MULTIPOINT ROD EXTENSOMETER

User Manual

INDICE

Notes on the use of product

For a 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 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 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 the manufacturer.
The user must strictly follow all the operations described in this manual.
Maintenance or repair of the device 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

Below are the symbols used to catch reader's attention on the manual:

Pay particular 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

Multipoint rod extensometers are used to measure the movements between the head and the anchor points installed at selected depths.

They are mostly employed in rocks, but they can also be used in loose soils with appropriate arrangements for the installation.

Typical applications are: rock pile strains during tunnel excavation, rock walls straining and buildings settlement.

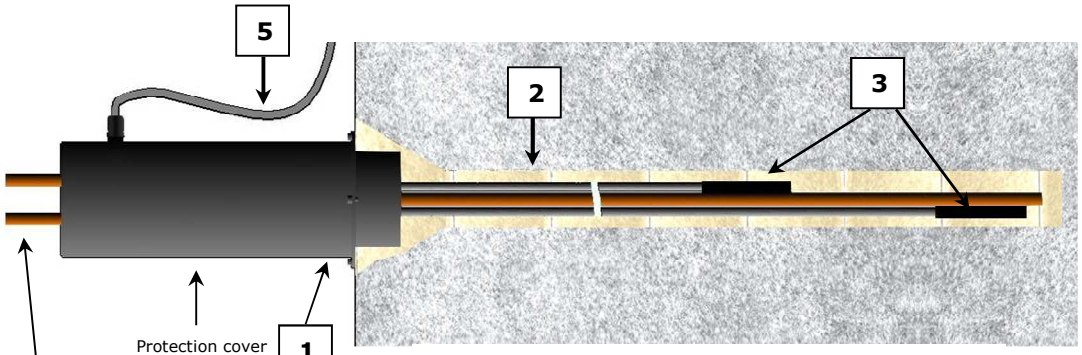
Sisgeo manufactures 2 models:

- Single-reading multipoint rod extensometer (mechanical or electric)
- Double-reading multipoint rod extensometer (contemporary mechanical and electric measure)

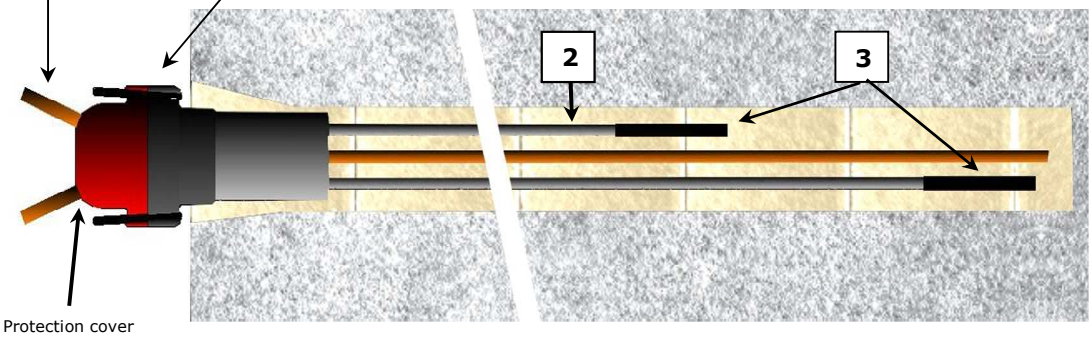
Description

Multipoint rod extensometer consists in:

1. A head where the rods are fixed.
2. One or more measuring rods. Available in fiberglass, steel or invar. They are protected from grouting through a protection sleeve.
3. Bottom anchors. One for each measuring rod, to be grouted in the ground.
4. 2 grouting tubes.
5. Multicore cable (optional) for connection to a readout.

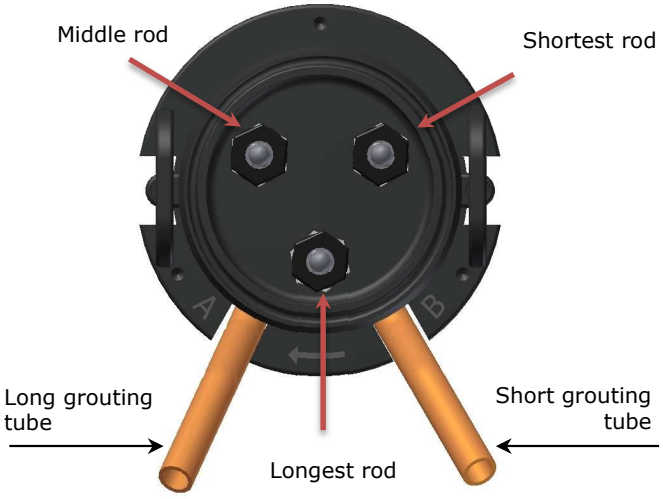


Double-reading multipoint rod extensometer

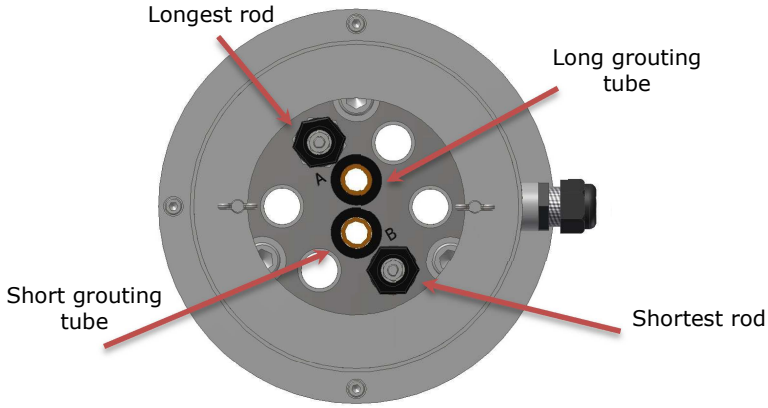


Single-reading multipoint rod extensometer

Single-reading measuring rods length agreement



Double-reading measuring rods lenght agreement



General notes

Sisgeo supplies fiberglass multipoint rod extensometers rolled up and ready for the installation, set up with the requested rod number and length.

In both steel and invar multipoint rod extensometers, the head with the grouting tubes and the protection sleeve are pre-assembled.

Rods, bottom quick joint, terminal tubes and terminal joints have to be assembled on site.

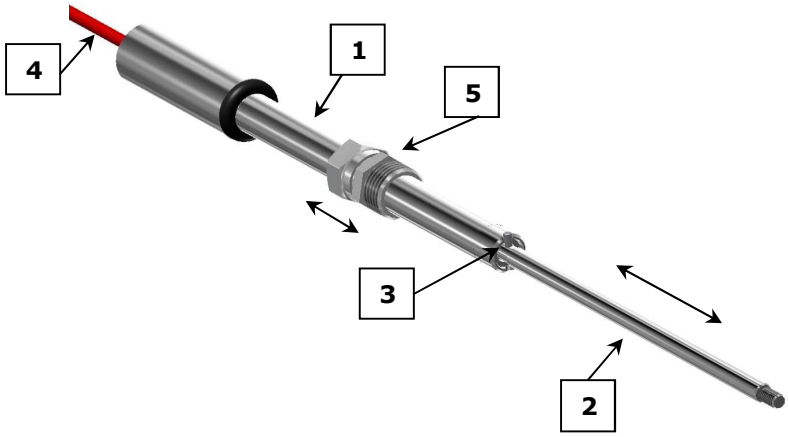
In double-reading fiberglass multipoint rod extensometers, the transducers are set up to 50% full scale, unless otherwise requested in the order.

Measuring methods

Measures are carried out through an electric transducer (electric measure) and/or with a digital caliper (mechanical measure).

The electric transducer consists in:

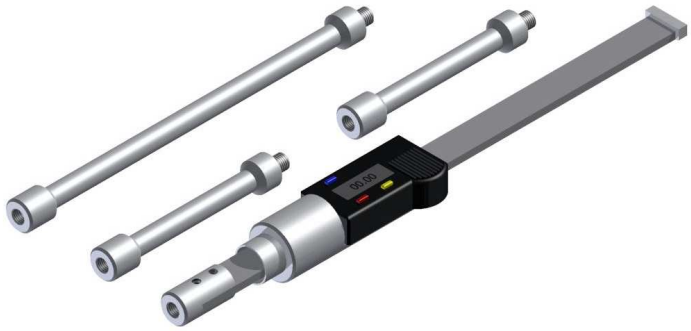
1. Transducer body
2. Measuring rod
3. Block pin
4. Cable for readout connection
5. Adjustable joint for the head-fixing.



Electric transducers, DTE, can be potentiometer with current loop signal 4-20mA (LP) or vibrating wire (VW) and are supplied:

- Dismantled, if requested, in single-reading multipoint rod extensometers;
- Assembled, in double-reading multipoint rod extensometers.

The digital caliper is supplied with extensions, to be used in case of need.



Preliminary checks

Extensometers shall be installed in boreholes with stabilized walls.

Boreholes must have a minimum diameter of:

- 45 mm for single point extensometers;
- 101mm for multipoint extensometers.

In the upper 50 cm, the hole must be enlarged up to Ø140mm in order to install extensomer head.

We recommend to contact Sisgeo for technical support if the installation would be performed in unstable grounds so that it is necessary to leave the convering in the borehole.

Before starting the electric transducers installation, we recommend to perform a control reading with a readout.

Useful tools (not supplied):

Double-reading multipoint fiberglass rod extensometer	Single-reading multipoint fiberglass rod extensometer	Double-reading multipoint steel or invar rod extensometer	Single-reading multipoint steel or invar rod extensometer
Allen key n° 4	Spanner n° 12, 13, 14, 24	2 spanner n° 14	Spanner n° 12, 13, 14, 17, 24
Adhesive tape	Tubular box wrench n° 10, 24	Allen key n° 4	Tubular box wrench n° 10, 24
	Adhesive tape	Pushing rod (assembly kit available in Sisgeo)	Pushing rod (assembly kit available in Sisgeo)
		Jig saw or cutter	Jig saw or cutter
		Adhesive tape	2 pliers
			Adhesive tape

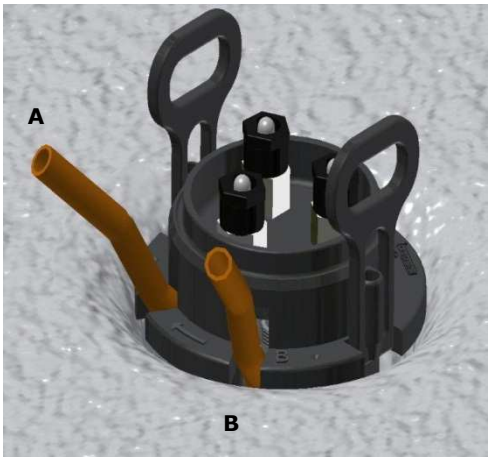
Installation

VERTICAL INSTALLATIONS DOWNWARD

Multipoint fiberglass rod extensometer

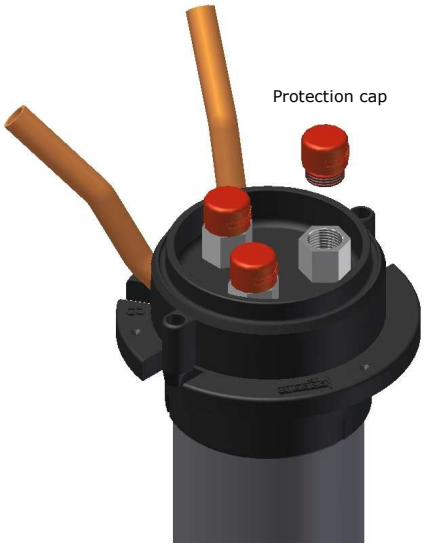
Unroll the instrument close to the drilling. Assemble the rod centering ring. If necessary, fix, with adhesive tape, the grouting tubes with the rods.

Insert the instrument within the borehole

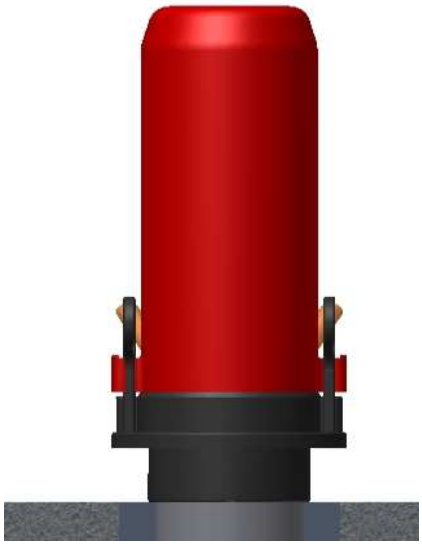


Hold up the head and grout the rod using the longer grouting tube "A". Grouting tube "B" is for drain and top up.

Once the grout hardened, release the rods unscrewing the internal nut first and then the black joint. Now the rod is free to slide in the sleeve. It is possible to assemble the transducers or to take readings with digital caliper.

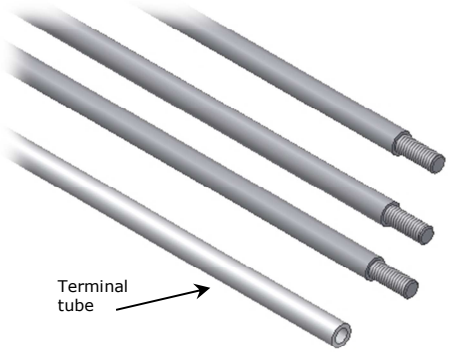


Install the transducers, or screw the protection cap.



Assemble the protection cover on the head.

Multipoint steel or invar rod extensometer

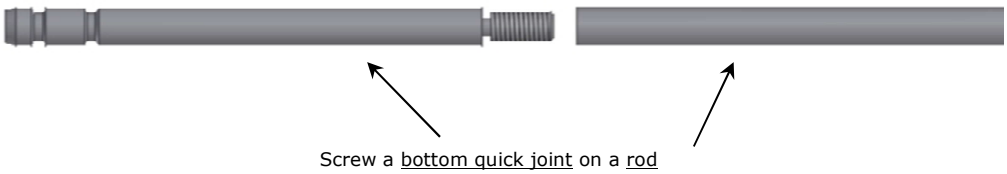


Locate, among the rods, the terminal tubes: they are within a plastic net and have a female thread on one side.

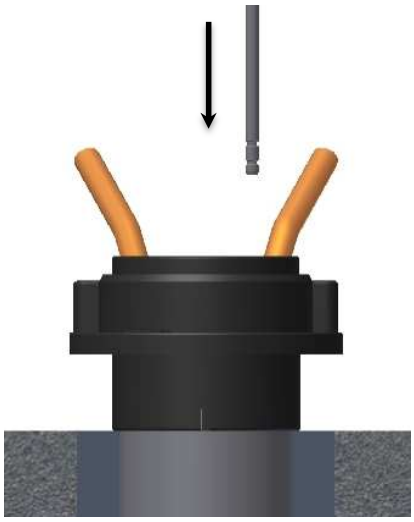
Unroll the instrument close to the drilling. Assemble the rod centering ring. If necessary, fix, with adhesive tape, the grouting tubes with the rods.

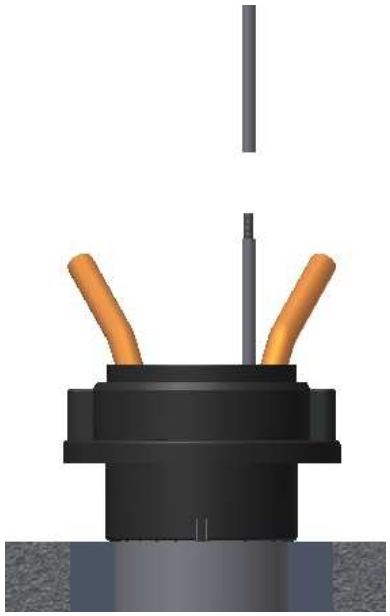
Insert the instrument within the borehole.

Hold up the head.



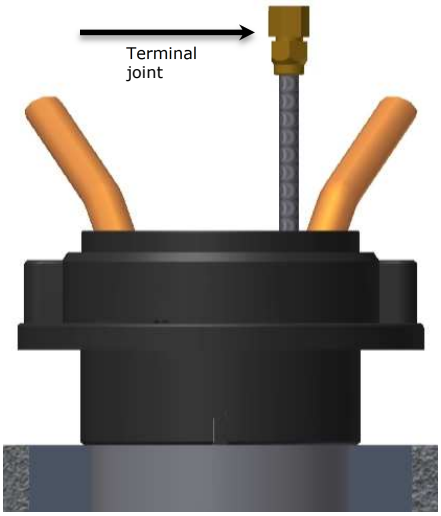
Screw a bottom quick joint on a rod





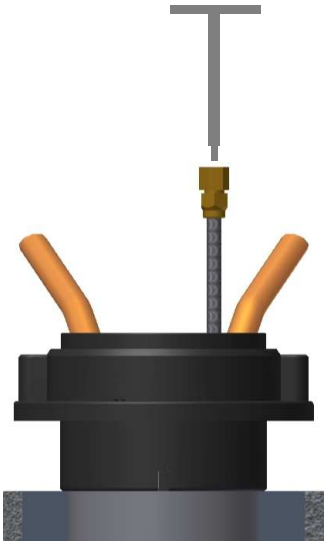
Insert, in the hole, the rod with the quick-joint downward. Hold it with the gripper and follow the convention on page 5.

Screw another rod until is blocked. Carry on for the entire length.
Attention: don't drop the rods.
The last rod must be the terminal tube.

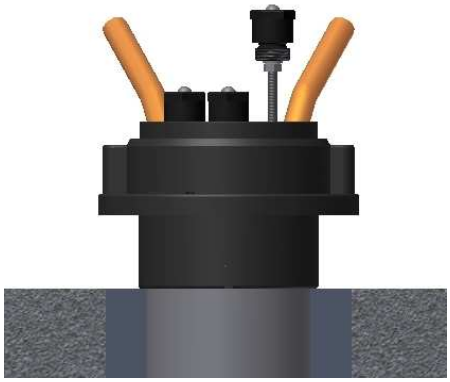


Place carefully the rod batch on the bottom and mark the terminal tube as shown in the picture.
Cut it under the mark at:
264mm for transducers up to 100mm
364mm for transducers above 100mm

Slide the terminal joint on the terminal tube until it stops. Screw the joint using 2 spanners nr. 14.



Screw the pushing rod on the terminal joint and push until the rods are hooked at the bottom.
Unscrew the pushing rod.



Assemble the block cap screwing both the threaded rod and the black cap

Carry out the same procedure for all the rods.
Grout the rods using the longer grouting tube "A". Grouting tube "B" is for drain and top up.

Once the grout hardened, release the rods unscrewing the internal nut first and then the black joint. Now the rod is free to slide in the sleeve. It is possible to assemble the transducers or to take readings with digital caliper.

Install the transducers, or screw the protection cap.
Assemble the protection cover on the head.

Double-reading multipoint fiberglass rod extensometer

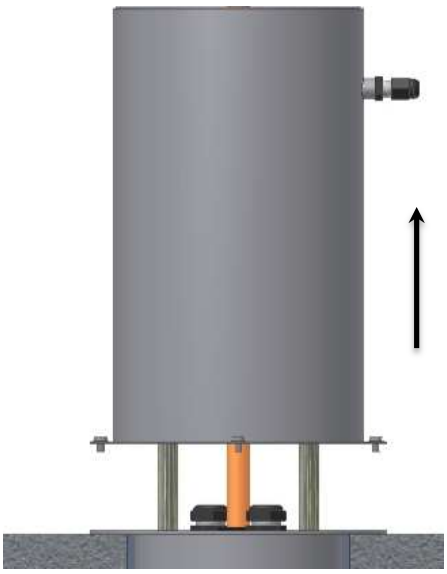
Unroll the instrument close to the drilling. Assemble the rod centering ring. If necessary, fix, with adhesive tape, the grouting tubes with the rods.

Insert the instrument within the borehole

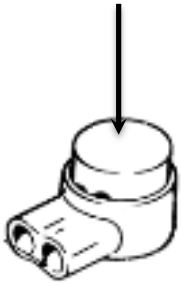
Hold up the head and grout the rod using the longer grouting tube "A". Grouting tube "B" is for drain and top up.

Once the grouting is ended, cut the tubes close to the plate.

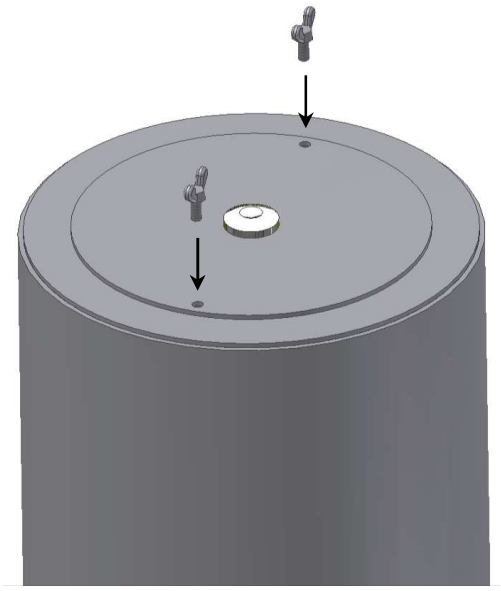
Once the grout hardened, release the rods unscrewing the internal nut first and then the black joint.



Remove the metal protection of the head unscrewing the four screws (allen key nr.4)

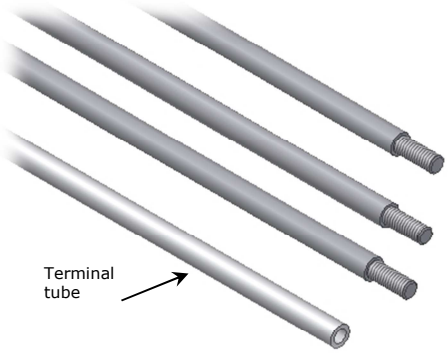


Connect transducer's conductors with the ones of multicore cable using the supplied clamps.



Put back the head metal protection and close the cover with its screws.

Double-reading multipoint steel or invar rod extensometer

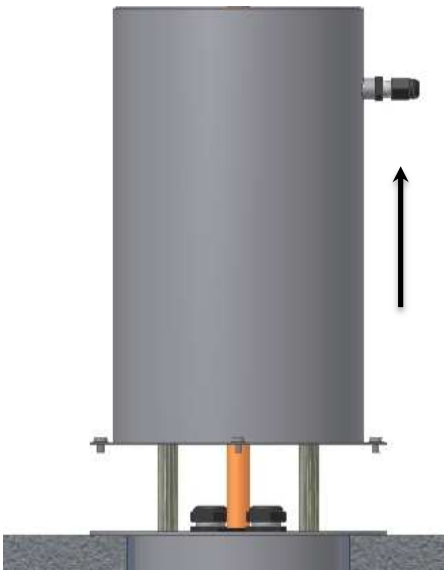


Locate, among the rods, the terminal tubes: they are within a plastic net and have a female thread on one side.

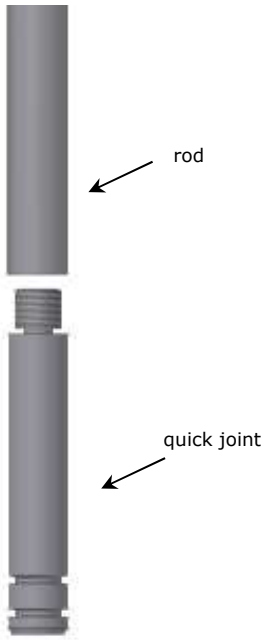
Unroll the instrument close to the drilling. Assemble the rod centering ring. If necessary, fix, with adhesive tape, the grouting tubes with the rods.

Insert the instrument within the borehole

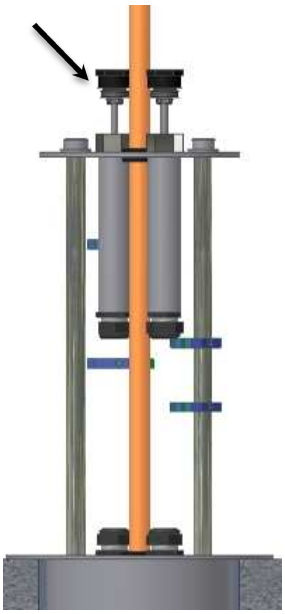
Hold up the head



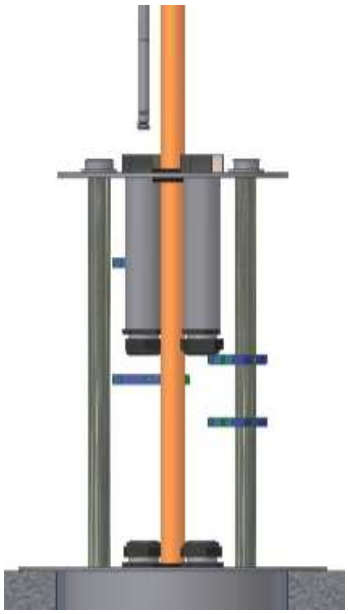
Remove the metal protection of the head unscrewing the four screws (allen key nr.4)



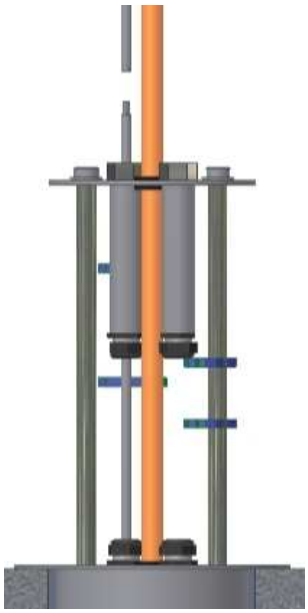
Screw a bottom quick joint on a rod



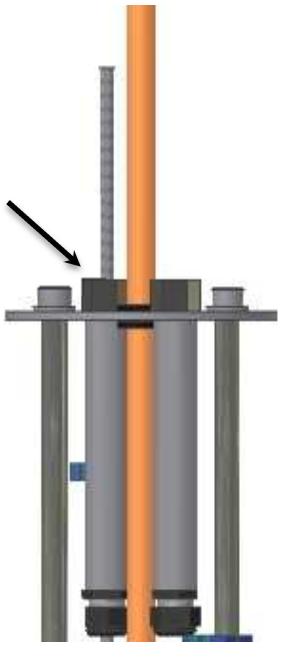
Remove the block caps



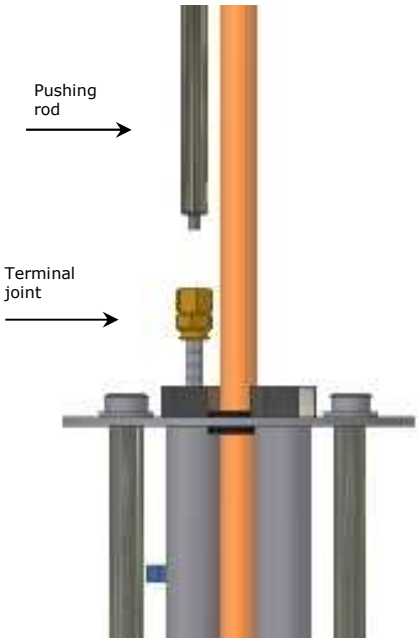
Insert, in the hole, the rod with the quick-joint downward. Hold it with the pliers and follow the convention on page 5.



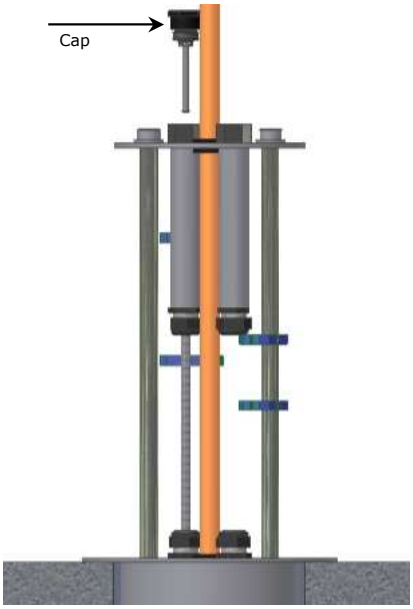
Screw another rod until is blocked. Carry on for the entire length. Attention: don't drop the rods.
The last rod must be the terminal tube.



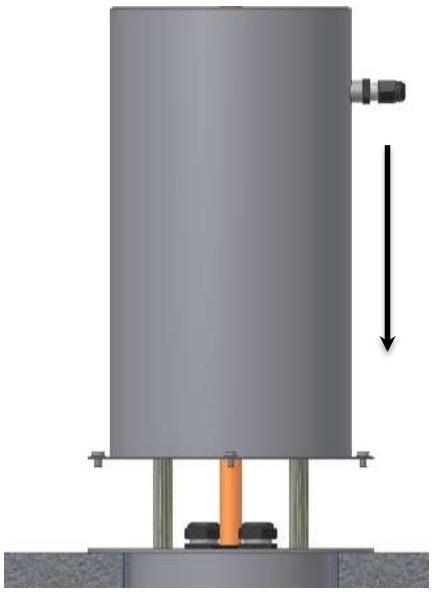
Place carefully the rod batch on the bottom and mark the terminal tube as shown in the picture.
Cut it at 107mm under the mark.



Slide the terminal joint on the terminal tube until it stops. Screw the joint using 2 spanners nr. 14.
Screw the pushing rod on the terminal joint and push until the rods are hooked at the bottom.
Unscrew the pushing rod.

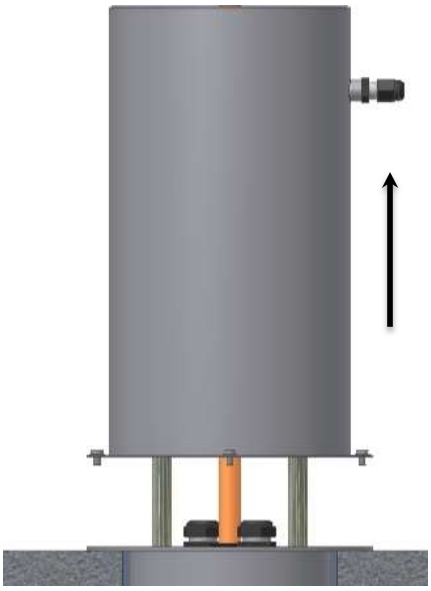


Screw the black joint and the internal nut. Repeat it for all rods.

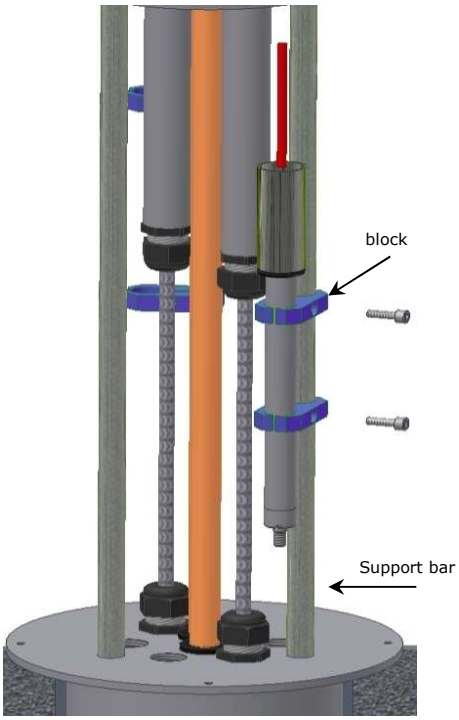


Assemble the head metal protection.
Grout the rod using the longer grouting tube "A". Grouting tube "B" is for drain and top up.

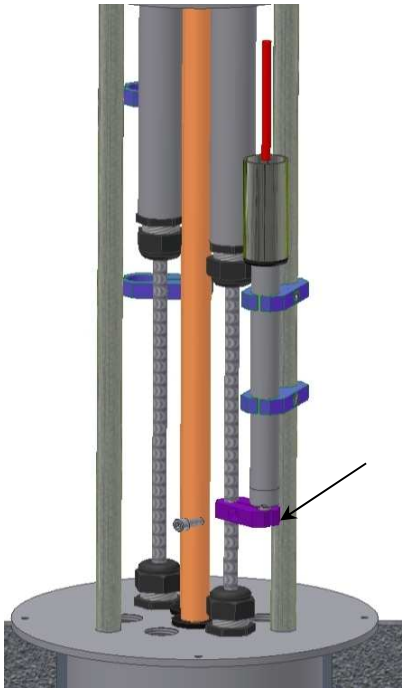
Once the grouting is ended, cut the tubes close to the plate.



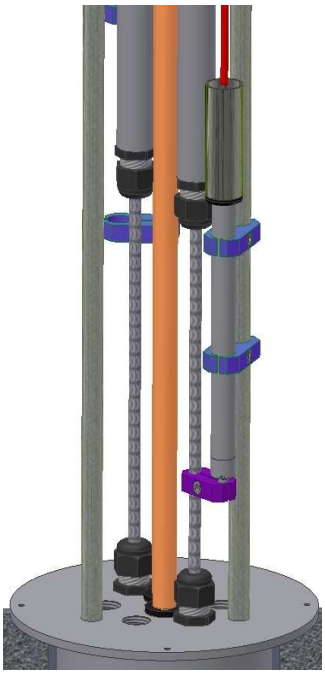
Once the grout hardened, remove the head metal protection from the instrument.

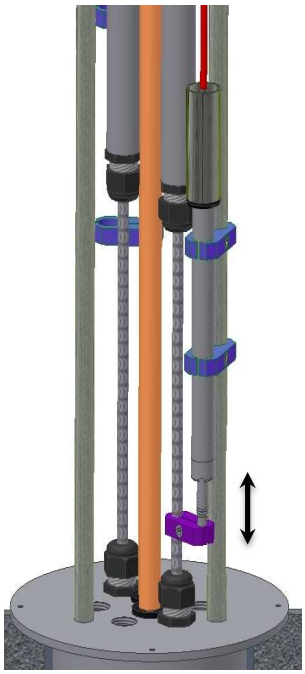


Fix the transducers to the support bar through blocks and supplied screws (allen key nr.4).

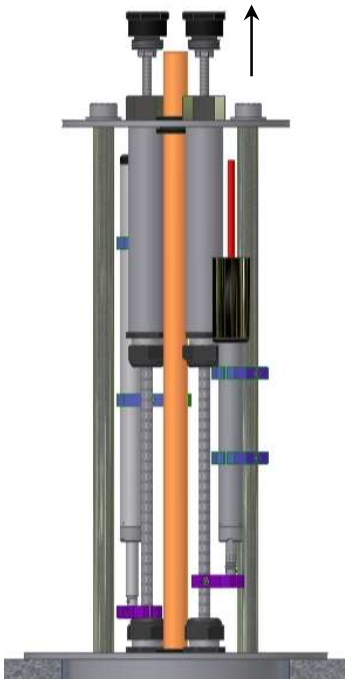


Fix the transducer rod to the installed rods (allen key nr. 4).

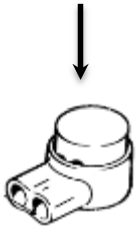




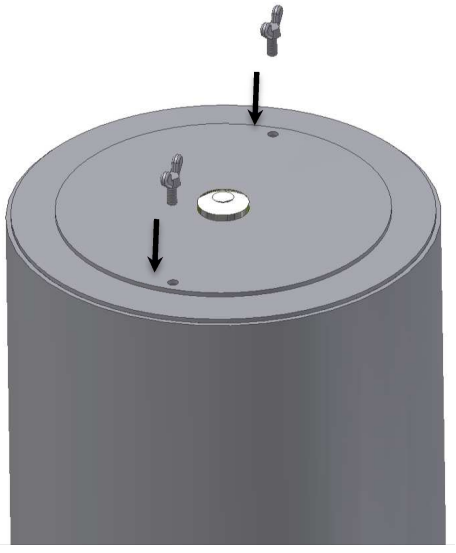
Connect the transducer to the readout.
Place the transducer in order to read the chosen value.



Remove the block cap unscrewing the internal nut first and then the black joint.



Connect transducer's conductors with the ones of multicore cable using the supplied clamps.

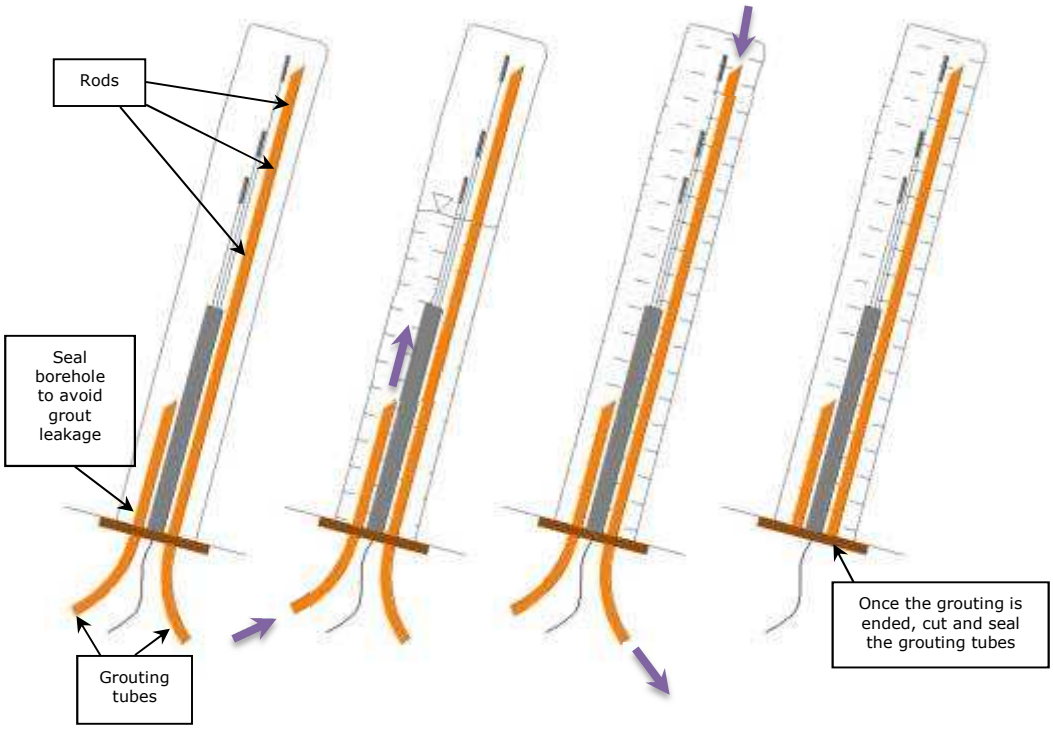


Put back the head metal protection and close the cover with its screws.

EXTENSOMETERS UPWARD INSTALLATION

In case the installation will be carried out upward, we recommend to harden the rods using, for example, a plastic tube (Ø 30mm ca.) instead of the centering ring, in order to push the rods in the hole.
Before starting the grouting, seal the hole (e.g. with foam or quick-setting cement).

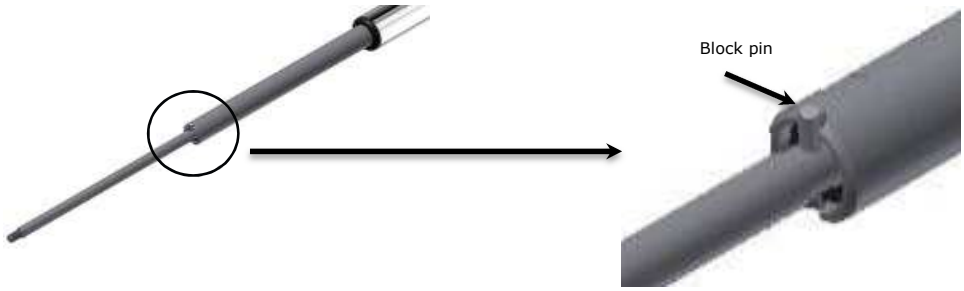
Scheme for upward hole grouting

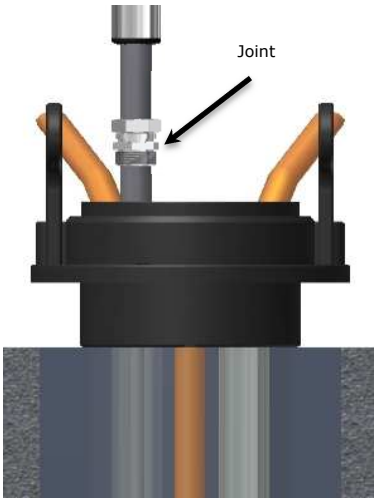


ELECTRIC TRANSDUCERS INSTALLATION (DTE)

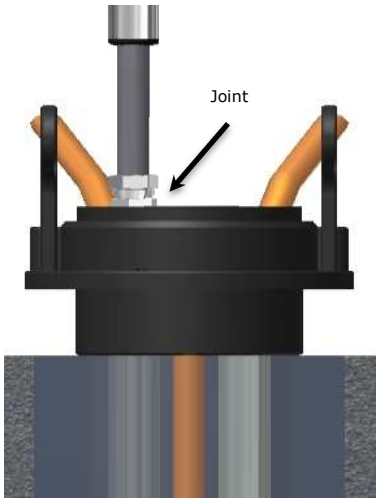
Before proceeding, make sure that the block pin is placed as shown.

Follow the procedure in reverse to dismantle the transducer.

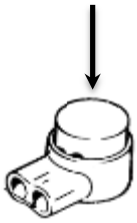




Screw the transducer on the rod



Screw the joint on the chromed ring. Connect the transducer to the readout, place it where needed and block it tightening the joint.

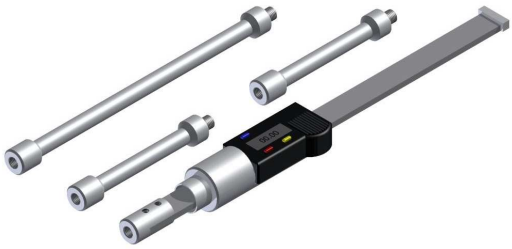


If necessary, connect transducer's conductors with the ones of multicore cable using the supplied clamps.

Taking measurements

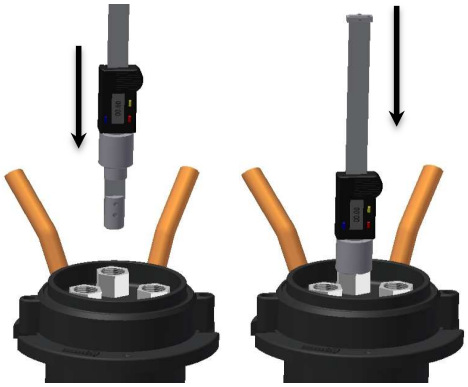
Taking measurements with digital caliper (mechanical measure)

Remove the cover from extensometer's head and the protection cap.



If necessary, assemble the extensions on the caliper.

Switch on the caliper, select the unit of measurement (mm or inch). Take the caliper to stop and reset with ZERO key.



Insert the caliper as shown, place it on the chromed ring and push the rod until stops. Take note of the value on the display

Taking measurements with electric transducer

Manual readings are taken connecting the conductors to a readout according to the following scheme:

Current loop 4-20 mA sensors	Red	+ Loop
	Black	- Loop
Vibrating wire sensors (VW)	Red	VW
	Black	VW
	White	Thermistor
	Green	Thermistor

To obtain reliable measures, with current loop instruments, we recommend a warm up time not less than 10 seconds.
For automatic measures, connect the instrument to a readout.

Data Processing

The digital caliper displays a displacement value in the chosen unit of measurement. The transducer displays an electric value that has to be converted as follows:

Linear factor ➔ $\mathbf{L_{eng} = L_{elec}/S\ [mm]}$
Polynomial factors ➔ $\mathbf{L_{eng} = (L_{elec}^2 \times A) + (L_{elec} \times B) + C\ [mm]}$

L_{eng} = engineering reading
L_{elec} = electric reading
S = sensitivity factor
A, B, C = polynomial conversion factors

S, A, B, C factors are stated on DTE Calibration Report

With regard to the measuring range (rod position) of DTE transducers herewith follows the table with the nominal values for both VW and LP DTEs:

DTE rod position	**Nominal values**	
	VW	LP
Max extension	**9000Dg**	**4mA**
Max compression	**2500Dg**	**20mA**

The exercise readings refer to the initial reading (zero reading).

$$\mathbf{D = L_i - L_0}$$

D = Displacement
L_0 = Zero reading
L_i = Exercise reading

Zero reading shall be taken carefully once the installation is performed and the instrument is in operating conditions.

Example

LP DTE range 50mm (mA readings)
S = 0.32051 mA/mm
A = -6.984 E-04 , B = 3.137 E+00 , C = -1.264 E+01
L_0 = 12.050 mA , L_1 = 16.048 mA ($L_1 > L_o$ ➔ Compression)

Using:
Linear factor (L_1-L_0)/S : *(16.048 – 12.050)/0.32051 = 12.47mm*
Polynomial Factor $[(L_1^2 \times A)+(L_1 \times B)+C] - [(L_0^2 \times A)+(L_0 \times B)+C]$= *37.522–25.0590=12.46mm*

Temperature Reading
Using readout units such as SISGEO CRD-400, New Leonardo, temperature will be displayed directly in °C (degrees Celsius); if the resistance value is read, the conversion formula or the table in Appendix 1 can be used.

Troubleshooting

VW transducers:

Problem	Possible cause	Solution
Unstable measure	Cable shield not connected	Connect the shield
	Electromagnetic fields generated by engines, generator, antennas, welders or high voltage lines nearby	Identify and remove the cause
	Grounding not well done	Provide efficient grounding
Wire not detected	Cable cut or damaged.	Repair the cable. Cable splicing kit available at SISGEO. Measure the resistance between Red and Black conductors: acceptable values 150Ω±15%. Consider cable length (for model 0WE116000, is about 88 Ω/km)
	Wiring not connect	Make proper wiring.

mA transducers

Problem	Possible cause	Solution
Unstable measure 0 mA measure Overrange measure	Wiring not connected.	Make proper wiring.
	Cable cut or damaged.	Repair the cable. Cable splicing kit available at SISGEO.

Maintenance

After-sales assistance 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: assistance@sisgeo.com

Appendix 1

THERMISTOR TEMPERATURE CONVERSION

Resistance to temperature equation:

$$T = \frac{1}{A + B(LnR) + C(LnR)^3} - 273.2$$

Where:
T= temperature in °C
LnR= natural Log of the thermistor resistance
A= 1.4051×10^{-3} (coefficents calculated over the -50 to +70°C span)
B= 2.369×10^{-4}
C=1.019×10^{-7}

Ohms	Temp	Ohms	Temp	Ohms	Temp	Ohms	Temp
16.60K	-10	5971	10	2417	30	1081	50
15.72K	-9	5692	11	2317	31	1040	51
14.90K	-8	5427	12	2221	32	1002	52
14.12K	-7	5177	13	2130	33	965.0	53
13.39K	-6	4939	14	2042	34	929.6	54
12.70K	-5	4714	15	1959	35	895.8	55
12.05K	-4	4500	16	1880	36	863.3	56
11.44K	-3	4297	17	1805	37	832.2	57
10.86K	-2	4105	18	1733	38	802.3	58
10.31K	-1	3922	19	1664	39	773.7	59
9796	0	3784	20	1598	40	746.3	60
9310	-1	3583	21	1535	41	719.9	61
8851	2	3426	22	1475	42	694.7	62
8417	3	3277	23	1418	43	670.4	63
8006	4	3135	24	1363	44	647.1	64
7618	5	3000	25	1310	45	624.7	65
7252	6	2872	26	1260	46	603.3	66
6905	7	2750	27	1212	47	582.6	67
6576	8	2633	28	1167	48	562.8	68
6265	9	2523	29	1123	49	543.7	69
						525.4	70