



HÖFLER

VIPER 500 ^{MFM}

CYLINDRICAL GEAR TECHNOLOGY – CYCLOID GRINDING MACHINES



KLINGELNBERG

Innovative Cylindrical Gear Machining for Flexible Requirements

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

The [Höfler Cylindrical Gear Technology](#) division does more than just allow users to manufacture cylindrical gears economically and with high precision. All machines have been perfectly designed to work together as a system family, enabling pre-machining and finishing of even the most complex gearings. And high research and development standards, a global service network, and an in-house application engineering service ensure a leadership position – now and in the years to come – thanks to our decades-long expertise and high innovation capacity.

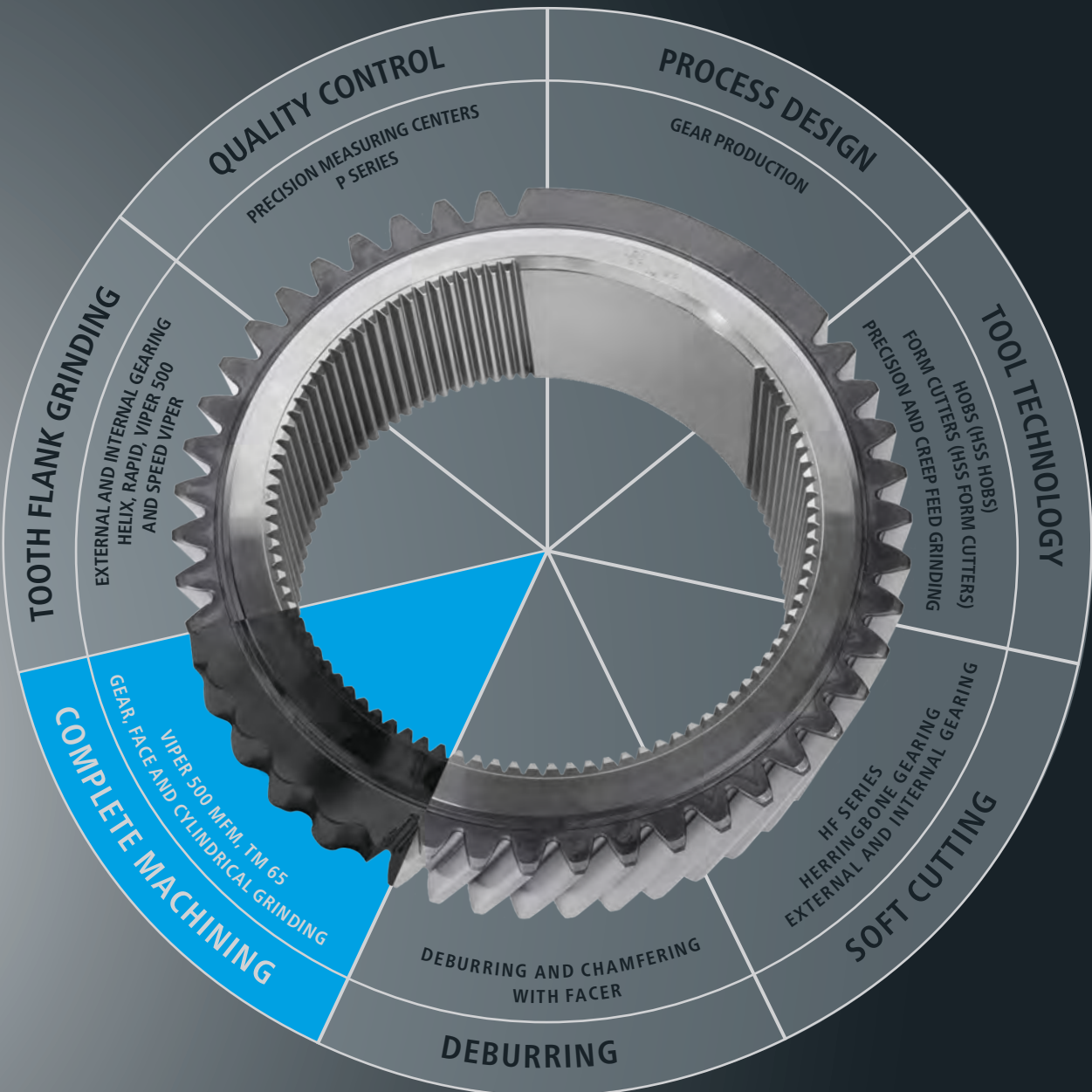
Klingelnberg offers the most advanced technology and efficient machines for each and every step in the cylindrical gear process chain: [process design](#), [cutting](#), [measuring](#), [deburring](#), [grinding](#) and [quality control](#). A key factor in the successful completion of each work step is the [Gear Production software](#), which provides optimal process control and extreme ease-of-operation to guarantee maximum efficiency in daily production routines.

Höfler cylindrical gear machines are developed with real-world applications in mind and satisfy a whole host of application industry requirements. Customers include contract gear manufacturers and transmission manufacturers from the aviation, automotive, mining, construction, industrial transmissions and wind power industries, among others.



Cell version of the HÖFLER VIPER 500 MFM cycloid grinding machine

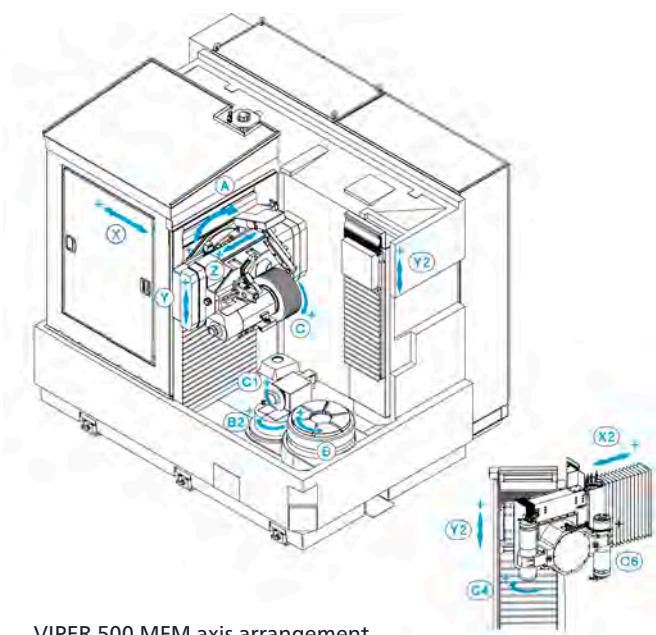
Exceptional Concepts for Every Step in the Gearing Process



Leading Technology for a Productive and Precise Production Process

The **VIPER 500 MFM (Multifunction Machine)** from Klingelnberg is a complete, coherent concept for finishing cycloidal disks in a fixed setting on a single machine. First, the gearing itself is quickly and precisely machined using a **profile or generating grinding method**. The innovative Klingelnberg 3D dressing method helps achieve maximum accuracy during profile grinding. Once the cycloid gearing has been ground, a newly developed additional grinding unit in place of the counter support in the tried-and-tested base machine makes it possible to finish the eccentric bores with maximum precision. The integrated precision measuring center used in "Adaptive Grinding" ensures precise alignment of the bores with the gearing. The complete concept also includes a newly developed clamping system, in which up to four disks in the package can be set up in parallel with machining and brought to the machine fully prepared on a clamping mandrel. An add-on automatic loader and integrated P 40 Precision Measuring Center make the VIPER MFM a cycloid grinding-measuring cell that is fit for Industry 4.0. In a fully automatic **Closed Loop** with the precision measuring center, the workpiece is automatically measured, and any required corrections are made. Klingelnberg thus offers its customers an unparalleled solution for machining cycloidal disks on a single machine.

- Specially designed machine for complete machining of cycloidal disks
- Machining of gearing and eccentric bores on a single machine without rechucking
- Additional grinding unit in place of the counter support
- Precise alignment of bores with the gearing thanks to an integrated measurement system and adaptive grinding
- No need for a second machine tool
- Setup in parallel with machining time on a separate setup station



VIPER 500 MFM axis arrangement

CNC Axes

X	radial axis	B ₂	dressing device swivel
Y	lifting slide	X2	radial axis for cylindrical grinding
B	machine table	Y ₂	lifting slide for cylindrical grinding
A	helix angle	C ₄	cylindrical grinding spindle ₁
Z	shift axis	B	cylindrical grinding spindle ₂
C ₁	controlled grinding wheel and dressing roll drives		

Done-in-One: Bore Grinding and Gear Grinding on One Machine

Profile grinding



- Grind gearing using the flexible profile grinding method

Generating grinding



- Grind gearing using the fast generating grinding method

Bore grinding



- Bore grinding with CBN grinding pins

HIGHLIGHTS

Adaptive Grinding: Increasing Productivity and Precision

The workpieces are clamped together in a package of four outside the machine. This package is then brought into the machine.

1. First, the gearing is rough-machined using the generating grinding method.
2. The measuring probe automatically calibrates itself on a reference collar and measures the root circle diameter of the gearing.
3. The next stage entails finishing to the final dimensions. The gearing is finish-ground and can be measured on the machine. The position of the gearing on the machine is known.
4. The position and diameter of the bores are determined. The bores are rough-machined and then automatically remeasured.
5. Finally, the bores are finish-machined and can be measured on the machine.

IN SUM: Thanks to superior technology, the time- and cost-intensive measurement and pairing of components can often be eliminated with the VIPER 500 MFM.

High-Tech can be so easy!

HÖFLER cylindrical gear grinding machines are the method of choice for high-precision machining of cycloid gearings, particularly in the robot industry. In the conventional process chain, additional machines are still required for grinding out eccentric bores in the cycloidal disks. As a consequence, machines must be linked together, additional space is required, and, most importantly, components must be reset, leading to decreased quality standards. The VIPER 500 MFM combines maximum precision with cost effectiveness for the first time by grinding the external gearing and the eccentric bore in a fixed setting.

- Time savings, since setup and handling are eliminated and production space is reduced
- No special machines required for hard-fine machining of eccentric bores
- Superior process quality through integrated quality monitoring



CELL VERSION OF THE HÖFLERVIPER 500 MFM cycloid grinding machine



Done-in-One: Integrating Bore Grinding and Gear Grinding on One Machine

- Highly efficient profile and generating grinding of cycloid gearings
- Bore grinding by an additional grinding head
- Direct drive for maximum precision
- Additional axis for roughing and finishing tools
- Grinding of centric and eccentric bores
- Grinding of bearing seats



Adaptive Grinding System

- Complete control of the grinding process with the new Adaptive Grinding System
- Automatic measurement and correction of workpieces during gear grinding for maximum precision
- Automatic measurement and correction of workpieces during bore grinding for maximum precision
- Superior process quality through integrated quality monitoring with an integrated measurement system



Simple Production of High-Precision Cycloid Gearing Thanks to the Closed Loop System

- High-precision cycloidal disks – so simple to manufacture thanks to the Closed Loop system
- Automatic correction based on measuring results, requires no operator intervention in the process
- Closed Loop in a flexible profile grinding method with universal shape dressers: automatic complete measurement of all cycloid gearing tooth spaces on the precision measuring center and therefore monitoring of the generated profile form
- Calculation and execution of an appropriate form correction through modified dressing



Fast Quality Inspection with KLINGELNBERG Precision Measuring Technology

- Klingelberg Precision Measuring Centers are optimized for fast measurement of axially symmetrical components
- Combination of form measurement, 3D coordinate measurements with high-precision 3D-NANOSCAN probing system, and high-precision rotary table enables complete measurement of reference bores (cam bores) in cycloid gearings
- High-precision, functional gear measurement, as well as dimensional measurement and form measurement of all geometry elements
- Fast scanning process for cycloid geometry and high-precision acquisition of the tooth form

HIGHLIGHTS



Minimal Retooling Times

- Quick changeover from generating grinding to profile grinding just by swapping out the grinding wheel, grinding wheel flange and dressing roll
- Quick grinding wheel changes using the swivel axis, which moves the grinding wheel 180 degrees toward the operator
- Tool quick clamping system for fast and easy tool changes
- Quick changing of the grinding pins thanks to the HSK interface



Industry 4.0 Solutions with the GearEngine® Complete System

- Everything at a glance: cell status is visualized on compact dashboards
- Leading-edge technology for a future-proof design: OPC UA standard for machine data
- Intuitive software: easy retrieval of measuring results with laser scanners
- Easy data integration through automatic archiving and scanning of measured data
- Elimination of operating errors thanks to software-assisted wizards for all steps



Convenient, Clearly Laid-out Operating Concept

- Intelligent control technology with fast, rational and intuitive dialog input and job engineering
- Clear navigation and visual workflow support prevent user errors
- Continuous graphical display of machine statuses and processes
- Graphical display of possible workpiece clamping collisions before the problem occurs on the machine

Cycloid Grinding-Measuring Cell: Measurement and Machining

1 Integration of bore grinding and gear grinding on one machine

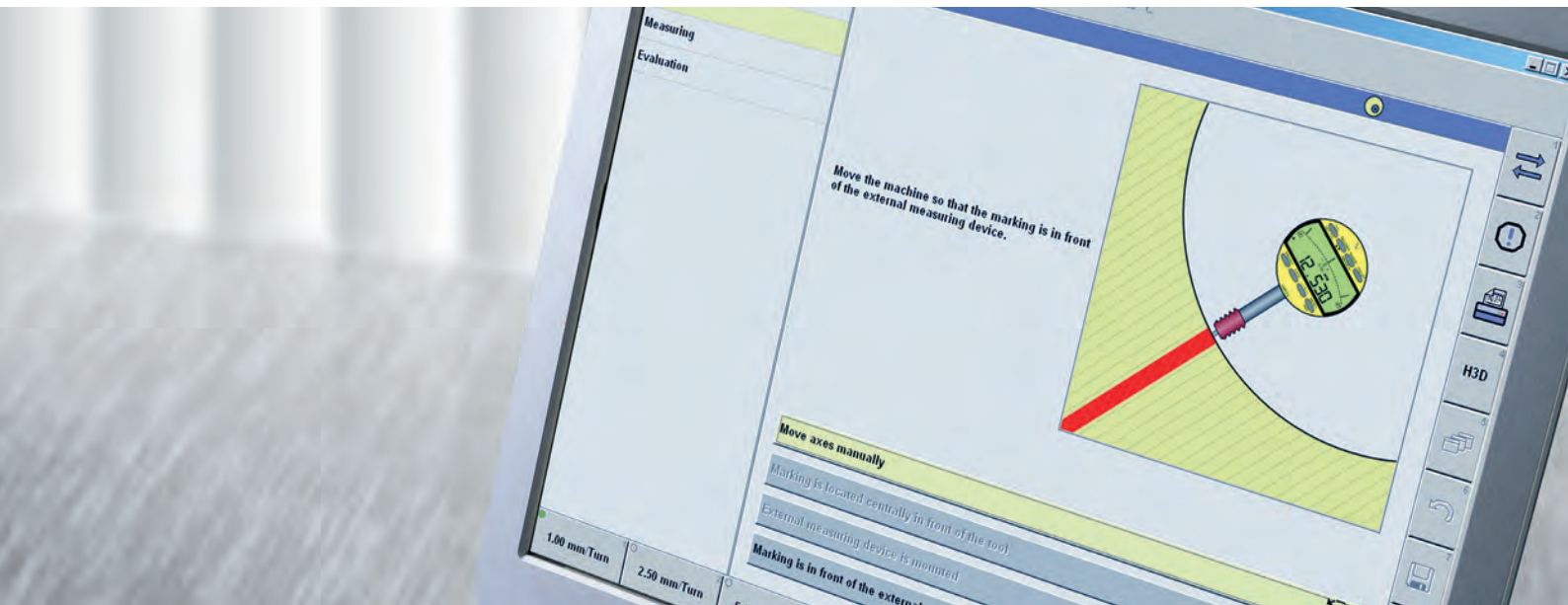
2 Linking of the machine tool and the precision measuring center through automation



3 Convenient, clearly laid-out operating concept with intelligent control technology

4 Ultra-easy operation thanks to guided setup process

USER-FRIENDLY SOFTWARE CONCEPT



Real Productivity Gains with Gear Production Software

Höfler cylindrical gear grinding machines don't just stand apart due to their reliable, advanced hardware. The Gear Production software, developed in-house, guarantees convenient machining of even complex topographies and ensures maximum efficiency in daily use. Only Gear Production delivers concentrated knowledge of state-of-the-art machining strategies and process sequences right to the user's hands.

And with its numerous functions, Gear Production plays an active role in achieving productivity gains. Software modules with Adaptive Grinding, 3D dressing, and Closed Loop for cycloids were developed to enable considerable reductions in production times and significantly increase the achievable accuracy.

Pre-analysis/job Engineering:

- Exact process time calculation with original machine data
- 3D analysis of the planned process steps with respect to working range and possible interference contours
- Pre-analysis of tool life
- Import of optimized tool profiles

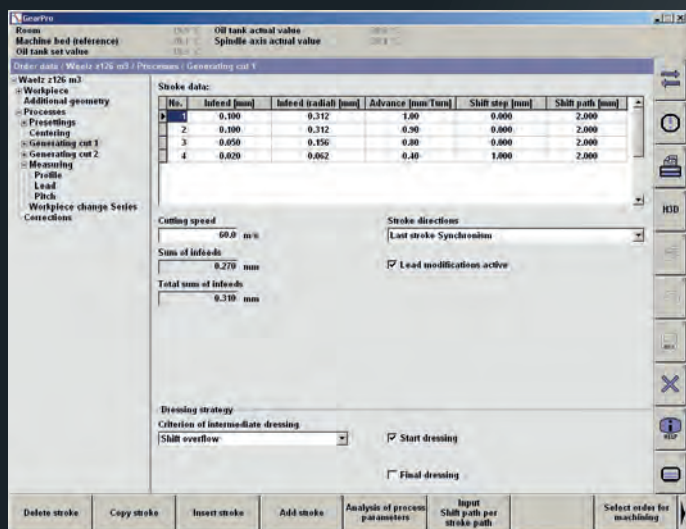
Data input/Operator Guidance:

- Easy navigation through clearly structured interface areas
- Well-organized Microsoft® Windows®-like data management
- Intuitive data input via graphical display
- Clear operator guidance from an automatically generated list of process steps
- Easy-to-understand input of even complex profile forms thanks to customer-specific wizards
- Various technology wizards for a range of tried-and-tested process variants

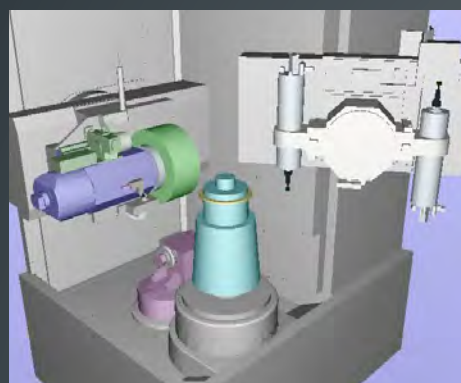
Automatic Archiving:

- Stock per flank and lead lines of the blank (optional)
- Wear indicators for dressing
- Test diagrams of finished part

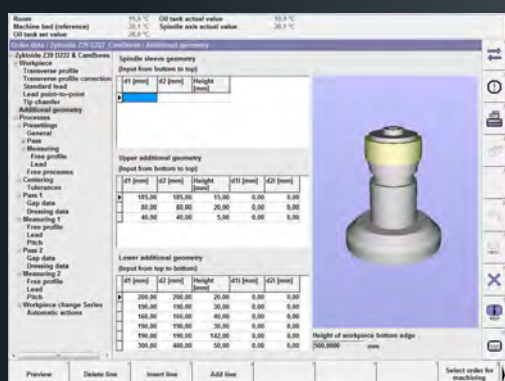
Maximum Process Efficiency with the Gear Production Software



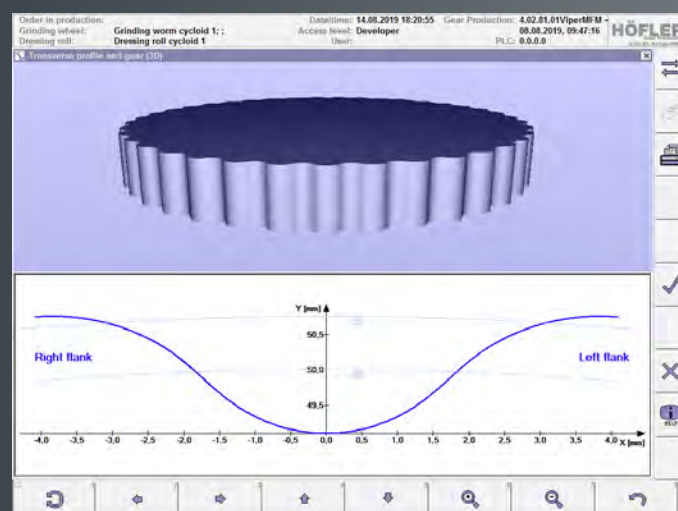
Input of process data for generating grinding



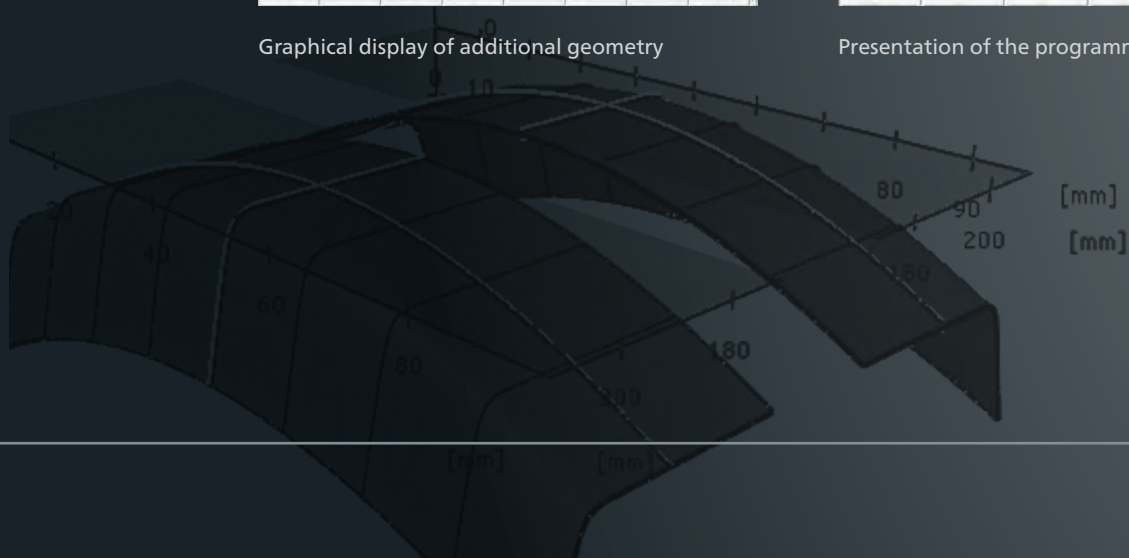
3D display of Gear Production-internal machine model



Graphical display of additional geometry



Presentation of the programmed profile form



Robot Industry



Robot joints require extremely rigid transmissions with a high ratio and minimum backlash. At the same time, they must be small and lightweight. Cycloid gearing has proven to be particularly well-suited to these special requirements and has gained ground in a wide range of industrial sectors. Compared with involute gearing, however, cycloids are sensitive to center distance variations – a significant technical disadvantage of this gearing type.

To obtain cycloid transmissions with good running qualities and high load capacity, extreme precision is required when manufacturing the gearings and base bodies. The root circle of the gearing must be maintained within extremely tight tolerances of just a few micrometers. In addition, the reference surfaces must run extremely accurately with respect to

the gearing. Owing to the principle, the reference surfaces are either a central bore or three star-shaped reference bores arranged in the base body, the so-called “cam bores”. Because the high accuracies cannot be adhered to with standard machine tools available on the market and typical machining sequences, the components are measured and paired according to their tolerance situation. This means high additional costs and tremendous logistical effort in production and assembly. With the VIPER 500 MFM, Klingelnberg has for the first time developed a machine that is capable of adhering to these tight tolerances. Significant cost savings can be achieved as a result.

Automotive Industry



Positioning work platforms in automotive engineering: Whether in conjunction with a robot or a human coworker — a positioner equipped with cycloid gears moves the assembly to be processed into an ergonomic work position with just as much flexibility as precision.

Line Production



Cycloid gears are used primarily in applications requiring an extremely high level of precision in the motion path and positioning accuracy in the limit position. They are also used to achieve maximum acceleration ramps and speed with zero backlash. Thanks to their compact design, gear ratios of up to 1:300 can typically be achieved without backgear. Cycloid gears are quiet and require minimal maintenance even under the most demanding conditions. Their application versatility starts with typical pick & place tasks on the assembly line.

Machine Tools



Workpieces and tools must be positioned precisely and at high speed, but so do tool magazines. In these applications as well, cycloid transmissions are capable of withstanding the toughest conditions. And they are even more compact than comparable torque motor drives.

Medical Engineering



Cycloid transmissions are also used in medical imaging techniques such as magnetic resonance imaging. In addition to the required precision, there is a special focus here on high operational safety in conjunction with low operating noise.

Packaging Industry



In the packaging industry applications, particularly in the food industry, speed and high precision are not the only key factors. Due to their low inertia alone, compact cycloid transmissions offer an advantage over other designs. They can also be hygienically sealed, making them suitable for use with food when coated with a special paint.

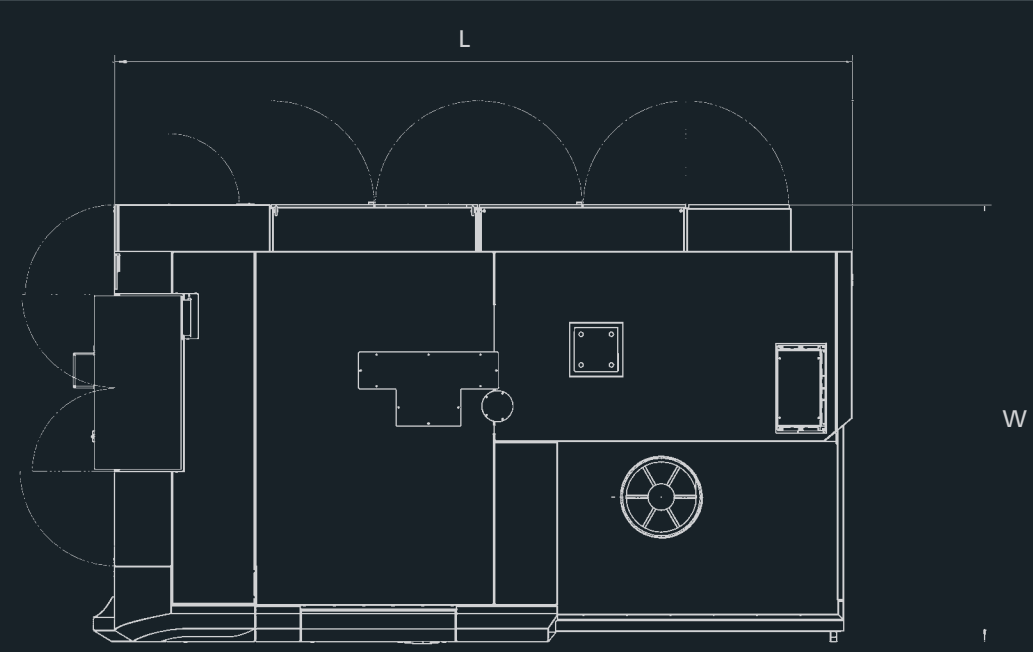
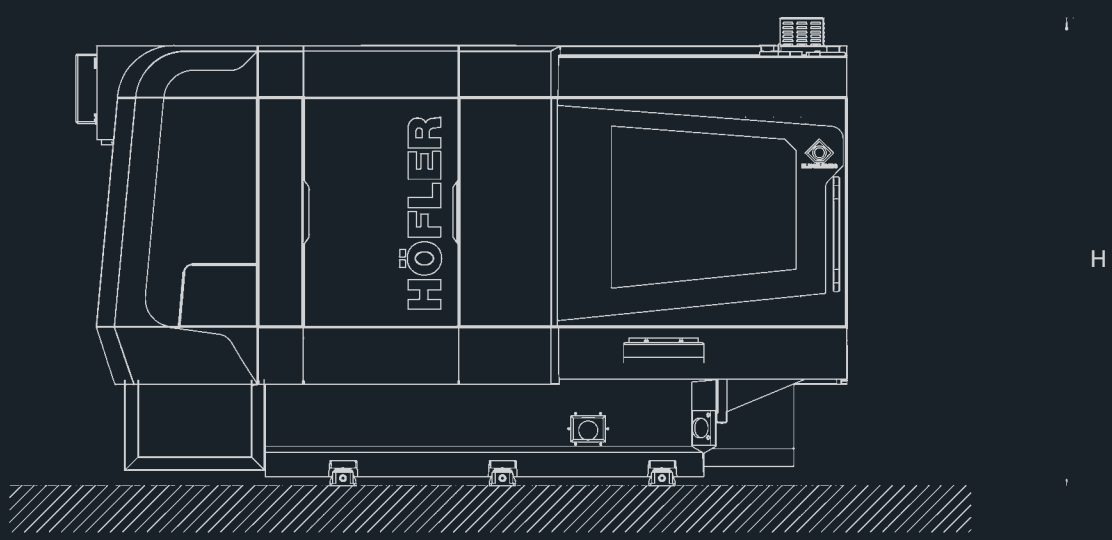
TECHNICAL DATA

	External gearing	Bore grinding
Grinding worm diameter (min. – max.)	Ø 230 mm – Ø 350 mm	Ø 15 mm – Ø 50 mm
Grinding worm width (max.)	150 mm	30 mm
Grinding worm speed (max.)	6,000 rpm	26,000 rpm
Outside diameter of workpiece (max.)	Ø 400 mm	
Workpiece width (one gear) (max.)	-	25 mm
Workpiece width (or stack width)	-	120 mm
Workpiece bore diameter (min.)	-	Ø 16 mm
Plunge depth into workpiece (grinding pin only) (max.)	-	150 mm
Distance between bore surface and workpiece axis X2 (max.)	-	175 mm
Total connected load	60 kW	
Machine dimensions (L x W x H)	approx. 4,790 x 3,120 x 2,690 mm	
Filter unit dimensions (L x W)	approx. 3,500 x 2,200 mm	
Net weight	approx. 16,500 kg	

The above-mentioned maximum values were determined for industry-typical transmissions. Further testing may be required to determine whether maximum values can be combined.

The dimensions of the standard configuration are provided as a guideline. Swivel ranges for doors, control panels, etc. are not taken into account here. The final space requirement is determined by the individual configuration of each machine.

Installation Dimensions



All specifications in mm

KLINGELNBERG Service

The KlingelInberg 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 and service offices and numerous trade representatives world-wide. On this basis, KlingelInberg 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

KlingelInberg 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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