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User Manual:

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 equipment 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 GmbH have proven their functionality in various applications; nevertheless TomTom-Tools GmbH does not take any responsibility for the application on site regarding safety. The user 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 condition and safety requirements.

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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 the measurement, the magnets might be very hot.

Use the T-handles for holding 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.



Magnetic 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:

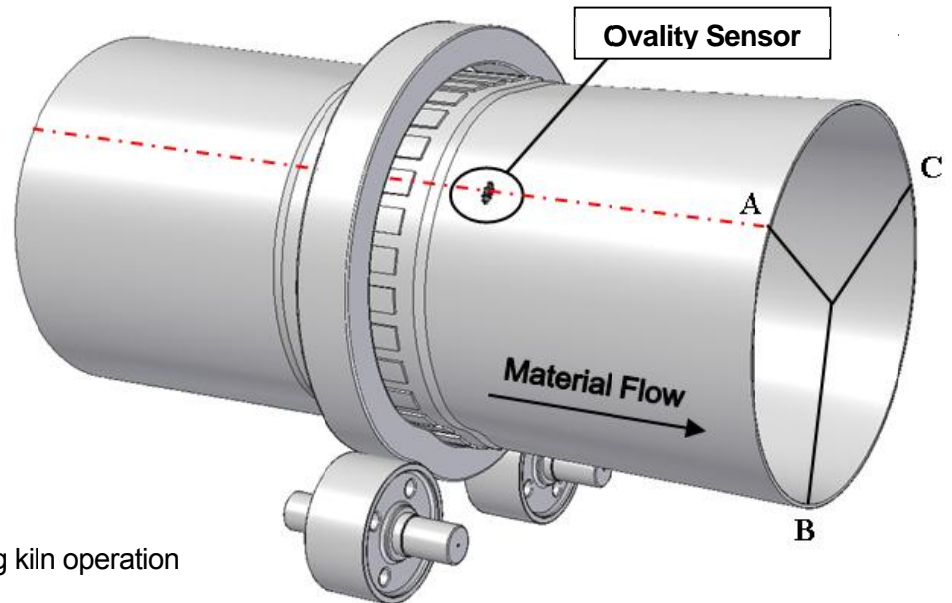
Be aware of the radio waves (Bluetooth) which are emitted from the tool as well from the Bluetooth adapter on the computer.

Do not keep the tool unnecessary in operation; switch it off, after usage.

1.2 Measuring Principle:

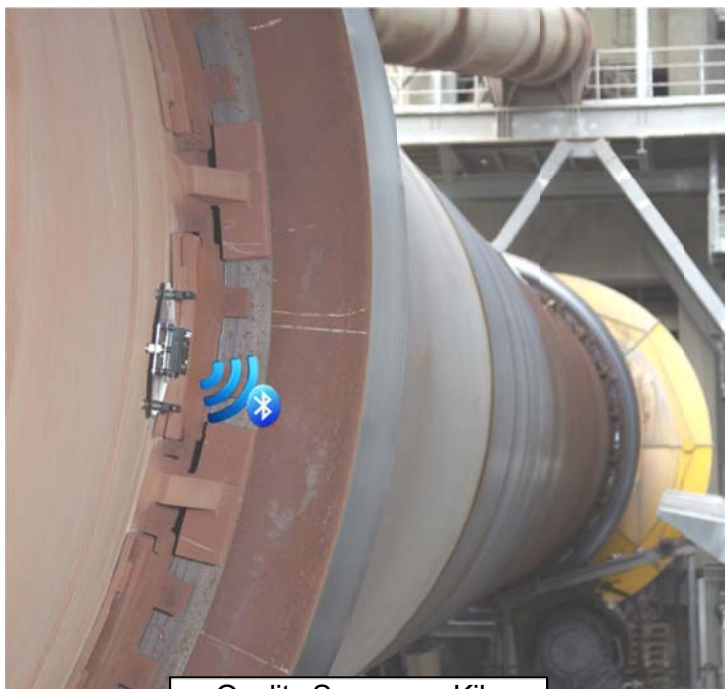
The Ovality Sensor consists of a Deflection Plate, which will be attached with heat resistant magnets to the kiln shell close to a tire. Due to the strong magnetic connection, the deflection in the Deflection Plate follows the deflection of the kiln shell below. Strain gauges are measuring the deflection 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.

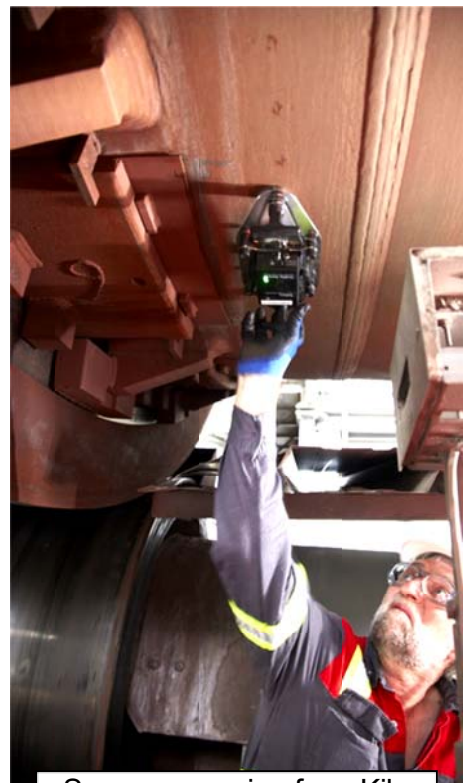


Advantages

- Measurement during kiln 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



Ovality Sensor on Kiln



Sensor removing from Kiln

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) on USB Flash Drive
6. Manual

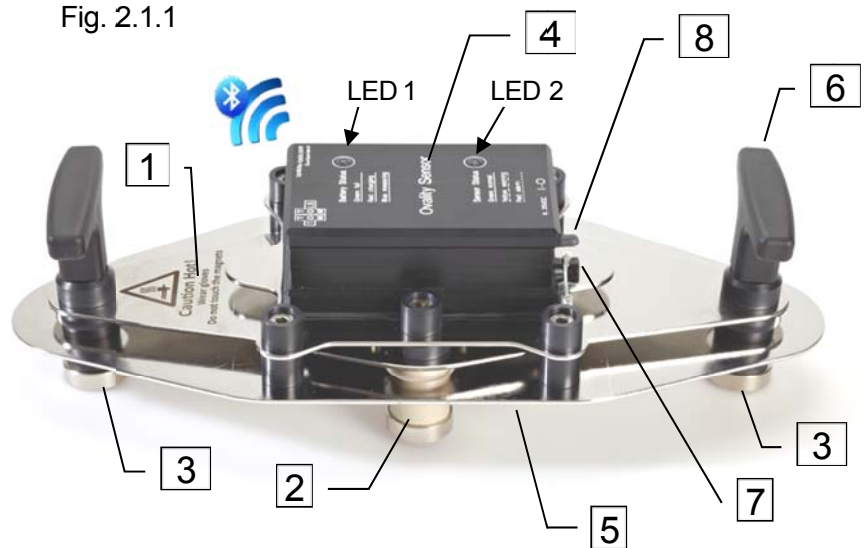


2. OVALITY SENSOR

2.1 Components:

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

Fig. 2.1.1



2.2 Features:




The Ovality Sensor gets charged by the charger, which is included in the tool kit or by any power source from 9 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 ensure, 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 another 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 (Windows generic Bluetooth)



3.2 Software Installation:

The software (**TomTom-Tools Measurement Studio**), which is used for the Ovality Sensor, comes along with the equipment on a USB Memory Stick. 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.

The image is a composite showing the website and its installation process. The top part is a banner for 'TomTom-Tools' with the tagline 'Measurement tools for the cement industry'. Below this is the website's navigation menu and a 'Downloads' section. In the 'Downloads' section, there are links for 'Manuals', 'Measurement Studio' (highlighted with a blue box and a callout box saying 'Click to download the Software'), 'Example-3 Animation-File', and 'IDM-Drivers 9.8 (for Measurement Studio up to version 3.5)'. The bottom part of the image shows a screenshot of the 'TomTom-Tools Measurement Studio Setup' window. The window title is 'TomTom-Tools Measurement Studio Setup'. It features the TomTom-Tools logo and the text 'TomTom-Tools Measurement Studio'. At the bottom of the window are three buttons: 'Options', 'Install' (highlighted with a callout box saying 'Click to install the Software'), and 'Close'.

4. START THE TOOL:

4.1 Connect Ovality Sensor with Laptop

When the software installation is completed, it starts automatically.
To connect a tool for the first time it has to be paired with the computer.
To do so, follow this sequence:

- Switch on the Ovality Sensor (green LED).
- Click on “Tools / Bluetooth Devices / Add a device”
- Wait until the tool got found
Note: Depending on the search speed of the computer, it might take up to one minute.
- Select the device, which has to be connected; (here the Ovality Sensor) and click “OK”

Fig. 4.1.1
(Add Device)

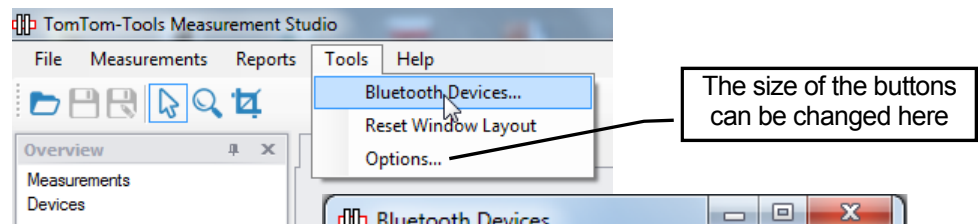
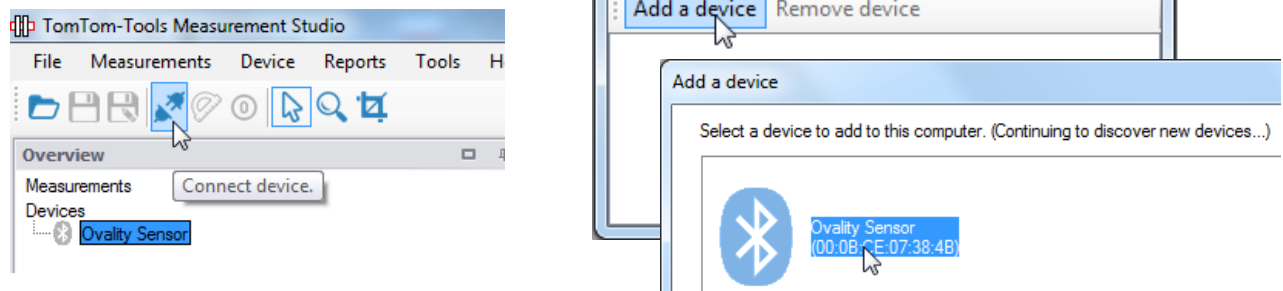
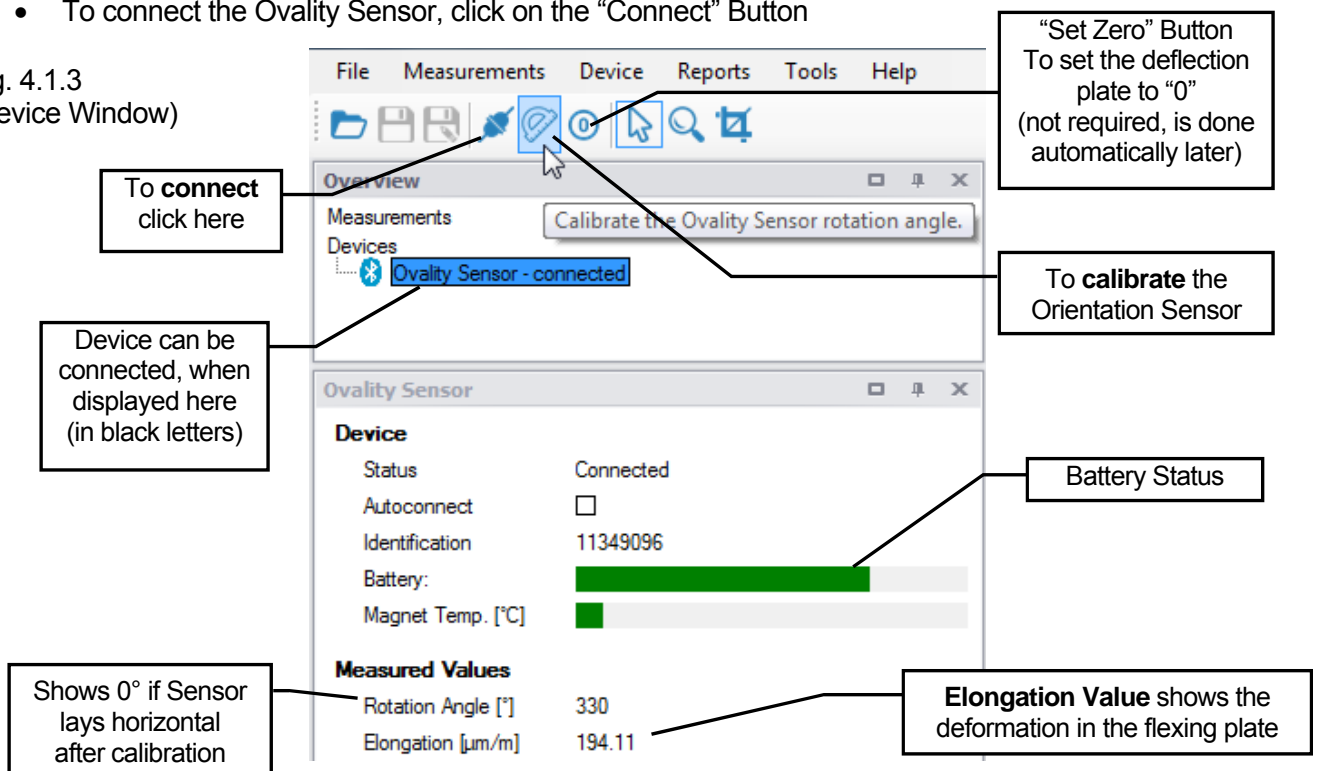


Fig. 4.1.2
(Connect Device)



- The Ovality Sensor gets added to the Device List
- To connect the Ovality Sensor, click on the “Connect” Button

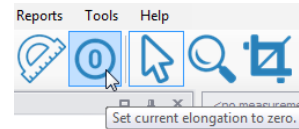
Fig. 4.1.3
(Device Window)



4.2 Signal from the Deflection Plate

The main Sensors in the Ovality 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 a simple test, it can be verified, if the flexing measurement is working correctly:

- Hold the Ovality Sensor on the electronic box horizontally that the magnets look downwards (do not touch the magnets nor the handles) then click the “Set Zero” Button.
- 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 25...28 um should be displayed

4.3 Calibration of Integrated Orientation Sensor

When the Ovality Sensor is connected, it constantly 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).

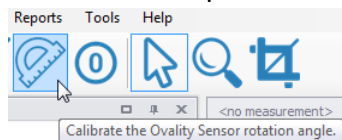
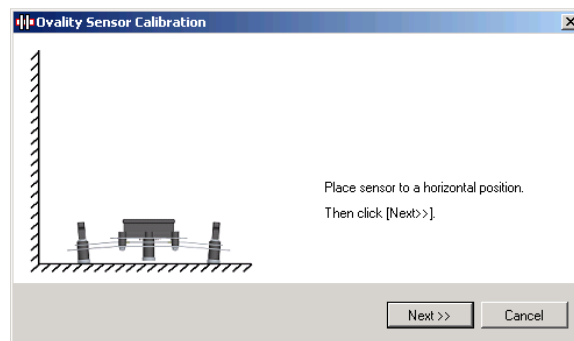


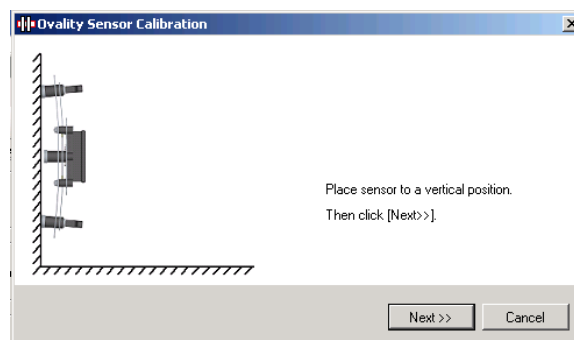
Fig. 4.2.1



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



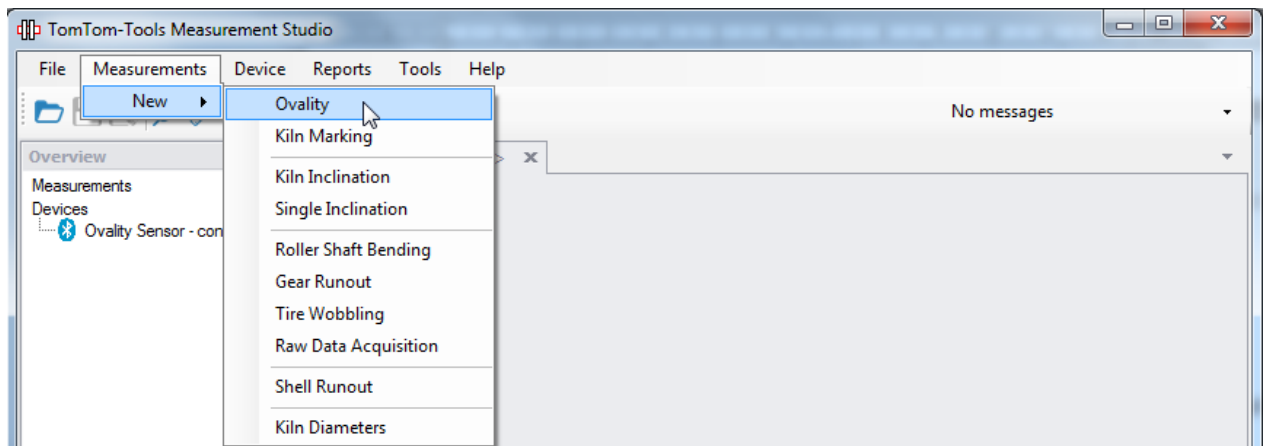
This calibration will be saved and remain in the registry of the computer. Hence the calibration has not to be done before each measurement. Nevertheless it is recommended to re-calibrate the sensor after a long period not in use.

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

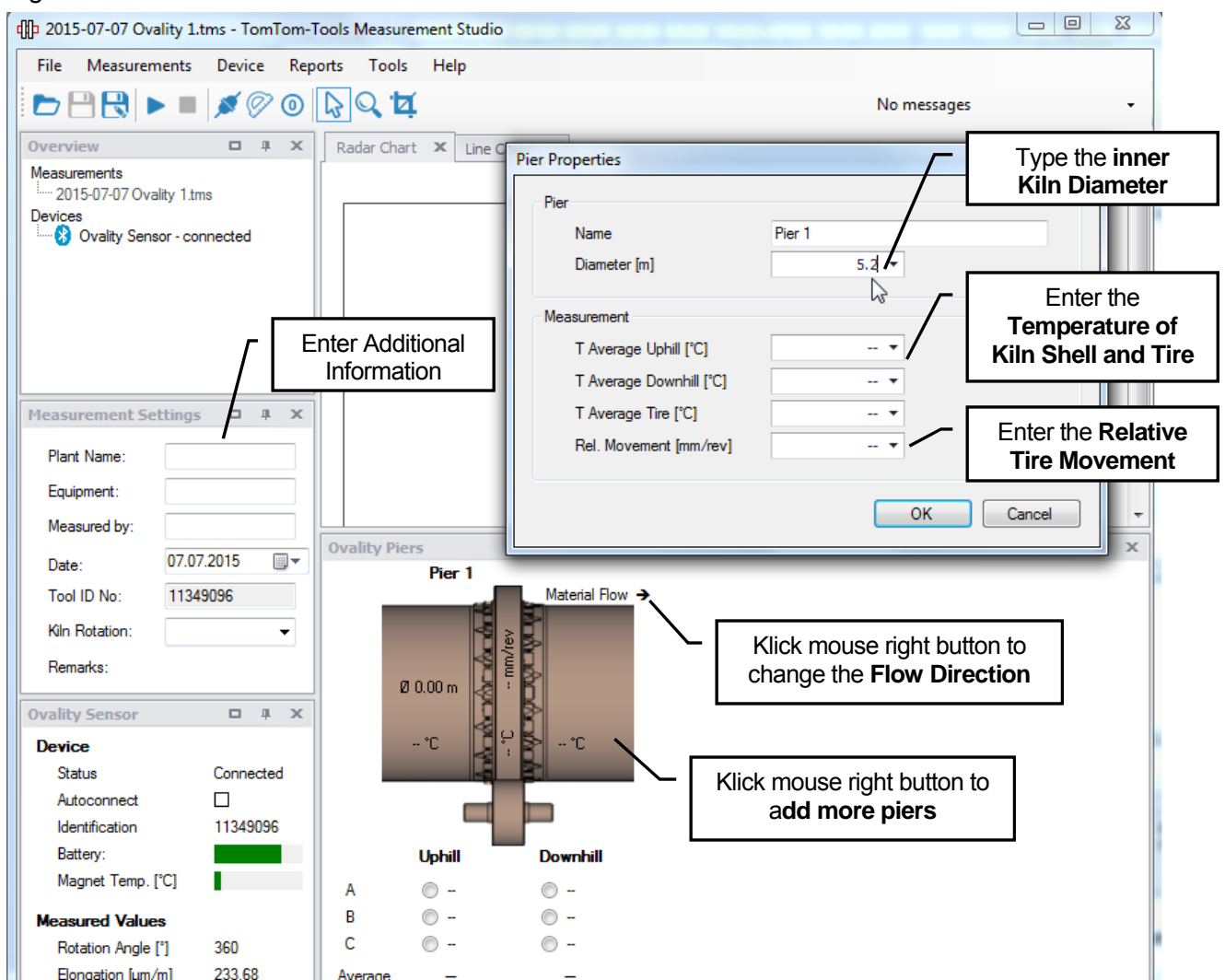
5.1 Set Up the Measurement Window

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



- b. The first pier will be displayed per default.
 c. More piers can be added by mouse right click to “Add Pier”
 d. Put some additional useful information about the measurement into the “Settings Window”

Fig. 5.1.2



5.2 Marking the Kiln Shell

Preferable the kiln shell is marked permanently to make repetitive measurement campaign efficient. Mark the measurement positions (A,B,C with 120° to each other) on both sides of each tire.

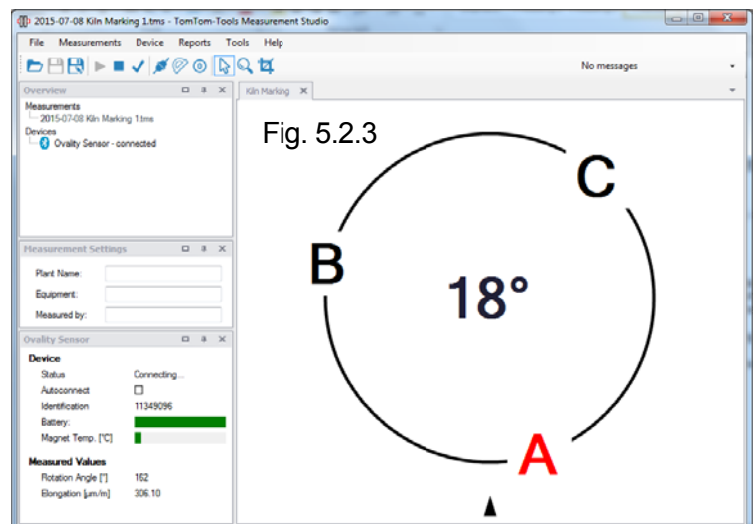
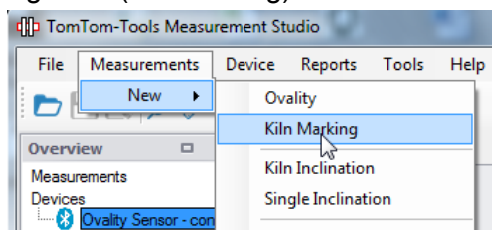
Normally A is the zero or reference position around the circumference, which should be the same reference as for other type of measurements as well.

For example the manhole position or the split of the girth gear can be used for defining the position of point A.

If there is no permanent making and it has to be done during kiln operation, the Measurement Studio gives the possibility to do that easily.

- Look for an area with low temperature, to avoid overheating of the Ovality Sensor
- Place the Ovality Sensor on the kiln shell, in line with the reference point (e.g. man hole)
- Click on Measurement / New / Kiln Marking
- The points to mark are shown in the graph and get highlighted when they reach the six o'clock position
- Mark the kiln shell with a chalk stick with the corresponding letter A, B, and C

Fig.5.2.2 (Kiln Marking)



5.3 Place Tool on Kiln

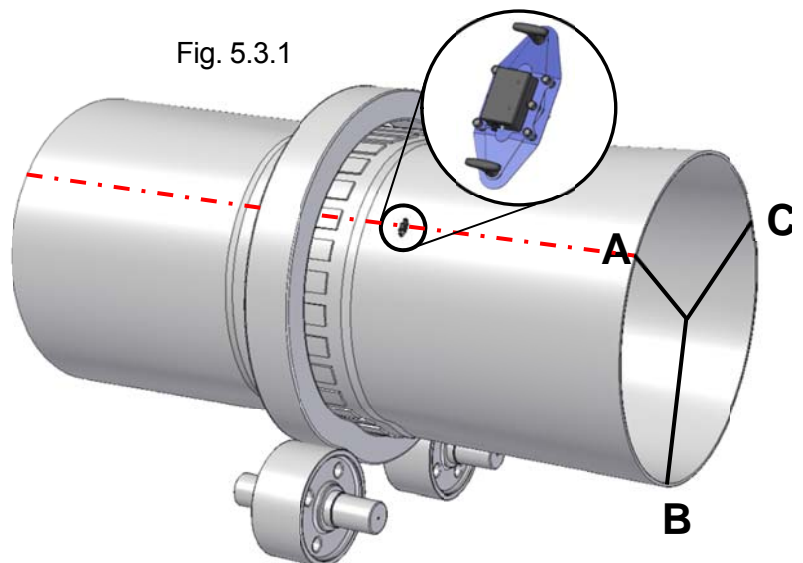
In order to get a sufficient hold of the tool, make sure the surface, where the sensor will be placed, is free of excessive corrosion and dust layers or debris and local deformations

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.

Fig. 5.3.1



- 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. 5.3.2)

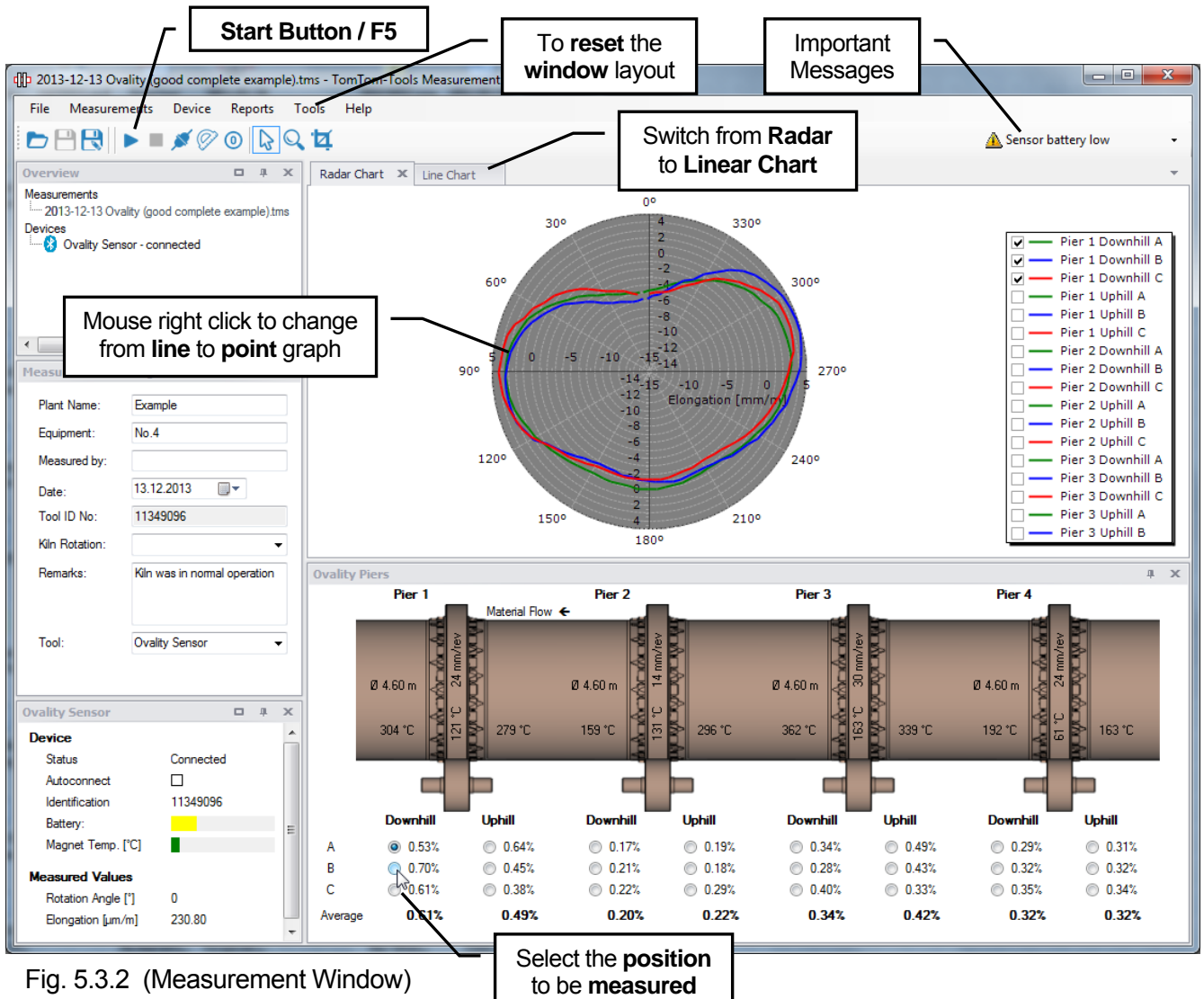
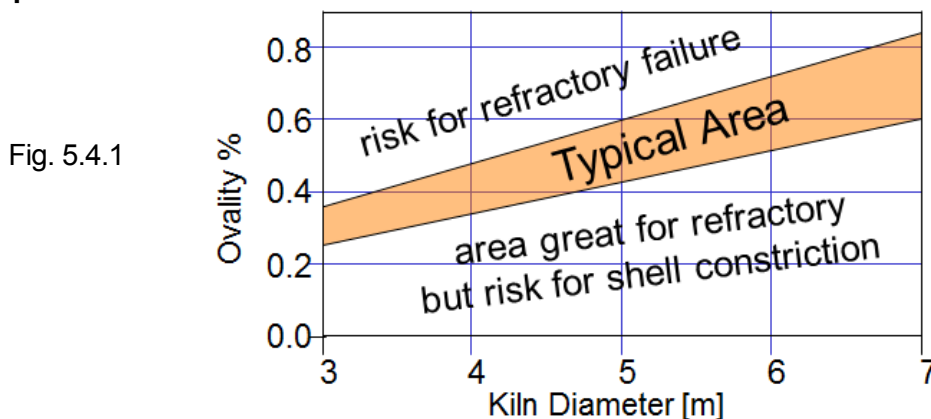


Fig. 5.3.2 (Measurement Window)

- g. 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.
- h. **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**

5.4 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:**



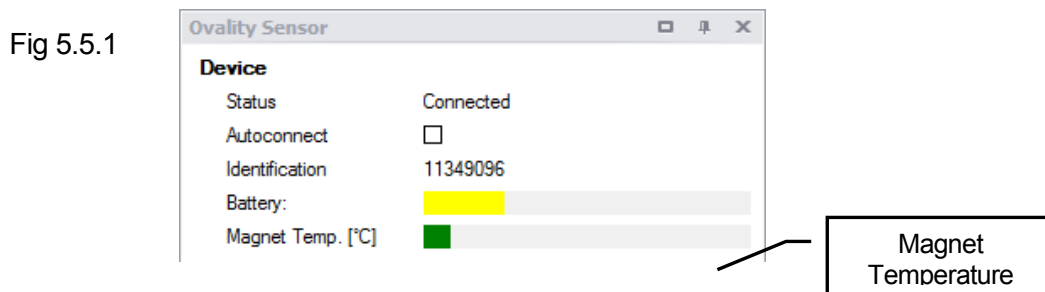
5.5 Temperature Resistance

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

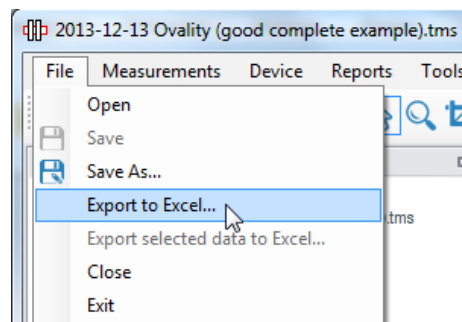


6. REPORT

6.1 Export to Excel

All data can easily be exported to excel.

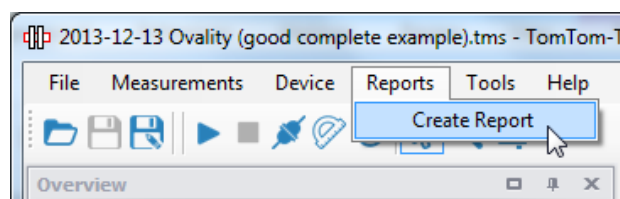
Fig.6.1.1



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



7. **ANNEX**

7.1 **Typical Graphs**

a. Low ovality:

Normal flattening on top
Moderate and symmetrical deflection
at contact with support rollers

b. High ovality:

Strong flattening on top
↳ Indication for high relative movement
↳ Tire shimming seems to be required

High, symmetrical deflection at contact with support rollers

b1.) In case A,B,C have similar shapes

↳ indication for possible overload due to vertical misalignment of kiln axis

B2.) In case A,B,C have very different ovality and roller contact

↳ indication for cyclic overload due to crank in kiln shell
↳ need verification by roller shaft bending measurement with IDM Tool Kit

c. Asymmetric roller load:

↳ Kiln axis is not aligned in horizontal direction

d. Tilted top area:

↳ particles and scuffing between tire inner diameter and the tire plates

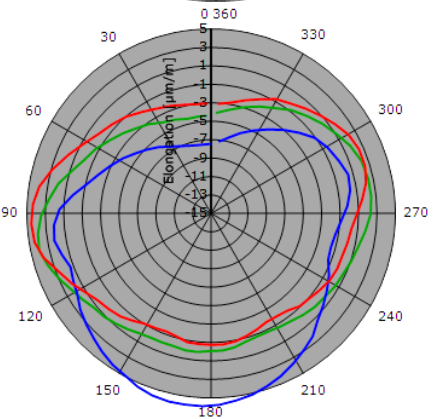
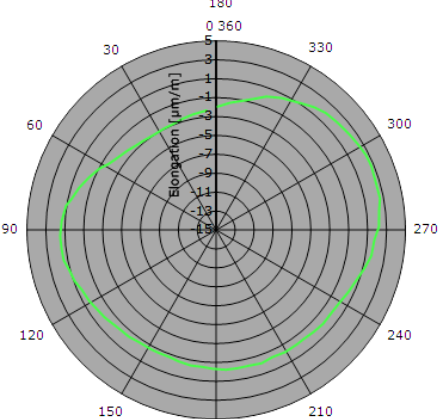
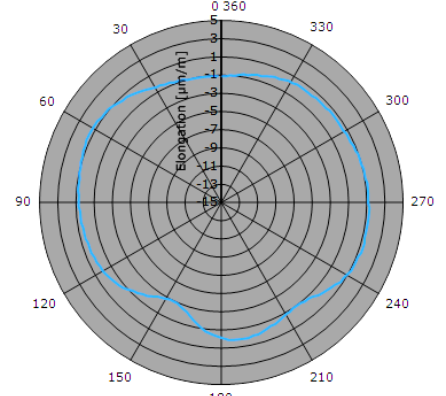
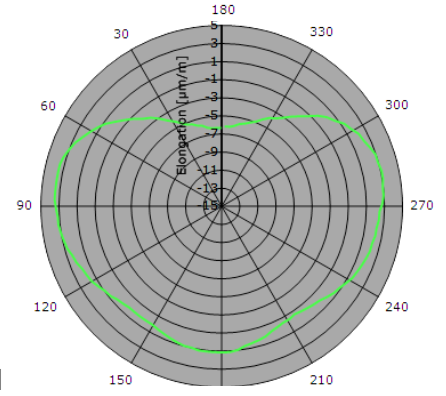
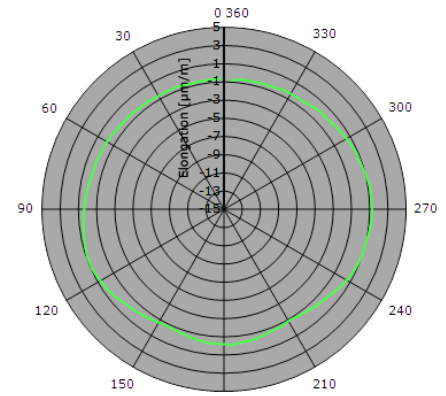
e. Inconsistent readings :

↳ In the blue reading, one of the middle magnets lost the contact to the kiln shell.
↳ clean the magnets and repeat measurement

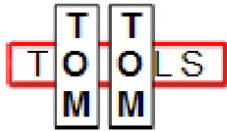
Note:

Jumps in the graph might also be indications for insufficient hold of the magnets.

Make sure, the magnets are clean and there is not excessive dust or corrosion on the kiln shell



7.2 Ovality Report

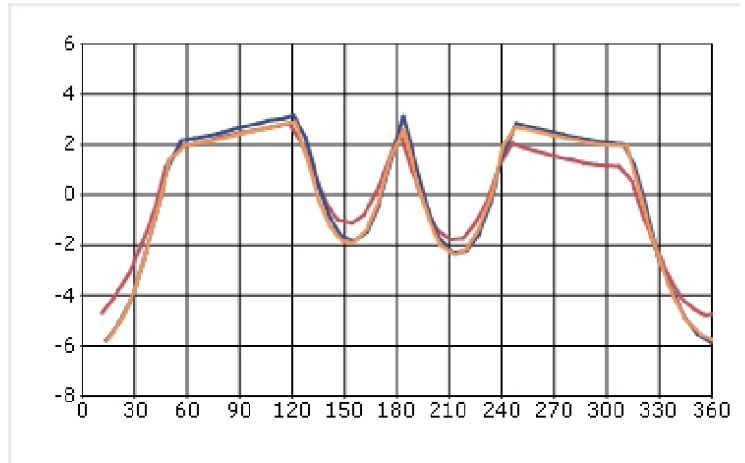
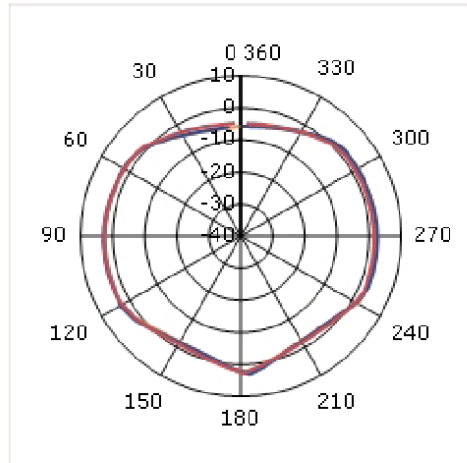


TomTom-Tools Measurement Studio

TomTom-Tools Ltd
Switzerland

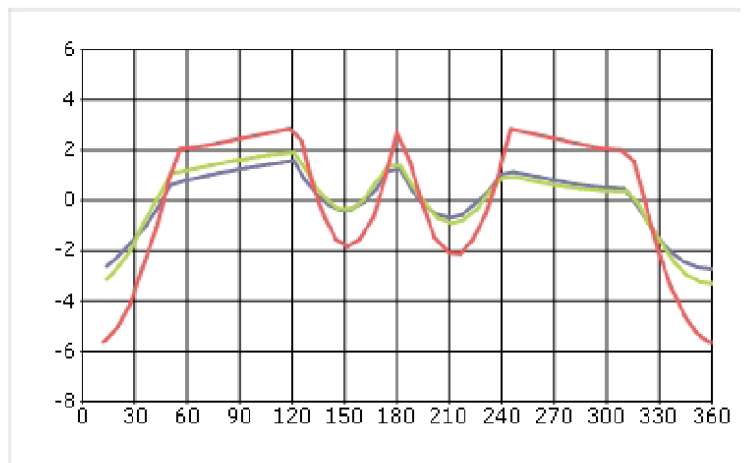
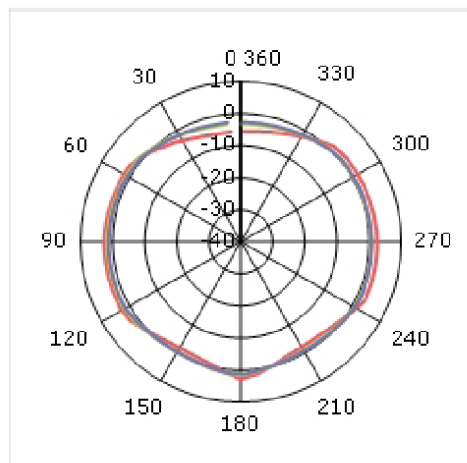
Version 2.4.3.131

Pier 1 Uphill



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

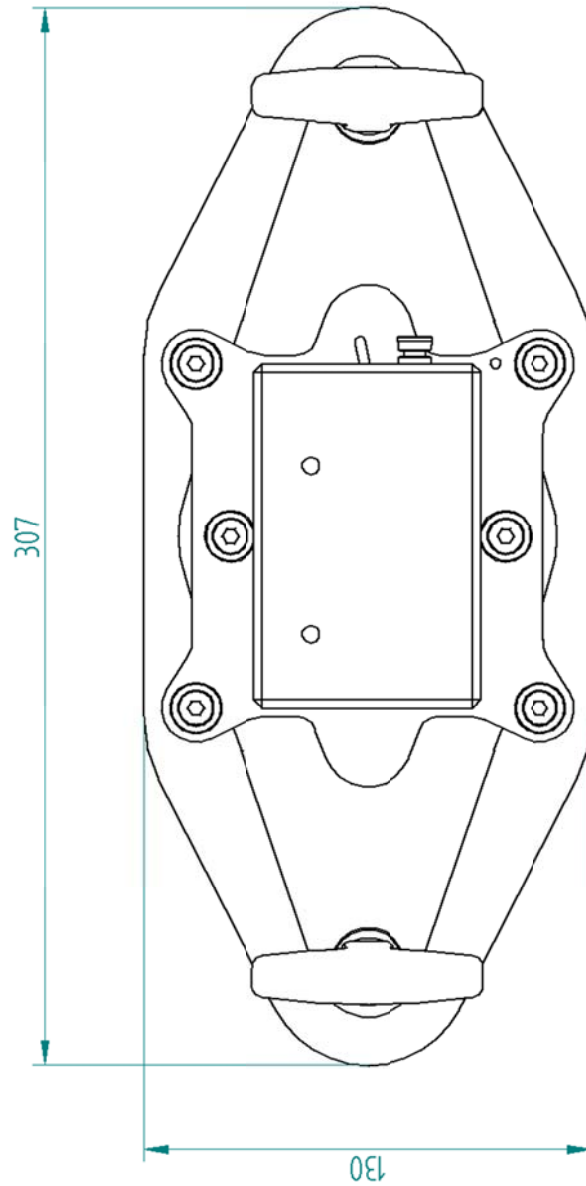
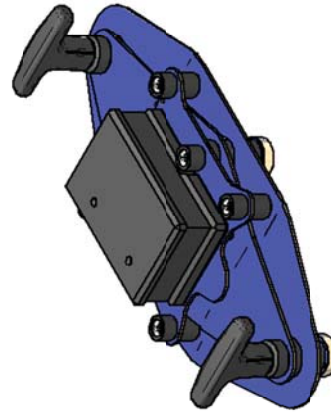
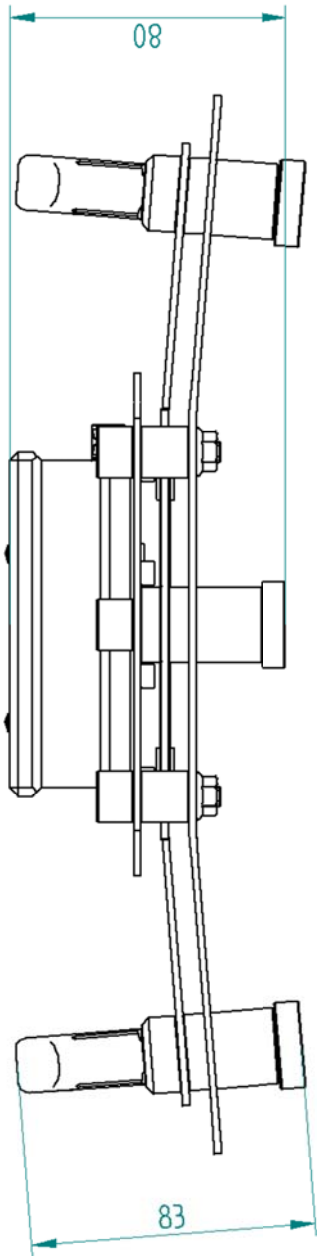
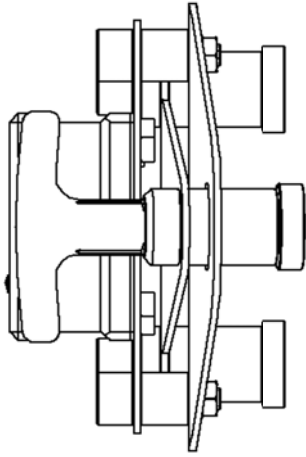
Pier 1 Downhill



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

7.3

Drawing



Quality Sensor
TomTom-Tools Ltd
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www.TomTom-Tools.com

