

KLINGELNBERG

P 16

PRECISION MEASURING CENTERS



KLINGELNBERG

Sustainable Quality Management of Drive Elements

Stringent precision requirements for gear tooth measurements and increasingly complex drive components demand the best measuring technology available and a machine and software concept optimized for these applications. That's why leading manufacturers put their trust in Klingelnberg precision measuring centers, which represent the most widely used standard in the industry, while also serving as the reference for metrology institutes.

Klingelnberg measuring centers (P-series) today are ideally suited to handle most measurement tasks in a wide range of sectors: Users in the automotive and commercial vehicle industries, the aerospace and aeronautical engineering industries, as well as the wind power industry rely on this technology, [which replaces up to six conventional measuring devices](#). This allows the following measurement tasks to be fully automated in a single setup:

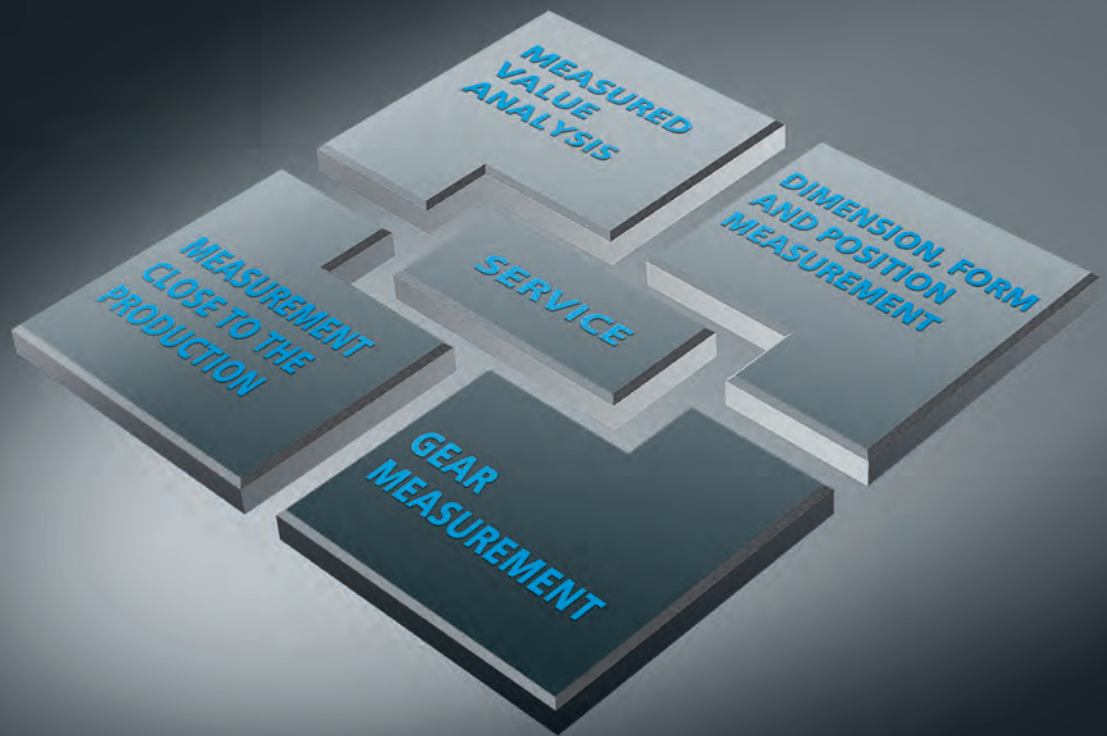
- Gear measurement
- Optical measurement
- General coordinate measurement
- Form and position measurement
- Roughness measurement
- Contour measurement

[The modular concept used in the P-series offers measuring devices in just the right size and a broad range of applications to provide the utmost in accuracy:](#)

- Measuring centers for workpieces up to 3800 mm in diameter and up to 20000 kg in weight
- Gear measurements starting from module 0.1



P 16 – workpiece diameter range up to 160 mm



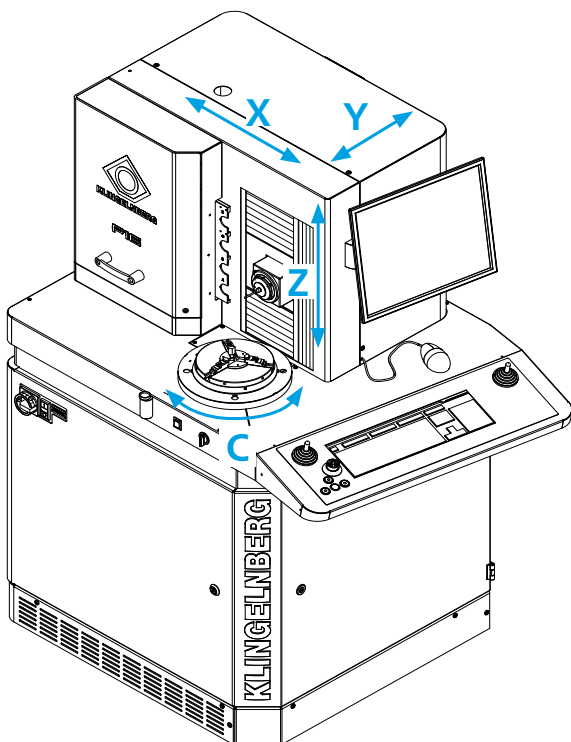
Close to Market and to User Requirements

- First-class machine quality guarantees reliable quality assurance over the long term
- Robust measuring machine technology with low maintenance and calibration effort
- Excellent measuring accuracy as a basis for testing drive components of the highest quality
- Machine design suitable for use on the production floor
- Simple, easy operation of the measuring centers for all applications
- Continuous development of evaluation standards according to the specifications of industry and the standards associations
- Comprehensive service offering: fast, competent, worldwide

Cutting-Edge Technology for Maximum Safety and Precision

At the heart of a precision measuring center is an accurate, durable rotary table. Configured as a measuring axis (**C axis**), it provides concentric seating of the workpieces to be tested. In combination with the three linear measuring axes, tangential (**X axis**), radial (**Y axis**) and vertical (**Z axis**), the measuring centers trace and inspect the functional surfaces of gears and general drive components in generator mode. This guarantees maximum measuring accuracy and reproducibility.

All Klingelnberg measuring centers are equipped with heavy-duty, stable beds and guide bodies made of cast iron. At the same time, all bearings and guides are backlash-free at the measuring axes. These form the basis for the measuring centers' high basic mechanical accuracy. The integrated 3D tracer head enables both discrete-point probing and scanning, continuous measured value logging. The powerful software makes it possible to evaluate the results quickly and easily (see page 10 for more on the software).



Axis arrangement on a P machine

- Machine concept with optimal axis arrangement
- High geometrical long-term stability thanks to optimally sized components for substructure and guide bodies
- Smooth, maintenance-free AC direct drives in all measuring axes
- Powerful, intuitive software
- Efficient data management through output of measuring results via a data network connection or printout

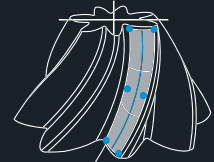
Bevel gear



Tooth thickness



Pitch, concentricity

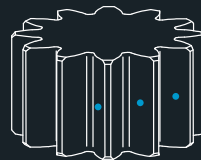


Topography

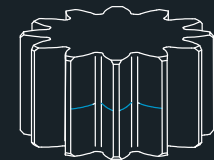
Cylindrical gear



Lead line



Pitch, concentricity



Profile

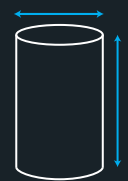
Shaft



Roundness

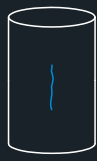


Straightness

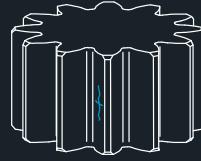


Diameter, length

Roughness



Shaft

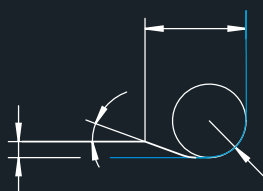


Cylindrical gear



Bevel gear

Contour



Radial and axial section scan



Tangential section scan



Normal section scan

HIGHLIGHTS

Six Combined Measurements in under 6 minutes!

A pump gear shaft impressively demonstrates the advantages of combined measurement:

Measuring run:

- Gearing $m_n = 2.5$ mm; 12 teeth; profile, tooth trace, gearing pitch; gearing runout with DIN 3962 evaluation
- Roundness and diameter at two bearing points with DIN EN ISO 1101 evaluation
- Roughness measurement in the profile direction at one tooth with evaluation of parameters R_a, R_z, R_t, R_{max} to DIN EN ISO 4287
- Measurement and compensation of workpiece temperature
- Determination of workpiece axis for clamping error compensation
- Fully automatic operation including probe change and workpiece temperature logging (manual)

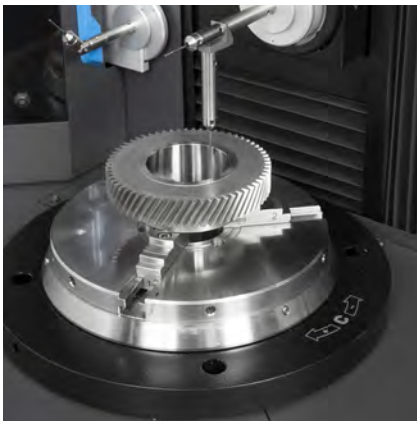
Total measuring time under 6 minutes!

Precise, from the Ground Up

The measuring technology and machine design are the same for the entire P-series line. All machine models can be enhanced with individual options.



- Optimally harmonized model series for all typical industrial applications
- Minimal space requirement and particularly low-maintenance technology minimize running costs.
- Suitable for use on the production floor thanks to temperature compensation – reliable results even in the +15 °C to +35 °C range
- Shielded guides, drives and measurement systems at the axes allow for trouble-free use



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



Innovative, Electrically Operated Clamping System

- Integrated electrically powered three-jaw clamping system
- Adjustable jaw clamping force
- Replaceable attachment jaws for internal and external clamping
- Hollow shaft for workpiece shank immersion
- Extremely easy handling without excessive force
- Made of stainless steel



Broad Range of Applications Thanks to Versatile 3D Tracer Head

- Scanning 3D tracer head with digital data capture 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 contact operation in the normal direction
- Trace direction releasing for general 3D measurements
- Automatic compensation of different probe weights and adaptation of probe rods with multiple probe elements
- Automatic measuring probe change (option)



Greater user-friendliness for a Variety of Conditions

- Ergonomically designed machine concept for easy operation and accessibility of all functional elements
- Probe case for safe storage of probe elements and setting gauge
- Easy machine and software operation by using the approved Klingelnberg combined user interface

HIGHLIGHTS



Maximum Protection 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 and workpiece-like normals of different types and sizes
- Traceability of measuring results to internationally recognized normals (PTB)
- Proof of length measurement uncertainty U1 (option)
- Proof of system suitability for form measurement tasks (option)
- Determination of parameters Cg/Ck and R&R testing (option)



Quick Availability of Measuring Results in Huge Time Savings

- Correction of measuring results for workpiece temperatures deviating from the reference temperature of +20 °C
- Measurement of the current workpiece temperature via a fast thermoelement
- Correction of the workpiece temperature in the range of +15 °C to +35 °C
- Algorithm usable for all metallic/axially symmetrical workpieces



Fully Automatic Roughness Measurement

- Roughness probe system for measured value logging on gears with modules starting at 0.9 mm
- Output values and charting according to DIN EN ISO 4287 (DIN 4762): R_a , R_z (DIN), R_t , R_{max}
- Scanning in the profile or tooth trace direction with standardized trace sections
- Fully automatic operation in connection with profile and tooth trace measurements
- Integrated actuator for diamond scanner alignment
- Probing systems for cylindrical and bevel gears
- Manual or (optional) fully automatic measuring probe change



Versatile Measurement Tasks in One Clamping

- Determination of measurement parameters such as diameter, length, angle, radius
- Determination of form and position parameters such as roundness, cylindrical shape, straightness, evenness, parallelism, symmetry, perpendicularity
- Measuring macros for checking keyways, curved washers and for checking bore reference circles
- Measured value chart output for form measurements with filter levels standardized according to DIN EN ISO 1101
- Linking of dimension/form/length measurements with gear measurements (cylindrical gear/bevel gear) for a continuous, fully automatic measuring run



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
- 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

USER-FRIENDLY SOFTWARE CONCEPT



Evaluation Software with Fully Automatic Measuring Runs

Software plays a crucial role in the performance of the measuring device. It must be possible to test mandatory gear evaluation parameters according to the national and international standards or special requirements of large corporations. The measuring run is fully automatic. The CNC control transmits the measured values online to the software, where the results are evaluated. During the measuring run itself, the program displays results on the screen and then prints all necessary information on easy-to-read measuring sheets, and can also store these locally or via a network.

- Intuitive user interface to Microsoft® Windows® standard – easy and secure operation with minimal training
- Function keys for fast measurement program creation
- Tree structure with direct access to all input levels
- Catalog of stored measurement programs with search function
- Measurement programs with additional image documentation on the workpiece clamping situation



- Password protection for securing programming levels
- Repeat measurement evaluation without new measured value logging
- Individual choice of operator guidance/documentation language
- Application manager for selecting different software modules
- Linking of cylindrical gear/bevel gear/shaft measurement programs (dimensional, form, positional deviations) for a fully automatic cycle
- Various interfaces for further processing of measuring results

More information about KlingelInberg software programs and modules is available in the special software folder



[illegible]

The screenshot displays a CAD software interface with a technical drawing of a shaft assembly. The drawing includes a shaft with various features like holes, threads, and a keyway. Dimensions and tolerances are specified for each feature. The software interface includes a toolbar with various drawing tools and a list of dimensions on the left side of the drawing area.

Dimensions and Tolerances:

- 7.1 $\frac{1}{16}$ AB
- 8 $\frac{1}{16}$ AB
- 9 $\frac{1}{16}$ AB
- 10 $\frac{1}{16}$ AB
- 11 $\frac{1}{16}$ AB
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EXPERTISE IN COUNTLESS INDUSTRIES

Drive Components with Guaranteed Quality Provide Optimal Performance

Drive systems with a wide range of transmission-component and toothed-gear designs are everyday occurrences in the modern world. Electrical drives, for instance, typically have gearboxes for adjusting rotation speed and torque. Thanks to this specific combination, optimum performance density is achieved in power tools and household appliances, as well as many other electrically driven units. And in the electromobility sector, electric drives are combined with extremely powerful gear transmissions. In recent years, transmission requirements in the conventional passenger-car drive train have also increased dramatically. Gearing components undergo a process of continual optimization in order to achieve a larger number of switching stages in addition to transmissions of high torques at compact gearbox sizes. And naturally, these components must perform their job as quietly as possible and without breakdowns. The highest quality requirements must be met to ensure this! With its range of application, integrated electrical clamping system and tried-and-true P series quality, the P 16 provides the ideal conditions for testing these components.



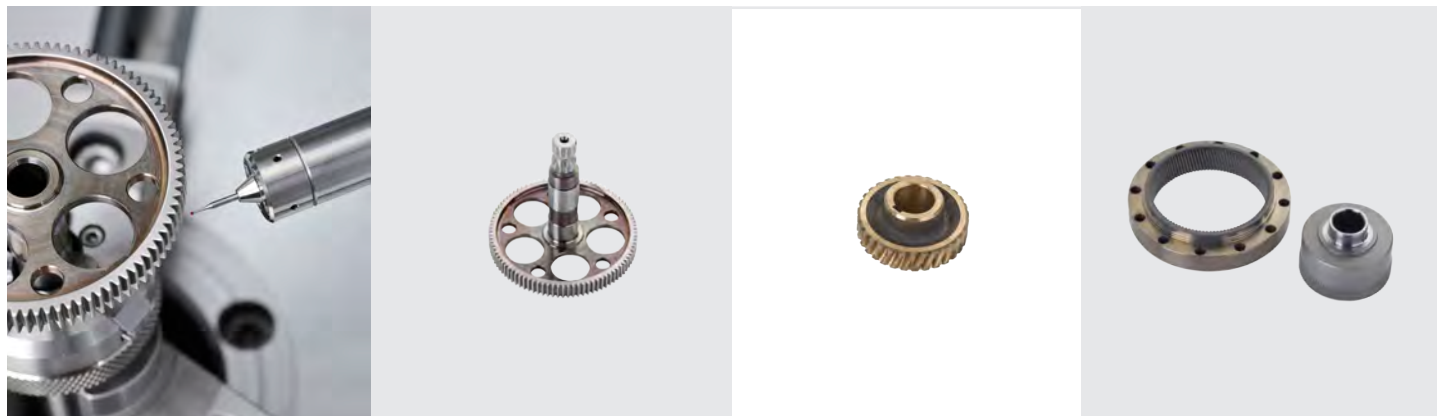
Transmission & Coupling Components



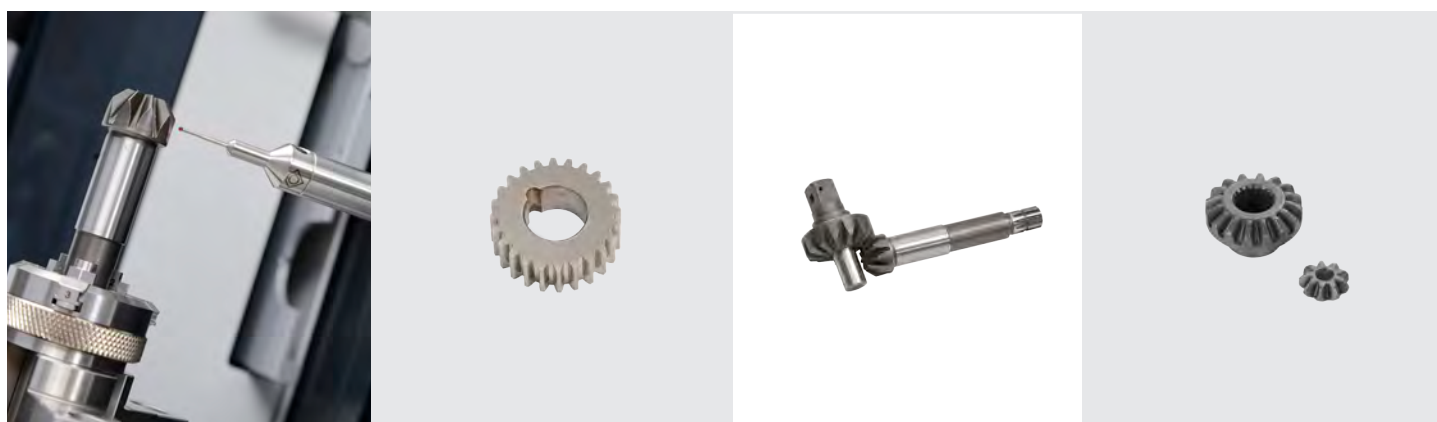
Motor & axis components



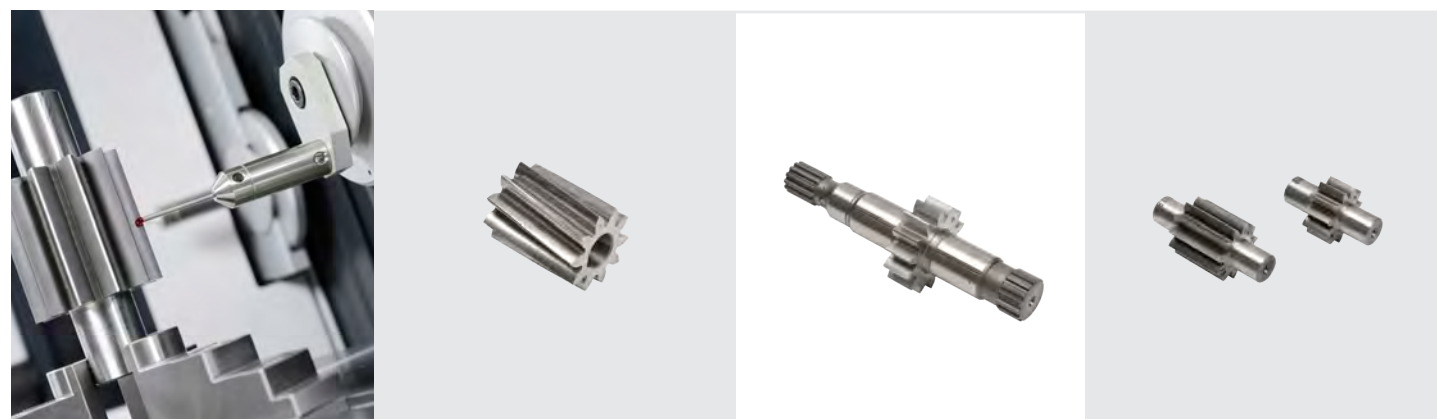
Small-Transmission Components



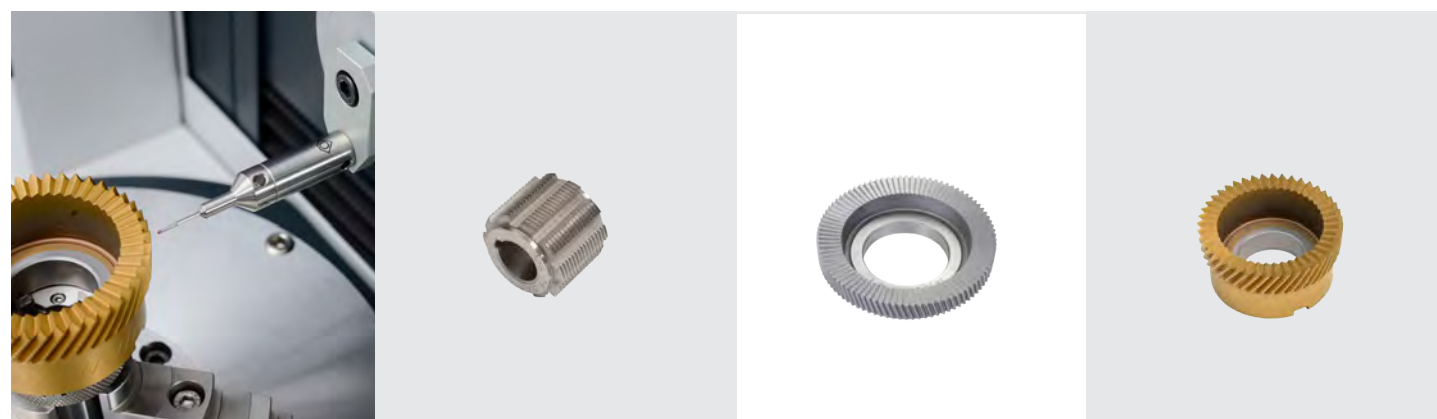
Power Tool Components



Pump Components



Gear Cutting Tools



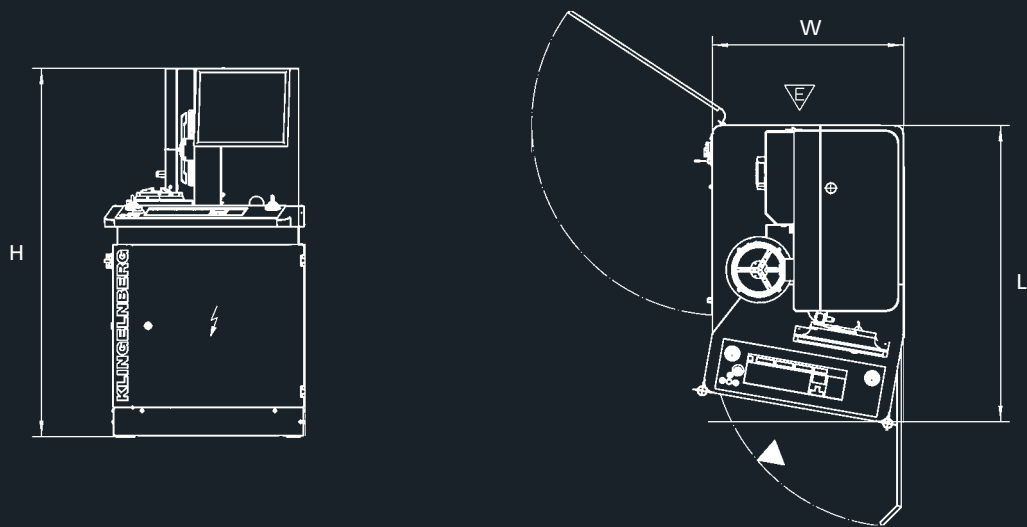
TECHNICAL DATA

P 16	
Module range	(0.1) 0.3 – 8 mm
Horizontal measuring range (rolling path X axis)	+/- 50 mm
Smallest/largest helix or lead angle	0° / 90°
Clamping/testing diameter of cylindrical gears between centers (max.)	160 mm
Permissible moment of inertia (max.)	0.1 kgm ²
Permissible test gear weight (max.)	10 (20) kg
Vertical measuring range (Z axis)	250 mm
Electric clamping system	
Internal clamping range	Ø 25 – 160 mm
External clamping range	Ø 0 – 160 mm
Shank immersion depth	200 mm at Ø 30; 75 mm at Ø 45
Chart recording magnification	50; 100; 200; 500; 1000; 2000 x
Chart length magnification	0.5; 1; 2; 4; 5; 10; 20 x
Measuring accuracy in observance of +20 °C reference temperature	
Gear measurement according to VDI/VDE 2612 Pt. 1 and 2, and 2613	Group I
Shaft measurement according to VDI/VDE 2617 Pt. 2.1, (¹) Reduced shape in axis-parallel direction	MPE _{E0} ISO 10360-2 (20110) 1,5+L/250 mm (¹)
Concentricity and axial runout in accordance with DIN EN ISO 1101	< 0,3 µm
Permissible temperature gradient	2 K/h; 12K/d; 2K/m (+15 – +35 °C)
Machine service readiness	+15 – +35 °C
Total connected load of the machine	approx. 0.7 kVA
Net weight incl. standard equipment	approx. 990 kg
Machine dimensions (L x W x H)	approx. 1,305 x 840 x 1,620 mm (1,305 x 1,340 x 1,620 mm)*

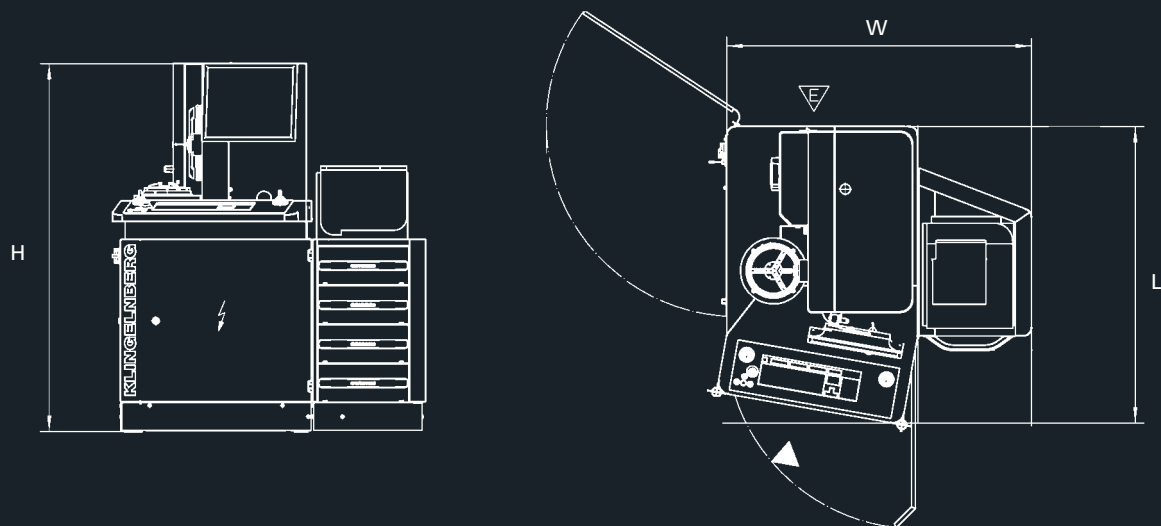
(values in parentheses are optional)

Installation Dimensions

P 16



P 16 with special equipment*



All dimensions in mm (inch)

KLINGELNBERG Service

The Klingelberg Group is a world leader in the development and manufacture of machines for bevel gear and cylindrical gear production, precision measuring centers for gearing and axially symmetrical components, and 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, and in Győr, Hungary.

The company also has sales offices and service centers and numerous trade representatives worldwide. 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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You can also find your local contact for sales advice at www.klingelberg.com/contact.