OPTIMUM

MASCHINEN - GERMANY

Operating manual

Version 1.1.6

CNC-milling machine

OPTImill® F 150

GB

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Preface

Dear customer,

Thank you very much for purchasing a product made by OPTIMUM.

OPTIMUM metal working machines offer a maximum of quality, technically optimum solutions and convince by an outstanding price performance ratio. Continuous enhancements and product innovations guarantee state-of-the-art products and safety at any time.

Before commissioning the machine please thoroughly read these operating instructions and get familiar with the machine. Please also make sure that all persons operating the machine have read and understood the operating instructions beforehand.
Keep these operating instructions in a safe place nearby the machine.

Information

The operating instructions include indications for safety-relevant and proper installation, operation and maintenance of the machine. The continuous observance of all notes included in this manual guarantee the safety of persons and of the machine.

The manual determines the intended use of the machine and includes all necessary information for its economic operation as well as its long service life.

In the paragraph "Maintenance" all maintenance works and functional tests are described which the operator must perform in regular intervals.

The illustration and information included in the present manual can possibly deviate from the current state of construction of your machine. Being the manufacturer we are continuously seeking for improvements and renewal of the products. Therefore, changes might be performed without prior notice. The illustrations of the machine may be different from the illustrations in these instructions with regard to a few details. However, this does not have any influence on the operability of the machine.
Therefore, no claims may be derived from the indications and descriptions. Changes and errors are reserved!

Your suggestion with regard to these operating instructions are an important contribution to optimising our work which we offer to our customers. For any questions or suggestions for improvement, please do not hesitate to contact our service department.

If you have any further questions after reading these operating instructions and you are not able to solve your problem with a help of these operating instructions, please contact your specialised dealer or directly the company OPTIMUM.

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1 Safety

This part of the operating instructions

- explains the meaning and use of the warning notices included in these operating instructions,
- defines the intended use of the CNC machine,
- points out the dangers that might arise for you or others if these instructions are not observed,
- informs you about how to avoid dangers.

In addition to these operation instructions, please observe

- the applicable laws and regulations,
- the legal regulations for accident prevention,
- the prohibition, warning and mandatory signs as well as the warning labels on the CNC machine.

Always keep this documentation close to the CNC machine.

1.1 Glossary of symbols

☞ provides further instructions

➜ calls on you to act

- enumerations

1.2 Safety instructions (warning notes)

1.2.1 Classification of hazards

We classify the safety warnings into various levels. The table below gives an overview of the classification of symbols (ideogram) and the warning signs for each specific danger and its (possible) consequences.

Symbol	Warning alert	Definition / consequence
	**DANGER!**	Impending danger that will cause serious injury or death to people.
	WARNING!	A danger that might cause severe injury to the personnel or can lead to death.
	CAUTION!	Danger or unsafe procedure that might cause injury to people or damage to property.
	**ATTENTION!**	Situation that could cause damage to the CNC machine and product and other types of damage. No risk of injury to people.
	**INFORMATION**	Application tips and other important or useful information and notes. No dangerous or harmful consequences for people or objects.

In case of specific dangers, we replace the pictogram with


general danger


with a warning of


injury of hands,


hazardous electrical voltage,


rotating parts.

1.2.2 Other pictograms


Activation forbidden!


Stepping into the machine prohibited!


Forbidden to extinguish with water!


Access forbidden!


Use protective boots!


Use ear protection!


Wear protective glasses!


Read the operating instruction!


Warning biological hazard!


Warning suspended loads!


Warning of oxidizing materials!


Warning of explosive!


Warning danger of slipping!


Protect the environment!


Contact address

1.3 Intended use

WARNING!

In the event of improper use, the CNC machine

- **will endanger personnel,**
- **the CNC machine and other material property of the operating company will be endangered,**
- **the correct function of the CNC machine may be affected.**

The CNC machine is designed and manufactured to be used for milling and drilling cold metals or other non-flammable materials or materials that do not constitute a health hazard by using commercial milling and drilling tools.
Using this machine it is possible to perform dry processing as well as processing by using cooling lubricants. ☞ "Cooling lubricants“ on page 93

The limit values of the balances of the tools need to be observed. ☞ "Tools and tool holding fixtures“ on page 27

The CNC machine must only be installed and operated in a dry and well-ventilated place.

The CNC machine is designed and manufactured to be used in environments where there is no potential danger of explosion.

If the CNC machine is used in any way other than described above, modified without the approval of the company Optimum Maschinen Germany GmbH then the drilling-milling machine is being used improperly. Intended use

We will not be held liable for any damages resulting from any operation which is not in accordance with the intended use.

We expressly point out that the guarantee or CE conformity will expire due to any constructive technical or procedural changes which had not been performed by the company Optimum Maschinen Germany GmbH.

It is also part of intended use that you

- observe the limits of performance of the CNC-machine,
- the operating manual is observed,
- the inspection and maintenance instructions are observed.

WARNING!

Severe injuries due to improper use.

It is forbidden to make any modifications or alternations to the operation values of the CNC machine. They could endanger employees and cause damage to the CNC machine.

1.4 Reasonably foreseeable misuses

Any other use as the one determined under the "Intended use" or any use beyond the described use shall be deemed as not in conformity and is forbidden.

Any other use has to be discussed with the manufacturer.

It is only allowed to process metal, cold and non-inflammable materials with the milling-machine.

In order to avoid misuses it is necessary to read and understand the operating instructions before the first commissioning.

The operators must be qualified.

1.4.1 Avoiding misuses

- ➜ Use of suitable cutting tools.
- ➜ Adapting the speed adjustment and feed to the material and workpiece.
- ➜ Clamp workpieces firmly and vibration-free.

ATTENTION!

The workpiece is always to be fixed by a machine vice, jaw chuck or by another appropriate clamping tool such as for the clamping claws.

WARNING!

Risk of injury caused by workpieces flying off.

Clamp the workpiece in the machine vice. Make sure that the workpiece is firmly clamped in the machine vice resp. that the machine vice is firmly clamped on the machine table.

- ➜ Use cooling and lubricating agents to increase the durability of the tool and to improve the surface quality.
- ➜ Clamp the cutting tools and workpieces on clean clamping surfaces.
- ➜ Sufficiently lubricate the machine.
- ➜ Correctly adjust the bearing clearance and the guidings.

It is recommended:

- ➜ Insert the drill in a way that it is exactly positioned between the three clamping jaws of the quick action chuck.
- ➜ Clamp and mills by means of the collet chuck and the corresponding collets.
- ➜ Clamp end face mills by means of shell end mill arbors.

When drilling make sure that

- ➜ the suitable speed is set depending on the diameter of the drill,
- ➜ the pressure must only be such that the drill can cut without load
- ➜ in case of too strong pressure the drill will get worn early or even might break resp. get jammed in the hole. If the drill gets jammed immediately stop the main motor by pressing the emergency stop button,
- ➜ for hard materials, e.g. steel, use commercial cooling / lubricating agents,
- ➜ generally always drive the turning spindle out of the workpiece.

ATTENTION!

Do not use the quick action drill chuck for milling tools. Never clamp a milling cutter into a quick action drill chuck. Use a collet chuck with collets for the end mill.

When milling make sure that

- ➜ the corresponding cutting speed is selected,
- ➜ for workpieces with normal strength values, e.g. steel 18-22 m/min,
- ➜ for workpieces with high strength values 10-14 m/min,
- ➜ the pressure is selected in a way that the cutting speed remains constant,
- ➜ for hard materials commercial cooling / lubricating agents are used.

1.5 Possible dangers caused by the CNC machine

The CNC machine has undergone a safety inspection.. The construction and type are state of the art.

Nevertheless, there is a residual risk as the CNC machineoperates with

- rotating parts,
- electrical voltage and currents,
- compressed air,
- rapid moves.

We have used construction resources and safety techniques to minimize the health risk to personnel resulting from these hazards.

If the CNCmachine is used and maintained by the personnel who are not duly qualified, there may be a risk resulting from incorrect or unsuitable maintenance of the CNCmachine.

INFORMATION

Everyone involved in the assembly, commissioning, operation and maintenance must

- be duly qualified,
- strictly follow these operating instructions.

In the event of improper use

- there may be a risk to the personnel,
- there may be a risk to the CNC machine and other material values,
- the correct function of the CNC machine may be affected.

Always switch off the CNC-machine and disconnect it from the mains if you perform cleaning or maintenance works.

WARNING!

The CNC machine may only be used with the safety devices activated. Disconnect the CNC-machine immediately, whenever you detect a failure in the safety devices or when they are not fitted!

All additional parts of the machine which had been added by the customer need to be equipped with the prescribed safety devices.

This is your responsibility being the operating company! ☞ **"Safety devices“ on page 13**

1.6 Qualification of personnel

1.6.1 Target group

This manual is addressed to

- the operating companies,
- operators having sufficient specialist knowledge,
- the maintenance personnel.

Therefore, the warning notes refer to both operation and maintenance of the CNC machine.

Determine clearly and explicitly who will be responsible for the different activities on the CNC-machine (operation, setting up, maintenance and repair). Please note the name of the responsible person into an operators´s log.

INFORMATION

Unclear responsibilities constitute a safety risk!

Always lock the main switch after switching off the CNC-machine. This will prevent it from being used by unauthorized persons.

The qualifications of the personnel for the different tasks are mentioned below:

Operator

The operator has been instructed by the operating company regarding the assigned tasks and possible risks in case of improper behaviour. Any tasks which need to be performed beyond the operation in the standard mode must only be performed by the operator if it is indicated in these instructions and if the operating company expressively commissioned the operator.

Electrical specialist

Due to professional training, knowledge and experience as well as knowledge of respective standards and regulations the electrical specialist is able to perform work on the electrical system and recognise and avoid any possible dangers.

The electrical specialist is specially trained for the working environment in which he is working and knows the relevant standards and regulations.

Qualified personnel

Due to their professional training, knowledge and experience as well as their knowledge of relevant regulations the qualified personnel is able to perform the assigned tasks and to recognise and avoid any possible dangers themselves.

Instructed person

Instructed personnel were instructed by the operating company about the assigned tasks and any possible risks in case of improper behaviour.

1.6.2 Authorized personnel

INFORMATION

For working on the CNC machine sufficient expertise is required. No one must work on the machine without having the necessary education, not even for a short while.

As aid for training and operation we recommend to use the CNC-Software SinuTrain.

SinuTrain made by Siemens is the perfect software supplement for the CNC-machine F150 of OPTIMUM.

This training software supports the rapid training for the operation of the control Sinumerik Siemens 828D. Employees having little CNC experience can learn the basics of the DIN programming by using SinuTrain and are finally able to write and test programs using Siemens 828D cycles.

Please find SinuTrain and further information on the website of Siemens.

WARNING!

Inappropriate operation and maintenance of the CNC machine constitutes a danger for the personnel, objects and the environment.

Only authorized personnel may operate the CNC machine!

Persons authorized to operate and maintain should be trained technical personnel and instructed by the ones who are working for the operating company and for the manufacturer.

Obligations of the operating company

Obligations of the operating company

- train the personnel,
- instruct the personnel in regular intervals (at least once a year) on
  - all safety standards that apply to the CNC machine,
  - the operation of the CNC machine,
  - accredited technical guidelines,
  - possible emergency situations,
- check personnel‘s state of knowledge,
- document training/instruction in a operation book,

- require personnel to confirm participation in training/instructions by means of a signature,
- check whether the personnel is working safety- and risk-conscious and observe the operating instructions.
- define and document the inspection deadlines for the machine in accordance with § 3 of the Factory Safety Act and perform an operational risk analysis in accordance with § 6 of the Work Safety Act.

Obligations of the operator

Obligations of the operator

- be specially trained in handling and programming the CNC-machine,
- know and understand the program sequence and which effects the individual process parameters will have,
- keep an operator‘s log,
- before taking the machine in operation
  - have read and understood the operating manual,
  - be familiar with all safety devices and instructions.

Additional requirements regarding the qualification

For work on the following CNC machine parts there are additional requirements:

- Electric components or operating materials: Must only be performed by a qualified electrician or person working under the instructions and supervision of a qualified electrician.

1.7 Operator positions

The operator position is in front of the CNC-machine at the sight window or on the machine control panel.

1.8 Safety devices

Use the CNC machine only with properly functioning safety devices.

Stop the CNCmachine immediately if there is a failure on the safety device or if it is not functioning for any reason.

It is your responsibility!

If a safety device has been activated or has failed, the CNC machinemust only be used if you

- have removed the cause of the failure,
- have verified that there is no danger resulting for the personnel or objects.

WARNING!

If you bypass, remove or override a safety device in any other way, you are endangering yourself and other persons working on the CNC machine. The possible consequences are:

- **injuries due to tools, workpieces or fragments hereof which are flying off at high speed,**
- **contact with rotating or moving parts,**
- **fatal electrocution,**
- **pulling-in of clothes.**

The CNC machine includes the following safety devices:

- a lockable main switch,
- One EMERGENCY STOP push-button on the machine control panel and on the electronic handwheel,
- A locked, separating protective equipment around the CNC-milling machine with sight windows made of break-proof Makrolon.
- Locking switch on the separating safety devices.

1.8.1 Lockable main switch

In the position " 0 " the lockable main switch can be secured against accidental or non-authorized switching-on by means of a padlock.

When the main switch is switched-off, the power supply is interrupted.

Except in the areas marked by the pictogram in the margin. In these areas there might be voltage, even if the main switch is switched-off.

Img. 1-1: Main switch

WARNING!

Dangerous voltage even if the main switch is switched-off.

In the areas marked by the pictogram in the margin, there might be live parts, even if the main switch is switched off.

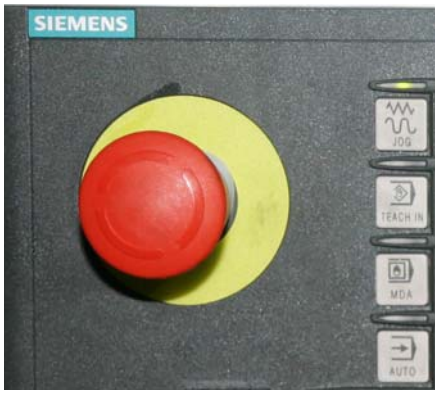
1.8.2 EMERGENCY STOP push button

ATTENTION!

The EMERGENCY STOP push button immediately stops the operation of the CNC machine.

Press the EMERGENCY STOP push button only if there is a risk! If this button is actuated in order to switch off the CNC machine in the standard operation the tool or workpiece might get damaged.

After having actuated the EMERGENCY STOP, turn the knob of the particular push button to the right in order to restart the machine.



Img. 1-2: Emergency-stop push button

1.8.3 Control technical protection

WARNING!

If you bypass a controller you endanger yourself and other persons working on the CNC machine.

- **injuries due to tools, workpieces or fragments hereof which are flying off at high speed,**
- **contact with rotating parts,**
- **fatal electrocution,**
- **pulling-in of clothes.**

If you bypass a controller in exceptional cases (e.g. during electrical repairs) short term you must continuously monitor the CNC machine during this time.

1.8.4 Polycarbonate windows

Polycarbonate windows which have a safety-critical function with respect to ejected parts, must be visual inspected by the customer responsible personnel at regular intervals to guarantee the operational safety of the CNC machine.

Polycarbonate windows are subject to an aging process and are classified as wear parts.

The aging of polycarbonate windows can not be detected by visual inspection. It is therefore necessary to replace the polycarbonate windows after a certain time.

Prolonged exposure from polycarbonate windows to cutting fluids can lead to accelerated ageing, i.e. deterioration of the mechanical properties (brittleness). Coolant vapours, detergents, greases and oils or other corrosive substances from the operator side can also lead to a deterioration of the polycarbonate windows. The result is a reduced parts retentivity of the polycarbonate windows. ☞ "Cleaning and replacing of the polycarbonate windows“ on page 100

1.8.5 Prohibition, warning and mandatory labels

INFORMATION

All warning and mandatory labels must be legible. Check them regularly.

1.9 Safety check

Check the CNC machine at least once per shift. Inform the person responsible immediately of any damage, defects or changes in the operating function.

Check all safety devices

- at the beginning of each shift (when the machine is operated continuously),
- once per day (during one-shift operation),
- once per week (when operated occasionally),
- after all maintenance and repair work.

Check that prohibition, warning and information signs and the labels on the CNC machine

- are legible (clean them, if necessary),
- are complete (replace them, if necessary).

INFORMATION

Use the following table in order to organize the checks.

General check		
Equipment	**Check**	**OK**
Protective housing	Switching function, firmly bolted and not damaged	
Signs, Markings	Installed and legible	
Sight window	Check for mechanical damage (scratches, cracks) ☞ "Polycarbonate windows“ on page 15	
Date:	**checked by (signature):**	

Functional check		
Equipment	**Check**	**OK**
EMERGENCY STOP button	After actuating an EMERGENCY STOP button the CNC machine must be switched off.	
Switch cabinet cooling	The cabinet cooling must be running.	
Separating protective equipment around the CNC machine	If the protective equipment is open it must not be possible to start program.	
Date:	**checked by (signature):**	

1.10 Personal protective equipment

For certain work personal protective equipment is required.

Protect your face and eyes: Wear a safety helmet with facial protection when performing works where your face and eyes are exposed to hazards.

Use protective gloves when handling pieces or tools with sharp edges.

Use safety shoes when you assemble, disassemble or transport heavy components.

Use ear protection if the noise level (emission) in the workplace exceeds 80 dB (A).

Before starting work make sure that the required personal protective equipment is available at the work station.

CAUTION!

Dirty or contaminated personnel protective equipment can cause illnesses. Clean it each time after use and at least once a week.

1.11 Safety during operation

WARNING!

Before activating the CNC machine ensure that this will neither endanger other persons nor cause damage to equipment.

Avoid any risky working practices:

- The instructions mentioned in these operating instructions have to be strictly observed during assembly, operation, maintenance and repair.
- Do not work on the CNC machine, if your concentration is reduced, for example, because you are taking medication.
- Stay on the CNC machine until the program is terminated.
  The running program can be identified by means of the signal lamp.
  - Continuous light: Program runs.
  - Flashing light: NC stop or program hold.

Img. 1-3: Signal lamp

- Safely and firmly clamp the workpiece before switching on the CNC machine.
- Never change the dosing of the coolant supply during operation.
- Never open the sliding door of the separating protective unit when the CNC-program is running.

WARNING!

When chipping magnesia materials (aluminium-/magnesium alloys) spontaneously inflammable or explosive particles (powder, dust, chips) might be generated which might result in a fire and/or an explosion (deflagration).

Magnesium is designated as a dangerous material in the list of dangerous materials and preparations according to §4a of Ordinance of Hazardous Substances.

In case of a fire with magnesium only use appropriate and admitted extinguishing agents. Never extinguish using water. If you extinguish burning magnesium with water it might lead to dangerous reactions (detonating gas). Water would be decomposed in its components hydrogen (H) and oxygen (O).

Only the following extinguishing agents are admitted:

- **solid extinguishing agent of the fire class D (fires of metals)**
- **dry covering salts for magnesium**
- **a mixture of sand and cast chips**
- **argon (Ar) or nitrogen (N_2)**

If fine mist and smoke is generated in the working room, suction unites need to provided in order to avoid the accumulation of ignitable mixtures and emissions.

We provide information about the specific dangers when working with and on the CNC machine in the descriptions for these types of work.

1.12 Safety during maintenance

Inform the operators in good time about any maintenance and repair works.

Report all safety relevant changes and performance details of the multifunctional CNCmachine. Document all changes, have the operating instructions updated accordingly and train machine operators.

1.13 Disconnecting and securing the CNC machine

Turn off the main switch of the CNC machine before starting any maintenance or repair work.

Use a padlock to prevent the switch from being turned on without authorization and keep the key in a safe place.

All machine parts as well as all dangerous voltages are switched off.

Only the positions which are marked with the pictogram on the side constitute an exception. These positions may be live even if the main switch is switched off.

Attach a warning sign on the CNCmachine.

Img.1-4: Warning sign

WARNING!

Live parts and machine part movements can lead to severe injury to you or others!

Proceed with extreme care if you cannot switch off
the CNC machine by turning off the main switch due to required works (e.g. functional control).

1.13.1 Using lifting equipment

WARNING!

The use of unstable lifting and load suspension equipment that might break under load can cause severe injuries or even death. Observe the accident prevention regulations issued by your Employers Liability Insurance Association or other supervisory authorities responsible for your company.

Check that the lifting equipment and load-suspension gears are of sufficient load capacity and are in perfect condition.

Fasten the loads properly.

Never walk under suspended loads!

1.13.2 Mechanical maintenance work

Remove or install protection safety devices before starting or after completing any maintenance work; these include:

- covers,
- safety indications and warning signs,
- earth (ground) connections.

If you remove protective or safety devices, re-fit them immediately after the completing the work.

Check if they are working properly!

1.14 Unattended Operation

CNC machines are designed to operate unattended. However, your machining process may not be safe to operate unmonitored. As it is the shop owner's responsibility to set up the machine safely and use best practice machining techniques, it is also their responsibility to manage the progress of these methods. The machining process must be monitored to prevent damage if a hazardous condition occurs.

For example, if there is the risk of fire due to the material machined, then you must install an appropriate fire suppression system to reduce the risk of harm to personnel, equipment and the building. Contact a specialist to install monitoring tools before machines are allowed to run unattended.

It is especially important to select monitoring equipment that can immediately perform an appropriate action without human intervention to prevent an accident, should a problem be detected.

1.15 Accident report

Inform your supervisors and Optimum Maschinen Germany GmbH immediately in the event of accidents, possible sources of danger and any actions which almost led to an accident (near misses).

There are many possible causes for "near misses".

The sooner they are notified, the faster the causes can be eliminated.

INFORMATION

We provide information about the specific dangers when working with and on theCNC machine in the descriptions for these types of work.

1.16 Electrical system

Have the machine and/or the electric equipment checked regularly. Immediately eliminate all defects such as loose connections, defective wires, etc.

A second person must be present during work on live components to disconnect the power in the event of an emergency. Disconnect the machine immediately if there is a malfunction in the power supply!

Comply with the required inspection intervals in accordance with the factory safety directive, operating equipment inspection DGUV, formerly BVG.

The operator of the machine must ensure that the electrical systems and operating equipment are inspected with regards to their proper condition, namely,

- by a qualified electrician or under the supervision and direction of a qualified electrician, prior to initial commissioning and after modifications or repairs, prior to recommissioning
- and at certain intervals.

The deadlines must be set so that arising, foreseeable defects can be detected in time.

The relevant electro-technical rules must be followed during the inspection.

The inspection prior to initial commissioning is not required if the operator receives confirmation from the manufacturer or installer that the electrical systems and operating equipment comply with the accident prevention regulations, see conformity declaration.

Permanently installed electrical systems and operating equipment are considered constantly monitored if they are continually serviced by qualified electricians and inspected by means of measurements in the framework of operation (e.g. monitoring the insulation resistance).

1.17 Inspection deadlines

Define and document the inspection deadlines for the machine in accordance with the Factory Safety Act and perform an operational risk analysis in accordance with the Work Safety Act. Also use the inspection intervals in the maintenance section as reference values.

1.18 Clamping devices for workpieces and tools

ATTENTION!

Attention when taking over the existing clamping devices. Pleased check critically if the clamping device is appropriate for your CNC machine.

- **Only use clamping devices which have a complete inherent stiffness.**
- **Contact the manufacturer of the clamping device regarding the reuse of the clamping devices after damages on the clamping devices due to collisions.**
- **Correctly insert the workpiece and make sure that the machine is proper working condition.**

1.19 Environmental protection and water conservation

The CNC machine is a device to produce, handle and use materials which are hazardous to water according the Water Resources Law.

When operating, decommissioning or disassembling the CNC machine or parts hereof, please follow the requirements of the Water Resources Law. Please find detailed information about this topic in the regulation about devices to treat materials which are hazardous to water.

2 Technical data

The following information are the dimensions and indications of weight and the manufacturer‘s approved machine data.

2.1 Electrical connection

Total connection	3 x 400V ~ 50Hz 25 kW
Cross section connection cable according to DIN 5710/VDE 0100	4 x 6 mm ^{2}
Fusing performed by the operator	32 A

2.2 Lubricant/coolant system

Power of the coolant/lubricant pumps [W]	1270
Delivery volume [l/min]	66-100
Tank capacity [l]	210

2.3 Compressed air supply

Connection [MPa]	0,5 - 0,7 (5 - 7 bar), fast locking coupling
Air consumption	0.1 - 0.15 m^3 / h at 0.6 MPa
Compressed air consumer	Tool changer forward / backward Tool clamp / unclamp Air purge
Recommended compressed air quality	ISO 8573.1 class 2

2.4 Dimensions

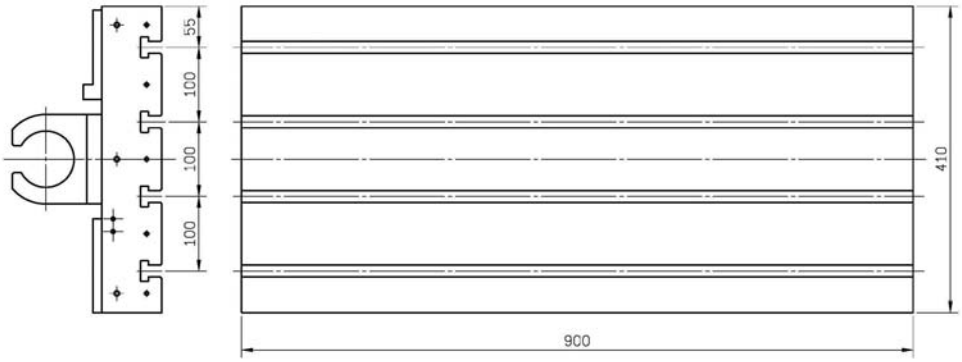
Height [mm]	☞ "Installation plan F150“ on page 30
Depth [mm]	
Width [mm]	
Total weight [kg]	about 3020
Load capacity of the substructure [kN/m^2]	16

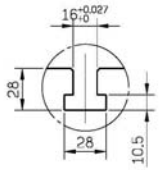
2.5 Working area

Height [mm]	3300
Depth [mm]	3900
Width [mm]	3200

2.6 Milling table

Table length [mm]	900
Table width [mm]	410
T - slot size / number / distance [mm]	16 / 4 / 100
Max. load [kg]	350





2.7 Feed drive axis

Type	NC servo motors
max. X feed [mm/min]	10000 (rapid traverse 24000)
max. Y-feed [mm/min]	
max. Z-feed [mm/min]	

2.8 Working area, traverse path

X-axis [mm]	760
Y-axis [mm]	430
Z-axis [mm]	460

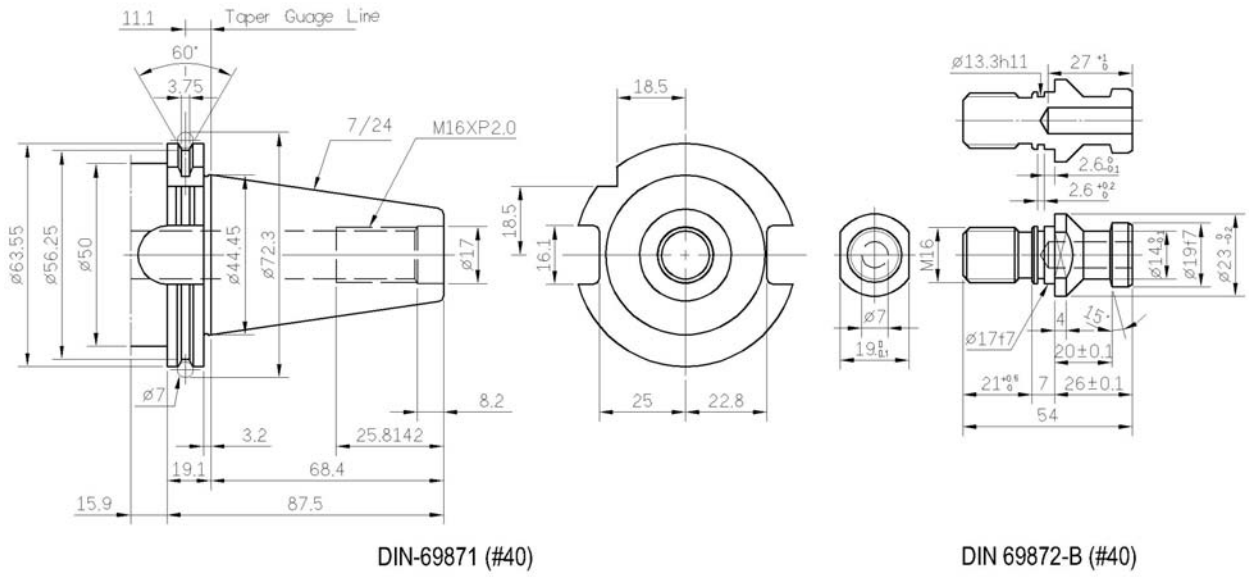
2.9 Standard tool changer carrousel

Max. number of tool places	16
max. tooling diameter [mm]	89
Max. tool weight [kg]	8
Cycle tool change (tool to tool) [sec.]	9

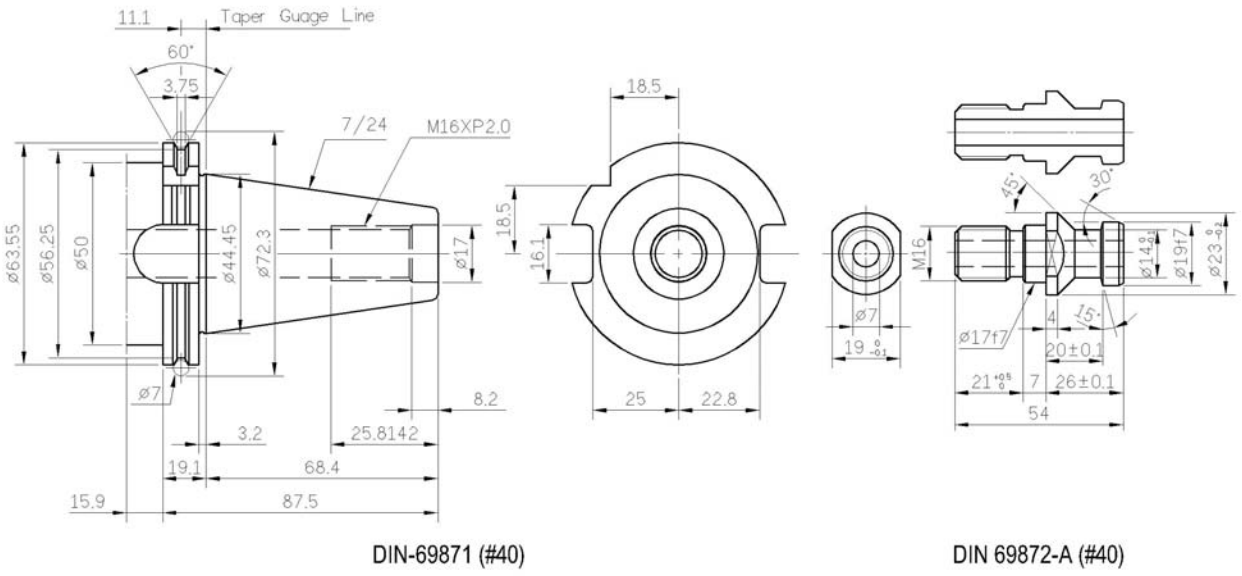
2.10 Optional tool changer double arm gripper

Max. number of tool places	24
max. tooling diameter [mm]	80
Max. tool weight [kg]	8
Cycle tool change (tool to tool) [sec.]	2

2.10.1 Standard milling spindle head

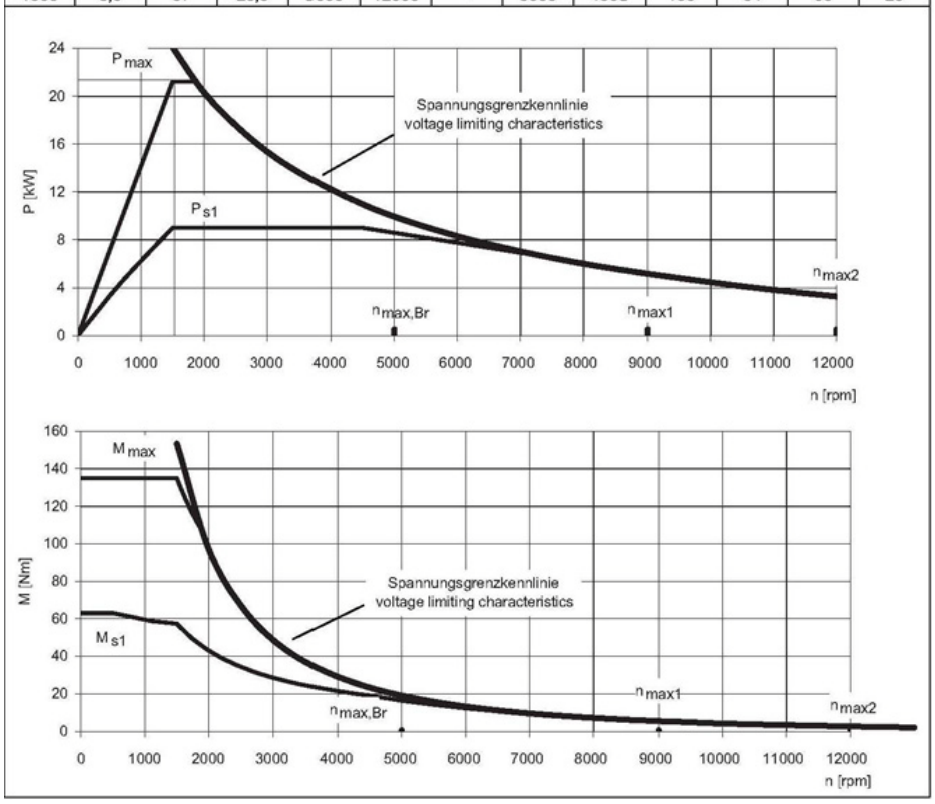
Spindle seat	
	
Speed range [min^{-1}]	10 -10000

2.10.2 milling spindle head with use of a CTS system

Spindle seat	
	
Speed range [min^{-1}]	10 -10000

2.11 Spindle capacity

n_N [rpm]	P_N [kW]	M_N [Nm]	I_N [A]	n_{max1} [rpm]	n_{max2} [rpm]	n_{max3} [rpm]	$n_{max, Br}$ [rpm]	n_2 [rpm]	M_{max} [Nm]	I_{max} [A]	M_0 [Nm]	I_0 [A]
1500	9,0	57	23,5	9000	12000	-	5000	4500	135	54	63	25



2.12 Environmental conditions- operation

Temperature	19 - 21 °C (for an optimum milling result) 19 - 21 °C (for operation without malfunctions)
Admissible relative humidity	5...80 % no condensation
Compressed air	700...1060 hPa

2.13 Environmental conditions - storage

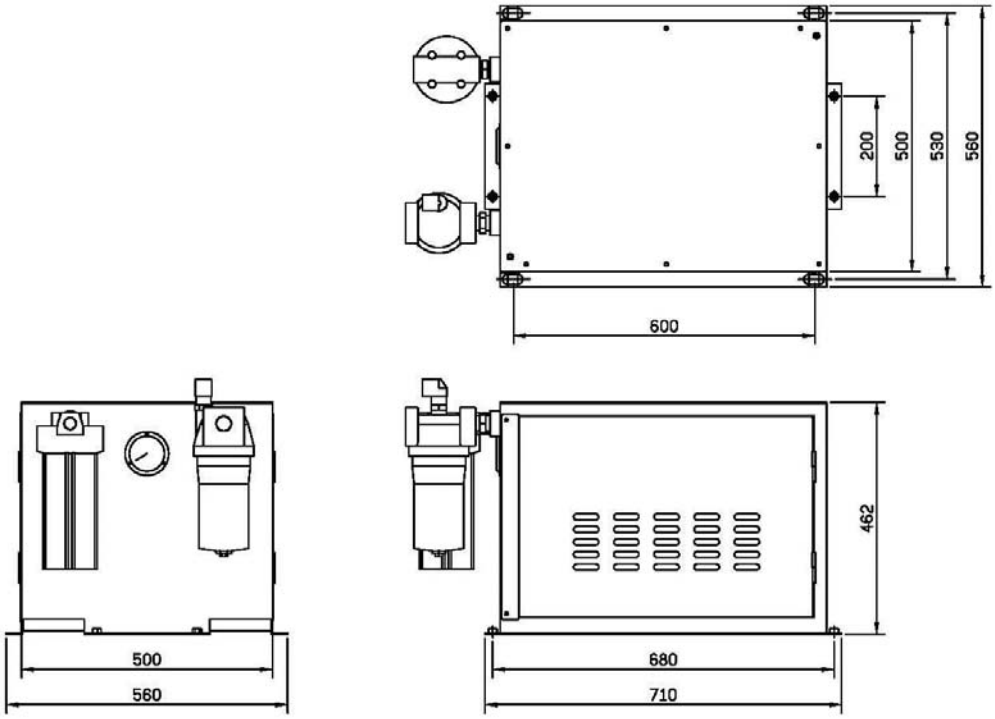
Temperature	5 - 45 °C

2.14 Optional coolant delivery through the spindle

CTS - C oolant T hroug S pindle

	Integrated unit	External unit	External unit
Item no.	351121008	351121009	351121003
Pump pressure	20 bar	20 bar	70 bar
Outlet filter	40µm	25µm	25µm
Pre filter pump	150µm	40µm	40µm
Tank capacity [liter]	-	165	

2.14.1 Dimensions integrated unit 20 bar

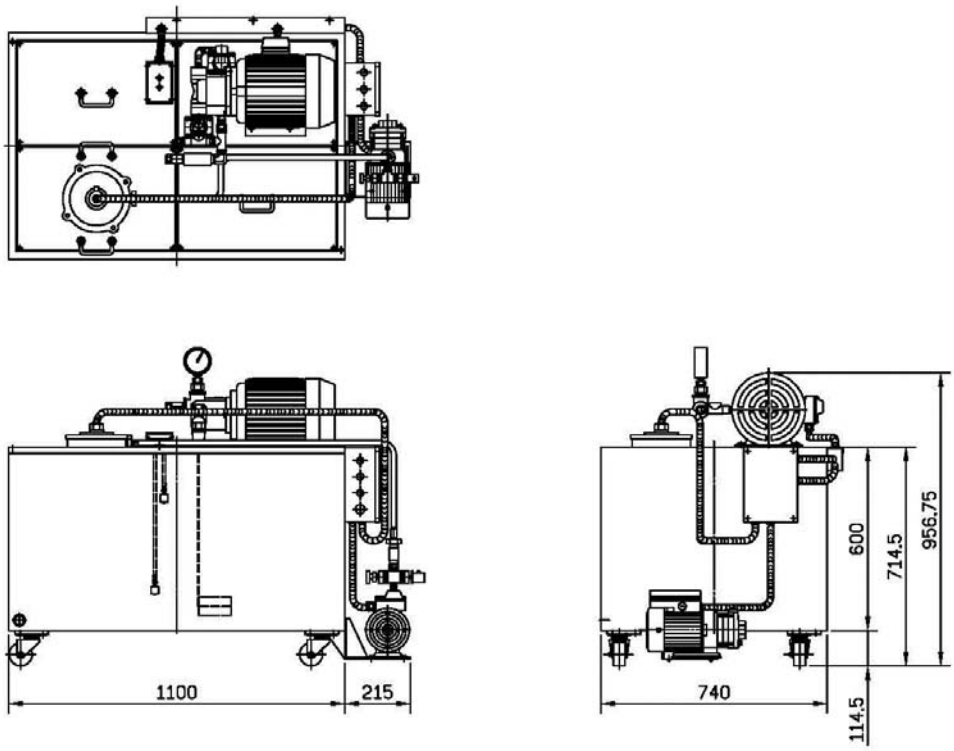


Img. 2-1: 351121008

INFORMATION

The integrated CTS unit is supplied with coolant from the coolant tank of the machine.

2.14.2 Dimensions external unit 20 bar and 70 bar



Img.2-2: 351121009 and 351121003

2.15 Emissions

The emission of the CNC machine is below 80 dB(A).
If the CNC machine is installed in an area where various machines are in operation, the noise exposure (immission) on the operator of the CNC machine at the working place may exceed 80dB(A).

INFORMATION

This numerical value was measured on a new machine under proper operating conditions. Depending on the age respectively on the wear of the machine it is possible that the noise behaviour of the machine changes.

Furthermore, the factor of the noise emission is also depending on manufacturing influencing factors, e.g. speed, material and clamping conditions.

INFORMATION

The specified numerical value is the emission level and not necessarily a safe working level.

Though there is a dependency between the degree of the noise emission and the degree of the noise disturbance it is not possible to use it reliably to determine if further precaution measures are required or not.

The following factors influence the actual degree of the noise exposure of the operator:

- Characteristics of the working area, e.g. size or damping behaviour,
- other noise sources, e.g. the number of machines,
- other processes taking place in proximity and the period of time during which the operator is exposed to the noise.

Furthermore, it is possible that the admissible exposure level might be different from country to country due to national regulations.
This information about the noise emission should, however, allow the operator of the machine to more easily evaluate the hazards and risks.

CAUTION!

Depending on the overall noise exposure and the basic threshold values the machine operators must wear appropriate hearing protection.

We generally recommend to use a noise protection and a hearing protection.

2.16 Tools and tool holding fixtures

CAUTION !

When using tools with larger diameters or at higher speeds!

The balancing of the tools has to amount to

- 0 - 6000 min $^{-1}$ - G 6,3
- from a speed of 6000 min $^{-1}$ - G 2,5

according to DIN / ISO 1940.

3 Assembly and commissioning

INFORMATION

The CNC machine is pre assembled. It is delivered in a transport box. After the unpacking and the transportation to the installation site it is necessary to mount and assemble the individual components of the CNC-machine.

3.1 Dimensions of the packing

	Length	Width	Height
Packaging F150	2540	2250	2380

3.2 Scope of delivery

Compare the delivery volume with the delivery note.

Check the status of theCNC machinesaw immediately upon receipt and claim possible damages at the last carrier also if the packing is not being damaged. In order to ensure claims towards the freight carrier we recommend you to leave the machines, devices and packing material for the time being in the status at which you have determined the damage or to take photos of this status. We would like to ask you to inform us about any other claims within six days upon receipt of the delivery.

Check if all parts are firmly seated.

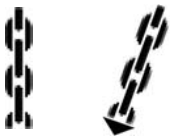
3.3 Transport

WARNING!

Severe or fatal injuries may occur if the machine or parts of the machine tumble or fall down from the forklift truck or from the transport vehicle. Follow the instructions and information on the transport crate.

- **Centres of gravity**

- **Load suspension points (Marking of the top surface - arrows pointing to the top)**



- **Prescribed transportation position (Marking of the top surface)**

- **Means of transport to be used**
- **Weights**

WARNING!

The use of unstable lifting and load suspension equipment that might break under load can cause severe injuries or even death.

Check that the lifting and load suspension gear has sufficient load capacity and that it is in perfect condition.

Observe the accident prevention regulations.

Fasten the loads properly.

Never walk under suspended loads!

3.4 Storage

ATTENTION!

In case of wrong and improper storage, electrical and mechanical machine components might get damaged and destroyed.

Store packed and unpacked parts only under the intended environmental conditions.

Follow the instructions and information on the transport crate.

- **Fragile goods**
  (Goods require careful handling)

- **Protect against moisture and humid environment**

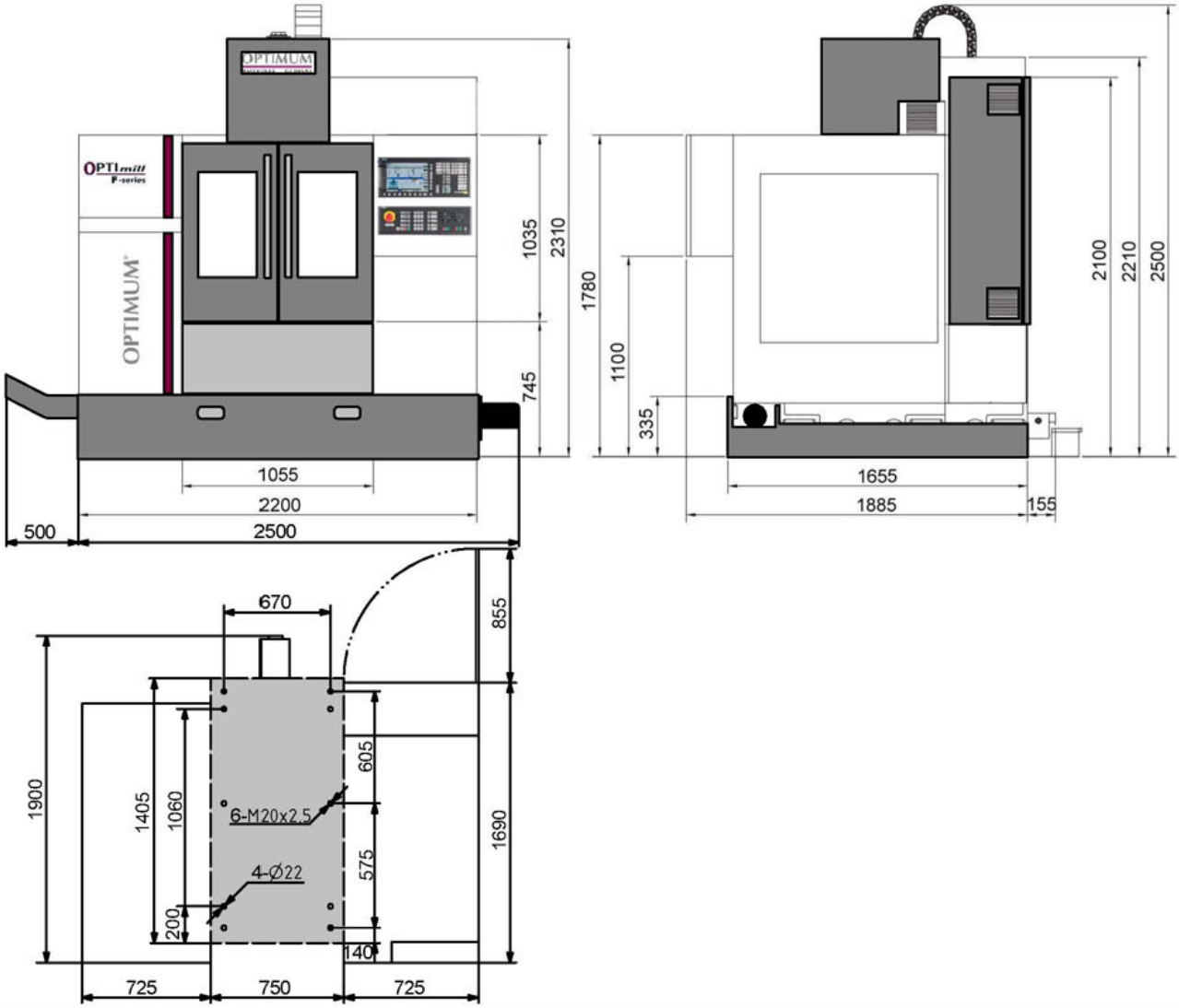
- **Prescribed position of the packing case (Marking the top surface - arrows pointing to the top)**

- **Maximum stacking height**

  Example: not stackable - do not stack a second packing case on top of the first packaging case

Consult Optimum Maschinen Germany GmbH if the CNC machine and accessories are stored for more than three months or are stored under different environmental conditions than those specified here. ☞ "Environmental conditions - storage“ on page 25

3.5 Installation plan F150



Img. 3-1: Installation plan

3.6 Requirements regarding the installation site

Organize the working area around the CNC machine according to the local safety regulations.

The working area for operating, maintenance and repair must not be hindered. Follow the prescribed safety areas and escape routes according to VDE 0100 part 729 as well as the environmental conditions for the operation of the CNC machine.

INFORMATION

The mains plug of the CNC machine must be freely accessible.

3.7 Transportation to the installation site

ATTENTION!

The CNC machine is lifted and transported at the machine substructure or at the load suspension points using an appropriate conveyor system.

➜ Check the substructure. The substructure has to bear the load. ☞ "Load capacity of the substructure [kN/m2]“ on page 21

ATTENTION!

Make sure that the load attachment point is balanced (Centre of gravity).

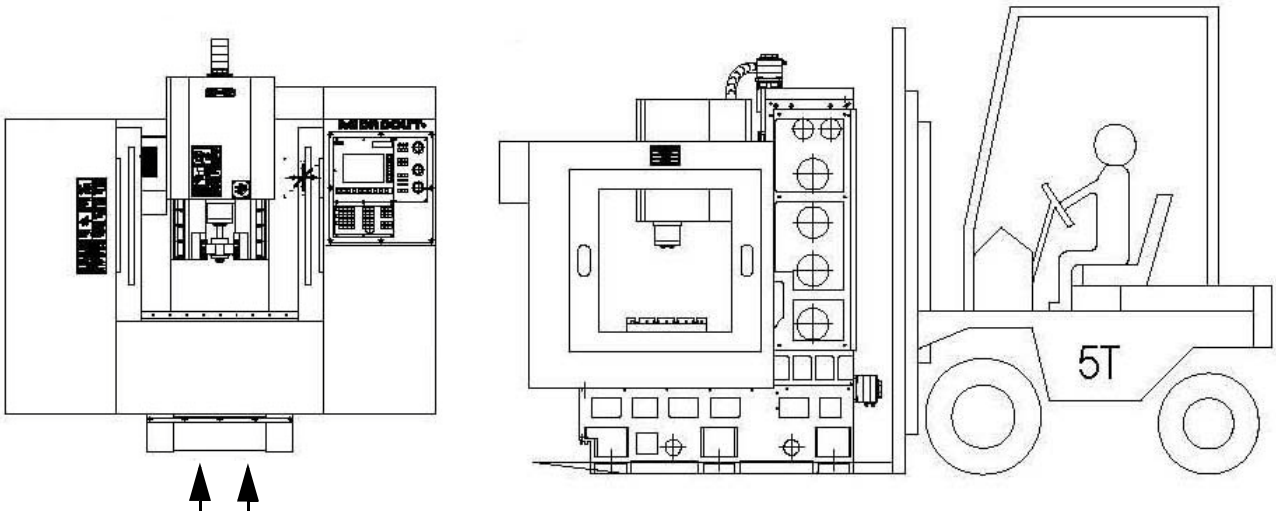
➜ Disassemble the clamping bolts which are used to fix the machine on the pallet.

➜ Lift the CNC machine carefully from the pallet of the transportation box by means of a crane or a fork-lift truck.

WARNING!

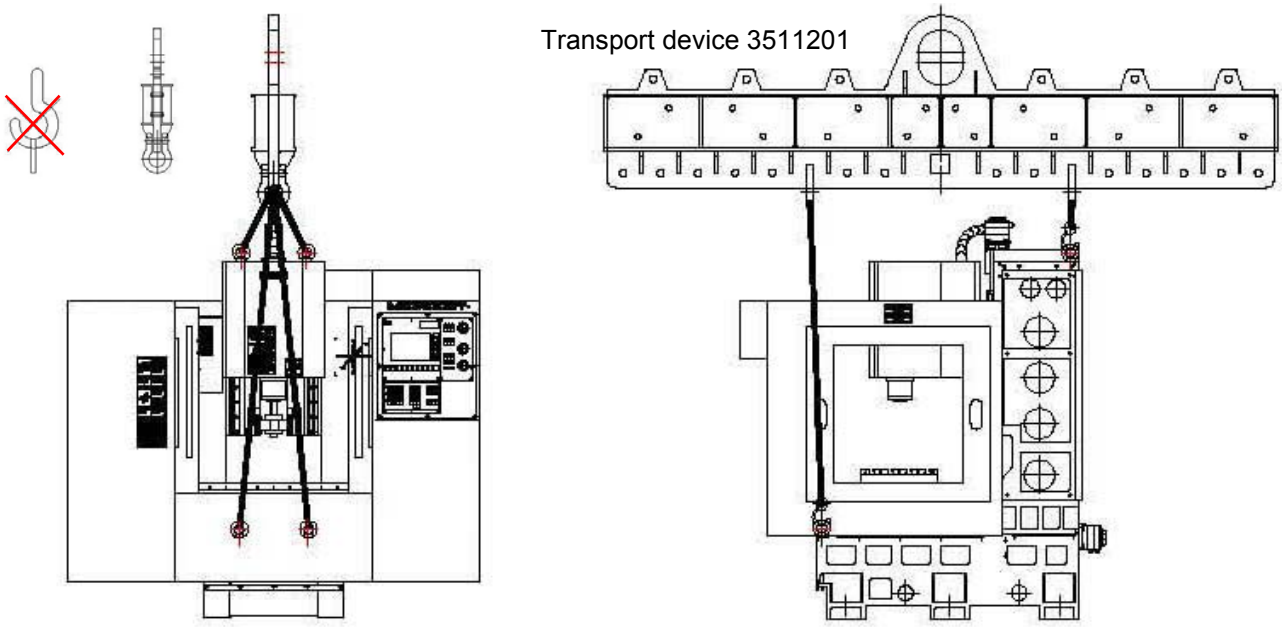
The use of unstable lifting and load suspension equipment that might break under load can cause severe injuries or even death.

3.7.1 Forklift truck



Img. 3-2: Transporting by fork-lift truck

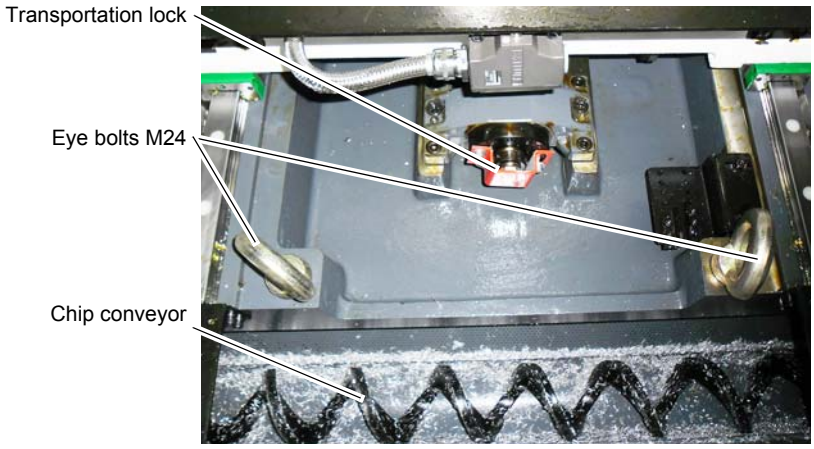
3.7.2 Crane



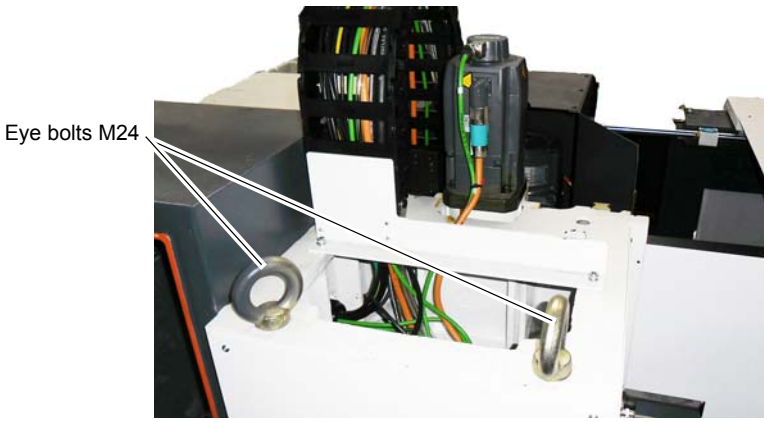
Img. 3-3: Transporting by crane

If not yet available you must mount four ring bolts at the provided load application points on the machine substructure and on the column.

➜ Attach the transport device, item no. 3511201 on the crane.



Img. 3-4: Load suspension point machine substructure



Img. 3-5: Load suspension point (column)

➜ Fix the load suspension gear (e.g. lifting slings) on the four ring bolts of the machine sub-structure and of the column. ☞ "Total weight [kg]“ on page 21.

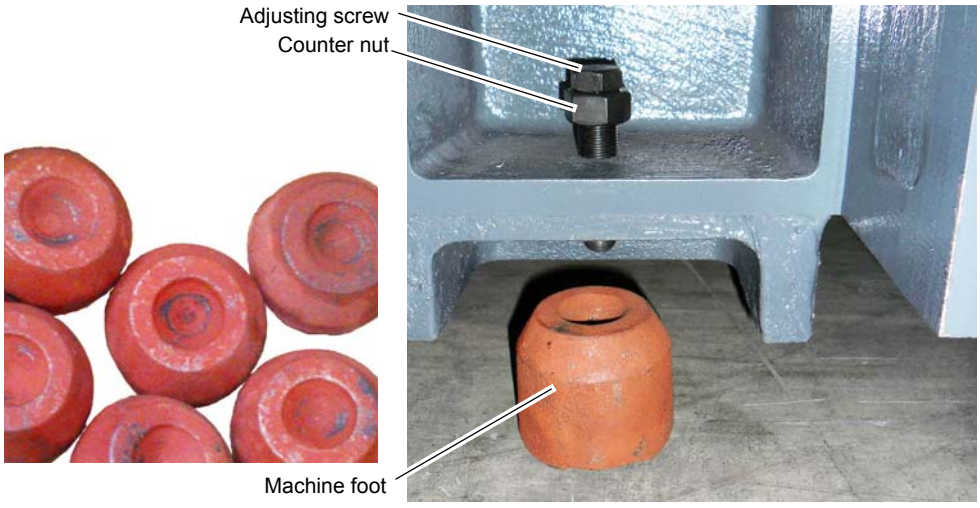
WARNING!

There must be no inclined traction due to the load suspension gear.
Img.3-3: “Transporting by crane“ on page 32

3.8 Installation and assembly

➜ Position the machine feet included in the delivery volume below the adjusting screws of the machine substructure.

➜ Align the CNC machine with a machine spirit level.



Img.3-6: Machine feet

3.8.1 Aligning the machine

➜ Align the CNC machine on the machine bed by means of a machine spirit level. Use the set screws in order to perform the required height levelling.

➜ The slope deviation of all levels must not exceed 0.03/1000mm.

ATTENTION!

An insufficient rigidity of the substructure leads to superposition of vibrations between the multifunctional CNC machine and the substructure (natural frequency of the components). Critical speeds and moves in the axis with displeasing vibrations are rapidly achieved in case of insufficient rigidity of the whole system and will lead to bad milling results.

➜ Check the correct alignment of the machine after a few days of usage.

➜ Fix by means of adjusting screws.

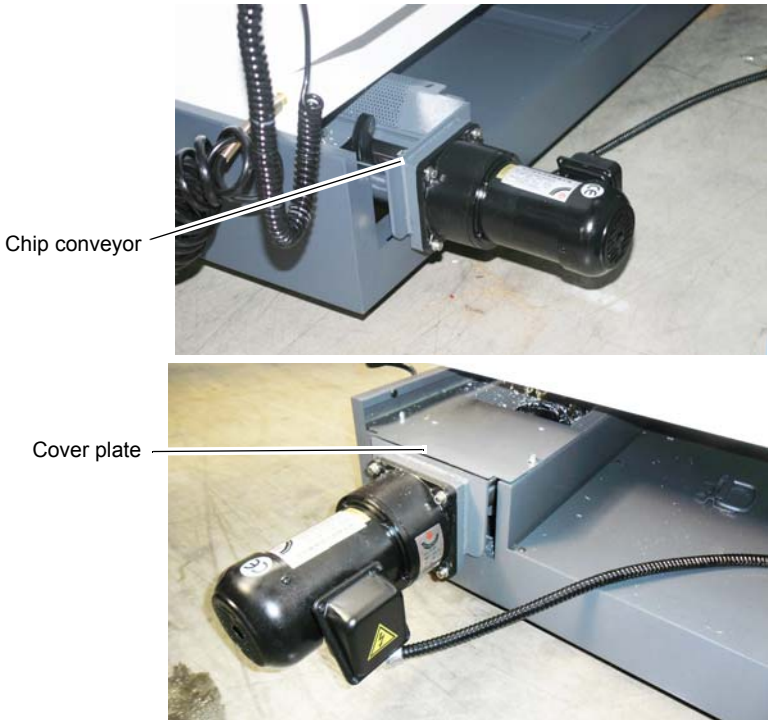
3.8.2 Assembly of the coolant / lubricant tank and of the chip conveyor

➜ Push the coolant / lubricant tank below the CNC machine.

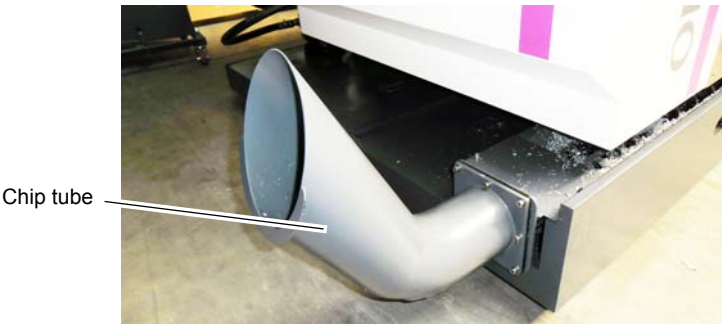
Img.3-7: Mounting the coolant / lubricant tank

➜ Make sure that the coolant / lubricant tank is correctly aligned underneath the CNC machine.

➜ Mount the chip conveyor incl. cover plate.



Img.3-8: Chip conveyor with drive motor



Img.3-9: Chip conveyor ☞ "Späneförderer - Chip convejor“ on page 135

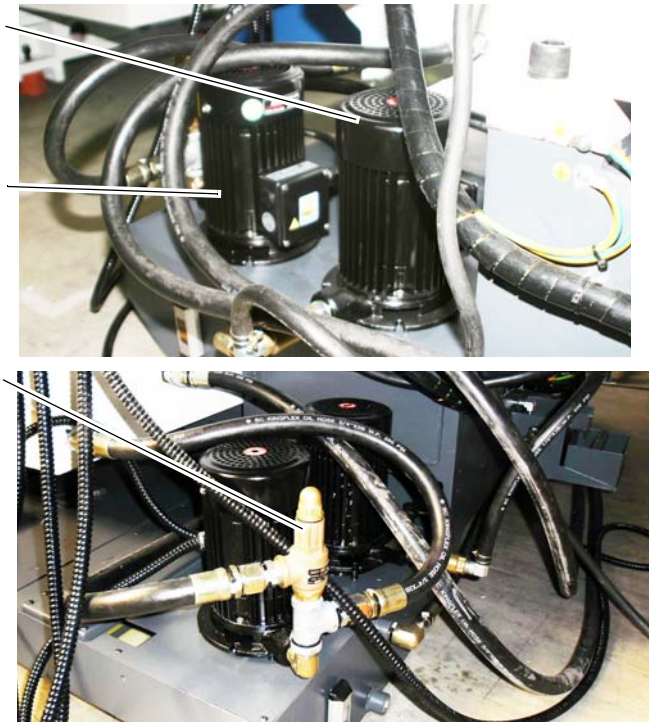
3.8.3 Assembly of the coolant / lubricant pumps

➜ Position the three coolant / lubricant pumps in the corresponding seat of the coolant / lubricant tray. Screw down the coolant / lubricant pumps on the coolant / lubricant tray.

Pump spindle cooling
Img.3-13: “Spindle cooling“ on page 36

Pump cleaning gun
Img.3-15: “Cleaning gun“ on page 37

Pressure reduction valve
Pump cleaning gun



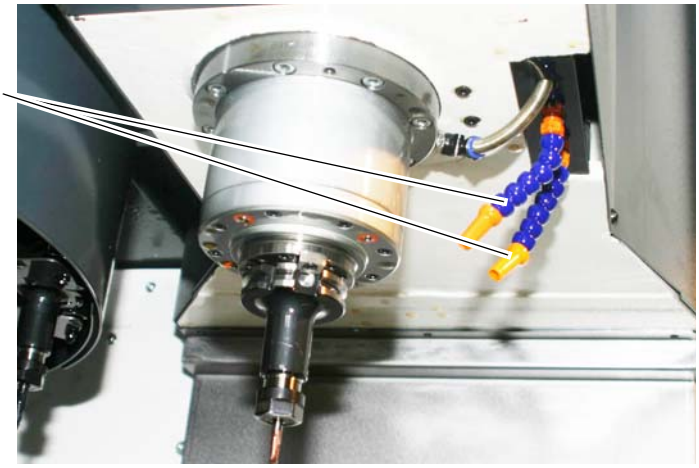
Img.3-10: Coolant / lubricant pumps

Pump chip flushing
Img.3-14: “Chip flushing“ on page 36

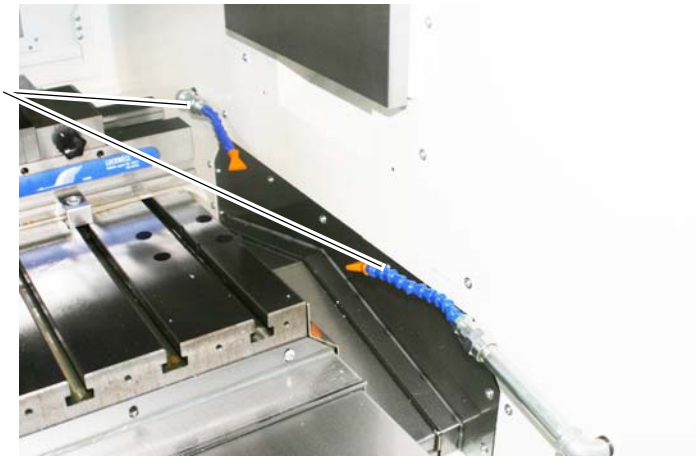
Img.3-11: Coolant / lubricant pumps

➜ Mount the coolant / lubricant hoses of the cooling lubricant equipment. The connections of the coolant / lubricant hoses have a designation, parts with the same designation belong together.

Img.3-12: Coolant lubricant hoses

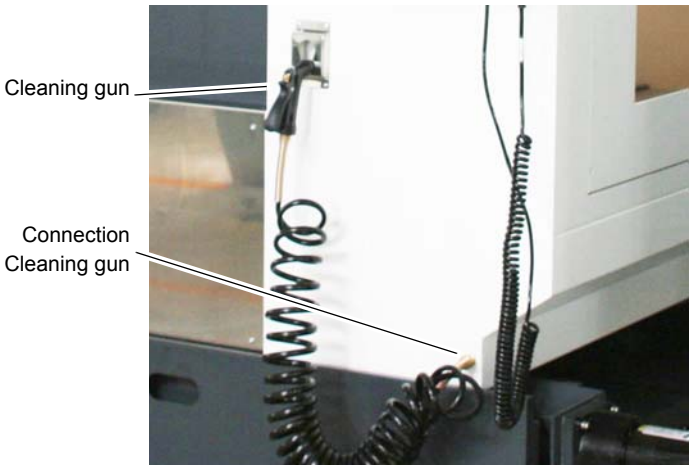


Img.3-13: Spindle cooling



Img.3-14: Chip flushing

➜ Mount the spiral hose incl. the cleaning gun.



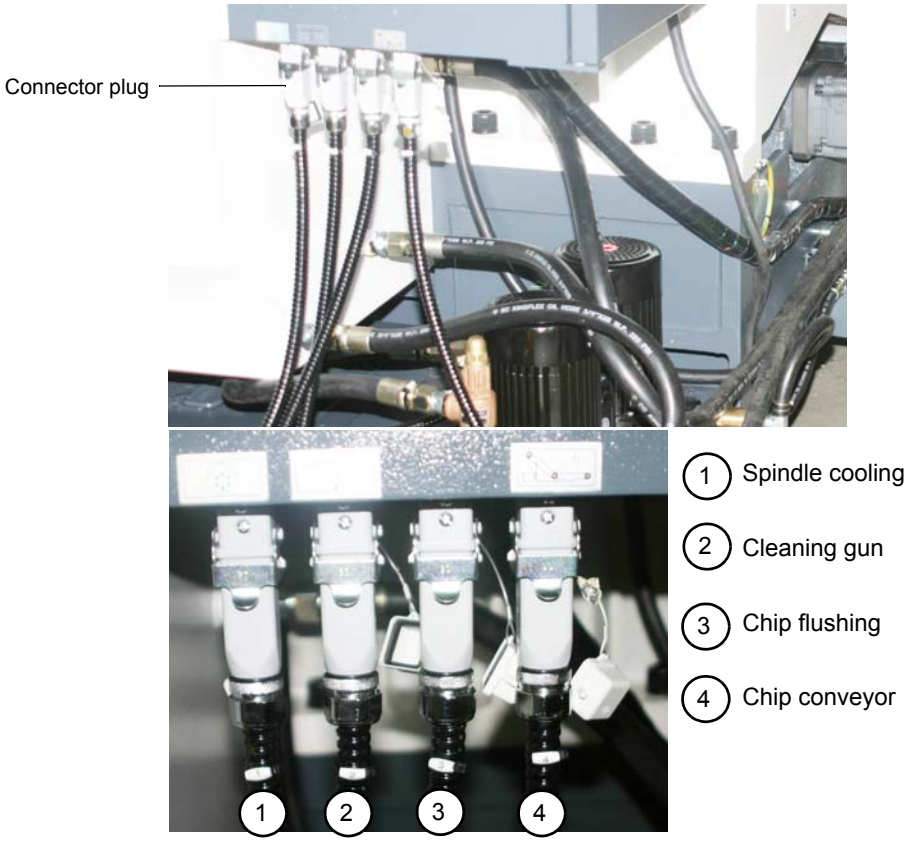
Img. 3-15: Cleaning gun

➜ Mount the oil separator of the coolant / lubricant tank.

Img. 3-16: Oil separator of the coolant / lubricant tank type 1

Img. 3-17: Oil separator of the coolant / lubricant tank type 2

➜ Connect the connector plugs of the coolant / lubricant pumps and of the chip conveyor, as well as the coolant / lubricant hoses of the coolant / lubricant tank. Make sure that the plug connections are correctly connected.



Img.3-18: Connector plug

3.8.4 Mounting the optional coolant through spindle

CTS - **C**oolant **T**hrough **S**pindle

ATTENTION!

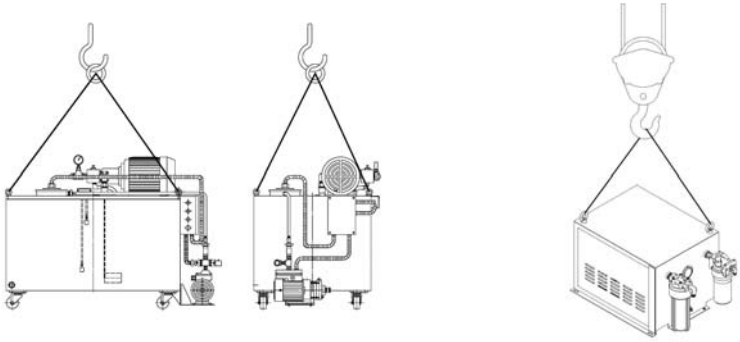
CTS the external system can be used only with a specific mixing ratio of the refrigeration lubricant. Use only a mixing ratio oil / water of 1/4

The CTS unit can be placed anywhere on the floor.

CAUTION!

Make sure for a balanced load stop, especially if coolant is still in the external unit.

Transport CTS unit

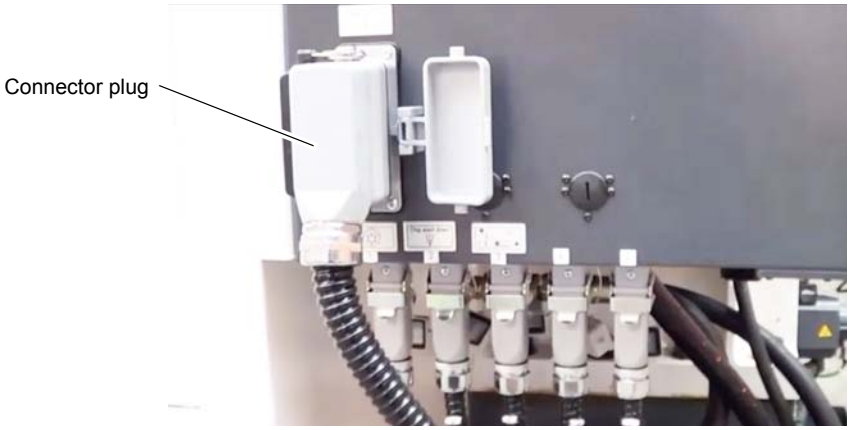


Img. 3-19: external unit internal unit

➜ Connect the connector of the external cooling unit.

➜ Check if the pump motor is turning in the correct rotation direction.

➜ Mount the coolant hoses. The connections of the coolant / lubricant hoses have a designation, parts with the same designation belong together.



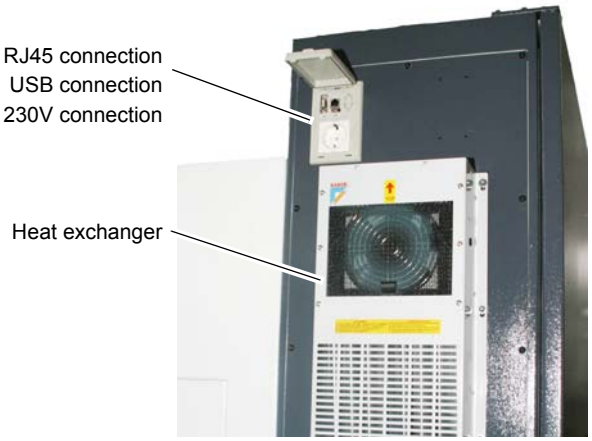
Img. 3-20: Connecting plug CTS unit

3.8.5 Mounting the heat exchanger on the switch cabinet

➜ Mount the heat exchanger onto the switch cabinet - if it had been disassembled since it is transported. Connect the heat exchanger into the switch cabinet to ~230V.

ATTENTION!

This work must only be performed by an electrical specialist. The guarantee will become null and void if the machine is wrongly connected!



Img.3-21: Heat exchanger on the switch cabinet

3.8.6 Mounting the electronic handwheel

➜ Mount the connection cable of the handwheel on the operating panel of the CNC machine

Img.3-22: Electronic handwheel

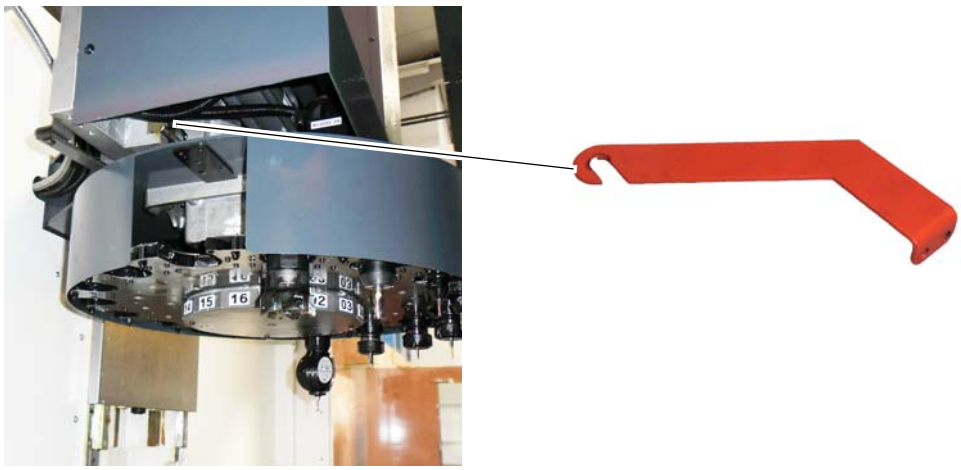
3.9 Transport locking devices

ATTENTION!

The machine is equipped with transport locks. Before performing the electrical connection it is necessary to remove the transport locks.

The transport locking devices are positioned on the axis, doors and tool changer.

3.9.1 Transport locking device, 16-type tool changer



Img. 3-23: Transport locking tool changer.

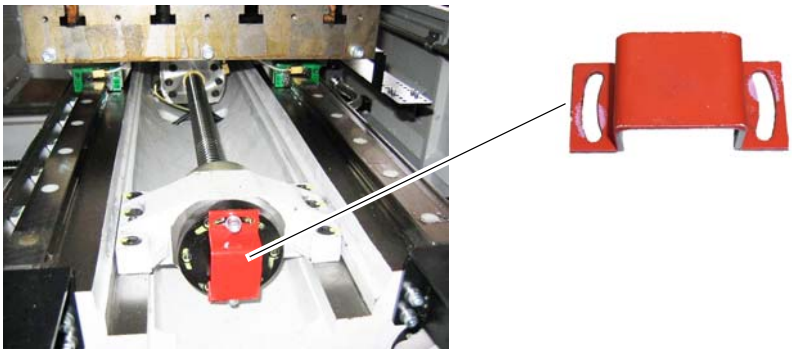
3.9.2 Transport locking device, doors

➜ Remove the transport lockings from the doors.

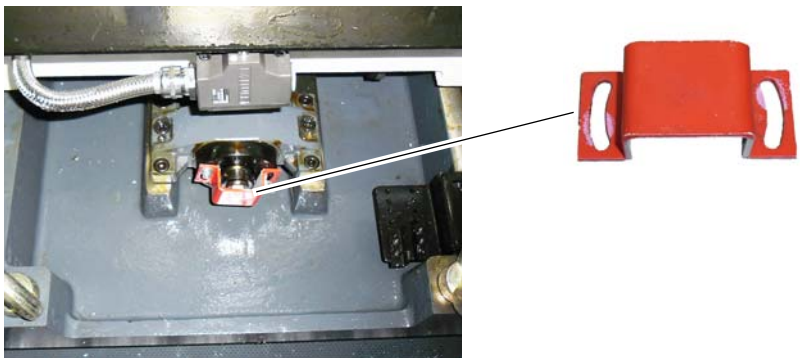
Img. 3-24: Transport locking door

3.9.3 Transport locking device, axes

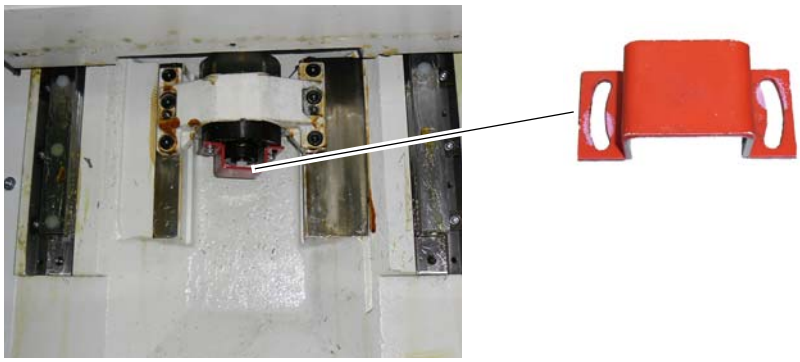
➜ Remove the transport lockings on the 3 axes X Y Z.



Img. 3-25: Transport lock X-axis



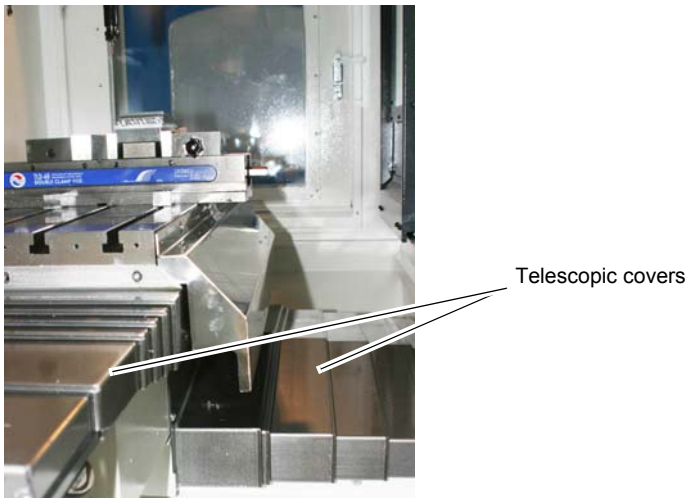
Img. 3-26: Transport lock Z-axis



Img. 3-27: Transport lock Y-axis

3.9.4 Mounting the telescopic covers

➜ Mount the telescopic covers on the axis.



Img. 3-28: Telescopic covers milling table

☞ "Frästisch - Milling table 2- 2“ on page 127

3.9.5 Corrosion protection

WARNING!

Observe the corresponding safety data sheet of your supplier when using methylbenzene

A corrosion protection is applied on the machine table and on the guiding surfaces for transport and storage. Remove the anti-corrosive agent from the CNC machine before first commissioning. To do so, use hard coal oil or methylbenzene, EU identification number 601-021-00-3 , CAS number 108-88-3. Have the medium react for about 15 minutes. The anticorrosive agent soaks and then it may be easily removed.
Methylbenzene, also called toluene, is a colourless, typically smelling volatile liquid which is similar to benzene in many respects. Toluene is an aromatic hydrocarbon, it often replaces the toxic benzene as solvent. Among others it is also included in petrol.

3.9.6 Electrical connection

ATTENTION!

Observe the rotating field!

☞ **"Warming up the machine“ on page 48**

The guarantee will become null and void if the machine is wrongly connected!

ATTENTION!

This work must only be performed by an electrical specialist. The guarantee will become null and void if the machine is wrongly connected!

☞ "Qualification of personnel“ on page 11

Firmly connect the CNC machine to the terminal box. It is not allowed to connect the machine using a standard 32 A CEE plug, since the stray current of the frequency converter is exceeding the admissible value of 3.5mA (refer to EN 50178 / VDE 5.2.11.1).

ATTENTION!

Under extreme circumstances and depending on the quality of the network it may lead to interferences caused by the machine. If necessary and in order to exclude retroactive effects on the internal power supply system, the operator should install a line filter on the machine. Therefore, at working places where lots of powerful consumers are connected it might also be necessary to use a system for network compensation. Please also request your electricity supplier for this purpose.

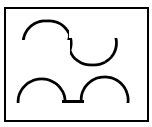
ATTENTION!

Frequency converter (drive regulator) might release the FI protected switch of your electrical supply. In order to avoid malfunction, you either need an FI protected switch sensitive for pulse current or AC/DC sensitive.

In case of malfunction or release of the FI protected switch, please check the installed type.

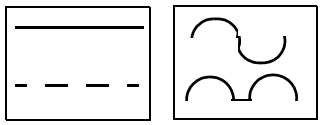
The following signs indicate if your machine is equipped with one of the FI protected switches described above.

FI protected switch sensitive for pulse current
Type A



300 mA

F protected switch sensitive to AC/DC
Type B



300 mA

Img.3-29: Symbols FI protected switch

We recommend you to use an FI protected switch sensitive to AC/DC. FI protected switches sensitive to AC/DC (RCCB, type B are adequate for 1-phase and 3-phase fed frequency converters (driving regulator).

An FI protected switch type AC (only for alternating current) is not appropriate for frequency converters. FI protected switches type AC are no longer used.

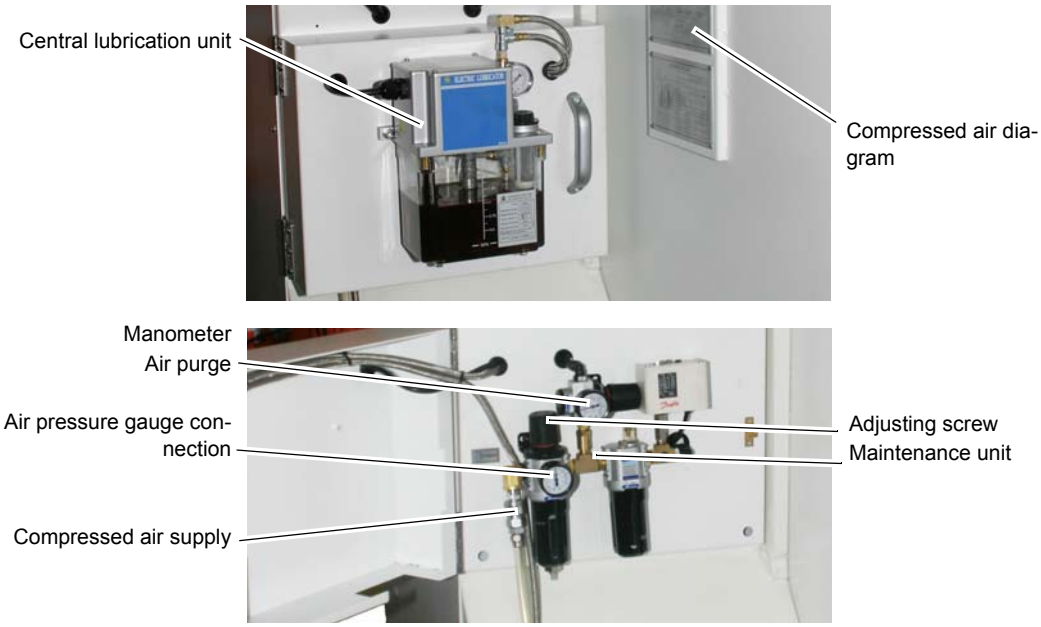
3.9.7 Connection compressed air supply

The compressed air maintenance unit is positioned behind the central lubrication unit.

➜ Open the cover on which the central lubrication unit is located.

➜ Connect the compressed air supply with at least 6.5 bars to the quick-action coupling of the compressed air maintenance unit.

➜ Adjust a pressure of 6.3 bars using the set screw of the maintenance unit.

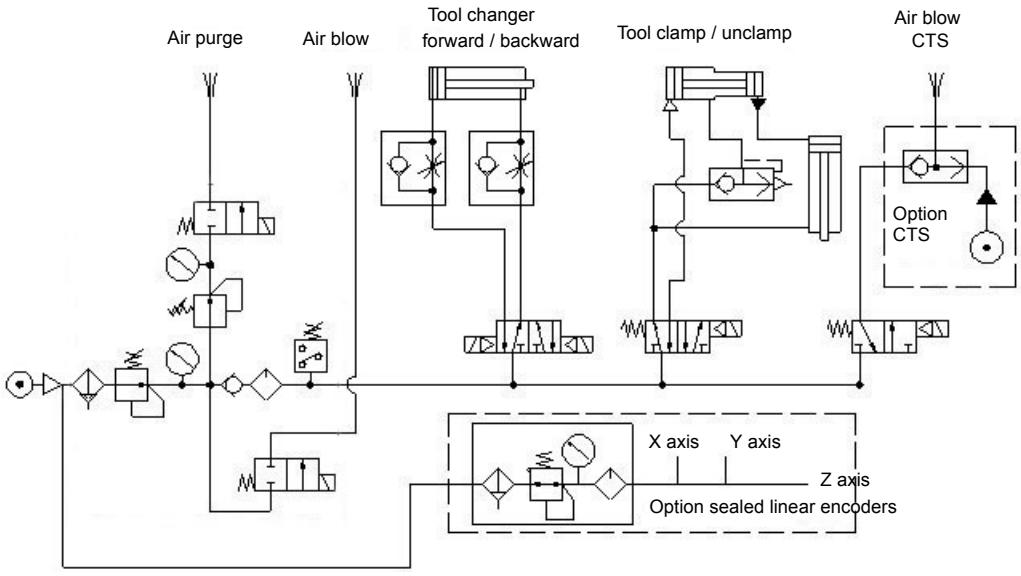


Img. 3-30: Compressed air maintenance unit

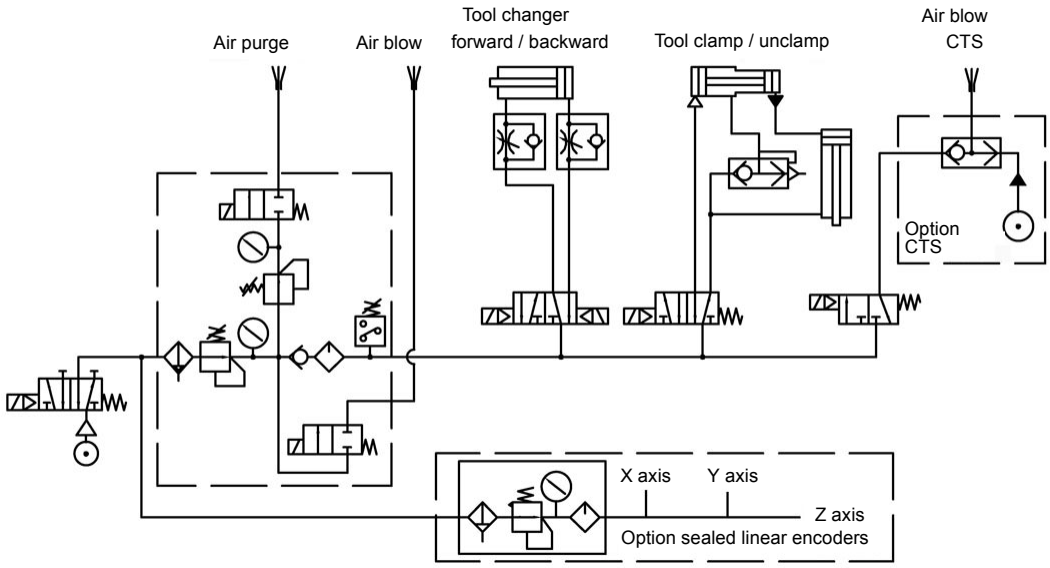
ATTENTION!

In order to ensure a failure-free operation of the machine it is necessary that the required air pressure is continuously applied on the machine at constant quality. In case of insufficient air supply, for instance interruptions occur during tool change.

☞ "Air consumption“ on page 21



Pneumatic diagram from year of construction 2014



3.10 First commissioning

3.10.1 Fill up coolant

INFORMATION

The CNC machine is delivered without cooling lubricant.

➜ Fill the coolant / lubricant tank with an appropriate cooling lubricant via the machining room CNC machine. ☞ "Cooling lubricants“ on page 93

Img. 3-31: Level indicator coolant / lubricant

ATTENTION!

Failure of the pumps in case of dry running. The pumps are lubricated by means of the cooling lubricant. Do not start up the pumps without cooling lubricant.

INFORMATION

Use a water soluble environmentally compliant drilling emulsion as cooling lubricant procured from the specialised trade.

Make sure that the cooling lubricant is properly absorbed.

Respect the environment when disposing of any lubricants and coolants. Follow the manufacturer's disposal instructions.

☞ **"Cooling lubricants and tanks" on page 108**

3.11 Refill central lubrication system

The CNC machine is equipped with a central lubrication system.

INFORMATION

The CNC-milling machine is delivered without lubricating oil.

➜ Fill the tank with lubricating oil via the filler hole.

☞ "Cooling lubricants" on page 93

☞ "Adjusting the amount of oil at the central lubrication" on page 116

Img. 3-32: Central lubrication system

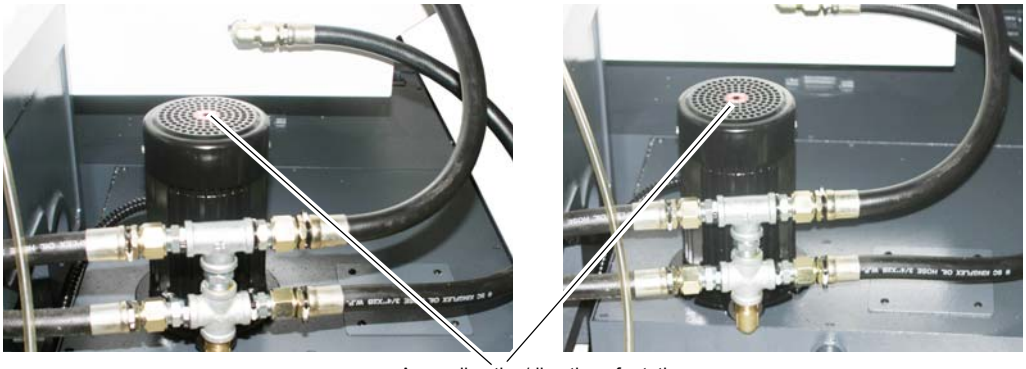
3.11.1 Functional test and controls

➜ Check the direction of rotation of the CNC machine. There must be a right-handed rotating field. If the direction of rotation is wrong, exchange two of the three phase conductors. At this, the correct direction of rotation only refers to the drive of the cooling lubricant pumps.

Proceeding to set the direction of rotation:

➜ Change over to the TSM mode "M8" or press the key.....

➜ Observe the arrow direction resp. the direction of rotation of the cooling lubricant pump.



Img. 3-33: Arrow direction/direction of rotation of the cooling lubricant pump

➜ If the coolant / lubricant pump turns anticlockwise it is necessary to switch off the machine and to have two of three phases (e.g. L1 and L2) exchanged by an electrical specialist!

➜ Check all oil levels and filling levels of lubricants in the reservoirs.

➜ Perform a safety test.

3.11.2 Warming up the machine

ATTENTION!

If the CNC machine and in particular the milling spindle are immediately operated at maximum load when cold, this may result in damages.

If the machine is cold, e.g. directly after having transported the machine, it should be warmed up at a spindle speed of only 500 1/min for the first 30 minutes.

3.11.3 Passwords

Upon delivery the control SINUMERIK 828 D is protected with a password. In order to be able to change parameters and data of the control it is necessary to enter a password. ☞ "Key switch“ on page 69

➜ Press the following keys (refer to figure) to change the password.

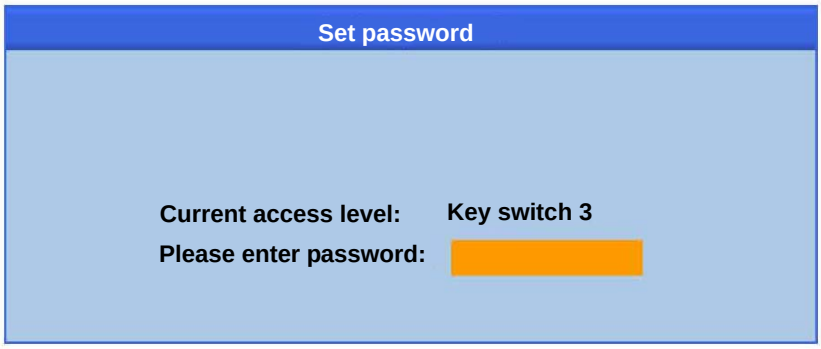
➜ Note down the passwords. In case of service these passwords are needed. In case of non existing passwords during servicing the servicing has to be interrupted at cost of the operator.

➜ Please also observe ☞ "access stage“ on page 69

INFORMATION

This illustration is an excerpt of the SINUMERIK 828D "Service documentation" of the company Siemens.

A dialogue box is opened, this box shows the current access level and allows a password to be entered using the keyboard.



After typing the password it is confirmed by pressing the „OK“ soft key.

Img. 3-34: Access stage

Please also refer to ☞ "Control technical protection“ on page 15 .

3.11.4 Data backup on the control

INFORMATION

The CNC control only provides a "transient working memory" for its internal machine programs losing its contents at the latest after 3 weeks.

For this reason it is imperatively necessary to perform a data backup after commissioning the machine respectively the machine control.

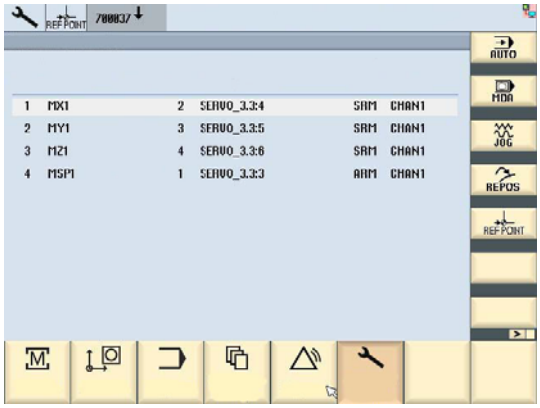
Furthermore, it is recommended to repeat this data backup in regular intervals.

Every eight hours the preset maintenance plan of the machines will remind you of performing a data backup.

To perform the data backup please proceed as follows:

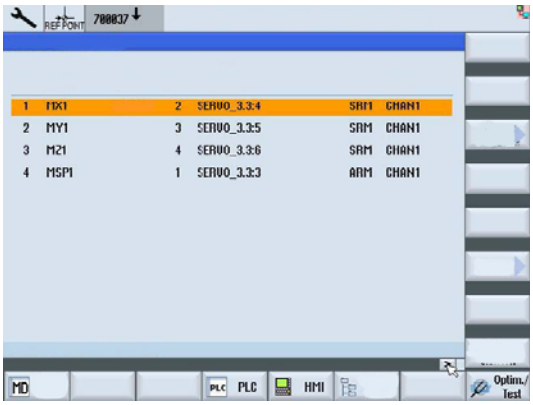
➜ Press the button "Menu select".

➜ Press the button "Start up".



Img. 3-35: Menu commissioning

➜ Then select the menu item "data backup" and follow the instructions.



Img. 3-36: Menu data backup

4 General information about CNC

4.1 Compensation of geometry

It is necessary to be able to measure any currently actual position of the CNC-controlled axis in order to perform tool moves on workpieces.The measured value is related to a machine fixed zero position and is compared to the target position which is predefined by the programs.

Required knowledge:

- coordinate systems of the machine and workpiece
- reference points of the machine, tool and workpiece
- type of distance measurement
- options of dimensioning and dimension compensation

Basics:

For chip removal relative moves between the tool and the workpiece are required. For programming all moves are related to the resting workpiece.

4.2 Coordinate systems on CNC machine tools

Types of coordinate systems

Coordinate systems allow the exact description of all points on a working plane, respectively in an area.

Generally they are divided into

- Cartesian coordinate system and
- the polar coordinate system

4.2.1 Cartesian coordinate system

A Cartesian coordinate system also called a rectangular coordinate system possesses two coordinate axes (two-dimensional Cartesian coordinate system) or also three coordinate axes (three-dimensional Cartesian coordinate system) which are perpendicular to one another in order to exactly describe the points.

On a two-dimensional Cartesian coordinate system, e.g. on the X, Y-coordinate system, each point is clearly defined on the plane by indicating the coordinates (X,Y).

The distance from the Y-axis is called the X-coordinate and the distance from the X-axis is called Y-coordinate. Those coordinates may possess positive or negative algebraic signs.

The three-dimensional Cartesian coordinate system is required to display and determine the position of special workpieces, e.g. milling parts.

In order to clearly describe a point in the space, three coordinates are required which are named according to the corresponding axes X-, Y- or Z-coordinates.

Such three-dimensional coordinate systems with positive and negative areas on the coordinate axis allow the exact description of any locations, e.g. in the working area of a CNC milling machine, independent from where the workpiece datum is set.

4.2.2 Polar coordinate system

In the Cartesian coordinate system a point is described by e.g. its X- and Y-coordinate. For rotation-symmetric outlines, e.g. circular drilling images the required coordinates can only be calculated with considerable effort.

In the polar coordinate system a point is described by means of its distance (radius r) to the coordinate origin and its angle (a) to the defined axis. The angle (a) is related to the X-axis of the X, Y coordinate system. In opposite direction it is negative.

4.2.3 Machine coordinate system

The machine coordinate system of the CNC- machine tool is determined by the manufacturer. It cannot be changed. The position of the origin point for the machine coordinate system, also called machine zero point cannot be changed.

Any tool moves are generally defined in a standardized, right-handed coordinate system.

Turns from +X to +Y are created in +Z direction, which result in a right-handed screw.

Z- axis:

According to the standard it is equal to the working spindle or continues in positive direction starting from the workpiece.For milling it continues directed to the spindle perpendicular on the clamping surface (only for perpendicular milling machines) for several spindles one main spindle is determined.

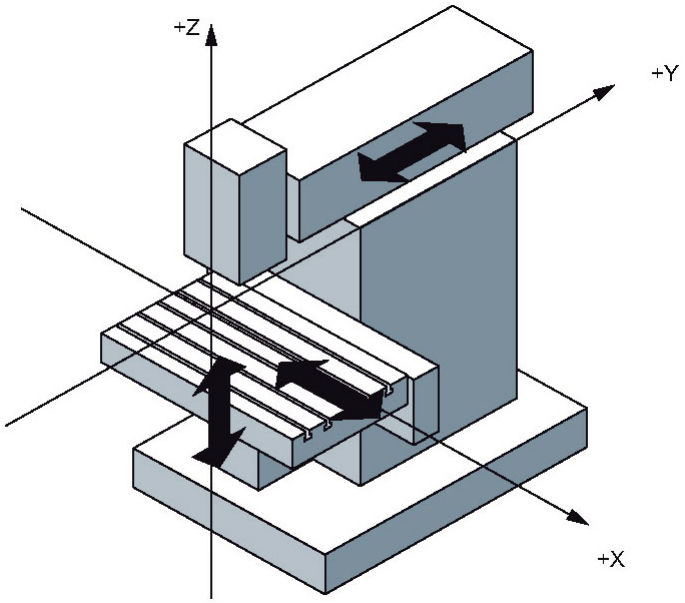
X- axis:

Continues horizontally and parallel to the clamping surface

for vertical Z-axis: +X to the right

for horizontal Z-axis: +X to the left

.



Img.4-1: Vertical Z-axis

Y- axis:

At a right angle to the Z- and X- axis in a way that a right-handed coordinate system is resulting

4.2.4 Workpiece coordinate system

The workpiece coordinate system is determined by the programmer. It can be changed. The location of the origin point for this workpiece coordinate system, also called workpiece origin point is generally user-defined.

4.2.5 Rotary axes and secondary axes

NC machines with rotary table or swivel head

Rotary axis: A B C

Positive turn around X, Y, Z (right- hand-rule)

NC machines with several feed axes

Secondary axis: U V W

Parallel to the X-,Y-,Z-axis

4.3 NC mathematics

4.3.1 Basics of the coordinate calculation

For the CNC programming the corresponding points of the outline which is to be machined need to be entered. In most cases if the drawing is suitable for NC purposes, it is possible to directly transfer these coordinate points from the drawing. In some cases it may be necessary to calculate the coordinates.

In the frame of the automation those coordinates are calculated by an NC programming system at external working places and the data are directly transferred to the machine. Therefore, in most cases the NC programming is directly performed on the product (3D pattern) in the construction or in the process engineering department.

For the computer-aided programming the switch and path information are entered over the keyboard in the dialogue using the menu technique.

4.3.2 Parameters of a triangle

In order to calculate the missing coordinates the relations valid for a triangle are very useful. There are several options to describe a triangle. Some of the following parameters e.g. corners, angles or sides are being used.

4.3.3 Angle on a triangle

The angles on a triangle determine the type of triangle. Depending on the size of the individual angles we distinguish between acute-angle, obtuse angle or rectangular triangles.

On triangles the following relation is applied:

the sum of the angles a, b and g in a triangle always amounts to 180°.

$a + b + g = 180°$

If two angles are known it is possible to determine the third unknown angle by means of this formula.

Rectangular triangle

The rectangular triangle has a special meaning in the analytic geometry as the sides of such a triangle are having a definite mathematic relation to one another.

On a rectangular triangle the single sides are specially named.

- The longest side is located opposite to the right angle and is named hypotenuse.
- The two sides of the triangle which are forming the right angle are named cathetus.
- The side opposite the angle a is named opposite leg.
- The side adjacent to the angle a is named adjacent leg.

On a rectangular triangle the right angle is described by an quarter circle and a point in the angle.

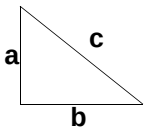
In a rectangular triangle it applies:

In a rectangular triangle you can calculate the missing leg if the other leg lengths are known. To do so, use the Pythagorean theorem.

The Greek Pythagoras (from about 580 to 496 before Jesus Christ) had been the first person to prove the following mathematic relation which had later on been named the Pythagorean theorem.

The sum of the cathetus square is equal to the hypotenuse square and expressed as a equation:

$$a^2 + b^2 = c^2$$



4.4 Trigonometric functions

The trigonometric functions describe the relations between the angles and the sides of a rectangular triangle. With the help of these trigonometric functions it is possible to calculate unknown leg lengths with an unknown angle and a known leg. It is depending on which side and which angle are known in order to choose the appropriate trigonometric function e.g. the sinus function, the cosine function or the tangent function.

For the calculation of unknown legs the corresponding equation needs to be transformed as described in the following example:

Known are: the angle and the length of the adjacent leg

Looking for: the length of the opposite leg

It applies: tan alpha = opposite leg / adjacent leg

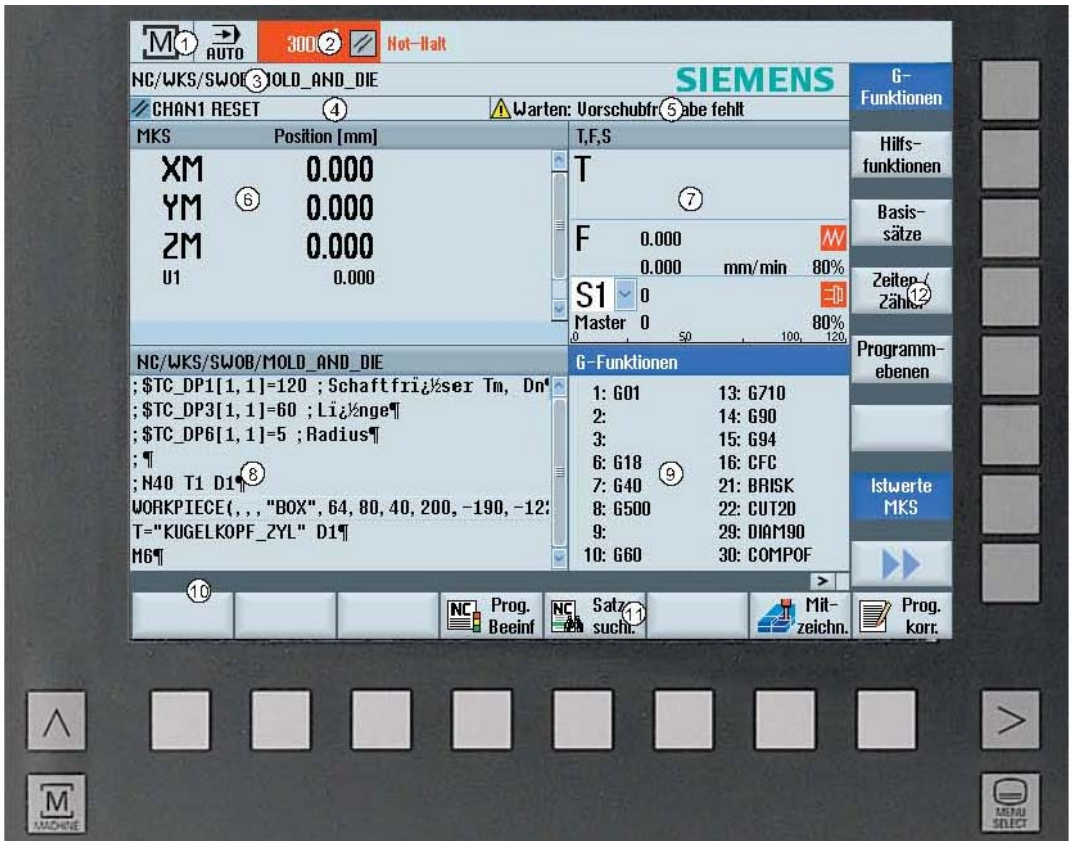
The results is:

opposite leg = adjacent leg x tan alpha

5 User interface, machine control panel

5.1 Screen arrangement

Excerpt from the manual of the operating instructions for "SINUMERIK 828 D"



Img.5-1: Screen arrangement

1. Active operating area and operating mode
2. Alarm-/message row
3. Program name
4. Channel condition and program influence
5. Channel operation messages
6. Position indication of the axes in the actual value window
7. Display for
   - active tool T
   - current feed F
   - active spindle in current condition (S)
   - Spindle utilization in percent
8. Working window including program record display
9. Display of active G functions, all G functions, H functions and input window for different functions (for example, skip blocks, program control)
10. Dialogue row for the transfer of additional user instructions
11. Horizontal softkey bar
12. Vertical softkey bar

5.2 Key definition of the CNC full keyboard

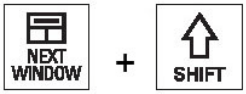
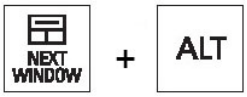
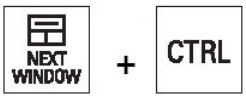
Excerpt from the manual of the operating instructions for "SINUMERIK 828 D".

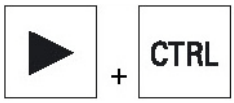
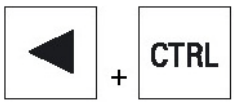
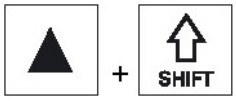
Img. 5-2: Control panel

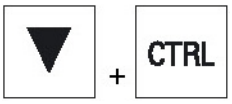
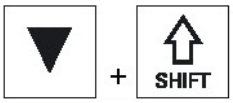
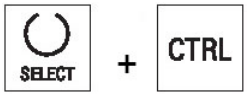
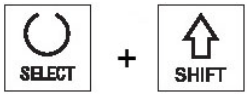
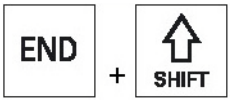
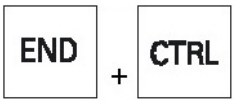
1. Alpha block
2. Numeric block
3. Softkeys
4. Control key block
5. Hotkey block
6. Cursor block
7. USB interface/ RS45/ CF card
8. Menu select key
9. Menu forward key
10. Machine area key
11. Menu forward key

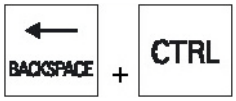
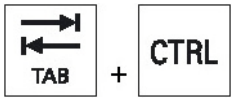
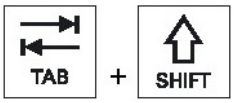
5.2.1 Keys and key combinations on the control panel

Excerpt from the manual of the operating instructions for "SINUMERIK 828 D"	
Key	**Function**
ALARM CANCEL	<ALARM CANCEL> Cancels alarms and messages that are marked with this symbol.
1...n CHANNEL	<CHANNEL> Advances for several channels.
HELP	<HELP> Calls the context-sensitive online help for the selected window.

Excerpt from the manual of the operating instructions for "SINUMERIK 828 D"	
Key	**Function**
	<NEXT WINDOW> • Toggles between the windows. • For a multi-channel view or for a multi-channel functionality, switches within a channel gap between the upper and lower window. • Selects the first entry in selection lists and in selection fields. • Moves the cursor to the beginning of a text. * on USB keyboards use the <Home> or <Pos 1> key
	<NEXT WINDOW> + <SHIFT> • Selects the first entry in selection lists and in selection fields. • Moves the cursor to the beginning of a text. • Selects a contiguous selection from the current cursor position up to the target position. • Selects a contiguous selection from the current cursor position up to the beginning of a program block.
	<NEXT WINDOW> + <ALT> • Moves the cursor to the first object. • Moves the cursor in the first column of a table row. • Moves the cursor to the beginning of a program block.
	<NEXT WINDOW> + <CTRL> • Moves the cursor to the beginning of a program. • Moves the cursor in the first row of the current column.
	<NEXT WINDOW> + <CTRL> + <SHIFT> • Moves the cursor to the beginning of a program. • Moves the cursor in the first row of the current column. • Selects a contiguous selection from the current cursor position up to the target position. • Selects a contiguous selection from the current cursor position up to the beginning of the program.
	<PAGE UP> Scrolls upwards by one page in a window.
	<PAGE UP> + <SHIFT> In the program manager and in the program editor from the cursor position, selects directories or program blocks up to the beginning of the window.
	<PAGE UP> + <CTRL> Positions the cursor to the topmost line of a window.
	<PAGE DOWN> Scrolls downwards by one page in a window.

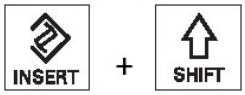
Excerpt from the manual of the operating instructions for "SINUMERIK 828 D"	
Key	**Function**
	<PAGE DOWN> + <SHIFT> In the program manager and in the program editor, from the cursor position, selects directories or program blocks up to the end of the window.
	<PAGE DOWN> + <CTRL> Positions the cursor to the lowest line of a window.
	<Cursor right> • Editing field Opens a directory or program (e.g. cycle) in the editor. • Navigation Moves the cursor further to the right by one character.
	<Cursor right> + <CTRL> • Editing box Moves the cursor further to the right by one word. • Navigation Moves the cursor in a table to the next cell to the right.
	<Cursor left> • Editing field Closes a directory or program (e.g. cycle) in the program editor. If you have made changed, then these are accepted. • Navigation Moves the cursor further to the left by one character.
	<Cursor left> + <CTRL> • Editing field Moves the cursor further to the left by one word. • Navigation Moves the cursor in a table to the next cell to the left.
	<Cursor up> • Editing box Moves the cursor into the next upper field. • Navigation - Moves the cursor in a table to the next cell upwards. - Moves the cursor upwards in a menu screen.
	<Cursor up> + <CTRL> • Moves the cursor in a table to the beginning of the table. • Moves the cursor to the beginning of a window.
	<Cursor up> + <SHIFT> In the program manager and in the program editor, selects a contiguous selection of directories and program blocks.

Excerpt from the manual of the operating instructions for "SINUMERIK 828 D"	
Key	**Function**
	<Cursor down> • Editing field - Moves the cursor downwards. • Navigation - Moves the cursor in a table to the next cell downwards. - Moves the cursor in a window downwards.
	<Cursor down> + <CTRL> • Navigation - Moves the cursor in a table to the end of the table. - Moves the cursor to the end of a window. • Simulation - Reduces the override.
	<Cursor down> + <SHIFT> In the program manager and in the program editor, selects a contiguous selection of directories and program blocks.
	<SELECT> Toggles between entries in the input field. Activates check boxes. In the program editor and in the program manager, selects a program block or a program.
	<SELECT> + <CTRL> When selecting table rows, switches between selected and not selected.
	<SELECT> + <SHIFT> Selects in selection lists and in selection fields the previous entry or the last entry.
	<END> Moves the cursor to the last entry field in a window, to the end of a table or a program block. Selects the last entry in selection lists and in selection fields.
	<END> + <SHIFT> Moves the cursor to the last entry. Selects a contiguous selection from the cursor position up to the end of a program block.
	<END> + <CTRL> Moves the cursor to the last entry in the last line of the actual column or to the end of a program.

Excerpt from the manual of the operating instructions for "SINUMERIK 828 D"	
Key	**Function**
	<END> + <CTRL> + <SHIFT> Moves the cursor to the last entry in the last line of the actual column or to the end of a program. Selects a contiguous selection from the cursor position up to the end of a program block.
	<BACKSPACE> • Editing box Deletes a character selected to the left of the cursor. • Navigation Deletes all of the selected characters to the left of the cursor.
	<BACKSPACE> + <CTRL> • Editing field Deletes a word selected to the left of the cursor. • Navigation Deletes all of the selected characters to the left of the cursor.
	<TAB> • In the program editor, indents the cursor by one character. • In the program manager, moves the cursor to the next right entry.
	<TAB> + <CTRL> • In the program editor, indents the cursor by one character. • In the program manager, moves the cursor to the next right entry.
	<TAB> + <SHIFT> • In the program editor, indents the cursor by one character. • In the program manager, moves the cursor to the next entry to the left.
	<TAB> + <CTRL> + <SHIFT> • In the program editor, indents the cursor by one character. • In the program manager, moves the cursor to the next entry to the left.
	<CTRL> + <A> In the actual window, selects all entries (only in the program editor and program manager).
	<CTRL> + <C> Copies the selected content.
	<CTRL> + <E> Calls the "Ctrl Energy" function.

Excerpt from the manual of the operating instructions for "SINUMERIK 828 D"	
Key	**Function**
CTRL + <F>	<CTRL> + <F> Opens the search dialog in the machine data and setting data lists, when loading and saving in the MDI editor as well as in the program manager and in the system data.
CTRL + <L>	<CTRL> + <L> Scrolls the actual user interface through all installed languages one after the other.
CTRL + SHIFT + <L>	<CTRL> + <SHIFT> + <L> Scrolls the actual operator interface through all installed languages in the inverse sequence.
CTRL + <P>	<CTRL> + <P> Generates a screenshot from the actual operator interface and saves it as file.
CTRL + <S>	<CTRL> + <S> Switches the single block in or out in the simulation.
CTRL + <V>	<CTRL> + <V> • Pastes the text from the clipboard at the actual cursor position. • Pastes text from the clipboard at the position of a selected text.
CTRL + <X>	<CTRL> + <X> Cuts out the selected text. The text is located in the clipboard.
CTRL + <Y>	<CTRL> + <Y> Reactivates changes that were undone (only in the program editor).
CTRL + <Z>	<CTRL> + <Z> Undoes the last action (only in the program editor).
CTRL + ALT + <C>	<CTRL> + <ALT> + <C> Creates a complete archive on an external data carrier (USBFlashDrive).

Excerpt from the manual of the operating instructions for "SINUMERIK 828 D"	
Key	**Function**
CTRL + ALT + <S>	<CTRL> + <ALT> + <S> Creates a complete archive on an external data carrier (USBFlashDrive).
CTRL + ALT + <D>	<CTRL> + <ALT> + <D> Backs up the log files on the USB-FlashDrive. If a USBFlashDrive is not inserted, then the files are backed-up in the manufacturer's area of the CF-Card.
SHIFT + ALT + <D>	<SHIFT> + <ALT> + <D> Backs up the log files on the USB-FlashDrive. If a USB Flash Drive is not inserted, then the files are backed-up in the manufacturer's area of the CF-Card.
SHIFT + ALT + <T>	<SHIFT> + <ALT> + <T> Starts "HMI Trace".
SHIFT + CTRL + <T>	<SHIFT> + <CTRL> + <T> Exits "HMI Trace".
ALT + <S>	<ALT> + <S> Opens the Editor to enter Asian characters.
DEL	<DEL> • Editing box Deletes the first character right of the cursor. • Navigation Deletes all characters.
DEL + CTRL	<DEL> + <CTRL> • Editing box Deletes the first word to the right of the cursor. • Navigation Deletes all characters.
␣	<Spacebar> • Editing field Editing field inserts a space • Toggles between entries in the input field.
+	<Plus> • Opens a directory, which contains the element. • Increases the size of the graphic view for simulation and traces.

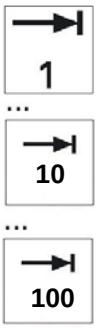
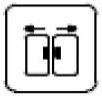
Excerpt from the manual of the operating instructions for "SINUMERIK 828 D"	
Key	**Function**
-	<Minus> • Closes a directory, which contains the element. • Reduces the size of the graphic view for simulation and traces.
=	<Equals> Opens the calculator in the entry fields.
*	<Asterisk> Opens a directory with all of the subdirectories.
~	<Asterisk> Opens a directory with all of the subdirectories.
	<INSERT> • Opens an editing window in the insert mode. Press the key again, exits the window and the entries are undone. • Opens a selection box and shows the selection possibilities. • In the machining step program, enters an empty line for G code.
	<INSERT> + <SHIFT> For G code programming, for a cycle call activates or deactivates the edit mode.
	<INPUT> • Completes input of a value in the entry field. • Opens a directory or a program. • Inserts an empty program block if the cursor is positioned at the end of a program block. • Inserts a character to select a new line and the program block is split up into 2 parts. • In the G code, inserts a new line after the program block. • In the machining step program, inserts a new line for G code.
	<ALARM> - only OP 010 and OP 010C Select the "Diagnosis" operating area.
	<PROGRAM> - only OP 010 and OP 010C Calls the "Program Manager" operating area.

Excerpt from the manual of the operating instructions for "SINUMERIK 828 D"	
Key	**Function**
	<OFFSET> - only OP 010 and OP 010C Calls the "Parameter" operating area.
	<PROGRAM MANAGER> - only OP 010 and OP 010C Calls the "Program Manager" operating area.
	Menu forward key Advances in the extended horizontal softkey bar.
	Menu back key Returns to the higher-level menu.
	<MACHINE> Calls the "Machine" operating area.
	<MENU SELECT> Calls the main menu to select the operating area.

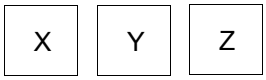
5.3 Controls on the machine control panel

Img.5-3: Machine Control Panel

	Elements on the MCP	
	Element	**Function**
		<EMERGENCY STOP button> Activate the button in situations where • life is at risk. • there is the danger of a machine or workpiece being damaged. All drives will be stopped with the greatest possible braking torque.
②		not used
③		<RESET> • Stop processing the current programs. The NCK control remains synchronized with the machine. It is in its initial state and ready for a new program run. • Cancel alarm.
		<SINGLE BLOCK> Single block mode on/off.
④		<CYCLE START> The key is also referred to as NC Start. Execution of a program is started.

	Elements on the MCP	
	Element	**Function**
④		<CYCLE STOP> The key is also referred to as NC Stop. Execution of a program is stopped.
		<JOG> Select "JOG" mode.
		<TEACH IN> Select "Teach In" submode.
		<MDI> Select "MDI" mode.
⑤		<AUTO> Select "AUTO" mode.
		<REPOS> Repositions, re-approaches the contour.
		<REF POINT> Approach reference point.
		Inc <VAR>(Incremental Feed Variable) Incremental mode with variable increment size.
		Inc (Incremental feed) Incremental mode with predefined increment size of 1, 10, 100 increments.
		Door open / close

	Elements on the MCP	
	Element	**Function**
⑤		Function not used in the standard delivery. Option - Coolant through spindle Command M7 = Coolant through spindle "On" Command M9 = Coolant through spindle "Off"
		<Coolant> Manual Coolant On/Off Control • Press the button to manually turn on the cooling. • Press the button again to turn off the cooling system. Command M8 "Coolant On", M9 "Coolant Off". The following conditions must be met for. • Front door is closed. • M01 is not active. • Alarm 700 064 (Waiting for tool change) is not active. • Alarm 700 153 (Main spindle pause) is not active. • Alarm 700 156 (Tool changer not at home position, Spindle stop) is not active. The LED above the push button starts to flash when: • By pressing the button or the command M8, the conditions are not met. Img.3-13: “Spindle cooling“ on page 36
		<Chip flushing> Press the push-button in order to switch on the chip flushing. By pressing the push-button once again, the chip flushing is switched off again. Command M12 = Chip flushing ON Command M9 = Chip flushing OFF Img.3-14: “Chip flushing“ on page 36
⑥		<Working Light> ON / OFF
		<Chip conveyor forward> Program command M24 = Chip conveyor ON Program command M25 = Chip conveyor OFF
		<Chip conveyor Stop> Press the push-button Chip conveyor Stop or the push-button <RESET> in order to stop the chip conveyor.
		<Chip conveyor reverse> Only for easy retracting the screw conveyor.
		<Spindle CW> Direction of rotation clockwise It is not possible to activate the system in the automatic mode.

	Elements on the MCP	
	Element	**Function**
⑥		<Spindle - Stop> It is not possible to activate the system in the automatic mode.
		<Spindle CCW> Direction of rotation counter-clockwise It is not possible to activate the system in the automatic mode.
		<Axis keys> Select axis.
		not used
		<WCS MCS> Switch over between the tool coordinate system and the machine coordinate system.
		<RAPID> Travel axis in the rapid traverse while pressing the direction key + or -
⑦		<MAG Turn> Rotate tool changer ☞ "Manual operation of the tool changer“ on page 76
		<MAG Move> Move tool changer ☞ "Manual operation of the tool changer“ on page 76
⑧		<SPINDLE STOP> Stop spindle
		<SPINDLE START> Spindle is released
⑨		<FEED START> Releasing for processing of the program in the current record as well as releasing to starting-up to the feed value preset by the program.
		<FEED STOP> Stopping processing of the current program and stopping axes drives

	Elements on the MCP	
	Element	**Function**
		Increases or reduces the programmed speed. The programmed spindle speed is set to 100% and can be controlled from 50 to 120%. The new spindle speed settings are displayed as an absolute value in percent in the spindle status display on the screen.
		Increases or reduces the programmed infeed. The programmed infeed or rapid speed is set to 100% and can be set from 0% to 120% (only up to 100% in the rapid traverse). The new infeed settings are displayed as an absolute value in percent in the infeed status display on the screen.
		<0> <1> Setting mode • Position <0> "Safety Integrated" function activated • Position <1> "Safety Integrated" function deactivated
		Drive voltage Push-button with indicator light • Indicator light ON, drive voltage activated • Indicator light OFF, drive voltage deactivated

	Elements on the MCP	
	Element	**Function**
		**5.3.1 Key switch** <1> <2> <3> Access rights of three keys:

Key colour	possible Position	for access stage
No key required	<0>	7
Black	<0> <1>	6 - 7
Green	<0> <1> <2>	5 - 7
Orange	<0> <1> <2> <3>	4 - 7

The key switch is located at the bottom right of the machine control panel and has got four positions. Three colour-coded key is available allowing access to another access stage with each key.

access stage	Provided for:	Protected by:
1	Manufacturer	Password: SUNRISE
2	Service	Password: EVENING
3	User	Password: CUSTOMER
4	Operator: Programmer	Key position <3>
5	Operator: Technician	Key position <2>
6	Operator: Supervisor	Key position <1>
7	Operator: Worker	Key position <0>

Example: The area machine data is not available unless access stage 4 (key position 3) or higher is released.

6 Operation

6.1 Safety

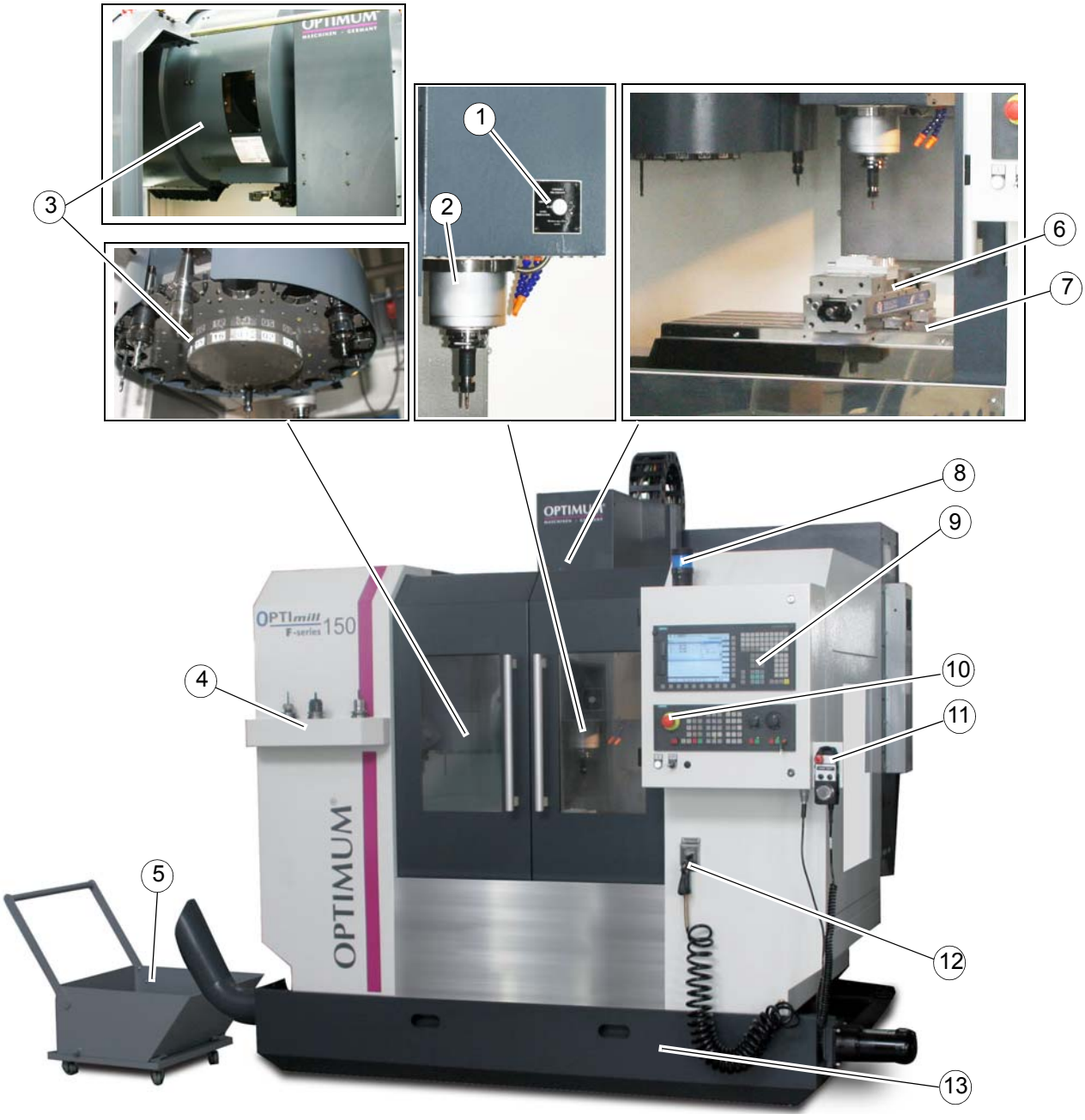
Commission the CNC machine only under the following conditions:

- The CNC machine is in proper working order.
- The CNC machine is used as prescribed.
- The operating manual is followed.
- All safety devices are installed and activated.

All failures should be eliminated immediately. Stop the CNC machine immediately in the event of any abnormality in operation and make sure it cannot be started up accidentally or without authorisation. Notify the person responsible immediately of any modification.

☞ "Safety during operation“ on page 17

6.2 Control and indicating elements



Img.6-1: F150

No.	Designation		
1	Touch-switch to release and clamp the tool	7	Milling table
2	Milling spindle	8	Signal lamp (if the signal lamp is illuminated --> CNC- program is running)
3	16-type tool change system	9	Machine Control Panel
	24-type optional tool change system	10	Emergency-stop push button
4	Tool deposit (17 spaces)	11	Handwheel for manual travelling with Emergency Stop push button and acknowledgement button
5	Chip collection container	12	Cleaning gun
6	Machine vice (optional)	13	Coolant / lubricant tank / chip conveyor

6.2.1 Operating the handwheel for manual travelling

<table>
<tr><td rowspan="5"> 
</td><td>Pos. No</td><td>Designation</td><td colspan="2">Description</td></tr>
<tr><td>6</td><td>Rotary switch</td><td colspan="2">Selector switch to control the individual axis.</td></tr>
<tr><td>7</td><td>Rotary switch</td><td colspan="2">Selector switch for the feed speed
(3 stages).</td></tr>
<tr><td>8</td><td>Hand wheel</td><td colspan="2">Handwheel to travel the individual axes.</td></tr>
<tr><td>9</td><td>Emergency-stop push button</td><td colspan="2">The EMERGENCY STOP push button switches off the CNC machine.</td></tr>
<tr><td rowspan="4"> 
</td><td>10</td><td>Push button resp. acknowledgement button</td><td colspan="2">In the setting mode resp. if the sliding door is open it is necessary to actuate the acknowledgement button in order to expressively allow the movement of the individual axes.</td></tr>
<tr><td>1</td><td>Drive tension ON</td><td colspan="2">Switches the control circuit of the servo motors</td></tr>
<tr><td rowspan="3">11</td><td>Key switch</td><td colspan="2">Safety switch to activate or
deactivate the tool setting operation</td></tr>
<tr><td rowspan="2">Switch position</td><td>0</td><td>Setting mode is not available
CNC program processing enabled possible</td></tr>
<tr><td>1</td><td>Setting mode</td></tr>
</table>

6.3 Switching on the CNC machine

When switching on the machine the integrated safety functions of the machine "Safety Integrated" are checked and scanned. Please proceed in the following sequence:

➜ Switch on the main switch.
☞ "Lockable main switch“ on page 14

➜ Please wait until the control is completely started.

➜ Unlock the "Emergency-Stop buttons".
☞ "EMERGENCY STOP push button“ on page 15

➜ Press the push button "Drive control ON" (1) .

➜ First press the push button "SPINDLE START" (2) and then the push button "FEED START" (3)

➜ Acknowledge the upcoming error message by pressing the push button "RESET". (4)

On the Display the message 700033 "Door check" is displayed. Open and close the door once in order to perform a safety test. Therefore, perform the following steps.

➜ Press the push button "Open - Close door" (5)

➜ Open and completely close the door.

➜ After closing the door, press the push button "RESET" (4)

Img.6-2: Control panel

➜ If possible, read the upcoming messages on the display, remove the error messages, such as e.g. insufficient compressed air, insufficient coolant / lubricant. ☞ "Notes, messages and error messages“ on page 86

➜ For the following working steps, please proceed as described in chapter 2 „Operation and programming“ of the Siemens „SINUMERIK 828 D" Operation instructions.

INFORMATION

Your CNC machine is equipped with an absolute measuring system.
A travel to reference point after power on is not necessary.

6.4 Switching off the CNC machine

➜ Push the EMERGENCY STOP push button.

➜ For a long-term standstill of the CNC machine switch it off at the main switch.
☞ "Disconnecting and securing the CNC machine“ on page 18

6.5 First insertion of a tool

When first commissioning the machine, the spindle is not located in a defined position. There is no saved position in the control which indicates if there is a tool inserted in the spindle.

The message 700088 "Empty the tool spindle" is displayed.

In order to remove the non defined position, perform the following working steps for safety reasons.

ATTENTION!

Hold your tool if there is a tool inserted in the spindle.

➜ Turn the key switch (1) to the position <0>

➜ Press the push button "Open/Close door" (2) and open the door.

➜ Press the push button once before releasing the tool.
Img.6-4: “Manual tool change“ on page 75

➜ Close the door again.

➜ Press the push button <CYCLE START> (3)

The axis travels to its maximum position, then close and open once the pneumatic acceleration of the tool. Thus the process is completed.

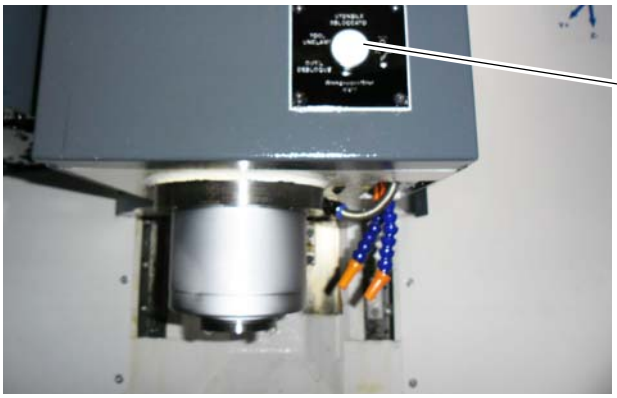
Img.6-3: Control panel

6.6 Insert tool

If you are working with only one tool which is directly inserted in the spindle it is possible to perform the inserting resp. changing in the operating mode "JOG". Press the corresponding push button at the spindle head in order to "loosen" or to "clamp" the tool pneumatically.

ATTENTION!

Firmly hold the tool when you press the push button for "loosening".

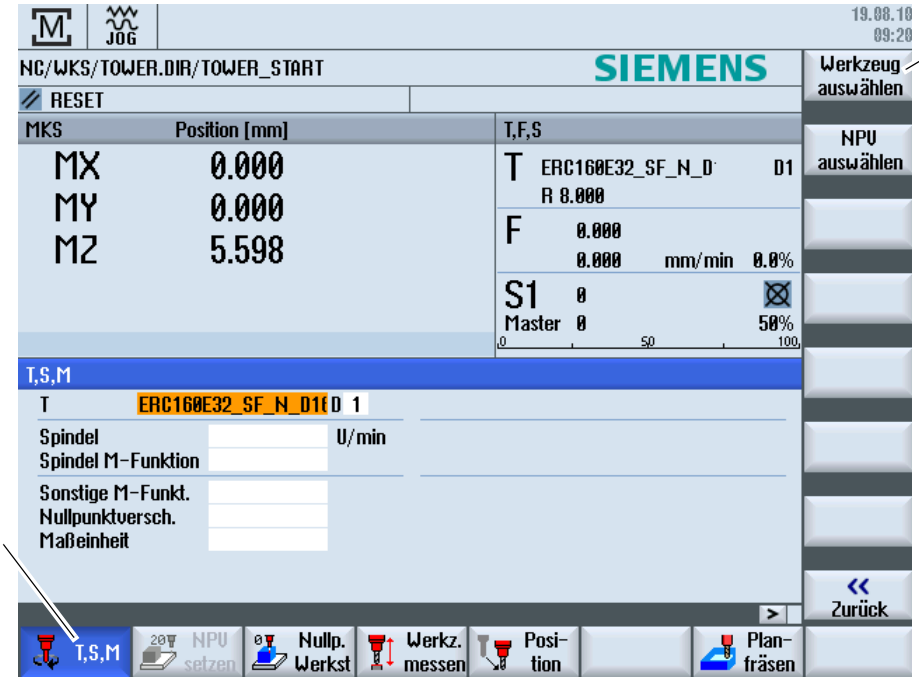


Img.6-4: Manual tool change

When inserting a tool for the first time, please observe ☞ "First insertion of a tool“ on page 74

In case that you are working using the tool changer and you would like to insert new tools you must change to the operating mode <JOG> (Jog mode) "T, S, M“ since it is only possible to change the tool via the spindle.

➜ Manually change the tool in the spindle as described above. Perform the following commands for changing resp. replacing.



➜ Press the softkey button "T, S, M".

➜ Actuate the softkey "Select tool".

NOTE!

The tool must be created in the tool magazine.

➜ Select the tool by means of the arrow key and press <CYCLE START>. The tool in the tool magazine is changed.

NOTE!

The tool is displayed in the tool list.

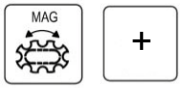
6.7 Manual operation of the tool changer

6.7.1 Manual operation of the 16-type tool changer

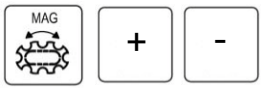
The operator can manually travel the tool changer to the reference point

➜ Press the key <JOG> and <REF.POINT> on the machine control panel in order to access the mode "Reference point approach".

➜ Press the key <MAG> and <+> in order to release the travelling of the tool changer



➜ Press the key <Turn MAG> and <+> or <MAG> and <-> in order to turn the tool changer to the desired direction.



➜ Press the key <FEED START> on the control panel of the machine 3 times continuously. The LED via the key <FEED START> starts flashing and the message 700095 *** Service mode*** is displayed. Then the system goes to the ATC service mode.

When the system has accessed the ATC-Service mode and the Z-axis and the spindle are in the tool changing position, the operator can manually operate the tool changer.

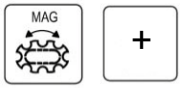
➜ Press the key <Move MAG> and <+> or <Move MAG> and <-> in order to move the tool changer to the desired direction. The key <+> moves the tool changer to the tool change position.

6.7.2 Manual operation of the 24-type tool changer

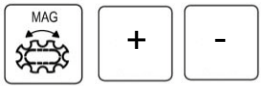
The operator can manually travel the tool changer to the reference point

➜ Press the key <JOG> and <REF.POINT> on the machine control panel in order to access the mode "Reference point approach".

➜ Press the key <MAG> and <+> in order to release the travelling of the tool changer



➜ Press the key <Turn MAG> and <+> or <MAG> and <-> in order to turn the tool changer to the desired direction.

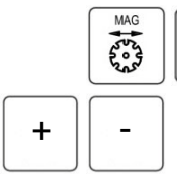


➜ Press the key <FEED START> on the control panel of the machine 3 times continuously. The LED via the key <FEED START> starts flashing and the message 700095 *** Service mode*** is displayed. Then the system goes to the ATC service mode.

When the system has accessed the ATC-Service mode and the Z-axis and the spindle are in the tool changing position, the operator can manually operate the tool changer.

➜ Press the key <move MAG> and the tool changer moves down to the tool change position.

➜ The key <+> and <-> moves the double arm of the tool changer .



6.7.3 Quit the ATC-Service mode

➜ Press the key <FEED START> or <FEED STOP> or <RESET> on the machine control panel in order to quit the ATC-Service mode.

6.8 Setting

INFORMATION

For the setup operation <JOG> (JOG operation) the sliding door for the separating protective equipment can be opened.

In the setting mode resp. if the sliding door is open it is necessary to actuate the acknowledgement button in order to expressively allow the movement of the individual axes.

Refer to chapter 4 "Setup machine" of the operating instructions for "SINUMERIK 828 D".

6.8.1 Clamping workpiece and setting workpiece datum

ATTENTION!

Clamp your workpiece safely and firmly on the milling table using appropriate clamping devices. When setting and using already created programs observe the safety clearance in order to avoid collisions with the selected clamping means.

➜ Use a 3D calliper or another appropriate measuring device in order determine the workpiece zero point.

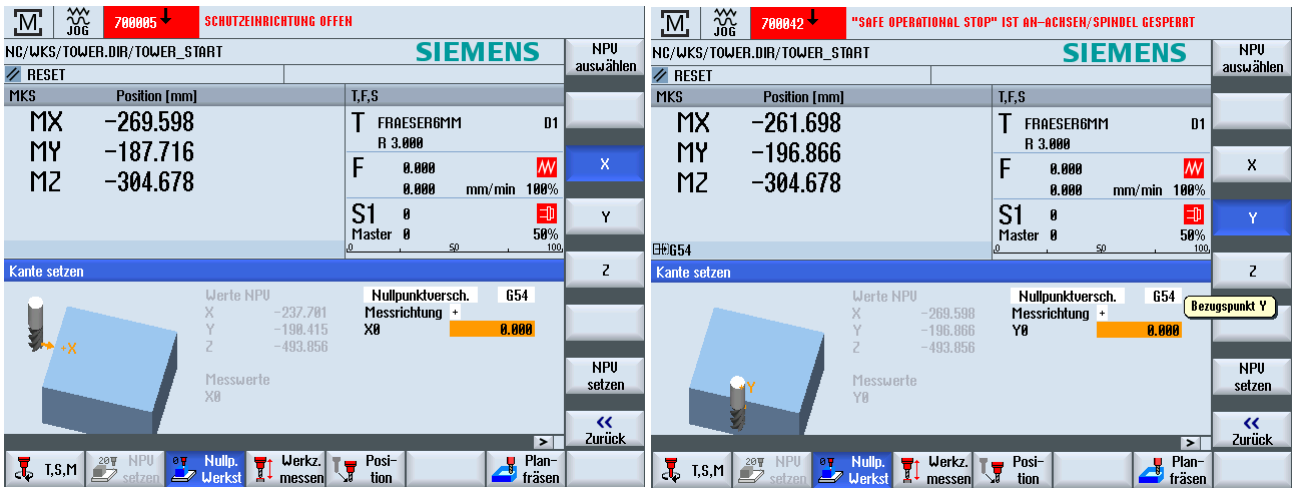
➜ Travel the X and Y axis using the handwheel until the 3D measuring probe indicates the value "0".

NOTE!

If you use a milling cutter to measure the workpiece datum the milling cutter radius is automatically calculated. Enter it for the zero offset.

➜ Press the button "Workpiece datum". Select the button X resp. Y axis.

Img.6-5: Determine workpiece datum X axis resp. Y axis



Img.6-6: Set workpiece datum X axis resp. Y axis

➜ Press the button "Zero offset".

➜ Press the key "Set NPU" after determining the workpiece datum of the corresponding axis.

Measuring the Z axis by means of a pressure sensor

➜ Change a tool with a length of "0" listed in the tool list

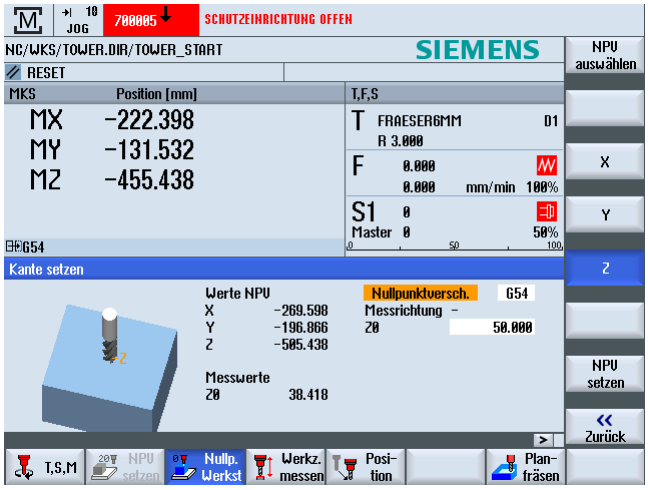
➜ Travel the spindle (Z axis) to the pressure sensor (by means of the handwheel) until the indicated value is "0".

Img.6-7: Workpiece datum Z axis with pressure sensor

➜ Enter for Z0 = 50mm . This is the height of the measuring probe.

NOTE!

Make sure to always enter positive values.



Img.6-8: Determining workpiece zero point Z axis

➜ Confirm the setting by pressing the button "Set NPU".

6.8.2 Setting resp. measuring tool

INFORMATION

For the setup operation (JOG operation) the sliding door for the separating protective equipment can be opened.

Also refer to chapter 4 "Setup machine" in the operating instructions for "SINUMERIK 828 D".

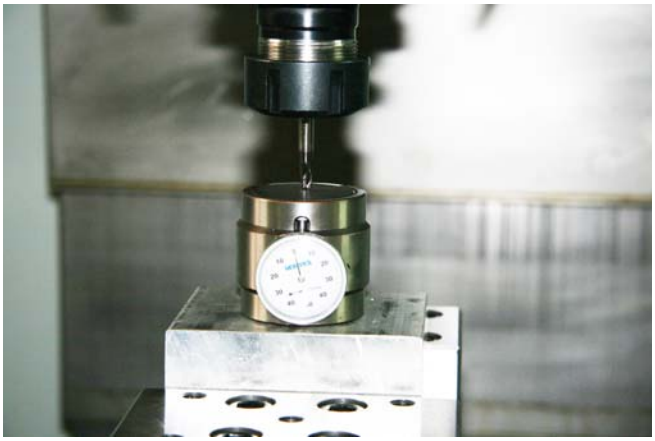
Measuring a milling cutter by means of a pressure sensor

➜ Change the tool in the spindle.

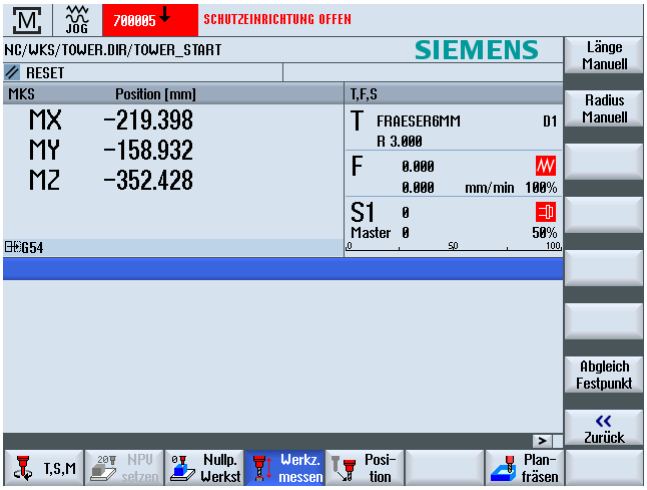
➜ Actuate the button "Measure tool".

➜ Travel the spindle (Z axis) to the pressure sensor (by means of the handwheel) until the indicated value is "0".

➜ Measuring tool



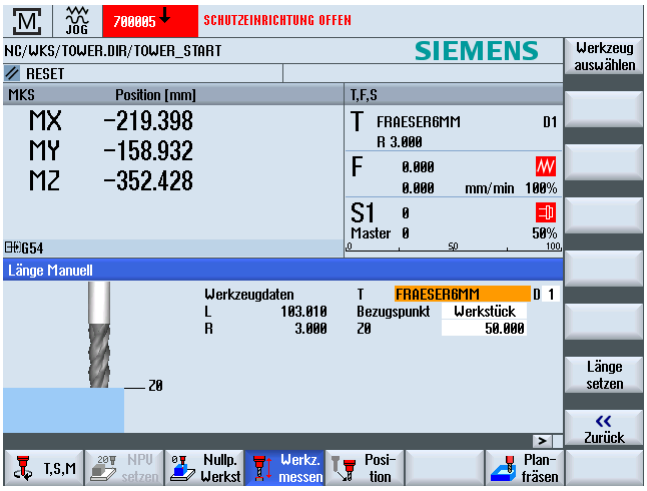
Img.6-9: Measuring tool



➜ Press the button "Set length".

NOTE!

Make sure that the display for active tool "T" is equipped with the correct tool. The workpiece is the reference point!



6.9 Operational modes

Manually controlled operation

The manually controlled operation is allowed in the operating mode "JOG" and in the operating mode "MDA". Refer to chapter 5 "Manually controlled operation" of the instructions "SINUMERIK 828 D".

Automatic mode

Refer to chapter 6 "Automatic mode" of the instructions "SINUMERIK 828 D".

6.10 Programming

For further working steps please proceed as described in the operating instructions "Part programming, system, programming and cycles“ for "SINUMERIK 828 D".

Manual resp. part programming:

For this kind of programming, the programs must be created manually and entered in the control. The direct programming in the DIN-Code is a complex method which requires lots of skills.Nowadays this task is mostly taken over by CAD/CAM systems which directly create an operating program using a graphical user interface.

Automatic programming:

By means of the CAD/CAM program (for instance a 3D-CAD program including downstream co-processor) construction data are transmitted (semi-)automatically to an executable program. For this kind of programming a 3D model is designed using a PC. By means of an operating sequence which is predefined by the user the motion-sequence of the machine are being calculated. These programs are accessing the tool data base which includes all tool parameters (speed, feed, diameter, etc.). Due to this systematic program structure the user is able to create complete programs within shortest time without having any knowledge of the individual program commands and its syntax.

As aid for training and operation we recommend to use the software SinuTrain made by Siemens.

SinuTrain is the ideal software supplement for the CNC milling machine F150 made by OPTIMUM.

This training software supports the rapid training for the operation of the control Sinumerik SINUMERIK 828 D. Employees having little CNC experience can learn the basics of the DIN programming by using SinuTrain and are finally able to write and test programs using SINUMERIK 828 D-cycles.

Please find SinuTrain and further information on the website of Siemens.

6.11 Start program

If necessary, open the setting screw for the coolant / lubricant supply on the spindle head before starting the program. It is only allowed to change the dosing during the setup operation. If necessary the cooling lubricant supply is switched on via your CNC-program.

WARNING!

Never change the dosing of the cooling lubricant supply and never seize into the machine when a program is running.

CAUTION!

Before starting the programs you have to close the sliding door of the separating protective equipment.

➜ Completely close the separating protective equipment.

➜ Change over to the mode "AUTO/MDA"

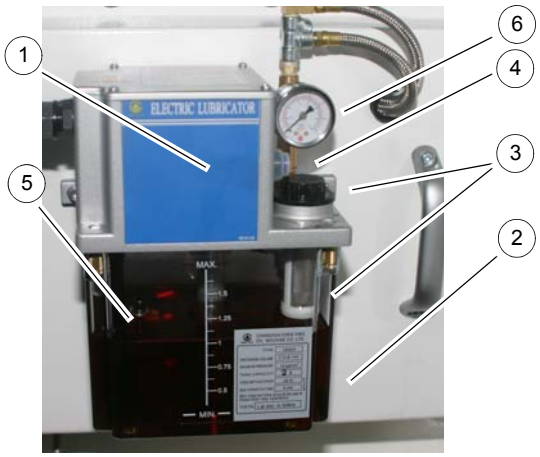
For further working steps please proceed as described in the chapter of the control"SINUMERIK 828 D".

6.12 Operating the central lubrication system

The CNC machine is equipped with a central lubrication system. This option is used to "manually" set the supply of the oil quantity. During operation the supply positions are automatically supplied with oil in regular intervals using a time measuring instrument.

The lubricating system is used to maintain an oil film on the slideways, the bearings, the ledges and the ball screws and to reduce their wear.

In case of a failure or a fault in the central lubricating system a stick-slip effect may occur. This effect describes the jerky sliding of solids moving opposite one another. For instance: creaking doors and rattling windscreen wipers.



Img.6-10: Operating elements of the central lubrication system

Pos. No	Meaning	Description
1	Pump	Manually conveys the machine oil
2	Oil tank	Includes the oil quantity
3	Oil filler hole / oil filter	It is possible to fill in machine oil via the filler hole resp. the machine oil is filtered via the oil filter.
4	Push button (function key)	Lubricating cycle activated
5	Float switch	Recognising the oil level in the tank
6	Manometer	Measuring device to collect and display the physical pressure of the medium

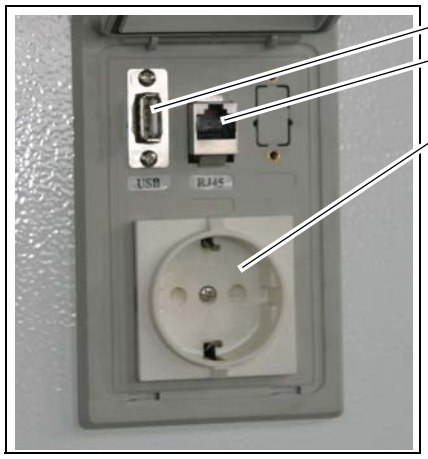
Designation		Specification
Timer	Act Time	controlled by the timer
	Interval Time	
Motor	Current consumption	2.5 A
	Phases	1
	Power	12 W
Pump	max. delivery flow	130 cc/min
	max. delivery pressure	15 kgf/cm²
	Diameter pressure joint	6mm
Storage reservoir	Capacity	2.5 litres
	Material	Resin
Oil viscosity		32-68 cSt@40°C

6.13 Data interfaces and current collection

When connecting data interfaces make sure that the data cable runs to the interface of the controlwithin shortest possible distance. The cable routing can be conducted along the measuring system lines. However the cable in the switch cabinet must never be routed nearby the drive apparatuses of the NC axis or the frequency converter itself. Errors occur during data transfer due to electromagnetic radiation (EMC-problems).

The control is equipped with the following data interfaces. They are located laterally on the control panel of the CNC machine:

- RJ45 plug- in connection
- USB connection
- Power connection (socket for current supply (230V) e.g. for a notebook)



USB interface

Network connection

Socket for current collection (230V) e.g. for a notebook

⚠Warning!

Do not use any devices which require more than 2 A current!

Img.6-11: Data interfaces and current collection

6.14 Executing from an external position

Excerpt from the manual of the operating instructions for "SINUMERIK 828 D".

12.13 EXTCALL

It is possible to access the files on the local drive , USB data carrier or networks using the command EXTCALL .

The programmer can determine the source directory by means of the setting date SD$SC42700 EXT_PROG_PATH and file name for the sub-program to be reloaded using the-command EXTCALL.

Edge conditions

Observe the following edge conditions for EXTCALL prompts:

- It is only possible to call files with the identification MPF or SPF via EXTCALL from a network.
- The files and paths have to correspond to the NCK nomenclature (max. 25 characters for the name, 3 characters for the identification).
- A program on a network can be found using the command EXTCALL if
  - the search path refers to the network or to a directory SD $SC42700 EXT_PROG_PATH. The program has to be directly filed, no sub-directories are browsed.
  - Without SD $SC42700: in the EXTCALL prompt the program is directly indicated and alsolocated there - via a fully qualified path, which can also refer to the network driv .

Examples for EXTCALL prompts

The setting data can be used to perform a target search for the program.

- Prompt USB drive to TCU (USB storage device on the interface X203), whenSD42700 is empty: e.g. EXTCALL "//TCU/TCU1 /X203 ,1/TEST.SPF"
  - Or -
    Prompt USB drive to TCU (USB storage device on the interface X203), whenSD42700 includes "//TCU/TCU1 /X203 ,1/TEST.SPF" EXTCALL "TEST.SPF"
- Prompt for USB Front connection (USB-FlashDrive), if SD $SC 42700 is empty : e.g. EXTCALL"//ACTTCU/FRONT,1/TEST.SPF"
  - Or -
    Prompt of USB Front connection (USB-FlashDrive), when SD42700 "//ACTTCU/FRONT,1" is included: EXTCALL "TEST.SPF"

7 M - code list, M functions

The following code list are the manufacturer-specific M-codes of the machine.

Some M-codes are provided for an optional equipment of the CNC machine and are only activated if the CNC machine is equipped with this equipment.

S / O	S = Standard O = Option	
No.	**Function**	**S / O**
M00	Programmed stop	S
M01	Optional Stop	S
M02	End of program	S
M03	Starting the milling spindle in positive direction (clockwise)	S
M04	Starting the milling spindle in negative direction (anti-clockwise)	S
M05	Stopping the milling spindle	S
M06	Automatic tool change	S
M07	Coolant through spindle ON	O
M08	Cooling lubricant pump ON	S
M09	Cooling lubricant pump OFF M07/M12/M50 OFF	S
M10	The 4th axis clamp	S
M11	The 4th axis unclamp	S
M12	Chip wash down coolant 1 ON	O
M13		
M14		
M15	Open front door	O
M16	Close front door	O
M17	End of subroutine	S
M18		
M19	Spindle stop in defined limit position (0 degree)	S
M20	Program end with resetting (Reset)	
M21		
M22		
M23		
M24	Chip Conveyor CW ON	O
M25	Chip Conveyor CW OFF	O
M26	Workpiece clamp	S

S / O	S = Standard O = Option	
No.	**Function**	**S / O**
M27	Workpiece unclamp	S
M28		
M29		
M30	Program end & Rewind	S
M31	Opening a lock	
M32		
M33		
M34		
M35		
M36		
M37		
M38		
M39		
M40	Automatic Spindle Gear Change (by S-Code)	S
M41	Spindle Gear Change to Stage 1	S
M42	Spindle Gear Change to Stage 2	S
M43	Spindle Gear Change to Stage 3	S
M44	Spindle Gear Change to Stage 4	S
M45	Spindle Gear Change to Stage 5	S
M46		
M47		
M48		
M49		
M50	Oil Mist / External Air Blower	O
M51		
M52		
M53		
M54		
M55		
M56		
M57		
M58		
M59		

S / O S = Standard O = Option		
No.	**Function**	**S / O**
M60	Workpiece replacement	
M61		
M62		
M63		
M64		
M65		
M66		
M67		
M68		
M69		
M70		
M71	Spindle position control on	S
M72		
M73		
M74		
M75		
M76		
M77		
M78		
M79		
M80	M81 / I11.2 (183) for finish	O
M81	for M80 finish	O
M82	M83 / I11.3 (184) for finish	O
M83	for M82 finish	O
M84	M85 / I11.4 (185) for finish	O
M85	for M84 finish	O
M86	M87 / I11.5 (186) for finish	O
M87	for M86 finish	O
M88	M89 / I11.6 (187) for finish	O
M89	for M88 finish	O
M90	M91 / I11.7 (188) for finish	O
M91	for M90 finish	O
M92		
M93		

S / O S = Standard O = Option		
No.	**Function**	**S / O**
M94		
M95		
M96		
M97		
M98		
M99		

7.1 G function according to PAL

G0	Travelling in rapid traverse
G1	Linear interpolation during process
G2	Circular interpolation clockwise
G3	Circular interpolation anti-clockwise
G4	Retention period
G9	Accurate stop
G10	Travelling in rapid feed in polar coordinates
G11	Linear interpolation with polar coordinates
G12	Circular interpolation clockwise with polar coordinates
G13	Circular interpolation anti-clockwise with polar coordinates
G45	Linear tangential travelling on a contour
G46	Linear tangential travelling off the contour
G64	Accurate stop off

8 Notes, messages and error messages

All messages and alarms are displayed in plain text on the operator panel. The alarm text contains the date, time and a suitable symbol for the cancel criterion.

Alarms and messages are displayed separately according to the following criteria:

- ❍ Alarms and messages in the part program.
- ❍ Alarms and messages from the plc and alarms and messages that concern the machine.

The following notes, messages and error messages are the vendor-specific messages of the machine.

Several messages and error messages are an optional feature of the CNC machine and provided only active when the CNC machine has these features.

Number	Message description
700000	Emergency stop button pressed, release it and press reset on MCP
Possible cause	• Unlock the Emergency stop button and press reset on the machine control panel (MCP). • Emergency stop button defect and gives an erroneous signal.
700008	Feed not enabled on machine control panel !
Possible cause and remedy	• Enable feed on machine control panel.
700009	Waiting for spindle up to speed. . .
700010	plc alarm DB1600.DBX1.2
700011	Automatic power off active, servo off!
Effect	• Drive off!
700016	Hydraulic pump overloaded.
Possible cause	Motor protection switch of the hydraulic pump is faulty. Motor protection switch setting faulty. Hydraulic pump is sucking air. Clamping pressure / working pressure set too high. Hydraulic pump or drive motor defective.
700017	Hydraulic pressure not reached.
Possible cause	• Subsequent alarm 700 016 • Pressure too low • Pressure switch is defective on the hydraulic unit.
700019	T code error.
700020	Tool change error.
700021	Tool change position data loading error.
700022	Axis %D PLC positioning error.
700023	Spindle zero position, check sensor not ON.
700024	Tool clamp / unclamp error.
700025	Arm rotate error.
700026	Tool pocket up/down error.
700027	Tool magazine position error.

Number	Message description
700028	Tool data error
possible remedy	• Check tool table!
700030	Machine control panel error (MCP)
possible remedy	Check type / MD / connection.
700031	Magazine in / out error.
700032	Waiting for SINAMICS ready. . .
700033	Operator door safety check, open door and close it again.
Cause and solution	Safety door needs test, open then close it again. • Press the push button "door open - close" • Open the door and close the door again completely. • Press after closing the door the push button "RESET. ☞ "Switching on the CNC machine“ on page 73
700040	Waiting for tool clamped.
700041	Waiting for tool unclamped.
700044	Tool probe Low battery
700046	Tool probe error
700048	Coolant motor overloaded
Possible cause and remedy	• Motor protection switch of the coolant pump is faulty. • Motor protection switch setting faulty. • Coolant pump is sucking air. • Shut-off cock is closed. • Pump or drive motor defective.
Possible cause and remedy	• Contactor of the coolant motor signals an incorrect switch status.
700050	Coolant level low.
Possible cause and remedy	• Fill up coolant • Float switch in the central oil lubrication
700051	CTS coolant motor overloaded.
700052	CTS recycle motor overloaded.
700053	CTS sub-tank level low, no coolant suction.
700055	CTS inlet filter clogged.
700056	CTS sub-tank level high.
700060	Spindle oil cooler alarm !
700064	Waiting for tool change . . .
700075	Waiting for gear changing. . .
700080	Asup1 initialise error, check PLCASUP1.SPF
700081	Asup2 initialise error, check PLCASUP2.SPF
700082	Asup1 execution error.

Number	Message description
700083	Asup2 execution error.
700084	Magazine rotation error.
700085	Magazine to home error.
700086	Magazine motor overloaded
700087	Arm motor overloaded
700088	Unclamp tool manually to confirm empty spindle for safety.
Possible cause and remedy	• First insertign of a tool • ☞ "First insertion of a tool“ on page 74
700089	Magazine gate manual operation active.
700090	Magazine manual rotation active.
700091	Manual tool unclamp active.
700092	Tool pocket manual up/down active.
700093	Arm manual rotation active.
700094	Safety door not locked,NC start disabled.
Possible cause and remedy	• Limit switch with door lock outputs a signal that the safety door is not locked. • Safety door not fully closed and locked.
700095	*** Service mode *** ☞ "Quit the ATC-Service mode“ on page 76
700104	Magazine manual in/out active.
700105	Handwheel 1 is active. (External)
700106	Handwheel 1 is active. (HMI)
700107	Handwheel 2 is active. (HMI)
700108	Door not closed to the magazine
700109	Right-hand door is not closed
700110	Left door is not closed
700128	Z axis is not referenced, positioning by PLC not possible.
700136	Tool changer not at home, Z axis inhibited
700137	Tool changer at spindle switch error, Z axis inhibited
700146	Spindle cooler unit not ready !
700152	Spindle not enabled ?
Possible cause and remedy	• Enable spindle on machine control panel.
700153	Spindle hold.
700154	Tool not clamped, spindle stop
700155	M00/M01 Spindle stop.
700156	Tool changer not at home, Spindle stop.

Number	Message description
700157	Spindle controlled by PLC
700158	Change phases on main electrical connection
700159	PLC-Alarm (DB1600.DBX19.7)
700160	Tool clamp/unclamp sensor fault.
700161	Lubrication time setting error,check setting data
700162	Lubrication level low.
700163	Lubrication pressure not reached.
700164	Chip conveyor motor overloaded.
700165	Chip conveyor motor contactor feedback error.
Possible cause and remedy	• Contactor of the conveyor motor signals an incorrect switch status. • Drive motor connector for chip conveyor is not connected ?
700166	Chip auger motor overloaded.
700167	Chip auger motor contactor feedback error.
Possible cause and remedy	• Contactor of the conveyor motor signals an incorrect switch status. • Drive motor connector for chip conveyor is not connected ?
700168	Magazine counter too fast(%Fsecond), position value is not valid.
700169	Magazine stop but not in position, position value is not valid.
700170	Magazine needs to go to reference.
700171	Magazine rotation control mode not in auto,tool change interrupted.
700172	Magazine location for return tool is not free, tool change not possible.
700173	Chip Wash motor overloaded
700176	Arm position sensor fault.
700179	plc alarm DB1600.DBX22.3
700180	Air pressure low.
Possible cause and remedy	• Compressed air switch in the near of the compressed air maintenance unit report a low pressure. • ☞ "Compressed air supply“ on page 21 • ☞ "Drain compressed air service unit“ on page 102 • ☞ "Connection compressed air supply“ on page 45
700181	Coolant system low.
700186	Automatic / manual switch must be switched
700190	CTS coolant tank is full
700202	Safety Integrated Test Stop Request
700203	Feed override =0
700205	Chip conveyor disabled, close door/release emergency stop.
700206	Chip conveyor disabled, close door/release emergency stop.

Number	Message description
700207	Manual tool unclamp disabled, stop spindle and program first.
700210	Magazine referencing . . .
700211	Magazine jog disabled, close door/reset program.
700212	Safety door operation disabled, stop program/spindle first!
700213	Tool pocket manual up/down disabled, close door/stop program,check magazine and arm.
700214	Arm rotate manual disabled, stop program and jog pocket down first.
700215	Magazine in/out disabled, close door/reset program
700216	ALM status: EP is ON
700217	ALM status: OFF1 is ON
700218	ALM status: OFF3 is ON
700220	ASUP1 initializing .
700221	ASUP2 initializing .
700222	Spindle clamp without tool, speed limited.
700224	Checking position . . .
700225	Unclamp spindle to continue . . .
700226	Clamp spindle to continue .
700227	Arm reverse from home position is not allowed.
700228	Safety Integrated Safe Operational Stop Active
700229	Safety Integrated Safe Stop 1 Active (ESTOP)
700230	Please go to reference !
700231	Safety Integrated Please Close Door for Test
700232	Maintenance Task 1 Alarm
700233	Maintenance Task 1 Message
700234	Maintenance Task 2 Alarm
700235	Maintenance Task 2 Message
700236	Maintenance Task 3 Alarm
700237	Maintenance Task 3 Message
700238	Maintenance Task 4 Alarm
700239	Maintenance Task 4 Message
700240	Maintenance Task 5 Alarm
700241	Maintenance Task 5 Message
700242	Maintenance Task 6 Alarm
700243	Maintenance Task 6 Message
700244	Maintenance Task 7 Alarm
700245	Maintenance Task 7 Message

Number	Message description
700246	Maintenance Task 8 Alarm
700247	Maintenance Task 8 Message

9 SINUMERIK 828 D

The instructions for the use of the SIEMENS control "SINUMERIK 828 D" is composed of the following items which are listed at the end of these operating instructions or separately attached to the machine.

Operating instructions

Edition: 06/2009

Document number: 6FC5398-7CP20-0AA0

Programming manual production planning

Edition: 06/2009

Document number: 6FC5398-2BP20-0AA0

Programming manual milling

Edition: 06/2009

Document number: 6FC5398-7BP10-1AA0

SinuTrain "Simple milling using ShopMill"

Edition: 06/2009

Document number: 6FC5095-0AB50-1AP0

Diagnosis manual

Edition: 06/2009

Document number: 6FC5398-8BP10-0AA0

For any questions regarding the CNC control, please contact:

Siemens AG, A&D techsupport

Phone (+49) 0180 50 50 222

mailto: techsupport@ad.siemens.de

Siemens AG Hotline, Helpline

Phone (+49) 0180 50 50 111

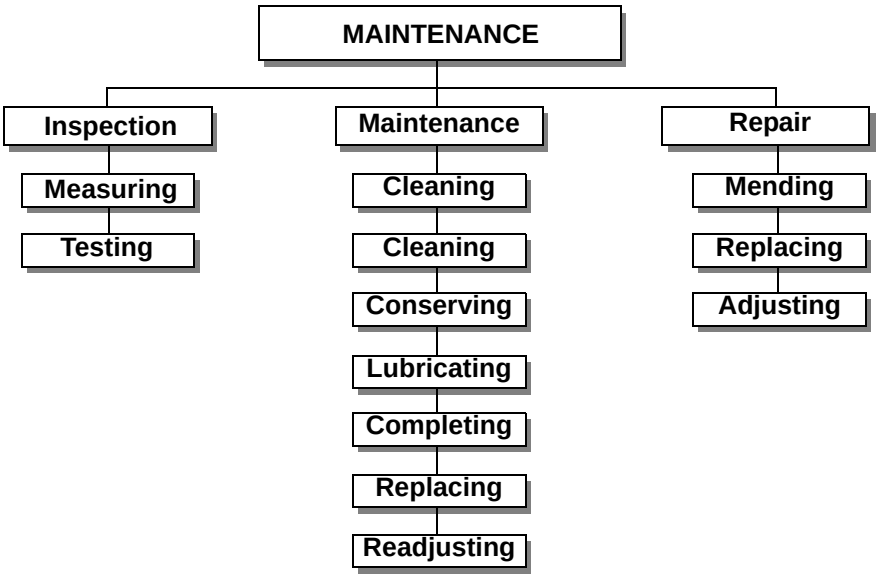
10 Maintenance

In this chapter you will find important information about

- Inspection
- Maintenance
- Repair

of the CNC machine

The diagram below shows you which tasks belongs to which term.



Img. 10-1: Maintenance – Definition according to DIN 31 051

ATTENTION!

Properly performed regular maintenance is an essential prerequisite for

- **operational safety,**
- **failure-free operation,**
- **long service life of the CNC machine and**
- **the quality of the products which you manufacture.**

Installations and equipment from other manufacturers must also be in good order and condition.

10.1 Operating material

10.1.1 Machine lubricants

Only use appropriate lubricants which guarantee a safe operation of the machine.

Recommended lubricant class: ISO V668
Recommended lubricant: guideway oil Mobil Vactra (Oil No. 2) 2)

10.1.2 Cooling lubricants

In order to avoid interferences during operation the water-mixed cooling lubricant and the slide-way oil or grease need to be compatible.

Read also: ☞ "Cooling lubricants and tanks“ on page 108

INFORMATION

The CNC milling machine is lacquered with a one-component paint. Observe this fact when selecting your cooling lubricant.

The company Optimum Maschinen Germany GmbH does not assume any guarantee on subsequent damages due to unsuitable cooling lubricants.

The flashpoint of the emulsion must be higher than 140°C.

When using cooling lubricants that cannot be mixed with water (oil content > 15%) with a flashpoint, ignitable aerosol air mixtures might develop. There is a potential danger of explosion.

ATTENTION!

Only the correct selection of an appropriate combination of cooling lubricants and slideway oils as well as the proper care and maintenance of the cooling lubricant can ensure that no problems such as stick-slip effects or deposits are resulting.

The selection of cooling lubricants and slideway oils, lubricating oils or greases as well as their care are being determined by the machine operator or operating company.

Therefore, Optimum Maschinen Germany GmbH cannot be held liable for machine damages caused by unsuitable coolants and lubricants as well as by inadequate maintenance and servicing of the coolant. In case of problems with the cooling lubricant and the slideway oil or grease, please contact your supplier for mineral oils.

ATTENTION!

Cooling lubricants and oils for the mechanic and pneumatic system of the machine have to be adjusted referring the water added initially, the cooling lubricant emulsion and the machining task.

We would like to ask you to have the following machine-related properties of the cooling lubricant confirmed in writing by the manufacturer of the cooling lubricant.

- The products must comply with the provisions of the current statutory regulations and the employers liability insurance association.
- Request documentation for the products such as the product description VKIS and EC safety data sheet from the cooling lubricants manufacturer. The EC safety data sheet gives you information about the water-hazard class.

They need to be environmentally friendly and workplace-friendly. Thus, they need to be free of nitrite, PCB, chlorine and nitrosinable diethanolamin (DEA), according to TRGS 611.

- The manufacturer should be able to submit a certificate concerning skin-tolerance.
- The mineral content according to DIN 51417 should be at least 40% concentrate.
- If possible, it should be universally applicable for all chippings and materials.
- Long service life of the emulsion e.g. long-term stable and resistant to bacteria.
- Safe corrosion protection according to DIN 51360/2.
- Re-emulsifiable and non-adhesive according to VKIS sheet 9: Sticking and residue behaviour.
- It should not attack the varnish of the machine according to VDI 3035.
- It should not attack any machine elements (metals, elastomeres).
- Low foaming behaviour of the emulsion.
- It should be as finely dispersed as possible in order to avoid clogging in the needle slot screen.

10.2 Safety

WARNING!

The consequences of incorrect maintenance and repair work may include:

- **Severe injuries of persons working on the CNC machine,**
- **damage to the CNC machine.**

Only qualified personnel should carry out maintenance and repair work on the circular CNC machine.

Validation

Check and maintain all safety-relevant stop, control and measuring devices (validation).

Documentation

Record all tests and works in a operator's log resp. log book.

10.2.1 Preparation

WARNING!

Only carry out work on the CNC machine, if the main switch is switched off and secured against restarting by means of a padlock.

☞ "Disconnecting and securing the CNC machine“ on page 18

Attach a warning sign.

10.2.2 Restarting

Before restarting, run a safety check.

☞ "Safety check“ on page 16

WARNING!

Before starting the CNC machine, you must check that there is no danger for persons and that the CNC machine is not damaged.

It is recommended to clean the electrical cabinet every 1000 operating hours.

10.3 Repair

10.3.1 Customer service technician

For any repair work request the assistance of an authorised customer service technician. Contact your specialist dealer if you do not have customer service's information or contact Stürmer Maschinen GmbH in Germany who can provide you with a specialist dealer's contact information. Optionally, the

Stürmer Maschinen GmbH

Dr.-Robert-Pfleger-Str. 26

D- 96103 Hallstadt

can provide a customer service technician, however, the request for a customer service technician can only be made via your specialist dealer.

If the repairs are carried out by qualified technical personnel, they must follow the indications given in these operating instructions.

The company Optimum Maschinen Germany GmbH does not take any liability nor does it guarantee against damage and operating malfunctions resulting from failure to observe this operating instructions.

For repairs only use

- faultless and suitable tools,
- original parts or parts from series expressly authorized by Optimum Maschinen Germany GmbH.

10.4 Inspection and maintenance

The type and level of wear depends to a large extent on the individual usage and operating conditions. Any indicated intervals therefore are only valid for the corresponding approved conditions.

Interval	Where?	What?	How?	Check ✔
Start of work, after each maintenance or repair work	**CNC milling machine**	☞ "Safety check“ on page 16		
	Sight window	Cleaning	Clean the sight windows made of polycarbonate using a suitable cleaning agent.	
	Compressed air supply	Draining	☞ "Drain compressed air service unit“ on page 102	
Start of work, Daily after every maintenance or repair work	**Lubricant tank Slideway oil**	Filling level control	Manual Check the quantity and refill the lubricant tank of the central lubrication system. See also ☞ "Cooling lubricants“ on page 93	
	Oil collecting tank	Empty	Check the oil level in the oil collecting gutter. Empty the oil collecting tank.	

Interval	Where?	What?	How?	Check ✔
Every week	CNC- milling machine	☞ "Data backup on the control“ on page 49		
Every week		Oiling Lubricating	Oil all bare steel surfaces. Use an acid-free oil, e.g. weapon oil or motor oil. Press the push-button of the central lubricating system.	
Every week	Cooling lubricant tank	Status control of filling level	Check for liquid level, concentration, pH value, bacteria and fungal decay. ☞ "Cooling lubricants and tanks“ on page 108	
every week	Cooling lubricant	pH value measuring	Check the ph-value. If required, replace the cooling lubricant. ☞ "Inspection plan for water-mixed cooling lubricants“ on page 109	
Every week	Drip feed lubricator Compressed air cylinder	Filling level control	Check the liquid level and refill if required.	
Every month	Gear belt Spindle head	Check Readjusting Replacing	Check the drive belt on wear and excessive clearance. If required, readjust the gear belt and/or replace it.	
	Air purge	Check Readjusting	Check the function of the air purge. If necessary re-adjust the amount of air. ☞ "Air purge“ on page 102	
Annually	Clutch Coupling Drive Z-, Y-, X-axis	Check Replacing	Check if coupling is worn and check coupling slack. If necessary, replace the coupling.	

Interval	Where?	What?	How?	Check ✔
Every 1000 operating hours	Wipers on the slides	Check Replacing	Check the wipers on the slides. Replace if damaged immediately.	
	Switch cabinet	Cleaning	☞ "Cleaning electrical cabinet“ on page 101	
	Servo motors	Inspection	Connections on the servo motors.	
Every six months	Tool changer	Check the tool change function. Positioning	By manual changing ☞ "Manual operation of the tool changer“ on page 76	
As required	Chip collection tray	Cleaning	Clean the chip collection tray of the cooling lubricant equipment.	
Annually	Chip conveyor	Check Readjusting	Check, readjust the scraper of the screw conveyor ☞ "Späneförderer - Chip convejor“ on page 135 Position No 10.	
Empirical value of the operator	Chip collection tray	Cleaning	Clean the precoat filter of the chip tray ☞ "Maschinengehäuse - Machine housing“ on page 134 Position No 49.	
60 months	Protective covers	Replacing the sight window	☞ "Cleaning and replacing of the polycarbonate windows“ on page 100	

Interval	Where?	What?	How?	Check ✔
based on operator's empirical values in accordance with German DGUV (BGV A3)	Electrical system	Electrical inspection	☞ "Obligations of the operating company“ on page 12 ☞ "Electrical system“ on page 20 ☞ "Validation“ on page 95	

10.4.1 Disassembly of the cooling lubricant tank

The coolant / lubricant tank can be completely extracted from below the CNC machine for cleaning purposes. In order to allow this, the following working steps are required.

- Disassemble the cooling pump and the hoses.
  ☞ "Coolant / lubricant pumps“ on page 35

Img. 10-2: Cooling lubricant tank

10.4.2 Cleaning and replacing of the polycarbonate windows

WARNING!

The polycarbonate viewing window are part of the safety device on your CNC machine.

Damaged, scratched or even broken polycarbonate windows must be replaced immediately.

A soft cloth should be used to clean the machine safety glass. Have been tested and approved by us:

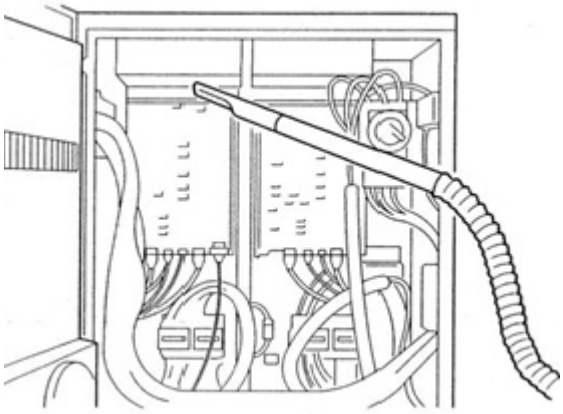
Hahnerol glass cleaner (Hahnerol), Sidolin Streak Free (Henkel), Active Window Cleaner (Neumann).

We recommend to replace the polycarbonate viewing window of the door after 60 months of commissioning of the CNC machine.

In the following cases, an immediate replacement is strongly recommended:

- plastic deformation (distortion) by previous impact stress,
- cracks,
- Damage to the edge seal,
- immersion of cooling agent in the composite structure,
- destroyed or damaged window (coating) on the workspace or operator position.

10.4.3 Cleaning electrical cabinet



Although the electrical cabinet is constructed to shut off external air, foreign particles such as dust and dirt may enter the cabinet when the door is open.

Accumulation of foreign particles on the printed circuit boards or other electronic components could cause machine malfunction.

Clean the inside of the electrical cabinet regularly.

Remove dust inside electrical cabinet with a vacuum cleaner. Do not use compressed air to clean inside the electrical cabinet.

Never touch circuit boards or parts around the connector. Also avoid hitting these parts with the vacuum.

Cleaning the electrical cabinet every 1000 operating hours is recommended.

10.4.4 Refill the compressed air oiler

The compressed air oiler ensures that pneumatic devices receive the necessary lubrication to reduce wear and prolong the service life.

Check the compressed air oiler at regular intervals. Refill oil If the oil level falls below the minimum level.

Img. 10-3: Compressed air service unit

10.4.5 Drain compressed air service unit

The filtration of water and other impurities in the compressed air is automatic when compressed air flows through the maintenance unit.

If the water level of the filter housing exceeds the maximum limit, the water enters the pneumatic equipment and cause damage.

Check the water level daily and drain the water level in the filter when needed. Drain the water by pressing a finger on the button at the bottom of the drainage filter housing.

Img.10-4: Compressed air service unit

10.4.6 Air purge

The air purge prevents the ingress of fine chips in the bearings of the spindle. During operation, the spindle is thus continuously supplied with compressed air. Make sure that the spindle is supplied by the air purging pressure regulator with compressed air.

Img.10-5: Compressed air service unit

10.4.7 Replacing of compressed air filter

The air filter can filter dust and moisture from the compressed air.

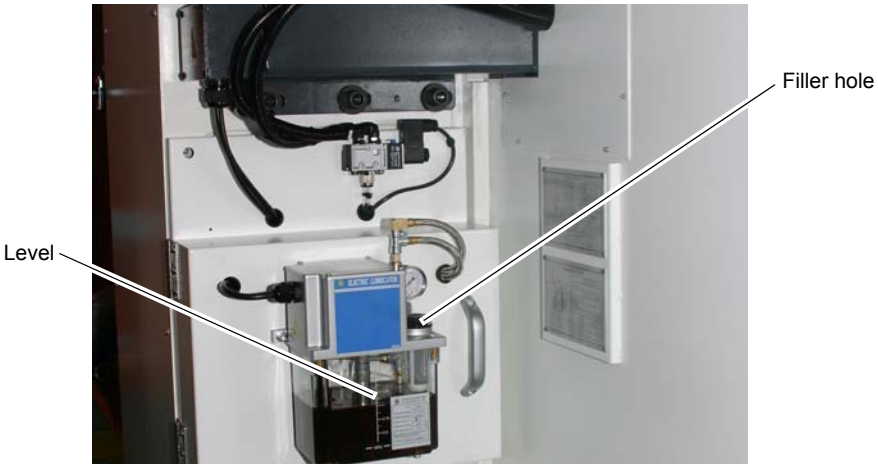
If the air filter is clogged, the amount of compressed air to the air actuators is reduced and the function is impaired or fails.

Be sure to check regularly the air filter for dirt or obstruction.

It is recommended to replace the air filter at least every 2000 operating hours.

10.4.8 Refill central lubrication system

The central lubrication system supplies important functionally parts of the CNC machine. With too low level warning is the No. 700 162 .

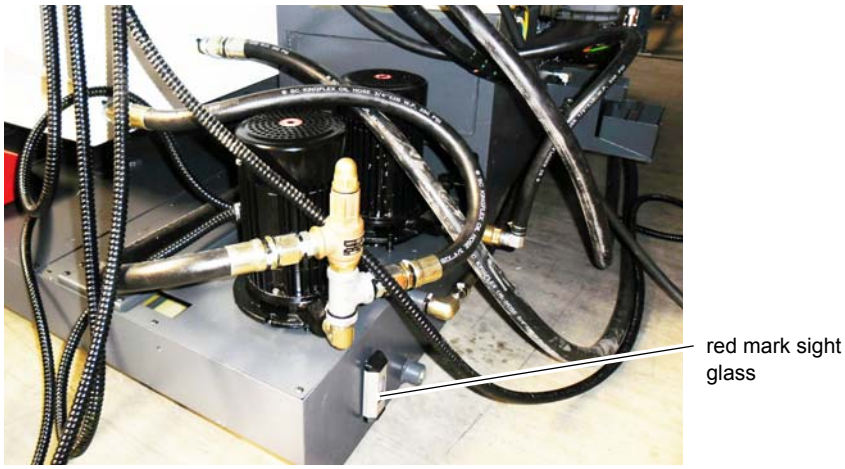


Img. 10-6: Central lubrication system

10.4.9 Fill up coolant

If the coolant level is lower than the red mark on the sight glass the amount of coolant to the cutting tool is insufficient. Continuing the processing under such conditions leads to a reduced service life of the cutting tool and reduces the life of the cooling lubricant pump.

Fill the coolant tank through the working area of CNC machine.



Img. 10-7: coolant tank and chip pan

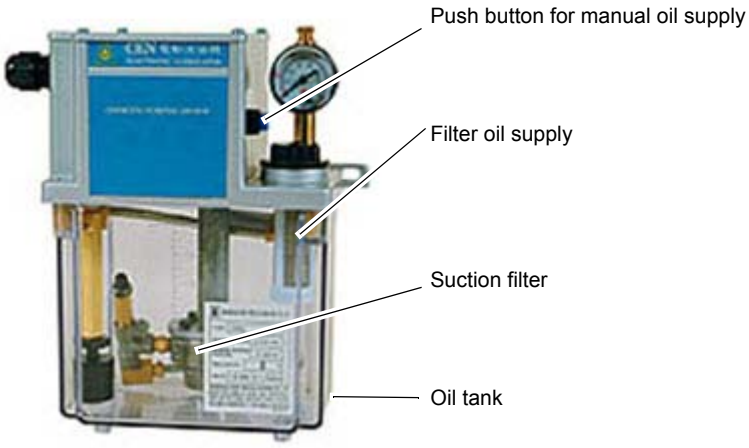
10.4.10Cleaning of oil tank and oil filters on the central lubrication system

- ➜ Remove the lubricating oil tank. Pay attention not to spill the lubricating oil when removing the tank.
- ➜ Clean the inside of the lubricating oil tank with diesel oil.
- ➜ Remove the suction filter from the suction port.
- ➜ Clean the suction filter with diesel oil.
- ➜ Blow the suction filter with compressed air.
- ➜ Remove the filter at the oil supply port.
- ➜ Clean oil supply port filter with diesel oil.
- ➜ Install the filter and the lubricating oil tank.
- ➜ Fill the tank with lubricating oil. ☞ "Refill central lubrication system“ on page 47
- ➜ Press the push button for manual oil supply.

ATTENTION!

Never press the push button for manual oil supply more than 3 minutes. When the temperature reaches 100°, the motor will shut down about 5 minutes to protect the motor. The motor is then turned off for approximately 5 minutes in order to protect the motor.

- ➜ Make sure that lubricating oil is supplied to the slideway surfaces.



Img. 10-8: Central lubrication system

10.5 Optional CTS system

Interval	Where?	What?	How?	Check ✔
Every day	CTS unit	Check the coolant level check	➜ Fill with coolant when the level reaches the minimum level. ➜ Make sure that the pressure gauge reaches the intended operating pressure. ➜ If the machine is out of pressure in a cutting condition, stop the machine immediately and ensure the inlet and outlet filters are not clogged. Check the level and the inlet and outlet filter for blockage.	
Every week		Mixture ratio oil / water	➜ Make sure that the return pipe is not clogged. ➜ Ensure that the proportion of water to coolant is within the range recommended by the coolant manufacturer.	
Every month	Filter and pump	Cleaning	➜ Clean the inlet and outlet filters to obtain a good filtering performance. ➜ Make sure that the system is not leaking. ➜ Ensure there is no abnormal noise when the motor is running.	
Annually	CTS unit	Replacing Check	➜ Replace the inlet and outlet filters to maintain high quality of coolant. ➜ Ensure that all switches, pressure switches, pressure gauges work properly.	

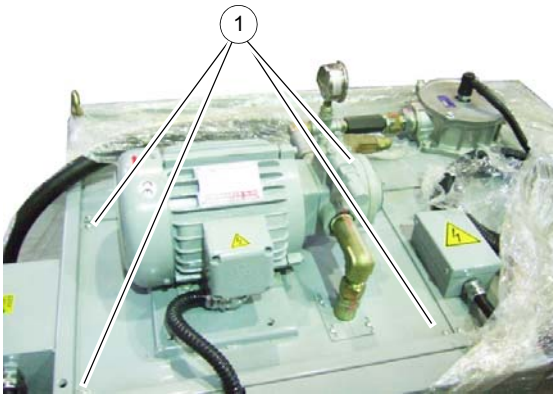
10.5.1 Cleaning and replacing the filters on the external CTS system

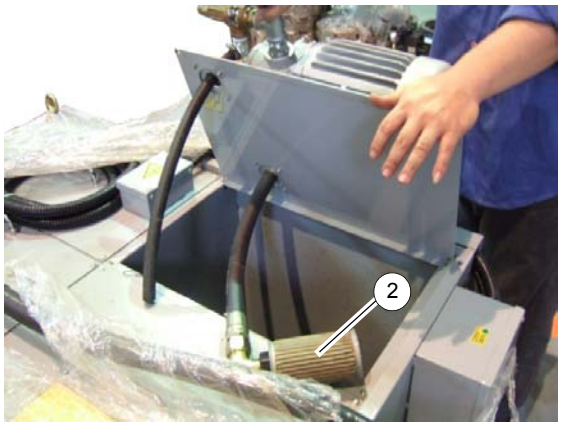
If the filters of CTS system are clogged, cavitation is generated. Cavitation could damage the piping and pump. In addition, if contaminated coolant is pumped to the CTS system, fine chips may enter the pump, generating abnormal noise and shortening the service life of the pump.

- ❍ Monthly - Clean the filter
- ❍ Annually - Changing the filter

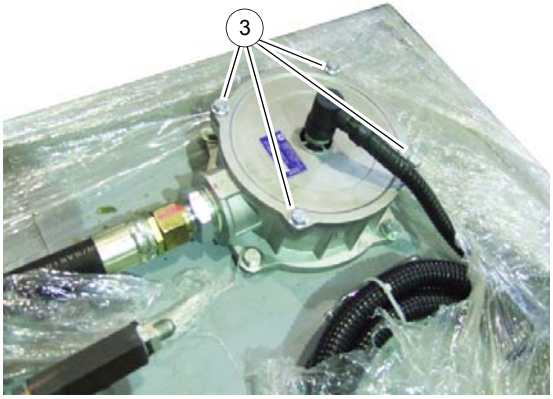
➜ Loosen the screws on the metal sheet of motor.

➜ Open the metal sheet of motor, remove the outlet filter and clean/replace it.





➜ Loosen the four screws (3) and lift the cover of the outlet filter (4) .



➜ Clean / replace the outlet filter (5).

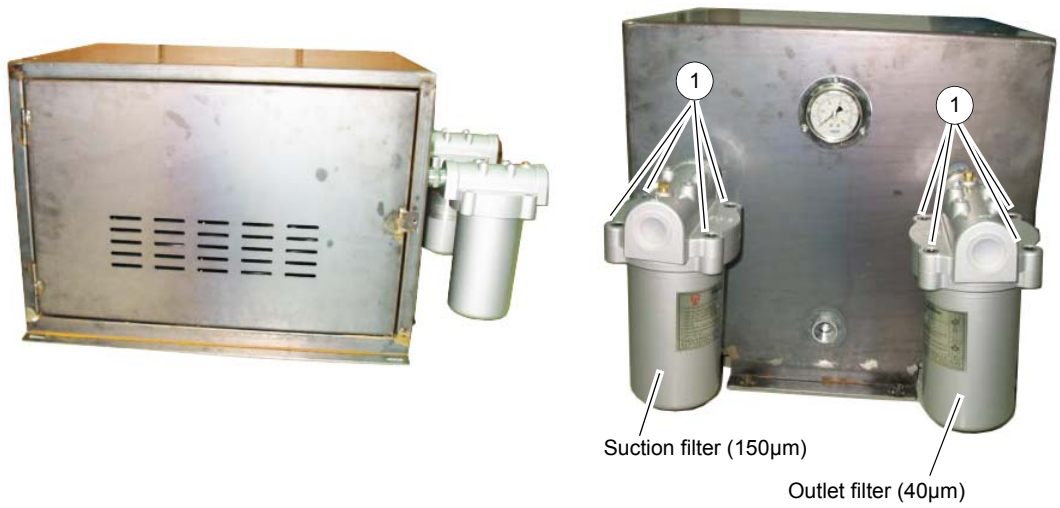
Img. 10-9: external CTS unit

10.5.2 Cleaning and replacing the filters on the internal CTS system

The internal CTS system is supplied with the coolant of the machine.

In order to clean or change the filter, the filter housing must be opened. To do this, loosen the screws (1) on the filter housings.

- Monthly - Clean the filter
- Annually - Changing the filter



Img. 10-10: external CTS unit

10.6 Cooling lubricants and tanks

CAUTION!

The cooling lubricant can cause diseases. Avoid direct contact with cooling lubricant or parts covered in cooling lubricant.

Cooling lubricant circuits and tanks for water-cooling lubricant mixtures must be completely emptied, cleaned and disinfected as needed, but at least once per year or every time the cooling lubricant is replaced.

If fine chips and other foreign matters are accumulated in the coolant tank, the machine can no longer be correctly supplied with coolant. Furthermore, the lifetime of the coolant pump is reduced.

When processing cast iron or similar materials generating fine chips, cleaning the coolant tank more often is recommended.

The cooling lubricant must be replaced, the cooling lubricant circuit and tank emptied, cleaned and disinfected if

- the pH value drops by more than 1 based on the value during initial filling. The maximum permissible pH value during initial filing is 9.3
- there is a perceivable change in the appearance, odour, floating oil or increase of the bacteria to more than 10/6/ml
- there is an increase in nitrite content to more than 20 ppm (mg/1) or nitrate content to more than 50 ppm (mg/1)
- there is an increase in the N-nitrosodiethanolamine (NDELA) to more than 5 ppm (mg/a)

CAUTION!

Comply with the manufacturer's specifications for mixture ratios, hazardous substances, e.g. system cleaners, including their permissible minimum use times.

CAUTION!

Since the cooling lubricant escapes under high pressure, pumping out the coolant by using the existing cooling lubricant pump via a pressure hose into a suitable tank is not recommended.

ENVIRONMENTAL PROTECTION

During work on the cooling lubricant equipment please make sure that

- **collector tanks are used with sufficient capacity for the amount of liquid to be collected.**
- **liquids and oils should not be spilled on the ground.**

Clean up any spilled liquid or oils immediately using proper oil-absorption methods and dispose of them in accordance with current statutory environmental regulations.

Collect leakages

Do not re-introduce liquids spilled outside the system during repair or as a result of leakage from the reserve tank, instead collect them in a collecting container for disposal.

Disposal

Never dump oil or other substances which are harmful to the environment into water inlets, rivers or channels. Used oils must be delivered to a collection centre. Consult your supervisor if you do not know where the collection centre is.

10.6.1 Inspection plan for water-mixed cooling lubricants

Company: No.: Date: used cooling lubricant			
size to be checked	Inspection methods	Inspection intervals	Procedure and comment
noticeable changes	Appearance, odour	daily	Find and rectify causes, e.g. skim off oil, check filter, ventilate KSS
pH value	Laboratory techniques electrometric with pH meter (DIN 51369) Local measurement method: with pH paper (Special indicators with suitable measuring range)	weekly [1)]	if pH value decreases > 0.5 based on initial filing: Measures in accordance manufacturer's recommendations > 1.0 based on initial filing: Replace KSS, clean KSS circulation system
Usage concentration	Manual refractometer	weekly [1)]	Method results in incorrect values with tramp oil content
Base reserve	Acid titration in accordance with Manufacturer's recommendation	as required	Method is independent of tramp oil content
Nitrite content	Test sticks method or laboratory method	weekly [1)]	> 20 mg/L nitrite: Replace KSS or part or inhibiting additives; otherwise NDELA in the KSS and in the air must be determined > 5 mg/L NDELA in the KSS: Replacement, clean and disinfect KSS circulation system, find nitrite source and, if possible, rectify.
Nitrate/nitrite content of the preparation water, if this is not removed from the public grid	Test sticks method or laboratory method	as required	Use water from the public grid if there is water from the pubic grid has > 50 mg/l nitrate: Inform the waterworks

[1)] The specified inspection intervals (frequency) are based on continuous operation. Other operational conditions can result in other inspection intervals; exceptions are possible in accordance with Sections 4.4 and 4.10 of the TGS 611.

Editor:

Signature:

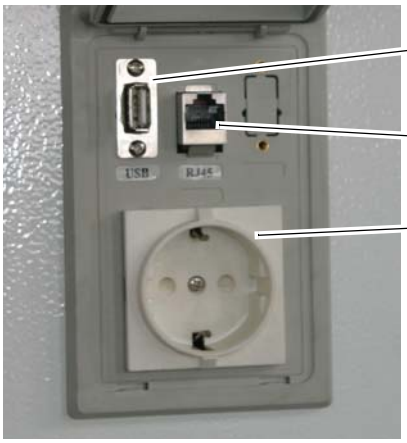
10.7 Network

10.8 Data interfaces and current collection

When connecting data interfaces make sure that the data cable runs to the interface of the controlwithin shortest possible distance. The cable routing can be conducted along the measuring system lines. However the cable in the switch cabinet must never be routed nearby the drive apparatuses of the NC axis or the frequency converter itself. Errors occur during data transfer due to electromagnetic radiation (EMC-problems).

The control is equipped with the following data interfaces. They are located laterally on the control panel of the CNC-maschine:

- RJ45 plug- in connection
- USB connection
- Power connection (socket for current supply (230V) e.g. for a notebook)



⚠Warning!

Do not use any devices which require more than 2 A current!

Img.10-11: Data interfaces and current collection

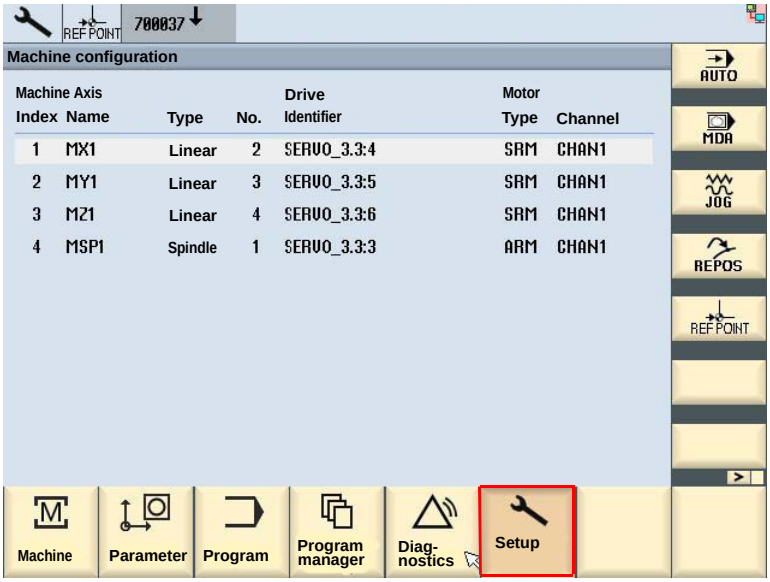
10.9 Installation and network connection

INFORMATION

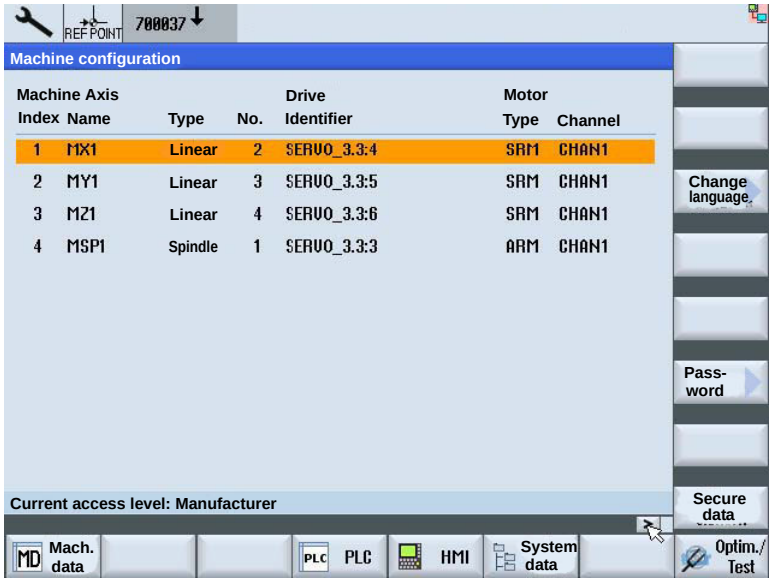
Note the level of access ☞ "Key switch“ on page 69 **in order to call the menu shown below.**

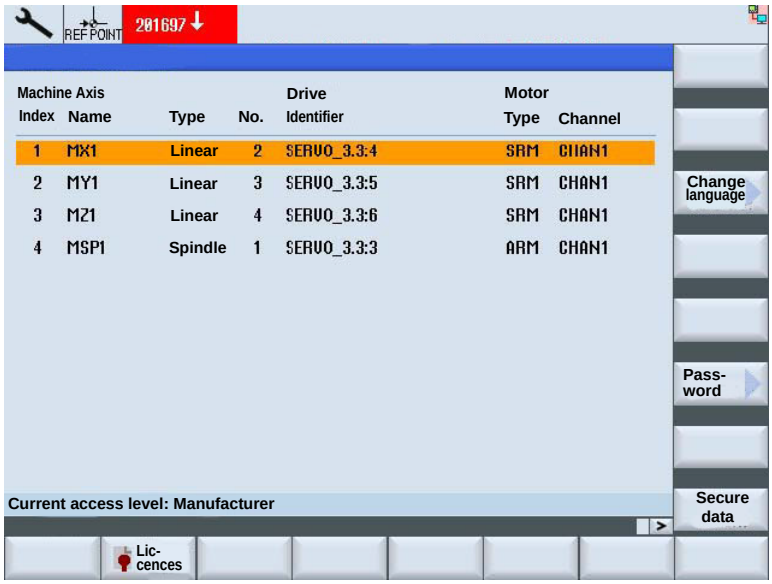
In order to install on the network connection it is necessary to execute the following steps.

➜ Press the key <Menu Select> and then the softkey "Setup".

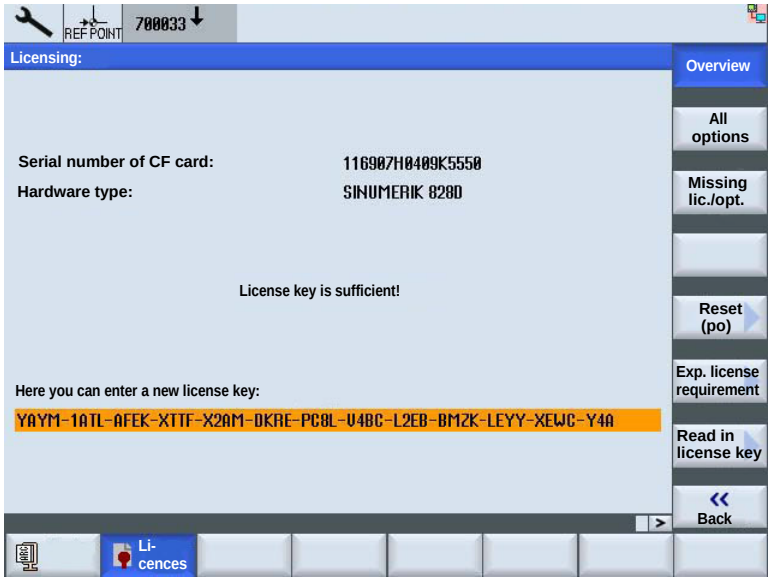


Press the button "Menu advance", until it appears on the horizontal softkey bar "Licenses".



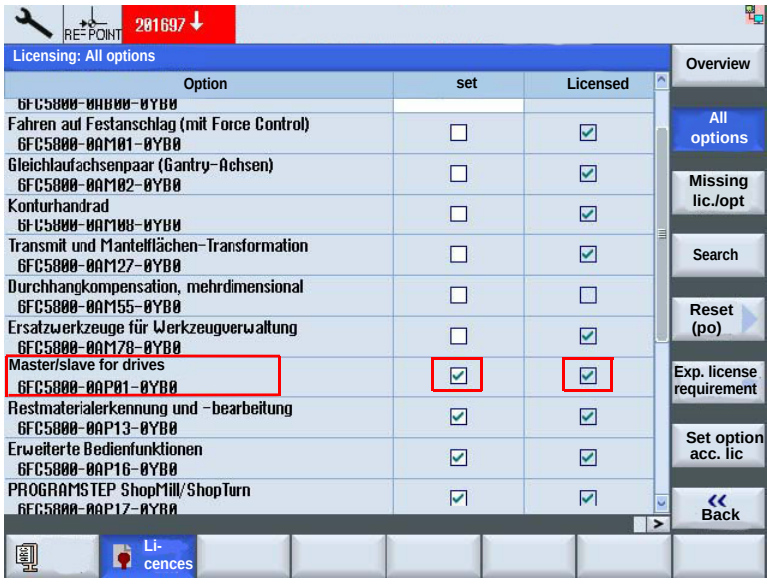


➜ Press the button "Licenses" and then "All options".



➜ Press the button "All options" and check the item "Administrate networks". Ignore this item if you have already executed it.

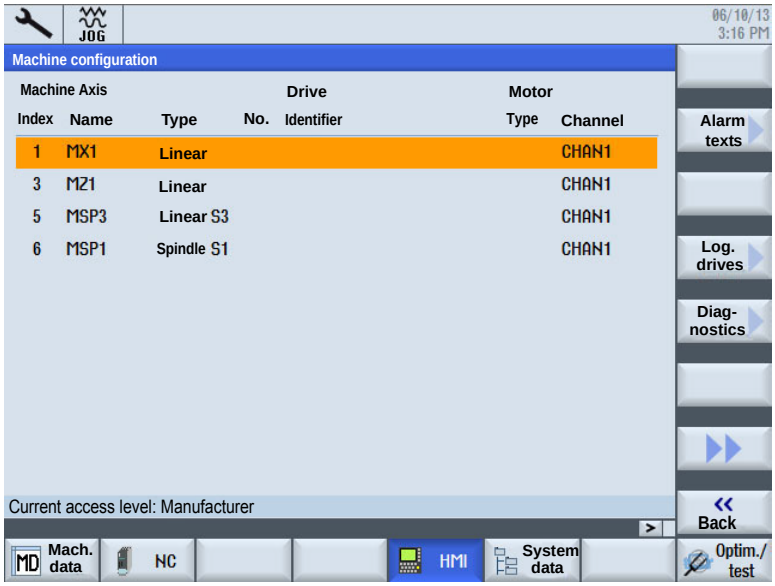
➜ Press the button "Back" until you get back to the main menu.



➜ Press the key <Menu Select> and then the softkey "Setup".

➜ Press the button "HMI button". If you cannot see the HMI icon 

it is necessary to enter the user password first.



➜ Press the button "Log. drives".

➜ Start the installation of the second drive on your network. Confirm by pressing the button "OK".

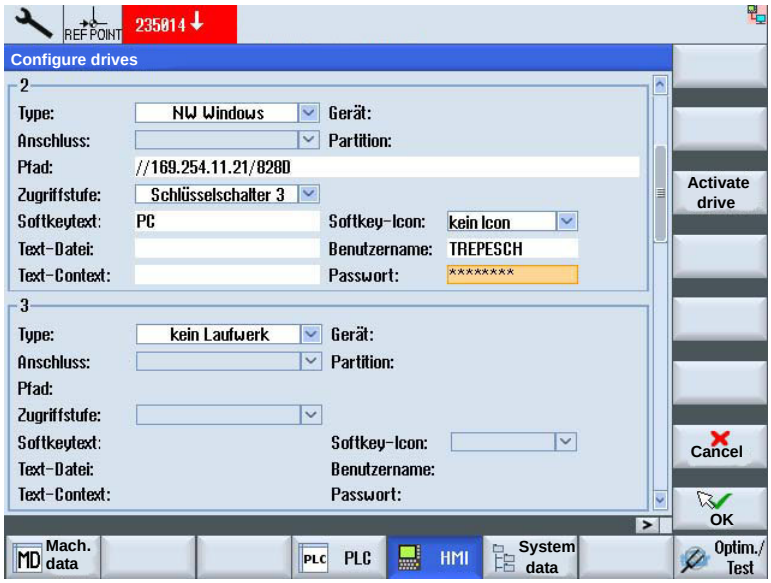
➜ Enter "NW Windows" as well as the IP address and the name of the folder to which you would like to connect the PC.

➜ Enter the following data:

- Type
- Connection:
- Path: IP address and folder
- Access level:
- Softkey text:
- User name
- Password: PC password

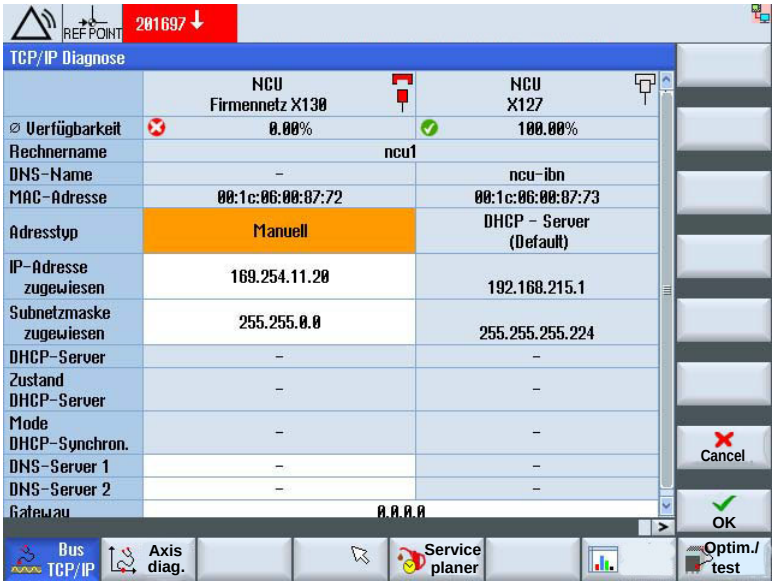
➜ Activate the drive.

➜ Confirm by pressing the button "OK".

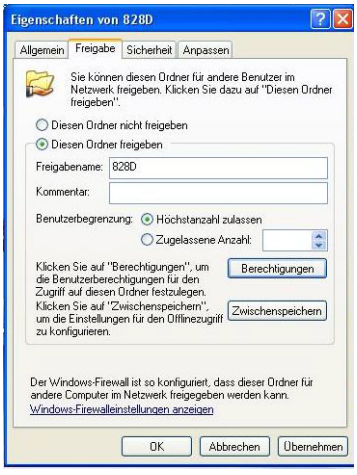


➜ Connect your PC to the rear of the 828D control.

➜ Press the buttons "Menu select" and "Diagnostics".
➜ Press the button "Menu advance", until "Bus TCP/IP" appears on the horizontal softkey bar. Press this button.
➜ Press the buttons "TCP/IP Diagnostics", "Details“ and "Change“.
➜ Select the address type "Manual".
➜ Enter the number of your PC in the field IP address.
➜ Confirm again by pressing "OK" and restart.



Perform the following settings for the folder on your PC where you have stored the software 828D (refer to illustrations above and below).



10.10 Executing from an external position

Excerpt from the manual of the operating instructions for "SINUMERIK 828 D".

12.13 EXTCALL

It is possible to access the files on the local drive , USB data carrier or networks using the command EXTCALL .

The programmer can determine the source directory by means of the setting date SD$SC42700 EXT_PROG_PATH and file name for the sub-program to be reloaded using the-command EXTCALL.

Edge conditions

Observe the following edge conditions for EXTCALL prompts:

- It is only possible to call files with the identification MPF or SPF via EXTCALL from a network.
- The files and paths have to correspond to the NCK nomenclature (max. 25 characters for the name, 3 characters for the identification).
- A program on a network can be found using the command EXTCALL if
  - the search path refers to the network or to a directory SD $SC42700 EXT_PROG_PATH. The program has to be directly filed, no sub-directories are browsed.
  - Without SD $SC42700: in the EXTCALL prompt the program is directly indicated and alsolocated there - via a fully qualified path, which can also refer to the network driv .

Examples for EXTCALL prompts

The setting data can be used to perform a target search for the program.

- Prompt USB drive to TCU (USB storage device on the interface X203), whenSD42700 is empty: e.g. EXTCALL "//TCU/TCU1 /X203 ,1/TEST.SPF"
  - Or -
    Prompt USB drive to TCU (USB storage device on the interface X203), whenSD42700 includes "//TCU/TCU1 /X203 ,1/TEST.SPF" EXTCALL "TEST.SPF"
- Prompt for USB Front connection (USB-FlashDrive), if SD $SC 42700 is empty : e.g. EXTCALL"//ACTTCU/FRONT,1/TEST.SPF"
  - Or -
    Prompt of USB Front connection (USB-FlashDrive), when SD42700 "//ACTTCU/FRONT,1" is included: EXTCALL "TEST.SPF"

10.11 Adjusting the amount of oil at the central lubrication

The amount of oil is controlled by PLC.

ATTENTION!

An incorrectly setting of the timer can leads to a wear of the guideways and the wipers.

Check the guideways after a change of the lubrication cycle at shorter intervals.

INFORMATION

The factory setting is 15 minutes as the interval between lubrication cycles.

The factory setting is 10 seconds for the ON period of the lubrication oil pump.

➜ Call up the main menu for selecting the control areas.

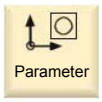
➜ Press the softkey <Startup>.

➜ Press the softkey <Password>.

➜ Press the softkey <Set password> and enter the password "SUNRISE" . ☞ "Passwords“ on page 48

➜ Confirm your entry with the softkey <OK>.

➜ Press the softkey <Parameter>.



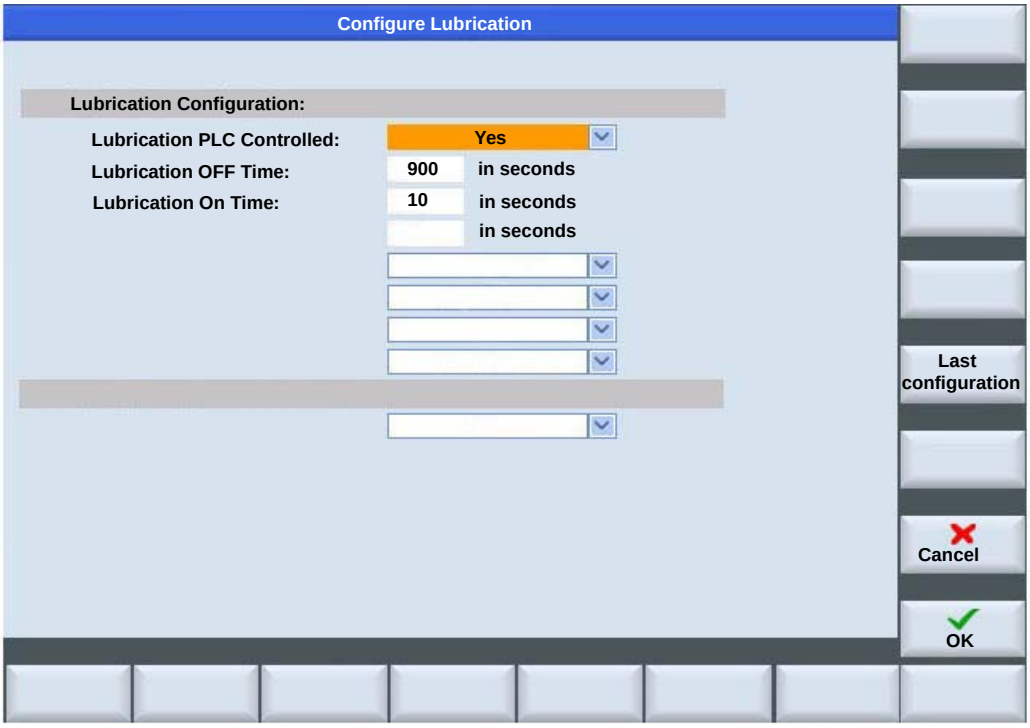
➜ Press the key <MENU FORWARD KEY> until the softkey <Easy Extend> is shown.

➜ Press the softkey <Easy Extend>.

➜ Go with the cursor in the line "lubrication"

➜ Press the emergency stop button and then the softkey <Deactivate>.

➜ Press the softkey <Addition. parameter>. This opens the menu shown below.

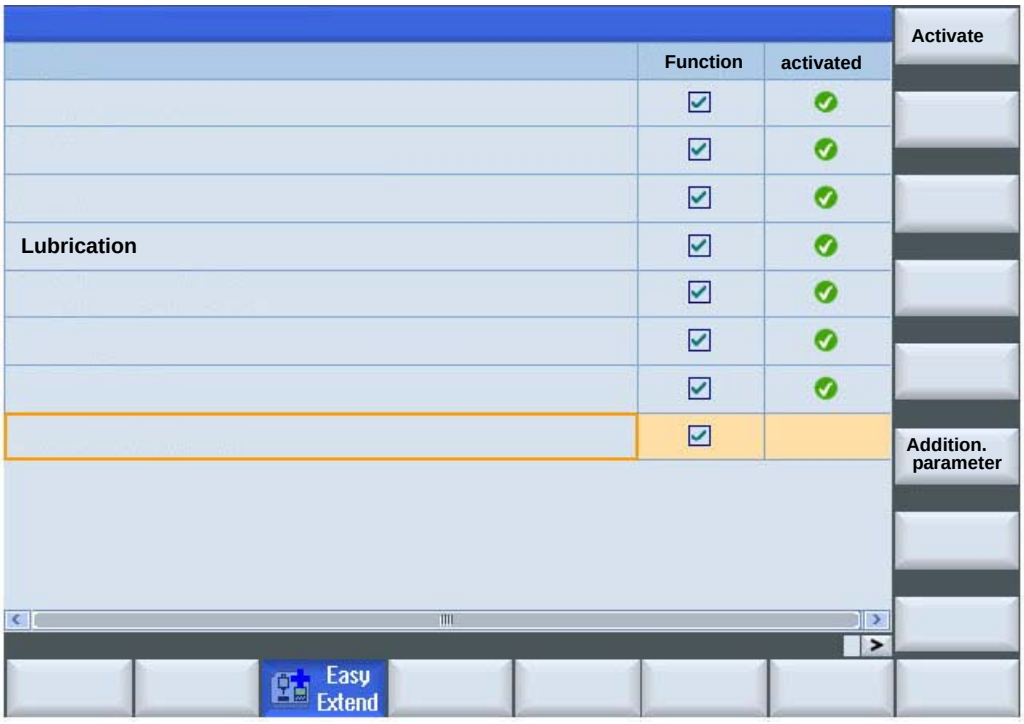


Img. 10-12: Lubrication configuration

➜ Enter the value of <OFF-Time> and <ON-Time> in seconds for lubrication.

➜ Confirm your entry with the softkey <OK>.

➜ Press the softkey <Activate> to accept the settings. The process of setting the amount of lubricating oil is thus completed.



Img. 10-13: Easy Extend

11 Mechanische Ersatzteile - Mechanical Spare parts

11.1 Ersatzteilbestellung - *Ordering spare parts*

Bitte geben Sie folgendes an - *Please indicate the following :*

- Seriennummer - *Serial No.*
- Maschinenbezeichnung - *Machines name*
- Herstellungsdatum - *Date of manufacture*
- Artikelnummer - *Article no.*

Die Artikelnummer befindet sich in der Ersatzteilliste. *The article no. is located in the spare parts list.*

Die Seriennummer befindet sich am Typenschild. *The serial no. is on the type plate.*

11.2 Elektrische Ersatzteile - Electrical spare parts

11.3 Schaltplan - Wiring diagram

Der aktuelle Schaltplan mit Ersatzteilliste befindet sich im Schaltschrank der CNC Maschine.
The current circuit diagram and spare parts list is located in the control cabinet of the CNC machine.

11.4 Fräskopf - Milling head

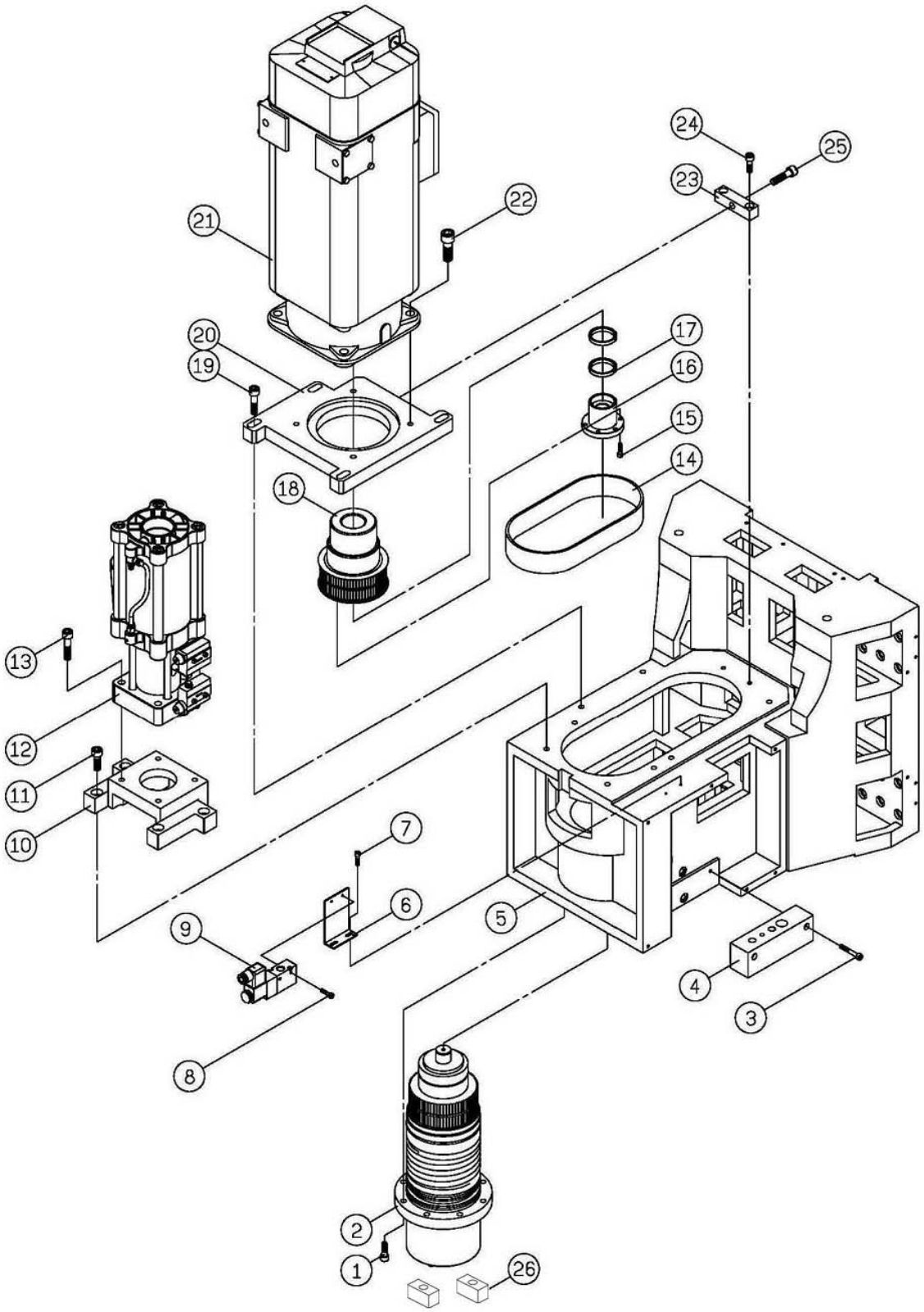


Abb. 11-1: Fräskopf - Milling head

Ersatzteilliste Fräskopf - Spare part list milling head

Pos.	Bezeichnung	Designation	Menge	Grösse	Artikel-nummer
			Qty.	Size	Item no.
1	Innensechskantschraube	Socket head screw	8	M8xP1.25x25L	03511210 01
2	Spindel	Spindle	1	B40-120(8000rpm)	03511210 02
3	Innensechskantschraube	Socket head screw	2	M6xP1.0x40L	03511210 03
4	Verteiler	Distributor	1		03511210 04
5	Spindelkopf	Spindle head	1		03511210 05
6	Halter	Fixing plate	1		03511210 06
7	Innensechskantschraube	Socket head screw	2	M4xP0.7x8L	03511210 07
8	Innensechskantschraube	Socket head screw	2	M4xP0.7x30L	03511210 08
9	Magnetventil	Solenoid valve	1	MVSC-220-3E1	03511210 09
10	Zylindergehäuse	Cylinder housing	1		03511210 10
11	Innensechskantschraube	Socket head screw	4	M10xP1.5x30L	03511210 11
12	Zylinder	Cylinder	1	G4000 2.5Tx13L	03511210 12
13	Innensechskantschraube	Socket head screw	4	M10xP1.5x45L	03511210 13
14	Riemen	Belt	1	5GT-40-675	03511210 14
15	Innensechskantschraube	Socket head screw	6	M5xP0.8x20L	03511210 15
16	Buchse	Blocker	1		03511210 16
17	Ring	Packing toggle	2		03511210 17
18	Riemenscheibe	Pulley	1		03511210 18
19	Hexagon socket screw	Socket head screw	4	M10xP1.5x40L	03511210 19
20	Motorplatte	Motor plate	1		03511210 20
21	Spindle motor	Spindle motor	1	1PH8107-1DF02-0lA1	03511210 21
22	Hexagon socket screw	Socket head screw	4	M12xP1.75x30L	03511210 22
23	Einstellplate	Adjusting plate	1		03511210 23
24	Hexagon socket screw	Socket head screw	2	M8xP1.25x25L	03511210 24
25	Hexagon socket screw	Socket head screw	1	M10xP1.5x40L	03511210 25
26	Nutenstein	Slot nut	2		03511210 26

11.5 Säule - Column

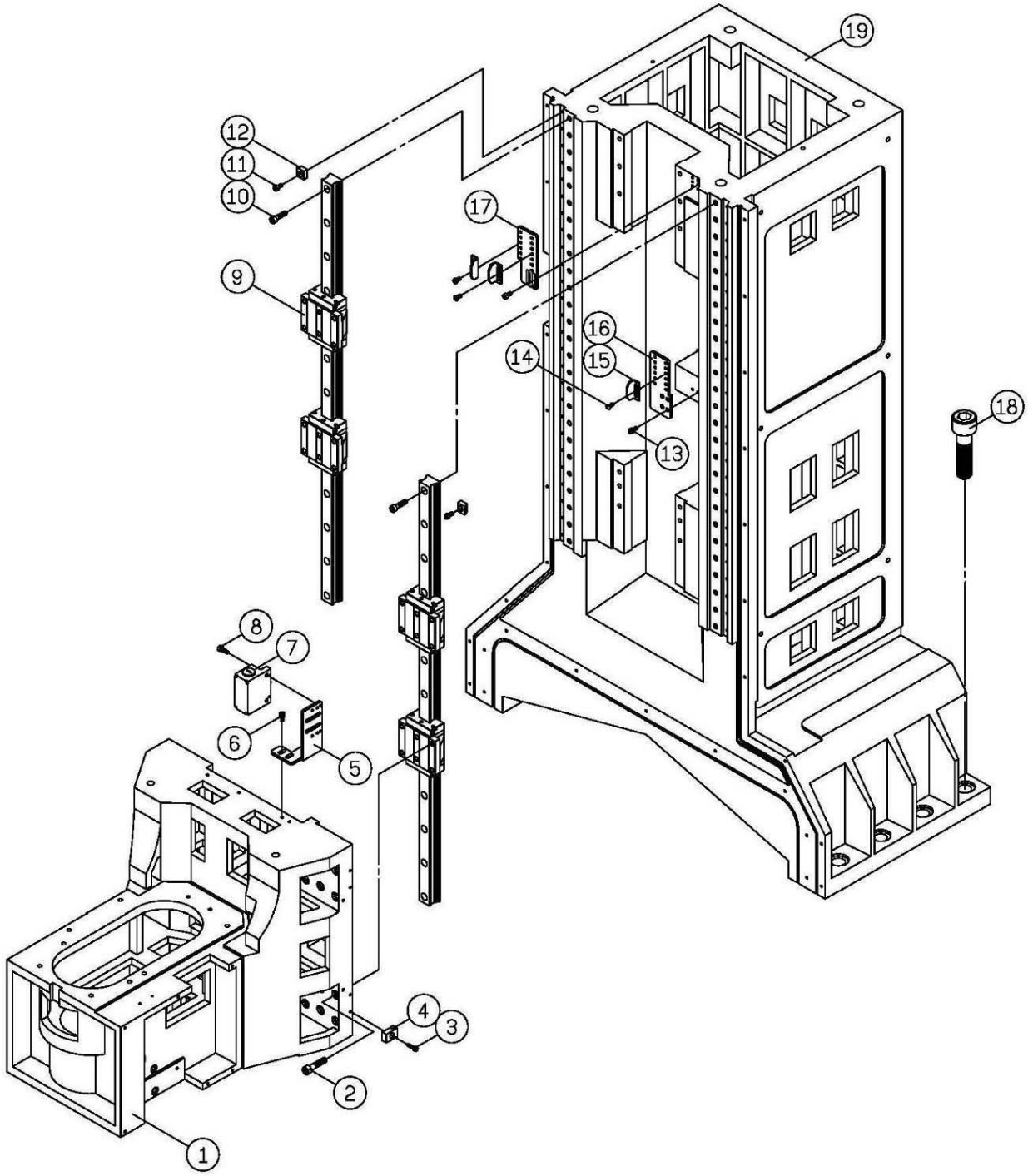


Abb. 11-2: Säule - Column

Ersatzteilliste Säule - Spare part list column

Pos.	Bezeichnung	Designation	Quantity	Size	Item number
			Qty.	Size	Item no.
1	Spindle head	Spindle head	1		035112101 01
2	Hexagon socket screw	Socket head screw	24	M10xP1.5x45L	035112101 02
3	Hexagon socket screw	Socket head screw	4	M5xP0.8x12L	035112101 03
4	Platte	Press plate	4		035112101 04
5	Halter Endschalter	Bracket of limit switch	1		035112101 05
6	Hexagon socket screw	Socket head screw	2	M6xP1.0x12L	035112101 06
7	Endschalter	Limit switch	1		035112101 07
8	Hexagon socket screw	Socket head screw	2	M6xP1.0x16L	035112101 08
9	Lineare Führung	Linear way	2		035112101 09
10	Hexagon socket screw	Socket head screw	26	M8xP1.25x30L	035112101 10
11	Hexagon socket screw	Socket head screw	26	M6xP1.0x12L	035112101 11
12	Klotz	Blocker	26		035112101 12
13	Hexagon socket screw	Socket head screw	4	M6xP1.0x12L	035112101 13
14	Hexagon socket screw	Socket head screw	6	M6xP1.0x12L	035112101 14
15	Platte	Dog	3		035112101 15
16	Halter Platte	Dog bracket	1		035112101 16
17	Plate	Dog base	1		035112101 17
18	Hexagon socket screw	Socket head screw	8	M24xP3.0x70L	035112101 18
19	Column	Column	1		035112101 19

11.6 Maschinenunterbau - Machine stand

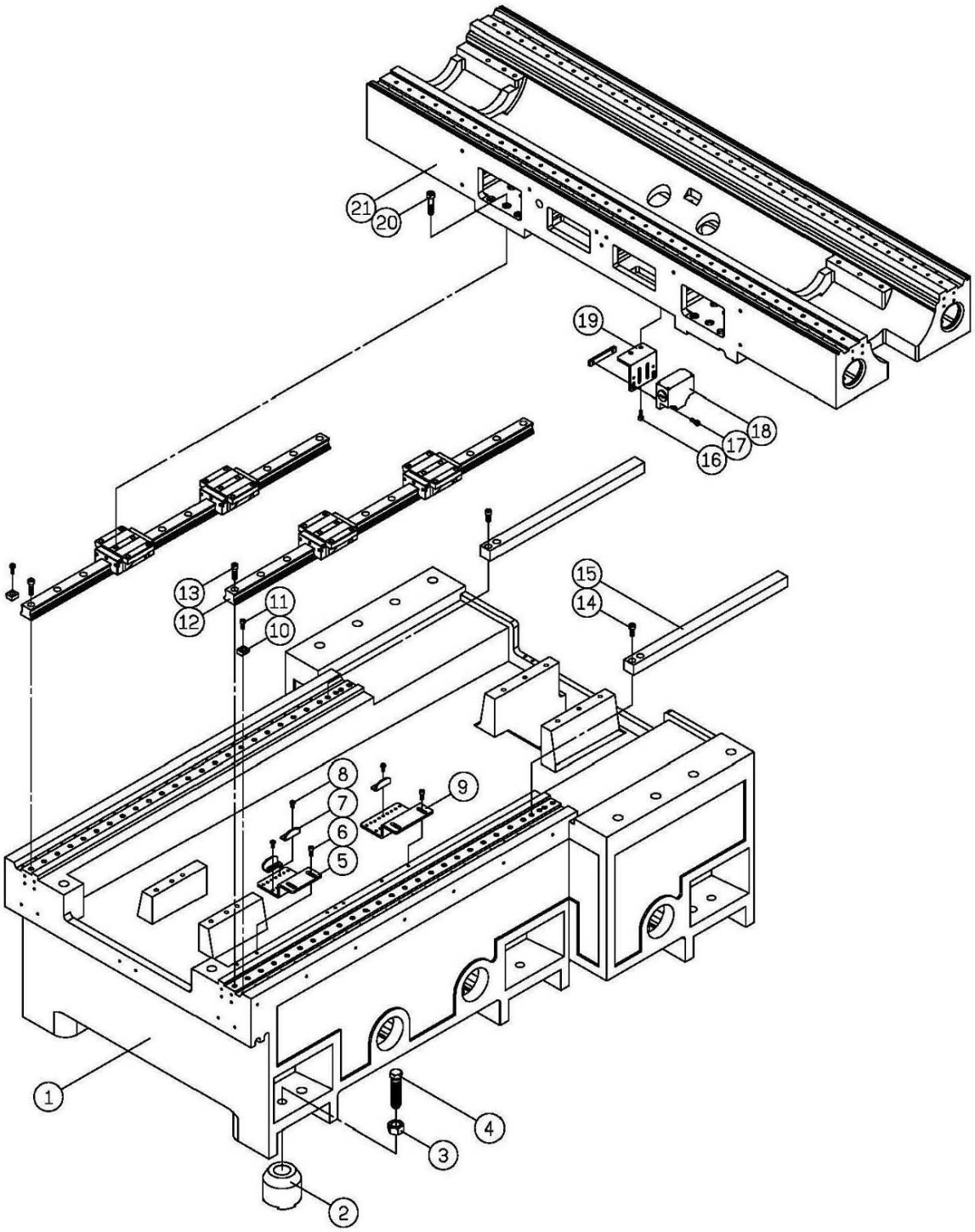


Abb. 11-3: Maschinenunterbau - Machine stand

Ersatzteilliste Maschinenunterbau - Spare part list machine stand

Pos.	Bezeichnung	Designation	Quantity	Size	Item number
			Qty.	Size	Item no.
1	Substructure	Base	1		035112102 01
2	Machine foot	Foundation pad	6		035112102 02
3	Sehskantmutter	Screw	6		035112102 03
4	Bolzen	Foundation bolt	6		035112102 04
5	Platte	Dog bracket	1		035112102 05
6	Hexagon socket screw	Socket head screw	4	M6xP1.0x12L	035112102 06
7	Platte	Dog	3		035112102 07
8	Hexagon socket screw	Socket head screw	6	M6xP1.0x12L	035112102 08
9	Holder	Dog bracket	1		035112102 09
10	Klotz	Blocker	24		035112102 10
11	Hexagon socket screw	Socket head screw	24	M6xP1.0x12L	035112102 11
12	Lineare Führung	Linear way	2		035112102 12
13	Hexagon socket screw	Socket head screw	24	M8xP1.25x30L	035112102 13
14	Hexagon socket screw	Socket head screw	4	M8xP1.25x20L	035112102 14
15	Führung	Extending guide way	2		035112102 15
16	Hexagon socket screw	Socket head screw	2	M6xP1.0x12L	035112102 16
17	Hexagon socket screw	Socket head screw	2	M6xP1.0x16L	035112102 17
18	Endschalter	Limit switch	1		035112102 18
19	Halter Endschalter	Bracket of limit switch	1		035112102 19
20	Hexagon socket screw	Socket head screw	24	M10xP1.5x45L	035112102 20
21	Führung	Saddle	1		035112102 21

11.7 Frästisch - Milling table 1- 2

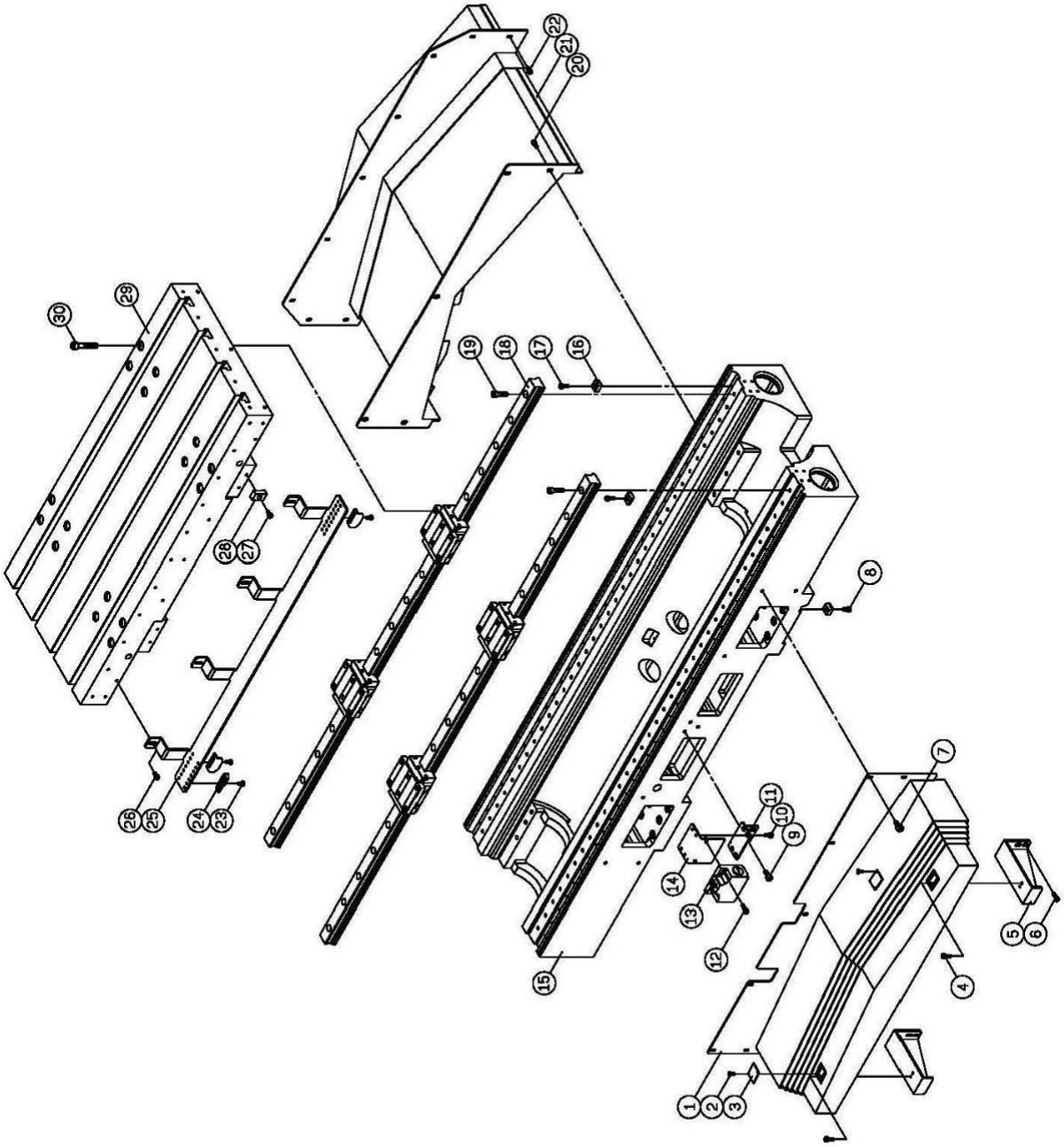


Abb.11-4: Frästisch- Milling table 1- 2

Ersatzteilliste Frästisch - Spare part list milling table 1- 2

Pos.	Bezeichnung	Designation	Quantity	Size	Item number
			Qty.	Size	Item no.
1	Teleskopabdeckung	Telescopic cover	1		035112103 01
2	Innensechkantschraube	Socket head screw	4	M4xP0.7x6L	035112103 02
3	Abdeckung	Cover	2		035112103 03
4	Innensechkantschraube	Socket head screw	2	M6xP1.0x12L	035112103 04
5	Halter Abdeckung	Bracket of telescopic cover	2		035112103 05
6	Innensechkantschraube	Socket head screw	8	M6xP1.0x16L	035112103 06
7	Innensechkantschraube	Socket head screw	7	M8xP1.25x16L	035112103 07
8	Innensechkantschraube	Socket head screw	4	M6xP1.0x12L	035112103 08
9	Innensechkantschraube	Socket head screw	2	M8xP1.25x16L	035112103 09
10	Innensechkantschraube	Socket head screw	4	M6xP1.0x16L	035112103 10
11	Halter Endschalter	Bracket of limit switch	1		035112103 11
12	Innensechkantschraube	Socket head screw	2	M6xP1.0x16L	035112103 12
13	Endschraube	Limit switch	1		035112103 13
14	Halter Endschalter	Bracket of limit switch	1		035112103 14
15	Führung	Saddle	1		035112103 15
16	Klotz	Blocker	40		035112103 16
17	Innensechkantschraube	Socket head screw	36	M6xP1.0x12L	035112103 17
18	Lineare Führung	Linear way	2		035112103 18
19	Innensechkantschraube	Socket head screw	36	M8xP1.25x30L	035112103 19
20	Innensechkantschraube	Socket head screw	5	M6xP1.0x12L	035112103 20
21	Abdeckung	Telescopic cover	1		035112103 21
22	Innensechkantschraube	Socket head screw	9	M6xP1.0x12L	035112103 22
23	Innensechkantschraube	Socket head screw	6	M6xP1.0x12L	035112103 23
24	Platte	Dog	3		035112103 24
25	Halter Platte	Dog bracket	1		035112103 25
26	Innensechkantschraube	Socket head screw	4	M6xP1.0x12L	035112103 26
27	Innensechkantschraube	Socket head screw	4	M6xP1.0x12L	035112103 27
28	Platte	Press plate	4		035112103 28
29	Milling table	Table	1		035112103 29
30	Innensechkantschraube	Socket head screw	24	M10xP1.5x55L	035112103 30

11.8 Frästisch - Milling table 2- 2

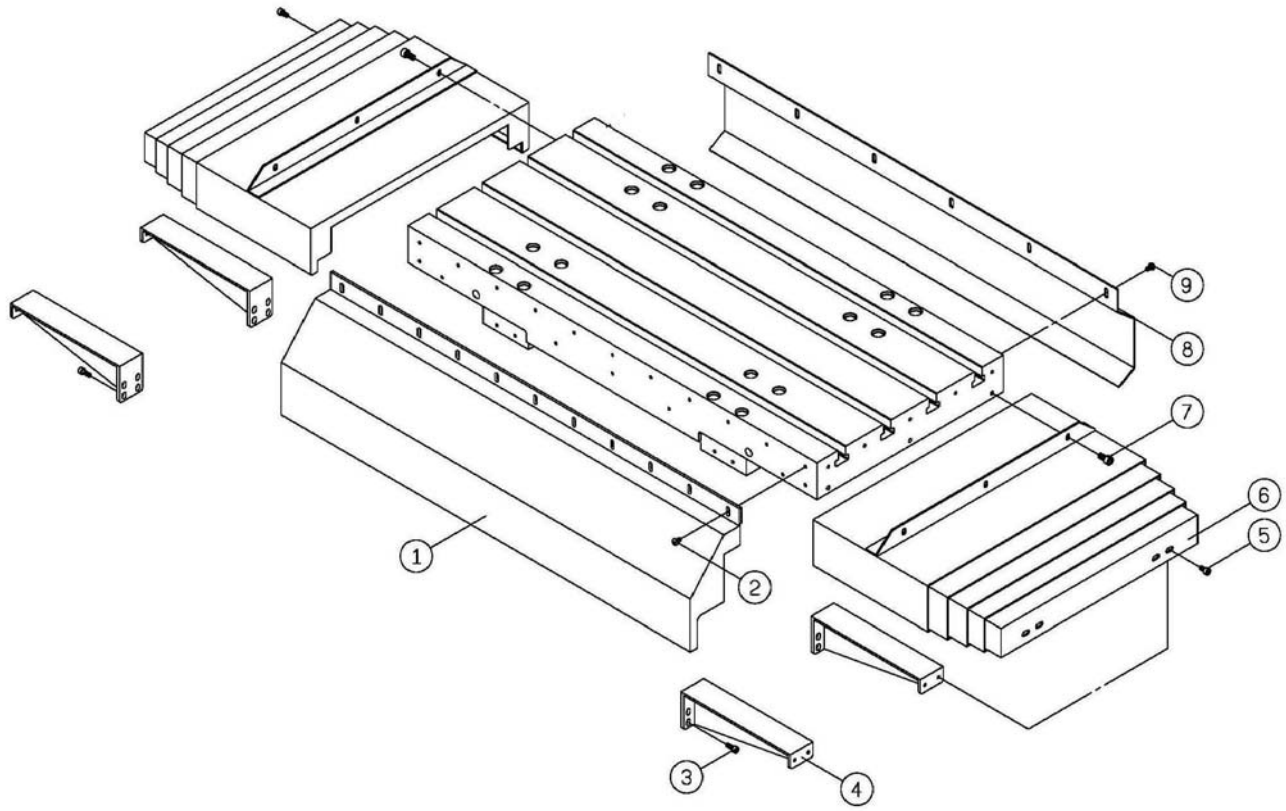


Abb. 11-5: Frästisch- Milling table 2- 2

Ersatzteilliste Frästisch - Spare part list milling table 2- 2

Pos.	Bezeichnung	Designation	Quan-tity	Size	Item number
			Qty.	Size	Item no.
1	Abdekung	Front cover	1		035112104 01
2	Hexagon socket screw	Socket head screw	11	M6xP1.0x12L	035112104 02
3	Hexagon socket screw	Socket head screw	16	M6xP1.0x16L	035112104 03
4	Hakter	Bracket of Telescopic Cover	4		035112104 04
5	Hexagon socket screw	Socket head screw	8	M6xP1.0x12L	035112104 05
6	Teleskopabdeckung	Telescopic cover	2		035112104 06
7	Hexagon socket screw	Socket head screw	16	M8xP1.25x16L	035112104 07
8	Abdeckung	Rear cover	1		035112104 08
9	Hexagon socket screw	Socket head screw	6	M6xP1.0x12L	035112104 09

11.9 Baugruppe X-Achse - Assembly X- Axis

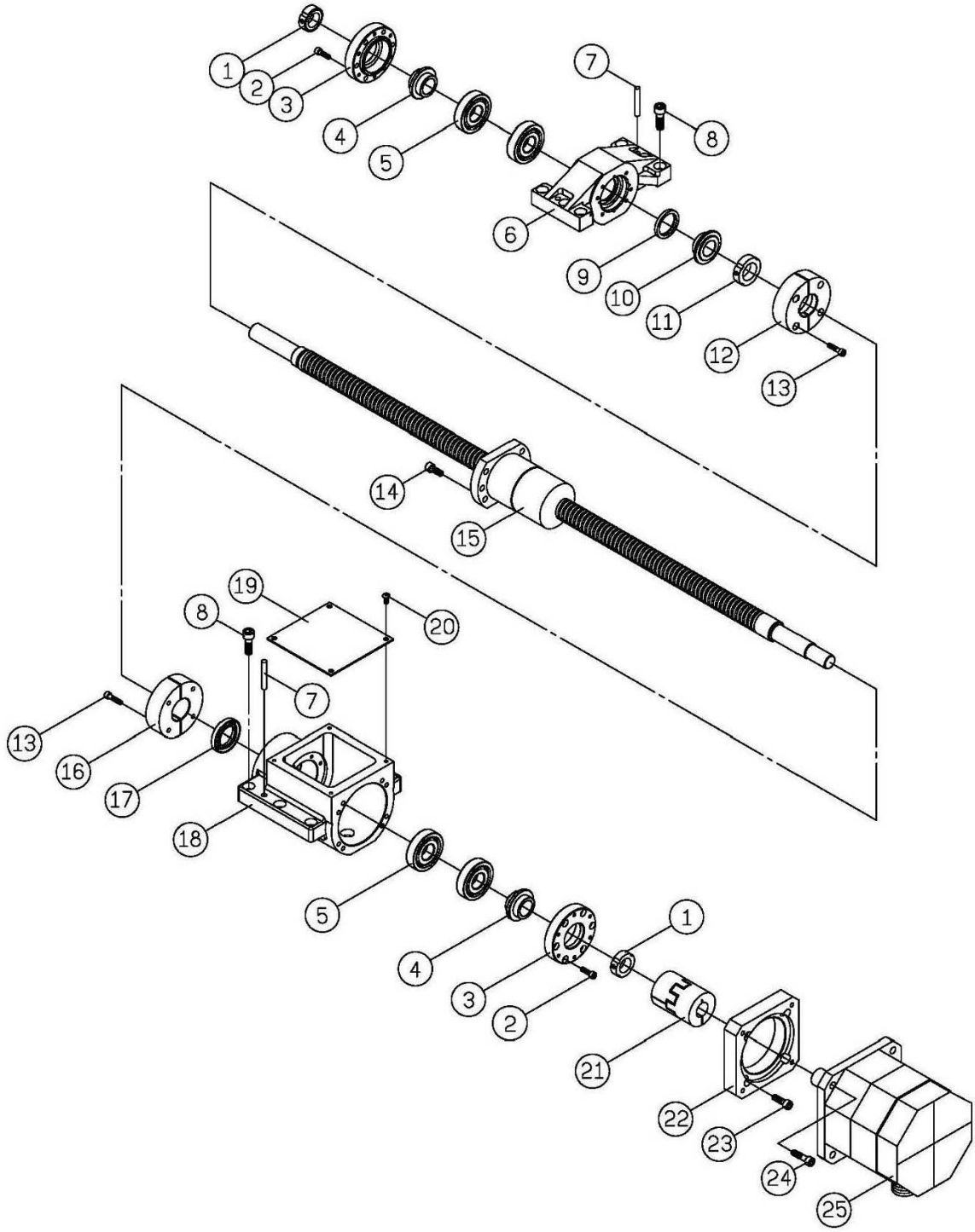


Abb. 11-6: Baugruppe X-Achse - Assembly X-Axis

Ersatzteilliste Baugruppe X-Achse - Spare part list assembly X-Axis

Pos.	Bezeichnung	Designation	Quantity	Size	Item number
			Qty.	Size	Item no.
1	Lock nut	Nutmutter	2	YSR M25xP1.5	035112105 01
2	Socket head screw	Hexagon socket screw	12	M6xP1.0x20L	035112105 02
3	Bearing cap	Lagerdeckel	2		035112105 03
4	Spacer	Ring	2		035112105 04
5	Bearing	Kugellager	2		035112105 05
6	Bearing housing	Lagergehäuse	1		035112105 06
7	Taper pin	Kegelstift	4	6x40L	035112105 07
8	Socket head screw	Hexagon socket screw	12	M10xP1.5x30L	035112105 08
9	Oil seal	Dichtung	1	TC-354505	035112105 09
10	Spacer	Ring	1		035112105 10
11	Lock nut	Nutmutter	1	YSR M30xP1.5	035112105 11
12	Stopper	Holder	1		035112105 12
13	Socket head screw	Hexagon socket screw	8	M6xP1.0x25L	035112105 13
14	Socket head screw	Hexagon socket screw	6	M8xP1.25x20L	035112105 14
15	Ballscrew	Ball screw	1		035112105 15
16	Stopper	Holder	1		035112105 16
17	Oil seal	Dichtung	1	TC-355207	035112105 17
18	Motor housing	Motorgehäuse	1		035112105 18
19	Cover plate	Abdeckung	1		035112105 19
20	Socket head screw	Hexagon socket screw	4	M6xP1.0x10L	035112105 20
21	Coupling	Coupling	1		035112105 21
22	Motor plate	Motorplatte	1		035112105 22
23	Socket head screw	Hexagon socket screw	4	M8xP1.25x25L	035112105 23
24	Socket head screw	Hexagon socket screw	4	M8xP1.25x30L	035112105 24

11.10 Baugruppe Y-Achse - Assembly Y- Axis

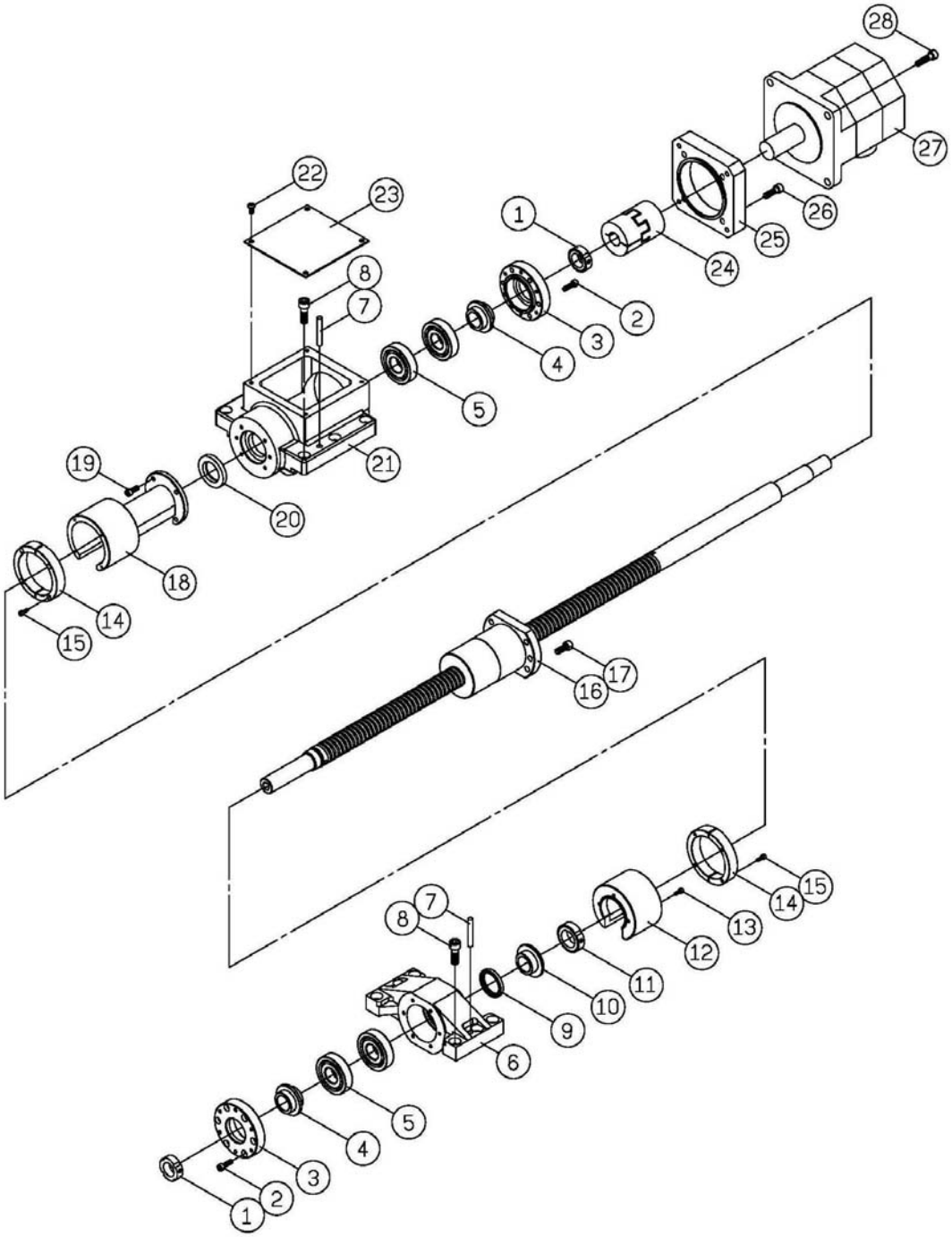


Abb. 11-7: Baugruppe Y-Achse - Assembly Y-Axis

Ersatzteilliste Baugruppe Y-Achse - Spare part list assembly Y-Axis

Pos.	Bezeichnung	Designation	Quantity	Size	Item number
			Qty.	Size	Item no.
1	Nutmutter	Lock nut	2	YSR M25xP1.5	035112106 01
2	Hexagon socket screw	Socket head screw	12	M6xP1.0x20L	035112106 02
3	Lagerdeckel	Bearing cap	2		035112106 03
4	Ring	Spacer	2		035112106 04
5	Kugellager	Bearing	2		035112106 05
6	Kugellagergehäuse	Bearing housing	1		035112106 06
7	Kegelstift	Taper pin	4	6x40L	035112106 07
8	Hexagon socket screw	Socket head screw	12	M10xP1.5x30L	035112106 08
9	Dichtung	Oil seal	1	TC-354505	035112106 09
10	Ring	Spacer	1		035112106 10
11	Nutmutter	Lock nut	1	YSR M30xP1.5	035112106 11
12	Housing	Mounting housing	1		035112106 12
13	Hexagon socket screw	Socket head screw	3	M4xP0.7x14L	035112106 13
14	Klotz	Stopper	2		035112106 14
15	Hexagon socket screw	Socket head screw	8	M4xP0.7x14L	035112106 15
16	Ball screw	Ballscrew	1		035112106 16
17	Hexagon socket screw	Socket head screw	6	M8xP1.25x20L	035112106 17
18	Holder	Support bracket	1		035112106 18
19	Hexagon socket screw	Socket head screw	4	M6xP1.0x16L	035112106 19
20	Dichtung	Oil seal	1	TC-355207	035112106 20
21	Motorgehäuse	Motor housing	1		035112106 21
22	Hexagon socket screw	Socket head screw	4	M6xP1.0x10L	035112106 22
23	Abdeckung	Cover plate	1		035112106 23
24	Coupling	Coupling	1		035112106 24
25	Motorplatte	Motor plate	1		035112106 25
26	Hexagon socket screw	Socket head screw	4	M8xP1.25x25L	035112106 26
27	Motor	Motor	1		035112106 27
28	Hexagon socket screw	Socket head screw	4	M8xP1.25x30L	035112106 28

11.11 Baugruppe Z-Achse - Assembly Z- Axis

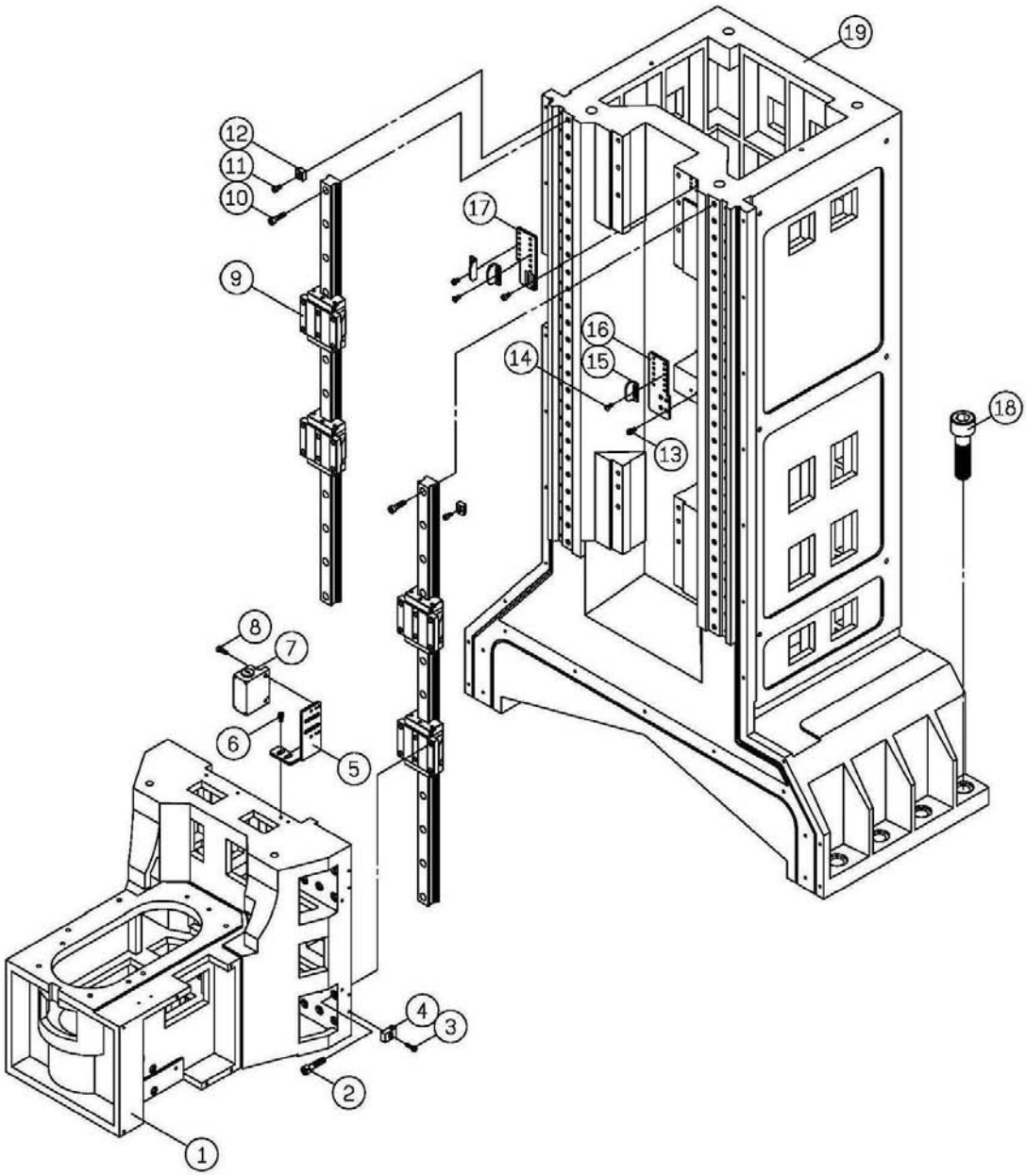


Abb. 11-8: Baugruppe Z-Achse - Assembly Z-Axis

Ersatzteilliste Baugruppe Z-Achse - Spare part list assembly Z-Axis

Pos.	Bezeichnung	Designation	Quantity	Size	Item number
			Qty.	Size	Item no.
1	Nutmutter	Lock nut	2	YSR M25xP1.5	035112107 01
2	Hexagon socket screw	Socket head screw	12	M6xP1.0x20L	035112107 02
3	Lagerdeckel	Bearing cap	2		035112107 03
4	Ring	Spacer	2		035112107 04
5	Kugellager	Bearing	2		035112107 05
6	Lagergehäuse	Bearing housing	1		035112107 06
7	Hexagon socket screw	Socket head screw	12	M10xP1.5x30L	035112107 07
8	Kegelstift	Taper pin	4	6x40L	035112107 08
9	Dichtung	Oil seal	1	TC-354505	035112107 09
10	Ring	Spacer	1		035112107 10
11	Nutmutter	Lock nut	1	YSR M30xP1.5	035112107 11
12	Klotz	Stopper	1		035112107 12
13	Hexagon socket screw	Socket head screw	4	M6xP1.0x25L	035112107 13
14	Ball screw	Ballscrew	1		035112107 14
15	Hexagon socket screw	Socket head screw	6	M8xP1.25x20L	035112107 15
16	Hexagon socket screw	Socket head screw	2	M6xP1.0x16L	035112107 16
17	Klotz	Stopper	2		035112107 17
18	Seal	Oil seal	1	TC-355207	035112107 18
19	Motorgehäuse	Motor housing	1		035112107 19
20	Abdeckung	Cover plate	1		035112107 20
21	Hexagon socket screw	Socket head screw	4	M6xP1.0x10L	035112107 21
22	Coupling	Coupling	1		035112107 22
23	Motorplatte	Motor plate	1		035112107 23
24	Hexagon socket screw	Socket head screw	4	M8xP1.25x25L	035112107 24
25	Hexagon socket screw	Socket head screw	4	M10xP1.5x30L	035112107 25
26	Motor	Motor	1		035112107 26

11.12 Maschinengehäuse - Machine housing

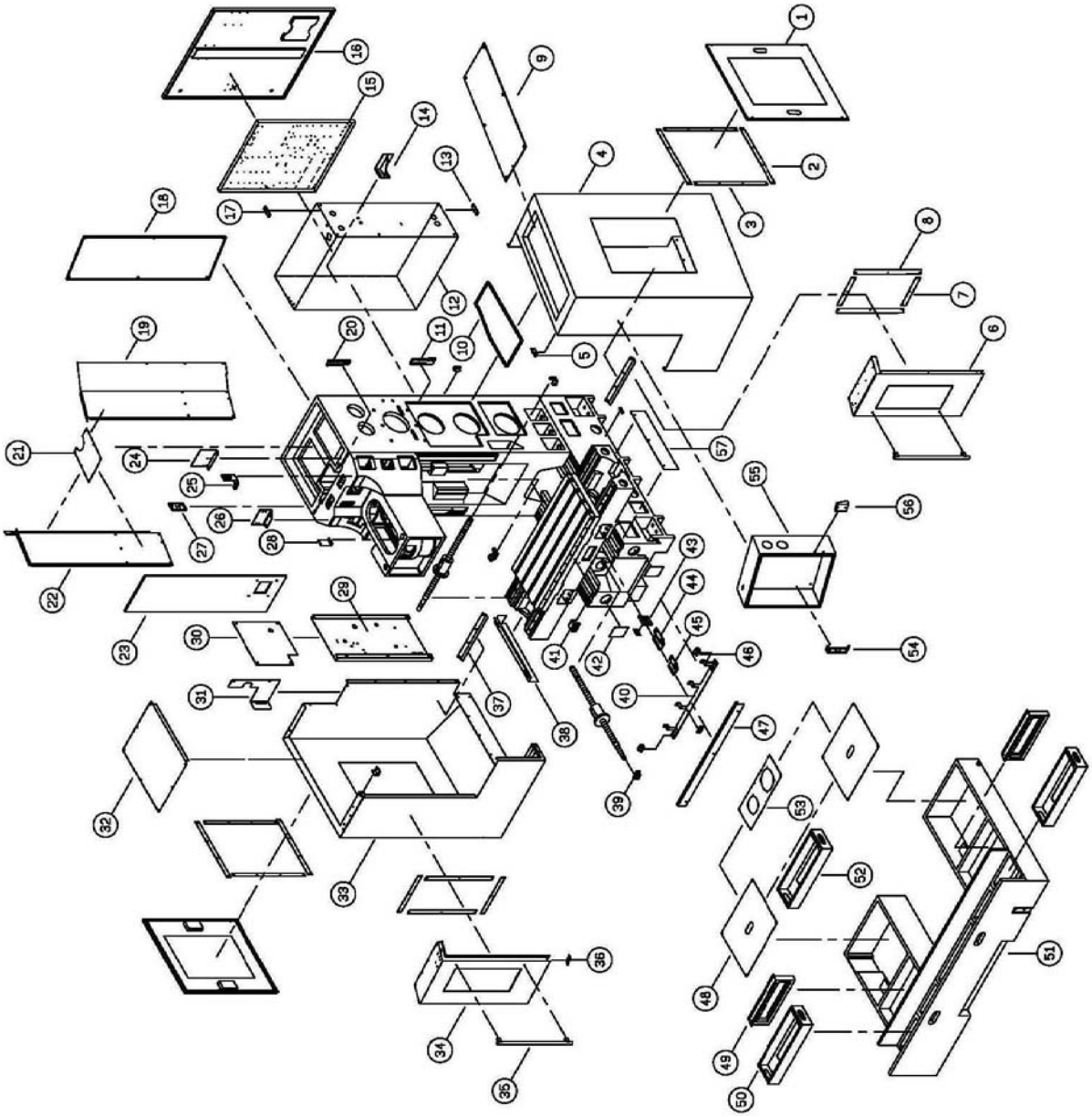


Abb. 11-9: Maschinengehäuse - Machine housing

11.13 Späneförderer - Chip convejor

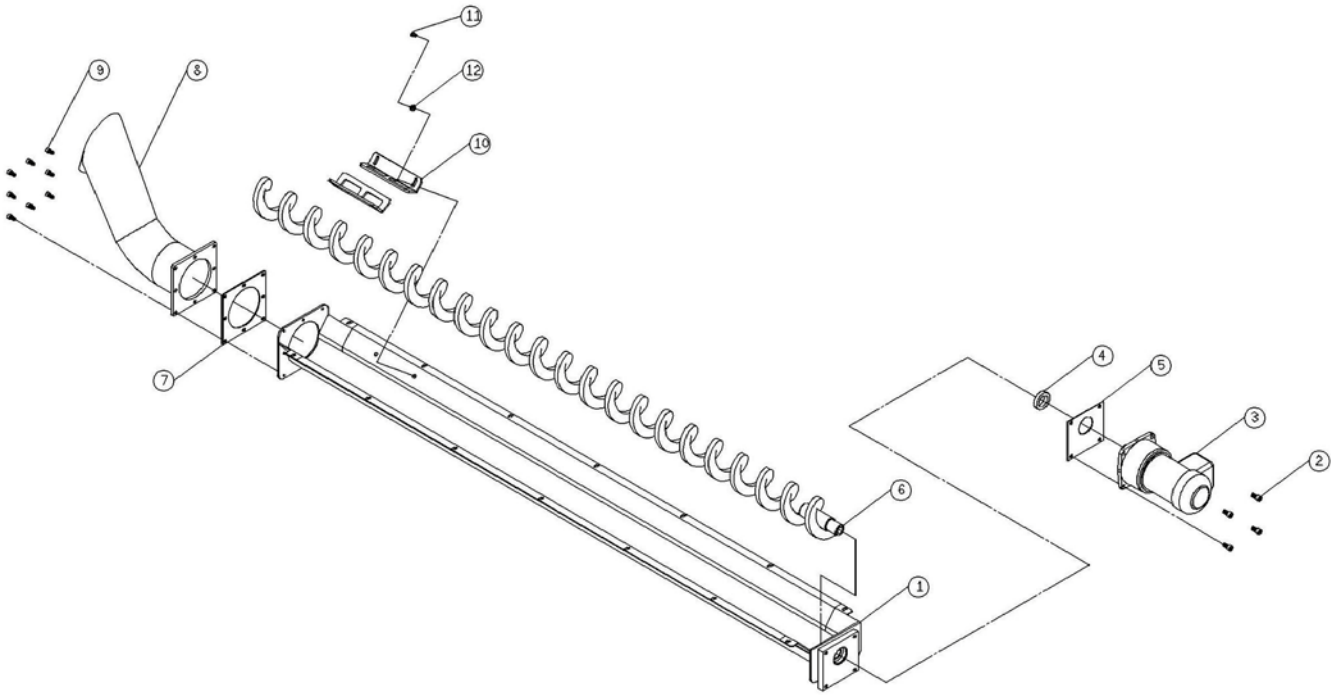


Abb. 11-10: Späneförderer - Chip convejer

Ersatzteilliste Späneförderer - Spare part list chip convejor

Pos.	Bezeichnung	Designation	Quan-tity	Size	Item number
			Qty.	Size	Item no.
1	Housing	Inner tuough	1		035112109 01
2	Hexagon socket screw	Socket head screw	4	M10xP1.5x20L	035112109 02
3	Motor	Motor	1		035112109 03
4	Dichtung	Seal	1	36x55x12	035112109 04
5	Platte	Motor spacer	1		035112109 05
6	Schnecke	Screw	1		035112109 06
7	Platte	Plate	1		035112109 07
8	Spänerohr	Chip pipe	1		035112109 08
9	Hexagon socket screw	Socket head screw	8	M10xP1.5x30L	035112109 09
10	Metallabstreifer	Metal wipers	2		035112109 10
11	Hexagon socket screw	Socket head screw	4	M8xP1.5x25L	035112109 11
12	Scheibe	Washer	4		035112109 12

11.14 16-fach Werkzeugwechsler - 16-station tool changer

11.14.1 Werkzeugwechsler 1-4 - Tool changer 1-4

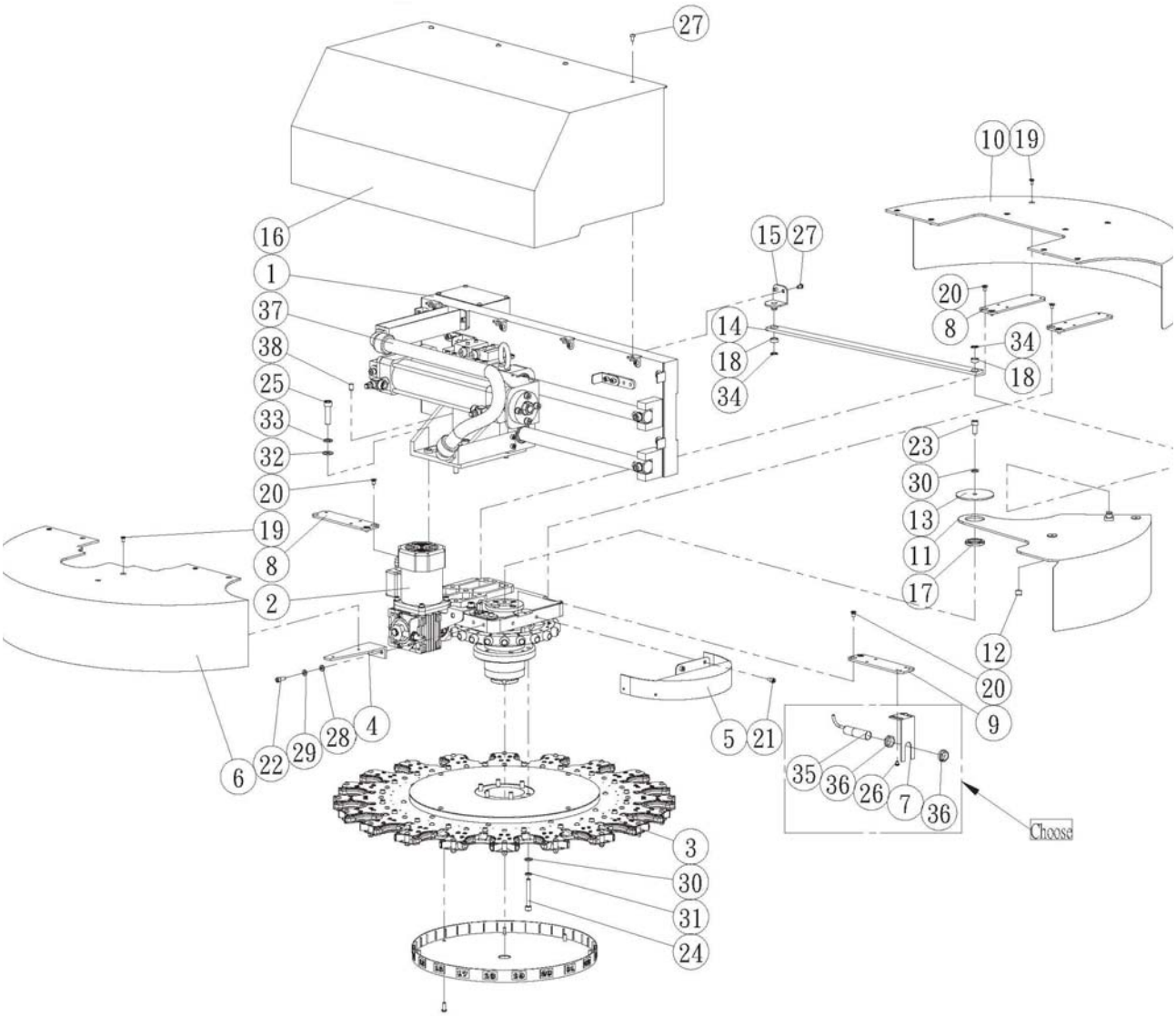


Abb. 11-11: Werkzeugwechsler 1-4 -Tool changer 1-4

Ersatzteilliste Werkzeugwechsler 1-4 - Spare part list tool changer 1-4

Pos.	Bezeichnung	Designation	Quantity	Size	Item number
			Qty.	Size	Item no.
1	Baugruppe Zylinder	Composition element glide bracket	1		0351121010 01
2	Baugruppe Motor	Composition element actuator motor	1		0351121010 02
3	Baugruppe Wechselscheibe	Composition element tool disk	1		0351121010 03
4	Fixture	Holder	1		0351121010 04
5	Abdeckung	Cover	1		0351121010 05
6	Abdeckung	Cover	1		0351121010 06
7	Fixture	Holder	1		0351121010 07
8	Fixture	Holder	1		0351121010 08
9	Fixture	Holder	1		0351121010 09
10	Abdeckung	Cover	1		0351121010 10
11	Abdeckung	Cover	1		0351121010 11
12	Scheibe	Washer	2		0351121010 12
13	Scheibe	Washer	1		0351121010 13
14	Zugstange	Pull rod	1		0351121010 14
15	Fixture	Holder	1		0351121010 15
16	Abdeckung	Cover	1		0351121010 16
17	Scheibe	Washer	1		0351121010 17
18	Scheibe	Washer	2		0351121010 18
19	Schraube	Screw	14	M5x10	
20	Schraube	Screw	8	M6x10	
21	Schraube	Screw	2	M6x10	
22	Schraube	Screw	2	M6x10	
23	Schraube	Screw	2	M8x20	
24	Schraube	Screw	6	M8x60	
25	Schraube	Screw	5	M10x40	
26	Schraube	Screw	2	M5x6	
27	Schraube	Screw	8	M6x10	
28	Scheibe	Washer	2	6	
29	Federscheibe	Spring washer	2	6	
30	Scheibe	Washer	7	8	
31	Federscheibe	Spring washer	6	8	
32	Scheibe	Washer	5	10	
33	Federscheibe	Spring washer	5	10	
34	Sealing ring	Locking ring	2	12	0351121010 34
35	Sensor	Sensor	1		0351121010 35
36	Mutter	Nut	2		0351121010 36
37	Druckluftschlauch	Protect tube	1		0351121010 37
38	Pin	Pin	2		0351121010 38

11.14.2 Werkzeugwechsler 2-4 -Tool changer 2-4

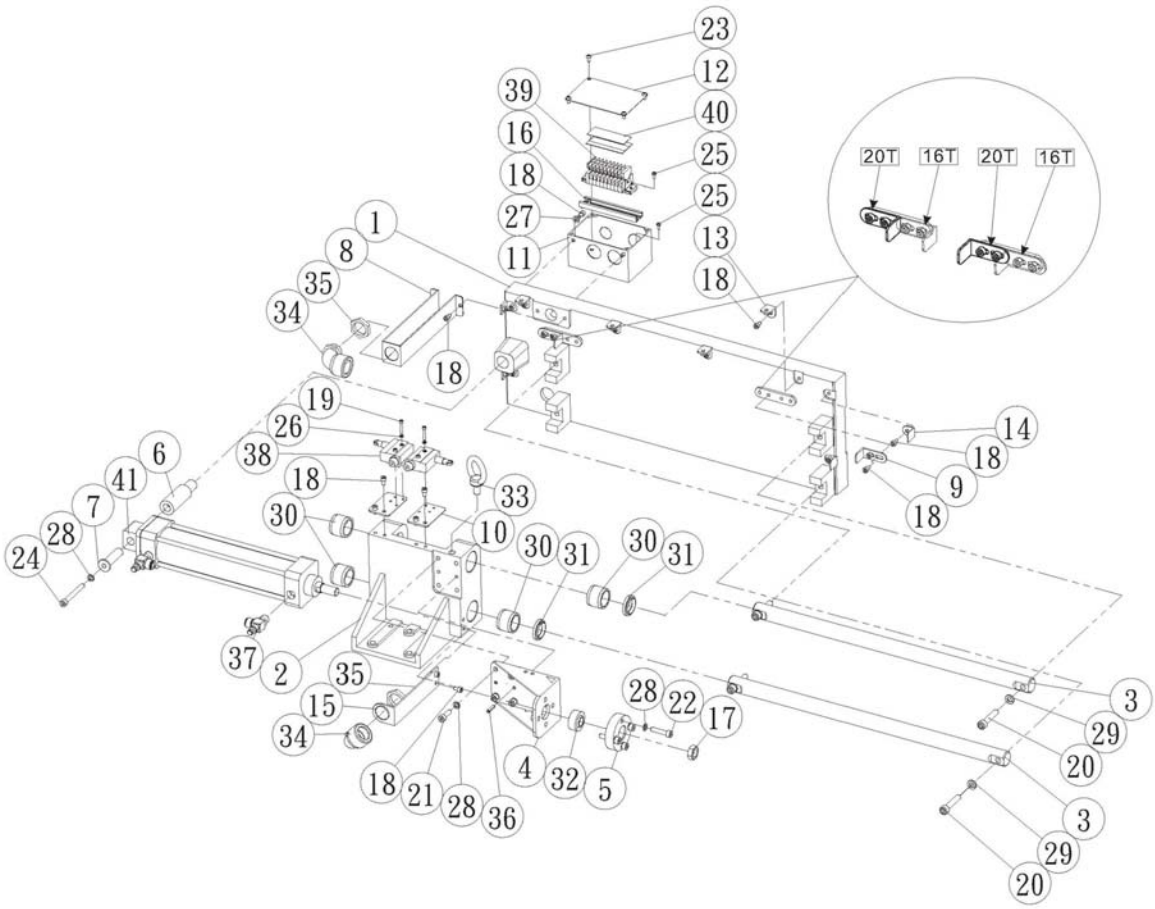


Abb. 11-12: Werkzeugwechsler 2-4 -Tool changer 2-4

Ersatzteilliste Werkzeugwechsler 2-4 - Spare part list tool changer 2-4

Pos.	Bezeichnung	Designation	Quantity	Size	Item number
			Qty.	Size	Item no.
1	Carrier	Carrier	1		0351121011 01
2	Fixture	Holder	1		0351121011 02
3	Zugstange	Pull rod	2		0351121011 03
4	Fixture	Holder	1		0351121011 04
5	Lagerbock	Bearing bracket	1		0351121011 05
6	Zwischenwelle	Counter shaft	1		0351121011 06
7	Buchse	Bushing	1		0351121011 07
8	Fixture	Holder	1		0351121011 08
9	Fixture	Holder	2		0351121011 09
10	Fixture	Holder	2		0351121011 10
11	Schaltkasten	Wire box	1		0351121011 11
12	Abdeckung	Cover	1		0351121011 12
13	Fixture	Holder	6		0351121011 13
14	Fixture	Holder	2		0351121011 14
15	Fixture	Holder	1		0351121011 15
16	Aluschiene	Aluminium track	1		0351121011 16
17	Mutter	Nut	1	M16	
18	Schraube	Screw	22	M6	
19	Schraube	Screw	4	M4	
20	Schraube	Screw	4	M10	
21	Schraube	Screw	4	M8	
22	Schraube	Screw	4	M8	
23	Schraube	Screw	4	M5	

Pos.	Bezeichnung	Designation	Quan-tity	Size	Item number
			Qty.	Size	Item no.
24	Schraube	Screw	1	M8	
25	Schraube	Screw	1	M4	
26	Scheibe	Washer	4	4	
27	Scheibe	Washer	2	4	
28	Federscheibe	Spring washer	9		
29	Federscheibe	Spring washer	4	10	
30	Schmierringlager	Lubricated bearing	4		0351121011 30
31	Dichtungsring	Oil seal	2		0351121011 31
32	Lager	Bearing	1		0351121011 32
33	Ringschraube	Eyebolt	1	M12	0351121011 33
34	Rohrkrümmer	Bend joint	2		0351121011 34
35	Mutter	Nut	2		0351121011 35
36	Stift	Pin	2		0351121011 36
37	Connection	Joint	2		0351121011 37
38	Endschalter	Limit switch	2		0351121011 38
39	Klemmleiste	Wire frame	1		0351121011 39
41	Zylinder	Cylinder	1		0351121011 41

11.14.3 Werkzeugwechsler 3-4 -Tool changer 3-4

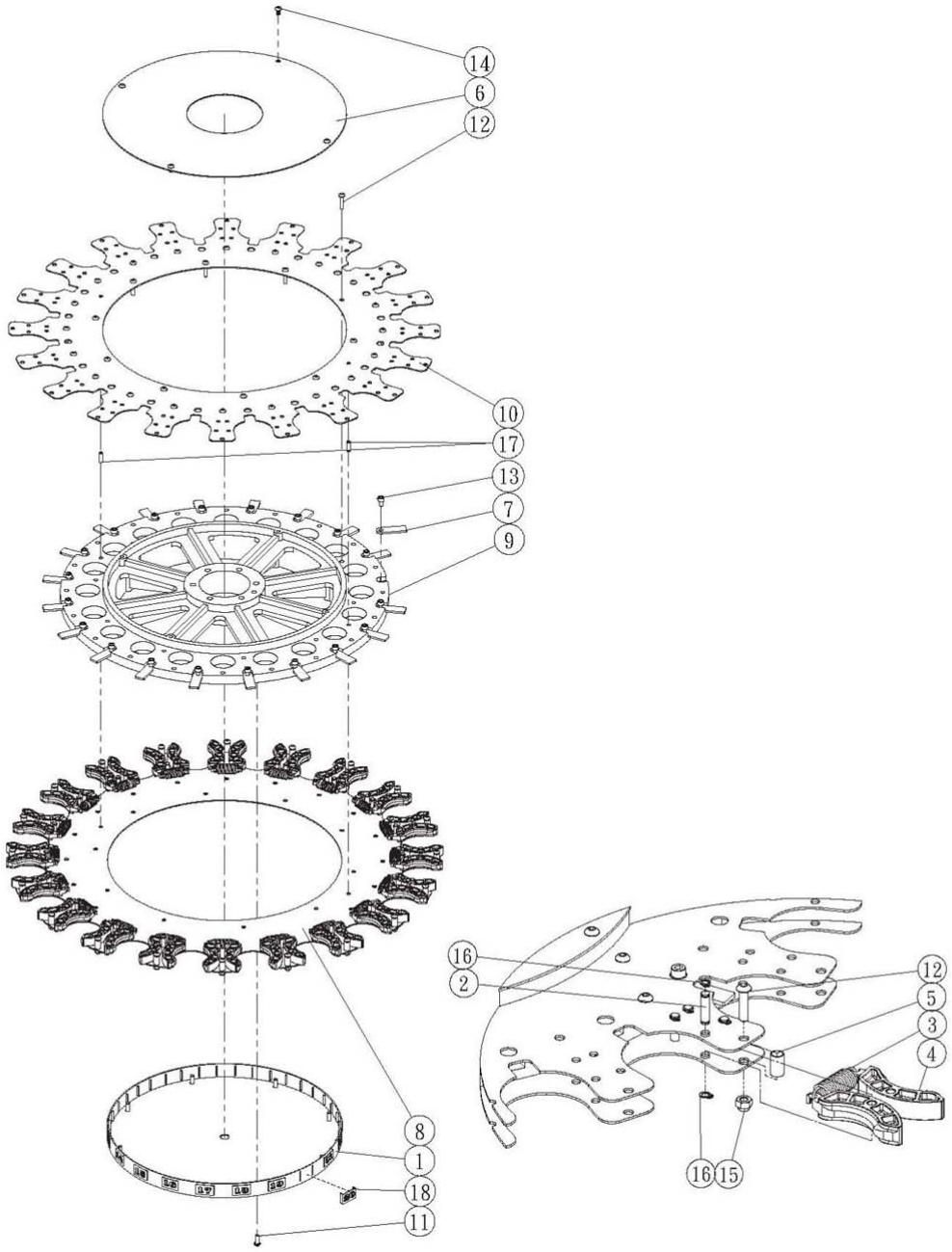


Abb. 11-13: Werkzeugwechsler 3-4 -Tool changer 3-4

Ersatzteilliste Werkzeugwechsler 3-4 - Spare part list tool changer 3-4

Pos.	Bezeichnung	Designation	Quantity	Size	Item number
			Qty.	Size	Item no.
1	Ring Werkzeugpositionsanzeige	Tool disk down cover	1		0351121012 01
2	Stift	Tool holder pin	80		0351121012 02
3	Feder	Spring	20		0351121012 03
4	Klemmhalter	Tool holder	40		0351121012 04
5	Buchse	Bush	20		0351121012 05
6	Abdeckung	Cover	1		0351121012 06
7	Zentrierstück	Positioning block	16		0351121012 07
8	Magazin	Magazine	1		0351121012 08

Pos.	Bezeichnung	Designation	Quantity	Size	Item number
			Qty.	Size	Item no.
9	Magazinteller	Magazine plate	1		0351121012 09
10	Aufnameplatte Magazin	Monting plate on magazine	1		0351121012 10
11	Schraube	Screw	4	M6	
12	Schraube	Screw	40	M6	
13	Schraube	Screw	16	M6	
14	Schraube	Screw	4	M6	
15	Rundmutter	Round nut	40	M6	
16	Sealing ring	Locking ring	128		0351121012 16
17	Zylinderstift	Pin	2	6x22	
18	Platte Werkzeuganzeige	Plate number tool	16		0351121012 18

11.14.4 Werkzeugwechsler 4-4 -Tool changer 4-4

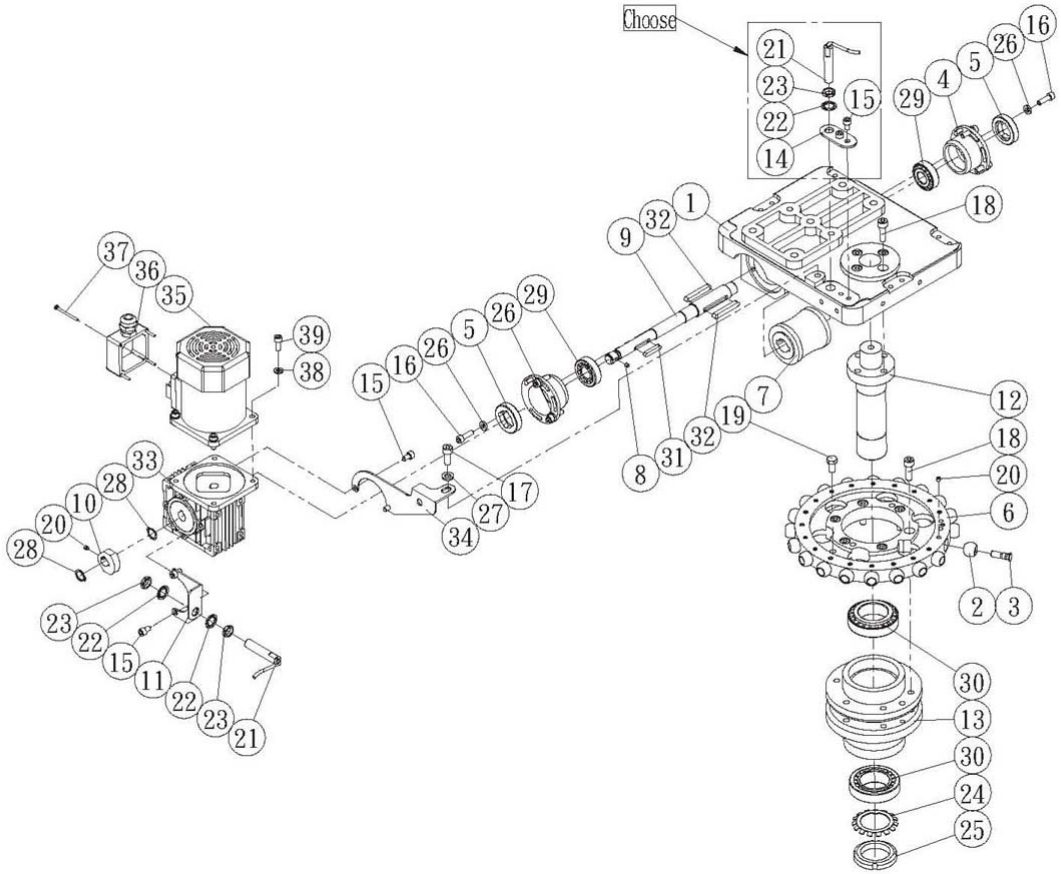


Abb. 11-14: Werkzeugwechsler 4-4 -Tool changer 4-4

Ersatzteilliste Werkzeugwechsler 4-4 - Spare part list tool changer 4-4

Pos.	Bezeichnung	Designation	Quantity	Size	Item number
			Qty.	Size	Item no.
1	Träger Motor	Disk bracket	1		0351121013 01
2	Treiber Exzenter	Driver eccentric cam	16		0351121013 02
3	Bolzen	Pin	16		0351121013 03
4	Lagerabdeckung	Bearing cover	1		0351121013 04
5	Einstellmutter	Bearing pressure cover	1		0351121013 05
6	Scheibe	Disk	1		0351121013 06
7	Nockenrad	Cam wheel	1		0351121013 07
8	Stiftschraube	Stud bolt	1		
9	Welle	Shaft	1		0351121013 09

Pos.	Bezeichnung	Designation	Quan-tity	Size	Item number
			Qty.	Size	Item no.
10	Nockenscheibe	Cam disk	1		0351121013 10
11	Sensorhalter	Sensor bracket	1		0351121013 11
12	Welle	Shaft	1		0351121013 12
13	Lagerbock	Bearing bracket	1		0351121013 13
14	Halter Sensor	Holder Sensor	1		0351121013 14
15	Schraube	Screw	6	M6	
16	Schraube	Screw	6	M6	
17	Schraube	Screw	1	M8	
18	Schraube	Screw	10	M8	
19	Schraube	Screw	1	M8	
20	Schraube	Screw	21	M5	
21	Schraube	Screw	2	M12	
22	Scheibe	Washer	3		
23	Mutter	Nut	3		
24	Scheibe	Washer	1		
25	Mutter	Nut	1		
26	Scheibe	Washer	6	6	
27	Scheibe	Washer	1	8	
28	Sealing ring	Sealing ring	2	14	
29	Lager	Bearing	2	30203	0351121013 29
30	Lager	Bearing	2	32008	0351121013 30
31	Nutenstein	Sliding block	1	5x30	0351121013 31
32	Nutenstein	Sliding block	2	6x40	0351121013 32
33	Gehäuse Getriebe	Worm gear	1		0351121013 33
34	Befestigungsarm	Fixed arm	1		0351121013 34
35	Motor	Motor	1		0351121013 35
36	Deckel Motor	Motor box cover	1		0351121013 36
37	Schraube	Screw	4	M3	
38	Federscheibe	Spring washer	4	4	
39	Schraube	Screw	4	M6	

11.15 Optionaler 24-fach Werkzeugwechsler - Optional 24-station tool changer

11.15.1 Werkzeugwechsler 1 von 5 - Tool changer 1 of 5

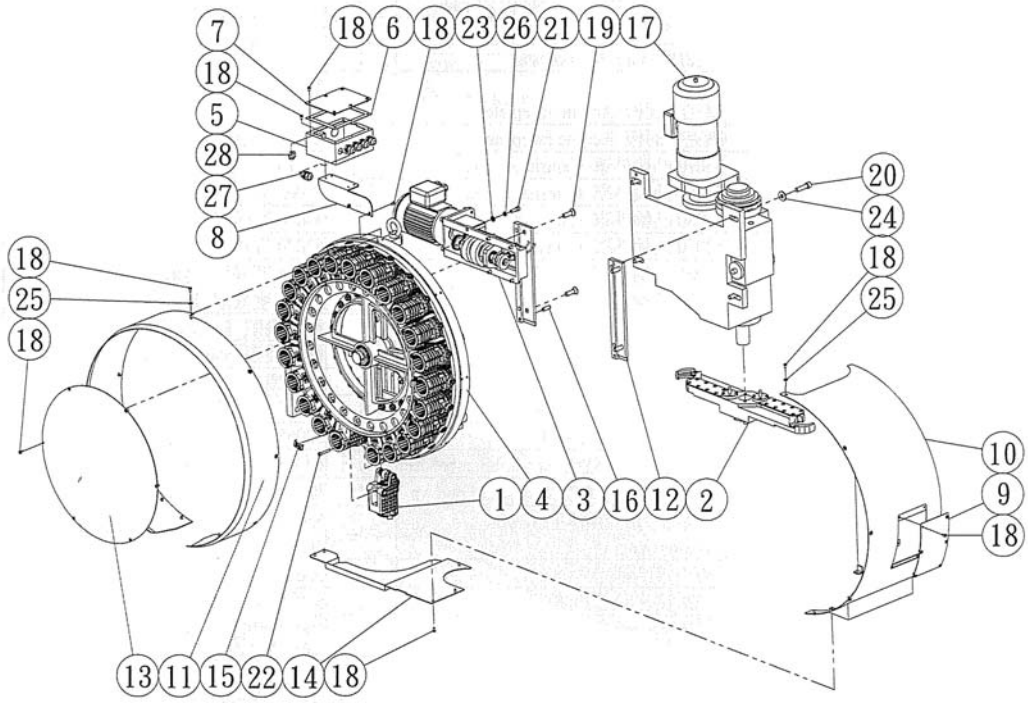


Abb. 11-15: Werkzeugwechsler - Tool changer

Ersatzteilliste Werkzeugwechsler 1 von 5 - Spare part list tool changer 1 of 5

Pos.	Bezeichnung	Designation	Menge Qty.	Grösse Size	Artikel-nummer Item no.
1	Werkzeughalter	Tool pocket element	24		03511210 1401
2	Werzeugarm	Ann component	1		03511210 1402
3	Antrieb	Driving component	1		03511210 1403
4	Werkzeugwechsler	Model component	1		03511210 1404
5	Schaltkasten	Wire box	1		03511210 1405
6	Dichtung	Box waterproof pad	1		03511210 1406
7	Abdeckung	Wire Box cap	1		03511210 1407
8	Halter	Wire Box pedestal	1		03511210 1408
9	Plexiglas	Acrylic faceplate	1		03511210 1409
10	Abdeckung	Camshaft cover	1		03511210 1410
11	Runde Abdeckung	Round cover	1		03511210 1411
12	Platte	Plate	2		03511210 1412
13	Abdeckung	Tool disk cap	1		03511210 1413
14	Platte	Cam plate	1		03511210 1414
15	Nummerschild	Number card	24		03511210 1415
16	Stift	Pin	2		03511210 1416
17	Verstelleinheit	Tool changing Cam	1		03511210 1417
18	Schraube	Screw	44		03511210 1418
19	Schraube	Screw	4		03511210 1419
20	Schraube	Screw	4		03511210 1420
21	Schraube	Screw	5		03511210 1421
22	Schraube	Screw	24		03511210 1422
23	Scheibe	Washer	5		03511210 1423
24	Scheibe	Washer	4		03511210 1424
25	Scheibe	Washer	18		03511210 1425
26	Federring	Spring washer	5		03511210 1426

Pos.	Bezeichnung	Designation	Menge	Grösse	Artikel-nummer
			Qty.	Size	Item no.
27	Zugentlaster	Cable fixed	5		03511210 1427
28	Zugentlaster	Cable fixed	5		03511210 1428

11.15.2 Werkzeugwechsler 2 von 5 - Tool changer 2 of 5

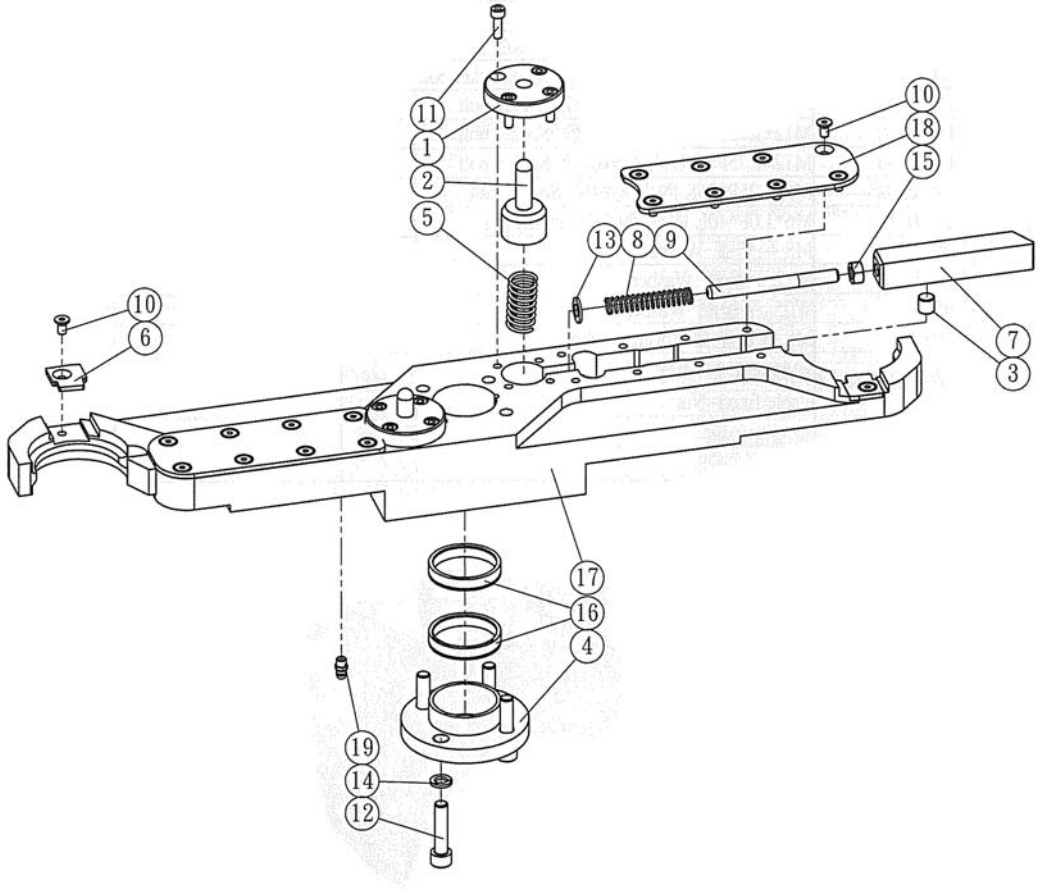


Abb. 11-16: Werkzeugwechsler - Tool changer

Ersatzteilliste Werkzeugwechsler 2 von 5 - Spare part list tool changer 2 of 5

Pos.	Bezeichnung	Designation	Menge	Grösse	Artikel-nummer
			Qty.	Size	Item no.
1	Flansch	Flange	1		03511210 1501
2	Bolzen	Bolt	1		03511210 1502
3	Buchse	Bushing	1		03511210 1503
4	Flansch	Flange	1		03511210 1504
5	Feder	Spring	1		03511210 1505
6	Platte	Plate	2		03511210 1506
7	Zylider	Cylinder	1		03511210 1507
8	Feder	Spring	1		03511210 1508
9	Welle	Shaft	1		03511210 1509
10	Schraube	Screw	8		03511210 1510
11	Schraube	Screw	4		03511210 1511
12	Schraube	Screw	4		03511210 1512
13	Scheibe	Washer	1		03511210 1513
14	Scheibe	Washer	2		03511210 1514
15	Sechskantmutter	Hexagon nut	1		03511210 1515
16	Dichtung	Seal	1		03511210 1516
17	Wechslerarm	Changer holder	2		03511210 1517
18	Platte	Plate	1		03511210 1518

Pos.	Bezeichnung	Designation	Menge	Grösse	Artikel-nummer
			Qty.	Size	Item no.
19	Bolzen	Bolt	1		03511210 1519

11.15.3 Werkzeugwechsler 3 von 5 - Tool changer 3 of 5

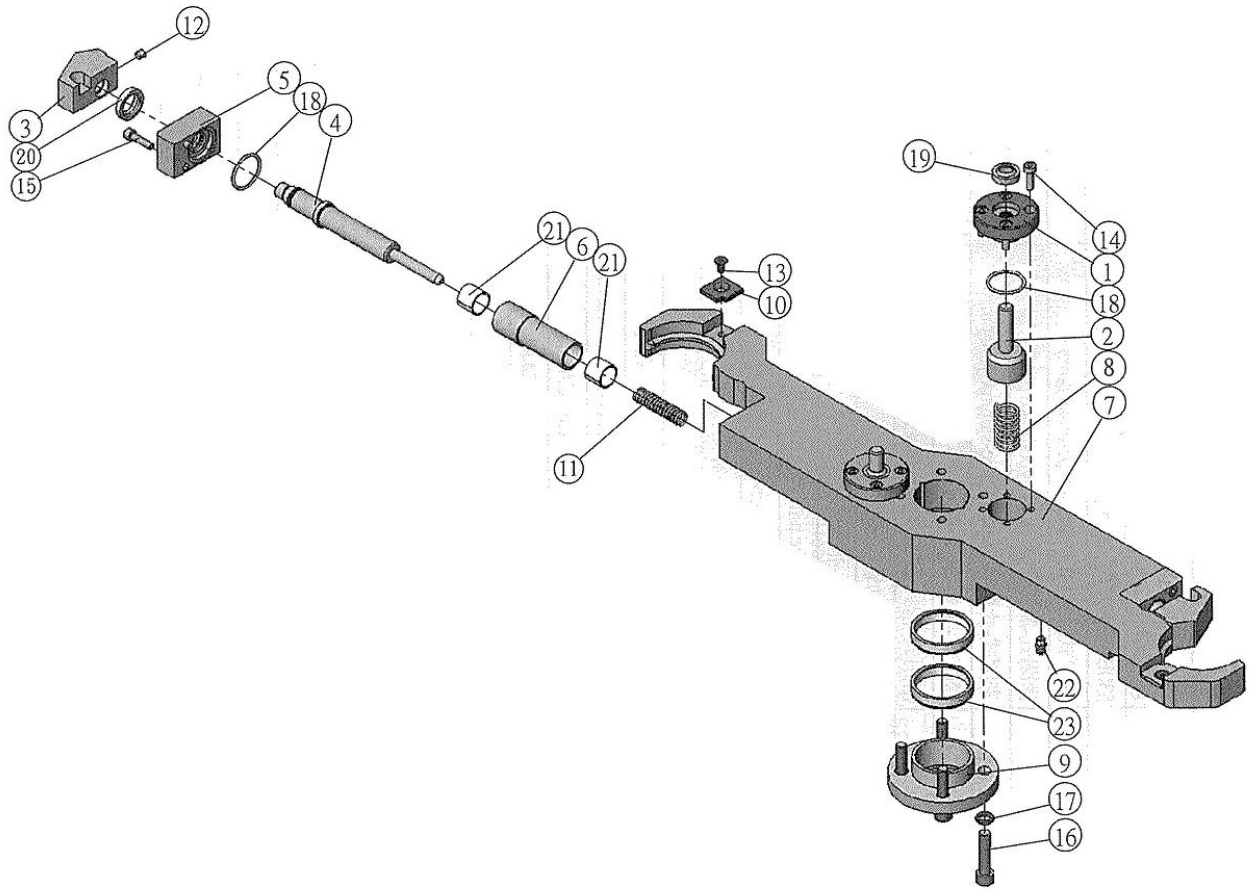


Abb. 11-17: Werkzeugwechsler - Tool changer

Ersatzteilliste Werkzeugwechsler 3 von 5 - Spare part list tool changer 3 of 5

Pos.	Bezeichnung	Designation	Menge	Grösse	Artikel-nummer
			Qty.	Size	Item no.
1	Flansch	Flange	1		03511210 1801
2	Bolzen	Bolt	2		03511210 1802
3	Block	Block	2		03511210 1803
4	Welle	Shaft	2		03511210 1804
5	Platte	Plate	2		03511210 1805
6	Hülse	Sleeve	2		03511210 1806
7	Wechslerarm	Change holder	2		03511210 1807
8	Feder	Spring	1		03511210 1808
9	Flansch	Flange	2		03511210 1809
10	Platte	Plate	2		03511210 1810
11	Feder	Spring	2		03511210 1811
12	Schraube	Screw	2		03511210 1812
13	Schraube	Screw	2		03511210 1813
14	Schraube	Screw	8		03511210 1814
15	Schraube	Screw	4		03511210 1815
16	Schraube	Screw	4		03511210 1816
17	Federring	Spring ring	4		03511210 1817
18	O-Ring	O-Ring	2		03511210 1818
19	Ring	Ring	2		03511210 1819

Pos.	Bezeichnung	Designation	Menge	Grösse	Artikel-nummer
			Qty.	Size	Item no.
20	Ring	Ring	4		03511210 1820
21	Buchse	Bushing	2		03511210 1821
22	Bolzen	Bolt	2		03511210 1822
23	Ring	Ring	4		03511210 1823
24	Ring	Ring	2		03511210 1824
25	Schmiernippel	Lubrication pin	2		03511210 1825

11.15.4 Werkzeugwechsler 4 von 5 - Tool changer 4 of 5

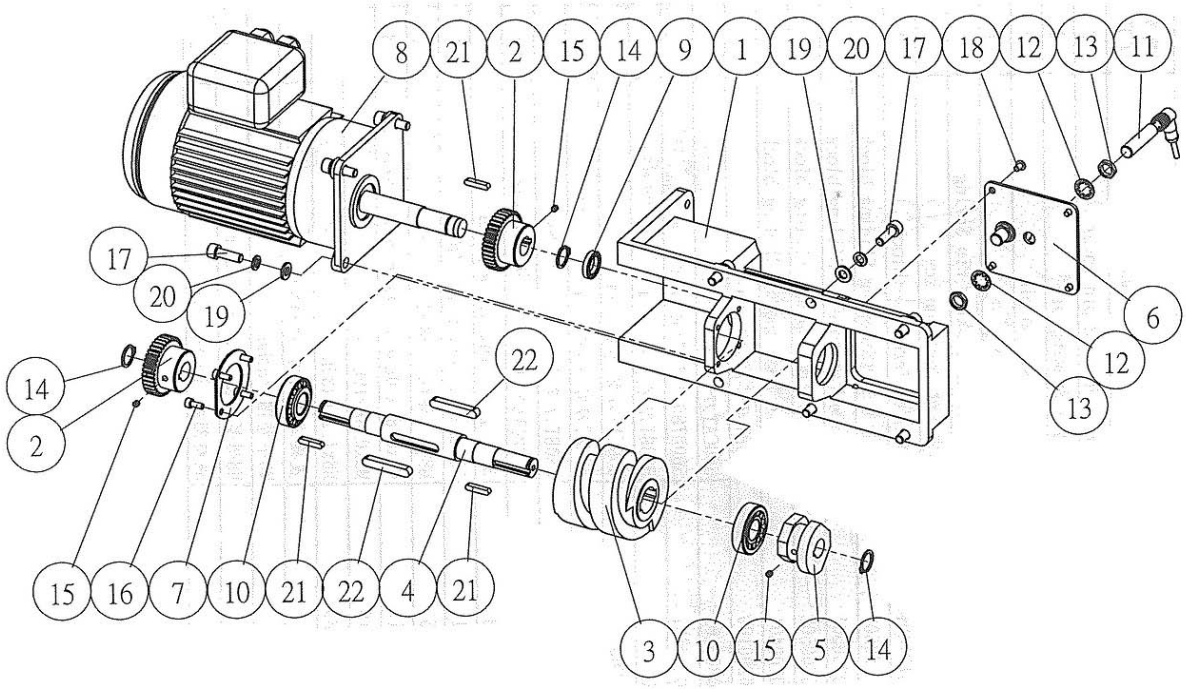


Abb. 11-18: Werkzeugwechsler - Tool changer

Ersatzteilliste Werkzeugwechsler 4 von 5 - Spare part list tool changer 4 of 5

Pos.	Bezeichnung	Designation	Menge	Grösse	Artikel-nummer
			Qty.	Size	Item no.
1	Gehäuse	Driving pedestal	1		03511210 1601
2	Zahnrad	Driving gear	2		03511210 1602
3	Exzenter	Dividing cam	1		03511210 1603
4	Welle	Cam shaft	1		03511210 1604
5	Block	Sensor block	1		03511210 1605
6	Platte	Plate	1		03511210 1606
7	Abdeckung	Ball bearing cover	1		03511210 1607
8	Motor	Motor	1		03511210 1608
9	Kugellager	Ball bearing	1		03511210 1609
10	Kugellager	Ball bearing	2		03511210 1610
11	Sensor	Proximity switch	2		03511210 1611
12	Scheibe	Tooth washer	4		03511210 1612
13	Sechskantmutter	Nut	4		03511210 1613
14	Sicherungsring	Shape ring	3		03511210 1614

Pos.	Bezeichnung	Designation	Menge Qty.	Grösse Size	Artikel-nummer Item no.
15	Gewindestift	Set screws	3		03511210 1615
16	Schraube	Screw	4		03511210 1616
17	Schraube	Screw	9		03511210 1617
18	Schraube	Screw	4		03511210 1618
19	Scheibe	Washer	9		03511210 1619
20	Federing	Spring washer	9		03511210 1620
21	Passfeder	Fitting key	3		03511210 1621
22	Passfeder	Fitting key	2		03511210 1622

11.15.5 Werkzeugwechsler 5 von 5 - Tool changer 5 of 5

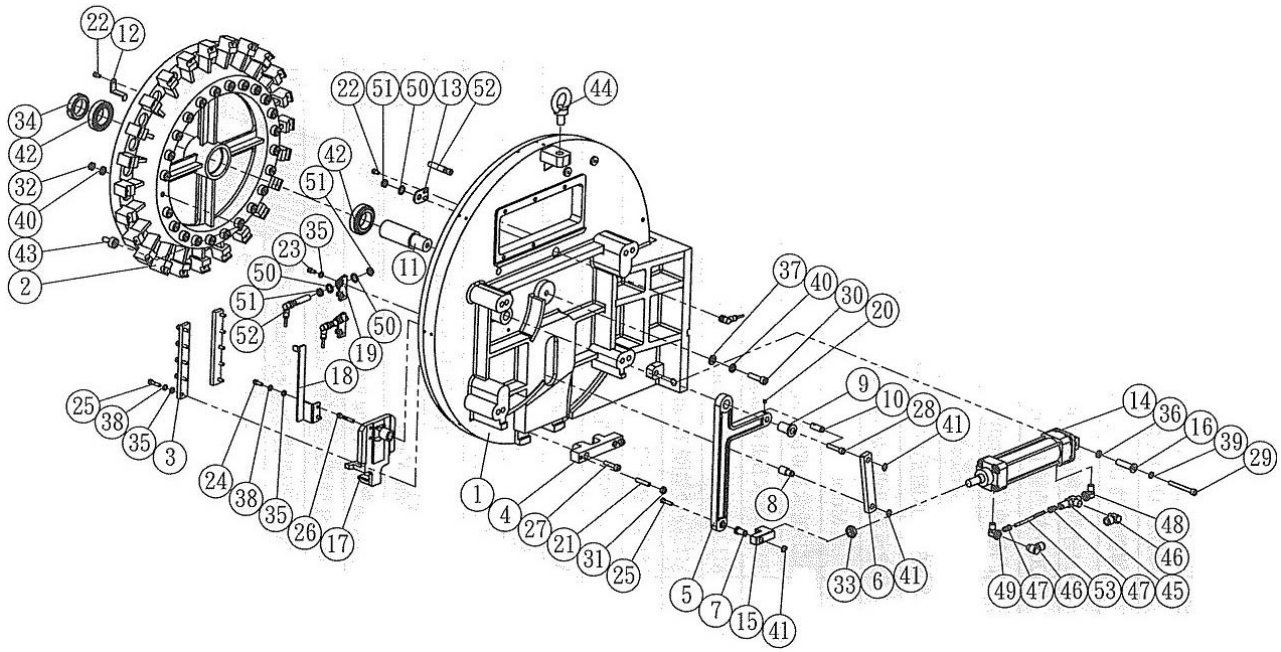


Abb. 11-19: Werkzeugwechsler - Tool changer

Ersatzteilliste Werkzeugwechsler 5 von 5 - Spare part list tool changer 5 of 5

Pos.	Bezeichnung	Designation	Menge Qty.	Grösse Size	Artikel-nummer Item no.
1	Gehäuse	Housing	1		03511210 1701
2	Werkzeugwechsler	Tool changer	1		03511210 1702
3	Platte	Plate	2		03511210 1703
4	Platte	Plate	1		03511210 1704
5	Pleuel	Plate	1		03511210 1705
6	Platte	Plate	1		03511210 1706
7	Bolzen	Bolt	1		03511210 1707
8	Buchse	Bushing	1		03511210 1708
9	Buchse	Bushing	1		03511210 1709
10	Stift	Pin	1		03511210 1710
11	Hülse	Sleeve	1		03511210 1711
12	Platte	Plate	1		03511210 1712

Pos.	Bezeichnung	Designation	Menge	Grösse	Artikel-nummer
			Qty.	Size	Item no.
13	Platte	Plate	1		03511210 1713
14	Pnuematik Zylinder	Air cylider	1		03511210 1714
15	Klotz	Block	1		03511210 1715
16	Stift	Pin	1		03511210 1716
17	Halter	Holder	1		03511210 1717
18	Halter	Holder	1		03511210 1718
19	Halter	Holder	2		03511210 1719
20	Bolzen	Bolt	1		03511210 1720
21	Bolzen	Bolt	2		03511210 1721
22	Schraube	Screw	3		03511210 1722
23	Schraube	Screw	4		03511210 1723
24	Schraube	Screw	2		03511210 1724
25	Schraube	Screw	11		03511210 1725
26	Schraube	Screw	1		03511210 1726
27	Schraube	Screw	2		03511210 1727
28	Schraube	Screw	1		03511210 1728
29	Schraube	Screw	1		03511210 1729
30	Schraube	Screw	1		03511210 1730
31	Sechskantmutter	Hexagon nut	2		03511210 1731
32	Sechskantmutter	Hexagon nut	24		03511210 1732
33	Sechskantmutter	Hexagon nut	1		03511210 1733
34	Nutmutter	Groove nut	1		03511210 1734
35	Scheibe	Washer	16		03511210 1735
36	Scheibe	Washer	1		03511210 1736
37	Scheibe	Washer	1		03511210 1737
38	Federring	Spring washer	12		03511210 1738
39	Federring	Spring washer	1		03511210 1739
40	Federring	Spring washer	25		03511210 1740
41	Sicherungsring	Retaining ring	3		03511210 1741
42	Kugellager	Ball bearing	2		03511210 1742
43	Bolzen	Bolt	24		03511210 1743
44	Ring	Ring	1		03511210 1744
45	Pneumatikventil	Air ventil	1		03511210 1745
46	Anschluss	Plug	2		03511210 1746
47	Kupplungsstück	Clutch	2		03511210 1747
48	Anscchluss	Plug	1		03511210 1748
49	Verteiler	Manifold	1		03511210 1749
50	Scheibe	Washer	5		03511210 1750
51	Sechskantmutter	Hexagon nut	5		03511210 1751
52	Sensor	Sensor	3		03511210 1752
53	Pneumatikschlauch	Air hose	1		03511210 1753

11.16 Integriertes Kühlaggregat 20 bar - Integrated cooling unit 20 bar

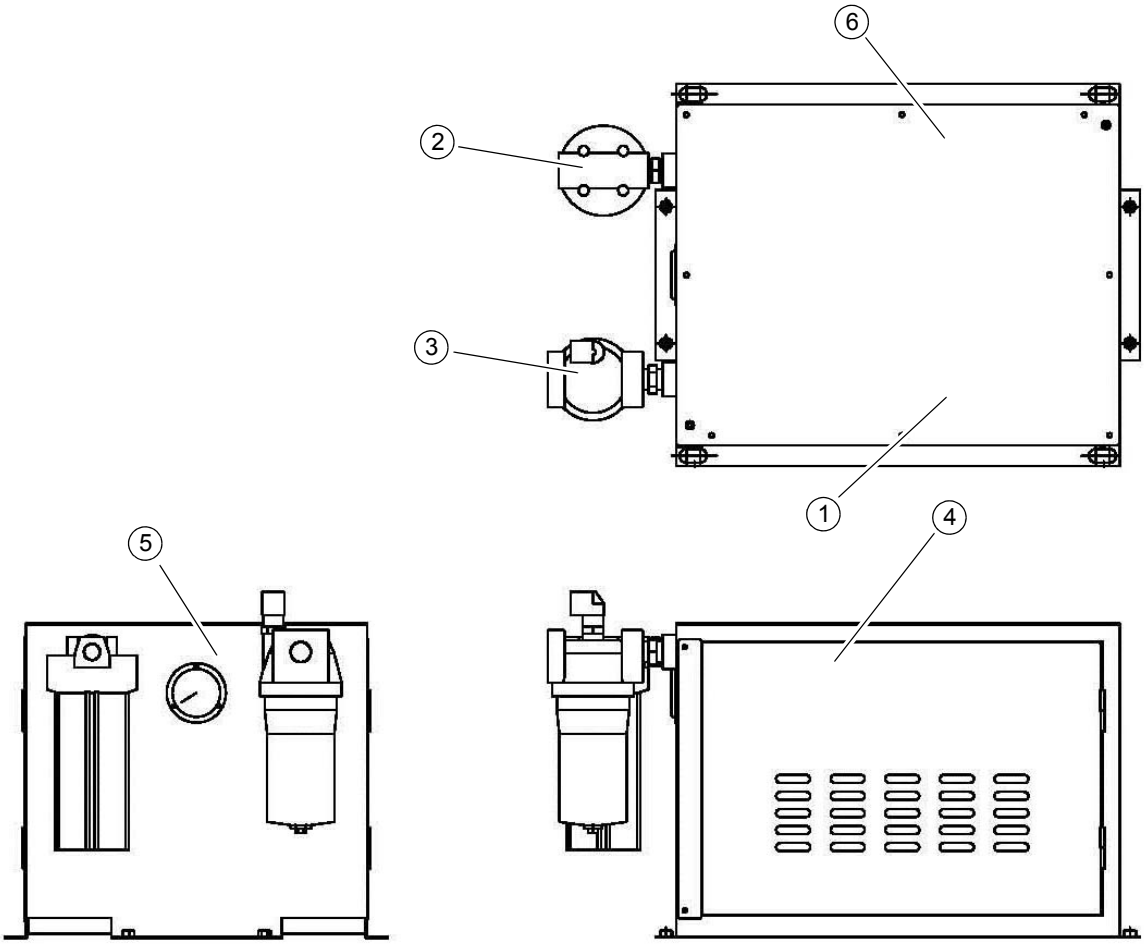


Abb. 11-20: Integriertes Kühlaggregat 20 bar - Integrated cooling unit 20 bar

Ersatzteilliste - Spare parts list

Pos.	Bezeichnung	Designation	Menge Qty.	Grösse Size	Artikelnummer Item no.
1	Abdeckung	Cover	1		035112100801
2	Filter Vorlauf	Inlet filter	1		035112100802
3	Filter Rücklauf	Outlet filter	1		035112100803
4	Gehäuse	Housing	1		035112100804
5	Manometer	Pressure gauge	1		035112100805
6	Kühlmittelpumpe	Motor pump	1		035112100806

11.17 Externes Kühlaggregat 20 bar - External cooling unit 20 bar

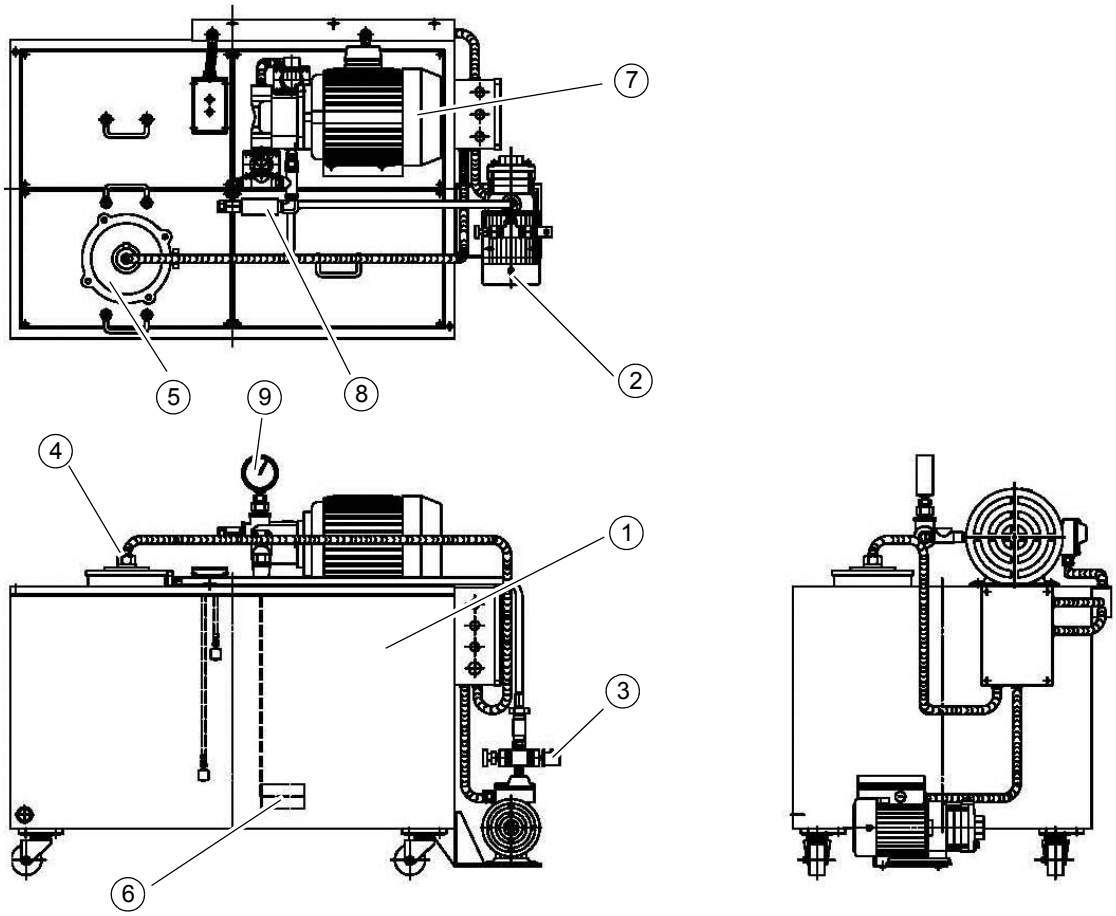


Abb.11-21: Externes Kühlaggregat 20 bar - External cooling unit 20 bar

Ersatzteilliste - Spare parts list

Pos.	Bezeichnung	Designation	Menge Qty.	Grösse Size	Artikelnummer Item no.
1	Kühlmittelbehälter	Tank	1		035112100901
2	Kühlmittelpumpe Vorlauf	Inlet pump	1		035112100902
3	Manometer	Pressure gauge	1		035112100903
4	Druckschalter	Pressure switch	1		035112100904
5	Filter Vorlauf	Inlet filter	1		035112100905
6	Filter Rücklauf	Outlet filter	1		035112100906
7	Kühlmittelpumpe Rücklauf	Outlet pump	1		035112100907
8	Druckventil	Pressuge valve	1		035112100908
9	Manometer	Pressure gauge	1		035112100909

11.18 Externes Kühlaggregat 70 bar - External cooling unit 70 bar

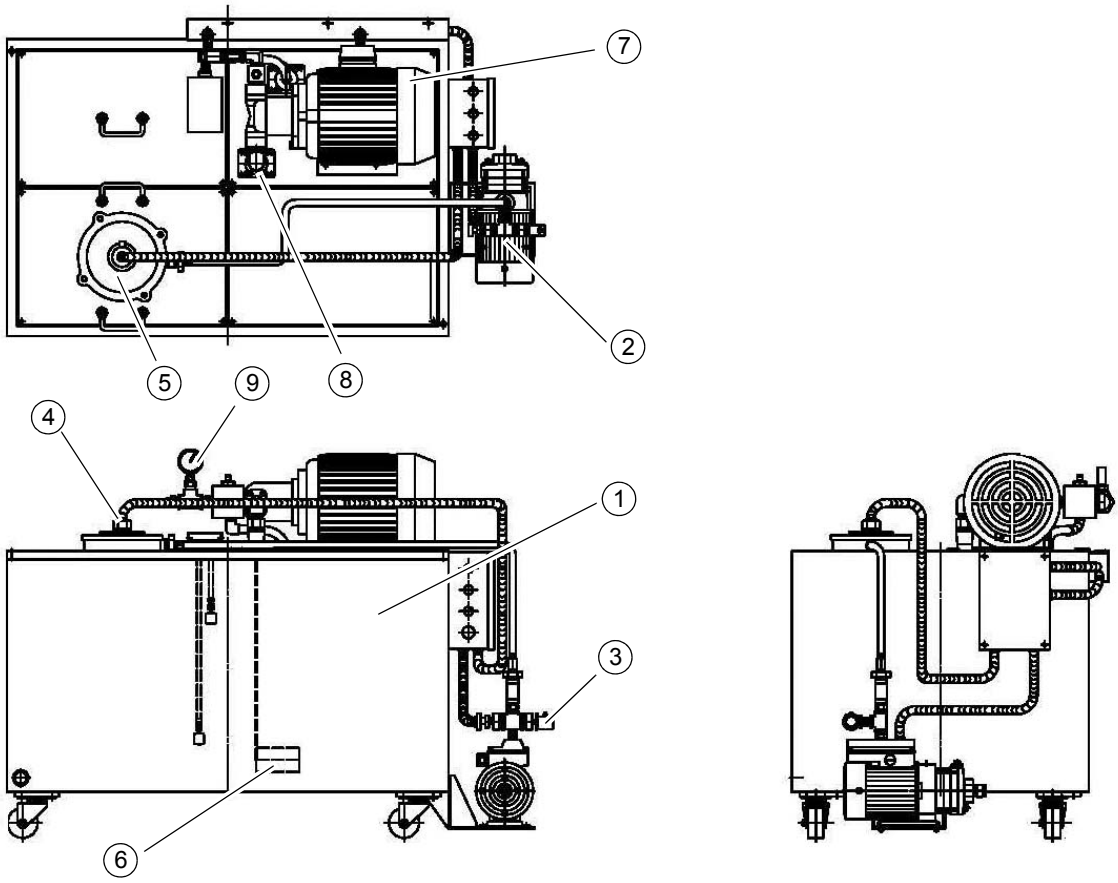


Abb. 11-22: Externes Kühlaggregat 70 bar - External cooling unit 70 bar

Ersatzteilliste - Spare parts list

Pos.	Bezeichnung	Designation	Menge Qty.	Grösse Size	Artikelnummer Item no.
1	Kühlmittelbehälter	Tank	1		035112100301
2	Kühlmittelpumpe Vorlauf	Inlet pump	1		035112100302
3	Manometer	Pressure gauge	1		035112100303
4	Druckschalter	Pressure switch	1		035112100304
5	Filter Vorlauf	Inlet filter	1		035112100305
6	Filter Rücklauf	Outlet filter	1		035112100306
7	Kühlmittelpumpe Rücklauf	Outlet pump	1		035112100307
8	Druckventil	Pressuge valve	1		035112100308
9	Manometer	Pressure gauge	1		035112100309

11.19 EC - Declaration of Conformity

Machinery Directive 2006/42/EC Annex II 1.A

The manufacturer / retailer:	Optimum Maschinen Germany GmbH Dr.-Robert-Pfleger-Str. 26 D - 96103 Hallstadt

hereby declares that the following product

Product designation:	F150
Type designation:	CNC- milling machine
Serial number:	__ __ __ __ __
Year of manufacture:	20__

CNC milling machine for craft and industrial plants which meets all the relevant provisions of the above mentioned Directive 2006/42/EC as well as the other directives applied (below) including their amendments in force at the time of declaration.

The following other EU Directives have been applied:

EMC Directive 2014/30/EC

Low Voltage Directive 2014/35/EC

The safety objective meet the requirement of EC Directive 2006/95/EC

The following harmonized standards were applied:

EN ISO 12100:2010 - Safety of machinery - General principles for design - Risk assessment and risk reduction

DIN EN 60204-1 - Safety of machines - Electrical equipment of machines, Part 1 General requirements

DIN EN 12417 - Machine tools - Safety - Machining centres

DIN 66025-1, Publication date:1983-01 - Numerical control of machines; general requirements

DIN 66025-2, Publication date:1988-09 - Industrial automation; numerical control of machines, preparatory and miscellaneous functions

Responsible for documentation: Kilian Stürmer, phone: +49 (0) 951 96555-800

Address:	Dr.-Robert-Pfleger-Str. 26 D - 96103 Hallstadt

Kilian Stürmer

Hallstadt, 29/07/2014

12 EC - Declaration of Conformity SIEMENS

SIEMENS

Manufacturer's declaration

Manufacturer:	SIEMENS AG
Address:	SIEMENS AG; Industry DT MC Frauenauracher Straße 80 D-91056 Erlangen Germany
Product description:	**SINAMICS S120, framesizes Booksize, Booksize Compact, and Chassis** (for included hardware and software releases see following pages)

The functional safety functions "Basic Functions" (STO, SBC, SS1) and "Extended Functions" (STO, SBC, SS1, SS2, SLS, SOS, SSM, safe I/Os) of the above mentioned product fulfill the requirements of SIL 2 according to [1] and [4], PL d according to [2] and category 3 according to [2]. The functions STO, SS1 and SS2 correspond with stop category 0, stop category 1 and stop category 2 respectively according to [3].

Reference number

[1]	EN 61508, part 1 to 7 (1998 - 2001)
[2]	EN ISO13849 part 1 (2007)
[3]	EN 60204 (2006)
[4]	EN 61800-5-2 (2008)

Erlangen, July 7th 2010

G. Bock
Leiter R&D Produkte
Name, function

i.V. .....
signature

T. Heinzelmann
Leiter Qualitätsmanagement
Name, function

i.V. .....
signature

13 Appendix

13.1 Copyright

Optimum Maschinen Germany GmbH

13.2 Changes

Any changes in the construction, equipment and accessories are reserved for reasons of enhancement. Therefore, no claims may be derived from the indications and descriptions. Errors excepted!

13.3 Product follow-up

We are required to perform a follow-up service for our products which extends beyond shipment.

We would be grateful if you could send us the following information:

- Modified settings
- Any experiences with the CNC machine which might be important for other users
- Recurring failures
- Difficulties with the documentation

Optimum Maschinen Germany GmbH

Dr.-Robert-Pfleger-Str. 26
D-96103 Hallstadt

Email: info@optimum-maschinen.de

13.4 Liability claims for defects / warranty

Beside the legal liability claims for defects of the customer towards the seller the manufacturer of the product, OPTIMUM GmbH, Robert-Pfleger-Straße 26, D-96103 Hallstadt, does not grant any further warranties unless they are listed below or were promised in the framework of a single contractual provision.

- The processing of the liability claims or of the warranty is performed as chosen by OPTIMUM GmbH either directly or through one of its dealers.
  Any defective products or components of such products will either be repaired or replaced by components which are free from defects. Ownership of replaced products or components is transferred to OPTIMUM Maschinen Germany GmbH.
- The automatically generated original proof of purchase which shows the date of purchase, the type of machine and the serial number, if applicable, is the precondition in order to assert liability or warranty claims. If the original proof of purchase is not presented, we are not able to perform any services.
- Defects resulting from the following circumstances are excluded from liability and warranty claims:
  - Using the product beyond the technical options and proper use, in particular due to overstraining of the machine.
  - Any defects arising by one's own fault due to faulty operation or if the operating manual is disregarded
  - Inattentive or incorrect handling and use of improper equipment
  - Unauthorized modifications and repairs
  - Insufficient installation and safeguarding of the machine
  - Disregarding the installation requirements and conditions of use
  - atmospheric discharges, overvoltage and lightning strokes as well as chemical influences
- The following items are also not subject to liability or warranty claims:
  - Wearing parts and components which are subject to a standard wear as intended such as e.g. V-belts, ball bearings, illuminants, filters, sealings, etc.
  - Non reproducible software errors
- Any services which OPTIMUM GmbH or one of its agents performs in order to fulfill in the frame of an additional guarantee are neither an acceptance of the defects nor an acceptance of its obligation to compensate. Such services do neither delay nor interrupt the warranty period.
- Place of jurisdiction among traders is Bamberg.
- If one of the aforementioned agreements is totally or partially inefficient and/or null, a provision closest to the intent of the warrantor and which remains in the framework of the limits of liability and warranty which are predefined by this contract is considered agreed upon.

13.5 Advice for disposal / Options of re-use

Please dispose of your machine in an environmentally friendly way, not by disposing of the waste not in the environment, but by acting in a professional way.

Please neither throw away the packaging nor the used machine later on, but dispose of them according to the guidelines established by your city council/municipality or by the corresponding waste management enterprise.

13.5.1 Decommissioning

CAUTION !

Immediately decommission used machines in order to avoid later misuse and endangering of the environment or of persons.

Cut the connection cable.

Remove all environmentally hazardous operating fluids from the used device.

If applicable remove batteries and accumulators.

Disassemble the machine if required into easy-to-handle and reusable assemblies and component parts.

Supply the machine components and operating fluids to the provided disposal routes.

13.5.2 Disposal of the packaging of new devices

All used packaging materials and packaging aids from the machine are recyclable and generally need to be supplied to the material reuse.

The packaging wood can be sent for disposal or recycling.

Any packaging components made of cardboard box can be chopped up and added to the waste paper collection.

The films are made of polyethylene (PE) and the cushion parts are made of polystyrene (PS). These materials can be reused after reconditioning if they are forwarded to a collection station or to the appropriate waste management enterprise.

Only forward the packaging materials correctly sorted to allow a direct reuse.

13.5.3 Disposal of the machine

INFORMATION

In your interest and in the interest of the environment please ensure that all component parts of the machine are only disposed of in the intended and permitted manner.

Please note that the electrical devices include a variety of reusable materials as well as environmentally hazardous components. Contribute toward these components being properly separated and professionally disposed. In case of doubt, please contact your municipal waste management. If necessary, consult a specialist waste disposal company for the treatment of the material.

13.5.4 Disposal of electrical and electronic components

Please make sure that the electrical components are disposed of professionally and according to the legal regulations.

The machine is composed of electrical and electronic components and must not be disposed of as household waste. According to the European directive 2002/96/EC regarding electrical and electronic used devices and the implementation of national legislation used power tools and electrical machines need to be collected separately and supplied to an environmentally friendly recycling centre.

Being the machine operator you should obtain information regarding the authorized collection or disposal system which applies for your company.

Please make sure that the batteries and/or accumulators are disposed of in a professional way according to the legal regulations. Please only throw discharged batteries in the collection boxes in shops or at municipal waste management companies.

13.5.5 Disposal of lubricants and coolants

ATTENTION!

Please imperatively make sure to dispose of the used coolant and lubricants in an environmentally compatible manner. Observe the disposal notes of your municipal waste management companies.

INFORMATION

Used coolant emulsions and oils should not be mixed up since it is only possible to reuse used oils that have not been mixed without pre-treatment.

The disposal notes for the used lubricants are made available by the manufacturer of the lubricants. If necessary, request the product-specific data sheets.

13.6 Disposal via municipal collection

Disposal of used electrical and electronic components
(Applicable in the countries of the European Union and other European countries with a separate collecting system for those devices).

The sign on the product or on its packing indicates that the product must not be handled as common household waste, but that is needs to be delivered to a central collection point for recycling. Your contribution to the correct disposal of this product will protect the environment and the health of your fellow men. The environment and health are endangered by incorrect disposal. Recycling of material will help to reduce the consumption of raw materials. Your District Office, the municipal waste collection station or the shop where you have bought the product will inform you about the recycling of this product.

13.7 RoHS, 2002/95/EC

The symbol on the product or on its packing indicates that this product complies with the European guideline 2002/95/EC.

13.8 Re-export

All contract products and technical knowledge are delivered by Optimum Maschinen Germany GmbH while ensuring the currently applicable AWG/AWV/ECDual-Use regulation as well as the US export regulations and are intended to be used and to remain in the delivery country which had been agreed with the customer. If the customer intends to re-export contract products he is obliged to follow US American, European and national export regulations. It is forbidden to re-export contract products contrary to these regulations.

The customer must inform himself about the currently applicable regulations and terms (Office for Export, 65760 Eschborn/Taunus or US Department of Commerce, Office of Export Administration, Washington D. C. 20230). Regardless of the fact if the customer indicates the final place of destination of the delivered contract products the customer is obliged to gather the necessary authorizations of the correspondingly responsible competent authorities for foreign trade before exporting such products. Optimum Maschinen Germany GmbH is not obliged to give any information and does not submit any guarantee that the contract products comply with the corresponding export regulations. The customer cannot claim that Optimum Maschinen Germany GmbH adapts the contract products to the corresponding export regulations.

Any forwarding of contract products to the customer by third parties with or without knowledge of Optimum Maschinen Germany GmbH requires at the same time the transfer of the export authorization conditions. The customer shall be completely liable in case of non-observance of the relevant conditions.

Without previous official approval the customer is not allowed to deliver contract products directly or indirectly to countries which are subject to an US embargo or to deliver to any natural or juridical persons in such countries as well as natural or juridical persons who are listed on the US American, European or national Indexes (e.g.: "Specifically Designated Nationals and Blocked Persons", "Entity List'V' Denied Persons List"). Moreover it is forbidden to deliver to natural or juridical persons who are in any relation with the support, development, production or use of chemical, biological or nuclear weapons of mass destruction in any way.

13.9 Terminology/Glossary

Term	Explanation
Cross table, milling table	Bearing surface, clamping surface for the workpiece with X- and Y-axis travel
CAD	C omputer A ided D esign
CAM	C omputer A ided M anufacturing
CAP	C omputer A ided P lanning
CNC	C omputerised N umerical C ontrol
CTS	C oolant T hrough S pindle
NC	N umericial C ontrol
ATC	A utomatic T ool C hanger
MCP	M achine C ontrol P anel
PLC	P rogrammable L ogic C ontroller
Work-piece	piece to be milled, drilled or machined.
Spindle head	Milling head, upper part of the CNC milling machine
Spindle sleeve	Hollow shaft in which the milling spindle turns.
Milling spindle	Shaft activated by the motor
Tool	Milling cutter, drill bit, etc.
Machine Control Panel	Control panel, keyboard and screen of the CNC machine
Separating protective equip-ment	Cover, housing
Step motor	Synchronous motor where the rotor (turnable piece of the motor with a shaft) can be turned targeted around an angle if the triggered stator coils (non-turnable piece of the motor) is well selected.
Servo motor	A motor which can travel to different predetermined positions and will main-tain there. In this case, the position is an angular position of a rotatory motor and in case of a linear motor it is a linear positioning. The starting-up and maintaining of the predetermined position is performed by means of a control.

13.10 Change information operating manual

Chapter	Short note	new version number
10.5	Axis-specific values	1.1.1
2.4	Recommended compressed air quality	1.1.2
01:11	Function signal lamp	1.1.3
new chapter	M- code list, M functions	1.1.4
EC declaration	modified standard, DIN EN 12100:2010	1.1.4
2 / 6 / 10	Optional integrated equipment	1.1.5
3.9.7	added new pneumatic circuit diagram	1.1.6
Maintenance	Advanced information on coolant lubricant	1.1.6

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