not present)

FINALIZATION OF THE INSTALLATION

Verify through the Move Cloud Platform™ that the Analog Node device and all its connected sensors are online and configured correctly. Check that there is an effective correspondence between sensor / channel both in the remote configuration and in the mechanical connection.

From the moment the Analog Node is switched on and the Gateway is powered, a maximum wait of about 30 minutes is required before the detected data can be displayed correctly. If no data is detected and displayed during this time, press the “reset” button located in the center of the Analog Node and wait.

NOTE

- Particularly complex or atypical sensors may require a particularly long pre-ignition time. This time can be adjusted by Move Solutions™ at the customer's request after the sensor has been installed.
-

If the data are unlikely during the installation phase, check that you have correctly performed the installation procedure described above and turn off and on the Analog Node device. If the verification procedure does not solve the problem, consult Move Solutions™ specifying the sensor model, in order to evaluate an adjustment of the pre-ignition time.

Once the correct operation of the entire installation has been ascertained, the acquisition time can be changed to optimize battery life. Then contact Move Solutions™ support to request the desired setting from those available: 2 minutes, 10 minutes, 30 minutes or 1 hour.



IMPORTANT

- DO NOT install the device near large metal structures that can cause interference by interrupting or modifying the radio communication signal.
 - DO NOT place objects around the product. Such objects could interfere with the radio communication signal.
 - DO NOT place the product in a highly trafficked area. If you need to place the product in a busy area, make sure it is in a safe place and away from accidental falls that can cause harm to people and seriously damage the product.
 - DO NOT place heavy objects on the product.
 - DO NOT place the product near devices that contain or generate magnetic fields. They could interfere with the operation of the product, causing detection quality problems.
 - DO NOT place the product near sources of radio waves, as this may cause interference with the operation of the electronic components of the product.
 - If the external structure of one of the components of the Analog Node device has sharp edges or edges following an accidental impact, such as to make it dangerous or make the IP protection degree doubtful, it is necessary to contact the authorized assistance and carefully follow the indications.
-



- DO NOT subject the electrical connections of the device to sources and sources of direct water or other liquids.
 - DO NOT place the product near chemicals or in places where chemicals can spill onto the product. Any contact of the product with chemicals could cause the risk of fire or electric shock. These substances could ruin and damage the antenna contact, with the consequent risk of product malfunction, fire or electric shock.
 - DO NOT install the device near high voltage cables.
-

Gateway SHM

10

The SHM Gateway is a control unit for receiving and sending data with which, thanks to the wide-range communication protocol LoRaWAN, it is possible to manage and communicate with dozens of devices and sensors at the same time.

This device, first of all, receives the information transmitted by the multiple sensors installed via LoRaWAN. Then, using Cellular connectivity, it forwards this data to the Move Solutions™ online servers.

The device is Outdoor IP67 and powered by PoE; optionally it can be powered with a solar panel. The SHM Gateway is equipped with LoRa, LTE, GPS and Wi-Fi high gain antennas. Thanks to the double LTE antenna it is possible to obtain greater cellular coverage. The device also implements a Wi-Fi hotspot and an integrated GPS for very precise synchronization and the geolocation of the product. It is very easy to configure thanks to the automatic APN and the included PoE adapter.



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Visit the website at www.movesolutions.it to download additional documentation relating to technical specifications and/or information on the Move Solutions™ structural monitoring system.

10.1 Quick use guide

Before being able to receive and transmit data, the Gateway SHM device must, first of all, be configured, powered and installed correctly.

The main steps to be taken for correct device operation, see the chapter “SHM Gateway Configuration” and “SHM Gateway Installation Guide”, are:

1. CONFIGURATION:

- Choose the type of configuration between Cellular LTE or LAN and follow the procedure described in “SHM Gateway Configuration”.

2. SCREWING OF THE ANTENNAS:

- Screw and connect correctly all the supplied antennas (LTE, GPS, Wi-Fi, LoRa) following the arrangement given by the labels.

3. INSTALLATION ON THE STRUCTURE:

- Securely install the device on a wall or pole using the appropriate installation kit supplied, see “Gateway SHM installation guide”.

4. POWER SUPPLY:

- Connect the SHM Gateway to the electricity supply according to the type of configuration previously chosen. The power supply procedure may vary depending on the configuration chosen, see “SHM Gateway Installation Guide” and “SHM Gateway Configuration”.



IMPORTANT

- Turn on the Gateway SHM only when all 5 antennas (LTE, GPS, Wi-Fi, LoRa) are correctly connected.

After having satisfied these configuration, installation and powering steps, the SHM Gateway will be able to receive and forward data continuously to the online servers. Verify, through the Move Cloud Platform™ viewing and management platform, the correct functioning of the monitoring system just installed.

From the moment the SHM Gateway is powered, a maximum wait of about 30 minutes is required before it is possible to view all the sensors online.

INTENDED USE GATEWAY SHM

In order to receive and transmit data, the Gateway SHM device must, first of all, be configured, powered and installed correctly.

To optimize the operation of the entire system for structural monitoring, all the devices in question must be in line of sight with the SHM Gateway.



IMPORTANT

- Make sure to screw all the antennas into their correct location.
- Make sure you have installed the entire sensor system, with the transmission antennas attached, before connecting to the electricity and making the SHM Gateway operational.

USE NOT INTENDED GATEWAY SHM

There is no intended use other than those described in this manual. There is no intended use other than those described in the chapter *“Safety and Use Guide”*, *“SHM Gateway Installation Guide”* and *“Intended use of the SHM Gateway”*.

It is forbidden to make any changes to the Move Solutions™ civil structural monitoring system. Disassembling this product may cause data reception anomalies. The use of the device modified improperly by an unauthorized operator relieves the manufacturer of any responsibility.

10.2 Unpacking Instructions

SHM Gateway

All devices distributed by Move Solutions™ are tested and fine-tuned by the manufacturer before shipping and delivery to the customer.

Make sure the package contains the following components:

SHM Gateway Components	Number of pieces
SHM Gateway device	1 pz.
WiFi Antenna	1 pz.
LTE Antenna	2 pz.
GPS Antenna	1 pz.
LoRa Antenna	1 pz.
PoE adapter	1 pz.
2m Ethernet cable	1 pz.
Ethernet cable gland	1 pz.
Installation kit	1 pz.
GPS installation plate	1 pz.

The Ethernet cable supplied is 2 meters long and can be used both for the connection between the PoE adapter and the SHM Gateway (in Cellular LTE or LAN operation) and for the connection between the PoE adapter and Router (in LAN operation). If the length of the supplied Ethernet cable is not sufficient, it will be necessary to purchase cables of the appropriate length. This Ethernet cable must be:

- Category CAT6.
- Maximum length 100m (only if used for the connection between the PoE adapter and the SHM Gateway).

Check for any damage to the device. Check that the various parts of the device do not show any damage due to impacts or abrasions. Check in particular that there are no marks or dents, indicative of impacts occurred during transport and that the inputs and outputs are not damaged.

NOTE

- Included components may vary depending on the model purchased. The components indicated refer to the device model GATEWAYSHM002.

10.3 SHM Gateway configuration

ACCESS TO THE NETWORK

Before proceeding with the installation on the SHM Gateway structure, it is necessary to choose the method of connection to the Internet. Based on this methodology, different setup and powering procedures are required. These possible operations for accessing the network can be:

- **Cellular LTE operation with Nano SIM Card.**
- **LAN operation with Ethernet.**



IMPORTANT

- It is strongly recommended to carry out the ignition and grid connection procedures before actual installation on site.



CELLULAR LTE OPERATION

Step 01

With this type of operation, in order to access the network via Cellular LTE communication, the Gateway SHM device requires:

- Nano SIM Card (Standard SIM or Micro SIM are not supported).

To guarantee a continuation of the network communication, based on the data consumption standards, it is required:

- A monthly pay-as-you-go telephone rate plan with at least 5 Giga-bytes of internet browsing.

Step 02

Before inserting the Nano Sim Card inside the SHM Gateway it is necessary:

1. Insert the Nano SIM Card into a mobile device.
1. Access the general settings of the mobile phone.
1. Deactivate the activation PIN code at login.

Step 03

After configuring the SIM Card, you can insert it into the SHM Gateway device, then:

2. Unscrew the 12 screws of the cover to access the inside of the SHM Gateway.
3. Insert the SIM with the chip facing down.
4. Screw on the cover of the SHM Gateway.

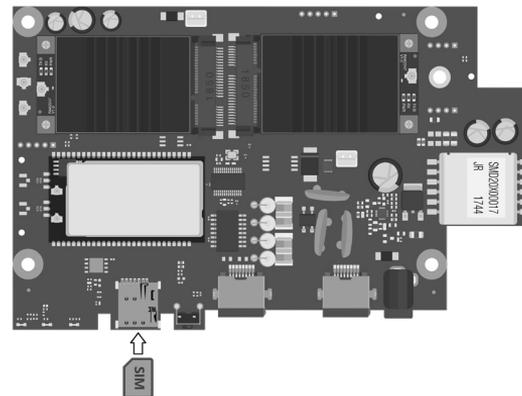
Step 04

For the detection of the APN there are two different cases and different procedures to follow according to the telephone company used for internet browsing, therefore:

- **Public SIM Card:** automatic APN detection, no particular configuration procedure is required to follow.
- **Private SIM Card:** manual APN configuration, follow the procedure described in *“Manual APN configuration with Private SIM”*.

To understand whether the type of SIM used requires manual configuration of the APN or not, it is recommended:

5. Power up and then turn on the SHM Gateway device, see *“SHM Gateway Installation Guide”*.
6. Log in to the Move Cloud Platform™ with the login information provided.
7. Check through the *“System Status”* panel if the SHM Gateway device is correctly Online. In the event that the device fails to automatically connect to the network resulting therefore Offline, a manual configuration of the SIM Card APN is required, see *“Manual APN configuration with private SIM”*.



MANUAL APN CONFIGURATION WITH PRIVATE SIM

If the Nano SIM Card used to access the network is a Private SIM, it is required to follow a specific manual procedure for configuring the APN, therefore:

1. Connect all antennas to the SHM Gateway (LTE, GPS, Wi-Fi, LoRa).
2. Turn on the SHM Gateway device by connecting the ETH (PoE) port of the SHM Gateway to the PoE port of the PoE adapter using an Ethernet cable.
3. Connect the PoE adapter to the power supply.
4. Wait for the SHM Gateway to generate a WiFi network, connect to it with your PC with the following login information:
 - WiFNAME: MG - xxxx [last four digits of the device code].
 - WiFiPWD: see the label on the PoE adapter box.
5. Access the internet with a search engine and type the following IP address in the URL bar:
 - 192.168.230.1
6. Access the configuration interface with the following access data:
 - Username: root
 - RootPWD: see the label on the PoE adapter box.
7. Click on "Cellular interface" under the "Network" section of the side menu.
8. Complete the configuration procedure of the new APN profile by filling in all the required fields and click on "Save & Apply".
9. Click on "Preview" under the "Status" section of the side menu and check that the data of the telephone operator used are correctly shown in the "Cellular" section.

If the device fails to connect to the network and is still Offline, we recommend repeating the APN configuration procedure, making sure to:

- Having removed the PIN from the SIM Card.
- Having entered the correct APN during the configuration procedure.

If the problem exists, contact technical assistance by contacting Customer Service directly at support@movesolutions.it.

After completing this configuration procedure for network access, the Gateway SHM device is ready to be installed on the reference structure, see "*Gateway SHM Installation Guide*".

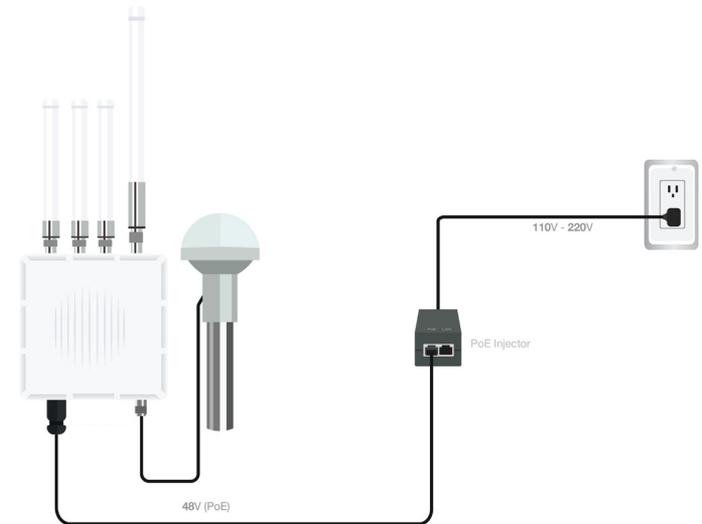


IMPORTANT

- Turn on the device only when the 5 antennas are connected.

AUTOMATIC APN DETECTION WITH PUBLIC SIM

As previously described, using a Public Nano SIM Card no APN configuration procedure is required. As this procedure is therefore completely automatic, the Gateway SHM device is ready to be installed on the reference structure, see "*Gateway SHM Installation Guide*".



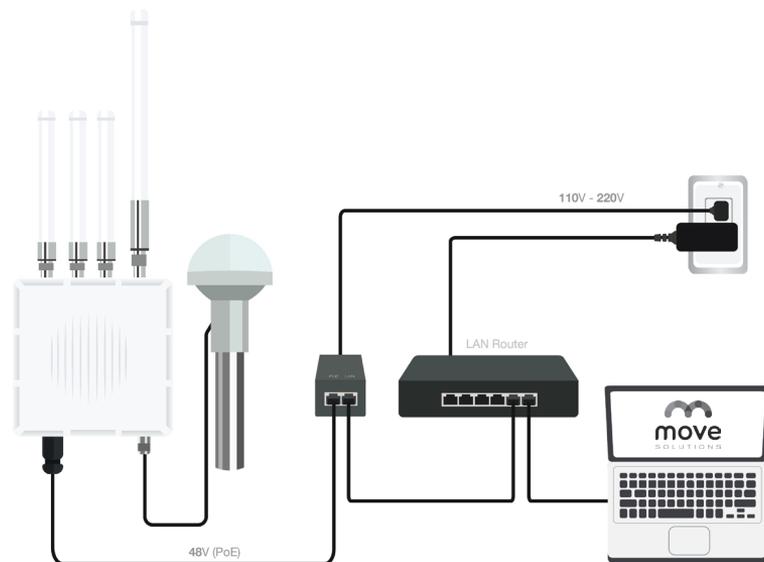
LAN OPERATION

If you want to transfer data through a LAN connection, instead of using a SIM Card, you need to:

1. Connect all antennas to the SHM Gateway (LTE, GPS, Wi-Fi, LoRa).
2. Connect the ETH (PoE) port of the SHM Gateway to the PoE port of the PoE adapter using an Ethernet cable.
3. Connect the LAN port of the PoE adapter to the Router with an Ethernet cable.
4. Connect the PoE adapter to the power supply.
5. Log in to the Move Cloud Platform™ with the login information provided.
6. Check through the "System Status" panel that the Gateway SHM device is correctly Online. It may take a few minutes before the SHM Gateway can be properly viewed Online.

If the SHM Gateway fails to connect to the network and is still Offline, we recommend repeating the procedure described above. If the problem exists, contact technical assistance by contacting Customer Service directly at support@movesolutions.it.

After successfully completing this network access procedure, the SHM Gateway appliance is ready to be installed on the reference structure.



IMPORTANT

- Turn on the Gateway SHM device only when all 5 antennas are correctly connected.

STATIC IP ADDRESS CONFIGURATION

If you want to transfer data via a LAN connection, instead of using a SIM Card, you may need to configure a static IP address on the device, to do this you need to:

1. Wait for the SHM Gateway to generate a WiFi network, connect to it with your PC with the following login information:
 - WiFiNAME: MG - xxxx [last four digits of the device code].
 - WiFiPWD: see the label on the PoE adapter box.
2. Access the internet with a search engine and type the following IP address in the URL bar:
 - 192.168.230.1
3. Access the configuration interface with the following access data:
 - User name: root
 - RootPWD: see the label on the PoE adapter box.
4. Click on "WAN Interface" under the "Network" section of the side menu.
5. Select "Static Address" in the drop-down menu of the "Protocol" item, and click on the "Change protocol" button.
6. Complete the Static Address configuration procedure by filling in all the required fields and click on "Save & Apply".
7. Restart the SHM Gateway device, then disconnect and reconnect the power supply to make the changes effective.

TEMPORARY NETWORK DISSERVICE

The Gateway SHM device is able to store the data detected and transmitted by the sensors even in the event of a network outage and forward them to the Move Cloud Platform™ as soon as it is available again.

10.4 SHM Gateway Installation Guide

DEVICE LOCATION

It is good to keep some aspects in mind before proceeding with the handling, installation and subsequent use of the device. In particular, it is necessary to verify that the following requirements are met:

- The installation site of the SHM Gateway must be as high as possible with respect to the sensor system installed.
- It is recommended to position the SHM Gateway so that it is in line of sight with each specific sensor to maximize radio coverage.
- Correctly screw the antennas following the arrangement given by the special labels placed on the device. All the antennas of the SHM Gateway must be oriented upwards.

POWER SUPPLY

The SHM Gateway device can be powered through two different options:

- Using the PoE adapter and the supplied Ethernet cable.
- Through a solar panel (available on request).

To power the SHM Gateway by connecting it directly to the power supply:

1. Connect all antennas to the SHM Gateway (LTE, GPS, Wi-Fi, LoRa).
2. Turn on the SHM Gateway device by connecting the ETH (PoE) port of the SHM Gateway to the PoE port of the PoE adapter using an Ethernet cable.
3. Connect the PoE adapter to the power supply.



IMPORTANT

- The PoE adapter has no degree of protection against the intrusion of solid particles and the access of liquids. It is therefore recommended to protect the product from dust, sand and in general any small solid body, as well as from humidity and rain.

The Ethernet cable supplied is 2 meters long and can be used both for the connection between the PoE adapter and the SHM Gateway (in Cellular LTE or LAN operation) and for the connection between the PoE adapter and Router (in LAN operation). In the event that the length of the supplied Ethernet cable is not sufficient, it will be necessary to purchase cables of the appropriate length. This Ethernet cable must be:

- Category CAT6.
- Maximum length 100m (only if used for the connection between the PoE adapter and the SHM Gateway).

NOTE

- From the moment the SHM Gateway is powered up, and therefore from its actual start-up and activation, a maximum wait of about 30 minutes is required before it is possible to correctly view all the sensors online on the Move Cloud Platform™.

INSTALLATION ON THE STRUCTURE

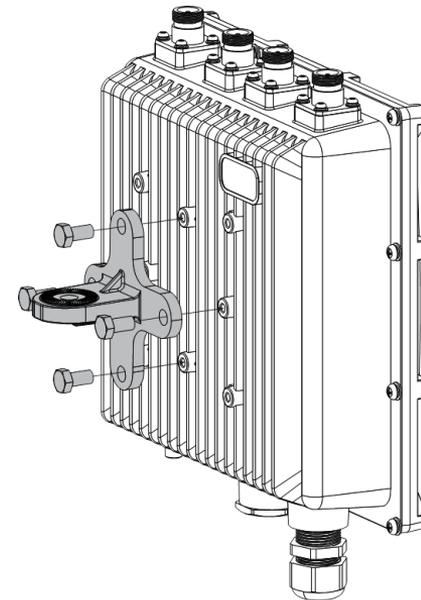
For proper operation, the Gateway SHM device must be securely installed on a wall or pole using the appropriate installation kit supplied.

Agree with the supplier company on the correct positioning of the SHM Gateway device with respect to the monitoring area. For technical assistance, please contact Customer Service directly at support@movesolutions.it.

POLE FIXING

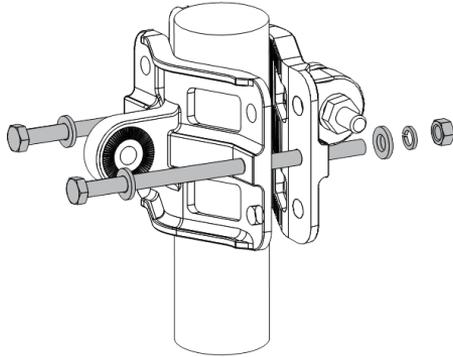
Step 01

Attach the supplied cross bracket to the bottom of the Gateway SHM with four M6 * 12 bolts.

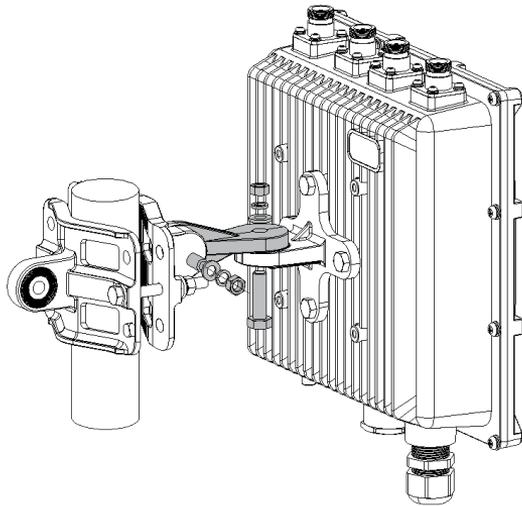


Step 02

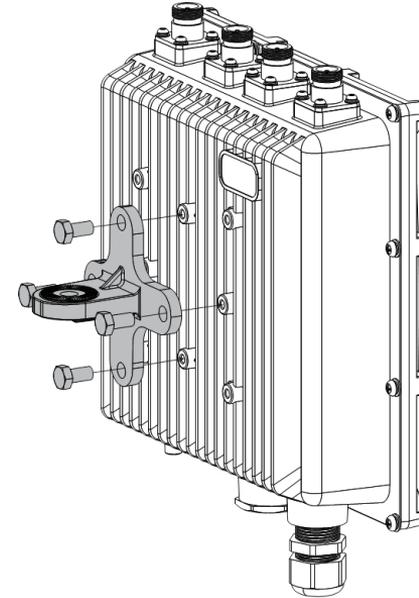
Place the two clamp elements around the pole and tighten them with the included M6 * 110 bolts, washers and nuts.

**Step 03**

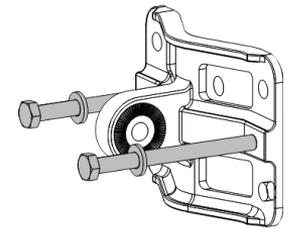
Connect the rod clamp and the cross bracket by fixing the last element of the mounting kit in place using M6 * 30 bolts, washers and nuts.

**WALL FIXING****Step 01**

Attach the supplied cross bracket to the bottom of the Gateway SHM with four M6 * 12 bolts.

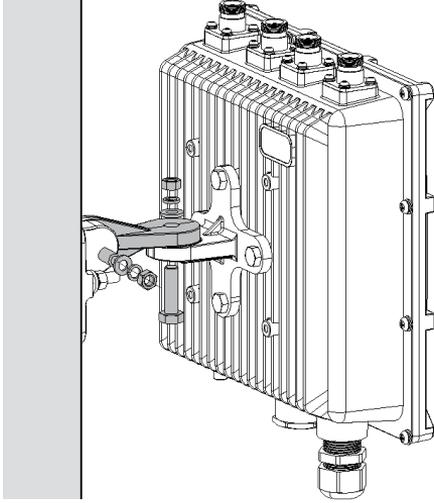
**Step 02**

Install one of the two fixing plates supplied on the wall using M6 screws and plugs (not supplied).



Step 03

Connect the fixing plate installed on the wall with the cross bracket by fixing the last element of the mounting kit in place using M6 * 30 bolts, washers and nuts.

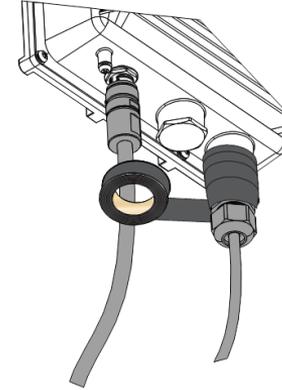


PROTECTION FROM WEATHER CONDITIONS

To better protect the Ethernet cable gland and the antenna connector from bad weather, it is necessary to cover them with PVC tape.

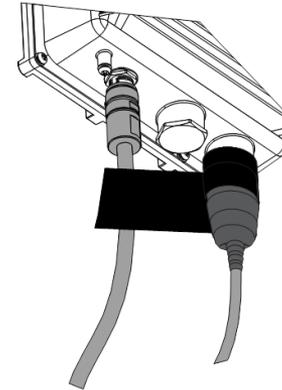
Step 01

Clean the surface of the connector that will be wrapped. Wrap a layer of PVC tape with a 50% overlap based on the direction of rotation of the connector. Continue to wrap the PVC tape up to about 10 mm below the end of the connector.



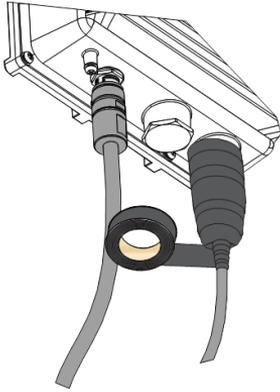
Step 02

Cut about 50 cm of waterproof tape. Stretch it to double the length. Wrap three layers around the connector with 50% overlap. Hold the tape in place with your hand for a few seconds.



Step 03

Wrap three additional layers with PVC tape with natural unrolling force and 50% overlap. Make sure you cover the head and tail of the connector.



EARTHING THE SHM GATEWAY

The SHM Gateway may experience power surges or be exposed to lightning in extreme weather conditions. These events can produce dangerously high electricity which can completely damage these electrical devices. By grounding the electrical system, all excess electricity will be discharged onto the ground instead of seriously damaging the appliances connected to the system. The appliances will be safe and protected from large electrical surges.

Electrical grounding is very important in increasing the levels of electrical safety in the existing arrangement and ensures that all electrical installations are safe and remain protected throughout their useful life.

Grounding of the SHM Gateway device is not technically essential. If necessary, therefore, it is possible to perform a negative grounding through the appropriate connectors located on the back of the case. In any case, comply with the national regulations in force in the individual countries.

It is therefore recommended to use a 10 AWG or larger ground wire to connect the screw terminal on the lower right side of the SHM Gateway enclosure to the grounding rail (bar).



- In case of non-compliance with the recommendations contained in this document, Move Solutions assumes no responsibility for any damage suffered by the equipment due to lightning.
- DO NOT subject the electrical connections of the device to sources and sources of direct water or other liquids.
- DO NOT install the device near high voltage cables.



IMPORTANT

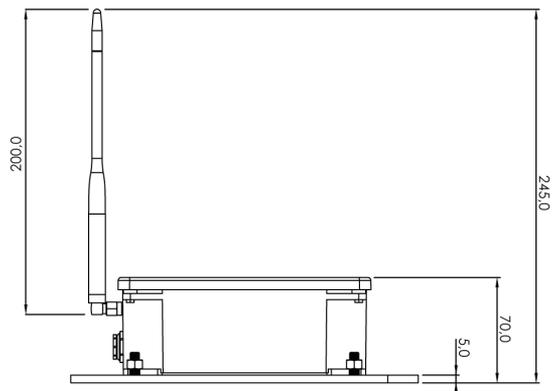
- DO NOT install the device near large metal structures that may cause interference or generate magnetic fields. They could interfere with the operation of the product, causing problems with the quality of the detections, interrupting or modifying the radio communication signal.
- DO NOT place the product near sources of radio waves, as this may cause interference with the operation of the electronic components of the product.
- DO NOT place the product in a highly trafficked area. If you need to place the product in a busy area, make sure it is in a safe place and away from accidental falls that can cause harm to people and seriously damage the product.
- DO NOT shield LTE, GPS, Wi-Fi, LoRa antennas.
- DO NOT use power supplies other than the one supplied.
- DO NOT interchange the arrangement of the antennas.
- DO NOT disassemble this product.
- The product has been designed, manufactured and tested to meet all specific standards if and only if installed, configured and powered correctly as described in this manual.
- Failure to comply with the warnings indicated in this section could generate the risk of altering the data detected by the sensors.
- If the installation, configuration, use and/or maintenance of the device are not carried out according to the manual, anomalies may occur during use.

Overall dimensions

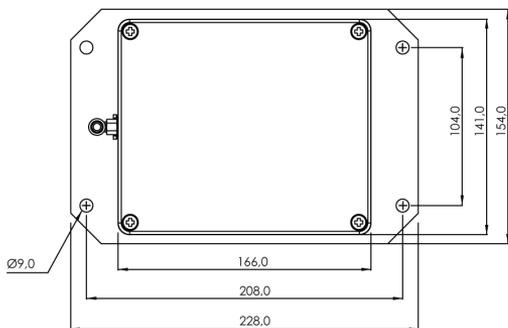
12

12.1 DECK device

Front view



Upper view

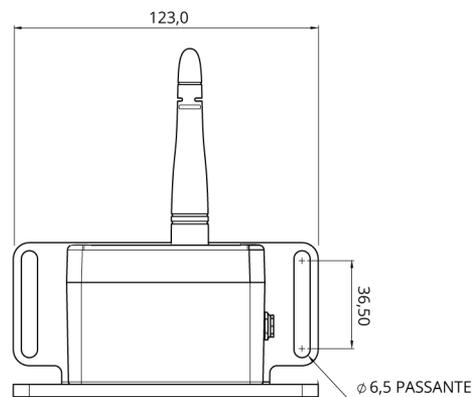


NOTE

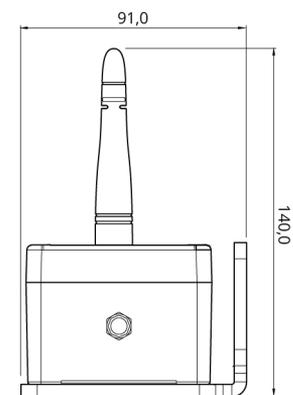
- The components included in the package may vary depending on the model or version purchased. The components indicated refer to the model of the DECK001-V-FU; DECK001-V-FD; DECK001-V-FW; DECK001-H-UD; DECK001-H-WP; DECK001-H-WF monitoring device.

12.2 Tiltmeter

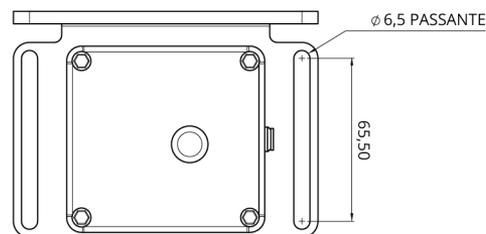
Front view



Right view



Upper view

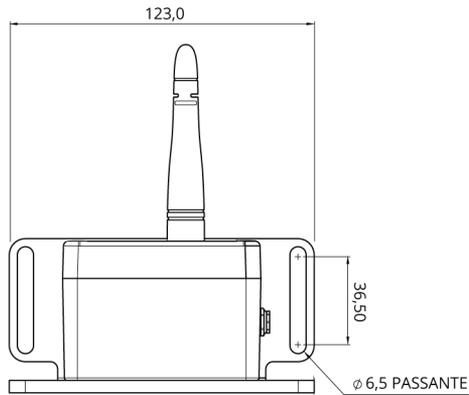


NOTE

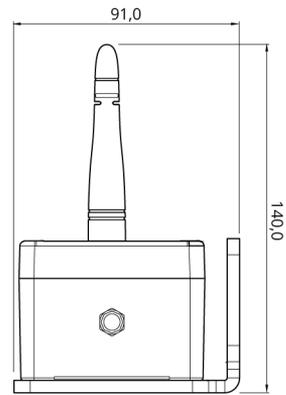
- The components included in the package may vary depending on the model or version purchased. The components indicated refer to the model of the DECKT-LT-STD monitoring device.

12.3 Triaxial Accelerometer

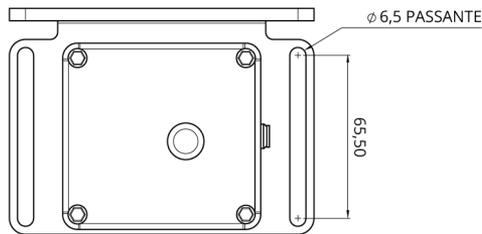
Front view



Right view



Upper view

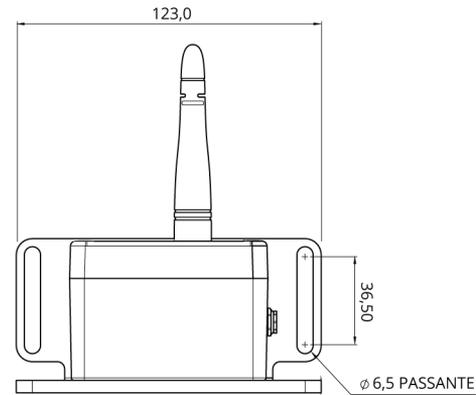


NOTE

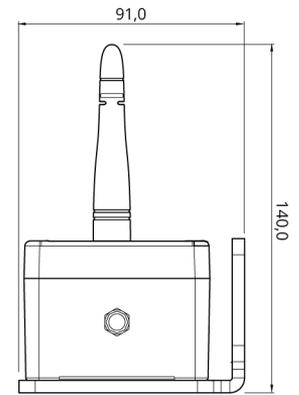
- The components included in the package may vary depending on the model or version purchased. The components indicated refer to the model of the DECKA-XE-STD monitoring device.

12.4 SHM Triaxial Accelerometer

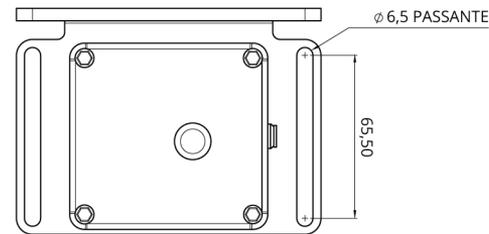
Front view



Right view



Upper view

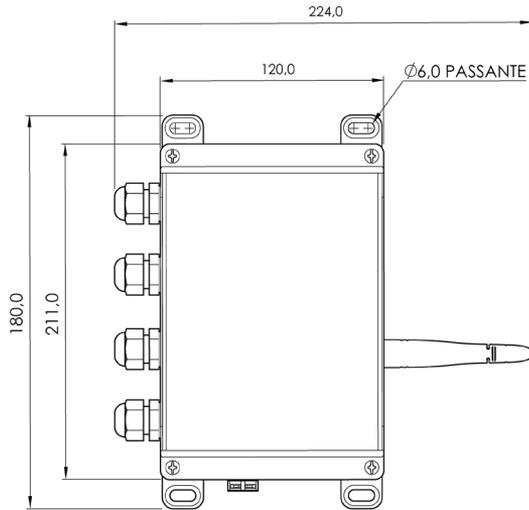


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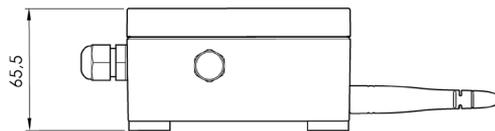
- The components included in the package may vary depending on the model or version purchased. The components indicated refer to the model of the DECKA-XE-SHM monitoring device.

12.5 Analog Communication Node

Upper view



Right view

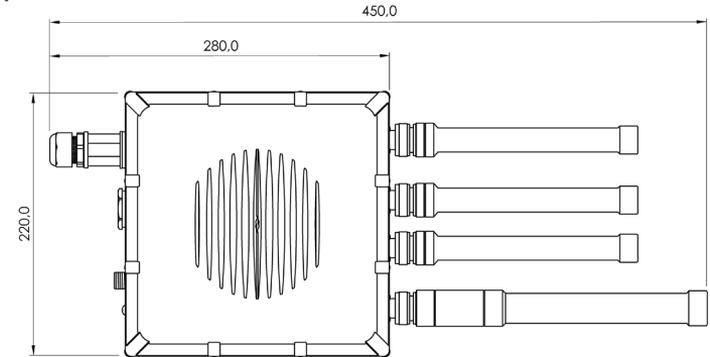


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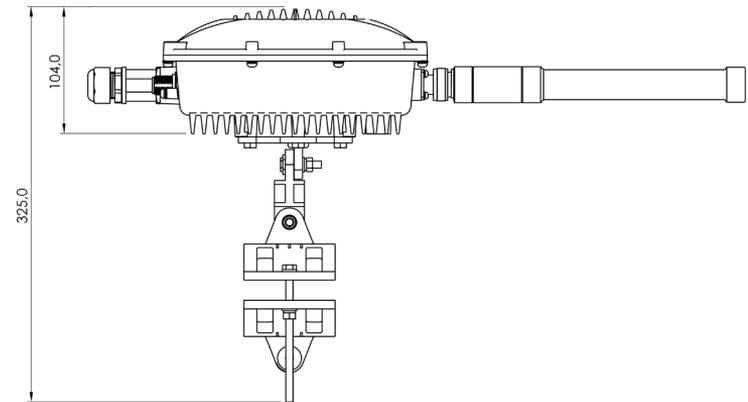
- The components included in the package may vary depending on the model or version purchased. The components indicated refer to the model of the DECKAN-STD monitoring device.

12.4 Gateway SHM

Upper view



Right view



NOTE

- The components included in the package may vary depending on the model or version purchased. The components indicated refer to the model of the DECKA-XE-SHM monitoring device.

Warranty

13

The warranty rules, listed in full in the purchase contract, are valid only if the device is used in the conditions of intended use.

With the exception of the interventions described in the present manual and only if carried out correctly according to the indicated procedures, any repair or modification made to the Move Solutions™ civil structural monitoring system by the user or by unauthorized companies will invalidate the warranty.

The warranty does not extend to damage caused by inexperience or negligence in the use of the devices, or by poor or omitted maintenance. Failure to comply with the methods of intervention and use of the system described in this manual will result in the forfeiture of the warranty terms.

Move Solutions™ devices are covered by warranty under the following conditions:

- The warranty is valid for a period of 12 or 24 months depending on the buyer's contract.
- The manufacturer Move Solutions™ undertakes to replace, at its own discretion, the malfunctioning or incorrectly manufactured parts, only after careful control and verification of incorrect assembly.
- The transport and/or shipping costs for the repair or replacement of the product are always charged to the buyer.
- After replacement under warranty, the recalled products become the property of the manufacturer.
- Only the original purchaser who has complied with the normal maintenance instructions contained in the manual can benefit from this warranty. Our warranty liability expires when: the original owner relinquishes ownership of the product, or changes have been made to the product.
- The warranty does not include damage resulting from excessive stress such as using the product after a fault has been detected, the use of unsuitable methods of operation as well as failure to observe the operating and maintenance instructions.
- The manufacturer assumes no responsibility for any difficulties that may arise in resale or use abroad due to the provisions applied in the country where the product was sold.

Frequently encountered problems

14

If the data and statistics displayed on the Move Cloud Platform™ relating to the installation period on the structure are abnormal and/or irregular:

- It means that the devices have not been installed in the correct order. That is, the Gateway was installed and connected to the power before installing the sensors.

In the event of unexpected anomalies or interference in the signal and data detection immediately after powering the Gateway and/or installing the sensors, it is recommended to follow the procedure below:

- Check the correctness of the installation of each single device;
- Check for the presence of external antennas, power cables or metal structures in the immediate vicinity of the devices;
- Check if the antennas are screwed on correctly;
- Check if the Gateway/sensors distance is optimal and not excessive;
- Verify that the Gateway is in line of sight with respect to each device;
- If the malfunction persists, contact Customer Service directly at support@move-solutions.it.

In the event of any unforeseen anomaly in the use of the Move Solutions™ monitoring system, it is recommended to follow the procedure below:

- Check that the Gateway is still in line of sight with respect to each device and that there is no object that can interrupt the radio signal;
- Check the correctness of the installation of each single device;
- Check the condition of each device and that there have been no tampering or injuries of any kind;
- Check that the antennas are not shielded;
- If the malfunction persists, contact Customer Service directly at support@move-solutions.it.

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DEV_EUI	Layout	Note
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MOVE SOLUTIONS CUSTOMER ASSISTANCE SERVICE

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Move S.r.l

Piazza Cavour 7, 20121 Milan - Italy

Via Guglielmo Lippi Francesconi 1256/J, 55100 Lucca - Italy

P.IVA: 09887990969