



VERTICAL INCLINOMETER PROBE

User Manual



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Notes on the use of product



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

Any use of the instrument other than the one described in this manual shall be considered at 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 on the matter of personal safety and health of persons in the workplace.

SISGEO is not responsible for any trouble, breakdowns, accidents etc.. due to the lack of knowledge and/or confidence (or non-compliance with) with the requirements contained in this manual.

Check that the instrument 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 the manufacturer.

The user must strictly follow all the operations described in this manual.

Maintenance or repair of the instrument is allowed only to authorized operators.

These operators must be physically and intellectually suitable.

For information about instrument or order spare parts request, please always specify data written on the identification label.

When replacing parts, always use ORIGINAL SPARE PARTS.

The manufacturer reserves the right to make changes without prior notice for any technical or commercial requests.

We'll try anyway to keep the manuals updated in order to reflect product's revisions/updates.

Symbols

This symbol will be used used to catch reader's attention on the manual:



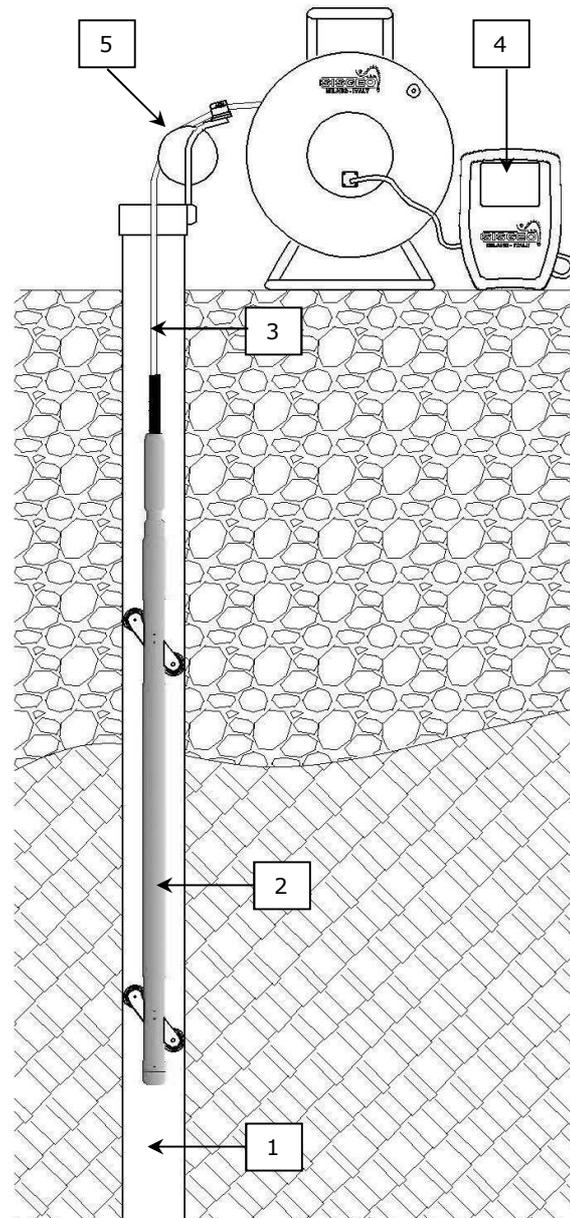
Pay special attention to the following instruction.

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

Introduction



Vertical inclinometer probes are used to measure ground displacements and deformations, as well as structures .

They are used mainly in landslides, embankments, dams, open drillings, bridges' piles, restrain walls, piles, tunnels.

Inclinometer probe is a part of a system which includes:

Aluminum or ABS Inclinometer casing (1), circular section, with four orthogonal grooves; it follows deformations where is installed;

Vertical inclinometer probe (2);

Inclinometer cable (3), to lower deeply the probe and for electrical connection to the datalogger;

Datalogger (4), to receive/record data from the probe and manage it.

Moreover, we advise to use the following accessories:

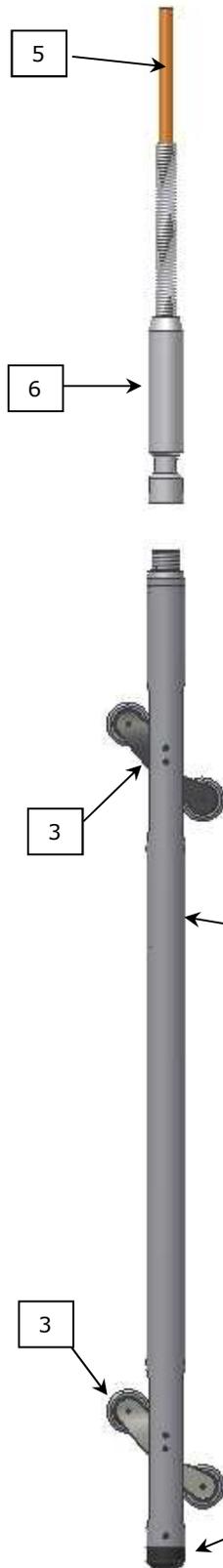
dummy probe, similar to the inclinometer probe, but without sensor. It allows to check the accessibility of the inclinometer casing;

spiralmeter, to measure the spiral angle of inclinometer casing's grooves;

pulley and cable stop (5), used to block the cable and as depth reference.

calibration frame, to check the inclinometer probe;

Description

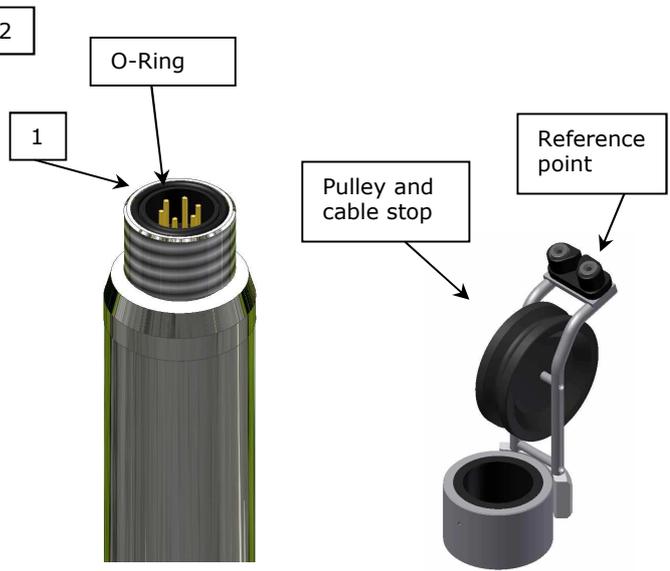


Vertical inclinometer probe consists of:

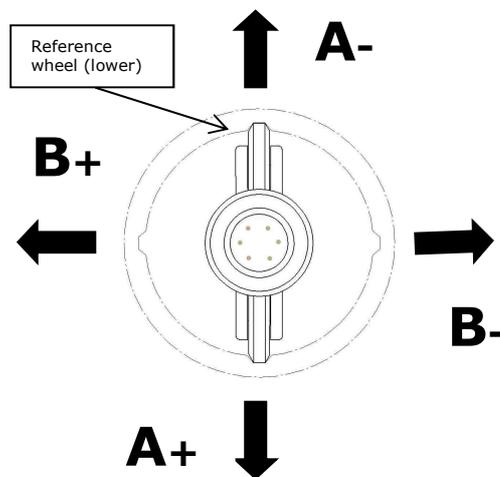
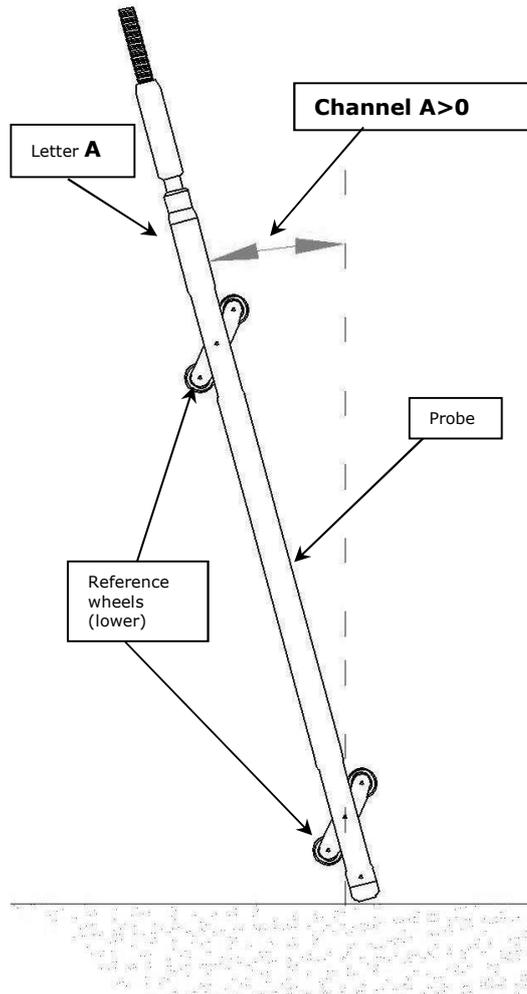
1. An electrical connector with O-Ring ;
2. A stainless steel body with a biaxial force balance servo-accelerometer or digitalized MEMS inclinometer, to measure inclinations in two orthogonal directions;
3. Two wheel assembly, at a distance of 50cm, to slide along the grooves of the inclinometer casing;
4. A rubber cap at the bottom to limit any damage due to accidental impacts.

Inclinometer cable (5) has a connector (6) to connect the probe. The universal model, suitable both for servo-accelerometer and digital probes, is reinforced with a stainless steel shield and cable to avoid torsions and elongations. The inclinometer cable for the digital probe has a kevlar core to avoid elongation and is lighter to allow an easier handle.

On the cable's outer sheath there are metal marks every 50cm. The first mark is 1m. far from the middle of wheels assembly. Every 5m. a colored reference helps to identify the depth (see Appendix 2).



Taking measurements



General

The designs shows the convention: the lower wheels and letter A are the probe's reference. If you put the probe on a flat surface and tilt it in the arrows direction, channel A and B (the 2 orthogonal axis) take different signs.

Inclinometer reading consists in a survey, at regular steps, of the tilt of the inclinometer casing compared to the vertical.

The step is usually the same of the wheels assembly interaxis or a multiple.

The first reading is said "zero reading" and is the reference reading compared to which will be calculated all the displacements of the inclinometer's casing; the following readings are called "exercise readings".

Inclinometer readings can be taken on two or four grooves.

It is useful that zero reading is taken on four grooves, because sometimes a casing could deform, avoiding probe's readings, while the cross grooves are still open.

Inclinometer's casing grooves, once installed, are identified with numbers 1-2-3-4, clockwise; the groove nr. 1 is the one closer to geographic north or the one turned towards the expected movement, or according to some site's references.

"Two grooves reading", typical of exercise readings, is the whole measurements taken with reference wheels in grooves 1 and 3.

Anyway, measures must always be taken matching the opposed grooves.

"Four grooves reading" are the measurements taken with reference wheels in all four grooves.

Before inserting the inclinometer probe in the casing, we advise to check casing's accessibility using the dummy probe, which has to slide along the casing with the reference wheels put in all 4 grooves.

To carry out inclinometer measurements proceed as follows:



- Remove the probe from carrying casing;
- Check wheels assembly and wheels functionality;
- Check the O-ring;
- Keep the probe in vertical and on the ground and connect it to the inclinometer cable paying attention to fit connector's references. DON'T TURN and DON'T STRAIN the connectors to avoid any irreparable damage;
- Once the connectors are matched, screw manually the nut until is fully locked. If well connected, the tightness is guaranteed up to 2MPa;
- Insert the probe in the inclinometer casing with the reference wheels in groove 1; if available, install the pulley and cable stop on the inclinometer casing, and drop slowly the probe until it reaches the bottom;
- Connect the datalogger to the inclinometer reel and switch it on. Be careful to respect connectors polarity;
- Wait 10-15 minutes to stabilize the temperature;
- Lift up the probe until the first available mark is on the expected reference point. Place very carefully the marks because, to have good results, their position must never change. Using the pulley and cable stop, the block point can be used as depth measure point;
- Wait for the values, identified as A1&B1, to stabilize. In case you are using a datalogger, record these values;
- Lift up the probe, placing the next mark at the reference point according to the step set;
- Proceed in this way for the whole length of the casing.
- Once ended with groove 1, pull out the measure probe from the casing;
- Turn the probe of 180°, put it back in the casing with the reference wheels in groove 3 and lower until it reaches the bottom;
- Proceed as already explained for groove 1. In this case the values will be identified as A3&B3.

You will have then, for each step, two inclination values for axis 1-3 (A1-A3) and two values for axis 2-4 (B1-B3).

- Once ended the reading, disconnect the datalogger, unscrew the nut and disconnect the probe from the inclinometer cable;
- Check the connectors (probe and cable): be sure that there is no humidity inside;
- Screw the protection caps;
- Clean carefully and dry the probe in its mechanical parts;
- Rewind carefully the inclinometer cable on the reel in order to avoid any torsion;
- Put back the probe in its carrying casing;

In case of four grooves reading, the described steps must be performed also with the wheels in groove 2 (A2-B2) and then in groove 4 (A4-B4).

Advices:

- Use always the same inclinometer system (probe-datalogger-cable) to survey the casing.
- Use the pulley and cable stop.
- Pay attention to the reference point.
- Switch on the datalogger 5-10 minutes before start measuring.
- Wait until that the inclinometer system temperature is stabilized: could be useful, in this case, to check the values shown from the datalogger.
- When you move from a quote to the next one, record the data only when the values are settled.
- In case of wrong positioning, drop the probe to a lower quote and rewind it until is blocked where requested.
- Avoid pulls and excessive speed in the probes' recovery.

Data processing



Usually the data processing is made using a dedicated software (i.e. FIELD-SISGEO's *INCL12*); see its manual for further details.

Below we are going to clarify basics notions for data processing.

SISGEO's inclinometer probes have a constant k of 20000.
The values (digits) displayed from SISGEO's datalogger are:

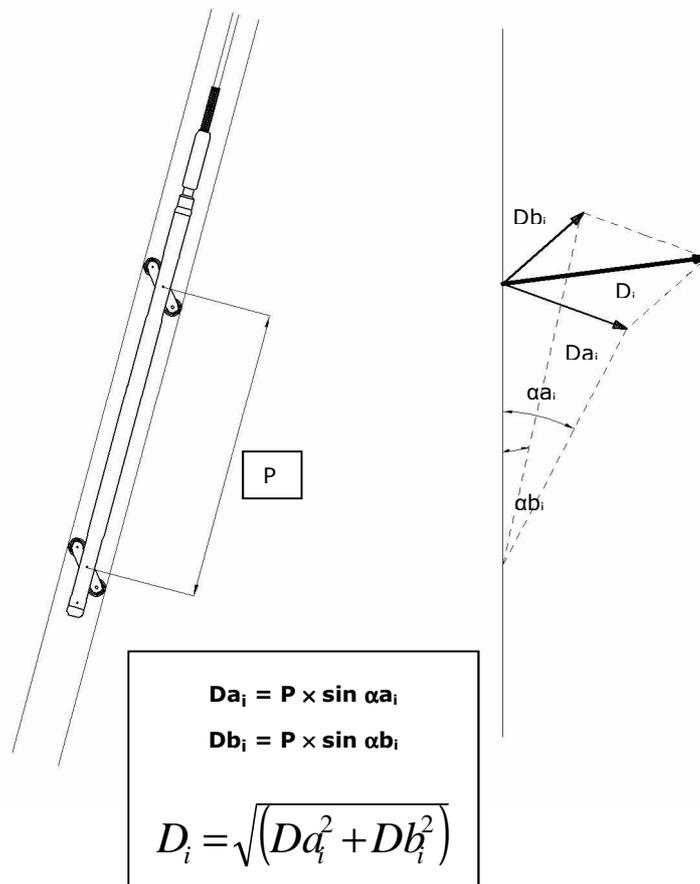
$$\text{digits} = (\sin\alpha) \times (k)$$

Example:

Ch. A: 698(digits)

$$\alpha = \arcsin (698/20000) = 2^\circ$$

To calculate the casing inclination at each quote proceed with the following formula:



where

D_{ai} , **D_{bi}**= casing displacements at the generic quote, in the two orthogonal directions A and B

P = measurement step

sin α_a , **sin α_b** = Casing inclination angles at the generic quote, at the two orthogonal directions A and B

Dⁱ = Casing displacement result at the generic quote

θ = Result deviation Azimuth of direction A and B, at the generic quote= $\arctg\left(\frac{D_{ai}}{D_{bi}}\right)$

Example:

At "i" quote we have the following values:

A1 = 480

A3 = -506

B1 = 270

B3 = -285

The inclination at the "i" quote is 14,39mm

Hints on checksum

The checksum is the algebraic half-sum of the measurements obtained on the matched grooves 1-3 or 2-4.

It's like an electric and mechanic "offset" of the inclinometer probe, and, as we'll see in the example, does not affect the final result: it is a sign of the well-functioning of the inclinometer system and it's important its regular check.

Checksum value can change in time, but, if the variation is not sudden (for example between 2 subsequent readings), usually there is nothing to worry, and is not necessary to contact SISGEO technical assistance.

Anyway, SISGEO advises a check of the inclinometer system for checksum values higher than 25.

Checksum can be affected from deposits in the grooves, from inclinometer casing dents and ovalization, from the wheel positioning near the coupling and also from the differences between different Dataloggers.

Example:

inclination 2°, theoretical value =698 (digits) , A1= 713, A3=-683

checksum= (A1+A3)/2= 15

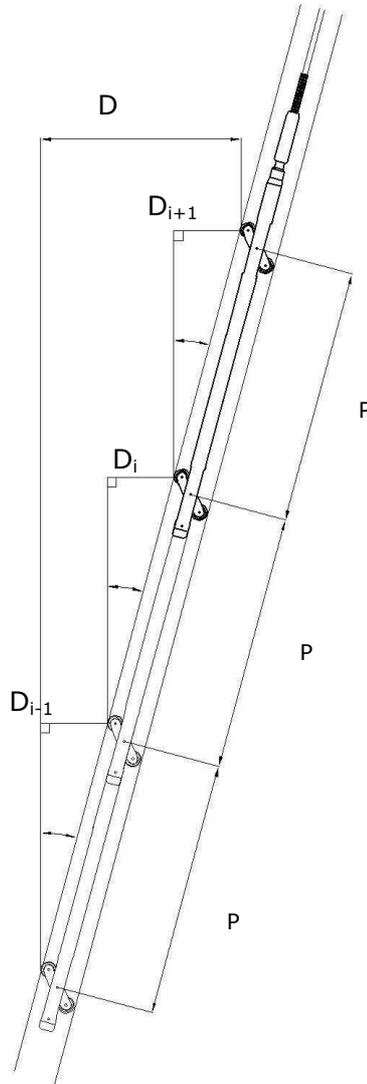
A1-checksum= 713-15=698; A3-checksum= -698-15=-698

Anyway, the value obtained from the matching measures at the end of the processing is:

Am= (A1-A3)/2= [713-(-683)]/2 = 698

To calculate the global displacement of the casing proceed with the following formula:

$$D = \sum_1^n D_i$$



The cumulative displacement calculation can be done:

- "from the bottom", when the casing's bottom is fixed
- or "from the top", when the casing's head is fixed.

Generally is used the calculation from the bottom with landslides.

Processing from the top is applied when the head of the pile or wall is fixed.

Troubleshooting

Problem	Possible cause	Solution
Wrong measure	Wrong or lost probe configuration	Verify and correct Datalogger's parameters (see the manual)
	Wrong choice of the reference	Use the correct reference groove
Instable measures	Low battery voltage	Check the voltage on the display and put in charge (see the manual)
	Low insulation	Measure the insulation between the pins of probe connector and the steel body. If less then 50 MΩ ,send back to Assistance
	Damp in the connector	Dry it. Verify the integrity of the "O-ring"
	One or more electric wires are disconnected	Verify wiring in Appendix 1. Send back to Assistance if the disconnection is found.
Checksum values unsteady	Excessive movement of the wheels	Verify wheels movement. If necessary, send back in Assistance.
	Wheels out of grooves	Verify and insert correctly the wheels in the grooves. Lower the probe more slowly.
	Dirty casing	Clean the casing

Maintenance

Probe maintainance



Inclinometer probe is a precision instrument and has to be handled carefully, avoiding accidental shocks both during the transport and the work. Use the carrying case during the transport and the storage. Clean the probe with water and lubricate, without using grease, the wheels spring. Clean up the possible mud and dirt on the spring. Take away the protection cap from the probe and inclinometer cable, clean and eventually dry the connector and the thread. Clean the connectors with cotton wads and alcohol. Don't use solvents or other products that can cause a damage. The probe and the accessories have to be stored in a dry place. If possible, store the probe always in vertical position. To avoid condensation we advise to store probe and cable without protection cap; they have to be put back on in case the instrument has to be moved. Be careful during the unwind and rewind of the cable to avoid stretching and rolling that can damage the cable. When they are not in use, always protect the connectors with their caps.

To keep the system in perfect conditions we advise a maintenance check in our laboratories once a year.

After-sales assistance on SISGEO's product for calibrations, maintenance and repairs, is performed by SISGEO's service department.
The authorization of shipment shall be activated by RMA "Return Manufacturer Authorization". Fill in the RMA module clicking on:

<http://www.sisgeo.com/en/assistance/repairs/>

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 suitable delivery document:

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

On the delivery document is mandatory to indicate the RMA code received.

Technical assistance e-mail: assistenza@sisgeo.com



Appendix 1

SERVO-ACCELEROMETER SYSTEM				
Probe	Functions	Inclinometer cable		
		Conn. 6 pins Female	Color	Conn. 7 pins Male Panel
A	+Vcc	A	Orange	A
B	-Vcc	B	Grey	C
C	GND Alim.	C	Black	B
D	+ OUT Ch.A	D	Yellow	D
E	+ OUT Ch.B	E	Blue	E
F	GND MEASURE	F	Green	F
			Shield	G

DIGITAL SYSTEM				
Probe	Function	Inclinometer cable		
		Conn. 6 pins Female	Color	Conn. 7 pins Male Panel
A	+Vcc	A	Red	A
B	-Vcc	B	Black	C
C	N.C.			
D	N.C.			
E	RS485 A	E	White	E
F	RS485 B	F	Green	F

FLYING CABLE ECAV07V2

Female Connector (at the cable pulley)	Male Connector (to Datalogger)
A	A
B	B
C	C
D	D
E	E
F	F
G	G

Appendix 2

DEPHT QUOTE REFERENCES TABLE

METERS	GREEN	BLACK	RED	WHITE
5	1			
10		1		
15	1	1		
20			1	
25	1		1	
30		1	1	
35	1	1	1	
40			2	
45	1		2	
50				1
55	1			1
60		1		1
65	1	1		1
70			1	1
75	1		1	1
80		1	1	1
85	1	1	1	1
90			2	1
95	1		2	1
100				2
105	1			2
110		1		2
115	1	1		2
120			1	2
125	1		1	2
130		1	1	2
135	1	1	1	2
140			2	2
145	1		2	2
150				3
155	1			3
160		1		3
165	1	1		3
170			1	3
175	1		1	3
180		1	1	3
185	1	1	1	3
190			2	3
195	1		2	3
200				4