T-REX
DIGITAL EXTENSOMETER

EXTENSOMETERS
T-REX
DIGITAL INCREMENTAL EXTENSOMETER

SISGEO designed the T-REX incremental extensometer 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.

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

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

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

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** (1)
  - Temperature
  - Humidity
  - Battery voltage

- **Operating Temperature**
  - -40 to 80°C (batteries -20 to 65°C)

- **Communication with probe**
  - RS485 Modbus RTU Protocol (2)

- **IP class and material**
  - IP65, unbreakable synthetic rubber

- **Environmental condition certification**
  - certified for extended environmental conditions: altitude above 2000m

- **Power supply**
  - 90-264 Vac, 50-60 Hz
  - IP41
  - 10 W
  - -20 to +40 °C

- **Operating time with NiMH batteries**
  - ≈ 6 h with T-REX probe always on (APP in reading mode)

- **Charger for NiMH batteries**
  - - Input voltage
  - - IP rate
  - - Max output power
  - - 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

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### B.R.A.IN. REELS WITH CONTROL CABLE

Control cables are 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) and Light cables are supplied assembled on B.R.A.IN. reel and include a factory-attached connector for the probe. Probe-end connectors are watertight up to 20 bar.

#### B.R.A.IN. HD CABLE (STANDARD FOR T-REX)

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.

<table>
<thead>
<tr>
<th>MODEL</th>
<th>Cable lengths</th>
<th>Conductors</th>
<th>Depth tactile marks</th>
<th>Max strength</th>
<th>Outer jacket</th>
<th>Cable diameter</th>
<th>Weight (cable+marks)</th>
<th>Operating temp. range</th>
<th>Total weight with 60 m cable</th>
</tr>
</thead>
<tbody>
<tr>
<td>0S2RC6000B0</td>
<td>30, 60, 100, 150, 200, 250 m</td>
<td>6x0.50 mm² (AWG 21)</td>
<td>copper, every 500 mm</td>
<td>370 kg</td>
<td>yellow, polyurethane</td>
<td>10.4 mm</td>
<td>0.150 kg/m</td>
<td>-30 to 80 °C</td>
<td>14 kg with B.R.A.IN reel</td>
</tr>
</tbody>
</table>

#### LIGHT CABLE (OPTION)

Light cable has a stainless steel stress member. Blue cable jacket has aluminum depth marks.

<table>
<thead>
<tr>
<th>MODEL</th>
<th>Cable lengths</th>
<th>Conductors</th>
<th>Depth tactile marks</th>
<th>Max strength</th>
<th>Outer jacket</th>
<th>Cable diameter</th>
<th>Weight (cable+marks)</th>
<th>Operating temp. range</th>
<th>Total weight with 60 m cable</th>
</tr>
</thead>
<tbody>
<tr>
<td>0S2RD6000B0</td>
<td>30, 60, 100, 150, 200 m</td>
<td>2x0.50mm² (AWG 21) + 2x0.24mm² (AWG 24)</td>
<td>aluminum, every 500 mm</td>
<td>150 kg</td>
<td>blue, polyurethane</td>
<td>6.5 mm</td>
<td>0.054 kg/m</td>
<td>-30 to 80 °C</td>
<td>6 kg with B.R.A.IN reel</td>
</tr>
</tbody>
</table>
T-REX PROBE TECHNICAL SPECIFICATIONS

MODELS

Applications
 vertical, horizontal, sub-horizontal

Measurement principle
 high performance displacement transducers

Measuring range
 ±40 mm

Signal output and protocol
 RS485 Modbus RTU\(^{(1)}\)

A/D converter
 sigma-delta 32 bit, 38-KSPS

Probe resolution
 0.0001 mm (with B.R.A.IN APP)

Accuracy: Pol. MPE \(^{(2)}\)
 ±0.2% FS (±0.16 mm/m)
 ±0.01 mm/m
 ±0.025 mm/m

Repeatability
 ±0.01 mm/m

Stability Ø24 hours \(^{(3)}\)
 –30°C to +75°C

Temp. operating range
 from 8 to 28 V

Power supply
 125 mA@24Vdc
 260 mA@12Vdc

Max consumption
 -40°C to +125°C
 ±1°C (-10°C to +85°C)

On-board temperature sensor \(^{(4)}\)
 0 to 100% RH
 ±5% RH (0 to 95% RH)

On-board humidity sensor \(^{(4)}\)
 0 to 36 V
 ±5% FS

On-board supply voltage monitor \(^{(4)}\)
 aluminum body and steel parts

Material
 40 mm
 1000 mm

Measuring base length
 pair of wheels (Ø 32 mm) mounted on long-life sealed ball bearings

Wheels carriage
 IP68 up to 2.0 MPa

IP class
 5.4 kg (probe only)

Weight
 2014/30/EU (EMC)

Compliant directive

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\(^{(1)}\) 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 (≤ Pol. MPE).

\(^{(3)}\) Difference after a 24 h period under repeatability conditions, constant temperature, probe powered continuously.

\(^{(4)}\) On-board sensors are installed on the internal electronic board to give information in the event of probe malfunction.

For any further information not inserted in this datasheet please refer to ISO 18674-3 international standard.
ACCESSORIES AND SPARE PARTS

T-REX POSITIONING DEVICE 0REX0CS1000
Improves accuracy of vertical surveys. Required if measurements are critical. The positioning device has clamps for T-REX top cap (product code 0REX0TS2350).

SET OF 10 POSITIONING RODS 0REXROD10BX
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.

REPLACEMENT CARRYING CASE 0REXOCASE00

POSITIONING ROD 0REXROD2000
Aluminum rod, 2 meters long, with nickel-plated connectors.

ANALYSIS SOFTWARE OSWXKLION000
Klion Software processes measurements from T-REX system, providing incremental or cumulative displacements. For more information refer to the relevant datasheet.

Aluminum rod, 2 meters long, with nickel-plated connectors.
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
0S143107000

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

BOTTOM CAP
0S143TF7000

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

REPAIRING KIT FOR CASING
0S143KITR00

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

ASSEMBLING KIT FOR 100 M
0S143KIT000

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

RING SETTING ROD
0REX0DIMA00

Setting rod for positioning the rings 1 m apart.

LOCKABLE TOP CAP
0S100CH1000

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

MAGNET REFERENCE RING
0REX0RING93

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

T-REX TOP CAP
0REX0TS2350

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

CALIBRATION DEVICE

The calibration device (product code 0REX0CAL0FR) is used to check the calibration of the probe in the office before and after surveying. The calibration device is mainly ceramic with a low thermal coefficient of expansion. It is supplied with two magnetic rings and support legs. One ring is fixed to the tube, the other one can be moved in a range of ±25 mm.

The calibration device is supplied with aluminium carrying case.

Probe and calibration device should be maintained at 20°C ±1°C for calibration.
AN EXAMPLE OF 3-D (INCLINOMETER AND EXTENSOMETER) SURVEY IN TUNNEL APPLICATION

- Bottom cap
- T-REX probe
- Magnet ring
- Tunnel in construction
- B.R.A.IN. cable reel
- T-REX positioning device

Ref. A

Ref. B

Deep [20kSenA]

22.4 °C

18.5 FEET

SALVA
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