Configuration Manual 04/2008 Edition

ECS Motor Spindle

2SP1

simodrive

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SIMODRIVE

ECS Motor Spindle 2SP1

Configuration Manual

04/2008 Edition

Designation of the documentation

Printing history

Brief details of this edition and previous editions are listed below.

The status of each edition is shown by the code in the ”Remarks” column.

Status code in the ”Remarks” column:

A . . . . . New documentation
B . . . . . Unrevised reprint with new Order No.
C . . . . . Revised edition with new status

Edition	Order No.	Remark
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The controller may support functions that are not described in this documentation. However, no claim can be made regarding the availability of these functions when the equipment is first supplied or in the event of servicing.

We have checked that the contents of this document correspond to the hardware and software described. Since deviations cannot be precluded entirely, we cannot guarantee complete conformance. The information given in this publication is reviewed at regular intervals and any corrections that might be necessary are made in the subsequent printings. Suggestions for improvement are also welcome.

Subject to change without prior notice.

Order No. 6SN1 197–0AD04–0BP4
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Siemens Aktiengesellschaft

Foreword

Information on the documentation

You will find an overview of the publications, which is updated on a monthly basis, in the available languages on the Internet under: http://www.siemens.com/motioncontrol.

Follow the menu items ”Support” → ”Technical Documentation” → ”Overview of Documents”.

The Internet version of DOConCD (DOConWEB) is available at:

http://www.siemens.com/motioncontrol under menu option ”Support”.

Target group

Planners and project engineers

Benefits

The Configuration Manual supports you when selecting motors, calculating the drive components, selecting the required accessories as well as when selecting line and motor–side power options.

Standard scope

The scope of the functionality described in this document can differ from the scope of the functionality of the drive system that is actually supplied. Other functions not described in this documentation might be able to be executed in the drive system. However, no claim can be made regarding the availability of these functions when the equipment is first supplied or in the event of servicing. The OEM documents any supplements or changes that he makes.

For reasons of transparency, this documentation does not contain all detailed information about all types of the product and cannot cover every conceivable case of installation, operation, or maintenance.

Technical Support

	Europe/Africa	Asia/Australia	America
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Note

Country telephone numbers for technical support are provided under the following Internet address: http://www.siemens.com/automation/service&support

Calls from the German fixed line network are charged (e.g. at 0.14 €/min). Charges of other phone services may be different and may vary.

Questions about the manual

If you have any questions (suggestions, corrections) regarding this documentation, please fax or e-mail us at:

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A fax form is available at the end of this document.

EC Declaration of Conformity

The EC Declaration of Conformity for the EMC Directive can be found/obtained in the Internet: http://www.ad.siemens.de/csinfo

under the Product/Order No. 15257461 or at the relevant branch office of the A&D MC Division of Siemens AG.

Definition of qualified personnel

For the purpose of this documentation and warning information on the product itself, qualified personnel are those personnel who are familiar with the installation, mounting, start-up and operation of the equipment and the hazards involved. They must have the following qualifications:

- Trained and authorized to energize/de-energize, circuits and equipment in accordance with established safety procedures.
- Trained in the proper care and use of protective equipment in accordance with established safety procedures.
- First aid training.

Explanation of symbols

The following danger and warning concept is used in this document:

Danger

This symbol is always used if death, severe personal injury or substantial material damage **will** result if proper precautions are not taken.

Warning

This symbol is always used if death, severe personal injury or substantial material damage **can** result if proper precautions are not taken.

Caution

This symbol is always used if minor personal injury or material damage **can** result if proper precautions are not taken.

Caution

The warning note (without a warning triangle) means that material damage **can** occur if proper precautions are not taken.

Notice

This warning note indicates that an undesirable result or an undesirable status **can** occur if the appropriate information is not observed.

Note

In this document, it can be advantageous to observe the information provided in a Note.

Danger and warning information

Danger

- Start–up/commissioning is absolutely prohibited until it has been completely ensured that the machine, in which the components described here are to be installed, is in full compliance with the specifications of Directive 98/37/EC.
- Only appropriately qualified personnel may commission the SIMODRIVE units and the motor spindles.
- This personnel must take into account the technical customer documentation belonging to the product and be knowledgeable and observe the specified information and instructions on the hazards and warnings.
- Operational electrical units and motor spindles have parts, components and electric circuits that are at hazardous voltage levels.
- When the machine or system is operated, hazardous axis movements can occur.
- All of the work carried–out on the electrical machine or system must be carried–out with it in a no–voltage condition.
- SIMODRIVE drive units are designed for operation on low–ohmic, grounded line supplies (TN line supplies).
- SIMODRIVE units with motor spindles may only be connected to the line supply through residual–current operated circuit–breakers, if corresponding to EN 50178, Chapter 5.2.11.2, it has been proven that the SIMODRIVE drive unit is compatible with the residual–current operated circuit–breaker.

Warning

- Perfect and safe operation of these units and motors assumes professional transport, storage, mounting and installation as well as careful operator control and servicing.
- The information provided in Catalogs and quotations additionally applies to special versions of units and motors.
- In addition to the danger and warning information/instructions in the technical customer documentation supplied, the applicable domestic, local and plant–specific regulations and requirements must be carefully taken into account.

Caution

- It is not permissible that temperature–sensitive parts – e.g. cables or electronic components – are in contact or mounted to the motor spindle.
- When handling cables, please observe the following:
  - They may not be damaged,
  - they may not be stressed,
  - they cannot come into contact with rotating parts.

Caution

- SIMODRIVE units with motor spindles are subject to a voltage test corresponding to EN50178 as part of the routine test. While the electrical equipment of industrial machines is being subject to a voltage test in compliance with EN 60204-1, Section 19.4, all of the SIMODRIVE equipment connections must be disconnected/withdrawn in order to avoid damaging the SIMODRIVE equipment.
- It is not permissible to directly connect the motor spindles to the three–phase line supply as this will destroy the motor spindles.

Notes

- SIMODRIVE equipment with motor spindles fulfill, in the operational state and in dry operating areas, the Low–Voltage Directive 73/23/EEC.
- SIMODRIVE equipment with motor spindles fulfill, in the configurations which are specified in the associated EC Declaration of the Conformity, the EMC Directive 89/336/EEC.

Notes on ESDS

Caution

Electro**S**tatic **D**ischarge **S**ensitive Devices (ESDS) are individual components, integrated circuits, or modules that can be damaged by electrostatic fields or discharges.

Handling regulations for ESDS:

- When handling components, make sure that personnel, workplaces, and packaging are well earthed.
- Electronic components may only be touched by people in ESDS areas with conductive flooring if
  - These persons are grounded with an ESDS wrist band
  - They are wearing ESDS shoes or ESDS shoe grounding strips.
- Electronic boards should only be touched if absolutely necessary.
- Electronic boards must not come into contact with plastics or items of clothing containing synthetic fibers.
- Electronic modules must only be placed on conductive surfaces (table with ESDS surface, conductive ESDS foam, ESDS packaging, ESDS transport container).
- Electronic boards may not be brought close to data terminals, monitors or television sets. Minimum clearance to the screen > 10 cm.
- Measurements must only be taken on boards when:
  - the measuring unit is grounded (e.g. via a protective conductor) or
  - when floating measuring equipment is used, the probe is briefly discharged before making measurements (e.g. a bare–metal control housing is touched).

Products from third–party manufacturers

The products from third–party manufacturers described in this document are products which we know to be essentially suitable. It goes without saying that equivalent products from other manufacturers may be used. Our recommendation should only be considered as such and not as a specification. We cannot accept any liability for the quality and properties/features of third–party products.

■

Table of Contents

Space for your notes

Safety Information 1

The specific issues relating to the functional safety of the motor spindle are explained in this Chapter. These functional safety issues involve defining and monitoring the spindle and tool–related speed limit values.

Table 1-1 Safety measures required

Measures to protect against	
Electric shock	**Potentially hazardous motion**
The spindle has the appropriate design. This means that there are no different measures required than are otherwise applied for motors. Measures are not specifically described here.	With reference to safe stopping, there are no different measures required than are otherwise applied for motors. **Specific for motor spindles:** **Functional safety** by defining and monitoring the spindle and tool–related **speed limits**.

1.1 Protection against potentially hazardous motion

In the following text, at several locations, reference will be made to the SINUMERIK Safety Integrated® safety package. The requirements relating to machine safety and the possibilities of using Safety Integrated® for machine tools is described in the associated Safety Integrated – Application Manual, especially in Chapters 1 and 5.

The 2SP1 motor spindle fulfills all of the relevant EU Directives. It is also possible, beyond this, to use the Safety Integrated® option. These are certified according to the EC–type examination test carried–out by a German regulatory body.

Depending on the operating mode (e.g. setting–up, production) of the machine, motor spindles, just like feed drives, represent a specific, potential hazard. This must be taken into account when designing and engineering the machine.

Precautions

The protective goals of the EC Machinery Directive must be fulfilled by applying suitable protective measures. It is important that the machine is correctly used.

In order to implement these protective goals, in addition to being knowledgeable about the applicable standards and Directives, it is also necessary to carefully observe the information and instructions in this Configuration Manual (refer to Table 1-2).

Table 1-2 Target group–specific documentation on the 2SP1 motor spindle

Target group	Task of the target group	Relevant documentation
Machine OEMs/ designers	– Carry–out a risk analysis – Draw–up a safety concept – Provide the necessary safety equipment at the machine – Instruct the operating company about the ”correct use” of the machine and spindle	Configuration Manual and Operating Instructions
Company operating the machine	– Inform/train employees about the ”correct use” of the spindle and the application of the safety functions and how they work – Reference to residual risks	Operating Instructions

When applied to the motor spindle, the potentially hazardous motion is when the maximum permissible speed for the spindle and/or tool is exceeded (refer to Figs. 1-1 and 1-2).

Speed monitoring

Table 1-3 Possible strategies to monitor the speed

Degree of reliability of the speed monitoring which is strived for	Features and requirements of the technology used
Standard	Can be implemented (without additional technology) using the **existing** operating and machine **technology**
Safe	Must be implemented in a **safety–related fashion** (e.g. through two channels).
	Must correspond to the required control category (according to **EN 954-1**).
	Must be **authorized/certified** for specific machines.

When using a machine tool spindle, the machinery construction OEM is always responsible in taking the appropriate measures to detect and to avoid speeds that are not permitted and their associated effects – and to instruct the company using the machine about these measures.

When an inadmissible speed occurs, then the spindle must be stopped. In this case, the limit value is interpreted as that value where the maximum permissible speed is exceeded. This limit value depends on the following factors:

- Operating state (setting–up or automatic mode)
- Tool which is currently being used (refer to Fig. 1-1)
- Maximum permissible spindle speed (refer to Fig. 1-2)

Table 1-4 Measures to prevent the maximum speed being exceeded and its effects

Level of the measures	Example of safety measures
Preventing the speed being exceeded	– Monitoring the spindle speed – Activating tool–specific limit values – Monitoring operational and cutting parameters – Monitoring the tool condition
Controlling the effect when the speed is exceeded	– Providing machine panels which can withstand the maximum impact of pieces which are thrown off at the maximum energy which can be assumed – Ensure that these machine panels can only be opened at a defined low spindle speed – Automatic stopping when faults/errors occur

Future–oriented strategies which are applied to limit risks, distinguish themselves by the fact that they are measures which are practical and safe and which are designed to avoid faults and errors. This means that the machinery construction company has a certain degree of flexibility in appropriately reducing the costs involved to control faults and errors.

Safety Integrated as a measure to avoid faults

Safety Integrated is an efficient measure which is optionally available at the fault prevention level. It can be used to monitor the drive functions.

The basic Safety Integrated® principle is based on a two–channel monitoring function. This means that the requirements from the EC Machinery Directive can be simply and cost–effectively fulfilled.

Example for Safety Integrated®:
The maximum energy of broken tool pieces, flung–out, can be safely limited using Safety Integrated by activating the tool–specific limit value. This means that the costs and resources which would otherwise be incurred for providing the appropriate machine panels with the corresponding strength, can be significantly reduced.

Table 1-5 Excessive speed – fault prevention using Safety Integrated®

Type of error	Avoided by ...
Excessive spindle speed	– ”Safely reduced speed” – Safe spindle stopping when faults occur
Excessive tool speed (for tools whose maximum speed lies below the maximum spindle speed)	– ”Safely reduced speed” as a function of the tool being used – The tool is detected in a safety–related fashion by ”safely reading” the tool coding, or – The tool is detected in a safety–related fashion by reading the tool coding and making a comparison with the program parameters – Safety–related stopping of the spindle

1.2 Speed limits

The spindle is designed for a maximum operating speed. This is specified as ”maximum speed” in Chapter 10. The operating company can use this speed in operation.

Maximum operating speed

The maximum operating speed is the highest speed that the spindle can be operated at. This speed can be saved in the control and part programs.

Shutdown speed

The speed limit, where the system is shutdown if this value is exceeded, is designated in this document as **”Shutdown speed”**.

The machinery construction manufacturer (OEM) defines this taking into account the secondary conditions and limitations which apply to the spindle and tool. The shutdown speed should be defined so that shutdown does not occur during normal operation and, on the other hand, the spindle system and tool are not overloaded due to speed peaks which are permitted. The spindle must be shutdown if erroneous functions occur and the speed is exceeded. Standard technology or also safety–related technology can be used to monitor the speed (refer to Table 1-3).

Adapting the shutdown speed to various tools

If the maximum speed, which is permitted for the tool currently being used, lies below the maximum operating speed of the spindle, then the speed monitoring and the shutdown speed must be adapted to the particular tool.

Warning

The shutdown speed may only be set a maximum of 15% above the maximum operating speed of the spindle.

The shutdown speed may not be set higher than the permitted maximum speed of the tool. The maximum operating speed, programmed for the tool, must be limited to a value, which lies a minimum of 5% below the shutdown speed (refer to Fig. 1-1).

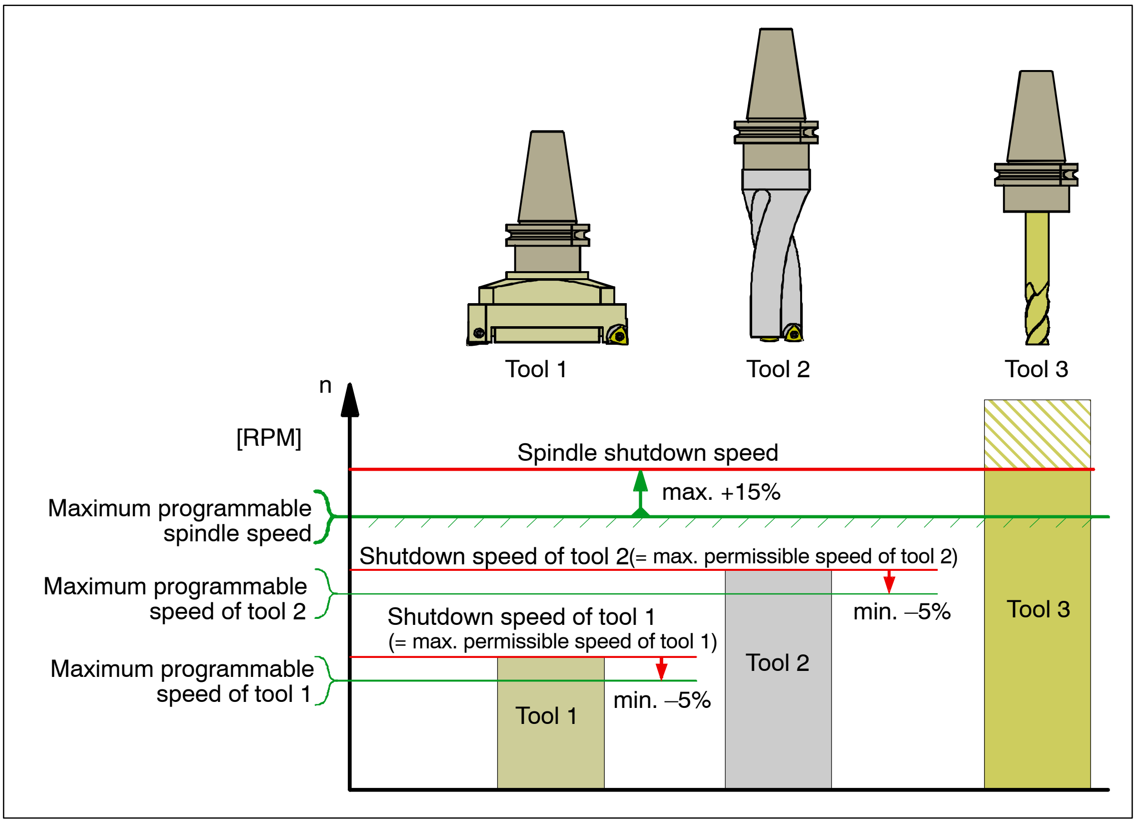


Fig. 1-1 Adapting the shutdown speed to various tools

Table 1-6 Translation for Fig. 1-1

English	German
RPM	Umdrehungen pro Minute
Maximum programmable spindle speed	Maximal programmierbare Drehzahl der Spindel
Maximum programmable speed of tool ...	Maximal programmierbare Drehzahl des Werkzeugs ...
Tool 1, Tool 2, Tool 3	Werkzeug 1, Werkzeug 2, Werkzeug 3
Spindle shutdown speed	Abschaltdrehzahl der Spindel
Shutdown speed of the tool	Abschaltdrehzahl des Werkzeugs
Max. permissible speed of tool ...	Maximal erlaubte Drehzahl für das Werkzeug...

Caution

If various shutdown speeds are programmed for various tools, then this must be adapted to the tool using the Tool Manager. The machinery construction manufacturer (OEM) is responsible in clearly indicating to the operating company that it is necessary to adapt the shutdown speed to the actual tool being used.

Critical speed

The critical speed is the speed where resonance vibration is excited in the complete mechanical structure.

Control–related speed peaks

The spindle speed is obtained as the result of a control (closed–loop) process. Depending on the particular controller setting and the load condition, it oscillates around the programmed setpoint. When the spindle is operated, it is therefore normal that the spindle shaft assumes speeds which briefly lie above the programmed operating speed. However, even if mechanical critical speeds are even briefly exceeded, this can result in excessive material stressing and in turn damage. This means that tools and spindle systems must be able to withstand normal speed peaks as a result of control operations.

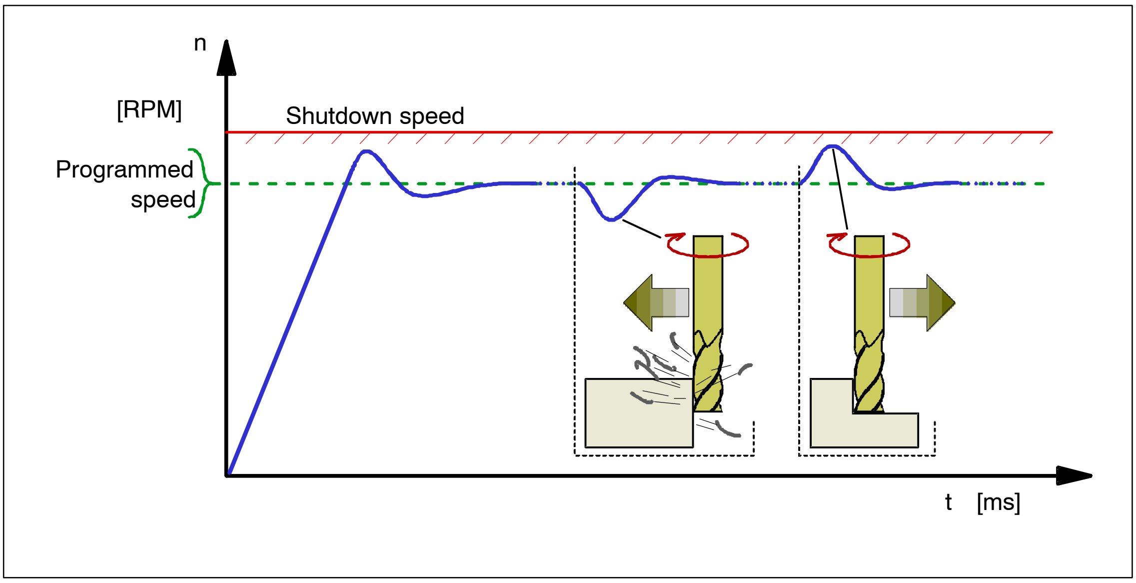


Fig. 1-2 Control–related speed peaks

Table 1-7 Translation for Fig. 1-2

English	German
RPM	Umdrehungen pro Minute
Programmed speed	maximale Betriebsdrehzahl
Shutdown speed	Abschaltdrehzahl

In order to ensure the appropriate degree of safety at all permitted operational speeds, the **speed peaks** must be taken into account when designing the machine (e.g. the natural resonance of the spindle support) and when selecting the tools.

This is the reason that the subjects relating to natural resonance and centrifugal force strength, discussed in Chapter 4, do not refer to the speed programmed for normal operation, but always refer to the **shutdown speed** which is higher.

1.3 Responsibility for providing information to the company operating the machine

Some of the information provided in this Configuration Manual must also be communicated to the machinery construction company (OEM).

It is the clear responsibility of the machinery construction company (or the company which markets the machine) to communicate the appropriate information and instructions to the company actually operating the machinery. Refer to Table 1-8 for a summary.

Table 1-8 Overview: Important information for the company operating the machine

Subject	Chapter
Instructing the company, operating the machine, about measures to detect and to avoid inadmissible speeds and their effects	1.1
Adapting the shutdown speed to the tool	1.2
In order to achieve the normal bearing lifetime, it is absolutely necessary that the air sealing system is correctly operated	4.3.1
The necessity to check the bearing load	4.3.3
Reference to possible damage when overloading the bearings	4.3.3
Information regarding the highest programmable angular acceleration = $\frac{15000\ \text{RPM}}{0.5\ \text{s}}$	4.3.5
Note that it is strictly forbidden to adjust the position of the clamping state sensors	4.5
Information on the the prerequisites which the tool must fulfill when used on an 2SP1 motor spindle	4.4.1
Reference to the potential hazards and potential damage when using tools which are not suitable	4.4.1

■

FAQ

2

2.1 What has to be observed after the equipment has been supplied?

Caution

Do not allow the crate with the spindle to fall.

Do not push–over the crate with spindle.

Always lay down the crate with spindle horizontally.

Only raise the crate using suitable equipment (fork–lift truck with the appropriate fork or crane).

The spindle may only be transported in the original crate.

While transporting the crate ensure that it is always in the horizontal position.

After the spindle has been supplied in the sealed packaging (wooden crate/foil), store it in a dry room with temperature control (10 to 35° C).

The spindle must be kept sealed in the packing until it is mounted/installed in the machine.

A maximum of 3 crates may be stacked on top of one another.

Fig. 2-1 Transport crate in which the spindle is shipped

2.2 How is a the shipment checked?

1. Place the crate with spindle in a horizontal position.
2. Remove the packaging straps using the appropriate shears.
3. Remove the crate cover (tools are not required).
4. Carefully open the foil.
5. Check that the contents are complete.
6. Check for damage during transport.
7. Re–package the spindle in the foil.
8. Close the crate using the cover and store (refer to Chapter 2.1).

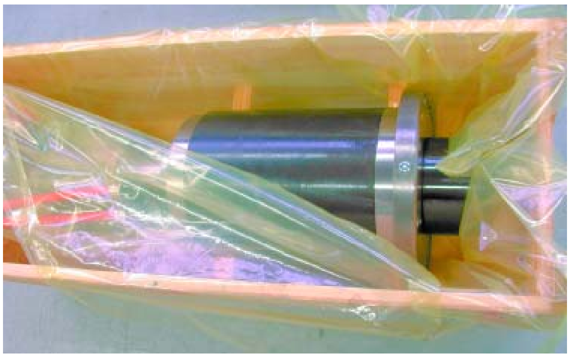


Fig. 2-2 To check the shipment open the foil

2.3 How is the spindle unpacked?

1. Screw the ring bolts (1) – supplied with the spindle – into the threads provided.
2. Attach the hoisting equipment to the ring bolts.
3. Lift the spindle from the crate in a horizontal position and place down on wooden blocks.

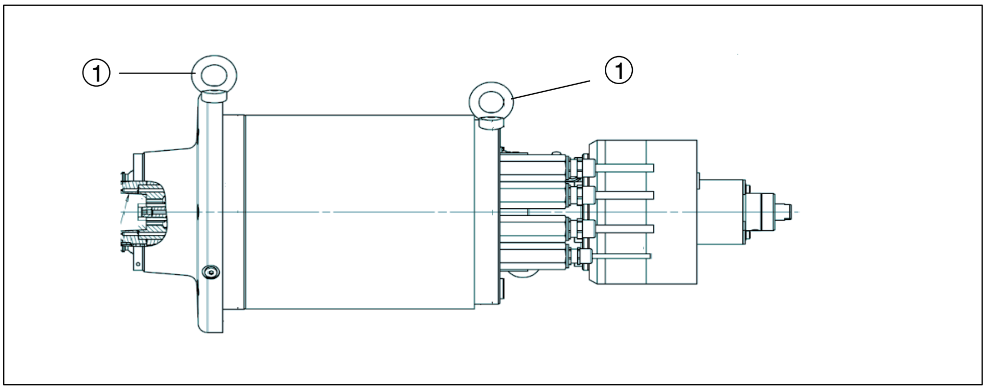


Fig. 2-3 Attaching the ring bolts (1)

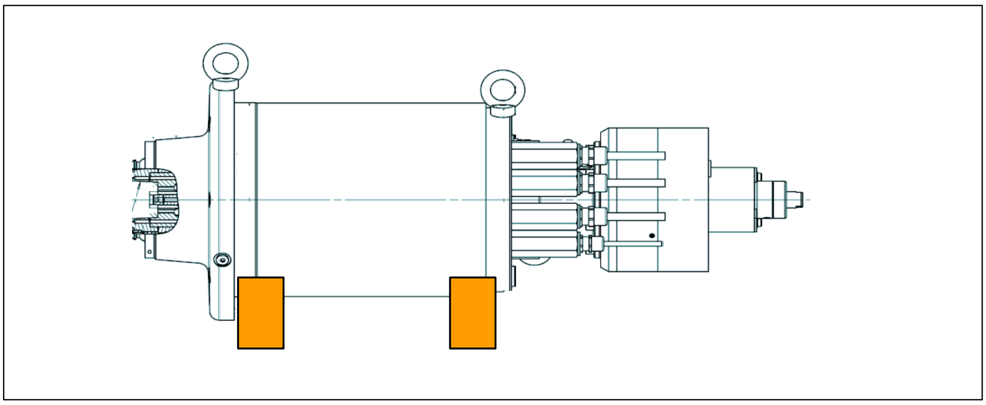


Fig. 2-4 Locating the spindle on the wooden V–shaped blocks in a horizontal position

Caution

Do not lift the spindle at the shaft (this will damage the bearings).

2.4 How is the spindle laid–down vertically?

1. Screw–in the 2 ring bolts into the bearing cover.
2. Cover the spindle head with a protective jacket (for the spindle jacket design, refer to Fig. 2-6.
3. Attach the hoisting equipment to the ring bolts attached to the bearing flange and carefully lift, refer to Fig. 2-5, Drawing A.
4. Carefully bring the spindle unit into the vertical position above the protective jacket, refer to Fig. 2-5, Drawing B. Secure the spindle so that it cannot slide. When bringing the spindle into the vertical position no force may be introduced into the shaft.
5. Set–down the spindle unit with protective jacket in the vertical position, refer to Fig. 2-5, Drawing C.

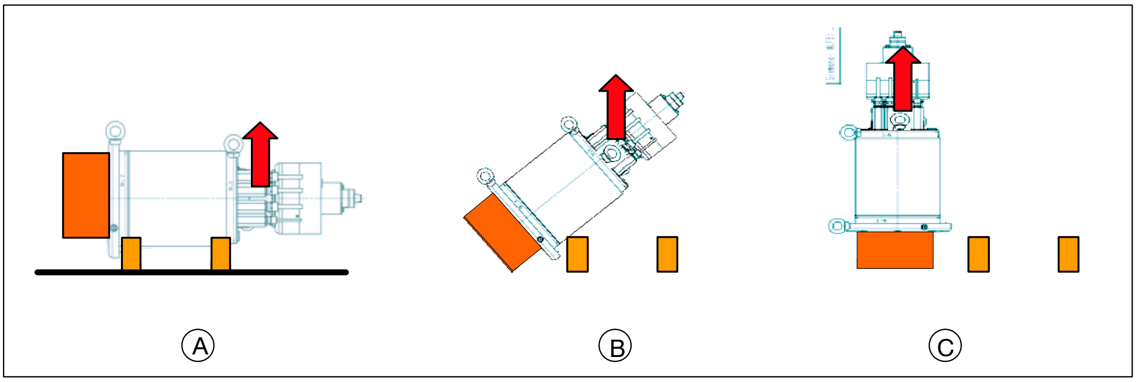
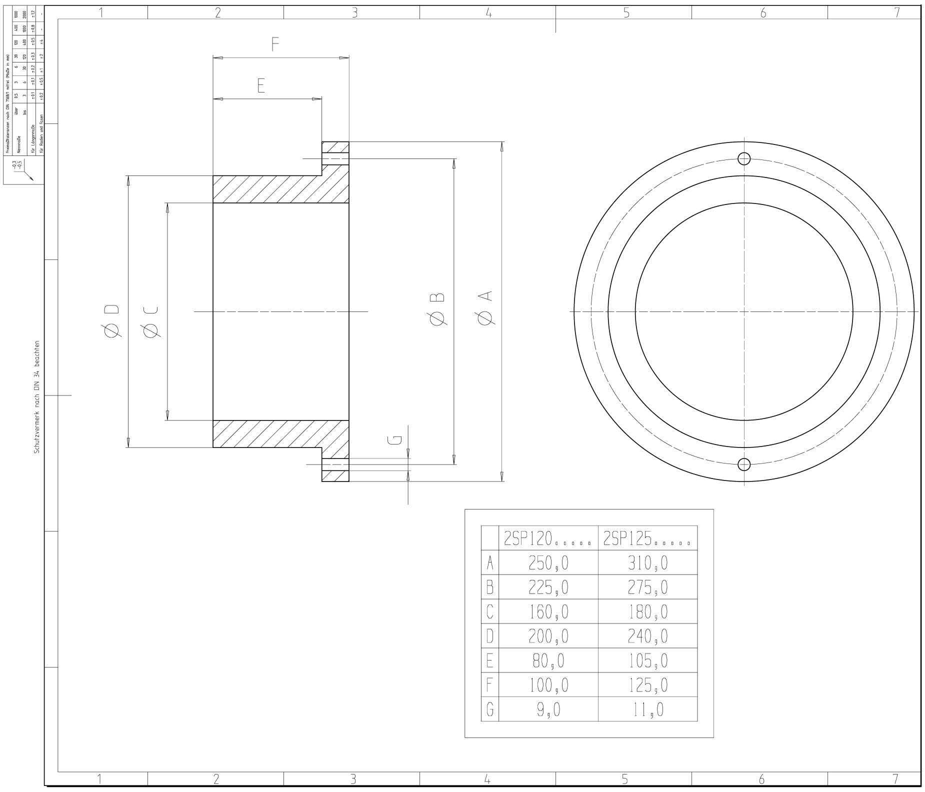


Fig. 2-5 Bringing the spindle into the vertical position



	2SP120.....	2SP125.....
A	250,0	310,0
B	225,0	275,0
C	160,0	180,0
D	200,0	240,0
E	80,0	105,0
F	100,0	125,0
G	9,0	11,0

Fig. 2-6 Protective jacket

2.5 How is the spindle installed/mounted?

1. Preparing the mounting location
   – The mounting location must be dry and dust–free
   – All of the required tools must be available
   – Only use suitable tools
2. Screw the ring bolts into the threads provided
3. Clean the spindle stock and apply a thin film of oil to the jointing surfaces
4. Horizontally/vertically install the spindle using the assembly equipment

---

Caution

Use guide rods to secure and support.

When mounting horizontally, also observe the alignment of the sealing air relief at the bottom.

Neither stress nor crush the power cable.

Do not apply excessive force when jointing (this could damage the bearings).

Tighten the flange retaining bolts with a tightening torque of 125 Nm.

2.6 Which media should be connected after mounting/installation?

- The inlet/outlet hoses for the motor cooling should attached. The correct assignment/inlet/outlet should be carefully observed. The supply pressures and flow rates must be checked against the specifications.
- The hose for the sealing air should be connected. Ensure that the supply pressure is correct.
- The hoses for ”release tool” and ”clamp tool” (hydraulic or pneumatic) should be connected. The supply pressures and flow rates must be checked against the specifications.

Notice

It is not permissible to close–off the ”clamp tool” bore. The transport plug must be removed.

- The hose for the tool purge air should be connected. Ensure that the supply pressure is sufficient correspond to the specifications.
- The hose for the optional internal tool cooling should be connected. Carefully observe the max. pressure specifications, excessive pressure will result in damage.

- The hose for the optional external tool cooling should be connected. Carefully observe the max. pressure specifications, excessive pressure will result in damage.
- For a detailed description, refer to section 6.

2.7 Which electrical connections must be made after mounting/installation?

- Electrical connections may not be made with the system under voltage (i.e. live).
- The power cables should be connected corresponding to the UVW coding (refer to the electrical data).
- The signal cable for rotary encoder and motor temperature should be connected. The coding to align the connector should be carefully observed (refer to sensors). Joint connections must be easy to rotate.
- The signal cables to monitor the clamping status should be connected (carefully observe the assignment of the sensors). The coding to align the connector should be carefully observed (refer to sensors). Joint connections must be easy to rotate.

2.8 What has to be checked before the spindle is commissioned?

- Check that the shaft can be easily manually rotated. For synchronous spindles, the slot notching (permanent magnet rotor) must be able to be felt.
- The setting dimension of the tool interface should checked. Dimensions and settings should be taken from the Operating Instructions.
- The tool draw–in force should be checked using the draw–in force measuring instrument (e.g. OTT Power Check). Pull–in forces, refer to the Operating Instructions.
- The switching logic for ”clamp tool” and ”release tool” should be checked (refer to the control). Checking the state ”clamped without tool”: Function check with the tool removed. Check the function of the other clamping states using the pull–in force measuring unit (”0” setting value for OTT power check). Check the ”draw bar in the release position” by manually releasing and check the function at the sensor and the PLC.
- It should be checked as to whether the sealing air discharge is available at the sealing gap at the spindle nose.
- Using compressed air it should be checked that the rotary seal does not leak before the cooling–lubricating medium is connected/switched–on (check for air leakage at the tool interface; no air should leak at the leakage opening of the rotary gland). The check must be made in the ”tool released” state.

2.9 What has to be observed when starting to work with the spindle?

Start of work

Check the tool interface to ensure that it is clean and if required, clean.

Switch–in the supply media (air, water).

When commissioning for the first time and when starting the machine from cold, the running–in and warm operating regulations must be carefully observed, refer to Chapter 4.3.2 or the Operating Instructions.

Notice

The spindle should already be in the warm operating state if the upper speed range is approached.

Running–in the spindle after longer non–operational periods

See Chapter 4.3.2 or the Operating Instructions.

■

2.9 What has to be observed when starting to work with the spindle?

Space for your notes

Function of the Spindle

3

Applications

The 2SP1 motor spindle is a high–speed directly–driven tool spindle for milling and drilling operations.

Fig. 3-1   2SP1 motor spindles

Features

The 2SP1 motor spindle is integrated into the SIMODRIVE drive system just like the feed and main spindle motors.

The drive motor and the tool holder of the spindle form a mechanical unit which has a common bearing system. This eliminates all of the generally used mechanical transmission elements, such as belts or toothed couplings. With the directly–driven 2SP1 motor spindle, the user has many advantages over conventional spindles with mechanical transmission elements. Further, directly–driven 2SP1 motor spindles are very compact. The advantages include:

- **High speeds** because there are no mechanical transmission elements
- **Smooth running properties** as a result of the stable balancing arrangement
- **Good speed stability**, good closed–loop speed control
- **High accuracy of the closed–loop position control**
- **Lower weight**, more compact dimensions
- **Lower mechanical design costs**, as all of the functions are integrated
- **Essentially compatible to the electrical drive system** as the spindle, drive converter and NC are engineered and supplied from a single source

3.1 Overview of the functionality

The 2SP1 motor spindle is ready to be built–in – and the functions that are required to operate a milling spindle and for drilling are already completely integrated in the system. This guarantees perfect interaction of the individual function elements and minimizes the mechanical design costs for the machinery construction company (OEM).

Table 3-1 Brief overview standard functions

Function	2SP1202 2SP1204	2SP1253 2SP1255
Tool holder	HSK A63	SK 40 for tools with non–symmetrical T sliding blocks [T–slot stones]
Tool clamping device	Released using a pneumatic cylinder, clamped using a spring assembly	Released using a pneumatic cylinder, clamped using a spring assembly
Tool cleaning	Compressed air	Compressed air
Working position	Horizontal, vertical	Horizontal, vertical
Housing	Cartridge with flange mounting	Cartridge with flange mounting
Bearing lubrication	Maintenance–free, permanently lubricated	Maintenance–free, permanently lubricated
Seal, bearing front	Sealing air	Sealing air
Hollow–shaft encoders	Incremental, sin/cos 1Vpp (256 pulses/rev) with zero mark	Incremental, sin/cos 1Vpp (256 pulses/rev) with zero mark
Thermal motor protection	KTY84–130 PTC for full thermal protection NTC PT3-51F, NTC K227 for third–party drive converters	KTY84–130
Sensor, clamping status (analog)	– Tool clamped – Draw bar in the release position – Clamped without tool	——
Sensor system, clamped status (digital)	– Position of the tool release unit	– Tool clamped [1)] – Draw bar in the release position – Clamped without tool
Cooling	Water–cooling	Water–cooling
Connections for the media	– for cooling – for sealing air – for air purge – to release the tool – to clamp the tool	– for cooling – for sealing air – for air purge – to release the tool – to clamp the tool
Electrical connections	– Power cable – Signal connectors for the encoder system and clamping state sensors	– Power cable – Signal connectors for the encoder system and clamping state sensors

1) All sensors for detection are required for an automatic tool change

Table 3-2 Brief overview of the possible options

Function	2SP1202 2SP1204	2SP1253 2SP1255
Tool cooling	– Inner tool cooling – Ring for external tool cooling	– Inner tool cooling
Max. speed	18,000 RPM	15,000 RPM (with HSK A63)
Thermal bearing monitor-ing	PT100	——
Tool clamping device	– Released using a hydraulic cylinder – Clamped using a spring assembly	——
Tool interface	——	BT 40, CAT 40, HSK A63

3.2 Drive motor

An integrated built–in motor drives the 2SP1 motor spindle. This built–in motor has a high torque and its rotor is directly mounted onto the tool spindle. The electric power is only fed to the stationary, outer section of the motor. The inner rotating part of the motor does not require any electric power.

These motor spindles are available in various speed classes. They are designed for dynamic load operations and can quickly follow changing torque requirements.

Synchronous/induction motors

Depending on the frame size, the following motor versions are available.

- Motor spindle as synchronous motor
- Motor spindle as induction motor (option)
  - The induction (asynchronous) motor version is prepared so that the torque can be adapted to the machining situation, for both the star and delta connection types. The operator can select the connection type as required (refer to Chapter 4.2).

Designs

The motor spindle is available in 2 types of construction in order to graduated the power demand:

- Short design
- Long design

3.3 Cooling concept

2SP1 motor spindles have integrated ducts to liquid–cool the stationary stator of the drive motor. The stator, which draws the electric drive power, represents the main source of power loss of the spindle unit. This is the reason that the cooling duct system is closely and thermally coupled to the drive motor stator. However, even sources of power loss (thermal energy) which are located further away are sufficiently cooled as a result of the integrated cooling ducts.

The spindle unit should be supplied with the cooling medium through a feed and return line. The cooling medium absorbs the power loss of the spindle which means that the cooling medium temperature appropriately increases. The cooling medium is cooled down to the original inlet temperature using an external cooling or heat–exchanger system mounted outside the spindle. This is the responsibility of the machinery construction company. A pump must be used to provide the necessary cooling medium pressure in the inlet line. This external pump is also the responsibility of the machinery construction company.

Refer to Chapter 6.2 for detailed basic data required to dimension and design the cooling medium supply.

3.4 Supply

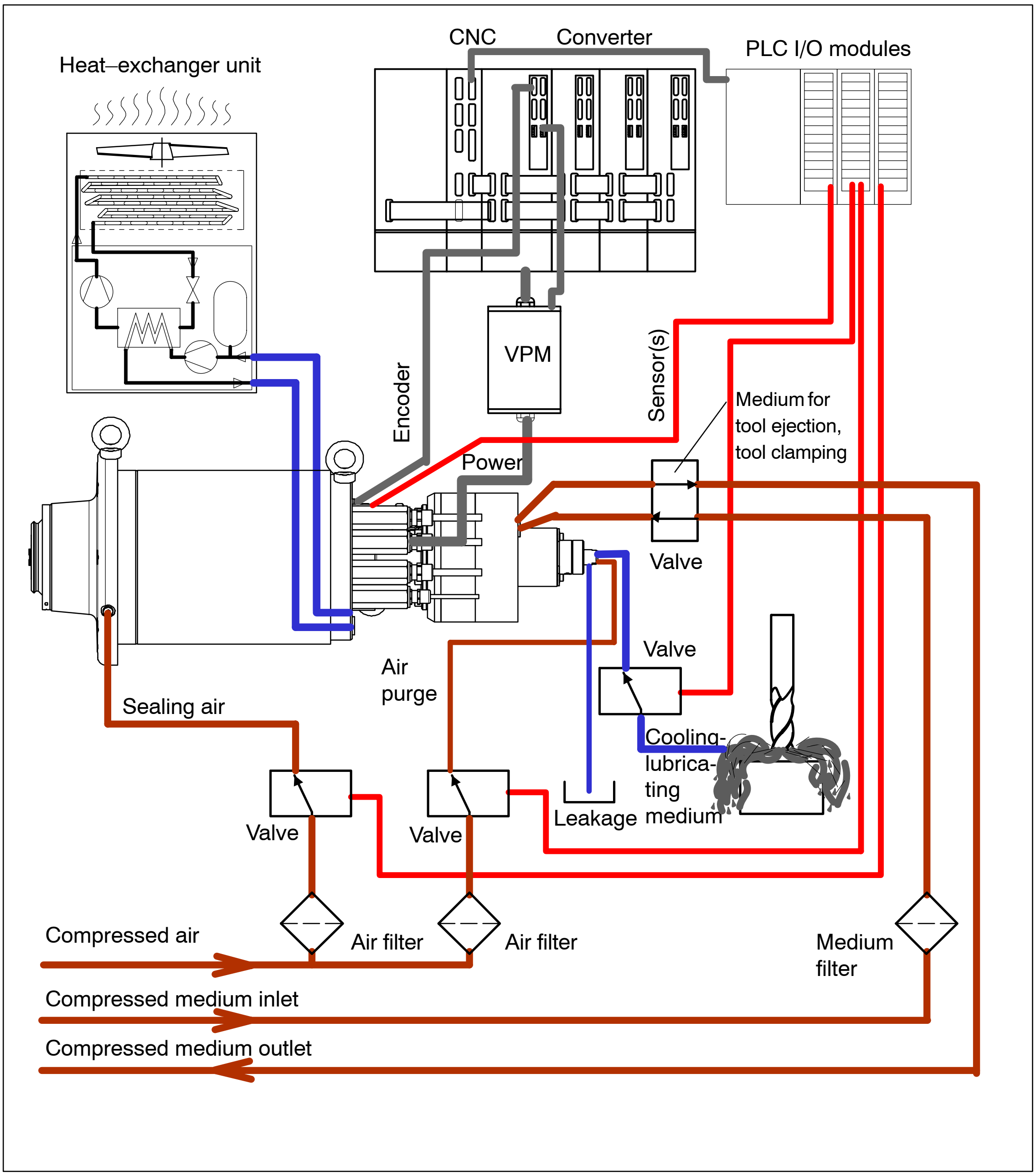


Fig. 3-2 Supplying the spindle

Table 3-3 Translation for Fig. 3-2

English	German
Motor spindle	Motorspindel
Compressed air	Druckluft
Compressed medium inlet	Druckmedium Zulauf
Compressed medium outlet	Druckmedium Rücklauf
Valve	Ventil
Air purge	Kegelreinigungsluft
Air filter	Luftfilter
Medium filter	Mediumfilter
Sealing air	Sperrluft
Medium for tool ejection, tool clamping	Medium für Werkzeug lösen, Werkzeug spannen
Cooling-lubricating medium	Kühlschmiermittel
Leakage	Leckage
Heat-exchanger unit	Wärmetauschersystem
Encoder	Geber
Sensor(s)	Sensor(en)
Electric power	Elektrische Leistung
Converter	Umrichter
PLC I/O unit	PLC Ein-/Ausgabeeinheit

2SP1 motor spindles have integrated function elements to operate and control the various operations and sequences. The following media must be provided for the spindle, either through suitable cables or hoses:

- **Electric power** for the **drive motor** (the consumption depends on the power drawn)
- **Cooling liquid** (continuous flow; load depends on the power level)
- **Compressed air or hydraulic oil** to actuate the tool clamping system – depending on the release unit type, either pneumatically or hydraulically operated (media only flows when releasing and clamping the tool)
- **Air purge** to clean the tool cone (this air is only used when releasing and ejecting the tool)
- **Sealing air** to protect the bearings from dirt accumulating (this air is continually used)
- **Optional cooling–lubricating medium supply** for internal tool cooling (the flow depends on the actual process)
- **Optional cooling–lubricating medium supply** for external tool cooling (the flow depends on the actual process)
- **24 V electrical supply** for the sensors to monitor the tool clamping state (power is continually drawn)
- **Power supply** for the **rotary encoder** (for SIEMENS drive converters, this is integrated in the encoder interface)

The requirements regarding the conditioning of the various media, and which are required to design and dimension the various units and equipment, are described in detail in Chapter 6 and Chapter 10.

■

4 Mechanical Data

The 2SP1 motor spindles allow operating companies to fully utilize the benefits of high–speed machining. At high speeds, the components involved in the machining operation are subject to significant levels of stress. This means that the machine must be mechanically designed to withstand the high speeds and the user must harmonize and align the tools and the process conditions to the load capability of the spindle.

4.1 Observing the shutdown speed

Even if the critical speed is briefly exceeded, the following can occur:

- Vibration of the spindle carrier (support structure),
- the centrifugal strength of the tools can be exceeded,

and excessive mechanical stress can cause damage.

Caution

The **shutdown speed** should be used **as basis for load assumptions and strength requirements.** It is not permissible to use the speed which can be programmed for operation (refer to Chapter 1.2).

4.2 Installation conditions

The spindle is integrated into the machine assembly as a complete unit. The static and especially the dynamic properties are obtained from the interaction between the spindle itself and the spindle carrier of the machine.

Degree of protection

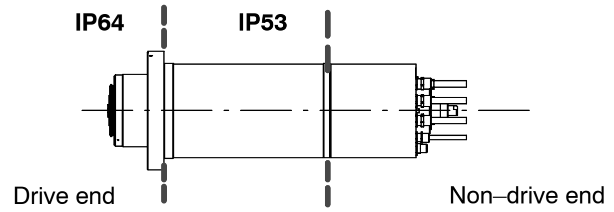


Fig. 4-1 Degree of protection of the 2SP120 spindle

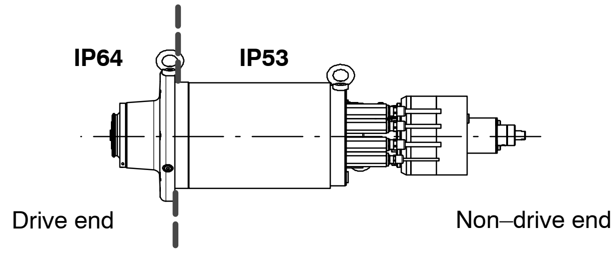


Fig. 4-2 Degree of protection of the 2SP125 spindle

Table 4-1 Translation for Fig. 4-2

English	German
Drive end	A-Seite
Non-drive end	B-Seite

Caution

The degree of protection refers to the ingress of water (DIN ISO EN 60034, Part 10). Cooling–lubricating mediums that contain oil, can creep and/or are aggressive, and can penetrate more than water.

Table 4-2 Degree of protection in front of and behind the mounting flange

	In front of the mounting flange (drive end)	Behind the mounting flange (non-drive end)
Degree of protection	IP64	IP53
Description	On the drive end, the spindle has a labyrinth seal and a connection for the sealing air. This therefore protects the spindle against the ingress of water spray and dirt. It is not permissible that cooling water acts directly on the labyrinth seal. The specifications for the sealing air must be carefully observed, refer to Chapter 6.3.1.	The spindle support design must guarantee suitable protection behind the mounting flange against the effects from the machining area.

Installing the spindle

The spindle must be installed in the machine so that liquids and dust–type dirt from the machining area cannot be permanently deposited on the spindle.

Caution

It is not permissible that spray water or other liquids are directly pointed at the sealing gap (labyrinth seal) or openings in the spindle (refer to Fig. 4-3).

It is not permissible that foreign bodies are drawn through the spindle. This is the reason that it is not permissible to have a pressure difference between the drive and drive–out sides.

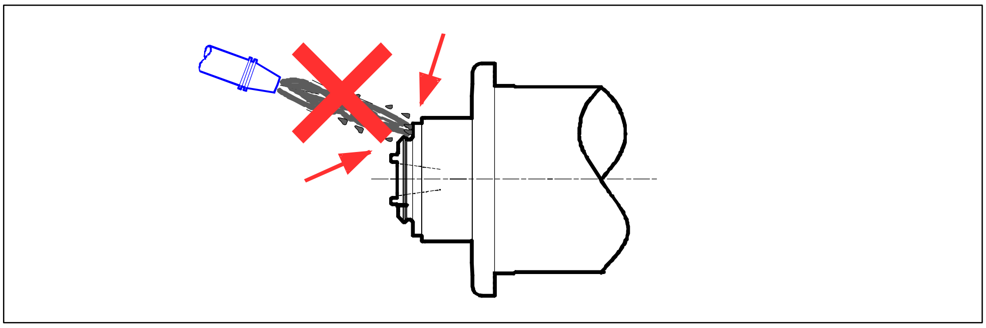


Fig. 4-3 The jet of cooling–lubricating medium may not be directly aimed at the labyrinth seal

Notice

Horizontal mounting:
When the spindle is mounted horizontally, the relief (compensating) holes for the sealing air, located at the spindle nose, must face downwards.

Orientation help: The position of the ring bolt thread, located at the retaining flange, when viewing the nose of the spindle from the front, must be inclined at a certain angle to the right (refer to Figs. 4-4 and 4-5).

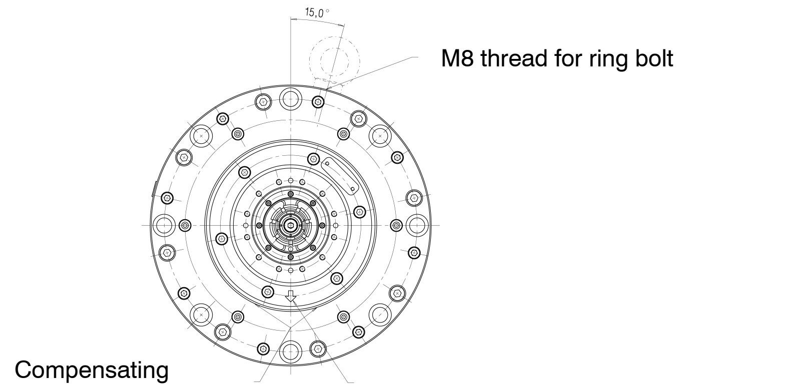


Fig. 4-4 Mounting position of the 2SP120☐ spindle

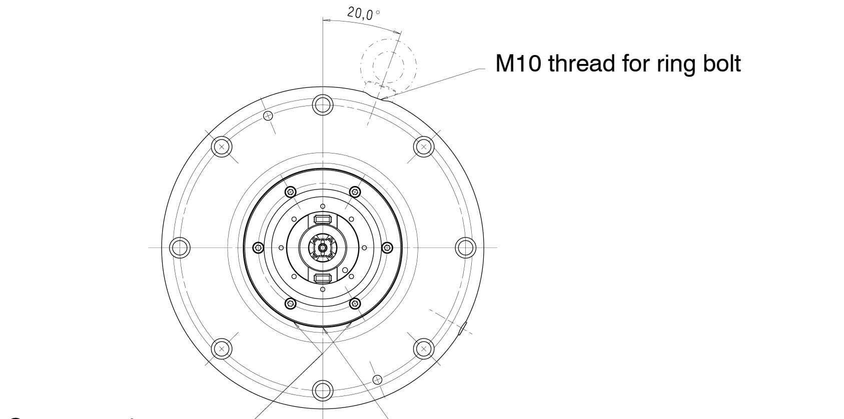


Fig. 4-5 Mounting position of the 2SP125☐ spindle

Table 4-3 Translation for Figs. 4-4, 4-5

English	German
M8/M10 thread for ring bolt	Gewinde M8/M10 für Ringschraube
Spindle below with horizontal mounting	Spindel unten bei horizontalem Einbau
Compensating holes for sealing air	Entlastungsbohrungen für Sperrluft

The spindle must be mounted so that the motor spindle is not subject to any compulsive forces. If the housing is subject to tension, this can result in a slight deformation and increased stressing on the roller bearings. This will have a negative impact on the smooth running characteristics, operating temperature and therefore the lifetime.

Axial tapped holes (on the rear bearing cover) and radial tapped holes (on the flange and at the rear bearing cover) are provided on the spindle for lifting lugs. These are used when the spindle is mounted.

4.2.1 Mechanical requirements placed on the spindle support

Load situation of the spindle support

The spindle is subject to an alternating force caused by the residual imbalance of the shaft and the tool. The residual imbalance transfers tilting and lateral forces to the spindle mounting flange so that principally, the following associated vibration types

- Tilting vibration (tilting from the non–drive end to the drive end)
- Lateral vibration (lateral movement of the spindle)

can be excited (refer to Fig. 4-6).

The forces excited by the residual imbalance increase with speed.

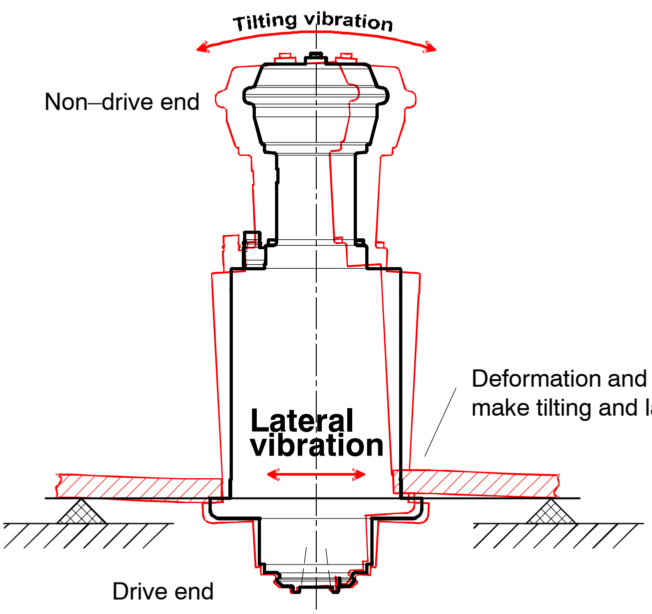


Fig. 4-6 Types of vibration which can be excited due to imbalance

Table 4-4 Translation for Fig. 4-6

English	German
Non-drive end	B-Seite
Drive end	A-Seite
Tilting vibration	Kippschwingung
Lateral vibration	Seitwärtsschwingung
Deformation and displacement of spindle support make tilting and lateral vibration possible.	Verformung und unterschiedliche Plazierung des Spindelträgers ermöglichen Kipp- und Seitwärtsschwingungen.

The alternating stressing frequency precisely corresponds to the rotating frequency of the spindle.

$f = 1\text{min}/60\text{s} \cdot N$ with f: exciting frequency in [Hz]
N: speed in RPM

Vibrational characteristics: Mechanical design requirements placed on the spindle support

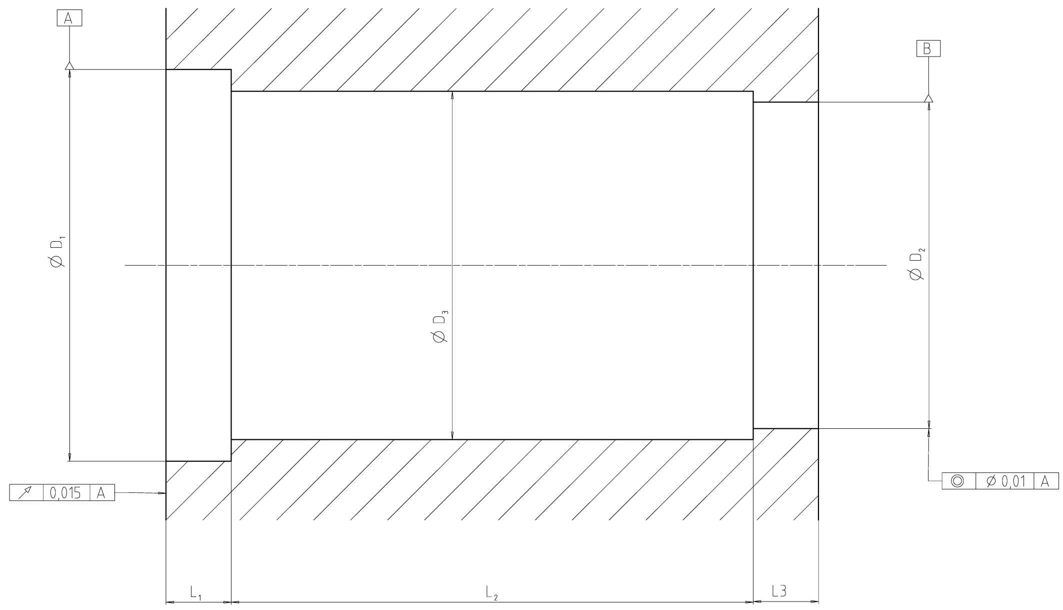
The spindle support must have a stiff design so that no natural resonance points of the appropriate vibration types can be generated over the complete speed range up to the shutdown speed. **The lowest resonant frequency must lie above the rotating frequency of the shutdown speed which can be excited by an imbalance condition.** In this frequency range, the spindle support must be able to absorb the tilting and lateral forces caused by the residual imbalance, without being deformed.

The spindle is mounted to the machine assembly at the drive end (front end) using the mounting flange. This must be taken into account in the mechanical design of the spindle support, especially when it comes to suppressing the tilting vibration of the rear (non–drive end) end of the spindle, which is relatively far away from the mounting flange.

Information regarding the design of the spindle support

The following points should be carefully observed when designing the spindle support to accept the motor spindle:

- **Material strength**
  The fit area around the mounting flange is extremely important due to the high force density to counteract the tilting vibration. The material thickness and strength must be adequately dimensioned.
- **Lateral stability of the flange plane**
  The plane of the mounting flange must be embedded so stiffly in the machine that in the frequency range up to the shutdown speed, no vibrational types are possible with lateral movement of the mounting flange. Designs, where the plane of the mounting flange is located far beyond the plane of the guide element of the spindle slide, are especially critical when it comes to a shift in the flange plane due to torsional rotation and deformation of the spindle support.
- **Carefully observe the fit and tolerance**
  The spindle mounting flange must be attached to the spindle support so that it is geometrically precise and is as dynamically stiff as possible. The mechanical design and the tolerances, which are documented in the drawings to accept the mounting flange, must be carefully maintained. For drawings and dimension dimension drawings, refer to Chapter 10. For the recommended tolerance for the spindle support, refer to Fig. 4-7.
- **Supporting the spindle support using the guide elements**
  The guide elements (linear guides) which support the spindle support with respect to the machine bed, should provide an appropriately wide basis to withstand tilting vibration (refer to Fig. 4-8).
- **Short length between the spindle mounting flange and where the spindle support is retained**
  If the spindle mounting flange extends in front of where the spindle support is retained, then this can undesirably reduce the resonant frequency of the tilting vibration (refer to Fig. 4-8). This means that the length which extends between the spindle mounting flange and the point where the spindle support is retained at the machine bed should be kept as short as possible. This is also the reason that the spindle support should not have a high mass close to the flange plane which does not directly serve to make the support assembly stiff.



	D1	D2	D3	L1	L2	L3
2SP1202	200 G6	199,0 G6	199,5 +0,2	23,0	215,0	20,0
2SP1204	200 G6	199,0 G6	199,5 +0,2	23,0	315,0	20,0
2SP1253	250 G6	237,0 G6	249,5 +0,2	30,0	277,0	33,0
2SP1255	250 G6	237,0 G6	249,5 +0,2	30,0	377,0	33,0

199	+0,015 / +0,044	(G6)
200	+0,015 / +0,044	(G6)
237	+0,015 / +0,044	(G6)
250	+0,015 / +0,044	(G6)

Fig. 4-7 Mounting the spindle in the spindle support

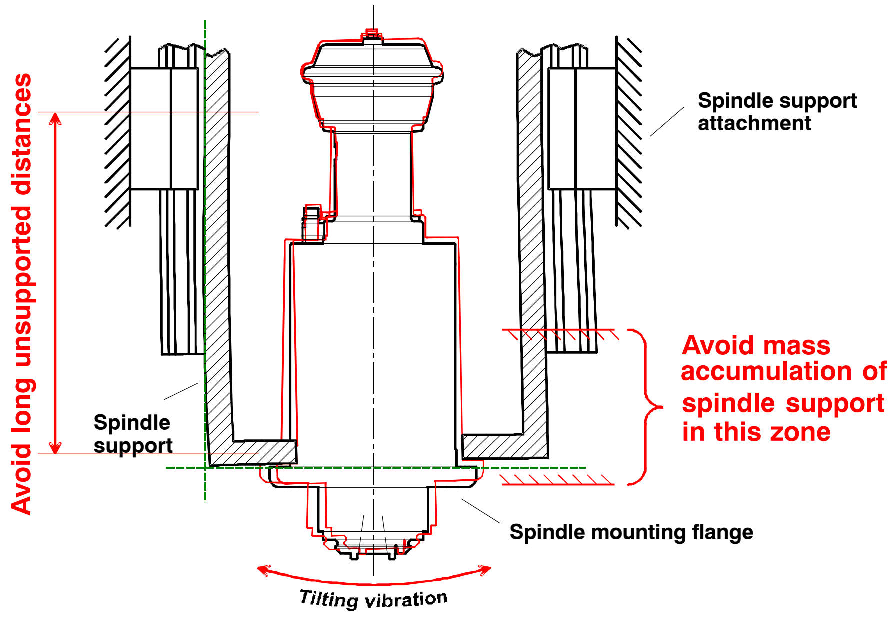


Fig. 4-8 Example: Tilting vibration for an extended spindle mounting flange

Table 4-5 Translation for Fig. 4-8

English	German
Avoid long unsupported distances	Größere frei tragende Längen vermeiden
Spindle support	Spindelträger
Tilting vibration	Kippschwingung
Spindle mounting flange	Spindelbefestigungsflansch
Spindle support attachment	Befestigung des Spindelträgers
Avoid mass accumulation of spindle support in this area	Masseansammlung in diesem Bereich des Spindelträgers vermeiden

- **Stiffening long unsupported lengths**
  Longer unsupported lengths should be avoided. If the spindle mounting flange is extended, then appropriate ribs and transverse reinforcing elements should be used. These reinforcing measures should be designed so that they counteract tilting vibrations (refer to Fig. 4-6).
- **No additional components mounted *directly* on the spindle**
  In order that the natural frequency of the tilting vibration is not undesirably reduced, it is not permissible to mount or anchor any components *directly* on the spindle. For example, connecting strain relief elements for drag cables.

Numerical techniques, such as the FEM–based modal analysis have proven themselves to be helpful when evaluating a mechanical design regarding its vibrational characteristics. For additional support, please contact your local Siemens office.

4.2.2 Support at the non–drive end

2SP1 motor spindles are available in several power classes. For the high–speed versions with high torques, an additional direct mechanical support is required between the non–drive end of the spindle and the spindle support.

For a list of the spindle types where the non–drive end support is specified, refer to Chapter 10, Table 10-4 and 10-5.

Function of the support

The direct support between the non–drive end of the spindle and the spindle support has the function to stabilize the spindle against tilting vibrations **so that the lowest resonance frequency lies above the rotational frequency of the shutdown speed.**

Properties and characteristics of the support

This is the reason that the support design must be as stiff as possible to counter the lateral vibration shown in Fig. 4-8. Further, this support must have a low mass close to the non–drive end. This is because an increase in the effective spindle mass at the non–drive end increases the moment of inertia of the tilting vibration and in so doing undesirably lowers the resonant frequency. Also in this case, FEM–supported modal analysis can be effectively used when evaluating the mechanical design.

4.3 Spindle bearings

High precision spindle bearings are used for the 2SP1 motor spindle shaft. They offer excellent precision and are designed to withstand loads at high speeds. Hybrid bearings are used for spindle versions which rotate at even higher speeds.

Special significance was placed on the ruggedness of the bearings. They have proven themselves over many years in applications ranging from job shops up to three–shift series production.

4.3.1 Features and operating conditions

The high precision spindle bearings absorb the radial and axis forces from the machining process without any play. Thermal stressing of the spindle shaft does not influence the mechanical tension. The bearings have excellent balance quality and extremely low roughness.

Radial eccentricity (run–out) at the tool holder, refer to Chapter 10.

The spindle's own sealing air system

The bearings are equipped with an integrated seal. The seal to the machining space at the spindle drive end is backed–up by the spindle's own sealing air system, refer to Chapter 6.

Notice

In order to achieve the specified bearing lifetime, the sealing air system must be correctly used. The machinery construction company is responsible in explaining this to the company operating the spindle.

Bearing lubrication

2SP1 motor spindles have permanently lubricated bearings. This is the reason that they are maintenance–free. A re–lubrication device is not required.

Notice

The permanent grease lubrication may not be negatively influenced or polluted by other materials and substances.

4.3.2 Warming–up phase of the motor spindle

Warming–up phase of the motor spindle (temperature distribution)

An uneven temperature distribution can have a negative impact on the bearing lifetime.

When commissioning for the first time and when starting the machine from cold, the running–in and warming–up specifications (refer to the the Operating Instructions) must be carefully observed.

Notice

The spindle should already be in the warm operating state if the upper speed range is approached.

Table 4-6 Warming–up phase of the motor spindle

Speed	Operating time
25% of the maximum speed	2 min
50 % of the maximum speed	2 min
75 % of the maximum speed	2 min
	Ready to operate

The machinery construction company can include a motor spindle warm–up cycle in the control software.

Longer periods of time where the spindle is not operational

Notice

A spindle must be run–in if it has not been used for more than one week.

Table 4-7 Running–in the spindle after longer non–operational periods

Speed	Operating time
25% of the maximum speed	5 min
50 % of the maximum speed	5 min
75 % of the maximum speed	5 min
	Ready to operate

Longer storage times

Notice

If the motor spindle has been stored for longer periods of time, the procedure for storing spindles, described in the Operating Instructions, must be carefully observed.

4.3.3 Load capability of the spindle bearings

Bearing overload

Notice

High–speed bearings are sensitive to overload conditions.

This is the reason that in operation and at standstill, overload conditions must be avoided.

Table 4-8 Possible damage due to bearing overload and how it is avoided

Overload situation	Damage	Possibilities of avoiding the overload situation
Applying force when assembling and disassembling	Immediate bearing damage	Machinery construction company and operating company: – When assembling the spindle, it is not permissible that forces are transferred to the spindle shaft and therefore to the bearings. The Operating Instructions must be carefully observed. Machinery construction company: – Design the space in which the spindle is to be mounted so that it can be easily accessed – Provide equipment for assembly and disassembly – Provide the operating company with the appropriate mounting/installation equipment and resources
The effect of force due to a collision	The bearings are immediately damaged or the bearing lifetime is significantly reduced	Operating company: – Check new workpiece programs using a slow path velocity – Visualize the programmed tool paths on the control side
Overload when a tool breaks	The bearing lifetime is reduced	Operating company: – When a tool breaks, the spindle should be quickly brought to a standstill

The machinery construction company (OEM) is responsible in informing the operating company about the possible damage if the spindle is overloaded.

4.3.4 Lifetime of the spindle bearings

Grease lifetime

In many applications, the grease lifetime is, with respect to the fatigue lifetime, the decisive factor which has to be taken into account therefore determining the spindle bearing lifetime The grease lifetime decreases with increasing speed (refer to Fig. 4-9).

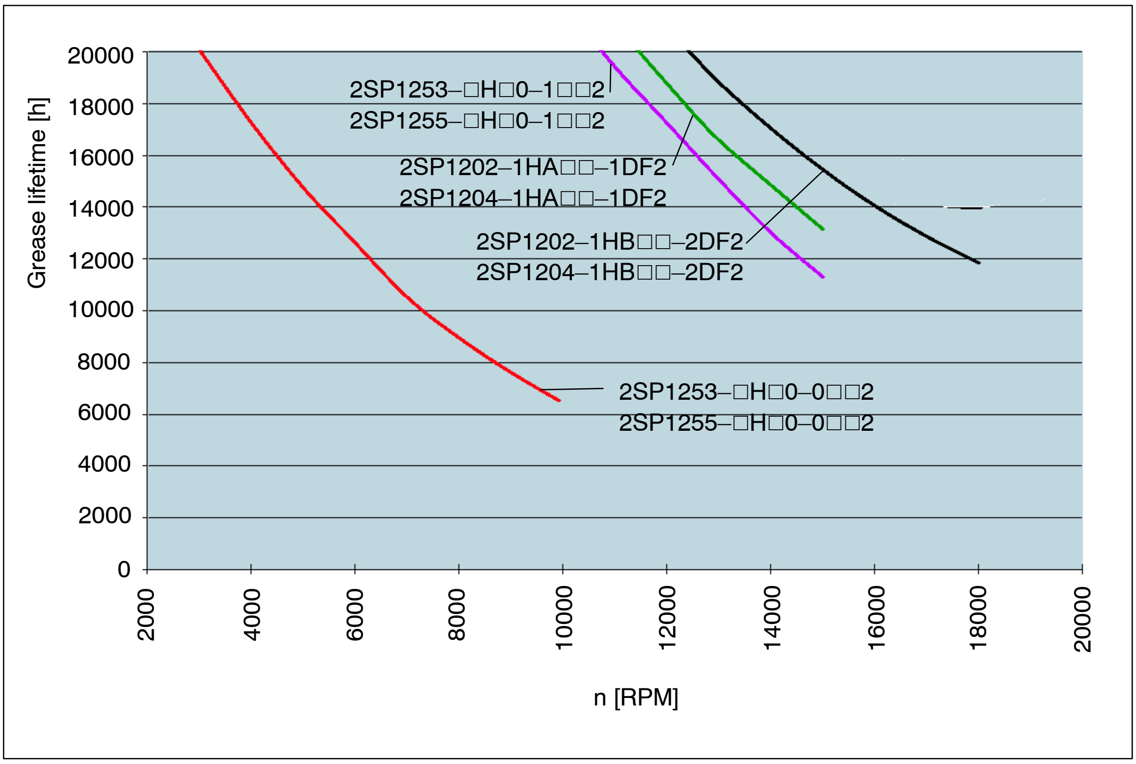


Fig. 4-9 Grease lifetime

A prerequisite for reaching the specified grease lifetime is that the permitted bearing temperatures are maintained.

The following must therefore be observed:

- The spindle cooling must be operated in compliance with the specifications
- It is not permissible that the bearing load is exceeded
- The maximum permissible ambient temperature in the operating state may not be exceeded

Table 4-9 Determining the probable grease lifetime

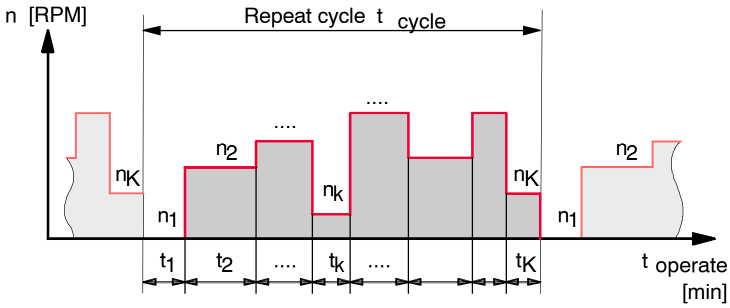
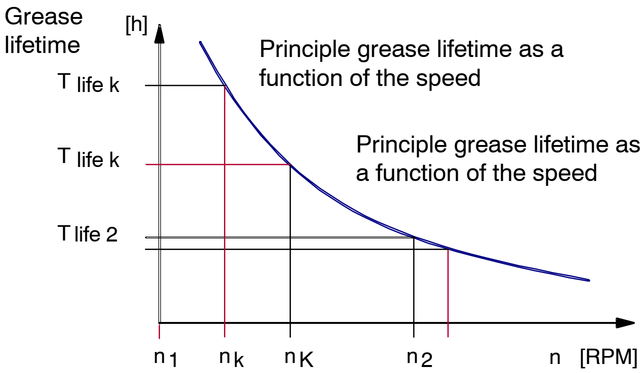
<table>
<tr><th>Sequence</th><th>Description, formulas</th></tr>
<tr><td>1. The spindle operation is sub–divided into constant speed phases</td><td>
</td></tr>
<tr><td>2. The relative duration of the speed phases is determined (relative proportion of the time in the cycle)</td><td>$t_{rel\ k} = \frac{t_k}{t_{cycle}}$</td></tr>
<tr><td>3. The individual grease lifetime $T_{use\ k}$ of the individual phases is determined</td><td>
</td></tr>
<tr><td>4. The individual lifetimes are added in a weighted fashion to obtain the complete grease life-time</td><td>$T_{use\ total} = \frac{1}{\frac{t_{rel\ 1}}{T_{life\ 1}} + \frac{t_{rel\ 2}}{T_{life\ 2}} + \ldots + \frac{t_{rel\ k}}{T_{life\ k}} + \ldots + \frac{t_{rel\ k}}{T_{life\ k}}}$</td></tr>
</table>

Table 4-10 Translation for Fig. 4-9

English	German
RPM	Umdrehungen pro Minute
Repeat cycle	Wiederholungszyklus
t_{cycle}	Zykluszeit
$t_{operate}$	Betriebsdauer
t_{rel}	relative Zeitdauer einer Drehzahlphase
Grease lifetime	Fettgebrauchsdauer
$T_{life\ total}$	Gebrauchsdauer gesamt
T_{life}	Gebrauchsdauer einer Phase

4.3.5 Maximum angular acceleration when the spindle is accelerating

For extreme rates of angular acceleration and extremely short accelerating times, the rollers of the spindle bearings can slide rather than rotate. This has a negative impact on the bearing lifetime and must be avoided. When programming the spindle acceleration (and braking) it is imperative that a maximum angular acceleration corresponding to 15000 RPM in 0.5 s is not exceeded.

$$\dot{N} \leq \frac{15000\ \text{RPM}}{0.5\ \text{s}}$$ with: $\dot{N}$ Programmed angular acceleration

The machinery construction company is responsible in clearly informing the operating company that higher levels of angular acceleration may not be programmed.

4.3.6 Stiffness

The mechanical stiffness at the tool holder with respect to radial and axial forces is documented in the data sheets, Chapter 10. The natural bending of the tool additionally shifts the cutting edge if radial forces are present. For narrow profile tools, the natural bending of the tool is significantly greater than the shift of the tool holder.

4.3.7 Axial shaft growth

The spindle shaft is subject to a geometrical shift in the axial direction. This shift is known as shaft growth.

The shaft growth comprises the following elements:

- Thermally–related shaft growth
- Speed–related shaft growth

The shaft growth is independent of the tool being used.

Thermal shaft growth

In the thermal stabilization phase, while the spindle warms up, the spindle shaft temperature increases up to its steady–state condition. This means that during this thermal stabilization phase, the tool holder shifts forwards (due to thermal expansion). After the warm–up phase has been completed, the spindle shaft essentially has a constant operating temperature so that the tool holder no longer moves as a result of thermal expansion.

Speed–related shaft growth

Due to the geometrical arrangement of the roller bearing assemblies, the rolling bearing contact point shifts in the bearing ring as a function of the speed. This causes the tool holder to shift forwards. This shift is a function of the speed and increases with increasing speed. This shift reverses as the speed decreases.

When required, this shaft growth can be equalized by correcting the Z axis. We recommend that the thermally–related shaft growth and the speed–related shaft growth are determined by machining sample workpieces. The appropriate correction tables can then be drawn–up for the Z axis position.

4.4 Tools and tool holders

4.4.1 Tools

The interaction between the motor spindle and the tools which are used has a decisive influence on the productivity and quality of the machining operation. When selecting the appropriate tools, the safety information and instructions relating to high speeds must be carefully observed.

As a result of the high speed, 2SP1 motors spindles allow excellent surface qualities and high productivity to be achieved. However, when incorrectly used, the high speeds can also represent potential risks and significant wear. It is especially important that the tools are carefully selected.

Only use tools which are in a perfect condition

The following behavior/characteristics in operation are only achieved when tools, which must be in a perfect condition, are correctly used:

- Perfect machining results
- Low **vibration levels**
- Low **wear** of the spindle bearings
- Low **noise emission**
- Safety of operating personnel and the machine

This is the reason that it must always be ensured that only tools in a perfect condition are in the tool magazine – and that these tools were checked to ensure that they are suitable for operation with the particular spindle. The machinery construction company is responsible in clearly informing the operating company the potential danger and damage if unsuitable tools were to be used.

Prerequisites for tools

The tools must fulfill the following prerequisites:

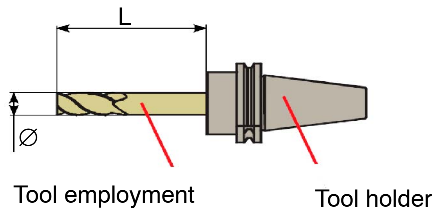
1. The tool must be **released/certified** for high speeds and centrifugal forces.
2. It is not permissible that the tool reduces the **natural frequency** of the spindle unit to below the critical rotating frequency.
3. The **cutting forces** and the intrinsic weight of the tool may not overload the bearings.
4. Ratio between the length and diameter, not greater than 3:1.
5. The tool must be perfectly **balanced**.

For a detailed description, of the specified prerequisites, refer to Table 4-11.

Table 4-11 Prerequisites for tools

	Description
High speeds and centrifugal forces	Depending on the tool diameter, at high speeds, extremely high centrifugal forces occur at the tool. Only those tools may be used, without any restrictions, whose permitted speed lies above the shutdown speed of the spindle. If a tool breaks at high speed, parts will be flung–out at a high velocity and can cause significant damage. Example: If a piece of a tool having a radius of 40 mm and a speed of 10,000 RPM is flung–out, this reaches a velocity of 150 km/h. **Using tools with the permitted speed < shutdown speed** The following conditions must be observed: • Speed monitoring (refer to Chapter 1.2) The threshold of the shutdown speed must lie below the permitted maximum tool speed. If various shutdown speeds are used for different tools, then these must be matched to the tool using the Tool Manager. For example, the speed monitoring function can be implemented by defining gear stages (refer to Chapter 1). • Limiting the programmable speed (refer to chapter 1.2) The programmable maximum operating speed must lie at least 5 % below the shutdown speed.
Do not allow the natural frequency of the spindle unit to drop below the critical rotational frequency	The resonant frequencies of the spindle support and spindle must always lie above the speed permitted for the particular tool. As a result of a clamped tool, resonant frequencies can be noticeably and undesirably reduced. The danger associated with reducing the resonant frequencies is especially critical for: • Long tools • Heavy tools • Tools with a large radius Generally, the best smooth running characteristics are achieved when short tools are used; when short tools are used, then these result in lower bearing stressing. This means that the tools must be clamped so that their effective length is as short as possible. The spindle manufacturer cannot define generally applicable limit data for tools. The reason for this is that the resonant frequencies of the spindle support and spindle are not determined just by the spindle alone, but mainly how the spindle is actually mounted in a mechanical assembly. The machinery construction company (OEM), which is responsible for mounting/installing the spindle, is responsible in providing the operating company with information and data about the permissible range of dimensions and weights of tools. In principle, a run–up test with the tool to be tested provides useful data. In this case, the tool is slowly accelerated up to the maximum permissible speed and is kept at a high speed for approximately one minute. The accelerating ramp should be slow. If the spindle runs smoothly without any vibration during the acceleration phase and at the maximum speed, then the tool can be released for operation. If a significant amount of noise or vibration occurs while the tool is being accelerated or at maximum speed, the run–up test should be immediately stopped and the tool being tested should be classified as unsuitable or ”not released for a specific speed”.
Cutting forces and own weight	A worn cutting edge can cause the cutting force to be increased a multiple number of times. This not only has a negative impact on the machining process but also on the bearing lifetime as the permissible bearing loads are exceeded. We therefore recommend that the condition of the cutting edge is continually monitored.

Table 4-11 Prerequisites for tools, continued

	Description
Ratio between the length and diameter	Tools should be used whose ratio between L and diameter ∅ does not exceed a value of 3:1 and whose total weight of the tool insert lies below 4.5 kg. The spindles are designed so that with these tools, the critical speeds lie above the maximum spindle speed. If tools are used whose dimensions deviate from this data, then the speed should be calculated. In addition to limiting the speed as a result of critical speeds of the spindle/tool system, speed limiting using technological data of the cutting process should be carefully taken into consideration.  $\frac{L}{\varnothing} < 3$
Balancing	Only the most finely–balanced tools in compliance with Q 6.3 may be used. Standards to be carefully observed and fulfilled: • VDI Directive 2056 • DIN EN ISO 15641 **Notice** **Balancing must be made after the tool insert has been inserted in the tool holder. It is not permissible to individually balance the tool insert and tool holder without balancing the whole assembly.** A worn tool can have a noticeable negative impact on the balance quality. If vibration and noise levels increase while a tool is being used, then the tool must be checked for wear and the balance must also be re–checked.

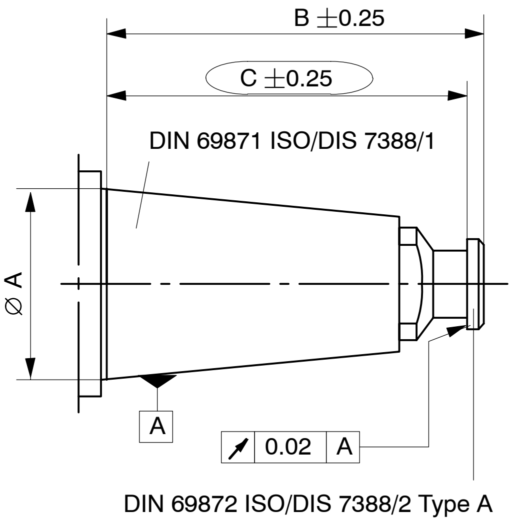
4.4.2 Tool holders

2SP1 motor spindles are available with several tool holders.

Table 4-12 Tool holders

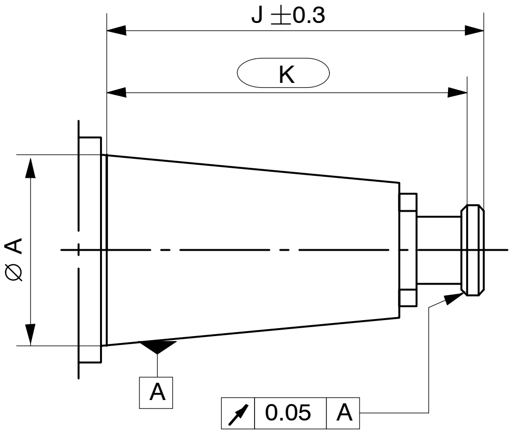
Type	Standard	for speed	Remark
SK 40 – non–symmetrical	DIN 69872, ISO 7388/1/2 Type A	≤ 10000 RPM	2SP125
CAT40 – non–symmetrical	ANSI B5.50-78, ISO 7388/1/2 Type B	≤ 10000 RPM	2SP125
BT 40 – non–symmetrical BT 40, 30°	MAS 403-1982, BT/PT30° Version E1	≤ 10000 RPM	2SP125
BT 40 – non–symmetrical BT 40, 45°	MAS 403-1982 BT/PT45° Version F1	≤ 10000 RPM	2SP125
HSK A63	DIN 69893-1, ISO 12164-1	≤ 18000 RPM ≤ 15000 RPM	2SP120 2SP125

Drawings, dimension tables and tolerance data, refer to Chapter10.



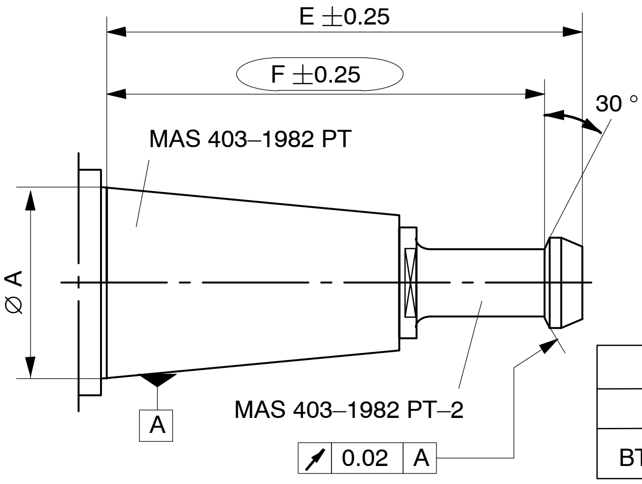
	A	B	C
		± 0.25	± 0.25
SK 40	44.45	94.25	88.25

Fig. 4-10 SK 40



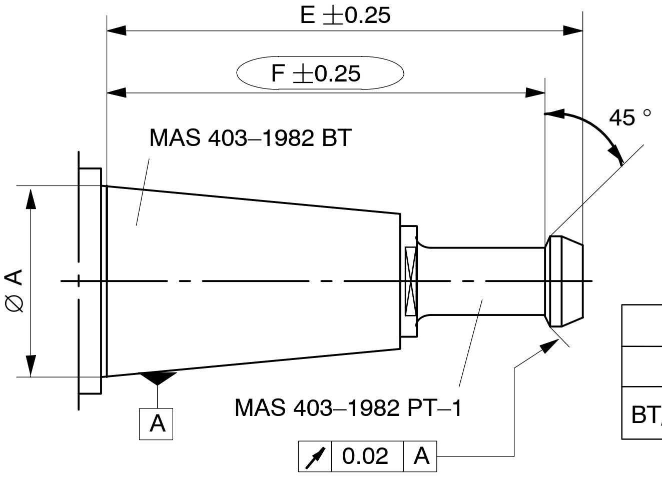
	A	J	K
		± 0.3	± 0.3
SK 40	44.45	84.50	79.25

Fig. 4-11 CAT 40



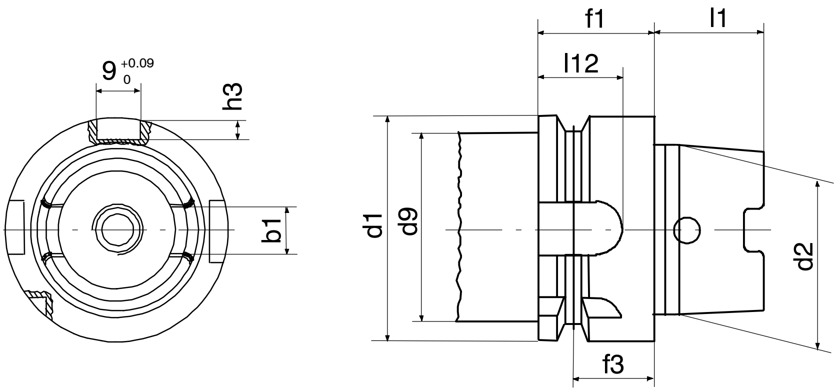
	A	E	F
		± 0.25	± 0.25
BT/PT 30°	44.45	100.35	93.35

Fig. 4-12 BT 40, 30°



	A	E	F
		± 0.25	± 0.25
BT/PT 45°	44.45	100.35	93.35

Fig. 4-13 BT 40, 45°



	b1	d1	d2	d9	f1	f3	h3	l1	l12
	± 0.04	h10			0/–01	± 0.1	+0.2/0	0/–0.2	
HSK A63	12.54	63	48.01	53	26	18	5	32	21

Fig. 4-14 HSK A63

Tool changer

A tool is changed depending on the machine tool using either a gripper or by directly gripping and placing the tool into a tool magazine.

Caution

In order to reliably prevent the spindle colliding with adjacent tools in the tool magazine or in the tool gripper, depending on the particular spindle, certain minimum clearances should be maintained (refer to Table 4-13 and Fig. 4-15).

Table 4-13 Minimum clearances for various tool holders

Motor spindle	Tool holder	Minimum clearance [mm]
2SP120□□–1H□□□–□DF2	HSK A63	A $\geq$ 100.0
2SP125□□–□H□0□–1D□2	HSK A63	A $\geq$ 100.0
2SP125□□–□H□0□–0□□2	SK40	A $\geq$ 100.0

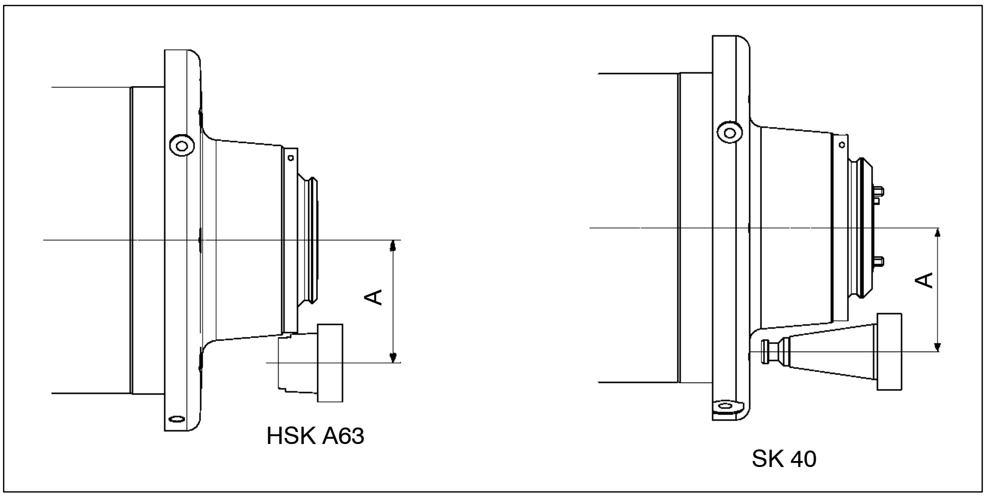


Fig. 4-15 Minimum clearance = dimension A

4.5 Clamping system and tool change

4.5.1 Clamping system

2SP1 motor spindles are equipped with a clamping system for automatic tool changing. This clamping system is integrated in the spindle shaft and rotates with the spindle.

The clamping system is designed for **max. 5 tool change cycles per minute**.

The pull–in force is provided by the spring system which rotates with the spindle. The tool is safely and reliably maintained in the clamped position even when the power fails and while the spindle is rotating. The magnitude of the pull–in force is described in Chapter 10.1.

Clamping state sensors

The spindle is equipped with sensors to monitor the clamping state. The various clamped states are detected by sensing the axial position of the clamping or actuation system.

Table 4-14 Sensors to monitor the clamped state 2SP1 20

Sensor	Message	Type	Remark
S1	Dependent on the measured voltage	Analog sensor	Basic equipment
S4	Position of the release cylinder	NO contact	Basic equipment

Table 4-15 Sensors to monitor the clamped state 2SP1 25

Sensor	Message	Type	Remark
S1	Draw bar in the release position	NO contact	Basic equipment
S2	Tool is clamped	NO contact	Basic equipment
S3	Collet is closed without a tool inserted	NO contact	Basic equipment

Electrical data of the sensors, refer to Chapter 7.2.
Evaluation of the sensors to control the tool change, refer to Chapter 8.

Warning

The mounting position of the clamped state sensors is carefully adjusted in the factory. It is not necessary for end users to move the position of the sensors and it is also strictly forbidden. The machinery construction company is responsible in informing the operating company that it is not permissible to adjust the position of the sensors.

4.5.2 Tool change

Caution

It is only permissible to insert and release the tool when the motor spindle is at a standstill (zero speed). The tool must be inserted up to the contact surface of the clamping taper.

The clamping system is either actuated pneumatically or hydraulically using a pneumatic or hydraulic cylinder.

Note

The air line between the compressed air source and the pneumatic/hydraulic cylinder must have an adequate cross–section in order to keep the times to establish pressure and reduce pressure of the pneumatic/hydraulic cylinder short.

Recommended cross–section for the air line to the pneumatic cylinder: 8 mm.

Recommended cross–section for the oil line to the hydraulic cylinder: 5 mm.

For longer compressed air lines using drag chains we recommend that the flow–related pressure loss and the associated time to establish pressure in the cylinder is theoretically estimated.

The details and the waiting times to be maintained, the control of the mechanical sequences of the clamping and release operations are described in Chapter 8.2.

The operating and flow rate data of the pneumatic/hydraulic cylinder are described in Chapter 6.3 and 6.4.

Values for clamping and release pressures refer to Table 10-2.

4.5.3 Tool changing for standard clamping systems

Releasing tool

Pressure is applied to the cylinder to **release** the tool. The actuation device releases the tool from the tool holder so that it can be removed by the tool changing gripper without any force being required.

Sensor S1 is adjusted so that for tools in compliance with the standard it supplies the ”draw bar in the release position” signal.

When removing the tool, the appropriate control diagram must be taken into account:

Fig. 8-4: Automatic tool change (with S1 and S4) for 2SP120□
Fig.8-5: Manual tool change (with S2) for 2SP125□
Fig. 8-6: Automatic tool change (withS1, S2 and S3) for 2SP125□

Caution

The released tool is only loosely located in the tool holder. It must be removed after it has been released. If it is not removed, then it can simply fall out and cause damage.

Jammed tools cannot be reliably detected using sensor S1.

Inserting and clamping the tool

The tool is **drawn–in and clamped** just using disk springs.

For this operation, for spindles with pneumatic cylinder, the air in the cylinder must first be released. In order to shorten the tool change times, compressed air can be additionally applied to the rear of the piston.

For spindles with hydraulic cylinder, the piston side must be relieved (the pressure reduced) using an appropriate valve – and pressure (hydraulic pressure) applied to the rear of the piston.

For 2SP120□, the voltage of analog sensor S1 is measured to determine that the tool has been correctly clamped.

For 2SP125□, digital sensor S2 indicates whether the tool has been correctly clamped.

While **inserting** a tool, the release pressure must be switched through to the pneumatic or hydraulic cylinder until sensor S1 signals that the clamping system is ready for tool insertion. The tool can only be inserted after this signal is present.

Caution

The gripper must completely introduce the tool into the tool holder. It must prevent the tool from either sliding or dropping–out until the clamped state has been achieved (e.g. an appropriate signal from sensor S1 for 2SP120□ motor spindles or from sensor S2 for 2SP125□ until a specific voltage level has been achieved).

Caution

The spindle may only rotate if the cylinder piston has withdrawn from the spindle shaft and has not contact with it. This means that it is not permissible that a release pressure is applied to the pneumatic or hydraulic cylinder!

When the release pressure is applied to the cylinder, the stationary cylinder piston makes contact with the rotating clamping system of the spindle shaft. If it would be in contact while the spindle is rotating, this would damage the clamping system. This is the reason that spindle rotation may only be enabled if there is no release pressure and the sensor system clearly indicates that a tool has been safely and reliably clamped. While the spindle is rotating, the pressure feed to release the tool must be safely and securely shut–off.

Caution

The spindle may not rotate if it does not have a clamped tool!
If a clamping operation is carried–out without a tool being ready at the front for insertion, then the collet and draw bar retract to behind their normal clamping position. This status is permitted – however, it is not permissible that the spindle rotates at a high speed. Only slow spindle speeds of below 100 RPM are permissible to position the spindle.

4.5.4 Changing tools for the HSK A63 Type C tool holder

Releasing tool

Pressure is applied to the cylinder to **release** the tool. The actuation mechanism releases the tool from the tool holder.

Sensor S1 is adjusted so that for tools in compliance with the standard it supplies the ”draw bar in the release position” signal.

When removing the tool, the appropriate control diagram must be taken into account:

See Fig. 8-4: Automatic tool change (with S1 and S4) for 2SP120□

For a holding clamping system, the tool is still held with a defined holding force in the tool holder using springs. A tool can only be removed after first overcoming the holding force. To do this, force must be applied by the tool changer.

Inserting and clamping the tool

While **inserting** a tool, the release pressure must be switched through to the pneumatic or hydraulic cylinder until sensor S1 signals that the clamping system is ready for tool insertion. The tool can only be inserted after this signal is present.

For a holding clamping system, when the tool is inserted, it is initially only held in the tool holder by the holding function of the springs without the tool being clamped in the tool holder. The tool change gripper no longer has to hold the tool after it has been inserted as this function is handled by the holding clamping system.

The tool is **drawn–in and clamped** just using disk springs.

For this operation, for spindles with pneumatic cylinder, the air in the cylinder must first be released. In order to shorten the tool change times, compressed air can be additionally applied to the rear of the piston.

For spindles with hydraulic cylinder, the piston side must be relieved (the pressure reduced) using an appropriate valve – and pressure (hydraulic pressure) applied to the rear of the piston.

For 2SP120□, the voltage of analog sensor S1 is measured to determine that the tool has been correctly clamped.

Caution

The spindle may only rotate if the cylinder piston has withdrawn from the spindle shaft and has not contact with it. This means that it is not permissible that a release pressure is applied to the pneumatic or hydraulic cylinder!

When the release pressure is applied to the cylinder, the stationary cylinder piston makes contact with the rotating clamping system of the spindle shaft. If it would be in contact while the spindle is rotating, this would damage the clamping system. This is the reason that spindle rotation may only be enabled if there is no release pressure and the sensor system clearly indicates that a tool has been safely and reliably clamped. While the spindle is rotating, the pressure feed to release the tool must be safely and securely shut–off.

Holding function

The clamping set is equipped with a holding function for the tool. As soon as the clamping set is in the tool change position, the tool is held in the change position with a defined force of 270 N. For an automatic tool change, it must be ensured that the tool changer is suitable for the extraction forces.

Acceleration in the various axial directions as well as cleaning air or cooling–lubricating medium to clean the tool create forces on the tool that can be higher than the holding force and can therefore case the tool to be pressed–out. Under all circumstances, users must ensure that the forces that are applied remain below the holding force.

Especially fast release cylinders can accelerate the tool so significantly that the impetus of the tool is sufficient to overcome the holding position of the clamping set. The settings for the release operation must also be carefully adapted to this situation.

The holding function is not permissible for vertical applications.

For tool changing with a horizontally arranged spindle, the wear at the contact surfaces due to the tool tilting, must be carefully taken into consideration, refer to Fig. 4-16.

Notice

Vertical applications with holding clamping set are not permissible.

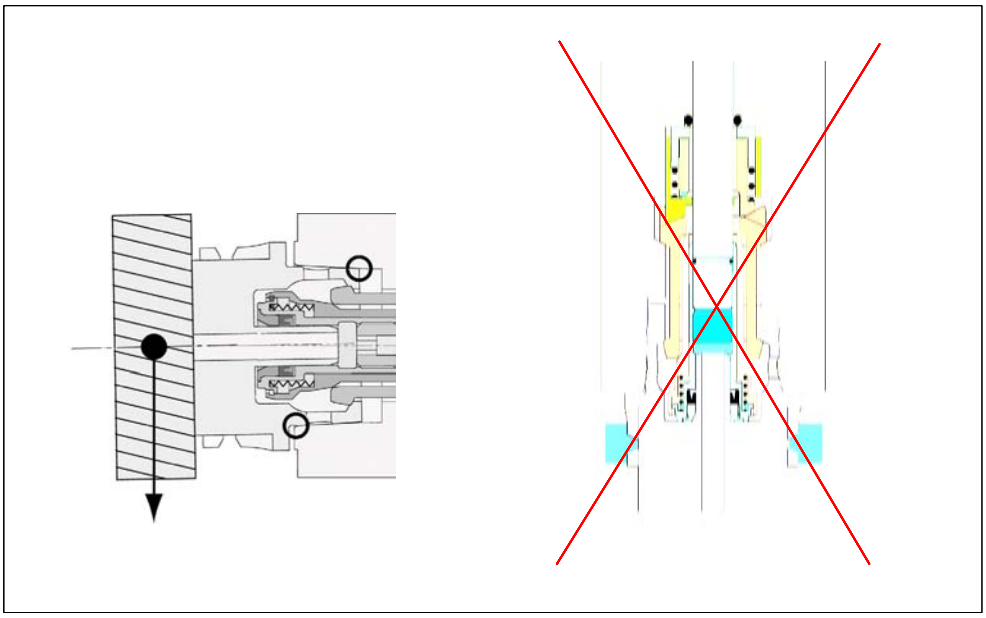


Fig. 4-16 Holding clamping system HSK A63 Type C

4.6 Operating modes

The spindle can be operated in the closed–loop speed and position controlled mode. The positioning accuracy and the control behavior of the spindle depend on the following secondary conditions:

- Low resonance of the spindle support
- The tool is free of natural vibration
- Degree of variation of the tool moment of inertia
- Clock cycle times of the closed–loop control

Permissible vibration levels

Over the complete speed range, the maximum permissible radial vibration velocity is limited to:

3 mm/s	under no–load conditions
6 mm/s	in continuous operation
10 mm/s	briefly (max. 5 s)

For the axial vibration velocity, half of the values apply.

When accepting, the spindle was balanced with a reference tool to = 1 mm/s under no–load conditions. The acceptance is not realized in the installed state, corresponding to VDI 2056.

The measured values determined (machining side value A, drive side value B) are documented in the acceptance report.

If a subsequent check is made in the field and the vibration quality measured, then this must be done with a precisely balanced tool (Q = 2.5). The vibration value determined when accepted is used as a nominal quantity (refer to the acceptance report).

It is possible that vibration velocities that deviate from those in the acceptance report are measured when in the installed state to the influence of the machine tool.

Notice

Vibration levels above 10 mm/s are not permissible for safety reasons – even if the machining result is OK. The spindle must be shut down immediately.

■

5 Electrical Data

5.1 Definitions

Mechanical limit speed n_{max}

The maximum permissible speed n_{max} is the max. permissible speed depending on the max. mechanical speed and the max. permissible electrical speed.

S1 duty (continuous operation)

This is operation with a constant load condition, whose duration is sufficient that the machine goes into a thermal steady–state condition.

S6 duty (intermittent load)

This is operation which comprises a sequence of similar load duty cycles; each of these load duty cycles comprises a time with constant motor load and a no–load time. If not otherwise specified, then the power–on time refers to a load duty cycle of 2 min.

S6 - 40 %: 40 % load
60 % no–load time

Maximum torque M_{max}

Torque which is briefly available for dynamic operations (e.g. when accelerating). The following formula is used to calculate this:

$M_{max} \approx 2 \cdot M_N$ (for more precise values, refer to the data sheets, Chapter 10)

Notice

For motor spindles with synchronous motor, the max. permissible motor current may not be exceeded, as this could destroy the rotor.

At higher speeds, i.e. in the constant power range, the maximum available torque M_{max} at a specific speed n is approximated according to the following formula:

$$M_{max}\,[\mathrm{Nm}] \approx 9.6 \cdot \frac{P_{max}\,[\mathrm{W}]}{n\,[\mathrm{RPM}]}$$

Characteristics, see Chapter 10.2.

5.2 Motor

The drive motor of the 2SP1 motor spindle is integrated onto the spindle shaft between the two spindle bearings. The rotor is electrically passive and does not require any power feed. The drive converter provides the power for the motor and is fed to the stator winding. The losses associated with converting the electrical power into the mechanical power, which are unavoidable, mainly occur in the motor stator. This means that the stator is equipped with a cooling system, which ensures the necessary cooling thus preventing the machine assembly from reaching excessively high, damaging temperatures.

Notice

The 2SP1 motor spindle has been designed for sinusoidal currents (line supply/motor). Other drive converter current waveforms (at the motor side) – e.g. squarewave or trapezoidal – are not permissible.

5.2.1 Advantages of a direct drive

The drive motor does not have its own bearings. Its rotor is a component of the spindle shaft and is located in the bearings of the spindle shaft. This type of drive is also known as a direct drive. For direct drives, there are no mechanical couplings between the motor shaft and the spindle shaft with the associated weak points.

When compared to mechanically–coupled drives, direct drives have the following advantages:

- **Ruggedness** even at high speeds
- The spindle rotor **does not have any play** with respect to the drive motor and this results in **high precision** in C axis operation
- **Low noise emission** and **high smooth running qualities**
- **Stable balancing**

The torque is contactlessly transmitted to the rotor which means that there is no mechanical wear. The high availability and ruggedness thus achieved mean that the drive motor does not require any maintenance therefore counter–acting the potential disadvantage associated with the fact that this type of motor is not quite so accessible.

5.2.2 Synchronous and induction motor versions

Table 5-1 Motor versions

Standard version	Synchronous motor
Option	Asynchronous motor

Both of these motor versions have their own specific advantages and place certain requirements on the AC drive converter. The machinery construction company (OEM) should be aware of this when designing his machine.

Selecting the motor versions

As far as power and torque are concerned, the synchronous motor is superior to the induction motor. It is more powerful and has noticeably less power loss than an induction motor. For synchronous motors, the motor shaft is subject to a lower thermal stressing which is important as it is more difficult to cool motor shafts.

The synchronous motor field weakening function is already included in the standard functional scope of the SIMODRIVE System 611 digital/universal. A well–tested and favorably–priced overvoltage protection module is available in the form of the VP module.

As part of the SIMODRIVE system, 2SP1 motor spindles are therefore offered, as standard, with synchronous motor.

The induction motor option should only be considered for cases where the spindle is to be fed from third–party drive systems which are not suitable for operating synchronous motors in the field weakening range.

Table 5-2 Comparison of the advantages of synchronous and induction motors

Advantages of synchronous motors	Advantages of induction motors
Lower thermal stressing on the spindle shaft due to the permanent–magnet rotor	Field weakening is also possible when using third–party drive converters
Higher efficiency	Protective measures against motor overvoltages are not required
Higher torque and higher power for a comparable frame size	Compatible to older drive converter systems

5.2.3 General motor characteristics

Field weakening

In addition to reducing the counter voltage, field weakening also reduces the maximum torque. When field weakening is used, the power yield is split–up into a constant torque range and a constant power range. The spindle power as a function of the speed is shown in Fig. 5-1.

Limiting the power using the reactive power drawn

As the speed increases, the reactive power (electrical) drawn by the motor increases. This reactive power demand in turn reduces the mechanical power. This means, in the uppermost speed range, the constant spindle power can no longer be maintained, but decreases with increasing speed. The power limiting is defined in the power diagrams using the ”limiting characteristic”. The level of the power limiting depends very heavily on the operating mode (star-delta) and the motor type (synchronous or induction motor). For synchronous motors, the spindle power always remains constant up to the maximum speed.

Refer to Chapter 10 for power diagrams of the individual motors.

- **Constant maximum torque:**
  Field weakening is not activated in the lower speed range and the rms magnetic flux is constant as long as the required voltage, which is proportional to the speed, does not exceed the maximum drive converter output voltage. This means that a constant torque is available in this range.

- **Constant maximum power:**
  The motor voltage reaches the maximum drive converter output voltage in the upper speed range of field weakening. This means that the magnetic flux must be reduced linearly with the speed. For induction motors, this is realized by reducing the flux–generating current, and for synchronous motors, by impressing a current or magnetic field which opposes the permanent magnet field. This means that the permanent magnet field is therefore "weakened". The torque also decreases proportionally with the flux which decreases with the speed. The mechanical power, as product of speed and torque, remains constant.
- **Restricted maximum power (only for induction motors):**
  The reactive power demand, which increases with the speed, can mean, depending on the motor type, that the maximum power has to be reduced in the uppermost speed range.

Influence of the DC link voltage

The speed at the start of field weakening and the power limiting depend on the magnitude of the DC link voltage.

Information regarding the DC link voltage is provided in the Configuration Manual for SIMODRIVE 611.

For synchronous motors, the spindle power always remains constant up to the maximum speed.

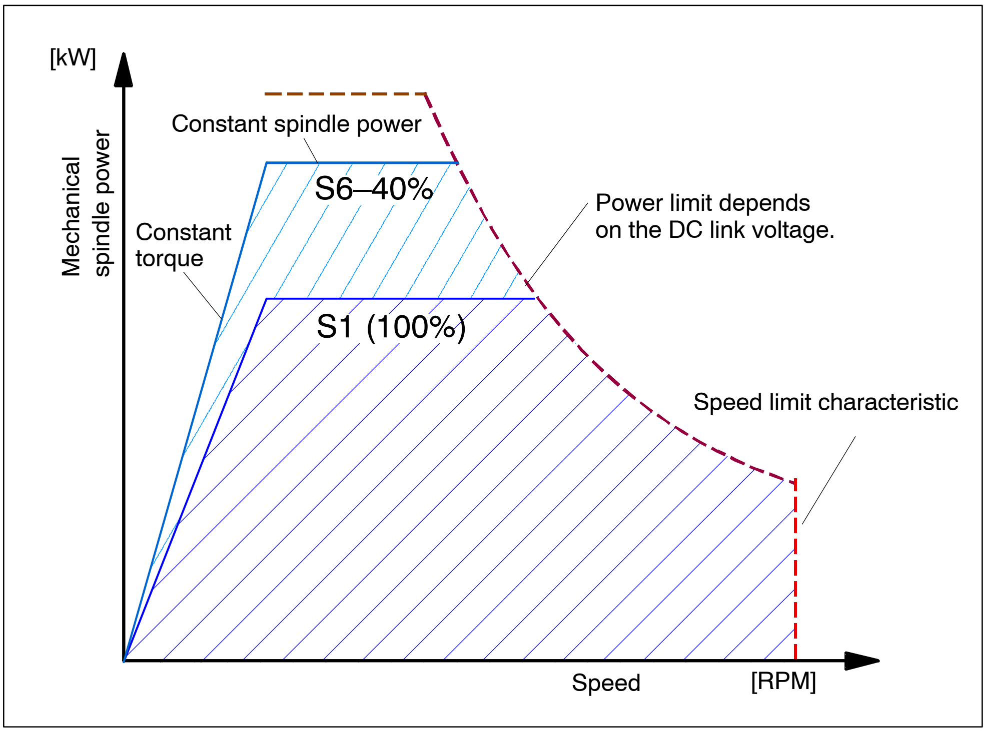


Fig. 5-1 Principle speed–power diagram (using an induction motor as an example)

Table 5-3 Translation for Fig. 5-1

English	German
Mechanical spindle power	Mechanische Spindelleistung
Constant torque	konstantes Drehmoment
Constant spindle power	konstante Spindelleistung
Power limit depends on the DC link voltage	Grenzleistungslinie ist abhängig von der Zwischenkreisspannung
Speed limit characteristic	Drehzahlgrenze
Speed	Drehzahl
RPM	Umdrehungen pro Minute

5.2.4 Suitable drive converter/system environment

Drive converters

2SP1 motor spindles are harmonized and coordinated with the SIMODRIVE system using the 611 digital and 611 universal drive converters. The angular data of the sin-cos encoder is multiplied in the encoder interface of the drive converter. 611 digital/universal drive converters are available with various multiplication factors. If the spindle must fulfill higher positioning accuracies (e.g. C axis) and load stiffness, we recommend the equipment/version with a multiplication factor of 2048.

Supply infeed

SIMODRIVE 611 drive converters can be operated from non–regulated and regulated infeed modules. The engineering and performance data refer to operation with a regulated infeed/regenerative feedback module and a 600 V DC link voltage. It may be necessary to correct this data if the equipment is operated from non–regulated infeed modules with different DC link voltages.

5.2.5 Overvoltage protection (only for synchronous motors)

For synchronous motors, overvoltage protection must be used to prevent the drive converter from being damaged due to overvoltage when a fault occurs. The VPM (Voltage Protection Module) fulfills this particular task in the SIMODRIVE system. If the power module fails at high spindle speeds, then the synchronous motor feeds back a high voltage into the DC link. The VP module detects a motor voltage which is too high and then short–circuits the three motor feeder cables. The rotational energy of the spindle is then converted into heat.

The VP module is mounted close to the drive converter (the maximum distance from the drive converter = 1.5 m). When the VP module is used, shielded Performance motor feeder cables should be used.

The VP module can only function in conjunction with SIMODRIVE 611 digital/universal.

The VP module is not included with the 2SP1 motor spindle and must be separately ordered. The associated documentation is provided in the References.

Assignment table for the VP module

Table 5-4 Assignment, spindle – VP module

Order No.	**VP module**	**Maximum speed** n_{max} [RPM]	**Rated current** I_N [A]	**Rated torque** M_N [Nm]
2SP1202-1□A	VPM 120	15000	30	42
2SP1202-1□B	VPM 120	18000	42	42
2SP1204-1□A	VPM 120	15000	60	84
2SP1204-1□B	VPM 120	18000	79	78
2SP1253-1□A	VPM 120	10000	45	80
2SP1253-1□B	VPM 120	15000	60	80
2SP1255-1□A	VPM 120	10000	85	150
2SP1255-1□B	VPM 120	15000	105	150

5.2.6 Star-delta mode (only for induction motors)

When induction motors are used, it is possible to select one of the following operating modes:

- Star circuit configuration
- Delta circuit configuration

Circuit to implement a star-delta changeover

For induction motors, all six connection leads of the three winding phases are fed out to be able to select the various operating modes.

The changeover is carried–out outside the spindle using switching devices and equipment that are not included with the motor spindle (i.e. these devices are not included in the scope of supply.

For information on how the star-delta changeover is realized, please refer to Fig. 5-2 and the Configuration Manual SIMODRIVE 611 Drive Converter.

Caution

A changeover may only be made when the spindle is in a no–load condition and with the power module pulses inhibited.

Notice

When changing over the circuit configuration (star-delta), the appropriate data set for the closed–loop motor control must also be changed–over.

Using the star circuit configuration

The star–circuit configuration offers some advantages at low speeds. The maximum torque in the star circuit configuration is approximately twice as high as in the delta circuit configuration. However, due to the higher reactive power requirement of the star circuit configuration, the available torque in the uppermost speed range is significantly restricted. This means that the star circuit configuration should only be activated when machining which requires a **high torque in the lower speed range.** An example of such a machining operation is roughing.

Using the delta circuit configuration

Although the delta circuit configuration provides, in the lower speed range, a lower maximum torque than the star circuit configuration, the torque remains available up to high speeds. This means that the delta circuit configuration should be activated for **all machining operations which are carried–out in the average and high speed ranges**.

Connection diagram for Y/D changeover

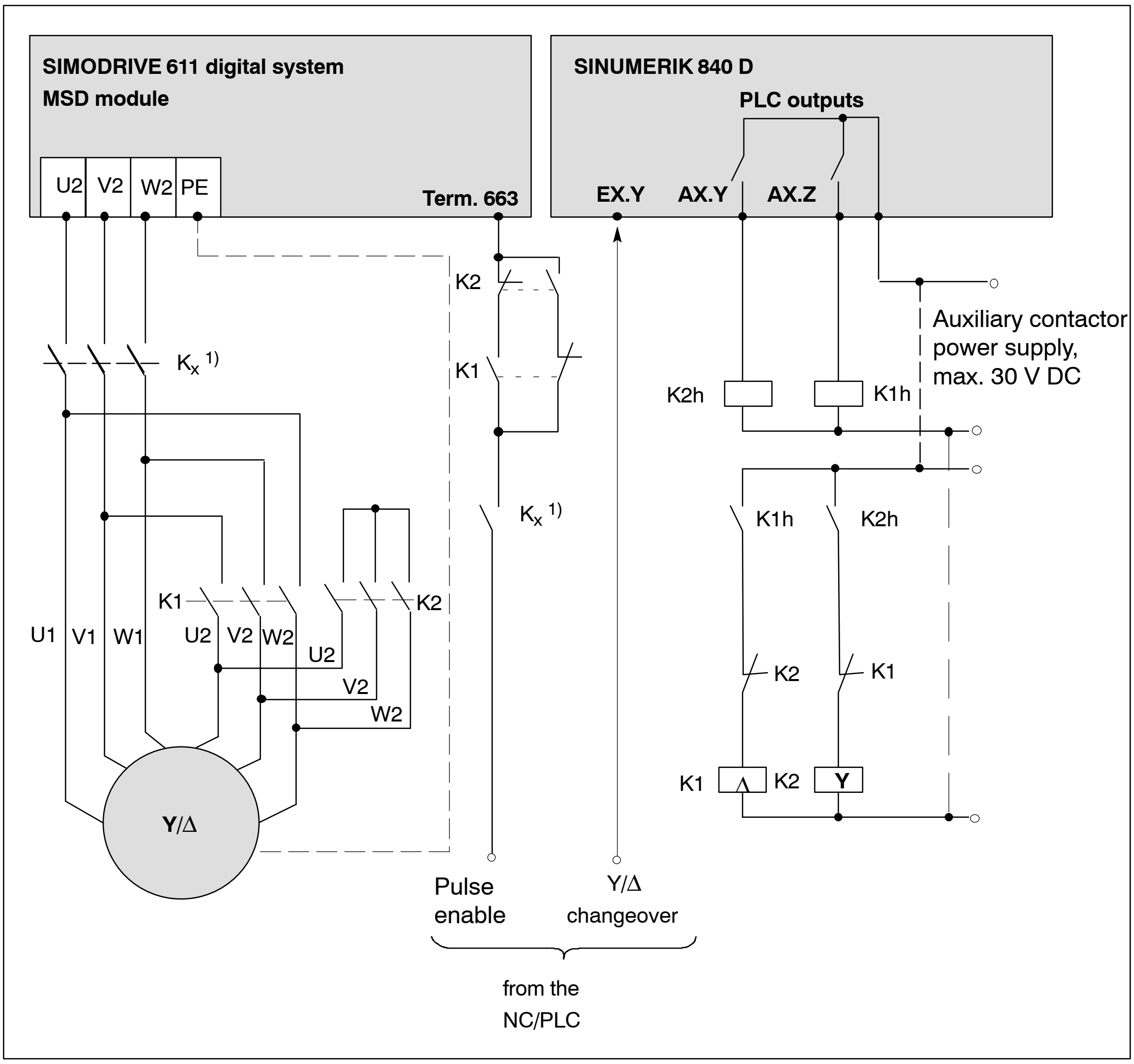


Fig. 5-2 Connection diagram for Y/D changeover with SIMODRIVE 611 digital

1) A safe operating stop is not guaranteed by just opening K1 and K2.
This is the reason that for safety–related reasons, contactor K should be used$_x$
to provide electrical isolation. This contactor may only be switched–in the no–current condition, i.e. the pulse enable must be withdrawn 40 ms before the contactor is opened (de–energized).

5.2.7 System overview and engineering information/instructions

System overview

2SP1 motor spindles are integrated into the SIMODRIVE drive system and suitable for converter operation:

- SIMODRIVE 611 digital
- SIMODRIVE 611 universal

The SIMODRIVE 611 digital drive converter is controlled from the SINUMERIK families 840 and 810D (CCU3 required for the spindles) via the drive bus.

The SIMODRIVE 611 universal drive converter also has a Profibus interface for control via the SINUMERIK systems 840Di and 802D as well as a +/–10V interface to couple analog control systems.

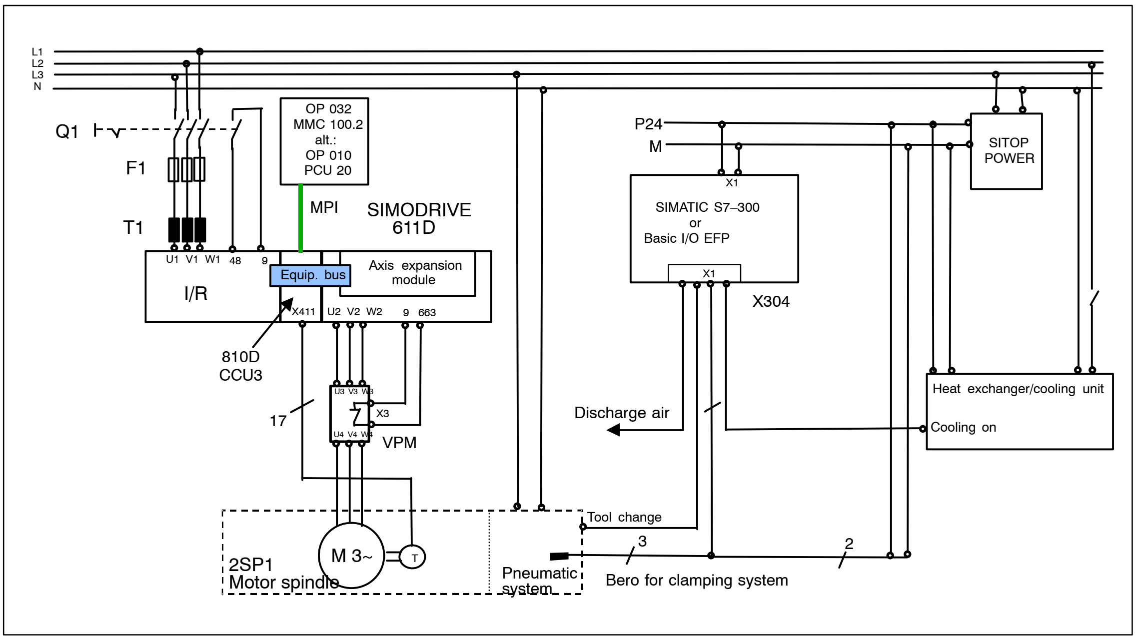


Fig. 5-3 System example with SINUMERIK 810 digital and SIMODRIVE 611 digital drive converters

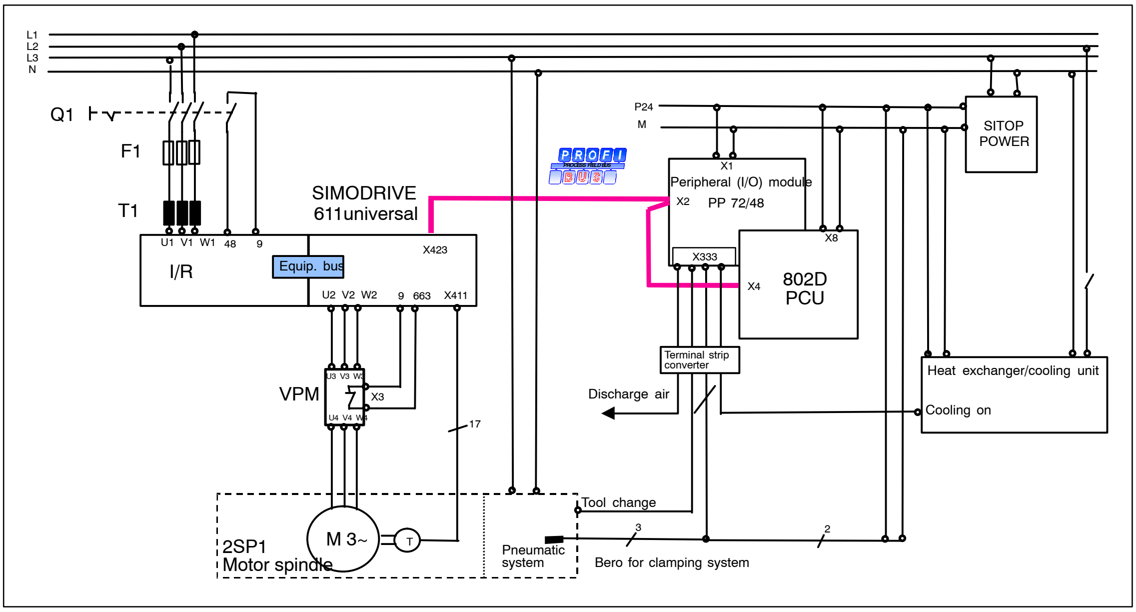


Fig. 5-4 System example with SINUMERIK 802 and SIMODRIVE 611 universal drive converter

Dimensioning the power module

The power modules are selected and engineered according to the rated current I_N of the spindle, refer to Table 5-5 and Chapter 10

Table 5-5 Spindle – drive converter assignment

Order designation 2SP1 motor spindle	Maxi-mum speed n_{max} [RPM]	Rated cur-rent I_N [A]	Rated torque M_N [Nm]	Motor type	Power module [A]	Order No. Power unit 6SN1123-1AA00-..
2SP1202-1☐A☐☐1	15000	30	42	Synch.	30/45/51	-0DA1
2SP1202-1☐B☐☐2	18000	42	42	Synch.	45/60/76	-0LA1
2SP1204-1☐A☐☐1	15000	60	84	Synch.	60/80/102	-0EA1
2SP1204-1☐B☐☐2	18000	79	78	Synch.	85/110/127	-0FA1
2SP1253-8☐A☐☐0	10000 1)	28 1)	70 1)	Induct.	30/45/51	-0DA1
2SP1253-8☐A☐☐1	15000 1)	28 1)	70 1)	Induct.	30/45/51	-0DA1
2SP1255-8☐A☐☐0	10000 1)	30 1)	140 1)	Induct.	30/45/51	-0DA1
2SP1255-8☐A☐☐1	15000 1)	30 1)	140 1)	Induct.	30/45/51	-0DA1
2SP1253-1☐A☐☐0	10000	53 (45)	100 (80)	Synch.	60/80/102 (45/60/76)	-0EA1 (-0LA1)
2SP1253-1☐B☐☐1	15000	68 (60)	100 (80)	Synch.	85/110/127 (60/80/102)	-0FA1 (-0EA1)
2SP1255-1☐A☐☐0	10000	95 (85)	170 (150)	Synch.	120/150/193 (85/110/127)	-0JA1 (-0FA1)
2SP1255-1☐B☐☐1	15000	120 (105)	170 (150)	Synch.	120/150/193	-0JA1

Values in brackets apply for operation with the next smaller power module.
1) Overview of the spindle values for a star circuit, drive converter selection applies for both the star and delta circuit configurations

Information regarding the spindle power data

Refer to Chapter 10 for the power data.

Information regarding synchronous motors

When using smaller (lower rating) power modules (refer to Table 5-5), then the complete speed range cannot be fully utilized (even when the motor has a reduced load). An additional field–weakening current is impressed from the rated speed onwards.

Also refer to the appropriate characteristics (refer to Chapter 10) or contact your local Siemens Office.

A minimum current is required for the pole position identification. This means that the following must apply when selecting the power module and the motor:

Rated current (S1 current), power unit - ≥ 50 % rated motor current

Drive converter pulse frequencies

In order to achieve optimum control characteristics, a minimum drive converter pulse frequency must be maintained which is a function of the maximum motor speed.

Minimum drive converter pulse frequency up to 15,000 RPM = 3.2 kHz
Minimum drive converter pulse frequency up to 18,000 RPM = 4.0 kHz

De–rating the drive converter rated current

For the drive converter, the rated current can depend on the pulse frequency and the rotating frequency of the output current. When engineering 2SP1 motor spindles, a de–rating, dependent on the rotational frequency, must be applied for the following drive converters (refer to Table 5-6).

Table 5-6 De–rating as a function of the rotational frequency (this only applies to synchronous motors)

Drive converter Order No.	**Speed < 15,000 RPM No derating** drive converter output current [A]	**Speed > 15,000 RPM de–rating** at f_t = 4.0 kHz (clock frequency) Drive converter output current [A]
6SN1123-1AA00-0DA1	30/40/51	28/37/47
6SN1123-1AA00-0LA1	45/60/76	42/56/70
6SN1123-1AA00-0EA1	60/80/102	55/73/94
6SN1123-1AA00-0FA1	85/110/127	79/102/117
6SN1123-1AA00-0JA1	120/150/193	110/130/150

For additional information on the influence of the rotational and pulse frequency, refer to the Configuration Manual ”SIMODRIVE 611 Drive Converters” and Synchronous Built–in Motors 1FE1, Chapter ”Drive converter pulse frequencies, controller data and de–rating”.

Information regarding the infeed/regenerative feedback unit

If an infeed unit is used without regenerative feedback, the braking power must be dissipated using pulsed resistors. These pulsed resistors must be appropriately dimensioned. For information on the infeed/regenerative feedback unit, refer to the Configuration Manual ”SIMODRIVE-611 Drive Converters”.

Spindle rating plate

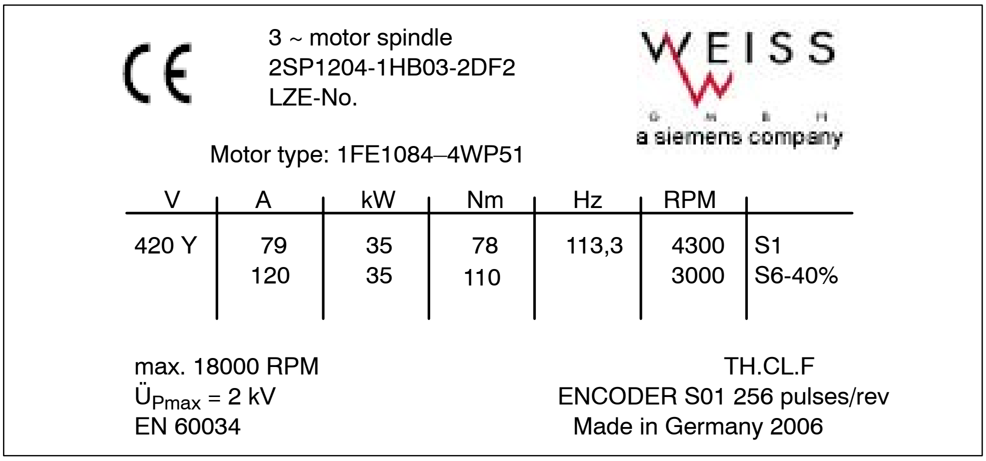


Fig. 5-5 Spindle rating plate

Table 5-7 Translation for Fig. 5-5

English	German
3~ motor spindle	3~ Motorspindel
TH.CL. F	Wärmeklasse F
ENCODER	Geber

5.3 Connecting cables/connector assignments

5.3.1 Power connection

2SP1 motor spindles are connected to the power source through cables. The connecting cables are 1.5 m long.

Table 5-8 Cable characteristics

Characteristics	Characteristic values	Remark
Cable type	1-conductor or 4-conductor, refer to Table 5-9	
Draggable	yes; carefully observe the minimum bending radius	
Minimum bending radius	Cable∅ x 10 mm Cable∅ x 15 mm	Fixed routing Draggable
Material	1-conductor cable: 4-conductor cable: PUR	e.g. PUR ... e.g. PUR ...

Table 5-9 Power connection

Order designation	Motor type	Circuit	Rated current I_N	Max. speed n_{max}	Cross-section, conn. cable	Connecting cable	Max. outer diameter	Shield
			[A]	[RPM]	[mm²]		[mm]	
2SP1202-1□A□□-1	Synch.	Y	30	15000	10	4 x 1-cond.	10	Individual[2)]
2SP1202-1□B□□-2	Synch.	Y	42	18000	10	4 x 1-cond.	10	Individual[2)]
2SP1204-1□A□□-1	Synch.	Y	60	15000	25	4 x 1-cond.	14	Individual[2)]
2SP1204-1□B□□-2	Synch.	Y	79	18000	25	4 x 1-cond.	14	Individual[2)]
2SP1253-8□A□□-0	Induct.	Y	28	10000 [1)]	6	2 x 4-cond.	16	Common[1)]
		Δ	29					
2SP1253-8□A□□-1	Induct.	Y	28	10000 [1)]	6	2 x 4-cond.	16	Common[1)]
		Δ	29					
2SP1255-8□A□□-0	Induct.	Y	30	10000 [1)]	6	2 x 4-cond.	16	Common[1)]
		Δ	29					
2SP1255-8□A□□-1	Induct.	Y	30	10000 [1)]	6	2 x 4-cond.	16	Common[1)]
		Δ	29					
2SP1253-1□A□□-0	Synch.	Y	45	10000	10	4 x 1-cond.	10	Individual[2)]
2SP1253-1□B□□-0	Synch.	Y	60	15000	16	4 x 1-cond.	12	Individual[2)]
2SP1255-1□A□□-0	Synch.	Y	85	10000	25	4 x 1-cond.	14	Individual[2)]
2SP1255-1□B□□-1	Synch.	Y	105	15000	35	4 x 1-cond.	16	Individual[2)]

1) 4-conductor cable with common shield
2) PE cable without shield

5.3.2 Direction of rotation

The direction of rotation of the spindle is defined when the power cables are connected to the drive converter.

Table 5-10 Connecting the cables for a clockwise direction of rotation

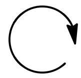
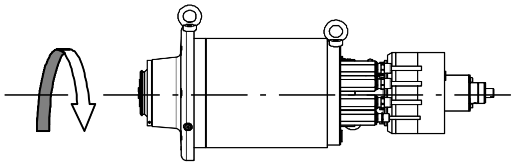
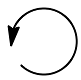
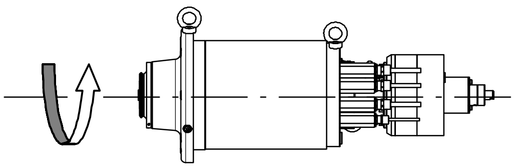
Cable designation, spindle	Connection designation, SIMODRIVE 611 drive converter	Direction of rotation of the spindle when viewing the drive side
U1 or conductor designation 1	U2	
V1 or conductor designation 2	V2	
W1 or conductor designation 3	W2	
Drive end 		

Table 5-11 Connecting the cables for a counter–clockwise direction of rotation

Cable designation, spindle	Connection designation, SIMODRIVE 611 drive converter	Direction of rotation of the spindle when viewing the drive side
U1 or conductor designation 1	V2	
V1 or conductor designation 2	U2	
W1 or conductor designation 3	W2	
Drive end 		

Warning

The drive converter rotating field must match the direction in which the encoder system counts. When connecting–up as specified in Table 5-11, the direction in which the encoder system counts must be adapted using the appropriate machine data; MD 1011 is used to make this adaptation for SIMODRIVE 611 digital/universal.

If the rotating field and counting direction of the encoder system do not match, then this can result in uncontrollable motion and destruction of the motor spindle.

Reference: SIMODRIVE 611 digital, Description of Functions
Drive functions,
Chap. 2.1 Configuration, actual value sensing (motor meas. system)

SINUMERIK 840D/SIMODRIVE 611 digital,
Commissioning Manual
Chapter 6.9.10, Position controller data, axis

■

Supplying the Various Media 6

6.1 Overview, supplying the various media

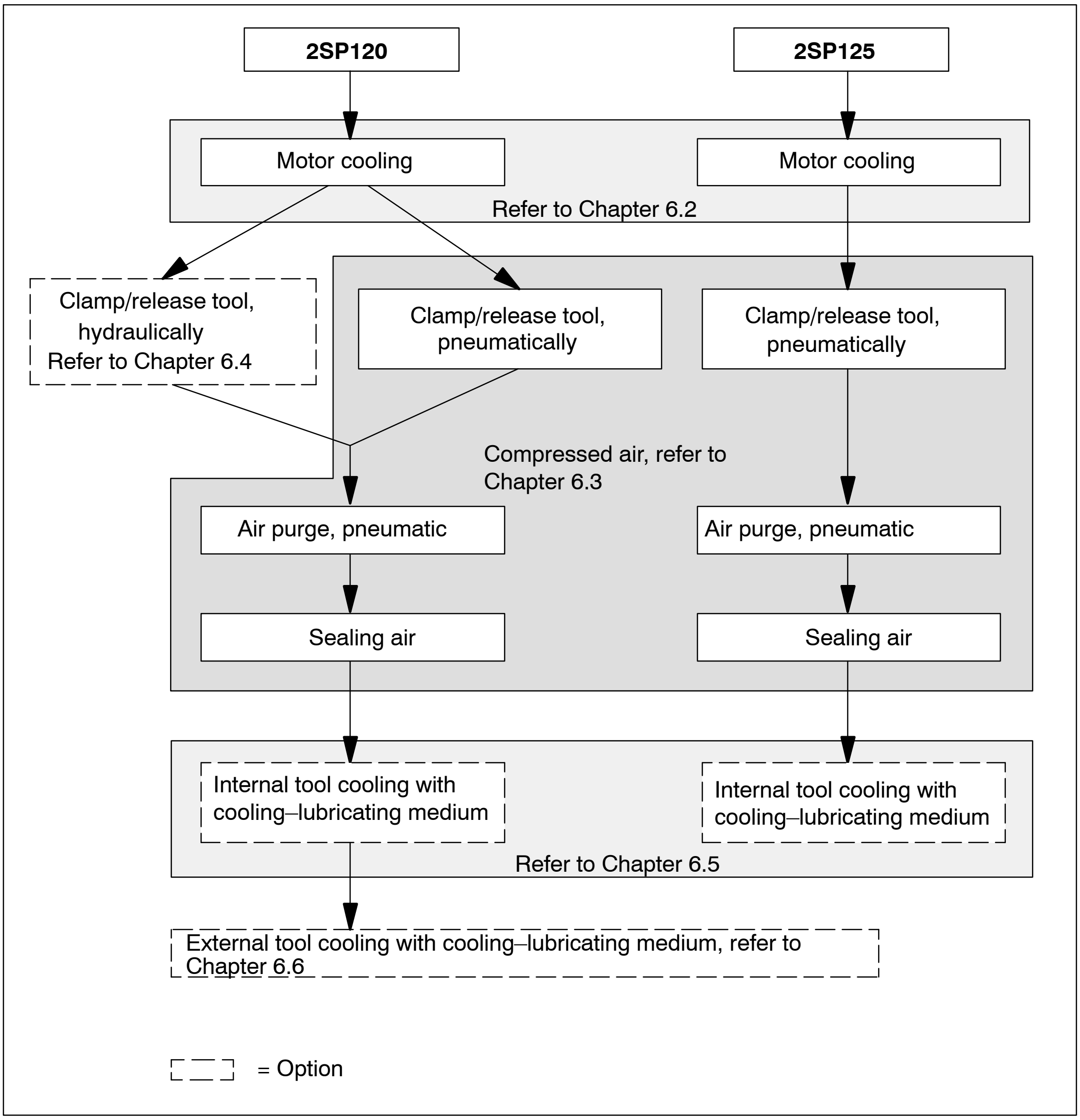


Fig. 6-1 Overview, supplying the various media

6.2 Cooling medium

The spindle is designed for water cooling. The spindle housing is equipped with cooling ducts, which transfer the stator power loss (heat) into the cooling water. The temperature of the cooling water increases when it flows through the spindle corresponding to the flow rate and the thermal power that it absorbs.

$$\Delta T = \frac{1}{\dot{V} \cdot \rho \cdot c_p} \cdot P_V$$

ΔT	=	Temperature difference between the cooling water input and output
$\dot{V}$	=	Cooling water flow rate
ρ	=	Density of the cooling water
c_p	=	Specific thermal capacitance of the cooling water
P_V	=	Power loss that has been absorbed

Notice

In order to guarantee the necessary thermal transition in the cooling ducts, the minimum cooling water flow, listed in Chapter 9, should be maintained.

Note

Higher cooling water flow rates are permissible as long as the permissible hydrostatic pressure in the system is not exceeded.

6.2.1 Cooling water connections

Table 6-1 Cooling water connections

	2SP120	2SP125	Remark
Connection fitting	Hose connector for hose ∅ 12/10 mm	G1/2” (inner thread) for hoses ∅ 9 mm	On the spindle side
Connection code	I = motor cooling ON II = motor cooling OFF	I = motor cooling ON II = motor cooling OFF	On the spindle side
Permitted tightening torque [Nm]	—	max. 100 Nm	When tightening

Notice

The feeder lines and hoses to the connections must be flexible and strain relieved. Rigid pipe connections are not permissible.

For the connectors of the 2SP120□□ spindle, only use connecting hoses in a PU/PA quality.

6.2.2 Conditioning the cooling water

The cooling water must be conditioned in order to maintain the correct functioning of the cooling system on the spindle side (refer to Table 6-2).

Table 6-2 Conditioning the cooling water

	Value
Min. incoming temperature	No moisture condensation
Max. incoming temperature	Without de–rating 25 °C With de–rating, refer to Table 6-3: 40 ° C
Max. hydrostatic pressure	5 bar
Max. particle size	100 µm
Recommended anti–corrosion agents	max. 25% Clariant, Antifrogen or Tyfocor

Caution

Cooling

- It is neither permissible to use water from the drinking water supply, nor
- to use cooling–lubricating medium.

The cooling water temperature must be set corresponding to the ambient temperature so that moisture condensation does not occur.

The S1 power (continuous duty) of the spindle depends on the inlet temperature of the cooling water. For inlet temperatures of up to 25°C the S1 power, specified in the data sheet, is achieved. Above a cooling water inlet temperature of 25°C, the S1 power is reduced (refer to Table 6-3).

Table 6-3 Reduced S1 power as a function of the cooling–water temperature

Inlet temperature [°C]	Reduction factor
25	1
35	0.95
40	0.90

Cooling water additives

Additives must be added to the cooling water to protect against corrosion and living organisms. These additives must be compatible with the materials used for the cooling water feed system on the spindle side. Further, they must also be compatible with the materials used in the cooling water feed system on the machine side. Electro–chemical incompatibility between the materials of the cooling water feed and the spindle side and on the machine side is not permissible. The machine–side cooling water feed system must be appropriately designed.

List of materials for the cooling water feed on the spindle side:

- Steel, grey cast iron
- Brass
- Stainless steel
- Viton
- GFP

Cooling water requirements

Refer to Chapter 10 for the flow quantity and pressure drop.

6.2.3 Cooling systems

The cooling water that is withdrawn from the spindle must be cooled using an external cooling system. The external cooling system is not included with the spindle.

The thermal load of the cooling water at the rated spindle power is described in Section 10.

Table 6-4 External cooling system versions

Version	Characteristics
The existing cooling system is used	– The existing cooling system must be increased by the spindle power loss – The compatibility of the materials must be carefully checked – The pump must be able to provide the additional flow at the required pressure
Air/water heat exchanger cooling system	– Favorable investment and operating costs as a compressor does not have to be used – The heat exchanger must be dimensioned so that the inlet temperature for the spindle is a max. 5 K above the ambient temperature – Higher space requirement of the heat exchanger than for the cooling unit
Stand–alone cooling system	– The inlet temperature for the spindle is independent of the ambient temperature

Cooling system manufacturers

Table 6-5 Cooling system manufacturers

BKW Kälte–Wärme–Versorgungstechnik GmbH
Benzstraße 2 72649 Wolfschlungen Tel.: +49 (0) 70 22 – 50 03 – 0 Telefax: +49 (0) 70 22 – 50 03 – 30 mailto:info@bkw–kuema.de http://www.bkw.kuema.de
DELTATHERM Hirmer GmbH
Gewerbegebiet Bövingen 122 53804 Much Tel.: +49 (0) 22 45 – 61 07 – 0 Telefax: +49 (0) 22 45 – 61 07 – 10 mailto:info@deltatherm.de http://www.deltatherm.de

Table 6-5 Cooling system manufacturers, continued

Glen Dimplex Deutschland GmbH, Geschäftsbereich RIEDEL Kältetechnik
Am Goldenen Feld 18 95326 Kulmbach Tel.: +49 (0) 92 21 – 709 –555 Telefax: +49 (0) 92 21 – 709 –549 mailto:info@riedel–cooling.de http://www.riedel–cooling.de
Hydac System GmbH
Postfach 1251 66273 Sulzbach/Saar Tel.: +49 (0) 68 97 – 509 – 708 Telefax: +49 (0) 68 97 – 509 – 454 http://www.hydac.com
Helmut Schimpke Industriekühlanlagen GmbH & Co. KG
Ginsterweg 25 – 27 42781 Haan Tel.: +49 (0) 21 29 – 94 38 – 0 Telefax: +49 (0) 21 29 – 94 38 – 99 mailto:info@schimpke.de http://www.schimpke.de
Hyfra Industriekühlanlagen GmbH
Industriepark 54 56593 Krunkel Tel.: +49 (0) 26 87 – 898 – 0 Telefax: +49 (0) 26 87 – 898 – 25 mailto:infohyfra@hyfra.com http://www.hyfra.de
KKT Kraus Kälte– und Klimatechnik
Mühllach 11 90552 Röthenbach a. d. Pegnitz Tel.: +49 (0) 911 – 953 33 – 40 Telefax: +49 (0) 911 – 953 33 – 33 http://www.kkt–kraus.de

Table 6-5 Cooling system manufacturers, continued

Pfannenberg GmbH
Werner–Witt–Straße 1 21035 Hamburg Tel.: +49 (0) 40 734 12 – 127 Telefax: +49 (0) 40 734 12 – 101 http://www.pfannenberg.de

6.3 Compressed air

6.3.1 Using compressed air

The functions, listed in Table 6-6 use compressed air.

Table 6-6 Using compressed air

Functions using compressed air	Description
Actuating the pneumatic cylinder	– The tool is clamped in and released from the tool holder using the pneumatic cylinder – The minimum pressure must be maintained – Compressed air is only used when clamping and releasing the tool – Particles in the compressed air are relatively non–critical
Bearing sealing air	– A high degree of purity is required (refer to Chapter 6.3.3) – A continuous airflow is required
Air purge	– Protects the tool holder from becoming dirty – between ejecting the old tool and inserting the new tool – Purge air is only used while the tool is being changed – An average degree of purity is required

It is the responsibility of the machinery construction company/operating company to provide the compressed air in the required quality and quantity. The machinery construction company is responsible in controlling the individual compressed air flows.

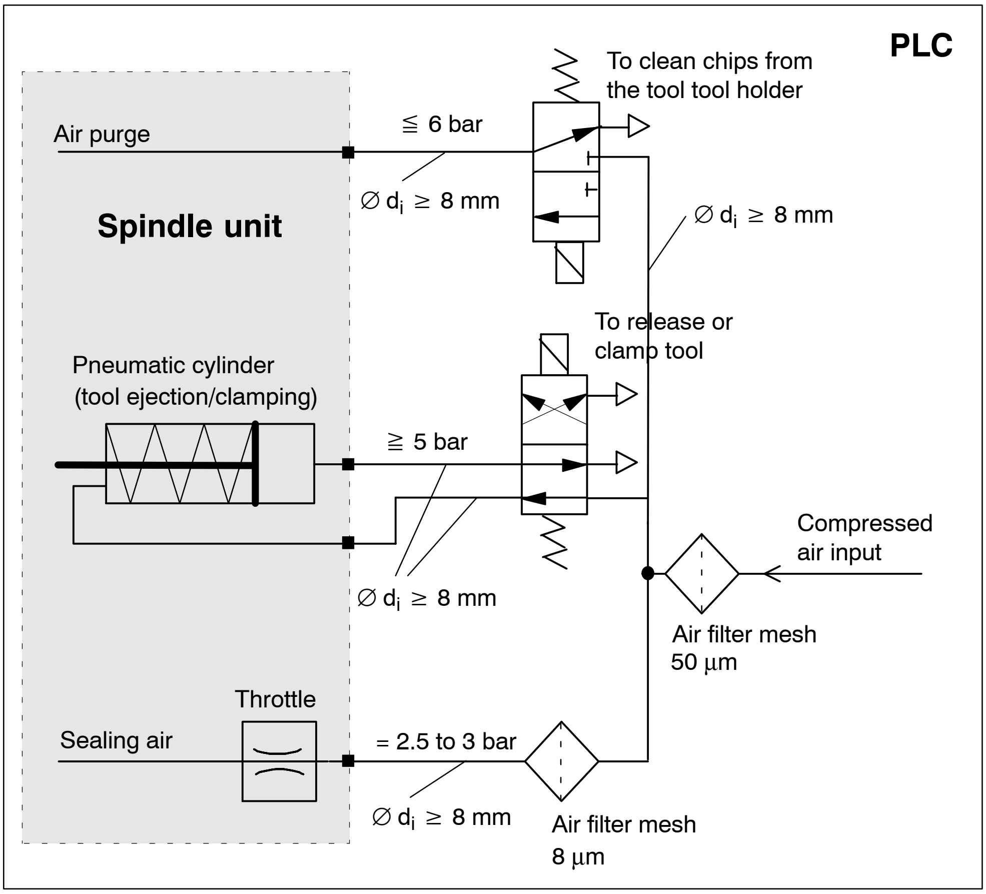


Fig. 6-2 Recommended pneumatic system

Table 6-7 Translation for Fig. 6-2

English	German
Air purge	Kegelreinigungsluft
Spindle unit	Spindeleinheit
Pneumatic cylinder (tool ejection)	Pneumatischer Zylinder (Ausstoß des Werkzeuges)
Sealing air	Sperrluft
Throttle	Drossel
To clean chips from the tool holder	Reinigung der Werkzeugaufnahme von Spänen
To release or clamp tool	Lösen oder Spannen des Werkzeuges
Air filter mesh	Luftfilterfeinheit
Compressed air supply	Drucklufteingang

6.3.2 Compressed air connections

All of the connections are compressed air feed connections (inlet). The compressed air which has been used is discharged to the environment.

Table 6-8 Compressed air connections for 2SP120

	Pneumatic cylinder		Sealing air	Air purge
Function	Release tool, air inlet	Clamp tool, air inlet	Air inlet	Air purge inlet
Connection fitting (on the spindle side)	1 x G1/4" (inner thread) for hoses ∅ ≥ 8 mm	1 x G1/8" (inner thread) for hoses ∅ ≥ 8 mm	Radial: G1/8" (inner thread) Axial: ∅ 5.0 mm (provide a 6 x 2 mm O ring) for hoses ∅ ≥ 8 mm	G1/4" (inner thread) for hoses ∅ ≥ 8 mm
Connection code (on the spindle side) [1)]	VIIa	VIIIa	V	IX
Perm. tightening torque	30 Nm	20 Nm	20 Nm	40 Nm

Table 6-9 Compressed air connections for 2SP125

	Pneumatic cylinder		Sealing air	Air purge
Function	Release tool, air inlet	Clamp tool, air inlet	Air inlet	Air purge inlet
Connection fitting (on the spindle side)	M16 x 1.5 (inner thread) for hoses ∅ ≥ 8 mm	G1/8" (inner thread) for hoses ∅ ≥ 8 mm	Radial: G1/8" (inner thread) for hoses ∅ ≥ 8 mm	G1/4" (inner thread) for hoses ∅ ≥ 8 mm
Connection code (on the spindle side) [1)]	X	XI	V	IXa
Perm. tightening torque	30 Nm	20 Nm	20 Nm	40 Nm

Notice

The feeder lines and hoses to the connections must be flexible and strain relieved. Rigid pipe connections are not permissible.

1) Connection codes, also refer to the dimension sheets, Chapter 10

6.3.3 Conditioning the compressed air

In addition to the different minimum requirements placed on the supply of the compressed air functions, the conditions, listed in Table 6-11 must be maintained.

Table 6-10 General compressed air conditioning

Min. air inlet temperature [°C]	Ambient temperature
Max. air inlet temperature	35 °C
Max. residual water content	0.12 g/m^3
Max. residual oil content	0.01 mg/m^3
Max. residual dust	0.1 mg/m^3

Table 6-11 Conditioning

	Minimum pressure [pa]	**Maximum pressure [pa]**	**Max. particle size [µm]**
Pneumatic cylinder	$5 \cdot 10^5$ (5 bar)	$10 \cdot 10^5$ (10 bar)	50
Sealing air	$2.5 \cdot 10^5$ (2.5 bar)	$3 \cdot 10^5$ (3 bar)	8
Air purge	$5 \cdot 10^5$ (5 bar)	$6 \cdot 10^5$ (6 bar)	50

6.3.4 Hydraulic fluid flow data and controlling the hydraulic fluid flow requirement

The compressed air functions should only be switched–in when actually required in order to minimize the air requirement.

Notice

The sealing air must be permanently active to protect the bearings as long as the motor spindle is operational.

Table 6-12 Air requirement

Compressed air function	Air flow requirement [Nl]	Controlling the air flow requirement
Pneumatic cylinder	Air usage per tool change 2SP120 800 cm^3/cycle 2SP125 846 cm^3/cycle	Flow rate only when changing a tool (releasing and clamping)
Air purge	2.1 Nm^3/h for 5 tool changes per minute.	Compressed air only has to be switched–in when the old tool is ejected up to when the new tool is drawn–in
Sealing air	1–1.5 Nm^3/h [1)]	The compressed air must be switched–in when the machine is powered–up

1) 1 Nm^3= standard cubic meters

6.3.5 Standalone units to generate compressed air

An external compressor must be used to provide the compressed air and appropriately condition it. The compressor equipment is not included with the spindle.

If the machine construction company uses a separate compressor, storage device and pressure controller for the compressed air generating system, then the structure, as shown in Fig. 6-3, is recommended.

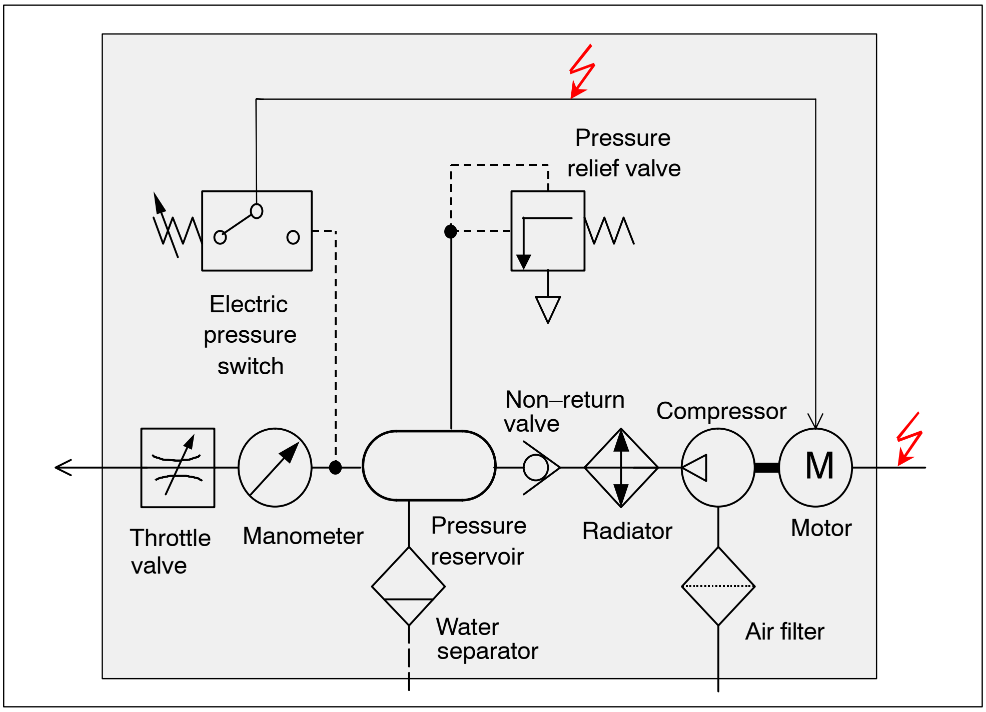


Fig. 6-3 Recommended circuit–diagram of a compressed air system

Table 6-13 Translation for Fig. 6-3

English	German
Pressure switch	Druckschalter
Throttle	Drosselventil
Manometer	Manometer
Water separator	Wasserabscheider
Non–return valve	Rückschlagventil
Pressure reservoir	Druckluftspeicher
Pressure relief valve	Druckbegrenzungsventil
Compressor	Kompressor
Cooler	Kühler
Motor	Motor
Air filter	Luftfilter

6.4 Hydraulic (option, only for 2SP120)

6.4.1 Using hydraulics

Hydraulics is used to clamp and release the tool holder.

Table 6-14 Using hydraulics

Hydraulic functions	Description
Actuating the hydraulic cylinder	– The tool is clamped in the tool holder and released from it using the hydraulic cylinder – The minimum pressure must be maintained – Hydraulics are only required when clamping and releasing the tool – Particles in the compressed air are relatively non–critical

The machinery construction OEM is responsible for:

- Providing the required quality and quantity of hydraulic fluid
- Controlling the individual hydraulic fluid flows

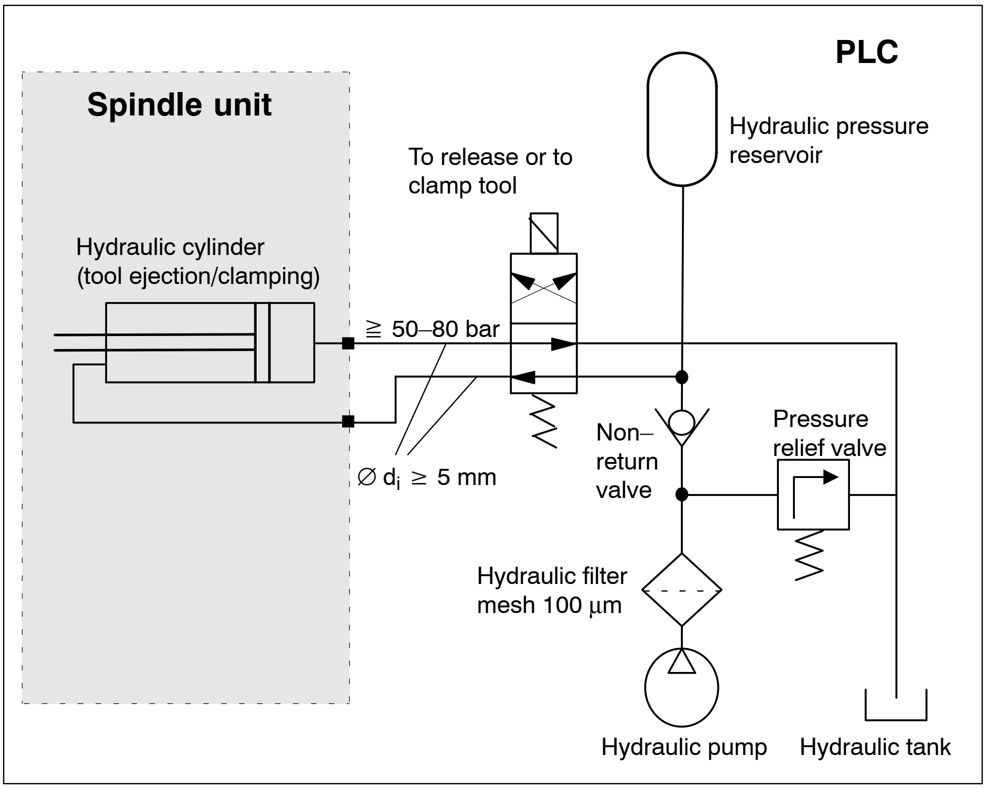


Fig. 6-4 Recommended hydraulic system layout

Table 6-15 Translation for Fig. 6-2

English	German
Spindle unit	Spindeleinheit
Hydraulic cylinder (tool ejection/clamping)	Hydraulik Zylinder (Lösen/Spannen des Werkzeuges)
To release or to clamp tool	Lösen oder Spannen des Werkzeuges
Hydraulic filter mesh	Ölfilterfeinheit
Hydraulic pump	Hydraulikpumpe
Hydraulic tank	Hydrauliktank
Non–return valve	Rückschlagventil
Hydraulic pressure reservoir	hydraulischer Druckspeicher

6.4.2 Hydraulic connections

All of the connections only comprise a hydraulic fluid feed.

Table 6-16 Technical data to control the hydraulics of the hydraulic cylinder

	Hydraulic cylinder	
Function	Release tool	Clamp tool
Connection fitting (on the spindle side)	G1/4”	G1/4”
Connection code (on the spindle side) [1)]	VII	VIII
Perm. tightening torque	40 Nm	40 Nm
Release/clamping pressure	50 to 80 bar	
Max. particle size	100 μm	

Notice

The feeder lines and hoses to the connections must be flexible and strain relieved. Rigid pipe connections are not permissible.

6.4.3 Hydraulic fluid flow data and controlling the hydraulic fluid flow requirement

The hydraulic functions should only be switched–in when actually required in order to minimize oil usage.

1) Connection codes, also refer to the dimension sheets, Chapter 10

6.5 Internal tool cooling using the cooling–lubricating medium (option)

The 2SP1 motor spindle is optionally available with the internal tool cooling function. In this case, cooling–lubricating medium is fed through a rotary gland from the rear of the shaft through the spindle shaft to the tool. The user must appropriately condition and provide this cooling–lubricating medium in order to guarantee the service lifetime of the rotary gland.

The ”internal tool cooling with cooling–lubricating medium” can only be retrofitted with the spindle removed and only by an authorized repair workshop.

Table 6-17 Connecting the internal tool cooling

	Cooling–lubricating medium inlet	**Leakage drain**
Connection fitting (on the spindle side)	G1/4” (inner thread)	G1/8” (inner thread)
Connection code (on the spindle side)	for 2SP120 X for 2SP125 IXb	IV
Permissible tightening torque [Nm]	40	20

Caution

It is not permissible to use a rigid pipe connections.

The piping must be free of any tension and pressure as well as bending torque and torsion. The piping may not be subject to tensile stress – neither when pressurized nor under a no–pressure condition.

The piping may not exert any torsion on the connection fitting of the cooling–lubricating medium feed. Flexible hoses with the appropriate loop must be used to make the connection.

Notice

Small cooling–lubricating medium leaks will occur in operation, especially when tools are being changed. The leaked cooling–medium fluid is collected in the cooling–lubricating medium gland and from where it can drain.

The fluid must be able to freely drain from the pipes.

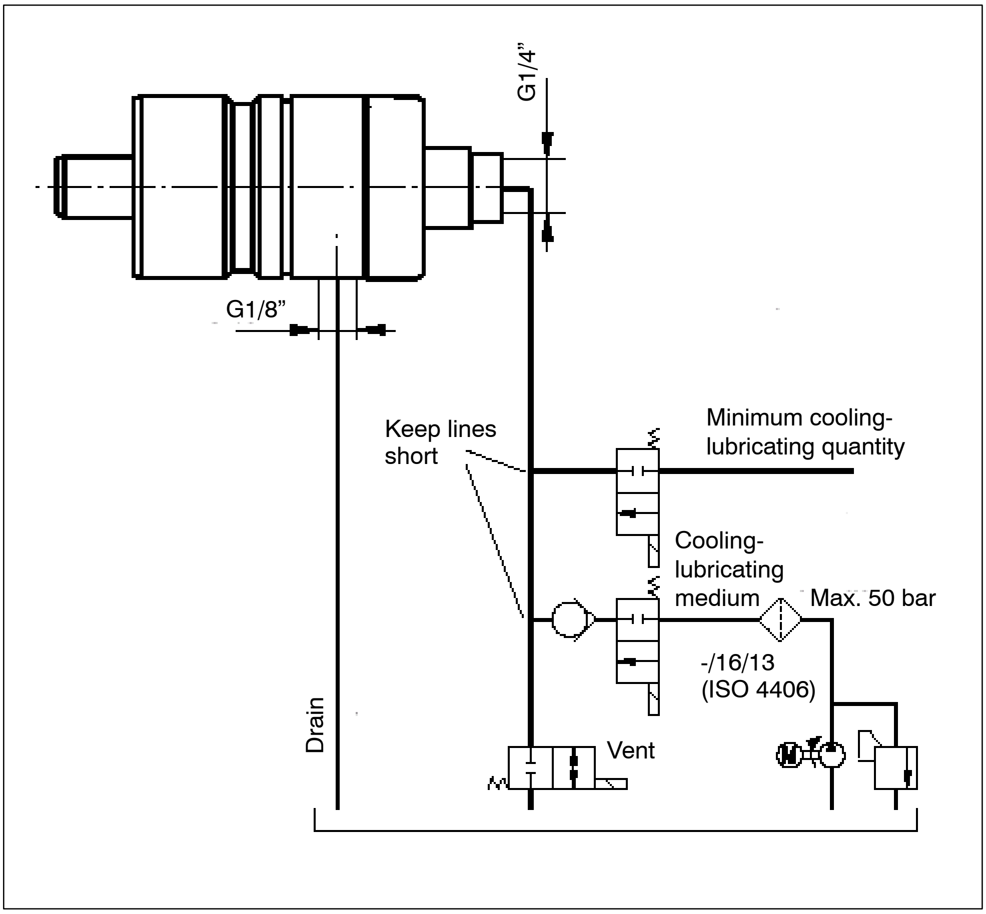


Fig. 6-5 Connections for various media

Table 6-18 Translation for Fig. 6-5

English	German
Minimum cooling-lubricating quantity	Minimalmengen-Kühlschmierung
Cooling-lubricating medium	Kühlschmiermittel
Vent	Entlüftung
Drain	Leckage
Keep lines short	Leitung kurz halten

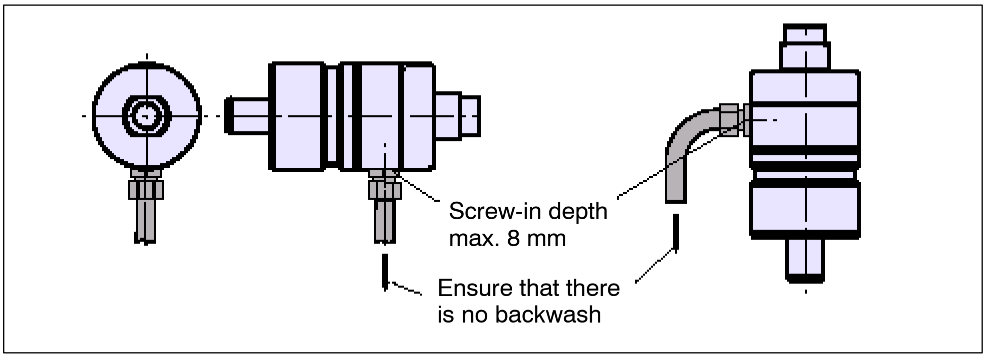


Fig. 6-6 Drain connection

Table 6-19 Translation for Fig. 6-6

English	German
Screw-in depth	Einschraubtiefe
Ensure that there is no backwash	rückstaufrei abführen

6.5.1 Operating conditions

The data in Table 6-20 apply for the cooling–lubricating medium flow when the spindle is being operated.

Table 6-20 Data of the cooling–lubricating medium gland

	Value	Remark
Max. pressure	$50 \cdot 10^5$ Pa (50 bar)	
Max. speed	18000 rpm	Also under no pressure conditions
Max. particle size	50 µm	Cooling–lubricating medium acc. to ISO 4406 (–/16/13)
Max. cooling–lubricating medium temperature	40 °C	
Max. flow rate	54 l/min	Dependent on the pressure
Pressure loss	$2.7 \cdot 10^5$ Pa (2.7 bar)	
Frictional torque	0.3 Nm	

The frictional torque of the cooling–lubricating medium gland means that its temperature increases and reduces the available maximum torque.

Table 6-21 Permissible media for the internal tool cooling

Operation with cooling–lubricating medium	The flow must be guaranteed
Operation with minimum quantity of cooling-lubricating medium	Mixture, maximum 5 bar
	Lubricating medium percentage, minimum 10 ml/h
	Lubrication must be guaranteed
	2/2path valve must allow unrestricted flow (as the fluids could possibly separate) (e.g. ball valve)
	Cooling–lubricating medium and compressed air may never be simultaneously applied to the MQL system
Dry machining without compressed air	The line must be vented; there may be no residual pressure

When changing a tool, to clean the tool cone/nose at standstill, compressed air can be fed–in through the integrated cooling–lubricating medium gland.

Caution

The cooling–lubricating medium must be conditioned so that pressure peaks in the feeder line are avoided. The maximum permissible pressure may never be exceeded – even during pressure peaks.

The integrated cooling–lubricating medium gland is not suitable to feed–in hydraulic fluids and compressed air while the spindle is rotating.

Only suitable tools with a through hole which allows the cooling–lubricating medium to be discharged may be used when feeding–in cooling–lubricating medium for internal tool cooling; there must always be a transfer pipe to connect the tool to the clamping system so that no fluid is lost.

If unsuitable tools are used, then the grease is flushed–out of the tool gripper and, depending on the pressure, can cause failure of the spindle or the rotary gland.

6.6 External tool cooling with cooling–lubricating medium (option, only for 2SP120□)

The 2SP120□motor spindle is optionally available with the ”external tool cooling” function. The ”external tool cooling with cooling–lubricating medium” function can also be retrofitted on spindles that have already been supplied.

The ”external tool cooling” function is implemented using a ring that is mounted at the motor spindle flange. The ring is available with adjustable spray nozzles or with threaded holes so that customer–specific spray nozzles can be used.

The cooling–lubricating medium is fed–in either through an axial or radial connection at the stationary mounting flange of the spindle. The connection that is not used must be sealed.

The cooling–lubricating medium jet can be aligned using the manually adjustable spray nozzles so that the cooling–lubricating medium cools the tool and the workpiece from the outside. In order to guarantee the function of the spray nozzles, the user must appropriately condition the cooling–lubricating medium (refer to Chapter 6.6.1).

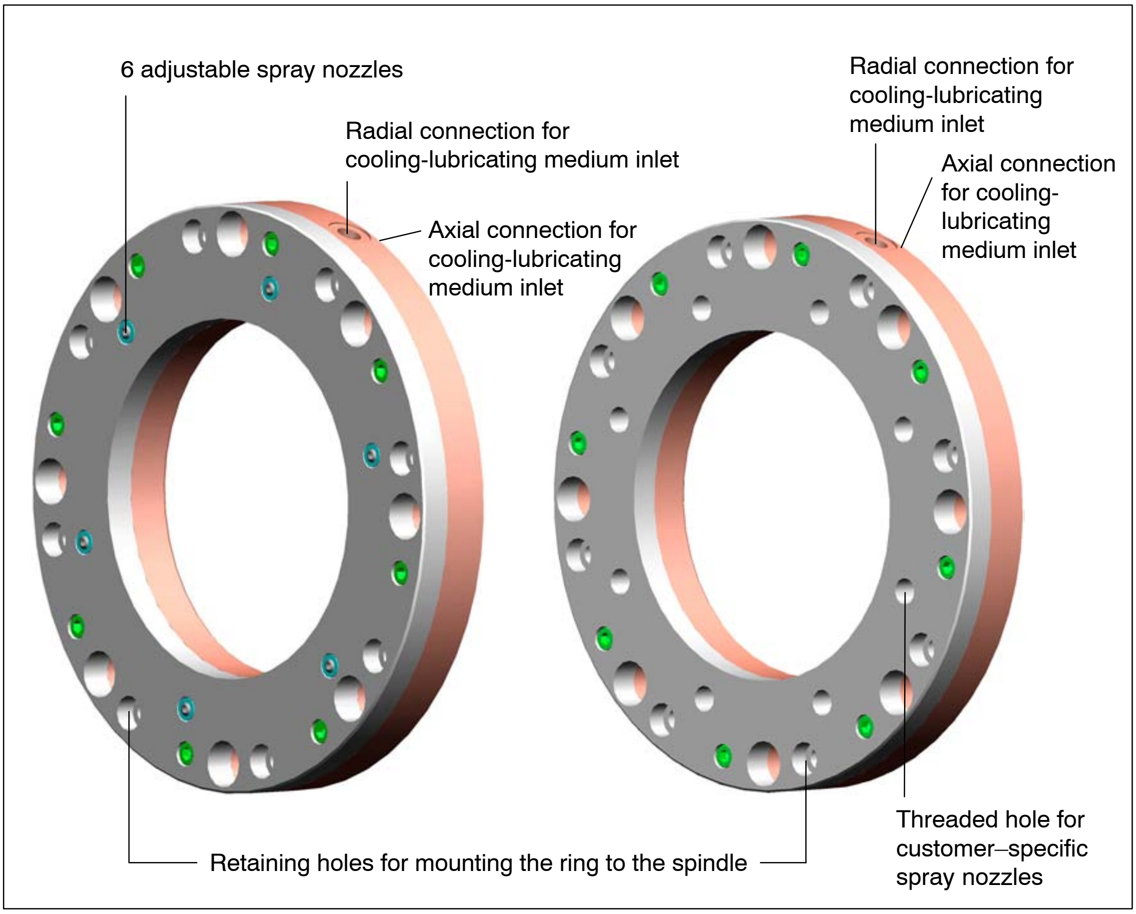


Fig. 6-7 Lefthand side: Ring with the adjustable spray nozzles for the external tool cooling; Righthand side: Ring with threaded holes to screw–in spray nozzles or chain elements for the external tool cooling

Table 6-22 Translation for Fig. 6-7

English	German
6 adjustable spray nozzles	6 einstellbare Spritzdüsen
Radial connection for cooling-lubricating medium inlet	radialer Anschluss der Kühlschmiermittelzufuhr
Axial connection for cooling-lubricating medium inlet	axialer Anschluss der Kühlschmiermittelzufuhr
Retaining holes for mounting the ring to the spindle	Befestigungsbohrungen für den Anbau des Rings an die Spindel
Threaded hole for customer–specific spray nozzles	Gewindebohrungen für kundenspezifische Spritzdüsen

Table 6-23 Connection for the external tool cooling (for 2SP120)

	Connection, cooling–lubricating inlet	
	Axial	Radial
Connection fitting (on the spindle side)	Bore ∅ 8.8 mm prepared for 11 x 2 mm O ring	G1/4” (inner thread)
Connection code (on the spindle side) [1)]	XI	XI
Perm. tightening torque	–	40 Nm
Cooling–lubricating medium outlet via adjustable spray nozzles (standard)	6 spray nozzles, adjustable from 0–30°	
Cooling–lubricating medium outlet through threaded holes for customer–specific spray nozzles (option)	Threaded holes 8 x G1/4”	

Caution

It is not permissible to use a rigid pipe connections. The piping must be free of any tension and pressure as well as bending torque and torsion.

The piping may not be subject to tensile stress – neither when pressurized nor under no–pressure conditions.
The piping may not exert any torsion on the connection fitting of the cooling–lubricating medium feed.

Flexible hoses with the appropriate loop must be used to make the connection.

1) Connection codes, also refer to the dimension sheets, Chapter 10

6.6.1 Operating conditions

The data in Table 6-24 apply for the cooling–lubricating medium flow when the spindle is being operated.

Table 6-24 Data of the external tool cooling with cooling–lubricating medium

	Value	Remark
Max. pressure	$5 \cdot 10^5$ Pa (5 bar)	
Max. particle size	50 µm	Cooling–lubricating medium acc. to ISO 4406 (–/16/13)
Max. cooling–lubricating medium temperature	40 °C	
Max. flow rate	Dependent on the pressure	

Caution

The cooling–lubricating medium must be conditioned so that pressure peaks are avoided. The maximum permissible pressure may not be exceeded.

6.7 Media connections and coding

6.7.1 Media connections for 2SP120□

Table 6-25 Media connections for 2SP120□ (on the spindle side)

Description	2SP120□	
	Coding [1]	**Connection fitting**
Motor cooling inlet	I	G1/2” connector for hoses ∅ ≥ 12/10 mm
Motor cooling outlet	II	G1/2” connector for hoses ∅ ≥ 12/10 mm
Sealing air inlet	V	G1/8” radial or axis through a ∅ 5 mm diameter bore for 6 x 2 mm seal
Release tool, air inlet	VIIa	1 x G1/4”
Clamp tool, air inlet	VIIIa	1 x G1/8”
Release tool, hydraulic inlet	VII	G1/4”
Clamp tool, hydraulic inlet	VIII	G1/4”
Air purge inlet	IX	G1/4”
Internal tool cooling with cooling–lubricating medium Cooling–lubricating medium inlet Leakage drain	 X IV	 G1/4” G1/8”
External tool cooling with cooling–lubricating medium Cooling–lubricating medium inlet Leakage drain	 XI IV	 G1/4” radial or axis through a ∅ 8.8 mm diameter bore for 11 x 2 mm seal G1/8”

(shaded box) = Option

[1] Connection codes, also refer to the dimension sheets, Chapter 10

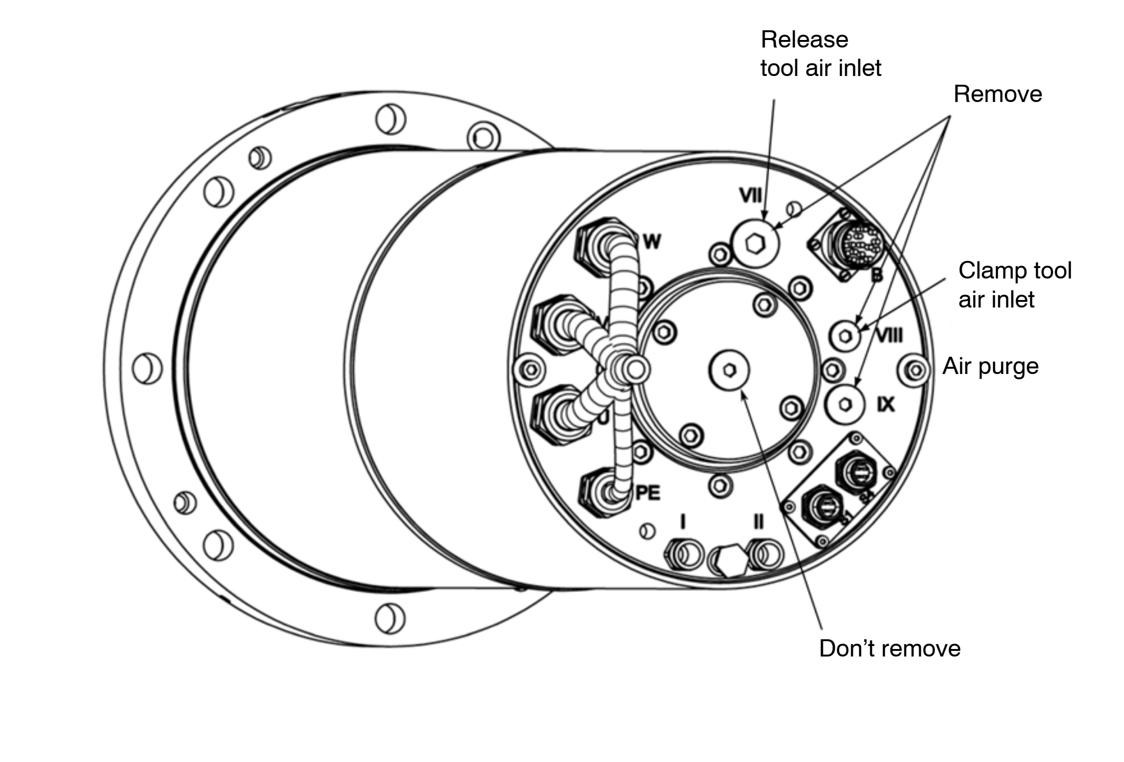


Fig. 6-8 ECS–M pneumatic 2SP120□–1H□2□–□□□□ without rotary gland

Table 6-26 Translation for Fig. 6-8

English	German
Release tool air inlet	Luft für ”Werkzeug lösen”
Remove	entfernen
Clamp tool air inlet	Luft für ”Werkzeug spannen”
Air purge	Kegelreinigungsluft
Don't remove	nicht entfernen

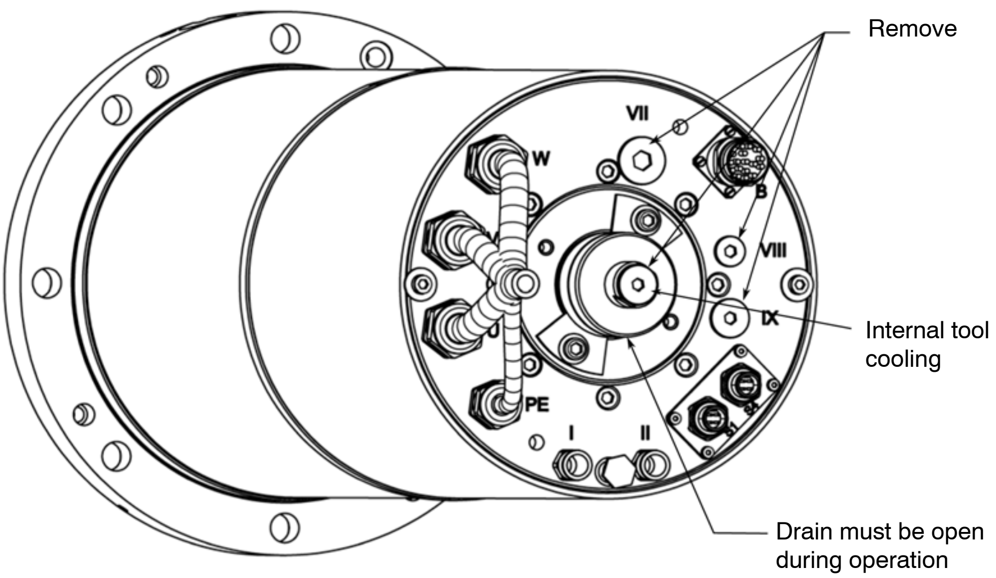


Fig. 6-9 ECS–M pneumatic 2SP120□–1H□2□–□□□□ with rotary gland

Table 6-27 Translation for Fig. 6-8

English	German
Remove	entfernen
Internal tool cooling	Werkzeuginnenkühlung
Drain must be open during operation	Leckage darf bei Betrieb nicht verschlossen sein

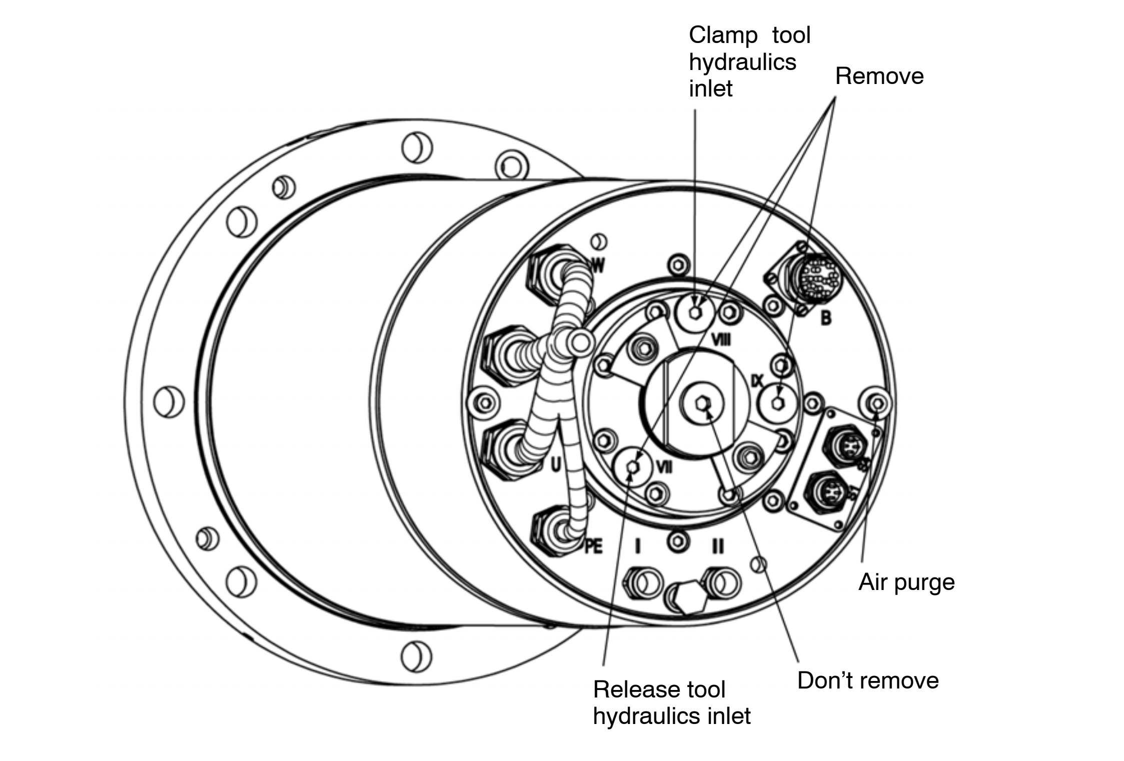


Fig. 6-10 ECS–M hydraulic 2SP120□–1H□3□–□□□□ without rotary gland

Table 6-28 Translation for Fig. 6-8

English	German
Clamp tool hydraulics inlet	Hydraulik für ”Werkzeug spannen”
Remove	entfernen
Air purge	Kegelreinigungsluft
Don't remove	nicht entfernen
Release tool hydraulics inlet	Hydraulik für ”Werkzeug lösen”

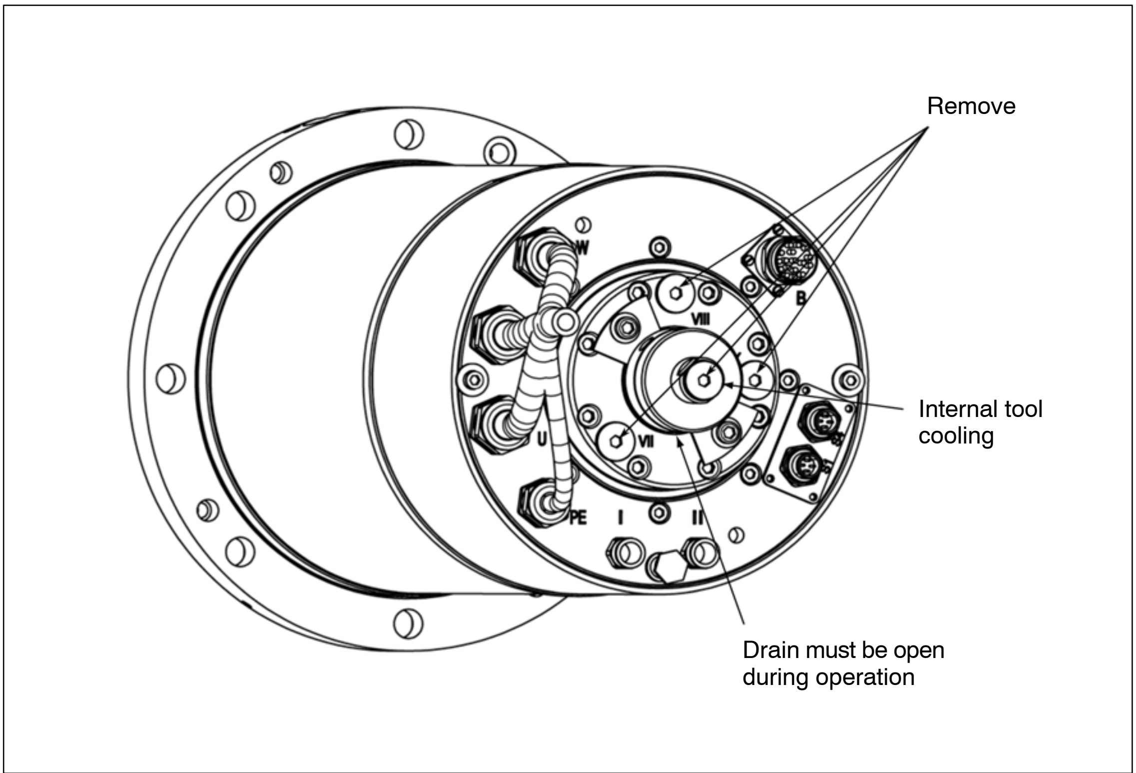


Fig. 6-11 ECS–M hydraulic 2SP120□–1H□3□–□□□□ with rotary gland

Table 6-29 Translation for Fig. 6-8

English	German
Remove	entfernen
Internal tool cooling	Werkzeuginnenkühlung
Drain must be open during operation	Leckage darf bei Betrieb nicht verschlossen sein

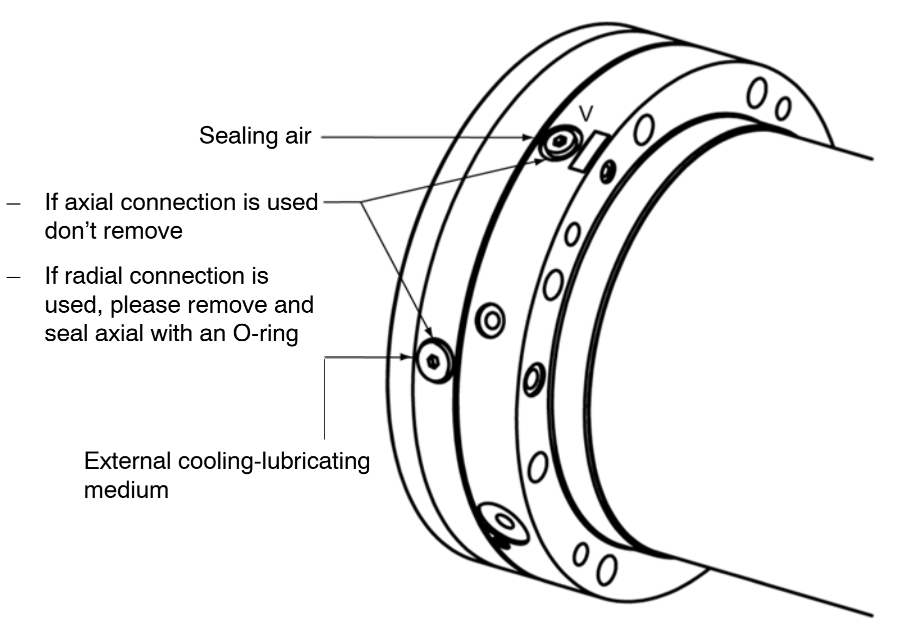


Fig. 6-12 ECS–M 2SP120□ optional external cooling–lubricating medium

Table 6-30 Translation for Fig. 6-12

English	German
Sealing air	Sperrluft
If axial connection is used don't remove	Bei axialem Anschluss nicht entfernen
If radial connection is used, please remove and seal axial with an O-ring	Bei radialem Anschluss entfernen und axial mit O-Ring abdichten
External cooling-lubricating medium	Externes Kühlschmiermittel

6.7.2 Media connections for 2SP125□

Table 6-31 Media connections for 2SP125□ (on the spindle side)

Description	2SP125□	
	Coding 1)	Connection fitting
Motor cooling inlet	I	G1/2”
Motor cooling outlet	II	G1/2”
Sealing air inlet	V	G1/8”
Release tool, air inlet	X	M16 x 1.5
Clamp tool, air inlet	XI	G1/8”
Air purge inlet	IXa	G1/4”
Internal tool cooling with cooling–lubricating medium Cooling–lubricating medium inlet Leakage drain	IXb IV	G1/4” G1/8”

(shaded box) = Option

1) Connection codes, also refer to the dimension sheets, Chapter 10

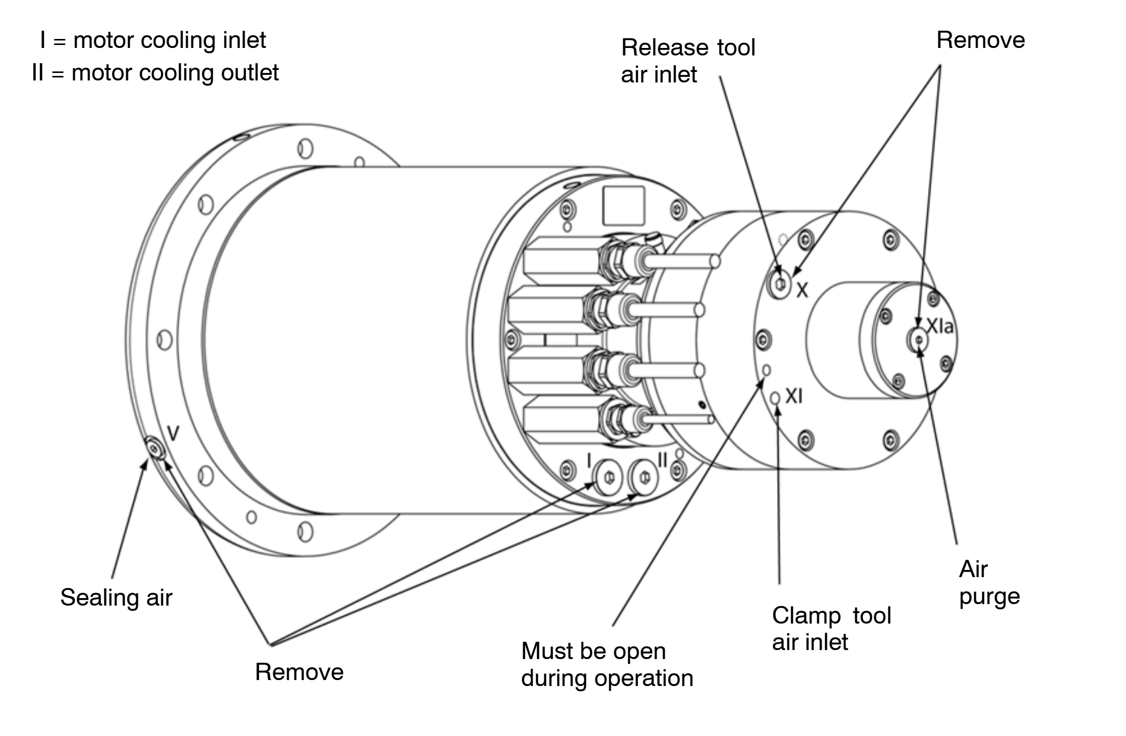


Fig. 6-13 ECS–L 2SP125□ without rotary gland

Table 6-32 Translation for Fig. 6-8

English	German
Motor cooling inlet	Motorkühlung Einlass
Motor cooling outlet	Motorkühlung Auslass
Release tool air inlet	Luft für "Werkzeug lösen"
Remove	entfernen
Air purge	Kegelreinigungsluft
Clamp tool air inlet	Luft für "Werkzeug spannen"
Must be open during operation	darf nicht verschlossen werden
Sealing air	Sealing air

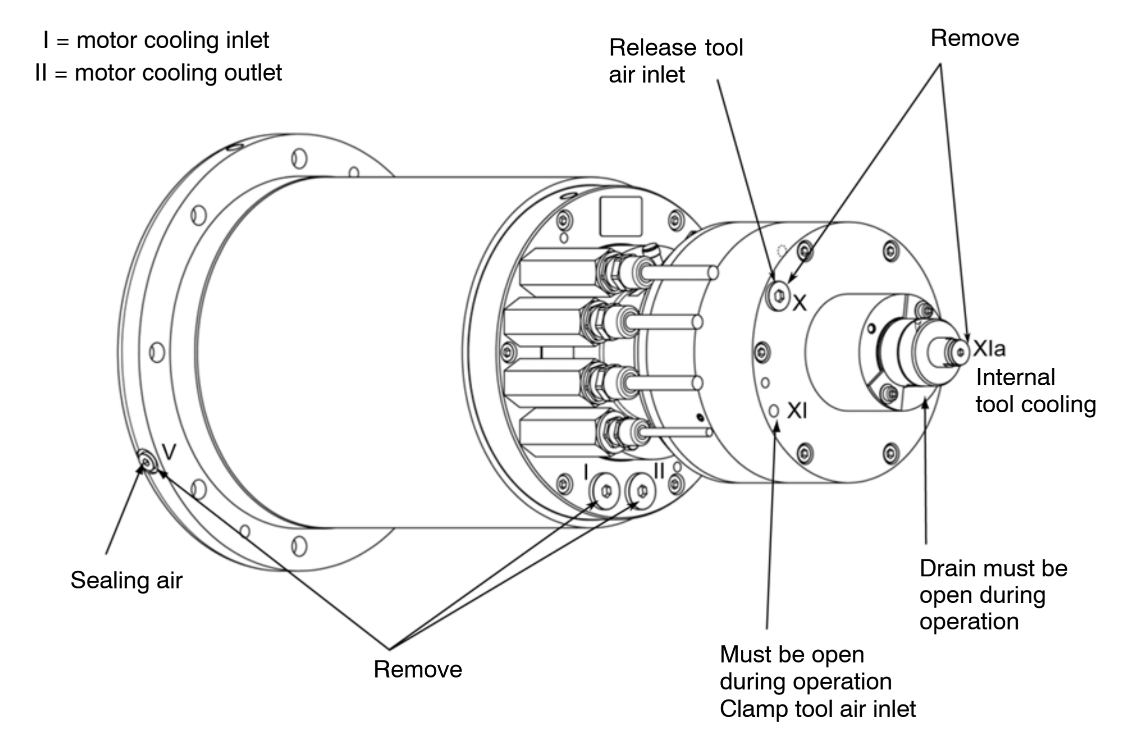


Fig. 6-14 ECS–L 2SP125□ with rotary gland

Table 6-33 Translation for Fig. 6-8

English	German
Release tool air inlet	Luft für "Werkzeug lösen"
Remove	entfernen
Internal tool cooling	Werkzeuginnenkühlung
Drain must be open during operation	Leckage darf bei Betrieb nicht verschlossen sein
Must be open during operation, clamp tool air inlet	darf nicht verschlossen werden, Luft für "Werkzeug spannen"
Sealing air	Sperrluft

■

Space for your notes

Sensors 7

7.1 Encoder/angular encoder

7.1.1 Electrical signals

2SP1 motor spindles are equipped with a hollow–shaft incremental encoder with 256 pulses. It is rugged and is insensitive to shock stressing and accumulated dirt.

The encoder works on a magnetic principle. The encoder has

- one sinusoidal signal
- one cosinusoidal signal
- one reference signal

The sinusoidal-cosinusoidal signal is suitable for fine interpolation.

The reference signal provides one pulse at each shaft revolution and allows the system to be referenced to the shaft angle.

For a synchronous motor, the reference pulse indicates the positive zero crossover of the voltage of phase U (in a clockwise rotating field/direction). The encoder interface is electrically and functionally compatible to the encoders used for SIEMENS main spindle motors.

Table 7-1 Designation of the encoder signals

Signal	Designation for a **non–inverted** electrical signal	Designation for an **inverted** electrical signal	Designation for a **differential signal**
Sinusoidal	A	A*	A
Cosinusoidal	B	B*	B
Reference	R	R*	R

Electrical signals

The signal data comprises, electrically, two individual signals – an inverted and a non–inverted signal. The individual signals have a DC voltage component with a magnitude of half of the encoder power supply voltage. The differential signal of 1 V_{pp} is obtained in the encoder interface of the drive converter by subtracting the individual signals (refer to Fig. 7-1). As a result of this subtraction, the DC voltage component of the signal track disappears and the signal amplitude doubles with respect to the individual signal.

This differential signal is relevant for the subsequent encoder evaluation. The features and properties of the differential signal are described in the following.

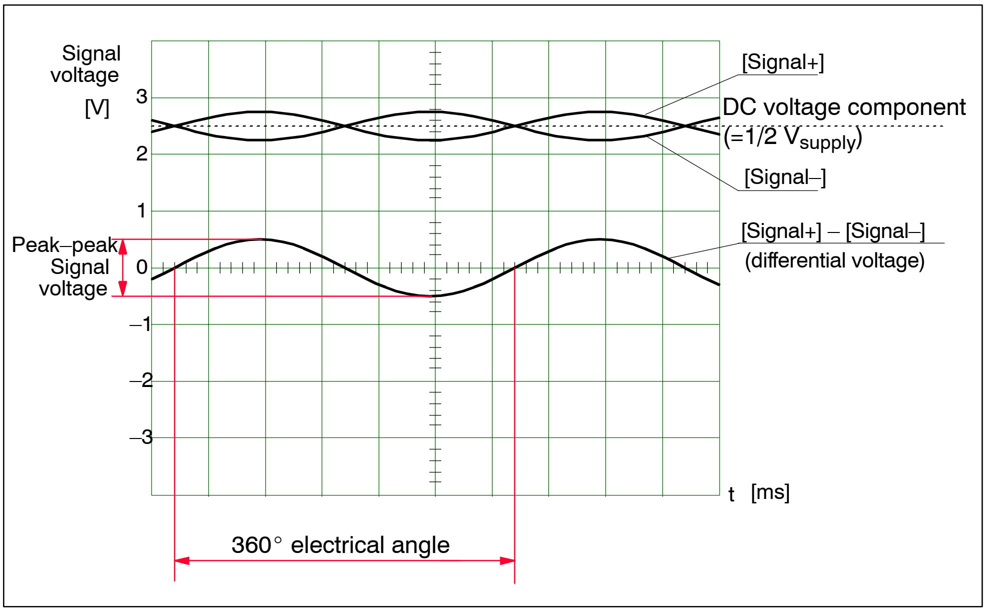


Fig. 7-1 Electrical signal level

Table 7-2 Translation for Fig. 7-1

English	German
Signal voltage	Signalspannung
Peak-peak signal voltage	Signalspannung Spitze–Spitze
Electrical angle	Winkel, elektrisch
Signal	Signal
DC voltage component	Gleichspannungsanteil
Differential voltage	Differenzspannung

Phase position of the reference signal

The phase position of the maximum of the reference signal is centered between the sinusoidal and cosinusoidal signals. The maximum deviation from the theoretical value is designated, in the encoder data table, as clear signal range α (refer to Fig. 7-2).

Phase position of the sinusoidal-cosinusoidal signals

There is a 90° phase offset between the sinusoidal and cosinusoidal signals. The maximum deviation from the theoretical value is designated as β in the encoder–data table (refer to Fig. 7-2).

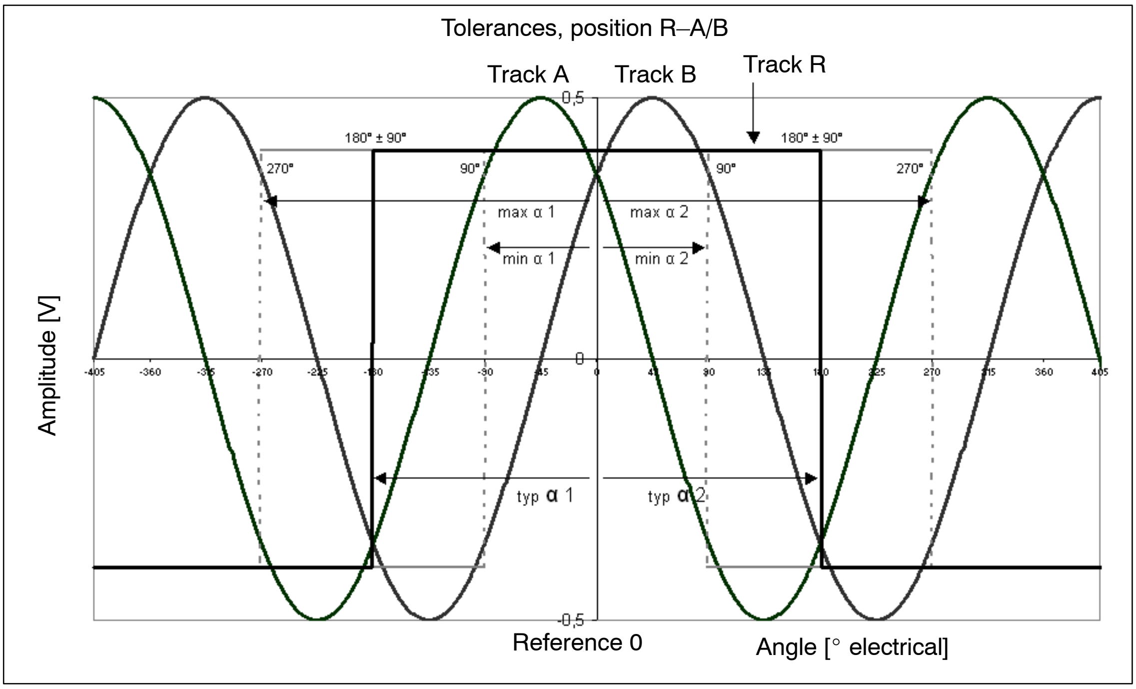


Fig. 7-2 Clear signal range of the reference track; phase relationship between the sinusoidal and cosinusoidal signal

Table 7-3 Translation for Fig. 7-2

English	German
Tolerances, position R–A/B	Toleranzen, Lage R–A/B
Track A, B, R	Spur A, B, R
Reference	Bezug
Angle [° electrical]	Winkel [° elektrisch]

DC voltage offset

The signals can have a DC voltage offset (refer to Fig. 7-3). The maximum offset voltages of the two incremental signals (sin, cos) and the reference signal are specified in the encoder data table.

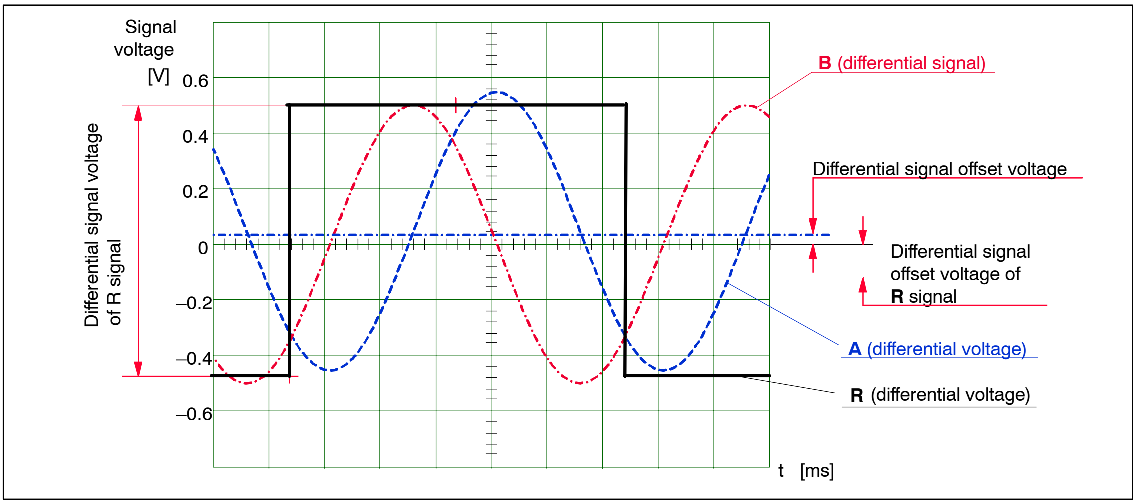


Fig. 7-3 Offset voltages of the encoder signals

Table 7-4 Translation for Fig. 7-3

English	German
Signal voltage	Signalspannung
Differential signal voltage of R signal	R-Signal Differenzspannung
Differential signal	Differenzsignal
Differential signal offset voltage	Offsetspannung Differenzsignal
Differential signal offset voltage of R signal	R-Signal Offsetspannung (Differenzsignal)
Differential voltage	Differenzspannung

Table 7-5 Electrical data of the incremental encoder

	Remark	Units	Characteristic values		
Supply voltage		V	5 +/–5%		
Supply current		mA	40 (typical)		
			Min.	**Typical**	**Max.**
Signal amplitude (A ; B)	Differential signal	V_{pp}	0.75	1.00 ... 1.10	1.20
Signal ratio (A ; B)			0.9	0.95 ... 1.05	1.1
Phase offset β	Between A and B	° el.	–5	–2 ... +2	+5
Signal offset	Differential signal	mV	–60	–15 ... +15	+60
Signal voltage R	Differential signal	V	0.4	1.0	1.2
Offset R signal		mV	–400	–450	–500
Clear signal range α		° el.	–200	–160... +160	+200

7.1.2 Connecting the signal lines

The signal cable is connected through a 17–pin flange–mounted socket. Pre–assembled cables should be used to connect the encoder to the drive converter.

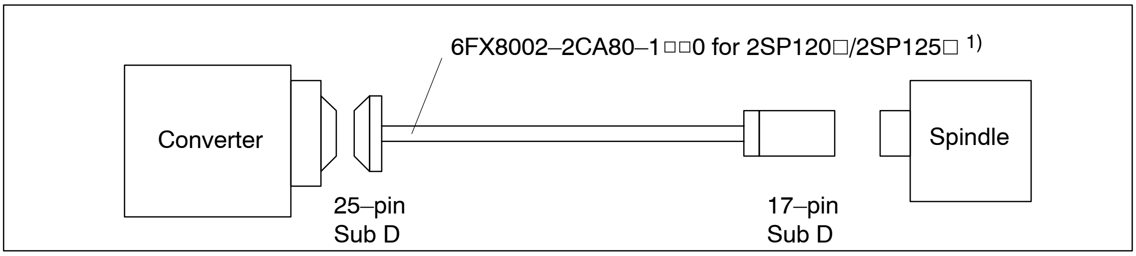


Fig. 7-4 Signal cable without the temperature sensor brought out

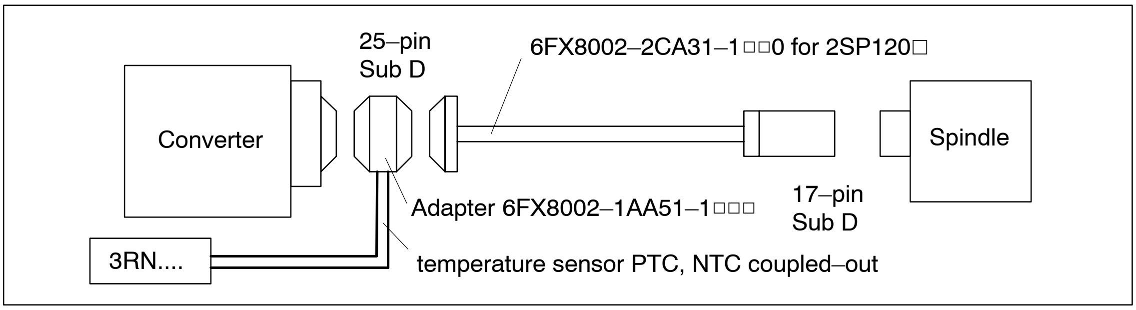


Fig. 7-5 Signal cable with the temperature sensors, PTC, NTC brought out

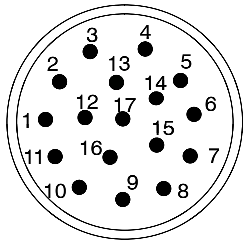
Table 7-6 Translation for 7-4 and 7-5

English	German
Converter	Umrichter
Spindle	Spindel
Temperature sensor coupled–out	Auskopplung Temperaturfühler

1) This avoids signals from the additional temperature sensors for third–party systems from being coupled–into the closed–loop control

PIN assignment

Table 7-7 PIN assignment for the encoder connection (17–pin flange–mounted socket)

PIN No.	Conductor color	Signal	View of the connector side
1	Blue	A	
2	Red	A*	
3	Green	R	
4	Brown	PTC, NTC K227 [2]	
5	White/brown	NTC K227, NTC PT3-51F [2]	
6	White	NTC PT3-51F [2]	
7	Black	M encoder	
8	Black	+KTY 84 [1]	
9	White	– KTY 84 [1]	
10	White	P encoder	
11	Gray	B	
12	Yellow	B*	
13	Brown	R*	
14	White	PTC [2]	
15	Violet	0 V sense	
16	Orange	5 V sense	
17		not connected	

For additional information on the signal cables, refer to Catalog NC 60, Chapter ”Connection system”.

1) 2-conductor temperature sensor cable

2) Connections, additional temperature sensors for spindle 2SP120□□

3) This avoids signals from the additional temperature sensors for third–party systems from being coupled–into the closed–loop control

7.2 Clamping state sensors

Function description, refer to Chapter 4.5.
Integration into the control, refer to Chapter 7.

7.2.1 Analog and digital sensors of the 2SP120 spindle

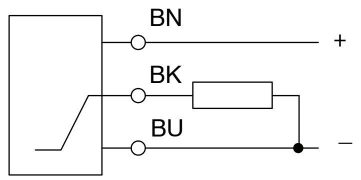
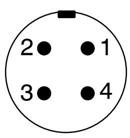
Information on the sensor systems to monitor the tool clamped status - (analog sensor S1) and to monitor the position of the piston of the release unit (digital sensor S4).

Connection

Connectors are used to connect–up the sensors (refer to drawings, Chapter 10)

The cables that are used to connect–up the sensors are not included with the spindle. These cables are commercially available as standard products.

Table 7-8 Electrical data and mechanical design of the connector for the clamping state sensor

Sensor S1 to display the clamped state (analog)	
Type	Analog sensor
	1 = +24 V 2 = not assigned 3 = 0 V 4 = analog signal 
Output signal	0 ... 10 V
Operating voltage	15 ... 30 VDC
Rated operating voltage	24 V DC
Nominal clearance	3 mm
Residual ripple	$\leq$ 15% of Ve
Max. linearity error	$\pm$ 3% of Va
Max. operating point offset	$\pm$ 0.3 mm
Linearity range	1 ... 5 mm
Connection	Connector
Short–circuit protection	Yes
Incorrect polarity protection	Yes
Connector (plug) at the cable end (on the spindle side)	Binder series 763, 4 pins, 763-09-3431-116-04
Connector (socket) at the sensor cable	Type, Siemens: Axial: 3RX1535 Radial: 3RX1548 (with LED) Type Balluff: Axial: BKS-S19-4 Radial: BKS-S20-4 (with LED)

The precise voltage values for the clamped states ”draw bar in the release position”, ”tool clamped” and ”clamped without tool” are specified in the acceptance report of the particular spindle.

Table 7-9 Electrical data and mechanical design of the connector for the clamping state sensor(digital)

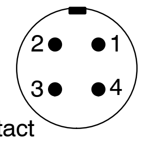
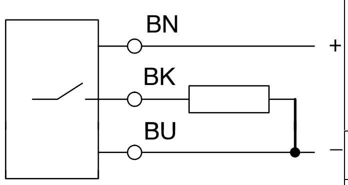
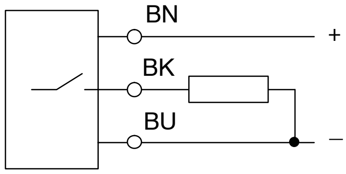
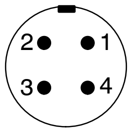
Sensor S1, S2, S3 to display the clamped state (digital)		
Pin assignment at the sensor	**Connector at the sensor**	**Socket at the cable**
1: +V 2: not assigned 3: –V 4: switching contact   		Type, Siemens with connector outlet Axial: 3RX1535 Radial: 3RX1548 (with LED) Type, Balluff with connector outlet Axial: BKS-S19-4 Radial: BKS-S20-4 (with LED)
	Plug contacts	Socket contacts
	M12 x 1	M12 x 1

Table 7-10 Electrical data and mechanical design of the connector for the position sensor of the release unit

Sensor S4 to display the piston position of the release unit	
Type	Digital sensor
	1 = +24 V 2 = not assigned 3 = 0 V 4 = switching contact 
Output signal	PNP
Operating voltage	12 ... 30 VDC
Rated operating voltage	24 V DC
Rated operating current	100 mA
Repeat accuracy	$\leq$ 5 % of Ve
Switching frequency	600 Hz
No–load current	$\leq$ 12 mA
Connection	Connector
Short–circuit protection	Yes
Incorrect polarity protection	Yes
Connector (plug) at the cable end (on the spindle side)	Binder series 763, 4 pins, 763-09-3431-116-04
Connector (socket) at the sensor cable	Type, Siemens Axial: 3RX1535 Radial: 3RX1548 (with LED) Type Balluff Axial: BKS-S19-4 Radial: BKS-S20-4 (with LED)

7.2.2 Digital sensors of 2SP125 spindles

Information on the sensor system to monitor the tool clamped status (digital sensors S1, S2 and S3).

Table 7-11 Electrical implementation of the clamping status sensors

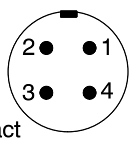
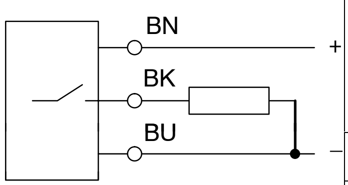
Supply	0 V		PIN 3
	+ 24 V	Max. tolerance ±20 % Current demand < 40 mA plus the load current	PIN 1
Switching contact	Switches to the pos. supply voltage	Active (H)	PIN 4
	Switches to the high–ohmic state	Inactive (L)	
Load capacity of the switching contact		200 mA max. **The following voltages are not permissible:** Greater than 5 V below the voltage at PIN 3 and greater than 5 V above the voltage at PIN 1 When an inductive load is connected to PIN 4, an appropriate measure must be provided to limit the voltage.	(PIN 4)

Connection

Contactless transistor switches with 3–wire connection are used for the clamping status sensors. Connectors are used to connect–up the sensors (refer to drawings, Chapter 10).

The cables that are used to connect–up the sensors are not included with the spindle. These cables are commercially available as standard products.

Table 7-12 Mechanical implementation of the plug–in connection

Pin assignment at the sensor	Connector at the sensor	Socket at the cable
1: +V 2: not assigned 3: –V 4: switching contact   		Type, Siemens with connector outlet Axial: 3RX1535 Radial: 3RX1548 (with LED) Type, Balluff with connector outlet Axial: BKS-S19-4 Radial: BKS-S20-4 (with LED)
	Plug contacts	Socket contacts
	M12 x 1	M12 x 1

7.3 Thermal sensors/motor protection

KTY 84 thermistors are used to sense the motor temperature.
These thermistors are suitable to measure temperatures in an analog fashion.

Additional temperature sensors to sense the motor temperature using NTC thermistors are included in the 2SP120 spindle; they can be used together with third–party systems. Further, the 2SP120 spindle has additional temperature sensors that allow full motor protection to be implemented (e.g. for loads that are applied when the spindle is stationary or at low speeds).

Temperature evaluation using KTY 84

For SIMODRIVE 611 drive converters, an external tripping device to evaluate the motor temperature is not required. The thermistor function is monitored.

1. Pre–alarm temperature

   When the pre–alarm temperature is exceeded, the drive converter signals this using an appropriate fault signal.

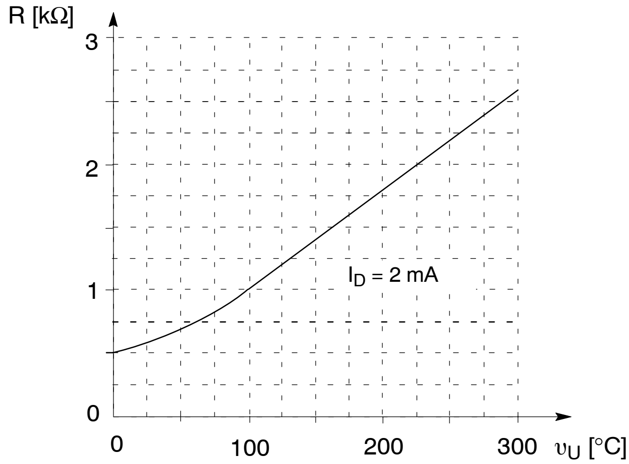
   This message must be externally evaluated.

   The signal is withdrawn if the motor temperature < pre–alarm temperature.

2. Motor limit temperature

   When the motor limiting temperature is exceeded, the drive converter shuts down and signals this using an appropriate fault message.

Table 7-13 Technical data of the KTY 84 thermistor

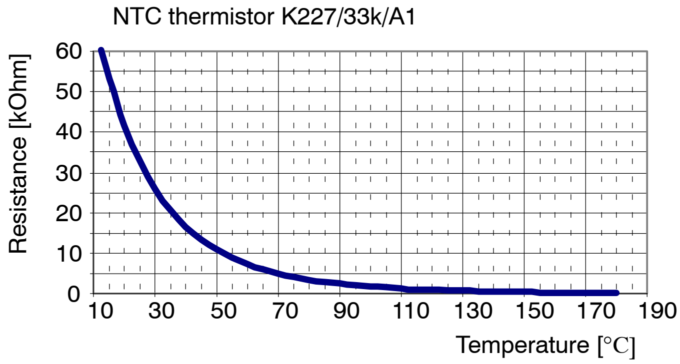
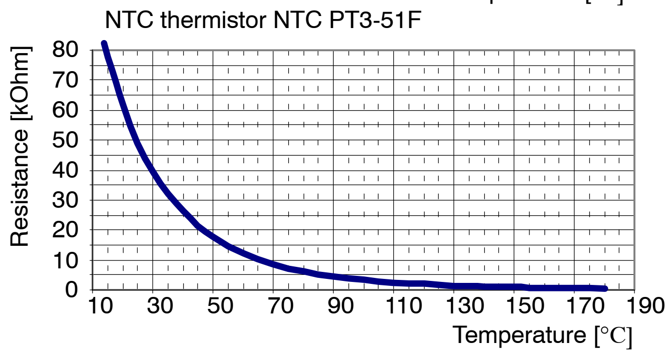
Designation	Description
Type	KTY 84
Resistance when cold (20 °C)	approx. 580 Ω
Resistance when warm (100 °C)	approx. 1000 Ω
Connection	via signal cable (please observe the polarity!)
Temperature characteristic	

Temperature evaluation using NTC thermistors (spindle 2SP120)

Both NTC K227 and NTC PT3–51F thermistors are included as standard and are used if the drive converter cannot evaluate the KTY thermistor.

The drive converter senses and evaluates the motor temperature using the sensor signal (refer to the drive converter documentation).

Table 7-14 Technical data, NTC K227 and NTC PT3-51

Designation	**Technical data**	
	NTC K227	**NTC PT3-51F**
Resistance when cold (25 °C)	approx. 32.8 kΩ	approx. 49.1 kΩ
Resistance when warm (100 °C)	approx. 1800 Ω	approx. 3300 Ω
Connection	Via signal cable	
Temperature characteristic   		

Temperature evaluation using a PTC thermistor triplet (spindle 2SP120)

The PTC thermistor triplet must be evaluated using an external tripping/evaluation unit (this is not included in the scope of supply). This means that the sensor cable is monitored for wire breakage and short–circuit by this unit.

The PTC signals must be retrieved (refer to Chapter -) close to the spindle using an intermediate connector or a terminal box.

The motor must be switched into a no–torque condition when the response temperature is exceeded.

Table 7-15 Technical data of the PTC thermistor triplet

Designation	Technical data
Type (acc. to DIN 44082–M180)	PTC thermistor triplet
Resistance when cold (20 °C)	≤ 750 Ω
Resistance when warm (180 °C)	≥ 1710 Ω
Response temperature	180 °C
Connection	Using an external evaluation unit, e.g. 3RN1013-1GW10
Note: The PTC thermistors do not have a linear characteristic and are therefore not suitable to determine the instantaneous temperature.	

Temperature monitoring machining–side bearings (spindle 2SP120)

The PT100 resistance sensor can be optionally ordered for the spindle 2SP120□.

The PT100 resistance sensor is used for

- Monitoring the bearing temperature
- Compensating the thermal length growth of the spindle (expansion)

The corresponding PT100 evaluation units must be used to make the evaluation. The connection is made using the signal cable.

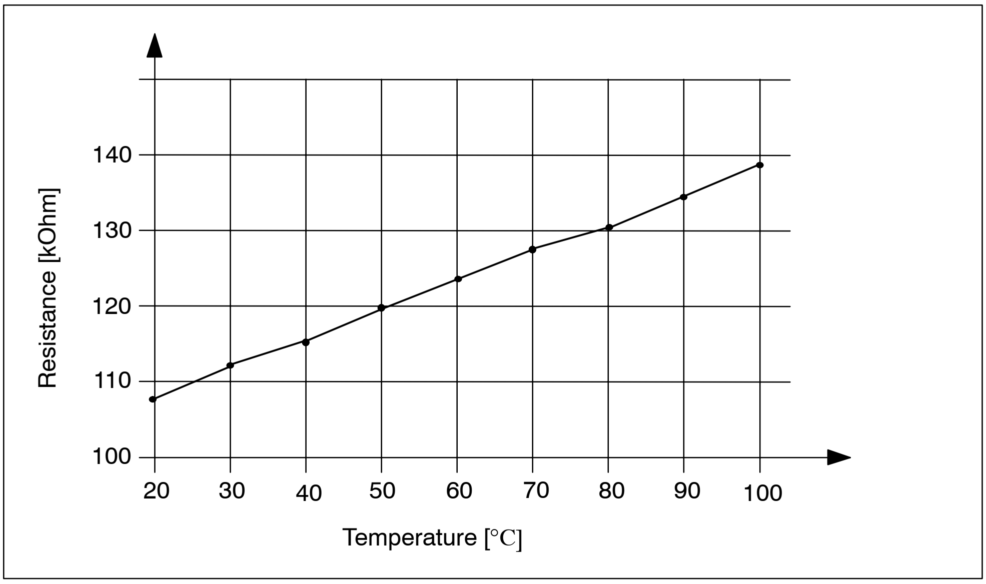


Fig. 7-6 Temperature characteristic PT100

■

Control 8

The central machine control (PLC) controls the following:

- The spindle
- The tool change mechanism
- The supply equipment and devices

The power–on and operating conditions for correct spindle operation are listed in the following.

8.1 Conditions that enable the spindle to rotate

Table 8-1 Enable signals for spindle rotation

Message/sensor interrogation	Required status	Remarks
Motor temperature	T_{KTY84} < 150 °C	KTY 84 (integrated motor temperature sensor)
Spindle cooling	• Cooling medium temperature in the reference range • Cooling medium flow rate in the reference range	Refer to Chapter 6.2.2
Pressure at the tool clamping and release unit	Pressure to clamp the tool is in the reference range [1)] The release cylinder piston is not in contact with the spindle shaft [2)]	Refer to Chapter 4.5
Sealing air	Input pressure in the reference range	Refer to Chapter 6.3.3
Clamping state sensors	Tool is clamped	Refer to Chapter 4.5

Warning

The machinery construction OEM must evaluate the sensor signals that can then be used to check the required states in order to permit the spindle to rotate (e.g. permissive signal). The spindle must be stopped if one of the enable conditions is no longer present.

1) The reference pressure depends on whether the motor spindle is equipped with a pneumatic or a hydraulic release unit.

2) For 2SP120 motor spindles, the position of the piston in the clamped state is additionally monitored using a sensor. This must display the following state: Tool clamping and release unit in the ”clamped” end position.

8.2 Clamping state sensors

The tool is clamped or ejected using the pulling or pushing force of the draw bar. When clamping or ejecting the tool, the draw bar always assumes an appropriate position in the axial direction. The clamping state is linked with the axial position of the draw bar and is interrogated using this (refer to Fig. 8-1).

8.2.1 Clamping state sensors 2SP120□□

Basic version with analog sensors

Sensor S1 Analog sensor to detect the tool clamped state
Sensor S4 Digital sensor to detect the position of the release cylinder

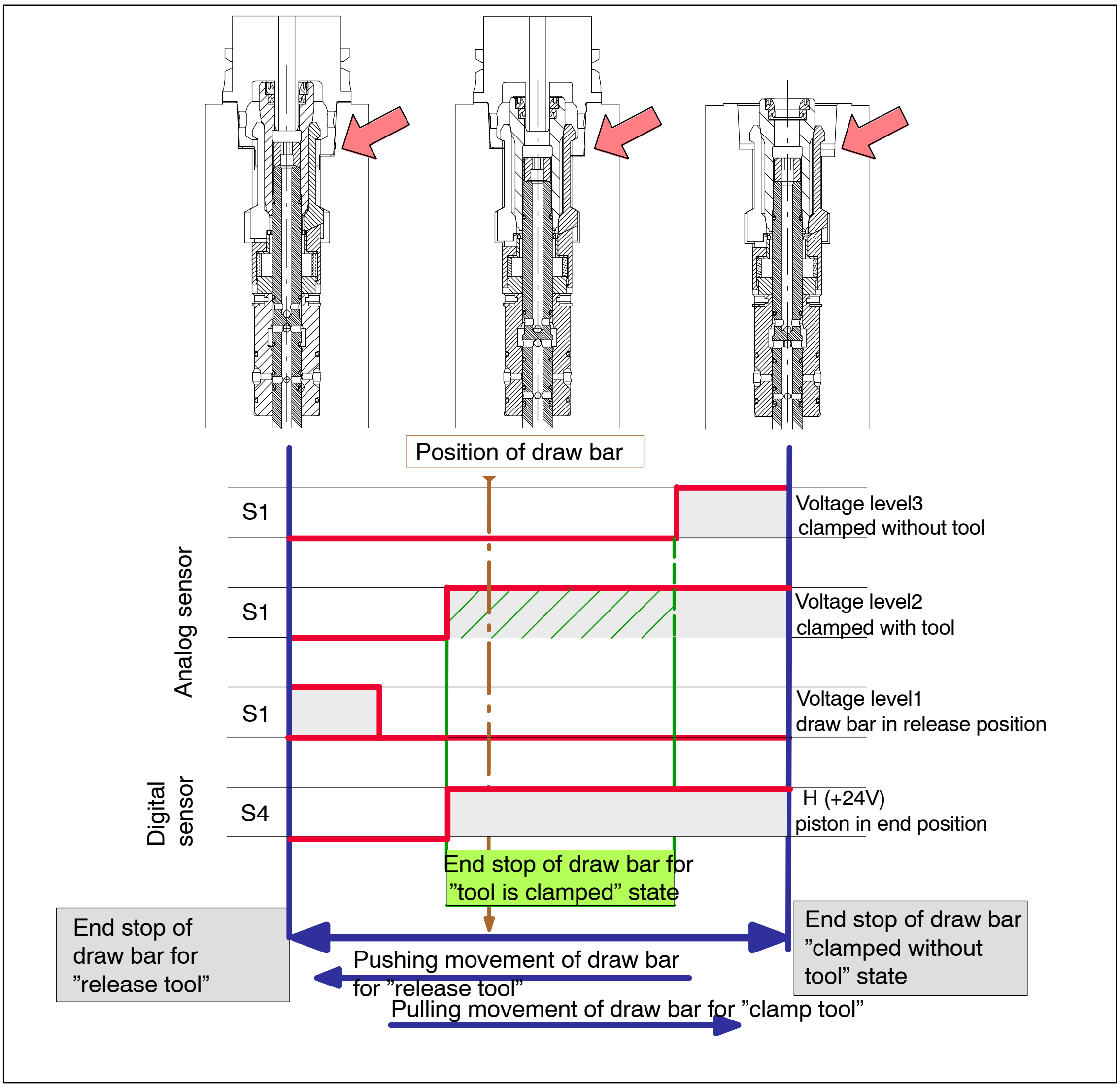


Fig. 8-1 Signal assignment of sensors S1 and S4 for 2SP120

Table 8-2 Translation for Fig. 8-1

English	German
Sensor S1, Sensor S4	Sensor S1, Sensor S4
End stop of draw bar for ”release tool”	Endposition der Zugstange bei ”Werkzeug lösen”
Position of draw bar	Position der Zugstange
End stop of draw bar for ”tool is clamped” state	Halteposition der Zugstange im Zustand ”Werkzeug gespannt”
Pushing movement of draw bar for ”release tool”	drückende Bewegung der Zugstange bei ”Werkzeug lösen”
Pulling movement of draw bar for ”clamp tool”	ziehende Bewegung der Zugstange bei ”Werkzeug spannen”
End stop of draw bar ”clamped without tool” state	Endposition der Zugstange bei ”gespannt ohne Werkzeug”
Voltage level x	Spannungspegel
clamped without tool	gespannt ohne Werkzeug
clamped with tool	gespannt mit Werkzeug
draw bar in release position	Zugstange in Löseposition
piston in end position	Zylinderkolben in Endlage

Notice

Under extreme machining conditions signal faults and disturbances can occur in operation.

Nominal states of S1 and S4

Table 8-3 Nominal states of S1
(for precise values, refer to the acceptance report for the particular spindle)

State	Voltage [V]
Draw bar in the release position	$\geq$ 8.5 V
Tool clamped	1.5 to 4.5 V
Clamped without tool	1 $\pm$0.2 V

Table 8-4 Nominal states of S4

State	Signal level: High, Low
Release piston at the back (status, tool clamped)	H
Release piston at the front (status, tool released)	L

Signals from S1 and S4

Table 8-5 Signals from the analog sensor regarding the tool clamping state and the digital sensor for the position of the release piston

State	S1 analog	S4 digital	PLC action	Possible fault causes
Draw bar in the release position, release piston at the front [1]	Highest voltage level ≥ 8.5 V [2]	L	– Enable signal to allow a tool to be changed after a defined delay time	
Draw bar in the release position, release piston at the back [1]	Highest voltage level ≥ 8.5 V [2]	H	– The spindle is not enabled for rotation – No enable signal to change the tool	– The clamping system jams – Defective sensors
Clamp tool the correct clamping position has not been reached	Average voltage level >4.5 to 8.5 V [2]	L	– The spindle is not enabled for rotation – No enable signal to change the tool Normal case at the transition from clamping/releasing	In case of fault – The release piston jams – Incorrect function of the switching valve
Clamp tool the correct clamping position has not been reached	Average voltage level >4.5 to 8.5 V [2]	H	– The spindle is not enabled for rotation – No enable signal to change the tool Normal case at the transition from releasing/clamping	In case of fault – Foreign body in the tool holder – Tool that is not in compliance with the standard – Tool does not match the tool interface of the spindle
Tool clamped, correct clamping position reached, release piston still at the shaft	Low voltage level 1.5 to 4.5 V [2]	L	– The spindle is not enabled for rotation – No enable signal to change the tool Normal case at the transition from releasing/clamping	In case of fault – The release piston jams
Tool clamped, the correct clamping position has been reached, release piston at the back	Low voltage level 1.5 to 4.5 V [2]	H	– The spindle is enabled for rotation after a defined waiting time – No enable signal to change the tool	
Draw bar is tensioned, but the clamping position was exceeded	Lowest voltage level <1.5 V [2]	L	– The spindle is not enabled for rotation – No enable signal to change the tool	– A tool has not been clamped – Tool that is not in compliance with the standard – Release piston still not at the end position
Draw bar is tensioned, but the clamping position was exceeded	Lowest voltage level <1.5 V [2]	H	– The spindle is not enabled for rotation – No enable signal to change the tool	– A tool has not been clamped – Tool that is not in compliance with the standard – Release piston at its end stop

[1] **Notice:** Jammed tools cannot be reliably detected with sensor S1
[2] The specified values are nominal values. The exact values are specified in the acceptance report of the particular spindle

Basic version with digital sensors

Sensor S1	Digital sensor to sense ”draw bar in release position”
Sensor S2	Digital sensor to sense ”tool clamped”
Sensor S3	Digital sensor to sense ”clamped without tool”
Sensor S4	Digital sensor to sense the position of the release cylinder

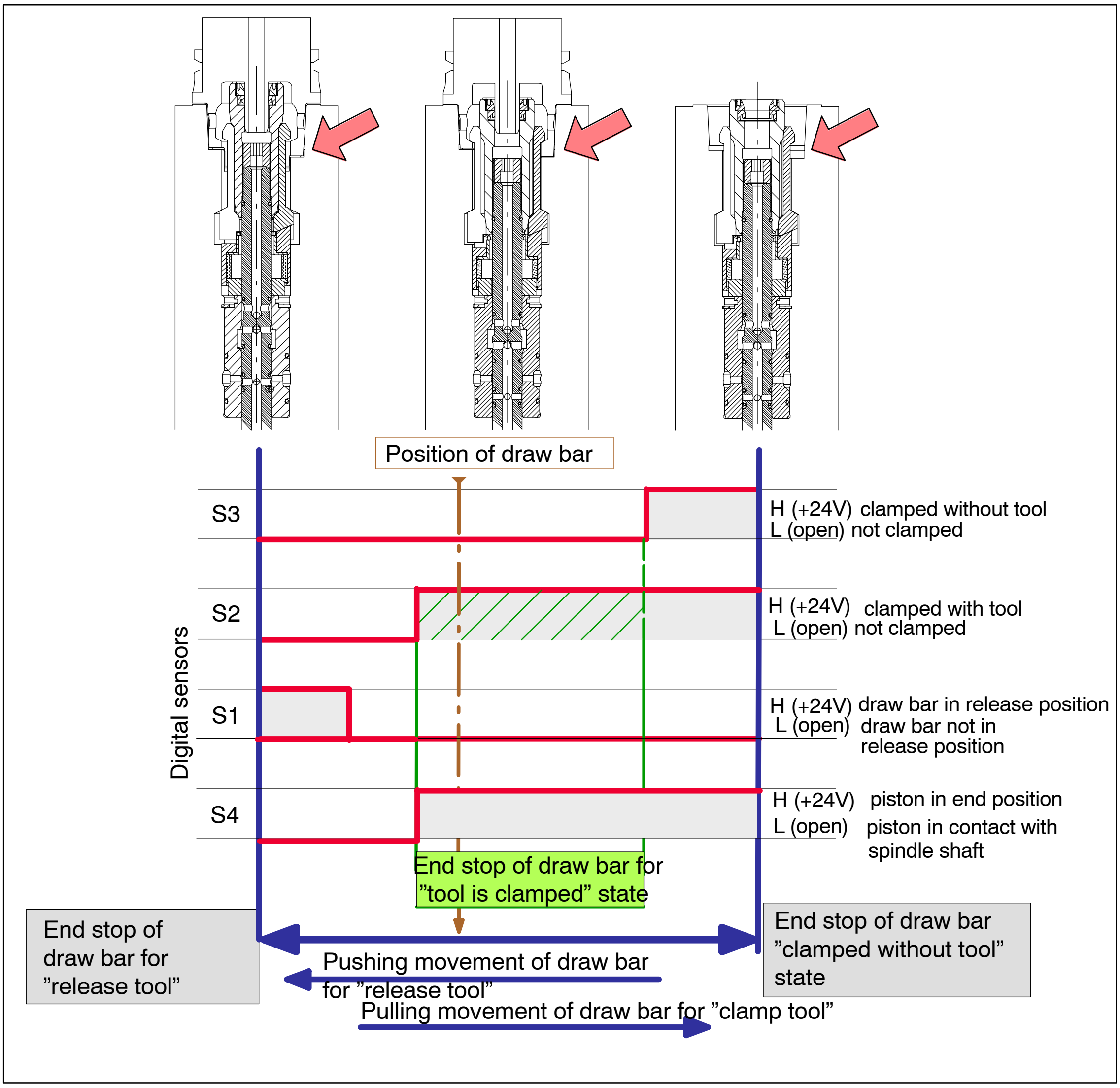


Fig. 8-2 Signal assignment of sensors S1, S2, S3 and S4 for 2SP120

Table 8-6 Translation for Fig. 8-2

English	German
End stop of draw bar for ”release tool”	Endposition Zugstange bei ”Werkzeug lösen”
Position of draw bar	Position der Zugstange
End stop of draw bar for ”tool is clamped” state	Halteposition Zugstange im Zustand ”Werkzeug gespannt”
Pushing movement of draw bar for ”release tool”	drückende Bewegung der Zugstange bei ”Werkzeug lösen”
Pulling movement of draw bar for ”clamp tool”	ziehende Bewegung der Zugstange bei ”Werkzeug spannen”
End stop of draw bar ”clamped without tool” state	Endposition Zugstange bei ”gespannt ohne Werkzeug”
draw bar in release position	Zugstange in Löseposition
draw bar not in release position	Zugstange nicht in Löseposition
tool clamped	Werkzeug gespannt
clamped without tool	gespannt ohne Werkzeug
not clamped	nicht gespannt
piston in end position	Lösekolben in Endposition
piston in contact with spindle shaft	Lösekolben liegt an der Spindelwelle an

Dependent on the position of the draw bar, the clamping state sensors respond and allow the clamping state to be detected (refer to Table 8-7).

Notice

Under extreme machining conditions signal faults and disturbances can occur in operation.

Signals from S1, S2, S3 and S4

Table 8-7 Signals from the digital sensors regarding the tool clamped state

State	S1	S2	S3	S4	PLC action	Possible fault causes
Draw bar in the release position, release piston at the front [1]	H	L	L	L	Enable signal to allow a tool to be changed after a defined waiting time	
Tool clamped, the correct clamping position has not been reached	L	L	L	L	– The spindle is not enabled for rotation – No enable signal to change the tool	– Foreign bodies (e.g. chips) in the tool holder – Tool, which is not in compliance with the standard, clamping head too short
Tool clamped, correct clamping position was reached, release piston still in contact with the shaft	L	H	L	L	– The spindle is not enabled for rotation – No enable signal to change the tool Transition, release/ clamping	– The release piston jams
Tool clamped, correct clamping position reached, release piston at the back → Tool is clamped	L	H	L	H	Spindle is enabled for rotation after a defined waiting time	
Draw bar is tensioned, but the clamping position was exceeded, release piston at the back	L	H	H	H	– The spindle is not enabled for rotation – No enable signal to change the tool	– A tool has not been clamped – Tool which is not in compliance with the standard, clamping head too long
Draw bar is tensioned, but the clamping position was exceeded, release piston at the back	L	L	H	H	– The spindle is not enabled for rotation – No enable signal to change the tool	– A tool has not been clamped – Tool which is not in compliance with the standard, clamping head too long – Incorrect function of either the sensors or evaluation unit
Draw bar in the release position, tool clamped, correct clamping position was reached, release piston at the back	H	H	L	H	– The spindle is not enabled for rotation – No enable signal to change the tool	– The clamping system jams – Incorrect function of either the sensors or evaluation unit
Draw bar is in the release position, draw bar is clamped, but the clamping position was exceeded, release piston at the back	H	H	H	H	– The spindle is not enabled for rotation – No enable signal to change the tool	– Incorrect function of either the sensors or evaluation unit

[1] **Notice:** Jammed tools cannot be reliably detected with sensor S1

8.2.2 Clamping state sensors 2SP125□□

Basic version with digital sensors

Table 8-8 Basic equipping and option of the digital sensors

Sensor	Status detection	Automatic tool change		Manual tool change	
		Basic equipment	Option	Basic equipment	Option
S1	”Draw bar in the release position”	X	—	—	X
S2	”Tool clamped”	X	—	X	—
S3	”Clamped without tool”	X	—	—	X

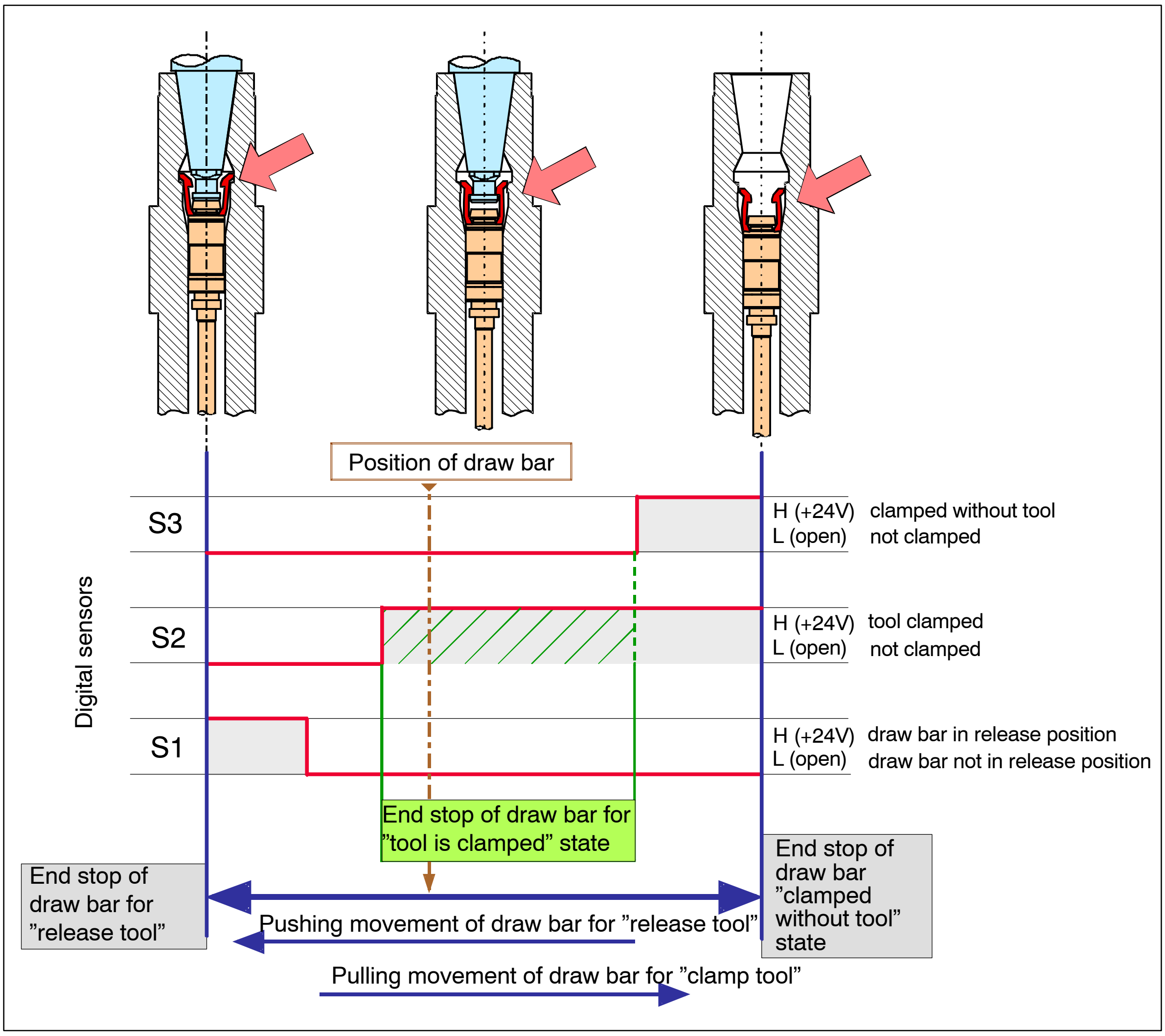


Fig. 8-3 Signal assignment of the digital sensors S1, S2 and S3 for 2SP125

Table 8-9 Translation for Fig. 8-3

English	German
Sensor S1, Sensor S2, Sensor S3	Sensor S1, Sensor S2, Sensor S3
End stop of draw bar for ”release tool”	Endposition Zugstange bei ”Werkzeug lösen”
Position of draw bar	Position der Zugstange
End stop of draw bar for ”tool is clamped” state	Halteposition Zugstange im Zustand ”Werkzeug gespannt”
Pushing movement of draw bar for ”release tool”	drückende Bewegung der Zugstange bei ”Werkzeug lösen”
Pulling movement of draw bar for ”clamp tool”	ziehende Bewegung der Zugstange bei ”Werkzeug spannen”
Open	offen
End stop of draw bar ”clamped without tool” state	Endposition Zugstange bei ”gespannt ohne Werkzeug”
Draw bar in release position	Zugstange in Löseposition
Draw bar not in release position	Zugstange nicht in Löseposition
Tool clamped	Werkzeug gespannt
Clamped without tool	gespannt ohne Werkzeug
Not clamped	nicht gespannt

Caution

Using the spindles without sensors S1 and S3:

If the spindle is used without sensors S1 or S3, then other measures must be applied to ensure that the correct clamping state is reached before the spindle is enabled for rotation or a tool can be changed. These measures include, for example, tool monitoring or specific operator actions.

Dependent on the position of the draw bar, the clamping state sensors respond and allow the clamping state to be detected (refer to Table 8-7).

Notice

Under extreme machining conditions signal faults and disturbances can occur in operation.

Signals from S1, S2 and S3

Table 8-10 Signals from the digital sensors regarding the tool clamped state

State	S1	S2	S3	PLC action	Possible fault causes
Draw bar in the release position[1)]	H	L	L	Enable signal to allow a tool to be changed after a defined delay time	
Tool clamped, the correct clamping position has not been reached	L	L	L	– The spindle is not enabled for rotation – No enable signal to change the tool	– Foreign bodies (e.g. chips) in the tool holder – Tool, which is not in compliance with the standard, clamping head too short
Tool clamped, the correct clamping position has been reached → Tool is clamped	L	H	L	Spindle is enabled for rotation after a defined delay time	
Draw bar is tensioned, but the clamping position was exceeded	L	H	H	– The spindle is not enabled for rotation – No enable signal to change the tool	– A tool has not been clamped – Tool which is not in compliance with the standard, clamping head too long
Draw bar is tensioned, but the clamping position was exceeded	L	L	H	– The spindle is not enabled for rotation – No enable signal to change the tool	– A tool has not been clamped – Tool which is not in compliance with the standard, clamping head too long – Incorrect function of either the sensors or evaluation unit
Draw bar in the release position, tool clamped, correct clamping position was reached	H	H	L	– The spindle is not enabled for rotation – No enable signal to change the tool	– The clamping system jams – Incorrect function of either the sensors or evaluation unit
Draw bar is in the release position, draw bar is clamped, but the clamping position was exceeded	H	H	H	– The spindle is not enabled for rotation – No enable signal to change the tool	– Incorrect function of either the sensors or evaluation unit

1) **Notice:** Jammed tools cannot be reliably detected with sensor S1

8.3 Tool change

A tool may only be changed when the spindle is at a complete standstill. The correct, specified pressure must be available at the pneumatic or hydraulic cylinder while removing and inserting the tool, refer to Chapter 6.3.3 and 6.4.

Caution

The clamping system could be damaged if tool change operations are carried–out without the pneumatic or hydraulic cylinder having the correct pressure.

8.3.1 Automatic tool change for 2SP120□□

The tool change and spindle enable for rotation can be controlled using sensors S1 and S4.

Table 8-11 Sensors S1 and S4

Sensor	Display/comments (minimum delay times)
S1 analog	Dependent on the tool clamped status, different voltage levels are displayed, 1 to 3: Level 1: ”Draw bar in the release position” ($\geq$ 8.5 V) Level 2: ”Tool clamped” (1.5 to 4.5 V) Level 3: ”Clamped without tool” (1 $\pm$0.2 V) The precise voltage values are specified in the acceptance report of the motor spindle. Minimum delay times $t_{wait\ to\ remove}$ and $t_{wait\ to\ enable}$ The following minimum delay time must be maintained between the ”draw bar in the release position” signal (Level 1) being output and actually removing the tool: $t_{wait\ to\ remove}$ = 100 ms **Caution:** Jammed tools cannot be reliably detected with sensor S1. The following minimum delay time must be maintained after the ”tool clamped” signal (Level 2) is output: $t_{wait\ to\ enable}$ = 100 ms
S4 digital	Displays the state if the hydraulically or pneumatically actuated release piston is in a safe end position without being in contact with the rotating spindle shaft. Release piston at the back (tool clamped state): H Release piston at the front (tool release state): L

Condition that enables the spindle to rotate

Spindle rotation can be enabled if the following prerequisites are fulfilled:

- S1 is, after $t_{wait\ to\ enable}$ at Level 2 (it is not permissible that Level 3 is reached)
- S4 has responded

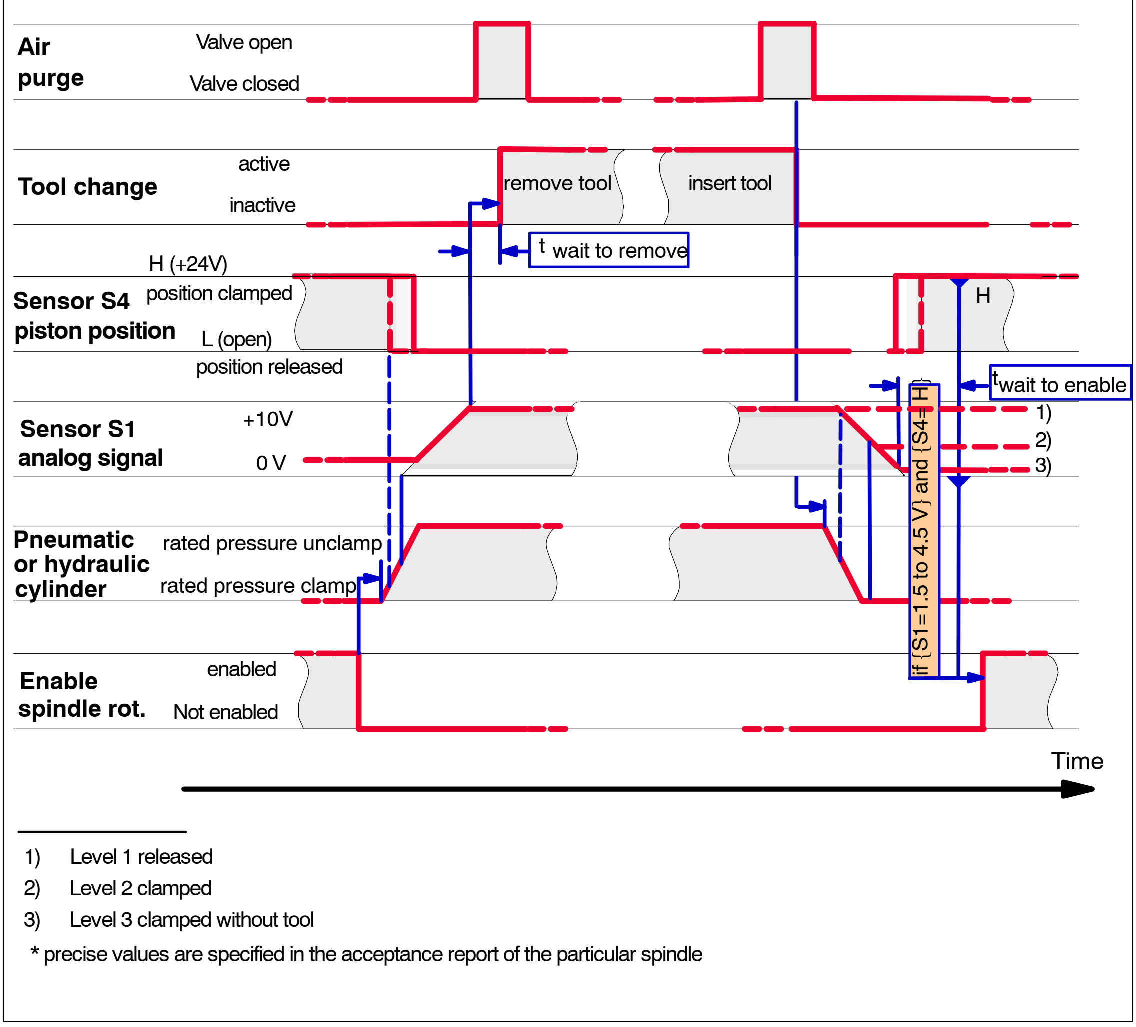


Fig. 8-4 Control diagram for an automatic tool change with S1 and S4

Table 8-12 Translation for Fig. 8-4

English	German
Air purge	Kegelreinigungsluft
Tool change	Werkzeugwechsel
Precise values are specified in the acceptance report of the particular spindle	die genauen Richtwerte, sind im Abnahmeprotokoll der jeweiligen Spindel angegeben
Sensor S1, analog signal	Sensor S1, Analogsignal

Table 8-12 Translation for Fig. 8-4, continued

English	German
Sensor S4, piston position	Sensor S4, Lösekolben Position
Pneumatic or hydraulic cylinder	Pneumatik- oder Hydraulikzylinder
Enable spindle rot.	Freigabe ”Drehbewegung Spindel”
Valve open	Ventil offen
Valve closed	Ventil geschlossen
Active	Aktiv
Inactive	Inaktiv
Open	Offen
Rated pressure release	Nenndruck lösen
Rated pressure clamp	Nenndruck spannen
No pressure	Kein Druck
Enabled	Freigabe
Not enabled	keine Freigabe
If {pressure > min rated pressure} and ...	Wenn {Druck > min. Nenndruck} und ...
Remove tool	Werkzeug entfernen
Insert tool	Werkzeug einsetzen
$t_{\text{wait to remove}}$	$t_{\text{warten bis zum Entfernen}}$
$t_{\text{wait to enable}}$	$t_{\text{warten bis zur Freigabe}}$
Time	Zeit
Position clamped	Position gespannt
position released	Position gelöst

8.3.2 Tool change sequence with standard clamping system and tool change gripper

Table 8-13 Recommended sequence for a tool change with standard clamping system and tool change gripper

Step	Description
1.	Stop the spindle (0 speed) in the oriented tool change position
2.	Shut down the internal tool cooling, open the bleed valve
3.	Open the door of the automatic tool change system
4.	Move the machine axes into the tool change position
5.	Prepare the tool magazine for the tool change
6.	Start the automatic tool change mechanism – tool change gripper takes the tool in the tool magazine and inserts the tool into the spindle.
7.	Stop the automatic tool change mechanism
8.	Activate the air purge
9.	Release the tool by controlling the valve ”release tool” Check sensor signal S1 [1)] for state ”draw bar in release position”
10.	Continue the automatic tool change mechanism – tool removal, 180°-Rotate the tool change gripper and insert the new tool into the spindle. Place the previously used tool into the tool magazine. The tool change gripper still holds the tool into the spindle.
11.	Shut off the air purge and close the bleed valve
12.	Clamp the tool Check the sensor signal S1 for state ”tool clamped” Check that the sensor S4 is at a ”high” signal (release piston at the back)
13.	Move the tool change gripper into the park position. Exit the automatic tool changing mechanism.
14.	Start the spindle. Close the door of the automatic tool change system.
15.	Move the axes into the machining position

1) Precise test values, refer to the acceptance report of the particular motor spindle

8.3.3 Tool change sequence with holding clamping system and tool change gripper

Table 8-14 Recommended sequence for a tool change with holding clamping system and tool change gripper

Step	Description
1.	Stop the spindle (0 speed) in the oriented tool change position
2.	Shut down the internal tool cooling, open the bleed valve
3.	Release the tool in the spindle by controlling the valve ”release tool”. Check sensor signal S1 [1] for state ”draw bar in the release position” The tool is still held by the collet. **Caution: The tool weight should not exceed the permissible limits, otherwise the tool can fall out of the tool holder.**
4.	Activate the air purge
5.	Open the door of the automatic tool change system
6.	Move the machine axes into the tool change position. **Caution: If the acceleration or deceleration is too high than the tool can drop out of the tool holder.**
7.	Prepare the tool magazine for the tool change
8.	Start the automatic tool change mechanism – tool change gripper takes the tool in the tool magazine and inserts the tool into the spindle. Tool removal (holding force of 270 N must be overcome). 180°-rotation of the tool gripper and insert the new tool into the spindle. Place the previously used tool into the tool magazine.
9.	Move the tool change gripper into the park position. Exit the automatic tool changing mechanism.
10.	Shut off the air purge and close the bleed valve
11.	Clamp the tool Check the sensor signal S1 for state ”tool clamped” Check that the sensor S4 is at a ”high” signal (release piston at the back)
12.	Start spindle. Close the door of the automatic tool change system.
13.	Move the axes into the machining position

[1] Precise test values, refer to the acceptance report of the particular motor spindle

8.3.4 Manual tool change for 2SP125□□

With the basic equipping (with sensor S2 – without S1 and S3), this version can be used for a manual tool change.

Notice

The appropriate operator actions must be applied to ensure that the appropriate clamping state has been reached before the spindle is allowed to rotate and before a tool may be changed.

Caution

Jammed tools cannot be reliably detected using sensor S1.

If the spindle is operated without the optional sensor S1, then it is the responsibility of the machinery construction company to detect the ”tool released” state.

If the spindle is operated without the optional sensor S3, then it is the responsibility of the machinery construction company to detect the ”clamped without tool” state.

Note

It is advantageous if additional information is incorporated in the tool change control sequence by using additional sensors.

The machinery construction company must provide any additional sensors.

The pressure at the release piston can also be incorporated in the tool change control system.

Enable condition

Enable condition to initiate a tool change:

- The required pressure – to release the tool – must be available

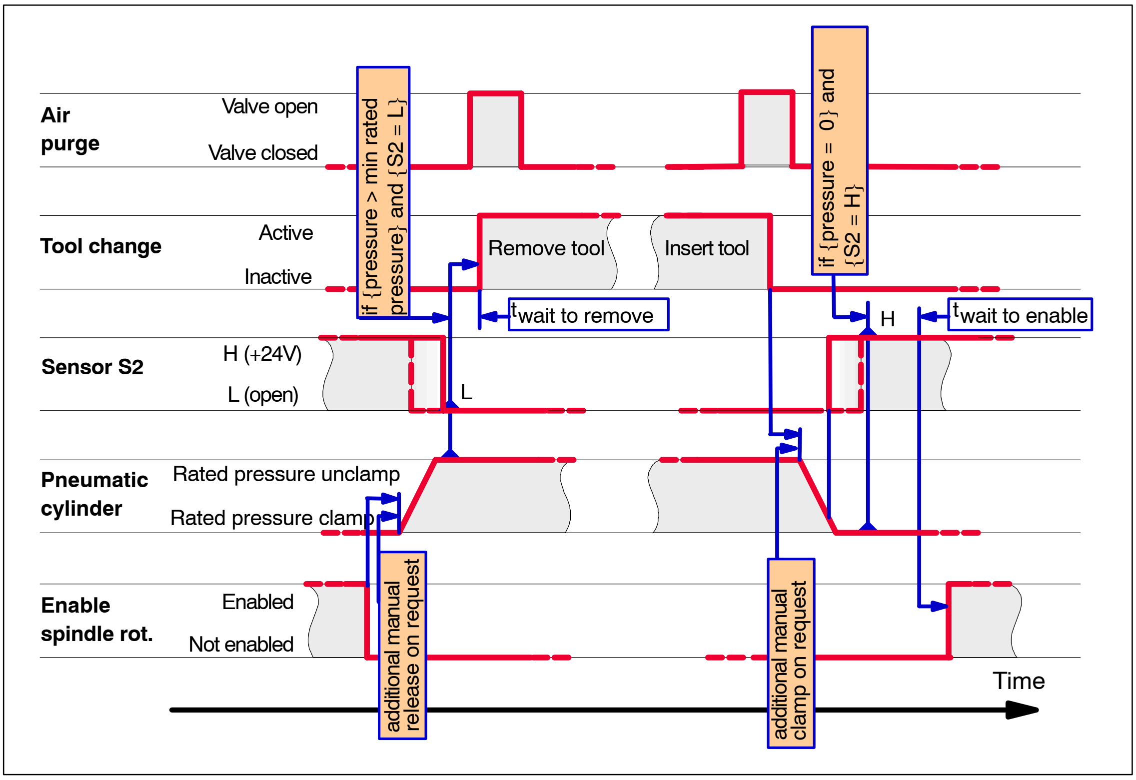


Fig. 8-5 Control diagram for a manual change with S2

Table 8-15 Translation for Fig. 8-5

English	German
Air purge	Kegelreinigungsluft
Additional manual release on request	zusätzlich manuelles lösen
Additional manual clamp on request	zusätzlich manuelles spannen
Tool change	Werkzeugwechsel
Sensor S2	Sensor S2
Pneumatic cylinder	Pneumatikzylinder
Enable spindle rot.	Freigabe ”Drehbewegung Spindel”
Valve open	Ventil offen
Valve closed	Ventil geschlossen
Active	Aktiv
Inactive	Inaktiv
if {pressure > min rated pressure} and {S2 = L}	Wenn {Druck > min. Nenndruck} und {S2 = L}
if {pressure = 0} and {S2 = H}	Wenn {Druck = 0} und {S2 = H}
Open	Offen
Rated pressure release	Nenndruck lösen
Rated pressure clamp	Nenndruck spannen

Table 8-15 Translation for Fig. 8-5, continued

English	German
Enabled	Freigabe
Not enabled	keine Freigabe
Remove tool	Werkzeug entfernen
Insert tool	Werkzeug einsetzen
$T_{\text{wait to remove}}$	$T_{\text{warten bis zum Entfernen}}$
$T_{\text{wait to enable}}$	$T_{\text{warten bis zur Freigabe}}$
Time	Zeit

8.3.5 Automatic tool change for 2SP125□□

If the spindle is operated with the digital sensors S1, S2 and S3, then this version can be used for an automatic tool change.

Table 8-16 Sensors S1, S2 and S3

Sensor	Display/comments (minimum delay times)
S1 digital	State display ”draw bar in the release position” Minimum delay time The following minimum delay time must be maintained between the ”draw bar in the release position” (H) signal being output and actually removing the tool: $t_{\text{wait to remove}}$ = 100 ms **Caution:** Jammed tools cannot be reliably detected with sensor S1.
S2 digital	State display, ”tool clamped” Minimum delay time The following minimum delay time must be maintained after the ”tool clamped” (H) signal is output: $t_{\text{wait to enable}}$ = 100 ms
S3 digital	Display the state, ”clamped, without tool”

Caution

For spindles with internal tool cooling, sufficient time must be provided to blow–out the cooling lubricating medium from the tool clamp. Only then may a new tool be clamped.

Condition which enables the spindle to rotate

The spindle can be allowed to rotate if the following prerequisite is fulfilled:

- After the minimum delay time $t_{\text{wait to enable}}$ S3 must be at L

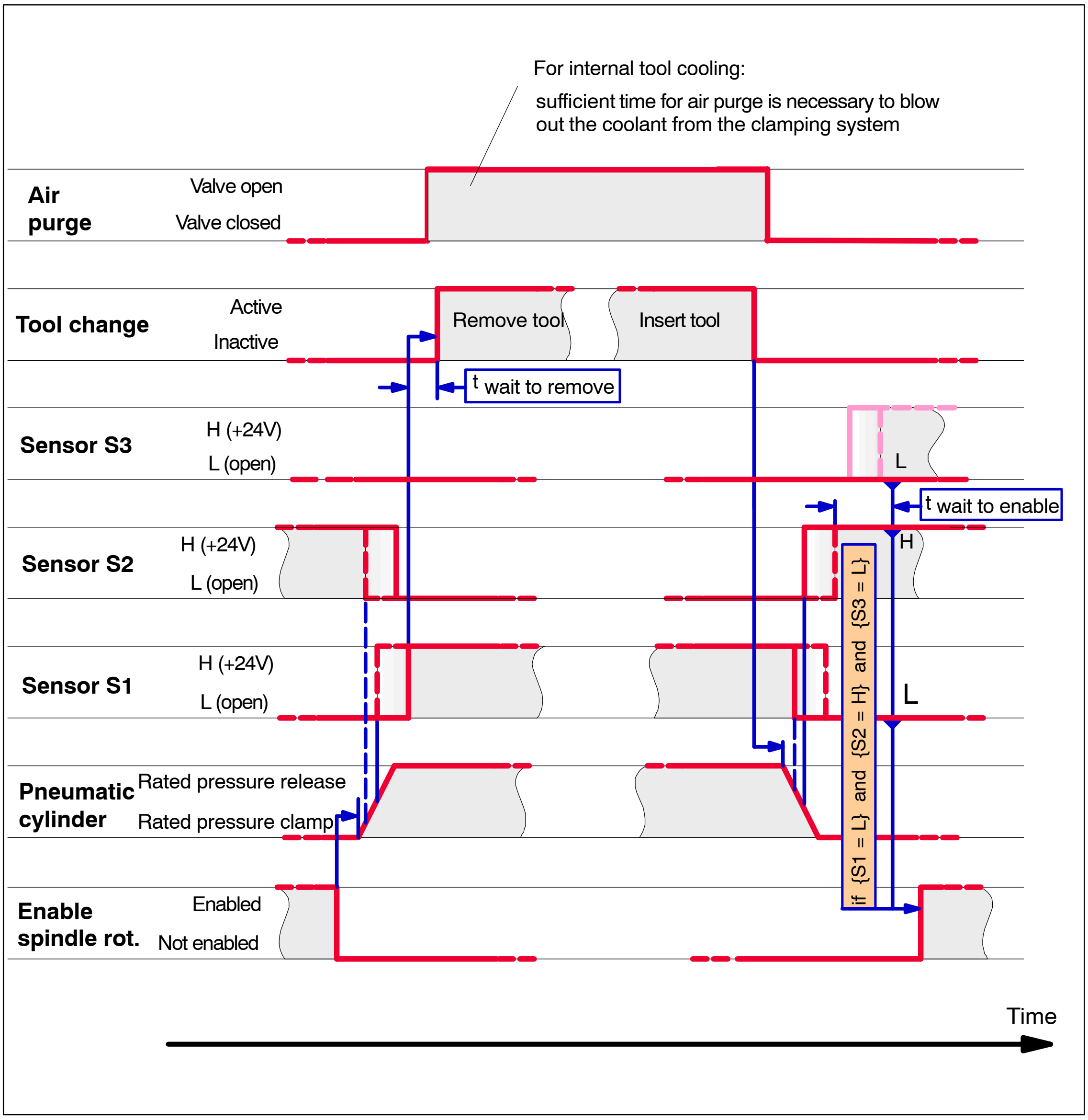


Fig. 8-6 Control diagram for an automatic tool change with S1, S2 and S3

Table 8-17 Translation for Fig. 8-6

English	German
For internal tool cooling: sufficient time for air purge is necessary to blow out the coolant from the clamping system	Bei Werkzeug-Innenkühlung: Ausreichend Zeit vorsehen zum Ausblasen des Kühlschmiermittels aus dem Werkzeugspanner
Air purge	Kegelreinigungsluft
Tool change	Werkzeugwechsel
Sensor S1, Sensor S2, Sensor S3	Sensor S1, Sensor S2, Sensor S3
Pneumatic cylinder	Pneumatikzylinder

Table 8-17 Translation for Fig. 8-6, continued

English	German
Enable spindle rot.	Freigabe ”Drebewegung Spindel”
Valve open	Ventil offen
Valve closed	Ventil geschlossen
Active	Aktiv
Inactive	Inaktiv
open, opened	offen, geöffnet
Rated pressure unclamp	Nenndruck lösen
Rated pressure clamp	Nenndruck spannen
Enabled	Freigabe
Not enabled	keine Freigabe
Remove tool	Werkzeug entfernen
Insert tool	Werkzeug einsetzen
$T_{\text{wait to remove}}$	$T_{\text{Warten bis zum Entfernen}}$
$T_{\text{wait to enable}}$	$T_{\text{Warten bis zur Freigabe}}$
if {S1=L} and {S2=H} and {S3=L}	wenn {S1=L} und {S2=H} und {S3=L}
Time	Zeit

■

Space for your notes

9 Order Designation

Structure of the order designation

The Order Number comprises a combination of digits and letters. It is sub–divided into three hyphenated blocks.

The spindle type is defined in the first block. Additional features are described in the 2nd and 3rd blocks.

Order designation for 2SP120□

Order number: 2 S P 1 2 0 . – 1 H . . . – . . . .

2SP1 motor spindle

Spindle diameter

20 = Spindle diameter 200 mm

Spindle length

2 = spindle length, short
4 = spindle length, long

Synchronous/induction 4-pole

1 = Synchronous

Encoder type

H = sin/cos 1 Vpp, 256 pulses/rev

Winding version

See Chapter ”Technical characteristic data”

Tool release and clamping device

2 = 2-channel technology, pneumatic
3 = 2-channel technology, hydraulic

Cooling

1 = Enclosed cooling jacked
3 = Enclosed cooling jacket and internal cooling
4 = Enclosed cooling jacket, with ring with 6 nozzles for external tool cooling
5 = Enclosed cooling jacket, internal tool cooling and ring with 6 nozzles for external tool cooling
6 = Enclosed cooling jacket, with ring with 8xG1/4” for external tool cooling
7 = Enclosed cooling jacket, internal tool cooling and ring with 8xG1/4” for external tool cooling

Bearings

1 = Bearings for max. speed up to 15000 rpm
2 = bearings for max. speed up to 18000 rpm

Tool interfaces

D = Tool interface HSK A63
R = Tool interface HSK A63 type C, holding clamping set

Sensor systems

D = 3 digital sensors for the tool clamped state: ”Tool clamped”, ”draw bar in the release position”, and ”clamped without tool”; 1 digital sensor for position ”release piston”.
F = 1 analog sensor for tool clamped state: ”Tool clamped”, ”draw bar in the release position”, and ”clamped without tool”;
1 digital sensor for position ”release piston”.
G = as for F + PT100 to monitor the bearing temperature
H = as D + PT100 to monitor the bearing temperature

Power cables and connectors

2 = 1.5 m power cable, signal connector for sensors
6 = 1.5 m power cable and connector size 1.5, signal connector for sensors (only for 2SP1202)
6 = 1.5 m power cable and connector size 3, signal connector for sensors (only for 2SP1204)

Fig. 9-1 Order designation for 2SP120□

Order designation for 2SP125

Order number: 2 S P 1 2 5 . – . H . 0 . – . . D 2

2SP1 motor spindle

Spindle diameter

25 = Spindle diameter 250 mm

Spindle length

3 = spindle length, short
5 = spindle length, long

Synchronous/induction 4-pole

1 = Synchronous
8 = Induction

Encoder type

H = sin/cos 1 Vpp, 256 pulses/rev

Winding version

See Chapter ”Technical characteristic data”

Tool release and clamping device

0 = 1-channel technology, pneumatic

Cooling

1 = Enclosed cooling jacket
3 = Enclosed cooling jacket and internal tool cooling

Bearings

0 = Bearings for max. speed up to 10000 rpm
1 = Bearings for max. speed up to 15000 rpm

Tool interfaces

A = Tool interface SK 40
B = Tool interface BT 40, 45°
C = Tool interface CAT 40
D = Tool interface HSK A63 (from 15000 rpm, general)
E = Tool interface BT 40, 30°

Sensor systems

D = 3 digital sensors for the tool clamped state: ”Tool clamped”, ”draw bar in the release position”, and ”clamped without tool”

Power cables and connectors

2 = 1.5 m power cable, signal connector for sensors

Fig. 9-2 Order designation for 2SP125□

■

Space for your notes

10 Data Sheets

10.1 Technical characteristic data

Electrical power data

The values in Table 10-1 are only applicable in conjunction with Siemens system components – SIMODRIVE 611 digital/universal.

Table 10-1 Electrical power data

Order No.	P_N S1 [kW]	M_N S1 [Nm]	n_N [RPM]	I_N S1 [A]	P_N S6-40% [kW]	M_N S6-40% [Nm]	P_N S1 [kW]	M_N S1 [Nm]	n_N [RPM]	I_N S1 [A]	I_{max} [1] [A]	n_{max} [RPM]
	Star configuration						**Delta configuration**					
Synchronous												
2SP1202-1HA□□-1DF	12.0	42	2700	30	12.0	55	—	—	—	—	60	15000
2SP1202-1HB□□-2DF	15.5	42	3500	42	15.5	55	—	—	—	—	84	18000
2SP1204-1HA□□-1DF	26.4	84	3000	60	26.4	110	—	—	—	—	120	15000
2SP1204-1HB□□-2DF	35.0	78	4300	79	35.0	110	—	—	—	—	160	18000
Induction												
2SP1253-8HA0□-0□□	13.2	70	1800	28	18.9	100	13.2	32	4000	29	51	10000
2SP1253-8HA0□-1D□	13.2	70	1800	28	18.9	100	13.2	32	4000	29	51	15000
2SP1255-8HA0□-0□□	11.7	140	800	30	16.7	200	11.7	62	1800	29	51	10000
2SP1255-8HA0□-1D□	11.7	140	800	30	16.7	200	11.7	62	1800	29	51	15000
Synchronous												
2SP1253-1HA0□-0□□	26.0	100	2500	53	29.0	130	—	—	—	—	106	10000
Reduced motor data [2]	22.5	80	2700	45	—	—	—	—	—	—	—	—
2SP1253-1HB0□-1D□	35.0	100	3300	68	38.0	130	—	—	—	—	136	15000
Reduced motor data [2]	30	80	3600	60	—	—	—	—	—	—	—	—
2SP1255-1HA0□-0□□	46.3	170	2600	95	55.0	236	—	—	—	—	170	10000
Reduced motor data [2]	40	150	2560	85	—	—	—	—	—	—	—	—
2SP1255-1HB0□-1D□	53.4	170	3000	120	64.0	236	—	—	—	—	240	15000
Reduced motor data [2]	40	150	3000	105	—	—	—	—	—	—	—	—

1) It is not permissible that the maximum current is exceeded due to danger of de–magnetization
2) The values apply for reduced motor data that match the next smaller power module

Supply data

Table 10-2 Supply data

Order No.	Motor type	Max. speed n_{max} [RPM]	Required cooling $Pcool_N$ [kW] at		Cooling medium flow rate V [l/min]	Cooling medium pressure drop 1) Δp [hpa]	Max. permissible cooling medium pressure p [bar]
			n_N	n_{max}			
2SP1202-1□A□□-0	Synch.	15000	2.0	2.0	10	0.5	5.0
2SP1202-1□B□□-1	Synch.	18000	2.0	2.6	10	0.5	5.0
2SP1204-1□A□□-0	Synch.	15000	3.6	4.2	10	1.0	5.0
2SP1204-1□B□□-1	Synch.	18000	3.6	5.0	10	1.0	5.0
2SP1253-8□A□□-0	Induct.	10000	2.8	2.8	10	0.75	5.0
2SP1253-8□A□□-1	Induct.	15000	2.8	2.8	10	0.75	5.0
2SP1255-8□A□□-0	Induct.	10000	4.3	4.3	10	1.0	5.0
2SP1255-8□A□□-1	Induct.	15000	4.3	4.3	10	1.0	5.0
2SP1253-1□A□□-0	Synch.	10000	2.1	3.0	10	0.75	5.0
2SP1253-1□B□□-1	Synch.	15000	2.1	4.5	10	0.75	5.0
2SP1255-1□A□□-0	Synch.	10000	3.5	4.5	10	1.0	5.0
2SP1255-1□B□□-1	Synch.	15000	3.5	6.0	10	1.0	5.0

1) At the specified flow quantity

Power data at the tool holder

Table 10-3 Power data at the tool holder

Order No.	Radial eccentricity [1) [µm]	Pull-force [2) [kN]	Typical time [3) [ms] to Clamp tool [4)	Release tool [5)	Minimum accel. time to n_{max} [6) [sec]
2SP1202-1□A0□-1	15	18	320	350	1.5
2SP1202-1□A1□-1	15	18	180	200	1.5
2SP1202-1□B0□-2	15	18	320	350	1.7
2SP1202-1□B1□-2	15	18	180	200	1.7
2SP1204-1□A0□-1	15	18	320	350	1.0
2SP1204-1□A1□-1	15	18	180	200	1.0
2SP1204-1□B0□-2	15	18	320	350	1.2
2SP1204-1□B1□-2	15	18	180	200	1.2
2SP1253-8□A□□-0	15	8	270	230	1.30
2SP1253-8□A□□-1	15	18	180	300	3.50
2SP1255-8□A□□-0	15	8	270	230	2.25
2SP1255-8□A□□-1	15	18	180	300	6.75
2SP1253-1□A□□-0	15	8	270	230	0.8
2SP1253-1□B□□-1	15	18	180	300	1.25
2SP1255-1□A□□-0	15	8	270	230	0.6
2SP1255-1□B□□-1	15	18	180	300	1.1

1) Radial eccentricity measured at the plug gauge 280 mm from the spindle nose.

2) Nominal value, dependent on the tool interface (SK40/HSK A63)
Tolerance values for SK40: +1.6 kN, –0.8 kN
Tolerance values for HSK A63: +5.4 kN, –1.9 kN

3) Characteristic values/parameters are dependent on the release pressure, flow rate and for the pneumatic release unit, from the number connections used;
Hydraulic release unit:
The specified values are reached for an 80 bar release pressure with a sufficient flow rate.
Pneumatic release unit:
The specified values are reached for a release pressure of 6 bar, sufficient flow rate and 2 connections.

4) Time between the valve switching up to the ”tool clamped” sensor signal.

5) Time between the valve switching up to the ”draw bar in release position” sensor signal.

6) For an adequately dimensioned power module.

Geometrical data for 2SP120□

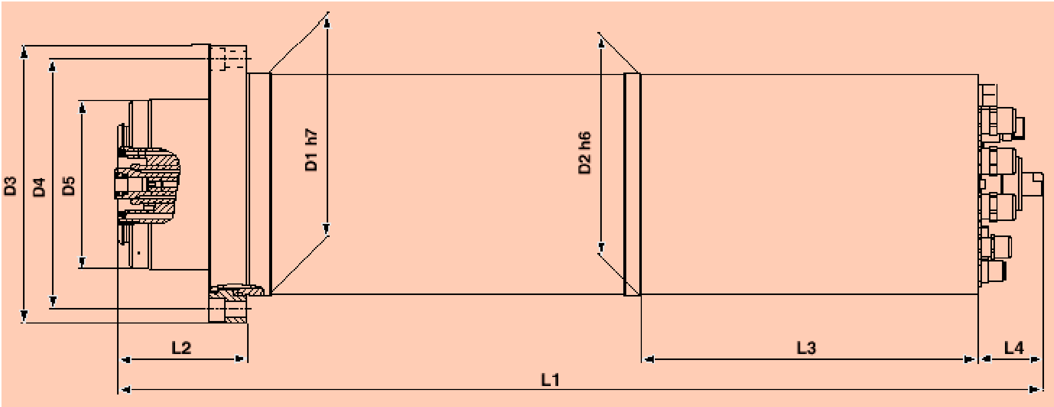


Fig. 10-1 Length and diameter codes for 2SP120□

Table 10-4 Geometrical data for 2SP120□

Order No.	**Length** L1 1) [mm]	**Diameter** [mm] (fit for cartridge) **Drive end/D1**	**Non–drive end/D2**	**Flange diameter** D3 [mm]	**Diameter of the circle of holes** D4 2) [mm]	**Weight** [kg]	**Support required at the non–drive end** 5)
2SP1202-1□A0□-0	684	200 h7	199 h6	250	225	83 3) 4)	Yes
2SP1202-1□A1□-1	593	200 h7	199 h6	250	225	82 3) 4)	Yes
2SP1202-1□B0□-2	684	200 h7	199 h6	250	225	83 3) 4)	Yes
2SP1202-1□B1□-2	593	200 h7	199 h6	250	225	82 3) 4)	Yes
2SP1204-1□A0□-1	784	200 h7	199 h6	250	225	101 3) 4)	Yes
2SP1204-1□A1□-1	693	200 h7	199 h6	250	225	100 3) 4)	Yes
2SP1204-1□B0□-2	784	200 h7	199 h6	250	225	101 3) 4)	Yes
2SP1204-1□B1□-2	693	200 h7	199 h6	250	225	100 3) 4)	Yes

1) When the internal tool cooling option is used, the spindle is 43 mm longer
2) 8 x M12 bolts should be used for mounting. These must have a minimum strength of 10.9. The spindle must be mounted so that the motor spindle is not subject to any compulsive forces.
3) With internal tool cooling, weight + 1 kg
4) With external tool cooling, weight + 8 kg
5) When supported, applicable for both horizontal or vertical working position

Geometrical data for 2SP125□

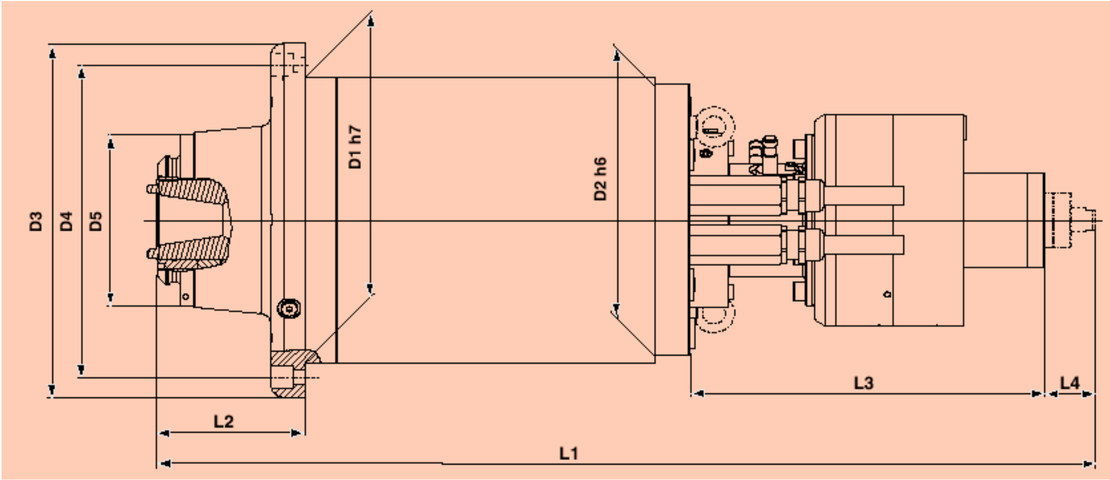


Fig. 10-2 Length and diameter codes for 2SP125□

Table 10-5 Geometrical data for 2SP125□

Order No.	Length L1 1) [mm]	Diameter [mm] (fit for cartridge)		Flange dia-meter D3 [mm]	Diameter of the circle of holes D4 2) [mm]	Weight [kg]	Support required at the non–drive end 5)
		Drive end/D1	Non–drive end/D2				
2SP1253-8□A□□-0	776	250 h7	237 h6	310	275	130 3)	No
2SP1253-8□A□□-1	770	250 h7	237 h6	310	275	130 3)	No
2SP1255-8□A□□-0	876	250 h7	237 h6	310	275	165 3)	No
2SP1255-8□A□□-1	870	250 h7	237 h6	310	275	165 3)	Yes
2SP1253-1□A□□-0	776	250 h7	237 h6	310	275	130 3)	No
2SP1253-1□B□□-0	770	250 h7	237 h6	310	275	130 3)	No
2SP1255-1□A□□-0	876	250 h7	237 h6	310	275	165 3)	No
2SP1255-1□B□□-1	870	250 h7	237 h6	310	275	165 3)	Yes

1) When the internal tool cooling option is used, the spindle is 43 mm longer
2) 8 x M12 bolts should be used for mounting. These must have a minimum strength of 10.9. The spindle must be mounted so that the motor spindle is not subject to any compulsive forces.
3) With internal tool cooling, weight + 1 kg
5) When supported, applicable for both horizontal or vertical working position

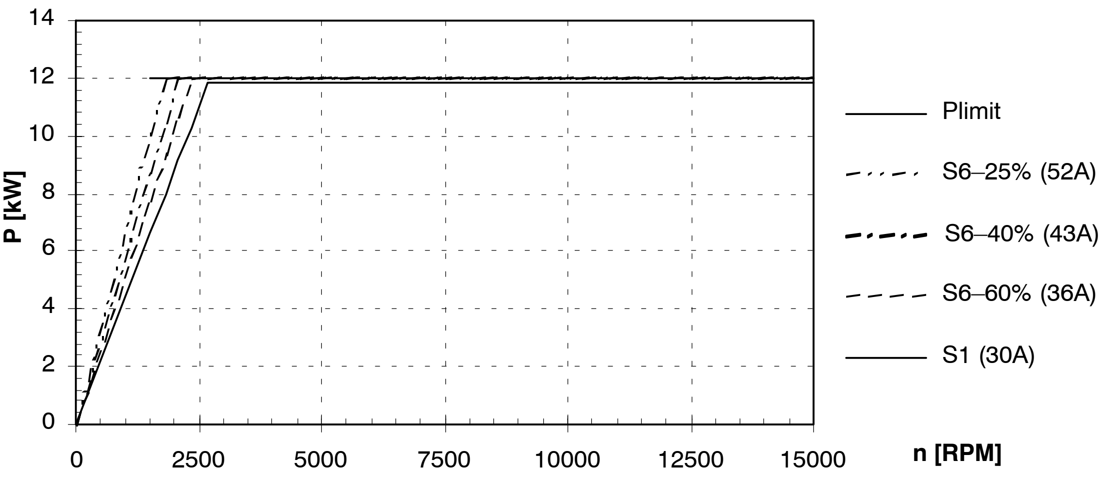
10.2 P/n and M/n diagrams

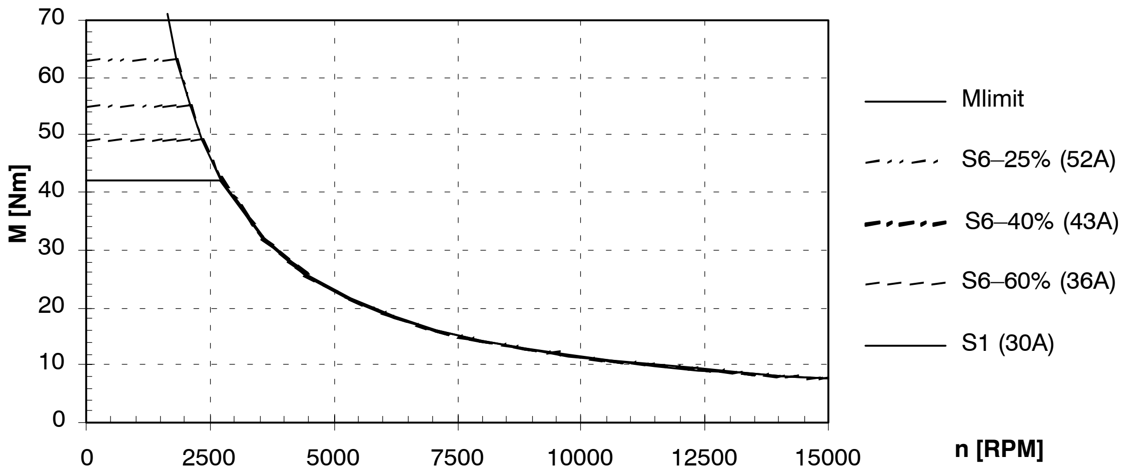
The diagrams apply for a 600 V DC link voltage

10.2.1 2SP120□ synchronous motor

Table 10-6 Motor spindle 2SP1202–1□A□□-1

Motor spindle 2SP1202 (only star circuit configuration)						
Circuit type	Rated power P_N [kW]	Rated speed n_N [RPM]	Rated torque M_N [Nm]	Rated current I_N [A]	Max. speed n_{max} [RPM]	Moment of inertia J [kgm^2]
Y	12.0	2700	42	30	15000	0.015
△	—	—	—	—	—	—

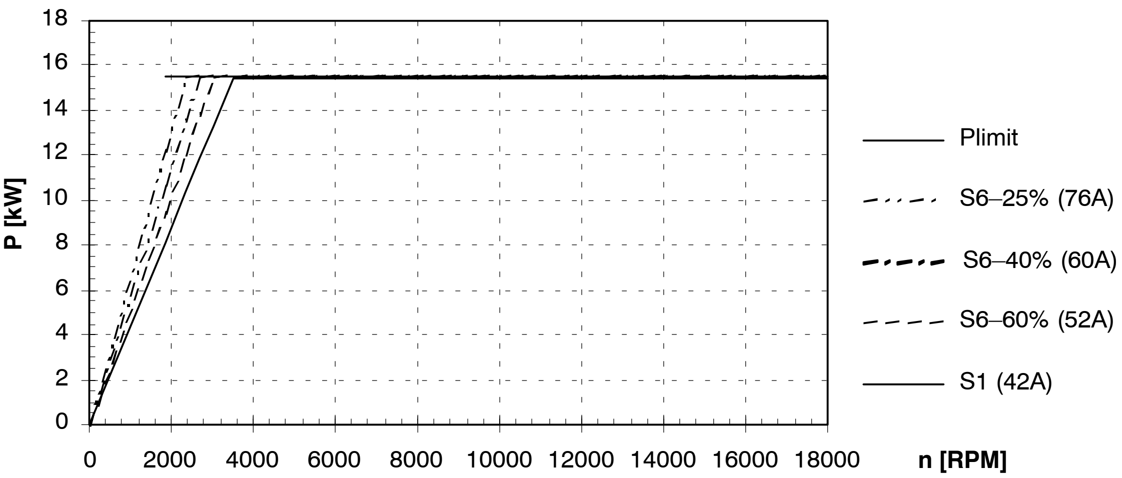


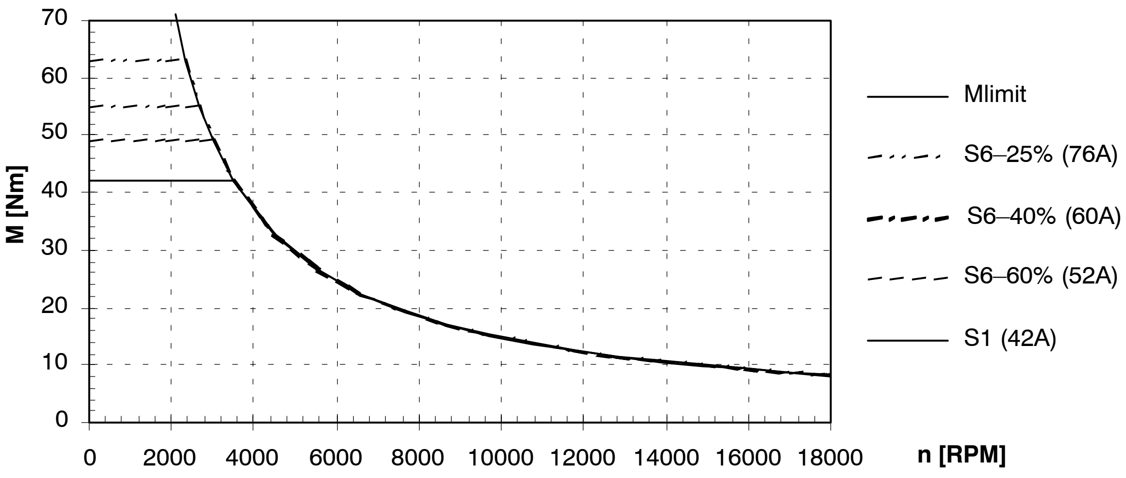


The data for duty type S6 are valid for a 2 min. duty cycle.

Table 10-7 Motor spindle 2SP1202–1□B□□-2

Motor spindle 2SP1202 (only star circuit configuration)						
Circuit type	**Rated power** P_N [kW]	**Rated speed** n_N [RPM]	**Rated torque** M_N [Nm]	**Rated current** I_N [A]	**Max. speed** n_{max} [RPM]	**Moment of inertia** J [kgm^2]
⅄	15.5	3500	42	42	18000	0.015
△	—	—	—	—	—	—

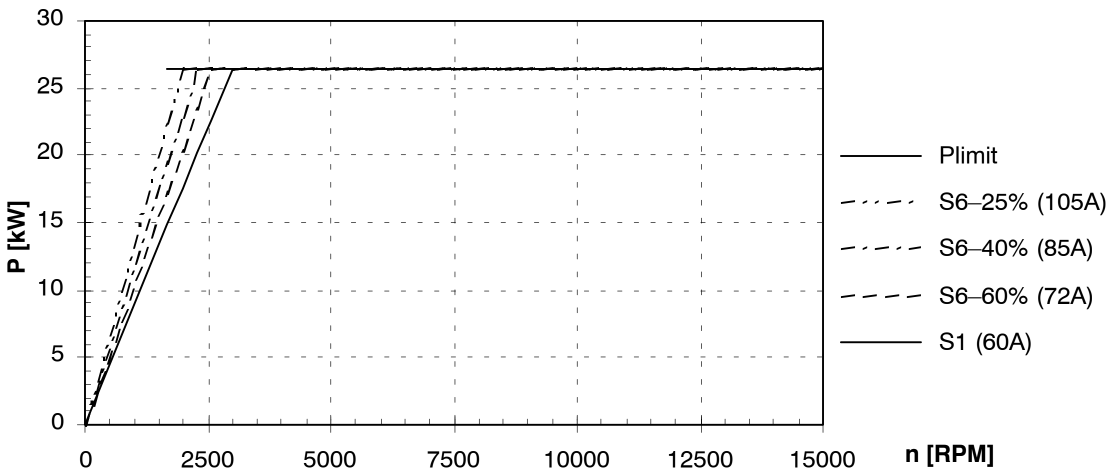


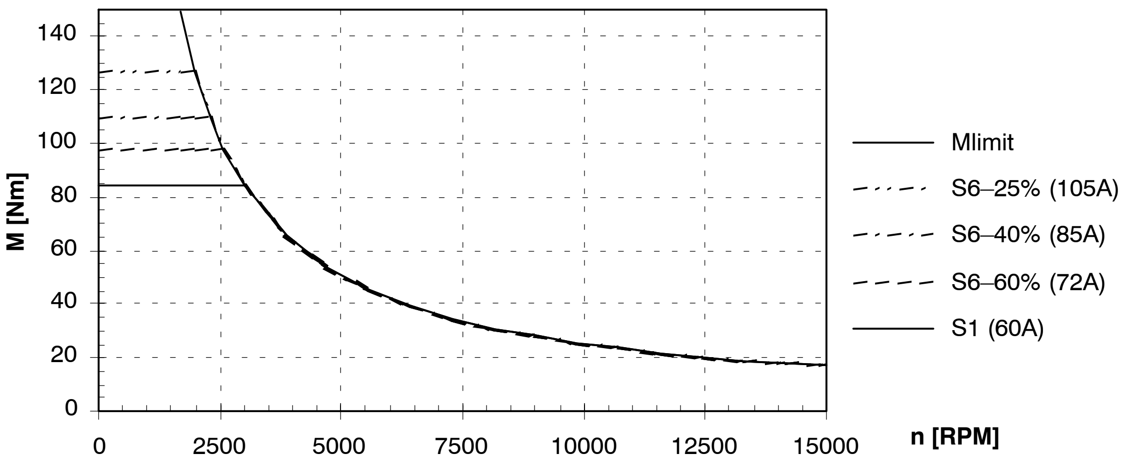


The data for duty type S6 are valid for a 2 min. duty cycle.

Table 10-8 Motor spindle 2SP1204–1□A□□-1

Motor spindle 2SP1204 (only star circuit configuration)						
Circuit type	**Rated power** P_N [kW]	**Rated speed** n_N [RPM]	**Rated torque** M_N [Nm]	**Rated current** I_N [A]	**Max. speed** n_{max} [RPM]	**Moment of inertia** J [kgm²]
Y	26.4	3000	84	60	15000	0.023
△	—	—	—	—	—	—

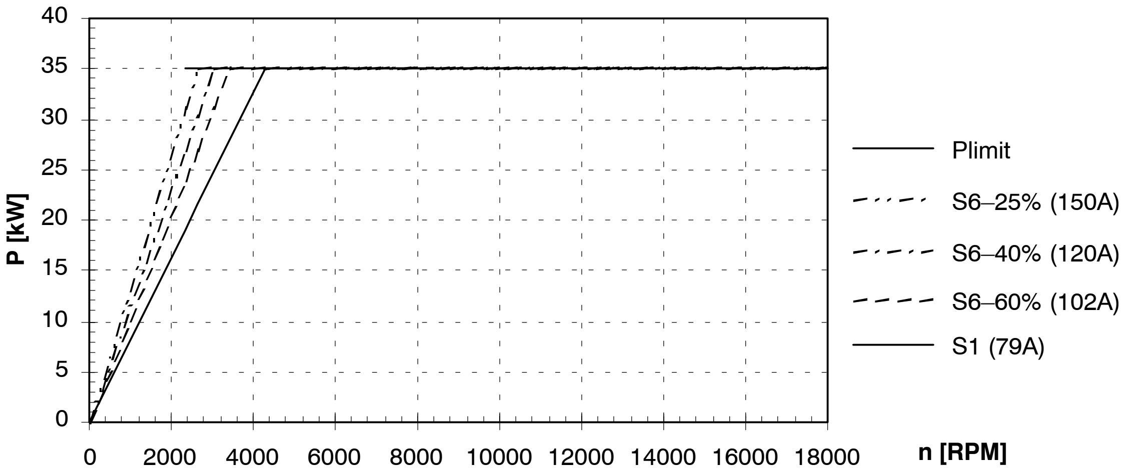


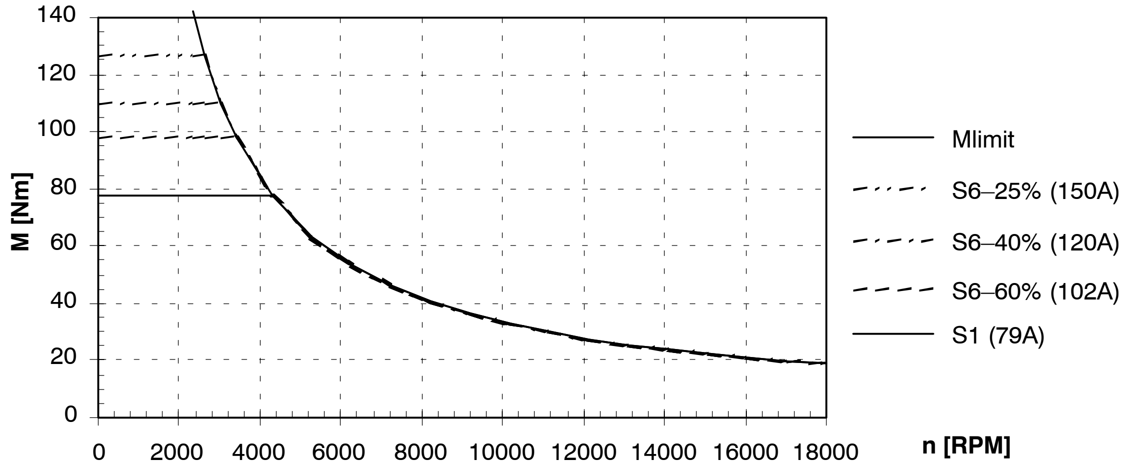


The data for duty type S6 are valid for a 2 min. duty cycle.

Table 10-9 Motor spindle 2SP1204–1□B□□-2

Motor spindle 2SP1204 (only star circuit configuration)						
Circuit type	**Rated power** P_N [**kW**]	**Rated speed** n_N [**RPM**]	**Rated torque** M_N [**Nm**]	**Rated current** I_N [**A**]	**Max. speed** n_{max} [**RPM**]	**Moment of inertia J** [**kgm²**]
Y	35.0	4300	78	79	18000	0.023
△	—	—	—	—	—	—



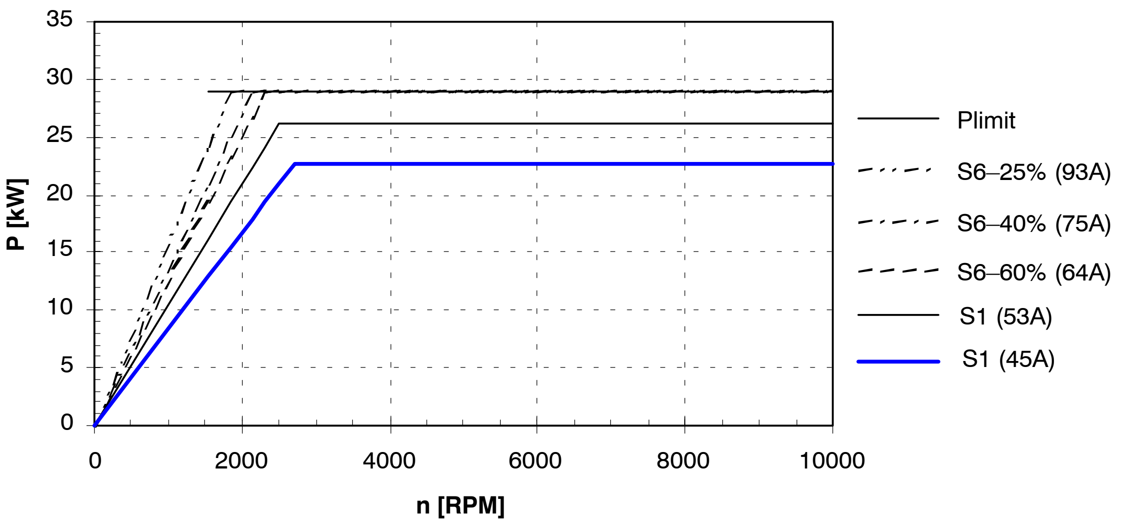


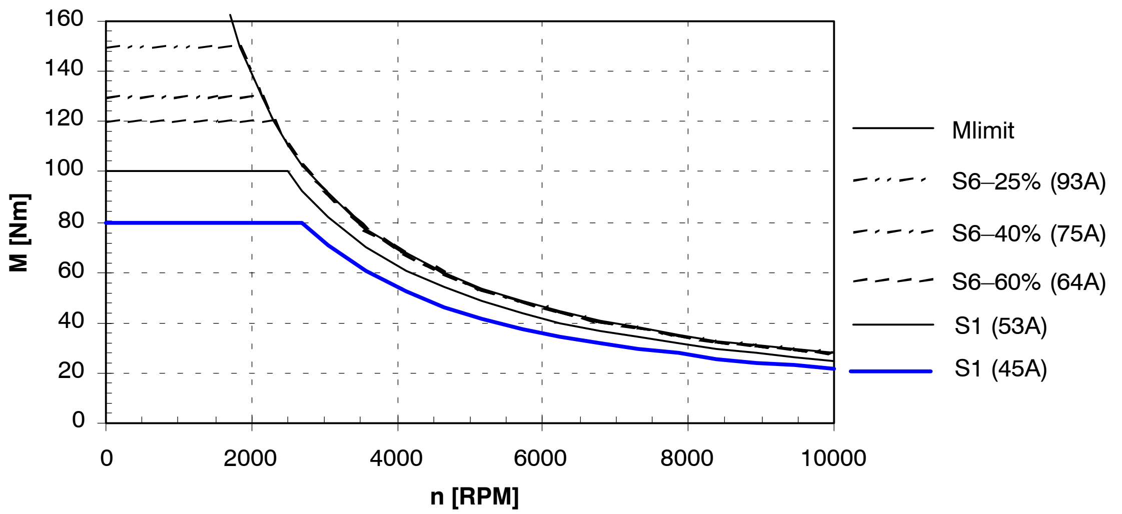
The data for duty type S6 are valid for a 2 min. duty cycle.

10.2.2 2SP125□ synchronous motor

Table 10-10 Motor spindle 2SP1253–1□A□□-0

Motor spindle 2SP1253–1□A□□-0 (only star circuit configuration)						
Circuit type	**Rated power** P_N [kW]	**Rated speed** n_N [RPM]	**Rated torque** M_N [Nm]	**Rated current** I_N [A]	**Max. speed** n_{max} [RPM]	**Moment of inertia** J [kgm^2]
Y	26	2500	100	53	10000	0.037
△	—	—	—	—	—	—

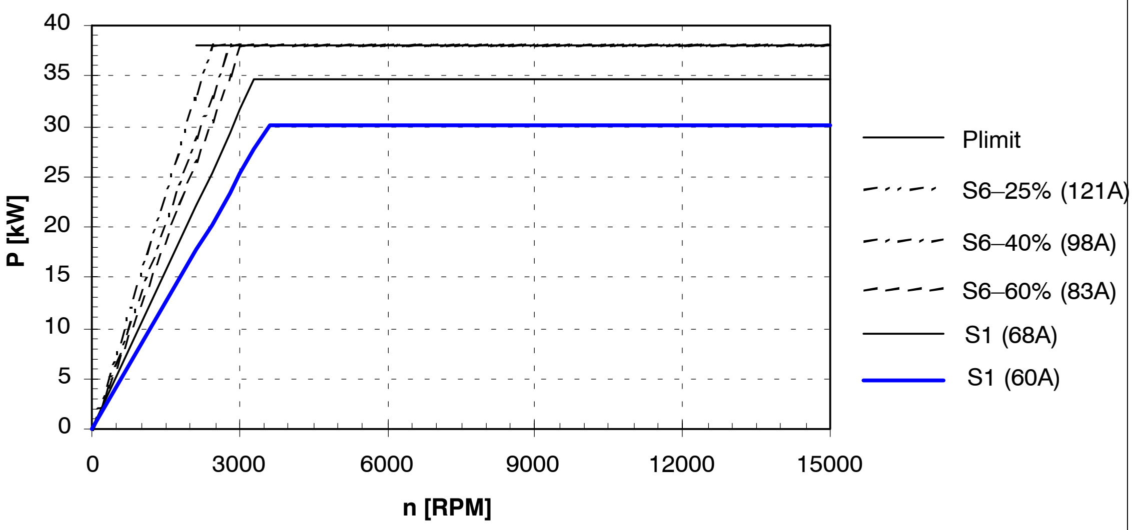


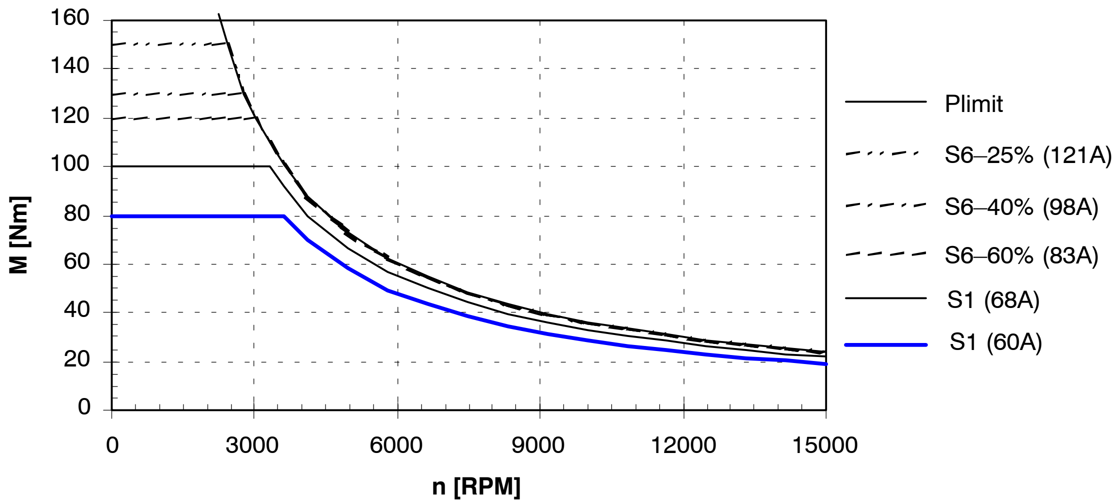


The data for duty type S6 are valid for a 2 min. duty cycle.

Table 10-11 Motor spindle 2SP1253–1□B□□-0

Motor spindle 2SP1253–1□B□□-0 (only star circuit configuration)						
Circuit type	**Rated power** P_N [kW]	**Rated speed** n_N [RPM]	**Rated torque** M_N [Nm]	**Rated current** I_N [A]	**Max. speed** n_{max} [RPM]	**Moment of inertia** J [kgm²]
Y (star)	35	3300	100	68	15000	0.037
△	—	—	—	—	—	—

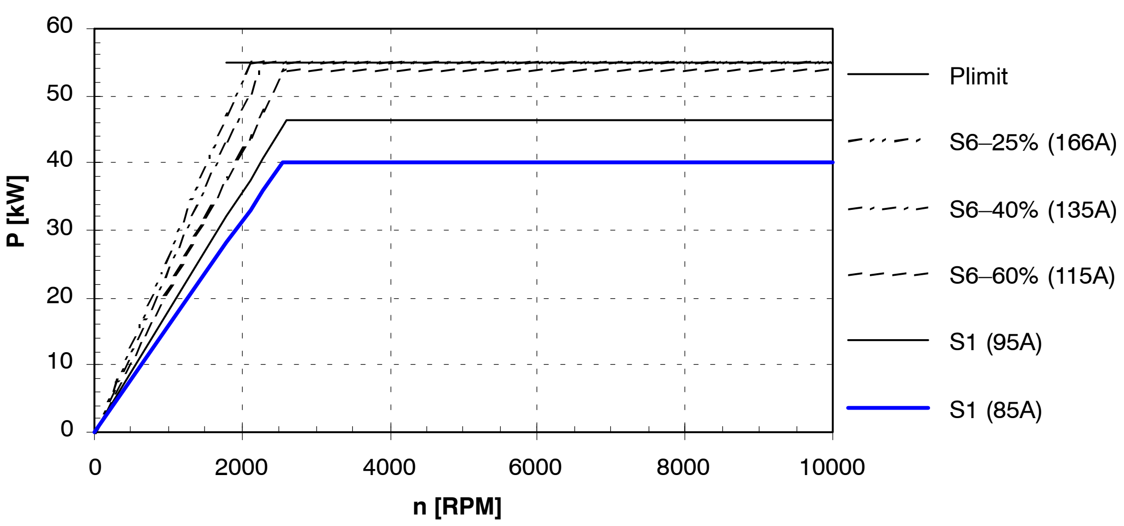


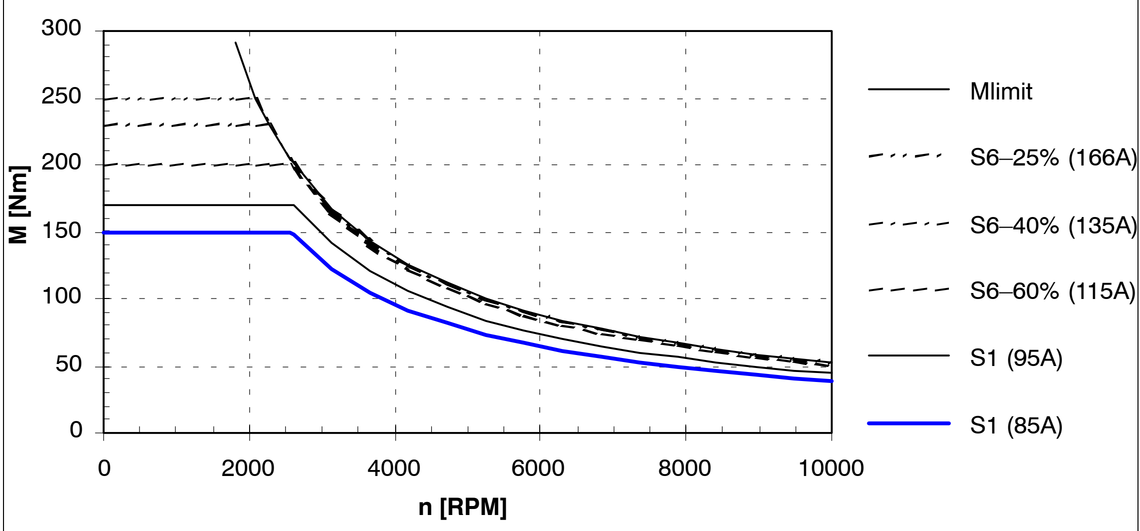


The data for duty type S6 are valid for a 2 min. duty cycle.

Table 10-12 Motor spindle 2SP1255–1□A□□-0

Motor spindle 2SP1255–1□A□□-0 (only star circuit configuration)						
Circuit type	**Rated power** P_N [**kW**]	**Rated speed** n_N [**RPM**]	**Rated torque** M_N [**Nm**]	**Rated current** I_N [**A**]	**Max. speed** n_{max} [**RPM**]	**Moment of inertia J** [**kgm²**]
⋏	46.3	2600	170	95	10000	0.055
△	—	—	—	—	—	—

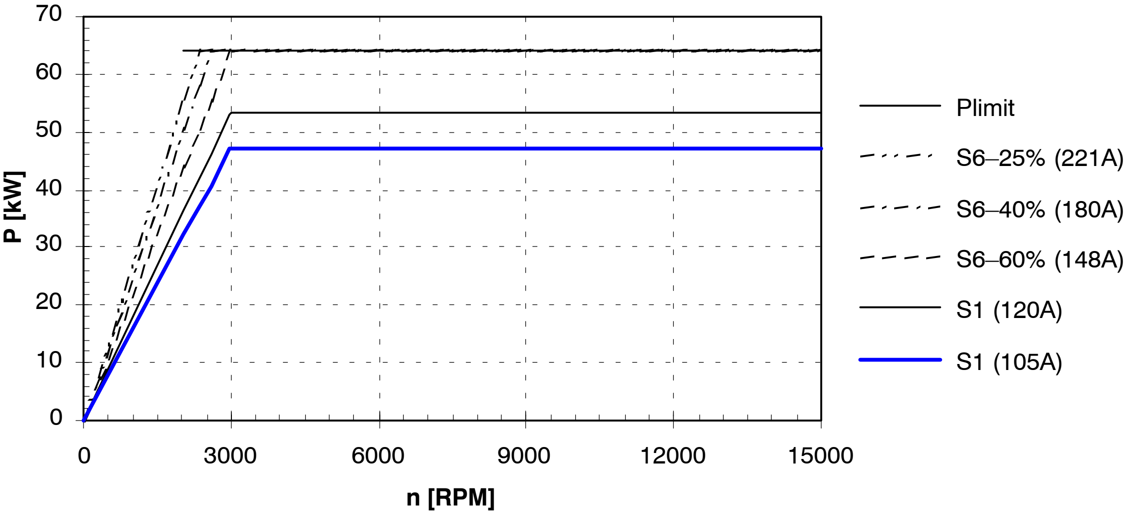


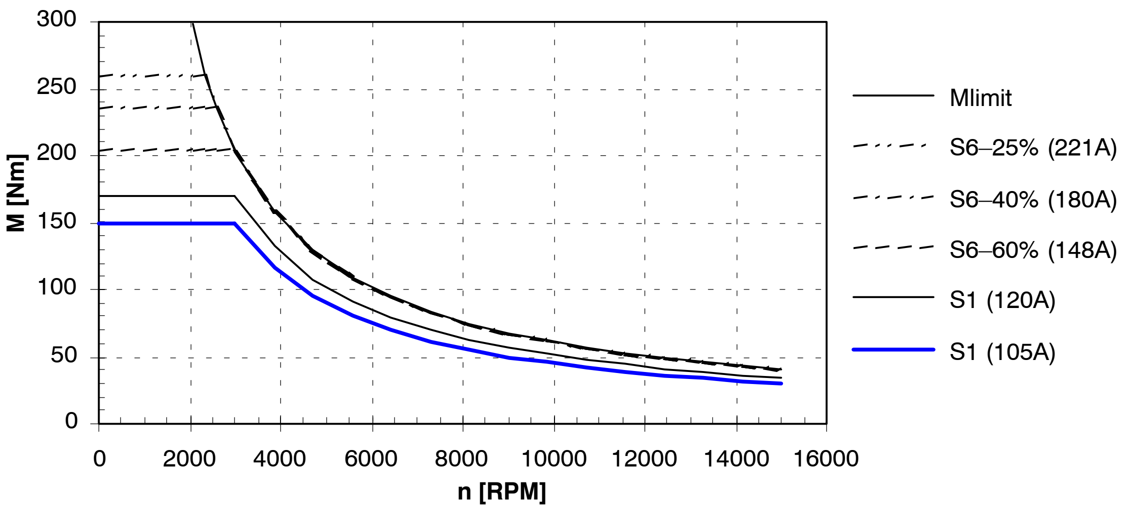


The data for duty type S6 are valid for a 2 min. duty cycle.

Table 10-13 Motor spindle 2SP1255–1□B□□-1

Motor spindle 2SP1255–1□B□□-1 (only star circuit configuration)						
Circuit type	**Rated power** P_N [kW]	**Rated speed** n_N [RPM]	**Rated torque** M_N [Nm]	**Rated current** I_N [A]	**Max. speed** n_{max} [RPM]	**Moment of inertia** J [kgm²]
Y	53.4	3000	170	120	15000	0.055
△	—	—	—	—	—	—



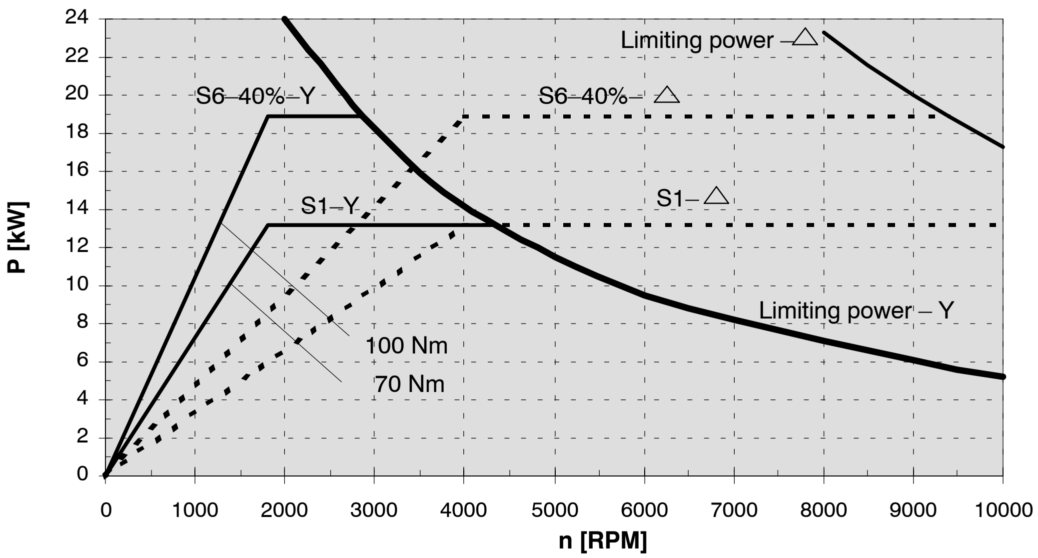


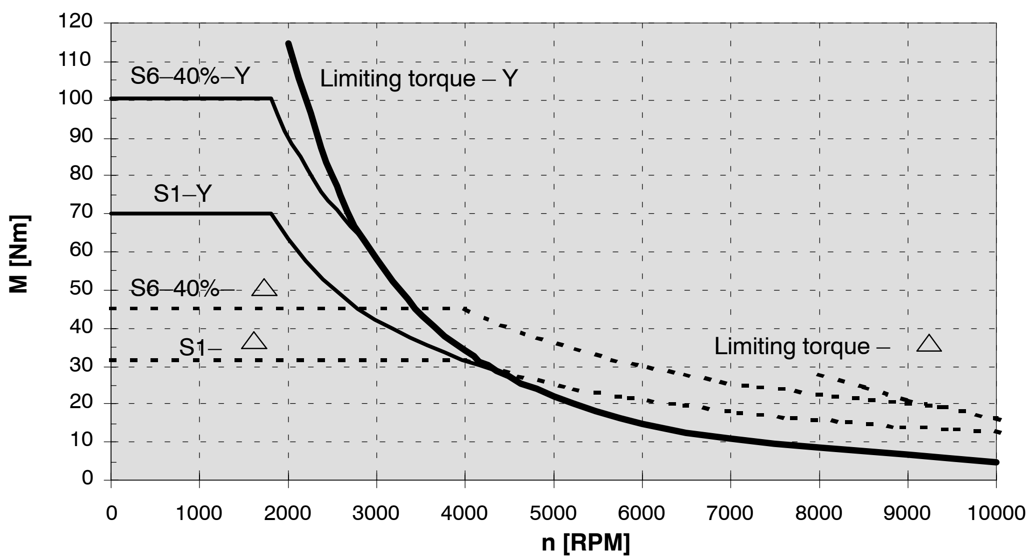
The data for duty type S6 are valid for a 2 min. duty cycle.

10.2.3 2SP125□ induction motor

Table 10-14 Motor spindle 2SP1253-8□A□□-0

Motor spindle 2SP1253–8□A□□-0						
Circuit type	**Rated power** P_N [kW]	**Rated speed** n_N [RPM]	**Rated torque** M_N [Nm]	**Rated current** I_N [A]	**Max. speed** n_{max} [RPM]	**Moment of inertia** J [kgm²]
Y	13.2	1800	70	28	10000	0.037
△	13.2	4000	32	29	10000	0.037

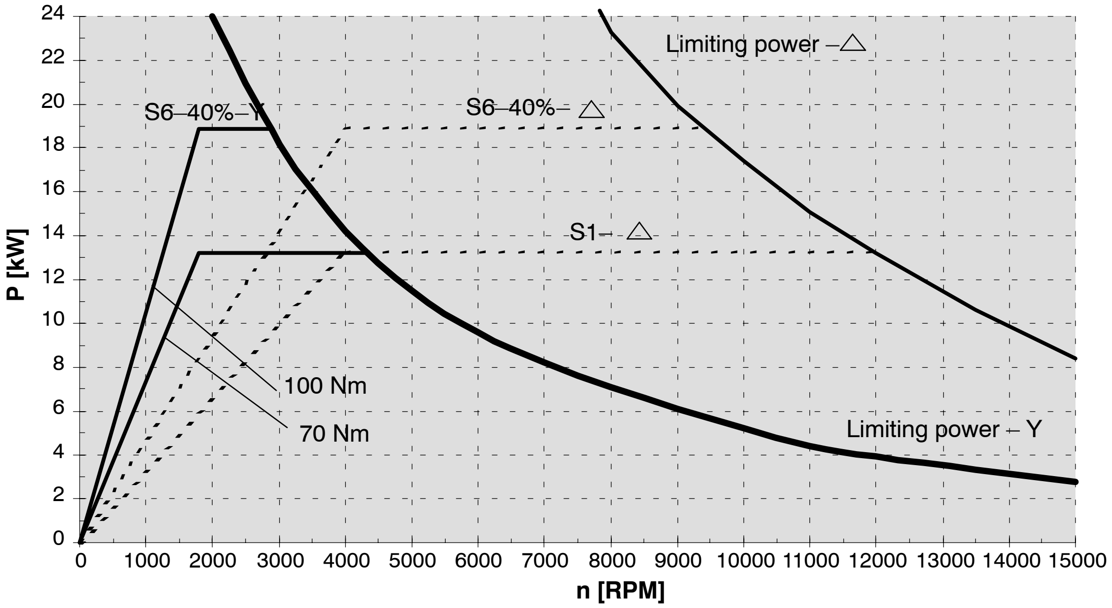


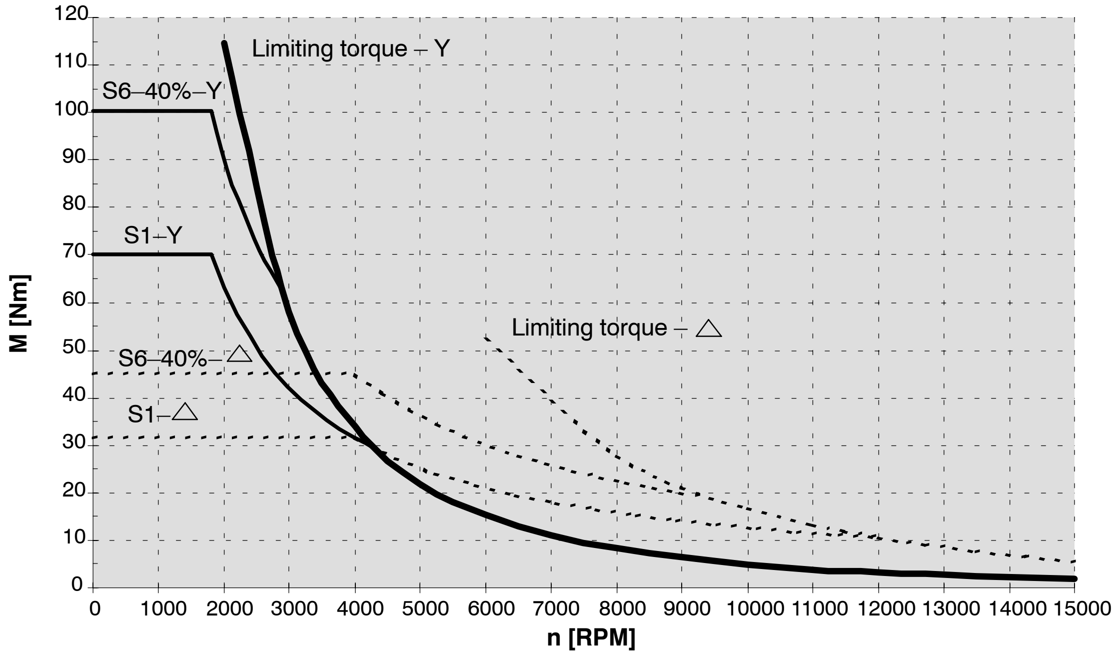


The data for duty type S6 are valid for a 2 min. duty cycle.

Table 10-15 Motor spindle 2SP1253–8□A□□-1

Motor spindle 2SP1253–8□A□□-1						
Circuit type	**Rated power** P_N [**kW**]	**Rated speed** n_N [**RPM**]	**Rated torque** M_N [**Nm**]	**Rated current** I_N [**A**]	**Max. speed** n_{max} [**RPM**]	**Moment of inertia** **J** [kgm^2]
Y	13.2	1800	70	28	15000	0.037
△	13.2	4000	32	29	15000	0.037

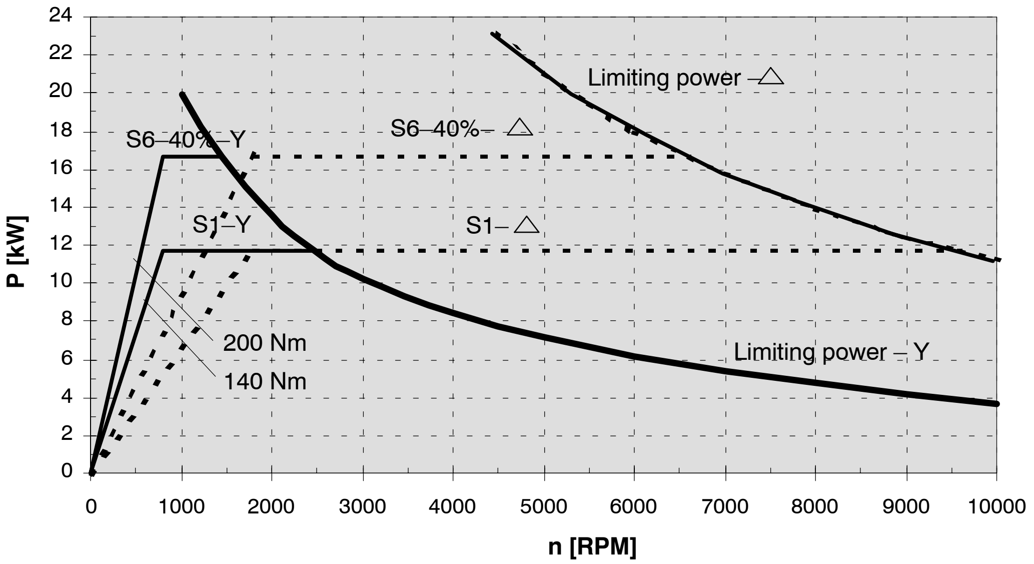


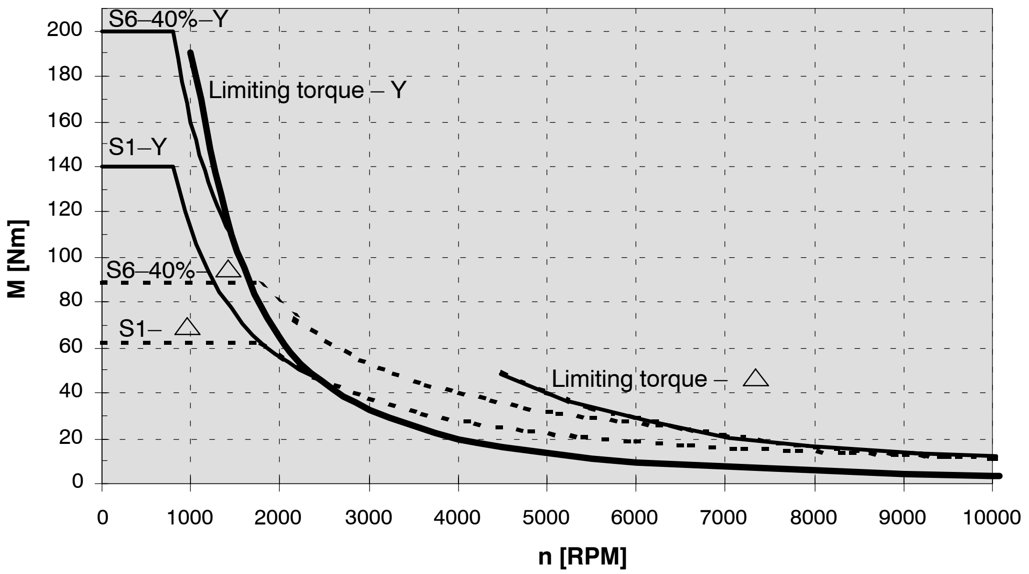


The data for duty type S6 are valid for a 2 min. duty cycle.

Table 10-16 Motor spindle 2SP1255–8□A□□-0

Motor spindle 2SP1255–8□A□□-0						
Circuit type	**Rated power** P_N [kW]	**Rated speed** n_N [RPM]	**Rated torque** M_N [Nm]	**Rated current** I_N [A]	**Max. speed** n_{max} [RPM]	**Moment of inertia** J [kgm^2]
Y	11.7	800	140	30	10000	0.055
△	11.7	1800	62	29	10000	0.055

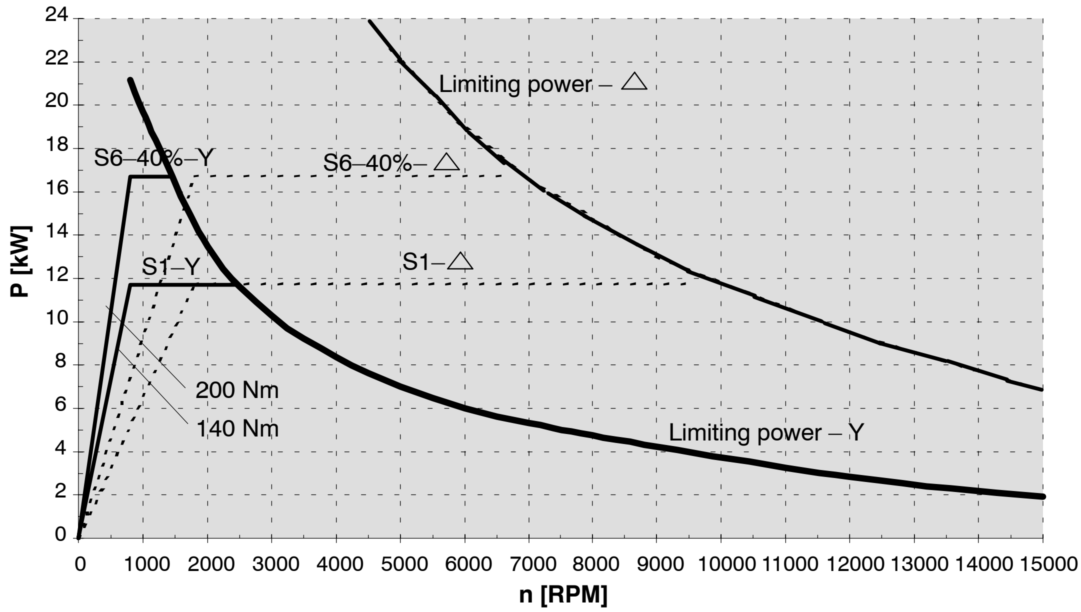


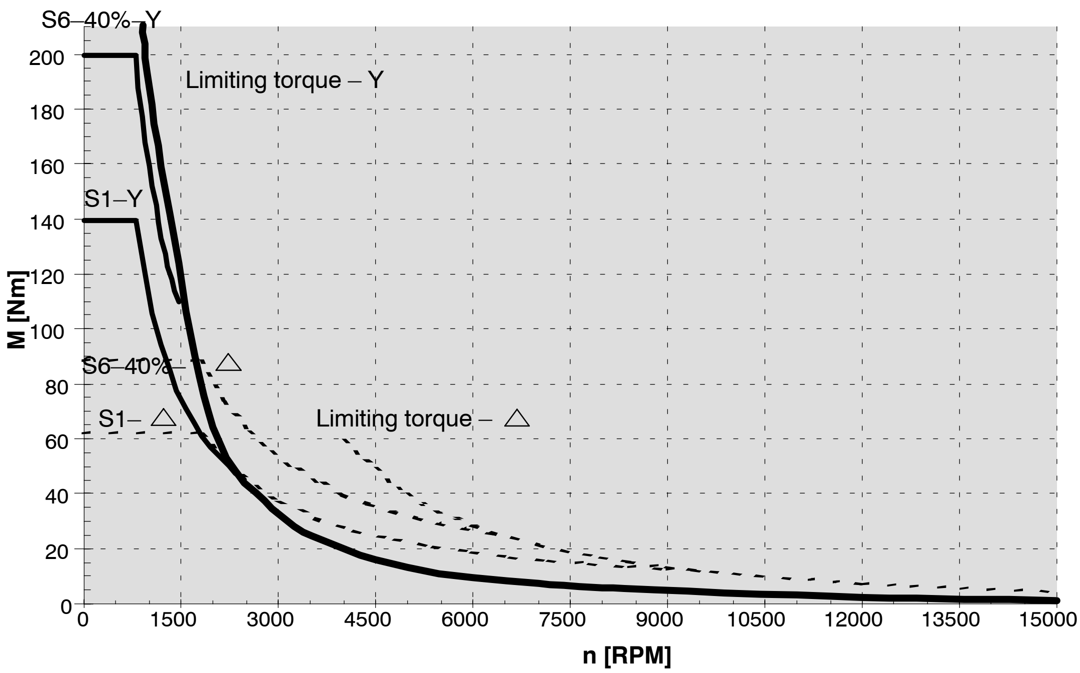


The data for duty type S6 are valid for a 2 min. duty cycle.

Table 10-17 Motor spindle 2SP1255–8□A□□-1

Motor spindle 2SP1255–8□A□□-1						
Circuit type	**Rated power** **P_N [kW]**	**Rated speed** **n_N [RPM]**	**Rated torque** **M_N [Nm]**	**Rated current** **I_N [A]**	**Max. speed** **n_{max} [RPM]**	**Moment of inertia** **J [kgm^2]**
Y	11.7	800	140	30	15000	0.055
△	11.7	1800	62	29	15000	0.055





The data for duty type S6 are valid for a 2 min. duty cycle.

10.3 Dimension drawings

Note

Siemens AG reserves the right to change the motor dimensions, as part of design improvements, without prior notification. The dimension drawings, provided in this documentation, can go out–of–date.

Current dimension drawings can be requested at no charge from your local Siemens office.

Table 10-18 Dimension table for Fig. 10-3

MLFB	Speed [RPM]	Motor	Release unit	Mom. of inertia [kgm^2]	A [mm]	A* [mm]	B [mm]	Power connector, optional
2SP1202–1HA3x–1xx2	15000	1FE082–4WP51	hydraulically	0.015	617	572	236	Size 1.5
2SP1202–1HA2x–1xx2	15000	1FE082–4WP51	pneumatically	0.015	735	692	236	Size 1.5
2SP1202–1HB3x–2xx2	18000	1FE082–4WN51	hydraulically	0.015	617	572	236	Size 1.5
2SP1202–1HA3x–2xx2	18000	1FE082–4WN51	pneumatically	0.015	735	692	236	Size 1.5
2SP1204–1HA3x–1xx2	15000	1FE084–4WT51	hydraulically	0.023	717	672	336	Size 3
2SP1204–1HA2x–1xx2	15000	1FE084–4WT51	pneumatically	0.023	835	792	336	Size 3
2SP1204–1HB3x–2xx2	18000	1FE082–4WP51	hydraulically	0.023	717	672	336	Size 3
2SP1204–1HB2x–2xx2	18000	1FE082–4WP51	pneumatically	0.023	835	792	336	Size 3

Dimension A* without rotary gland

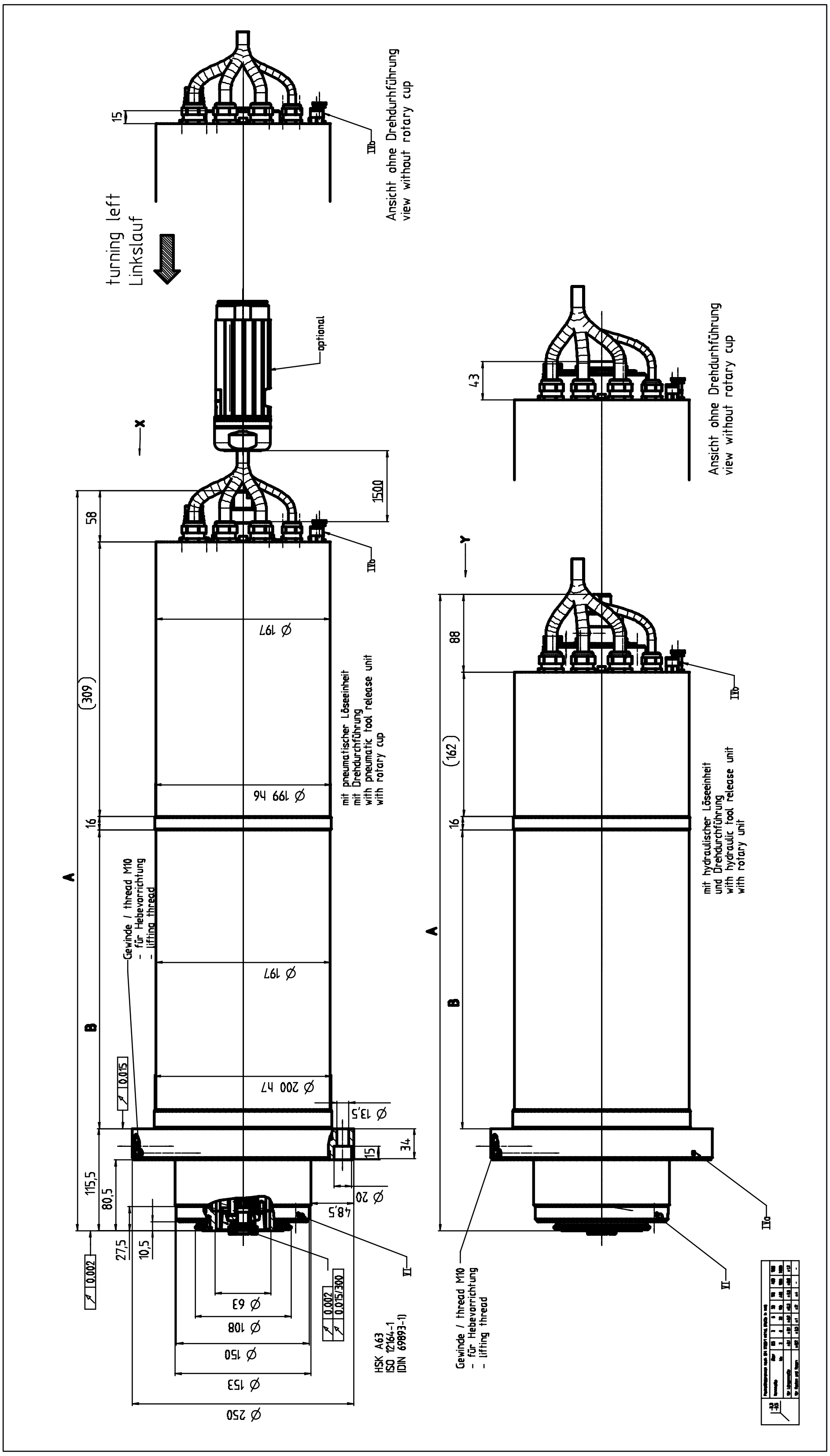


Fig. 10-3 Spindle 2SP120□–1

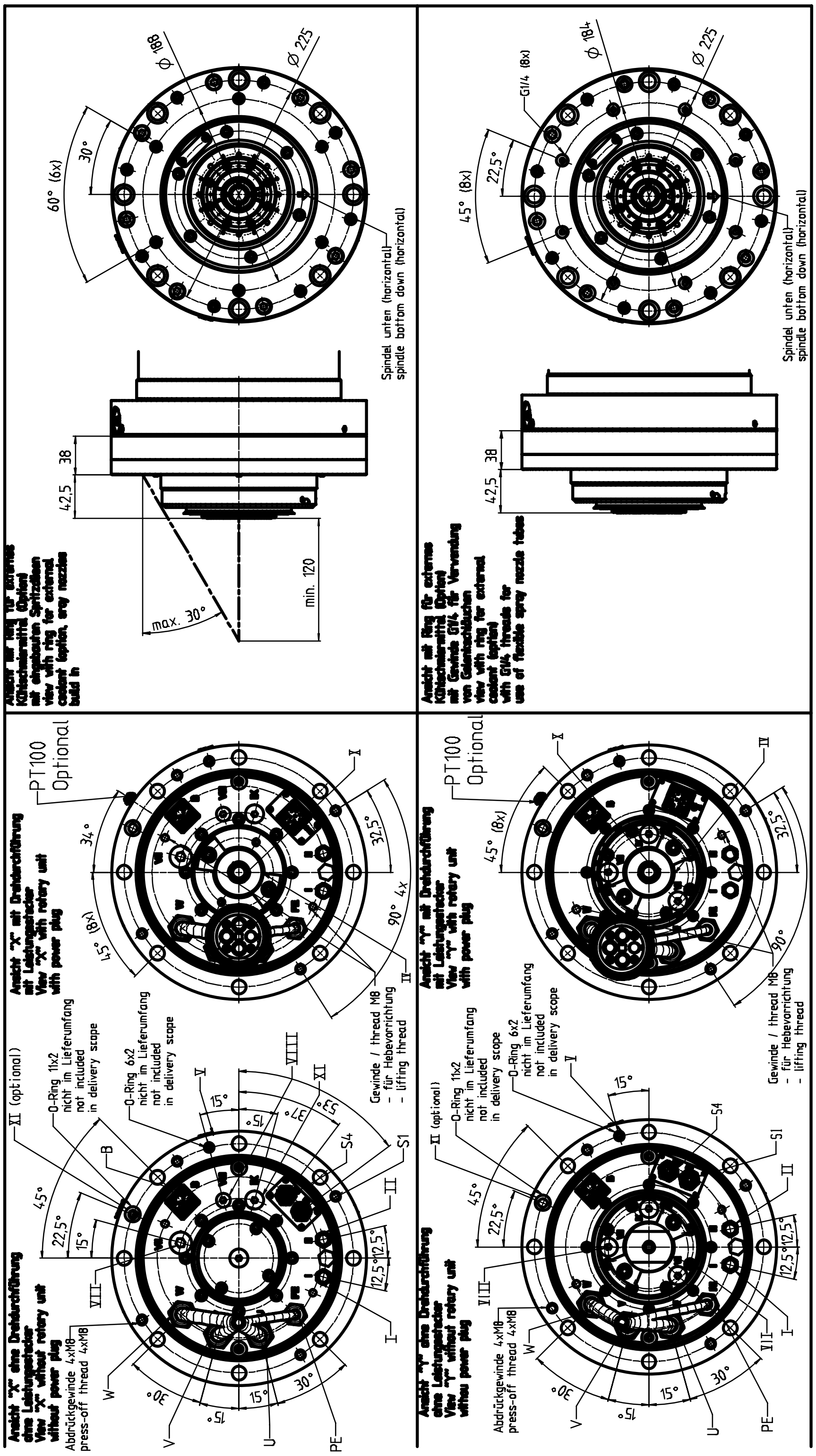


Fig. 10-4 Spindle 2SP120□–1, spindle nose and spindle connections

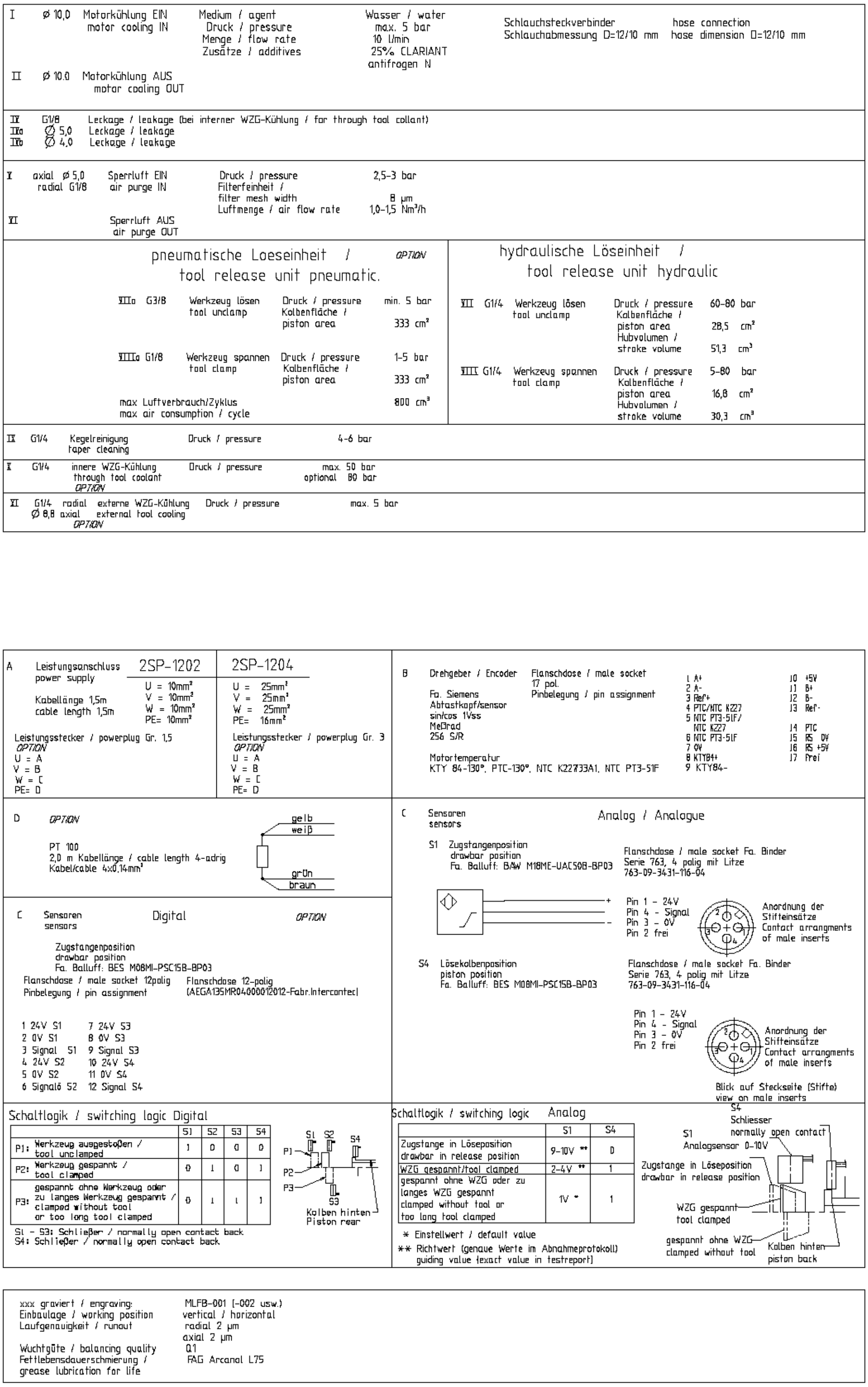


Fig. 10-5 Connection designations

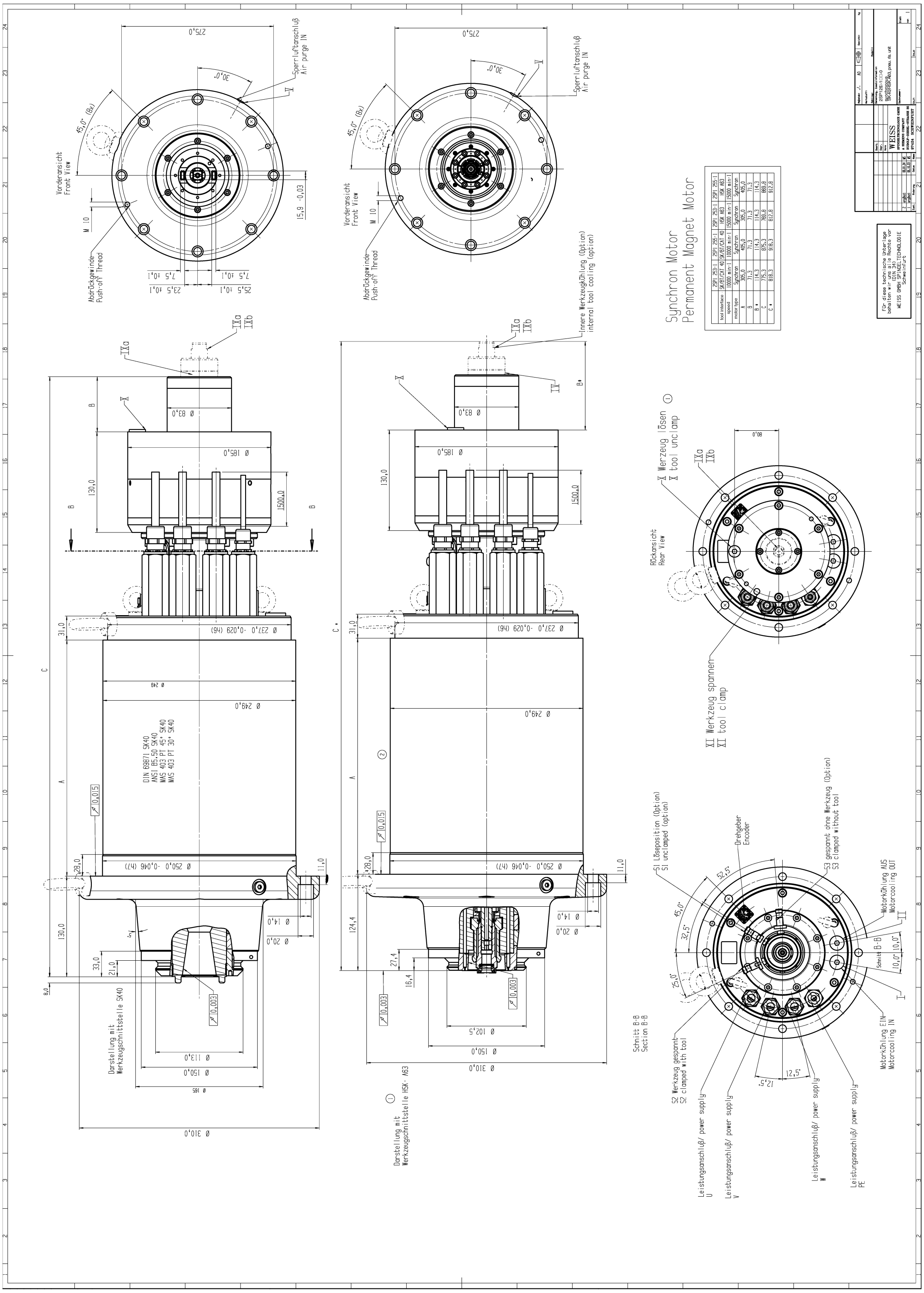


Fig. 10-6 Dimension drawing, spindles 2SP125□–1□□0 (pneumatic release unit)

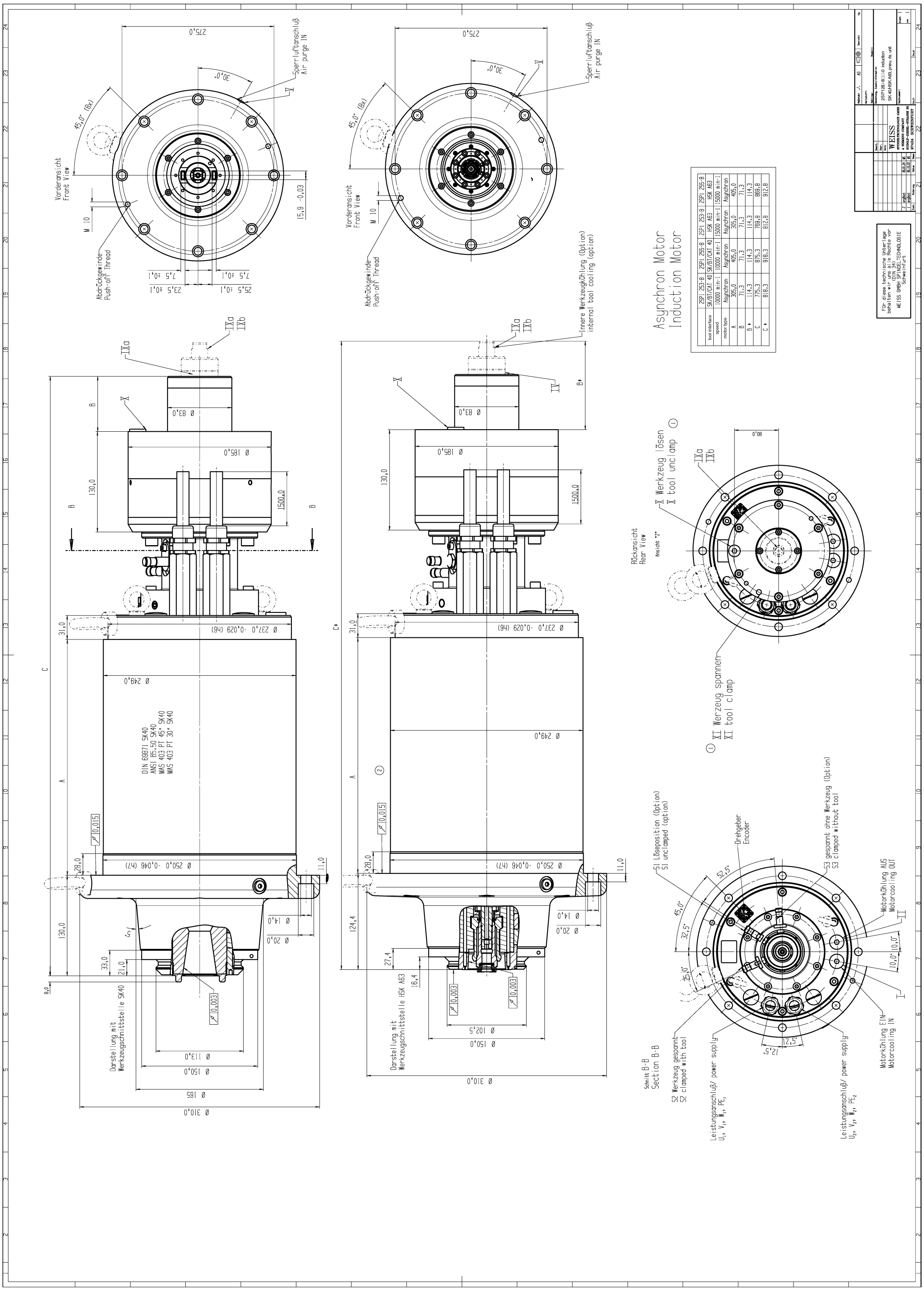


Fig. 10-7 Dimension drawing, spindles 2SP125□–8□□0 (pneumatic release unit)

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References

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http://www.siemens.com/motioncontrol
through "Support", "Technical Documentation", "Overview of Publications"

General Documentation

/BU/ **Catalog NC 60**
Automation Systems for Machine Tools

Manufacturer/Service Documentation

/PJM/ **Configuration Manual, Synchronous Motors**
SIMODRIVE 611, MASTERDRIVES MC
General Section, 1FT5, 1FT6, 1FK6, 1FK7

/PJAL/ **Configuration Manual, Synchronous Motors**
SIMODRIVE 611, MASTERDRIVES MC
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/PFK6/ **Configuration Manual, Synchronous Motors**
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/APH4/ **Configuration Manual, Induction Motors**
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/PFU/ **Configuration Manual, Synchronous Motors**
SINAMICS, SIMODRIVE, MASTERDRIVES
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Complete Torque Motors 1FW3

/PJTM/ **Configuration Manual, Built–in Torque Motors**

SIMODRIVE
Built–in Torque Motors 1FW6

/PMS/ **Configuration Manual, Motor Spindle**

SIMODRIVE
ECS Motor Spindle 2SP1

/PJLM/ **Configuration Manual, Linear Motors**

SIMODRIVE
Linear Motors 1FN1 and 1FN3

/PJU/ **Configuration Manual Converters**

SIMODRIVE 611

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Abbreviations and Terminology

MQL	Minimum quantity lubrication system
Operating speed, max.	Max. speed
Safety Integrated®	Option to monitor the drive function through 2 channels
Shutdown speed	Speed limit value; the system initiates that the spindle is shutdown if the shutdown speed is exceeded.

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