



HÖFLER

TM 65

CYLINDRICAL GEAR TECHNOLOGY – COMPLETE MACHINING



KLINGELNBERG

Innovative Cylindrical Gear Machining for Flexible Requirements

All around the world, manufacturers of gears and gear-boxes ensure their leading edge in gear machining with innovative, advanced technology by Klingelnberg.

The [Höfler Cylindrical Gear Technology](#) division allows users to manufacture cylindrical gears with diameters from 20 millimeters up to 10 meters economically and with high precision. Moreover, thanks to decades-long expertise and great innovative strength, Klingelnberg is able to maintain a leadership position not only through its high research and development standards, but also its in-house application engineering services.

Klingelnberg offers advanced technology and efficient machines for cylindrical gear manufacturing. The company sees itself as a solutions provider that supports its customers from gear design to quality assurance, in order to produce top quality gearing. Klingelnberg's software system for production management from process design to quality control is called [Closed Loop](#) – and is now also available for cylindrical gears.

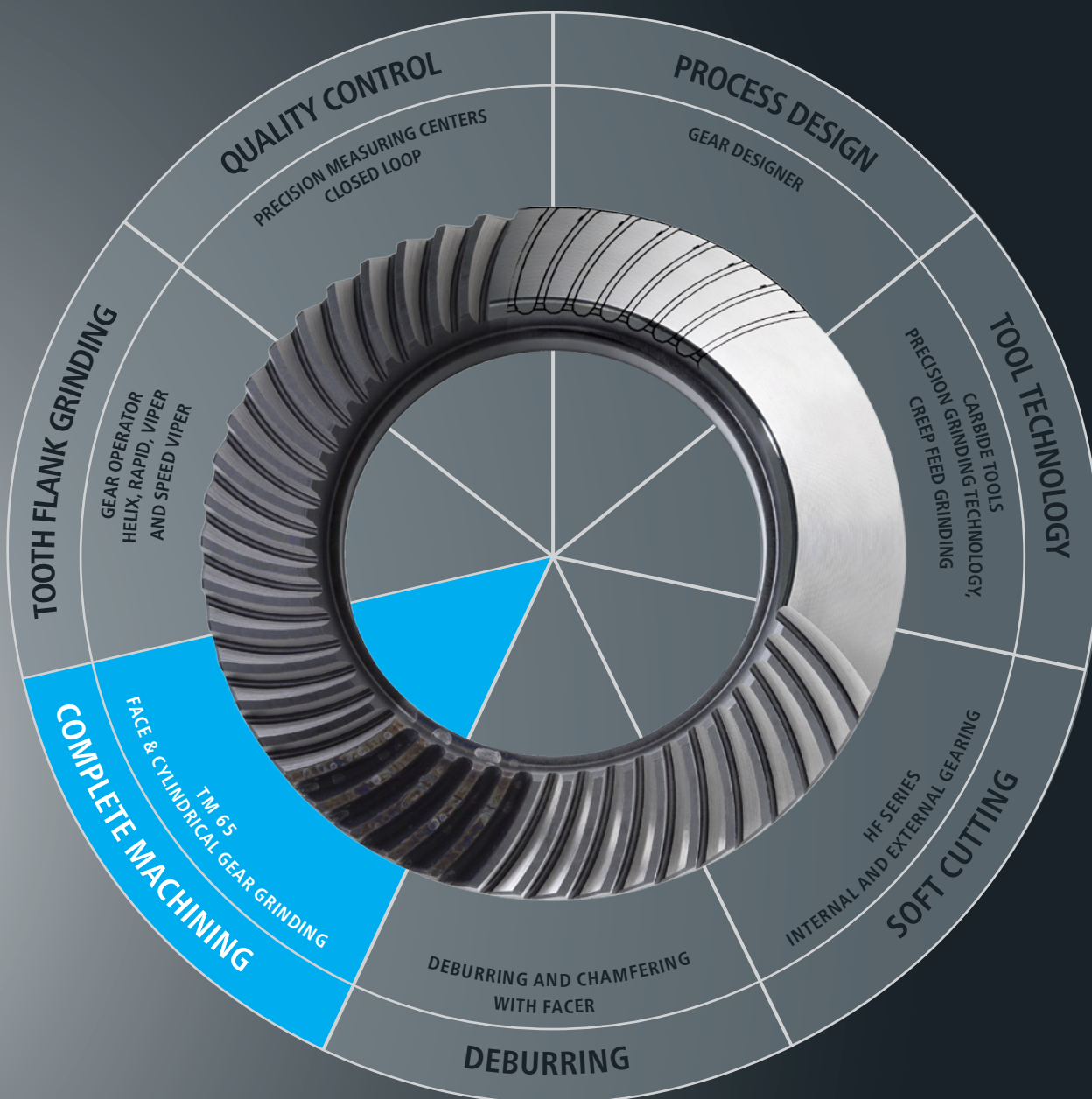
Its core component is the powerful duo, [Gear Designer](#) and [Gear Operator](#) – two newly developed software solutions that accurately simulate the entire manufacturing process using a digital twin of the workpiece to be ground, providing optimal support for gear design and manufacturing.

Höfler cylindrical gear machines are developed with real-world applications in mind and satisfy a whole host of application industry requirements. Customers include all gearbox manufacturers in the precision engineering, aviation and automotive industries, as well as manufacturers of large gears for the energy industry.



HÖFLER complete machining center TM 65

Exceptional Concepts for Every Step in the Gearing Process



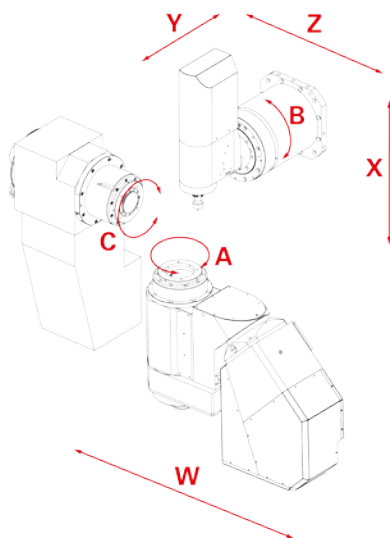
Customized Solutions for Every Production Requirement

With the HÖFLER complete machining center TM 65, Klingelnberg has designed a machine that can produce gear bodies and gearing systems of any complexity **up to 65 mm in diameter, in a complete machining process starting with rod material** – whether bevel gears, cylindrical gears or internal gearing with an involute or non-involute tooth profile.

The presence of a main spindle and subspindle allows complete machining of even complex components on a single machine. These two workpiece spindles make it possible to machine every surface of a component within the machine, regardless of whether it's a shaft or disk-shaped component. And thanks to the swivel unit on which the subspindle sits, there are no collision problems. The tool spindle on the TM 65 is capable of up to 30,000 rpm, allowing the use of grinding tools in addition to small cutting and drilling tools.

Another highlight of the TM 65 is the tool changer integrated into the machine, which has space for up to 90 tools and ensures that no manual intervention is required during the machining process. The machine bed is water-cooled and temperature-stable; the linear drives are wear-free and highly dynamic.

- Complete machining of gears from rod material up to 65 mm
- Klingelnberg gear technology for bevel and cylindrical gearing
- Turning, cutting, boring, slotting and gearing on a single machine
- Maximum spindle speed of 30,000 rpm
- Subspindle freely pivots by 90°
- Integrated tool changer with up to 90 tool slots
- Easy system accessibility and compact design
- Wear-free, highly dynamic linear drives

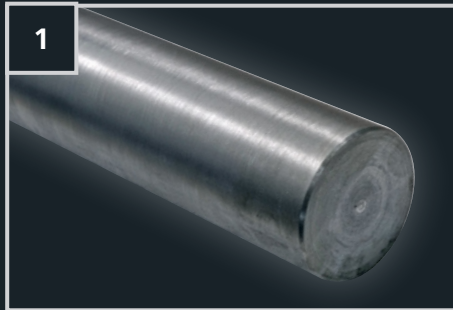


Spindle concept

Axis diagram:

A	Subspindle
B	Tool spindle
C	Main spindle
X	Vertical axis
Y	Lateral axis
Z	Horizontal axis
W	Horizontal axis

From the Rod to the Gear in Six Process Steps



BLANK



TURNING



CUTTING



BORING



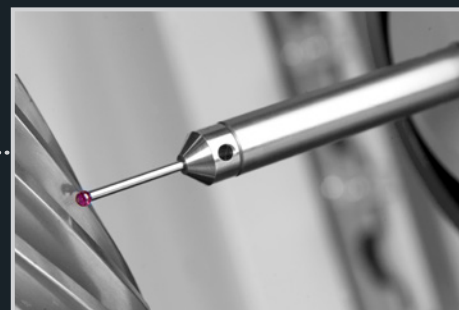
GEARING



GRINDING



MEASUREMENT



MEASUREMENT

CORRECTION

CORRECTION

HIGHLIGHTS

All-In-One Solution

Bevel gears, cylindrical gears and internal gearing with involute or non-involute tooth profiles can be manufactured "from the rod" with the TM 65:

The toothed gear is simulated in a CAD model, and data records for the NC are generated via a CAD/CAM interface. The large tool magazine with up to 90 slots allows for a variety of processing steps, without retooling. Gears are designed with the familiar Klingelnberg software packages:

- Flexible bevel gear production with ARCOFLEX
- Gear design with KIMoS (Klingelnberg Integrated Manufacturing of Spiral Bevel Gears)
- Use of the Klingelnberg Closed Loop process
- Machining of face gears with powerskiving and hobbing

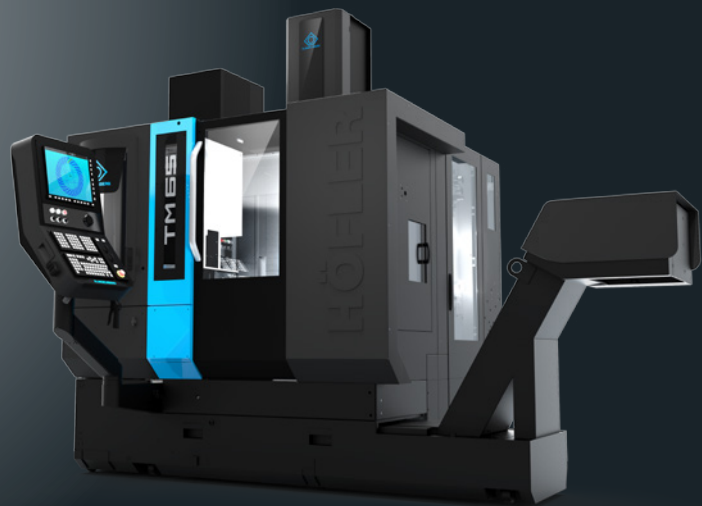
Result:

The TM 65 combines gear cutting technology and the Klingelnberg Closed Loop concept with the flexibility of a modern machining center – without lengthy machining times.

Turning, Cutting, Boring, Slotting and Gearing on a Single Machine

"The gear cutting industry is in transition" – Gear manufacturing today is not just limited to gear cutting machines. These days, machining centers are equally capable of manufacturing gears. With the TM 65, Klingelnberg is taking a fresh approach to complete machining of toothed gears using a method that relies on Klingelnberg's Closed Loop system. Bevel gears designed with KIMoS are manufactured true to design on the basis of a virtual twin, making technological know-how for the automotive industry available for small-batch production. TM 65's success factors include:

- Bevel gear manufacture using the Klingelnberg production system
- Face gear manufacture with powerskiving and hobbing
- Finishing of complex components on a single machine



HÖFLER complete machining center TM 65



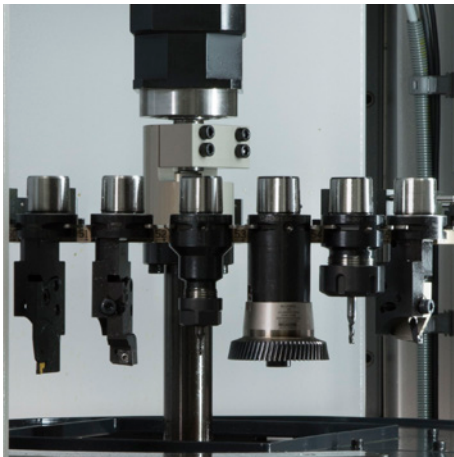
Complete Processing from the Rod

- Hainbuch main spindle / subspindle clamping system designed to process all surfaces of a component inside the machine
- Clamping system change-out takes just a few minutes
- Standard mounting arbors for grinding work
- Innovative kinematics for maximum processing with minimal space requirements
- Up to 90 tools allow for all types of machining



Tool Spindle with High Speed and Torque Levels

- Direct lubrication at the bearing points enables continuously high speeds and long spindle life
- High-frequency spindles with speeds of up to 30,000 rpm
- Strong acceleration/deceleration of the tool spindle
- High-pressure interior cooling for grinding work and extremely compact tools
- Processing with extremely compact carbide cutters and cutter heads up to 80 mm in diameter



Universality to the Highest Degree

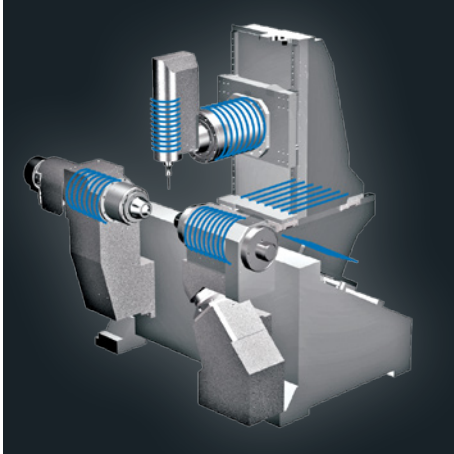
- Turning, boring, cutting and slotting on a single machine
- Universal tool magazine
- Integrated tool changer with up to 90 tool slots
- Capto C4 holder as interface to the tool spindle for high rotational torque with maximum concentricity and axial runout accuracy
- Outstanding tool monitoring thanks to easy accessibility of the 30, 60 or 90 tool slots
- Hard finishing with electroplated CBN grinding wheels



Innovative and Intuitive Operating Concept

- Use of Fanuc 31i control – the world's most widely used NC control
- Easy, user-friendly use and programming
- KIMoS software for bevel gear set creation
- Universal CAD/CAM system based on customer requirements
- Integration of KIMoS and Gear Designer into the Closed Loop process
- Unlimited Closed Loop-capability for bevel and cylindrical gear processing

HIGHLIGHTS



Maximum Tooling Precision

- Stabilized cooling circuit for all heat-generating elements ensures stable production and reduces warm-up times
- Combination of cutting-edge technologies enables superior surface quality with minimal processing time
- Linear drives in the horizontal axes allow for reduced auxiliary times and excellent dynamics
- Maximum tool service life
- Wear-free linear drives



Quality and Efficiency thanks to the Closed Loop System

- Gearing correction based on a virtual twin
- Efficient data management for optimizing production and ensuring high quality standards
- Complete integration of the machine into the Klingelnberg production system



Energy Efficiency (e²) for Maximum Savings

- Compact design
- Short processing times
- Thermal stability
- Custom dimensioning of drives
- Recuperation of kinetic energy through direct drives and linear motors

Versatile Allrounder with a Broad Range of Machining Methods



ARCOFLEX Method

- Only one blade required for an entire module range
- Module range 0.3 mm to 3 mm
- Normal pressure angle 20°



Cylindrical Gear Hobbing

- Module range up to 2.5 mm
- High productivity



Cylindrical Gear Powerskiving

- Internal powerskiving from tip circle diameter $D = 8$ mm
- Method saves machine wear
- High productivity



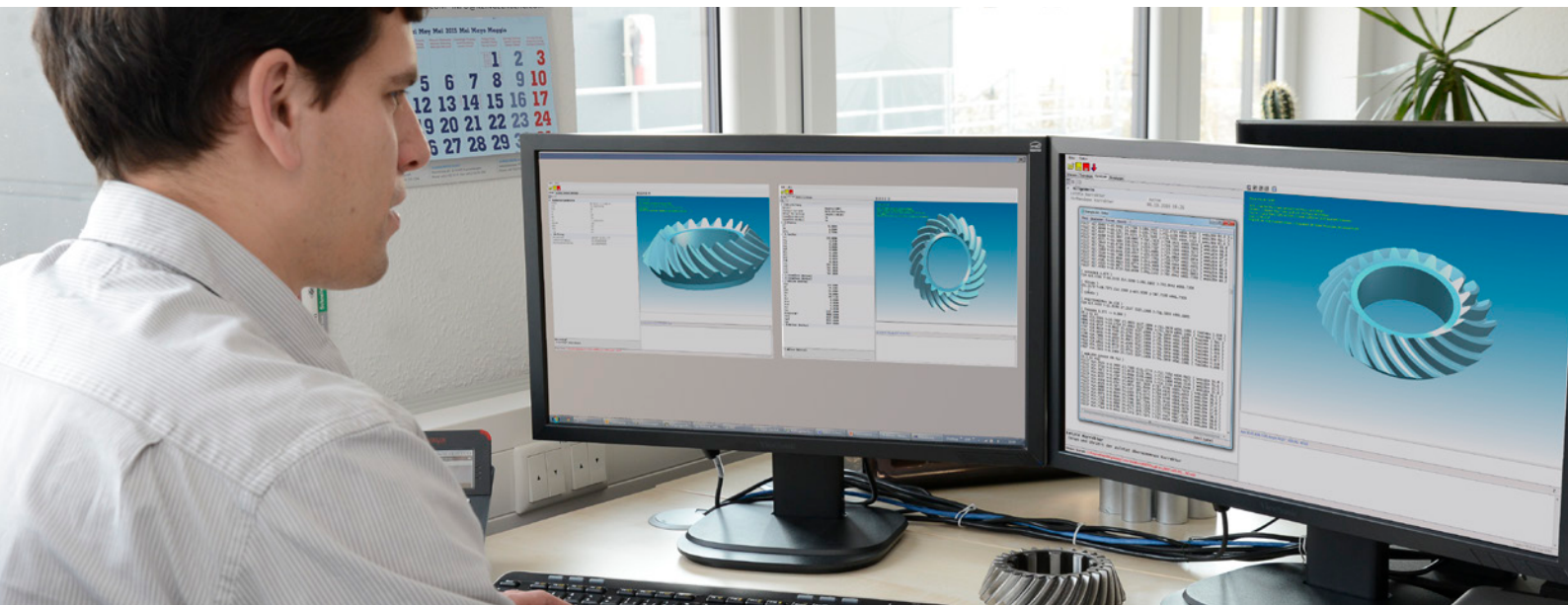
CBN Grinding System

- No dressing required
- Standardized grinding wheels



Tools for Broaching and Slotting

- Broaching of feather keys
- Slotting according to DIN 5480



Real Productivity Gains with the Klingelnberg Software Environment

Productivity is often reduced to the machining process, and the work involved in NC programming is not taken into account. Yet particularly when processing toothed gears using five-axis free-form cutting, the time it takes for the NC programming is often greater than for the actual machining process.

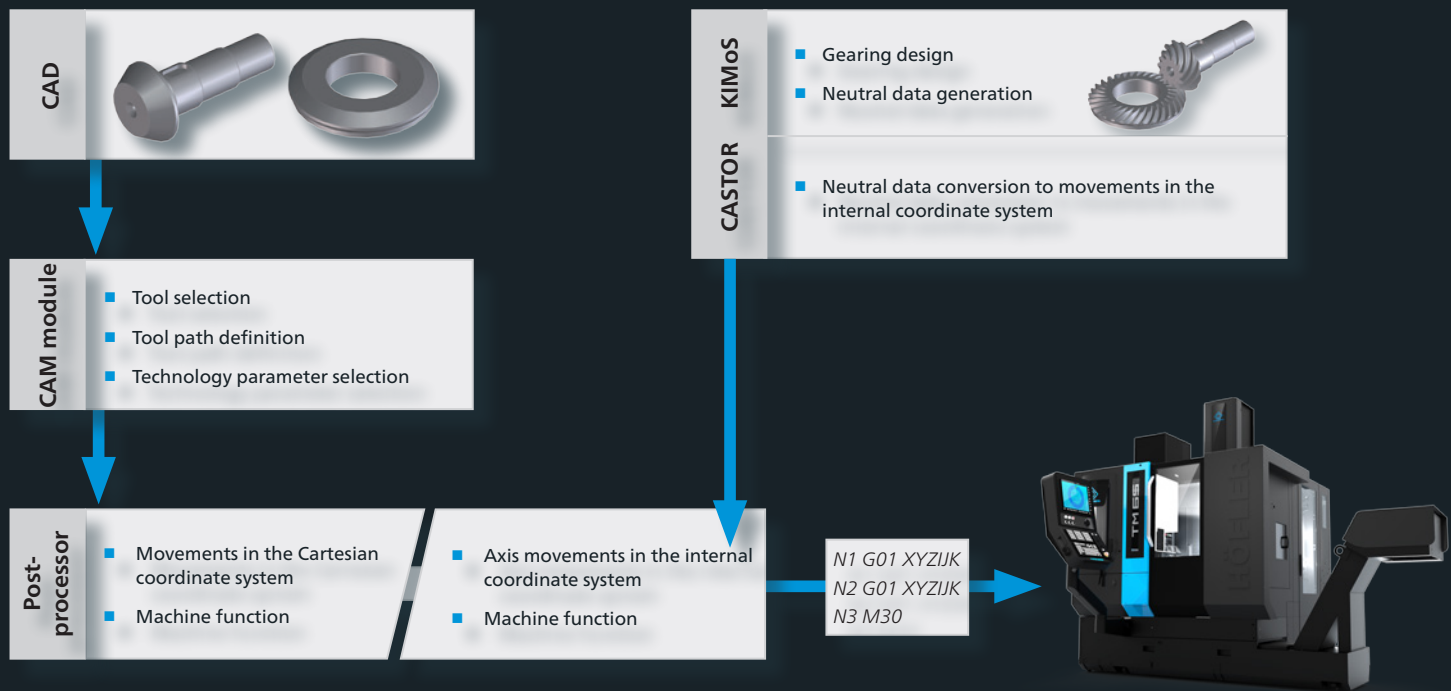
Klingelnberg has developed a software package for the TM 65 in which five-axis machining can be seamlessly combined with the high-performance gear design programs. Users simply select the preferred system as soon as the CAM manufacturer's post-processor is available. To ensure the flexibility to employ various CAM systems, the machine axes are not used directly in the CAM module; instead, the movement between the tool and the workpiece is generated based on a simple virtual coordinate system.

To process the gear body, common CAD/CAM systems are used, as well as universal tools in the tool magazine. These systems provide the capability to process the most complex form elements in a flexible manner. Generation of NC data for gear production, however, is fundamentally different: It relies on neutral data based on the geometry of a universal cutting machine. The **CASTOR software package** designed specifically for the TM 65 converts the neutral data to generate NC data in the (x,y,z,i,j,k) coordinate system for gear cutting. The different programs, **KIMoS for bevel gears** and **Gear Designer for**

cylindrical gears, not only describe the geometry of the gears; they also calculate the production motion that the workpiece and tool must follow to produce the calculated gearing.

Klingelnberg uses two different systems to generate NC data, since it is much more productive to produce bevel gears using an end milling cutter than it is to employ multipass cutting with a shank-type cutter. In addition, by using neutral data as the basis for gear calculation, users have Klingelnberg's entire technology toolbox at their disposal. Users can then decide in the gear design phase whether to use ARCOFLEX, a universal tool system for small to mid-sized batches or ARCON®, a special tool for large numbers of units. A major advantage of the Klingelnberg software solution is its unlimited Closed Loop-capability. The familiar **KOMET** and **Gear Corrector** programs make implementing gear geometry corrections quick and easy. On the TM 65, manufacturing deviations of all types are eliminated with the touch of a button.

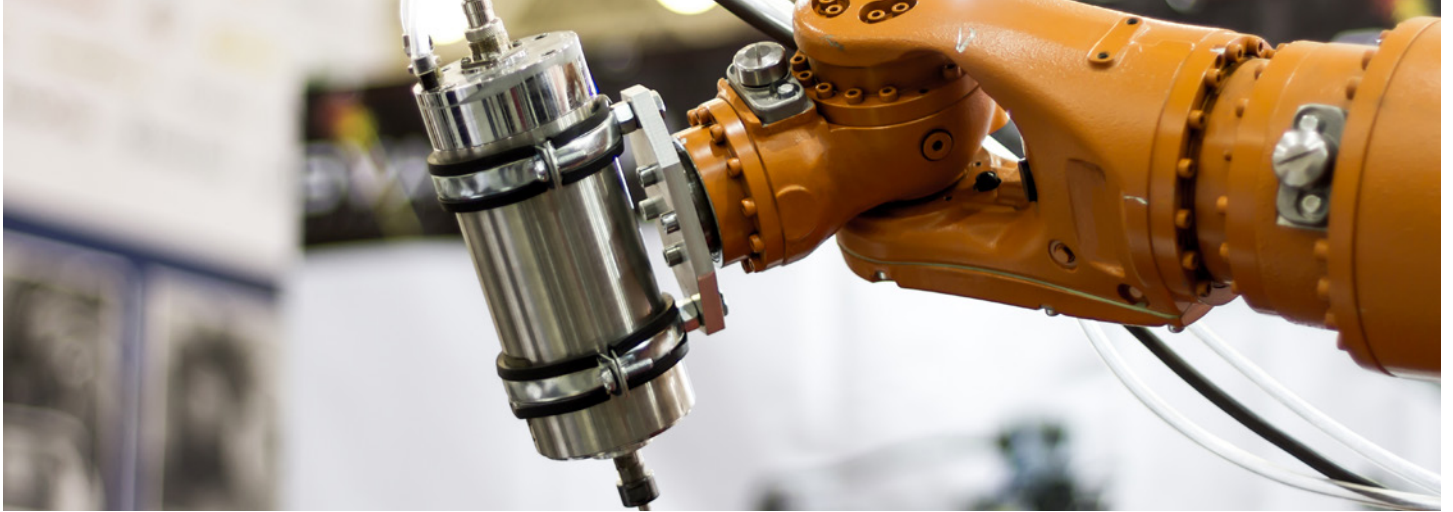
The Industry 4.0 Software Environment



Convenient, Universal Software for Five-axis Machining and Gear Cutting

- Direct connection of powerful KIMoS and Gear Designer gear calculation programs
- Closed Loop integration for compensation of manufacturing deviations
- Fast NC programming
- Cutting, grinding for bevel and cylindrical gears
- Powerskiving for internal and external gears
- Full software support for manufacturing custom profiles such as cycloids, splines, etc.

Robots – an Integral Part of Modern Production and Handling Systems



These days, robot-based automation solutions are considered an integral part of industrial production facilities. But other industries, such as medical engineering, also benefit from modern production and handling systems. When robots are charged with performing highly complex tasks, this can significantly reduce physical stress on workers resulting from repetitive or ergonomically critical activities. Compared with conventional manual and mechanized processing solutions, the key benefits include high availability and reliability in particular, as well as positioning accuracy and reproducibility in the motion sequences. For these reasons, robot systems have become a permanent fixture in countless areas of application.

The challenge for robot systems

The growing demand for robot systems results in the need for a price and quantity-driven market of efficient, robust production of quality-defining components. For efficient, cost-effective implementation of motion and handling tasks, robot systems

must be highly mobile and highly dynamic in their traversing and positioning operations. At the same time, precise, uniform transmission of motion and torque is a major challenge for the gearboxes used in the joints and actuators in robot systems. This in turn requires minimal backlash and high torsional strength.

Solutions for high-precision drives

Klingelnberg has embraced this challenge by offering a production system that delivers solutions for manufacturing high-precision drives in series. Complete machining of complex, toothed components in small, mid-sized and large batches is an offer in the robot industry for which no alternative exists.

Cycloid gear cutting, shown here on a HÖFLER cylindrical gear grinding machine VIPER 500 K



Machine Tools



Today's powered tools come in a broad range of designs. The challenge: to manufacture bevel gear sets in quantities of one to two sets. The solution: with the TM 65, Klingelnberg has developed one machine that can be used to manufacture a broad array of bevel gear sets in many different sizes and with widely varying shaft angles.

Medical Engineering



Modern operating methods require increasingly sophisticated instruments. For example, tooth drills and surgical knives are powered by miniature bevel gears. Tip circle diameters of less than 8 mm with modules as small as 0.2 are not uncommon. With the TM 65, Klingelnberg offers tailor-made solution concepts for the production of modern miniature bevel gears.

Industrial Gear Units



The industrial gear unit sector comprises many different applications, all of which place great demands on the reliability of gear wheels. The gears for these sectors are often produced by companies specializing in small batch sizes and a variety of products. A stiff machine design and flexible, cost-effective tool systems are the keys to success for ranking among the market leaders in these sectors.

Precision Engineering



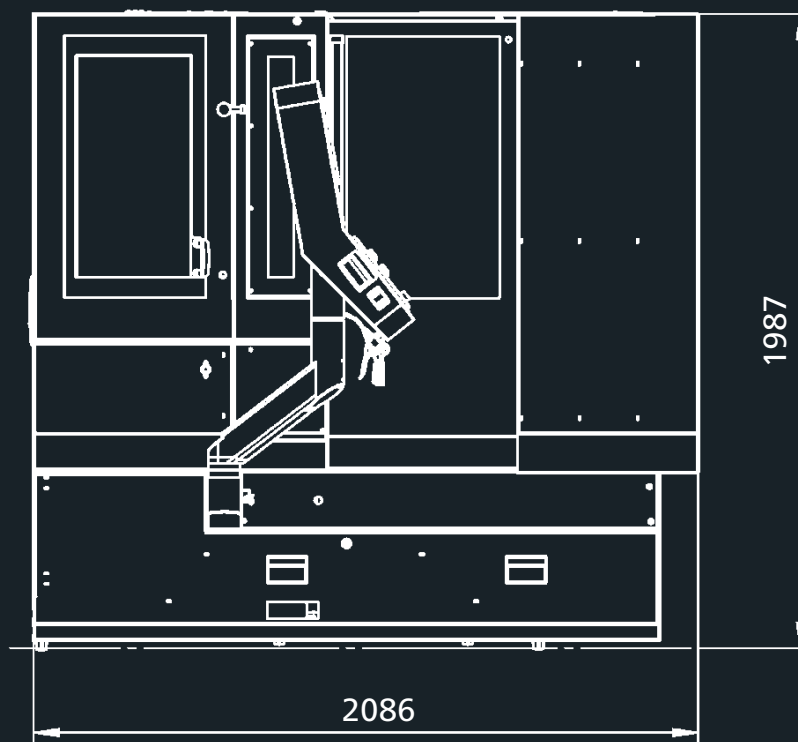
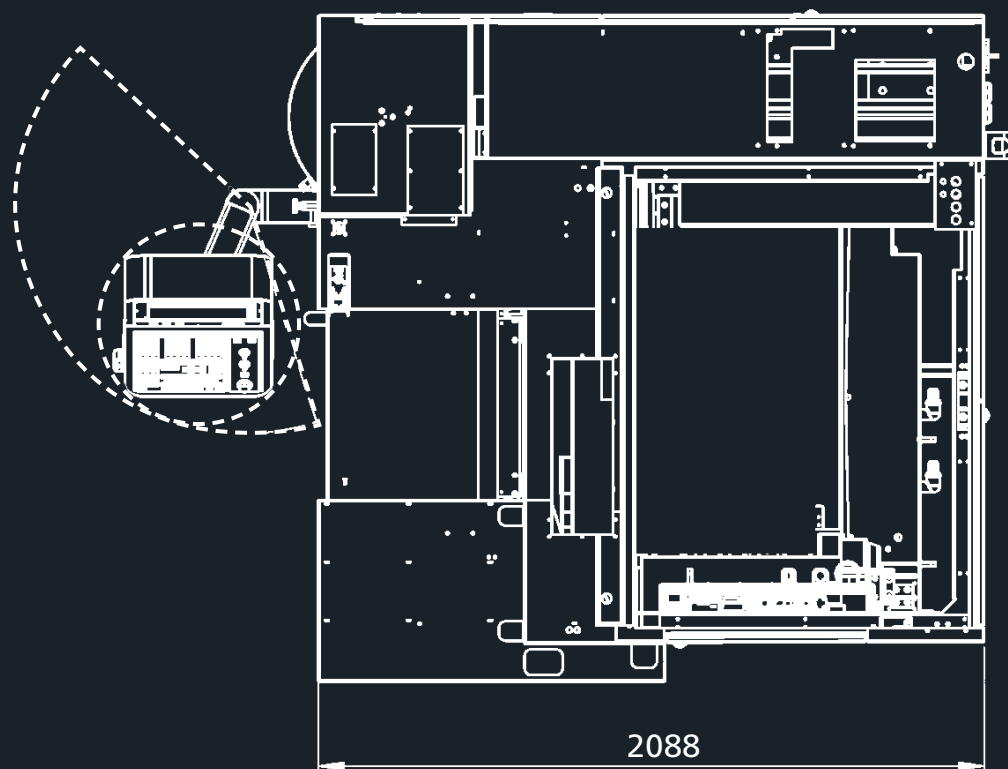
Drive systems with a wide range of transmission component and gear designs are now part of everyday life. Electrical drives, for instance, typically have gearboxes for adjusting the rotation speed and torque. Thanks to this specific combination, optimum performance density is achieved in power tools and household appliances, as well as many other electrically driven units.

TECHNICAL DATA

TM 65

Basic machine	
Traversing paths	X = 410 mm x 200 mm x 400 mm
Power X-Y-Z	X = 4.5 kW / Y = 4.8 kW / Z = 7.2 kW
Axial force X-Y-Z	X = 360 daN / Y = 240 daN / Z = 360 daN
Rapid traverse X-Y-Z	50 m/min
Main spindle C	
Power (direct drive)	15 kW
Torque S1 S2 S3	84 / 104 / 124 Nm
Rotation speed (max.)	6,000 rpm
Partial speed (max.)	90,000 °/min
Resolution	0.0001°
Rod capacity	Ø 65 mm
Subspindle A	
Power	15 kw
Rotation speed (max.)	6,000
Tool spindle	
Power	13 kw
Torque duration/peak	S1 = 9.5 Nm / S6 = 11.5 Nm
Rotation speed (max.)	30,000 rpm (40,000 optional)
Interior cooling pressure (max.)	100 bar (optional)
Tool spindle	CAPTO C4
Total weight	approx. 4,200 kg
Machine dimensions (L x W x H)	approx. 2,086 x 2,088 x 1,987 mm

Installation Dimensions



All dimensions in mm

KLINGELNBERG Service

The Klingelberg 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 its headquarters in Zürich, Switzerland, 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 100 patent grants, the company consistently demonstrates its capacity for innovation.

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