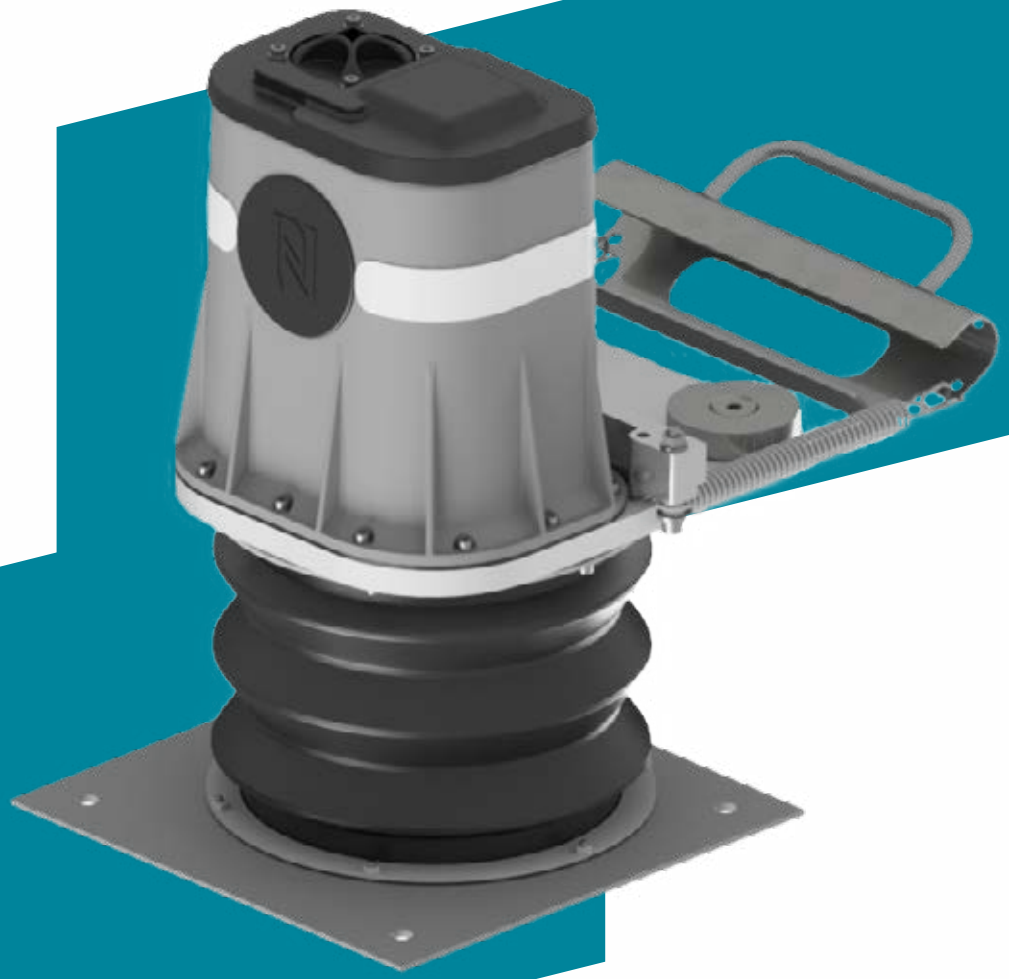
SISGEO®
RAIL
IOT IN MOTION

LoRaWAN® FLX-RAIL®

USER MANUAL



FLX-RAIL

INDEX

Notes on the use of product

For safe and efficient use of the product, please read carefully the following instructions before starting any operation.

Any use of the product other than the one described in this manual shall be considered the user's full responsibility. The same applies for any unauthorized modifications.

In addition to the hereby listed standards, the user must comply with the provisions of the current legislation regarding personal safety and health together with all other persons in the workplace. SISGEO is not responsible for any accident, breakdown or other problems due to lack of knowledge and / or non-compliance with the requirements contained in this manual.

Check that the product has not been damaged during the transport. Verify that the package includes all items as well as any requested optional accessories; if anything is missing, please promptly contact SISGEO. The user must strictly follow all the operations described in this manual. Maintenance or repair of the device is permitted only by authorized operators. These operators must be physically and intellectually suitable. For information about instrument or to order spare parts, always specify the product information which can be found on the identification label. When replacing parts, always use ORIGINAL SPARE PARTS.

The manufacturer reserves the right to make either technical and / or commercial changes without prior notice. It is our policy to keep manuals continuously updated.

Symbols

Direct current symbol

RAEE symbol: the symbol indicates that the product must not be disposed of as unsorted waste, but must be sent to separate collection facilities for recovery and recycling

CE certification symbol: graphical demonstration that the product to which it is applied complies with the regulations in force within the European Community and that govern the production and marketing of that product. This device complies with the requirements for being placed on the market within the European Union (CE – RED). Use in other countries may be subject to local regulations governing radio equipment. It is the responsibility of the importer or the end user to ensure compliance with the applicable regulations in the country of use.

Symbol of warning. Handle the product with care, following the instructions given in this manual in order to do not damage the readout.

Symbol of attention. Pay particular attention to the following instruction in order to use the readout in the right and best way

Identification

Instruments can be identified

- From a production lot number (written on the Compliance Certificate)
- From a serial number (s/n) engraved indelibly on the instrument
- From a label on the instrument
- From a label on the cable

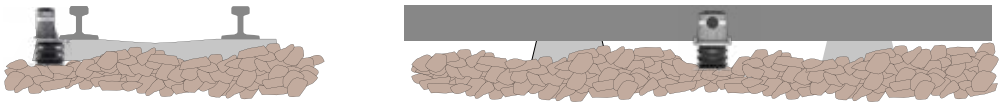
Note

The present Manual is issued by SISGEO in English Language and translated in other different languages.

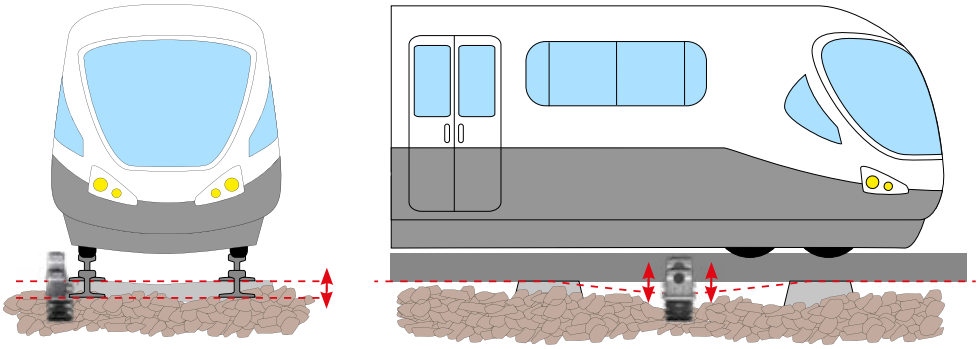
In order to avoid discrepancies and disagreements on the interpretation of the meanings, Sisgeo Srl declares that English Language prevails

INTRODUCTION

FLX-Rail® is an instrument developed to measure the maximum deflection of the track at each passage of the train. **In this manual is described the FLX-Rail® with LoRa WAN technology.** The measurement consists in reading the variation of distance between the ballast/concrete surface and the track, to which the instrument is fixed by two strong magnets and by a fixing hang.



The instrument is equipped with SBV® technology (Start By Vibe®) in order to switch on the instrument only when the train approaches (energy saving).



In addition to the vertical measurement at each passage of the train, it is also possible to have an integrated biaxial tiltmeter.
Measures from tiltmeter gauge are taken in static condition (no train passage) in order vibrations to do not interfere with the reading.

LoRa WAN FLX-Rail® MODELS

SISGEO RAIL supplies 4 different FLX-Rail® ® models

- LoRa WAN® FLX-Rail® for **VERT DISPL:** able to monitor the vertical deflexion of the rail
- LoRa WAN® FLX-Rail® ® for **VERT DISPL+TILT:** able to monitor the vertical deflexion of the rail and the rail tilting

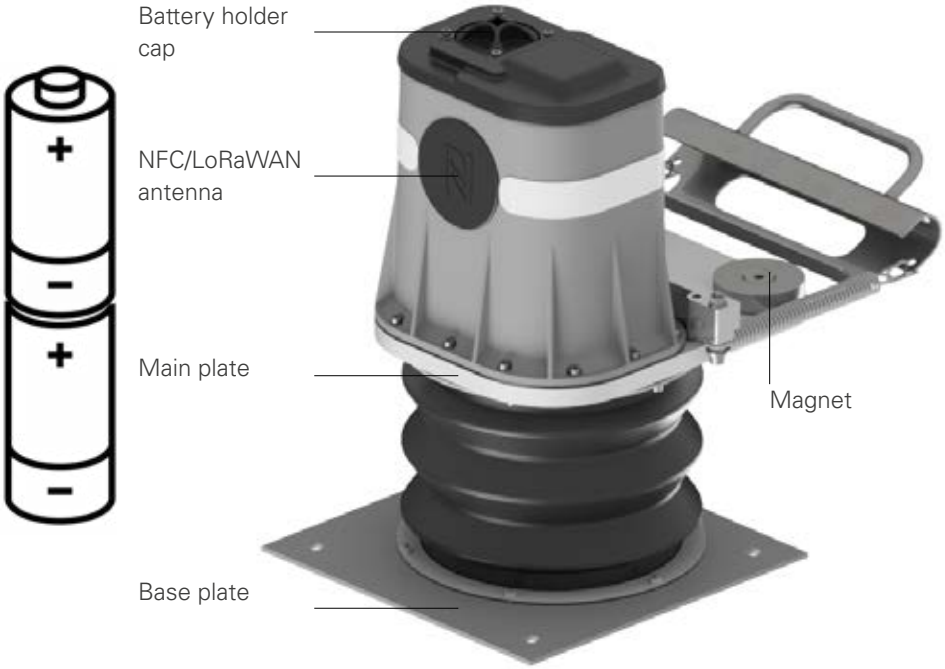
The instrument is powered by **non-rechargeable (disposable) batteries. It is mandatory to use correct type of batteries to avoid to damage electronic board.**
The indication about batteries type to use is on the label on side, as shown on following pictures.

DESCRIPTION

The FLX-Rail® gauge is composed by:

- A main body with
  1. the sensor **cover** with antenna for NFC® and LoRaWAN® communications
  2. the **main plate** with two **neodymium magnets** and **two rail supports**
  3. the foot with a **springed-leg** *and a* **steel base plate**
  4. **fixing hang** to fix sensor to rail
- Two **size D batteries**

NOTE: only use the battery models foreseen by SISGEO: these models have in fact passed the qualification tests based on the EN 50125-3 standard (track level); any other model may not guarantee the correct functioning of the instrument or even damage it.
For safety reasons, insert the batteries with the right polarity.



TESTED BATTERY MODELS

Not-rechargeable type (disposable):
TADIRAN SL-2780; 3.6V Lithium Thionyl Chloride Non-Rechargeable Cell;
Nominal Capacity:19Ah; Size: D

For further information, refer to the technical data sheets available on the manufacturer's website

According to the needs SISGEO can therefore supply different models of FLX-Rail®.

FLX-Rail® is equipped with a **LoRaWAN® communication** interface for data transmission

NOTE: . FLX-Rail® uses transmission on the 868MHz frequency: you must ensure whether there is radio coverage with this frequency at the installation site via a local utility provider. Also check that the 868MHz frequency is allowed at the installation site.

NOTE: to obtain the documentation related to the payload format of the radio message for the integration in your applications, please contact your Sales Representative or Sisgeo Customer Care Department (assistance@ sisgeo.com).

FLX-Rail® is equipped also with **NFC® connectivity** for local connection via a dedicated APP.

Main parameters configured at factory for each gauge:

- Serial number;
- Calibration parameters;
- Device EUI
- App Key
- Join EUI
- Unit of measurement
  1 - for displacement transducer, the standard output is **mm.**
  2 - for embedded biaxial tiltmeter version, the standard output is **sin*α*.**
  3 - for internal humidity gauge, the standard output is **%RH**
  4 - for internal power supply level, the standard output is **V (Volt)**
  5 - for internal temperature gauge, the standard output is **°C.**

Each FLX-Rail® is equipped with **diagnostic sensors** such as: measurement of temperature and humidity inside the instrument, measurement of the power supply voltage.

PRELIMINARY CHECKS

FLX-Rail® uses LoRaWAN® transmission on the frequency of 868MHz. In case a local gateway is not used and a public LoRaWAN® network is to be used, please preliminarily check the coverage at the sensor installation site and then arrange for activation of the contract with the provider..

Useful tools :

For installation there is no specific tool needed. Nevertheless the complete installation would be performed with means of:

- a shovel and/or a pickaxe
- a metallic brush in case of rust on the rail
- a measuring tape (used only to check the correct installation position of the instrument)

Before installation it is recommended to check the compression of the instrument which must take place smoothly and without noise, and clean the magnet.

In case of re-use, it is strongly advised to:

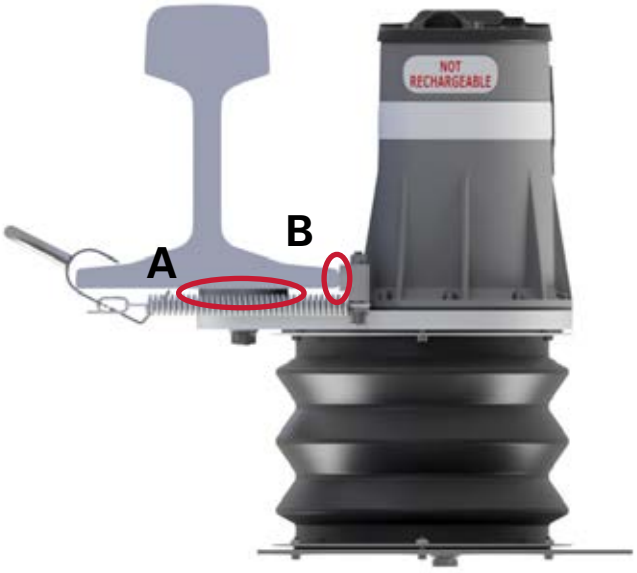
- clean completely the outside of the instrument with degreasing detergent
- remove oxidation or any deposit (if any) with specific brush
- check the mechanical functionnality

INSTALLATION

NOTE: the installation of these systems, being on a railway track, is subject to strict safety regulations. Please refer to the safety procedure issued by the relevant railway authority.

To install a FLX-Rail® unit, please follow this general guideline:

- Remove the ballast under the track and clean with brush the underside of the track where the instrument will be fixed.
  NOTE: Scrub off the rust from the rail in the zone where the magnets (A) and lateral leaning (B) will be in contact with the rail is really important in order to have a better and stronger connection.



- Insert the instrument under the track keeping the two plates close together, taking care not to put fingers between the upper plate of the instrument and the track, and then release them once the instrument is fixed under the track by magnets.

NOTE: read the Appendix 3 "Safety information for neodymium magnets"

Pay attention to keep in contact FLX-Rail® ® and rail on point (B): this operation is mandatory to avoid any gap between track and FLX-Rail® ®. If you need to move FLX-Rail® ® once is already connected to rail by magnets don't hit cover. Move FLX-Rail® ® only by aluminum plate.

- Grab the handle fixing using protective gloves; be careful not to close your fingers between the hook and the rail during placement.

Pull handle to extend the spring and anchor the hook to rail.

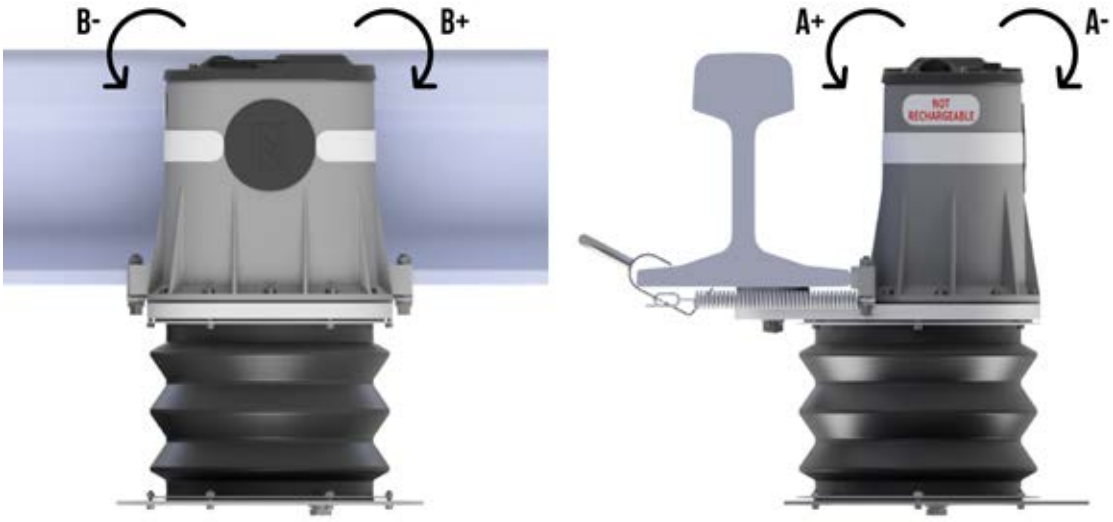
- Fill in or remove ballast over the bottom plate to obtain 95 mm distance between two plates: in this configuration FLX-Rail® ® can move approx. 50mm in compression and 20 in extension.

NOTE: with the plates at a distance of 45mm, the output is around 0mm; with the plates at a distance of 115mm , the output is around 70mm.

The FLX-Rail gauge is locked in position through the magnets and the springs on the rail. The lower plate is rested on the ballast.

NOTE CONCERNING BI-AXIAL TILTMETER DATA

Sign convention for the tiltmeter



In its dedicated version, the FLX-Rail® ® gauge gives tilt reading directly in engineering units (sin alpha, degrees or mm/m).

CONNECTION AND RANGE CONTROL TEST

In order to verify the position of FLX-Rail® at the correct installation range, it is advised The relative reading refered to the reference measurement can be calculated with the following formula:

NOTE: Please refer to APPENDIX 1 for the definition of "Reference measurement"

NOTE: Reference reading (or reference measurement) shall be taken carefully once the installation is performed, after the stabilization (suggested 2-3 days) and baseline period, and the instrument is in operating conditions.

to use the APP. With APP, the function READ will be used. This function simply scans all channels of the instruments and show the last value reading.

After powered the instrument try to join the Network Server. After this make a test measure.
So, after the join and test measure, it is possible check the measure with APP or see the reading on Application Server.

Therefore it will be necessary to proceed as follows:

1. Install all the FLX-Rail® ® with the two plates at the appropriate inter-distance, checking with a measuring tape
2. Insert the batteries and close the cap of batteries holder
3. Compress, one after the other, all installed FLX-Rail® ® to wake them up by simulating an event (train passage).
4. Be sure that the Network Server is available
5. Wait some minutes after the join procedure, then read the value with FLX-Rail® APP via NFC or check on your Application Server.

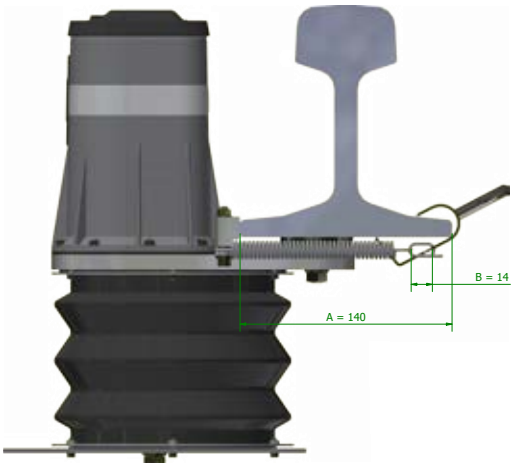
The value to be checked is the **AVERAGE MEASURE** value in millimeters [mm], present among the acquired values, which must report an installation measurement of around 50mm.
Refer also to the chapter "DATA MANAGEMENT" in this manual.

If some instruments do not have the correct measurement value, it will be necessary to arrange the installation by acting on the underlying surface and re-check by repeating the above steps.

NOTE: FLX-Rail® comes with standard connection rings between spring and handle for 140mm rail foot length. Change standard rings with longer rings (provide by SISGEO) to use FLX-Rail® on 150mm rail foot length.

LENGTH ADJUSTMENT

Default installation involves to use FLX-Rail® on 140 mm length rail (A): in this configuration connection ring is 14 mm wide (B).

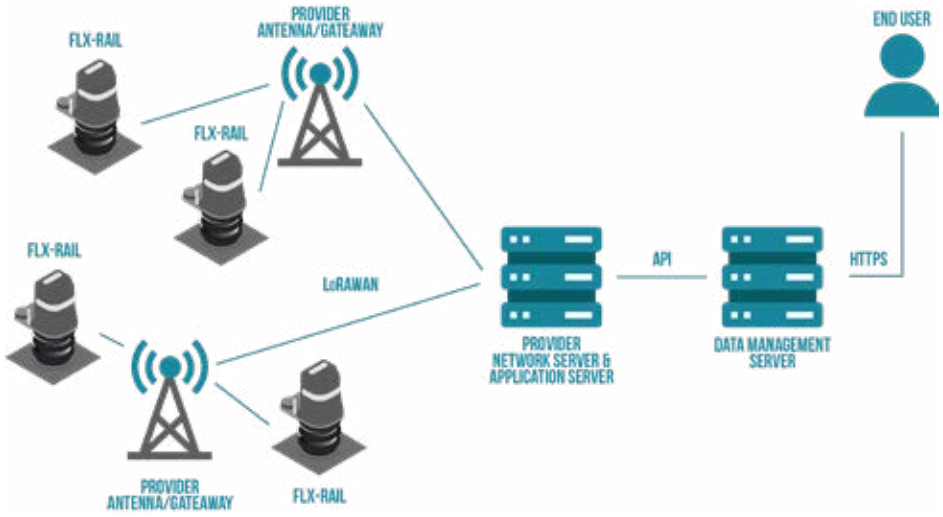


Is it possible to install FLX-Rail® also on 150 mm rail length changing the standard rings with other provide by SISGEO 24mm wide. During ring substitution pay attention to maintain spiring in their position without apply any rotation or torque/extension force on them.

NOTE: Using FLX-Rail® on wider length foot rail than those indicated lead to lack of stability in fixing on rail. If springs will be extended more than allowed by SISGEO's directions, irreversible damage will occur on them.

NETWORK DESCRIPTION

As a general guidance, the installation layout of a complete monitoring survey with FLX-Rail® ® could be described like on the below scheme.



FLX-Rail® is supported by the LoRaWAN® network and is therefore capable of autonomously sending data over this network.

The LoRaWAN® network is typically composed of the elements in the diagram above, in particular:

- **END-DEVICE (NODE):** in this case the FLX-RAIL®
- **Network LoRaWAN®** supplied by the provider, which is typically composed of:
    - **Antennas/Gateway:** devices designed to receive messages sent by the NODE and deliver them to the NETWORK SERVER
    - **NETWORK SERVER/APPLICATION SERVER:** message destination server. In the Network Server there is usually also a Join Server and an Application Server. These have the task of identifying the nodes intended for them and managing incoming messages, making them available to the end user.
- **DATA MANAGMENT SERVER** which is a server/application capable of retrieving/receiving information from the Network Server and making it available to the user in a graphical and tabular manner. It is typically the server that the end user accesses to view and manage the data (e.g. WMS/AIDA software).
- **END USER** which is the end user who will be in charge of managing the data coming from the field.

TAKING MEASUREMENTS

FLX-Rail® is autonomous and, after the acquisition of the data, it will send them to the network server supplied by the provider: there is no need to be interrogated by a data logger.

PRINCIPLE OF OPERATION

The FLX-Rail® ®, in its most complete version, is able to measure:

- maximum deflexion of the rail (VERT DISP)
- bi-axial inclination of the track (TILT)

FLX-RAIL® can perform two types of measurement, one **scheduled (static)** and one in the presence of **train passage (dynamic).**

a) STATIC MEASUREMENT

Static measurement takes readings from the following sensors:

- **bi-axial inclination** of the track (TILT)
- **diagnostic data** (onboard temperature, onboard humidity and batteries voltage)
- **deflection** (deflexion of the rail in rest condition)

The frequency of acquisition (and therefore transmission) of this measurement can be configured by the user via the FLX-RAIL® APP.

NOTE: a very dense acquisition range drastically reduces battery autonomy; we suggest an acquisition every 6 hours.

b) DYNAMIC MEASUREMENT

FLX-Rail® is able to detect in real time the passage of a train and to measure -during its passage- the maximum deflection

A sensor inside the FLX-Rail® identifies the approach of the train a few seconds before its actual passage, and starts the dynamic acquisition of the rail movement; to make this measurement, 350 measurements are made per second and, once the train has passed, the maximum deflexion value of the track is saved.

After train passage and without vibrations, it can detect its inclination on two axis (if foreseen by the model used).

After this the instruments send the data on the NETWORK SERVER.

In the next page you can find a block diagram that explains how it works.

RTC (Real Time Clock) SYNCHRONIZATION

FLX-Rail® does not have an internal backup battery; therefore, its internal clock is reset every time the power is turned off.

The first time that the sensors join the network server, the LoRaWAN® network send the date and time to FLX-Rail®.

If the networks not provide date and time the instruments start to work assuming 01/01/1970 00:00:00 as date and time.

APP FLX-RAIL ®

To manage the FLX-RAIL® instrument locally, SISGEO provides an APP for smartphones that allows the instrument to be started and configured.

The APP is available for Android and iOS devices that meet the following requirements:

- ANDROID v.11 or higher with NFC capabilities
- iOS V. 17 or higher with NFC capabilities

The APP can be downloaded from the Play Store (Android) and App Store (iOS).

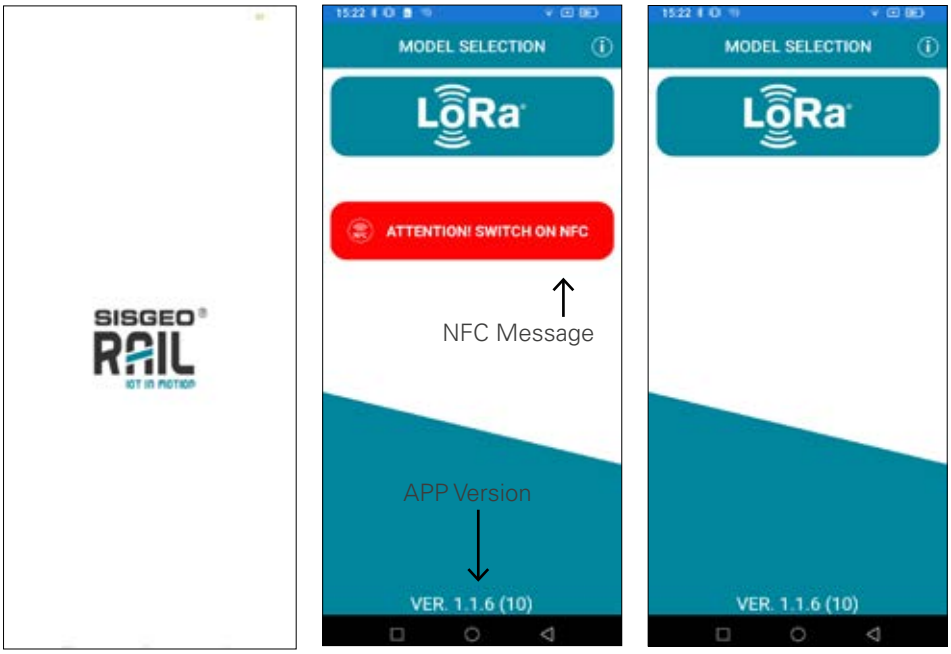
The FLX-RAIL® APP allows:

- the display of the last measurement taken
- the configuration of the measurement parameters
- configuration of LoRaWAN® network parameters
- the display of the LoRaWAN® connection quality
- The saving of instrument configurations.

STARTING THE APP

Once you have downloaded the APP, you can start it by simply pressing on its icon.

Once the APP has been launched, the HOME screen will appear in a few seconds.



The Home screen will show the APP version and possibly a message indicating to enable FLX-Rail® NFC in case it has been deactivated in the device settings.

Selecting LoRa will then take you to the other configuration pages.

INSTRUMENT READING

The FLX-RAIL® instrument is a totally autonomous instrument. Therefore with the APP it is possible to simply read the last reading taken by the sensor and not to force a new measurement. For this reason, the date and time inherent to the read measurement is also read.

To be able to read the last measurement taken, it is necessary:

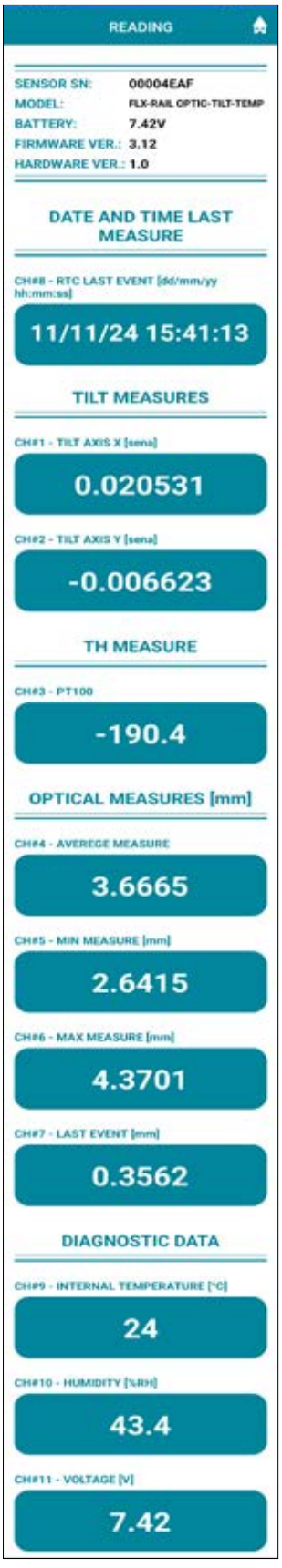
- Select READ in the menu following model selection:

- Press READ again on the page indicating how to proceed with reading

- Bring the phone close to the NFC antenna of the FLX-RAIL® as shown in the picture and hold it until read confirmation is received

NOTE: the sound/vibration notification from the smartphone does not indicate that the content of the NFC TAG has been read but simply that an NFC TAG has been detected. It is therefore recommended to hold the phone in place for a few seconds after the notification or until the APP shows the read or confirmation page. In addition, the speed of TAG detection may depend both on the phone itself and on the operating system in use.

- Once the NFC TAG has been read, a measurement page will be displayed showing all read data.



Sensor information

DATE and TIME of last event

Tiltmeter measurement (if model with tilt measurement is present)

Sensor no longer present (typically value shown at -200°C)

Measures related to the EVENT

Diagnostic measures

NOTE: Data is not saved but only displayed in the APP for control or information during installation of the instrument to the track.

CONFIGURATION

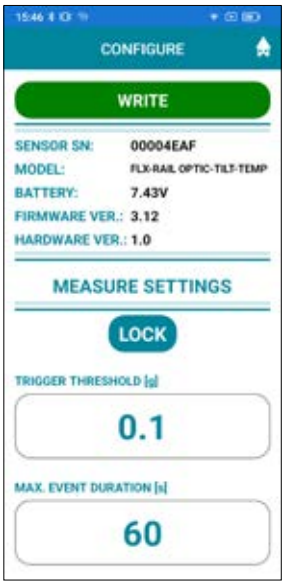
Using the FLX-RAIL® APP, both measurement and LoRaWAN® Network settings can be configured.

MEASUREMENT PARAMETER CONFIGURATION

To configure measurement parameters, select CONFIGURATION and then MEASURE SETTINGS on the following pages:

You will be asked to bring the phone close to the instrument to be able to read the current configuration on board the instrument and then allow it to be changed if necessary.

Once the configuration is read, it is shown in the APP. The values shown are those currently on board the instrument.
To avoid unwanted changes, the various parameters will be disabled and cannot be modified. In order to edit them, it will be necessary to click on the padlock button.
By clicking, the fields will become editable.



It is now possible to edit any field. By clicking on the value you wish to edit, the keyboard will appear, allowing you to edit values. When a value is changed, it will appear in **orange** to indicate that the value has been changed from the one on the instrument.

As can be seen from the image above, several fields can be edited at the same time.

For the GPS position, however, you can press the GET POSITION button and the phone will automatically indicate the current position. If there is no GPS coverage or the configuration is taking place in a different location from the installation site, you can enter the coordinates by hand if known.

NOTE: GPS position is important if you plan to geolocate instruments on a synoptic map in the Data Management software.

By editing any field, the WRITE button is also activated, which allows the new configuration to be written to the instrument when the changes are complete.

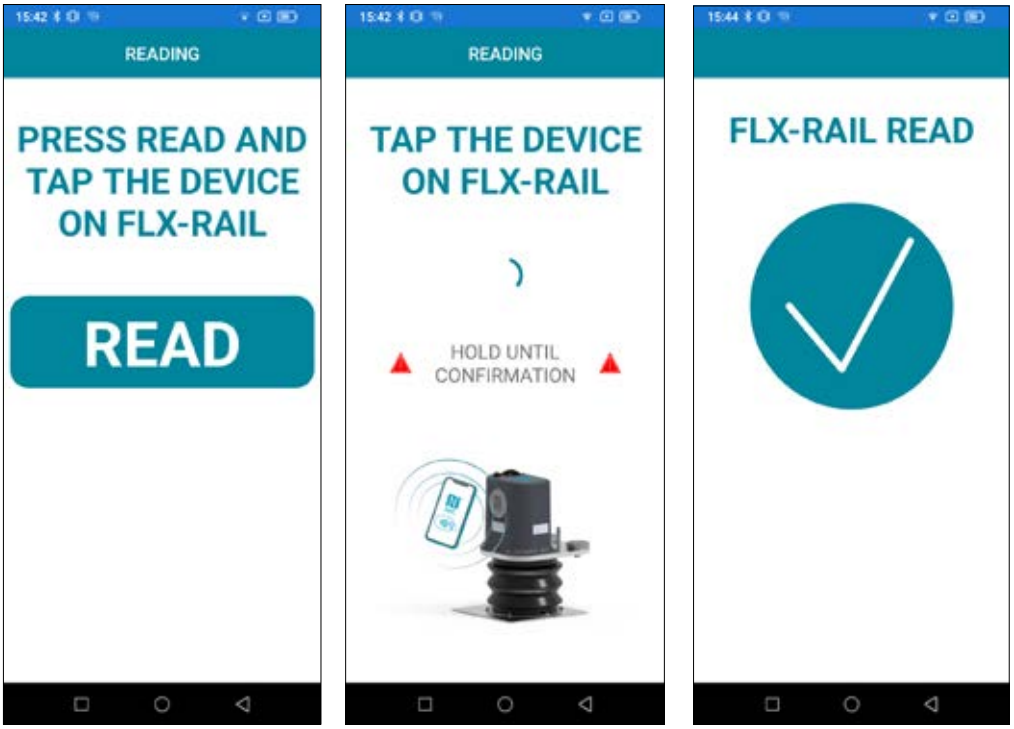
When you have finished editing, you can press WRITE and follow the prompts to write the new configuration to the instrument.

If the configuration write-out fails, a screen will appear indicating the failure of the reconfiguration and allowing you to retry the write-out. The page also provides some tips for successful reconfiguration.

NETWORK PARAMETERS CONFIGURATION

To configure network parameters, select CONFIGURATION and then NETWORK SETTINGS on the following pages:

You will be asked to bring the phone close to the instrument to be able to read the current configuration on board the instrument and then allow it to be changed if necessary.



Once the configuration is read, it is shown in the APP. The values shown are those currently on board the instrument.

To avoid unwanted changes, some parameters will be disabled and cannot be changed.
In order to change them, it will be necessary to click on the padlock button.
By clicking, the fields will become editable.


15:45
CONFIGURE
WRITE
SENSOR SN: 00004EAF
MODEL: FLX-RAIL OPTIC-TILT-TEMP
BATTERY: 7.43V
FIRMWARE VER.: 3.12
HARDWARE VER.: 1.0
DOWNLINK MSG. SETTING
ASK CONFIG
NETWORK DATE
SERVER DATE
MESSAGES CONFIRM.
OTAA MODE
DEVICE EUI
986EE88000004EAF
JOIN EUI
0000000000(
APPLICATION KEY
1F1EEAE67F1(

It is now possible to edit any field. By clicking on the value you wish to edit, the keyboard will appear, allowing you to edit values. When a value is changed, it will appear in **orange** to indicate that the value has been changed from the one on the instrument.

By editing any field, the WRITE button is also activated, which allows the new configuration to be written to the instrument when the changes are complete.

When you have finished editing, you can press WRITE and follow the prompts to write the new configuration to the instrument

WARNING: Changing the keys, if not done properly, will not allow the FLX-RAIL® to communicate with the Network Server.
SISGEO supplies the FLX-RAIL® with a configuration in OTAA mode used for factory verification of the product.
To increase security the end-user should generate new keys on the Network Server and upload them to the FLX-RAIL® .
SISGEO strongly recommends to regenerate keys and not to use DEFAULT keys.

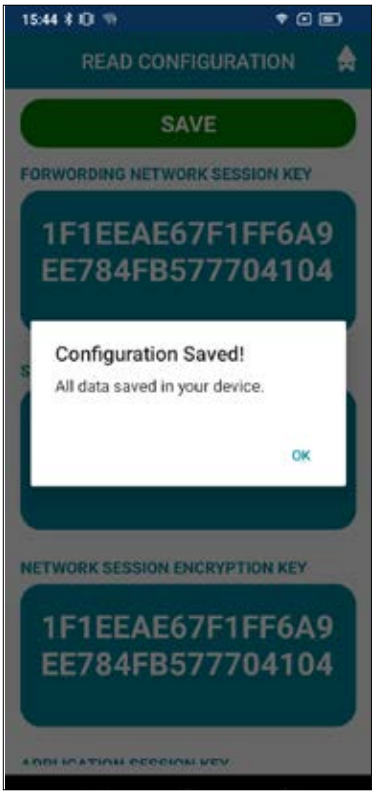
If the configuration write-out fails, a screen will appear indicating the failure of the reconfiguration and allowing you to retry the write-out. The page also provides some tips for successful reconfiguration.

READ CONFIGURATION

Through the APP it is also possible to read the configuration on board the instrument in its entirety.
To do so, simply select READ CONFIG. and then follow the instructions that will appear in the APP.

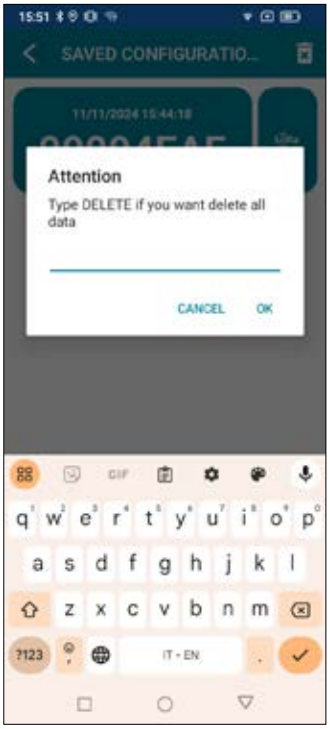

READ CONFIGURATION
SAVE
SENSOR SN: 00004EAF
MODEL: FLX-RAIL OPTIC-TILT-TEMP
BATTERY: 7.42V
FIRMWARE VER.: 3.12
HARDWARE VER.: 1.0
DEVICE EUI
986EE88000004EAF
APP KEY
1F1EEAE67F1FF6A9EE784FB577704104
NETWORK EUI
1F1EEAE67F1FF6A9EE784FB577704104
ADVANCED SETTINGS
FORWORDING NETWORK SESSION KEY
1F1EEAE67F1FF6A9EE784FB577704104
SERVING NETWORK SESSION KEY
1F1EEAE67F1FF6A9EE784FB577704104
NETWORK SESSION ENCRYPTION KEY
1F1EEAE67F1FF6A9EE784FB577704104
APPLICATION SESSION KEY
79F478AC052490CF56BC8A9CC54DC3BB
DEVICE ADDRESS
00004EAF
DEVICE JOIN EUI
0000000000000000
SENSOR PARAMETERS
TRIGGER THRESHOLD [g]
0.1
MAX. EVENT DURATION [s]
60
MIN. EVENT THRESHOLD [mm]
1

Once the configuration is confirmed, it will be displayed in a non-editable format.
It will be possible to save the configuration to the phone by pressing the SAVE button.



SEE SAVED CONFIGURATION

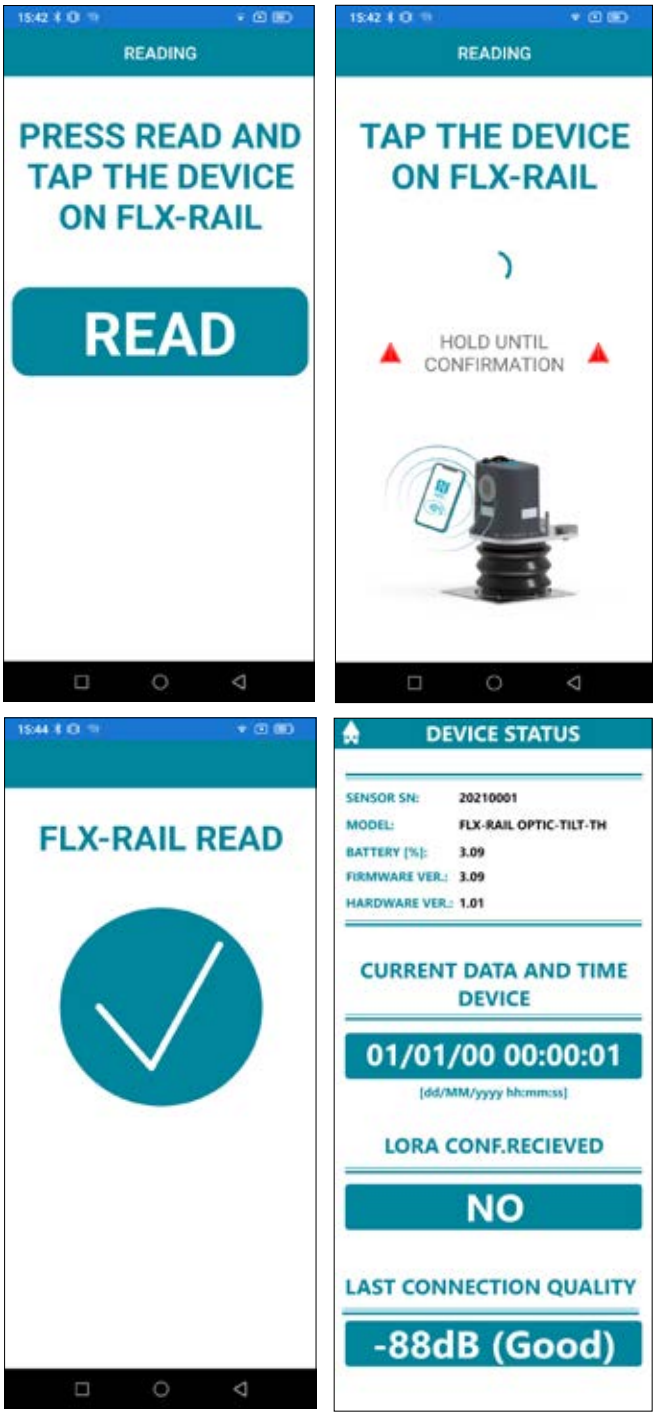
Selecting the SEE SAVED CONFIGURATION option, it will be possible to view previously saved configurations.



Clicking on the **SERIAL NUMBER** icon will display the saved configuration.
Clicking on the **BIN** icon will allow you to delete saved configurations

DEVICE STATUS

Via the DEVICE STATUS menu, it is possible to obtain information on the status of the sensor itself.
In addition, a test can also be carried out on this page to assess the quality of the LoRaWAN® signal following installation.



The data shown are relevant to the last communication that took place. In the case of standard configurations, which are only messages in UPLINK (from the FLX-RAIL® to the NETWORK) these values may not be present.
In this case it will be necessary to check them directly on the NETWORK SERVER

TROUBLESHOOTING

Problem	***Possible cause***	***Solution***
No new events	*Threshold trigger too high*	*Decrease trigger threshold (TRIGGER TREESHOLD) via APP*
	Minimum measurement value too high	*Decrease the minimum measurement value via APP*
	Instrument turned off	*Check the state of the batteries with a measuring tester: if dead, replace them*
No measurements received on the Network Server	*Incorrect LoRaWAN® keys*	*Check that the keys entered in the instrument are identical to those entered on the Network Server*
	Instrument turned off	*Check the state of the batteries with a measuring tester: if dead, replace them*
	Low signal	*Make sure there is an adequate signal in the installation area* *Any obstructions that could block the signal should be removed*
Unstable measure	*Sensor powering not correct*	• *Check battery status*
	Incorrect installation	• *Check the condition of the ballast* • *Check the attachment of the instrument*

SYSTEM SENSITIVITY

After the installation, the following anomalous situations may occur:

1. train passage not detected: real events would therefore be lost.
2. event detected even without the passage of the train: false non-significant events would be identified (e.g. passage of the train on an adjacent track)
3. awakening of the instrument without detection of any event: there would be an unnecessary awakening of the instrument (there being no event)

- **SBV® THRESHOLD (TRIGGER TREESHOLD)** for sensor activation
- **MINIMUM MOVEMENT THRESHOLD** for event saving
- **EVENT DURATION**

The **SBV® THRESHOLD (TRIGGER TREESHOLD)** is a parameter that allows you to set the awakening sensitivity. This can for example be raised if there is an area subject to vibrations to discriminate the real passage of the train from a possible disturbance (train passage nearby, operating machines in progress, etc.).

By acting on this parameter it is possible to solve the problem described in point 1 if the SBV® threshold is too high and therefore *the awakening is not activated or point 3 where the SBV® threshold is too low and the instrument wakes up without a valid reason.*

The **MINIMUM DISPLACEMENT THRESHOLD,** on the other hand, intervenes after the sensor activation and allows the event to be saved only if the minimum variation exceeds a certain threshold, this is to prevent micro-movements from being recorded as track movements, generating unnecessary or insignificant acquisitions.
By acting on this parameter, it is possible to solve the situation described in point 2 if the threshold is too low or to solve point 3 if the threshold is too high.

All these parameters can be set using the FLX-RAIL® APP

NOTE: SISGEO has identified optimal values for most installations (test fields). However, it may be necessary to make changes to these parameters.

20 Technical Information

- Readout for outdoor use
- Temperature range:
  Operating / Storage: -30°C to +80°C
- Relative humidity:
  Operating / Storage: 0-90 % RH
  Non-condensing
- Suitable for wet environments
- Degree of pollution of the expected environment: Grade 3
- Sound pressure level noise lower than 80 dBA
- IP protection class: IP67
- IK grade class: IK08
- Altitude: up to 2000 m a.s.l

20.1 LoRaWAN® module technical features

LoRaWAN® Module: band: 868 MHz Band (863-870 MHz) - power: 25 mW ERP (14dBm) Max

MAINTENANCE

FLX-Rail® is an instrument designed for the railway environment. Anyway some extraordinary or particular local events could affect the proper functioning of the instrument.
SISGEO suggests a periodic visual inspection of the instruments installed to verify that:
- the magnet-track contact is maintained and therefore the instruments are connected and aligned correctly to the track;
- check that the cable protection conduits and the other parts of the system are in good condition.

If the track displacement data are blocked (unchanged values), we suggest removing the instrument and trying to move it to check the proper functioning of the internal sensor.
SISGEO suggests having a suitable number of FLX-Rail® as spare parts in case the replacement of a tool is required for maintenance.

If the FLX-Rail® needs to be sent back to the factory, please contact the Customer Care Department, by requesting an RMA ticket (Return Manufacturer Authorization).
Please create your account and then fill in the RMA form clicking on:

https://support.sisgeo.com/

Please read carefully the instruction published on Sisgeo's web site.
Send back the instrument/equipment with the complete accessories, using suitable packaging, or, even better, the original ones.
The shipping costs shall be covered by the sender.
Please return to the following address with correct delivery documentation reporting the RMA code received:

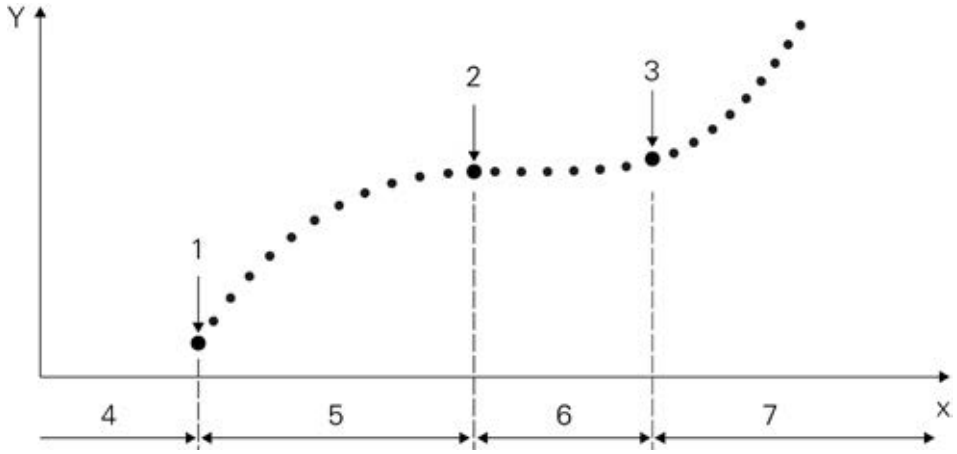
SISGEO S.r.l.
Via F.Serpero, 4/F1 20060 MASATE (MI)

Customer Care Department e-mail: **assistance@sisgeo.com**

APPENDIX 1

DEFINITION OF DISTINCT MEASURING POINTS DURING A GEOTECHNICAL MONITORING PROJECT AS FOR ISO 18674-1

The standard ISO 18674-1 well describe the various measuring points distributed along the project timing. Here below are the description and definition as for the standard:



1 - Initial measurement: it is the first measurement after installation.

2 - Zero measurement: it is the measurement carried out after stabilization of installation effects.
The zero measurement is often taken as reference for subsequent measurements, as it is commonly related to local space and time coordinates.
The zero measurement is commonly carried out with increased measuring effort, e.g. repetition of measurements, to provide a reliable datum for subsequent measurements.

3 - Reference measurement: it is a measurement which serves as reference base for previous and subsequent measurements.
The reference measurement is also known as datum measurement.
A new reference measurement is often used for a new construction phase. The reference measurement is often derived from several measurements.

4 - Installation period

5 - Stabilization period

6 - Period of baseline measurements: measurements carried out, subsequent to the zero measurement, over a period of time before any construction starts, to help in the definition of changes that occur from causes other than construction.
EXAMPLE Seasonal changes in groundwater levels, tidal and moisture content changes, climatic changes such as temperature, and incidence of sunlight.

7 - Construction period

X - time
Y – reading

APPENDIX 2

Safety information for neodymium magnets

Tips for the safe handling of ferrite magnets: see https://www.supermagnete.it/eng/safety-ferrite.pdf

Danger 	**Swallowing** Children could swallow small magnets. If several magnets are swallowed, they could get stuck in the intestine and cause perilous complications. Magnets are not toys! Make sure that children don't play with magnets.
Danger 	**Electrical conductivity** Magnets are made of metal and conduct electricity. Children might try to put magnets into a power outlet and thereby suffer from an electric shock. Magnets are not toys! Make sure that children don't play with magnets.
Warning 	**Contusions** Big magnets have a very strong attractive force. • Unsafe handling could cause jamming of fingers or skin in between magnets. This may lead to contusions and bruises. • Powerful, very large magnets could cause bone fractures. Wear heavy protective gloves when handling larger magnets.
Warning 	**Pacemaker** Magnets could affect the functioning of pacemakers and implanted heart defibrillators. • A pacemaker could switch into test mode and cause illness. • A heart defibrillator may stop working. • If you wear these devices keep sufficient distance to magnets: www.supermagnete.it/eng/faq/distance • Warn others who wear these devices from getting too close to magnets.
Warning 	**Heavy objects** Too heavy loads, symptoms of fatigue as well as material defect could cause a magnet or magnetic hook to loosen from the surface that is was attached to. Falling objects could lead to serious injuries. • The indicated adhesive force applies only to ideal conditions. Allow for a high safety cushion. • Don't use magnets in places where people could sustain injuries in case of material failure.
Warning 	**Metal splinters** Neodymium magnets are brittle. Colliding magnets could crack. Sharp splinters could be catapulted away for several meters and injure your eyes. • Avoid the collision of magnets. • Wear safety glasses when handling larger magnets. • Make sure that nearby people are also protected or keep their distance.
Caution 	**Magnetic field** Magnets produce a far-reaching, strong magnetic field. They could damage TVs and laptops, computer hard drives, credit and ATM cards, data storage media, mechanical watches, hearing aids and speakers. • Keep magnets away from devices and objects that could be damaged by strong magnetic fields. • Please refer to our table of recommended distances: www.supermagnete.it/eng/faq/distance
Caution 	**Combustibility** When machining magnets, the drilling dust could easily ignite. Stay away from machining magnets or use appropriate tools and sufficient cooling water.

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Caution 	**Nickel allergy** Many of our magnets contain nickel, also those without nickel coating. • Some people have an allergic reaction when they come into contact with nickel. • Nickel allergies could develop from perpetual contact with nickel-plated objects. • Avoid perpetual skin contact with magnets. • Avoid contact with magnets if you already have a nickel allergy.
Caution 	**Airfreight** Magnetic fields of improperly packaged magnets could influence airplane navigation devices. In the worst case it could lead to an accident. • Airfreight magnets only in packaging with sufficient magnetic shielding. • Please refer to the respective regulations: www.supermagnete.it/eng/faq/airfreight
Caution 	**Postage** Magnetic fields of improperly packaged magnets could cause disturbances in sorting machines and damage fragile goods in other packages. • Please refer to our shipping tips: www.supermagnete.it/eng/faq/shipping • Use a large box and place the magnet in the middle surrounded by lots of padding material. • Arrange magnets in a package in a way that the magnetic fields neutralise each other. • If necessary, use sheet iron to shield the magnetic field. • There are stricter rules for airfreight: Refer to the warning notice "Airfreight".
Notice 	**Influence on people** According to the current level of knowledge, magnetic fields of permanent magnets do not have a measurable positive or negative influence on people. It is unlikely that permanent magnets constitute a health risk, but it cannot be ruled out entirely. • For your own safety, avoid constant contact with magnets. • Store large magnets at least one metre away from your body.
Notice 	**Splintering of coating** Most of our neodymium magnets have a thin nickel-copper-nickel coating to protect them from erosion. This coating could splinter or crack due to collision or large pressure. This makes them vulnerable to environmental influences like moisture and they could oxidise. • Separate big magnets, especially spheres, with a piece of cardboard. • Avoid collisions of magnets as well as repeated mechanical exposure (e.g. blows, bashes).
Notice 	**Oxidation, corrosion, rust** Untreated neodymium magnets oxidise quickly and disintegrate. Most of our magnets have a nickel-copper-nickel coating to protect them from corrosion. This coating provides some protection against corrosion, but it is not robust enough for continuous outdoor use. • Use magnets only in the dry indoors or protect them against environmental influences. • Avoid damages to the coating.
Notice 	**Temperature resistance** Neodymium magnets have a maximum working temperature of 80 to 200°C. Most neodymium magnets lose part of their adhesive force permanently at a temperature of 80°C. • Don't use magnets in places where they are exposed to extreme heat. • If you use an adhesive, don't harden it with hot air.
Notice 	**Mechanical treatment** Neodymium magnets are brittle, heat-sensitive and oxidise easily. • When drilling or sawing a magnet with improper tools, the magnet may break. • The emerging heat may demagnetise the magnet. • The magnet will oxidise and disintegrate due to the damaged coating. Avoid machining magnets if you do not have the necessary machines and experience. Let us provide you with an offer for a custom-made order instead: www.supermagnete.it/eng/custom_form.php