



**KLINGELNBERG**

**DONE-IN-ONE**

Measurement Solutions for Axially Symmetrical Workpieces



**KLINGELNBERG**

## **KLINGELNBERG Group: Tradition, Expertise and Passion**

The **KLINGELNBERG Group** is a world leader in developing and manufacturing machines for bevel gear and cylindrical gear machining and precision measuring centers for axially symmetrical components and gearings. The Group also manufactures spiral-cut bevel gears to customer specifications – with ultimate precision using in-house technology.

The machine and software concept of the **KLINGELNBERG Precision Measuring Centers business division** is optimized for measuring complex components. The technology replaces up to six conventional measuring machines: gear measurement, general coordinate measurement, optical measurement, form and position measurement, roughness measurement, and contour measurement. These measurement tasks can be fully automated in a single clamping. These measuring machines ensure that reliable measuring results are obtained not just in measurement rooms and geometry laboratories, but also in the shop-floor environment. It is not without reason that the Klingelberg Precision Measuring Centers represent a widely used standard in the industry and serve as a reference for metrology institutes.

The origins of this machine manufacturer date back to 1863. Still today, the Klingelberg family remains invested in the company as an anchor shareholder. With numerous R&D engineers worldwide and more than 200 registered patents, the company demonstrates its capacity for innovation each and every day. Klingelberg operates engineering and manufacturing facilities in Switzerland and Germany. The company ensures a global presence with regional sales and service offices.



Zürich, Switzerland



Hückeswagen, Germany

## Precise and Efficient from the Ground up

- Optimally harmonized Precision Measuring Centers for all typical industrial applications
- Cost reduction due to minimum space requirements and a particularly low-maintenance technology
- Suitable for use in production thanks to temperature compensation – reliable results, even in the +15°C to +35°C range
- Replaces up to six conventional measuring machines: gear measurement, general coordinate measurement, optical measurement, form and position measurement, roughness measurement, and contour measurement
- Great savings in energy costs due to extremely low power and air consumption (1 l/min)



G-Variant Precision Measuring Center:  
Winner of the Best of Industry Award 2020  
in the "Measurement Technology" category for  
its "Complete Measurement in a Single Stage –  
Done-in-One" solution



Modern, rail-guided, flow production assembly line with  
ten workstations in final assembly in Hückeswagen



Power generation – for transportation, electricity production, or individual mobility, among other things – requires rapidly rotating parts. Not only are these parts subjected to extreme temperatures over prolonged periods, but they must also withstand high stress conditions. This results in extremely stringent precision requirements for axially symmetrical parts. The quality requirements for wind power plants, for example, set the bar extremely high, with a 20-year service life that should require as little maintenance as possible with the greatest possible availability and load capacity. The highest known torques in any technical installations occur in wind power plants, for example. These high torques present a tremendous technical challenge for the downstream transmissions and generators, in particular. Maximum precision and traceable results of all components lead to a high degree of efficiency with minimal losses, high availability, and precise exchangeability of parts and components. Klingelnberg Precision Measuring Centers meet these requirements of performing measurements with traceable results.



### Complete Measurement of Wind Power Drive Components

- Gear measurement of sun gears, planetary gears, and internal gears
- Dimension/form/position measurements, GD&T (Geometrical Dimension and Tolerancing) measurements of shaft and gearing elements
- Contour measurements to determine radii, grinding shoulders, and tooth fillets



## Complete Measurement of High-Precision Slewing Rings

- Measurement of bearing-specific characteristics and gearings
- Precise dimension/form/position measurements, GD&T (Geometrical Dimension and Tolerancing) measurements
- Sensing of complex functional contours
- Comprehensive roughness measurement of tooth flanks and functional surfaces



## Complete Measurement of Crankshafts

- Comprehensive crankshaft evaluations
- Roughness measurements (radial and axial) of shafts and crankpins
- Gear measurements and evaluations according to widely used standards
- Dimension/form/position measurements, GD&T (Geometrical Dimension and Tolerancing) measurements for determining dimensions and deviations in form, including on crankpins



## Complete Measurement of Roller Bearings

- GD&T (Geometrical Dimension and Tolerancing), contour and roughness measurement, and FFT (Fast Fourier Transform) analyses in one measuring run
- Automatic parameterized generation of programs based on roller bearing data
- Innovative clamping solutions for roller bearing rings

## POWERTRAIN AND STEERING



Driving assistance systems; semi-autonomous driving; and advancements in combustion engines, hybrid engines, and electric motors demand high quality, minimal tolerances, and traceable results for all components and assemblies. Safety systems in particular must operate reliably and without error – especially in moments of extreme utilization. The efficiency rates of the transmission must also be as high as possible. Achieving these demanding goals of future vehicle generations requires highly precise, traceable and reliable measurement of individual components. The extremely high rotation speeds of electrically driven transmissions call for a modified surface quality of the components used. For years, waviness and roughness measurement of gearings, as well as form and roughness measurement of axially symmetrical components, such as shafts and bearings, have been part of the available scope of services of the Klingelberg Precision Measuring Centers. In the area of steering, the quality requirement for parts is likewise high, due to the use of additional safety technology and assistance systems, and often extreme loads. Klingelberg covers nearly all aspects of quality measurement for the powertrain and steering – with maximum precision, repeatability, and traceable results.



### Comprehensive Measurement of Drive Shafts and Propeller Shafts

- Complete measurement of gear elements, such as spline gears
- Dimension sensing as well as form and position evaluations, such as coaxialities, axial runouts, and concentricities
- Roughness measurement of sensitive transitions and functional surfaces
- Waviness and crowning



## Complete Measurement of Steering Components

- Gear measurement of gear worms and worm wheels
- Waviness evaluation of gear worms for detecting surface influences inducing noise excitation
- Dimension, form and position measurement of bearing seats, feather key grooves, and bore holes



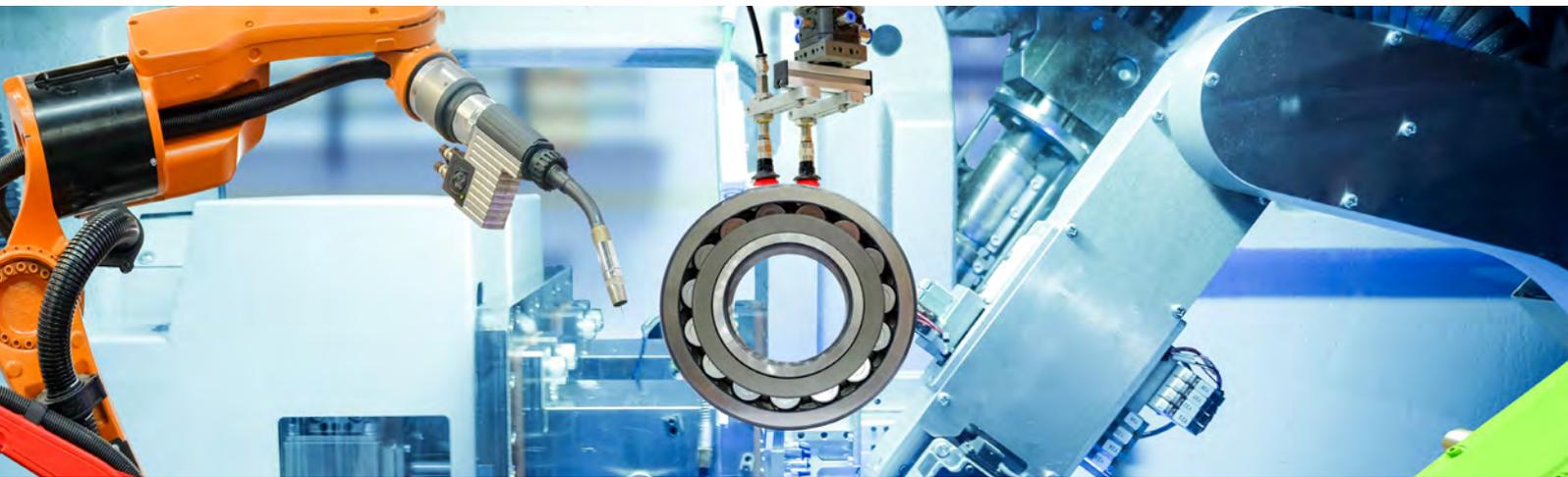
## Complete Measurement of Steering Gear Components

- Gear measurement for racks, including variable pitch
- Dimension, form and position measurement of wave-shaped base bodies
- Roughness measurement of functional surfaces



## Complete Measurement of Transmission Parts

- Gear measurements and evaluations according to all widely used standards
- Waviness evaluation of gears for detecting deviations inducing noise excitation
- Dimension, form and position measurement for comprehensive measurement in a single clamping
- FFT (Fast Fourier Transform) analyses for precise evaluation of bearing seats
- Automatic roughness measurement of internal and external gearings and functional surfaces



Due to continuing competitive pressure, companies are increasingly confronted with the task of becoming more efficient. At the same time, they must measure up to increased quality requirements. Automation plants and their components are therefore taking on increasingly precise and sophisticated tasks. This is the case in all areas, from mechanical production all the way to sophisticated medical assistance. In robotics, repetitive tasks can be completely automated, thereby freeing up personnel resources. Klingelberg Precision Measuring Centers deliver results that are highly precise, repeatable, reliable, and traceable. As is frequently the case in automation, the P-Series is a scalable solution that can be tailored to meet the user's individual process requirements and operates autonomously in the background. Electric-operated clamping chucks and motorized counter supports, standardized interfaces, automatically interchangeable roughness probe systems, and the many innovative solutions for complete measurement of axially symmetrical components make Klingelberg a reliable partner in implementing efficient automation concepts.



### Measurements of Robot Drive Components

- Dimension, form and position measurement of all components involved
- Position deviations of bore hole groups, e.g. in cycloid gearings
- FFT (Fast Fourier Transform) analyses for bearing seat
- Automatic roughness measurement of internal and external gearings and cylinder jacket surfaces
- Complete measurement of cycloid and harmonic drive gearings



## Complete Measurement of Cycloids

- Complete profile measurement in one step
- Evaluations of form and pitch based on profile measurements
- Deviation in form (diagrams and values)
- Offset/dilatation
- Calculation of bottom-bottom values
- Measurements and evaluations of disk and case



## Complete Measurement of Harmonic Drives

- Complete profile, individual profiles, and tooth traces
- Pitch and concentricity measurements
- Deviation in form (diagrams and values)
- Internal and external gearings
- Measurements starting from a module of 0.12 mm



## Comprehensive Measurement of Actuating Units

- Complete measurement of gear worms and worm wheels
- Roughness measurement of functional surfaces
- Contour sensing and evaluation of complex components
- Dimension, form and position measurement of axially symmetrical components



There is much hope resting on electromobility. Renewable energy sources are the preferred source of power generation for electric vehicles. The challenge for industry is to ramp up research and development activities. At the same time, automotive manufacturers must continually improve the energy efficiency of conventional drives. Overall, the cost of electromobility ensures that the quality standard is at an extremely high level straightaway. The performance and quality standards are on par with the standards of the combustion engine solution. Thus for power generation, the highest quality is required for all components of these units. As with hybrid solutions, a high degree of efficiency, high availability, and low wear can only be achieved with the highest-precision parts. In order to document this in a reliable, repeatable manner and with traceable results, a Klingelberg Precision Measuring Center is the ideal solution because it automatically determines these under controlled process conditions, with maximum precision and repeatable, absolute results.



## Complete Measurement of Electric Drive Parts

- Complete measurement of all geared components in the powertrain
- Dimension, form and position measurement of axially symmetrical parts of the drive unit, among others
- Noise analyses of gearings
- Complete measurement of bearing parts
- Roughness measurement of functional surfaces
- Contour measurements, including complex transitions



## Comprehensive Measurement of Industrial Rotors

- Profile measurements in the transverse and axial sections
- Determination of variations in lead and parallelism, as well as individual pitch variations
- Dimensional measurements such as length and diameter determinations
- Form and position measurement of bearing points, such as roundness and cylinder form



## Complete Measurement of Electric Drive Parts

- Roughness measurement of critical contour transitions and functional surfaces
- Dimensional form and position measurements, such as toleranced dimensions and coaxialities
- Roughness measurement of functional surfaces, e.g. bearing seats



## Complete Measurement of Electric Motor Parts

- Dimensional measurements of axially symmetrical parts
- Form/position measurements, e.g. of shaft bearing seats
- Roughness measurement of functional surfaces

# HIGHLIGHTS

## Precise and Efficient from the Ground up



P 40 Precision Measuring Center with counter support



P 40 Precision Measuring Center without counter support

The measuring technology and machine design are the same for all Precision Measuring Centers. All machine models can be enhanced with individual options.

- Optimally harmonized model series for all typical industrial applications
- Cost reduction due to minimum space requirements and a particularly low-maintenance technology
- Suitable for use in production thanks to temperature compensation – reliable results, even in the +15°C to +35°C range
- Protected guides, drives and measurement systems at the axes allow for seamless use
- Great savings in energy costs due to extremely low power and air consumption (1l/ min)



## Fast and Accurate Measured Value Logging in Connection with a High-Precision Workpiece Rotary Table

- Extremely smooth-running rotary table axis in form-measurement quality
- Load reserves for impacts during workpiece loading
- Rotary table drive via AC torque motor (direct drive)
- Uniform, constant rotary transmission even at extremely slow motion
- Directly coupled angle measuring system with high absolute accuracy
- Table freely rotatable when drive is shut down



## High-Speed Measured Value Logging with Continuous Path Control

- CNC measurement control based on a PowerPC processor
- Coupled measuring movements of up to four axes simultaneously, also for form measurements
- High-speed measuring even with high measuring point densities
- Intelligent control response of rotary table axis for different workpieces (moments of inertia/workpiece coupling)



## Broad Range of Applications Thanks to Versatile 3D NANOSCAN Probing System

- High-resolution scanning 3D tracer head with digital measured value logging in all coordinate directions
- Parallel-deflecting system for constant data calculation even with extended probe elements
- Automatic specification of trace direction in the X/Y plane when measuring lead lines with touching in the normal direction
- Measured value logging in form measurement quality
- Automatic compensation of different probe weights and adaptation of probe rods with multiple probe elements
- Automatic measuring probe change (optional)
- Scanning in axial, face, tangential and normal section



## Optical Measuring Technology

- Extremely fast measured value logging with high point density
- Rapid changeover between tactile and optical probing systems
- Optical Pitch Measurement

## HIGHLIGHTS



### Maximum Safety with Collision Protection

- Software operator guidance with plausibility check of program data
- 3D tracer head with deflection motion monitoring via sensors and a mechanical protective device
- Probe change rack with bistable magnet holding system for easy handling and reliable collision protection
- Monitored measuring axis drives with overload protection function



### Industry-compatible Calibration According to Recognized Standards

- Testing of all measuring centers with normals for profile and tooth trace, as well as workpiece-like normals of different types and sizes
- Traceability of measuring results to internationally recognized normals
- Proof of length measurement uncertainty  $MPE_E$  (optional)
- Proof of system suitability for form measurement tasks (optional)
- Determination of parameters  $C_g/C_{gk}$  and R&R testing (optional)



### Quick Availability of Measuring Results Enables Huge Time Savings

- Correction of measuring results for workpiece temperatures deviating from the reference temperature in the +15 to +35 °C range
- Measurement of the current workpiece temperature via a fast thermo-element
- Algorithm can be used for all metallic/axially symmetrical workpieces



## Fully Automatic Roughness Measurement Inside and Out

- Skid-mounted tracer head for measured value logging on gearing with modules starting at 0.9 mm
- Output values according to DIN EN ISO 4287 (DIN 4762):  $R_a$ ,  $R_z$  (DIN),  $R_t$ ,  $R_{max}$ ,  $R_{3z}$ ,  $R_q$ ,  $R_{pc}$ ,  $R_k$ ,  $R_{pk}$ ,  $R_{vk}$ ,  $MR_1$ ,  $MR_2$ ,  $R$ ,  $AR$
- Scanning in the profile or lead line direction with standardized trace sections
- Fully automatic operation in connection with profile and lead measurements, as well as for shaft probing and on plane surfaces
- Integrated actuator for diamond scanner alignment
- Probing systems for dimension, form and position of cylindrical and bevel gear toothing
- Manual or (optional) fully automatic measuring probe change



## Measurement on the Shop Floor

- The highest specifications in the production environment (from +15 to +35°C) with great temperature gradients for time and space
- Reliable and proven machine and workpiece temperature compensations
- Resists external environmental influences and vibrations thanks to active vibration damping (optional)
- Environmentally resistant components for safe use in production



## Fast Gear Development According to Nominal Data with "Closed Loop" Data Exchange

- Bevel gear tooth trace measurement compared against nominal data to be calculated
- Measurement of correction setting data for the machining method (cutting/grinding) based on current measured data
- Network data transmission for all integrated production facilities
- Ability to manufacture bevel gear sets (ring gear/pinion) as replaceable individual parts (grinding work)
- Reverse Engineering of bevel gear sets
- Tool measurement (stick blades) compared against calculated nominal data and reverse engineering with correction on the stick blade grinding machine



## Incredibly Easy Operation for Complete Measurement of Complex Components

Software is a key factor in measuring device performance. It also provides simple and intuitive operation in the G-variant: either the workpiece ID number is selected or a barcode/QR code scanner is used in the EasyStart screen to start the measuring run automatically. All mandatory evaluation parameters for components according to national and international standards can be tested, as well as specific requirements.

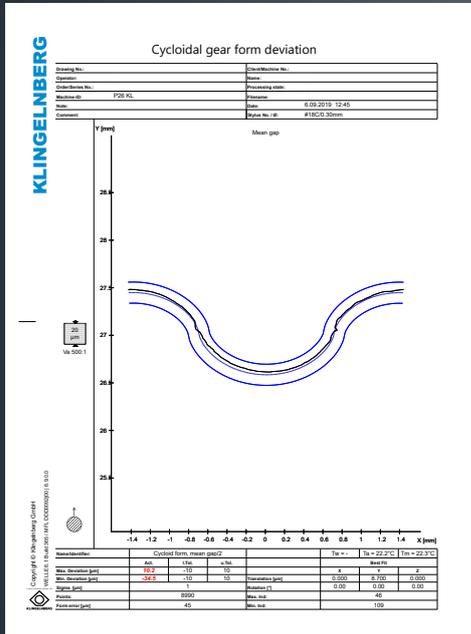
The CNC control transmits the measured values online to the evaluation software, where the results are evaluated and logged. During the measurement itself, the program displays results on the screen and then prints all the relevant information on easy-to-read measuring sheets. The measuring results can also be saved locally or via a network, and also transmitted to a statistics program (qs-STAT).

Since the G-variant is equipped with O-QIS software, the quality control map can be evaluated. In this case, the measuring run also begins automatically as soon as the workpiece ID number is selected.

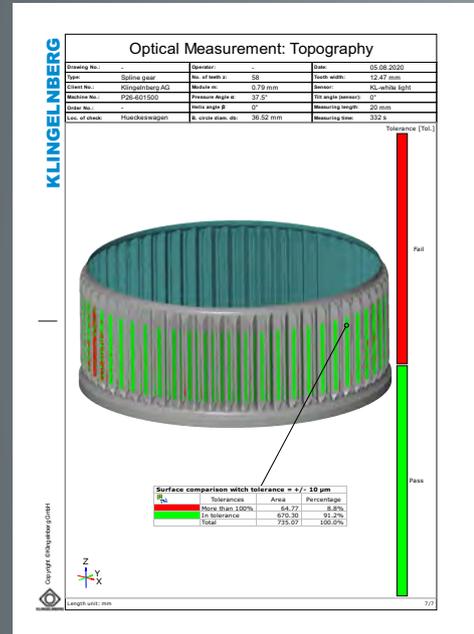
- EasyStart program for selecting different software modules
- Fast measurement program creation via buttons
- Catalog of stored measurement programs with search functions
- Custom language selection in the operator guide/documentation
- qs-STAT interface and connection to a quality control map
- Fully automatic measuring run with all parameters of the GD&T form, position, contour and roughness measurement



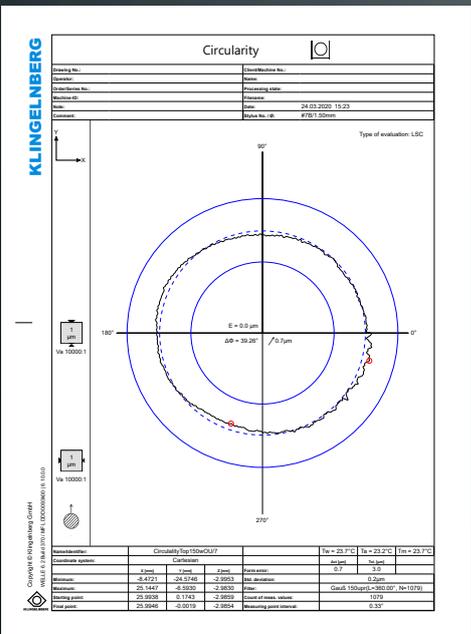
# Done-in-One – The Comprehensive Solution



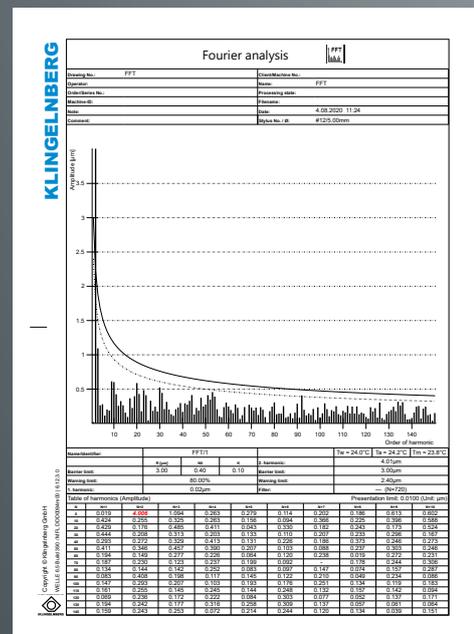
Measurement of special profiles against coordinates



Optical measuring technology for rapid pitch measurement and digitization



GD&T measurements and evaluations



FFT analysis for detecting frequency components

# PRODUCT PORTFOLIO

	P 16 G	P 26 G
Horizontal measuring range (generating path, X axis)	±50 mm	±75 mm
Clamping/testing diameter of components (max.)	160 mm	260 mm
Permissible moment of inertia (max.)	0.1 kgm <sup>2</sup>	1 kgm <sup>2</sup>
Permissible test gear weight	10 (20) kg	80 kg
Vertical measuring range (Z axis)	250 mm	400 (550) mm
Machine accuracy at + 18 °C – 22 °C		
Reference temperatures	0.5 K/h; 2 K/d; 2 K/m	0.5 K/h; 2 K/d; 2 K/m
MPEE0 ISO 10360-2 (2010) *3/*4/*6	1.8 + L/450 mm	1.8 + L/450 mm
Roundness Ø 100/L VDI/VDE2617- sheet 8 *4/*5/*6	0.3 µm	0.3 µm
Total axial runout VDI/VDE2617- sheet 8 *4/*6	1.5 µm	1.5 µm
Machine accuracy at +15 °C – 35 °C		
Reference temperatures	2 K/h; 12 K/d; 2 K/m	2 K/h; 12 K/d; 2 K/m
MPEE0 ISO 10360-2 (2010) *3/*4/*6	1.8 + L/250 mm	1.8 + L/250 mm
Roundness Ø 100/L VDI/VDE2617- sheet 8 *4/*5/*6	0.5 µm	0.5 µm
Total axial runout VDI/VDE2617- sheet 8 *4/*6	1.8 µm	1.8 µm
Total connected load of the machine	1.8 kVA	1.8 kVA
Compressed air connection	6 bar / 60 l/h	6 bar / 60 l/h
Net weight incl. standard equipment approx.	990 kg	1,450 kg
Machine dimensions (L x W x H) approx.	1,305 x 840 x 1,620 mm	1,465 x 1,335 x 1,680 mm
<p>(Values in brackets are optional)</p> <p>*2 Only in combination with options,            *3 Reduced shape in axis-parallel direction,            *4 Use of the prescribed Klingelnberg stylus configurations respectively at Klingelnberg SFP Normal, *5 At turn table height,            *6 Maximum permissible vibration speed, vertical, horizontal: 0.1 mm/s peak to peak,            *7 Not with enhanced vibration isolation,            *8 without tailstock.</p> <p>Counter support available as an option (Series P 26 – P 65),            Technical changes reserved.</p>		
		

P 40 G	P 65 G	P 100 – 350
±115 mm	±200 mm	±200 – 300 mm
400 mm	650 mm	2,000 – 3,800 mm
5 kgm <sup>2</sup>	30 kgm <sup>2</sup>	100 kgm <sup>2</sup>
300 kg	500 kg	2,000 – 20,000 kg
550 (700) mm	800 (1,200) mm	800 – 1,200 (1,200 – 2,000) mm *7
0.5 K/h; 2 K/d; 2 K/m	0.5 K/h; 2 K/d; 2 K/m	from P 150 18 – 22°C (0.5K/h; 2K/d; 2K/m)
1.8 + L/450 mm	1.8 + L/450 mm	1.8 µm + L/450 mm/ from P 150 2.2 µm + L/250 mm
0.3 µm	0.3 µm	0.3 – 0,6 µm
1.5 µm	1.5 µm	1.5 – 1,8 µm
2 K/h; 12 K/d; 2 K/m	2 K/h; 12 K/d; 2 K/m	-
1.8 + L/250 mm	1.8 + L/250 mm	-
0.5 µm	0.5 µm	-
1.8 µm	1.8 µm	-
1.8 kVA	2.5 kVA	2.5 – 6.5 kVA
6 bar / 60 l/h	6 bar / 60 l/h	6 bar / 60 l/h
1,900 kg	3,600 kg	4,900 – 23,000 kg
1,535 x 1,630 x 1,960 mm	1,770 x 2,125 x 2,420 mm	1,820 x 2,315 x 2,430 mm – 5,310 x 2,485 x 3,885 mm
		

## Contact

Talk to us if you have special requirements for part size, measurement tasks and evaluation.

### E-mail:

[gearmeasuring@klingelberg.com](mailto:gearmeasuring@klingelberg.com)

For more detailed production information, visit our website at: [klingelberg.com](http://klingelberg.com)

## Video on roller bearing measurement

The Klingelberg Done-in-One comprehensive solution for bearing measurements. You can find our video at the following link (QR code):



## KLINGELNBERG Service

The KLINGELNBERG Group is a world leader in the development and manufacture of machines for bevel gear and cylindrical gear production, and precision measuring centers for gearing and axially symmetrical components, as well as the production of customized high-precision drive components. In addition to the headquarters in Zurich, Switzerland, further development and production facilities are located in Hückeswagen and Ettlingen, Germany.

The company also maintains a presence with Sales and Service offices and numerous marketing agents. On this basis, Klingelberg offers users a comprehensive range of services for all aspects of toothed gear design, manufacturing, and quality inspection. The spectrum includes technical consulting, on-site machine acceptance, operator and software training as well as maintenance contracts.

## KLINGELNBERG Solutions

Klingelberg solutions are used in the automotive, commercial vehicle, and aviation industries, as well as in shipbuilding, the wind power industry, and the general transmission manufacturing industry. With numerous R&D engineers around the globe and over 200 registered patents, the company consistently demonstrates its capacity for innovation.

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FOLLOW US AND STAY UP TO DATE:



### KLINGELNBERG AG

Binzmühlestrasse 171  
8050 Zürich, Switzerland  
Fon: +41 44 278 7979  
Fax: +41 44 273 1594

### KLINGELNBERG GmbH

Peterstraße 45  
42499 Hückeswagen, Germany  
Fon: +49 2192 81-0  
Fax: +49 2192 81-200

### KLINGELNBERG GmbH

Industriestraße 5-9  
76275 Ettlingen, Germany  
Fon: +49 7243 599-0  
Fax: +49 7243 599-165

You can also find your local contact for sales advice at <https://klingelberg.com/en/contact>

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Binzmühlestrasse 171  
8050 Zürich, Switzerland  
Fon: +41 44 278 7979  
Fax: +41 44 273 1594

### KLINGELNBERG GmbH

Peterstraße 45  
42499 Hückeswagen, Germany  
Fon: +49 2192 81-0  
Fax: +49 2192 81-200

### KLINGELNBERG GmbH

Industriestraße 5-9  
76275 Ettlingen, Germany  
Fon: +49 7243 599-0  
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