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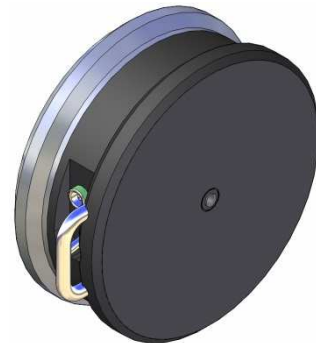
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User Manual:

Rotary Inclinometer III



1. INTRODUCTION:

The Rotary Inclinometer is a measurement tool, which measures the axle inclinations of slow rotating parts during operation (e.g. Rotary Kilns, Dryers, Ball Mills in barring mode). It measures deviations in vertical direction with a high accuracy, which makes the alignment work much easier.

It can be considered as a water level for slow rotating parts.

Typical applications:

- Kiln Tires and Girth Gears max.: 8 rpm
- Kiln Support Rollers max.: 15 rpm (side face of roller body)
- Kiln Support Rollers or pinions max.: 30 rpm (in center)

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 Rotary Inclinometer, 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 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.

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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 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.



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.

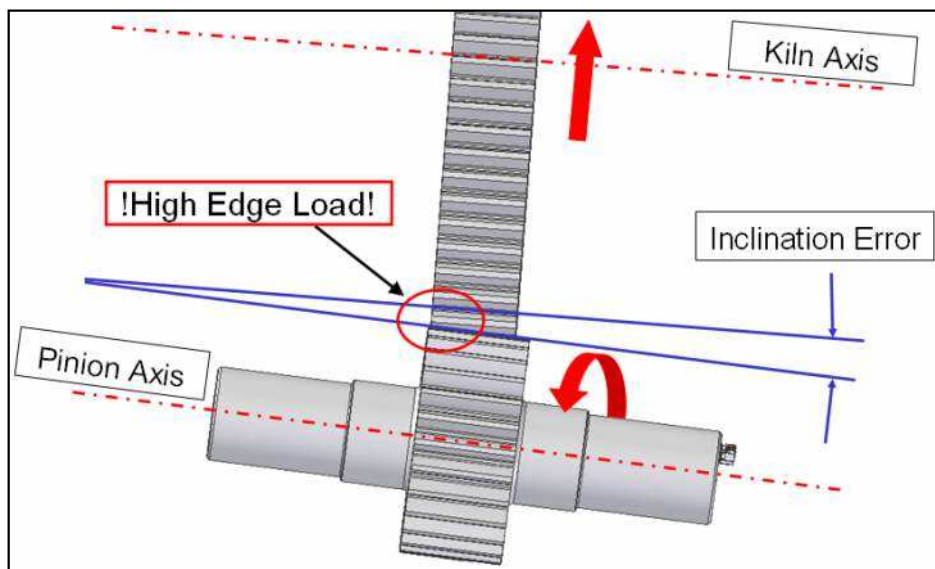
1.2 Measuring Principle:

The Inclinometer has to be attached on an axial surface of the rotating part, whose axle inclination needs to be measured (e.g. Girth Gear, Pinion, Kiln Tire, Kiln Roller...). A high accurate inclination sensor, which is integrated in the Inclinometer, sends continuously values about its angle in respect to the gravity via Bluetooth[®] connection to a Laptop PC.

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 Inclinometer.

The high number of relative inclination values, which are taken during one or more revolutions, appear as a wave curve on the screen. The software fits a sine curve into the graph of the measured values and calculates the mean value of the angle. The inclination of the axis is equivalent to the fitted mean value of all these points. The result is calculated and displayed continuously during the measurement.

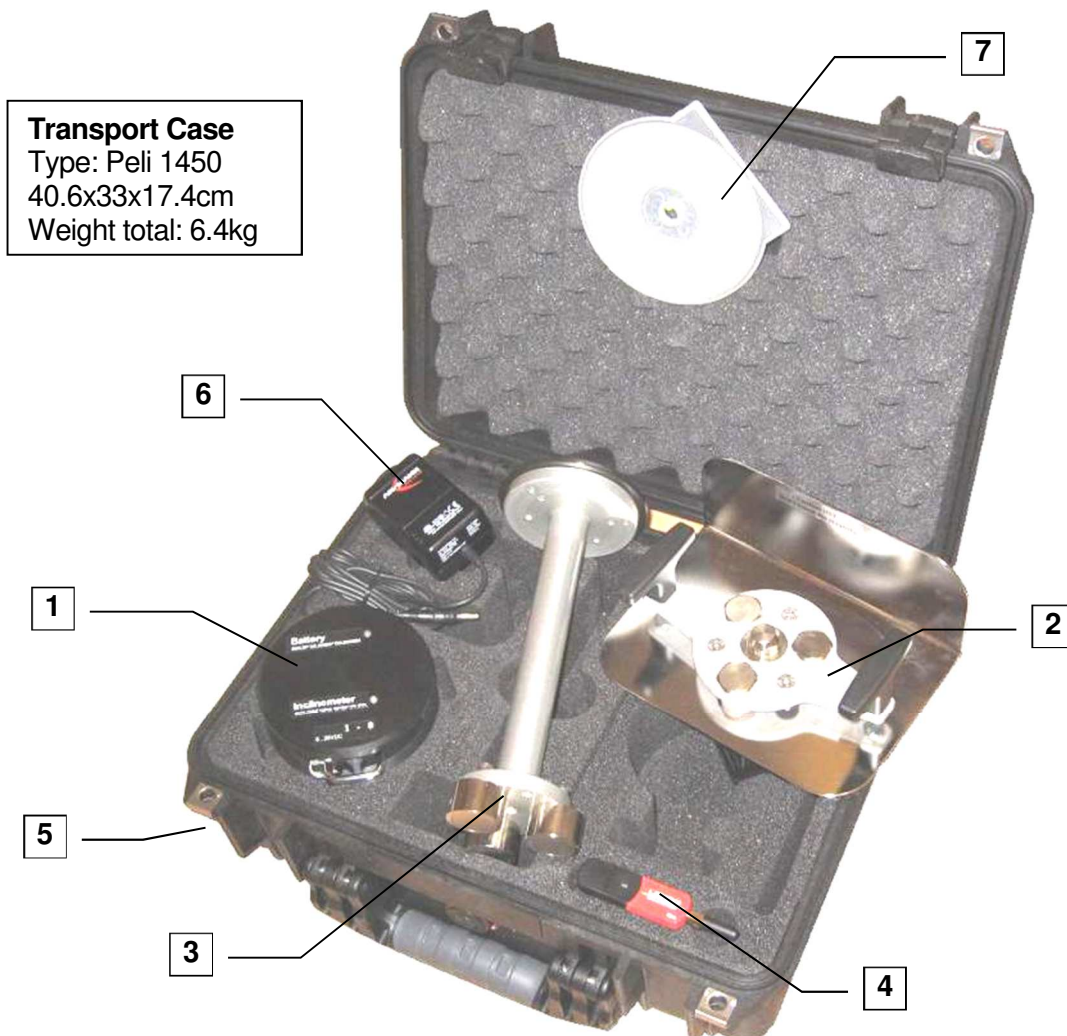
Example: Different inclinations on Girth Gear and Pinion results in high edge load on tooth. This problem can easily be detected by the Rotary Inclinometer



1.3 Tool Kit includes:

The Rotary Inclinometer is coming as a tool kit in a strong and tight transport case, which includes the following items:

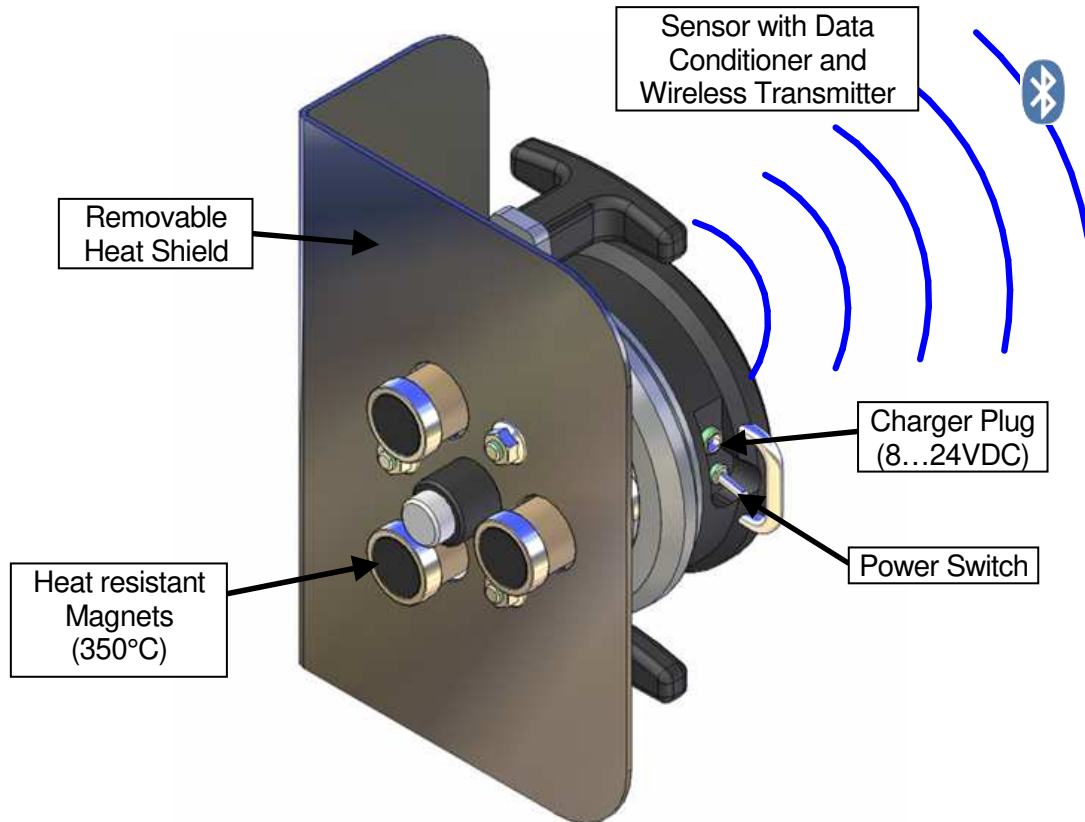
1. **Rotary Inclinometer**
Sensor with Bluetooth Transmitter and Data Conditioner
Range: $\pm 10^\circ$ @ 360° Accuracy: $< 0.3\text{mm/m}$ ($< 0.03\%$)
2. **Heat Shield**
With heat resistant magnets (300°C) and shock absorber
3. **Shaft Center Adapter**
To reach into bearing housings
4. High Range **Bluetooth Adapter** for USB
5. **Transport Case** with foam cushioning
extra tough, water and dust seal (suitable for air cargo, Dimensions: $40.6 \times 33 \times 17.4 \text{ cm}$)
6. **Battery Charger** (Input: 90-264VAC)
Incl. Adapter for EUR, US, AUS, J
7. **Manual** and **Software** for Windows (in lid)
TomTom-Tools Measurement Studio:



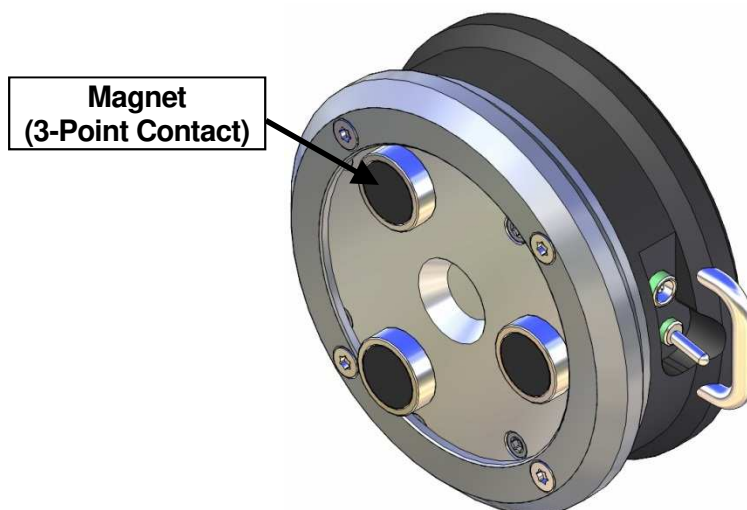
2. **THE SENSOR**

2.1 **Components:**

Rotary Incliner (with heat shield attached):



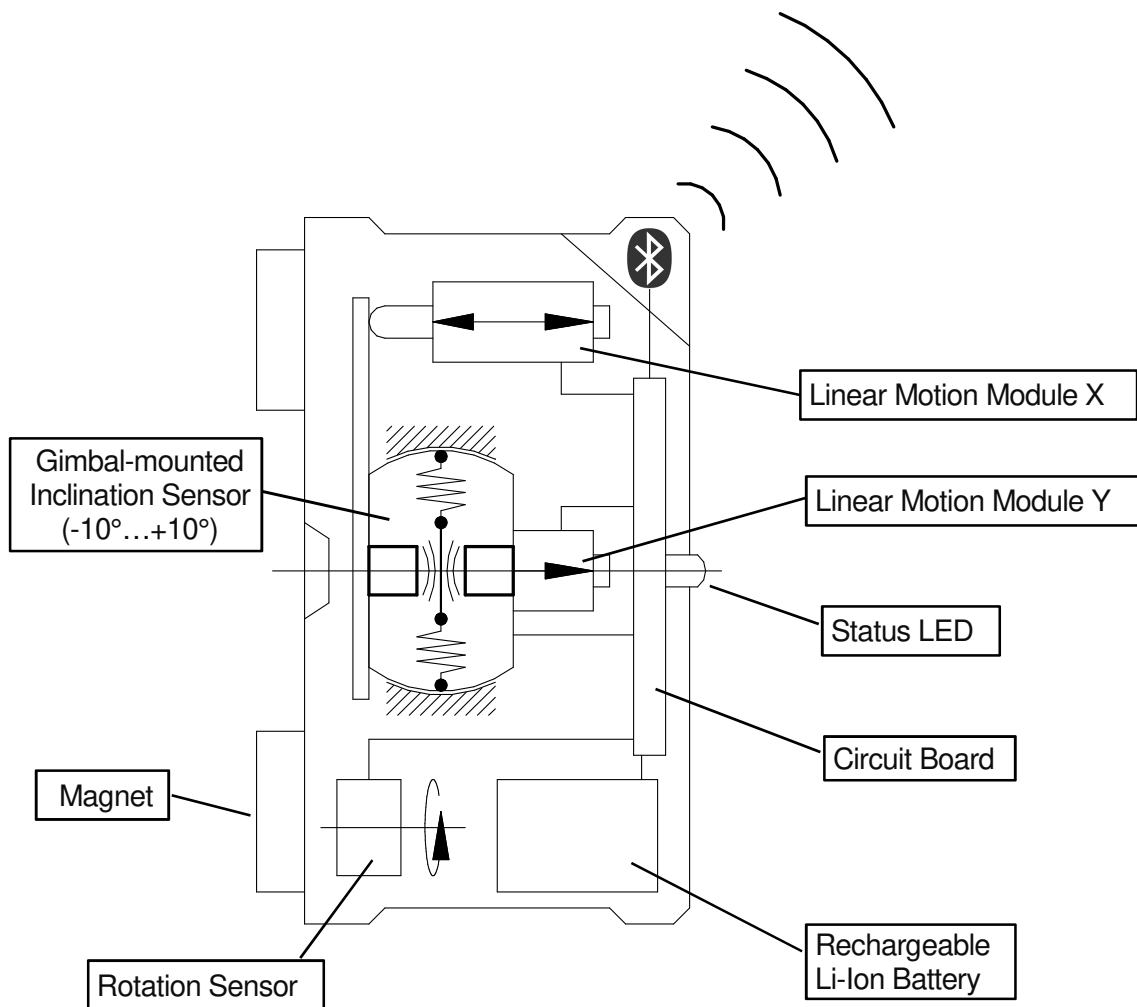
Rotary Incliner (without heat shield):



Schematic:

The Rotary Inclinometer contains an inclination sensor, which consist of a very sensitive membrane between two electrodes. The membrane gets moved out of it center position by gravity according to the inclination. These movements are transformed into inclination values, filtered and sent to the Computer via Bluetooth.

To minimize the influence of centrifugal forces in combination with uneven surfaces, the inclinometer is equipped with two linear motion modules. These modules are tuning the gimbal-mounted inclination sensor into the geometrical plane of rotation before measuring. The sensor tuning can be observed during the first one or two revolution after pushing the start button.



Features:

The Rotary Inclinometer gets charged by the charger, which is included in the tool kit or by any power source from 9 to 25VDC (center pin positive).

With the power switch, the tool can be switched on and off.

The light (LED) indicates the condition of the Rotary Inclinometer.

A **constant green** light shows that the tool is switched on and is in **normal operation**.






Slowly green blinking indicates battery **charging**

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.

A **constant blue light** indicates that the tool is **measuring**.

LED (Tool Condition)

OK	
Battery charging	
Measurement	
Warning	
Alarm	

3. SOFTWARE:


3.1 Software Installation:

The software (**TomTom-Tools Measurement Studio**), which is used for the Rotary Inclinometer and for all others of our tools, is pre-installed on the tablet PC and comes along with the tool kit 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.

Please keep your PC up to date.


Softwares & Resources



Measurement Studio

Size: 52 MB
Downloads: 1372

Download

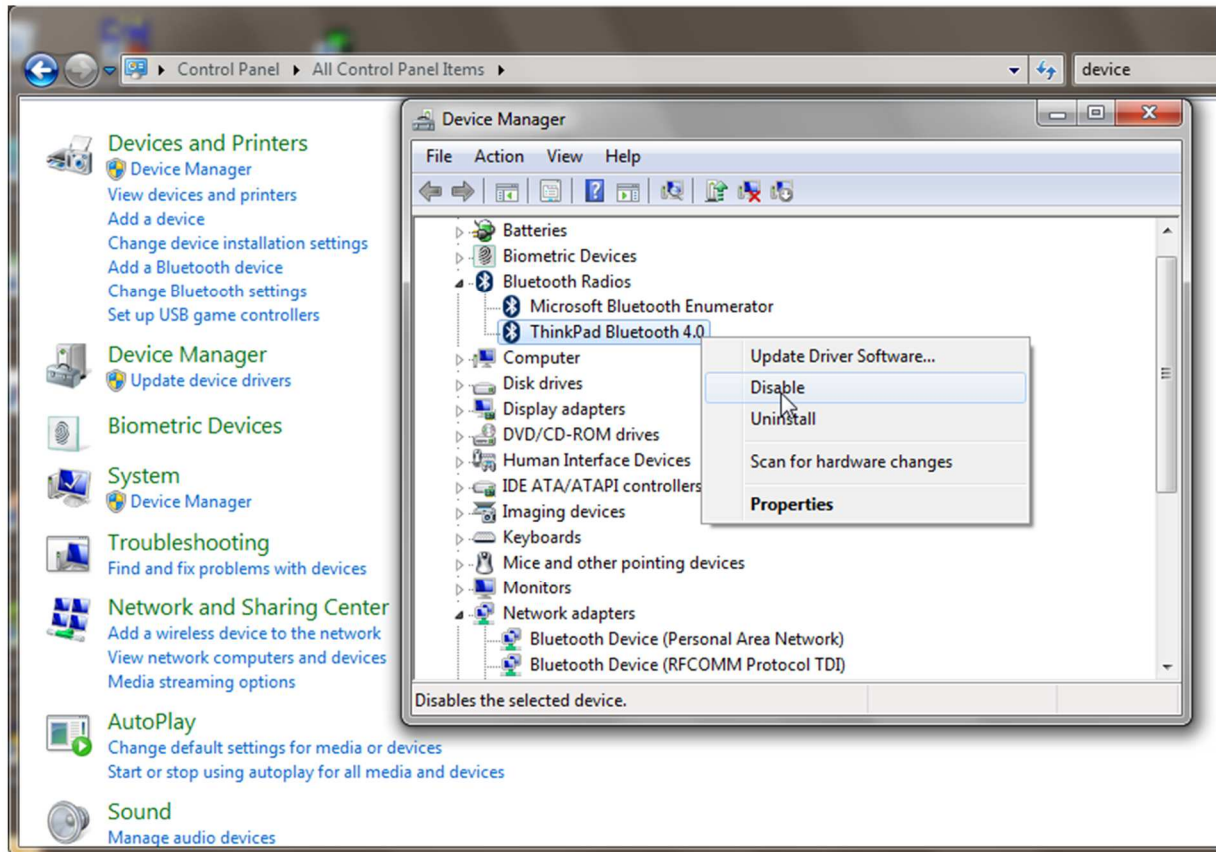


3.2 Bluetooth Adapter

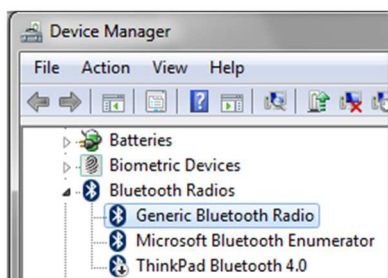
To ensure, the data connection between the Rotary Inclinometer and the PC is reliable, even in the difficult environment around a rotary kiln, a Long Range Bluetooth adapter (Sena Parani UD100) comes along with the tool kit.

Note:

- The TomTom-Tools are designed to communicate **only with the generic Windows Bluetooth Stack**. If there is another Bluetooth software installed (e.g. Toshiba, Widcomm, Intel, ThinkPad,...), **deactivate it in the Device Manager** as shown below:



- Then plug the Bluetooth adapter UD100. Windows will recognize the new hardware and automatically install the suitable Windows driver (Windows generic Bluetooth)
- The Device Manager will show the following:
 - Generic Bluetooth Radio
 - Microsoft Bluetooth Enumerator
 - the not required Bluetooth is down (indicated by the small arrow at the Bluetooth icon)



4. START THE TOOL:

4.1 Connect Rotary Inclinometer with Laptop

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 Rotary Inclinometer (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 Rotary Inclinometer) and click “OK”

Fig. 4.1.1
(Add Device)

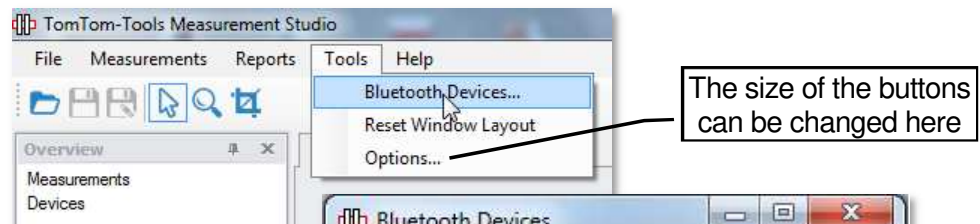
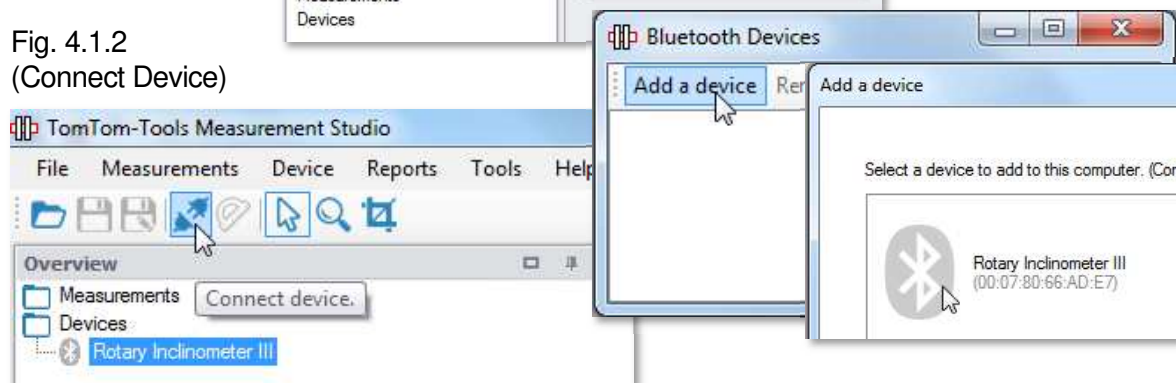
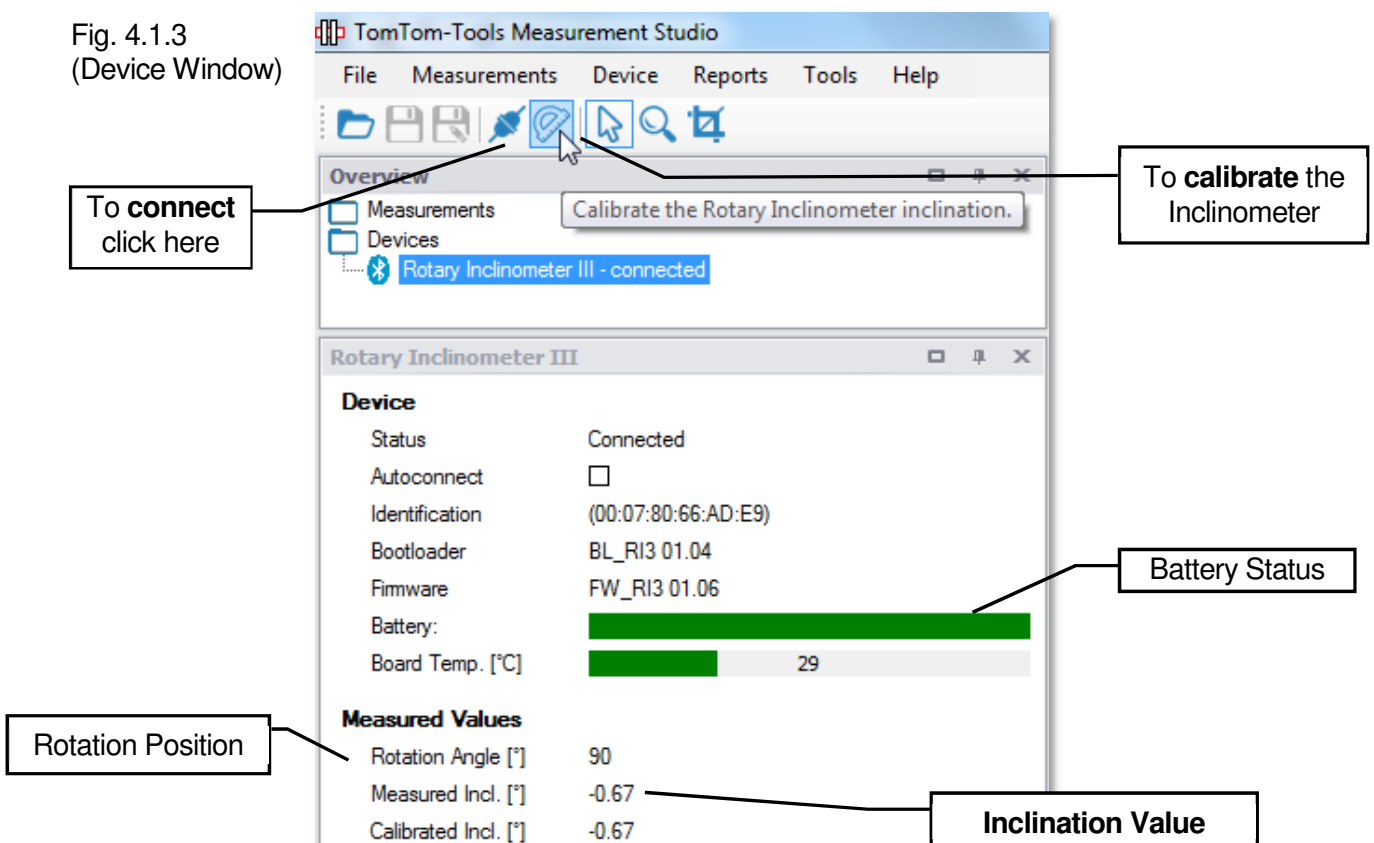


Fig. 4.1.2
(Connect Device)



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

Fig. 4.1.3
(Device Window)



4.2 Function Check of the Inclination Sensor

The main Sensor in the Rotary Inclinerometer is the accurate Inclination sensor. When the sensor gets moved, the inclination values will change within its range of $\pm 12^\circ$ (see in Fig. 4.1.1). From this angle values, the inclination will be calculated.

4.3 Calibration of Inclination Sensor

When the Inclinerometer is connected the Inclination Sensor has to be calibrated on a rotating part. Normally this is done on the same part, which will be measured later. Preferred is the calibration on a kiln roller, because it rotates uniformly without vibration and with a moderate speed.

Note: In order to **minimize** the negative impact of **centrifugal forces**, it is recommended to attach the Inclinerometer as close as possible to the center of rotation. Of course on kiln tires and girth gears, the sensor cannot be attached in the center of rotation, but in this application the speed is also very low (typically $< 6\text{rpm}$), hence the error caused by centrifugal forces can be neglected.

For more information how to place the Inclinerometer onto a rotating part, please see chapter 5.3.

The calibration consists basically of two normal inclination measurements, which are performed on the same rotating part, but in different directions. That means, for example on a support roller: once on the uphill side and once on the downhill side.

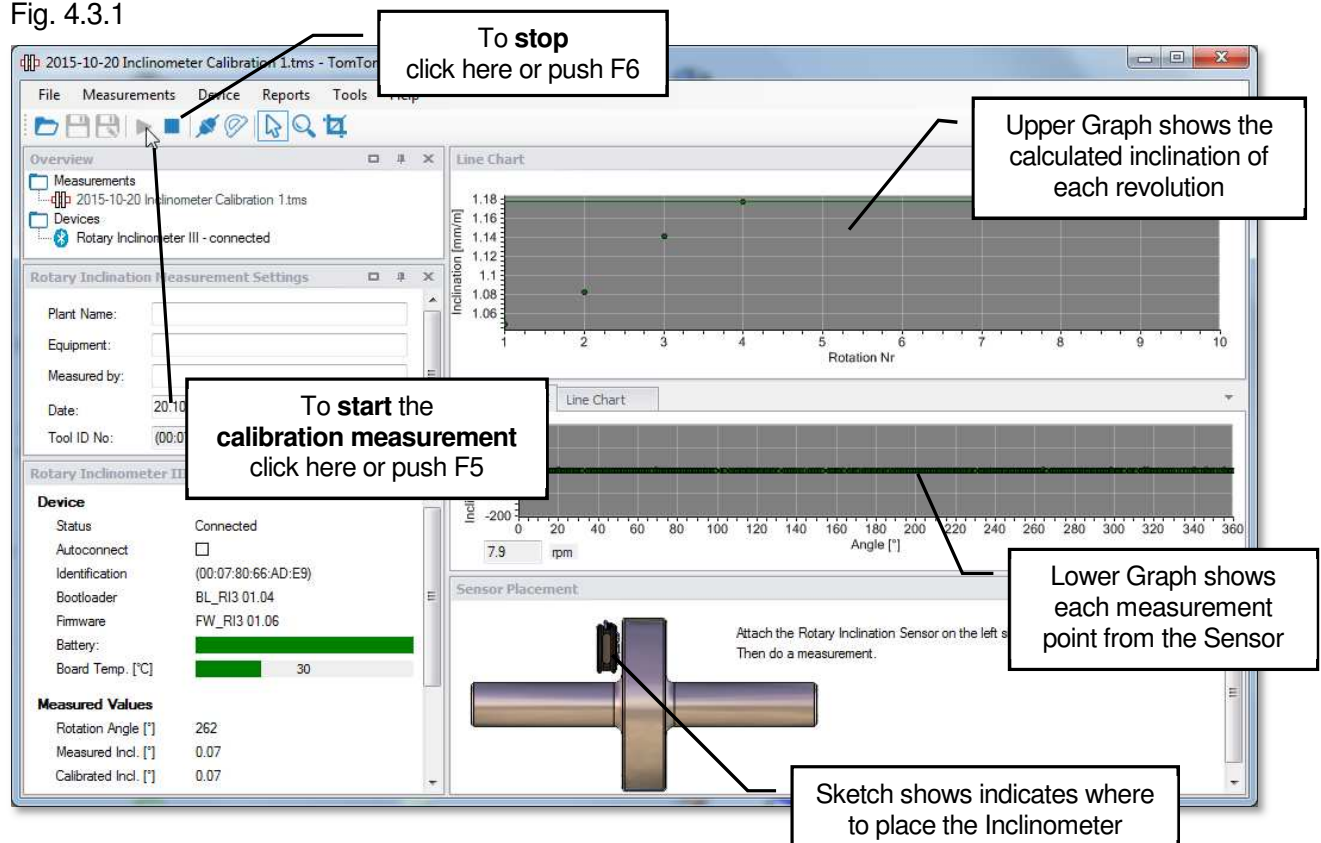
When the tool is attached to the rotating part, click on the start button or press F5 to start the first measurement.

Within the first one to three revolutions the sensor is tuned into the vertical plane to the rotation axis, which is visible by the reduction of the amplitude of the sinusoidal signal shown in the measurement window.

As soon as the sensor is tuned, the measurement results are appearing in the lower graph. After a few revolutions, the inclination values should become stable (see lower graph in Fig. 4.4.1), and the measurement can be stopped by clicking the stop button or pushing F6.

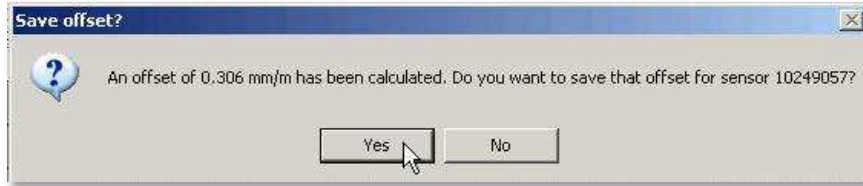
The sketch in the lower part of the Measurement Studio will change and indicate to place the sensor onto the opposite side of the rotating part.

Fig. 4.3.1



After completion of the second calibration measurement, the offset value is calculated. By accepting the value (Fig. 4.4.2), it will be stored in the registry of the computer and remain also when the computer is switched off. Nevertheless, to guarantee the accuracy of the measurement, the calibration should be repeated for each measurement campaign; therefore the software will remind you after restart.

Fig. 4.3.2



5. TAKE MEASUREMENTS:

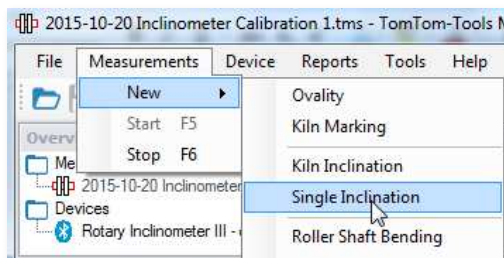
Depending on the part to be measured, two types of applications are possible:

5.1 Single Inclination Measurement

This application is used to measure single axis. It can be used for any kind of slow rotating drive shaft (up to approx. 30rpm, depending the center distance). For the main components on a rotary kiln, typically the “Kiln Inclination” application will be used (see next chapter 5.2)

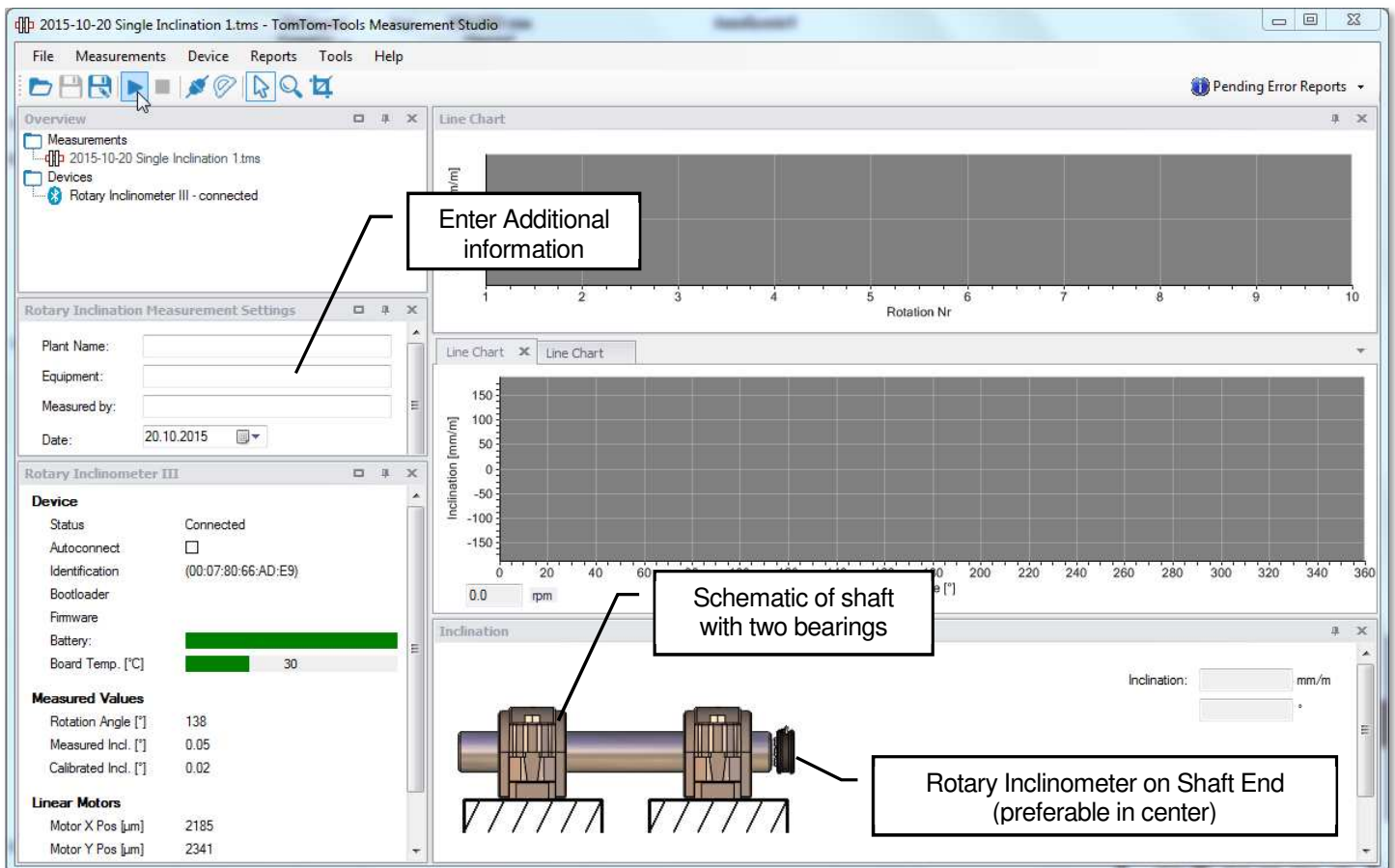
- To start a new measurement, click on “Measurement / New / Single Inclination” as shown in Fig. 5.1.1

Fig. 5.1.1



- A sketch of a shaft will be displayed.
- Put some additional useful information about the measurement into the “Settings Window”

Fig. 5.1.2

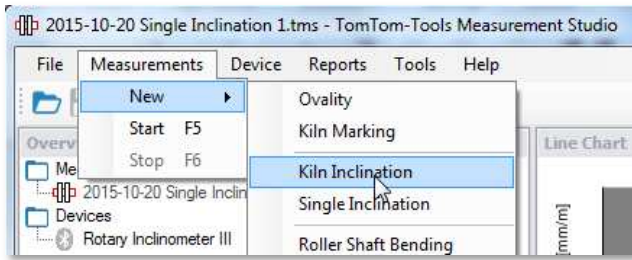


5.2 Kiln Inclination Measurement

This application is used to measure axes of kiln rollers, tires, pinions and girth gears (up to approx. 30rpm, depending the center distance).

- To start a new measurement, click on “Measurement / New / Kiln Inclination” as shown in Fig. 5.2.1

Fig. 5.2.1



- The first pier will be displayed per default.
- The kiln drive can be added also by mouse right click to “**Add Drive**” (see Fig. 5.2.2) To add a pinion, which is in front of the kiln view: click “Front”, if it is on the opposite side (back side) click “Back” if the kiln is equipped with a double pinion drive: click “Double”
- More piers can be added by mouse right click to “**Add Pier**” as shown in Fig. 5.2.3
- Put some additional useful information about the measurement into the “Settings Window”

Fig. 5.2.2

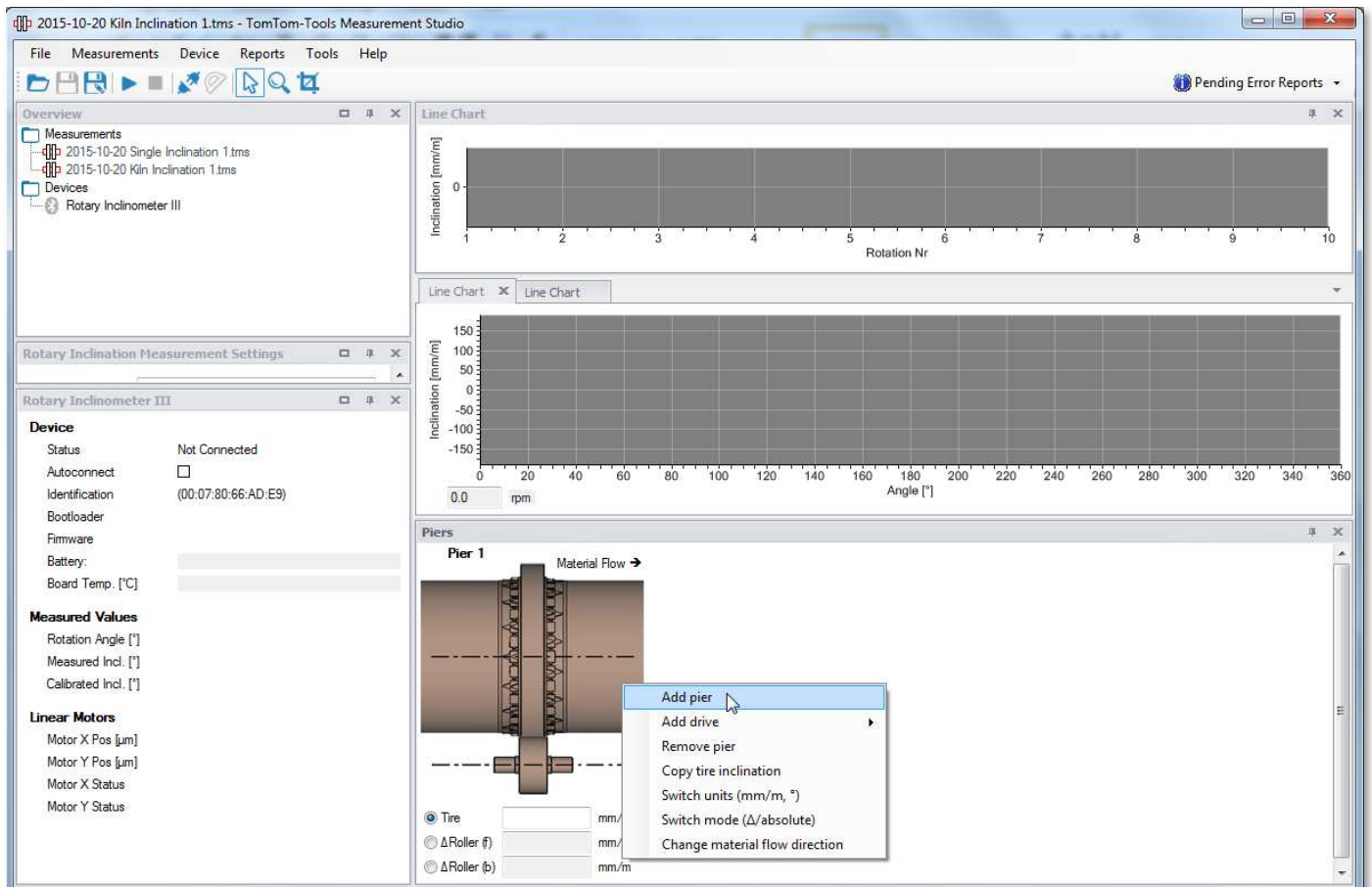
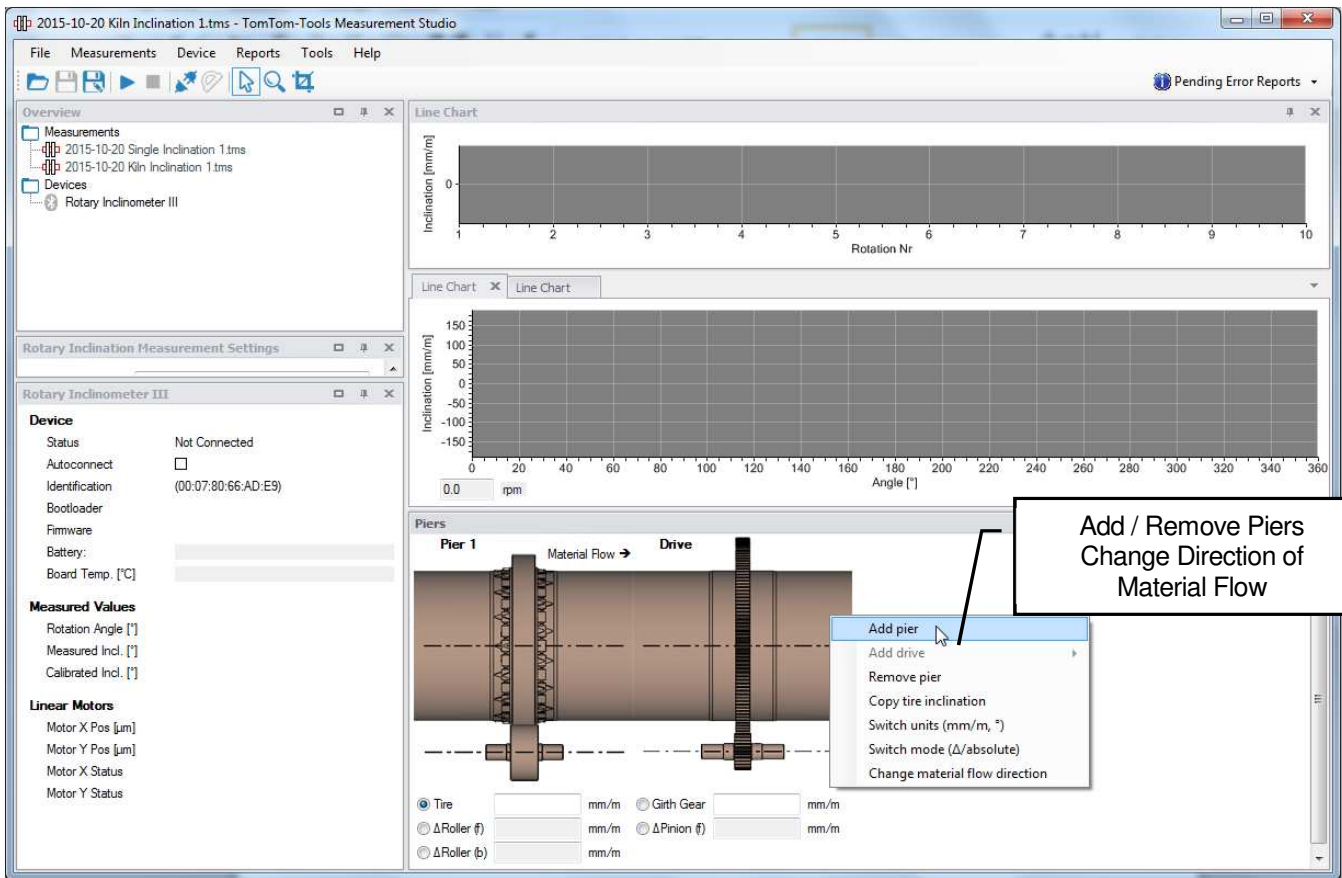


Fig. 5.2.3



Note:
the flow direction can be changed by right mouse click on “**Change material flow direction**”

5.3 Place Tool on Rotating Part

The Rotary Inclinometer has to be placed onto the side face of a rotating part, which has to rotate during the measurement. The surface has not to be straight nor machined, but magnetizable and clean enough, that the magnets apply sufficient force that the tool does not fall off or shift during the measurement.

Note: The result will be wrong, if the tool shifts or moves during the measurement relatively to the surface where it is attached.

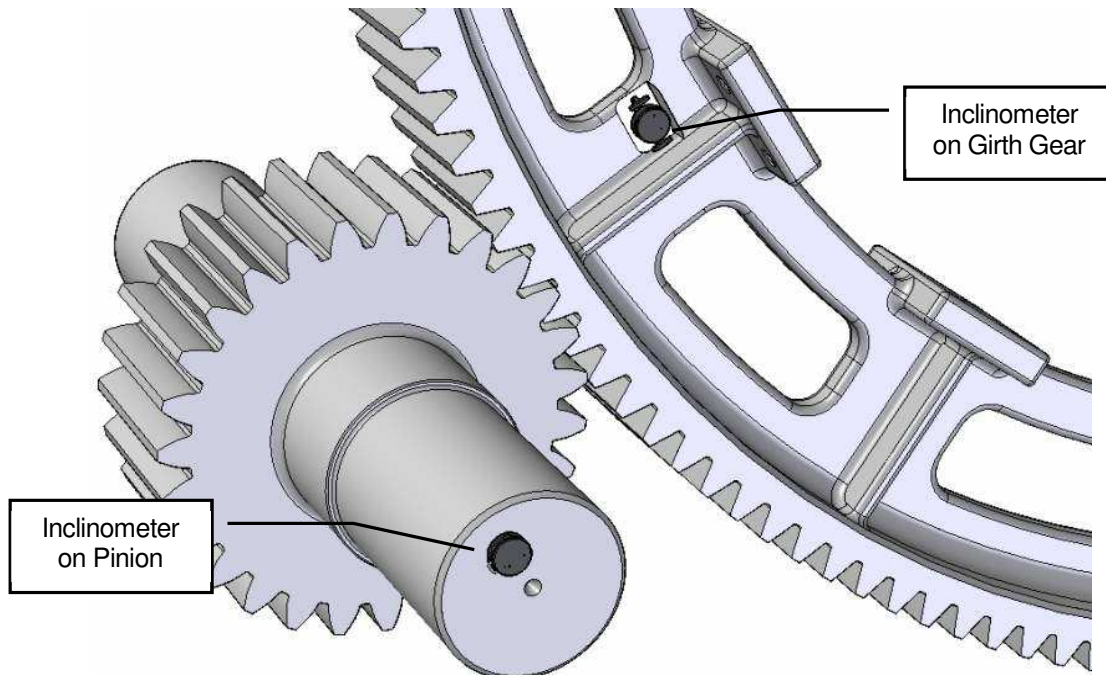
As already mentioned in chapter 4.4, it is recommended to place the Inclinometer always as close as possible to the center of rotation in order to minimize the negative impact of centrifugal forces. On kiln tires and girth gears, the sensor cannot be attached in the center of rotation, but in this application the speed is also very low (typically < 6rpm), hence the error caused by centrifugal forces can be neglected.

To attach the Inclinometer into the center of a pinion or roller shaft, the “Center Adapter”, which comes along with the tool kit, can be used. It allows the access to the shaft through the small inspection hole in the center of the bearing housing.

The Rotary Inclinometer is typically placed on to the rotating parts during normal operation, hence the safety rules have to be applied (see also the chapter **1.1 Safety**)

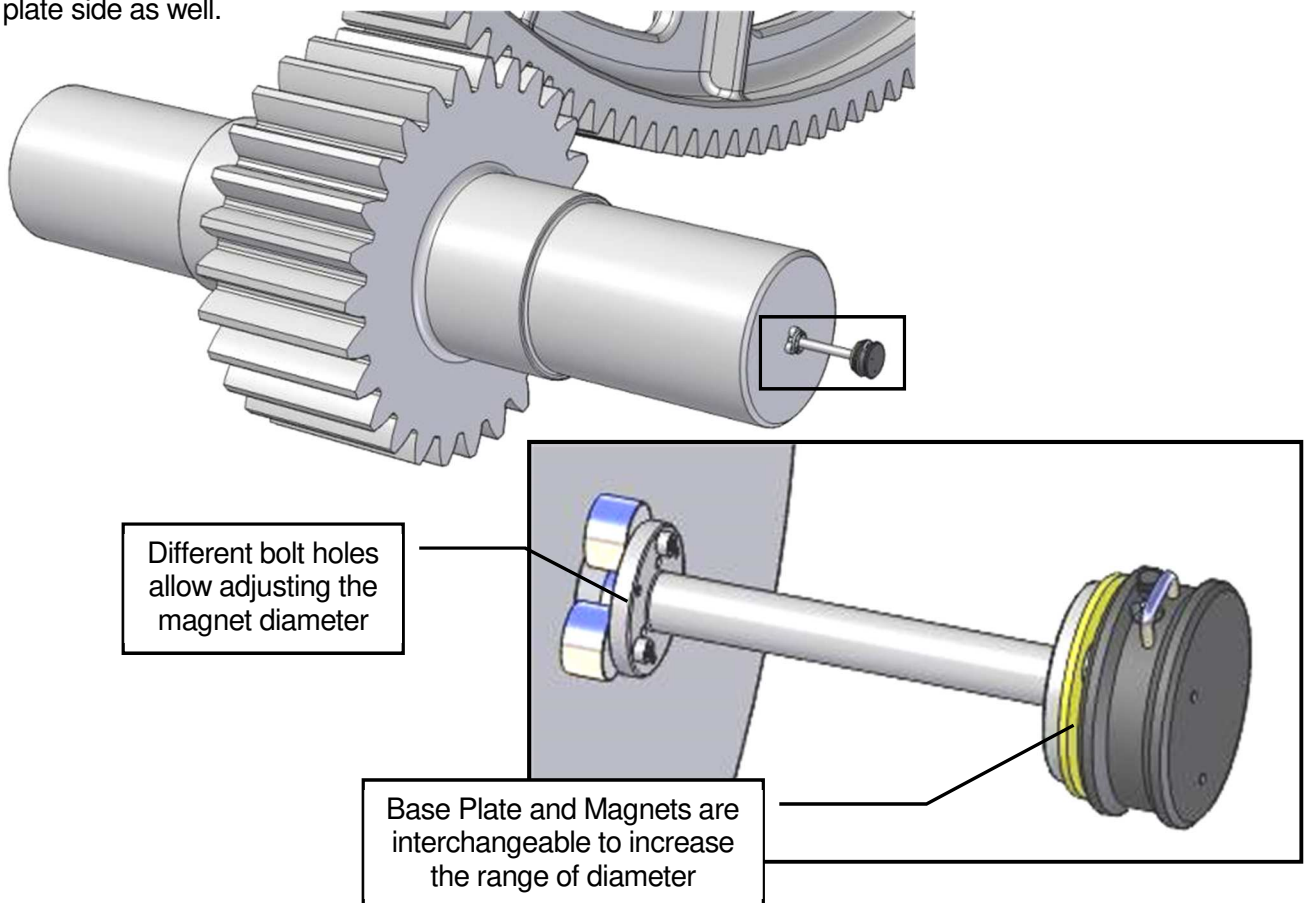
Example:

The inclination of pinion and girth gear on a rotary kiln get measured and compared:



Example:

The Center Adapter can be used to access the shaft through the inspection hole in the center of bearing housings. The magnets on the Center Adapter can be mounted on different holes to adjust the diameter. To increase the range of different diameters, the magnets can be placed on the base plate side as well.



Example:

The inclination of rollers and tires on a rotary kiln get measured and compared:

Deviations in the inclination of kiln tires and support rollers create high edge load and cause damage on the components. The error can easily be measured with the Rotary Inclinometer.

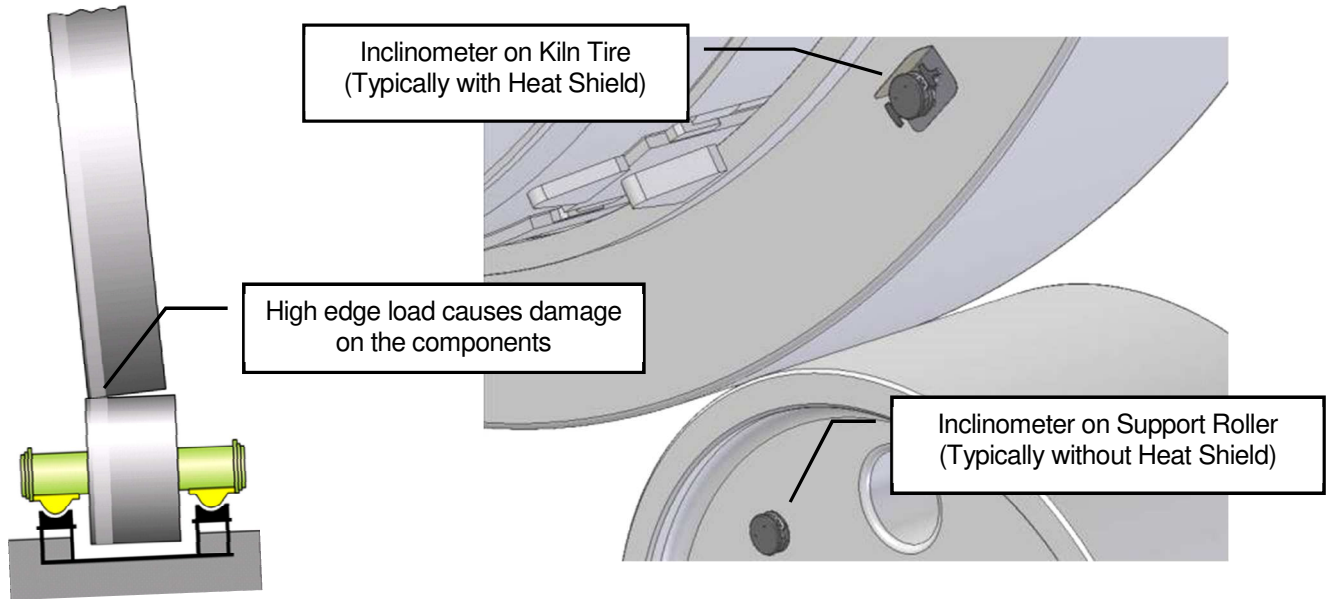
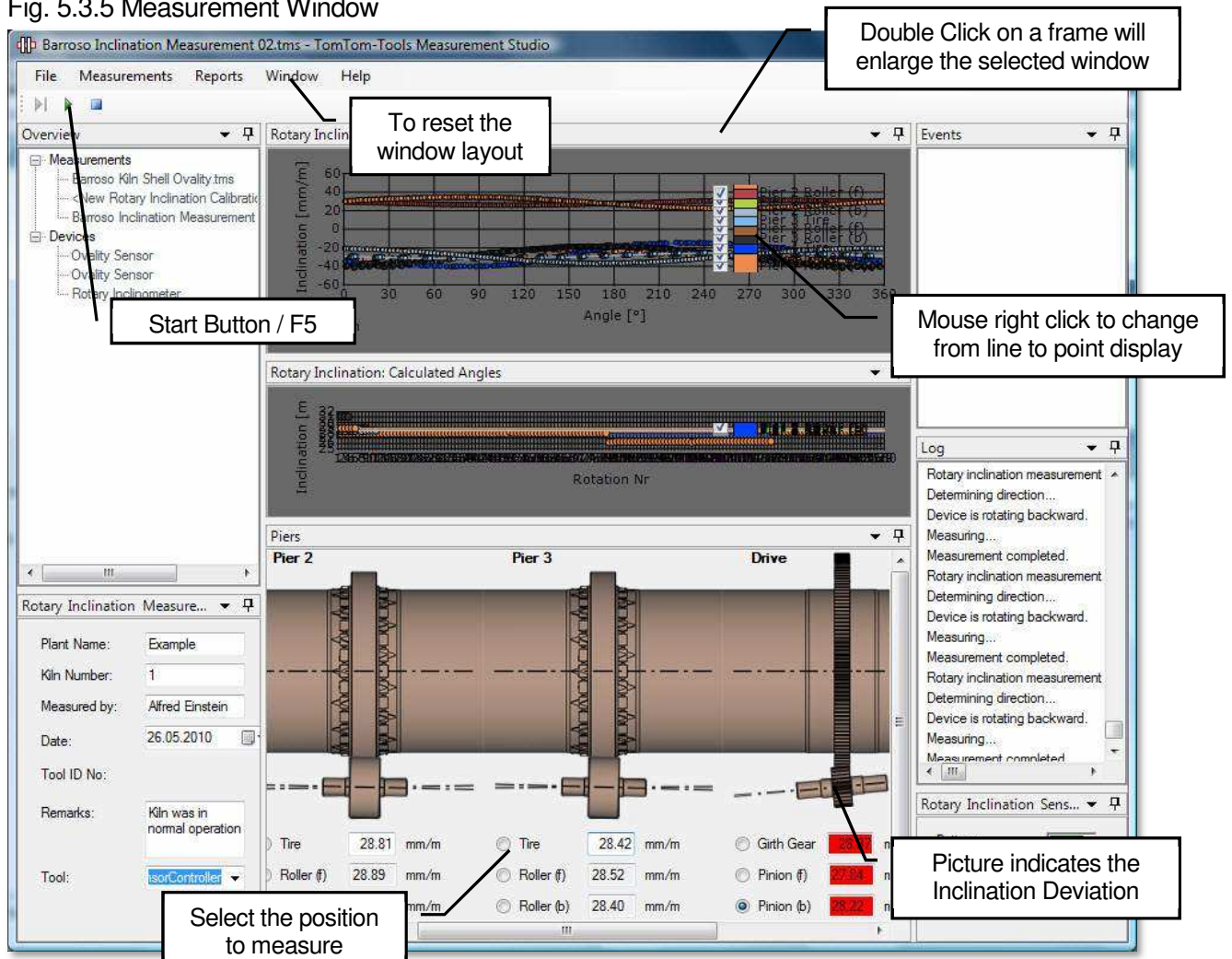


Fig. 5.3.5 Measurement Window



5.4 Results

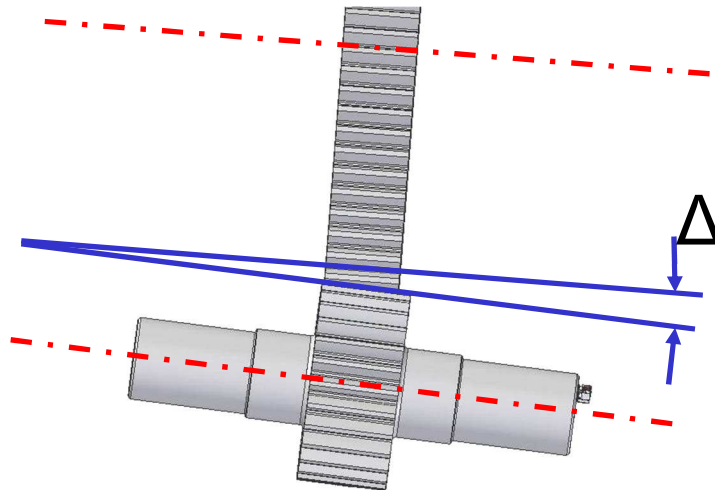
TomTom-Tools Ltd. does not provide guide lines about acceptable inclination deviations or limits.

It has to be according to the equipment manual or discussed with the suppliers, how much inclination deviation 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:**

- Between Kiln Tires and Support Rollers
- Between Kiln Girth Gear and Pinions

Good	Need to be Monitored	Need Re-Alignment
$\Delta < 0.8\text{mm/m}$	$0.8 < \Delta < 1.5\text{mm/m}$	$\Delta > 1.5\text{mm/m}$



5.5 Temperature Resistance

The Rotary Inclinometer together with the Heat Shield is made for hot applications; nevertheless it has to be kept as cool as possible to prevent damages. The magnets on the Heat Shield are heat resistant up to 300°C. The electronic board in the sensor is temperature resistant up to 65°C. To measure the inclination, for example, of a hot kiln tire, the Inclinometer has to be protected by the Heat Shield. If the internal temperature reaches 60°C a warning will be given by the LED. (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, the tool will alarm you (red flashing light and pop up window). In this case, the Rotary Inclinometer has to be removed from the kiln and cooled down as soon as possible.

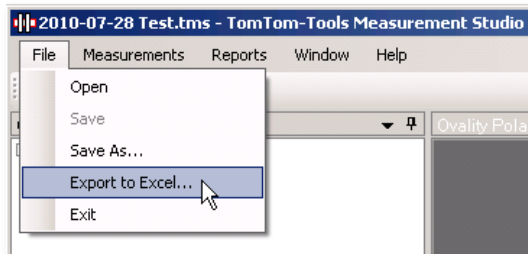
To cool down the tool, let it cool on the fresh air or by a ventilator (e.g. kiln shell cooling fan), never use water.

6. REPORT

6.1 Export to Excel

All data can easily be exported to excel.

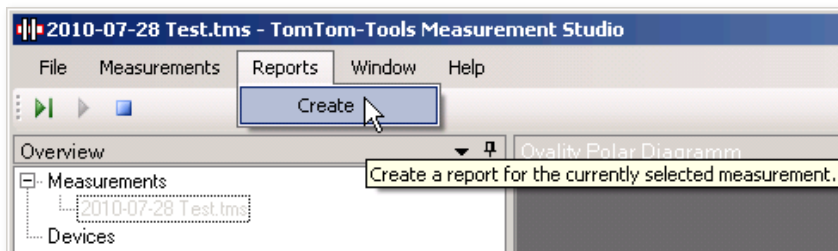
Fig.6.1.1



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



6.3 **Drawing**

Dimensions:

