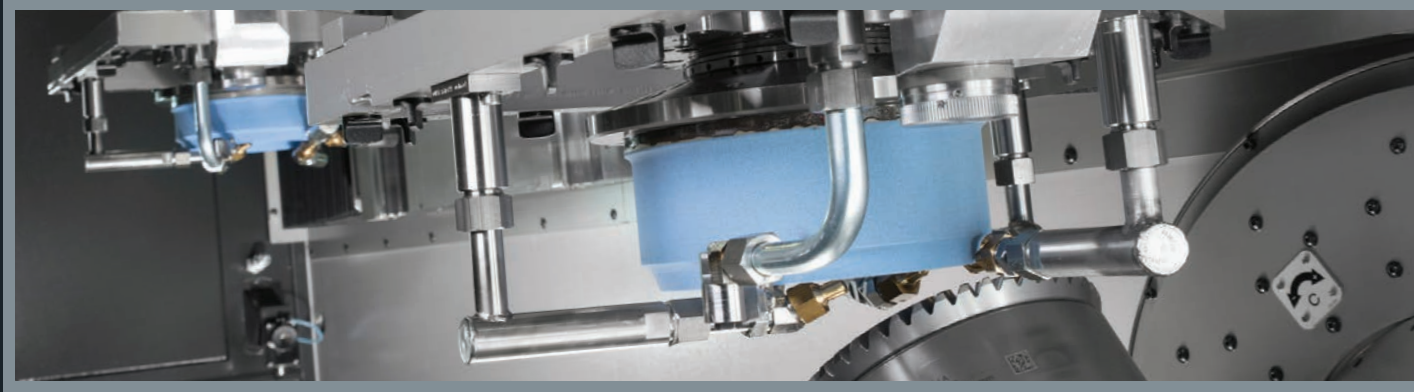




OERLIKON

G 35

BEVEL GEAR TECHNOLOGY – GRINDING MACHINES



Intelligent Solutions for Discerning Users

Around the world, manufacturers of gears and gearboxes ensure their leading edge in gear machining with innovative solution concepts from KlingelInberg.

The **Oerlikon Bevel Gear Technology** division does not just allow users to manufacture bevel gears economically and with high precision. All machines in the system have been designed to work together to enable pre-machining and finishing of even the most complex gears.

KlingelInberg offers the most advanced technology and the most efficient machines for each and every step in the process chain. The production process chain for bevel gears includes **tool preparation, cutting, measuring**, hardening, **grinding or lapping** and **testing**, among others. The powerful **KIMoS** (KlingelInberg Integrated Manufacturing of Spiral Bevel Gears) design software and the **Closed Loop concept** ensure transparency and documented quality throughout the entire process chain.

Oerlikon bevel gear machines are developed with real-world applications in mind and meet the varying demands of a whole range of industries. The target markets include the automotive industry, commercial vehicle industry, agricultural industry, ship-building and aviation, as well as industrial gearbox manufacturing and industrial engineering.

As a leading system supplier and in combination with these high-performance tool systems, KlingelInberg meets every requirement for flexible, efficient production — for the smallest and the largest batch sizes.

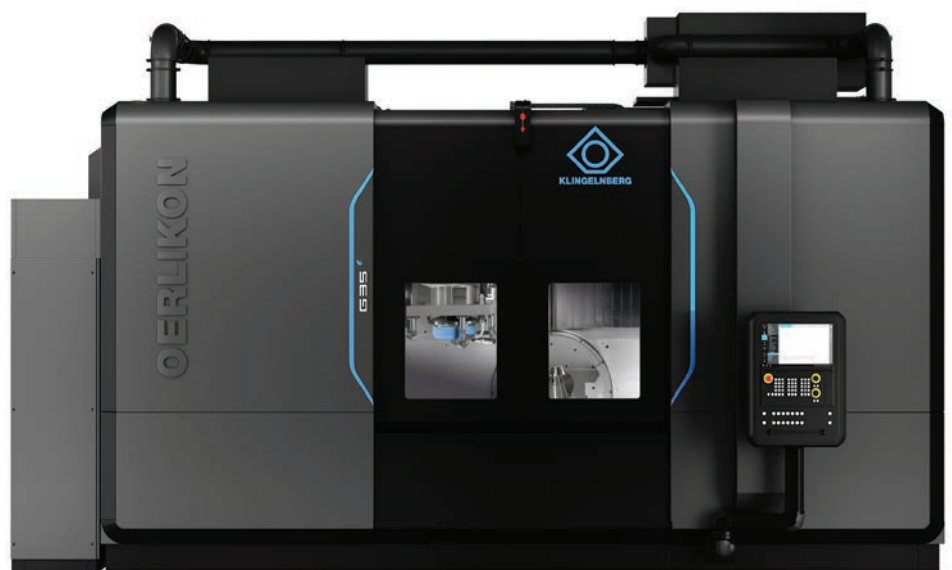
全世界的齒輪和變速箱製造商都使用KlingelInberg的創新解決方案概念來確保其在齒輪加工領域的領先優勢。

Oerlikon傘齒輪技術部不僅讓用戶經濟、高精度地製造傘齒輪。系統中的所有機器均設計為可協同工作，以實現即使最複雜的齒輪也可進行預加工和精加工。

KlingelInberg為製程的每一步都提供了最先進的技術和最高效的設備。傘齒輪的生產製程包括刀具準備，切削，測量，硬化，磨削或研磨和測試等。強大的KIMoS（KlingelInberg整合傘齒輪製造）設計軟件和“閉迴路”概念確保了整個製程的透明性和品質精度。

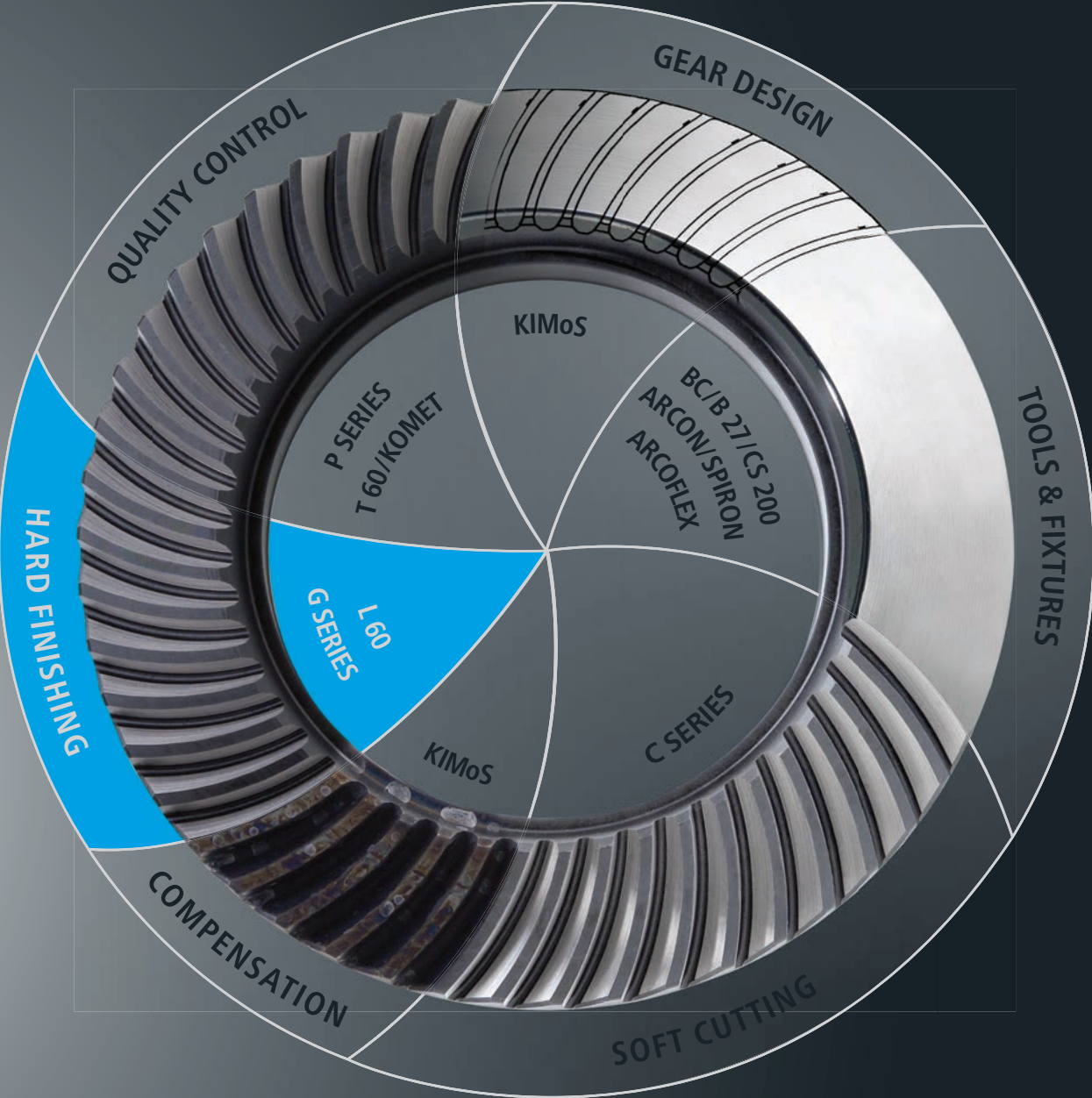
Oerlikon傘齒輪機的開發考慮了現實世界的應用，可滿足整個產業的各種需求。目標市場包括汽車業，商用車業，農業，造船業和航空業，以及工業變速箱製造和工業工程。

作為領先的系統供應商，並與這些高性能工具系統結合使用，KlingelInberg滿足最小與大批量的靈活和高效生產的所有需求。



Oerlikon G 35 bevel gear grinding machine with numerous equipment details

Exceptional Concepts for
Every Process Step in Gear Technology



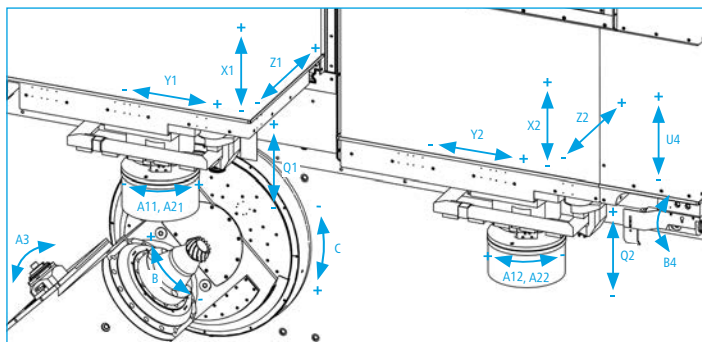
Oerlikon G 35傘齒輪磨床專門針對航空業的要求量身定制，它的兩個垂直研磨主軸將航空齒輪製造提升到一個新的水平。使用經過驗證的概念和組件來確保此專用設備的最佳功能和最大的備品可用性。經過驗證的技術再次加強了新的功能，可在設備上高效執行。該設備的基本概念基於當前的Oerlikon G 30單主軸機器。由於其高剛性和熱穩定性，即使在高生產率的過程中，該機床也能在汽車工業中獲得最佳的加工結果。

Leading-Edge Technology for Optimal Flexibility and Maximum Productivity in the Aviation Industry

Specifically tailored to the requirements of the aviation industry, the Oerlikon G 35 bevel gear grinding machine takes aviation gear manufacturing to a new level with its two vertical grinding spindles. Tried and tested concepts and components were used to ensure optimal functionality and the best possible availability of spare parts for this special-purpose machine. The proven technology has been enhanced to include new functionalities that allow for efficient work practices on the machine. The machine's basic concept is based on the current Oerlikon G 30 single-spindle machine. Owing to its high rigidity and thermal stability, this machine achieves optimal machining results in the automotive industry, even in highly productive processes.

The G 35 is equipped with two grinding heads that can be positioned independently, allowing pinions, for example, to be machined using the fixed setting method, in which the convex and concave tooth flanks are machined with different tools in a fixed setting. Unlike older dual-spindle concepts, the G 35 presents no additional collision contours that limit the operation of the machine, thanks to the second grinding head. To ensure rapid positioning of the grinding heads, they are equipped in the main direction of motion (Y1 and Y2) with highly dynamic linear motors, whose design has already been proven in the larger G series machines (G 60 and G 80). All of the bevel gear machines in the G series are equipped with a thermostable, vibration-damping machine bed. The axis concept ensures a rigid design of the complete machine.

G 35配有兩個可以獨立定位的研磨頭，可以使用固定設置方法加工小齒輪(pinions)，其中，用不同的刀具在固定設置中加工凸面和凹面。與舊的雙主軸概念不同，由於有了第二個研磨頭，G 35不會出現任何限制機器運行的額外碰撞輪廓。為了確保研磨頭的快速定位，它們在主運動方向（Y1和Y2）上裝有高動態線性馬達，其設計已在較大的G系列機床（G60和G80）中得到驗證。G系列的所有傘齒輪機均配備了熱穩定的減振機座。軸的設計概念可確保整個機器的剛性。



Axis arrangement of an OERLIKON G 35 bevel gear grinding machine

- Two independently positionable grinding heads enable easy set-up and maximum flexibility
- Extremely rigid and thermally stable machine for optimal machining results, even in highly productive processes
- “Clean cabin concept” eliminates grinding sludge deposits in the working chamber
- Innovative operating concept with intuitive touch screen navigation
- Optimal energy efficiency (e^2) thanks to recovery and on-demand control of units

- ④ 兩個可獨立定位的磨頭，易於安裝並具有最大的靈活性
- ④ 極高的剛性和熱穩定性，即使在高生產率的過程中也能獲得最佳加工結果
- ④ “乾淨工作室概念”消除了工作室中的研磨污泥沉積
- ④ 創新的操作理念和直觀的觸控螢幕導航
- ④ 能源效率優化歸功於能源回收與依應用需求控制單元

CNC axes:

- A11 Grinding spindle left
- A12 Grinding spindle right
- A21 Eccentric spindle left
- A22 Eccentric spindle right
- B Workpiece spindle
- C Base angle setting

- Q1 Cooling lubricant adjustment axis left
- Q2 Cooling lubricant adjustment axis right
- A3 Dressing spindle
- B4 Deburrer rotational axis
- U4 Deburrer linear axis
- X1, Y1, Z1, X2, Y2, Z2 Linear axis

One Machine, Two Spindles: Vertical Machine Designed to Meet Aviation Industry Requirements

Dressing 修砂



- Custom grinding wheel profiling and conditioning
定制砂輪齒型和調節

Deep grinding 深研磨



- Soft cutting of bevel gears for prototype and small-lot production
傘齒輪的軟切削，用於原型和小批量生產

Deburring 去毛邊



- Precise abutting face deburring of deep ground components in the same setup (optional)
在相同的設置中，對研磨部件做精確鄰接面去毛刺（選配）

Finish grinding 精研磨



- Hard finishing of bevel gears to the highest standards of quality and productivity
傘齒輪的硬後精加工達到最高的品質和生產率標準

Quality assurance 品質保證



- Gear and stock removal measurement to document the production process with the optional KOMPASS measuring device
使用選配的KOMPASS測量設備進行齒輪和坯料去除量測量以記錄生產過程

Complete Machining of Aircraft Bevel Gears on One Machine

雙主軸機床可在固定設置下加工兩個小齒輪側面。這達成齒輪的最佳同心度，並允許一步驟確定兩個齒面的局部切削量。例：

■ Soft cutting:

主軸A11的凸齒側面和主軸A12的凹齒側面進行深磨，以及主軸B4的鄰接面上去毛刺

■ Finish cutting:

使用KOMPASS測量齒輪的初始形貌(拓譜)；最後用主軸A11研磨凸齒面，並用主軸A12研磨凹齒面。用KOMPASS測量兩個齒面的拓譜圖和胚料去除量

High-Tech Can Also Be Simple!

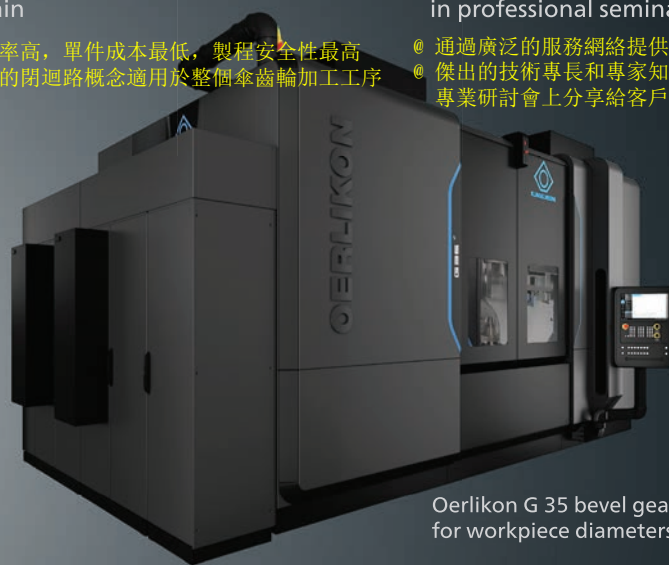
“Simplified with Passion” – true to this motto, Klingelnberg is driven to provide simple, unconventional solutions to high-tech challenges. A team of engineers and technical experts makes it possible — always with the goal of ensuring the highest technological standards in application-matched machine designs that are also easy to use.

“用激情簡化” – 秉承這一座右銘，Klingelnberg一直致力於為高科技挑戰提供簡單，非常規的解決方案。工程師和技術專家團隊使之成為可能 – 始終以確保應用匹配的機器設計中易於使用的最高技術標準為目標。Case in point: the Oerlikon G 35 bevel gear grinding machine is based on established development concepts that are optimized on an ongoing basis. Klingelnberg’s success factors include:

實例：Oerlikon G 35傘齒輪磨床基於既定的開發理念，並不斷進行優化。

Klingelnberg的成功因素包括：

- High productivity with the lowest possible per-piece costs and maximum process safety
 - Unique Closed Loop concept for the entire bevel gear machining process chain
 - Comprehensive service offering with a broad service network
 - Outstanding technical expertise and expert knowledge, which Klingelnberg passes on to customers in professional seminars
- Ⓢ 生產率高，單件成本最低，製程安全性最高
Ⓢ 獨特的閉迴路概念適用於整個傘齒輪加工工序
- Ⓢ 通過廣泛的服務網絡提供全面的服務
Ⓢ 傑出的技術專長和專家知識，Klingelnberg在專業研討會上分享給客戶



Oerlikon G 35 bevel gear grinding machine for workpiece diameters up to 350 mm

立式機床設計，確保安全的製造流程

Vertical Machine Concept for Reliable Process Sequences

- Vertical grinding spindles for optimal chip removal
立式研磨軸有助於切屑順暢排放
- Excellent visual process monitoring capability during process positioning, thanks to an optimal machining position of the vertical grinding spindles
由於垂直研磨主軸的最佳加工位置，在定位過程中具有出色的製程監控能力
- Component and clamping device change option “with gravity” in the vertical direction
在垂直方向上另用“重力”即可實現部件與夾具更換
- Smooth surfaces and minimal interference contours in the working chamber combined with efficient interior cleaning to eliminate grinding sludge deposits (optional)
加工空間內的光滑表面和盡可能避免的輪廓干擾，搭配高效的室內清潔系統，避免研磨切屑堆積(選配)





利用兩個砂輪進行加工的雙主軸概念

Dual-Spindle Concept for Machining with Two Grinding Wheels

- Aircraft gearings produced by the 5-cut method in a fixed setting for optimal gear concentricity
採用五切法, 一次夾持即完成航空產業齒輪生產, 降低徑向偏擺誤差
- Use of separate grinding wheels for roughing and finishing enables highly productive grinding of duplex gearings with ultra-high quality surface finishes
使用單一砂輪進行粗磨和精磨, 能高效研磨雙齒部, 實現優異的表面精加工品質
- Two independently positionable grinding heads for maximum flexibility, collision-free operation, and easy set-up
兩個獨立研磨頭可單獨移動, 帶來更高的靈活性, 免於碰撞問題且裝配更容易
- Grinding head positioning with highly dynamic linear drives minimizes auxiliary time
透過高動態的線性馬達定位研磨頭, 縮短生產以外的準備時間



縮短裝備與設置時間

Minimal Retooling and Configuration Times

- Simultaneous, automatic set-down and pick-up of grinding wheel and oil ring for fast tool changes
砂輪和油杯的放置和接納過程全自動, 一步到位, 加快刀具更換速度
- Fully accessible working chamber through front service door
加工區前方配有防護門, 進出方便
- Two dressing position options on the grinding wheel periphery provide greater flexibility for optimal adjustment of the cooling nozzles
在砂輪周圍設有兩個修砂裝置, 提高靈活性, 進而能夠適當調整冷卻噴嘴
- Efficient grinding wheel preprofiling and reprofiling with special dressing software
透過專門的修砂軟體對砂輪進行高效的預研磨和再次研磨輪廓調整



持續監控提高製程安全性

Maximum Process Reliability with Continuous Monitoring

- Automatic contact detection for dressing with AE sensor (optional) enables minimal dressing amounts without risk of profile loss
修砂時透過AE傳感器(選配)自動識別接觸點, 減少修整量, 降低輪廓損失風險
- Air gap control (optional) to ensure correct component seating for automatic loading
端面接觸監控裝置(選配)確保自動上料時工件正確就位
- Allowance check for time-neutral detection of improperly machined components
加工餘量控制在加工循環內探測那些預加工出錯的零件
- Grinding power monitoring with emergency retraction for automatic stopping of the machine in the event of a sudden power increase
研磨功率監控帶緊急退刀保護, 讓機床在功率突然升高時自動停止

HIGHLIGHTS



機床整合的防啟動安全裝置和品質保證功能(選配)

Machine-Integrated Start-Up and Quality Assurance (Optional)

- Measurements in the machine during the production process itself ensure that production goes quickly
透過量測, 在機床生產過程階段便實現快速的生產品質保證
- Topography measurement before and after machining to document stock removal
在加工前後進行形貌(拓譜)量測, 對去除的材料進行紀錄
- Automated correction calculation in the machine for maximum precision from the first component
設備上進行自動修正計算, 從第一個工件起就確保高精度
- High indexing accuracy requires no in-depth user know-how
高度準確的分度, 不需要操作員具備精深的know-how



研磨油供應“一體成形”

“Single-Piece” Grinding Oil Supply

- Nozzles for process cooling and cleaning mounted on a removable single-piece element (oil ring) ensure optimal reproducibility of the grinding oil supply
安裝在可拆卸一體成形元件(油環)上用於過程冷卻和清潔的噴嘴確保了研磨油供應的最佳重現性
- Automatic oil ring change (optional)
全自動油環更換(選配)
- Innovative, high-pressure-resistant telescope system for quick and easy adjustment of the grinding oil supply with minimal tool requirements for shorter retooling times
創新耐高壓的伸縮系統, 有助於快速而簡單地設置研磨油供應系統, 減少工具需求和裝配時間
- Fully leak-proof system for maximum process cooling efficiency
全密封系統, 讓製程冷卻處理效率更高
- Constant machining conditions thanks to automatic adjustment over the grinding wheel service life
自動調整砂輪使用壽命, 保持穩定的加工條件

滿足高需求的能源效率

Energy Efficiency (e²) for the Most Stringent Demands

- Energy-saving cooling technology thanks to effective control of the cooling units
透過對冷卻機組的有效控制, 讓冷卻系統更加節能
- High energy-efficiency-class drives
高效能等級驅動器
- Intelligent reactive current compensation
智能無功電流補償
- Efficient energy recovery
高效能量回收



Intuitive Operating Concept with Trend-Setting Touch Technology

趨勢設定觸控技術提供直觀的操作概念

- 1 Multilingual menu navigation allows for worldwide use

多語言選單導航可在全球使用

- 2 Menu navigation is easy and requires minimal training thanks to innovative workflow support

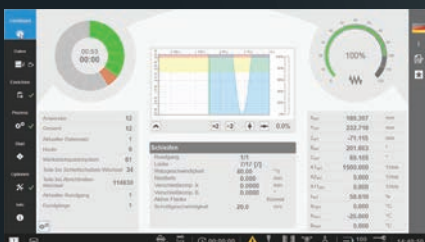
借助創新的工作流程支援，選單導航非常容易，只需很少的訓練

- 3 Input errors are avoided by the intelligent warning function preventing costly incidents or even accidents

智能警告功能可避免輸入錯誤，從而避免發生重大事故甚至事故

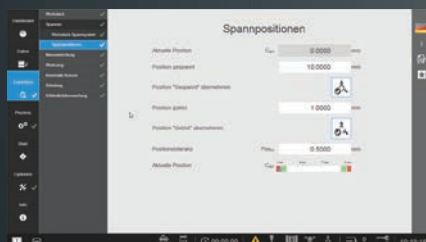
- 4 Machine configuration is successfully completed in just a few steps

僅需幾個步驟即可成功完成機器配置



- 5 High production reliability ensured by visualization of the production workflow in real time (dashboard)

實時視絕化生產流程（儀表板），確保了高生產可靠性



- 6 Fast, easy control of all program functions in a single graphical user interface

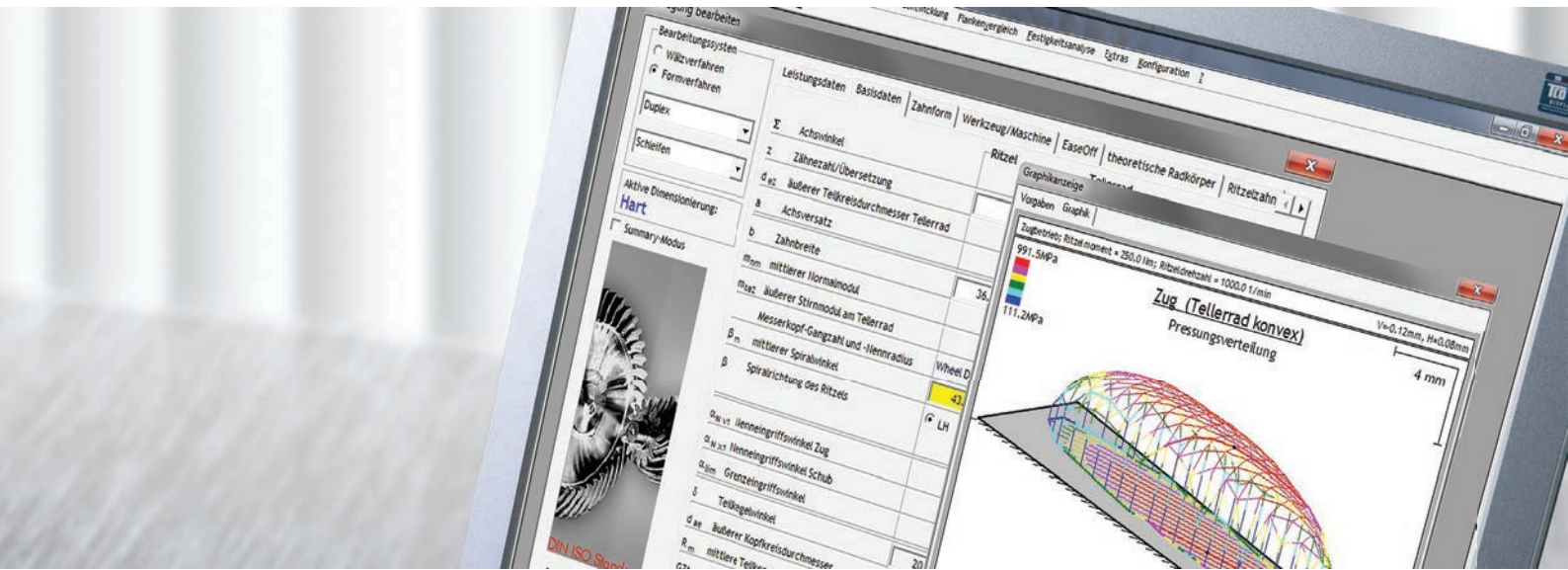
在單個圖形用戶界面中快速，輕鬆地控制所有程序功能



- 7 Easy-to-read display of current consumer data places the focus on energy efficiency

易於閱讀的當前消耗數據顯示，將重點放在能效上

GEAR DEVELOPMENT BASED ON NOMINAL DATA



Design and Optimization of High-Performance Bevel Gear Sets

KIMoS (Kingelberg整合螺旋傘齒輪製造) 軟體包支持傘齒輪設計和優化的每個步驟。

KOMET會測量機器設置和任何刀具數據的校正值，以最大程度地減少側面的測量變化。

KIMoS不可或缺的組成部分包括具有易於操作的對話框的切齒優化功能，分析齒輪的預期操作行為以及通過負載能力和強度計算來評估結果。

作為此過程的一部分，將並行準備齒輪切削過程，工具準備以及傘齒輪品質控制的所有必要數據。

方便的數據處理提供了一種在開發階段使用可自由定義的開發數據庫，以及將生產數據庫中生產批准的數據提供給過程中使用的生產和測量機器的方式。

因此，該軟體包根據“閉迴路”方法為生產超現代傘齒輪提供了最佳基礎：最終結果與先前在計算機上設計和優化的結果完全匹配。

KIMoS是模組化程序包，為用戶提供了為特定應用創建適合應用的齒輪設計所需的全部功能。

支援所有常見的齒輪切割製程，機器和刀具系統。

For gear design, KIMoS provides:

- Independent design with individual production possibilities taken into account
獨立設計並考慮了個別生產可能性
- Cultivation of expertise within the company as a competitive advantage
在公司內部培養專業知識作為競爭優勢
- Fast, accurate analysis of testing and production results and gear damage
快速，準確地分析測試和生產結果以及齒輪損壞

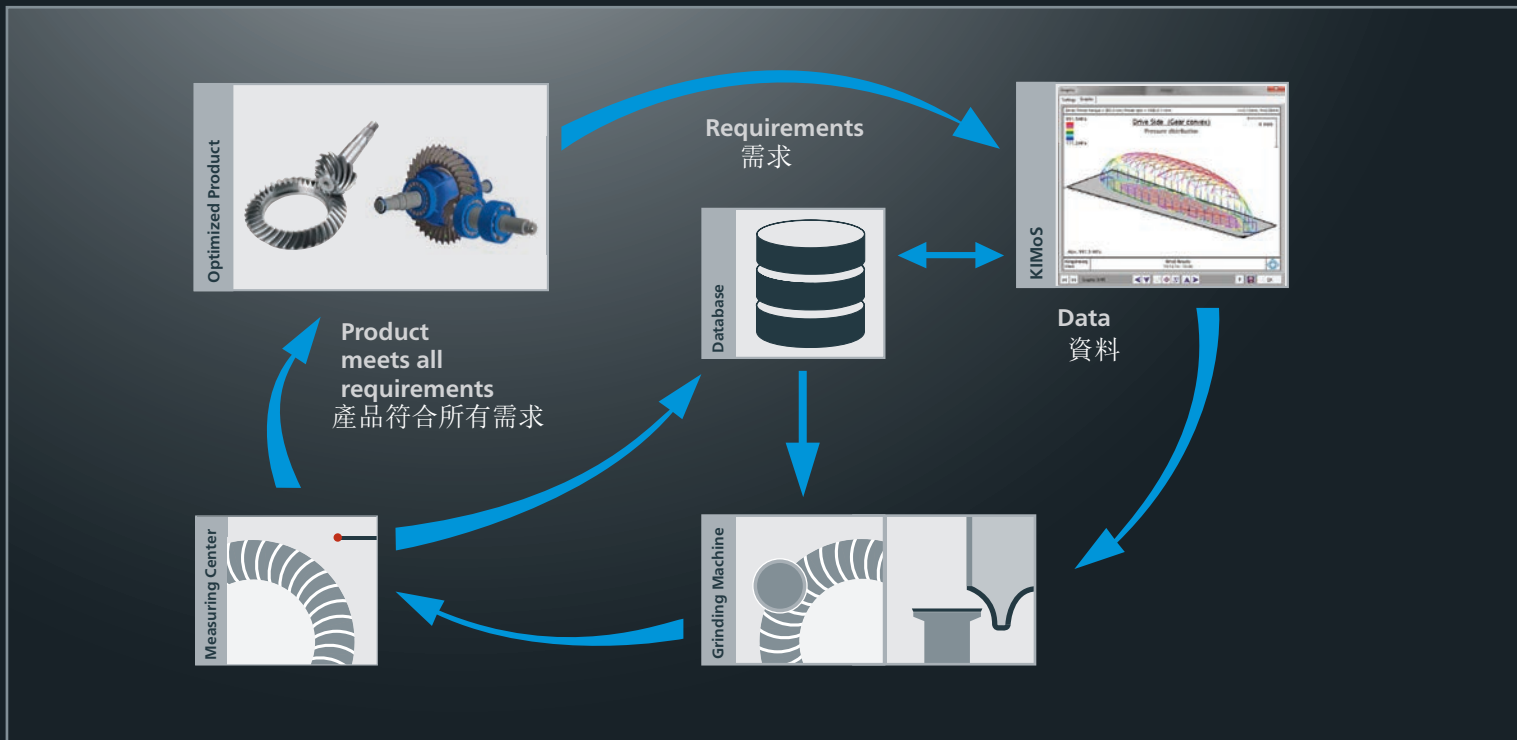
For gear production, KOMET provides:

- Reliable calculation of correction data immediately following gear measurement
齒輪測量後立即可靠地計算校正數據
- Machine-specific correction data for bevel gear production
傘齒輪生產的機器特定校正數據
- Maximum process safety by interfacing with the Klingelberg database
通過與Klingelberg數據庫進行交互，可最大程度地提高製程安全性

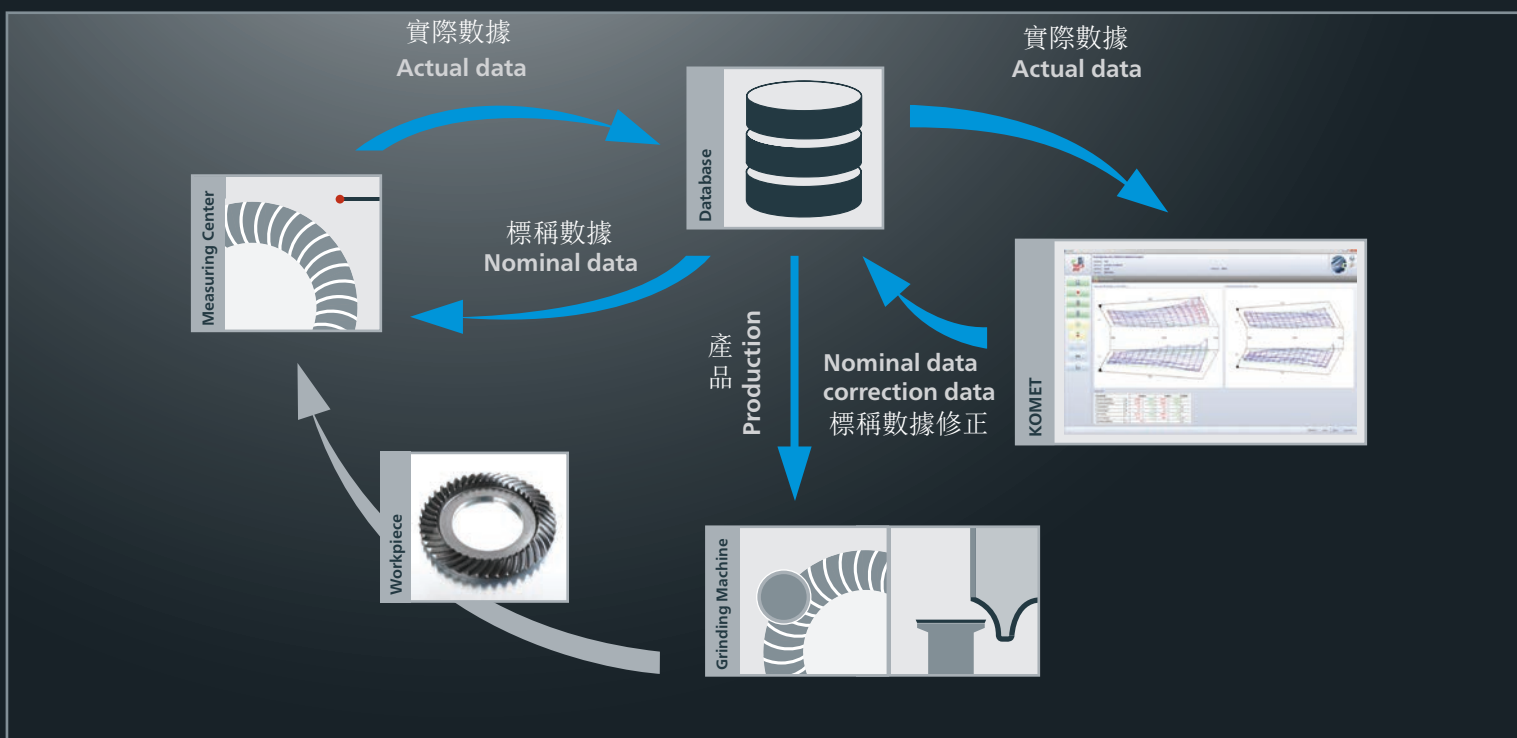
Advanced Bevel Gear Production in a Unique Closed Loop Process

在獨特的閉迴路製程中進行先進的傘齒輪生產

KIMoS – for Optimal Design KIMoS – 最佳化設計



KOMET – from Design to Optimal Production Result KOMET – 從設計到最佳生產結果



Drive Components with Guaranteed Quality Provide Optimal Performance

具有保證質量的驅動組件可提供最佳性能

In countless industries, KlingelInberg solutions have become a fixture in the international market. To meet market requirements for high productivity in mass production and flexibility in small-batch production, KlingelInberg offers a range of solution concepts for just about any requirement.

Used throughout the world, the “**Simplified with Passion**” system plays an important part in ensuring that machine tasks are made simple. Moreover, the KlingelInberg system contributes to standardization and quality assurance on a global scale.

在無數產業中，KlingelInberg解決方案已成為國際市場的固定裝置。為了滿足大規模生產中的高生產率和小批量生產中的靈活性的市場需求，KlingelInberg提供了滿足幾乎所有需求的一系列解決方案概念。

在全世界範圍內廣泛使用的“用激情簡化”系統在確保簡化機器任務方面發揮著重要作用。此外，KlingelInberg系統在全球範圍內為標準化和品質保證做出了貢獻。



Automotive



In cars, spiral bevel gears are used in all-wheel-drive systems and rear-wheel-drive systems to transmit torque "from the transmission to the road". Due to increasing performance requirements, these drives must transmit outputs of over 300 kW in some cases. The bevel gears they use must be efficient, smooth-running, and low-maintenance. Reproducible quality in standard production with the fastest possible production times are key requirements in this industry.

Commercial Vehicles



Commercial vehicles are always rear-wheel-driven. The bevel gear sets they use must transmit power in the range of 500 kW – at extremely high torques. This places high demands on durability and strength. The bevel gears must be efficient, rugged and low-maintenance. Use of the integrated KlingelInberg system makes it possible to mass-produce bevel gears with the quality required.

Industrial Gear Units



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

Aviation



Bevel gears used in airplanes must embody the highest quality in terms of pitch and runout (DIN 1–3) and must also execute rotational movements with absolute reliability. Just as important are other geometrical features such as surface quality, root geometry, rotational error, high strength and low weight. Frequently used in this industry are special materials, which place extreme demands on tools and processes.

Maritime Propulsion Technology



The bevel gears used in shipbuilding must demonstrate great reliability and durability even under the most extreme external conditions. The high range of component diameters (up to 2 m) requires extensive bevel gear know-how to master the production process. Klingelberg's many years of experience and its certification by all major classification societies are the customer's guarantee of the utmost product quality.

Agriculture



In agricultural applications such as tractors, spiral bevel gears are built into the rear axles. Harvesters and hay machines use straight bevel gears to enable the corresponding functions. Whereas the bevel gear set in a tractor rear axle drive must transmit up to 400 kW, the loads on straight bevel gears are comparably low. The most important market requirement for straight bevel gears is a modern production and a cost efficient solution.

TECHNICAL DATA

G 35

Workpiece data 工件資訊		
Workpiece diameter (max.) 工件直徑	Ø 350 mm	
Normal module range (min. – max.) 模數範圍	0.7 – 8 mm	
Face width (max.) 面寬	60 mm	
Number of teeth (max.) 齒數	180	
Basic angle setting range 基本角度調整範圍	±90°	
Tool data 刀具資訊		
Grinding wheel diameter 砂輪直徑	31 mm - 114 mm (1,25" - 4,5")	127 mm - 355 mm (5" - 14")
Grinding wheel height incl. base plate (max.) 砂輪高度, 包括底板	110 mm	135 mm
Tool spindle 刀具主軸		
Seat 刀具座	HSK-E50 E DIN 69893-5	
Grinding spindle rotation speed (max.) 研磨主軸轉速	8,000 (12,000)* rpm	
Eccentric speed (max.) 偏心輪轉速	3,800 rpm	
Dresser speed (max.) 修砂器轉速	10,000 rpm	
Nominal grinding wheel drive rating 砂輪驅動馬達額定功率	14 (22)** kW	
Workpiece spindle standard 標準工件主軸		
Seating diameter: Oerlikon outer cone 1:4 支架直徑:Oerlikon外錐	Ø 140.11 mm	
Seating diameter: Oerlikon inner cone 1:19.764 測針架:Oerlikon內錐	Ø 99.258 mm (3.9")	
Work spindle bore 工件主軸孔徑	Ø 93 mm	
Workpiece spindle rotation speed (max.) 工件主軸轉速	1,500 rpm	
Workpiece spindle optional 選配工件主軸		
Seating diameter: Oerlikon inner cone 1:18,285 支架直徑:Oerlikon外錐	Ø 128.224 mm (5 3/64")	
Work spindle bore 工件主軸孔徑	Ø 120 mm	
Workpiece spindle rotation speed (max.) 工件主軸轉速	1,500 rpm	
General machine data 設備資訊		
Total connected load 總負載功率	55 kVA	
Machine dimensions with filter system (L x W x H) 機床尺寸, 含過濾系統	approx. 6,545 x 6,220 x 3,980 mm	
Machine net weight (without filter system) 機床淨重 (不含過濾系統)	approx. 37,000 kg	

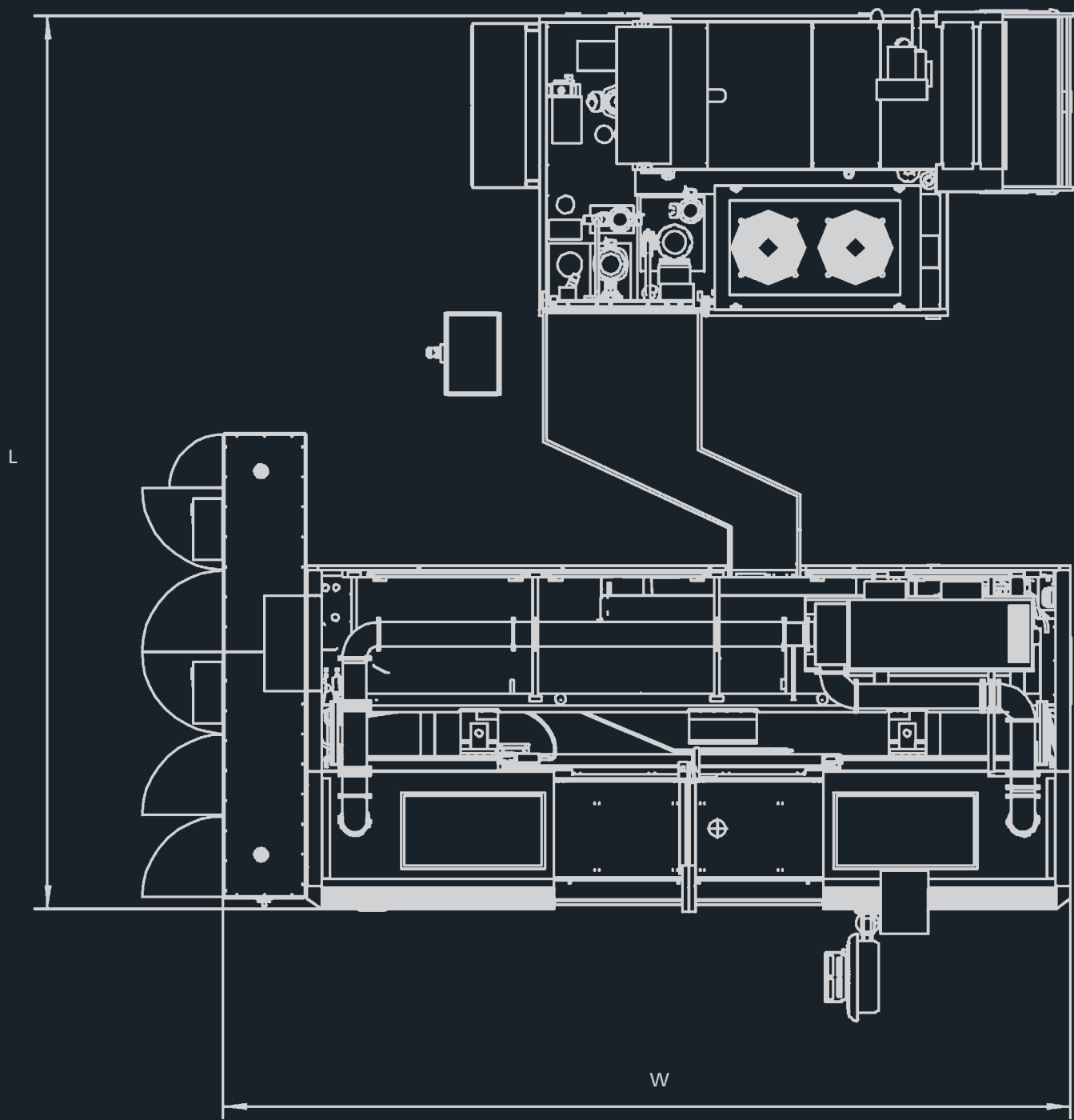
The above-mentioned maximum values were determined for industry-typical transmissions. Further testing may be required to determine whether maximum values can be combined.

*/** Option (not combinable)

The dimensions of the standard version 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

G 35: Top View, incl. Filter System



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 offices and service centers and numerous trade representatives worldwide. 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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