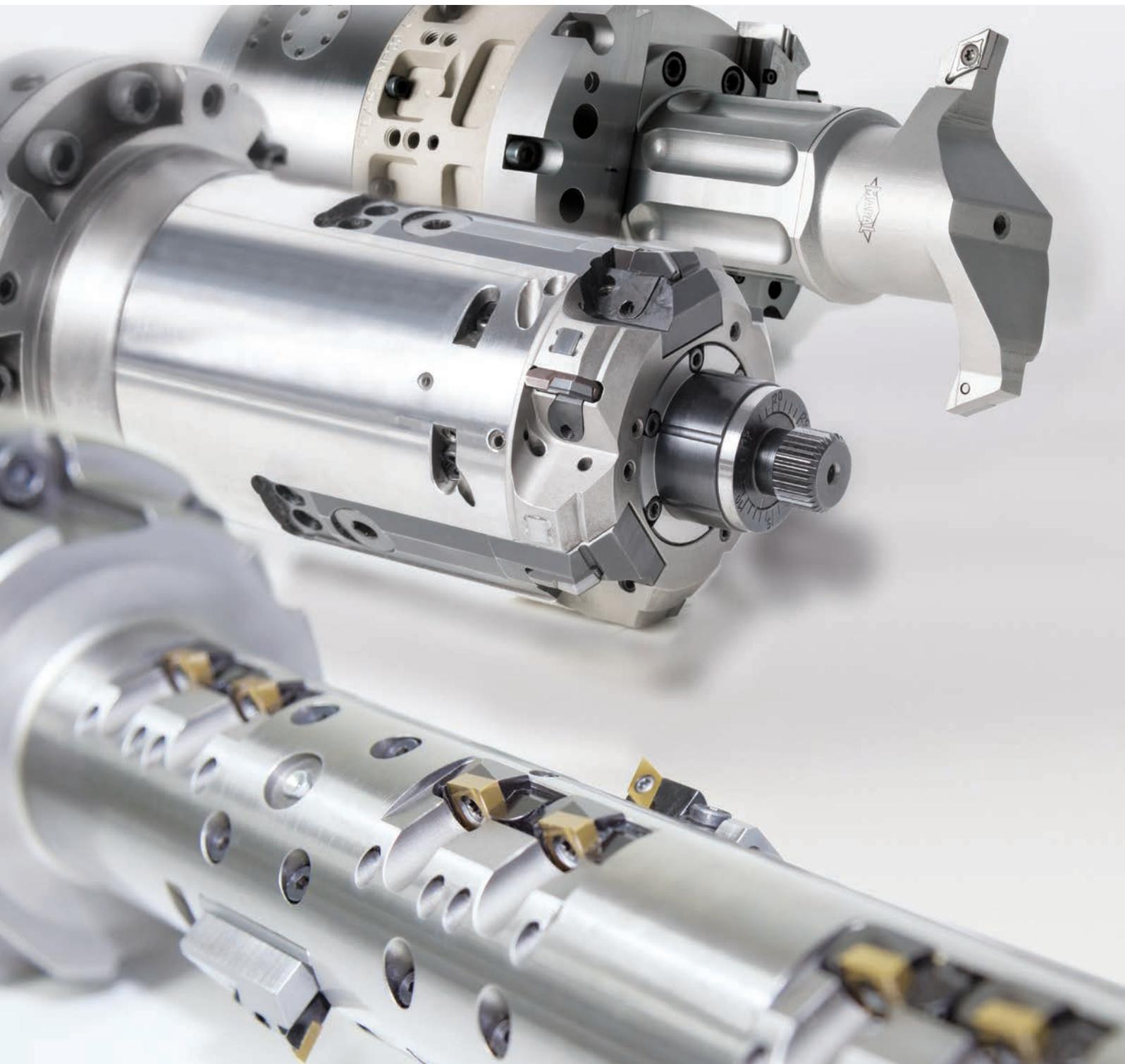




Your technology partner for cost-effective machining

## ACTUATING



When there's something more between you and us:  
That's the MAPAL effect.





Subsidiaries with production,  
sales and service in 21 countries

Representatives in 25 countries

Over **4,800**  
staff worldwide

**No. 1**  
technology leader for  
the machining of cubic parts

### Tool and process solutions combined with comprehensive services

We see ourselves as a technology partner, supporting you with the development of efficient and resource-saving manufacturing processes using standard tools, individual tool concepts and the optimisation of tool details. Our tools satisfy all the requirements on process reliability, precision and simple handling. How? Using advanced development and design methods as well as production using the latest manufacturing facilities.

You do not just need the optimal tool for your task, you are also looking for a partner who takes over the entire planning and management of your process? We are also there for you in this situation. We support you during all production phases and keep your manufacturing at the top level: highly productive, cost-effective and reliable. We also offer you complete networked solutions for all peripheral tasks related to the actual machining process.



Reaming and fine  
boring



Drilling from the solid,  
boring and countersinking



Milling



Turning



Actuating



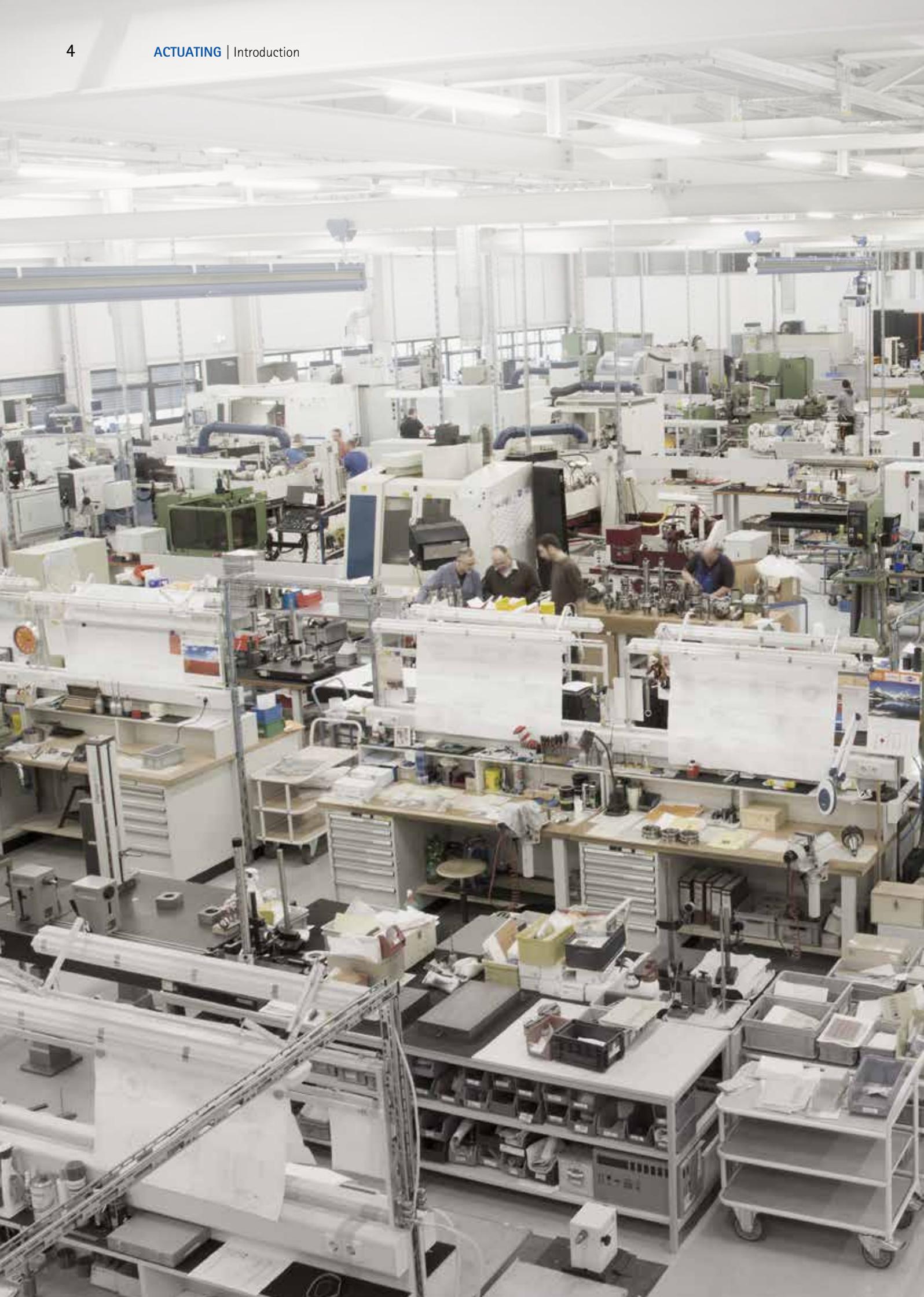
Clamping



Setting, measuring and  
dispensing



Services



# CONTENTS

<b>01 Introduction</b>	
Actuating competence	06
<b>02 Types of input / types of output</b>	14
Types of input in detail	16
Coolant pressure   Contact stop principle   TOOLTRONIC® U axis   U axis of the machine   Drawbar/push rod	
Types of output in detail	28
Linear slide   Inclined slide   Pivoting slide   Rotary slide Deflection holder   Tilting holder	
<b>03 Combination of input and output</b>	30
Selection matrix	32
Actuating systems   Possible applications	
Coolant pressure	34
Contact stop principle	40
TOOLTRONIC® U axis	46
U axis on the machine	56
Drawbar/push rod	60
<b>04 Standard programme</b>	70
TOOLTRONIC® U axis	72
Facing heads	84
<b>05 Line boring bars</b>	98
Design and accessories	100
Possible applications	102
<b>06 Other applications</b>	106
Wobble tools	108
Interpolation turning	110
<b>07 Services</b>	112
<b>08 Technical appendix – TOOLTRONIC®</b>	120
Position monitoring with TOOLTRONIC-S®	122
Data transfer	124
Machine preparation U axis	126
Integration variants	128

# ACTUATING COMPETENCE

Actuating tools stand for maximum rationalisation and optimisation potential in machining. For this reason, and to address the requirements for complete tool ranges, innovative actuating tools, boring bars and facing heads have formed part of the MAPAL portfolio since the 1990s. Whether for special machines or for complete machining on flexible machining centres – if the issue is to machine complex contours, non-cylindrical bores, face surfaces or recesses on cubic parts, MAPAL offers the optimal tool.

The product range includes mechanical actuating tools, which on the machine side are driven by drawbars/push rods or U axis systems, as well as NC-controlled tools, and the particularly flexible mechatronic tool system TOOLTRONIC, for machines without an additional feed unit. The experienced, highly specialised MAPAL engineering team prepares the optimal solution for

a machining task in close collaboration with the customer. Complex, exactly calibrated mechanisms and the numerous different parts inside an actuating tool require the highest accuracy and care during every production step. To safeguard the high precision of the tools, they are only assembled manually at MAPAL. To commission the tools as quickly and efficiently as possible at the customer,

complex actuating tools are comprehensively tested in advance under extreme loads and real application conditions. Commissioning at the customer is then undertaken by a MAPAL machining specialist.

## Machine-side operating conditions for actuating tools:



**Machining centre without actuating function**  
(actuating tool is inserted via magazine)



**Special machine without actuating function**  
(TOOLTRONIC input integrated into the spindle)



**Machining centre with U axis**  
(actuating tool is inserted via magazine)



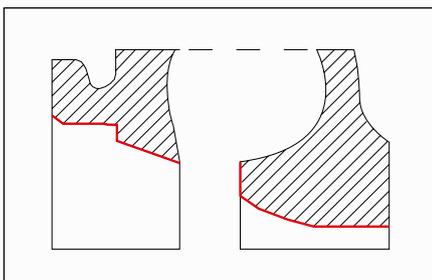
**Special machine with drawbar/push rod**  
(actuating tool adapted to spindle)

# WHEN TO USE ACTUATION

1

## Complex contours

Machining turning geometries on cubic parts



Page 8

2

## Complete machining on machining centres

Productive and cost-effective



Page 12

3

## Cutting edge wear compensation

Flexible and reliable



Page 13

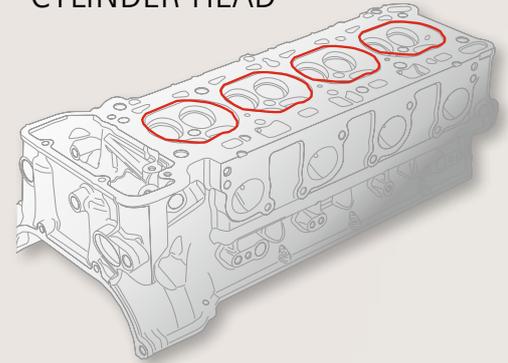


# 1 COMPLEX CONTOURS

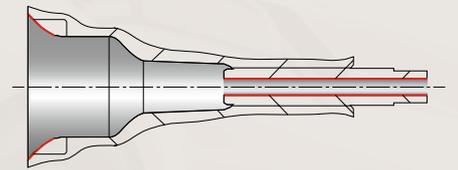
Machining turning geometries on cubic parts

## AUTOMOTIVE

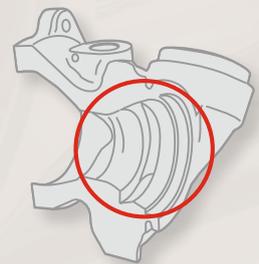
### CYLINDER HEAD



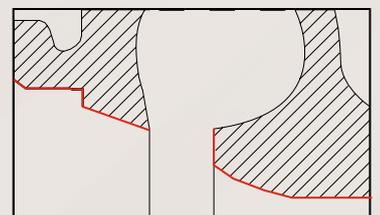
Valve seat and valve guide machining



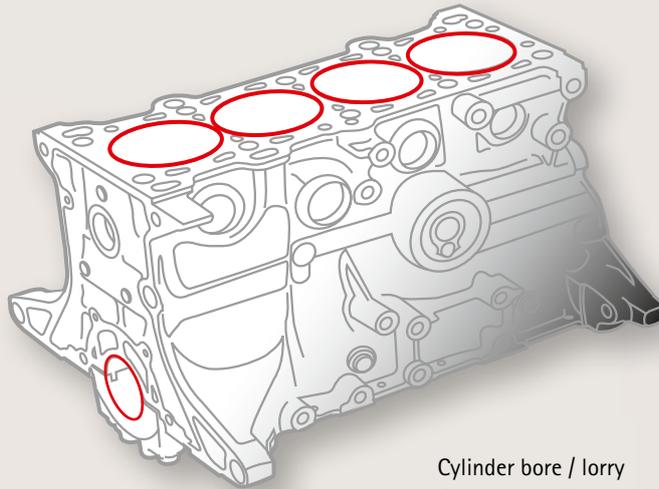
### TURBOCHARGER



Contour

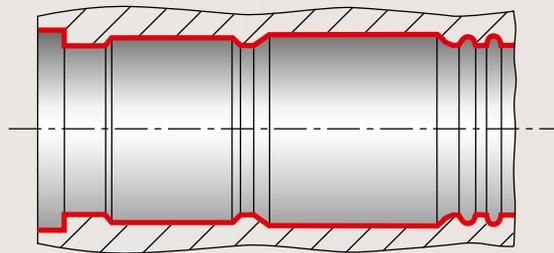
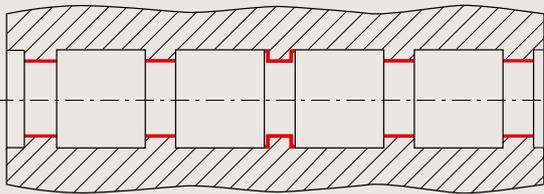


# CRANKCASE



Crankshaft bearings

Cylinder bore / lorry  
Contour machining prior to pressing in the cylinder liner

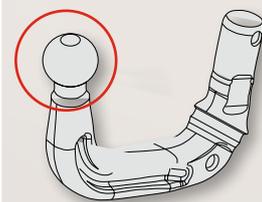
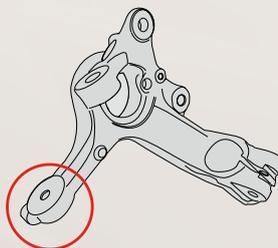
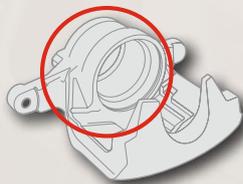


## CONNECTING ROD

## BRAKE CALIPER

## SWIVEL BEARING

## TRAILER COUPLING

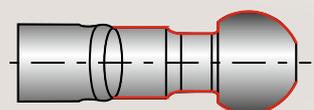
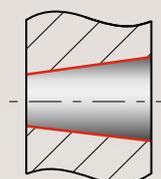
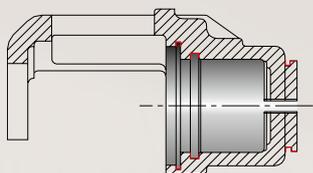
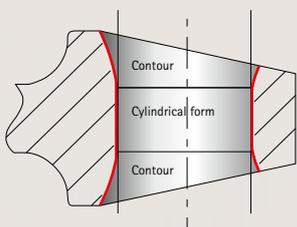


Bell-mouthed shape small bore

Sealing groove and electronic handbrake connection

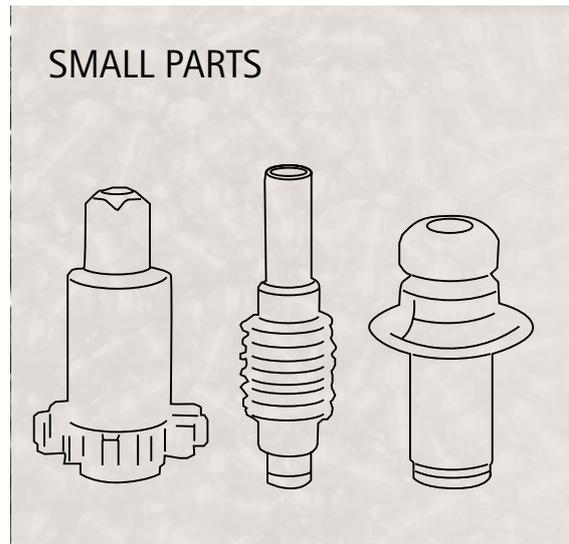
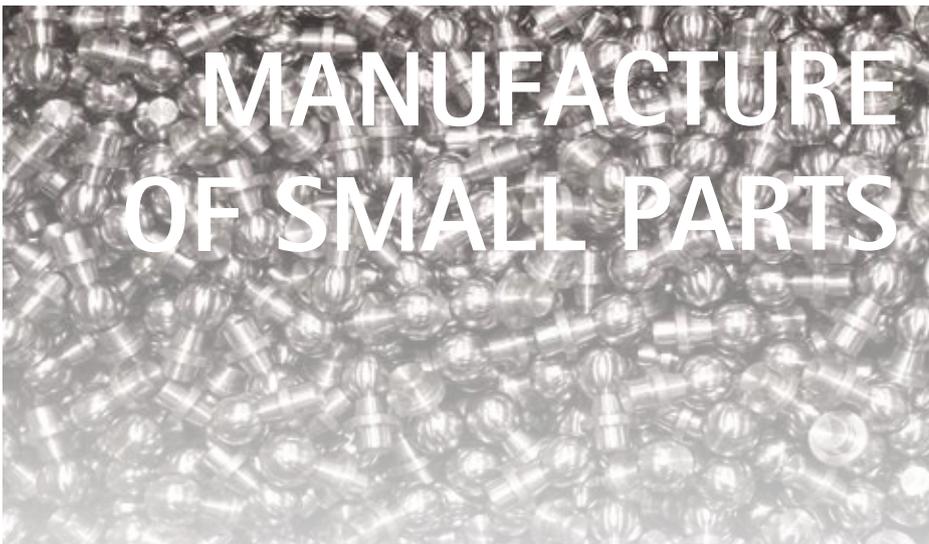
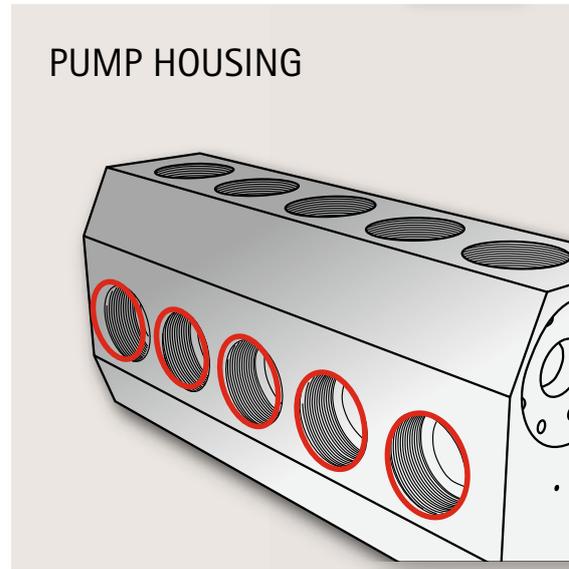
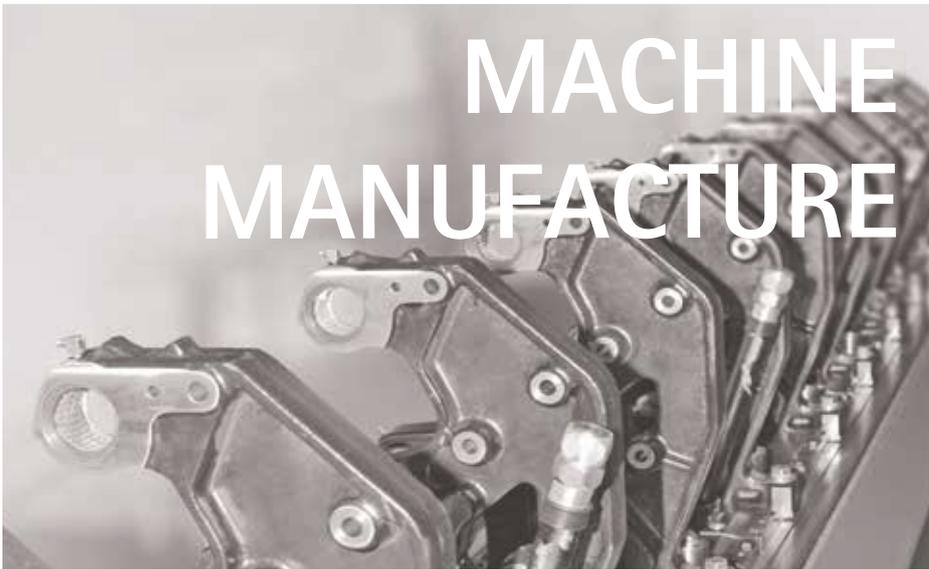
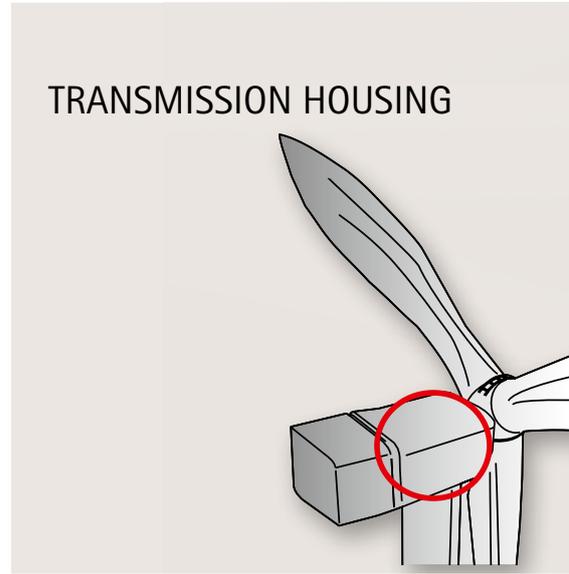
Taper turning

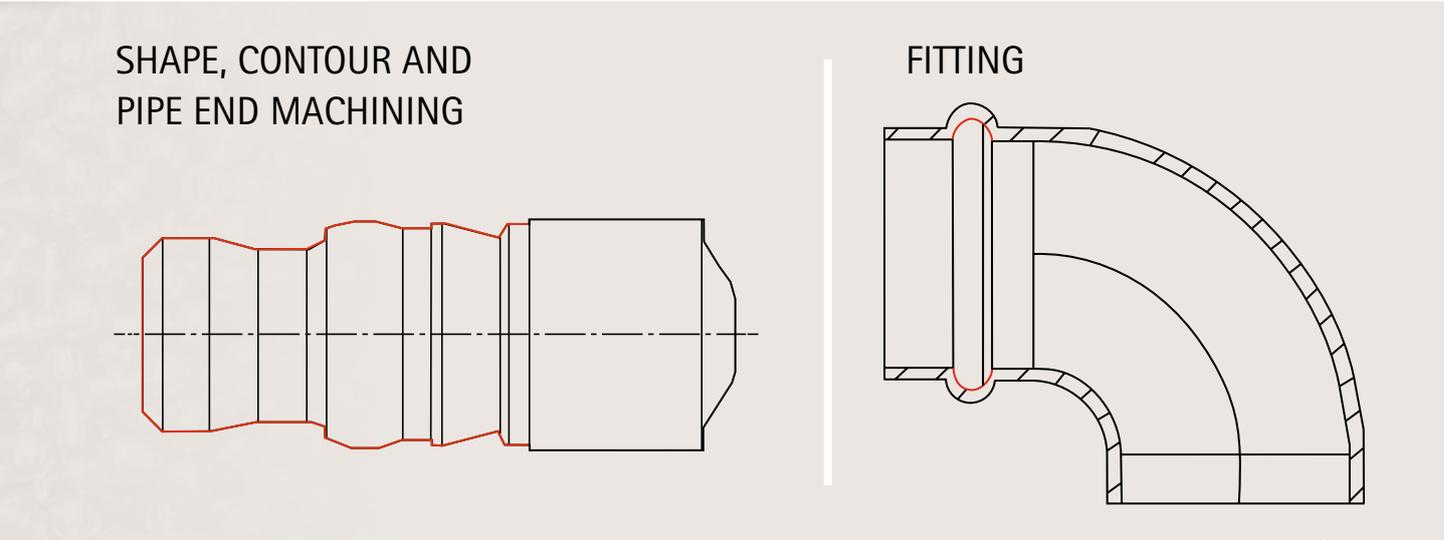
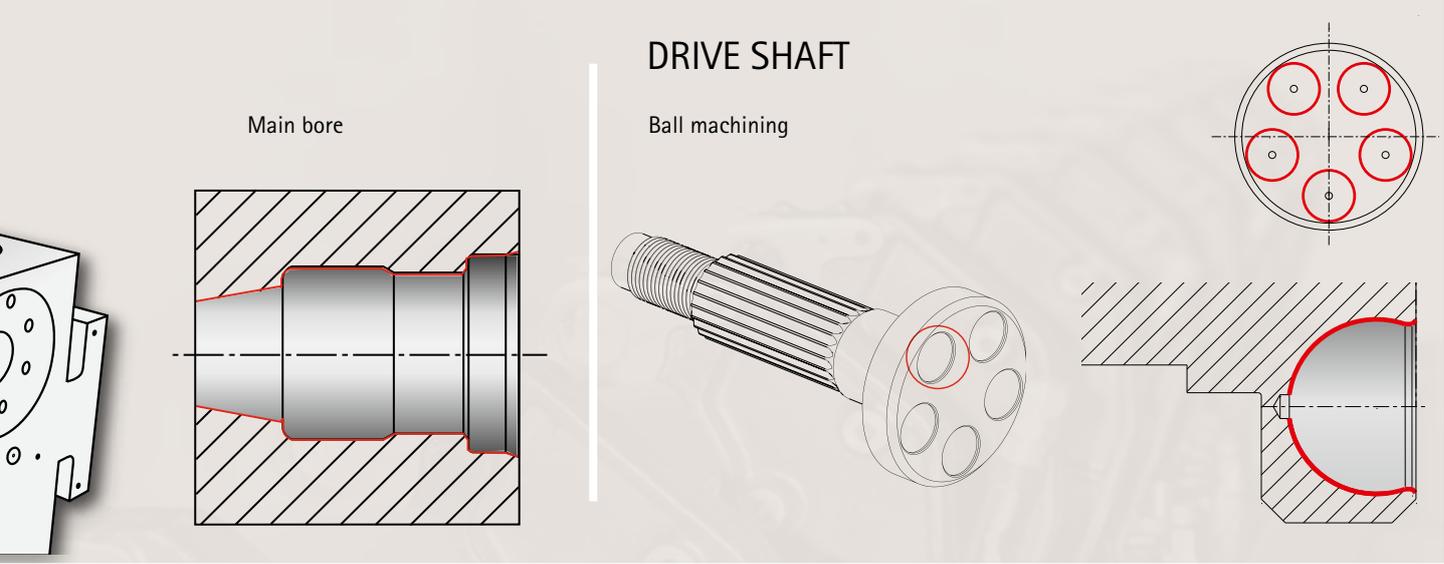
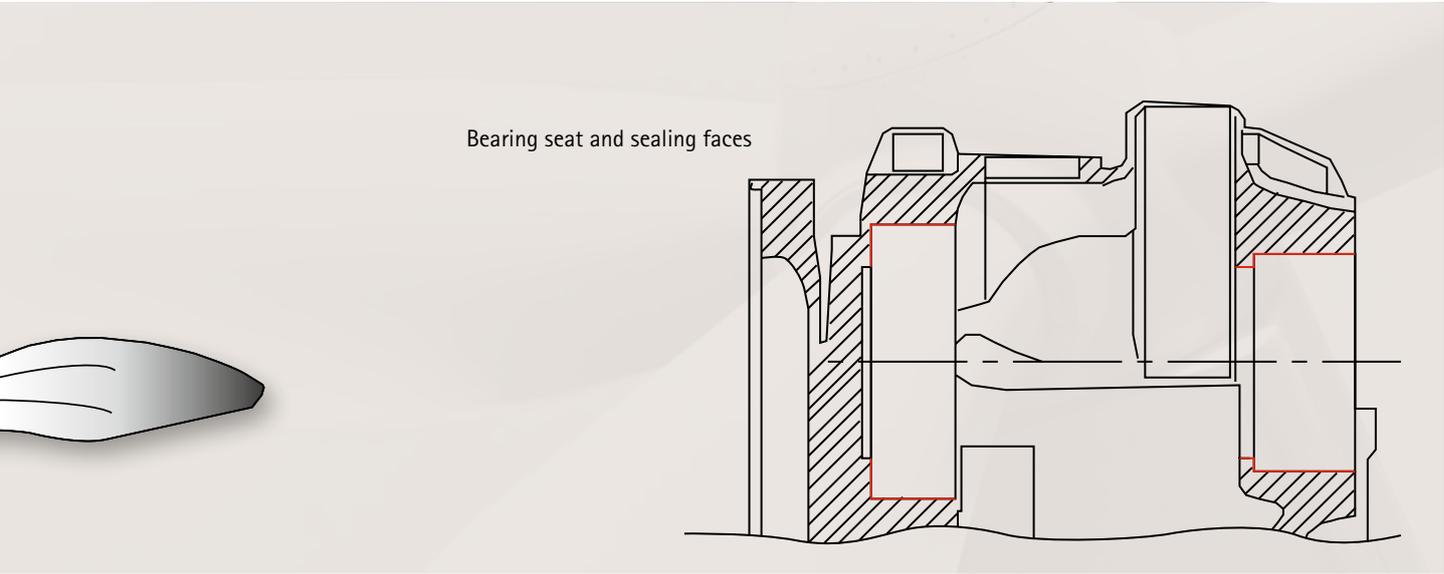
Ball machining



# 1 COMPLEX CONTOURS

Machining turning geometries on cubic parts





# 2 COMPLETE MACHINING

## TOOLTRONIC® on machining centre replaces lathe

The trend toward increasingly complex workpieces in metal machining is continuing unreciently. There is also high pressure on costs. For this reason it is necessary to manufacture contours, recesses or non-cylindrical bores on cubic workpieces efficiently and with high precision in one clamping system on machining centres. Mechanical

actuating tools or the mechatronic tool system TOOLTRONIC from MAPAL makes it possible to produce these workpieces on the machining centre. It is not necessary to use lathes for these machining steps.

### ADVANTAGES

- No costs for interlinking, as only one clamping system
- Reduced investment costs through the elimination of lathes
- Short idle times

#### Example: main bore in turbine and compressor housing

Downsizing and turbochargers are now indispensable in modern engine development. In the past machining centres and lathes were often necessary for the production of the turbine and compressor housing for a turbocharger. MAPAL has developed a manufacturing method that makes possible

complete machining on one machining centre. Contours and recesses are machined using the mechatronic tool system TOOLTRONIC and interpolation turning. Combination tools also combine a large number of machining steps.



Cycle time reduced by 60 %  
Tool life increased by 40 %

Interpolation turning tool



Lathe saved Interchangeable tool axis

TOOLTRONIC®



6 machining features  
1 control cut

ISO combination tool

# 3 CUTTING EDGE WEAR COMPENSATION

## Reliable control loop

Precision bores, in particular in engine manufacture, place high requirements on the quality, as very tight dimensional, position, shape and surface tolerances are required. In addition, the machining processes must be designed for maximum productivity, this means high tool lives with a short cycle time. To meet reliably the necessary tolerance requirements over a long tool life, MAPAL actuating tools are designed with fine adjustment for automatic wear compensation. During this process, the workpiece is meas-

ured in a downstream measuring station or outside the machining centre. The actual value measured for the bore is reported to the machining centre's controller. The inserts are then automatically re-adjusted at the device to suit the values measured and the wear determined compensated automatically. In this way closed control loops are created in conjunction with suitable measuring systems.

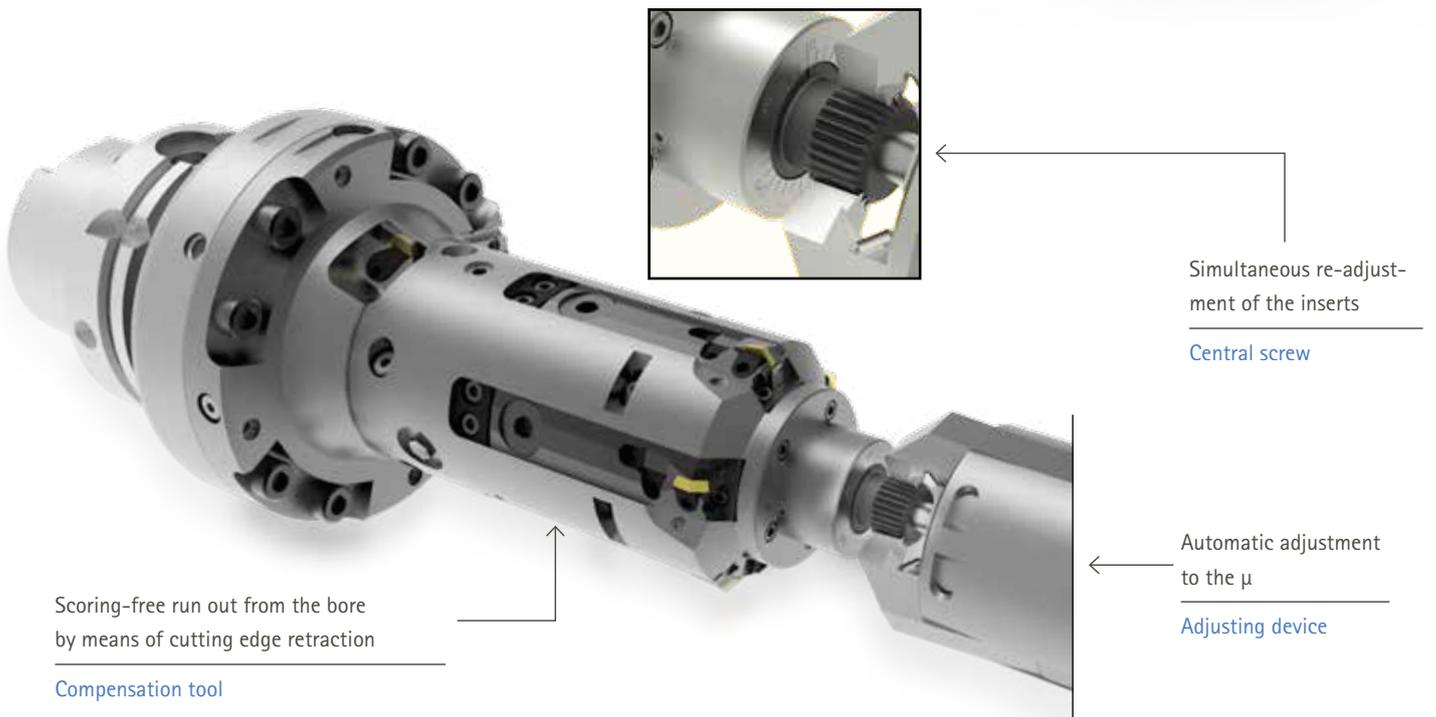
### ADVANTAGES

- High accuracy due to closed control loop
- Longer tool life due to better utilisation of the cutting edges

### Example: cylinder bore in engine blocks

Up to now these tool systems were mostly used on transfer lines via drawbar/push rod actuation. Shorter product life cycles, smaller lot sizes and excessively high investment costs require, however, the usage of more flexible manufacturing systems and machining centres. MAPAL offers the solution to this problem: a tool powered by the central coolant pressure on the machining centre. After machining the cylinder bore with low

coolant pressure, the inserts are retracted by increasing the pressure and the tool can then run out of the bore without scoring. Cutting edge wear compensation takes place, after feedback from a measuring station, automatically at an adjusting device via the central screw on the face side. (For example  $10^\circ = 1 \mu\text{m}$  in radius)



Scoring-free run out from the bore by means of cutting edge retraction

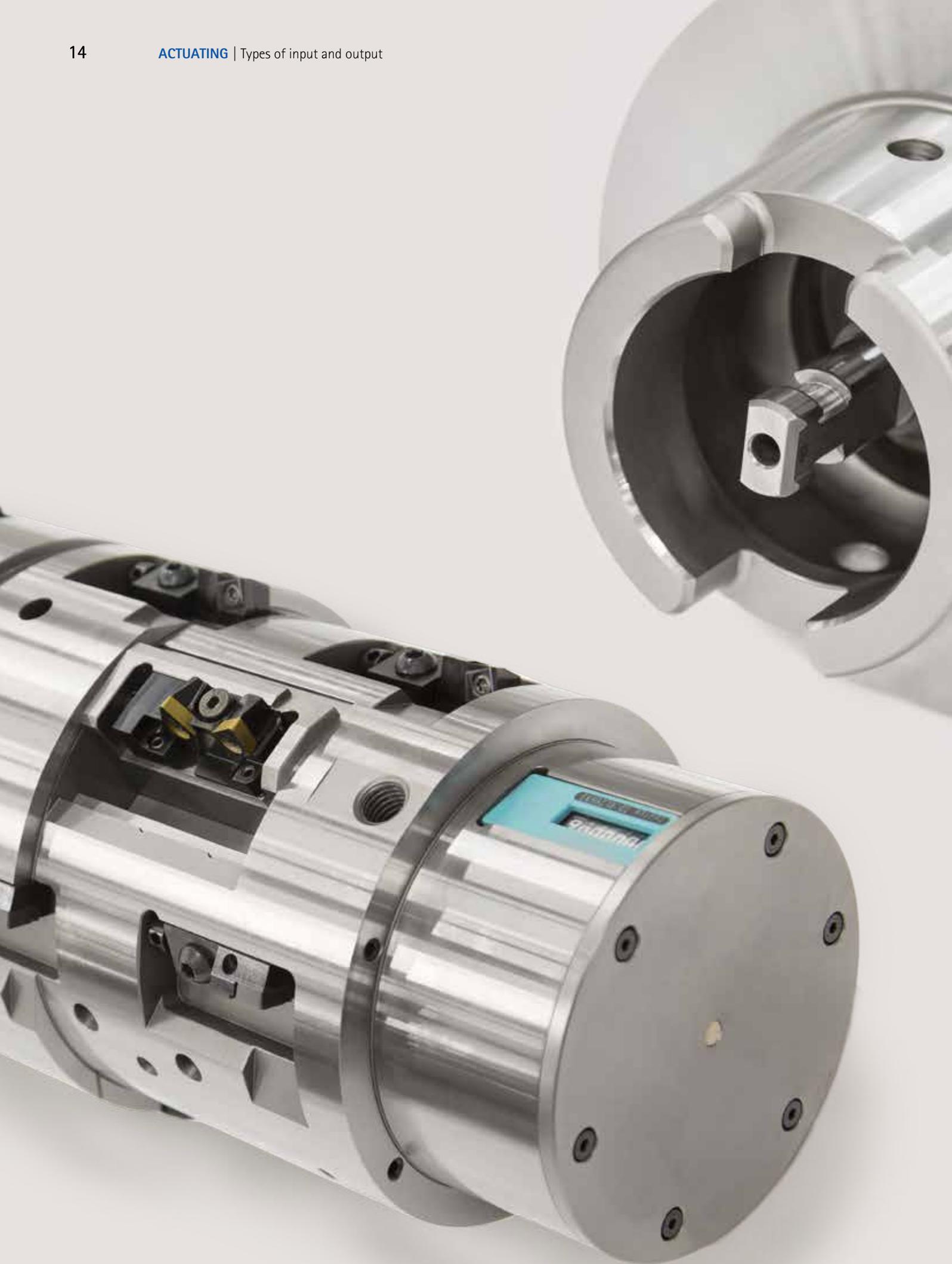
Compensation tool

Simultaneous re-adjustment of the inserts

Central screw

Automatic adjustment to the  $\mu$

Adjusting device





# TYPES OF INPUT AND OUTPUT

---

Details | Function

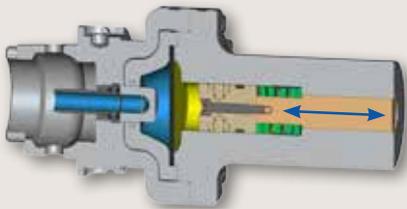
# TYPES OF INPUT IN DETAIL



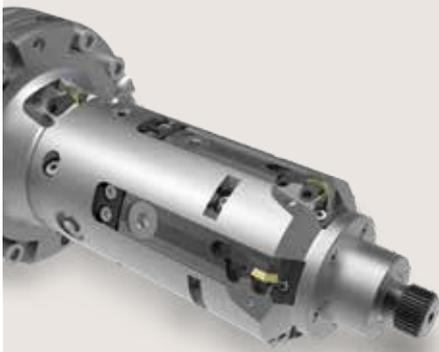
## Machining centre without actuating function

1

Input by means of coolant pressure



The coolant pressure regulates the actuation of the slide or the positioning of the inserts. The feed rate is set manually via a regulator valve. Slides or inserts are returned via an internal spring.

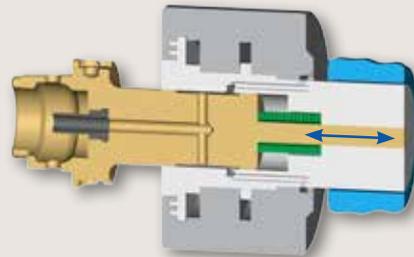


Applications and function  
Application examples

Page 18  
Page 36

2

Input by means of contact stop principle



With this principle the contact stop socket comes into contact with the fixture or the workpiece. As a consequence the tool adapter is pressed into the tool and the slide actuated. The feed rate is defined by the machine axis. The slide is retracted by an internal spring.

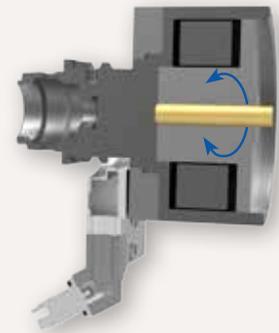


Applications and function  
Application examples

Page 20  
Page 42

3

Input by means of TOOLTRONIC® U axis



As a self-contained drive module, TOOLTRONIC represents a fully-fledged NC axis integrated into the machine control system that makes possible a wide range of applications using inductive energy and bidirectional data transmission. The slide is actuated by an actuating motor in the tool. Which mounting tool is used with TOOLTRONIC ▶



Applications and function  
Application examples

Page 22  
Page 48



**Special machine without actuating function**

**3**

Input by means of TOOLTRONIC® U axis spindle integration



depends on the machining task. As a general rule, actuating tools that were activated in the past by coolant pressure, the contact stop principle or using a drawbar, can be driven and controlled with TOOLTRONIC.



Applications and function  
Application examples

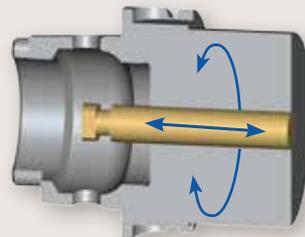
Page 22  
Page 53



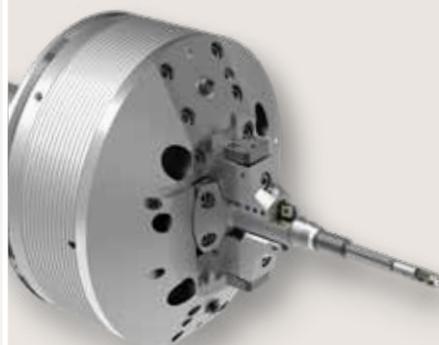
**Machining centre with U axis**

**4**

Input by means of machine's U axis



The slide is actuated via the U axis on the machine tool. The feed rate is set via the U axis. As a rule this axis is rotary and a fully functional NC axis.



Applications and function  
Application examples

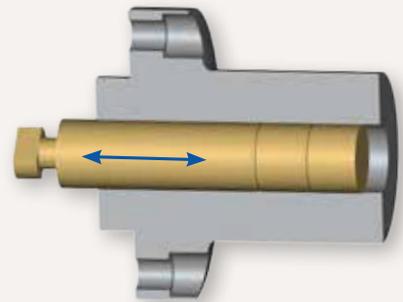
Page 24  
Page 58



**Special machine with drawbar/push rod**

**5**

Input by means of drawbar/push rod



In a special machine, the central drawbar/push rod can be used for actuating the slide or positioning the inserts. The feed rate is set via the U axis. This axis also provides the retraction (NC-controlled).



Applications and function  
Application examples

Page 26  
Page 62

# TYPE OF INPUT COOLANT PRESSURE

**1****Applications:**

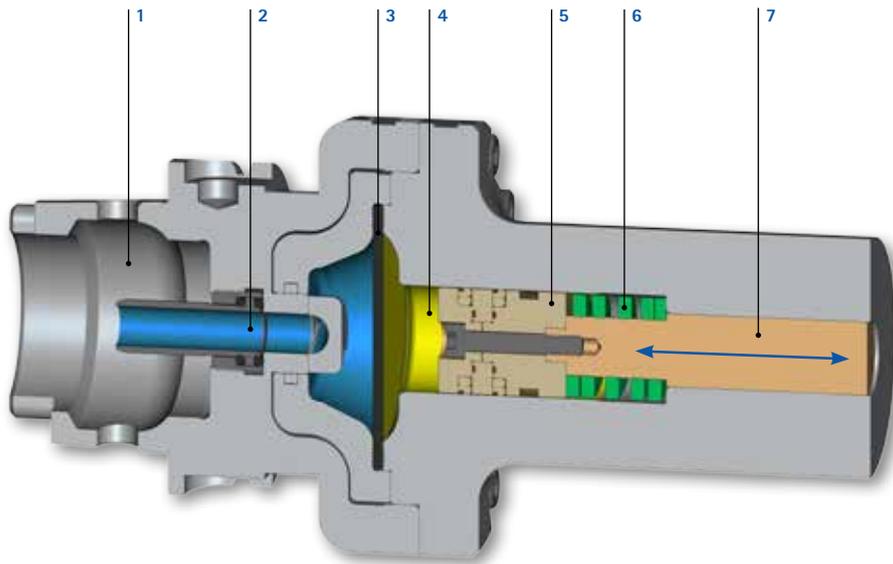
Tools actuated by coolant pressure can be used in machining centres due to their variable connection.

**Function:**

The MAPAL actuating tool is controlled via the machine tool's internal coolant supply. During this process the coolant pressure acts on a piston in the internal oil circuit; this piston is connected to the push rod. With the translational movement of the push rod, the slide is moved radially outwards by highly accurately ground serrated surfaces or deflection elements and moved into position.

To prevent soiling in the piston area due to coolant, the coolant is separated from the inner oil circuit via a diaphragm. The actuating speed of the slide is adjusted with the aid of the integrated regulator. Retraction is via spring force. Coolant is supplied through the tool body to the cutting edge via a bypass.





**CONSTRUCTION:**

- 1 | Machine connection (HSK, alternatively other connections)
- 2 | Internal coolant supply
- 3 | Diaphragm
- 4 | Oil reservoir
- 5 | Piston
- 6 | Return spring
- 7 | Drawbar/push rod

**FEATURES**

- Actuating with defined feed to fixed stop
- Axial position of the recess can be defined via machine's Z axis

**ADVANTAGES**

- Tool type can be used on every machine
- Type of input is used for recessing or for cutting edge lifting



# TYPE OF INPUT CONTACT STOP PRINCIPLE

**2****Applications:**

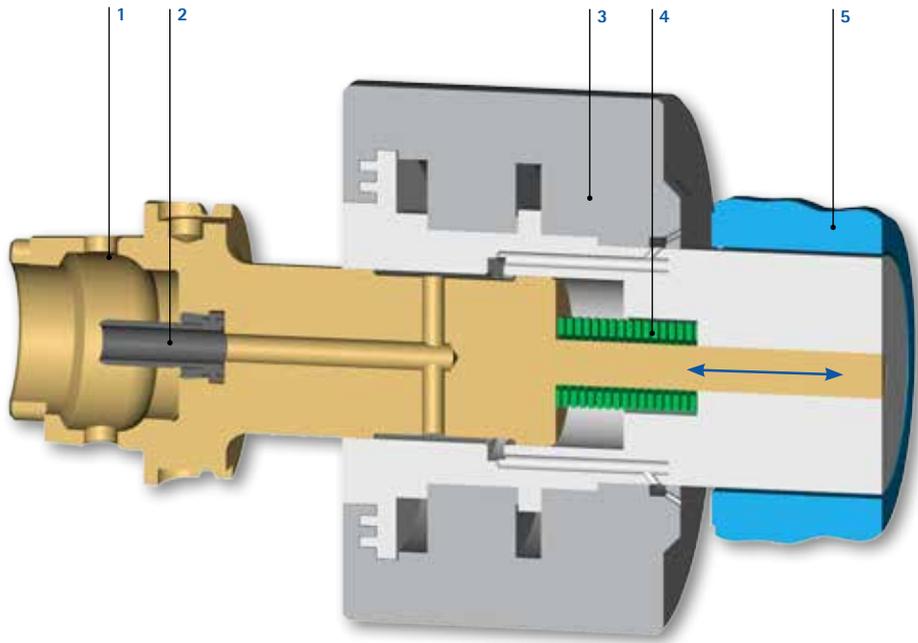
Tools actuated by contact stop can be used in machining centres due to their variable connection.

**Function:**

The MAPAL actuating tool is controlled via the contact of the contact stop socket or the contact stop arbor with the workpiece or the fixture. During this process the tool's contact stop remains stationary axially and the drawbar that is connected directly to the connection is moved axially into the contact stop body.

Regulated feed is achieved via the machine's z axis. The slider return stroke and the tool return are via spring force.





**CONSTRUCTION:**

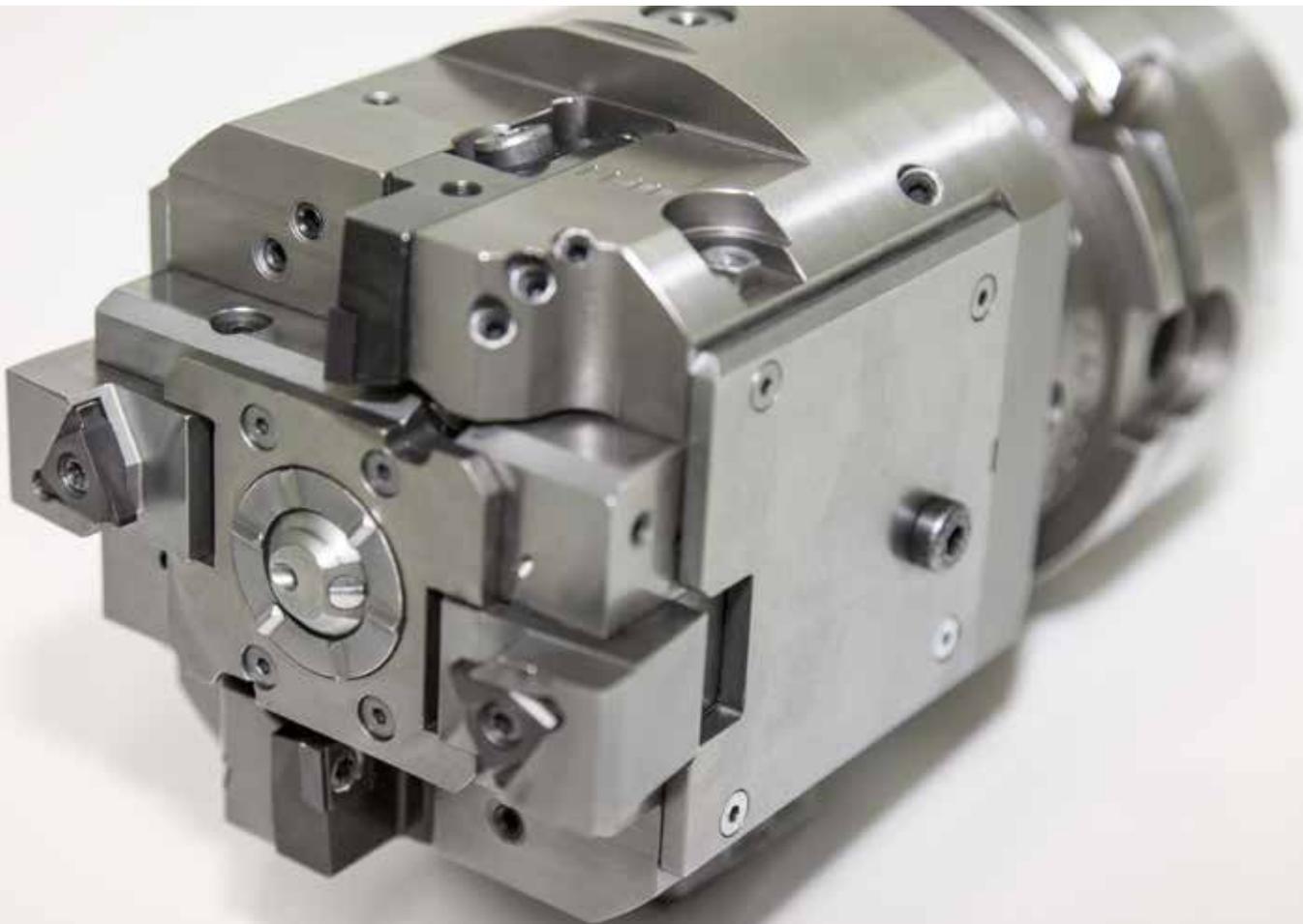
- 1 | Machine connection  
(HSK, alternatively other connections)
- 2 | Internal coolant supply possible
- 3 | Contact stop socket
- 4 | Return spring
- 5 | Workpiece / fixture

**FEATURES**

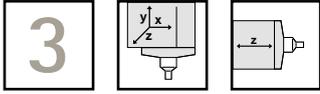
- Actuating with defined feed to fixed stop
- Position of the recess fixed and defined

**ADVANTAGES**

- Shorter machining time due to the substitution of milling
- Tool type can be used on every machining centre



# TYPE OF INPUT TOOLTRONIC® U AXIS



## TOOLTRONIC® – precise, imbalance-free and low maintenance

Coolant-pressure operated tools or actuating tools with contact stop have the disadvantage that they are limited in relation to machining complexity. Not every contour can be realised with the required accuracy. TOOLTRONIC, the mechatronic tool system from MAPAL, offers more. TOOLTRONIC performs actuating movements easily and reliably

on both machining centres and special machines. This also makes it possible to machine contours, recesses and non-cylindrical bores, as well as closed control loops for cutting compensation. It is also easy to manufacture families of parts with numerous variants. As a self-contained drive module, the TOOLTRONIC represents a fully-fledged

NC axis integrated into the machine control system. It enables a significant reduction in manufacturing times and lead times with improved surface quality and greater contour accuracy, without limiting the performance of the machine.

## TOOLTRONIC® for machining centres

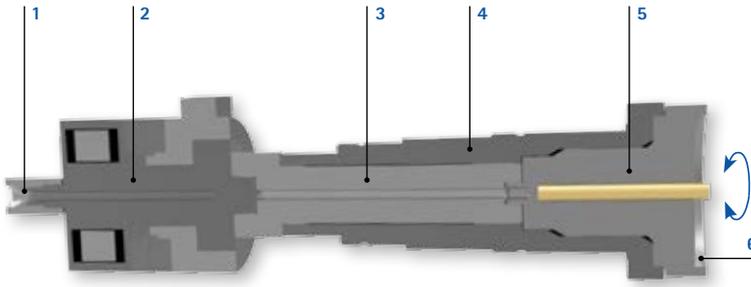
With the internal coolant supply, the different tool connections that can be realised and the automatic tool change, TOOLTRONIC represents an interchangeable input for machining centres for many applications.

TOOLTRONIC is flexible and can be adapted to part variations by means of simple programming. The number of different tools is reduced and manufacturing times and lead times are reduced. The TOOLTRONIC drive unit is available as a standard component with different machine connections. Actuating tool variants can be attached to the drive unit; depending on the machining task these actuating tools contain a suitable actuating principle and the related gearbox components.

## TOOLTRONIC® for special machines

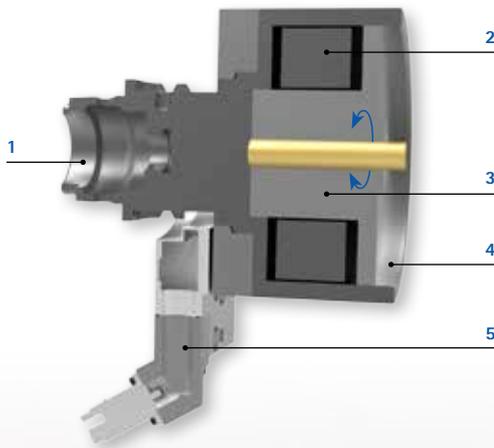
Integrated into spindles, TOOLTRONIC is used in production lines and in rotary transfer machines. Complex manufacturing operations can be reduced to one machine tool or machining station. In this way lead times and costs are reduced to a minimum. Despite a custom solution, the modular design permits short response times as well as standard components that are easy to assemble and maintain. The relocation of the inductive energy and bidirectional data transmission outside the machine tool's machining compartment makes possible a short design. In turn, this aspect ensures a high degree of rigidity on the TOOLTRONIC spindle. A further feature is the internal coolant supply, the optimal chip transport and increased lives of the tool cutting edges.





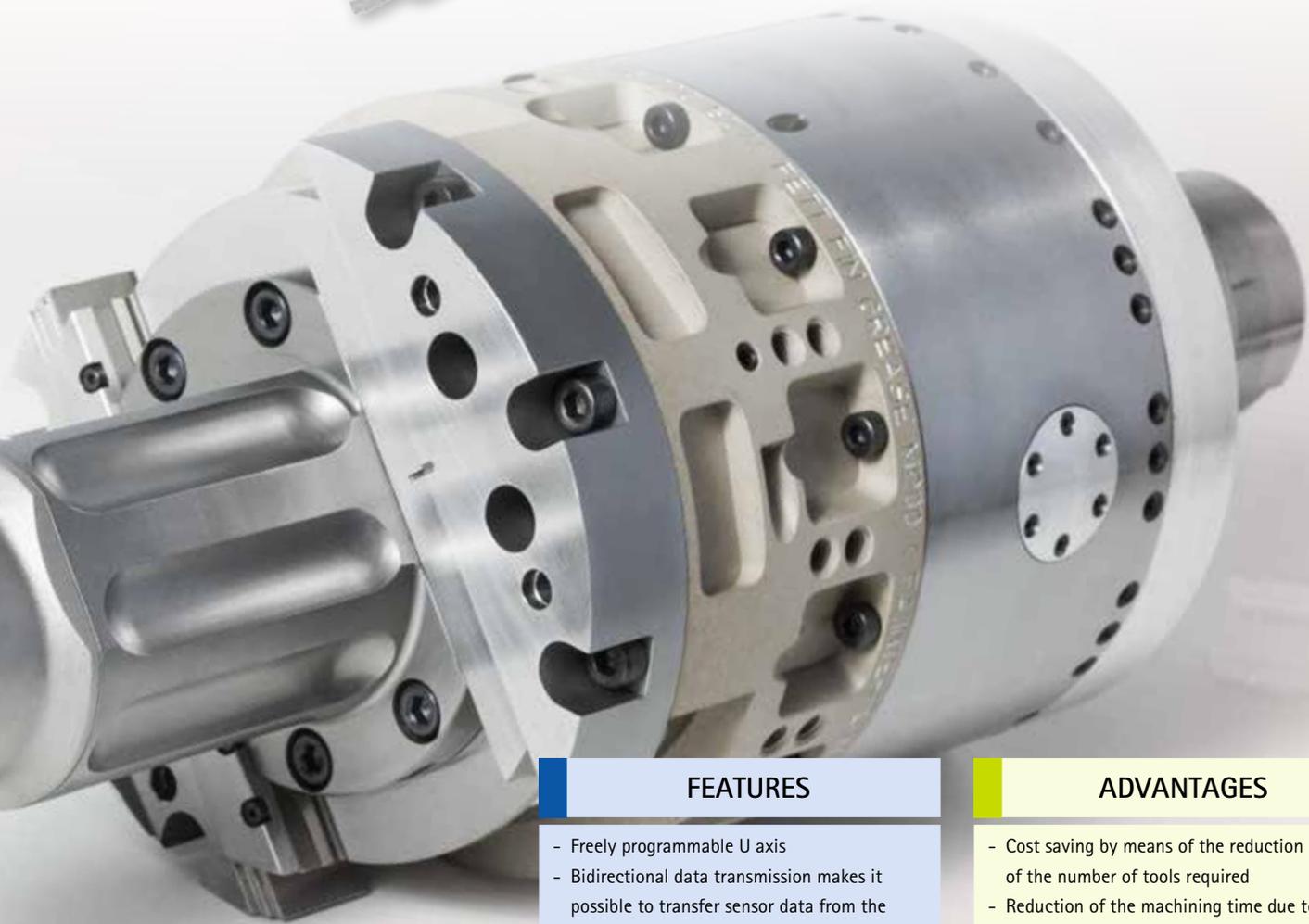
**TOOLTRONIC® CONSTRUCTION FOR SPECIAL MACHINES:**

- 1 | Coolant transfer
- 2 | Transfer unit
- 3 | Spindle mandrel
- 4 | Spindle shaft
- 5 | Motor unit
- 6 | Modular connection



**TOOLTRONIC® CONSTRUCTION FOR MACHINING CENTRES:**

- 1 | Machine connection
- 2 | Electronics
- 3 | Motor unit with defined connection point
- 4 | Modular connection
- 5 | Stator (stationary unit)



**FEATURES**

- Freely programmable U axis
- Bidirectional data transmission makes it possible to transfer sensor data from the TOOLTRONIC to the machine control system, thereby allowing users to develop new machining and control concepts

**ADVANTAGES**

- Cost saving by means of the reduction of the number of tools required
- Reduction of the machining time due to complete machining on one machine

# TYPE OF INPUT MACHINE'S U AXIS

4

**Applications:**

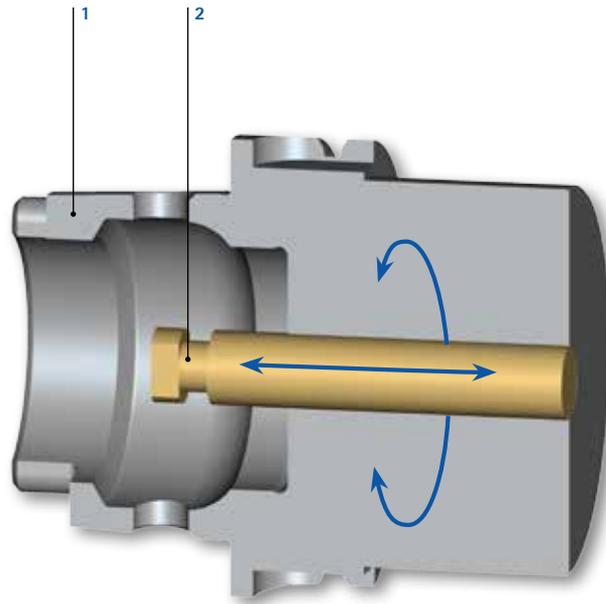
Wherever machines are equipped with U axis systems, suitably prepared controllable tools can be used.

Any contours, recesses or non-cylindrical bores on pump housings, hydraulic housings and valve housings can be produced using this additional NC axis.

**Function:**

The controllable tool is inserted in the machine from the tool magazine like any other standard tool. Then the machine's U axis couples to the tool's U axis. Actuation can be rotational or translational and represents a full NC axis.





**CONSTRUCTION:**

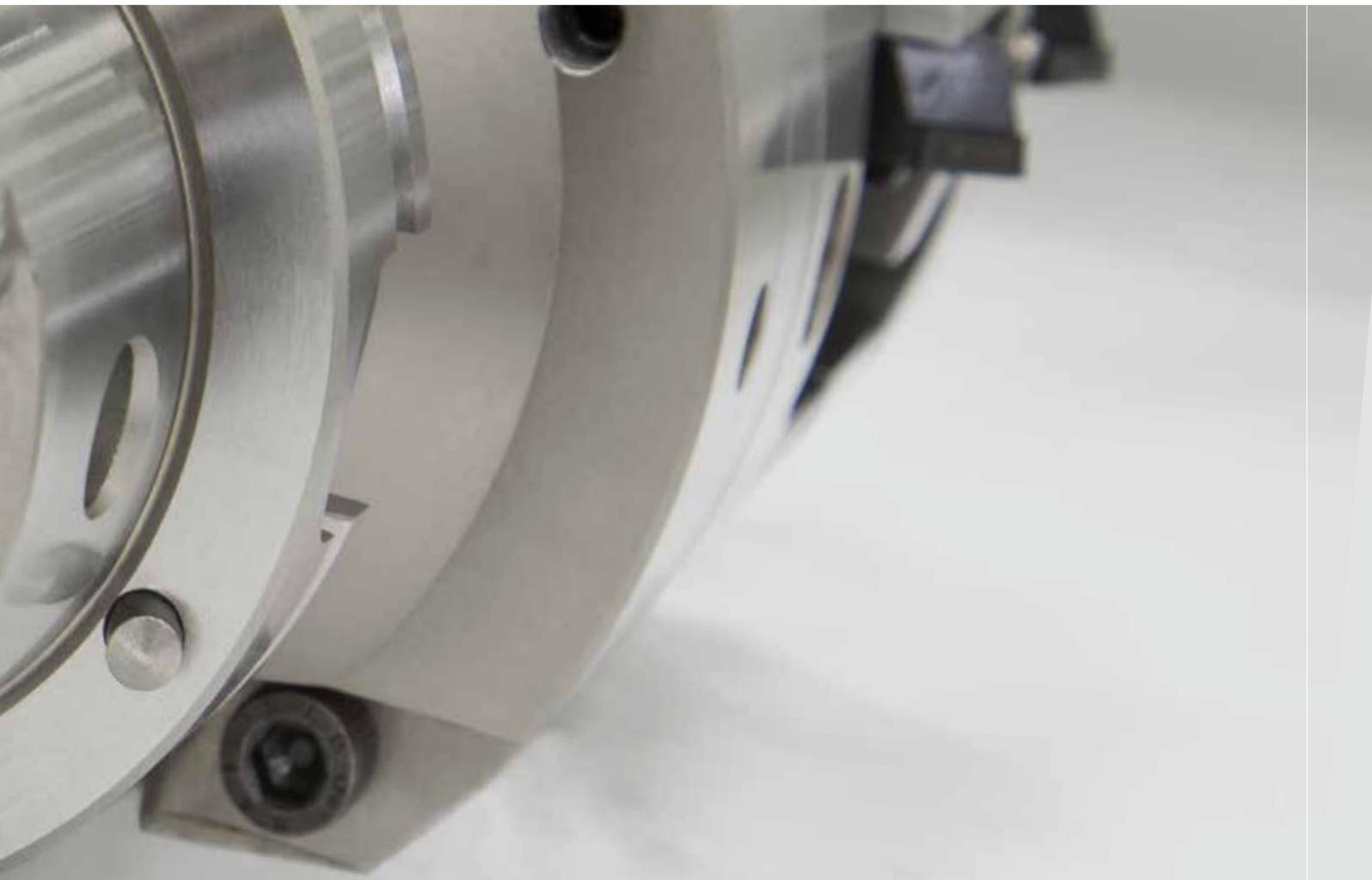
- 1 | Hollow shank taper (HSK) machine connection, alternatively steep taper (SK)
- 2 | Linear or rotatory operation of the U axis

**FEATURES**

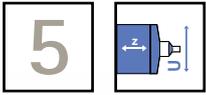
- Various machine connections possible
- Linear and rotatory actuation of the U axis

**ADVANTAGES**

- Time-saving due to the avoidance of the re-clamping process on a lathe
- Outstanding machining quality
- High flexibility in manufacturing
- High process reliability
- Low maintenance effort



# TYPE OF INPUT DRAWBAR/PUSH ROD

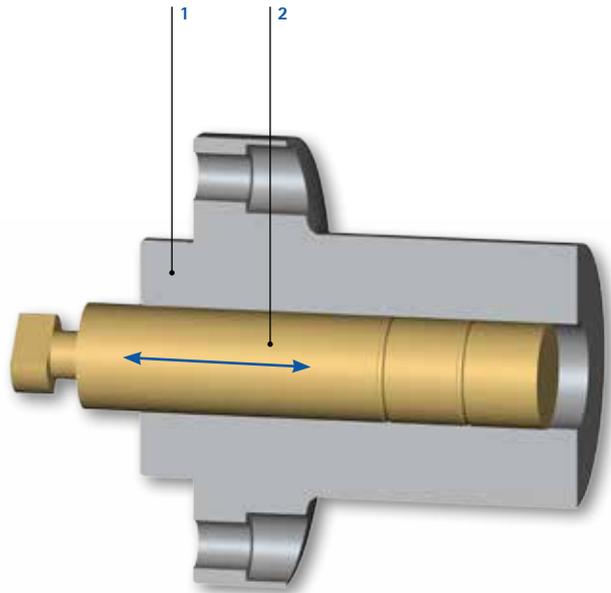
**Applications:**

Due to their drawbar attachment to the actuator, tools controlled via drawbar/push rod can be used in appropriately modified machine tools.

**Function:**

The MAPAL actuating tool is actuated via the centrally located drawbar/push rod. With the translational movement of the drawbar/push rod, the slide is moved radially outwards by highly accurately ground serrated surfaces or deflection elements and moved into position.





**CONSTRUCTION:**

- 1 | Machine connection, different flange modules
- 2 | Drawbar/push rod

**FEATURES**

- Regulated actuation or positioning possible with NC input
- Fine machining of complex contours on cubic parts on special machines
- Robust design for any application

**ADVANTAGES**

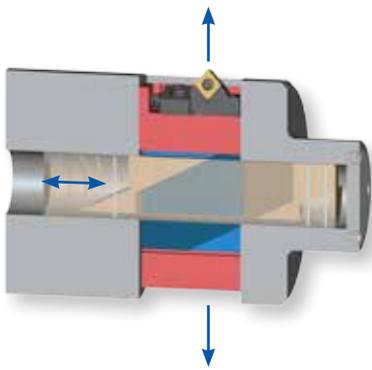
- High actuation forces can be realised
- Large parts / large strokes



# TYPES OF OUTPUT IN DETAIL

## Moving and controlling

### Linear slide



The linear slide, which is perpendicular to the centre line of the tool, is actuated via angled teeth on the drawbar/push rod.

**Applications:**

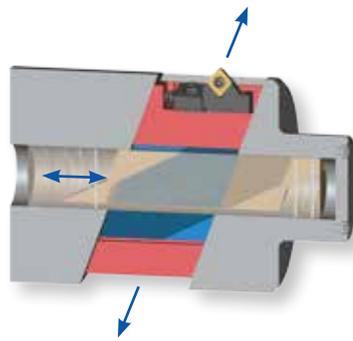
Brake housing | Cylinder crankcase | Transmission housing | Pump housing | Swivel bearing

**Machining operations:**

Recessing | Contour turning | Facing | Thrust bearing turning



### Inclined slide



Function as by linear slide, however the slide angle in relation to the centre line of the tool is not 90°.

**Applications:**

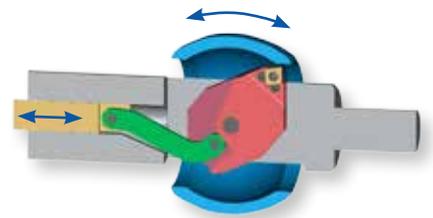
Brake housing | cylinder head

**Machining operations:**

Recessing | Chamfering | Taper turning



### Pivoting slide



The pivoting slide is operated via a central pin using an internal lever mechanism. A spherical segment is produced by the inherent rotation of the tool and the superimposed rotation of the pivoting slide.

**Applications:**

Differential housing | Ball pin

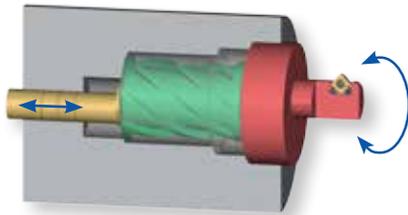
**Machining operations:**

Turning spherical ball

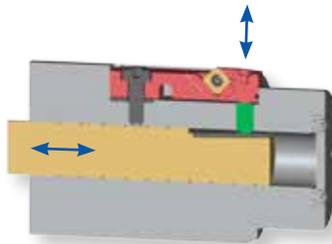


## Compensating and lifting

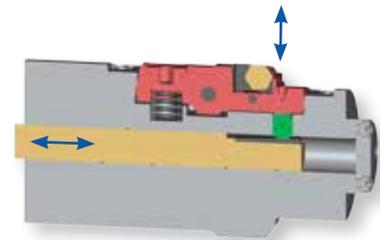
Rotary slide



Deflection holder



Tilting holder



The rotary slide is actuated via a combination of twist shaft and twist sleeve. During this process the axial movement of the twist shaft is converted into a rotation using a twist sleeve. The radial stroke is provided by an eccentric located slide.

**Applications:**

Small series production parts | Gearbox housing

**Machining operations:**

Recessing | Contour turning | Facing | Thrust bearing turning



An angled surface on the drawbar/push rod is responsible for the actuation of the cartridge on the deflection holder and the tilting holder. The holder is set to the appropriate centrifugal circle diameter depending on the position of the drawbar/push rod.

**Applications:**

Brake housing | Cylinder crankcase | Transmission housing | Pump housing | Swivel bearing

**Machining operations:**

Compensating cutting edge wear | Turning small contours | Recessing







# COMBINATION OF INPUT AND OUTPUT

---

Selection matrix | Possible applications

# SELECTION MATRIX

Possible combinations of input and output for actuating tools



**Machining centre without actuating function**  
(actuating tool is inserted via magazine)



**Machining centre with U axis**  
(actuating tool is inserted via magazine)



**Special machine without actuating function**  
(TOOLTRONIC input integrated into the spindle)

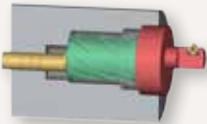
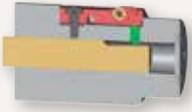


**Special machine with drawbar/push rod**  
(actuating tool adapted to spindle)

INPUTS		<p>COOLANT PRESSURE <a href="#">(SEE PAGE 18)</a></p>	<p>1</p>	<p>Tolerance in <math>\mu\text{m}</math> &lt; 10</p> <p>Radial stroke in mm &lt; 20</p> <p>Spindle speed in rpm &lt; 3,000</p>	<p>Linear slide (radial)</p>	<p>Slide boring bar <a href="#">1.2   PAGE 37</a> <a href="#">1.3   PAGE 38</a></p>
		<p>CONTACT STOP PRINCIPLE <a href="#">(SEE PAGE 20)</a></p>	<p>2</p>	<p>Tolerance in <math>\mu\text{m}</math> &lt; 10</p> <p>Radial stroke in mm &lt; 15</p> <p>Spindle speed in rpm &lt; 2,000</p>	<p>Slide tool <a href="#">2.2   PAGE 43</a> <a href="#">2.4   PAGE 45</a></p> <p>Slide boring bar <a href="#">2.3   PAGE 44</a></p>	
		<p>TOOLTRONIC® U AXIS <a href="#">(SEE PAGE 22)</a></p>	<p>3</p>	<p>Tolerance in <math>\mu\text{m}</math> &lt; 10</p> <p>Radial stroke in mm &lt; 56</p> <p>Spindle speed in rpm &lt; 4,000</p>	<p>LAT* <a href="#">3.3   PAGE 50</a> <a href="#">3.4   PAGE 51</a></p> <p>TOOLTRONIC Honing <a href="#">3.5   PAGE 52</a></p> <p>Slide boring bar</p>	
		<p>TOOLTRONIC® U AXIS AS FEATURE INTEGRATED INTO SPINDLE <a href="#">(SEE PAGE 22)</a></p>	<p>3</p>	<p>Tolerance in <math>\mu\text{m}</math> &lt; 10</p> <p>Radial stroke in mm &lt; 92</p> <p>Spindle speed in rpm &lt; 4,000</p>	<p>LAT* <a href="#">3.7   PAGE 54</a></p> <p>Slide boring bar</p>	
		<p>MACHINE'S U AXIS LINEAR/ROTATORY <a href="#">(SEE PAGE 24)</a></p>	<p>4</p>	<p>Tolerance in <math>\mu\text{m}</math> &lt; 10</p> <p>Radial stroke in mm &lt; 56</p> <p>Spindle speed in rpm &lt; 4,000</p>	<p>Slide tool <a href="#">4.2   PAGE 59</a></p>	
		<p>DRAWBAR/PUSH ROD LINEAR/ROTATORY <a href="#">(SEE PAGE 26)</a></p>	<p>5</p>	<p>Tolerance in <math>\mu\text{m}</math> &lt; 10</p> <p>Radial stroke in mm &lt; 20</p> <p>Spindle speed in rpm &lt; 3,000</p>	<p>Slide tool <a href="#">5.3   PAGE 64</a></p> <p>LAT* <a href="#">5.5   PAGE 66</a> <a href="#">5.7   PAGE 68</a> <a href="#">5.8   PAGE 69</a></p>	

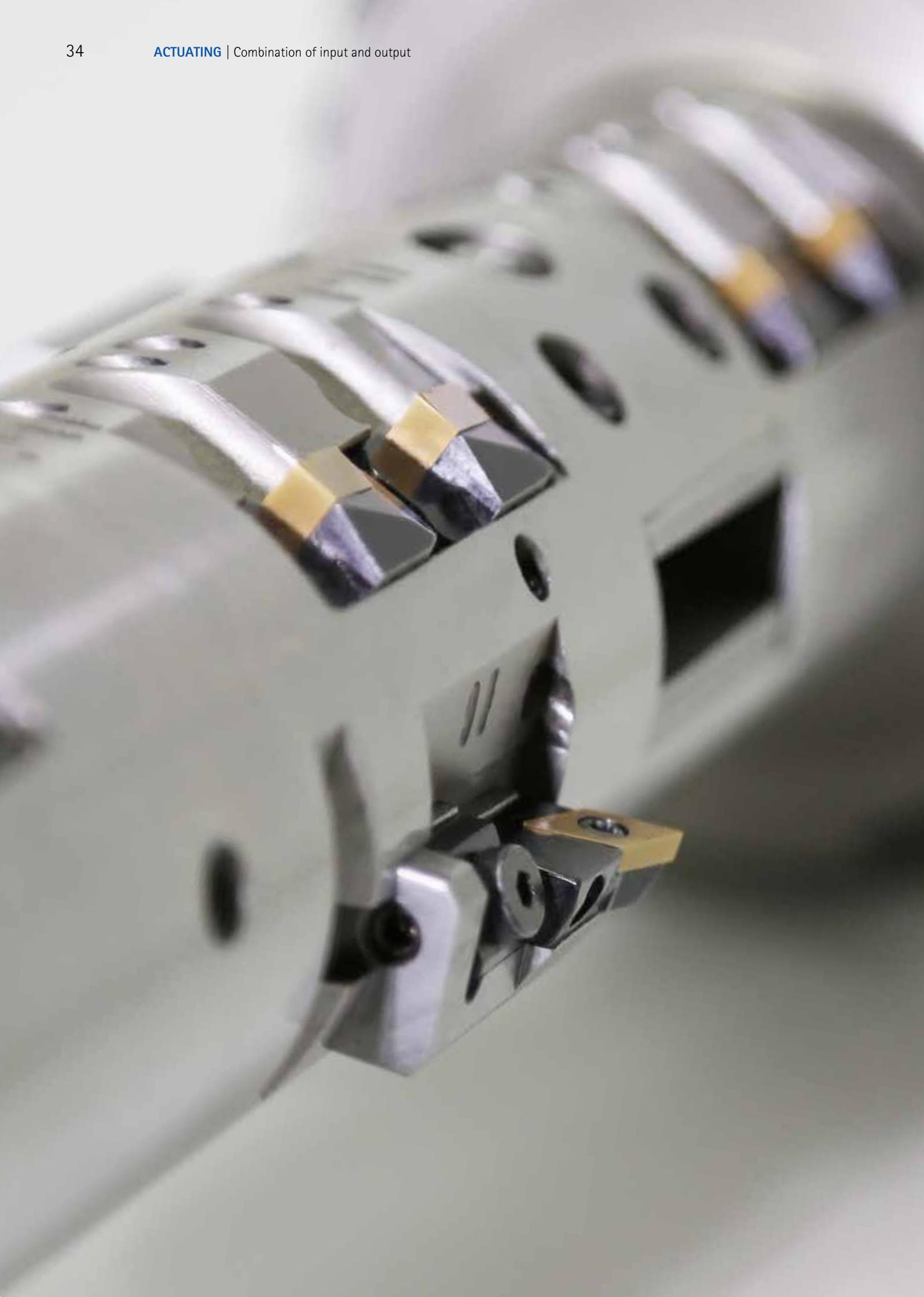
Note: Recommended possible combinations are shown in this matrix – in the catalogue you will find possible applications for all the fields marked in blue (see page references).

# OUTPUTS

Inclined slide		Pivoting slide		Rotary slide		Deflection holder		Tilting holder		
										
< 10	Taper turning tool	< 10	Spherical turning tool		< 5	Fine boring tool	< 5	Fine boring tool	Fine boring tool	
< 20	Grooving tool	<sup>1)</sup> 120°			< 0.2			< 1	Grooving tool	1.1   PAGE 36
< 3,000	1.4   PAGE 39	< 2,000			< 10,000			< 10,000		
< 10	Taper turning tool	< 10	Spherical turning tool				< 5	Grooving tool	2.1   PAGE 42	
< 15	Grooving tool	<sup>1)</sup> 120°					< 3			
< 2,000		< 2,000					< 10,000			
< 10	Taper turning tool	< 10	Spherical turning tool	< 3	EAT* 3.1   PAGE 48 3.2   PAGE 49	< 5	Fine boring tool (can be compensated)	< 5	Fine boring tool (can be compensated)	
< 15	Grooving tool	<sup>1)</sup> 120°		< 11		< 0.2		< 1		Grooving tool
< 2,000		< 2,000		< 8,000		< 10,000		< 10,000		
< 10	Taper turning tool	< 10	Spherical turning tool	< 5	EAT* 3.6   PAGE 53	< 5	Fine boring tool (can be compensated)	< 5	Fine boring tool (can be compensated)	
< 20	Grooving tool	<sup>1)</sup> 120°		< 11		< 0.2		< 1		Grooving tool
< 3,000		< 2,000		< 8,000		< 10,000		< 10,000		
< 10	Taper turning tool	< 10	Spherical turning tool	< 10	EAT*	< 5	Fine boring tool (can be compensated)	< 5	Fine boring tool (can be compensated)	
< 20	Grooving tool	<sup>1)</sup> 120°		< 20		< 0.2		< 1		Grooving tool
< 3,000		< 2,000		< 6,000		< 10,000		< 10,000		
< 10	Taper turning tool	< 10	Spherical turning tool	< 10	EAT* 5.4   PAGE 65 5.6   PAGE 67	< 5	Fine boring tool (can be compensated)	< 5	Fine boring tool (can be compensated)	
< 20	Grooving tool	<sup>1)</sup> 120°		< 20		< 0.2		< 1		Grooving tool
< 3,000		< 2,000		< 10,000		< 10,000		< 10,000		

Combination of input and output

Note: Possible combinations for 90 % of applications. Different special cases on request.  
 \*Standard programme for linear actuating tools (LAT) and eccentric actuating tools (EAT).  
<sup>1)</sup> Stroke information in degrees [°]



# COOLANT PRESSURE

---

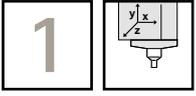
## 1

### Applications

- 1.1 Cylinder bore in a crankcase ..... 36
- 1.2 Crankshaft thrust bearing bore in a crankcase ..... 37
- 1.3 Main bore in a brake caliper ..... 38
- 1.4 Fine machining of tapered and inclined recesses ..... 39

# Actuation by means of coolant pressure

## Applications



### 1.1 Fine machining of the cylinder bores on a 6-cylinder engine block

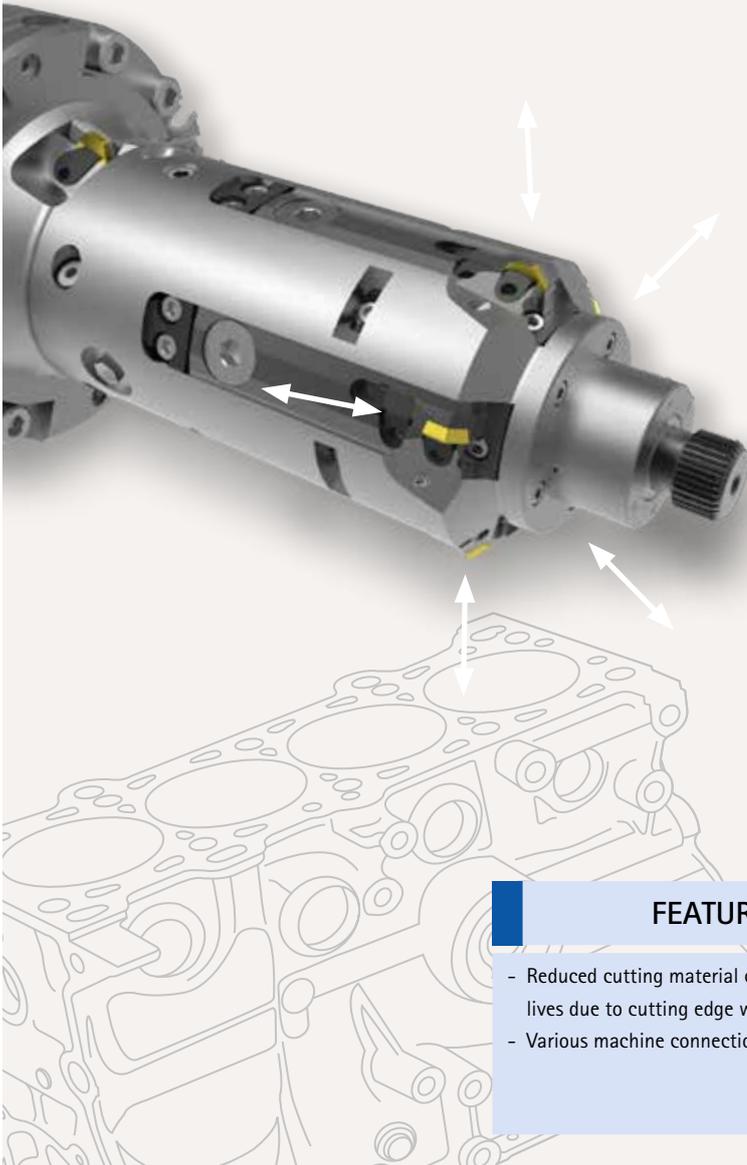
#### TASK:

- Machining the cylinder bore to the required dimensional and surface quality.
- Extension of tool life with simultaneous insert cost savings due to automated wear compensation.

#### SOLUTION:

Initially the adjustable blades are positioned at the machining diameter set by controlling the coolant pressure (approx. 40-50 bar) and the cylinder bore is machined. On completion of the machining, the coolant pressure is switched off, the adjustable arms with the finishing blades lift off the workpiece and the tool can be retracted from the

bore without scoring. The inserts can be re-adjusted to the  $\mu$  either manually using an assembly tool on the central screw attached to the end, or automatically via an adjusting device in the machining centre, to compensate for cutting edge wear.



#### CUTTING DATA

- Material	GG26Cr
- Cutting material	PcBN
- Diameter	92.9 mm
- Cutting speed	1,000 m/min
- Cutting depth	0.3 mm
- Spindle speed	3,430 rpm
- Number of teeth	5
- Feed rate	3,083 mm/min
- Feed	0.9 mm
- Machining time	3 s
- Cutting power	4 KW
- Tool weight	12 kg

#### FEATURES

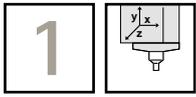
- Reduced cutting material costs and high tool lives due to cutting edge wear compensation
- Various machine connections possible

#### ADVANTAGES

- High process reliability due to scoring-free machining with cutting edge lifting
- Simple manual or automatic setting of the finishing inserts to the  $\mu$

# Actuation by means of coolant pressure

## Applications



### 1.2 Fine machining of crankshaft thrust bearings

**TASK:**

- Finish machining of a thrust bearing journal using the face turning process on a machining centre without U axis (in the related tolerance range)

**SOLUTION:**

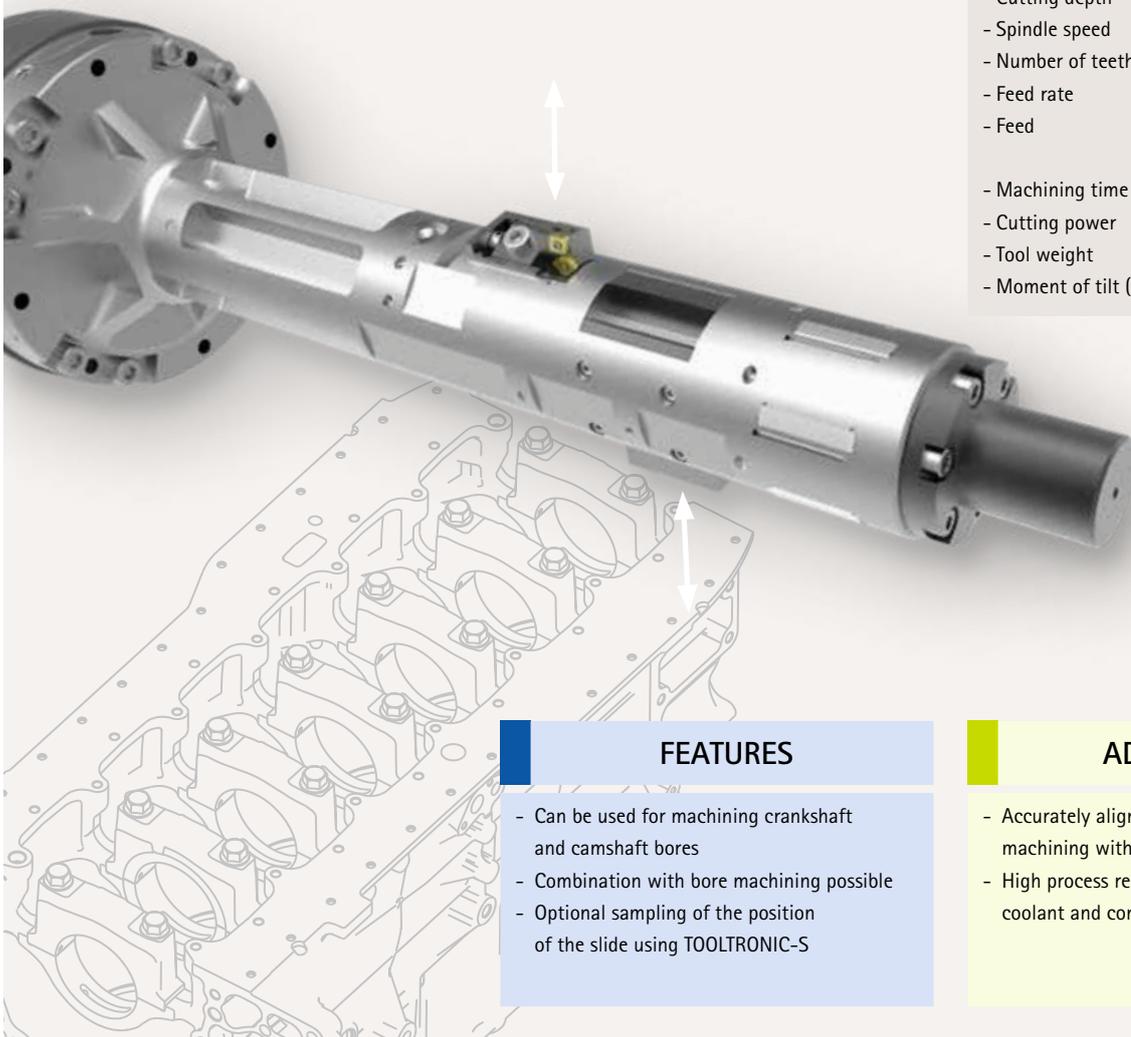
Due to the depth of the bore the tool is supported in the fully machined crankshaft

bearing bore using guide pads. The coolant enters the tool centrally and becomes a control medium for an inner oil circuit by regulating the coolant pressure (approx. 40-80 bar). This circuit evenly actuates the machining slides. During this process machining can be either on one side or both sides depending on the how the insert for machining is set. On completion

of the machining, the coolant pressure is switched off, the extended slides with the finishing inserts move inwards and the tool can be retracted from the bore.

#### CUTTING DATA

- Material	AlSi8Cu3 / GG
- Cutting material	Carbide coated
- Diameter	60 - 81.5 mm
- Stroke (slides)	11 mm
- Cutting speed	94 - 128 m/min
- Cutting depth	0.5 mm
- Spindle speed	500 rpm
- Number of teeth	1 + 1 (both sides)
- Feed rate	75 mm/min
- Feed	0.15 mm (adjustable)
- Machining time	9 s
- Cutting power	1 KW
- Tool weight	17.5 kg
- Moment of tilt (at HSK)	22 Nm



#### FEATURES

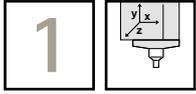
- Can be used for machining crankshaft and camshaft bores
- Combination with bore machining possible
- Optional sampling of the position of the slide using TOOLTRONIC-S

#### ADVANTAGES

- Accurately aligned thrust bearing machining without additional support
- High process reliability due to separate coolant and control media circuits

# Actuation by means of coolant pressure

## Applications



### 1.3 Machining recesses on a brake caliper

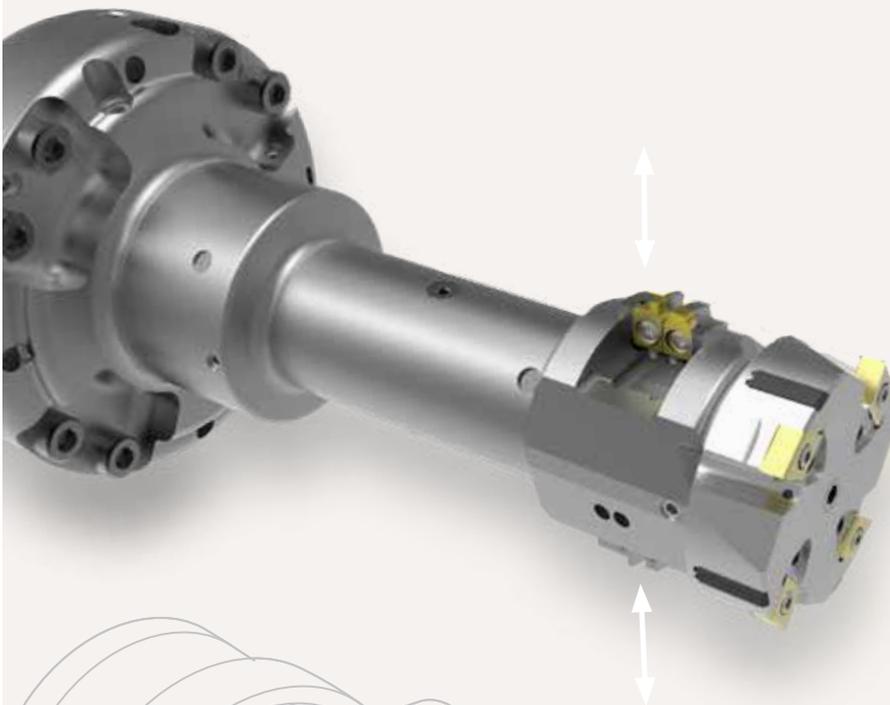
#### TASK:

- Machining a piston bore in a brake caliper on the machining centre with a short cycle time.

#### SOLUTION:

Combination of recess and diameter machining realised. A push rod is actuated via a closed oil circuit. With the translational movement of the push rod, two radial slides are moved outwards by highly accurately ground serrated surfaces to produce the groove recesses. A highlight is the combined

roughing and fine machining of the two recesses; by means of innovative technology the slide for fine machining overtakes the roughing slide just before the end of the machining to produce the finished recess profile.



#### CUTTING DATA

- Material	GG50 / GG60
- Cutting material	Carbide coated (HP455)
- Diameter	59.4 - 67.6 mm
- Stroke (slides)	4.2 mm
- Cutting speed	100 m/min
- Spindle speed	502 rpm
- Number of teeth	1 + 1
- Feed	0.1 mm (adjustable)
- Tool weight	8 kg

#### FEATURES

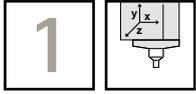
- Design for drawbar/push rod actuation also possible
- Optional sampling of the position of the slide via TOOLTRONIC-S
- Integrated end position control

#### ADVANTAGES

- Shorter machining time without tool change
- Higher accuracy of the recesses in relation to the blind hole, as manufacturing is undertaken in one clamping system
- Pre-machining and fine machining using one tool

# Actuation by means of coolant pressure

## Applications



### 1.4 Fine machining of tapers or inclined recesses on a pneumatic control unit

#### TASK:

- Produce an inclined recess on a face surface on a cubic pneumatic part
- Automatic tool change is required

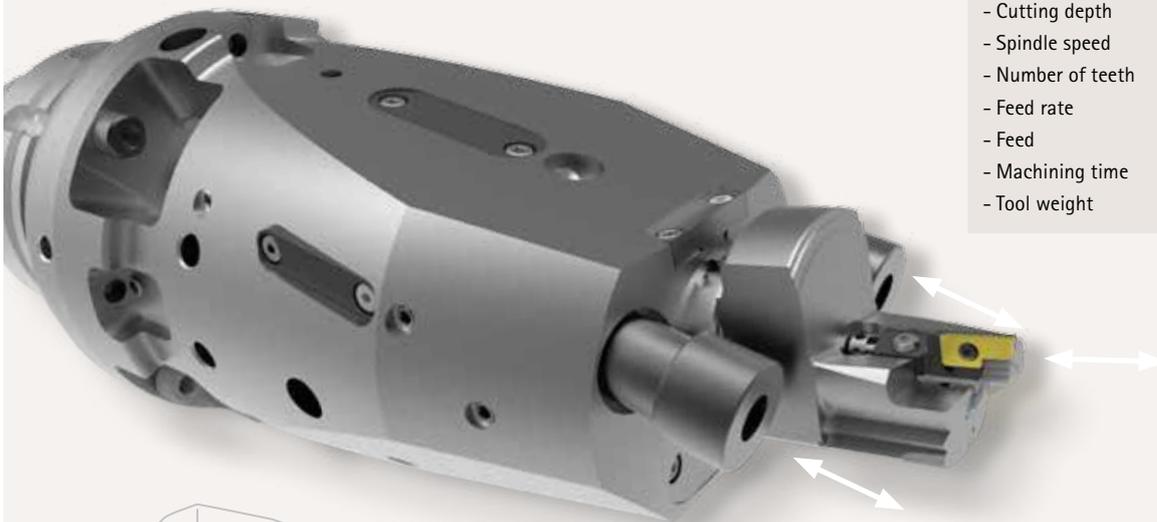
#### SOLUTION:

On slide tools actuated by coolant pressure, the operating slide and compensating slide are controlled via the pressure in the central inner coolant supply (from 20 bar) from the machining centre. The operating slide is pushed out of the tool body at a defined angle and in this way produces the contour

on the workpiece. The feed rate for the slide is set via a special setting screw (regulator) in a closed oil circuit. After reaching the end position, the coolant pressure is switched off. Gas struts integrated into the tool ensure the slides return quickly to their initial position.

#### CUTTING DATA

- Material	AlSi1
- Cutting material	Carbide coated
- Diameter	38 mm
- Stroke (slides)	11 mm
- Cutting speed	330 m/min
- Cutting depth	5.5 mm
- Spindle speed	2,800 rpm
- Number of teeth	1
- Feed rate	56 mm/min
- Feed	0.02 (adjustable)
- Machining time	5 s
- Tool weight	17.2 kg

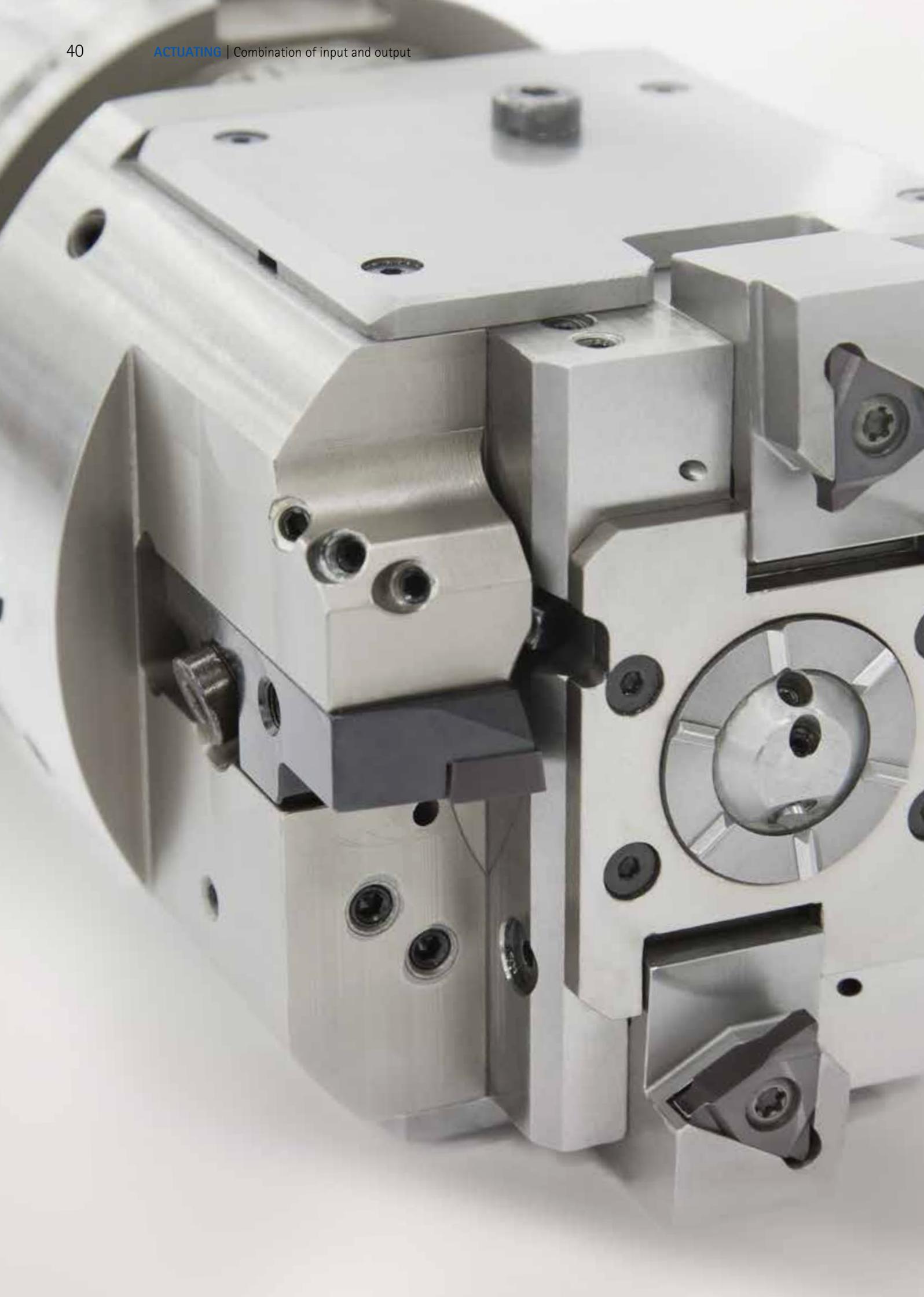


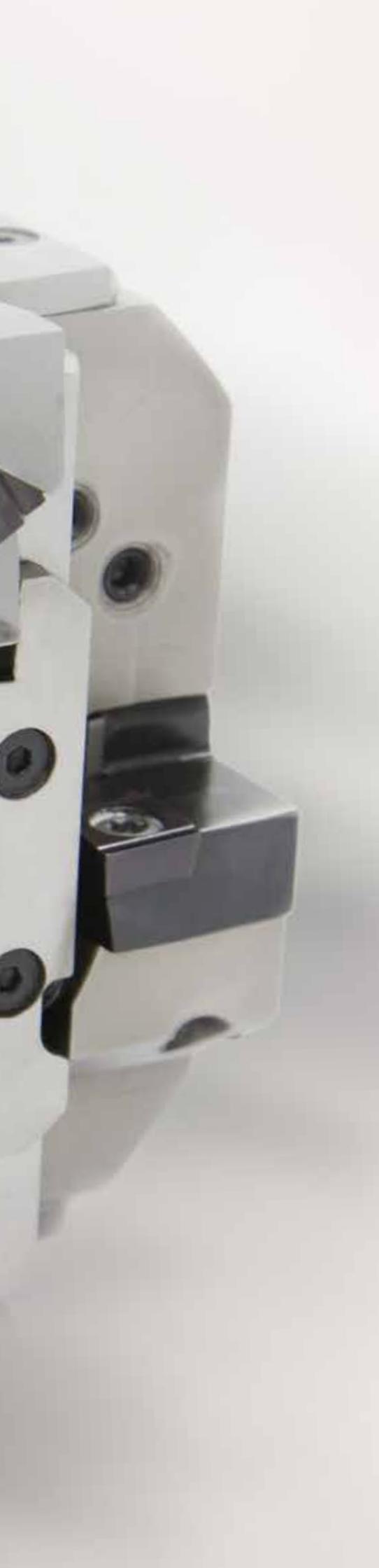
#### FEATURES

- Taper machining from the small diameter to the large diameter possible
- End position control can be integrated
- Flexible usage on different machining centres

#### ADVANTAGES

- Short machining time due to turning operation on machining centre
- Turned surface finish (of relevance for sealing)





# CONTACT STOP PRINCIPLE

---

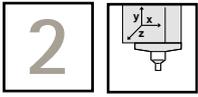
## 2

### Applications

- 2.1 Electronic handbrake connection on a brake caliper ..... 42
- 2.2 Balcony seat depth on the cylinder bore in a lorry engine block ..... 43
- 2.3 Crankshaft thrust bearing bore in a crankcase ..... 44
- 2.4 Chamfer machining the cylinder bore in a crankcase ..... 45

# Actuation by means of contact stop principle

## Applications



### 2.1 Fine machining of a brake caliper receptacle

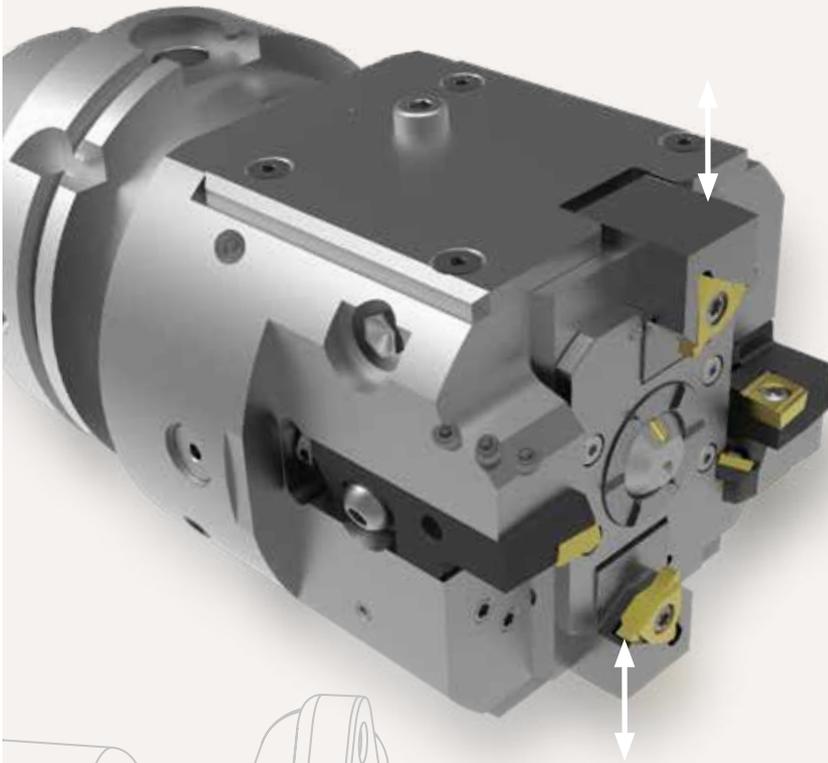
#### TASK:

- By combining several machining steps, the machining time is to be reduced.
- Machining the connection contour for the electronic handbrake on a brake caliper.

#### SOLUTION:

Two finely adjustable cartridges turn the outside diameter and two further inserts chamfer the outside diameter produced. At the same time, due to the contact with the workpiece – and due to the rigid connection to the internal drawbar – two

moving arms are activated that radially cut grooves in the outside diameter turned from the outside using special inserts. In this way three separate operations – diameter turning, chamfering and recessing – are combined in one tool.



#### CUTTING DATA

- Material	GGG
- Cutting material	Carbide coated
- Diameter	50.2 mm
- Cutting speed	80 m/min
- Cutting depth	0.25 (3.5) mm
- Spindle speed	510 rpm
- Number of teeth	2
- Feed rate	102 mm/min
- Feed	0.1 mm (adjustable)
- Machining time	6 s
- Cutting power	1 KW
- Tool weight	8 kg

#### FEATURES

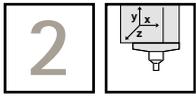
- Special machines can be avoided due to the flexible usage on machining centres
- Straightforward cutting edge wear compensation and correction of the machining diameter via machine's z axis
- Multi-spindle applications possible

#### ADVANTAGES

- Reduced machining time due to conversion from a milling operation to a turning operation
- Various machine connections possible

# Actuation by means of contact stop principle

## Applications



### 2.2 Fine machining of the balcony seat depth on a lorry engine block

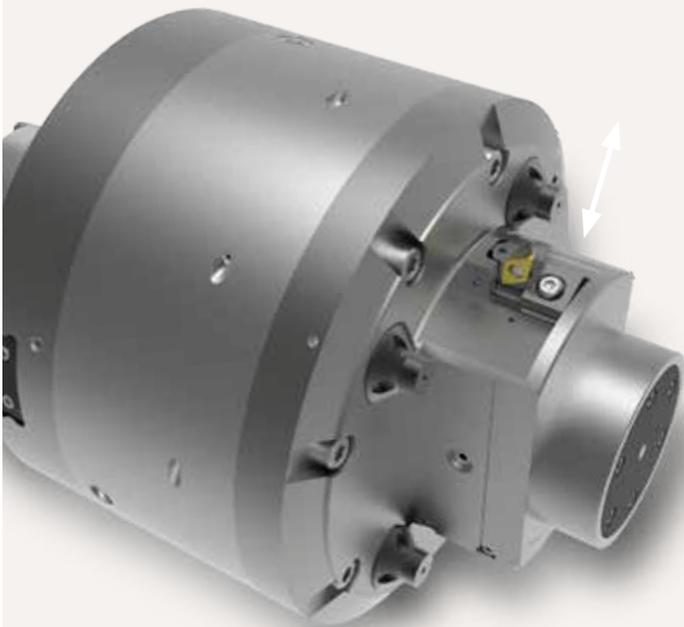
**TASK:**

- Production of the balcony seat with closely defined tolerance in relation to the sealing face for the cylinder head
- Avoidance of the measuring task in the process due to accuracy in the tool

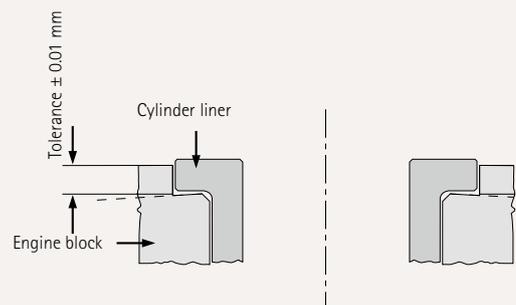
**SOLUTION:**

The face surface for the cylinder liner seating (balcony seat) is traditionally produced on transfer machines with drawbar operated actuating tools. For smaller lot sizes or interlinked production lines, often a special machine is not used for cost reasons. The requirements on a high-precision seat for the cylinder liner – with defined, close

tolerance geometry of the seat depth and angle – remain, however. The face shoulder is often so wide that it cannot be produced to the required accuracy using the axial grooving process. For this purpose MAPAL has developed an actuating tool with contact stop that produces the required precision also on machining centres.



CUTTING DATA	
- Material	GG25
- Cutting material	Carbide TiN coated
- Diameter	144 mm
- Cutting speed	120 m/min
- Cutting depth	0.25 mm
- Spindle speed	265 rpm
- Number of teeth	1
- Feed	0.1 mm
- Machining time	9 s
- Cutting power	0.5 kW
- Tool weight	20 kg



#### FEATURES

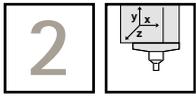
- Face turning on machining centres also possible
- No additional measurements necessary due to the defined balcony seat depth in relation to the milled cylinder head surface
- Radial and axial recess using only one tool
- Face turning can be combined with recessing

#### ADVANTAGES

- High flexibility, as several slides with different angles are possible
- Flushing or blowing clear the contact stop surface possible
- For special machines, design with drawbar/push rod actuation

# Actuation by means of contact stop principle

## Applications



### 2.3 Fine machining crankshaft thrust bearings

#### TASK:

- Fine machining of a thrust bearing journal using the face turning process on a machining centre without U axis.

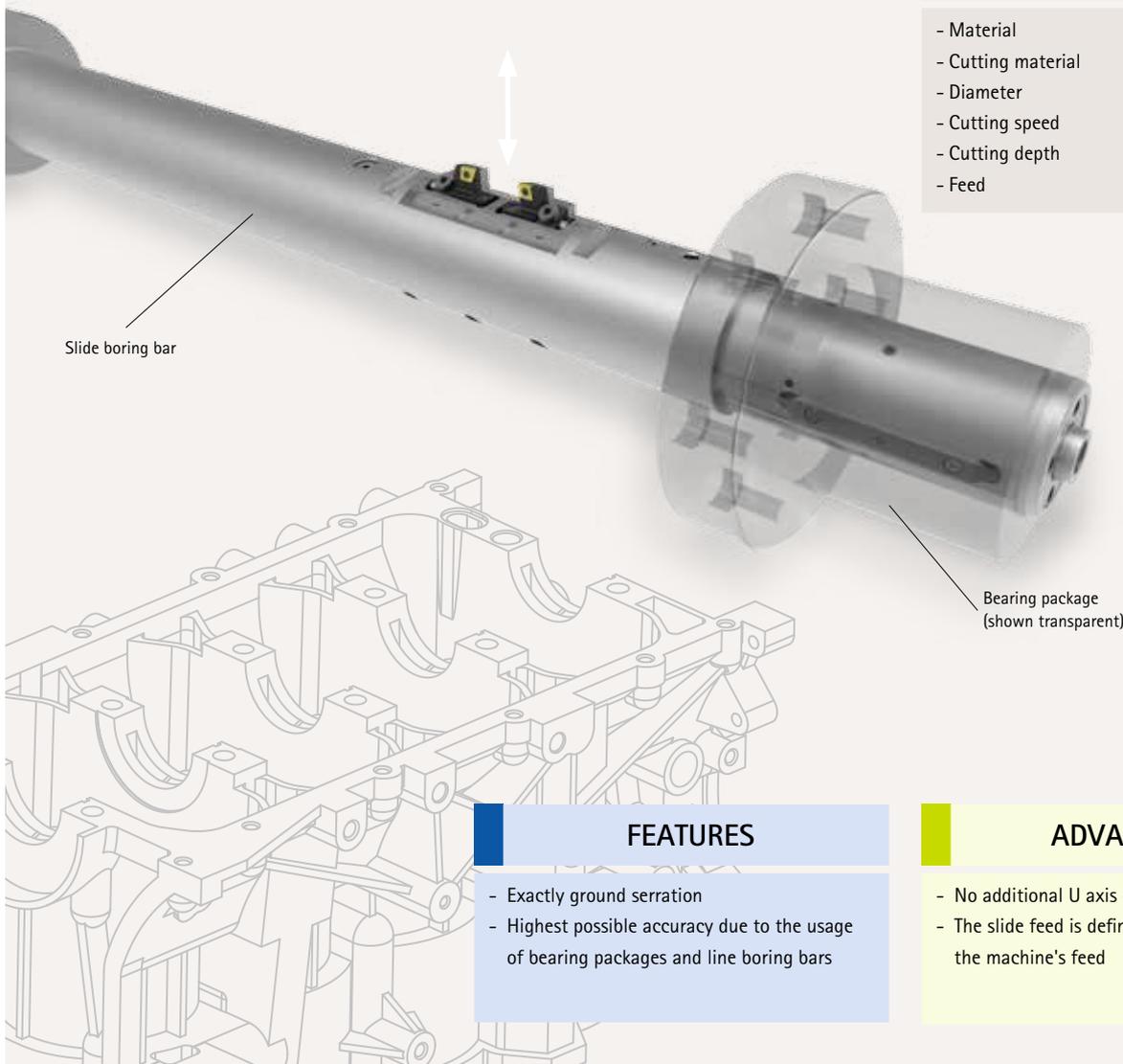
#### SOLUTION:

While the tool moves into the crankshaft bore on the crankcase or while the tool is outside the machine, both slides are in the retracted position. In the first machining step, the tip of the tool moves into a bearing package that is opposite until it comes into contact with the shoulder of the bearing package and in this way the tool body is fixed axially.

Further movement of the machine's z axis causes the internal drawbar to press into the tool body and in this way push the slides radially out of the tool body via exactly ground serrations. Cartridges are used on this slide for face machining. The slides/drawbar are retracted by an internal spring.

#### CUTTING DATA

- Material	Aluminium / GG
- Cutting material	Carbide coated
- Diameter	74 - 92 mm
- Cutting speed	120 m/min
- Cutting depth	0.15 mm
- Feed	0.1 mm



#### FEATURES

- Exactly ground serration
- Highest possible accuracy due to the usage of bearing packages and line boring bars

#### ADVANTAGES

- No additional U axis drive necessary
- The slide feed is defined via the machine's feed

# Actuation by means of contact stop principle

## Applications



### 2.4 Chamfer machining the cylinder bore in a crankcase

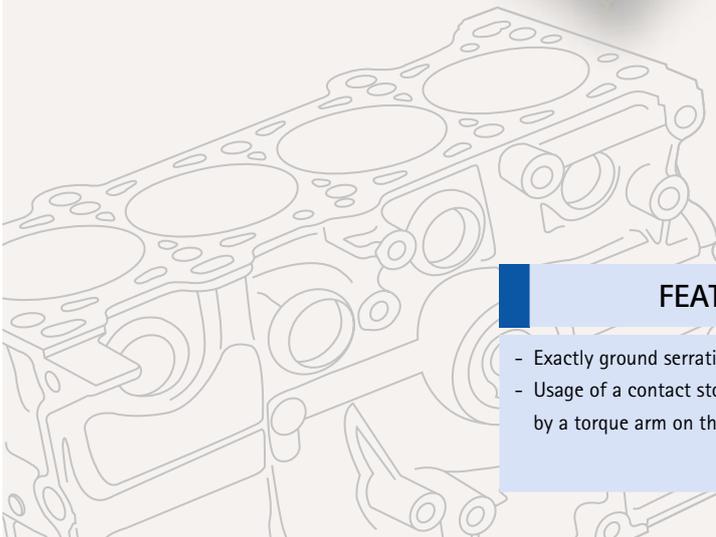
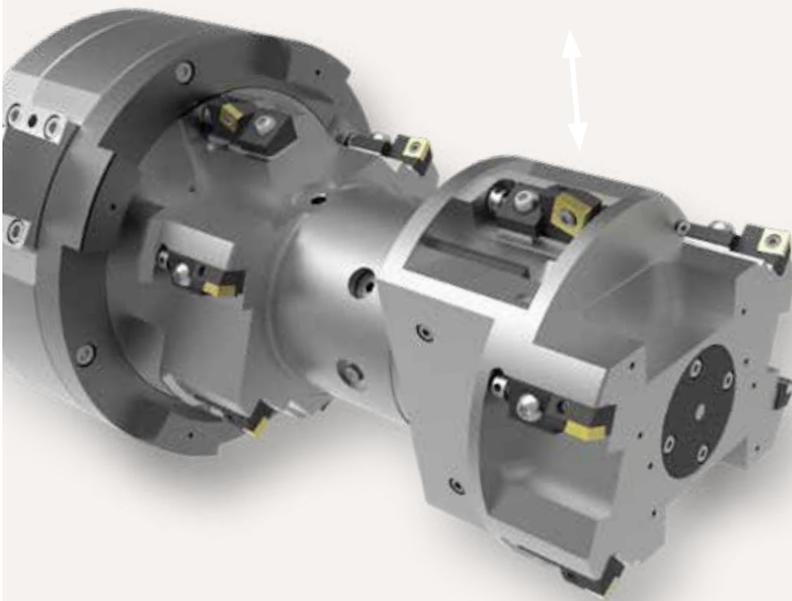
#### TASK:

- Combination of several machine steps including actuating operations on a machining centre instead of a special machine

#### SOLUTION:

While the tool is inserted, the contact stop socket is fixed rotationally by a torque arm on the machine. The rotating tool can now be moved to the workpiece, as the contact stop socket is stationary. When the socket comes into contact with the workpiece, the tool body is maintained axially in position.

Further forward movement of the machine's z axis causes the internal drawbar (HSK connection) to press into the tool body and in this way push the slides radially out of the tool body via exactly ground teeth. Cartridges are fitted to this slide for chamfer machining in an axial grooving process. The slides/drawbar are retracted by an internal spring.



#### CUTTING DATA

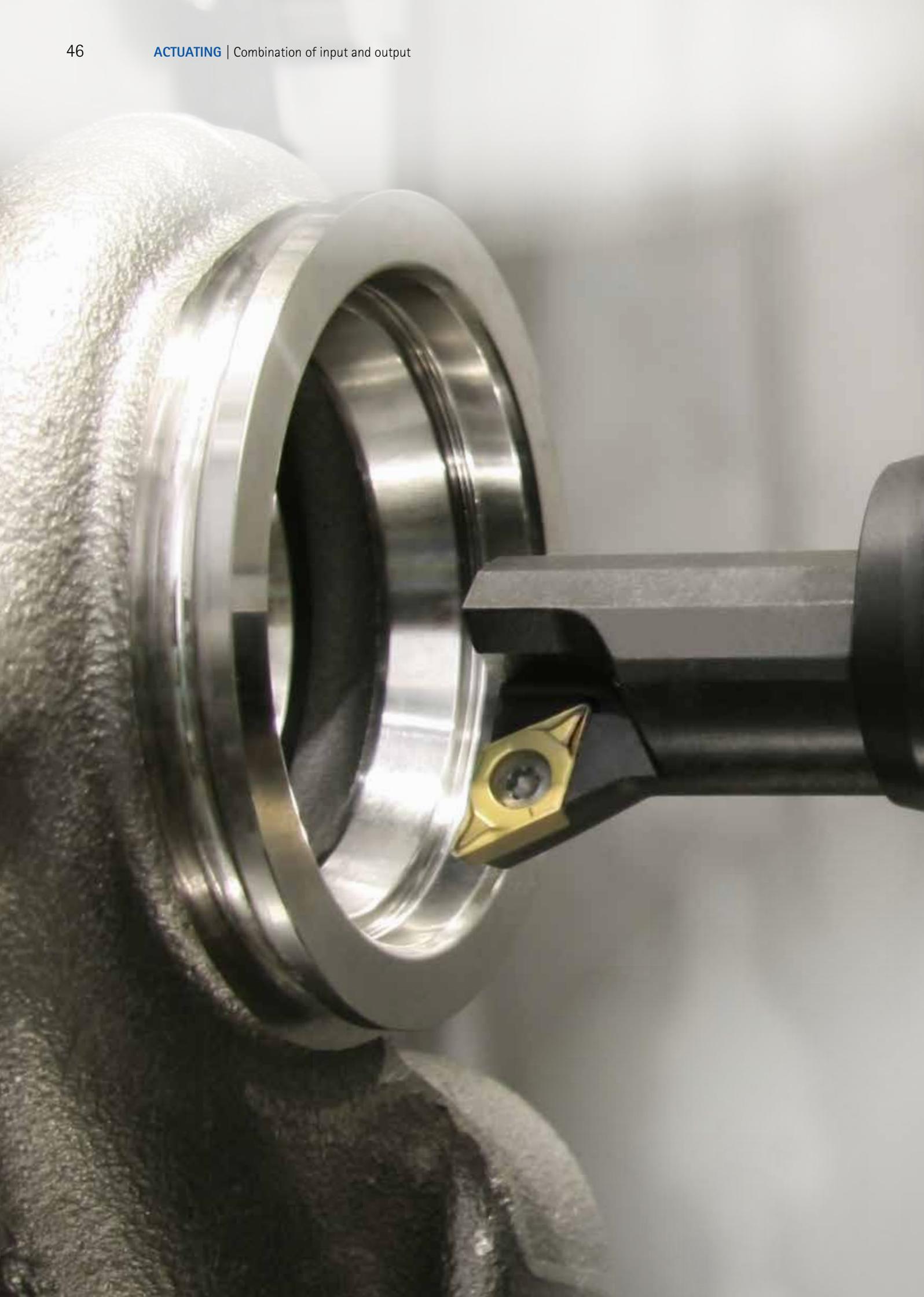
- Material	GG
- Cutting material	Carbide coated
- Diameter	130 mm
- Cutting speed	140 m/min
- Cutting depth	0.25 - 0.5 mm
- Number of teeth	1 - 4
- Feed	0.1 - 0.2 mm
- Tool weight	30 kg

#### FEATURES

- Exactly ground serration
- Usage of a contact stop socket that is held by a torque arm on the machine

#### ADVANTAGES

- Exact positioning of the grooving slide due to contact position of the socket
- The slide feed is defined via the machine's feed





# TOOLTRONIC® U AXIS

---

## 3

### Applications

3.1 Small and large bore on a connecting rod .....	48
3.2 Valve seat and valve guide on a cylinder head .....	49
3.3 Main bore in a turbocharger .....	50
3.4 Ball machining on a trailer coupling .....	51
3.5 Honing using TOOLTRONIC® .....	52
3.6 Inner contour on switching valves .....	53
3.7 Gearbox housing for wind power .....	54

# Actuating by means of TOOLTRONIC® U axis

## Applications



### 3.1 Machining small and large bore on a connecting rod

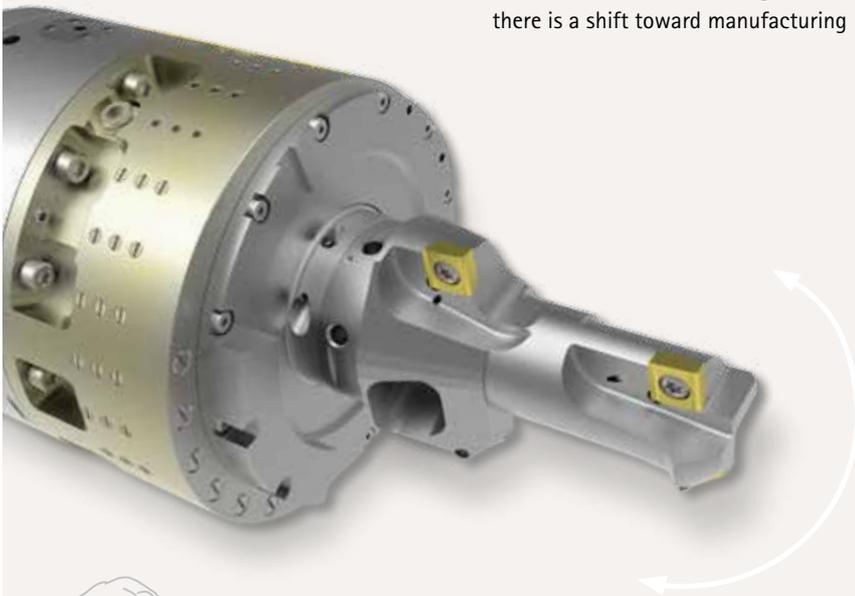
#### TASK:

- Machining the large and small bore on a machining centre.
- Smallest feed movement in the  $\mu$ -range required for close tolerance bell-mouthed shape.

#### SOLUTION:

During the explosion in the engine's combustion chamber, the forces produced act directly on the gudgeon pin. As a consequence the pin deforms in the pin bore. So that optimal force transmission between the gudgeon pin and connecting rod occurs despite this deformation, the gudgeon pin bore must have a specific shape. The increasingly high specific performance of parts with ever lower weight means that material properties must be fully exploited. For this reason, in connecting rod machining there is a shift toward manufacturing

the pin bore in a bell-mouthed shape to minimise the edge loading. During this process the connecting rod is supported at three points and exactly clamped in relation to the contact points. The mounting tool adapted to the machining has four inserts. The insert for roughing the bronze, pressed connecting rod sleeve is made of coated cermet and the finishing insert is made of polycrystalline diamond. For the large bore on the connecting rod made of the material 70MnVS4, two inserts made of coated cermet are used (roughing and finish machining).



#### CUTTING DATA

##### Small pin bore with bell-mouthed shape on both sides

- Material	Bronze
- Diameter	30 mm
- Spindle speed	3,000 rpm
- Feed	0.1 mm (semi) 0.05 mm (finish)

##### Large pin bore – single point cutting with chamfer on both sides

- Material	70MnVS4
- Diameter	55.6 mm
- Spindle speed	1,500 rpm
- Feed	0.1 mm

#### FEATURES

- Machining of small and large bore using eccentric actuating tool
- Bell-mouthed shape with contour tolerance  $\pm 1.5 \mu\text{m}$  with a machining stroke of only  $10 \mu\text{m}$
- Innovative tool solution with 4-cutting edged combination tool: One semi-finishing machining and one finish machining with separate insert per stage
- Flexibility with high process reliability and accuracy with standard components

#### ADVANTAGES

- Due to large stroke, different diameter ranges can be covered with the TOOLTRONIC
- High accuracy of repetition
- Shape accuracy: a standard deviation of  $0.5\text{--}0.7 \mu\text{m}$  is achieved with the EAT actuating tool despite reversal of the actuating direction, as the EAT has practically no reversing backlash
- All inserts can be compensated separately

# Actuating by means of TOOLTRONIC® U axis

## Applications



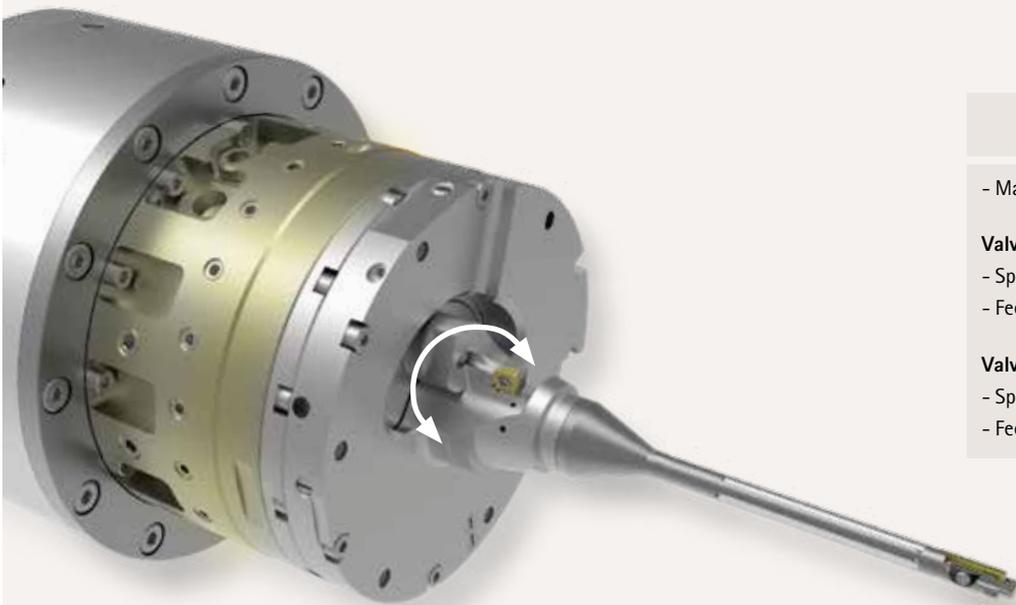
### 3.2 Machining valve seat and valve guide on a cylinder head

#### TASK:

- Combined machining of valve seat and valve guide
- Programming of flexible contours as required

#### SOLUTION:

- Reaming the valve guide using rigid reamer (single-bladed tool or multi-bladed tool).
- Turning valve seat using TOOLTRONIC input and EAT on standard machining centre.



#### CUTTING DATA

- Material	Sintered metal
<b>Valve guide reaming:</b>	
- Spindle speed	2,200 rpm
- Feed/cutting edge	0.12 mm
<b>Valve seat turning:</b>	
- Spindle speed	1,400 rpm
- Feed/cutting edge	0.06 mm

#### FEATURES

- Highest quality requirements
- Circularity < 2  $\mu\text{m}$ , straightness < 2  $\mu\text{m}$

#### ADVANTAGES

- Turned valve seats in machining centres
- Contour machining can be programmed as required
- Different angles can be machined using the same tool
- Inlet and exhaust valve, different workpiece types are possible

# Actuating by means of TOOLTRONIC® U axis

## Applications



### 3.3 Machining the main bore of a turbocharger

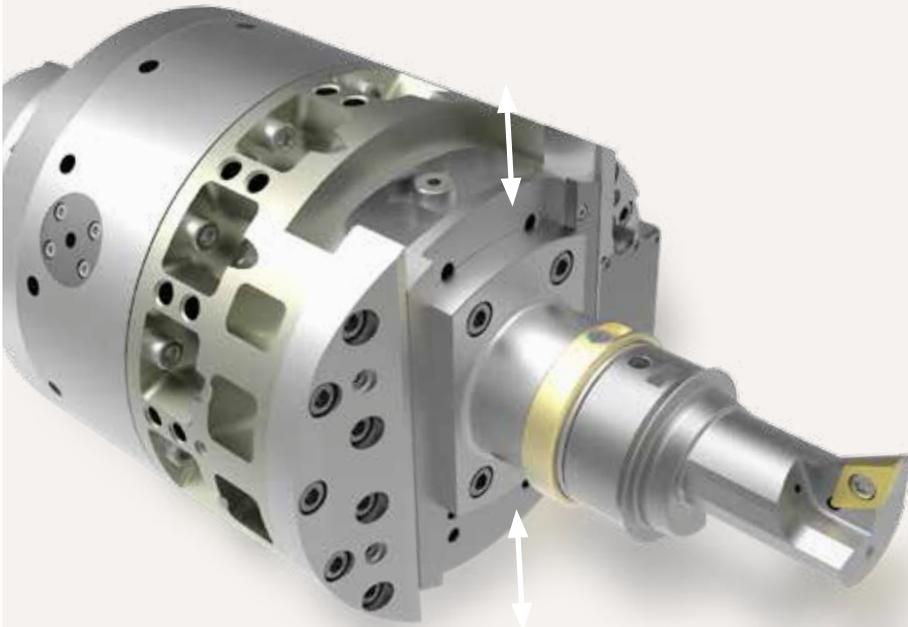
#### TASK:

- Finish machining the complete contour of the main bore on a machining centre instead of a lathe.

#### SOLUTION:

Irrespective of whether turbine or compressor housing, in conventional machining processes a lathe was often used to fine machine the complete contours inside the housing. This time-consuming and expensive production process is replaced by TOOLTRONIC, a mechatronic tool system for machining centres. To machine the contours inside

the turbocharger housing, the drive unit is combined with a linear actuating tool. The fine machining of the contour is then performed using a mounting tool with turning inserts.



#### CUTTING DATA

- Material	Heat-resistant cast steel (1.4849) GX40NiCrSiNb38-19
- Cutting speed	90 m/min
- Feed/cutting edge	0.15 mm
- Cutting depth	0.1 - 0.5 mm

#### FEATURES

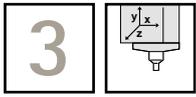
- Machining any contours and recesses possible

#### ADVANTAGES

- TOOLTRONIC replaces a lathe
- Fine machining of the complete contour using one tool

# Actuating by means of TOOLTRONIC® U axis

## Applications



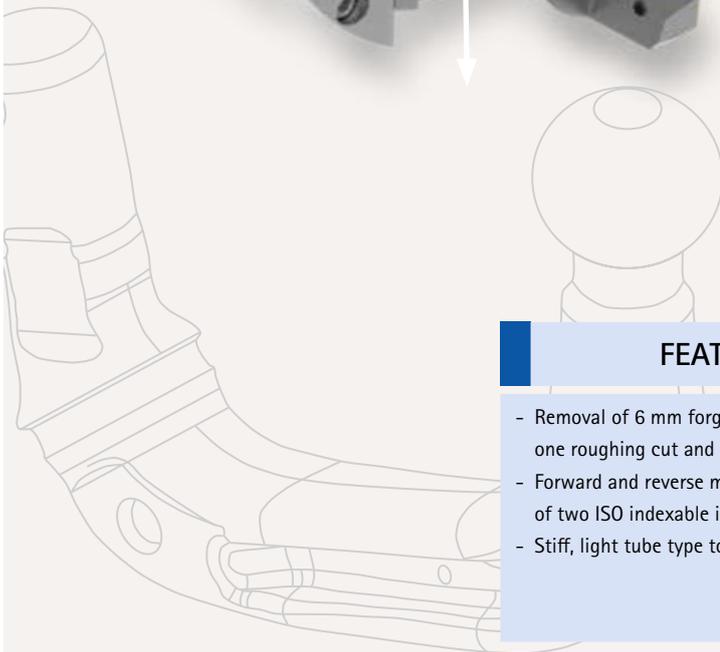
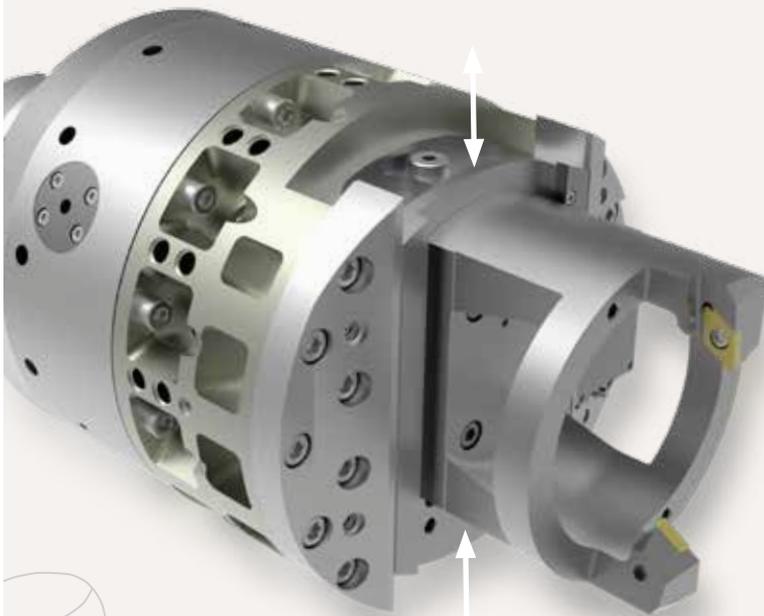
### 3.4 Machining the contour of the ball on a trailer coupling

**TASK:**

- Machining the ball shape on a machining centre instead of a lathe.

**SOLUTION:**

The ball is machined with the part clamped in a fixed position and stationary. The machining is undertaken using freely programmable contour turning using TOOLTRONIC input with LAT on a machining centre.



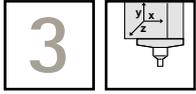
CUTTING DATA	
- Material	42CrMo4
- Diameter	50 h13
- Spindle speed	1,100 rpm
- Feed	0.2 mm
- Feed rate	229 mm/min
- Cutting speed	180 m/min
- Cutting depth	
Roughing:	2 mm
Finishing:	1 mm

FEATURES
- Removal of 6 mm forging allowance using one roughing cut and one finishing cut
- Forward and reverse machining by means of two ISO indexable inserts fitted differently
- Stiff, light tube type tool layout

ADVANTAGES
- Complete machining in one clamping system on one machining centre
- No re-tooling, no separate lathe
- No complex clamping fixture necessary for turning the ball
- Complete machining of the ball and the rear ball neck using only one tool

# Actuating by means of TOOLTRONIC® U axis

## Applications



### 3.5 Honing using TOOLTRONIC®

#### TASK:

- Honing small and medium-scale production runs.
- Complete machining on one machine.

#### SOLUTION:

A large number of bores are fine machined in the final production step on a separate honing machine. The objective is to further improve the surface quality, dimensional accuracy and the accuracy of the shape. The primary application area of the honing production process is the entire metal machining industry.

#### CUTTING DATA

- Material	GG40
- Spindle speed	750 rpm
- Feed rate	2,000 mm/min
- Stock removal	0.03 mm
- Cutting depth/ material removal rate	1 µm per double stroke

#### FEATURES

- Very tight manufacturing tolerances as well as flexibility in manufacture
- Reliably compensates the wear on the honing bars by means of very sensitive, high-precision actuating movement of the TOOLTRONIC
- High surface quality and dimensional accuracy

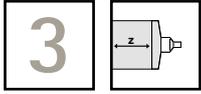
#### ADVANTAGES

- Regulated honing process on standard machining centre
- Time and cost-saving
- Major saving and quality potential for small and medium-scale series production runs
- Same clamping system as for the roughing
- Time-consuming re-tooling is not necessary



# Actuating by means of TOOLTRONIC® U axis

## Applications



### 3.6 Machining switching valves on rotary transfer machine

**TASK:**

- Machining contours and IT 7 fits in aluminium housings at the highest spindle speeds.

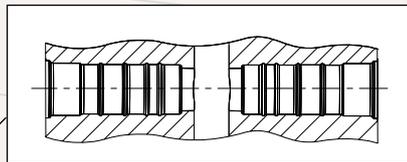
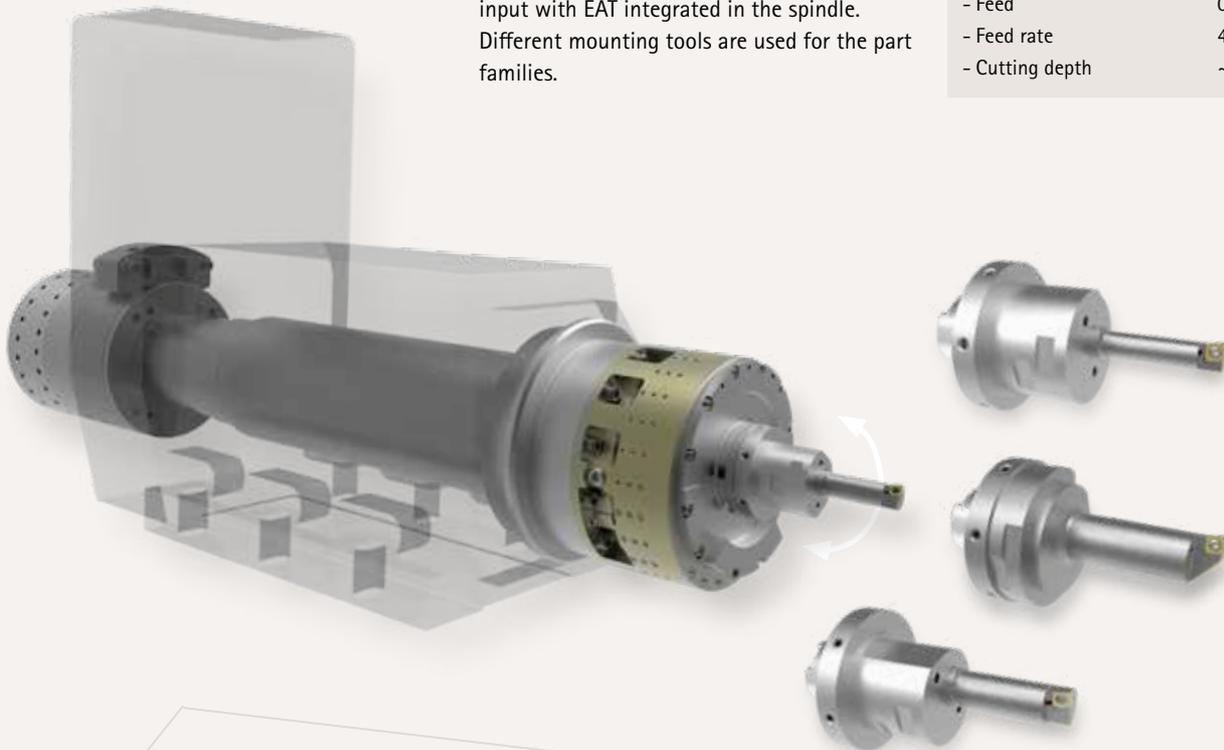
**SOLUTION:**

Several TOOLTRONIC units are integrated into the spindle on the rotary transfer machine. It is possible to turn different diameters, transitions and recesses, as well as to turn freely programmable contours in one contouring operation using TOOLTRONIC input with EAT integrated in the spindle. Different mounting tools are used for the part families.

**CUTTING DATA**

**Switching bore**

- Material	Aluminium
- Diameter	10 mm
- Spindle speed	6,000 rpm
- Cutting speed	180 m/min
- Feed	0.08 mm
- Feed rate	480 mm/min
- Cutting depth	~ 1 mm



**FEATURES**

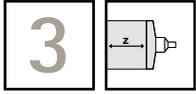
- Diameter accuracy IT 6
- Circularity < 5 µm
- Machining large a variety of parts using "turning tool"
- Neutrally balanced – high spindle speeds

**ADVANTAGES**

- Turning with the part clamped in a fixed position and stationary
- Burr-free, rounded transitions possible
- Reduction of the number of custom tools
- Low-maintenance EAT system

# Actuating by means of TOOLTRONIC® U axis

## Applications



### 3.7 Gearbox housing for wind power

#### TASK:

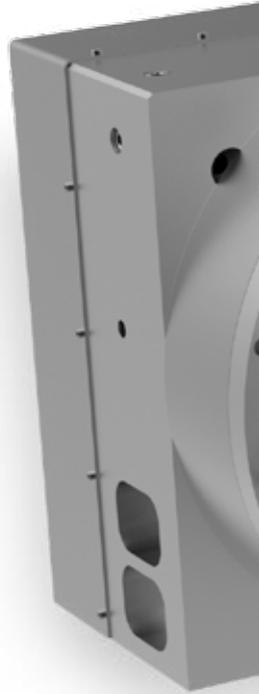
- Roughing and finish machining bearing seats and contours deep in the housing.

#### SOLUTION:

Turning using TOOLTRONIC provides stable preconditions compared to milling operations. This situation is due to the long projection length. The series of face turning units can be configured to suit the machining task. This means that certain dimensions and elements can be adapted to the space and conditions on the machine. Primarily this aspect relates to the projection length and the coupling to the machine.

On this series the facing slides are actuated using a TOOLTRONIC unit that is driven by an integrated electric motor. The TOOLTRONIC is supplied with energy and the related data by the machine. This mechatronic construction requires significantly fewer mechanical parts than a conventional boring head. As a consequence the MAPAL face turning units are very robust and are not susceptible to faults.

For the cutting cartridges mounted on the facing head, along with standard holders there is also a series of special holders that are designed to suit the machining task.



#### Face turning unit examples



**Face turning unit  $\varnothing$  230 mm**

Dimension

Approx. 500 x 500 mm,  
length to suit part

Spindle speed

Approx. 500 rpm

Working area

Stroke 75 mm  
(Example: 230 - 380 mm  
machining diameter)

Machining

Roughing or finishing



**Face turning unit  $\varnothing$  320 mm**

Approx. 500 x 500 mm,  
length to suit part

Approx. 350 rpm

Stroke 75 mm

(Example: 320 - 470 mm  
machining diameter)

Roughing or finishing



**Face turning unit  $\varnothing$  500 mm**

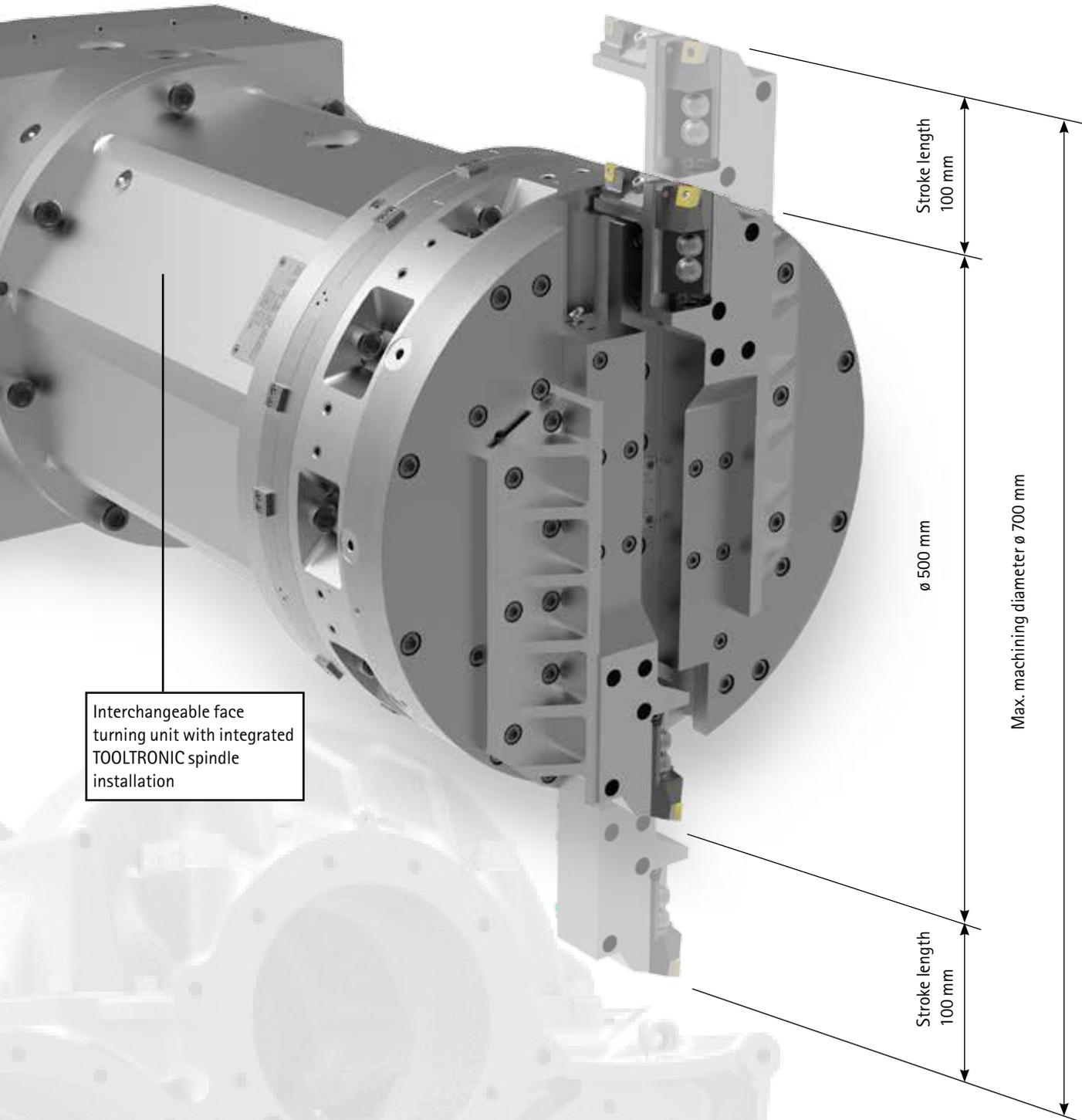
Approx. 500 x 500 mm,  
length to suit part

Approx. 200 rpm

Stroke 100 mm

(Example: 500 - 700 mm  
machining diameter)

Roughing or finishing



Interchangeable face turning unit with integrated TOOLTRONIC spindle installation

Stroke length 100 mm

Stroke length 100 mm

∅ 500 mm

Max. machining diameter ∅ 700 mm

Combination of input and output

### FEATURES

- Double slide for machining  $z = 2$
- Machining diameter max. 700 mm
- More stable preconditions due to turning operation instead of milling operation because of long projection length
- Flexible, cost-effective machining of large bores and parts in gearboxes, in shipbuilding, for wind and water power, or in large-scale mechanical engineering

### ADVANTAGES

- Application for large diameter range
- High facing slide position accuracy due to position measuring system on the slide
- Tool change via portal loader into the machine





# MACHINE'S U AXIS

---

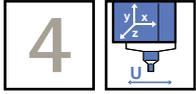
## 4

### Applications

- 4.1 Cylinder bore in an engine block \_\_\_\_\_ 58
- 4.2 Honing relief on a cylinder bore in an engine block \_\_\_\_\_ 59

# Actuating by means of machine's U axis

## Applications



### 4.1 Linear actuating | Fine machining a cylinder bore

#### TASK:

- Fine machining of a cylinder bore with cutting edge lifting and wear compensation.

#### SOLUTION:

Flexible usage of the tool on machining centres instead of special machines. The cutting material costs can be reduced due to longer tool lives as a result of the wear compensation. Due to the cutting edge lifting the tool can be moved out of the bore without scoring. Depending on the diameter, the tool can be designed with up to seven inserts.



#### CUTTING DATA

- Material	Aluminium
- Cutting material	PcBN, PCD
- Diameter	88 mm
- Cutting speed	800 m/min
- Spindle speed	2,760 rpm
- Feed/cutting edge	0.1 mm
- Tool weight	9.7 kg

#### FEATURES

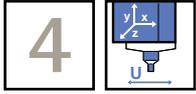
- Stroke 0.3 mm
- Cooling lubricant emulsion (alternatively MQL)
- Spindle speeds up to 4,000 rpm possible
- Flexible cutting edge distribution possible

#### ADVANTAGES

- High tool lives due to wear compensation
- Withdrawal-scoring-free run out due to cutting edge lifting
- Quick changing via HSK connection
- Tool can be pre-set on setting fixture
- Cycle time reduction

# Actuating by means of machine's U axis

## Applications



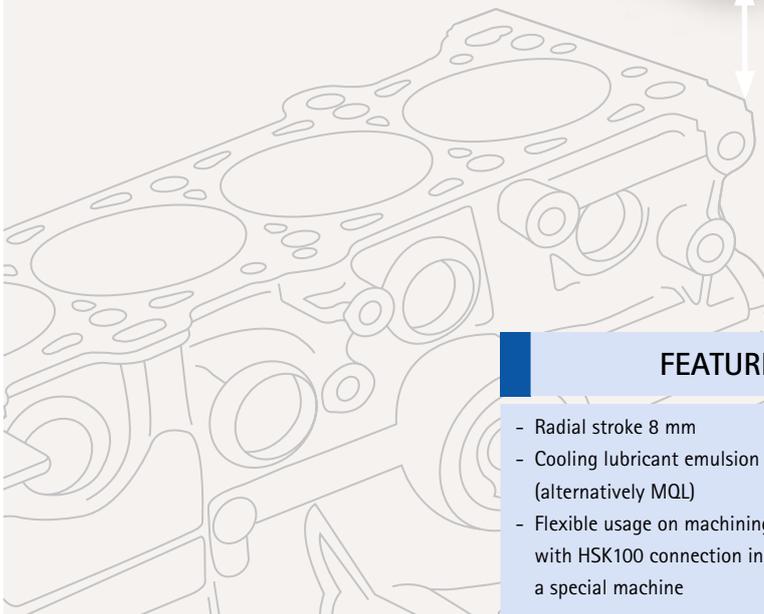
### 4.2 Rotatory operation | Honing relief with thermal spray coating

**TASK:**

- Removal of overspray in the honing relief area
- Milling causes chipping of the thermal spray coating (LDS).

**SOLUTION:**

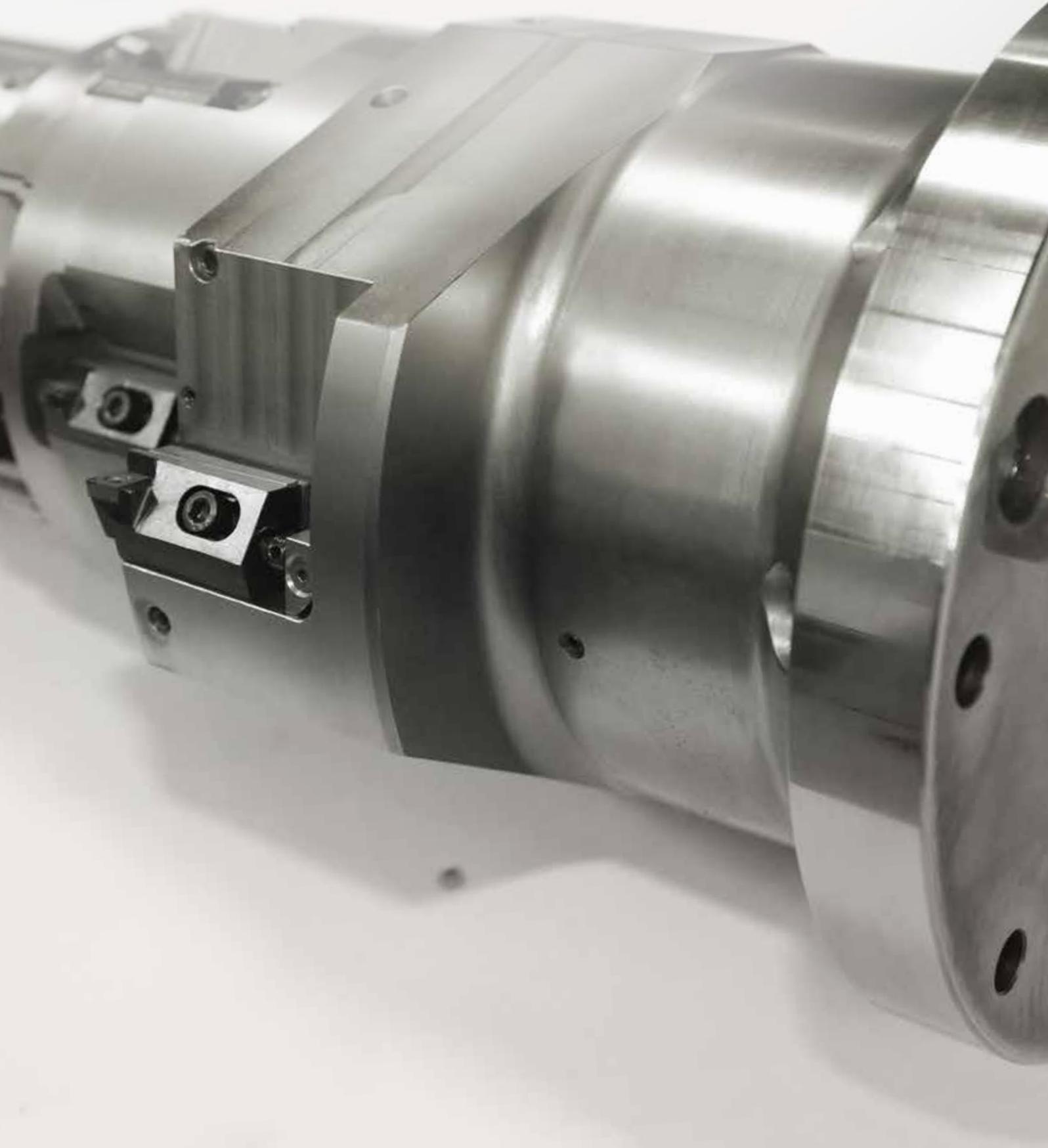
The thermal spray coating may chip during milling. This problem is avoided by turning. The contour machining is actuated via the machine's U axis. The facing slides are designed with two inserts for machining the honing relief and the chamfer at the bore entry.



CUTTING DATA	
- Material	Thermal spray plasma coating / aluminium
- Cutting material	PCD
- Diameter	82 - 92 mm
- Cutting speed	260 m/min
- Spindle speed	1,000 rpm
- Feed/cutting edge	0.1 mm
- Tool weight	8 kg

FEATURES
- Radial stroke 8 mm
- Cooling lubricant emulsion (alternatively MQL)
- Flexible usage on machining centre with HSK100 connection instead of a special machine

ADVANTAGES
- Boring out instead of milling prevents chipping on the thermal spray coating
- Flexible programming





# DRAWBAR/PUSH ROD

---

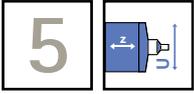
## 5

### Applications

5.1 Spherical shape in a differential housing .....	62
5.2 Valve seat and valve guide in a cylinder head .....	63
5.3 Water jacket control cut in a cylinder bore in an engine block .....	64
5.4 Small bore on a connecting rod .....	65
5.5 Small part machining using LAT .....	66
5.6 Pipe end machining using EAT .....	67
5.7 Pipe end machining using LAT .....	68
5.8 Face machining using LAT .....	69

# Actuating by means of drawbar/push rod

## Applications



### 5.1 Machining a spherical contour in a differential housing

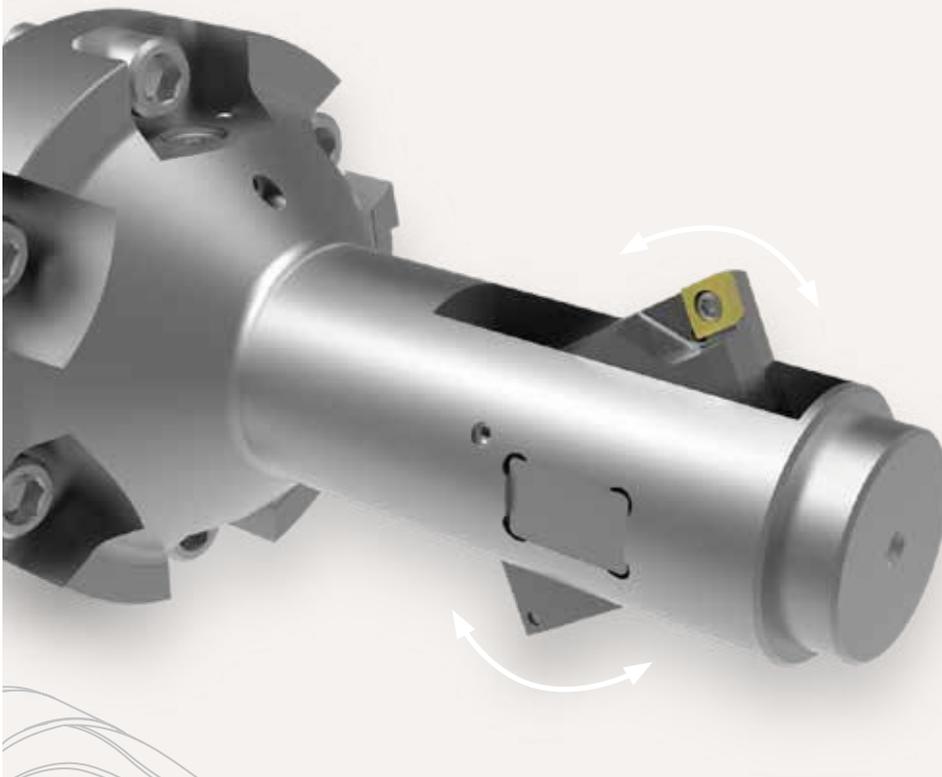
#### TASK:

- Productive manufacture of differential housings on special machine by splitting roughing and finish machining.

#### SOLUTION:

During the machining of differential housings, the machining of the spherical segment is the most difficult task due to its shape and position tolerance. During this process the pivoting slide is operated

via a central pin using an internal lever mechanism. A spherical segment is produced by the inherent rotation of the tool and the superimposed rotation of the pivoting slide.



#### CUTTING DATA

- Material	GGG40
- Cutting speed	130 m/min
- Spindle speed	410 - 1,300 rpm
- Roughing:	
Number of teeth	2
Feed	0.5 mm
- Fine machining:	
Number of teeth	1
Feed	0.2 mm

#### FEATURES

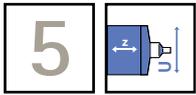
- Machining a tapered section by turning

#### ADVANTAGES

- No contour distortion on the part due to swivel movement
- No NC machining required

# Actuating by means of drawbar/push rod

## Applications



### 5.2 Machining valve seat and valve guide in a six-cylinder head

**TASK:**

- Close tolerance concentricity on valve seat and valve guide requires clamping system in one station.

**SOLUTION:**

Valve seat and valve guide can be machined independently of each other in the same clamping system. The two inclined slides are driven by a central drawbar. Advantage: the two machining operations can be undertaken with different spindle speeds and feeds.

Separate, easy to change mounting tools ensure a high level of flexibility by workpiece changes or for part variants. The integrated reamer sleeve with the MAPAL clamping system is operated independently.



#### CUTTING DATA

Material	GG25
<b>Valve seat</b>	
- Cutting material	PcBN
- Diameter	34 - 48 mm
- Cutting speed	299 - 352 m/min
- Spindle speed	2,800 rpm
<b>Valve guide</b>	
- Cutting material	Carbide
- Diameter	9 mm
- Cutting speed	98 m/min
- Spindle speed	3,466 rpm

#### FEATURES

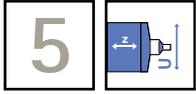
- Combination of semi-finishing and finish machining or imbalance compensation possible due to two opposite slides
- Reduced cutting material costs due to usage of MAPAL ISO indexable inserts and standard reaming cutting edges

#### ADVANTAGES

- Accuracy of the taper angle for valve seat tolerance is produced by the tool
- Usage on special machines and transfer lines with to some extent multi-spindle variants
- High process reliability and process accuracy due to tailored tool solution

# Actuating by means of drawbar/push rod

## Applications



### 5.3 Machining all recesses for the water jacket control cut

#### TASK:

- During the machining of large, heavy crankcases, drawbar operated slide tools are often used in multiple spindles
- The high requirements on shape and position tolerances with low quantities of parts at the same time require the combination of several machining steps on a special machine with drawbar.

#### SOLUTION:

The tool undertakes the preparation for pressing the finished liner into the crankcase. Here all shoulders are initially rough turned and then finish turned using special tilting holders. During this process the holder is moved into position with the aid of an internal drawbar/push rod to undertake exactly the finish machining.

The necessary recesses are also double-edge machined using the slide-drawbar combination. In this way it is ensured that all recesses and shoulders are positioned absolutely in relation to each other and an optimal result is obtained.



#### CUTTING DATA

- Material	GG26Cr
- Cutting material	Carbide coated
- Diameter	120 mm
- Stroke	10 mm
- Cutting speed	130 m/min
- Number of teeth	2
- Feed	0.15 mm
- Tool weight	38 kg

#### FEATURES

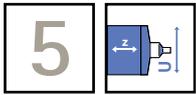
- Semi-finishing and finish machining including all recesses and water jacket control cuts on HGV crankcases
- Multi-cutting edge machining of the recess and shoulder contours

#### ADVANTAGES

- Nine machining steps combined in one station
- Automatic wear compensation possible

# Actuating by means of drawbar/push rod

## Applications



### 5.4 Fine machining small connecting rod bores

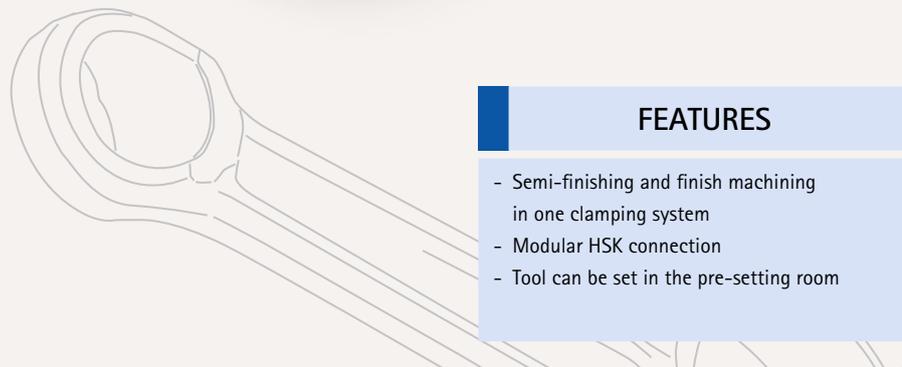
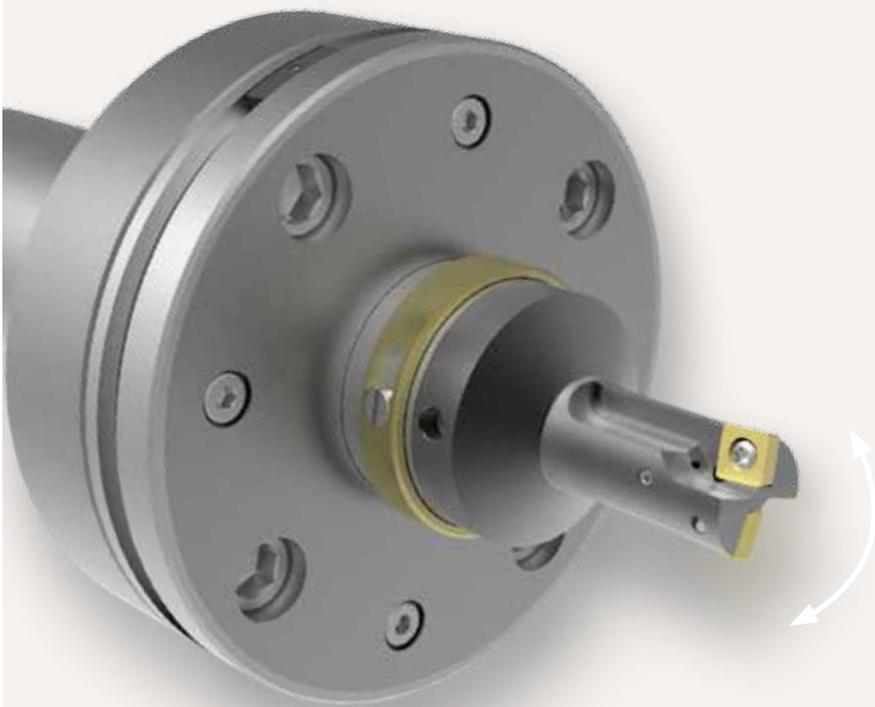
**TASK:**

- Semi-finishing and finish machining with close tolerances, to some extent with shaped bores and transitions in the  $\mu$  range.

**SOLUTION:**

For machining the bore with extremely fine contours and transitions, the so-called tilting head is used. Operation is via drawbar/push rod and is heavily geared down to position

the insert with accuracy to the  $\mu$ . The modular design of the tool connection, for example HSK, permits external setting of the mounting tools.



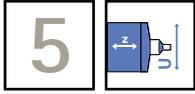
CUTTING DATA	
- Material	C70 / sleeve
- Cutting material	Carbide coated / PCD
- Diameter	20 mm
- Stroke	$\pm 0.3$ mm
- Cutting speed	200 - 600 m/min
- Number of teeth	1 + 1
- Feed	0.12 mm

FEATURES
- Semi-finishing and finish machining in one clamping system
- Modular HSK connection
- Tool can be set in the pre-setting room

ADVANTAGES
- Automatic wear compensation possible
- Short design as tilting head can be integrated far into the spindle
- Contour machining possible on usage of drawbar with NC axis

# Actuating by means of drawbar/push rod

## Applications



### 5.5 Machining small parts using facing head

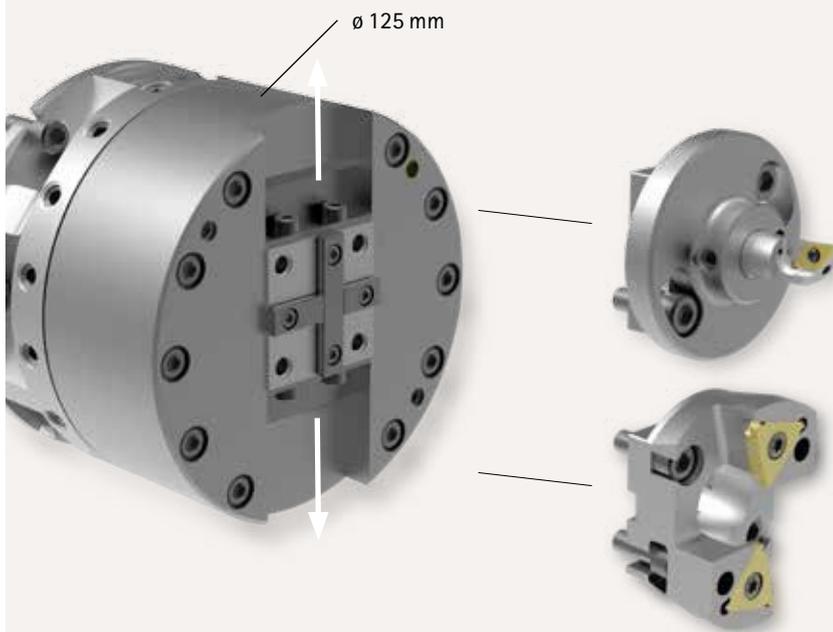
#### TASK:

- Machining small parts in a very wide range of versions and materials at very high spindle speeds.
- Cycle time-defining machining on special machine using several stations.

#### SOLUTION:

The facing head that is equipped with the mounting tool specially developed for the specific machining case is controlled by pulling or pushing a central drawbar. Using angled teeth, the axial movement of the drawbar is converted into the linear radial stroke of the operating slide. This slide has a maximum radial stroke of 12.6 mm

(= delta diameter 25.2 mm) and operates almost play-free. Due to the imbalance compensation system developed by MAPAL, the unit comprising the slide and mounting tool is dynamically balanced in every slide position. In this way vibration-free machining is ensured at spindle speeds of up to 6,000 rpm. This situation has a direct positive effect on the tool life and on the surfaces produced. The machining is also gentle on the spindle bearings.



#### CUTTING DATA

##### Small parts for ABS brake system

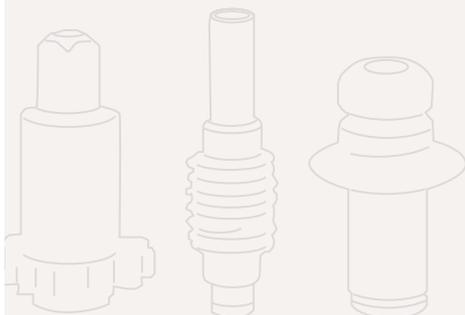
- Workpiece material	ETG 100
- Cutting material	Carbide coated
- Diameter	4 - 8 mm
- Cutting speed	73 - 145 m/min
- Spindle speed	6,000 rpm
- Cycle time	2.5 s
- Max. radial stroke	12.6 mm

#### FEATURES

- High spindle speeds, up to 6,000 rpm
- On special machines and transfer lines with to some extent multi-spindle variants
- Very short machining times for complete parts
- Imbalance compensation in slide plane
- Connection sizes to the spindle can be tailored to suit the specific customer using an intermediate flange
- Tools for external and internal machining

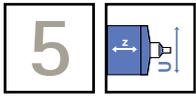
#### ADVANTAGES

- Finely balanced at high spindle speeds, for this reason it is possible to use coated carbide or PcBN
- Compact design
- Low lubricant usage due to sealed system
- Low set-up and cycle times



# Actuating by means of drawbar/push rod

## Applications



### 5.6 Facing and pipe end machining using EAT facing head

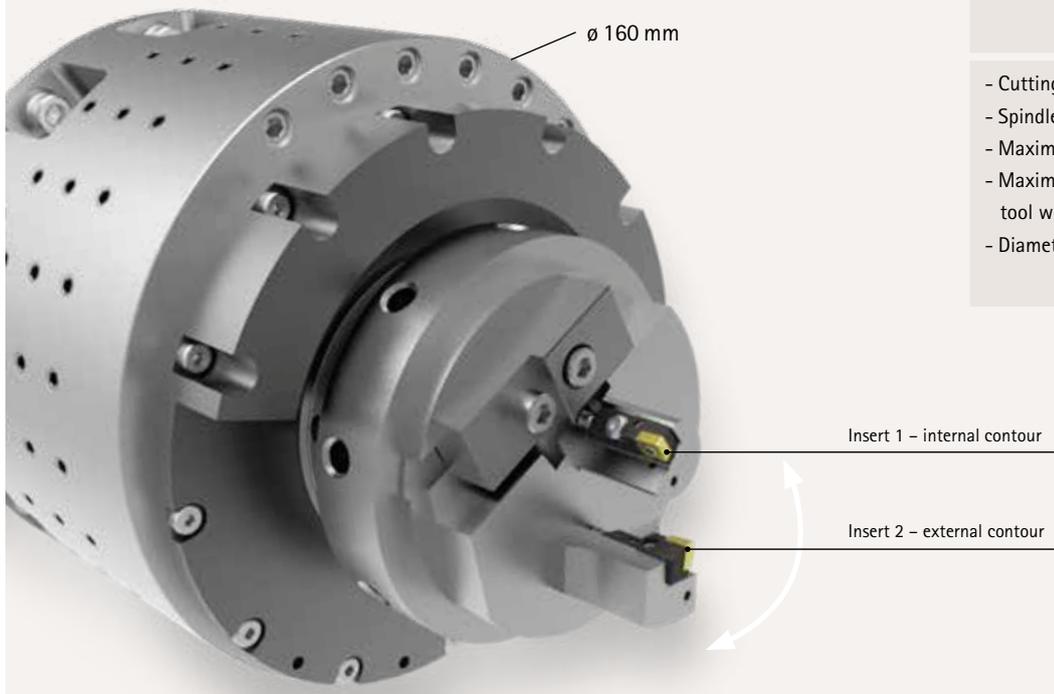
**TASK:**

- Face machining with high cutting speeds and accuracies.
- Internal, external and face machining on one station.

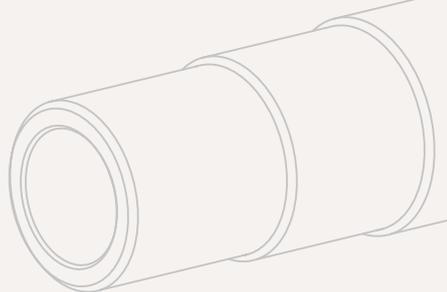
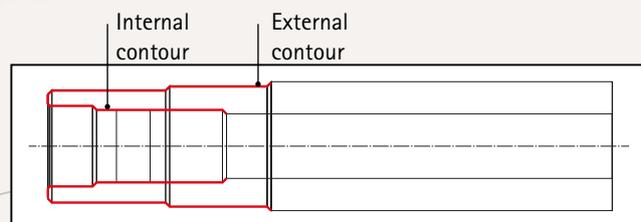
**SOLUTION:**

A facing head with an eccentrically arranged operating slide with HSK connection is used. Eccentric facing heads together with the mounting tool are free of imbalance in every position. The facing head is operated

with the aid of a superimposed rotary drive (U axis) from the machine. Due to the rotational movement of the operating slide and the diameter change of the inserts produced as a result, very exact diameters can be machined.



CUTTING DATA	
- Cutting speed	300 m/min
- Spindle speed	2,000 rpm
- Maximum face stroke	6 mm
- Maximum mounting tool weight	1.7 kg
- Diameter	Depending on mounting tool



**FEATURES**

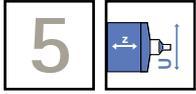
- Up to 10,000 rpm possible
- HSK connection for the mounting tool
- Central coolant supply

**ADVANTAGES**

- Most accurate form of positioning an insert on a facing head

# Actuating by means of drawbar/push rod

## Applications



### 5.7 Pipe end machining using LAT facing head

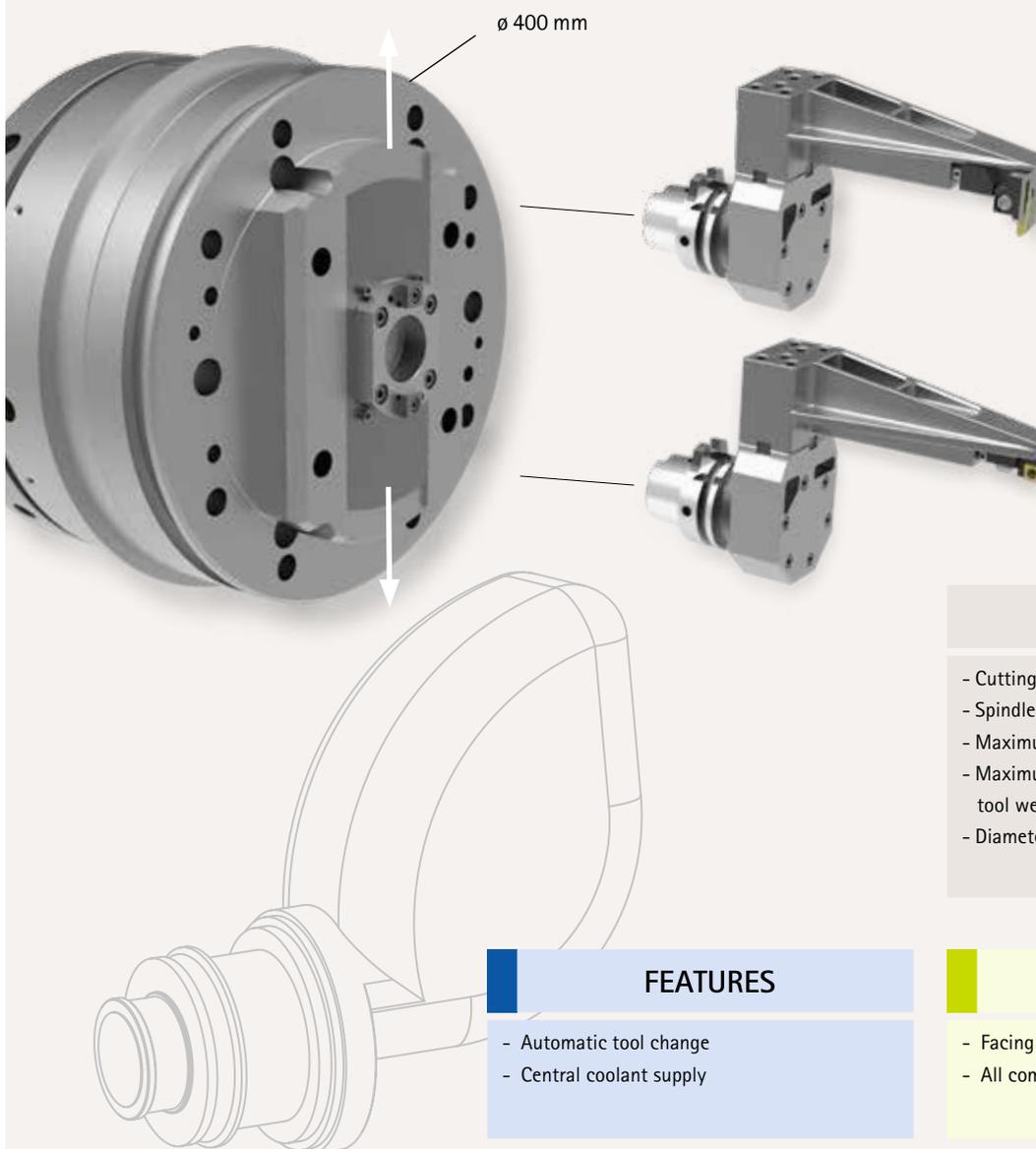
#### TASK:

- Turning asymmetric part families of varying size.

#### SOLUTION:

The two slides are operated via the central drawbar that is connected to the machine's U axis. One of the two slides is the operating slide, the second (concealed) slide is used as imbalance compensation for the operating slide. A hydraulic system is fitted in the operating slide. This system makes possible

automatic insertion and removal of mounting tools used on the facing head with the aid of the machine's changer. The facing head also has a central coolant supply for the exchanged mounting tools.



#### CUTTING DATA

- Cutting speed	300 m/min
- Spindle speed	700 rpm
- Maximum face stroke	50 mm
- Maximum mounting tool weight	8 kg
- Diameter	Depending on mounting tool

#### FEATURES

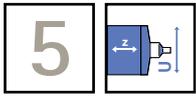
- Automatic tool change
- Central coolant supply

#### ADVANTAGES

- Facing head acts as front edge of spindle
- All common tool types can be inserted

# Actuating by means of drawbar/push rod

## Applications



### 5.8 Face machining of cylindrical solid material using LAT facing head

**TASK:**

- Countersinking, facing and chamfering
- Flexible face and external machining of different pipe sizes.

**SOLUTION:**

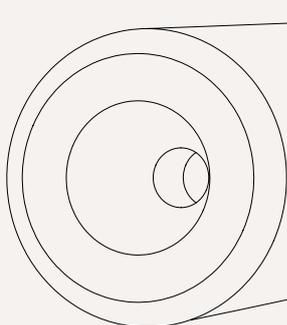
The two opposing operating slides are operated with the aid of a superimposed rotary drive. Two exactly ground slides move simultaneously and ensure imbalance compensation in every position. Both slide holders are of modular design and can be

equipped with various mounting tools. Due to its diametral design, a further central machining tool can be fitted modularly. This facing head is used for facing, centring and chamfering round material; the workpiece does not rotate during this process.



**CUTTING DATA**

- Cutting speed	300 m/min
- Spindle speed	600 rpm
- Maximum face stroke	200 mm
- Maximum mounting tool weight	2.5 kg
- Diameter machining	20 - 400 mm



**FEATURES**

- Exactly ground slideways / serrations
- Modular mounting tools

**ADVANTAGES**

- No superimposition gearbox necessary
- Additional central tool possible
- Workpiece does not need to rotate

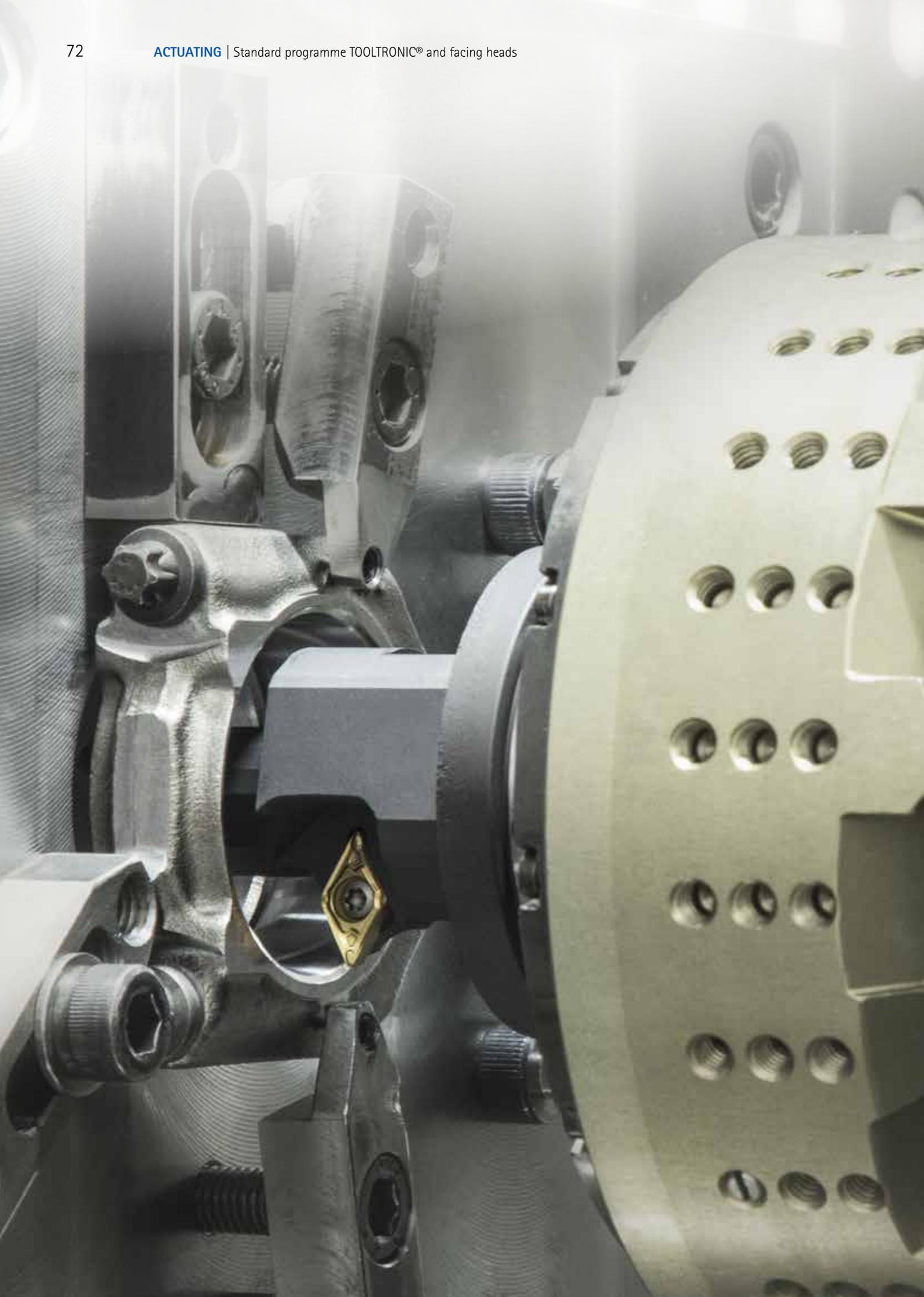




# STANDARD PROGRAMME TOOLTRONIC® AND FACING HEADS

1 | Controller    2 | TOOLTRONIC® unit    3 | Stator box







# TOOLTRONIC®

TOOLTRONIC – the universal input for more manufacturing versatility and flexibility on machining centres and special machines. TOOLTRONIC for machining centres is a full interchangeable tool axis that permits a broad spectrum of applications.

## TOOLTRONIC®

---

TOOLTRONIC® integration _____	74
Standard programme TOOLTRONIC® _____	76
– Systems for machining centres _____	78
– Systems for special machines _____	82

# TOOLTRONIC® INTEGRATION

## General system overview

To achieve a high level of accuracy for the TOOLTRONIC U axis in combination with the machine tool, the TOOLTRONIC U axis is integrated into the position control of the machine tool and can be interpolated

with other machine axes. A prerequisite for regulating the axis is an analogue axis module with an output for speed settings and an input for incremental position transmission. In addition, inputs and outputs

on the PLC (Programmable Logic Controller) are required. The signals and electrical energy for the U axis motor are transferred to the rotating section (drive spindle) by a non-contact and wear-free inductive transmitter (TOOLTRONIC stator).

## MACHINERY MANUFACTURER

### MACHINE CONTROLLER

SIEMENS  
HEIDENHAIN  
FANUC  
BOSCH REXROTH  
.....

### ENERGY

### DATA RELEASE / STATUS

### DATA CONTROL

### SERVICE INTERFACE



#### Requirements on machine controller

- Integration of TOOLTRONIC as analogue axis (a corresponding module must be available in the controller portfolio, for example SIEMENS ADI4, HLA,...)

#### Minimum requirements on axis module

- Set valve output  $\pm 10$  V
  - Actual value input 1 Vpp, alternatively RS422
- Minimum requirements PLC + energy supply**
- 24 V DC, 1.5 A
  - 9 spare digital inputs / 12 spare digital outputs; alternatively Profibus 1.5 Mbit
  - 230 V AC 6.7 A, alternatively 400 V AC 13.5

#### Controller options

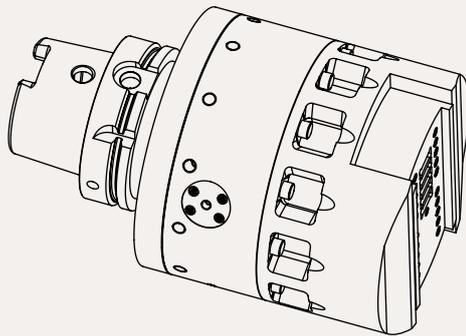
- PLC logic programmable by machine manufacturer
- Cutting edge radius compensation possible for turning tools
- Programming with constant cutting speed
- Turning cycles
- Support for U axes / turning tools in the tool management

# MAPAL STANDARD PROGRAMME

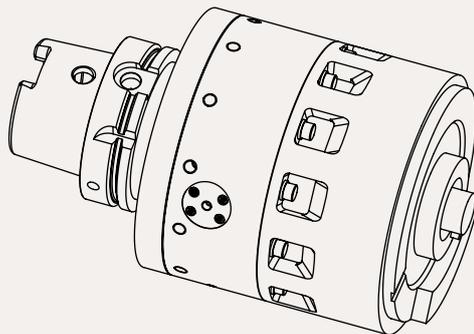
## MACHINE CONNECTION

HSK63  
HSK100  
SK40  
SK50

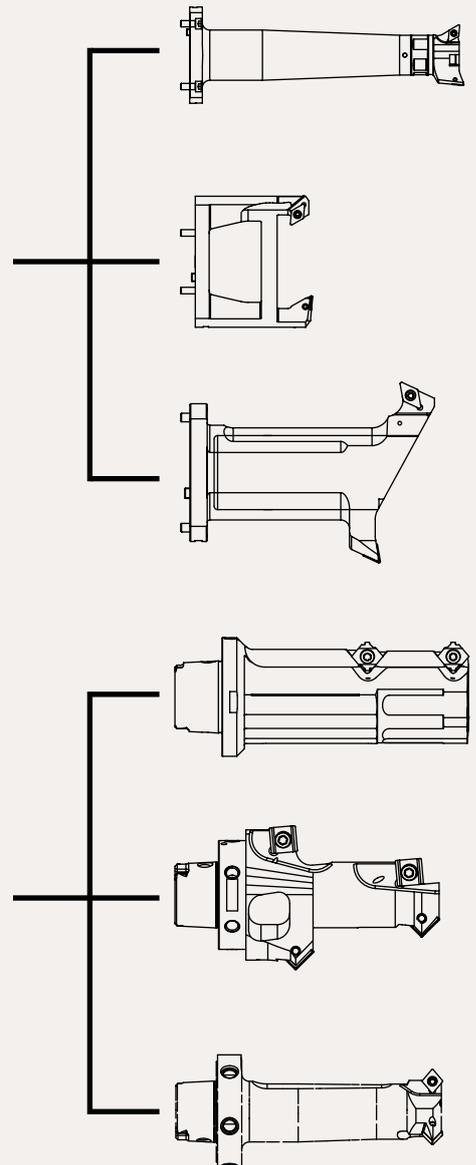
UNITS WITH LINEAR ACTUATING TOOLS - LAT



UNITS WITH ECCENTRIC ACTUATING TOOLS - EAT



EXAMPLES FOR MOUNTING TOOLS

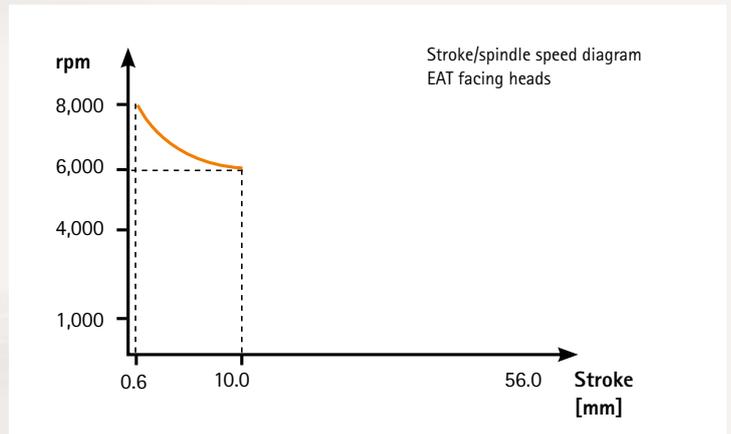
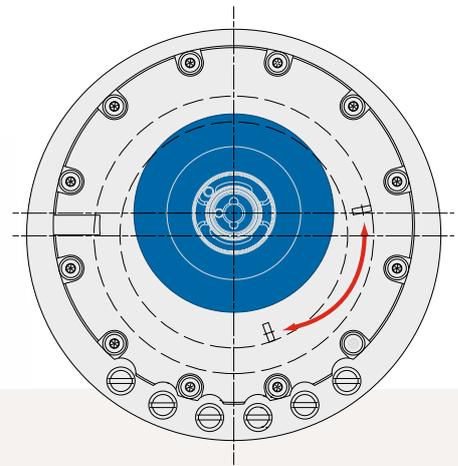
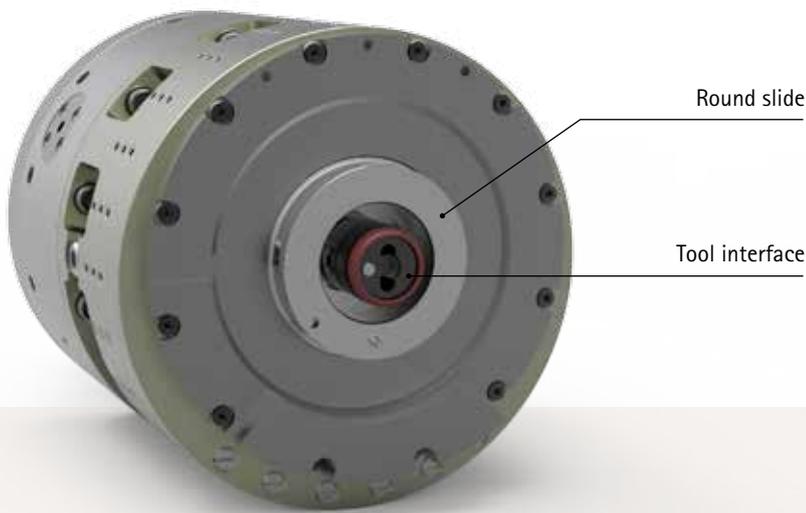


# STANDARD PROGRAMME TOOLTRONIC®

## EAT facing heads – eccentric actuating tool for high spindle speeds

Depending on the machining task, different facing heads (outputs) from MAPAL are used on the modular TOOLTRONIC connection.

As standard, eccentric actuating tools (EAT) are used.



### FEATURES

- Very high accuracy with small strokes
- Sealed, low-maintenance round slide with roller bearings
- Adjusting movement and spindle speed have practically no effect on static imbalance
- Various outputs can be used on the TOOLTRONIC's modular connection
- Internal coolant supply up to maximum 40 bar

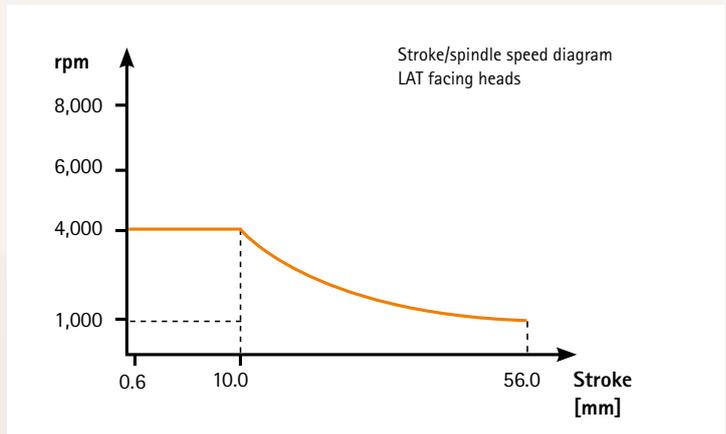
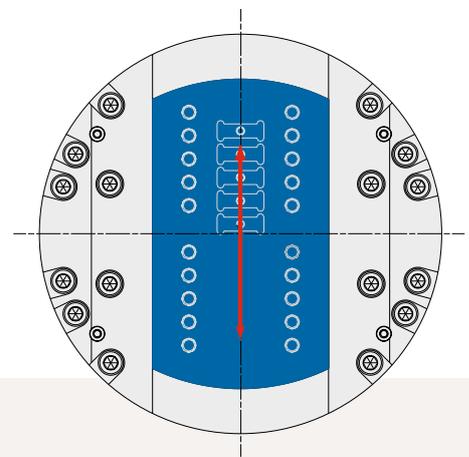
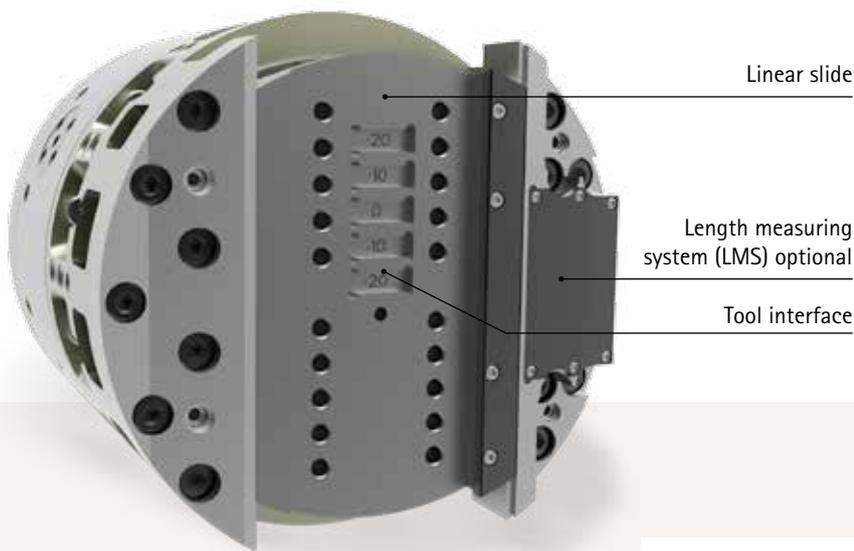
### ADVANTAGES

- High accuracy at the highest spindle speeds
- Static imbalance compensated by eccentric principle
- Lower actuation forces and drive powers
- Particularly suitable for HSC machining
- Facing head is lubricated for life

## LAT facing heads – linear actuating tool for large strokes

Applications that require a large stroke with a tailored spindle speed are covered as standard using linear actuating tools (LAT).

Linear actuating tools can be used in a modular manner with TOOLTRONIC on machining centres or special machines.



### FEATURES

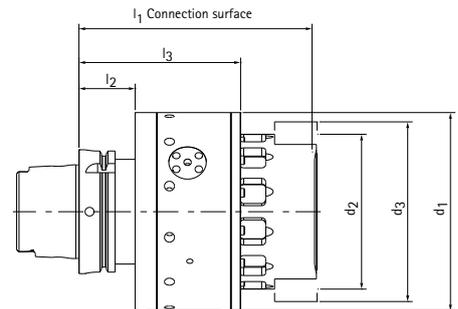
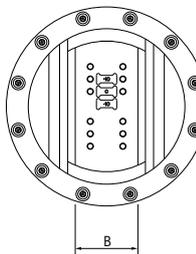
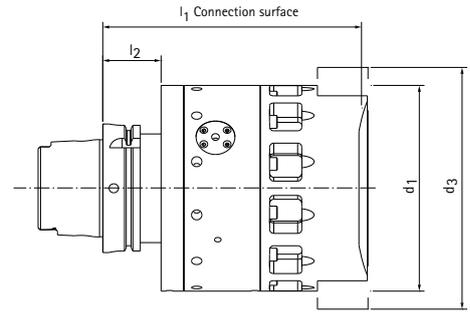
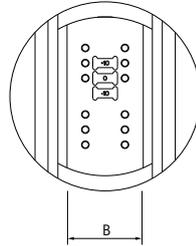
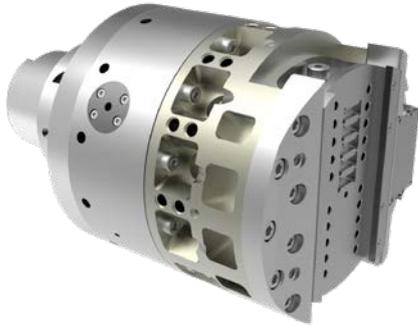
- For fine machining at large strokes
- Low-maintenance linear slide
- Imbalance can be compensated to some extent by imbalance compensation slide
- Possible radial stroke up to maximum 56 mm
- Internal coolant supply up to maximum 40 bar

### ADVANTAGES

- Large strokes possible with matched spindle speed
- Linear actuating tools can be used in a modular manner on TOOLTRONIC for machining centres or as a special solution
- Flexible interfaces for mounting tools
- Depending on the specific application, spindle speeds up to 4,000 rpm can be realised

# TOOLTRONIC®

Systems for machining centres with LAT



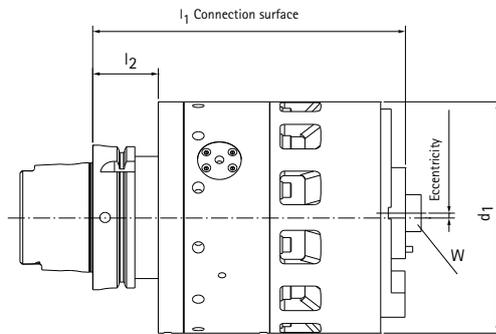
## Units with linear actuating tools (LAT)

Nominal size	d <sub>1</sub>	d <sub>2</sub>	d <sub>3</sub>	l <sub>1</sub>	l <sub>2</sub>	l <sub>3</sub>	B	Weight [kg]	Radial stroke	Delta D	n max. [rpm]	<sup>2)</sup> v <sub>f</sub> [mm/rpm]	Specification	Order No.
HSK63	125	-	145	186.3	42	-	50	7	40 (+/- 20)	80	4,000	900	D-HSK-A63-LAT125	30534639
HSK100	160	125	145	186.7	45	129.5	50	12	40 (+/- 20)	80	4,000	900	D-HSK-A100-LAT125	30534643
HSK100	160	-	188	199.7	45	-	58	17	56 (+/- 28)	112	4,000	900	D-HSK-A100-LAT160	30534649
SK40	125	-	145	179.3	35	-	50	7.2	40 (+/- 20)	80	4,000	900	D-SK040-LAT125	30534651
SK50	160	125	145	176.7	35	119.5	50	13	40 (+/- 20)	80	4,000	900	D-SK050-LAT125	30534655
SK50	160	-	188	189.7	35	-	58	18	56 (+/- 28)	112	4,000	900	D-SK050-LAT160	30534661
BT40	125	-	145	179.3	35	-	50	7.2	40 (+/- 20)	80	4,000	900	D-BT040-LAT125	30778516
BT50	160	125	145	176.7	35	119.5	50	13	40 (+/- 20)	80	4,000	900	D-BT050-LAT125	30778521
BT50	160	-	188	189.7	35	-	58	18	56 (+/- 20)	112	4,000	900	D-BT050-LAT160	30778528
CAT50	160	125	145	176.7	35	119.5	50	13	40 (+/- 20)	80	4,000	900	D-CAT050-LAT125	30534663
CAT50	160	-	188	189.7	35	-	58	18	56 (+/- 28)	112	4,000	900	D-CAT050-LAT160	30534669
C6	125	-	145	174.3	30	-	50	7.2	40 (+/- 20)	80	4,000	900	D-CAP063-LAT125	30534671
C8	160	-	188	184.7	30	-	58	17	56 (+/- 28)	112	4,000	900	D-CAP080-LAT160	30602295

## Units with linear actuating tools (LAT) and length measuring system (LMS)

HSK63	125	-	145	186.3	42	-	50	7	40 (+/- 20)	80	4,000	900	D-HSK-A63-LAT125-LMS	30534638
HSK100	160	125	145	186.7	45	129.5	50	12	40 (+/- 20)	80	4,000	900	D-HSK-A100-LAT125-LMS	30534642
HSK100	160	-	188	199.7	45	-	58	17	56 (+/- 28)	112	4,000	900	D-HSK-A100-LAT160-LMS	30534648
SK40	125	-	145	179.3	35	-	50	7.2	40 (+/- 20)	80	4,000	900	D-SK040-LAT125-LMS	30534650
SK50	160	125	145	176.7	35	119.5	50	13	40 (+/- 20)	80	4,000	900	D-SK050-LAT125-LMS	30534654
SK50	160	-	188	189.7	35	-	58	18	56 (+/- 28)	112	4,000	900	D-SK050-LAT160-LMS	30534660
BT40	125	-	145	179.3	35	-	50	7.2	40 (+/- 20)	80	4,000	900	D-BT040-LAT125-LMS	30778515
BT50	160	125	145	176.7	35	119.5	50	13	40 (+/- 20)	80	4,000	900	D-BT050-LAT125-LMS	30778520
BT50	160	-	188	189.7	35	-	58	18	56 (+/- 28)	112	4,000	900	D-BT050-LAT160-LMS	30778527
CAT50	160	125	145	176.7	35	119.5	50	13	40 (+/- 20)	80	4,000	900	D-CAT050-LAT125-LMS	30534662
CAT50	160	-	188	189.7	35	-	58	18	56 (+/- 28)	112	4,000	900	D-CAT050-LAT160-LMS	30534668
C6	125	-	145	174.3	30	-	50	7.2	40 (+/- 20)	80	4,000	900	D-CAP063-LAT125-LMS	30534670
C8	160	-	188	184.7	30	-	58	17	56 (+/- 28)	112	4,000	900	D-CAP080-LAT160-LMS	30602294

## Systems for machining centres with EAT



### Units with eccentric actuating tools (EAT)

Nominal size	d <sub>1</sub>	l <sub>1</sub>	l <sub>2</sub>	<sup>3)</sup> W	Weight [kg]	Eccentricity	<sup>1)</sup> Max. radial stroke	<sup>1)</sup> Max. Delta D	n max. [rpm]	<sup>1,2)</sup> v <sub>f</sub> [mm/min <sup>-1</sup> ]	Specification	Order No.
HSK63	125	204.3	42	HSK-C32	7	3	5	10	8,000	150	D-HSK-A63-EAT125-3	30534640
HSK63	125	204.3	42	HSK-C32	7	6	11	22	7,000	300	D-HSK-A63-EAT125-6	30534641
HSK100	160	214.7	45	HSK-C50	15	3	5	10	8,000	150	D-HSK-A100-EAT160-3	30534644
HSK100	160	214.7	45	HSK-C50	15	6	11	22	7,000	300	D-HSK-A100-EAT160-6	30534645
SK40	125	197.3	35	HSK-C32	7.2	3	5	10	8,000	150	D-SK040-EAT125-3	30534652
SK40	125	197.3	35	HSK-C32	7.2	6	11	22	7,000	300	D-SK040-EAT125-6	30534653
SK50	160	204.7	35	HSK-C50	16	3	5	10	8,000	150	D-SK050-EAT160-3	30534656
SK50	160	204.7	35	HSK-C50	16	6	11	22	7,000	300	D-SK050-EAT160-6	30534657
BT40	125	197.3	35	HSK-C32	7.2	3	5	10	8,000	150	D-BT040-EAT125-3	30778517
BT40	125	197.3	35	HSK-C32	7.2	6	11	22	7,000	300	D-BT040-EAT125-6	30778518
BT50	160	204.7	35	HSK-C50	16	3	5	10	8,000	150	D-BT050-EAT160-3	30778522
BT50	160	204.7	35	HSK-C50	16	6	11	22	7,000	300	D-BT050-EAT160-6	30778523
CAT50	160	204.7	35	HSK-C50	16	3	5	10	8,000	150	D-CAT050-EAT160-3	30534664
CAT50	160	204.7	35	HSK-C50	16	6	11	22	7,000	300	D-CAT050-EAT160-6	30534665

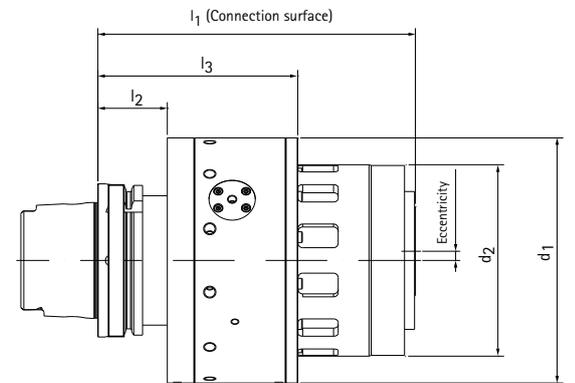
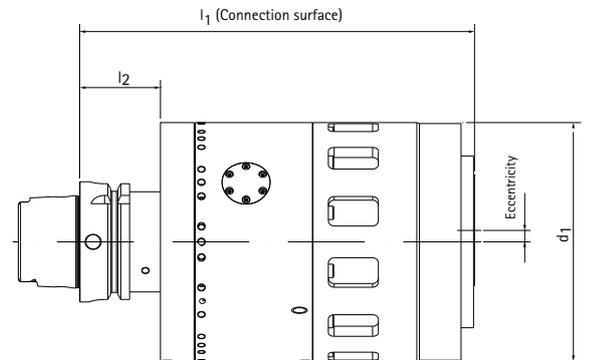
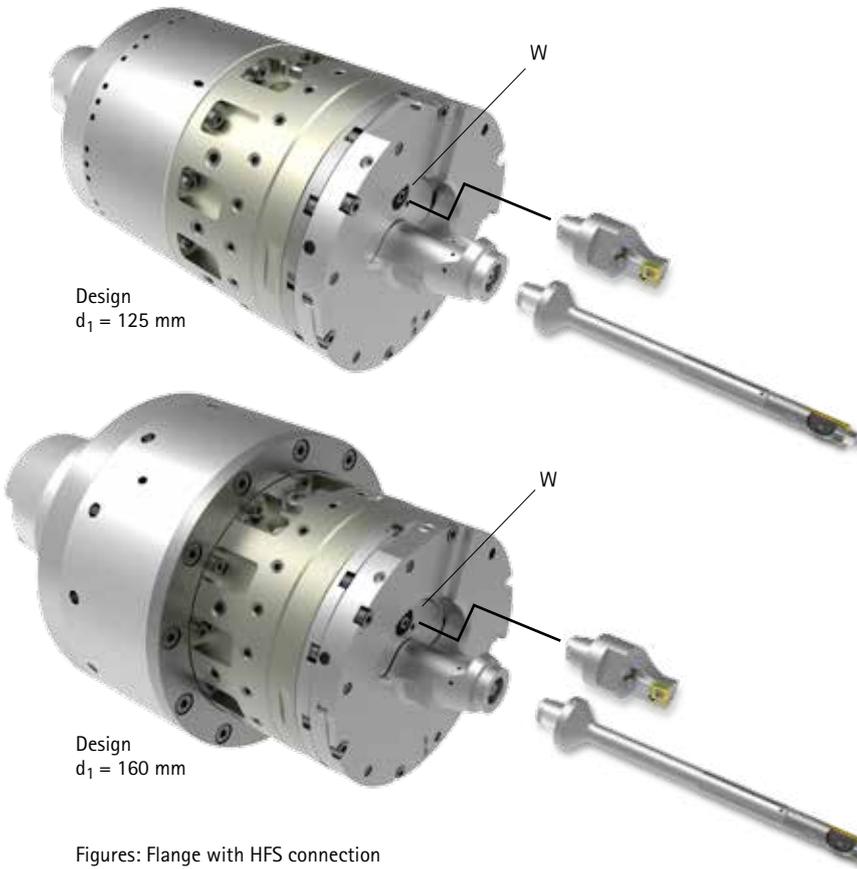
<sup>1)</sup> Depending on the mounting tool

<sup>2)</sup> v<sub>f</sub> = Maximum adjustment speed

<sup>3)</sup> Tool connection, mounting tool

# TOOLTRONIC®

Systems for machining valve seat and valve guide on machining centres with EAT



## Units with eccentric actuating tools / combined machining of valve seat and guide

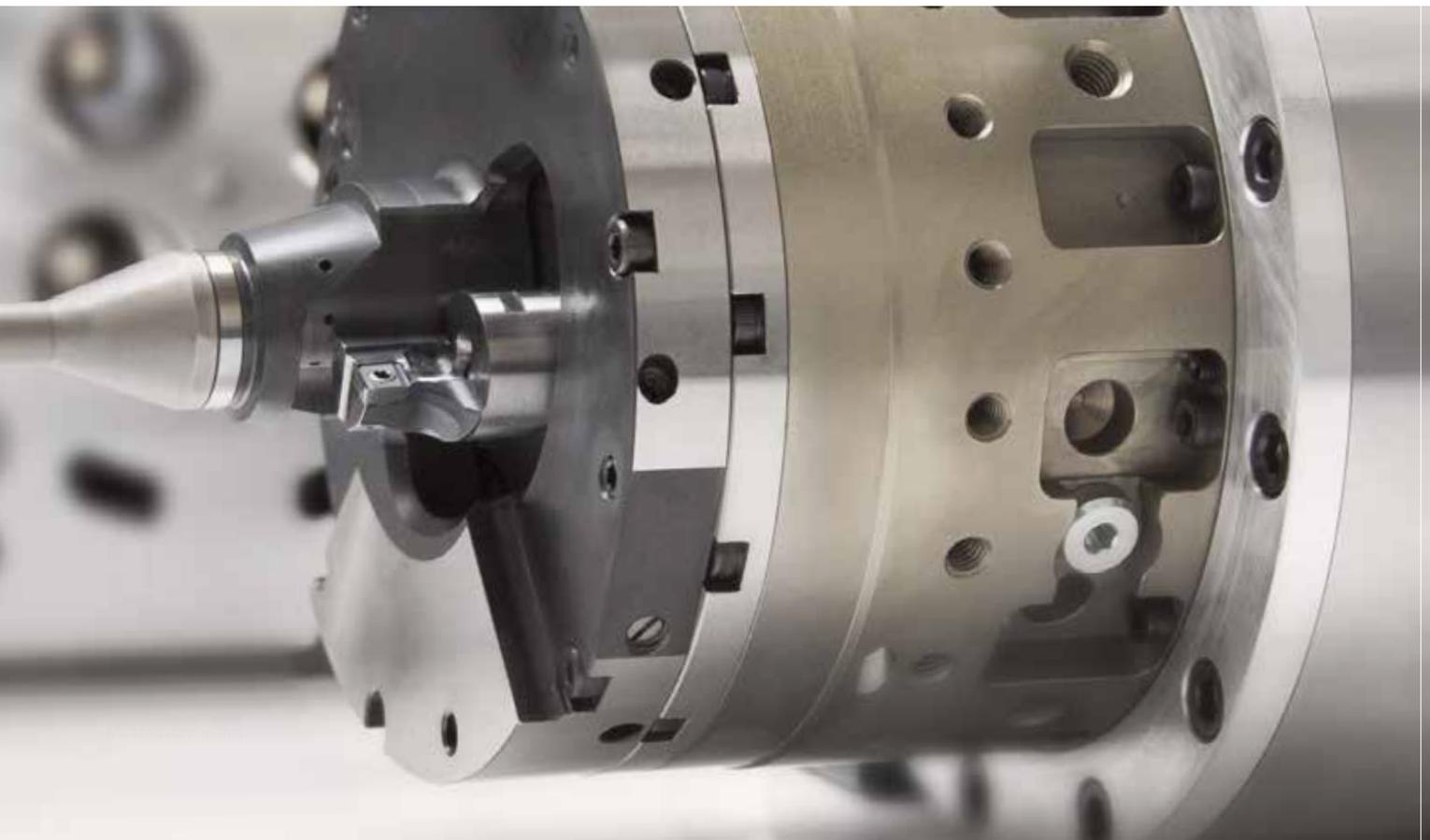
Nominal size	d <sub>1</sub>	d <sub>2</sub>	l <sub>1</sub>	l <sub>2</sub>	l <sub>3</sub>	<sup>1)</sup> W	Weight [kg]	Eccentricity	Max. radial stroke	Max. Delta D	Max. spindle speed [rpm]	<sup>2)</sup> v <sub>f</sub> [mm/rpm]	Specification	Order No.
HSK63	125	-	205.3	42	-	HFS12	8.3	6	6	12	7,000	300	D-HSK-A63-EAT125-6-S	30601534
HSK100	160	125	205.7	45	129.5	HFS12	13	6	6	12	7,000	300	D-HSK-A100-EAT125-6-S	30601544
SK40	125	-	198.3	35	-	HFS12	8.5	6	6	12	7,000	300	D-SK040-EAT125-6-S	30601568
SK50	160	125	195.7	35	119.5	HFS12	14	6	6	12	7,000	300	D-SK050-EAT125-6-S	30601569
BT40	125	-	198.3	35	-	HFS12	8.5	6	6	12	7,000	300	D-BT040-EAT125-6-S	30778519
BT50	160	125	195.7	35	119.5	HFS12	14	6	6	12	7,000	300	D-BT050-EAT125-6-S	30778526
CAT50	160	125	195.7	35	119.5	HFS12	14	6	6	12	7,000	300	D-CAT050-EAT125-6-S	30601570

<sup>1)</sup> W = Tool connection

<sup>2)</sup> v<sub>f</sub> = Maximum adjustment speed

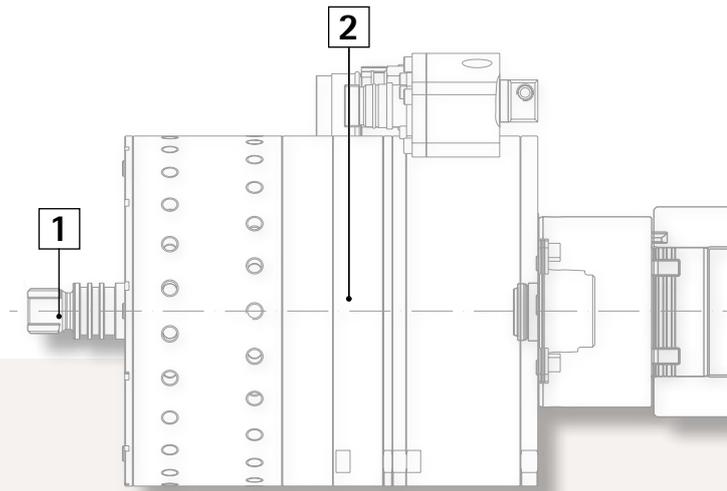
Note: The specification only includes the basic unit "input with EAT mounted".  
The adapter flange for reaming tool, mounting tool and reamer (figure on page 80) must be designed and ordered to suit the specific part.

Dimensions in mm.

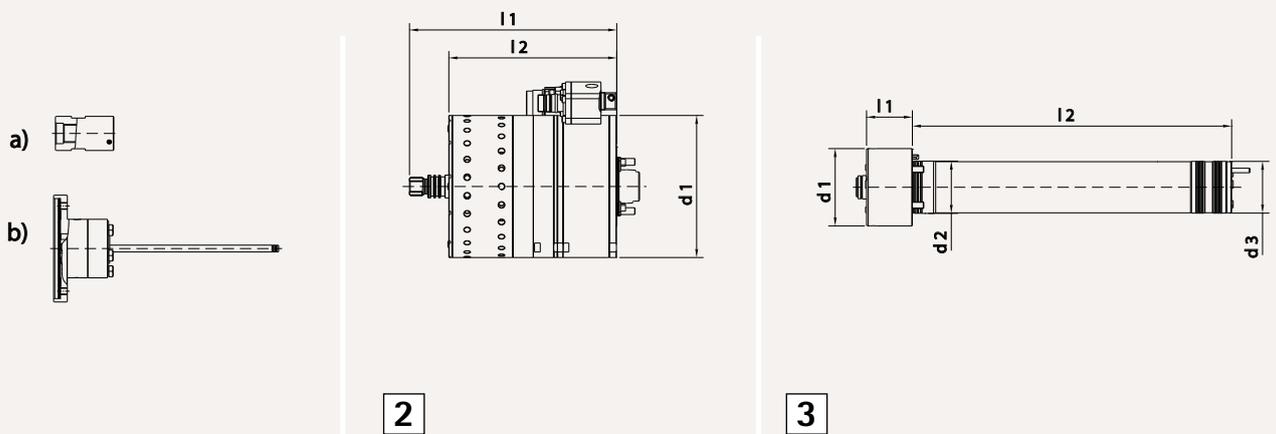


# TOOLTRONIC®

Systems for special machines



## Example of spindle integration



### 1 Coolant/lubricant transfer device (attachments)

Connection	Specification	Order No.
a) 1 medium		
M16x1.5 LH	1K	30649685
b) 2 media		
Flange	2K	30649687

### 2 Transfer unit – standard

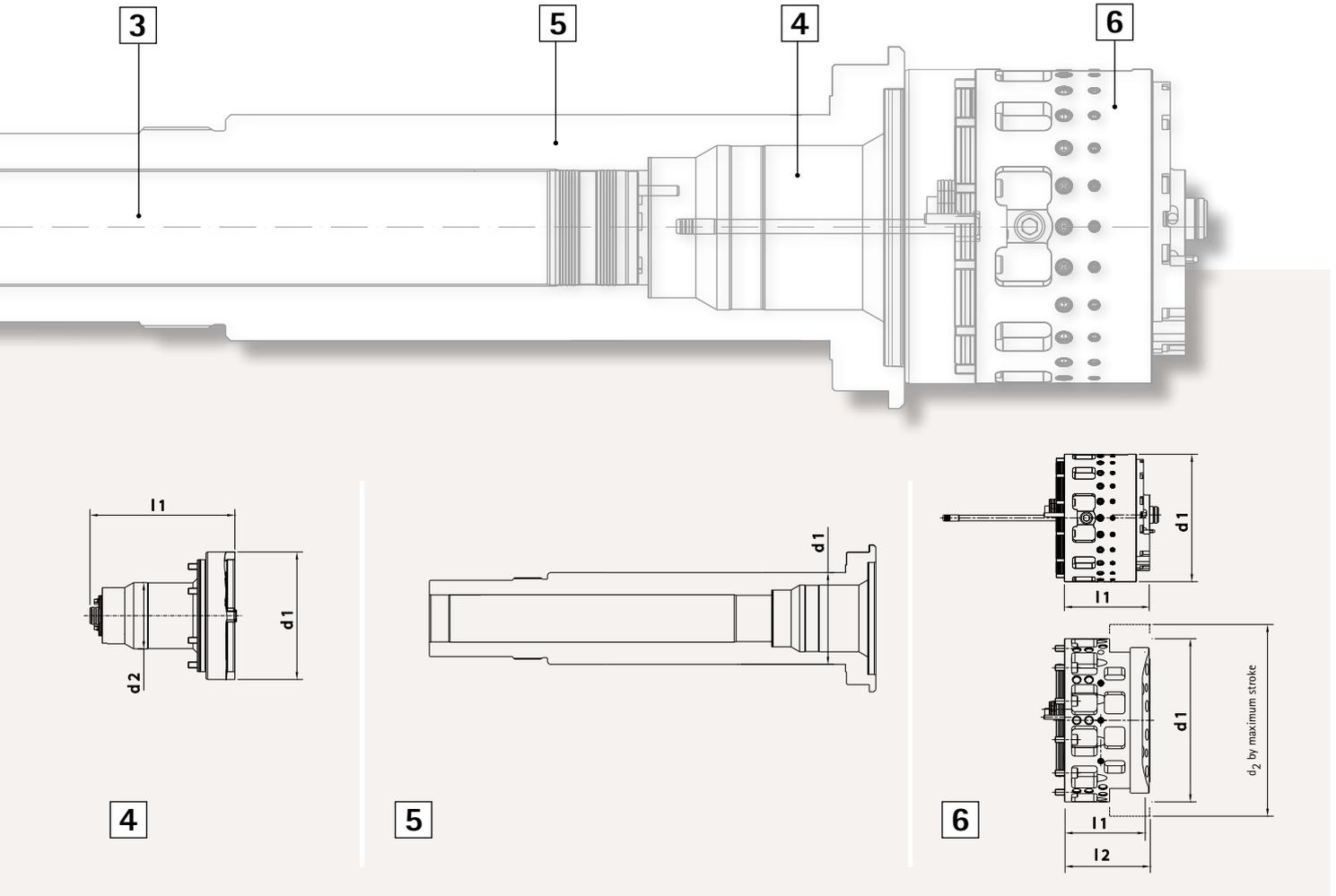
	d <sub>1</sub>	l <sub>1</sub>	l <sub>2</sub>	Specification	Order No.
Without length measuring system					
1 medium	125	181	147	OS-AD-HSK-C40-181-1	30649337
2 media	125	181	147	OS-AD-HSK-C40-181-4	30644464
With length measuring system					
1 medium	125	181	147	OS-AD-HSK-C40-181-1-LMS	30649410
2 media	125	181	147	OS-AD-HSK-C40-181-4-LMS	30649411

### 3 Spindle mandrel

d <sub>1</sub>	d <sub>2</sub>	d <sub>3</sub>	l <sub>1</sub>	l <sub>2</sub>	Order No.
68	46	45.5	40	<sup>1)</sup>	--

### 4 Motor unit – standard

d <sub>1</sub>	d <sub>2</sub>	l <sub>1</sub>	Specification	Order No.
125	65	141	SU	K70314-00



Standard programme  
TOOLTRONIC® / facing heads

**5 Spindle shaft – optional MAPAL or machine / spindle manufacturer**

Internal contour	d <sub>1</sub>	Order No.
According to MN686bl1	Min. 90	-- 1)

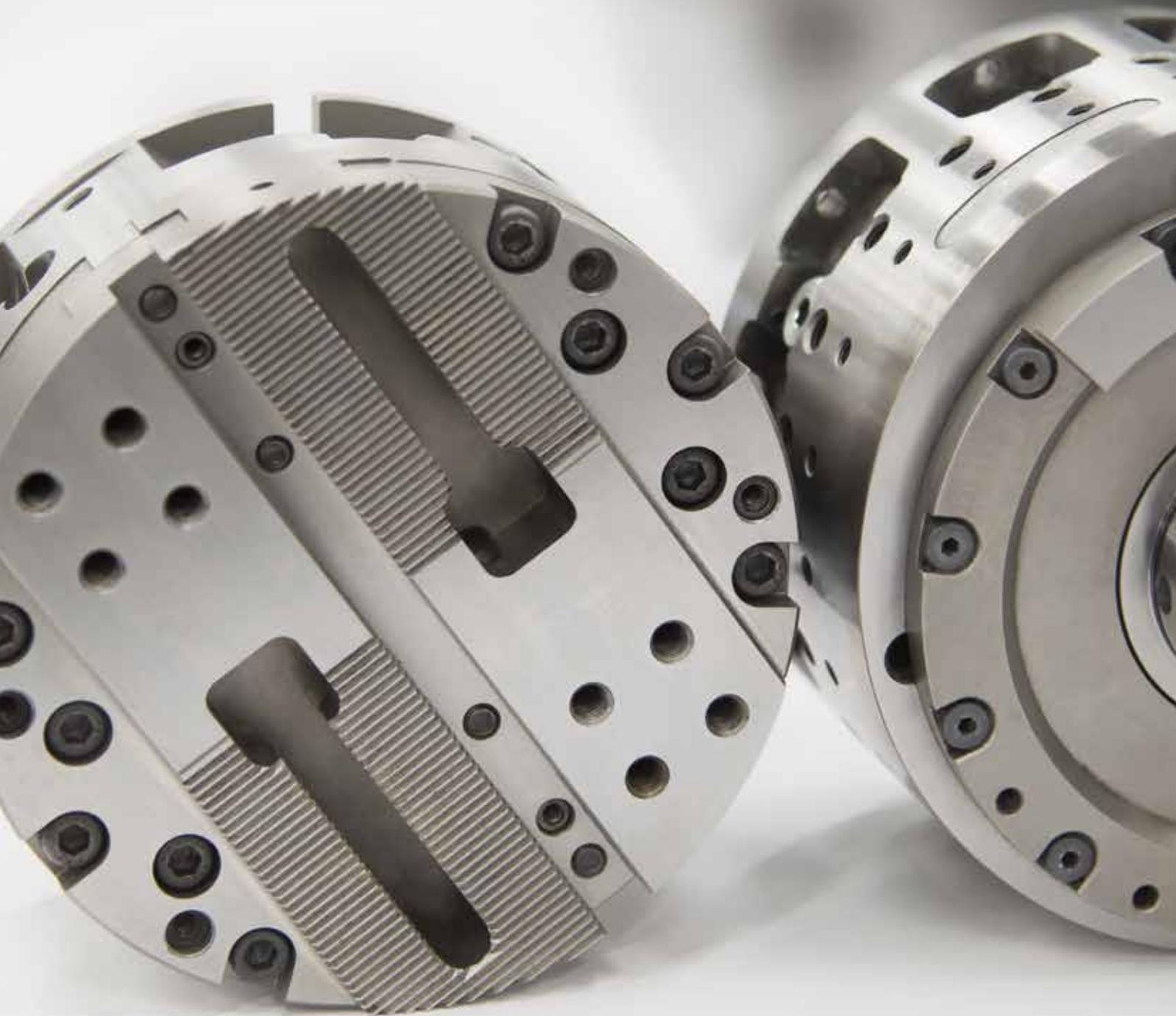
**6 Actuating tool – eccentric design EAT**

d <sub>1</sub>	l <sub>1</sub>	Tool interface	Eccentricity	Max. radial stroke	Max. Delta D	Max. spindle speed [min <sup>-1</sup> ]	<sup>2)</sup> v <sub>f</sub> [mm/min <sup>-1</sup> ]	Specification	Order No.
125	83	HSK-C32	3	5	10	8,000	150	TT-EAT-125-3-HSK32-1	30240585
125	83	HSK-C32	6	11	22	7,000	300	TT-EAT-125-6-HSK32-1	30240589
160	93	HSK-C50	3	5	10	8,000	150	TT-EAT-160-3-HSK50-1	30240593
160	93	HSK-C50	6	11	22	7,000	300	TT-EAT-160-6-HSK50-1	30240594

**Actuating tool – linear design LAT**

d <sub>1</sub>	d <sub>2</sub>	l <sub>1</sub>	l <sub>2</sub>	B	Radial stroke	Max. Delta D [mm]	Max. spindle speed [min <sup>-1</sup> ]	<sup>2)</sup> v <sub>f</sub> [mm/rpm]	Specification	Order No.
Without length measuring system										
125	145	65	69	50	40 (+/- 20)	80	4,000	900	TT-LAT-125-40	30272151
160	188	78	83	58	56 (+/- 28)	112	4,000	900	TT-LAT-160-56	12-30-017656
With length measuring system										
125	145	65	77.5	50	40 (+/- 20)	80	4,000	900	TT-LAT-125-40-LMS	30435367
160	188	78	85.5	58	56 (+/- 28)	112	4,000	900	TT-LAT-160-56-LMS	30435368

<sup>1)</sup> Customer-specific <sup>2)</sup> v<sub>f</sub> = Maximum adjustment speed Dimensions in mm.





# FACING HEADS

Facing heads are used for face turning, recessing and machining contours predominantly in large-scale series production on special machines. The operation of this slide tool and the actuation of the tool holder and inserts is via an NC-controlled crossfeed device that is on the spindle drive or on the rear of the feed unit.

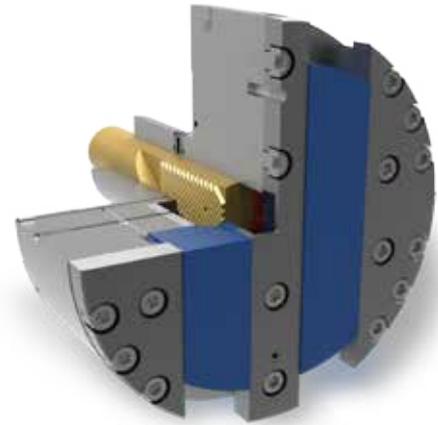
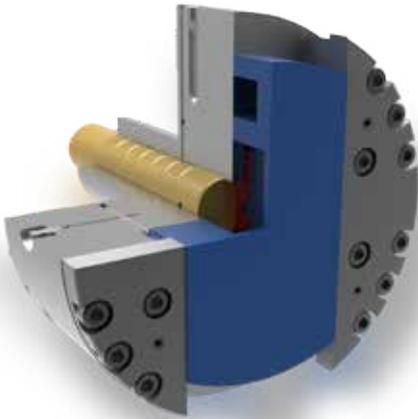
## Facing heads

---

Single slide – LAT 1 _____	88
Parallel double slide – LAT 2 _____	90
Single slide with concealed imbalance compensation slide – LAT C _____	92
Round slide – EAT _____	94

# STANDARD PROGRAMME, FACING HEADS

## Actuating with drawbar/push rod



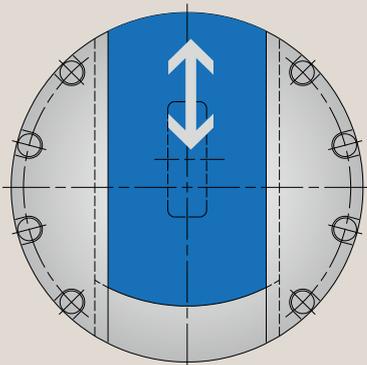
### Single slide LAT 1

#### Features:

- Medium to heavy machining with maximum overall stiffness
- Designed for central lubrication through the drawbar
- Standard range, LAT without internal coolant supply

#### Spindle speed range:

- Low spindle speeds, without balancing compensation
- Rule of thumb for spindle speed limit:  $n_{\max} = \frac{2,400}{\sqrt{\text{stroke}}}$
- Spindle speed limit and actuating force are dependent on LAT size, tool weight, tool length and slide position



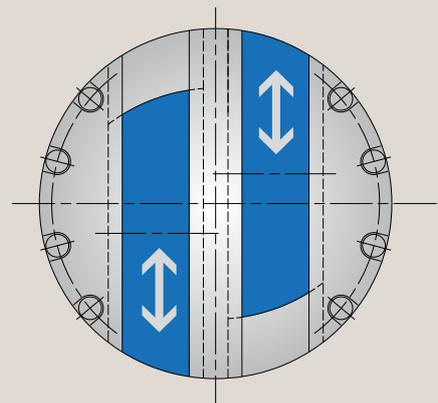
### Parallel double slide LAT 2

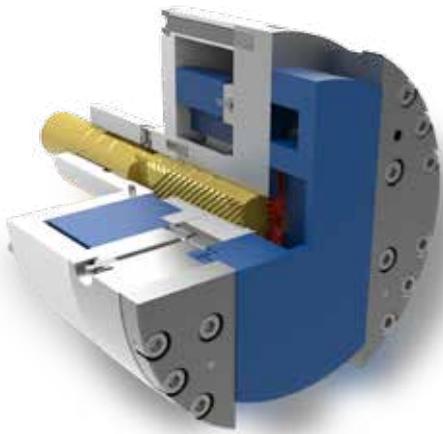
#### Features:

- Medium to heavy machining with maximum overall stiffness
- Machining variants  $z = 1$  or  $z = 2$ , both slides equipped with mounting tool or slide 1 equipped with mounting tool, slide 2 with compensation weight
- Designed for central lubrication through the drawbar
- Standard range, LAT without internal coolant supply

#### Spindle speed range:

- Medium spindle speeds, balance compensation by means of symmetrical double slide
- Spindle speed limit and actuating force are dependent on LAT size, tool weight, tool length and slide position





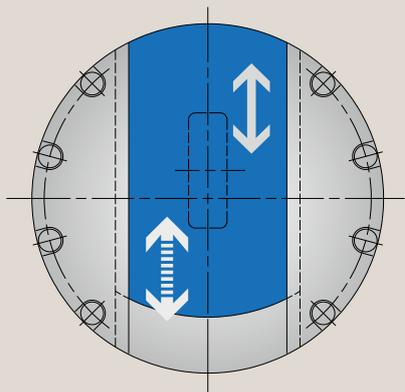
**Single slide LAT C with concealed imbalance compensation slide**

**Features:**

- Medium to heavy machining with maximum overall stiffness
- Defined mounting tool weight is compensated by matched balance weight
- Designed for central lubrication through the drawbar
- Standard range, LAT without internal coolant supply

**Spindle speed range:**

- High spindle speeds, balance compensation by means of counter slide
- Spindle speed limit and actuating force are dependent on LAT size, tool weight, tool length and slide position



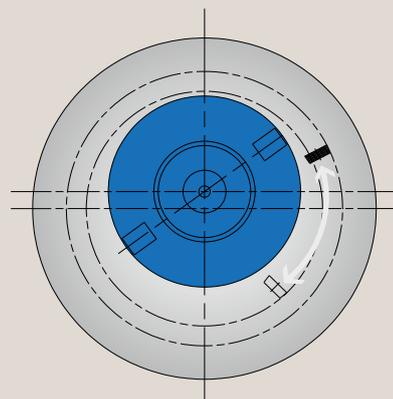
**Round slide EAT with HSK**

**Features:**

- Medium machining at very high spindle speeds over complete stroke range
- Defined mounting tool weight is compensated by matched balance weight
- Low angle change at the cutting edge geometry
- Designed for central lubrication through the drawbar
- Standard range, EAT without internal coolant supply

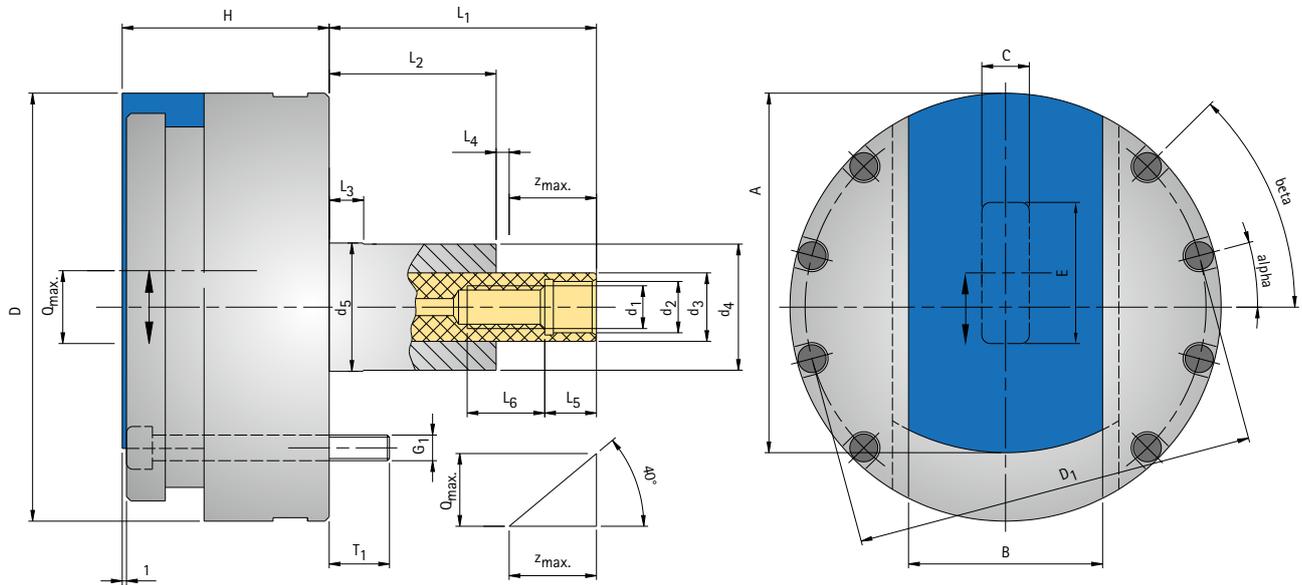
**Spindle speed range:**

- Very high spindle speeds, there is no imbalance due to the nature of the system
- Spindle speed limit and actuating force are dependent on EAT size, tool weight and tool length
- Actuating force independent of the slide position



# FACING HEAD

## Single slide – LAT 1

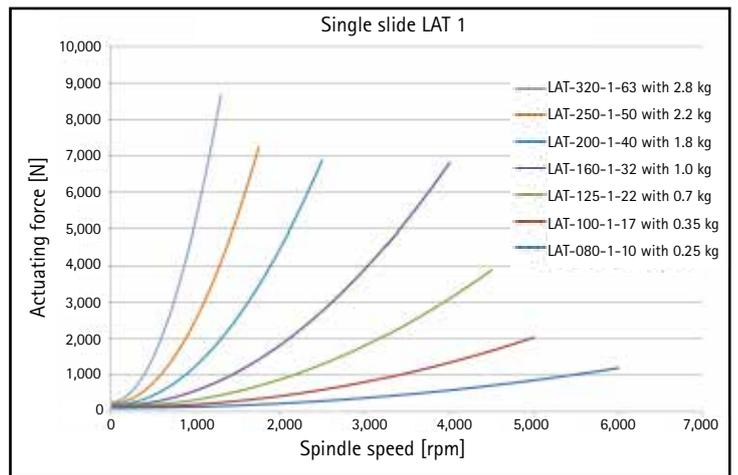
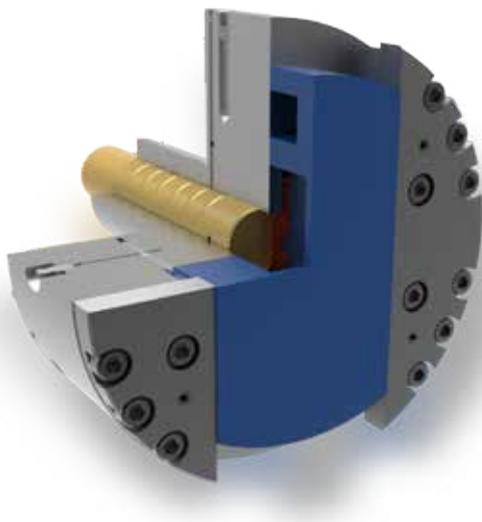
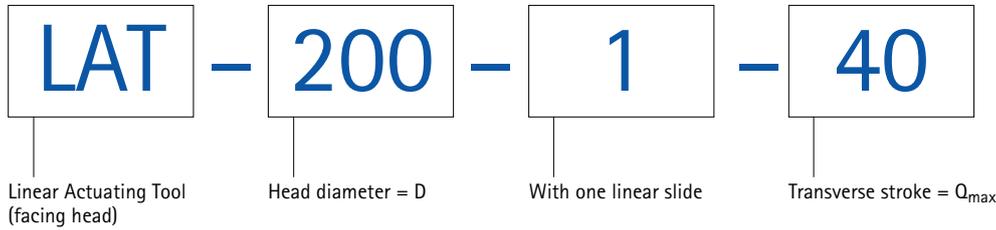


Models, single slide – LAT 1

		LAT-080-1-10	LAT-100-1-17	LAT-125-1-22	LAT-160-1-32	LAT-200-1-40	LAT-250-1-50	LAT-320-1-63
Primary dimensions	D	80	100	125	160	200	250	320
	$Q_{max}$	10	17	22	32	40	50	63
	$Z_{max}$	11.92	20.26	26.22	38.14	47.67	59.59	75.08
	H	42	48	58	70	85	100	125
Connection sizes	$D_1$	66.7	89	114	149	186	232	300
	$d_1$	M10x1 LH.	M10x1 LH.	M12x1.5 LH.	M16x1.5 LH.	M16x1.5 LH.	M20x1.5 LH.	M20x1.5 LH.
	$d_2^{H7}$	12	12	14	18	18	25	25
	$d_3$	16	16	18	25	32	40	40
	$d_4$	29.5	29.5	31.5	39.5	55.5	69.5	69.5
	$d_5 j_5$	30	30	32	40	56	70	70
	$L_1$	46	62	73	93	125	153	168
	$L_2$	31.08	38.74	43.78	50.86	72.33	88.41	87.92
	$L_3$	6	8	10	10	10	20	30
	$L_4$	3	3	3	4	5	5	5
	$L_5$	8	12	12	12	12	15	15
	$L_6$	14	18	18	24	32	40	40
	$G_1$	M6 (3x)	M6 (4x)	M6 (6x)	M6 (8x)	M8 (8x)	M10 (8x)	M12 (8x)
	$T_1$	7.5	14	14.8	13	15	21	29
alpha	-	-	-	15°	15°	15°	15°	
beta	-	35°	35°	45°	45°	45°	50°	
gamma	3 x 120°	-	-	-	-	-	-	
Slide dimensions	A	70	83	103	128	160	200	257
	B	36	40	53	70	90	110	130
	C	12	12	14	17	19	24	28
	E	28	35	42	60	76	94	107

Dimensions in mm.

Ordering example:



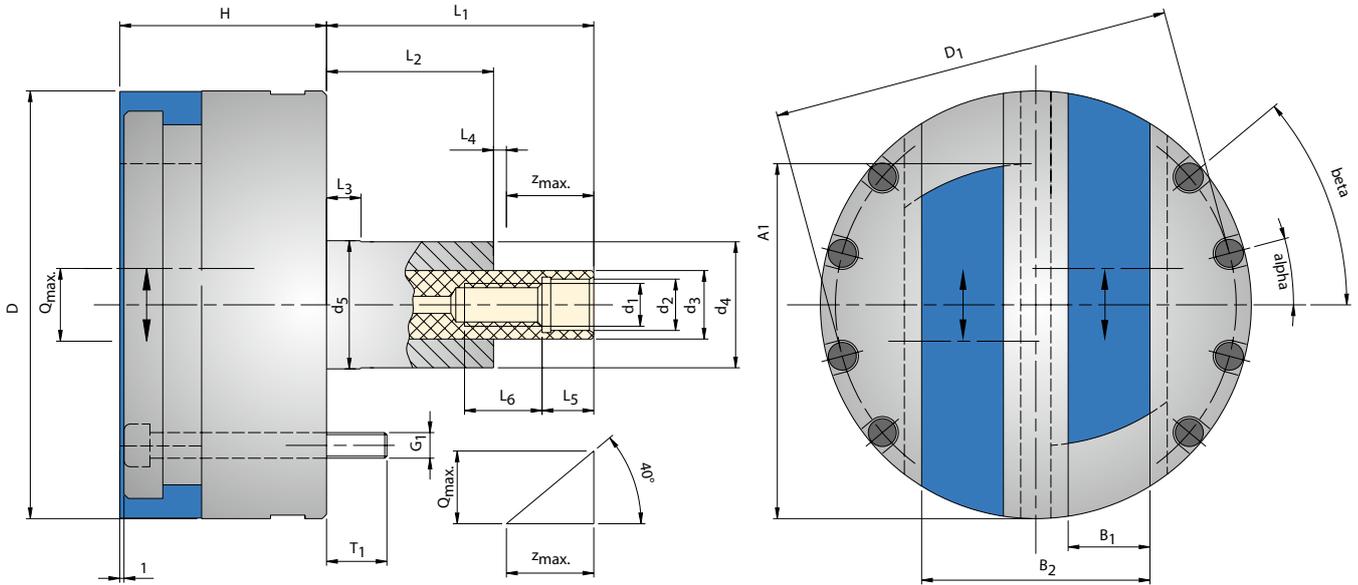
Tool adapter is tailored to the specific customer.

Examples for the design of the tool adapter

Flange connection	HSK	ABS
<ul style="list-style-type: none"> <li>- Short, stable mounting tool</li> <li>- Only indexable inserts are changed</li> </ul>	<ul style="list-style-type: none"> <li>- Tool can be changed quickly and pre-set</li> <li>- High changeover accuracy</li> </ul>	<ul style="list-style-type: none"> <li>- Tool can be changed quickly and pre-set</li> </ul>

# FACING HEAD

## Parallel double slide – LAT 2

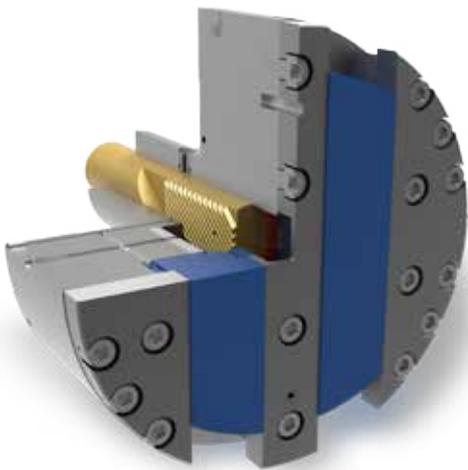
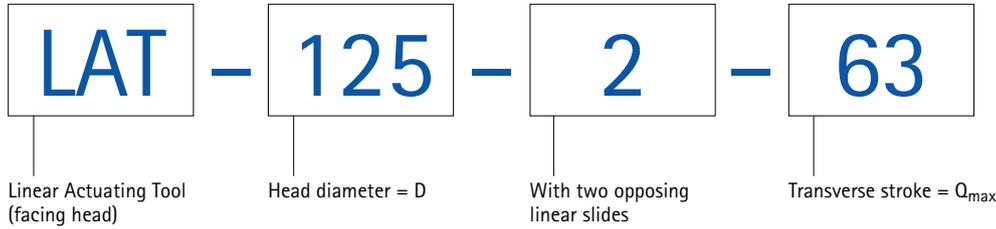


Models, parallel double slide – LAT 2

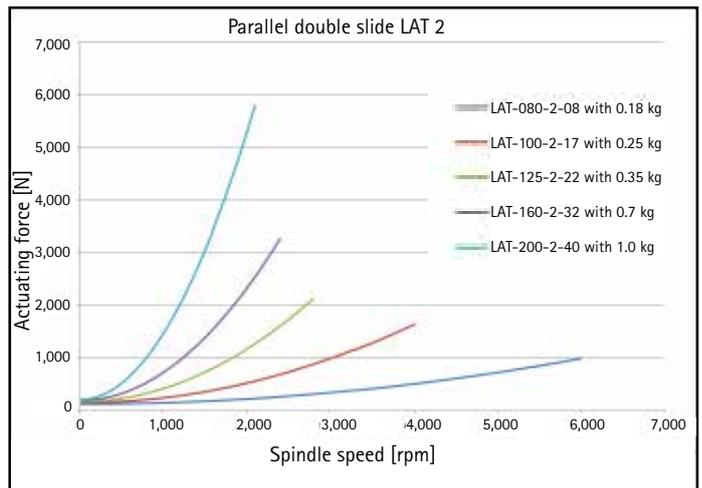
		LAT-080-2-10	LAT-100-2-17	LAT-125-2-22	LAT-160-2-32	LAT-200-2-40	LAT-250-2-50	LAT-320-2-63
Primary dimensions	D	80	100	125	160	200	250	320
	$Q_{max}$	10	17	22	32	40	50	63
	$Z_{max}$	11.92	20.26	26.22	38.14	47.67	59.59	75.08
	H	42	48	58	70	85	100	125
Connection sizes	$D_1$	66.7	89	114	149	186	232	300
	$d_1$	M10x1 LH.	M10x1 LH.	M12x1.5 LH.	M16x1.5 LH.	M16x1.5 LH.	M20x1.5 LH.	M20x1.5 LH.
	$d_2^{H7}$	12	12	14	18	18	25	25
	$d_3$	16	16	18	25	32	40	40
	$d_4$	29.5	29.5	31.5	39.5	55.5	69.5	69.5
	$d_5^{j5}$	30	30	32	40	56	70	70
	$L_1$	46	62	73	93	125	153	168
	$L_2$	31.08	38.74	43.78	50.86	72.33	88.41	87.92
	$L_3$	6	8	10	10	10	20	30
	$L_4$	3	3	3	4	5	5	5
	$L_5$	8	12	12	12	12	15	15
	$L_6$	14	18	18	24	32	40	40
	$G_1$	M6 (3x)	M6 (4x)	M6 (6x)	M6 (8x)	M8 (8x)	M10 (8x)	M12 (8x)
	$T_1$	7.5	14	14.8	13	15	21	29
alpha	-	-	0°	15°	15°	15°	15°	
beta	-	35°	35°	45°	45°	45°	50°	
gamma	3x120°	-	-	-	-	-	-	
Slide dimensions	A1	70	83	103	128	158	200	257
	B1	45	53	68	80	102	115	145
	B2	15	19	24	28	36	40	52.5

Dimensions in mm.

Ordering example:



Tool adapter is tailored to the specific customer.



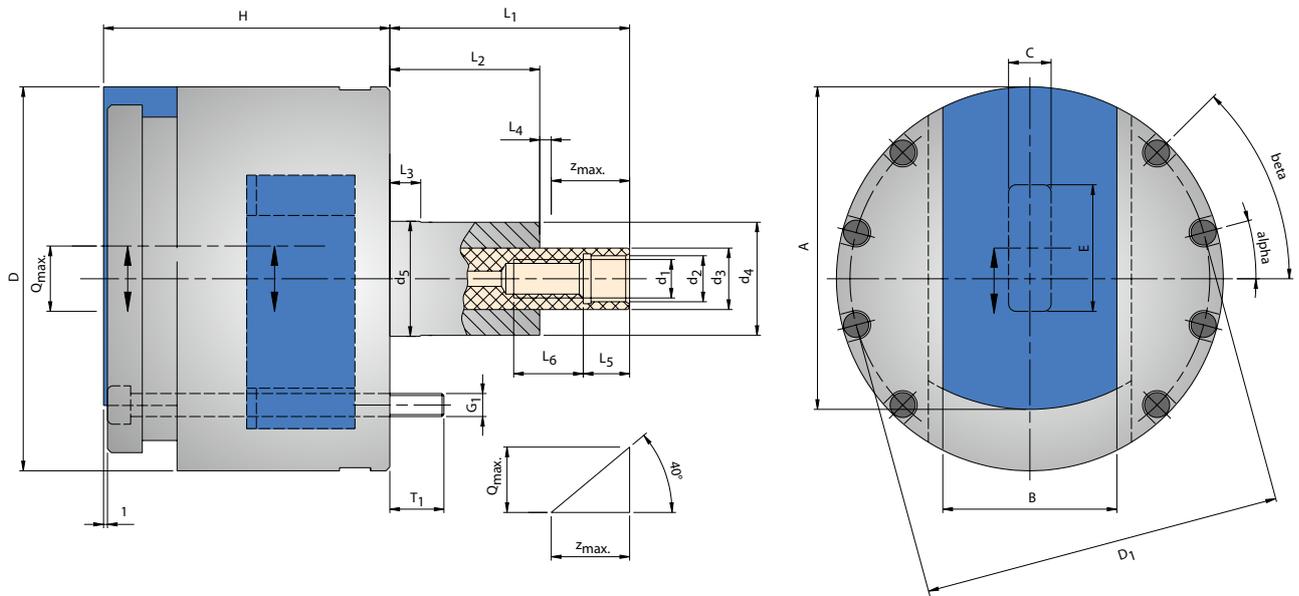
Standard programme TOOLTRONIC® / facing heads

Examples for the design of the tool adapter

ABS	Flange connection
<p>- Tool can be changed quickly</p>	

# FACING HEAD

Single slide with concealed imbalance compensation slide – LAT C

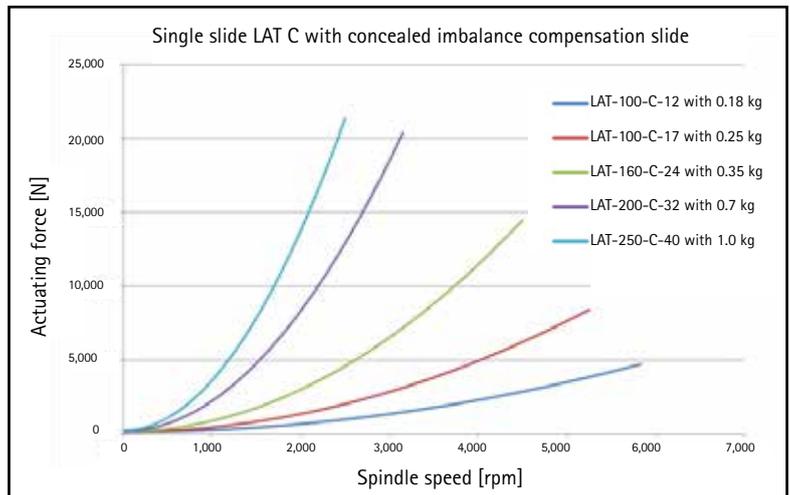
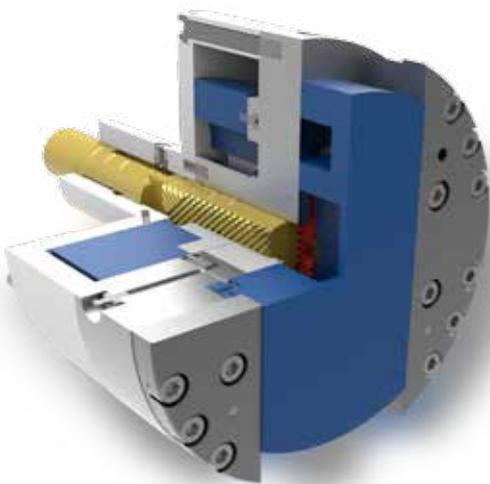
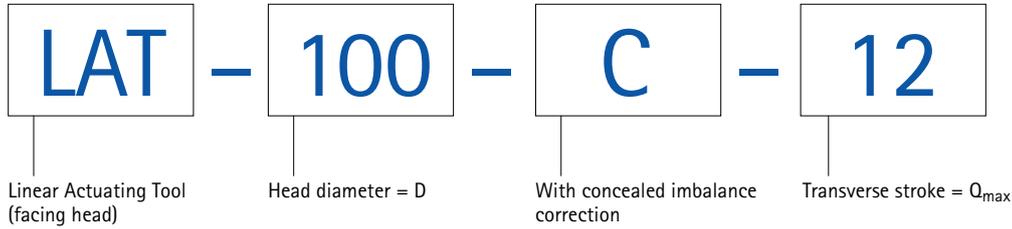


Models, single slide with concealed imbalance compensation slide – LAT C

		LAT-100-C-12	LAT-125-C-16	LAT-160-C-24	LAT-200-C-32	LAT-250-C-40
Primary dimensions	D	100	125	160	200	250
	$Q_{max}$	12	16	24	32	40
	$Z_{max}$	14.30	19.07	28.60	38.14	47.67
	H	74	92	105	123	145
Connection sizes	$D_1$	89	114	149	186	232
	$d_1$	M10x1 LH.	M12x1.5 LH.	M16x1.5 LH.	M16x1.5 LH.	M20x1.5 LH.
	$d_2^{H7}$	12	14	18	18	25
	$d_3$	16	18	25	32	40
	$d_4$	29.5	31.5	39.5	55.5	69.5
	$d_5^{j5}$	30	32	40	56	70
	$L_1$	56	73	93	125	141
	$L_2$	38.70	50.93	60.40	81.86	88.33
	$L_3$	8	10	20	10	20
	$L_4$	3	3	4	5	5
	$L_5$	12	12	12	12	15
	$L_6$	18	18	24	24	40
	$G_1$	M6 (4x)	M6 (6x)	M6 (8x)	M8 (8x)	M10 (8x)
	$T_1$	12	14	12.5	17	17
alpha	-	0°	15°	15°	15°	
beta	35°	35°	45°	45°	45°	
Slide dimensions	A	88	109	136	168	210
	B	40	56	70	90	110
	C	14	14	19	22	24
	E	30	36	52	66	90

Dimensions in mm.

Ordering example:



Standard programme TOOLTRONIC® / facing heads

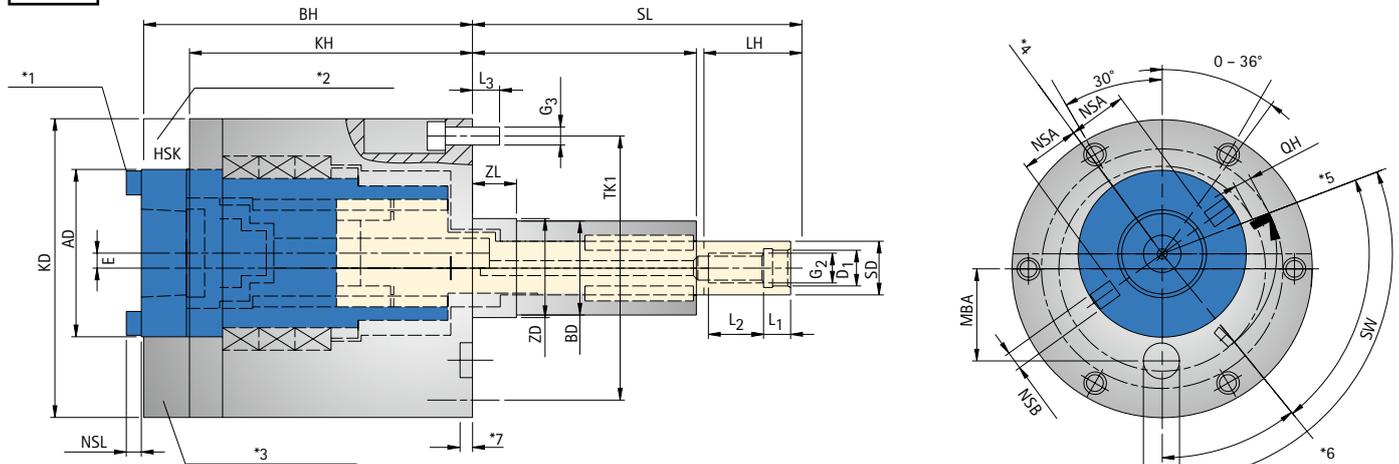
Tool adapter is tailored to the specific customer.

Examples for the design of the tool adapter

Flange connection	HSK	ABS
<ul style="list-style-type: none"> <li>- Short, stable mounting tool</li> <li>- Only indexable inserts are changed</li> </ul>	<ul style="list-style-type: none"> <li>- Tool can be changed quickly and pre-set</li> <li>- High changeover accuracy</li> </ul>	<ul style="list-style-type: none"> <li>- Tool can be changed quickly and pre-set</li> </ul>

# FACING HEAD

## Round slide with eccentric actuation – EAT



- \*1 Driving element drawn offset
- \*2 Balance weight tool restriction
- \*3 Balance weight for mounting tool
- \*4 Wrench access high driving element HSK
- \*5 Insert end position / rod pulled
- \*6 End position / rod pressed
- \*7 Deep driving element (7 mm)

### Models, round slide with eccentric actuation – EAT

EAT-085-032-HSK-C32   EAT-100-050-HSK-C40   EAT-125-080-HSK-C50   EAT-160-125-HSK-C63   EAT-200-200-HSK-C80   EAT-280-320-HSK-C80

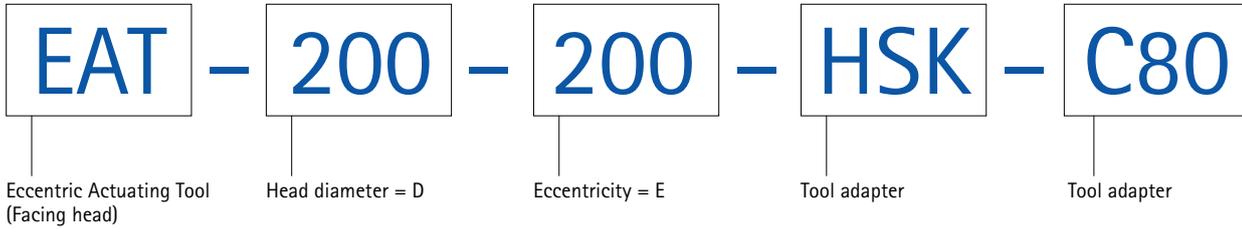
Primary dimensions	AD	55	60	70	90	110	110
	KD	85	100	125	160	200	180
	KH	85	98	111	129	149	177
	BH	95	113	131	154	180	203
	E	3.2	5	8	12.5	20	32
	QH	3.7	5.9	9.4	14.7	23.5	37.6

Connection sizes, sleeve and rod dimensions with thread	LH	22.4	28.8	36	44.8	56.8	72
	BD	28.8	32.4	39.6	50.4	63	81
	BL	69	83	98	18	145	178
	SD	16	18	22	28	35	45
	SL	97	118	140	168	208	256
	D <sub>1</sub> <sup>H7</sup>	11	13	16	20	22	25
	L <sub>1</sub>	12.5	13.8	16	19	20.5	22.8
	G <sub>2</sub>	10x1	12x1.5	14x1.5	18x1.5	20x1.5	22x1.5
	L <sub>2</sub>	12.5	15	17.5	22.5	25	27.5

Connection sizes, spindle dimensions	ZD	30	35	45	60	80	100
	ZL	10	14	19	25	35	50
	TK1	74	88	110	145	182	260
	G <sub>3</sub>	M5	M6	M8	M8	M10	M12
	L <sub>3</sub>	7.5	9	12	12	15	15
	MBD	9	14.7	14.7	16.6	16.6	24
	MBA	35	40	52	68	88	100

Slide dimensions	NSB	6	8	10	12	16	16
	NSA	16	20.5	25.5	32	40.5	50
	NSL	4	4	5	6	8	8
	SW	72	72	72	72	72	72
	HSK	C32	C40	C50	C63	C80	C80

Ordering example:



Actuating force at maximum spindle speed and cutting depth 2 mm

EAT085	5000 N
EAT100	5000 N
EAT125	7500 N
EAT160	7500 N
EAT200	9000 N
EAT280	9000 N

Standard programme  
TOOLTRONIC® / facing heads

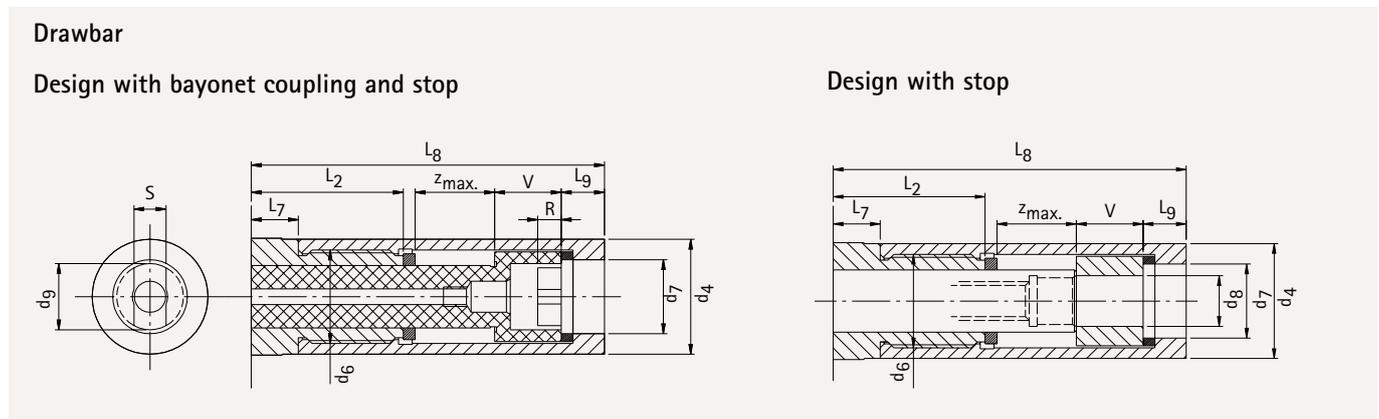
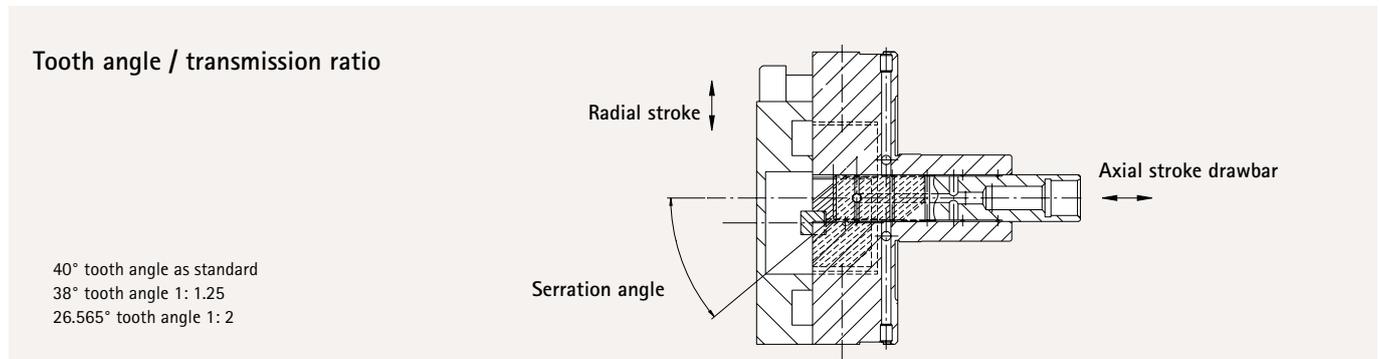
Examples for the design of the tool adapter

**HSK-C connection**

- Standard EAT without internal cooling
- Maximum spindle speed dependent on the design of the mounting tool
- All mounting tools used are balanced and adjusted to the same weight
- Central lubrication through drawbar
- Non-linear actuation can be compensated via controller
- EAT heads in special designs on request

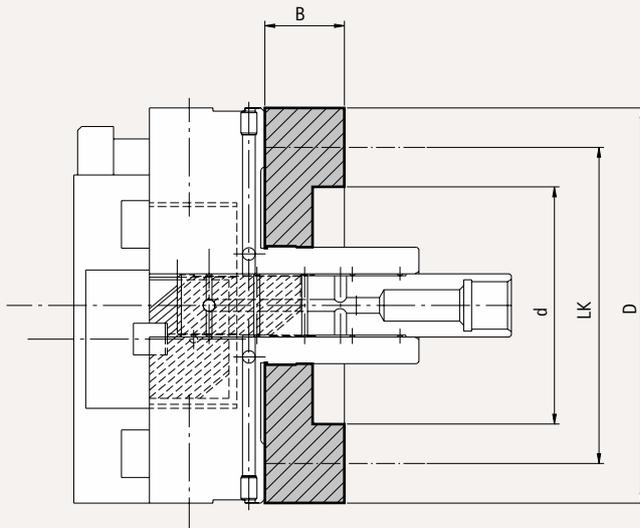
# CUSTOMER-SPECIFIC MODIFICATIONS

The following variants are available to suit the machining task and the prerequisites on the machine.



Models for special drawbar designs											
		d <sub>6</sub>	d <sub>7</sub>	d <sub>8</sub>	d <sub>9</sub>	L <sub>7</sub>	L <sub>8</sub>	L <sub>9</sub>	V	S	R h <sub>6</sub>
LAT 1	LAT-080-1-10	M24x1.5	19	13	17	8	74	11	17	8.2	6
	LAT-100-1-17	M24x1.5	19	13	17	12	90	11	17	8.2	6
	LAT-125-1-22	M27x1.5	19	15	17	18	105	13	19	8.2	6
	LAT-160-1-32	M33x1.5	26	19	21	20.5	133	13	27	10.2	10
	LAT-200-1-40	M45x1.5	33	19	26	32.5	172	15	32	12.2	10
	LAT-250-1-50	M56x1.5	41	26	33	38	210	19	38	15.2	12
LAT-320-1-63	M56x1.5	41	26	33	36	225	19	38	15.2	12	
LAT 2	LAT-080-2-10	M24x1.5	19	13	17	8	74	11	17	8.2	6
	LAT-100-2-17	M24x1.5	19	13	17	12	90	11	17	8.2	6
	LAT-125-2-22	M27x1.5	19	15	17	18	105	13	19	8.2	6
	LAT-160-2-32	M33x1.5	26	19	21	20.5	133	13	27	10.2	10
	LAT-200-2-40	M45x1.5	33	19	26	32.5	172	15	32	12.2	10
	LAT-250-2-50	M56x1.5	41	26	33	38	210	19	38	15.2	12
LAT-320-2-63	M56x1.5	41	26	33	36	225	19	38	15.2	12	
LAT C	LAT-100-C-12	M24x1.5	19	13	17	12	84	11	17	8.2	6
	LAT-125-C-16	M27x1.5	19	15	17	18	105	13	19	8.2	6
	LAT-160-C-24	M33x1.5	26	19	21	30	133	13	27	10.2	10
	LAT-200-C-32	M45x1.5	33	19	26	42	172	15	32	12.2	10
	LAT-250-C-40	M56x1.5	41	26	33	38	198	19	38	15.2	12

Intermediate flanges for standardised spindle heads and for special spindles are available on request.



$D$  = Flange diameter  
 $LK$  = Pitch circle diameter  
 $d$  = Centre diameter  
 $B$  = Flange thickness





# LINE BORING BARS

---

Design | Accessories | Applications



Line boring bars

# LINE BORING BARS

## Design and accessories

Line boring bars are tools for the special machining of bearing journals in housings. During this process the tool is guided by at least one guide bearing in the fixture (workpiece clamping). Several inserts in the tool permit the simultaneous machining of several journals. An optional drawbar/push rod makes possible additional face machining at the related journal and/or cutting edge lifting to compensate for cutting edge wear.

Line boring bars are used for machining crankshaft and camshaft bores. They are considered the most accurate way of manufacturing these bores in the crankcase.



### Design



#### Connections

- All common standard connections that can be changed quickly as well as flange modules can be combined with line boring bars
- Standard: HSK-A, HSK-C, SK, ABS, BT, CAT
- Customer-specific flange modules

#### Facing slides / tilting holders

- Facing slides for machining the crankshaft thrust bearing
- Tilting holder for cutting edge wear compensation and a score free run out from the bore

#### Holder systems

- Finely adjustable cartridge with indexable insert for every application
- ISO-KKH (ISO cartridge)
- FA-KKH (fine adjustable cartridge)
- EFA-KKH (external fine adjustable cartridge)
- Tool bit
- Holder systems can be straightforwardly set to the  $\mu$

#### Vibration dampers

- Corresponding design of vibration dampers in line boring bars with critical length/diameter ratio
- Reduction / elimination of residual vibration
- Protection of the cutting edges due to low-vibration machining
- Longer tool life



Line boring bars

Accessories



Caliper gauges

- Setting gauges and master gauges for setting custom tools
- Modular system
- Fast setting in the machine



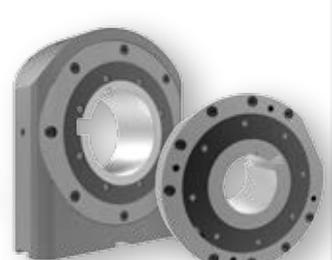
Fixtures

- Measuring fixtures and setting tables
- Setting adapters
- Adjusting wrenches



Floating holders / floating chucks

- Compensation of the offset on machine spindle in relation to bearing packages
- Spindle and tool connections are adapted to suit the specific customer



Bearing packages

- Bearing packages are used to support the line boring bar
- High accuracy due to very tight fit tolerances on bearing ring and line boring bar
- Preferably roller bearings, or alternatively plain bearings
- Locking and unlocking the bearings by means of an external hydraulic device or by means of self-locking bearing inner ring

# Slide boring bar with drawbar/push rod

## Applications



### Crankshaft bearing bore car crankcase

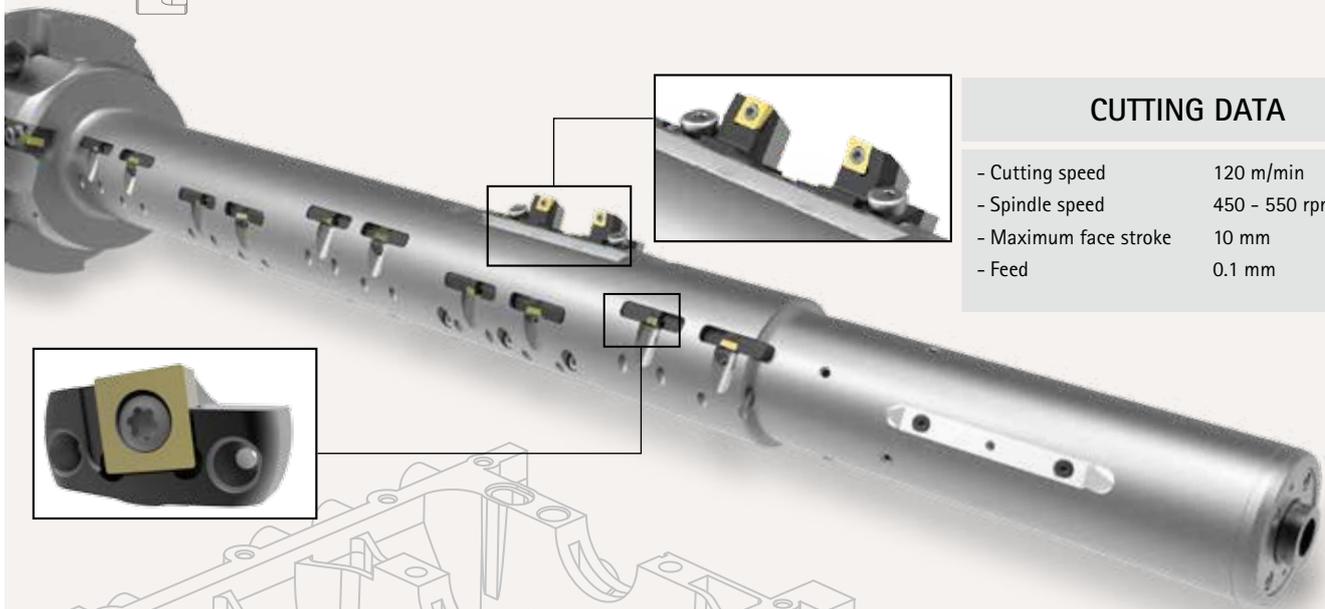
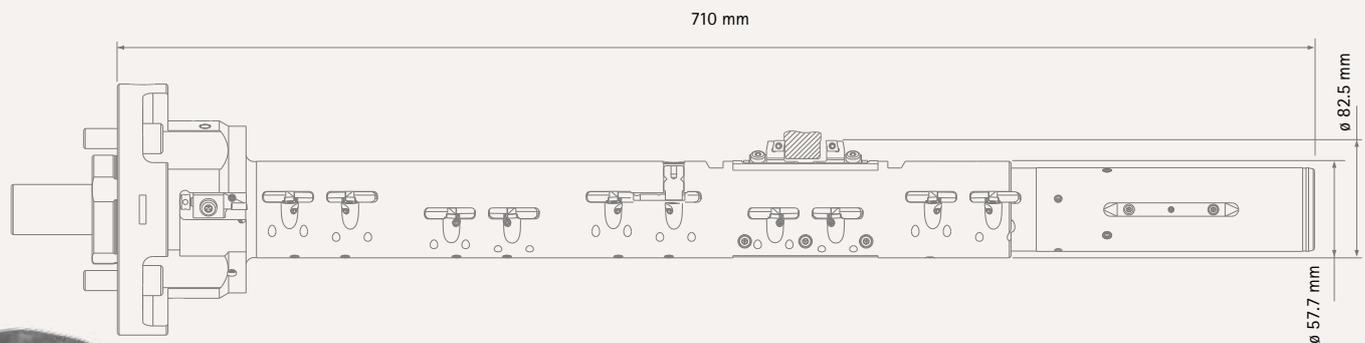
#### TASK:

- Machining bearing journals and thrust bearing seat with appropriate tolerances and short cycle time.

#### SOLUTION:

The diameter machining is undertaken in two machining steps. Simultaneous roughing of all bearing journals with subsequent finish machining.

The thrust bearing seat is machined using the same slide boring bar by face turning using the actuated facing slide. In this way very good surface quality and significantly faster machining is achieved compared to milling.



#### CUTTING DATA

- Cutting speed	120 m/min
- Spindle speed	450 - 550 rpm
- Maximum face stroke	10 mm
- Feed	0.1 mm

#### FEATURES

- Combination of journal and thrust bearing machining
- Integrated slide for thrust bearing machining
- Exact, simplified setting of the inserts using FA-KKH

#### ADVANTAGES

- High accuracy due to support in aligned guide bearings

# Line boring bar with floating holder

## Applications



### Crankshaft bearing bore HGV crankcase

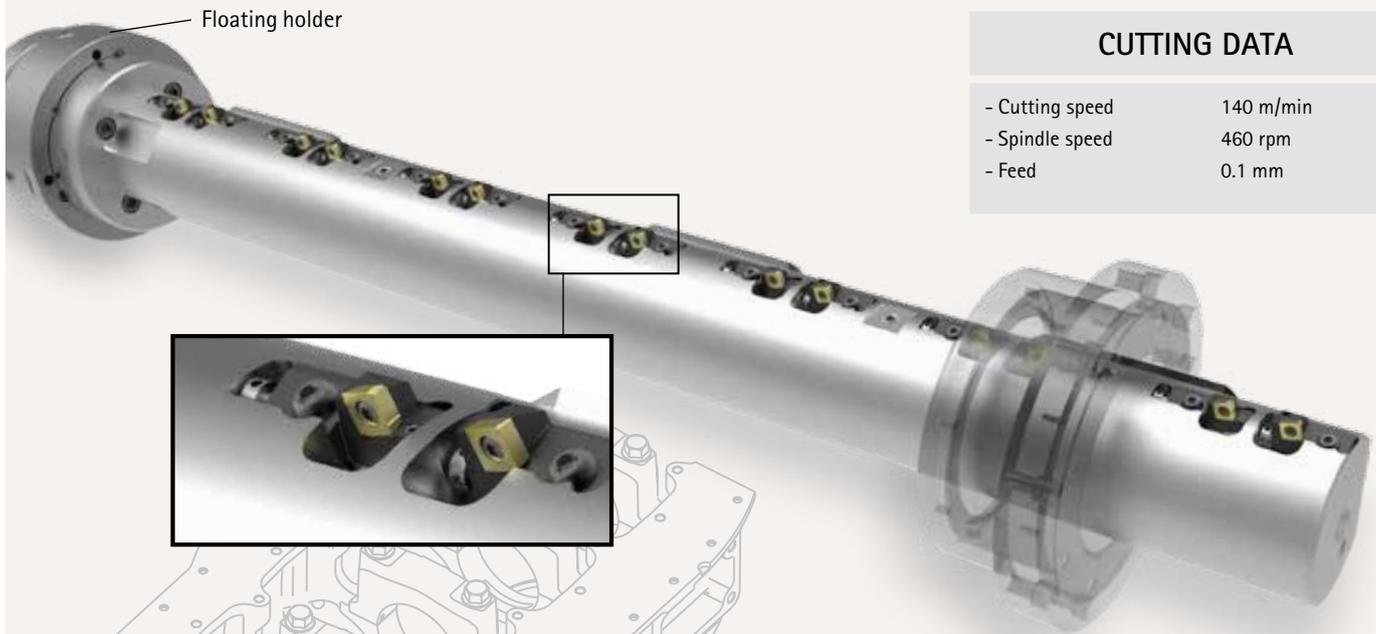
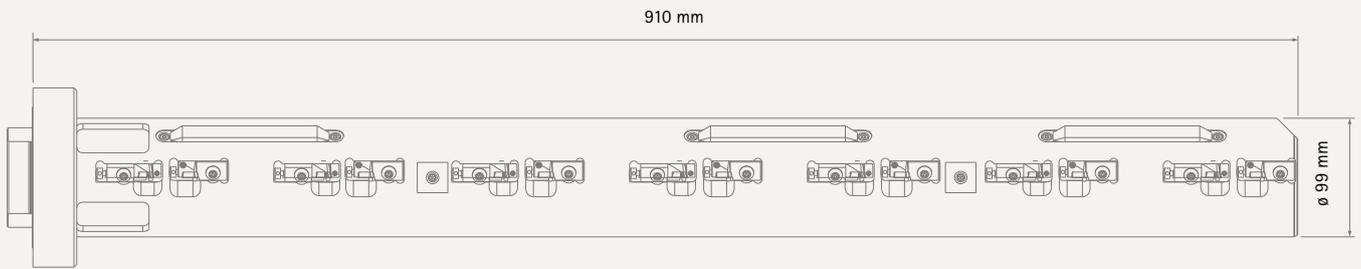
**TASK:**

- Process-capable machining of the bearing journals with tight tolerance dimensions and short cycle time.

**SOLUTION:**

The machining is undertaken on a transfer machine with several bearings. During this process the crankcase is raised, the line boring bar inserted in the bearing packages, and then the crankcase lowered again.

The bearing journals are then pre-machined and finish machined. A floating holder compensates for a possible offset between the machine, fixture and crankcase.



CUTTING DATA	
- Cutting speed	140 m/min
- Spindle speed	460 rpm
- Feed	0.1 mm

Line boring bars

#### FEATURES

- Accuracy of the boring bar stems from the fixture aligned in relation to the workpiece

#### ADVANTAGES

- Very high accuracy due to bearing packages exactly matched to the line boring bar
- MAPAL supplies all components
- Reduction of the machining time due to simultaneous machining of all journals

# Line boring bar with integrated bearing packages

## Applications



### Camshaft bearing bore HGV crankcase

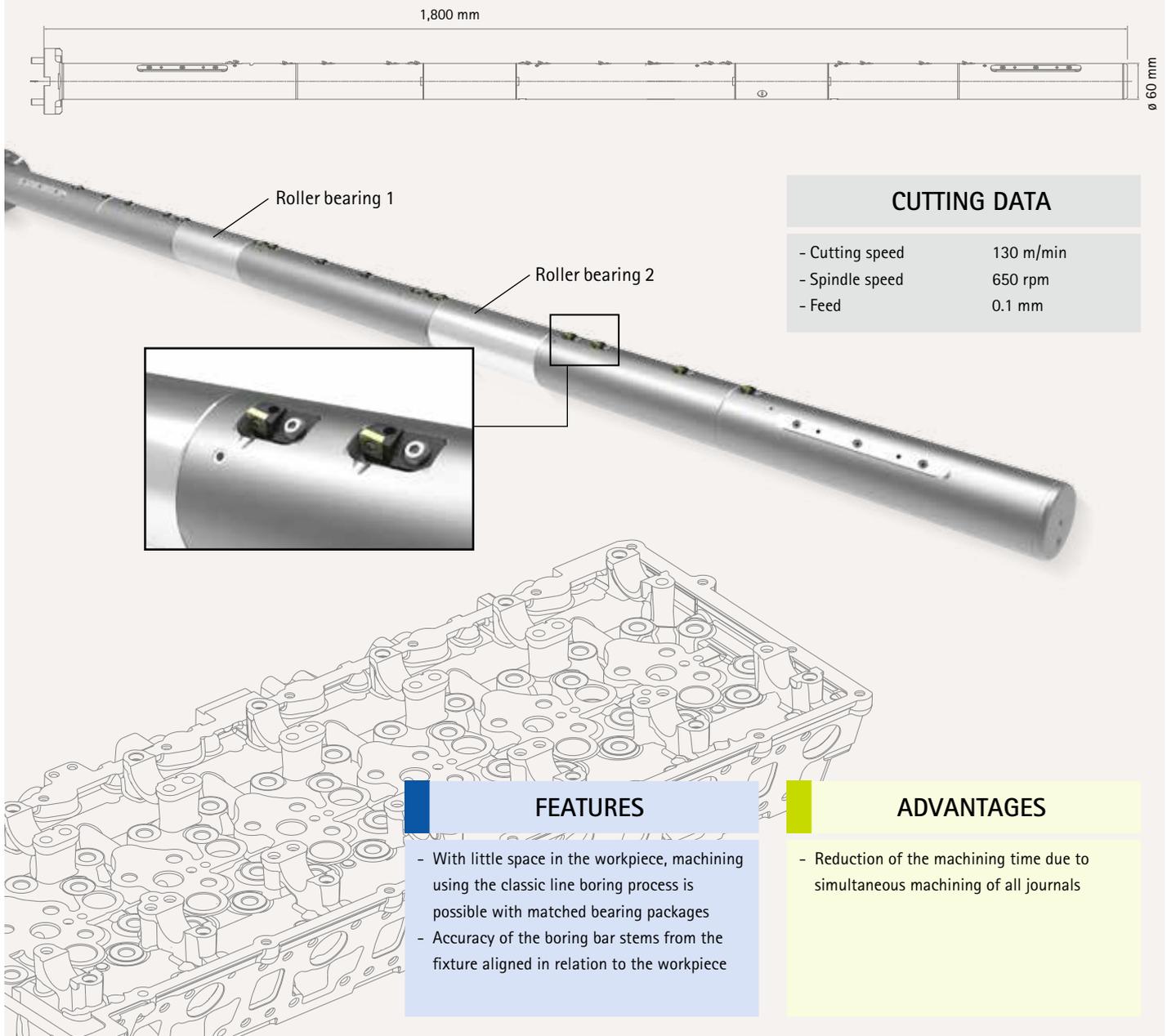
#### TASK:

- Machining an extra-long camshaft bearing bore with the required shape and position tolerance. Due to the part geometry, support using roller bearing mounted bearing packages is not possible.

#### SOLUTION:

The roller bearing mounted support is integrated into the line boring bar, in this way a space-saving fixed ring on the fixture can be used in the part. The machining

is undertaken using the classic line boring process: running in and out of the bearings with workpiece offset from the middle. Semi-finishing and finishing inserts are used simultaneously.



#### CUTTING DATA

- |                 |           |
|-----------------|-----------|
| - Cutting speed | 130 m/min |
| - Spindle speed | 650 rpm   |
| - Feed          | 0.1 mm    |

#### FEATURES

- With little space in the workpiece, machining using the classic line boring process is possible with matched bearing packages
- Accuracy of the boring bar stems from the fixture aligned in relation to the workpiece

#### ADVANTAGES

- Reduction of the machining time due to simultaneous machining of all journals

# Line boring bar with tool bits

## Applications



### Camshaft bearing bore car crankcase

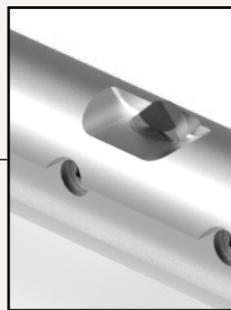
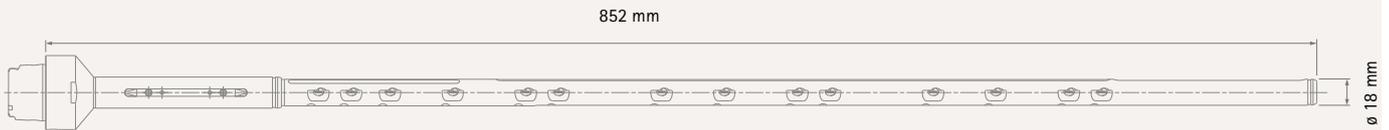
**TASK:**

- Machining a camshaft bearing bore with very large diameter/length ratio and particularly tight shape and position tolerances.

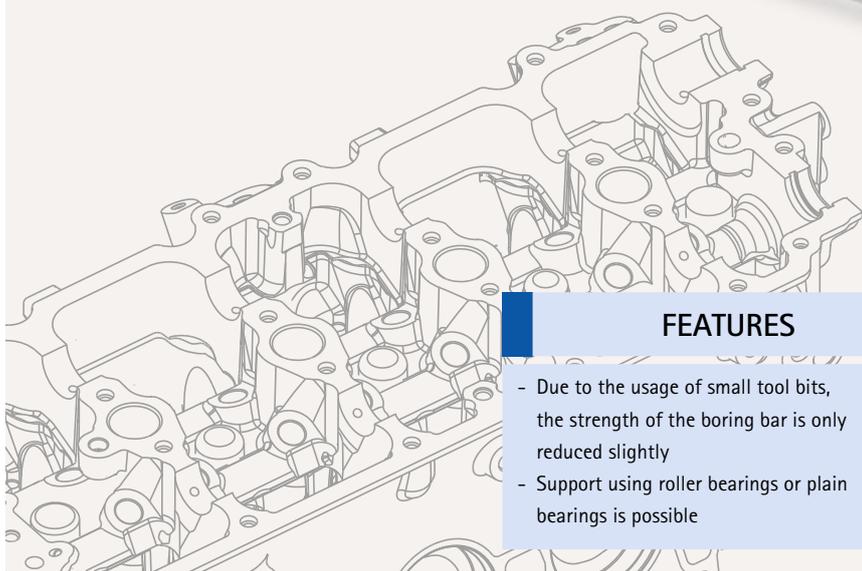
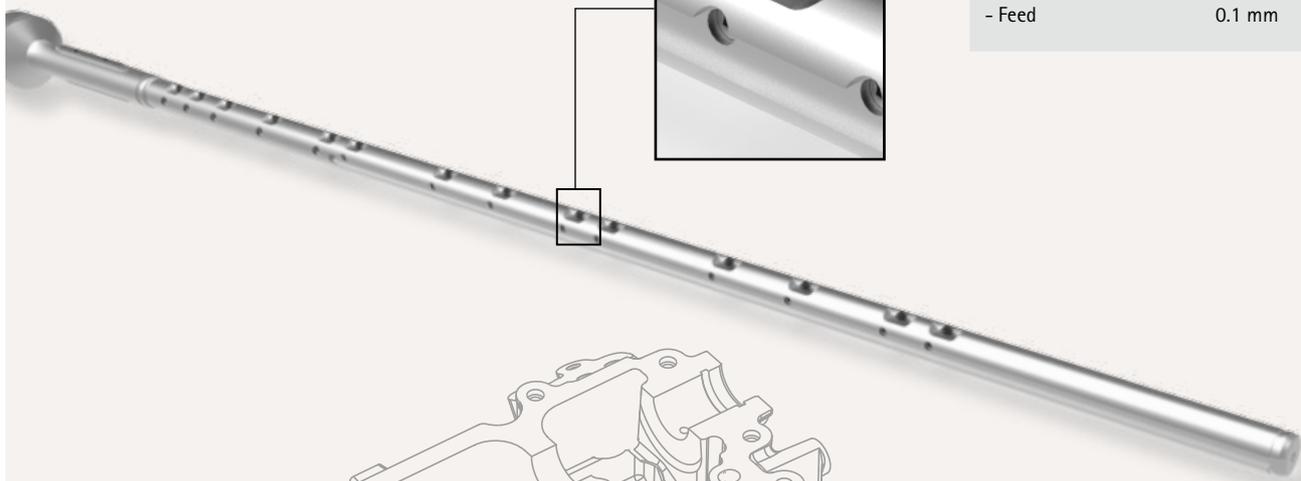
**SOLUTION:**

Due to the small tool diameter (little space), tool bits are used. The tool is mounted on the spindle using an HSK-C connection and supported via several bearing packages.

Prior to machining, the part is raised and the line boring bar run into the fixture's bearing packages. As a consequence of the very tight space envelope, these packages are designed as plain bearings.



CUTTING DATA	
- Cutting speed	100 m/min
- Spindle speed	1,500 rpm
- Feed	0.1 mm



**FEATURES**

- Due to the usage of small tool bits, the strength of the boring bar is only reduced slightly
- Support using roller bearings or plain bearings is possible

**ADVANTAGES**

- Despite long length very good straightness of the bore is achieved due to multiple bearings and perfectly aligned line boring bar.





# OTHER APPLICATIONS

---

Wobble tools | Interpolation turning

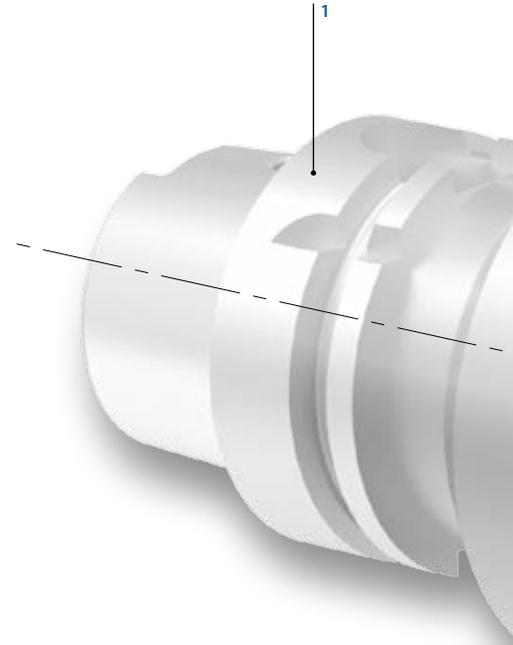
# WOBBLE TOOLS

## Manufacture of internal and external profiles



MAPAL wobble tools make possible the cost-effective manufacture of internal and external profiles that is also gentle on the machine. A wobble movement is generated by the rotation of the wobble bar. Due to this wobble, only the point on these tools is used and therefore

the load is also only on the point. The feed force required is significantly lower than during the conventional broaching and shaping process and therefore reduces the load on the machine tool's feed unit.



Programming example, helical slot:

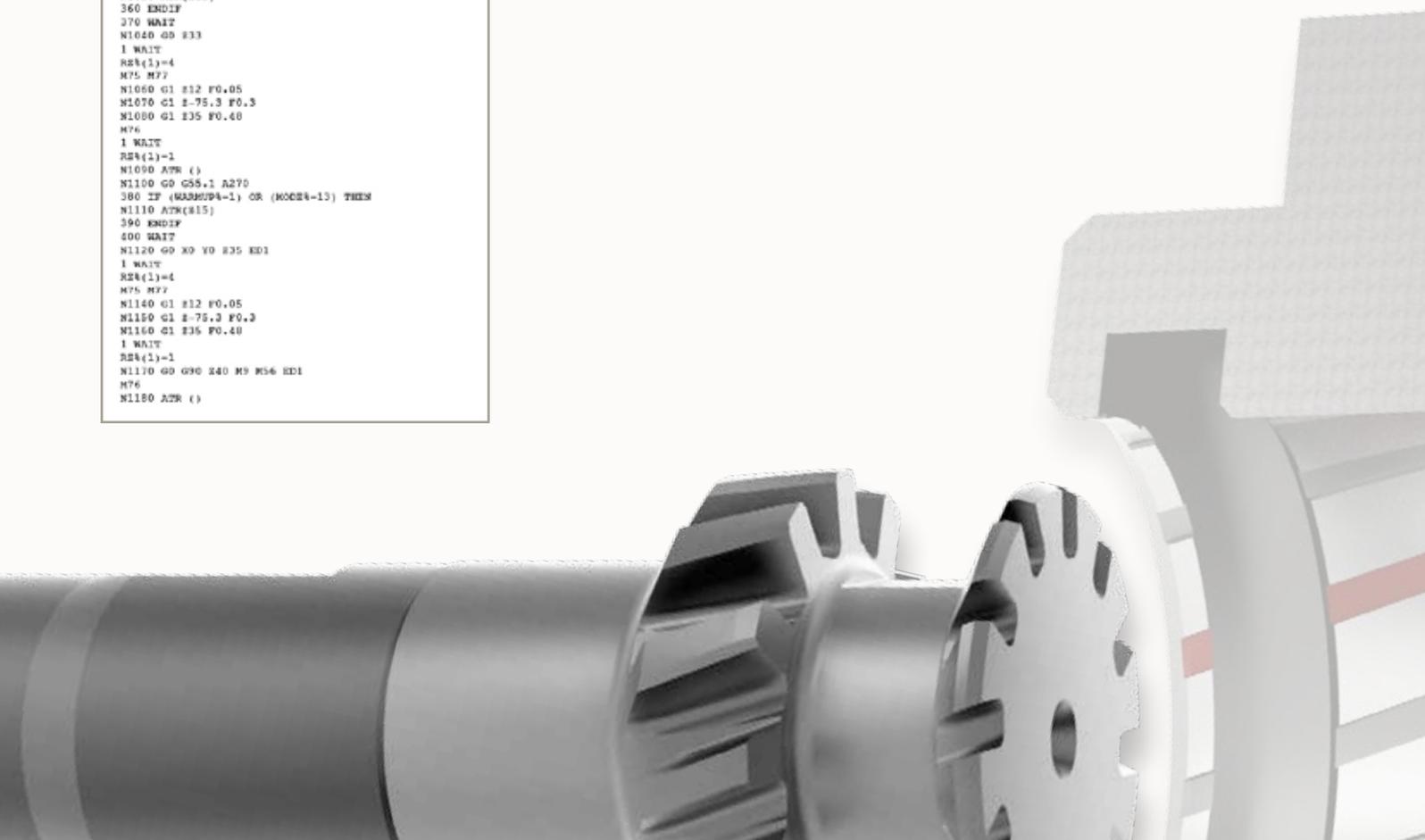
```
***** HELIX GROOVE D24.26 *****
R24(1)=1
N1000 WAK(A)
M300 S11=20 M7 MB
N1010 G0 G54.1 A270 G0 G62 G71 G95 X0 Y0 Z40 G47 ED1
340 WAIT
350 IF (WARMUP4=1) OR (MODE4=24) THEN
N1020 ATR(R15)
360 ENDIF
370 WAIT
N1040 G0 Z33
I WAIT
R24(1)=4
M75 M77
N1060 G1 Z12 F0.05
N1070 G1 Z-75.3 F0.3
N1080 G1 Z35 F0.40
M76
I WAIT
R24(1)=2
N1100 ATR ( )
N1100 G0 G55.1 A270
380 IF (WARMUP4=1) OR (MODE4=13) THEN
N1110 ATR(R15)
390 ENDIF
400 WAIT
N1120 G0 X0 Y0 Z35 ED1
I WAIT
R24(1)=4
M75 M77
N1140 G1 Z12 F0.05
N1150 G1 Z-75.3 F0.3
N1160 G1 Z35 F0.40
I WAIT
R24(1)=1
N1170 G0 G90 Z40 M9 M56 ED1
M76
N1180 ATR ( )
```

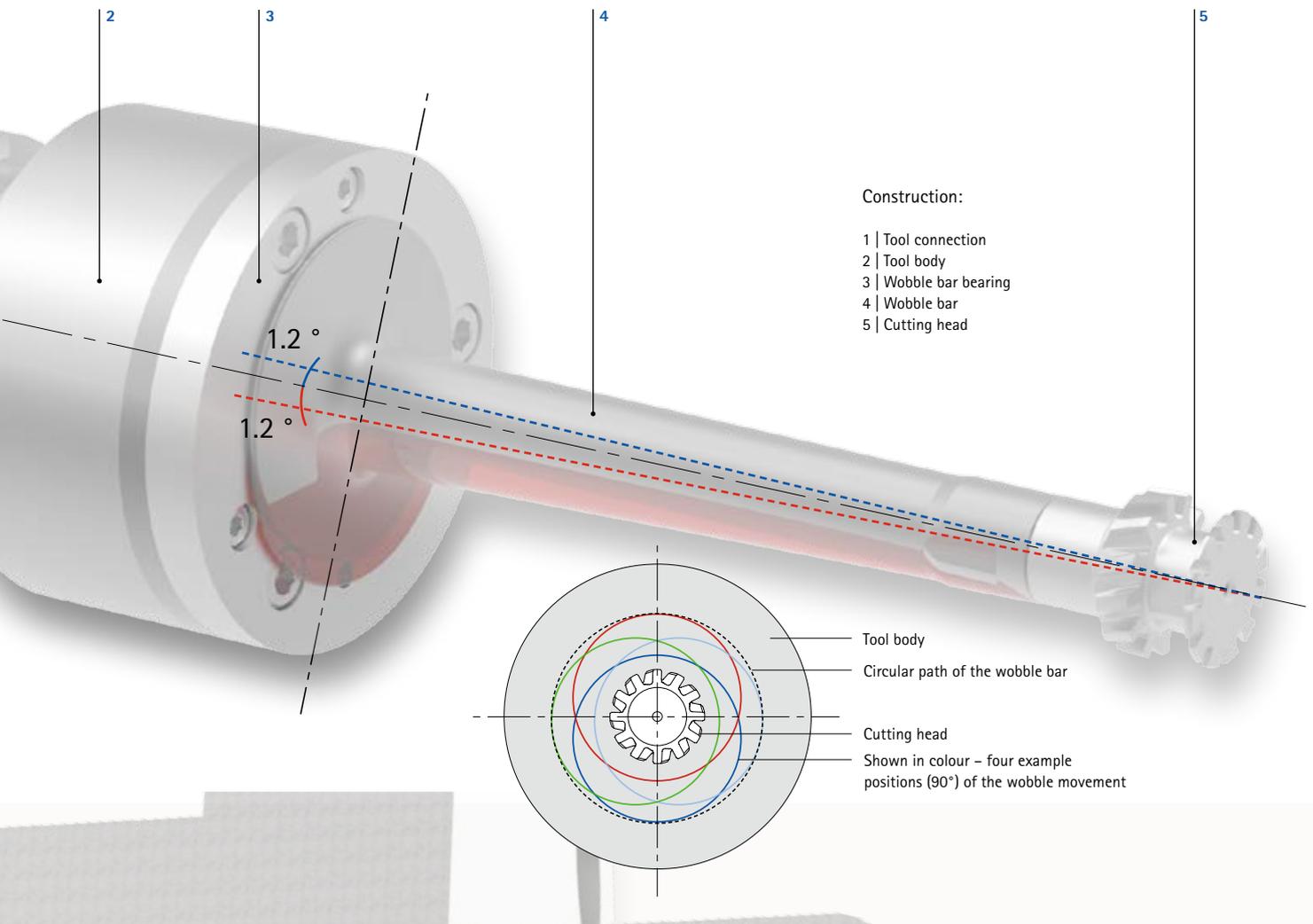
### FEATURES

- Wobble angle always 1.2°
- Distance face surface / fit of the tool head to wobble point always 18 mm

### ADVANTAGES

- Complete profile machining in one machining step
- Low feed force
- Machining that is gentle on the machine





# INTERPOLATION TURNING

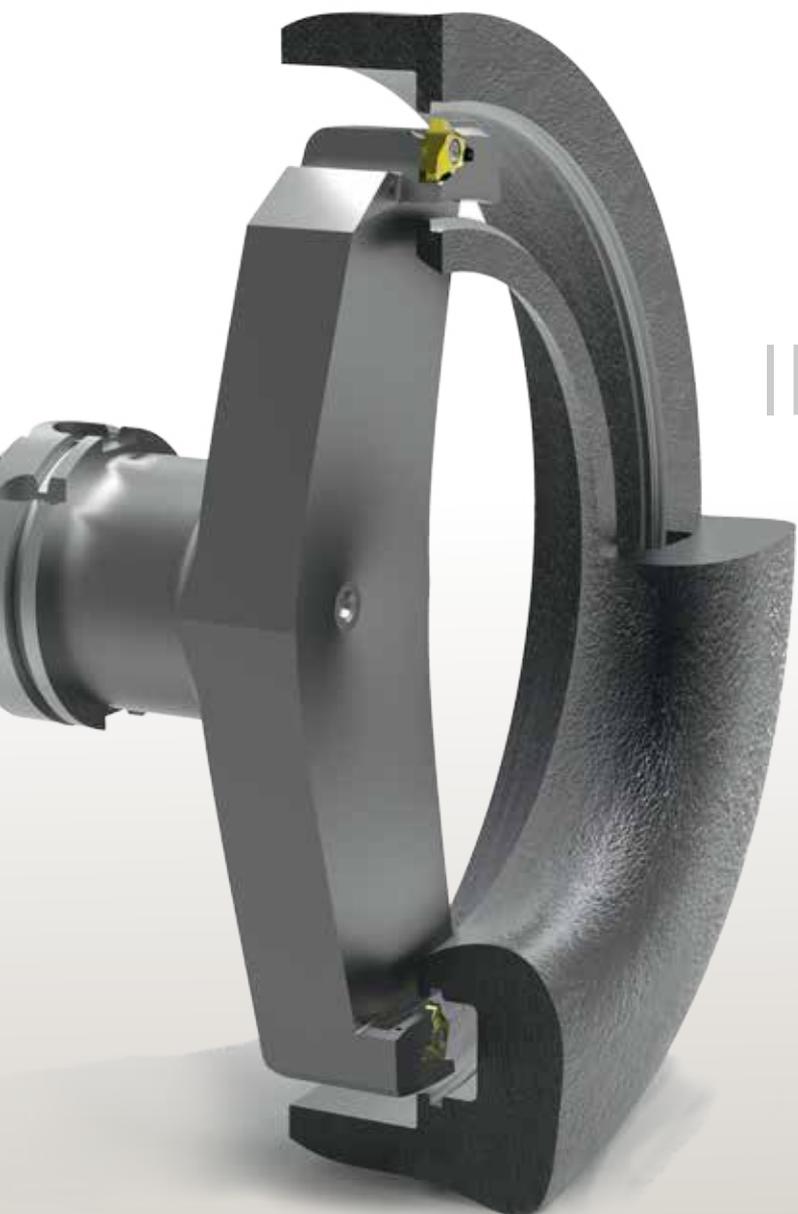
## Turning process on machining centres



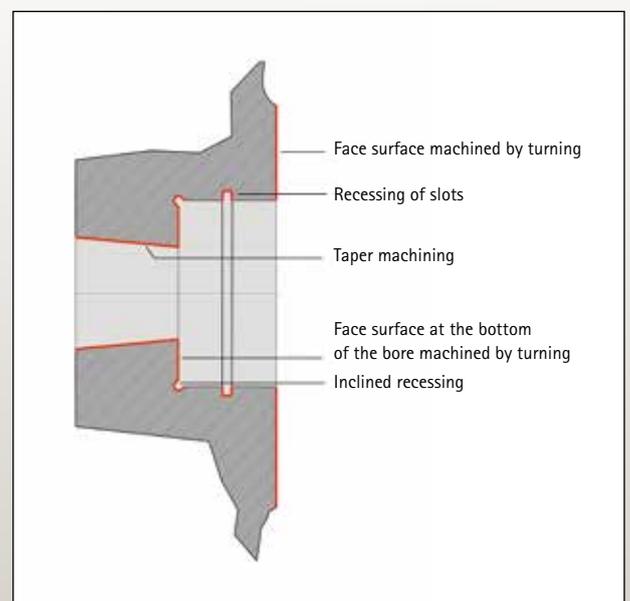
Interpolation turning is a machining process that can be used to realise turning processes on machining centres. It is used, for example, for recesses on cubic workpieces that are otherwise produced using circular milling. However, many other geometries typical for turning, for example the taper form, can also be

produced using interpolation turning on machining centres.

An important prerequisite for the use of this process is that the machine has a main spindle that can be operated as a position-controlled axis.



FACE SURFACE  
TAPER SURFACE  
GROOVES  
INCLINED RECESS



**Function:**

For interpolation turning the main spindle on the machining centre is switched to position-controlled operation (also called axis operation). It can then be operated like a rotating axis.

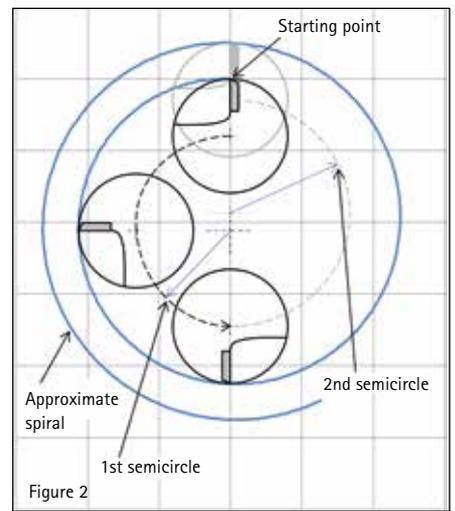
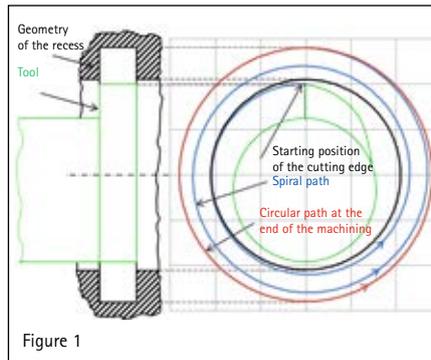
During recessing or facing on lathes, the cutting edge forms a spiral as it moves toward the workpiece. Here the feed per revolution is the pitch of the spiral. This spiral movement is normally approximated during interpolation turning on machining centres using

semicircles, i.e. the feed axes move in a semicircle (in the x-y plane) during circular interpolation and at the same time the main spindle is synchronised to the movement of the feed axes (Figure 1). The centres of the semicircles are slightly displaced in relation to the central axis of the recess. The result is movement of the cutting edge that is very similar to the spiral during conventional turning on lathes.

The maximum error on the radius of the path actually covered compared to the spiral is around 5 percent of the radial feed per revolution. At a feed of 0.15 mm the maximum error compared to the spiral is therefore approx. 7.5 µm.

Figure 1: Orientation of the tool synchronised to the position in the xy plane

Figure 2: Tool movements during interpolation turning (spiral, circular path)



**FEATURES**

- Chipping thickness and cutting force are constant
- Machining recesses, grooves for sealing rings, relief grooves and rotary machining of face surfaces (for example hydraulic valve housing, swivel bearings, gearbox housings, brake calipers)
- Short, compact tools
- Machining stepped diameters using one insert
- Combination of milling/facing tool and interpolation tool

**ADVANTAGES**

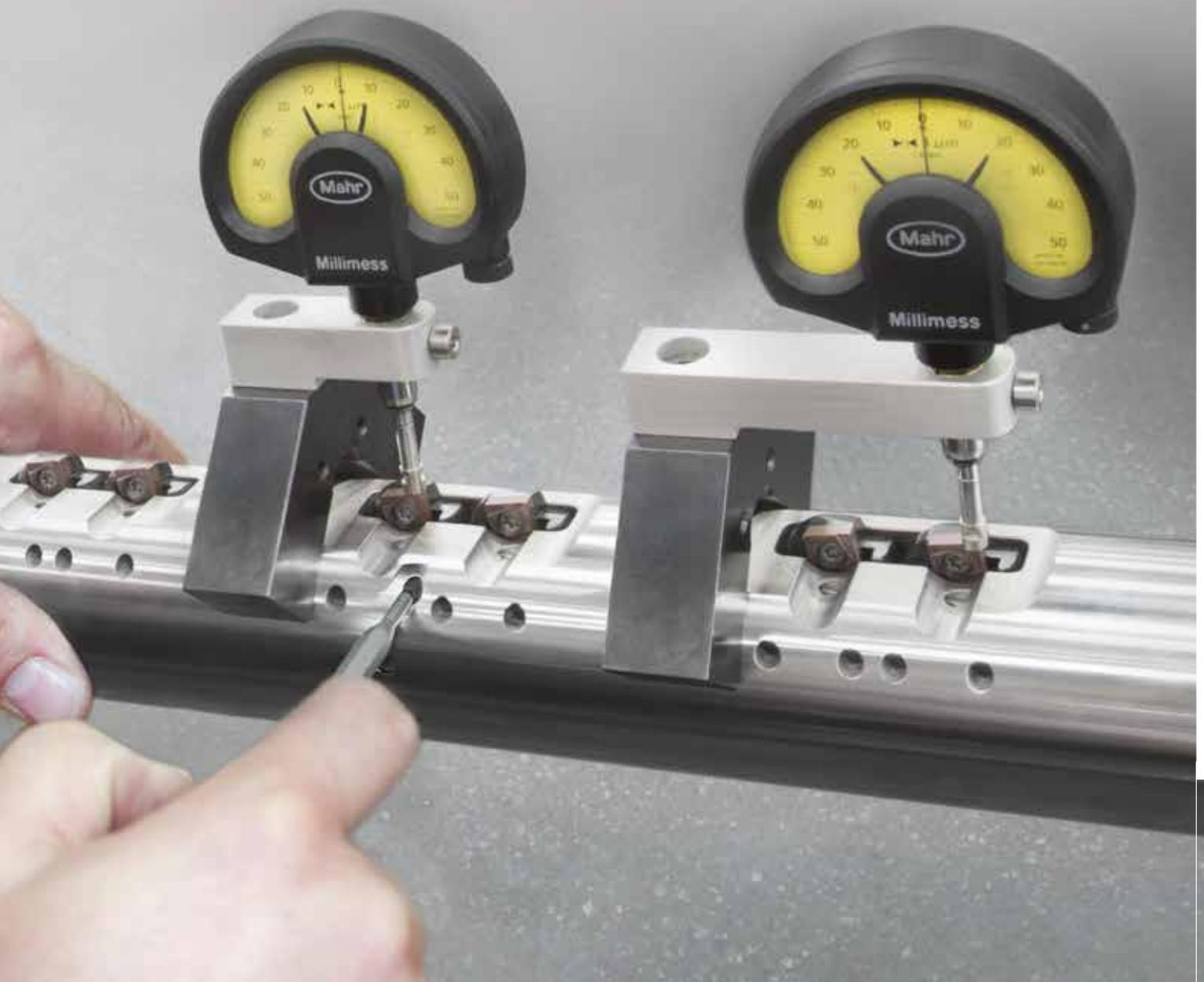
- Low-vibration machining compared to milling
- Machining time shorter than for circular milling
- Higher material removal rate
- High process reliability
- Higher tool stiffness compared to circular milling



# SERVICES

---

Service process | Service contracts | Maintenance intervals



# SERVICE FOR ACTUATING TOOLS

Everything from a single source

## ENGINEERING DESIGN COMMISSIONING MAINTENANCE

In the actuating tool sector, MAPAL offers comprehensive advice on the entire product portfolio.

During initial conversations the requirements on the machining process are recorded by the salesperson so that a tailored product can be offered to the customer.

As a specialist for custom solutions, customer-specific modifications are also

offered using standardised components. To be able to plan maintenance deadlines and to reduce the service costs, it is possible to conclude a tailored service contract (see page 119).

The MAPAL service team checks the tools at a defined maintenance interval.

### YOUR ADVANTAGES

- Reduced overall operating costs
- Constant machining quality and process reliability
- Increased service life





## MAINTENANCE PROCESS

### MAXIMUM OPERATING HOURS REACHED

Maintenance of the tool is necessary



### MAKE CONTACT, COLLECTION OR SHIPMENT

Shipment of the actuating tools to MAPAL



### DETAILED INSPECTION

Disassembly of the tools and analysis of the actual condition



### AGREEMENT AND QUOTATION

Definition of the maintenance effort with subsequent preparation of a quotation including delivery date.



### MAINTENANCE AND REPAIR

Repair and maintenance after customer approval



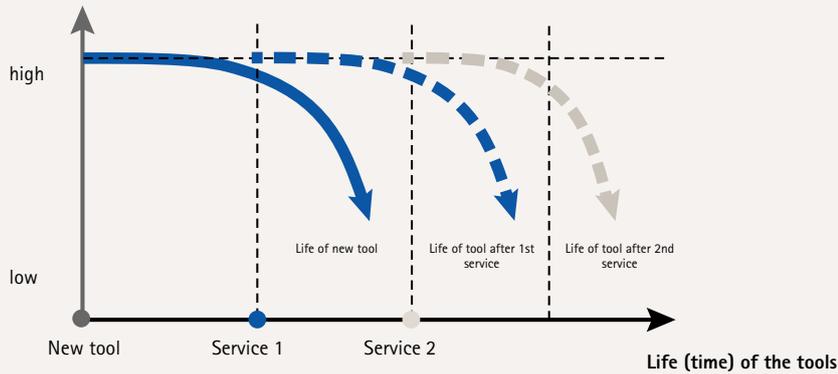
### RETURN SHIPMENT

Punctual return shipment of the tool to the customer

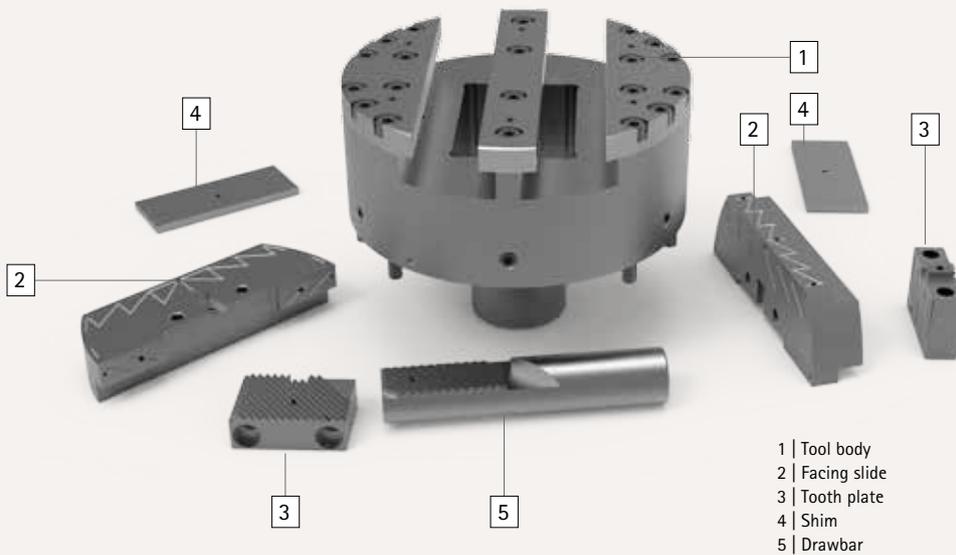
# SERVICE FOR ACTUATING TOOLS

## Maintenance intervals

### Quality and accuracy



### Facing head in detail



### Tool wear based on the example of a facing slide



### Depending on the condition of the tool

- Scratches are removed
- Surfaces are refined
- Slide is re-adjusted
- Components are replaced
- Tool functions are tested





Type	Lubrication	Tools	Maintenance intervals* (general figure) (operating hours before maintenance)
TOOLTRONIC® LAT	Manual		4,000 – 5,000
TOOLTRONIC® EAT	Lubricated for life		4,000 – 5,000
Slide tools + facing heads with drawbar (LAT and EAT)	Central, automatic lubricating cycle		8,000 – 10,000
Actuating tools with contact stop	Manual		4,000 – 5,000
Tools actuated by coolant pressure	Manual		4,000 – 5,000

\* The general figures stated apply on compliance with the lubricating cycles in the tool documentation.

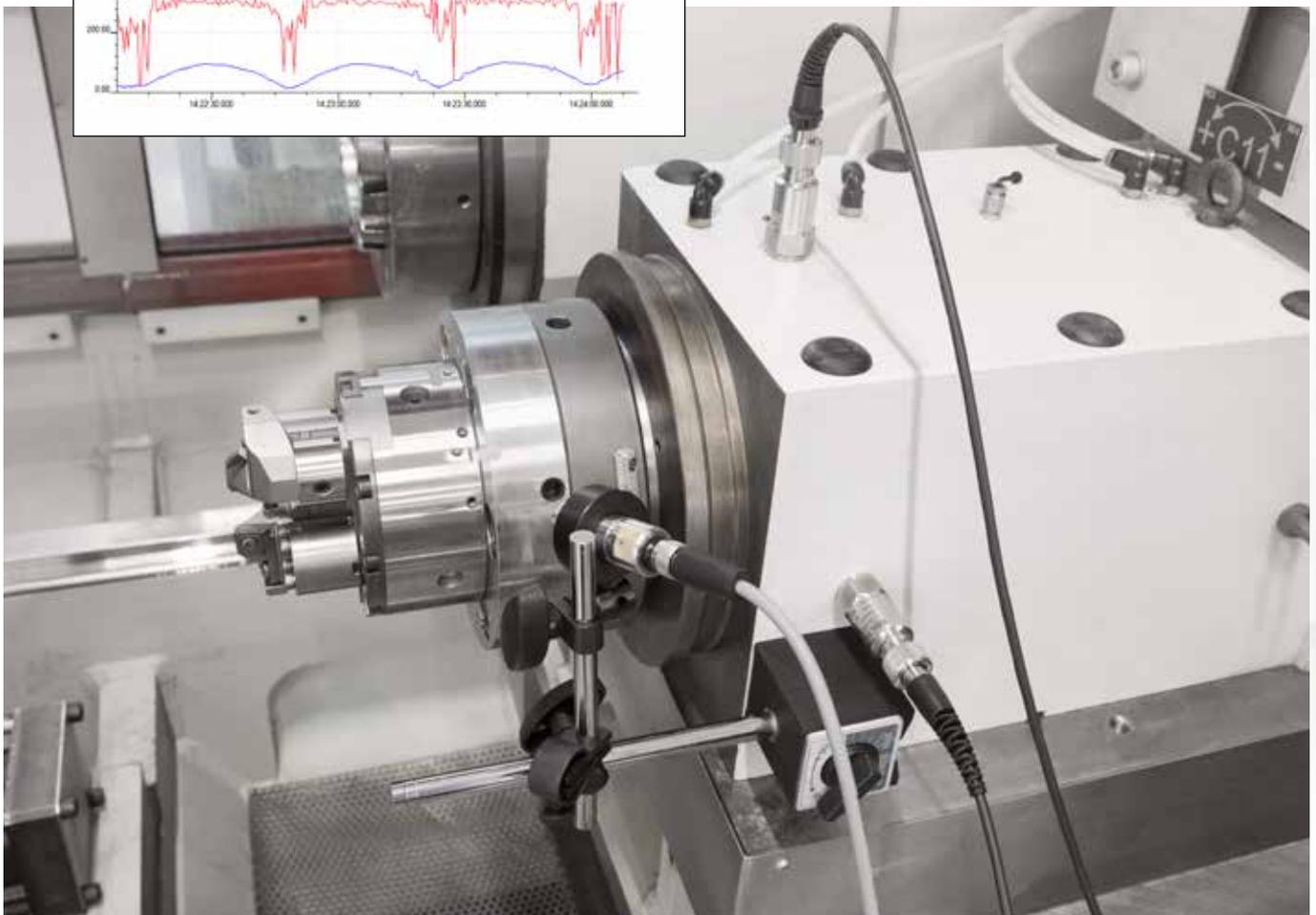
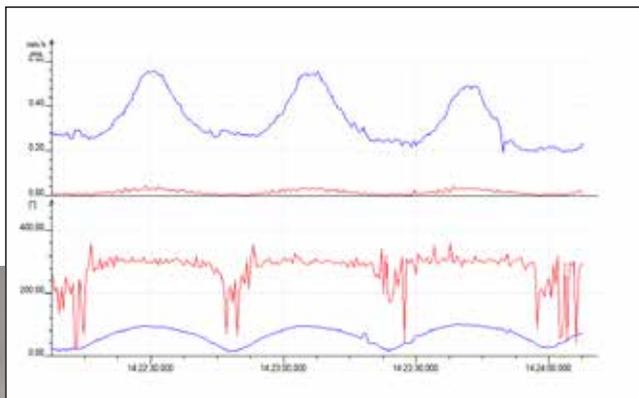
# SERVICE FOR ACTUATING TOOLS

## Balancing on-site and individual service contracts

MAPAL tools are balanced to the balancing quality required by the customer before delivery. To further improve the result of the machining, the complete "spindle / tool" system should be finely balanced after mounting the tool on the spindle.

Due to the reduced vibration after the fine balancing, the surface finish and the circularity on the workpiece are improved. In addition, the reduction of the vibration has a positive effect on the life of the inserts.

MAPAL offers this balancing on-site as a service. The complete system is analysed directly on the machine with the aid of a mobile balancing device and the vibration is reduced. Resonance analyses, for example the spindle speed range in which the spindle runs the quietest, are also possible. High machining quality and a stable process are ensured by this service.





## INDIVIDUAL SERVICE CONTRACTS

We would be pleased to prepare, with you, a service concept optimised to your specific needs. Our range of service models includes, for example, customer-specific maintenance contracts that cover all the costs for personnel and their travel expenses. For actuating tools you can conclude three types of service contracts:

### 1 BASIC

We maintain your various tools at intervals defined in advance. Here we also agree how the maintenance is undertaken with you in advance.

### 2 COMFORT

Upon request we also stock wearing parts defined together with you. In this way we can repair your tools significantly faster if they need service or repair.

### 3 COMPLETE

With your service contract, you can completely transfer to us not only the arising maintenance work, but also the logistics processing and the documentation of the maintenance.

MAINTENANCE OF THE TOOLS

■

■

■

SPARE PART STOCKING

-

■

■

LOGISTICS PROCESSING

-

-

■



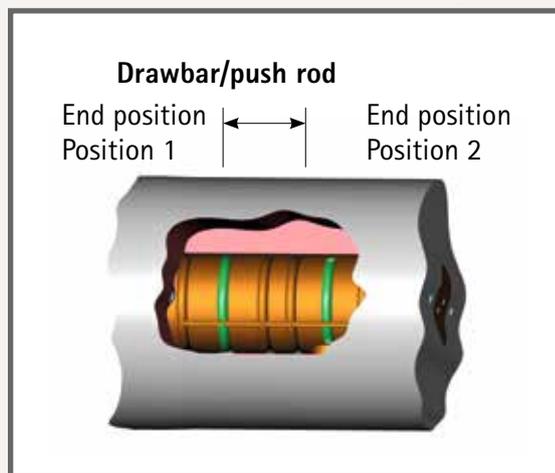
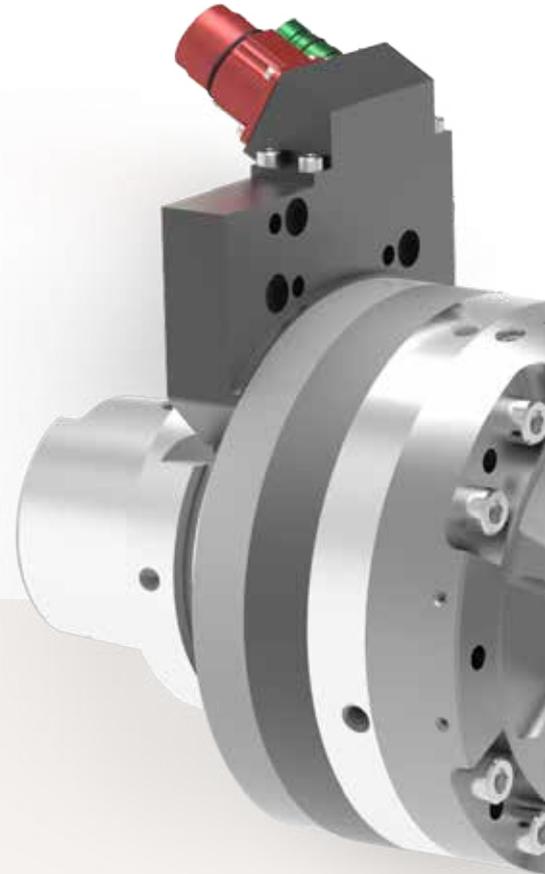
# TECHNICAL APPENDIX TOOLTRONIC®

---

Position monitoring | Data transfer | Machine preparation | Integration variants

# POSITION MONITORING

TOOLTRONIC-S® – actuating tools with end position control



## More certainty and less machining time

To be able to undertake cost-effectively difficult machining operations, such as recesses or turning relief on parts in large-scale production, custom tools with actuating functions are mostly used. These tools are mainly used on special machines that have the necessary features such as drawbars. The general trend is, however, away from the special machine toward modern, flexible machining centres. For this purpose MAPAL also offers innovative tool solutions that can implement actuating functions without an additional feed unit – tools actuated by coolant pressure or actuating tools with contact stop. The tools actuated by coolant pressure have the greatest potential here. This medium is available in almost all machining centres, with to some extent varying pressure levels. A disadvantage of the systems used up

to now is that there is no feedback as to whether the slide is extended or retracted. For increased safety, additional dwell times are programmed. However, these additional times increase the overall machining time and do not provide 100-percent certainty that the slide is in the correct position.

## TOOLTRONIC-S® for all slide tools

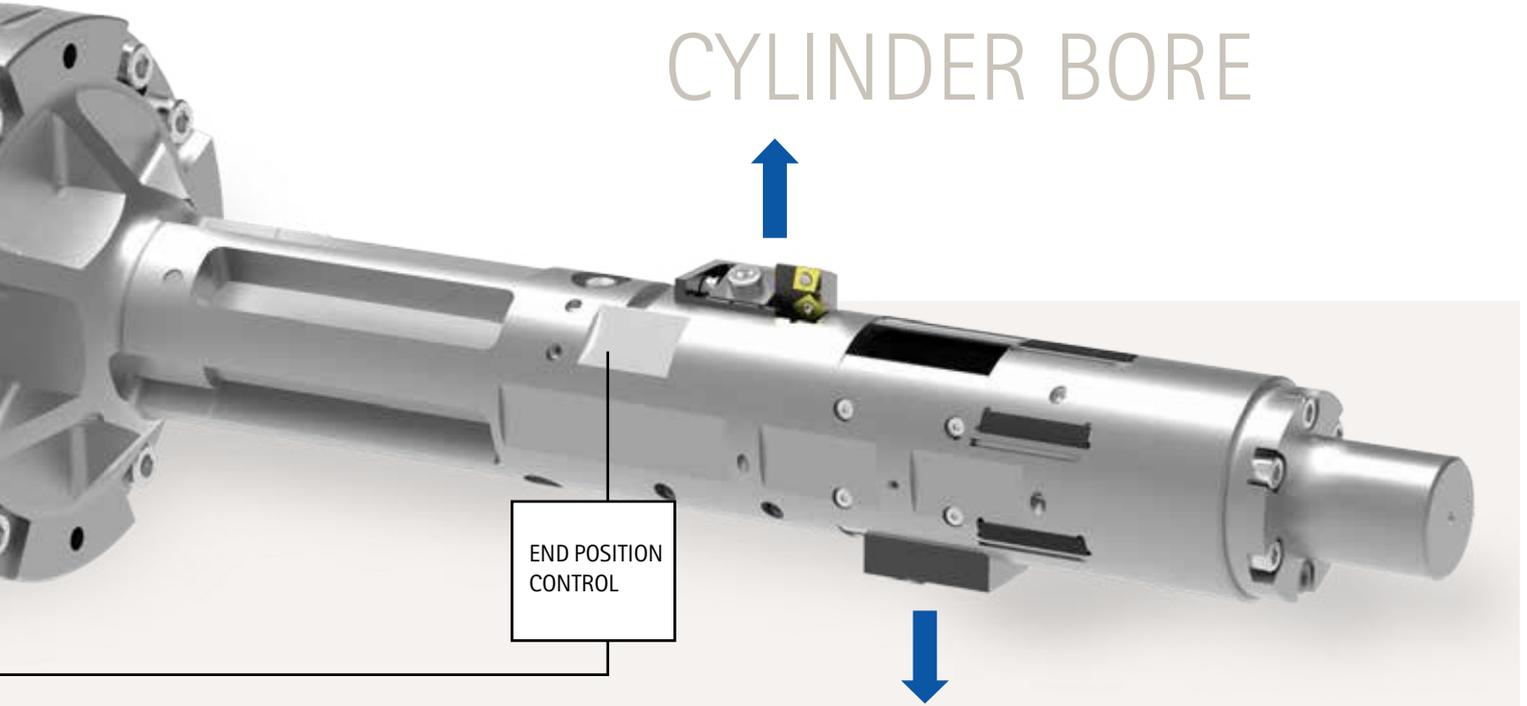
With this system the end positions are sampled independent of the related type of actuation. The information is transmitted to the machine's controller via sensors in the tool. The next block in the machine program can then be initiated immediately without any additional dwell time. Time savings of up to 20 seconds per machining cycle are the result. The MAPAL TOOLTRONIC stator is used for the connection between the tool and the machine. The inductive transmission of the data and the energy make the system very

reliable. An internal power supply (battery) in the tool, as for rf systems, is not required. The stator attached to the machine side can be used very easily for the operation of a fully configured TOOLTRONIC axis. It is then also possible to machine complete contours.

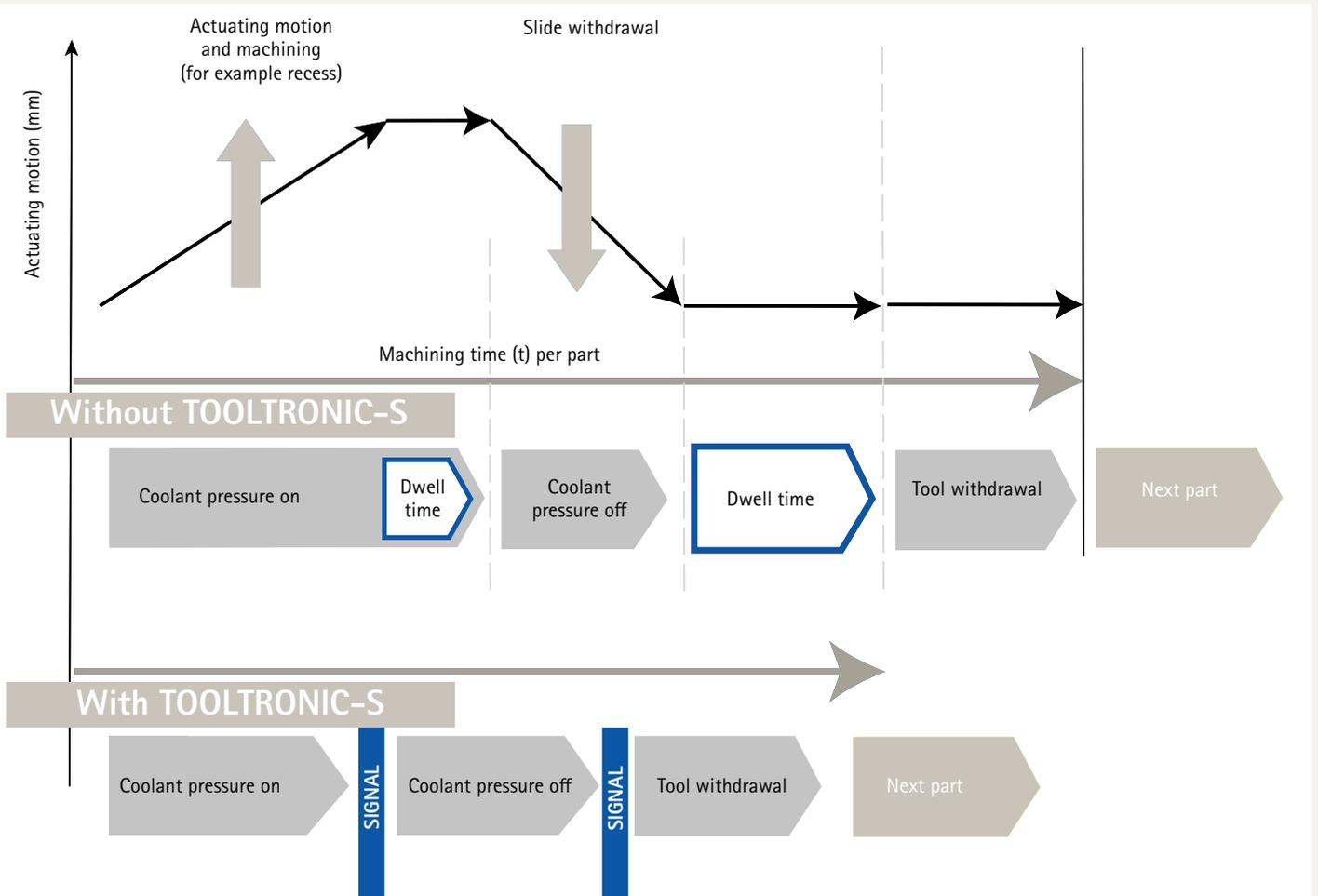
## ADVANTAGES

- Highest process reliability due to sampling of the end positions
- Time-saving (no dwell times)
- Possible to upgrade to TOOLTRONIC (contour machining)

# THRUST BEARING PISTON BORE CYLINDER BORE



The machining cycle without and with TOOLTRONIC-S®



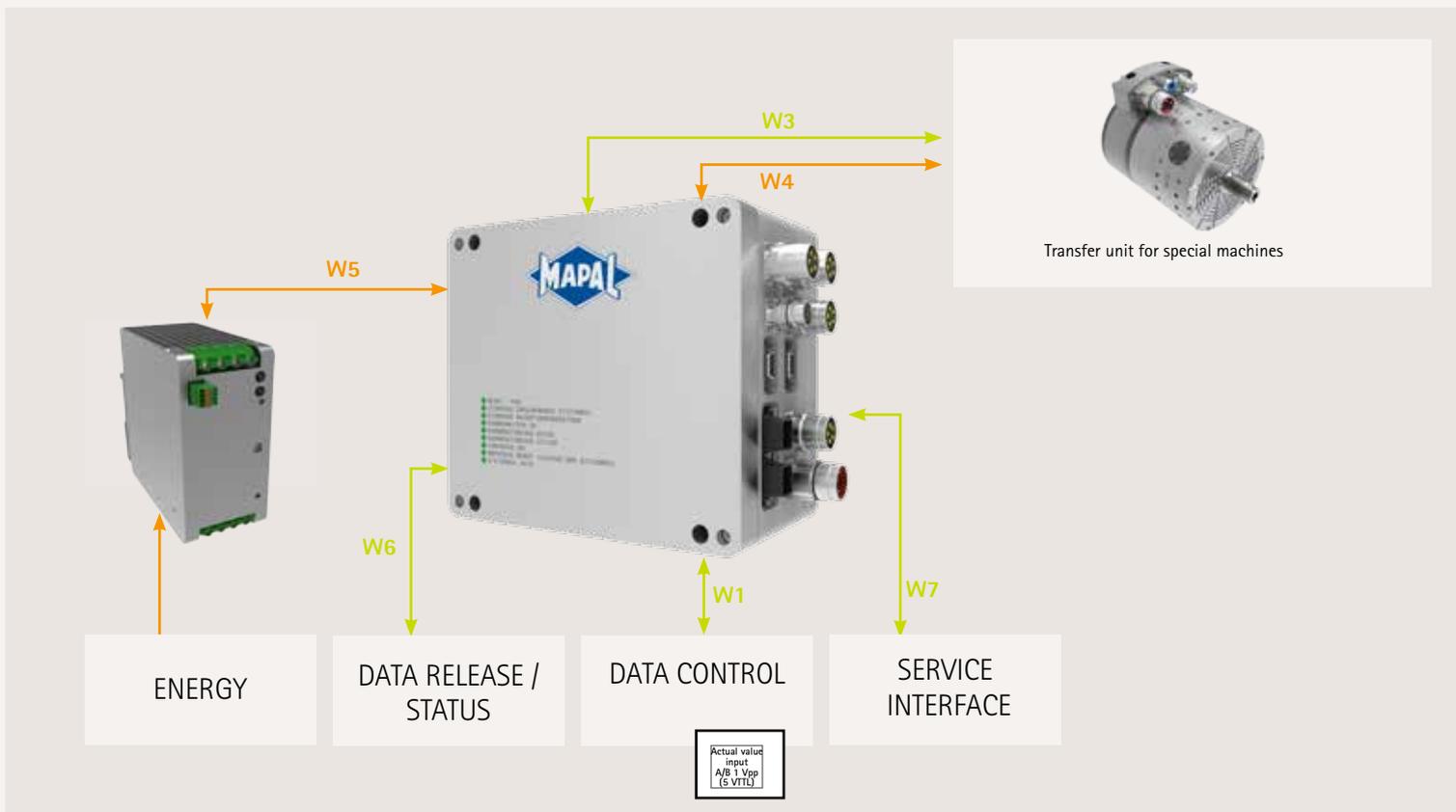
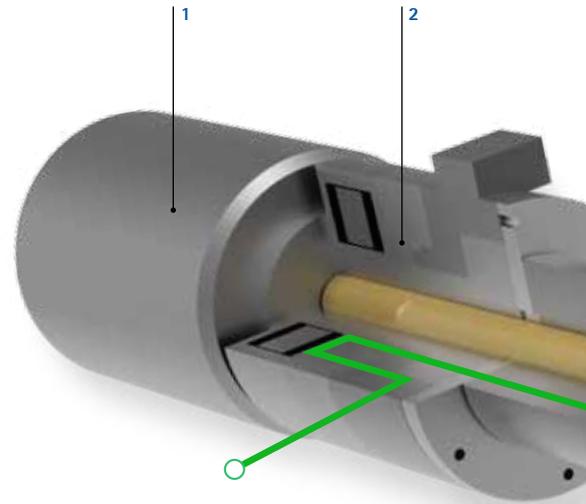
# DATA TRANSFER

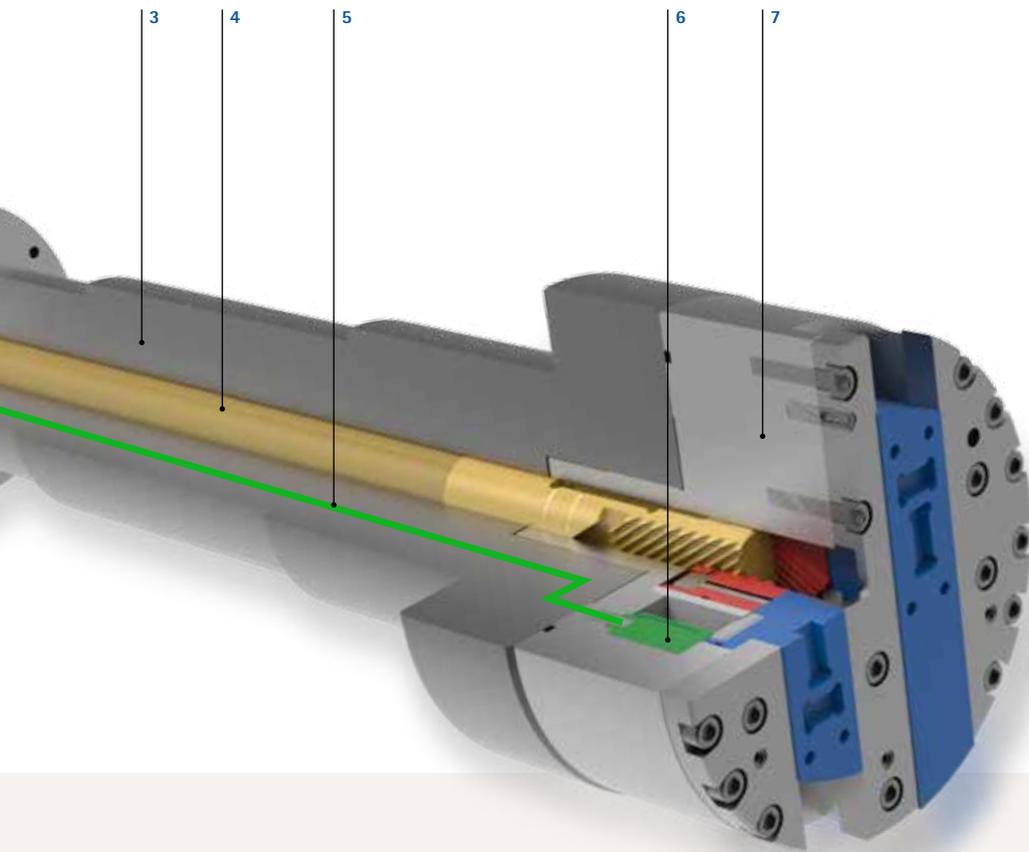
## Direct travel measurement in drawbar operated actuating systems



Actuating systems equipped with a measuring system are operated conventionally using a drawbar. The positioning accuracy is increased by a high-resolution measuring system directly attached to the slide. Mechanical tolerances on the drive elements as well as the thermal behaviour can be compensated in this manner. As a consequence machining accuracies are achieved that cannot be realised using mechanical actuating systems without a measuring system.

For the first time it is possible to measure the slide movement directly and therefore be directly controlled. The slide is moved using a drawbar via a drive on the machine. The signals measured are transmitted via non-contact energy and data transmission on the end of the spindle. Signal wires must be routed through the machine spindle to connect to the position measuring system.





Construction:

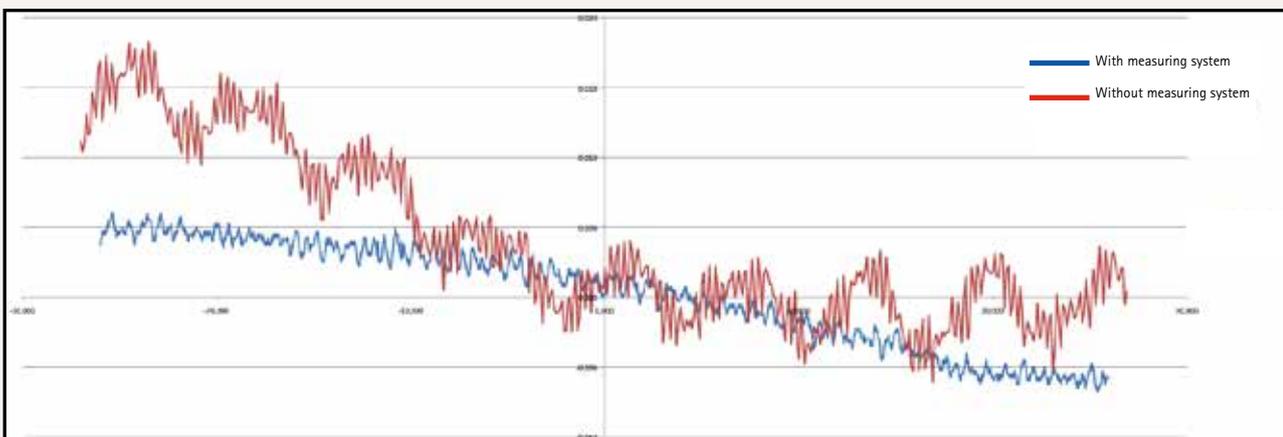
- 1 | Drawbar drive
- 2 | Transfer unit
- 3 | Spindle shaft
- 4 | Drawbar/push rod
- 5 | Signal wire
- 6 | Position measuring system
- 7 | LAT facing head

FEATURES

- Compensation of the reversing backlash also if there is a change due to wear
- Influence of wear on the machining quality is reduced

ADVANTAGES

- Direct measuring system on the slide increases the positioning accuracy and with it the machining quality
- Thermal expansion of the drawbar drive can be compensated
- Process capability is improved



Residual inaccuracies on mechanical actuating systems can be compensated by direct measurement at the slide.

# MACHINE PREPARATION

TOOLTRONIC® U axis – more certainty and less machining time



When a machine is procured, it is often not clear whether in future parts will be machined that it would be better to manufacture using an interchangeable U axis.

Subsequent full integration in machines already installed is considerably more expensive than prior integration of the U axis.

Minimum pre-installation costs give you the option of straightforwardly and

quickly equipping your machine tool with a U axis system. Thanks to standardisation of the technical interfaces, it is also possible to decide which U axis system best meets the requirements only on actual integration.

Stator / stator interchangeable part



U axis tool



STATOR BASIC MODULE

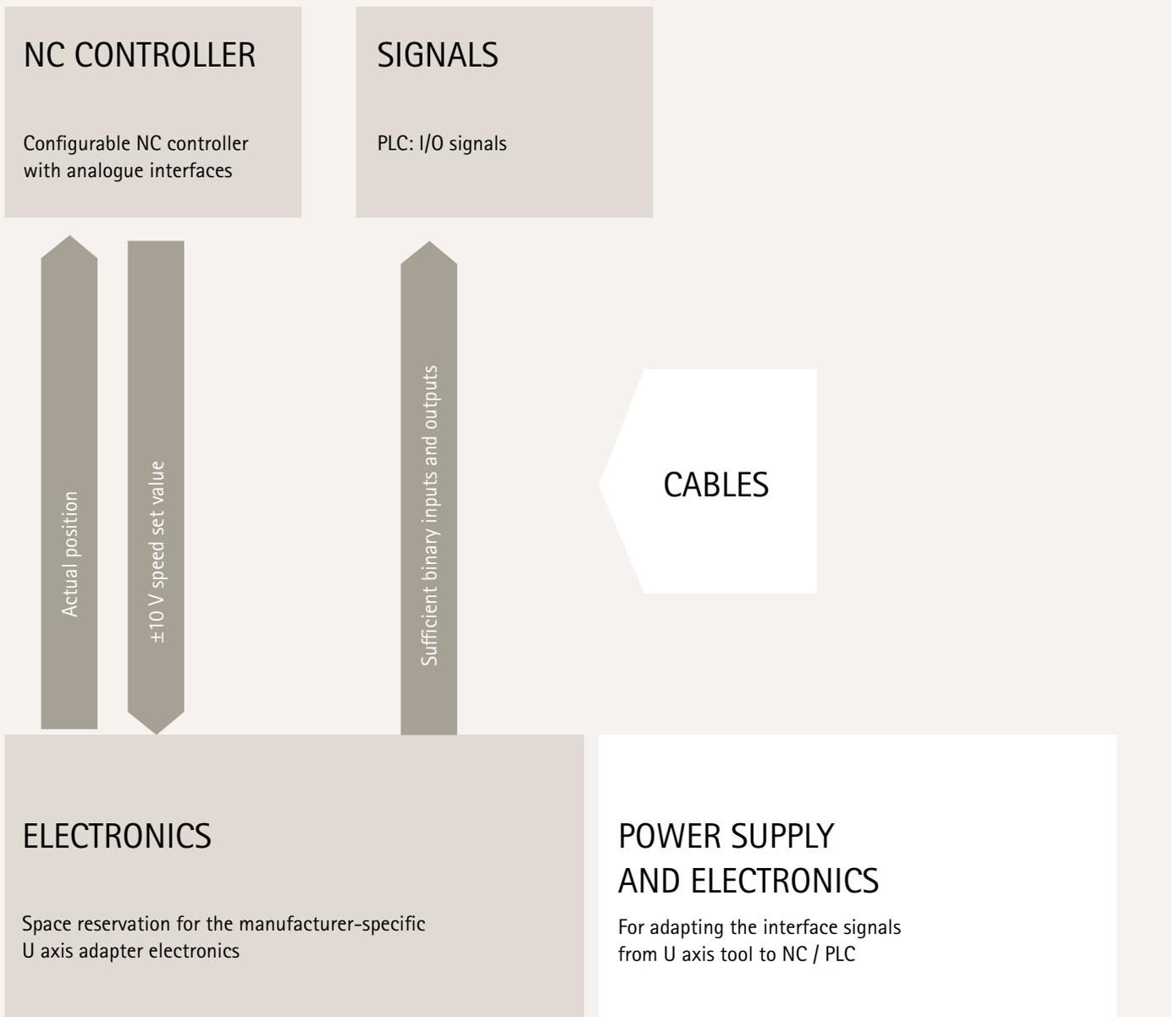
WIRING



Combox

For provisionally housing the cables between stator and U axis adapter electronics

FEATURES	ADVANTAGES
<ul style="list-style-type: none"> <li>- Machine manufacturer offers the preparation for a U axis system</li> <li>- Option for the individualisation of the machine</li> <li>- Expanded possibilities for machine tools</li> </ul>	<ul style="list-style-type: none"> <li>- Expansion options in the switch cabinet for manufacturer-specific electronic components</li> <li>- Expansion options for analogue module in the NC machine</li> <li>- Consideration of the U axis in the controller configuration</li> </ul>

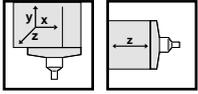


Machine preparation for U axis system

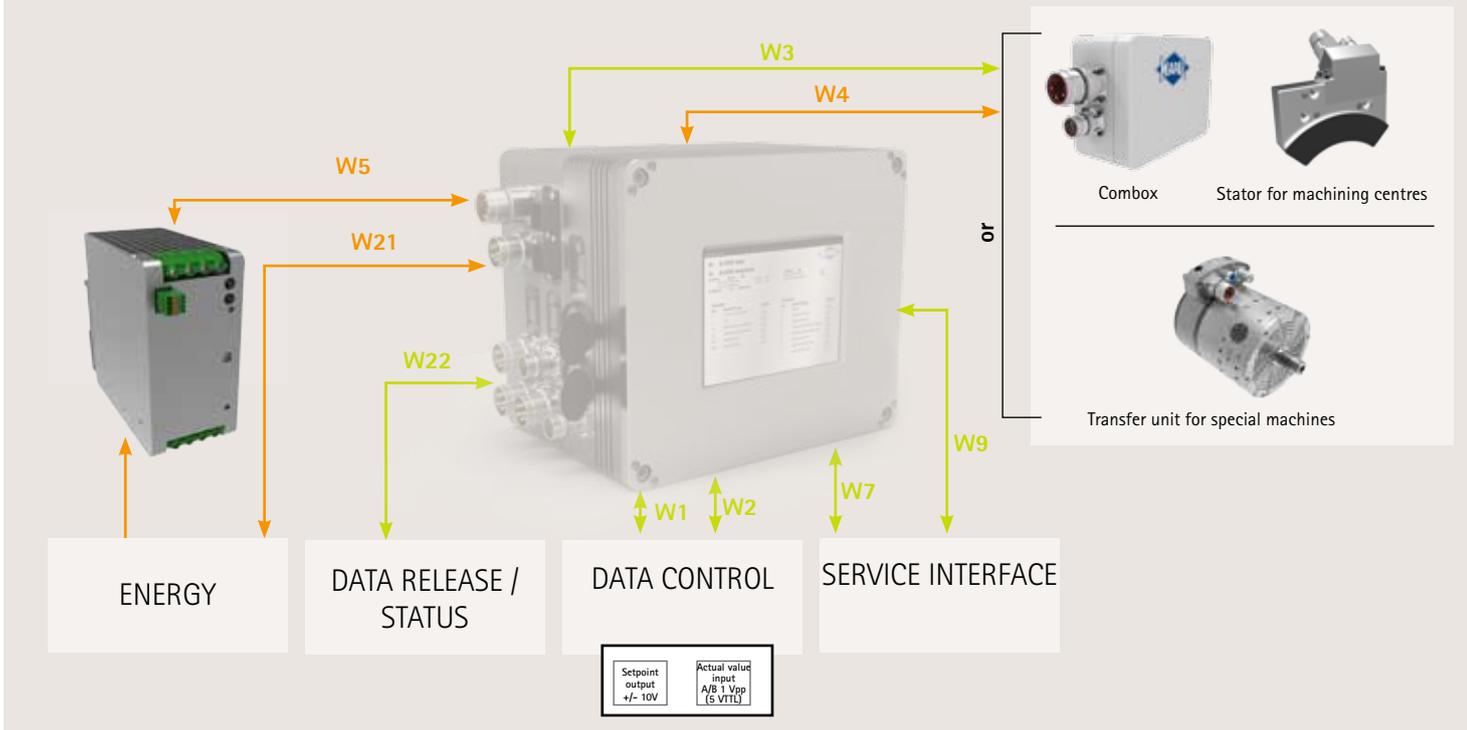
Integration components

# INTEGRATION VARIANTS

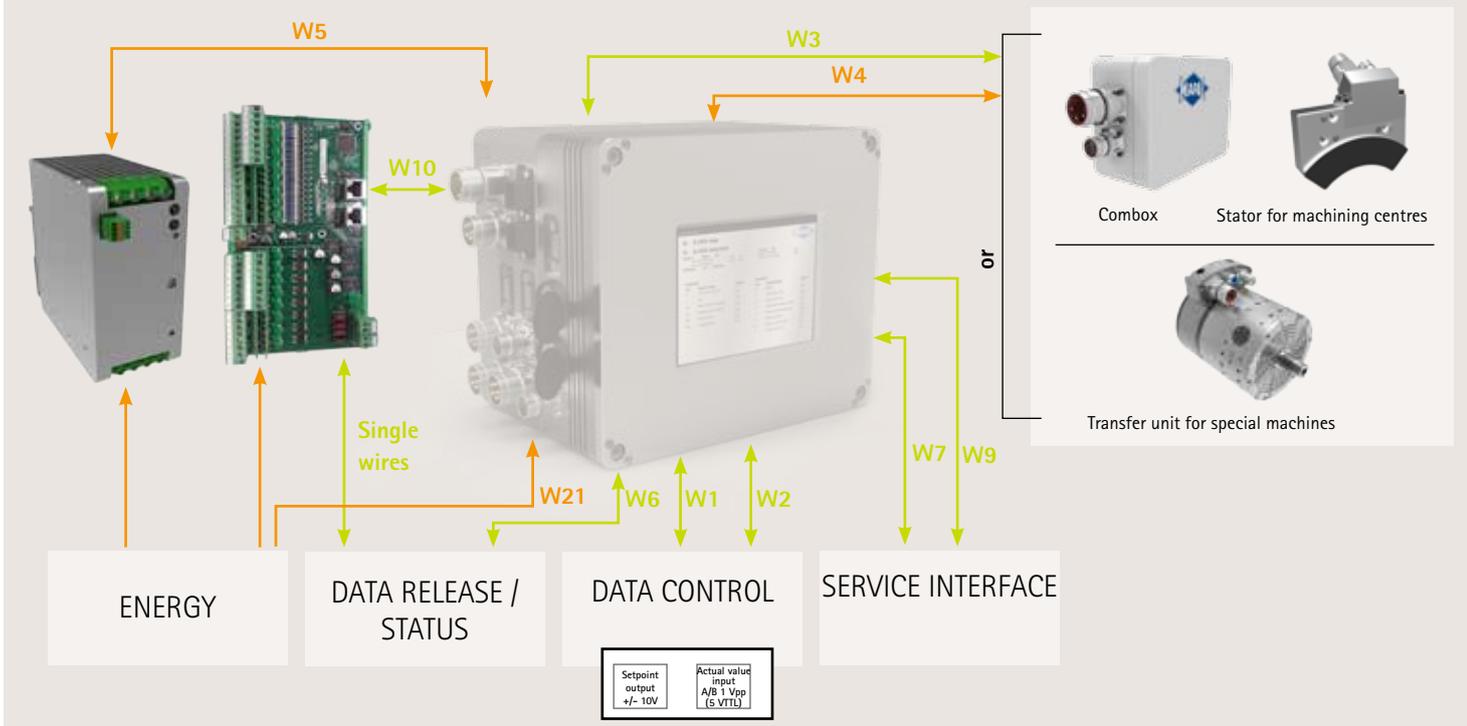
## Variants



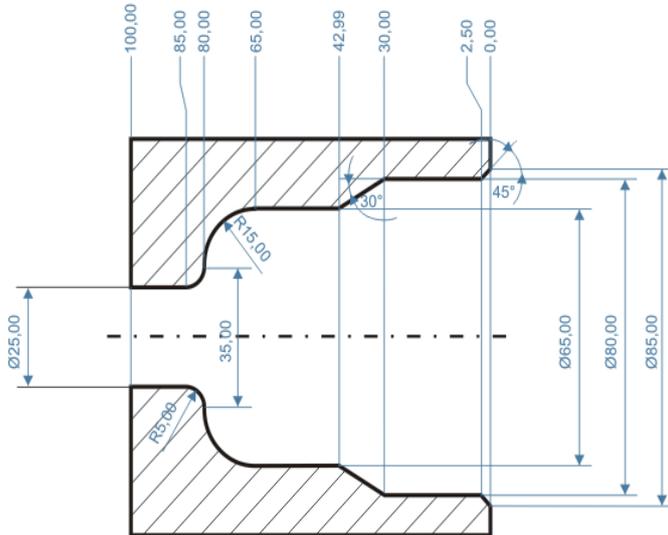
### PROFIBUS



### DIGITAL I/O



## Programming example



```
N100 G17 G90;
SELECT WORKING PLANE / ABSOLUTE POSITION
```

```
N190 G54;
RETRIEVE WORKPIECE ZERO POINT
N200 GO X0 Y0 D0          POSITION X/Y AXIS
(WITHOUT TOOL LENGTH CORRECTION)
```

```
UP_TOOLTRONIC_EIN;
CALL SUBROUTINE TT-EIN
```

```
N220 D1      RETRIEVE TOOL CORRECTION
```

```
N290 G95
N300 G0 Z2 X39
N310 G1 X87 Z1 G41 F0.1
RETRIEVE SRK (ATTENTION: CUTTING EDGE POSITION IN
TOOL MAGAZINE)
```

```
N320 G1 X80 Z-2.5
```

```
N330 G1 Z-30
```

```
N340 G1 X65  Z-42
```

```
N350 G1      Z-65
```

```
N360 G3 X35 Z-80 CR=15
```

```
N370 G2 X25 Z-85 CR=5
```

```
N380 G1      Z-102
```

```
N390 G1 X24
```

```
N400 G40;
```

```
CLEAR SELECTION
```





Discover tool and service solutions now that give you a lead:

REAMING | FINE BORING

DRILLING FROM THE SOLID | BORING | COUNTERSINKING

MILLING

TURNING

CLAMPING

ACTUATING

SETTING | MEASURING | DISPENSING

SERVICES

[www.mapal.com](http://www.mapal.com)