Motor Spindle Generation 4

Type 3

HSK 63 / 95 Nm / 16000

A.1295.7816

Operating Manual

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Table of Contents

1 Introduction

1.1 General Information

This operating manual informs you about the structure and function as well as the maintenance and repair of the unit.

Changes

The manual corresponds to the latest state of the art. Changes in the course of technical progress cannot be ruled out.

Information

We will be glad to answer your technical questions.

1.2 Intended Use

The motor spindle is a specially adapted module for installation in machine tool centres. The motor spindle serves exclusively for holding tools to carry out cutting processing with the machine tool centre.

The motor spindle may only be operated when the following conditions are satisfied:

- The parameters specified in the technical data are complied with.
- All the protective devices of the machine tool centre are in full working order.
- Operation is only allowed in perfect technical condition and with an awareness of safety and dangers under consideration of the operating instructions and the rules for the prevention of accidents and protection of the environment. Faults which could impair the safety must be remedied immediately.
- The used tools have the matching cone for the tool holder of the motor spindle and are suitable for the intended machining and speeds.

Any other use will be considered as improper use. The manufacturer will not be liable for any resulting damage. The owner bears the sole risk.
Intended use also includes the compliance with the prescribed inspection and maintenance intervals.

1.3 Conformity

The motor spindle complies with

- the Machinery Directive 98/37/EC (from 29.12.2009: 2006/42/EC) and
- the Low Voltage Directive 2006/95/EC

and all supplements.

2 Safety

The motor spindle is designed in such a way that it can be operated safely after proper installation of all media lines. Prerequisite for this is that this operating manual has been read carefully and understood before installation and commissioning of the motor spindle.

2.1 Warnings and Danger Symbols

The following names or symbols are used in this operating manual for particularly important information:

Danger!

This symbol indicates an immediate threat. Failure to heed these warnings can result in serious irreversible or even fatal injuries, serious effects on health or considerable material damage.

Warning!

This symbol indicates a possible threat. Failure to heed these warnings can result in serious irreversible or even fatal injuries, serious effects on health or considerable material damage.

Caution

This symbol indicates a possibly dangerous situation. Failure to heed these warnings can result in slight or minor injuries or material damage.

Important

This symbol indicates a possibly damaging situation. Failure to heed these warnings can result in the product or other objects in the vicinity being damaged.

Danger!

Danger of fire (fire or explosion hazard)

This symbol indicates situations in which a fire or explosion could be caused. Keep away naked lights and prevent flying sparks!
Failure to heed these warnings can result in fires or explosions which can consequently cause serious irreversible or even fatal injuries, serious effects on health or considerable material damage.

Danger!

Electrical danger

This symbol warns against dangers from electrical voltage.
Failure to heed these warnings can result in serious irreversible or even fatal injuries due to electric shock. This symbol indicates a danger area in which only authorised persons may work under consideration of suitable protective measures.

Danger!

Danger from rotating parts

This symbol warns against dangers from rotating parts.
Failure to heed these warnings can result in serious irreversible damage from injuries to fingers or hands.

Note

This symbol indicates tips for the user and other useful information for the optimum use of the motor spindle.

2.2 Basic Safety Regulations

The spindle is designed according to the state of the art and the applicable safety regulations.
Safe operation depends on the machine with the spindle being operated by sufficiently trained personnel in the proper way for the purpose for which it was intended.

2.2.1 Prerequisites for Operating the Module

The user is obliged to only operate the spindle in perfect condition. This assumes that the module is properly cleaned, maintained and serviced. Any changes which impair the safety must be remedied immediately.

The terms for periodic tests/inspections must be kept. Information about the maintenance can be found in chapter 8 of the operating manual.

The operating manual must be kept at the application site at all times and be accessible to the operating and maintenance personnel. The generally valid and local and national rules for the prevention of accidents and protection of the environment must be provided in addition to the operating manual and compliance with them checked regularly.

All safety and danger signs on the module must be kept legible and may not be removed.

The necessary personal safety equipment must be provided by the owner. It is also the owner's duty to take measures to ensure the proper use of all necessary safety equipment by the personnel.

2.2.2 Retrofitting and Conversion

Do not make any changes, additions or conversions to the module! This can result in loss of all liability and warranty.

2.2.3 Spare Parts

Spare parts must meet the technical requirements defined by the manufacturer. This is always guaranteed with original spare parts. The use of non-original spare parts bears a risk of personal injury and material damage.

2.2.4 Requirements for Operating and Repair Personnel

Every person who is involved in the installation, commissioning, operation and repair of the module must have read and understood the operating manual and particularly the chapter "Safety" before starting work.

Only persons with a qualification suitable for performing the activity may be allowed to operate and repair the module. This applies especially for work on the electrical, pneumatic or hydraulic equipment.

Persons who are not in perfect health must find out what additional dangers the machine might expose them to before working on the machine. This applies for persons with implants or pacemakers for example.

2.3 Special Dangers

2.3.1 Dangers from electrical energy

Electrical danger!

Electrical voltages can be fatal when improperly handled!
Failure to heed these warnings can result in serious damage to health and even fatal injury.

The electrical equipment of a machine must be checked regularly. Defects such as loose connections or damaged cables must be eliminated immediately. Connection of the motor spindle to the electrical mains supply and work on the electrical equipment may only be carried out by qualified personnel. The rules and regulations for the installation and operation of electrical systems at the installation site must be observed.

2.3.2 Dangers from hydraulic and pneumatic energy and coolants

If damage to pressurized hoses and pipes as well as screw connections is detected (e.g. chafing or leakage), the machine must be shut down immediately even in case of minor defects and may not be restarted until the defect has been repaired.
There is a danger of injury, explosion and fire from media escaping under high pressure.

2.3.3 Dangers from operating and auxiliary media

Coolant-lubricants, lubricants and hydraulic fluids are damaging to the environment. The national regulations must be observed!
It must be prevented that

- the limit values for components which are hazardous to health or the environment are exceeded,
- explosive mixtures are formed,
- machine elements (especially cables, plugs, seals) are attacked. This applies above all when the originally used product is changed.

Caution

The materials can

- easily ignite,
- form fumes which are hazardous to health,
- cause skin irritation and allergies.

2.3.4 Dangers from great centrifugal forces

Danger!

Danger from great centrifugal forces on rotating parts

Great centrifugal forces occur at high speed depending on the tool diameter. Never reach into the area of the rotating spindles.

The motor spindle may only

- be operated with all the prescribed safety devices,
- be operated with a clamped tool and in enclosed work rooms.

2.4 Safety Measures

2.4.1 Safety during operation

The following points must basically be observed during operation of the machine tool with the motor spindle:

- To avoid damage to the spindle bearing, the resulting natural frequency of the arrangement must be observed when working with a large mass or large overhang of the tool.
- Only use balanced tools. See chapter 11.6 for balancing quality.
- Also see the information in chapter 7.3 regarding the vibration speed of the motor spindle.

2.4.2 Safety during repairs

Always take the following safety precautions before starting maintenance and repair work:

- Position the device so that place of intervention is easily accessible.
- Switch off the machine tool centre.
- Switch off the main switch and secure it against being switched back on accidentally with a padlock.
- Also switch off any external voltage circuits.
- Release pressure from the hydraulic and pneumatic system.
- Deactivate the automatic fire extinguisher system before entering the work room.
- Cordon off the maintenance area widely if necessary and post warning signs!

During repairs it must be ruled out that
- machines can move,
- pressurised media are available,
- electrical voltages are applied!

Maintenance and repair work may only be performed by persons who have the qualification suitable for the type of activity.

The setting, maintenance and inspection activities and intervals for changing operating media and wearable parts prescribed in this operating manual must be observed!

Inform the operating personnel before starting special work and repairs. Appoint a supervisor!

Workshop equipment which is suitable for the work is absolutely essential for carrying out repairs.

Always retighten loosened screw connections at the end of maintenance and repair work.

If safety panels and safety devices have been removed for maintenance and repair work, these must be replaced and their function checked immediately after completing the maintenance and repair work.

Cleaning

Do not use aggressive substances which are damaging to health and the environment such as chlorinated hydrocarbons (PER, TRI and similar).

Only use commercially available machine cleaners.

Never use steam jets, water jets or compressed air for cleaning. There is a risk that dirt and cleaning agents may get into the guides and seals. This could impair functions, especially safety functions, limit switches or measuring systems.

Remove chips with a chip hook. Do not touch with your bare hands!

Make sure that cleaning agents are disposed of in an environmentally friendly way.

Hydraulics and pneumatics

Work on the hydraulic or pneumatic system may only be carried out by qualified personnel under consideration of the rules and regulations applicable at the installation site.

Pressure must be relieved from the system before disconnecting a line or removing a control or drive unit. Reduce and secure loads.

There is a danger of injury, explosion and fire from hydraulic fluid escaping under high pressure. Leaks and damage to the pipe system must therefore be repaired immediately.

Check pressurised hoses and pipes as well as screw connections at regular intervals and replace immediately even if the damage is only minor.

Change pressurised hoses regularly according to the valid regulations.

Lay and install hydraulic and compressed air lines properly! Do not confuse connections! The fittings, length and quality of the hose pipes must meet the requirements.

Damage to pipes, hoses and machine parts may be caused if the hydraulic system is not vented before restarting after repair or moving the module.
Oil may never be allowed to seep into the ground.

Electrical equipment

Work on the electrical equipment may only be carried out by qualified personnel. The rules and regulations for the installation and operation of electrical systems at the installation site must be observed.

Machine and plant parts on which inspection, maintenance or repair work is carried out must be disconnected from the power supply if prescribed. Check the disconnected parts for voltage first, then earth and short circuit and insulate adjacent live parts!

Only use original fuses with the prescribed rating and prescribed time response! Switch off the machine immediately in the event of faults in the electrical power supply!

When working with earthed tools, e.g. soldering irons, hand drills or similar, the main switch of the machine and any external voltage circuits must be switched off.

Boards or plug connections may only be removed when the machine or the device concerned is disconnected from the power supply.

Unused plugs must be covered with dummy caps or dummy plugs to prevent soiling.

Pay attention to stored electrical charges. Use a measuring instrument to check that there is no voltage.

2.4.3 Safety during transport

Danger!

Danger from falling loads!

Danger from falling components.
Do not stand or work beneath suspended loads!

You will find the following data for the spindle in chapter "5 Transport and Storage" of this operating manual:

- weight,
- attachment points
- prescribed lifting gear.

These instructions must be strictly observed when transporting the spindle. No other type of transport is allowed.

The lifting gear must be in perfect technical condition and have a sufficient permissible load capacity. Chains, ropes, hooks and similar must also have safe breaking strengths for these weights.

Only enlist experienced persons to attach loads! The person giving directions must have visual or voice contact with the operator.

Never lift the spindle quickly or abruptly with the lifting gear or crane. Start lifting slowly.

Make sure that the load is well-balanced.

3 Technical Data

General Information		
Module number		A.1295.7816
Type		3 / HSK 63
Max. speed	RPM	16.000
Tool holder		HSK63A
Dimensions Installation diameter Max. diameter Installation length (approx.)	 mm mm mm	 241 284 825
Weight	kg	160
Installation position		horizontal
Power		
Nominal speed	RPM	approx. 4000
Nominal torque S1	Nm	95
Nominal power S1	kW	approx. 40
Max. torque S6 at 40 % turn-on time	Nm	125
Run-up time to 16,000 RPM	s	1,5
Motor		
Manufacturer		ATE
Motor type		asynchronous
Nominal current	A	85
Designation		AC 170/250/4
Encoder		SIMAG H2
Motor cooling		
Coolant		Water-glycol mixture
Pressure	bar	max. 3
Power loss P_v	kW	max. 2
Internal coolant feed	mm	ø 8
Pressure p_{max}	bar	50
Bearing		
Type		Hybrid
Diameter	mm	80
Lubrication		Grease
Seal		
Air pressure for seal	bar	4 – 6 (throttling in the spindle)

Clamping system		
Type		Ott-Jakob (spring clamp, 2 channels for cleaning air and IK)
Pull-in force	kN	20
Release unit		hydraulic
Release pressure	bar	70
Monitoring		analogue
Ambient conditions		
Temperature at:		
Storage		+ 5 °C to + 40 °C
Operation without accuracy requirements		+ 15 °C to + 35 °C
Operation with accuracy requirements		+ 20 °C to + 25 °C
Maximum temperature fluctuation		± 2 °C
Maximum temperature gradient		± 0.5 °C per hour
Noise		
Continuous sound pressure level	dB(A)	< 70

4 Structure and Function

4.1 Spindle

The motor spindle is mounted on hybrid spindle bearings. The integrated built-in motor is largely thermally shielded from the spindle bearing by cooling water channels.

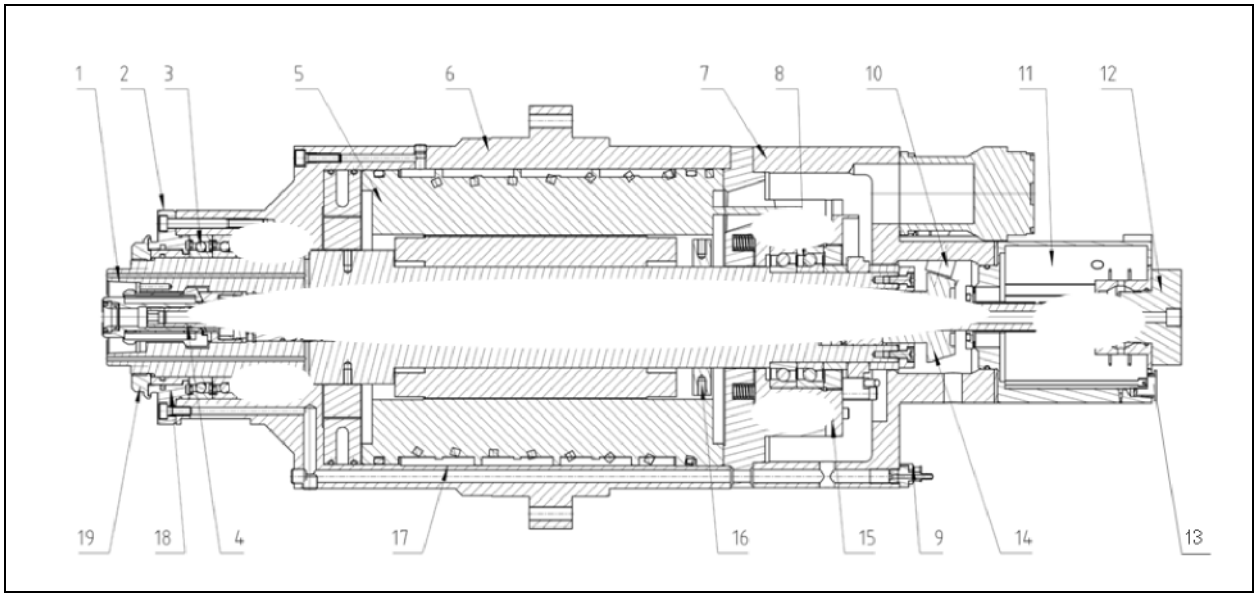


Fig. 1 Structure of motor spindle

1) Tool holder
   - HSK A63, DIN 69893
   - Contains the tool clamp with coolant supply (see chapter 4.2).
   - The contact area of the tool holder is cleaned with blown air (5 to 6 bar / 73 .. 87 psi) when changing the tool. The device for supplying the blown air is a part of the motor spindle.
2) Cover
   - The shape of the cover and the support by sealing air prevents penetration by liquid and dirt.
   - The cover is matched and may not be changed. Changing it affects the gap seal.
3) Hybrid spindle bearing (front) in sealed design
4) Clamping set
5) Assembly kit motor
6) Housing front
7) Housing rear
8) Hybrid spindle bearing (rear)
9) Media connections for motor cooling and sealing air
10) Analogue sensor
11) Release unit

12) Rotating feed for internal coolant supply
13) Hydraulic connection for clamping-releasing
14) Switching ring for analogue sensor
15) Bearing cover for loose bearing
16) Balancing ring
17) Motor cooling
18) Non-contact sealing ring
19) Nut
    – The shape of the nut prevents penetration by liquid and dirt. The particles are flung off.

4.2 Tool Clamp

Tool clamping system for wet machining

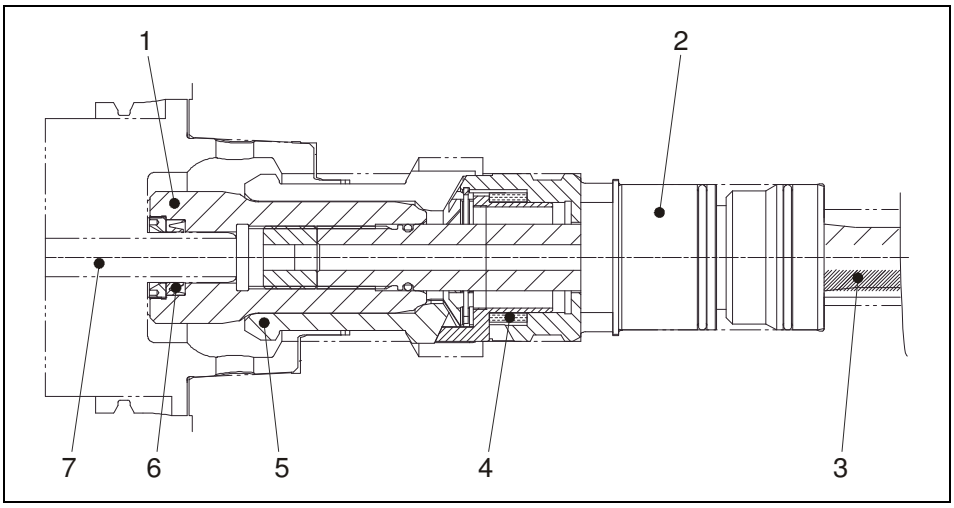


Fig. 2 Tool clamping system

1 clamping cone with internal locking screw
2 sealing sleeve
3 drawbar
4 spacer
5 clamping segments
6 grooved ring
7 tool holder coolant pipe

The tool clamping system consists of the components in the front section of the spindle, the drawbar and the rotating feed and release unit.

The front section consists of the components:

- Clamping jaw with spacer
- clamping cone with internal locking nut

Clamping jaw with spacer

The clamping jaw consists of individual clamping segments (5). The clamping segments are guided by the spacer (4) so that they are touching the clamping cone (1) all the time.

Clamping cone with internal locking nut

The clamping cone (1) is screwed to the drawbar (3). The clamping cone (1) is moved in stroke direction to the two end positions "tool released" and "tool clamped" by the drawbar (3).

The clamping cone (1) splays the clamping segments (5) of the clamping jaw outwards in the clamping process.

The spring force of the clamping device is multiplied by three by the angle of the clamping cone (1) and serves as a clamping force for the tool holder.
The clamping cone (1) is moved forward by the stroke movement of the drawbar (3) in the "tool released" position. The tool holder is ejected.

There is a hollow nut in the clamping cone (1) with which the setting dimension of the clamping cone is fixed by locking onto the thread of the drawbar head.

The grooved ring (6) forms the sealing element between the clamping cone (1) and the coolant pipe (7) of the tool holder. The no-loss transition of the coolant from the clamping cone (1) to the tool holder of the cutting tool is ensured by the grooved ring.

Blown air channels

There are air channels to the spindle end and to the conical part in the spindle body. The blown air is switched on during tool change.
The blown air keeps coolant and chips away from the end contact surface and the holding cone of the tool holder.

The drawbar section consists of the components:

- Drawbar with internal coolant-lubricant supply
- Plate spring assembly and switching ring

Drawbar with internal coolant-lubricant supply

(see Fig. 2, page 19)
The drawbar (3) is the connecting element between the clamping cone (1) and the modules on the rear side.
The drawbar performs the stroke movement of the clamping-release function.
Plate springs supply the tool clamping force.
The tool release force is generated hydraulically. To release, the drawbar is moved to the front end position against the force of the plate springs.
The coolant is fed to the clamping jaw by the rotating feed in the drawbar.

Plate spring assembly and switching ring

The plate springs are pushed onto the drawbar and pretensioned to a third of the necessary clamping force.
The switching ring (1) is screwed onto the back of the drawbar body.
The switching ring (1) actuates an analogue proximity switch. The proximity switch signals the voltage values for the switching positions depending on the switching distance:

- released
- clamped with tool
- Clamped without tool

to the PLC controller.

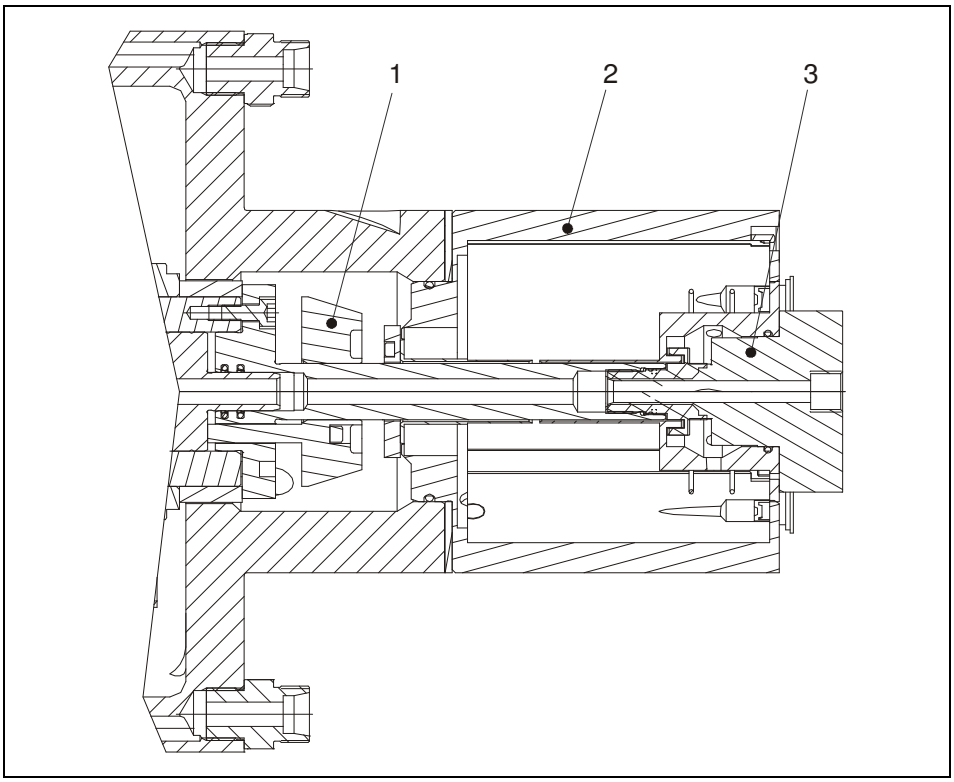


Fig. 3 Release unit and rotating feed

1 switching ring
2 release unit
3 rotating feed

The rear section consists of the modules

- release unit and
- Rotating feed

Release unit

The release unit (2) is built as a hydraulic cylinder. The piston force moves the drawbar into the release position against the force of the plate springs.
A safety distance is constructed between the end face of the release piston and the opposite contact surface of the drawbar. Pressure is also applied to the release piston in "clamping" direction during operation of the machine. Both of these prevent contact between the non-rotating piston surface and the rotating contact surface of the drawbar.

The rotating feed and a compressed air line are connected to the back of the release unit. The tool holder is blown out by compressed air when changing the tool.

Rotating feed

The rotating feed (3) serves as a media feeder for internal coolant.

Caution

The rotating feed may only be allowed to run dry very briefly.
Running dry for longer leads to damage!

The housing of the rotating feed is screwed to the release unit.

Leak holes are drilled in the release unit and the housing of the rotating feed.
The rotating feed is defective if there is any leakage.

Important

Use of the spindle with minimum lubrication or dry air is only allowed after consulting the manufacturer.

5 Transport and Storage

5.1 Safety Instructions for Transport and Storage

Danger from falling loads!

Danger from falling components.
Do not stand or work beneath suspended loads!

Caution

All persons who work on the machine are obliged to observe the basic regulations for work safety and prevention of accidents and to read the chapter 2 Safety of this operating manual and confirm that they have understood it by signing before beginning work.

- Only enlist experienced persons to attach loads! The person giving directions must have visual or voice contact with the operator.
- Only use suitable lifting gear in perfect technical condition with sufficient load capacity.

5.2 Storage

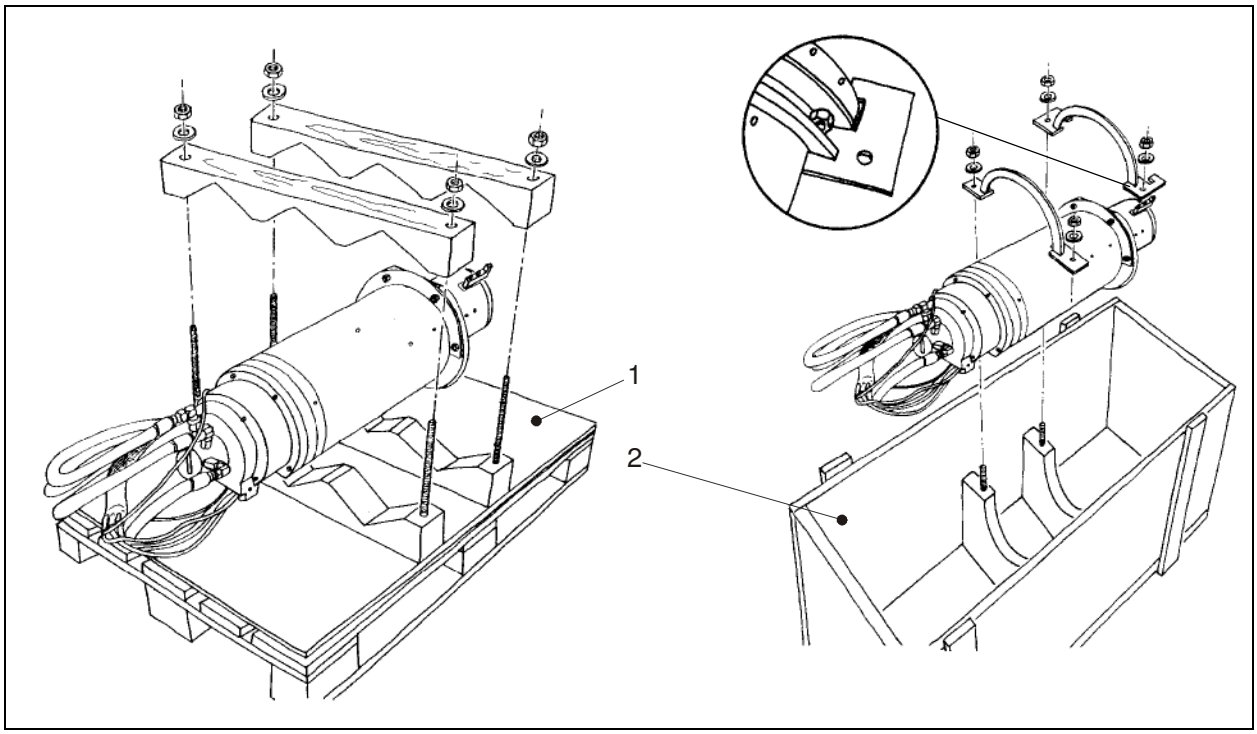


Fig. 4 Transport diagram motor spindle

1 transport/storage on pallet

2 transport crate for shipment of the motor spindle

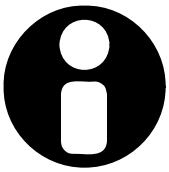
- The motor spindle must be kept preserved in a transport crate (see Fig. 4).
- The motor spindle must be stored in a dry place free from dust and dirt. The temperature at the storage location should be between + 10 °C and + 35 °C and should not fluctuate too much.
- When storing the motor spindle for more than three months, the spindle shaft should be turned by hand (about 10 turns) every two months to distribute the grease.
- The quality of the storage site and the ambient influences (e.g. humidity, temperature ...) can cause changes in the lubricating properties of the grease over long storage periods (more than two years).

5.3 Transport

Danger from falling loads!

Danger from falling components.
Do not stand or work beneath suspended loads!

The following points must be observed for transporting the spindle:



Note

Dirt and chips may get into the cooling water and air channel of the spindle. This destroys the motor spindle! Clean the spindle every time it is removed!

- Clamp the spindle fixture tight so that the spindle cannot slip during transport.
- Mark the floor side of the crate. Never tip up the crate.
- Conserve the spindle with rust protector before shipment.
- Pay attention to cables and hydraulic hoses. Do not bend!
- The motor spindle should not be lifted out of the transport packing before arriving at the application site if possible.
- A special hoisting unit (A.1289.7956) must be used for lifting the motor spindle.
- The eye bolt must be screwed into hole 3 (see Fig. 5):

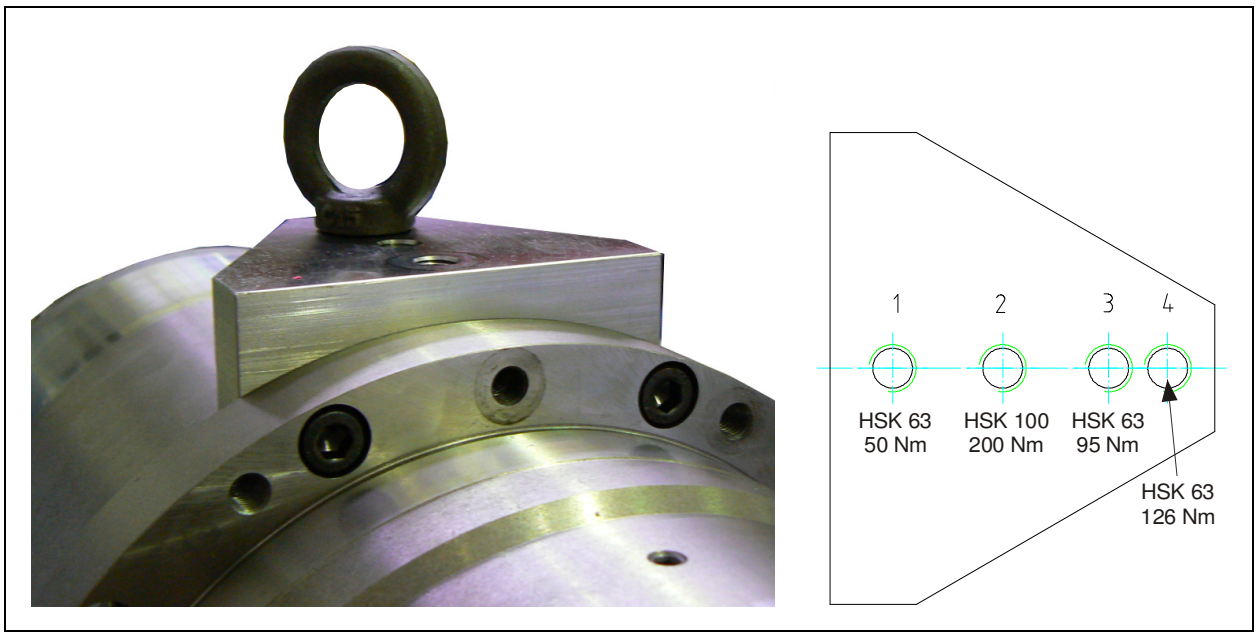


Fig. 5 Lifting device (A.1289.7956) of the motor spindle

Weight of the motor spindle: 160 kg.

5.4 Transport Damage

The whole shipment must be checked for completeness based on the enclosed delivery document and for transport damage immediately upon arrival of the module.

Note

Transport damage must be reported to Customer Service of MAG CORCOM GmbH immediately (within 48 hours).
MAG CORCOM GmbH, Siebenlindenstrasse 25, 72108 Rottenburg am Neckar.

6 Installation and Commissioning

6.1 Safety Instructions for Installation and Commissioning

Caution

All persons who work on the machine are obliged to observe the basic regulations for work safety and prevention of accidents and to read the chapter 2 Safety of this operating manual and confirm that they have understood it by signing before beginning work.

Danger from rotating parts!

Contact with rotating parts of the motor spindle can result in serious injury and even death or considerable material damage.
The manufacturer of the machine tool is responsible for the necessary constructional safety devices and the attaching of appropriate warning signs.
Protective devices must be integrated which ensure that the machine is only commissioned by trained personnel (e.g. emergency stop key-operated switches).

Danger from flying parts!

Panels or protective hoods must be attached and designed for protection against workpieces or tools which may come loose in such a way that they provide adequate protection against flying parts.
Protective devices must be integrated which ensure that the machine is only commissioned by trained personnel (e.g. emergency stop key-operated switches).

6.2 Installation

6.2.1 Aids and Tools

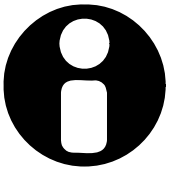
Please also see section 6.1.

- Lifting device order no. A.1289.7956
- Lifting gear
- Cleaning cloths
- Protective cap of the initiator plug order no. A.1123.2135
- Protective cap of the sealing air connection order no. A.1123.2135
- Set of wrenches (spanners, Allen keys)
- Compressed air connection
- Hose for returning the cooling water from the motor spindle

6.2.2 Installation

Note

Two persons are required to install the motor spindle.



Note

Your motor spindle version may differ from the one shown in the figures here.

The motor spindle can be installed from the front (from work room direction) and from the rear. It is installed preferably from the rear:

1) Clean the fitting seat of the motor spindle and coat lightly with grease before installation.
2) Fit the lifting device A.1289.7956 or another suitable lifting device to the flange of the motor spindle.
3) Fit the lifting attachments to the lifting device.

4) Push the motor spindle into the fitting seat from the rear (maintenance room of the machine tool).

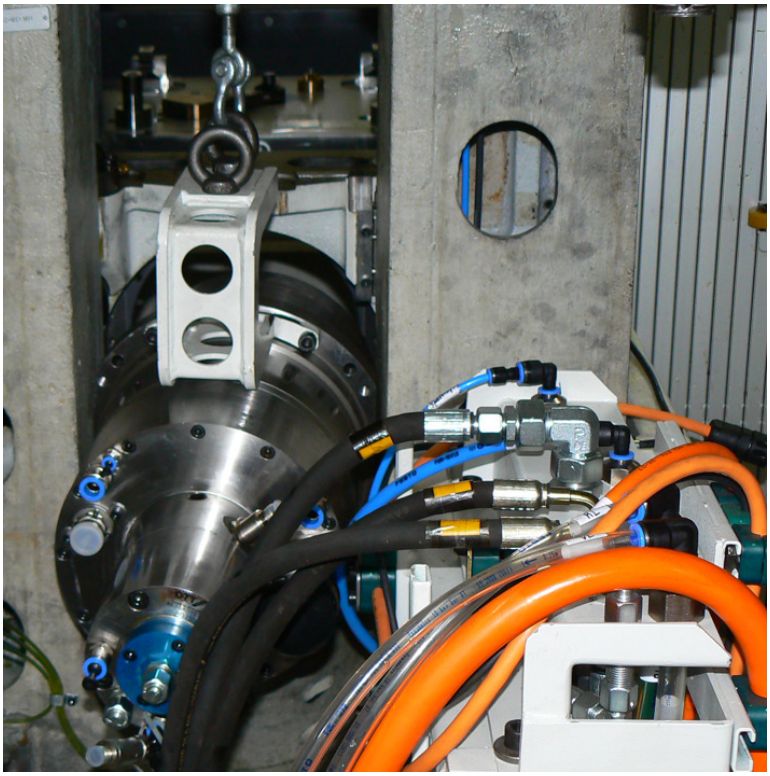


Fig. 6 Installation of the motor spindle

5) Tighten the collar screws of the motor spindle diagonally with 69 Nm.

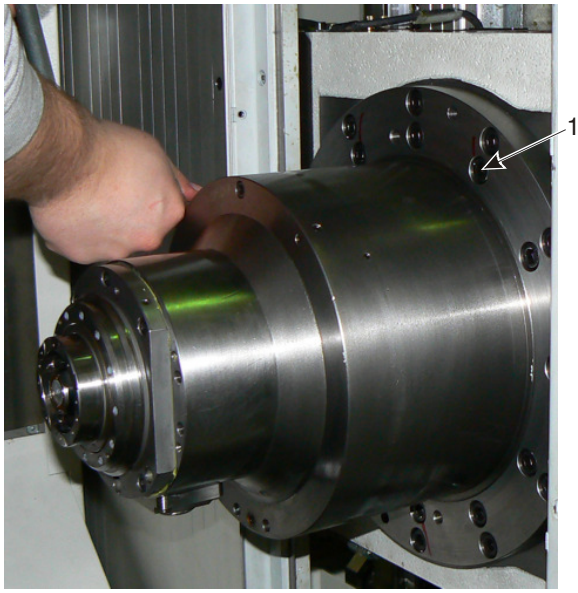


Fig. 7 Tighten collar screws of the motor spindle

1 collar screws (10 x M10)

6) Carry out necessary installation work on the machine tool side (e.g. installation of cover plates, installation of panels, etc.).
7) Fit all rear supply connections (see also Fig. 8 and Fig. 9).

Fig. 8 Rear supply connections

8) Vent motor spindle (see chapter 6.2.4).
9) Align motor spindle (see chapter 6.2.5).

6.2.3 Supply Connections

Electrical danger!

Connection of the motor spindle to the electrical mains supply and work on the electrical equipment may only be carried out by qualified personnel. The rules and regulations for the installation and operation of electrical systems at the installation site of the machine must be observed.

Warning!

Hydraulic oil under high pressure!
Hydraulic oil can cause skin and eye irritation on contact.
Switch off the machine and relieve pressure from the hydraulic system before working on the hydraulic system.
Always wear protective glasses when working on the hydraulic system.
Avoid skin contact.

The interfaces for the supply connections are on the back of the motor spindle:

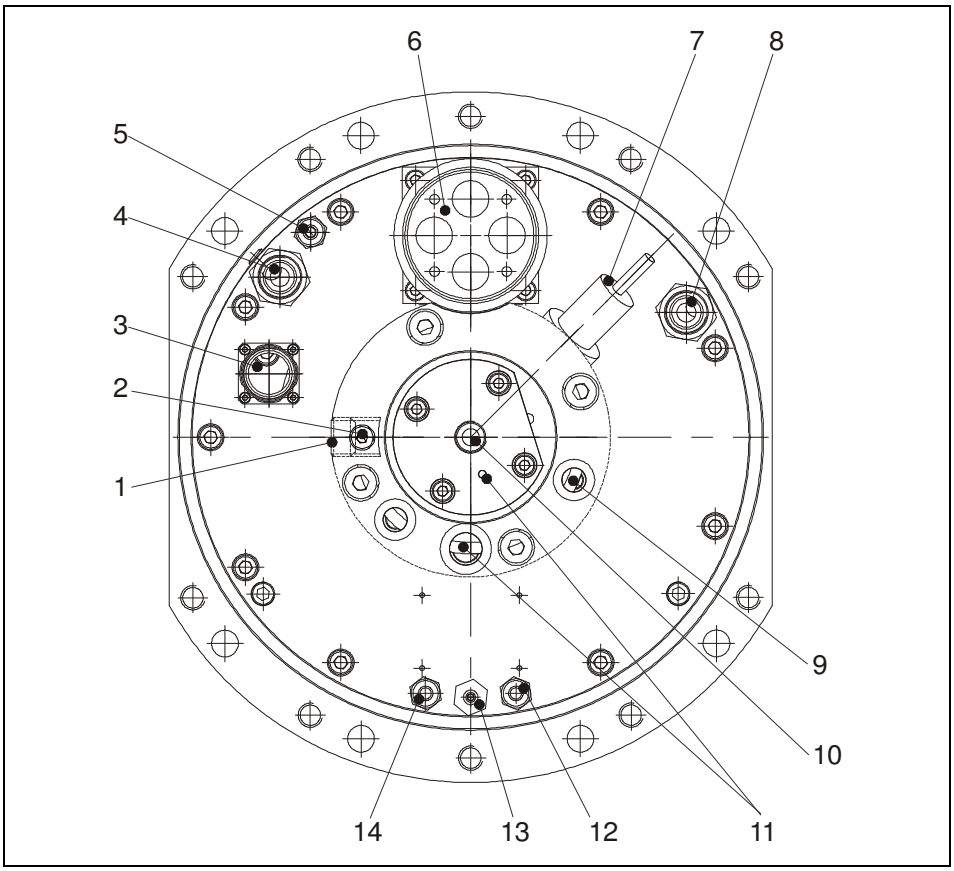


Fig. 9 Supply connections on the motor spindle (view from rear)

1 opening for balancing
2 connection control-cleaning air
3 feedback connection
4 return motor cooling
5 sealing air connection
6 power plug
7 analogue sensor for clamping position prompt
8 feed motor cooling
9 clamp tool
10 internal coolant supply
11 leak holes
12 leak connection
13 cable output for option vibration sensor
14 relief bore IK

6.2.4 Venting

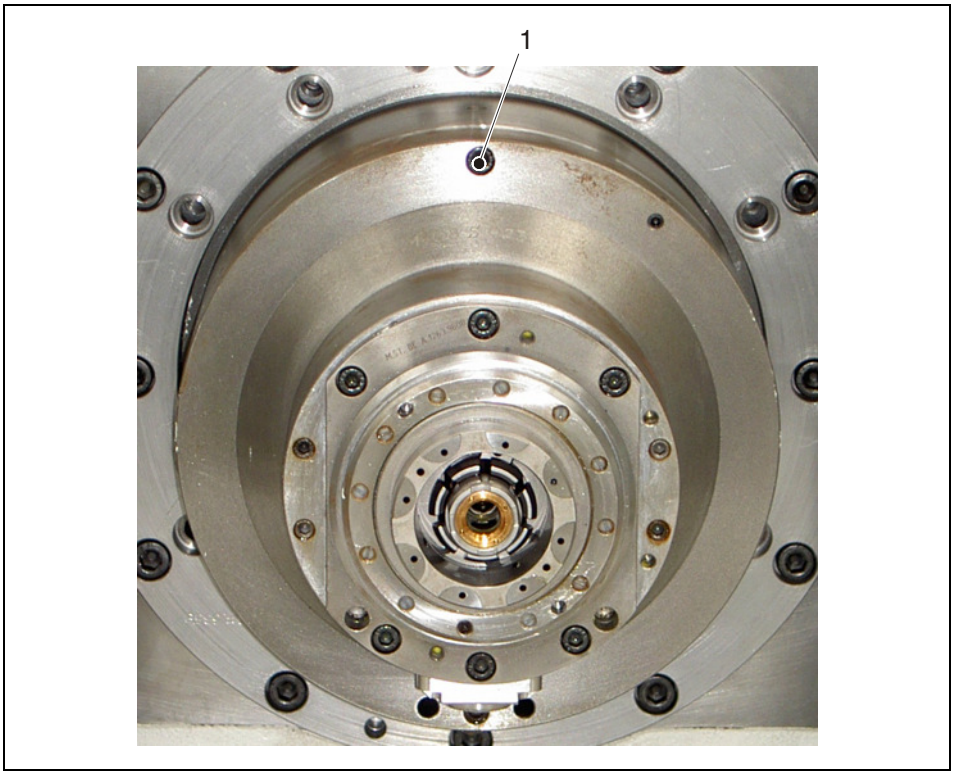


Fig. 10 Venting

1 venting screw

Note

When the machine is switched on, the cooling water pump is also switched on and the cooling water circuit built up. Pressure must be allowed to build up in the cooling water circuit after venting.

1) Start cooling circuit - control on.
2) Switch off circulation pump - control off.
3) Open venting screw (1) and close again when water emerges.
4) After about 15 minutes, check the filling level of the glycol-water tank and refill if necessary.
5) The zero position of the spindle must also be set.

6.2.5 Alignment

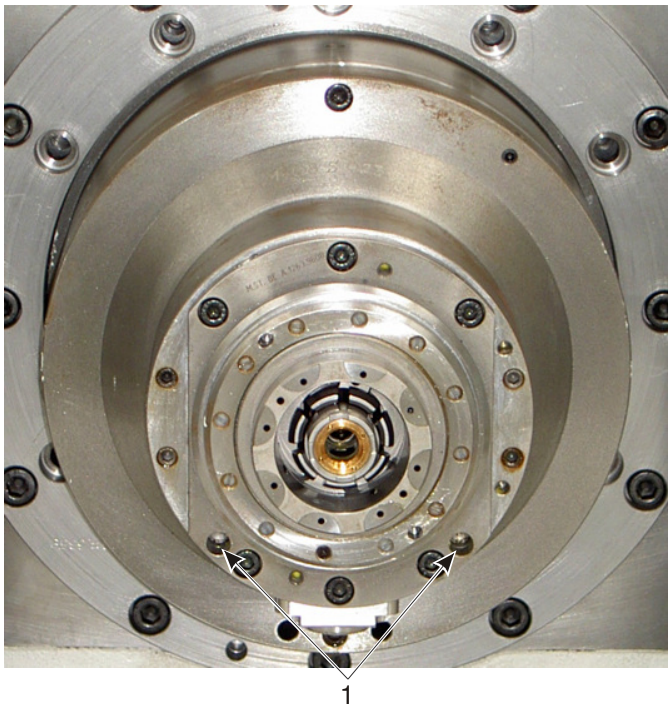


Fig. 11 Alignment of the motor spindle (view from front)

1 holes for accommodating the alignment pins

There are two holes of ø 9 mm in the motor spindle cover.

1) Insert a pin in each hole.
2) Place a spirit level over the pins.
3) Turn the motor spindle until the horizontal position is reached.
4) Tighten all collar screws of the motor spindle with 69 Nm diagonally and gradually.

6.2.6 Run-in Cycle of the New Motor Spindle

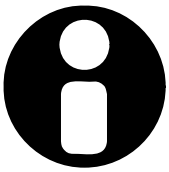
Before the new motor spindle is fully loaded, a run-in cycle must be carried out according to the values in the table. The switch-on time per speed stage is 5 minutes and the pause time between the individual speed stages 2 minutes:

[rpm]	Speed of the motor spindle at n_{max} = 16,000 [rpm]
0.2 n_{max}	3 200
0.4 n_{max}	6 400
0.6 n_{max}	9 600
0.8 n_{max}	12 800

6.3 Commissioning

Caution

Access and clear view of the emergency stop switches must be kept clear. Everyone working in the vicinity of the machine must be familiar with the arrangement of the emergency stop switches.



Note

The connected media must be checked before every commissioning.

Prerequisite for the commissioning is the operational readiness of the machine (e.g. electrical connection completed, oil tanks filled or filling levels okay and pneumatic system connected)

7 Operation

7.1 Safety Instructions for Operation

Caution

All persons who work on the machine are obliged to observe the basic regulations for work safety and prevention of accidents and to read the chapter 2 Safety of this operating manual and confirm that they have understood it by signing before beginning work.

Danger from rotating parts!

Contact with rotating parts of the motor spindle can result in serious injury and even death or considerable material damage.
Rotating sharp tools can cut off or crush fingers and hands.
The manufacturer of the machine tool is responsible for the necessary constructional safety devices and the attaching of appropriate warning signs.
Protective devices must be integrated which ensure that the machine is only commissioned by trained personnel (e.g. emergency stop key-operated switches).

Danger from flying parts!

Panels or protective hoods must be attached and designed for protection against workpieces or tools which may come loose in such a way that they provide adequate protection against flying parts.
Protective devices must be integrated which ensure that the machine is only commissioned by trained personnel (e.g. emergency stop key-operated switches).

7.2 Spindle Standstill Monitor

Note

When the machine is switched off, the tool spindles are not shut down immediately but require a certain time span to run out.
For safety reasons, it is not possible to open a safety door during this time span. Opening is prevented by a "spindle standstill monitor".

Danger!

Do not manipulate safety door locks!
You will otherwise impair the "Spindle Standstill Monitor" safety package.

Danger from rotating parts!

Rotating parts!
Rotating sharp tools can cut off or crush fingers and hands.
Do not reach into the danger area of the machine before shutting down the machine first.

7.3 Vibration Speeds of the Motor Spindle

Caution

To avoid damage to the spindle bearing, the resulting natural frequency of the arrangement must be observed when working with a large mass or large overhang of the tool.

- If the motor should start vibrating, switch off the machine tool immediately!
- Only use balanced tools. See chapter 11.6 for balancing quality.

In no-load:

The maximum permissible vibration speed of 1.8 mm/s may not be exceeded in the whole speed range of the spindle.

During processing:

The permissible vibration speed during processing is divided into three ranges which are valid for the whole speed range. The vibration speed must be measured in the area of the front spindle bearing.

Range 1	< 8 mm/s	Permissible vibration speed
Range 2	8-12 mm/s	Increased vibration speed which is only permitted briefly (< 30 s). **The life of the spindle and the tool can be reduced drastically by an increased vibration speed.**
Range 3	> 12 mm/s	Impermissible range

Possible causes of increased vibration speeds:

- Unbalanced tools at high speeds
- Worn or broken tools
- Unfavourable choice of machining parameters or tools

Warning!

Danger of injury to persons by rotating motor spindle.
Rotation of the working spindle without a clamped tool is not permitted.

Important

Do not leave any tools in the spindle during longer standstills or at the end of a shift.
Only pull jammed tools out of the spindle cone with an extraction tool which is supported on the spindle nose.
Do not hit the working spindle with a hammer or similar otherwise the spindle bearing will be damaged.

7.4 Troubleshooting

Caution

Dangerous situations could arise when eliminating a fault.
Switch off the machine tool centre before repairing a fault.

Fault	Cause	Remedy
Loud running noises of the motor spindle (SE value of new spindles < 16 gSE).	Bearing defective	Vibration measurement necessary (see machine operating manual).
	○ SE value < 50 gSE	No intervention necessary
	○ SE value > 50 gSE	New spindle bearing necessary Contact the spindle manufacturer.
Tool not clamped correctly	Clamping force and/or ejection dimension of the tie bolt not okay	Check clamping force and ejection dimension of the tie bolt (see 8.4).
	○ Clamping force not OK	Change clamp set
	○ Ejection dimension not OK	The plate spring assembly is probably defective. Contact the spindle manufacturer.
Coolant emerges from the leak hole	Rotating feed leaking	Change seal set of the rotating feed (see 8.4.5)
Oil leak from the leak hole	Release unit leaking	Change release unit (see 10.3)
Motor spindle cannot be turned	Tool released	Clamp tool
	○ Turning still not possible:	Check clamping/release cycle and ejection dimension of the tie bolt and correct if necessary
	○ Turning still not possible:	There is a bearing problem. Contact the spindle manufacturer.
Motor spindle not running true	Geometry problem	Check radial runout with measuring bolt, check axial and radial runout of the spindle nose (see 10.4) Check tool visually for any damage and replace if necessary. Carry out vibration measurement (see machine operating manual).
	○ Fault persists:	Contact the spindle manufacturer.
No "tool clamped" signal	Clamping force not OK	Check clamping force and adjust if necessary
	Analogue sensor set incorrectly or defective	Check analogue sensor and change if necessary Check signal settings in the machine

Fault	Cause	Remedy
No "tool released" signal	Clamping force and travel of the tie bolt not okay	Check clamping force and travel and adjust if necessary (see 8.4).
	Analogue sensor set incorrectly or defective	Check analogue sensor (see 10.5) and change if necessary Check signal settings in the machine
No signal "clamped without tool"	Clamping force and travel of the tie bolt not okay	Check clamping force and travel and adjust if necessary (see 8.4).
	Analogue sensor set incorrectly or defective	Check analogue sensor (see 10.5) and change if necessary. Check signal settings in the machine.
	Analogue sensor OK	The spring assembly is defective. Contact the spindle manufacturer.
Motor spindle cannot find the zero point	Position encoder defective	Check position decoder and change if necessary (see 12.3.3).
	Plug of feedback cable damp	Unplug and dry the plug Find the cause of the dampness and remedy it.
	The plug is dry:	Contact the spindle manufacturer.

8 Maintenance

8.1 Safety Instructions for Maintenance

Caution

All persons who work on the machine are obliged to observe the basic regulations for work safety and prevention of accidents and to read the chapter 2 Safety of this operating manual and confirm that they have understood it by signing before beginning work.

Warning!

Hydraulic oil under high pressure!
Hydraulic oil can cause skin and eye irritation on contact.
Switch off the machine and relieve pressure from the hydraulic system before working on the hydraulic system.
Always wear protective glasses when working on the hydraulic system.
Avoid skin contact.

Note

Spare parts must meet the technical requirements defined by us. This is always guaranteed with original spare parts.

The operator must set the machine in the following initial state to prepare the machine tool centre for maintenance of the motor spindle:

- All doors with a safety lock must be unlocked and opened.
- Switch off the machine tool centre.
- Secure the main switch with at least 2 padlocks, keep the keys in a safe place.
- All unlocked safety doors must be locked after completing the maintenance and inspection work.

8.2 Maintenance Schedule

Regular maintenance work must be carried out on the motor spindle to protect the warranty.
The work to be performed regularly is listed in the maintenance schedule. It is divided into time intervals.
The column "additional work" tells the maintenance personnel that other work needs to be done in addition to the usual activities such as cleaning and lubrication.

Component	**Maintenance activities**				**Interval**			**Detailed description on page**
	Clean	Lubricate	Inspect	Additional work	Weekly	Every six months	Other	
Whole module								
Motor spindle	X						as required	42
HSK clamp set								
Grooved ring in clamping cone			X	X	X		Weekly check; change the grooved ring annually or after 500,000 tool changes	42
Clamping jaw		X	X		X			43
Setting dimension			X			X	after 200,000 tool changes at the latest	43
Pull-in force			X	X		X	after 200,000 tool changes at the latest	43
Rotating feed								
Seal set			X	X			as required, when leakage occurs	44

Legend: X...something has to be done here.

8.3 Cleaning the Motor Spindle

The motor spindle must be cleaned as required in case of soiling.

- Clean the spindle nose of the motor spindle with a dry cloth. The tool A.1085.3063 (HSK 63) must be used to clean the spindle cone.
- Check the motor spindle for corrosion. If corroded parts are detected, the pH value of the coolant must be checked.

8.4 Inspection and Replacement Work on the HSK Clamp Set of the Motor Spindle

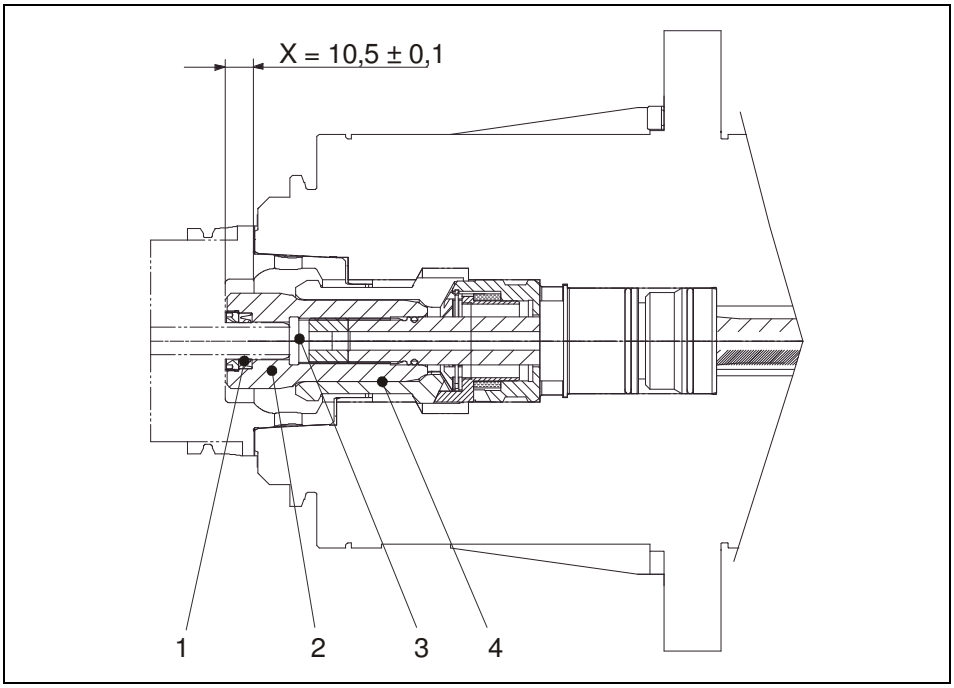


Fig. 12 HSK clamp set with setting dimension X

1 grooved ring
2 clamping cone
3 locking screw
4 clamping jaw

8.4.1 Checking/Changing the Grooved Ring in the Clamping Cone

- The grooved ring (1) must be checked for visible damage.
- Damaged grooved rings must be changed immediately.
- The grooved ring must be changed routinely every 3 months.
- The replacement is described in the clamp set manufacturer's documentation (see appendix to this operating manual).

8.4.2 Checking the Clamping Jaw

Initial state of the clamping jaw: Clamped without tool

- Visual inspection of all clamping jaw segments for damage, soiling and sufficient lubrication.

Causes for the degreasing of the clamping jaw may be:

- The clamping ring in the clamping cone is defective, coolant-lubricant can penetrate.
- Grease dissolving cleaners were used.
- The clamp set was sprayed directly when cleaning.
- The regreasing is described in the manufacturer's documentation (see appendix to this operating manual).

8.4.3 Checking of the Setting Dimension

The setting dimension must be 10.5 ± 0.1 mm in the released state (see Fig. 12).

- Check the tight fit of the locking screw in case of deviations (see item 3 Fig. 12).
- After correcting the setting dimension, the locking screw must be retightened after 100 clamping strokes (see appendix to this operating manual).

8.4.4 Checking the Pull-in Force

The tool pull-in force must be checked with a suitable measuring instrument.
The clamp set manufacturer offers the "Power Check" instrument for this.
The static value of the pull-in force is 20 kN.
If the pull-in force drops below 70% of the nominal value, the following work must be carried out in the specified order:

- Regreasing of the clamp set and rechecking of the pull-in force
- Replacement of the clamp set and rechecking of the pull-in force
- Complete replacement of the tool clamp is described in the manufacturer's documentation (see appendix to this operating manual).

8.4.5 Changing the Seal Set of the Rotating Feed

If a leak is detected at the leak hole at the end of the spindle or at the seal set (5), the seal set of the rotating feed must be changed.

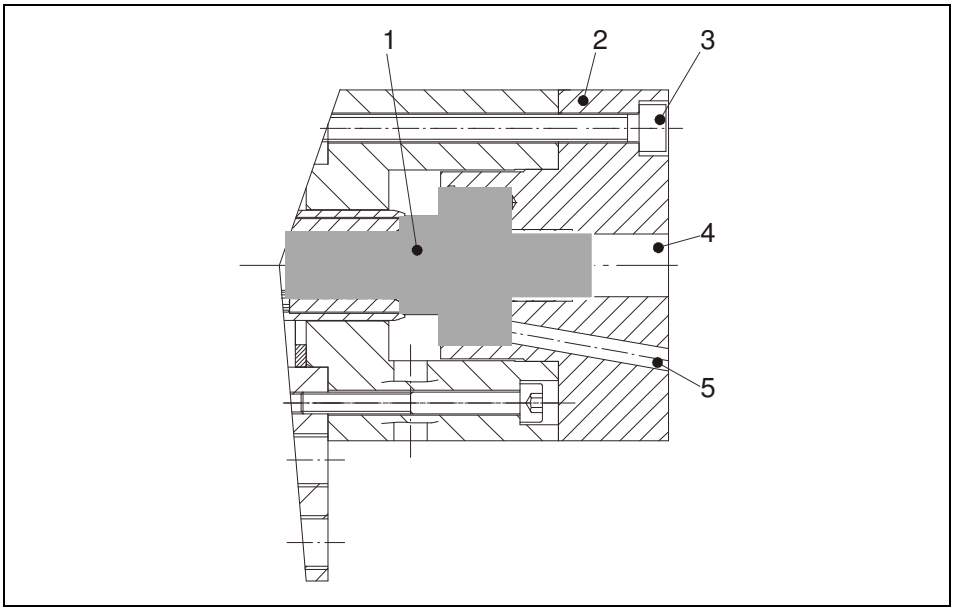


Fig. 13 Changing the seal set

1 rotor of the seal set
2 stator of the seal set
3 fastening screws (4x)
4 connection for coolant-lubricant supply
5 leak hole

1) Move the tool clamp to the "released" position.
2) Disconnect the coolant-lubricant supply line (4).
3) Loosen the fastening screws (3) and pull off the seal set (2).
4) Unscrew the rotor (1) of the seal set with a size 19 Allen key (position 6, Fig. 14). Caution: left-handed thread!

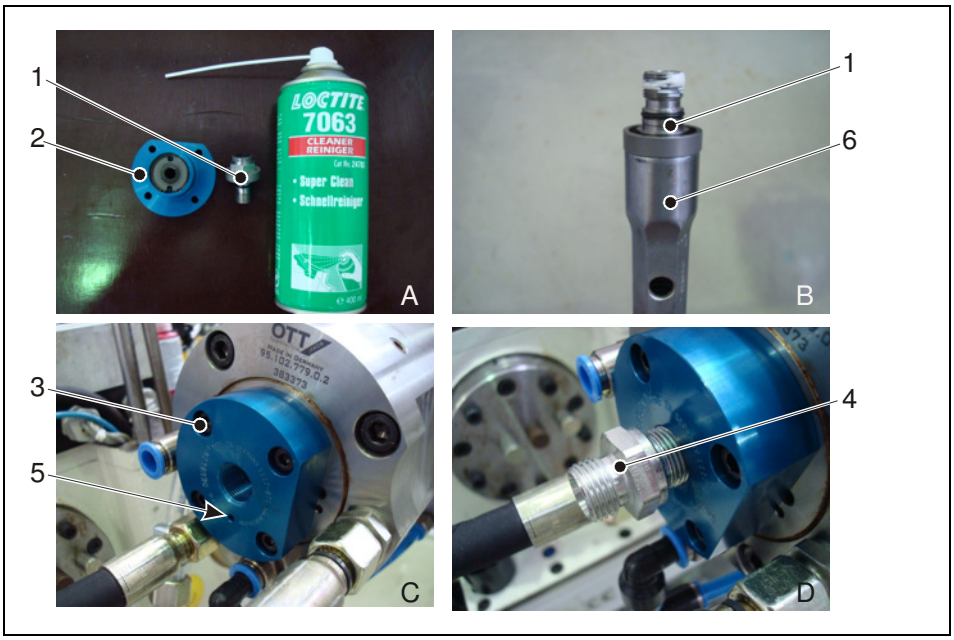


Fig. 14 Installation rotating feed

Note

Clean the axial face of the new rotor (1) and coat with a fine film of oil (see Fig. 14 – A and B)!

5) Screw in new rotor (1) with size 19 Allen key (6).
6) Fit seal set (2) and tighten fastening screws (3) evenly.
7) Reconnect the coolant supply line (4).
8) Move the tool clamp to the "clamped" position.

9 Recommended Coolant-lubricants

On the basis of long-term tests at MAG CORCOM GmbH or the customer, we can recommend the coolant-lubricants listed below. Note that this recommendation is exclusively valid:

- for the respective material listed in the table,
- under consideration of the required water quality (preparation water),
- for proper monitoring of the coolant-lubricant emulsion or coolant-lubricating oil.

Caution

All coolant-lubricants not listed and deviations in the water quality or monitoring of coolant-lubricant emulsion or oil must be expressly approved by MAG CORCOM GmbH before use. Otherwise we will refuse to accept any liability for resulting damage!

9.1 Water Quality

The preparation water must satisfy the following quality criteria:

pH value	[-]	6,5 – 8.0	Cl	[mg/litre]	≤ 50
Conductivity	[µS/cm]	< 700	NO2	[mg/litre]	≤ 20
Total hardness	[°dH]	5 - 15	NO3	[mg/litre]	≤ 50
Bacteria	[/litre]	≤ 10^3			

9.2 Monitoring the Coolant-Lubricant Emulsion

The coolant-lubricant emulsion must satisfy the following quality criteria and be monitored accordingly:

Coolant-lubricant concentration	according to table (depending on machining)	
pH value (DIN 51369)	according to table (depending on make)	
Nitrite content (measuring tabs)	[ppm]	≤ 20
Nitrate content (measuring tabs)	[ppm]	≤ 50
Chloride content	[ppm]	≤ 100
Conductivity (DIN 51412/2)	[µS/cm]	≤ 5000
Water hardness	[°dH]	5 – 70
Fine particle content up to 100 µm	[mg/litre]	≤ 150
Fine particle content up to 40 µm	[mg/litre]	≤ 60
Total germs	[/litre]	≤ 10^5
Bacteria (Dipslick)	[/litre]	≤ 10^5
Fungi, yeasts	[/litre]	≤ 10^3
Temperature	[°C]	22 - 24
Temperature fluctuation	[deg]	± 1

9.3 Monitoring the Coolant-lubricating Oil

The coolant-lubricating oil must satisfy the following quality criteria and be monitored accordingly:

Viscosity	according to table (depending on make)
Fine particle content up to 100 µm	[mg/litre] ≤ 150
Fine particle content up to 40 µm	[mg/litre] ≤ 60

9.4 Recommended Coolant-lubricant Emulsions

Designation	Manufacturer	Code letter (DIN 51385)	Concen-tration [%]	Oil content [%]	EP/AW additives	pH value in 5 % concentration
Material: Steel, strength 400 N/mm² and cast iron (all machining processes)						
Blasocut 4000 CF, Art. 877	Blaser	2,1	4 – 6	51	Polar	9.1
Blasocut 2000 CF, Art. 875			5 – 7	65	additives	8.9
CMT Aquasol 5-58 Alu 3.1	Houghton	2,1	5 - 6	45	--	9.5
Material: Steel, strength 700 N/mm² (all machining processes)						
Blasocut 4000 CF, Art. 877	Blaser	2,1	6 – 7	51	Polar	9.1
Blasocut 2000 CF, Art. 875			6 – 8	65	additives	8.9
Material: Steel, strength 1000 N/mm² (all machining processes)						
Blasocut 4000 CF, Art. 877	Blaser	2,1	7 – 10	51	Polar	9.1
Blasocut 2000 CF, Art. 875			7 - 12	65	additives	8.9
Material: Aluminium die-cast alloys (all machining processes)						
Blasocut 4000 CF, Art. 877	Blaser	2,1	5 – 7	51	Polar	9.1
Blasocut 2000 CF, Art. 875			6 – 8	65	additives	8.9
Castrol Alusol MF	Castrol	SEM	5 – 10 G – Mg 5 – 12)	45	10 % polar additives	8.9
CMT Aquasol 5-58 Alu 3.1	Houghton	2,1	8 – 10	45	--	9.5
Material: Plastic						
Blasocut 4000 CF, Art. 877	Blaser	2,1	4 – 6	51	Polar	9.1
Blasocut 2000 CF, Art. 875			5 – 6	65	additives	8.9

9.5 Recommended Coolant-lubricants (Cutting Oils, Minimum Lubrication)

Designation	Manufacturer	Viscosity (DIN 51385) at 40 °C [mm²/s]	Density (DIN 51757) at 15 °C [g/ml]	Flashpoint (ISO 9592) [°C]
Material:				
Planto Mikro 830 S-CS	Fuchs	34	0,971	190
Multicut Micro SP51	Zeller & Gmelin	50	0,880	160

9.6 Specification of the Cooling Water for the Motor Spindles

Coolant

Mixture of cooler antifreeze (approx. 35 %) with treated water.

Cooler antifreeze

Brand make for vehicle aluminium engines according to release list of leading car manufacturers.

Water

- Demineralised water via softening plant with ion exchange material (resin) treated mains water or
- reverse osmosis water via reverse osmosis plant (filter membranes) treated water

If the mains water at the application site satisfies the conditions listed below, the coolant can be made with mains water.

Necessary water quality

Total hardness	< 8° dH
pH value	> 7.5 to < 9
Si-Index	6.5 to 7.5
Conductivity	< 2000 µS/cm
Ammonia	free, may not be proven
Sulphide	free, may not be proven
Aggressive carbonic acid	free, may not be proven
Chloride ions	< 50 mg/l *
Nitrate	< 10 mg/l
Nitrite	< 1 mg/l
Oxygen	< 10 mg/l
CSB	< 10 mg/l
Iron	< 0.2 mg/l
Manganese	< 0.05 mg/l *
Sulphate ions	< 250 mg/l *
Sulphate reducer	none
Potassium manganate consumption	< 25 mg/l
Number of bacteria colonies	< 1000 /ml
Suspended matter	< 3 mg/l
Evaporation residue	< 500 mg/l

*) components mainly responsible for corrosion!

10 Repair

10.1 Safety Instructions for Repair

Caution

All persons who work on the machine are obliged to observe the basic regulations for work safety and prevention of accidents and to read the chapter 2 Safety of this operating manual and confirm that they have understood it by signing before beginning work.

Note

Repair work on the motor spindle is only allowed under the following conditions:
The customer's personnel were trained accordingly on our premises.
The customer has the necessary measuring and test equipment and installation tools.
Documentation of the regular maintenance is submitted continuously to MAG.

Please note that all rights under warranty will be rescinded in case of:

- collision
- failure to keep the prescribed maintenance intervals
- interventions by untrained personnel
- interventions which go beyond what is described here
- exceeding of the permissible forces and torques
- proven improper handling

A general overhaul of the motor spindle is only possible at MAG!

Note

Spare parts must meet the technical requirements defined by us. This is always guaranteed with original spare parts.

10.2 Removal and Installation of the Motor Spindle

A closed cooling water circuit flows through the jacket of the motor spindle. The pressure must be relieved from the cooling water circuit to remove the motor spindle.
The cooling water of the motor spindle is pressed carefully into the tank by compressed air (see Fig. 15).

Caution

Dirt and chips may get into the cooling water and air channel of the spindle. This destroys the motor spindle!
Clean the spindle and close the sealing air connection every time before removing (see Fig. 9).
To avoid malfunctioning of the tool clamp, the cable plugs of the initiators must be sealed with protective caps.

10.2.1 Aids and Tools

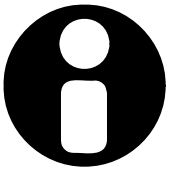
Please also see section 10.1.

- Lifting device order no. A.1289.7956
- Lifting gear
- Cleaning cloths
- Protective cap of the initiator plug order no. A.1123.2135
- Protective cap of the sealing air connection order no. A.1123.2135
- Set of wrenches (spanners, Allen keys)
- Compressed air connection
- Hose for returning the cooling water from the motor spindle

10.2.2 Removal

Note

Two persons are required to remove the motor spindle.



Note

Before the motor spindle is separated from the Y slide (see Fig. 15) the remaining cooling water must be removed completely from the channels. Cooling water must be prevented from getting into the pneumatic channels. Penetration by cooling water will damage the spindle bearing. Therefore blow cooling water out of the motor spindle first.

Note

Your motor spindle version may differ from the one shown in the figures here.

1) Move machine axes to a collision-free position.
2) Clamp tool clamp without tool.
3) Unlock and open all doors.
4) Close the gantry flap if available.
5) Switch off the machine according to instructions in the operating manual.
6) Blow the cooling water out of the motor spindle:

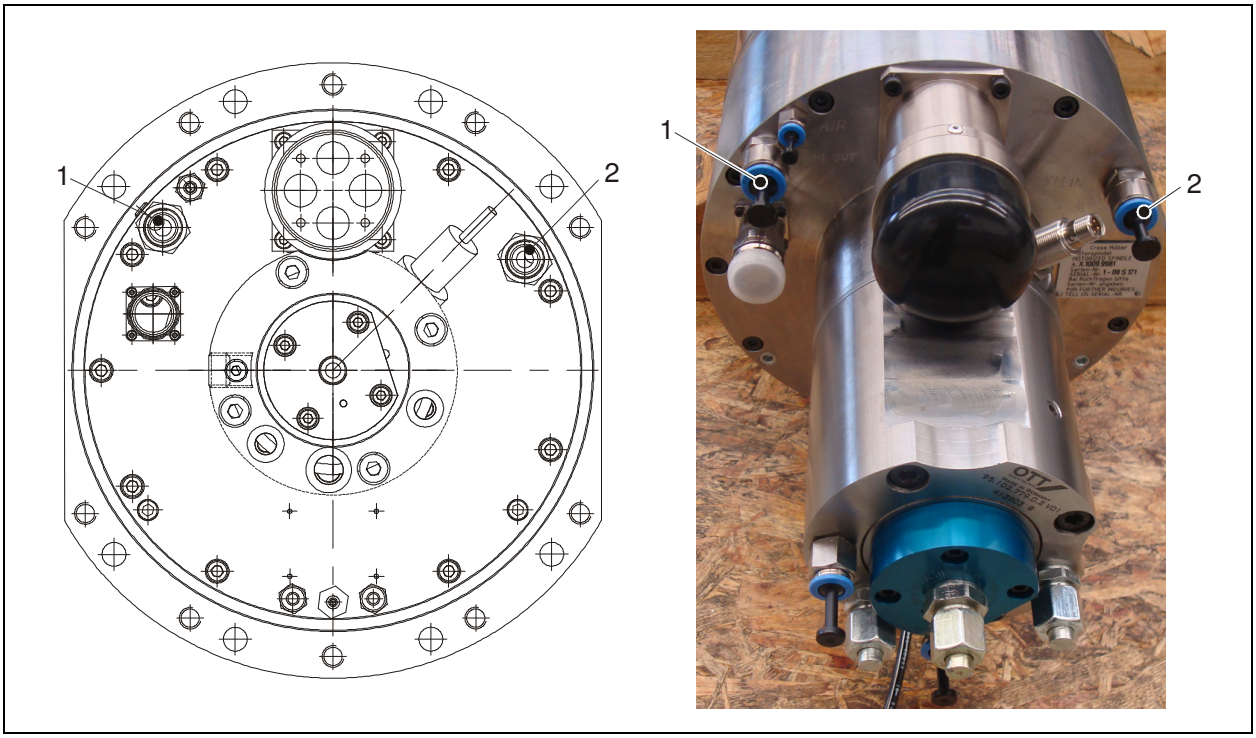


Fig. 15 Empty the cooling water circuit

1 return motor cooling 2 feed motor cooling

- Collect the remaining cooling water in the line in a vessel.
- Remove the screw connections at the supply (2) and return (1).
- Fix the compressed air pistol to the supply line and the hose to the return line.
- Blow the remaining cooling water out of the motor spindle into the tank (2 l) with compressed air.

7) Loosen all connections in the area behind the spindle without a tool.
   - All hose connections are marked.
8) Fit protective caps and seal sealing air connection with a protective cap.

9) Mount the eye bolt (2) of the lifting device as shown in Fig. 5.
10) Fix the lifting device (3) or other suitable lifting device with 2 screws (4) on the flange socket of the motor spindle (5).
11) Fit the lifting attachments (1) of the lifting gear.
12) Carefully tension the lifting attachment (1), do not lift!

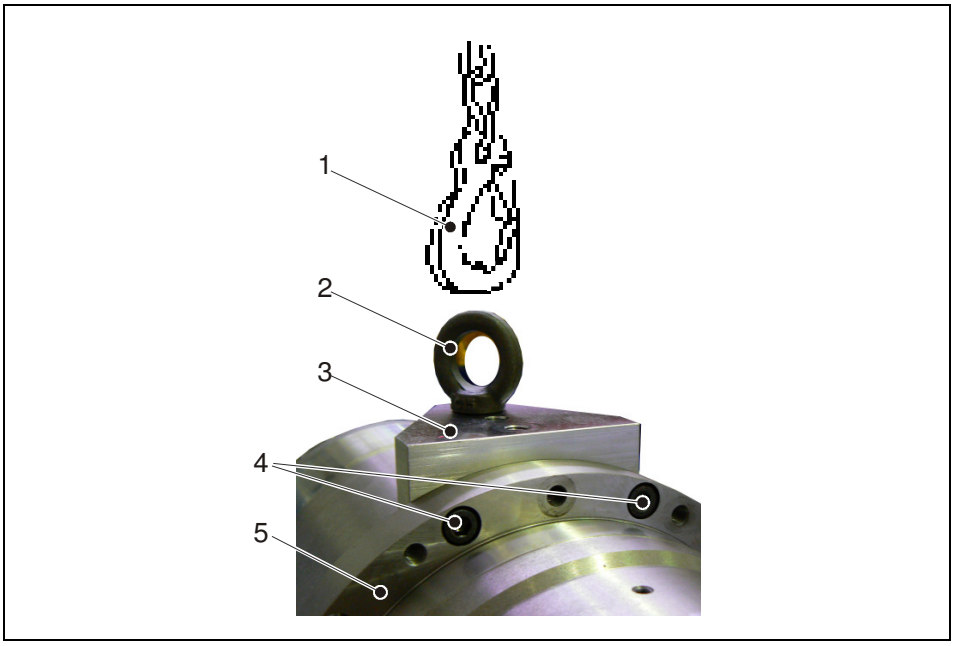


Fig. 16 Lifting device of the motor spindle

1 lifting attachment
2 eye bolt
3 lifting device A.1289.7956
4 fastening screws (2x)
5 flange socket of the motor spindle

13) Loosen and remove fastening screws (1).

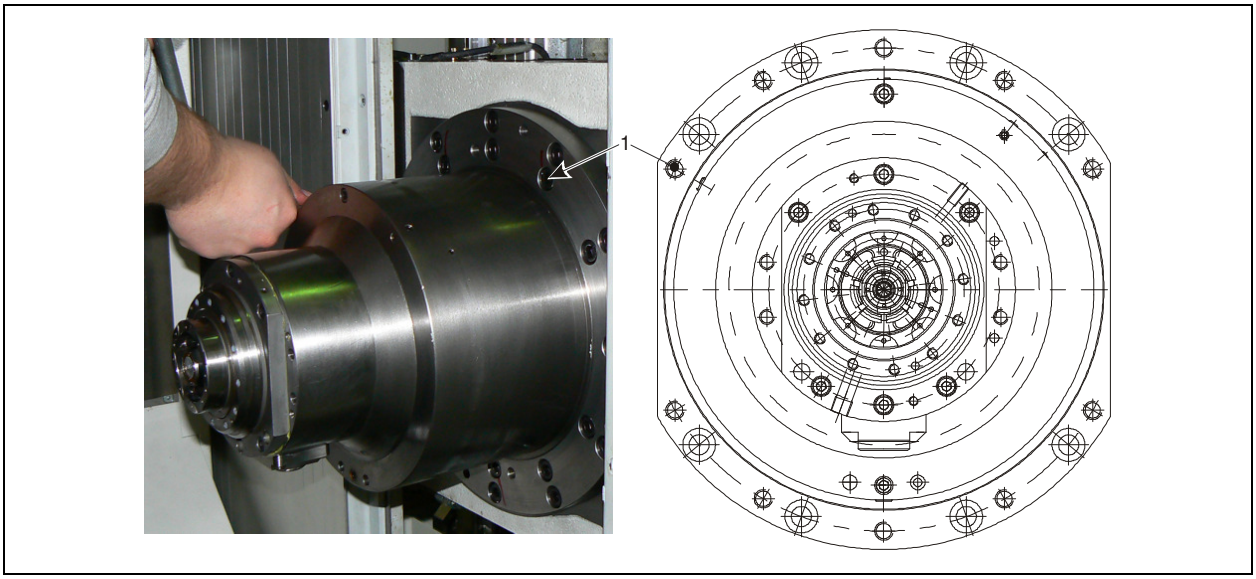


Fig. 17 Screw connection motor spindle

1 fastening screws (10 x M10)

14) Carry out necessary disassembly work on the machine tool side (e.g. disassembly of cover plates, disassembly of panels, etc.).
15) Pull out the motor spindle from the front.

Weight of the motor spindle: 160 kg.

10.2.3 Installation

Install the motor spindle (see chapter 6.2.2).

10.3 Changing the Release Unit

The release unit (3) must be changed in case of malfunctions of the tool clamping system and hydraulic oil leaks. Hydraulic oil leaks from the leak hole (1) in case of hydraulic piston leakage.

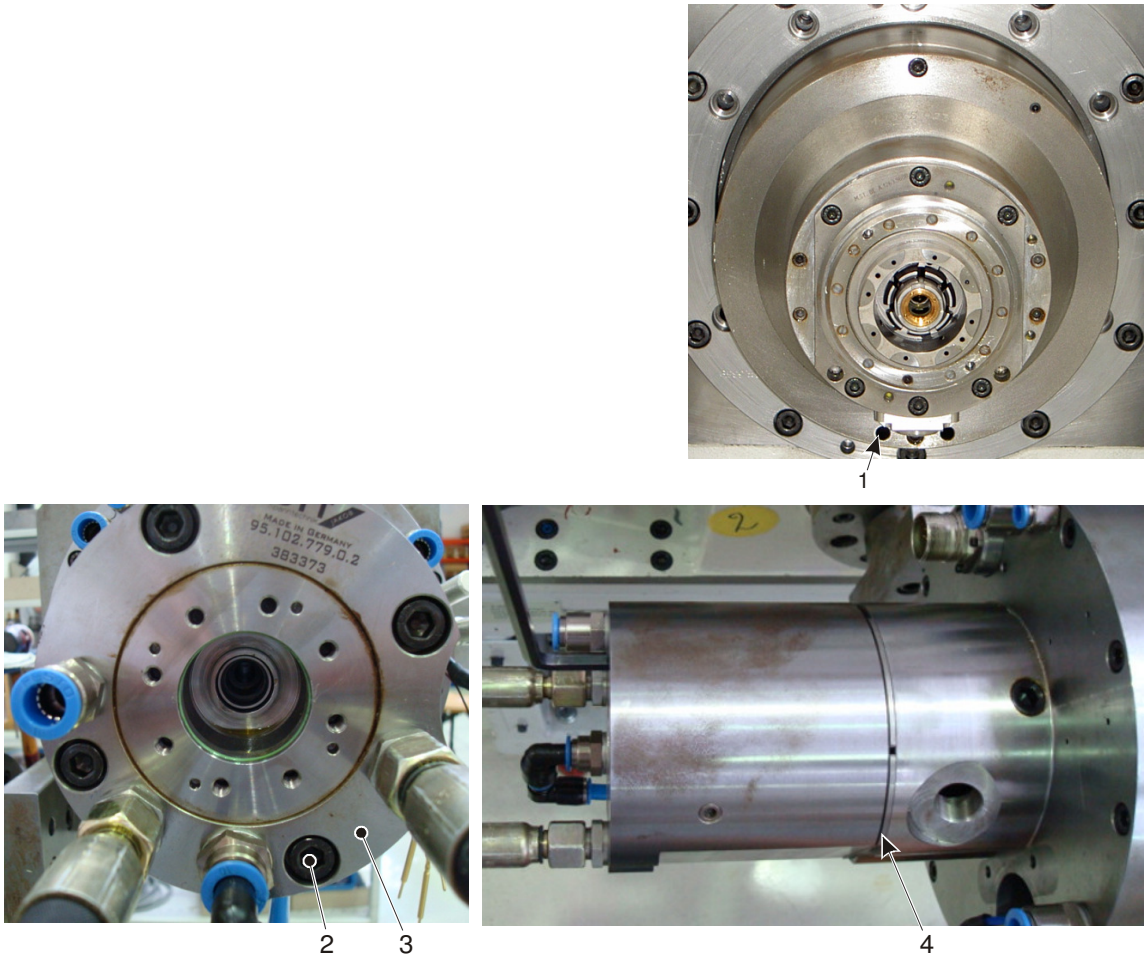


Fig. 18 Changing the release unit

1 leak hole (spindle front)
2 screws (4x)
3 release unit
4 tuning ring

1) Disassemble rotating feed (see chapter 8.4.5).
2) Disconnect hydraulic and pneumatic lines.
3) Remove screws (2) of the module.
4) Replace the defective release unit (3) with a new release unit.

Note

The tuning ring (4) of the old release unit must be reused!

5) Fit new release unit and install rotating feed according to chapter 8.4.5.
6) Connect hydraulic supply line and pneumatic supply line.

10.4 Checking runout of the motor spindle

Note

- The runout of the motor spindle must be checked after every crash.
- A runout check is always made during a general overhaul.
- Use dial gauges with an accuracy of 1 µm!

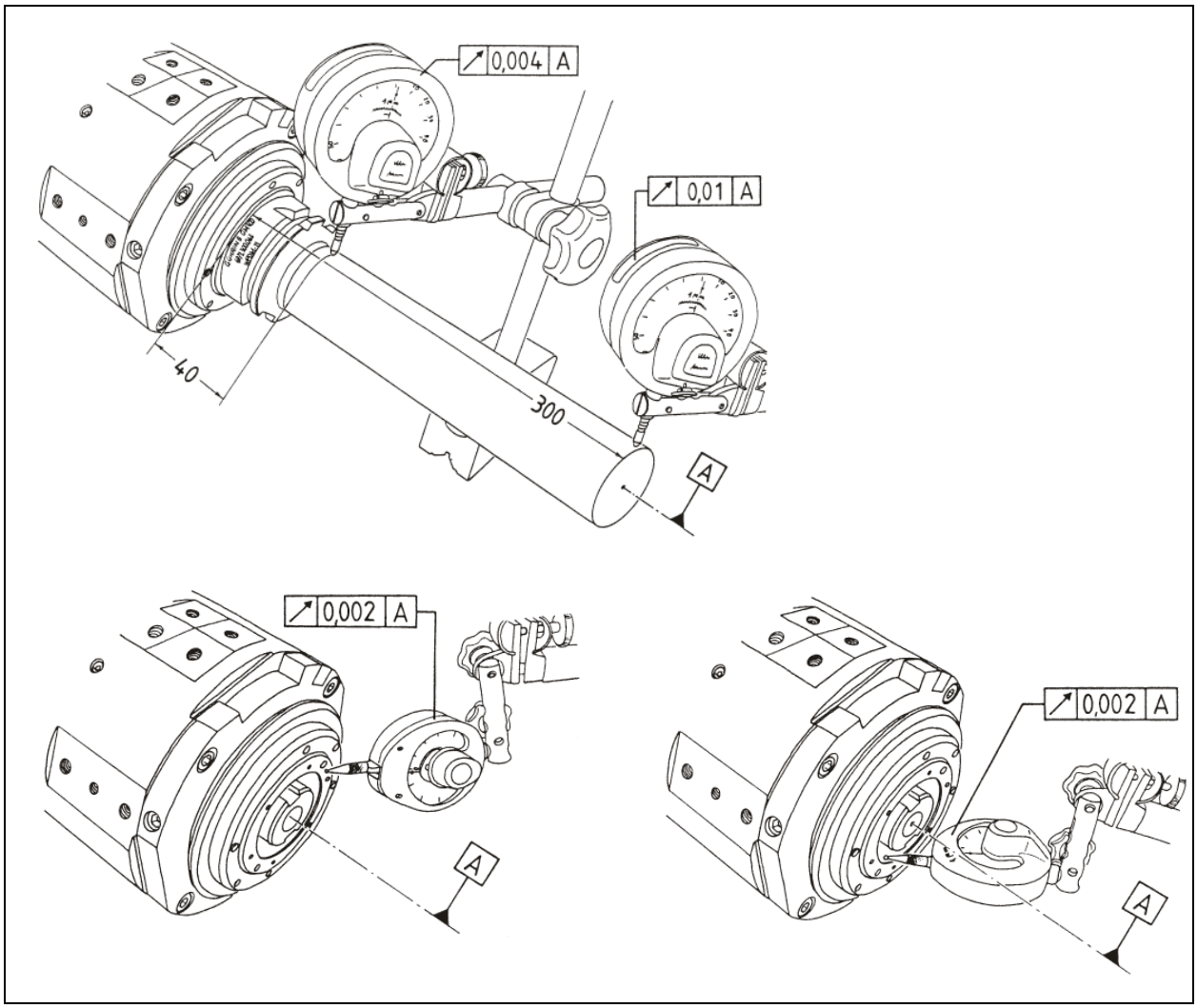


Fig. 19 Checking runout of the motor spindle

10.5 Setting the Status Initiator of the Tool Voltage

Volt values are reported to the electrical controller by the "tool voltage" module. To get the three signals:

- tool voltage in "clamped without tool" position
- tool voltage in "clamped with tool" position
- tool voltage in the "released" position.

an analogue sensor (1) is used. A Volt value is output respectively for the three positions depending on the switching distance between the sensor (1) and the switching ring (3).
The following work steps must be performed if the sensor has to be changed:

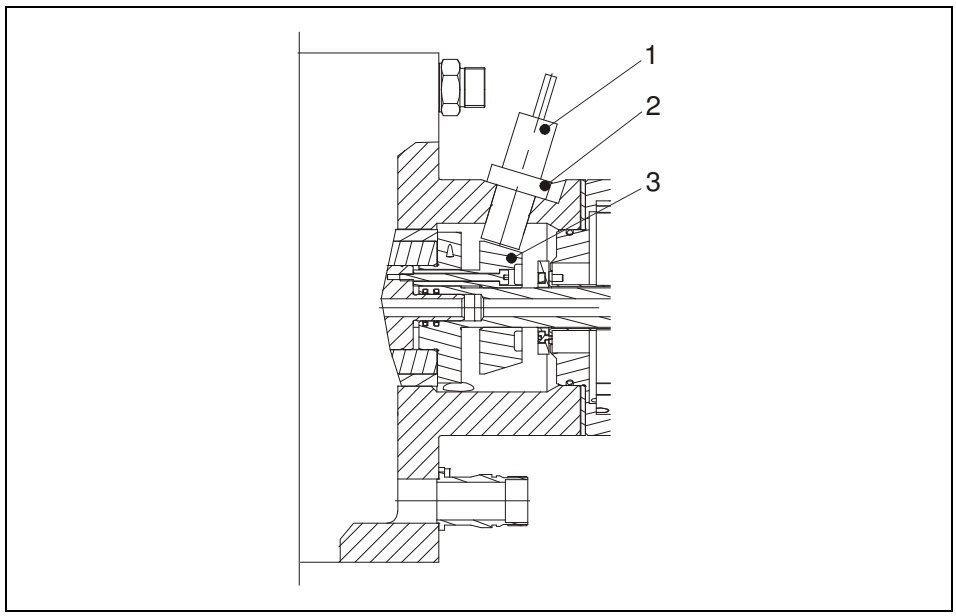


Fig. 20 Analogue sensor of the tool voltage

1 analogue sensor
2 nut
3 switching ring

1) Remove existing tool from the motor spindle so that the module adopts the "clamped without tool" position.
2) Remove the old sensor (1) and replace with a new one.
3) Turn the sensor (1) by hand to the stop on the switching ring (3).
4) Measure the protruding part of the sensor with a depth gauge.
5) Turn back the sensor 1 mm.
6) Turn in the inside nut (2) to the stop and lock with the outside nut.

Note

The sensor may not turn.

11 Tool Handling

11.1 HSK Tool Holder and Coolant Transfer Sets

Note

Do not use coolant pipes which do not comply with the following specification! Otherwise the motor spindle could be damaged!

Only use coolant pipes from KELCH or according to DIN 69895. Only this type is released by us because the pipes:

- are designed with a double O-ring (ensures flexibility and recoil)
- comply with DIN 69893-1 outer diameter for HSK 63-A = 12^{f8}
- satisfy our prescribed surface middle roughness of R_a max. 0.4 (ground surface).
- have a polished radius at the end which considerably reduces wear on the sealing ring.

The condition of the sealing ring proves whether it has been checked for tightness once a week. The warranty is voided in the event of motor spindle failure as a result of a worn sealing ring in the HSK tie bolt.

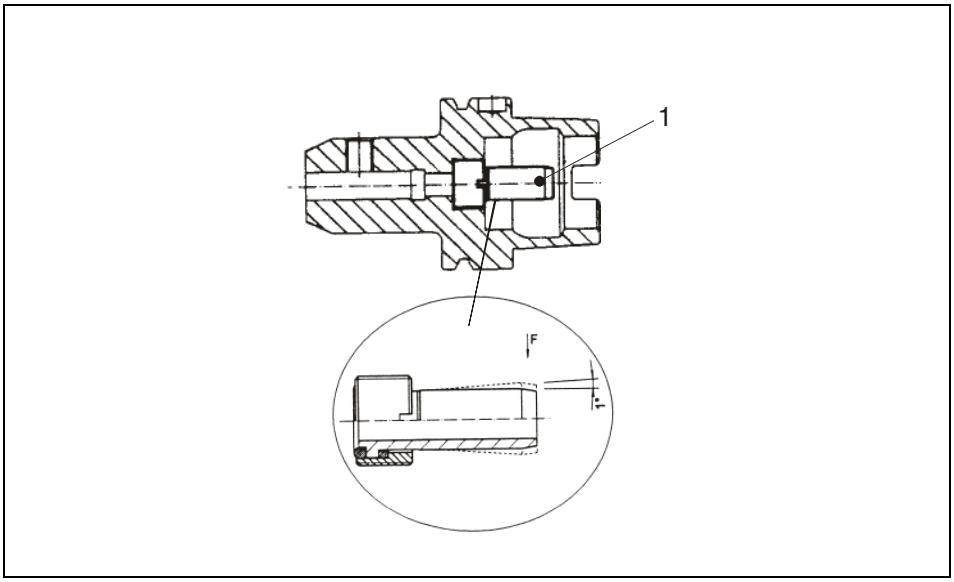


Fig. 21 Coolant transfer set

1 coolant pipe

- The coolant transfer set must be tightened correctly. The tightening torque is HSK 63-A = 15 Nm

- The thread may not come loose. It should be checked after a tool change but after 200 operating hours at the latest.
  - Tools (Allen keys) with the MAG drawing number AD.0057.5540 for HSK 63-A are available for fastening the coolant pipe (1).

11.2 Checking the 30° Clamping Angle

Caution

Dimensional deviations at the 30° clamping angle of the HSK tool holder can cause great material damage.

- No guarantee can be given in case of damage when using non-standard tool holders.
- Check all HSK tool holders for dimensional stability before use.
- Use measuring gauge from Kelch & Links GmbH or Mapal and proceed according to the operating instructions of Kelch & Links GmbH (see 12.3.2 supplier's instructions).

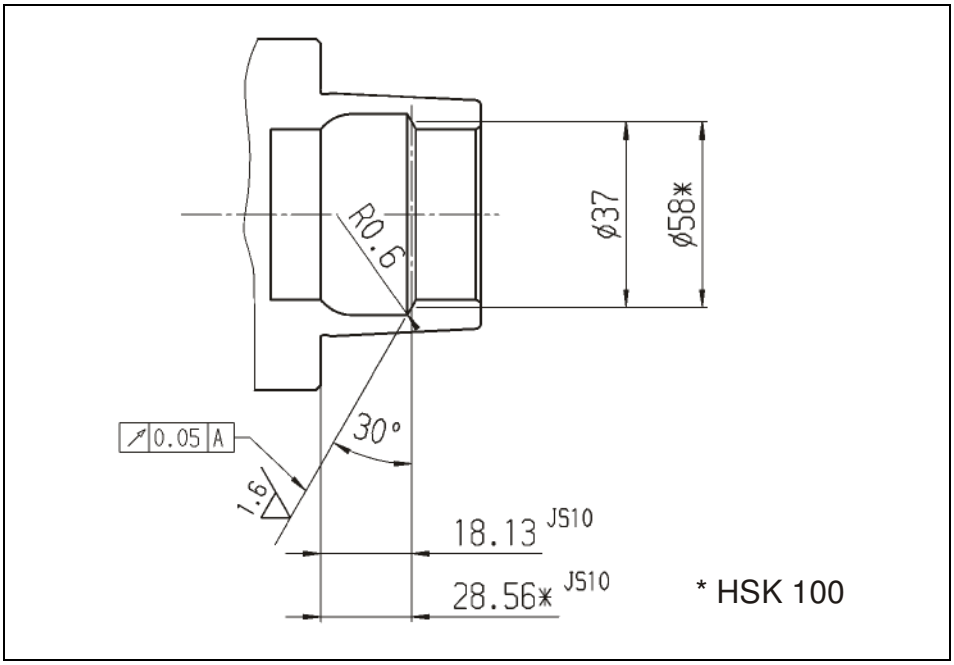


Fig. 22 30° clamping angle

11.3 Calculating the Tool Tilting Moment at the Gripping Groove (Static!)

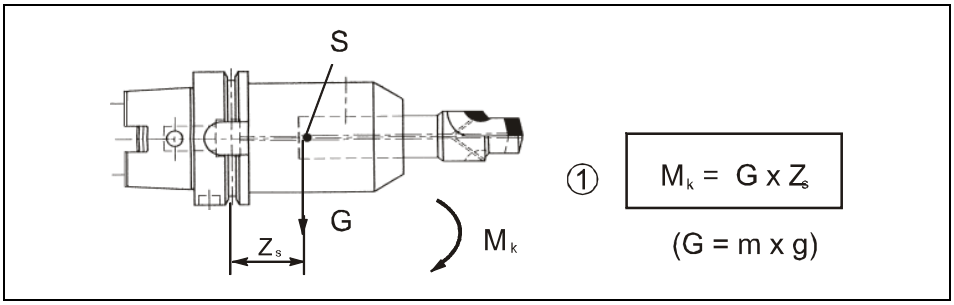


Fig. 23 Calculation of the tool tilting moment

M_k	Tool tilting moment [Nm]
G	Weight force [N]
Z_s	Distance of centre of gravity [m]
m	Mass of the tool [kg]
g	Gravity 9.81 m/s² ~ 10 m/s²
S	Centre of gravity

Note

The permissible tool weight and the max. tilting moment must be observed according to the machine specification.

Formula (1) (see Fig. 23) suffices in most cases! The tool weight is determined by weighing and the centre of gravity distance Z_S is estimated.

In tools which come close to the permissible tilting moment due to the named estimation, the following, exact calculation is recommended:

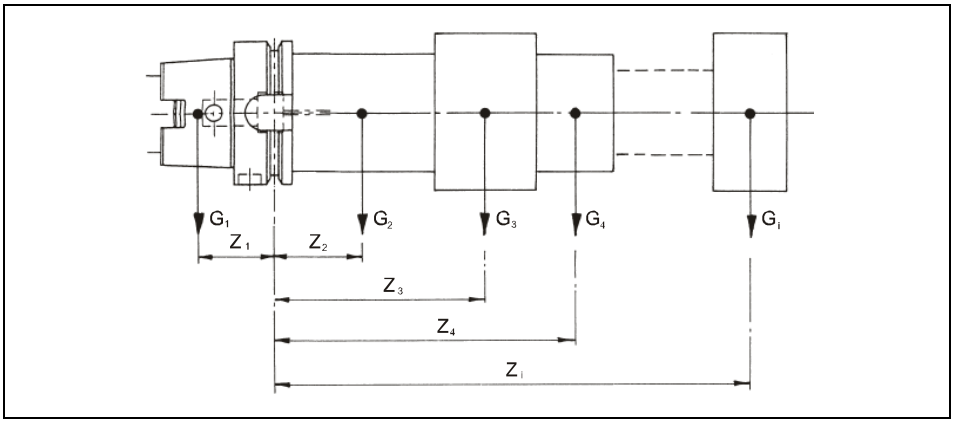


Fig. 24 Calculation by the individual moments

$M_k = G_2 \times Z_2 + G_3 \times Z_3 + G_4 \times Z_4 + ... + G_i \times Z_i - G_1 \times Z_1$
whereby $G_i = m_i \times g$ and m_i have to be calculated by the volumina.

11.4 Permissible Machining Forces on the Motor Spindle

Axial and radial forces act on the motor spindle during machining. The permissible limit values can be taken from the following formulae and tables.

Note

Exceeding of the limit values can shorten the life of the motor spindle considerably and cause damage to the tool clamping jaw and tool magazine. Extreme overloading leads to destruction of the bearing!

The machining forces on the motor spindle are divided into axial forces and radial forces whereby the radial forces can be critical especially in cutting operations with high feed values.
The radial force is made up of the circumferential force of the tool and the radial feed force. Both forces add up vector-wise to a total radial feed force of F_{perm}:

$$F_{perm} = \sqrt{F^2_{perm} + F^2_{rad}}$$

This radial force F_{perm} generates the tilting moment M on the motor spindle at a tool length L:

$$M = F_{perm} \times L$$

The maximum permissible tilting moment M_{max} depends on the spindle size and the pull-in force of the clamping jaw. The clamping jaw of the tool clamp can break on exceeding the permissible values. The bearing of the spindle is overloaded additionally. The life of the motor spindle is shortened accordingly.

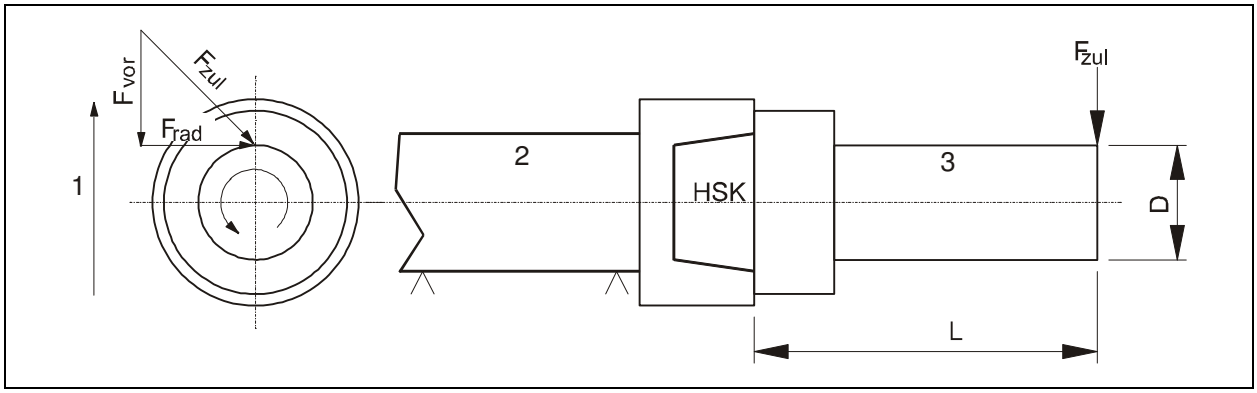


Fig. 25 Machining forces on the motor spindle

1 cutting direction
2 spindle
3 tool

Note

Combined loads must be calculated separately! The following values refer exclusively to the tool interface and the spindle bearing. The static rigidity must be calculated separately for far protruding tools.

Maximum tilting moment (tool interface): $M_{max} = F_{perm} \times L = 300$ Nm. Maximum feed force (radial forces spindle bearing X-Y): F_{perm} depending on the tool length L:

Speed	RPM	500	1000	2500	5000	8000	12000	16000
F1, radial	N	3810	3050	2250	1750	1520	1310	1200
Tool length	70	2807	2247	1658	1289	1120	965	884
	100	2658	2127	1569	1221	1060	914	837
	150	*2000*	1954	1441	1121	974	839	769
	200	*1500*	*1500*	1332	1036	900	776	711
	250	*1200*	*1200*	*1200*	963	837	721	661
	300	*1000*	*1000*	*1000*	900	782	674	617
	350	*860*	*860*	*860*	845	734	632	579
	400	*750*	*750*	*750*	*750*	691	596	546
	450	*670*	*670*	*670*	*670*	653	563	516
F, axial	N	6400	5000	3800	3000	2500	2200	2000

11.5 Safety-relevant Speeds

Tool or machining plans of the machine manufacturer contain cutting data default values. These data must be complied with.

Note

There are fixed application data for all tools. The tools must be checked for technical safety with regard to their rotation energies.
Tool speeds specified in the machine manufacturer's tool plan are therefore binding and may not be exceeded on any account.

11.6 Balancing Quality of the Used Tools

The balancing quality of the used tools has a decisive importance for the life of the spindle bearing and the components of the tool clamp.

Note

Generally only tools which comply with the balancing quality
G 2.5 at a balancing speed of 1.25 x operating speed may be used.

Limit value for expansion and shrink chucks with HSK interface:

HSK63-A: maximum 6.0 gmm/kg

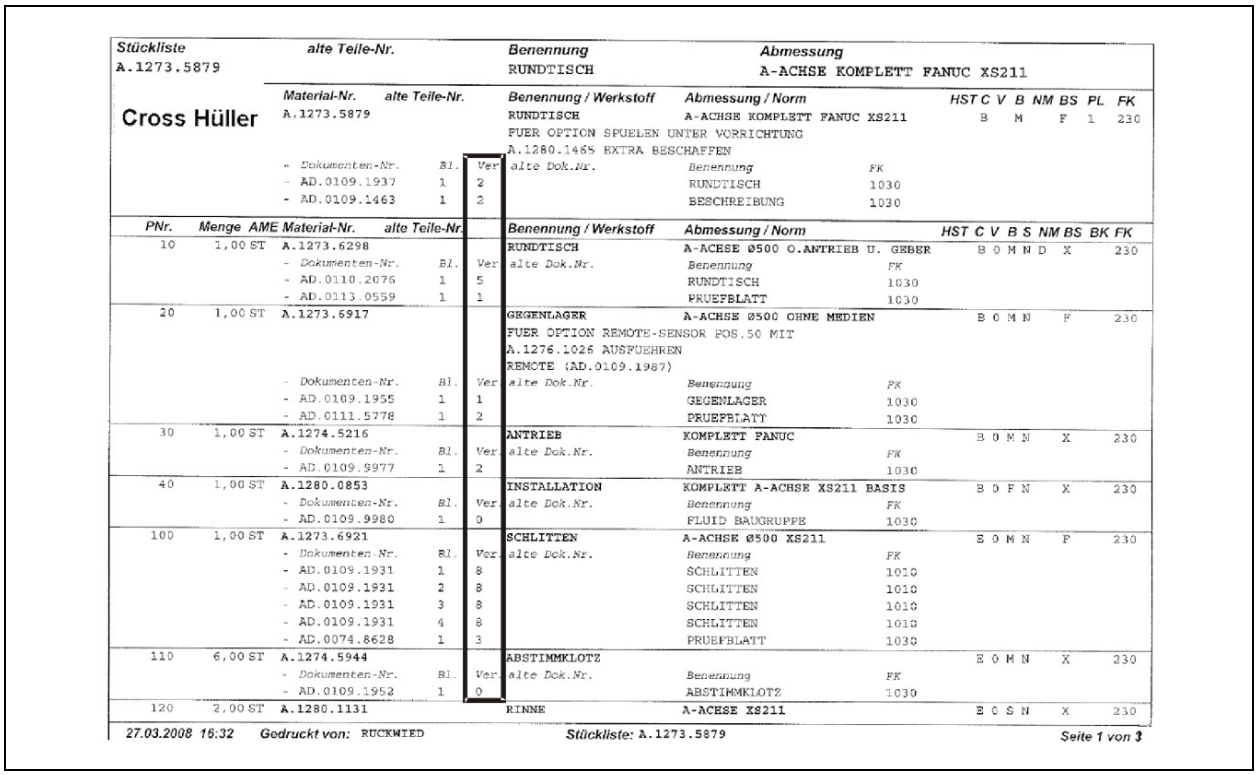
11.7 Maximum Mass Moment of Inertia of the Tools

The maximum mass moment of inertia of the tools is 0.03 kgm².
You must reduce the acceleration values of the spindle if this value is exceeded.

12 Appendix

12.1 Spare and Wearable Part Identification - Valency Code

You will find valency codes in the "Ver." column in the spare and wearable parts list:



Stückliste A.1273.5879 — alte Teile-Nr. — Benennung RUNDTISCH — Abmessung A-ACHSE KOMPLETT FANUC XS211

Cross Hüller

Material-Nr.	alte Teile-Nr.	Benennung / Werkstoff	Abmessung / Norm	HST	C	V	B	NM	BS	PL	FK
A.1273.5879		RUNDTISCH	A-ACHSE KOMPLETT FANUC XS211				B	M		F	1	230
		FUER OPTION SPUELEN UNTER VORRICHTUNG A.1280.1468 EXTRA BESCHAFFEN										

Dokumenten-Nr.	Bl.	Ver	alte Dok.Nr.	Benennung	FK
AD.0109.1937	1	2		RUNDTISCH	1030
AD.0109.1463	1	2		BESCHREIBUNG	1030

PNr.	Menge	AME	Material-Nr.	alte Teile-Nr.	Benennung / Werkstoff	Abmessung / Norm	HST	C	V	B	S	NM	BS	BK	FK
10	1,00	ST	A.1273.6298		RUNDTISCH	A-ACHSE Ø500 O.ANTRIEB U. GEBER		B	O	M	N	D	X		230
			Dokumenten-Nr.	Bl.	Ver	alte Dok.Nr.	Benennung	FK							
			AD.0110.2076	1	5		RUNDTISCH	1030							
			AD.0113.0559	1	1		PRUEFBLATT	1030							
20	1,00	ST	A.1273.6917		GEGENLAGER	A-ACHSE Ø500 OHNE MEDIEN		B	O	M	N		F		230
					FUER OPTION REMOTE-SENSOR POS.50 MIT A.1276.1026 AUSFUEHREN REMOTE (AD.0109.1987)										
			Dokumenten-Nr.	Bl.	Ver	alte Dok.Nr.	Benennung	FK							
			AD.0109.1955	1	1		GEGENLAGER	1030							
			AD.0111.5778	1	2		PRUEFBLATT	1030							
30	1,00	ST	A.1274.5216		ANTRIEB	KOMPLETT PANUC		B	O	M	N		X		230
			Dokumenten-Nr.	Bl.	Ver	alte Dok.Nr.	Benennung	FK							
			AD.0109.9977	1	2		ANTRIEB	1030							
40	1,00	ST	A.1280.0853		INSTALLATION	KOMPLETT A-ACHSE XS211 BASIS		B	O	F	N		X		230
			Dokumenten-Nr.	Bl.	Ver	alte Dok.Nr.	Benennung	FK							
			AD.0109.9980	1	0		FLUID BAUGRUPPE	1030							
100	1,00	ST	A.1273.6921		SCHLITTEN	A-ACHSE Ø500 XS211		B	O	M	N		F		230
			Dokumenten-Nr.	Bl.	Ver	alte Dok.Nr.	Benennung	FK							
			AD.0109.1931	1	8		SCHLITTEN	1010							
			AD.0109.1931	2	8		SCHLITTEN	1010							
			AD.0109.1931	3	8		SCHLITTEN	1010							
			AD.0109.1931	4	8		SCHLITTEN	1010							
			AD.0074.8628	1	3		PRUEFBLATT	1030							
110	6,00	ST	A.1274.5944		ABSTIMMKLOTZ			B	O	M	N		X		230
			Dokumenten-Nr.	Bl.	Ver	alte Dok.Nr.	Benennung	FK							
			AD.0109.1952	1	0		ABSTIMMKLOTZ	1030							
120	2,00	ST	A.1280.1131		RINNE	A-ACHSE XS211		B	O	S	N		X		230

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Fig. 26 "Ver." column with valency code

The life of the component can be determined from these valency codes:

Valency code	Explanation
1	Life up to 2 000 operating hours
2	Life up to 4 000 operating hours
3	Life up to 10 000 operating hours
4	Life up to 20 000 operating hours
5	Life more than 20 000 operating hours
6	Devices (fluid or electrical purchased parts without wear but with long delivery time. These parts should be kept on stock to avoid failure!)
7	Part contact (parts which have to be inspected and changed at regular intervals such as safety discs, hydraulic hoses, etc.)
0	not spare and wearable part

12.2 Manufacturer Declaration

12.3 Supplier Instructions

12.3.1 Tool Clamp Operating Manual - Ott-Jakob Spanntechnik GmbH

AD.0109.5778-4

12.3.2 Operating Instructions Firma Kelch&Links

12.3.3 Position Encoder Configuration Manual Siemens