Electrical Tiltmeter

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STRUMENTI E MISURE GEOTECNICHE
E STRUTTURALI

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WARNINGS

This instrument must be utilized only for the application it has been designed for, OTR declines all responsability for any improper use.

During the installation phase, disconnect the instrument from measuring devices or from any device connected to the AC power supply;

Do not use intrument near potentially explosive gases; If the inclinometer is installed on structures that are subject to vibration continously (e.g. bridges) fix all mechanisms of the plate with retaining

Do not use the instrument in water where an electric dissipation is in progress.

Use protective gloves.

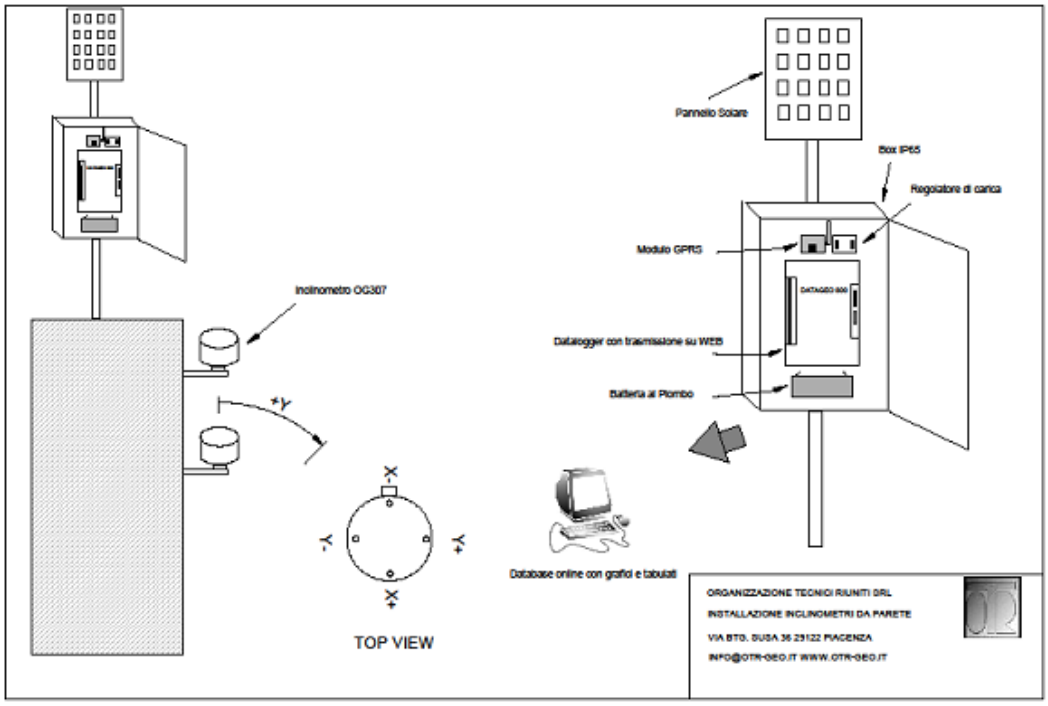
Furthermore

- Do not open the instrument, contact the manufacturer for checks and repairs;
- Keep out of reach of children;
- Do not connect the instrument to the readout unit with wet hands;
- Do not connect the instrument to the readout unit with wet hands;
- Clean the instrument and its cable with alcohol or water, do not use acetone or aggressive liquids for plastics or labels;
- Use surge arresters for installations with unprotected cables longer than 30 meters.
- Be always sure that the plate of inclinometer is fixed properly;

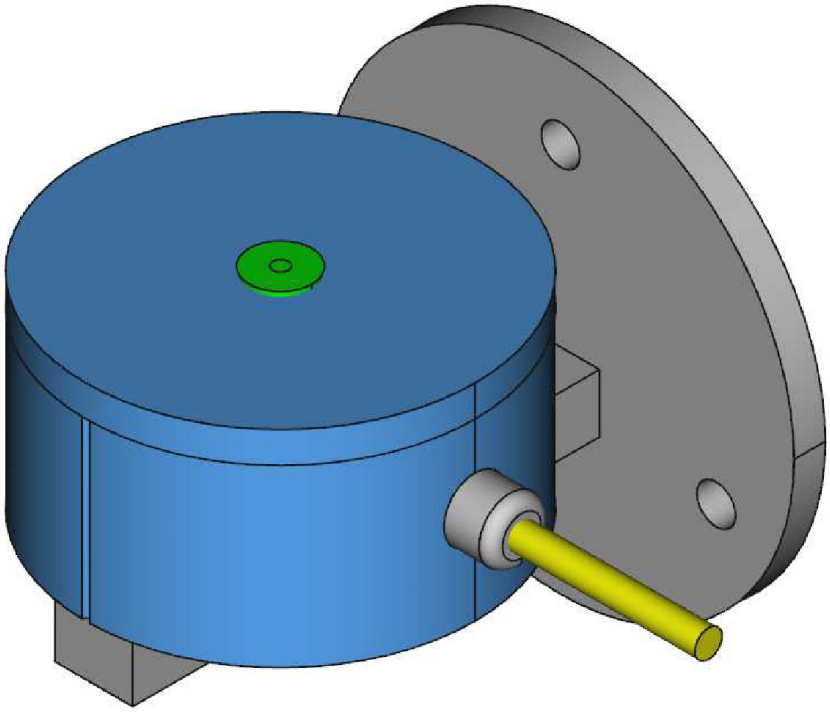
Application

Tiltmeters are used to measure the variations of inclination of a rock mass or a civil structures. It can be used in the following situations:

- Monitoring buildings damaged by landslides or earthquakes
- Turning control of berliner walls and diaphragms during excavations
- Retaining walls, bridges
- Towers, bell



Description



In-place inclinometers consist of a cylinder equipped with a sensor and a suspension ring, which is mounted on a stainless steel bogie. The bogie features two pairs of castor wheels which make it possible to make the sensor slide into the tube while maintaining its orientation. The distance between the two sets of wheels (wheelbase) is 1000 mm.
The probe can be equipped with uniaxial or biaxial micro electromechanical MEMS sensors, which ensure great sturdiness. The sensors inside the cylinder are embedded in resin, and can withstand high pressure. The full scales of +/-10° or +/-15° or +/-30° allow measurement resolution and stability which are appropriate to the normal conditions of use.
The electrical tiltmeter consists of an aluminium cylinder which is mounted on the inclinometer sensors, a circular stainless steeel plate to connect the instrument to the structure and an adjustable bracket to position it precisely and reliably. The tiltmeter can be equipped with uniaxial or biaxial micro electromechanical MEMS sensors, which ensure great sturdiness.. Available full scales are ±2° / ±5° / ±10°, these values are usually what a monitoring system needs. Built in thermistor is available on demand, this allows to correlate thermal effect on a structure with the inclination data. Instrument can be ordered with IP67 protection on demand.

Identification

Every tiltmeter is identified by:

- Serial number associated with a calibration report;
- Model;

Technical Specifications

Voltage Supply	12-24 Vdc
Current Consumption	Max 20 mA
Output	±4V 0-10 V
Temp Output	10 mV/K
Resoluton	0.001°
Precision	0.3%
Full scale	±5° ±10°

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Installation

Electrical tiltmeter is provided already ready to be installed, installation is quite simple.
In order to install the instrument, proceed as follows:
▪Before installation take a reading with a manual readout unit to make a check. Impose, if possible, a known inclination to perform a quick functioning test before use.
▪Smooth and clean the surface on the instrument will be installed. The circular plate must have a flat surface to be installed correctly.;

▪Put the circular plate on the wall/structure.
▪Mark on the wall/structure the positions of the holes on the circular plate.;
▪Drill the marked holes;
▪Install the bracket on the plate;
▪Install the tiltmeter on the bracket and adjust vertical and horizontal inclination to start measures from a zero position;
▪Take a zero reading with a manual readout unit.

Readout

Measurements can be taken by a portable, manual readout unit or by a data logger (which is advised for continuous monitoring) and they are expressed in electrical units (mV) or they can directly be converted into angles [°].
The Geotester readout unit can display the value as a tension (mV) and/or as a physical quantity [°].
For indications on how to use a given readout unit, please refer to its instruction manual.

Taking Measurements

In order to take measurements, it is necessary to connect the instrument cable to the readout unit, following the instruction manual of the instrument in use:

- Whether the instrument is equipped with a uniaxial or biaxial sensor with output signal in mV, the wiring has to be carried out connecting the cable connectors according to their functions, which are shown below.

Red cable	= + 15 volt
Black cable	= GND
Light blue cable	= Signal Y
Green cable	= Signal X
Shield	= Earth on datalogger

Data Processing

The measurement of the local displacement of tiltmeter is obtained by measuring the tension (mV) with the electrical inclination transducer for the X- and Y-axes.

- Depending on the instrument and the reading unit in use, the electrical measurement is expressed in mV to be converted in [°] degrees using the instrument's sensitivity factor shown on the instrument's calibration sheet (supplied by OTR):

- Here follows an example of a conversion of electrical data (in mV) with a vertical in-place inclinometer equipped with a MEMS sensor.

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Calculations & Formulas

According to the following definitions and given a generic reading

Yo = Y-axis inclination expressed in mV (reading "Zero" Yo) – along the plane of the castor wheels

Xo = X-axis inclination expressed in mV (reading "Zero" Xo) – perpendicular to the plane of the castor wheels

Y' = Inclination on the Y-axis expressed in in mV (reading "Performance" Y')
X' =Inclination on the X-axis expressed in in mV (reading "Performance" X')
1000 = 1000 mm wheelbase of the in-place probe

KY = Y axis sensor sensitivity factor
KX= X axis sensor sensitivity factor

Y axis local displacement:

$$\Delta IX = \arcsin(X'/KX) - \arcsin(Xo/KX) \text{ dove: } KX = mV/Sin(a)$$

$$\Delta IX = (X' - Xo)/KX \text{ dove } KX = \text{in mV/Grado}$$

X axis local displacement:

$$\Delta IY = \arcsin(Y'/KY) - \arcsin(Yo/KY) \text{ dove } KY = mV/Sin(a)$$

$$\Delta IY = (Y' - Yo)/KY \text{ dove } KY = mV/Gradi$$

Result of the local displacement of the Electrical Tiltmeter probe on the Y-X plane, expressed in mm:

$$\Delta I = \sqrt{(\Delta IY^2 + \Delta IX^2)}$$

Direction of the local displacement of the Electrical Tiltmeter probe on the Y-X plane, or azimuthal angle:

$$\theta = \text{arctg}(\Delta IY/\Delta IX)$$