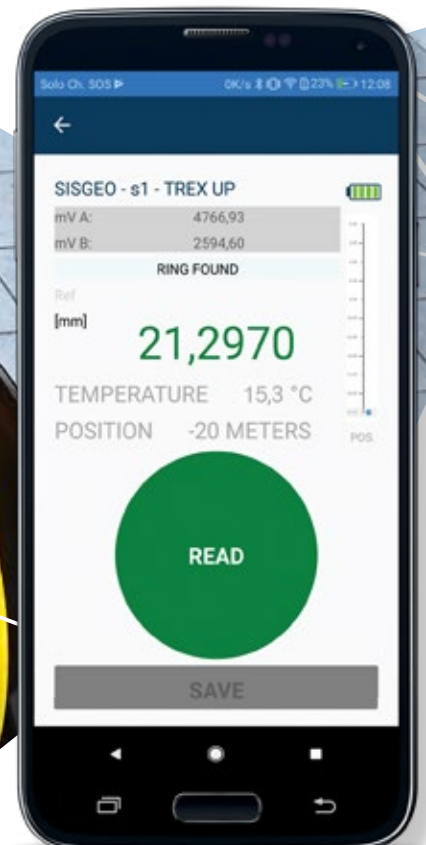


T-REX

## T-REX

### DIGITAL EXTENSOMETER

EXTENSOMETERS





# T-REX

## DIGITAL INCREMENTAL EXTENSOMETER

T-REX is a double-point probe-extensometer designed to measure the position of magnetic rings set along the axis of inclinometer casing. Measurements are later used to calculate changes in position, which indicate displacement.

The system is mainly composed by T-REX digital probe, B.R.A.IN bluetooth reel with control cable and APP compatible with Android and iOS mobile operative systems.

The electronics' readout is integrated into the reel and the BLE (Bluetooth Low Energy) wireless protocol permits a fast and safe communication.

The intuitive B.R.A.IN APP allows the user to manage the extensometer surveys and immediately share the readings with the most popular APP installed in the device (i.e. email, Dropbox, Whatsapp, Google DRIVE, OneDrive, iCloud Drive etc.)

Survey could be then imported in KLION software for data analysis and export professional and customizable reports.

### APPLICATIONS

- Extrusion (detensioning) on tunnel face
- Vertical displacements in embankment dam
- Settlements along path of tunnelling machine
- Displacements related to consolidation activities

### FEATURES

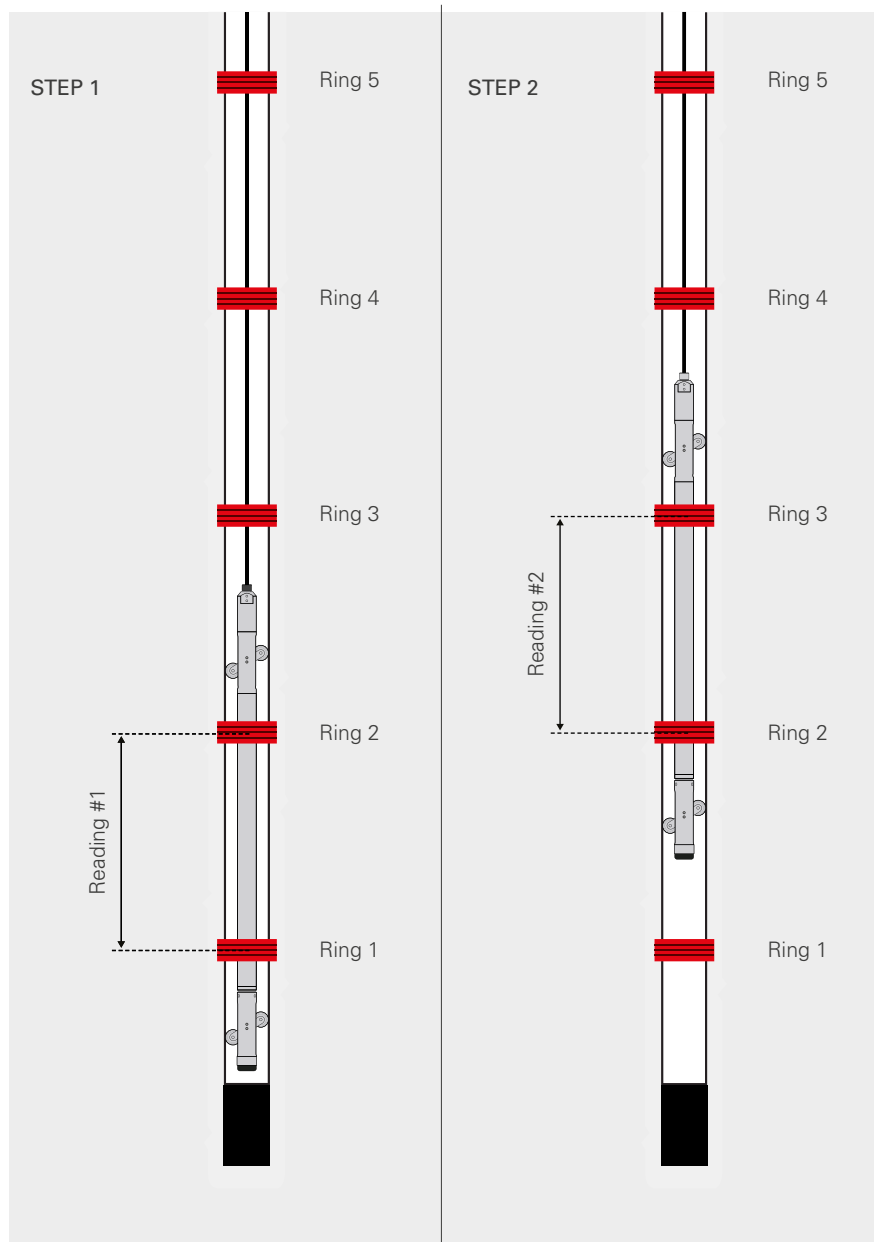
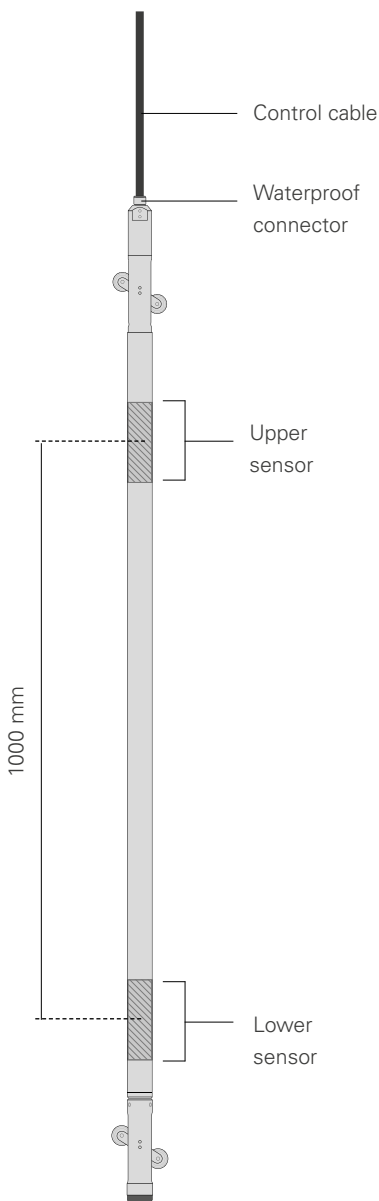
- Large measuring range for operation in both rock and soil
- High accuracy and repeatability
- Fully compatible with inclinometer components (casings' tubes, B.R.A.IN reels)
- On-site plots on APP



Meet the essential requirements of the EMC Directive 2014/30/UE

## OPERATING PRINCIPLE

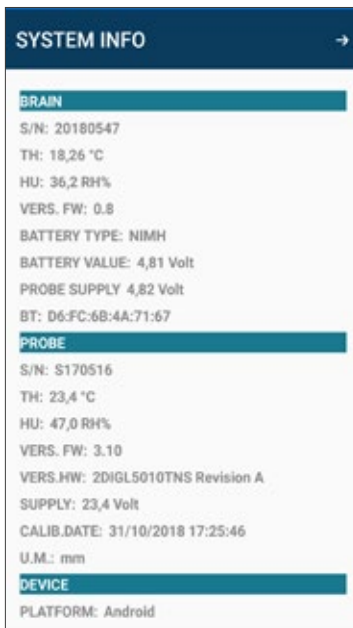
The T-REX system requires Sisgeo S143 ABS inclinometer casing installed with external magnet rings fixed at 1 meter intervals along the length of the casing. The T-REX probe has an aluminum body: two sensors inside the body are able to detect the magnetic field generated by the magnetic rings fixed to the casing. The sensors inside the probe are mounted exactly 1000 mm apart. The system is able to detect the relative distance between two rings with high accuracy. T-REX surveys usually start from the bottom of the casing, if the bottom is in stable ground. First, the operator reads the relative distance between the two lower rings (ring 1 and ring 2). Then, the operator pulls the probe 1000 mm upwards to read the relative distance between ring 2 and ring 3, then ring 3 and 4, and so on, until all rings have been read. The first complete survey of the ring positions serves as the reference (baseline) survey. Subsequent surveys are compared to the first. Changes in the distance between rings indicate settlements or heaves. It is possible to use the top ring as the reference, if the top of the casing is surveyed optically each time measurements are made.



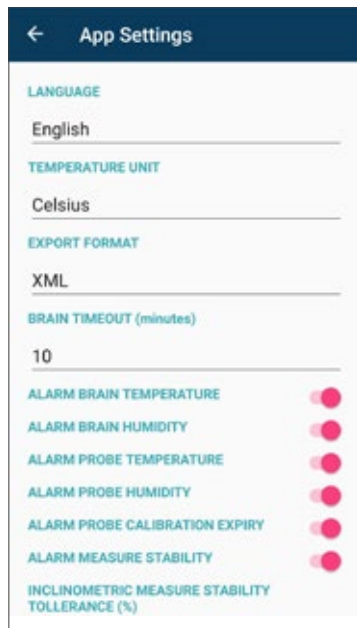


## B.R.A.I.N APP FOR T-REX SYSTEM MANAGEMENT

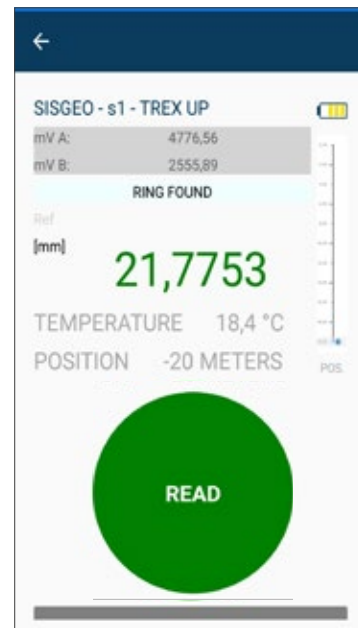
T-REX\_EN\_10\_03/2024



System information page allows you to have the entire system (device, probe and reel) always under control.



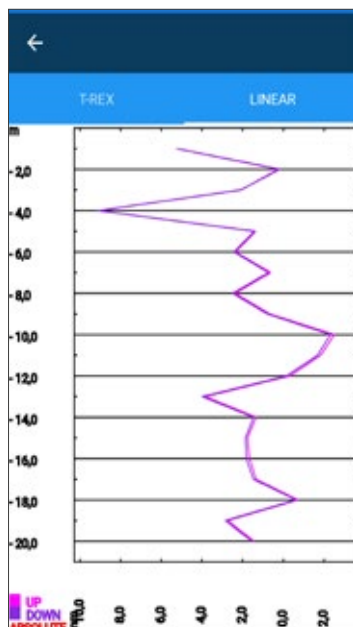
Various alarms can be settled in order to be always informed regarding the system health.



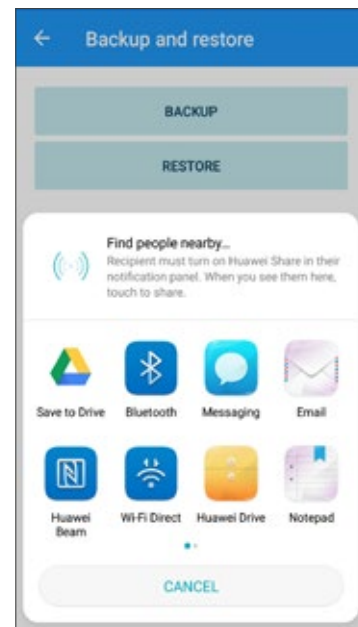
Reading page gives a lot of information such as actual position, data, probe internal temperature, etc.

#	UP	DOWN
-1,00	-5,2539	-5,2356
-2,00	-0,2497	-0,1616
-3,00	-2,0726	-2,0951
-4,00	-9,0958	-9,1243
-5,00	-1,3587	-1,4323
-6,00	-2,3515	-2,4272
-7,00	-0,6189	-0,7313
-8,00	-2,3699	-2,4896
-9,00	-0,6664	-0,7879
-10,00	2,5061	2,3092
-11,00	1,8315	1,6879
-12,00	0,3205	0,1579
-13,00	-3,8363	-3,9918
-14,00	-1,3349	-1,4701
-15,00	-1,7658	-1,8665
-16,00	-1,6658	-1,8267
-17,00	-1,3407	-1,4694

Data tables are available during and after the surveys.



Local displacement graph can be shown after the survey.




Survey data can be immediately sent through any sharing APP installed on your device such as Drive, email, etc.

Minimum Device Specifications  
(device not supplied by SISGEO)

Bluetooth Low Energy BLE 4.2  
ANDROID OS V. 7 or higher  
APPLE iOS 11 or higher



## BLUETOOTH REEL SPECIFICATIONS

Bluetooth module	band: 2.4 GHz ISM Band (2402-2480 MHz) - power: 4dBm Max		
Communication with device	BLE (Bluetooth Low Energy) 4.2		
On-board sensors <sup>(1)</sup>	Resolution	Accuracy	Range
- Temperature	0.01°C	±1°C (-10°C to +85°C)	-40°C to +125°C
- Humidity	0.025%RH	±5% (0 to 95%RH)	0 to 100%RH
- Battery voltage	0.01 V	±5% FS	0 to 36 V
Operating Temperature	-40 to 80°C (batteries -20 to 65°C)		
Communication with probe	RS485 Modbus RTU Protocol <sup>(2)</sup>		
IP class and material	IP65, unbreakable synthetic rubber		
Environmental condition certification	certified for extended environmental conditions: altitude above 2000m		
Power supply	4 x 1.2 V - 5 Ah - Ni-MH rechargeable batteries		
Operating time with NiMH batteries <sup>(4)</sup>	≈ 6 h with T-REX probe always on (APP in reading mode)		
Charger for NiMH batteries	90-264 Vac, 50-60 Hz		
- Input voltage	IP41		
- IP rate	10 W		
- Max output power	-20 +40 °C		
- Temperature range			
Led	Different colors for local notifications		
 Directive compliance	2014/53/EU (RED)		



(1) On-board sensors are installed on the internal electronic board to give information in the event of BRAIN reel malfunction.

(2) RS485 not-optoisolated Modbus communication with RTU Protocol (4) Typical values

## CONTROL CABLE


Control cable is used to move the probe incrementally and transmit readings from the probe to B.R.A.IN. bluetooth reel and then to the B.R.A.IN. APP. The HD (Heavy Duty) cable is supplied assembled on B.R.A.IN. reel and includes a factory-attached connector for the probe.

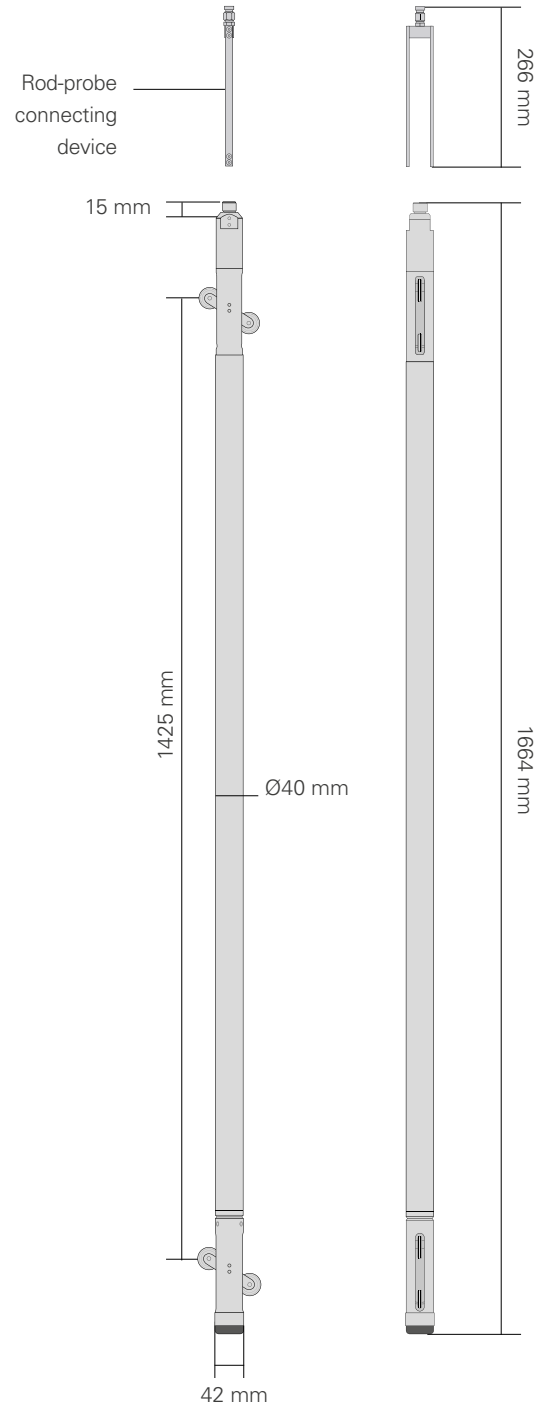
### B.R.A.IN. HD CABLE

HD cable has a stainless steel core wire to control stretching and a stainless steel torsion braid to prevent twisting. Yellow cable jacket has copper depth marks.

MODEL	<b>0S2RC6000B0</b>
Cable lengths	30,60,100,150, 200, 250 m
Conductors	6x0.50 mm <sup>2</sup> (AWG 21)
Depth tactile marks	copper, every 500 mm
Max strength	370 kg
Outer jacket	yellow, polyurethane
Cable diameter	10.4 mm
Weight (cable+marks)	0.150 kg/m
Operating temp. range	-30 to 80 °C
Total weight with 60 m cable	14 kg with B.R.A.IN reel

## T-REX PROBE TECHNICAL SPECIFICATIONS

MODELS	<b>OREX45100D0</b>
Applications	<b>vertical, horizontal, sub-horizontal</b>
Measurement principle	high performance displacement transducers
Measuring range	±40 mm
Signal output and protocol	RS485 Modbus RTU <sup>(1)</sup>
A/D converter	sigma-delta 32 bit, 38-KSPS
Probe resolution	0.0001 mm (with B.R.A.IN APP)
Sensor accuracy (MPE) <sup>(2)</sup>	<±0.3% FS (±0.24 mm/m) <sup>(3)</sup>
Repeatability	±0.01 mm/m
Stability @24 hours <sup>(4)</sup>	±0.025 mm/m
Temp. operating range	-30°C to +75°C
Power supply	from 8 to 28 V
Max consumption	127 mA@24Vdc 265 mA@12Vdc
On-board temperature sensor <sup>(5)</sup>	
<ul style="list-style-type: none"> <li>measuring range</li> <li>accuracy</li> </ul>	- 40°C to +125°C ±1°C (-10°C to +85°C)
On-board humidity sensor <sup>(5)</sup>	
<ul style="list-style-type: none"> <li>measuring range</li> <li>accuracy</li> </ul>	0 to 100% RH ±5% RH (0 to 95% RH)
On-board supply voltage monitor <sup>(5)</sup>	
<ul style="list-style-type: none"> <li>measuring range</li> <li>accuracy</li> </ul>	0 to 36 V ±5% FS
Material	aluminum body and steel parts
Body diameter	40 mm
Measuring base length	1000 mm
Wheels carriage	pair of wheels (Ø 32 mm) mounted on long-life sealed ball bearings
IP class	IP68 up to 2.0 MPa
Weight	5.4 kg (probe only)
 compliant directive	2014/30/EU (EMC)



(1) RS485 not-optoisolated Modbus communication with RTU Protocol

(2) MPE is the Maximum Permitted Error on the measuring range (FSR). In the Calibration Report, the accuracies of the gauge are calculated using polynomial correction ( $\leq$  Pol. MPE).

(3) The data shown refers to the instrument calibrated with red magnetic rings for use in casings with new red rings. If the calibrated probe with red rings is used in existing casings with old black rings, the accuracy (MPE) is  $\leq \pm 1.0\%$  FS (0.8 mm/m)

Upon request, it is possible to calibrate the T-REX probe using old black magnetic rings for main use in casings with old black rings: in this case the accuracy (MPE) is  $\leq \pm 0.2\%$  FS.

(4) Difference after a 24 h period under repeatability conditions, constant temperature, probe powered continuously.

(5) On-board sensors are installed on the internal electronic board to give information in the event of probe malfunction.

## ACCESSORIES AND SPARE PARTS

### T-REX POSITIONING DEVICE OREXOCS1000

Improves accuracy of vertical surveys. Required if measurements are critical. The positioning device has clamps for T-REX top cap (product code OREX0TS2350).

### SET OF 10 POSITIONING RODS OREXROD10BX

The positioning rods are needed for horizontal measurements with T-REX system. The aluminum rods are 2 meters long and have nickel-plated connectors. Supplied with carrying bag.

### klion ANALYSIS SOFTWARE OSWKLION000

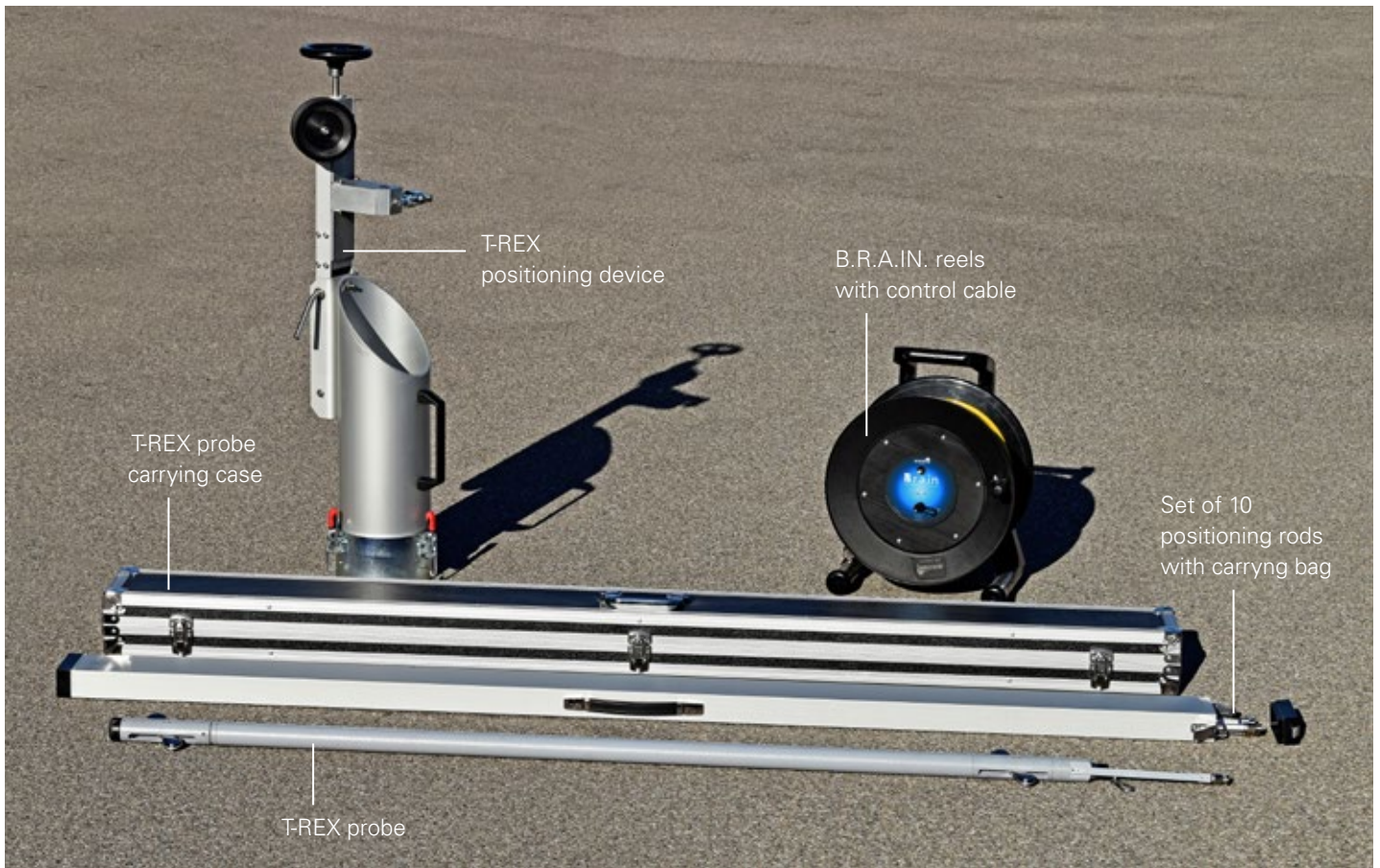
Klion Software processes measurements from T-REX system, providing incremental or cumulative displacements. For more information refer to the relevant datasheet.

### REPLACEMENT CARRYING CASE OREXOCASE00

Replacement shock-resistance carrying case for T-REX probe, made in aluminium.

### POSITIONING ROD OREXROD2000

Aluminum rod, 2 meters long, with nickel-plated connectors.



T-REX complete system



## MEASURING TUBES

The T-REX probe operates in S143 ABS inclinometer casings with magnet target rings externally attached every meter. In vertical applications, the T-REX top cap is needed to hold the positioning device. For horizontal applications, Sisgeo suggests to install the lockable top cap on the accessible end of the tube. For further information refer to S143 casing datasheet.

### ABS INCLIN. CASING OS143107000

Easy-lock ABS inclinometer casing model S143, 3 m length, OD 70 mm, ID 58 mm.

### BOTTOM CAP OS143TF7000

Simple bottom cap for Easy-lock casings, made of ABS. Suitable for inclinometer column or extenso-inclinometer column.

### REPAIRING KIT FOR CASING OS143KITR00

Repairing kit for S143 Easy-lock casings composed by five spare couplings, mounting jig and glue.

### ASSEMBLING KIT FOR 100 M OS143KIT000

Assembling set composed by 5 O-rings, locking wire and Sisgeo adhesive tape. (Mandatory)

### RING SETTING ROD OREXODIMA00

Setting rod for positioning the rings 1 m apart.

### LOCKABLE TOP CAP OS100CH1000

Lockable cap for horizontal application with survey pin permits topographical surveying in order to define and check the borehole coordinates.

### MAGNET REFERENCE RING OREXORINGRO

Magnet ring for T-REX incremental extensometer OD 93 mm, ID 71 mm. Material: PVC with permanent magnet

### T-REX TOP CAP OREX0TS2350

Lockable top cap for vertical application ready with fixing plate for T-REX positioning device.



## FUNCTIONAL CHECK DEVICE (FCD)

The aim of the Functional Check Device (FCD, product code **OREX0CAL0FR**) is to have a stable reference to verify that the T-REX probe, before and after the campaign readings, has the same check-value without offset caused by improper use of the probe (e.g., mechanical shock, electrical shock, etc.). This test is very important when very accurate readings are needed, i.e. within concrete or rocks.

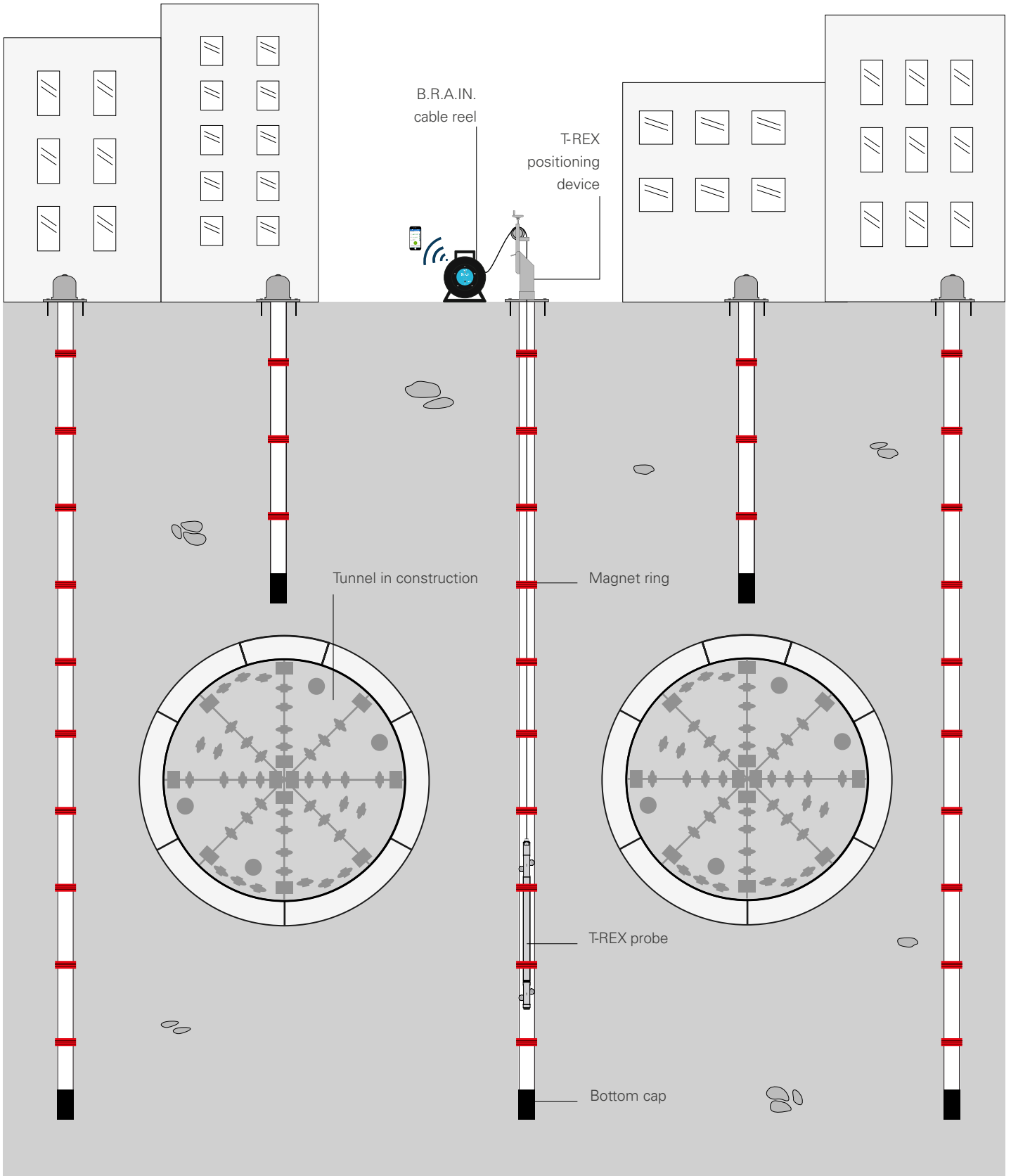
**FCD is NOT a tool to verify the probe calibration. The T-REX extensometer should be calibrated at least once a year, as required by the standard ISO 18674-2.**

The test with FCD shall be done at constant temperature, so that we recommend to stock and use the FCD in a temperature-controlled room with a maximum  $\pm 1^\circ\text{C}$  temperature gradient (e.g.,  $20^\circ\text{C} \pm 1^\circ\text{C}$ ).





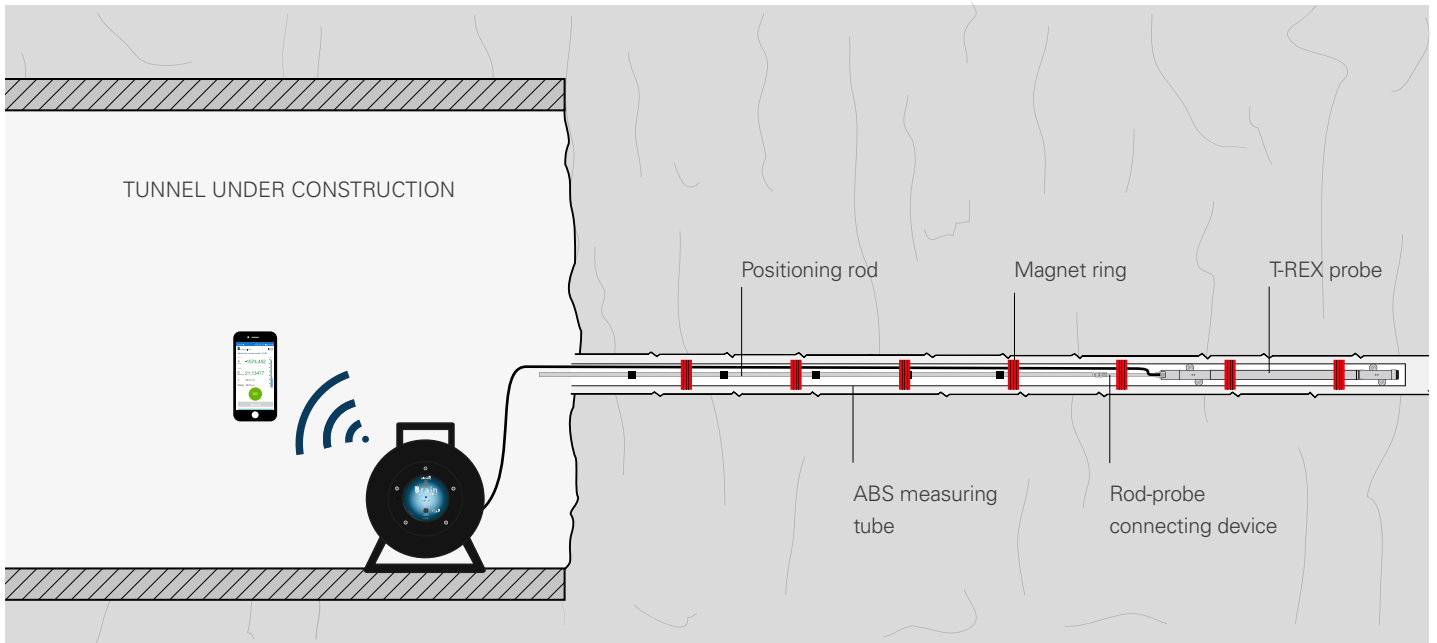
AN EXAMPLE OF 3-D (INCLINOMETER AND EXTENSOMETER) SURVEY IN TUNNEL APPLICATION



## AN EXAMPLE OF TUNNEL FACE EXTRUSION

T-REX incremental extensometer is often used in tunnelling to monitor the tunnel face detensioning and ground displacement vs distance from the face.

The system consists of a measuring tube with pre-attached magnet target rings installed in a horizontal borehole drilled from the tunnel face. Usual tube lengths are 15 m to 30 m. The probe is inserted into the tube and pushed to reach the farthest magnetic ring. The first survey will give the zero position of all the magnetic targets. Subsequent surveys are performed after each tunnel excavation step (the exposed portion of the tube is destroyed at each step). These surveys are compared to the reference survey to calculate displacements of the face.



*Preparing T-REX probe for horizontal surveying*

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