



WITTENSTEIN

alpha

## alpha Rack&Pinion System

Operating Manual



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## 1 About this manual

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

If this manual is supplied with an amendment (e.g. for special applications), then the information in the amendment is valid. Contradictory specifications in this manual thereby become 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 and warning notices** to avoid injuries.

The original manual was created in German; all other language versions are translations of these instructions.

### 1.1 Information symbols

The following information symbols are used:

- Indicates an action to be performed
- ➔ Indicates the results of an action
- ⓘ Provides additional information about the action

A cross reference refers to the chapter number and the header of the target section (e.g. 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.
- ⓘ 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 only in accordance with its intended use and when it is in a technically flawless and safe state.
- 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. also test run only with lubrication).
- Only operate the gearbox drive system with intact protective devices and equipment.
- Operate the drive system only with lubrication (type and amount).
- Prevent soiling 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 drive 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 food processing / pharmaceutical / cosmetics, 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 danger to the operator or damage to the machine, apply the drive system only for its intended use and in a technically flawless and safe state.
- If you notice any altered operating behavior, check the drive system in accordance with Chapter 8 “Malfunctions”.
- Read the general safety instructions before beginning work (see Chapter 2.5 “General safety instructions”).

## 2.4 Reasonably foreseeable misuse

All other applications other than the aforementioned intended use specified, 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 movements during assembly and maintenance work.
- **Hot components** (e.g. gearbox) of the drive system can cause serious burns:
- Touch hot components only with protective gloves.

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

- ① For specifications on a particular product, the user should refer to our catalog on our website at [www.wittenstein-alpha.de](http://www.wittenstein-alpha.de) or contact our Customer Service / Sales department.
- For noise protection measures, observe the total noise pressure level of the machine.

**Loose or overloaded bolted connections** may cause damage to the drive system:

- Always use a calibrated torque wrench to tighten and check all screw connections for which a tightening torque has been specified.

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

- In case of fire: Do not spray with 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 cleaning solvents and lubricants properly.

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

- Immediately shut down the drive system if it 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

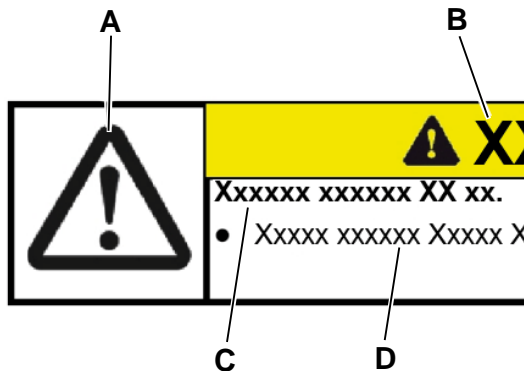


Fig. 2.1

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

## 2.7 Safety symbols

The following safety symbols are used to indicate possible hazards, prohibitions, and important information:



General hazard



Entanglement



Substances that represent a fire risk



Suspended loads



Environmental protection



Information

## 2.8 Signal words

The following signal words are used to indicate possible hazards, prohibitions, and important information:

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

## 3 Description of the drive system

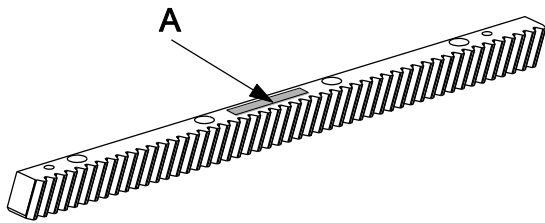
The drive system consists of:

- 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](http://www.wittenstein-alpha.de).

For the assembly described in this operating manual, additional parts/tools are required, which are available as separate accessories (see Chapter 9.8 “Overview of the assembly accessories”).

### 3.1 Ordering code / Identification plate



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](http://www.wittenstein-alpha.de).

Fig. 3.1

The identification plate for

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

- ① More information is available in our catalog at [www.wittenstein-alpha.de](http://www.wittenstein-alpha.de) or in the respective operating manual.

### 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
- at [www.wittenstein-alpha.de](http://www.wittenstein-alpha.de)
- in 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 For the weight of the individual racks, see Chapter 9.1 “Weight”.
- 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.

Anti-corrosion agent has been applied to the gearbox's 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. Observe the applicable national regulations concerning disposal.

### 4.2 Transport

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

Information on the weight of the drive system can be found in the Chapter 3.3 "Weight".

### 4.3 Storage

Store the drive system in the original packaging in horizontal position and in dry surroundings at a temperature of 0 °C to +40 °C. 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 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 mounting, please consult our Customer Service department.

### 5.1 Requirements in respect of installation location and mounting base

Requirements in respect of installation 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 system running requirements, the aim should be to achieve low deviation. For applications with low requirements, greater deviation may be allowed.
- ① For assembly surface requirements, refer to the Chapter 9.5 “Permissible parallelism deviation of the assembly surface”.

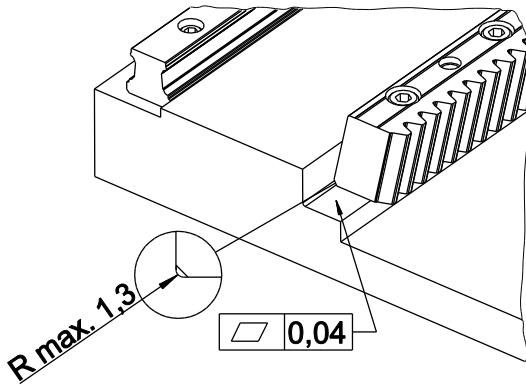


Fig. 5.1

Requirements in respect of mounting base:

- The rack is designed with a chamfer at the transition point between the screw-on and backing surface. This allows the mounting base to be constructed without recesses. 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 constructed in such a way that facilitates the clamping of the assembly of the rack. 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 have to feature a sufficient screw-in depth depending on the material of 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.

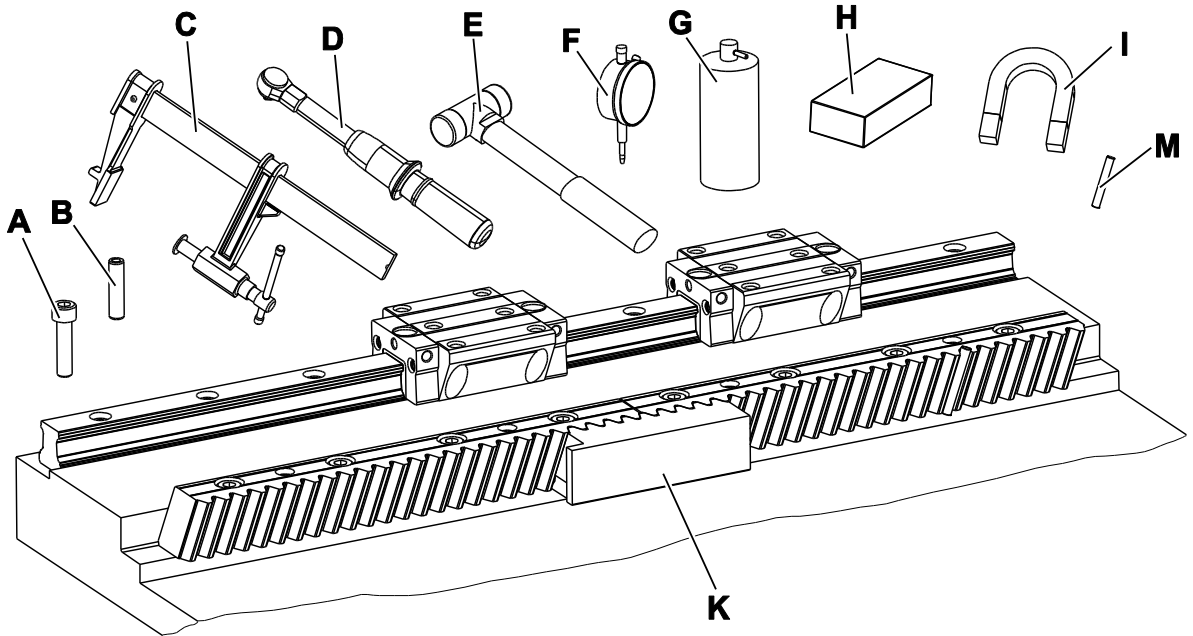



Fig. 5.2

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 cylinder 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. C-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
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		

Pos.	Tool / Material	Task / Purpose	Additional information
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

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

	<ul style="list-style-type: none"> <li>• Observe the safety and processing instructions of the cleaning agents to be used.</li> </ul>
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- 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 / Identification plate”) of all 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.

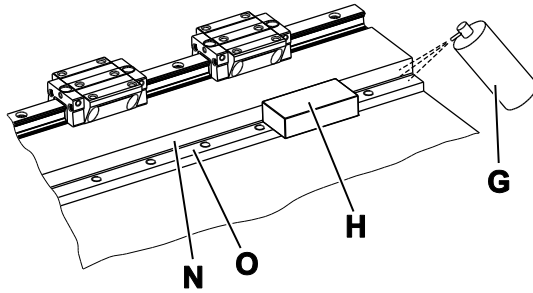


Fig. 5.3

- 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.

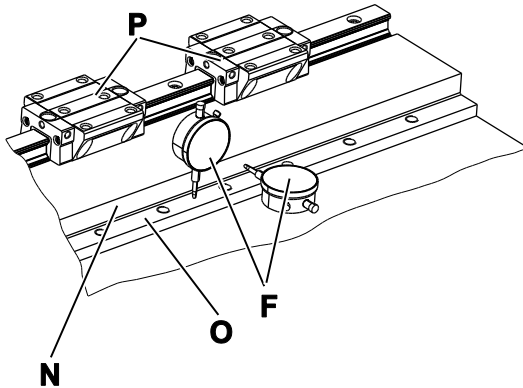


Fig. 5.4

- Check the parallelism between the stop surface (N) / screw-on surface (O), and the linear guide (P) with a dial gauge (F).
- ① For permissible tolerances, see Chapter 5.1 “Requirements in respect of installation location and mounting base”.

**5.3.1 After the cleaning**

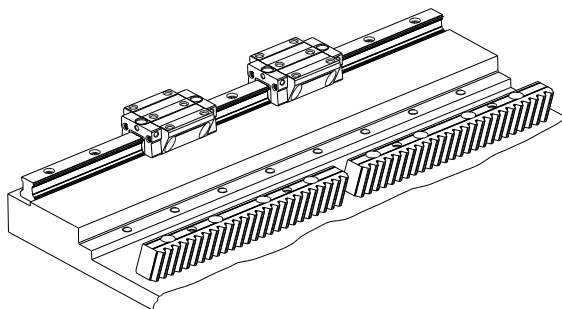



Fig. 5.5

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

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

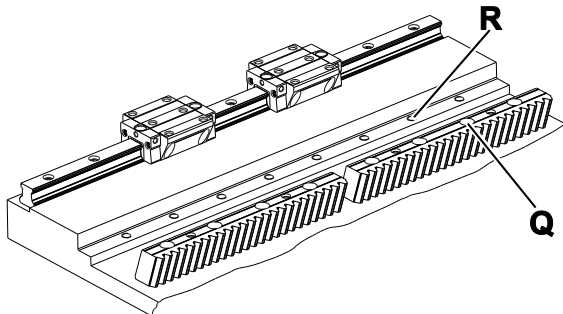
**5.4 Assembling the racks**

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

- 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**

- 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”.



- 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.

Fig. 5.6

- 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.

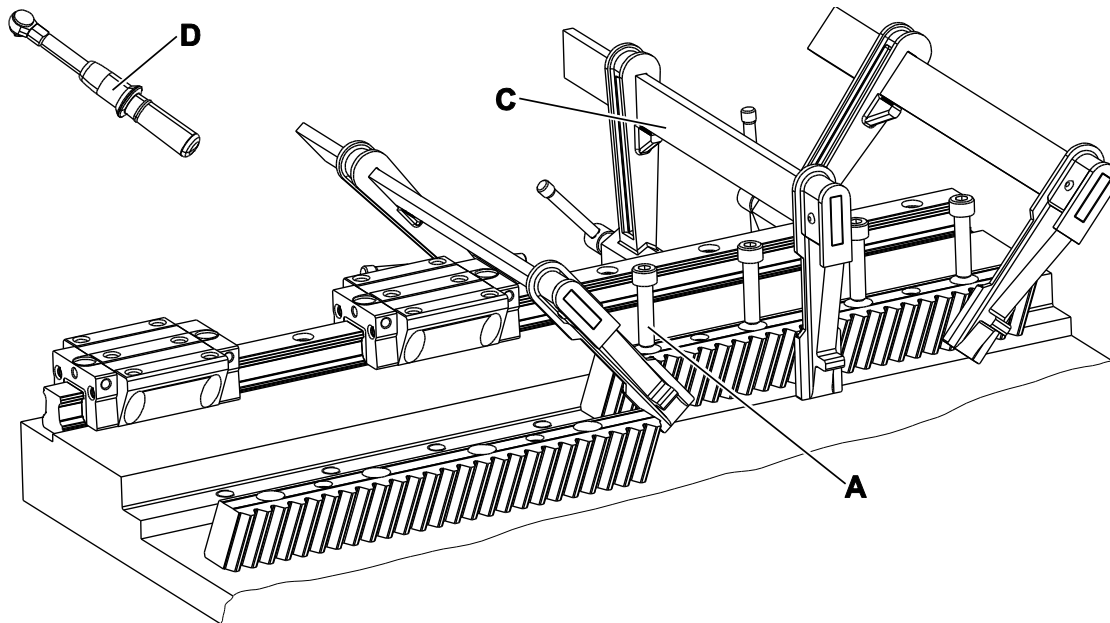


Fig. 5.7

- 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 threadlocker (e.g. Loctite® 243).
- Tighten the cylinder head screws with the required tightening torque, while the clamping device (in the following simply called C-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 C-clamps.

### 5.4.2 Assembling subsequent rack

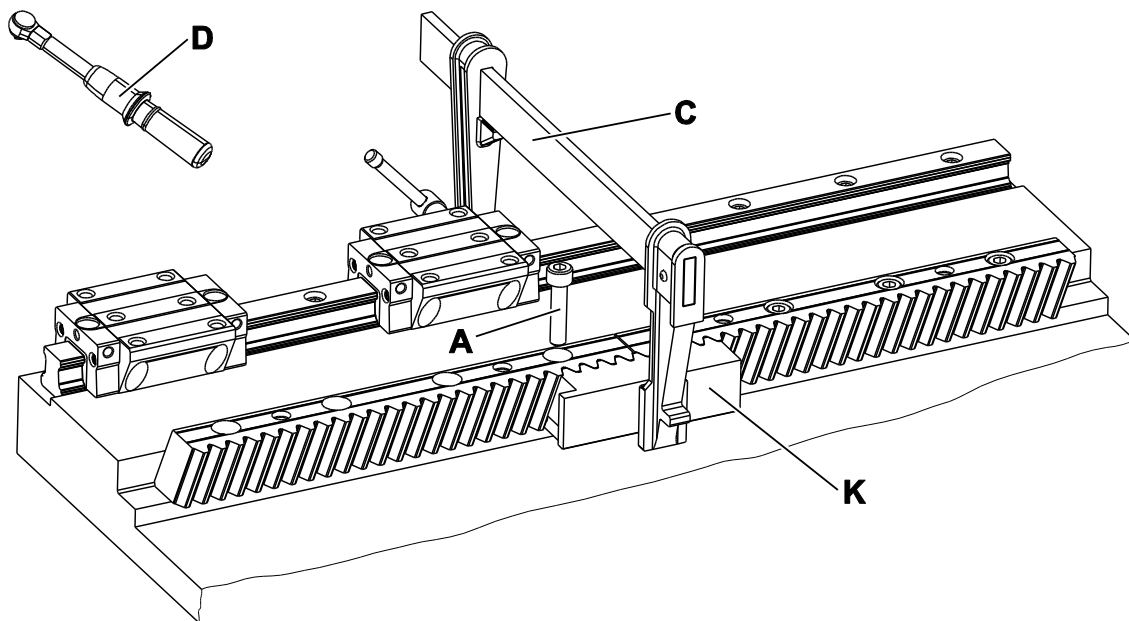
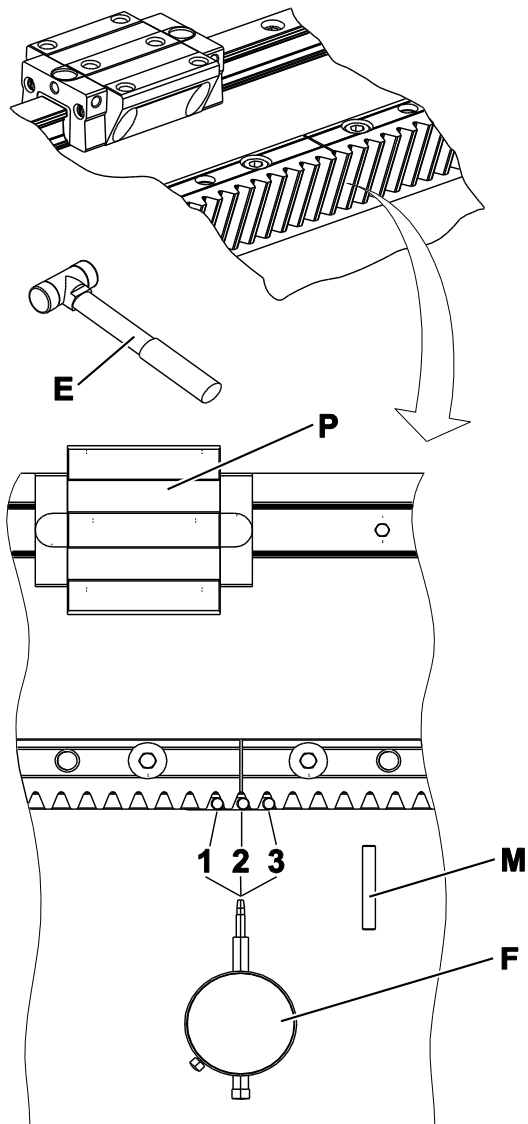


Fig. 5.8

- ➔ 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.
- ⓘ To secure the cylinder head screws, we recommend using a threadlocker (e.g. Loctite® 243).
- Tighten the cylinder head screw in assembly direction with half of the predetermined tightening torque.
- ⓘ 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 C-clamps (C) and the assembly jig.
- ➔ Check the planarity of the butt joint as described in Chapter 5.4.3 “Checking the transition between the racks” before mounting the next rack.

5.4.3 Checking the transition between the racks

	NOTICE
<p><b>Placing the dial gauge holder on a rack can permanently magnetize it.</b></p> <ul style="list-style-type: none"> <li>Fasten the dial gauge holder only on the guiding carriage or the machine sled.</li> </ul>	



- 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 roll size fluctuation at the rack transition”.
- Measure the highest point of the needle roller at position 2 with the dial gauge.
- If the values lies **within** the tolerance range, clamp only the C-clamps tight again and tighten the cylinder head screws with the 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.

Fig. 5.9



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

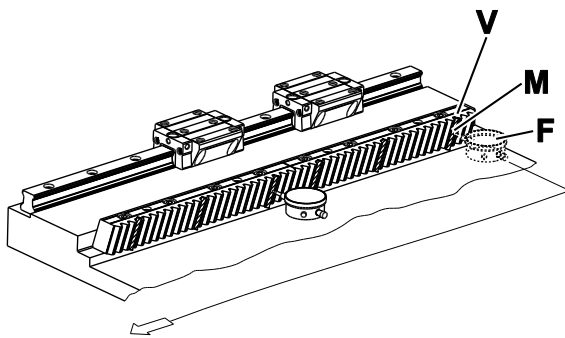
Carry out the following step in case the transfer between the racks exceeds the tolerance range:

- 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 measurement point (V) (reference point) with a pin on the rack.

Fig. 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 measurement point.
- ① For permissible deviations within an axis, see Chapter 9.7 "Permissible roll size fluctuation within an axis".
- ① Identify the highest point of measurement of the entire axle and mark this.
- ① This measurement 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)**

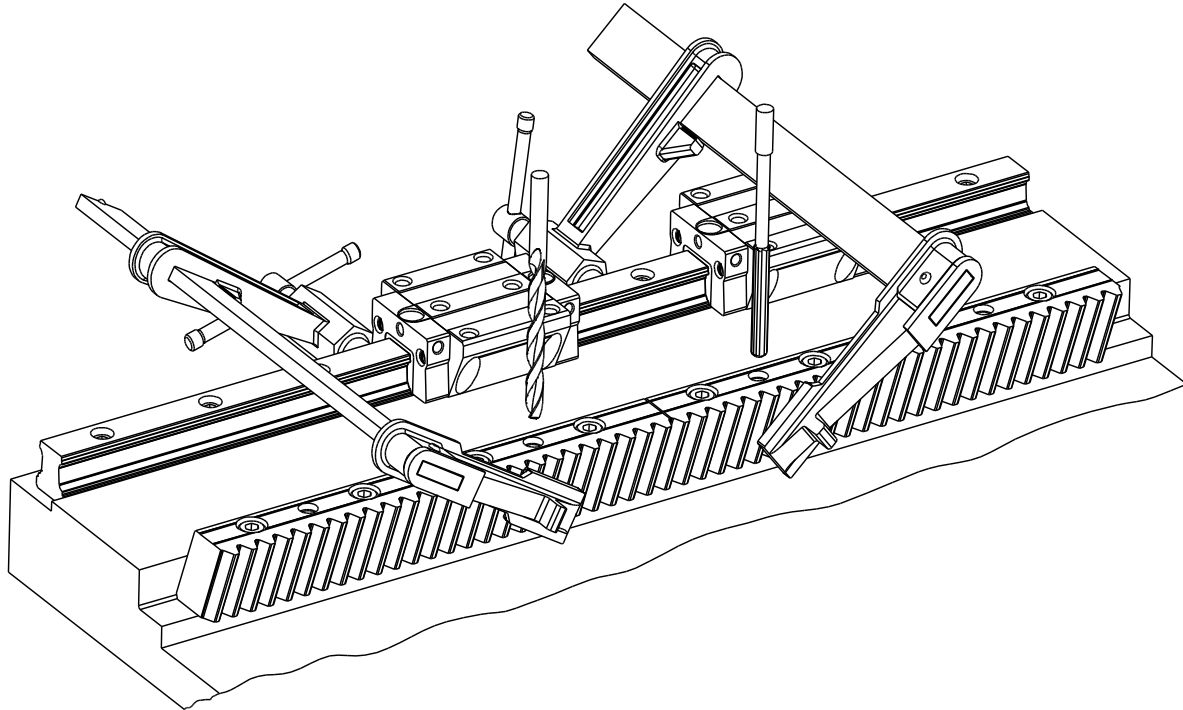


Fig. 5.11

- Clamp the rack tightly at all pin holes using C-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 delivery status is smaller 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 cylinder pins”).
- ① The tolerance range for the bores is H7. For specifications on the diameters of cylindrical pins, see Chapter 9.2.2 “Overview of cylinder pins”.
- ① Remove the accumulating chips with a suction tube.

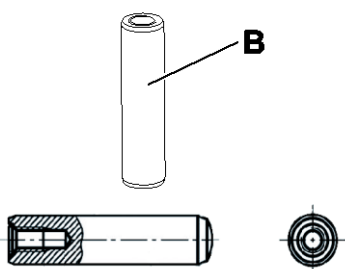


Fig. 5.12

- 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.

- If the machine is not to be put into operation immediately, conserve the racks using a suitable anti-corrosion agent.

### 5.6.2 Pinning the racks with INIRA® pinning

No conventional pinning with INIRA® is intended for this type of rack.

With INIRA® pinning, we have made the assembly process significantly quicker as well as more precise and ergonomic. Drilling and grinding is not necessary. The assembly effort for the pinning is reduced to about 1 minute per rack.

- ① More information on INIRA® can be found in the assembly instructions “INIRA®” or at [www.wittenstein-alpha.de/INIRA](http://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&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 adjustment mechanism) should be easy.

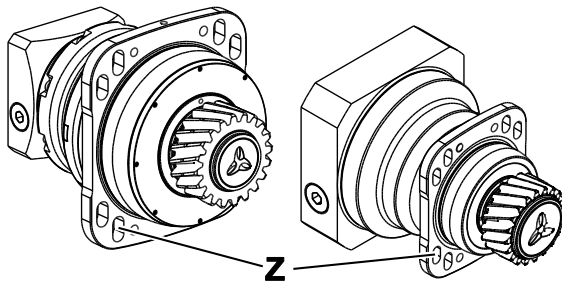


Fig. 5.13

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

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

**5.7.1 Inserting the gearbox at the highest point**

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

The gearbox can be installed in any mounting position.

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

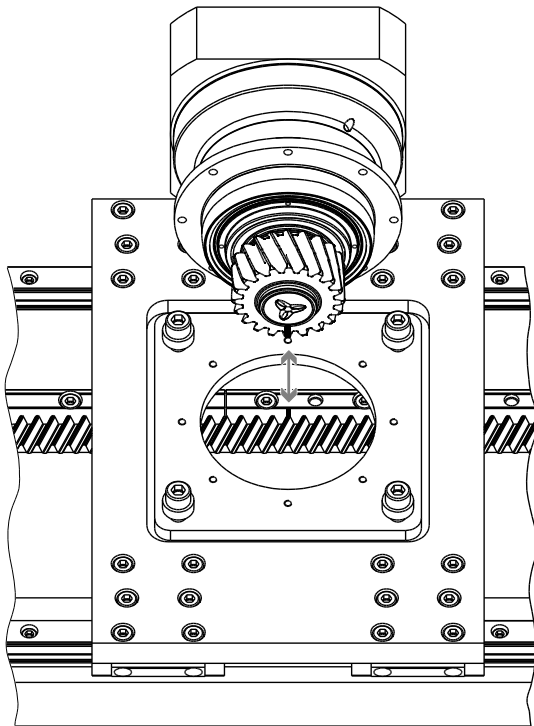


Fig. 5.14

- Align the “highest points” of the pinion and rack with one another using the machine’s adjustment mechanism.
- Slide the gearbox pinion unit into the rack by hand. The tooth flanks of the pinion and rack should be without backlash and without pretension at their “highest points”.
- Coat the screws with a threadlocker and fix the gearbox.

**Feeding in the gearbox**

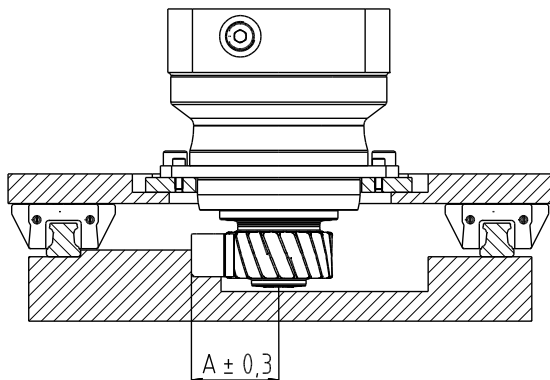


Fig.

- ① Refer to our catalog or our website for feed dimension “A”: [www.wittenstein-alpha.de](http://www.wittenstein-alpha.de).

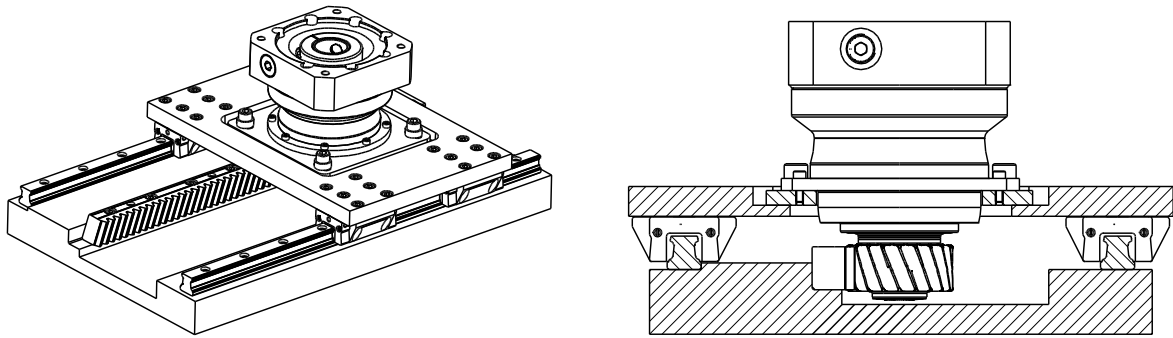


Fig. 5.16

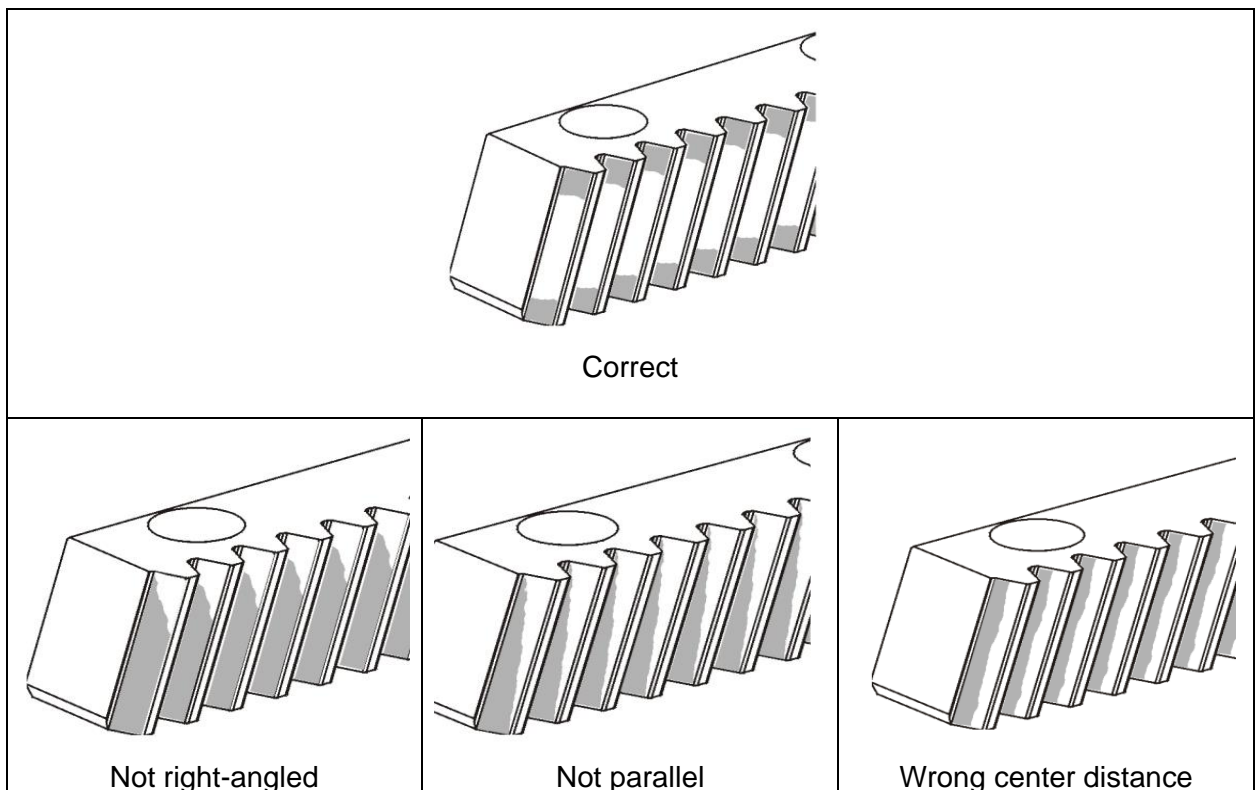
A flank play is possible in some segments of the travel path. Clamping of toothed parts is **not** permitted.

## 5.8 Final inspection

### 5.8.1 Contact pattern inspection

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

- 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 sled several times so that the pinion runs over the coated tooth flanks.
- ➡ Check thereby that the tothing 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

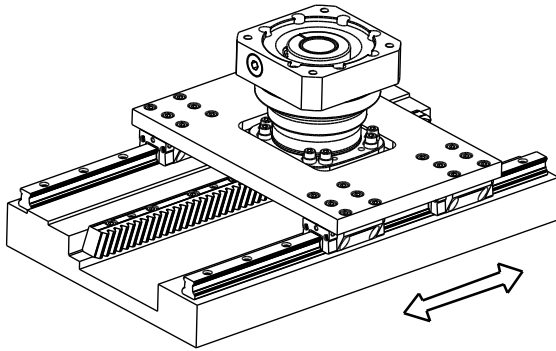


Fig. 5.17

- Shift or move the sled 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.

## 5.9 Mounting the lubrication system

- |  |   |
|--|---|
|  | <ul style="list-style-type: none"> <li>• Read the general safety instructions in the lubricator's manual and in Chapter 2.5 "General safety instructions" before beginning work.</li> </ul> |
|--|---|

The rack&pinion system is lubricated by a lubrication system, which dispenses lubricant onto the pinion and/or rack through a lubricator by means of a plastic hose line and a lubricating pinion.

- ① The lubricator is filled with grease that is optimized for the application and approved by WITTENSTEIN at the factory.
- ① The recommended, adjustable quantity of lubricant depends on the application. This can be found in the catalog or on our website [www.wittenstein-alpha.de](http://www.wittenstein-alpha.de), or can be requested from WITTENSTEIN alpha's Customer Service department.

### 5.9.1 Mounting the lubricating pinion on the lubricating axis

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

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.
- Oil the lubricating pinion. To do so, place the lubricating pinion into suitable adhesive oil for at least 60 minutes.
- ① WITTENSTEIN alpha GmbH offers the corresponding adhesive oils for the lubrication pinions. Further information on the pre-oiling of the lubrication pinion and the suitable adhesive oils can be found in the separate operating manual "Pre-Oiling the Lubrication Pinion" (Doc. no. 2098-D070886). The manual will be provided by our Sales / Customer Service department on request. Please always provide the serial number.

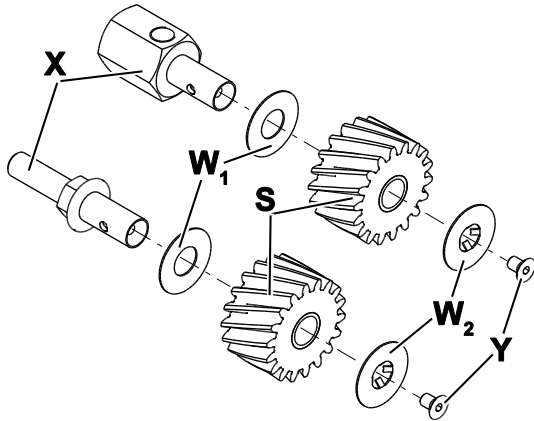


Fig. 5.18

- Slide the flat flanged wheel (W<sub>1</sub>) 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 (W<sub>2</sub>).
- Coat the flat head screw with a threadlocker (e.g. Loctite® 243).
- Screw the flanged wheel onto the lubricating axis using the flat head screw. Align the flanged wheel.
- ⓘ The permissible tightening torque is 6 Nm.

**5.9.2 Mounting the lubrication system**

<b>i</b>	<p>The maximum length of the plastic hose line for grease lubrication is for the</p> <ul style="list-style-type: none"> <li>- LUC<sup>+</sup>400: 10 m</li> <li>- LUC<sup>+</sup>125: 8 m</li> </ul> <p>The minimum bending radius for plastic hose lines is 30 mm.</p> <p>The minimum bending radius for plastic hose lines laid in a drag chain is 40 mm.</p>
----------	---

- Calculate the center distance between the pinion and lubricating pinion approximately using the following formula:

$$\text{Center distance} = \frac{d \text{ lubricating pinion} + d_A \text{ pinion}^a)}{2}$$

or

$$\text{Center distance} = \frac{d \text{ lubricating pinion}}{2} + h \text{ rack}$$

a)  $d_A \text{ pinion} = d \text{ pinion} + 2 * x * m$   
 $d \text{ pinion}$  = Reference circle diameter pinion [mm]  
 $x$  = Profile shift factor  
 $m$  = Normal module [mm]

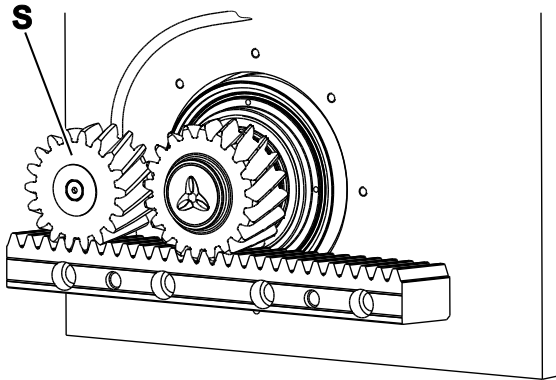


Fig. 5.19

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

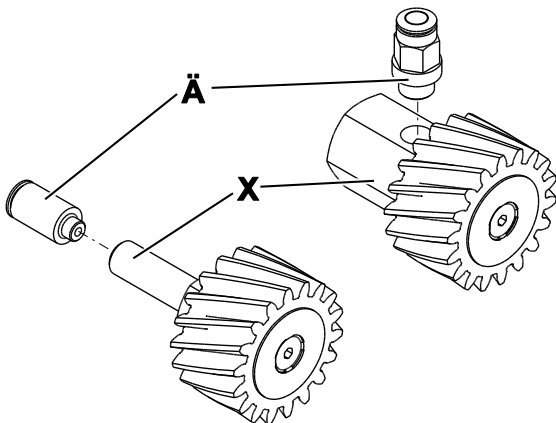


Fig. 5.20

- ➡ Check that the O-ring is seated correctly on the hose fitting.
- Screw the hose fitting (Ä) with the prescribed tightening torque into the lubricating axis (X) (see Table 2).

Hose fitting	Tightening torque [Nm]
M6x1	2
M10x1	15

Table 2: Tightening torques, hose fitting

- Slide the plastic hose up to the stop on the hose fitting. The correct insertion depth is 18 mm.
- ⓘ Install the bubble-free filled plastic hose so that it cannot be kinked during operation.
- ⓘ Use a special hose cutter to cut the plastic hose. This ensures a square cut and avoids damage to the hose.
- ⓘ Refer to our catalog or our website for specifications on the installation dimensions: [www.wittenstein-alpha.de](http://www.wittenstein-alpha.de)
- Close off plastic hoses that are not being used with the hose end caps provided.

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

- ⓘ Further information on the lubricator can be found in the relevant operating manual.
- ⓘ Special operating conditions may make different lubricants and amounts of lubricant necessary. In this case, consult our Customer Service department.



## 6 Startup and operation

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

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

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

## 7 Maintenance and disposal

- Read the general safety instructions before beginning 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 3: Maintenance schedule

### 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 special information on maintenance-related issues, contact our Customer Service department.

#### 7.3.2 Checking the lubrication system

<b>NOTICE</b>
<p><b>Too little lubrication damages the gear teeth.</b></p> <ul style="list-style-type: none"> <li>• Always make sure that there is sufficient lubrication and exchange the lubricant cartridge in time.</li> </ul>

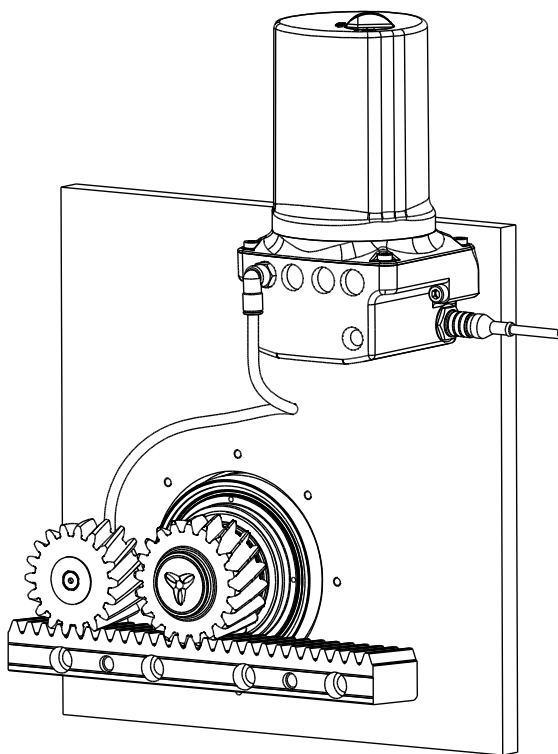



Fig. 7.1

- 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.

- ❗ Further information on the lubricants in the gearbox and in the lubricator can be found in the relevant operating manual.
- ❗ Even though the lubrication pinion made of polyurethane foam has a comparably long service life, we recommend the preventative replacement of the lubrication pinion after a runtime of two years.

## 7.4 Replacing the rack

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

### 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 system 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 rack”.
- ➡ 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 C-clamps.
- Select the next larger cylindrical pin than specified in Chapter 9.2.1 “Overview of the required cylinder head screws”.
- ⓘ Only the standard sizes are specified in Chapter 9.2.1 “Overview of the required cylinder head screws”.
- Drill and grind the rack and machine bed to the required fit size.
- ⓘ The tolerance range for the bores is H7.
- ⓘ For an easier disassembly, we recommend the cylindrical pins with internal threads.
- ⓘ Remove the accumulating chips with a suction tube.
- 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

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

- 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 racks as described in Chapter 7.4.1 “Disassembling the rack”.

## 7.7 Lubricants

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


- Remove all deposits of lubricant from the individual racks.
- Dispose of the lubricant deposits and the racks at the appropriate disposal sites.
- ① Observe the applicable national regulations concerning 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 Observe the applicable national regulations concerning disposal.

## 8 Malfunctions

	NOTICE
	<p><b>Changed operational behavior can be an indication of existing damage to the drive system or can cause damage to the drive system.</b></p> <ul style="list-style-type: none"> <li>• 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.</li> <li>• Do not put the drive system back into operation until the cause of the malfunction has been rectified.</li> </ul>

	<p>Rectifying of malfunctions may only be done by specially trained technicians.</p>
---	--

Fault	Possible cause	Solution
<b>Increased operating temperature</b>	Drive system overloaded	Check the technical specifications
	Motor is heating the gearbox.	Check the controller's settings.
	Ambient temperature too high.	Ensure adequate cooling.
<b>Increased operating noises</b>	Distorted motor/gearbox unit	Consult our Customer Service department.
	Damaged bearings	
	Damaged gear teeth	
	Distorted rack&pinion unit	
	Imprecise rack assembly	
<b>Loss of lubricant</b>	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.
<b>Formation of bubbles in the lubricant feed line</b>	Amount of lubricant too low	Change the settings on the lubricator. Information for setting the automated lubrication amount/duration can be found in the instructions of the lubricator. As an alternative, the use of a check valve is possible. Contact our Customer Service department for this.

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

Table 4: Malfunctions

## 9 Appendix

### 9.1 Weight of racks

Weight <b>helically toothed</b> 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 <b>spur-tooth</b> 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	on request						

Table 5: 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 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 6: Cylinder head screws

**9.2.2 Overview of cylinder pins**

Cylinder 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 7: Cylinder pins for standard rack assembly

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

No conventional pinning with INIRA® is intended for this type of rack.

**9.4 Maximum height of the stop edges on the machine bed**

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

**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 8: Parallelism deviation of the assembly surfaces

**9.6 Permissible roll size fluctuation at the rack transition**

Rack module [mm]	Measurement over pins 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 9: Recommended measurement over pins deviation between two neighboring tooth gaps at the rack transition



### 9.7 Permissible roll size fluctuation within an axis

Rack module [mm]	Roll size 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 10: 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 11: Assembly accessories

**9.9 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 setting possibilities.

- Set these values precisely on the scale.

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

Table 12: 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 specifications	All
05	04/28/08	Chapter on lubricator added	11
06	04/22/09	Chapter on lubricator removed	11
07	12/16/10	Technical specifications	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	4/5/3
12	04/15/2019	Revision INIRA pinning	All



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