



Optical surface measurements

- Roundness
- Waviness
- Roughness

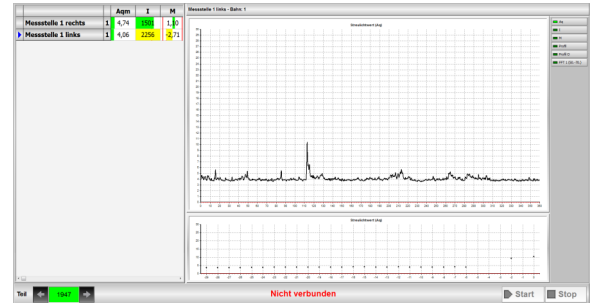
The OptoRack measuring machine is a semi-automatic inspection station for measuring waviness and roughness on raceways of ball screws. Optionally also the tooth rack back can be measured.

By means of an electrical precision pivoting device, the sensor is adjusted to several angles of the gothic arch. Every contact position is inspected individually and by measuring several lines even 3D scans of the raceway are possible.

Application

Roughness measurement

In addition to commonly known roughness parameters like Ra / Rz which give height information, the optical roughness value Aq responds to frictional behavior, which is related to the detected micro profile angles. The roughness measurement is performed continuously on the whole measured area. Optional area scans are possible (picture below)

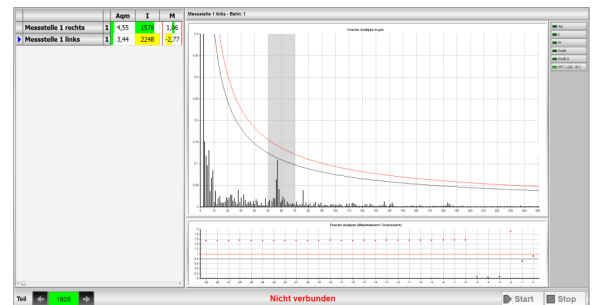


Roughness of one winding. Information of left and right flanks are given separately.

Roundness and waviness measurement

For measuring roundness and waviness, continuous information of the local profile angle is recorded while moving the sensor alongside the raceway. With the given encoder signal roundness and waviness is calculated by integrating all angle values. The results are absolutely comparable to those of tactile measuring machines.

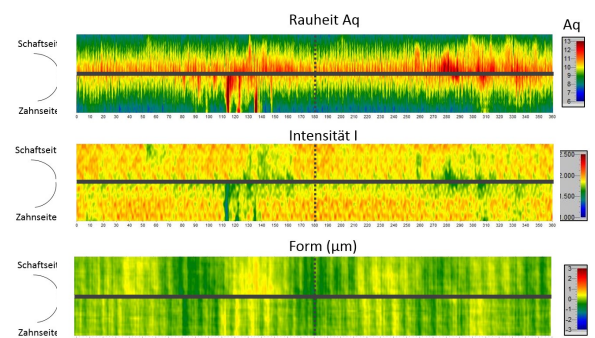
A huge advantage of the optical scattered light measurement is the separated measurement of the left and right sided raceway.



Top: Waviness analysis (FFT). Bottom: Control chart (waviness) for process control.

Surface scans

In Research and Development it is advantageous to scan several measuring tracks and to display the results in a 3D software. Roughness and waviness can be represented.



Roughness, form and intensity over the whole scanned area of two windings are displayed.

Application

Measurement procedure

After sensor adjustment, a steering rack with a maximum length of 800 mm is placed in a tailstock. An additional available support prevents defects on the steering rack. In the software, a predefined measurement program for the spindle type (containing its positions, measurement length and lead screw) is chosen by the operator.

The sensor positions itself automatically in the starting point. Rotating the sensor to the second flank also is performed automatically.

As soon as the measurement is done, the part can be removed. For measuring the tooth rack back the sensor needs to be re-adjusted.

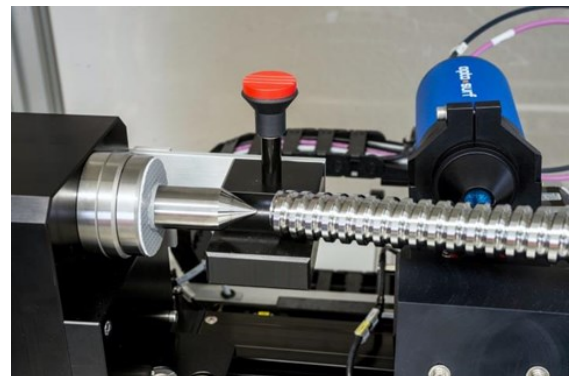
Optionally a robot can be used to put the part in the machine. For this application an automatic mode is programmable.



Automated electrical pivoting device

Data evaluation

Data is stored in a SQL database and can be exported (q-das). Displaying the results in a ok/nok (red-yellow-green light) scheme is intended for quality assurance. An optionally available QR code reader assigns the measured data directly to the parts.



Support for positioning the steering rack

Calibration of the measurement device

In daily use, sensor and measuring device do not need to be calibrated. Correct function can be tested using master parts.

The measurement method is traceable and is calibrated with a waviness standard (300 waves with 0.1 μm amplitude on a circumference of 30 mm). If needed, a certificate according to ISO/IEC 17025 can be ordered for the standard.

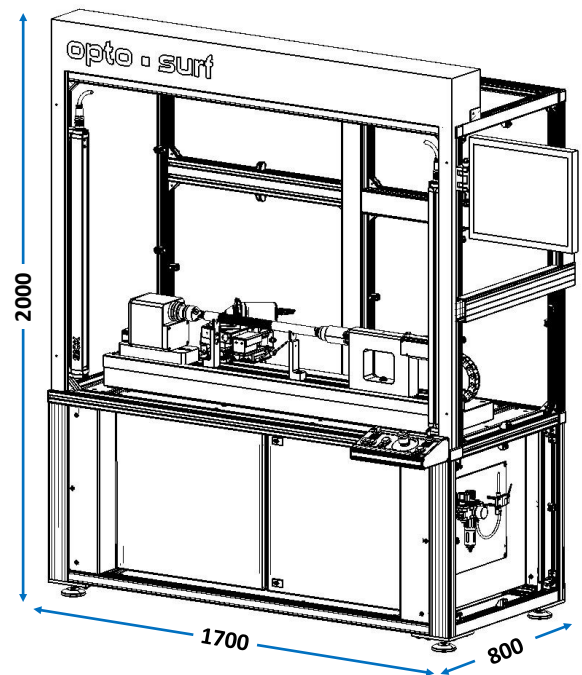


Measurement on a waviness standard WS 300/01

Specifications

SYSTEM

Measured parts	Tooth racks with ball screw up to 800 mm, part fixed in a tailstock
Measuring principle	Scattered light (VDA 2009)
Light source	LED 670 nm with \varnothing 0.9 mm spot, switchable 2. spot with \varnothing 0,03 mm (Laser c1)
Measured values (see below)	Roughness Aq, roundness PV (LSC) waviness FFT analysis
Measuring speed	Sensor: 2,000 measurements / sec Measurement from starting point: 1 winding with 4,096 measured vaules \approx 2 sec. 3 windings \approx 10 sec
Resolution:	Roundness: $< 0,2 \mu\text{m}$, waviness: $0,02 \mu\text{m}$, roughness $< 0,001 \mu\text{m}$ (Rz)
Axis	Stepping motor controlled CNC axis
Sensor holding	electrical precision pivoting device, positioning accuracy $< 0,01^\circ$
PC	Industrial compact-PC fanless (Win 10)
Power supply	230V / 50 Hz, 1 kVA
Interface	qs-Stat
Calibration	Waviness standard \varnothing 30 mm, 300 waves, $0,1 \mu\text{m}$ amplitude



MEASURED VALUES

Roughness	The roughness value is recorded continuously. Roughness is evaluated in running direction, which enables frictional behaviour to be assessed.
Roundness / waviness	The results of roundness and waviness measurements are absolutely comparable to those of tactile measuring machines. In comparison to a CMM left and right flanks are measured separately. Waviness is evaluated with a FFT analysis.
Defects	Morphological filtering for scratch and impact mark detection.