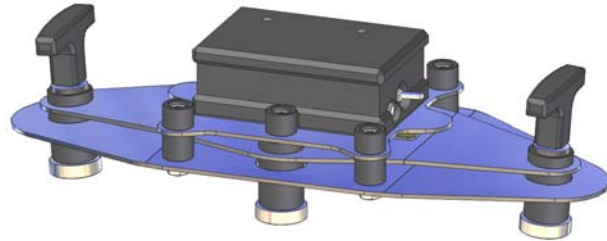User Manual: (Draft Version)

OVALITY SENSOR

1.   INTRODUCTION:

The Ovality Sensor is a measurement tool for rotary kilns, which measures the changes of the roundness / curvature in the kiln shell during operation. This elastic deformation is called Ovality and is primarily present in the area of a kiln tire. The measurement gives accurate information about the degree of mechanical loads in the refractory / kiln shell and allows defining the countermeasures in advance to increase the lifetime of the kiln components.

The Ovality Sensor is small, easy to use and comes along with a tough transport case.

1.1   Safety:

Rotary kilns or dryers, where this tool is used, are huge rotating equipments with many pinch points, they can cause serious injuries. Therefore only specialized and trained personnel shall work close to these machines. To use the Ovality Sensor, follow strictly the local safety rules given by the respective plant / factory / local authorities and discuss the application with the safety engineer in charge.

The tools provided by TomTom-Tools Ltd have proven their functionality in various applications; nevertheless TomTom-Tools Ltd does not take any responsibility for the application on site regarding safety. The plant is responsible for the safety, according to the local law, in a way that nobody can be hurt or injured. The application and safety instructions below are guidelines, which include the experience from previous measurement campaigns and might need to be adapted to the local safety requirements.

TABLE OF CONTENT

Caution:

Falling:
The tool might fall off the attached surface, if it is not properly attached.
Dust, dirt, corrosion, roughness or high surface temperature (>330°C) increase the risk.
Do not stand in the area and keep it clear, where the tool might fall down

Helmet:
Wear a proper helmet while using the measurement tool.

Hot Surface:
After using the tool, the magnets might be very hot.
Use the T-handles and do not touch the downside of the tool, especially not the magnets.
Let the tool cool down before stowage. Otherwise the box may get damaged.

Gloves:
Wear proper gloves, which prevent burning the hands.
Especially for attaching, removing and handling the tool, when it is hot.

Magnet Fields:
Be aware of the strong magnet field on the magnet surface.
Keep the tool away from people with pace makers or any other sensitive item as credit cards or magnetic data carrier.

Clamping:
Do not put fingers between the magnets and magnetic surface. There is the risk for clamping or pinching, due to the strong magnetic force.

Radio Waves:
Be aware of the radio waves (Bluetooth) which are emitted from the tool as well from the Bluetooth adapter on the computer.
Do not keep the tool unnecessary in operation; switch it off, after usage.

1.2   Measuring Principle:

The Ovality Sensor consists of a Deflection Plate, which will be attached with heat resistant magnets to the kiln shell close to a tire. Due to the strong magnetic connection, the deflection in the Deflection Plate follows the deflection of the kiln shell below. Strain gauges are measuring the deflection in the Deflection Plate. The electronic converter is amplifying and conditioning the signals from the strain gauges and sending them together with the values of the orientation sensor via Bluetooth connection to a laptop.

The software **TomTom-Tools Measurement Studio** (for Windows), which comes together with the measurement tool is made to receive, store and process the values from the Ovality Sensor.

During the measurement, the values are displayed and calculated directly in real time.

There are different display, zoom and report printing options available.
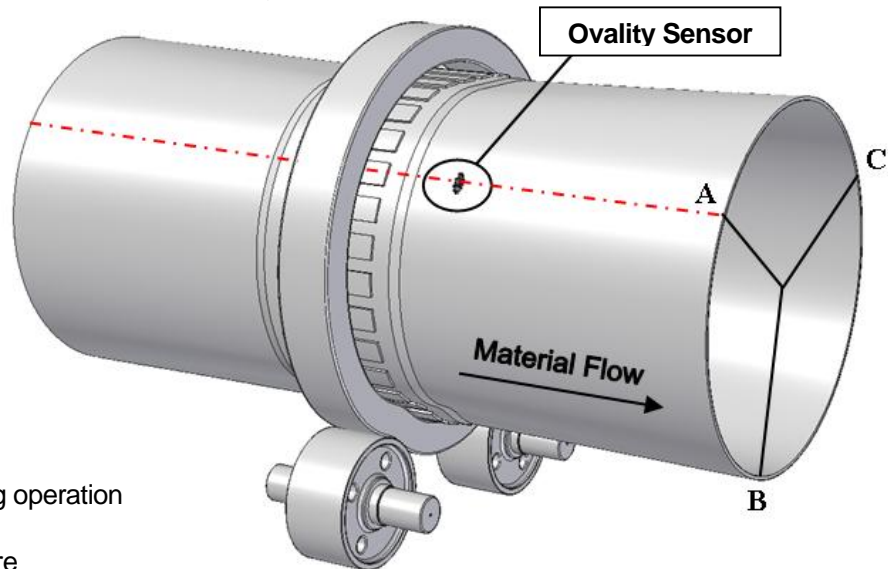
Advantages
- Measurement during operation
- High accuracy
- User friendly software
- Small size (mostly pass easily between heat shields or thrust roller and kiln shell)
- Small weight (Sensor: ~1.5kg / Total incl. Case ~3.5kg)
- Convenient for travelling
- Measurement directly displayed on computer

Disadvantages
- Kiln need to rotate
- Laptop required

Application:
- Ovality Sensor attached to the kiln shell
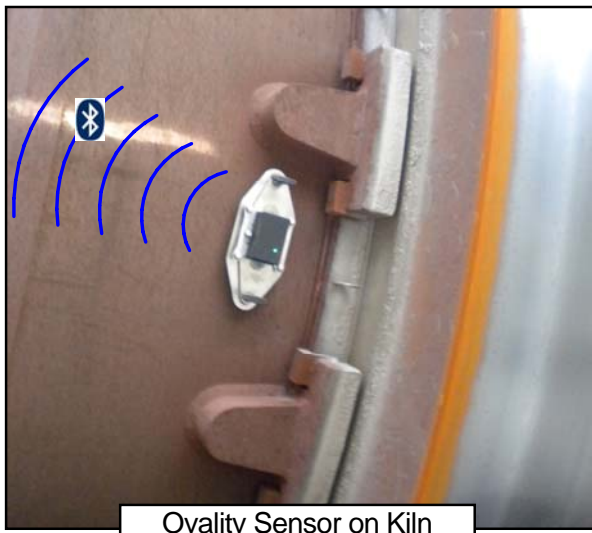
Ovality Sensor on Kiln

Ovality Sensor ready to measure

1.3   Tool Kit includes:

1. Ovality Sensor
2. Battery Charger with different plug adapters (100…240VAC)
3. Bluetooth USB Adapter (high range)
4. Tough transport case (Dimensions: 33.9 x 29.5 x 15.2 cm)
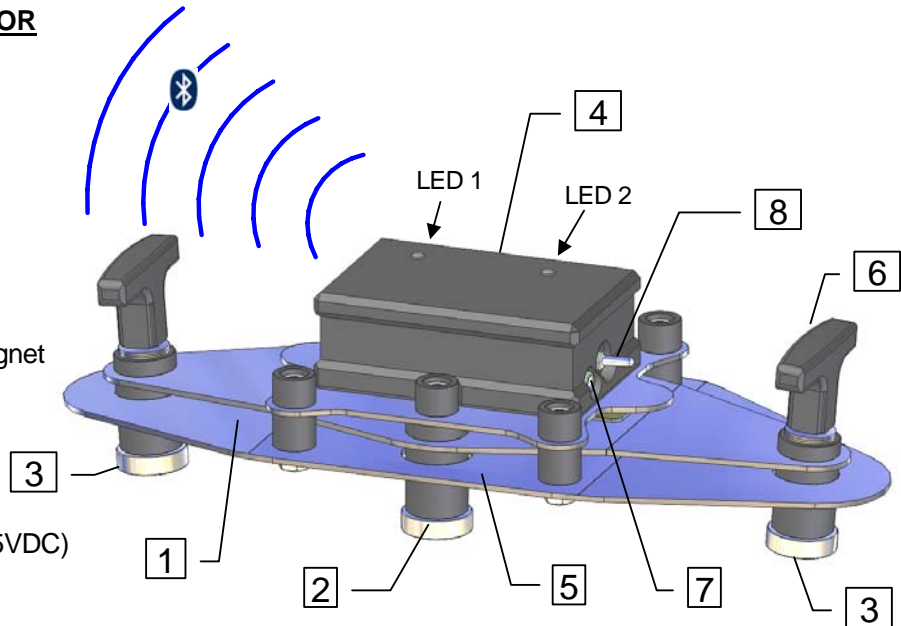5. Software (TomTom-Tools Measurement Studio)
6. Manual

2.   OVALITY SENSOR

2.1   Components:

Fig. 2.1.1

1. Deflection Plate
2. Fixed Magnet
3. Lateral Movable Magnet
4. Converter
5. Heat Shield
6. T-bar Handle
7. Charger Plug (8…25VDC)
8. Power Switch

2.2   Features:

The Ovality Sensor gets charged by the charger, which is included in the tool kit or by any power source from 8 to 25VDC (center pin positive).
Note: The sensors made before September 2010 have to be switched on for charging.
With the power switch 7, the tool can be switched on and off.
The light (LED 1) indicates the battery charging or if the tool is measuring as shown in the following table.

LED 1 (Battery Charger / Measurement)

Battery full	
Battery charging	
Measurement	

The light (LED2) indicates the condition of the Ovality Sensor.
A **constant green** light shows that the tool is switched on and is in normal operation.
Slowly yellow blinking indicates a **warning** as high temperature or low battery status. If the tool is connected to the PC, a warning window will appear on the screen as well. Ongoing Measurements can be completed without problems.
Fast red flashing shows an **alarm** as dangerous high temperature in the sensor or battery completely empty. In case of temperature alarm, the tool has to be removed immediately from the kiln to prevent damage. It creates also an alarm window on the PC screen.

LED 2 (Tool Condition)

OK	
Warning	
Alarm	

3.   SOFTWARE:

3.1   Bluetooth Adapter

To make sure, the data connection between the Ovality Sensor and the PC is reliable, even in the difficult environment around a rotary kiln, it is recommended to use the Bluetooth adapter (Parani UD100), which comes along with the Sensor.

Note:

- The TomTom-Tools are designed to communicate **only with Windows Bluetooth Stack**. If there is an other Bluetooth software installed (e.g. Toshiba, Widcomm), **deactivate it or uninstall it.**
- Then plug the Bluetooth adapter UD100. Windows will recognize the new hardware and automatically install the suitable Windows driver

3.2   Installation:

The software (**TomTom-Tools Measurement Studio**), which is used for the Ovality Sensor, comes along with the equipment on a CD. Nevertheless it is recommended to **install the software from www.tomtom-tools.com** , where always the latest version is available.

During any start of the Measurement Studio, it is checking for updates if the computer is connected to the internet. In case of available upgrades the user gets asked if they should be downloaded and installed.
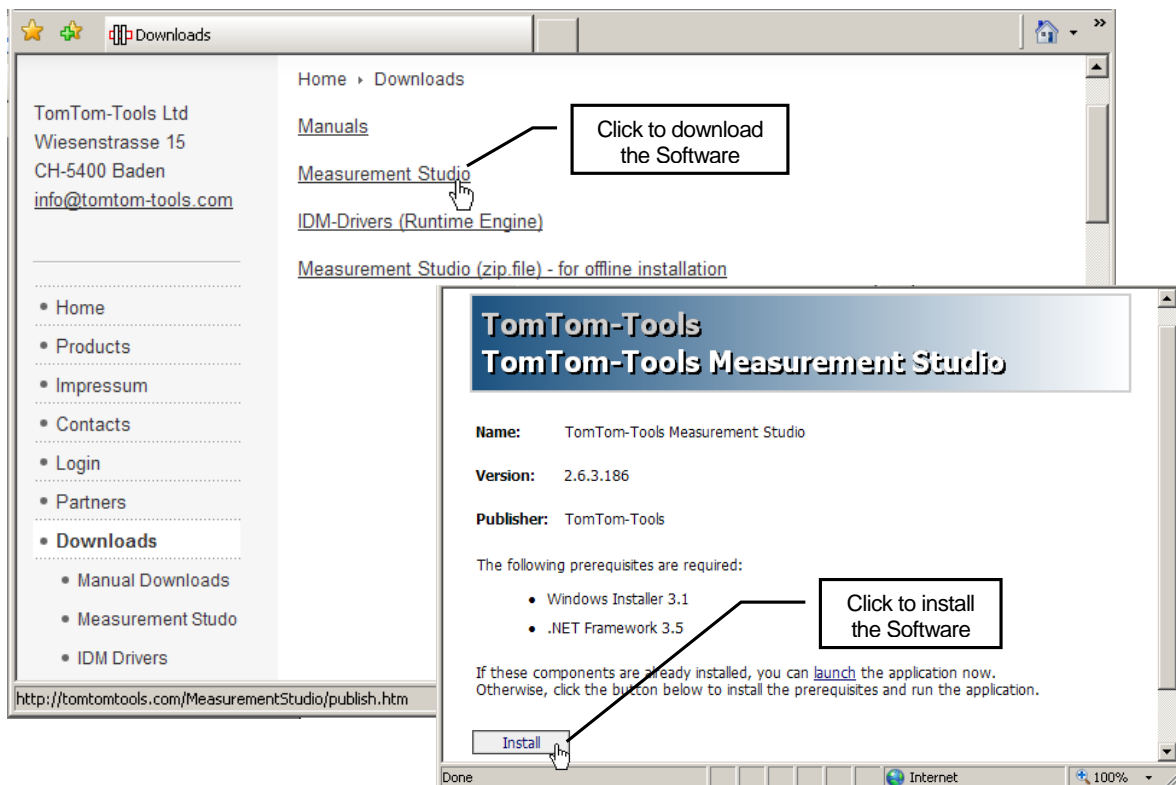
4.   START THE TOOL:

4.1   Connect Ovality Sensor with Laptop

After the software installation is completed, switch on the Ovality Sensor (LED2: green).
Whenever the Measurement Studio is started it will search for known devices; for TomTom-Tools.
If a TomTom-Tool is detected, it will be displayed in the "Overview" Window under devices.

Note: Depending on the search speed of the computer, it might take up to one minute.

Click onto the device, which has to be connected; (here the Ovality Sensor) and the device window
will open. After clicking the "connect" button, the Sensor gets connected, which will be indicated in
the Device List.

Fig. 4.1.1 (Device Window)
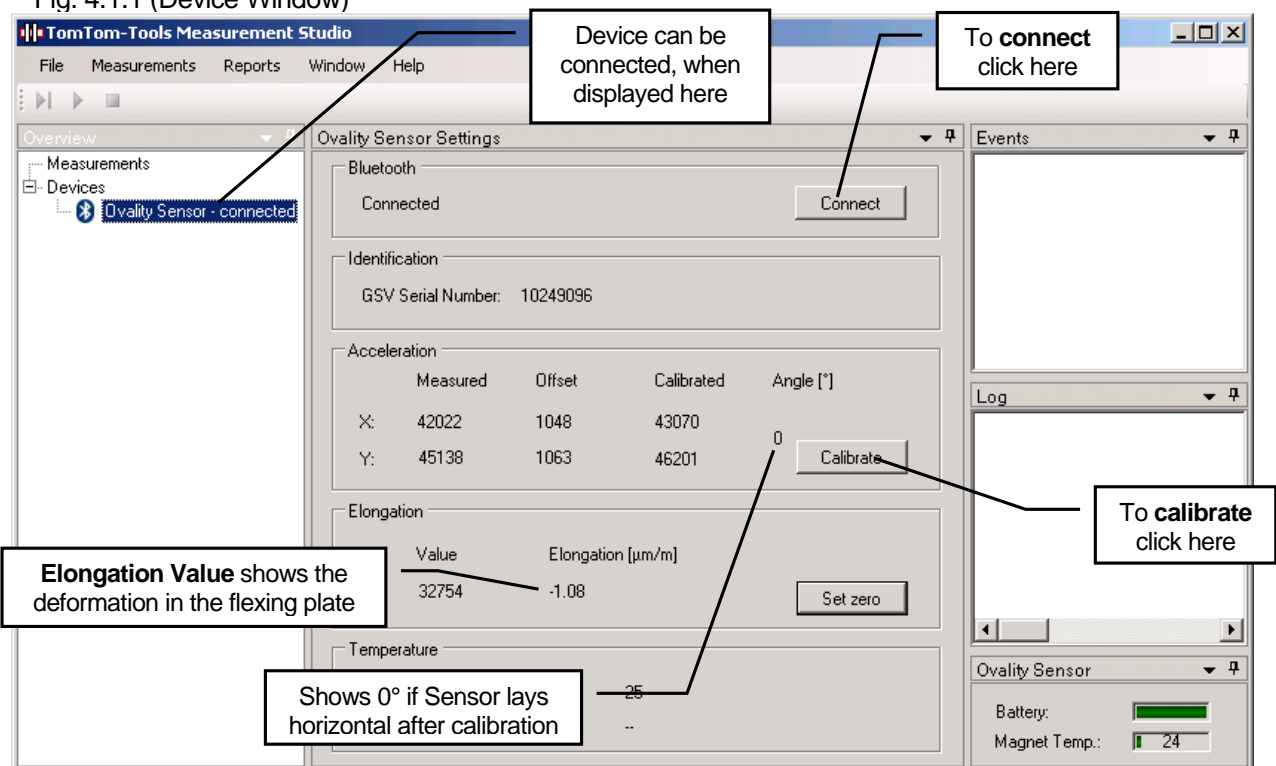
4.2   Flexing of the Deflection Plate

The main Sensors in the Ovalily Sensor are the strain gauges, which are attached to the Deflection
Plate (see Fig. 2.1.1). When the Deflection Plate gets deformed, it is shown as changes in the
elongation of its surface (see in Fig. 4.1.1). Out of this elongation value, the ovality will be
calculated.
Note: With this simple Test, it can be verified, if the flexing measurement is correctly taken:
- Hold the Ovality Sensor on the electronic box horizontal that the magnet look downwards
  (do not touch the magnets nor the handles) then click "Set zero"
- Turn the Ovality Sensor 180° that the magnets look upwards
  Due to the own weight of the magnets, the Deflection Plate gets slightly deformed and an
 Elongation of about 20…24 um should be displayed

4.3   Calibration of Integrated Orientation Sensor

When the Ovality Sensor is connected, it already transfers its orientation values and the deflection values from the deflection plate to the computer, which can be seen in the moving numbers in the Device Window.
Note: First the orientation sensor has to be calibrated. Push the button "calibrate" and the following sketch indicates to place the sensor on a horizontal surface (e.g. table, floor).

Fig. 4.2.1
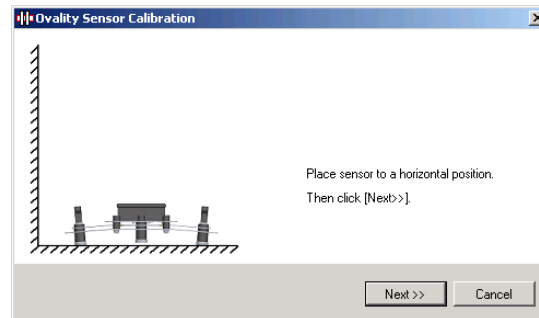
Push "next" and hold the sensor onto a vertical surface (e.g. wall), as shown in the next sketch.
Note: There is no high accuracy of the surfaces required. An error of 2° will not influence the accuracy of the sensor.

Fig. 4.2.1
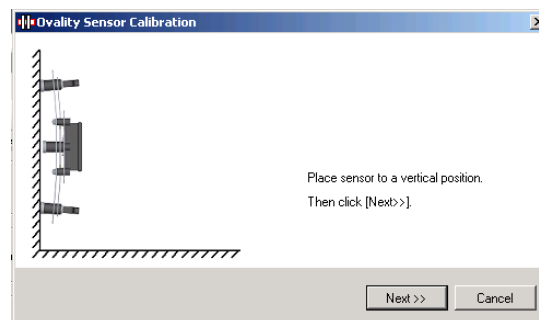
This calibration will be saved and remain in the registry of the computer. Hence the calibration has not to be done before each measurement. Nevertheless it is recommended to re-calibrate the sensor after a long period not in use.

A re-calibration is required when the tool is placed onto a horizontal surface and the angle value does not show values close to 0°, resp. hold onto a vertical surface and the value is not close to 90° or 270° (see Fig. 4.1.1)

5.   MEASUREMENTS

5.1   Set Up the Measurement Window

- To start a new measurement, click on "Measurement / New / Ovality" as shown in Fig. 5.1.1

Fig. 5.1.1
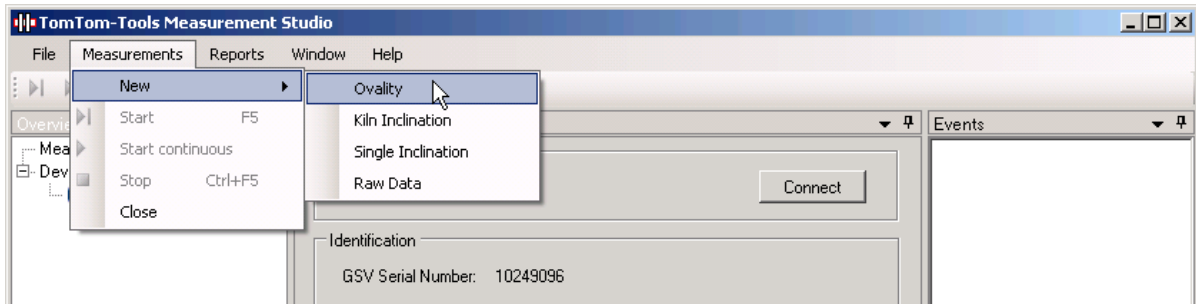
- The first pier will be displayed per default.
- More piers can be added by mouse right click to **"Add Pier"** as shown in Fig. 5.1.2
- Put some additional useful information about the measurement into the "Settings Window"

Fig. 5.1.2
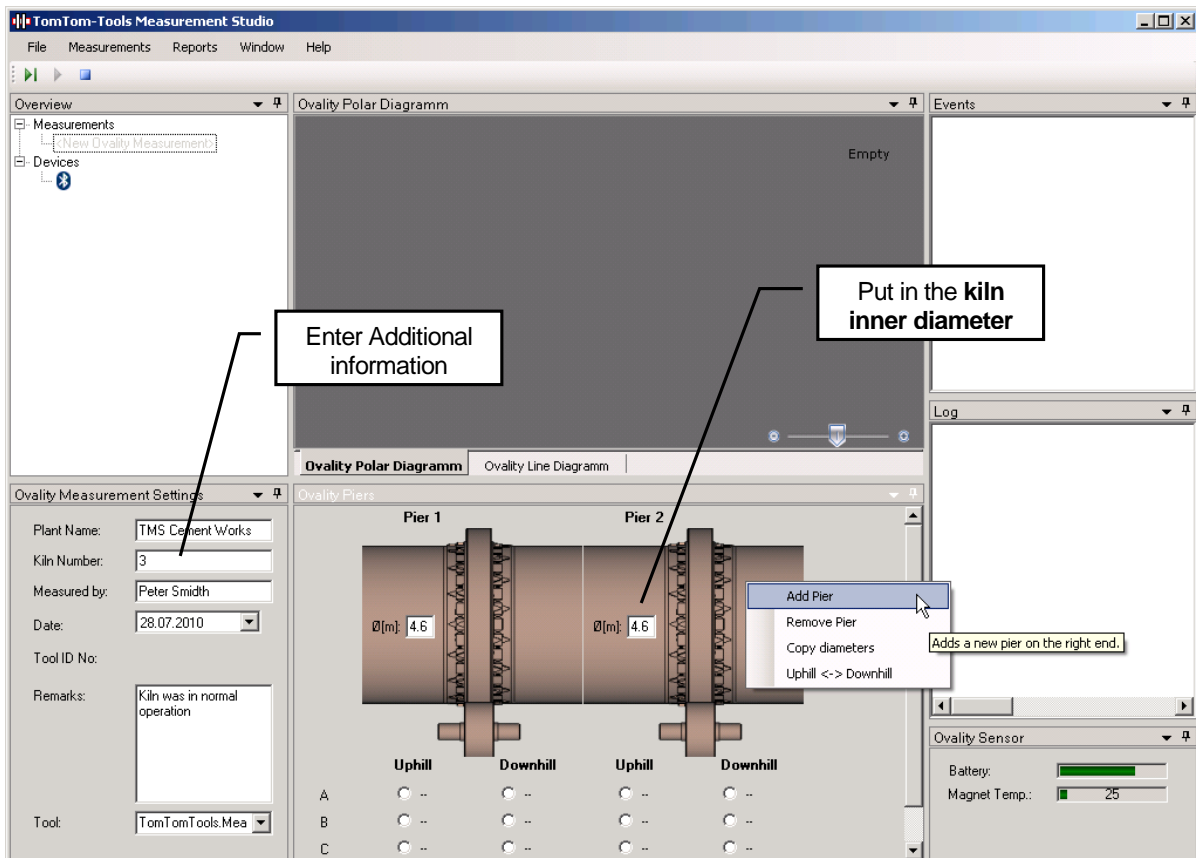
Note: the sense of numbering can be switched by right mouse click on **"uphill ⟵⟶ downhill"**

5.2   Place Tool on Kiln

- Preferable mark the measurement positions (A,B,C with 120° to each other) on both sides of each tire. Normally A is the zero or reference position around the circumference, which should be the same reference as for other type of measurements as well.
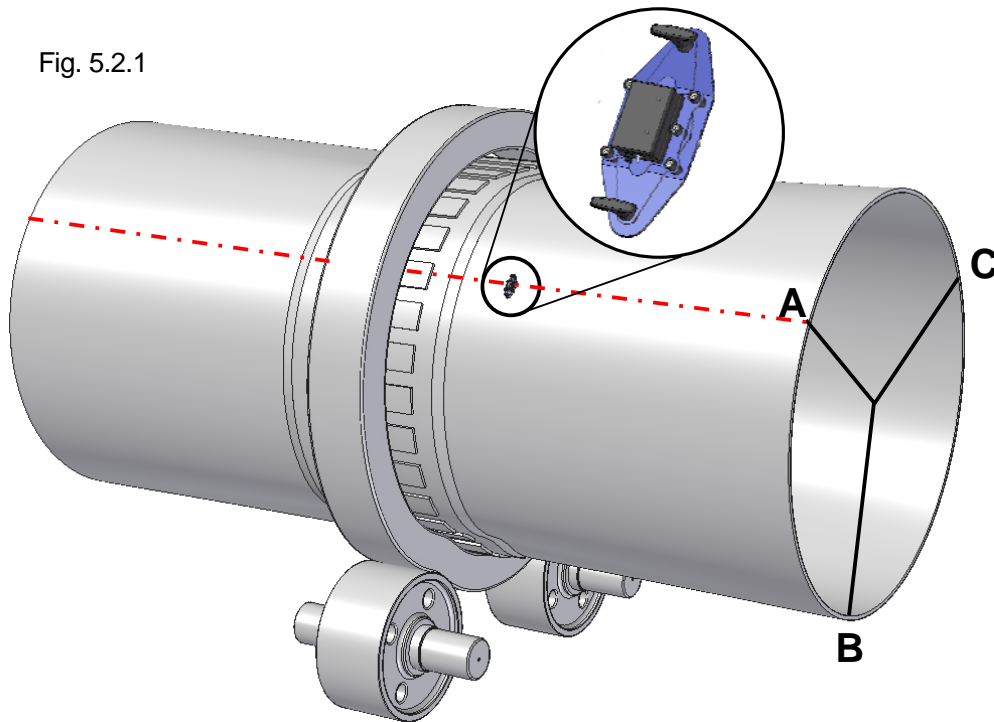 For example the manhole position or the split of the girth gear can be used for defining the position of point A.

- In order to get a sufficient hold of the tool, make sure the surface, where the sensor will be placed, is free of excessive corrosion and dust layers or debris and local deformations.

Fig. 5.2.1

Note: Due to the fact, that the ovality is most dominant under the tires, the measurements should not been taken too far away from them.
Distances within 1m…1.5m from the tires are ok and give normally negligible errors.
On the other hand, measuring close to stiff tire fixation blocks can have an impact on the ovality value.

- Place the Ovality Sensor during normal operation onto the kiln shell at the marked position. **Respect the local safety rules and see the chapter 1.1 Safety.**

- To start the measurement, select the position to measure in the kiln schematic and push the **start button** or **F5**   (see Fig. 5.2.2)

Start Button / F5

Double Click on a frame will enlarge the selected window

Mouse right click to change from line to point display

To **reset** the **window** layout
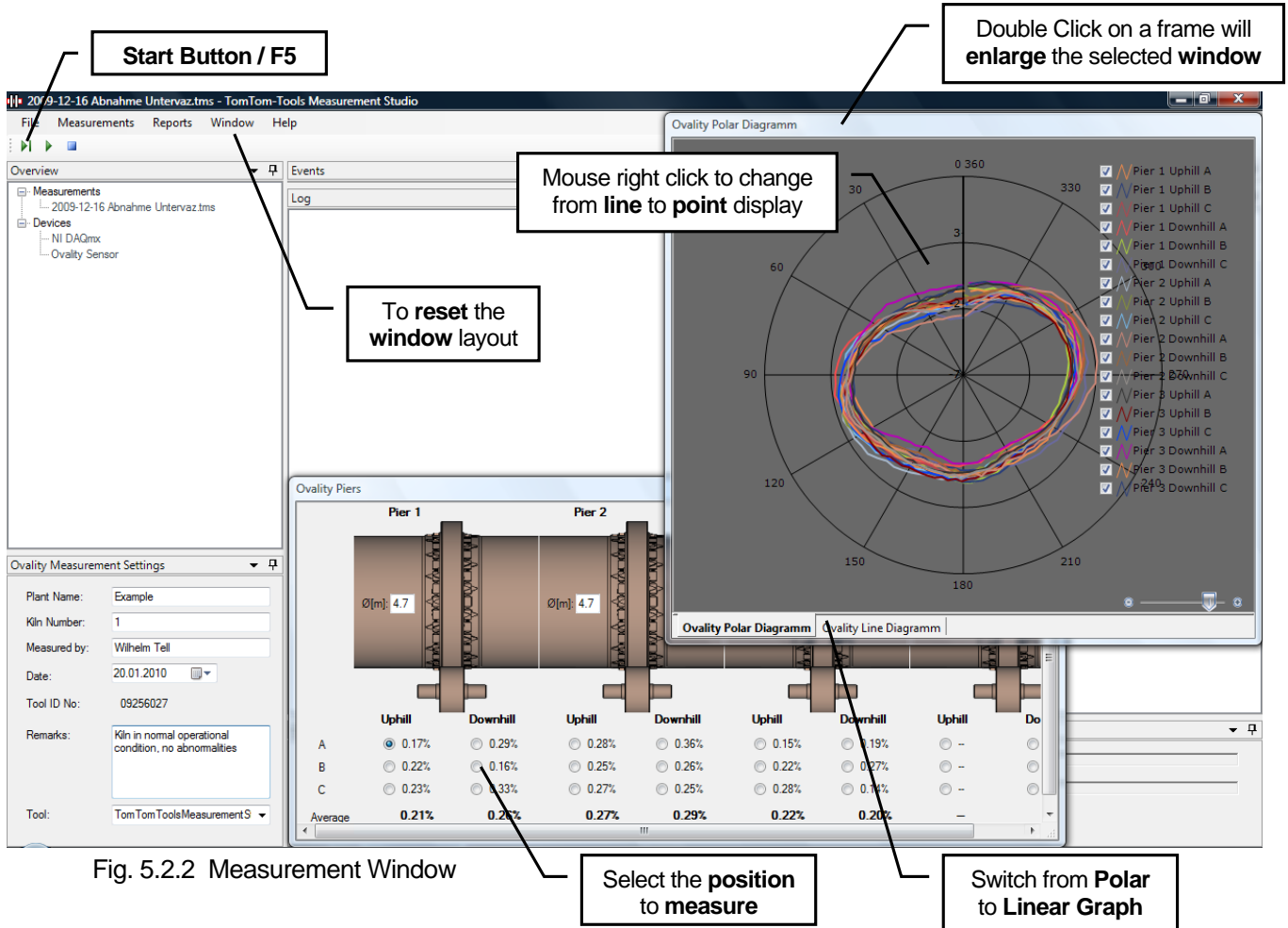
Fig. 5.2.2 Measurement Window

Select the **position** to **measure**

Switch from **Polar** to **Linear Graph**

- The measurement will be taken, after the tool reaches the top point. The measured points are displayed continuously until the tool reaches the second time the top point.
- **Remove the tool, when the measurement is taken. Do not let the instrument unnecessary attached to the hot kiln, it might overheat after a while**

5.3 Results

TomTom-Tools Ltd. does not provide guide lines about acceptable ovality values or limits.
It has to be discussed with the refractory suppliers, how much ovality can be allowed.
Out of experience the following table can be taken as an example but **might need to be adjusted to the specific case:**

Fig. 5.3.1

5.4   Temperature Resistance

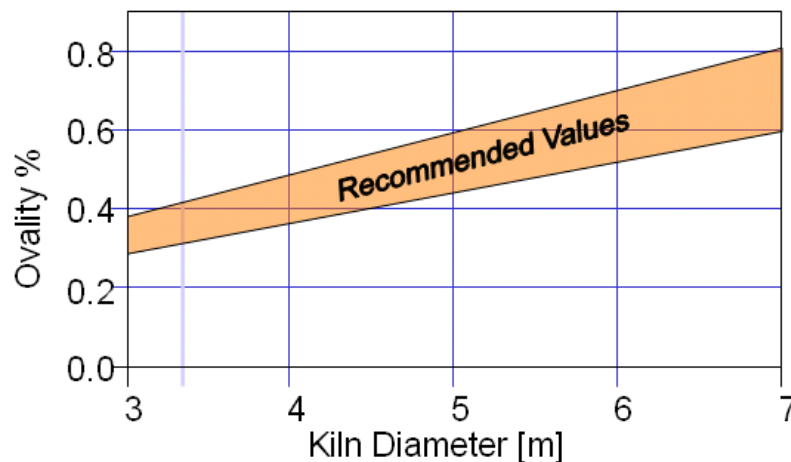The Ovality Sensor is made for hot applications; nevertheless it has to be kept as cool as possible to prevent damages. The magnets are heat resistant up to 330°C. The electronic board in the sensor is temperature resistant up to 65°C, therefore it is protected by the heat shield and by insulators. If the internal temperature reaches 60°C or the magnet temperature reaches 300°C, a warning will be given by the LED2 (yellow blinking) (see chapter 2.2). Also a pop up window in the Measurement Studio will indicate the increased temperature. The measurement still can be finished.
If the temperatures reach 65° in the electronic board or 330°C at the magnet, the tool will alarm you (LED2 red flashing and pop up window). In this case, the Ovality Sensor has to be removed from the kiln and cooled down as fast as possible.
To cool down the tool, let it cool on the fresh air or by a ventilator (e.g. kiln shell cooling fan), never use water.

- The temperature of one of the magnets and the battery status are measured and displayed in the right lower corner of the Measurement Studio

Fig 5.2.3

Ovality Sensor	▼ 📌
Battery:	�██████
Magnet Temp.:	**208**
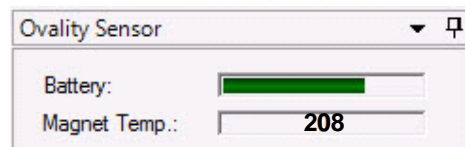
6.   REPORT

6.1   Export to Excel

All data can easily be exported to excel.

Fig.6.1.1

ıᴵᴵ•2010-07-28 Test.tms - TomTom-Tools Measurement Studio
File   Measurements   Reports   Window   Help
Open
Save
Save As…
Export to Excel…
Exit
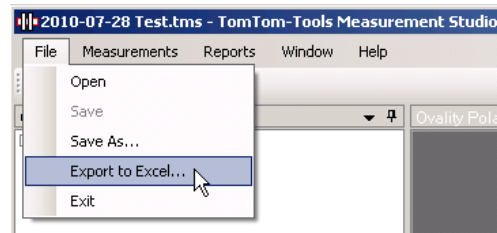
6.2   Create a report

The measurements can be extracted into a report. All additional information from "Setting Window" is included in the report as well.

Fig. 6.2.1

ıᴵᴵ•2010-07-28 Test.tms - TomTom-Tools Measurement Studio
File   Measurements   Reports   Window   Help
▶ı ▶ ■   Create
Overview   ▼ 📌
Measurements
2010-07-28 Test.tms   Create a report for the currently selected measurement.
Devices

TomTom-Tools Ltd   Switzerland   www.tomtom-tools.com   info@tomtom-tools.com
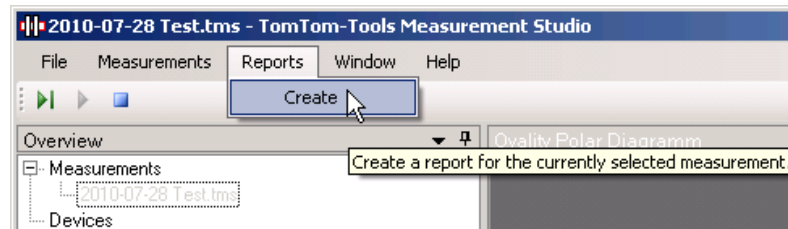
7.   ANNEX

7.1   Export to Excel

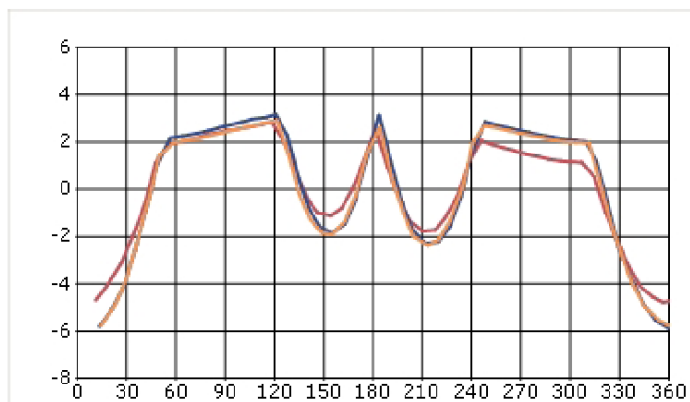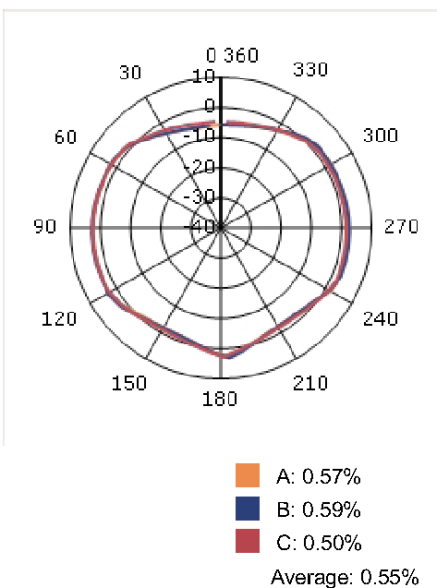| TomTom-Tools Measurement Studio											
Ovality Measurement - Pier 1 of 3											
Uphill A				Uphill B				Uphill C			
Angle [°]	Elongation	Temperature [°C]		Angle [°]	Elongation	Temperature [°C]		Angle [°]	Elongation	Temperature [°C]	
14	-4.96	24.93		13	-5.73	24.96		11	-4.09	24.96	
23	-4.16	24.93		21	-5.02	24.96		18	-3.47	24.96	
30	-3.00	24.93		29	-3.97	24.96		26	-2.56	24.96	
36	-1.51	24.93		35	-2.56	24.96		34	-1.37	24.99	
43	0.25	24.93		42	-0.84	24.96		42	0.06	24.96	
50	2.17	24.93		49	1.10	24.96		47	1.67	24.93	
59	2.70	24.93		56	2.19	24.96		55	2.44	24.96	
64	2.76	24.93		64	2.27	24.96		63	2.56	24.96	
73	2.84	24.93		72	2.36	24.96		71	2.67	24.96	
80	2.96	24.96		80	2.48	24.96		77	2.80	24.96	
87	3.07	24.93		86	2.60	24.96		84	2.91	24.96	
94	3.18	24.96		93	2.72	24.96		91	3.00	24.96	
101	3.28	24.93		100	2.83	24.96		99	3.08	24.96	
108	3.37	24.93		106	2.94	24.96		106	3.16	24.96	
114	3.47	24.93		115	3.02	24.96		112	3.26	24.96	
122	3.55	24.93		121	3.13	24.96		118	3.34	24.96	
128	2.12	24.93		128	2.25	24.96		126	2.43	24.96	
135	0.49	24.93		135	0.38	24.96		134	1.02	24.96	
141	-0.65	24.96		141	-0.92	24.96		140	0.06	24.96	
149	-1.26	24.96		148	-1.71	24.96		146	-0.52	24.96	
155	-1.31	24.93		155	-1.90	24.96		154	-0.65	24.96	
163	-0.76	24.93		163	-1.53	24.96		161	-0.33	24.96	
170	0.39	24.93		169	-0.50	24.96		167	0.49	24.96	
176	2.12	24.93		176	1.10	24.96		175	1.74	24.96	
184	3.16	24.93		184	3.04	24.96		181	3.07	24.96	
191	1.10	24.93		191	1.13	24.96		189	1.37	24.96	
199	-0.50	24.93		197	-0.66	24.96		196	0.01	24.96	
205	-1.48	24.93		204	-1.87	24.93		202	-0.92	24.96	
213	-1.87	24.93		212	-2.41	24.93		210	-1.35	24.96	
220	-1.64	24.93		220	-2.35	24.93		218	-1.31	24.96	
227	-0.84	24.93		227	-1.69	24.96		224	-0.81	24.96	
234	0.54	24.93		234	-0.44	24.93		232	0.14	24.96	
241	2.44	24.93		240	1.35	24.96		238	1.48	24.96	
248	3.15	24.93		248	2.70	24.96		246	2.44	24.96	
256	3.04	24.93		255	2.57	24.96		252	2.27	24.96	
263	2.91	24.93		262	2.44	24.96		260	2.12	24.96	
269	2.80	24.93		268	2.33	24.96		266	1.99	24.96	
276	2.68	24.93		275	2.22	24.96		273	1.85	24.96	
283	2.59	24.93		282	2.11	24.96		281	1.74	24.96	
289	2.48	24.93		289	2.01	24.96		287	1.63	24.96	
296	2.40	24.93		296	1.91	24.96		294	1.55	24.96	
304	2.35	24.93		303	1.85	24.96		301	1.50	24.96	
311	2.32	24.93		309	1.80	24.96		307	1.48	24.96	
317	0.95	24.93		316	0.99	24.99		315	0.83	24.96	
324	-0.87	24.93		323	-0.99	24.96		321	-0.65	24.96	
331	-2.48	24.93		329	-2.70	24.96		329	-1.93	24.96	
338	-3.74	24.93		338	-4.09	24.96		336	-2.99	24.96	
345	-4.69	24.93		345	-5.12	24.96		342	-3.77	24.96	
354	-5.25	24.93		352	-5.79	24.96		350	-4.27	24.96	
0	-5.49	24.93		359	-6.11	24.96		357	-4.49	24.96	
				7	-6.06	24.96		4	-4.41	24.96	

7.2   Ovality Report
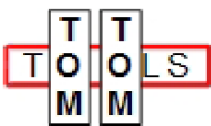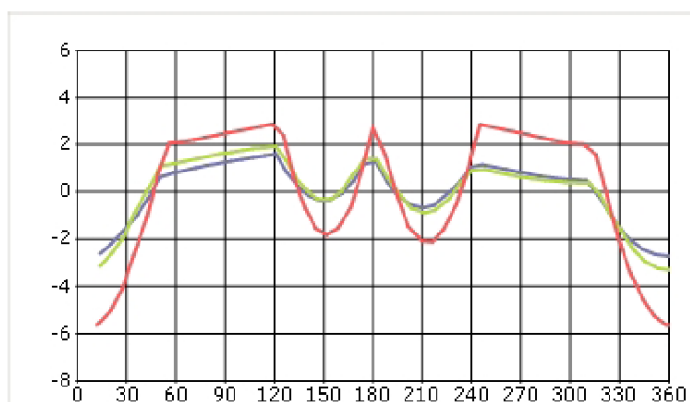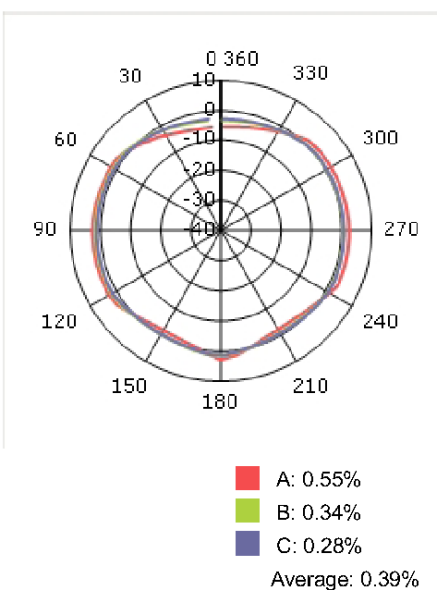
TomTom-Tools
Measurement Studio
Version 2.4.3.131
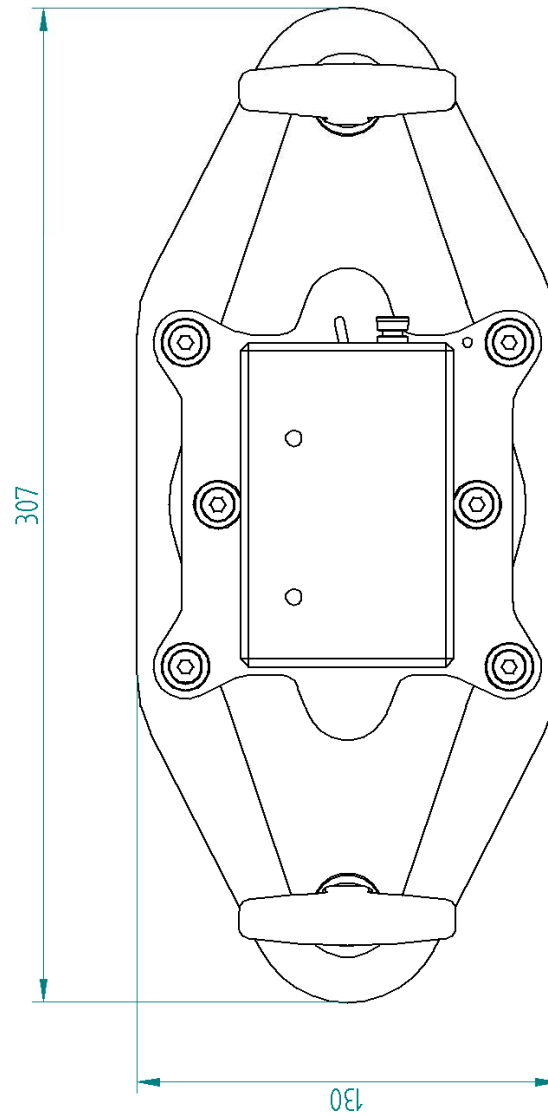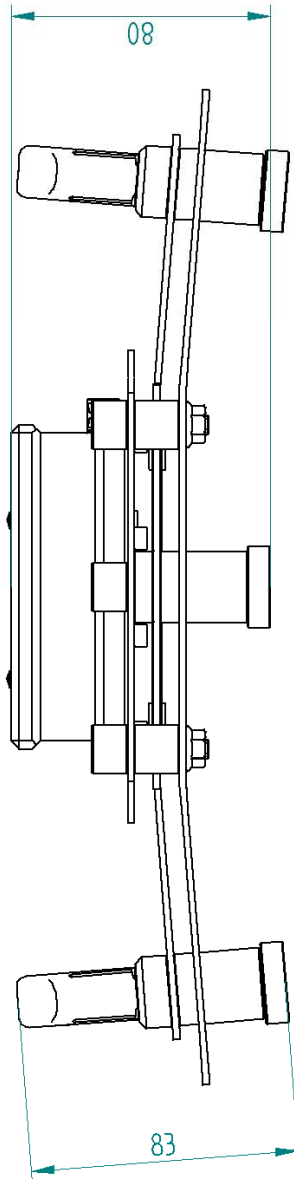
TomTom-Tools Ltd
Switzerland

Pier 1 Uphill

A: 0.57%
B: 0.59%
C: 0.50%
Average: 0.55%

Pier 1 Downhill

A: 0.55%
B: 0.34%
C: 0.28%
Average: 0.39%

7.3   **Drawing**

80

83

307

130
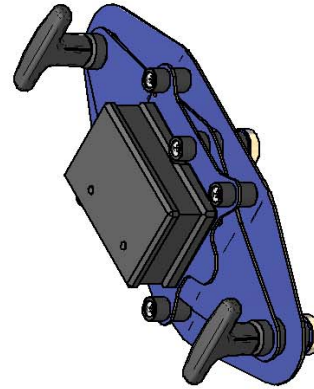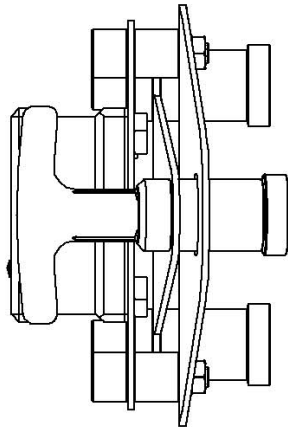
Ovality Sensor
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