



WITTENSTEIN

alpha

alpha rack and pinion system

Technical documents



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1 About this manual

This manual contains necessary information to safely use the rack and pinion system, hereinafter referred to as drive system.

If this manual is supplied with amendment sheets (e.g. for special applications), then the information in the amendment is valid. Contradictory specifications in this manual are therefore void.

The user should contact **WITTENSTEIN alpha GmbH** with any questions about special applications. The operator must ensure that this operating manual is read through by all persons assigned to install, operate, or maintain the drive system, and that they fully comprehend its content.

Store this manual within reach of the drive system.

Inform colleagues who work in the area around the machine about the **safety instructions and warnings** so that no one sustains injuries.

The original was written in German, all other language versions are translations of the original manual.

1.1 Information symbols

The following information symbols are used:

- Indicates an action to be performed
- ➔ Indicates the results of an action
- ① Provides additional handling information

A cross reference refers to the chapter number and the header of the target section (z. B. 2.3 "Intended use").

A cross reference on a table refers to the table number (e. g. Table "Tbl-15").

1.2 Scope of delivery

- Check the completeness of the delivery against the delivery note.
- ① Immediately notify the carrier, the insurance company, or **WITTENSTEIN alpha GmbH** in writing of any missing parts or damage.

2 Safety

These instructions, especially the safety and warning notices and the rules and regulations valid for the operating site, must be observed by all persons working with the racks.

The following, especially, must be strictly adhered to:

- Observe the instructions for transport and storage.
- Use the drive system exclusively in accordance with its intended use and in a technically flawless and safe condition.
- Carry out maintenance and repair work appropriately and professionally in conformity with the specified intervals.
- Always mount, dismantle, and operate the drive system properly (e.g. even test run only with lubrication).
- Only operate the drive system with intact protective devices and equipment.
- Only operate the drive system with lubrication (type and quantity).
- Prevent pollution of the drive system.
- Only carry out modifications or reconstructions when these are approved in writing by **WITTENSTEIN alpha GmbH**.

Personal injuries or material damage, or other claims arising from non-observance of these minimum requirements, are the sole responsibility of the operator.

In addition to the safety-related information in this manual, also observe any legal and otherwise applicable rules and regulations, particularly for accident prevention (e.g. personal safety equipment) and environmental protection.

2.1 EC/EU Directives

2.1.1 Machinery Directive

The rack and pinion system is considered a "machine component" and is therefore not subject to the EC Machinery Directive 2006/42/EC.

Operation is prohibited within the scope of the EC directive until it has been determined that the machine in which this product is installed corresponds to the regulations within this directive.

2.2 Personnel

Only technicians who have read and understood this operating manual may perform work on the drive system. Based on their training and experience, technicians must be able to evaluate the tasks assigned to them in order to recognize and avoid risks.

2.3 Intended use

The drive system is used to convert rotational motion to linear motion (e.g. for feed drives) or vice versa and is intended to be installed in a machine.

It is suitable for industrial applications.

The drive system may not be operated in potentially explosive atmospheres. In the food processing/pharmaceutical/cosmetics industry, the drive system may only be used next to or under the product area.

The drive system has been constructed according to current technological standards and accepted safety regulations.

- To avoid any hazard to the operator or damage to the machine, use the drive system only in accordance with its intended use and in a technically flawless and safe condition.
- If you notice any altered operating behavior, check the gearbox in accordance with chapter 8 "Malfunctions".
- Read the general safety instructions before beginning to work (see chapter 2.5 "General safety instructions").

2.4 Reasonably foreseeable misuse

All other applications other than the intended use specified above, are deemed to be improper use and are therefore prohibited.

2.5 General safety instructions

The operation of the drive system involves residual risks even when adhering to the intended use.

Moving components can cause serious injuries:

- Before startup, remove objects, loose components, and tools from the drive system, in order to avoid danger from thrown parts.
- Keep a sufficient distance to moving machine components when the drive system is running.
- Secure the machine against restarting and unintentional movement during assembly and maintenance work.
- **Hot components** (e.g. gearboxes) of the drive system can cause serious burns:
- Touch hot components only with protective gloves.

The **noise emissions** can cause hearing damage. The continuous noise pressure level may vary according to product type and size:

- ① Information about your specific product is available in the catalog under www.wittenstein-alpha.de or from our Customer Service / Sales department.
- For noise protection measures, observe the total noise pressure level of the machine.

Loose or overloaded screw connections can cause damage to the drive system:

- Use a calibrated torque wrench to tighten and check all screw connections for which tightening torques have been specified.

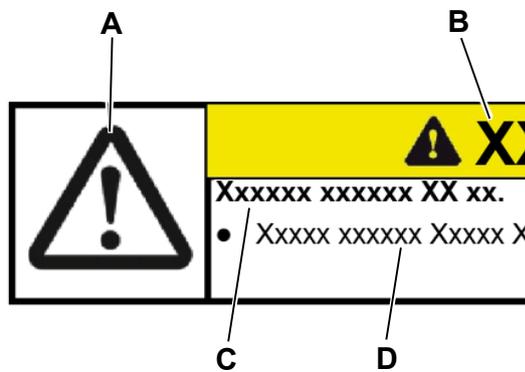
Solvents and lubricants are flammable, can cause skin irritation, and can pollute soil and water:

- In case of fire: Do not use a jet of water to extinguish.
- ① Suitable extinguishing agents are powder, foam, water mist and carbon dioxide. Observe the safety instructions of the lubricant manufacturer (see chapter 7.3.2 "Checking the lubrication system").
- Use protective gloves to avoid direct skin contact with solvents and lubricants.
- Use and dispose of solvents and lubricants properly.

A **damaged drive system** can cause accidents and injury:

- Immediately shut down a gearbox that has been overloaded due to misuse or a machine crash (see chapter 2.4 "Reasonably foreseeable misuse").
- Replace the damaged drive system, even if no external damage is visible.

2.6 Structure of warning instructions



Warning instructions are situation-specific. They will be precisely where tasks are described in which dangers can arise.

The warning instructions in this manual are designed according to the following pattern:

- A** = Safety symbol
(See chapter 2.7 "Safety symbols")
- B** = Signal word
(See chapter 2.8 "Signal words")
- C** = Type and consequence of the danger
- D** = Avoiding the danger

Figure 2.1

2.7 Safety symbols

The following safety symbols are used to indicate hazards, things that are forbidden and important information:



General danger



Entanglement



Substances that represent a fire risk



Suspended loads



Environmental protection



Information

2.8 Signal words

The following signal words are used to indicate hazards, things that are forbidden and important information:

	⚠ DANGER This signal word indicates an imminent danger that will cause serious injuries or even death.
	⚠ WARNING This signal word indicates a potential hazard that could cause serious injuries and even death.
	⚠ CAUTION This signal word indicates a potential hazard that could cause minor or serious injuries.
	NOTE This signal word indicates a potential hazard that could lead to property damage.
	A note without a signal word indicates application tips or especially important information for handling the drive system.

3 Description of the drive system

The drive system consists of:

- racks,
- the corresponding gearbox with one pinion at the output
- and a lubrication system.

The drive system is available in different versions. Refer to our catalog or our website for the corresponding installation dimensions: www.wittenstein-alpha.de.

For the assembly described in this manual, additional parts/tools are required which are available as self-contained accessories (see chapter 9.8 "Overview of the assembly accessories").

3.1 Ordering code / Name plate

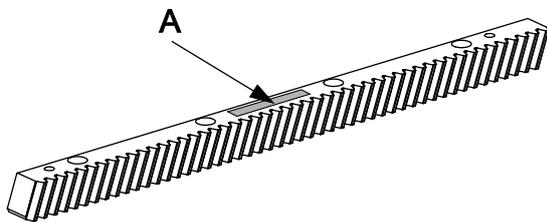


Figure 3.1

The ordering code (A) for the racks is located on the racks (e.g.: ZST 200-XXX-1000-XXX-R11 or ZST 200-XXX-1000-R11).

- ① More information is available in our catalog or at www.wittenstein-alpha.de.

The name plate for

- the gearbox is located on the gearbox housing or drive flange.
- the lubrication system is located on the lubricator.

- ① More information is available in our catalog at www.wittenstein-alpha.de or in the respective instructions.

3.2 Dimensions and performance data

The dimensions, the maximum permissible speeds and torques, and information on the service life can be found

- in our catalog,
- under www.wittenstein-alpha.de
- with the respective customer-specific performance data (2093–D...).

For additional information, contact **WITTENSTEIN alpha GmbH**. Always provide the ordering code / serial number.

- ① Consult our Customer Service department if the drive system is older than one year. The user will then receive the valid performance data.

3.3 Weight

The total weight of the drive system is the combination of the weight of the gearbox with the pinion and the corresponding racks.

- ① The mass of the individual racks can be found in chapter 9.1 "Weight of racks".
- ① For the weight of the gearbox and the lubricator (components of the lubrication system), refer to the relevant operating manual.

4 Transport and storage

4.1 Packaging

The racks are delivered individually wrapped in VCI paper / protective foil and packed in cardboard boxes if necessary.

The gearbox has corrosion protection agent on the unpainted interfaces and on the mounted output pinion and is packaged in foil and cardboard boxes.

- Dispose of the packaging materials at the recycling sites intended for this purpose. Please observe the valid national regulations for waste disposal.

4.2 Transport

	<p style="text-align: center;">⚠ WARNING</p> <p>Suspended loads can fall and can cause serious injuries and even death.</p> <ul style="list-style-type: none"> • Do not stand under suspended loads. • Secure the drive system before transport with suitable fasteners (e.g. belts).
	<p style="text-align: center;">⚠ CAUTION</p> <p>There is a risk of injury or damage due to sharp edges on the rack.</p> <ul style="list-style-type: none"> • Wear protective gloves and safety shoes.
	<p style="text-align: center;">NOTE</p> <p>Hard knocks, for instance because of falling or hard dropping, can damage the drive train.</p> <ul style="list-style-type: none"> • Only use hoisting equipment and lifting accessories with sufficient capacity. • Never exceed the maximum permissible load for hoisting equipment. • Lower the drive system slowly.

For information on the mass of the drive system, see chapter 3.3 "Weight".

4.3 Storage

Store the drive system in horizontal position and dry surroundings at a temperature of 0 °C to +40 °C in the original packaging. Store the drive system for a maximum of 2 years. Consult our Customer Service department if conditions are different.

For storage logistics, we recommend the "first in – first out" method.

5 Assembly

- Read the general safety instructions before beginning to work (see chapter 2.5 "General safety instructions").
- Observe the instructions in the relevant manual for the gearbox and lubrication system.
- If you have questions about correct assembly, consult our Customer Service department.

5.1 Requirements in respect of assembly location and mounting base

Requirements in respect of assembly location:

- The racks must be installed in a clean and dry environment. Dust and liquids of any kind impair its function.
 - The precision of installation and geometric tolerance of the assembly surfaces in the mounting base depend on the application in question. For applications with high positioning accuracy and smooth drive train running requirements, the aim should be to achieve low deviation. For applications with low requirements, greater deviation may be allowed.
- ① For specifications regarding the assembly surfaces, see chapter 9.5 "Permissible parallelism deviation of the assembly surface".

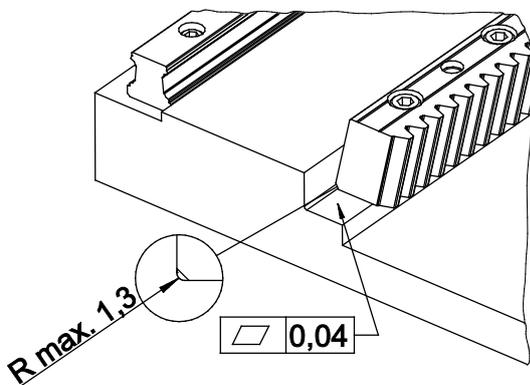


Figure 5.1

Mounting base requirements:

- There is a chamfer on the rack at the transition point between the mounting and rear surface. Recesses can be omitted from the mounting base as a result. The mounting base on the machine must be designed in such a way that the milling edge does not collide with the rack chamfer.
 - The stop surface should be designed in such a way that the rack can be clamped easily. This is achieved when the height of the stop surface is more than 50 % of the rack height and when a suitable opposing surface is available for clamping using a clamping device.
 - The threaded holes for the fastening screws must allow a sufficient screw-in depth, depending on the material used for the mounting base.
- ① Our Customer Service department is available to answer any questions regarding calculation of the screw-in depth.

5.2 Required tool and assembly material

Below is an overview of the tools/materials needed for assembly.

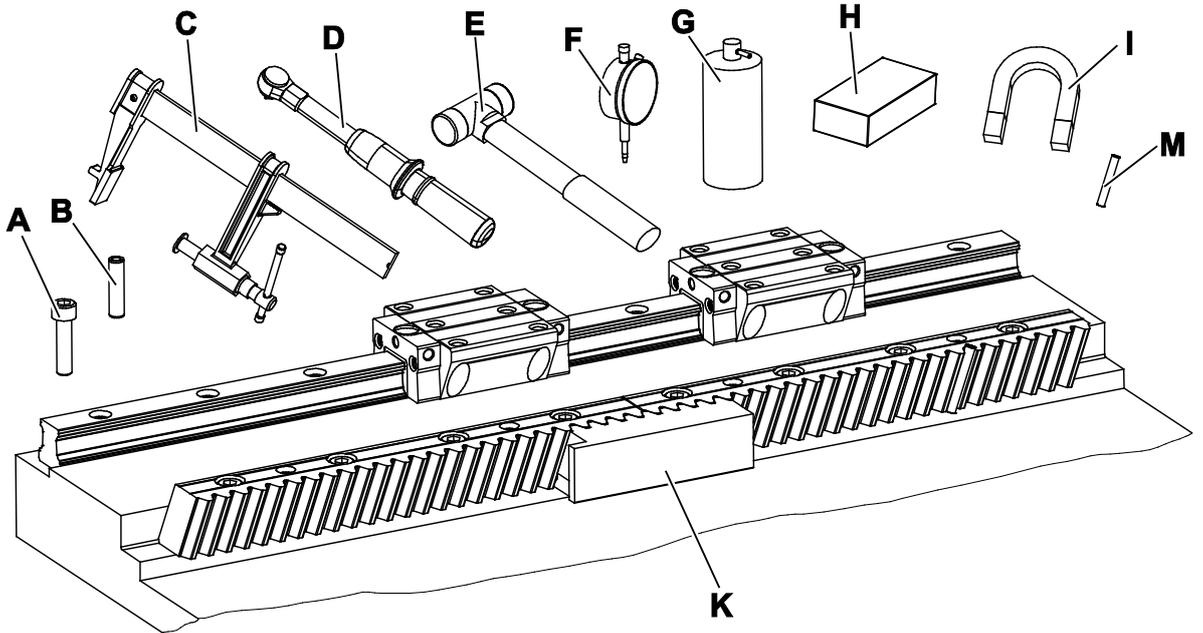


Figure 5.2

Pos.	Tool / Material	Task / Purpose	Additional information
A	Fastening screws	To affix the racks to the screw-on surface	Required size: see chapter 9.2.1 "Overview of the required cylinder head screws". The length of the fastening screws must be chosen depending on the material of the mounting base on the machine. The number of fastening screws required depends on the bores provided in the rack.
B	Cylindrical pins	To pin the racks to the screw-on surface	Required size: see chapter 9.2.2 "Overview of cylindrical pins" The length of the cylindrical pins must be chosen depending on the material of the mounting base on the machine. The number of cylindrical pins required depends on the bores provided in the rack.
C	Clamping devices (e.g. screw clamps with protective caps)	To clamp the racks to the machine bed	-
D	Torque wrench with hex key insert	To tighten the fastening screws	Tightening torque: see chapter 9.2.1 Overview of the required cylinder head screws

Pos.	Tool / Material	Task / Purpose	Additional information
E	Soft-head hammer	To adjust the transition point between two racks	-
F	Dial gauge holder with dial gauge	To check the assembly surfaces and the assembled racks	Resolution: min. 0.01 mm
G	Cleaning agent	To clean the assembly surfaces	-
H	Sharpening stone		
I	Magnet	To magnetize the needle rollers (M)	-
K	Assembly jig	To align the transition point between two racks	Size: See chapter 9.8 Overview of the assembly accessories
M	Needle roller	To check the roll dimensions using a dial gauge	Size: See chapter 9.8 Overview of the assembly accessories

Table 1: List of necessary tools/materials

5.3 Preparations

	<h2>⚠ CAUTION</h2>
	<p>There is a risk of injury or damage due to falling racks and sharp edges on the rack.</p> <ul style="list-style-type: none"> • Suitable hoisting equipment should be used when transporting heavy racks. • When using hoisting equipment, do not stand below the suspended load. • Wear protective gloves and safety shoes.
	<ul style="list-style-type: none"> • Observe the safety and processing instructions of the cleaning agents to be used.

- Unpack the racks to be assembled and remove the VCI paper or protective foil in which the racks are packed.
- Check the ordering codes (see chapter 3.1 "Ordering code / Name plate") of all toothed racks. Use only racks with the same ordering code for the same application.
- ① Always enter the ordering code when ordering spare parts in order to receive precisely coordinated racks and pinions.

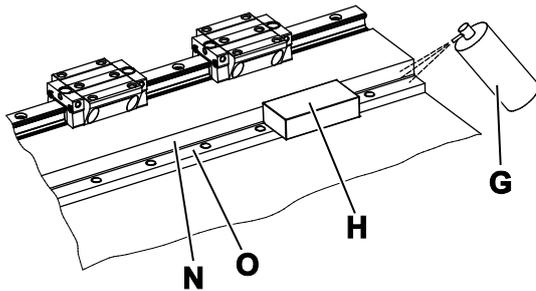


Figure 5.3

- Remove all traces of the anti-corrosion agent before mounting the racks. Use a clean, lint-free cloth and a grease-dissolving, non-aggressive cleaning agent.
- Clean the stop surface (N) and the screw-on surface (O) with a sharpening stone (H), a suitable cleaning agent (G), and a lint-free cloth.

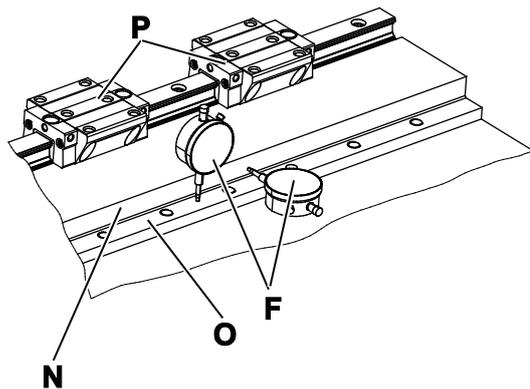


Figure 5.4

- Check the parallelism between the stop surface (N) / screw-on surface (O), and the linear guide (P).
- ① For permissible tolerances, see chapter 5.1 "Requirements in respect of assembly location and mounting base".

5.3.1 After the cleaning

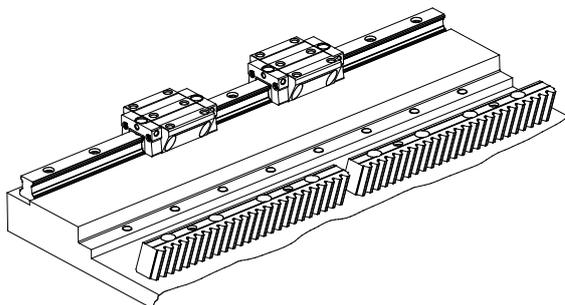


Figure 5.5

Uneven temperatures between the rack and mounting base can have a considerable impact on the smooth running and positioning accuracy of the drive train.

- Place the unpacked racks on the mounting base in good time before assembly in order to allow the temperatures to equalize.

5.4 Mounting the racks

	<p style="text-align: center;">NOTE</p> <p>The improper usage of clamping devices (e.g. such as screw clamps) can damage the gear teeth of the racks.</p> <ul style="list-style-type: none"> • Only use clamping devices with protective caps or use immediate layers of plastic or brass.
	<ul style="list-style-type: none"> • Observe the safety and processing instructions for the threadlocker to be used.

- ① Optimum precision of installation can be achieved through prior alignment of the linear guide or guide rails with the racks' assembly surfaces.

5.4.1 Assembling the first rack

	<ul style="list-style-type: none"> • Only cylinder head screws in property class 12.9. are approved for fastening the racks. ① For Screw sizes and prescribed tightening torques, see chapter 9.2.1 "Overview of the required cylinder head screws".
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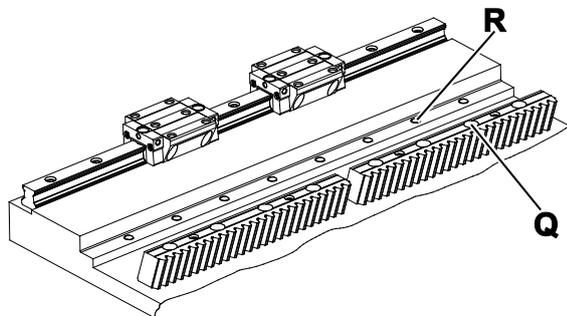


Figure 5.6

- Position the first rack in the middle of the machine bed.
- ① The through bore holes (Q) of the rack must be centered above the corresponding threaded holes (R) of the screw-on surface.
- ① It is recommended that the user commences installation in the center of the axle, particularly in the case of long axles. If installation commences at the end of the axle, pitch deviation in the racks and position deviations in the bores can accumulate to such an extent that the through bore holes in the racks and the threaded holes in the mounting base no longer sit above one another.

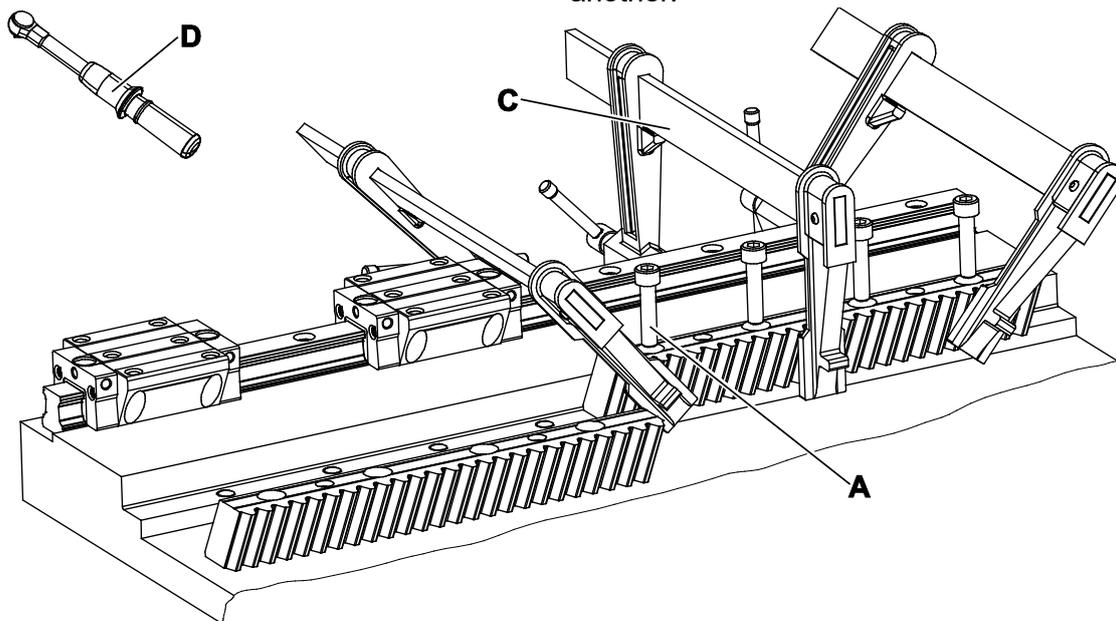


Figure 5.7

- Clamp the rack to the machine bed in the area of the fastening bores using clamping devices (C).
- Insert the first cylinder head screw (A).
- ① To secure the cylinder head screws, we recommend using a thread locking glue (e.g. Loctite® 243).
- Tighten the cylinder head screws with the required tightening torque, while the clamping device (in the following simply called screw clamp) holds the position.
- ① For Screw sizes and prescribed tightening torques, see chapter 9.2.1 "Overview of the required cylinder head screws".
- Repeat the previous steps for the remaining cylinder head screws.
- ① For Screw sizes and prescribed tightening torques, see chapter 9.2.1 "Overview of the required cylinder head screws".
- Remove the screw clamps.

5.4.2 Assembling subsequent racks

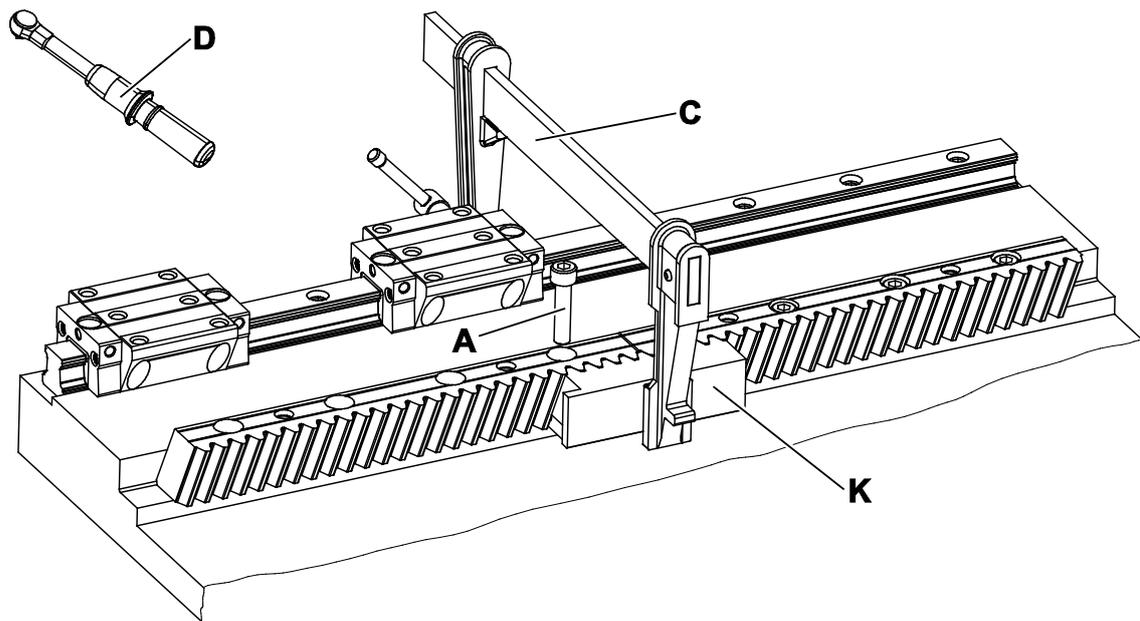
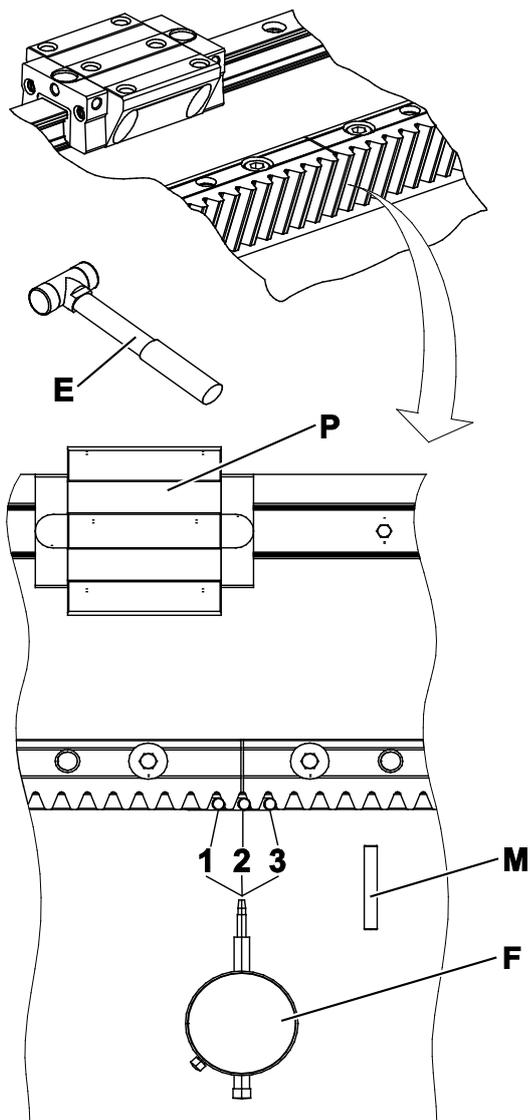


Figure 5.8

- ➔ Due to too much pressing force of the assembly jig for the connection of two racks, the rack gap can widen. The assembly jig should serve only as an insert between two racks.
- Position the rack to be assembled beside the previously assembled rack.
- Insert the assembly jig (K) into both racks at the transition point, in order to adjust the transition between the two racks.
- Clamp the rack to the machine bed in the area of the through bore holes.
- Insert the first cylinder head screw (A) in assembly direction.
- ① To secure the cylinder head screws, we recommend using a thread locking glue (e.g. Loctite® 243).
- Tighten the cylinder head screw in assembly direction with half of the predetermined tightening torque.
- ① For Screw sizes and prescribed tightening torques, see chapter 9.2.1 "Overview of the required cylinder head screws".
- Repeat the previous steps for the remaining cylinder head screws.
- Loosen all screw clamps (C) and the assembly jig.
- ➔ Check the levelness of the butt joint as described in chapter 5.4.3 "Checking the transition between the racks" before you mount the next rack.

5.4.3 Checking the transition between the racks

	NOTE
<p>A rack can be permanently magnetized by placing the dial gauge holder on it.</p> <ul style="list-style-type: none"> Fasten the dial gauge holder on the guiding carriage or the machine slide only. 	



- Magnetize the needle rollers (M) with a suitable magnet.
- Insert the magnetized needle rollers into positions 1, 2 and 3, as shown in the diagram.
- Due to the magnetization, the needle rollers remain attached to the positions.
- Attach the dial gauge holder to the guiding carriage (P) and insert the dial gauge.
- Measure the highest point at each of the needle rollers at position 1 and position 3 using the dial gauge (F) and calculate the midpoint of the two points.
- The midpoint is the target value for the highest point of the needle roller at position 2.
- For the maximum permissible deviation in height from position 1 to position 3, see chapter 9.6 "Permissible measurement over pin fluctuation at the rack transition".
- Measure the highest point of the needle roller at position 2 with the dial gauge.
- If the value is **within** the tolerance range, clamp only the screw clamps and tighten the cylinder head screws with full tightening torque (see chapter 9.2.1 "Overview of the required cylinder head screws").
- If the value falls **outside of** the range of tolerance, correct the transition between the two racks as described in the following section.

Figure 5.9

5.4.4 Correcting the transition between the toothed racks (only if necessary)

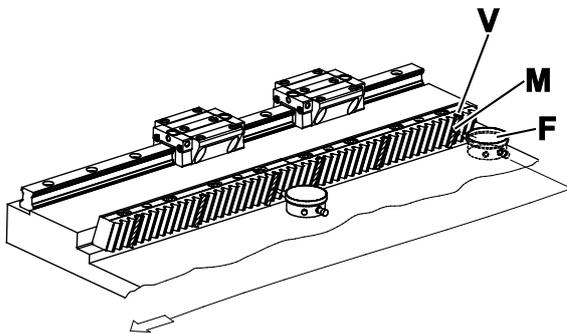
Carry out the following step in case the transition between the racks exceeds the tolerance range:

- Correct the transition between the two racks by hitting them in the corresponding direction with a copper punch and/or a soft-headed hammer (E). To do this, place the copper punch on one of the rack's fastening bores.

5.4.5 Assembling additional racks

- Assemble all additional racks in the same manner as described in the chapters above.

5.5 Checking the parallelism of all racks



- Attach the dial gauge holder to the guiding carriage and move this to the end of the axle.
- Place a magnetized needle roller (M) if possible at the outer end of the axle into a tooth gap.
- Move the dial gauge (F) towards the highest point of this needle roller and set the dial gauge to "0".
- Mark the measurement value at the measuring point (V) (reference point) with a pin on the rack.

Figure 5.10

- Insert needle rollers into tooth gaps at regular intervals (at least 5 needle rollers per 1000 mm of axle length).
- Check the deviation from the reference point with the dial gauge.
- Mark the deviation from the reference point at each measuring point.
- ① For permissible deviations within an axis, see chapter 9.7 "Permissible measurement over pin fluctuation within an axis".
- ① Identify the highest point of measurement of the entire axle and mark this.
- ① This measuring point is necessary for the correct adjustment of the gearing backlash between the pinion and the rack.

5.6 Pinning the racks

5.6.1 Pinning the racks (conventional)

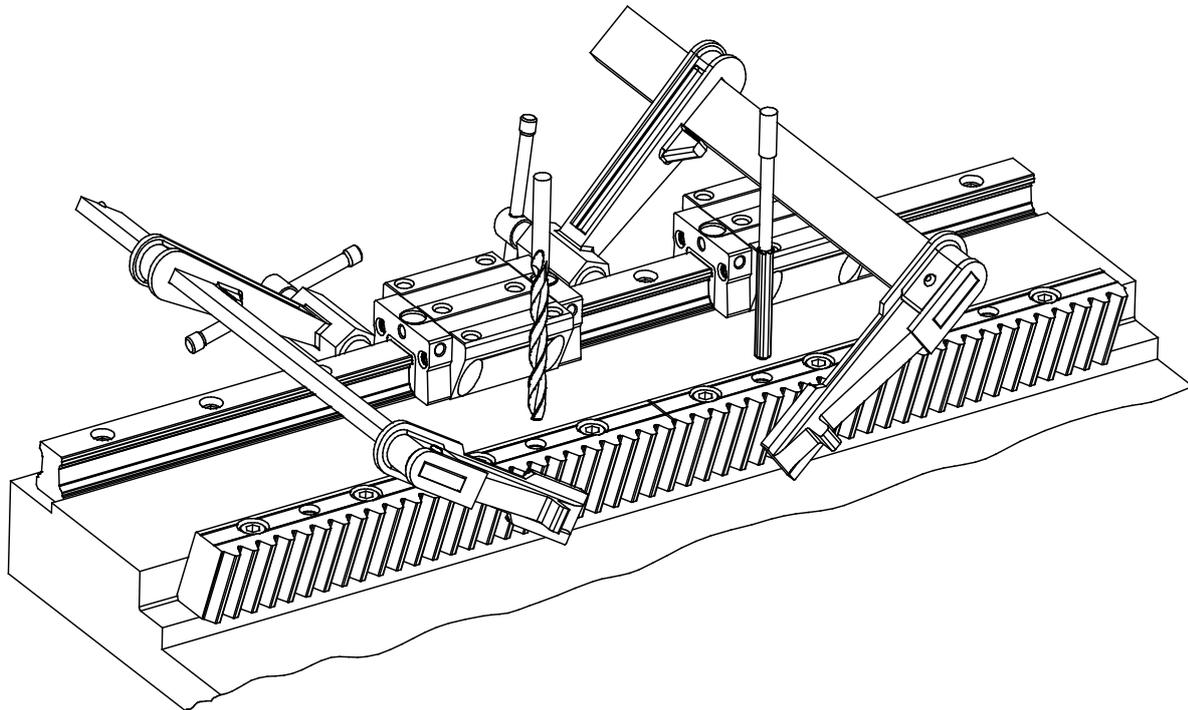


Figure 5.11

- Clamp the rack tightly at all pin holes using screw clamps.
- Drill the pin holes in the mounting base on the machine at the locations provided.
- ① The pin holes are pre-drilled in the racks by the manufacturer. The diameter of the pin holes in condition of delivery is lower than the final dimension to be achieved.
- Grind the bores in the rack and the machine bed to the required fit size for the cylindrical pins (see chapter 9.2.2 "Overview of cylindrical pins").
- ① The tolerance range for the bores is H7. For specifications on the diameters of the cylindrical pins, see chapter 9.2.2 "Overview of cylindrical pins".
- ① Remove the accumulating chips with a vacuum cleaner.

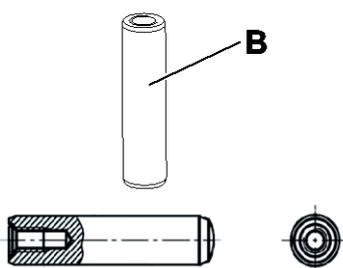


Figure 5.12

- ① To enable easier disassembly of the rack, cylindrical pins (B) with internal threads are recommended.
- Fasten the racks with cylindrical pins.
- ① If it is not possible to pin the racks, contact our Customer Service department.

- | | |
|--|---|
| | <ul style="list-style-type: none"> • If the machine is not to be put into operation immediately, conserve the racks using a suitable corrosion protection agent. |
|--|---|

5.6.2 Pinning the racks with INIRA® pinning

For this type of rack, **no** pinning with INIRA® pinning is intended.

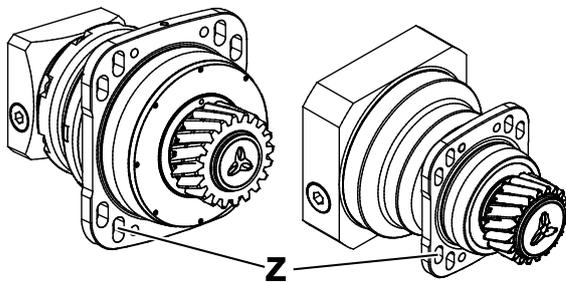
With INIRA® pinning, we have already made the assembly process much faster, more accurate and more ergonomic. There is no need to drill and grate. The time requirement for pinning is reduced to about 1 min per rack.

- ① For more information about INIRA®, see the "INIRA®" installation instructions or www.wittenstein-alpha.de/INIRA.

5.7 Mounting the gearbox

The gearbox is delivered with the mounted pinion. To ensure an easy assembly procedure, we recommend not mounting the motor until the rack and pinion system has been adjusted and checked.

The machine's gearbox interface should be constructed in such a way that assembly and aligning (e.g. with an adjusting tool) should be easy.



When employing a gearbox with integrated slotted holes (Z) in the gearbox flange no additional adjusting tool is necessary.

- ① More information about assembly and the mounting base on this gearbox can be found in the relevant operating manual.

Figure 5.13

5.7.1 Inserting the gearbox at the highest point

	<ul style="list-style-type: none"> Observe the safety and processing instructions for the threadlocker to be used.
--	---

The gearbox can be installed in any mounting position.

The highest point, i.e. the tooth with the greatest radial runout deviation, is marked on the output pinion by the manufacturer.

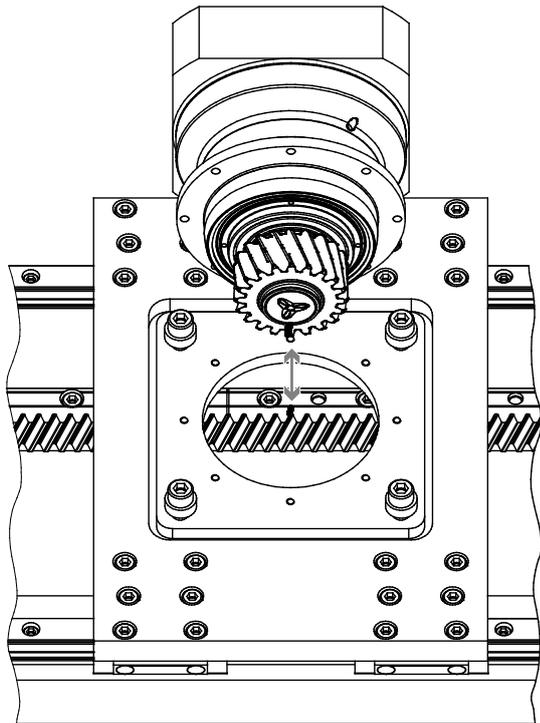


Figure 5.14

- Align the "highest points" of the pinion and rack with one another using the machine's adjusting tool.
- Slide the gearbox pinion unit into the rack by hand. The tooth flanks of the pinion and rack should be free of backlash and without preload at their "highest points".
- Wet the screws with thread locking glue and fix the gearbox.

Feeding in the gearbox

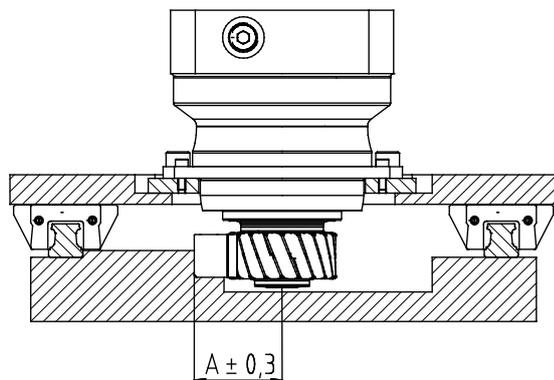


Figure 5.15

- Refer to our catalog or our website for feed dimension "A": www.wittenstein-alpha.de.

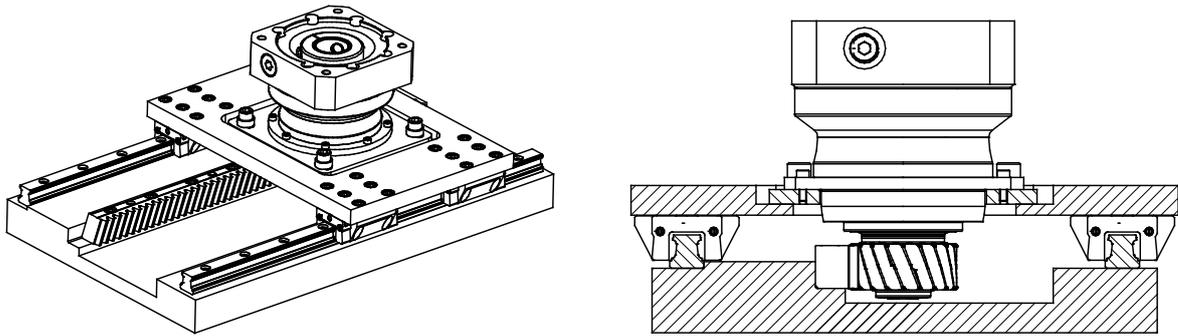


Figure 5.16

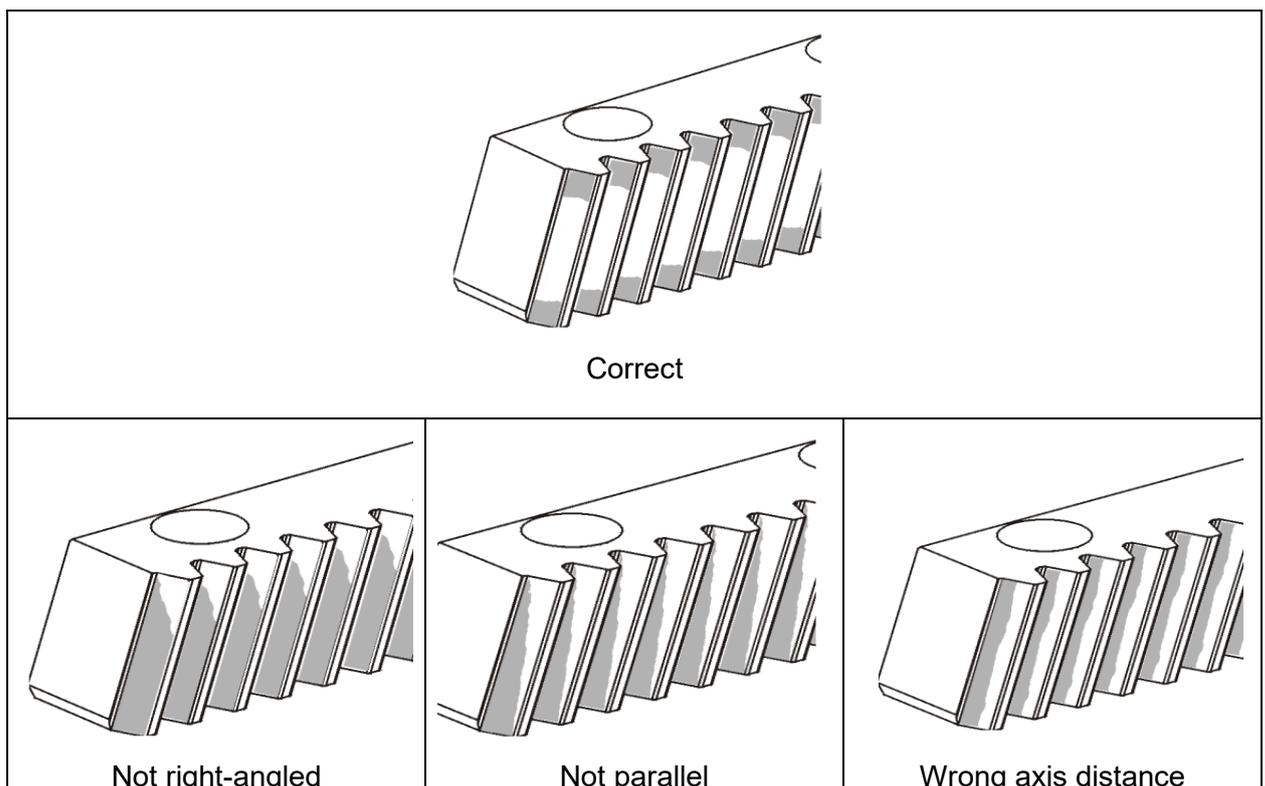
A flank play is possible in some segments of the travel path. Clamping of toothed parts is **not** permitted.

5.8 Final inspection

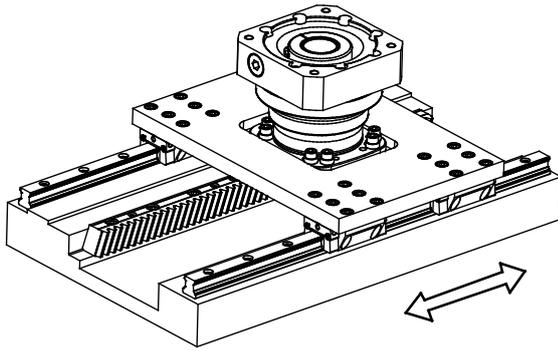
5.8.1 Contact pattern inspection

	<ul style="list-style-type: none"> Observe the safety and processing instructions of the cleaning agents to be used and the gear marking compound.
--	---

- Degrease the tooth flanks of the rack (e.g. with acetone).
- Coat the tooth flanks with gear marking compound or with a water-proof pen.
- Shift or move the slide several times so that the pinion runs over the coated tooth flanks.
- ➡ Check thereby that the gearing runs smoothly.
- ➡ Check in which range the color is removed from the tooth flanks.
- ➡ Evaluate the alignment of the gearbox based on the following illustrations.
- If necessary, correct the alignment of the gearbox.
- ⓘ Oil or grease all blank parts with a cloth against corrosion.



5.8.2 Checking the running characteristics after assembly



- Shift or move the slide several times across the entire movement range.
- ① The exerted force and the running noise need to remain the same.
- ① Use a hand wheel or crank connected to the clamping hub in the gearbox. Consult our Customer Service department to receive further information.

Figure 5.17

5.9 Mounting the lubrication system

	<ul style="list-style-type: none"> • Read the general safety instructions in the lubricator's manual and in chapter 2.5 "General safety instructions".
--	---

The lubrication of the rack and pinion system is effected by a lubrication system. Depending on the configuration, lubricant is transferred from a lubricator via

- a plastic hose,
 - a distribution system,
 - a lubricating pinion for lubricating the rack and pinion drive; or
 - another lubrication point, e.g. a guiding carriage.
- ① The lubricator is filled with grease that is optimized for the application and approved by WITTENSTEIN at the factory.
 - ① The operating manuals for our LUC+125 and LUC+400 lubricators can be found in the download area on our website www.wittenstein-alpha.de.
 - ① The recommended, adjustable amount of lubricant depends on the application. The recommended amount of lubricant can be found in the catalog in the download area on our website www.wittenstein-alpha.de or you can contact our sales department.

5.9.1 Mounting the lubricating pinion on the lubricating axis

	<ul style="list-style-type: none"> • Observe the safety and processing instructions for the threadlocker to be used.
--	---

The lubricating pinion is made of PU foam and is delivered dry.

- ① We recommend that our standard lubricants WITTENSTEIN alpha G11, G12, and G13 be used for lubrication.

Pre-oiling the lubricating pinion

- Insert the lubricating pinion into a suitable oil for a maximum of 2 minutes. The lubricating pinion must be immersed completely in the oil bath.
- ① WITTENSTEIN alpha GmbH offers suitable lubricants, see chapter 9.9 "Lubricants for pre-oiling / venting / pre-greasing".

Rack and pinion system

Mounting the lubricating pinion

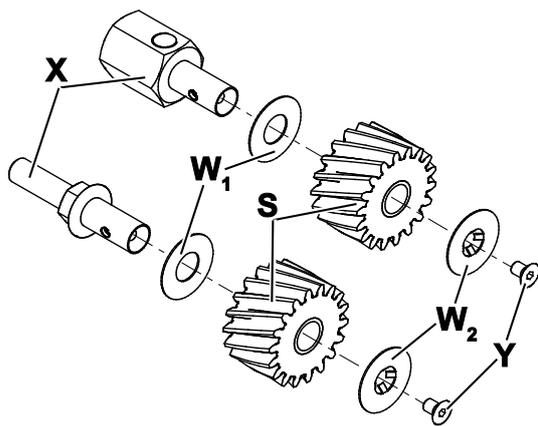


Figure 5.18

- Slide the flat flanged wheel (W₁) up to the stop on the lubricating axis (X).
- Grease the lubricating axis slightly.
- Slide the pre-oiled lubricating pinion (S) up to the stop on the lubricating axis.
- ➡ Check that there is enough grease between the lubricating axis and the slide bearing on the lubricating pinion.
- Insert the flat head screw (Y) into the second flanged wheel (W₂).
- Wet the flat head screw with a thread locking glue (e.g. Loctite® 243).
- Screw the flanged wheel onto the lubricating axis using the flat head screw. Align the flange wheel.
- ① The permissible tightening torque is 6 Nm.

Installing the hose connector

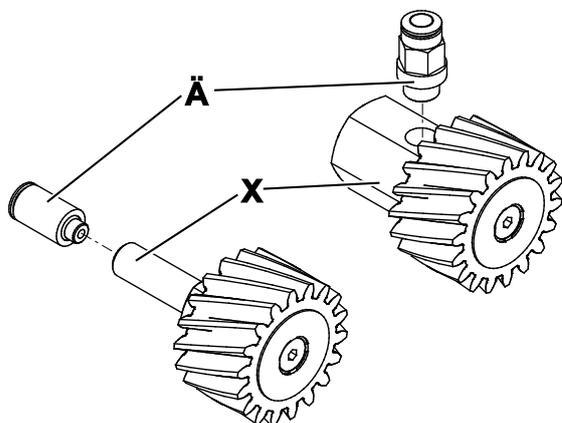


Figure 5.19

- ➡ Check that the O-ring is sitting correctly on the hose connector.
- Screw the hose connector (Ä) into the lubricating axis (X) with the specified tightening torque (see table 2).

Hose connector	Tightening torque [Nm]
M6x1	2
M10x1	15

Table 2: Hose connector tightening torques

i	The maximum length of the plastic hose line for grease lubrication depends on the lubricant used and the temperature, see Table 3.
----------	---

Lubricant	Temperature [°C]	Max. hose length (without distribution system*) [m]	
		LUC+400	LUC+125 (24V)
WITTENSTEIN alpha G11	20	10	5
WITTENSTEIN alpha G12	20	5	2
WITTENSTEIN alpha G13	20	8	3

* When using a distribution system, the permissible hose length must be reduced. Please observe your design documentation or contact our Customer Service / Sales department.

Table 3: max. hose length

- Slide the pre-filled plastic hose, included in delivery, up to the stop on the hose connector.
- ① Install the plastic hose so that it cannot bend during operation (minimum bending radius static 30 mm; dynamic 40 mm).
- ① Use a hose cutter to cut the plastic hose. This ensures a rectangular and clean cut without damaging the hose.

	NOTE
<p>Faulty disassembly of the plastic hose can damage the hose connector and lead to leaks.</p> <ul style="list-style-type: none"> • To disassemble a plastic hose, press in the release ring on the hose connector until it stops and pull out the plastic hose. 	

5.9.2 Venting the lubricating axis and lubricating pinion

In order to ensure perfect operation from the start, the lubricating pinion and lubricating axis must be vented.

Venting using the ventilation function of the lubricator

- Connect the pre-filled plastic hose, included in LUC+ delivery, to the mounting axis.
- Vent the lubricating pinion and lubricating axis using the lubricator vent function
 - LUC+125/400 impulse-controlled via the 12 s signal.
 - LUC+125 timed via the Fill function.
- ① The lubricating pinion must be rotated during the venting process.
- ① For further information, see the instructions of the respective lubricator.

Venting with a grease gun

Alternatively, it is possible to vent using a grease gun.

- Use a suitable intermediate piece or screw a lubricating nipple into the mounting axis instead of a hose connector.
- Use the grease gun to pump the appropriate volume of grease into the mounting axis. The corresponding amount of grease is shown in Table 4.
- ① The lubricating pinion must be rotated during the venting process.

Venting volume of the lubricating pinion and mounting axis							
Module [mm]	1.5	2	3	4	5	6	8
Amount of grease for initial greasing [cm³]	4	4	5	6	12	14	18
Number of strokes LUC+ (0.15 cm³ stroke)	27	27	33	40	80	94	120

Table 4: Venting volume

5.9.3 Mounting the lubrication system

- Calculate the approximate axis distance between the rack/pinion and lubrication pinion using the following formula:

Calculating the axis distance between pinion and lubrication pinion

$$A = \frac{d_{\text{lubricating pinion}} + d_{\text{pinion}}}{2}$$

$$d_{\text{pinion}} = d + 2 \cdot x \cdot m_n$$

Calculating the axis distance between rack and lubrication pinion

$$A = \frac{d_{\text{lubricating pinion}}}{2} + h$$

$$h = H - m_n$$

A = distance between axes
 d = pinion reference circle diameter [mm]
 H = rack height [mm]
 h = rack engagement height [mm]
 m_n = normal module [mm]
 x = profile shift factor

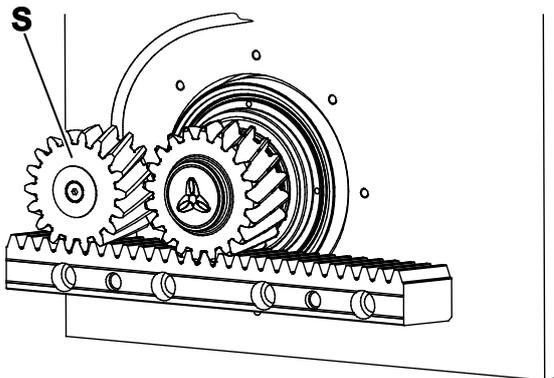


Figure 5.20

- Mount the lubricating axis with the installed lubricating pinion (S), without pretensioning on the pinion or rack, onto the mounting base.
- ① To secure the screws, we recommend using a thread locking glue (e.g. Loctite® 243).

- ① Refer to our catalog or our website for specifications on the installation dimensions: www.wittenstein-alpha.de
- Close off plastic hoses that are not being used with the hose end caps provided.

NOTE	
<p>Too little or incorrect lubrication of the drive system damages the gearing.</p> <ul style="list-style-type: none"> • Always ensure sufficient lubrication with a suitable lubricant. • Grease the racks and the pinion before startup. 	

- ① Further information on the lubricator can be found in the respective instructions of the lubricator.
- ① Special operating conditions may require different lubricants and lubricant quantities. In this case, consult our Customer Service department.

5.9.4 Installing distribution systems (optional)

Splitter - LUS

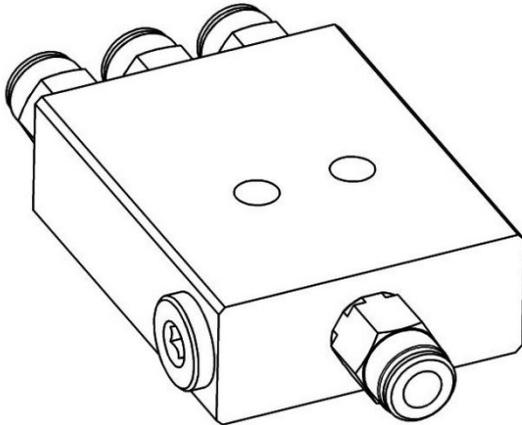


Figure 5.21

Splitters evenly divide the lubricant volume between 2, 3 or 4 outlets.

This function is realized by means of chokes leading to a pressure difference of approx. 10 bar between the inlet and outlet of the splitter. The outlets are equipped with integrated non-return valves to prevent backflow of lubricants.

Application conditions:

- Comparable lengths of the hoses at the outlet (+/-10 % difference).
 - Comparable back pressures at the lubrication point
 - Identical line cross sections at the outlet
 - Operating temperature +10 °C to +60 °C (please see technical data sheet of lubricant)
 - Permitted lubricants: WITTENSTEIN alpha G11, G12, G13
- ❗ Splitters are vented with a food grade H1 grease. Before commissioning, flushing with several pulses of the lubricator is recommended.
- ❗ Splitters must not be set up in a cascaded arrangement.

Progressive distributor – LUP

- ❗ For instructions on installing the progressive distributor, see the separate instructions "Progressive distributor LUP" (doc. no. 1000080446).

6 Startup and operation

- Read the general safety instructions before beginning to work (see chapter 2.5 "General safety instructions").
- Observe the instructions in the relevant manual for the gearbox and lubrication system.

NOTE	
	<p>Insufficient lubrication upon startup of the drive system damages the toothings.</p> <ul style="list-style-type: none">• Always make sure that there is sufficient lubrication and exchange the lubricant cartridge in the lubricator in time.

	<p>Improper use can cause damage to the drive system.</p> <ul style="list-style-type: none">• Ensure that<ul style="list-style-type: none">- the ambient temperature does not drop below +10 °C or exceed +40 °C and- the operating temperature does not exceed +90 °C.• For other conditions of use, consult our Customer Service department.• Only use the gearbox up to its maximum limit values, see 3.2 "Dimensions and performance data". For other conditions of use, consult our Customer Service department.• Use the drive system only in a clean, dust-free and dry environment.
--	--

7 Maintenance and disposal

- Read the general safety instructions before beginning to work (see chapter 2.5 "General safety instructions").
- Observe the instructions in the relevant manual for the gearbox and lubrication system.

7.1 Shutdown, preparation

- Shut down the machine that contains the drive system.
- Disconnect the machine from the mains before starting maintenance work.

7.2 Maintenance schedule

Maintenance work	At startup	After 500 operating hours or 3 months	Every 3 months
Visual inspection and cleaning	X	X	X
Checking the lubrication system	X	X	X

Table 5: Maintenance schedule

To ensure reliable lubrication in the long term, we recommend replacing the components after the following period of use:

Exchange work			
Components	After 3 years	After 5 years	After 10 years
Lubricating pinion	X*		
Lubricant cartridge LUC ⁺	X		
Hoses		X	
Lubricator LUC ⁺			X

* in two-shift operation after 2 years
 ⓘ Should you have any further questions about replacements, please contact our Customer Service department.

Table 6: Exchange work

7.3 Maintenance work

7.3.1 Visual inspection

- Check the entire drive system by carrying out a thorough visual inspection for exterior damage and sufficient lubrication.
- Repair or replace defective parts immediately.
- ⓘ For specific information on maintenance-related issues, contact our Customer Service department.

NOTE

Too little lubrication damages the gearing.

- Always make sure that there is sufficient lubrication and exchange the lubricant cartridge in time.

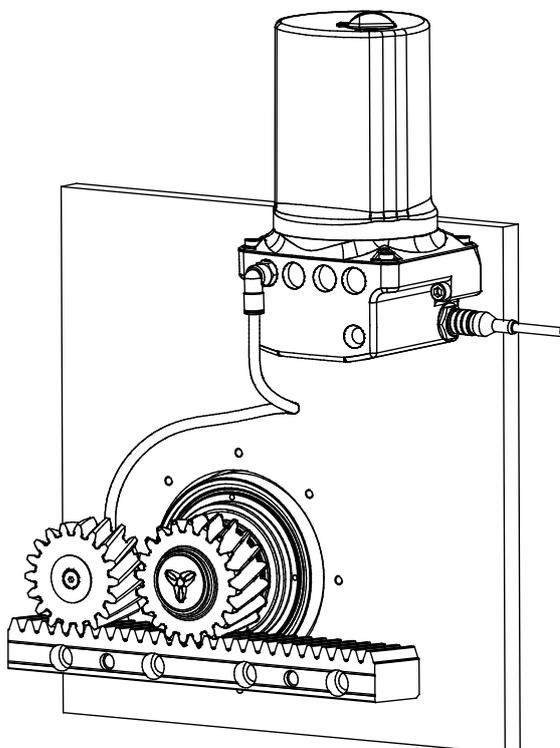


Figure 7.1

- Check the entire lubrication system by carrying out a thorough visual inspection for exterior damage such as loosened or defective hoses and worn or soiled (plugged) lubricating pinions.
- Replace damaged parts immediately to ensure a continuous lubrication.
- The service life of the lubricating pinion depends on the ambient conditions.
- Check the fill level in the lubricator.

- ① Further information on the lubricants in the gearbox and in the lubricator can be found in the relevant instructions.
- ① Despite the comparatively long service life of the polyurethane foam lubricating pinion, we recommend the preventive replacement of the lubricating pinion after a running time of 2-3 years. The replacement intervals depend on the duration of use. In case of visible wear we recommend an immediate replacement.
- ① We also recommend that you consider replacing the lubricant cartridge, hoses and lubricator in the maintenance schedule, see chapter 7.2 Maintenance schedule.

7.4 Replacing the rack

	<p>⚠ CAUTION</p>
	<p>There is a risk of injury or damage due to falling racks and sharp edges on the rack.</p> <ul style="list-style-type: none"> • Suitable hoisting equipment should be used when transporting heavy racks. • When using hoisting equipment, do not stand below the suspended load. • Wear protective gloves and safety shoes.
	<p>NOTE</p>
	<p>Avoid heat transfer to the racks during assembly.</p> <ul style="list-style-type: none"> • Wear protective gloves during assembly.
	<p>Improper replacement of a rack can cause damage to the drive system and the neighboring parts.</p> <ul style="list-style-type: none"> • Make sure that the rack is replaced only by trained technicians.

7.4.1 Disassembling the rack

- Remove the pins of the racks with a suitable tool.
- Loosen all fastening screws and remove the rack.
- Remove the rack with care, so as to safeguard the drive train and adjacent parts against damage.

7.4.2 Assembling the rack

- Use only racks with the same ordering code for the same application.
- Carry out the assembly of the new rack as described in chapter 5.4.2 Assembling subsequent racks.
- ➡ During the assembly of the rack, check the transitions to the adjacent racks.

7.4.3 Pinning the mounted and aligned rack

- Clamp the rack tightly at all pin holes using screw clamps.
- Select the next larger cylinder pins than specified in chapter 9.2.1 Overview of the required cylinder head screws.
- ① In chapter 9.2.1 Overview of the required cylinder head screws only the standard sizes are given.
- Drill and ream the rack and machine bed to the required fit size.
- ① The tolerance range for the bores is H7.
- ① For an easier disassembly, we recommend the cylindrical pins with internal threads.
- ① Remove the accumulating chips with a vacuum cleaner.
- Fasten the racks with cylindrical pins.
- If a pinning of the racks is not possible, consult our Customer Service department.

7.5 Startup after maintenance work

- Clean and grease the racks and the pinion.
- Attach all safety devices.
- Do a test run before re-releasing the machine for operation.

7.6 Disassembly

	<h3>⚠ CAUTION</h3>
	<p>Improperly executed work can lead to injury and damage.</p> <ul style="list-style-type: none"> • Ensure that the drive system is only installed, maintained, and dismantled by trained technicians.

- ① The disassembly of the gearbox and lubricator is described in the relevant operating manuals.

7.6.1 Preparation

- Shut down the machine that contains the drive system.
- Ensure that it is possible to dismantle the drive system without constituting a damage hazard for the whole machine.
- Before starting work, disconnect the machine from the mains.

7.6.2 Disassembling the rack

- Carry out the disassembly of the toothed racks as described in chapter 7.4.1 Disassembling the rack.

7.7 Lubricants

	<p>Solvents and lubricants are hazardous substances that can contaminate soil and water.</p> <ul style="list-style-type: none"> • Use and dispose of cleaning solvents and lubricants properly. • Do not mix polyglycol with mineral oils that are intended for recycling.
---	---

- Remove all deposits of lubricant from the individual racks.
- Dispose of the lubricant deposits and the racks at the appropriate disposal sites.
- ① Please observe the valid national regulations for waste disposal.

7.8 Disposal

Consult our Customer Service department for supplementary information on disposal of the drive system.

- Dispose of the drive system at the appropriate disposal sites.
- ① Please observe the valid national regulations for waste disposal.

8 Malfunctions

	NOTE
<p>Changed operational behavior can be an indication of existing damage to the drive system or can cause damage to the drive system.</p> <ul style="list-style-type: none"> • Take action immediately if lubricant loss, increased operating noise, increased operating temperatures, frictional corrosion on tooth flanks, broken teeth, or position deviations become noticeable within the travel path. • Do not put the drive system back into operation until the cause of the malfunction has been rectified. 	

	<p>Malfunctions may only be rectified by specially trained technicians.</p>
---	---

Fault	Possible cause	Remedy
Increased operating temperature	Input system overloaded	Check the technical specifications
	Motor is heating the gearbox.	Check the controller's settings.
	Ambient temperature too high.	Ensure adequate cooling.
Increased operating noises	Braced motor/gearbox unit	Consult our Customer Service department.
	Damaged bearings	
	Toothing damage	
	Distorted rack and pinion unit	
	Imprecise rack assembly	
Loss of lubricant	Excessive amount of lubricant	Change the settings on the lubricator and wipe away excess lubricant. Information for setting the automated lubrication amount/duration can be found in the manual for the lubricator.
	Seals not tight	Consult our Customer Service department.
Formation of bubbles in the lubricant feed line	Lubricant quantity too low	Change the settings on the lubricator. Information for setting the automated lubrication amount/duration can be found in the manual for the lubricator. As an alternative, the use of a check valve is possible. Contact our Customer Service department for this.

Fault	Possible cause	Remedy
Frictional corrosion on tooth flanks	Defective lubrication	Install a lubricating pinion on the output pinion or rack. Make sure on short travel paths that the tooth contact on the output pinion and racks are lubricated sufficiently. Information for setting the automated lubrication amount can be found in the manual for the lubricator.
	Ambient influences	The rack always has to be installed in a clean and dry environment and protect the rack against outer influences (e.g. chips, cleaning agents)
	Wrong lubricant	Use only lubricants that have been approved by us.
Tooth breakage	Overload	Check the dimensioning for normal and emergency stop conditions.
	Machine collision	
	Foreign medium	Check the output pinion / rack for possible foreign medium (e.g. chips, forgotten assembly tools)
	Lubrication faults	Always ensure sufficient lubrication. Information for setting the automated lubrication duration can be found in the manual for the lubricator.
Position of the output pinion compared to the rack	Carry out a contact pattern inspection (see chapter 5.8.1 Contact pattern inspection). Correct the alignment of the gearbox if necessary.	
Position deviation or great flank backlash within the travel path	Wrong alignment between output pinion and rack	Correct the axis distance (highest point of the output pinion to highest point of the rack) and the alignment of the gearbox/rack.

Table 7: Malfunctions

9 Appendix

9.1 Weight of racks

Weight of helically toothed racks [kg]							
Length [mm]	Module 1.5 mm	Module 2 mm	Module 3 mm	Module 4 mm	Module 5 mm	Module 6 mm	Module 8 mm
167	-	0.7	-	-	-	-	-
250	-	-	1.5	-	-	-	-
333	-	1.4	-	-	-	-	-
480	-	1.9	2.7	4.7	-	-	21.0
500	1.3	2.1	3.0	-	6.5	9.9	-
506	-	-	-	5.4	-	-	-
960	-	-	-	-	-	-	42.0
1000	2.5	4.1	5.9	10.7	13.1	19.9	-
1500	3.8	6,2	8.9	-	19.5	27.1	-
2000	5.0	8.2	11.0	21.4	26.0	36.2	-
Weight of straight toothed racks [kg]							
Length [mm]	Module 1.5 mm	Module 2 mm	Module 3 mm	Module 4 mm	Module 5 mm	Module 6 mm	Module 8 mm
167 - 2000	upon request						

Table 8: Weight

9.2 Information for mounting the racks

9.2.1 Overview of the required cylinder head screws

Cylinder head screw EN ISO 4762, property class 12.9		
Bore [mm]	Thread	Tightening torque [Nm]
Ø 6	M5	9
Ø 7	M6	15.4
Ø 10	M8	37.3
Ø 12	M10	73.4
Ø 14	M12	126
Ø 18	M16	310
Ø 22	M20	604

Table 9: Cylinder head screws

9.2.2 Overview of cylindrical pins

Cylindrical pin with interior thread Shape A acc. to DIN 7979 or EN ISO 8735	
Bore [mm]	Cylindrical pin size
Ø 5.7	6 m6
Ø 7.7	8 m6
Ø 9.7	10 m6
Ø 11.7	12 m6
Ø 15.7	16 m6
Ø 19.7	20 m6

Table 10: Cylindrical pins for standard rack mounting

9.3 Specifications for mounting onto a mounting base (INIRA® pinning)

For this type of rack, **no** pinning with INIRA® pinning is intended.

9.4 Maximum height of the stop edges on the machine base

For this type of rack, **no** maximum height of the stop edges is defined.

9.5 Permissible parallelism deviation of the assembly surface

Rack module [mm]	Parallelism deviation [µm]		
	Requirements in respect of positioning accuracy and smooth running		
	High	Normal	Low
1.5 – 8	10	15	30

Table 11: Parallelism deviation of the assembly surfaces

9.6 Permissible measurement over pin fluctuation at the rack transition

Rack module [mm]	Measurement over pin deviation [µm]		
	Requirements in respect of positioning accuracy and smooth running		
	High	Normal	Low
1.5	10	15	25
2	10	15	30
3	15	20	40
4	15	20	45
5	20	25	45
6	20	25	50
8	20	30	55

Table 12: Recommended measurement over pin deviation between two neighboring tooth gaps at the rack transition

9.7 Permissible measurement over pin fluctuation within an axis

Rack module [mm]	Measurement over pin fluctuation [µm]		
	Requirements in respect of positioning accuracy and smooth running		
	High	Normal	Low
1.5	30	45	80
2	30	45	85
3	35	50	100
4	40	55	110
5	40	60	120
6	40	60	120
8	50	70	130

Table 13: Recommended roll size fluctuation within an axis

9.8 Overview of the assembly accessories

Rack module [mm]	Assembly jig		Needle roller	
	Size	Order number	Diameter [mm]	Order number
1.5	ZMT 150	20064154	2.5 ⁰ / _{-0.002}	20006839
2	ZMT 200	20020582	3.5 ⁰ / _{-0.002}	20001001
3	ZMT 300	20021966	5.0 ⁰ / _{-0.002}	20000049
4	ZMT 400	20037466	7.0 ⁰ / _{-0.002}	20038001
5	ZMT 500	20037469	9.0 ⁰ / _{-0.002}	20038002
6	ZMT 600	20037470	10.0 ⁰ / _{-0.002}	20038003
8	ZMT 800	20052289	14.0 ⁰ / _{-0.002}	20052298

Table 14: Assembly accessories

9.9 Lubricants for pre-oiling / venting / pre-greasing

Use	Version	Quantity	Lubricant	Designation	Order number
Venting / pre-greasing	Grease gun cartridge	400 cm ³	G11	LGC 400-05	20058111
Venting / pre-greasing	Grease gun cartridge	400 cm ³	G12	LGC 400-06	20058112
Venting / pre-greasing	Grease gun cartridge	400 cm ³	G13	LGC 400-07	20058113
Pre-oiling	Box	1 l	G11 / G13	LUO 1000-11	20074218
Pre-oiling	Can	5 l	G11 / G13	LUO 5000-11	20074219
Pre-oiling	Box	1 l	G12	LUO 1000-12	20074353
Pre-oiling	Can	5 l	G12	LUO 5000-12	20074354

Table 15: Lubricants

9.10 Tightening torques for common thread sizes in general mechanical engineering

The specified tightening torques for headless screws and nuts are calculated values and are based on the following conditions:

- Calculation in accordance with VDI 2230 (February 2003 version)
- Friction value for thread and contact surfaces $\mu = 0.10$
- Utilization of the yield stress 90%
- Torque tools type II classes A and D in accordance with ISO 6789

The settings are values rounded to usual commercial scale gradations or settings.

- Use the exact values in this table to set your tools.

Property class Screw/nut	Tightening torque [Nm] with thread												
	M3	M4	M5	M6	M8	M10	M12	M14	M16	M18	M20	M22	M24
8.8 / 8	1.15	2.64	5.2	9.0	21.5	42.5	73.5	118	180	258	362	495	625
10.9 / 10	1.68	3.88	7.6	13.2	32.0	62.5	108	173	264	368	520	700	890
12.9 / 12	1.97	4.55	9.0	15.4	37.5	73.5	126	202	310	430	605	820	1040

Table 16: Tightening torques

Revision history

Revision	Date	Comment	Chapter
01	08/23/01	New version	All
02	10/18/05	Ordering code	4.5
03	11/10/06	Revision	All
04	12/14/06	Technical data	All
05	04/28/08	Chapter on lubricator added	11
06	04/22/09	Chapter on lubricator removed	11
07	12/16/10	Technical data	All
08	07/20/11	Revision	All
09	09/19/13	New safety instruction	3.3.1
10	10/21/16	Revision; new product line	All
11	02/28/17	Revision	5.4.3
12	04/15/2019	Revision of INIRA pinning	All
13	10/13/2022	Lubrication system	5.9, 9
14	06/24/2024	Formula distance between axes Module 1.5 mm	5.9.3 9.2.1



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